SYSTEM SERVICE MANUAL

FOURIER ANALYZER
SYSTEM
5450A

HEWLETT *hp* **PACKARD**

FOURIER ANALYZER SYSTEM

5450A

ALL SERIALS

This manual applies directly to all standard
Hewlett-Packard Fourier Analyzer Systems
using the following hardware:
  HP Specification H51-180AR Oscilloscope
  HP Model 2115A or 2116B Computer
  HP Model 5460A Display Plug-in Unit
  HP Model 2737A Punched Tape Reader
  HP Model 2752A Teleprinter
  HP Model 5465A ADC Plug-in Unit
  HP Model 5475A Control Unit

See Instrument Identification, Paragraph 1-7.

SPECIAL SYSTEMS

The information required to relate this man-
ual to special systems is supplied on special
insert sheets. If this information is missing,
c o n t a c t any HP Sales and Service Office,
giving full specification number, system or
instrument name, and serial number.

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MANUAL CONTENT AND ORGANIZATION

This manual provides general information required for servicing the Hewlett-Packard 5450A Fourier Analyzer System. Operating information and specific servicing information for each unit in the system is in other manuals, as follows:

System Operating Manual

General System Information
Packaging Information
System Installation Information
System Signal Connection Descriptions
Receiving Checkout Procedure
Fourier Analyzer Operation Description
Description of Controls, Connectors,
    and Indicators
Operation Procedures

System Service Manual

Principles of System Operation
Operational Check Procedure
Adjustment Procedure, including adjustment
    and test point locations
Troubleshooting
Description of Service Kit

Computer Operating and Service Manuals

The computer and its peripherals are a subsystem of the 5450A system. The computer system manuals describe the computer and its peripherals (teleprinter and high speed tape reader), and include the following information.

General Description
Operating Information
Principles of Operation
Adjustment Procedures
Parts Lists
Circuit Diagrams
Software Manuals

The computer subsystem also includes the necessary tapes; these are listed in Volume I of the computer manual.

180A/AR Oscilloscope Operating and Service Manual with H51-180AR Special Insert Sheet

General Information
Installation
Operation
Principles of Operation
Performance Check and Adjustments
Parts Lists
Circuit Diagrams

5460A Display Plug-in Service Manual

General Description
Operating Information for Display Plug-in
    and H51-180AR Oscilloscope Mainframe
Principles of Operation
Adjustment Procedures
Troubleshooting Procedures
Parts Lists
Circuit Diagrams

5465A ADC Plug-in Service Manual

General Description
Operating Information
Principles of Operation
Adjustment Procedures
Troubleshooting Procedures
Parts Lists
Circuit Diagrams

5475A Keyboard/Power Supply Service Manual

General Description
Operating Information
Principles of Operation
Adjustment Procedures
Troubleshooting Procedures
Parts Lists
Circuit Diagrams

MANUAL AND MANUAL CHANGES (ORDERING INFORMATION)

This manual provides service information for all Hewlett-Packard 5450A Fourier Analyzer Systems. Manual changes required for special systems will be detailed in special change sheets included with manuals for those systems. If information is missing, it may be obtained by contacting the nearest Hewlett-Packard Sales and Service Office listed at the back of this manual. When requesting information or additional manuals for your system, be sure to include complete model or specification number, name, and identification number. For identification number information, see Paragraph 1-7.

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Figure 1-1. 5450A Fourier Analyzer System

SECTION I

GENERAL INFORMATION

1-1. SYSTEM DESCRIPTION

1-2. The HP 5450A Fourier Analyzer System performs statistical analysis using Fourier analysis techniques. Analysis control can be on an operation-by-operation basis or, using the six programming keys on the 5475A Control Unit, measurement routines may be automatically executed. Keyboard programming allows the 5450A to perform the following operations automatically, without special software:

    Forward and Inverse Fourier Transform
    Power Spectrum
    Magnitude and Phase Spectrum
    Auto and Cross Correlation
    Cepstrum
    Digital Filtering
    Convolution
    Histogram
    Scaling
    Hanning and other weighting functions
    Ensemble Averaging (Time and Frequency)

Six editing keys provide on-line editing so that automatically controlled measurement procedures may be changed on-line, without the need for off-line compiling or testing.

1-3. The 5450A is a completely calibrated system; all displays and data outputs are accompanied by a scale factor relating them to physical units. This calibration results from digital techniques being used in all computations. The 5450A uses the HP 2115A Computer as its Digital Processor, with 8192-word

memory; optionally, the HP 2116B Computer can be used, providing 8192 or 16384-word memory. Either computer can also be used as a stand-alone computer by setting a switch on the 5475A keyboard to COMPUTER NORMAL. Computer programming knowledge is not required for operation of the 5450A; all operations are controlled through the 5475A Control Unit keyboard.

1-4. The 5475A keyboard contains keys for thirty-one input/output and basic analysis operations. Additional numeric address keys control data flow into and out of data blocks, and permit entry of numeric values into memory. All control and data entry operations use decimal numbers for data values and data identification.

1-5. Data may be entered into the 5450A as analog signals through the two-channel 10-bit 5465A Analog-to-Digital Converter (ADC), or as digital or binary information through the Computer input channels. The 5465A ADC Plug-in can operate as a single or dual channel unit. It has a calibrated input attenuator. Two modes of internal sampling allow equal spacing of samples in either the time domain or the frequency domain.

1-6. Data may be outputted from the 5450A through the Oscilloscope display or the teleprinter, or optionally through a paper tape punch, X-Y Recorder or other recording device. The 5460A Display Plug-in and H51-180AR Oscilloscope mainframe provide a linear or logarithmic display of the stored data and signals for driving an X-Y Recorder or X-Y Display.

Table 1-1. Specifications

STANDARD SYSTEM COMPONENTS
(Ordered as 5450A)

Quantity	Model No.	Name
1	5460A	Display Plug-In
2	5465A	Analog-to-Digital Converter
1	5475A	Control Unit
2	12566A	Interface Kit
1	5450A	Interface Cable Set

Table 1-1. Specifications (Cont'd)

REQUIRED OPTIONS

The Standard System Components are items which are required for all 5450A systems. By themselves, however, these units do not form a complete system. To form a complete system, one option from each category below must also be provided.

Category	Possible Option	Comments
Display Unit Main Frame	001; H51-180A Display Main Frame	Recommended for simplest, most convenient operation
	019; H51-181A Variable Persistance Display Main Frame	Should be used only where absolutely necessary
Computer	002, 502, 602*; 2115A Computer with 8K of memory and EAU	Provides 3K of data memory divisible into 3 blocks of 1024 points down to 48 blocks of 64 points
	003, 503, 603*; 2116B Computer with 8K of memory and EAU	Provides same data memory capability as Option 002. Field Option available to expand this Option to 004, 20% faster than Option 003.
	004, 504, 604*; 2116B Computer with 16K of memory and EAU	Provides 8K of data memory divisible into 2 blocks of 4096 down to 128 blocks of 64 points. 20% faster than Option 002. Provides for larger number of peripheral devices.
Photoreader	005, 505; 2737A Paper Tape Reader	More economical photoreader
	010, 510; 2758A Paper Tape Reader Reroller	Photoreader with automatic tape reroller
Teleprinter	006, 506; 2752A Teleprinter	
	007, 507; 2752A Heavy Duty Teleprinter	
System Tapes	008; 8K System Tapes	Use with Option 002, 502, 003, 503
	009; 16K System Tapes	Use with Option 004, 504

*If computer is already available

Table 1-1. Specifications (Cont'd)

OPTIONS FOR EXPANDED FLEXIBILITY

Any of the following options may be added at the factory or in the field to expand the flexibility of the 5450A.

Category	Options	Comments
Paper Tape Punch	011, 511; 2753A High Speed Paper Tape Punch	
Binary Channel	012; 12566A Interface Kit	Each order of this option activates one of the two Binary Input/Output channels. Provides for 5 volt ground true logic levels at the interface.
	112; 12566A-M2 Interface Kit	Same as Option 012 except that .5 volt positive true logic is provided at the interface.
	212; 12554A-M1 Interface Kit	Same as Option 012 except that 12 volt ground true logic levels are provided at the interface.
	312; 12554A Interface Kit	Same as Option 212 except that 12 volt positive true logic is provided at the interface.
BCD to Binary Digital Converter	014; 10618A BCD to Binary Digital Converter Plug-In	Allows input of BCD logic signals to be converted to binary form for use in the analyzer. Plugs in, in place of ADC.
Time Interval Histogram	015; 10618A BCD to Binary Converter and 5325B Counter	This combination of instruments provides for the taking of time interval histograms with a resolution of .1 μs or .1% (whichever is less).
Large Screen Display	016; 1300A XY Display Scope	Provides auxiliary large screen display.
Point Plotter Systems	017; 7591A XY Display point plotter	Point plotter system with 2 input attenuators
	018; 7591A XY Display point plotter and chart advance	Same as 017 but with chart advance.

OPTION DESCRIPTIONS

Option	Description
001	H51-180A oscilloscope (Display Unit Main Frame)
002	2115A Computer with 8K memory and extended arithmetic unit
502	230V 50 Hz Option 002
602	Field installation to computer Option 002
003	2116B Computer with 8K memory and extended arithmetic unit

Table 1-1. Specifications (Cont'd)

OPTION DESCRIPTIONS (Cont'd)

Option	Description
503	230V 50 Hz Option 003
603	Field installation to computer Option 003
004	2116B Computer with 16K memory and extended arithmetic unit
504	230V 50 Hz Option 004
604	Field installation to computer Option 004
005	2737A High Speed Paper Tape Reader
505	230V 50 Hz Option 005
006	2752 Teleprinter
506	230V 50 Hz Option 006
007	2754 Heavy Duty Teleprinter
507	230V 50 Hz Option 007
008	System Tapes (8K Processor, Options 002, 502, 003, 503)
009	System Tapes (16K Processor, Options 004, 504)
010	2758 Paper Tape Reader Reroller
510	230V 50 Hz Option 010
011	2753A High Speed Paper Tape Punch
511	230V 50 Hz Option 011
012	1 ea Binary Channel Interface, 12566A Interface Kit, (2 Binary Channels maximum). 5 volt true logic
112	Same as 012 except +5 volt true logic
212	Same as 012 except uses 12554A-M1 Interface Kit for +12 volt ground true logic.
312	Same as 212 except +12 positive true logic
014	10618A BCD to Binary Digital Converter Plug-in
015	Time Interval Histogram (consists of 10618A Plug-in and 5325B Counter)
016	1300A auxiliary 8" x 10" display oscilloscope
017	7591A XY Point Plotter System
018	7591A XY Point Plotter System with Chart Advance
019	H51-181A Variable Persistence Main Frame for Display Unit

Table 1-1. Specifications (Cont'd)

RACK CABINET OPTIONS

Option	Description
030	1 Bay Rack Cabinet 56"
530	230V 50 Hz Option 030
031	1 Bay Rack Cabinet 70" with base extension
531	230V 50 Hz Option 031
032	2 Bay Rack Cabinet 56" with base extension
532	230V 50 Hz Option 032
033	2 Bay Rack Cabinet 70" with base extension
533	230V 50 Hz Option 033
034	3 Bay Rack Cabinet 56" with base extension
534	230V 50 Hz Option 034
035	3 Bay Rack Cabinet 70" with base extension
535	230V 50 Hz Option 035

ACCESSORIES

HP Part Number	Description
10623A	Service Extender Kit, includes: Two 5060-0049 Extender Cards One 5060-0630 Extender Card One 10603A Display Plug-in Extender Unit One 10628A ADC Extender Cable
10645A	Replacement Board Kit, includes all plug-in boards for 5460A, 5465A, 5475A.
10647A	Isolated Spares Kit, includes components to repair 5460A, 5465A, and 5475A.
10648A	Service Kit for 5450A, includes: 10623A Service Extender Kit 10645A Replacement Board Kit 10647A Isolated Spares Kit

Table 1-1. Specifications (Cont'd)

ANALOG INPUT

The 5465A Analog-to-Digital Converter accepts one or two inputs. In two-channel operation both inputs are sampled simultaneously. Resolution of the ADC is 10 bits.

Amplitude Range: 0.1V to 10V maximum in steps of 1, 2, 4, 10.

Input Impedance: 1 MΩ ± 1% shunted by 45 pF max.

Sensitivity: 30 μV RMS (sine wave)

**Conversion Gain
(Channel A):** Accuracy (as function of frequency): ±0.1% ±3 x 10^{-5}%/Hz
Temperature Stability: 0.005%/°C

Linearity: Integral, ±0.05%; Differential, ±3%

**Gain and Phase
Channel A to B:** Conversion Gain A/B: ±0.2% ±2 x 10^{-4}%/Hz
Temperature Stability: 0.01%/°C.
Phase and Delay A to B: ±0.2° ±0.5 μs.

Trigger Modes: Slope and level controls are provided. The trigger Input can be ac or dc coupled.
Internal: ADC triggers on signal to Channel A
External: ADC triggers on signal applied to External Input
Line: ADC triggers on power line frequency
Free Run: ADC triggers on data request from Processor

DIGITAL ACCURACY AND RESOLUTION

All calculations use floating point arithmetic on a block basis. Data overflow does not occur. Amplitude resolution is 1 part in 16,000 worst case.

Data Memory Size: 3072 words (8192 for a 16,384 word memory)

Data Block Size: Any power of 2 from 64 to 1024 (to 4096 with a 16,384 word memory)

Data Word Size: 16 bit real and 16 bit imaginary or 16 bit magnitude and 16 bit phase

**Computational
Range:** ±150 decades

**Transform
Accuracy:** 0.1% worst case error during the forward or inverse calculation

COMPUTATIONAL SPEED

The following are typical operations and their analysis times. These times are reduced by 20% if the 2116B Digital Processor is used.

Fourier Transform:
Block Size 1024: 3.4 s for one data block or two independent data blocks simultaneously
Block Size 64: 130 ms for one data block or two independent data blocks simultaneously

Power Spectrum Ensemble Average:
Block Size 1024: 2.4 s per spectral estimate (2 degrees of freedom)
Block Size 64: 120 ms per spectral estimate (2 degrees of freedom)

Table 1-1. Specifications (Cont'd)

COMPUTATIONAL SPEED (Cont'd)

Cross Power Spectrum Ensemble Average:
> Block Size 1024: 4.2 s per spectral estimate
> Block Size 64:   220 ms per spectral estimate

SPECTRAL RESOLUTION

The element of spectral resolution is the frequency channel width, the maximum frequency divided by 1/2 the data block size.

Maximum Frequency: 25 kHz single channel; 10 kHz dual channel. Adjustable in steps of 1, 2, 5 down to 0.2 Hz.

Frequency Channel Width: < 3.2% down to < 0.2% of the maximum frequency in steps of 2 (down to < 0.05% for 16,384 word processor)

Spectral Resolution of Two Equal Amplitude Sine Waves: If separated by 3 frequency channel widths, there will be a null of at least 3 dB between them; if separated by 7 frequency channel widths the relative magnitudes will be correct to within 0.1%. The power spectrum for two equal amplitude sine waves separated by 5 frequency channels will have the correct relative magnitude to within 0.1%.

Dynamic Range: 4 decades over ±150 decades

Frequency Accuracy: ±0.01%

TIME DOMAIN RESOLUTION

The element of time resolution is the time channel width, the time sample record length divided by the block size.

Maximum Sample Record Length: Product of data block size and time channel width. (In Ensemble Averaging up to 32,767 Sample Record Lengths may be used for a statistical estimate.)

Time Channel Width: 20 μs, single channel; 50 μs, dual channel, up to 5 s in steps of 1, 2, 5. Accuracy 0.01%.

DISPLAY UNIT

Data may be displayed on the 8 x 10 cm oscilloscope or output to a plotter or remote oscilloscope in the following forms.

Y AXIS	X AXIS
Real Part Amplitude	Time
Real Part Amplitude	Frequency (Linear or Log)
Imaginary Part Amplitude	Frequency (Linear or Log)
Magnitude (Linear or Log)	Frequency (Linear or Log)
Phase	Frequency (Linear or Log)
Imaginary Part Amplitude	Real Part Amplitude
(Nyquist Plot)	

Table 1-1. Specifications (Cont'd)

DISPLAY UNIT (Cont'd)

Analog Display Accuracy: ±1%

Amplitude Scale: Data in memory is automatically scaled to give a maximum on-screen calibrated
display. A scale factor is given in volts/division or volts^2/division.

Linear Display Range: ±4 divisions with scale factor ranging from 1×10^{-150}
to $5 \times 10^{+150}$ in steps of 1, 2, 5.

Log Display Range: 4 decades with a scale factor ranging from 0 to -99.9 decades.

Time and Frequency Scale:
Linear Sweep Length: 10, 10.24, or 12.8 division

Log Horizontal: 0.5 decade/division

Markers: Intensity markers every 8th or every 32nd point

Analog Plotter Output:
Amplitude: 0.5V per oscilloscope display division

Output Range: 1 − 20 pts/s (500 pts/s external timing)

Linearity: 0.1% of Full Scale

GENERAL

Power Source: 115/230V ±10%, 50/60 Hz

Environmental Conditions: +10°C to +40°C (0°C to 55°C using the 2116B Processor)

1-7. IDENTIFICATION NUMBERS

1-8. Model Number and Name

1-9. Each unit in the standard Fourier Analyzer Sys-
tem is identified by model or specification number
and name as a separate instrument; these are:

Specif. H51-180AR Oscilloscope
Model 2115A or 2116B Computer
Model 2737A Punched Tape Reader
Model 2752 Teleprinter
Model 5460A Display Plug-in Unit
Model 5465A ADC Plug-in Unit
Model 5475A Control Unit

1-10. Serial Numbers

1-11. 5450A System

1-12. Each 5450A System is identified by a two-
section system serial number (000-5450A). The
number is on a stick-on plate mounted inside rear of
system cabinet. The 3-digit number is a serial
number unique to each 5450A system, and the other
portion provides the system model number.

1-13. Each unit in the 5450A System is identified by
a two-section serial number (000-00000). The first
section is a serial prefix number, used to document
changes to the unit; the second portion of the serial
number is a number unique to each instrument (of
that model number).

1-14. Computer Subsystem

1-15. Components of the Computer Subsystem have
stick-on serial number plates with the legend "SYS-
TEM SERIAL 00000." The "system" serial number
on these plates is for the Computer Subsystem of the
5450A only, and is not the 5450A system serial number.

1-16. Include complete model name, model number,
and serial number of any unit or units in all corre-
spondence about your system.

1-17. CRT WARRANTY

1-18. The 5450A and each of its individual units are
certified and warranted as stated on inside front cover
of this manual. The CRT (Cathode Ray Tube), how-
ever, is covered by a warranty separate from the rest
of the system. The CRT warranty and warranty claim
form are located in the H51-180A/AR Oscilloscope
manual. Should CRT fail within time specified on
warranty, return CRT with warranty form completed.

1-19. STORAGE AND SHIPMENT

1-20. Packaging

1-21. To protect valuable electronic equipment during storage or shipment, always use the best packaging methods available. Your Hewlett-Packard Sales and Service Office can provide packaging material such as that used for original factory packaging. Contract packaging companies in many cities can provide dependable packaging on short notice.

1-22. SCOPE OF THIS MANUAL

1-23. Operating Information

1-24. This manual contains only the operating information required to service or troubleshoot the 5450A Fourier Analyzer system. For more extensive operating information, refer to the system Operating Manual.

1-25. System Coverage

1-26. This manual provides service information for the basic 5450A system (which uses the 2115A Computer), with some additional information for systems including the 2116B Computer. Computer peripheral devices (Photoreader, Teleprinter, Tape Punch, etc.) should be documented as part of the Computer Subsystem. Other system options are also documented separately, as separate instruments.

Table 1-2. System Installation

HP PART NUMBER OF CABLE	CONNECTIONS	LABEL IN PHOTOS (Some locations may not be visible)
02116-6112	Computer: "READER" card, Channel 10	A1
	Photoreader: Rear connection	A2
05450-60001	Computer: To cable from front-panel switches	B1
	Computer: To FPC card A8	B2
	Control Unit: J11A, B	B3
05450-60002	Computer: "DISPLAY" card, Channel 15	C1
	Oscilloscope: J113A, B	C2
	Control Unit: J18	C3
05450-60003	Computer: "ADC" card, Channel 14	D1
	Control Unit: J12	D2
05450-60004	Computer: "BUFF. TTY", Channel 11	E1
	Control Unit: J14	E2
Teleprinter Cable	Control Unit: J13	F1
Power Cables (for 2115 only)	Computer:	G, H 1
	Power Supply: J2, 3	G, H 2
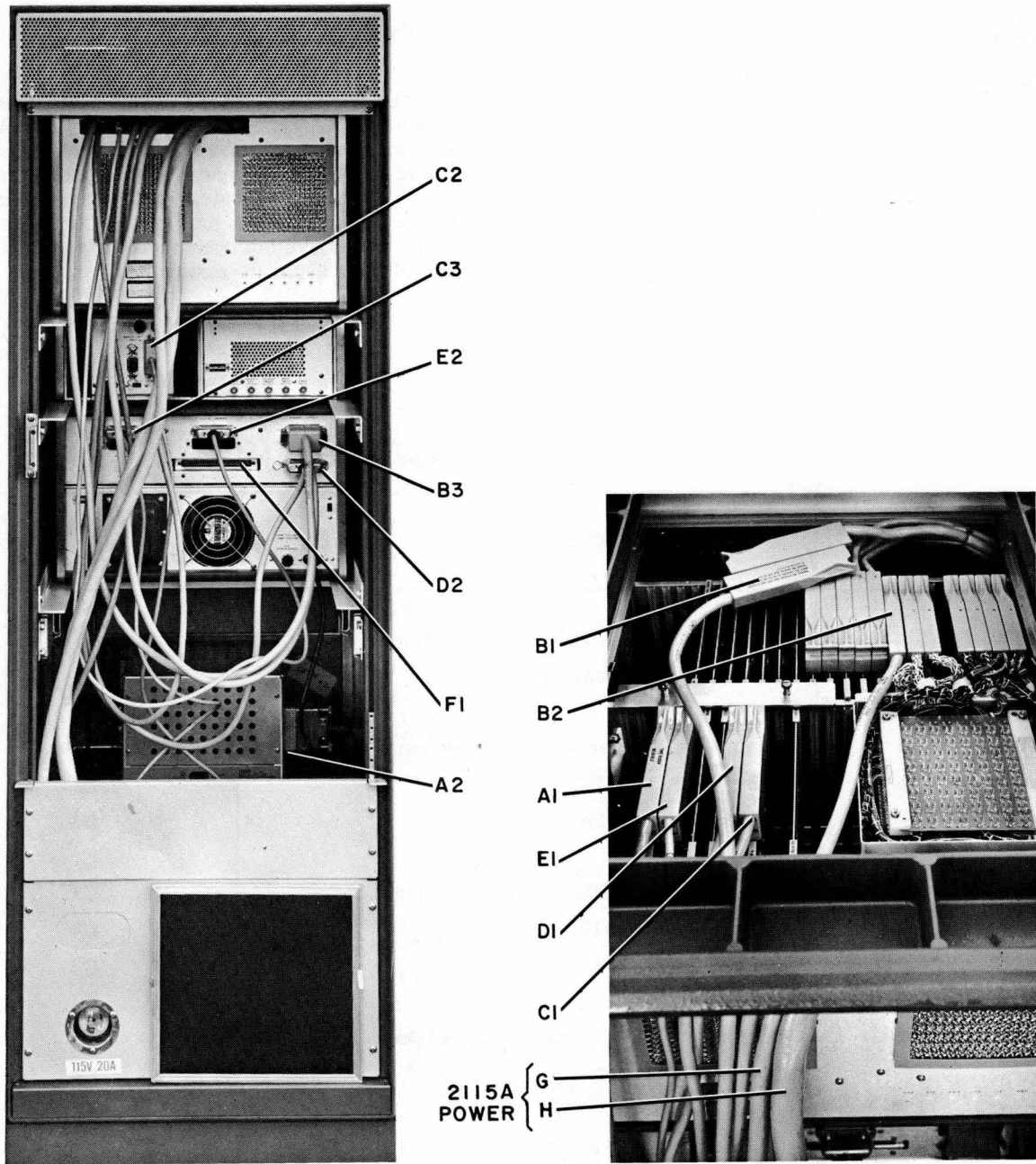
Table 1-2. System Installation (Cont'd)

SYSTEM WITH 2115A

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Table 1-2. System Installation (Cont'd)

C2
E2
B3
D2
FI
C3
B2
AI
A2
EI
DI
CI
BI
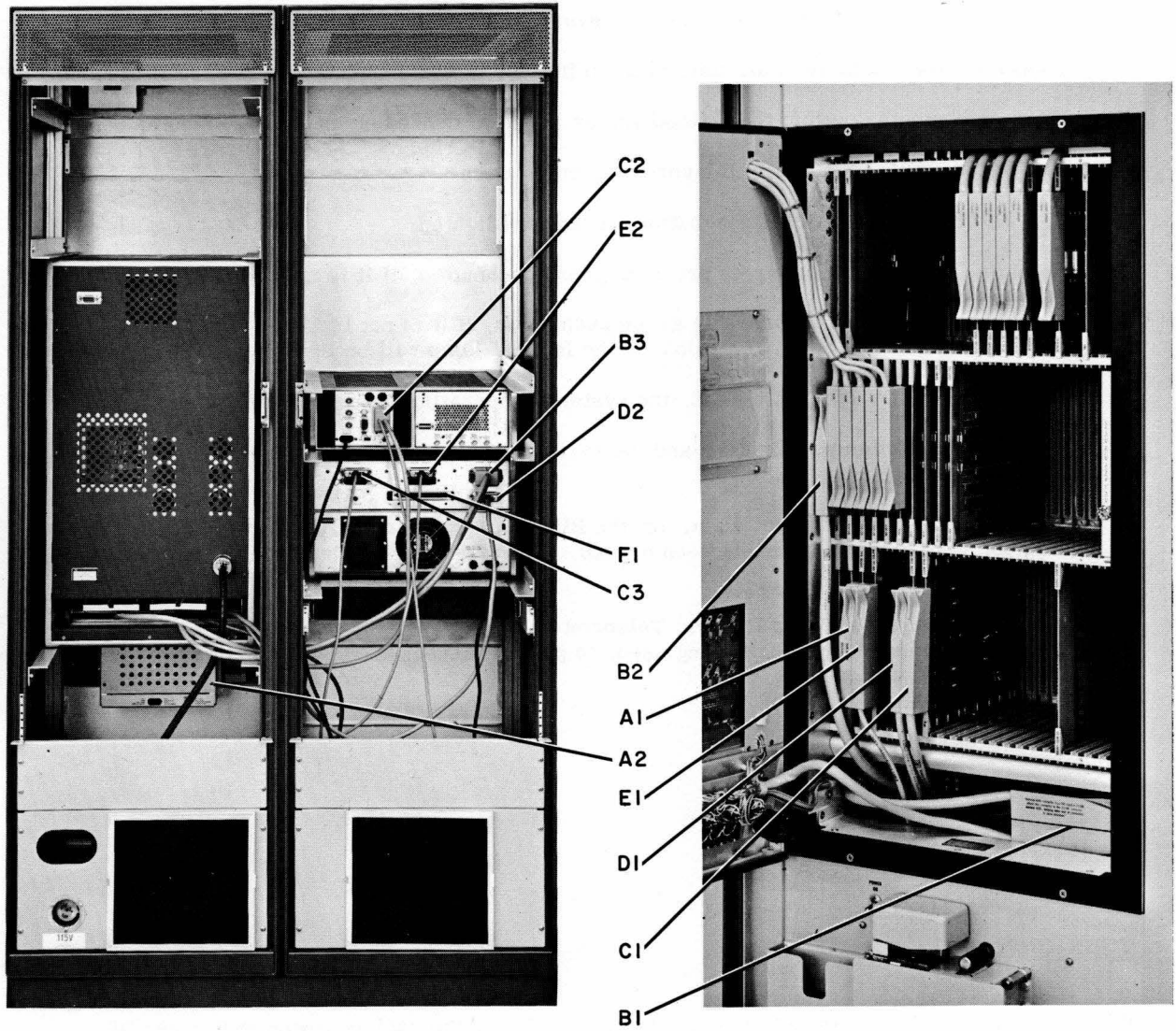
SYSTEM WITH 2116B

Table 1-3.   System Turn-On and Turn-Off

TURN-ON

1.   Set 5475A keyboard COMPUTER NORMAL/FOURIER ANALYZER switch to FOURIER
     ANALYZER.

2.   Turn on cabinet power; the method varies slightly, depending on the cabinet in which your
     system is mounted.

     a.   Press red button/lens at upper right-hand corner of cabinet, in trim strip.
          or
     b.   Switch the dual-handle power switch lever to its upper position.

     Power is now available to all units plugged into the power connector strip at rear of cabinet.

3.   Turn on computer power; the method varies slightly, depending on which computer you have.

     a.   2115A: Flip toggle switch lever to its up position.

     b.   2116B: Press POWER pushbutton, if it is not lighted.

4.   Turn on Oscilloscope power by pressing green pushbutton, if it is not lighted.

5.   Turn on 5475A power by pressing green pushbutton, if it is not lighted. When the
     5475A is turned on, either the BUSY or the READY lamp will be lighted.

     a.   If the READY lamp is lighted, the system is operating properly in the Fourier mode.

     b.   If the BUSY lamp is lighted, and the system does not seem to respond to keyboard
          commands, press RESTART.

     If the READY lamp does not light, or the BUSY lamp goes out, all or part of the Master
     Fourier Program has probably been erased. Load the Fourier Program as described in
     Table 1-4.

6.   Auxiliary equipment (Tape Reader; Teleprinter; Tape Punch, if your system has one; etc.)
     should be turned off when not being used, to prevent unnecessary wear on the mechanical
     parts of these devices.

TURN-OFF

With all system instruments turned on as described above, the cabinet power switch can be
used as the main system power switch; to turn the system off, turn off power at this switch.
When the system is turned on, the Computer (Digital Processor) returns to the state (address,
program, etc.) it was at when the system was turned off. If the Computer had been operating
in the COMPUTER NORMAL mode, and the 5475A COMPUTER NORMAL/FOURIER ANALYZER
switch is switched to FOURIER ANALYZER, the RESTART button must be pressed before any
Fourier Analysis can begin.

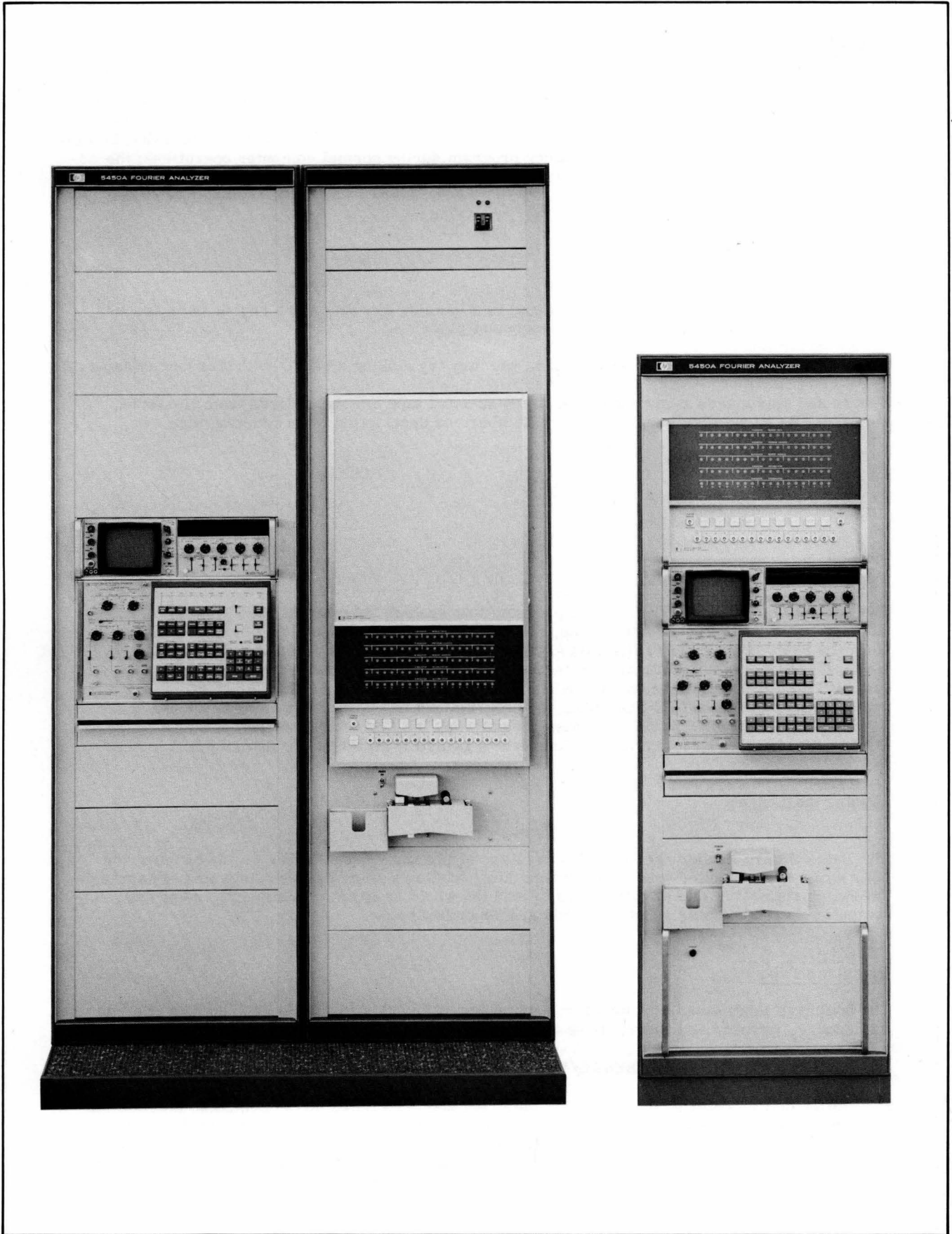Table 1-3.   System Turn-On and Turn-Off (Cont'd)

Table 1-4. Loading Punched Paper Tape

GENERAL

Punched paper tapes are normally loaded into the Computer through the High Speed Tape Reader (Photoreader). Input through the Photoreader is controlled by the Basic Binary Loader program, which occupies the last 64 locations of the Computer memory; these locations can be PROTECTED to prevent accidental erasure of the Loader program during normal computer operations; the protection is eliminated when the LOADER is ENABLED to read in a tape.

CARING FOR PAPER TAPES

Wind tape so identification (beginning of tape) is at outside of roll. Put a rubber band around the tape roll. Store the roll in a safe, convenient place.

Take care not to tear tape. If tape is torn, you may try making a repair with transparent tape.

If wear and tear makes a tape unusable, a replacement tape may be ordered from Hewlett-Packard. Be sure to include the HP Part Number and description when ordering tape.

BASIC BINARY LOADER

General

The Basic Binary Loader (BBL) is the program that enables tapes to be loaded into the Computer memory through the Photoreader. The BBL occupies the last 64 locations in 8K or 16K memories. When the 5475A COMPUTER NORMAL/FOURIER ANALYZER switch is set to FOURIER ANALYZER, the BBL program is automatically protected from erasure when other programs or data are entered into the Computer memory. When the COMPUTER NORMAL/FOURIER ANALYZER switch is set to COMPUTER NORMAL, the program can be protected by placing the Computer's LOADER switch to PROTECTED. Thus, the only way the BBL can be erased is by operating in COMPUTER NORMAL mode with the Computer's LOADER switch set to ENABLED.

Loading the Loader

The Basic Binary Loader can be loaded in either of two ways. The faster way is by using the "bootstrap" tape supplied with your system, after loading a short program into memory through the switch register. The slower way is to load the whole program into memory, using the computer switch register. Both methods are described below.

Bootstrap Tape

The bootstrap tape, supplied with your Fourier Analyzer system, should have no feed holes in the leader. To load the Loader, using the "bootstrap" tape:

1. Set 5475A COMPUTER NORMAL/FOURIER ANALYZER switch to COMPUTER NORMAL.

2. Using the Computer switch register, enter the numbers listed on the bootstrap tape, in the order given. The first will be "SA-20," meaning Starting Address 20 (this is the first address of the program that loads the loader); load this information by setting the switch register to 000020_8, then pressing LOAD ADDRESS. Check that the switch positions are correct by reading number on the M- and P-REGISTERS; the numbers should both be 000020_8.

Table 1-4. Loading Punched Paper Tape (Cont'd)

BASIC BINARY LOADER (Cont'd)

Bootstrap Tape (Cont'd)

Set Switch Register to (Octal Number)	Press Computer button labeled
000020	LOAD ADDRESS
103710* 102310* 026021 102510* 001727 103710* 102310* 026026 102410* 170001 006004 026020	LOAD MEMORY
077700	LOAD B

*The last two digits in these numbers are the number of the Photoreader input channel in typical systems, as shipped from the factory. If your system has the Photoreader input in a different Computer channel, replace the last two digits of these numbers with the two digits that identify the channel being used.

3. Set switch register to 000020_8, then press LOAD ADDRESS.

4. Place bootstrap in Photoreader. Feed holes in tape (evenly spaced holes, slightly smaller than data holes) should be toward Photoreader panel. All data and feed holes should be to left-hand side of reading head; to ensure this, place leader (on which numbers are printed) in Photoreader between lamp and photodiodes.

5. Set Computer LOADER switch to ENABLED.

6. Press Computer RUN. Bootstrap tape should run through reader. After tape has run through reader, press Computer HALT and set LOADER to PROTECTED. If tape does not run through reader, check the following:

Are feeder holes in tape toward reader front panel (away from you)?

Are feeder holes in reader mechanism clean? Cleaning instructions are provided elsewhere in this table (see LOADING PROBLEMS).

Is the tape under the wire guide in the Photoreader?

If the above items have been checked, and are OK and the tape still does not run through the photo-reader after RUN is pressed, a number may have been entered incorrectly prior to loading the bootstrap tape. Check each number by performing the following procedure:

Set switch register to 000020_8.

Press LOAD ADDRESS. M- and P-REGISTERs should show 000020_8, T-REGISTER contents are immaterial.

Press DISPLAY MEMORY. T-REGISTER should show contents of address 20 (this was first number loaded into memory). M and P-REGISTERs are incremented one address at this time.

Press DISPLAY MEMORY. T-REGISTER will show contents of memory location whose address was in M- and P-REGISTERS when button was pressed. M- and P-REGISTERS will be incremented to next address.

Repeat above step until you have checked all numbers on bootstrap tape leader, or until you come to a number that disagrees with what's on the bootstrap, in the correct sequence. If you find an incorrect entry, return to address 20. Press DISPLAY MEMORY until you are at the memory location immediately preceding the one to be changed. Set the switch register to the number to be entered, and press LOAD MEMORY. Set the switch register to 000020_8 again, and recheck memory contents against above list of numbers.

Table 1-4. Loading Punched Paper Tape (Cont'd)

<u>BASIC BINARY LOADER</u> (Cont'd)

<u>Bootstrap Tape</u> (Cont'd)

If the program to load the loader cannot be loaded correctly, or if the loader tape will not run when the program is correct, refer to Computer service manuals.

If the program to load the loader is correctly loaded and the loader tape runs, press the HALT button when loader tape is through reader. Set LOADER switch to PROTECTED.

This completes instructions for loading the Basic Binary Loader using the bootstrap tape. With this program in the computer's memory, you can now load any other punched paper tape.

<u>Switch Register</u>

To load the Basic Binary Loader program, using only the Computer's front-panel switch register:

1. Set Switch Register to starting address of Loader 0m7700, listed in chart below.
2. Press LOAD ADDRESS.
3. Set LOADER switch to ENABLED.
4. Set Switch Register to value of first instruction (see chart below).
5. Press LOAD MEMORY.
6. Set Switch Register to value of next sequential instruction.
7. Press LOAD MEMORY.
8. Repeat Steps 6 and 7 until all 64 instructions have been loaded.
9. Set LOADER switch to PROTECTED.

Instructions for Basic Binary Loader

Address	0	1	2	3	4	5	6	7
0m7700:	107700	063770	106501	004010	002400	006020	063771	073736
0m7710:	006401	067773	006006	027717	107700	102077	027700	017762
0m7720:	002003	027712	003104	073774	017762	017753	070001	073775
0m7730:	063775	043772	002040	027751	017753	044000	000000*	002101
0m7740:	102000	037775	037774	027730	017753	054000	027711	102011
0m7750:	027700	102055	027700	000000*	017762	001727	073776	017762
0m7760:	033776	127753	000000*	103710	102310	027764	102510	127762
0m7770:	173775	153775	1n0100	177765	000000*	000000*	000000*	000000*

m = 1 for 8K memory

= 3 for 16K memory

n = 6 for 8K memory

= 4 for 16K memory

*Can be some number other than 000000

This completes instructions for loading the Basic Binary Loader using the switch register. With this program in the computer's memory, you can now load any punched paper tape.

Table 1-4. Loading Punched Paper Tape (Cont'd)

LOADING FOURIER PROGRAM TAPE

General

The 5450A is shipped from the factory with the Fourier Program Tape loaded into the Computer's memory; it should be necessary only to follow the turn-on procedure (Table 1-3) to turn the system on. However, if the Computer has been used as a general-purpose digital computer (i. e., operating in the COMPUTER NORMAL mode), or if some accident has destroyed the Fourier program in memory, it will be necessary to reload the Fourier Program Tape, using the following procedure. If you are not sure that the complete and correct program is in memory, load the tape. Reloading will not modify data that was previously stored in memory by the Fourier Program.

Procedure

1. Set 5475A COMPUTER NORMAL/FOURIER ANALYZER switch to FOURIER ANALYZER, to enable keyboard control.

2. If your 5450A has a High Speed Tape Punch, use the Fourier Program Tape labelled "A1." This tape will cause the Tape Punch to operate when the 5475A keyboard PUNCH key is pressed. If your 5450A does not have a High Speed Tape Punch, use the Fourier Program Tape labelled "A2." This tape will cause the Teleprinter tape punch to operate when the PUNCH key is pressed.

3. Place tape in Photoreader, as described in reader operating instructions.

4. Press 5475A LOAD TAPE button. Tape should run through reader and stop at the end. If it does, remove tape from reader as per loading instructions, rewind it, and store it as described above, and press RESTART. If tape does not perform as described, make the following checks:

    Is COMPUTER NORMAL/FOURIER ANALYZER switch set to FOURIER ANALYZER?

    Are tape feed holes toward instrument front panel?

    Are you starting close enough to beginning of tape so no data is lost?

    Is tape running under wire guide in reader?

    If you still have problems loading the Fourier Program Tape, refer to LOADING PROBLEMS section of this table.

    Finally, go back to the beginning, and reload the Basic Binary Loader.

Loading Fourier Tape (Summary)

1. Set 5475A keyboard switch to FOURIER ANALYZER.

2. Use "A1" tape if your system includes High Speed Tape Punch, otherwise use "A2" tape.

3. Place tape in Reader.

4. Press 5475A LOAD TAPE.

5. After tape has been run, and halted correctly, press RESTART.

Table 1-4. Loading Punched Paper Tape (Cont'd)

2737A PUNCHED TAPE READER OPERATING INSTRUCTIONS

1. Set power switch ON. To prepare for loading tape, place in LOAD position by pressing RUN tab down.

2. Place tape in holder with feed holes toward the panel and positioned so that the tape will unwind counterclockwise when it is being read.

3. Feed tape through reader from left to right. The first data frames must be to the left of the read element. The tape leader must pass between the rollers on the right.

4. Ensure tape is under wire guide in Photoreader.

5. Place in RUN position by pressing up LOAD tab.

6. To unload tape after it has been loaded or read, press RUN tab down and remove tape.
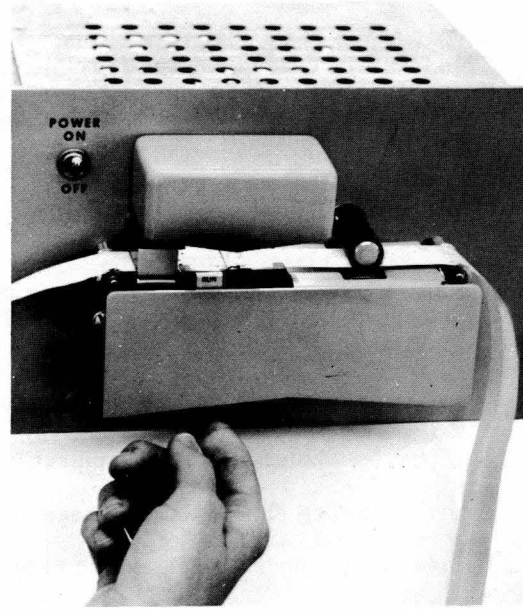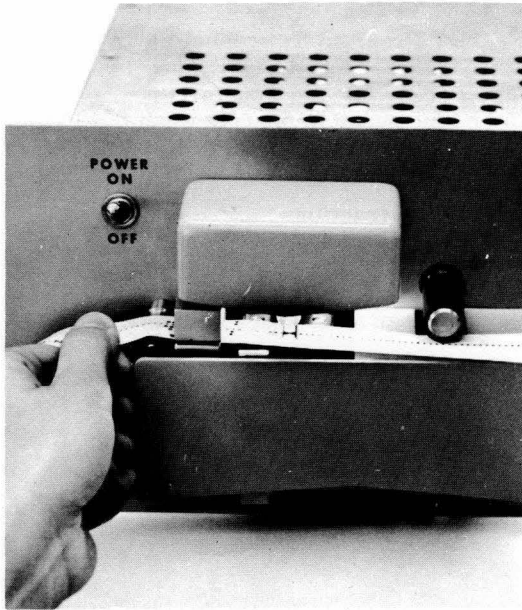
LOADING PROBLEMS

Sometimes operator error or dirty equipment can prevent a tape from being loaded properly. If you are having trouble loading tape consider the possibility of one or more of the following problems:

1. Tape not correctly placed in reader.

   a. The row of small feed holes (except for bootstrap loader leader) is not centered on the tape; when the tape is placed in the reader, these holes should be toward the reader front panel, instead of toward you.

   b. Tape placed too far to right through reader. Unless otherwise instructed, all data holes should be to left of reading element before tape begins its run through reader.

Table 1-4. Loading Punched Paper Tape (Cont'd)

LOADING PROBLEMS (Cont'd)

    c.   Tape loaded backward in reader. All tapes supplied with your system are identified by a label at the beginning of the tape. When rewinding the tape, be sure this leader is at the outside of the roll.

  2. Tape torn or dirty. Tape that is faulty, or not clean, may be read incorrectly.

  3. Dirty reader. To clean reader:

    a.   Try blowing dirt away with your breath.

    b.   Remove tape and clean reader using alcohol and brush supplied with your 5450A system. Brush feeder holes clean; also lightly brush buttom of reader lens. Blow dirt away with your breath.

1-27. USING COMPUTER IN "COMPUTER NORMAL" MODE

The 2115A or 2116B Digital Computer can be used as a stand-alone Computer. To do this, place the 5475A Keyboard COMPUTER NORMAL/FOURIER ANALY-ZER switch in COMPUTER/NORMAL position before turning on main power. To operate the Computer, it is also necessary to have the 5475A Keyboard ON/OFF switch set to ON.

1-28. SERVICE AIDS

1-29. Service Kit

1-30. This System Service Manual is intended to support the Service Kit for the HP 5450A Fourier Analyzer System. The kit contains most-often-needed replaceable parts for the following 5450A system units:

        5460A Display Plug-in Unit
        5465A ADC Plug-in Unit
        5475A Control Unit

1-31. Board Exchange

1-32. Hewlett-Packard provides exchange printed circuit boards for the following 5450A system units:

        5460A Display Plug-in Unit
        5465A ADC Plug-in Unit
        5475A Control Unit

The board exchange program works as follows:

  a. Repair 5450A Fourier Analyzer System with Service Kit. Replace faulty boards in system with good boards from kit. Tag bad boards with a description of trouble caused in system.

  b. Order rebuilt board(s) from Hewlett-Packard.

  c. When a replacement board arrives, place it in the 5450A Service Kit. Save the box the board came in.

  d. The box in which you received your replacement board will also contain an address label to be used for returning the board to the repair center, and a form to provide information about the trouble the board caused. Place the bad board in the box, along with the trouble description form (filled in), and stick the address label over the old address on the box. Send the board to the repair center.

Table 1-5. Access Information

PULL-OUT TABLE

One unit in the 5450A system is a pull-out writing table. For access to the table pull out on the trim strip/handle on front panel of the table unit.

PLUG-INS

The 5450A system contains two plug-ins. One plug-in is mounted in the H51-180AR Oscilloscope; the other one is in the 5475A Control Unit. To remove either plug-in, loosen the one or two knurled mounting screws that attach it to its mainframe unit. Pull out gently on the screw(s) for initial separation of the plug-in from the mainframe unit connectors. Now grasp the plug-in at one or more convenient points and pull it out of its mainframe unit.

To replace a plug-in, reverse the above procedure.

REAR DOOR

To prevent unauthorized access to connections at rear of system, the system cabinet is fitted with a lockable rear door; two keys for the door are provided.

To open the door, unlock it, turn latch handle 90° from locked position, and open the door.

To remove door, pull down on handle of "L"-shaped upper hinge pin and separate upper hinged corner of door from cabinet. The door can be lifted out of its lower mounting bracket. To install the door, reverse the above procedure. The cabinet design allows the door to be mounted as either a right-hand-opening or left-hand-opening door. To reverse door mounting, remove it (as described above), move latching bracket to other side of cabinet rear, and install door so it opens as desired.

REMOVING AN INSTRUMENT

To remove one of the rack-mounted units from the cabinet, proceed as follows:

1. Turn off system power.

2. Disconnect all cables from rear of instrument to be removed.

3. Remove plastic trim strips at each side of cabinet front (see photo). To remove trim strip, use fingernail or some other convenient wedge to pull one end out of cabinet channel in which it is mounted. Then carefully remove strip from cabinet. Do not make any sharp bend in strip.

4. With both trim strips removed, all mounting screws are accessible. These are Pozidriv screws and may be removed with either a Pozidriv or phillips screw driver. The unit may now be removed from the system and a new unit put in its place.

5. When installing a new unit in the cabinet, put first rack mounting screws in the bottom holes of the unit's rack mounting brackets; then proceed up brackets with remaining screws. After attaching new unit to rack, connect it as described in Table 1-2.

6. Complete installation by replacing plastic trim strips removed in Step 3 of this procedure. To replace a strip, place one end in the guide channel and press it into the guide channel for its length. When replacing the trim strip, be sure it is mounted firmly in its channel so it will clear the pull-out table when the table is opened and closed.

TOP COVER

The cabinet top cover is held in place by four flat-head Pozidriv screws and/or four eyebolts. To remove the cover, remove retaining screws and/or eyebolts. Eyebolts simply unscrew from cabinet frame.

Table 1-5. Access Information (Cont'd)

KEYBOARD REMOVAL

The 5475A Control Unit Keyboard may be removed for maintenance (contact cleaning) or replacement.

1. Pull 5475A four to six inches forward from its normal rack-mounting position (see REMOVING AN INSTRUMENT, on previous page).

2. Loosen three pozi-driv screws at top of keyboard unit.

3. Remove three pozi-driv screws at bottom of keyboard unit.

NOTE

Keyboard unit is connected to 5475A Main Frame by two cables. When separating these two units, be sure to be gentle, to avoid straining cable or damaging connectors.

4. Gently separate keyboard unit from main frame. When you feel movement stopped by cable pull, stop, reach behind keyboard unit, and disconnect the two cables, then continue removing keyboard from main frame.

To replace keyboard, reverse the above procedure.

Table 1-5. Access Information (Cont'd)
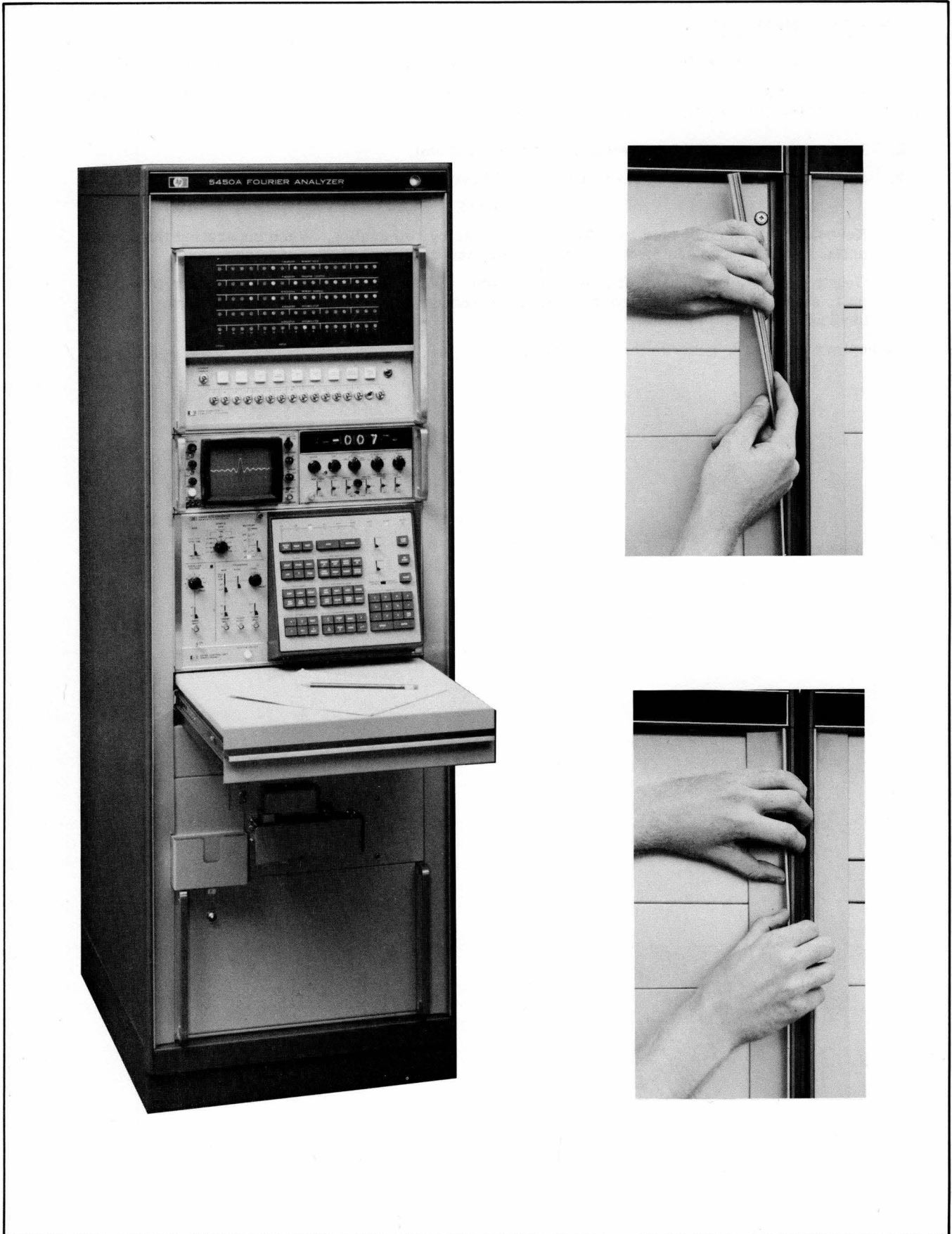
Table 1-6. Test Equipment Specifications

This table lists specifications for test equipment required to maintain the 5460A, 5465A, and 5475A portions of your 5450A Fourier Analyzer System.

Equipment Type and Critical Specifications	Recommended Instrument Model (Hewlett-Packard instruments, unless noted otherwise)	Use*
RF Voltmeter Frequency range 500 kHz to 1 GHz Voltage range 10 mV to 10V	411A	2, 3
DC Voltmeter Voltage range 1 mV to 500V Accuracy ±1% of full scale	412A	2, 3
AC Voltmeter Voltage range 10 mV to 5V Frequency range 10 Hz to 1 MHz	427A	1, 2, 3
Digital DC Voltmeter 6-digit readout voltage range 1 to 100V. Accuracy 0.004% of reading	3460B	2
Oscilloscope Frequency range DC to 50 MHz Sensitivity range .005V/div to 20V/div Sweep range .05 μsec/div to 2 sec/div	180A + 1801A + 1820A	2, 3
Frequency Counter Frequency range DC to 50 MHz Accuracy ±1 count Sensitivity 0.1 Vrms	5245L/M	2, 3
Oscillator Frequency range 4 Hz to 2 MHz Output voltage (maximum) 20V P-P in open circuit	209A	1, 2

*1 = Operational Check, Table 3-1
 2 = Adjustments, Table 3-2
 3 = Troubleshooting, Table 4-1

Table 1-6. Test Equipment Specifications (Cont'd)

Equipment Type and Critical Specifications	Recommended Instrument Model (Hewlett-Packard Instruments, unless noted otherwise)	Use*
Pulse Generator 10 nanosecond rise time Overshoot + ringing < 5% of pulse and amplitude Repetition rate 20 Hz to 100 kHz Positive pulse out from .05V to 5V	8002A	2, 3
DC Standard Voltmeter Calibrator Output range 0–10V - 5 place readout Accuracy .002% of setting + .0004% of range	740B	2, 3

*1 = Operational Check, Table 3-1
 2 = Adjustments, Table 3-2
 3 = Troubleshooting, Table 4-1

SECTION II

PRINCIPLES OF OPERATION

2-1. INTRODUCTION

2-2. Operation of the 5450A Fourier Analyzer can be separated into three basic functions: data input-- data processing--data output. Refer to the block diagram of Figure 2-1. Input devices to the computer consist of the 5465A A/D Converter, 2752A Teleprinter (keyboard and paper tape reader), and 5475A Control Unit keyboard. The ADC samples raw data in the form of analog signals and digitizes these signals for input to the computer. The teleprinter contains a paper tape reader and keyboard for digital input in ASCII format to the computer. The 5475A Control Unit transfers manual entries on the front keyboard to the computer (also ASCII format). An optional binary input channel accepts digital information for transfer to the computer from a magnetic tape device or external computer.

2-3. The 2115A or 2116B computer processes the input data under control of the software program and in accordance with system mode. The processed data is displayed or recorded on various output devices.

2-4. The 5460A Display Unit accepts data from the computer and provides X and Y axis outputs to the H51-180AR Oscilloscope display, and to the optional X-Y display screen or plotting device, if desired. The 2752A Teleprinter either prints out the computer data or punches the data on the attached paper tape punch, upon computer command. An optional 2753A High Speed Paper Tape Punch may also be used to store the data on paper tape, or the optional binary output channel may be used to store the output data on magnetic tape or external memory.

Figure 2-1. 5450A Overall Block Diagram
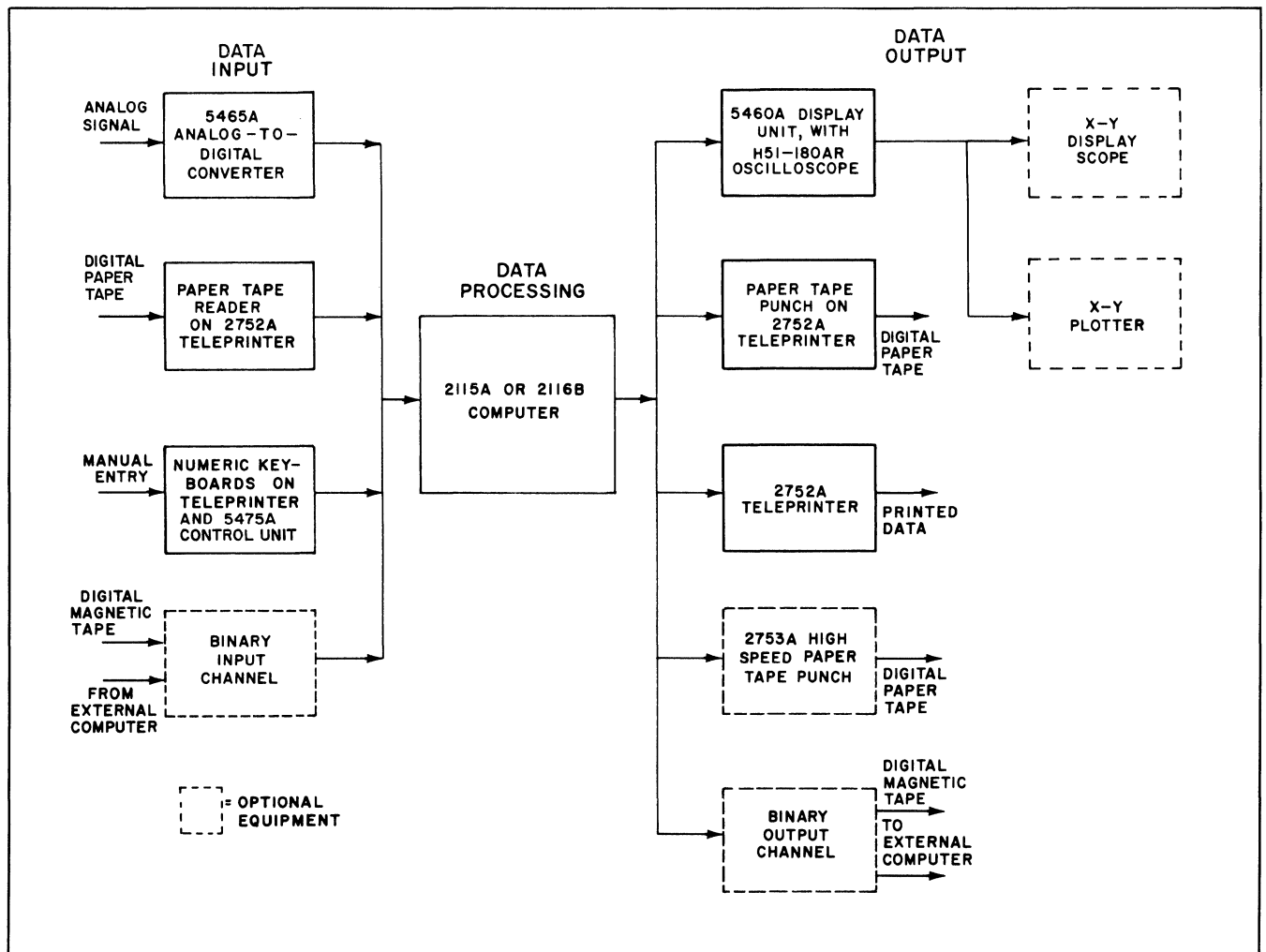
2-5. SYSTEM OPERATION

2-6. Operation of the 2115A/2116B Computer, H51-180AR Oscilloscope, and 2752A Teleprinter peripherals are fully documented in separate manuals included with the system. The following paragraphs describe operation of the hardware modules that are unique to the system: 5460A Display Unit, 5475A Control Unit and Keyboard, and 5465A Analog-to-Digital Converter.

2-7. 5460A DISPLAY UNIT

2-8. The 5460A Display Unit accepts 16-bit data words from computer I/O channel 15 and displays the information in analog and digital form. The information is converted to analog for display on the 180AR oscilloscope. Digital information is displayed on the 5460A front panel Nixie ® tubes and indicator lights. Front panel switches control various modes of display on the oscilloscope.

2-9. Data Transfer Sequence

2-10. The display unit accepts and processes one computer word at a time. The first two words in a data sequence always contain information for the front panel incandescent and Nixie ® displays. The second two words (and any subsequent pair of words) normally alternate one word of horizontal (X) data and one word of vertical (Y) data for the oscilloscope display. Refer to Figure 2-5, Operation Flow Diagram, during the ensuing discussion. (Foldout diagrams are placed at end of section.)

2-11. DATA WORD 1

2-12. A data transfer sequence is initiated with an encode command ($\overline{EN}$ signal) from the computer. If the data ready flag ($\overline{DAR}$ signal) in the display unit is active, this flag is cleared and bit 0 of the first word is examined. Bit 0 contains a 1 for the first data word and contains a 0 for all subsequent words in the record. (Ground-true logic between computer I/O channels and system devices.) Bit 0 set to 1 causes the data word counter to be cleared (set to 0) upon receipt of the first word (see Figure 2-5, column 2). The remainder of word 1 (bits 1 thru 15) contains part of the information required for the front panel display and is stored. A delay of 35 microseconds is encountered between each word time to allow processing of the CRT beam. If the DISPLAY FUNCTION SWITCH is set to PLOT, signifying external plotter operation, the display unit will lock up until the switch is placed to ARM. At this point the unblanking circuit is cleared (not significant until the third and fourth words when the CRT beam is turned on). The settings of the HORIZONTAL ORIGIN, VERTICAL MODE, VERTICAL POLAR ANG/DIV, and VERTICAL SCALE switches are clocked into the computer interface card when the data ready flag is set. Setting the data ready flag indicates completion of the first cycle and readiness to accept the second word.

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2-13. DATA WORD 2

2-14. The second word in a data transfer sequence contains a zero in bit 0 and the balance of front panel display information in bits 1 through 15. The encode command precedes the second word and causes the data ready flag to be reset during processing of word 2. Since bit 0 of the second word contains a zero, and the data word counter was set to 0 for word 1, the data word counter now advances to 1 (see Figure 2-5, column 3). Data word 2 is received and stored, completing the information needed for the front panel displays. After a 35-microsecond delay, the unblanking circuit is cleared (neither function applicable to first two words), and the front panel switches are again clocked in. The data ready flag is then set preparatory to receiving the next word.

2-15. DATA WORD 3

2-16. The third word in a data transfer sequence contains horizontal or X data for the oscilloscope (or plotter) display. An encode command precedes word 3 and the data ready flag is cleared. Bit 0 contains a 0 and with the data word counter left at a count of 1, internal logic advances the data word counter to 2 (see Figure 2-5, column 4). Bits 5 through 15 of the third word contain the X data and are temporarily stored. If the DISPLAY TYPE switch is set to CONT (X and Y data to be shown continuous) the X data remains stored until the following word containing Y data is received. With the DISPLAY TYPE switch in any other position, the X data is transferred to the horizontal digital-to-analog converter. This transfer allows the X data to be positioned on the screen during the 35-microsecond delay. The beam is not turned on until the Y data in the next word completes the display; however, the unblanking circuit is cleared nonetheless. Front panel switch settings are again transferred to the computer, and the data ready flag is set for receipt of the next word.

2-17. DATA WORD 4

2-18. The fourth word in a data transfer sequence contains vertical or Y data for the oscilloscope display. An encode command precedes arrival of the word and clears the data ready flag. Bit 0 contains a 0, and with the data word counter left at 2, the counter is advanced to 3 (see Figure 2-5, column 5). Data word 4 contains Y data in bits 5 through 15; these bits are not stored but sent directly to the vertical digital-to-analog converter.

2-19. If the DISPLAY TYPE switch is set to CONT, the X data in the previous word is now transferred from word storage to the horizontal D to A converter. When the CRT beam is turned on, both X and Y information are displayed in continuous fashion during the 35-microsecond delay.

2-20. If the DISPLAY TYPE switch is set to POINT, a 25-microsecond delay is encountered before the beam is turned on, permitting the Y data to be

positioned (X data positioned in previous cycle). The beam remains on for 10 microseconds to illuminate the X-Y point position.

2-21. If the VERTICAL MODE switch is set to COMPLEX, the X and Y data is displayed as described in the previous paragraph. This switch setting also overrides DISPLAY TYPE set to BAR position; if the switch is not set to COMPLEX, (and DISPLAY TYPE is not set to CONT or POINT) the BAR mode is indicated and the beam is turned on prior to the 35-microsecond delay. With input of subsequent Y data words, a vertical bar will be displayed (during the 35-microsecond delay after beam turn-on) from the midscreen X position upward (or downward) to the Y position. In this mode the dot is reset each cycle to the mid position for the next bar display. After the Y data has been displayed on the oscilloscope, the unblanking circuit is cleared to turn off the beam.

2-22. During display, the position of the DISPLAY FUNCTION switch is tested. If the switch is in the PLOT position (after initially having been thrown to ARM), the word transfer sequence must wait until a complete plot pulse (CPP) is received from the external plotter accessory. After this pulse is received, signifying end of plotter arm movement, the front panel switch settings are sent to the computer as in previous word operation and the data ready flag is set.

2-23. SUBSEQUENT DATA WORDS

2-24. Data transfer normally continues in word pairs alternating X and Y information until the display information is complete. Referring to Figure 2-5, top row, a data word subsequent to word 4 (that contains a 0 in bit 0) will decrement the data word counter from 3 to 2. This results in the processing of this data word for X information in a manner identical to data word 3. Similarly, the next data word (with a 0 in bit 0 and Y information in the remaining bits) advances the data word counter to 3 and is processed for Y data identical to data word 4. This alternating sequence continues until all X and Y data are displayed as required and bit 0 is set to a 1. Each new data sequence begins with words 1 and 2 containing new front panel display information.

2-25. Z DATA BITS

2-26. Data words 3 and 4 also contain a provision in bits 1 through 4 to convey Z-axis information for modulating the intensity of the CRT beam under program direction. This type of control is not required under the present display unit configuration; however the logic for digital Z-axis modulation is included for possible future options.

2-27. Display Unit Connectors

2-28. The 5460A Display Unit is installed in the cabinet aperture to the right of the H51-180AR Oscilloscope. Three rear panel connectors (P1, P3, P4) are aligned with three mating connectors (J1, J3,

J4) at the rear of the cabinet. A fourth connector (P2) consists of a sliding PC contact on the upper left cabinet rail and mates with a spring contact (J2). This connector supplies a high voltage output to the oscilloscope vertical deflection plates. P1 consists of a 32-pin male ribbon connector that interfaces with the oscilloscope. P3 and P4 consist of 50-pin female ribbon connectors. P3 interfaces with the power supply and X-Y plotter device. P4 interfaces with the computer. Refer to Figure 2-6, Wiring Block Diagram, for display unit interconnection with the system.

2-29. Display Unit Circuit Cards

2-30. The display unit contains nine printed circuit cards, mounted with discrete components and integrated circuits, that accomplish the display logic and control functions. The circuit card input/output functions are discussed in the following paragraphs. Refer to Figure 2-6 during the discussion. Signal names with a bar (e.g. $\overline{DAR}$) indicate that the active state of the signal is at ground level.

2-31. A1 VERTICAL AMPLIFIER ASSEMBLY (05460-60001)

2-32. The A1 card converts the Y-axis output of the A2 Vertical DAC (via VERTICAL GAIN control R2) to a voltage sufficient to drive the CRT deflection plates. The $\overline{BEAM}$ signal represents the input from the FIND BEAM switch (S102 via P1) on the oscilloscope. The VOUTA+ signal originates from the front panel GAIN control (R2) and the VPOSN1, 2, 3 signals originate from the POSITION control (R1). The VSIGP and VSIGM signals represent the output voltage to the vertical deflection plates in the oscilloscope (via P2).

2-33. A2 VERTICAL DAC ASSEMBLY (05460-60002)

2-34. The A2 card accepts vertical or Y-axis information in digital form and converts the binary value into an equivalent analog signal (VOUT 1+) for output to the A1 Vertical Amplifier (via R2) and A5 Control. Similar signals VOUT 2+ and PLOTY+ convey the analog Y information to connectors P4 (for external output) and to P3 (for plotter output). Vertical information is received in digital form from the computer via P4 over lines $\overline{BIT\ 5}$ through $\overline{BIT\ 15}$. The V LOAD input signal from A5 Control clocks the binary information into storage elements on the A2 card. The MID signal from A5 forces the vertical display to mid-scale after each point has been displayed in the DISPLAY TYPE BAR mode. Switch (S8) inputs $\overline{DCORG}$, $\overline{DCMFS}$, $\overline{DCPFS}$ represent switch positions DISPLAY CALIBRATE ORIGIN, DISPLAY CALIBRATE MINUS FULL SCALE, and DISPLAY CALIBRATE PLUS FULL SCALE respectively.

2-35. A3 HORIZONTAL DAC ASSEMBLY (05460-60002)

2-36. The A3 card accepts horizontal or X-axis information in digital form and converts the binary value into an equivalent analog signal (HSIG+, HSIGE+, PLOTX+) for respective output to connectors P1 (oscilloscope), P4 (external BNC) and P3 (plotter). Horizontal information is received in digital form over bit lines $\overline{XDTO}$ through $\overline{XDT10}$ from word storage in the A4 card. The same information is initially input to the A4 card over lines $\overline{BIT\ 5}$ through $\overline{BIT\ 15}$ from the computer. The HLOAD signal from A5 Control clocks the bits into A3 storage elements. Switch (S8) positions $\overline{DCORG}$, $\overline{DCMFS}$, and $\overline{DCPFS}$ apply equally to the horizontal information as referenced in the preceding paragraph for vertical data. Also applicable are switch (S4) positions representing HORIZONTAL SWEEP LENGTHS per centimeter of 12.8 ($\overline{HS.\ 8}$), 10 ($\overline{HS10}$) and 10.24 ($\overline{HS.\ 24}$). With the VERTICAL MODE switch (S1) to COMPLEX, the $\overline{HS8.\ 0}$ signal is active, representing a horizontal sweep length of 8.0 centimeters.

2-37. A4 WORD STORAGE ASSEMBLY (05460-60002)

2-38. The A4 card maintains a count of the incoming data words from the computer, and directs the storage and distribution of the words according to the type of information involved. A data word counter on the A4 card counts the incoming words in a data transfer sequence (1-2-3-4-, 3-4, 3-4, etc.) and outputs signals to A5 Control and A8 Nixie® Display representative of the word counter sequence ($\overline{DWCO}$ through $\overline{DWC3}$). The data words are received in binary format over digital lines $\overline{BIT\ 0}$ through $\overline{BIT\ 15}$. Each word is preceded by an encode ($\overline{EN}$) command from the computer that is recognized by A4 logic. Depending upon which data word counter signal ($\overline{DWC0}$ - $\overline{DWC3}$) is active, the word is accepted by A3 Horizontal DAC ($\overline{XDT0}$ thru $\overline{XDT10}$), A2 Vertical DAC ($\overline{BIT\ 5}$ thru $\overline{BIT\ 15}$), A8 Nixie Display ($\overline{BIT\ 1}$ thru $\overline{BIT\ 10}$), or A9 Light Driver cards. Signals to A9 consist of decoded bits representing front panel incandescent lamp functions: Scale Factor Sign (SFS), Frequency (FREQ), Logarithmic (LOG) that also lights decibel (dB), Polar (PLAR), Rectangular (RECT) display, and scale factor multipliers ONE, TWO, FIVE (that also light X10). Signals to A5 Control consist of word counter outputs $\overline{DWCO}$, $\overline{DWC2}$, $\overline{DWC3}$, a pulse from the encode signal (ENN), and Z-axis bit lines $\overline{ZDT1}$ thru $\overline{ZDT5}$ (not used in present configuration). Data word counter outputs ($\overline{DWC0}$, $\overline{DWC1}$) are also sent to A8 Nixie® Display. See Figure 2-2, Word Format, for bit configuration of each word.

Figure 2-2. Word Format

BIT	WORD 1 (DWC0)	WORD 2 (DWC1)	WORD 3 (DWC2)	WORD 4 (DWC3)
0	1	0	0	0
1	POLAR (0 - RECT)	1 Unit	ZDT5	ZDT1
2	LOG (dB)	2 Units		ZDT2
3	FREQ	4 Units		ZDT3
4	8 Units	1 Ten		ZDT4
5		2 Tens	XDT0	YDT0
6		4 Tens	XDT1	YDT1
7	8 Tens	1 Hundred	XDT2	YDT2
8		2 Hundreds	XDT3	YDT3
9		4 Hundreds	XDT4	YDT4
10	8 Hundreds		XDT5	YDT5
11			XDT6	YDT6
12			XDT7	YDT7
13		One	XDT8	YDT8
14		Two	XDT9	YDT9
15	SFS	Five	XDT10	YDT10

2-39. A5 CONTROL ASSEMBLY (05460-60004)

2-40. The A5 card contains timing and control logic to provide overall coordination of the front panel and oscilloscope displays. The $\overline{DWCO}$ signal starts a marker clock on the A5 card; every eighth point or every thirty-second point is intensified according to HORIZONTAL MARKER switch (S6) setting 8 PT ($\overline{HM\ 8}$) or 32 PT ($\overline{HM\ 32}$). The $\overline{DWC2}$ signal identifies the third or horizontal data word and enables the H LOAD clock signal to the A3 Horizontal DAC. The $\overline{DWC3}$ signal identifies the fourth or vertical data word and enables the V LOAD clock signal to the A2 Vertical DAC. The $\overline{MID}$ signal sets the vertical DAC output to mid-scale when the DISPLAY type switch (S9) is set to BAR (and VERTICAL MODE is not set to COMPLEX nor VERTICAL DISPLAY set to PLOT. These switch settings are determined in A5 logic circuits by switch inputs DTPNT, DTCNT, $\overline{DFPLT}$,

and $\overline{\text{VDCMP2}}$. The ENN signal from A4 Control represents an incoming computer encode command that clears the data ready flag ($\overline{\text{DAR}}$), and triggers a delay circuit to set the data ready flag again after 35 microseconds. An unblanking circuit on A5 is activated each fourth data word and sends a BLANK signal to P1 for unblanking the oscilloscope and an E BLANK signal to P4 for external unblanking.

2-41. When an X-Y plotter device is used, switch S7 provides an active $\overline{\text{DFPLT}}$ signal. With the ARM/PLOT switch (S11) to ARM an inactive PLOT 1 signal is applied to A5, inhibiting the $\overline{\text{DAR}}$ signal after the fourth word and causing the plotter arm to stop after the first point has been plotted. Placing the ARM/PLOT switch to PLOT provides an active $\overline{\text{PLOT 1}}$ signal that inhibits $\overline{\text{DAR}}$ after the first word, causing the plotter to stop after the last point has been plotted. Setting or resetting $\overline{\text{DAR}}$ also enables or disables the PLOT signal to A7 Plotter Control. Receipt of a complete plot pulse (CPP) from A7 sets $\overline{\text{DAR}}$ after the final fourth word. The PEN 1 or PEN 2 relay signal is active to control pen lift when $\overline{\text{PLOT 1}}$ signal is active and $\overline{\text{DWCO}}$ is inactive. The Z-AXIS signal provides a variable analog voltage output for modulating intensity of the CRT beam. An amplifier circuit on the A5 card controls Z-axis modulation by monitoring the rate of change of the A5 Vertical DAC output (VOUT 2+) with respect to time. This results in a stable intensity level regardless of length traveled. A digital-to-analog converter is included on the A5 card to accept digital information on $\overline{\text{ZDT1}}$ through $\overline{\text{ZDT5}}$ lines for Z-axis modulation; this form of Z-axis control is not used under the present configuration.

2-42. A6 REFERENCE POWER SUPPLY ASSEMBLY (05460-60005)

2-43. The A6 card uses the +15V supply voltage from P1 to produce a stable +10V reference output for the A2 Vertical DAC and A3 Horizontal DAC cards. The +5V input from P3 and -12.6V input from P1 are not connected.

2-44. A7 PLOTTER CONTROL BOARD (05431-6007)

2-45. The A7 card controls an external X-Y plotting device by providing an enabling signal (SEEK) to P3 in response to an input signal (PLOT) from A5. Plot rate is controlled by the $\overline{\text{RATE X}}$ input from the PLOT RATE switch (S10) when rotated from EXT to 20. A completed plot signal (CP) from the plotter (via P3) is relayed to A5 control as the completed plot pulse (CPP) signal.

2-46. A8 NIXIE ® DISPLAY ASSEMBLY (05460-60006)

2-47. The A8 card controls display of the front panel incandescent and Nixie ® lights. Input lines $\overline{\text{BIT 1}}$ through $\overline{\text{BIT 10}}$ transfer binary numbers during

data words 1 and 2. The $\overline{\text{DWCO}}$ signal clocks in the most significant bits and $\overline{\text{DWC1}}$ clocks in the least significant bits. This binary information is converted to BCD format and displayed on Nixie ® tubes DS2, DS3, and DS4 at the end of word 2. Nine incandescent indicators are driven by the A9 Light Driver to display functional mode (see Figure 2-6). The +170V supply voltage for the numerical Nixie ® tubes and minus-sign neon tube is also supplied from the A9 card. The incandescent lamps are driven with +24V from P3.

2-48. A9 LIGHT DRIVER ASSEMBLY (05460-60007)

2-49. The A9 card converts incoming control signals from low voltage logic levels to levels sufficient to drive the front panel incandescent lamps. The A9 card also derives +70V from the 130 VAC transformer T1, and adds this voltage to the +100V supply from P1 to provide +170V for the A8 neon and Nixie ® tubes.

2-50. 5475A CONTROL UNIT AND KEYBOARD

2-51. The 5475A Control Unit consists of a rack cabinet that houses the keyboard panel assembly, keyboard and control logic comprising seven circuit cards, a power supply consisting of six circuit cards, and a receptacle for the 5465A ADC plug-in. Refer to Figure 2-7, Wiring Block Diagram, for signal interconnection between the keyboard assembly and control unit circuit cards.

2-52. Control Unit Connectors

2-53. The 5475A Control Unit contains three connectors within the cabinet for internal connection, and four connectors at the rear of the unit for cable hookup. The three internal connectors are shown on the left side of Figure 2-7. The J15 connector is a 50-pin ribbon-type female connector that mates with the male connector on the installed 5465A/D Converter. The J16 and J19 connectors are mounted on the baseplate of the control unit directly behind the keyboard panel. J16 is a 24-pin ribbon-type female connector that mates with a cable from the keyboard front panel lights and switches. J19 (A and B) consists of dual 50-pin ribbon-type female connectors that mate with a cable from the keyboard panel pushbuttons. The four rear panel connectors are shown on the right side of Figure 2-7. The J11 (A and B) connector consists of dual 36-pin ribbon-type female connectors that mate with dual cables in a single male connector. One cable (connector A) originates from the computer front panel connector and the other cable (connector B) terminates on the computer front panel coupler card. The J12 connector is a 36-pin ribbon-type female connector that mates with a cable from the computer ADC/keyboard interface card. The J13 connector is a 48-pin etched-circuit male connector that mates with a cable from the 2752A Teleprinter I/O connector. The J14 connector is a 36-pin ribbon-type female connector that

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mates with a cable connected to the computer tele-printer interface card. Power connectors on the rear panel are described in Paragraph 2-79.

2-54. A11 Keyboard Assembly

2-55. The keyboard is a self-contained assembly with a front panel enclosing 64 pushbuttons, 2 lever switches, a slide switch, and 10 indicator lights. The keyboard pushbuttons are connected to the control unit by a cable terminating in dual 50-pin connectors (P19/J19). The switches and indicator lights are connected to the control unit by an additional cable terminated by a 24-pin connector (P16/J16). See Figure 2-7.

2-56. The keyboard pushbuttons simulate the function of a teletypewriter. Sixty lines transfer signals from sixty pushbuttons on the keyboard to circuit cards A12 Matrix A and A13 Matrix B in the control unit. (One of the sixty lines is not presently used and is represented by a blank button on the keyboard.) Refer to Table 2-1 for signal names and pin connections

between the keyboard and control unit cards. Four additional pushbuttons (LOAD TAPE, RESTART, STOP, and CONTINUE) simulate functions of the computer front panel. These signals are transferred over four pairs of lines from the keyboard to the A15 Function card in the control unit (see Figure 2-7).

2-57. The slide switch (S1) on the keyboard panel labelled COMPUTER NORMAL/FOURIER ANALYZER transfers an active (ground level) $\overline{FOURIER}$ signal to the A16 Switch Register, A15 Function, and A14 Shift Register cards when the switch is in the FOURIER ANALYZER position. Lever switches RUN/STEP (S2) and SINGLE/REPEAT (S3) transfer ground level $\overline{STEP}$ and $\overline{REPEAT}$ signals to the A16 Switch Register card when placed in the STEP and REPEAT positions, respectively. Keyboard panel indicator lights (DS1-DS10) signifying block size of 64, 128, 256, 512, 1024, 2048, 4098 plus READY, BUSY, and WHAT? indications are activated by corresponding signals from the A17 Buffer card.

Table 2-1. Keyboard Signals to Matrix A and B

KEYBOARD CONNECTOR P19A/J19A	SIGNAL	MATRIX CONNECTOR	KEYBOARD CONNECTOR P19B/J19B	SIGNAL	MATRIX CONNECTOR
7	BLOCK SIZE	A12A(3)	11	SUB JUMP	A12A(12)
8	POINT	A12A(4)	12	JUMP	A12A(13, P)
9	PROT	A12A(5)	13	COUNT	A12A(14, R)
11	DELET	A12A(6)	14	SUB RTRN	A12A(15)
12	RPLAC	A12A(7)	15	LABEL	A12A(S)
13	INSRT	A12A(8)	16	END	A12B(1, A)
14	LIST	A12A(9)	18	EXP MAG	A13A(C)
15	(?)	A12A(10)	19	RECT	A13A(D)
16	TERM	A12A(11)	20	LOAD	A13A(E)
18	BINARY	A12B(8, J)	21	STORE	A13A(F)
19	KEYBOARD	A12B(9, K)	22	LOG MAG	A13A(H)
20	PHOTO READR	A12B(10)	23	POLAR	A13A(J)
21	ANALG IN	A12B(11)	24	INTERCHNG	A13A(K)
22	(Not Used)	A12B(12)	25	DSPLY	A13A(L)
23	PRINT	A12B(13)	36	(+)	A12B(2, B)
24	PUNCH	A12B(14)	37	(÷)	A12B(3, C)
25	HISTOGRAM	A12B(15, S)	38	(—)	A12B(4, D)
35	ENTER	A13B(2)	39	(−)	A12B(5, E)
36	SPACE	A13B(3)	40	MULT	A12B(6, F)
37	CLEAR	A13B(4)	41	*MULT	A12B(7, H)
38	(−)	A13B(5)	43	($\int$)	A13A(M)
39	RUB OUT	A13B(6)	44	HANN I	A13A(N)
41	(1)	A13B(8)	45	CONV	A13A(13)
42	(2)	A13B(9)	46	F	A13A(R)
43	(3)	A13B(L)	47	d/dx	A13A(S)
44	(4)	A13B(M)	48	HANN O	A13A(14)
45	(5)	A13B(N)	49	CORR	A13A(15)
46	(6)	A13B(P)	50	F^{-1}	A13B(1)
47	(7)	A13B(R)			
48	(8)	A13B(S)			
49	(9)	A13B(15)			
50	(0)	A13B(7)			

2-58. ADC Interface

2-59. The 5465A A/D Converter transfers nine signals representative of 5465A panel switch settings to the control unit A16 Switch Register card (FAST, DUAL, RVSE, F1, F2, F4, F8, DF, EO). An additional 24 signals are transferred between ADC and computer, and pass straight through the control unit between connectors J15 and J12. (Refer to Table 2-2 for signal names and pin connections.)

2-60. Control Unit Circuit Cards

2-61. A15 SWITCH REGISTER ASSEMBLY
(05475-60004)

2-62. The switch register card is inserted electrically between the computer switch register and the computer front panel coupler card. The switch register card can either pass or interrupt signals from the switch register to the computer. When the keyboard panel slide switch is set to COMPUTER NORMAL, switch register settings are routed to the computer as in normal computer operation. When the slide switch is set to FOURIER ANALYZER (input line $\overline{FOURIER}$ at ground level) the switch register is disabled and switch settings from the 5465A ADC and 5475A Control Unit are instead transferred to the computer.

Table 2-2. Feedthru Signals Computer to ADC

P12/J12 CONNECTOR	SIGNAL	J15/P15 CONNECTOR
20	$\overline{BSI\ 64}$ $(\overline{N6})$	27
21	$\overline{BSI\ 128}$ $(\overline{N7})$	28
22	$\overline{BSI\ 256}$ $(\overline{N8})$	29
23	$\overline{BSI\ 512}$ $(\overline{N9})$	30
24	$\overline{BSI\ 1024}$ $(\overline{N10})$	31
25	$\overline{BSI\ 2048}$ $(\overline{N11})$	32
Via XA17B(L)	$\overline{BSI\ 4096}$ $(\overline{N12})$	26
29	RNG A1	11
30	RNG A2	12
31	RNG A4	13
32	RNG B1	14
33	RNG B2	33
35	RNG B4	44
34	$\overline{EN}$	15
36	$\overline{DAR}$	16
18	BIT 0	1
17	BIT 1	2
16	BIT 2	3
15	BIT 3	4
14	BIT 4	5
13	BIT 5	6
12	BIT 6	7
11	BIT 7	8
10	BIT 8	9
9	BIT 9	10

2-63. Inputs reflective of switch register toggle settings are brought into the control unit through connector J11A. Sixteen input/output bit <u>in</u> (IOBI 0 thru IOBI 15) lines enter the switch register card and return to the computer via input/output bit <u>out</u> (IOBO 0 thru IOBO 15) lines through connector J11B. (Refer to Figure 2-7.) If the switch register inputs are disabled, nine inputs representing switch settings on the ADC are transferred through connector J15 to the switch register card. ADC inputs F1, F2, F4, F8, DF, and EO are gated through the card and passed to the computer on lines IOBO 0 through IOBO 5, respectively. ADC inputs RVSE, DUAL, and FAST are gated through on lines IOBO 9, IOBO 10, and IOBO 12, respectively. Two inputs from the keyboard panel representative of lever switch settings ($\overline{REPEAT}$ and $\overline{STEP}$) are gated through the card on lines IOBO 11 and IOBO 14, respectively. Inputs STOP OUT and CONT OUT from the A15 Function card represent keyboard commands of STOP or CONTINUE, and are sent to the computer on lines IOBO 15 and IOBO 13, respectively. Inputs $\overline{Y}$ and X from the A15 Function card generate addresses for RESTART and LOAD TAPE commands on the switch register card, activating output lines IOBO 1 (address 000002) and IOBO 6 thru 12 (address 017700), respectively. If either $\overline{Y}$ or X is active, all other inputs are disabled.

2-64. A15 FUNCTION ASSEMBLY (05475-60006)

2-65. The function card intercepts command signals from the computer front panel pushbuttons (via connector J11A) and routes the signals to the computer front panel coupler card (via A17 Buffer and connector J11B). These commands consist of SINGLE CYCLE (SICY IN), LOAD MEMORY (LD MEM IN), RUN (RUN IN), LOAD ADDRESS (LDADR IN), PRESET (PRES IN), HALT (HALT IN), and LOADER PROTECTED (PROT IN). Both levels of the signals are brought into the function card. Corresponding outputs to A17 Buffer card are SICY, LDMEM, RUN, LOADR, PRES, and HALT. The protect memory signal (PROT MEM) to J11B is a result of the PROT IN signal in the COMPUTER mode, RESTART or LOAD TAPE commands in the FOURIER mode, or LOAD ADDRESS command in either mode. An active PROT MEM signal protects contents of the loader; absence of the signal indicates the computer front panel LOADER switch is set to ENABLE, allowing the contents of the loader to be changed. The incoming computer commands pass directly through function logic for return to the computer so long as the slide switch on the keyboard panel is set to COMPUTER NORMAL. With the slide switch set to FOURIER ANALYZER (input signal $\overline{FOURIER}$), all commands except PRESET and LOAD ADDRESS are disabled and commands are accepted instead from the keyboard.

2-66. The LOAD TAPE, RESTART, STOP, and CONTINUE commands are initiated at the keyboard panel pushbuttons. These commands are brought into the function card as high and low signals LD TAPE, RESTART IN, STOP IN, and CONT IN when the $\overline{FOURIER}$ signal is active. An active LD TAPE signal from the keyboard creates a sequence of logic

events on the function card that result in output of
the following order of commands to the computer:
HALT, ENABLE MEMORY (PROT MEM removed),
PRESET, LOAD ADDRESS (X signal generated ad-
dress 017700 on switch register card) and RUN. This
sequence causes the computer to load the tape and
halt. The loader remains unprotected until either
the LOAD ADDRESS or RESTART button is depressed.
An active RESTART IN signal from the keyboard
creates the following sequence of events on the func-
tion card for output to the computer; HALT, PRO-
TECT MEMORY, PRESET, LOAD ADDRESS ($\overline{Y}$ signal
generates address 000002 on switch register card),
and RUN. This sequence causes the computer to
start the main program. The STOP IN signal from
the keyboard can be activated during the busy mode
(i.e. $\overline{RDYI}$ signal inactive) to light the ready indica-
tor with an active STOP OUT signal to the A17 Buffer.
The STOP OUT signal is also sent to A16 Switch Reg-
ister to cause the computer to halt after the current
instruction is executed. The CONT IN signal from
the keyboard can be activated in the ready mode (i.e.
$\overline{RDYI}$ active) to continue a program that has been
interrupted. This is accomplished with the CONT
OUT signal relayed through A16 Switch Register to
the computer. The POW ON output signal to the A14
Shift Register is generated on the function card each
time power is applied to the control unit by sensing
the +5V supply voltage. The POW ON signal is used
internally on the function card to generate the follow-
ing sequence of commands: HALT, PROTECT MEM-
ORY, PRESET, LOAD ADDRESS ($\overline{Y}$ initiates address
000002), and RUN.

2-67. A17 BUFFER ASSEMBLY (05475-60007)

2-68. The buffer card contains 12 output buffers and
11 lamp drivers. The output buffers transfer the
HALT, PRES, LDADR, RUN, LDMEM, and SICY
commands through connector J11B to the computer
front panel coupler card. These commands are the
result of inputs from the computer front panel push-
buttons (via J11A connector) when the keyboard slide
switch is set to COMPUTER NORMAL, or the result
of sequential commands generated in the function card
from pushbuttons depressed on the keyboard (slide
switch to FOURIER ANALYZER).

2-69. The lamp drivers accept block size inputs
($\overline{BSI\ 64-4096}$) from the computer via connector J12,
and provide block size outputs ($\overline{BSO\ 64-4096}$) to con-
nector J16 to light the block size indicators on the
keyboard panel. The block size inputs are also rou-
ted from connector J12 to J15 to permit computer
control of block size in the ADC (refer to Table 2-2).
A ground-level $\overline{RDYI}$ input signal results in a high
level RDYO signal to light the keyboard panel READY
light (DS9). A high-level RDYI input signal results
in a high-level BUSYO signal to light the keyboard
BUSY indicator (DS8). A high-level STOP OUT sig-
nal from the A15 Function card results in a high-level
STOP LIGHT signal, which in turn is jumpered to the
RDYO signal. This causes the READY indicator to
light when the STOP button is depressed in the BUSY
(i.e. not ready) mode. A ground level $\overline{WHATI}$ input
signal results in a high-level WHATO output signal
to light the keyboard WHAT? indicator.

2-70. A12 MATRIX A ASSEMBLY (05475-60003)

2-71. The matrix A card contains 29 diode arrays,
with a possible 15 diodes in each array. The num-
ber and placement of diodes in each array is ar-
ranged to coincide with a specific ASCII configuration.
Thus, an active ground-level input from a keyboard
pushbutton over one of the 29 input lines activates a
particular array and results in a ground-level coded
output on the 15 signal lines M1 through M15 (two
7-bit ASCII words plus a start bit in parallel).

2-72. A13 MATRIX B ASSEMBLY (05475-60008)

2-73. The matrix B card functions as an extension
of the matrix A card, by accepting the remaining 31
keyboard input lines to encompass a total of 60 key-
board pushbuttons (excepting the 4 command push-
buttons sensed by the function card). The combination
of matrix A and B constitutes 60 different vertical
diode arrays. Fifteen horizontal lines divide the
vertical arrays into 15 segments. The presence or
absence of a diode in each segment (diode connecting
vertical and horizontal line) determines the ASCII
format for each vertical array. A ground input ap-
plied to a vertical line pulls down the diodes in the
array and results in ground-level outputs on those
horizontal lines connected to a diode. Each of the
60 different ASCII combinations on the 15 output lines
M1 through M15 is sensed as a unique character by
the A14 Shift Register.

2-74. A14 SHIFT REGISTER (05475-60001)

2-75. The shift register card accepts the parallel
ASCII double-character (representative of a keyboard
pushbutton) on input lines M1 through M15. The
character is shifted through a 20-bit register and
output serially on the TTY DATA OUT line to the
computer via connector J14. An active $\overline{FOURIER}$
signal from the keyboard enables the data shift. The
data is clocked out at a 100 Hz rate by an internal
oscillator. The oscillator is enabled each time a
data character enters the register and is disabled
when the register is empty of information (i.e. con-
tains all ones in keeping with ground-true logic).
Teleprinter character signals are accepted (in either
mode) on the TTY DATA IN line and transferred
also on the TTY DATA OUT line to the computer.

2-76. The shift register contains logic to eliminate
pushbutton contact bounce, and to prevent redundant
or simultaneous keyboard inputs. The START/$\overline{START}$
signals sense key motion by assuming the active
state when a key is fully depressed. This action
creates a momentary pulse to set off shift register
logic and process the incoming character. The read-
only-memory enable ($\overline{ROM\ ENAB}$) signal is enabled
by the active START pulse and provides a contact
closure to ground for the pushbutton; this permits
transfer of the character through matrix A and B
to the shift register. When the character has en-
tered the shift register, $\overline{ROM\ ENAB}$ is disabled until
the character has shifted out and a new START pulse
can be received. This combination prevents a sec-
ond character from entering the shift register or the
same character entering twice during the shifting

process. The POW ON signal from the function card assures that the logic circuits are set to the proper state upon system turn-on.

2-77. The relay and crowbar card contains a relay circuit to switch +12V on the TTY DATA IN line when the +12V sense line is opened. Opening of the sense line indicates that a teleprinter is not connected to the system; placing +12V on the TTY DATA IN line assures that the control unit keyboard data can be transferred through the A14 Shift Register on the TTY DATA OUT line. (Teleprinter when connected supplies a nominal +12V through J13 pin 4.) The crowbar circuit protects the +5V supply against any over-voltage damaging to the integrated circuits.

2-78. Power Supply Circuit

2-79. The power supply is enclosed in the rear of the control unit cabinet and consists of the T1 transformer, A1 rectifier board, and a motherboard with four plug-in cards. The power supply generates plus and minus 24 volts, plus and minus 12 volts, and plus and minus 5 volts for distribution throughout the 5450A system. The supply voltages are provided through the rear panel connector J18 DISPLAY for distribution to the display subsystem and through connector J17 POWER SUPPLY for external distribution (see Figure 2-8). Protection circuits are included to prevent damage to the instrument. In case of a voltage short to ground or another voltage, the OVERLOAD lamp DS2 on the rear panel lights.

2-80. 5465A A/D CONVERTER

2-81. The 5465A ADC is an input device that quantizes analog signals into 10-bit binary words suitable for processing by the computer. The ADC can be operated in either a single or dual channel mode. In a dual channel mode, the first channel input (normally Channel A) is quantized while the Channel B input is stored. After the digital word for Channel A is transferred to the output buffer register, the Channel B input is quantized. See Figure 2-3, ADC Block Diagram.

2-82. A ramp technique is used to convert the input voltage to a proportionate length of time. The length of the ramp is a function of signal amplitude at sample time over a range of full scale to 0V.

2-83. At the start of sample time, a gate is opened as the ramp runs down to 0V. While the gate is open, a clock generator sends pulses through the gate at a 100 MHz rate to a binary pulse counter. When the ramp crosses 0V, the gate closes and the clock pulses are shut off. At this point, the binary pulse counter contains a 10-bit word representing the digital value of the input signal. The 10-bit word is sent through an output buffer register for transfer to the computer.

2-84. A stabilizing circuit periodically verifies accuracy of the ramp baseline and slope. The stabilizer consists of a digital servo that inserts a known

Figure 2-3. (5465A) ADC Block Diagram
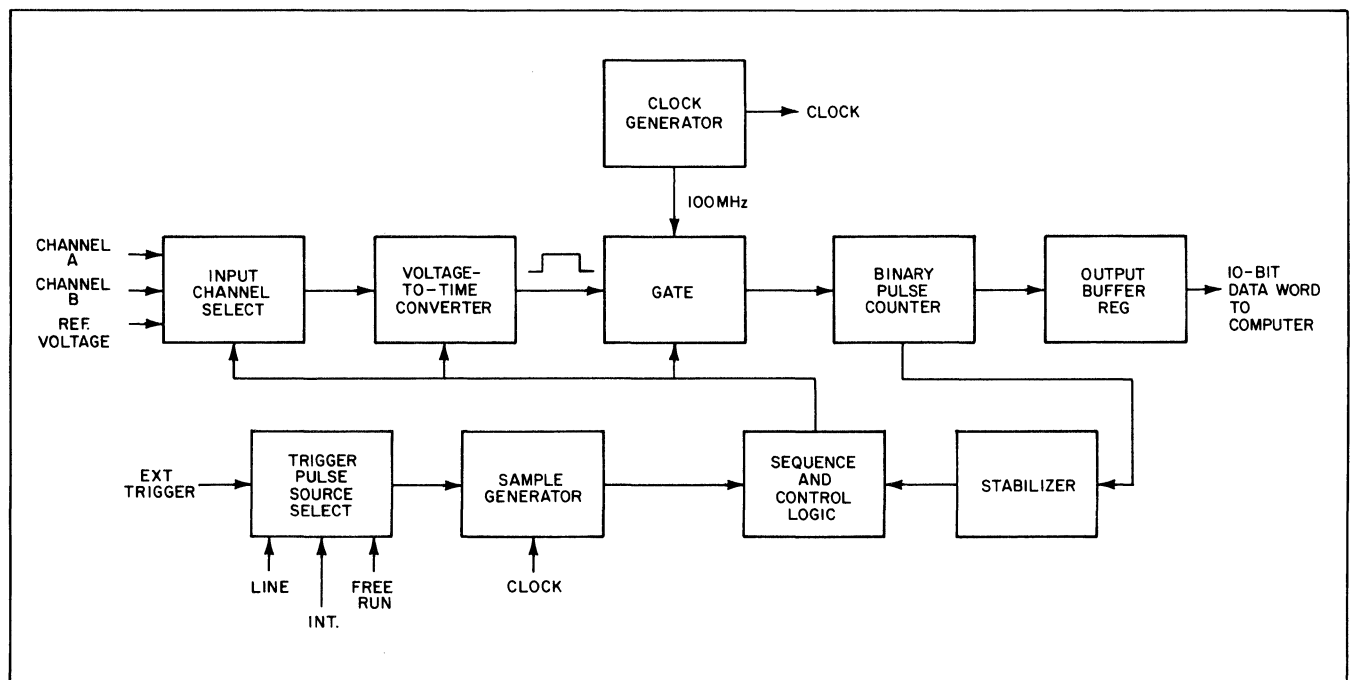
voltage into the voltage-to-time converter and checks the binary pulse counter for the exact digital equivalent. Thus, the linear gain of the ramp is effectively checked from the 0V baseline to full scale. The stabilizer corrects errors in ramp gain by adjusting the ADC input reference voltage. When the stabilizer detects an error above a specific magnitude, a speedy stabilize mode is entered that prohibits further sampling by locking up the ADC. The stabilize cycle is always initiated unless the fast mode is selected. In the fast mode, the sample rate is too fast to allow stabilization, hence the circuit is disabled during collection of a block of data and the computer is notified to accept data at a faster rate.

2-85. ADC Interface

2-86. The ADC plugs into the left side of the 5475A Control Unit cabinet. A 50-pin male ribbon-type

connector (P15) on the rear of the ADC plugs into a mating connector (J15) in the control unit. All input and output signals of the ADC (other than front panel jacks) pass through P15 for interface with the control unit and computer. All power for the ADC is provided by the control unit power supply. Refer to Table 2-3 and Figure 2-4 for ADC input/output signals.
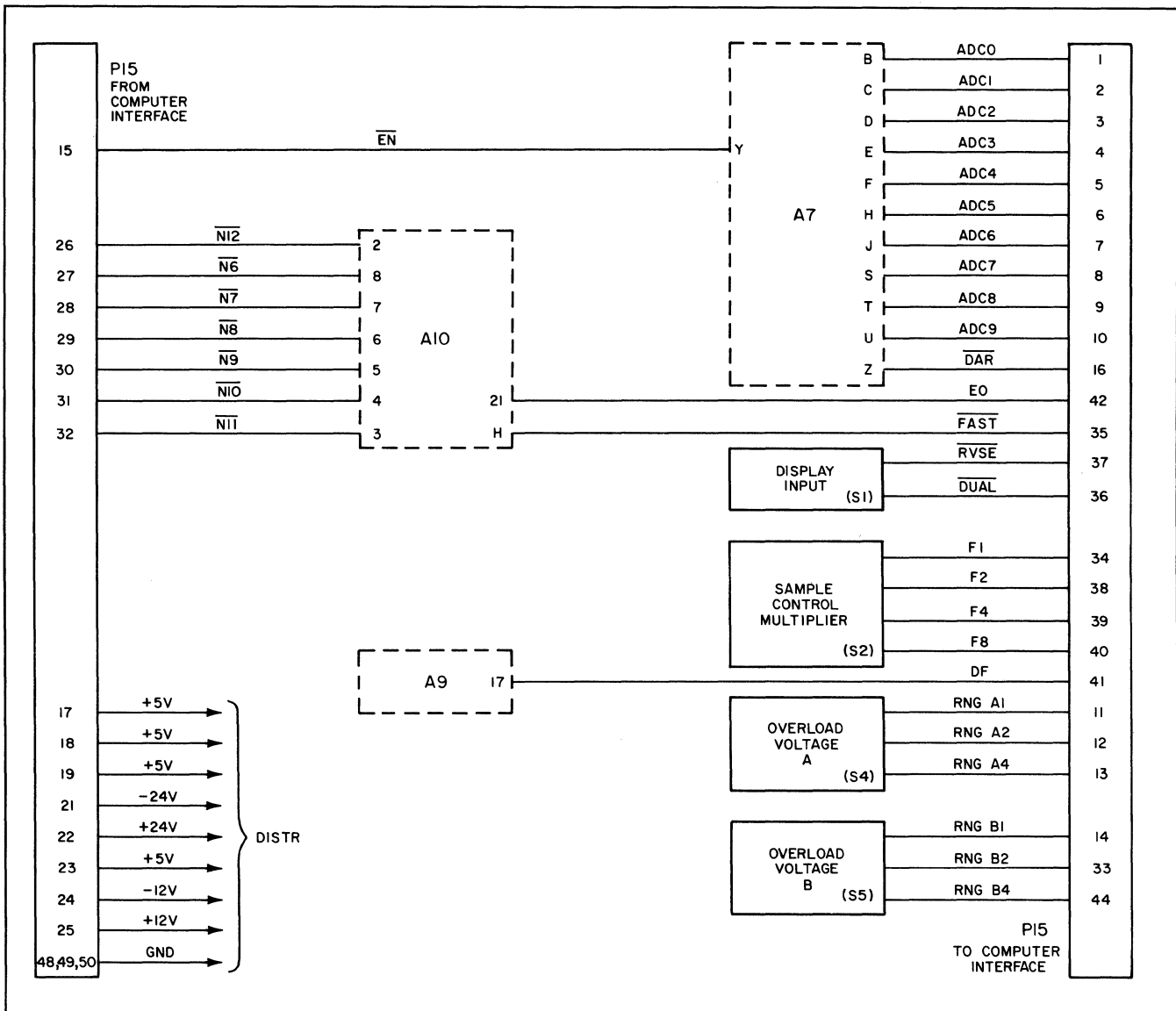
2-87. ADC Circuit Cards

The ADC contains 12 circuit cards. The cards are described in the following paragraphs; major signal flow shown functionally in the flow diagram of Figure 2-9.

2-88. A1 INPUT BUFFER ASSEMBLY (05465-60001)

2-89. The input buffer card contains isolation amplifiers for Channel A and B inputs. While Channel A

Figure 2-4. (5465A) ADC Input/Output Signals

is sampled and quantized, Channel B data is stored until the digitize process (and stabilize cycle) is completed. When the HOLD signal is inactivated, Channel B is digitized. Also included on the card is trigger select logic that is activated by the front panel switches associated with trigger input and trigger sync functions.

2-90. A2 STRETCHER ASSEMBLY

2-91. The inputs to the stretcher card are the Channel A and Channel B signals from the A1 Input Buffer. The inputs are time-shared and each is used to form a gate pulse, the width of which is a function of the signal amplitude. The amplitude of the input forms a ramp from which the gate pulse is formed. The sample signals INAS and INBS select the Channel A and B inputs in sequence. Also on the card are logic circuits for controlling and adjusting baseline and gain reference currents. These circuits are part of a digital servo and are adjusted during the stabilize cycle.

2-92. A3 CONTROL ASSEMBLY (05465-60002)

2-93. The control card sequences the stabilize cycle through baseline and gain checks, and monitors sample rate switch positions vs. block size from the computer. The stabilize control logic forms part of the digital servo that corrects for baseline and gain errors in the stretcher card. During the baseline phase of the stabilize cycle, a baseline voltage reference is switched to the ramp generator on the stretcher card and $\overline{BLL}$ or $\overline{BLR}$ lowers or raises the baseline reference as required for 1 channel resolution. During the gain phase of the stabilize cycle, a gain reference voltage is switched to the ramp generator and $\overline{CSL}$ or $\overline{CSR}$ lower or raise the current source to effectively change the slope of the ramp. The uncal detector logic monitors the switch positions of the sample rate and block size data received from the computer. Should the operator's selection of sample rate be above the allowed maximum, the UNCAL signal is generated and the UNCAL lamp is illuminated.

Table 2-3. Input/Output Signals

P15 PIN	SIGNAL	FUNCTION
1-10	BITS 0-9	10-bit digital word defining amplitude of analog input.
11	RNG A1	
12	RNG A2	3-bit binary word defining switch setting of OVERLOAD VOLTAGE A.
13	RNG A4	
14	RNG B1	
33	RNG B2	3-bit binary word defining switch setting of OVERLOAD VOLTAGE B.
44	RNG B4	
15	$\overline{EN}$	Enable gate from computer to allow ADC to commence processing of input data signal(s) (ground true).
16	$\overline{DAR}$	Data ready signal notifies computer data is on the ADC output lines. In fast mode, DAR repeats at ADC rate without interlaced stabilize cycle (ground true).
26	$\overline{N12}$	
27	$\overline{N6}$	
28	$\overline{N7}$	
29	$\overline{N8}$	Seven binary flags used to select block size (4096-64) in binary increments (ground true).
30	$\overline{N9}$	
31	$\overline{N10}$	
32	$\overline{N11}$	
34	F1	
38	F2	BCD word defining the nine frequency positions of MAX FREQ selector switch.
39	F4	
40	F8	
35	$\overline{FAST}$	Level to computer signifying stabilize cycle is locked out and data will be on the output lines in FAST mode (ground true).
36	DUAL	Notifies computer whether dual channel operation has been selected.
37	RVSE	Notifies computer whether Channel A is digitized first then B (normal) or vice versa (reverse).
41	$\overline{DF}$	Signals indicating the position of the SAMPLE MODE switch (ground true).
42	$\overline{EO}$	
43	LINE +	60 Hz signal and shield for trigger.
47	LINE -	

2-94. A4 SEQUENCER ASSEMBLY (05465-60004)

2-95. The sequencer card generates the start scaler ($\overline{SS}$) pulse and times-out the ADC conversion for a full-scale input signal level. At the generation of a DONE pulse, a sample of the input analog voltage will have been digitized and can be loaded into the output buffer register. Counter reset signals R0 and R1 are generated as a function of DONE. At the termination of the one-shot timer, $\overline{DUMP}$ is generated to quickly discharge the ramp capacitor. A disable stretcher pulse (DS) is generated to remove or effectively disconnect the input signal from the ramp generator at sample time, during the ramp rundown.

2-96. A5 HIGH SPEED SCALER ASSEMBLY (05415-6007)

2-97. This high speed scaler card contains the first three stages of the 10-bit counter and the input clock gate. Because of the high clock rate (100 MHz), the high speed scaler is operated in the current mode to attain fast switching characteristics. The output of the third stage is HSS2 (12.5 MHz), used to increment the low speed scaler. Stages HSS0 −HSS2 are the first three bits of the ADC digital word and are sent to the output buffer register.

2-98. A6 LOW SPEED SCALER ASSEMBLY (05465-60006)

2-99. The low speed scaler card contains the next seven bits of the ADC digital word and two additional flip flops connected as part of the counter chain. Also included on the card are output gates and a zero baseline detector circuit. The outputs of the two additional flip flops (LSS10 and OVER ZERO) are used to generate a load pulse if the data contents of the counter are valid within zero to full-scale limits. The zero baseline detector produces an output signifying that the stabilize cycle has not been able to correct for errors greater than ±4 channels. This output places the stabilize digital servo into the speedy stabilize mode until the error is less than ±4 channels. The total 10-bit digital word (7-bits from A6 and 3-bits from A5) are routed through output gates to the output buffer register card (A7).

2-100. A7 BUFFER REGISTER AND CONTROL ASSEMBLY (05465-60007)

2-101. The buffer register card is a 10-bit parallel register used for data output to the computer. Each time the DONE pulse is generated and the data contents of the counter on A6 is valid, a transfer of data is made from the counter to the buffer. Load logic for the buffer register evaluates the state of LSS10 and OVER ZERO flip flops. For a negative fullscale input a 1000000000 word is sent to the computer in place of the digitized word and 0000000001 is sent for over positive fullscale. Also included on the card is the logic for generating the data ready pulse $\overline{DAR}$. This pulse is sent to the computer and is derived from the start of sample time and DONE pulse.

2-102. A8 10 to 100 MHz CLOCK MULTIPLIER ASSEMBLY (05415-6009)

2-103. The multiplier card converts the 10 MHz clock rate from the clock generator to 100 MHz which is the clock for the high speed scaler.

2-104. A9 CLOCK GENERATOR ASSEMBLY (05465-60009)

2-105. The clock generator card provides three clock functions: 10 MHz generator, 10.24 MHz generator, and line trigger generator. The 10.24 and 10 MHz generators are crystal oscillators followed by pulse shapers. Gating circuits are used to enable the output of one and disable the other, depending on the setting of the sample mode switch. The line trigger circuit reshapes 50-60 Hz line frequency into trigger pulses for use when the trigger source is selected as LINE.

2-106. A10 SAMPLE GENERATOR ASSEMBLY (05465-60010)

2-107. The sample generator card contains the logic to produce sample triggers interlaced with stabilize triggers. The rates of these are determined by front panel switch settings. A 7-bit word (N6-N12) received from the computer is decoded to provide selection of 10.24 MHz clock as a function of data block size (see Table 2-4).

2-108. A11, A12 INPUT ATTENUATOR ASSEMBLIES (05465-60011)

2-109. The attenuator cards are the attenuators for Channel A and Channel B inputs. The amount of attenuation is selected with the front panel controls as determined by the amplitude of the input signal. Incorrect setting of these controls will result in an over-fullscale word sent to the computer.

Table 2-4. Computer Block Size Selection

BLOCK SIZE	N = 1	FREQ AT IC 13
4096	N12	10.24 MHz
2048	N11	5.12 MHz
1024	N10	2.56 MHz
512	N9	1.28 MHz
256	N8	.64 MHz
128	N7	.32 MHz
64	N6	.16 MHz
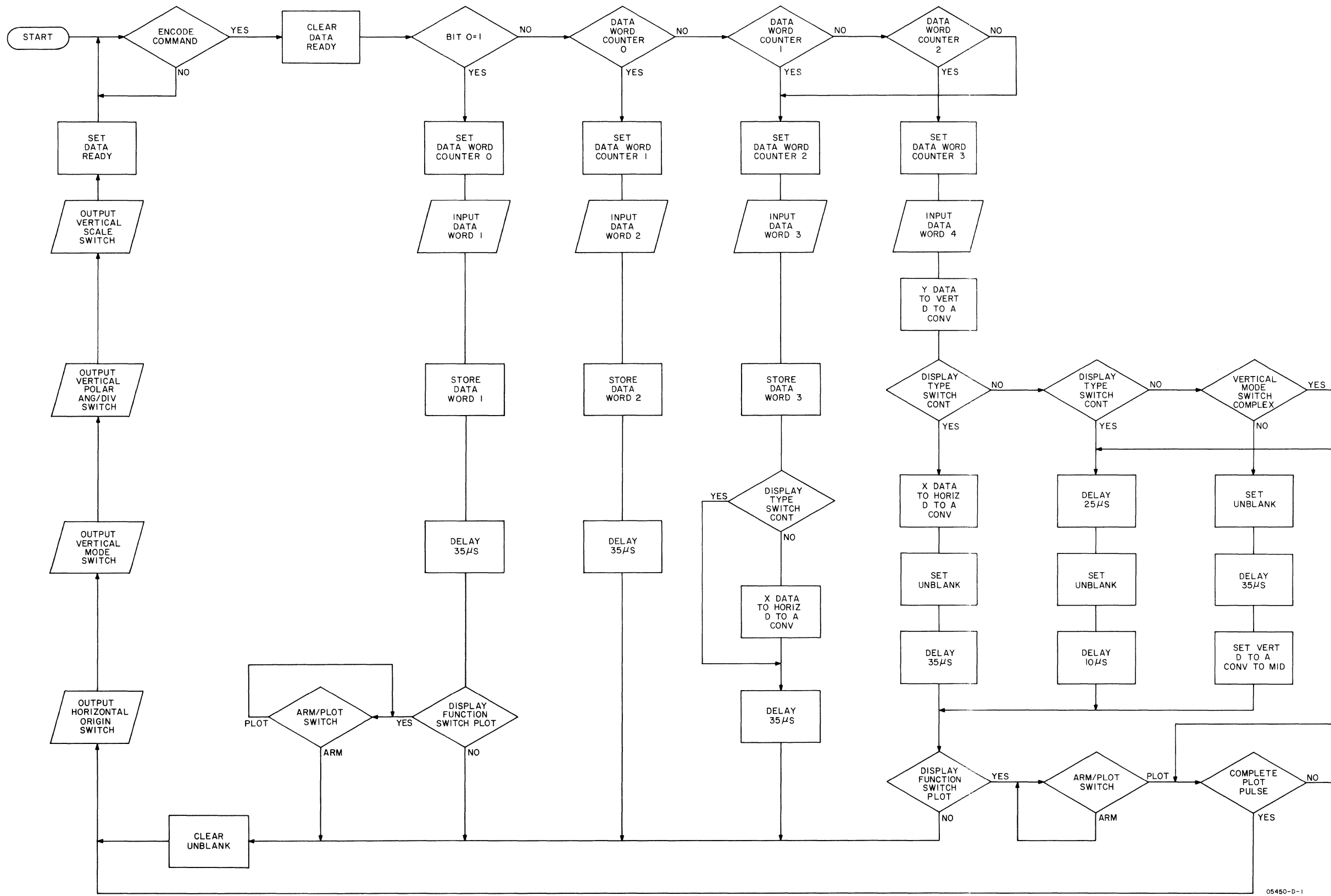
Figure 2-5. (5460A) Operation Flow Diagram

05450-D-1
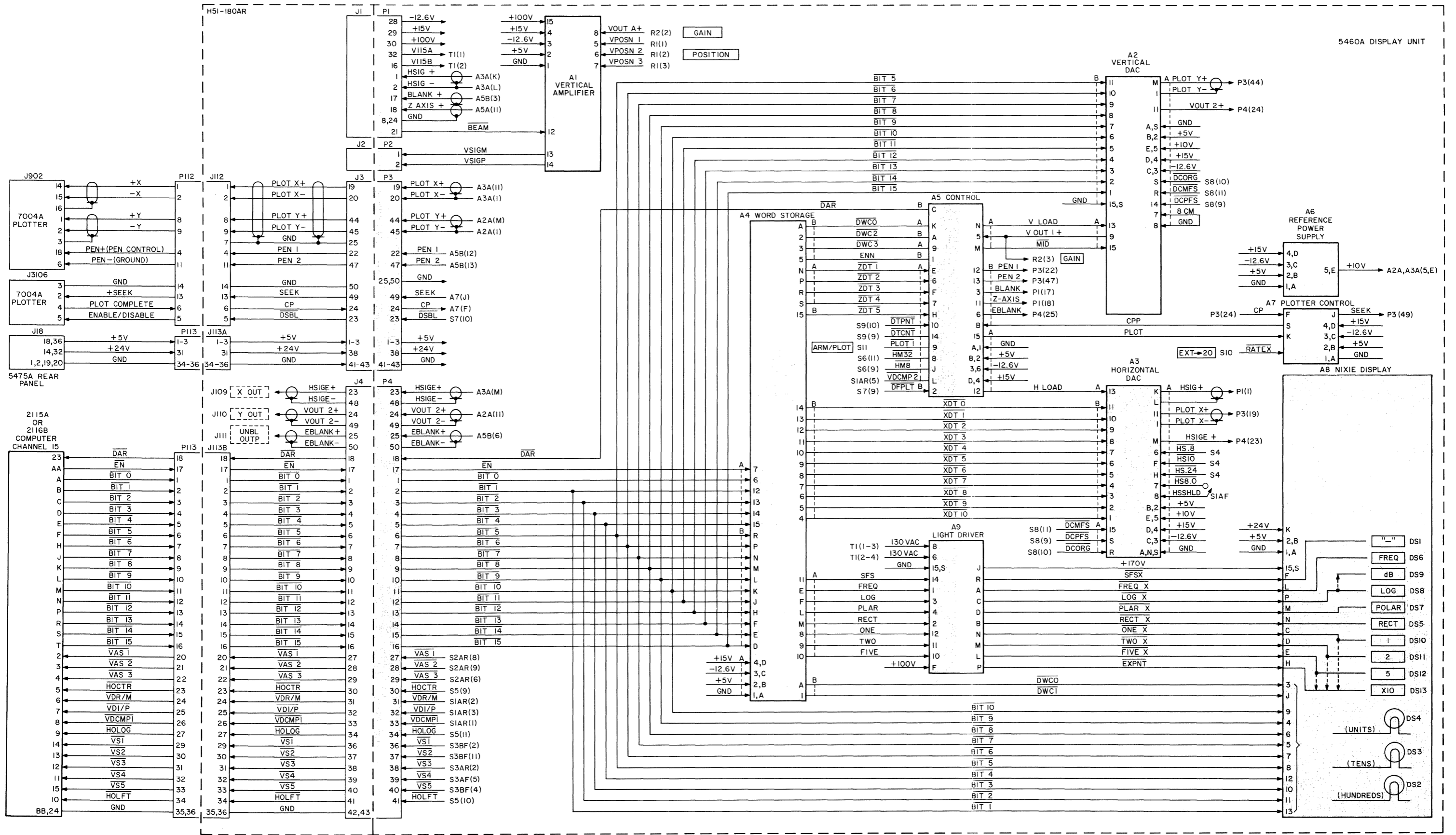
Figure 2-6. (5460A) Display Unit Wiring Block Diagram
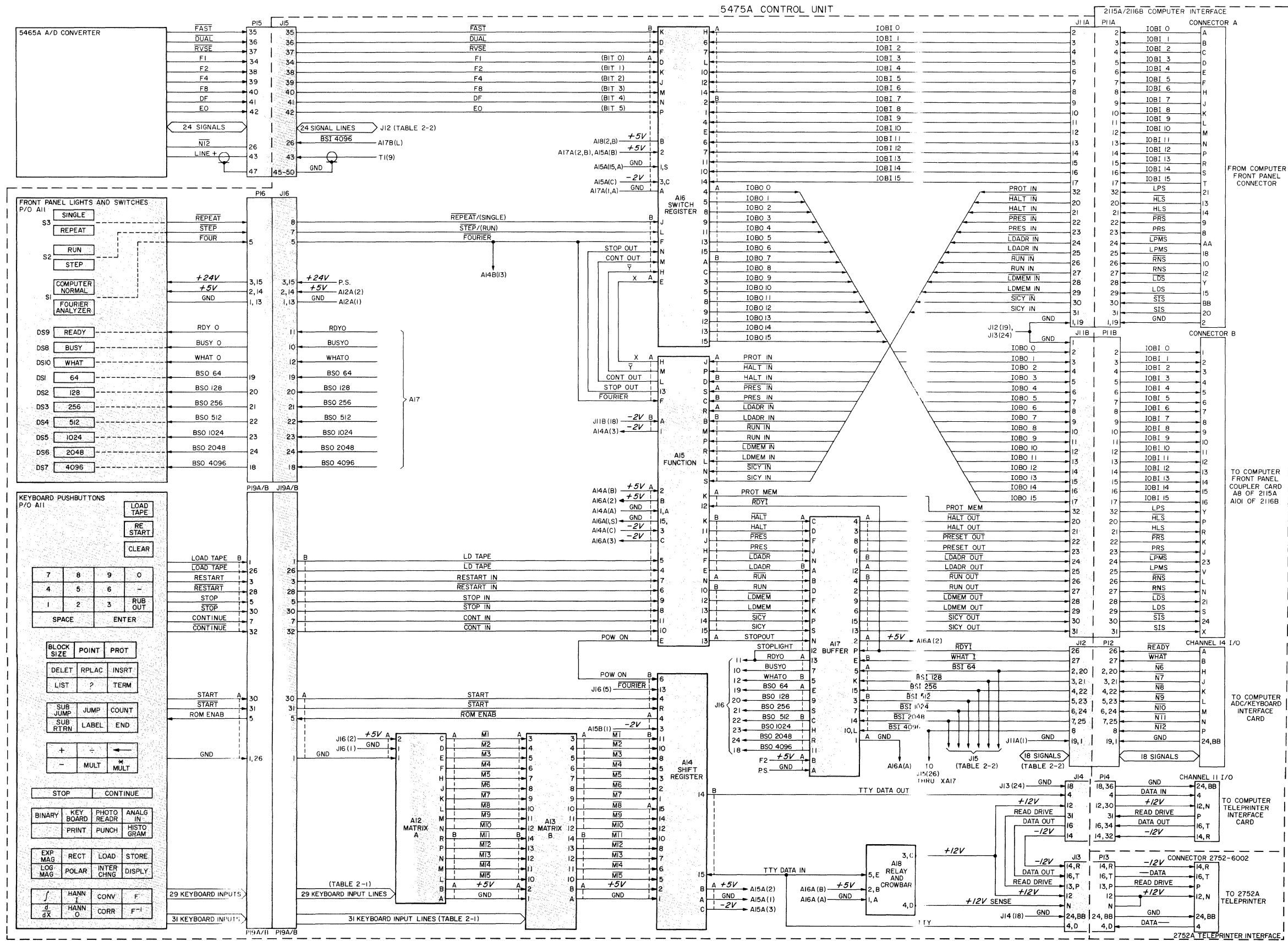
Figure 2-7. (5475A) Control Unit/Keyboard Wiring
Block Diagram
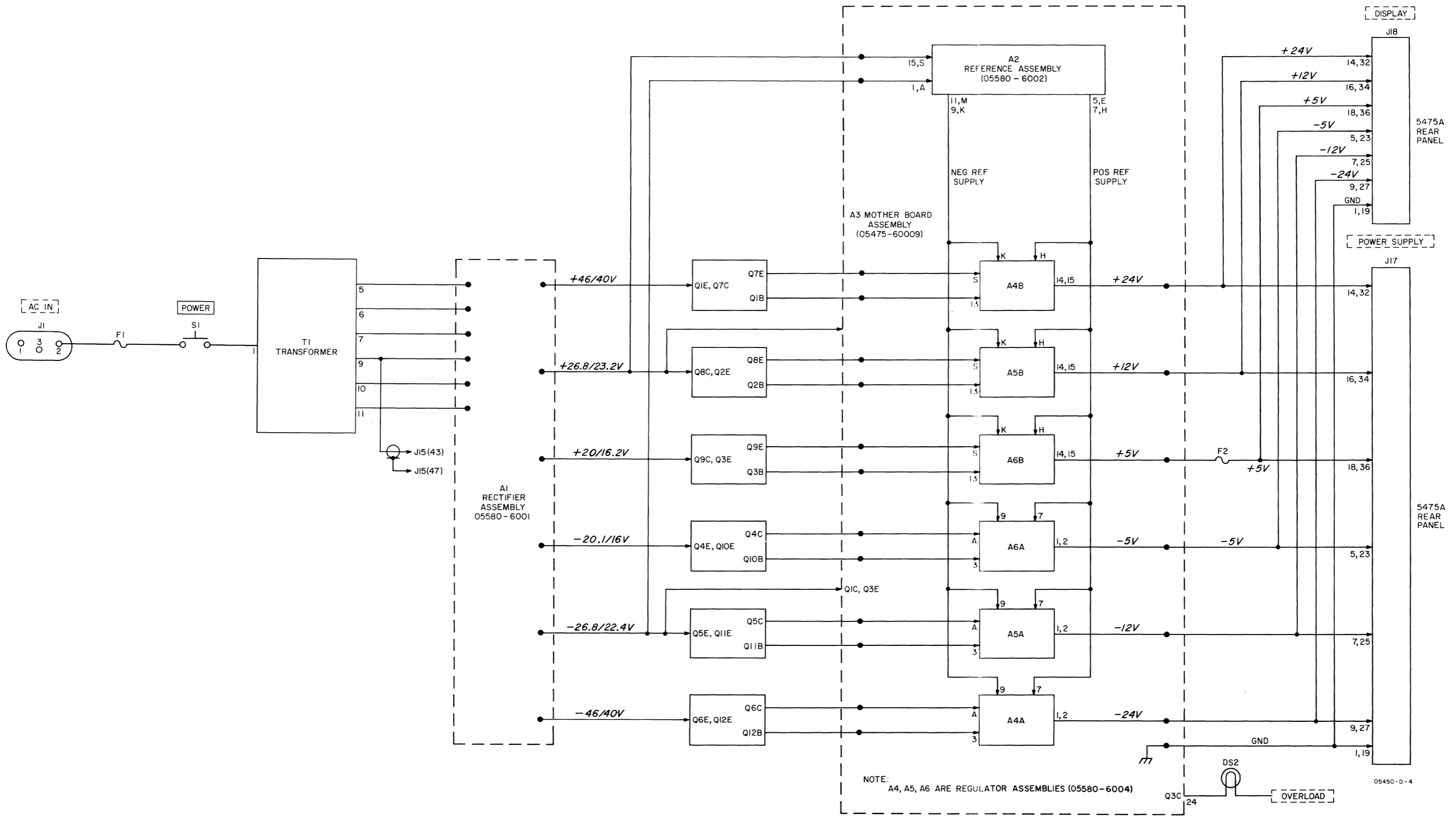
Figure 2-8. (5475A) Power Supply Wiring Block
Diagram
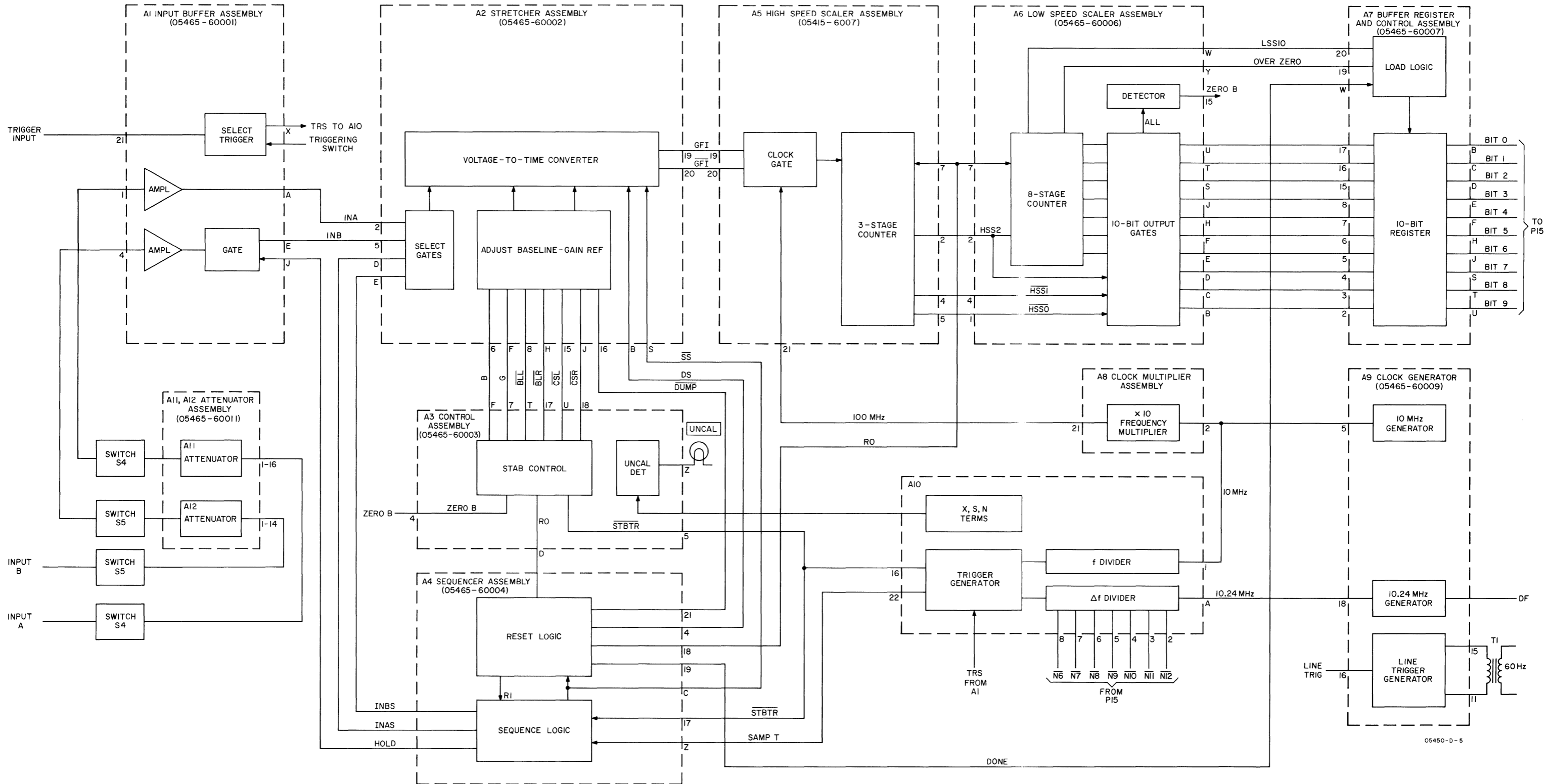
Figure 2-9. (5465A) ADC Functional Flow Diagram

SECTION III

CHECKS AND ADJUSTMENTS

3-1. INTRODUCTION

3-2. The four tables in this section describe Operational Checks for the 5450A Fourier Analyzer System, and Adjustment Procedures for the 5460A and 5475A units of the system; there are no adjustments that can be made on a 5465A in the field. The tables in this section are:

Each table is self-contained, and includes descriptions of the tests or adjustments to be performed, equipment required, and procedure to use.

Table 3-1. Operational Check

DESCRIPTION

By using the required test tape, a complete operational check of the 5450A system may be made. Typing various codes into the computer will lead to separate checks (i.e., Keyboard, Display, ADC checks). If the System fails any check, refer to Table 4-1 (Troubleshooting).

EQUIPMENT REQUIRED

Description	HP Part Number
Test Tape	05450-90007
Sine Square Oscillator	209A
Voltmeter	427A
51Ω Load	

PROCEDURE

Loading Test Tape

1. Set Control Unit COMPUTER NORMAL/FOURIER ANALYZER switch to COMPUTER NORMAL.

2. Before turning on Computer, be sure LOADER switch is set to PROTECTED. It is possible to lose all or part of a special program in the last 64 memory locations of the computer if the LOADER switch is in the ENABLED position. This program is known as the Basic Binary Loader, and is used to enable loading the computer from the High-Speed Tape Reader.

   NOTE: If Computer is running, press HALT before loading test tape.

3. Load Test Tape into the Tape Reader.

   a. Turn cabinet power on, switch button will light.

   b. Turn Tape Reader power on. NOTE: To save reader lamp, it is advisable to leave the tape reader power off except when using reader.

   c. Load paper tape into photoreader as shown in illustration on the following page. The feed holes (small holes in tape) should be toward panel. The first data frames must be to the left of the read element. The tape leader must pass under the hairpin on the read element and between the rollers on the right.

   d. Press up on the LOAD tab at bottom of reader block. This will push Run Gate up, exposing the word "RUN" and enabling the tape to be read.

Table 3-1. Operational Check (Cont'd)

Loading Test Tape (Cont'd)
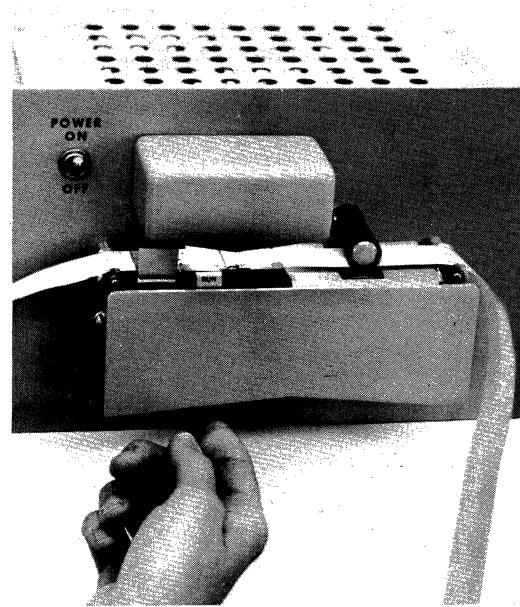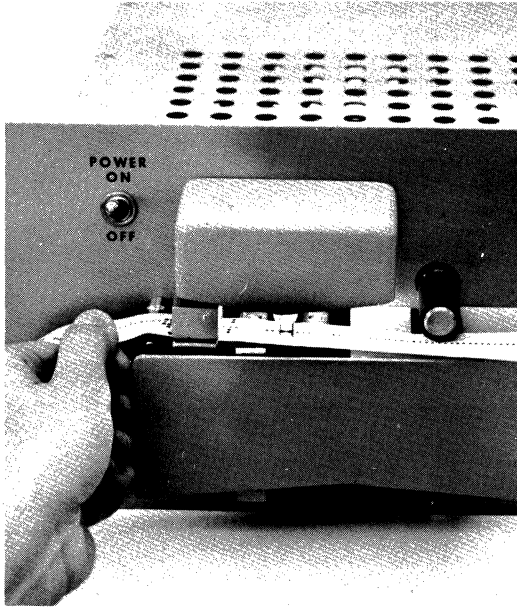
e. Set Computer switch register to starting address of Basic Binary Loader (e.g., 017700_8 for 8K Memory, 037700_8 for 16K Memory).

f. Press LOAD ADDRESS.

g. Set LOADER switch to ENABLED.

h. Press PRESET.

i. Press RUN.

j. When tape is loaded, Computer should HALT with 102077_8 in the T register. If contents of T register are correct, set the LOADER switch to PROTECTED and rewind the tape. If the T register contains another number, the program may have been incorrectly loaded and must be reloaded, using the above instructions. If the computer continues to HALT with some number other than 102077_8 in the T register, it is possible that the Basic Binary Loader program has been written over (erased) or there may be a Checksum error. Refer to instructions for reloading the Basic Binary Loader, or to Computer manuals.

k. Set the switch register to 006000_8.

l. Press LOAD ADDRESS.

m. Press PRESET.

n. Press RUN.

The system checkout tape is now loaded, and running in the computer.

Table 3-1. Operational Check (Cont'd)

<u>PROCEDURE</u> (Cont'd)

<u>Loading Test Tape</u> (Cont'd)

The following message will be printed on the teleprinter. Read "ENTERING A TEST PROGRAM" before proceeding.

```
                THIS IS THE 5450 TEST PROGRAM
                TYPING SA LEADS TO THE ADC TEST
                TYPING SD LEADS TO THE DISPLAY TEST
                TYPING SK LEADS TO THE KEYBOARD TEST


                TO RETURN TO FOURIER TYPE SC
```

<u>Entering a Test Program</u>

To enter any of the test programs listed in the teleprinter message above, type the required instruction, then press RETURN (CR), followed by LINE FEED (LF).

Refer to ADC TEST after typing SA, RETURN, LINE FEED.

Refer to DISPLAY TEST after typing SD, RETURN, LINE FEED.

Refer to KEYBOARD TEST after typing SK, RETURN, LINE FEED.

SC, CR, LF, returns computer operation back to the Fourier-Analyzer Program, if the Program was previously in memory, otherwise do not type SC.

<u>ADC TEST</u>

<u>Description</u>

This test checks functioning of the 5465A ADC Plug-in Unit. If your system fails any portion of this test, refer to Table 4-1, Troubleshooting.

<u>Entry</u>

Typed SA, RETURN, LINE FEED on teleprinter.

<u>Triggering Tests</u>

DESCRIPTION

This procedure checks all 5465A ADC Unit triggering modes for proper operation. Computer switch register switch 15 switching from down to up ($\emptyset$ to 1 position) enables an encode (computer ready) signal to the ADC, arming the triggering cycle. The TRIGGERING lamp lights, indicating that the trigger circuit is functioning.

Table 3-1. Operational Check (Cont'd)

ADC TEST (Cont'd)

Triggering Tests (Cont'd)

PROCEDURE

1. Set Controls as follows:

    5465A:

        SAMPLE MODE to kHz/μsec
        MULTIPLIER to 25/20/50
        DISPLAY/INPUT to A/A
        OVERLOAD VOLTAGE (both) to .1
        AC/DC (both) to DC
        SLOPE to POS
        TRIGGER LEVEL to PRESET

    5475A:

        COMPUTER NORMAL/FOURIER ANALYZER to COMPUTER NORMAL

    Computer:

        Switch Register switch 15 down

2. Set 5465A TRIGGER SOURCE to FREE RUN. TRIGGERING lamp should be out.

3. Set Computer switch register switch 15 up. TRIGGERING lamp must light, indicating that trigger circuit is armed.

4. Set Computer switch register switch 15 down. TRIGGERING lamp must go out.

5. Set 5465A TRIGGER SOURCE to LINE. Repeat Steps 3 and 4.

6. Set 5465A TRIGGER SOURCE switch to INTERNAL. Connect 10 Hz, 12 mV sinewave through a 51Ω termination to INPUT A. Repeat Steps 3 and 4.

7. Set controls as follows:

    5465A:

        TRIGGER SOURCE to EXT. DC.

    Computer:

        Switch register switch 15 down.

8. Connect 100 Hz, 100 mV external sine wave source through 51Ω feedthrough termination to 5465A EXT. TRIGGER connector.

9. Repeat steps 3 and 4.

10. Repeat steps 8 and 9 for TRIGGER SOURCE set to EXT. AC.

Table 3-1. Operational Check (Cont'd)

ADC TEST (Cont'd)

Uncal Lamp Test

DESCRIPTION

Certain combinations of SAMPLE MODE and MULTIPLIER switch settings indicate a MAX FREQ or TOTAL TIME range that is beyond the capability of the Fourier Analyzer, therefore the Analyzer is uncalibrated. If you select one of these combinations, the UNCAL lamp lights, indicating that you should select another switch setting combination.

PROCEDURE

The UNCAL lamp must light only for certain combinations of switch settings as listed in the table below. NOTE: Where a computer switch register switch is specified as being "up", it is up only for the one 5465A switch combination with which it is listed, not for all other switch settings within the same block; all other computer switch register switches are "down".

SAMPLE MODE	5465A MULTIPLIER	DISPLAY/INPUT	Computer SWITCH REGISTER SETTING (All switches down unless noted.)	5465A UNCAL LIGHT STATUS
KHz, μs	50/100/10	A/A		ON
	25/50/20			OFF
	25/50/20	A/DUAL		ON
	10/20/50			OFF
ΔTIME, Hz, ms				OFF
ΔFREQ, Hz, ms	50/100/10	A/A	12 UP ONLY	ON
	25/50/20			ON
	10/20/50			ON
	5/10/100			OFF
	5/10/100	A/DUAL		ON
	50/100/10			ON
	25/50/20			ON
	10/20/50			ON
	50/100/10	A/A	11 UP ONLY	ON
	25/20/50			ON
	10/20/50			OFF
	10/20/50	A/DUAL		ON
	25/20/50			ON
	50/100/10			ON
	50/100/10	A/A	10 UP ONLY	ON
	25/50/20			OFF
	25/50/20	A/DUAL		ON
				ON
	50/100/10	A/A	9 UP ONLY	OFF
	50/100/10	A/DUAL		ON
	25/50/20			ON
	10/20/50			OFF
	10/20/50	A/A	8 UP ONLY	OFF
	50/100/10	A/DUAL		ON
	50/100/10	A/A	7 UP ONLY	OFF
	50/100/10	A/DUAL		ON

Table 3-1. Operational Check (Cont'd)

ADC TEST (Cont'd)

Attenuator Code Test

DESCRIPTION

Each OVERLOAD VOLTAGE switch setting provides an output code to the computer. This test ensures that the OVERLOAD VOLTAGE attenuator codes are correct for all switch settings

PROCEDURE

1. Set controls as follows:

    5465A:

        SAMPLE MODE to Hz/ms (MAX FREQ)

        MULTIPLIER to 50/100/10

        TRIGGER SOURCE to FREE RUN

    5475A:

        COMPUTER NORMAL/FOURIER ANALYZER switch to COMPUTER NORMAL

2. Set A and B OVERLOAD switches to each combination listed in the chart below. Computer A-REGISTER lamps must light correctly for each switch setting.

A OVERLOAD VOLTAGE

5465A SWITCH AND SETTING	COMPUTER A-REGISTER BITS AFFECTED AND ACTION		
	BIT 2	BIT 1	BIT 0
CHECK	OFF	OFF	OFF
.1	OFF	OFF	ON
.2	OFF	ON	OFF
.4	OFF	ON	ON
1	ON	OFF	OFF
2	ON	OFF	ON
4	ON	ON	OFF
10	ON	ON	ON

Table 3-1. Operational Check (Cont'd)

ADC TEST (Cont'd)

Attenuator Code Test (Cont'd)

B OVERLOAD VOLTAGE

5465A SWITCH AND SETTING	COMPUTER A-REGISTER BITS AFFECTED AND ACTION		
	BIT 5	BIT 4	BIT 3
CHECK	OFF	OFF	OFF
.1	OFF	OFF	ON
.2	OFF	ON	OFF
.4	OFF	ON	ON
1	ON	OFF	OFF
2	ON	OFF	ON
4	ON	ON	OFF
10	ON	ON	ON

Calibration Test

DESCRIPTION

The test program is set up to receive information from the 5465A and display it as a digital number on the 5460A Display Plug-in Unit readout tubes.

The 5465A ADC has a resolution of 1024 levels (2^{10}, or 10 bits). This ADC is analogous to a zero-centered voltmeter. A zero-volt input gives a readout of the binary equivalent of zero counts. Full input voltage (positive or negative) on any OVERLOAD VOLTAGE range gives a binary output equivalent of + or - 511 counts, proportional to the input voltage. If the input voltage at either connector exceeds the OVERLOAD VOLTAGE setting of the corresponding attenuator switch, the OVERLOAD VOLTAGE lamp will light; this lamp is checked elsewhere in the ADC TESTS.

The procedure below determines the APPROXIMATE accuracy of the 5465A ADC by using the CHECK pulse, supplied internally, and noting the ADC output.

There is no attenuation of input voltage in either the CHECK or .1 OVERLOAD VOLTAGE range of either attenuator. Positive .1V gives positive full-value output, the binary equivalent for +511 counts; negative .1V input gives the binary equivalent of -511 counts, full-scale negative output. The CHECK pulse is 53 mV (.053V) in amplitude, and should give an output of the binary equivalent of 261 ±3 counts.

PROCEDURE

1. Set controls as follows:

    5465A:

        SAMPLE MODE to kHz/μs

        MULTIPLIER to 5/100/10

Table 3-1. Operational Check (Cont'd)

<u>ADC TEST</u> (Cont'd)

<u>Calibration Test</u> (Cont'd)

PROCEDURE (Cont'd)

1. 5465A: DISPLAY/INPUT to A/DUAL

    A, B OVERLOAD VOLTAGE to CHECK

    TRIGGER SOURCE to INTERNAL A

    A, B AC/DC to DC

    SLOPE to NEG

    TRIGGER LEVEL to trigger on CHECK PULSE

    Computer:

    Switch register switch 15 down, switch 14 up. Switch 14 determines which
    ADC channel is connected to the computer; up = A, down = B.

2. Measure DC Zero offset of the check signal from ADC by reading number in 5465A Display
    Unit readout; count should be 000 ±8 counts. Record this number as "initial value" in chart
    below.

3. Set controls as follows:

    5465A:
            SLOPE to POS

            TRIGGER LEVEL, rotate CCW from PRESET until ADC triggers, as
            indicated by 5465A Digital Display readout tubes (Computer P- and M-REGISTERS
            will change from a static display to active lamp action, indicating triggering).

4. Record number now displayed on 5465A as "final value" in chart below. Difference between
    this and "initial value" must be 261 ±3 counts.

            Final Value_____

            Initial Value_____

               subtract

            Difference_____
                         (must be between 258 and 264)

5. Repeat the above check for Channel B by setting computer switch 14 down.

            Final Value_____

            Initial Value_____

               subtract

            Difference_____
                         (must be between 258 and 264)

Table 3-1. Operational Check (Cont'd)

ADC TEST (Cont'd)

Sample Rate Test

DESCRIPTION

This check ensures correct operation of the ADC in the main Fourier program by setting certain sample rates and inserting corresponding input signals. NOTE: Once you have typed SC, RETURN, LINE FEED, and have entered the main Fourier program, you cannot get back into the test tape programs without reloading the test tape as described at the beginning of this table. Therefore, it is suggested you complete all other tests of the Fourier Analyzer system (Display Unit and Control Unit) before performing this test.

PROCEDURE

1. Enter main Fourier program by typing SC, RETURN, and LINE FEED on teleprinter. The main Fourier program is now in operation, you are no longer in the test program. To return to this program, from the main Fourier program, you must reload test tape, and type SA, RETURN, LINE FEED on the teleprinter.

2. Set controls as follows:

    5465A:
                    DISPLAY/INPUT to A/DUAL

                    OVERLOAD VOLTAGE (both) to 1

                    TRIGGER SOURCE to INTERNAL (A)

                    TRIGGER LEVEL to PRESET

    5460A:
                    DISPLAY lever switches (all) to center positions.

                    SCALE switch so arrow on knob points straight up.

                    VERTICAL POSITION to center trace on CRT screen.

                    VERTICAL GAIN to CAL.

    5475A:
                    REPEAT/SINGLE to REPEAT

                    COMPUTER NORMAL/FOURIER ANALYZER switch to FOURIER ANALYZER

3. Connect oscillator through 51Ω feedthrough termination to INPUT A and INPUT B. Monitor oscillator amplitude to maintain 0.6V output at all frequencies.

4. Observe Fourier Analyzer CRT for each of the combinations of 5465A control settings listed in the chart below.

5465A Sample Rate Test

	5465A SWITCHES		OSCILLATOR	CRT
DISPLAY/INPUT	SAMPLE MODE	MULTIPLIER	FREQUENCY @ .6V	DISPLAY (CYCLES OF SINE WAVE)
B/DUAL	Hz/ms (ΔFREQ/ TOTAL TIME)	10/20/50	20 Hz	1
A/DUAL	"	"	"	1
A/DUAL	"	2.5/5/200	10 Hz	2
A/DUAL	Hz/ms (MAX FREQ/ΔTIME)	5/10/100	"	1
A/DUAL	kHz/ms	1K/1/.5	15.6 Hz	1
A/DUAL	kHz/μs	1K/1/.5	15.6 Hz	10 (set DISPLAY TYPE to CONT. to view 10 cycles of sine wave)

Table 3-1. Operational Check (Cont'd)

ADC TEST (Cont'd)

Sample Rate Test (Cont'd)

5. Set controls as follows:

    5475A: REPEAT/SINGLE switch to SINGLE

    5465A: SAMPLE MODE to TOTAL TIME MS

            MULTIPLIER to 5/100/10

    In the ΔFREQ mode, changing a BLOCK SIZE does not affect the total time (one complete sweep) required to take a single record; therefore, no change in the period of the input will be noted when changing block sizes.

6. Enter a block size of 64 by pressing the keys BLOCK SIZE, 6, 4, and ENTER, in that order. BLOCK SIZE lamp 64 will light.

7. Set sine wave oscillator frequency to 10 Hz.

8. Enter sweeping mode by pressing the keys ANALOG IN, 0, SPACE, 1, SPACE, and ENTER, in that order. CRT should display one cycle of sine wave.

9. Repeat steps 6 and 8 for block sizes 128, 256, 512, and 1024. CRT display should be one cycle of sine wave at each block size.

10. If your computer has a 16K memory, repeat steps 6 and 7 for block sizes 2048 and 4096. Set 5465A MULTIPLIER to 1/500/2. CRT should display 5 sine wave cycles.

External Clock Test

DESCRIPTION

This check ensures proper operation of the 5465A EXTERNAL CLOCK in the main Fourier program. NOTE: Once you have typed SC, RETURN, LINE FEED, and have entered the main Fourier program, you cannot get back to the test tape programs without reloading the test tape as described at the beginning of this table. Therefore, you should complete all other tests of the Fourier Analyzer system (Display Unit and Control Unit) before performing this test. If you have just performed the SAMPLE RATE test described above, you are already in the main Fourier Analyzer Program.

PROCEDURE

1. Type SC, RETURN, LINE FEED, to enter the main Fourier program. If you were already in the main Fourier program, the 5475A "WHAT?" lamp would light, and the teleprinter would print SC "WHAT?"

2. Set controls as follows:

    5465A:
            SAMPLE MODE to EXT. CLOCK

            MULTIPLIER to 50/10/100

            TRIGGER SOURCE to FREE RUN

    5475A:
            REPEAT/SINGLE to SINGLE

Table 3-1. Operational Check (Cont'd)

ADC TEST (Cont'd)

External Clock Test (Cont'd)

3. Set sine wave input for 1 MHz at 1.4V, terminated in 51 ohms.

4. Connect sine wave input to 5465A EXT. CLOCK connector through 51-Ω feedthrough connector.

5. Set a block size of 64 by pressing the keys BLOCK SIZE, 6, 4, and ENTER, in that order.

6. Enter into the sweeping mode by pressing the keys ANALOG IN, 0, SPACE, 1, SPACE, and ENTER, in that order. At this time, the BUSY lamp should light momentarily and 64 dots should be displayed (sweeping) and then BUSY/READY lite will return to READY indicating a record has been taken.

Dual Input Test

DESCRIPTION

This test ensures that both A and B channel inputs are adjusted to provide the same value of input voltage.

PROCEDURE

1. Set controls as follows:

    5465A ADC:

            SAMPLE MODE to kHz/μsec

            MULTIPLIER to 5/10/100

            DISPLAY/INPUT to A/DUAL

            TRIGGER SOURCE to FREE RUN

            TRIGGER SLOPE to POS

            OVERLOAD A & B to .1

            AC/DC to AC

    5475A:
            FOURIER ANALYZER/COMPUTER NORMAL switch to FOURIER ANALYZER.
            NOTE: The 5450A should be running in the main Fourier program; if not,
            type SC, RETURN, LINE FEED.

    Oscillator:
            For a frequency of 100 Hz with an amplitude of 30 mV terminated in 51Ω.

2. Connect OSCILLATOR output to 5465A INPUT A and INPUT B thru a "T" connector and 51Ω termination.

3. Enter a BLOCK SIZE of 256 in the following manner: Press keys BLOCK SIZE, 2, 5, 6, and ENTER. BLOCK SIZE 256 lamp must light.

4. Enter into the Record-taking mode by pressing the ANALOG IN, 0, SPACE, 1, SPACE, 0, and ENTER keys. One record will be taken and the waveform of one sine wave cycle will appear on the CRT Display.

5. We will now subtract Block 0 (Channel A's information) from Block 1 (Channel B's information) in the following manner:

    a. Press "-", 1, and ENTER keys. A horizontal line will appear on the CRT Display.

    b. Rotate the 5460A DISPLAY SCALE switch clockwise until readout section of 5460A shows a scale factor of 5 x 10^{-4}.

Table 3-1. Operational Check (Cont'd)

ADC TEST (Cont'd)

Dual Input Test (Cont'd)

There should be a random pattern of dots displayed on the CRT. This represents the difference between Channel A and Channel B. The "noise" pattern should not be vertically spread more than 2 major divisions, centered on baseline.

Repeat the above procedure for a SAMPLE RATE of 2.5/5/200.

Histogram Test

DESCRIPTION

This test has two purposes: 1) to test the OVERLOAD lamp and 2) to ensure that the ADC places the information from an Overload condition into the proper channels.

PROCEDURE

1. Set controls as follows:

    5460A: LEVER SWITCHES (all) to Center position

              DISPLAY SCALE switch to 12 o'clock position.

              Center trace with horizontal and vertical position controls.

    5465A: INPUT/DISPLAY to A/A

              SAMPLE MODE to kHz, μs

              SAMPLE MULTIPLIER to 2.5/5/200

              TRIGGERING to FREE RUN

              TRIGGER SLOPE to POS

              OVERLOAD A to .1

    5475A: FOURIER ANALYZER/COMPUTER NORMAL to FOURIER ANALYZER

              REPEAT/SINGLE to SINGLE

    OSCILLATOR   to 100 Hz at an amplitude of 100 mV.

2. Enter a BLOCK SIZE of 1024 in the following manner: press keys BLOCK SIZE, 1, 0, 2, 4 ENTER. BLOCK SIZE 1024 lamp must light.

3. Clear block 0 by pushing keys CLEAR, 0, ENTER.

4. Enter into the HISTOGRAM mode by pressing HISTOGRAM and ENTER keys.

The 5475A BUSY LAMP should light, the 5465A TRIGGERING LAMP should light, and the 5465A OVER-LOAD Lamp should be on. Two dots, one at each end of the CRT horizontal display, will be moving upward, indicating that counts are being added to the first channel (due to a negative overflow) and to the last channel (due to a positive overlow). After approximately 20 seconds, the record-taking action will cease and the 5450A will return to the READY mode. There should be two dots and a baseline displayed on the CRT. The left dot is the first channel and the right dot is the last channel. The dots should be approximately 2 cm above the base line.

Table 3-1. Operational Check (Cont'd)

DISPLAY TEST

Description

This test checks every switch and function of the 5460A Display Plug-in Unit via the 16 computer switch register switches. If system fails any portion of this test, refer to Troubleshooting Table (Table 4-1).

Entry

Control Unit COMPUTER NORMAL/FOURIER ANALYZER switch must be set to COMPUTER NORMAL.

Typed SD, RETURN, LINE FEED on teleprinter.

Setup

Computer switch register switch 10 down and 11 up

VERTICAL	HORIZONTAL
Position to center trace or at 11 o'clock position	SWEEP LENGTH to 10
GAIN to CAL	ORIGIN to CENTER
(Switch engaged)	MARKER OFF
MODE to REAL MAGNITUDE	PLOT RATE to 20
	ARM/PLOT to ARM
POLAR AVG/DIV to 45	DISPLAY
SCALE full CCW position (-2)	Function to DISPLAY
	CALIBRATE to ORIGIN
	TYPE to POINT
	INTENSITY approximately at 4 o'clock position.

Program Operation

1. Check 5460A front-panel lights. Computer switches 0 through 9 control these lights, as listed in the chart below.

Computer Switch (Number) Position	Action
(0) UP	Polar light on. Rect. light off.
(0) DN	Rect. light on. Polar light off.
(1) UP	Log light on. +.1 Dec. light on.
(1) DN	Log light off. +.1 Dec. light off.
(2) UP	FREQ. light on.
(2) DN	FREQ. light off.
(3) UP	Units Nixie ® digit counts 1-9 at 1 sec rate than blanks out for 6 seconds (15 binary count).
(3) DN	Units Nixie ® readout of last digit before interrupt.
(4) UP	Tens Nixie ® performs same function as units switch above.
(4) DN	Holds tens Nixie ® at last count before interrupt.
(5) UP	Hundreds Nixie ® performs as tens and units above.
(5) DN	Holds hundreds Nixie ® at last count before interrupt.
(6) UP	Minus sign on.
(6) DN	Minus sign off.
(7) UP	5 light on; X10 light on.
(7) DN	5 light off; X10 light off.
(8) UP	2 light on; X10 light on.
(8) DN	2 light off; X10 light off.
(9) UP	1 light on; X10 light on.
(9) DN	1 light off; X10 light off.

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Table 3-1. Operational Check (Cont'd)

1. (Cont'd)

NOTE: A combination of switches 10, 11 are used for the following checks.

Computer Switch (Number) Position	Action
10 UP, 11 DN	17 points displayed (in line from lower left hand corner to upper right hand corner of CRT).
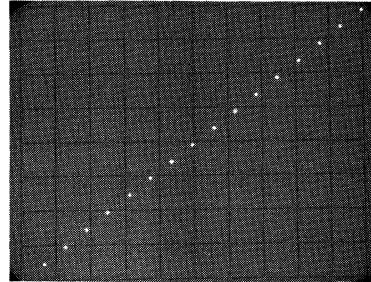
10 DN, 11 UP	129 points displayed (sweeping from lower left hand corner of CRT to upper right hand corner).
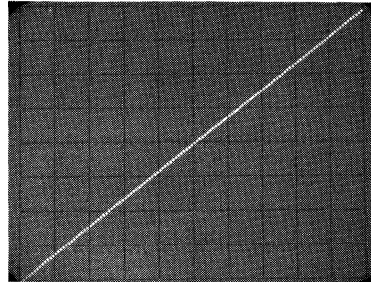
10 UP, 11 UP	3 dots displayed. One in lower left hand corner of CRT. Second at middle graticule crossing point. Third at upper right hand corner.
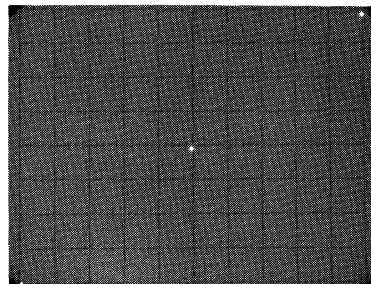
10 DN, 11 DN	2049 points display (sweeping from lower left hand corner of CRT to upper right hand corner).
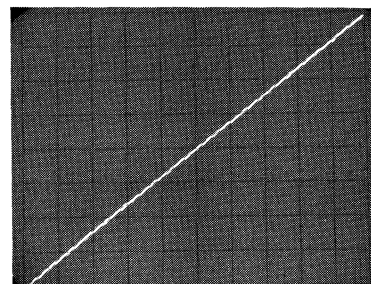
Table 3-1. Operational Check (Cont'd)

2. Check 5460A front-panel switches. Switches control lighting of lamps in computer B-REGISTER display, as indicated in chart below.

5460A Switch Name and Setting	Computer B REGISTER Bits Affected and Action
HORIZONTAL ORIGIN	9, 8, 4 affected
LEFT	9 lighted, 8 off, 4 off
LOG	9 off, 8 lighted, 4 off
CENTER	9 off, 8 off, 4 lighted
VERTICAL MODE	7, 6, 5 affected
COMPLEX	7 lighted, 6 off, 5 off
IMAG-PHASE	7 off, 6 lighted, 5 off
READ-MAGTD	7 off, 6 off, 5 lighted
VERTICAL SCALE	14, 13, 12, 11, 10 affected
Full CCW -2	14 and 11 lighted; 13, 12, 10 off
-1	14 and 10 lighted; 13, 12, 11 off
UP 0	14, 13, 12, 11, 10 all off
1	10 lighted; 14, 13, 12, 11 off
2	11 lighted; 14, 13, 12, and 10 off
3	11 and 10 lighted; 14, 13, 12 off
4	12 lighted; 14, 13, 11, and 10 off
5	12 and 10 lighted; 14, 13, 11 off
6	12 and 11 lighted; 14, 13, 10 off
7	12, 11, 10 lighted; 14 and 13 off
Full CW 8	13 lighted; 14, 12, 11, and 10 off
POLAR ANG/DIV	3, 2, 1, 0 affected
100	2 lighted; 3, 1, 0 off
50	3 lighted; 2, 1, 0 off
45	3, 2, 1, 0 all off
10	1 lighted; 3, 2, 0 off
RAD	3, 2 lighted; 1, 0 off

3. Additional switch checks.
   (See following page.)

Table 3-1. Operational Check (Cont'd)

3. Additional switch checks. Switch effects are indicated in the table below. For the following checks set the 5450A controls as follows:

5460A Switch Name and Setting	Switch Effect Note: Adjust intensity, if necessary.
HORIZONTAL MARKERS	Intensifies certain points in trace.
32 PT	Intensified trace every 32nd point
8 PT	Intensified trace every 8th point
OFF	No intensification of trace
DISPLAY TYPE	
BAR	Vertical bars on CRT from mid-scale to point being displayed. (Note: VERTICAL MODE switch in COMPLEX will disable vertical bar.)
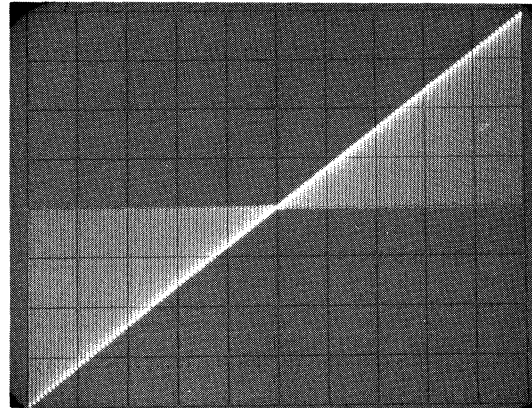
CONT	Continuous line between each point being displayed. (Note: VERTICAL MODE must be set to REAL MAGNITUDE.)
POINT	Small dot at each point being displayed.
HORIZONTAL SWEEP LENGTH (Set DISPLAY FUNCTION to CAL and DISPLAY CALIBRATE to - FS	Point displayed on CRT at horizontal position (cm)
10. 24	5. 05 to 5. 2
12. 8	6. 3 to 6. 5
10	as listed for VERTICAL MODE settings below.
VERTICAL MODE (Set DISPLAY FUNCTION to CAL, and HORIZONTAL SWEEP LENGTH to 10)	Point at (cm)
COMPLEX	3. 95 to 4. 05
REAL/MAGTD	4. 95 to 5. 05
IMAG/PHASE	4. 95 to 5. 05

Table 3-1. Operational Check (Cont'd)

KEYBOARD TEST

Description

This test provides several checks of Control Unit keyboard functions. Each check is described separately. If system fails any portion of these tests, refer to Table 4-1, Troubleshooting.

Entry

Typed SK, RETURN, LINE FEED on the teleprinter. The teleprinter will respond with the following output:

```
TYPE SL TO TEST ALL INDICATOR LIGHTS

TYPE SSN TO TEST A BLOCK SIZE LIGHT

TYPE SR TO TEST LOADER PROTECT

TYPE SW TO TEST WHAT LIGHT
```

In each case, the RETURN (CR) and LINE FEED (LF) keys must be used after typing the indicated letters, in order to begin a test. Descriptions and procedures for the four tests are given below.

SR, CR, LF tests to see if the computer loader is protected: the teleprinter will print PROTECTED or UNPROTECTED depending on the state of the loader.

SL, CR, LF lights all keyboard front panel lights in a repetitive pattern.

SSN, CR, LF: DO NOT type "SSN" on teleprinter; instead, type "SS", then "64", "128", "256", "512", "1024", "2048", or "4096" for "N". When you follow this with CR and LF, the appropriate BLOCK SIZE lamp should light. If some other number is typed for "N" the command will be ignored.

SW, CR, LF will light the WHAT indicator for about 1 second.

Keyboard Disable Test

DESCRIPTION

This check ensures proper functioning of the COMPUTER NORMAL/FOURIER ANALYZER switch.

PROCEDURE

1. Set COMPUTER NORMAL/FOURIER ANALYZER switch to COMPUTER NORMAL.

2. Press RESTART.

3. Press BLOCK SIZE, followed by the numbers "6" and "4". There should be no action.

4. Set COMPUTER NORMAL/FOURIER ANALYZER switch to FOURIER ANALYZER.

5. Press RESTART. Teleprinter will print START, and do CR and LF.

6. Press BLOCK SIZE. Teleprinter will print BS.

7. Press "6" and "4". Teleprinter will print these numbers. (Teleprinter output is: START BS64.)

Table 3-1. Operational Check (Cont'd)

Load Tape Test

DESCRIPTION

This test checks operation of the 5475A Control Unit in the FOURIER ANALYZER mode; specifically, it checks the LOAD TAPE button. The LOAD TAPE button simplifies use of the Computer's Basic Binary Loader by enabling "direct" loading of the tape. The normal loading sequence (load starting address, enable loader, press PRESET and RUN, protect loader) is bypassed, and the new program is loaded simply by pressing the LOAD TAPE button. To accomplish this check, part of the test program is destroyed. The computer is instructed to add HALT statements (102000) at several points in the program. If at this time these points are used as starting points, the computer will always HALT. The program is then reloaded into memory by pressing the LOAD TAPE button and, therefore, again writing over the halt instructions.

PROCEDURE

1. Set Control Unit COMPUTER NORMAL/FOURIER ANALYZER switch to COMPUTER NORMAL.

2. Press HALT.

3. Set switch register to 004000_8.

4. Press LOAD ADDRESS.

5. Set switch register to 102000_8 (machine language HALT instruction).

6. Press LOAD MEMORY.

7. Set COMPUTER NORMAL/FOURIER ANALYZER switch to FOURIER ANALYZER.

8. Insert Test Tape (05450-90007) into tape reader.

9. Press up on LOAD tab to expose the word "RUN" and enable tape to be advanced through reader. NOTE: See Tape Loading Instructions (Table 1-4).

10. Press LOAD TAPE. Tape should be loaded, and HALT with 102077_8 in the T-REGISTER. Remove Tape and rewind as per loading instructions (Table 1-4).

11. Set the COMPUTER NORMAL/FOURIER ANALYZER switch to COMPUTER NORMAL.

12. Set switch register to 004000_8.

13. Press LOAD ADDRESS.

14. Press PRESET.

15. Press RUN. If computer RUN button is not lighted, the 5475A did not enable the Basic Binary Loader and allow the new information to be loaded in.

16. Type SR, RETURN, LINE FEED. Teleprinter should respond with "PROTECTED".

Keyboard/Teleprinter Test

DESCRIPTION

This check tests the proper functioning of the 5475A Control Unit keyboard buttons.

PROCEDURE

1. Set the COMPUTER NORMAL/FOURIER ANALYZER switch to FOURIER ANALYZER.

2. Press each 5475A keyboard button, then ENTER, in the order listed below. Compare teleprinter output with required output listed below.

Table 3-1. Operational Check (Cont'd)

SIGNAL NAME	TELEPRINT	SIGNAL NAME	TELEPRINT
BLOCK SIZE	B S	EXP MAG	T E
POINT	/ .	RECT	T R
PROT	/ P	LOAD	X <
DELET	/ D	STORE	X >
RPLAC	/ R	LAG MAG	T L
INSRT	/ I	POLAR	T P
LIST	/ L	INTER CHNG	X *
?	/ ?	DSPLY	D ษ †
TERM	/	$\int$	$
SUB JUMP	>	HANN I	H 1
JUMP	J	CONV	C V
COUNT	#	F	F ษ †
SUB RTRN	<	$\dfrac{d}{dx}$	% ษ †
LABEL	L	HANN 0	H Ø
END		CORR	C R
+	A +	F^{-1}	F _
÷	: ษ †	ENTER	CR LF
←	←ษ †	SPACE	ษ †
–	A _	CLEAR	C L
MULT	* ษ †	-	-
* MULT	* _	RUBOUT	BELL DEL
BINARY	I	0	0
KEYBOARD	K ษ †	1	1
PHOTOREADR	R ษ †	2	2
ANALG	R A	3	3
(BLANK KEY)	T A	4	4
PRINT	W ษ †	5	5
PUNCH	P ษ †	6	6
HISTOGRAM	R H	7	7
		8	8
		9	9

† ษ means SPACE. In order to test this, press the key twice. (ษ is not printed)

Example: MULT has to print the following way: * *

Table 3-1. Operational Check (Cont'd)

Switch Setting Test

DESCRIPTION

This check ensures proper functioning of 5465A and 5475A keyboard switches not checked in other tests.

PROCEDURE

Switches control lighting of lamps in Computer B-REGISTER, as indicated below.

Switch name and setting	Computer B-REGISTER bits affected and action
5475A	
STEP/RUN	14 affected
STEP	14 lighted
RUN	14 off
REPT/SNGL	11 affected
REPT	11 lighted
SNGL	11 off
5465A	12, 5, 4 affected
SAMPLE MODE kHz/us SAMPLE MULTIPLIER 50/100/10	12 and 5 lighted; 4 off
SAMPLE MODE kHz/us SAMPLE MULTIPLIER 2.5/5/200	5 lighted; 12 and 4 off
SAMPLE MODE	
∆TIME Hz/ms	5 and 4 off, 12 on or off
∆FREQ Hz/ms	5 and 4 lighted; 12 on or off
∆FREQ MHz/sec	4 lighted; 5 off, 12 on or off
DISPLAY/INPUT	10 and 9 affected
A/A	9 and 10 lighted
A DUAL	9 lighted; 10 off
B DUAL	9 and 10 off
SAMPLE MULTIPLIER	3, 2, 1, 0 affected
5/00/10	3, 2, 1, 0 all lighted
25/50/20	3, 2, 1 lighted; 0 off
10/20/50	3, 2, 0 lighted; 1 off
5/100/100	3, 2 lighted; 1, 0 off
2.5/5/200	3, 1, 0 lighted; 2 off
500/2/1	3, 1 lighted; 2, 0 off
1K/1/.5	3, 0 lighted; 2, 1 off
2K/.5/.25	3 lighted, 2, 1, 0 off
5K/.2/.1	2, 1, 0 lighted; 3 off

Table 3-1. Operational Check (Cont'd)

Power on Test

DESCRIPTION

When 5450A Fourier Analyzer System power is lost (or turned off) and then restored (or turned on),
the system should return to the RUN mode. There should be no loss of memory, and it should not
be necessary to reload the system tape. This check ensures this operation.

PROCEDURE

1.   Set 5475A COMPUTER NORMAL/FOURIER ANALYZER switch to FOURIER ANALYZER.

2.   Turn off 5450A system power by pressing and releasing red button in trim strip at upper right-
     hand corner of cabinet, or flipping system power switch handles down.

3.   Wait 5 seconds.

4.   Turn 5450A system power on by pressing same button as in step 3, or flipping power switch
     handles up.

5.   Teleprinter should print START.

6.   Type SR, RETURN, LINE FEED on teleprinter.

7.   Teleprinter should respond with PROTECTED, indicating last 64 memory locations (Basic
     Binary Loader) are not enabled.

Front Panel Lights Test

1.   Press 5475A RESTART button. Teleprinter should print START.

2.   Type SL, RETURN, LINE FEED. Each 5475A lamp will light, in sequence, for about 2 seconds,
     then go off and the next lamp will light. Note: BUSY lamp will be lighted most of the time; this
     is not a malfunction of the unit. Sequence will repeat until RESTART is again pressed.

3.   Type SW, RETURN, LINE FEED. "WHAT?" lamp will light for about 1 second.

Stop-Continue Test

1.   Press 5475A STOP button. 5475A will go to READY mode, and BUSY lamp will go off 1 second
     after READY lamp lights.

2.   Press CONTINUE and condition will reverse -- BUSY lamp will light and READY light will go out.

This completes checking of the 5475A Control Unit. Refer to main part of this checkout procedure for
additional checks of the system.

Table 3-2. Adjustment and Calibration (5460A)

EQUIPMENT REQUIRED

HP Model 412A DC VACUUM TUBE VOLTMETER

HP Model 3460B Digital Voltmeter (6-digit readout)

Short clip lead

HP 10623A Service Extender Kit

Other equipment may be substituted, if it meets specifications of equipment listed above.

PROCEDURE

1. **Preparation**

    The adjustment procedures below require that the 5460A plug-in be removed from the H51-180AR Oscilloscope main frame, and its top and bottom covers removed. The 5460A will be connected to the H51-180AR through the 10603A Display Service Extender. Refer to Section I of this manual for detailed access information.

2. **Bus Voltage Measurements**

    The voltage readings listed below are those for normally operating power supplies. There are no voltage adjustments for these supplies in the 5460A unit. Refer to 5475A Adjustments and 180AR manual for adjustments. If a supply voltage is not within the specified limits, refer to the Troubleshooting procedure in Section IV of this manual.

Test Point (all in 5460A)	Voltage (Note: All voltages respect to ground)
XA1(15)	+95 V to +105 V
XA8(15, S)	+165 V to +180 V
XA1(4)	+14.5 V to +15.5 V
XA1(3)	-12 V to -13 V
XA1(2)	+4.5 V to +5.5 V
XA8(2, B)	+4.5 V to +5.5 V
XA8(K)	+22 V to +25 V

3. **Reference Voltage Measurement/Adjustment**

    a. Connect Digital Voltmeter "hot" lead to XA6(5, E).

    b. Voltage between XA6(5, E) and ground must be +9.9950 V to +10.0050 V.

    c. Adjust A6R9, if necessary, to bring voltage within specified range.

4. **DAC Output Voltage Measurement/Adjustment**

    a. Connect Digital Voltmeter "hot" lead to H51-180AR rear-panel "X" output connector center conductor.

    b. Set 5460A DISPLAY CALIBRATE to +FS.

    c. Set 5460A DISPLAY FUNCTION to CAL.

    d. Digital Voltmeter should read +2.5025 V to +2.5050 V.

    e. If Voltmeter reading is not correct, adjust 5460A A3R107 as required.

5. **Horizontal CRT Gain Test/Adjustment**

    a. Set 5460A DISPLAY CALIBRATE to ORIGIN.

    b. Adjust H51-180AR HORIZONTAL POSITION for dot on vertical line at left-hand edge of graticule.

    c. Set 5460A DISPLAY CALIBRATE to +FS.

    d. Adjust 5460A A3R116 to place dot on center vertical line of graticule.

    e. Repeat steps a through d above until A3R116 requires no further adjustment.

Table 3-2. Adjustment and Calibration (5460A) (Cont'd)

6. Vertical DAC Output Voltage Check/Adjustment

a. Connect Digital Voltmeter "hot" lead to H51-180AR rear-panel "Y" output connector center conductor.

b. Set 5460A DISPLAY FUNCTION to CAL.

c. Set 5460A DISPLAY CALIBRATE to +FS.

d. Connect clip lead between 5460A XA2(12) and chassis.

e. Voltmeter must indicate +4.0060 V to +4.0100 V.

f. If voltmeter reading is not within specifications, adjust 5460A A2R107.

g. Remove clip lead from XA2(12).

7. Vertical CRT Gain Calibration

a. Set 5460A DISPLAY CALIBRATE switch to ORIGIN.

b. Adjust 5460A VERTICAL POSITION to center dot on vertical line at left-hand edge of CRT graticule.

c. Set 5460A DISPLAY CALIBRATE switch to +FS.

d. Adjust 5460A VERTICAL CAL (front-panel) to position dot on upper horizontal line of CRT graticule.

e. Set 5460A DISPLAY CALIBRATE to -FS. Dot should appear on lower horizontal line of CRT graticule.

8. Vertical Position Control Test

a. Set Computer switches as follows:

10 down ("0")

11 up ("1")

b. Set 5460A DISPLAY CALIBRATE to ORIGIN.

c. Set 5460A FUNCTION to DISPLAY

d. Turn 5460A VERTICAL POSITION fully CCW. Upper end of CRT trace should be less than 3.5 cm from bottom graticule line.

e. Turn 5460A VERTICAL POSITION fully CW. Lower end of CRT trace should be less than 3.5 cm from top graticule line.

f. Adjust 5460A VERTICAL POSITION to center trace on CRT.

9. Vertical CRT Gain Adjustment

a. Slowly turn 5460A VERTICAL GAIN CW.

b. CRT display should slowly expand to approximately 2-1/4 times its calibrated size. The center portion of the display should not move more than 1 cm, and the CRT trace at top and bottom of screen should move in approximately 3 cm toward center of screen.

10. Plotter Rate Adjustment

a. Set 5460A PLOT RATE fully CCW, but not switched to EXT.

b. Connect oscilloscope probe to H51-180AR J112(13) (plotter output).

c. Set function to plotter.

d. Move slide switch from ARM to PLOT.

e. Adjust A7R8 for 1 Hz. NOTE: If plotter completes plot, re-arm then PLOT.

f. Set 5460A PLOT RATE control fully CW.

g. Observe plotter pulse rate on oscilloscope. Rate should be 20 Hz.

Table 3-2. Adjustment and Calibration (5460A) (Cont'd)

GND

+4.5 TO 5.5V

−12 TO −13V

+14.5 TO 15.5V

+95 TO 105V

TOP

Table 3-2. Adjustment and Calibration (5460A) (Cont'd)

PLOTTER RATE ADJ
A7R8

RIGHT SIDE

ADJUST FOR
+9.9950 TO 10.0050V
AT XA6(5,E)
A6R9

+165
TO 180V

+22
TO 25V

+4.5
TO 5.5V

HORIZ GAIN
A3R116

HORIZ DAC
OUT ADJ
A3R107

VERT DAC
OUT ADJ
A2R107

BOTTOM
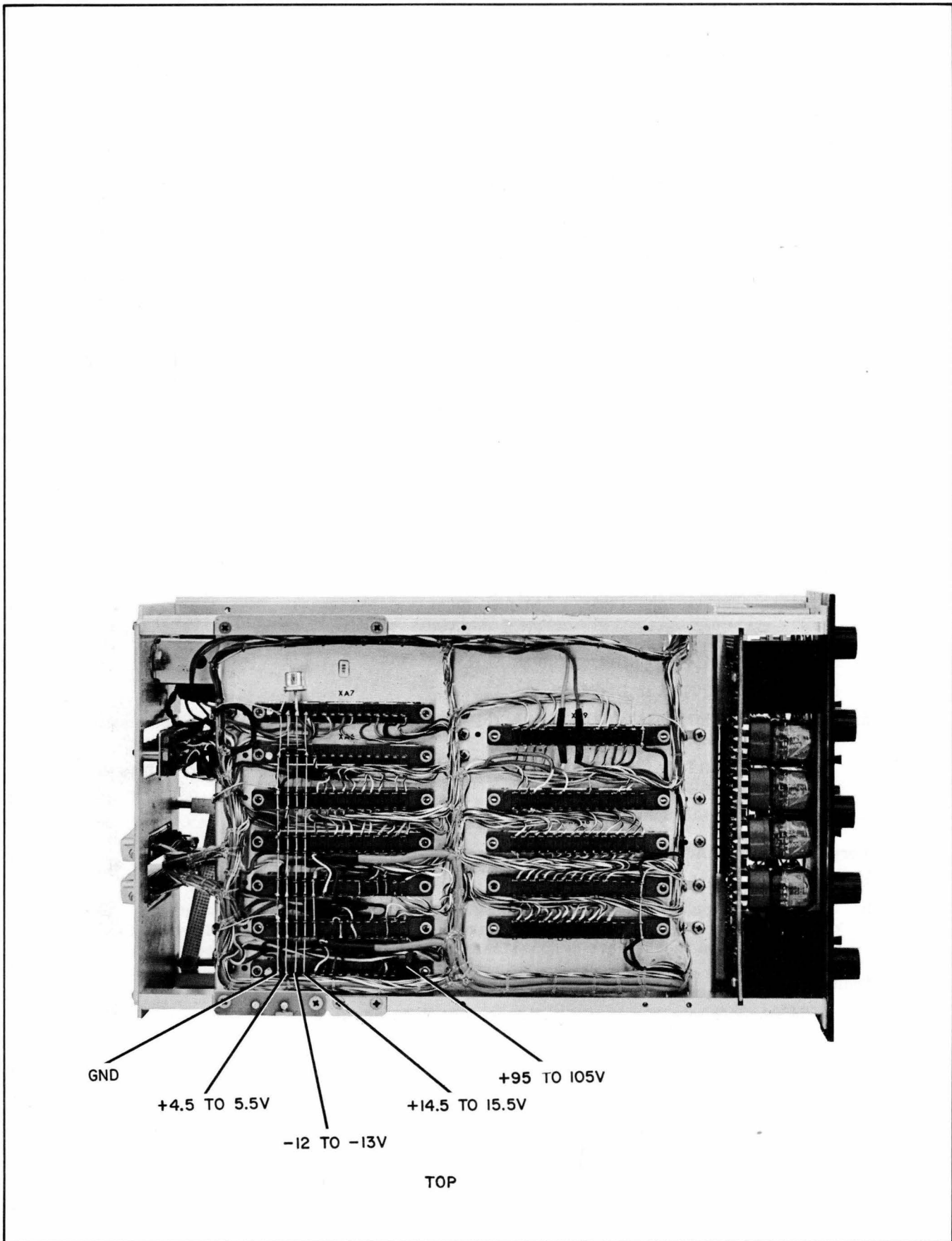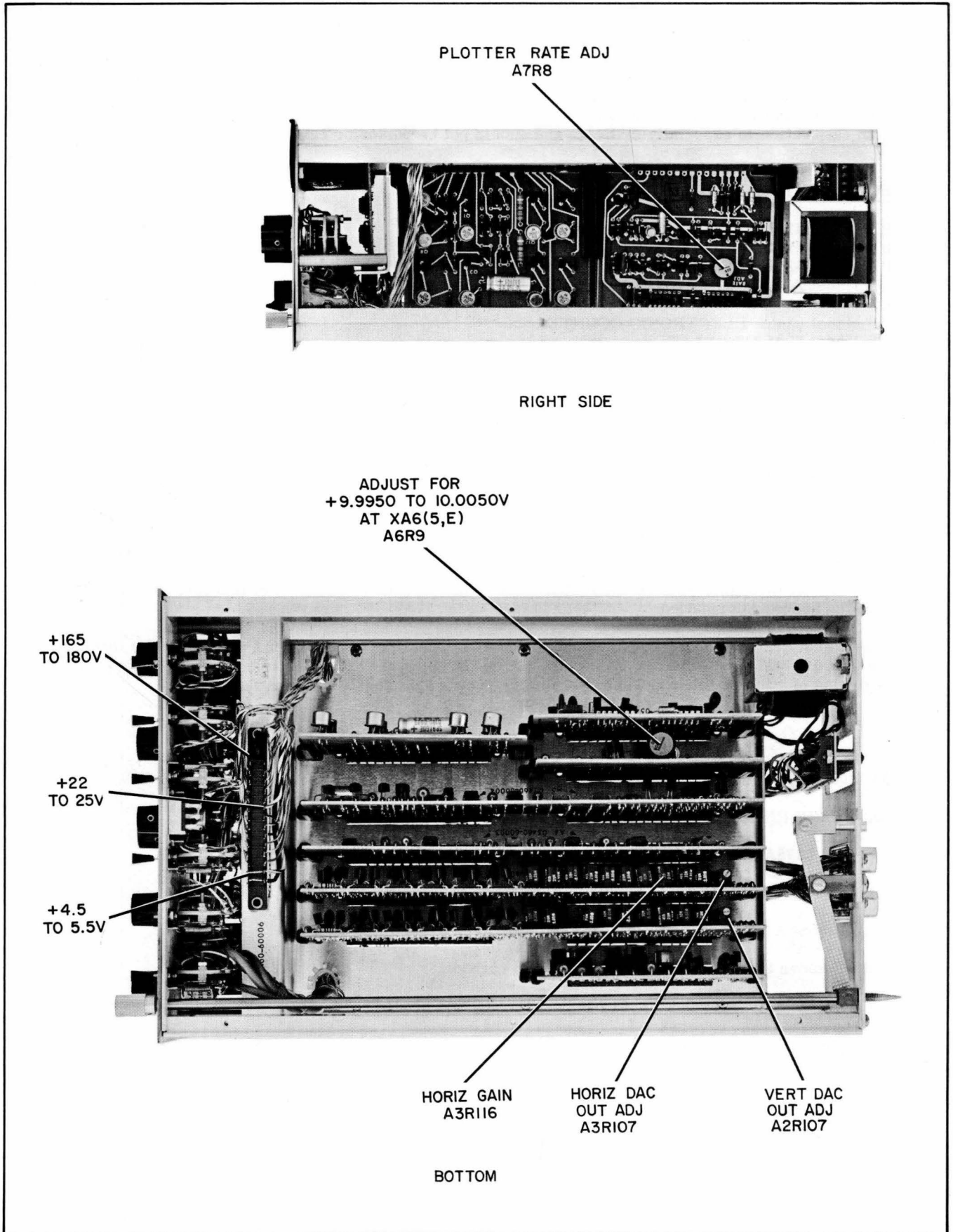
Table 3-3. Adjustments (5465A)

BEFORE YOU BEGIN

Before adjusting any part of your 5465A, be very sure that adjustment is needed, and that you understand how to make the adjustment. Casual adjustment of any component in the 5465A may disable the unit completely, or cause serious inaccuracies in your measurement. Note that the gain calibration is especially critical, and should not be performed unnecessarily.

EQUIPMENT REQUIRED

HP Model 411A RF Millivoltmeter
HP Model 412A DC VACUUM TUBE VOLTMETER
HP Model 427A VOLTMETER
HP Model 3460B DIGITAL VOLTMETER
HP Model 180A OSCILLOSCOPE with 1801A and 1820A PLUG-INS
HP Model 5245L ELECTRONIC COUNTER
HP Model 209A OSCILLATOR
HP Model 8002A PULSE GENERATOR
HP Model 740B DC STANDARD

Other equipment may be used if it meets specifications of equipment listed above.

PROCEDURE

Preparation

The adjustment procedures below require that the 5465A plug-in be removed from the 5475A Control unit, and its left-hand and right-hand side covers be removed. The 5465A will be connected to the 5475A through the 10628A ADC Extender Cable. Refer to Section I of this manual for detailed access information.

This adjustment procedure requires use of the ADC Test program. Enter the program by loading the 05450-90007 Test Tape and typing SA, RETURN, LINE FEED on the teleprinter. Refer to the beginning of PROCEDURE in Table 3-1 for instructions on how to load the Test Tape.

A1 Input Buffer Assembly (05465-60001) Adjustments

BASE LINE REFERENCE SUPPLY ADJUSTMENT

   a. Set 5475A COMPUTER NORMAL/FOURIER ANALYZER to COMPUTER NORMAL

   b. Ground CR5 A1CR5 anode, "Stabilize" lamp on A7 will light.

   c. Adjust A1R46 for 0V ±1 mV between A1(C) and ground.

   d. Remove ground connection from A1CR5 cathode.

   e. Adjust A1R37 for 0.5V ±.01V between A1(C) and ground.

   f. "Stabilize" lamp on A7 should not be lighted.

Table 3-3. Adjustments (5465A) (Cont'd)

GAIN CALIBRATION

a. Set controls as follows:

5465A:

SAMPLE MODE to kHz/μs

MULTIPLIER to 500, 2, 1

DISPLAY/INPUT to A/DUAL

OVERLOAD VOLTAGE (both) to 1

TRIGGER SOURCE to FREE RUN

5475A:

COMPUTER NORMAL/FOURIER ANALYZER to COMPUTER NORMAL

Computer:

Switch register switches 15 and 14 down.

b. Channel A Calibration

1) Connect HP 740B through 11055B output cable OUTPUT ± to 5465A A and B INPUTS.

2) Set Computer switch register switch 14 "up", so Computer looks at ADC Channel A.

3) Set 740B to provide .0000V output.

4) Adjust A1R47 for readout of ±000 on 5460A display tubes.

5) Set 740B VOLTAGE SET to .5000V.

6) Adjust A1R37 for transition between 255/256 on 5465A display tubes.

7) Return to step 3 and continue adjustments until no further adjustment is required.

c. Channel B Calibration

1) Set Computer switch register switch 14 down, so Computer looks at ADC Channel B.

2) Set 740B to provide .0000V output.

3) Adjust A1R48 for a readout of ±000 on 5460A display tubes.

4) Set 740B VOLTAGE SET to .5000V.

5) Adjust A1R40 for transition between 255/256 on 5460A display tubes.

6) Return to step 2 and continue making adjustments until no further adjustment is required.

d. Calibration Check (Channels A and B)

1) Set Computer switch 14 up to view Channel A output.

2) Set 740B VOLTAGE SET switches to provide each output voltage listed in the chart below.
5460A display tube indication should be as indicated for that voltage.

Table 3-3. Adjustments (5465A) (Cont'd)

GAIN CALIBRATION (Cont'd)

d. Calibration Check (Channels A and B) (Cont'd)

HP 740B VOLTAGE SET	5460A DISPLAY TUBE INDICATION
.0000	±000
.1250	+64 ±1 Count
.2500	+128 ±1 Count
.3750	+192 ±1 Count
.5000	+256 ±1 Count
.6250	+320 ±1 Count
.7500	+384 ±1 Count
.8750	+458 ±1 Count

   3) Set Computer switch 14 down to view Channel B output.

   4) Repeat step 2) above.

This completes the GAIN CALIBRATION. Do not make any further adjustment of these components, unless absolutely necessary.

TRIGGER ADJUSTMENT

a. Set controls as follows:

5465A:
     OVERLOAD VOLTAGE to .1
     TRIGGER SOURCE to INTERNAL (A)
     A AC/DC to DC
     SLOPE to POS
     TRIGGER LEVEL to PRESET

Computer:
     Switch register switch 15 down

b. Set oscillator to provide a 100 Hz sine wave at 75 mV through a 51Ω load.

c. Connect oscillator to 5465A INPUT A through 51Ω feedthrough connector.

d. Set Computer switch register switch 15 up.

e. Adjust A1R4 until TRIGGERING lamp lights.

f. Adjust oscillator amplitude downward in 10 mV steps and readjust A1R4 for the most sensitive setting.

g. Set Computer switch register switch 15 down.

h. Disconnect oscillator from INPUT A.

Table 3-3. Adjustments (5465A) (Cont'd)

TRIGGER ADJUSTMENT (Cont'd)

A1 Input Buffer
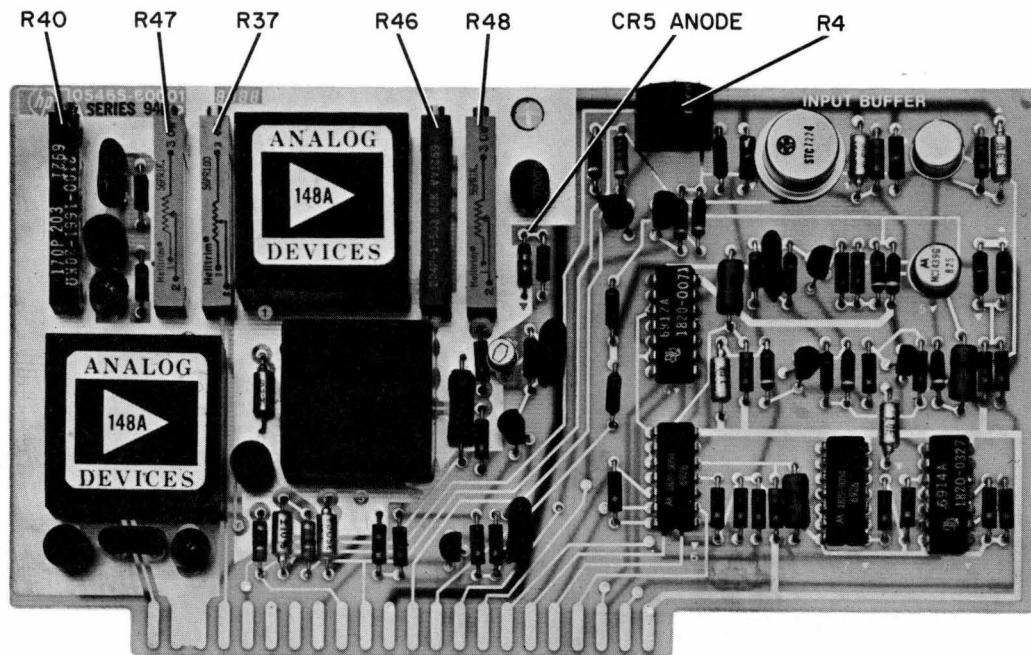
A2 Stretcher Assembly (05465-60002) Adjustments

    a. Set 5475A COMPUTER NORMAL/FOURIER ANALYZER switch to COMPUTER NORMAL.

    b. Set Computer switch register switch 12 up, all other switch register switches down.

    c. Adjust A2R50 for 10V ± .5V between R47-R48 Junction and ground.

    d. Set 5465A controls as follows:

               SAMPLE MODE to kHz/μsec

               MULTIPLIER to 2.5/5/200

    e. "Stabilize" lamp on A7 must be off, indicating a normal stabilize cycle.

    f. Turn 5475A power off, wait 10 seconds, and turn power on again. Stabilize lamp on A7 should turn on when power is restored, and then turn off within 10 seconds.

Table 3-3. Adjustments (5465A) (Cont'd)

A2 Stretcher Assembly (05465-60002) Adjustments (Cont'd)

A2 Stretcher
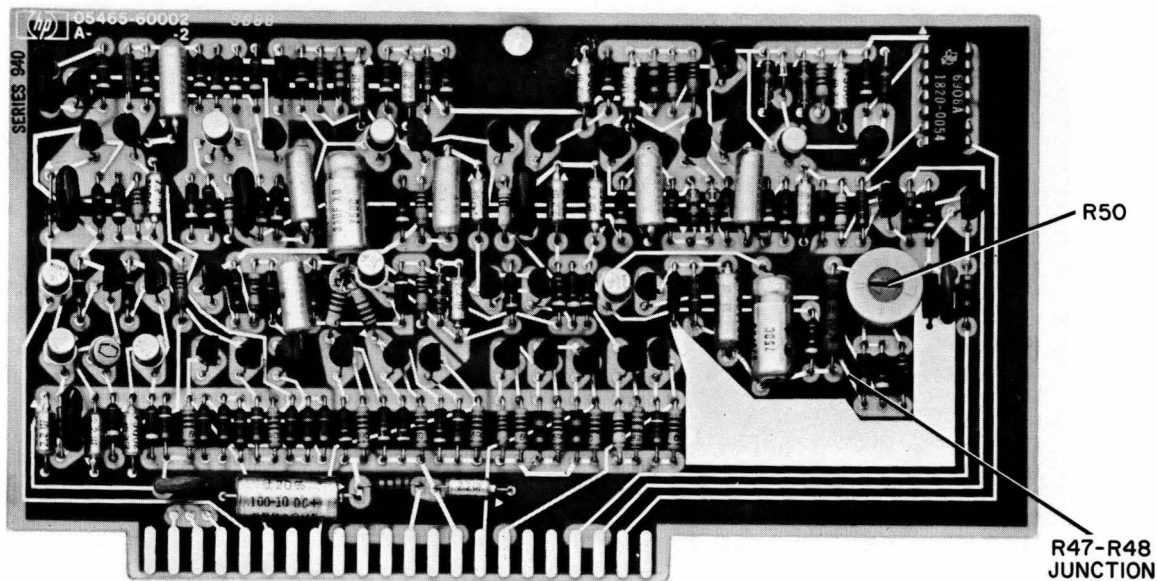
A5 High Speed Gate and Scaler Assembly (05415-6007) Adjustments

a. Turn pot A5R20 fully CCW. NOTE: Lamp on A7 should be lighted; a slight clicking will be
    noted for full CCW rotation.

b. SLOWLY turn A5R20 CW until Stabilize lamp on A7 goes out (this will require approximately
    11 turns of the pot).

c. SLOWLY turn the pot CCW until the lamp on A7 again lights, estabilshing a starting point
    for the next adjustment.

d. NOTE: Read this step completely before performing any part of it.   SLOWLY turn the pot
    on A5 CW. The lamp on A7 will go out, and, after some number of CW turns of the A5 pot,
    will re-light.   Count the number of full full turns you make on the A5 pot from the initial
    setting in step c until the lamp re-lights.   Now turn the pot CCW half this number of turns.
    Example, if four full CW turns are required to cause the lamp to re-light, set the pot back
    two full CCW turns.

Table 3-3. Adjustments (5465A) (Cont'd)

A8 10-to-100 MHz Multiplier and Phase Adjustment Assy (05415-6009) Adjustment

NOTE: Do not use an extender board for A8 when making these adjustments.

    a. Preset all variable capacitors on A8 as shown in drawing.

TOP VIEW OF A8

C6   CII   C16   C20   C23   C26   C30   C34   C39   C43
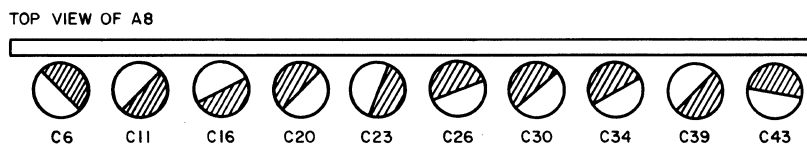
NOTE: C6 IS THE PHASE ADJUSTMENT, AND SHOULD NOT BE CHANGED.

KEY: SILVERED HALF

    b. Preset A8R31 10 full turns CCW from maximum CW position.

    c. Connect RF voltmeter common to A8(22) and hot lead to A8(21).

    d. Adjust A8C11, 16, 20, 23, 26, 30, 34, 39, and 43 for maximum indication on RF Voltmeter.

    e. Adjust A8R31 for .6V ± .1V indication on RF Voltmeter.

A9 Clock Generator Assembly (05465-60009) Adjustments

    a. Set 5465A SAMPLE MODE to kHz/μsec

    b. Connect electronic counter through a coaxial lead to the 5465A; coax center conductor to A9(5), shield to A9(3).

    c. Adjust A9C11 for counter reading of 10000.000 kHz, ± .010 kHz.

    d. Set SAMPLE MODE to TOTAL TIME Hz/ms

    e. Disconnect coax conductor from 5465A. Connect center conductor to 5465A A9(18), shield to A9(20).

    f. Adjust A9C12 for counter reading of 10240.000 kHz, ± .010 kHz.

Table 3-3. Adjustments (5465A) (Cont'd)

A11, 12, Overload Voltage Attenuator (05465-60011) Adjustment and Check

a. Set controls as follows:

Pulse Generator

        REP RATE to 300 Hz

        REP RATE VERNIER to "12 o'clock" (straight up)

        PULSE WIDTH(S) to 0.1 ms

        PULSE WIDTH VERNIER to "12 o'clock" (straight up)

        RISE and FALL TIMES to 10 ns

        RISE and FALL VERNIERS to full CCW

        PULSE POLARITY to "+"

        AMPLITUDE as indicated in table below.

Oscilloscope

        Vertical

                VOLTS/DIV to .02
                Channel A AC/DC to DC

        Horizontal

                TIME/DIV to 10 μsec

        Trigger

                TRIGGER SOURCE to EXT

                TRIGGER MODE to NORMAL

                TRIGGER SLOPE to "+"

                TRIGGER to AC

    5465A:

        DISPLAY/INPUT to A/A

        A OVERLOAD VOLTAGE (both) to .1

        A AC/DC (both) to DC

    5475A:

        COMPUTER NORMAL/FOURIER ANALYZER to COMPUTER NORMAL

b. Connect Pulse Generator TRIGGER OUT (+) to oscilloscope EXT. TRIGGER INPUT.

c. Connect Pulse Generator PULSE OUTPUT (terminated in 51 ohms) to 5465A INPUT A and INPUT B.

d. Connect oscilloscope Channel A INPUT directly (not through attenuator probe) to 5465A A1(B).

e. Adjust oscilloscope controls for trace as shown in photograph.

Table 3-3. Adjustments (5465A) (Cont'd)

A11, 12, Overload Voltage Attenuator Adjustment and Check (Cont'd)
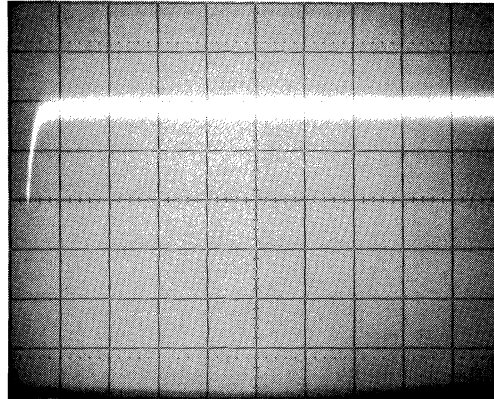
Note: Start of trace offset slightly from left-hand case of CRT graticule.

f. Set 5465A A OVERLOAD VOLTAGE to each position listed below and adjust the corresponding capacitor for a flat square wave response. Adjust pulse generator amplitude as listed in table.

g. Disconnect oscilloscope from 5465A. Connect oscilloscope Channel A INPUT directly to 5465A A1(E).

h. Set B OVERLOAD VOLTAGE to each position listed below and adjust the corresponding capacitor for a flat square wave response. Adjust pulse generator amplitude as listed in table.

OVERLOAD VOLTAGE SETTING	PULSE GENERATOR AMPLITUDE (VOLTS)	OVERLOAD ATTENUATOR COMPENSATING CAPACITOR
.1	.05	None
.2	.10	C3
.4	.25	C4
1	.5	C5
2	1.0	C6
4	2.5	C7
10	5.0	C8

Table 3-3. Adjustments (5465A) (Cont'd)
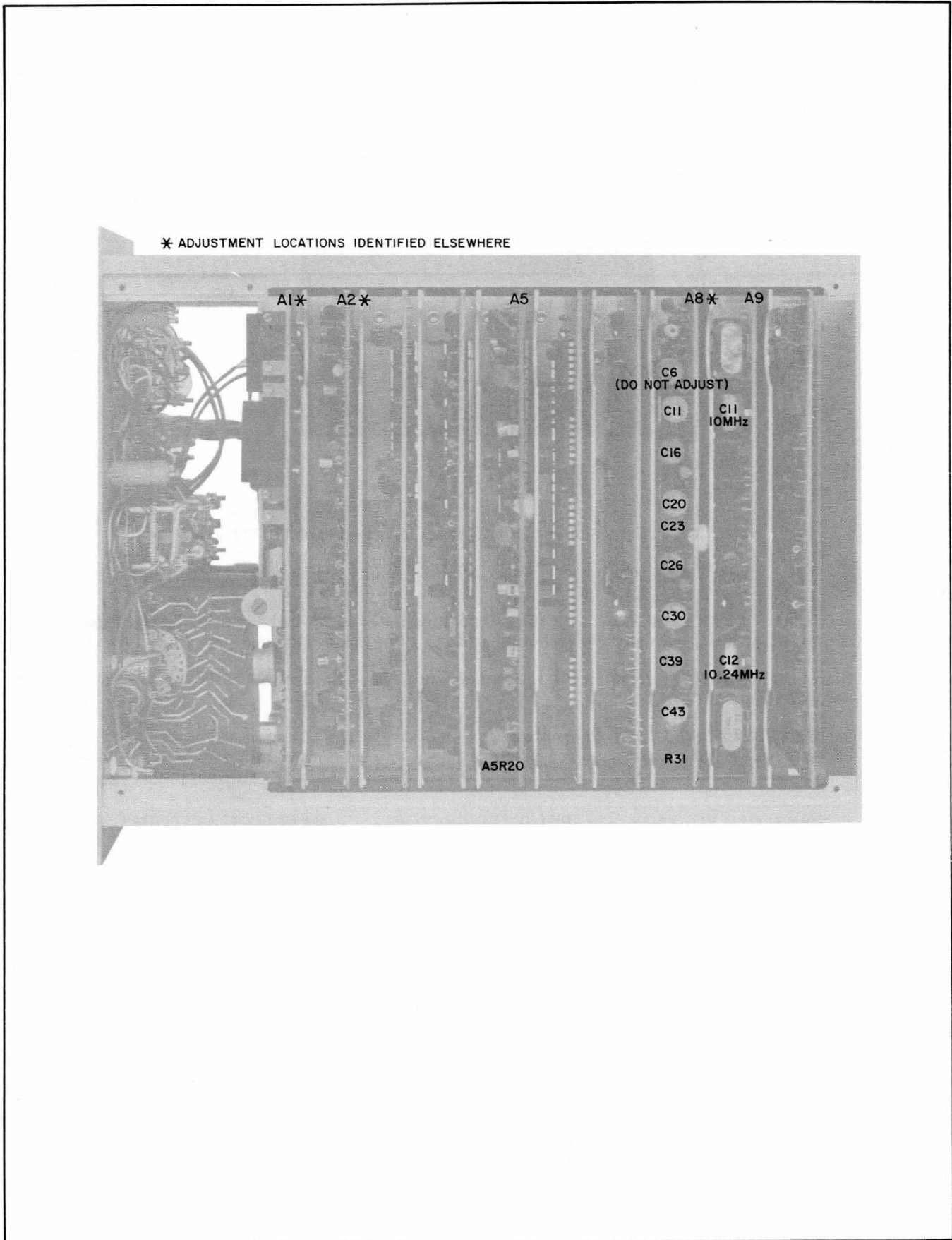
Table 3-3. Adjustments (5465A) (Cont'd)
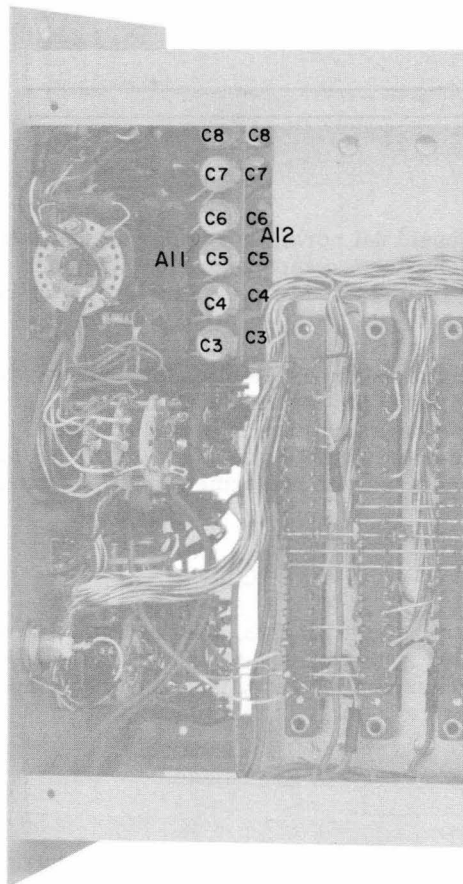
Table 3-4. Adjustment Procedure (5475A)

EQUIPMENT REQUIRED

HP Model 412A DC VACUUM TUBE VOLTMETER

HP Model 3460B DIGITAL VOLTMETER (6-digit readout)

HP 5211A/B COUNTER

Short Clip Lead

Substitute equipment must equal or exceed specifications of equipment listed above.

POWER SUPPLY ADJUSTMENTS

General

The Model 5475A power supplies should not normally require adjustment. However, the replacement of a malfunctioning component or long-term component aging may cause the Model 5475A to become out-of-adjustment. All power supply adjustments are on the regulator board assemblies.

No interaction exists between regulator board assemblies and between dc output voltages. Therefore, only the voltage and overcurrent adjustments for an individual dc output voltage need by performed, without checking the adjustments for the remaining dc output voltages. The voltage adjustment must be performed first, followed by the overcurrent adjustment. If more than one dc output voltage is to be adjusted, all voltage adjustments may be performed first, followed by all overcurrent adjustments.

NOTE

While performing adjustments, the regulator board assemblies
must be seated in their respective connectors and not on an ex-
tender board assembly. Stray inductance can induce oscillations
when the board assembly is extended.

Preliminary Instructions

These preliminary instructions are to be performed prior to any adjustments. Included is quick-reference information to enable an adjustment to be made without necessitating repeated reference to other portions of the manual.

a. Remove 5465A plug-in from 5475A.

b. Adjust overcurrent control potentiometers associated with power supplies being adjusted to center of their travel.

NOTE

The following list provides a quick-reference to locations of
overcurrent control and voltage control potentiometers.

1. Overcurrent control adjustments:

Negative: Extreme left of board, extreme rear
of instrument.

Table 3-4. Adjustment Procedure (5475A) (Continued)

Positive: Extreme right of board, extreme front of power supply section.

2. Voltage adjustments

Negative: Second from left on board, second from rear of instrument

Positive: Third from left on board, third from rear of instrument.

3. Assemblies

+ and - 24 V: A3A4
+ and - 12 V: A3A5
+ and - 5 V: A3A6

c. Connect load resistors listed below between designated pin on rear-panel connector J17 and chassis ground for dc output voltages to be ajdusted.

CAUTION

Do not exceed 120 W total load capability of instrument. If necessary, perform adjustment procedure with only part of the loads connected, then repeat this step for remaining dc output voltages.

NOTE

Both pins should be used in parallel to check voltages.

+24 V: connect 12 ohms between J17(14, 32) and ground*
-24 V: connect 12 ohms between J17(9, 27) and ground*
+12 V: connect 3 ohms between J17(16, 34) and ground*
-12 V: connect 3 ohms between J17(7, 24) and ground*
+5 V: connect 1.2 ohms between J17(18, 36) and ground*
-5 V: connect 1.2 ohms between J17 (5, 23) and ground*

*ground connections are J17(1, 2, 19, 20)

d. Connect Digital Voltmeter across load resistor of first dc output voltage to be adjusted.

e. Turn on cabinet power and 5475A power.

Voltage Adjustments

To adjust any of the dc output voltages, perform the following procedure for its supply:

a. Perform preliminary instructions listed above.

b. Adjust associated voltage potentiometer for nearest value displayed on digital voltmeter to designated magnitude. Value displayed shall be within ± 0.5 percent of designated magnitude.

c. Repeat step b for each additional dc output voltage to be adjusted, ensuring associated load resistor is connected and Digital Voltmeter is across the resistor.

d. Disconnect all test equipment.

Table 3-4. Adjustment Procedure (5475A) (Continued)

Overcurrent Control Adjustment

To establish the point at which overcurrent from a supply is sensed, perform the following procedure:

    a. Ensure voltage adjustment for the supply has been performed as described above.

    b. Apply one of the following fixed load resistors, or a variable load resistor with an ammeter to produce given current condition between designated pin and chassis ground for first supply to be adjusted.

        +24 V: connect 10. 1 ohms for 2. 36 amps between J17(14, 32) and ground*
        -24 V: connect 10. 1 ohms for 2. 36 amps between J17(9, 27) and ground*
        +12 V: connect 2. 5 ohms for 4. 72 amps between J17(16, 34) and ground*
        -12 V: connect 2. 5 ohms for 4. 72 amps between J17(7, 25) and ground*
        +5 V: connect 1. 0 ohms for 5. 0 amps between J17(18, 36) and ground*
        -5 V: connect 1. 0 ohms for 5. 0 amps between J17(5, 23) and ground*

*ground is J17(1, 2, 19, 20).

    c. Adjust associated overcurrent control potentiometer until 5475A rear-panel OVERLOAD indicator lights.

    d. Disconnect load resistor presently connected.

    e. Repeat steps a through d for each additional power supply that is to have the overcurrent control adjusted.

OSCILLATOR ADJUSTMENT

General

This procedure synchronizes the shift register clock rate with the clock rate of the teleprinter and the teletype interface card in the computer. The Oscillator is located on the shift register board A14 (05475-60001).

Procedure

    a. Remove:

        5465A ADC Plug-in
        5475A A12 (05475-60003)
        5475A A13 (05475-60008).

    b. Connect A14 test pin 1 (TP1) to ground.

    c. Connect A14 test pin 2 (TP2) to counter.

    d. Adjust A14 potentiometer so period of signal at TP2 is 9. 09 msec ± 0. 04 msec (ambient temperature 20-25°C).

Table 3-4. Adjustment Procedure (5475A) (Cont'd)

POWER SUPPLY
CONNECTIONS ON J17

V	+	−
24	14, 32	9, 27
12	16, 34	7, 25
5	18, 36	5, 23

GND 1, 2, 19, 20
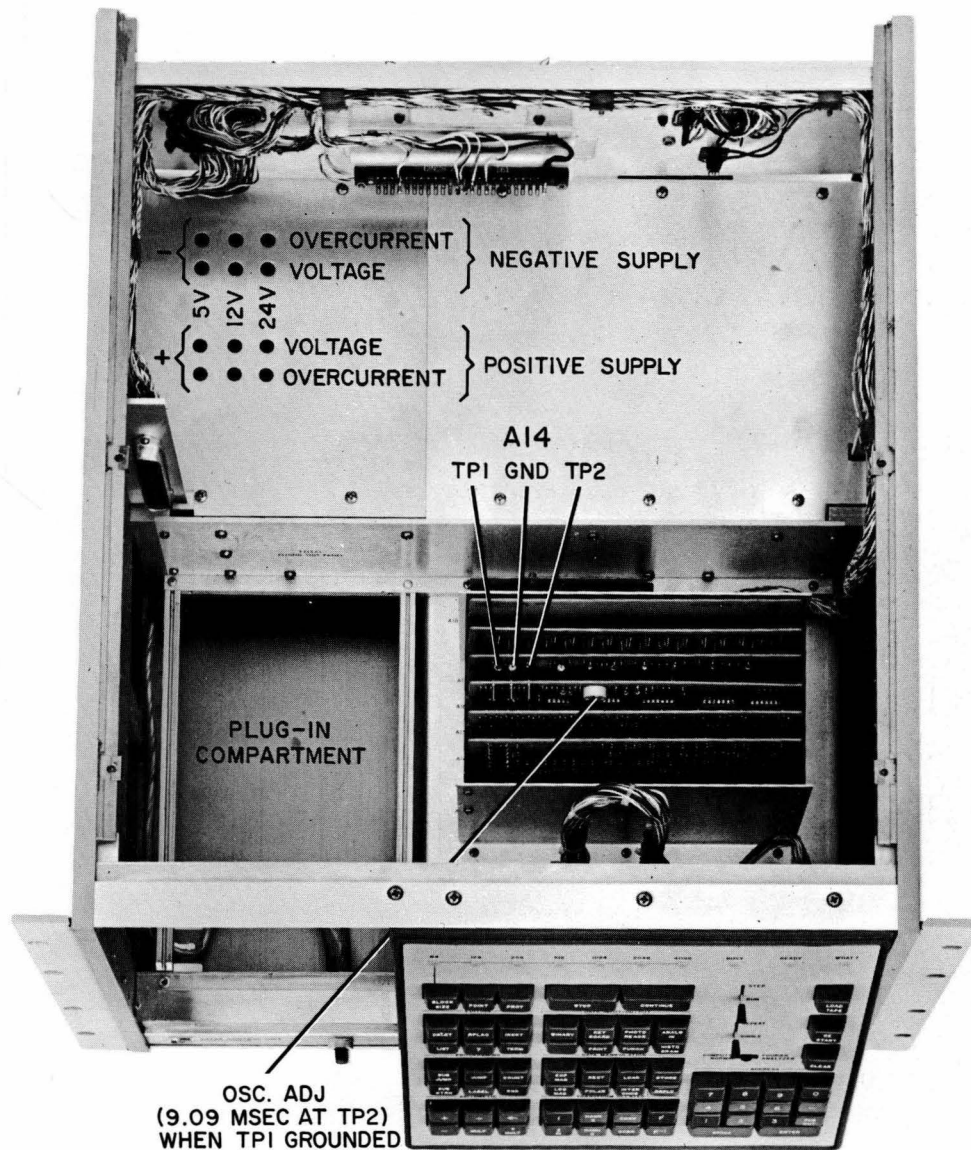
SECTION IV

TROUBLESHOOTING

4-1. This section provides troubleshooting for all 5450A
Fourier Analyzer systems. Information provided includes
a troubleshooting table based on the test tape, lists of
most-often-replaced parts, description of service kits,
and a description of the board exchange program for the
5460A, 5465A, and 5475A units of the system.

Table 4-1. Troubleshooting

DESCRIPTION

For convenience in troubleshooting, the 5450A system may be considered as being made up of the following six units:

> H51-180AR Oscilloscope Mainframe Unit
>
> 5460A Display Plug-in Unit
>
> Keyboard 5475A (part of Control Unit)
>
> 5465A ADC Plug-in Unit
>
> Main Power Supply (part of 5475A Control Unit)
>
> Computer (2115A, 2116B)

Operation of the 5450A system requires both hardware, which was listed above, and software. Hardware is the actual physical instrument itself; software is the program which exercises the hardware.

As a new user of the 5450A system you may have some problems recognizing whether the system is performing as expected. There will probably be many applications-type problems before you experience an actual hardware breakdown. If you believe you are experiencing a hardware break-down, load the test tape (HP Part No. 05450-90007) used for the Operational Check in Section III. After loading the tape, perform the Operational Check until you come to a point where a check is not passed, where the 5450A system does not perform as specified for that procedure. From that point refer back into this troubleshooting table to find the probable causes of the problem. This troubleshooting procedure assumes that software is the variable part of the system, and that hardware is the fixed part. Also it is assumed that if the hardware is exercised in the way in which it was intended to function (in this case by an operational check), and it performs its job (passes the operational check), then the hardware is functioning properly.

NOTE: If you replace the I/O card in Computer Channel 14 or Channel 15, be sure to perform the following procedure:

a. Connect "W1" to "A" with a short jumper wire, soldered in place on the board.

b. Connect "W4" to "B" with a short jumper wire, soldered in place on the board.

c. If the board is to be installed in Channel 14, remove the wire jumper connected to "W2"; this step is not to be performed for the board installed for Channel 15.

The above procedure applies whenever you are instructed to replace the I/O card in Computer Channel 14 or 15.

EQUIPMENT REQUIRED

Description	HP Part Number
Test Tape	05450-90007
Service Kit (for 5450A)	10648A

Table 4-1. Troubleshooting (Cont'd)

5465A ADC PLUG-IN UNIT PROBLEMS

Description

The 5465A has a unique system for checking its own calibration. In normal operation the input is turned off periodically, and the ADC enters a "Stabilize" cycle, during which calibration at the baseline and at half-scale are checked. The checks are accomplished by presetting an internal counter to a known value, applying an internal reference voltage, and comparing the results of an analog-to-digital conversion. If either the baseline or half-scale check produces an invalid reading, the ADC immediately recycles to perform another "stabilize" cycle. The ADC does not accept another input until it satisfies itself that it is calibrated; thus the 5465A is always in full calibration. Malfunction of almost any component in the ADC will tend to produce a nonlinear condition that will cause the unit to stop accepting inputs and perform a continuous sequence of "stabilize" cycles.

Procedure

5465A Problem Description	Action
Check to determine if the "stabilize" cycle is on full time, due to a sensed nonlinearity in the ADC.	a. Turn off system power; Remove ADC from 5475A; Remove ADC right side cover; Connect ADC to 5475A through 10628A ADC Extender Cable supplied; Turn system power on; Check "Stabilize" lamp on ADC Assy A7.
	b. If lamp is glowing brightly, it means your ADC is sensing an internal problem and is performing a continuous series of "Stabilize" cycles. Beginning with ADC assembly A10 and working forward toward A1, replace each board in the ADC one at a time (read below procedure first) and check to see if it had any effect on the problem. Procedure is: Turn off system power; Remove board from ADC; Place new board in ADC; Turn on system power; Check "Stabilize" lamp on A7; If new board does not cause lamp to be dim instead of bright, turn off power, replace old board, and repeat this procedure for the next board in order. If new board does cause lamp to be dim, instead of bright, old board was faulty. Refer to Board Exchange Program information, described elsewhere in this manual section.
	c. If lamp is glowing dimly, problem is probably in ADC input circuits. Beginning with ADC assembly A1 and working toward A10, replace each board in the ADC and check to see if it had any effect on the problem (inputting data). The "Stabilize" lamp should continue to glow dimly. Procedure for board replacement is:

Table 4-1. Troubleshooting (Cont'd)

5465A ADC PLUG-IN UNIT PROBLEMS (Cont'd)

Procedure (Cont'd)

5465A Problem Description	Action
Check to determine if the "stabilize" cycle is on full time, due to a sensed nonlinearity in the ADC. (Cont'd)	c. Turn off system power; Remove board from ADC; Place new board in ADC; Turn on system power; Check to see if ADC accepts input signals. If new board does not cure problem, turn off system power, replace old board and repeat procedure for next board in order. If all boards in ADC have been replaced and problem still exists, replace I/O card in Computer Channel 14 (note NOTE at beginning of troubleshooting table). If new board cures problem, old board was faulty; refer to Board Exchange Program description elsewhere in this manual section.

5460A DISPLAY PLUG-IN UNIT PROBLEMS

Description

These troubleshooting procedures are to be used if your 5450A System fails a check in the portion of the Test Tape Program entered by typing SD, RETURN, LINE FEED.

5460A Problem Description	Action
1. LAMPS: problem with one or more of the following 5460A lamps: POLAR, RECT, LOG, FREQ, 1, 2, 5, X10, +.1, DEC.	
a. One or more of the lamps does not light.	a. Replace 5460A boards (in order listed) 1) A8--lamps are mounted on this board. 2) A9--lamp drivers are on this board. 3) A4--T^{2}L driver lines are on this board. 4) I/O card in computer Channel 15 5) 05450-60002--cable between computer and H51-180AR Oscilloscope.
b. None of the lamps light.	b. 1) Replace 05450-60002 cable--cable between 5475A and H51-180AR 2) Replace ±24V Regulator in 5475A 3) Check +24V line at A8(K).
c. Lamps light, but cannot be controlled from computer switch register.	c. Check Computer B-REGISTER Bit No. 15 1) If lamp is flashing, on for about 3 seconds, off for about 3 seconds, set Computer switch No. 15 up, then down. This should re-engage the DATA READY (FLAG) line to computer and Display Unit, and lamps should light as described in DISPLAY TESTS, Table 3-1.

Table 4-1. Troubleshooting (Cont'd)

5460A Problem Description	Action
1. LAMPS: (continued)	
c. (continued)	If lamps still do not light properly, set Computer switch No. 15 up, and try switching other switches. With switch No. 15 up, computer doesn't wait for a FLAG signal. If lamps function properly with switch 15 up, replace A5 and perform tests again with the switch down.
	If lamps now do not light properly,
	a) Replace I/O card in Computer Channel 15.
	b) Replace 05450-60002 cable
	2) If lamp is not flashing, try reloading test tape (part of program may have been destroyed). If lamp still does not flash, and FOURIER program does not function properly, refer to Computer service manual for computer check-out procedure.
2. READ-OUT TUBES: problem with one or more Digital Display Tubes	
a. No Digital Display Tube is lighted	a. 1) Replace A9 (Light Driver Assembly. 2) Check +170V line from A8(J) to A9(15, S)
b. All Digital Display Tubes function, but are dim.	b. Replace A9
c. Any Digital Display Tube counts, but not in proper sequence (skips numbers or is dead for counts 0 thru 9; or resets to 0 and recounts at the wrong time). NOTE: Normal operation includes blanking for 6 counts after "9," while the 4-bit counter counts up to "0."	c. Replace A8
d. All Digital Display Tubes count, but sequence is bad.	d. 1) Replace A8 2) Replace A4 3) Replace I/O card in Computer Channel 15 4) Replace 05450-60002 cable
e. None of the tubes count.	e. Replace A8 Replace A4
f. "-" indicator does not light	f. Replace (in order) 1) 5460A A9 2) 5460A A8 3) 5460A A4

Table 4-1. Troubleshooting (Cont'd)

5460A Problem Description	Action
3. CRT DISPLAY problems:	
a. No sweep, but dot appears	a. Check Computer B-REGISTER Bit No. 15 lamp.
	1) If lamp is flashing, set computer switch No. 15 up. If display does not appear, replace 5460A A5.
	2) If lamp is not flashing,
	a) Replace 5460A A6
	b) Re-load test tape
	c) Refer to Computer Service Manuals for computer check-out procedure.
b. No CRT sweep or vertical deflection, and no spot	b. Press BEAM FINDER
	1) If dot appears, and computer B-REGISTER Bit No. 15 lamp is flashing, be sure 5460A FUNCTION is set to DISPLAY, not to PLOT.
	2) If dot appears, and computer B-REGISTER Bit No. 15 lamp is not flashing,
	a) Reload test tape
	b) Replace I/O card in Computer channel No. 15
	c) Refer to Computer check-out procedure in Computer Service Manual.
	3) If dot does not appear,
	a) Replace A1
	b) Check High Voltage to CRT--refer to H51-180AR Manual
c. Horizontal sweep, but VERTICAL GAIN, POSITION or CAL controls have no effect	c. Replace A1
d. Sweep nonlinear, either vertically or horizontally	d. Interchange 5460A A2 and A3.
	1) If problem changes,
	a) Replace A2 if problem is now Vertical nonlinearity
	b) Replace A3 if problem is now Horizontal linearity
	2) If problem does not change,
	a) Replace A1 if problem is in Vertical deflection
	b) Refer to H51-180AR if problem is in Horizontal deflection

Table 4-1. Troubleshooting (Cont'd)
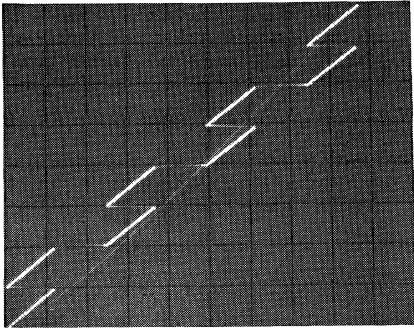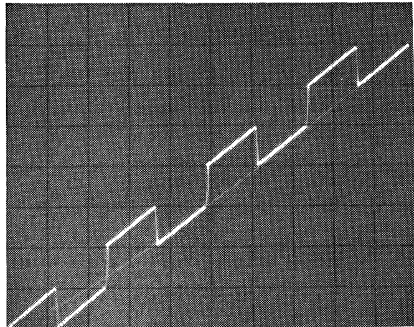
5460A Problem Description	Action
3. CRT DISPLAY: (Continued)	

e. If oscilloscope pattern resembles one shown below
 	
HORIZONTAL PROBLEM
 	
	e. Interchange A2 and A3
	1) If problem changes, replace A2
	2) If problem doesn't change,
	  a) Replace A4
	  b) Replace I/O board in Computer Channel No. 15
	  c) Replace 05450-60002 cable
	  d) Check wiring in H51-180AR associated with Display Plug-in Unit
	  e) Check 5460A wiring

f. If oscilloscope pattern resembles one shown below
 	
VERTICAL PROBLEM
 	
	f. Interchange A2 and A3
	1) If pattern changes, replace A3
	2) If pattern doesn't change
	  a) Replace I/O card in Computer channel No. 15
	  b) Check H51-180AR and 5460A wiring

g. Sweeps, but HORIZONTAL POSITION and X5, X10 MAGNIFICATION controls have no effect	g. Refer to H51-180AR manual
h. Display is Vertical line	h. 1) Replace A4 2) Replace A5 3) Replace A3 4) Refer to H51-180AR manual
i. Display is only Horizontal line	i. 1) Replace A1 2) Replace A4 3) Replace A5 4) Replace A3 5) Refer to H51-180AR manual

Table 4-1. Troubleshooting (Cont'd)

5460A Problem Description	Action
3. CRT DISPLAY: (Continued)	
j. Sweeps OK but problem with vertical bars	j. Interchange A2, A3 If problem is corrected, replace the board NOW in A3. If problem is not corrected, replace A5.
4. SWITCH problems:	
a. HORIZONTAL MARKER switch causes no intensification of trace in either 8PT or 32PT position	a. 1) Replace A5 2) Replace A4 3) Z-axis problem in oscilloscope mainframe, refer to H51-180AR manual
b. HORIZONTAL MARKER switch causes intensification of trace only in 8PT or 32PT position, but not in both.	b. 1) Replace A5 2) Check HORIZONTAL MARKER switch circuit for bad contacts or broken wires
c. DISPLAY TYPE "BAR" or "CONT" does not function	c. 1) Replace A5 2) Replace A2
d. HORIZONTAL SWEEP LENGTH switch does not change sweep length	d. 1) Be sure VERTICAL MODE switch is not in COMPLEX setting 2) Replace A3

e. Remaining switch settings: Computer B-REGISTER lamps do not light as specified in Operation Check, for following switches:
 	
HORIZONTAL ORIGIN
VERTICAL MODE
VERTICAL SCALE
POLAR ANG/DIV
	e. 1) Re-load test tape
	2) Check switch circuit wiring
	3) Possible problems with computer; not likely if other portions of test can be performed correctly
	4) Perform the following computer check to determine if B-REGISTER LAMP is operating
	    a) Ensure COMPUTER NORMAL/FOURIER ANALYZER switch is in COMPUTER NORMAL
	    b) Press Computer HALT button
	    c) Set SWITCH REGISTER switch corresponding to bit causing problem up. (i.e.) if check showed bit 12 of B-REGISTER should light at a particular switch setting, set the switch register to that bit (12 in this case). Press LOAD B. B-REGISTER bit corresponding to the particular switch setting should light. If it does not, refer to Computer manual for check-out procedure.

Table 4-1. Troubleshooting (Cont'd)

5460A Problem Description	Action
5. PLOTTER problems:	
a. No Seek to Plotter or after plotter completes one plot it starts over.	a. 1) Replace A7 2) Replace A5 3) Check complete plot pulse from plotter 4) Check plotter cable
b. Plot works on internal plot rate but does not work on external.	b. 1) Replace A7 2) Check Plotter
c. No plot rate control	c. Replace A7

5475A CONTROL UNIT PROBLEMS

Description

These troubleshooting procedures are to be used if your 5450A System fails a check in the portion of the Test Tape Program entered by typing SK, RETURN, LINE FEED.

5475A Problem Description	Action
1. Keyboard Switches	

GROUP A

GROUP B

a. Wrong or no teleprinter output when a GROUP A switch is pressed. Teleprinter OK for GROUP B switches.	a. Replace A12
b. Wrong or no teleprinter output when a GROUP B switch is pressed. Teleprinter OK for GROUP A switches.	b. Replace A13

Table 4-1. Troubleshooting (Cont'd)

5475A Problem Description	Action
1. Keyboard Switches (Continued)	
c. No teleprinter output for either GROUP A or GROUP B switches	c. 1) One of the most common problems encountered when none of the Group A or Group B switches functions is a problem with the Key-Motion Sense (KMS) switches. The KMS line ensures that when any key is pressed, all other keys are disabled. The KMS line consists of 10 SPDT switches wired in series (key movement opens the series circuit and connects the KMS line to ground). If any of the KMS switches becomes dirty or out of alignment, all keyboard action will stop. To determine if the KMS line is faulty, use a continuity checker at 5475A XA14(4 and R). Pin 4 is normally grounded, and opens when a switch is pressed; pin R does the opposite. If a continuity problem (open) is found, blow out the keyboard switch contacts with an air gun. If an air gun is not available, remove the keyboard assembly (see Table 1-5), and use a service station compressed air hose for the above procedure. If compressed air does not cure your problem, try a contact cleaning spray on the defective contacts. If cleaning does not cure the continuity problem, replace the keyboard assembly.
	2) Replace A18
	3) Replace A14
	4) Replace cable from Computer front panel controls to 5475A
d. Wrong telerpinter output for GROUP A and GROUP B switches	d. 1) Adjust A14 Oscillator (see 5475A Adjustments).
	2) Replace A14
e. Correct letters print out when the keyboard buttons are pressed, but there is still a problem when returning to the main Fourier program (i. e. pushing a button does not perform the correct function), it is desirable to check the coding of the bits into the computer. The A-REGISTER decodes this information and the equivalent ASCII code is displayed in octal form. Refer to the following chart for correct A-REGISTER coding:	

NOTE: Bit 9 may be either a one or a zero, disregard in binary count. That is, Block size has a code of 102(3)23 but the Computer may have 102(7)23 (count of 400 added to 323 because of bit 9 being "1"). Actual ASC11 code is 323.

Table 4-1. Troubleshooting (Cont'd)

5475A Problem Description		Action

1. Keyboard Switches (Continued)

SIGNAL NAME	TELEPRINT	ASCII EQUIVALENT (OCTAL CODE)
BLOCK SIZE	B S	102323
POINT	/.	057256
PROT	/P	057320
DELET	/D	057304
RPLAC	/R	057322
INSRT	/I	057311
LIST	/L	057314
?	/?	057277
TERM	/	057000
SUB JUMP	>	076000
JUMP	J	112000
COUNT	#	043000
SUB RTRN	<	074000
LABEL	L	114000
END	.	056000
+	A+	101253
÷	: ƀ	072240
	ƀ	137240
−	A −	101255
MULT	* ƀ	052240
*MULT	* −	052255
BINARY	I	111000
KEY BOARD	K ƀ	113240
PHOTO READR	R ƀ	122240
ANALG IN	R A	122301
(BLANK KEY)	TA	124201
PRINT	W ƀ	127340
PUNCH	P ƀ	120240
HISTOGRAM	RH	122310
EXP MAG	TE	124305
RECT	TR	124322
LOAD	X <	130274
STORE	X >	130276
LOG MAG	TL	124314
POLAR	TP.	124320
INTER CHNG.	X	130240
DSPLY	D ƀ	104240
	$	044240
HANN I	H1	110261
CONV	CV	103326
F	F ƀ	106240
$\dfrac{d}{dx}$	% ƀ	045240
HANN 0	H Ø	110260
CORR	CR	103322
F -1	F −	106255

Table 4-1. Troubleshooting (Cont'd)

5475A Problem Description   Action

1. Keyboard Switches (Continued)

SIGNAL NAME	TELEPRINT	ASCII EQUIVALENT (OCTAL CODE)
ENTER	CR LF	015212
SPACE	ƀ	040000
CLEAR	C	103214
-	-	055000
RUBOUT	BELL DEL	007377
0	0	060000
1	1	061000
2	2	062000
3	3	063000
4	4	064000
5	5	065000
6	6	066000
7	7	067000
8	8	070000
9	9	071000

5475A Problem Description   Action

f. Teleprinter "clatters" all the time

    f. Replace A14

g. No action when LOAD TAPE is pressed

    g. 1) Be sure COMPUTER NORMAL/FOURIER ANALYZER switch is set to FOURIER ANALYZER

    2) Replace A15

    3) Replace A16

    4) Replace A17

    5) Switch COMPUTER NORMAL/FOURIER ANALYZER to COMPUTER NORMAL. Press Computer HALT. Set Computer switch register to first address of your basic binary loader (017700_8 or 037700_8), and press LOAD ADDRESS. Set LOADER switch to ENABLED. Press Computer RUN.

    a) If tape now does not load, check Basic Binary Loader Program.

    b) If tape does not load, and Basic Binary Loader is known to be OK, return computer to normal hook-up and check it for proper functioning, independent of the rest of the 5450A system.

Table 4-1. Troubleshooting (Cont'd)

5475A Problem Description	Action
1. Keyboard Switches (Continued)	

h. Tape Load switch causes tape to move but halts with other number instead of 102077_8, or tape fails to halt and runs out of tape reader at the end of tape.	h. 1) Set COMPUTER NORMAL/FOURIER ANALYZER to COMPUTER NORMAL.
	
	2) Replace tape in tape reader.
	
	3) Push HALT on Computer.
	
	4) Set switch register to 017700_8 (8K) or 037700 (1K). Press LOAD ADDRESS, enable LOADER, push RUN.
	
	   a) If tape now loads correctly, replace A15 (5475).
	
	   b) If tape still does not load, reload the loader (refer to bootstrap loader instructions).
	
	   c) If there is still a problem, refer to Computer manual.
	
	   d) Re-focus TAPE READER LIGHT.

i. No action when RESTART is pressed	i. 1) Replace A15 2) Replace A16 3) Replace A17 4) Switch COMPUTER NORMAL/FOURIER ANALYZER to COMPUTER NORMAL. Press Computer HALT. Set Computer switch register to 000002_8. Press LOAD ADDRESS, then press RUN. Teleprinter should print START. NOTE: If, before RESTART was pressed, SC was typing on Teleprinter, the Computer will change the word stored at address 000002_8; therefore this test is invalid at this time. Reload test tape.
j. Teleprinter does not print START when 5450A System power is turned on. (NOTE: This assumes that teleprinter is set to LINE when power is turned on.)	j. 1) Computer does a RESTART program when power is turned on. Refer to RESTART problem above. 2) Replace A15
k. 5475A STOP button has no effect.	k. 1) Replace A15 2) Replace A16 3) Replace A17 4) Reload test tape 5) Check Computer
l. 5475A CONTINUE button has no effect.	l. Refer to STOP button problem, above.

Table 4-1. Troubleshooting (Cont'd)

5475A Problem Description	Action
1. Keyboard Switches (Continued)	

m. Step/RUN or REPEAT/SINGLE does not function as described.	m. 1) Replace A16(5475).
	    2) Check cable to FPC board in Computer.
	    3) Refer to Computer manuals.

n. COMPUTER NORMAL/FOURIER ANALYZER switch does not allow normal action of computer in COMPUTER NORMAL position.	n. 1) Replace A16 (5475).
	    2) Replace A15 (5475).
	    3) Check FPC board in Computer.
	    4) Replace I/O board in Computer Channel 15.

o. BUSY Lamp or READY Lamp does not function.	o. 1) Replace A17 (5475) 2) Replace I/O card in Channel 14.
2. POWER SUPPLY problems:	
OVERLOAD LAMP lights. This lamp, located on 5475A rear panel, lights if any supply in the 5450A system is being overloaded.	To find where current is being overdrawn, perform the following procedure. (NOTE: Turn off power when breaking or making connections.) a. Remove 5465A plug-in. If lamp goes out, overload is in plug-in. b. One-at-a-time, remove all cables from 5475A rear panel. If disconnecting any cable causes Overload Lamp to turn off, problem is in circuit served by that cable. Re-connect the cable, and with a voltmeter and the 5475A power supply adjustment procedure locate the supply being overloaded. c. If problem appears to be within the 5475A, check voltages as in Step b, above. Replace the regulator board assembly for the overloaded circuit.

Table 4-2. Replacement Parts

This table lists most-often-replaced parts of the 5460A, 5465A, and 5475A units of the 5450A System. Some of these parts are available as part of the Service Kit for these units. Address replacement parts order or inquiry to nearest Hewlett-Packard Sales and Service Office listed at the back of this manual. Be sure to identify parts by their Hewlett-Packard Part Numbers. To obtain a part not listed, include:

    a. Instrument model number (or Option or Specification number)

    b. Complete instrument and system serial number

    c. Description of part, including function and location.

5460A DISPLAY UNIT

REFERENCE DESIGNATOR	DESCRIPTION	HP PART NUMBER
A1	Board Assembly: Vertical Amplifier	05460-60001 (new); 05460-60013 (rebuilt)
A2, A3	Board Assembly: DAC (Digital-to-Analog Converter)	05460-60002 (new); 05460-60014 (rebuilt)
A4	Board Assembly: Word Storage	05460-60003 (new); 05460-60015 (rebuilt)
A5	Board Assembly: Control	05460-60004 (new); 05460-60016 (rebuilt)
A6	Board Assembly: Reference Power Supply	05460-60005 (new); 05460-60017 (rebuilt)
A7	Board Assembly: Plot Control	05431-6007
A8	Board Assembly: Nixie® Display	05460-60006 (new); 05460-60018 (rebuilt)
A8DS1	Tube: "±" Indicator	1970-0012
A8DS1-4	Tube: Readout	1970-0009
A8DS5-13	Lamp: Incandescent, 28V, 40 mA, T 1-3/4 Bulb, Bipin	2140-0213
A8X1-4	Socket: Tube	1200-0413
A9	Board Assembly: Light Driver	05460-60007 (new); 05460-60019 (rebuilt)
	Plastic Window: Front Panel	05460-20017

5465A ADC UNIT

REFERENCE DESIGNATOR	DESCRIPTION	HP PART NUMBER
A1	Board Assembly: Input Buffer	05465-60001 (new); 05465-60026 (rebuilt)
A2	Board Assembly: Stretcher	05465-60002 (new); 05465-60027 (rebuilt)
A3	Board Assembly: Control	05465-60003 (new); 05465-60028 (rebuilt)
A4	Board Assembly: Sequencer	05465-60004 (new); 05465-60029 (rebuilt)
A5	Board Assembly: High Speed Scaler	05415-6007 (new); 05415-6023 (rebuilt)
A6	Board Assembly: Low Speed Scaler	05465-60006 (new); 05465-60030 (rebuilt)

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Table 4-2. Replacement Parts (Cont'd)

5465A ADC UNIT (Cont'd)

REFERENCE DESIGNATOR	DESCRIPTION	HP PART NUMBER
A7	Board Assembly: Output Buffer	05465-60007 (new); 05465-60031 (rebuilt)
	Lamp, Incandescent, T 1-3/4	2140-0300
A8	Board Assembly: 10-100 MHz Multiplier	05415-6009 (new); 05415-6025 (rebuilt)
A9	Board Assembly: Clock	05465-60009 (new); 05465-60032 (rebuilt)
A10	Board Assembly: Sample Generator	05465-60010 (new); 05465-60033 (rebuilt)
A11	Board Assembly: Attenuator	05465-60011
	Lamp Assembly	05465-60012
	Lamp	2140-0037
	Lamp Header	05415-4001
	Lamp Holder	05415-4002
	Lens: Clear	05465-40001
	Lens: Red	05465-40002

5475A CONTROL UNIT

REFERENCE DESIGNATOR	DESCRIPTION	HP PART NUMBER
A1	Board Assembly: Rectifier	05580-6001
A2	Board Assembly: Reference	05580-6002
A3	Board Assembly: Mother	05475-60009
A4 thru A6	Board Assembly: Regulator	05580-6004
A7 thru A10	Not assigned	
A11	Keyboard Assembly	05475-60025
	DS1-10 Lamp	2140-0037
	Lampholder Base	5040-0235
	Lampholder	5040-0279
A12	Board Assembly: Matrix A	05475-60003 (new); 05475-60027 (rebuilt)
A13	Board Assembly: Matrix B	05475-60008 (new); 05475-60032 (rebuilt)
A14	Board Assembly: Shift Register	05475-60001 (new); 05475-60026 (rebuilt)
A15	Board Assembly: Function	05475-60006 (new); 05475-60030 (rebuilt)
A16	Board Assembly: Switch Register	05475-60004 (new); 05475-60028 (rebuilt)
A17	Board Assembly: Buffer	05475-60007 (new); 05475-60031 (rebuilt)
A18	Board Assembly: Relay	05475-60010
	Lamp, Incandescent, T 1-3/4	2140-0300
DS2	Light, Indicator: Red	1450-0132
F1 (115V)	Fuse: 4 Amp, Slow-blow	2110-0014
(230V)	Fuse: 2 Amp, Slow-blow	2110-0006
F2 (5V Sup.)	Fuse: 5 Amp, Norm-blow	2110-0010
W1	Power Cord	8120-0078
XF1, 2	Fuseholder	1400-0084
	Rack Mounting Bracket: Left-hand	5020-0714
	Rack Mounting Bracket: Right-hand	5020-0715

Table 4-3. Service Kit

GENERAL

A service kit (HP Part Number 10648A) for the 5450A System includes the items listed below. Each item may be ordered separately by using the HP Part Number shown.

DESCRIPTION	HP PART NUMBER
Extender Kit. Includes 10603A Display Plug-in Extender Unit. Enables 5460A to be operated outside H51-180AR plug-in compartment. Extender Cards (1) 5060-0630 (2) 5060-0049.	10623A
ADC Extender Cable. Enables 5465A to be operated outside 5475A plug-in compartment.	10628A
Replacement Board Kit. Includes boards listed below. Where both new and rebuilt boards are available, the kit may contain either board, but not both.	10645A
Isolated Spares Kit. Includes replacement transistors, IC's, diodes, and lamps for one year's isolated service of 5450A. These parts are listed below.	10647A

REPLACEMENT BOARD KIT (10645A) (Includes one of each of the following boards)

5460A Display Unit

REFERENCE DESIGNATOR	DESCRIPTION	HP PART NUMBER
A1	Board Assembly: Vertical Amplifier	05460-60001 (new); 05460-60013 (rebuilt)
A2, A3	Board Assembly: DAC (Digital-to-Analog Converter)	05460-60002 (new); 05460-60014 (rebuilt)
A4	Board Assembly: Word Storage	05460-60003 (new); 05460-60015 (rebuilt)
A5	Board Assembly: Control	05460-60004 (new); 05460-60016 (rebuilt)
A6	Board Assembly: Reference Power Supply	05460-60005 (new); 05460-60017 (rebuilt)
A7	Board Assembly: Plot Control	05431-6007
A8	Board Assembly: Nixie® Display	05460-60006 (new); 05460-60018 (rebuilt)
A9	Board Assembly: Light Driver	05460-60007 (new); 05460-60019 (rebuilt)

5465A ADC Unit

REFERENCE DESIGNATOR	DESCRIPTION	HP PART NUMBER
A1	Board Assembly: Input Buffer	05465-60001 (new); 05465-60026 (rebuilt)
A2	Board Assembly: Stretcher	05465-60002 (new); 05465-60027 (rebuilt)
A3	Board Assembly: Control	05465-60003 (new); 05465-60028 (rebuilt)
A4	Board Assembly: Sequencer	05465-60004 (new); 05465-60029 (rebuilt)
A5	Board Assembly: High Speed Scaler	05415-6007 (new); 05415-6023 (rebuilt)
A6	Board Assembly: Low Speed Scaler	05465-60006 (new); 05465-60030 (rebuilt)

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Table 4-3. Service Kit (Cont'd)

REPLACEMENT BOARD KIT (Cont'd)

5465A ADC Unit (Cont'd)

REFERENCE DESIGNATOR	DESCRIPTION	HP PART NUMBER
A7	Board Assembly: Output Buffer	05465-60007 (new); 05465-60031 (rebuilt)
A8	Board Assembly: 10 - 100 MHz Multiplier	05415-6009 (new); 05415-6025 (rebuilt)
A9	Board Assembly: Clock	05465-60009 (new); 05465-60032 (rebuilt)
A10	Board Assembly: Sample Generator	05465-60010 (new); 05465-60023 (rebuilt)

5475A Control Unit

REFERENCE DESIGNATOR	DESCRIPTION	HP PART NUMBER
A2	Board Assembly: Reference	05580-6002
A4 thru A6	Board Assembly: Regulator	05580-6004
A12	Board Assembly: Matrix A	05475-60003 (new); 05475-60027 (rebuilt)
A13	Board Assembly: Matrix B	05475-60008 (new); 05475-60032 (rebuilt)
A14	Board Assembly: Shift Register	05475-60001 (new); 05475-60026 (rebuilt)
A15	Board Assembly: Function	05475-60006 (new); 05475-60030 (rebuilt)
A16	Board Assembly: Switch Register	05475-60004 (new); 05475-60028 (rebuilt)
A17	Board Assembly: Buffer	05475-60007 (new); 05475-60031 (rebuilt)

Table 4-3. Service Kit (Cont'd)

ISOLATED SPARES KIT (10647A) (Includes replacement components as listed below:)

RESISTORS		SCR	
Part No.	Quantity	Part No.	Quantity
0811-0436	1	1884-0063	1
0811-0233	1		
0811-1397	1		
0811-1398	1		
0811-1517	1		

OP AMPS		DIODES	
Part No.	Quantity	Part No.	Quantity
0960-0025	1	1901-0028	2
0960-0049	1	1901-0040	10
		1901-0041	2
INTEGRATED CIRCUITS		1901-0044	1
		1901-0156	1
Part No.	Quantity	1901-0179	1
1820-0054	4	1901-0415	2
1820-0055	2	1902-0025	1
1820-0068	2	1902-0049	1
1820-0069	1	1902-0071	2
1820-0070	2	1902-0244	1
1820-0071	2	1902-0556	1
1820-0077	4	1902-3002	1
1820-0092	1	1902-3024	2
1820-0116	2	1902-3104	1
1820-0174	1	1902-3193	1
1820-0201	1	1902-3234	1
1820-0327	2	1902-3268	1
1820-0328	1		

TRANSISTORS			
Part No.	Quantity		
1850-0099	1		
1853-0015	1	**DIGITAL DISPLAY TUBES**	
1853-0020	4		
1853-0027	1	Part No.	Quantity
1853-0034	1	1970-0009	1
1853-0036	2	1970-0012	1
1853-0088	2		
1854-0003	2		
1854-0005	1	**LAMPS**	
1854-0019	2	Part No.	Quantity
1854-0020	1	2140-0213	2
1854-0022	1	2140-0300	1
1854-0039	2		
1854-0071	6	**FUSES**	
1854-0092	2	Part No.	Quantity
1854-0094	2	2110-0006	1
1854-0215	2	2110-0014	1
1854-0326	2	2110-0010	1
1855-0020	2		
1855-0049	1		
1855-0051	1		

Table 4-4. Board Replacement Program

The Board Exchange Program described in this table provides the quickest way to achieve "on-site" repair/replacement of bad boards in the 5460A, 5465A, or 5475A units of the 5450A system.

START

Locate bad board. Refer to Table 4-1 for troubleshooting.

Is a good board available (either in stock or service kit)?

YES → Replace bad board with good board from stock or kit. Keep bad board available for return to Hewlett-Packard.

NO

Order rebuilt replacement board from HP, refer to Table 4-2 for part numbers.

Rebuilt replacement boards are shipped individually in boxes like the one shown at right. In addition to the board, the box contains:
    Module repair report
    Return address label
    Tape for re-sealing box

Swap replacement board and bad board.

Open shipping box carefully; it will be used to return bad board to HP. Complete module repair report; place it and bad board in box as shown in photo at right. Be sure to remove return address label before sealing box.

Return board to HP.

Moisten back of return address label and place it over address already on box. Return box to HP. We pay postage if box is mailed in United States.

END

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TWX: 910-950-1282

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Tucson 85716
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TWX: 910-952-1162

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TWX: 910-367-2092

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San Diego 92106
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TWX: 910-335-2000

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Englewood 80110
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TWX: 910-935-0705

CONNECTICUT
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East Hartford 06108
Tel: (203) 289-9394
TWX: 710-425-3416

111 East Avenue
Norwalk 06851
Tel: (203) 853-1251
TWX: 710-468-3750

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Wilmington 19807
Tel: (302) 655-6161
TWX: 510-666-2214

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Miami Shores 33153
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TWX: 810-848-7262

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Herndon Station 32814
621 Commonwealth Avenue
Orlando
Tel: (305) 841-3970
TWX: 810-850-0113

P.O. Box 8128
Madeira Beach 33708
410 150th Avenue
St. Petersburg
Tel: (813) 391-0211
TWX: 810-863-0366

GEORGIA
P.O. Box 28234
450 Interstate North
Atlanta 30328
Tel: (404) 436-6181
TWX: 810-766-4890

ILLINOIS
5500 Howard Street
Skokie 60076
Tel: (312) 677-0400
TWX: 910-223-3613

INDIANA
3839 Meadows Drive
Indianapolis 46205
Tel: (317) 546-4891
TWX: 810-341-3263

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1942 Williams Boulevard
Kenner 70062
Tel: (504) 721-6201
TWX: 810-955-5524

MARYLAND
6707 Whitestone Road
Baltimore 21207
Tel: (301) 944-5400
TWX: 710-862-0850

P.O. Box 1648
2 Choke Cherry Road
Rockville 20850
Tel: (301) 948-6370
TWX: 710-828-9684

MASSACHUSETTS
32 Hartwell Ave.
Lexington 02173
Tel: (617) 861-8960
TWX: 710-326-6904

MICHIGAN
24315 Northwestern Highway
Southfield 48075
Tel: (313) 353-9100
TWX: 810-232-1532

MINNESOTA
2459 University Avenue
St. Paul 55114
Tel: (612) 645-9461
TWX: 910-563-3734

MISSOURI
11131 Colorado Ave.
Kansas City 64137
Tel: (816) 763-8000
TWX: 910-771-2087

2812 South Brentwood Blvd.
St. Louis 63144
Tel: (314) 962-5000
TWX: 910-760-1670

NEW JERSEY
W. 120 Century Road
Paramus 07652
Tel: (201) 265-5000
TWX: 710-990-4951

1060 N. Kings Highway
Cherry Hill 08034
Tel: (609) 667-4000
TWX: 710-892-4945

NEW MEXICO
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Station C
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Albuquerque 87108
Tel: (505) 255-5586
TWX: 910-989-1665

156 Wyatt Drive
Las Cruces 88001
Tel: (505) 526-2485
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NEW YORK
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TWX: 710-441-8270

1219 Campville Road
Endicott 13760
Tel: (607) 754-0050
TWX: 510-252-0890

82 Washington Street
Poughkeepsie 12601
Tel: (914) 454-7330
TWX: 510-248-0012

39 Saginaw Drive
Rochester 14623
Tel: (716) 473-9500
TWX: 510-253-5981

1025 Northern Boulevard
Roslyn, Long Island 11576
Tel: (516) 869-8400
TWX: 510-223-0811

5858 East Molloy Road
Syracuse 13211
Tel: (315) 454-2486
TWX: 710-541-0482

NORTH CAROLINA
P.O. Box 5188
1923 North Main Street
High Point 27262
Tel: (919) 885-8101
TWX: 510-926-1516

OHIO
25575 Center Ridge Road
Cleveland 44145
Tel: (216) 835-0300
TWX: 810-427-9129

3460 South Dixie Drive
Dayton 45439
Tel: (513) 298-0351
TWX: 810-459-1925

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