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EPICS
Input Output Controller (IOC)
Record Reference Manual

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Chapter 1: Introduction

1. Overview

This manual describes all supported EPICS record types. The first chapter gives the introduction and describes the field summary table. The second chapter describes the fields in database common, i.e. the fields that are present in every record type. The third chapter describes the input and output field that are common to many record types and have the same usage wherever they are used. Following the third chapter is a separate chapter for each record type containing a description of all the fields for that record type except those in database common.

2. Field Summary Table

Each chapter contains a field summary table of the form:

Field	Type	DCT	Initial	Access	Modify	Rec Proc Monitor	PP

The meaning of each component of the summary table is as follows:

- **Field:** The field name
- **Type:** The database field type, i.e. DBF_<type>
- **DCT:** Is this field definable via the database configuration tool?
- **Initial:** Initial value when record is created
- **Access:** Is this field accessible via database access?

- **Modify:** Can this field be modified via database access?
- **Rec Proc Monitor:** Does the record processing routine trigger monitors by a call to `db_post_event` when this field changes value?
- **PP:** Process passive? Will `dbPutField` call `dbProcessPassive` when this field is processed?

Chapter 2: Fields Common to All Record Types

1. Introduction

This chapter contains a description of fields that are common to all records. These fields are defined in `dbcommon.ascii`.

2. Database Common: Field Summary

Field	Type	DCT	Initial	Access	Modify	Rec Proc Monitor	PP
NAME	STRING	Yes	0	Yes	No		No
DESC	STRING	Yes	Null	Yes	Yes	No	No
ASG	STRING	Yes	Null	Yes	Yes		No
SCAN	GBLCHOICE	Yes	0	Yes	Yes	No	No
PINI	GBLCHOICE	Yes	0	Yes	Yes	No	No
PHAS	SHORT	Yes	0	Yes	Yes	No	No
EVNT	SHORT	Yes	0	Yes	Yes	No	No
TSE	SHORT	No	0	Yes	Yes		No
TSEL	INLINK	Yes	Null	No	No	N/A	No
DTYP	DEVCHOICE	Yes	0	Yes	No		No
DISV	SHORT	Yes	1	Yes	Yes	No	No

Chapter 2: Fields Common to All Record Types
Database Common: Field Summary

Field	Type	DCT	Initial	Access	Modify	Rec Proc Monitor	PP
DISA	SHORT	No	0	Yes	Yes	No	No
SDIS	INLINK	Yes	0	No	No	N/A	No
MLOK	NOACCESS	No	8	No	No		No
MLIS	NOACCESS	No	12	No	No		No
DISP	UCHAR	No	0	Yes	Yes	Yes	No
PROC	UCHAR	No	0	Yes	Yes	No	Yes
STAT	GBLCHOICE	No	UDF_ALARM	Yes	No	Yes	No
SEVR	GBLCHOICE	No	INVALID_ALARM	Yes	No	Yes	No
NSTA	GBLCHOICE	No	0	Yes	No	No	No
NSEV	GBLCHOICE	No	0	Yes	No	No	No
ACKS	GBLCHOICE	No	0	Yes	No		No
ACKT	GBLCHOICE	No	11	Yes	No		No
DISS	GBLCHOICE	Yes	0	Yes	Yes	No	No
LSET	SHORT	No	0	Yes	No		No
LCNT	UCHAR	No	0	Yes	No		No
PACT	UCHAR	No	0	Yes	No		No
PUTF	UCHAR	No	0	Yes	No		No
RPRO	UCHAR	No	0	Yes	No		No
ASP	NOACCESS	No	4	No	No		No
PPN	NOACCESS	No	4	No	No		No
PPNN	NOACCESS	No	4	No	No		No
SPVT	NOACCESS	No	4	No	No		No
RSET	NOACCESS	No	4	No	No		No
DSET	NOACCESS	No	4	No	No		No
DPVT	NOACCESS	No	4	No	No		No
PRIO	GBLCHOICE	Yes	0	Yes	Yes	No	No
TPRO	UCHAR	No	0	Yes	Yes	No	No
BKPT	NOACCESS	No	1	No	No		No
UDF	UCHAR	No	1	Yes	Yes	No	Yes
TIME	NOACCESS	No	8	Option	No	No	No
FLNK	FWDLINK	Yes	Null	No	No	N/A	No

3. Database Common: Field Descriptions

Name	Summary	Description
NAME	Record Name	An arbitrary 28 character record name supplied by the application developer. This name is the means of identifying a specific record. It must have a unique value across all IOCs attached to the same local area subnet.
DESC	Description	An arbitrary 28 character record description supplied by the application developer.
ASG	Access Security Group	A character string value defining the access security group for this record. If left NULL, the record is placed in group DEFAULT.
SCAN	Scanning Algorithm	This can be one of the periodic intervals, I/O event, event, or passive.
PINI	Process at Initialization	If this field is set to TRUE during database configuration, then the record is processed once at IOC initialization (before the normal scan tasks are started).
PHAS	Scan Phase Number	This field orders the records within a specific SCAN group. This is not meaningful for passive records. All records of a specified phase are processed before those with higher phase number. Whenever possible it is better to use linked passive records to enforce the order of processing rather than phase number.
EVNT	Event Number	Event number for scan type SCAN_EVENT. All records with scan type event and the same EVNT value will be processed when a call to post_event for EVNT is made. The call to post_event is: post_event(short event_number)
TSE	Time Stamp Event	The event number for time stamp. This is only meaningful if the IOC has an associated hardware event receiver. See 'er' record for details.
TSEL	Time Stamp Event Link	An input link for obtaining the time stamp event number.
DTYP	Device Type	This field specifies the device type for the record. Each record type has its own set of device support routines which are specified in devSup.ASCII. If a record type does not have any associated device support, DTYP and DSET are meaningless.
DISV	Disable Value	If DISV=DISA, then the record will be disabled, i.e. dbProcess will not process the record.
DISA	Scan Disable Input Link Value	This is the value that is compared with DISV to determine if the record is disabled. Its value is obtained via SDIS if SDIS is a database or channel access link. If SDIS is not a database or channel access link, then DISA can be set via dbPutField or dbPutLink.

Name	Summary	Description
SDIS	Scan Disable Input Link	An input link from which to obtain a value for DISA. This field is ignored unless it is a database link or a channel access link. If it is a database or a channel access link, dbProcess calls dbGetLink to obtain a value for DISA before deciding to call the processing routine.
MLOK	Monitor Lock	The lock used by the monitor routines when the monitor list is being used. The list is locked whenever monitors are being scheduled, invoked, or when monitors are being added to or removed from the list. This field is accessed only by the dbEvent routines.
MLIS	Monitor List	This is the head of the list of monitors connected to this record. Each record support module is responsible for triggering monitors for any fields that change as a result of record processing. Monitors are present if mlis.count is greater than zero. The call to trigger monitors is: db_post_event (precord, &data, mask) Where "mask" is some combination of DBE_ALARM, DBE_VALUE, and DBE_LOG.
DISP	Disable putFields	If this field is set to TRUE, then all dbPutFields (normally issued by channel access) directed to this record are ignored except to the field DISP itself.
PROC	Process Record	A record will be processed whenever a dbPutField is directed to this field.
STAT	Current Alarm Status	These four fields are the alarm status and severity fields. STAT and SEVR are the values seen outside database access. NSTA and NSEV are the fields the database access, record support, and device support use to set new alarm status and severity values. Whenever any software component discovers an alarm condition, it uses the following macro function: recGblSetSevr (precord, new_status, new_severity) This ensures that the current alarm severity is set equal to the highest outstanding alarm. The file alarm.h defines all allowed alarm status and severity values.
SEVR	Current Alarm Severity	
NSTA	New Alarm Status	
NSEV	New Alarm Severity	
ACKS	Alarm Acknowledge Severity	Highest severity unacknowledged alarm
ACKT	Alarm Acknowledge Transient	Is it necessary to acknowledge transient alarms?
DISS	Disable Alarm Severity	When this record is disabled, it will be put into alarm with this severity and a status of DISABLE_ALARM.
LSET	Lock Set	The lock set to which this record belongs. All records linked in any way via input, output, or forward database links belong to the same lock set. The only exception is that non-process passive input links do not force the linked record to be in the same lock set. The lock sets are determined at IOC initialization time.

Name	Summary	Description
LCNT	Lock Count	The number of times in succession dbProcess finds the record active, i.e. PACT is TRUE. If dbProcess finds the record active MAX_LOCK (currently set to 10) times in succession, it raises a SCAN_ALARM.
PACT	Processing Active	See <i>Application Developers Guide</i> for details on usage. PACT is TRUE while the record is being processed. For asynchronous records PACT can be TRUE from the time record processing is started until the asynchronous completion occurs. As long as PACT is TRUE, dbProcess will not call the record processing routine.
PUTF	dbPutField Process	Did dbPutField cause the current record processing?
RPRO	Reprocess	Reprocess record when current processing completes.
ASP	Access Security Private	
PPN	Address of putNotify	Address of putNotify callback.
PPNN	Next Record for putNotify	Next record for PutNotify.
SPVT	Scan Private	This field is for private use of the scanning system.
RSET	Address of Record Support Entry Table	See <i>Application Developers Guide</i> for details on usage.
DSET	Address of Device Support Entry Table	This address of the device support entry table for this record. The value of this field is determined at IOC initialization time. Record support routines use this field to locate their device support routines.
DPVT	Device Private	This field is for private use of the device support modules.
PRIO	Priority	Scheduling priority for processing I/O Event scanned records and asynchronous record completion tasks.
TPRO	Trace Processing	If this field is set TRUE, a message is printed each time this record is processed and a message is printed for each record processed as a result of this record being processed
BKPT	BreakPoint	
UDF	VAL Undefined	UDF is initialized to TRUE at IOC initialization. Record and device support routines which write to the VAL field are responsible for setting UDF to FALSE.
TIME	Time	The time when this record was last processed, in standard format.
FLNK	Forward Link	This field is a database link. If FLNK is specified, processing this record will force a processing of the scan passive forward link record.

Chapter 3: Fields Common to Many Record Types

1. Introduction

This chapter describes input and output fields that are common to multiple record types. These fields have the same meaning whenever they are used.

2. Input Records

Common Fields

Name	Summary	Description
INP	Input Link	This field is used by the device support routines to obtain input. For soft analog records it can be a constant, a database link, or a channel access link.
DTYP	Device Type	DTYP specifies the name of the device support module that will input values. Each record type has its own set of device support routines which are specified in <code>devSup.ascii</code> . If a record type does not have any associated device support, DTYP is meaningless.
RVAL	Raw Value	Whenever possible this field contains the raw data value exactly as it is obtained from the hardware or from the associated device driver.
VAL	Value	This is the record's final value, after any needed conversions have been performed.

- If the INP link type is CA_LINK, then dbCaGetLink is called to obtain a new input value. If dbCaGetLink returns an error, a LINK alarm with a severity of INVALID is raised. RecGblGetLinkValue returns the status of dbCaGetLink.

If the return status of recGblGetLinkValue is zero and the INP link type is not CONSTANT, then UDF is set to FALSE. The device support read routine normally returns the status of recGblGetLinkValue.

Simulation Mode

A record can be switched into simulation mode of operation by setting the value of SIMM to YES. During simulation, the record will be put into alarm with a severity of SIMS and a status of SIMM_ALARM. While in simulation mode, input values, in engineering units, will be obtained from SIOL instead of INP. Also, while the record is in simulation mode, there will be no raw value conversion and no calls to device support during record processing.

Normally input records contain a private readValue routine which performs the following steps:

- If PACT is TRUE, the device support read routine is called, status is set to its return code, and readValue returns.
- Call recGblGetLinkValue to get a new value for SIMM if SIML is a DB_LINK or a CA_LINK.
- Check value of SIMM.
- If SIMM is NO, then call the device support read routine, set status to its return code, and return.
- If SIMM is YES, then call recGblGetLinkValue to read the input value from SIOL into SVAL. If success, then set VAL to SVAL and UDF to FALSE and set status to 2 (don't convert) if input record supports conversion. If SIMS is greater than zero, set alarm status to SIMM and severity to SIMS. Set status to the return code from recGblGetLinkValue and return.
- IF SIMM is NOT YES or NO, a SOFT alarm with a severity of INVALID is raised, and return status is set to -1.

3. Output Records

Common Fields

Name	Summary	Description
OUT	Output Link	This field is used by the device support routines to decide where to send output. For soft records, it can be a constant, a database link, or a channel access link. If the link is a constant, the result is no output.
DTYP	Device Type	DTYP specifies the device support module that will receive values.
VAL	Value	This is the desired value before any conversions to raw output have been performed.

Name	Summary	Description
OVAL	Output Value	OVAL is used to decide when to invoke monitors. Archive and value change monitors are invoked if OVAL is not equal to VAL. If a record type needs to make adjustments, OVAL is used to enforce the maximum rate of change limit before converting the desired value to a raw value.
RVAL	Raw Value	Whenever possible this is the actual value sent to the hardware itself or to the associated device driver.
RBV	Read Back Value	Whenever possible this is the actual read back value obtained from the hardware itself or from the associated device driver.
DOL	Desired Output Location (an Input Link)	DOL can be a constant, a database link, or a channel access link. There is no device support associated with DOL. If DOL is a database or channel access link and OMSL is CLOSED_LOOP, then VAL is obtained from DOL.
OMSL	Output Mode Select	This field has either the value SUPERVISORY or CLOSED_LOOP. DOL is used to determine VAL only if OMSL has the value CLOSED_LOOP. By setting this field the record can be switched between supervisory and closed loop mode of operation. While in closed loop mode, the VAL field cannot be set via dbPuts.
OIF	Output Full or Incremental (ao record only)	This field, which is only used when input is obtained from DOL, determines if the value obtained from DOL is an increment to add to the current VAL or is the actual VAL desired.
SIMM	Simulation Mode	This field has either the value YES or NO. By setting this field to YES, the record can be switched into simulation mode of operation. While in simulation mode, output will be written to SIOL instead of OUT.
SIML	Simulation Mode Location	This field can be a constant, a database link, or a channel access link. If SIML is a database or channel access link, then SIMM is read from SIML. If SIML is a constant link then SIMM is initialized with the constant value but can be changed via dbPuts.
SIOL	Simulation Value Location	This field can be a constant, a database link, or a channel access link. If SIOL is a database or channel access link, then the output value is written to SIOL. If this link is a constant, the result is no output.
SIMS	Simulation Mode Alarm Severity	When this record is in simulation mode, it will be put into alarm with this severity and a status of SIMM_ALARM.
IVOA	Invalid Alarm Output Action	Whenever the record is put into INVALID alarm severity IVOA specifies an action. IVOA can be one of the following actions. <ul style="list-style-type: none"> • Continue normally • Don't drive outputs • Set output equal to IVOV

Name	Summary	Description
IVOV	Invalid Alarm Output Value, In Engineering Units	When new severity has been set to INVALID alarm and IVOA is "Set output equal to IVOV", then, VAL is set to IVOV and converted to RVAL before device support is called.

Soft Output

Normally two soft output device support modules are provided Soft and Raw Soft. Both allow the output link OUT to be a constant, a database link, or a channel access link. It is normally meaningless to use constant output links. The Soft support module writes output from the value associated with OVAL or VAL (if OVAL does not exist). The Raw Soft support module writes the value associated with the RVAL field after conversion has been performed.

The device support write routine normally calls `recGblPutLinkValue` which performs the following steps:

- If the OUT link type is CONSTANT `recGblPutLinkValue` does nothing and returns with a status of zero.
- If the OUT link type is DB_LINK, then `dbPutLink` is called to write the current value. If `dbPutLink` returns an error, a LINK_ALARM with a severity of INVALID_ALARM is raised. `recGblPutLinkValue` returns the status of `dbPutLink`.
- If the OUT link type is CA_LINK, then `dbCaPutLink` is called to write the current value. If `dbCaPutLink` returns an error, a LINK_ALARM with a severity of INVALID_ALARM is raised. `recGblPutLinkValue` returns the status of `dbCaPutLink`.

The device support write routine normally returns the status of `recGblPutLinkValue`.

Output Mode Select

The fields DOL and OMSL are used to allow the output record to be part of a closed loop control algorithm. OMSL is meaningful only if DOL refers to a database or channel access link. It can have the values SUPERVISORY or CLOSED_LOOP. If the mode is SUPERVISORY, then nothing is done to VAL. If the mode is CLOSED_LOOP and the record type does not contain an OIF field, then each time the record is processed, VAL is set equal to the value obtained from the location referenced by DOL. If the mode is CLOSED_LOOP in record types with an OIF field and OIF is Full, VAL is set equal to the value obtained from the location referenced by DOL; if OIF is Incremental VAL is incremented by the value obtained from DOL.

Simulation Mode

An output record can be switched into simulation mode of operation by setting the value of SIMM to YES. During simulation, the record will be put into alarm with a severity of SIMS and a status of SIMM_ALARM. While in simulation mode, output values, in engineering units, will be written to SIOL instead of OUT. Also, while the record is in simulation mode, there will be no calls to device support during record processing.

Normally output records contain a private `writeValue` routine which performs the following steps:

- If PACT is TRUE, the device support write routine is called, status is set to its return code, and `readValue` returns.
- Call `recGblGetLinkValue` to get a new value for SIMM if SIML is a DB_LINK or a CA_LINK.
- Check value of SIMM.

- If `SIMM` is `NO`, then call the device support write routine, set status to its return code, and return.
- If `SIMM` is `YES`, then call `recGblPutLinkValue` to write the output value from `VAL` or `OVAL` to `SIOL`. Set alarm status to `SIMM` and severity to `SIMS`, if `SIMS` is greater than zero. Set status to the return code from `recGblPutLinkValue` and return.
- If `SIMM` not one of the above, a `SOFT` alarm with a severity of `INVALID` is raised, and return status is set to `-1`.

Invalid Alarm Output Action

Whenever an output record is put into `INVALID` alarm severity, `IVOA` specifies an action to take. The record support process routine for each output record contains code which performs the following steps.

- If new severity is less than `INVALID`, then call `writeValue`:
- Else do the following:
 - If `IVOA` is `CONTINUE`, then call `writeValue`.
 - If `IVOA` is `NO_OUTPUT`, then do not write output.
 - If `IVOA` is `OUTPUT_IVOV`, then set `VAL` to `IVOV`, call `convert` if necessary, and then call `writeValue`.
 - If `IVOA` not one of the above, an error message is generated.

Chapter 4: *ai* - Analog Input

1. Introduction

The normal use for this record type is to obtain an analog value converted to engineering units. Most device support modules obtain values from hardware. Soft device modules are provided to obtain input via database or channel access links or via `dbPutField` or `dbPutLink` requests. The record supports alarm limits, conversion to engineering units, smoothing, and graphics and control limits.

Two soft device support modules are provided. One reads values directly into `VAL`. The other reads values into `RVAL`, which is then converted just like raw values obtained from hardware device support modules. If soft device support with a constant `INP` link is chosen, then the `VAL` field can be modified via `dbPuts`.

2. Field Summary

Field	Type	DCT	Initial	Access	Modify	Rec Proc Monitor	PP
VAL	DOUBLE	No	0	Yes	Yes	Yes	Yes
INP	INLINK	Yes	0	No	No	N/A	No
PREC	SHORT	Yes	0	Yes	Yes	No	No
LINR	CVTCHOICE	Yes	0	Yes	Yes	No	Yes
EGUF	FLOAT	Yes	0	Yes	Yes	No	Yes
EGUL	FLOAT	Yes	0	Yes	Yes	No	Yes

Field	Type	DCT	Initial	Access	Modify	Rec Proc Monitor	PP
EGU	STRING	Yes	null	Yes	Yes	No	No
HOPR	FLOAT	Yes	0	Yes	Yes	No	No
LOPR	FLOAT	Yes	0	Yes	Yes	No	No
AOFF	FLOAT	Yes	0	Yes	Yes	No	Yes
ASLO	FLOAT	Yes	1	Yes	Yes	No	Yes
SMOO	FLOAT	Yes	0	Yes	Yes	No	No
HIHI	FLOAT	Yes	0	Yes	Yes	No	Yes
LOLO	FLOAT	Yes	0	Yes	Yes	No	Yes
HIGH	FLOAT	Yes	0	Yes	Yes	No	Yes
LOW	FLOAT	Yes	0	Yes	Yes	No	Yes
HHSV	GBLCHOICE	Yes	0	Yes	Yes	No	Yes
LLSV	GBLCHOICE	Yes	0	Yes	Yes	No	Yes
HSV	GBLCHOICE	Yes	0	Yes	Yes	No	Yes
LSV	GBLCHOICE	Yes	0	Yes	Yes	No	Yes
HYST	DOUBLE	Yes	0	Yes	Yes	No	No
ADEL	DOUBLE	Yes	0	Yes	Yes	No	No
MDEL	DOUBLE	Yes	0	Yes	Yes	No	No
ROFF	LONG	No	0	Yes	Yes	No	Yes
ESLO	DOUBLE	No	1	Yes	No	No	No
LALM	DOUBLE	No	0	Yes	No	No	No
ALST	DOUBLE	No	0	Yes	No	No	No
MLST	DOUBLE	No	0	Yes	No	No	No
PBRK	NOACCESS	No	4	No	No		No
INIT	SHORT	No	0	Yes	No	No	No
LBRK	SHORT	No	0	Yes	No	No	No
RVAL	LONG	No	0	Yes	Yes	Yes	Yes
ORAW	LONG	No	0	Yes	No	No	No
SIOL	INLINK	Yes	0	No	No	N/A	No
SVAL	DOUBLE	No	0	Yes	Yes	No	No
SIML	INLINK	Yes	0	No	No	N/A	No
SIMM	GBLCHOICE	No	0	Yes	Yes	No	No
SIMS	GBLCHOICE	Yes	0	Yes	Yes	No	No

3. Field Descriptions

Name	Summary	Description
VAL	Value Field	Unless INP is a constant link and the device support module specifies no conversion, this is the value resulting from the record being processed. If INP is a constant, then VAL is initialized to the INP value but can be changed dynamically via dbPutField or dbPutLink.
INP	Input Link	This field is used by the device support routines to obtain input. For soft analog records it can be a constant, a database link, or a channel access link.
PREC	Display Precision	Precision with which to display VAL and OVAL. This field is used by record support to supply a value when get_precision is called.
LINR	Conversion Type	No conversion, linear and breakpoint table conversion are supported.
EGUF	Engineering Units Full	These fields are used to perform linear conversions. It is the responsibility of the device support routines to use EGUF and EGUL to compute ESLO and ROFF. EGUF and EGUL must be set by the user to the engineering units corresponding to the high and low ADC limits. For example if the ADC has a range of -10 to +10 Volts, then EGUF must be the engineering units value corresponding to 10 volts and EGUL to -10 volts. If a linear conversion is specified, recAi uses ESLO, ROFF, and EGUL to convert the raw value to engineering units according to the formula: $VAL = (RVAL + ROFF) * ESLO + EGUL$
EGUL	Engineering Units Low	
ROFF	Raw Value Offset	
ESLO	Slope for Linear Conversions	
EGU	Engineering Units	An ASCII string of up to 16 characters describing the engineering units. This field is used by record support to supply a units description string when get_units is called.
HOPR	High Operating Range	These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are used by record support to honor calls to get_graphic_double or get_control_double.
LOPR	Low Operating Range	
AOFF	Adjustment Offset	These fields are adjustment parameters for the raw input values. They are applied to the raw data value returned by the device support routine before any other conversions are performed.
ASLO	Adjustment Slope	
SMOO	Smoothing Factor	The converted data value is subjected to the following algorithm: $val = newvalue * (1 - smoo) + oldvalue * smoo$ SMOO should have a value between 0 and 1, with 0 meaning no smoothing and 1 meaning ultimate smoothing (in fact, the data value will never change).

Name	Summary	Description
HIHI	Hihi Alarm Limit	These fields specify the alarm limits and severities.
HIGH	High Alarm Limit	
LOW	Low Alarm Limit	
LOLO	Lolo Alarm Limit	
HHSV	Hihi Alarm Severity	
HSV	High Alarm Severity	
LSV	Low Alarm Severity	
LLSV	Lolo Alarm Severity	
HYST	Alarm Deadband	These parameters specify hysteresis factors for triggering monitors by a call to db_post_event or monitor callbacks, i.e. callbacks specified by calls to caAddEvent or dbAddEvent. A monitor will not be triggered until VAL changes by more than the specified amount.
ADEL	Archive Deadband	
MDEL	Monitor, i.e. value change, Deadband	
LALM	Last Alarm Monitor Trigger Value	These fields are used to implement the hysteresis factors for monitor callbacks.
ALST	Last Archiver Monitor Trigger Value	
MLST	Last Value Change Monitor Trigger Value	
INIT	Initialize	This field is used by record support to perform initialization for LBRK and for smoothing.
LBRK	Last Breakpoint	Index of last breakpoint interval. LBRK is used to perform conversions via breakpoint tables.
PBRK	Address of Breakpoint Table	PBRK is used to perform conversions via breakpoint tables.
RVAL	Raw Value	RVAL is the raw data value obtained by the device support routine. Unless the device support routine returns value requests that no conversion should be performed, the record support routine converts this value to engineering units.
ORAW	Old Raw Value	ORAW is used to decide if monitors should be triggered for RVAL at the same time monitors are triggered for changes in VAL.

Name	Summary	Description
SIMM	Simulation Mode	Simulation mode process variables. Refer to Chapter 3 Section "Simulation Mode" on page 11 for more information.
SIML	Simulation Mode Location	
SVAL	Simulation Value	
SIOL	Simulation Value Location	
SIMS	Simulation Mode Alarm Severity	

4. Record Support Routines

init_record

This routine initializes `SIMM` with the value of `SIML` if `SIML` type is `CONSTANT` link or creates a channel access link if `SIML` type is `PV_LINK`. `SVAL` is likewise initialized if `SIOL` is `CONSTANT` or `PV_LINK`.

This routine next checks to see that device support is available and a device support `read_ai` routine is defined. If either does not exist, an error message is issued and processing is terminated.

`INIT` is then set to `TRUE`.

If device support includes `init_record`, it is called.

process

See next section.

special

The only special processing for analog input records is `SPC_LINCONV`, which is invoked whenever any of the fields `LINR`, `EGUF`, `EGUL` or `ROFF` is changed.

If the device support routine `special_linconv` exists, it is called.

`INIT` is set `TRUE`. This causes `PBRK`, `LBRK`, and smoothing to be reinitialized.

get_value

Fills in the values of the structure `valueDes` so that they refer to `VAL`.

get_units

Retrieves `EGU`.

get_precision

Retrieves `PREC`.

- get_graphic_double** Sets the upper display and lower display limits for a field. If the field is VAL, HIHI, HIGH, LOW, or LOLO, the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.
- get_control_double** Sets the upper control and the lower control limits for a field. If the field is VAL, HIHI, HIGH, LOW, or LOLO, the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.
- get_alarm_double** Sets the following values:
- ```
upper_alarm_limit = HIHI
upper_warning_limit = HIGH
lower_warning_limit = LOW
lower_alarm_limit = LOLO
```

---

## 5. Record Processing

---

Routine process implements the following algorithm:

1. Check to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the PACT field set to TRUE. This ensures that processes will no longer be called for this record. Thus error storms will not occur.
2. readValue is called. See Chapter 3 Section "Simulation Mode" on page 11 for details.
3. If PACT has been changed to TRUE, the device support read routine has started but has not completed writing the new value. In this case, the processing routine merely returns, leaving PACT TRUE.
4. PACT is then set to TRUE, TIME is set to tslocaltime and the return status value of readValue is checked. convert is called only if status is 0. If status is 2, then convert is not called, but status is reset to 0.
5. convert (if necessary): The new raw data value is expected to be in field RVAL. The first step is to set val equal to RVAL + ROFF. The next step is to adjust the raw value via the equation:  
$$val = val * ASLO + AOFF$$

If the conversion algorithm is linear, the raw value is converted via the equation:  
$$val = val * ESLO + EGUL$$

If the conversion is via a breakpoint table, the new value is obtained.  
The next step is to apply the following smoothing algorithm:  
if SMOO equal to 0. or INIT is True, VAL = val  
else VAL = val \* (1 - SMOO) + Previous\_value \* SMOO  
Since VAL is now defined, the last step is to set UDF to FALSE.
6. Check alarms: This routine checks to see if the new VAL causes the alarm status and severity to change. If so, NSEV, NSTA and LALM are set. It also honors the alarm hysteresis factor (HYST). Thus the value must change by more than HYST before the alarm status and severity is lowered.
7. Check to see if monitors should be invoked:
  - Alarm monitors are invoked if the alarm status or severity has changed.

- Archive and value change monitors are invoked if ADEL and MDEL conditions are met.
  - Monitors for RVAL are checked whenever other monitors are invoked.
  - NSEV and NSTA are reset to 0.
8. Scan forward link if necessary, set PACT and INIT to FALSE, and return.

## 6. Device Support

### Fields Of Interest To Device Support

Each analog input record must have an associated set of device support routines. The primary responsibility of the device support routines is to obtain a new raw analog input value whenever `read_ai` is called. The device support routines are primarily interested in the following fields:

| Name | Summary                | Description                                                                                                                                                                                                              |
|------|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PACT | Processing Active      | See Chapter 2 Section "Database Common: Field Descriptions" on page 5 for descriptions.                                                                                                                                  |
| DPVT | Device Private         |                                                                                                                                                                                                                          |
| UDF  | VAL Undefined          |                                                                                                                                                                                                                          |
| NSEV | New Alarm Severity     |                                                                                                                                                                                                                          |
| NSTA | New Alarm Status       |                                                                                                                                                                                                                          |
| VAL  | Value                  | This field is used by device support only if it obtains a value already converted to engineering units. See RVAL below.                                                                                                  |
| INP  | Input Link             | This field is used by the device support routines to locate its input.                                                                                                                                                   |
| EGUF | Engineering Units Full | These fields are used to calculate ESLO. Note that these fields correspond to the high and low hardware limits.                                                                                                          |
| EGUL | Engineering Unit Low   |                                                                                                                                                                                                                          |
| ESLO | Slope                  | These fields are used for linear conversions from raw to engineering units. The device support routines must calculate these fields unless they obtain values already in engineering units.                              |
| ROFF | Raw Offset             |                                                                                                                                                                                                                          |
| RVAL | Raw Value              | It is the responsibility of the device support routine to give this field a value. If the device support routine obtains a value already in engineering units, it should place the value in VAL and return a value of 2. |

### Device Support Routines

Device support consists of the following routines:

*report*

`report (FILE fp, paddr)`

Not currently used.

*init*

`init()`

This routine is called once during IOC initialization.

*init\_record*

`init_record (precord)`

This routine is optional. If provided, it is called by the record support `init_record` routine.

*get\_ioint\_info*

`get_ioint_info (int cmd, struct dbCommon *precord, IOSCANPVT *ppvt)`

This routine is called by the `ioEventScan` system each time the record is added or deleted from an I/O event scan list. `cmd` has the value (0,1) if the record is being (added to, deleted from) an I/O event list. It must be provided for any device type that can use the `ioEvent` scanner.

*read\_ai*

`read_ai (precord)`

This routine must provide a new input value. Asynchronous device support routines will return with `PACT` set to `TRUE`. If `PACT` is `TRUE`, the process routine will just return and not continue processing. When the asynchronous routine completes, it can call `process` which will again call `read_ai`. Because `PACT` is still `TRUE` `read_ai` knows that this is a request to retrieve the data obtained by the previous call. When finished, `read_ai` should set `PACT` to `FALSE` and return one the following values:

- **0:** Success. A new raw value is placed in `RVAL`. `convert` will be called.
- **2:** Success, but don't call `convert`. This is useful if `read_ai` obtains a value already converted to engineering units or in the event a hardware failure is detected.
- **Other:** Error.

*special\_linconv*

`special_linconv (precord, after)`

This routine is called whenever any of the fields `LINR`, `EGUF`, `EGUL` or `ROFF` is modified.

---

## 7. Device Support For Soft Records

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Two soft device support modules `Soft Channel` and `Raw Soft Channel` are provided for input records not related to actual hardware devices. The `INP` link type must be either `CONSTANT`, `DB_LINK` or `CA_LINK`.

**Soft Channel**

This module places a value directly in `VAL`. `read_ai` always returns a value of 2, which means that no conversion will ever be attempted.

If the `INP` link type is constant, then the constant value is stored into `VAL` by `init_record`, and `UDF` is set to `FALSE`. If the `INP` link type is `PV_LINK`, then `dbCaAddInlink` is called by `init_record`.

`read_ai` calls `recGblGetLinkValue` to read the current value of `VAL`. See Chapter 3 Section "Soft Input" on page 10 for details.

If the return status of `recGblGetLinkValue` is zero, then `read_ai` sets `UDF` to `FALSE`. The status of `recGblGetLinkValue` is returned.

If soft support is chosen, the following fields become meaningless: `LINR`, `EGUF`, `EGUL`, `ESLO`, `ROFF`, `AOFF`, `ASLO`, and `SMOO`. The `read_ai` routine always returns a value of 2 which means don't convert.

### **Raw Soft Channel**

This module is like the previous except that it places its value in `RVAL` and `read_ai` returns a value of 0. Thus the record processing routine will convert the raw value in the normal way.

If raw soft support is chosen, the fields `EGUF` and `EGUL` become meaningless. `ESLO` and `ROFF` always have their default values of 1 and 0.





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## Chapter 5: ao - Analog Output

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### 1. Introduction

---

The normal use for this record type is to store values to be sent to Digital to Analog Converters. It can also be used to write values to other records via database or channel access links. The OUT field determines how the record is used. The record supports alarm limits, conversion from/to engineering units, and graphics and control limits.

---

### 2. Field Summary

---

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| VAL   | DOUBLE    | No  | 0       | Yes    | Yes    | Yes              | Yes |
| OVAL  | DOUBLE    | No  | 0       | Yes    | Yes    | Yes              | No  |
| OUT   | OUTLINK   | Yes | 0       | No     | No     | N/A              | No  |
| OROC  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| DOL   | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| OMSL  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| OIF   | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| PREC  | SHORT     | Yes | 0       | Yes    | Yes    | No               | No  |
| LINR  | CVTCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| EGUF  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |

Chapter 5: ao - Analog Output  
Field Summary

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| EGUL  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| EGU   | STRING    | Yes | null    | Yes    | Yes    | No               | No  |
| ESLO  | DOUBLE    | No  | 1       | Yes    | No     | No               | No  |
| ROFF  | LONG      | No  | 0       | Yes    | Yes    | No               | Yes |
| DRVH  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| DRVL  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| HOPR  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| LOPR  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| AOFF  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| ASLO  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| HIHI  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| LOLO  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| HIGH  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| LOW   | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| HHSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| LLSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| HSV   | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| LSV   | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| HYST  | DOUBLE    | Yes | 0       | Yes    | Yes    | No               | No  |
| ADEL  | DOUBLE    | Yes | 0       | Yes    | Yes    | No               | No  |
| MDEL  | DOUBLE    | Yes | 0       | Yes    | Yes    | No               | No  |
| RVAL  | LONG      | No  | 0       | Yes    | Yes    | Yes              | Yes |
| ORAW  | LONG      | No  | 0       | Yes    | No     | No               | No  |
| RBV   | LONG      | No  | 0       | Yes    | No     | Yes              | No  |
| ORBV  | LONG      | No  | 0       | Yes    | No     | No               | No  |
| PVAL  | DOUBLE    | No  | 0       | Yes    | No     | No               | No  |
| LALM  | DOUBLE    | No  | 0       | Yes    | No     | No               | No  |
| ALST  | DOUBLE    | No  | 0       | Yes    | No     | No               | No  |
| MLST  | DOUBLE    | No  | 0       | Yes    | No     | No               | No  |
| PBRK  | NOACCESS  | No  | 4       | No     | No     |                  | No  |
| INIT  | SHORT     | No  | 0       | Yes    | No     | No               | No  |
| LBRK  | SHORT     | No  | 0       | Yes    | No     | No               | No  |

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP |
|-------|-----------|-----|---------|--------|--------|------------------|----|
| SIOL  | INLINK    | Yes | 0       | No     | No     | N/A              | No |
| SIML  | INLINK    | Yes | 0       | No     | No     | N/A              | No |
| SIMM  | GBLCHOICE | No  | 0       | Yes    | Yes    | No               | No |
| SIMS  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No |
| IVOA  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No |
| IVOV  | DOUBLE    | Yes | 0       | Yes    | Yes    | No               | No |

### 3. Field Descriptions

| Name | Summary                                 | Description                                                                                                                                                                                                                                                                                                                                                                                     |
|------|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VAL  | Value                                   | This is the desired output value, in engineering units. If DRVH and DRVL are defined, VAL is forced to be within the drive limits. VAL is either obtained from DOL or set via dbPuts.                                                                                                                                                                                                           |
| OVAL | Output Value                            | This is the desired output value, after adjustments, in engineering units. It is just VAL possibly adjusted by OROC. This is the value used to compute RVAL. OVAL is used to enforce a maximum rate of change limit before converting the desired value to a raw value. If soft device support is selected and OUT is a database or channel access link, this is the value written to the link. |
| OUT  | Output Link                             | This field is used by the device support routines to decide where to send output. For soft records, it can be a constant, a database link, or a channel access link. If the link is a constant, the result is no output.                                                                                                                                                                        |
| OROC | Maximum Output Rate of Change           | If this is not zero, it specifies the maximum change in value (engineering units) to be sent to OUT each time the record is processed. It is this field that can cause VAL and OVAL to differ.                                                                                                                                                                                                  |
| DOL  | Desired Output Location (an Input Link) | If DOL is a database or channel access link and OMSL is CLOSED_LOOP, then VAL is read from DOL. After the check for drive limits, VAL will be set to the value determined by DOL.                                                                                                                                                                                                               |
| OMSL | Output Mode Select                      | This field has either the value SUPERVISORY or CLOSED_LOOP. DOL is used to determine VAL only if OMSL has the value CLOSED_LOOP. By setting this field the record can be switched between supervisory and closed loop mode of operation. While in closed loop mode, the VAL field cannot be set via dbPuts.                                                                                     |
| OIF  | Out Full or Incremental                 | This field is used when input is obtained from DOL, and determines if the value obtained from DOL is an increment to add to the current VAL or is the actual VAL desired.                                                                                                                                                                                                                       |

| Name | Summary                      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|------|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PREC | Display Precision            | Precision with which to display VAL. This field is used by record support to supply a value when get_precision is called.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| LINR | Conversion Type              | No conversion, linear and breakpoint table conversion are supported.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| EGUF | Engineering Units Full       | These fields are used to perform linear conversions. It is the responsibility of the device support routines to use EGUF and EGUL to compute ESLO and ROFF. EGUF and EGUL must be set by the user to the engineering units corresponding to the high and low ADC limits. For example if the DAC has a range of -10 to +10 Volts, then EGUF must be the engineering units value corresponding to 10 volts and EGUL to -10 volts. If a linear conversion is specified ESLO, ROFF, and EGUL are used to convert the value from/to engineering units using the following formula:<br>$RVAL = (OVAL - EGUL) / ESLO - ROFF$ |
| EGUL | Engineering Units Low        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| ESLO | Slope For Linear Conversions |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| ROFF | Raw Value Offset             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| EGU  | Engineering Units            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| DRVH | Drive High                   | If these values are defined then VAL will forced to be in the range:<br>$DRVL \leq VAL \leq DRVH$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| DRVL | Drive Low                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| HOPR | High Operating Range         | These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are used by record support to honor calls to get_graphic_double or get_control_double. If these values are defined, they must be in the range:<br>$DRVL \leq LOPR \leq HOPR \leq DRVH.$                                                                                                                                                                                                                                                                       |
| LOPR | Low Operating Range          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| AOFF | Adjustment Offset            | These fields are adjustment parameters for the raw output values. They are applied to the raw output value after conversion from engineering units.                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| ASLO | Adjustment Slope             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| HIHI | Hihi Alarm Limit             | These fields specify the alarm limits and severities.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| HIGH | High Alarm Limit             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| LOW  | Low Alarm Limit              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| LOLO | Lolo Alarm Limit             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| HHSV | Hihi Alarm Severity          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| HSV  | High Alarm Severity          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| LSV  | Low Alarm Severity           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| LLSV | Lolo Alarm Severity          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

| Name | Summary                                 | Description                                                                                                                                                                                                                       |
|------|-----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| HYST | Alarm Deadband                          | These parameters specify hysteresis factors for triggering monitor callbacks, i.e. callbacks specified by calls to caAddEvent or dbAddEvent. A monitor will not be triggered until VAL changes by more than the specified amount. |
| ADEL | Archive Deadband                        |                                                                                                                                                                                                                                   |
| MDEL | Monitor, i.e. value change, Deadband    |                                                                                                                                                                                                                                   |
| RVAL | Raw Data Value                          | RVAL is the value actually sent to the device.                                                                                                                                                                                    |
| ORAW | Old raw data value                      | ORAW is used to decide if monitors should be triggered for RVAL.                                                                                                                                                                  |
| RBV  | Read Back Value                         | This is the actual read back value obtained from the hardware itself or from the associated device driver. It is the responsibility of the device support routine to give this field a value.                                     |
| ORBV | Old read back value                     | ORBV is used to decide if monitors should be triggered for RBV at the same time monitors are triggered for changes in VAL.                                                                                                        |
| PVAL | Previous Data Value                     |                                                                                                                                                                                                                                   |
| LALM | Last Alarm Monitor Trigger Value        | These fields are used to implement the hysteresis factors for monitors.                                                                                                                                                           |
| ALST | Last Archiver Monitor Trigger Value     |                                                                                                                                                                                                                                   |
| MLST | Last Value Change Monitor Trigger Value |                                                                                                                                                                                                                                   |
| INIT | Initialize                              | This field is used by record support to perform initialization for LBRK and for smoothing.                                                                                                                                        |
| LBRK | Last Breakpoint                         | Index of last breakpoint interval                                                                                                                                                                                                 |
| PBRK | Breakpoint Pointer                      | Address of breakpoint table                                                                                                                                                                                                       |
| SIMM | Simulation Mode                         | Simulation mode process variables. Refer to Chapter 3, Section "Simulation Mode" on page 13 for more information.                                                                                                                 |
| SIML | Simulation Mode Location                |                                                                                                                                                                                                                                   |
| SIOL | Simulation Value Location               |                                                                                                                                                                                                                                   |
| SIMS | Simulation Mode Alarm Severity          |                                                                                                                                                                                                                                   |
| IVOA | Invalid Alarm Output Action             | Whenever the record is put into INVALID alarm severity IVOA specifies an action. See Chapter 3, Section "Invalid Alarm Output Action" on page 14 for more information.                                                            |
| IVOV | Invalid Alarm Output Value              |                                                                                                                                                                                                                                   |

## 4. Record Support Routines

---

- init\_record** This routine initializes `SIMM` if `SIML` is a constant or creates a channel access link if `SIML` is `PV_LINK`. If `SIOL` is `PV_LINK` a channel access link is created.
- This routine next checks to see that device support is available. If `DOL` is a constant, then `VAL` is initialized with its value and `UDF` is set to `FALSE`.
- The routine next checks to see if the device support write routine is defined. If either device support or the device support write routine does not exist, an error message is issued and processing is terminated.
- If device support includes `init_record`, it is called.
- `INIT` is set `TRUE`. This causes `PBRK`, `LBRK`, and smoothing to be reinitialized
- If linear conversion is requested, then `VAL` is computed from `RVAL` using the algorithm:
- $$VAL = (RVAL + ROFF) / ESLO + EGUL$$
- and `UDF` is set to `FALSE`.
- For breakpoint conversion, a call is made to `cvtEngToRawBpt` and `UDF` is then set to `FALSE`. `PVAL` is set to `VAL`.
- process** See next section.
- special** The only special processing for analog output records is `SPC_LINCONV` which is invoked whenever either of the fields `LINR`, `EGUF`, `EGUL` or `ROFF` is changed
- If the device support routine `special_linconv` exists it is called.
- `INIT` is set `TRUE`. This causes `PBRK`, `LBRK`, and smoothing to be reinitialized.
- get\_value** Fills in the values of `struct valueDes` so that they refer to `VAL`.
- get\_units** Retrieves `EGU`.
- get\_precision** Retrieves `PREC`.
- get\_graphic\_double** Sets the upper display and lower display limits for the field. If the field is `VAL`, `HIHI`, `HIGH`, `LOW`, or `LOLO`, the limits are set to `HOPR` and `LOPR`, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

**get\_control\_double** Sets the upper display and lower control limits for the field. If the field is VAL, HIHI, HIGH, LOW, or LOLO, the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

**get\_alarm\_double** Sets the following values:

```

upper_alarm_limit = HIHI
upper_warning_limit = HIGH
lower_warning_limit = LOW
lower_alarm_limit = LOLO

```

## 5. Record Processing

Routine `process` implements the following algorithm:

1. Check to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the `PACT` field set to `TRUE`. This ensures that processes will no longer be called for this record. Thus error storms will not occur.
2. Check `PACT`: If `PACT` is `FALSE` call `fetch_values` and `convert` which perform the following steps:
  - `fetch_values`:
    - if `DOL` is `DB_LINK` and `OMSL` is `CLOSED_LOOP` get value from `DOL`
    - if `OIF` is `INCREMENTAL` then set `value = value + VAL`
    - else `value = VAL`
  - `convert`:
    - If Drive limits are defined force `value` to be within limits
    - Set `VAL` equal to `value`
    - Set `UDF` to `FALSE`.
    - If `OVAL` is undefined set it equal to `value`
    - If `OROC` is defined and not 0 make `|value-OVAL| <=OROC`
    - Set `OVAL` equal to `value`
    - Compute `RVAL` from `OVAL`. using linear or break point table conversion. For linear conversions the algorithm is:
$$RVAL = (OVAL-EGUL) / ESLO - ROFF$$
    - For break point table conversion a call is made to `cvtEngToRawBpt`.
3. Check alarms: This routine checks to see if the new `VAL` causes the alarm status and severity to change. If so, `NSEV`, `NSTA` and `γ` are set. It also honors the alarm hysteresis factor (`HYST`). Thus the value must change by at least `HYST` before the alarm status and severity is reduced.
4. Check severity and write the new value. See Chapter 3, Section "Invalid Alarm Output Action" on page 14 for details.
5. If `PACT` has been changed to `TRUE`, the device support write output routine has started but has not completed writing the new value. In this case, the processing routine merely returns, leaving `PACT TRUE`.
6. Check to see if monitors should be invoked:
  - Alarm monitors are invoked if the alarm status or severity has changed.
  - Archive and value change monitors are invoked if `ADEL` and `MDEL` conditions are met.



- Monitors for RVAL and for RBV are checked whenever other monitors are invoked.
  - NSEV and NSTA are reset to 0.
7. Scan forward link if necessary, set PACT and INIT FALSE, and return.

## 6. Device Support

### Fields Of Interest To Device Support

Each analog output record must have an associated set of device support routines. The primary responsibility of the device support routines is to output a new value whenever `write_ao` is called. The device support routines are primarily interested in the following fields:

| Name | Summary                | Description                                                                                                                                                                                 |
|------|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PACT | Processing Active      | See Chapter 2, Section "Database Common: Field Descriptions" on page 5 for descriptions.                                                                                                    |
| DPVT | Device Private         |                                                                                                                                                                                             |
| NSEV | New Alarm Severity     |                                                                                                                                                                                             |
| NSTA | New Alarm Status       |                                                                                                                                                                                             |
| OUT  | Output Link            | This field is used by the device support routines to locate its output.                                                                                                                     |
| EGUF | Engineering Units Full | These fields are used to calculate ESLO. Note that these fields correspond to the high and low hardware limits.                                                                             |
| EGUL | Engineering Unit Low   |                                                                                                                                                                                             |
| ESLO | Slope                  | These fields are used for linear conversions from raw to engineering units. The device support routines must calculate these fields unless they obtain values already in engineering units. |
| ROFF | Raw Offset             |                                                                                                                                                                                             |
| RVAL | Raw Value              | This is the value to write OUT.                                                                                                                                                             |

### Device Support routines

Device support consists of the following routines:

#### *init*

`init()`

This routine is called once during IOC initialization.

#### *init\_record*

`init_record(precord)`

This routine is optional. If provided, it is called by the record support `init_record` routine. It returns a zero for success or a 2 for success, don't convert.

#### *get\_ioint\_info*

`get_ioint_info(int cmd, struct dbCommon *precord, IOSCANPVT *ppvt)`

This routine is called by the `ioEventScan` system each time the record is added or deleted from an I/O event scan list. `cmd` has the value (0,1) if the record is being (added to, deleted from) an I/O event list. It must be provided for any device type that can use the `ioEventScanner`.

*write\_ao*

`write_ao(precord)`

This routine must output a new value. Asynchronous device support routines will return with `PACT` set to `TRUE`. If `PACT` is `TRUE`, the process routine will just return and not continue processing. When the asynchronous routine completes, it can call `process` which will again call `write_ao`. When finished, `write_ao` should set `PACT` to `FALSE` and return one of the following values:

- 0: Success.
- other: Error.

*special\_linconv*

`special_linconv(precord, after)`

This routine is called whenever either of the fields `LINR`, `EGUF`, `EGUL` or `ROFF` is modified.

---

## 7. Device Support For Soft Records

---

Two soft device support modules `Soft Channel` and `Raw Soft Channel` are provided for output records not related to actual hardware devices. The `OUT` link type must be either a `CONSTANT`, `DB_LINK`, or `CA_LINK`.

### Soft Channel

This module writes the current value of `OVAL`.

If the `OUT` link type is `PV_LINK`, then `dbCaAddInlink` is called by `init_record`. `init_record` always returns a value of 2, which means that no conversion will ever be attempted.

`write_ao` calls `recGblPutLinkValue` to write the current value of `VAL`. See Chapter 3, Section "Soft Output" on page 13 for details.

### Raw Soft Channel

This module is like the previous except that it writes the current value of `RVAL`.



---

# Chapter 6: *bi* - Binary Input

---

## 1. Introduction

---

The normal use for this record type is to obtain a binary value, i.e. a value that is 0 or 1. Most device support modules obtain values from hardware and place the value in RVAL. For these devices record processing sets VAL = (0,1) if RVAL is (0, not 0). Devices may optionally read a value directly into VAL. Soft device modules are provided to obtain input via database or channel access links or via dbPutField or dbPutLink requests. Two soft device support modules are provided. One allows VAL to be an arbitrary unsigned short integer. The other reads the value into RVAL just like normal hardware modules.

---

## 2. Field Summary

---

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| VAL   | ENUM      | No  | 0       | Yes    | Yes    | Yes              | Yes |
| INP   | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| ZSV   | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OSV   | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| COSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| ZNAM  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| ONAM  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| RVAL  | ULONG     | No  | 0       | Yes    | Yes    | Yes              | Yes |

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP |
|-------|-----------|-----|---------|--------|--------|------------------|----|
| ORAW  | ULONG     | No  | 0       | Yes    | No     | No               | No |
| MASK  | ULONG     | No  | compute | Yes    | No     | No               | No |
| LALM  | USHORT    | No  | 0       | Yes    | No     | No               | No |
| MLST  | USHORT    | No  | 0       | Yes    | No     | No               | No |
| SIOL  | INLINK    | Yes | 0       | No     | No     | N/A              | No |
| SVAL  | USHORT    | No  | 0       | Yes    | Yes    | No               | No |
| SIML  | INLINK    | Yes | 0       | No     | No     | N/A              | No |
| SIMM  | GBLCHOICE | No  | 0       | Yes    | Yes    | No               | No |
| SIMS  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No |

### 3. Field Descriptions

| Name | Summary                  | Description                                                                                                                                                                                       |
|------|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VAL  | Value Field              | This is the value resulting from record processing unless soft device support with a constant INP is chosen. If the later is chosen, VAL, which is an unsigned short, is given values via dbPuts. |
| INP  | Input Link               | This field is used by the device support routines to obtain input. For soft records, it can be a constant, a database link, or a channel access link.                                             |
| ZSV  | Zero Severity            | Alarm Severity for state zero.                                                                                                                                                                    |
| OSV  | One Severity             | Alarm Severity for state one.                                                                                                                                                                     |
| COSV | Change of State Severity | Alarm Severity for change of state.                                                                                                                                                               |
| ZNAM | Zero Name                | ASCII string defining state zero.                                                                                                                                                                 |
| ONAM | One Name                 | ASCII string defining state one.                                                                                                                                                                  |
| RVAL | Raw Value                | RVAL is the value obtained by the device support routine.                                                                                                                                         |
| ORAW | Old Raw Value            | ORAW is used to decide if monitors should be triggered for RVAL at the same time monitors are triggered for changes in VAL.                                                                       |
| MASK | Hardware mask            |                                                                                                                                                                                                   |
| LALM | Last Alarmed Value       | Value when last change of state alarm was issued.                                                                                                                                                 |
| MLST | Last Monitored Value     | Value when last monitor for value changes was triggered.                                                                                                                                          |

| Name | Summary                        | Description                                                                                                       |
|------|--------------------------------|-------------------------------------------------------------------------------------------------------------------|
| SIMM | Simulation Mode                | Simulation mode process variables. Refer to Chapter 3, Section "Simulation Mode" on page 11 for more information. |
| SIML | Simulation Mode Location       |                                                                                                                   |
| SVAL | Simulation Value               |                                                                                                                   |
| SIOL | Simulation Value Location      |                                                                                                                   |
| SIMS | Simulation Mode Alarm Severity |                                                                                                                   |

## 4. Record Support Routines

### **init\_record**

This routine initializes `SIMM` with the value of `SIML` if `SIML` type is `CONSTANT` link or creates a channel access link if `SIML` type is `PV_LINK`. `SVAL` is likewise initialized if `SIOL` is `CONSTANT` or `PV_LINK`.

This routine next checks to see that device support is available and a device support read routine is defined. If either does not exist, an error message is issued and processing is terminated.

If device support includes `init_record`, it is called.

### **process**

See next section.

### **get\_value**

Fills in the values of struct `valueDes` so that they refer to `VAL`.

### **get\_enum\_str**

Retrieves ASCII string corresponding to `VAL`.

### **get\_enum\_strs**

Retrieves ASCII strings for `ZNAM` and `ONAM`.

### **put\_enum\_str**

Checks if string matches `ZNAM` or `ONAM`, and if it does, sets `VAL`.

## 5. Record Processing

Routine `process` implements the following algorithm:

1. Check to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the PACT field still set to TRUE. This ensures that processes will no longer be called for this record. Thus error storms will not occur.
2. readValue is called. See Chapter 3, Section "Simulation Mode" on page 11 for details.
3. If PACT has been changed to TRUE, the device support read routine has started but has not completed reading a new input value. In this case, the processing routine merely returns, leaving PACT TRUE.
4. Convert
 

```

status=read_bi
PACT = TRUE
TIME = tslocaltime
if status is 0, then set VAL=(0,1) if RVAL is (0, not 0) and UDF = False
if status is 2, set status = 0

```
5. Check alarms: This routine checks to see if the new VAL causes the alarm status and severity to change. If so, NSEV and NSTA and LALM are set. Note that if VAL is greater than 1, no checking is performed.
6. Check to see if monitors should be invoked:
  - Alarm monitors are invoked if the alarm status or severity has changed.
  - Archive and value change monitors are invoked if MLST is not equal to VAL.
  - Monitors for RVAL are checked whenever other monitors are invoked.
  - NSEV and NSTA are reset to 0.
7. Scan forward link if necessary, set PACT FALSE, and return.

## 6. Device Support

### Fields Of Interest To Device Support

Each input record must have an associated set of device support routines. The primary responsibility of the device support routines is to obtain a new raw input value whenever read\_bi is called. The device support routines are primarily interested in the following fields:

| Name | Summary            | Description                                                                                      |
|------|--------------------|--------------------------------------------------------------------------------------------------|
| PACT | Processing Active  | See Chapter 2, Section "Database Common: Field Descriptions" on page 5 for descriptions.         |
| DPVT | Device Private     |                                                                                                  |
| UDF  | VAL Undefined      |                                                                                                  |
| NSEV | New Alarm Severity |                                                                                                  |
| NSTA | New Alarm Status   |                                                                                                  |
| VAL  | Value Field        | This field is set by a device support routines only if it doesn't want record support to set it. |
| INP  | Input Link         | This field is used by the device support routines to locate its input.                           |
| RVAL | Raw Value          | It is the responsibility of the device support routine to give this field a value.               |

| Name | Summary        | Description                                                                    |
|------|----------------|--------------------------------------------------------------------------------|
| MASK | Hardware mask. | The device support routine must give this field a value if it needs to use it. |

## Device Support routines

Device support consists of the following routines:

### *report*

```
report(FILE fp, paddr)
```

Not currently used.

### *init*

```
init()
```

This routine is called once during IOC initialization.

### *init\_record*

```
init_record(precord)
```

This routine is optional. If provided, it is called by the record support `init_record` routine.

### *get\_ioint\_info*

```
get_ioint_info(int cmd, struct dbCommon *precord, IOSCANPVT *ppvt)
```

This routine is called by the `ioEventScan` system each time the record is added or deleted from an I/O event scan list. `cmd` has the value (0,1) if the record is being (added to, deleted from) an I/O event list. It must be provided for any device type that can use the `ioEvent` scanner.

### *read\_bi*

```
read_bi(precord)
```

This routine must provide a new input value. It returns the following values:

- **0:** Success. A new raw value is placed in `RVAL`. The record support module forces `VAL` to be (0,1) if `RVAL` is (0, not 0).
- **2:** Success, but don't modify `VAL`.
- **other:** Error.

## 7. Device Support For Soft Records

Two soft device support modules `Soft Channel` and `Raw Soft Channel` are provided for input records not related to actual hardware devices. The `INP` link type must be either `CONSTANT`, `DB_LINK`, or `CA_LINK`.

### Soft Channel

`read_bi` always returns a value of 2, which means that no conversion is performed.

If the `INP` link type is constant, then the constant value is stored into `VAL` by `init_record`, and `UDF` is set to `FALSE`. `VAL` can be changed via `dbPut` requests. If the `INP` link type is `PV_LINK`, then `dbCaAddInlink` is called by `init_record`.



`read_bi` calls `recGblGetLinkValue` to read the current value of `VAL`. See Chapter 3, Section "Soft Input" on page 10 for details.

If the return status of `recGblGetLinkValue` is zero, then `read_bi` sets `UDF` to `FALSE`. The status of `recGblGetLinkValue` is returned.

**Raw Soft  
Channel**

This module is like the previous except that values are read into `RVAL`. `read_bi` returns a value of 0. Thus the record processing routine will force `VAL` to be 0 or 1.

---

# Chapter 7: *bo* - Binary Output

---

## 1. Introduction

---

The normal use for this record type is to store a binary (0 or 1) value to be sent to a Digital Output module. It can also be used to write binary values into other records via database or channel access links.

---

## 2. Field Summary

---

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| VAL   | ENUM      | No  | 0       | Yes    | Yes    | Yes              | Yes |
| OMSL  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| OUT   | OUTLINK   | Yes | 0       | No     | No     | N/A              | No  |
| DOL   | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| HIGH  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| ZNAM  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| ONAM  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| RVAL  | ULONG     | No  | 0       | Yes    | Yes    | Yes              | Yes |
| ORAW  | ULONG     | No  | 0       | Yes    | No     | No               | No  |
| MASK  | ULONG     | No  | compute | Yes    | No     | No               | No  |

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| RPVT  | NOACCESS  | No  | 0       | No     | No     |                  | No  |
| WDPT  | NOACCESS  | No  | 0       | No     | No     |                  | No  |
| ZSV   | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OSV   | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| COSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| RBV   | ULONG     | No  | 0       | Yes    | No     | Yes              | No  |
| ORBV  | ULONG     | No  | 0       | Yes    | No     | No               | No  |
| MLST  | USHORT    | No  | 0       | Yes    | No     | No               | No  |
| LALM  | USHORT    | No  | 0       | Yes    | No     | No               | No  |
| SIOL  | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| SIML  | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| SIMM  | GBLCHOICE | No  | 0       | Yes    | Yes    | No               | No  |
| SIMS  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| IVOA  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| IVOV  | USHORT    | Yes | 0       | Yes    | Yes    | No               | No  |

### 3. Field Descriptions

| Name | Summary                              | Description                                                                                                                                                                                                                                                                                                 |
|------|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VAL  | Value Field                          | This is the value to be sent to OUT. It is either obtained from DOL or else given a value via dbPuts.                                                                                                                                                                                                       |
| OMSL | Output Mode Select                   | This field has either the value SUPERVISORY or CLOSED_LOOP. DOL is used to determine VAL only if OMSL has the value CLOSED_LOOP. By setting this field the record can be switched between supervisory and closed loop mode of operation. While in closed loop mode, the VAL field cannot be set via dbPuts. |
| DOL  | Desired Output Location (Input Link) | If DOL is a database or channel access link and OMSL is CLOSED_LOOP, then VAL is read from DOL.                                                                                                                                                                                                             |
| OUT  | Output Link                          | This field is used by the device support routines to decide where to send output. For soft records, it can be a constant, a database link, or a channel access link. If the link is a constant, the result is no output.                                                                                    |
| HIGH | Seconds to Hold High                 | If this value is greater than zero, then whenever VAL is set equal to 1, it is reset to zero after HIGH seconds.                                                                                                                                                                                            |

| Name | Summary                        | Description                                                                                                                                                                                   |
|------|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ZNAM | Zero Name                      | ASCII string defining state zero.                                                                                                                                                             |
| ONAM | One Name                       | ASCII string defining state one.                                                                                                                                                              |
| RVAL | Raw Data Value                 | RVAL is the value written by the device support routine. If MASK is set by the device support routine, RVAL is computed by record support.                                                    |
| ORAW | Old Raw Data Value             | ORAW is used to decide if monitors should be triggered for RVAL at the same time monitors are triggered for changes in VAL.                                                                   |
| MASK | Hardware Mask                  | This value can be set by the device support routine. It is the value sent to the hardware when VAL is not zero.                                                                               |
| RPVT | Record Private                 |                                                                                                                                                                                               |
| WDPT | Watchdog Pointer               | Private field for honoring second to hold HIGH.                                                                                                                                               |
| ZSV  | Zero Severity                  | Alarm Severity for state zero.                                                                                                                                                                |
| OSV  | One Severity                   | Alarm Severity for state one.                                                                                                                                                                 |
| COSV | Change of State Severity       | Alarm Severity for change of state.                                                                                                                                                           |
| RBV  | Read Back Value                | This is the actual read back value obtained from the hardware itself or from the associated device driver. It is the responsibility of the device support routine to give this field a value. |
| ORBV | Old Read Back Value            | ORBV is used to decide if monitors should be triggered for RBV at the same time monitors are triggered for changes in VAL.                                                                    |
| MLST | Monitor Last                   | Value when last monitor for value changes was triggered                                                                                                                                       |
| LALM | Last Alarmed                   | Value when last change of state alarm was issued.                                                                                                                                             |
| SIMM | Simulation Mode                | Simulation mode process variables. Refer to Chapter 3, Section "Simulation Mode" on page 13 for more information.                                                                             |
| SIML | Simulation Mode Location       |                                                                                                                                                                                               |
| SIOL | Simulation Value Location      |                                                                                                                                                                                               |
| SIMS | Simulation Mode Alarm Severity |                                                                                                                                                                                               |
| IVOA | Invalid Alarm Output Action    | Whenever the record is put into INVALID alarm severity IVOA specifies an action. See Chapter 3, Section "Invalid Alarm Output Action" on page 14 for more information.                        |
| IVOV | Invalid Alarm Output Value     |                                                                                                                                                                                               |

#### 4. Record Support Routines

|                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>init_record</b>   | <p>This routine initializes <code>STMM</code> if <code>SIML</code> is a constant or creates a channel access link if <code>SIML</code> is <code>PV_LINK</code>. If <code>STOL</code> is <code>PV_LINK</code> a channel access link is created .</p> <p>This routine next checks to see that device support is available. The routine next checks to see if the device support write routine is defined. If either device support or the device support write routine does not exist, an error message is issued and processing is terminated.</p> <p>If <code>DOL</code> is a constant, then <code>VAL</code> is initialized to 1 if its value is nonzero or initialized to 0 if <code>DOL</code> is zero, and <code>UDF</code> is set to <code>FALSE</code>.</p> <p>If device support includes <code>init_record</code>, it is called. <code>VAL</code> is set using <code>RVAL</code>, and <code>UDF</code> is set to <code>FALSE</code>.</p> |
| <b>process</b>       | See next section.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>get_value</b>     | Fills in the values of struct <code>valueDes</code> so that they refer to <code>VAL</code> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>get_enum_str</b>  | Retrieves ASCII string corresponding to <code>VAL</code> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>get_enum_strs</b> | Retrieves ASCII strings for <code>ZNAM</code> and <code>ONAM</code> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>put_enum_str</b>  | Checks if string matches <code>ZNAM</code> or <code>ONAM</code> , and if it does, sets <code>VAL</code> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

---

## 5. Record Processing

---

Routine `process` implements the following algorithm:

1. Check to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the `PACT` field still set to `TRUE`. This ensures that processes will no longer be called for this record. Thus error storms will not occur.
2. If `PACT` is `FALSE`
  - if `DOL` is `DB_LINK` and `OMSL` is `CLOSED_LOOP`
    - get value from `DOL`
    - check for link alarm
    - force `VAL` to be 0 or 1
    - if `MASK` is defined
      - if `VAL` is 0 set `RVAL` = 0
    - else set `RVAL` = `MASK`
3. Check alarms: This routine checks to see if the new `VAL` causes the alarm status and severity to change. If so, `NSEV`, `NSTA` and `LALM` are set.
4. Check severity and write the new value. See Chapter 3, Section "Invalid Alarm Output Action" on page 14 for details.

5. If PACT has been changed to TRUE, the device support write output routine has started but has not completed writing the new value. In this case, the processing routine merely returns, leaving PACT TRUE.
6. Check WAIT. If VAL is 1 and WAIT is greater than 0, process again with a VAL=0 after WAIT seconds.
7. Check to see if monitors should be invoked.
  - Alarm monitors are invoked if the alarm status or severity has changed.
  - Archive and value change monitors are invoked if MLST is not equal to VAL.
  - Monitors for RVAL and for RBV are checked whenever other monitors are invoked.
  - NSEV and NSTA are reset to 0.
8. Scan forward link if necessary, set PACT FALSE, and return.

## 6. Device Support

### Fields Of Interest To Device Support

Each binary output record must have an associated set of device support routines. The primary responsibility of the device support routines is to write a new value whenever write\_bo is called. The device support routines are primarily interested in the following fields:

| Name | Summary            | Description                                                                                                                                                                                   |
|------|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PACT | Processing Active  | See Chapter 2, Section "Database Common: Field Descriptions" on page 5 for descriptions.                                                                                                      |
| DPVT | Device Private     |                                                                                                                                                                                               |
| NSEV | New Alarm Severity |                                                                                                                                                                                               |
| NSTA | New Alarm Status   |                                                                                                                                                                                               |
| VAL  | Value Field        | This field is only of interest to device support routines that do not use MASK and RVAL.                                                                                                      |
| OUT  | Output Link        | This field is used by the device support routines to locate its output.                                                                                                                       |
| RVAL | Raw Data Value     | If MASK is defined then record support sets RVAL=(0,MASK) if VAL is (0, not zero).                                                                                                            |
| MASK | Hardware mask.     | The device support module must set this field. Not that if VAL is 1, then record processing sets RVAL = MASK.                                                                                 |
| RBV  | Read Back Value    | This is the actual read back value obtained from the hardware itself or from the associated device driver. It is the responsibility of the device support routine to give this field a value. |

### Device Support routines

Device support consists of the following routines:

|                       |                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>report</i>         | <code>report(FILE fp, paddr)</code><br>Not currently used.                                                                                                                                                                                                                                                                                                                                                            |
| <i>init</i>           | <code>init()</code><br>This routine is called once during IOC initialization.                                                                                                                                                                                                                                                                                                                                         |
| <i>init_record</i>    | <code>init_record(precord)</code><br>This routine is optional. If provided, it is called by the record support <code>init_record</code> routine. It should determine <code>MASK</code> if it is needed.                                                                                                                                                                                                               |
| <i>get_ioint_info</i> | <code>get_ioint_info(int cmd, struct dbCommon *precord, IOSCANPVT *ppvt)</code><br>This routine is called by the <code>ioEventScan</code> system each time the record is added or deleted from an I/O event scan list. <code>cmd</code> has the value (0,1) if the record is being (added to, deleted from) an I/O event list. It must be provided for any device type that can use the <code>ioEvent</code> scanner. |
| <i>write_bo</i>       | <code>write_bo(precord)</code><br>This routine must output an new value. It returns the following values: <ul style="list-style-type: none"><li>• 0: Success.</li><li>• other: Error.</li></ul>                                                                                                                                                                                                                       |

---

## 7. Device Support For Soft Records

---

Two soft device support modules Soft Channel and Raw Soft Channel are provided for output records not related to actual hardware devices. The `OUT` link type must be either a `CONSTANT`, `DB_LINK`, or `CA_LINK`.

### Soft Channel

This module writes the current value of `VAL`.

If the `OUT` link type is `PV_LINK`, then `dbCaAddInlink` is called by `init_record`. `init_record` always returns a value of 2, which means that no conversion will ever be attempted.

`write_bo` calls `recGblPutLinkValue` to write the current value of `VAL`. See Chapter 3, Section "Soft Output" on page 13 for details.

### Raw Soft Channel

This module is like the previous except that it writes the current value of `RVAL`.

---

## Chapter 8: *calc* - Calculation

---

### 1. Introduction

---

This record calculates an expression.

---

### 2. Field Summary

---

| Field | Type   | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|--------|-----|---------|--------|--------|------------------|-----|
| VAL   | DOUBLE | No  | 0       | Yes    | Yes    | Yes              | No  |
| CALC  | STRING | Yes | Null    | Yes    | Yes    | Yes              | Yes |
| INPA  | INLINK | Yes | 0       | No     | No     | N/A              | No  |
| INPB  | INLINK | Yes | 0       | No     | No     | N/A              | No  |
| INPC  | INLINK | Yes | 0       | No     | No     | N/A              | No  |
| INPD  | INLINK | Yes | 0       | No     | No     | N/A              | No  |
| INPE  | INLINK | Yes | 0       | No     | No     | N/A              | No  |
| INPF  | INLINK | Yes | 0       | No     | No     | N/A              | No  |
| INPG  | INLINK | Yes | 0       | No     | No     | N/A              | No  |
| INPH  | INLINK | Yes | 0       | No     | No     | N/A              | No  |
| INPI  | INLINK | Yes | 0       | No     | No     | N/A              | No  |
| INPJ  | INLINK | Yes | 0       | No     | No     | N/A              | No  |



| Field | Type   | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|--------|-----|---------|--------|--------|------------------|-----|
| INPK  | INLINK | Yes | 0       | No     | No     | N/A              | No  |
| INPL  | INLINK | Yes | 0       | No     | No     | N/A              | No  |
| A     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| B     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| C     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| D     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| E     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| F     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| G     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| H     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| I     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| J     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| K     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| L     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| LA    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LB    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LC    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LD    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LE    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LF    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LG    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LH    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LI    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LJ    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LK    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LL    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| EGU   | STRING | Yes | Null    | Yes    | Yes    | No               | No  |
| PREC  | SHORT  | Yes | 0       | Yes    | Yes    | No               | No  |
| HOPR  | FLOAT  | Yes | 0       | Yes    | Yes    | No               | No  |
| LOPR  | FLOAT  | Yes | 0       | Yes    | Yes    | No               | No  |
| HIHI  | FLOAT  | Yes | 0       | Yes    | Yes    | No               | Yes |
| LOLO  | FLOAT  | Yes | 0       | Yes    | Yes    | No               | Yes |

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| HIGH  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| LOW   | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| HHSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| LLSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| HSV   | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| LSV   | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| HYST  | DOUBLE    | Yes | 0       | Yes    | Yes    | No               | No  |
| ADEL  | DOUBLE    | Yes | 0       | Yes    | Yes    | No               | No  |
| MDEL  | DOUBLE    | Yes | 0       | Yes    | Yes    | No               | No  |
| LALM  | DOUBLE    | No  | 0       | Yes    | No     | No               | No  |
| ALST  | DOUBLE    | No  | 0       | Yes    | No     | No               | No  |
| MLST  | DOUBLE    | No  | 0       | Yes    | No     | No               | No  |
| RPCL  | NOACCESS  | No  | 0       | No     | No     |                  | No  |

### 3. Field Descriptions

| Name          | Summary               | Description                                                                                                                                                   |
|---------------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VAL           | Value Field           | This field is calculated, via the CALC expression, each time the record is processed.                                                                         |
| CALC          | Infix Expression      | See below for details                                                                                                                                         |
| INPA,...,INPL | Input Links           | Each may be a constant, a database link, or a channel access link. Any link not defined is ignored.                                                           |
| A,...,L       | Input Values          | If the corresponding INP field is a constant, this field is initialized with the constant value but can be changed via dbPuts.                                |
| LA,...,LL     | Previous Input Values | These fields are used to decide when to trigger monitors on A,...,L.                                                                                          |
| EGU           | Engineering Units     | A 16 character ASCII string describing Engineering units. This field is used by record support to supply a units description string when get_units is called. |
| PREC          | Display Precision     | Precision with which to display VAL. This field is used by record support to supply a value when get_precision is called.                                     |

| Name | Summary                              | Description                                                                                                                                                                                                                                                               |
|------|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| HOPR | High Operating Range                 | These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are used by record support to honor calls to <code>get_graphic_double</code> or <code>get_control_double</code> . |
| LOPR | Low Operating Range                  |                                                                                                                                                                                                                                                                           |
| HIHI | Hihi Alarm Limit                     | These fields specify the alarm limits and severities.                                                                                                                                                                                                                     |
| HIGH | High Alarm Limit                     |                                                                                                                                                                                                                                                                           |
| LOW  | Low Alarm Limit                      |                                                                                                                                                                                                                                                                           |
| LOLO | Lolo Alarm Limit                     |                                                                                                                                                                                                                                                                           |
| HHSV | Severity for a Hihi Alarm            |                                                                                                                                                                                                                                                                           |
| HSV  | Severity for a High Alarm            |                                                                                                                                                                                                                                                                           |
| LSV  | Severity for a Low Alarm             |                                                                                                                                                                                                                                                                           |
| LLSV | Severity for a Lolo Alarm            |                                                                                                                                                                                                                                                                           |
| HYST | Alarm Deadband                       |                                                                                                                                                                                                                                                                           |
| ADEL | Archive Deadband                     |                                                                                                                                                                                                                                                                           |
| MDEL | Monitor, i.e. value change, Deadband |                                                                                                                                                                                                                                                                           |
| LALM | Last Alarmed Value                   | Values when monitors were last triggered. These fields are used to implement the hysteresis factors for monitors.                                                                                                                                                         |
| ALST | Archive Last Value                   |                                                                                                                                                                                                                                                                           |
| MLST | Monitor Last Value                   |                                                                                                                                                                                                                                                                           |
| RPCL | Expression in reverse polish         |                                                                                                                                                                                                                                                                           |

#### 4. Record Support Routines

##### **init\_record**

For each constant input link, the corresponding value field is initialized with the constant value if the input link is `CONSTANT` or a channel access link is created if the input link is `PV_LINK`.

A routine `postfix` is called to convert the infix expression in `CALC` to reverse polish notation. The result is stored in `RPCL`.

##### **process**

See next section.

---

|                           |                                                                                                                                                                                                                                                                                                                                                                                                        |
|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>special</b>            | This is called if <code>CALC</code> is changed. <code>special</code> calls <code>postfix</code> .                                                                                                                                                                                                                                                                                                      |
| <b>get_value</b>          | Fills in the values of <code>struct valueDes</code> so that they refer to <code>VAL</code> .                                                                                                                                                                                                                                                                                                           |
| <b>get_units</b>          | Retrieves <code>EGU</code> .                                                                                                                                                                                                                                                                                                                                                                           |
| <b>get_precision</b>      | Retrieves <code>PREC</code> .                                                                                                                                                                                                                                                                                                                                                                          |
| <b>get_graphic_double</b> | Sets the upper display and lower display limits for a field. If the field is <code>VAL</code> , <code>HIHI</code> , <code>HIGH</code> , <code>LOW</code> , or <code>LOLO</code> , the limits are set to <code>HOPR</code> and <code>LOPR</code> , else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.     |
| <b>get_control_double</b> | Sets the upper control and the lower control limits for a field. If the field is <code>VAL</code> , <code>HIHI</code> , <code>HIGH</code> , <code>LOW</code> , or <code>LOLO</code> , the limits are set to <code>HOPR</code> and <code>LOPR</code> , else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used. |
| <b>get_alarm_double</b>   | Sets the following values:<br><pre> upper_alarm_limit = HIHI upper_warning_limit = HIGH lower_warning_limit = LOW lower_alarm_limit = LOLO </pre>                                                                                                                                                                                                                                                      |

---

## 5. Record Processing

---

Routine `process` implements the following algorithm:

1. Fetch all arguments.
2. Call routine `calcPerform`, which calculates `VAL` from the `postfix` version of the expression given in `CALC`. If `calcPerform` returns success `UDF` is set to `FALSE`.
3. Check alarms. This routine checks to see if the new `VAL` causes the alarm status and severity to change. If so, `NSEV`, `NSTA` and `LALM` are set. It also honors the alarm hysteresis factor (`HYST`). Thus the value must change by at least `HYST` before the alarm status and severity changes.
4. Check to see if monitors should be invoked.
  - Alarm monitors are invoked if the alarm status or severity has changed.
  - Archive and value change monitors are invoked if `ADEL` and `MDEL` conditions are met.
  - Monitors for `A-L` are checked whenever other monitors are invoked.
  - `NSEV` and `NSTA` are reset to 0.
5. Scan forward link if necessary, set `PACT` `FALSE`, and return.

## 6. Allowed Expressions

---

The calculation can express algebraic, relational, and logical expressions. The expression is converted to opcode and stored as reverse polish notation in the calculation record. The database fields are as follows:

- **CALC**: infix expression as entered
- **RPCL**: reverse polish expression

The reverse polish calculation is most efficient to evaluate during run-time. The range of expressions supported by the calculation record are separated into operands, algebraic operations, trigonometric, relational operations, logical operations, parenthesis, and the question mark operator.

### Operands

- **A**: Use the value specified by input A
- **B**: Use the value specified by input B
- **C**: Use the value specified by input C
- **D**: Use the value specified by input D
- **E**: Use the value specified by input E
- **F**: Use the value specified by input F
- **G**: Use the value specified by input G
- **H**: Use the value specified by input H
- **I**: Use the value specified by input I
- **J**: Use the value specified by input J
- **K**: Use the value specified by input K
- **L**: Use the value specified by input L
- **RNDM**: Random number (unary), random number between 0-1

### Algebraic Operators

- **ABS**: Absolute value (unary)
- **SQR**: Square root (unary)
- **MIN**: Minimum (binary function)
- **MAX**: Maximum (binary function)
- **CEIL**: Ceiling (unary)
- **FLOOR**: Floor (unary)
- **LOG**: Log base 10 (unary)
- **LOGE**: Natural log (unary)
- **EXP**: Exponential function (unary)
- **^**: Exponential (binary)
- **\*\***: Exponential (binary)
- **+**: Addition (binary)
- **-**: Subtraction (binary)
- **\***: Multiplication (binary)
- **/**: Division (binary)
- **%**: Modulo (binary)
- **NOT**: Negate (unary)

---

**Trigonometric  
Operators**

- **SIN:** Sine
- **SINH:** Hyperbolic sine
- **ASIN:** Arc sine
- **COS:** Cosine
- **COSH:** Hyperbolic cosine
- **ACOS:** Arc cosine
- **TAN:** Tangent
- **TANH:** Hyperbolic tangent
- **ATAN:** Arc tangent

**Relational  
Operators**

- **>= :** Greater than or equal to
- **> :** Greater than
- **<= :** Less than or equal to
- **< :** Less than
- **# :** Not equal to
- **= :** Equal to

**Logical  
Operators**

- **&& :** And
- **|| :** Or
- **! :** Not

**Bitwise  
Operators**

- **| :** Bitwise Or
- **& :** Bitwise And
- **OR :** Bitwise Or
- **AND :** Bitwise And
- **XOR :** Bitwise Exclusive Or
- **~ :** One's Complement
- **<< :** Left shift
- **>> :** Right shift

**Parenthesis and  
Comma**

The open and close parenthesis are supported. Nested parenthesis are supported.  
The comma is supported when used to separate the arguments of a binary function.

**Conditional  
Expression**

The "C" question mark operator is supported. The format is:  
`(condition)? True result : False result`

## 7. Example Expressions

---

### Algebraic

$A + B$

- Result is  $A + B$

### Relational

$(A + B) < (C + D)$

- Result is 1 if  $(A+B) < (C+D)$
- Result is 0 if  $(A+B) \geq (C+D)$

### Question Mark

$(A+B) < (C+D) ? E : F$

- Result is E if  $(A+B) < (C+D)$
- Result is F if  $(A+B) \geq (C+D)$

$(A+B) < (C+D) ? E$

- Result is E if  $(A+B) < (C+D)$
- Result is unchanged if  $(A+B) \geq (C+D)$

### Logical

$A \& B$

- Causes the following to occur:
  - Convert A to integer
  - Convert B to integer
  - Bit-wise And A and B
  - Convert result to floating point

---

# Chapter 9: *compress* - Compression

---

## 1. Introduction

---

The `VAL` field of this record refers to an array of length `NSAM`. Unless `INP` is a database link, the compression algorithm is ignored. If, however, `INP` is a database link, then this record type supports several algorithms: `CIRBUF`, `AVERAGE`, `NTO1LOW`, `NTO1HIGH`, and `NTO1AVE`. Each will be discussed separately.

`CIRBUF` keeps a circular buffer of length `NSAM`. Each time the record is processed, it gets the data referenced by `INP` and puts it into the circular buffer referenced by `VAL`. Note that when `INP` refers to a scalar, `VAL` is just a time ordered circular buffer of values obtained from `INP`.

If `AVERAGE` is chosen, then `VAL` refers to an array of length `NSAM` that contains an element by element time average of values taken from the array referenced by `INP`. `N` successive samples of `INP` are averaged in order to compute `VAL`.

If `NTO1LOW`, `NTO1HIGH`, or `NTO1AVE` are chosen, then `VAL` is a circular buffer of length `NSAM`. The actual algorithm depends on whether `INP` references a scalar or an array. If `INP` refers to a scalar, then `N` successive time ordered samples of `INP` are taken. After the `N`th sample is obtained a new value, determined by the algorithm (`LOW`, `HIGH`, or `AVE`), is written to the circular buffer referenced by `VAL`. If `INP` refers to an array, then each time the record is processed, the array referenced by `INP` is obtained, divided into sub-arrays each of length `N`, and the algorithm applied to each sub-array. The result obtained from each subarray is written to the circular buffer referenced by `VAL`.



## 2. Field Summary

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| VAL   | DOUBLE    | No  | 0       | Yes    | Yes    | Yes              | Yes |
| INP   | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| RES   | SHORT     | No  | 0       | Yes    | Yes    | No               | No  |
| ALG   | RECCHOICE | Yes | 0       | Yes    | No     | No               | No  |
| NSAM  | ULONG     | Yes | 1       | Yes    | No     | No               | No  |
| N     | ULONG     | Yes | 1       | Yes    | No     | No               | No  |
| ILIL  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| IHIL  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| HOPR  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| LOPR  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| PREC  | SHORT     | Yes | 0       | Yes    | Yes    | No               | No  |
| EGU   | STRING    | Yes | null    | Yes    | Yes    | No               | No  |
| OFF   | ULONG     | No  | 0       | Yes    | No     | No               | No  |
| NUSE  | ULONG     | No  | 0       | Yes    | No     | No               | No  |
| BPTR  | NOACCESS  | No  | 0       | No     | No     |                  | No  |
| SPTR  | NOACCESS  | No  | 0       | No     | No     |                  | No  |
| WPTR  | NOACCESS  | No  | 0       | No     | No     |                  | No  |
| CVB   | DOUBLE    | No  | 0       | Yes    | No     | No               | No  |
| INX   | ULONG     | No  | 0       | Yes    | No     | No               | No  |

## 3. Field Descriptions

| Name | Summary     | Description                                                                                                         |
|------|-------------|---------------------------------------------------------------------------------------------------------------------|
| VAL  | Value Field | This field is determined as a result of record processing. It is a double precision array of length NSAM.           |
| INP  | Input Link  | INP can be a constant, a database link, or a channel access link. Unless it is a database link, ALG is meaningless. |
| RES  | Reset       | Setting this field causes the algorithm to start over from the beginning.                                           |
| ALG  | Algorithm   | CIRBUF, AVERAGE, NTO1LOW, NTO1HIGH, or NTO1AVE.                                                                     |

| Name | Summary                     | Description                                                                                                                                                                                                                                    |
|------|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NSAM | Number in Sample            | Number of elements in VAL.                                                                                                                                                                                                                     |
| N    | Number                      | Value of N for AVERAGE and NTO1xxx algorithms.                                                                                                                                                                                                 |
| ILIL | Initial Low Interest Value  | Applies to NTO1xxx applied to INP arrays.                                                                                                                                                                                                      |
| IHIL | Initial High Interest Value |                                                                                                                                                                                                                                                |
| HOPR | High Operating Range        | These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are used by record support to honor calls to get_graphic_double or get_control_double. |
| LOPR | Low Operating Range         |                                                                                                                                                                                                                                                |
| PREC | Display Precision           | Precision with which to display VAL. This field is used by record support to supply a value when get_precision is called.                                                                                                                      |
| EGU  | Engineering Units           | ASCII string describing Engineering units. This field is used by record support to supply a units description string when get_units is called.                                                                                                 |
| OFF  | Current Offset              |                                                                                                                                                                                                                                                |
| NUSE | Number Used                 | Number of elements currently stored.                                                                                                                                                                                                           |
| BPTR | Buffer Pointer              | Holds array referenced by VAL                                                                                                                                                                                                                  |
| SPTR | Summing Buffer Pointer      | For array averages.                                                                                                                                                                                                                            |
| WPTR | Work Buffer Pointer         | For dbGetLinks.                                                                                                                                                                                                                                |
| CVB  | Compress Value Buffer       |                                                                                                                                                                                                                                                |
| INX  | Current Index of 1,...,N    |                                                                                                                                                                                                                                                |

#### 4. Record Support Routines

**init\_record** Space for all necessary arrays is allocated. The addresses are stored in the appropriate fields in the record.

**process** See next section.

**special** This routine is called when RSET is set. It performs a reset.

|                           |                                                                                                                                                                                                                                                                                                       |
|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>get_value</b>          | Fills in the values of struct valueDes so that they refer to VAL.                                                                                                                                                                                                                                     |
| <b>cvt_dbaddr</b>         | This is called by dbNameToAddr. It makes the dbAddr structure refer to the actual buffer holding the result.                                                                                                                                                                                          |
| <b>get_array_info</b>     | Obtains values from the circular buffer referenced by VAL.                                                                                                                                                                                                                                            |
| <b>put_array_info</b>     | Writes values into the circular buffer referenced by VAL.                                                                                                                                                                                                                                             |
| <b>get_units</b>          | Retrieves EGU.                                                                                                                                                                                                                                                                                        |
| <b>get_precision</b>      | Retrieves PREC.                                                                                                                                                                                                                                                                                       |
| <b>get_graphic_double</b> | Sets the upper display and lower display limits for a field. If the field is VAL, HIHI, HIGH, LOW, or LOLO, the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.     |
| <b>get_control_double</b> | Sets the upper control and the lower control limits for a field. If the field is VAL, HIHI, HIGH, LOW, or LOLO, the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used. |

---

## 5. Record Processing

---

Routine process implements the following algorithm:

1. If INP is not a database link, check monitors and the forward link and return.
2. Get the current data referenced by INP.
3. Perform the appropriate algorithm:
  - a. AVERAGE: Read N successive instances of INP and perform an element by element average. Until N instances have been obtained it just return without checking monitors or the forward link. When N instances have been obtained complete the algorithm, store the result in the VAL array, check monitors and the forward link, and return.
  - b. CIRBUF: Write the values obtained from INP into the VAL array as a circular buffer, check monitors and the forward link, and return.
  - c. NTOLxxx and INP refers to a scalar: Obtain N successive values from INP and apply the NTOLxxx algorithm to these values. Until N values are obtained monitors and forward links are not checked. When N successive values have been obtained, complete the algorithm, check monitors and the forward link, and return.

- d. `NFO1xxx` and `INP` refers to an array: The `ILIL` and `IHIL` are honored if `ILIL < IHIL`. The input array is divided into subarrays of length `N`. The specified `NFO1xxx` compression algorithm is applied to each subarray and the result stored in the array referenced by `VAL`. The monitors and forward link are checked.
4. If success, set `UDF` to `FALSE`.
  5. Check to see if monitors should be invoked:
    - Alarm monitors are invoked if the alarm status or severity has changed.
    - `NSEV` and `NSTA` are reset to 0.
  6. Scan forward link if necessary, set `PACT` `FALSE`, and return.



---

# Chapter 10: *dfanout*

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## 1. Introduction

---

This record is used to forward data to up to eight other records. It has no associated device support.

---

## 2. Field Summary

---

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| VAL   | LONG      | No  | 0       | Yes    | Yes    | No               | Yes |
| OUTA  | OUTLINK   | Yes | 0       | No     | No     | N/A              | No  |
| OUTB  | OUTLINK   | Yes | 0       | No     | No     | N/A              | No  |
| OUTC  | OUTLINK   | Yes | 0       | No     | No     | N/A              | No  |
| OUTD  | OUTLINK   | Yes | 0       | No     | No     | N/A              | No  |
| OUTE  | OUTLINK   | Yes | 0       | No     | No     | N/A              | No  |
| OUTF  | OUTLINK   | Yes | 0       | No     | No     | N/A              | No  |
| OUTG  | OUTLINK   | Yes | 0       | No     | No     | N/A              | No  |
| OUTH  | OUTLINK   | Yes | 0       | No     | No     | N/A              | No  |
| DOL   | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| OMSL  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| EGU   | STRING    | Yes | Null    | Yes    | Yes    | No               | No  |
| HOPR  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| LOPR  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| HIHI  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| LOLO  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| HIGH  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| LOW   | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| HHSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| LLSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| HSV   | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| LSV   | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| HYST  | DOUBLE    | Yes | 0       | Yes    | Yes    | No               | No  |
| ADEL  | DOUBLE    | Yes | 0       | Yes    | Yes    | No               | No  |
| MDEL  | DOUBLE    | Yes | 0       | Yes    | Yes    | No               | No  |
| LALM  | DOUBLE    | No  | 0       | Yes    | No     | No               | No  |
| ALST  | DOUBLE    | No  | 0       | Yes    | No     | No               | No  |
| MLST  | DOUBLE    | No  | 0       | Yes    | No     | No               | No  |
| SIOL  | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| SIML  | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| SIMM  | GBLCHOICE | No  | 0       | Yes    | Yes    | No               | No  |
| SIMS  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| IVOA  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| IVOV  | DOUBLE    | Yes | 0       | Yes    | Yes    | No               | No  |

### 3. Field Descriptions

| Name             | Summary     | Description                                                                                               |
|------------------|-------------|-----------------------------------------------------------------------------------------------------------|
| VAL              | Value Field | This field is the input value which is used for passing data for all of the output links.                 |
| OUTA,,,,<br>OUTH | Output Link | On processing of this record, each of these links to which another record is connected will be triggered. |

| Name | Summary                              | Description                                                                                                                                                                                                                                                                                                                       |
|------|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DOL  | Desired Output Location (Input Link) | If DOL is a database or channel access link and OMSL is CLOSED_LOOP, then VAL is read from DOL. After the check for drive limits, VAL will be set to the value determined by DOL.                                                                                                                                                 |
| OMSL | Output Mode Select                   | This field has either the value SUPERVISORY or CLOSED_LOOP. DOL is used to determine VAL only if OMSL has the value CLOSED_LOOP. By setting this field the record can be switched between supervisory and closed loop mode of operation. While in closed loop mode, the VAL field cannot be set via dbPuts.                       |
| EGU  | Engineering Units                    | ASCII string describing Engineering units. This field is used by record support to supply a units description string when get_units is called.                                                                                                                                                                                    |
| HOPR | High Operating Range                 | These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are used by record support to honor calls to get_graphic_double or get_control_double. If these values are defined, they must be in the range:<br>DRVL<=LOPR<=HOPR<=DRVH. |
| LOPR | Low Operating Range                  |                                                                                                                                                                                                                                                                                                                                   |
| HIHI | Hihi Alarm Limit                     | These fields specify the alarm limits and severities.                                                                                                                                                                                                                                                                             |
| HIGH | High Alarm Limit                     |                                                                                                                                                                                                                                                                                                                                   |
| LOW  | Low Alarm Limit                      |                                                                                                                                                                                                                                                                                                                                   |
| LOLO | Lolo Alarm Limit                     |                                                                                                                                                                                                                                                                                                                                   |
| HHSV | Hihi Alarm Severity                  |                                                                                                                                                                                                                                                                                                                                   |
| HSV  | High Alarm Severity                  |                                                                                                                                                                                                                                                                                                                                   |
| LSV  | Low Alarm Severity                   |                                                                                                                                                                                                                                                                                                                                   |
| LLSV | Lolo Alarm Severity                  |                                                                                                                                                                                                                                                                                                                                   |
| HYST | Alarm Deadband                       | These parameters specify hysteresis factors for triggering monitor callbacks, i.e. callbacks specified by calls to caAddEvent or dbAddEvent. A monitor will not be triggered until VAL changes by more than the specified amount.                                                                                                 |
| ADEL | Archive Deadband                     |                                                                                                                                                                                                                                                                                                                                   |
| MDEL | Monitor, i.e. value change, Deadband |                                                                                                                                                                                                                                                                                                                                   |
| LALM | Last Alarm Value                     | These fields are used to implement the hysteresis factors for monitors.                                                                                                                                                                                                                                                           |
| ALST | Last Archiver Value                  |                                                                                                                                                                                                                                                                                                                                   |
| MLST | Last Monitored Value                 |                                                                                                                                                                                                                                                                                                                                   |



| Name | Summary                        | Description                                                                                                                                                           |
|------|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SIMM | Simulation Mode                | Simulation mode process variables. Refer to Chapter 3, Section "Simulation Mode" on page 13 for more information.                                                     |
| SIML | Simulation Mode Location       |                                                                                                                                                                       |
| SIOL | Simulation Value Location      |                                                                                                                                                                       |
| SIMS | Simulation Mode Alarm Severity |                                                                                                                                                                       |
| IVOA | Invalid Alarm Output Action    | Whenever the record is put into INVALID alarm severity IVOA specifies an action. See Chapter 3, Section "Invalid Alarm Output Action" on page 14 for more information |
| IVOV | Invalid Alarm Output Value     |                                                                                                                                                                       |

---

## 4. Record Support Routines

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**init\_record**

**process**

See next section.

---

## 5. Record Processing

---

Routine `process` implements the following algorithm:

- 1.

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# Chapter 11: *eg* - Event Generator

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## 1. Introduction

---

The support for the global event system has been designed to allow application developers to control the APS event generator and receiver boards. This is done by the use of four new record types: *eg*, *egevent*, *er*, *erevent*. These records are customized and are only supported by the device support modules for the APS event generator and receiver boards.

The use of the global event system and its associated records should not be confused with the vanilla EPICS events and the associated event records. They are very different.

### **The Event Generator**

The Event Generator is used to generate global event codes and send them out to one or more Event Receivers. A group of interconnected event generators and receivers is referred to as an 'event circuit.' There may be more than one event generator on the same event circuit. And it is possible for a single IOC to be part of multiple event circuits.

### **EG Records**

The *eg* record type is used to select the options of a specific event generator card. In order to properly configure it, you should first be familiar with its operating modes. This is specified in the document "Event System" by Frank Lenksus.

## 2. Field Summary

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| OUT   | OUTLINK   | Yes |         | No     | No     | No               | No  |
| MOD1  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| R1SP  | DOUBLE    | Yes | 0       | Yes    | No     | No               | Yes |
| MOD2  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| R2SP  | DOUBLE    | Yes | 0       | Yes    | No     | No               | Yes |
| LMD1  | RECCHOICE | No  | 0       | Yes    | No     | No               | Yes |
| LMD2  | RECCHOICE | No  | 0       | Yes    | No     | No               | Yes |
| FIFO  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| LFFO  | GBLCHOICE | No  | 0       | Yes    | No     | No               | Yes |
| CLR1  | CHAR      | No  | 0       | Yes    | Yes    | No               | Yes |
| CLR2  | CHAR      | No  | 0       | Yes    | Yes    | No               | Yes |
| TRG1  | CHAR      | No  | 0       | Yes    | Yes    | No               | Yes |
| TRG2  | CHAR      | No  | 0       | Yes    | Yes    | No               | Yes |
| ENAB  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| LENA  | LONG      | No  | 0       | Yes    | No     | No               | Yes |
| TAXI  | LONG      | No  | 0       | Yes    | Yes    | Yes              | No  |
| LTAX  | LONG      | No  | 0       | Yes    | No     | No               | No  |
| VME   | LONG      | No  | 0       | Yes    | Yes    | No               | Yes |
| ETE0  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| ET0   | LONG      | Yes | 0       | Yes    | Yes    | No               | Yes |
| LET0  | LONG      | No  | 0       | Yes    | No     | No               | Yes |
| ETE1  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| ET1   | LONG      | Yes | 0       | Yes    | Yes    | No               | Yes |
| LET1  | LONG      | No  | 0       | Yes    | No     | No               | Yes |
| ETE2  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| ET2   | LONG      | Yes | 0       | Yes    | Yes    | No               | Yes |
| LET2  | LONG      | No  | 0       | Yes    | No     | No               | Yes |
| ETE3  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| ET3   | LONG      | Yes | 0       | Yes    | Yes    | No               | Yes |
| LET3  | LONG      | No  | 0       | Yes    | No     | No               | Yes |

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| ETE4  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| ET4   | LONG      | Yes | 0       | Yes    | Yes    | No               | Yes |
| LET4  | LONG      | No  | 0       | Yes    | No     | No               | Yes |
| ETE5  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| ET5   | LONG      | Yes | 0       | Yes    | Yes    | No               | Yes |
| LET5  | LONG      | No  | 0       | Yes    | No     | No               | Yes |
| ETE6  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| ET6   | LONG      | Yes | 0       | Yes    | Yes    | No               | Yes |
| LET6  | LONG      | No  | 0       | Yes    | No     | No               | Yes |
| ETE7  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| ET7   | LONG      | Yes | 0       | Yes    | Yes    | No               | Yes |
| LET7  | LONG      | No  | 0       | Yes    | No     | No               | Yes |
| VAL   | CHAR      | No  | 0       | Yes    | No     | Yes              | No  |

### 3. Field Descriptions

| Name | Summary               | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OUT  | Output Link           | Specifies the link number of the event generator board. Only the 'Card' value of the link specification is used.                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| MOD1 | Mode Select for RAM 1 | Used to select the operating mode of event sequence RAM1 or RAM2. It is important to know that the configuration of the events in the RAM may not be altered unless it is either 'Off' or in 'Alternate Mode'. Should a configuration attempt be made when the RAM is not in one of these modes, it will be deferred until the RAM mode is changed to either 'Off' or 'Alternate'. When MOD1 is set to alternate from any other mode, MOD2 will also be set to alternate. If MOD1 is changed from alternate to any other mode, MOD2 will be set to off. |
| MOD2 | Mode Select for RAM 2 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| R1SP | RAM 1 Speed           | Event clock 1 rate in Hz. This must be set to the clock rate of the signal source on the Event CLK 1 input. It is only used to calculate the 'desired position' value of events that are placed into the sequence RAM. These events are specified by the use of 'egevent' records. If all 'egevent' record types that use the generator being configured will be using 'Clock Ticks' as their 'Delay Units' the value placed into R1SP is not used and may be left as zero.                                                                             |
| R2SP | RAM 2 Speed           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

| Name | Summary                                | Description                                                                                                                                                                                                                                                     |
|------|----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| LMD1 | Last Operating Mode 1                  |                                                                                                                                                                                                                                                                 |
| LMD2 | Last Operating Mode 2                  |                                                                                                                                                                                                                                                                 |
| FIFO | FIFO Enable                            | Used to enable or disable the input-fifo on the generator board. The fifo is used to allow more than one event generator to exist on the same fiber-optic line.                                                                                                 |
| LFFO | Last FIFO Enable                       |                                                                                                                                                                                                                                                                 |
| CLR1 | Clear RAM 1                            | Performing a 'put' operation on this field causes sequence RAM1 or RAM2 to be cleared. The use of this field is undefined (and will cause great problems) if there are any 'egevent' records configured in the database. This is provided for testing purposes. |
| CLR2 | Clear RAM 2                            |                                                                                                                                                                                                                                                                 |
| TRG1 | Manual Trigger RAM 1                   | If a 'put' operation is performed on this field, a one-time trigger on sequence RAM1 or RAM2 will be initiated. The result would be that same as if there were a hardware trigger applied to the 'Event TRG1' input on the card.                                |
| TRG2 | Manual Trigger RAM 2                   |                                                                                                                                                                                                                                                                 |
| ENAB | Master Enable                          | Master card enable. No events are generated unless the card is enabled. In general, there should never be any reason to disable an event generator. This is provided for testing purposes.                                                                      |
| LENA | Last Master Enable                     |                                                                                                                                                                                                                                                                 |
| TAXI | Taxi Violation Flag                    | This is set to a non-zero value when there has been a taxi violation. It simply reflects that state of the violation signal on the taxi receiver module. Taxi violations can not occur when FIFO is set to 'OFF.'                                               |
| LTAX | Last Taxi Violation                    |                                                                                                                                                                                                                                                                 |
| VME  | Manual Event Generation via VME Access | Used to send out a one-shot event code. A put to this field will cause the event to be sent. It appears to be zero if it is ever read. This can be 'OUT-LINKed' to by an other record in order to generate an arbitrary event when it is processed.             |
| ETEn | Event Trigger Enable                   | (n=0-7) These are the enables for the trigger event inputs on the card. They must be set to 'On' in order to send the trigger event codes.                                                                                                                      |
| ETn  | Event Trigger                          | (n=0-7) These are used to program the event codes that correspond to the trigger event inputs on the card.                                                                                                                                                      |
| LETn | Last Trigger Event                     | (n=0-7)                                                                                                                                                                                                                                                         |
| VAL  | Value                                  | Not Used.                                                                                                                                                                                                                                                       |

---

## 4. Record Processing

---

It is intended that `eg` records be set to passive processing only. They are not altered by the device support code in response to being processed. Their purpose is only to specify the operating modes of the event generator and, as such, are processed if and when a value in it is altered by a `put` operation. To start things going, however, they should have their `'process at init'` flag set to `YES`.

As an observation, it is not advisable to alter the `R1SP` or `R2SP` fields. You may, but then all related `egevent` records must be processed again, in order to recalculate their desired position values. The `MOD1` and `MOD2` fields can also cause some nasty side effects if they are altered between any two non-off modes. In general, the operating mode should be set to `OFF` and then to some other mode if it is desired to switch between two modes.

---

## 5. Device Support

---

The device support module for the event generator may be used by `eg` and `egevent` record types.

In order to configure the event generator device support, a call must be made to set the address for each of the event generator cards present in the IOC. This configuration call is as follows:

```
EgConfigure(<card number>, <Base address in A16>)
```

The `<card number>` field may be 0-4 and is used to specify which card is to be configured. This is the card number that is referenced in the `eg` and `egevent` records when building the database. The `<Base address in A16>` field is a 16-bit number that represents the address of the card in the A16 memory space.

Database records that specify card numbers that are not configured will generate 'bad field' errors when they are initialized by `iocInit`. And will then be ignored by the event generator device support if ever processed.

---

## 6. Event Records

---

The regular EPICS event records may be used when it is desired to cause a record to process upon a given event code by the global event system. This is accomplished by configuring an event record (the regular EPICS event record) and selecting the APS event receiver for the `DTYPE` field. The card and signal are then used to select the event receiver card and event number, respectively. Any time the event number specified is received by the event receiver, that event record will be processed.

This is the only relationship between the vanilla EPICS event codes (and their associated records) and the global APS event system.

## 7. Event System Observations

---

This section describes a few observations that would otherwise be left to experimentation for the user figure out. Much of the annoyances described here have been left in the system because there are simple work arounds, or they represent situations that should never be encountered on a running system.

### Event Generator Sequence RAM Modes

It is intended that the modes of the eg never be altered. It was considered that the MOD1 and MOD2 fields be made SPC\_NOMOD fields. But, during the system testing of the event hardware itself, it became useful to be able to make adjustments to the operating mode. Thus the ability to change the mode was put into the record and device support. However, exactly what is done when the mode is changed is probably not useful to the database designer.

First of all, remember that the sequence RAMS can not be updated unless they are either in ALT mode or OFF. This is due to the hardware constraints. In order to alter a sequence RAM that is not set to ALT or OFF, the RAM must be changed to one of those modes, altered, and then reset back to the desired mode. (No it is not reasonable to do this automatically.) Should the mode be carelessly altered, the EG card will have the mode updated, but the sequence RAM(s) will not be updated again until the mode is set to ALT or OFF. (In an actual application program, it is not reasonable to think that the operating modes of the sequence RAMS will be changed.)

Unless you have a strong need to use more than one sequence RAM at the same time, it is strongly recommended that the ALT mode be used. This is so that you may alter the event positions on the fly when debugging.

### EGevent Records

The delay selected in an egevent record is done by specifying the desired period of delay. The period is converted to clock ticks by the use of the R1SP and R2SP values specified in the eg record. Since only one event code may be in any single sequence RAM position at any given time, any collisions are resolved at RAM load time by scanning for the 'next' unused position. Thus it is possible that the same database end up loading the RAMS in two different images depending on the order that the records get processed (that earlier records get higher priority.) If this causes problems, it is recommended that the units of delay be specified in 'clock ticks' and that the same delay values not be used in multiple records.

The use of 'clock ticks' as the delay units specification will eliminate the rounding caused by the conversion from alternate units into clock ticks.

### ER Interrupts

It should be obvious that the event system is capable of generating VME interrupts at a rate that far exceeds the CPU's ability to process them. Much care should be put into the design of the databases that control the event system so that this does not happen. It has been observed that when such a problem does occur, vxWorks dies and prints "Work queue overflow" on its console.

## 8. Example Database for Global Time Synchronization

This section describes a few example database records that are used to set up the event system. The records shown here are those used by the global synchronous timing system. This provides a good example of event generation from database records as well as from trigger inputs. It also includes a heartbeat generator that is required by the event system itself.

### Timing System Overview

The example timing system uses a free running 1000 hertz clock. This clock is input on the TRG0 line of the EG card on the master timing IOC. Each time the TRG0 input is pulsed, an Increment Time Stamp (0x7C) event should be sent out so that the ER cards can update their notion of the time.

Additionally, the timing system has to take care of high order counter truncation and slave resynchronization. This is handled by the use of the Reset Time Stamp Counters (0x7D) event (the processing of the time stamp information is described in more detail in the document on the global timing system.)

### Event Generator Database Records

The records related to the event generator card are used to initialize and generate events. The eg record used on the timing system master is:

```
record(eg, "$(prefix)_eg")
(
 field(DESC, "")
 field(ASG, "")
 field(SCAN, "Passive")
 field(PINI, "YES")
 field(PHAS, "0")
 field(EVNT, "0")
 field(TSE, "0")
 field(TSEL, "0")
 field(DTYP, "APS event generator G")
 field(DISV, "1")
 field(SDIS, "0")
 field(DISS, "NO_ALARM")
 field(PRIO, "LOW")
 field(FLNK, "0")
 field(OUT, "#C0 S0 @")
 field(MOD1, "Off")
 field(R1SP, "0")
 field(MOD2, "Off")
 field(R2SP, "0")
 field(FIFO, "NO")
 field(ENAB, "YES")
 field(ETE0, "YES")
 field(ET0, "0x7c")
 field(ETE1, "NO")
 field(ET1, "0x0")
 field(ETE2, "NO")
 field(ET2, "0x0")
 field(ETE3, "NO")
 field(ET3, "0x0")
 field(ETE4, "NO")
 field(ET4, "0x0")
 field(ETE5, "NO")
 field(ET5, "0x0")
 field(ETE6, "NO")
 field(ET6, "0x0")
 field(ETE7, "NO")
 field(ET7, "0x0")
)
```



The important items of note are that ENAB is YES, ETE0 is YES, ET0 is set to 0x7C, and that the record be set to process at init time. The scan should always be set to passive since it only makes sense to process the record when the field values change.

In order to take care of the heart beat (0x7A) and time stamp reset/resync (0x7D) events, longout records are used that have their output links pointed to the VME field on the above eg record. When they are processed, the VAL field of the longout record is sent out on the event system.

```
record(longout, "${prefix}_hbeat")
(
 field(DESC, "")
 field(ASG, "")
 field(SCAN, "1 second")
 field(PINI, "NO")
 field(PHAS, "0")
 field(EVNT, "0")
 field(TSE, "0")
 field(TSEL, "0")
 field(DTYP, "Soft Channel")
 field(DISV, "1")
 field(SDIS, "0")
 field(DISS, "NO_ALARM")
 field(PRIO, "LOW")
 field(FLNK, "0")
 field(OUT, "${prefix}_eg.VME PP NMS")
 field(DOL, "122")
 field(OMSL, "supervisory")
 field(EGU, "rocks")
 field(HOPR, "0")
 field(LOPR, "0")
 field(HIHT, "0")
 field(LOLO, "0")
 field(HIGH, "0")
 field(LOW, "0")
 field(HHSV, "NO_ALARM")
 field(LLSV, "NO_ALARM")
 field(HSV, "NO_ALARM")
 field(LSV, "NO_ALARM")
 field(HYST, "0")
 field(ADEL, "0")
 field(MDEL, "0")
 field(SIOL, "0")
 field(SIML, "0")
 field(SIMS, "NO_ALARM")
 field(IVOA, "Continue normally")
 field(IVOV, "0")
)

record(longout, "${prefix}_resync")
(
 field(DESC, "")
 field(ASG, "")
 field(SCAN, "10 second")
 field(PINI, "NO")
 field(PHAS, "0")
 field(EVNT, "0")
 field(TSE, "0")
 field(TSEL, "0")
 field(DTYP, "Soft Channel")
 field(DISV, "1")
 field(SDIS, "0")
 field(DISS, "NO_ALARM")
 field(PRIO, "LOW")
 field(FLNK, "0")
 field(OUT, "${prefix}_eg.VME PP MS")
)
```

```

 field(DOL, "125")
 field(OMSL, "supervisory")
 field(EGU, "rocks")
 field(HOPR, "0")
 field(LOPR, "0")
 field(HIHI, "0")
 field(LOLO, "0")
 field(HIGH, "0")
 field(LOW, "0")
 field(HHSV, "NO_ALARM")
 field(LLSV, "NO_ALARM")
 field(HSV, "NO_ALARM")
 field(LSV, "NO_ALARM")
 field(HYST, "0")
 field(ADEL, "0")
 field(MDEL, "0")
 field(SIOL, "0")
 field(SIML, "0")
 field(SIMS, "NO_ALARM")
 field(IVOA, "Continue normally")
 field(IVOV, "0")
 }

```

There should be nothing interesting about the longout records described above. The only important thing is that they properly point to the VME field of the eg record.

### *Event Receiver Database Records*

The records used in the event receiver database are used to initialize the event receiver card. The er record used in the receiver database is:

```

record(er, "$(prefix)_ER")
 {
 field(DESC, "")
 field(ASG, "")
 field(SCAN, "Passive")
 field(PINI, "YES")
 field(PHAS, "0")
 field(EVNT, "0")
 field(TSE, "0")
 field(TSEL, "0")
 field(DTYP, "APS event receiver")
 field(DISV, "1")
 field(SDIS, "0")
 field(DISS, "NO_ALARM")
 field(PRIO, "LOW")
 field(FLNK, "0")
 field(OUT, "#C0 S0 @")
 field(ENAB, "YES")
 field(TRG0, "Disabled")
 field(TRG1, "Disabled")
 field(TRG2, "Disabled")
 field(TRG3, "Disabled")
 field(TRG4, "Disabled")
 field(TRG5, "Disabled")
 field(TRG6, "Disabled")
 field(OTP0, "Disabled")
 field(OTP1, "Disabled")
 field(OTP2, "Disabled")
 field(OTP3, "Disabled")
 field(OTP4, "Disabled")
 field(OTP5, "Disabled")
 field(OTP6, "Disabled")
 field(OTP7, "Disabled")
 field(OTP8, "Disabled")
 field(OTP9, "Disabled")
 field(OTPA, "Disabled")
 field(OTPB, "Disabled")
 }

```

```
field(OTPC, "Disabled")
field(OTPD, "Disabled")
field(OTL0, "Disabled")
field(OTL1, "Disabled")
field(OTL2, "Disabled")
field(OTL3, "Disabled")
field(OTL4, "Disabled")
field(OTL5, "Disabled")
field(OTL6, "Disabled")
field(DGOE, "Disabled")
field(DGOD, "0")
field(DGOW, "0")
field(DG1E, "Disabled")
field(DG1D, "0")
field(DG1W, "0")
field(DG2E, "Disabled")
field(DG2D, "0")
field(DG2W, "0")
field(DG3E, "Disabled")
field(DG3D, "0")
field(DG3W, "0")
}
```

Much like the eg record, the only interesting to note is that this record is passive and processed at init time.

Now, in order to cause an IRQ to occur when the reset/resync time stamp event is received, we use the following erevent record:

```
record(erevent, "$(prefix)_erevent7d")
{
 field(DESC, "")
 field(ASG, "")
 field(SCAN, "Passive")
 field(PINI, "YES")
 field(PHAS, "0")
 field(EVNT, "0")
 field(TSE, "0")
 field(TSEL, "0")
 field(DTYP, "APS event receiver")
 field(DISV, "1")
 field(SDIS, "0")
 field(DISS, "NO_ALARM")
 field(PRIO, "LOW")
 field(FLNK, "0")
 field(OUT, "#C0 S0 @")
 field(ENAB, "Enabled")
 field(ENM, "0x7d")
 field(OUT0, "Disabled")
 field(OUT1, "Disabled")
 field(OUT2, "Disabled")
 field(OUT3, "Disabled")
 field(OUT4, "Disabled")
 field(OUT5, "Disabled")
 field(OUT6, "Disabled")
 field(OUT7, "Disabled")
 field(OUT8, "Disabled")
 field(OUT9, "Disabled")
 field(OUTA, "Disabled")
 field(OUTB, "Disabled")
 field(OUTC, "Disabled")
 field(OUTD, "Disabled")
 field(VME, "Enabled")
}
```

Interesting points here are that the output link field points to the same ER card as the above er record. The event number specified in the ENM field is the reset/resync time stamp event, and we can see that the VME field is set to `ENABLED`. This does nothing more than to tell the ER card that we want an IRQ on event number `0x7D`. Note that we could also have turned on any of the output pulse/level outputs as well.

We need not include a record to enable anything on the increment time stamp or heart beat events as they are handled by the ER card automatically.

Exactly what happens when the IRQ arrives for event `0x7D` is described in detail in the global timing documentation. Suffice it to say that the timing system registers a callback with the event receiver driver that gets called upon receipt of the event.

Should you desire to process a database record upon the receipt of an event (in this case event number `0x7D`) you may use a regular EPICS event record and set it up like this:

```
record(event, "$(prefix)_event")
{
 field(DESC, "")
 field(ASG, "")
 field(SCAN, "Passive")
 field(PINI, "NO")
 field(PHAS, "0")
 field(EVNT, "0")
 field(TSE, "0")
 field(TSEL, "0")
 field(DTYP, "APS event receiver")
 field(DISV, "1")
 field(SDIS, "0")
 field(DISS, "NO_ALARM")
 field(PRIO, "LOW")
 field(FLNK, "$(prefix)_calc1.PROC PP MS")
 field(INP, "#C0 S125 @")
 field(SIOL, "0")
 field(SIML, "0")
 field(SIMS, "NO_ALARM")
}
```

Interesting tidbits here are that the record's `INP` link is set to the ER card, the signal number is set to the event number of interest, and that the forward link field be set to the record you wish to process upon receipt of the event code. Remember also that the VME interrupt must be enabled for the desired event code (in this case, `125 (0x7D)`) by the use of an erevent record type for the same event number, that has the `VME` field set to `ENABLED`.

## 9. Event System Observations

This section describes those items that might otherwise be overlooked by the overwhelming detail of the record support fields. Here we provide a simple overview of the ways events can be generated by the EG card and what can be done with them by the ER card.

## Event Generator Input Sources

### *50 ohm Trigger Inputs*

The Event Generator hardware can generate event codes from 50 ohm input sources. The event codes generated are configured in the `ET0-ETn` fields and enabled by the `ETE0-ETEn` fields in the event generator record. The trigger inputs are edge sensitive and generate the event code placed in the corresponding `ETn` field of the EG record.

### *Software (EG records)*

It is possible to generate any event code at any time by writing it to the `VME` field of the eg record. The `VME` field has a 'write-only' kind-of operation. Reading it will always return the value zero and not cause any events to be transmitted.

### *Sequence RAMs*

The sequence RAMs are programmed by the use of the `egevent` records. Each record represents a single event code that is placed into a sequence RAM. The record describes the event code number and its position in the RAM (in terms of time offset from trigger.) If the RAM is enabled in the eg record, and a trigger is present (either 50 ohm input or by writing a value to the eg records `TRGn` field) the sequence RAM will be cycled thru and the present events will be sent out.

## Event Receiver Outputs

The event receiver has many output configurations available. This section provides an overview of each one.

### *One Time Output Pulse*

Any given event can generate a one-time one microsecond output pulse if the output pulse enable is set for the desired signal in the `er` record and the related trigger bits are set in the mapping RAM via an `erevent` record.

### *Programmable Delay and Width Pulse*

Any given event that is received can cause a pulse to be generated after a specified delay, and last for a specified width. The `delay` and `width` values are specified for the desired signal by the `er` record's `DGnD` and `DGnW` fields. It has to be enabled by the use of the `DGnE` field as well and the corresponding bits have to be set in the mapping RAM by the use of `erevent` records.

### *Level Outputs*

Any pair of events may be used to toggle an output signal by enabling it in the `er` record and by setting the corresponding bits in the mapping RAM by use of `erevent` records.

### *Special One Time Output Pulse*

These outputs are designed such that if the event code has its high order bit set, the seven low order bits are presented on these output lines as 1 microsecond pulses. The idea here is that you can have up to seven pulses generated simultaneously. This mode is NOT configurable, but can be enabled on a per-bit basis.

### *VME Interrupt and Record Processing*

The `er` board is capable of generating a VME interrupt upon receipt of an event code. This is enabled via an `erevent` record that has the `VME` field enabled. When this is done, a regular EPICS event record can be processed when the IRQs are received. The event record to be processed has to have its scan rate set to "I/O Intr" mode. The card and signal fields in the event record's link are used to specify the ER card number and the event number that is to cause the record to be processed.

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# Chapter 12: *egevent* - Event Generator Event

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## 1. Introduction

---

The support for the global event system has been designed to allow an application developer to control the APS event generator and receiver boards. This is done by the use of four new record types: `eg`, `egevent`, `er`, `erevent`. These records are customized and are only supported by the device support modules for the APS event generator and receiver boards.

For more detailed information on the APS event generator and receiver records refer to Chapter 11 on page 65.

### **The Event Generator**

The Event Generator is used to generate global event codes and send them out to one or more Event Receivers. A group of interconnected event generators and receivers is referred to as an 'event circuit.' There may be more than one event generator on the same event circuit. And it is possible for a single IOC to be part of multiple event circuits.

### **EGEVENT Records**

The `egevent` record is used in conjunction with an `eg` record in order to specify a single event that is to be placed into a sequence RAM. The event code and its time displacement from the trigger are specified in this record.

## 2. Field Summary

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| OUT   | OUTLINK   | Yes | 0       | No     | No     | No               | No  |
| ENM   | LONG      | Yes | 0       | Yes    | Yes    | No               | Yes |
| LEVT  | LONG      | No  | 0       | Yes    | No     | No               | Yes |
| RAM   | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| LRAM  | RECCHOICE | No  | 0       | Yes    | No     | No               | Yes |
| DELY  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| ADLY  | FLOAT     | No  | 0       | Yes    | No     | No               | No  |
| DPOS  | LONG      | No  | 0       | Yes    | No     | No               | No  |
| APOS  | LONG      | No  | 0       | Yes    | No     | No               | No  |
| LDLY  | FLOAT     | No  | 0       | Yes    | No     | No               | No  |
| UNIT  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| VAL   | CHAR      | No  | 0       | Yes    | No     | Yes              | No  |
| ELN   | NOACCESS  | No  | 12      | No     | No     | No               | No  |
| SELF  | NOACCESS  | No  | 4       | No     | No     | No               | No  |

## 3. Field Descriptions

| Name | Summary                | Description                                                                                                                                                                                       |
|------|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OUT  | Output Link            | Used to specify what event generator link that this event is related to. Only the Card number is used                                                                                             |
| ENM  | Event Number           | The event number that is to be placed into the sequence RAM.                                                                                                                                      |
| LEVT | Last Event Number      |                                                                                                                                                                                                   |
| RAM  | Sequence RAM Specifier | Which RAM the event is to be placed into. (Ignored when the generator is in 'Alternate' mode.)                                                                                                    |
| LRAM | Last RAM               |                                                                                                                                                                                                   |
| DELY | Desired Delay          | The desired time delay between the trigger that starts the RAM sequence and when this event should be sent. This field must be expressed in the units selected in the UNIT field described below. |

| Name | Summary               | Description                                                                                                                                                                                                                             |
|------|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ADLY | Actual Delay          | This is a read-only field that is set to the actual delay value after accounting for rounding caused by the clock resolution as well as collisions that can occur if more than one event is placed into the same sequence RAM location. |
| DPOS | Desired Position      | This is a read-only field that represents desired position in the sequence RAM that the event should be placed. It is expressed in clock ticks.                                                                                         |
| APOS | Actual Position       | This is a read-only field that represents the actual position in the sequence RAM that the event is placed. It is expressed in clock ticks.                                                                                             |
| LDLY | Last Desired Delay    |                                                                                                                                                                                                                                         |
| UNIT | Delay Specifier Units | The time units used to express the delay value in the DELY and ADLY fields.                                                                                                                                                             |
| VAL  | Value Field           | Not used.                                                                                                                                                                                                                               |
| ELN  | List Node             |                                                                                                                                                                                                                                         |
| SELF | Self Pointer          |                                                                                                                                                                                                                                         |

#### 4. Record Processing

It is intended that egevent records be set to passive processing only. They are not altered by the device support code in response to being processed. Their purpose is only to specify the desired position and code of an event in a sequence RAM. The read-only fields will be updated as necessary when ever the sequence RAM is reloaded. To start things going, however, they should have their 'process at init' flag set to YES.

Sequence RAMs are reloaded when ever any of the egevent records related to it has its DELY, ENM or UNIT values changed. It is not advisable to alter the UNIT field unless the associated sequence RAM mode is set to 'Off'.

#### 5. Device Support

The device support module for the event generator may be used by eg and egevent record types.

In order to configure the event generator device support, a call must be made to set the address for each of the event generator cards present in the IOC. This configuration call is as follows:

```
EgConfigure(<card number>, <Base address in A16>)
```

The <card number> field may be 0-4 and is used to specify which card is to be configured. This is the card number that is referenced in the eg and egevent records when building the database. The <Base address in A16> field is a 16-bit number that represents the address of the card in the A16 memory space.



Database records that specify card numbers that are not configured will generate 'bad field' errors when they are initialized by `iocInit`. And will then be ignored by the event generator device support if ever processed.

---

# Chapter 13: *er* - Event Receiver

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## 1. Introduction

---

The support for the global event system has been designed to allow an application developer to control the APS event generator and receiver boards. This is done by the use of four new record types: eg, egevent, er, erevent. These records are customized and are only supported by the device support modules for the APS event generator and receiver boards.

For more detailed information on the APS event generator and receiver records refer to Chapter 11 on page 65.

### ER Records

The *er* record type is used to select the options of a specific event receiver card. In order to properly configure it, you should first be familiar with its operating modes. This is specified in the document "Event System" by Frank Lenksus.

---

## 2. Field Summary

---

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| VAL   | CHAR      | No  | 0       | Yes    | No     | Yes              | No  |
| OUT   | OUTLINK   | Yes | 0       | No     | No     | No               | No  |
| ENAB  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| TAXI  | LONG      | No  | 0       | Yes    | No     | Yes              | No  |
| LTAX  | LONG      | No  | 0       | Yes    | No     | No               | No  |

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| TRG0  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| TRG1  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| TRG2  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| TRG3  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| TRG4  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| TRG5  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| TRG6  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OTP0  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OTP1  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OTP2  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OTP3  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OTP4  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OTP5  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OTP6  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OTP7  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OTP8  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OTP9  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OTPA  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OTPB  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OTPC  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OTPD  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OTL0  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OTL1  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OTL2  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OTL3  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OTL4  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OTL5  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OTL6  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| DGCM  | LONG      | No  | 0       | Yes    | No     | No               | No  |
| DG0E  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| DG0D  | USHORT    | Yes | 0       | Yes    | Yes    | No               | Yes |
| DG0W  | USHORT    | Yes | 0       | Yes    | Yes    | No               | Yes |

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| DG1E  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| DG1D  | USHORT    | Yes | 0       | Yes    | Yes    | No               | Yes |
| DG1W  | USHORT    | Yes | 0       | Yes    | Yes    | No               | Yes |
| DG2E  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| DG2D  | USHORT    | Yes | 0       | Yes    | Yes    | No               | Yes |
| DG2W  | USHORT    | Yes | 0       | Yes    | Yes    | No               | Yes |
| DG3E  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| DG3D  | USHORT    | Yes | 0       | Yes    | Yes    | No               | Yes |
| DG3W  | USHORT    | Yes | 0       | Yes    | Yes    | No               | Yes |

### 3. Field Descriptions

| Name | Summary                     | Description                                                                                                                                                       |
|------|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OUT  | Output Link                 | Used to specify which event receiver board is represented by this record.                                                                                         |
| ENAB | Master Enable               | Master card enable. No events will be received if the card is disabled.                                                                                           |
| TAXI | Taxi Violation Flag         | Set to a non-zero value if there is a taxi violation on the event receiver board.                                                                                 |
| LTAX | Last Taxi Violation         |                                                                                                                                                                   |
| TRGn | Trigger Enable              | (n=0-6) Trigger event enables. Setting these allows the corresponding bit to be set on the event receiver.                                                        |
| OTPN | One Time Pulse Enable       | (n=0-D) Setting these allows the corresponding bit to be set in the event receiver.                                                                               |
| OTLn | Output Level Enable         | (n=0-6) Output level enables. Setting these allows the corresponding bit to be set in the event receiver.                                                         |
| DGCM | Delay Generator Change Mask |                                                                                                                                                                   |
| DGnE | Delay Generator Enable      | (n=1-3) Programmable pulse delay enables.                                                                                                                         |
| DGnD | Delay Generator Delay Value | (n=1-3) Delay value used for the programmable pulse delay outputs. These values must be expressed in 10-mHz clock periods and has no other selectable resolution. |
| DGnW | Delay generator Width Value | (n=1-3) Width of the programmable pulse. These values must be expressed in 10-mHz clock periods.                                                                  |
| VAL  | Value Field                 | Not used.                                                                                                                                                         |

## 4. Record Processing

---

It is intended that er records be set to passive processing only. They are not altered by the device support code in response to being processed. Their purpose is only to specify the operating modes of the event receiver and, as such, are processed if and when a value in it is altered by a put operation. To start things going, however, they should have their 'process at init' flag set to YES.

## 5. Device Support

---

The device support for the event receiver may be used by er, erevent and event record types.

In order to configure the event receiver device support, a call must be made to set the address for each of the event receiver cards present in the IOC. This configuration call is as follows:

```
ErConfigure(<card>, <A16 board address>, <IRQ Vector>, <IRQ Level>)
```

Where <card> is the card to be configured, <A16 board address> is the 16-bit address of the board in A16 space, <IRQ Vector> is the vector number to use when generating VME interrupts, and <IRQ Level> is the VME backplane.

---

# Chapter 14: erevent - Event Receiver Event

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## 1. Introduction

---

The support for the global event system has been designed to allow an application developer to control the APS event generator and receiver boards. This is done by the use of four new record types: eg, egevent, er, erevent. These records are customized and are only supported by the device support modules for the APS event generator and receiver boards.

For more detailed information on the APS event generator and receiver records refer to Chapter 11 on page 65.

### **EREVENT Records**

The erevent records are used to specify what bits are to be set in the event receiver mapping RAM. The use of these bits depend on the which outputs are enabled on the event receiver card (specified in the er record.) Additionally, this record type is used to select the VME interrupt and time-latch option.

---

## 2. Field Summary

---

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| VAL   | CHAR      | No  | 0       | Yes    | No     | Yes              | No  |
| OUT   | OUTLINK   | Yes | 0       | No     | No     | No               | No  |
| ENAB  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| ENM   | LONG      | Yes | 0       | Yes    | Yes    | No               | Yes |
| LENM  | LONG      | No  | 0       | Yes    | No     | No               | Yes |
| LOUT  | LONG      | No  | 0       | Yes    | No     | No               | Yes |
| OUT0  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OUT1  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OUT2  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OUT3  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OUT4  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OUT5  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OUT6  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OUT7  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OUT8  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OUT9  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OUTA  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OUTB  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OUTC  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| OUTD  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| VME   | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |

### 3. Field Descriptions

| Name | Summary                 | Description                                                                                                    |
|------|-------------------------|----------------------------------------------------------------------------------------------------------------|
| OUT  | Output Link             | Specifies the card containing the mapping RAM to be programmed.                                                |
| ENAB | Event Enable            | Enables the operation of this record. If this is set to 'Disabled', then the values in the record are ignored. |
| ENM  | Event Number            | The event number to be described. This indicates the position in the mapping RAM that is to be programmed.     |
| LENM | Last Event Number       |                                                                                                                |
| LOUT | Last Output Enable Mask |                                                                                                                |

| Name | Summary              | Description                                                                                                                                                                                                                                                                                                     |
|------|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OUTn | Output Enable        | (n=0-D) May be set to 'Enable' or 'Disable' in order to set or clear the corresponding bit in the mapping RAM. The meanings of these bits depend on what outputs are enabled on the event receiver board (selected in the related er record) and are described in the document "Event System" by Frank Lenksus. |
| VME  | VME Interrupt Enable | May be set to 'Enable' or 'Disable' in order to select a VME interrupt upon the occurrence of event ENM. The time is automatically latched when the VME interrupt is generated.                                                                                                                                 |
| VAL  | Value Field          | Not used.                                                                                                                                                                                                                                                                                                       |

#### 4. Record Processing

It is intended that erevent records be set to passive processing only. They are not altered by the device support code in response to being processed. Their purpose is only to specify the desired actions to be performed upon receipt of a specific event code. To start things going, however, they should have their 'process at init' flag set to YES.

#### 5. Device Support

The device support for the event receiver may be used by er, erevent and event record types.

In order to configure the event receiver device support, a call must be made to set the address for each of the event receiver cards present in the IOC. This configuration call is as follows:

```
ErConfigure(<card>, <A16 board address>, <IRQ Vector>, <IRQ Level>)
```

Where <card> is the card to be configured, <A16 board address> is the 16-bit address of the board in A16 space, <IRQ Vector> is the vector number to use when generating VME interrupts, and <IRQ Level> is the VME backplane.





---

# Chapter 15: Event

---

## 1. Introduction

---

The normal use for this record type is to post an event and/or process a forward link. Device support for this record can provide a hardware interrupt handler routine for I/O Event scanned records.

---

## 2. Field Summary

---

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP |
|-------|-----------|-----|---------|--------|--------|------------------|----|
| VAL   | SHORT     | Yes | 0       | Yes    | Yes    | Yes              | No |
| INP   | INLINK    | Yes | 0       | No     | No     | N/A              | No |
| SIOL  | INLINK    | Yes | 0       | No     | No     | N/A              | No |
| SVAL  | USHORT    | No  | 0       | Yes    | Yes    | No               | No |
| SIML  | INLINK    | Yes | 0       | No     | No     | N/A              | No |
| SIMM  | GBLCHOICE | No  | 0       | Yes    | Yes    | No               | No |
| SIMS  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No |

### 3. Field Descriptions

| Name | Summary                        | Description                                                                                                                                           |
|------|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| VAL  | Value Field                    | Event number to post.                                                                                                                                 |
| INP  | Input Link                     | This field is used by the device support routines to obtain input. For soft records, it can be a constant, a database link, or a channel access link. |
| SIMM | Simulation Mode                | Simulation mode process variables. Refer to Chapter 3, Section "Simulation Mode" on page 11 for more information.                                     |
| SIML | Simulation Mode Location       |                                                                                                                                                       |
| SVAL | Simulation Value               |                                                                                                                                                       |
| SIOL | Simulation Value Location      |                                                                                                                                                       |
| SIMS | Simulation Mode Alarm Severity |                                                                                                                                                       |

### 4. Record Support Routines

#### init\_record

This routine initializes `SIMM` with the value of `SIML` if `SIML` type is `CONSTANT` link or creates a channel access link if `SIML` type is `PV_LINK`. `SVAL` is likewise initialized if `SIOL` is `CONSTANT` or `PV_LINK`.

If device support includes `init_record`, it is called.

#### process

See next section.

#### get\_value

Fills in the values of struct `valueDes` so that they refer to `VAL`.

### 5. Record Processing

Routine `process` implements the following algorithm:

1. `readValue` is called. See Chapter 3, Section "Simulation Mode" on page 11 for details.
2. If `PACT` has been changed to `TRUE`, the device support read routine has started but has not completed reading a new input value. In this case, the processing routine merely returns, leaving `PACT TRUE`.
3. If `VAL > 0`, post event number `VAL`.
4. Check to see if monitors should be invoked. Alarm monitors are invoked if the alarm status or severity has changed. `NSEV` and `NSTA` are reset to 0.

5. Scan forward link if necessary, set `PACT FALSE`, and return.

## 6. Device Support

### Fields Of Interest To Device Support

Each record must have an associated set of device support routines. The device support routines are primarily interested in the following fields:

| Name | Summary            | Description                                                                                                                |
|------|--------------------|----------------------------------------------------------------------------------------------------------------------------|
| PACT | Processing Active  | See Chapter 2, Section "Database Common: Field Descriptions" on page 5 for descriptions.                                   |
| DPVT | Device Private     |                                                                                                                            |
| UDF  | VAL Undefined      |                                                                                                                            |
| NSEV | New Alarm Severity |                                                                                                                            |
| NSTA | New Alarm Status   |                                                                                                                            |
| INP  | Input Link         | This field is used by the device support routines to locate its input.                                                     |
| PRIO | Priority           | This value must be used by the device support interrupt handler to set the scheduling priority for processing this record. |

### Device Support Routines

Device support consists of the following routines:

*report*

```
report(FILE fp, interest)
```

Not currently used.

*init*

```
init()
```

This routine is called once during IOC initialization.

*init\_record*

```
init_record(precord)
```

This routine is optional. If provided, it is called by the record support `init_record` routine.

*get\_ioint\_info*

```
get_ioint_info(int cmd, struct dbCommon *precord, IOSCANPVT *ppvt)
```

This routine is called by the `ioEventScan` system each time the record is added or deleted from an I/O event scan list. `cmd` has the value (0,1) if the record is being (added to, deleted from) an I/O event list. It must be provided for any device type that can use the `ioEvent` scanner.

*read\_event*

```
read_event(precord)
```

This routine returns the following values:

- **0:** Success.
- **Other:** Error.

---

## 7. Device Support For Soft Records

---

A soft device support module is provided. The INP link type must be either `CONSTANT`, `DB_LINK`, or `CA_LINK`.

If the INP link type is `CONSTANT`, then the constant value is stored into `VAL` by `init_record`, and `UDF` is set to `FALSE`. If the INP link type is `PV_LINK`, then `dbCaAddInlink` is called by `init_record`.

`read_event` calls `recGblGetLinkValue` to read the current value of `VAL`. See Chapter 3, Section "Soft Input" on page 10 for details.

If the return status of `recGblGetLinkValue` is zero, then `read_event` sets `UDF` to `FALSE`. The status of `recGblGetLinkValue` is returned.

---

# Chapter 16: Fanout

---

## 1. Introduction

---

This record is used to trigger the processing of up to six other records. It has no associated device support.

---

## 2. Field Summary

---

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| VAL   | LONG      | No  | 0       | Yes    | Yes    | No               | Yes |
| SELM  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| SELN  | USHORT    | No  | 1       | Yes    | Yes    | No               | No  |
| SELL  | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| LNK1  | FWDLINK   | Yes | 0       | No     | No     | N/A              | No  |
| LNK2  | FWDLINK   | Yes | 0       | No     | No     | N/A              | No  |
| LNK3  | FWDLINK   | Yes | 0       | No     | No     | N/A              | No  |
| LNK4  | FWDLINK   | Yes | 0       | No     | No     | N/A              | No  |
| LNK5  | FWDLINK   | Yes | 0       | No     | No     | N/A              | No  |
| LNK6  | FWDLINK   | Yes | 0       | No     | No     | N/A              | No  |

### 3. Field Descriptions

| Name          | Summary                      | Description                                                                                                                                                                                                                                                                                                                                                                                |
|---------------|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VAL           | Value Field                  | This field exists only because every record type must have a VAL field so that <code>dNameToAddr</code> succeeds when a field name is not specified.                                                                                                                                                                                                                                       |
| SELM          | Select Mechanism:            | <b>SELECT_ALL:</b> Select all links<br><b>SELECTED:</b> Use SELN as index (1 to 6)<br><b>MASK:</b> Use SELN as a mask to select an arbitrary combination of links.                                                                                                                                                                                                                         |
| SELN          | Link Selection               | If SELM=SELECT_ALL then this field is not used.<br>If SELM=SELECTED then this is the index (1 to 6) of the link to select.<br>If SELM=MASK then this is the mask (in decimal) used to determine the selected links. For example, if SELN=1, then LNK1 will be processed. If SELN=3 then LNK1 and LNK2 will be processed. If SELN=63 then all links LNK1, LNK2, ... LNK6 will be processed. |
| SELL          | Link Selection Location      | SELN is read from SELL. SELL can be a constant, a database link, or a channel access link.                                                                                                                                                                                                                                                                                                 |
| LNK1,...,LNK6 | Link Selection Forward Links | Link selection forward links are always processed in numeric order. That is LNK1 is always processed before LNK2, LNK2 before LNK3, etc.                                                                                                                                                                                                                                                   |

### 4. Record Support Routines

#### **init\_record**

This routine initializes SELN with the value of SELL, if SELL type is CONSTANT link, or creates a channel access link if SELL type is PV\_LINK.

#### **process**

See next section.

### 5. Record Processing

Routine `process` implements the following algorithm:

1. PACT is set to TRUE.
2. The link selection SELN is fetched.
3. Depending on the selection mechanism, the link selection forward links are processed. and UDF is set to FALSE.
4. Check to see if monitors should be invoked.
  - Alarm monitors are invoked if the alarm status or severity has changed.

- NSEV and NSTA are reset to 0.
5. Scan forward link if necessary, set PACT FALSE, and return.





---

# Chapter 17: Histogram

---

## 1. Introduction

---

The histogram record type is used to store frequency counts of a signal into an array of arbitrary length.

---

## 2. Field Summary

---

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP |
|-------|-----------|-----|---------|--------|--------|------------------|----|
| VAL   | See BPTR  | No  | 0       | Yes    | No     | No               | No |
| NELM  | USHORT    | Yes | 1       | Yes    | No     | No               | No |
| CSTA  | SHORT     | No  | 1       | Yes    | No     |                  | No |
| CMD   | RECCHOICE | No  | 0       | Yes    | Yes    |                  | No |
| ULIM  | DOUBLE    | Yes | 0       | Yes    | Yes    | No               | No |
| LLIM  | DOUBLE    | Yes | 0       | Yes    | Yes    | No               | No |
| WDTH  | DOUBLE    | No  | 0       | Yes    | No     |                  | No |
| SGNL  | DOUBLE    | No  | 0       | Yes    | Yes    | Yes              | No |
| SVL   | INLINK    | Yes | 0       | No     | No     | N/A              | No |
| BPTR  | NOACCESS  | No  | 0       | No     | No     |                  | No |
| WDOG  | NOACCESS  | No  | 0       | No     | No     |                  | No |

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP |
|-------|-----------|-----|---------|--------|--------|------------------|----|
| MCNT  | SHORT     | No  | 0       | Yes    | No     |                  | No |
| MDEL  | SHORT     | Yes | 0       | Yes    | Yes    | No               | No |
| SDEL  | FLOAT     | Yes | 0       | Yes    | No     |                  | No |
| SIOL  | INLINK    | Yes | 0       | No     | No     | N/A              | No |
| SVAL  | DOUBLE    | No  | 0       | Yes    | Yes    | No               | No |
| SIML  | INLINK    | Yes | 0       | No     | No     | N/A              | No |
| SIMM  | GBLCHOICE | No  | 0       | Yes    | Yes    | No               | No |
| SIMS  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No |

### 3. Field Descriptions

| Name | Summary                            | Description                                                                                                                                                                                                                                                                                                                                                                            |
|------|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VAL  | Value Field                        | This field is used to reference the array.                                                                                                                                                                                                                                                                                                                                             |
| NELM | Number of elements in array        |                                                                                                                                                                                                                                                                                                                                                                                        |
| CSTA | Collections Status                 |                                                                                                                                                                                                                                                                                                                                                                                        |
| CMD  | Collections Control                |                                                                                                                                                                                                                                                                                                                                                                                        |
| ULIM | Upper Signal Limit                 | These fields determine the range of signal values to be used. This range is subdivided into NELM equal intervals. The histogram array elements contain frequency counts of SGNL values for these intervals. Values of the signal outside these limits are not used by the record support routines. Whenever ULIM or LLIM are changed, the array elements counts will be reset to zero. |
| LLIM | Lower Signal Limit                 |                                                                                                                                                                                                                                                                                                                                                                                        |
| WDTH | Element Width                      |                                                                                                                                                                                                                                                                                                                                                                                        |
| SGNL | Signal Value                       |                                                                                                                                                                                                                                                                                                                                                                                        |
| SVL  | Signal Value Location (input link) | This field can be a constant, a database link, or a channel access link. If SVL is a database or channel access link, then SGNL is read from SVL. If SVL is a constant link then SGNL is initialized with the constant value but can be changed via dbPut.s.                                                                                                                           |
| BPTR | Buffer Pointer                     | Address of unsigned long array of frequency values.                                                                                                                                                                                                                                                                                                                                    |
| WDOG | Watchdog Callback                  |                                                                                                                                                                                                                                                                                                                                                                                        |
| MCNT | Monitor Counts                     | Number of counts since last monitor.                                                                                                                                                                                                                                                                                                                                                   |
| MDEL | Monitor Delta                      | Monitor count deadband.                                                                                                                                                                                                                                                                                                                                                                |

| Name | Summary                           | Description                                                                                                       |
|------|-----------------------------------|-------------------------------------------------------------------------------------------------------------------|
| SDEL | Monitor Seconds<br>Dband          |                                                                                                                   |
| SIMM | Simulation Mode                   | Simulation mode process variables. Refer to Chapter 3, Section "Simulation Mode" on page 11 for more information. |
| SIML | Simulation Mode<br>Location       |                                                                                                                   |
| SVAL | Simulation Value                  |                                                                                                                   |
| SIOL | Simulation Value<br>Location      |                                                                                                                   |
| SIMS | Simulation Mode<br>Alarm Severity |                                                                                                                   |
|      |                                   |                                                                                                                   |

## 4. Record Support Routines

### **init\_record**

Using NELM, space for the unsigned long array is allocated and the width WIDTH of the array is calculated

This routine initializes SIMM with the value of SIML if SIML type is CONSTANT link or creates a channel access link if SIML type is PV\_LINK. SVAL is likewise initialized if SIOL is CONSTANT or PV\_LINK.

This routine next checks to see that device support and a device support read routine are available. If device support includes init\_record, it is called.

### **process**

See next section.

### **special**

Special is invoked whenever the fields CMD, SGNL, ULIM, or LLIM are changed. If SGNL is changed, add\_count is called.

If ULIM or LLIM are changed, WIDTH is recalculated and clear\_histogram is called.

If CMD is less or equal to 1, clear\_histogram is called and CMD is reset to 0. If CMD is 2, CSTA is set to TRUE and CMD is reset to 0. If CMD is 3, CSTA is set to FALSE and CMD is reset to 0.

clear\_histogram zeros out the histogram array. add\_count increments the frequency in the histogram array.

### **get\_value**

Fills in the values of struct valueDes so that they refer to the array.

### **cvt\_dbaddr**

This is called by dbNameToAddr. It makes the dbAddr structure refer to the actual buffer holding the array.

**get\_array\_info**      Obtains values from the array referenced by VAL.

**put\_array\_info**      Writes values into the array referenced by VAL.

---

## 5. Record Processing

---

Routine `process` implements the following algorithm:

1. Check to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the `PACT` field set to `TRUE`. This ensures that processes will no longer be called for this record. Thus error storms will not occur.
2. `readValue` is called. See Chapter 3, Section "Simulation Mode" on page 11 for details.
3. If `PACT` has been changed to `TRUE`, the device support read routine has started but has not completed writing the new value. In this case, the processing routine merely returns, leaving `PACT TRUE`.
4. Add count to histogram array.
5. Check to see if monitors should be invoked. Alarm monitors are invoked if the alarm status or severity has changed. Archive and value change monitors are invoked if `MDEL` conditions are met. `NSEV` and `NSTA` are reset to 0.
6. Scan forward link if necessary, set `PACT` and `INIT` to `FALSE`, and return.

---

# Chapter 18: longin - Long Input

---

## 1. Introduction

---

The normal use for the longin record type is to input an integer value of up to 32 bits. Soft device modules are provided to obtain input via database or channel access links or via dbPutField or dbPutLink requests.

---

## 2. Field Summary

---

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| VAL   | LONG      | No  | 0       | Yes    | Yes    | Yes              | Yes |
| INP   | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| EGU   | STRING    | Yes | Null    | Yes    | Yes    | No               | No  |
| HOPR  | LONG      | Yes | 0       | Yes    | Yes    | No               | No  |
| LOPR  | LONG      | Yes | 0       | Yes    | Yes    | No               | No  |
| HIHI  | LONG      | Yes | 0       | Yes    | Yes    | No               | Yes |
| LOLO  | LONG      | Yes | 0       | Yes    | Yes    | No               | Yes |
| HIGH  | LONG      | Yes | 0       | Yes    | Yes    | No               | Yes |
| LOW   | LONG      | Yes | 0       | Yes    | Yes    | No               | Yes |
| HHSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| LLSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| HSV   | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| LSV   | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| HYST  | LONG      | Yes | 0       | Yes    | Yes    | No               | No  |
| ADEL  | LONG      | Yes | 0       | Yes    | Yes    | No               | No  |
| MDEL  | LONG      | Yes | 0       | Yes    | Yes    | No               | No  |
| LALM  | LONG      | No  | 0       | Yes    | No     | No               | No  |
| ALST  | LONG      | No  | 0       | Yes    | No     | No               | No  |
| MLST  | LONG      | No  | 0       | Yes    | No     | No               | No  |
| SIOL  | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| SVAL  | LONG      | No  | 0       | Yes    | Yes    | No               | No  |
| SIML  | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| SIMM  | GBLCHOICE | No  | 0       | Yes    | Yes    | No               | No  |
| SIMS  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |

### 3. Field Descriptions

| Name | Summary              | Description                                                                                                                                                                                                                                    |
|------|----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VAL  | Value Field          | This is the value resulting from record processing. If INP is a constant, then VAL is initialized to the INP value but it can be changed dynamically via dbPutField or dbPutLink.                                                              |
| INP  | Input Link           | This field is used by the device support routines to obtain input. For soft records, it can be a constant, a database link, or a channel access link.                                                                                          |
| EGU  | Engineering Units    | ASCII string describing Engineering units. This field is used by record support to supply a units description string when get_units is called.                                                                                                 |
| HOPR | High Operating Range | These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are used by record support to honor calls to get_graphic_double or get_control_double. |
| LOPR | Low Operating Range  |                                                                                                                                                                                                                                                |

| Name | Summary                              | Description                                                                                                                                                                                                                                                  |
|------|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| HIHI | Hihi Alarm Limit                     | These fields specify the alarm limits and severities.                                                                                                                                                                                                        |
| HIGH | High Alarm Limit                     |                                                                                                                                                                                                                                                              |
| LOW  | Low Alarm Limit                      |                                                                                                                                                                                                                                                              |
| LOLO | Lolo Alarm Limit                     |                                                                                                                                                                                                                                                              |
| HHSV | Severity for a Hihi Alarm            |                                                                                                                                                                                                                                                              |
| HSV  | Severity for a High Alarm            |                                                                                                                                                                                                                                                              |
| LSV  | Severity for a Low Alarm             |                                                                                                                                                                                                                                                              |
| LLSV | Severity for a Lolo Alarm            |                                                                                                                                                                                                                                                              |
| HYST | Alarm Deadband                       | These parameters specify hysteresis factors for triggering monitor callbacks, i.e. callbacks specified by calls to <code>caAddEvent</code> or <code>dbAddEvent</code> . A monitor will not be triggered until VAL changes by more than the specified amount. |
| ADEL | Archive Deadband                     |                                                                                                                                                                                                                                                              |
| MDEL | Monitor, i.e. value change, Deadband |                                                                                                                                                                                                                                                              |
| LALM | Last Alarmed Value                   | Value when last monitors for alarm/archiver/value changes were triggered. These fields are used to implement the hysteresis factors for monitor callbacks.                                                                                                   |
| ALST | Archive Last Value                   |                                                                                                                                                                                                                                                              |
| MLST | Monitor Last Value                   |                                                                                                                                                                                                                                                              |
| SIMM | Simulation Mode                      | Simulation mode process variables. Refer to Chapter 3, Section "Simulation Mode" on page 11 for more information.                                                                                                                                            |
| SIML | Simulation Mode Location             |                                                                                                                                                                                                                                                              |
| SVAL | Simulation Value                     |                                                                                                                                                                                                                                                              |
| SIOL | Simulation Value Location            |                                                                                                                                                                                                                                                              |
| SIMS | Simulation Mode Alarm Severity       |                                                                                                                                                                                                                                                              |

#### 4. Record Support Routines

##### **init\_record**

This routine initializes `SIMM` with the value of `SIML` if `SIML` type is `CONSTANT` link or creates a channel access link if `SIML` type is `PV_LINK`. `SVAL` is likewise initialized if `SIOL` is `CONSTANT` or `PV_LINK`.



This routine next checks to see that device support is available and a device support read routine is defined. If either does not exist, an error message is issued and processing is terminated.

If device support includes `init_record`, it is called.

|                           |                                                                                                                                                                                                                                                                                                                                                                                                        |
|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>process</b>            | See next section.                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>get_value</b>          | Fills in the values of struct <code>valueDes</code> so that they refer to <code>VAL</code> .                                                                                                                                                                                                                                                                                                           |
| <b>get_units</b>          | Retrieves <code>EGU</code> .                                                                                                                                                                                                                                                                                                                                                                           |
| <b>get_graphic_double</b> | Sets the upper display and lower display limits for a field. If the field is <code>VAL</code> , <code>HIHI</code> , <code>HIGH</code> , <code>LOW</code> , or <code>LOLO</code> , the limits are set to <code>HOPR</code> and <code>LOPR</code> , else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.     |
| <b>get_control_double</b> | Sets the upper control and the lower control limits for a field. If the field is <code>VAL</code> , <code>HIHI</code> , <code>HIGH</code> , <code>LOW</code> , or <code>LOLO</code> , the limits are set to <code>HOPR</code> and <code>LOPR</code> , else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used. |
| <b>get_alarm_double</b>   | Sets the following values:<br><pre>upper_alarm_limit = HIHI upper_warning_limit = HIGH lower_warning_limit = LOW lower_alarm_limit = LOLO</pre>                                                                                                                                                                                                                                                        |

---

## 5. Record Processing

---

Routine `process` implements the following algorithm:

1. Check to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the `PACT` field still set to `TRUE`. This ensures that processes will no longer be called for this record. Thus error storms will not occur.
2. `readValue` is called. See Chapter 3, Section "Simulation Mode" on page 11 for details.
3. If `PACT` has been changed to `TRUE`, the device support read routine has started but has not completed reading a new input value. In this case, the processing routine merely returns, leaving `PACT TRUE`.
4. Check alarms. This routine checks to see if the new `VAL` causes the alarm status and severity to change. If so, `NSEV`, `NSTA` and `LALM` are set. It also honors the alarm hysteresis factor (`HYST`). Thus the value must change by more than `HYST` before the alarm status and severity is lowered.

5. Check to see if monitors should be invoked.
  - Alarm monitors are invoked if the alarm status or severity has changed.
  - Archive and value change monitors are invoked if ADEL and MDEL conditions are met.
  - NSEV and NSTA are reset to 0.
6. Scan forward link if necessary, set PACT FALSE, and return.

## 6. Device Support

### Fields Of Interest To Device Support

Each long input record must have an associated set of device support routines. The primary responsibility of the device support routines is to obtain a new input value whenever `read_longin` is called. The device support routines are primarily interested in the following fields:

| Name | Summary            | Description                                                                              |
|------|--------------------|------------------------------------------------------------------------------------------|
| PACT | Processing Active  | See Chapter 2, Section "Database Common: Field Descriptions" on page 5 for descriptions. |
| DPVT | Device Private     |                                                                                          |
| UDF  | VAL Undefined      |                                                                                          |
| NSEV | New Alarm Severity |                                                                                          |
| NSTA | New Alarm Status   |                                                                                          |
| VAL  | Value Field        | This field is set by device support routines.                                            |
| INP  | Input Link         | This field is used by the device support routines to locate its input.                   |

### Device Support routines

Device support consists of the following routines:

*report*

```
report(FILE fp, paddr)
```

Not currently used.

*init*

```
init()
```

This routine is called once during IOC initialization.

*init\_record*

```
init_record(precord)
```

This routine is optional. If provided, it is called by the record support `init_record` routine.

*get\_ioint\_info*

```
get_ioint_info(int cmd, struct dbCommon *precord, IOSCANPVT *ppvt)
```

This routine is called by the `ioEventScan` system each time the record is added or deleted from an I/O event scan list. `cmd` has the value (0,1) if the record is being (added to, deleted from) an I/O event list. It must be provided for any device type that can use the `ioEvent` scanner.

*read\_longin*

`read_longin(precord)`

This routine must provide a new input value. It returns the following values:

- **0:** Success. A new value is placed in `VAL`.
- **Other:** Error.

---

## 7. Device Support For Soft Records

---

This module places a value directly in `VAL`.

If the `INP` link type is constant, then the constant value is stored into `VAL` by `init_record`, and `UDF` is set to `FALSE`. If the `INP` link type is `PV_LINK`, then `dbCaAddInLink` is called by `init_record`.

`read_longin` calls `recGblGetLinkValue` to read the current value of `VAL`. See Chapter 3, Section "Soft Input" on page 10 for details.

If the return status of `recGblGetLinkValue` is zero then `read_longin` sets `UDF` to `FALSE`. `read_longin` returns the status of `recGblGetLinkValue`.

---

# Chapter 19: longout - Long Output

---

## 1. Introduction

---

The normal use for the longout record type is to store integer values of up to 31 bits. It can also be used to write values to other records via database or channel access links. The OUT field determines how the record is used. The record supports alarm limits and graphics and control limits.

---

## 2. Field Summary

---

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| VAL   | LONG      | No  | 0       | Yes    | Yes    | Yes              | Yes |
| OUT   | OUTLINK   | Yes | 0       | No     | No     | N/A              | No  |
| DOL   | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| OMSL  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| EGU   | STRING    | Yes | Null    | Yes    | Yes    | No               | No  |
| HOPR  | LONG      | Yes | 0       | Yes    | Yes    | No               | No  |
| LOPR  | LONG      | Yes | 0       | Yes    | Yes    | No               | No  |
| HIHI  | LONG      | Yes | 0       | Yes    | Yes    | No               | Yes |
| LOLO  | LONG      | Yes | 0       | Yes    | Yes    | No               | Yes |
| HIGH  | LONG      | Yes | 0       | Yes    | Yes    | No               | Yes |

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| LOW   | LONG      | Yes | 0       | Yes    | Yes    | No               | Yes |
| HHSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| LLSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| HSV   | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| LSV   | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| HYST  | LONG      | Yes | 0       | Yes    | Yes    | No               | No  |
| ADEL  | LONG      | Yes | 0       | Yes    | Yes    | No               | No  |
| MDEL  | LONG      | Yes | 0       | Yes    | Yes    | No               | No  |
| LALM  | LONG      | No  | 0       | Yes    | No     | No               | No  |
| ALST  | LONG      | No  | 0       | Yes    | No     | No               | No  |
| MLST  | LONG      | No  | 0       | Yes    | No     | No               | No  |
| SIOL  | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| SIML  | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| SIMM  | GBLCHOICE | No  | 0       | Yes    | Yes    | No               | No  |
| SIMS  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| IVOA  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| IVOV  | LONG      | Yes | 0       | Yes    | Yes    | No               | No  |

### 3. Field Descriptions

| Name | Summary                              | Description                                                                                                                                                                                                              |
|------|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VAL  | Value                                | This is the desired output value, in engineering units. If DRVH and DRVL are defined, VAL is forced to be within the drive limits. VAL is either obtained from DOL or set via dbPuts.                                    |
| OUT  | Output Link                          | This field is used by the device support routines to decide where to send output. For soft records, it can be a constant, a database link, or a channel access link. If the link is a constant, the result is no output. |
| DOL  | Desired Output Location (input link) | If DOL is a database or channel access link and OMSL is CLOSED_LOOP, then VAL is read from DOL. After the check for drive limits VAL will be set to the value determined by DOL.                                         |

| Name | Summary                              | Description                                                                                                                                                                                                                                                                                                                      |
|------|--------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OMSL | Output Mode Select                   | This field has either the value SUPERVISORY or CLOSED_LOOP. DOL is used to determine VAL only if OMSL has the value CLOSED_LOOP. By setting this field the record can be switched between supervisory and closed loop mode of operation. While in closed loop mode, the VAL field cannot be set via dbPuts.                      |
| EGU  | Engineering Units                    | ASCII string describing Engineering units. This field is used by record support to supply a units description string when get_units is called.                                                                                                                                                                                   |
| HOPR | High Operating Range                 | These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are used by record support to honor calls to get_graphic_double or get_control_double. If these values are defined, they must be in the range<br>DRVL<=LOPR<=HOPR<=DRVH. |
| LOPR | Low Operating Range                  |                                                                                                                                                                                                                                                                                                                                  |
| HIHI | Hihi Alarm Limit                     | These fields specify the alarm limits and severities.                                                                                                                                                                                                                                                                            |
| HIGH | High Alarm Limit                     |                                                                                                                                                                                                                                                                                                                                  |
| LOW  | Low Alarm Limit                      |                                                                                                                                                                                                                                                                                                                                  |
| LOLO | Lolo Alarm Limit                     |                                                                                                                                                                                                                                                                                                                                  |
| HHSV | Hihi Alarm Severity                  |                                                                                                                                                                                                                                                                                                                                  |
| HSV  | High Alarm Severity                  |                                                                                                                                                                                                                                                                                                                                  |
| LSV  | Low Alarm Severity                   |                                                                                                                                                                                                                                                                                                                                  |
| LLSV | Lolo Alarm Severity                  |                                                                                                                                                                                                                                                                                                                                  |
| HYST | Alarm Deadband                       | These parameters specify hysteresis factors for triggering monitor callbacks, i.e. callbacks specified by calls to caAddEvent or dbAddEvent. A monitor will not be triggered until VAL changes by more than the specified amount.                                                                                                |
| ADEL | Archive Deadband                     |                                                                                                                                                                                                                                                                                                                                  |
| MDEL | Monitor, i.e. value change, Deadband |                                                                                                                                                                                                                                                                                                                                  |
| LALM | Last Alarmed Value                   | Value when last monitors for alarm/archiver/value change were triggered. These fields are used to implement the hysteresis factors for monitors.                                                                                                                                                                                 |
| ALST | Archive Last Value                   |                                                                                                                                                                                                                                                                                                                                  |
| MLST | Monitor Last Value                   |                                                                                                                                                                                                                                                                                                                                  |

| Name | Summary                        | Description                                                                                                                                                           |
|------|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SIMM | Simulation Mode                | Simulation mode process variables. Refer to Chapter 3 Section "Simulation Mode" on page 13 for more information.                                                      |
| SIML | Simulation Mode Location       |                                                                                                                                                                       |
| SIOL | Simulation Value Location      |                                                                                                                                                                       |
| SIMS | Simulation Mode Alarm Severity |                                                                                                                                                                       |
| IVOA | Invalid Alarm Output Action    | Whenever the record is put into INVALID alarm severity IVOA specifies an action. See Chapter 3 Section "Invalid Alarm Output Action" on page 14 for more information. |
| IVOV | Invalid Alarm Output Value     |                                                                                                                                                                       |

## 4. Record Support Routines

### **init\_record**

This routine initializes *SIMM* if *SIML* is a constant or creates a channel access link if *SIML* is *PV\_LINK*. If *SIOL* is *PV\_LINK* a channel access link is created.

This routine next checks to see that device support is available. The routine next checks to see if the device support write routine is defined. If either device support or the device support write routine does not exist, an error message is issued and processing is terminated.

If *DOL* is a constant, then *VAL* is initialized to its value and *UDF* is set to *FALSE*. If *DOL* type is a *PV\_LINK* then *dbCaAddInLink* is called to create a channel access link.

If device support includes *init\_record*, it is called.

### **process**

See next section.

### **get\_value**

Fills in the values of struct *valueDes* so that they refer to *VAL*.

### **get\_units**

Retrieves *EGU*.

### **get\_graphic\_double**

Sets the upper display and lower display limits for a field. If the field is *VAL*, *HIHI*, *HIGH*, *LOW*, or *LOLO*, the limits are set to *HOPR* and *LOPR*, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

**get\_control\_double** Sets the upper control and the lower control limits for a field. If the field is VAL, HIHI, HIGH, LOW, or LOLO, the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

**get\_alarm\_double** Sets the following values:

```
upper_alarm_limit = HIHI
upper_warning_limit = HIGH
lower_warning_limit = LOW
lower_alarm_limit = LOLO
```

---

## 5. Record Processing

---

Routine `process` implements the following algorithm:

1. Check to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the `PACT` field still set to `TRUE`. This ensures that processes will no longer be called for this record. Thus error storms will not occur.
2. If `PACT` is `FALSE` and `OMSL` is `CLOSED_LOOP` `recGblGetLinkValue` is called to read the current value of `VAL`. See Chapter 3 Section "Soft Input" on page 10 for details. If the return status of `recGblGetLinkValue` is zero then `UDF` is set to `FALSE`.
3. Check alarms. This routine checks to see if the new `VAL` causes the alarm status and severity to change. If so, `NSEV`, `NSTA` and `LALM` are set. It also honors the alarm hysteresis factor (`HYST`). Thus the value must change by more than `HYST` before the alarm status and severity is lowered.
4. Check severity and write the new value. See Chapter 3 Section "Simulation Mode" on page 13 and Chapter 3 Section "Invalid Alarm Output Action" on page 14 for details.
5. If `PACT` has been changed to `TRUE`, the device support write output routine has started but has not completed writing the new value. In this case, the processing routine merely returns, leaving `PACT TRUE`.
6. Check to see if monitors should be invoked.
  - Alarm monitors are invoked if the alarm status or severity has changed.
  - Archive and value change monitors are invoked if `ADEL` and `MDEL` conditions are met.
  - `NSEV` and `NSTA` are reset to 0.
7. Scan forward link if necessary, set `PACT FALSE`, and return.



---

## 6. Device Support

---

### Fields Of Interest To Device Support

Each long output record must have an associated set of device support routines. The primary responsibility of the device support routines is to output a new value whenever `write_longout` is called. The device support routines are primarily interested in the following fields:

| Name | Summary            | Description                                                                             |
|------|--------------------|-----------------------------------------------------------------------------------------|
| PACT | Processing Active  | See Chapter 2 Section "Database Common: Field Descriptions" on page 5 for descriptions. |
| DPVT | Device Private     |                                                                                         |
| NSEV | New Alarm Severity |                                                                                         |
| NSTA | New Alarm Status   |                                                                                         |
| OUT  | Output Link        | This field is used by the device support routines to locate its output.                 |

### Device Support Routines

Device support consists of the following routines:

#### *init*

```
init()
```

This routine is called once during IOC initialization.

#### *init\_record*

```
init_record(precord)
```

This routine is optional. If provided, it is called by the record support `init_record` routine.

#### *get\_ioint\_info*

```
get_ioint_info(int cmd, struct dbCommon *precord, IOSCANPVT *ppvt)
```

This routine is called by the `ioEventScan` system each time the record is added or deleted from an I/O event scan list. `cmd` has the value (0,1) if the record is being (added to, deleted from) an I/O event list. It must be provided for any device type that can use the `ioEvent` scanner.

#### *write\_longout*

```
write_longout(precord)
```

This routine must output a new value. It returns the following values:

- 0: Success.
- Other: Error.

---

## 7. Device Support For Soft Records

---

This module writes the current value of `VAL`.

If the OUT link type is PV\_LINK, then dbCaAddInlink is called by init\_record.

write\_longout calls recGblPutLinkValue to write the current value of VAL. See Chapter 3 Section "Soft Output" on page 13 for details.



---

# Chapter 20: *mbbi* - MultiBit Binary Input

---

## 1. Introduction

---

The normal use for the *mbbi* record type is to obtain a binary value that represents one of up to 16 states. Most device support modules obtain values from hardware and place the value in *RVAL*. For these devices record processing uses *RVAL* to determine the current state (*VAL* is given a value between 0 and 15). Devices may optionally read a value directly into *VAL*. Soft device modules are provided to obtain input via database or channel access links or via *dbPutField* or *dbPutLink* requests. Two soft device support modules are provided. One allows *VAL* to be an arbitrary unsigned short integer. The other reads the value into *RVAL* just like normal hardware modules.

---

## 2. Field Summary

---

| Field | Type   | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|--------|-----|---------|--------|--------|------------------|-----|
| VAL   | ENUM   | No  | 0       | Yes    | Yes    | Yes              | Yes |
| NOBT  | SHORT  | Yes | 0       | Yes    | No     |                  | No  |
| INP   | INLINK | Yes | 0       | No     | No     | N/A              | No  |
| ZRVL  | ULONG  | Yes | 0       | Yes    | Yes    | No               | Yes |
| ONVL  | ULONG  | Yes | 0       | Yes    | Yes    | No               | Yes |
| TWVL  | ULONG  | Yes | 0       | Yes    | Yes    | No               | Yes |
| THVL  | ULONG  | Yes | 0       | Yes    | Yes    | No               | Yes |

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| FRVL  | ULONG     | Yes | 0       | Yes    | Yes    | No               | Yes |
| FVVL  | ULONG     | Yes | 0       | Yes    | Yes    | No               | Yes |
| SXVL  | ULONG     | Yes | 0       | Yes    | Yes    | No               | Yes |
| SVVL  | ULONG     | Yes | 0       | Yes    | Yes    | No               | Yes |
| EIVL  | ULONG     | Yes | 0       | Yes    | Yes    | No               | Yes |
| NIVL  | ULONG     | Yes | 0       | Yes    | Yes    | No               | Yes |
| TEVL  | ULONG     | Yes | 0       | Yes    | Yes    | No               | Yes |
| ELVL  | ULONG     | Yes | 0       | Yes    | Yes    | No               | Yes |
| TVVL  | ULONG     | Yes | 0       | Yes    | Yes    | No               | Yes |
| TTVL  | ULONG     | Yes | 0       | Yes    | Yes    | No               | Yes |
| FTVL  | ULONG     | Yes | 0       | Yes    | Yes    | No               | Yes |
| FFVL  | ULONG     | Yes | 0       | Yes    | Yes    | No               | Yes |
| ZRST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| ONST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| TWST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| THST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| FRST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| FVST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| SXST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| SVST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| EIST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| NIST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| TEST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| ELST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| TVST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| TTST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| FTST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| FFST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| ZRSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| ONSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| TWSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| THSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| FRSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| FVSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| SXSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| SVSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| EISV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| NISV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| TESV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| ELSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| TVSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| TTSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| FTSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| FFSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| UNSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| COSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| RVAL  | ULONG     | No  | 0       | Yes    | Yes    | Yes              | Yes |
| ORAW  | ULONG     | No  | 0       | Yes    | No     | No               | No  |
| MASK  | ULONG     | No  | 0       | Yes    | No     | No               | No  |
| MLST  | USHORT    | No  | 0       | Yes    | No     | No               | No  |
| LALM  | USHORT    | No  | 0       | Yes    | No     | No               | No  |
| SDEF  | SHORT     | No  | 0       | Yes    | No     | No               | No  |
| SHFT  | USHORT    | No  | 0       | Yes    | No     | No               | No  |
| SIOL  | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| SVAL  | USHORT    | No  | 0       | Yes    | Yes    | No               | No  |
| SIML  | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| SIMM  | GBLCHOICE | No  | 0       | Yes    | Yes    | No               | No  |
| SIMS  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |

### 3. Field Descriptions

| Name           | Summary                         | Description                                                                                                                                                                                                                                                                                                       |
|----------------|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VAL            | Value Field                     | Unless INP is a constant link, this is the value resulting from the record being processed. If INP is a constant, then VAL is initialized to the INP value but can be changed dynamically via dbPutField or dbPutLink. It normally is the index (0 to 15) of the current state.                                   |
| NOBT           | Number of Bits                  | Number of bits set in hardware mask.                                                                                                                                                                                                                                                                              |
| INP            | Input Link                      | This field is used by the device support routines to obtain input. For soft records, it can be a constant, a database link, or a channel access link.                                                                                                                                                             |
| ZRVL,....,FFVL | Zero Value, One Value ...       | Masks for hardware value associated with each state.                                                                                                                                                                                                                                                              |
| ZRST,....,FFST | Zero String, One String ...     | Strings associated with each state.                                                                                                                                                                                                                                                                               |
| ZRSV,....,FFSV | Zero Severity, One Severity,... | Alarm severity associated with each state.                                                                                                                                                                                                                                                                        |
| UNSV           | Unknown State Severity          |                                                                                                                                                                                                                                                                                                                   |
| COSV           | Change of State Severity        |                                                                                                                                                                                                                                                                                                                   |
| RVAL           | Raw Data Value                  | RVAL is the value obtained by the device support routine. Unless the device support routine specifies no conversion, VAL is determined as follows: A temporary variable rva.1 is set equal to RVAL. It is then shifted right SHFT bits. After shifting, the result should match one of the values ZRVL,....,FFVL. |
| ORAW           | Old Raw Data Value              | ORAW is used to decide if monitors should be triggered for RVAL at the same time monitors are triggered for changes in VAL.                                                                                                                                                                                       |
| MASK           | Mask                            | Mask used by device support routine to read hardware register. Record support sets low order NOBT bits. Device support can shift this value.                                                                                                                                                                      |
| SHFT           | Shift                           | Number of bits to shift values obtained from RVAL.                                                                                                                                                                                                                                                                |
| LALM           | Last Alarmed                    | Value when last change of state alarm was issued.                                                                                                                                                                                                                                                                 |
| MLST           | Monitor Last                    | Value when last monitor for value changes was triggered                                                                                                                                                                                                                                                           |
| SDEF           | States Defined?                 | Record support uses this field to save time if no states are defined                                                                                                                                                                                                                                              |

| Name | Summary                        | Description                                                                                                       |
|------|--------------------------------|-------------------------------------------------------------------------------------------------------------------|
| SIMM | Simulation Mode                | Simulation mode process variables. Refer to Chapter 3, Section "Simulation Mode" on page 11 for more information. |
| SIML | Simulation Mode Location       |                                                                                                                   |
| SVAL | Simulation Value               |                                                                                                                   |
| SIOL | Simulation Value Location      |                                                                                                                   |
| SIMS | Simulation Mode Alarm Severity |                                                                                                                   |

## 4. Record Support Routines

### **init\_record**

This routine initializes `SIMM` with the value of `SIML` if `SIML` type is `CONSTANT` link or creates a channel access link if `SIML` type is `PV_LINK`. `SVAL` is likewise initialized if `SIOL` is `CONSTANT` or `PV_LINK`.

This routine next checks to see that device support is available and a device support read routine is defined. If either does not exist, an error message is issued and processing is terminated.

Clears `MASK` and then sets the `NOBT` low order bits.

If device support includes `init_record`, it is called.

`init_common` is then called to determine if any states are defined. If states are defined, `SDEF` is set to `TRUE`.

### **process**

See next section.

### **special**

Calls `init_common` to compute `SDEF` when any of the fields `ZRVL`, ... `FFVL` change value.

### **get\_value**

Fills in the values of struct `valueDes` so that they refer to `VAL`.

### **get\_enum\_str**

Retrieves ASCII string corresponding to `VAL`.

### **get\_enum\_strs**

Retrieves ASCII strings for `ZRST`,...`FFST`.

### **put\_enum\_str**

Checks if string matches `ZRST`,...`FFST` and if it does, sets `VAL`.



## 5. Record Processing

---

Routine `process` implements the following algorithm:

1. Check to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the `PACT` field still set to `TRUE`. This ensures that processes will no longer be called for this record. Thus error storms will not occur.
2. `readValue` is called. See Chapter 3, Section "Simulation Mode" on page 11 for details.
3. If `PACT` has been changed to `TRUE`, the device support read routine has started but has not completed reading a new input value. In this case, the processing routine merely returns, leaving `PACT TRUE`.
4. Convert.
  - `status=read_mbbi`
  - `PACT = TRUE`
  - `TIME = tsLocalTime`
  - If `status` is 0, then determine `VAL`
    - Set `rval = RVAL`
    - Shift `rval` right `SHFT` bits
    - If at least one state value is defined
      - Set `UDF` to `TRUE`
      - If `RVAL` is `ZRVL,...,FFVL` then set
        - `VAL` equals index of state
        - `UDF` set to `FALSE`
        - Else set `VAL = undefined`
      - Else set `VAL = RVAL`
        - Set `UDF` to `FALSE`
    - If `status` is 1, return(0)
    - If `status` is 2, set `status = 0`
  - 5. Check alarms. This routine checks to see if the new `VAL` causes the alarm status and severity to change. If so, `NSEV`, `NSTA` and `LALM` are set.
  - 6. Check to see if monitors should be invoked.
    - Alarm monitors are invoked if the alarm status or severity has changed.
    - Archive and value change monitors are invoked if `MLST` is not equal to `VAL`.
    - Monitors for `RVAL` are checked whenever other monitors are invoked.
    - `NSEV` and `NSTA` are reset to 0.
  - 7. Scan forward link if necessary, set `PACT FALSE`, and return.

## 6. Device Support

### Fields Of Interest To Device Support

Each input record must have an associated set of device support routines. The primary responsibility of the device support routines is to obtain a new raw input value whenever `read_mbbi` is called. The device support routines are primarily interested in the following fields:

| Name | Summary            | Description                                                                                                                                                                                                             |
|------|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PACT | Processing Active  | See Chapter 2, Section "Database Common: Field Descriptions" on page 5 for descriptions.                                                                                                                                |
| DPVT | Device Private     |                                                                                                                                                                                                                         |
| UDF  | VAL Undefined      |                                                                                                                                                                                                                         |
| NSEV | New Alarm Severity |                                                                                                                                                                                                                         |
| NSTA | New Alarm Status   |                                                                                                                                                                                                                         |
| NOBT | Number of Bits     | Number of hardware bits accessed. They must be consecutive.                                                                                                                                                             |
| VAL  | Value Field        | This field is set by the device support routines if they don't want record support to set it.                                                                                                                           |
| INP  | Input Link         | This field is used by the device support routines to locate its input.                                                                                                                                                  |
| RVAL | Raw Data Value     | It is the responsibility of the device support routine to give this field a value.                                                                                                                                      |
| MASK | Mask               | This is a mask used to read the hardware. Record support sets the low order NOBT bits. The device support routine can shift the bits. The device support routine should perform the shift in <code>init_record</code> . |
| SHFT | Shift              | This can be set by the device support module at <code>init_record</code> time.                                                                                                                                          |

### Device Support Routines

Device support consists of the following routines:

*report*

```
report(FILE fp, paddr)
```

Not currently used.

*init*

```
init()
```

This routine is called once during IOC initialization.

*init\_record*

```
init_record(precord)
```

This routine is optional. If provided, it is called by the record support `init_record` routine. If it uses `MASK`, it should shift it as necessary and also give `SHIFT` a value.

### *get\_ioint\_info*

```
get_ioint_info(int cmd, struct dbCommon *precord, IOSCANPVT *ppvt)
```

This routine is called by the `ioEventScan` system each time the record is added or deleted from an I/O event scan list. `cmd` has the value (0,1) if the record is being (added to, deleted from) an I/O event list. It must be provided for any device type that can use the `ioEvent` scanner.

### *read\_mbbi*

```
read_mbbi (precord)
```

This routine must provide a new input value. It returns the following values:

- **0:** Success. A new raw value is placed in `RVAL`. The record support module determines `VAL` from `RVAL`, `SHIFT`, and `ZEVL ... FFVL`.
- **2:** Success, but don't modify `VAL`.
- **Other:** Error.

---

## 7. Device Support For Soft Records

---

Two soft device support modules `Soft Channel` and `Raw Soft Channel` are provided for multibit binary input records not related to actual hardware devices. The `INP` link type must be either `CONSTANT`, `DB_LINK`, or `CA_LINK`.

### **Soft Channel**

`read_mbbi` always returns a value of 2, which means that no conversion is performed.

If the `INP` link type is constant, then the constant value is stored into `VAL` by `init_record`, and `UDF` is set to `FALSE`. `VAL` can be changed via `dbPut` requests. If the `INP` link type is `PV_LINK`, then `dbCaAddInlink` is called by `init_record`.

`read_mbbi` calls `recGblGetLinkValue` to read the current value of `VAL`. See Chapter 3, Section "Soft Input" on page 10 for details.

If the return status of `recGblGetLinkValue` is zero, then `read_mbbi` sets `UDF` to `FALSE`. The status of `recGblGetLinkValue` is returned.

### **Raw Soft Channel**

This module is like the previous except that values are read into `RVAL`, `VAL` is computed from `RVAL`, and `read_mbbi` returns a value of 0. Thus the record processing routine will determine `VAL` in the normal way.

---

# Chapter 21: *mbbo* - MultiBit Binary Output

---

## 1. Introduction

---

The normal use for the *mbbo* record type is to send a binary value (representing one of up to 16 states) to a Digital Output module. It can also be used to write to other records via database or channel access links.

---

## 2. Field Summary

---

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| VAL   | ENUM      | No  | 0       | Yes    | Yes    | Yes              | Yes |
| DOL   | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| OMSL  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| NOBT  | SHORT     | Yes | 0       | Yes    | No     |                  | No  |
| OUT   | OUTLINK   | Yes | 0       | No     | No     | N/A              | No  |
| ZRVL  | ULONG     | Yes | 0       | Yes    | Yes    | No               | Yes |
| ONVL  | ULONG     | Yes | 0       | Yes    | Yes    | No               | Yes |
| TWVL  | ULONG     | Yes | 0       | Yes    | Yes    | No               | Yes |
| THVL  | ULONG     | Yes | 0       | Yes    | Yes    | No               | Yes |
| FRVL  | ULONG     | Yes | 0       | Yes    | Yes    | No               | Yes |

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| FVVL  | ULONG     | Yes | 0       | Yes    | Yes    | No               | Yes |
| SXVL  | ULONG     | Yes | 0       | Yes    | Yes    | No               | Yes |
| SVVL  | ULONG     | Yes | 0       | Yes    | Yes    | No               | Yes |
| EIVL  | ULONG     | Yes | 0       | Yes    | Yes    | No               | Yes |
| NIVL  | ULONG     | Yes | 0       | Yes    | Yes    | No               | Yes |
| TEVL  | ULONG     | Yes | 0       | Yes    | Yes    | No               | Yes |
| ELVL  | ULONG     | Yes | 0       | Yes    | Yes    | No               | Yes |
| TVVL  | ULONG     | Yes | 0       | Yes    | Yes    | No               | Yes |
| TTVL  | ULONG     | Yes | 0       | Yes    | Yes    | No               | Yes |
| FTVL  | ULONG     | Yes | 0       | Yes    | Yes    | No               | Yes |
| FFVL  | ULONG     | Yes | 0       | Yes    | Yes    | No               | Yes |
| ZRST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| ONST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| TWST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| THST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| FRST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| FVST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| SXST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| SVST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| EIST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| NIST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| TEST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| ELST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| TVST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| TTST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| FTST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| FFST  | STRING    | Yes | Null    | Yes    | Yes    | No               | Yes |
| ZRSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| ONSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| TWSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| THSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| FRSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |

| Field | Type      | DCT | Initial | Access | Modify | RecProc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|-----------------|-----|
| FVSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No              | Yes |
| SXSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No              | Yes |
| SVSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No              | Yes |
| EISV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No              | Yes |
| NISV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No              | Yes |
| TESV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No              | Yes |
| ELSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No              | Yes |
| TVSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No              | Yes |
| TTSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No              | Yes |
| FTSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No              | Yes |
| FFSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No              | Yes |
| UNSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No              | Yes |
| COSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No              | Yes |
| RVAL  | ULONG     | No  | 0       | Yes    | Yes    | Yes             | Yes |
| ORAW  | ULONG     | No  | 0       | Yes    | No     | No              | No  |
| RBV   | ULONG     | No  | 0       | Yes    | No     | Yes             | No  |
| ORBV  | ULONG     | No  | 0       | Yes    | No     | No              | No  |
| MASK  | ULONG     | No  | 0       | Yes    | No     | No              | No  |
| MLST  | USHORT    | No  | 0       | Yes    | No     | No              | No  |
| LALM  | USHORT    | No  | 0       | Yes    | No     | No              | No  |
| SDEF  | SHORT     | No  | 0       | Yes    | No     | No              | No  |
| SHFT  | USHORT    | No  | 0       | Yes    | No     | No              | No  |
| SIOL  | INLINK    | Yes | 0       | No     | No     | N/A             | No  |
| SIML  | INLINK    | Yes | 0       | No     | No     | N/A             | No  |
| SIMM  | GBLCHOICE | No  | 0       | Yes    | Yes    | No              | No  |
| SIMS  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No              | No  |
| IVOA  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No              | No  |
| IVOV  | USHORT    | Yes | 0       | Yes    | Yes    | No              | No  |

### 3. Field Descriptions

| Name          | Summary                                 | Description                                                                                                                                                                                                                                                                                                  |
|---------------|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VAL           | Value Field                             | This is the index of the state value to be sent to OUT.                                                                                                                                                                                                                                                      |
| DOL           | Desired Output Location (an Input Link) | If DOL is a database or channel access link and OMSL is CLOSED_LOOP, then VAL is read from DOL.                                                                                                                                                                                                              |
| OMSL          | Output Mode Select                      | This field has either the value SUPERVISORY or CLOSED_LOOP. DOL is used to determine VAL only if OMSL has the value CLOSED_LOOP. By setting this field, the record can be switched between supervisory and closed loop mode of operation. While in closed loop mode, the VAL field cannot be set via dbPuts. |
| NOBT          | Number of Bits                          | Number of bits in hardware mask.                                                                                                                                                                                                                                                                             |
| OUT           | Output Link                             | This field is used by the device support routines to decide where to send output. For soft records, it can be a constant, a database link, or a channel access link. If the link is a constant, the result is no output.                                                                                     |
| ZRVL,...,FFVL | Zero Value, One Value, ...              | Masks for hardware value associated with each state.                                                                                                                                                                                                                                                         |
| ZRST,...,FFST | Zero State, One State, ...              | Strings associated with each state.                                                                                                                                                                                                                                                                          |
| ZRSV,...,FFSV | Zero Severity, One Severity, ...        | Alarm severity associated with each state.                                                                                                                                                                                                                                                                   |
| UNSV          | Unknown State Severity                  |                                                                                                                                                                                                                                                                                                              |
| COSV          | Change of State Severity                |                                                                                                                                                                                                                                                                                                              |
| RVAL          | Raw Data Value                          | RVAL is the value to be written to the hardware device. It is determined by the record support module using VAL as the index of the values stored in ZRVL,...,FFVL. The value is also shifted left SHFT bits.                                                                                                |
| ORAW          | Old Raw Data Value                      | ORAW is used to decide if monitors should be triggered for RVAL at the same time monitors are generated for changes in VAL.                                                                                                                                                                                  |
| RBV           | Read Back Value                         | This is the actual read back value obtained from the hardware itself or from the associated device driver. It is the responsibility of the device support routine to give this field a value.                                                                                                                |
| ORAV          | Old Read Back Value                     | ORAV is used to decide if monitors should be triggered for RBV at the same time monitors are triggered for changes in VAL.                                                                                                                                                                                   |
| MASK          | Mask                                    | Mask used by device support routine to read hardware register. Record support sets low order NOBT bits. Device support can shift this value.                                                                                                                                                                 |

| Name | Summary                        | Description                                                                                                                                                           |
|------|--------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| MLST | Monitor Last                   | Value when last monitor for value changes was triggered.                                                                                                              |
| LALM | Last Alarmed                   | Value when last change of state alarm was issued.                                                                                                                     |
| SDEF | States Defined?                | Record support uses this field to save time if no states are defined.                                                                                                 |
| SHFT | Shift                          | Number of bits to shift values obtained from ZRVL,...,FFVL.                                                                                                           |
| SIMM | Simulation Mode                | Simulation mode process variables. Refer to Chapter 3, Section "Simulation Mode" on page 13 for more information.                                                     |
| SIML | Simulation Mode Location       |                                                                                                                                                                       |
| SIOL | Simulation Value Location      |                                                                                                                                                                       |
| SIMS | Simulation Mode Alarm Severity |                                                                                                                                                                       |
| IVOA | Invalid Alarm Output Action    | Whenever the record is put into INVALID alarm severity IVOA specifies an action. See Chapter 3, Section "Invalid Alarm Output Action" on page 14 for more information |
| IVOV | Invalid Alarm Output Value     |                                                                                                                                                                       |

## 4. Record Support Routines

### **init\_record**

This routine initializes SIMM if SIML is a constant or creates a channel access link if SIML is PV\_LINK. If SIOL is PV\_LINK a channel access link is created.

This routine next checks to see that device support is available. The routine next checks to see if the device support write routine is defined. If either device support or the device support write routine does not exist, an error message is issued and processing is terminated.

If DOL is a constant, then VAL is initialized to its value and UDF is set to FALSE.

MASK is cleared and then the NOBT low order bits are set.

If device support includes init\_record, it is called.

init\_common is then called to determine if any states are defined. If states are defined, SDEF is set to TRUE.

If device support returns success, VAL is then set from RVAL and UDF is set to FALSE.

### **process**

See next section.

### **special**

Computes SDEF when any of the fields ZRVL,...,FFVL change value.



|                      |                                                                                              |
|----------------------|----------------------------------------------------------------------------------------------|
| <b>get_value</b>     | Fills in the values of struct <code>valueDes</code> so that they refer to <code>VAL</code> . |
| <b>get_enum_str</b>  | Retrieves ASCII string corresponding to <code>VAL</code> .                                   |
| <b>get_enum_strs</b> | Retrieves ASCII strings for <code>ZRST,...FFST</code> .                                      |
| <b>put_enum_str</b>  | Checks if string matches <code>ZRST,...FFST</code> and if it does, sets <code>VAL</code> .   |

---

## 5. Record Processing

---

Routine `process` implements the following algorithm:

1. Check to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the `PACT` field still set to `TRUE`. This ensures that processes will no longer be called for this record. Thus error storms will not occur.
2. If `PACT` is `FALSE`
  - If `DOL` is `DB_LINK` and `OMSL` is `CLOSED_LOOP`
    - Get value from `DOL`
    - Set `UDF` to `FALSE`
    - Check for link alarm
  - If any state values are defined
    - If `VAL > 15`, then raise alarm and go to 4
    - Else using `VAL` as index set `RVAL = one of ZRVL,...FFVL`
  - Else set `RVAL = VAL`
  - Shift `RVAL` left `SHFT` bits
3. Convert
  - If `PACT` is `FALSE`, compute `RVAL`
    - If `VAL` is `0,...,15`, set `RVAL` from `ZRVL,...,FFVL`
    - If `VAL` out of range, set `RVAL = undefined`
  - `Status=write_mbbo`
4. Check alarms. This routine checks to see if the new `VAL` causes the alarm status and severity to change. If so, `NSEV`, `NSTA` and `LALM` are set.
5. Check severity and write the new value. See Chapter 3, Section "Simulation Mode" on page 13 and Chapter 3, Section "Invalid Alarm Output Action" on page 14 for details.
6. If `PACT` has been changed to `TRUE`, the device support write output routine has started but has not completed writing the new value. In this case, the processing routine merely returns, leaving `PACT TRUE`.
7. Check to see if monitors should be invoked.
  - Alarm monitors are invoked if the alarm status or severity has changed.
  - Archive and value change monitors are invoked if `MLST` is not equal to `VAL`.
  - Monitors for `RVAL` and `RBV` are checked whenever other monitors are invoked.
  - `NSEV` and `NSTA` are reset to 0.

8. Scan forward link if necessary, set PACT FALSE, and return.

## 6. Device Support

### Fields Of Interest To Device Support

Each mbbo record must have an associated set of device support routines. The primary responsibility of the device support routines is to obtain a new raw mbbo value whenever `write_mbbo` is called. The device support routines are primarily interested in the following fields:

| Name | Summary            | Description                                                                                                                                                                                                             |
|------|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PACT | Processing Active  | See Chapter 2, Section "Database Common: Field Descriptions" on page 5 for descriptions.                                                                                                                                |
| DPVT | Device Private     |                                                                                                                                                                                                                         |
| NSEV | New Alarm Severity |                                                                                                                                                                                                                         |
| NSTA | New Alarm Status   |                                                                                                                                                                                                                         |
| NOBT | Number of Bits     | Number of hardware bits accessed. They must be consecutive.                                                                                                                                                             |
| OUT  | Output Link        | This field is used by the device support routines to locate its output.                                                                                                                                                 |
| RVAL | Raw data value.    | This is the value to be written to OUT.                                                                                                                                                                                 |
| RBV  | Read Back Value    | It is the responsibility of the device support modules to set this field.                                                                                                                                               |
| MASK | Mask               | This is a mask used to read the hardware. Record support sets the low order NOBT bits. The device support routine can shift the bits. The device support routine should perform the shift in <code>init_record</code> . |
| SHFT | Shift              | This can be set by the device support module at <code>init_record</code> time.                                                                                                                                          |

### Device Support Routines

Device support consists of the following routines:

*report*

`report(FILE fp, paddr)`

Not currently used.

*init*

`init()`

This routine is called once during IOC initialization.

*init\_record*

`init_record(precord)`

This routine is optional. If provided, it is called by the record support `init_record` routine. If `MASK` is used, it should be shifted if necessary and `SHIFT` given a value.

### *get\_ioint\_info*

```
get_ioint_info(int cmd, struct dbCommon *precord, IOSCANPVT *ppvt)
```

This routine is called by the `ioEventScan` system each time the record is added or deleted from an I/O event scan list. `cmd` has the value (0,1) if the record is being (added to, deleted from) an I/O event list. It must be provided for any device type that can use the `ioEvent` scanner.

### *write\_mbbo*

```
write_mbbo(precord)
```

This routine must output a new value. It returns the following values:

- **0:** Success.
- **Other:** Error.

---

## 7. Device Support For Soft Records

---

This module writes the current value of `VAL`.

If the `OUT` link type is `PV_LINK`, then `dbCaAddInlink` is called by `init_record`.

`write_mbbo` calls `recGblPutLinkValue` to write the current value of `VAL`. See Chapter 3, Section "Soft Output" on page 13 for details.

---

# Chapter 22: *mbbiDirect* - MultiBit Binary Input Direct

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---

## 1. Introduction

---

The `mbbiDirect` record retrieves a sixteen bit hardware value and converts it to an array of sixteen unsigned characters, each representing a bit of the word. These fields (B0-B15) are set to one if a bit is set, and zero if not. This record's operation is similar to that of an `mbbi`, and it has many fields in common with it.

---

## 2. Field Summary

---

| Field | Type   | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|--------|-----|---------|--------|--------|------------------|-----|
| VAL   | USHORT | No  | 0       | Yes    | No     | Yes              | Yes |
| NOBT  | SHORT  | Yes | 0       | Yes    | No     |                  | No  |
| INP   | INLINK | Yes | 0       | No     | No     | N/A              | No  |
| RVAL  | ULONG  | No  | 0       | Yes    | Yes    | Yes              | Yes |
| ORAW  | ULONG  | No  | 0       | Yes    | No     | No               | No  |
| MASK  | ULONG  | No  | 0       | Yes    | No     | No               | No  |
| MLST  | USHORT | No  | 0       | Yes    | No     | No               | No  |
| LALM  | USHORT | No  | 0       | Yes    | No     | No               | No  |
| SDEF  | SHORT  | No  | 0       | Yes    | No     | No               | No  |
| SHFT  | USHORT | No  | 0       | Yes    | No     | No               | No  |

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| SIOL  | INLINK    | Yes | 0       | No     | No     | No               | No  |
| SVAL  | USHORT    | No  | 0       | Yes    | Yes    | No               | No  |
| SIML  | INLINK    | Yes | 0       | No     | No     | No               | No  |
| SIMM  | GBLCHOICE | No  | 0       | Yes    | Yes    | No               | No  |
| SIMS  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| B0    | UCHAR     | Yes | 0       | Yes    | Yes    | Yes              | Yes |
| B1    | UCHAR     | Yes | 0       | Yes    | Yes    | Yes              | Yes |
| B2    | UCHAR     | Yes | 0       | Yes    | Yes    | Yes              | Yes |
| B3    | UCHAR     | Yes | 0       | Yes    | Yes    | Yes              | Yes |
| B4    | UCHAR     | Yes | 0       | Yes    | Yes    | Yes              | Yes |
| B5    | UCHAR     | Yes | 0       | Yes    | Yes    | Yes              | Yes |
| B6    | UCHAR     | Yes | 0       | Yes    | Yes    | Yes              | Yes |
| B7    | UCHAR     | Yes | 0       | Yes    | Yes    | Yes              | Yes |
| B8    | UCHAR     | Yes | 0       | Yes    | Yes    | Yes              | Yes |
| B9    | UCHAR     | Yes | 0       | Yes    | Yes    | Yes              | Yes |
| BA    | UCHAR     | Yes | 0       | Yes    | Yes    | Yes              | Yes |
| BB    | UCHAR     | Yes | 0       | Yes    | Yes    | Yes              | Yes |
| BC    | UCHAR     | Yes | 0       | Yes    | Yes    | Yes              | Yes |
| BD    | UCHAR     | Yes | 0       | Yes    | Yes    | Yes              | Yes |
| BE    | UCHAR     | Yes | 0       | Yes    | Yes    | Yes              | Yes |
| BF    | UCHAR     | Yes | 0       | Yes    | Yes    | Yes              | Yes |

### 3. Field Descriptions

| Name | Summary        | Description                                                                                                                                                                                                            |
|------|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VAL  | Value Field    | Unless INP is a constant link, this is the value resulting from the record being processed. If INP is a constant, then VAL is initialized to the INP value but can be changed dynamically via dbPutField or dbPutLink. |
| NOBT | Number of Bits | Number of bits set in hardware mask.                                                                                                                                                                                   |
| INP  | Input Link     | This field is used by the device support routines to obtain input. For soft records, it can be a constant, a database link, or a channel access link.                                                                  |

| Name        | Summary                        | Description                                                                                                                                                                                        |
|-------------|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| B0, ..., BF | Bit 0 Value, Bit 1 Value ...   | Each represents a bit of the word.                                                                                                                                                                 |
| RVAL        | Raw Data Value                 | RVAL is the value obtained by the device support routine. Unless the device support routine specifies no conversion, VAL is determined as follows: A temporary variable rval is set equal to RVAL. |
| ORAW        | Old Raw Data Value             | ORAW is used to decide if monitors should be triggered for RVAL at the same time monitors are triggered for changes in VAL.                                                                        |
| MASK        | Mask                           | Mask used by device support routine to read hardware register. Record support sets low order NOBT bits. Device support can shift this value.                                                       |
| SHFT        | Shift                          | Number of bits to shift values obtained from RVAL.                                                                                                                                                 |
| LALM        | Last Alarmed                   | Value when last change of state alarm was issued.                                                                                                                                                  |
| MLST        | Monitor Last                   | Value when last monitor for value changes was triggered.                                                                                                                                           |
| SDEF        | States Defined                 |                                                                                                                                                                                                    |
| SIMM        | Simulation Mode                | Simulation mode process variables. Refer to Chapter 3, Section "Simulation Mode" on page 11 for more information.                                                                                  |
| SIML        | Simulation Mode Location       |                                                                                                                                                                                                    |
| SVAL        | Simulation Value               |                                                                                                                                                                                                    |
| SIOL        | Simulation Value Location      |                                                                                                                                                                                                    |
| SIMS        | Simulation Mode Alarm Severity |                                                                                                                                                                                                    |

## 4. Record Support Routines

### init\_record

This routine initializes SIMM with the value of SIML if SIML type is CONSTANT link or creates a channel access link if SIML type is PV\_LINK. SVAL is likewise initialized if SIOL is CONSTANT or PV\_LINK.

This routine next checks to see that device support is available and a device support read routine is defined. If either does not exist, an error message is issued and processing is terminated.

Clears MASK and then sets the NOBT low order bits.

If device support includes init\_record, it is called.

refresh\_bits is then called to refresh all the bit fields based on a hardware value.

|                  |                                                                                              |
|------------------|----------------------------------------------------------------------------------------------|
| <b>process</b>   | See next section.                                                                            |
| <b>get_value</b> | Fills in the values of struct <code>valueDes</code> so that they refer to <code>VAL</code> . |

---

## 5. Record Processing

---

Routine `process` implements the following algorithm:

1. Check to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the `PACT` field still set to `TRUE`. This ensures that processes will no longer be called for this record. Thus error storms will not occur.
2. `readValue` is called. See Chapter 3, Section "Simulation Mode" on page 11 for details.
3. If `PACT` has been changed to `TRUE`, the device support read routine has started but has not completed reading a new input value. In this case, the processing routine merely returns, leaving `PACT TRUE`.
4. Convert.
  - `status=read_mbbiDirect`
  - `PACT = TRUE`
  - `TIME = tsLocalTime`
  - If `status` is 0, then determine `VAL`
    - Set `rval = RVAL`
    - Shift `rval` right `SHFT` bits
    - Set `VAL = RVAL`
    - If `status` is 1, return(0)
  - If `status` is 2, set `status = 0`
5. Check to see if monitors should be invoked.
  - Alarm monitors are invoked if the alarm status or severity has changed.
  - Archive and value change monitors are invoked if `MLST` is not equal to `VAL`.
  - Monitors for `RVAL` are checked whenever other monitors are invoked.
  - `NSEV` and `NSTA` are reset to 0.
6. Scan forward link if necessary, set `PACT FALSE`, and return.

---

## 6. Device Support

---

### Fields Of Interest To Device Support

Each input record must have an associated set of device support routines. The primary responsibility of the device support routines is to obtain a new raw input value whenever `read_mbbiDirect` is called. The device support routines are primarily interested in the following fields:

| Name | Summary            | Description                                                                                                                                                                                                             |
|------|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PACT | Processing Active  | See Chapter 2, Section "Database Common: Field Descriptions" on page 5 for descriptions.                                                                                                                                |
| DPVT | Device Private     |                                                                                                                                                                                                                         |
| UDF  | VAL Undefined      |                                                                                                                                                                                                                         |
| NSEV | New Alarm Severity |                                                                                                                                                                                                                         |
| NSTA | New Alarm Status   |                                                                                                                                                                                                                         |
| NOBT | Number of Bits     | Number of hardware bits accessed. They must be consecutive.                                                                                                                                                             |
| VAL  | Value Field        | This field is set by the device support routines if they don't want record support to set it.                                                                                                                           |
| INP  | Input Link         | This field is used by the device support routines to locate its input.                                                                                                                                                  |
| RVAL | Raw Data Value     | It is the responsibility of the device support routine to give this field a value.                                                                                                                                      |
| MASK | Mask               | This is a mask used to read the hardware. Record support sets the low order NOBT bits. The device support routine can shift the bits. The device support routine should perform the shift in <code>init_record</code> . |
| SHFT | Shift              | This can be set by the device support module at <code>init_record</code> time.                                                                                                                                          |

### Device Support Routines

Device support consists of the following routines:

*report*

```
report(FILE fp, paddr)
```

Not currently used.

*init*

```
init()
```

This routine is called once during IOC initialization.

*init\_record*

```
init_record(precord)
```



This routine is optional. If provided, it is called by the record support `init_record` routine. If it uses `MASK`, it should shift it as necessary and also give `SHFT` a value.

### *get\_ioint\_info*

```
get_ioint_info(int cmd, struct dbCommon *precord, IOSCANPVT *ppvt)
```

This routine is called by the `ioEventScan` system each time the record is added or deleted from an I/O event scan list. `cmd` has the value (0,1) if the record is being (added to, deleted from) an I/O event list. It must be provided for any device type that can use the `ioEvent` scanner.

### *read\_mbbiDirect*

```
read_mbbiDirect(precord)
```

This routine must provide a new input value. It returns the following values:

- **0:** Success. A new raw value is placed in `RVAL`. The record support module determines `VAL` from `RVAL` and `SHFT`.
- **2:** Success, but don't modify `VAL`.
- **Other:** Error.

---

## 7. Device Support For Soft Records

---

Two soft device support modules `Soft Channel` and `Raw Soft Channel` are provided for multibit binary input direct records not related to actual hardware devices. The `INP` link type must be either `CONSTANT`, `DB_LINK`, or `CA_LINK`.

### **Soft Channel**

`read_mbbiDirect` always returns a value of 2, which means that no conversion is performed.

If the `INP` link type is constant, then the constant value is stored into `VAL` by `init_record`, and `UDF` is set to `FALSE`. `VAL` can be changed via `dbPut` requests. If the `INP` link type is `PV_LINK`, then `dbCaAddInlink` is called by `init_record`.

`read_mbbiDirect` calls `recGblGetLinkValue` to read the current value of `VAL`. See Chapter 3, Section "Soft Input" on page 10 for details.

If the return status of `recGblGetLinkValue` is zero, then `read_mbbi` sets `UDF` to `FALSE`. The status of `recGblGetLinkValue` is returned.

### **Raw Soft Channel**

This module is like the previous except that values are read into `RVAL`, `VAL` is computed from `RVAL`, and `read_mbbiDirect` returns a value of 0. Thus the record processing routine will determine `VAL` in the normal way.

---

# Chapter 23: *mbboDirect* - MultiBit Binary Output Direct

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## 1. Introduction

---

The `mbboDirect` record performs the opposite function to that of the `mbbiDirect` record. It accumulates bits (in the fields B0 - BF) as unsigned characters, and converts them to a word which is then written out to hardware. If a bit field is non-zero, it is interpreted as a binary one. On the other hand, if it is zero, it is interpreted as a binary zero.

---

## 2. Field Summary

---

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| VAL   | USHORT    | No  | 0       | Yes    | No     | Yes              | Yes |
| DOL   | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| OMSL  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| NOBT  | SHORT     | Yes | 0       | Yes    | No     |                  | No  |
| OUT   | OUTLINK   | Yes | 0       | No     | No     | N/A              | No  |
| B0    | UCHAR     | No  | 0       | Yes    | Yes    | No               | Yes |
| B1    | UCHAR     | No  | 0       | Yes    | Yes    | No               | Yes |
| B2    | UCHAR     | No  | 0       | Yes    | Yes    | No               | Yes |
| B3    | UCHAR     | No  | 0       | Yes    | Yes    | No               | Yes |
| B4    | UCHAR     | No  | 0       | Yes    | Yes    | No               | Yes |

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| B5    | UCHAR     | No  | 0       | Yes    | Yes    | No               | Yes |
| B6    | UCHAR     | No  | 0       | Yes    | Yes    | No               | Yes |
| B7    | UCHAR     | No  | 0       | Yes    | Yes    | No               | Yes |
| B8    | UCHAR     | No  | 0       | Yes    | Yes    | No               | Yes |
| B9    | UCHAR     | No  | 0       | Yes    | Yes    | No               | Yes |
| BA    | UCHAR     | No  | 0       | Yes    | Yes    | No               | Yes |
| BB    | UCHAR     | No  | 0       | Yes    | Yes    | No               | Yes |
| BC    | UCHAR     | No  | 0       | Yes    | Yes    | No               | Yes |
| BD    | UCHAR     | No  | 0       | Yes    | Yes    | No               | Yes |
| BE    | UCHAR     | No  | 0       | Yes    | Yes    | No               | Yes |
| BF    | UCHAR     | No  | 0       | Yes    | Yes    | No               | Yes |
| RVAL  | ULONG     | No  | 0       | Yes    | No     | Yes              | Yes |
| ORAW  | ULONG     | No  | 0       | Yes    | No     | No               | No  |
| RBV   | ULONG     | No  | 0       | Yes    | No     | Yes              | No  |
| ORBV  | ULONG     | No  | 0       | Yes    | No     | No               | No  |
| MASK  | ULONG     | No  | 0       | Yes    | No     | No               | No  |
| MLST  | ULONG     | No  | 0       | Yes    | No     | No               | No  |
| LALM  | ULONG     | No  | 0       | Yes    | No     | No               | No  |
| SHFT  | ULONG     | No  | 0       | Yes    | No     | No               | No  |
| SIOL  | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| SIML  | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| SIMM  | GBLCHOICE | No  | 0       | Yes    | Yes    | No               | No  |
| SIMS  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| IVOA  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| IVOV  | USHORT    | Yes | 0       | Yes    | Yes    | No               | No  |

### 3. Field Descriptions

| Name | Summary     | Description                          |
|------|-------------|--------------------------------------|
| VAL  | Value Field | This is the value to be sent to OUT. |

| Name      | Summary                              | Description                                                                                                                                                                                                                                                                                                   |
|-----------|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DOL       | Desired Output Location (Input Link) | If DOL is a database or channel access link and OMSL is CLOSED_LOOP, then VAL is read from DOL.                                                                                                                                                                                                               |
| OMSL      | Output Mode Select                   | This field has either the value SUPERVISORY or CLOSED_LOOP. DOL is used to determine VAL only if OMSL has the value CLOSED_LOOP. By setting this field, the record can be switched between supervisory and closed loop mode of operation. While in closed loop mode, the VAL field cannot be set via dbPut.s. |
| NOBT      | Number of Bits                       | Number of bits in hardware mask.                                                                                                                                                                                                                                                                              |
| OUT       | Output Link                          | This field is used by the device support routines to decide where to send output. For soft records, it can be a constant, a database link, or a channel access link. If the link is a constant, the result is no output.                                                                                      |
| B0,...,BF | Bit 0 Value, Bit 1 Value, ...        | Each represents a bit of the word to be output.                                                                                                                                                                                                                                                               |
| RVAL      | Raw Data Value                       | RVAL is the value to be written to the hardware device. It is determined by the record support module using VAL as the bit values stored in B0,...,BF. The value is also shifted left SHFT bits.                                                                                                              |
| ORAW      | Old Raw Data Value                   | ORAW is used to decide if monitors should be triggered for RVAL at the same time monitors are generated for changes in VAL.                                                                                                                                                                                   |
| RBV       | Read Back Value                      | This is the actual read back value obtained from the hardware itself or from the associated device driver. It is the responsibility of the device support routine to give this field a value                                                                                                                  |
| ORBV      | Old Read Back Value                  | ORBV is used to decide if monitors should be triggered for RBV at the same time monitors are triggered for changes in VAL.                                                                                                                                                                                    |
| MASK      | Mask                                 | Mask used by device support routine to read hardware register. Record support sets low order NOBT bits. Device support can shift this value.                                                                                                                                                                  |
| MLST      | Monitor Last                         | Value when last monitor for value changes was triggered.                                                                                                                                                                                                                                                      |
| LALM      | Last Alarmed                         | Value when last change of state alarm was issued.                                                                                                                                                                                                                                                             |
| SHFT      | Shift                                | Number of bits to shift values obtained from VAL.                                                                                                                                                                                                                                                             |
| SIMM      | Simulation Mode                      | Simulation mode process variables. Refer to Chapter 3, Section "Simulation Mode" on page 13 for more information.                                                                                                                                                                                             |
| SIML      | Simulation Mode Location             |                                                                                                                                                                                                                                                                                                               |
| SIOL      | Simulation Value Location            |                                                                                                                                                                                                                                                                                                               |
| SIMS      | Simulation Mode Alarm Severity       |                                                                                                                                                                                                                                                                                                               |

| Name | Summary                     | Description                                                                                                                                                           |
|------|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| IVOA | Invalid Alarm Output Action | Whenever the record is put into INVALID alarm severity IVOA specifies an action. See Chapter 3, Section "Invalid Alarm Output Action" on page 14 for more information |
| IVOV | Invalid Alarm Output Value  |                                                                                                                                                                       |

## 4. Record Support Routines

### init\_record

This routine initializes *SIMM* if *SIML* is a constant or creates a channel access link if *SIML* is *PV\_LINK*. If *SIOL* is *PV\_LINK* a channel access link is created.

This routine next checks to see that device support is available. The routine next checks to see if the device support write routine is defined. If either device support or the device support write routine does not exist, an error message is issued and processing is terminated.

If *DOL* is a constant, then *VAL* is initialized to its value and *UDF* is set to *FALSE*.

*MASK* is cleared and then the *NOBT* low order bits are set.

If device support includes *init\_record*, it is called.

*init\_common* is then called to determine if any states are defined. If states are defined, *SDEF* is set to *TRUE*.

If device support returns success, *VAL* is then set from *RVAL* and *UDF* is set to *FALSE*.

### process

See next section.

### get\_value

Fills in the values of struct *valueDes* so that they refer to *VAL*.

## 5. Record Processing

Routine *process* implements the following algorithm:

1. Check to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the *PACT* field still set to *TRUE*. This ensures that processes will no longer be called for this record. Thus error storms will not occur.
2. If *PACT* is *FALSE*
  - If *DOL* is *DB\_LINK* and *OMSL* is *CLOSED\_LOOP*
    - Get value from *DOL*
    - Set *PACT* to *FALSE*
3. Convert
  - If *PACT* is *FALSE*, compute *RVAL*
  - Set *RVAL* = *VAL*

- Shift RVAL left SHFT bits
  - Status=write\_mbboDirect
4. If PACT has been changed to TRUE, the device support write output routine has started but has not completed writing the new value. In this case, the processing routine merely returns, leaving PACT TRUE.
  5. Check to see if monitors should be invoked.
    - Alarm monitors are invoked if the alarm status or severity has changed.
    - Archive and value change monitors are invoked if MLST is not equal to VAL.
    - Monitors for RVAL and RBV are checked whenever other monitors are invoked.
    - NSEV and NSTA are reset to 0.
  6. Scan forward link if necessary, set PACT FALSE, and return.

## 6. Device Support

### Fields Of Interest To Device Support

Each mbboDirect record must have an associated set of device support routines. The primary responsibility of the device support routines is to obtain a new raw mbbo value whenever write\_mbboDirect is called. The device support routines are primarily interested in the following fields:

| Name | Summary            | Description                                                                                                                                                                                                  |
|------|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PACT | Processing Active  | See Chapter 2, Section "Database Common: Field Descriptions" on page 5 for descriptions.                                                                                                                     |
| DPVT | Device Private     |                                                                                                                                                                                                              |
| UDF  | VAL Undefined      |                                                                                                                                                                                                              |
| NSEV | New Alarm Severity |                                                                                                                                                                                                              |
| NSTA | New Alarm Status   |                                                                                                                                                                                                              |
| NOBT | Number of Bits     | Number of hardware bits accessed. They must be consecutive.                                                                                                                                                  |
| OUT  | Output Link        | This field is used by the device support routines to locate its output.                                                                                                                                      |
| RVAL | Raw data value     | This is the value to be written to OUT.                                                                                                                                                                      |
| RBV  | Read Back Value    | It is the responsibility of the device support modules to set this field.                                                                                                                                    |
| MASK | Mask               | This is a mask used to read the hardware. Record support sets the low order NOBT bits. The device support routine can shift the bits. The device support routine should perform the shift in in init_record. |
| SHFT | Shift              | This can be set by the device support module at init_record time.                                                                                                                                            |

## Device Support Routines

Device support consists of the following routines:

*report*

```
report(FILE fp, paddr)
```

Not currently used.

*init*

```
init()
```

This routine is called once during IOC initialization.

*init\_record*

```
init_record(precord)
```

This routine is optional. If provided, it is called by the record support `init_record` routine. If `MASK` is used, it should be shifted if necessary and `SHFT` given a value.

*get\_ioint\_info*

```
get_ioint_info(int cmd, struct dbCommon *precord, IOSCANPVT *ppvt)
```

This routine is called by the `ioEventScan` system each time the record is added or deleted from an I/O event scan list. `cmd` has the value (0,1) if the record is being (added to, deleted from) an I/O event list. It must be provided for any device type that can use the `ioEvent` scanner.

*write\_mbboDirect*

```
write_mbboDirect(precord)
```

This routine must output a new value. It returns the following values:

- **0:** Success.
- **Other:** Error.

---

## 7. Device Support For Soft Records

---

This module writes the current value of `VAL`.

If the `OUT` link type is `PV_LINK`, then `dbCaAddInlink` is called by `init_record`.

`write_mbboDirect` calls `recGblPutLinkValue` to write the current value of `VAL`. See Chapter 3, Section "Soft Output" on page 13 for details.

---

# Chapter 24: Permissive

---

## 1. Introduction

---

The permissive record is for communication between a server and a client. An example is a sequence program client and an operator interface server. Two fields are used VAL and WFLG. The method of use is as follows:

1. Initially both VAL and WFLG are 0, which means OFF.
2. When the server is ready to accept a request, it sets WFLG equal to 1, which means ON.
3. The client monitors WFLG. Until it turns ON, the client must not change VAL.
4. When the client wants to notify the server it turns VAL ON.
5. The server notices that VAL is ON. He sets both WFLG and VAL OFF. Performs whatever action is associated with this permissive (a private matter server and client), and when ready to accept a new request sets WFLG ON.

By using multiple permissive records a sequence program can communicate its current state to a client.

---

## 2. Field Summary

---

| Field | Type   | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|--------|-----|---------|--------|--------|------------------|-----|
| LABL  | STRING | Yes | Null    | Yes    | Yes    | No               | Yes |
| VAL   | USHORT | No  | 0       | Yes    | Yes    | Yes              | Yes |
| OVAL  | USHORT | No  | 0       | Yes    | No     |                  | No  |



| Field | Type   | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|--------|-----|---------|--------|--------|------------------|-----|
| WFLG  | USHORT | No  | 0       | Yes    | Yes    | Yes              | Yes |
| OFLG  | USHORT | No  | 0       | Yes    | No     |                  | No  |

### 3. Field Descriptions

| Name | Summary        | Description                                                                                                            |
|------|----------------|------------------------------------------------------------------------------------------------------------------------|
| LABL | Label          | A descriptive string.                                                                                                  |
| VAL  | Value          | Client sets this field when it wants service from server. Only the client should set this field. The server clears it. |
| OVAL | Old Value      | Used to decide if monitors should be triggered. Value change monitors are invoked if OVAL is not equal to VAL.         |
| WFLG | Watchdog Flag  | Server sets this field when it is ready to accept a request. Only the server should modify this field.                 |
| OFLG | Old Flag Value | Used to decide if monitors should be triggered.                                                                        |

### 4. Record Support Routines

Two record support routines are provided: `process`, and `get_value`.

#### **process**

`process` sets UDF to FALSE, triggers monitors on VAL and WFLG when they change, and scans the forward link if necessary.

#### **get\_value**

`get_value` fills in struct `valueDes` so that it refers to VAL.

---

# Chapter 25: pid - PID Control

---

## 1. Introduction

---

The pid record type provides a Proportional, Integral, and Derivative (PID) control algorithm. A discrete form of the PID algorithm is:

$$M_n = KP * (E_n + KI * \text{SUM}_i (E_i * dT_i)) + KD * (E_n - E_{n-1})/dT_n + Mr$$

Where:

- $M_n$ : Value of manipulated variable at nth sampling instant
- KP, KI, KD: Proportional, Integral, and Derivative gains
- $E_n$ : Error at nth sampling instant
- $\text{SUM}_i$ : Sum from  $i=0$  to  $i=n$
- $dT_n$ : Time difference between  $n-1$  and  $n$
- Mr: Midrange adjustment

Taking the first difference yields:

$$\text{delM}(n) = KP * ((E_n - E_{n-1}) + E_n * dT_n * KI + KD * ((E_n - E_{n-1})/dT_n - (E_{n-1} - E_{n-2})/dT_{n-1}))$$

For this record:

- DM: This is  $\text{delM}(n)$
- VAL: This is the setpoint
- CVAL: This is current value
- ERR:  $E_n = \text{VAL} - \text{CVAL}$

## 2. Field Summary

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| VAL   | FLOAT     | No  | 0       | Yes    | Yes    | Yes              | Yes |
| CVL   | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| STPL  | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| SMSL  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| PREC  | SHORT     | Yes | 0       | Yes    | Yes    | No               | No  |
| MDT   | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| KP    | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| KI    | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| KD    | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| EGU   | STRING    | Yes | Null    | Yes    | Yes    | No               | No  |
| HOPR  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| LOPR  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| HIHI  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| LOLO  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| HIGH  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| LOW   | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| HHSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| LLSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| HSV   | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| LSV   | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| HYST  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| ADEL  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| MDEL  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| ODEL  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| CVAL  | FLOAT     | No  | 0       | Yes    | Yes    | No               | No  |
| DM    | FLOAT     | No  | 0       | Yes    | No     | Yes              | No  |
| ODM   | FLOAT     | No  | 0       | Yes    | No     | Yes              | No  |
| P     | FLOAT     | No  | 0       | Yes    | No     | Yes              | No  |
| I     | FLOAT     | No  | 0       | Yes    | No     | Yes              | No  |
| D     | FLOAT     | No  | 0       | Yes    | No     | Yes              | No  |

| Field | Type  | DCT | Initial | Access | Modify | RecProc Monitor | PP |
|-------|-------|-----|---------|--------|--------|-----------------|----|
| CT    | ULONG | No  | 0       | Yes    | No     | Yes             | No |
| DT    | FLOAT | No  | 0       | Yes    | No     | Yes             | No |
| ERR   | FLOAT | No  | 0       | Yes    | No     | Yes             | No |
| DERR  | FLOAT | No  | 0       | Yes    | No     | Yes             | No |
| LALM  | FLOAT | No  | 0       | Yes    | No     | No              | No |
| ALST  | FLOAT | No  | 0       | Yes    | No     | No              | No |
| MLST  | FLOAT | No  | 0       | Yes    | No     | No              | No |

### 3. Field Descriptions

| Name | Summary                                | Description                                                                                                                                                                                                                                       |
|------|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VAL  | Setpoint Value, in engineering units   | This is the value that the control algorithm attempts to achieve.                                                                                                                                                                                 |
| CVL  | Controlled Value Location (input link) | This is a link specifying the location of the controlled variable. This must be a database link. Each time the record is processed the current value referenced by CVL is read into CVAL.                                                         |
| STPL | Setpoint Location (input link)         | If STPL is a database or channel access link and SMSL is CLOSED_LOOP, then VAL is read from STPL. STPL and SMSL act just like DOL and OMSL.                                                                                                       |
| SMSL | Setpoint Mode Select                   | This is SUPERVISORY or CLOSED_LOOP. VAL is obtained from STPL only when this is CLOSED_LOOP. By setting this field, the record can be switched between supervisory and closed loop. Note that closed loop is useful for cascaded control records. |
| PREC | Display Precision                      | Precision with which to display VAL. This field is used by record support to supply a value when <code>get_precision</code> is called.                                                                                                            |
| MDT  | Minimum Delta Time, in seconds         | Minimum time difference between processing in seconds. If this is zero, the minimum time is one clock tick.                                                                                                                                       |
| KP   | Proportional Gain                      |                                                                                                                                                                                                                                                   |
| KI   | Integral Gain, in repeats per minute   | The number of times per minute that the integral contribution repeats the proportional contribution.                                                                                                                                              |
| KD   | Derivative Gain, in minutes per repeat | The number of minutes until the derivative contribution repeats the proportional contribution.                                                                                                                                                    |
| EGU  | Engineering Units                      | ASCII string describing Engineering units. This field is used by record to supply a units description string when <code>get_units</code> is called.                                                                                               |

| Name | Summary                                            | Description                                                                                                                                                                                                                                                                |
|------|----------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| HOPR | High Operating Range                               | These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are used by record support to honor calls to <code>get_graphic_double</code> or <code>get_control_double</code> .  |
| LOPR | Low Operating Range                                |                                                                                                                                                                                                                                                                            |
| HIHI | Hihi Alarm Limit                                   | These fields specify the alarm limits and severities.                                                                                                                                                                                                                      |
| HIGH | High Alarm Limit                                   |                                                                                                                                                                                                                                                                            |
| LOW  | Low Alarm Limit                                    |                                                                                                                                                                                                                                                                            |
| LOLO | Lolo Alarm Limit                                   |                                                                                                                                                                                                                                                                            |
| HHSV | Severity for a Hihi Alarm                          |                                                                                                                                                                                                                                                                            |
| HSV  | Severity for a High Alarm                          |                                                                                                                                                                                                                                                                            |
| LSV  | Severity for a Low Alarm                           |                                                                                                                                                                                                                                                                            |
| LLSV | Severity for a Lolo Alarm                          |                                                                                                                                                                                                                                                                            |
| HYST | Alarm Deadband                                     | These parameters specify hysteresis factors for triggering monitor callbacks, i.e. monitors specified by calls to <code>caAddEvent</code> or <code>dbAddEvent</code> . A monitor will not be triggered until VAL changes by more than the specified amount.                |
| ADEL | Archive Deadband                                   |                                                                                                                                                                                                                                                                            |
| MDEL | Monitor, i.e. value change, Deadband               |                                                                                                                                                                                                                                                                            |
| ODEL | Output Delta                                       | This parameter specifies a hysteresis factor for triggering monitor callbacks for DM, P, I, D, CT, DT, ERR, and DERR. It refers to the change in DM. Whenever monitors are triggered for DM, monitors for the other fields are also triggered.                             |
| CVAL | Value of Controlled Variable, in engineering units | This value is obtained from CVL each time the record is processed.                                                                                                                                                                                                         |
| DM   | Change in Manipulated Variable                     | This is the value computed by the pid algorithm. It is an increment to be added to the controller output. Note that in most cases this will be read via the DOL field of an analog output record. The analog output record will be configured with OIF set to incremental. |
| ODM  | Old DM                                             | ODM is used to decide if monitors should be triggered for DM.                                                                                                                                                                                                              |
| P    | Proportional contribution                          | Proportional contribution to DM, in engineering units.                                                                                                                                                                                                                     |
| I    | Integral contribution to DM, in repeats per minute | The number of times per minute that the integral contribution repeats the proportional contribution.                                                                                                                                                                       |

| Name | Summary                                                   | Description                                                                                    |
|------|-----------------------------------------------------------|------------------------------------------------------------------------------------------------|
| D    | Derivative contribution to DM, in minutes                 | The number of minutes until the derivative contribution repeats the proportional contribution. |
| CT   | Clocks Ticks                                              | Clock ticks when previous process occurred.                                                    |
| DT   | Time difference                                           | Time difference in seconds between processing steps.                                           |
| ERR  | Error                                                     | Current error (VAL - CVAL).                                                                    |
| DERR | Delta Error                                               | Change in error since last time step.                                                          |
| LALM | Value when last monitors for alarm were triggered         | These fields are used to implement the hysteresis factors for monitors.                        |
| ALST | Value when last monitors for archiver were triggered      |                                                                                                |
| MLST | Value when last monitors for value changes were triggered |                                                                                                |

#### 4. Record Support Routines

##### **init\_record**

This routine initializes VAL with the value of STPL and sets UDF to FALSE if STPL type is CONSTANT link or creates a channel access link if STPL type is PV\_LINK.

##### **process**

See next section.

##### **get\_value**

Fills in the values of struct valueDes so that they refer to VAL.

##### **get\_units**

Retrieves EGU.

##### **get\_precision**

Retrieves PREC.

##### **get\_graphic\_double**

Sets the upper display and lower display limits for a field. If the field is P, I, D, CVAL, VAL, HIHI, HIGH, LOW, or LOLO, the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

**get\_control\_double** Sets the upper control and the lower control limits for a field. If the field is P, I, D, CVAL, VAL, HIHI, HIGH, LOW, or LOLO, the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

**get\_alarm\_double** Sets the following values:

```
upper_alarm_limit = HIHI
upper_warning_limit = HIGH
lower_warning_limit = LOW
lower_alarm_limit = LOLO
```

---

## 5. Record Processing

---

Routine `process` implements the following algorithm:

1. If CVAL is not a database link, a major alarm is declared and the algorithm completes.
2. The current value of CVAL is obtained from CVL.
3. If STPL is a database or channel access link and SMSL is CLOSED\_LOOP, then VAL is obtained from STPL and UDF is set to FALSE.
4. The time difference since the last time step is calculated. If it is less than MDT or if no ticks have occurred since the last time the algorithm was executed, process just completes without raising any alarms, checking monitors, or scanning the forward link.
5. The new values of P, I, D, OUT, CT, DT, ERR, and DERR are computed.
6. Check alarms. This routine checks to see if the new VAL causes the alarm status and severity to change. If so, NSEV, NSTA and LALM are set. It also honors the alarm hysteresis factor (HYST). Thus the value must change by more than HYST before the alarm status and severity is lowered.
7. Check to see if monitors should be invoked.
  - Alarm monitors are invoked if the alarm status or severity has changed.
  - Archive and value change monitors are invoked if ADEL and MDEL conditions are met.
  - Value change monitors on DM are invoked if ODEL conditions are met. If monitors are triggered from DM, they are also triggered for P, I, D, CT, DT, ERR, and DERR.
  - NSEV and NSTA are reset to 0.
8. Scan forward link if necessary, set PACT FALSE, and return.

---

# Chapter 26: *pulseCounter*

---

## 1. Introduction

---

The normal use for the pulseCounter record type is to record counts.

---

## 2. Field Summary

---

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP |
|-------|-----------|-----|---------|--------|--------|------------------|----|
| VAL   | ULONG     | No  | 0       | Yes    | Yes    | Yes              | No |
| OUT   | OUTLINK   | Yes | 0       | No     | No     | N/A              | No |
| GTYP  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | No |
| HGV   | SHORT     | Yes | 0       | Yes    | Yes    | No               | No |
| SGL   | INLINK    | Yes | 0       | No     | No     | N/A              | No |
| SGV   | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | No |
| OSGV  | SHORT     | No  | 0       | Yes    | No     |                  | No |
| CSIZ  | RECCHOICE | Yes | 1       | Yes    | Yes    |                  | No |
| CNTE  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | No |
| CNTS  | SHORT     | Yes | 0       | Yes    | Yes    | No               | No |
| HOPR  | FLOAT     | Yes | 4.3e+9  | Yes    | Yes    | No               | No |
| LOPR  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No |



| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| CMD   | RECCHOICE | No  | 0       | Yes    | Yes    | Yes              | Yes |
| SCMD  | USHORT    | No  | 0       | Yes    | No     |                  | No  |
| CPTR  | ULONG     | No  | 0       | Yes    | No     |                  | No  |

### 3. Field Descriptions

| Name | Summary                         | Description                                                                                                                                                                                                                                                                                                                                                                   |
|------|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VAL  | Counter Value                   | The read command places the current value of the counter into the VAL field.                                                                                                                                                                                                                                                                                                  |
| OUT  | Output Link                     | This field is used by the device support routines to decide where to send output. For soft records, it can be a constant, a database link, or a channel access link. If the link is a constant, the result is no output.                                                                                                                                                      |
| GTYP | Gate Type                       | This can be Hardware or software. If GTYP is hardware, then HGV determines gating control. If GTYP is software, the SGV determines gating control.                                                                                                                                                                                                                            |
| HGV  | Hardware Gate Value             | If GTYP is hardware, then this field is device dependent.                                                                                                                                                                                                                                                                                                                     |
| SGL  | Soft Gate Location (Input Link) | If SGL is a database link and GTYP is software, then SGV will be set to the value read from SGL.                                                                                                                                                                                                                                                                              |
| SGV  | Soft Gate Value                 | This can be inactive or active. This will enable and disable counting if GTYP is software.                                                                                                                                                                                                                                                                                    |
| OSGV | Old Soft Gate Value             | This is the previous value of SGV.                                                                                                                                                                                                                                                                                                                                            |
| CSIZ | Counter size                    | 16 bit or 32 bit counter.                                                                                                                                                                                                                                                                                                                                                     |
| CNTE | Count Edge                      | This can be Rising Edge or Falling Edge. This field forces counting on rising or falling edge of source signal.                                                                                                                                                                                                                                                               |
| CNTS | Count Source                    |                                                                                                                                                                                                                                                                                                                                                                               |
| HOPR | High Operating Range            | These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are used by record support routines to honor calls to <code>get_graphic_double</code> or <code>get_control_double</code> .                                                                                            |
| LOPR | Low Operating Range             |                                                                                                                                                                                                                                                                                                                                                                               |
| CMD  | Command                         | <p><b>Read:</b> Read the current value of the counter.</p> <p><b>Clear:</b> Clear the counter. Note that the counter is also stopped. The Start command must be issued to restart the counter.</p> <p><b>Start:</b> Start counting.</p> <p><b>Stop:</b> Stop counting.</p> <p><b>Setup:</b> Setup the counter. Counting will not begin until the Start command is issued.</p> |

| Name | Summary      | Description                     |
|------|--------------|---------------------------------|
| SCMD | Save Command | This is the saved value of CMD. |
| CPTR | Callback     |                                 |

---

## 4. Record Support Routines

---

**init\_record**

This routine next checks to see that device support is available. If it does not exist, an error message is issued and processing is terminated.

If `SGL` is a constant and `GTYP` is software, then `SGV` is initialized with its value. If `SGL` type is `PV_LINK` a channel access link is created.

Device support is then checked to see if `cmd_pc` is defined.

If device support includes `init_record`, it is called.

**process**

See next section.

**get\_value**

Fills in the values of `struct valueDes` so that they refer to `VAL`.

**get\_graphic\_double**

Sets the upper display and lower display limits for a field. If the field is `VAL` the limits are set to `HOPR` and `LOPR`, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

**get\_control\_double**

Sets the upper control and the lower control limits for a field. If the field is `VAL` the limits are set to `HOPR` and `LOPR`, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

---

## 5. Record Processing

---

The routine `process` implements the following algorithm:

1. Check to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the `PACT` field still set to `TRUE`. This ensures that processes will no longer be called for this record. Thus error storms will not occur.
2. If `SGL` is `DB_LINK` and `GTYP` is Software, get `SGV` from `SGL`. If `SGV` has changed, save the `CMD` value, call the command routine with `START` if `SGV = 0` or with `STOP` if `SGV` is 1, reset the command to the saved value, and set alarms if return status not zero. If the device is not done (`PACT TRUE`), then issue a callback request for this record to process and return

3. If `CMD` is not `READ`, call command routine and set `CMD` to `READ`. If the device is not done (`PACT TRUE`), then issue a callback request for this record to process again and return.
4. Call command routine. If device support set `PACT` to `TRUE`, then return.
5. Check to see if monitors should be invoked.
  - Alarm monitors are invoked if the alarm status or severity has changed.
  - Archive and value change monitors on `CMD` are invoked if values have changed.
  - `NSEV` and `NSTA` are reset to 0.
6. Scan forward link if necessary, set `PACT FALSE`, and return.

## 6. Device Support

### Fields Of Interest To Device Support

Each record must have an associated set of device support routines. The primary responsibility of the device support routines is to issue commands to the output device. The device support routines are primarily interested in the following fields:

| Name                  | Summary      | Description                                                                                                                                                                      |
|-----------------------|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>CSIZ</code>     | Counter size | This will determine to a 16 bit or 32 bit count is to be used. With 32 bit, two counters are used.                                                                               |
| <code>CMD</code>      | Command      | The device support routine is responsible for processing the commands <code>READ</code> , <code>CLEAR</code> , <code>START</code> , <code>STOP</code> , and <code>SETUP</code> . |
| <code>GTYP,IGV</code> | Gate Type    | If <code>GTYP</code> is internal, device support is responsible for using <code>IGV</code> to determine gating control.                                                          |
| <code>CNTE</code>     | Count Edge   | This field is used by the device support routines to force counting on leading or falling edge of signal.                                                                        |
| <code>CNTS</code>     | Count Source | Device support must use <code>CNTS</code> to set count source during setup.                                                                                                      |

### Device Support Routines

Device support consists of the following routines:

*report*

`report()`

This routine is optional. If provided, it prints a report of all device modules.

*init*

`init()`

This routine is called once during IOC initialization.

*init\_record*

`init_record(record)`

This routine is optional. If provided, it is called by the record support `init_record` routine.

*get\_ioint\_info*

```
get_ioint_info(int cmd, struct dbCommon *precord, IOSCANPVT *ppvt)
```

This routine is called by the `ioEventScan` system each time the record is added or deleted from an I/O event scan list. `cmd` has the value (0,1) if the record is being (added to, deleted from) an I/O event list. It must be provided for any device type that can use the `ioEvent` scanner.

*cmd\_pc*

```
cmd_pc (precord)
```

This routine issues commands to the output device. It returns the following values:

- **0:** Success.
- **Other:** Error.



---

# Chapter 27: *pulseDelay*

---

## 1. Introduction

---

The normal use for the `pulseDelay` record type is to generate output pulses.

---

## 2. Field Summary

---

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| OUT   | OUTLINK   | Yes | 0       | No     | No     | N/A              | No  |
| UNIT  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| DLY   | DOUBLE    | Yes | 0       | Yes    | Yes    | Yes              | Yes |
| WIDE  | DOUBLE    | Yes | 0       | Yes    | Yes    | Yes              | Yes |
| ODLY  | DOUBLE    | No  | 0       | Yes    | No     |                  | No  |
| OWID  | DOUBLE    | No  | 0       | Yes    | No     |                  | No  |
| CTYP  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| CEDG  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| ECS   | SHORT     | Yes | 0       | Yes    | Yes    | No               | No  |
| ECR   | DOUBLE    | Yes | 0       | Yes    | Yes    | No               | No  |
| VAL   | RECCHOICE | No  | 0       | Yes    | Yes    | Yes              | No  |
| PFLD  | USHORT    | No  | 0       | Yes    | No     |                  | No  |

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| LLOW  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| TTYD  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| HTS   | ENUM      | Yes | 0       | Yes    | Yes    | No               | Yes |
| STL   | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| STV   | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| HOPR  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| LOPR  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| PREC  | SHORT     | Yes | 0       | Yes    | Yes    | No               | No  |
| GATE  | RECCHOICE | Yes | 1       | Yes    | Yes    | No               | Yes |
| GLNK  | INLINK    | Yes | 0       | Yes    | No     | N/A              | No  |

### 3. Field Descriptions

| Name | Summary                       | Description                                                                                                                                                                                                              |
|------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OUT  | Output Link                   | This field is used by the device support routines to decide where to send output. For soft records, it can be a constant, a database link, or a channel access link. If the link is a constant, the result is no output. |
| UNIT | Time units                    | Time units of delay and width. (Seconds, Milliseconds, Microseconds, Nanoseconds, Picoseconds).                                                                                                                          |
| DLY  | Pulse Delay, in UNITS of time | Delay after trigger edge until beginning of pulse.                                                                                                                                                                       |
| WIDE | Pulse Width, in UNITS of time | Width of pulse generated.                                                                                                                                                                                                |
| ODLY | Old Delay                     | Value when last monitors for delay were triggered.                                                                                                                                                                       |
| OWID | Old Width                     | Value when last monitors for width were triggered.                                                                                                                                                                       |
| CTYP | Clock Type                    | Hardware/Software. If software selected, then clock automatically determined by software. If hardware selected, then clock determined by ECS and ECR.                                                                    |
| CEDG | Clock Signal Edge             | This can be Rising Edge or Falling Edge. This field forces clock timing on rising or falling edge of source signal.                                                                                                      |
| ECS  | External Clock Source         | If CTYP is internal, this field is ignored. If CTYP is external, then this field is device dependent.                                                                                                                    |
| ECR  | External Clock Rate, in Hz    | Clock rate for external clock source.                                                                                                                                                                                    |

| Name | Summary                                            | Description                                                                                                                                                                                                                                                               |
|------|----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VAL  | Value                                              | This field will contain value 1 if a trigger was detected since the last time the record was processed and a 0 otherwise.                                                                                                                                                 |
| PFLD | Processing Field                                   | This field is set to indicate if which of the following fields changed since last processed: DLY, WIDE, STV, GATE, or HTS.                                                                                                                                                |
| LLOW | Low Logic Level                                    | 0: Logic Low=0<br>1: Logic Low=1                                                                                                                                                                                                                                          |
| TTYP | Trigger Type.<br>(Hardware/<br>Software)           | This field indicates where the pulse trigger will come from. Hardware indicates HTS will be used, software will use STL, STV.                                                                                                                                             |
| HTS  | Hardware Trigger<br>source                         | The source of the delayed pulse trigger.                                                                                                                                                                                                                                  |
| STL  | Soft Trigger<br>Location (Input<br>link)           | This value for STV will be read from here if this is set.                                                                                                                                                                                                                 |
| STV  | Soft Trigger Value                                 | This can be enabled or disabled. This will trigger a delayed pulse if TTYP set to software and device allows it.                                                                                                                                                          |
| HOPR | High Operating<br>Range                            | These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are used by record support to honor calls to <code>get_graphic_double</code> or <code>get_control_double</code> . |
| LOPR | Low Operating<br>Range                             |                                                                                                                                                                                                                                                                           |
| PREC | Display Precision                                  | Precision with which to display DLY. This field is used by record support to supply a value when <code>get_precision</code> is called.                                                                                                                                    |
| GATE | Gate for enable/<br>disable of pulse<br>generation | This field can be used to enable and disable the pulses.                                                                                                                                                                                                                  |
| GLNK | Gate Location                                      | This field is used to determine where to get the value for GATE.                                                                                                                                                                                                          |

## 4. Record Support Routines

### **init\_record**

This routine first checks that device support is available. Device support is then checked to see if `write_pd` is defined.

Next this routine initializes STV with the value of STL if STL type is CONSTANT link or creates a channel access link if STL type is PV\_LINK.

GATE is likewise initialized if GLNK is CONSTANT or PV\_LINK.

If device support includes `init_record`, it is called.



|                           |                                                                                                                                                                                                                                                                                                     |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>process</b>            | See next section.                                                                                                                                                                                                                                                                                   |
| <b>special</b>            | Sets the PFLD field to indicate if write to DLY, STV, GATE or HTS field caused processing of the record.                                                                                                                                                                                            |
| <b>get_value</b>          | Fills in the values of struct valueDes so that they refer to VAL.                                                                                                                                                                                                                                   |
| <b>get_precision</b>      | Retrieves PREC.                                                                                                                                                                                                                                                                                     |
| <b>get_graphic_double</b> | Sets the upper display and lower display limits for a field. If the field is VAL, DLY, ODLY, WIDE or OWID the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.     |
| <b>get_control_double</b> | Sets the upper control and the lower control limits for a field. If the field is VAL, DLY, ODLY, WIDE or OWID the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used. |

---

## 5. Record Processing

---

Routine process implements the following algorithm:

1. Check to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the PACT field still set to TRUE. This ensures that processes will no longer be called for this record. Thus error storms will not occur.
2. The values for STV and GATE are then fetched.
3. Call write\_pd routine.
4. PFLD is reset to zero.
5. If device support set PACT to TRUE, then return.
6. Set UDF to FALSE.
7. Check to see if monitors should be invoked.
  - Alarm monitors are invoked if the alarm status or severity has changed.
  - Archive and value change monitors on DLY and WIDE are invoked if values have changed.
  - NSEV and NSTA are reset to 0.
8. Scan forward link if necessary, set PACT FALSE, and return.

## 6. Device Support

### Fields Of Interest To Device Support

Each record must have an associated set of device support routines. The primary responsibility of the device support routines is to issue commands to the output device. The device support routines are primarily interested in the following fields:

| Name | Summary                 | Description                                                                                                                                                                                                                                                                        |
|------|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OUT  | Output Link             | This field is used by the device support routines to locate its output.                                                                                                                                                                                                            |
| WIDE | Pulse Width             | Device support must use WIDE for pulse width                                                                                                                                                                                                                                       |
| DLY  | Pulse Delay             | Device support must use DLY for the delay after trigger edge until beginning of pulse.                                                                                                                                                                                             |
| LLOW | Low Logic Level         | Device support must use to determine logic low level.                                                                                                                                                                                                                              |
| UNIT | Time Units              | All values that refer to time measure will be in this time unit.                                                                                                                                                                                                                   |
| VAL  | Value                   | This field will contain a 1 if a trigger occurred since the last time the record was processed if the device supports it.                                                                                                                                                          |
| PFLD | Processing Field        | This field is used by some devices to indicate if the record was scanned to adjust certain fields such as delay or trigger source. If the device has a destructive read, then changes to these types of fields will only could writes to the device instead of a read and a write. |
| TTYP | Trigger Type            | This field is used by the device support routines to force triggering on leading or falling edge of signal if the specified device supports it.                                                                                                                                    |
| HTS  | Hardware Trigger Source | This field will be used to set the hardware trigger source if the device supports it.                                                                                                                                                                                              |
| STV  | Soft Trigger Source     | This field will be used for software to trigger an output delayed pulse if the device supports it.                                                                                                                                                                                 |
| CEDG | Clock Signal Edge       | This field is used by the device support routines to force clock timing on leading or falling edge of signal.                                                                                                                                                                      |
| CTYP | Clock Type              | If CTYP is external, device support is responsible for using ECR for the clock rate and if CTYP is internal, ECS is the clock source.                                                                                                                                              |
| ECS  | External Clock Source   |                                                                                                                                                                                                                                                                                    |
| ECR  | External Clock Rate     |                                                                                                                                                                                                                                                                                    |

### Device Support Routines

Device support consists of the following routines:

*report*

`report()`

This routine is optional. If provided, it prints a report of all device modules.

*init*

`init()`

This routine is called once during IOC initialization.

*init\_record*

`init_record(precord)`

This routine is optional. If provided, it is called by the record support `init_record` routine.

*get\_ioint\_info*

`get_ioint_info(int cmd, struct dbCommon *precord, IOSCANPVT *ppvt)`

This routine is called by the `ioEventScan` system each time the record is added or deleted from an I/O event scan list. `cmd` has the value (0,1) if the record is being (added to, deleted from) an I/O event list. It must be provided for any device type that can use the `ioEvent` scanner.

*write\_pd*

`write_pd(precord)`

This routine issues commands to the output device.

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# Chapter 28: *pulseTrain*

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## 1. Introduction

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The normal use for the `pulseTrain` record type is to generate an output pulse train.

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## 2. Field Summary

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| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| OUT   | OUTLINK   | Yes | 0       | No     | No     | N/A              | No  |
| UNIT  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| PER   | DOUBLE    | Yes | 0       | Yes    | Yes    | Yes              | No  |
| DCY   | DOUBLE    | Yes | 0       | Yes    | Yes    | Yes              | No  |
| OPER  | DOUBLE    | No  | 0       | Yes    | No     |                  | Yes |
| ODCY  | DOUBLE    | No  | 0       | Yes    | No     |                  | Yes |
| GTYP  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| HGV   | SHORT     | Yes | 0       | Yes    | Yes    | No               | No  |
| SGL   | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| SGV   | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| OSGV  | SHORT     | No  | 0       | Yes    | No     |                  | No  |
| VAL   | SHORT     | No  | 0       | Yes    | Yes    | Yes              | Yes |

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP |
|-------|-----------|-----|---------|--------|--------|------------------|----|
| CTYP  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | No |
| CEDG  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | No |
| ECS   | SHORT     | Yes | 0       | Yes    | Yes    | No               | No |
| ECR   | DOUBLE    | Yes | 0       | Yes    | Yes    | No               | No |
| HOPR  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No |
| LOPR  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No |
| PREC  | SHORT     | Yes | 0       | Yes    | Yes    | No               | No |
| LLOW  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | No |

### 3. Field Descriptions

| Name | Summary                         | Description                                                                                                                                                                                                              |
|------|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| OUT  | Output Link                     | This field is used by the device support routines to decide where to send output. For soft records, it can be a constant, a database link, or a channel access link. If the link is a constant, the result is no output. |
| UNIT | Units of time                   | Units of time (Seconds, milliseconds, microseconds, nanoseconds, picoseconds).                                                                                                                                           |
| PER  | Period, in UNITS                | Pulse train period.                                                                                                                                                                                                      |
| DCY  | Duty Cycle, percent             | Percent of time that signal is high.                                                                                                                                                                                     |
| OPER | Old Period, in UNITS            | Value when last monitors for period were triggered.                                                                                                                                                                      |
| ODCY | Old Duty Cycle, percent         | Value when last monitors for duty cycle were triggered.                                                                                                                                                                  |
| GTYP | Gate Type                       | This can be hardware or software. If GTYP is hardware, then HGV determines gating control. If GTYP is software, the SGV determines gating control.                                                                       |
| HGV  | Hardware Gate Value             | This field is device dependant.                                                                                                                                                                                          |
| SGL  | Soft Gate Location (Input Link) | If SGL is a database link and GTYP is software, then SGV will be set to the value read from SGL.                                                                                                                         |
| SGV  | Soft Gate Value                 | This can be inactive (no gating) or active.                                                                                                                                                                              |
| OSGV | Old Soft Gate Value             | This is the previous value of SGV.                                                                                                                                                                                       |
| VAL  | Value                           | This field is not used.                                                                                                                                                                                                  |
| CTYP | Clock Type                      | This can be internal or external.                                                                                                                                                                                        |

| Name | Summary                    | Description                                                                                                                                                                                                                                                               |
|------|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CEDG | Clock Signal Edge          | This can be Rising Edge or Falling Edge. This field forces counting on rising or falling edge of source signal.                                                                                                                                                           |
| ECS  | External Clock Source      | If CTYP is internal, this field is ignored. If CTYP is external, then this field is device dependent.                                                                                                                                                                     |
| ECR  | External Clock Rate, in Hz | Clock rate for external clock source.                                                                                                                                                                                                                                     |
| HOPR | High Operating Range       | These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are used by record support to honor calls to <code>get_graphic_double</code> or <code>get_control_double</code> . |
| LOPR | Low Operating Range        |                                                                                                                                                                                                                                                                           |
| PREC | Display Precision          | Precision with which to display DLY. This field is used by record support to supply a value when <code>get_precision</code> is called.                                                                                                                                    |
| LLOW | Low Logic Level            | Logic Low=0<br>Logic Low=1                                                                                                                                                                                                                                                |

#### 4. Record Support Routines

##### **init\_record**

This routine first checks that device support is available. If SGL is a constant then HGV is initialized with its value or a channel access link is created if SGL type is PV\_LINK.

Device support is then checked to see if `write_pt` is defined.

If device support includes `init_record`, it is called.

##### **process**

See next section.

##### **get\_value**

Fills in the values of struct `valueDes` so that they refer to VAL.

##### **get\_precision**

Retrieves PREC.

##### **get\_graphic\_double**

Sets the upper display and lower display limits for a field. If the field is VAL, PER, or OPER the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

##### **get\_control\_double**

Sets the upper control and the lower control limits for a field. If the field is VAL or PER the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

## 5. Record Processing

Routine `process` implements the following algorithm:

1. Check to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the `PACT` field still set to `TRUE`. This ensures that processes will no longer be called for this record. Thus error storms will not occur.
2. If `SGL` is `DB_LINK` and `GTYP` is `Software`, get `SGV` from `SGL`. If `SGV` has changed, save the duty cycle `DCY` value, call the `write_pt` routine with duty cycle =0, reset the duty cycle to the saved value, and set alarms if return status not zero. Then set the old soft gate value `OSGV` to `SGV`.
3. Call `write_pt` routine. If device support set `PACT` to `TRUE`, then return.
4. Set `UDF` to `FALSE`.
5. Check to see if monitors should be invoked.
  - Alarm monitors are invoked if the alarm status or severity has changed.
  - Archive and value change monitors on `PER` and `DCY` are invoked if values have changed.
  - `NSEV` and `NSTA` are reset to 0.
6. Scan forward link if necessary, set `PACT` `FALSE`, and return.

## 6. Device Support

### Fields Of Interest To Device Support

Each record must have an associated set of device support routines. The primary responsibility of the device support routines is to issue commands to the output device. The device support routines are primarily interested in the following fields:

| Name | Summary             | Description                                                                                                                                                                  |
|------|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| UNIT | Units of time       | This field will be used to identify the time units used for time fields.                                                                                                     |
| OUT  | Output Link         | This field is used by the device support routines to locate its output.                                                                                                      |
| PER  | Period, in UNITS    | Device support must use <code>PER</code> for pulse period.                                                                                                                   |
| DCY  | Duty Cycle, percent | Device support must use <code>DCY</code> for the percent of time the signal is high.                                                                                         |
| LLOW | Low Logic Level     | Device support must use to determine logic low level.                                                                                                                        |
| CEDG | Clock Signal Edge   | This field is used by the device support routines to force counting on leading or falling edge of signal.                                                                    |
| GTYP | Gate Type           | Device support is responsible for using <code>IGV</code> to determine gating control if <code>GTYP</code> is internal, or <code>SGV</code> if <code>GTYP</code> is external. |
| IGV  |                     |                                                                                                                                                                              |
| SGV  | Soft Gate Value     |                                                                                                                                                                              |

| Name | Summary                    | Description                                                                                                                           |
|------|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| CTYP | Clock Type                 | If CTYP is external, device support is responsible for using ECR for the clock rate and if CTYP is internal, ECS is the clock source. |
| ECS  | External Clock Source      |                                                                                                                                       |
| ECR  | External Clock Rate, in Hz |                                                                                                                                       |

## Device Support Routines

Device support consists of the following routines:

### *report*

`report()`

This routine is optional. If provided, it prints a report of all device modules.

### *init*

`init()`

This routine is called once during IOC initialization.

### *init\_record*

`init_record(precord)`

This routine is optional. If provided, it is called by the record support `init_record` routine.

### *get\_ioint\_info*

`get_ioint_info(int cmd, struct dbCommon *precord, IOSCANPVT *ppvt)`

This routine is called by the `ioEventScan` system each time the record is added or deleted from an I/O event scan list. `cmd` has the value (0,1) if the record is being (added to, deleted from) an I/O event list. It must be provided for any device type that can use the `ioEvent` scanner.

### *write\_pt*

`write_pt(precord)`

This routine issues commands to the output device. It returns the following values:

- 0: Success.
- Other: Error.





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# Chapter 29: scan

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## 1. Introduction

---

The basic function of a *scan* record is to move “positioners” through a series of steps and record “detector” data at each of the positions (the whole sequence is referred to as a “scan”). Once the scan parameters are properly initialized, the *scan* record coordinates the entire scan and notifies any interested “clients” when the scan is complete. The data is stored in arrays within the record rather than collected point by point by an external application program. This allows for much faster scans than those coordinated from an external application program on a point to point basis.

A single *scan* record supports a one dimensional scan. It is also possible to link *scan* records together to define multi-dimensional scans in a quite complex configuration.

Each *scan* record can control up to four “positioners” and acquire data from up to four process variables (typically detector data or measured positions of devices) during a scan. Two additional output variables can be defined to trigger other process variables (usually “detectors”) between the positioning phase and the data acquisition phase. These outputs will be referred to as “detector triggers”.

Although the typical use of a *scan* record is to move “positioners” and record “detector” data at each position, it can also be used for other applications. Any controllable device can be scanned through incremental values while recording data from any other process variables. For example, one of the “positioner” PVs could be used to vary the gain of a detector or the speed of a motor during a scan. Another example would be to use the *scan* record to vary several power supplies and record the beam position at each value of the supplies. In this context, the *scan* record becomes a general purpose “Vary w, x, y, z and record a, b, c, d” record. Therefore, throughout this document the word “positioner” and “controller” will be used synonymously. When referring to the data being recorded at each point, the word “detector” will be used.

All of the process variable names used to identify controllers, detectors, and detector triggers are specified using "reassignable links". This allows a scan to be configured on the fly. Scan parameters, including the names of controllers and detectors, can be saved and restored using the BURT.

NOTE: In this version, the PVs used in the "reassignable links" fields must reside in the same IOC.

### A Simple Single Dimensional Scan

The simplest database configuration for using a scan record is shown in Figure 1. A thorough understanding of the operation of this configuration will allow more complex scans to be developed easily.

In Figure 1, when the scan is initiated, the scan record commands several positioners (transform record and motor record) to move to their starting positions. The WAIT\_1 record detects when all movement is complete and forces the SCAN record to process again. The SCAN record realizes that the positioning is complete and thus triggers the Detectors. The WAIT\_2 record detects when data is valid and forces the SCAN record to process yet again. The SCAN record will then read the Detector Data and command the positioners to their next step. This will continue until the SCAN record has completed the appropriate number of steps. At the end of the scan, the SCAN record contains data arrays for each of the "detectors", as well as arrays that contain the positions to which each controller was commanded at each point. A simple x-y plot using this data will provide the detector data vs. position results.

Figure 1: Typical Database Support for a SCAN

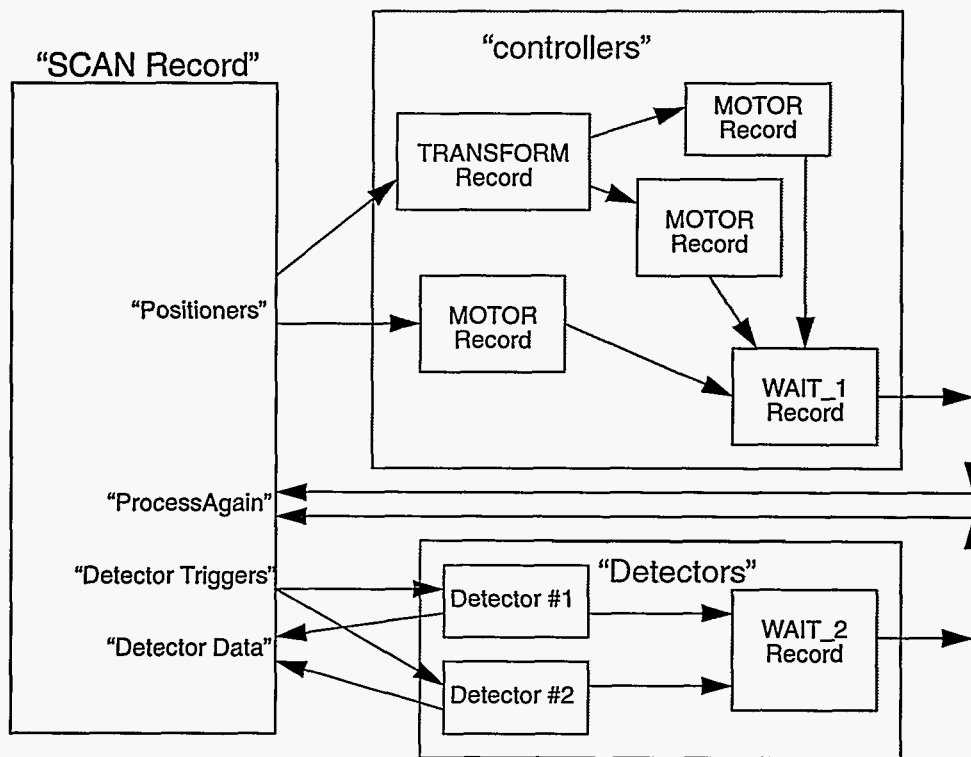
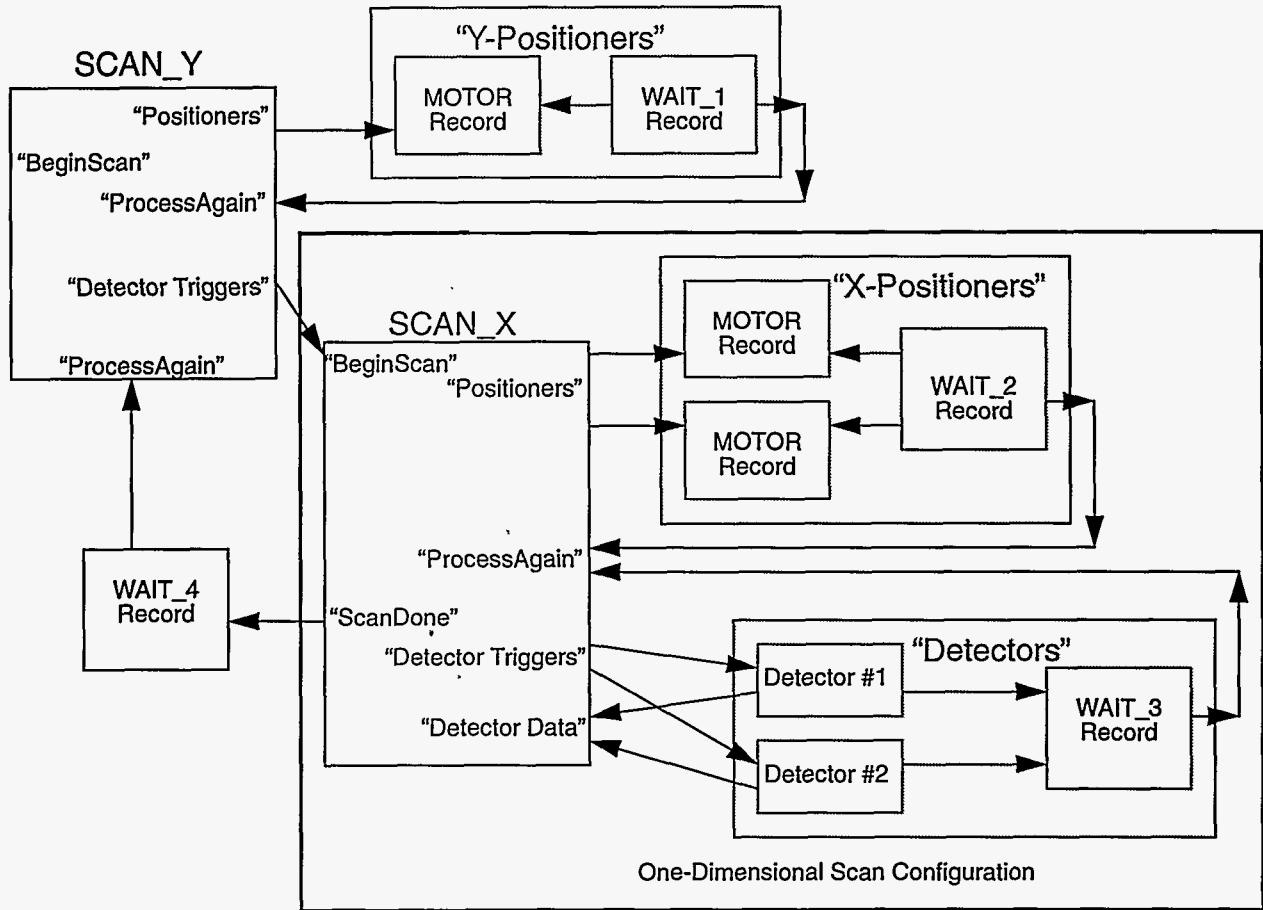


Figure 2: A Two Dimensional Scan Implementation



## Two Dimensional Scanning

Figure 2 illustrates using two scan records to accomplish a two dimensional scan. The SCAN\_X record controls the positioners for the X axis, the SCAN\_Y record controls the Y positioner.

To initiate a scan, the SCAN\_Y record is commanded to begin. It commands its "positioners" to the specified starting point. The WAIT\_1 record detects when all motors are stopped and forces the SCAN\_Y record to process again. The SCAN\_Y record will now write to its "Detector Trigger", which in this case begins a scan of the SCAN\_X record. The SCAN\_X record will now go through its entire programmed scan, acquiring data from the detectors at each point.

When the SCAN\_X record is complete, the WAIT\_4 record will force the processing of SCAN\_Y, which will increment the position of the y-controller and initiate the x scan once again.

This approach to configuring a two dimensional scan is very flexible. Note that to "test" the x scan, one could write to the "BeginScan" field of SCAN\_X which would perform an entire x scan. Although the SCAN\_Y record would get processed after the x scan was complete (via the WAIT\_4 record), nothing would happen because it was not in the middle of a scan. In addition, any of the motors can be moved individually when a scan is not in process without

any unexpected behavior (detectors would not be triggered unless the operator did it deliberately). One could even build a three dimensional scan by adding an additional scan record that initiates the y-scan after positioning a z-controller.

## Defining a Scan

Several options are available to control the execution of a scan. All parameters must be properly configured prior to initiating the scan. This section describes the options that are available while the next section itemizes all the parameters required.

## Positioners

Each scan record may control up to four "positioners" that are commanded to a new "desired position" prior to collecting data at each point. The positioners are defined by typing in an ASCII string that represents the process variable name of the controller.

There are three modes for determining the desired value for the positioner. If a positioner is specified as "linear", its desired value is determined by using parameters such as `start_position`, `step_increment`, `number_of_steps`, and `end_position`. This mode will be discussed in more detail in the next paragraph. If a positioner is specified as "lookup", its next position is found in an array that has been loaded into the record prior to initiating a scan. If the positioner is specified as "on-the-fly", it is commanded to the `end_position` after the first data point is collected and not changed again for the duration of the scan.

A linear scan involving a single positioner is fully defined by three parameters, e.g., the start position, the step size, and the number of data points. A scan involving  $N$  controllers is defined by merely  $2N+1$  parameters, since the number of data points must be the same for all controllers. For the convenience of interactive users, and to support channel-access clients that define scans differently, the scan record provides for six redundant scan-definition parameters (for the first controller only): `START`, `END`, `CENTER`, `WIDTH`, `STEP`, and `NPTS`. The record calculates values for unspecified parameters so that the set is always self consistent, and it imposes an upper limit (`MAXPTS`) on `NPTS`. `WIDTH` may be negative.

There is no unique prescription for removing inconsistencies among redundant parameters, and no hardcoded set of preferences among parameters is likely to please everyone. Therefore, the scan record allows the user to "freeze" parameters, so that they will not be changed in the record's internal attempts to ensure self-consistency of the parameter set. Frozen parameters can be changed by the user and by any other client. It is the user's responsibility to ensure that frozen parameters do not prevent freely specifying unfrozen parameters. For example, if both `STEP` and `NPTS` are frozen, changes to `WIDTH` will be rejected. Similarly, if both `START` and `CENTER` are frozen, changes to `END` and `WIDTH` will have no effect. By default, `START`, `STEP`, and `NPTS` are frozen. When the record cannot adjust the parameters to be consistent, a flag is raised (`ALRT`) and a message reported (`MSG`).

Although this approach may seem to present the user with an overwhelming number of choices, it should be noted that "by default" the user only has to enter `START`, `STEP`, and `NPTS` to fully define the scan of a controller. The "user interface" (usually `medm` or another CA client) need only present the user with these fields. However, by changing the "freeze flags" from the default and presenting the user with different fields to fill in, the scan can be defined in a completely flexible way. The result is that a simple scan can be defined easily, but advanced users are not limited in flexibility.

For those controllers defined as "linear", each desired position is placed in the "desired position" array that is used for lookup mode. Therefore, after the scan is complete, this array will always contain the sequence of desired positions to which the controller was commanded.

---

These values will have been provided by the user for “lookup” mode and calculated by the scan record for “linear” mode. This array will contain no useful data if “on-the-fly” mode was used.

*Position  
Verification  
Readback  
Process Variable  
and Delta*

For each positioner, the user may specify a process variable that corresponds to the actual (or measured) position of the motor. If this readback field is configured, the scan record will confirm after each movement that the actual position is within a specified delta to the desired position. If the delta is exceeded, the scan will abort and the record will go into an alarm state. A text field within the record (MSG) will inform the operator of the error condition.

*Detector Trigger  
Process Variables  
and Desired  
Command*

If valid process variable names are entered into the “Detector Trigger” fields, the scan record will write the specified “Desired Command” (a floating point number) to that process variable between the positioning phase and the data acquisition phase.

If neither Detector Trigger contains a valid PV, the scan record will skip this step and acquire the data immediately. Note that specifying a “Detector Trigger” requires the scan record to be processed an additional time each point.

*Data to be  
Acquired*

Each scan record can acquire data from four process variables at each point in the scan. This data will most commonly be from a detector or from a position readback (which would record the actual motor positions at each point and could then be compared to the desired position array).

**Reading SCAN  
Results**

The scan results will most frequently be read as arrays of positions and arrays of detector data where each detector data element corresponds to the position element.

For single dimension scans, the scan is complete when the ExecuteScan flag is set back to zero by the record processing routine. The application program can then read the position arrays and the data arrays (or have a monitor set on them so the record will “post\_monitors” when complete).

For two dimension scans similar to Figure 2, the application program should read the arrays from the SCAN\_X record after the completion of each x scan and correlate it to the current y controller information. This will allow the application program to display data after each x scan. The scan record will buffer the data for only one x scan, so the application must read the arrays before the next x scan is completed. If the scan is fast enough that this may prevent a problem, the application program can contribute to the wait record algorithm such that the y - controllers are not moved until the application program has completely read the previous SCAN\_X data.

On slow scans, the application program may want to see the scan is process on a point by point basis. Therefore, the scan record will “post\_monitors” on fields that it updates each point, but it will not post monitors faster than 20 times per second. If a scan is proceeding at a rate less than 20 points per second, every point will be posted. If a scan is proceeding at 100 steps per second, scalar values will be posted every 5th point (approx). In either case, the array data will contain every point at the completion of the scan. It is not recommended that the application program use the point to point data except for keeping the operator aware of the progress of the scan.

### Checking Scan Parameters Against Limits

Prior to beginning an actual scan, the record can be commanded to check the scan parameters to ensure that all positioner requests are within reasonable limits. The record will do a “dry run” by calculating every positioner value (or looking it up in the table) and comparing it with the “drive limits” associated with that positioner’s Process Variable (drive limits are an attribute of most process variables). If any step would exceed the drive limits, the operator is notified via the *SMSG* field.

---

## 2. Configurable Parameters

---

A brief summary of the configurable parameters within a scan record is presented below. For a more detailed explanation, see Field Description section.

- Record Initialization
  - Maximum Number of Steps in any scan (used to allocate memory)
- SCAN Definition Parameters
  - Number of steps for This Scan
  - SCAN Record SCAN Mechanism (Normal Choices for any record)
- Positioner Definition (Four positioners)
  - PV Name
  - PV Name Valid Flag (monitor only)
  - “Lookup/Linear/On-the-Fly” Mode Selection
  - Start Position and Freeze Flag
  - Width and Freeze Flag
  - Center and Freeze Flag
  - Step Increment and Freeze Flag
  - End Position and Freeze Flag
  - Desired Position Array
  - Position Verification Readback PV Name
  - Position Verification Readback PV Name Valid Flag (monitor only)
  - Position Verification Delta
  - Current Position (monitor only)
- Detector Definition (Four Detectors)
  - PV Name
  - PV Name Valid Flag (monitor only)
  - Current value (monitor only)
  - Detector Data Array (monitor only)
- Detector Trigger (if desired)
  - PV Name
  - Command to write

### 3. Field Summary

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP |
|-------|-----------|-----|---------|--------|--------|------------------|----|
| VERS  | FLOAT     | No  | 1.0     | Yes    | No     | No               | No |
| VAL   | DOUBLE    | No  | 0       | Yes    | Yes    | No               | No |
| SMSG  | STRING    | No  | Null    | Yes    | Yes    | Yes              | No |
| CMND  | ENUM      | No  | 0       | Yes    | Yes    | Yes              | No |
| ALRT  | UCHAR     | No  | 0       | Yes    | No     | Yes              | No |
| RPVT  | NOACCESS  | No  | Null    | No     | No     | No               | No |
| MPTS  | SHORT     | Yes | 100     | Yes    | No     | No               | No |
| EXSC  | SHORT     | No  | 0       | Yes    | Yes    | Yes              | No |
| PXSC  | UCHAR     | No  | 0       | Yes    | No     | No               | No |
| NPTS  | SHORT     | Yes | 100     | Yes    | Yes    | Yes              | No |
| FPTS  | RECCHOICE | Yes | 1       | Yes    | Yes    | No               | No |
| CPT   | SHORT     | No  | 0       | Yes    | No     | Yes*             | No |
| PCPT  | SHORT     | No  | 0       | Yes    | No     | No               | No |
| TOLP  | ULONG     | No  | 0       | Yes    | No     | No               | No |
| P1PV  | STRING    | Yes | Null    | Yes    | Yes    | No               | No |
| P2PV  | STRING    | Yes | Null    | Yes    | Yes    | No               | No |
| P3PV  | STRING    | Yes | Null    | Yes    | Yes    | No               | No |
| P4PV  | STRING    | Yes | Null    | Yes    | Yes    | No               | No |
| R1PV  | STRING    | Yes | Null    | Yes    | Yes    | No               | No |
| R2PV  | STRING    | Yes | Null    | Yes    | Yes    | No               | No |
| R3PV  | STRING    | Yes | Null    | Yes    | Yes    | No               | No |
| R4PV  | STRING    | Yes | Null    | Yes    | Yes    | No               | No |
| T1PV  | STRING    | Yes | Null    | Yes    | Yes    | No               | No |
| T2PV  | STRING    | Yes | Null    | Yes    | Yes    | No               | No |
| D1PV  | STRING    | Yes | Null    | Yes    | Yes    | No               | No |
| D2PV  | STRING    | Yes | Null    | Yes    | Yes    | No               | No |
| D3PV  | STRING    | Yes | Null    | Yes    | Yes    | No               | No |
| D4PV  | STRING    | Yes | Null    | Yes    | Yes    | No               | No |
| P1DB  | NOACCESS  | No  | Null    | No     | No     | No               | No |
| P2DB  | NOACCESS  | No  | Null    | No     | No     | No               | No |



| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP |
|-------|-----------|-----|---------|--------|--------|------------------|----|
| P3DB  | NOACCESS  | No  | Null    | No     | No     | No               | No |
| P4DB  | NOACCESS  | No  | Null    | No     | No     | No               | No |
| R1DB  | NOACCESS  | No  | Null    | No     | No     | No               | No |
| R2DB  | NOACCESS  | No  | Null    | No     | No     | No               | No |
| R3DB  | NOACCESS  | No  | Null    | No     | No     | No               | No |
| R4DB  | NOACCESS  | No  | Null    | No     | No     | No               | No |
| T1DB  | NOACCESS  | No  | Null    | No     | No     | No               | No |
| T2DB  | NOACCESS  | No  | Null    | No     | No     | No               | No |
| D1DB  | NOACCESS  | No  | Null    | No     | No     | No               | No |
| D2DB  | NOACCESS  | No  | Null    | No     | No     | No               | No |
| D3DB  | NOACCESS  | No  | Null    | No     | No     | No               | No |
| D4DB  | NOACCESS  | No  | Null    | No     | No     | No               | No |
| P1NV  | LONG      | No  | 0       | Yes    | Yes    | Yes              | No |
| P2NV  | LONG      | No  | 0       | Yes    | Yes    | Yes              | No |
| P3NV  | LONG      | No  | 0       | Yes    | Yes    | Yes              | No |
| P4NV  | LONG      | No  | 0       | Yes    | Yes    | Yes              | No |
| R1NV  | LONG      | No  | 0       | Yes    | Yes    | Yes              | No |
| R2NV  | LONG      | No  | 0       | Yes    | Yes    | Yes              | No |
| R3NV  | LONG      | No  | 0       | Yes    | Yes    | Yes              | No |
| R4NV  | LONG      | No  | 0       | Yes    | Yes    | Yes              | No |
| T1NV  | LONG      | No  | 0       | Yes    | Yes    | Yes              | No |
| T2NV  | LONG      | No  | 0       | Yes    | Yes    | Yes              | No |
| D1NV  | LONG      | No  | 0       | Yes    | Yes    | Yes              | No |
| D2NV  | LONG      | No  | 0       | Yes    | Yes    | Yes              | No |
| D3NV  | LONG      | No  | 0       | Yes    | Yes    | Yes              | No |
| D4NV  | LONG      | No  | 0       | Yes    | Yes    | Yes              | No |
| P1SM  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | No |
| P1SP  | FLOAT     | Yes | 0       | Yes    | Yes    | Yes              | No |
| P1FS  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | No |
| P1SI  | FLOAT     | Yes | 0       | Yes    | Yes    | Yes              | No |
| P1FI  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | No |
| P1CP  | FLOAT     | Yes | 0       | Yes    | Yes    | Yes              | No |

| Field | Type        | DCT | Initial | Access | Modify | Rec Proc Monitor | PP |
|-------|-------------|-----|---------|--------|--------|------------------|----|
| P1FC  | RECCHOICE   | Yes | 0       | Yes    | Yes    | No               | No |
| P1EP  | FLOAT       | Yes | 0       | Yes    | Yes    | Yes              | No |
| P1FE  | RECCHOICE   | Yes | 0       | Yes    | Yes    | No               | No |
| P1WD  | FLOAT       | Yes | 0       | Yes    | Yes    | Yes              | No |
| P1FW  | RECCHOICE   | Yes | 0       | Yes    | Yes    | No               | No |
| P1DV  | FLOAT       | No  | 0       | Yes    | No     | Yes*             | No |
| P1LV  | FLOAT       | No  | 0       | Yes    | No     | No               | No |
| R1CV  | FLOAT       | No  | 0       | Yes    | No     | Yes*             | No |
| R1LV  | FLOAT       | No  | 0       | Yes    | No     | No               | No |
| R1DL  | FLOAT       | Yes | 0       | Yes    | Yes    | No               | No |
| P1EU  | STRING      | Yes | 16      | Yes    | Yes    | No               | No |
| P1HR  | FLOAT       | Yes | 0       | Yes    | Yes    | No               | No |
| P1LR  | FLOAT       | Yes | 0       | Yes    | Yes    | No               | No |
| P1PR  | SHORT       | Yes | 0       | Yes    | Yes    | No               | No |
| P1PA  | FLOAT ARRAY | No  | Null    | Yes    | Yes    | Yes              | No |
| P2SM  | RECCHOICE   | Yes | 0       | Yes    | Yes    | No               | No |
| P2SP  | FLOAT       | Yes | 0       | Yes    | Yes    | Yes              | No |
| P2FS  | RECCHOICE   | Yes | 0       | Yes    | Yes    | No               | No |
| P2SI  | FLOAT       | Yes | 0       | Yes    | Yes    | Yes              | No |
| P2FI  | RECCHOICE   | Yes | 0       | Yes    | Yes    | No               | No |
| P2CP  | FLOAT       | Yes | 0       | Yes    | Yes    | Yes              | No |
| P2FC  | RECCHOICE   | Yes | 0       | Yes    | Yes    | No               | No |
| P2EP  | FLOAT       | Yes | 0       | Yes    | Yes    | Yes              | No |
| P2FE  | RECCHOICE   | Yes | 0       | Yes    | Yes    | No               | No |
| P2WD  | FLOAT       | Yes | 0       | Yes    | Yes    | Yes              | No |
| P2FW  | RECCHOICE   | Yes | 0       | Yes    | Yes    | No               | No |
| P2DV  | FLOAT       | No  | 0       | Yes    | No     | Yes*             | No |
| P2LV  | FLOAT       | No  | 0       | Yes    | No     | No               | No |
| R2CV  | FLOAT       | No  | 0       | Yes    | No     | Yes*             | No |
| R2LV  | FLOAT       | No  | 0       | Yes    | No     | No               | No |
| R2DL  | FLOAT       | Yes | 0       | Yes    | Yes    | No               | No |
| P2EU  | STRING      | Yes | 16      | Yes    | Yes    | No               | No |

| Field | Type        | DCT | Initial | Access | Modify | Rec Proc Monitor | PP |
|-------|-------------|-----|---------|--------|--------|------------------|----|
| P2HR  | FLOAT       | Yes | 0       | Yes    | Yes    | No               | No |
| P2LR  | FLOAT       | Yes | 0       | Yes    | Yes    | No               | No |
| P2PR  | SHORT       | Yes | 0       | Yes    | Yes    | No               | No |
| P2PA  | FLOAT ARRAY | No  | Null    | Yes    | Yes    | Yes              | No |
| P3SM  | RECCHOICE   | Yes | 0       | Yes    | Yes    | No               | No |
| P3SP  | FLOAT       | Yes | 0       | Yes    | Yes    | Yes              | No |
| P3FS  | RECCHOICE   | Yes | 0       | Yes    | Yes    | No               | No |
| P3SI  | FLOAT       | Yes | 0       | Yes    | Yes    | Yes              | No |
| P3FI  | RECCHOICE   | Yes | 0       | Yes    | Yes    | No               | No |
| P3CP  | FLOAT       | Yes | 0       | Yes    | Yes    | Yes              | No |
| P3FC  | RECCHOICE   | Yes | 0       | Yes    | Yes    | No               | No |
| P3EP  | FLOAT       | Yes | 0       | Yes    | Yes    | Yes              | No |
| P3FE  | RECCHOICE   | Yes | 0       | Yes    | Yes    | No               | No |
| P3WD  | FLOAT       | Yes | 0       | Yes    | Yes    | Yes              | No |
| P3FW  | RECCHOICE   | Yes | 0       | Yes    | Yes    | No               | No |
| P3DV  | FLOAT       | No  | 0       | Yes    | No     | Yes*             | No |
| P3LV  | FLOAT       | No  | 0       | Yes    | No     | No               | No |
| R3CV  | FLOAT       | No  | 0       | Yes    | No     | Yes*             | No |
| R3LV  | FLOAT       | No  | 0       | Yes    | No     | No               | No |
| R3DL  | FLOAT       | Yes | 0       | Yes    | Yes    | No               | No |
| P3EU  | STRING      | Yes | 16      | Yes    | Yes    | No               | No |
| P3HR  | FLOAT       | Yes | 0       | Yes    | Yes    | No               | No |
| P3LR  | FLOAT       | Yes | 0       | Yes    | Yes    | No               | No |
| P3PR  | SHORT       | Yes | 0       | Yes    | Yes    | No               | No |
| P3PA  | FLOAT ARRAY | No  | Null    | Yes    | Yes    | Yes              | No |
| P4SM  | RECCHOICE   | Yes | 0       | Yes    | Yes    | No               | No |
| P4SP  | FLOAT       | Yes | 0       | Yes    | Yes    | Yes              | No |
| P4FS  | RECCHOICE   | Yes | 0       | Yes    | Yes    | No               | No |
| P4SI  | FLOAT       | Yes | 0       | Yes    | Yes    | Yes              | No |
| P4FI  | RECCHOICE   | Yes | 0       | Yes    | Yes    | No               | No |
| P4CP  | FLOAT       | Yes | 0       | Yes    | Yes    | Yes              | No |
| P4FC  | RECCHOICE   | Yes | 0       | Yes    | Yes    | No               | No |

| Field | Type        | DCT | Initial | Access | Modify | Rec Proc Monitor | PP |
|-------|-------------|-----|---------|--------|--------|------------------|----|
| P4EP  | FLOAT       | Yes | 0       | Yes    | Yes    | Yes              | No |
| P4FE  | RECCHOICE   | Yes | 0       | Yes    | Yes    | No               | No |
| P4WD  | FLOAT       | Yes | 0       | Yes    | Yes    | Yes              | No |
| P4FW  | RECCHOICE   | Yes | 0       | Yes    | Yes    | No               | No |
| P4DV  | FLOAT       | No  | 0       | Yes    | No     | Yes*             | No |
| P4LV  | FLOAT       | No  | 0       | Yes    | No     | No               | No |
| R4CV  | FLOAT       | No  | 0       | Yes    | No     | Yes*             | No |
| R4LV  | FLOAT       | No  | 0       | Yes    | No     | No               | No |
| R4DL  | FLOAT       | Yes | 0       | Yes    | Yes    | No               | No |
| P4EU  | STRING      | Yes | 16      | Yes    | Yes    | No               | No |
| P4HR  | FLOAT       | Yes | 0       | Yes    | Yes    | No               | No |
| P4LR  | FLOAT       | Yes | 0       | Yes    | Yes    | No               | No |
| P4PR  | SHORT       | Yes | 0       | Yes    | Yes    | No               | No |
| P4PA  | FLOAT ARRAY | No  | Null    | Yes    | Yes    | Yes              | No |
| D1CV  | FLOAT       | No  | 0       | Yes    | No     | Yes*             | No |
| D1LV  | FLOAT       | No  | 0       | Yes    | No     | No               | No |
| D1EU  | STRING      | Yes | 16      | Yes    | Yes    | No               | No |
| D1HR  | FLOAT       | Yes | 0       | Yes    | Yes    | No               | No |
| D1LR  | FLOAT       | Yes | 0       | Yes    | Yes    | No               | No |
| D1PR  | SHORT       | Yes | 0       | Yes    | Yes    | No               | No |
| D1DA  | FLOAT ARRAY | No  | Null    | Yes    | No     | Yes              | No |
| D2CV  | FLOAT       | No  | 0       | Yes    | No     | Yes*             | No |
| D2LV  | FLOAT       | No  | 0       | Yes    | No     | No               | No |
| D2EU  | STRING      | Yes | 16      | Yes    | Yes    | No               | No |
| D2HR  | FLOAT       | Yes | 0       | Yes    | Yes    | No               | No |
| D2LR  | FLOAT       | Yes | 0       | Yes    | Yes    | No               | No |
| D2PR  | SHORT       | Yes | 0       | Yes    | Yes    | No               | No |
| D2DA  | FLOAT ARRAY | No  | Null    | Yes    | No     | Yes              | No |
| D3CV  | FLOAT       | No  | 0       | Yes    | No     | Yes*             | No |
| D3LV  | FLOAT       | No  | 0       | Yes    | No     | No               | No |
| D3EU  | STRING      | Yes | 16      | Yes    | Yes    | No               | No |
| D3HR  | FLOAT       | Yes | 0       | Yes    | Yes    | No               | No |

| Field | Type        | DCT | Initial | Access | Modify | Rec Proc Monitor | PP |
|-------|-------------|-----|---------|--------|--------|------------------|----|
| D3LR  | FLOAT       | Yes | 0       | Yes    | Yes    | No               | No |
| D3PR  | SHORT       | Yes | 0       | Yes    | Yes    | No               | No |
| D3DA  | FLOAT ARRAY | No  | Null    | Yes    | No     | Yes              | No |
| D4CV  | FLOAT       | No  | 0       | Yes    | No     | Yes*             | No |
| D4LV  | FLOAT       | No  | 0       | Yes    | No     | No               | No |
| D4EU  | STRING      | Yes | 16      | Yes    | Yes    | No               | No |
| D4HR  | FLOAT       | Yes | 0       | Yes    | Yes    | No               | No |
| D4LR  | FLOAT       | Yes | 0       | Yes    | Yes    | No               | No |
| D4PR  | SHORT       | Yes | 0       | Yes    | Yes    | No               | No |
| D4DA  | FLOAT ARRAY | No  | Null    | Yes    | No     | Yes              | No |
| T1CD  | FLOAT       | Yes | 0       | Yes    | Yes    | No               | No |
| T2CD  | FLOAT       | Yes | 0       | Yes    | Yes    | No               | No |

\* Monitors on these fields are not posted any faster than 20 Hz. Some changes may not be posted! Do not rely on these fields for step-to-step info.

#### 4. Field Descriptions

This section describes the fields that will be of interest to a typical application developer. All array field names end with the character "A". It is hoped that this convention will make it easier to remember field name abbreviations.

| Name | Summary       | Description                                                                                                                                                                                                                                            |
|------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VERS | Code Version  | Reflects the version of scan record processing routines.                                                                                                                                                                                               |
| VAL  | Value Field   | Not Used.                                                                                                                                                                                                                                              |
| SMSG | State Message | This field contains a message from the record alerting the operator to any error conditions. It can be cleared by writing a '0' to the CMND field.                                                                                                     |
| CMND | Command Field | This field is used to send commands to the record. The following commands are currently defined:<br>0 - Clear the State Message Field<br>1 - Execute a "dry run" scan and check the desired positions against the control limits of the positioner(s). |
| ALRT | Alert Field   | This field is set to one when an alert condition exists in the record (e.g Scan parameters too constrained, defined scan exceeds limits, scan aborted, etc). The cause of the alert will be indicated in the State Message Field (SMSG).               |

| Name | Summary                       | Description                                                                                                                                                                                                                                          |
|------|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RPVT | Record Private                | Pointer to a structure that maintains information about the scan record.                                                                                                                                                                             |
| MPTS | Maximum Number of Points      | This field is used to specify the maximum number of points that will be used for any scan defined for this record. This value is used to allocate memory for all the array oriented fields, so the value will significantly affect memory usage.     |
| EXSC | Execute Scan                  | Writing a '1' to this field will initiate a scan. Writing a '0' will abort the scan. The record will reset this field to '0' when the scan is finished.                                                                                              |
| PXSC | Previous Execute Scan         | Status of the EXSC flag the last time the record was processed.                                                                                                                                                                                      |
| NPTS | Number of Points              | This entry defines the number of points for the scan. If the freeze flag is set, the record will not change this value in its attempt to keep the scan definition parameters consistent. This value is constrained to be less than or equal to MPTS. |
| FPTS | Freeze Flag                   |                                                                                                                                                                                                                                                      |
| CPT  | Current Point                 | This field contains the current point of an active scan. The posting of events on this field is throttled to 20 Hz, so for fast scans not every new value will be posted.                                                                            |
| PCPT | Previous Current Point        | This field contains the value of CPT that was last posted (not every change is posted, see CPT description).                                                                                                                                         |
| TOLP | Time of Last Posting          | Tick count of last time monitors were posted on the "throttled" fields (e.g. CPT)                                                                                                                                                                    |
| PnPV | Positioner n Process Variable | (n=1-4): These fields contain the Process Variable names of the controllers that will be commanded during the scan.                                                                                                                                  |
| PnNV | Positioner n Name Valid       | (n=1-4): These flags indicate if the ASCII string entered in PnPV was found to be an existing Process Variable.                                                                                                                                      |
| PnDV | Positioner n Desired Value    | (n=1-4): These fields contain the desired value for each positioner for the current point in the scan. The posting of events on these fields is throttled to 20 Hz, so for fast scans not every "desired value" will be posted.                      |
| PnLV | Positioner n Last Value       | (n=1-4): Last value 'posted' for PnDv.                                                                                                                                                                                                               |
| RnPV | Readback n Process Variable   | (n=1-4): If specified, the scan record will read this "actual position" of the controller to confirm it has reached its "desired position". If this value is within a specified deadband of the desired position, the scan will continue.            |
| RnNV | Readback n Name Valid         | (n=1-4): These flags indicate if the ASCII string entered in RnPV was found to be an existing Process Variable.                                                                                                                                      |
| RnCV | Readback n Current Value      | (n=1-4) : These fields contain the current value for each positioner readback for the current point in the scan. The posting of events on these fields is throttled to 20 Hz, so for fast scans not every new value will be posted.                  |

| Name | Summary                      | Description                                                                                                                                                                                                                                                                                                             |
|------|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RnLV | Readback n Last Value        | (n=1-4): Last value 'posted' for RnCV.                                                                                                                                                                                                                                                                                  |
| RnDL | Readback n Delta             | (n=1-4) : If RnPV is specified, the scan record will confirm that the Read Back value is within this dead band, or the scan will be halted.                                                                                                                                                                             |
| PnSM | Positioner n Step Mode       | (n=1-4) : Indicates if the desired positions for a controller are to be calculated in a linear fashion (incremented by step size), found in a "desired position array", or given a final position command at the beginning of the scan (on-the-fly).                                                                    |
| PnPA | Positioner n Position Array  | (n=1-4): This array contains the step positions for a controller if it uses the "lookup" mode (see PnSM). This array is filled in by the record during a scan if the controller was in "linear" mode. If the number of steps was less than MPTS, the remainder of the array is filled with the data from the last step. |
| PnSP | Positioner n Start Position  | (n=1-4): For controllers in the "linear" or "on-the-fly" mode, this field specifies the start position for the controller. If the freeze flag is set, the record will not change this value in its attempt to keep the scan definition parameters consistent.                                                           |
| PnFS | Positioner n Freeze Flag     |                                                                                                                                                                                                                                                                                                                         |
| PnSI | Positioner n Step Increment  | (n=1-4): For controllers in the "linear" mode, this field specifies the step increment. If the freeze flag is set, the record will not change this value in its attempt to keep the scan definition parameters consistent.                                                                                              |
| PnFI | Positioner n Freeze Flag     |                                                                                                                                                                                                                                                                                                                         |
| PnEP | End Position                 | (n=1-4): For controllers in the "linear" mode, this field contains the last position to which the controller will be commanded. If the freeze flag is set, the record will not change this value in its attempt to keep the scan definition parameters consistent.                                                      |
| PnFE | Positioner n Freeze Flag     |                                                                                                                                                                                                                                                                                                                         |
| PnCP | Positioner n Center Position | (n=1-4): For controllers in the "linear" mode, this field may be used to define the center position of a scan. If the freeze flag is set, the record will not change this value in its attempt to keep the scan definition parameters consistent.                                                                       |
| PnFC | Positioner n Freeze Flag     |                                                                                                                                                                                                                                                                                                                         |
| PnWD | Positioner n Width           | (n=1-4): For controllers in the "linear" mode, this field may be used to define the width of the scan (the distance from the start position to the finish position). If the freeze flag is set, the record will not change this value in its attempt to keep the scan definition parameters consistent.                 |
| PnFW | Positioner n Freeze Flag     |                                                                                                                                                                                                                                                                                                                         |
| PnLR | Positioner n Low Range       | (n=1-4): These are user configurable fields to describe low and high ranges for the positioner data (used by some channel access clients).                                                                                                                                                                              |
| PnHR | Positioner n High Range      |                                                                                                                                                                                                                                                                                                                         |

| Name | Summary                             | Description                                                                                                                                                                                                             |
|------|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PnPR | Positioner n Precision              | (n=1-4) : This is a user configurable fields to describe the display precision for the positioner data (used by some channel access clients).                                                                           |
| PnEU | Positioner n Engineering Units      | (n=1-4) : This is a user configurable fields to describe the units for the positioner data (used by some channel access clients).                                                                                       |
| TnPV | Detector Trigger n Process Variable | (n=1-2): These fields contain the Process Variable names of the "Detector Triggers" that are written to between the positioning phase and the data acquisition phase of the record.                                     |
| TnNV | Trigger n Name Valid                | (n=1-2): These flags indicate if the ASCII string entered in TnPV was found to be an existing Process Variable.                                                                                                         |
| TnCD | Trigger n Command                   | (n=1-2): This is the data that is written to the Detector Trigger PV's.                                                                                                                                                 |
| DnPV | Data n Process Variable             | (n=1-4): These fields contain the Process Variable names of the data that will be recorded at each point within the scan.                                                                                               |
| DnNV | Data n Name Valid                   | (n=1-4): These flags indicate if the ascii string entered in DnPV was found to be an existing Process Variable.                                                                                                         |
| DnCV | Detector n Current Value            | (n=1-4): These fields contain the current value for each detector for the current point in the scan. The posting of events on these fields is throttled to 20 Hz, so for fast scans not every new value will be posted. |
| DnLV | Detector n Last Value               | (n=1-4): Last value 'posted' for DnCV.                                                                                                                                                                                  |
| DnDA | Detector n Data Array               | (n=1-4): This array (length = MPTS) contains the detector data for each point in the scan. If the number of steps was less than MPTS, the remainder of the array is filled with the data from the last step.            |
| DnLR | Detector n Low Range                | (n=1-4): These are user configurable fields to describe low and high ranges for the detector data (used by some channel access clients).                                                                                |
| DnHR | Detector n High Range               |                                                                                                                                                                                                                         |
| DnPR | Detector n Precision                | (n=1-4): This is a user configurable fields to describe the display precision for the detector data (used by some channel access clients).                                                                              |
| DnEU | Detector n Engineering Units        | (n=1-4): This is a user configurable fields to describe the units for the detector data (used by some channel access clients).                                                                                          |
| PnDB | Positioner n dbAddr                 | (n=1-4): Pointer to the dbAddr structure of the PV entered in PnPv. If PV is not found, the value is NULL.                                                                                                              |
| RnDB | Readback n dbAddr                   | (n=1-4): Pointer to the dbAddr structure of the PV entered in RnPv. If PV is not found, the value is NULL.                                                                                                              |



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| Name | Summary           | Description                                                                                                |
|------|-------------------|------------------------------------------------------------------------------------------------------------|
| TnDB | Trigger n dbAddr  | (n=1-2): Pointer to the dbAddr structure of the PV entered in TnPv. If PV is not found, the value is NULL. |
| DnDB | Detector n dbAddr | (n=1-4): Pointer to the dbAddr structure of the PV entered in DnPv. If PV is not found, the value is NULL. |

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## 5. Record Support Routines

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## 6. Record Processing

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## 7. Device Support

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## 8. Device Support For Soft Records

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## Chapter 30: *sel* - Select

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### 1. Introduction

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The *sel* record computes a value based on input obtained from up to 12 inputs. The selection algorithm can be one of the following: Specified, Highest, Lowest, Median. Each input can be a constant, a database link, or a channel access link.

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### 2. Field Summary

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| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP |
|-------|-----------|-----|---------|--------|--------|------------------|----|
| VAL   | DOUBLE    | No  | 0       | Yes    | No     | Yes              | No |
| SELM  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | No |
| SELN  | USHORT    | No  | 0       | Yes    | Yes    | No               | No |
| PREC  | SHORT     | Yes | 0       | Yes    | Yes    | No               | No |
| NVL   | INLINK    | Yes | 0       | No     | No     | N/A              | No |
| INPA  | INLINK    | Yes | 0       | No     | No     | N/A              | No |
| INPB  | INLINK    | Yes | 0       | No     | No     | N/A              | No |
| INPC  | INLINK    | Yes | 0       | No     | No     | N/A              | No |
| INPD  | INLINK    | Yes | 0       | No     | No     | N/A              | No |
| INPE  | INLINK    | Yes | 0       | No     | No     | N/A              | No |

| Field | Type   | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|--------|-----|---------|--------|--------|------------------|-----|
| INPF  | INLINK | Yes | 0       | No     | No     | N/A              | No  |
| INPG  | INLINK | Yes | 0       | No     | No     | N/A              | No  |
| INPH  | INLINK | Yes | 0       | No     | No     | N/A              | No  |
| INPI  | INLINK | Yes | 0       | No     | No     | N/A              | No  |
| INPJ  | INLINK | Yes | 0       | No     | No     | N/A              | No  |
| INPK  | INLINK | Yes | 0       | No     | No     | N/A              | No  |
| INPL  | INLINK | Yes | 0       | No     | No     | N/A              | No  |
| A     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| B     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| C     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| D     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| E     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| F     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| G     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| H     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| I     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| J     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| K     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| L     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| LA    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LB    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LC    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LD    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LE    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LF    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LG    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LH    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LI    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LJ    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LK    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LL    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| EGU   | STRING | Yes | Null    | Yes    | Yes    | No               | No  |

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| HOPR  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| LOPR  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| HIHI  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| LOLO  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| HIGH  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| LOW   | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| HHSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| LLSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| HSV   | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| LSV   | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| HYST  | DOUBLE    | Yes | 0       | Yes    | Yes    | No               | No  |
| ADEL  | DOUBLE    | Yes | 0       | Yes    | Yes    | No               | No  |
| MDEL  | DOUBLE    | Yes | 0       | Yes    | Yes    | No               | No  |
| LALM  | DOUBLE    | No  | 0       | Yes    | No     | No               | No  |
| ALST  | DOUBLE    | No  | 0       | Yes    | No     | No               | No  |
| MLST  | DOUBLE    | No  | 0       | Yes    | No     | No               | No  |

### 3. Field Descriptions

| Name | Summary                             | Description                                                                                                                              |
|------|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| VAL  | Value Field                         | This field is the computed value, determined as a result of record processing.                                                           |
| SELM | Select Mechanism                    | SELECTED: Use SELN as index (0 to 15)<br>SELECT_HIGH: Select highest<br>SELECT_LOW: Select lowest<br>SELECT_MEDIAN: Select median value. |
| SELN | Select Number                       | Index of selected input. If SELM=SELECTED, then this is the index (0 to 15) of the input to select.                                      |
| PREC | Display Precision                   | Precision with which to display VAL. This field is used by record support to supply a value when get_precision is called.                |
| NVL  | Index Value Location, an input link | IF NVL is a constant, SELN is set to the constant value. If NVL is a database or channel access link then SELN is read from NVL.         |

| Name          | Summary                              | Description                                                                                                                                                                                                                                                                                                                                                                                                |
|---------------|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| INPA,...,INPL | Input A, Input B, ...                | The input links. Each may be a constant, a database link, or a channel access link. Any link not defined is ignored. NOTE: In order to implement SELM it is necessary to recognize missing values. The value 1e30 was selected to represent MISSING. If a link is a constant with value 0 (zero, the default) then at record initialization time the corresponding A, ... L field is set equal to MISSING. |
| A,...,L       | A, B, ...                            | The input values. If the corresponding INP field is a constant, this field is initialized with the constant value but can be changed via dbPuts.                                                                                                                                                                                                                                                           |
| LA,...,LL     | Last A, Last B, ...                  | Previous input values. These fields are used to decide when to trigger monitors on A,...,L.                                                                                                                                                                                                                                                                                                                |
| EGU           | Engineering Units                    | ASCII string describing Engineering units. This field is used by record support to supply a units description string when get_units is called.                                                                                                                                                                                                                                                             |
| HOPR          | High Operating Range                 | These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are used by record support to honor calls to get_graphic_double or get_control_double.                                                                                                                                                             |
| LOPR          | Low Operating Range                  |                                                                                                                                                                                                                                                                                                                                                                                                            |
| HIHI          | Hihi Alarm Limit                     | These fields specify the alarm limits and severities.                                                                                                                                                                                                                                                                                                                                                      |
| HIGH          | High Alarm Limit                     |                                                                                                                                                                                                                                                                                                                                                                                                            |
| LOW           | Low Alarm Limit                      |                                                                                                                                                                                                                                                                                                                                                                                                            |
| LOLO          | Lolo Alarm Limit                     |                                                                                                                                                                                                                                                                                                                                                                                                            |
| HHSV          | Severity for a Hihi Alarm            |                                                                                                                                                                                                                                                                                                                                                                                                            |
| HSV           | Severity for a High Alarm            |                                                                                                                                                                                                                                                                                                                                                                                                            |
| LSV           | Severity for a Low Alarm             |                                                                                                                                                                                                                                                                                                                                                                                                            |
| LLSV          | Severity for a Lolo Alarm            |                                                                                                                                                                                                                                                                                                                                                                                                            |
| HYST          | Alarm Deadband                       | These parameters specify hysteresis factors for triggering monitor callbacks, i.e. monitors specified by calls to caAddEvent or dbAddEvent. A monitor will not be triggered until VAL changes by more than the specified amount.                                                                                                                                                                           |
| ADEL          | Archive Deadband                     |                                                                                                                                                                                                                                                                                                                                                                                                            |
| MDEL          | Monitor, i.e. value change, Deadband |                                                                                                                                                                                                                                                                                                                                                                                                            |
| LALM          | Last Alarmed Value                   | These fields are used to implement the hysteresis factors for monitors.                                                                                                                                                                                                                                                                                                                                    |
| ALST          | Archive Last Value                   |                                                                                                                                                                                                                                                                                                                                                                                                            |
| MLST          | Monitor Last Value                   |                                                                                                                                                                                                                                                                                                                                                                                                            |

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## 4. Record Support Routines

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|                           |                                                                                                                                                                                                                                                                                                                                                                                                                          |
|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>init_record</b>        | <p>IF <code>NVL</code> is a constant, <code>SELN</code> is set to its value. If <code>NVL</code> is a <code>PV_LINK</code> a channel access link is created.</p> <p>For each constant input link, the corresponding value field is initialized with the constant value (or 1e30 if the constant has the value 0).</p> <p>For each input link that is of type <code>PV_LINK</code>, a channel access link is created.</p> |
| <b>process</b>            | See next section.                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>get_value</b>          | Fills in the values of struct <code>valueDes</code> so that they refer to <code>VAL</code> .                                                                                                                                                                                                                                                                                                                             |
| <b>get_units</b>          | Retrieves <code>EGU</code> .                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>get_precision</b>      | Retrieves <code>PREC</code> .                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>get_graphic_double</b> | Sets the upper display and lower display limits for a field. If the field is <code>VAL</code> , <code>HIHI</code> , <code>HIGH</code> , <code>LOW</code> , or <code>LOLO</code> , the limits are set to <code>HOPR</code> and <code>LOPR</code> , else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.                       |
| <b>get_control_double</b> | Sets the upper control and the lower control limits for a field. If the field is <code>VAL</code> , <code>HIHI</code> , <code>HIGH</code> , <code>LOW</code> , or <code>LOLO</code> , the limits are set to <code>HOPR</code> and <code>LOPR</code> , else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.                   |
| <b>get_alarm_double</b>   | <p>Sets the following values:</p> <pre> upper_alarm_limit = HIHI upper_warning_limit = HIGH lower_warning_limit = LOW lower_alarm_limit = LOLO </pre>                                                                                                                                                                                                                                                                    |

---

## 5. Record Processing

---

Routine `process` implements the following algorithm:

1. If `NVL` is a database or channel access link, `SELN` is obtained from `NVL`. Fetch all values if database or channel access links. If `SELN` is `SELECTED`, then only the selected link is fetched.

2. Implement the appropriate selection algorithm. For `SELECT_HIGH`, `SELECT_LOW`, and `SELECT_MEDIAN`, input fields are ignored if they are undefined. If success, `UDF` is set to `FALSE`.
3. Check alarms. This routine checks to see if the new `VAL` causes the alarm status and severity to change. If so, `NSEV`, `NSTA` and `LALM` are set. It also honors the alarm hysteresis factor (`HYST`). Thus the value must change by more than `HYST` before the alarm status and severity is lowered.
4. Check to see if monitors should be invoked.
  - Alarm monitors are invoked if the alarm status or severity has changed.
  - Archive and value change monitors are invoked if `ADEL` and `MDEL` conditions are met
  - Monitors for A-L are checked whenever other monitors are invoked
  - `NSEV` and `NSTA` are reset to 0.
5. Scan forward link if necessary, set `PACT FALSE`, and return.

---

# Chapter 31: seq - Sequence

---

## 1. Introduction

---

The seq record is used to trigger the processing of up to ten other records. It has no associated device support. It is similar to the fanout record except it will fetch an input value and write an output value instead of simply processing a collection of forward links.

---

## 2. Field Summary

---

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| VAL   | LONG      | No  | 0       | Yes    | Yes    | No               | Yes |
| SELM  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| SELN  | USHORT    | No  | 1       | Yes    | Yes    | No               | No  |
| SELL  | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| PREC  | SHORT     | Yes | 0       | Yes    | Yes    | No               | No  |
| DLY1  | DOUBLE    | Yes | 0       | Yes    | Yes    | No               | No  |
| DOL1  | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| DO1   | DOUBLE    | No  | 0       | Yes    | Yes    | No               | No  |
| LNK1  | OUTLINK   | Yes | 0       | No     | No     | N/A              | No  |
| DLY2  | DOUBLE    | Yes | 0       | Yes    | Yes    | No               | No  |



| Field | Type    | DCT | Initial | Access | Modify | Rec Proc Monitor | PP |
|-------|---------|-----|---------|--------|--------|------------------|----|
| DOL2  | INLINK  | Yes | 0       | No     | No     | N/A              | No |
| DO2   | DOUBLE  | No  | 0       | Yes    | Yes    | No               | No |
| LNK2  | OUTLINK | Yes | 0       | No     | No     | N/A              | No |
| DLY3  | DOUBLE  | Yes | 0       | Yes    | Yes    | No               | No |
| DOL3  | INLINK  | Yes | 0       | No     | No     | N/A              | No |
| DO3   | DOUBLE  | No  | 0       | Yes    | Yes    | No               | No |
| LNK3  | OUTLINK | Yes | 0       | No     | No     | N/A              | No |
| DLY4  | DOUBLE  | Yes | 0       | Yes    | Yes    | No               | No |
| DOL4  | INLINK  | Yes | 0       | No     | No     | N/A              | No |
| DO4   | DOUBLE  | No  | 0       | Yes    | Yes    | No               | No |
| LNK4  | OUTLINK | Yes | 0       | No     | No     | N/A              | No |
| DLY5  | DOUBLE  | Yes | 0       | Yes    | Yes    | No               | No |
| DOL5  | INLINK  | Yes | 0       | No     | No     | N/A              | No |
| DO5   | DOUBLE  | No  | 0       | Yes    | Yes    | No               | No |
| LNK5  | OUTLINK | Yes | 0       | No     | No     | N/A              | No |
| DLY6  | DOUBLE  | Yes | 0       | Yes    | Yes    | No               | No |
| DOL6  | INLINK  | Yes | 0       | No     | No     | N/A              | No |
| DO6   | DOUBLE  | No  | 0       | Yes    | Yes    | No               | No |
| LNK6  | OUTLINK | Yes | 0       | No     | No     | N/A              | No |
| DLY7  | DOUBLE  | Yes | 0       | Yes    | Yes    | No               | No |
| DOL7  | INLINK  | Yes | 0       | No     | No     | N/A              | No |
| DO7   | DOUBLE  | No  | 0       | Yes    | Yes    | No               | No |
| LNK7  | OUTLINK | Yes | 0       | No     | No     | N/A              | No |
| DLY8  | DOUBLE  | Yes | 0       | Yes    | Yes    | No               | No |
| DOL8  | INLINK  | Yes | 0       | No     | No     | N/A              | No |
| DO8   | DOUBLE  | No  | 0       | Yes    | Yes    | No               | No |
| LNK8  | OUTLINK | Yes | 0       | No     | No     | N/A              | No |
| DLY9  | DOUBLE  | Yes | 0       | Yes    | Yes    | No               | No |
| DOL9  | INLINK  | Yes | 0       | No     | No     | N/A              | No |
| DO9   | DOUBLE  | No  | 0       | Yes    | Yes    | No               | No |
| LNK9  | OUTLINK | Yes | 0       | No     | No     | N/A              | No |
| DLYA  | DOUBLE  | Yes | 0       | Yes    | Yes    | No               | No |

| Field | Type    | DCT | Initial | Access | Modify | Rec Proc Monitor | PP |
|-------|---------|-----|---------|--------|--------|------------------|----|
| DOLA  | INLINK  | Yes | 0       | No     | No     | N/A              | No |
| DOA   | DOUBLE  | No  | 0       | Yes    | Yes    | No               | No |
| LNKA  | OUTLINK | Yes | 0       | No     | No     | N/A              | No |

### 3. Field Descriptions

| Name      | Summary                 | Description                                                                                                                                                                                                                                                                                                                                                                                           |
|-----------|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VAL       | Value Field             | Not used.                                                                                                                                                                                                                                                                                                                                                                                             |
| SELM      | Select Mechanism:       | <p><b>SELECT_ALL:</b> Select all links</p> <p><b>SELECTED:</b> Use SELN as index (1 to 6)</p> <p><b>MASK:</b> Use SELN as a mask to select an arbitrary combination of links.</p>                                                                                                                                                                                                                     |
| SELN      | Link Selection          | <p>If SELM=SELECT_ALL then this field is not used.</p> <p>If SELM=SELECTED then this is the index (1 to 6) of the link to select.</p> <p>If SELM=MASK then this is the mask (in decimal) used to determine the selected links. For example, if SELN=1, then LNK1 will be processed. If SELN=3 then LNK1 and LNK2 will be processed. If SELN=63 then links LNK1, LNK2, ... LNK6 will be processed.</p> |
| SELL      | Link Selection Location | SELN is read from SELL. SELL can be a constant, a database link, or a channel access link.                                                                                                                                                                                                                                                                                                            |
| PREC      | Display Precision       | Precision with which to display DLY1-DLYA and DO1-DOA fields. This field is used by record support to supply a value when get_precision is called.                                                                                                                                                                                                                                                    |
| DLY1-DLYA | Delay time              | This represents the delay time (in seconds) to wait before processing the input and output link pair (ie. DOLn and LNKn.)                                                                                                                                                                                                                                                                             |
| DO1-DOLA  | Input link selection    | DO is read from DOL. DOL can be a constant, database link or channel access link. If it is a constant, it is only copied to the DO field once at initialization time. Otherwise, it is re-fetched each time the record is processed.                                                                                                                                                                  |
| DO1-DOA   | Desired output value    | This field holds the desired output value that will be placed in the output location indicated by the LNK field.                                                                                                                                                                                                                                                                                      |
| LNK1-LNKA | Output link field       | DO is written to LNK. LNK can be a database link or a channel access link.                                                                                                                                                                                                                                                                                                                            |

## 4. Record Support Routines

---

The only record support routine is `process`.

First, `PACT` is set to `TRUE`, and the link selection is fetched. Depending on the selection mechanism, the link selection output links are processed in order from `LNK1` to `LNKA`. When `LNKn` is processed, the corresponding `DLYn` value is used to generate a delay via watchdog timer.

After `DLYn` seconds have expired, the input value is fetched from `DOn` (if `DOLn` is constant) or `DOLn` (if `DOLn` is a database link or channel access link) and written to `LNKn`.

When all links are completed, an asynchronous completion call back to `dbProcess` is made (see the *Application Developer's Guide* for more information on asynchronous processing.)

Then `UDF` is set to `FALSE`.

Monitors are checked.

The forward link is scanned, `PACT` is set `FALSE`, and the `process` routine returns.

For the delay mechanism to operate properly, the record is processed asynchronously. The only time the record will not be processed asynchronously is when there are no non-NULL output links selected (ie. when it has nothing to do.) The processing of the links is done via callback tasks at the priority set in the `PRI0` field in `dbCommon` (see the *Application Developer's Guide* for more information on callback tasks.)

---

# Chapter 32: State

---

## 1. Introduction

---

The state record is used to store an arbitrary ASCII string.

---

## 2. Field Summary

---

| Field | Type   | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|--------|-----|---------|--------|--------|------------------|-----|
| VAL   | STRING | Yes | Null    | Yes    | Yes    | Yes              | Yes |
| OVAL  | STRING | No  | Null    | Yes    | No     |                  |     |

---

## 3. Field Descriptions

---

| Name | Summary     | Description                             |
|------|-------------|-----------------------------------------|
| VAL  | Value Field | An arbitrary string value               |
| OVAL | Old Value   | Used to decide when to invoke monitors. |

## 4. Record Support Routines

---

Two record support routines are provided:

**process**

`process` triggers monitors on `VAL` when it changes and scans the forward link if necessary.

**get\_value**

`get_value` fills in struct `valueDes` so that it refers to `VAL`.

---

# Chapter 33: Stepper Motor

---

## 1. Introduction

---

The steppermotor record type is used to control stepper motors.

---

## 2. Field Summary

---

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| VAL   | FLOAT     | No  | 0       | Yes    | Yes    | Yes              | Yes |
| OUT   | OUTLINK   | Yes | 0       | No     | No     | N/A              | No  |
| RDBL  | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| DOL   | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| OMSL  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| ACCL  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| VELO  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| DIST  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| IVAL  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| MODE  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| CMOD  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| IALG  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| MRES  | USHORT    | Yes | 0       | Yes    | Yes    | No               | No  |
| ERES  | USHORT    | Yes | 0       | Yes    | Yes    | No               | No  |
| PREC  | SHORT     | Yes | 0       | Yes    | Yes    | No               | No  |
| EGU   | STRING    | Yes | Null    | Yes    | Yes    | No               | No  |
| DRVH  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| DRVL  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| HOPR  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| LOPR  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| HIHI  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| LOLO  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| HIGH  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| LOW   | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| HHSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| LLSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| HSV   | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| LSV   | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| HLSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| ADEL  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| MDEL  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| RDBD  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| RTRY  | SHORT     | Yes | 0       | Yes    | Yes    | No               | No  |
| STHM  | SHORT     | No  | 0       | Yes    | Yes    | No               | Yes |
| STOP  | SHORT     | No  | 0       | Yes    | Yes    | No               | Yes |
| DMOV  | SHORT     | No  | 0       | Yes    | Yes    | No               | No  |
| RVAL  | LONG      | No  | 0       | Yes    | Yes    | Yes              | Yes |
| RBV   | FLOAT     | No  | 0       | Yes    | Yes    | Yes              | No  |
| RRBV  | LONG      | No  | 0       | Yes    | Yes    | Yes              | No  |
| ALST  | FLOAT     | No  | 0       | Yes    | No     | No               | No  |
| MLST  | FLOAT     | No  | 0       | Yes    | No     | No               | No  |
| INIT  | SHORT     | No  | 0       | Yes    | Yes    | No               | Yes |
| MCW   | SHORT     | No  | 0       | Yes    | Yes    | No               | Yes |
| MCCW  | SHORT     | No  | 0       | Yes    | Yes    | No               | Yes |

| Field | Type  | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-------|-----|---------|--------|--------|------------------|-----|
| CW    | SHORT | No  | 0       | Yes    | Yes    | No               | Yes |
| CCW   | SHORT | No  | 0       | Yes    | Yes    | No               | Yes |
| DIR   | SHORT | No  | 0       | Yes    | Yes    | No               | Yes |
| MOVN  | SHORT | No  | 0       | Yes    | Yes    | No               | No  |
| CVEL  | SHORT | No  | 0       | Yes    | Yes    | No               | No  |
| RCNT  | SHORT | No  | 0       | Yes    | Yes    | No               | No  |
| POSM  | SHORT | No  | 0       | Yes    | Yes    | No               | No  |
| LVAL  | FLOAT | No  | 0       | Yes    | No     | No               | No  |
| EPOS  | FLOAT | No  | 0       | Yes    | Yes    | No               | No  |
| MPOS  | FLOAT | No  | 0       | Yes    | Yes    | No               | No  |
| MISS  | FLOAT | No  | 0       | Yes    | Yes    | No               | No  |
| LVEL  | FLOAT | No  | 0       | Yes    | Yes    | No               | No  |
| LACC  | FLOAT | No  | 0       | Yes    | Yes    | No               | No  |

### 3. Field Descriptions

| Name | Summary                              | Description                                                                                                                                                                                                                                                                                                  |
|------|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VAL  | Value                                | This is the desired output value, in engineering units. If DRVH and DRVL are defined, VAL is forced to be within the drive limits. VAL is either obtained from DOL or set via dbPuts.                                                                                                                        |
| OUT  | Output Link                          | This field is used by the device support routines to locate the stepper motor.                                                                                                                                                                                                                               |
| RDBL | Read Back Location (Input link)      | This link is used to obtain the read back value when a physical read back is attached to the device being driven from the stepper motor.                                                                                                                                                                     |
| DOL  | Desired Output Location (Input Link) | If DOL is a database or channel access link and OMSL is CLOSED_LOOP, then VAL is read from DOL. After the check for drive limits, VAL will be set to the value determined by DOL.                                                                                                                            |
| OMSL | Output Mode Select                   | This field has either the value SUPERVISORY or CLOSED_LOOP. DOL is used to determine VAL only if OMSL has the value CLOSED_LOOP. By setting this field, the record can be switched between supervisory and closed loop mode of operation. While in closed loop mode, the VAL field cannot be set via dbPuts. |
| ACCL | Acceleration                         | Number of seconds to reach VELO velocity.                                                                                                                                                                                                                                                                    |



| Name | Summary                              | Description                                                                                                                                                                                                                                                               |
|------|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VELO | Velocity                             | Rotations per second.                                                                                                                                                                                                                                                     |
| DIST | Distance                             | Distance moved by each pulse of the stepper motor.                                                                                                                                                                                                                        |
| IVAL | Initial Value                        |                                                                                                                                                                                                                                                                           |
| MODE | Mode                                 | Velocity or Position.                                                                                                                                                                                                                                                     |
| CMOD | Current Mode                         | Velocity or Position.                                                                                                                                                                                                                                                     |
| IALG | Initialization Algorithm             | None, Move to positive limit, Move to negative limit.                                                                                                                                                                                                                     |
| MRES | Motor Pulses per Revolution          |                                                                                                                                                                                                                                                                           |
| ERES | Encoder Pulses per Revolution        |                                                                                                                                                                                                                                                                           |
| PREC | Display Precision                    | Precision with which to display. This field is used by record support to supply a value when <code>get_precision</code> is called.                                                                                                                                        |
| EGU  | Engineering Units                    | ASCII string describing Engineering units. This field is used by record support to supply a units description string when <code>get_units</code> is called.                                                                                                               |
| DRVH | Drive High                           | If these values are defined, then VAL will forced to be in the range $DRVL \leq VAL \leq DRVH$                                                                                                                                                                            |
| DRVL | Drive Low                            |                                                                                                                                                                                                                                                                           |
| HOPR | High Operating Range                 | These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are used by record support to honor calls to <code>get_graphic_double</code> or <code>get_control_double</code> . |
| LOPR | Low Operating Range                  |                                                                                                                                                                                                                                                                           |
| HIHI | HiHi Alarm Limit                     | These fields specify the alarm limits.                                                                                                                                                                                                                                    |
| HIGH | High Alarm Limit                     |                                                                                                                                                                                                                                                                           |
| LOW  | Low Alarm Limit                      |                                                                                                                                                                                                                                                                           |
| LOLO | LoLo Alarm Limit                     |                                                                                                                                                                                                                                                                           |
| HHSV | HiHi Alarm Severity                  | These fields specify the alarm severities.                                                                                                                                                                                                                                |
| HSV  | High Alarm Severity                  |                                                                                                                                                                                                                                                                           |
| LSV  | Low Alarm Severity                   |                                                                                                                                                                                                                                                                           |
| LLSV | LoLo Alarm Severity                  |                                                                                                                                                                                                                                                                           |
| HLSV | Hardware Limit Violation Severity    |                                                                                                                                                                                                                                                                           |
| ADEL | Archive Deadband                     | These parameters specify hysteresis factors for triggering monitor callbacks, i.e. monitors specified by calls to <code>caAddEvent</code> or <code>dbAddEvent</code> . A monitor will not be triggered until VAL changes by more than the specified amount.               |
| MDEL | Monitor, i.e. value change, Deadband |                                                                                                                                                                                                                                                                           |

| Name | Summary                                    | Description                                                                                                                                                                                   |
|------|--------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RDBD | Retry Deadband                             |                                                                                                                                                                                               |
| RTRY | Number Of Retries Before Failure           |                                                                                                                                                                                               |
| STHM | Set Home                                   | Setting this field to 1 via a dbPut is a command to set home to the current position of the stepper motor. This field will automatically be reset to 0 after the command is accepted.         |
| STOP | Stop                                       | Setting this field to 1 will cause the motor to stop if it is moving. This field will automatically be reset to 0 after the command is accepted.                                              |
| DMOV | Done Moving to Value                       |                                                                                                                                                                                               |
| RVAL | Raw Data Value                             | RVAL is the value actually sent to the device.                                                                                                                                                |
| RBV  | Read Back Value                            | This is the actual read back value obtained from the hardware itself or from the associated device driver. It is the responsibility of the device support routine to give this field a value. |
| RRBV | Raw Read Back Value                        | Raw read back value obtained from the encoder.                                                                                                                                                |
| ALST | Archive Last Value                         | Value when last monitors for archiver were triggered<br>These fields are used to implement the hysteresis factors for monitors.                                                               |
| MLST | Monitor Last Value                         |                                                                                                                                                                                               |
| INIT | Initialize                                 |                                                                                                                                                                                               |
| MCW  | Motor Clockwise Limit Switch Value         |                                                                                                                                                                                               |
| MCCW | Motor Counter Clockwise Limit Switch Value |                                                                                                                                                                                               |
| CW   |                                            | Is motor clockwise limit switch TRUE?                                                                                                                                                         |
| CCW  |                                            | Is motor counter clockwise limit switch True?                                                                                                                                                 |
| DIR  | Current Direction                          |                                                                                                                                                                                               |
| MOVN |                                            | Is motor moving?                                                                                                                                                                              |
| CVEL |                                            | Has Constant velocity been attained?                                                                                                                                                          |
| RCNT | Current Retry Count                        |                                                                                                                                                                                               |
| LVAL | Last Value                                 |                                                                                                                                                                                               |
| POSM | Positive Motion                            |                                                                                                                                                                                               |
| EPOS | Encoder Read Back Position                 |                                                                                                                                                                                               |
| MPOS | Motor Position                             |                                                                                                                                                                                               |

| Name | Summary               | Description |
|------|-----------------------|-------------|
| MISS | First Attempt Error   |             |
| LVEL | Last Velocity Set     |             |
| LACC | Last Acceleration Set |             |

#### 4. Record Support Routines

- init\_record** This routine checks to see that device support is available. The routine next checks to see if the device support `sm_command` routine is defined. If either device support or the device support write routine does not exist, an error message is issued and processing is terminated.
- If device support includes `init_record`, it is called.
- If `DOL` is a constant, then `VAL` is initialized with its value and `UDF` is set to `FALSE`. If `DOL` is a `PV_LINK` then a channel access link is created.
- `init_sm` is then called.
- init\_record** Not written yet.
- process** See next section.
- get\_value** Fills in the values of struct `valueDes` so that they refer to `VAL`.
- get\_units** Retrieves `EGU`.
- get\_precision** Retrieves `PREC`.
- get\_graphic\_double** Sets the upper display and lower display limits for a field. If the field is `VAL`, `LVAL`, `MPOS`, `RBV`, `EPOS`, `HIHI`, `HIGH`, `LOW`, or `LOLO`, the limits are set to `HOPR` and `LOPR`, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.
- get\_control\_double** Sets the upper control and the lower control limits for a field. If the field is `VAL`, `LVAL`, `MPOS`, `RBV`, `EPOS`, `HIHI`, `HIGH`, `LOW`, or `LOLO`, the limits are set to `HOPR` and `LOPR`, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

**get\_alarm\_double**      Sets the following values:

```
upper_alarm_limit = HIHI
upper_warning_limit = HIGH
lower_warning_limit = LOW
lower_alarm_limit = LOLO
```

---

## 5. Record Processing

---

Not yet written

---

## 6. Device Support

---

At the present time, device support is intimately connected to record support. The compumotor 1830 and the OMS 6 axis controllers are supported.



---

# Chapter 34: *stringin* - String Input

---

## 1. Introduction

---

The *stringin* record is used to input an arbitrary ASCII string.

---

## 2. Field Summary

---

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| VAL   | STRING    | Yes | Null    | Yes    | Yes    | Yes              | Yes |
| OVAL  | STRING    | No  | Null    | Yes    | No     |                  | No  |
| INP   | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| SIOL  | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| SVAL  | STRING    | No  | Null    | Yes    | Yes    | No               | Yes |
| SIML  | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| SIMM  | GBLCHOICE | No  | 0       | Yes    | Yes    | No               | No  |
| SIMS  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |

---

### 3. Field Descriptions

---

| Name | Summary                        | Description                                                                                                                                           |
|------|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| VAL  | Value                          | An arbitrary ASCII string of 40 characters. It is either obtained from INP or else given a value via dbPuts.                                          |
| OVAL | Output Value                   | Old ASCII string. Used to decide when to invoke monitors. If VAL differs from OVAL, monitors will be invoked.                                         |
| INP  | Input Link                     | This field is used by the device support routines to obtain input. For soft records, it can be a constant, a database link, or a channel access link. |
| SIMM | Simulation Mode                | Simulation mode process variables. Refer to Chapter 3, Section "Simulation Mode" on page 11 for more information.                                     |
| SIML | Simulation Mode Location       |                                                                                                                                                       |
| SVAL | Simulation Value               |                                                                                                                                                       |
| SIOL | Simulation Value Location      |                                                                                                                                                       |
| SIMS | Simulation Mode Alarm Severity |                                                                                                                                                       |

---

### 4. Record Support Routines

---

Three record support routines are provided: `init_record`, `process`, and `get_value`.

#### **init\_record**

This routine initializes `SIMM` with the value of `SIML` if `SIML` type is `CONSTANT` link or creates a channel access link if `SIML` type is `PV_LINK`. `SVAL` is likewise initialized if `SIOL` is `CONSTANT` or `PV_LINK`.

This routine next checks to see that device support is available and a record support read routine is defined. If either does not exist, an error message is issued and processing is terminated.

If device support includes `init_record`, it is called.

#### **process**

See next section.

#### **get\_value**

Fills in the values of struct `valueDes` so that they refer to `VAL`.

---

## 5. Record Processing

---

Routine `process` implements the following algorithm:

1. Check to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the `PACT` field still set to `TRUE`. This ensures that processes will no longer be called for this record. Thus error storms will not occur.
2. `readValue` is called. See Chapter 3, Section "Simulation Mode" on page 11 for details.
3. If `PACT` has been changed to `TRUE`, the device support read routine has started but has not completed reading a new input value. In this case, the processing routine merely returns, leaving `PACT TRUE`.
4. `TIME` is set to `tslocaltime`
5. Check to see if monitors should be invoked.
  - Alarm monitors are invoked if the alarm status or severity has changed.
  - Archive and value change monitors are invoked if `OVAL` is not equal to `VAL`.
  - `NSEV` and `NSTA` are reset to 0.
6. Scan forward link if necessary, set `PACT FALSE`, and return.

---

## 6. Device Support

---

### Fields Of Interest To Device Support

Each `stringin` input record must have an associated set of device support routines. The primary responsibility of the device support routines is to obtain a new ASCII string value whenever `read_stringin` is called. The device support routines are primarily interested in the following fields:

| Name              | Summary                    | Description                                                                              |
|-------------------|----------------------------|------------------------------------------------------------------------------------------|
| <code>PACT</code> | Processing Active          | See Chapter 2, Section "Database Common: Field Descriptions" on page 5 for descriptions. |
| <code>DPVT</code> | Device Private             |                                                                                          |
| <code>UDF</code>  | <code>VAL</code> Undefined |                                                                                          |
| <code>VAL</code>  | Value                      | This field is set by the device support routines.                                        |
| <code>INP</code>  | Input Link.                | This field is used by the device support routines to locate its input.                   |

### Device Support Routines

Device support consists of the following routines:

#### *report*

`report (FILE fp, paddr)`

Not currently used.



*init*

`init()`

This routine is called once during IOC initialization.

*init\_record*

`init_record(precord)`

This routine is optional. If provided, it is called by the record support `init_record` routine.

*get\_ioint\_info*

`get_ioint_info(int cmd, struct dbCommon *precord, IOSCANPVT *ppvt)`

This routine is called by the `ioEventScan` system each time the record is added or deleted from an I/O event scan list. `cmd` has the value (0,1) if the record is being (added to, deleted from) an I/O event list. It must be provided for any device type that can use the `ioEvent` scanner.

*read\_stringin*

`read_stringin(precord)`

This routine must provide a new input value. It returns the following values:

- **0:** Success. A new ASCII string is stored into `VAL`.
- **Other:** Error.

---

## 7. Device Support For Soft Records

---

This module places a value directly in `VAL`.

If the `INP` link type is constant, the double constant, if non-zero, is converted to a string and stored into `VAL` by `init_record`, and `UDF` is set to `FALSE`. If the `INP` link type is `PV_LINK`, then `dbCaAddInlink` is called by `init_record`.

`read_stringin` calls `recGblGetLinkValue` to read the current value of `VAL`. See Chapter 3, Section "Soft Input" on page 10 for details.

If the return status of `recGblGetLinkValue` is zero, then `read_stringin` sets `UDF` to `FALSE`. The status of `recGblGetLinkValue` is returned.

---

# Chapter 35: *stringout* - String Output

---

## 1. Introduction

---

The *stringout* record is used to output an arbitrary ASCII string.

---

## 2. Field Summary

---

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| VAL   | STRING    | Yes | Null    | Yes    | Yes    | Yes              | Yes |
| OVAL  | STRING    | No  | Null    | Yes    | No     |                  | No  |
| DOL   | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| OMSL  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| OUT   | OUTLINK   | Yes | 0       | No     | No     | N/A              | No  |
| SIOL  | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| SIML  | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| SIMM  | GBLCHOICE | No  | 0       | Yes    | Yes    | No               | No  |
| SIMS  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| IVOA  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| IVOV  | STRING    | Yes | Null    | Yes    | Yes    | No               | No  |

### 3. Field Descriptions

| Name | Summary                              | Description                                                                                                                                                                                                                                                                                                  |
|------|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VAL  | Value                                | An arbitrary ASCII string of 40 characters. This is the field to be sent to OUT. It is either obtained from DOL or else given a value via dbPuts.                                                                                                                                                            |
| OVAL | Old Value                            | Used to decide when to invoke monitors. If VAL differs from OVAL, then monitors will be invoked.                                                                                                                                                                                                             |
| DOL  | Desired Output Location (Input Link) | If DOL is a database or channel access link and OMSL is CLOSED_LOOP, then VAL is read from DOL.                                                                                                                                                                                                              |
| OMSL | Output Mode Select                   | This field has either the value SUPERVISORY or CLOSED_LOOP. DOL is used to determine VAL only if OMSL has the value CLOSED_LOOP. By setting this field, the record can be switched between supervisory and closed loop mode of operation. While in closed loop mode, the VAL field cannot be set via dbPuts. |
| OUT  | Output Link                          | This field is used by the device support routines to decide where to send output. For soft records, it can be a constant, a database link, or a channel access link. If the link is a constant, the result is no output.                                                                                     |
| SIMM | Simulation Mode                      | Simulation mode process variables. Refer to Chapter 3, Section "Simulation Mode" on page 13 for more information.                                                                                                                                                                                            |
| SIML | Simulation Mode Location             |                                                                                                                                                                                                                                                                                                              |
| SIOL | Simulation Value Location            |                                                                                                                                                                                                                                                                                                              |
| SIMS | Simulation Mode Alarm Severity       |                                                                                                                                                                                                                                                                                                              |
| IVOA | Invalid Alarm Output Action          | Whenever the record is put into INVALID alarm severity IVOA specifies an action. See Chapter 3, Section "Invalid Alarm Output Action" on page 14 for more information                                                                                                                                        |
| IVOV | Invalid Alarm Output Value           |                                                                                                                                                                                                                                                                                                              |

### 4. Record Support Routines

Three record support routines are provided: `init_record`, `process`, and `get_value`.

#### **init\_record**

This routine initializes SIMM if SIML is a constant or creates a channel access link if SIML is PV\_LINK. If SIOL is PV\_LINK a channel access link is created.

This routine next checks to see that device support is available. The routine next checks to see if the device support write routine is defined. If either device support or the device support write routine does not exist, an error message is issued and processing is terminated.

If DOL is a constant, then the type double constant, if non-zero, is converted to a string and stored into VAL and UDF is set to FALSE. If DOL type is a PV\_LINK then dbCaAddInlink is called to create a channel access link.

If device support includes `init_record`, it is called.

**process**

See next section.

**get\_value**

Fills in the values of struct `valueDes` so that they refer to VAL.

---

## 5. Record Processing

---

Routine `process` implements the following algorithm:

1. Check to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the PACT field still set to TRUE. This ensures that processes will no longer be called for this record. Thus error storms will not occur.
2. If PACT is FALSE and OMSL is CLOSED\_LOOP, `recGblGetLinkValue` is called to read the current value of VAL. See Chapter 3, Section "Soft Input" on page 10 for details. If the return status of `recGblGetLinkValue` is zero then UDF is set to FALSE.
3. Check severity and write the new value. See Chapter 3, Section "Simulation Mode" on page 13 and Chapter 3, Section "Invalid Alarm Output Action" on page 14 for details.
4. If PACT has been changed to TRUE, the device support write output routine has started but has not completed writing the new value. In this case, the processing routine merely returns, leaving PACT TRUE.
5. Check to see if monitors should be invoked.
  - Alarm monitors are invoked if the alarm status or severity has changed.
  - Archive and value change monitors are invoked if OVAL is not equal to VAL.
  - NSEV and NSTA are reset to 0.
6. Scan forward link if necessary, set PACT FALSE, and return.

---

## 6. Device Support

---

### Fields Of Interest To Device Support

Each *stringout* output record must have an associated set of device support routines. The primary responsibility of the device support routines is to write a new value whenever *write\_stringout* is called. The device support routines are primarily interested in the following fields:

| Name | Summary            | Description                                                                              |
|------|--------------------|------------------------------------------------------------------------------------------|
| PACT | Processing Active  | See Chapter 2, Section "Database Common: Field Descriptions" on page 5 for descriptions. |
| DPVT | Device Private     |                                                                                          |
| NSEV | New Alarm Severity |                                                                                          |
| NSTA | New Alarm Status   |                                                                                          |
| VAL  | Value              | This is the field written by the device support routines.                                |
| OUT  | Output Link        | This field is used by the device support routines to locate its output.                  |

### Device Support Routines

Device support consists of the following routines:

*report*

```
report(FILE fp, paddr)
```

Not currently used.

*init*

```
init()
```

This routine is called once during IOC initialization.

*init\_record*

```
init_record(precord)
```

This routine is optional. If provided, it is called by the record support *init\_record* routine.

*get\_ioint\_info*

```
get_ioint_info(int cmd, struct dbCommon *precord, IOSCANPVT *ppvt)
```

This routine is called by the *ioEventScan* system each time the record is added or deleted from an I/O event scan list. *cmd* has the value (0,1) if the record is being (added to, deleted from) an I/O event list. It must be provided for any device type that can use the *ioEvent* scanner.

*write\_stringout*

```
write_stringout(precord)
```

This routine must output a new value. It returns the following values:

- **0:** Success.
- **Other:** Error.

---

## 7. Device Support For Soft Records

---

This module writes the current value of VAL.

If the OUT link type is PV\_LINK, then dbCaAddInlink is called by init\_record.

write\_so calls recGblPutLinkValue to write the current value of VAL. See Chapter 3, Section "Soft Output" on page 13 for details.



---

# Chapter 36: *subArray*

Who is this from?

---

## 1. Introduction

---

The normal use for the *subArray* record type is to obtain sub-arrays from waveform records. Setting either the *NELM* or *INDX* fields causes the record to be processed with the new value, so that applications in which the length and position of a subarray of a waveform record are dynamically varied can be implemented using standard EPICS operator interface tools. The first element of the sub-array, that at location *INDX* in the referenced waveform record, can be displayed as a scalar, or the entire subarray (of length *NELM*) can be displayed in the same way as a waveform record. If there are fewer than *NELM* elements in the referenced waveform after the *INDX*, only that number of elements actually available are returned, and *NORD* is set to reflect this. This record type does not support writing new values into waveform records.

---

## 2. Field Summary

---

| Field | Type       | DCT | Initial | Access | Modify | Rec Proc Monitor | PP |
|-------|------------|-----|---------|--------|--------|------------------|----|
| VAL   | (See FTVL) | No  | 0       | Yes    | Yes    | Yes              | No |
| PREC  | SHORT      | Yes | 0       | Yes    | Yes    | No               | No |
| FTVL  | GBLCHOICE  | Yes | 0       | Yes    | No     | No               |    |
| INP   | INLINK     | Yes | 0       | No     |        | N/A              |    |
| EGU   | STRING     | Yes | Null    | Yes    | Yes    | No               | No |
| HOPR  | FLOAT      | Yes | 0       | Yes    | Yes    | No               | No |
| LOPR  | FLOAT      | Yes | 0       | Yes    | Yes    | No               | No |



| Field | Type     | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|----------|-----|---------|--------|--------|------------------|-----|
| MALM  | ULONG    | Yes | 1       | Yes    | No     | No               |     |
| NELM  | ULONG    | Yes | 1       | Yes    | Yes    | No               | Yes |
| INDX  | ULONG    | Yes | 0       | Yes    | Yes    | No               | Yes |
| NORD  | LONG     | No  | 0       | Yes    | No     | No               |     |
| BPTR  | NOACCESS | No  |         |        |        |                  |     |

### 3. Field Descriptions

| Name | Summary                                 | Description                                                                                                                                                                                                                                                               |
|------|-----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VAL  | Value Field                             | This is used to reference the sub-array.                                                                                                                                                                                                                                  |
| PREC | Display Precision                       | Precision with which to display VAL. This field is not used by record support other than to supply a value when <code>get_precision</code> is called.                                                                                                                     |
| FTVL | Field Type of Value                     | This is <code>DBF_STRING, ... ,DBF_ENUM</code> .                                                                                                                                                                                                                          |
| INP  | Input Link                              | This field is used by the device support routines to obtain input. It can be a database link, or a channel access link.                                                                                                                                                   |
| EGU  | Engineering Units                       | ASCII string describing Engineering units. This field is used by record support to supply a units description string when <code>get_units</code> is called.                                                                                                               |
| HOPR | High Operating Range                    | These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are used by record support to honor calls to <code>get_graphic_double</code> or <code>get_control_double</code> . |
| LOPR | Low Operating Range                     |                                                                                                                                                                                                                                                                           |
| MALM | Maximum Number Of Elements In Sub-array | Generally this should be set to the <code>NELM</code> of the waveform record being pointed to.                                                                                                                                                                            |
| NELM | Number Of Elements In Sub-array         |                                                                                                                                                                                                                                                                           |
| INDX | Index Into Referenced Array             | Index of (offset into) waveform record being referenced; used as first element of sub-array.                                                                                                                                                                              |
| NORD | Number of Elements Read                 | Number of elements that were read of the desired subarray. This could be less than <code>NELM</code> depending on <code>INDX</code> and the <code>NELM</code> of the referenced waveform record.                                                                          |
| BPTR | Buffer Pointer                          | Holds address of sub-array.                                                                                                                                                                                                                                               |

---

## 4. Record Support Routines

---

|                       |                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>init_record</b>    | Using <code>MALM</code> and <code>FTVL</code> , space for the array is allocated. The array address is stored in <code>BPTR</code> . This routine checks to see that device support is available and a device support read routine is defined. If either does not exist, an error message is issued and processing is terminated. If device support includes <code>init_record</code> , it is called. |
| <b>process</b>        | See next section.                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>get_value</b>      | Fills in the values of struct <code>valueDes</code> so that they refer to the sub-array.                                                                                                                                                                                                                                                                                                              |
| <b>cvt_dbaddr</b>     | This is called by <code>dbNameToAddr</code> . It makes the <code>dbAddr</code> structure refer to the actual buffer holding the result.                                                                                                                                                                                                                                                               |
| <b>get_array_info</b> | Retrieves <code>NELM</code> .                                                                                                                                                                                                                                                                                                                                                                         |
| <b>put_array_info</b> | Sets <code>NORD</code> .                                                                                                                                                                                                                                                                                                                                                                              |
| <b>get_units</b>      | Retrieves <code>EGU</code> .                                                                                                                                                                                                                                                                                                                                                                          |
| <b>get_prec</b>       | Retrieves <code>PREC</code> .                                                                                                                                                                                                                                                                                                                                                                         |

---

## 5. Record Processing

---

Routine `process` implements the following algorithm:

1. Check to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the `PACT` field still set to `TRUE`. This ensures that processes will no longer be called for this record. Thus error storms will not occur.
2. Sanity check `NELM` and `INDX`. If `NELM` is greater than `MALM` it is set to `MALM`. If `INDX` is greater than `MALM` it is set to `MALM-1`.
3. Call device support read routine. This routine is expected to place the desired sub-array at the beginning of the buffer and set `NORD` to the number of elements of the sub-array that were read.
4. If `PACT` has been changed to `TRUE`, the device support read routine has started but has not completed writing the new value. In this case, the processing routine merely returns,

leaving PACT TRUE. Otherwise, process sets PACT TRUE at this time. This asynchronous processing logic is not currently used but has been left in place.

5. Check to see if monitors should be invoked.
  - Alarm monitors are invoked if the alarm status or severity has changed.
  - Archive and value change monitors are always invoked.
  - NSEV and NSTA are reset to 0.
6. Scan forward link if necessary, set PACT FALSE, and return.

## 6. Device Support

### Fields Of Interest To Device Support

The device support routines are primarily interested in the following fields:

| Name | Summary                                 | Description                                                                                                                  |
|------|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------|
| PACT | Processing Active                       | See Chapter 2 Section "Database Common: Field Descriptions" on page 5 for descriptions.                                      |
| DPVT | Device Private                          |                                                                                                                              |
| UDF  | VAL Undefined                           |                                                                                                                              |
| NSEV | New Alarm Severity                      |                                                                                                                              |
| NSTA | New Alarm Status                        |                                                                                                                              |
| INP  | Input Link                              | This field is used by the device support routines to locate its input.                                                       |
| FTVL | Field Type of Value                     | This is DBF_STRING, ... ,DBF_ENUM. The device support routine should check that this is correctly defined.                   |
| MALM | Maximum Number Of Elements In Sub-array | Number of elements that will fit in the array the record allocates. Device support must never return more elements than this |
| NELM | Number Sub-array Elements               | Number of elements in desired sub-array.                                                                                     |
| INDX | Index Into Referenced Array             | Index of beginning of desired sub-array in source array.                                                                     |
| BPTR | Buffer Pointer                          | Address of array device support must copy the source array into.                                                             |
| NORD | Number Of Elements Read                 | Device support must set this value when it completes.                                                                        |

### Device Support Routines

Device support consists of the following routines:

*report*

`report(FILE fp, paddr)`

Not currently used.

*init*

`init()`

Not currently used.

*init\_record*

`init_record(precord)`

This routine is called by the record support `init_record` routine.

*read\_sa*

`read_sa(precord)`

Enough of the source waveform is read into `BPTR`, from the beginning of the source, to include the requested sub-array. The sub-array is then copied to the beginning of the buffer. `NORD` is set to indicate how many elements of the sub-array were acquired.

---

## 7. Device Support For Soft Records

---

Only the device support module Soft Channel is provided. The `INP` link type must be either `DB_LINK` or `CA_LINK`.

**Soft Channel**

`INP` is expected to point to a waveform record.



---

# Chapter 37: *sub* - Subroutine

---

## 1. Introduction

---

The sub record provides a subroutine escape mechanism.

---

## 2. Field Summary

---

| Field | Type     | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|----------|-----|---------|--------|--------|------------------|-----|
| VAL   | DOUBLE   | No  | 0       | Yes    | Yes    | Yes              | Yes |
| INAM  | STRING   | Yes | Null    | Yes    | No     |                  | No  |
| SNAM  | STRING   | Yes | Null    | Yes    | No     |                  | No  |
| SADR  | NOACCESS | No  | 0       | No     | No     |                  | No  |
| STYP  | SHORT    | No  | 0       | Yes    | No     | No               | No  |
| INPA  | INLINK   | Yes | 0       | No     | No     | N/A              | No  |
| INPB  | INLINK   | Yes | 0       | No     | No     | N/A              | No  |
| INPC  | INLINK   | Yes | 0       | No     | No     | N/A              | No  |
| INPD  | INLINK   | Yes | 0       | No     | No     | N/A              | No  |
| INPE  | INLINK   | Yes | 0       | No     | No     | N/A              | No  |
| INPF  | INLINK   | Yes | 0       | No     | No     | N/A              | No  |
| INPG  | INLINK   | Yes | 0       | No     | No     | N/A              | No  |

| Field | Type   | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|--------|-----|---------|--------|--------|------------------|-----|
| INPH  | INLINK | Yes | 0       | No     | No     | N/A              | No  |
| INPI  | INLINK | Yes | 0       | No     | No     | N/A              | No  |
| INPJ  | INLINK | Yes | 0       | No     | No     | N/A              | No  |
| INPK  | INLINK | Yes | 0       | No     | No     | N/A              | No  |
| INPL  | INLINK | Yes | 0       | No     | No     | N/A              | No  |
| A     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| B     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| C     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| D     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| E     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| F     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| G     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| H     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| I     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| J     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| K     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| L     | DOUBLE | No  | 0       | Yes    | Yes/No | Yes              | Yes |
| LA    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LB    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LC    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LD    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LE    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LF    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LG    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LH    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LI    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LJ    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LK    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| LL    | DOUBLE | No  | 0       | Yes    | No     | No               | No  |
| PREC  | SHORT  | Yes | 0       | Yes    | Yes    | No               | No  |
| EGU   | STRING | Yes | Null    | Yes    | Yes    | No               | No  |
| HOPR  | FLOAT  | Yes | 0       | Yes    | Yes    | No               | No  |

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| LOPR  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| HIHI  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| LOLO  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| HIGH  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| LOW   | FLOAT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| BRSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| HHSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| LLSV  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| HSV   | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| LSV   | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| HYST  | DOUBLE    | Yes | 0       | Yes    | Yes    | No               | No  |
| ADEL  | DOUBLE    | Yes | 0       | Yes    | Yes    | No               | No  |
| MDEL  | DOUBLE    | Yes | 0       | Yes    | Yes    | No               | No  |
| LALM  | DOUBLE    | No  | 0       | Yes    | No     | No               | No  |
| ALST  | DOUBLE    | No  | 0       | Yes    | No     | No               | No  |
| MLST  | DOUBLE    | No  | 0       | Yes    | No     | No               | No  |

### 3. Field Descriptions

| Name          | Summary                         | Description                                                                                                                                       |
|---------------|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| VAL           | Value Field                     | This field is determined by the subroutine as a result of record processing.                                                                      |
| INAM          | Initialization Name             | This is the name of the initialization entry. It is called once at record initialization time.                                                    |
| SNAM          | Subroutine Name                 | This the the name of the processing routine. It is called by the the record processing routine.                                                   |
| SADR          | Subroutine Address              | Filled in by record processing.                                                                                                                   |
| STYP          | Subroutine Symbol Type          | Filled in by record processing.                                                                                                                   |
| INPA,...,INPL | Input Link A, Input Link B, ... | The input links. Each may be a constant, a database link, or a channel access link. Any link not defined is ignored.                              |
| A,...,L       | A, B, ...                       | The input values. If the corresponding INP field is a constant, this field is initialized with the constant value but can be changed via dbPut.s. |



| Name       | Summary                                             | Description                                                                                                                                                                                                                                    |
|------------|-----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| LA,....,LL | Last A, Last B, ...                                 | Previous input values These fields are used to decide when to trigger monitors on A,....,L.                                                                                                                                                    |
| PREC       | Display Precision                                   | Precision with which to display VAL. This field is used by record support to supply a value when get_precision is called.                                                                                                                      |
| EGU        | Engineering Units                                   | ASCII string describing Engineering units. This field is used by record support to supply a units description string when get_units is called.                                                                                                 |
| HOPR       | High Operating Range                                | These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are used by record support to honor calls to get_graphic_double or get_control_double. |
| LOPR       | Low Operating Range                                 |                                                                                                                                                                                                                                                |
| HIHI       | Hihi Alarm Limit                                    | These fields specify the alarm limits and severities.                                                                                                                                                                                          |
| HIGH       | High Alarm Limit                                    |                                                                                                                                                                                                                                                |
| LOW        | Low Alarm Limit                                     |                                                                                                                                                                                                                                                |
| LOLO       | Lolo Alarm Limit                                    |                                                                                                                                                                                                                                                |
| BRSV       | Severity for a subroutine return value less than 0. |                                                                                                                                                                                                                                                |
| HHSV       | Severity for a Hihi Alarm                           |                                                                                                                                                                                                                                                |
| HSV        | Severity for a High Alarm                           |                                                                                                                                                                                                                                                |
| LSV        | Severity for a Low Alarm                            |                                                                                                                                                                                                                                                |
| LLSV       | Severity for a Lolo Alarm                           |                                                                                                                                                                                                                                                |
| HYST       | Alarm Deadband                                      |                                                                                                                                                                                                                                                |
| ADEL       | Archive Deadband                                    |                                                                                                                                                                                                                                                |
| MDEL       | Monitor, i.e. value change, Deadband                |                                                                                                                                                                                                                                                |
| LALM       | Last Alarm Monitor Trigger Value                    | These fields are used to implement the hysteresis factors for monitors.                                                                                                                                                                        |
| ALST       | Last Archiver Monitor Trigger Value                 |                                                                                                                                                                                                                                                |
| MLST       | Last Value Change Monitor Trigger Value             |                                                                                                                                                                                                                                                |

---

## 4. Record Support Routines

---

|                           |                                                                                                                                                                                                                                                                                                                                                                                                             |
|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>init_record</b>        | <p>For each constant input link, the corresponding value field is initialized with the constant value. For each input link that is of type <code>PV_LINK</code>, a channel access link is created.</p> <p>If an initialization subroutine is defined, it is located and called.</p> <p>The processing subroutine is located and its address and type stored in <code>SADR</code> and <code>STYP</code>.</p> |
| <b>process</b>            | <p>See next section.</p>                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>get_value</b>          | <p>Fills in the values of struct <code>valueDes</code> so that they refer to <code>VAL</code>.</p>                                                                                                                                                                                                                                                                                                          |
| <b>get_units</b>          | <p>Retrieves <code>EGU</code>.</p>                                                                                                                                                                                                                                                                                                                                                                          |
| <b>get_precision</b>      | <p>Retrieves <code>PREC</code>.</p>                                                                                                                                                                                                                                                                                                                                                                         |
| <b>get_graphic_double</b> | <p>Sets the upper display and lower display limits for a field. If the field is <code>VAL</code>, <code>HIHI</code>, <code>HIGH</code>, <code>LOW</code>, or <code>LOLO</code>, the limits are set to <code>HOPR</code> and <code>LOPR</code>, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.</p>         |
| <b>get_control_double</b> | <p>Sets the upper control and the lower control limits for a field. If the field is <code>VAL</code>, <code>HIHI</code>, <code>HIGH</code>, <code>LOW</code>, or <code>LOLO</code>, the limits are set to <code>HOPR</code> and <code>LOPR</code>, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.</p>     |
| <b>get_alarm_double</b>   | <p>Sets the following values:</p> <pre>upper_alarm_limit = HIHI upper_warning_limit = HIGH lower_warning_limit = LOW lower_alarm_limit = LOLO</pre>                                                                                                                                                                                                                                                         |

---

## 5. Record Processing

---

Routine `process` implements the following algorithm:

1. If `PACT` is `FALSE` then fetch all arguments.
2. Call the subroutine and check return value.
  - Call subroutine
  - Set `PACT TRUE`

- If return value is 1, return
3. Check alarms. This routine checks to see if the new VAL causes the alarm status and severity to change. If so, NSEV, NSTA and LALM are set. It also honors the alarm hysteresis factor (HYST). Thus the value must change by more than HYST before the alarm status and severity is lowered.
  4. Check to see if monitors should be invoked.
    - Alarm monitors are invoked if the alarm status or severity has changed.
    - Archive and value change monitors are invoked if ADEL and MDEL conditions are met.
    - Monitors for A-L are are invoked if value has changed.
    - NSEV and NSTA are reset to 0.
  5. Scan forward link if necessary, set PACT FALSE, and return.

---

## 6. Example Synchronous Subroutine

---

This is an example that merely increments VAL each time process is called.

```
#include <vxWorks.h>
#include <types.h>
#include <stdioLib.h>

#include <dbDefs.h>
#include <subRecord.h>
#include <dbCommon.h>
#include <recSup.h>

long subInit(psub)
 struct subRecord *psub;
{
 printf("subInit was called\n");
 return(0);
}

long subProcess(psub)
 struct subRecord *psub;
{
 psub->val++;
 return(0);
}
```

---

## 7. Example Asynchronous Subroutine

---

This example shows an asynchronous subroutine. It uses (actually misuses) fields A and B. Field A is taken as the number of seconds until asynchronous completion. Field B is a flag to decide if messages should be printed. Lets assume A>0 and B=1. The following sequence of actions will occur:

1. subProcess is called with pact FALSE. It performs the following steps.
  - a. Computes, from A, the number of ticks until asynchronous completion should occur.
  - b. Prints a message stating that it is requesting an asynchronous callback.

- c. Calls the vxWorks watchdog start routine.
  - d. Sets pact TRUE and returns a value of 0. This tells record support to complete without checking alarms, monitors, or the forward link.
2. When the time expires, the system wide callback task calls myCallback. myCallback locks the record, calls process, and unlocks the record.
  3. Process again calls subProcess, but now pact is TRUE. Thus the following is done:
    - a. VAL is incremented.
    - b. A completion message is printed.
    - c. subProcess returns 0. The record processing routine will complete record processing.

```

#include <vxWorks.h>
#include <types.h>
#include <stdioLib.h>
#include <wdLib.h>
#include <callback.h>
#include <dbDefs.h>
#include <dbAccess.h>
#include <subRecord.h>
/* control block for callback*/
struct callback {
 CALLBACK callback;
 struct dbCommon *precord;
 WDOG_ID wd_id;
};
void myCallback(pcallback)
 struct callback *pcallback;
{
 struct dbCommon *precord=pcallback->precord;
 struct rset *prset=(struct rset *) (precord->rset);
 dbScanLock(precord);
 (*prset->process) (precord);
 dbScanUnlock(precord);
}
long subInit(psub)
 struct subRecord *psub;
{
 struct callback *pcallback;
 pcallback = (struct callback *) (calloc(1, sizeof(struct callback)));
 psub->dpvt = (void *) pcallback;
 callbackSetCallback(myCallback, pcallback);
 pcallback->precord = (struct dbCommon *) psub;
 pcallback->wd_id = wdCreate();
 printf("subInit was called\n");
 return(0);
}
long subProcess(psub)
 struct subRecord *psub;
{
 struct callback *pcallback=(struct callback *) (psub->dpvt);
 int wait_time;
 /* sub.inp must be a CONSTANT*/
 if(psub->pact) {
 psub->val++;
 if(psub->b)
 printf("%s subProcess Completed\n", psub->name);
 return(0);
 } else {
 wait_time = (long) (psub->a * vxTicksPerSecond);
 if(wait_time<=0){
 if (psub->b)
 printf("%s subProcess synchronous processing\n", psub->name);
 psub->pact = TRUE;
 return(0);
 }
 }
}

```

```
 }
 if (psub->b) {
 callbackSetPriority(psub->prio, pcallback);
 printf("%s Starting asynchronous processing\n", psub->name);
 wdStart(pcallback->wd_id, wait_time, callbackRequest, (int)pcallback);
 return(1);
 }
 }
 return(0);
}
```

---

# Chapter 38: Timer

---

## 1. Introduction

---

The function of the timer record has been replaced by the pulseCounter, pulseDelay, pulseTrain, and Event records. The Timer record type is included for backward compatibility.

This record type interacts with timer modules.

---

## 2. Field Summary

---

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| TORG  | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| OUT   | OUTLINK   | Yes | 0       | No     | No     | N/A              | No  |
| VAL   | SHORT     | No  | 0       | Yes    | Yes    | Yes              | Yes |
| TSRC  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| PTST  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | Yes |
| TEVT  | SHORT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| PREC  | SHORT     | Yes | 0       | Yes    | Yes    | No               | No  |
| TIMU  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | No  |
| MAIN  | GBLCHOICE | Yes | 1       | Yes    | Yes    | No               | Yes |

| Field | Type   | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|--------|-----|---------|--------|--------|------------------|-----|
| RDT1  | FLOAT  | No  | 0       | Yes    | Yes    | No               | No  |
| RDW1  | FLOAT  | No  | 0       | Yes    | Yes    | No               | No  |
| PDLY  | FLOAT  | Yes | 0       | Yes    | Yes    | No               | No  |
| DUT1  | FLOAT  | Yes | 0       | Yes    | Yes    | No               | Yes |
| OPW1  | FLOAT  | Yes | 0       | Yes    | Yes    | No               | Yes |
| DUT2  | FLOAT  | Yes | 0       | Yes    | Yes    | No               | Yes |
| OPW2  | FLOAT  | Yes | 0       | Yes    | Yes    | No               | Yes |
| DUT3  | FLOAT  | Yes | 0       | Yes    | Yes    | No               | Yes |
| OPW3  | FLOAT  | Yes | 0       | Yes    | Yes    | No               | Yes |
| DUT4  | FLOAT  | Yes | 0       | Yes    | Yes    | No               | Yes |
| OPW4  | FLOAT  | Yes | 0       | Yes    | Yes    | No               | Yes |
| DUT5  | FLOAT  | Yes | 0       | Yes    | Yes    | No               | Yes |
| OPW5  | FLOAT  | Yes | 0       | Yes    | Yes    | No               | Yes |
| T1DL  | DOUBLE | No  | 0       | Yes    | Yes    | No               | No  |
| T1WD  | DOUBLE | No  | 0       | Yes    | Yes    | Yes              | No  |
| T2DL  | DOUBLE | No  | 0       | Yes    | Yes    | No               | No  |
| T2WD  | DOUBLE | No  | 0       | Yes    | Yes    | No               | No  |
| T3DL  | DOUBLE | No  | 0       | Yes    | Yes    | No               | No  |
| T3WD  | DOUBLE | No  | 0       | Yes    | Yes    | No               | No  |
| T4DL  | DOUBLE | No  | 0       | Yes    | Yes    | No               | No  |
| T4WD  | DOUBLE | No  | 0       | Yes    | Yes    | No               | No  |
| T5DL  | DOUBLE | No  | 0       | Yes    | Yes    | No               | No  |
| T5WD  | DOUBLE | No  | 0       | Yes    | Yes    | No               | No  |
| T1TD  | FLOAT  | No  | 0       | Yes    | Yes    | Yes              | No  |
| T1LD  | FLOAT  | No  | 0       | Yes    | Yes    | Yes              | No  |
| T2TD  | FLOAT  | No  | 0       | Yes    | Yes    | No               | No  |
| T2LD  | FLOAT  | No  | 0       | Yes    | Yes    | No               | No  |
| T3TD  | FLOAT  | No  | 0       | Yes    | Yes    | No               | No  |
| T3LD  | FLOAT  | No  | 0       | Yes    | Yes    | No               | No  |
| T4TD  | FLOAT  | No  | 0       | Yes    | Yes    | No               | No  |
| T4LD  | FLOAT  | No  | 0       | Yes    | Yes    | No               | No  |
| T5TD  | FLOAT  | No  | 0       | Yes    | Yes    | No               | No  |

| Field | Type  | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-------|-----|---------|--------|--------|------------------|-----|
| T5LD  | FLOAT | No  | 0       | Yes    | Yes    | No               | No  |
| TRDL  | FLOAT | No  | 0       | Yes    | Yes    | No               | No  |
| TDIS  | SHORT | No  | 0       | Yes    | Yes    | No               | Yes |

### 3. Field Descriptions

| Name | Summary                           | Description                                                                                                                                                                                     |
|------|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TORG | Trigger Delay Origin (input link) | This is a link specifying the location of the trigger delay value. This must be a constant, a database link, or a channel access link. If TORG is a database link, then TRDL is read from TORG. |
| OUT  | Output Link                       | This field is used by the device support routines to decide where to send output.                                                                                                               |
| VAL  | Value Field                       | This field is used to force record processing.                                                                                                                                                  |
| TSRC | Clock Source                      | External or internal                                                                                                                                                                            |
| PTST | Pre-Trigger State                 | Low or high                                                                                                                                                                                     |
| TEVT |                                   | Event Number To Be Posted On Trigger                                                                                                                                                            |
| PREC | Display Precision                 |                                                                                                                                                                                                 |
| TIMU | Timer Units                       | Milli, micro, nano, pico seconds                                                                                                                                                                |
| MAIN | Maintain on Reboot                |                                                                                                                                                                                                 |
| RDT1 | Reboot Delay of 1                 |                                                                                                                                                                                                 |
| RPW1 | Reboot Width of 1                 |                                                                                                                                                                                                 |
| PDLY | Delay Source to Input             |                                                                                                                                                                                                 |
| DUTn | Delay Width For Trigger n         | (n=1-5): In timer units.                                                                                                                                                                        |
| OPWn | Output Pulse Width For Trigger n  | (n=1-5): In timer units.                                                                                                                                                                        |
| TnDL | Delay Width For Trigger n         | (n=1-5): In seconds.                                                                                                                                                                            |
| TnWD | Pulse Width Of Trigger n          | (n=1-5): In seconds.                                                                                                                                                                            |
| TnTD | Trailing Delay Of Trigger n       | (n=1-5): ( TnLD+OPWn )                                                                                                                                                                          |
| TnLD | Leading Delay Of Trigger n        | (n=1-5): ( DUTn+TRDL )                                                                                                                                                                          |



---

| Name | Summary              | Description                              |
|------|----------------------|------------------------------------------|
| TRDL | Trigger Delay        | Obtained from trigger delay origin TORG. |
| TDIS | Timing Pulse Disable |                                          |

---

#### 4. Record Support Routines

---

**init\_record**

**process**

See next section.

**get\_value**

Fills in the values of struct valueDes so that they refer to the array.

---

#### 5. Record Processing

---

This section not yet written.

---

#### 6. Device Support

---

Currently device support is intimately combined with record support.

---

# Chapter 39: *Wait*

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---

## 1. Introduction

---

This chapter describes the capabilities and use of the `wait` record. The `wait` record is derived from the standard `calc` record with the following additional features: “Reassignable” PV links, an Output Link, a Desired Output input link, an output event number to post, and several options as to when it will execute the output link and event posting. The `wait` record also has the capability to “process” as a result of an input changing (via CA monitors).

The `wait` record is a powerful record type that can be used to do “conditional” processing within the database. Its name is derived from the original requirement that initiated its development, i.e. “I want to *wait* until all the motors have stopped and then trigger the detector”. The sections below describe the capabilities of the record.

### “Reassignable” PV Links

Like the `calc` record, the `wait` record has 12 input links for fetching variables used in the calculation. Unlike the `calc` record, these input links can be modified during run time. The record contains ASCII fields in which a new `Process_Variable.Field` name may be written. The record will use the new link the next time the record is processed.

A consequence of reassignable links is that one cannot force the processing of an input record prior to retrieving the data (i.e. there is no `.PP` flag). This should be considered when designing a database using the `wait` record.

In this initial version, the “reassignable” PV links do not support channel access connections external to the IOC. Until this feature is added, the specified Process Variables must reside on the same IOC.

## Output Links and Output Events

The `wait` record has two kinds of “outputs”. The first is an output link to which data will be written when appropriate (see next section). The data to be written can be the result of the calculation (use `VAL`), fetched from another link (use `DOL` and specify a “Desired Output Location Name” - `DOLN`) or a user entered constant ( use `DOL`, leave `DOLN` blank, enter constant in `DOLD`).

As a result of the “reassignable links”, there is no application specific control over whether the record specified as the output link will be processed when the data is “put” (i.e. there is no `.PP` flag associated with the link.) The processing of the destination record will depend on its scan mechanism and ASCII record definition file `Process Passive` values.

The other “output” of a `wait` record is an event. If a non-zero value is entered into the `OEVT` (Output Event) field, the record will “post an event” (using the entered number as the event number) whenever the output link is executed. This is a way of initiating *several* other records to process as a result of a calculation.

## Output Link Execution Options

The outputs of the `wait` record are not necessarily executed every time the record processes. This allows “downstream” processing of records to be done conditionally. The “output execution” options are described below.

- **Every Time:** Outputs are executed every time the record processes.
- **On Change:** Outputs are executed if the result of the calculation (`VAL`) is different than the previous time the record was processed.
- **When Zero:** Outputs are executed if the result of the calculation is zero.
- **When Non-zero:** Outputs are executed if the result of the calculation is not zero.
- **Transition To Zero:** Outputs are executed if the result of the calculation is zero and the previous value was not zero.
- **Transition To Non-zero:** Outputs are executed if the result of the calculation is not zero and the previous value was zero.

## Process Record on Input Change

In addition to the standard scan mechanisms available to all records (periodic, passive, event, etc), the `wait` record can be specified to process as a result of one of its input values changing (using channel access monitors). This offers immediate response to an input change (rather than waiting for the next periodic scan) while minimizing record processing that is not required. The scan mechanism choice of `I/O Intr` will enable this feature.

For this release, an additional module, `caMonitor.o`, must be compiled and loaded with the `wait` record support to provide this feature.

A word of caution is in order. Because of the event driven nature of this feature, it is quite easy to configure a database that results in an infinite loop that uses all available CPU time. If the `wait` record is set to process as a result of a channel changing and the processing of the `wait` record causes the channel to change again, an infinite loop will result. The symptom will be a loss of all channel access connections (lower priority tasks) even though the shell responds normally. Using the `vxWorks` utility “`spy`” will confirm the predicament by showing 0% free CPU time.

## 2. Field Summary

| Field | Type     | DCT | Initial | Access | Modify | Rec Proc Monitor | PP |
|-------|----------|-----|---------|--------|--------|------------------|----|
| HOPR  | FLOAT    | Yes | 0       | Yes    | Yes    | No               | No |
| LOPR  | FLOAT    | Yes | 0       | Yes    | Yes    | No               | No |
| INIT  | SHORT    | No  | 0       | Yes    | No     | No               | No |
| CBST  | NOACCESS | No  | Null    | No     | No     | No               | No |
| INAN  | STRING   | Yes | Null    | Yes    | Yes    | No               | No |
| INBN  | STRING   | Yes | Null    | Yes    | Yes    | No               | No |
| INCN  | STRING   | Yes | Null    | Yes    | Yes    | No               | No |
| INDN  | STRING   | Yes | Null    | Yes    | Yes    | No               | No |
| INEN  | STRING   | Yes | Null    | Yes    | Yes    | No               | No |
| INFN  | STRING   | Yes | Null    | Yes    | Yes    | No               | No |
| INGN  | STRING   | Yes | Null    | Yes    | Yes    | No               | No |
| INHN  | STRING   | Yes | Null    | Yes    | Yes    | No               | No |
| ININ  | STRING   | Yes | Null    | Yes    | Yes    | No               | No |
| INJN  | STRING   | Yes | Null    | Yes    | Yes    | No               | No |
| INKN  | STRING   | Yes | Null    | Yes    | Yes    | No               | No |
| INLN  | STRING   | Yes | Null    | Yes    | Yes    | No               | No |
| INAA  | NOACCESS | No  | Null    | No     | No     | No               | No |
| INBA  | NOACCESS | No  | Null    | No     | No     | No               | No |
| INCA  | NOACCESS | No  | Null    | No     | No     | No               | No |
| INDA  | NOACCESS | No  | Null    | No     | No     | No               | No |
| INEA  | NOACCESS | No  | Null    | No     | No     | No               | No |
| INFA  | NOACCESS | No  | Null    | No     | No     | No               | No |
| INGA  | NOACCESS | No  | Null    | No     | No     | No               | No |
| INHA  | NOACCESS | No  | Null    | No     | No     | No               | No |
| INIA  | NOACCESS | No  | Null    | No     | No     | No               | No |
| INJA  | NOACCESS | No  | Null    | No     | No     | No               | No |
| INKA  | NOACCESS | No  | Null    | No     | No     | No               | No |
| INLA  | NOACCESS | No  | Null    | No     | No     | No               | No |
| INAV  | LONG     | No  | 0       | Yes    | Yes    | Yes              | No |
| INBV  | LONG     | No  | 0       | Yes    | Yes    | Yes              | No |

| Field | Type   | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|--------|-----|---------|--------|--------|------------------|-----|
| INCV  | LONG   | No  | 0       | Yes    | Yes    | Yes              | No  |
| INDV  | LONG   | No  | 0       | Yes    | Yes    | Yes              | No  |
| INEV  | LONG   | No  | 0       | Yes    | Yes    | Yes              | No  |
| INFV  | LONG   | No  | 0       | Yes    | Yes    | Yes              | No  |
| INGV  | LONG   | No  | 0       | Yes    | Yes    | Yes              | No  |
| INHV  | LONG   | No  | 0       | Yes    | Yes    | Yes              | No  |
| INIV  | LONG   | No  | 0       | Yes    | Yes    | Yes              | No  |
| INJV  | LONG   | No  | 0       | Yes    | Yes    | Yes              | No  |
| INKV  | LONG   | No  | 0       | Yes    | Yes    | Yes              | No  |
| INLV  | LONG   | No  | 0       | Yes    | Yes    | Yes              | No  |
| A     | DOUBLE | No  | 0       | Yes    | Yes    | Yes              | Yes |
| B     | DOUBLE | No  | 0       | Yes    | Yes    | Yes              | Yes |
| C     | DOUBLE | No  | 0       | Yes    | Yes    | Yes              | Yes |
| D     | DOUBLE | No  | 0       | Yes    | Yes    | Yes              | Yes |
| E     | DOUBLE | No  | 0       | Yes    | Yes    | Yes              | Yes |
| F     | DOUBLE | No  | 0       | Yes    | Yes    | Yes              | Yes |
| G     | DOUBLE | No  | 0       | Yes    | Yes    | Yes              | Yes |
| H     | DOUBLE | No  | 0       | Yes    | Yes    | Yes              | Yes |
| I     | DOUBLE | No  | 0       | Yes    | Yes    | Yes              | Yes |
| J     | DOUBLE | No  | 0       | Yes    | Yes    | Yes              | Yes |
| K     | DOUBLE | No  | 0       | Yes    | Yes    | Yes              | Yes |
| L     | DOUBLE | No  | 0       | Yes    | Yes    | Yes              | Yes |
| LA    | DOUBLE | No  | 0       | Yes    | Yes    | No               | No  |
| LB    | DOUBLE | No  | 0       | Yes    | Yes    | No               | No  |
| LC    | DOUBLE | No  | 0       | Yes    | Yes    | No               | No  |
| LD    | DOUBLE | No  | 0       | Yes    | Yes    | No               | No  |
| LE    | DOUBLE | No  | 0       | Yes    | Yes    | No               | No  |
| LF    | DOUBLE | No  | 0       | Yes    | Yes    | No               | No  |
| LG    | DOUBLE | No  | 0       | Yes    | Yes    | No               | No  |
| LH    | DOUBLE | No  | 0       | Yes    | Yes    | No               | No  |
| LI    | DOUBLE | No  | 0       | Yes    | Yes    | No               | No  |
| LJ    | DOUBLE | No  | 0       | Yes    | Yes    | No               | No  |

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP |
|-------|-----------|-----|---------|--------|--------|------------------|----|
| LK    | DOUBLE    | No  | 0       | Yes    | Yes    | No               | No |
| LL    | DOUBLE    | No  | 0       | Yes    | Yes    | No               | No |
| CALC  | STRING    | Yes | 36      | Yes    | Yes    | No               | No |
| RPCL  | NOACCESS  | No  | 184     | No     | No     | No               | No |
| CLCV  | LONG      | No  | 0       | Yes    | Yes    | Yes              | No |
| VAL   | DOUBLE    | No  | 0       | Yes    | Yes    | Yes              | No |
| OVAL  | DOUBLE    | No  | 0       | Yes    | Yes    | No               | No |
| PREC  | SHORT     | Yes | 0       | Yes    | Yes    | No               | No |
| OOPT  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | No |
| OUTN  | STRING    | Yes | Null    | Yes    | Yes    | No               | No |
| OUTA  | NOACCESS  | No  | Null    | No     | No     | No               | No |
| OUTV  | LONG      | No  | 0       | Yes    | Yes    | Yes              | No |
| DOPT  | RECCHOICE | Yes | 0       | Yes    | Yes    | No               | No |
| DOLN  | STRING    | Yes | Null    | Yes    | Yes    | No               | No |
| DOLA  | NOACCESS  | No  | Null    | No     | No     | No               | No |
| DOLV  | LONG      | No  | 0       | Yes    | Yes    | Yes              | No |
| DOLD  | DOUBLE    | Yes | 0       | Yes    | Yes    | Yes              | No |
| OEVT  | USHORT    | Yes | 0       | Yes    | Yes    | No               | No |
| ADEL  | DOUBLE    | Yes | 0       | Yes    | Yes    | No               | No |
| MDEL  | DOUBLE    | Yes | 0       | Yes    | Yes    | No               | No |
| ALST  | DOUBLE    | No  | 0       | Yes    | No     | No               | No |
| MLST  | DOUBLE    | No  | 0       | Yes    | No     | No               | No |
| SIOL  | INLINK    | No  | Null    | Yes    | No     | No               | No |
| SVAL  | DOUBLE    | No  | 0       | Yes    | Yes    | No               | No |
| SIML  | INLINK    | No  | Null    | Yes    | No     | No               | No |
| SIMM  | GBLCHOICE | No  | 0       | Yes    | Yes    | No               | No |
| SIMS  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No |

### 3. Field Descriptions

This section describes the fields that will be of interest to a typical application developer.

| Name      | Summary                           | Description                                                                                                                                                                                                                                                               |
|-----------|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| HOPR      | High Operating Range              | These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are used by record support to honor calls to <code>get_graphic_double</code> or <code>get_control_double</code> . |
| LOPR      | Low Operating Range               |                                                                                                                                                                                                                                                                           |
| CBST      | Callback Structure                | Pointer to a record private structure.                                                                                                                                                                                                                                    |
| INnN      | Input n Process Variable Name     | (n=A thru L): These fields contain the Process Variable names of the inputs that will be used for the calculation.                                                                                                                                                        |
| INnV      | Input n Valid                     | (n=A thru L): These flags indicate if the ASCII string entered in INnN was found to be a valid (existing) Process Variable.                                                                                                                                               |
| A,...,L   | Input Values                      | If the corresponding INP field is a constant, this field is initialized with the constant value but can be changed via <code>dbPuts</code> .                                                                                                                              |
| LA,...,LL | Previous Input Values             | These fields are used to decide when to trigger monitors on A,...,L.                                                                                                                                                                                                      |
| CALC      | Calculation String                | Expression to be calculated when the record is processed. Identical to the CALC field in the <code>calc</code> record.                                                                                                                                                    |
| RPCL      | Reverse Polish Calc String        | String used for interpreting CALC string.                                                                                                                                                                                                                                 |
| CLCV      | Calculation String Valid          | This flag is set when the CALC string is valid.                                                                                                                                                                                                                           |
| VAL       | Value Field                       | This field is calculated, via the CALC expression, each time the record is processed.                                                                                                                                                                                     |
| OVAL      | Old Value                         |                                                                                                                                                                                                                                                                           |
| PREC      | Display Precision                 | Precision with which to display VAL. This field is used by record support to supply a value when <code>get_precision</code> is called.                                                                                                                                    |
| OOPT      | Output Option                     | This menu specifies when to execute the output link and post the output event. Choices are "Every Time", "On Change", "When Zero", "When Non-zero", "Transition To Zero", "Transition To Non-zero"                                                                        |
| OUTN      | Output Link Process Variable Name | This field contains the Process Variable name of the output link.                                                                                                                                                                                                         |
| OUTA      | Output Address                    | Pointer to the <code>dbAddr</code> structure of the PV in OUTN.                                                                                                                                                                                                           |
| OUTV      | Output Link Valid                 | This flag indicates if the ASCII string entered in OUTN was found to be a valid (existing) Process Variable.                                                                                                                                                              |

| Name | Summary                                       | Description                                                                                                                                                                                                                      |
|------|-----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DOLN | Desired Output Location Process Variable Name | This field contains the name of the Process Variable from which the desired output data will be retrieved (if DOPT so indicates).                                                                                                |
| DOLA | Desired Output Location Address               | Pointer to the dbAddr Structure of the PV in DOLN.                                                                                                                                                                               |
| DOLV | Desired Output Location Valid                 | This flag indicates if the ASCII string entered in DOLN was found to be a valid (existing) Process Variable.                                                                                                                     |
| DOLD | Desired Output Location Data                  | This field contains the data fetched from the PV specified in DOLN (if valid) or a user entered value (if DOLN is not valid).                                                                                                    |
| DOPT | Data Option                                   | This menu specifies whether to use the DOLD field or the VAL field as output data.                                                                                                                                               |
| OEVT | Output Event                                  | If non-zero, the specified event number will be "posted" when the output link is executed.                                                                                                                                       |
| ADEL | Archive Deadband                              | These parameters specify hysteresis factors for triggering monitor callbacks, i.e. monitors specified by calls to caAddEvent or dbAddEvent. A monitor will not be triggered until VAL changes by more than the specified amount. |
| MDEL | Monitor, i.e. value change, Deadband          |                                                                                                                                                                                                                                  |
| ALST | Archive Last Value                            | These fields are used to implement the hysteresis factors for monitors.                                                                                                                                                          |
| MLST | Monitor Last Value                            |                                                                                                                                                                                                                                  |
| SIMM | Simulation Mode                               | Simulation mode process variables. Refer to Chapter 3, Section "Simulation Mode" on page 11 for more information.                                                                                                                |
| SIML | Simulation Mode Location                      |                                                                                                                                                                                                                                  |
| SVAL | Simulation Value                              |                                                                                                                                                                                                                                  |
| SIOL | Simulation Value Location                     |                                                                                                                                                                                                                                  |
| SIMS | Simulation Mode Alarm Severity                |                                                                                                                                                                                                                                  |

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#### 4. Record Support Routines

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#### 5. Record Processing

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## **6. Device Support**

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## **7. Device Support For Soft Records**

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# Chapter 40: Waveform

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## 1. Introduction

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The waveform record type stores arrays as data. The array can contain any of the supported data types.

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## 2. Field Summary

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| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP  |
|-------|-----------|-----|---------|--------|--------|------------------|-----|
| VAL   | See FTVL  | No  | 0       | Yes    | Yes    | Yes              | Yes |
| RARM  | SHORT     | Yes | 0       | Yes    | Yes    | No               | Yes |
| PREC  | SHORT     | Yes | 0       | Yes    | Yes    | No               | No  |
| INP   | INLINK    | Yes | 0       | No     | No     | N/A              | No  |
| EGU   | STRING    | Yes | Null    | Yes    | Yes    | No               | No  |
| HOPR  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| LOPR  | FLOAT     | Yes | 0       | Yes    | Yes    | No               | No  |
| NELM  | ULONG     | Yes | 1       | Yes    | No     | No               | No  |
| FTVL  | GBLCHOICE | Yes | 0       | Yes    | No     | No               | No  |
| BPTR  | NOACCESS  | No  | 0       | No     | No     |                  | No  |
| NORD  | ULONG     | No  | 0       | Yes    | No     | No               | No  |

| Field | Type      | DCT | Initial | Access | Modify | Rec Proc Monitor | PP |
|-------|-----------|-----|---------|--------|--------|------------------|----|
| BUSY  | SHORT     | No  | 0       | Yes    | No     | No               | No |
| SIOL  | INLINK    | Yes | 0       | No     | No     | N/A              | No |
| SIML  | INLINK    | Yes | 0       | No     | No     | N/A              | No |
| SIMM  | GBLCHOICE | No  | 0       | Yes    | Yes    | No               | No |
| SIMS  | GBLCHOICE | Yes | 0       | Yes    | Yes    | No               | No |

### 3. Field Descriptions

| Name | Summary                      | Description                                                                                                                                                                                                                                                               |
|------|------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VAL  | Value Field                  | This is used to reference the array.                                                                                                                                                                                                                                      |
| RARM | Rearm                        | When set to 1, the device will be rearmed.                                                                                                                                                                                                                                |
| PREC | Display Precision            | Precision with which to display VAL. This field is used by record support to supply a value when <code>get_precision</code> is called.                                                                                                                                    |
| INP  | Input Link                   | This field is used by the device support routines to obtain input.                                                                                                                                                                                                        |
| EGU  | Engineering Units            | ASCII string describing Engineering units. This field is used by record support to supply a units description string when <code>get_units</code> is called.                                                                                                               |
| HOPR | High Operating Range         | These fields determine the upper and lower display limits for graphics displays and the upper and lower control limits for control displays. The fields are used by record support to honor calls to <code>get_graphic_double</code> or <code>get_control_double</code> . |
| LOPR | Low Operating Range          |                                                                                                                                                                                                                                                                           |
| NELM | Number of Elements, in array |                                                                                                                                                                                                                                                                           |
| FTVL | Field Type of Value          | This is <code>DBF_STRING, ... , DBF_ENUM</code> .                                                                                                                                                                                                                         |
| BPTR | Buffer Pointer               | Holds address of array.                                                                                                                                                                                                                                                   |
| NORD | Number of Elements Read      |                                                                                                                                                                                                                                                                           |
| BUSY | Busy                         | Is device busy?                                                                                                                                                                                                                                                           |

| Name | Summary                        | Description                                                                                                       |
|------|--------------------------------|-------------------------------------------------------------------------------------------------------------------|
| SIMM | Simulation Mode                | Simulation mode process variables. Refer to Chapter 3, Section "Simulation Mode" on page 13 for more information. |
| SIML | Simulation Mode Location       |                                                                                                                   |
| SIOL | Simulation Value Location      |                                                                                                                   |
| SIMS | Simulation Mode Alarm Severity |                                                                                                                   |

## 4. Record Support Routines

### **init\_record**

Using `NELM` and `FTVL` space for the array is allocated. The array address is stored in the record.

This routine initializes `SIMM` with the value of `SIML` if `SIML` type is `CONSTANT` link or creates a channel access link if `SIML` type is `PV_LINK`. `VAL` is likewise initialized if `SIOL` is `CONSTANT` or `PV_LINK`.

This routine next checks to see that device support is available and a device support read routine is defined. If either does not exist, an error message is issued and processing is terminated.

If device support includes `init_record`, it is called.

### **process**

See next section.

### **get\_value**

Fills in the values of struct `valueDes` so that they refer to the array.

### **cvt\_dbaddr**

This is called by `dbNameToAddr`. It makes the `dbAddr` structure refer to the actual buffer holding the result.

### **get\_array\_info**

Obtains values from the array referenced by `VAL`.

### **put\_array\_info**

Writes values into the array referenced by `VAL`.

### **get\_units**

Retrieves `EGU`.

### **get\_prec**

Retrieves `PREC`.

**get\_graphic\_double** Sets the upper display and lower display limits for a field. If the field is VAL the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

**get\_control\_double** Sets the upper control and the lower control limits for a field. If the field is VAL the limits are set to HOPR and LOPR, else if the field has upper and lower limits defined they will be used, else the upper and lower maximum values for the field type will be used.

**get\_graphic\_double** Sets the following values:

```
upper_disp_limit = HOPR
lower_disp_limit = LOPR
```

**get\_control\_double** Sets the following values

```
upper_ctrl_limit = HOPR
lower_ctrl_limit = LOPR
```

---

## 5. Record Processing

---

Routine `process` implements the following algorithm:

1. Check to see that the appropriate device support module exists. If it doesn't, an error message is issued and processing is terminated with the `PACT` field still set to `TRUE`. This ensures that processes will no longer be called for this record. Thus error storms will not occur.
2. Call device support read routine.
3. If `PACT` has been changed to `TRUE`, the device support read routine has started but has not completed writing the new value. In this case, the processing routine merely returns, leaving `PACT TRUE`.
4. Check to see if monitors should be invoked.
  - Alarm monitors are invoked if the alarm status or severity has changed.
  - Archive and value change monitors are always invoked.
  - `NSEV` and `NSTA` are reset to 0.
5. Scan forward link if necessary, set `PACT FALSE`, and return.

## 6. Device Support

### Fields Of Interest To Device Support

Each waveform record must have an associated set of device support routines. The primary responsibility of the device support routines is to obtain a new array value whenever `read_wf` is called. The device support routines are primarily interested in the following fields:

| Name | Summary                     | Description                                                                                                               |
|------|-----------------------------|---------------------------------------------------------------------------------------------------------------------------|
| PACT | Processing Active           | See Chapter 2, Section "Database Common: Field Descriptions" on page 5 for descriptions.                                  |
| DPVT | Device Private              |                                                                                                                           |
| NSEV | New Alarm Severity          |                                                                                                                           |
| NSTA | New Alarm Status            |                                                                                                                           |
| INP  | Input Link                  | This field is used by the device support routines to locate its input.                                                    |
| RATE | Sampling Rate               | Some device support modules may find this useful.                                                                         |
| PTSS | Pretrigger Samples          | Some device support modules may find this useful.                                                                         |
| NELM | Number Of Elements In Array |                                                                                                                           |
| FTVL | Field Type Of Value         | This is <code>DBF_STRING, ... , DBF_ENUM</code> . The device support routine should check that this is correctly defined. |
| RARM | Rearm                       | When set to 1, the device will be rearmed. The device support routine should reset it to 0 when done.                     |
| BPTR | Holds Address Of Array      |                                                                                                                           |
| NORD | Number Of Elements Read     | Device support must set this value when it completes.                                                                     |
| BUSY | Is device busy?             |                                                                                                                           |

### Device Support Routines

Device support consists of the following routines:

*report*

```
report(FILE fp, paddr)
```

Not currently used.

*init*

```
init()
```

This routine is called once during IOC initialization.

*init\_record*

```
init_record(precord)
```

This routine is optional. If provided, it is called by the record support `init_record` routine.

*get\_ioint\_info*

`get_ioint_info(int cmd, struct dbCommon *precord, IOSCANPVT *ppvt)`

This routine is called by the `ioEventScan` system each time the record is added or deleted from an I/O event scan list. `cmd` has the value (0,1) if the record is being (added to, deleted from) an I/O event list. It must be provided for any device type that can use the `ioEvent` scanner.

*read\_wf*

`read_wf(precord)`

This routine must provide a new input value. It returns the following values:

- 0: Success.
- Other: Error.

---

## 7. Device Support For Soft Records

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If `INP` is a constant link, then `read_wf` does nothing. In this case, the record can be used to hold arrays written via `dbPuts`. If `INP` is a database or channel access link, the new array value is read from the link. `NORD` is set.

This module places a value directly in `VAL`.

If the `INP` link type is constant, then `NORD` is set to zero. If the `INP` link type is `PV_LINK`, then `dbCaAddInLink` is called by `init_record`.

`read_wf` calls `recGblGetLinkValue` which performs the following steps:

- If the `INP` link type is `CONSTANT` `recGblGetLinkValue` does nothing.
- If the `INP` link type is `DB_LINK`, then `dbGetLink` is called to obtain a new input value. If `dbGetLink` returns an error, a `LINK_ALARM` with a severity of `INVALID_ALARM` is raised.
- If the `INP` link type is `CA_LINK`, then `dbCaGetLink` is called to obtain a new input value. If `dbCaGetLink` returns an error, a `LINK_ALARM` with a severity of `INVALID_ALARM` is raised.

`NORD` is set to the number of values returned and `read_wf` returns.