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AUTOMATIC CALIBRATION AND SIGNAL SWITCHING SYSTEM
FOR THE ELECTRON BEAM FUSION RESEARCH
DATA ACQUISITION FACILITY

William B. Boyer

Sandia Laboratories

MASILL

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by

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ABSTRACT

This report describes both the hardware and software components of an automatic calibration and signal system (Autocal) for the data acquisition system for the Sandia particle beam fusion research accelerators Hydra, Proto I, and Proto II. The Autocal hardware consists of off-the-shelf commercial equipment. The various hardware components, special modifications and overall system configuration are described. Special software has been developed to support the Autocal hardware. Software operation and maintenance are described.

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1. Summary

An automatic calibration and signal switching system (Autocal) has been incorporated into the particle beam fusion data acquisition facility.¹ The Autocal hardware is capable of generating horizontal and vertical reference calibration signals and switching them to each channel of each 7912 Transient Digitizer. The system is also used to route signals from different accelerators to the same digitizer. All Autocal functions are computer controllable. Software has been written to support the capabilities of the Autocal hardware. The purpose of this report is to describe both the hardware and software in the Autocal system.

2. Hardware

The Autocal hardware consists of a Tektronix 1340 Data Coupler and six SM-2 Signal Switcher matrices. The Data Coupler contains two ASCII interface cards, a controller card for each SM-2, a vertical reference signal generator card and a horizontal reference signal generator card. The system is interfaced to the facility Modular Computer Systems Modcomp II computer via a Modcomp 4811 Asynchronous Communications Interface. A block diagram of the system is shown in Fig. 1. Each hardware component is described briefly below. Detailed descriptions of each item may be found in the appropriate manual.

2.1 Data Coupler (Tektronix 1340)²

The Data Coupler box is used to house the ASCII interface, switch controller, and reference signal cards. It provides power to each card. All input and output signals for each card are bussed from external connectors to the proper card.

2.2 ASCII Interface (Tektronix 021-0061-00)³

Communication between the computer and the Autocal system is

accomplished via two ASCII interface cards (input, output) in the Data Coupler. The data transfer rate is currently set at 1200 baud (bit/sec). This is a modification to the original set-up which operated at only 100 baud. The modification was done by simply turning up the clock rate. The input card converts ASCII data from the computer into 16 bit binary words. These data words are then routed to the appropriate card. Input data consists of commands to the various cards. The ASCII output card converts 16 bit binary data to ASCII characters and transmits it to the computer. Output data consists of the status words from the switch controller and reference signal generator cards.

2.3 Switch Controller Cards (Tektronix 070-3094-00)⁴

Each SM-2 switch matrix unit requires a 32-bit output controller card in the Data Coupler. The purpose of this card is primarily to latch up and hold switch status commands sent from the computer. This latched data is placed on the control input line for the appropriate SM-2. The switch control data consists of two 16-bit words. These two words completely define every switch position in the matrix. The latched data may be interrogated by the computer to determine how each switch is currently positioned.

2.4 Reference Signal Generator Cards (Tektronix 021-0052-00)⁵

The Data Coupler contains vertical and horizontal reference signals generator cards. The vertical card can generate the following positive dc levels:

1.	0.0	V
2.	.01	V
3.	.025	V
4.	.05	V
5.	.1	V
6.	.25	V
7.	.5	V
8.	1.0	V
9.	2.5	V

The accuracy of the output levels is ± 0.25 percent or $\pm 75 \mu\text{V}$ into 50Ω or higher loads. The horizontal card can produce periodic signals with rep rates from $0.25 \text{ Hz} - 125 \text{ MHz}$. The signals are at fixed frequencies in a

$$0.25, 0.625, 1.25 \times 10^i \quad i = 0, 1, \dots, 8$$

sequence. The output period accuracy is $\pm 0.02\%$. The output amplitude is $> 150 \text{ mV}$ into 50Ω . The signal is a square wave at frequencies below about 25 MHz . Above this frequency, the signal becomes distorted due to loss of harmonics and reflections. The resultant steady state signal is still very usable for time calibrations.

2.5 Signal Switcher Matrix (Tektronix SM-2)⁶

Each SM-2 Signal Switcher Matrix contains twelve four-to-one 50Ω switching modules. In this report modules will be numbered 0-11. Each module can switch signals from one of four inputs to the output. In addition the first eight modules can be completely disconnected. The switch positions of all the modules are determined by the two 16-bit matrix status words. All switches are generally affected when these words are changed. The manufacturers electrical characteristics are as follows:

<u>Characteristic</u>	<u>Value (Max)</u>
Switched Voltage	100 VDC
Switched Current	250 ma DC
Breakdown Voltage	250 VRMS
Risetime (50 Ω source)	350 ps
Aberration (when driven with a 1 ns risetime pulse) ...	4%

In addition, the VSWR was measured to be 1.2 with a Hewlett-Packard 1415A Time Domain Reflectometer.

The SM-2 Switch Matrices have been slightly modified. In their original configuration modules 0-6 and 8 could be completely disconnected. The modification was to make 0-7 disconnectable. This was done to make

the programming easier.

2.6 System Configuration

Two switch modules are dedicated to each 7912, one for each vertical input channel. The switch inputs are used as follows:

<u>Input</u>	<u>Signal Input</u>
1	Hydra
2	Proto I
3	Proto II
4	Autocal

In addition, one switch module called the Autocal switch is used to send either the vertical reference signal or the horizontal reference signal to the 7912 switch module Autocal input ports. The vertical signal is fed into input 3 and the horizontal signal is fed into input 4. Inputs 1 and 2 are not used. A 0.2-500 MHz amplifier is available for boosting the horizontal reference signal level to about 2 vpp. The signal is normally routed through this amplifier before going to the Autocal switch.

2.7 Computer Interface

The autocal hardware is interfaced to the Modcomp computer via a 4811 Asynchronous Communications Interface card located in a Peripheral Controller Interface box in one of the computer cabinets. The 4811 reads and writes ASCII data compatible with the ASCII interface in the Autocal Data Coupler. The Autocal hardware uses channel 2 of the 4811. This channel operates in a full-duplex (simultaneous read/write) no echo, no parity mode. The channel input device is called AI2. And the output device is called AO2 in the CPU operating system.

3. Software

A Fortran program, CAL7912, has been written to utilize the Autocal system to calibrate the 7912 digitizers. Calibration can be performed automatically or manually. The program maintains the files of calibration data on the disc.

3.1 Activation

The program is catalogued on disc file LMT as an overlay under the alias ACL. The program may be activated by pressing the Control Interrupt button on either the console or the user 4010 terminal. If no program is using the terminal, the control program will type the message

READY

The user then must type

GO CAL (return)

within seven seconds. If the program is not already in use and if there is sufficient core, the program will be activated.⁸ If the Autocal program is requested from the user 4010 terminal, it will be running in core partition 2 as a task under the name ACL.⁹ If it is requested from the console terminal, it will be running in core partition 3 under the name AC2. The program may be simultaneously running on both terminals. However, in general two programs cannot be talking to the 7912's at the same time.

3.2 File Assignments

3.2.1 Operator Communications

User communication with the program is via logical unit numbers 10 and 11 for program output and input respectively. These files are automatically assigned to the terminal from which the program was activated.

3.2.2 Autocal Hardware Communications

Communications with the Autocal hardware is via logical unit numbers 12 and 13 for output and input respectively. Logical unit 12 is always assigned to device A02; logical unit 13 is always assigned to device AI2.

3.2.3 Calibration Data Files

Horizontal calibration data is stored on logical unit 25.

This unit is defined as a direct access subpartition of the file name CAL. CAL is assigned to partition ACA on disc pack 2.¹⁰ This subpartition has the following direct access characteristics:

- 1) 400 records
- 2) 110 words/record
- 3) records unformatted.

Each record contains one complete horizontal calibration curve. Each 7912 has calibration data for four different time base sweep speeds.

Vertical calibration data is stored on logical unit 26. This unit is also defined as a direct access subpartition of the file CAL.

The vertical calibration subpartition has the following characteristics:

- 1) 800 records
- 2) 25 words/record
- 3) records unformatted.

each record contains one complete set of vertical calibration data. Each 7912 channel has calibration data for four different amplifier gain settings.

3.2.4 EBD Shot Set-Up Data

The program reads shot set-up information produced by the data acquisition program EBD from logical unit 27.¹¹ This unit is a direct access subpartition of file name DAT. DAT is assigned to disc partition ADA on pack 2. Unit 27 has the following direct access characteristics:

- 1) 4 records
- 2) 500 words/record
- 3) records unformatted.

3.2.5 7912 Communications

Communications with the 7912 Transient Digitizers is via the file name TEK. This file is assigned to the 7912 logical device TD. TD is the software symbiont driver which processes all communication with the 7912's.¹²

3.3 Operation

The program announces its presence after activation by erasing the terminal screen and typing

PROGRAM AUTOCAL ACTIVE

ENTER CAL MODE: AUTO, MANUAL, PRINT

The user must then enter the mode he desires. Valid entries are described below.

<u>Entry</u>	<u>Effect</u>
A	Automatic calibration overlay run.
M	Manual calibration overlay run.
P	Print overlay run.

Each overlay is described in detail in the following sections.

Many operator commands are typed in response to the message

READY
d

The following prompt delimiters "d" are used

<u>d</u>	<u>Program</u>
\$	AUTCAL errors
?	MANCAL commands
@	PRICAL commands.

Command responses are typed in on the terminal keyboard. Each command consists of a directive word followed by up to three parameters. Parameter entries may be alphanumeric text strings, integer numbers, or floating point numbers. Valid commands for the different overlays are described in the appropriate section.

Capital letters in command descriptions indicate entries which must be typed generally as shown. Small letters indicate user supplied numbers. Only the first three characters of directive words need be typed. Only the first two characters of alphanumeric parameters are required.

3.3.1 Automatic Calibration Overlay

3.3.1.1 Start Up

The overlay AUTOCAL starts by turning off switch modules 0-7 and setting modules 8-11 to position 1 on all SM-2 matrices. It also turns off vertical and horizontal reference signals. The program then erases the 4010 terminal screen and prints

AUTOMATIC CALIBRATION PROGRAM

ENTER UNITS TO BE CALIBRATED OR "ALL" OR "SHOT" OR "NONE"

The valid responses are described below.

<u>Response</u>	<u>Effect</u>
n1, n2,...	7912 unit numbers n1, n2,... will be automatically calibrated.
ALL	All 7912's will be calibrated.
SHOT	The 7912's selected for use the last time program EBD was run will be calibrated. ¹¹ Unit numbers are read from the disc.
NONE	No units will be calibrated. The overlay will exit.

If an entry is invalid, the program types

ILLEGAL ENTRY

and the user may try again. If the entry is valid, the program then types the message

ENTER CAL MODE: VERT, HORZ, BOTH

valid responses are:

- V - vertical calibration only.
- H - horizontal calibration only.
- B - both horizontal and vertical calibration.

It is possible to do both vertical and horizontal calibrations on the same run. However, it is generally unadvisable. The end of the cable linking the Autocal reference signals to the #4 inputs on the switch matrices has provisions for connecting a 50 Ω terminator. This terminator cleans up reflections on the horizontal cal signal. However, it loads down the vertical cal signal by about 30%. Thus the

terminator must be removed when doing vertical calibrations.

3.3.1.2 Vertical Calibration

The first step in the vertical calibration process is to digitize a baseline on the proper unit. (In this and all subsequent steps the 7912 is armed and triggered automatically by the computer.) If the knobs readout data from the unit indicates that only one channel is active, the program proceeds to calibrate that channel. If both channels are active, the program tries to determine if the amplifier is in ADD or ALT mode. Operation in CHOP mode is not allowed. This is done by digitizing a second baseline. If the trace stays in the same place, the program assumes ADD mode. Only channel 1 will be calibrated in ADD mode since there is no way to locate the channel 2 baseline. If ALT mode is detected, the program tries to decide which channel triggered first. The program first checks if the unit is in single sweep mode. If it is not, an error message is printed; and the operator must correct the situation. The trigger sequence is deduced by putting a voltage of one division on the channel 1 input and digitizing the trace. If the trace position is different from the first baseline value, the program assumes channel 1 triggered first. If channel 1 did trigger first, the unit is armed and triggered again so channel 1 will trigger when the actual calibration starts. Both channel 1 and channel 2 will be calibrated independently if ALT mode is detected.

After the program has decided where the vertical amplifier mode switch is set, it goes through the following steps to actually calibrate each channel in use.

- 1) A baseline is acquired again for the channel being calibrated.
- 2) The program checks if there is room for at least a one division reference signal. If there is not, a VPOS error is printed; and

the operator must reposition the trace to continue. The program then switches the maximum reference voltage that will fit on the screen to the channel being calibrated. The space available is normally the distance between the baseline and the top of the screen. However, in the case of inverted operation, it is the space between the baseline and the bottom of the screen.

- 3) This signal is digitized; the baseline is subtracted; and the signal average is computed.
- 4) The calibration factor is then the actual reference voltage divided by the average deflection in 7912 addresses computer above.

Steps 1-4 are done twice for each channel, and the calibration factor is taken to be the average of both passes. If the unit is in ALT mode it is triggered twice in steps 1 and 3 to insure the proper channel will be digitized. If the average signal deflection in step 3 is less than half a division (32 addresses), a VCAL error message is printed. This indicates that either a hardware malfunction exists or something is not connected.

The program next attempts to write the calibration curve to the disc. Each channel of each 7912 has room for four calibration curves. Each curve corresponds to a different sensitivity switch setting. If the program finds an existing curve corresponding to the current channel sensitivity setting, that curve is replaced. If no existing curve is found, the program prints a message and a listing of which curves are present. A typical example is shown below

NO EXISTING CAL CURVE FOR UNIT 1 CHANNEL 1

EXISTING CURVES ARE FOR:

- 1 1V
- 2 100MV
- 3 500MV

4 50 MV

ENTER NEW CAL RECORD #.

The operator then must choose which old cal curve he wants to replace by typing a number from 1 to 4. The vertical calibration data will then be written to disc in one record. The components of the record are:

1. Amplifier sensitivity setting (6 ASCII characters),
2. Number of cal points (= 1) (integer),
3. Average vertical deflection (floating point),
4. Reference voltage (floating point),
5. Date (3 integers).

This completes the vertical calibration sequence for the unit being calibrated.

3.3.1.3 Horizontal (Time Base) Calibration

This section describes the horizontal calibration sequence. Calibration signals are fed into vertical amplifier channel 1 if it is on, i.e., mode switch set to CH1, ADD, or ALT. Otherwise channel 2 input is used. First a baseline is digitized. Then the horizontal reference signal whose period is 0.8 times the current time base sweep rate is switched on and digitized. The baseline is subtracted point by point from the reference signal.

The unit time cal curve is then generated by computing the number of 7912 addresses between every other signal zero crossing. Every other crossing must be used since the calibration signal may not be symmetric. The time corresponding to each such zero crossing is simply

$$T(I) = (I - 1) * \text{PERIOD} \quad I = 1, 2, \dots, \text{NCAL}$$

PERIOD = reference signal period,

NCAL = number of cal points.

The total number of cal points will usually be 12. If the horizontal sweep is non-linear, the distances between crossings will not be constant. The program measures the non-linearity by averaging all the distances

between crossings and then computing the per cent deviation between each crossing distance and the average. The program will produce TCAL errors if (1) the number of cal points is less than 3 or greater than 25 or (2) any non-linearity error exceeds 20%.

The AUTCAL overlay then tries to write the calibration data to the disc. The new horizontal cal data will overwrite any existing data that corresponds to the current time base sweep speed knob setting. If none of the 4 possible cal records contain data for the current sweep speed, the operator must select where he wants the new data to be written as described above (3.3.1.2) for the vertical case. The channel number in the message will either be a 3 or 4 depending on whether the 7912 has a 7B53A or 7B92A time base plug in. The calibration data record written to the disc contains the following information:

- 1) Time base sweep speed (6 ASCII characters)
- 2) Number of cal points - NCAL (integer)
- 3) NCAL pairs of cal points - XCAL, YCAL (floating point)
 XCAL ~ zero crossing address
 YCAL ~ zero crossing time
- 4) Date (3 integers)

This completes the calibration process for the current unit.

3.3.1.4 Error Response

If any errors were detected in the calibration processes described above, the user must determine the correct problem to continue the program. Several commands are available for doing this. These commands are entered in response to the message

READY
\$

as described in 3.3. Valid commands are described below.

3.3.1.4.1 TV

The unit currently undergoing calibration will be placed in TV mode, and the dot graticule will be turned on.

3.3.1.4.2 PRINT

This command causes the program to print out the following parameters used in the calibration process.

1. Unit number
2. Date
3. Knobs settings
4. Last normalization status
5. Horizontal cal curve location
6. Vertical cal curve locations.

Some or all of the above parameters may be invalid depending on where the error occurred. Horizontal and vertical calibration data will also be printed if it has been computed.

3.3.1.4.3 PLOT

The last signal digitized will be plotted.

3.3.1.4.4 SWITCH, unit, channel, position

The switch module corresponding to the 'unit' and 'channel' selected will be switched to the desired 'position'. The valid 'unit' entries are 0-28. Valid 'channel' entries are 1 or 2. Valid 'position' entries are 0-4. The Autocal switch is the module corresponding to unit 29 channel. The switching is done so as to maintain the previous positions of all other modules in the matrix.

3.3.1.4.5 VCAL, value

This command causes the vertical reference card to generate the reference signal closest to but not greater than the 'value' requested. No switch positions are affected.

3.3.1.4.6 HCAL, value

This command causes the horizontal reference card to

generate the reference signal closest to the value requested. No switch positions are affected.

3.3.1.4.7 GO, (destination)

This command causes transfer of program control.

Valid 'destination' entries are described below.

<u>Destination</u>	<u>Effect</u>
(None)	Program continues on to calibrate next unit (if any).
EXIT	Overlay exits. Print overlay is loaded.
START	Overlay tries again to calibrate unit for which error occurred.

3.3.1.5 Finish

After all selected units have been calibrated, the AUTCAL overlay prints the message

CALIBRATION SEQUENCE COMPLETE.

It then returns to the root program which automatically runs the print out overlay described in 3.3.3.

3.3.2 Manual Calibration Overlay

The overlay MANCAL allows the operator to calibrate the 7912's manually with or without the Autocal hardware. The overlay is run by the root task when selected as described in 3.3. The overlay begins by erasing the terminal screen and typing

MANUAL CALIBRATION PROGRAM

The program is controlled by typing commands in response to the message

READY
?

as described in 3.3. Valid commands are described below.

3.3.2.1 DIG, (unit), $\begin{pmatrix} \text{TV} \\ \text{BA} \end{pmatrix}$

This command causes a signal to be digitized, acquired,

and normalized from the selected 7912 'unit'. If the 'unit' parameter is omitted, the last unit addressed will be used. If the 'BA' or 'TV' option is selected, the unit will be placed on TV mode and the dot graticule will be turned on prior to digitization. The following message will be printed

BASELINE SHOT ('BA' only)

SET UP UNIT 'unit', RETURN WHEN READY.

The operator may then set up the unit using the TV monitor. When he is ready to digitize a trace, the user simply hits the RETURN key. The 7912 will be placed in digital mode and armed to digitize when the next trigger occurs. The computer does not trigger the 7912 in the MANCAL overlay. If the 'BA' option is selected, the digitized signal will be stored in a special baseline array. If this option was not selected, the contents of the baseline array are subtracted point-by-point from the digitized signal. In both cases the signal is then plotted on the terminal screen.

3.3.2.2 SWITCH, unit, channel, position

This command is used to select switch module input positions. It is described in 3.3.1.4.4.

3.3.2.3 SWITCH, INIT

All switch modules are either turned off (0-7) or set to position 1 (8-11) on all SM-2 matrices.

3.3.2.4 VCAL, 'voltage'

The vertical reference card generates the signal level closest to but not greater than the desired 'voltage'. 'Voltage' should be entered in volts with a decimal point. The Autocal reference select switch is positioned to the vertical signal input.

3.3.2.5 HCAL, 'frequency'

The horizontal reference card generates the signal with frequency closest to that selected. 'Frequency' should be in Hz with a

decimal point. The Autocal reference select switch is positioned to the horizontal reference input.

2.3.2.6 VCal, A, (voltage)

This command generates vertical calibration data. The last signal digitized is averaged to get the deflection. If the parameter 'voltage' is present, the calibration voltage will be set to this value. If 'voltage' is omitted, the last reference signal generated will be used. The program then erases the screen and prints out the following items.

- 1) Unit number
- 2) Knobs setting for channel being calibrated
- 3) Date
- 4) Reference voltage (V)
- 5) Deflection (D)
- 6) Deflection factor (F)

The deflection factor is computed from

$$F = 64 * V/D \quad \text{volts/division}$$

The factor 64 is the nominal number of 7912 addresses per division. The deflection factor should be within about 10% of the knobs setting. After the calibration data is printed out, the program prints the following message

SATISFIED? (Y, N)

The operator must answer 'Y' or 'N'. If 'N' is entered, the program digitizes another trace. The baseline array is subtracted and the vertical calibration process described above is repeated using this new signal. The operator may continue this sequence as often as he wishes by entering 'N' after each printout. Entering a 'Y' enables the program to accept a new command.

2.3.2.7 HCal, A, (frequency)

This command generates a horizontal calibration curve. If the 'frequency' parameter is present, it is used as the calibration signal

frequency. If it is omitted, the last value generated by the horizontal reference card is used. Calibration is done by locating the alternate zero crossings in the last signal digitized as described in 3.3.1.3. The program then erases the screen and prints out the following:

- 1) Unit number
- 2) Time base knob setting
- 3) Date
- 4) Average sweep speed (S)
- 5) Zero crossing number (I)
- 6) Zero crossing address (ZC(I))
- 7) Time of zero crossing (ZT(I))
- 8) Non-linearity error from one crossing to the next.

Items 5 through 8 are printed for each crossing found. The average sweep speed is computed from

$$S = 51.2 * ZC(NCAL) / (ZC(NCAL) - ZC(1))$$

The factor 51.2 is the nominal number of 7912 addresses per horizontal division. It should be within 1% of the time base knob setting. After the calibration data is printed, the program types the message

SATISFIED? (Y, N)

The reply has the same effect described in 3.3.2.5 except that any new signal digitized is time calibrated.

3.3.2.8 DWRITE, VCAL

The program attempts to write vertical calibration data to the disc. It will only try if valid vertical calibration data exists. This command will only be accepted immediately after the vertical calibration process described in 3.3.2.5 is performed. The program searches the disc for an existing curve that matches the vertical amplifier sensitivity. If one is found, the new curve is written over the old one. If one is not found, the operator must select which curve he wants to replace as described in 3.3.1.2. After the vertical data is written to disc, it is immediately read back and printed out for operator verification as in 3.3.2.5.

3.3.2.9 DWRITE, HCAL

The program attempts to write horizontal calibration data to the disc. All procedures are similar to those described in 3.3.2.8 above.

3.3.2.10 GO, (EXIT)

This command transfers program control. If the EXIT parameter is present, the program exits. If it is omitted, control is transferred to the calibration printout overlay described in 3.3.3.

3.3.2.11 Examples

3.3.2.11.1 Vertical Calibration Using Autocal (Unit 1, channel 1, 1 v/div, 20 ns)

SWI, 1, 1, 0	Turn off input.
DIG, 1, BA	Digitize baseline.
VCAL, 2.5	Get 2.5 v ref signal.
SWI, 1, 1, 4	Switch ref to unit.
DIG,, TV	Check ref signal and digitize
VCAL, A	Calibrate signal.
(Printout)	(Several 'N's may be entered to see if calibration changes.)
DWR, VCAL	Write cal data to disc.
(Printout)	(New cal curve reprinted.)

3.3.2.11.2 Vertical Calibration Without Autocal

DIG, 1, BA	Digitize baseline.
DIG,, TV	Place external reference signal (dc voltage) directly into 7912 and digitize.
VCAL, A, REF	Calibrate trace with specified amplitude.
DWR, VCAL	Write cal data to disc.

3.3.2.11.3 Horizontal Calibration Using Autocal

SWI, 1, 1, 0	Turn off input.
DIG, 1, BA	Digitize baseline.
HCAL, 62, 5E6	Turn on cal signal.
SWI, 1, 1, 4	Switch to unit.
DIG,, TV	Inspect and digitize cal signal.
HCAL, A	Generate cal curve.
(Print out)	(Repeat if necessary)
DWR, HCAL	Copy cal to disc.
(Print out)	

3.3.2.11.4 Horizontal Calibration Without Autocal

DIG, 1, BA	Digitize baseline.
DIG,, TV	Inspect and digitize cal signal.
HCAL, A, frequency	Calibrate trace with specified frequency.
(Print out)	
DWR, HCAL	
(Print out)	

3.3.3 Calibration Data Printout Overlay

The overlay PRICAL is used to print out calibration data for 7912's. The overlay accepts commands in response to the message

READY
@

as described in 3.3. Valid commands are described below.

3.3.3.1 PRINT, ALL, ALL

All cal curves for all units are printed out. First the screen is erased and the unit number is printed. Then each horizontal curve is read from the disc and printed. The items printed for each curve are:

- 1) Time base sweep speed knob setting
- 2) Date
- 3) Disc file record number

- 4) Average sweep speed
- 5) Zero crossing addresses
- 6) Zero crossing times.

The operator must then return a number from 0-9 to continue. If an 0 is entered, a hard copy is made; and the program continues. If a 5 is entered, printing ceases; and the operator may enter a new command. Any other number will allow the program to continue. The program again erases the screen and prints out the unit number. Next it reads from the disc the vertical calibration data sets for channel 1 and prints them in the first column. It then reads the data for channel 2 and prints it in the second column. The items printed for each set of cal data are:

- 1) Channel number
- 2) Vertical amplifier sensitivity knobs setting
- 3) Date
- 4) Disc file record number
- 5) Reference voltage
- 6) Deflection
- 7) Deflection factor.

The operator must return a number between 0-9 to continue the program. Numbers have the same effect described above.

3.3.3.2 Print, unit, (ALL)

Only the cal data for the selected 'unit' will be printed.

If the 'ALL' parameter is present, all data for the unit will be printed using the format described in 3.3.3.1. If 'ALL' is omitted, only the new cal data produced by the AUTCAL overlay will be printed. If the unit was not calibrated by AUTCAL, a command error will be printed. Otherwise the screen will be erased, and the unit number will be printed. Next the new horizontal cal curve will be read from disc and printed. Finally the new vertical cal curve will be read and printed on the same page. Items printed for each cal curve are the same as indicated in 3.3.3.1. The operator must return to continue the program.

3.3.3.3 PRINT, NEW (ALL)

Cal data for units calibrated in the AUTCAL overlay will be printed. If the 'ALL' parameter is present, all cal data will be printed using the format described in 3.3.3.1. If 'ALL' is omitted, only the new cal data will be printed. The format is the same as used in 3.3.3.2.

3.3.3.4 GO, (destination)

This command transfers program control. Valid 'destination' entries are described below.

<u>Destination</u>	<u>Effect</u>
EXIT	Calibration program exits.
START	Program EBD activated from start. ¹¹
TV	EBD activated at TV baseline checkou.
ARM	EBD activated at arm units for shot.
READ	EBD activated at read out units.
FAWTEK	Program FAWTEK activated. ¹³
USER	Program USER activated.
DIODE	Program DIODEØ activated. ¹⁴
CAL	Calibration program started at select cal mode.
TRACE	TRACE program activated. ¹⁵

Any other 'destination' entry will give a command error.

3.4 Error Messages

Errors may occur in various portions of the program, especially in the AUTCAL overlay. Error messages are printed in the following format.

ERROR*name, CLUE = value, UNIT = number

The 'name' parameter is a four character error type identifier. The

'value' parameter is either a numeric or alphabetic indicator as to what the error actually is. Finally the 'number' parameter is the 7912 unit being processed when the error occurred. Error messages and clues are described below.

Error Name	Meaning	CLUE
7912	Status error in 7912 communications.	7912 status (hexadecimal). ¹²
RAW	Raw 7912 data invalid.	Normalization status (integer): 1-no valid vertical positions 2-first data point not a scan number 3-scan found with too many verticals
OFFS	7912 trace went offscale	Extrapolated vertical value
INTY	Trace intensity too high or too low	Number of scans with good intensity (integer)
VPOS	Amplifier vertical position too close to top or bottom edge of screen	Trace position (integer)
VCAL	Deflection due to applied calibration voltage too small, i.e., less than 25	Deflection (integer)
TCAL	Error in computing time calibration data	Computation status (integer): 1-number of points (zero crossings) is less than 3 or greater than 25 2-non-linearity error exceeded 20%.

4. Program Maintenance

This section provides maintenance documentation for the program CAL7912, its overlays, and major subroutines. A brief description, glossary of variables, flowchart, and listing are given for each program element. Common storage areas are also described.

4.1 Program CAL7912

The program starts by assigning communications to the proper terminal, i.e., the one from which it was called. It then picks which overlay to run as described in 3.3.

4.1.1 Glossary of Variables

INUSE	- flag array of units calibrated automatically.
IOPI	- 'alternate header' option word in common GLOCOM. ¹⁴
IOP2	- terminal select option in GLOCOM.
IPRST	- new program select option in common MGLCOM.
IRP	- user selected overlay name.
ISTRNG (5)	- location where 'AH' (alternate header) option word will be stored in a GO command.
ITRM	- terminal number in use in MGLCOM.
IUFT	- user file table for 7912 communications.
MACHNO	- machine number in use in MGLCOM.
NAC	- ASCII name of AUTCAL overlay.
NMC	- ASCII name of MANCAL overlay.
NPR	- ASCII name of PRICAL overlay.

4.1.2 Flowchart

4.1.3 Listing

AUTOCAL (V) NEW M 00

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1      PROGRAM CAL7912
2      C
3      C FOOT PROGRAM IN AUTOCAL SERIES
4      C THIS PROGRAM CONTROLS LOADING OF MAJOR OVERLAYS
5      C
6      DIMENSION NAC(4),NMC(4),NPR(4), INUSE(32)
7      INTEGER CALSW
8      COMMON/KALDAT/NPH,NINSEP,MAXSEP,IUN,IRAU,STAB
9      COMMON/DG7912/IUFT(8),YNOS(16),RNNOS(4),NORSTAB,NF,ST,TR
10     COMMON/GLOCOM/NSH,MACH,NAS,IPP,IOP1,IOP2,IDATE(3)
11     COMMON/MGLOCOM/NSHOT,MACHNO,NARS,IPRST,IHOR,ITRM,M7912,NRAB
12     *MUSH,NXIN,MXOH,MXCAP,IR1,IONE,YONE,CALSW,ISTAT,INUSE,IAUT,IER
13     *IRP,NUS(18)
14     COMMON/NKAPC/AC(515),AZER(515),XCAL(25),YCAL(25),ERR(25),IDATE(3)
15     *ITCAL(32),IYCAL(2,32)
16     COMMON/TEXT/ISTPNG(25),NMC,IER
17     DEFINE FILE 25(400,110,U,K25),26(800,25,U,125),27(4,50,U,117
18     DATA NAC(1),NAC(2),NAC(3)/'AUT','TC','CAL'
19     DATA NMC(1),NMC(2),NMC(3)/'MAN','MC','CAL'
20     DATA NPR(1),NPR(2),NPR(3)/'PP','IC','CAL'
21     DATA INUSE(32)/
22     IAUT=0
23     MX7912=29
24     NPH=5
25     MXUSH=29
26     CALSW=29
27     INUR=MACH
28     MACHNO=1
29     CALL DATE,IDATE
30     CALL PLTBEG
31     DO 101 I=1,6
32     101 IUFT(I)=0
33     IUFT(7)='TE'
34     IUFT(8)='K'
35     ITRM=IOP2
36     CALL TRMSEL
37     1 CONTINUE
38     IPRST=0
39     CALL ERASE
40     2 WRITE (10,3)
41     3 FORMAT (' PROGRAM AUTOCAL ACTIVE',/,' ENTER CAL MODE AUTO/MANUAL'
42     *PRINT)
43     READ(11,5) IRP
44     5 FORMAT (A1)
45     IF(IRP EQ 'A') GO TO 10
46     IF(IRP EQ 'M') GO TO 20
47     IF(IRP EQ 'P') GO TO 300
48     GO TO 2
49     C
50     C LOAD AND RUN AUTOCAL OVERLAY
51     10 CONTINUE
52     CALL OVERL(NAC,0)
53     CALL OVRUN(NAC,INUSE)
54     IAUT=1
55     GO TO 301
56     C
57     C LOAD AND RUN MANUHL CALIBRATION OVERLAY
58     20 CONTINUE
59     CALL OVERL(NMC,0)
60     CALL OVRUN(NMC)

```

27

4.2 Overlay AUTCAL

This overlay first allows the user to select which 7912's and mode for calibration. It then attempts to calibrate the units. New cal curves are written to the disc. The program provides the operator with several commands for correcting errors. The program operation is described fully in 3.3.1.

4.2.1 Glossary of Variables

A(515)	- working array in common WRKARE.
ALT	- logical variable; TRUE if amplifier in alternate mode.
AV(2)	- trace position for each channel in vertical calibration.
AVV	- vertical cal signal trace position.
AZER(515)	- baseline array in WRKARE for time calibration.
BASE	- baseline value in vertical cal sequence.
CALOPT	- calibration mode: horizontal, vertical, both.
CALPOS	- SM-2 module Autocal input position(= 4).
CALSW	- SM-2 module dedicated to selecting horizontal or vertical reference signal(= 17).
CTV	- COMINT TV select command index. ¹
ERR(25)	- array of time base calibration non-linearity errors in WRKARE.
EXCLPT	- ASCII "!" for channel 2 invert check.
GO	- COMINT GO command index.
GRAT	- 7912 graticule enable command index. ¹²
HCAL	- COMINT HCAL command index
HREF	- horizontal reference signal frequency.
IB	- test byte for channel 2 invert check.
IBUF	- output text interpretation buffer from MYCOL. ¹
ICH	- vertical amplifier channel in use.

ICHK - 7912 knobs character being examined for channel
 2 invert check.

ID - calibration knobs data read from disc.

IDATE - date buffer.

IE - end index for writing knobs data to disc.

IER - COMINT command error status.

IHV - flag to VHREF subroutine for turning on horizontal
 or vertical reference signal.

IDP - option in common DG7912 to have computer trigger
 7912's in a digitize operation.

IPOS - operator selected switch position.

INTENS - maximum vertical address separation for a valid
 7912 raw array trace.

INUSE - flag array of units selected to be calibrated.

INV2 - flag for channel 2 inverted.

IPRST - new program select status in MGLCOM.

IREC - cal curve record number on disc.

IS - start index for writing knobs data to disc.

ISTAT - status returned from various subroutines.

ISTRNG(20) - array in common TEXT for storing input text strings.

ITCAL(32) - array containing time cal curve record numbers for
 units currently being calibrated.

ITCL - time cal curve record number for unit currently
 being calibrated.

IUFT - user file table for 7912 communications.

IUN - unit number being calibrated.

IUNIT - IUN + 1.

IUNST(32) - cross reference array of unit numbers to input
 header line numbers from EBD.¹¹

IVCL - vertical calibration record number on disc for
 unit being processed.

IVCAL(32) - array of vertical calibration record numbers for units calibrated or -1 for units not calibrated.
 KKT - offset in knobs array to time base sweep speed setting.
 KKV - offset in knobs array to vertical amplifier sensitivity setting.
 KNOBS - type of time base in 7912.
 KV - first channel active in 7912 vertical amplifier.
 LCH - operator selected channel number in SWITCH command.
 LSTAT - text interpretation status from MYCOL.
 LUN - operator selected unit number in SWITCH command.
 MAXSEP - = INTENS.
 MAXUN - maximum number of 7912 units on line.
 MINSEP - minimum separation between vertical addresses for valid 7912 raw array trace.
 MXPS - number of passes per channel for vertical calibration.
 NCAL - number of points in horizontal calibration curve.
 NCH - number of vertical amplifier channels in use on unit being calibrated.
 NORSTA - raw array normalization status in common RAWDAT.
 NP - number of points in a digitized array.
 NPL - NP + 2.
 NUNIT - number of units to be calibrated.
 OFFPOS - SM-2 module off position(= 0).
 PERIOD - time calibration signal period.
 PLOT - COMINT plot command index.
 PRINT - COMINT print command index.
 REF - reference signal value desired in a VCAL or HCAL command.
 RKNOPS(4) - array of floating point 7912 knobs settings.

SCALE - average deflection factor for vertical or horizontal calibration.
 SPACE(2) - room on 7912 screen for vertical cal signal for both channels.
 SSWP - single sweep status bit in 7912 status word, IUFT(1).
 SWHP - Autocal SM-2 module horizontal signal input position(= 3).
 SWVP - Autocal SM-2 module vertical signal input position(= 4).
 SWIT - COMINT switch command index.
 TEMP - temporary location for storing swapped variables.
 TV - 7912 TV mode select command index.
 UNREM - 7912 remote channel select disable command index.
 VREF - vertical reference signal value for alternate mode check.
 VREFSV - vertical reference signal value for calibration.
 VXCAL - trace deflection due to cal signal.
 VYCAL - VREFSV.
 XCAL(25) - array of zero crossing addresses in time cal.
 YCAL(25) - array of zero crossing times in time cal.

4.2.2 Flowchart

4.2.3 Listing

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1      OVERLAY AUTOCAL(INUSE)
2
3      C AUTOMATIC CALIBRATION OVERLAY
4      C THIS OVERLAY AUTOMATICALLY CALIBRATES SELECTED PARAMETERS
5
6      DIMENSION INUSE(1), IDC(247), IUNST(32)
7      DIMENSION IBUF(6), MUFT(8), SPACE(2), AXX(2), IDATE(3), LCL(2), IT(1)
8      INTEC = TV, CT, GRAT, UNREM, SWVP, SWHP, ESHP
9      INTEGER VCAL, HCAL, PRINT, GO, SWIT, PLOT, EXCLPT
10     INTEGER OFFPOS, CALSW, CALPOS, CALOPT
11     LOGICAL ALT, TESTB
12     COMMON/NKARE/A(515), AZER(515), NCAL(25), VCAL(25), EFF(25), IDATE(3)
13     * ITCAL(32), IVCAL(2,32)
14     COMMON/MOLCOM/NSHOT, NACHNO, NARS, IPAST, INCP, ITRM, NUT912, IERNP
15     *MXUSW, MXIH, MXOH, MXDAR, IR1, IDNE, KONE, CALSW, KSTAT, NIUSE, IAUT, IFF
16     *ICD, SHHP, SWVP, MXPS, ALT, NUS(5)
17     COMMON/DG7912/IUFT(8), KNOBS(16), RKNOS(4), NOFSTA, S, NPL, NVAL, IEP
18     COMMON/TEXT/ISTRNG(35), NND, IEP
19     COMMON/PAWDAT/NRH, MINSEP, MAXSEP, IUN, IRAW(2500)
20     EQUIVALENCE (REF, ISTRNG(2))
21     EQUIVALENCE (IDC(1), A(1)), (IUNST(1), AZER(1))
22     DATA MUFT/0.0, 420000.0, 0.0, 0.0, 111111.11/
23     DATA INIT, TV, GRAT, UNREM/0. -2.3, -4/
24     DATA VCAL, HCAL, PRINT, GO, SWIT, PLOT/52, 53, 21, 24, 54, 23/
25     DATA SSWP, CTV, EXCLPT/11.6, 2221/
26     DATA OFFPOS, CALPOS/1.4/
27     C AUTOCAL SWITCH IS ALWAYS THE SECOND TO LAST SWITCH ON THE LAST SW-2 BAR
28     IOP=1
29     NMXUN=MX7912-1
30     MAXSEP=25
31     MXPSE=2
32     MINSEP=0
33     SWHP=3
34     SWVP=4
35     1 CONTINUE
36     3 CALL ERASE
37     WRITE (10,5)
38     5 FORMAT (' AUTOMATIC CALIBRATION PROGRAM',X10, 'INITIALIZING SWITCHES')
39     * FIRST')
40     C MAKE SURE ALL SWITCHES ARE EITHER OFF OR NOT CONNECTED TO CAL SIGNALS
41     DO 109 I=1, NBANK
42     109 CALL SWITCH(6*(I-1), 1.0, -1, ISTAT)
43     C DISABLE HORIZONTAL REFERENCE OUTPUT
44     CALL VHREF(-1., 0, ISTAT)
45     4 WRITE (10,2)
46     2 FORMAT (' ENTER UNITS TO BE CALIBRATED OR "ALL" OR "SHOT" OR "NND")
47     *E" ')
48     DO 7 I=1, MX7912
49     7 INUSE(I)=0
50     C READ RESPONSE IN FREE FORM AND INTERPRET
51     READ(11,6) ISTRNG
52     NUNIT=0
53     6 FORMAT (35A2)
54     ISTRNG(35)=0
55     IBUF(6)=0
56     C GET PARAMETERS ENTERED
57     10 CONTINUE
58     CALL MYCOL(ISTRNG, IBUF, LSTAT, 0)
59     C CHECK IF ALL UNITS ARE TO CALIBRATED
60     IF (IBUF(1).EQ.'AL') GO TO 22

```



```

21 C CHECK IF ONLY UNITS FOR THIS SHOT ARE TO BE CALCULATED
22 IF (IBUF(1) EQ 0) SH GO TO 25
23 C CHECK FOR END OF ENTRIES
24 IF (IBUF(2) EQ 0) GO TO 14
25 C CHECK IF FINISHED
26 IF (IBUF(1) EQ 0) GO TO 100
27 C TO GET HERE ENTRY MUST BE A NUMBER
28 IF (LSTAT EQ 0) GO TO 10
29 C IF NUSN 1 ERROR ERROR
30 12 WRITE (10,1)
31 12 FORMAT (1) ILLEGAL ENTRY
32 GO TO 4
33 C SHOW UNIT SELECTED TO BE CAL ED
34 20 IF (IBUF(2) LT 0 OR IBUF(2) GT NUSN) GO TO 12
35 NUNIT=NUNIT+1
36 INUSE=IBUF(2)+1
37 GO TO 10
38 C SHOW ALL UNITS TO BE CAL ED
39 12 CONTINUE
40 DO 11 I=1,NUNIT
41 11 IN USE=I
42 NUNIT=NUNIT+1
43 GO TO 10
44 C READ DATA FROM END OF DISC TO GET UNITS FOR THIS SHOT
45 25 CONTINUE
46 READ(27) INUP+1, 100, IUNST
47 C SHOW PROPER UNITS TO BE CAL ED
48 DO 26 I=1,NUNIT
49 IF (IUNST(I) EQ 0) GO TO 26
50 INUSE(I)=1
51 NUNIT=NUNIT+1
52 26 CONTINUE
53 C ERROR IF ALL BLANKS ENTERED IF NO UNITS SELECTED
54 28 IF (NUNIT EQ 0) GO TO 12
55 28 CONTINUE
56 134 WRITE (10,135)
57 135 FORMAT (1) ENTER CAL MODE VERT,HORZ,BOTH
58 READ(11,136) CALOPT
59 136 FORMAT (A1)
60 IF (CALOPT NE 'V') AND (CALOPT NE 'H') AND (CALOPT NE 'B') GO TO 100
61 C INITIALIZE CAL LOCATIONS FOR PRINT NEW COMMAND
62 DO 138 I=1,32
63 138 ITCAL(I)=1
64 138 IVCAL(1,I)=1
65 138 IVCAL(2,I)=1
66 138 CONTINUE
67 C
68 C
69 C BEGIN CAL SEQUENCE
70 DO 310 I=1,NUNIT
71 IF (INUSE(I) EQ 0) GO TO 310
72 31 CONTINUE
73 IUN=IK-1
74 IUFT(4)=IUN
75 ISTAT=1
76 IF (IUN GT NUSN) GO TO 255
77 IUNIT=IK
78 ITCAL=2
79 IVCAL=2
80 KV=1

```

```

121 CALL WRITE (UNREM,2,IUFT)
122
123
124 C START VERTICAL CALIBRATION SEQUENCE
125 C GET BASELINE BY TURNING OFF CAL SWITCH
126 C TURN OFF CAL SWITCH SWITCH BOTH CHANNELS TO CAL SWITCH POSITION
127 CALL SWITCH(CALSW,1,OFFPOS,-1,ISTAT)
128 CALL SWITCH(IUN,1,CALPOS,-1,ISTAT)
129 IF(ISTAT.NE.0) GO TO 255
130 CALL SWITCH(IUN,2,CALPOS,1,ISTAT)
131 DO 51 I=1,2
132 AV(I)=0
133 SPACE(I)=0
134 51 IVCAL(I,IUNIT)=-1
135 CALL DIGTIZ(A)
136 IF(IUFT(1).LT.0) GO TO 279
137 IF(NORSTA(3).LT.450) GO TO 25
138 ALT=FALSE
139 NCH=1
140 C CHECK IF CHANNEL 2 INVERTED ( ANY BYTE=1 )
141 INV2=0
142 IF(RKNOBS(2).EQ.0) GO TO 54
143 DO 52 I=1,2
144 ICHK=RKNOBS(3+I)
145 DO 52 J=1,2
146 IB=ISHFT(ISHFT(ICHK,24-16*J),8*(J-2))
147 52 IF( (IB.EQ.EXCLPT) INV2=1
148 54 CONTINUE
149 C GET TRACE POSITION AND ROOM TO TOP OF SCREEN
150 AV(KV)=AVER(R(3),NP)
151 SPACE(KV)=500.-AV(KV)
152 C CHECK IF ONLY ONE CHANNEL ON
153 IF(KV.EQ.2.OR.RKNOBS(2).EQ.0) GO TO 68
154 C BOTH CHANNELS ARE ON. CHECK FOR ALT MODE
155 C FORGET IT IF NOT IN SINGLE SWEEP
156 IF(TEST0(IUFT(1),SSWP)) GO TO 250
157 C DO THIS BY DIGITIZING AGAIN AND SEEING IF TRACE MOVES
158 CALL DIGTIZ(A)
159 IF(IUFT(1).LT.0) GO TO 279
160 AV(2)=AVER(R(3),NP)
161 SPACE(2)=500.-AV(2)
162 C TURN OFF CHANNEL 2 REGARDLESS OF ADD OR ALT MODE
163 CALL SWITCH(IUN,2,OFFPOS,1,ISTAT)
164 IF(ABS(AV(1)-AV(2)).LT.5) GO TO 68
165 C APPARENTLY WE'RE IN 'ALT' MODE. FIND WHICH CHANNEL TRIGGERED FIRST
166 C DO THIS BY PUTTING A VOLTAGE ON CH1 INPUT. TRIGGER SCOPE
167 C IF TRACE MOVES, CH1 JUST TRIGGERED
168 ALT=TRUE
169 NCH=2
170 C SET VERT REF TO 1 DIV
171 VREF=ABS(RKNOBS(1))
172 CALL VREF(VREF,1,ISTAT)
173 C SET CAL SWITCH TO VERT REF INPUT
174 CALL SWITCH(CALSW,1,SWVP,1,ISTAT)
175 CALL DIGTIZ(A)
176 IF(IUFT(1).LT.0) GO TO 279
177 AVV=AVER(R(3),NP)
178 C SEE IF CHANNEL 1 TRIGGERED FIRST AND THIRD
179 IF(ABS(AVV-AV(1)).LT.25) GO TO 48
180 47 CALL REWIND(IUFT)

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```

191      CALL TRIG
192 C CHANNEL 1 NOW SET TO TRIGGER
193      GO TO 68
194 C CHANNEL 2 TRIG ED FIRST SWITCH SPACE PARAMETERS
195      48 CONTINUE
196      TEMP=SPACE(1)
197      SPACE(1)=SPACE(2)
198      SPACE(2)=TEMP
199      TEMP=AV(1)
200      AV(1)=AV(2)
201      AV(2)=TEMP
202 C
203 C THE FOLLOWING LOOP HANDLES ALL CASES OF MODE SWITCH CH1,CH2,ADD,ALT
204 C WE CAN'T CAL CH2 IN ADD MODE SINCE WE CAN'T FIND THE BASELINE
205      68 CONTINUE
206      IF(CALOPT EQ 'H') GO TO 100
207 C IF CHANNEL TWO INVERTED SPACE IS POOR BETWEEN TRACE AND BOTTOM OF CURVE
208      IF(INV2 EQ 1) SPACE(2)=AV(2)
209      DO 98 ICH=1,NCH
210      KCH=KV+ICH-1
211      IF(SPACE(KCH) GT 64) GO TO 70
212      CALL ERROUT('VPOS',IFIX(AV(KCH)),IUNIT,-1)
213      GO TO 279
214      70 VREFSV=SPACE(KCH)+ABS(RYNOBS(KCH))/64
215      VXCL=0
216 C THIS SWITCH ALSO HAS THE EFFECT OF DISABLING OTHER CHANNEL
217      CALL SWITCH(IUN,KCH,CALPOS,-1,ISTAT)
218      DO 80 IPS=1,MXPS
219      U GET BASELINE BY TURNING OFF CAL SWITCH
220      CALL SWITCH(CALSW,1,OFFPOS,1,ISTAT)
221      CALL DIGTIZ(A)
222      IF(IUFT(1).LT.0) GO TO 279
223      BASE=AVER(A(3),NP)
224      IF(.NOT.ALT) GO TO 82
225      CALL REWIND(IUFT)
226      CALL TRIG
227      82 CONTINUE
228      CALL VHREF(VREFSV,1,ISTAT)
229      CALL SWITCH(CALSW,1,SWVP,1,ISTAT)
230      CALL DIGTIZ(A)
231      IF(IUFT(1).LT.0) GO TO 279
232      AVV=AVER(A(3),NP)
233 C TAKE ABSOLUTE VALUE OF AVERAGE IN CASE CHANNEL 2 INVERTED
234      AVV=ABS(AVV-BASE)
235      IF(AVV GT.25) GO TO 66
236      CALL ERROUT('VCL',IFIX(AVV),IUNIT,-1)
237      GO TO 279
238      66 CONTINUE
239      VXCL=VXCL+AVV
240      IF(.NOT.ALT.OR IPS EQ MXPS) GO TO 80
241      CALL REWIND(IUFT)
242      CALL TRIG
243      80 CONTINUE
244      VXCL=VXCL/MXPS
245      VVCL=VREFSV
246      KKV=2+4*(KCH-1)
247      IVCL=LCL(KNOBS(KKV),IUN,KCH+1)
248 C IF CAL CURVE NOT FOUND LET USER SELECT ONE
249      IF(IVCL GT 0) GO TO 83
250      CALL PICK1(IVCL,KCH)

```

```

141      30 CONTINUE
142      NCAL=1
143      IS=2+4*(FCH-1)
144      IE=IS+2
145      WRITE (26) IVCL,KNBS(I),I=IS,IE,NCAL,VYCAL,ICATE
146      IVCAL=ICH IUNIT=IVCL
147      30 CONTINUE
148      C IF WE'RE IN ALT MODE WE'RE LEAVING WITH CH1 READY TO TRIGGER NEXT
149      IF CALOPT EQ 0 GO TO 229
150      C
151      C
152      C DO TIME CALIBRATION
153      100 CONTINUE
154      ICH=1
155      C WE MAY HAVE TO PUT HORIZONTAL CAL SIGNAL IN ON CHANNEL TWO
156      IF (NCH EQ 1) ICH=KV
157      C GET BASELINE BY TURNING OFF CAL SWITCH
158      CALL SWITCH(CALSW,1,OFFPOS,-1,ISTAT)
159      CALL SWITCH(IUN,KV,CALPOS,-1,ISTAT)
160      IF (ISTAT NE 0) GO TO 255
161      C DIGITIZE BASELINE
162      CALL DIGITIZ(AZER)
163      IF (IUFT(1) LT 0) GO TO 279
164      IF (NORSTAT) GT 450) GO TO 37
165      35 CALL ERRROUT('INTV' NORSTAT),IUNIT,-1)
166      GO TO 279
167      37 CONTINUE
168      C SELECT HORIZONTAL FREQUENCY AND SWITCH IT IN
169      HREF=1 /ABS(KRNOBS(KT))
170      CALL VHREF(HREF,0,ISTAT)
171      CALL SWITCH(CALSW,1,SNHP,1,ISTAT)
172      C TRIGGER SCOPE IF IN ALT MODE
173      IF (.NOT. ALT) GO TO 39
174      IF (TESTB(IUFT(1),SSWP),IUFT(3)=422000
175      CALL REWIND(IUFT)
176      CALL TRIG
177      CALL WAIT(20,0,10)
178      39 CALL DIGITIZ(A)
179      IF (IUFT(1) LT 0) GO TO 279
180      NPL=NP+3
181      DO 40 I=3,NPL
182      40 A(I)=A(I)-AZER(I)
183      PERIOD=1 /HREF
184      ITCL=-1
185      CALL TIMCAL(A,PERIOD,-1,NCAL,VYCAL,EPP,NCAL,ISTAT)
186      IF (ISTAT EQ 0) GO TO 41
187      CALL ERRROUT('TCAL',ISTAT,IUNIT,-1)
188      GO TO 279
189      41 CONTINUE
190      KKT=10+4*(KT-3)
191      ITCL=LCAL(KNOBS(KKT),IUN,1)
192      IF (ITCL GT 0) GO TO 44
193      CALL PICK(ITCL,KT)
194      44 CONTINUE
195      IS=10+4*(KT-3)
196      IE=IS+2
197      42 WRITE (25)ITCL,KNBS(I),I=IS,IE,NCAL,VYCAL,I,I=1,NCAL,
198      +,ICATE
199      ITCAL(IUNIT)=ITCL
200      GO TO 229

```

```

301 C
302 C
303 C DIGITIZING ERROR
304 250 CONTINUE
305 CALL ERRROUT('7912', IUFT(1), IUNIT, -1)
306 GO TO 279
307 C CALLER ASKED FOR A UNIT TO BE CAL'ED THAT HANST SWITCHED
308 255 CONTINUE
309 CALL ERRROUT('SWIT', ISTAT, IK, -1)
310 GO TO 279
311 C
312 C
313 C READ OPERATOR COMMAND AND INTERPRET IT
314 279 IER=0
315 280 CALL COMINT(' #')
316 ICD=ISTRNG(1)
317 IF(ICD.EQ.GO) GO TO 290
318 IF(ICD.EQ.CTV) GO TO 282
319 IF(ICD.EQ.PRINT) GO TO 291
320 IF(ICD.EQ.VCAL) GO TO 260
321 IF(ICD.EQ.HCAL) GO TO 261
322 IF(ICD.EQ.PLOT) GO TO 265
323 IF(ICD.EQ.SWIT) GO TO 270
324 281 IER=1
325 GO TO 280
326 C TURN ON VERT OR HORZ REF SIGNAL PER COMINT ORDER
327 260 CONTINUE
328 IHV=1
329 GO TO 262
330 261 IHV=0
331 262 CONTINUE
332 CALL VHREF(REF, IHV, ISTAT)
333 GO TO 279
334 265 CONTINUE
335 CALL EBPLT(A, 0, 0, 0, 0, ISTAT)
336 GO TO 279
337 C SET SWITCH POSITION REQUESTED
338 270 CONTINUE
339 CALL SWITCH(ISTRNG(3), ISTRNG(6), ISTRNG(9), IER)
340 GO TO 280
341 282 CALL WRITE (TV, 2, IUFT)
342 CALL WRITE (GRAT, 2, IUFT)
343 GO TO 280
344 C ARBRITRATE 'GO TO'S
345 290 CONTINUE
346 CALL BRANCH(IPRST)
347 C EXI ST TV ARM RE FTK USR DIO CAL TRA ERR
348 GO TO (299, 400, 31, 281, 281, 281, 400, 281, 281, 400, 281, 281), IPRST
349 C
350 C PRINT OUT VARIOUS DIAGNOSTICS
351 291 CONTINUE
352 CALL ERASE
353 WRITE (10, 292) IUN, IDATE, KNOBS, NORSTA, IVCL, IVCAL(1, IUNIT), 1+1, 2+
354 292 FORMAT ('+CALIBRATION DATA UNIT', I3, I4, '/', I2, '/', I2, '/')
355 * KNOB SETTINGS: 1, 16A2, /
356 * LAST NORMALIZE STATUS: 1, 51A, /
357 * TIME CAL CURVE: 1, 14, 3X, / VERT CAL CURVES: 1, 214)
358 C
359 C PRINT OUT VERTICAL CAL INFO IF ANY
360 IF(IVCL.EQ.-2) GO TO 327

```

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4.3 Overlay MANCAL

This program provides the operator with the commands necessary to manually calibrate the 7912's. Commands to control the Autocal hardware are also available. A complete description of the command usage is given in 3.3.2.

4.3.1 Glossary of Variables

A(515) - working array of digitized data in common WRKARE.
ABASE - trace baseline position.
AZER(515) - trace baseline array in WRKARE.
DIG - COMINT digitize command index.¹
DWRIIE - COMINT disc write command index.
ERR - time cal non-linearity error array in WRKARE.
GO - COMINT program transfer command index.
HCAL - COMINT horizontal calibration command index.
IBR - program transfer branch index.
IC - command index computed by COMINT.
IDATE - date array
IE - end index for transferring knobs data.
IER - COMINT command error flag.
IHV - VHREF horizontal or vertical signal selector.
IOP - computer trigger option for DIGTIZ in common DG7912.
IPRST - program transfer index in common MGLCOM.
IRP - yes or no response to 'SATISFIED?' message.
ISTAT - status return from subroutines.
ISTRNG - interpreted text string in common TEXT returned by COMINT.
ITCL - time call curve record number on disc.
IVCL - vertical cal curve record number on disc.

LUFT - 7912 communications user file table.
 KE - ending index for accessing ASCII knobs data.
 KKV - start index for vertical amplifier knobs data.
 KNOBS - array of 7912 ASCII knobs data.
 KS - start index for accessing ASCII knobs data.
 KT - type of time base in 7912.
 LCAL - function to search for cal curve on disc.
 LCH - requested channel number in SWITCH command.
 LOCK - status of current cal data.
 LPO - requested input position in SWITCH command.
 LUN - requested unit number in SWITCH command.
 MAXSEP - maximum vertical address separation for valid 7912 raw trace.
 MINSEP - minimum valid vertical address separation for 7912 raw trace.
 NCAL - number of time calibration points.
 NP - number of data points in digitized array.
 NSD - number of valid words in ISTRNG after a call to COMINT.
 PERIOD - time calibration signal period.
 REF - requested reference signal value in HCAL or VCAL command, equivalenced to ISTRNG (2) and (3).
 REFS - reference signal value actually generated by VHREF.
 RP2 - floating point number equivalenced to ISTRNG (5) and (6) and interpreted by COMINT.
 SCALE - average deflection for vertical and horizontal calibration data printouts.
 SWI - COMINT switch command index.
 VCAL - COMINT vertical calibration command index.
 VXCAL - deflection in 7912 addresses due to applied calibration signal.

VYCAL - magnitude of applied vertical calibration signal.

XCAL - array of time cal signal alternate zero crossings
 in 7912 scan numbers.

YCAL - array of time of occurrence of alternate time cal
 signal zero crossings.

4.3.2 Flowchart

4.3.3 Listing

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```

1      OVERLAY MANCAL
2      C
3      C MANUAL CALIBRATION OVERLAY
4      C THIS PROGRAM PROVIDES THE COMMANDS NECESSARY TO MANUALLY CALIBRATE
5      C THE 7912
6      C CALIBRATION MAY BE DONE EITHER WITH THE AUTOCAL HARDWARE OR OTHER
7      C EXTERNAL TEST EQUIPMENT
8      C
9      C INTEGER CALSW
10     C INTEGER DIG, VCAL, HCAL, SWIT , DWRITE, GO
11     C COMMON/MGLCOM/NSHOT, MACHNO, NARS, IPAST, IHDR, ITPM, NTS12, NBRM ,
12     C *MXUSN, MXIH, MXOH, MXDAR, IR1, IONE, KONE, CALSW, KSTAT, NIUSE, IAUT, IEF,
13     C *IC, IRP, IHV, ARG, REFS, LUN, LCH, LPO, LOCK
14     C COMMON/DG7912/IUFT(8), KNOBS(16), RKNOBS(4), NORSTA(5), NP, I, V, FT, TOP
15     C COMMON/TEXT/ISTRNG(35), NND, IER
16     C COMMON/WRKARE/A(515), AZER(515), XCAL(25), VCAL(25), EPP(25), IDATE(5)
17     C 4. ITCAL(32), IVCAL(2, 32)
18     C COMMON/RAWDAT/NKW, MINSEP, MAXSEP, IUN, IPAW(2500)
19     C EQUIVALENCE (REF, ISTRNG(2)), (RP2, ISTRNG(5))
20     C DATA DIG, VCAL, HCAL, SWIT , DWRITE, GD/13, 52, 53, 54, 29, 24
21     C MINSEP=0
22     C MAXSEP=25
23     C CALL PLTBEG
24     C CALL ERASE
25     C CALL DATE (IDATE)
26     C TOP=0
27     C WRITE (10, 4)
28     C 4 FORMAT (' MANUAL CALIBRATION PROGRAM')
29     C _LOCK=0
30     C
31     C
32     C READ A COMMAND AND INTERPRET IT
33     C 5 IER=0
34     C 6 CALL COMINT(' ?')
35     C IC=ISTRNG(1)
36     C IF(IC.EQ.DIG) GO TO 20
37     C IF(IC.EQ.VCAL) GO TO 40
38     C IF(IC.EQ.HCAL) GO TO 42
39     C IF(IC.EQ.SWIT ) GO TO 50
40     C IF(IC.EQ.DWRITE) GO TO 250
41     C IF(IC.EQ.GO) GO TO 400
42     C 7 IER=1
43     C GO TO 6
44     C
45     C
46     C DIGITIZE A SIGNAL FROM 7912
47     C ***DIG, (UNIT), (TV OR BA)
48     C 20 CONTINUE
49     C IER=0
50     C CALL TEKDIQ(A, ABASE)
51     C IF(IUFT(1).LT.0. OR IER.NE.0) GO TO 6
52     C IF(ISTRNG(5).NE.'BA') GO TO 25
53     C DO 32 I=1, 515
54     C 32 AZER(I)=A(I)
55     C GO TO 28
56     C 25 CONTINUE
57     C NP=AMINI(A(1), AZER(1))
58     C DO 28 I=1, NP
59     C A(2+I)=A(2+I)-AZER(2+I)
60     C 28 CONTINUE

```

```

81      CALL EEPLOT(A,0,0,1,0,0)
82      GO TO 5
83  C
84  C
85      40 CONTINUE
86  C COME HERE IF COMMAND IS 'VICAL' EITHER TURN ON REF SIGNAL
87  C OR GO ON TO DO A ACTUAL VERTICAL CALIBRATION
88      IF(ISTRNG(4) EQ 1) GO TO 200
89  C *** VICAL REF
90      IHV=1
91      GO TO 42
92  C
93      42 CONTINUE
94  C COME HERE IF COMMAND IS 'HCAL' EITHER TURN HORIZ REF SIGNAL
95  C OR DO AN ACTUAL HORIZONTAL CALIBRATION
96      IF(ISTRNG(4) EQ 1) GO TO 100
97  C *** HCAL REF
98      IHV=0
99      43 CONTINUE
100     REF=REF+1.01
101     CALL VHPREF(REF,IHV,ISTAT)
102     CALL SWITCH(CALSW,1,3+IHV,1,IER)
103     REFS=REF
104     GO TO 5
105  C
106  C SWITCH POSITION CHANGE REQUESTED
107      50 CONTINUE
108  C *** SWITCH UNIT CHANNEL POSITION
109      IF(ISTRNG(2) EQ 'IN') GO TO 55
110      LUN=ISTRNG(3)
111      LCH=ISTRNG(6)
112      LPO=ISTRNG(9)
113      CALL SWITCH(LUN,LCH,LPO,1,IER)
114      GO TO 6
115  C
116  C INITIALIZE ALL SWITCHES TO DISABLED OR POS 1
117  C ***SWI INIT
118      55 CONTINUE
119      DO 58 I=1,NBANK
120      CALL SWITCH(6+(I-1),1,0,-1,ISTAT)
121      58 CONTINUE
122      GO TO 6
123  C
124  C
125  C TIME CALIBRATE ARRAY 'A'
126  C ***HCAL A (PERIOD)
127      100 CONTINUE
128      NWR=0
129      PERIOD=1 /REFS
130      IF(NWR GT 4) PERIOD=1 /RP2
131      CALL TIMCAL(A,PERIOD,-1,VCAL,VICAL,ERR,NCAL,ISTAT)
132      IF(ISTAT EQ 0) GO TO 105
133      CALL ERROUT('TCAL',ISTAT,IUKT(4)+1,-1)
134      GO TO 5
135  C TIME CAL COMPLETED. PRINT OUT DATA
136      105 CONTINUE
137      KS=10+4*(KT-3)
138      KE=KS+2
139      CALL ERASE
140      SCALE=51.2*VCAL(NCAL)/(VCAL(NCAL)-VCAL(1))

```

```

121 WRITE (10,106) IUFT(4), (KNOBS(K), K=KS, KE), IDATE, SCALE, (1, NCAL, 1)
122 *VCAL(1), ERR(1), I=1, NCAL)
123 106 FORMAT (1 TIME BASE CAL FOR UNIT', I4, 2X, 3A2, X, 12, /, 12, /, 12
124 *', /, AVG SWEEP SPEED=', E11, 4, /, 5/DIV', /, 3X, 'N', 5X, 'X ADDR', 8X,
125 *TIME', 5X, 'X ERROR', 25X, /, 15, 3E12, 4))
126 IF(NMR.EQ.1) GO TO 5
127 117 WRITE (10,118)
128 118 FORMAT (///, 'SATISFIED? (Y,N)')
129 READ(11,120) IRP
130 120 FORMH1 (R1)
131 LOCK=-1
132 IF(IRP.EQ.'Y') GO TO 5
133 IF(IRP.NE.'N') GO TO 117
134 CALL DIGTIZ(R)
135 IF(IUFT(1).LT.0) GO TO 6
136 NP=AMIN1(A(1), AZER(1))
137 DO 102 I=1, NP
138 102 A(2+I)=A(2+I)-AZER(2+I)
139 GO TO 100
140 C
141 C CALIBRATE VERTICAL AMPLIFIER
142 C***VCAL A (VOLTAGE)
143 200 CONTINUE
144 NMR=0
145 VXCAL=AVER(A(3), NP)
146 VVCAL=REFS
147 IF(NMD.GT.4) VVCAL=RP2
148 205 CONTINUE
149 KS=2+4*(KV-1)
150 KE=KS+2
151 SCALE=VVCAL*64/VXCAL
152 CALL ERASE
153 WRITE (10,215) IUFT(4), (KNOBS(K), K=KS, KE), IDATE, VVCAL, VXCAL, SCALE
154 215 FORMAT (1 VERTICAL CAL FOR UNIT', I3, 2X, 3A2, X, 13, /, 12, /, 12
155 *', /, REF VOLT=', F10, 4, /, V', /,
156 * DEFLECTION=', F10, 2, /, ADDR', /,
157 * DEF. FAC=', F10, 4, /, V/DIV')
158 IF(NMR.EQ.1) GO TO 5
159 217 WRITE (10,118)
160 READ(11,120) IRP
161 LOCK=1
162 IF(IRP.EQ.'Y') GO TO 5
163 IF(IRP.NE.'N') GO TO 217
164 CALL DIGTIZ(R)
165 IF(IUFT(1).LT.0) GO TO 6
166 NP=AMIN1(A(1), AZER(1))
167 DO 210 I=1, NP
168 210 A(2+I)=A(2+I)-AZER(2+I)
169 GO TO 200
170 C
171 C
172 C WRITE EITHER TIME OR VERT CAL DATA TO DISC
173 C
174 250 CONTINUE
175 NMR=1
176 IF(ISTRNG(2).EQ.'VC') GO TO 275
177 IF(ISTRNG(2).NE.'HC'.OR.LOCK.NE.-1) GO TO 7
178 C***WRITE HCAL
179 C TRY TO FIND CAL CURVE MATCHING CURRENT KNOBS
180 KKT=10+4*(KT-3)

```



```

181      ITCL=LCAL(KNOBS(IKT),IUN,1)
182      IF ITCL GT 0 GO TO 255
183      CALL PICK1(ITCL,KT)
184      255 CONTINUE
185      IE=1 I=2
186      WRITE (25 ITCL) (KNOBS(I),I=IKT,IE),NCAL,VXCAL,VYCAL,I=1,I
187      *NCAL=IDATE
188      GO 255 I=1,25
189      VXCAL(IC)=0
190      255 *NCAL(IC)=0
191      READ(25 ITCL) (KNOBS(I),I=IKT,IE),NCAL,VXCAL,VYCAL,I=1,I
192      *NCAL=IDATE
193      LOCK=0
194      GO TO 105
195 C
196 C*** WRITE VXCAL
197      275 CONTINUE
198      IF(LOCK NE 1) GO TO 7
199 C TRY TO FIND VERY CAL CURVE THAT MATCHES CURRENT KNOBS
200      KKV=2+4*(KV-1)
201      IVCL=LCAL(KNOBS(KKV),KV+1)
202      IF(IVCL GT 0) GO TO 280
203      CALL PICK1(IVCL,KV)
204      280 CONTINUE
205      NCAL=1
206      IE=KKV+2
207      WRITE (26 IVCL) (KNOBS(I),I=KKV,IE),NCAL,VXCAL,VYCAL,IDATE
208      VXCAL=0
209      VYCAL=0
210      READ(26 IVCL) (KNOBS(I),I=KKV,IE),NCAL,VXCAL,VYCAL,IDATE
211      LOCK=0
212      GO TO 205
213      400 CONTINUE
214 C ONLY COMMANDS ACCEPTED ARE
215 C***GO
216 C***GO EXIT
217      CALL BRANCH(1BR)
218      IF(1BR EQ 12) GO TO 7
219      IPRST=1BR
220      RETURN
221      END

```

4.4 Overlay PRICAL

This overlay processes calibration data printout commands.

Operation is described in detail in 3.3.3.

4.4.1 Glossary of Variables

CO - COMINT program transfer command index.¹

ICH - amplifier channel number being printed.

ID - calibration knobs settings read from disc.

IER - COMINT 'COMMAND ERROR' flag.

INUSE - array of units calibrated passed from AUTCAL.

IPRST - program transfer status word.

IREC - calibration curve disc record number.

ISTAT - user returned status.

ISTRNG - interpreted text string array from COMINT.

IT - loop counter for time base cal curve printouts.

ITCAL - array of new time base cal curve record numbers passed from AUTCAL.

IUN - unit number being processed.

IUNIT - IUN + 1.

IV - loop counter for vertical cal curve printouts.

IYCAL - array of new vertical cal curve record numbers passed from AUTCAL.

IDATE - cal curve date read from disc.

LCL - cal curve record number for each vertical channel.

LLCAL - vertical cal curve record number read from disc.

LOF - offset to time base cal curves for unit being processed.

MAXUN - maximum number of 7912's on line.

NCAL - number of points in calibration curve.

NT - number of time cal curves to be printed out for unit.

NV - flag to print either all or new only vertical cal
 curves for unit being processed.
 NVV - number of vertical cal curves to be printed out.
 PRINT - COMINT print command index.
 SCALF - average deflection factor computed for horizontal
 and vertical data printouts.
 VXCAL - deflection in 7912 address due to cal voltage.
 VYCAL - vertical calibration voltage.
 XCAL - array of horizontal calibration alternate zero
 crossing addresses.
 YCAL - array of horizontal calibration time between
 alternate zero crossings.

4.4.2 Flowchart

4.4.3 Listing

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```

1      OVERLAY PRICAL(INUSE)
2      C
3      C PRINT CAL DATA OVERLAY
4      C THIS PROGRAM PROVIDES COMMANDS TO PRINT CALIBRATION DATA
5      C
6      DIMENSION JDATE(3), INUSE(1), LCL(2), ID(3)
7      INTEGER GO, PRINT
8      INTEGER CALSW
9      COMMON/MGLCOM/NSHOT, MACHNO, NARS, IPRST, IHDF, ITRM, MK7912, NEARK,
10     *MXUSW, MXIM, MXDH, MKDAR, IRI, IONE, KONE, CALSW, KSTAT, INUSE, IAUT, IEP,
11     *NUS(11)
12     COMMON/DG7912/IUFT(8), KNOBS(16), RKNOBS(4), NORSTA(5), NP, KW, NT, IOP
13     COMMON/WRKARE/A(515), AZER(515), XCAL(25), YCAL(25), EPR(25), IDATE(1)
14     *ITCAL(32), IVCAL(2, 32)
15     COMMON/TEXT/ISTRNG(35), NND, IEP
16     DATA GO, PRINT/24, 21/
17     C
18     C READ A COMMAND AND INTERPRET IT.
19     IER=0
20     301 CALL COMINT(<< 0)
21     IF(ISTRNG(1).EQ GO) GO TO 311
22     IF(ISTRNG(1).EQ PRINT) GO TO 320
23     302 IER=1
24     GO TO 301
25     311 CONTINUE
26     CALL BRANCH(IPRST)
27     IF(IPRST.EQ 1 OR IPRST.EQ 12) GO TO 302
28     RETURN
29     320 CONTINUE
30     C
31     C PRINT COMMAND FORMATS ARE:
32     C PRINT ALL ALL--ALLUNITS ALL CAL CURVES PRINTED
33     C PRINT NEW (ALL)--UNITS JUST CAL'ED (ALL CAL CURVES) PRINTED
34     C PRINT, 'N', (ALL)--UNIT 'N' (ALL CAL CURVES) PRINTED OUT
35     NT=4
36     NV=0
37     IF(ISTRNG(2).EQ 'AL' OR ISTRNG(5).EQ 'AL') GO TO 322
38     C PRINT NEW SELECTED. MAKE SURE AUTCAL HAS BEEN RUN IE ITCAL, IVCALAPPRYS
39     IF(IAUT.NE.1) GO TO 302
40     NT=1
41     NV=0
42     322 CONTINUE
43     WRITE (1, 310) NV, NT, (ISTRNG(J), J=1, NND)
44     310 FORMAT (216, 5(/, 820))
45     DO 350 IUNIT=1, MK7912
46     IUN=IUNIT-1
47     C DECIDE WHETHER TO PRINT ANY CAL CURVES FOR THIS UNIT
48     IF(ISTRNG(2).EQ 'AL') GO TO 324
49     IF(ISTRNG(2).EQ 'NE' AND INUSE(IUNIT).EQ 1) GO TO 324
50     IF(ISTRNG(3).NE IUN) GO TO 350
51     IF(ISTRNG(5).NE 'AL' AND INUSE(IUNIT).NE.1) GO TO 302
52     324 CONTINUE
53     CALL ERASE
54     WRITE(10, 325) IUN
55     325 FORMAT ('+CALIBRATION DATA FOR UNIT', 13, /)
56     LOF=4+IUN
57     IF(NT.EQ.1) LOF=ITCAL(IUNIT)-1
58     IF(LOF.LT.0) GO TO 331
59     DO 330 IT=1, NT
60     C

```

```

61 C PRINT TIME CAL DATA
62 IREC=IT+LOF
63 READ(25,IREC) ID,NCAL,VXCAL,YCAL,YCAL(I),I=1,NCAL,JDATE
64 SCALE=YCAL(NCAL)*51.2/VXCAL(NCAL)-YCAL(1)
65 NP=MIN0(NCAL,13)
66 NP=MAX0(NP,1)
67 WRITE (10,325) ID,JDATE,SCALE,VXCAL(Y),YCAL(Y),I=1,NP
68 325 FORMAT (11 TIME BASE CAL FOR 1.2A2X.13.12.12.12.12)
69 * AVE SWEEP SPEED=1E11 4.1 S/DIV 1.2A2X.12.12.12.12
70 *25V.1.2E12 4.1
71 330 CONTINUE
72 IF(NP.NE.4) GO TO 331
73 C ERASE SCREEN FOR VERT DATA IF WE PRINTED ALL 4 TIME CAL CURVES
74 CALL RTSTAT(ISTAT)
75 IF(ISTAT.EQ.5) GO TO 301
76 CALL ERASE
77 WRITE (10,325) IUN
78 331 CONTINUE
79 C
80 C PRINT VERTICAL CAL DATA
81 NVV=0
82 IF(NV.EQ.0) GO TO 335
83 NVV=0
84 IF(YCAL(1.IUNIT) LT 0) GO TO 333
85 NVV=1
86 LCL(1)=YCAL(1.IUNIT)
87 333 IF(YCAL(2.IUNIT) LT 0) GO TO 335
88 NVV=NVV+1
89 LCL(NVV)=YCAL(2.IUNIT)
90 335 IF(NVV.EQ.0) GO TO 345
91 DO 345 IV=1,NVV
92 LLCAL=0*IUN+IV
93 IF(NVV.GT.2) GO TO 338
94 LLCAL=LCL(IV)
95 338 CONTINUE
96 READ(26,LLCAL) ID,NCAL,VXCAL,VYCAL,JDATE
97 ICH=1+MOD(LLCAL-1,8)/4
98 SCALE=VYCAL*64/VXCAL
99 WRITE (10,340) ICH,ID,JDATE,LLCAL,VYCAL,VXCAL,SCALE
100 340 FORMAT (11 VERT CAL CH 1.2.2X.3A2X.13.12.12.12.12)
101 * CAL RECORD #14.1
102 * REF VOLT=1F10 4.1 V/1.1
103 * DEFLECTION=1F10 2.1 ADDR.1.1
104 * DEFL. FAC=1F10 4.1 V/DIV.1.1
105 IF(IV.EQ.4) WRITE (10,343)
106 343 FORMAT (10)
107 345 CONTINUE
108 CALL RTSTAT(ISTAT)
109 IF(ISTAT.EQ.5) GO TO 301
110 350 CONTINUE
111 GO TO 301
112 END

```

4.5 Subroutine TIMCAL

This program locates every other zero crossing in a digitized time calibration curve array. It returns this information in array XCAL. It returns the time between crossings in array YCAL. TIMCAL will also compute one of two possible types of error. First, if a particular zero crossing distance is required, the error is computed with respect to this value for each crossing pair. Second, if no desired calibration is given, the program computes the average crossing distance and then computes errors with respect to this value. Thus in the second case, the error is a measure of the non-linearity. The first value in the error array ERR will always be zero. Subsequent values will give the error between the previous and corresponding crossings.

4.5.1 Call Arguments (A, PERIOD, DESCAL, XCAL, YCAL, ERR, NCAL, ISTAT)

A(515) - input digitized time calibration trace.

PERIOD - input time period of calibration signal.

DESCAL - input desired time between horizontal addresses.
If zero, errors will be non-linearity errors.

XCAL - output array of alternate zero crossing addresses.

YCAL - output array of alternate zero crossing times.

ERR - output array of errors. If input DESCAL is greater than zero,

ERR (1) = 0

$$ERR(I) = 100 * \frac{(1 - (XCAL(I) - XCAL(I-1)) * DESCAL)}{PERIOD}$$

I = 2, 3, ..., NCAL.

If DESCAL is less than or equal to zero,

ERR (1) = 0

$$ERR(I) = 100 * (1 - \frac{XCAL(I) - XCAL(I-1)}{XCAL(NCAL) - XCAL(1)}) * (NCAL - 1)$$

I = 2, 3, ..., NCAL.

NCAL - number of points in XCAL and YCAL.

ISTAT - output program status:

0 = calibration successful;

1 = 3 > NCAL > 25

2 = some ERR(I) > 20%.

4.5.2 Glossary of Variables

A - input digitized time calibration array.

AV - average value of A.

DESCAL - input desired calibration distance between zero crossings.

ERR - output array of calibration per cent errors.

ERRFAC - calibration for error check.

IA - starting index in A array for crossing check.

ICAL - index for cal point being computed.

ICRS - index for zero crossing being located.

ISTAT - output program error status.

KUM - cumulative number of A array points examined.

NCAL - output number of call points located.

NP - number of points in input A array.

NPL - number of points left in A array for crossing examination.

PERIOD - input time calibration curve period.

XCAL - output array of crossing addresses.

XCROSS - latest crossing address located.

YCAL - output array of crossing times.

4.5.3 Flowchart

4.5.4 Listing

PORTMAN IV REV M 00

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```

1      SUBROUTINE TIMCAL( A, PERIOD, DESCAL, XCAL, YCAL, ERR, NCAL, ISTAT)
2      C
3      C TIME CALIBRATION SUBROUTINE
4      C THIS PROGRAM GENERATES TIME CALIBRATION CURVE XCAL VS YCAL
5      C INPUTS
6      C   A-ARRAY TO BE CALIBRATED, STANDARD FORMAT, PERIODIC
7      C   PERIOD=PERIOD OF SIGNAL IN 'A'
8      C   DESCAL=DESIRED CAL FACTOR IN SECONDS/ADDRESS (OPTIONAL)
9      C OUTPUTS
10     C   XCAL=ARRAY OF ADDRESSES BETWEEN ZERO CROSSINGS FOR CAL CURVE
11     C   YCAL=ARRAY OF TIME BETWEEN ZERO CROSSINGS FOR CAL CURVE
12     C   ERR=ARRAY OF ERRORS FROM ONE CROSSING TO THE NEXT
13     C   NCAL=NUMBER OF POINTS IN XCAL, YCAL, ERR.
14     C   ISTAT=PROGRAM STATUS
15     C       =0 SEZ ALL OK
16     C       =1 SEZ NCAL GREATER THAN 25 OR LESS THAN 1
17     C       =2 SEZ SOME ERROR ESCEEDED 20%
18     C IF DESCAL PRESENT( GT 0 ) ERROR IS COMPUTED W R T TO DESCAL
19     C OTHERWISE ERROR IS MEASURE OF NONLINEARITY
20     C
21     DIMENSION A(1), XCAL(1), YCAL(1), ERR(1)
22     20 ICAL=0
23     IA=3
24     KUM=-1
25     NP=A(1)
26     NPL=NP
27     AV=AVR(A(3), NP)
28     DO 30 ICRS=1, 50
29     C FIND CAL SIGNAL ZERO CROSSINGS
30     XCROSS=CROSS(A(IA), NPL, 0.)
31     IF(XCROSS LT 0.) GO TO 40
32     IF(MOD(ICRS,2) EQ 0) GO TO 29
33     C ONLY SAVE EVERY OTHER CROSSING
34     ICAL=ICAL+1
35     XCAL(ICAL)=XCROSS+KUM
36     YCAL(ICAL)=(ICAL-1)*PERIOD
37     29 IA=XCROSS+KUM+4
38     KUM=IA-4
39     NPL=NP-KUM-1
40     30 CONTINUE
41     NCAL=26
42     C TOO MANY OR TOO FEW CAL POINTS. RETURN WITH ERROR 1
43     31 CONTINUE
44     ISTAT=1
45     RETURN
46     C GET HERE AFTER NO MORE CROSSINGS
47     40 CONTINUE
48     NCAL=ICAL
49     IF(NCAL LT 3) GO TO 31
50     ERRFAC=(XCAL(NCAL)-XCAL(1))/NCAL-1)
51     IF(DESCAL GT 0.) ERRFAC=PERIOD/DESCAL
52     ERR(1)=0.
53     ISTAT=0
54     DO 50 I=2, NCAL
55     ERR(I)=1. -(XCAL(I)-XCAL(I-1))/ERRFAC)*100
56     IF(ABS(ERR(I)) GT 20.) ISTAT=2
57     50 CONTINUE
58     RETURN
59     END

```

4.6 Subroutine SWITCH

This program positions the SM-2 switch modules. It takes the input desired unit, channel and position data and converts it to appropriate switch status words. If the caller elects to maintain all other switches in the affected module in their current position, the program reads in the current status words and only modifies the bits pertaining to the selected module. If the caller does not care about other switch settings, they will be set to zero status, i.e., either turned off (modules 0-7), or set to position 1 (modules 8-11). The subroutine SWRDWR performs all actual reading and writing of the switch status words.

4.6.1 Call Arguments (IUN, ICH, IPOS, IALL, ISTAT)

IUN - input unit number (0-M, $M = 6 * (\text{number of SM-2 matrices}) - 1$, currently $M = 30$).

ICH - input channel number (1, 2).

IPOS - input position number (0-4, 0 = disconnected).

IALL - input flag to save other SM-2 settings:
0 - do not save settings;
not zero - Save settings.

ISTAT - output status: 0 - switch successfully performed.
1 - unit number invalid,
2 - channel number invalid,
3 - position invalid,
4 - communications failure.

4.6.2 Glossary of Variables

D(2) - (integer) SM-2 status words.

IALL - input flag to maintain other switch positions.

IBANK - SM-2 containing desired unit switch.

ICH - input channel number.

ID - index for D.

IOFS - offset for bit setting in D.

IPDS - input switch position.

IREAD - SWRDWR read data flag (= 0), 4.8.
ISTAT - output status.
ISW - switch module in SM-2 being addressed.
IUN - input unit number.
IWRITE - SWRDWR write data flag (= 1), 4.8.
MAXUN - maximum possible unit number.

4.6.3 Flowchart

4.6.4 Listing

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```

1      SUBROUTINE SWITCH(IUN, ICH, KPOS, IALL, ISTAT)
2      C
3      C PROGRAM TO SWITCH SM-2 MODULES
4      C INPUTS:
5      C      IUN- 7912 UNIT NUMBER (0-17)
6      C      ICH- 7912 CHANNEL NUMBER (1,2)
7      C      KPOS-DESIRED POSITION (0-4)
8      C      IALL-FLAG THAT SEZ WHETHER TO SAVE CURRENT SWITCH SETTINGS
9      C      =-1 SEZ IGNORE CURRENT SETTINGS
10     C      =0 SEZ SAVE CURRENT SETTINGS
11     C OUTPUT: ISTAT- SUBROUTINE ERROR STATUS
12     C      =0 SEZ ALL OK
13     C      =1 SEZ UNIT INPUT INVALID
14     C      =2 SEZ CHANNEL INPUT INVALID
15     C      =3 SEZ POSITION INPUT INVALID
16     C      =4 SEZ AUTOCAL MALFUNCTIONED
17     C SWITCH POSITION 0 CAUSES MODULE TO BE DISCONNECTED
18     C SWITCHES 0-11 ON EACH BANK CANNOT BE COMPLETELY DISCONNECTED
19     C
20     C      INTEGER D(2), IT(2)
21     C      LOGICAL TESTB
22     C      INTEGER CALSW
23     C      COMMON/MOLCOM/NSHOT, MACHNO, NAPS, IPRST, IMDR, ITIM, MX7912, NEARX
24     C      *MXUSW, MXIH, MXOH, MXDAR, TRI, IONE, KONE, CALSW, KSTAT, NIUSE, IAUT, IEF
25     C      *NUS(11)
26     C      DATA IREAD, IWRITE/0,1/
27     C      ISTAT=1
28     C DON'T CHANGE CALLER'S ARGUMENTS
29     C      IPOS=KPOS
30     C      IBANK=IUN/6
31     C      IF (IBANK.LT.0.OR.IBANK.GT.NBANK) RETURN
32     C      ISTAT=2
33     C      IF (ICH.NE.1.AND.ICH.NE.2) RETURN
34     C      ISTAT=3
35     C      IF (IPOS.LT.0.OR.IPOS.GT.4) RETURN
36     C UNITS 0-5 ARE ON BANK 0. UNITS 6-10 ARE ON BANK 1. UNITS 11-14 BANK 2
37     C CHANNELS ALTERNATE IN NUMBERING SCHEME
38     C      ISW=2*MOD(IUN,6)+ICH-1
39     C      IF (IALL.EQ.-1) GO TO 11
40     C READ IN CURRENT SWITCH SETTINGS SO WE CAN SAVE THEM
41     C      CALL SHRDWR(IBANK,D,IREAD,ISTAT)
42     C      IF (ISTAT.NE.0) RETURN
43     C      GO TO 12
44     C      11 CONTINUE
45     C INIT DATA WORDS TO ALL OFF OR ON POS 1 WHEN 'DON'T CARE' OPTION SET
46     C      D(1)=0
47     C      D(2)=0
48     C      12 CONTINUE
49     C SET UP FIRST SWITCH WORD
50     C SET UP PROPER ENABLE BIT
51     C      IF (ISW.GT.7) GO TO 17
52     C      IBIT=8-ISW
53     C 'SETBT' SETS BIT TO ZERO. BITS RUN FROM 1-16 MSB-LSB
54     C 'SETBF' SETS BIT TO ONE
55     C      IF (IPOS.EQ.0) CALL SETBT(D(1),IBIT)
56     C      IF (IPOS.GT.0) CALL SETBF(D(1),IBIT)
57     C      17 CONTINUE
58     C SET UP PARAMETERS FOR SWITCH POSITION SETUP
59     C NOTE THAT POSITION 0 GETS MAPPED INTO POSITION 1 IE BOTH BITS RESET
60     C      IF (IPOS.GT.0) IPOS=IPOS-1

```

```

61      ISW=2*ISW
62      C SWITCHES 0-7 ARE SET UP IN SECOND WORD
63      ID=2
64      IOFS=17
65      C REMEMBER WE MULTIPLIED SWITCH # BY 2
66      IF (ISW LE. 14) GO TO 20
67      ID=1
68      IOFS=33
69      20 DO 18 I=1,2
70      IBIT=IOFS-ISW-I
71      C TESTB IS TRUE WHEN BIT IS ZERO AND FALSE IF BIT IS ONE
72      IF (TESTB(IPOS,17-I)) CALL SETBT(D(ID),IBIT)
73      18 IF (NOT TESTB(IPOS,17-I)) CALL SETBF(D(ID),IBIT)
74      ISTAT=0
75      CALL SWPDWR(IBANK,D,IWRITE,ISTAT)
76      RETURN
77      END

```


4.7 Subroutine VHREF

This program takes input vertical and horizontal signal input values and sends the appropriate commands to the Autocal system. The value passed to the subroutine need not be exactly equal to an Autocal value. The program will pick an appropriate value.

4.7.1 Call Arguments (VAL, IHV, ISTAT)

- VAL - reference signal value for either vertical cal signal amplitude or horizontal cal signal frequency depending on IHV. On input this is the desired value. On output it will be either the Autocal horizontal cal signal frequency closest to the desired value or the vertical signal amplitude closest to but less than the input. An input value less than zero will turn off the appropriate signal generator.
- IHV - flag which determines whether to send vertical or horizontal command: = 0 - send horizontal command,
= 1 - send vertical command.
- ISTAT - not used.

4.7.2 Glossary of Variables

- ADIF - absolute difference between Autocal signal value and desired value.
- AM - increment factor in generator Autocal vertical values.
- DIV(3) - step sizes in generating horizontal values.
- IEX - exponent in generating horizontal values.
- IEXS - saved value of IEX in case next computed horizontal value is further from desired value than one just computed.
- IHV - input flag which determines whether to send horizontal or vertical command.
- IM - index to step size for both horizontal and vertical value generation.
- IMS - saved value of IM (for same use as IEXS).
- ISTRNG - ASCII command string transmitted to Autocal system.
- IWD - temporary computation of ISTRNG words.

MSKLB - mask for generating lower byte of horizontal
 command string words.
 MSKUB - mask for generating upper byte of horizontal
 command string words.
 MSKVRF - mask for generating vertical command string words.
 MSK00 - base word mask for generating horizontal command
 string words.
 REF - computed value of Autocal horizontal or vertical
 signal for comparison to desired value.
 REFS - saved value of REF (same reason as IEXS).
 SPCR - ASCII space/carriage return characters.
 VAL - input desired value, output transmitted value.
 VMIN - difference between computed value and desired value.

4.7.3 Flowchart

4.7.4 Listing

C:\MSD\BIN\REF.M 000

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```

1      SUBROUTINE VAREF(VAL,IMV,ISTAT)
2      C
3      C PROGRAM TO WRITE OUT CALIBRATION REFERENCE SIGNAL COMMANDS TO AUTO
4      C INPUTS
5      C      VAL=REFERENCE VALUE DESIRED / 0
6      C      VAL=REFERENCE VALUE DESIRED / VAL<0 SEZ TURN OFF SIGNAL
7      C      IMV=FLAG TO GO VERTICAL OR HORIZONTAL REFERENCE
8      C      =0 SEZ SELECT A HORIZONTAL REFERENCE FREQUENCY
9      C      =1 SEZ ENABLE A VERTICAL REFERENCE / VOLTAGE
10     C
11     C FOR VERT CAL FREQUENCY GENERATED IS ONE CLOSEST TO INPUT VAL
12     C THAN 'VAL'
13     C OUTPUT ISTAT=(NOT USED)
14     C
15     C DIMENSION DIV(2), ISTRNG(5)
16     C INTEGER SFUP
17     C DATA DIV/5 , 2 , 1 /
18     C DATA MSKUB,MSKLB,MSK00,MSKVRP,SPCP/420020,42000F,42000,477100
19     C      *422000/
20     C INIT DATA WORD TO SHUTDOWN
21     C REFS=VAL
22     C VMIN=1.E20
23     C ISTRNG(4)=MSK00
24     C CHECK IF VERT OR HORZ CAL REQUESTED
25     C IF(IMV EQ 1) GO TO 50
26     C ISTRNG(1)='*H'
27     C VAL LT 0 SEZ SHUTDOWN
28     C IF(VAL LT 0) GO TO 100
29     C SEE TEKTRONIX 'REF' MANUAL PAGE 3 FOR CODES
30     C GENERATE REFERENCE FREQUENCIES
31     C DO 20 I=1,27
32     C IM=1+MOD(I-1,3)
33     C IEX=(I+2)/3
34     C IEX SHOULD RUN FROM 1-9
35     C REF=(1.25/DIV/IM)**10 **((IEX-1))
36     C ADIF=ABS(REF-VAL)
37     C IF(ADIF GE VMIN) GO TO 20
38     C VMIN=ADIF
39     C IMS=IM
40     C IEXS=IEX
41     C REFS=REF
42     C 20 CONTINUE
43     C SET UP ASCII DATA WORDS TO GENERATE CORRECT REF CODE
44     C 22 CONTINUE
45     C IWD=IEXS*4+4-IMS
46     C SEND 3RD NIBBLE TO BE 2ND NIBBLE
47     C ISTRNG(4)=IAND(IWD,MSKUB)*16+IAND(IWD,MSKLB)+MSK00
48     C GO TO 100
49     C
50     C VERTICAL LEVEL DESIRED GENERATE VOLTAGES FIND ONE CLOSEST TO VAL
51     C 50 CONTINUE
52     C ISTRNG(1)='*V'
53     C IF(VAL.LT.0) GO TO 100
54     C REF=0
55     C DO 70 I=1,9
56     C IM=MOD(I-1,3)/2
57     C AM=2.+5*IM
58     C REF=AM*REF
59     C ADIF=VAL-REF
60     C IF(ADIF.LT.0 .OR. ADIF GE VMIN) GO TO 69

```

```

01 20)NOR=0
02 IF=1
03 KEYS=KEY
04 GO CONTINUE
05 IF 1 EQ 1, KEYS=000
06 GO CONTINUE
07 C MATCH FOUND. GENERATE ASL II CODE FOR APPROPRIATE REF
08 "5" CONTINUE
09 INC=INC+1
10 ISTRNG=4+LINE-NOR*REF
11 GO TO 100
12
13 C INITIAL COMMAND STRING TO 1048 DATA COUPLER
14 100 CONTINUE
15 ISTRNG(2)=R
16 ISTRNG(3)=00
17 ISTRNG(4)=SPACE
18 WRITE(1,101) ISTRNG
19 101 FORMAT(10,52)
20 VAL=KEYS
21 ISTATE=0
22 RETURN
23 END

```

4.8 Subroutine SWRDWR

This program reads and writes SM-2 switch bank status words. For write operations input data words are converted from Tektronix 32 bit format to ASCII format and transmitted to the Autocal system. For read operations ASCII data is read from the Autocal system and converted to Tektronix 32 bit format. If a read operation is not completed within 5 seconds, the program assumes the Autocal is malfunctioning and returns an error status.

4.8.1 Call Arguments (IB, D, ICODE, ISTAT)

IB - input SM-2 bank number (0-4).
D(2) - switch status words in Tektronix format. For
(integer) write operations D is an input; for read
operations D is an output.
ICODE - input flag which determines whether read or
write is to be performed: 0 = read; 1 = write.
ISTAT - output status: 0 = operation successfully performed;
1 = bank number invalid;
2 = Autocal malfunctioned.

4.8.2 Glossary of Variables

ADCR - ASCII address/carriage return characters.
ADSP - ASCII address/space characters.
D(2) - SM-2 switch bank status words in Tektronix format.
IB - input SM-2 bank number.
IBUF - ASCII data buffer read from Autocal.
ICODE - input read/write operation flag.
ISH - bit shift parameter.
ISTAT - output program status.
ISTRNG - ASCII data transmitted to Autocal.
IT - temporary storage for computing ISTRNG values.
IUFT - user file table for read operations.

MASK(2) - bit masks for converting ASCII status words to
and from Tektronix 32 bit status words.

MASK1 - bit mask for status word conversion.

MXWAIT - maximum number of seconds to wait for read to
complete.

OUTT - user file table for write operations.

SPCR - ASCII space/carriage return characters.

SPTE - ASCII space/terminate characters.

4.6.1: Flowchart

4.8.4 Listing

C:\PROGRAM\KEY.M86

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```

1 SUBROUTINE SUBROUTINE(B:O,ICODE,ISTAT)
2 C
3 C PROGRAM TO READ AND WRITE SM-2 STATUS WORDS
4 C INPUT
5 C      IE= SM-2 BANK NUMBER (0-2)
6 C      D(2)= INTEGER ARRAY OF TWO STATUS WORDS
7 C      ICODE=READ OR WRITE FLAG
8 C           =0 SEZ READ STATUS
9 C           =1 SEZ WRITE STATUS
10 C OUTPUT
11 C      D(2)=TWO INTEGER STATUS ARRAY FROM READ OPERATION
12 C      ISTAT= OPERATION STATUS
13 C           =0 SEZ ALL OK
14 C           =1 SEZ INPUT ARGUMENT BAD
15 C           =2 SEZ AUTOCAL HARDWARE MALFUNCTION
16 C
17 C      DIMENSION IST(6)
18 C      DIMENSION ISTRNG(5),IBUF(4),MASK(2),IUFT(10)
19 C      INTEGER D(2),ADCR,SPT,ADSP,DUFT(10),SPCR
20 C      INTEGER CALSW
21 C      COMMON/MGLCOM/NSHOT,MACHNO,NARS,IPRST,IHDR,ITRM,MX7912,NBANK,
22 C      *MXUSW,MXIH,MXOH,MXDAR,IP1,IONE,KONE,CALSW,KSTAT,NIUSE,IAUT,IEF
23 C      *NUS(11)
24 C      DATA ADCR,SPT,ADSP,SPCR/424100, 0, 0, 0, 422000
25 C      DATA MASK,MASK1/420F00,42000F,423030/
26 C      DATA IUFT/0,0,424000,0,0,0,11,0,0,0,0,0/
27 C      DATA DUFT/0,0,424000,0,0,0,12,0,0,0,0,0/
28 C MAX AUTOCAL WAIT IN SECONDS
29 C      MXWAIT=5
30 C      ISTAT=1
31 C      IF(IE LT 0 OR IE GT NBANK) RETURN
32 C      ISTRNG(1)='S'
33 C      IF(ICODE.EQ.1) GO TO 30
34 C READ DATA REQUESTED
35 C LOOP TO READ EACH BANK STATUS WORD
36 C CONVERT MAX WAIT TO 50 MS CHUNKS
37 C      MXWAIT=MXWAIT/.05
38 C      DO 20 I=1,2
39 C          ISTRNG(2)=ADCR+(2*IE+I-1)*256
40 C          ISTRNG(3)=SPT
41 C          CALL WRITE(ISTRNG,6,DUFT,FALSE)
42 C          CALL WAIT(2,0,IST)
43 C DO QUICK RETURN READ SO WE WON'T WAIT FOREVER IF AUTOCAL IS BROKE
44 C READ 4 DATA BYTES AND A CR BYTE
45 C          CALL READ(IBUF,5,IUFT,FALSE)
46 C ONLY WAIT SO LONG FOR READ TO COMPLETE
47 C          DO 10 IW=1,MXWAIT
48 C              CALL WAIT(5,0,IST)
49 C              IF(IUFT(1).EQ.0) GO TO 12
50 C          CONTINUE
51 C          ISTAT=2
52 C          GO TO 50
53 C          12 IBUF(3)=IBUF(2)
54 C          IBUF(2)=IBUF(1)*256
55 C          IBUF(4)=IBUF(3)*256
56 C          D(I)=0
57 C LOOP TO CONVEF. 4 ASCII CHARACTERS TO ONE BINARY WORD
58 C          DO 20 J=1,4
59 C              ISH=8-4*J
60 C              IBUF(J)=IAND(IBUF(J),MASK(1))

```

```

61      IBUF(J)=ISHFT(IBUF(J),ISH)
62      D(I)=D(I)+IBUF(J)
63      20 CONTINUE
64      ISTAT=0
65      RETURN
66 C WRITE REQUESTED CONVERT BINARY STATUS TO ASCII
67 30 CONTINUE
68      ISTRNG(5)=SPCR
69 C LOOP TO SET UP TWO BANK WORDS
70 40 I=1,2
71      ISTRNG(2)=ADSP+(2*IB+I-1)*256
72 C LOOP TO SET UP TWO ASCII WORDS FROM ONE BINARY WORD
73 50 J=1,2
74      JP2=J+2
75      ISTRNG(JP2)=MASK1
76 C LOOP TO CONVERT TWO NIBBLES PER PASS TO ASCII
77 60 K=1,2
78      IT=ISHFT(D(I),-4*K+(J-1)*8)
79      IT=IAND(IT,MASK(K))
80 C
81      ISTRNG(JP2)=ISTRNG(JP2)+IT
82 35 CONTINUE
83      CALL WRITE (ISTRNG,10,OUFT )
84      45 CONTINUE
85      ISTAT=0
86 50 CONTINUE
87      CALL TERMIN(OUFT)
88      CALL TERMIN(OUFT)
89      RETURN
90      END

```

4.9 Subroutine PICK1

This program reads in knobs settings from disc for a desired set of calibration curves. The knobs settings are printed on the screen. The program then reads from the operator which curve he wants to replace. This number is returned to the calling program.

4.9.1 Call Arguments (ICAL, KTV)

ICAL - output cal curve number operator wishes to replace.

KTV - input flag to set of cal curves:

- 1 - vertical amplifier channel 1;
- 2 - vertical amplifier channel 2;
- 3,4 - time base.

In addition, the program picks up the 7912 unit number from common D6/7912
DEF(4)(4,10,4).

4.9.2 Glossary of Variables

I - relative cal curve record number.

ICAL - output relative and absolute cal curve record number to be replaced.

ID - array for reading in knobs setting data.

IOFS - offset to call curves depending on unit number.

IREC - absolute cal curve record number for reads.

IUN - 7912 unit number.

IUFT - 7912 communications user file table.

KTV - input flag for which type of cal curve to read.

1.8.3 Flowchart

4.9.4 Listing

COMMON/DP7912/IDFTY(8),KNOBS(16),RKNBS(4),NORSTA(5),NFK(5),T(10)

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```

1      SUBROUTINE PICKYICAL,KTV,
2      DIMENSION ID(2)
3      COMMON/DP7912/IDFTY(8),KNOBS(16),RKNBS(4),NORSTA(5),NFK(5),T(10)
4
5      C PROGRAM TO ALLOW USER TO SELECT WHICH CAL CURVE HE WANTS TO READ
6      C WHEN NONE EXISTS FOR CURRENT KNOBS SETTINGS
7      C INPUT KTV- CHANNEL NUMBER TO BE USED
8      C      =1 SEZ DO VERT AMP CHANNEL 1
9      C      =2 SEZ DO VERT AMP CHANNEL 2
10     C      =3 OR 4 SEZ DO TIME BASE
11     C      IUN- UNIT NUMBER MUST BE SUPPLIED IN COMMON/DP7912
12     C OUTPUT IICAL- DISC RECORD NUMBER WHERE TO PUT NEW CAL CURVE
13     C
14     IUN=IDFTY(4)
15     WRITE (10,5) IUN,KTV
16     5 FORMAT (' NO EXISTING CAL CURVE FOR UNIT ID CHANNEL ID ')
17     44 EXISTING CURVES ARE FOR
18     IOFS=8+IUN+4*(KTV-1)
19     IF(KTV GT 2) IOFS=4+IUN
20     DO 30 I=1,4
21     IREC=IOFS+I
22     IF(KTV LT 3) GO TO 10
23     C READ TIME CAL CURVE IDENTIFICATION
24     READ(25,IREC) ID
25     GO TO 12
26     C READ A VERT CAL CURVE IDENTIFICATION
27     10 READ(26,IREC) ID
28     12 WRITE (10,14) I, ID
29     14 FORMAT ('14,2X,3A2')
30     30 CONTINUE
31     32 WRITE (10,34)
32     34 FORMAT (' ENTER NEW CAL RECORD # ')
33     READ(11,36) IICAL
34     36 FORMAT ('11')
35     IF(IICAL LT 1 OR IICAL GT 4) GO TO 32
36     IICAL=IICAL+IOFS
37     RETURN
38     END

```

4.10 Common Storage Areas

The various labelled common areas used in the Autocal program are described in the following sections.

4.10.1 COMMON/GLOCOM/NSH, MACH, NAS, IPR, IOP1, IOP2, IDAST(38)

This common area is global. It can be accessed by all properly edited overlays and tasks. It is used to pass arguments among various programs. The variables used by the Autocal program are described below. Variables not described are not used.

IPR - new program request. The control program INI uses this value to determine which new program (if any) to activate when Autocal exits.^{8,16}

IOP1 - alternate header option word.

IOP2 - last 4010 terminal in use: 1 = user terminal;
2 = console terminal.

4.10.2 COMMON/MGLCOM/NSHOT, MACHNO, NARS, IPRST, JHRD, ITRM, NUS(6)

This common area is used to internally store information passed to the program in GLOCOM. This is necessary since other programs could modify the original data in GLOCOM while Autocal is running. This common area is also used in many utility subroutines. Only the variables used by Autocal are described.

MACHNO - machine number in use.

IPRST - program transfer status.

ITRM - terminal in use.

IHDR - storage for machine number passed to program.

4.10.3 COMMON/WRKARE/A(515), AZER(515), XCAL(25), YCAL(25), ERR(25), IDATE(3), ITCAL(32), ITCAL(32)

This common area is used as a work area by all three overlay programs.

A - working array of digitized 7912 data.

AZER - array of digitized baseline data.

XCAL - time cal zero crossing addresses.
 VCAL - time cal zero crossing times.
 ERR - errors in zero crossing addresses.
 IDATE - date: month, day, year.
 ITCAL - time call curve record numbers from AUTCAL.
 IYCAL - amplifier cal curve record numbers from AUTCAL.

4.10.4 COMMON/DG7912/IUFT(8), KNOBS(16), RKNNOBS(4), NORSTA(5)
NP, KV, KT, IOP

IUFT - user file table for 7912 communications.₁₂
 KNOBS - ASCII knobs setting data packed two characters
 per word, 4 words per setting.
 RKNNOBS - floating point knobs settings.
 NORSTA(5) - status words from normalized routine:
 (1) first scan with two good verticals + 1024
 bias flag;
 (2) last scan with two good verticals + 1024
 bias flag;
 (3) total number of scans with two good verticals;
 (4) final number of points in normalized array;
 (5) error status: 0 = no errors;
 -1 = trace offscale;
 1 = no data;
 2 = raw array invalid;
 3 = scan found with too many
 verticals.
 NP - number of points in digitized array.
 KV - first vertical amplifier channel active.
 KT - type of 7912 time base: 3 = 7B52A;
 4 = 7B92A.
 IOP - option to have computer trigger 7912's in digitize
 operation.

4.10.5 COMMON/RAWDAT/NRW, MINSEP, MAXSEP, IUN, IRAW(2500)

This common area is used for storing raw 7912 data and
 related parameters.

NRW - location of end-of-data flag in IRAW.

MINSEP - minimum separation between vertical addresses
for a valid trace.

MAXSEP - maximum separation between vertical addresses
for a valid trace.

IUN - 7912 unit number.

IRAW - raw 7912 data array.

4.10.6 COMMON/TEXT/ISTRNG(20), NWD, IER

This common area is used for storing text string information.

Subroutine COMINT stores interpreted commands here.¹

ISTRNG - text string data.

NWD - number of words in ISTRNG interpreted by COMINT.

IER - command error status sent to COMINT.

5. ASCII Input Strap Characters

The ASCII interface cards in the Data Coupler convert ASCII serial data strings into 16 bit parallel words. The ASCII input card also interprets control characters and card address selection characters. A complete description is contained in (3). Some control characters and all address characters must be customer wired. The wiring is summarized in the following table.

<u>Character Function</u>		<u>Alpha- numeric</u>	<u>Hex</u>	
1.	Enable	*	2A	
2.	Terminate	#	23	
3.	Horizontal Reference Card Address	HR	48	52
4.	Vertical Reference Card Address	VR	56	52
5.	Switch Matrix Card Addresses			
5.1	Matrix 0			
	a. word 1	SA	53	41
	b. word 2	SB	53	42

<u>Character</u>	<u>Function</u>	<u>Alpha- numeric</u>	<u>Hex</u>	
5.2	Matrix 1			
	a. word 1	SC	53	43
	b. word 2	SD	53	44
5.3	Matrix 2			
	a. word 1	SE	53	45
	b. word 2	SF	53	46
5.4	Matrix 3			
	a. word 1	SG	53	47
	b. word 2	SH	53	48
5.5	Matrix 4			
	a. word 1	SI	53	49
	b. word 2	SJ	53	4A

6. References

1. Boyer, W. B., Electron Beam Data Acquisition System Facility User Manual, Sandia 5242/5022, Sept. 1976.
2. "Automated Measurement Systems 1340 Data Coupler SN B040000 Up", Tektronix, 1972.
3. "1340 Circuit Card Package ASCII Interface 021-0061-00", Tektronix, 1972.
4. "1340 Circuit Card Package 32-bit Output/Echo Check Manual 021-3094-00", Tektronix, 1973.
5. "1340 Circuit Card Package Reference Signal Interface 021-0052-00", Tektronix, 1972.
6. "SM-2 Signal Switcher D013-0134-01", Tektronix 1973.
7. "Technical Manual 481X Series Communications Channels Vol I, II", Modular Computer Systems, 1973.
8. Boyer, W. B., Electron Beam Program Control Task IN1. (unpublished).
9. "Technical Manual: MAX II/III System Generation", Modular Computer Systems, 1976, pp 1-26.
10. "Reference Manual: MAX II/III System Processors Direct Access Maintenance Processor", Modular Computer Systems, 1976.
11. Boyer, W. B., Electron Beam Fusion Data Acquisition Program DELTA (EBD), Sandia SAND77-0204, 1977.
12. Krone, J. L., TD a Symbion Task for a Tektronix 7912 Transient Digitizer Interfaced on a MODCOMP II Computer, Sandia (unpublished), 1976.
13. Boyer, W. B., Electron Beam Interactive Data Manipulation Program FAWTEK, Sandia SAND77-0210, 1977.
14. Boyer, W. B., Electron Beam Diode Performance Analysis Program DIODE0, Sandia SAND77-0394, 1977.
15. Richards, M., Dabbs, R.D., TRACE Image Digitizing System, Sandia SAND77-0355, 1977.

Fig. 1. Block Diagram of Autocal System Hardware