SAN/0499-54
MDC G8528

10-MWe Solar-Thermal
Central-Receiver Pilot Plant

SOLAR FACILITIES DESIGN INTEGRATION

SYSTEM INTEGRATION LABORATORY TEST PLAN (RADL ITEM 6-4)

MASTER

DO NOT MICROFILM COVER

Revised October 1980
May 1980

WORK PERFORMED UNDER CONTRACT
DE-AC03-79SF10499

MCDONNELL DOUGLAS ASTRONAUTICS COMPANY
5301 BOLSA AVENUE
HUNTINGTON BEACH, CA 92647

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PREPARED FOR THE
U.S. DEPARTMENT OF ENERGY
SOLAR ENERGY
UNDER CONTRACT DE-AC-03-79SF10499

PREFACE

This document is provided by the McDonnell Douglas Astronautics Company (MDAC) in accordance with Department of Energy Contract No. DE-AC-03-79 SF 10499, Reports and Deliverables List, Item 6.4. The material contained describes the System Integration Laboratory Test Plan.

Questions concerning this document should be directed to J. C. Grosse (714) 896-4316.

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FIGURES

TABLES

GLOSSARY

AK	Annunciator Keyboard
B/W	Black and White
BCS	Beam Characterization System
C&I	Controls and Instrumentation
CAB	Cabinet
CAM	Camera
CB	Control Building
CCM-PS	Communications Control Module Power Supply
CCP	Communications and Control Processor
CCU	Central ControlUnit
CFIC	Collector Field Interface Cabinet
CTM	Communications Translator Module
CLCU	Camera Lens ControlUnit
COHU	Trademark of Video Systems Equipment Manufacturing Company
CPU	Central Processing Unit
CRT	Cathode Ray Tube
CS	Collector Subsystem
CSM	Configuration Storage Module
DARMS	Data Acquisition and Remote Multiplexing System
DAS	Data Acquisition System
DBIOP	Dual Branch Input and Output Processor
DEC 10	Digital Equipment Corporation Computer Model Number
DIR	Digital Image Radiometer
DTMF	Dual Tone Modulating Frequency
EAU	Extended Arithmetic Unit
EER	Engineering Evaluation Room
EES	Electronics Environmental Shelter
EPGS	Electric Power Generating System
EXT INT	External Interrupt
GE	General Electric Company

H COPIER	Hard Copier
HAC	Heliostat Array Controller
HCP	Host Communications Processor
HTP	Historic Trend Processor
HP	Hewlett Packard Company
HZ	Hertz or Frequency
I/F	Interface
I/O	Input and Output
IPAC	Trademark of Digital Data Acquisition Equipment Manufacturing Company
IR	Infra Red
ISC	Intelligent Systems Corporation
J-BOX	Junction Box
KB or Kb	Kilobit
KBP	Keyboard Processor
LPM	Lines Per Minute
MA/V	Milliamp to Voltage Converter
MAX (IV)	Trademark of MODCOMP Operating System Software
MAXNET (IV)	Trademark of MODCOMP Multicomputer Operating System Software
MB or Mb	Mega Bit
MCS	Master Control Subsystem
MODACS	Trademark of MODCOMP for Modular Data Acquisition and Control Subsystem
MODCOMP	Trademark of MODCOMP for Modular Computer Systems Incorporated
MOS	Metal Oxide Semiconductor Memory
MUX	Multiplexor
MVCU	Multivariable Control Unit
N/A	Not Available
OCS	Operational Control System
OK	Operator Keyboard
OLSF	On-Line Simulation Facility
OPCU	Operator Programmable Control Unit - Same as Operator Programmable Interface Unit (OPIU)
OPIU	Operator Programmable Interface Unit
OSP	Operator Station Processor
P/N	Part Number
PDP-10	Digital Equipment Corporation Computer Model Number

PIP	Peripheral Interface Processor
RADL	Reports and Deliverables List
RAS	Remote Acquisition System
RGP	Report Generation Processor
RG (11)	Coaxial Wire Cable Type (11)
RI	Rockwell International
RLU	Red Line Unit
RMU	Remote Multiplexor Unit
RS	Receiver Subsystem
RS-232-C	Telecommunications Interface Standard Specification
RTT	Resistant Temperature Transmitter
S/C	Signal Conditioning
S/R	Stearns Roger Company
SCU	Signal Conditioning Unit
SDPC	Subsystem Distributed Process Control System
SETF	Solar Energy Test Facility
SHIMMS	Special Heliostat Instrumentation and Meteorlogical Measurements System
SHM	Short Haul Modem
SIL	System Integration Laboratory
STA	Station
SW	Switch
T/G	Turbine Generator
TCD	Test Control Drawing
TELCO	Telephone Communications
TGT	Target
TSS	Thermal Storage Subsystem
TV	Television
TWR	Tower
V/MA	Voltage to Milliamp Converter
VAC	Alternating Current Voltage
W/S	Weather Station
WDS	Words
WWV	Call Letters of Time Standard

Section 1
INTRODUCTION

The purpose of this document is to provide a general demonstration test plan for the activities to be accomplished at the SFDI Systems Integration Laboratory (SIL) at Huntington Beach. The Master Control System (MCS), the Subsystem Distributed Process Control (SDPC), Representative Signal Conditioning Units (SCU), and Redline Units (RLU) from the Receiver Subsystem (RS) and the Thermal Storage Subsystem (TSS) and other external interface operational functions will be integrated and functionally demonstrated. This document presents the overall plan for the SIL activities. Subsequent documents will present the detailed plans and procedures for integration and testing of the various subsystems.

1.1 TEST DESCRIPTION SUMMARY

The demonstration testing will be accomplished in four major phases.

A. Performance demonstration of Beckman Multivariable Control Unit (MVCU)

B. Maximum System Integration Laboratory (Maxi SIL)

C. Minimum System Integration Laboratory (Mini SIL)

D. BCS System Integration Laboratory

1.1.1 <u>MVCU Testing</u>

The Beckman MVCU will be tested for frequency response, static checks, configuration changes, switching transients, and input/output interfaces. Figure 1-1 indicates the configuration.

1.1.2 <u>Maxi SIL</u>

Maxi SIL testing will demonstrate the operational readiness of Pilot Plant controls and external interfaces that are available. Figure 1-2 is an overview block diagram of the test configuration. The subsystems will be installed and readiness tested. The various subsystems will then be interconnected and the interfaces tested to determine readiness to support integrated system

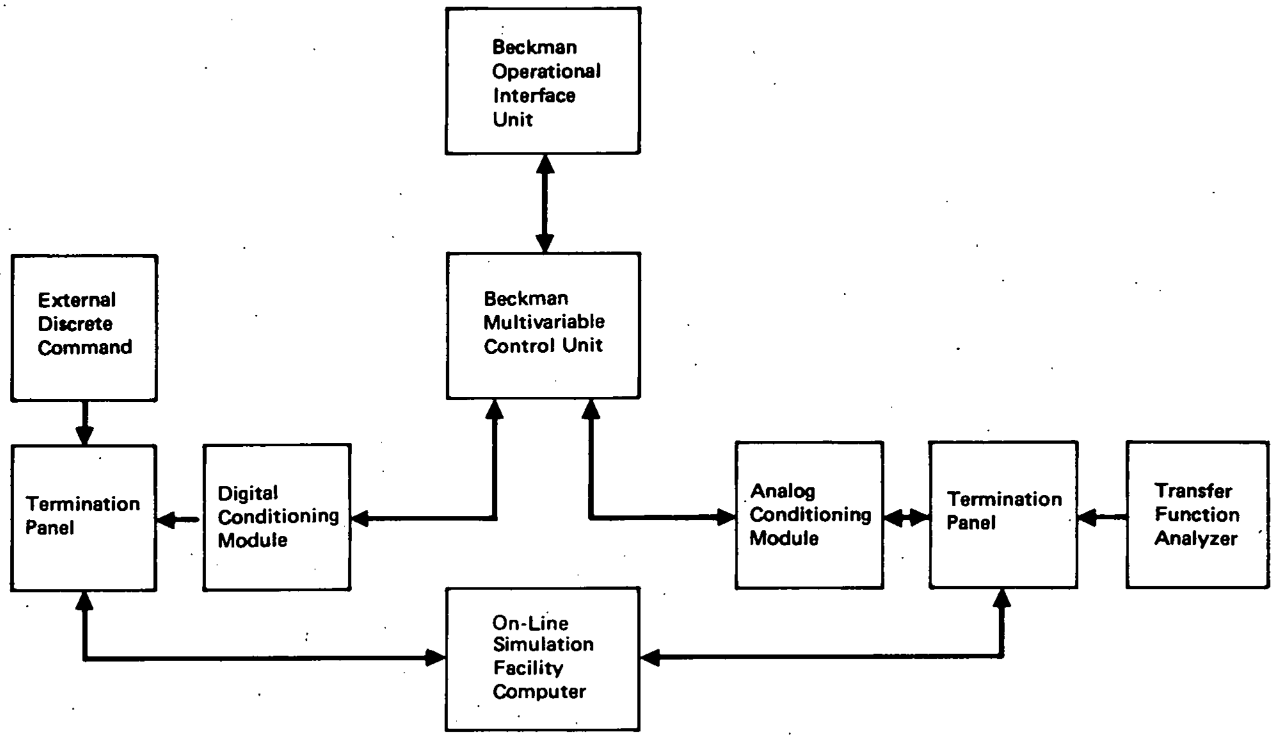


Figure 1-1. Beckman Multivariable Controller Performance Test Configuration

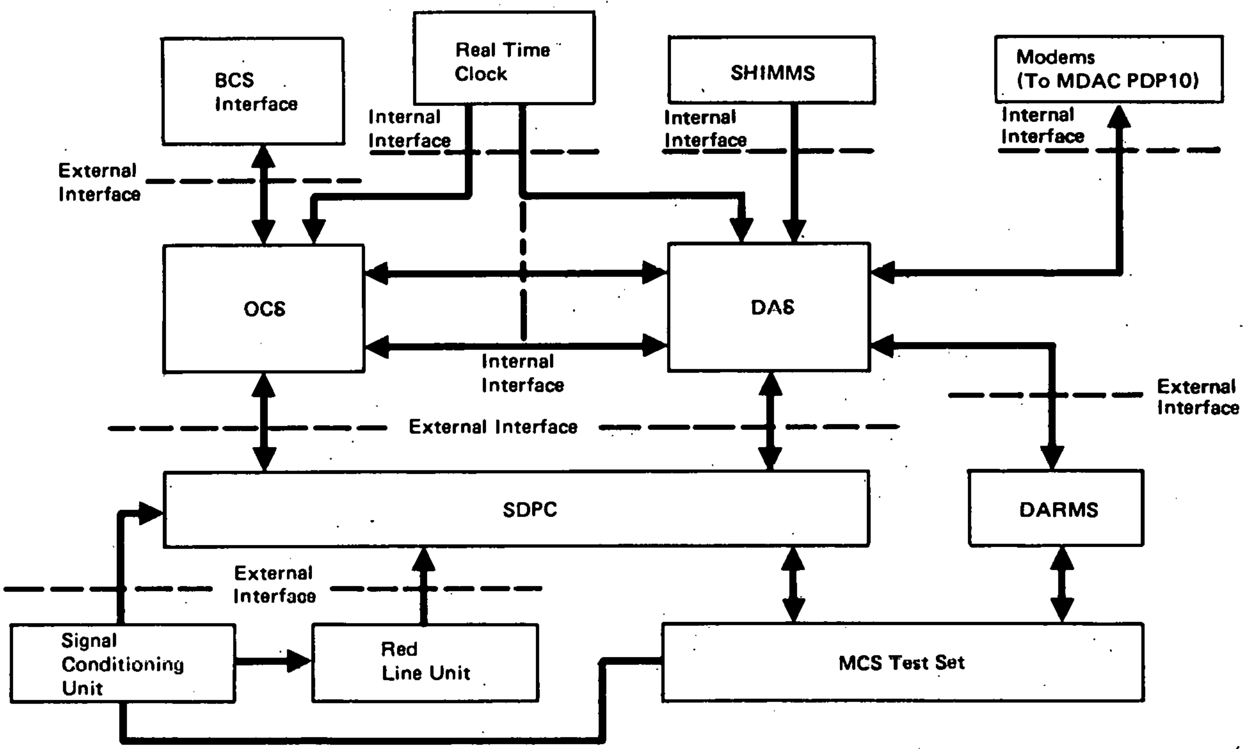


Figure 1-2. SIL Plant Controls Test Configuration

demonstrations. Certain system-level testing will then be accomplished. Hardware, software, and firmware are involved in this activity.

1.1.3 Mini SIL

Mini SIL testing will be accomplished with a reduced (mini) set of hardware after delivery of equipment from maxi SIL to the site. The mini SIL hardware configuration, as illustrated in Figure 1-3, will provide capability for continued development and demonstration of Operational Control System (OCS) plant control application software. The OCS computer and its essential interfaces are provided in mini SIL so that the last increment of software can continue development and hardware/software integration can proceed while the system hardware is being installed, interconnected, and checked out at the site.

1.1.4 BCS SIL

BCS SIL testing will demonstrate the operational readiness of the BCS equipment and software. Figure 1-4 provides an overview block diagram of the BCS hardware configuration. The components and software will be installed and interfaced to a surrogate OCS computer and target located in the Solar Energy Test Facility (SETF) at MDAC Huntington Beach and functionally tested. The system will then be installed in the MCS System Integration Laboratory with the final interfacing tests being run with the BCS software installed in the OCS computer.

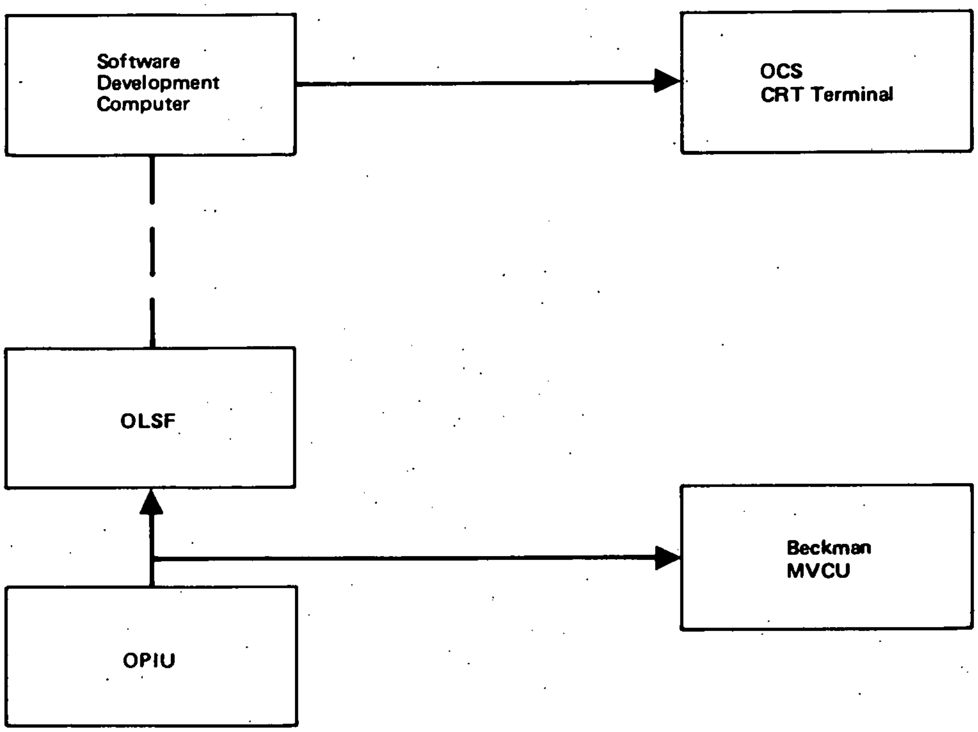


Figure 1-3. Mini SIL Software Development Support Configuration

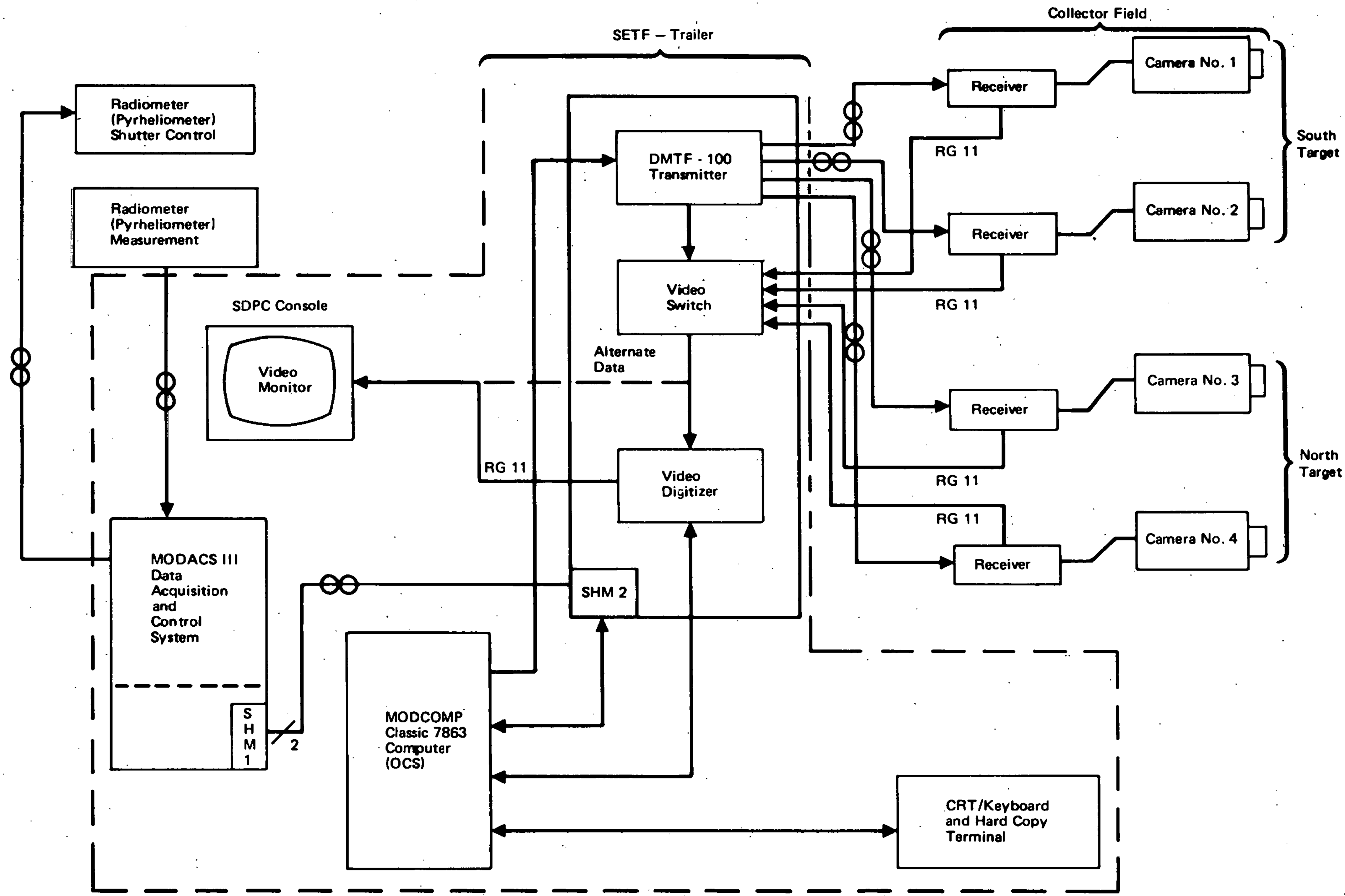


Figure 1-4. – BCS Hardware Configuration

Section 2
APPLICABLE DOCUMENTS

2.1 REPORTS AND DELIVERABLE LIST (RADL) DOCUMENTS

10 MW System Specification
(RADL Item 2-3) November 1979

MCS Hardware Design Specification
(RADL Item 6-1) April 1980

MCS Software Design Specification
(RADL Item 6-1) April 1980

2.2 INTERFACE DOCUMENTS

CS-MCS and CS-Plant Interface Requirements
(RADL Item 2-30-1) Preliminary June 1979

2.3 VENDOR DOCUMENTS

Reference Manual, MAX IV General Operating System,
MODCOMP 210-610304-000, Revision E1.1, June 1979

Reference Manual, MAXNET IV,
MODCOMP 210-610314-000, Revision 1 (E.1), July 1979

Classic Central Processor,
MODCOMP 210-140000-000

TD-0780-01, Acceptance Test Procedure Data Acquisition System
Operating Manual Cyber

Acceptance Test Procedure MV8000 Control System
Beckman

Operating Manual MV8000 Control System
Beckman

2.4 STANDARDS/MANUALS

Appendix A, Unit Development Folder, Appendix to MCS Software Project Plan,
MDAC Drawing 1D44799

Appendix B, Programming Standards, Appendix to MCS Software Project Plan,
MDAC Drawing 1D44799

Appendix C, Flow Charting Standards and Guidelines, Appendix to MCS
Software Project Plan, MDAC Drawing 1D44799.

Section 3
SIL OPERATIONS AND REQUIREMENTS

3.1 TEST OBJECTIVES

The objectives of the SIL activities is to demonstrate that Pilot Plant control equipment and software are compatible and ready for plant installation and integration. Systems and components to be tested in SIL are comprised of the OCS computer, OCS color CRTs, SDPC, ILS, SCU, RLU, BCS, DAS computer, DAS color CRT/printers, strip chart recorders, DARMS, SHIMMS, WWV receiver and time code generator, and special switch panels.

Systems and components which will not be tested in SIL because of unavailability during this time period are SHIMMS field instruments, turbine/generator (T/G) controls, trip logic box, HAC, circumsolar telescope, and the control building weather station equipment.

3.1.1 MVCU Objectives

The MVCU testing will provide early assurance that algorithms as implemented within SDPC can meet functional and performance requirements. Particular objectives are determination of accuracy of implemented algorithms at various frequencies; evaluation of nonlinear effects such as saturation and round off; effects of update rate; determination of switching transients due to gain, configuration, and mode changes.

3.1.2 SIL Objectives

The SIL operation will verify the mechanical and electrical integrity of the control system components. It will then verify proper component functioning and proper component interfacing with other components. Finally system checks will demonstrate overall plant control system functions.

3.1.2.1 Mechanical/Physical Integrity

The first objective to be accomplished in the maxi SIL is to determine that the control equipment planned for the site equipment room and remote stations are compatible with their planned installations. Power input, cable lengths, terminations, air conditioning, equipment footprint, access, etc., will be examined.

3.1.2.2 Electrical Integrity

The second objective to be accomplished in maxi SIL is to determine power, grounding, and interface electrical compatibility of major control components.

3.1.2.3 Component Functions

The third objective is to demonstrate each major component functions in accordance with manufacturer's specification:

A. Test with manufacturer's diagnostics.
B. Operation with manufacturer's procedures.
C. Operation with factory test procedures.

3.1.2.4 Interface Functions

The fourth objective is to evaluate subsystem internal and external interfaces (hardware and software). These interfaces are:

A. SDPC/DAS computer
B. SDPC/OCS computer
C. DARMS/DAS computer
D. SHIMMS/DAS computer
E. Time-of-Day/DAS computer
F. Time-of-Day/DAS computer
G. DAS displays/DAS computer
H. OCS displays/OCS computer
I. RLU/SDPC
J. SCU/SDPC
K. SCU/DARMS
L. SCU/ILS

The fifth objective is to demonstrate the following plant control functions:

A. Operator interfaces
B. Input data processing
C. Output data processing
Data displays/printing
D. Operating modes
Data archiving
E. Tool software
F. Plant control configuring, displays, graphics

3.1.3 Mini SIL Objectives

The mini SIL operation will provide the capability to continue development of the OCS control application software and modify or repair DAS software as required after the SIL equipment has been sent to the site.

3.1.3.1 Application Software

The essential interfaces between OCS and the plant control system will be proven in maxi SIL. The primary objective of the mini SIL is to complete the development of the OCS control application software. Figure 1-3 indicates that sufficient hardware is present in mini SIL to continue development and demonstration of the OCS applications software.

3.1.3.2 Modification of OCS/DAS Software

Mini SIL will provide a local capability to modify the OCS/DAS software as required during initial checkout and startup operations, thus obviating extensive on-site TDY.

3.2 TEST FACILITY

3.2.1 MVCU Testing

MVCU tests will be accomplished in the On-Line Simulation Facility (OLSF) at MDAC-HB. The MVCU will interface with the OLSF analog computer as shown in Figure 3-1. Level changing isolation circuits are required to interface the two systems.

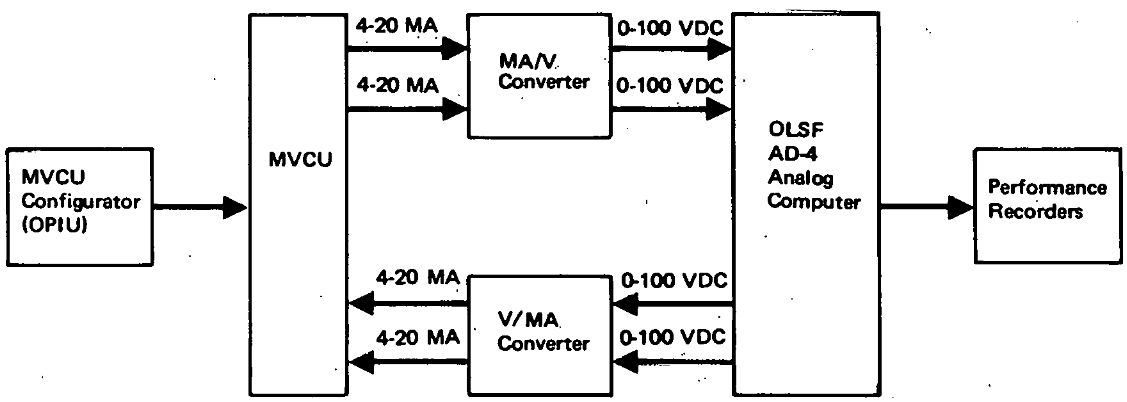


Figure 3-1. MVCU Facility Configuration

3.2.2 Maxi SIL

Maxi SIL is located on the third floor of Building 22 at the MDAC-HB facility. The equipment configuration for the maxi SIL is shown in Figure 3-2. The SIL will provide a controlled-entry, air-conditioned area for:

A. Equipment receiving, assembly, and installation.

B. Fabrication of electrical/electronic assemblies, wiring, test cabling, test set, etc.

C. General-purpose test equipment.

D. Storage, office work area.

E. System testing.

3.2.3 Mini SIL

Mini SIL is comprised of facilities in two locations at MDAC-HB. A MODCOMP computer facility to support OCS software development and modifications to DAS computer software will be located on the first floor of Building 10 at the MDAC-HB facility. A Beckman Operator Programming Interface Unit (OPIU) and a Multivariable Control Unit (MVCU) to support evaluation and changes to control algorithms will be located in the OLSF in Building 22 at MDAC-HB. The equipment configuration for the mini SIL located in Building 10 is shown in Figure 3-3. The SIL will provide a controlled-entry, air-conditioned area for equipment installation and system testing.

The equipment configuration for the mini SIL located in Building 22 is shown in Figure 3-1.

3.3 SCHEDULE

The beginning of maxi SIL is expected in October 1980. The end is scheduled on March 16, 1981. Figure 3-4 indicates the planned schedule for the maxi SIL, BCS SIL, and mini SIL phases of the SIL program.

3.3.1 Maxi SIL Buildup and Test Schedule

The actual plan for buildup and test of the maxi SIL is shown in Figures 3-5 through 3-8. The key milestones are: installation of the initial DAS computer the first week of October followed closely by installation of the initial OCS computer; installation of the SDPC equipment the first

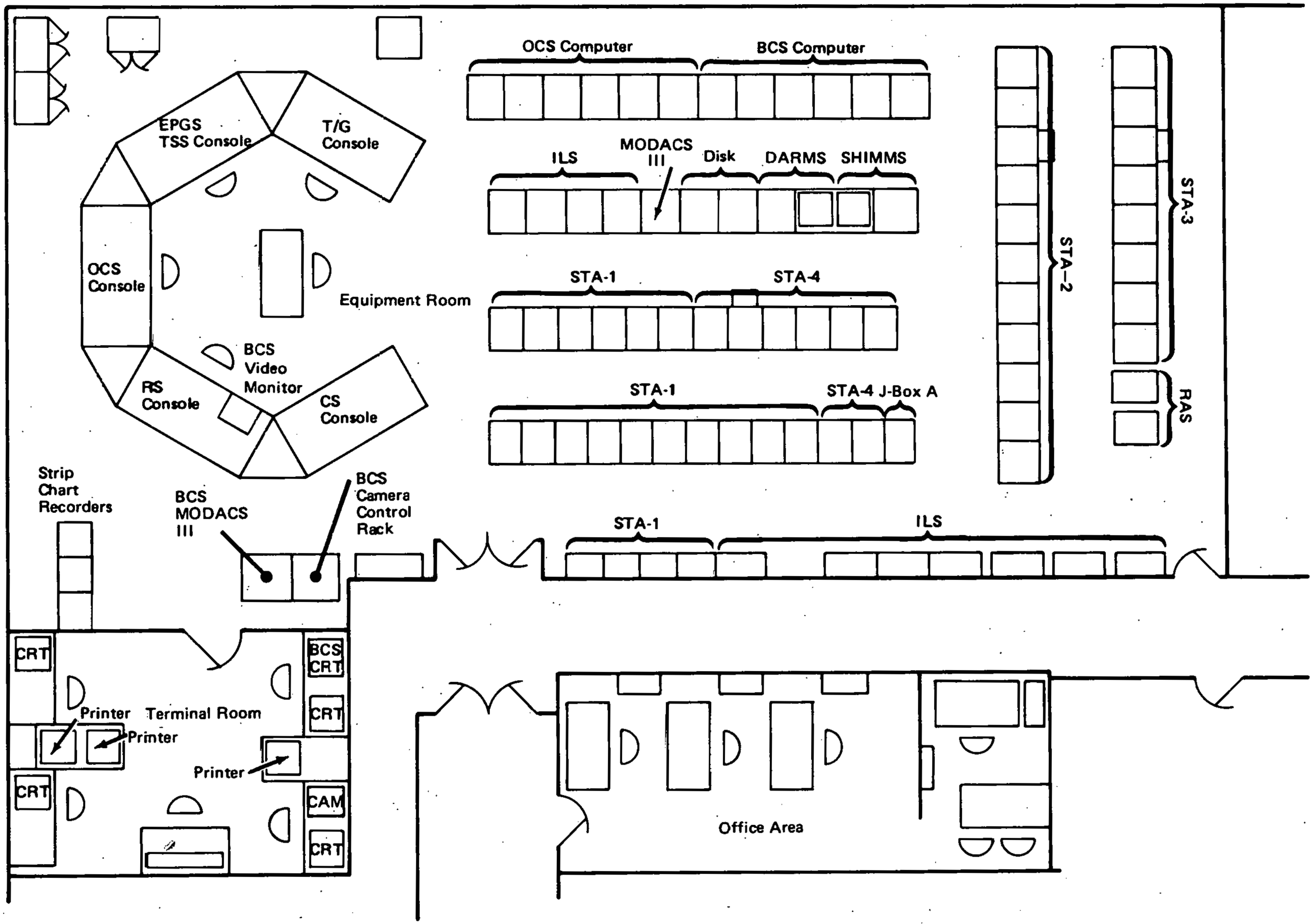


Figure 3-2. Maximum System Integration Laboratory

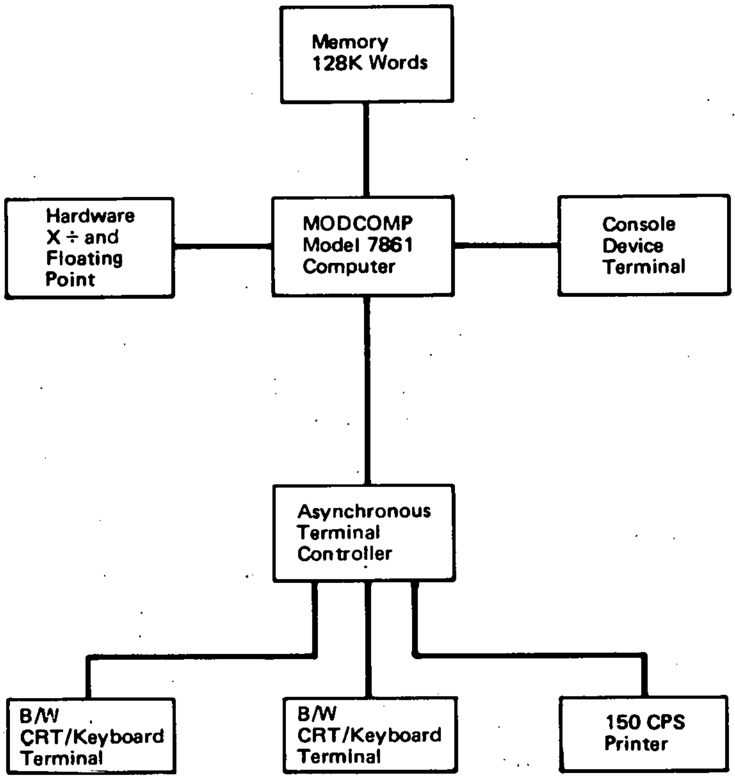


Figure 3-3. Equipment Configuration — MINI SIL

week in December; update of the DAS and OCS computers to the operational configurations in mid-December; completion of all equipment installation and checkout by the first week in February; completion of system evaluation by the first week in March; and delivery of the equipment to the plant site by the first of April 1981.

The maxi SIL activities are segmented into eight stages as shown in Figure 3-5. The stages are based on expected arrival dates of the primary hardware components. In some instances, the stage activities overlap in time. The relationship of the hardware systems and components to the SIL stages is shown in Table 3-1.

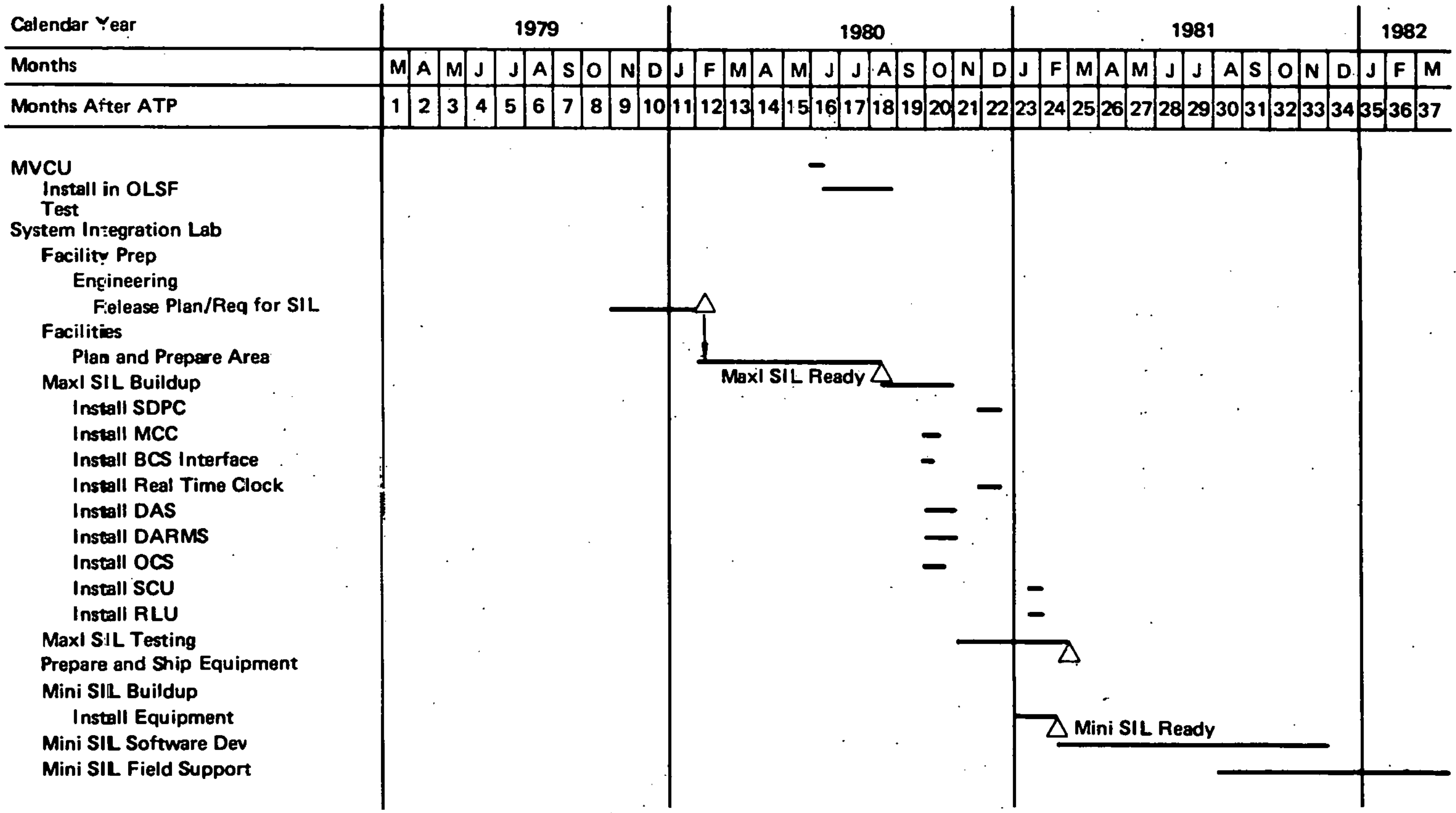


Figure 3-4. Systems Integration Laboratory Overall Activities Schedule

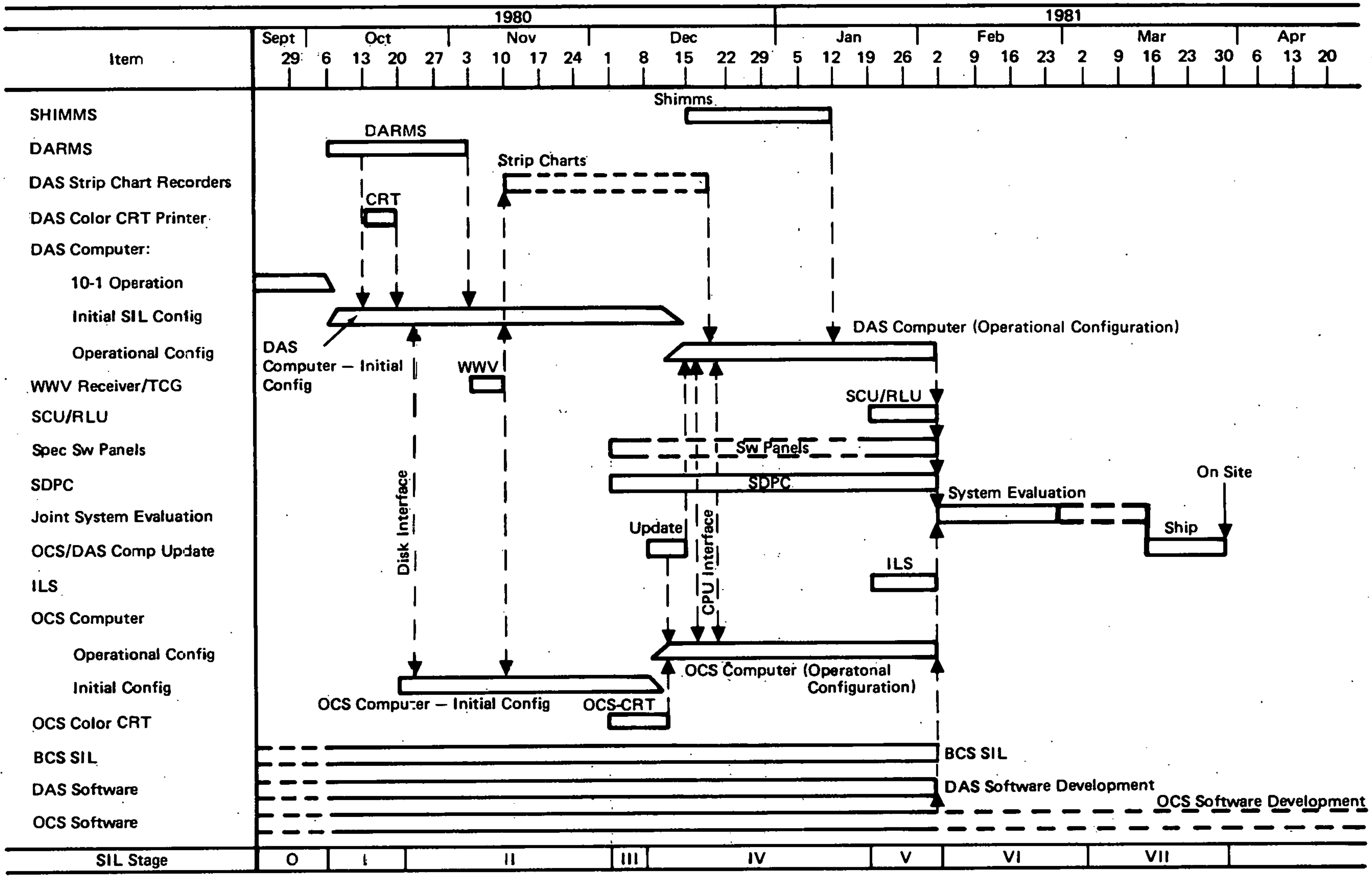


Figure 3-5. Maxi SIL Buildup and Test Schedule

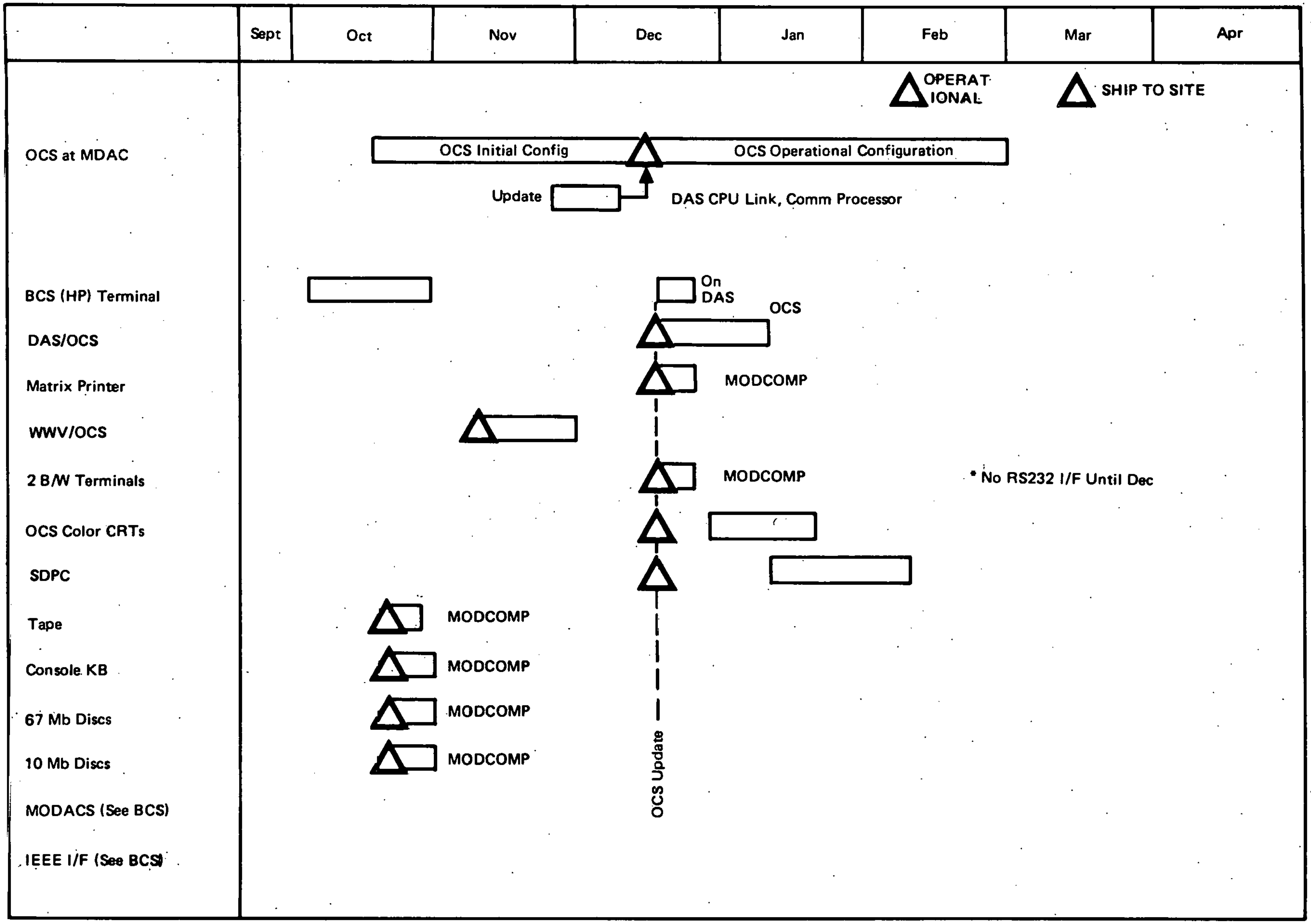


Figure 3-6. SIL Software OCS Schedule

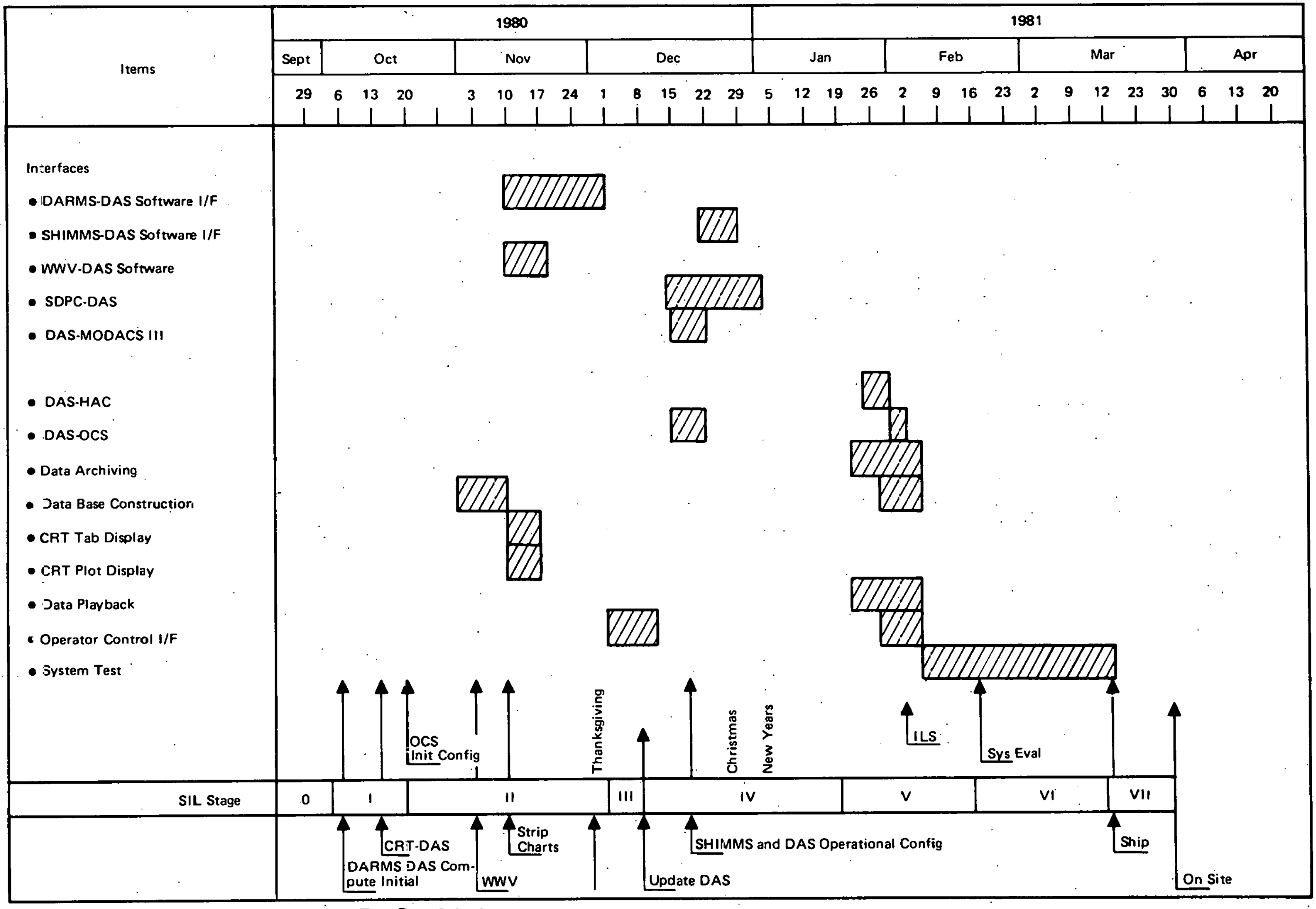


Figure 3-7. SIL DAS Software Integration Test Plan Schedule

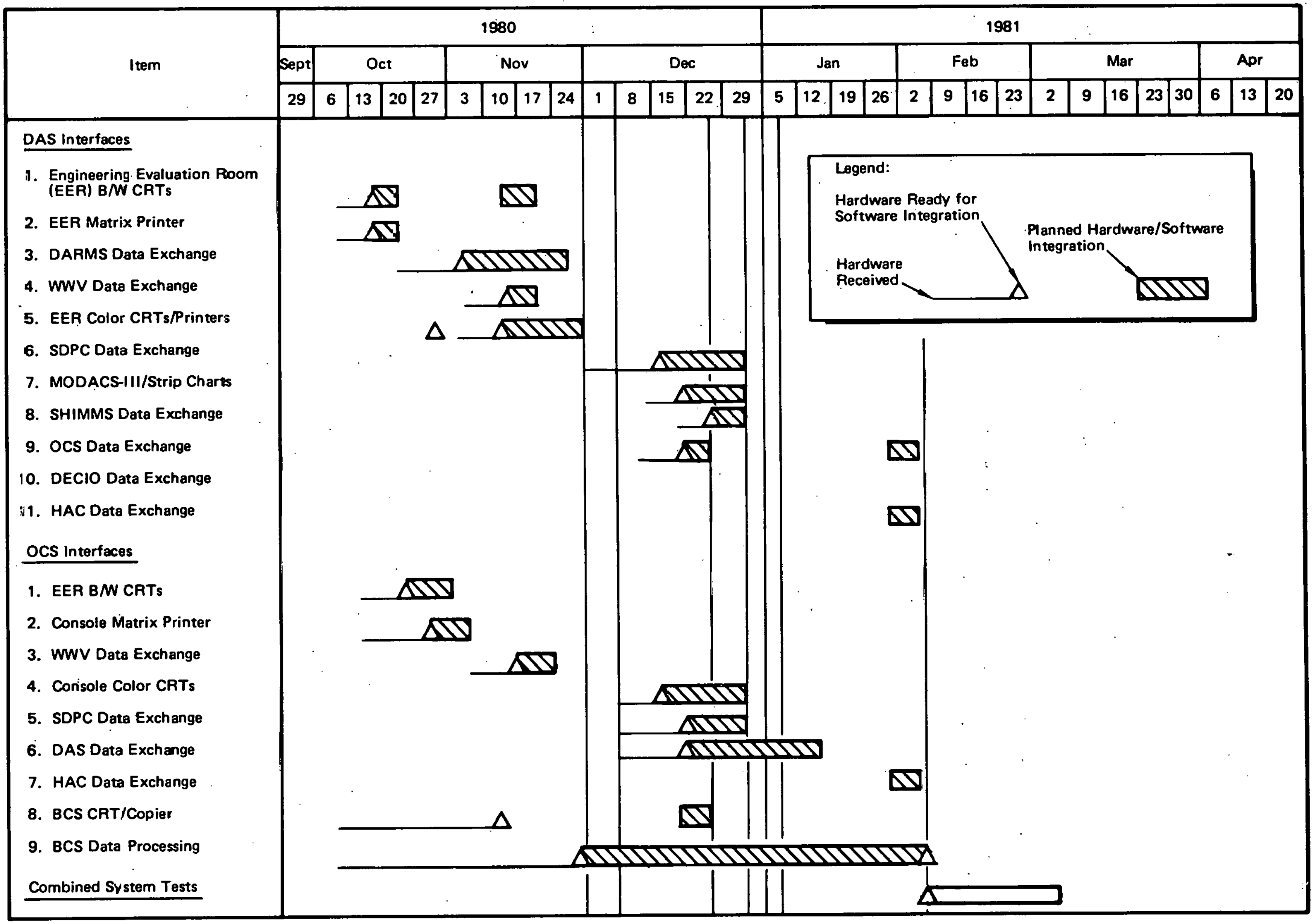


Figure 3-8. DAS/OCS Interface Integration

Table 3-1. SIL Equipment Integration (Page 1 of 2)

Seq	Item	Supplier	Delivery date	Stage I	Stage II	Stage III	Stage IV	Stage V	Remarks*
1	Basic OCS Computer	Modcomp	10-20-80		*				2, 3
1A	OCS Computer add-on	Modcomp	12-8-80				*		2
1B	OCS Color CRTs	Beckman	12-1-80			*			
2	SDPC Consoles/ Remotes	Beckman	12-1-80			*			
3	ILS	Beckman	1-15-81					*	
4	SCU	Rocketdyne	1-15-80					*	
5	RLU	Rocketdyne	1-15-80					*	
6	BCS	MDAC	2-2-80					*	8
7	Basic DAS Computer	Modcomp	in-house	*					1, 2
7A	DAS Computer add-on	Modcomp	12-8-80				*		2
7B	DAS Color CRTs/ Printers	ISC	10-13-80	*					
7C	Strip Chart Recorders	Gould	11-10-80		*				9
8	DARMS	Cyber	10-6-80	*					4, 5
9	SHIMMS	Cyber	12-15-80				*		
9A	SHIMMS field instruments		N/A						6
10	WWV Receiver/TCG	System Donner	11-3-80		*				7
11	T/G Control	GE	N/A						6
12	Trip Logic	S/R	N/A						6
13	HAC	Martin	N/A						6
14	Special Switch Panels	Beckman	12-1-80						10
15	Circumsolar Telescope		N/A						6
16	IR Camera		N/A						6
17	Cont Build Weather Sta		N/A						6
18	Plant Devices		N/A						6

Table 3-1. SIL Equipment Integration (Page 2 of 2)

*Remarks:

1. Basic DAS computer to be moved from 10-1 to 22-3.
2. Relocate power panels to afford bottom cable access to cabinets.
3. Basic OCS computer will be initially installed without communications processor for asynchronous RS232 communication controller.
4. Add termination resistors and jumpers.
5. Add circuit for interrupt line to DAS computer.
6. N/A indicates equipment will not be available for integration into SIL activities.
7. Install in DARMS CCU cabinet for SIL.
8. BCS development by MDAC will proceed in parallel with and independent of SIL using surrogate OCS computer. Software to be tested with MAXNET operating system in SIL OCS computer during Stage V.
9. Strip chart recorders will be integrated with MODACS-III in Stage IV.
10. Switch panels will be integrated with ILS and RLU in Stage V.

A description of the activities to be performed for each stage is given in the following paragraphs.

3.3.2 <u>SIL Stage 0 Activities (SIL Preparation)</u>

The following activities will be performed during Stage 0.

A. Prepare SIL facility.

1. Define and install electrical power for SIL equipment.
2. Define and obtain furniture.
3. Define and install telephones.
4. Define, install, and checkout four wire lines from SIL area to software development terminal area.
5. Define and install door locks.

B. Prepare SIL equipment layouts.

1. Physical location.
2. Electrical power cable routing.
3. Signal cable routing.

C. Define SIL unique cable requirements.

1. Power
2. Signal

D. Fabricate Stage I cables.

1. Power
2. Signal

E. Prepare SIL area floor.

1. Clean
2. Mark equipment locations
3. Cut cable access holes in floor tiles for Stage I equipment.

F. Define SIL support equipment requirements for:

1. J-Box A substitute
2. Temporary mounting racks for SHIMMS remote acquisition (RAS) units.
3. Plant interface checkout devices for: SDPC; DARMS; ILS; SHIMMS; SCU; RLU; Modems for MDAC data link and plant trip logic
4. Interface checkout devices for plant control and instrumentation (C&I) equipment not available for SIL integration including: T/G Control Unit and weather stations

G. Fabricate SIL support equipment for Stage I.

H. Prepare for move of initial DAS computer to SIL area.

I. Define and arrange for consumable supplies.

J. Set up Stage I equipment log books.

K. Prepare Test Control Drawing for Stage I.

L. Define and fabricate power panel extension mounts for MODCOMP computer cabinets.

3.3.3 SIL Stage I Activities (Initial DAS Integration)

The following activities will be performed during Stage I:

A. Move initial DAS computer from temporary area to SIL area and run standard MODCOMP computer functional tests.

B. Remove bottom screen from MODCOMP computer cabinets and relocate power panels using new extension mounts.

C. Receive, install, and checkout Stage I equipment identified in Table 3-1.

D. Perform Stage I equipment additions/modifications as shown in Table 3-2.

E. Connect and checkout Stage I interfaces in accordance with Table 3-3.

F. Connect DAS computer to software development terminals via four wire lines and checkout.

G. Fabricate Stage II cables.

H. Fabricate Stage II SIL support equipment.

I. Set up Stage II equipment test log books.

J. Maintain equipment test log books.

3.3.4 SIL Stage II Activities (Initial OCS Integration)

The following activities will be performed during Stage II:

A. Receive, install, and checkout Stage II equipment as shown in Table 3-1.

B. Perform Stage II equipment additions/modifications as shown in Table 3-2.

C. Connect and checkout Stage II interfaces in accordance with Table 3-3.

D. Fabricate Stage III cables.

Table 3-2. Control and Instrumentation Equipment Modifications in SIL

		SIL Stage				
Seq	Description	I	II	III	IV	V
1	Modify Modcomp computer cabinets for bottom cable access	*	*			
2	Add terminations to DARMS RMUs	*				
3	Add 5-volt output circuit to DARMS CCU for DAS computer external interrupt	*				
4	Add component ID tags to equipment cabinets and cables					*

Table 3-3. SIL Interface Checkout Plan (Page 1 of 5)

Seq	Interface			Qty	SIL Stage					Remarks*
	From	To	Description		I	II	III	IV	V	
1	OCS	OCS	Control Room Color CRTs	2				4.1		
2	OCS	OCS	Control Room Matrix Printer	1		2.1				
3	OCS	OCS	Engineering Evaluation Room B/W CRTs	2		2.2				
4	OCS	OCS	Console Device	1		2.3				
5	OCS	OCS	Magnetic Tape Drive	1		2.4				
6	OCS	OCS	10 MB Disk	1		2.5				
7	OCS	OCS	67 MB Disk	2		2.6				1
8	OCS	SDPC	Data Link	6				4.2		
9	OCS	BCS	Digitizer data link	1						5
10	OCS	BCS	Dual Tone Modulating Frequency (DTMF) data link	1						5
11	OCS	BCS	Link to modem for Modacs III	1						5
12	OCS	BCS	BCS CRT/Copier	1						5
13	OCS	DAS	OCS CPU-DAS CPU data link	1				4.3		
14	OCS	WWV	Time of year data to OCS	1				4.4		
15	OCS	HAC	CPU-CPU data link	2				4.5		6
16	SDPC	SDPC	Console CRTs	3			3.1			
17	SDPC	SDPC	Console Loggers	3			3.2			
18	SDPC	SDPC	Console Strip Chart Recorders	3			3.3			
19	SDPC	SDCP	MVCUs (at 4 Remote Stations)	21			3.4			
20	SDPC	SDPC	Multiplexer Units (at 4 Remote Stations)	8			3.5			

Table 3-3. SIL Interface Checkout Plan (Page 2 of 5)

	Interface				SIL Stage					
Seq	From	To	Description	Qty	I	II	III	IV	V	Remarks*
21	SDPC	ILS	Data link to MODICON 584 Units	3					5.1	
22	SDPC	ILS	Data link to IPAC Units	3					5.2	
23	SDPC	SCU	Measurement data to MVCU (at Remote Station)	3					5.3	
24	SDPC	SCU	Measurement data to MUX (at Remote Station)	3					5.4	
25	SDPC	DAS	Data link	6				4.6		
26	SDPC	Trip Logic	Trip data to Station 4 MUX	1				4.7		7
27	SDPC	Plant	MVCU commands and data	4				4.8		8
28	SDPC	Plant	MUX data	4				4.9		8
29	ILS	ILS	ILS remote units	5					5.5	
30	ILS	SCU	Measurement data to ILS	3					5.6	
31	ILS	RLU	Manual reset commands	2					5.7	
32	ILS	Trip Logic	Steam Dump System reset command	1					5.8	7
33	ILS	Sw Panels	Manual commands to ILS via Modicon 584	4					5.9	
34	ILS	Sw Panels	Manual commands to SDPC via IPAC	4					5.10	
35	SCU	RLU	Measurement data to RLU	2					5.11	
36	SCU	DARMS	Measurement data to DARMS RMU	3					5.12	
37	RLU	DARMS	High-speed scan interrupt	2					5.13	
38	RLU	Trip Logic	Trip indications	2					5.14	7
39	RLU	HAC	Trip indication	1					5.15	6
40	RLU	Sw Panels	Trip commands	4					5.16	

Table 3-3. SIL Interface Checkout Plan (Page 3 of 5)

	Interface				SIL Stage					
Seq	From	To	Description	Qty	I	II	III	IV	V	Remarks*
41	BCS	BCS	Control room video monitor	1						5
42	BCS	BCS	TV Cameras	4						5
43	BCS	BCS	TV Control receivers	4						5
44	BCS	BCS	Target Pyrheliometer data	16						5
45	BCS	BCS	Target Shutter controls	16						5
46	BCS	BCS	Modem to Station MODACS-III	1						5
47	DAS	DAS	Strip chart data to MODACS III	1				4.10		
48	DAS	DAS	Analog signals to strip charts	24				4.11		
49	DAS	DAS	Data link to DEC 10 at MDAC (A3)	3				4.12		9
50	DAS	DAS	Display data to color CRTs	2	1.1					
51	DAS	DAS	Output data to CRT printer/ plotter	2	1.2					
52	DAS	DAS	B/W CRT Terminals	2	1.3					
53	DAS	DAS	Matrix printer	1	1.4					
54	DAS	DAS	600 Lpm printer	1	1.5					
55	DAS	DAS	Console device	1	1.6					
56	DAS	DAS	Magnetic tape drive	2	1.7					
57	DAS	DAS	67 MB disk	2	1.8					1
58	DAS	DAS	CRT programming terminals	2	1.9					2
59	DAS	DARMS	Data link	1	1.10					
60	DAS	DARMS	Command link	1	1.11					
61	DAS	DARMS	High-speed scan interrupt	1	1.12					

Table 3-3. SIL Interface Checkout Plan (Page 4 of 5)

	Interface				SIL Stage					
Seq	From	To	Description	Qty	I	II	III	IV	V	Remarks*
62	DAS	SHIMMS	Data link	1				4.13		
63	DAS	SHIMMS	Command link	1				4.14		
64	DAS	WWV	Time of year data to DAS	1		2.7				
65	DAS	WWV	Serial time code to S/C recorders	1		2.8				
66	DAS	HAC	CPU-CPU data link	1				4.15		6
67	DARMS	DARMS	CCU CRT Terminal	1	1.13					
68	DARMS	DARMS	Remote Station RMUs	8	1.14					
69	DARMS	T/G Control	High-speed scan Interrupt	1	1.15					10
70	SHIMMS	SHIMMS	CRT Terminal	1				4.16		
71	SHIMMS	SHIMMS	Sta-1 Remote Acquisition System (Tower weather station)	1				4.17		
72	SHIMMS	SHIMMS	RAS	1				4.18		3
73	SHIMMS	SHIMMS	Collector field Remote Acquisition Systems	4				4.19		4
74	WWV	WWV	Antenna	1		2.9				
75	T/G Control	T/G Control	Console operator panel	1						11
76	T/G Control	Trip Logic	Trip indication	1						11
77	T/G Control	Sw Panels	Manual Commands	1		2.10				10
78	Trip Logic	Sw Panels	Master Trip	1		2.11				7
79	ILS	Plant	ILS commands and data	5					5.17	8
80	SCU	Plant	Data to SCU	3					5.18	8
81	RLU	Plant	RLU commands and data	2					5.19	8
82	DARMS	Plant	Data to DARMS	4	1.16					8

Table 3-3. SIL Interface Checkout Plan (Page 5 of 5)

*Remarks:

1. Disk Units shared by OCS and DAS computers.
2. Used in SIL only.
3. Data input from six wind towers and six sets of special heliostat instrumentation.
4. Data input from four weather stations and the circumsolar telescope.
5. BCS interfaces will be checked separate from the primary SIL using serrogate OCS computer.
6. HAC equipment must be simulated.
7. Trip logic must be simulated.
8. Plant interface devices must be simulated.
9. Interface at DEC-10 probably not available during SIL time frame. Simulation may be required.
10. T/G control equipment must be simulated.
11. Equipment not available for SIL; test at site.

E. Fabricate Stage III SIL support equipment.

F. Prepare test control drawing for Stage VI.

G. Set up equipment test log books for Stage III.

H. Maintain equipment test log books.

3.3.5 SIL Stage III Activities (SDPC Integration)

The following activities will be performed during Stage III:

A. Receive, install, and checkout Stage III equipment as shown in Table 3-1.

B. Perform Stage III equipment additions/modifications as shown in Table 3-2.

C. Connect and check out Stage III interfaces in accordance with Table 3-3.

D. Fabricate Stage IV cables.

E. Fabricate Stage IV SIL support equipment.

F. Set up equipment test log books for Stage IV.

G. Maintain equipment test log books.

3.3.6 SIL Stage IV Activities (Computer Update)

The following activities will be performed during Stage IV:

A. Receive, install, and checkout Stage IV equipment as shown in Table 3-1.

B. Perform Stage IV equipment additions/modifications as shown in Table 3-2.

C. Connect and checkout Stage IV interfaces in accordance with Table 3-3.

D. Fabricate Stage V cables.

E. Fabricate Stage V SIL support equipment.

F. Set up equipment test log books for Stage V.

G. Maintain equipment test log books.

3.3.7 SIL Stage V Activities (SCU/RLU/ILS Integration)

The following activities will be performed during Stage V:

A. Receive, install, and checkout Stage V equipment as shown in Table 3-1.

B. Perform Stage V equipment additions/modifications as shown in Table 3-2.

C. Connect and checkout Stage V interfaces in accordance with Table 3-3.

D. Release test control drawing for Stage VI.

E. Maintain equipment test log books.

3.3.8 SIL Stage VI Activities (System Evaluation)

The following activities will be performed during Stage VI:

A. Perform system-level functional tests identified in Table 3-4 to the extent possible within the scheduled time of SIL activities.

B. Prepare plan for Stage VII (packing and shipping).

C. Maintain equipment test log books.

D. Move BCS SIL control building equipment to maxi SIL area, integrate with OCS computer and checkout with software running under the Maxnet Operating System.

3.3.9 SIL Stage VII Activities (Pack and Ship)

The following activities will be performed during Stage VII:

A. Prepare control and instrumentation (C&I) equipment for shipment to plant site.

B. Ship C&I equipment to plant site.

C. Prepare SIL report.

3.4 TEST CONFIGURATIONS

3.4.1 MVCU Testing Configuration

A Beckman multivariable control unit, which is the key element of the SDPC, will be installed in a laboratory area along with a Beckman Operator Interface Unit and terminating equipment. A minimum number of drivers will be fabricated to allow interfacing with the OLSF computer. Capability to manually input external discrete commands and analog functions and to measure responses will be provided.

3.4.1.1 Test Hardware

Figure 1-3 illustrates the configuration of the test hardware.

3.4.1.2 Test Software

Beckman "fill-in-the-blanks" firmware and operating procedures will be utilized to operate and configure the Beckman equipment. Some software will

Table 3-4. System Functional Tests (Page 1 of 2)

Line item	Affected components	Functional test
1	DAS/DARMS	Operate DAS/DARMS interface with DAS tool software installed in the following modes: a. DAS data acquisition b. DAS data acquisition and strip chart data acquisition c. Trip data d. a. and b. together
2	DAS/SHIMMS	Operate DAS/SHIMMS interface with DAS tool software installed in the following modes: a. DAS data and meteorological data acquisition b. Special heliostat data acquisition c. a. and b. together
3	DAS/SDPC	Operate the DAS/SDPC interface with DAS tool software installed in the following modes: a. DAS request of SDPC data b. SDPC data broadcast to DAS
4	DAS/OCS	Operate the DAS and OCS computers with tool software installed in the following modes: a. DAS data request for OCS data b. OCS data request for DAS data
5	DAS/Time-of-day	Operate the DAS computer with tool software installed to update DAS computer clock from WWV time-of-day clock
6	DAS Computer	Operate the DAS computer with the tool software installed in the following modes: a. Data acquisition setup b. Data acquisition and data processing for all serviced interfaces c. Data output to strip charts d. Data output to color CRT display-graphic and tabular mode of operation e. Data output to DEC-PDP-10 computer f. Data archive to magnetic tape g. Data output to OCS computer

Table 3-4. System Functional Tests (Page 2 of 2)

Line item	Affected components	Functional test
6	DAS Computer (cont.)	h. a. through g. coordinated to simulate typical site operation i. DAS computer diagnostics
7	OCS/OCS Graphics (See Note 1)	Operate the OCS computer with the OCS graphic terminal interface software installed in the following modes: a. Graphic picture building b. Graphic picture display of background with simulated dynamic data. c. Graphic picture select from keyboard for one and two display terminals
8	OCS/DAS/SDPC (See Note 1)	Operate the OCS computer with OCS tool software that acquires data to be displayed on the OCS graphics terminal in the following modes: a. SDPC data acquire and display b. DAS computer data acquire and display c. DAS/SDPC data acquire concurrently and display
9	SDPC/ILS	Operate the SDPC with the ILS connected in the following modes: a. Configure SDPC for plant start up b. Configure ILS for plant start up c. Build graphic display on SDPC terminal d. Operate from the SDPC console with selected simulated inputs from the SDPC and ILS remote hardware e. Display selected inputs on graphic display
10	SDPC/ILS/SCU/RLU	a. Simulate a plant trip initiated from the RLU b. Operate from the SDPC console with selected simulated inputs from the SCU

be provided to be resident in the OLSF computer to simulate responses to the MVCU.

3.4.2 Maximum SIL Test Configuration

The maximum SIL test configuration will include as many elements of the Pilot Plant controls as are available. Figure 3-9 is an overview of the planned maximum SIL test configuration, and each major component will be tested for readiness prior to interfacing and then integrated to support system testings. The Master Control Console houses many elements from different components and should be the central operating point for all SIL activities.

3.4.2.1 Operational Control System

Hardware

The OCS hardware to be tested is illustrated in Figure 3-10. The MODCOMP computer and its peripherals and the color CRT terminals make up this component. Figures 3-11 and 3-12 are a block diagram of OCS computer and Figure 3-13 is a block diagram of the color CRT terminals. MODCOMP diagnostics shall be utilized to demonstrate MODCOMP hardware readiness. Test support software shall be utilized to demonstrate the internal interface between the MODCOMP and the color CRT terminals.

OCS Software Configuration

The following paragraphs discuss the software configuration that will be used to accomplish the interfacing of computer vendor supplied peripherals and peripherals supplied by subcontractors to the SFDI.

The OCS computer system will be delivered to the SIL in an initial configuration.

An additional set of peripheral equipment will be provided, as indicated by the schedule in Figure 3-6, to bring the OCS to the final as-delivered configuration midway through the SIL testing period.

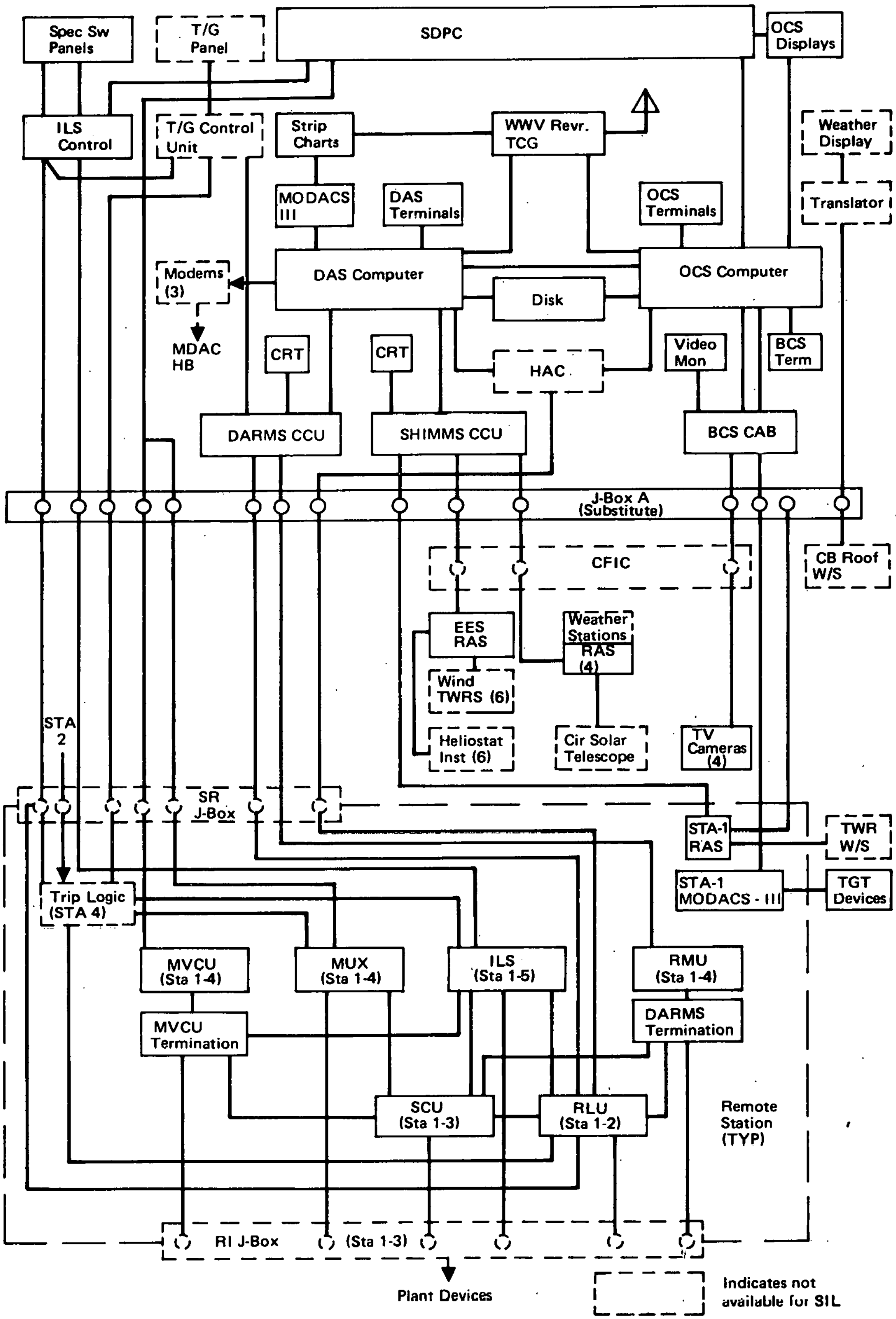


Figure 3-9. Maxi SIL Test Configuration

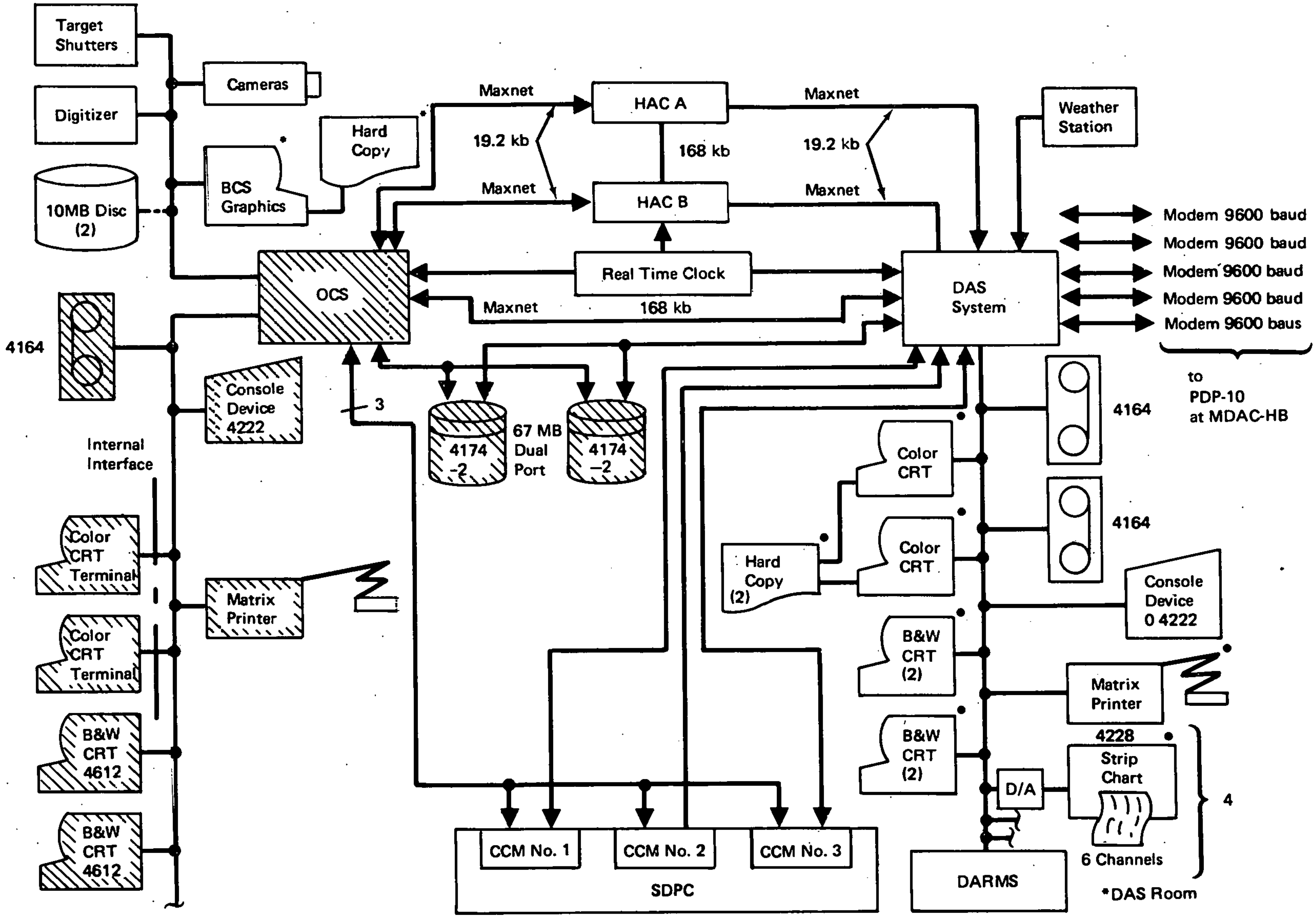


Figure 3-10. OCS Computer Configuration

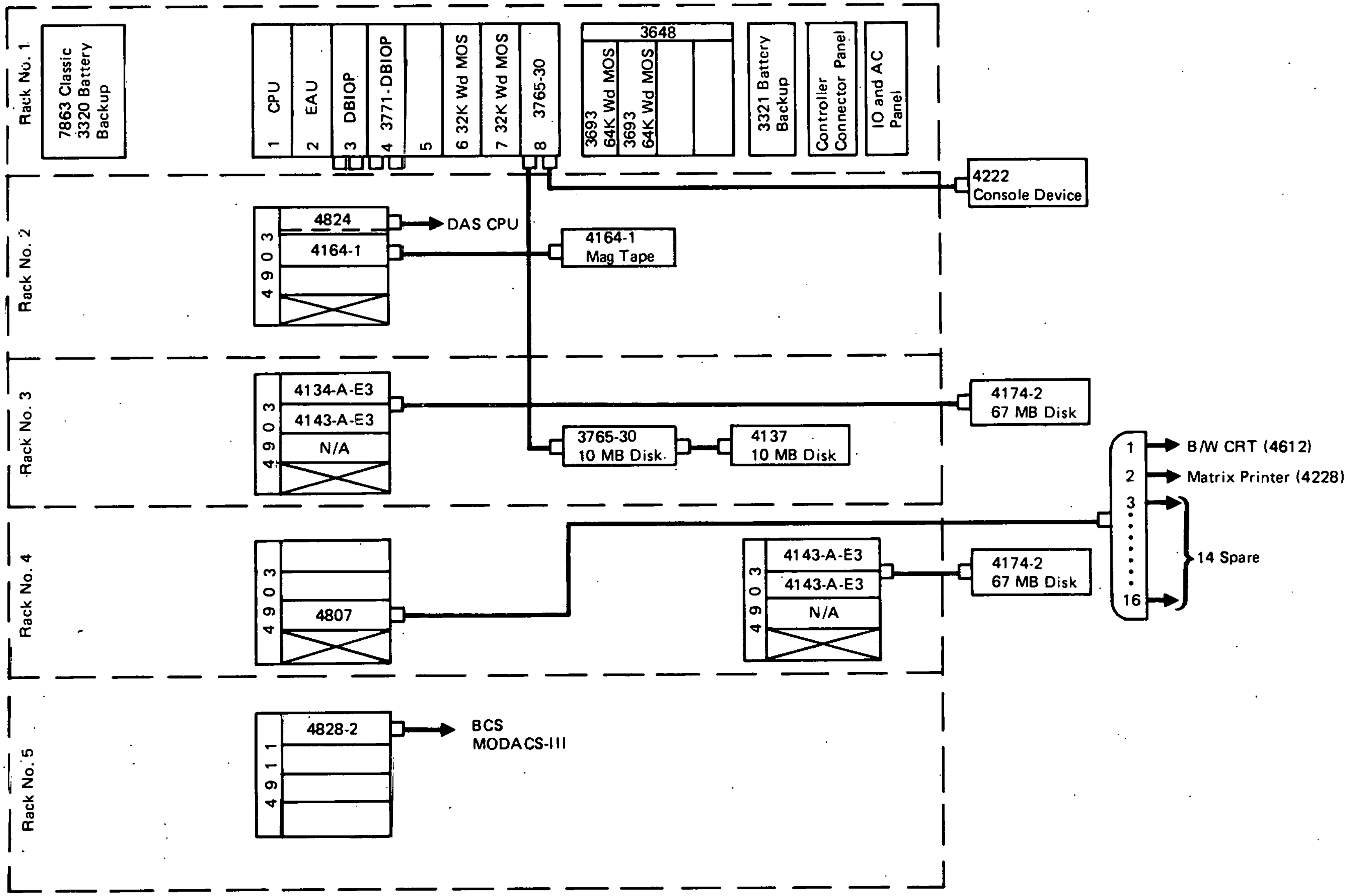


Figure 3-11. OCS Computer Block Diagram (Initial Configuration)

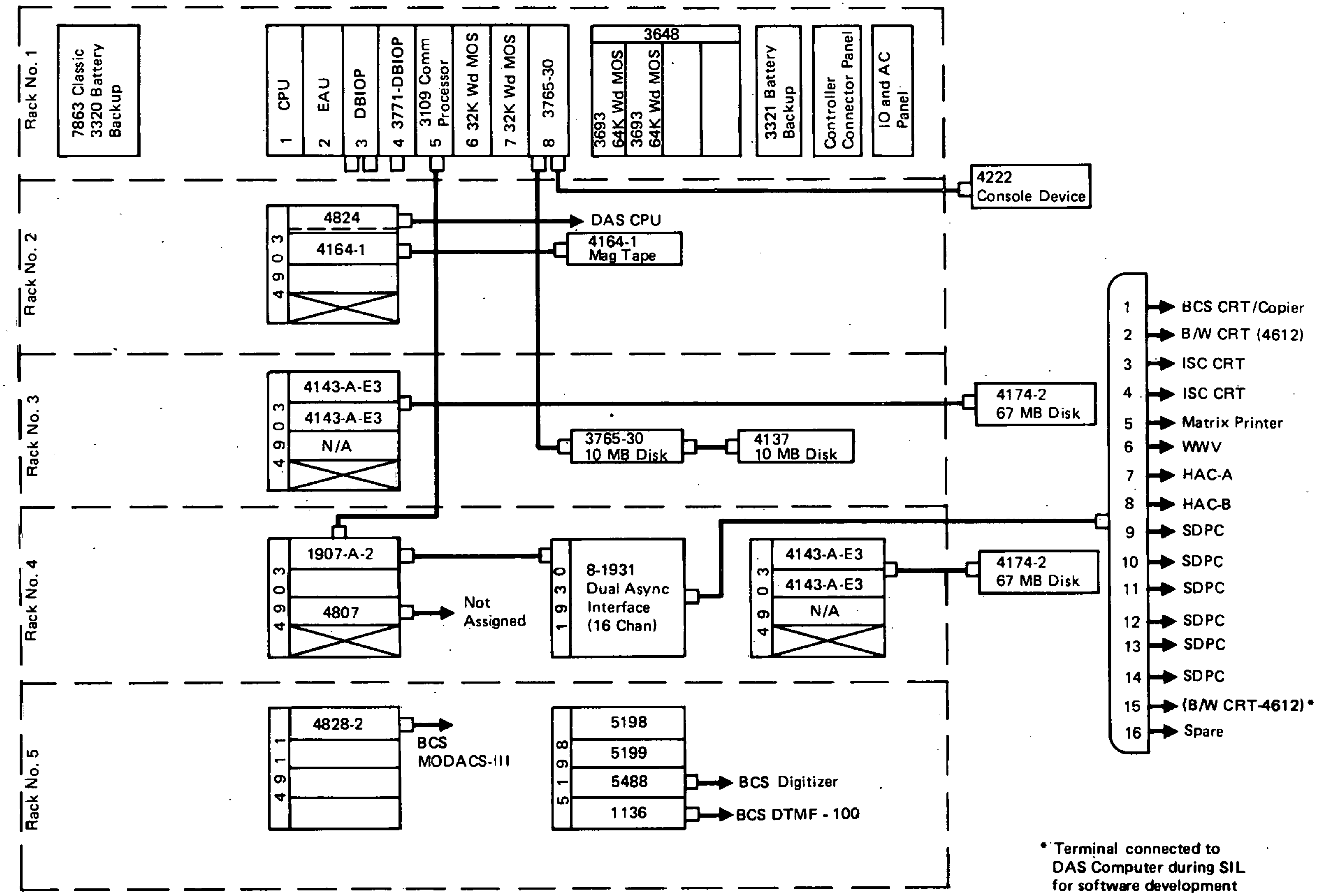


Figure 3-12. OCS Computer Block Diagram (Operational Configuration)

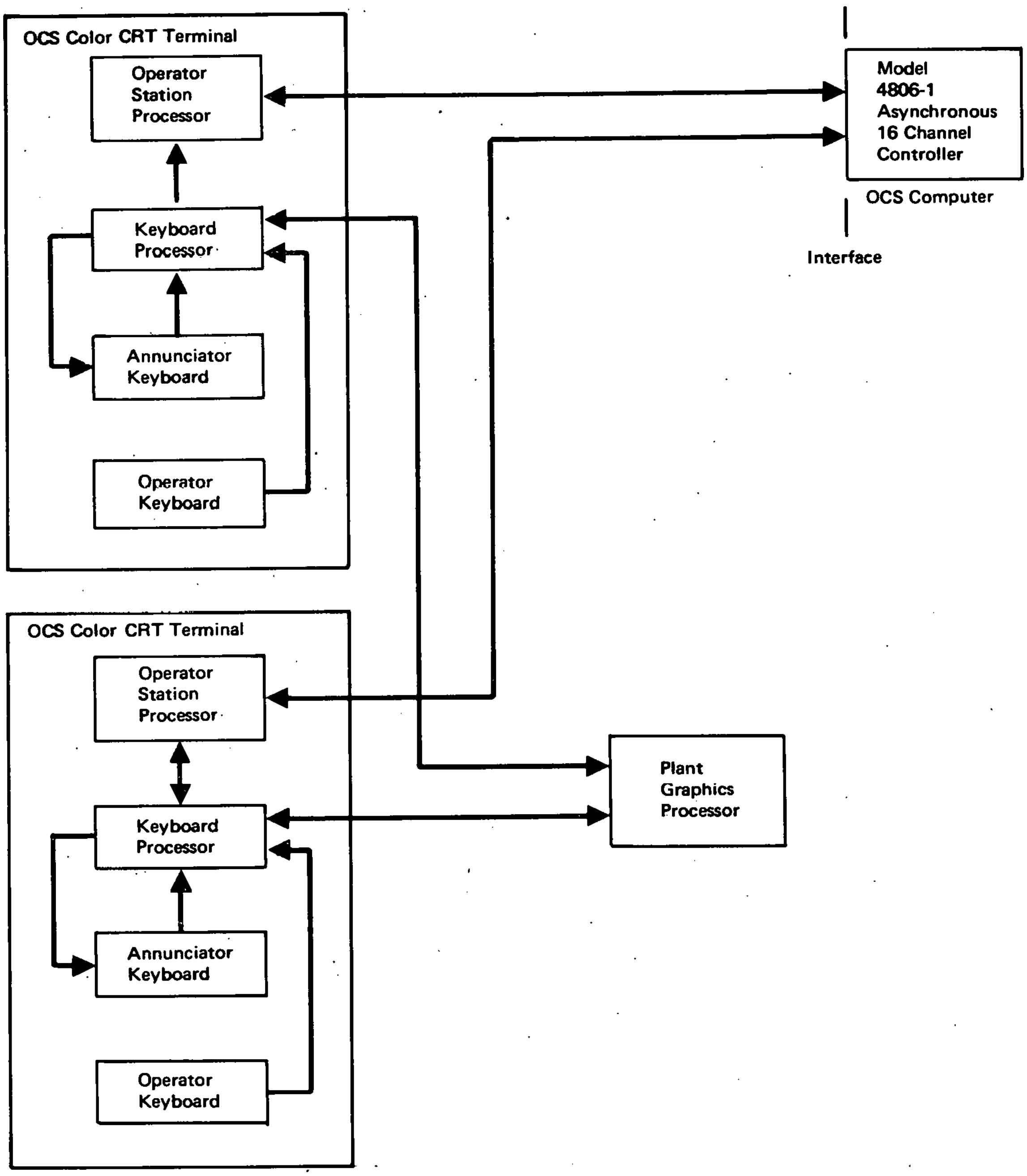


Figure 3-13. OCS Color CRT Terminal Block Diagram

MODCOMP Peripheral Equipment. When the OCS computer system is delivered in its initial configuration, the following MODCOMP supplied peripheral devices will be tested by MODCOMP field installation personnel using standard MODCOMP diagnostic programs.

A. OCS tape drive, 9 track, 800 BPI, 75 IPS

B. Console device (keyboard/printer)

C. 67 MB disc drives (dual ports)

D. 10 MB disc drives

WWV. This peripheral device is designed to generate electrical signals which represent coordinated universal time information in a coded format. Operational receiving and decoding software will be exercised to verify that the WWV signals are being received by the OCS.

A special test software module will be required to continuously monitor the output of the WWV decode module and display that output to a CRT in conventional time format, i.e., HH:MM:SS.

OCS Final Configuration. When MODCOMP installs the additional peripherals to the OCS computer system, the following devices will be installed and tested by MODCOMP field personnel:

A. The MAXNET IV interface between the OCS and DAS computer systems. MODCOMP will verify that the communications link between the two computers is operational and that messages can be sent from one application program to another.

B. The matrix printer will be installed and verified by MODCOMP personnel using standard diagnostic test programs supplied by MODCOMP.

C. Two additional black and white CRT terminals will be connected to the OCS. MODCOMP personnel will test the terminals using standard MODCOMP test diagnostic software.

Color CRTs. Two special Beckman supplied color CRTs will be interfaced to the OCS after the OCS is equipped with all MODCOMP supplied peripherals.

These special CRTs will have to be tested in several stages which are described below:

A. It is expected that the interface (I/F) to these CRTs will be a standard I/F corresponding to RS-232-C; therefore, a standard software driver can be used to perform the physical tasks of testing status, performing the necessary "are-you-ready?" tests and moving messages across the I/F.

B. The message content will be verified by designing and building special test software to invoke the standard driver to send or receive "canned" messages to/from the color CRT.

The test software must be designed to permit a test operator to select which "canned" message is to be sent via the system support software from one of the black and white terminals. This special piece of test software plus the debugging capability of the MODCOMP system will allow a preselected set of messages to be sent to and received from the CRTs. This set of messages will test all operational capabilities of the CRTs.

SDPC. The OCS interfaces with the Beckman SDPC in two ways. The first is a connection to the SDPC Host Communications Processor (HCP) and to the Peripheral Interface Processor (PIP). See Figure 3-14. Interfaces to the HCP are used to read data from the CCM and write new data information into the CCM.

Interfaces to the PIP are used to collect data on a periodic basis from the OCS. In this usage, the OCS will be simulating a MVCU which allows the OCS to provide calculated parameters to the SDPC as if those parameters were collected from the field.

Reading Data from CCM. The first step in checking out the OCS/SDPC interface is to load a CCM with hexadecimal data via the SDPC debugging program. This provides a known reference from which a comparison can be made once the data is read over to the OCS.

The next step is to enable the MODCOMP debugging program and allow the HCP read program to execute once in the OCS and return to the debug monitor. When this happens, the data buffer that was read can be dumped to either a CRT or printer where it can be verified that the data read is indeed the data that is expected.

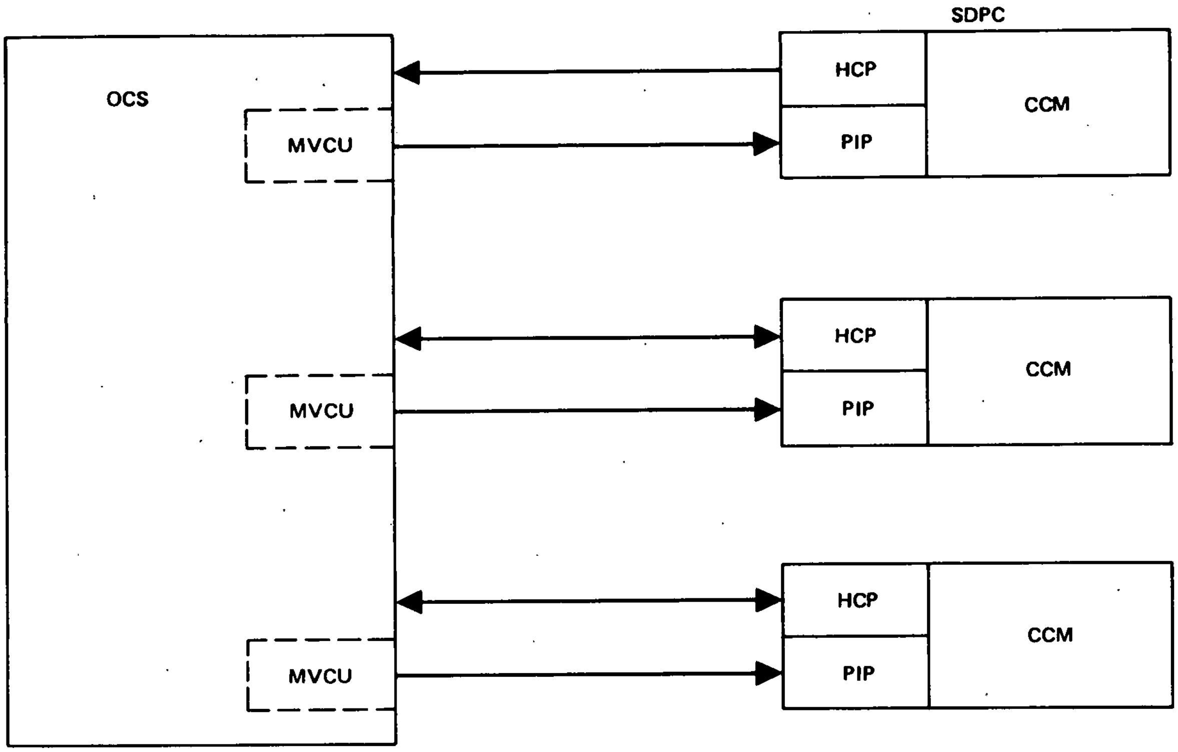


Figure 3-14. OCS/SDPC Interface

In a similar way, data can be structured in the OCS data buffer and sent to the HCP and deposited into the CCM and the SDPC debug program can verify that the CCM did receive the data in the proper form.

Data transfer between the OCS and PIP/CCMs can be verified in the same manner as described above.

3.4.2.2 Data Acquisition System Configuration

Hardware

The DAS hardware to be tested is illustrated in Figure 3-15. The MODCOMP computer and its peripherals, the color CRT terminals, the strip chart recorders, the data acquisition and remote multiplexer system and the hard copier make up this component. Figures 3-16 and 3-17 are detailed block diagrams of the DAS computer, and Figure 3-18 is a block diagram of DARMS. Figure 3-19 is a block diagram of the color CRT terminals.

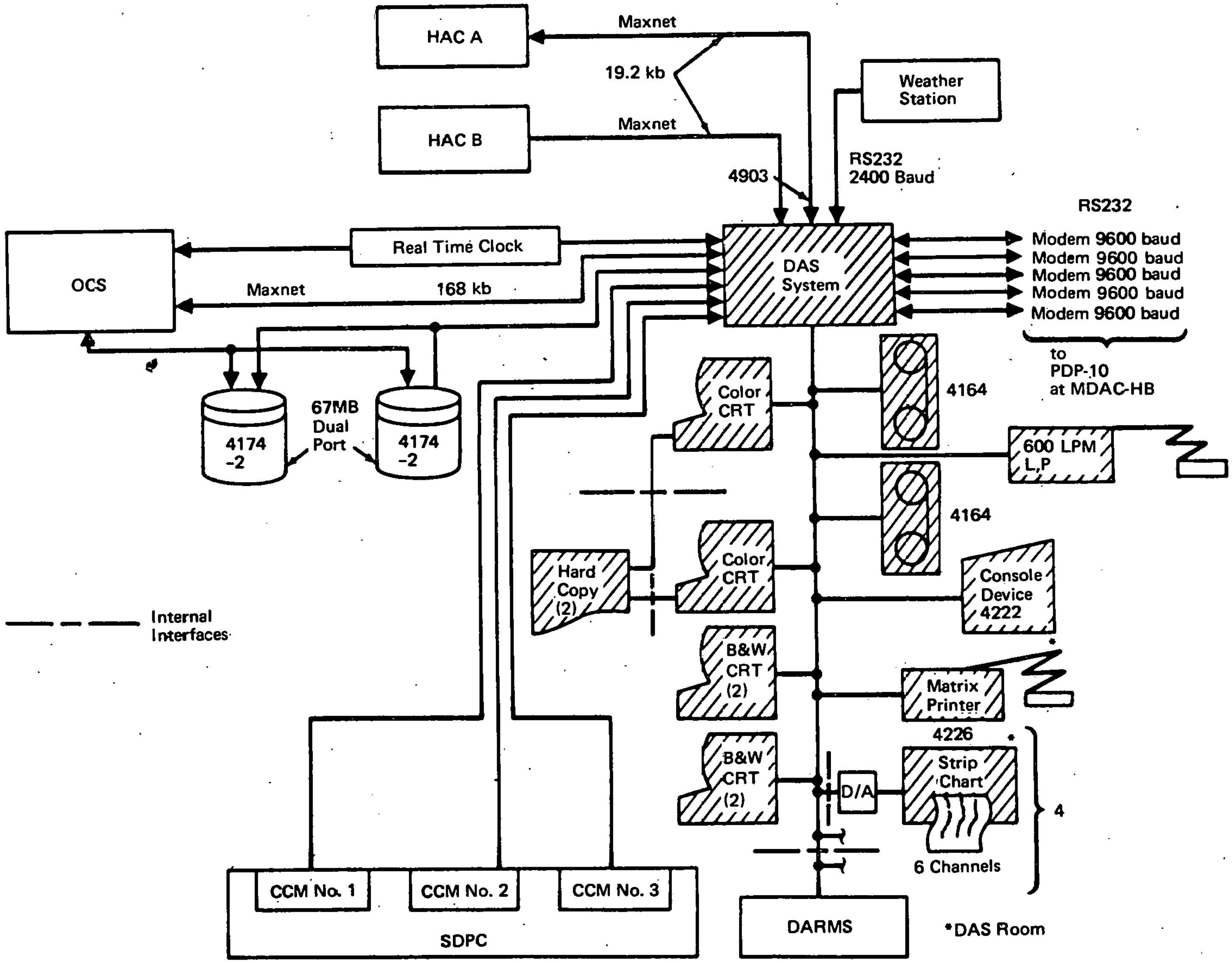


Figure 3-15. DAS Configuration

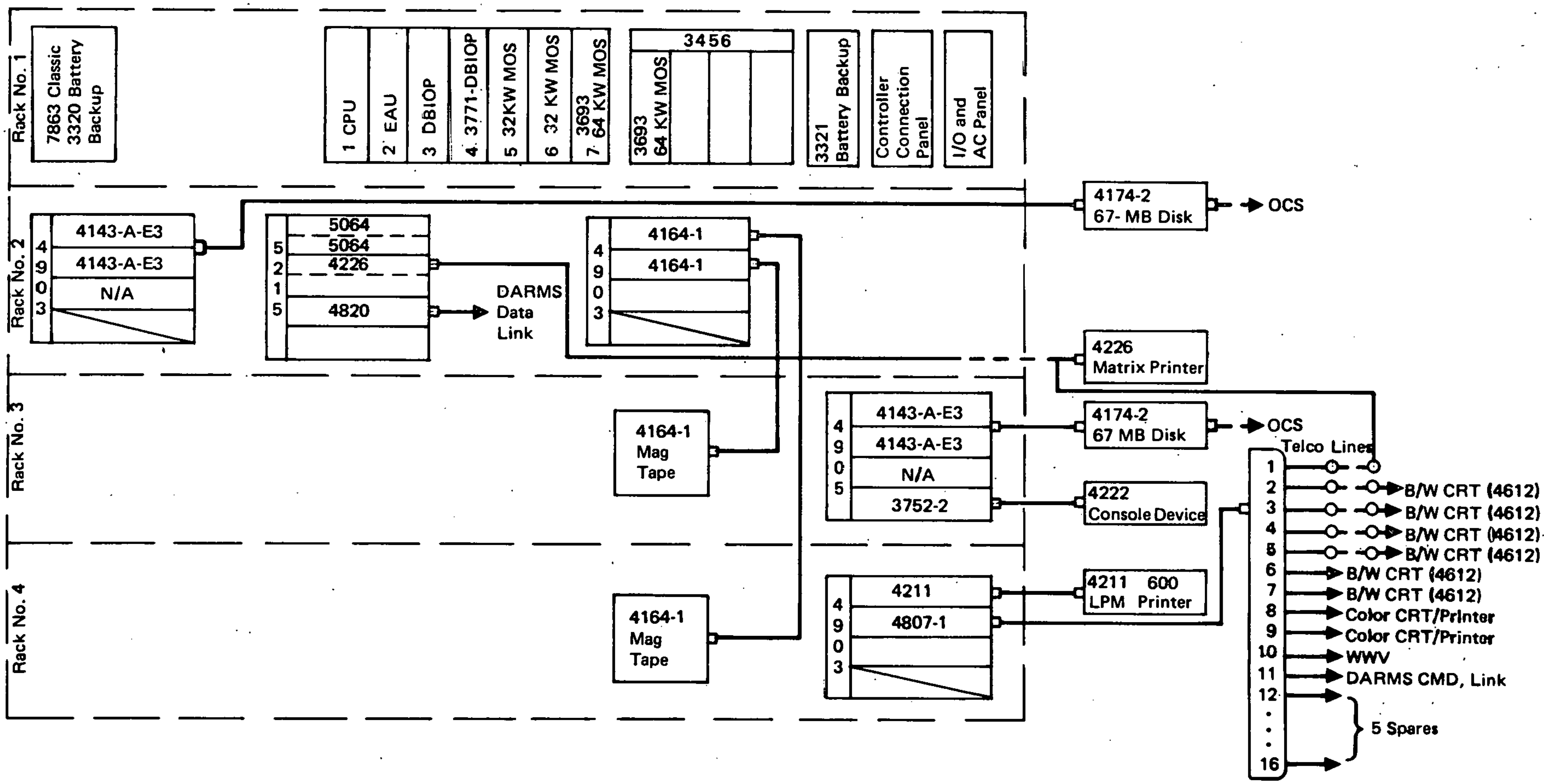


Figure 3-16. DAS Computer Block Diagram (Initial Configuration)

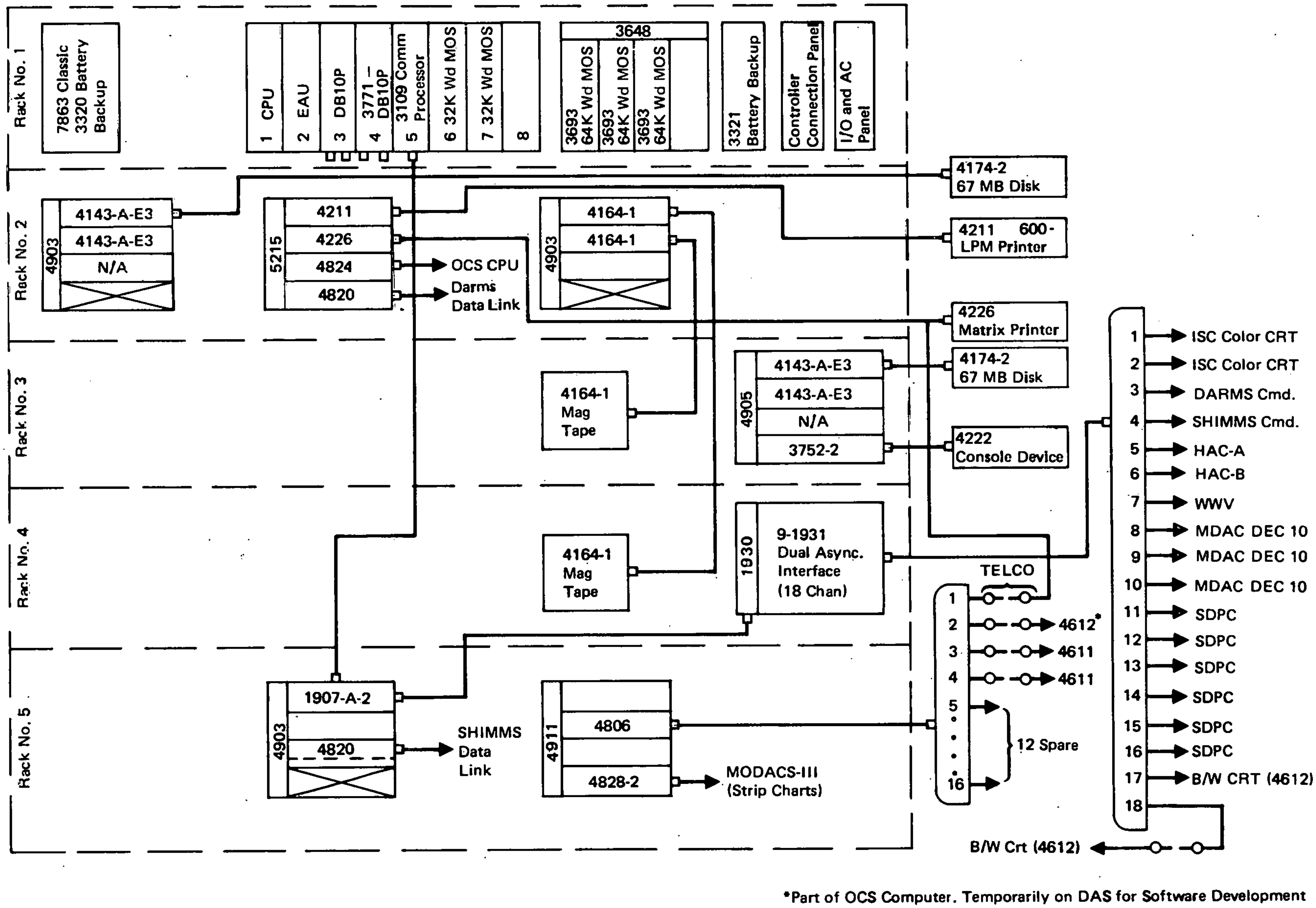


Figure 3-17. DAS Computer Block Diagram (Operational Configuration)

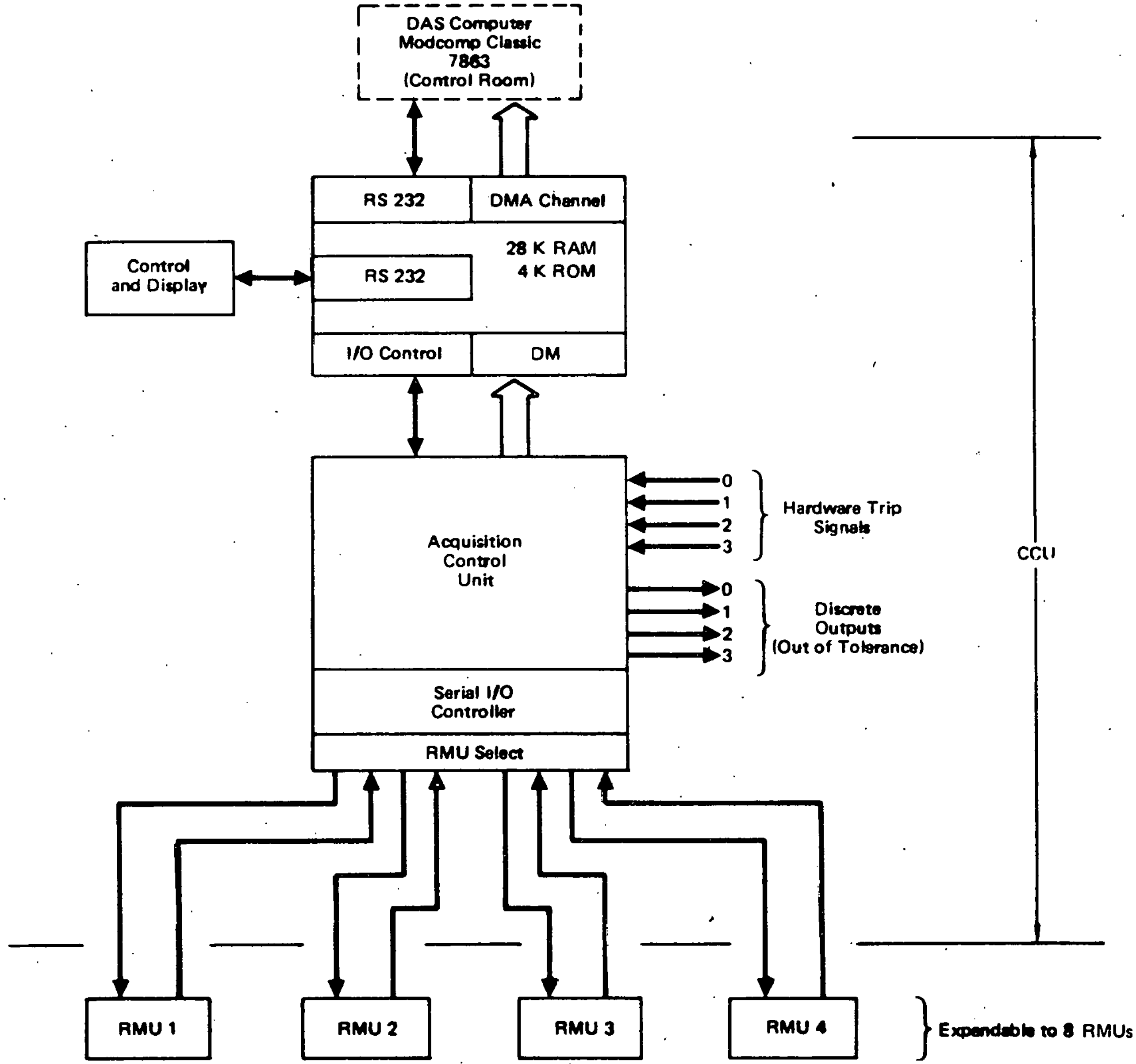


Figure 3-18. Data Acquisition Remote Multiplexer System

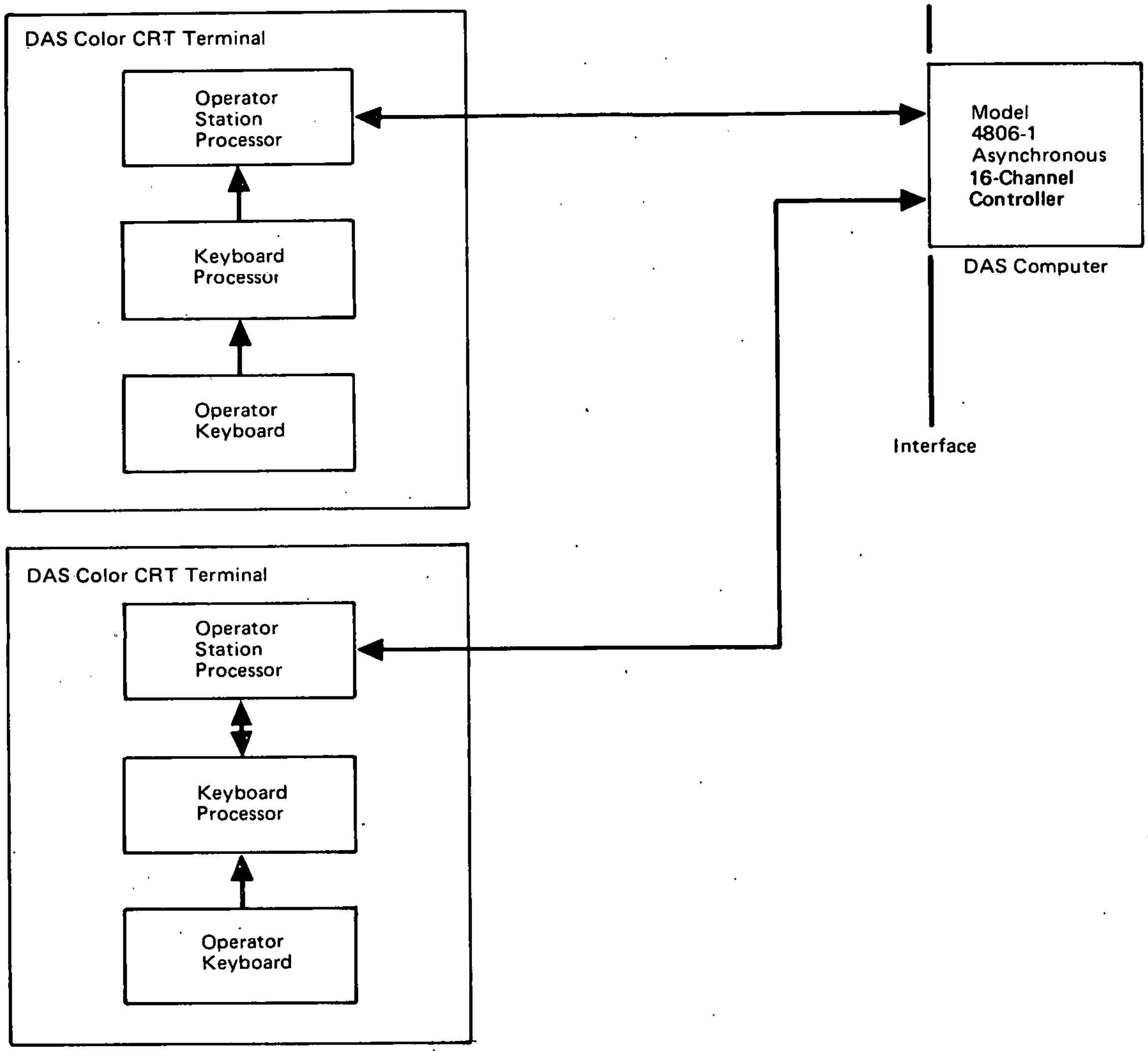


Figure 3-19. DAS Color CRT Terminal Block Diagram

MODCOMP software diagnostics will be used to demonstrate MODCOMP computer hardware readiness. The DARMS will use a diagnostic program provided in firmware by Cyber to determine readiness. Test support software will be utilized to demonstrate the internal interfaces between the MODCOMP and the color CRT terminals, the DARMS, the hard copier, and the strip chart recorders.

Software

Software is shown in Figure 3-20.

A. Interface Verifications

1. DARMS-DAS Interface

a. Command Link - RS-232 - Standard software will be used to download known data to DARMS. The DARMS will perform balance and calibration operations and transmit calibration coefficients to DAS.

b. Data Link - The software interface will be verified by proper acquisition of data per standard software. Selected data channels will be stimulated to provide known data outputs.

c. High-Speed Scan Interrupt - A simulated trip condition to the DARMS will be verified to initiate collection of high-speed data scan via SFDI developed software.

2. SHIMMS-DAS Interface

a. Command Link - Requirements identical to DARMS-DAS interface except that the software utilized will be for SHIMMS instead of DARMS.

b. Data Link - Requirements identical to DARMS-DAS interface except that the SHIMMS acquisition program will be used.

3. WWV-DAS - The driver developed for the OCS computer will be used to show that DAS computer time can be synchronized to WWV time using special test software module.

4. SDPC-DAS Data Link - SFDI developed software will be used to acquire data from the SDPC. Acquired data will be analyzed using special test software to verify correct operation of the communication protocol and the software interfaces.

5. DAS to MODACS III - A special driver will be developed to down load MODACS III with applications software and to transmit canned data to MODACS III. Expected strip chart responses will constitute verification of the software interfaces.

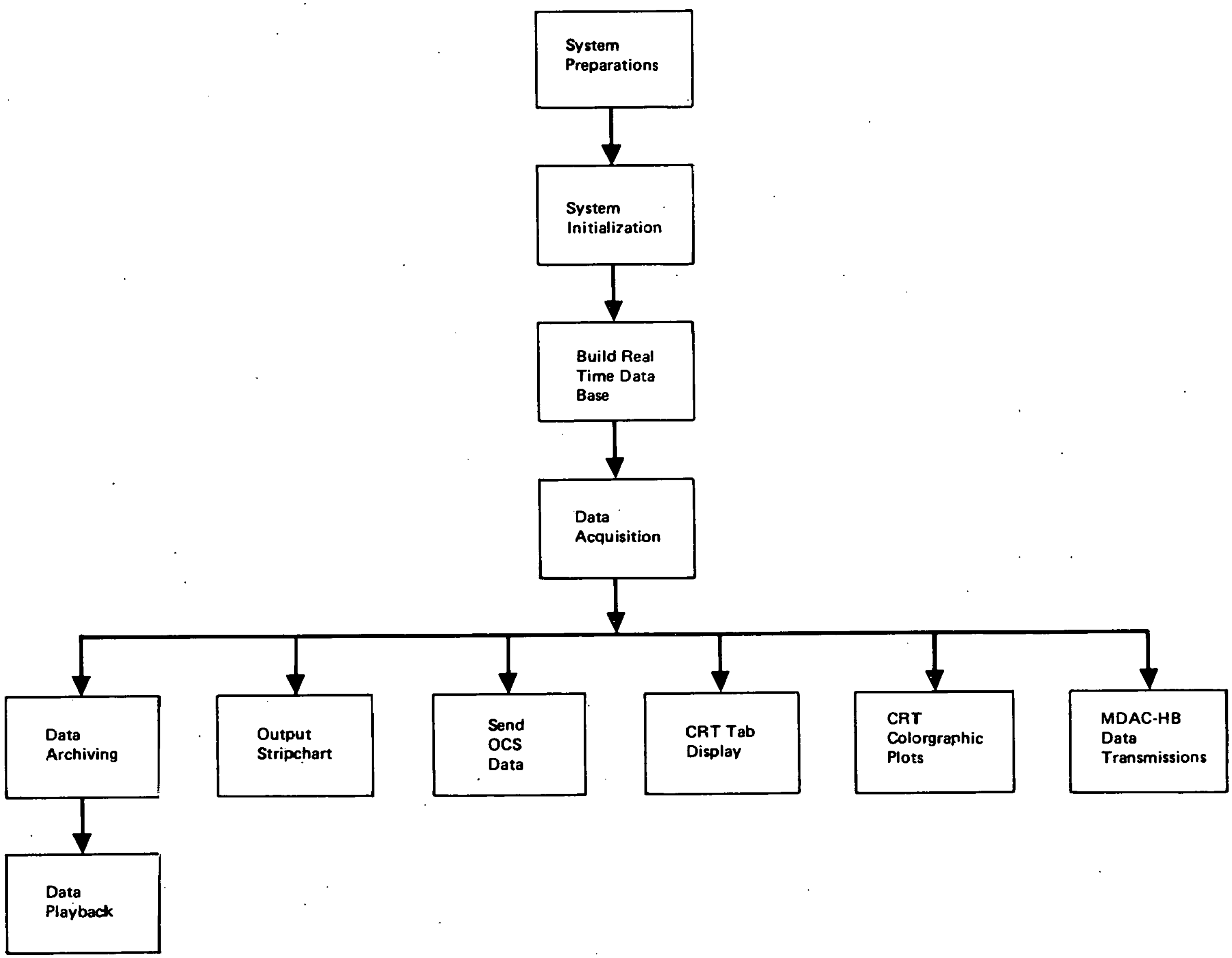


Figure 3-20. DAS Software Hierarchy Chart, Major Functions

6. DAS to MDAC-DEC 10 - Special driver will be developed to control SFDI developed software used to transmit data via phone lines to test hardware thatwill verify DAS software interfaces.

7. DAS to HAC - Special driver shall be developed to simulate the HAC. A terminal shall be used as anI/O device to check out SFDI developed HAC acquisition software.

8. DAS to OCS - Special driver will be developed to control standard software that will furnish or retrieve OCS/DAS status data or process OCS/DAS data requests via MAXNET core devices.

Data Processing

B. Data Archiving - SFDI developed software will be exercised to verify that data from external sources can be archived on magnetic tape and that disk files can be archieved to tape.

C. Data Base Construction - SFDI developed software will be exercised to verify that the real time data base can be constructed and maintained by DAS.

D. CRT Format and Tabulate Data - SFDI developed software will be exercised to verify that data residing in the real time data base can be displayed on the color CRTs.

E. CRT Format and Plot - SFDI developed software will be used to demonstrate that data residing in the real time data base can be displayed on the color CRTs.

F. Data Playback

1. Trip Data Processing - SFDI developed software will be exercised to demonstrate that trip data residing on disk can be processed to yield a sequence of events line printer output.

2. Normal Playback - SFDI developed software will be exercised to demosntrate that data residuing on tape can be played back for display on DAST CRTs.

G. Operator Control Interface - SFDI developed software will be exercised to demonstrate that operator can initiate tasks and perform various DAS functions.

H. DAS System Test - DAS system operation from startup thru wrapup will be demonstrated using SFDI developed software.

3.4.2.3 Subsystem Distributed Process Control

Hardware

The SDPC hardware to be tested, illustrated in Figure 3-21, will be centrally located in the Master Control Console Equipment illustrated in Figures 3-22 through 3-25 which will be located at remote stations and interconnected by data highways to the equipment in the master control console. The major elements of the SDPC are the color CRT terminals, the strip chart recorders, the printer/loggers, interlock logic, remote multivariable controllers, IPAC multiplexers and interlock logic I/O. Beckmann "fill-in-the-blank" firmware will be used to configure the SDPC and demonstrate hardware readiness.

Software

No SDPC software is required.

3.4.2.4 Real-Time Clock

Hardware

A real-time clock located in the master control console will be verified with the WWV/time code generator supplied for OCS and DAS computers.

Software

No software is required.

3.4.2.5 Signal Conditioning Unit

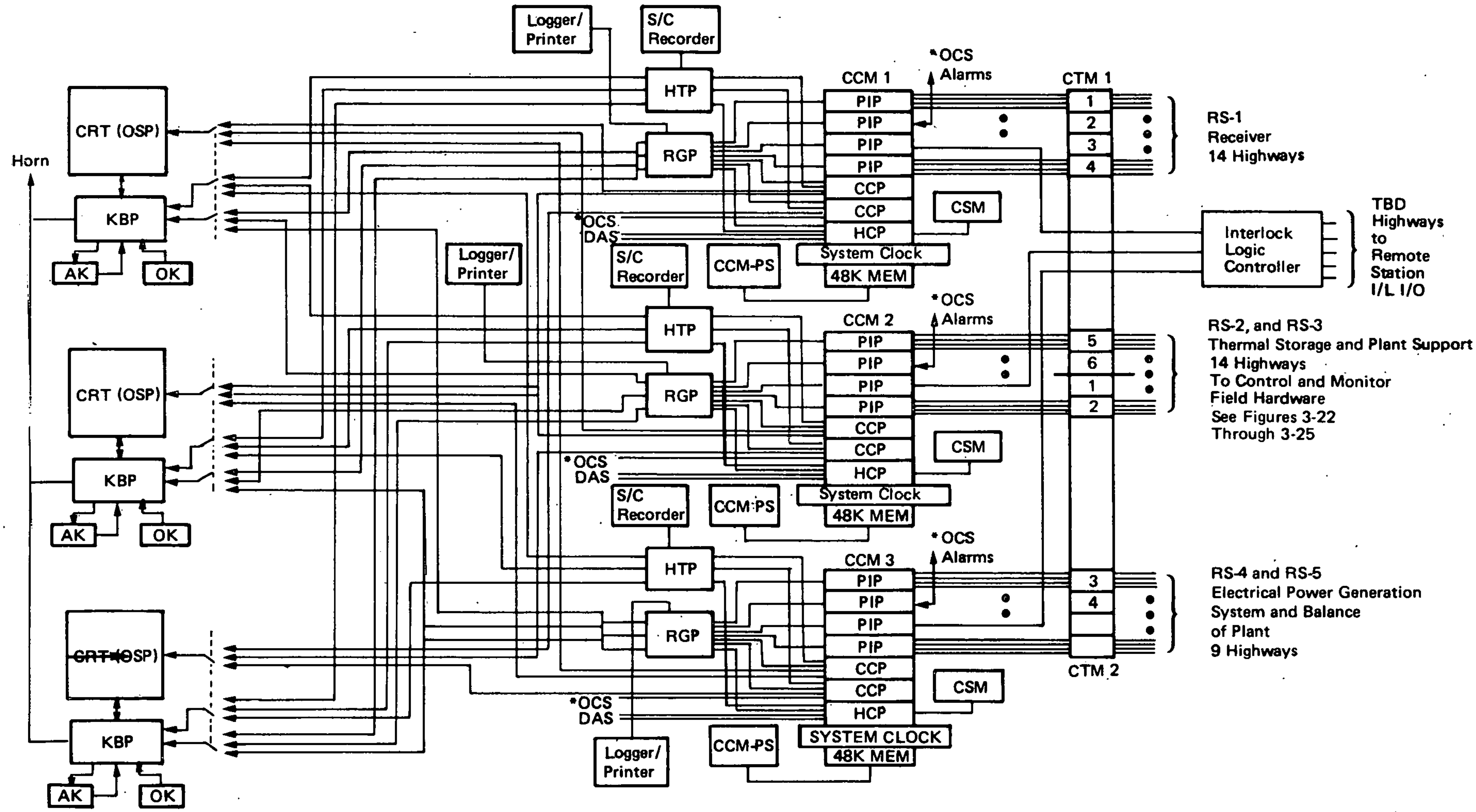
Hardware

Representative signal conditioning units for the Receiver Subsystem and Thermal Storage Subsystem to be tested will be supplied by Rocketdyne.

Software

No Signal Conditioning Unit software is required.

3.4.2.6 Red Line Unit



*OCS and DAS Computers Are I/F by P/N 771715

Figure 3-21. SDPC Test Configuration (Equipment Installed in Master Control Console P/N 610617)

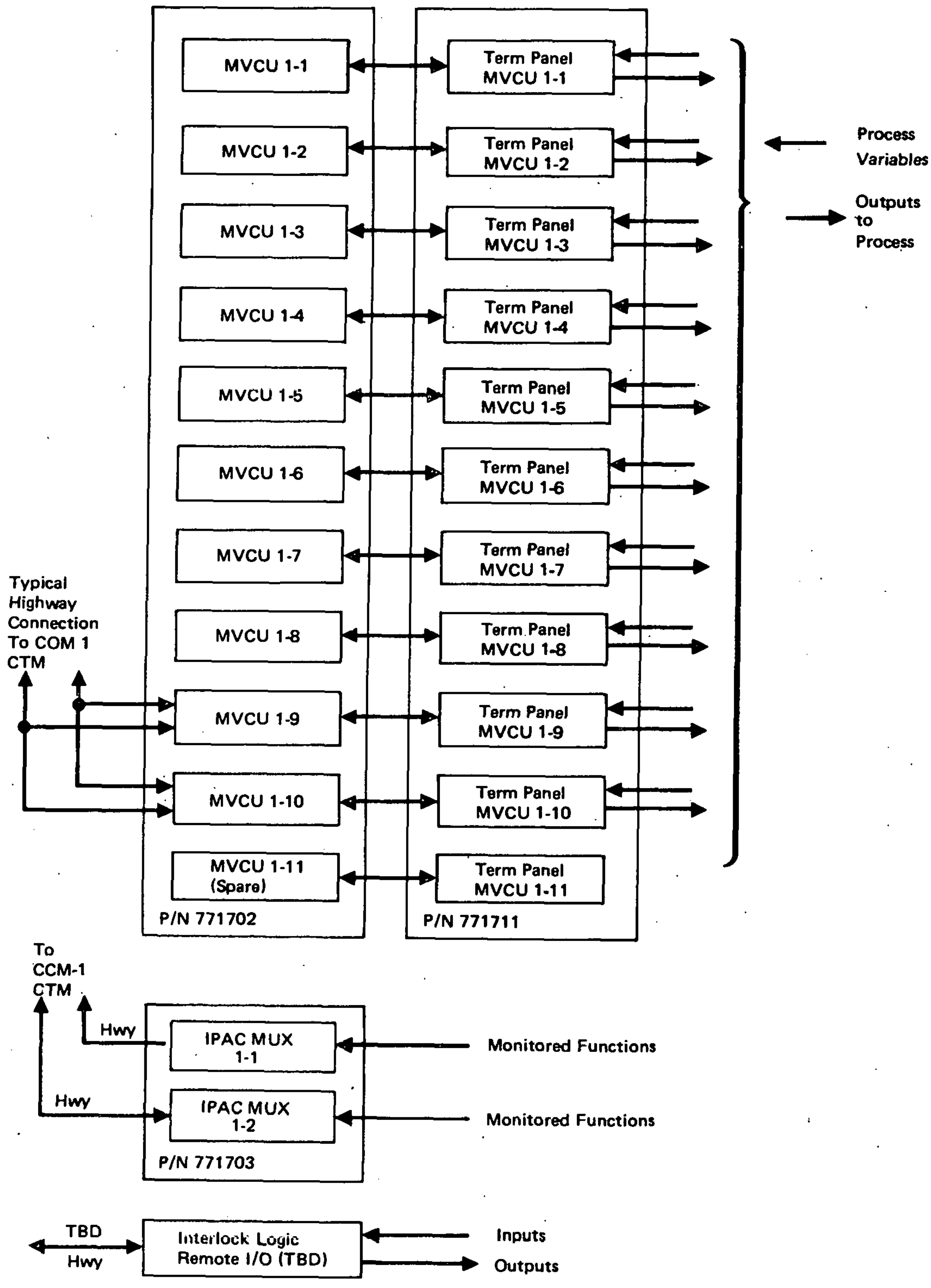


Figure 3-22. SDPC Remote Station – 1

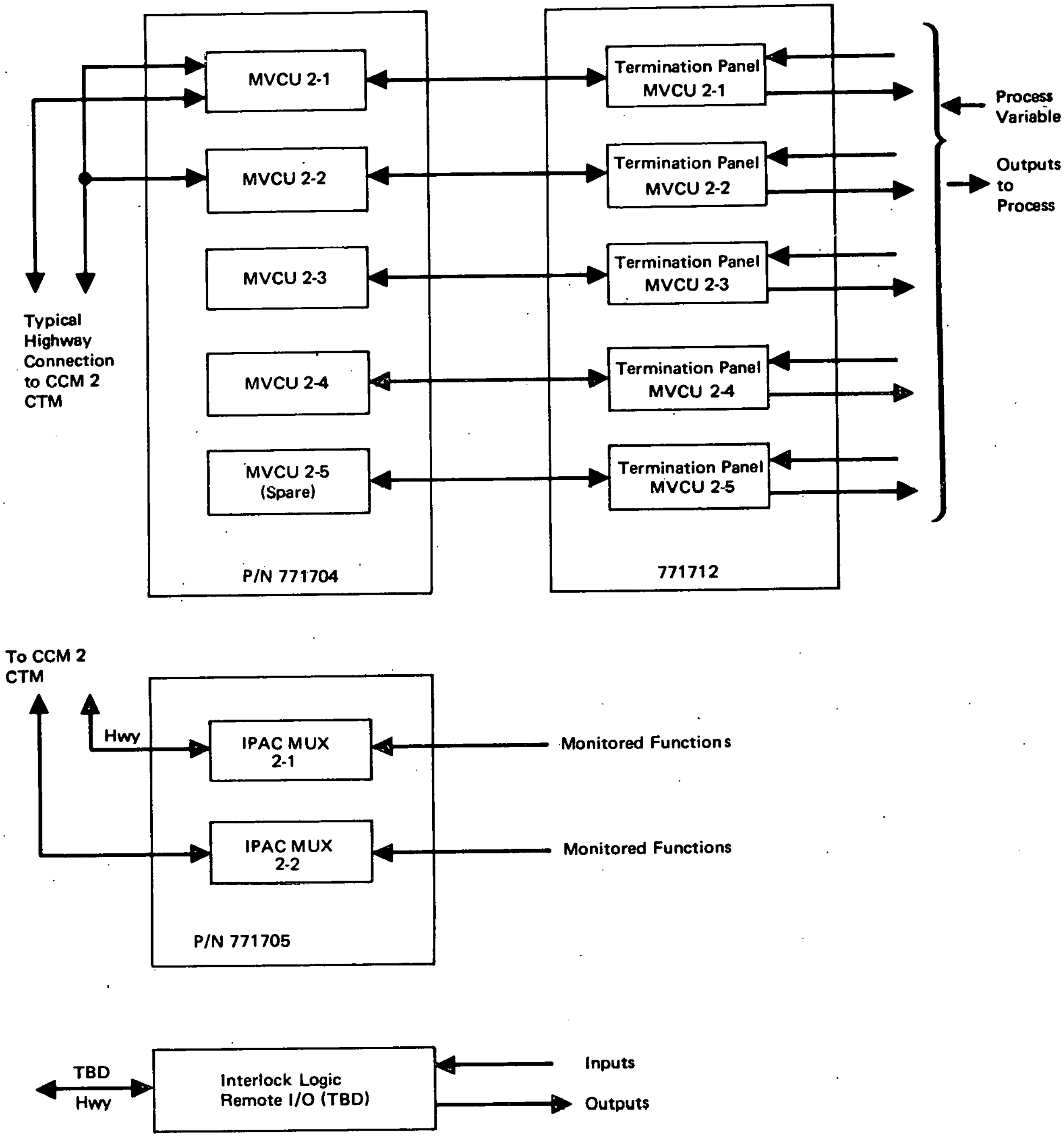


Figure 3-23. SDPC Remote Station – 2

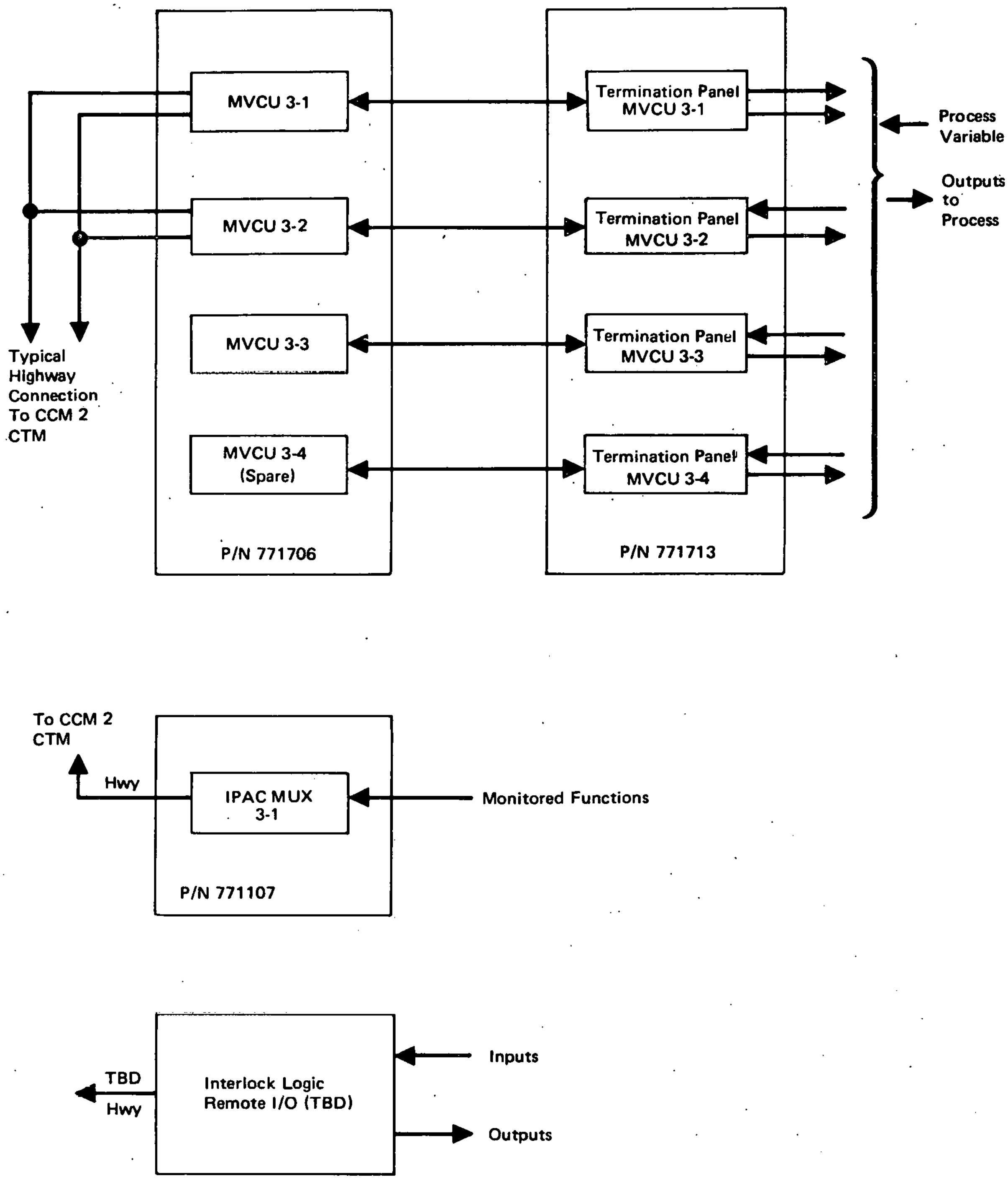


Figure 3-24. SDPC Remote Station — 3

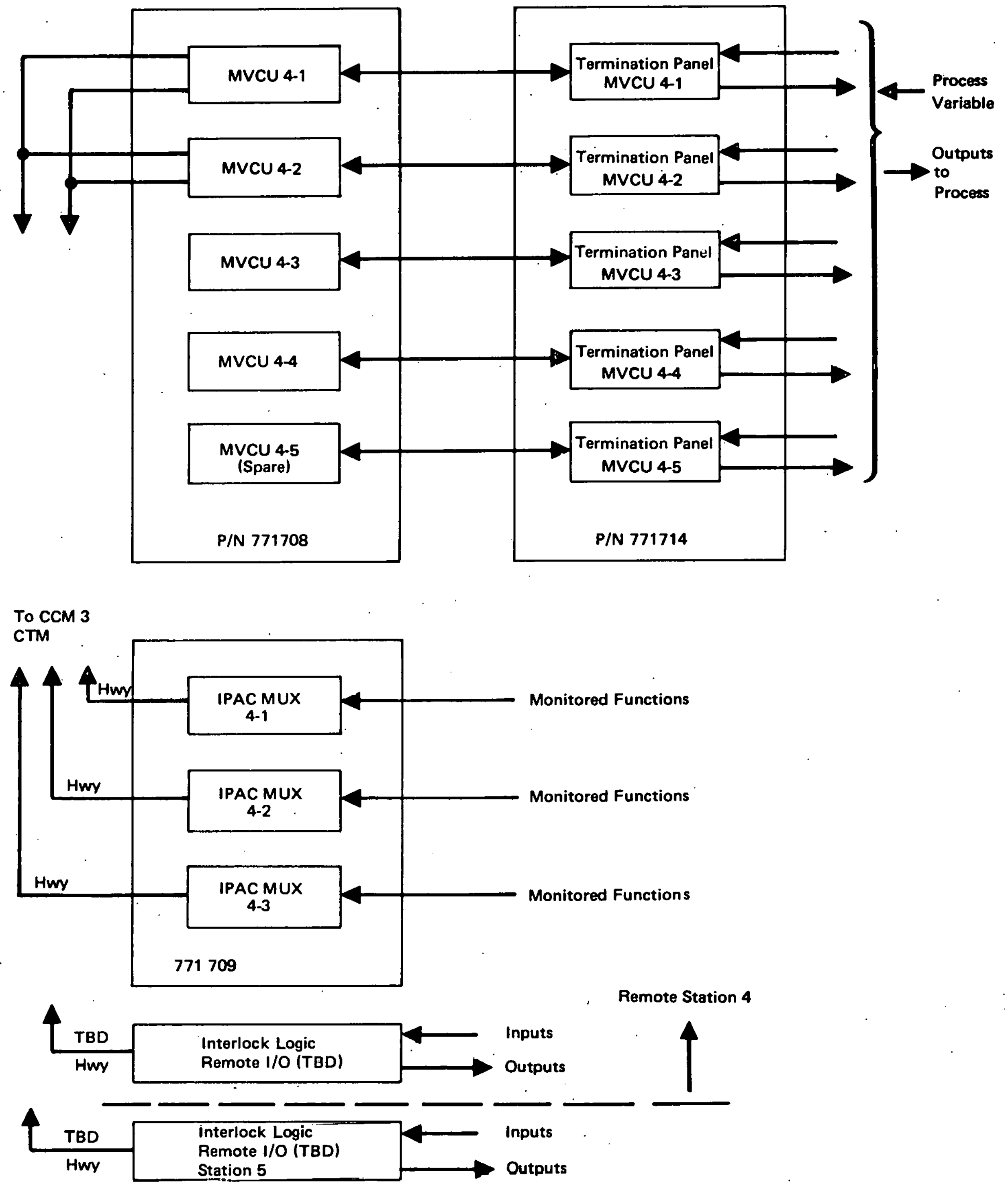


Figure 3-25. SDPC Remote Station — 4, and 5

Hardware

The red line units for the Receiver Subsystem and Thermal Storage Subsystem to be tested will be supplied by Rocketdyne. Diagnostic test support software furnished by Rocketdyne will be used to demonstrate the hardware readiness of the RLU.

Software

The red line unit software to be tested will be supplied by Rocketdyne. The red line units will be configured by loading this software.

3.4.2.7 Master Control Test Set

The Master Control Test Set will be an assembly of test equipment which will provide input signals to the SDPC and DARMS, and provide measurement and calibration references. The equipment planned consists of:

A. Transfer function analyzer
B. Oscilloscope
C. Precision DC power supplies
D. Simulated end instruments
    1. Strain gage bridge
    2. RTT
    3. Signal and calibration voltages
    4. Current sources
E. Electronic multimeter
F. Control switching panel

3.4.2.8 Major Interfaces

Figure 3-9 illustrates the major interfaces in the Pilot Plant controls test configuration. The external interfaces are those that are the responsibility of the supplier of the equipment or is between equipment supplied by subcontractors or associate contractors.

OCS Interfaces

The major OCS interfaces are:

A. OCS to HAC A
B. OCS to HAC B
C. OCS to Real Time Clock
D. OCS to SDPC

E. OCS to DAS
F. OCS to BCS
G. OCS to OCS color CRT terminals

Figure 3-26 is a block diagram of the OCS major interfaces and the data rate capability between them. The OCS software related to the HAC will be demonstrated by communicating with limited simulation software resident in the DAS computer. The HAC computers and software will not be available to the SIL.

Major DAS Interfaces

The major DAS interfaces are:

A. DAS to SHIMMS
B. DAS to HAC A
C. DAS to HAC B
D. DAS to Real Time Clock
E. DAS to SDPC
F. DAS to DARMS
G. DAS to MDAC PDP-10
H. DAS to DAS color CRT terminals

Figure 3-27 is a block diagram of the DAS major interfaces and the data rate capability between them. The DAS software related to the HAC will be demonstrated by communicating with limited special first software resident in the OCS computer. The HAC computers and software will not be available to the SIL.

SDPC to Receiver and Thermal Storage Electronics

The SDPC to receiver and thermal storage electronics includes an interface with input process variable signal conditioning, process monitor signal conditioning, unconditioned monitor inputs, and high level discrete talkback and interlock signals (SCU). The SDPC also interfaces with the Red Line Units in both a functional operating and monitoring mode.

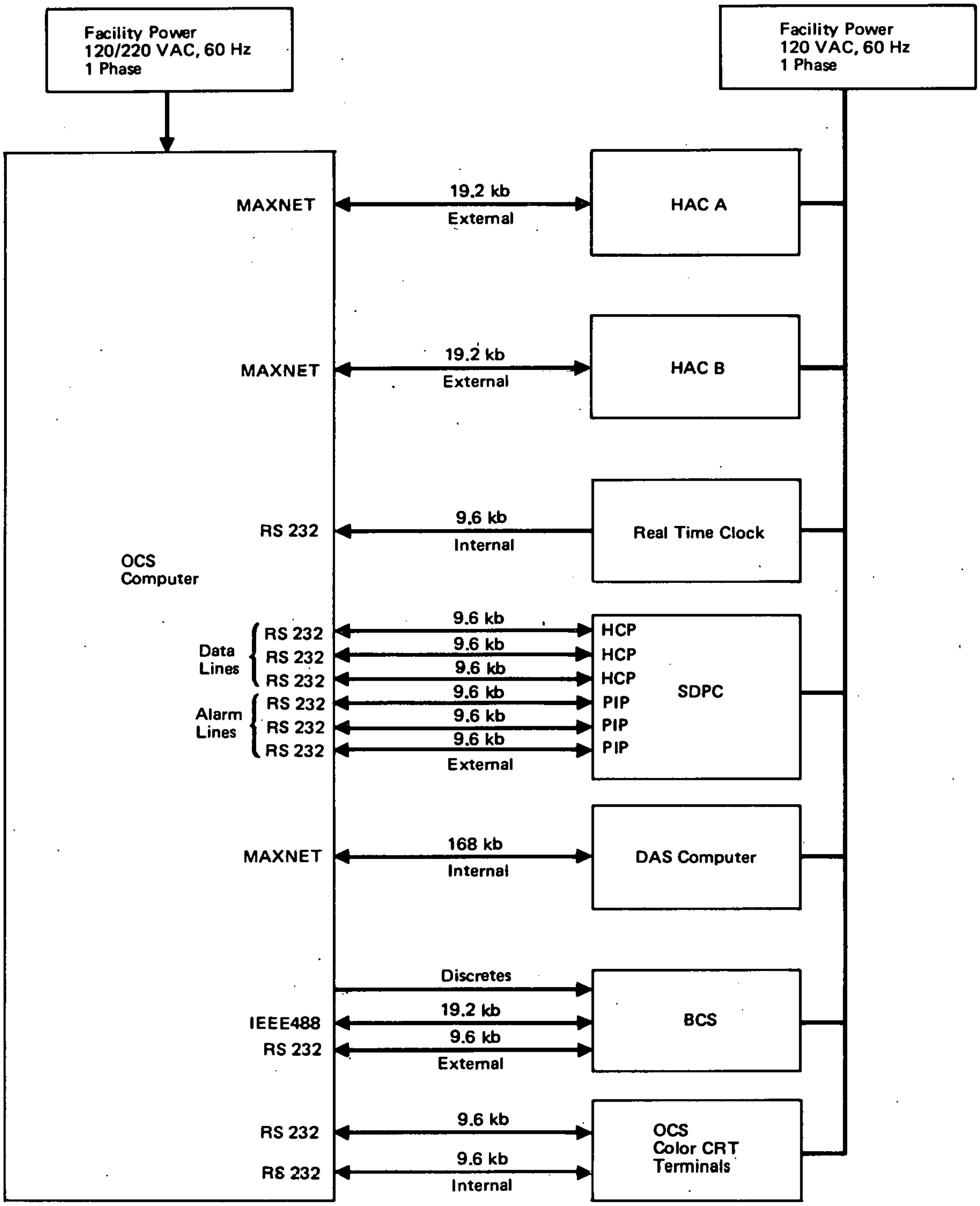


Figure 3-26. OCS Computer Major Interfaces

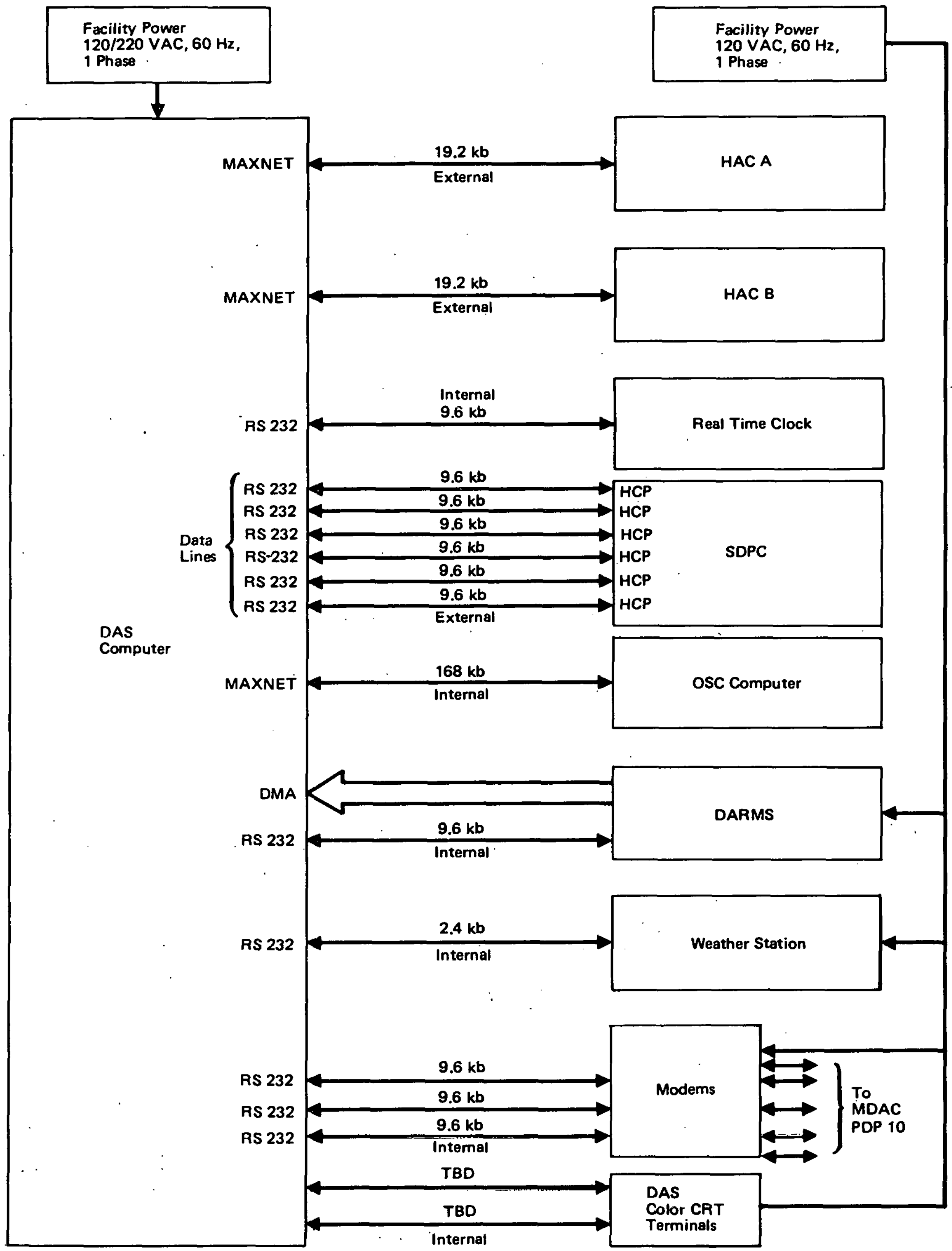


Figure 3-27. DAS Computer Major Interfaces

3.4.3 Minimum SIL Test Configuration

The minimum SIL test configuration will include the minimum hardware necessary to support application software development and field changes and demonstrate their capability within limits.

3.4.3.1 Hardware

The major elements of the mini SIL hardware, illustrated in Figure 1-3, are a MODCOMP 7861 computer, Beckman operator programmable control unit (OPCU) terminal, and Beckman multivariable control unit. MODCOMP software diagnostics will be utilized to demonstrate the MODCOMP computer and peripheral readiness. Beckman "fill-in-the-blanks" firmware will be used to configure and operate the Beckman elements.

3.4.3.2 Software

The following software will be developed for the OCS computer using the computer resources of the mini SIL:

A. OCS Tool Software
   1. Logging
   2. Supervisory control routines
   3. Data base
   4. Man-machine interface

B. OCS Applications Software
   1. Supervisory control
   2. Coordinated control
   3. Clear day control

3.5 INTEGRATION TESTING

3.5.1 Maxi SIL

The hardware interfaces between subsystems will be demonstrated to be functionally operable to assure readiness to support system integration. After hardware readiness has been established, tests will be performed that functionally demonstrate a hardware and software linkage capability between each interface. Performance under conditions such as an electrical noise environment, induced errors, maximum throughputs, and recovery conditions (power failure) will be evaluated (see Figure 3-28).

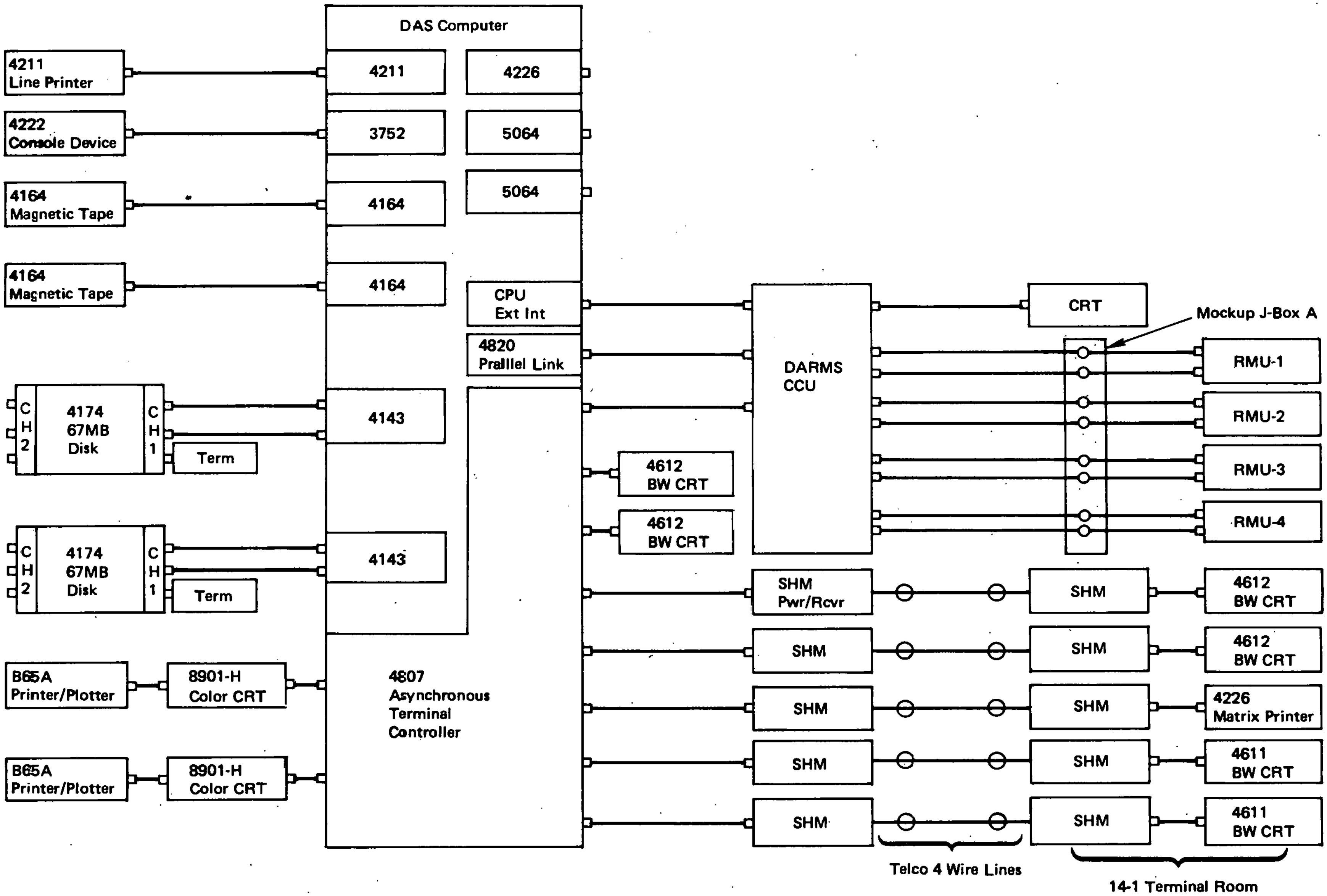


Figure 3-28. Stage I Equipment Configuration

3.5.1.1 Hardware

Representative tests will be conducted, insofar as possible in the system integration laboratory, to demonstrate:

A. SDPC controls including subsystem signal conditioning and red line unit operation using manual operating procedures

B. DAS system including MCS test set simulated inputs, DAS application software, and all major interfaces

C. OCS system including MCS test set simulated inputs, OCS tool software, and all major interfaces

D. Master Control Test Set

3.5.1.2 Test Control Drawing

The SIL activities will be planned, controlled, and documented by the use of a Test Control Drawing (TCD). This drawing will identify and define the requirements for the system checks to be performed during the various stages of test. It will specify test configurations both physical and electrical and identify any special requirements for running the test. It will provide the means to document results of individual tests and provide a means for overall evaluation of the system operation.

3.5.2 Mini SIL

The interfaces between all elements of the mini SIL equipment will be demonstrated to be functionally operable. These interfaces will not be evaluated to the restrictive conditions previously tested in maxi SIL, since the interfaces of the mini SIL equipment is similar.

Representative tests will be conducted within the limits of the mini SIL equipment to demonstrate the OCS tool software completion, OCS application software, and "field fix" software.

Section 4
BCS SIL OPERATION

The BCS System will be assembled, configured into test modes, and checked out for proper hardware and software operation to the extent described in this section. The equivalent of SIL testing for the BCS hardware and software will be performed in parallel with, but independent of SIL, using a surrogate MODCOMP CLASSIC computer in place of OCS computer linked to the basic complement of BCS equipment. The major portion of the BCS interface and integration testing (Phase I) will be performed at the Solar Energy Test Facility (SETF) site which is separate from the SIL but also located at the MDAC-HB facility (Figure 4-1). The SETF site provides the capability to test the BCS using redirected light beam images on target surfaces generated by heliostats tracking the sun.

BCS integration functions also require magnetic tape operations as well as operations with MAXNET software installed in the OCS computer. These integration functions will be performed in Stage VI of SIL, when the BCS hardware and software will be removed from the surrogate computer and installed with the OCS computer in the SIL facility.

4.1 BCS TEST OBJECTIVE

The tests conducted on the BCS system will verify the operational integrity of the hardware and demonstrate the proper software operation in interfacing with the OCS and DAS computers and peripheral equipment. The BCS hardware to be tested is illustrated in Figure 4-2. The COHU video camera system black/white CRT keyboard/hardcopier terminal with built in hard copier diagrammed in Figures 4-3 and 4-4 respectively along with the MODCOMP computer and peripherals, video digitizer, and Modular Data Acquisition and Control System III (MODACS III) makeup the system hardware.

The BCS will test heliostat reflected beam quality. MODCOMP software, processed data from beam quality tests, and diagnostic software will be used to

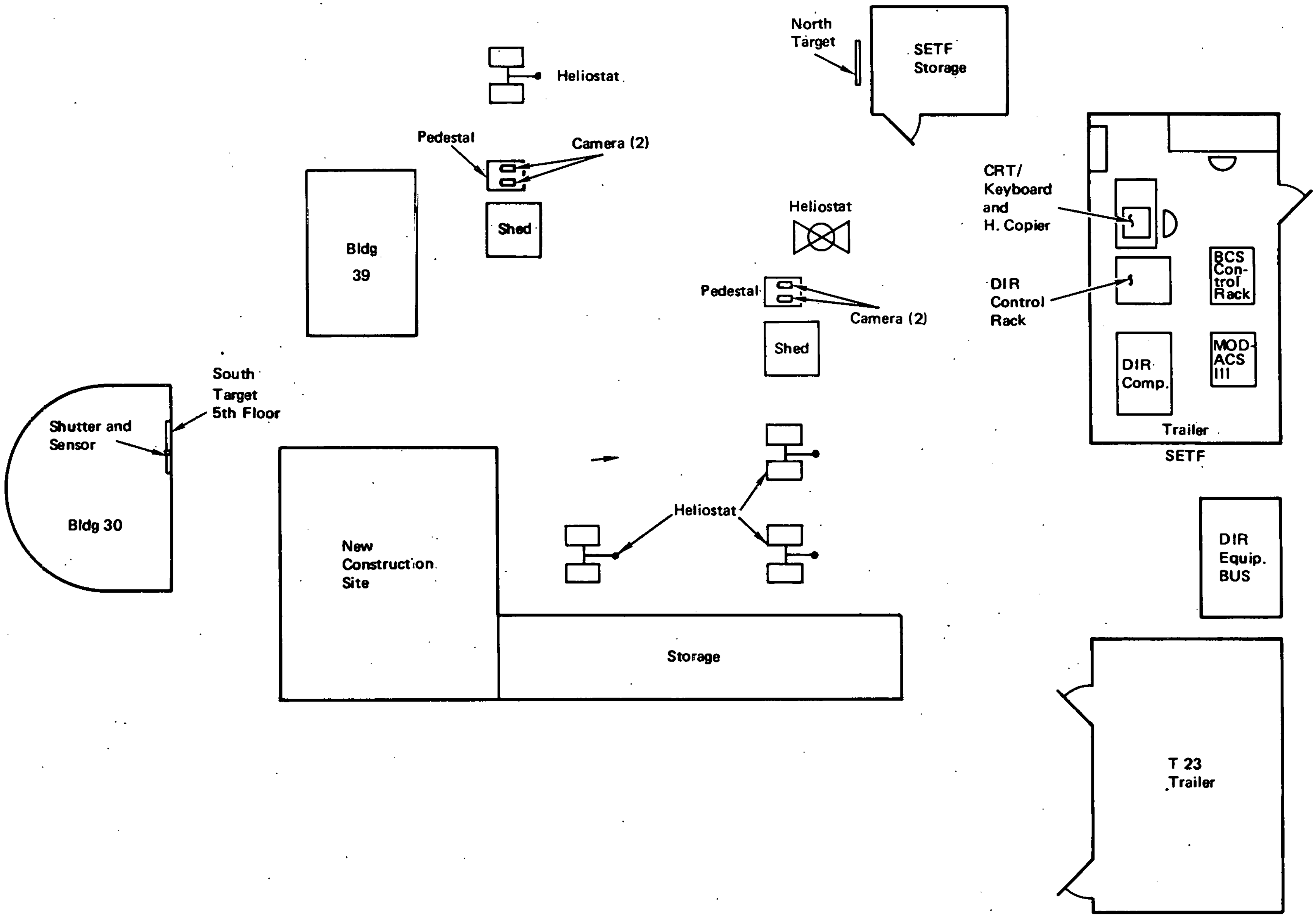


Figure 4-1. BCS Test Site Configuration (Solar Energy Test Facility)

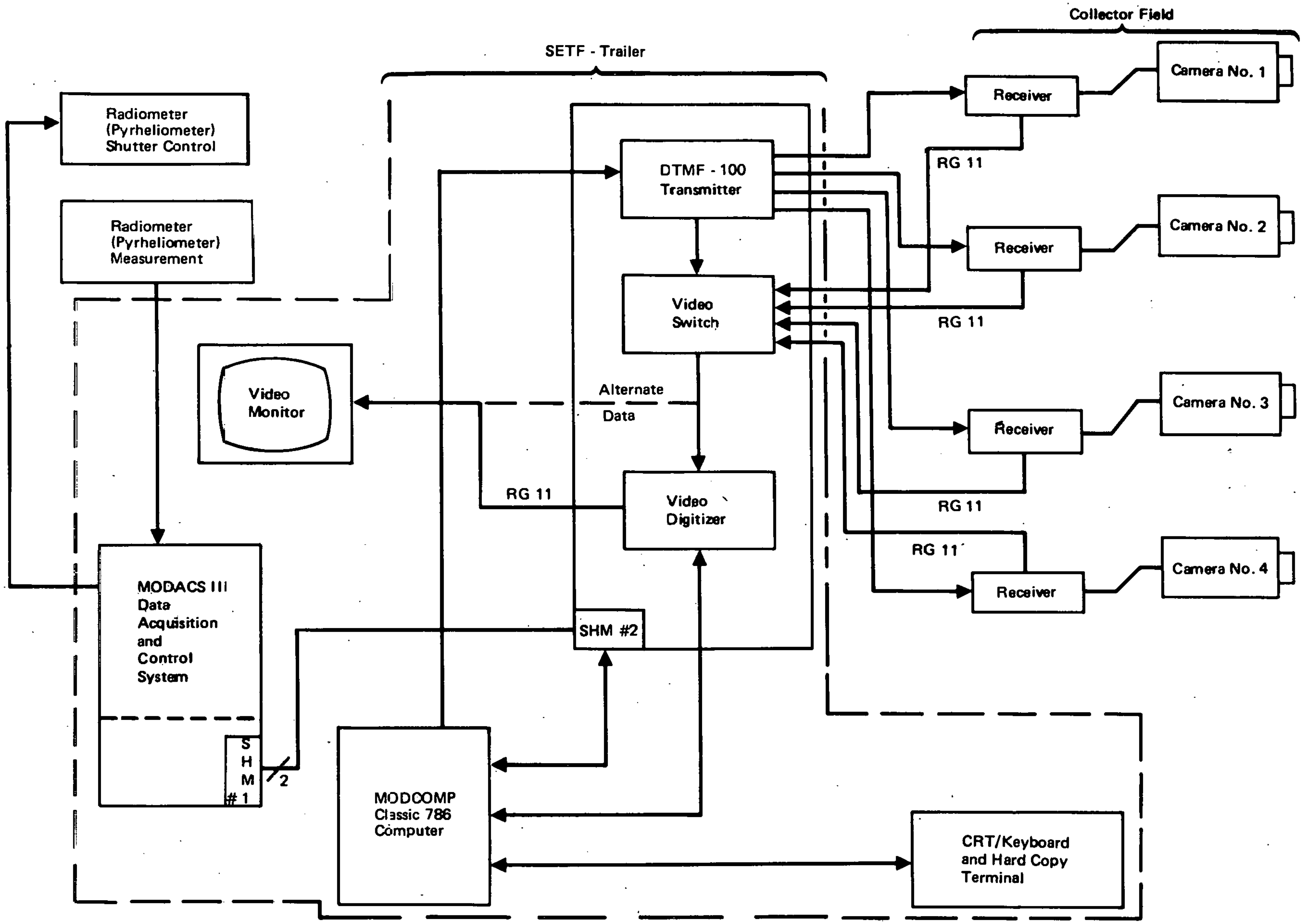


Figure 4-2. — BCS Hardware Configuration

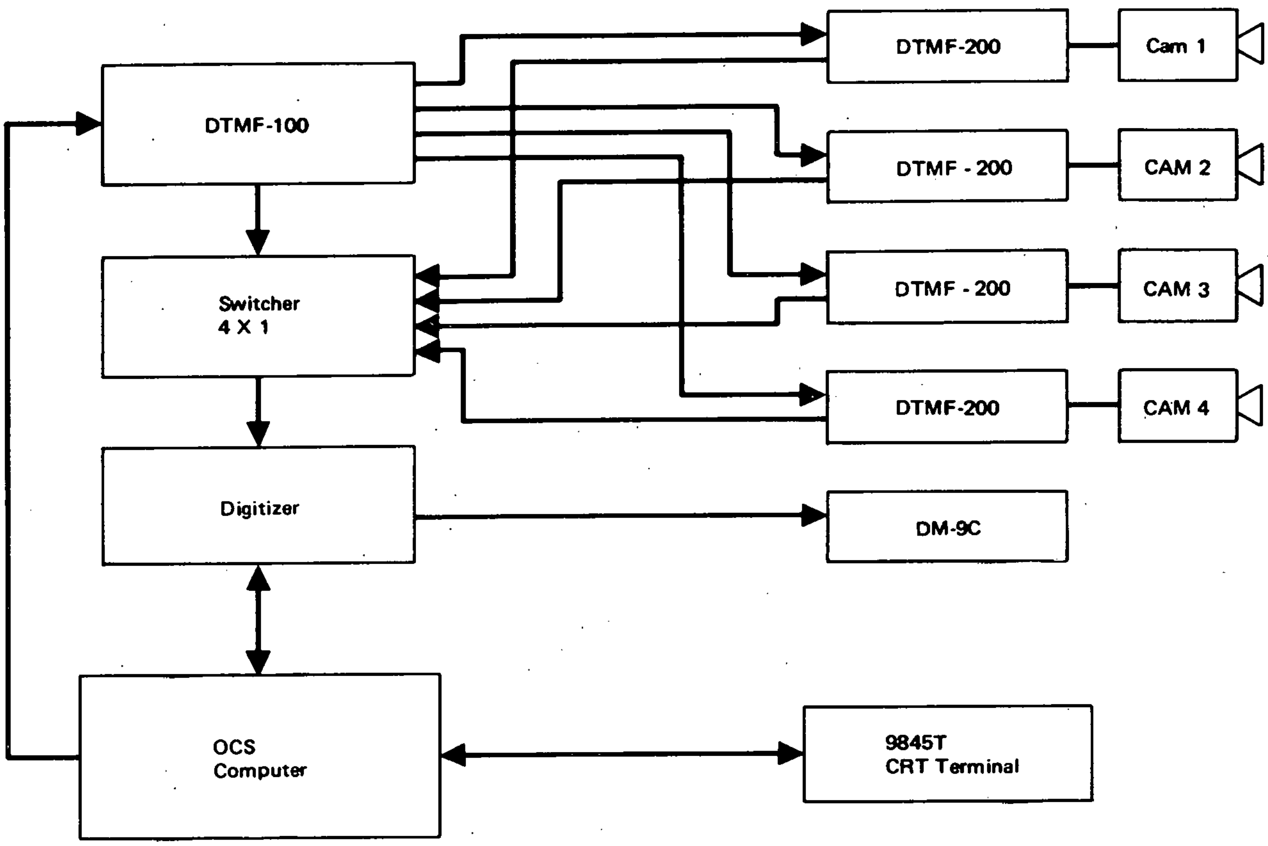


Figure 4-3. Video Camera Configuration

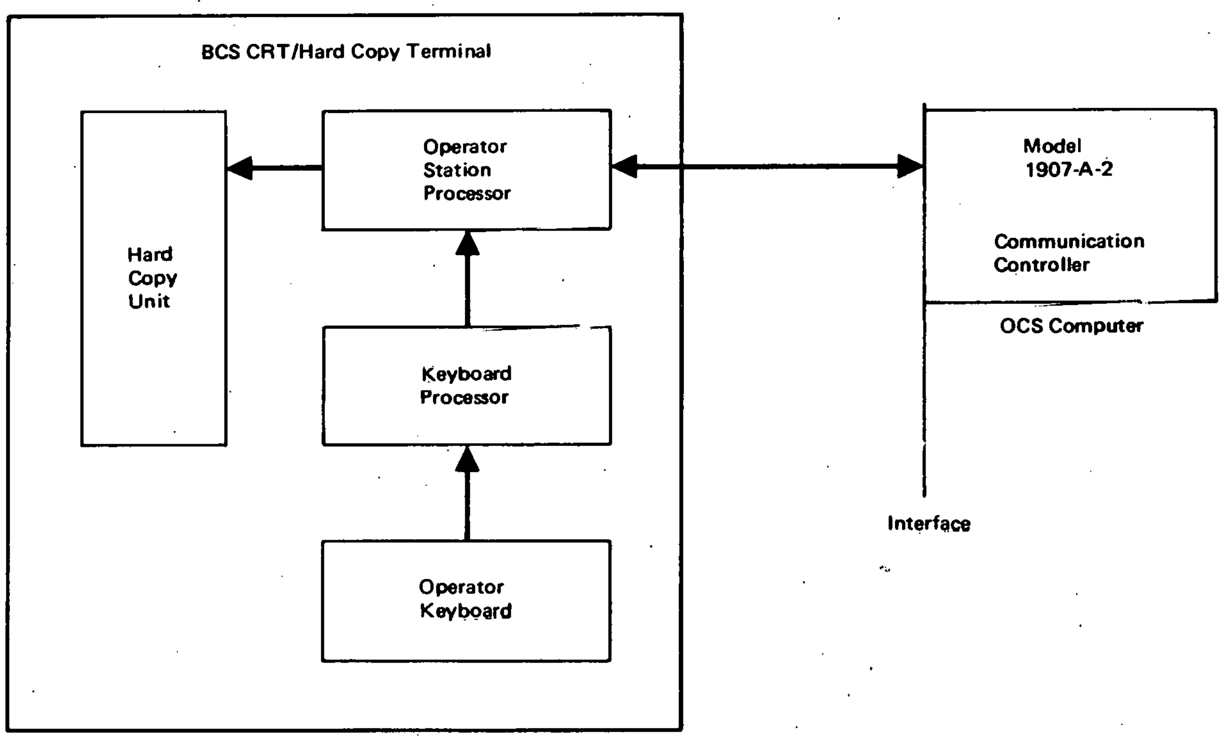


Figure 4-4. BCS B/W CRT/Hard Copier Terminal Block Diagram

demonstrate MODCOMP hardware readiness. Applications and test support software will be used to verify the internal interfaces between the MODCOMP computer, the CRT/hard copier terminal and the video camera system.

4.2 BCS TEST FACILITY

The BCS and external interface operational functions will be integrated and functionally demonstrated at the SETF as a part of SIL activities. The BCS will be checked out in two phases. Phase I will be performed outside of the main SIL area at the SETF site and will interface with a surrogate OCS computer. Phase II will utilize SIL to checkout the software and hardware interfaces with the deliverable OCS computer.

4.2.1 BCS Phase I Activities

The following activities will be performed during Phase I:

A. Prepare BCS test facility
B. Define BCS Phase I equipment layouts
C. Define BCS special cable requirements
D. Fabricate Phase I cables
E. Define special BCS test equipment
F. Assemble special BCS test equipment
G. Install BCS equipment physically per Figure 4-1
H. Connect test configuration per Figures 4-5, 4-6, and 4-7
I. Perform hardware functional testing
J. Perform hardware integration testing
K. Perform software integration and verification testing

4.2.1.1 BCS Test Facility Preparation

A. Define and install electrical power for BCS equipment
B. Define and fabricate temporary camera pedestals

4.2.1.2 BCS Phase I Equipment Layouts

A. Define physical locations for all equipment
B. Define electrical power cable locations
C. Define signal cable routing

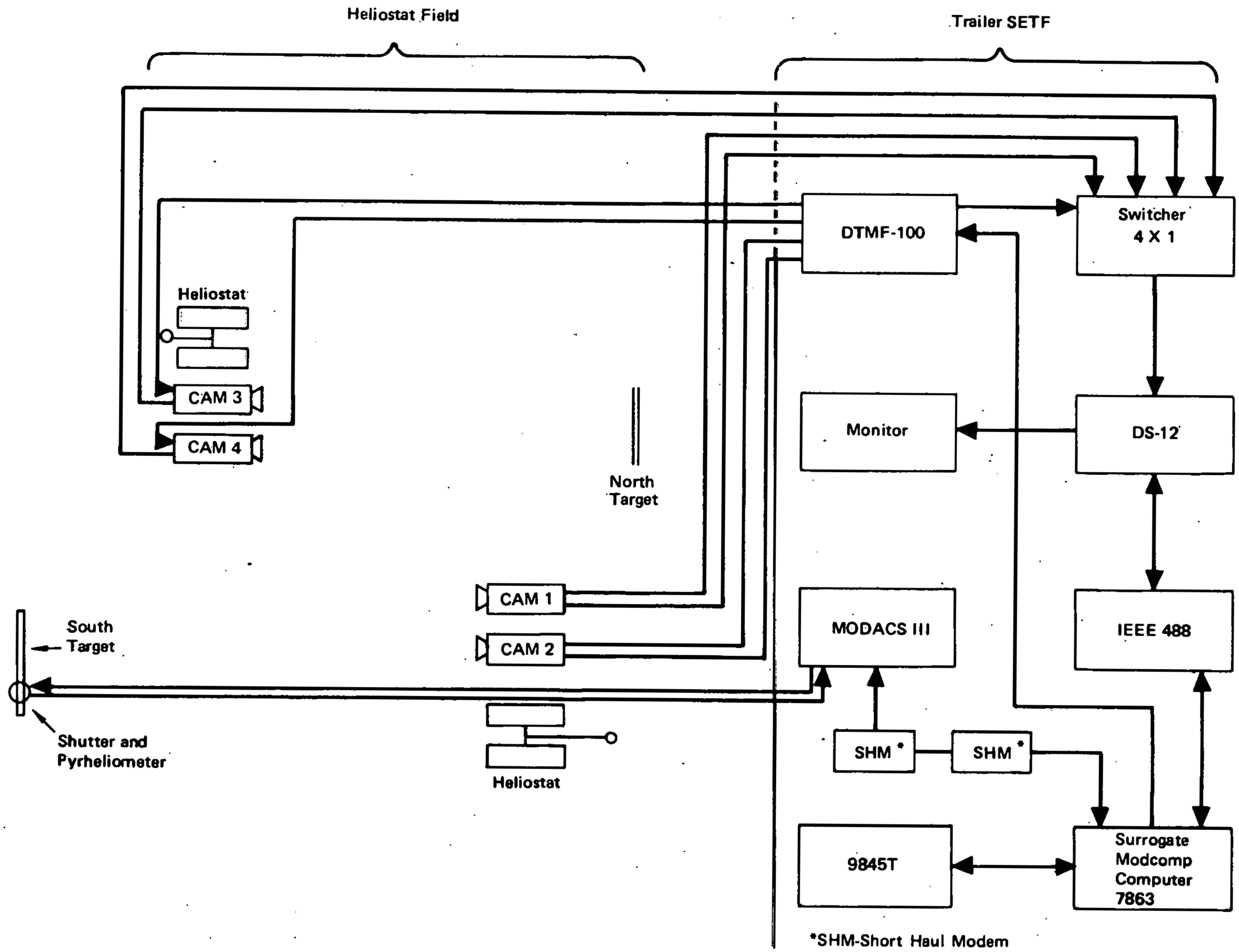


Figure 4-5. BCS Functional Block Diagram

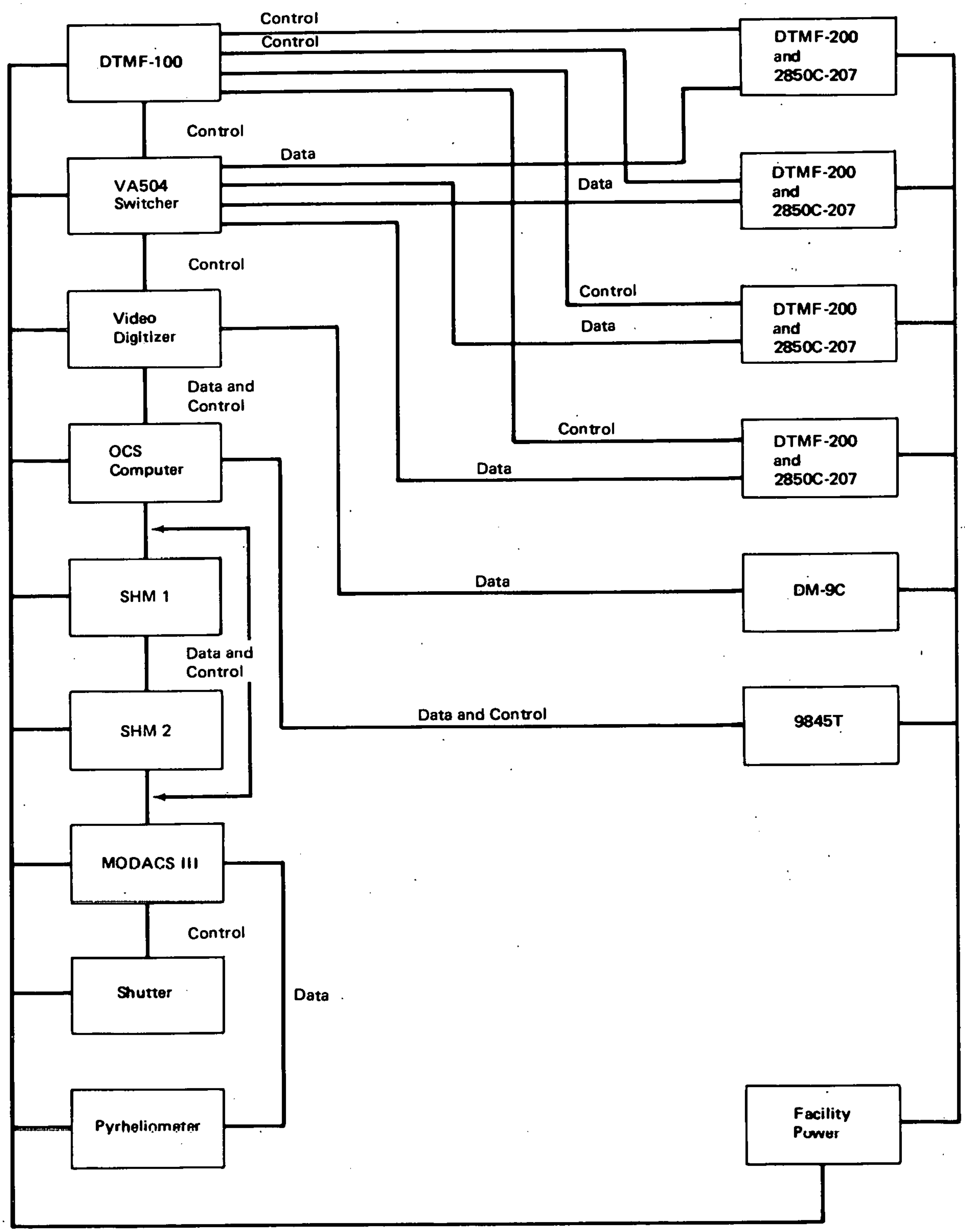


Figure 4-6. BCS Internal/External Interface Block Diagram

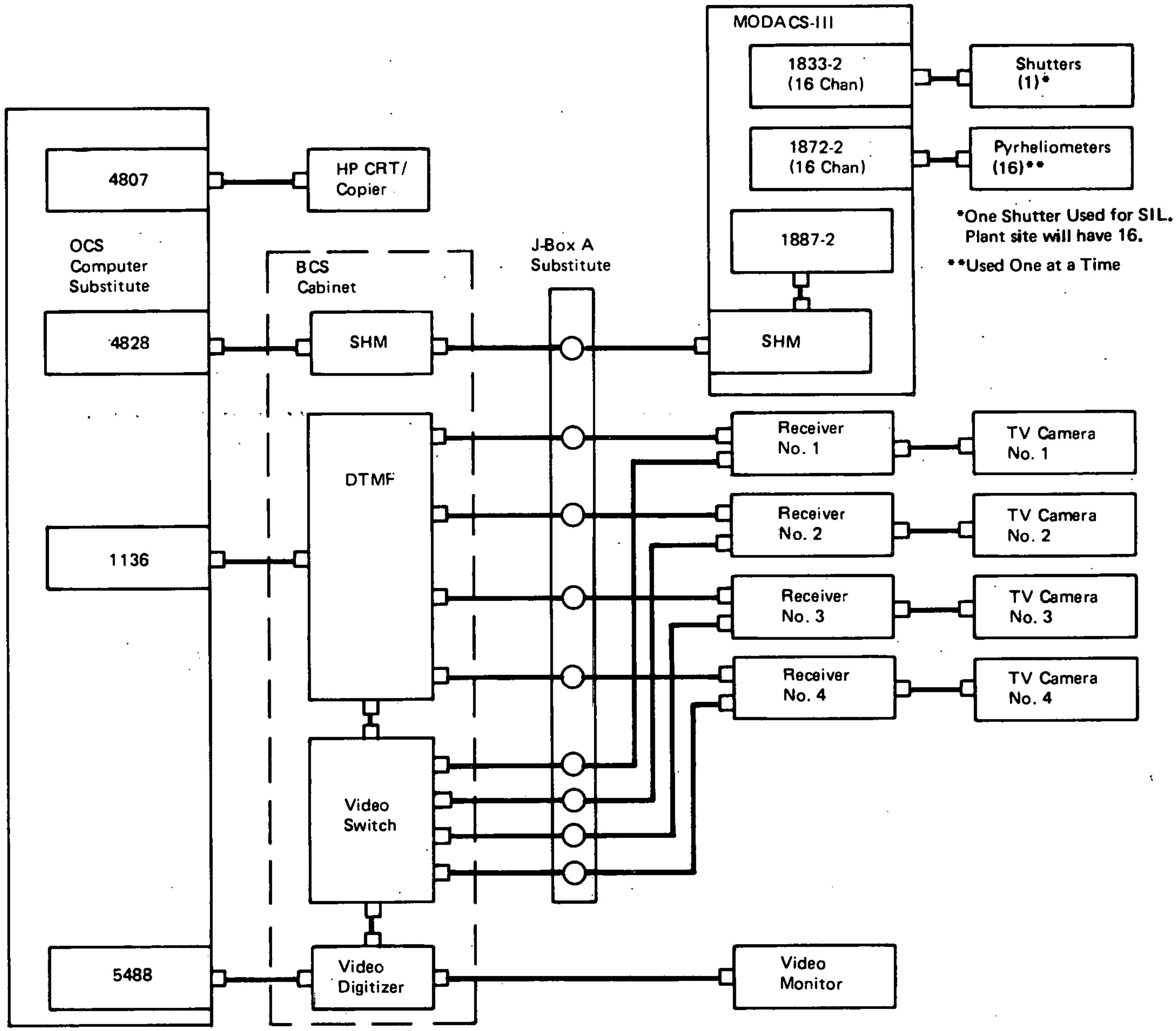


Figure 4-7. Solar SIL — BCS Equipment Configuration

4.2.1.3 BCS Special Cable Requirements

A. Define and provide a fabrications drawing for a temporary power cable

B. Define and provide a fabrication drawing for temporary signal cables

2.4.1.4 Phase I Cable Fabrication

A. Fabricate special power cables

B. Fabricate special signal cables

4.2.1.5 Special BCS Test Equipment

Obtain and place into readiness the following special test equipment:

A. Waveform Monitor - Textronic RM529 or equivalent

B. Camera Test JIG - COHU Model CTJ-2

C. Bar-Dot Generator - COHU Model 2380-004

D. Volt/Ohmeter - Fluke Model 8500A or equivalent

E. Camera Lens Control Unit (CLCU) - COHU Model

F. Active Cavity Radiometer -

4.2.1.6 BCS Hardware Functional Testing

The following BCS hardware functional tests will be performed with the equipment installed in the SETF.

Camera Tests

Camera checkout will be made by performing an initial continuity check on all interconnecting cables. The system will then be hooked up as shown in Figure 4-6 and the camera lens control unit (CLCU) will be utilized to adjust and calibrate the zoom, focus and iris of each camera. (See Figure 4-8)

Shutter Test

Verification of shutter operation will be made manually by activating the on/off switch on the front panel and observing that the shutter responds correctly to the open and close commands.

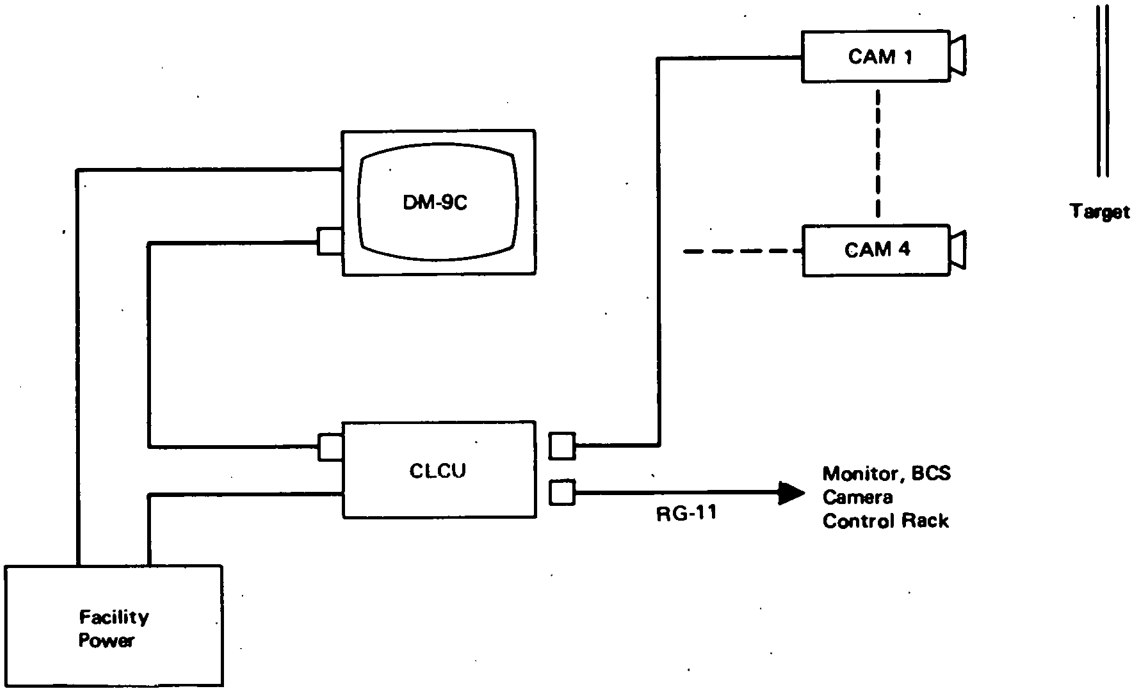


Figure 4-8. CLCU Setup Configuration

Pyrheliometer Tests

Each of the 16 BCS pyrheliometers will be tested to determine first, if they are operational and second, if they are calibrated properly.

Hardware Integration Testing

Hardware integration testing will be performed with all hardware components connected to the surrogate OCS computer. Computer test software will verify hardware interfaces. The equipment will be connected as shown in Figure 4-2. The operator will operate the BCS as a system through the BCS CRT/keyboard terminal. Tests will be conducted to check auto/manual control, iris control camera switching, data acquisition, data display and hardcopying functions.

4.2.1.7 Software Integration and Verification Testing

Software integration and verification tests will demonstrate the following:

A. That individual modules perform according to the BCS requirements.

B. That BCS software modules can communicate with each other and perform in a coordinated manner.

C. That BCS software can exercise the major hardware interfaces of BCS.

D. The BCS software can demonstrate the ability to command certain BCS hardware that includes:

1. The camera
   - For camera switching to digitizer
   - Iris control
2. The shutters (via MODACS III)
3. The pyrheliometers (via MODACS III)
4. The BCS display/hardcopy terminal

E. Verify the BCS/HAC interface operation to the extent possible using simulated or externally applied inputs and verify the ability of the BCS software to process all input messages and generate all output messages as specified in the CS to MCS interface specification RADL 2-30-1.

F. Demonstrate the operation of the BCS software in the OCS computer under supervision of the MAXNET operating system and with other non related tasks sharing the computer resources concurrently.

In accordance with the above, the following subparagraphs specify the software verification procedure for the major software functions of BCS to be demonstrated during Phase I testing.

Figure 4-9 depicts the BCS top level functional flow and illustrates the relationships between the major software components of BCS. Figure 4-10 illustrates the primary test configuration to be verified during Phase I testing.

BCS Initialization Function

The BCS initialization function will be activated at the BCS terminal and its operation will be verified by printout of the initialized data base, and real time files and observing and verifying the prespecified man-machine dialogue at the terminal.

HAC Input Executive

The HAC Input Executive function will be verified by supplying all BCS messages from the collector system (CS) to the OCS as specified in RADL 2-30-1 over a simulated RS-232 link defined under the MAXNET operating system. This

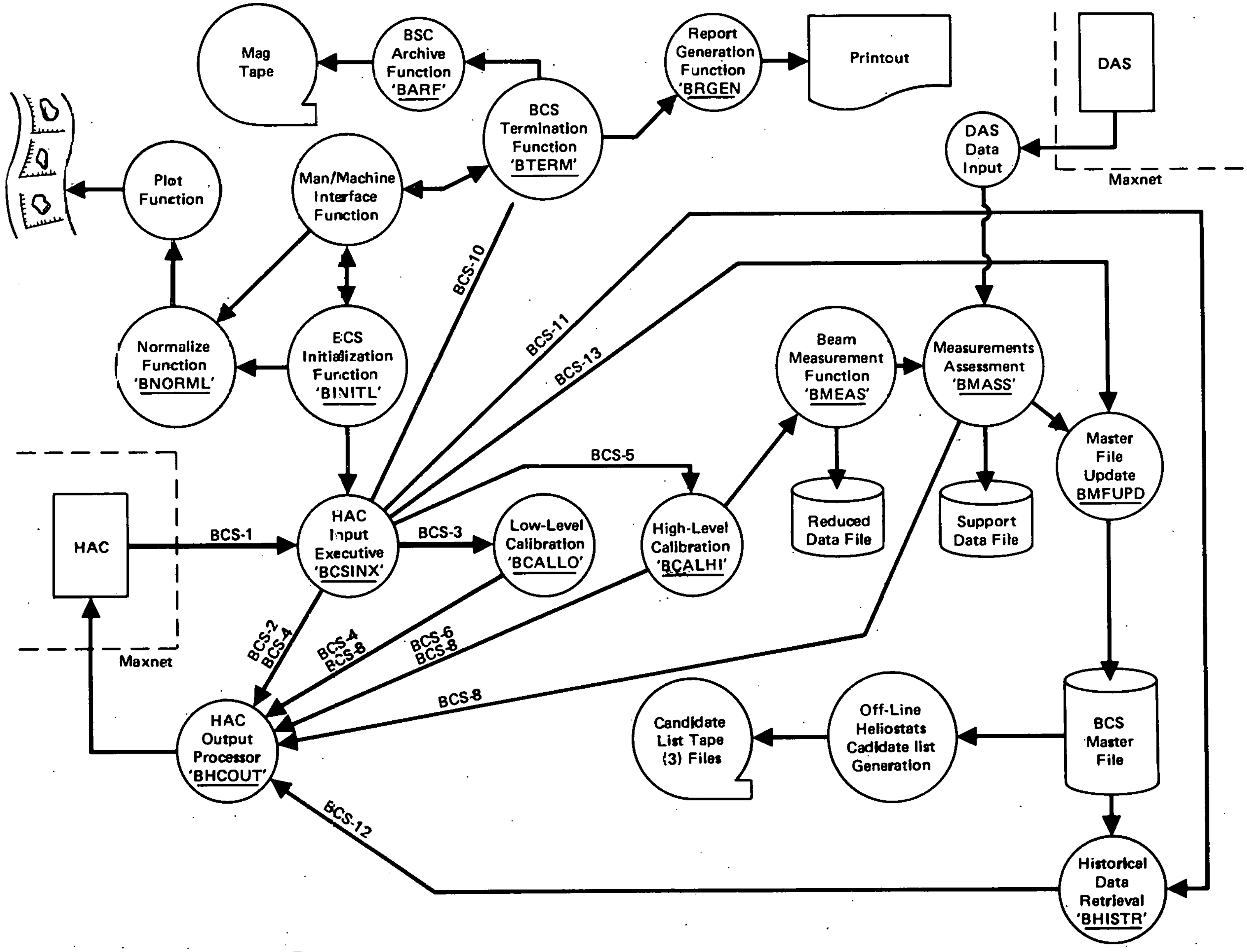


Figure 4-9. BCS Top Level Functional Flow

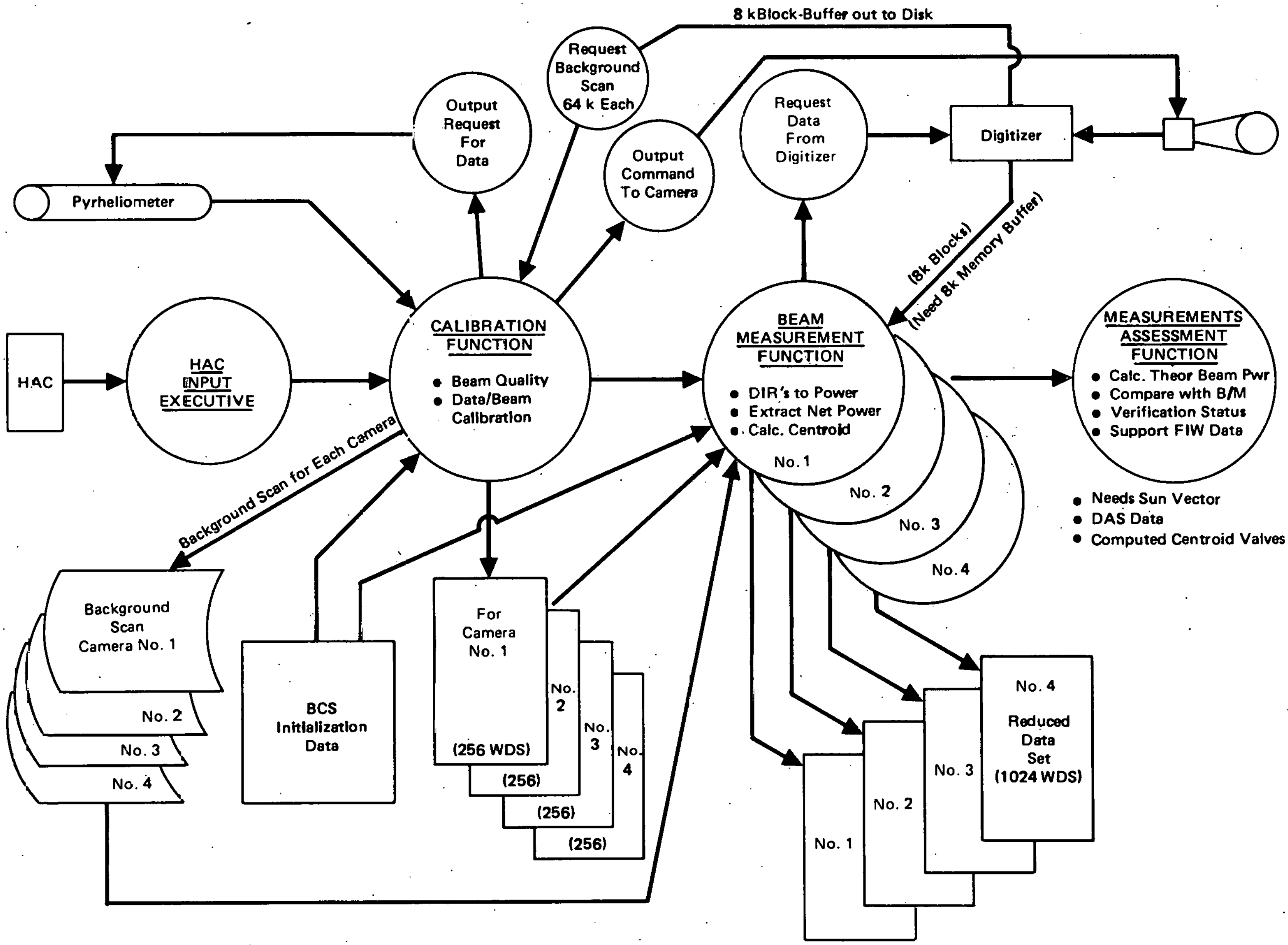


Figure 4-10. BCS Software/Hardware Relationships

function will be the primary driver for other BCS functions which will be demonstrated MODCOMP supplied software.

HAC Output Processor

The HAC output processor function will be verified by activating test sequences which result in the request for generation of all BCS messages acceptable by the CS from the OCS as specified in RADL 2-30-1. Constructed messages will be directed to the line printer for manual verification of structure and content.

Low-Level Calibration Function

MODCOMP supplied software will be exercised to demonstrate the low-level calibration function. The capability of the BCS software to communicate with the pyrheliometers and the shutters through the MODACS III processor via MAXNET shall be verified. In addition, the capability to request and process data from the video digitizer via the IEEE-488 interface will be exercised. This function will also provide verification that the BCS software can determine if a beam is off the target, that it can command the switching of cameras as a function of target selected, obtain Digital Image Radiometer (DIR) values and pyrheliometer measurements and obtain and store background scan data for subsequent use.

High-Level Calibration Function

The high-level calibration function will also exercise and demonstrate the capability of BCS software to command the cameras, receive data from the digitizer via the IEEE-488 interface and command the shutters and the pyrheliometers through the MODACS III processor via MAXNET. This shall be accomplished using SFDI developed software. This function will provide verification that the BCS software performs the following functions:

A. Determine if the beam is on target.
B. Verify the data range and exposure from the camera.
C. Command the cameras for iris adjustment, switching, and image grab.
D. Perform high-level calibration and construct calibration tables.

Beam Measurement Function

The beam measurement function also communicates with the camera and the digitizer via the IEEE-488 interface. Therefore, this software module will also serve to verify the interface between the camera, the digitizer and MODCOMP computer. This shall be accomplished using SFDI developed software. The following BCS functions will be verified by execution of this BCS software component:

A. The capability to command the switching of cameras.
B. The capability to command the camera to take an image grab.
C. Processing of data received from the digitizer.
D. Performance of power calculations.
E. Calculations of beam centroid.
F. Generation of reduced data file information.

Measurements Assessment Function

The measurements assessment function will be activated by the Beam Measurement function and will demonstrate the capability of the BCS software to calculate the theoretical beam power and to update latest calculated measurements information on the support data file. Subsequent printout of the updated data files will be used as a method of verification.

Master File Update

The master file update function will demonstrate the capability of the BCS software to update selected parameters on the BCS master file. This function will be activated by a special test driver as well as by the Measurements Assessment function; verification will be accomplished by printout of updated data files.

Normalize Function

The BCS normalize function will perform calculations of data contained in the reduced data file and will prepare data for the presentation of a contour plot which provides a means of assessment as to the calibration of a particular heliostat. SFDI developed software shall be exericsed to verify this function.

Plot Function

The BCS man-machine interface software will be utilized to verify the capability of the BCS plot function software to generate selected contour plots on the BCS terminal. This function will also demonstrate the capability to produce hardcopy output of displayed plots at the BCS terminal upon operator request. Verification shall be accomplished by observation of plotted information on the CRT and comparison of the hardcopy output to the display.

Historical Data Retrieval

A special test driver shall be utilized to exercise and verify the historical data retrieval function. The capability of the BCS software to extract information from the BCS master file, required for bias calculations in the HAC, and set the data up for transmission to the HAC will be verified by directing HAC output messages to the printer and verifying that the proper information was retrieved and properly formatted.

BCS Termination Function

The BCS termination function will be activated via special test driver to demonstrate the BCS functions can be orderly terminated upon receipt of a unique message from the HAC. In addition, a prespecified man-machine dialogue which presents various BCS termination options will be verified by observations at the BCS terminal.

Man-Machine Interface Function

The man-machine interface function of BCS will be demonstrated using the BCS terminal and invoking various operational sequences mechanized within the initialization, termination, plot and report generation functions of the BCS software, and observing the display of special prompts and fill in the blank formats. Verification that manual inputs have been accepted by the BCS software will be done with special test software to read and subsequently print out information of interest.

Report Generation Function

The report generation function will demonstrate the capability of the BCS software to generate reports on a line printer device in a prespecified format. This function shall be activated via the BCS man-machine interface and verified by examination of the generated printer output.

4.2.2 BCS Phase II Activities

The following activities will be performed during Phase II:

A. Layout BCS equipment Phase II configuration in test facility area in SIL.

1. Allocate physical location of BCS hardware
2. Establish power receptacle locations for BCS hardware
3. Layout signal cable routine from equipment bay to equipment bay

B. Define BCS special Phase II cable requirements

1. Define and provide fabrication drawings for Phase II power cables
2. Define and provide fabrication drawings for Phase II signal cables

C. Fabricate special Phase II cables

1. Fabricate special power cables
2. Fabricate special control

D. Define special BCS test equipment from equipment listed in Section 4.2.1.5

E. Install BCS equipment in the Phase II test configuration

1. Dismantle Phase I test set up
2. Relocate equipment per Figure 3-2.

F. Connect test configuration per Figure 4-11

G. Perform hardware functional testing

H. Perform hardware integration testing

I. Perform software integration and verification testing

4.2.2.1 Hardware Functional Testing

Hardware functional testing will be performed in accordance with Sections 4.2.1.6.1 then 4.2.1.6.3.

4.2.2.2 Hardware Integration Testing

Hardware integration testing shall be performed in accordance with Section 4.2.1.6.4 where applicable.

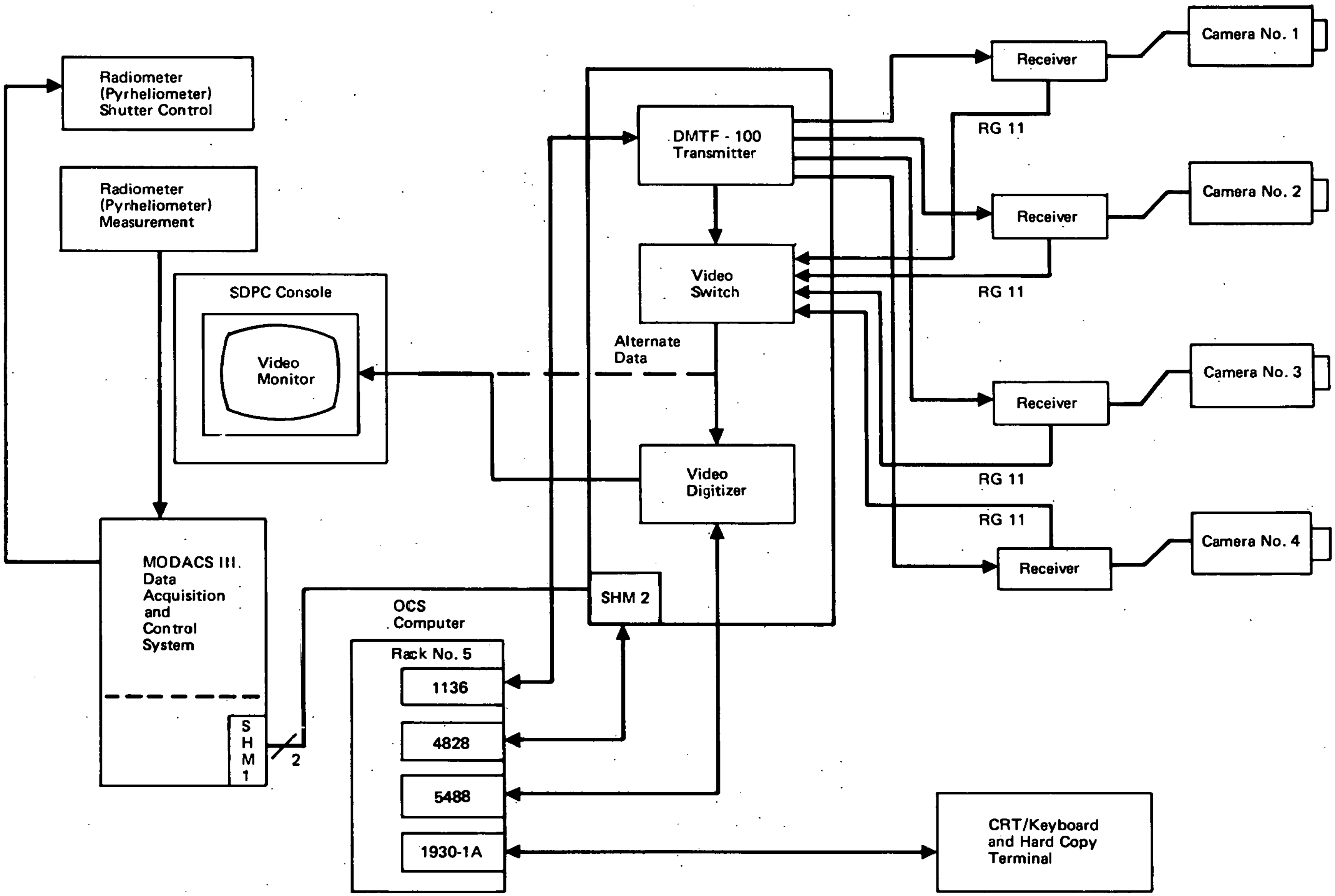


Figure 4-11. BCS Hardware Configuration

4.2.2.3 Software Integration and Verification Testing

The major complement of the BCS software will have been tested, integrated and verified during Phase I testing. Figure 4-12 indicates with cross hatching those portions of the BCS software deferred to Phase II testing activities. These functions are confined to the software modules interface with the OCS magnetic tape unit as well as the DAS computer via MAXNET. In support of BCS Phase II testing the following functions shall be performed.

A. Install BCS software on OCS computer in SIL

B. Create BCS files as required on the OCS disk

C. Perform software readiness test to determine validity of BCS software configuration

D. Demonstrate the operability of the Off-Line Heliostats Candidate List Generation Function.

E. Demonstrate the BCS archive function

F. Exercise and verify the MAXNET interface between the OCS and DAS computers with respect to acquisition of data for BCS from the DAS computer.

G. Demonstrate operation of the BCS software with other tasks resident in the OCS computer and all tasks executing concurrently.

BCS Software Readiness Testing

In order to verify the BCS software configuration loaded into the OCS computer a top level software readiness testing activity shall be performed as follows:

A. Exercise the BCS initialization function thereby verifying the man-machine interface and the operability of the BCS terminal.

B. Verify by manual input, expected HAC input commands that will serve to stimulate the operational execution of various BCS functions and list the outputs of those functions.

C. Use reduced data and support data files to verify the operability of the plot function as well as the report generation function on the OCS computer.

Heliostats Off-Line Candidate List Generation

Since there will not be a magnetic tape unit available in the special BCS test facility, BCS Heliostats Off-Line Candidate List Generation will be

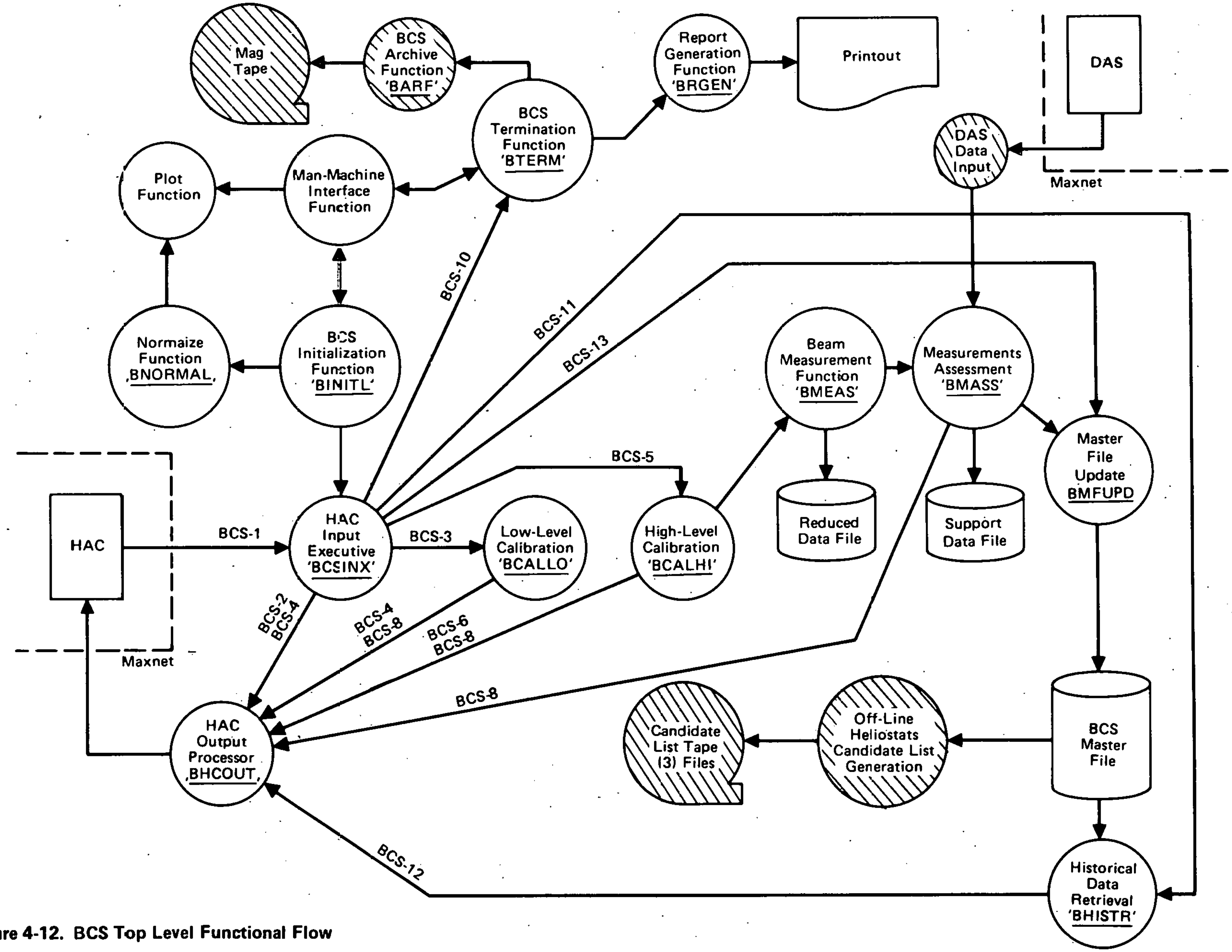


Figure 4-12. BCS Top Level Functional Flow

demonstrated in the SIL using the OCS computer and its magnetic tape unit(s). The BCS master file will be used as the primary source of input. Its content will be printed to verify the selection process by this program. The list tape generated will be listed and compared to the BCS master file entries for verification.

BCS Archive Function

The BCS archive function will be demonstrated in the SIL using the OCS hardware configuration primarily because of the magnetic tape unit availability. A simulated archive tape will be generated using special test software.

The generated tape will be verified by printing the contents thereof and comparing it to a printout of the simulated data which was generated prior to the archive operation. Verification that reinitialization of archived data files has been performed will also be determined through inquiry to the MODCOMP system.

DAS Data Input Function

The MAXNET interface with the BCS software will be verified for BCS operations in the SIL. Results will be verified by using special test software to generate DAS data. This data will be printed out on the DAS computer printer and printout of data to be transferred to OCS computer, and printed on OCS printer for comparison.

4.3 BCS SCHEDULE

The BCS hardware/software development and testing schedules are shown in Figures 4-13 and 4-14.

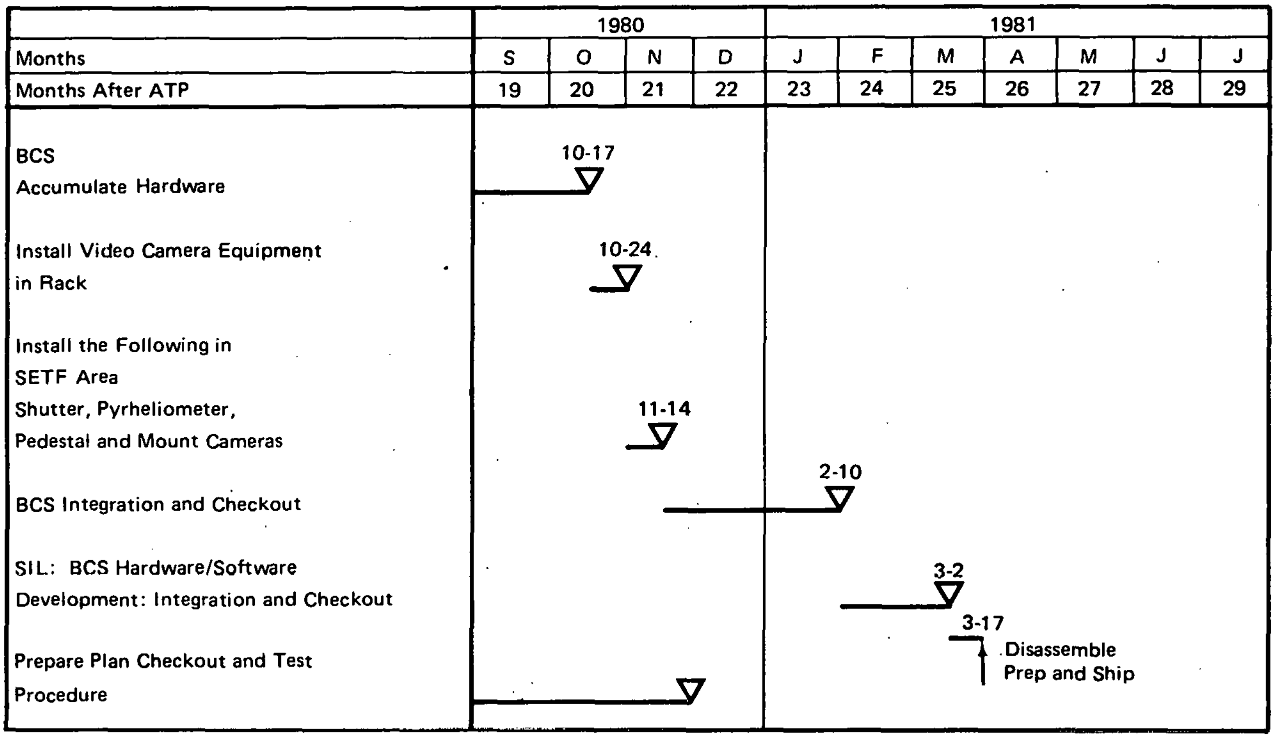


Figure 4-13. BCS System Overall Activities Schedule

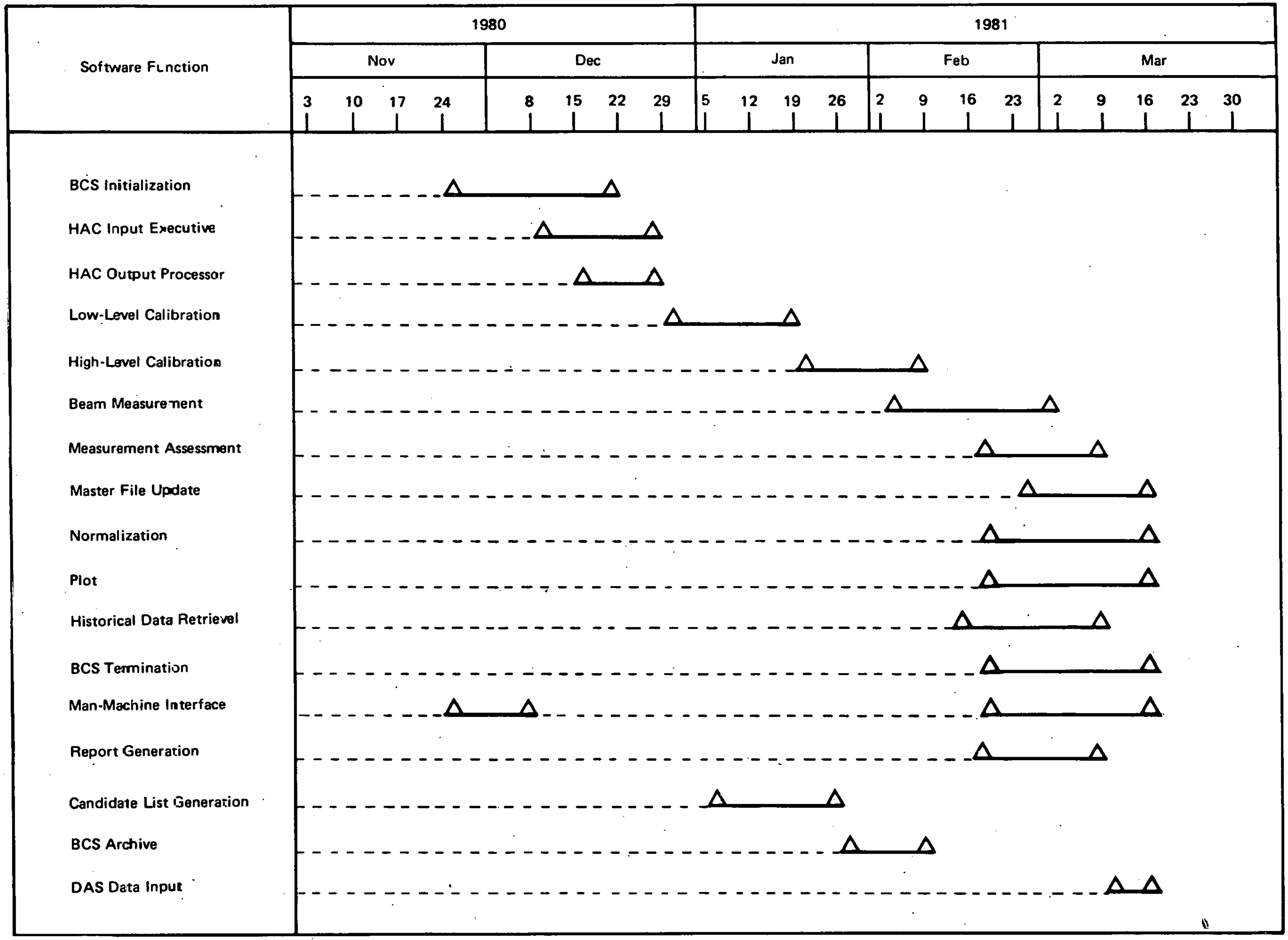


Figure 4-14. BCS Software Integration Test Schedule