HEWLETT PACKARD

8559A

OPERATION

SECTION III
OPERATION

3-1. INTRODUCTION

3-2. This section provides operating information for the HP 8559A Spectrum Analyzer plug-in. It also provides a brief description of display mainframe controls. For a detailed description of the display mainframe, refer to its manual.

3-3. The HP 8559A Spectrum Analyzer plug-in can be used with either the 180-series display mainframes or the HP 853A Spectrum Analyzer Display mainframe.

3-4. DESCRIPTION

3-5. HP 8559A Spectrum Analyzer

3-6. The HP 8559A employs harmonic mixing to cover a measurement range of 10 MHz to 21 GHz in six frequency bands. It can display frequency spans as narrow as 100 kHz, and as wide as 9 GHz (the latter in full span mode). A five-digit LED readout indicates the spectrum analyzer center frequency with a resolution of 1 MHz. The HP 8559A can be used to measure signals over an amplitude range of −111 dBm to +30 dBm.

3-7. HP 853A Spectrum Analyzer Display

3-8. The HP 853A Spectrum Analyzer Display is a large-screen, digital storage display mainframe for use exclusively with the HP 8559A, 8558B, and 8557A Spectrum Analyzer plug-ins. Digital memory provides buffer storage for two independent traces, both of which can be displayed or blanked as desired. Digital processing also provides push-button features such as maximum signal hold, digital averaging, and trace normalization. A conventional analog display mode can also be selected.

3-9. HP-IB

3-10. The HP 853A has limited HP-IB capabilities. CRT trace and graticule data is dumped directly to a listen-only HP-IB plotter by pressing two front-panel push buttons. Control settings on the spectrum analyzer plug-in cannot be monitored via the HP-IB; however, all digital display functions are programmable via a controller, and two lines of annotation can be displayed on the CRT for labelling purposes or operator prompting. In addition, controller commands allow transfer of trace data for analysis or storage.

3-11. CONTROLS, INDICATORS, AND CONNECTORS

3-12. Control Grouping

3-13. The Spectrum Analyzer plug-in and Display mainframe front-panel controls fall into three general groups: those that deal with the display, those that deal with frequency, and those that deal with amplitude. These controls are shown in Figure 3-1 and accompanied by detailed explanations of their use.

3-14. Display. The display group consists of:

SWEEP TIME/DIV	VIDEO FILTER
SWEEP TRIGGER	BASELINE CLIPPER
VERT POSN	HORIZONTAL POSITION
VERT GAIN	INTENSITY
MANUAL SWEEP	FOCUS
HORIZ GAIN (rear panel of HP 8559A)	TRACE ALIGN

3-15. The display group enables the operator to calibrate the display and to select a variety of scan and display conditions. However, when the SWEEP TIME/DIV Control is placed in the AUTO position, sweep time is controlled by the RESOLUTION BW, FREQ SPAN/DIV, and VIDEO FILTER controls.

3-16. Frequency. The frequency group consists of:

TUNING
FREQUENCY BAND GHz
ALT IF
SIG IDENT
RESOLUTION BW
FREQ SPAN/DIV

3-17. The frequency group enables the operator to control how the Spectrum Analyzer displays the frequency domain. The RESOLUTION BW and FREQ SPAN/DIV controls, when pushed in, are coupled together, and moving either control moves the other. When the SWEEP TIME/DIV control is in the AUTO position, varying the RESOLUTION BW or the FREQ SPAN/DIV (coupled or uncoupled) will change the sweep time to maintain calibration. With the two controls coupled together in the optimum position, RESOLUTION BW's of 3 MHz to 1 kHz will be automatically selected as the FREQ SPAN/DIV is narrowed from F (Full) to 0 (Zero). TUNING controls coarse and fine (coarse is larger knob) set the center frequency of the displayed spectrum. RESOLUTION BW control determines the resolution of the signals on the CRT.

3-18. Amplitude. The amplitude group consists of:

REFERENCE LEVEL dBm
INPUT ATTEN
REF LEVEL FINE
REF LEVEL CAL
10 dB/DIV – 1 dB/DIV – LIN (Amplitude Scale)

3-19. The amplitude group enables the operator to measure signal amplitude in units of either voltage or dBm.

3-20. OPERATING PRECAUTIONS

3-21. Signal Input

3-22. The HP 8559A Spectrum Analyzer plug-in is a sensitive measuring instrument. Overloading the input with too much power, peak voltage, or dc voltage will permanently damage the input circuits. Do not exceed the input levels specified below:

Maximum Input (Damage) Levels

HP 8559A

Total Power:
+20 dBm (0.1W, 2.2 Vrms) with 0 dB input attenuation
+30 dBm (1W, 7.1 Vrms) with ≥10 dB input attenuation

dc or ac (<100 Hz): ±7.1V

Peak Pulse Power: +50 dBm (100W, >10μsec pulse width, 0.01% duty cycle) with ≥30 dB input attenuation

NOTE

When you are measuring input signals of unknown power levels, a preliminary instrument setting of ≥30 dB INPUT ATTEN is recommended.

CAUTION

Although the spectrum analyzer's reference level can be set for power levels up to +60 dBm, the total input power must not exceed the absolute maximum limits listed above.

3-23. Line Power On

3-24. Before connecting the line power cord, make sure the proper line voltage and line fuse have been selected for the display mainframe. Failure to set the ac power input selector on the display mainframe to correspond with the level of the ac source voltage could cause damage to the instrument when the power cord is plugged in.

WARNING

The spectrum analyzer and any device connected to it must be connected to power line ground. Failure to ensure proper grounding could result in a shock hazard to personnel or damage to the instrument.

3-25. LINE power is switched at the display mainframe front panel. A safety indicator lights when the ac power is on. **NEVER** remove a spectrum analyzer plug-in from the display mainframe without first switching the ac LINE power switch to OFF.

3-26. For optimum performance, you should allow the spectrum analyzer to warm up for at least 30 minutes before using it to make measurements.

3-27. FRONT-PANEL ADJUSTMENT PROCEDURE

3-28. The front-panel adjustment procedure adapts the HP 8559A Spectrum Analyzer plug-in to a particular display mainframe, and should be performed daily after instrument warm-up. The step-by-step adjustment is also an excellent way for new users to become acquainted with the various spectrum analyzer controls. Once the procedure is completed, the

spectrum analyzer is calibrated for absolute amplitude and frequency measurements. Set the controls as shown in Table 1 before you start the adjustment procedure.

TABLE 1. ADJUSTMENT SETTINGS

Function	Setting
Spectrum Analyzer Plug-In	
INPUT ATTEN (dB)*	10 dB
REFERENCE LEVEL	0 dBm
Option 002	+50 dBmV
REF LEVEL FINE	0 dBm
Amplitude Scale	LIN
FREQ SPAN/DIV	10 MHz (uncoupled)
RESOLUTION BW	1 MHz (uncoupled)
SWEEP TIME/DIV	AUTO
SWEEP TRIGGER	FREE RUN
START–CENTER (8558B, 8557A)	CENTER
FREQUENCY BAND GHz (8559A)	.01–3
TUNING	>60 MHz
BASELINE CLIPPER	OFF
VIDEO FILTER	OFF
*On older plug-ins, set OPTIMUM INPUT to –30 dBm.	
HP 853A Spectrum Analyzer Display	
TRACE A	WRITE
TRACE B	STORE BLANK
DGTL AVG	OFF
INPUT–B→A	OFF
HP 180-Series Display Mainframe	
DISPLAY	INT
MAGNIFIER	X1
SCALE (180TR, 182T)	OFF
PERSISTENCE (181T/TR)	MIN
Display Mode (181T/TR)	WRITE

3-29. Display Adjustments – HP 853A Spectrum Analyzer Display

1. Switch LINE power OFF then ON while holding PLOT GRAT push button depressed to activate the digital test routines. The "#0" that appears on the left side of the CRT means digital test routine #0 is now activated.
2. Press and release the PLOT GRAT push button four times to step to digital test routine #4, as indicated by the "#4" displayed on the left side of the CRT.
3. With an adjustment tool, adjust the FOCUS control as necessary to make the characters on the CRT as clear as possible.
4. Adjust the X POSN and Y POSN controls the align the square trace pattern with the outermost CRT graticule lines.
5. Momentarily press the PLOT GRAT and PLOT TRACE push buttons simultaneously to exit the digital test routines.

3-30. Display Adjustments – HP 180-Series Display Mainframe

1. With an adjustment tool, adjust the VERTICAL POSN control to place the CRT trace on a horizontal graticule line near the CRT center.
2. Reduce the INTENSITY and set the SWEEP TIME/DIV control to MAN. Use the MAN SWEEP knob to center the CRT dot.

CAUTION

Leaving a dot on the CRT for prolonged periods at high intensity can burn the phosphor.

3. Adjust FOCUS and ASTIG controls for the smallest round dot possible.
4. Reset the SWEEP TIME/DIV control to AUTO and increase the INTENSITY for an optimum CRT trace. Adjust the HORIZONTAL POSITION control to center the CRT trace. If the horizontal deflection is not exactly 10 divisions, adjust the HORIZ GAIN control located on the rear panel of the spectrum analyzer plug-in.

NOTE

To adjust the HORIZ GAIN, you must switch the LINE power OFF, then remove the spectrum analyzer plug-in from the mainframe.

5. Adjust TRACE ALIGN so that the CRT trace is parallel to the horizontal graticule line.

3-31. Frequency and Amplitude Adjustments

1. Adjust VERTICAL POSN to align the CRT trace with the bottom graticule line.

2. Center the LO feedthrough (i.e., the "signal" at 0 MHz) on the CRT with the TUNING control.

3. Narrow the FREQ SPAN/DIV to 200 kHz. Adjust the REF LEVEL FINE control as necessary to position the signal peak near the top CRT graticule line.

4. Center the LO feedthrough again, if necessary, and adjust the FREQ ZERO to calibrate the FREQUENCY MHz readout at 00.0 MHz.

5. Set the FREQ SPAN/DIV control to 1 MHz and the REF LEVEL FINE control to 0. Adjust the TUNING control for a FREQUENCY MHz readout of approximately 250 MHz.

6. Press the 10 dB/DIV Amplitude Scale push button, and set the REFERENCE LEVEL control to −20 dBm (+30 dBmV for Option 002 instruments).

7. Connect the 250 MHz CAL OUTPUT to the spectrum analyzer input, and center the signal on the CRT with the TUNING control. The FREQUENCY MHz readout will indicate 250 MHz ±3 MHz.

8. Press the LIN Amplitude Scale push button. Adjust the REF LEVEL FINE control to place the signal peak at the top CRT graticule line.

9. Press the 10 dB/DIV Amplitude Scale push button. Adjust VERTICAL GAIN to place the signal peak at the top CRT graticule line.

10. Repeat steps 8 and 9 until the signal peak remains at the top CRT graticule line when the Amplitude Scale is alternated between 10 dB/DIV and LIN.

11. Set the REF LEVEL FINE control to 0, and the REFERENCE LEVEL control to −30 dBm (+20 dBmV for Option 002 instruments).

12. Press the LIN Amplitude Scale push button, and adjust REF LEVEL CAL to place the signal peak at the top CRT graticule line.

HP 853A SPECTRUM ANALYZER DISPLAY

REAR PANEL FEATURES

1 Line Power Receptacle: Three-conductor male receptacle for connecting ac power cable. Power plug retaining bracket, included with standard instrument, can be installed to prevent power cable disconnection when instrument is in transit. Power cable coils on special rear feet when not in use.

2 FUSE: Spring-loaded holder for cartridge-type primary power fuse.

3 SELECTOR (VOLTS): Adapts primary power transformer configuration to voltage of ac primary power source.

4 ADDRESS: Switch settings determine address of instrument to be used for communications via HP-IB. Address is set as sum of the switches, where A5 = 16, A4 = 8, A3 = 4, A2 = 2, and A1 = 1.

5 HORIZ (SWEEP) OUTPUT: BNC jack is a sweep output or sweep input, depending on the position of SWEEP switch on Interface Assembly A9. SWEEP switch on assembly A9 is factory set for sweep output (INT).

As a BNC output, HORIZ (SWEEP) OUTPUT provides horizontal sweep voltage from a 5K-ohm output impedance. The −5V to +5V output range corresponds to a full 10-division CRT horizontal deflection.

As a BNC input with a 20K-ohm input impedance, HORIZ (SWEEP) OUTPUT allows the CRT display to be swept by a −5V to +5V external horizontal sweep signal (approximately 30V/sec maximum sweep rate for digital display mode).

6 VERTICAL (VIDEO) OUTPUT: BNC output provides detected video signal from a 50-ohm output impedance. Typical 0 − 800 mV output range corresponds to full 8-division CRT vertical deflection.

7 BLANK (PENLIFT) OUTPUT: BNC output provides a +15V penlift/blanking signal from a 10K-ohm output impedance when CRT trace is blanked. Otherwise, output is low at 0V (low impedance, 150 mA max.) for an unblanked trace.

8 21.4 MHz IF OUTPUT: BNC output provides 21.4 MHz IF signal (linearly related to spectrum RF input) from a 50-ohm output impedance. Spectrum analyzer RESOLUTION BW controls the output bandwidth. Spectrum analyzer INPUT ATTEN, REFERENCE LEVEL FINE, and the first six REFERENCE LEVEL positions control the output amplitude. Output level is approximately −10 dBm into 50 ohms with a signal displayed at Reference Level.

9 HP-IB Connector: Hewlett-Packard Interface Bus connection allows remote instrument operation and direct digital plotting of CRT display.

FRONT PANEL FEATURES

10 TRACE A, B: Selects CRT display mode for each of two independent digital trace memories.

CLEAR WRITE: Continuously updates trace memory with current input signal data and displays trace memory contents on CRT.

MAXHOLD: Updates trace memory with maximum input signal data and displays trace memory contents on CRT.

STORE VIEW: Current trace memory contents are preserved and displayed on CRT.

STORE BLANK: Current trace memory contents are preserved without being displayed on CRT.

ANALOG DISPLAY: CRT display switches to conventional analog display of current input signal when both STORE BLANK push buttons are depressed.

11 DGTL AVG: Activates digital filtering algorithm that averages trace data over successive sweeps. Digital averaging should be restarted after any change in spectrum analyzer control settings.

12 INPUT − B→A: Subtracts contents of trace B memory point-by-point from current input signal data and stores result (normalized input signal data) in trace A memory. Reference line is factory-preset at center horizontal CRT graticule line; normalized trace appears at reference line when input signal data is identical to stored trace B. Reference line indicates 0 dB for relative amplitude measurements.

13 PLOT GRAT/HP-IB CLEAR: Initiates sequence of plotter commands over HP-IB to plot CRT graticule lines (and remotely-programmed annotation). Press push button again to abort active plot. HP-IB plotter must be set to listen-only mode.

To recover from illegal HP-IB commands (SYNTAX ERR) and to reset display state, press push button for at least 3 seconds to perform HP-IB CLEAR. Instrument returns to LOCAL and discontinues any HP-IB operation in progress.

Activate digital test routines by pressing PLOT GRAT push button while switching LINE power ON. Push button then selects desired test routine. Press both PLOT GRAT and PLOT TRACE push buttons to revert to normal display state.

14 PLOT TRACE: Initiates sequence of plotter commands over HP-IB to plot displayed CRT trace(s). Press push button again to abort active plot. HP-IB plotter must be set to listen-only mode.

15 LINE: AC line switch. Switches instrument primary power ON and OFF.

16 INTENSITY: Adjusts brightness of CRT trace(s) and annotation characters.

17 SCALE: Adjusts CRT background illumination. SCALE control is disabled in ANALOG DISPLAY mode.

18 Y POSN: Adjusts vertical position CRT trace. Use Y POSN with reference pattern in digital test routine #4 to align digital trace memory coordinates with corresponding CRT graticule lines.

19 X POSN: Adjusts horizontal position of CRT trace. Use X POSN with reference pattern in digital test routine #4 to align digital trace memory coordinates with corresponding CRT graticule lines.

20 TRACE ALIGN: Rotates trace about center of CRT.

21 FOCUS: Adjusts sharpness of CRT trace.

22 CRT Annotation: Indicates display control settings.

HP 8559A SPECTRUM ANALYZER PLUG-IN

23 FREQUENCY GHz: Displays spectrum analyzer center frequency.

24 FREQ CAL: Adjusts FREQUENCY GHz (**23**) readout for calibration on 35 MHz CAL OUTPUT signal.

25 TUNING: Adjusts spectrum analyzer start or center frequency. Coarse tuning is provided by large knob; smaller knob provides FINE tuning.

26 FREQUENCY BAND GHz (HP 8559A): Selects calibrated frequency band. Shifts FREQUENCY GHz (**23**) readout and adjusts CRT frequency and amplitude calibration for proper display of in-band signals.

27 ALT IF: Shifts first IF 15 MHz to eliminate baseline lift caused by input signals at approximately 3.0075 GHz.

28 SIG IDENT: Identifies correct FREQUENCY BAND GHz (**26**) for unknown signal. Shifts IF and lowers displayed signals on alternate spectrum analyzer sweeps. Correct response is 1 MHz shift to left.

29 VERTICAL POSN: Adjusts vertical position of CRT trace.

30 VERTICAL GAIN: Adjusts deflection circuit gain for amplitude scale calibration of CRT display.

31 BASELINE CLIPPER: Prevents CRT blooming in variable persistence, storage display mainframes (such as the HP 181T/TR) by blanking the lower portion of the CRT display. When it is operating in its digital display mode, the HP 853A Spectrum Analyzer Display does not respond to this control.

32 VIDEO FILTER: Post-detection low-pass filter smooths CRT trace by averaging random noise. The MAX (detent) position selects 1.5 Hz bandwidth for maximum noise averaging and noise level measurements. The VIDEO FILTER bandwidth is scaled by resolution bandwidth (**39**) setting. The MAX VIDEO FILTER should **not** be used for CW signal analysis.

33 SW
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34 SWI

35 INP
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36 SWI
swee

icates display control set-

VI ANALYZER PLUG-IN

Displays spectrum analyzer

FREQUENCY GHz (**23**)
on 35 MHz CAL OUTPUT

pectrum analyzer start or
tuning is provided by large
ides FINE tuning.

GHz (HP 8559A): Selects
ind. Shifts FREQUENCY
djusts CRT frequency and
r proper display of in-band

15 MHz to eliminate base-
t signals at approximately

es correct FREQUENCY
nown signal. Shifts IF and
on alternate spectrum ana-
sponse is 1 MHz shift to

djusts vertical position of

Adjusts deflection circuit
calibration of CRT display.

Prevents CRT blooming
torage display mainframes
R) by blanking the lower
ay. When it is operating in
, the HP 853A Spectrum
t respond to this control.

-detection low-pass filter
averaging random noise.
tion selects 1.5 Hz band-
e averaging and noise level
EO FILTER bandwidth is
idwidth (**39**) setting. The
hould **not** be used for CW

33 SWEEP Indicator: Remains lit during each sweep.

34 SWEEP TRIGGER: Selects sweep trigger mode.

VIDEO: Sweep triggered on internal post-detection video waveform. One-half major division of vertical deflection (noise, AM signal, etc.) is required to trigger sweep. VIDEO is normally used with 0 (zero) frequency span for time-domain analysis.

LINE: Sweep triggered at ac line frequency.

FREE RUN: End of each sweep triggers new sweep.

SINGLE: Single sweep triggered or reset by turning SWEEP TRIGGER clockwise momentarily.

35 INPUT 50Ω: Precision type N (female) or BNC (female) signal input connector with 50-ohm input impedance.
Options 001 and 002: INPUT 75Ω – 75-ohm BNC (female) signal input connector.

CAUTION

50-ohm BNC connectors might cause damage if used directly with Option 001 and 002 75-ohm BNC INPUT and CAL OUTPUT connectors.

36 SWEEP TIME/DIV: Selects time required to sweep one major horizontal division on CRT.

AUTO: Automatically selects fastest allowable sweep time as a function of FREQ SPAN/DIV (**38**), RESOLUTION BW (**39**), and VIDEO FILTER (**32**) settings to maintain display amplitude calibration. AUTO operation retained with FREQ SPAN/DIV and RESOLUTION BW controls uncoupled.

TIME/DIV: Selects calibrated sweep time. TIME/DIV is used primarily with 0 (Zero) frequency span for time-domain analysis of modulation waveforms. Display amplitude calibration not guaranteed for other frequency spans.

MAN: Enables manual frequency scan using MAN SWEEP knob.

37 REF LEVEL CAL: Adjusts spectrum analyzer RF gain to calibrate top CRT graticule line for absolute amplitude measurements.

38 FREQ SPAN/DIV: Selects CRT horizontal axis frequency calibration.

MHz/DIV
kHz/DIV: Selects desired frequency span. Alignment of OPTIMUM markings (> <) selects optimum resolution bandwidth (**39**).

0 (Zero Span): Spectrum analyzer operates as a manually-tuned receiver, at frequency indicated by FREQUENCY GHz or FREQUENCY MHz readout, for time-domain display of signal modulation.

F (Full Band): Spectrum analyzer sweeps entire selected frequency band. FREQUENCY GHz (**23**) readout corresponds to location of tuning marker displayed on CRT.

39 RESOLUTION BW: Selects spectrum analyzer 3-dB bandwidth. Alignment of OPTIMUM markings (> <) automatically selects optimum resolution bandwidth for any frequency span. When pushed in, RESOLUTION BW couples mechanically with FREQ SPAN/DIV (**38**).

40 CAL OUTPUT: BNC (female) output provides calibration signal from 50-ohm output impedance.
Options 001 and 002: 75-ohm output impedance.

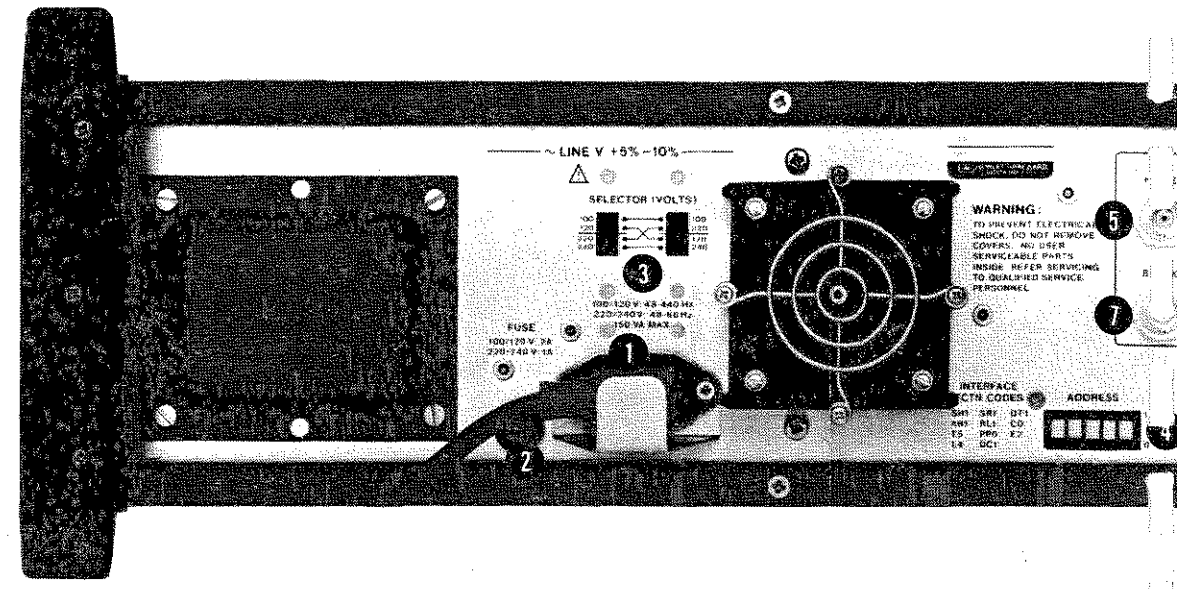
CAUTION

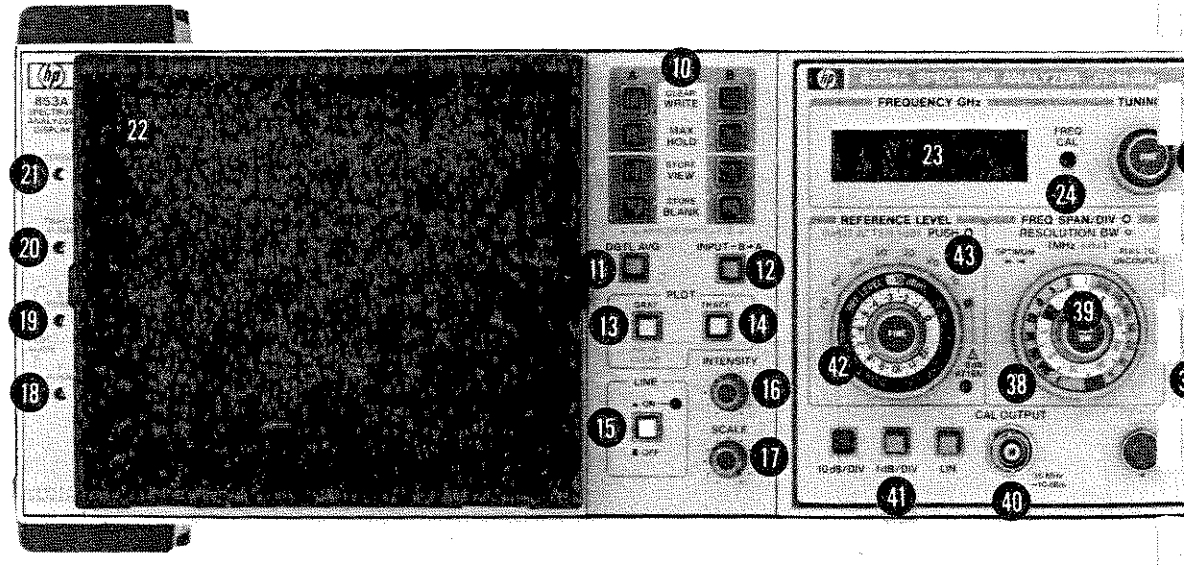
50-ohm BNC connectors might cause damage if used directly with Option 001 and 002 75-ohm BNC INPUT and CAL OUTPUT connectors.

41 10 dB/DIV – 1 dB/DIV – LIN (Amplitude Scale): Selects CRT vertical axis amplitude calibration (logarithmic or linear scale). Reference Level remains constant at top CRT graticule line.

42 REFERENCE LEVEL: Adjusts power level (in dBm or dBmV) represented by top CRT graticule line. Large outer knob adjusts REFERENCE LEVEL in calibrated 10-dB steps; FINE vernier provides 12 dB of continuous adjustment.

43 INPUT ATTEN: Selects desired RF input attenuation, indicated by blue numbers (push and turn).





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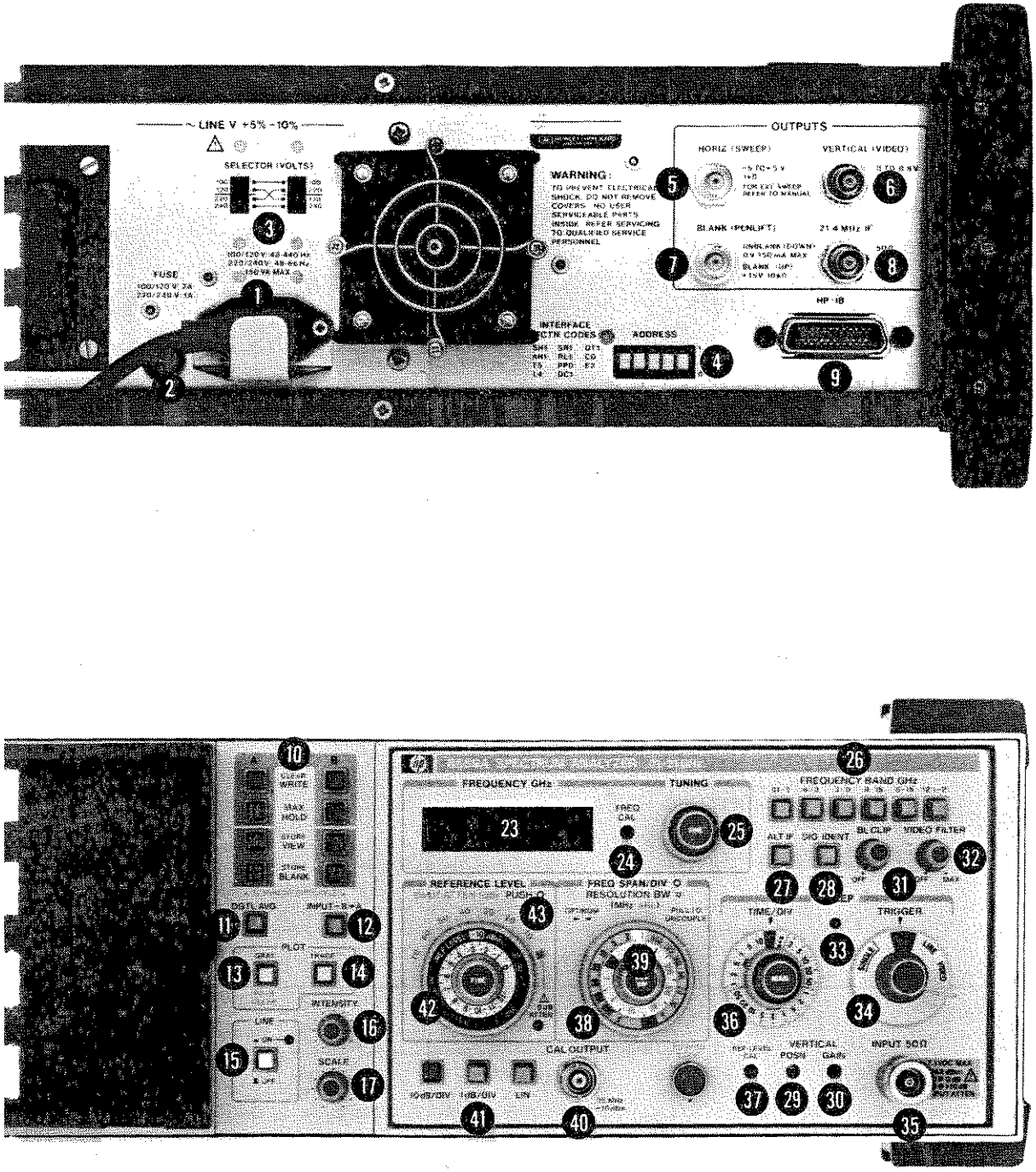

FIGURE 3-1. HP 8559A/853A CONTROLS, CONNECTORS, AND INDICATORS