

HEWLETT  PACKARD

SIGNAL ANALYZER
OPERATING MANUAL
PART NO. 05480-90011 (MANUAL)
APRIL 1971

5480A
SERIAL PFX ALL SERIALS
05480-90014 (FICHE)
2 of 2

MAINTENANCE

SECTION IV MAINTENANCE

4-1. SCHEDULING

4-2. Preventive maintenance scheduling depends, partly, on the system with which the 5480A Signal Analyzer System is used. The maintenance intervals below are intended to serve as a guide to maintenance scheduling.

- DAILY: Operator adjustments (Paragraph 4-5).
- MONTHLY: Perform Incoming Inspection Check, Table 2-2. (Time: approximately one hour.)
- EVERY THREE MONTHS:
 - Clean all assemblies (see Paragraph 4-12). (Time: approximately one hour.)
 - Perform Incoming Inspection Check, Table 2-2. (Time: approximately one hour.)
- EVERY SIX MONTHS:
 - Clean all assemblies (see Paragraph 4-12). (Time: approximately one hour.)
 - Perform complete Calibration and Adjustment procedure (see 5480A Service Manual, Volume I). (Time: approximately two hours.)
 - Perform Incoming Inspection Check, Table 2-2. (Time: approximately one hour.)

4-3. LUBRICATION

4-4. The Models 5480A, 5485A, and 5486A require no lubrication.

4-5. OPERATOR ADJUSTMENTS

4-6. The procedures below should be performed only if necessary. Adjustments are for DC BAL and BASELINE of 5485A plug-in.

- 4-7. Set Signal Analyzer controls as follows:
- FUNCTION to AVERAGE
 - TRIGGER SOURCE to INTERNAL
 - PRE-ANALYSIS DELAY to "0"
 - POST-ANALYSIS DELAY to OFF
 - SWEEP NUMBER to "0"
 - PRESET/NORMAL to NORMAL
 - SWEEP TIME to 1 sec/cm
 - SENSITIVITY MULTIPLIER to AUTO
 - PRESET TOTALIZER to OFF
 - MAGNIFIER to X1
 - SCALE CAL to OFF
 - SAMPLE to INT
 - SAWTOOTH/TRIANGLE to SAWTOOTH
 - DISPLAY INTERLACE to IN
 - A DISPLAY to DATA
 - B DISPLAY to DATA

A MEMORY SELECTOR to FULL
B MEMORY SELECTOR to FULL
A+B/ALT to ALT
HISTOGRAM to OFF
A SENSITIVITY to .005 V/CM
B SENSITIVITY to .005 V/CM
A SENSITIVITY VERNIER to CAL
B SENSITIVITY VERNIER to CAL
A POLARITY to UP+
B POLARITY to UP+
A AC/GND/DC to GND
B AC/GND/DC to GND
POWER switch up (POWER ON)

4-8. DC BAL A+B.

- Set Signal Analyzer controls as in Paragraph 4-4.
- Set A+B/ALT to A+B.
- Press both CLEAR DISPLAY pushbuttons.
- Press PROCESS START.
- Observe moving discontinuity on CRT trace.
- Adjust DC BAL A+B to minimize discontinuity; discontinuity should be less than 0.2 cm.
- Check adjustment by repeating steps c, d, and e.

4-9. DC BAL A.

- Set Signal Analyzer controls as in Paragraph 4-4.
- Set A+B/ALT to ALT.
- Press both CLEAR DISPLAY pushbuttons.
- Press PROCESS START.
- Observe moving discontinuity on CRT trace.
- Adjust DC BAL A to minimize discontinuity; discontinuity should be less than 0.2 cm.
- Check adjustment by repeating steps c, d, and e.

4-10. DC BAL B.

- Set Signal Analyzer controls as in Paragraph 4-4.
- Set Channel A DISPLAY to OFF.
- Set A+B/ALT to ALT.
- Press both CLEAR DISPLAY pushbuttons.
- Press PROCESS START.
- Observe moving discontinuity on CRT trace.
- Adjust DC BAL B to minimize discontinuity; discontinuity should be less than 0.2 cm.
- Check adjustment by repeating steps d, e, and f.

4-11. BASELINE.

- Set Signal Analyzer controls as in Paragraph 4-4.
 - Set FUNCTION to SUMMATION.
 - Press both CLEAR DISPLAY pushbuttons.
 - Press PROCESS START.
 - Observe moving discontinuity on CRT trace.
 - Adjust BASELINE ADJ to minimize discontinuity.
- NOTE: If bipolar signals are going to be summed, it may be desirable to purposely offset the SUMMATION baseline so cumulative zero crossing errors will not be present in summed waveform.

4-12. CLEANING

4-13. Remove dust and dirt from all assemblies, especially power supplies and memory section. Check printed circuit board contacts for tarnish and/or corrosion. Clean assemblies more often than recommended interval, if Signal Analyzer System is used in a dirty or dusty area.

4-14. For access to internal assemblies, remove instrument top and bottom covers. The five sections of the Model 5480A are located within the instrument as follows:

- Display section: Upper left-hand, front.
- Main Frame logic section: Lower left-hand, rear.
- Memory section: Upper right-hand, front, on swing-out deck. To swing deck, loosen locking screws located at front of deck and lift front of deck.
- Switch logic section: Upper right-hand, front, just below front of memory deck.
- Power supply section: Lower right-hand, rear.

4-15. CALIBRATION AND ADJUSTMENT PROCEDURE

4-16. Calibration and Adjustment procedure for the Signal Analyzer system is in 5480A Service Manual, Volume I.

CATHODE RAY TUBE WARRANTY

The cathode ray tube (CRT) supplied in the Hewlett-Packard 5480A, and replacement CRTs purchased from HP, are guaranteed by the Hewlett-Packard Company against electrical failure for a period of one year from date of sale. Broken tubes or tubes with burned phosphor are not included under this guarantee. If the CRT is broken when received, a claim should be made with the responsible carrier.

Your nearest Hewlett-Packard Sales and Service office (listed at rear of instrument manual) maintains a stock of replacement tubes and will assist in processing the warranty claim.

In order to ensure credit for a CRT under the warranty period, the reverse side of this sheet should be filled out completely and returned with the defective tube to the nearest HP Sales and Service office. To avoid damage to the tube while in shipment, carefully follow the shipping instructions listed on the reverse side of this sheet; credit is not allowed on broken tubes.

CRT WARRANTY CLAIM

SHIPPING INSTRUCTIONS

1. Carefully wrap the tube in 1/4 inch thick cotton batting or other soft padding material.
2. Wrap the above in heavy kraft paper.
3. Pack wrapped tube in a rigid container which is at least 4 inches larger than the tube in each dimension.
4. Surround the tube with at least 4 inches of packed excelsior or similar shock absorbing material; be sure the packing is tight all around the tube.

FROM: _____ DATE: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

For additional information, contact:

NAME: _____

COMPANY: _____

ADDRESS: _____

1. HP INSTRUMENT a) MODEL _____

b) SERIAL NO. _____

2. CRT a) TYPE (on bulb) _____

b) SERIAL NO. (on CRT base) _____

3. Is defective tube original? YES _____ NO _____

4. Date purchased (if available) _____

5. Describe nature and/or symptoms of trouble. _____

6. Describe operation conditions prior to and at time of failure. (Please estimate CRT "on-time" since purchase.) _____

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MANUAL CHANGES

HEWLETT  PACKARD

MANUAL CHANGES

MODEL 5480A SIGNAL ANALYZER
OPERATING MANUAL

All Serials
Manual Printed: NOV 1968

MAKE ALL CORRECTIONS IN THIS MANUAL ACCORDING TO ERRATA BELOW. THEN CHECK THE FOLLOWING TABLE FOR YOUR INSTRUMENT SERIAL PREFIX (3 DIGITS) OR SERIAL NUMBER (8 DIGITS) AND MAKE ANY LISTED CHANGE(S) IN THE MANUAL.

► NEW ITEM.

SERIAL PREFIX OR NUMBER	MAKE MANUAL CHANGES	SERIAL PREFIX OR NUMBER	MAKE MANUAL CHANGES
ALL	Addenda		
928- and above	1		
5480B	1, 2		
5485A (serial prefix 964 and above)	3		

ADDENDA (ALL)

The following information describes:

- I) The 5487A Four Channel Input Plug-in
- II) Option 01 (Variance), available for 5485A, 5487A, or 5488A Input Plug-in.
- III) The 5488A Average/Correlation Input Plug-In.

I. 5487A FOUR CHANNEL INPUT PLUG-IN.

1-1. INTRODUCTION.

1-2. The Hewlett-Packard Model 5487A Four Channel Input Plug-in enables the HP 5480 Signal Analyzer System to process and display up to four channels of information instead of only two, as is the case with the 5485A Two Channel Input Plug-in. In most respects, operation and nomenclature of this plug-in is the same as that for the 5485A described in the 5480A Operating Manual. Table 1 of this addendum lists specifications that are different from those listed in Table 1-1 of the 5480 Operating Manual when using the 5487A Plug-in.

1-3. OPERATION.

1-4. The following control differences between the 5487A and 5485A Plug-Ins should be noted:

a. MEMORY in 5487A selects portion of memory to be used for storage, display, or processing. Memory is divided into four quarters; MEMORY switch controls which plug-in channel is connected to which memory quarter. Table 2 of this addendum lists memory section-vs-plug-in channel allocations. FULL memory provides 1000-point resolution for any one channel; HALF memory provides 500-point resolution for any one channel; QUARTER memory provides 250-point resolution for any one channel.

b. DISPLAY in 5487A selects CRT display for all channels turned on (see Table 2 of this addendum). INPUT displays sampled input signals. DATA displays averaged signal; MCS, or histogram. NOISE displays difference between INPUT and averaged signal (DATA).

c. ON/OFF switches, plus MEMORY switch and some internal logic determine which channels will be processed or displayed. See Table 2 of this addendum for details. At least one channel must be turned on or there will be no processing or display.

1-5. To operate in any function (AVERAGE, SUMMATION, HISTOGRAM, or MCS), the instructions given for the Signal Analyzer System using the 5485A can be used with only slight changes required by the 5487A.

1-6. MAINTENANCE.

1-7. Maintenance is the same as that for the System using the 5485A. There are only two front-panel adjustments. BASELINE is made as described in the manual, DC BALANCE is made as described for any one channel of the 5485A (adjust for minimal offset).

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ADDENDA
(Cont'd)

Table 1. Specifications (5480A Signal Analyzer System with 5487A Input Plug-in).

This table lists only those specifications for the 5480 Signal Analyzer System that are different when the 5485A Two Channel Input Plug-In is replaced with the 5487A Four Channel Input Plug-In. Specifications are listed in the order in which they are listed in Table 1-3 of the 5480A Operating Manual.

AVERAGING:

1. CALIBRATED AVERAGING MODE:

Input Characteristics (for 5487A Four Channel Input Plug-in):

Bandwidth: dc (2 Hz ac coupled) to 25 Hz.

Sensitivity: 50 mV/cm to 20 V/cm in 1, 2, 5 sequence, 3% accuracy.

Polarity Inversion: not available.

A+B: not available.

ALT: not available.

Overlap Display: not available.

Display: For all channels that are on, operator may select CRT display of waveform as it is averaged, noise as it is removed from signal, or input signal after sampling.

Input Priorities: Channel A takes precedence over B, B takes precedence over C, C takes precedence over D.

Input Sampling Sequence: ABCDADCDABCD.

Variance: Variance output can be ordered as 5487A Option 01. Variance option provides a square of the noise signal as an output.

Table 2. MEMORY SECTION VS PLUG-IN CHANNEL

MEMORY switch selects whether any one Plug-in channel will be connected to one (QUARTER), two (HALF), or four (FULL) quarters of memory.

FULL

All four memory quarters are connected to the highest priority channel that is turned "ON". Channel A has highest priority, followed, in order, by B, C, and D.

FULL MEMORY

connected to this channel when channel is "ON".....

Unless.

A	----
B	Channel A is ON
C	Channel A or B is ON
D	Channel A, B, or C is ON

HALF

Memory quarters are connected to Plug-In Channels as shown in chart below.

NOTES:

- Numbers indicate identification numbers for the two memory quarters connected to a channel when that channel is ON.
- ON/OFF indicates that all memory quarters are taken by higher-priority channels, and it makes no difference whether this channel is ON or OFF.
- OFF indicates that this channel must be OFF to have this condition.

A	B	C	D
1, 2	OFF	OFF	OFF
OFF	3, 4	OFF	OFF
OFF	OFF	1, 2	OFF
OFF	OFF	OFF	3, 4
*1, 2	3, 4	ON/OFF	ON/OFF
1, 2	OFF	3, 4	ON/OFF
1, 2	OFF	OFF	3, 4
OFF	3, 4	1, 2	ON/OFF
OFF	3, 4	OFF	1, 2
OFF	OFF	1, 2	3, 4

*Recommended usage for two-channel operation.

ADDENDA
(Cont'd)

Table 2. MEMORY SECTION VS PLUG-IN CHANNEL (CONT'D)

QUARTER

Each memory quarter is connected to a specified Plug-in channel when that channel is ON. There is no change in quarter allocation when a channel is OFF.

Channel A always gets quarter 1
Channel B always gets quarter 2
Channel C always gets quarter 3
Channel D always gets quarter 4

II. OPTION 01 (VARIANCE).

2-1. DESCRIPTION.

This Option, available for the 5485A, 5487A, or 5488A Input Plug-in, enables use of the 5480 VARIANCE OUTPUT signal to check validity of the averaged signal. The Option may be ordered installed and tested at the factory, or it may be installed in the field. Field installation consists of replacing the Switching Logic B Assembly (05485-60010) with Switching Logic B Assembly (05485-60020); no wiring changes are required.

As the input waveform is processed, its average pattern is stored in the Signal Analyzer's memory. The Variance Option compares the input signal against this pattern, and its trace represents differences between the two. The variance trace can be used to identify points in the averaged waveform where there is additional activity other than that added simply by random noise. If the variance trace is a straight line, then the averaged waveform is the result of a single repetitive input which was time-locked to the synchronizing pulse (except for the special case where the absolute deviation of the spurious input from the average is the same at all points on the waveform).

If the leading or trailing edge of a pulse or square wave is jittering (or appears to be jittering due to a jittering trigger signal), the variance trace will not be a straight line (thus indicating that there was something in the signal besides noise and data). If the input signal waveform changes, the variance will not be a straight line, but will have a shape of its own, reflecting the signal change. The variance trace is also useful for detecting when a signal is not present during the entire analysis interval, by showing the difference between the stored averaged signal and the missing input signal. All that would happen to the averaged signal trace is that its amplitude would shrink slightly (depending on number of sweeps that had been averaged).

2-2. OPERATION.

To operate the variance option, connect 5480 rear-panel VARIANCE OUTPUT connector through a BNC-to-BNC cable to the 5485A, 5487A, or 5488A front-panel connector for any unused channel; use this channel to display the variance output; set DISPLAY for this channel to DATA; set MEMORY SELECTOR to any unused QUARTER or HALF. Each point in the variance output corresponds to the point immediately preceding it in the averaged signal waveform.

III. 5488A/H01-5485A AVERAGE/CORRELATION INPUT PLUG-IN

NOTE: Except for minor differences in front-panel engraving and parts numbers, the 5488A and H01-5485A are identical. In general, text will use 5488A terminology and numbers; differences between these and those for the H01-5485A will be described where necessary.

3-1. DESCRIPTION.

3-2. The Hewlett-Packard Model 5488A (or Specification H01-5485A) Average/Correlation Input Plug-in accepts one or two channels of input data to be presented as the vertical input portion of a 5480 Signal Analyzer System to perform cross- or auto-correlation function on input signals, in addition to other 5480 functions.

ADDENDA
(Cont'd)

3-3. OPERATION

3-4. Average, Summation, Histogram, MCS.

3-5. For the Average, Summation, Histogram, and MCS FUNCTIONS, the 5488A/H01-5485A is operated in the same manner as the standard 5485A illustrated in the Operating Manual. Note, however, that the ALT/A+B and POLARITY switches are not provided on this instrument.

3-6. Correlation

3-7. Correlation is a measure of the similarity between two waveforms. Correlation is computed by multiplying the two waveforms ordinate-by-ordinate and finding the average product. Finding the correlation function of two different signals is cross-correlation; finding the correlation function of a signal with itself is auto-correlation. Auto-correlation can be used to determine if there is any periodicity in an unknown input signal; the period of the auto-correlation function is the same as the period of the original input signal. Cross-correlation is used to show how closely two "independent" signals are related.

3-8. To perform a correlation function, perform the following procedure:

a. SETUP AND TURN ON: Perform Setup and Turn-on Procedure described in Figure 3-6 in the Operating Manual.

b. CONTROL SETTINGS: To obtain a valid correlation function, the input signals must not be "clipped". Steps 1 through 14 of this procedure assure proper settings of the Channel A and Channel B attenuators.

- 1) To perform cross-correlation, connect each of the two input signals to one of the 5488A INPUT connectors. To perform auto-correlation, connect the single input signal through a "T" connector to both inputs.
- 2) Set FUNCTION to AVERAGE.
- 3) Set SENSITIVITY MULTIPLIER fully CCW.
- 4) Set TRIGGER SOURCE to INTERNAL.
NOTE: Correlation requires that sampling pulses not be sync'd to either input signal. Random triggering is most easily achieved by setting TRIGGER SOURCE to INTERNAL.
- 5) Set PRESET/NORMAL to NORMAL.
- 6) Set Channel A DISPLAY to INPUT.
- 7) Set Channel B DISPLAY to OFF.
- 8) Set MEMORY SELECTOR switches for both channels to the same setting. FULL provides greatest resolution; correlation functions can be stored for comparison by processing in HALF or QUARTER and changing MEMORY SELECTOR settings before next processing.
- 9) MODE (CORRELATION) to AVG (OFF).
- 10) Set Channel A SENSITIVITY VERNIER fully CCW, to display full signal on CRT.
- 11) Starting from 20V/cm, rotate Channel A SENSITIVITY Control until you see clipping of INPUT signal. Go back one switch position; this is maximum sensitivity for SENSITIVITY that can be tolerated without clipping.
- 12) Set Channel A DISPLAY to OFF.
- 13) Set Channel B DISPLAY to INPUT.
- 14) Repeat steps 10 and 11 for Channel B SENSITIVITY control.

The Signal Analyzer system is now set for maximum sensitivity, without clipping.

Do not change SENSITIVITY control settings; Channel A VERNIER can be set for larger picture without disturbing processing.

- 15) Set MODE (CORRELATION) to CORR (ON).
- 16) Set Channel A DISPLAY to DATA.
- 17) Set Channel B DISPLAY to OFF.
- 18) Press both CLEAR DISPLAY pushbuttons.
- 19) Press PROCESS START button.

ADDENDA
(Cont'd)

- 20) Rotate SWEEP TIME and PRE-ANALYSIS DELAY switches as necessary for best presentation of correlation function. SWEEP TIME determines delay (time offset) between input signals, PRE-ANALYSIS DELAY determines delay in sampling of both input signals.

CRT DISPLAY

The signal at INPUT A is sampled once, at the beginning of each process sweep. The value of its amplitude is digitized and stored in a buffer register in the 5488A. Signal B is sampled 1000 (or 500 or 250) times during each processing sweep. Each signal B sample is digitized and stored in another buffer register in the 5488A. The contents of the two buffer registers are multiplied, and the product converted to an analog value. The analog value of the signal product is compared with the analog value of the memory contents for the same point; the analog difference is digitized and added to the memory contents to form the new correlation value for that point.

On the next sweep, the next point of the INPUT A signal is sampled, digitized, stored, and multiplied by all digital values of Signal B, as described above. Thus, after some number of sweeps, the value of the correlation signal is built up in the 5480A memory. This is the signal displayed on the 5480 CRT.

Amplitude and polarity of the correlation function depend on amplitude and relative phase (polarity) of the two input signals. Positive points of correlation function mean that input signals are in-phase (have same polarity), negative points of correlation function mean that input signals are out-of-phase.

The autocorrelation function of a periodic signal will have the same period as the input signal. A sync signal with this period may be used when the input signal is being averaged.

The horizontal display axis is calibrated by the SWEEP TIME and X1/X5 switch settings. The period of the correlation function may be calculated as follows:

$$\text{Period} = \text{distance between corresponding points (cm)} \times \frac{\text{SWEEP TIME}}{\text{X1/X5 setting}}$$

The vertical display axis is calibrated by settings of both Channel A and Channel B SENSITIVITY controls. The vertical signal units are volts-squared, calculated as follows:

$$20 \times \text{Vertical deflection from baseline (cm)} \times \text{SENSITIVITY A} \times \text{SENSITIVITY B}$$

Example: Vertical point 2 cm above baseline, when A SENSITIVITY is .1V/cm and B SENSITIVITY is .2V/cm is: $20 \times 2 \times .1 \times .2 = .8V^2$.

Vertical accuracy is $\pm 5\%$.

CHANGE 1
(928- & above)
(& 5480B)

The following rear-panel changes were made:

Connectors eliminated:

- J12 External Data Input
- J13 Seek
- J14 Plot
- J15 System Logic Interconnection (A)
- J17 System Logic Interconnection (C1)

Switches eliminated:

- S6 Sawtooth/Triangle
- S7 Sample Int/Ext

Connector moved to new location on rear panel:

- J19 Sweep Voltage Output

Switch moved to new location on rear panel:

- S5 Scale Cal

Connector added:

- J36 Plotter, 14-contact female ribbon connector (HP Part No. 1251-0143), Amphenol or Cinch type 57-40140 MATING CONNECTOR: HP Part No. 1251-0142, Amphenol or Cinch type 57-30140).

J36 connections

- (1) Horizontal DAC Output, same as J9 center
- (2) Horizontal DAC Ground.
- (3) No Connection
- (4) Pen Lift Control Output, same as J30 center
- (5) Record Light Output
- (6) Plot (Input)
- (7) No Connection
- (8) Vertical DAC Output, same as J10 center.
- (9) Vertical DAC Ground
- (10) No Connection
- (11) Ground
- (12) No Connection
- (13) Seek (Output)
- (14) Ground

Fuse Added:

- F2, +5VDC Supply (10-Amp, HP Part No. 2110-0051)

These changes do not materially affect 5480A operation. The SAWTOOTH/TRIANGLE switch (now eliminated) was used only in MCS operation; the standard 5480A is now restricted to Sawtooth sweeps in all operating modes and FUNCTIONS.

The new Plotter connector allows use of the HP 10640B Plotter Interface Cable.

CHANGE 2
(5480B)

The circuit changes that were made to convert the 5480 and 5486 from "A" to "B" models did not materially affect the Operating controls or indicators. The 5480B system is identical in most respects to the 5480A system, which it replaces.

The 5480B includes two HP 10503A BNC-BNC cables.

The Variance feature, described in ADDENDA (Part II), is standard in the 5485A, 5487A, or 5488A Input Plug-in included in a 5480B system.

The 5486B SWEEP NUMBER and PRESET controls can be used in MCS to cause MCS processing to stop after a preset number of sweeps have been performed.

Pen lift output is changed from 5480A as follows:

Contact closure to ground during sweep only, in OUTPUT RECORD mode, lowers pen at start of sweep, lifts pen at end of sweep. 50 mA maximum current. Parallel output provided by BNC connector J30.

CHANGE 2
(5480B)
(Cont'd)

J36(8) connection is changed from Vertical DAC Output to Vertical Scope Output (Same as J29 center).

SAMPLE OUTPUT (rear panel) is now gated, to provide one pulse for each processed point (1000 pulses for full memory, 500 pulses for half memory, 250 pulses for quarter memory). (PROCESS START lamp must be lighted to obtain pulses.)

CHANGE 3
(5485A)

5485A's with serial prefix 964 and above are set to provide 2 cm separation between traces in OVERLAP. Other 5485A's are set to provide 1 cm. The OVERLAP separation can be adjusted in the field; the adjustment is described in the 5480A/B System Service Manual, Volume I, Table 3-1, Part B.6.i. Adjustment location is shown on page 3-25 of the above manual.

END