AUTOMATED AN/FRM-19(V) TEST SYSTEM OPERATION AND MAINTENANCE MANUAL

Version 3

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AUTOMATED AN/FRM-19(V) TEST SYSTEM
OPERATION AND MAINTENANCE MANUAL

I. GENERAL INFORMATION

A. PURPOSE

This manual provides information and instructions on the operation of the AUTOMATED AN/FRM-19(V) Test System. It will explain the test set-up (using the HP 8407A/8412A or the HP 3577A Network Analyzer) and procedures in order to run the various automated tests which include the Automated Antenna and Multicoupler Tests, Automated Beamformer Test, and Automated Noise Measurement System (ANMS). It will also provide the necessary procedures to follow when interpreting the test results and corrective measures if any problems are detected.

B. INTRODUCTION

The AUTOMATED AN/FRM-19(V) Test System automatically measures the uniformity of the Circular Disposed Antenna Array (CDAA) system components: the antennas/transmission lines (Antenna Test), primary multicouplers (Coupler Test), and beamformers (Beamformer Test). An additional test, the ANMS, will allow the site to measure their baseline noise/strong signal level on a periodic basis. A block diagram of the AUTOMATED AN/FRM-19(V) Test System using the HP 8407A/8412A and the HP 3577A Network Analyzer is shown in Figures 1 and 6, respectively.

The AN/FRM-19(V) Antenna and Coupler Tests, as described in the Technical Manual for Antenna System Test Set AN/FRM-19(V), Naval Electronic Systems Command, can still be done manually. The manual method is a Continuous Wave (CW) test and can be very time-consuming to set-up and calibrate, acquire and record data, and then analyze the test results. On the other hand, the AUTOMATED AN/FRM-19(V) Test System can be easily set-up and calibrated (in less than 30 minutes) to automatically begin acquiring and analyzing test data. Once calibrated, the automated system will run continuously and begin testing the antennas, primary multicouplers, and beamformers at a specified start-up time without operator intervention. The antenna and multicoupler tests measure the amplitude and phase responses of one element and compare them to the response of another element across the full operating frequency band. The beamformer test is only an amplitude response comparison between elements that form a beam.

The automated test eliminates the tedious job of manually indexing from one element to the next and the possibility of error introduced in acquiring and recording test data. The AUTOMATED AN/FRM-19(V) Test System will therefore perform the required checks of the antennas and multicouplers as specified in the Maintenance Requirement Cards.

C. SOFTWARE DESCRIPTION

The AUTOMATED AN/FRM-19(V) Test System has two Automated Antenna and Multicoupler Tests. In order to distinguish between the two, we will refer to the tests as: (1) the Daily Automated Antenna and Multicoupler Test and

(2) the Detailed Automated Antenna and Multicoupler Test. Once the system has been calibrated, the Daily Automated Antenna and Multicoupler Test will run without operator intervention. This test acquires and analyzes test data at 5 to 14 predetermined test frequencies. The test results are a list of possible antennas and multicouplers with problems. The Detailed Automated Antenna and Multicoupler Test will acquire and analyze test data at 200 frequencies. This test is optional and can be selected by pressing a Special Function Key (SFK "f10"). This test will run for approximately 2 hours, therefore the station may decide to run this test once a week or once a month.

The Automated Beamformer Test will test all elements that form the lowband/highband monitor, omni, goniometer, and SPECOMM beams. This test will follow the Daily Automated Antenna and Multicoupler Test each day.

The Automated Noise Measurement System acquires data every two hours at seven frequencies over a period of seven days. This data is then averaged over the seven day period and a baseline noise/strong signal level can be found. This is an optional test which is selected by pressing SFK "f11". Since this test runs for a week, the station may decide to run this test monthly or quarterly.

D. TEST SET-UP

Cable connections necessary to set-up the AUTOMATED AN/FRM-19(V) Test System using the HP 8407A/8412A Network Analyzer are shown in Figures 1 to 5 and Table 1. Cable connections necessary to set-up the AUTOMATED AN/FRM-19(V) Test System using the HP 3577A Network Analyzer are shown in Figures 5 to 7 and Table 2. Figures 8 and 9 are sample printouts of the Daily Automated Antenna and Multicoupler and Automated Beamformer Test results. A hardware description of the AUTOMATED AN/FRM-19(V) Test System is contained in Appendix A. A detailed description of the various test equipment controls and connections is provided in Appendix B.

E. OPERATING PROCEDURES

Test procedures to boot and run the AUTOMATED AN/FRM-19(V) Test System are provided in Table 3. Once the system is set-up and booted, prompts are displayed on the HP 9825T Desktop Calculator to lead the operator through each module. The automated antenna and coupler tests and the automated beamformer test use the same calibration and parameter modules, therefore they may be run any time after running the calibration module. The ANMS requires a separate calibration module from the other three automated tests. The ANMS calibration module is activated when you press the SFK "f11" for the ANMS Test.

F. REPORTING SYSTEM PROBLEMS

Procedures for reporting system errors or any equipment faults are provided in Appendix C. If possible, problems will be solved over the telephone or through correspondence. However, if these attempts are not successful, other action will be taken. Refer to the Operational Logistic Support Summary for the AUTOMATED AN/FRM-19(V) Test System, Naval Electronics Systems Command, July 1984, for more details.

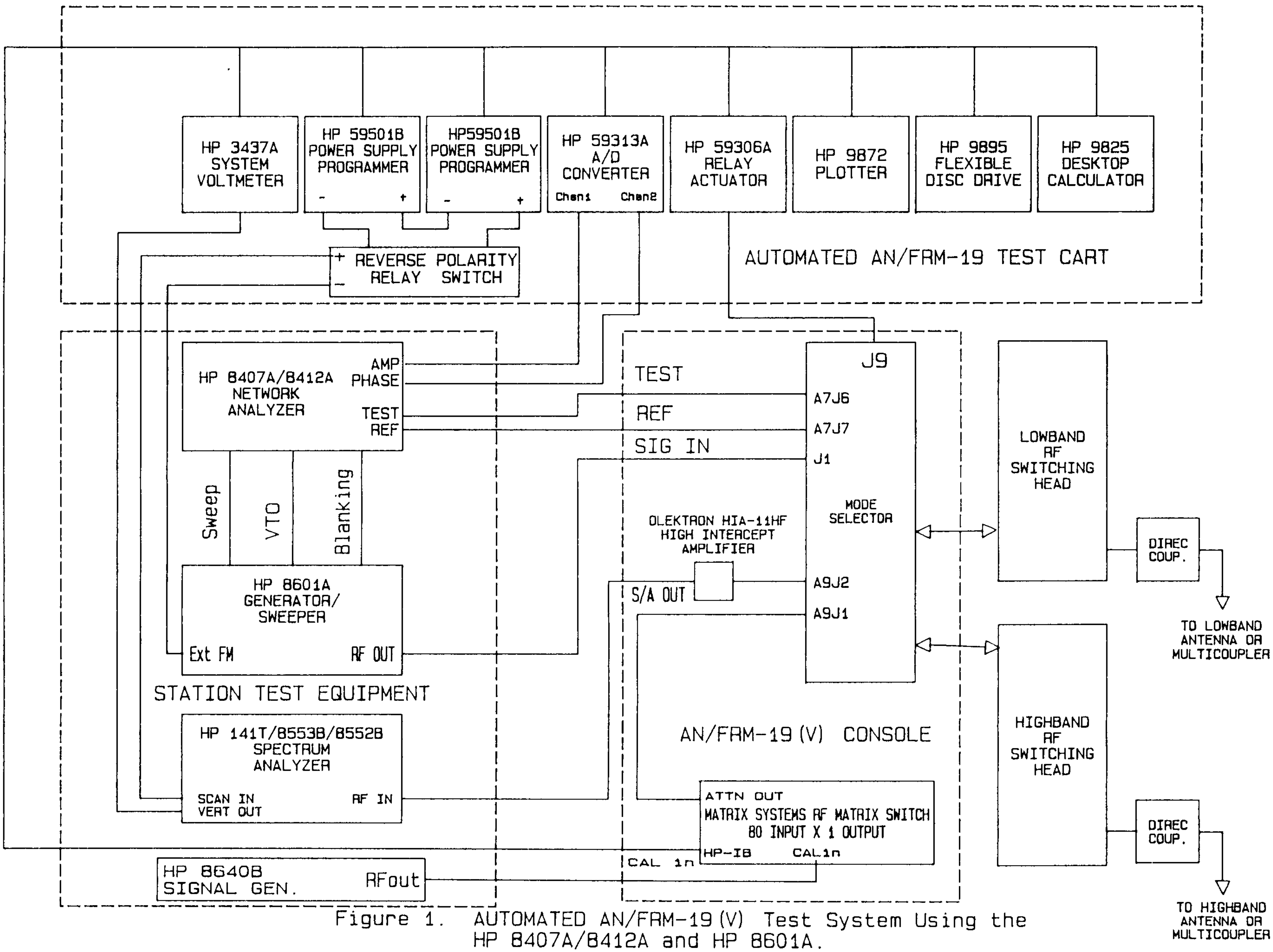


Figure 1. AUTOMATED AN/FRM-19 (V) Test System Using the HP 8407A/8412A and HP 8601A.

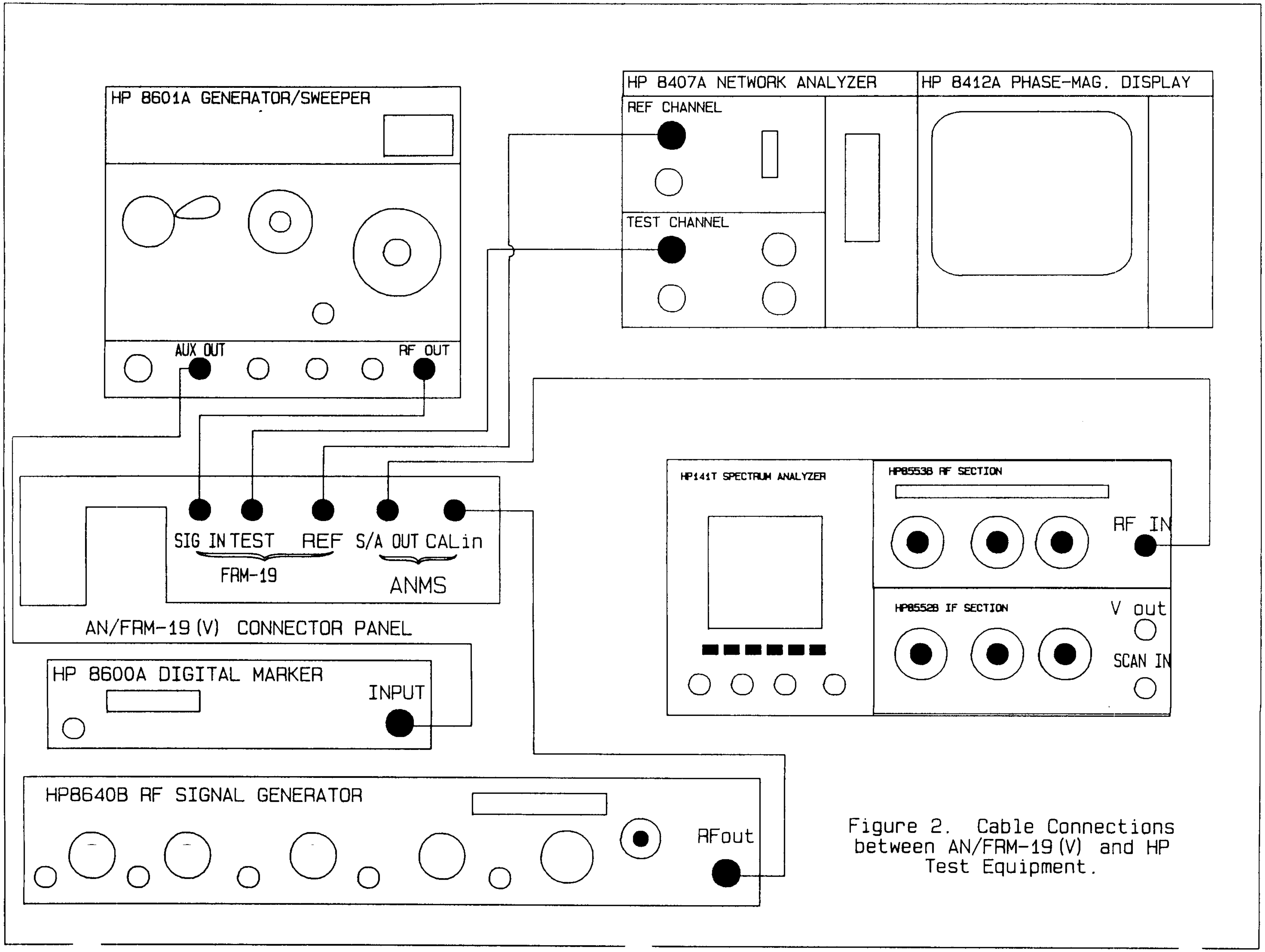


Figure 2. Cable Connections between AN/FRM-19 (V) and HP Test Equipment.

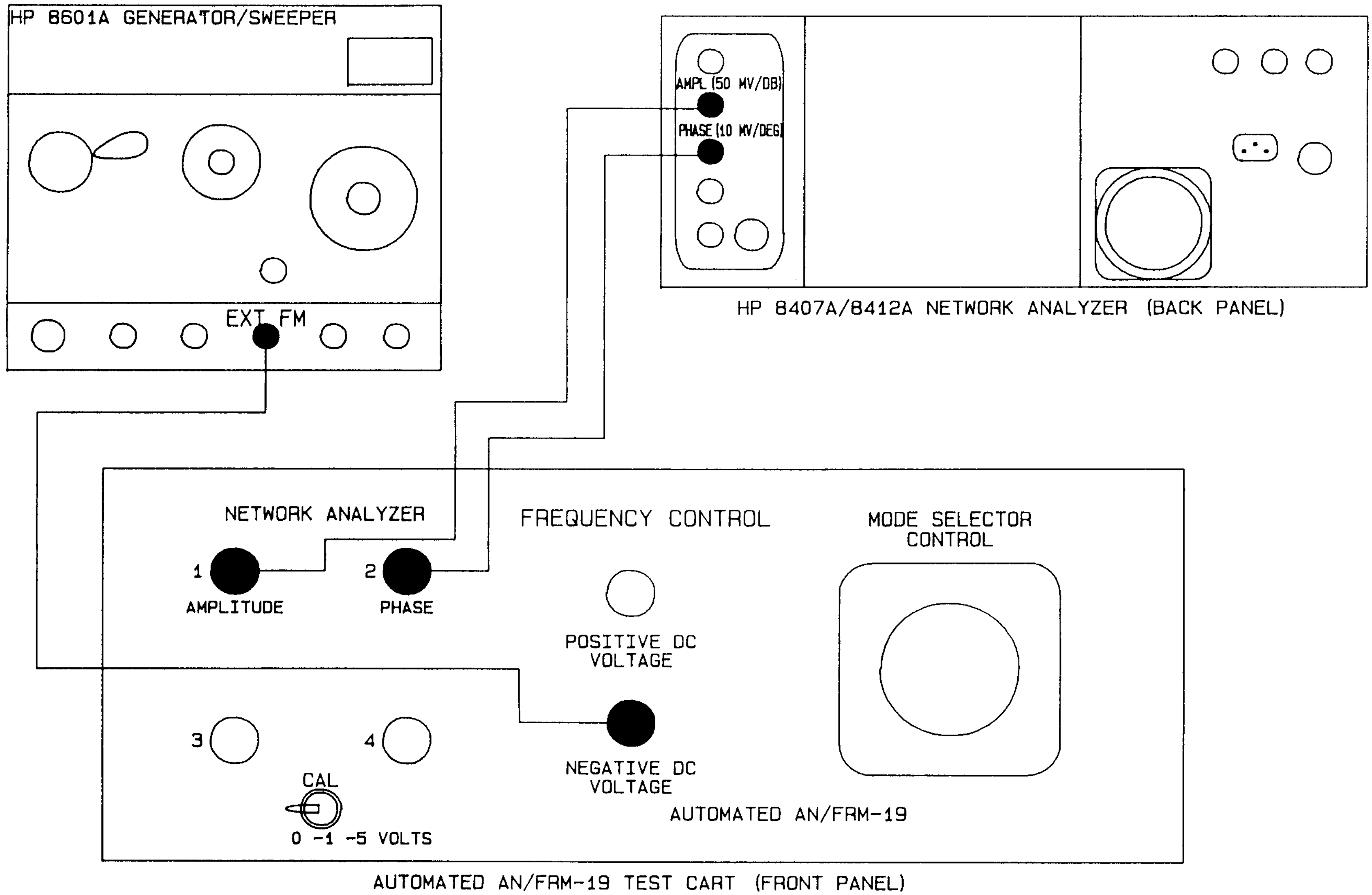


Figure 3. Cable Connections for HP 8601A, HP 8407A/8412A and AUTOMATED AN/FRM-19 Test Cart.

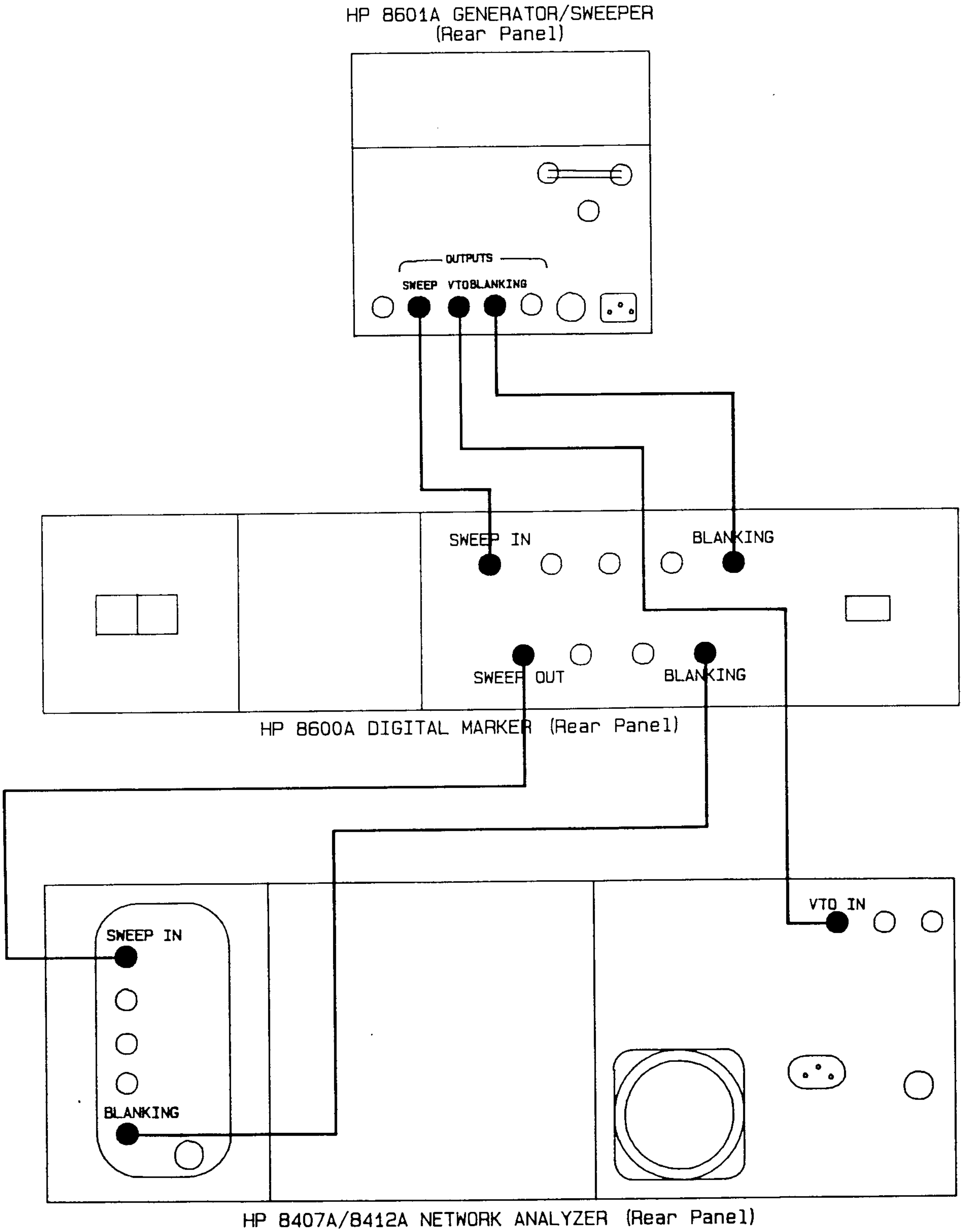
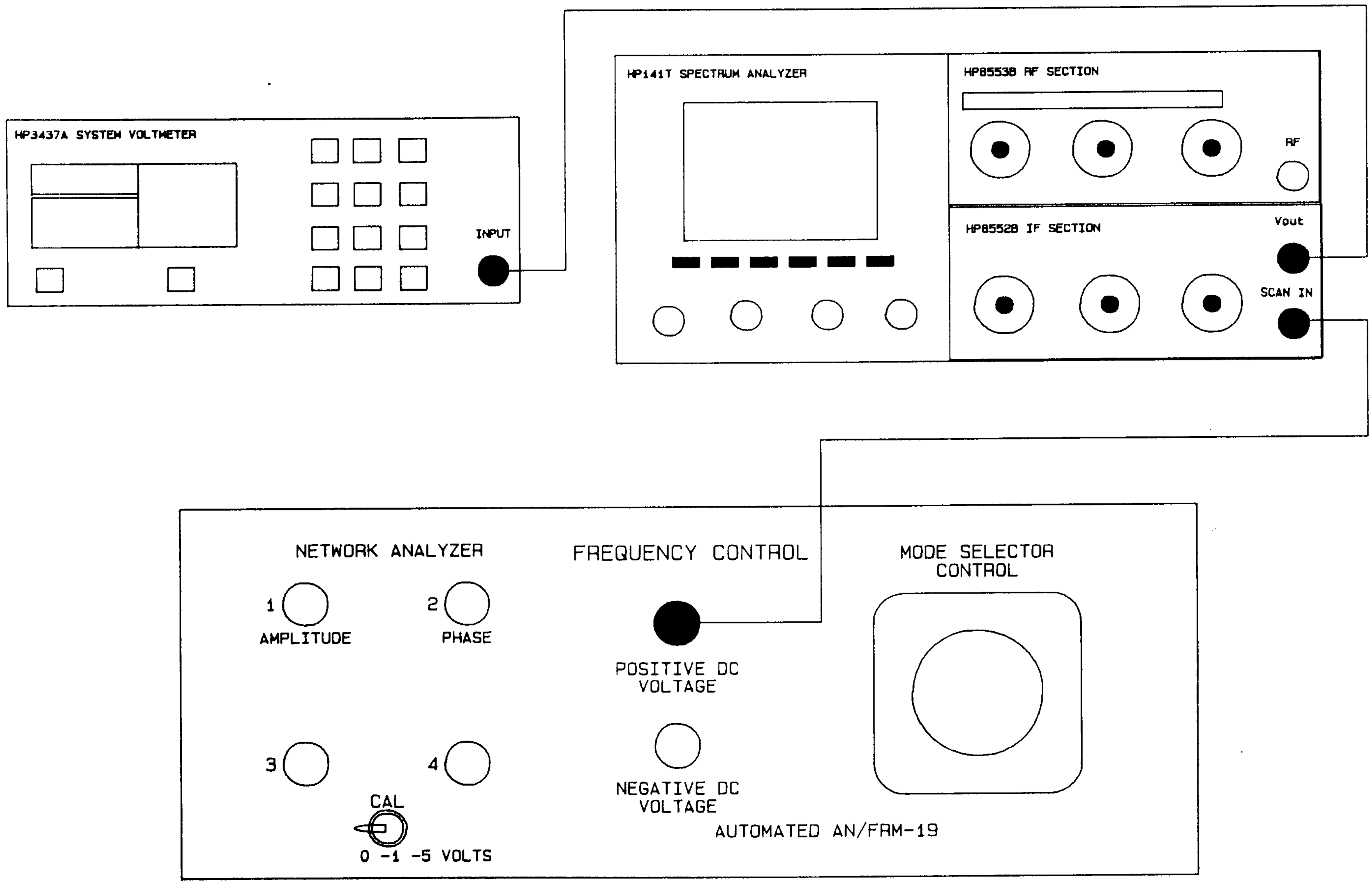


Figure 4. Cable Connections for HP 8601A, 8600A, and 8407A/8412A.



AUTOMATED AN/FRM-19 TEST CART (FRONT PANEL)

Figure 5. Cable Connections for HP 141T, HP 3437A, and Test Equipment Panel of the AUTOMATED AN/FRM-19(V) Test Cart.

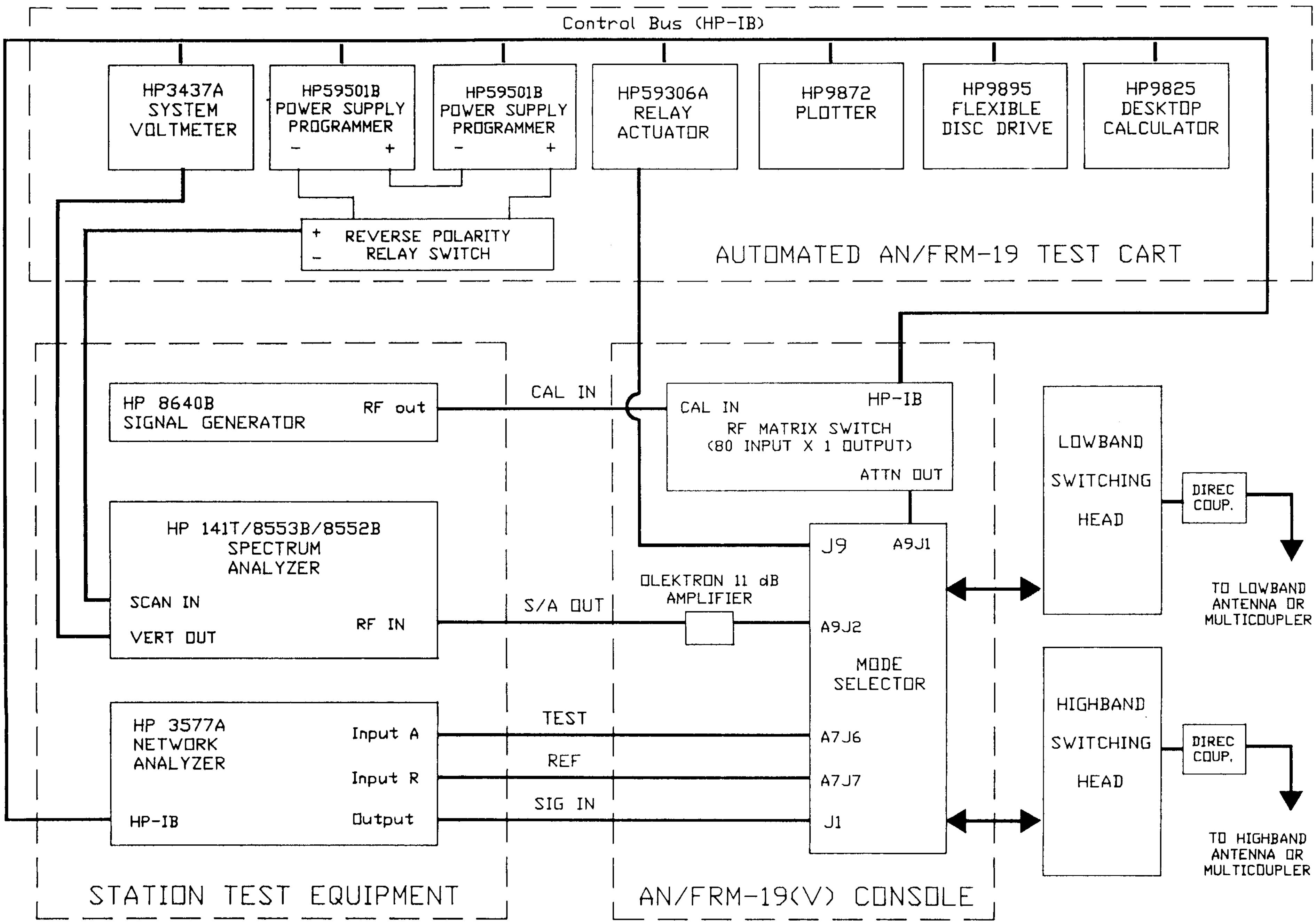


Figure 6. AUTOMATED AN/FF 19(V) Test System Using the HP 3577A.

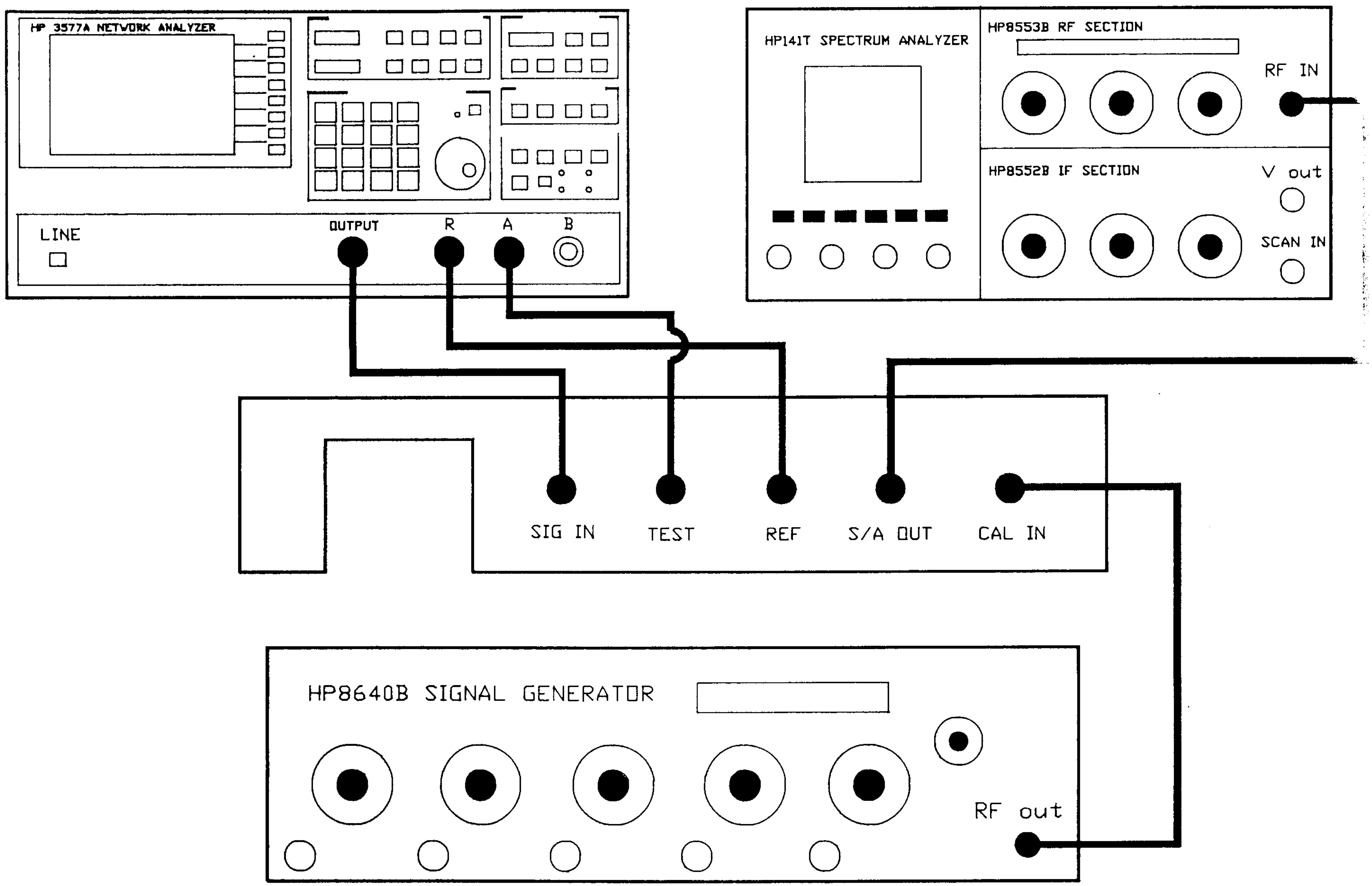
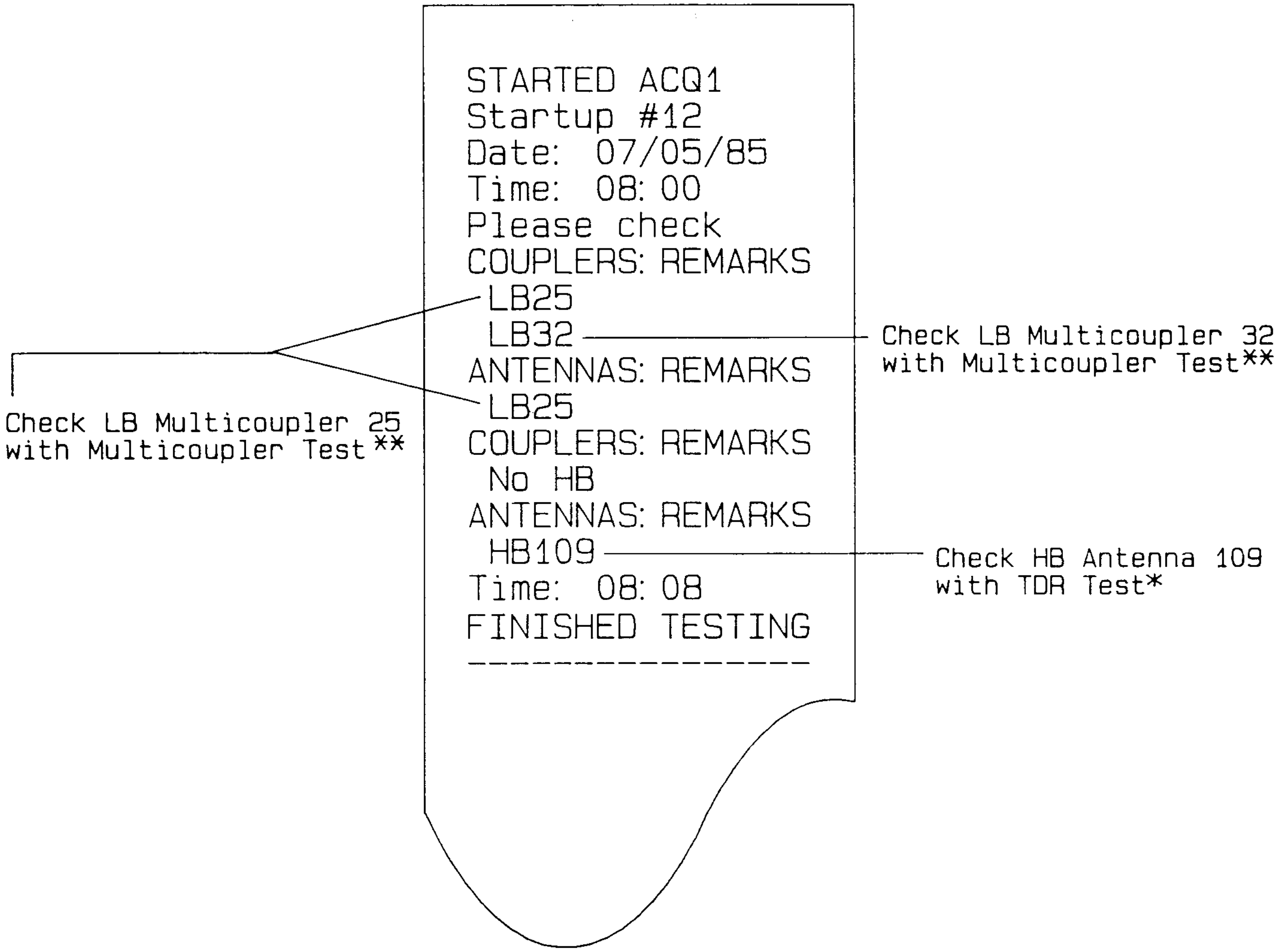


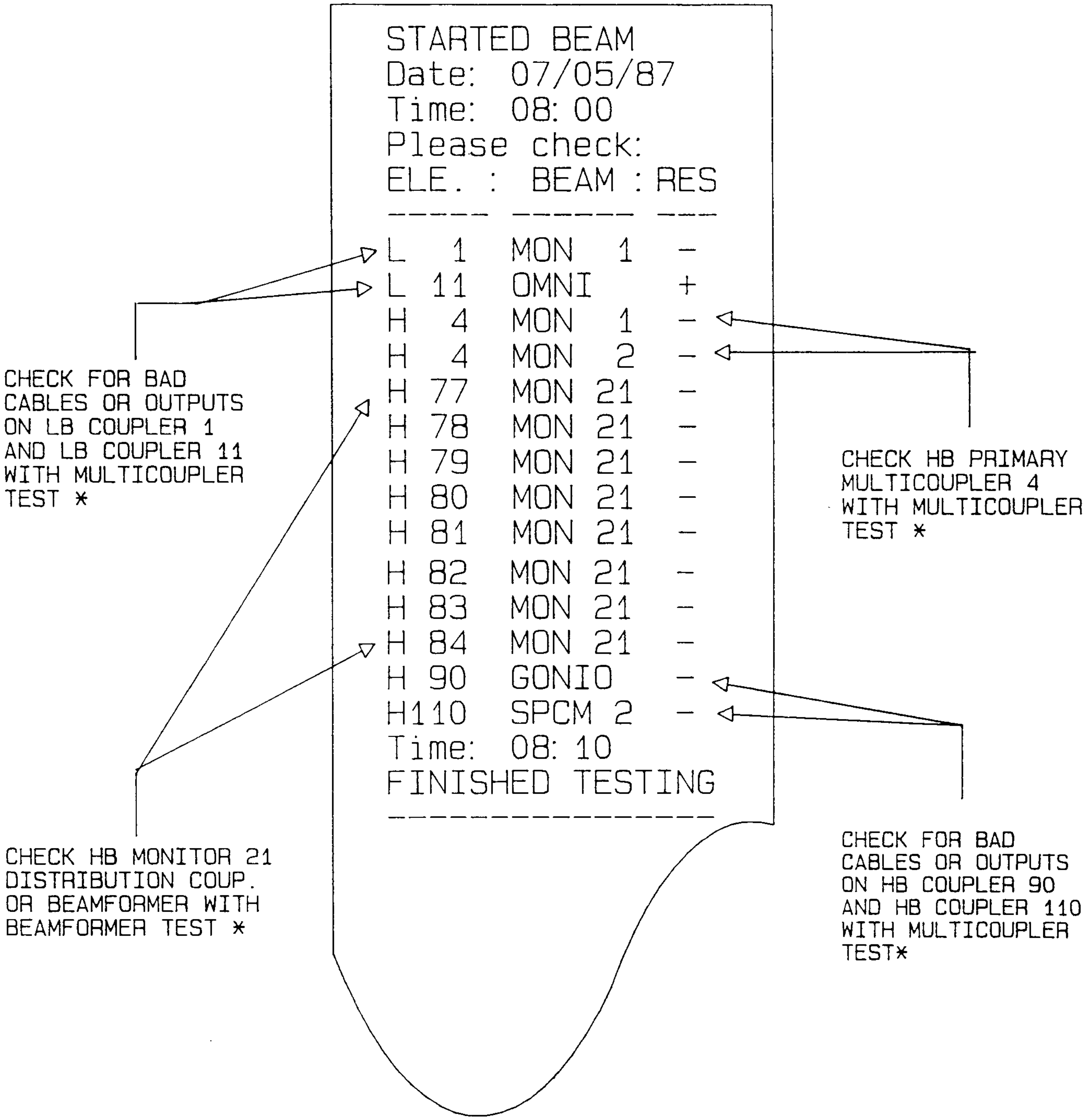
Figure 7. Cable Connections between AN/FRM-19(V) and HP Test Equipment.



* Refer to "Time Domain Reflectometer Training Manual", NEEACT PAC, July 1984.

** Refer to "Comprehensive Training Manual on CDAA Electronic Maintenance (FRD-10)", NEEACT PAC, February 1985.

Figure 8. Interpretation of HP 9825 Daily Antenna and Multicoupler Test Result Printout.



*Refer to "Comprehensive Training Manual on CDAA Electronic Maintenance (FRD-10)", NEEACT PAC, February 1985.

Figure 9. Interpetation of HP 9825 Automated Beamformer Test Result Printout.

Table 1. AUTOMATED AN/FRM-19(V) Cable Connections
Using the HP 8407A/8412A Network Analyzer

		Front/Rear	Cable
HP 8407A/8412A Network Analyzer (Figure 4)		Front/Rear	Cable
(Rear Panel)	Connected To	Panel	Type
VTO IN	HP 8601A VTO OUTPUT	Rear	RG-58/223
SWEEP IN	HP 8600A SWEEP OUTPUT	Rear	RG-58/223
BLANKING	HP 8600A BLANKING OUTPUT	Rear	RG-58/223
HP 8601A Generator/Sweeper (Figure 4)		Front/Rear	Cable
(Rear Panel)	Connected To	Panel	Type
SWEEP OUTPUT	HP 8600A SWEEP IN	Rear	RG-58/223
BLANKING OUTPUT	HP 8600A BLANKING IN	Rear	RG-58/223
HP 8407A/8412A Network Analyzer (Figure 2)		Front/Rear	Cable
(Front Panel)	Connected To	Panel	Type
TEST CHANNEL	AN/FRM-19 CONN. PNL TEST	Front	RG-59/307*
REF CHANNEL	AN/FRM-19 CONN. PNL REF	Front	RG-59/307*
HP 8601A Generator/Sweeper (Figure 2)		Front/Rear	Cable
(Front Panel)	Connected To	Panel	Type
RF OUT	AN/FRM-19 CONN. PNL SIG IN	Front	RG-58/223
AUX OUT	HP 8600A INPUT	Front	RG-58/223
AUTOMATED AN/FRM-19(V) Test Cart (Figure 3, 5)		Front/Rear	Cable
(Front Panel)	Connected To	Panel	Type
CHANNEL 1	HP 8412A AMP (50 MV/DB)	Rear	RG-58/223
CHANNEL 2	HP 8412A PHASE (10MV/DEG)	Rear	RG-58/223
NEG. DC VOLT.	HP 8601A EXT. FM	Front	RG-58/223
POS. DC VOLT.	HP 141T/8552B SCAN IN	Front	RG-58/223
MODE SEL.CNTRL	AN/FRM-19 MODE SEL. J9	Rear	W1
HP 3437A SYSTEM VOLTMETER (Figure 5)		Front/Rear	Cable
(Front Panel)	Connected To	Panel	Type
INPUT	HP 141T/8552B VERT. OUT	Front	RG-58/223
HP 141T/8553B SPECTRUM ANALYZER (Figure 2)		Front/Rear	Cable
(Front Panel)	Connected To	Panel	Type
RF IN	AN/FRM-19 CONN. PANEL S/A OUT	Front	RG-223
HP 8640A RF SIGNAL GENERATOR (Figure 2)		Front/Rear	Cable
(Front Panel)	Connected To	Panel	Type
RF OUT	AN/FRM-19 CONN. PNL CAL IN.	Front	RG-58/223
MODEL 4027B 80x1 RF MATRIX SWITCH		Front/Rear	Cable
(Rear Panel)	Connected To	Panel	Type
HP-IB	HP 9872 or 7475 PLOTTER	Rear	HP-IB (HP 10833C)

* Cables should be amplitude and phase matched. 50/75 ohm impedance adapters required if HP 8407A/8412A Network Analyzer does not have 75 ohm inputs (option 008).

Table 2. AUTOMATED AN/FRM-19(V) Cable Connections
Using the HP 3577A Network Analyzer

HP 3577A Network Analyzer (Figure 7) (Front Panel)	Connected To	Front/Rear Panel	Cable Type
OUTPUT	AN/FRM-19 CONN. PNL SIG IN	Front	RG-58/223
INPUT A	AN/FRM-19 CONN. PNL TEST	Front	RG-58/223
INPUT R	AN/FRM-19 CONN. PNL REF	Front	RG-58/223

AUTOMATED AN/FRM-19(V) Test Cart (Figure 5) (Front Panel)	Connected To	Front/Rear Panel	Cable Type
POS. DC VOLT.	HP 141T/8552B SCAN IN	Front	RG-58/223
MODE SEL.CNTRL	AN/FRM-19 MODE SEL. J9	Rear	W1

HP 3437 SYSTEM VOLTMETER (Figure 5) (Front Panel)	Connected To	Front/Rear Panel	Cable Type
INPUT	HP 141T/8552B VERT. OUT	Front	RG-58/223

HP 141T/8553B SPECTRUM ANALYZER (Figure 7) (Front Panel)	Connected To	Front/Rear Panel	Cable Type
RF IN	AN/FRM-19 CONN. PNL S/A OUT	Front	RG-223

HP 8640B RF SIGNAL GENERATOR (Figure 7) (Front Panel)	Connected To	Front/Rear Panel	Cable Type
RF OUT	AN/FRM-19 CONN. PNL CAL IN	Front	RG-58/223

MODEL 4027B 80x1 RF MATRIX SWITCH (Rear Panel)	Connected To	Front/Rear Panel	Cable Type
HP-IB	HP 9872 or 7475 PLOTTER	Rear	HP-IB

HP 3577A NETWORK ANALYZER (Rear Panel)	Connected To	Front/Rear Panel	Cable Type
HP-IB	HP 9872 or 7475 PLOTTER	Rear	HP-IB

Table 3. Operating Procedure

OPERATION	PROCEDURE
1) To Boot the system	a. Insert PROGRAM disc into drive 0 of HP 9895 b. Insert FRM(Data) disc into drive 1 of HP 9895 c. Turn off HP 9825 Calculator d. Insert AUTOSTART Tape cartridge into HP 9825 e. Turn on the HP 9825 Calculator f. Wait for "Press "f6" to begin AUTOFRM-19" prompt g. Press special function key "f6"
2) To Calibrate AUTO FRM-19 system	a. Follow Operation Mode (1) or Press special function key "f0"
3) To change AUTO FRM-19 start time	a. Press special function key "f1"
4) To run Daily Ant. & Multicoupler Test	a. Press special function key "f2" (provided the system has been calibrated)
5) To Plot the test results	a. Press special function key "f3" b. Choose the plot option desired
6) To run Automated Beamformer	a. Press special function key "f4" (provided the system has been calibrated)
7) For an explanation of modules	a. Press special function key "f5"
8) a) To format a FRM data disc	a. Press special function key "f7"
b) To format a ANMS data disc.	a. Place a blank disc into drive 1 of HP 9895 (make sure the disc has a write protect tab over the notch) b. Type in "init 1,707" on the HP 9825 and press the {EXECUTE} key c. Then press special function key "f11"
9) To change the FRM test parameters	a. Press special function key "f8"
10) To checkout the test equipment	a. Press special function key "f9"
11) To run the Detailed Ant. and Multi. Analysis Test	a. Press special function key "f10" (provided that the system has been calibrated)
12) To run the ANMS	a. Press special function key "f11"

Note: Press {STOP} key before pressing the special function keys.

II. AUTOMATED AN/FRM-19(V) Daily Tests

The AUTOMATED AN/FRM-19(V) Daily Tests consist of the Daily Automated Antenna and Multicoupler Test and the Automated Beamformer Test. Once the system has been calibrated, both tests are designed to run each day with the antenna and coupler tests running first and the beamformer test to follow. These tests require minimal operator assistance.

A. Daily Automated Antenna and Multicoupler Test

1. Software Description

The Daily Automated Antenna and Multicoupler Test utilizes eight separate program modules in which each module has a specific function. These eight modules are AUTOST, CAL, TIME, ACQ1, PLOT, FORMAT, PARM, and MAINT.

a. AUTOST Module

The AUTOMATED AN/FRM-19(V) Test System is booted up by loading and running the Autostart (AUTOST) Module. The system flow diagram is provided in Figures 10 through 13. By pressing Special Function Key (SFK) "f6", this module sets up the special function keys to the configuration shown in Figure 14. The system will then be linked to the CAL module for test set-up procedures.

> SPECIAL NOTE: A second function of the AUTOST Module is to restart the AUTOMATED AN/FRM-19(V) after a power failure. If the power went out in any Daily Test Module (CAL, TIME, MAINT, PARM, FORMAT, BEAM, ACQ1, and PLOT), the system will automatically link back to ACQ1 module and begin testing at the preset start time after a wait of fifteen minutes which allows for equipment warm-up. If the power went out in the Detailed Automated Antenna and Multicoupler Test modules (ACQ2, ANLY2, and TBL2), it will link back to ACQ1 and the test data will be aborted. If the Automated Noise Measurement System modules were running before the power outage, then AUTOST will link back to the ANMS until it has been completed.

b. CAL Module

This module automatically indexes the AN/FRM-19(V) Mode Selector to the first element under test. If using the HP 8407A/8412A Network Analyzer, this module will prompt the operator to calibrate the HP 8407A/8412A and tune the HP 8601A Generator/Sweeper to the test frequency band of 2.5 to 32 MHz. If using the HP 3577A Network Analyzer, this module will automatically set-up and calibrate the HP 3577A.

The first phase of calibration prompts the operator to enter the element number displayed on the AN/FRM-19(V) Mode Selector display. This will synchronize the computer with the current position of the AN/FRM-19(V) RF switching head. Once synchronized, the system can automatically index the Mode Selector to the first test element.

When using the HP 8407A/8412A Network Analyzer, the second phase of calibration scales the Network Analyzer CRT amplitude and phase displays. The third phase tunes the HP 8601A Generator/Sweeper to the frequency band of interest. Tables 4 and 5 show the equipment control settings for the second and third phases, respectively. The calibration data is then stored on disc.

SPECIAL NOTE: Although the system records calibration settings, both the HP 8407A/8412A Network Analyzer and the HP 8601A Generator/Sweeper should not be manually readjusted after calibration because these units are not fully programmable. The CAL Module needs to be run again if the HP 8407A/8412A, HP 8601A, or the AN/FRM-19(V) Mode Selector settings are changed.

When using the HP 3577A Network Analyzer, the second phase of the calibration sets up the HP 3577A screen display format, test frequency band, and the test signal source. Also, both the amplitude and phase traces are normalized to calibrate out the effects of measurement hardware imperfections (i.e. cable length differences).

SPECIAL NOTE: Unlike the HP 8407A/8412A Network Analyzer, the HP 3577A is fully programmable. Therefore, as soon as the system is booted up, the HP 3577A is programmed to remote mode to secure the system from operator interference. After boot-up, the settings cannot be manually adjusted unless the "LCL" key on the HP 3577A is pressed.

c. TIME Module

After calibrating the test equipment, this module will allow the operator to specify the daily start-up time for the Daily Automated Antenna and Multicoupler Test. When the start-up time is set, the test system will automatically begin testing once a day at that specified time.

d. ACQ1

Once the operator has calibrated the test equipment (CAL Module) and set the test start-up time (TIME Module), the system will begin running the daily antenna and multicoupler tests. This module conducts four tests: (1) lowband multicoupler, (2) lowband antenna, (3) highband multicoupler, and (4) highband antenna tests. The amplitude and phase responses of each antenna and coupler are tested at 5 to 14 predetermined frequencies. Figure 15 shows the test configuration for the AN/FRM-19(V) antenna and coupler modes that are computer controlled via the relays internal to the AN/FRM-19(V) Mode Selector. Once the antenna and coupler test data is acquired, it is analyzed internally by the HP 9825T Desktop Calculator as shown in Figures 16 and 17, respectively.

SPECIAL NOTE: By pressing special function key "f2" the operator can run the Daily Automated Antenna and Multicoupler Test (ACQ3) without waiting for the specified start time.

e. PLOT Module

This module will print a plot selection menu. The first plot option, FRM(DAILY), is used in conjunction with the Daily Automated Antenna and Multicoupler Test and will plot a bar chart with each bar representing the percentage of tests in which an element was out of tolerance. Figure 18 shows a sample plot of the test results. When a plot is completed, the accumulated test results can be either cleared or saved. The second and third plotting options pertain to the optional AUTOMATED AN/FRM-19(V) tests and are discussed later in their respective sections.

f. FORMAT Module

This module formats blank flexible (floppy) data discs to store test parameters and test data for the antenna, multicoupler, and beamformer tests. Formatting of the discs are seldomly done, that is, this module will only be used if the files on the Test Data Disc (in drive 1) are destroyed.

> SPECIAL NOTE: To create a back-up disc, place the SOURCE Disc in drive 0 and the BLANK initialized disc in drive 1. Press {RESET} key, type in {copy 0,707,"to",1,707}, and then press the {EXECUTE} key on the Calculator.

g. PARM Module

This module allows the operator to specify the parameters which defines the operator's test plan. These parameters are usually set during initial checkout of the installation and should be changed only if problems occur. The first phase allows the operator to change the lowband and highband test frequencies used in the Daily Tests. The test frequencies can be varied from station to station. The number of test frequencies can vary from 5 to 14. The operator can also select the number of samples to be taken for each test frequency. By taking multiple samples, the system can distinguish between on-the-air signals and an actual test response. Then the operator can change the antenna and coupler test specifications used in the Daily and Detailed Tests. The test specifications that can be changed are the antenna and coupler amplitude and phase tolerances and the lowband and highband reference couplers. The operator also has the option to change the Beamformer Test frequencies and/or specifications.

h. MAINT Module

This module checks to see that the AUTOMATED AN/FRM-19(V) test equipment are properly calibrated and in working condition. The MAINT module allows the operator to check the following equipment:

1) HP 59306A Relay Actuator
2) HP 59313A A/D Converter
3) HP 59501B D/A Converters
4) AN/FRM-19(V) Mode Selector
5) HP 8407A/8412A Network Analyzer and HP 8601A Generator/Sweeper

or HP 3577A Network Analyzer
6) HP 3437A System Voltmeter
7) HP 98035A Real Time Clock
8) HP 9895A Disc Drive
9) HP 9872C or HP 7475A Plotter
10) Model 4027B 80 Input x 1 Output RF Matrix Switch

2. Interpretation of Test Results

After the Daily Automated Antenna and Multicoupler Test is completed, the test results are printed out on the HP 9825T internal printer. A sample is shown in Figure 8. The following are the steps to follow when interpreting the test results.

a. Antenna Element N Fails Antenna Test

1) Because the Antenna Test signal returns through the primary multicoupler, a bad primary multicoupler will cause a bad Antenna Test result measurement. Did Primary Multicoupler Number N fail the Coupler Test?

Yes - Problem is probably not Antenna Element N. Check Primary Multicoupler N. See Step b below.
No - Continue

2) Check to see if the signal path from the antenna to the multicoupler is in good condition. Ensure that Antenna Element N's RG-12 transmission line is connected to the directional coupler and the directional coupler is connected to the primary multicoupler input. Ensure that all cables and connectors are in good condition. Has a problem been found?

Yes - Correct problem.
No - Continue

3) Perform TDR measurement of Antenna Element N using Tek 1502 or HP 1415 TDR and a X-Y recorder following the procedure in the Time Domain Reflectometer Training Manual, NEEACT PAC, July 1984. Compare TDR measurement with a measurement of a known good element and with a past measurement of the same antenna element. Does TDR measurement indicate a problem?

Yes - Note problem for correction by antenna mechanic.
No - Continue

4) Check AN/FRM-19(V) test cable connections. Ensure that the test cable from the AN/FRM-19(V) to the directional coupler (J3) and the test cable from the primary multicoupler (typically J4 for highband and J8 for lowband) to the AN/FRM-19(V) are both in good condition and properly connected . Has a problem been found?

Yes - Correct problem
No - Continue

5) On-the-air signals can interfere with the test signal and cause an antenna element to fail the test. If the test fails repeatedly from a direction with known high on-the-air signal levels, then either change the test starting time to about one hour after sunrise or raise the test tolerance about 0.5 db. Finally, if there is still signal interference, change the test frequency(s).

b. Primary Multicoupler N Fails Coupler Test

1) Check the AN/FRM-19(V) test cable connections. Ensure that the cable from the AN/FRM-19(V) to the directional coupler (J2) and the test cable from the primary multicoupler output (typically J4 for highband and J8 for lowband) to the AN/FRM-19 (V) are both in good condition and properly connected. Has a problem been found?

Yes - Correct Problem
No - Continue

2) Replace primary multicoupler N and perform amplitude and phase measurements of primary multicoupler N against the standard multicoupler. Follow procedures in the Comprehensive Training Manual on CDAA Electronic Maintenance (FRD-10), NEEACT PAC, February 1985. Be sure to test all outputs.

3. Test Limitations

The AUTOMATED AN/FRM-19(V) is primarily designed to check for severe problems. Some of these problems are disconnected cables, short or open antennas, and dead multicoupler outputs. The following are some of the things to keep in mind when interpreting the test results.

a. Antenna Test

1) Only severe antenna problems are detected, such as completely shorted or opened antennas. Monthly TDR tests should still be continued on the antennas for a detailed check of the antenna characteristics.

2) Screenwire problems are not detected in the Daily Automated Antenna and Multicoupler Test.

3) The Antenna Test is very susceptible to on-the-air signal interference. This is especially true for lowband antennas. Therefore, the daily test should have an early morning start time (0600-1200) when on-the-air signals are the lowest.

b. Multicoupler Test

1) Since the CU-1382G/H and CU-2289 multicoupler outputs normally fail in pairs, the output that the AN/FRM-19(V) test cable is connected to may pass but the other outputs could be bad or vice a versa. In order to get a better idea of the overall condition of the coupler, the test results of the Automated Beamformer Test will help to indicate a bad

coupler. If the results of the automated multicoupler and beamformer tests both show that a certain multicoupler is bad then it would indicate that a replacement multicoupler is needed.

2) The software of the coupler test performs amplitude and phase comparisons between a primary multicoupler under test and a reference primary multicoupler. Ideally, the reference primary multicoupler has a response which is the median amplitude and phase response of all primary multicouplers. Using an out of tolerance multicoupler as the reference will result in invalid test results and a high percentage of bad multicouplers to be printed out. Therefore, it is important to select a good reference primary multicoupler. If the coupler test results appear invalid, the PARM Module (SFK "f8") may be used to select another reference multicoupler.

B. Automated Beamformer Test

1. Software Description

The Automated Beamformer Test utilizes four program modules in which three (CAL, PARM, and MAINT) are shared with the Daily Automated Antenna and Multicoupler Test. The four program modules are CAL, BEAM, PARM, and MAINT.

a. CAL Module

This module automatically indexes the AN/FRM-19(V) Mode Selector to the first element under test. If using the HP 8407A/8412A Network Analyzer, this module will prompt the operator to calibrate the HP 8407A/8412A and tune the HP 8601A Generator/Sweeper to the test frequency band of 2.5 to 32 MHz. If using the HP 3577A Network Analyzer, this module will automatically set-up and calibrate the HP 3577A.

The first phase of calibration prompts the operator to enter the element number displayed on the AN/FRM-19(V) Mode Selector display. This will synchronize the computer with the current position of the AN/FRM-19(V) RF switching head. Once synchronized, the system can automatically index the Mode Selector to the first test element.

If using the HP 8407A/8412A Network Analyzer, the second phase of calibration scales the Network Analyzer CRT amplitude and phase displays. The third phase tunes the HP 8601A Generator/Sweeper to the frequency band of interest. The calibration data is then stored on disc.

SPECIAL NOTE: Although the system records calibration settings, both the HP 8407A/8412A Network Analyzer and the HP 8601A Generator/Sweeper should not be manually readjusted after calibration because these units are not fully programmable. The CAL Module needs to be run again if the HP 8407A/8412A, HP 8601A, or the AN/FRM-19(V) Mode Selector settings are changed.

When using the HP 3577A Network Analyzer, the second phase of the calibration sets up the HP 3577A screen display format, test frequency band, and the test signal source. Also, both the amplitude and phase traces are normalized to calibrate out the effects of measurement hardware imperfections (i.e. cable length differences).

SPECIAL NOTE: Unlike the HP 8407A/8412A Network Analyzer, the HP 3577A is fully programmable. Therefore, as soon as the system is booted up, the HP 3577A is programmed to remote mode to secure the system from operator interference. After boot-up, the settings cannot be manually adjusted unless the "LCL" key on the HP 3577A is pressed.

b. BEAM Module

The BEAM Module conducts an amplitude response test between the elements that form a monitor, omni, goniometer, or SPECOMM beams and compares it with a reference beamformer. The AN/FRM-19(V) Mode Selector is switched to the first element under test and is placed in coupler mode. Then the HP 9825T Calculator can select the different beams using the 80 input x 1 output RF Matrix Switch to check that each element is connected to the correct beamformer. Any bad beamformer and related elements are printed out on the calculator's internal printer as shown in Figure 9.

SPECIAL NOTE: The Automated Beamformer Test will follow the Daily Automated Antenna and Multicoupler Test on a daily basis. However, if the operator presses the SFK "f4", the Automated Beamformer Test will begin the testing of the beamformers.

c. PARM Module

This module allows the operator to specify the parameters which define the operator's test plan. These parameters are usually set during initial checkout of the installation and should be changed only if problems occur. The first section allows the operator to change the test parameters for the Daily and Detailed Automated Antenna and Multicoupler Tests. The second section allows the operator to change the Beamformer Test parameters. The first phase is selection of 5 to 14 test frequencies. Then the monitor and omni beamformer's amplitude tolerances can be changed. Selection of the lowband and highband reference beamformers will follow.

d. MAINT Module

This module checks to see that the AUTOMATED AN/FRM-19(V) test equipment are properly calibrated and in working condition. The MAINT module allows the operator to check the following equipment:

1) HP 59306A Relay Actuator
2) HP 59313A A/D Converter
3) HP 59501B D/A Converters
4) AN/FRM-19(V) Mode Selector
5) HP 8407A/8412A Network Analyzer and HP 8601A Generator/Sweeper

or HP 3577A Network Analyzer

6) HP 3437A System Voltmeter
7) HP 98035A Real Time Clock
8) HP 9895A Disc Drive
9) HP 9872C or HP 7475A Plotter
10) Model 4027B 80 Inputs x 1 Output RF Matrix Switch

2. Interpretation of Test Results

After the Automated Beamformer Test is completed, the test results are printed out on the HP 9825T internal printer. A sample printout is shown in Figure 9. The following are the steps to follow when interpreting the test results.

a. All Beams for Element N are bad.

If element N also showed up bad on the coupler test, this would indicated that Multicoupler N is probably bad or that the directional coupler is not connected to the input of the primary coupler. Run a multicoupler amplitude and phase test, as outlined in the Comprehensive Training Manual on CDAA Electronic Maintenance (FRD-10), NEEACT PAC, February 1985, to find the problem. Correct the problem.

b. All Elements of Beam N are bad.

This would probably indicate a bad cable from the beamformer to the distribution coupler or a bad cable from the distribution coupler output to the 80 inputs x 1 output RF Matrix Switch in the AN/FRM-19(V) bay. If none of these cables are bad, then it could be a bad output on the distribution coupler. If the problem still has not been found, it could be an internal beamformer problem or a bad output connector on the beamformer. Correct the problem.

c. Element N fails for Beam M.

Locate the cable that connects the primary multicoupler N's output to the input of beamformer M. Send a TDR test signal through the cable to verify that it is good. If the cable is good, then verify that the primary multicoupler's output is good by using the multicoupler test as outlined in the Comprehensive Training Manual on CDAA Electronic Maintenance (FRD-10), NEEACT PAC, February 1985. If the problem is not in the primary multicoupler or cable, then verify the test path through the beamformer is good. Use the beamformer test procedure outlined in the previously mentioned manual.

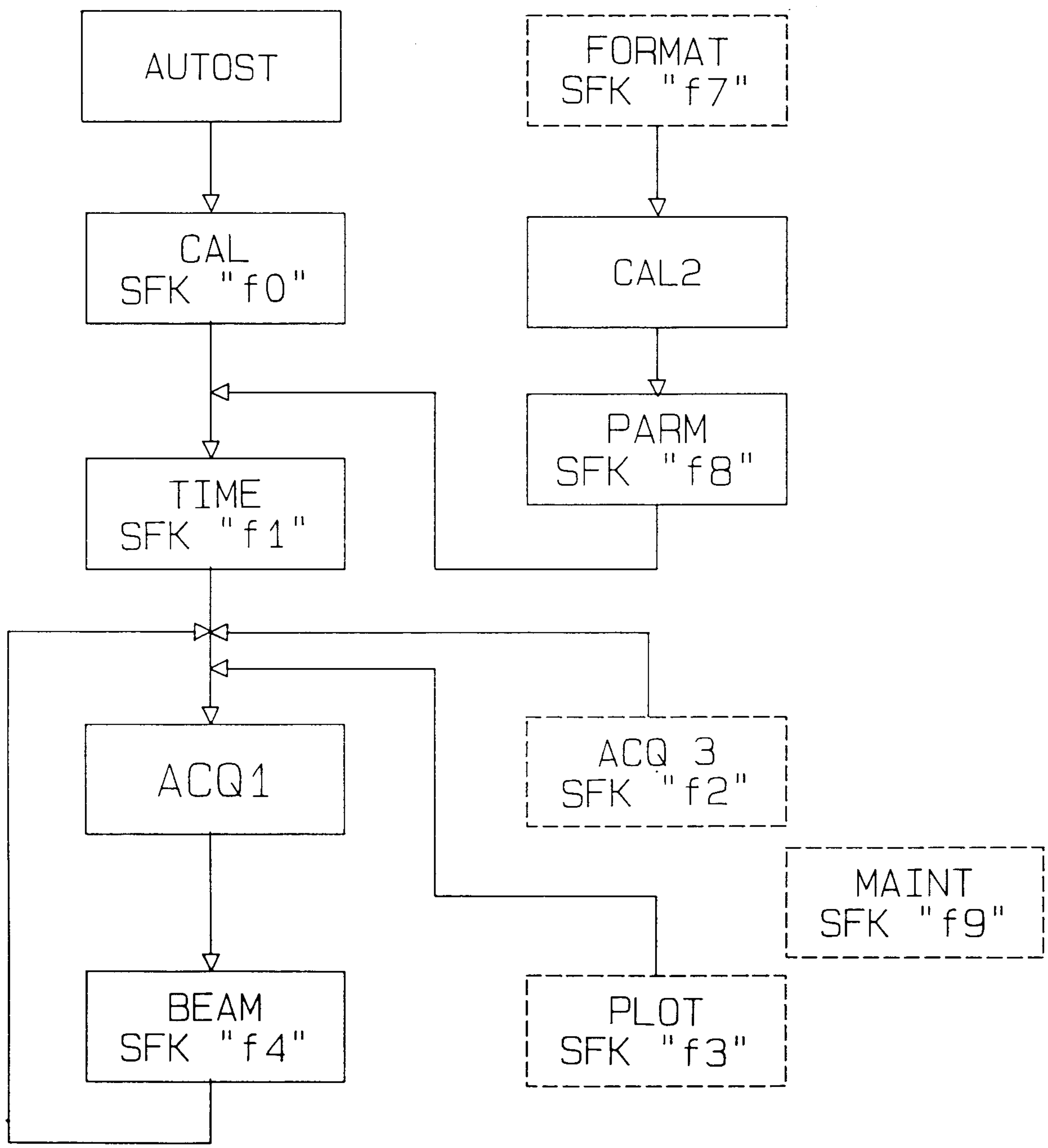
SPECIAL NOTE: If the printout shows a bad SPECOMM beam output, please notify SPECOMM of the problem.

3. Test Limitations

The Automated Beamformer Test is primarily designed to check that the correct elements are connected to the proper beamformer. It will also find shorted or open cables between the primary multicoupler as well as checking additional coupler outputs. Once a problem is detected, it is the responsibility of the operator to identify the exact problem.

If a high percentage of beamformers show up bad, it may be a bad reference beamformer. Select a good reference beamformer by running the PARM Module.

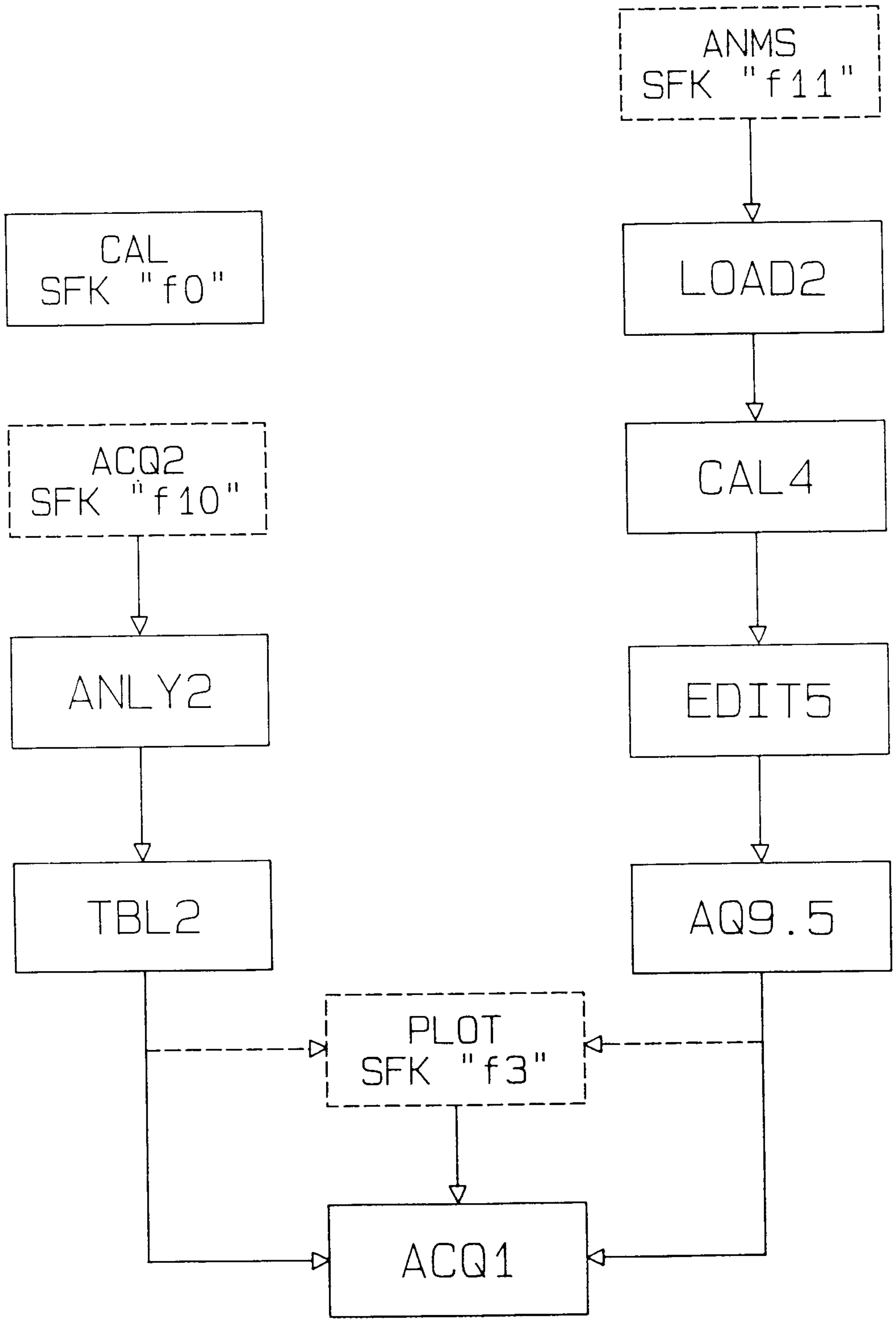
If the test fails repeatedly from a certain direction with known strong on-the-air signal levels, it may be necessary to change the test frequencies (using the PARM Module SFK "f8").



LEGEND:

- (solid box) Automatically executed module when the system is booted up with the AUTOSTART tape.
- (dashed box) Modules executed when the corresponding Special Function Key (SFK) is pressed.

Figure 10. AUTOMATED AN/FRM-19(V) Daily Test Flow Diagram.



LEGEND:

[solid box] Automatically executed modules.

[dashed box] Modules executed when the corresponding Special Function Key (SFK) is pressed.

Figure 11. AUTOMATED AN/FRM-19(V) Optional Test Flow Diagram.

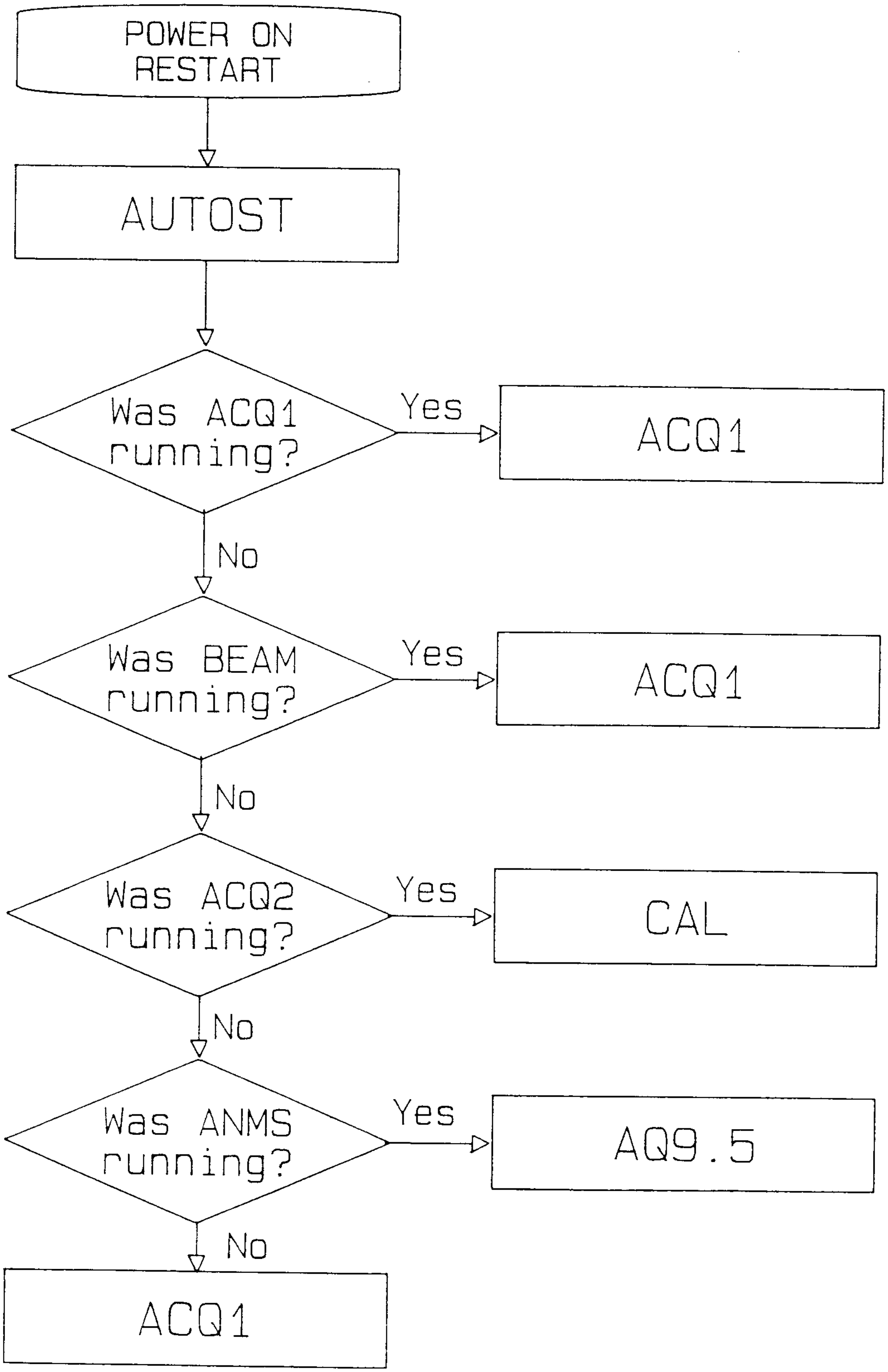


Figure 12. AUTOMATED AN/FRM-19(V) Power Failure Restart Flow Diagram.

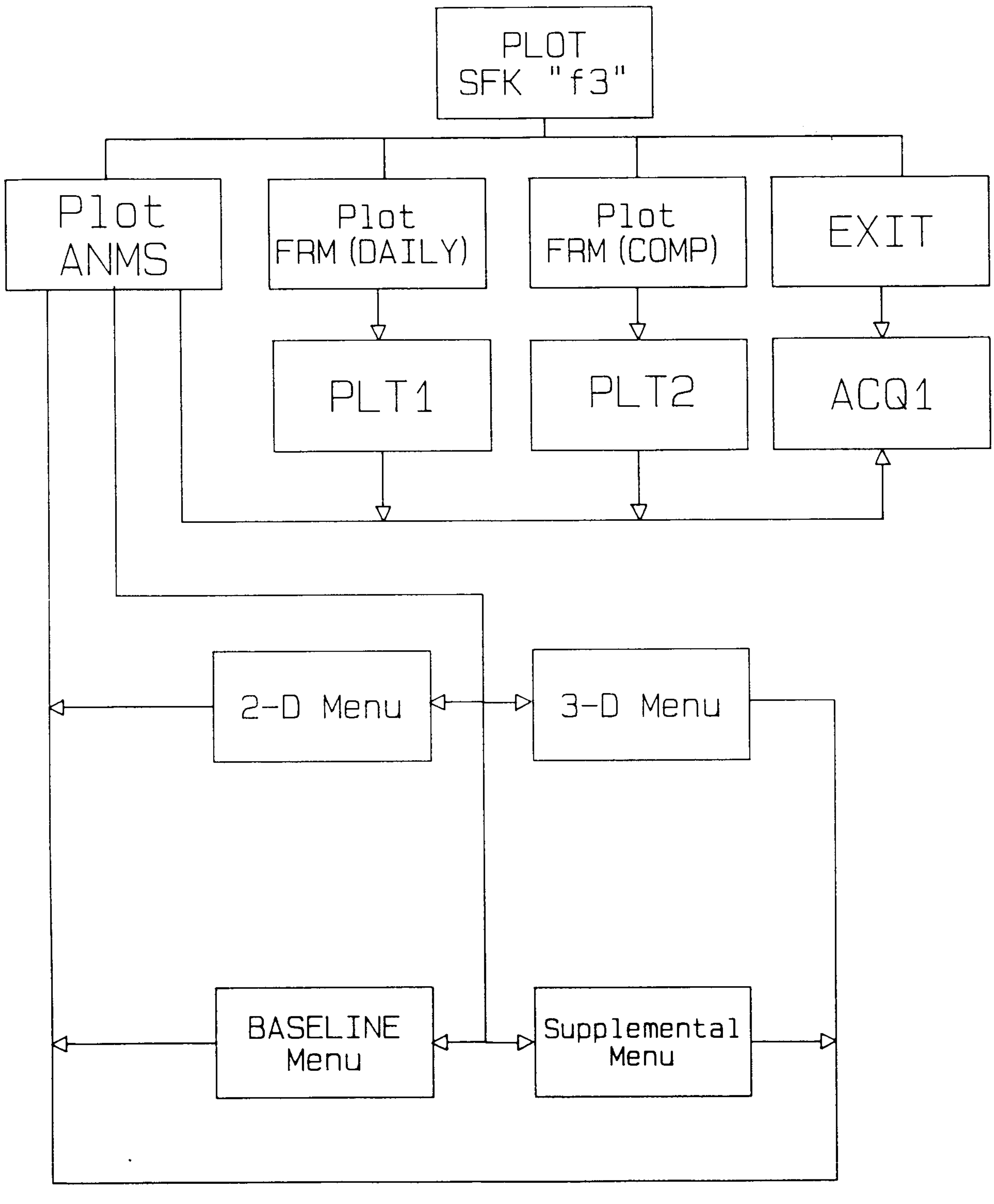
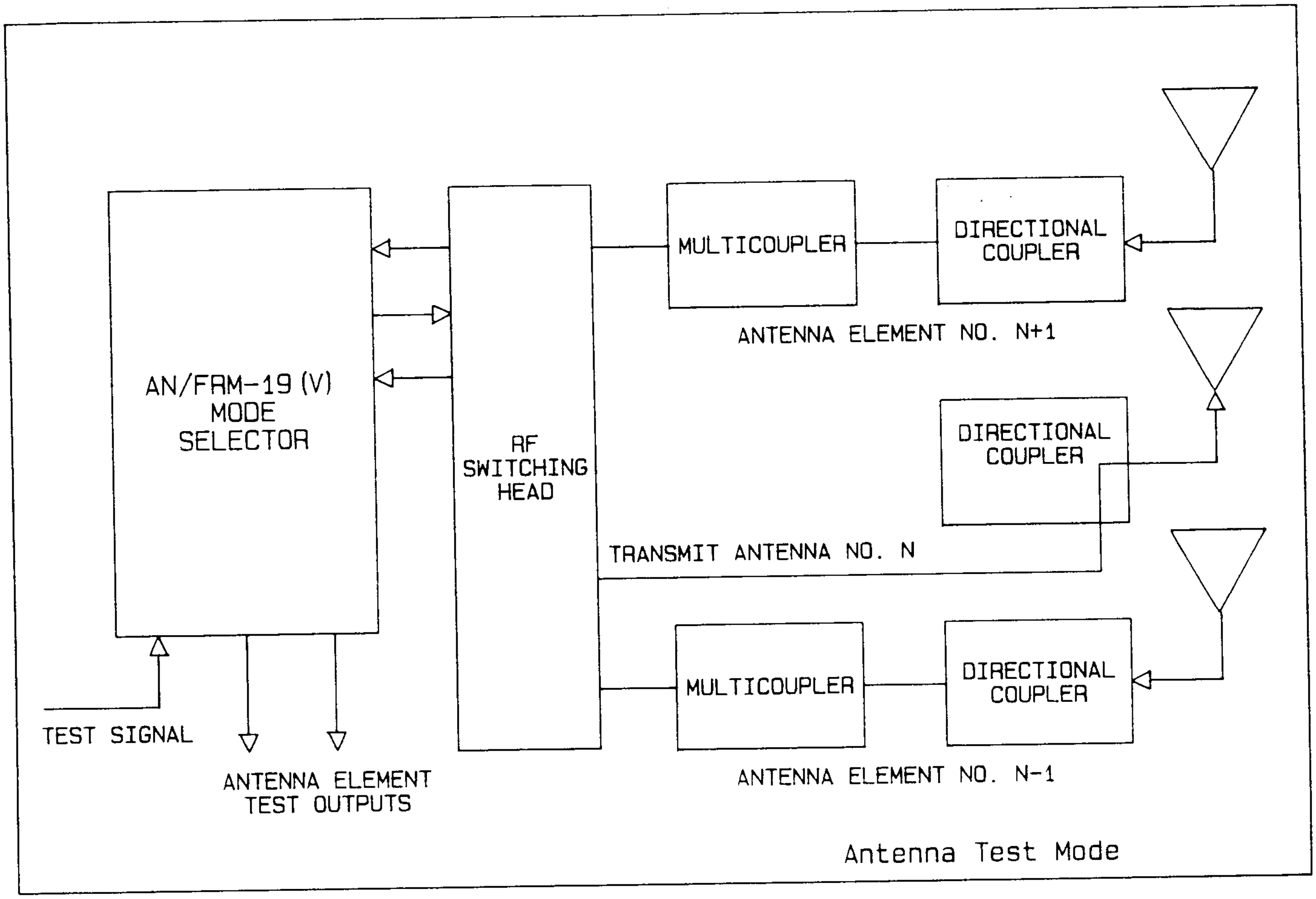


Figure 13. AUTOMATED AN/FRM-19(V) Plot Option Flow Diagram.

CAL	TIME	ACQ3	PLOT	BEAM	HELP
f0	f1	f2	f3	f4	f5
AUTOST	FORMAT	PARM	MAINT	ACQ2	ANMS
f6	f7	f8	f9	f10	f11

SPECIAL FUNCTION KEY	FUNCTION PERFORMED
CAL (f0)	Calibrates the HP 8407A/8412A or HP 3577A Network Analyzer and sets the test frequency range.
TIME (f1)	Sets the Daily Test's start time.
ACQ3 (f2)	Performs the Daily Antenna and Multicoupler Test. Records the amplitude and phase comparison test results.
PLOT (f3)	Prints out a plot option menu. Allows the operator to select different plotting routines to analyze the test data from the different automated tests.
BEAM (f4)	Performs the Automated Beamformer Test. Prints out the amplitude comparison test results.
HELP (f5)	Lists the functions of each module on the HP 9825 Calculator's internal printer.
AUTOST (f6)	Boots up the AUTOMATED AN/FRM-19(V) Test System.
FORMAT (f7)	Formats the data discs used by the different FRM-19 Tests (Daily Tests and the Detailed Antenna and Multicoupler Analysis Test).
PARM (f8)	Defines the FRM-19 test parameters which are used in the analysis of the test results.
MAINT (f9)	Performs calibration and/or checkout of the computer controlled test equipment.
ACQ2 (f10)	Performs the Detailed Antenna and Multicoupler Analysis Test. It performs a swept-frequency amplitude and phase comparison test on the antennas and multicouplers. Records the test data for further analysis.
ANMS (f11)	Performs an Automated Noise Measurement System Test. Samples the noise environment around the CDAA. It records noise data for a week for future analysis.

Figure 14. AUTOMATED AN/FRM-19(V) Test System Special Function Keys.



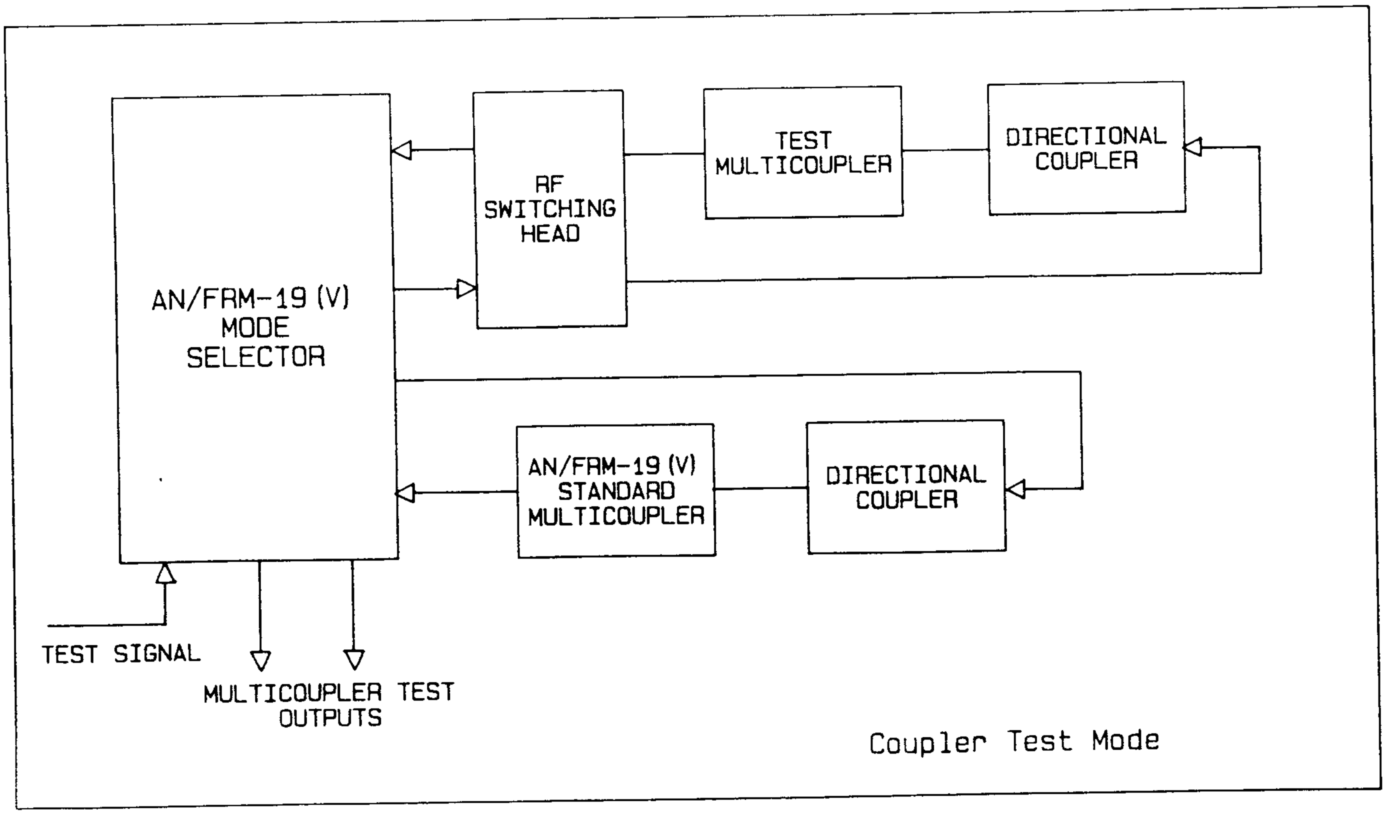


Figure 15. AN/FRM-19 (V) Antenna and Coupler Test Modes.

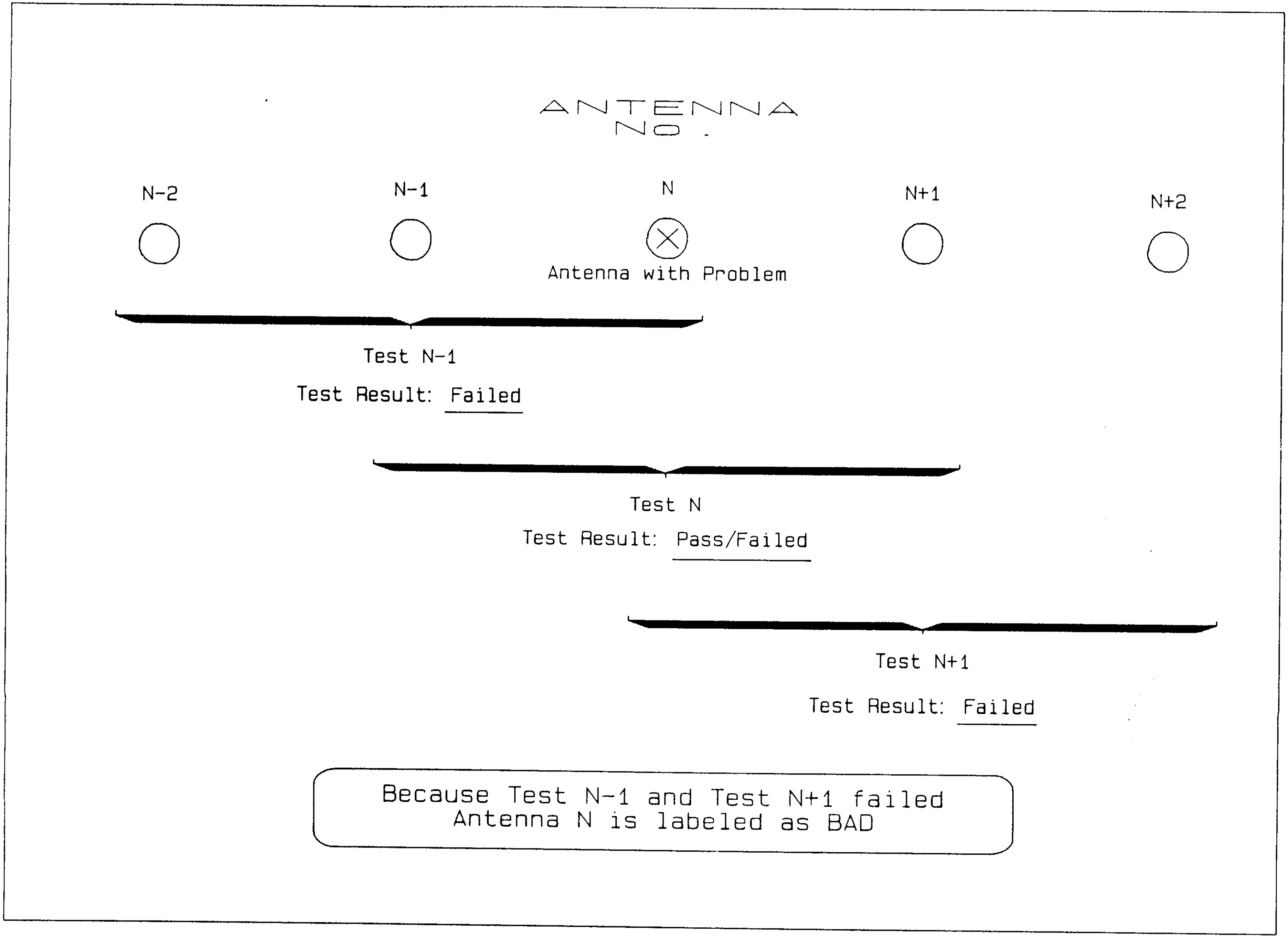


Figure 16. Analysis of Antenna Test Results.

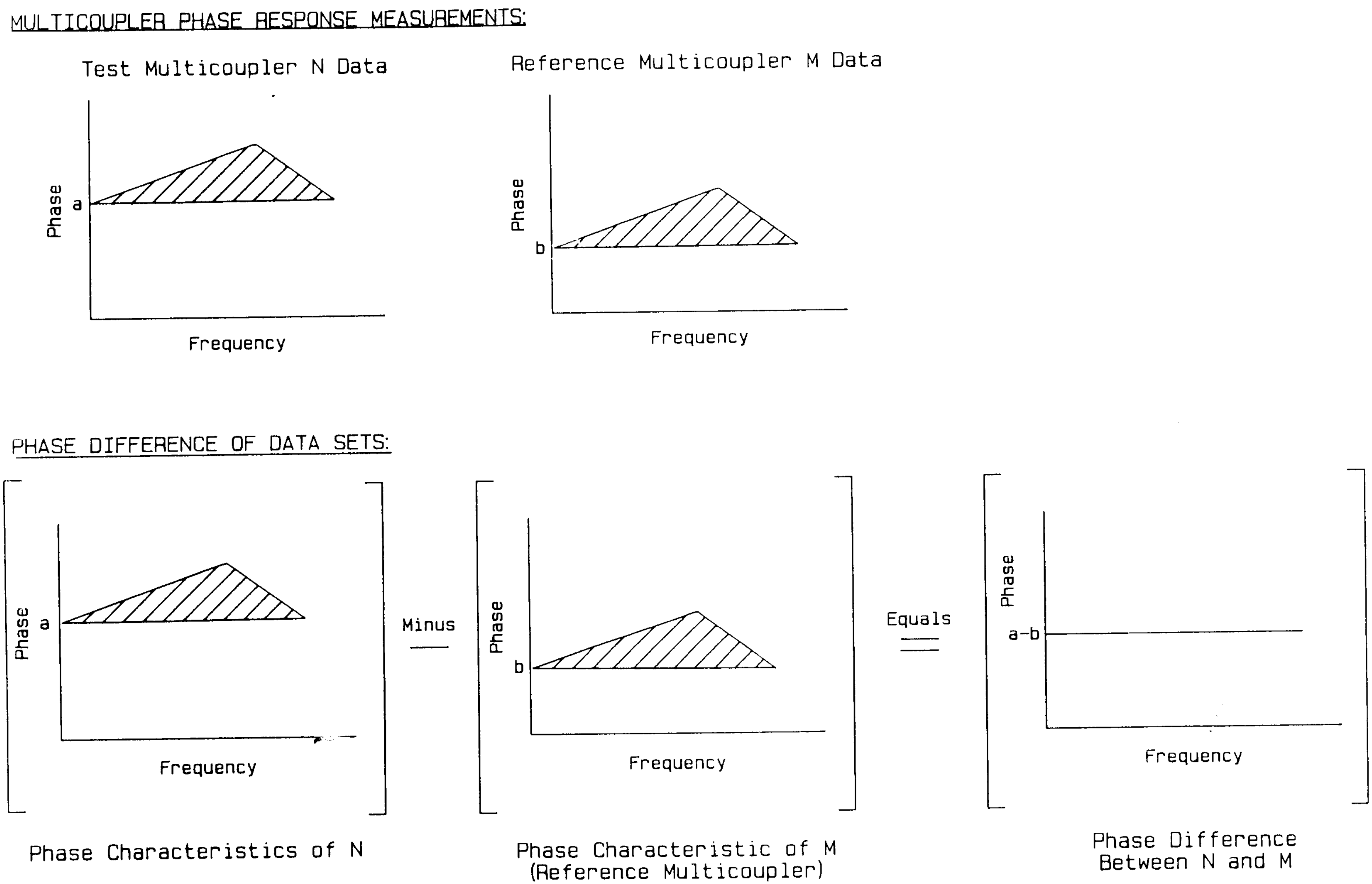


Figure 17. Analysis of Multicoupler Data.

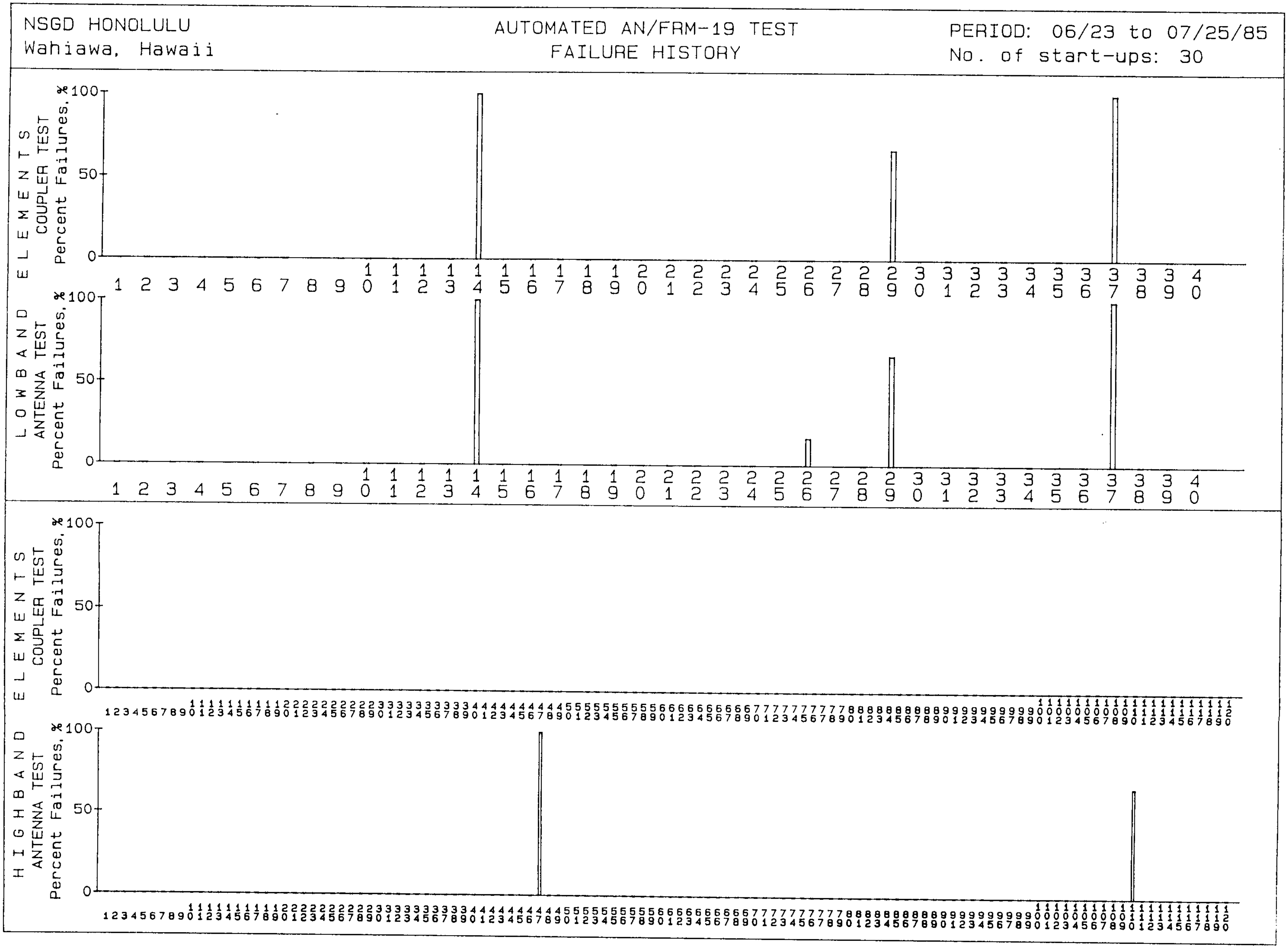


Figure 18. AUTOMATED AN/FRM-19(V) Daily tenna and Multicoupler Test Results

Table 4. Equipment Control Settings for the Calibration (CAL) Module Using the HP 8407A/8412A and HP 8601A

HP 8601A GENERATOR/SWEEPER

Control	Setting for Amp/Phase Cal.	Setting for Frequency Cal.
POWER	ON	ON
SWEEP	VIDEO	VIDEO
RANGE	110	110
FREQUENCY	2.5 MHz	2.5 MHz
SYM SWEEP WIDTH/VERNIER	N/A	N/A
CRYSTAL CAL	OFF	OFF
SWEEP MODE	FREE, FAST	FREE, MANUAL
MANUAL SWEEP CONTROL (black adj. knob)	Fully CW	Fully CW
OUTPUT LEVEL	+10 dBm	+10 dBm
1 kHz MOD	OFF	OFF

HP 8407A/8412A NETWORK ANALYZER

Control	Setting for Amp/Phase Cal.	Setting for Frequency Cal.
HP 8407A:		
POWER	ON	ON
DISPLAY REF(dB) Ten dB/Step	Adj. as needed	Do not touch.
DISPLAY REF(dB) One dB/Step	Adj. as needed	Do not touch.
AMPL VERNIER	Adj. as needed	Do not touch.
PHASE VERNIER	Adj. as needed	Do not touch.
DISPLAY REF CAL 10 dB STEPS	Adj. as needed	Do not touch.
DISPLAY REF CAL 1 dB STEPS	Adj. as needed	Do not touch.
HP 8412A:		
MODE	Adj. as needed	Any position
PHASE OFFSET	Adj. as needed	+ or -
AMPL DB/DIV	1.0	1.0
PHASE DEG/DIV	10	10
PHASE OFFSET DEGREES	Adj. as needed	0
INTENSITY	Set for bight display without blooming.	
FOCUS	Set for the sharpest display.	
BW (kHz)	0.1 kHz	0.1 kHz

Table 5. Equipment Control Setting for the Acquisition (ACQ1, ACQ2, BEAM) Modules Using the HP 8407A/8412A and HP 8601A

HP 8601A GENERATOR/SWEEPER

Control	Setting
POWER	ON
SWEEP	VIDEO
RANGE	110
FREQUENCY	2.5 MHz
SYM SWEEP WIDTH/VERNIER	N/A
CRYSTAL CAL	OFF
SWEEP MODE	FREE, MANUAL
MANUAL SWEEP CONTROL (black adj. knob)	Fully CW
OUTPUT LEVEL	+10 dBm
1 kHz MOD	OFF

HP 8407A/8412A NETWORK ANALYZER

Control	Setting
HP 8407A:	
POWER	ON
DISPLAY REF(dB) Ten dB/Step	Do not touch, set in CAL module.
DISPLAY REF(dB) One dB/Step	Do not touch, set in CAL module.
AMPL VERNIER	Do not touch, set in CAL module.
PHASE VERNIER	Do not touch, set in CAL module.
DISPLAY REF CAL 10 dB STEPS	Do not touch, set in CAL module.
DISPLAY REF CAL 1 dB STEPS	Do not touch, set in CAL module.
HP 8412A:	
MODE	Any Position
PHASE OFFSET	+ or -
AMPL DB/DIV	1.0
PHASE DEG/DIV	10
PHASE OFFSET DEGREES	0
INTENSITY	Set for bight display without blooming.
FOCUS	Set for the sharpest display.
BW (kHz)	0.1 kHz

III. AUTOMATED AN/FRM-19(V) Optional Tests

The AUTOMATED AN/FRM-19(V) optional tests are the Detailed Automated Antenna and Multicoupler Test and the Automated Noise Measurement System. Both of these tests can be started by the operator with a push of a button. These optional tests require some operator interaction and run for some length of time. The Detailed Test runs for approximately two hours and the ANMS will run for seven days.

A. Detailed Automated Antenna and Multicoupler Test

1. Software Description

The Detailed Automated Antenna and Multicoupler Test uses eight program modules. The eight modules are CAL, ACQ2, ANLY2, TBL2, PLOT, FORMAT, PARM, and MAINT. Five of the modules (CAL, PLOT, FORMAT, PARM, and MAINT) are also used in the Daily Tests.

a. CAL Module

This module automatically indexes the AN/FRM-19(V) Mode Selector to the first element under test. If using the HP 8407A/8412A Network Analyzer, this module will prompt the operator to calibrate the HP 8407A/8412A and tune the HP 8601A Generator/Sweeper to the test frequency band of 2.5 to 32 MHz. If using the HP 3577A Network Analyzer, this module will automatically set-up and calibrate the HP 3577A.

The first phase of calibration prompts the operator to enter the element number displayed on the AN/FRM-19(V) Mode Selector display. This will synchronize the computer with the current position of the AN/FRM-19(V) RF switching head. Once synchronized, the system can automatically index the Mode Selector to the first test element.

When using the HP 8407A/8412A Network Analyzer, the second phase of calibration scales the Network Analyzer CRT amplitude and phase displays. The third phase tunes the HP 8601A Generator/Sweeper to the frequency band of interest. The calibration data is then stored on disc.

SPECIAL NOTE: Although the system records calibration settings, both the HP 8407A/8412A Network Analyzer and the HP 8601A Generator/Sweeper should not be manually readjusted after calibration because these units are not fully programmable. The CAL Module needs to be run again if the HP 8407A/8412A, HP 8601A, or the AN/FRM-19(V) Mode Selector settings are changed.

When using the HP 3577A Network Analyzer, the second phase of the calibration sets up the HP 3577A screen display format, test frequency band, and the test signal source. Also, both the amplitude and phase traces are normalized to calibrate out the effects of measurement hardware imperfections (i.e. cable length differences).

SPECIAL NOTE: Unlike the HP 8407A/8412A Network Analyzer, the HP 3577A is fully programmable. Therefore, as soon as the system is booted up, the HP 3577A is programmed to remote mode to secure the system from operator interference. After boot-up, the settings cannot be manually adjusted unless the "LCL" key on the HP 3577A is pressed.

b. ACQ2 Module

Once the operator has calibrated the test equipment (CAL Module), the operator may run the Detailed Automated Antenna and Multicoupler Test by pressing special function key "f10". This module conducts the same four amplitude and phase response tests (lowband multicoupler, lowband antenna, highband multicoupler, and highband antenna tests) as the Daily Automated Antenna and Multicoupler Test. However, instead of 5 to 14 test frequencies it tests 200 frequencies for both lowband and highband. Thus, the results provide a detailed swept-frequency test.

c. ANLY2 Module

After the Detailed Automated Antenna and Multicoupler Test has acquired the test data, the ANLY2 Module is automatically loaded and executed. When using the HP 8407A/8412A Network Analyzer, this module converts the "raw" acquired data from voltages to dB (amplitude) or degree (phase) units, then analyzes the converted data, and stores the test results on the Test Data Disc in drive 1. However, when using the HP 3577A Network Analyzer, the test data is transferred to the HP 9825T Calculator via the HP-IB interface in dB and degree units. Therefore, using the HP 3577A, no conversion is necessary so this module simply analyzes the test data and stores the test results on the Test Data Disc in drive 1.

d. TBL2 Module

The TBL2 Module then links automatically to the ANLY2 module. The antenna and multicoupler results are plotted in tabular form as shown in Figures 19 and 20, respectively. Interpretation of these tables are provided in section 2.

e. PLOT Module

This module will print a plot selection menu. Upon completion of the Detailed Automated Antenna and Multicoupler Test, the operator can plot the amplitude and phase responses of the different elements by selecting the FRM(COMP) option. A sample plot is shown in Figure 21. Upon completion of plotting, this module will link back to the Daily Automated Antenna and Multicoupler Test.

f. FORMAT Module

This module formats blank flexible (floppy) data discs and creates the data files needed by the Detailed Automated Antenna and Multicoupler Test to store the results of the antenna and multicoupler tests. Formatting of discs are seldomly done, except when the Test Data Disc is destroyed.

g. PARM Module

This module allows the operator to specify the parameters which define the operator's test plan. These parameters are usually set during initial checkout of the installation and should be changed only if problems occur. The first section allows the operator to change the test parameter for the Daily and Detailed Automated Antenna and Multicoupler Tests. The first phase allows the operator to change the test frequencies and number of samples per frequency used in the Daily Test. Then the operator can change the antenna/coupler amplitude and phase tolerances and the lowband/highband reference couplers used in the Daily and Detailed Tests. The second section allows the operator to change the Beamformer Test parameters.

h. MAINT Module

This module checks to see that the AUTOMATED AN/FRM-19(V) test equipment are properly calibrated and in working condition. The MAINT module allows the operator to check the following equipment:

1) HP 59306A Relay Actuator
2) HP 59313A A/D Converter
3) HP 59501B D/A Converters
4) AN/FRM-19(V) Mode Selector
5) HP 8407A/8412A Network Analyzer and HP 8601A Generator/Sweeper and HP 3577A Network Analyzer
6) HP 3437A System Voltmeter
7) HP 98035A Real Time Clock
8) HP 9895A Disc Drive
9) HP 9872C or HP 7475A Plotter
10) Model 4027B 80 Input x 1 Output RF Matrix Switch

2. Interpretation of Test Results

After the Detailed Automated Antenna and Multicoupler Test has been completed, the test results are stored on a data disc in drive 1. This data can then be plotted out using the PLOT Module. Samples are shown in Figures 22 thru 25. Below are the steps to follow when interpreting the test results.

a. Antenna Test

For each antenna element N, the antenna test result is summarized as an "A" if the antenna amplitude measurements for antennas N-1 and N+1 are out of the test tolerances by a percentage which is greater than the Bad Data Allowance percentage entered in the PARM module. A "P" is plotted if the antenna phase measurements of antennas N-1 and N+1 are out of the test tolerances by a percentage which is greater than the Bad Data Allowance percentage. If nothing is plotted for antenna element N then the amplitude and phase measurements are within the antenna's test tolerances. If the antenna element N has the test results "A", "P", or both, then proceed with the following steps.

1) To show the condition of antenna element N, the test results for antenna elements N-1 and N+1 should be plotted. This is because the antenna test uses three adjacent antennas to isolate a bad antenna. The antenna test involves transmitting the test signal from the center antenna element and comparing the received signal from the two adjacent antenna elements. Plots of good and bad antenna elements are shown in Figures 22 and 23, respectively. Figure 22 has a portion of amplitude and phase measurements out of tolerance, but it is still within the Bad Data Allowance of 15%. Also, the test data within the frequency ranges of 6-7 MHz for lowband antennas and 28-31 MHz for highband antennas are ignored due to the antenna anomaly present at those frequencies. In contrast to Figure 22, Figure 23 is an example of an antenna that has failed because the amplitude measurements exceeded the test tolerance over the Bad Data Allowance of 10% for highband antennas.

2) Continue following the steps a1 through a4 on page 18.

3) On-the-air signals can interfere with the test signal and cause an antenna element to fail the test. If the test fails repeatedly from a direction with known strong on-the-air signal levels, then either try starting the test about one hour before sunrise or raise the test tolerance about 0.5 dB. An example of test measurements with on-the-air signal interference is shown in Figure 24. If the signal interference is between 5 and 20 percent of the total test measurements taken, then the TBL2 module will ignore that percent of test measurements.

The system also analyzes the antenna test data for possible screen wire problems. A broken or improperly terminated screen wire will cause a sharp negative spike and corresponding sharp positive spike at the same frequency in consecutive antenna elements under test. To help the operator physically locate the screen problems, the TBL 2 module uses a "+ or "-" sign in the SCREEN column as shown in Figure 19. For example, when the test signal is transmitted from antenna N, the phase response from antennas N-1 and N+1 may show a sharp negative phase error (designated by a "-" sign in the SCREEN column for antenna N). In the next consecutive test, transmitting from antenna N+1, the phase response of antennas N and N+2 may show a sharp positive phase error (designated by a "+" sign in the SCREEN column for antenna N+1), at the same test frequencies. A "-" sign followed by a "+" sign for consecutive antenna elements detects a possible screen wire problem between antenna elements N and N+1.

b. Multicoupler Test

In the coupler column of the Antenna Element Analysis Test Summary a multicoupler N is labeled with an "A" if the percent of the amplitude measurements that are out of test tolerance is greater than the Bad Data Allowance percent entered in the PARM module. Likewise, a "P" is shown if the phase measurement for multicoupler N exceeded the percent allowed for bad test data. If multicoupler N shows an "A" or "P" proceed with the following steps.

1) The Multicoupler Analysis Test Summary, shown in Figure 20, describes the degree that the multicoupler failed the amplitude or phase comparison test. For example, for lowband coupler number 10, the coupler has a value of 2.1 dB listed under the dB column. This value is the numeric average (absolute value) that the coupler exceeds the test tolerance. The adjacent percentage, 37%, is the percentage of the total amplitude test data that exceeds the test tolerance. These two numbers, 2.1 dB and 37%, describe the extent that this multicoupler exceeded the amplitude tolerance. Similarly, results listed below the phase column describe the extent that a multicoupler exceeds the phase test tolerance.

2) Plot out the test results of multicoupler N. Samples of typical multicoupler test measurements which have passed and failed are shown in Figure 25. Figure 25 shows that the test measurements of Coupler 1 are within the test tolerances. In contrast, Coupler 10 represents test measurements that have failed. The percentage of test measurements of Coupler 10 exceeded the Bad Data Allowance of 15%. The plot of Coupler 10 shows an oscillating coupler.

3) Continue following steps b1 through b2 on page 19.

B. AUTOMATED NOISE MEASUREMENT SYSTEM

1. Software Description

The Automated Noise Measurement System utilizes five main program modules. The five modules are LOAD2, CAL4, EDIT5, AQ9.5, and PLOT. Only the PLOT module is shared with the other tests. The following is a brief description of each module.

a. LOAD2 Module

LOAD2 module boots the ANMS by loading the various test parameters into the HP 9825T Calculator. It will also create the Test Parameter files "*TEST*" and "*YEAR*" if they are not found on the program or data discs.

SPECIAL NOTE: To format an ANMS data disc place a blank disc into drive 1 and press the {RESET} key, type in {init 1,707}, and then press {EXECUTE} key on the HP 9825T Calculator. It takes approximately 5 minutes to format a blank disc. The ANMS data files will be created when you run through the ANMS modules.

b. CAL4 Module

The Calibration (CAL4) Module calibrates and sets up the HP 141T/8553B/8552B Spectrum Analyzer before starting the acquisition of data.

c. EDIT5 Module

The Test Plan Edit (EDIT5) Module lists the various test parameters of the ANMS. This module allows the operator to enter in the current year and any needed beam attenuation. The operator will also have the option to pre-open the data files for the ANMS test.

SPECIAL NOTE: The ANMS data disc is a separate disc from the Detailed Automated Antenna and Multicoupler Test data disc. It is also recommended that the operator pre-open the test data files before running the ANMS acquisition module because it will help reduce the run time of the ANMS test.

d. AQ9.5 Module

1) Noise Measurement

The Acquisition (AQ9.5) Module, which is the heart of the ANMS, acquires data from a 0.5 MHz window centered about seven frequencies (2.5, 5.0, 7.5, 10.0, 12.5, 20.0, and 30.0 MHz) of interest. Figure 26 is a flow chart of the acquisition and processing of noise data. The ANMS searches for the lowest power level or "hole" in this 0.5 MHz window. Figure 27 shows how this window about the frequency of interest is divided into 83 channels of 3.6 kHz. The ANMS then samples the noise waveform in each channel by taking 50 consecutive points. By taking 50 samples, a window is set-up in the time domain that will capture time related RFI noise, such as powerlines. Each of the 50 samples of the input noise waveform is a sum of the actual noise level plus the system noise level. Consequently, if the actual noise level is small then the system noise level becomes significant and needs to be subtracted from the total power level of the input noise sample. Therefore, after the ANMS scans the 0.5 MHz window from (f - 0.25 MHz) to (f + 0.25 MHz), it returns to the "hole" to measure the system noise level. Figures 28 to 30 are flow charts that show how the actual noise is measured. The average power (true rms voltage) and Vd (voltage deviation) are then calculated from the digitized noise waveform. Impulsive type noise is characterized by a large Vd value. When highly impulsive noise problems are detected, then 4096 consecutive samples (1.8 seconds) of the noise waveform are stored automatically for later analysis to characterize the nature of the noise interference.

2) Strong Signal Measurement

Acquisition of strong signal data is performed by scanning a 1 MHz window centered about each whole frequency from 2 MHz, 3 MHz, etc. up to 30 MHz. Each 1 MHz window is divided into 167 channels of 3.6 kHz, and the ANMS searches for the channel with the highest power level or strongest signal. The ANMS then takes 3 consecutive samples and computes the average power (true rms voltage) and Vd (voltage deviation). Strong signals are characterized by a low Vd value.

e. PLOT Module

The PLOT Module contains a menu selection of the different plotting options. After obtaining the noise/signal data, the operator can then plot the results and analyze the noise/signal measurements in various ways. Selection of "ANMS" from the PLOT menu will allow the operator to access the different plotting options. He will be able to choose between 2-D, 3-D, Baseline, and Supplemental plots. The 2-D menu will give the operator the option of plotting the average noise power levels for omni and monitor beams versus frequency and azimuths, respectively. The polar plot option in the 2-D menu will plot the average noise power levels versus azimuths for the monitor beams in a polar format. The last option is a plot of strong signal levels versus frequency. The 2-D plots represent the noise/signal environment at a specific time. The noise/signal environment, however, varies with time. Consequently, to be able to see these changes, the noise/signal data is acquired automatically every two hours for a seven day period. Therefore, 3-D plots of the previously mentioned 2-D plots can be made which show the noise/signal environment over a 24 hour period. A Baseline plot for a particular site is obtained by running the ANMS continuously for a seven day period. All of this data is then averaged and plotted to show how the noise/signal environment varied for a typical 24 hour day. The Supplemental plots will help in the analysis of noise problems. The Supplemental plots are Amplitude Probability Distribution (APD), Average Crossing Rate (ACR), Normalized Probability Density and Distribution Functions, Fast Fourier Transform (FFT), Pulse Spacing and Duration Distribution, Power Spectral Density, and Autocorrelation Function (AF). Each plot will be described in the following section.

2. Test Results

After the ANMS has collected the noise/signal data for seven days, the operator can then proceed to plot out the data using the different plotting modules to analyze the noise/signal environment.

a. 2-D Plots

Figures 31 and 32 are plots of the average noise and strong signal power levels versus frequency from the Omni beam output at a particular time. The Vd ratios are also included.

Figure 33 is a plot of the average noise power level versus azimuth from each of the 30 Monitor beams at 2.5 MHz for a particular time. A similar type of plot can be obtained for each of the other six test frequencies. These Monitor beam plots give an indication of the direction of the noise for a specific frequency, whereas Figure 31 gives an indication of how the noise omnidirectionally varied with frequency.

Figure 34 is the same Monitor beam noise data, as shown in Figure 33, plotted in polar format.

b. 3-D Plots

The previous plots present the noise/signal environment at a specific time, however, the noise/signal environment varies with time. Therefore, to be able to see these changes, the noise data is acquired automatically every two hours over a seven day period. The average power levels can then be plotted as shown in Figures 35, 36, and 37. These plots are similar to Figures 31, 32, and 33, respectively, but also show how the noise/signal environment varied over the 24-hour period.

c. Baseline Plots

A baseline plot is a median of the average power levels obtained over the seven day period. These plots, as shown in Figures 38, 39, and 40, show the variation in the noise/signal environment over a typical day at the different frequencies of interest.

Figures 41 and 42 show the effect the noise environment has on the operations of a site. These figures are the same plots that are shown in Figures 38 and 40, but they also include the Minimum Discernible Signal (MDS) level (-107 dBm) of a typical receiver. The dotted portions of the plots indicate the frequency, direction, and time that the noise is above the MDS level. Conversely, the solid-line portions of the plots indicate the noise that is below the MDS level. The dotted region represents when the site is noise limited and the solid region is when the site is receiver sensitivity limited which would be the ideal situation for the site.

d. Supplemental Plots

Figure 43 is a plot of the Amplitude Probability Distribution (APD) for 1500 samples (0.67 second) of a noise waveform. The slope of the dashed line in the APD plot is -1/2, which is equivalent to the slope for bandlimited Gaussian type noise. The solid-line curve represents the APD of the waveform. No portion of the solid line has a slope of -1/2. Therefore, this noise waveform is not Gaussian in nature. In addition, the steepness of the curve between -70 dBm and -100 dBm indicates that the noise is relatively impulsive within these levels, which is in agreement with what is shown by the noise waveform plot.

Figure 44 is a plot of the Average Crossing Rate (ACR) for the noise waveform. The ACR represents the number of times the noise waveform traverses a particular level, from the greater than to less than direction, in one second. The ACR plot shows that the maximum number of crossings for this noise waveform occurred at -105 dBm at a rate of 550 crossings per second.

Figure 45 is a plot of the Normalized Probability Density and Distribution Functions. The Normalized Probability Density Function basically is a histogram of the 1500 samples. The Normalized Probability Distribution Function is derived by integrating and normalizing the area from negative infinity to positive infinity under the curve. It is also referred to as a cumulative histogram. From the Normalized Probability Distribution Function, the probability of finding a noise sample that is greater than the -120 dBm and less than or equal to -105 dBm is 0.50 or 50%.

Figure 46 is a plot of the 1024-point Fast Fourier Transform (FFT). The FFT plot shows that the noise waveform is basically made up of a 120 Hz component. This plot indicates that this noise is related to some type of power line interference.

Figure 47 is a plot of the Pulse Spacing and Duration Distribution. The Pulse Spacing Distribution displays the percentage of time a pulse spacing exceeds a certain time. The Pulse Duration Distribution displays the percentage of time a pulse duration exceeds a certain time.

Figure 48 is a Power Spectral Density plot. The Power Spectral Density plot displays the power in the frequency components.

Figure 49 is a plot of the Autocorrelation Function (AF). This plot shows that the noise waveform correlates with itself every 16.7 milliseconds (60 Hz) and 8.3 milliseconds (120 Hz). The AF plot verifies in the time domain the same result that was obtained in the frequency domain (FFT), that the noise waveform is related to some type of powerline interference.

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ANTENNA ELEMENT ANALYSIS DATE: 10/28/85 TIME: 07:55

NSGD GUAM TOLERANCES: Antenna (2dB, 10deg) Coupler (2dB, 4deg)

LOWBAND	No.	ANTENNA	COUPLER	SCREEN	HIGHBAND	No.	ANTENNA	COUPLER	SCREEN		No.	ANTENNA	COUPLER	SCREEN		No.	ANTENNA	COUPLER	SCREEN
	1			–		1					41			+		81			
	2			+		2					42			–		82			
	3					3					43					83			
	4					4					44					84			
	5					5					45				X	85	A		
	6					6					46		P			86			
	7					7					47				X	87	AP		
	8					8					48					88			
	9					9					49		P		X	89	AP		
X	10		AP			10					50					90			
	11					11					51					91			
	12					12					52					92			
	13					13					53					93			
	14				X	14	AP				54					94			
	15					15					55					95			
	16					16					56					96			
	17					17					57					97			
	18					18					58					98			
R	19					19				R	59					99			
R	20					20				R	60					100			
	21					21				X	61	P				101			
	22					22					62					102			
	23					23					63					103			
	24					24					64				X	104	AP		
	25					25					65					105		P	
	26					26					66					106			
	27					27					67					107			
	28					28					68					108			
	29					29					69				X	109	P		
	30					30					70				X	110	AP		
	31					31					71					111			
	32					32					72					112			
X	33	P				33					73					113			
	34					34					74					114			
	35					35				X	75	P			X	115	AP	P	
	36					36					76					116			
	37					37					77				X	117	P		
	38					38					78					118		P	
	39					39					79				X	119	P		
	40					40					80					120			

LEGEND : A = Amplitude Failed, P = Phase Failed, R = Access Road

Figure 19. Antenna Test Result Summary from the Detailed Analysis Test.

MULTICOUPLER ANALYSIS DATE: 10/28/85 07:55

Lowband: (Amp: 2.0dB, Phase: 4.0deg, Ref: 2, Allowance: 15%)

Highband: (Amp: 2.0dB, Phase: 4.0deg, Ref: 4, Allowance: 10%)

LOWBAND

No.		AMP dB	AMP %	PHASE deg	PHASE %
1	G				
2		REFERENCE COUPLER			
3	G				
4	G				
5	G				
6	G				
7	G				
8	G				
9	G				
10	B	2.1	37	8.2	35
11	G				
12	G				
13	G				
14	G				
15	G				
16	G				
17	G				
18	G				
19	G				
20	G				
21	G				
22	G				
23	G				
24	G				
25	G				
26	G				
27	G				
28	G				
29	G				
30	G				
31	G				
32	G				
33	G				
34	G				
35	G				
36	G				
37	G				
38	G				
39	G				
40	G				

HIGHBAND

No.		AMP dB	AMP %	PHASE deg	PHASE %
1	G				
2	G				
3	G				
4		REFERENCE COUPLER			
5	G				
6	G				
7	G				
8	G				
9	G				
10	G				
11	G				
12	G				
13	G				
14	G				
15	G				
16	G				
17	G				
18	G				
19	G				
20	G				
21	G				
22	G				
23	G				
24	G				
25	G				
26	G				
27	G				
28	G				
29	G				
30	G				
31	G				
32	G				
33	G				
34	G				
35	G				
36	G				
37	G				
38	G				
39	G				
40	G				

No.		AMP dB	AMP %	PHASE deg	PHASE %
41	G				
42	G				
43	G				
44	G				
45	G				
46	M			4.9	30
47	G				
48	G				
49	M			4.8	26
50	G				
51	G				
52	G				
53	G				
54	G				
55	G				
56	G				
57	G				
58	G				
59	G				
60	G				
61	G				
62	G				
63	G				
64	G				
65	G				
66	G				
67	G				
68	G				
69	G				
70	G				
71	G				
72	G				
73	G				
74	G				
75	G				
76	G				
77	G				
78	G				
79	G				
80	G				

No.		AMP dB	AMP %	PHASE deg	PHASE %
81	G				
82	G				
83	G				
84	G				
85	G				
86	G				
87	G				
88	G				
89	G				
90	G				
91	G				
92	G				
93	G				
94	G				
95	G				
96	G				
97	G				
98	G				
99	G				
100	G				
101	G				
102	G				
103	G				
104	G				
105	M			5.2	51
106	G				
107	G				
108	G				
109	G				
110	G				
111	G				
112	G				
113	G				
114	G				
115	M			6.7	32
116	G				
117	G				
118	M			5.8	27
119	G				
120	G				

Lowband: 0 = M, 1 = B
Highband: 5 = M, 0 = B

LEGEND : G = GOOD, M = MARGINAL, B = BAD, * = DATA FILE PROBLEM, - = NO DATA

Figure 20. Coupler Test Result Sum y from the Detailed Analysis Test.

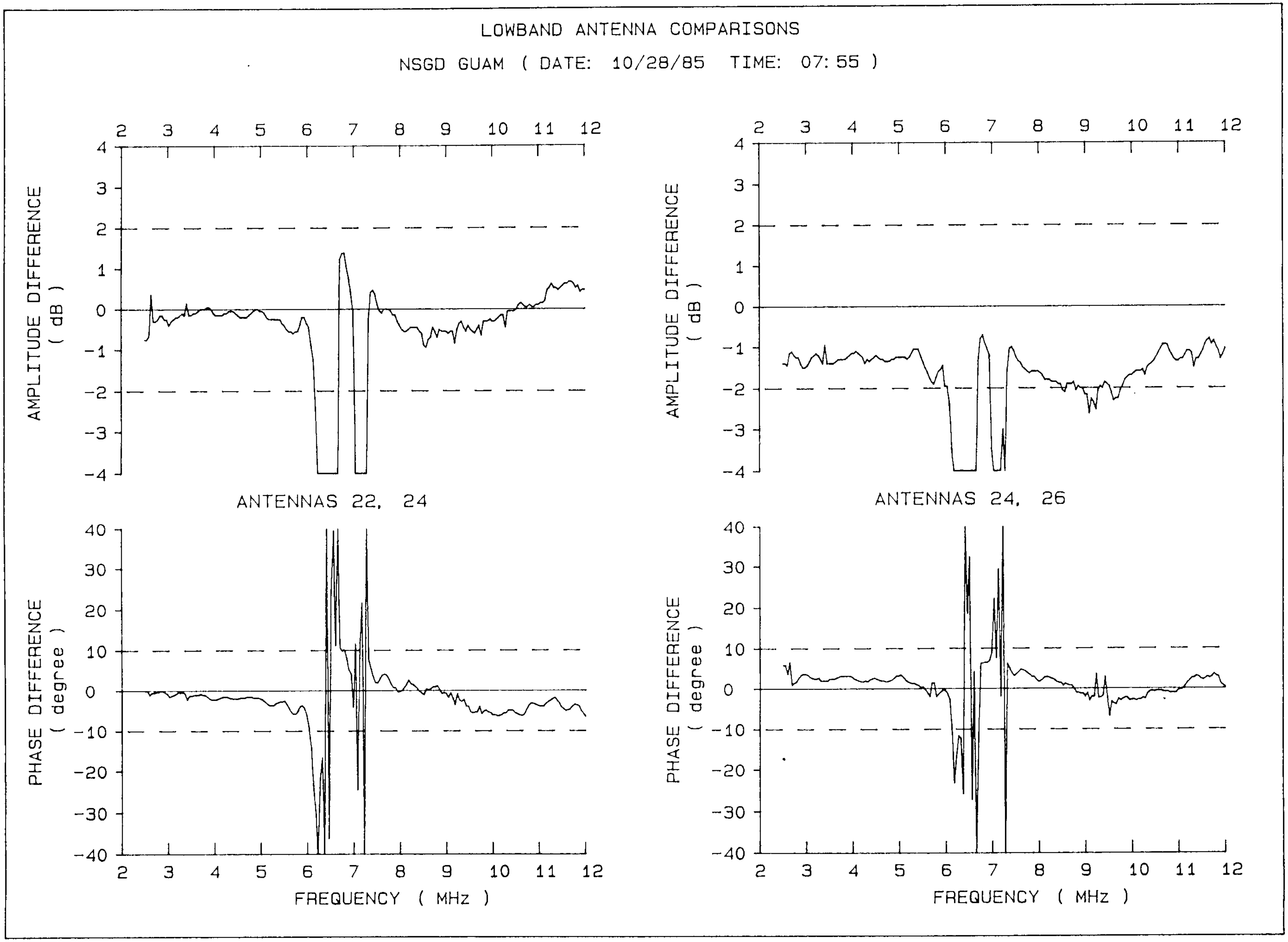


Figure 21. Sample Plot of the Amplitude and Phase Response.

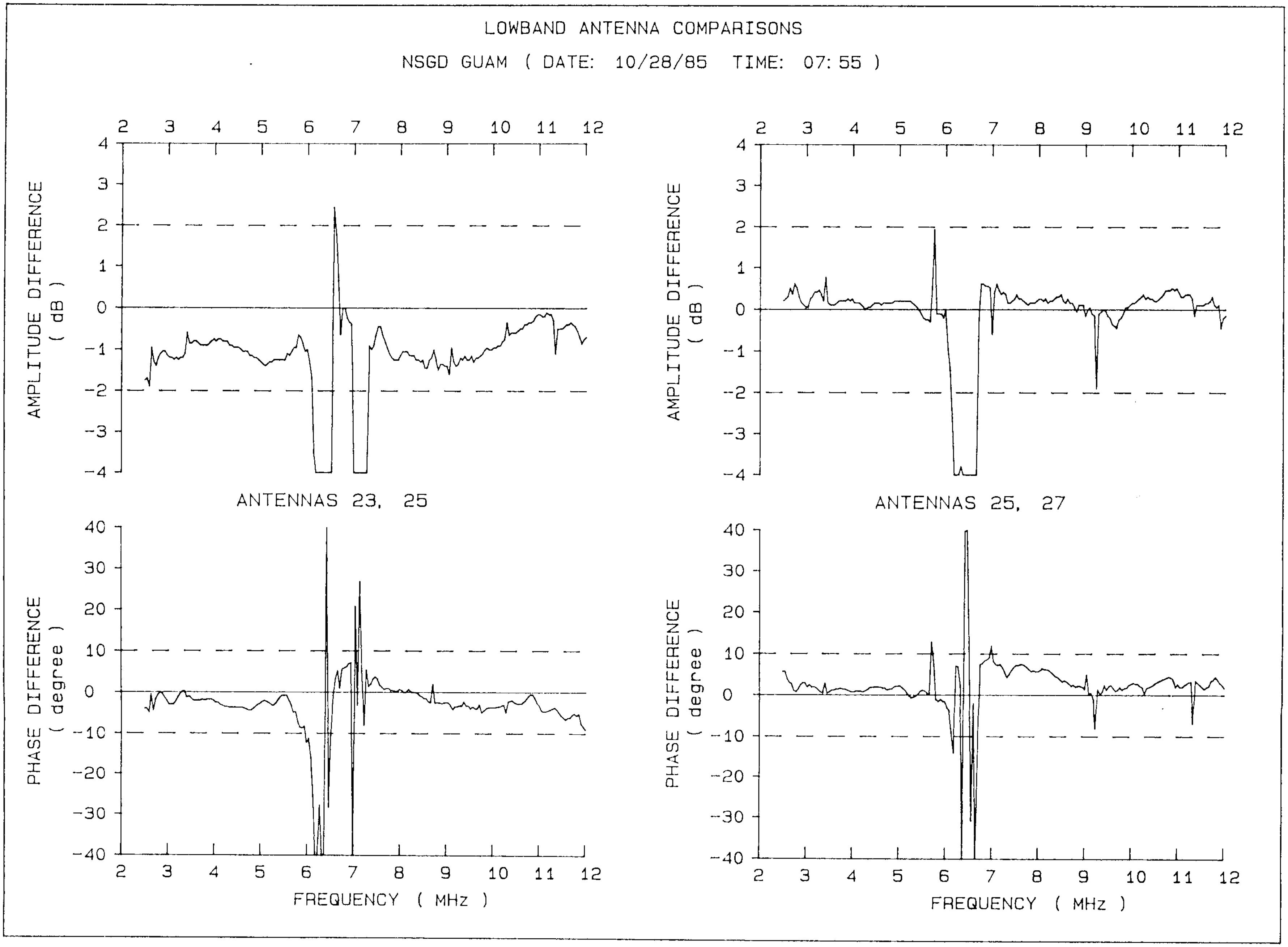


Figure 22. Antenna Test Mea ements Which Have Passed.

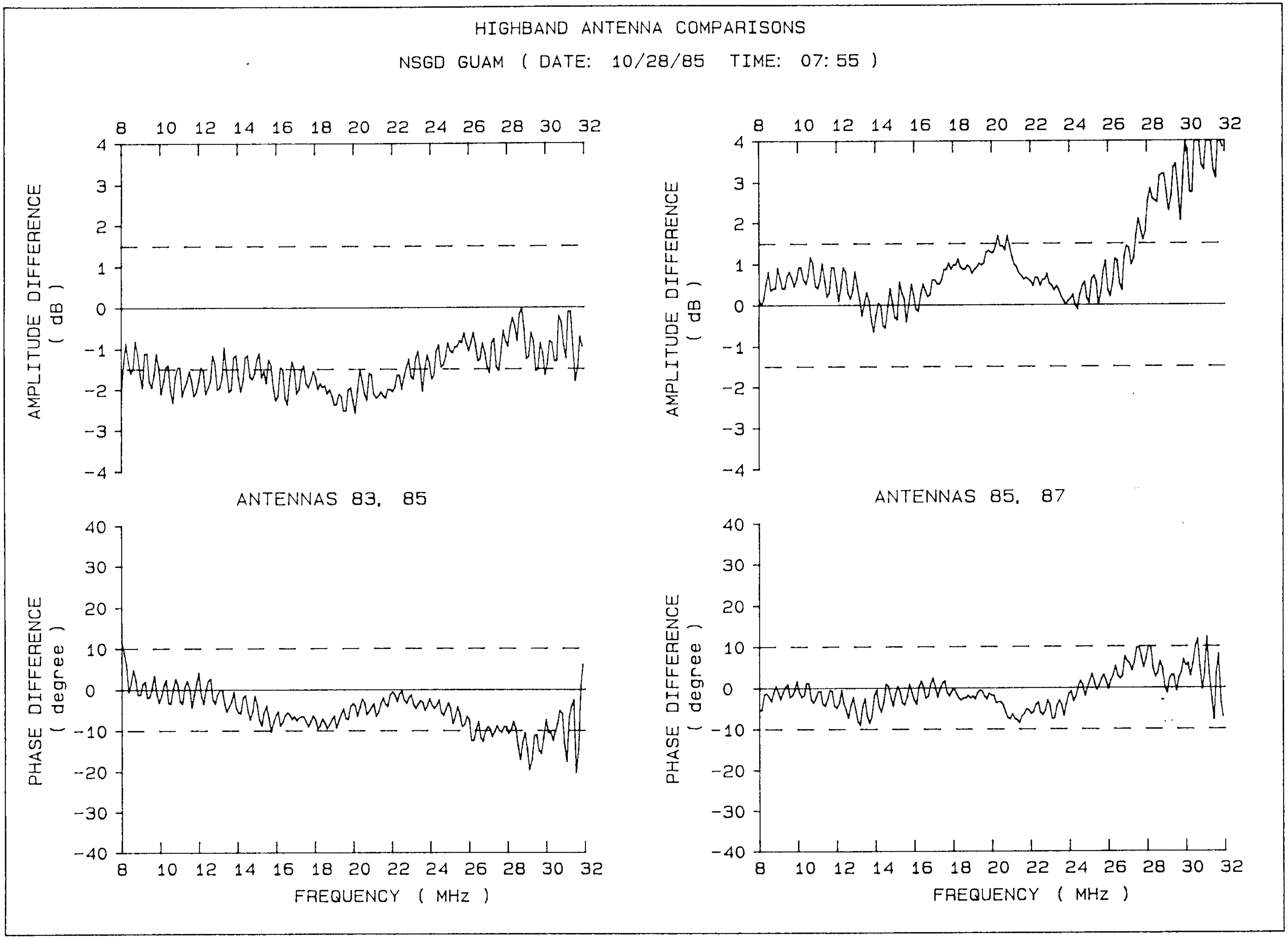


Figure 23. Antenna Test Measurements Which Have Failed.

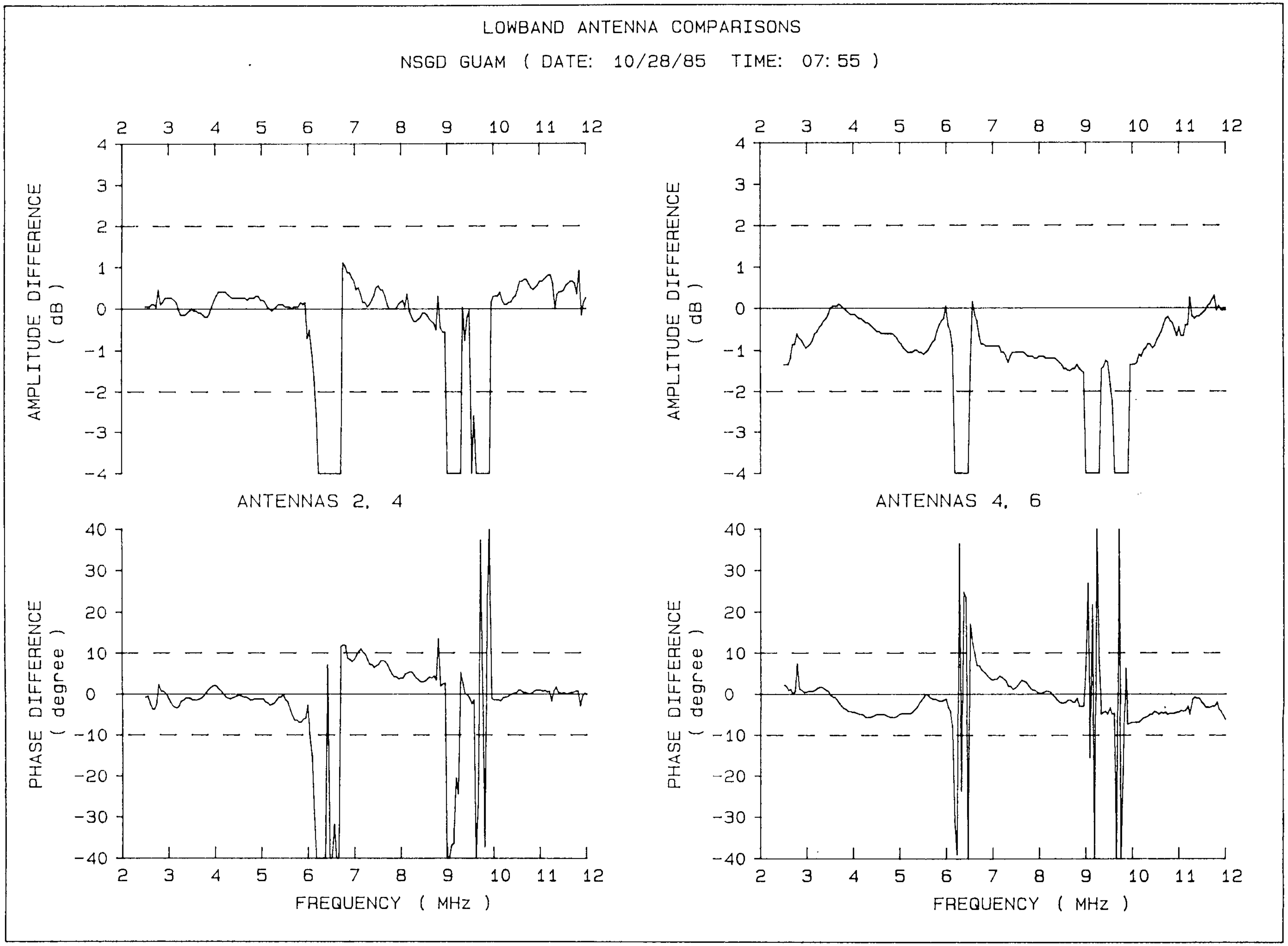


Figure 24. Antenna Test Measurements th On-the-air Signal Interference.

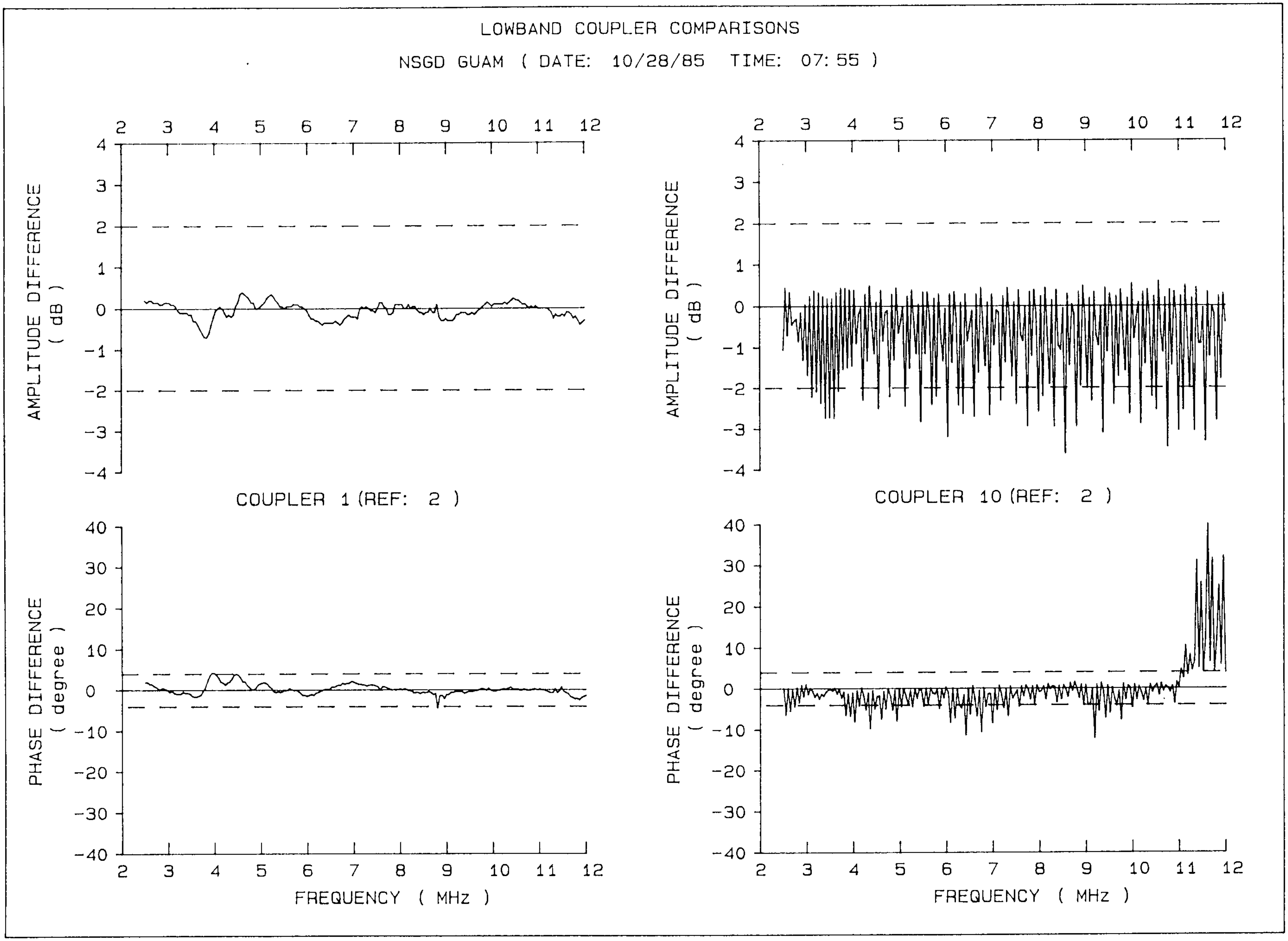


Figure 25. Coupler Test Measurements.

FLOW CHART

"ACQUISITION & PROCESSING OF NOISE DATA"

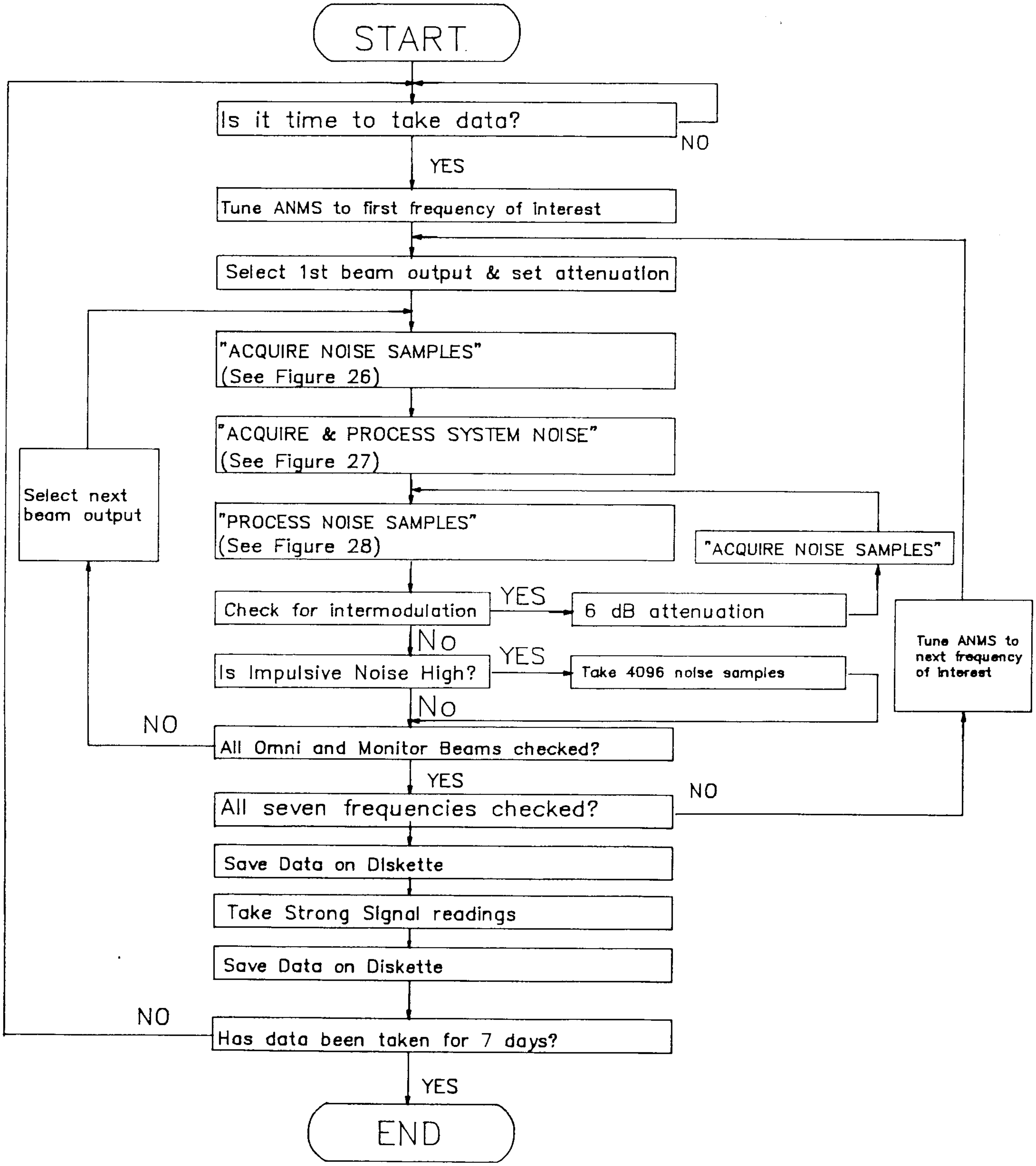


Figure 26. Flow Chart – Overall Acquisition & Processing of Noise Data.

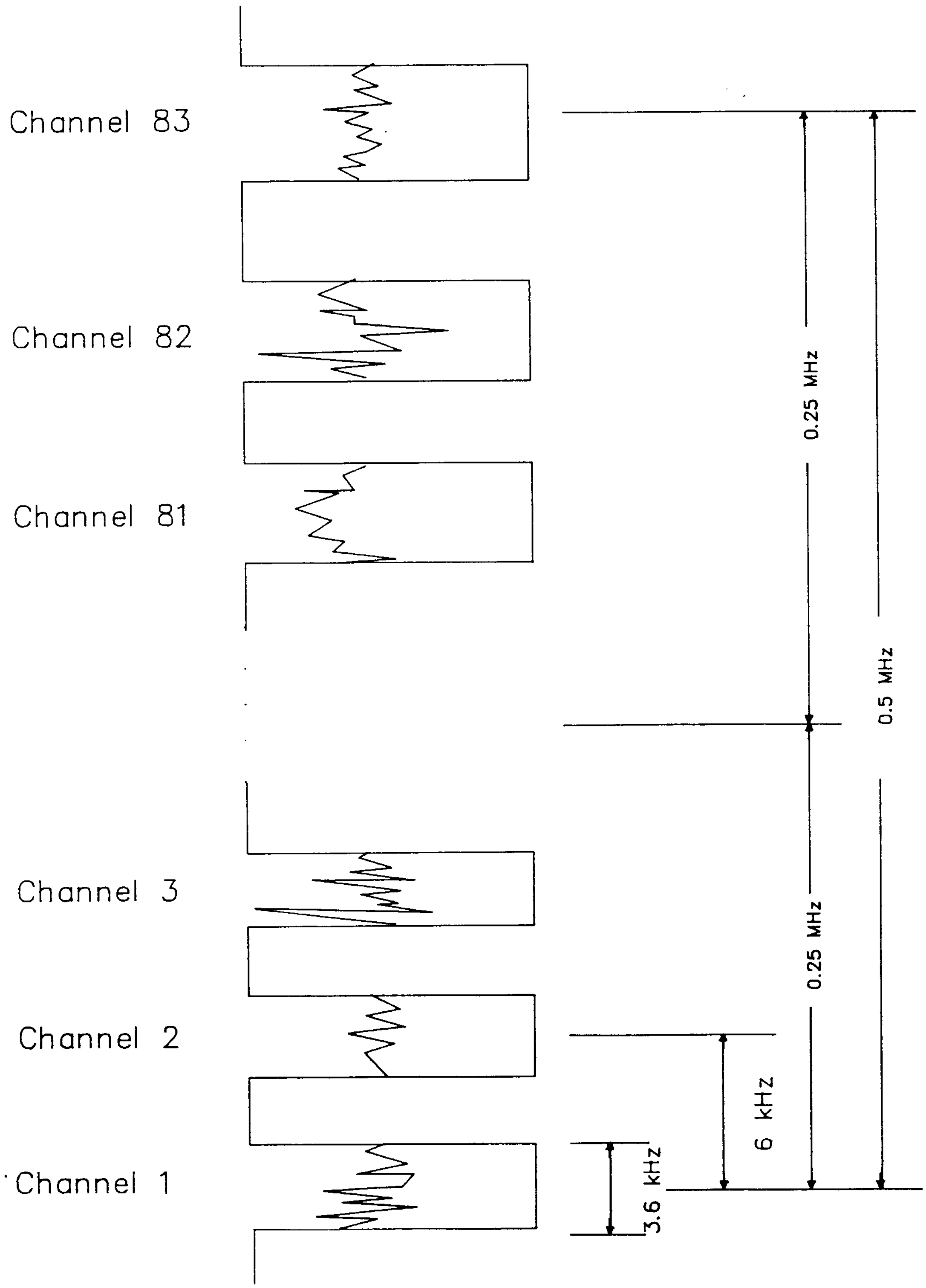


Figure 27. Structure of Windows in Frequency Domain.

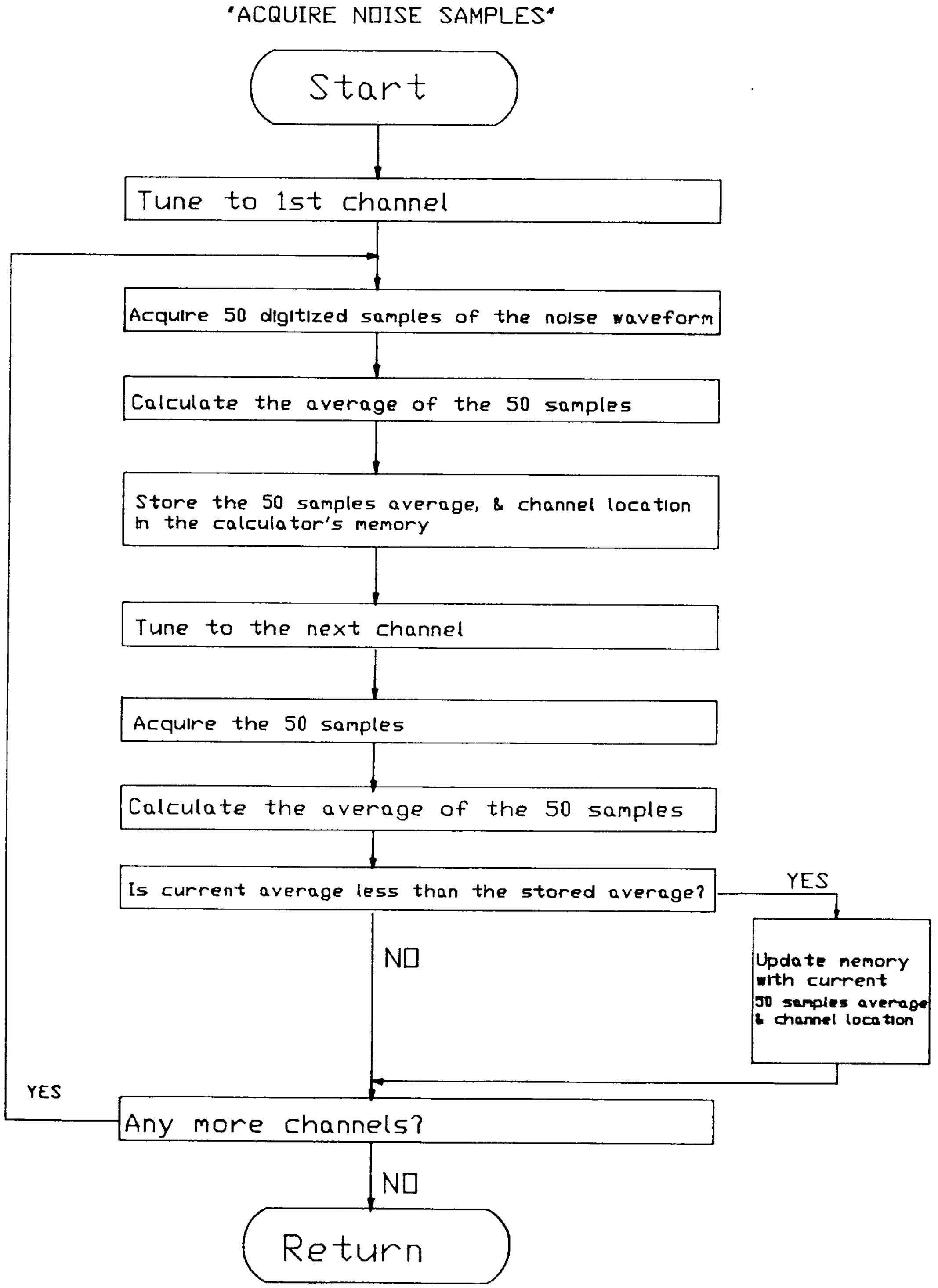


Figure 28. Flow Chart - Noise Sample Acquisition.

FLOW CHART

'ACQUIRE AND PROCESS SYSTEM NOISE'

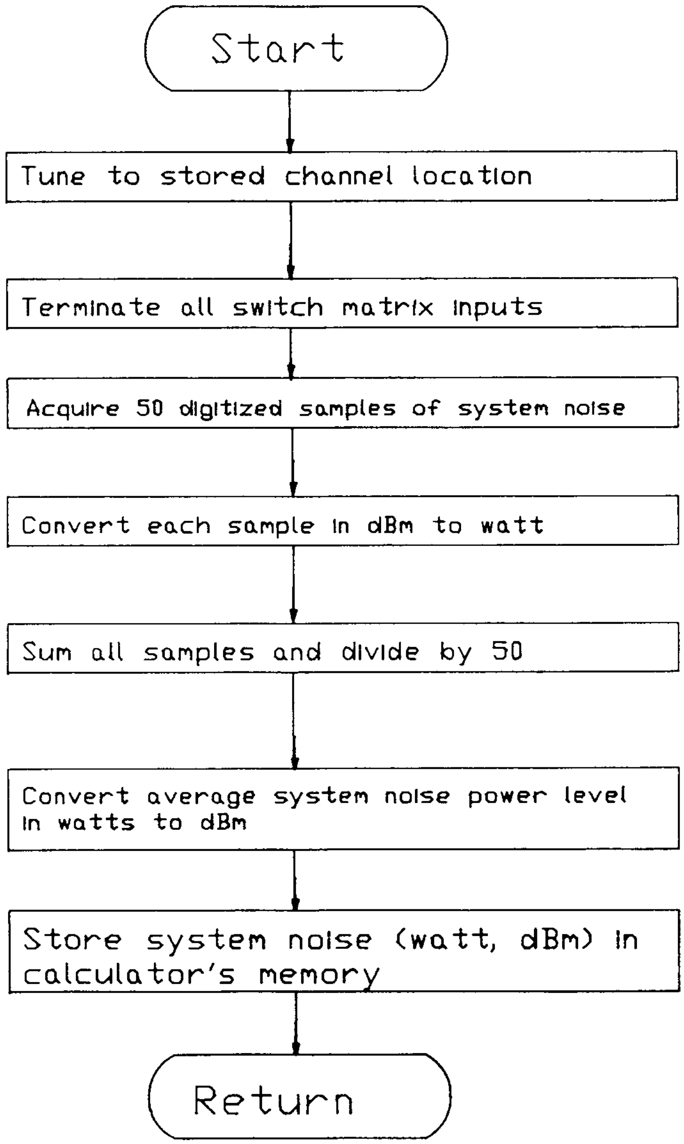


Figure 29. Flow Chart - Acquisition & Processing of System Noise.

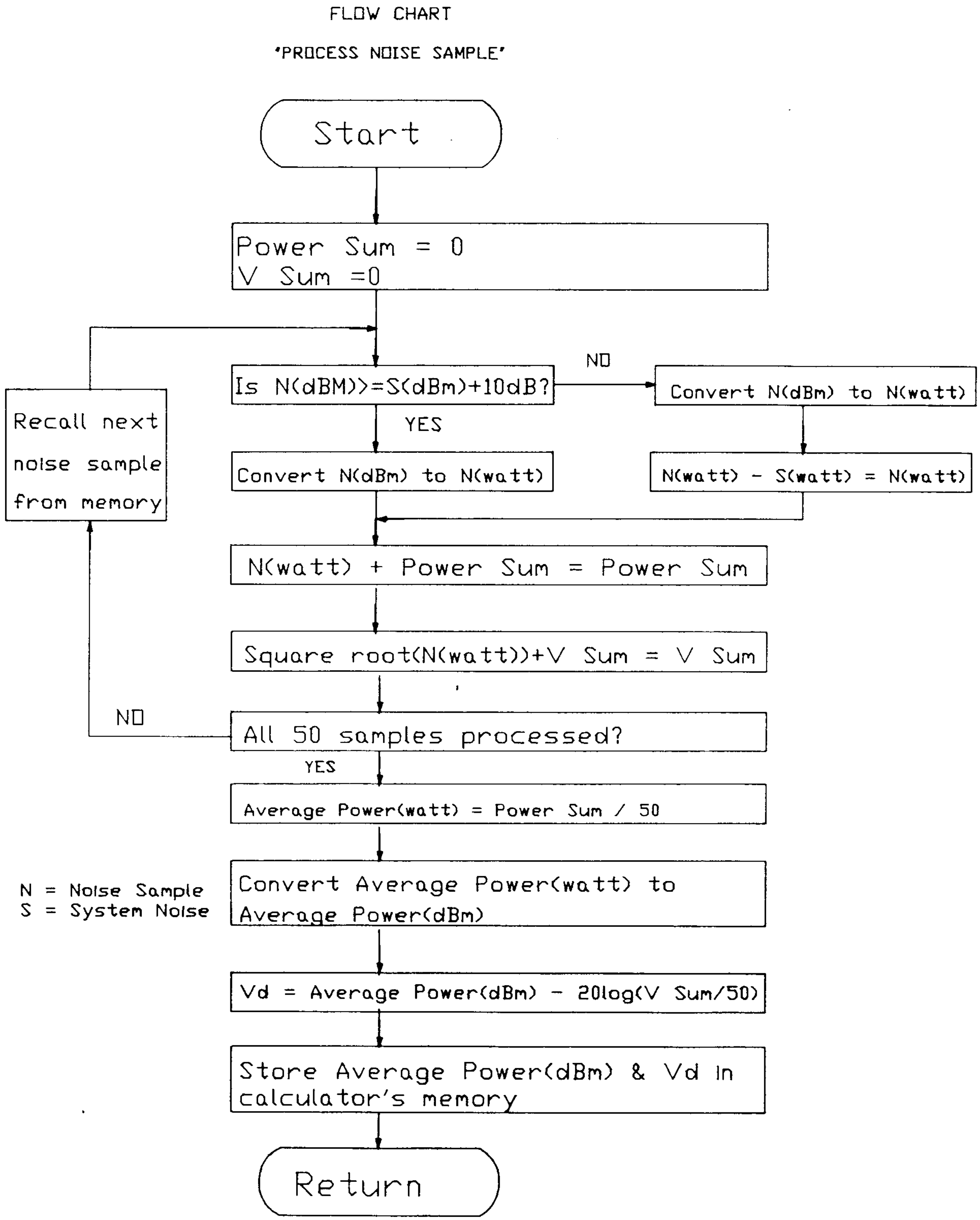


Figure 30. Flow Chart - Processing Noise Samples.

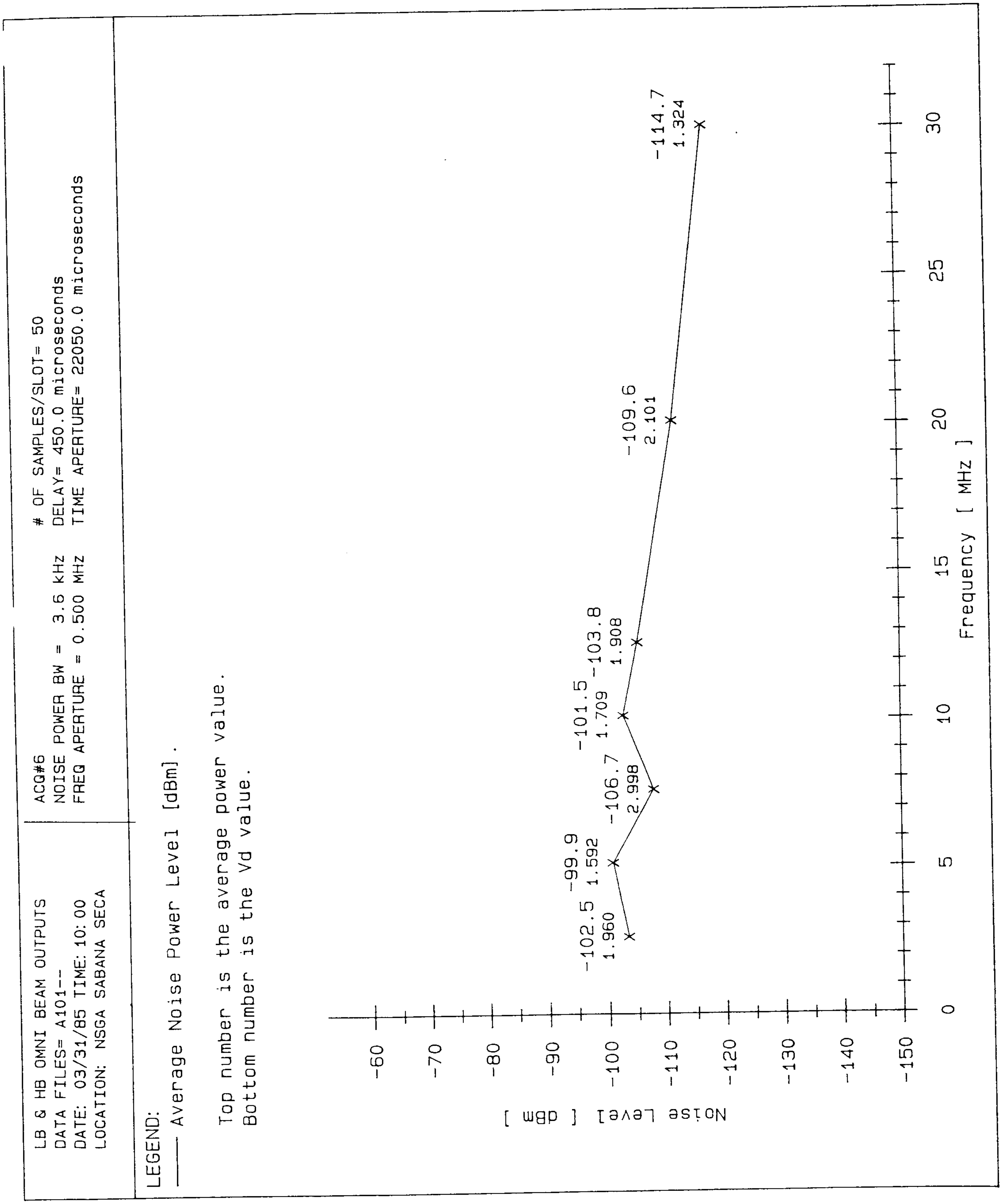


Figure 31. 2-D Plot - LB & HB Omni Beam Outputs.

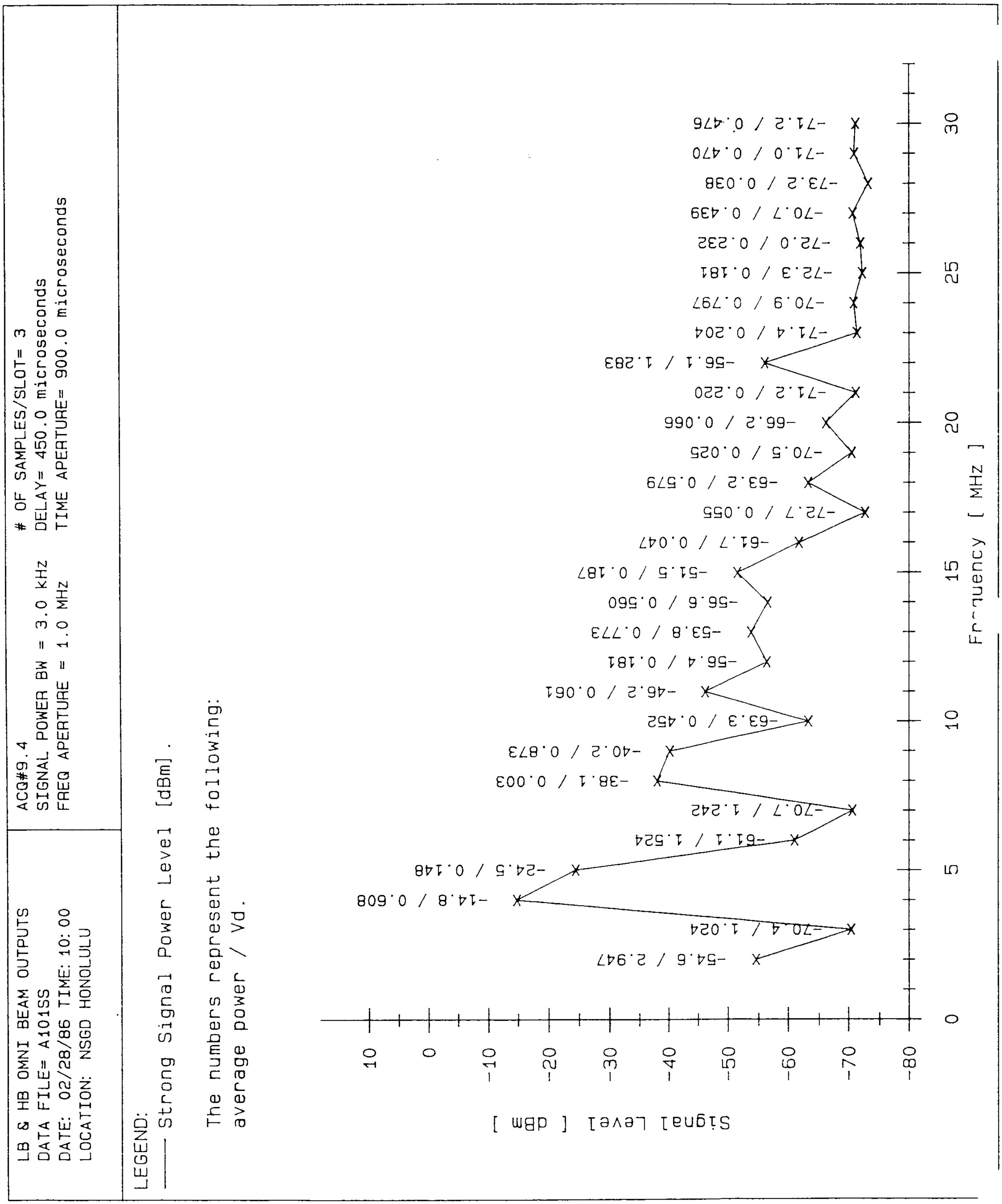


Figure 32. 2-D Plot - Strong Signal.

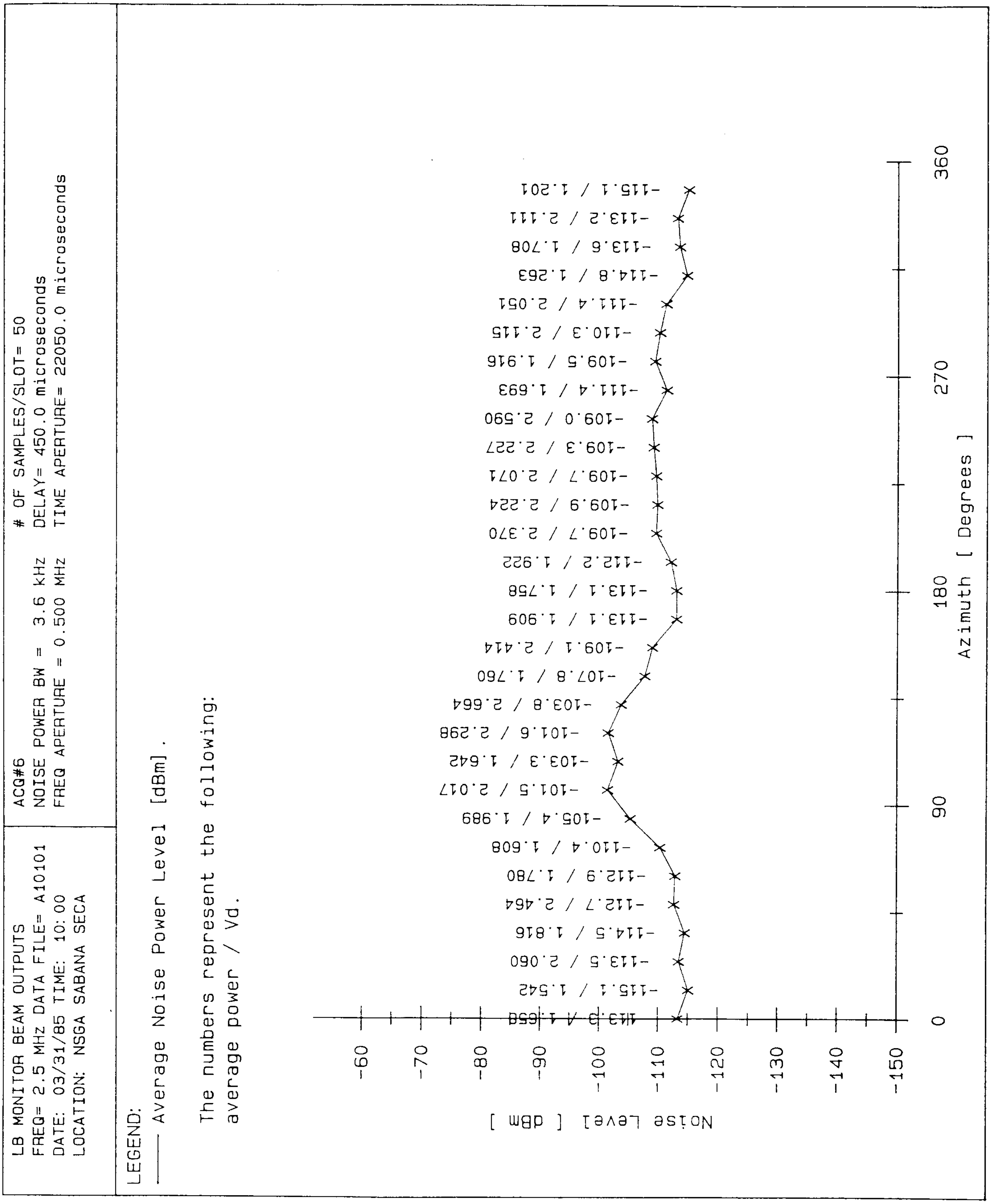


Figure 33. 2-D Plot - LB Monitor Beam Outputs.

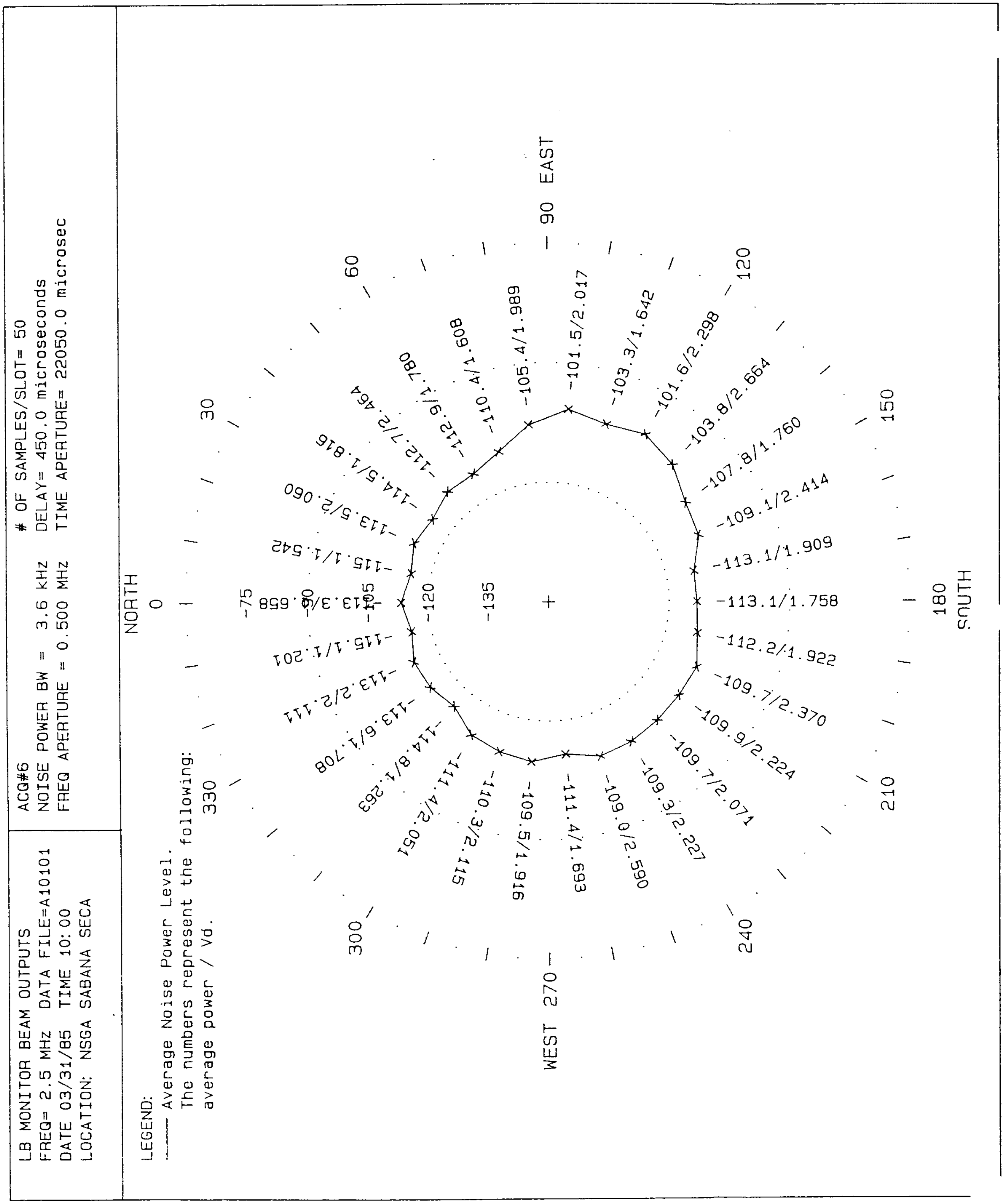


Figure 34. Polar Plot - LB Monitor Beam Outputs.

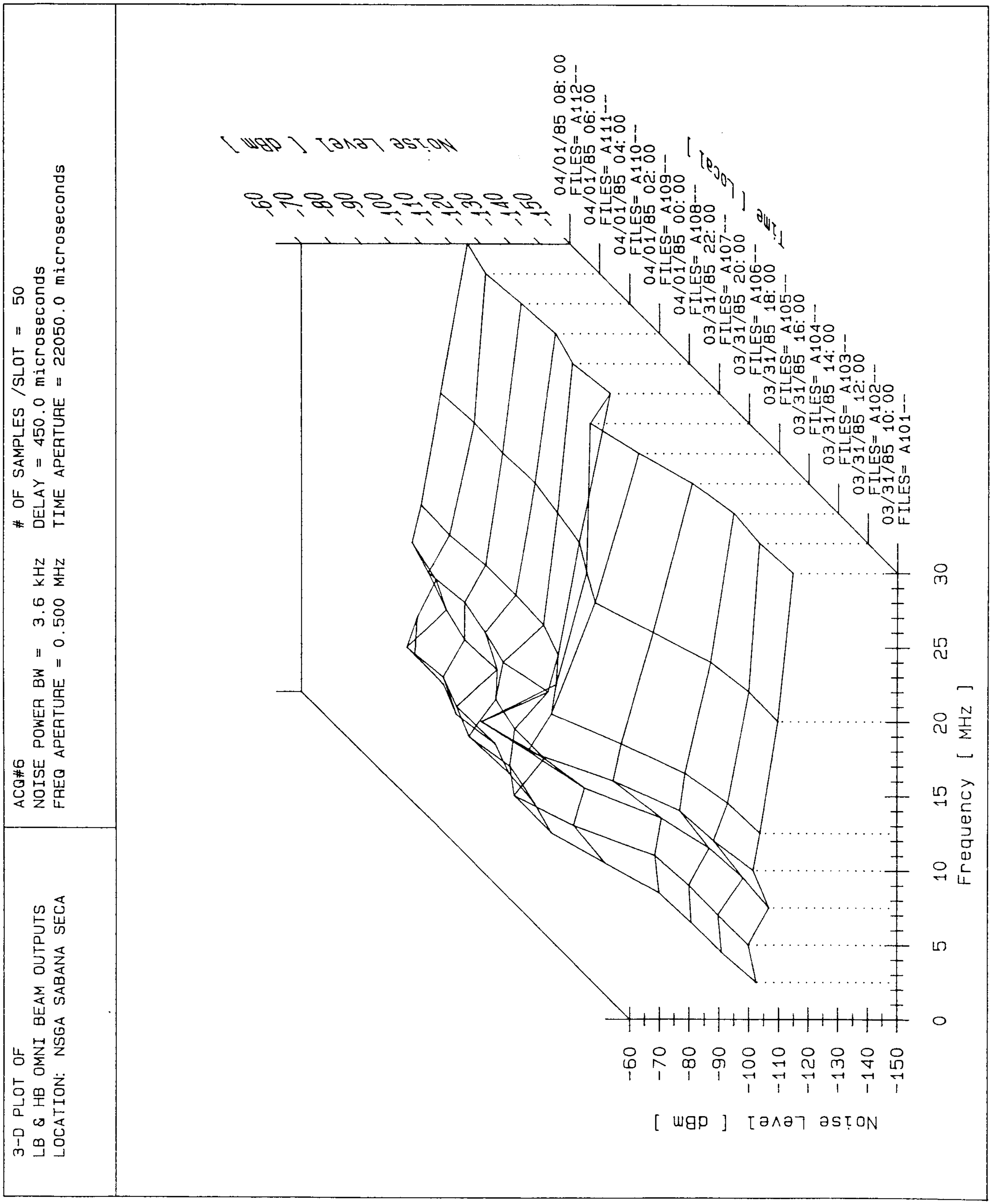


Figure 35. 3-D Plot - LB & HB Omni Beam Outputs.

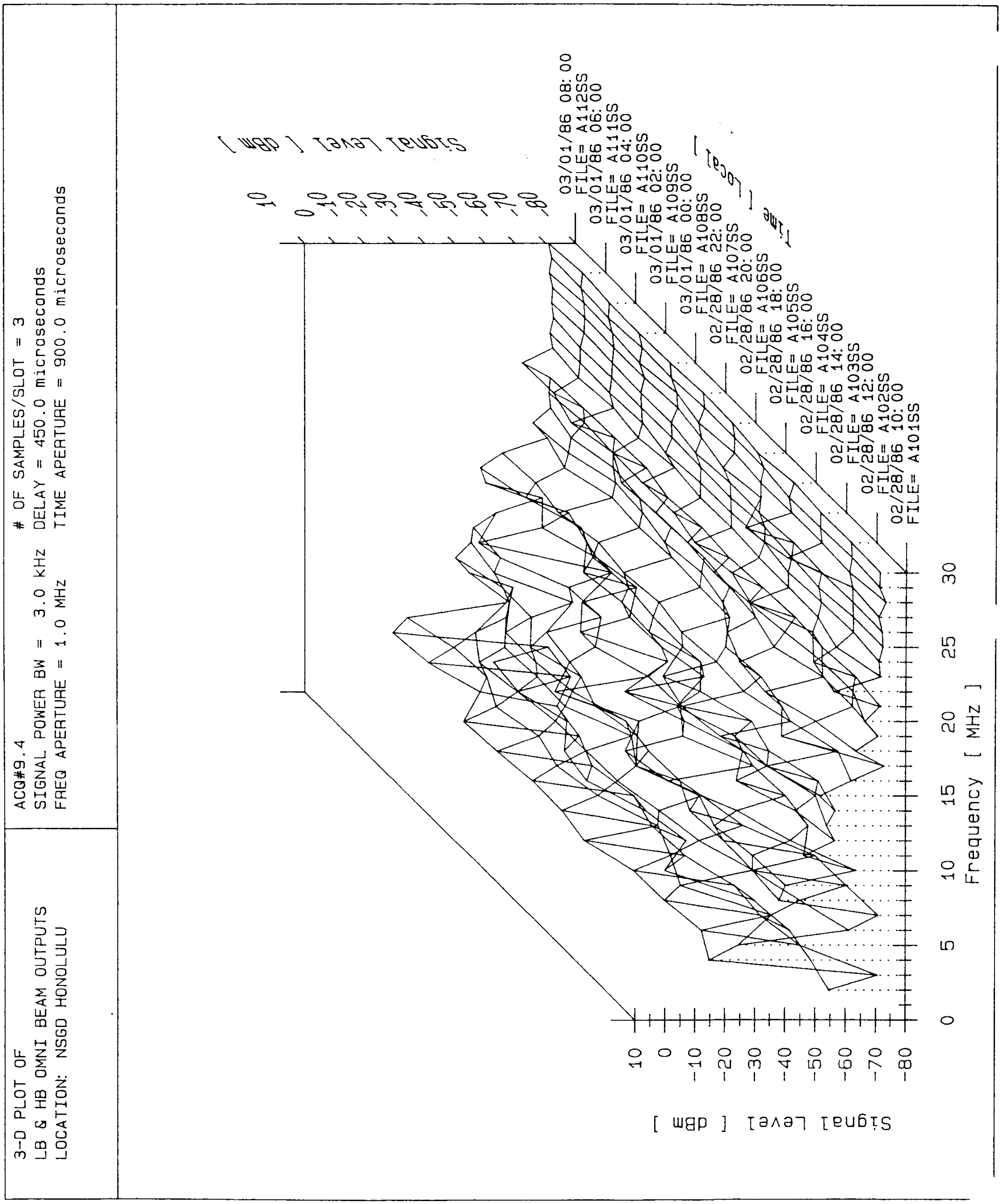


Figure 36. 3-D Plot - Strong Signal.

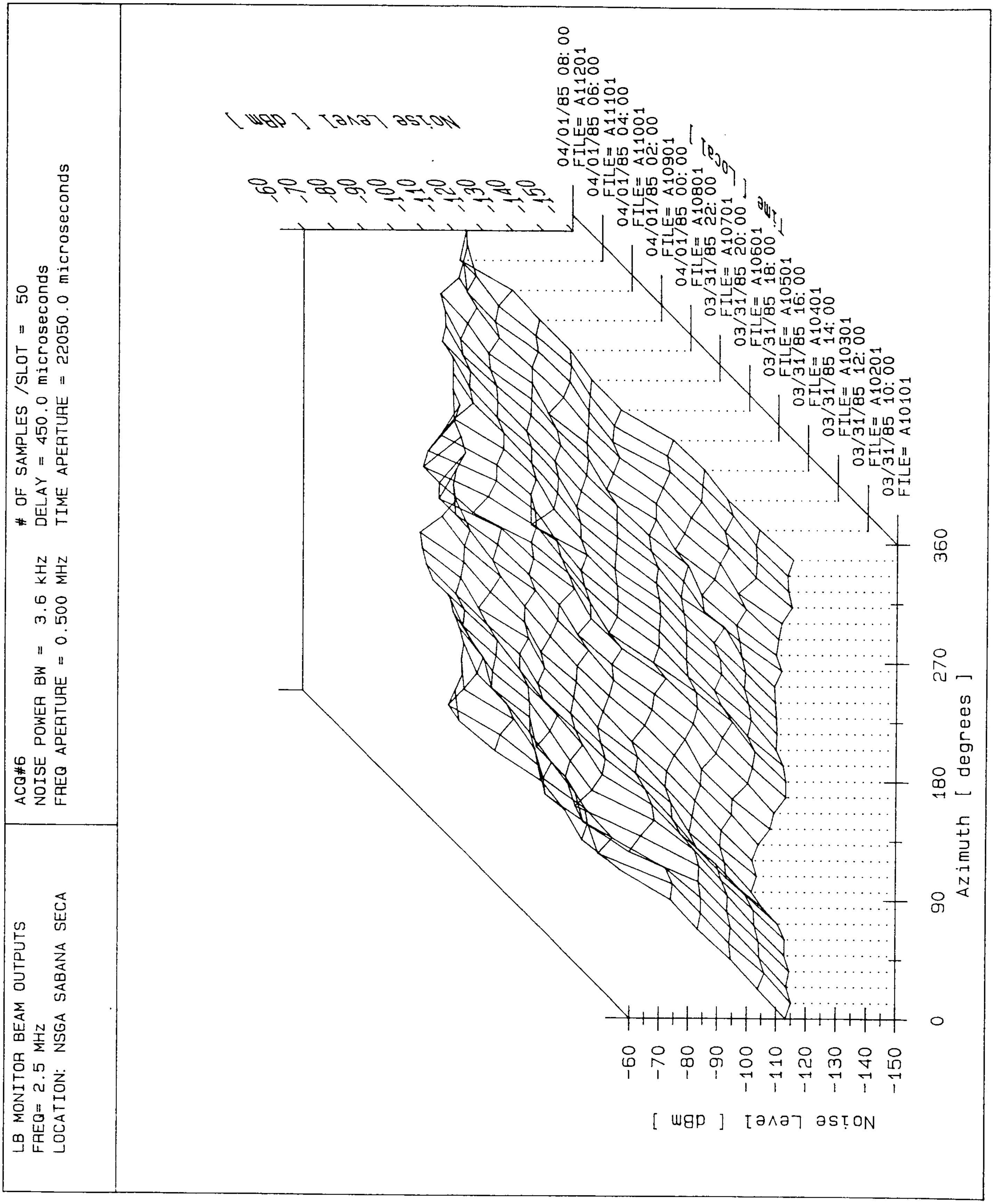


Figure 37. 3-D Plot - LB Monitor Beam Outputs.

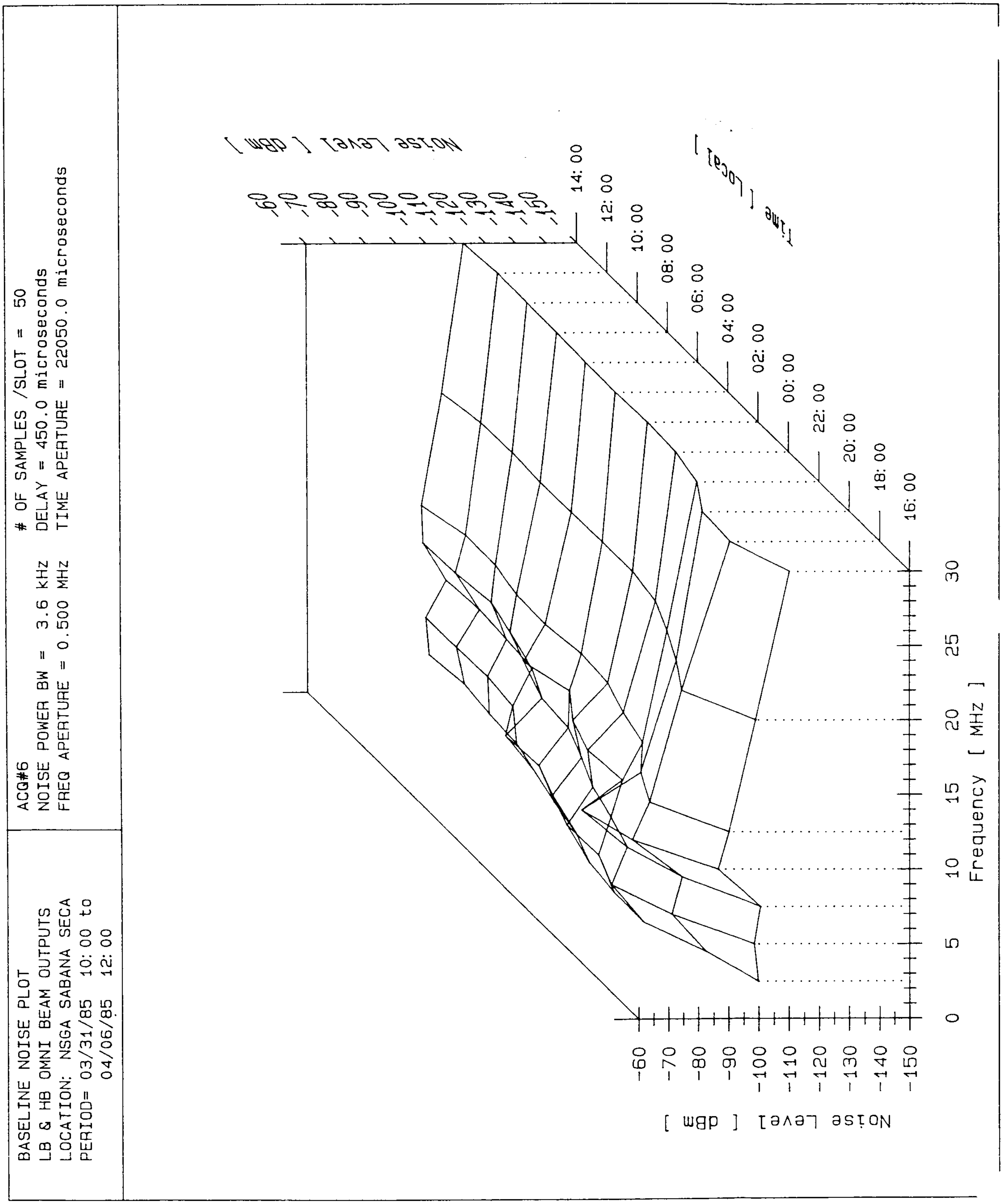


Figure 38. Baseline Plot - LB & HB Omni Beam Outputs.

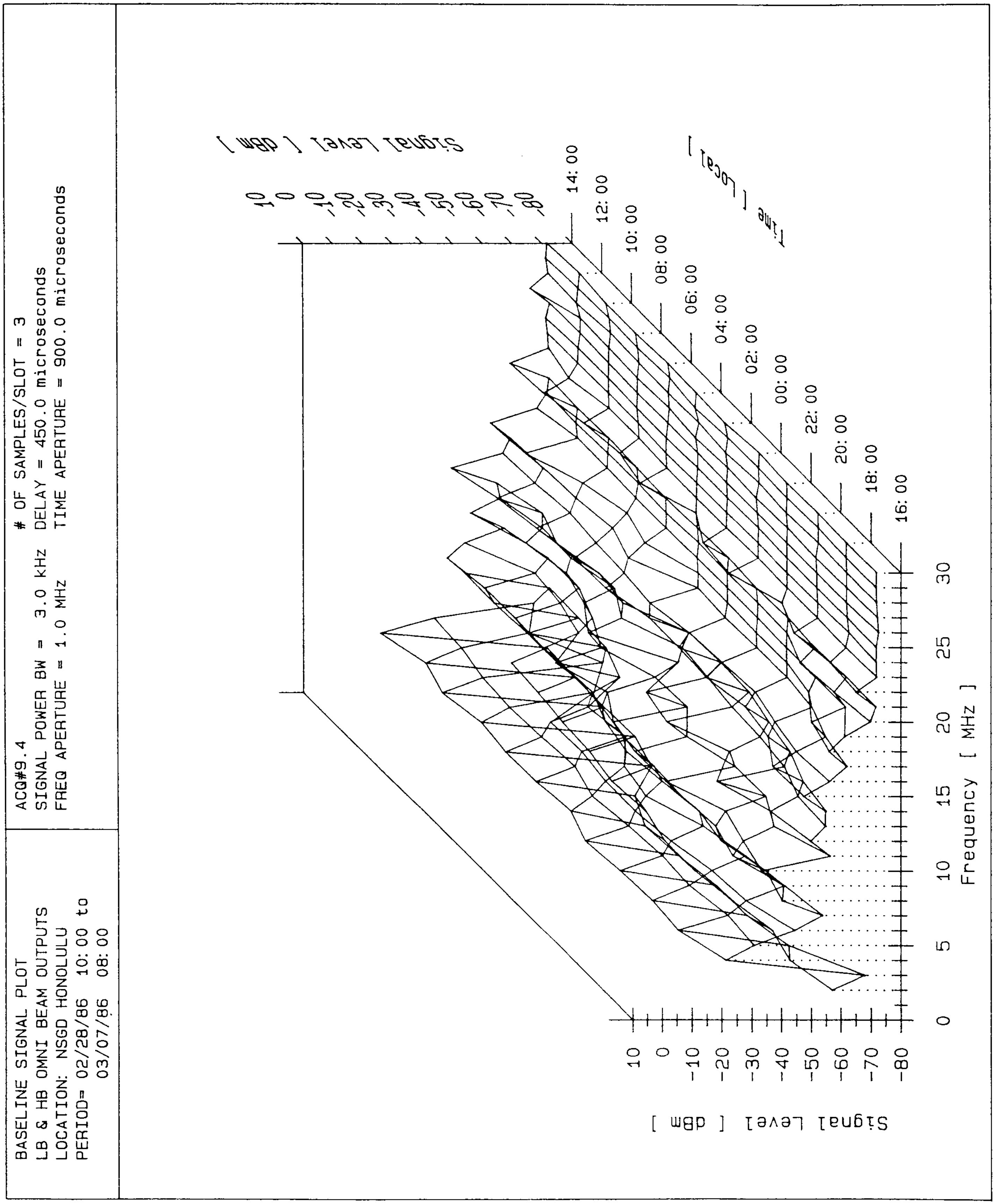


Figure 39. Baseline Plot - Strong Signal.

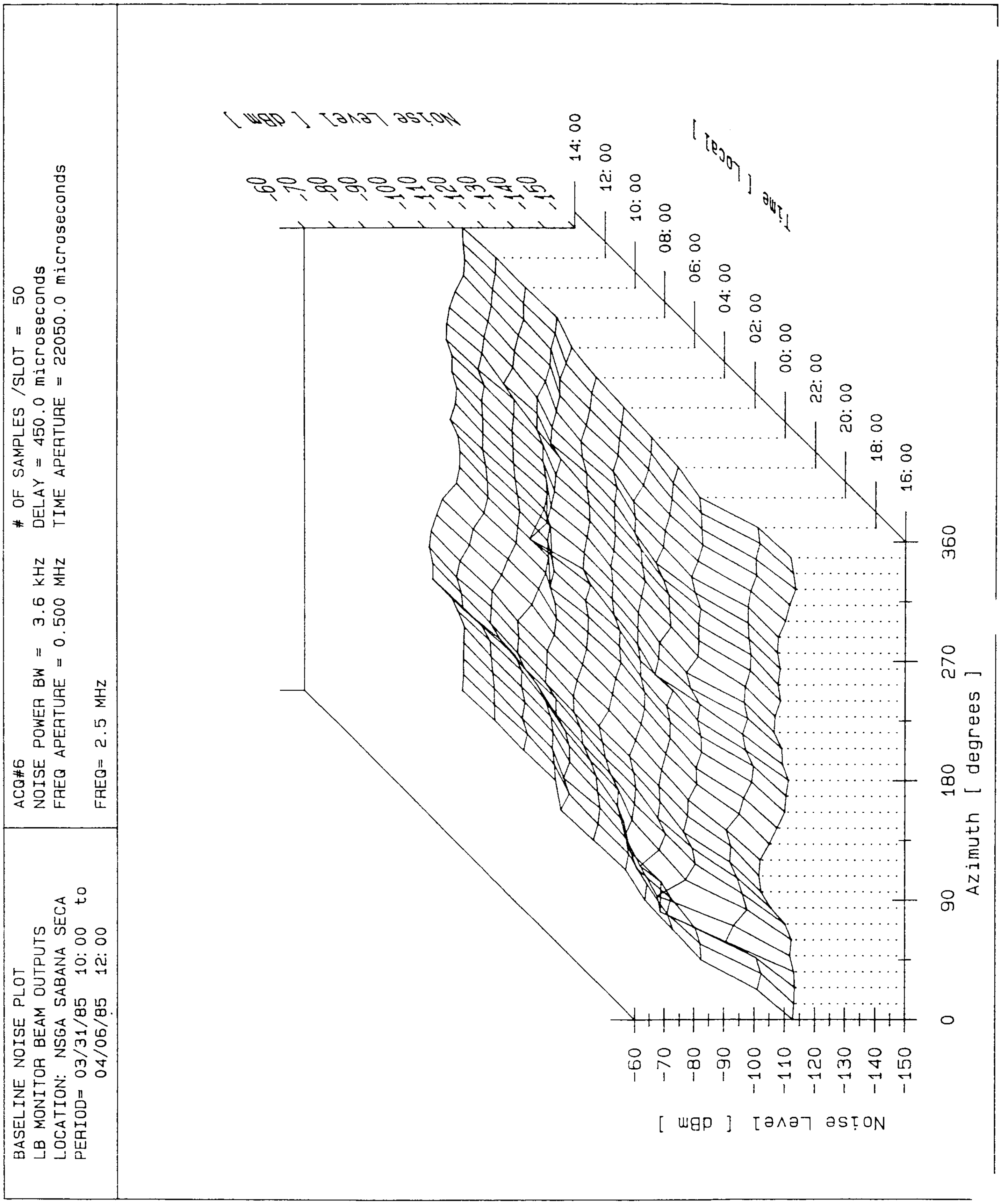


Figure 40. Baseline Plot - LB Monitor Beam Outputs.

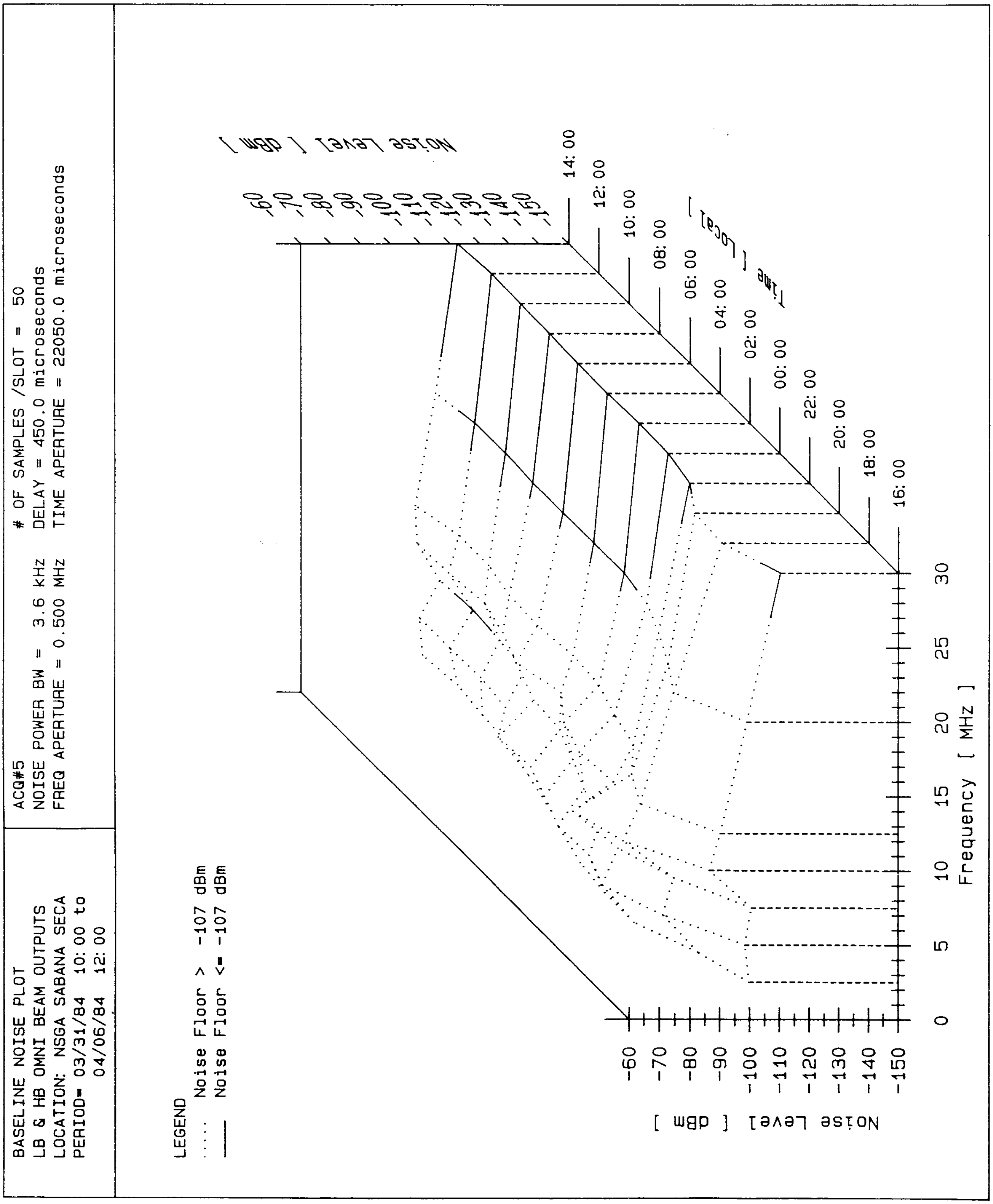


Figure 41. Baseline Plot - Minimum Discernible Signal of LB & HB Omni Beam Outputs.

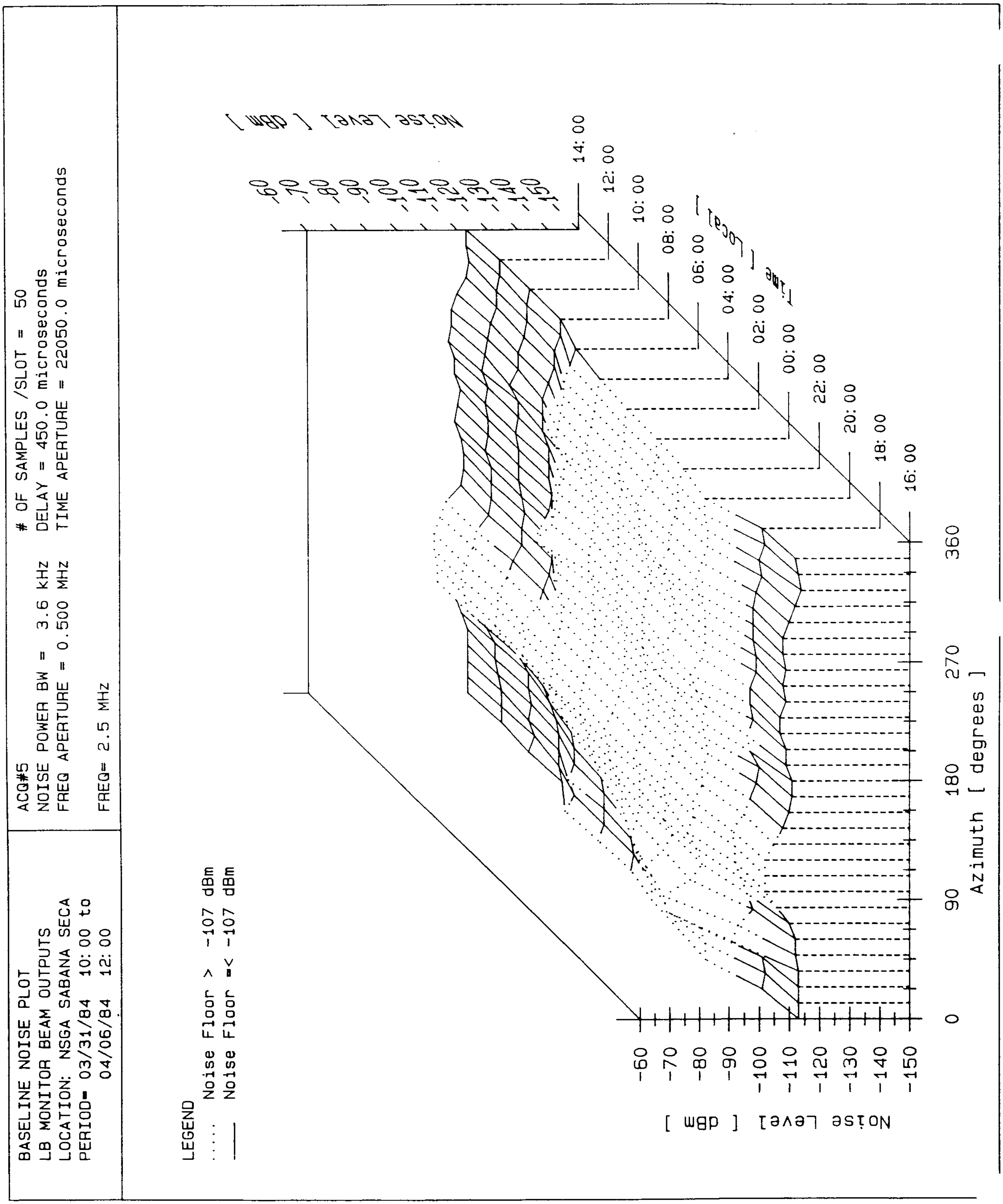
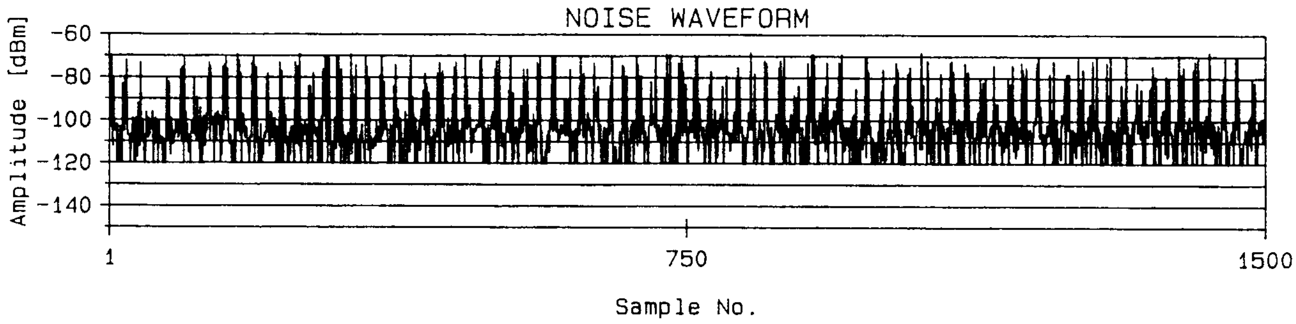
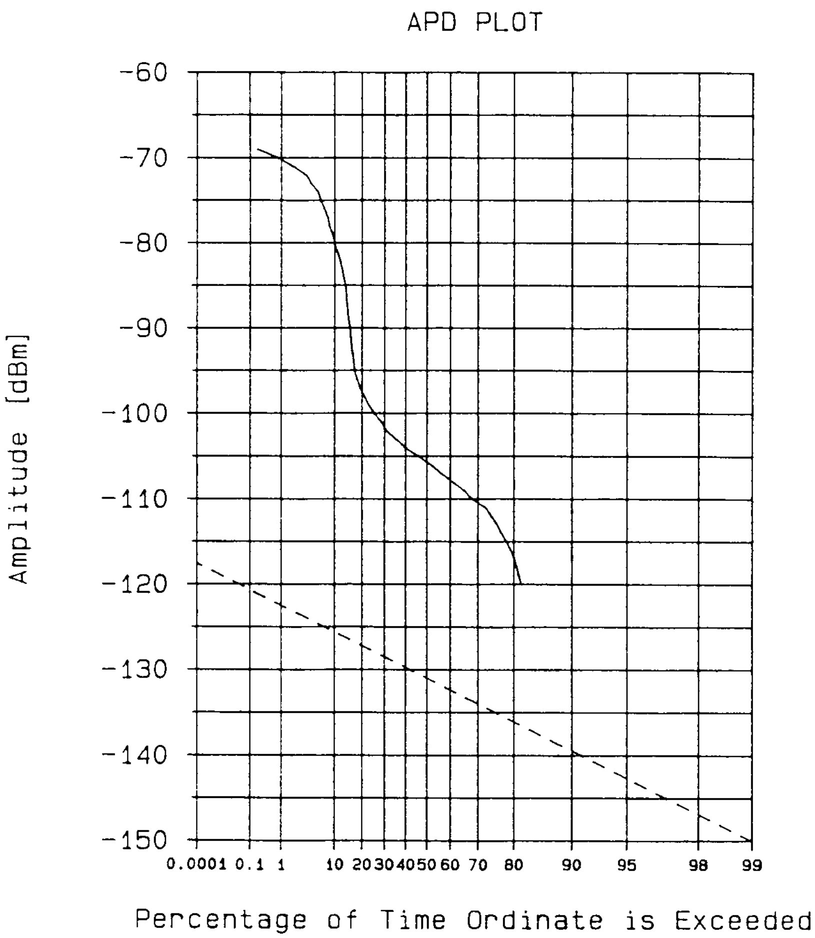


Figure 42. Baseline Plot - Minimum Discernible Signal of LB Monitor Beam Outputs.

FILE: AAPD4
LOCATION: NSGA SABANA SECA
DATE: 04: 06: 85
TIME: 16: 14
FREQUENCY: 2.833 MHz
BEAM: LB Mon 23

BANDWIDTH: 3.6 kHz
NO. OF SAMPLES: 1500
DELAY = 450.0 microseconds
TOTAL SAMPLE TIME: 674550.0 microseconds





Average Power [dBm] = -83 (-82)
Vd [dB] = 8.05 (8.00)

Figure 43. Supplemental Plot - Amplitude Probability Distribution.

FILE: AAPD4
LOCATION: NSGA SABANA SECA
DATE: 04: 06: 85
TIME: 16: 14
FREQUENCY: 2.833 MHz
BEAM: LB Mon 23

BANDWIDTH: 3.6 kHz
NO. OF SAMPLES: 1500
DELAY = 450.0 microseconds
TOTAL SAMPLE TIME: 674550.0 microseconds

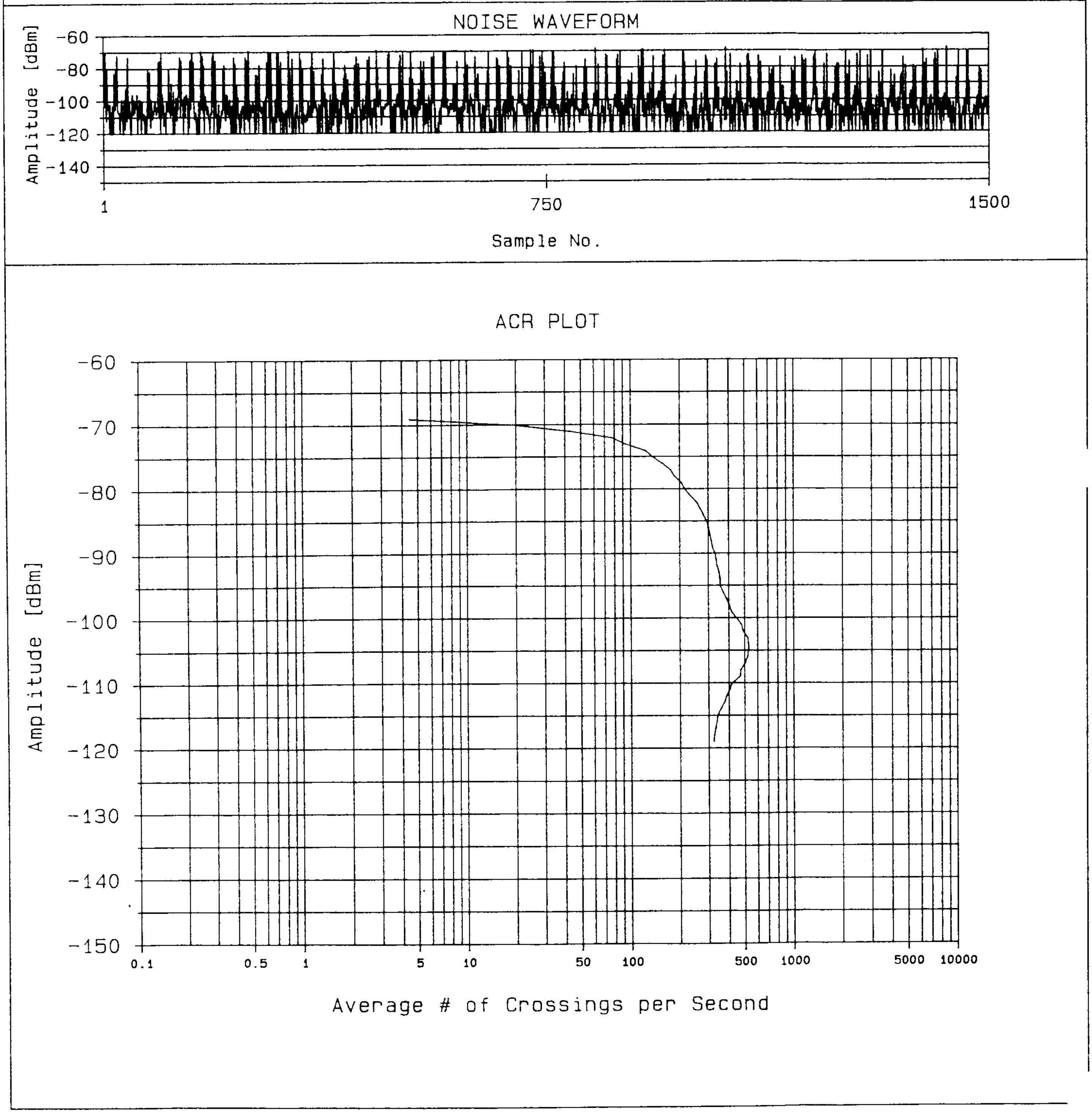
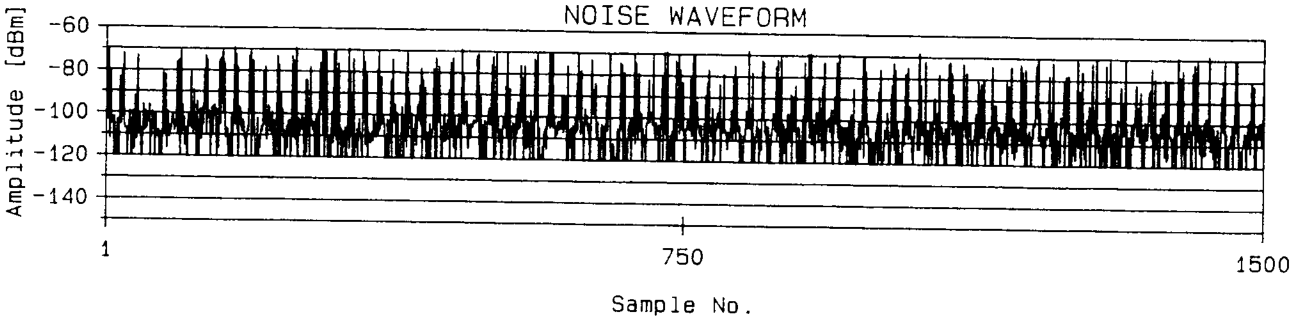


Figure 44. Supplemental Plot - Average Crossing Rate.

FILE: AAPD4
LOCATION: NSGA SABANA SECA
DATE: 04:06:85
TIME: 16:14
FREQUENCY: 2.833 MHz
BEAM: LB Mon 23

BANDWIDTH: 3.6 kHz
NO. OF SAMPLES: 1500
DELAY = 450.0 microseconds
TOTAL SAMPLE TIME: 674550.0 microseconds



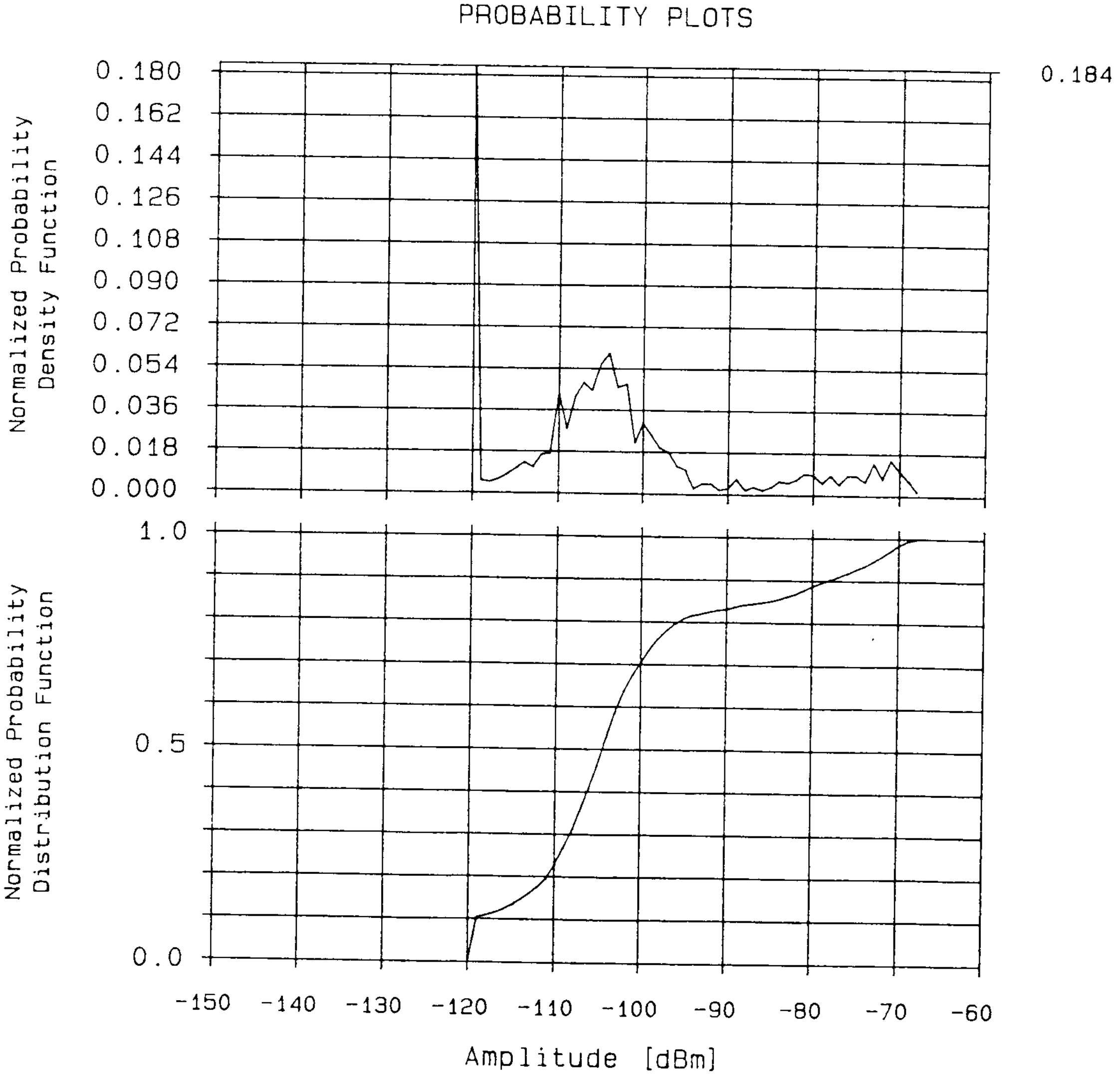


Figure 45. Supplemental Plot - Probability Density & Distribution Functions.

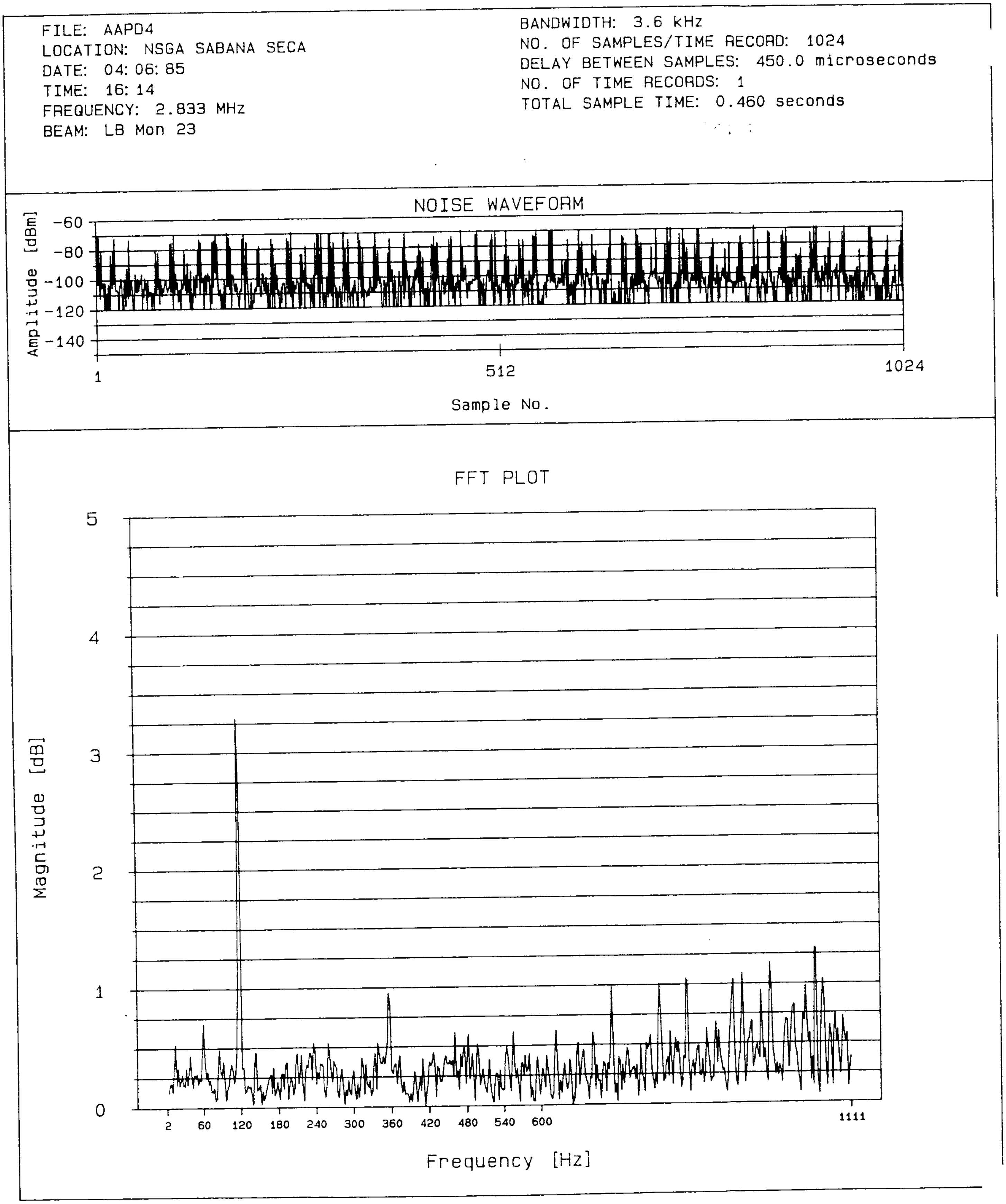


Figure 46. Supplemental Plot - Fast Fourier Transform.

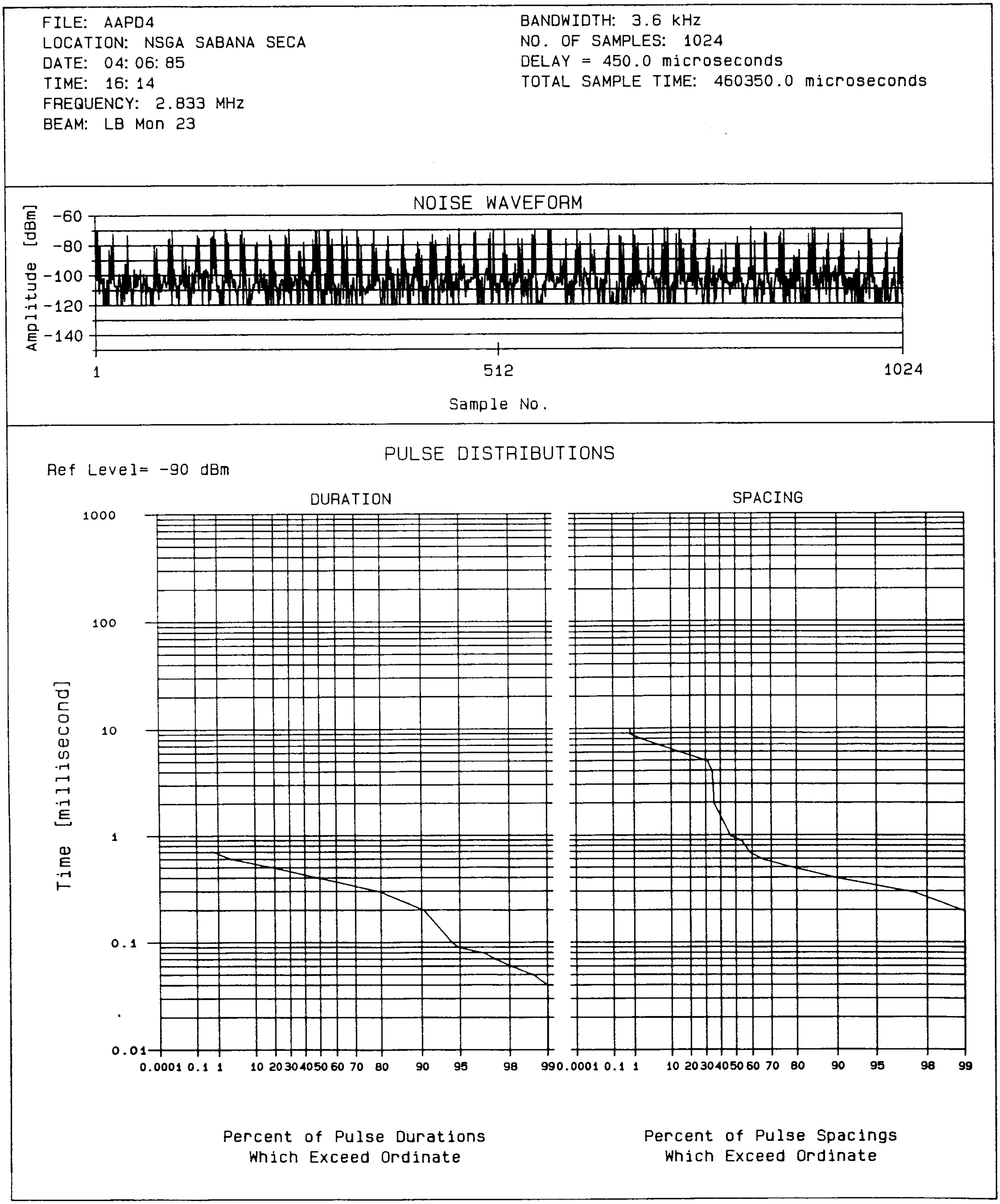


Figure 17. Supplemental Plot - Pulse Spacing and Duration Distribution.

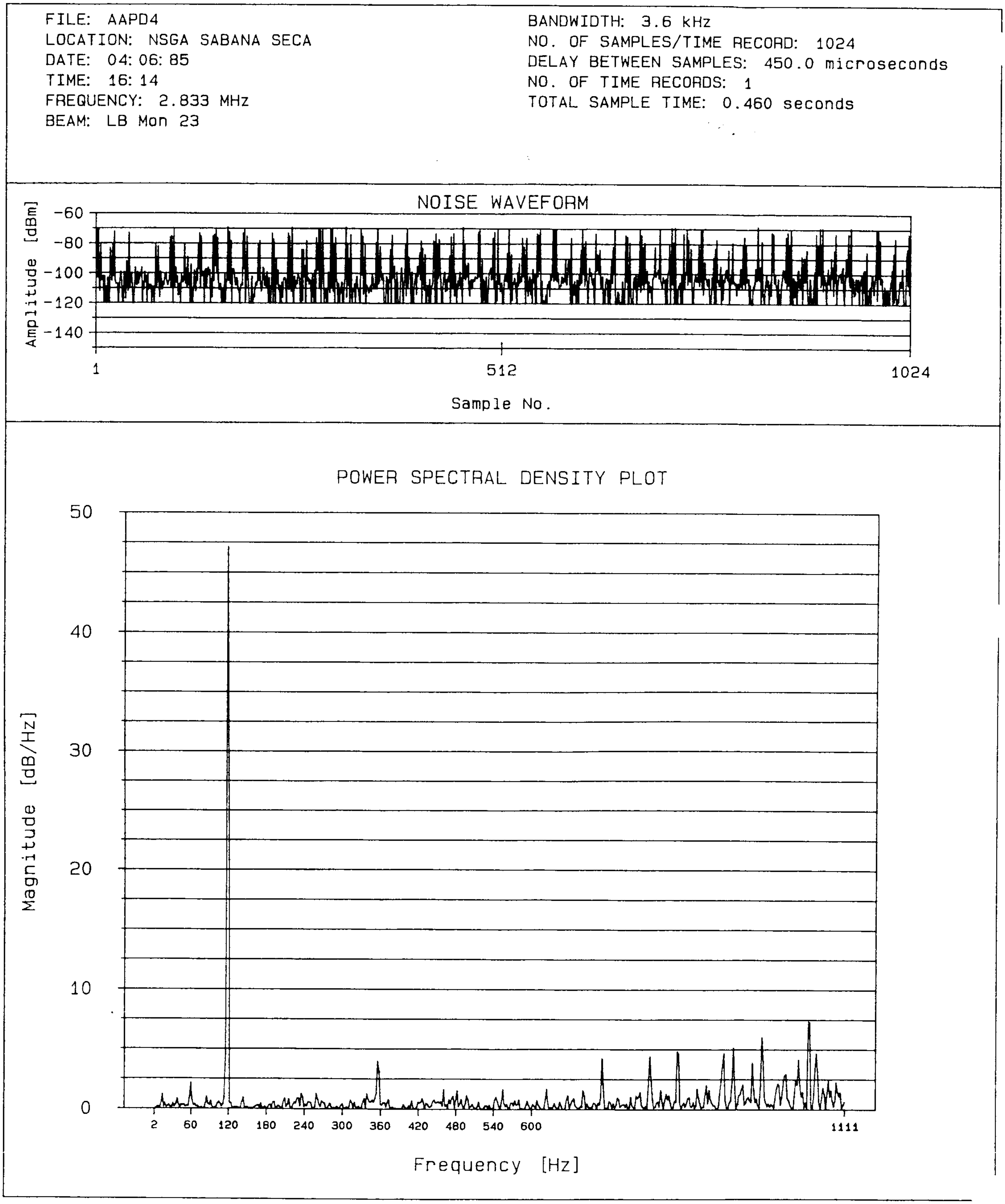


Figure 48. Supplemental Plot - Power Spectral Density.

FILE: AAPD4
LOCATION: NSGA SABANA SECA
DATE: 04: 06: 85
TIME: 16: 14
FREQUENCY: 2.833 MHz
BEAM: LB Mon 23

BANDWIDTH: 3.6 kHz
NO. OF SAMPLES: 512
DELAY BETWEEN SAMPLES: 450.0 microseconds
TOTAL SAMPLE TIME: 0.230 seconds

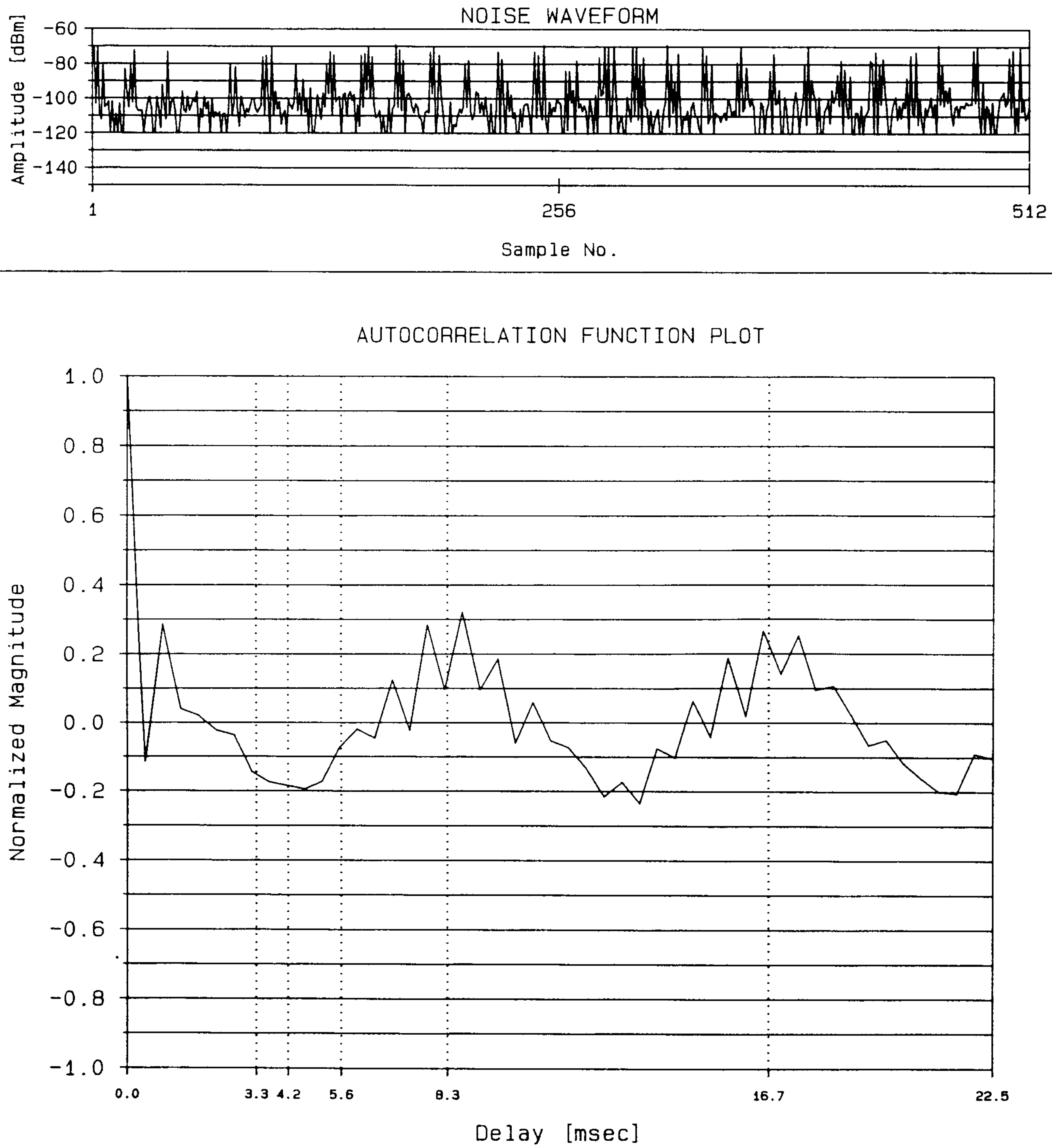


Figure [illegible]9. Supplemental Plot - Autocorrelation Function.

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APPENDIX A

HARDWARE DESCRIPTION OF THE AUTOMATED AN/FRM-19(V) TEST SYSTEM

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APPENDIX A

HARDWARE DESCRIPTION OF THE AUTOMATED AN/FRM-19(V) TEST SYSTEM

Testing and analysis are the two main functions of the AUTOMATED AN/FRM-19(V) Test System. In order to understand the basic mechanics of the automated testing process, it should be remembered that the HP 8407A/8412A Network Analyzer and HP 8601A Generator/Sweeper are not fully programmable and that the HP 9825T Calculator utilizes interfacing equipment to both control and read measurements from these test equipment. The HP 8407A/8412A and HP 8601A can also be replaced by an HP 3577A Network Analyzer which is fully programmable and interfaces directly with the HP 9825T Calculator. Figures A1 and A2 are block diagrams of the AUTOMATED AN/FRM-19(V) Test System using either the HP 8407A/8412A and HP 8601A or the HP 3577A, respectively. Table A1 lists the components shown in Figures A1 and A2 and describes their function. Table A2 is a list of test equipment for the AUTOMATED AN/FRM-19(V) Test System.

A. Automated Antenna and Multicoupler Test.

The control center of the AUTOMATED AN/FRM-19(V) Test System is the HP 9825T Desktop Calculator which controls the acquisition of test measurements from the HP 8407A/8412A Network Analyzer with the help of an Analog to Digital (A/D) Converter or directly from the HP 3577 Network Analyzer via the HP-IB interface. The operator communicates with the system by inputting through the calculator's keyboard. Once the operator has calibrated the test equipment and specified the start-up time, no further operator intervention is required for running the Daily Automated Antenna and Multicoupler Tests. The operator has the choice of also running the Detailed Automated Antenna and Multicoupler Test. The calculator uses the HP 59306A Relay Actuator to emulate an operator manually setting the AN/FRM-19(V) Mode Selector to the appropriate mode and to the desired element under test. The Relay Actuator consists of six independently programmable (single pole double throw) relays which are wired to the control circuits of the AN/FRM-19(V) Mode Selector. The calculator closes or opens the appropriate relay contacts to simulate the switching of the front control panels. The calculator sends its commands through an HP-IB interface to the units that are contained within the AUTOMATED AN/FRM-19(V) Test Cart.

<u>Using the HP 8407A/8412A Network Analyzer:</u>

Once the test mode is set and the AN/FRM-19(V) switching head is positioned to the first element under test, the calculator tunes the HP 8601A Generator/Sweeper to the first test frequency in the test band. The test signal frequency is tuned through the use of the external FM modulation input of the HP 8601A, by setting a negative DC voltage from the HP 59501B Power Supply Programmer that corresponds to the desired test frequency. The test signal is inserted into the AN/FRM-19(V) and the corresponding test elements (antenna or multicoupler) responses are returned back through the AN/FRM-19(V) and then into the TEST and REFERENCE inputs of the HP 8407A/8412A. Ideally, the responses which come from two similar array elements (antenna or multicoupler) should be identical since both are excited by the same test signal. The HP

8407A/8412A measures the amplitude and phase differences between the TEST and REFERENCE inputs and produces DC voltages (CRT vertical deflection voltages) proportional to the amplitude and phase differences which are displayed on the CRT. These DC voltages are also digitized by the HP 59313A Analog-Digital Converter and transferred to the calculator which analyzes the test data using the test parameters. The calculator then increments the power supply programmer output to set the next test frequency and the measurement cycle is repeated. After all frequencies are tested, the test results for this element are stored in memory.

Using the HP 3577A Network Analyzer:

Once the test mode is set and the AN/FRM-19(V) switching head is positioned to the first element under test, the HP 9825T Calculator sets up the test frequency band, 2.5 to 12 MHz for lowband testing and 8 to 32 MHz for highband testing. The test signal is inserted into the AN/FRM-19(V) and the corresponding test elements (antenna or multicoupler) responses are returned back through the AN/FRM-19(V) and then into the "A" input (test) and "R" input (reference) of the HP 3577A. Ideally, the responses which come from two similar array elements (antenna or multicoupler) should be identical since both are excited by the same test signal. The HP 3577A measures the amplitude and phase differences between the "A" and "R" inputs and displays the differences on the CRT screen. The amplitude and phase differences are transferred to the Calculator via the HP-IB interface in a trace consisting of 51 points (for the Daily Test) or 201 points (for the Detailed Test). The calculator then analyzes the test data for each test frequency using the test parameters. After all test frequencies are analyzed, the test results for this element are stored in memory.

When testing of the current element is done, the calculator then signals the relay actuator to tell the AN/FRM-19(V) Mode Selector to switch to the next element under test and then the testing procedure is repeated. Once the measurements have been completed, the system will automatically tabulate the test results.

In order for the calculator to selectively control the equipment connected to the instrumentation bus, each unit is assigned a unique device address. Each unit contains a select address switch (refer to the equipment manual for the location of the switch) and it should be set to the addresses listed in Table A3.

B. Automated Beamformer Test.

The Automated Beamformer Test utilizes the HP 8407A/8412A or the HP 3577A Network Analyzer to determine if the beamformer's amplitude response is within the test tolerances. The Automated Beamformer Test uses the same technique in gathering the test data as mention in the section above. The beamformer "test" signal is routed through the primary multicoupler, through the beamformer, into a distribution multicoupler, then into the RF Matrix Switch (which is computer controlled by the calculator), into the AN/FRM-19(V) Mode Selector, and then finally out to the HP 8407A/8412A TEST input or the HP 3577A "A" input for analysis. The "reference" signal returns through the AN/FRM-19(V) standard multicoupler, to the AN/FRM-19(V) Mode

Selector, then to the HP 8407A/8412A REFERENCE input or the HP 3577A "R" input. The calculator can select lowband or highband omni, monitor, goniometer, and SPECOMM beams with the use of the Matrix Systems Model 4027B 80x1 RF matrix switch for testing purposes.

C. Automated Noise Measurement System.

The ANMS hardware consists basically of 6 main blocks: the RF Switch, Front End, Noise Detector, Controller/Processor (HP 9825T), Memory, and Documentation. The RF Switch consists of an 80 input x 1 output switching matrix which has at least 64 of its inputs connected to the beam outputs (1 lowband omni, 30 lowband monitors, 1 lowband goniometer low angle difference, 1 highband omni, 30 highband monitors, and 1 highband goniometer low angle difference). This is the same RF matrix switch used by the Automated Beamformer Test. Commands from the Controller/Processor selects which of the beam outputs is to be connected to the Front End. The Front End controls the level of RF power entering the Noise Detector. The gain of the Front End must be high enough to provide adequate sensitivity, but still set low enough to prevent intermodulation products or noise that may be created from large RF signals overdriving the mixer within the HP 141T/8553B/8552B Spectrum Analyzer. The noise detection is provided by a Spectrum Analyzer which is a highly sensitive superheterodyne receiver that can be externally tuned to a specific frequency and from which an analog output of the noise waveform at that frequency can be obtained. The Controller/Processor manages the acquisition and processing of the noise waveform. The HP 141T has no digital capabilities. Consequently, the interfacing between the HP 141T and HP 9825T Calculator is provided by the two HP 59501B Digital-to-Analog (D/A) and one HP 3437A Analog-to-Digital (A/D) units. The two D/A units receive digital commands from the HP 9825T and outputs an analog voltage which tunes the HP 141T to a specific frequency. The analog noise waveform from the HP 141T is digitized by the A/D converter. The digitized data is transferred to the HP 9825T where it is processed then passed to the Memory for storage. The memory for the ANMS is provided by the HP 9895A 8-inch Dual Floppy Disk Drive units. One drive is loaded with the program files (drive 0) and the other drive contains the disk where all the noise data is stored (drive 1).

SPECIAL NOTE: The Detailed Automated Antenna and Multicoupler Test also stores its test data on drive 1. Therefore, separate data discs are needed for the AUTOMATED AN/FRM-19(V) Optional Tests.

Documentation is provided by an HP 9872 or HP 7475 plotter which generates plots of the data in various formats for analysis.

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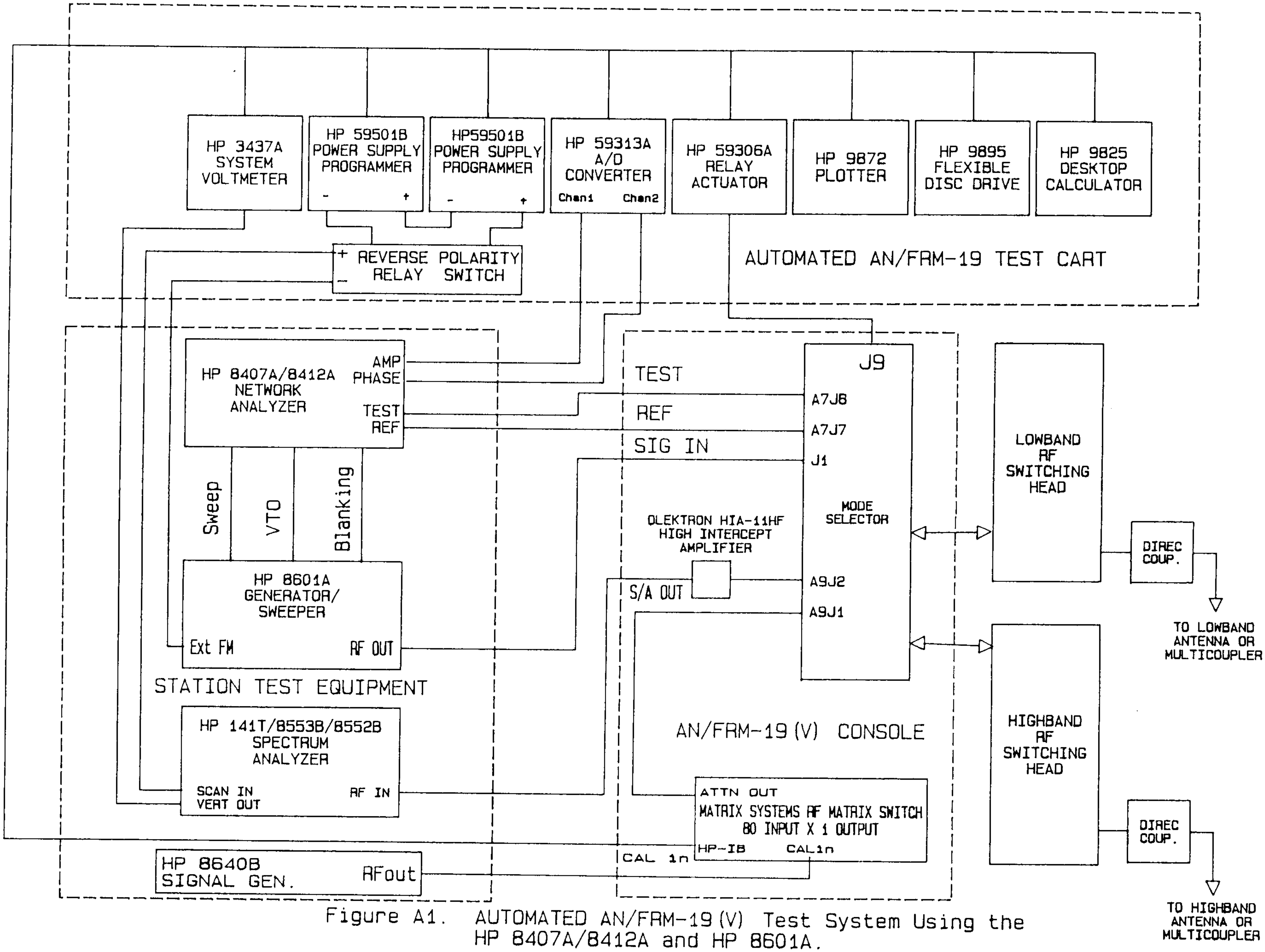

Figure A1. AUTOMATED AN/FRM-19 (V) Test System Using the HP 8407A/8412A and HP 8601A.

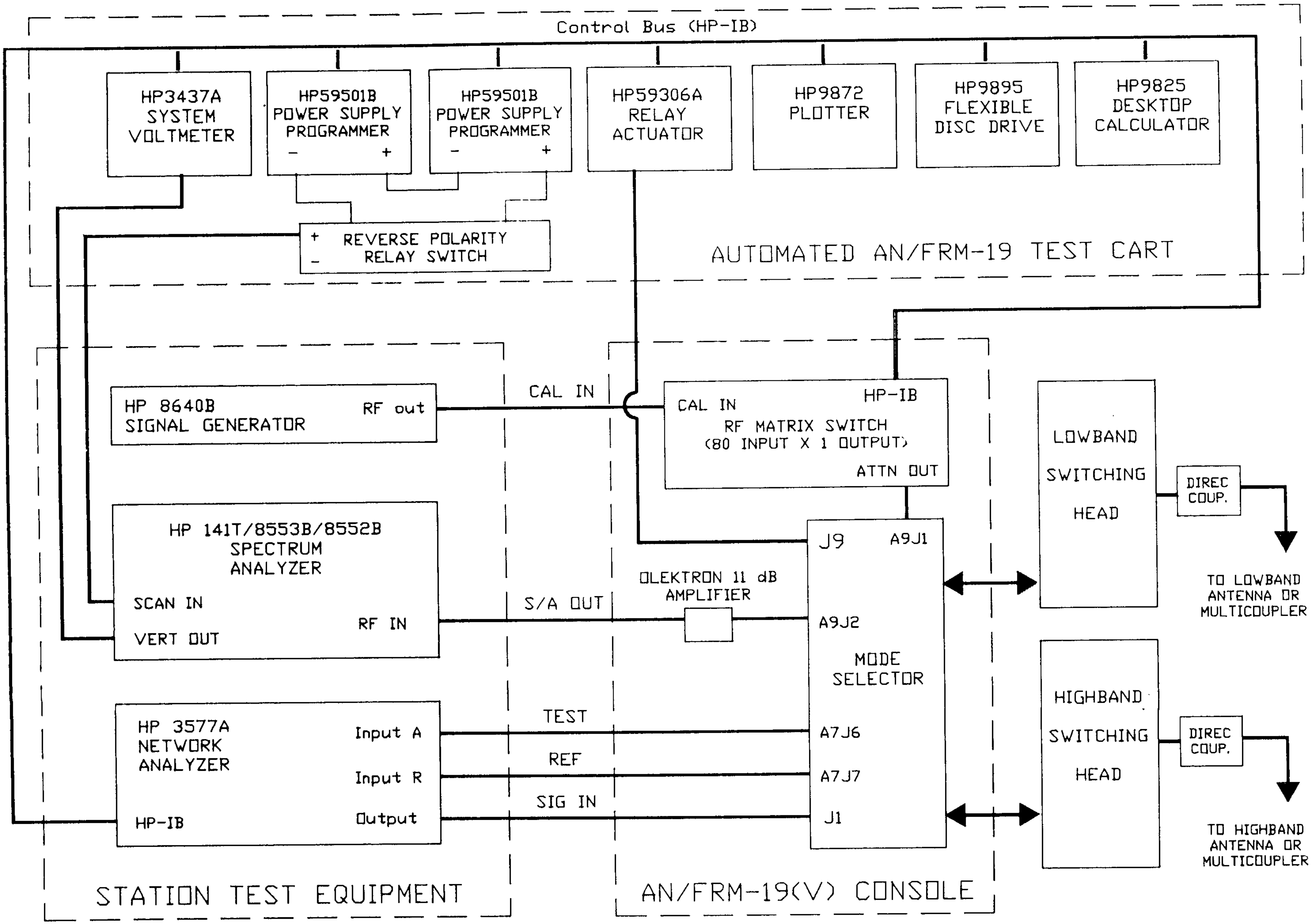

Figure A2. AUTOMATED AN/FRM-19(V) Test System Using the HP 3577A.

Table A1. EQUIPMENT FUNCTIONS

Equipment	Function in AUTOMATED AN/FRM-19(V) Test System
HP 9825T Desktop Calculator	The calculator is the control center of the system. It controls both the peripherals and the test equipment. The HP 9825T uses an IEEE-488 (HP-IB) interface bus to send and receive data from its peripheral devices (HP 59501B, HP 59313A, HP 3437A, HP 59306A, HP 9872C/7475A, HP 9895A, and Model 4027B RF Matrix Switch. The test equipments are controlled through the use of the HP 59501B, HP 59313A, and HP 59306A peripheral devices.
HP 9895A Flexible Disc Drive	The flexible disc drives stores critical test parameters and test data for the Daily and Optional Tests.
HP 9872C or 7475A Plotter	The plotter is used to plot the different options in the PLOT Module.
HP 59306A Relay Actuator	The Relay Actuator consists of six individually programmable relays. These relays control the different test modes (Calibrate, Antenna, Coupler, and Simulator) of the AN/FRM-19(V) Mode Selector.
HP 59501B Programmable Power Supply	The Programmable Power Supply provides the Calculator with digital to analog control of the HP 8601A Generator/Sweeper (EXT FM input) and the HP 141T Spectrum Analyzer (SCAN IN input). The DC voltage is used for frequency control in both cases.
HP 59313A A/D Converter	The A/D Converter provides the Calculator with the analog to digital capabilities to receive test data from the HP 8407A/8412A Network Analyzer.
HP 3437A System Voltmeter	The System Voltmeter provides the Calculator with a fast read-write capability to take in noise test data from the HP 141T/8553B/8552B Spectrum Analyzer. This device is used as an A/D converter for the ANMS tests.
Model 4027B 80x1 RF Matrix Switch	The Calculator can select the lowband or highband omni, monitor, goniometer, or SPECOMM beams through the RF Matrix Switch. The Matrix Switch also contains a programmable attenuator which is used in the ANMS test to control the received signal levels to prevent intermodulation on the HP 141T Spectrum Analyzer.
Reverse Polarity Relay Switch	The Reverse Polarity Relay Switch is used to change the polarity of the HP 59501B Programmable Power Supply's DC voltage. This is because the HP 8601A EXT FM input requires a negative voltage and the HP 141T SCAN IN input requires a positive voltage for frequency control.

Table A2. TEST EQUIPMENT REQUIRED

Controller

1. HP 9825T Desktop Calculator
2. HP 98034B HP-IB Interface Card
3. HP 98035A Real Time Clock
4. HP 98211A Matrix ROM
5. HP 98228A Mass Storage ROM (for HP 9895A)

Peripheral Equipment

1. HP 9895A Flexible Disc Drives with Option 025
2. HP 59501B Power Supply Programmer (D/A Converter); QTY. 2
3. HP 59313A Analog to Digital Converter
4. HP 3437A System Voltmeter
5. HP 59306A Relay Actuator
6. HP 9872C Plotter with Option 025 or HP 7475A Plotter
7. Model 4027B Matrix Systems 80 input x 1 output RF Matrix Switch

Test Equipment

1. AN/FRM-19(V) Antenna Test Set
2. HP 8407A/8412A Network Analyzer and HP 8601A Generator/Sweeper or HP 3577A Network Analyzer
3. HP 141T/8553B/8552B Spectrum Analyzer
4. HP 8640B RF Signal Generator
5. One pair 75-ohm phase matched cables (approximately 3 meters)
6. Three 50-ohm cables (approximately 3 meters)
7. Miscellaneous cables, connectors, and adapters

Table A3. DIGITAL EQUIPMENT HP-IB ADDRESS

	Equipment	Device Address
1.	HP 9825T Desktop Calculator	721
2.	HP 9895A Flexible Disk Drive	707
3.	HP 59313A Analog to Digital Converter	706
4.	HP 59501B Programmable Power Supply (D/A1)	729
5.	HP 59501B Programmable Power Supply (D/A2)	730
6.	HP 59306A Relay Actuator	715
7.	HP 3437A System Voltmeter	724
8.	HP 9872C or HP 7475A Plotter	705
9.	Model 4027B 80xl RF Matrix Switch	701
10.	HP 3577A Network Analyzer	711
11.	HP 98034B HP-IB Interface	7
12.	HP 98035A Real Time Clock	9

NOTE: The instrumentation control interface (HP 98034B HP-IB bus) can be set to various select codes. The select code is the first number in the device address. The Real Time Clock uses a separate slot on the rear of the Desktop Calculator and has a different select code (9) from the HP-IB interface.

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APPENDIX B

DESCRIPTION OF THE CONTROLS, CONNECTORS, AND INDICATORS FOR THE AUTOMATED AN/FRM-19(V) TEST EQUIPMENT

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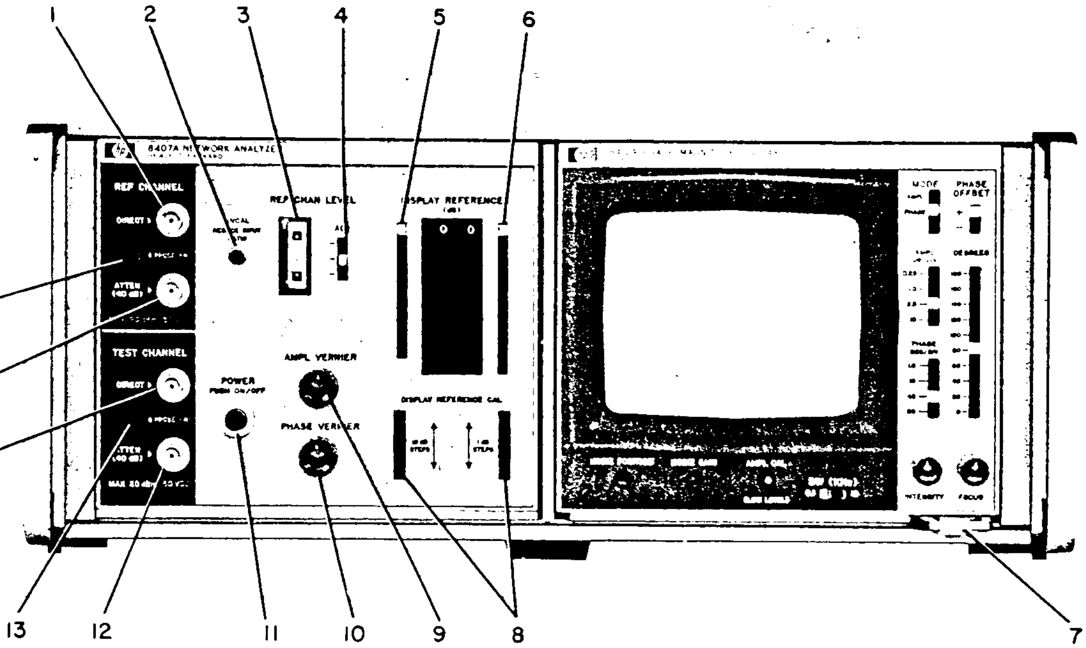
Table B1. HP 8407A Controls, Connectors, and Indicators



FRONT PANEL

1. REF CHANNEL DIRECT Input Connector. Reference channel RF input for signal inputs in the range of -10 to -90 dBm. If the input RF signal is greater than -10 dBm, the ATTEN input should be used. In this case a 50-ohm termination must be connected to DIRECT input.

2. UNCAL REDUCE INPUT RATIO light. This is an overload indicator that monitors signal levels of the test channel within the instrument. When an overload occurs, either the reference channel signal must be increased, or the test channel signal must be decreased. The reference channel signal may be increased by either adjusting the REF CHANNEL LEVEL ADJ attenuator switch or by changing the RF input cable from ATTEN to DIRECT input. The test channel signal may be decreased by changing the RF input cable from DIRECT to ATTEN input, or by reducing the RF signal level from the sweep oscillator.

3. REF CHAN LEVEL Meter. An indication in the OPERATE range of the meter shows that the reference channel input signal level is in the correct range to make signal measurements.

4. REF CHAN LEVEL ADJ. The switch is a three-position attenuator in the reference channel. Each step is 20 dB. The switch allows the reference channel signal to be adjusted to produce a REF CHAN LEVEL meter indication in the OPERATE range.

5. DISPLAY REFERENCE(dB) Ten dB/Step. This switch offsets the amplitude trace on the HP 8412A display by adding or reducing gain of the test channel in 10 dB steps.

6. DISPLAY REFERENCE(dB) One dB/Step. This switch offsets the amplitude trace on the HP 8412A display by adding or reducing gain of the test channel in 1 dB steps.

7. Pivoting lever installs, retains, and extracts the plug-in display units.

8. DISPLAY REFERENCE CAL Thumbwheels. These thumbwheels set the scales for the DISPLAY REFERENCE 10 dB/Step and 1 dB/Step switches. This allows the scales to be set at zero dB for the calibration position of the switches. When measuring gain or attenuation, the displayed magnitude trace may be returned to the calibration point on the graticule with the DISPLAY REFERENCE switches. This allows the total gain or attenuation of the unit under test to be read directly from the DISPLAY REFERENCE scales.

9. AMPL VERNIER. Uncalibrated test channel gain vernier with at least 2 dB of continuous range. Gain increases with clockwise rotation.

10. PHASE VERNIER. Uncalibrated vernier adjustments of the phase between reference and test channel signals. Range is at least 50 degrees.

11. POWER ON/OFF. Combination line power switch and power indicator. Switch lights when instrument is on.

12. TEST CHANNEL ATTEN(40 dB) Input Connector. Test channel RF input that attenuates the RF input signal by 40 dB greater than the TEST CHANNEL DIRECT input. Signal input range for the ATTEN input is between +20 and -50 dBm. If the input RF signal is less than -50 dBm, the DIRECT input should be used. Damage level is above +26 dBm and 50 Vdc.

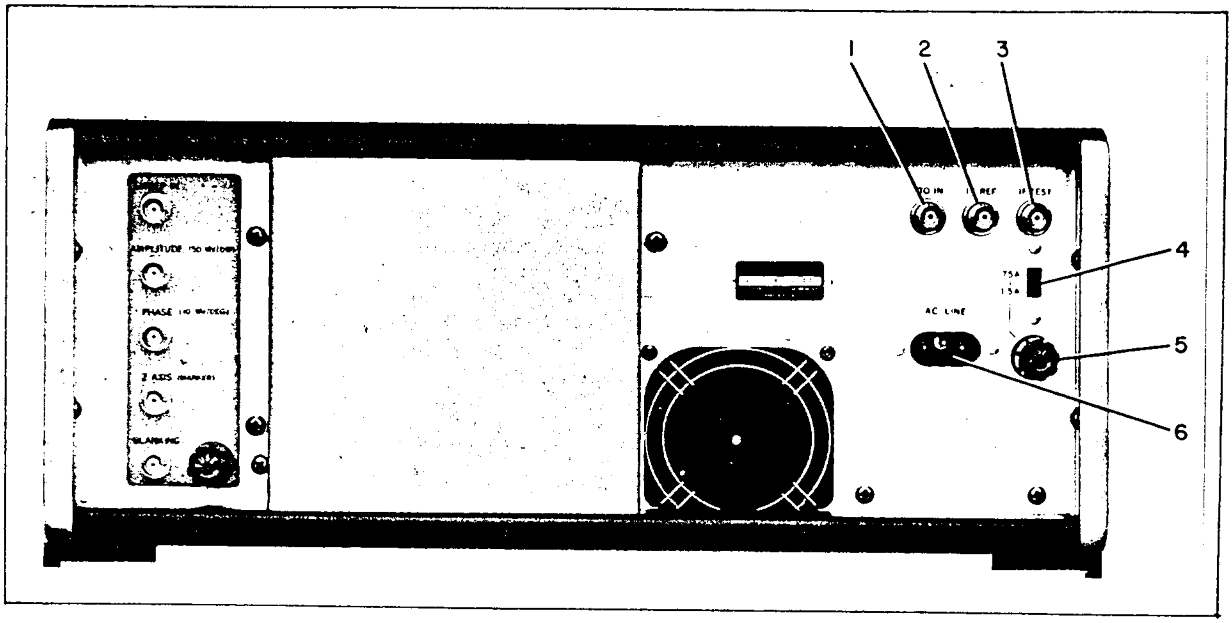
13. TEST CHANNEL PROBE POWER Connector. Provides power for active test-channel accessory probe.

14. TEST CHANNEL DIRECT Input Connector. Test channel RF input that is used for signal inputs in the range of -10 to -90 dBm. If the input RF signal is greater than -10 dBm, the ATTEN input should be used. In this case, a 50-ohm termination must be connected to DIRECT input. Damage level is above +26 dBm and 50 Vdc.

15. REF CHANNEL ATTEN(40 dB) Input Connector. Reference channel RF input that attenuates the RF input signal by 40 dB greater than the REF CHANNEL DIRECT input. Signal input range for the ATTEN input is between +20 and -50 dBm. Damage level is above +20 dBm and 50 Vdc.

16. REF CHANNEL PROBE POWER Connector. Provides power for active reference channel accessory probe.

Table B2. HP 8407A Controls and Connectors



REAR PANEL

1. VTO IN Connector. Input for voltage tuned oscillator (VTO) signal from sweeper. VTO signal frequency should be in the range of 200.1 to 310 MHz and power level should be between -5 and -15 dBm nominal. The VTO signal is frequency locked to the sweeper RF output signal. The HP 8601A or 8690B/8698B Sweep Oscillator VTO output provides the proper signal.

2. IF REF Connector. IF reference channel signal output. This signal is a 278 kHz sine wave with fixed amplitude at about 1 volt p-p.

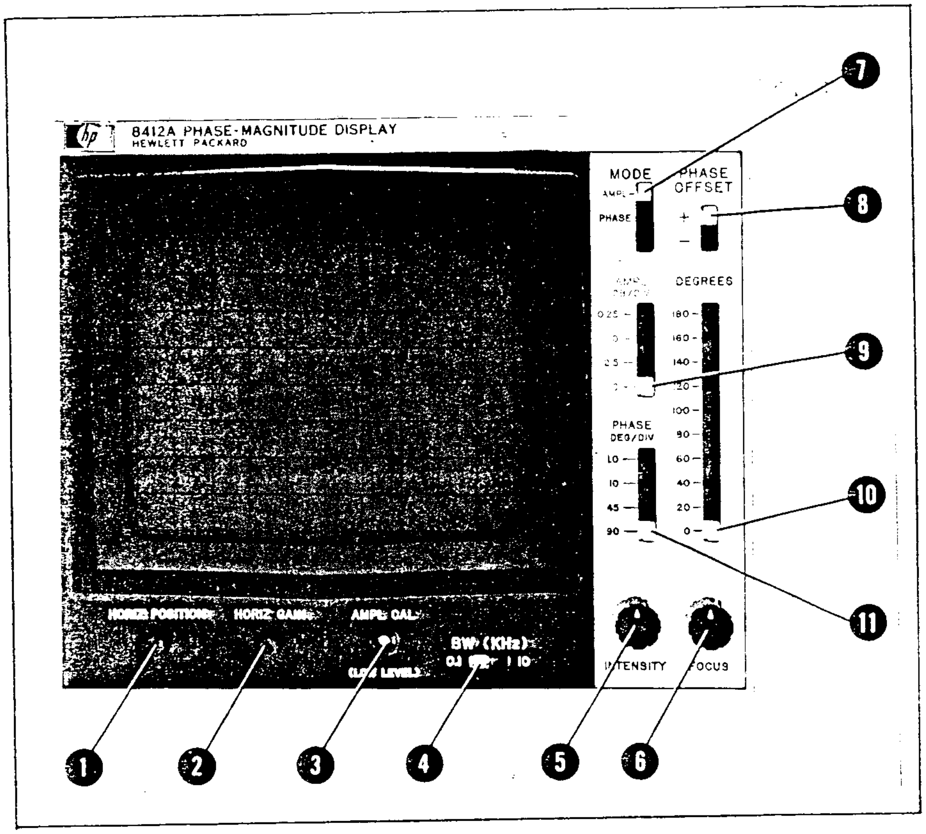
3. IF TEST Connector. IF test channel signal output. This is a 278 kHz sine wave signal containing all the amplitude and phase information present on the RF input signal. Amplitude range is 0 to about 1 volt p-p.

4. Line Voltage Selector. Permits operation from 115 to 230 Vac. Number showing on the slider is the selected operating voltage. Adjacent number on the panel is the correct line fuse rating.

5. Power Line Fuseholder. Fuse should have rating shown adjacent to the number on line voltage selector.

6. AC LINE Power Cable Connector. NEMA type with offset pin connected to 8407A cabinet. Power requirements: 115 or 230 Vac ±10%, 50 to 60 Hz, approximately 85 watts.

Table B3. HP 8412A Controls



FRONT PANEL

1. HORIZ POSITION. Sets the horizontal position of the display. (Does not require frequent adjustment.)

2. HORIZ GAIN. Adjusts gain of horizontal amplifier to change length of displayed trace. (Does not require frequent adjustment.)

3. AMPL CAL (LOW LEVEL). Adjusts calibration of amplitude amplifier for signals displayed on lower half of CRT screen. (Does not require frequent adjustment.)

4. BW (kHz). Selects bandwidth passed by the reference and test channels. This allows decreasing bandwidth when necessary to filter noise from the display.

5. INTENSITY. Controls the brightness of the trace.

6. FOCUS. Controls the sharpness of the trace.

7. MODE. Selects AMPL (amplitude), PHASE, or both amplitude and phase (DUAL) to display on the screen. When both amplitude and phase are displayed, the amplitude trace is brighter than the phase trace for easy identification.

8. PHASE OFFSET polarity switch. From zero degrees, offset is selected

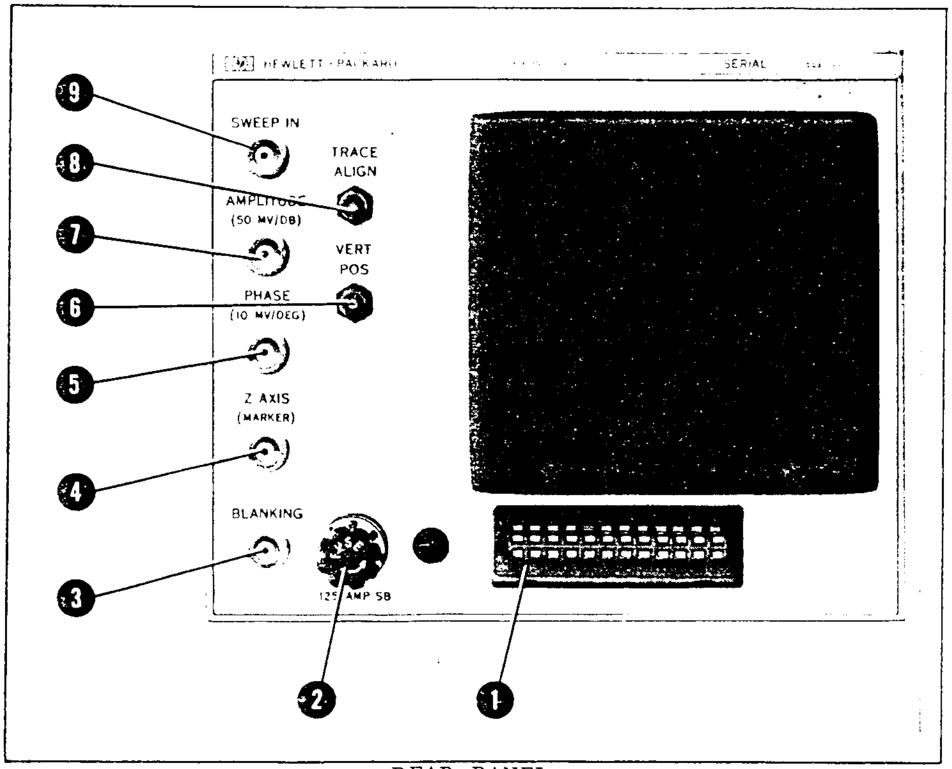
either in the negative or positive direction up to 180 degrees. The polarity switch selects the direction from zero and works in connection with the DEGREES switch to select offset.

9. AMPL DB/DIV. Selects the calibrated resolution of the test channel amplitude display.

10. PHASE OFFSET DEGREES. Selects offset in 20-degree steps. The switch works in conjunction with the PHASE OFFSET polarity switch to select up to 180 degrees in either the positive or negative direction from zero degrees. The phase offset plus the display reading gives the measured phase reading.

11. PHASE DEG/DIV. Selects the calibrated resolution of phase display.

Table B4. HP 8412A Controls and Connectors



REAR PANEL

1. Mainframe interface connector J1. Makes all necessary connections with 8407A or 8410A mainframe.

2. Fuse holder. Fuse protection in 175 Vac line from mainframe. Fuse is 1/8 ampere slow blow.

3. BLANKING connector J6. Input for blanking signal from sweeper. The signal blanks the trace during sweeper retrace(-4V blanks, 0V unblanked).

4. Z-AXIS connector J5. Marker input to Z-axis that intensity modulates the trace, placing a bright dot on the trace at the selected marker frequency with HP Model 8690A/B. The input can both mark and blank(-5V intensifies, +5V blanks).

5. PHASE (10 MV/DEG) connector J4. Voltage output is proportional to the phase angle of the test signal compared to the reference signal. Output is 10 mV/degree positive voltage for phase angles of 0 to +180 degrees and negative voltage for angles of 0 to -180 degrees.

6. VERT POS. Zeroes phase and amplitude traces vertically.

7. AMPLITUDE (50 MV/DB) connector J3. Depending on the transducer used on the unit under test, the voltage output is proportional to the amplitude ratio of:

(1) $[20\log_{10}(V_{TEST}/V_{REF})]$,

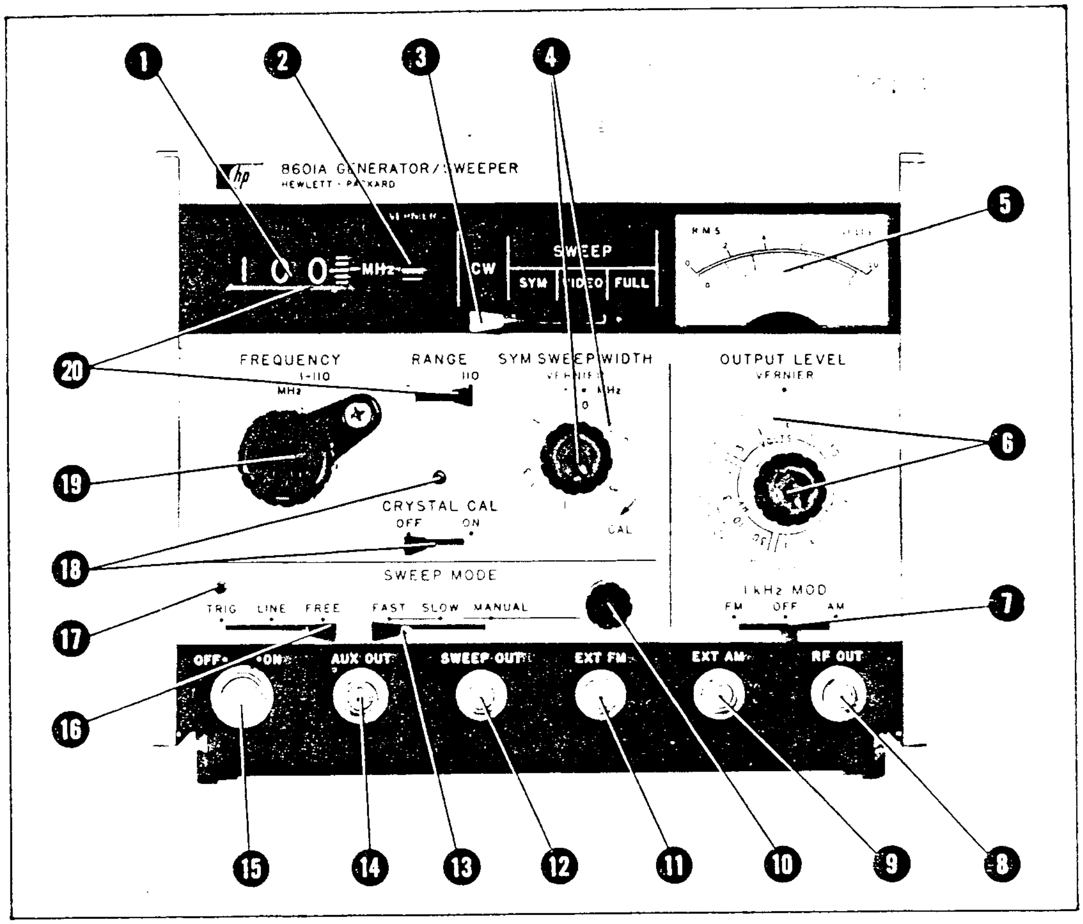
(2) $[20\log_{10}(I_{TEST}/I_{REF})]$, or

(3) $[20\log_{10}V_{RETURN}/V_{INCIDENT})]$.

8. TRACE ALIGN. Used to align CRT trace to the horizontal graticule. Adjustment should be performed with sweep oscillator set for minimum sweep width.

9. SWEEP IN connector J2. Input for sweeper signal that goes to horizontal (x-axis) amplifier.

Table B5. HP 8601A Controls, Connectors, and Indicators



FRONT PANEL

1. Digital Frequency Readout. Indicates CW frequency, SYM sweep center frequency, or VIDEO sweep upper frequency limit, depending on position of CW/SWEEP switch. Numerals rotate upward with increase in frequency.

2. FREQUENCY VERNIER. Fine tunes RF output frequency. Adjustment range is approximately ±0.1% of frequency. Upward rotation increases frequency.

3. CW/SWEEP. Selects FULL, VIDEO, SYMMETRICAL sweeps or CW operation. FULL sweeps full range; 0.1 to 11 MHz (range 11). 1.0 to 110 MHz (range 110). VIDEO sweeps from bottom of the band to frequency indicated on digital frequency readout. SYM sweeps symmetrically about the center frequency indicated on the digital frequency readout. CW generates a fixed frequency that is selected by the digital frequency readout.

4. SYM SWEEP WIDTH/VERNIER. Selects sweep width about center frequency. Blue numbers correspond to range 11; black numbers correspond to 110. The SWEEP WIDTH VERNIER adjusts the sweep width from the calibrated position to zero width.

5. Meter. Indicates RF output level in dBm or volts rms into 50 ohms.

6. OUTPUT LEVEL/VERNIER. Adjusts RF output level. Output is calibrated when OUTPUT LEVEL VERNIER is adjusted for 0 dBm meter reading. Blue numbers correspond to black meter scale (volts rms). Clockwise rotation increases output level.

7. 1 kHz MOD. Turns on either internal frequency or amplitude modulation of RF output. In AM position output is amplitude modulated at 30%, 1kHz rate. In FM position output is frequency modulated at 7.5 kHz deviation, 1 kHz rate (75 kHz peak deviation on high range).

8. RF OUT. Calibrated RF output (into 50 ohms).

9. EXT AM. Input for external amplitude modulating signals.

10. Manual/Sweep Speed Control. Manual sweep control in MANUAL mode; sweep speed vernier in FAST and SLOW modes. Clockwise rotation sweeps upward across band (in MANUAL) or increases sweep speed (in SLOW and FAST).

11. EXT FM. Input for modulation signals at rates up to 10 kHz. Modulation (deviation) sensitivity is 5 MHz/volt in range 110; 0.5 MHz/volt in range 11.

12. SWEEP OUT. Output ramp voltage concurrent with RF sweep. Output is approximately 0 to +7V in all sweep modes.

13. FAST/SLOW/MANUAL. Selects sweep speed or manual operation.

14. AUX OUT. Auxiliary output used for frequency monitoring. Output level is approximately 0.5V p-p into 200 ohms. Output frequency is 0.1 to 11 MHz on both ranges. (Range 110 output is divided by ten.) Provides about a -5 volt DC level for decimal point movement when using HP Model 8600A for frequency measurement.

15. ON/OFF. Depressing turns instrument on or off; lamp lights when instrument is on.

16. TRIG/LINE/FREE. Selects sweep trigger. In TRIG position, sweep is started by depressing trigger button. Retrace occurs automatically, or sweep can be terminated manually by depressing trigger button a second time. In LINE position, sweep repetition rate is synchronized with line frequency. In FREE position, sweep is derived from internal sweep generator and system is free running.

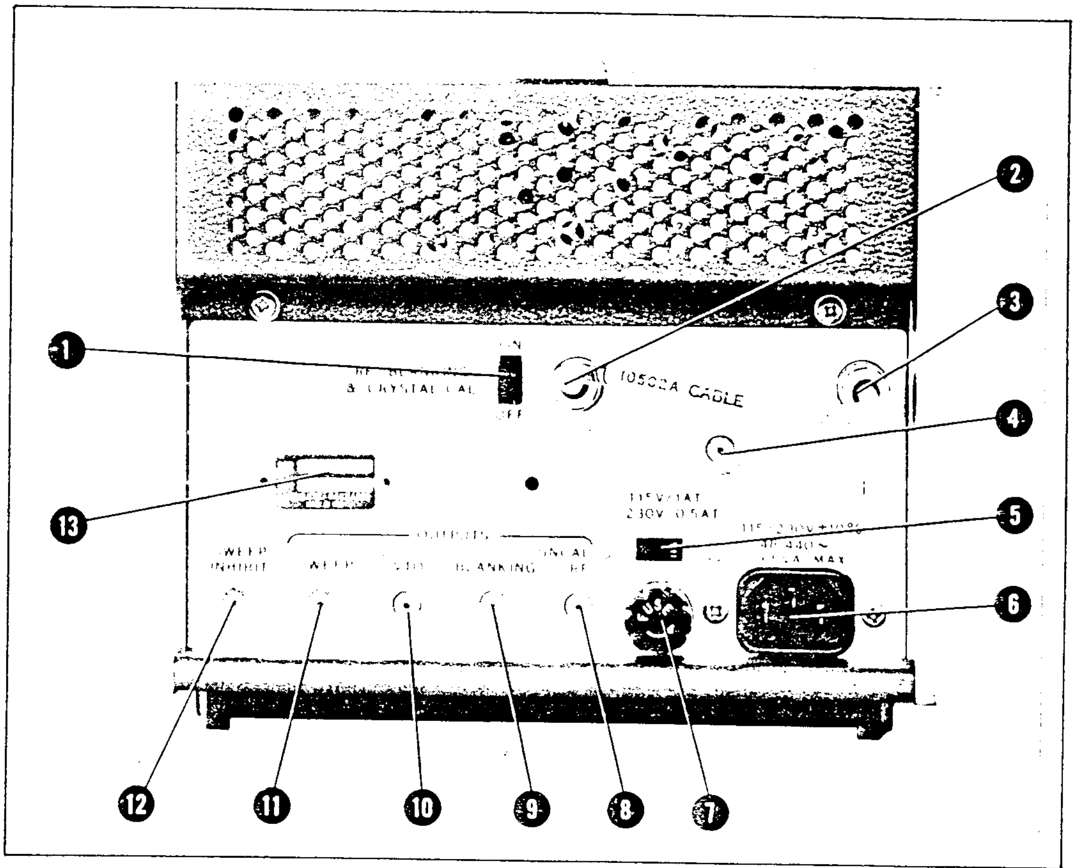
17. Trigger Pushbutton. Initiates single sweep each time it is pressed momentarily when TRIG/LINE/FREE switch is in TRIG position (SYM, VIDEO or FULL SWEEP modes).

18. CRYSTAL CAL. Activates 5 MHz calibrator circuit. Output beat-signals at 5 MHz intervals are used to calibrate single or very slow swept frequency readout.

19. FREQUENCY. Selects CW frequency, SYMMETRICAL sweep center frequency, or VIDEO sweep upper frequency limit, depending on position of CW/SWEEP switch. Clockwise rotation increases frequency.

20. RANGE. Selects desired frequency range. Decimal point indicator light is automatically placed for correct frequency readout (MHz).

Figure B6. HP 8601A Controls and Connectors



REAR PANEL

1. RF BLANKING/CRYSTAL CAL. Enables and disables RF blanking and crystal calibrator circuit.

2. VTO Output (Option 007 only). 200.1 to 211 MHz in Range 11, 201 to 310 MHz in Range 110. Minimum amplitude is -15 dBm. For normal operating modes connect this VTO output to the LO INPUT. When using 8601A as a tracking generator leave VTO output unconnected.

3. LO INPUT (Option 007 only). For normal operating modes, connect VTO output to LO INPUT. When using 8601A as a tracking generator connect output of external oscillator to LO INPUT.

4. AUX OUT (Option 004 only). Auxiliary output used for frequency monitoring. Output level is approximately 0.5 Vp-p into 200 ohms. Output frequency is 0.1 to 11 MHz on both ranges. (Range 110 output is divided by ten.)

5. Line Voltage Switch. Slide switch selects proper primary circuit for 115 or 230 Vac operation. Exposed number indicates primary voltage to be used.

CAUTION

Before plugging in power cable, check that line voltage switch is set for correct ac line voltage.

6. Power cable connector.

7. LINE FUSE. Primary circuit overcurrent protection. For 115 Vac operation, use 1 amp, slow-blow fuse. For 230 Vac operation, use 0.5 amp, slow-blow fuse.

8. UNCAL RF. RF output concurrent with front panel RF OUT but is not calibrated or blanked during sweep retrace.

9. BLANKING. Output is a rectangular pulse of approximately -4V that occurs during retrace portion of sweep.

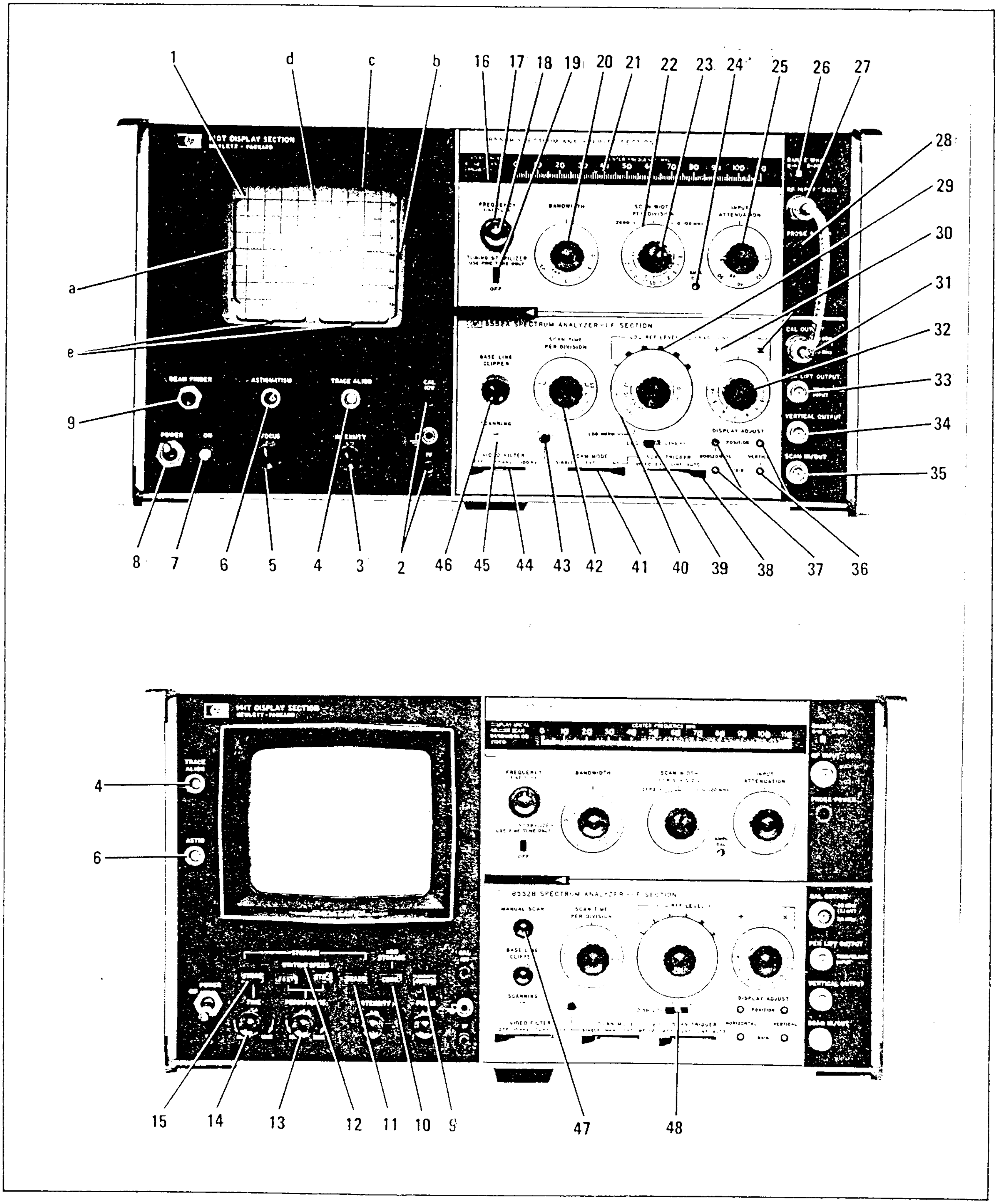
10. VTO OUTPUT. 200.1 to 211 MHz in Range 11; 201 to 310 MHz in Range 110. Minimum amplitude is -15 dBm.

11. SWEEP. Sweep voltage output concurrent with RF sweep. Output is approximately 0 to +7V in all sweep modes.

12. SWEEP INHIBIT. A sweep inhibit pulse (momentary ground), adjustable for any frequency point across the swept range, is applied to momentarily stop the 8601A sweep. This pause enables the HP Model 8600A Digital Marker to measure the frequency at that particular point in the sweep.

13. Identification Plate. Serial number that identifies individual instrument. First three or four digits identify the serial prefix. If instrument includes a standard modification (called an Option) then the option number is given on the identification plate just below the serial number.

Figure B7. HP 141T/8552B/8553B Controls, Connectors, and Indicators



Front Panel

HP 141T (140T) DISPLAY SECTION

1. Display Screen with Graticule.

   a. LINear calibration (read from bottom to top of screen).

   b. LOGarithmic calibration (read from top LOG REF line towards bottom of screen).

   c. Amplitude calibration reference.

   d. Center frequency of selected scan width.

   e. Relative frequencies with respect to center frequency.

2. CAL 10V/1V. Provides 1- and 10-volt, peak-to-peak, 60 Hz squarewave outputs.

CAUTION

These calibrated outputs must never be used with the spectrum analyzer. (These outputs are for use only with the 1400-series oscilloscope plug-ins).

3. INTENSITY. Adjusts brightness of CRT display.

CAUTION

Excessive brightness for a static or very slow-moving trace may burn the phosphor and permanently damage the CRT. This caution is applicable to both the fixed and variable-persistence/storage CRT; however, the latter is especially vulnerable to operational errors of this type.

4. TRACE ALIGN. Makes base line parallel with the horizontal graticule line.

5. FOCUS. Focuses CRT beam.

6. ASTIG. Used with FOCUS control to obtain smallest spot with maximum roundness.

7. Lights when line voltage is applied and instrument is turned on.

8. POWER. Switches line voltage to instrument.

9. BEAM FINDER. When used with 1400-series oscilloscope plug-ins, intensifies and returns beam to CRT, regardless of deflection potentials. When used with 8550 series plug-ins, the beam finder has no function.

10. CONV. Selects non-storage function.

CAUTION

Use storage function when possible to prevent damage to the CRT.

11. ERASE. Press to ERASE when in STD or FAST writing speed.

12. WRITING SPEED. Selects writing speed.

13. PERSISTENCE. Varies time the trace is visible.

14. TIME. Selects storage time.

15. STORE. Press to store signal display. Storage time (relative display brightness) in storage mode is adjusted by Item 45.

HP 8553B SPECTRUM ANALYZER-RF SECTION

16. Lights when relationship between scan time, scan width, bandwidth, and video filtering is such that accuracy of vertical calibration is impaired.

17. FREQUENCY. Coarse-tunes analyzer center frequency.

18. FINE TUNE. Fine tunes analyzer center frequency.

19. TUNING STABILIZER. In TUNING STABILIZER position, first LO is automatically phase-locked to a reference crystal harmonic for scan widths of 20 kHz/DIV and less.

20. BANDWIDTH. Selects 3-dB IF bandwidths.

21. CENTER FREQUENCY. Indicates center frequency to which instrument is tuned.

22. SCAN WIDTH. Indicates per-division scan width.

23. ZERO/PER DIVISION/0-100 MHz. Selects 0-100 MHz full-spectrum "preset" scan, PER DIVISION SCAN as determined by setting of outer dial, or "fixed-frequency" receiver in ZERO scan position.

24. AMPL CAL. RF amplitude gain calibration.

25. INPUT ATTENUATION. Attenuates input signal in 10-dB steps and lights one index lamp for each of its six positions. The left index lamp lights for 0 attenuation. The lighted lamp and steps-in attenuation then progress in clockwise order; thus, absolute amplitude calibration is preserved.

26. RANGE. Controls the tuning range of the FREQUENCY control. In 0-11 MHz position, tuning range of the FREQUENCY control is limited to 11 MHz. In 0-110 MHz position, tuning range of FREQUENCY control is extended to 110 MHz.

27. RF INPUT. 50-Ohm coaxial input connector.

28. PROBE POWER. Supplies power to active probe.

HP 8552B (8552A) SPECTRUM ANALYZER-IF SECTION

29. With LOG/LINEAR switch set to LOG, lighted index lamp refers matching dB graduation to top LOG REF line of graticule; for example, if -30 dBm is opposite lighted lamp, then top LOG REF line is -30 dBm and so serves as an absolute amplitude reference. With LOG/LINEAR switch set to LINEAR, lighted index lamp indicates the matching voltage graduation to be used as a per-division multiplier for calibrated voltage readings (blue marking).

30. LOG REF LEVEL - LINEAR SENSITIVITY Mode Indicators. Plus "+" lights when

logarithmic amplification is selected; times "x" lights when linear amplification is selected. With "+" lighted, LOG REF line is sum (black numerals) of LOG REF LEVEL controls. With "x" lighted, per division absolute voltage amplitude is product (blue numerals) of LINEAR SENSITIVITY controls.

31. CAL OUTPUT. Provides a 30-MHz signal at -30 dBm for amplitude calibration of spectrum analyzer.

CAUTION

> To prevent mixer burnout, attenuator damage, or both, the RF INPUT level should never exceed 1.4 Vac peak or ±50 Vdc.

32. LOG REF LEVEL - LINEAR SENSITIVITY Vernier. Indicates 1-dB increments for logarithmic amplification; indicates multiplication factors up to unity for linear amplification.

33. PEN LIFT OUTPUT. Provides penlift operation to HP 7005, 7035, 7004, 7034, and all new TTL compatible HP recorders. Provides a blanking input for external scan mode operation. Provides an input for external trigger operation.

34. VERTICAL OUTPUT. Detected video output proportional to vertical deflection on CRT.

35. SCAN IN/OUT. For receiving an external scan ramp or output coupling for the internally-generated scan ramp. Input or output function determined by INT/EXT positions of SCAN MODE switch.

36. VERTICAL DISPLAY ADJUST. Adjusts vertical position and gain of trace.

37. HORIZONTAL DISPLAY ADJUST. Adjusts horizontal position and gain of trace.

38. SCAN TRIGGER. Selects scan trigger mode.

39. LOG/LINEAR. Selects logarithmic or linear display mode (HP 8552A only).

40. LOG REF LEVEL - LINEAR SENSITIVITY. Assuming that dB graduation (black numerals) matches position of lighted index lamp, LOG REF graticule line indicates power level when LOG/LINEAR is set to LOG. With LOG/LINEAR set to LINEAR, indicates per division multiplier for calibrated voltage amplitude for whatever voltage graduation (blue numerals) matches position of lighted index lamp.

41. SCAN MODE. Selects scan ramp mode. Ramp is internally generated for SINGLE/INT positions but it must be externally supplied for EXT position.

42. SCAN TIME PER DIVISION. Controls SCAN TIME.

43. SINGLE. Press to initiate scan with SCAN MODE switch set to SINGLE; press during scan to stop and reset scan.

44. VIDEO FILTER. May select 100 Hz, 10 kHz, or OFF position of low-pass filter for detected video.

45. SCANNING. Lights for duration of each scan for SINGLE and INT scan modes.

46. BASE LINE CLIPPER. Blanks lower part of trace to prevent over-exposure of photographs (due to high intensity baseline). Blanking function also prevents blooming with a variable-persistence/storage display section.

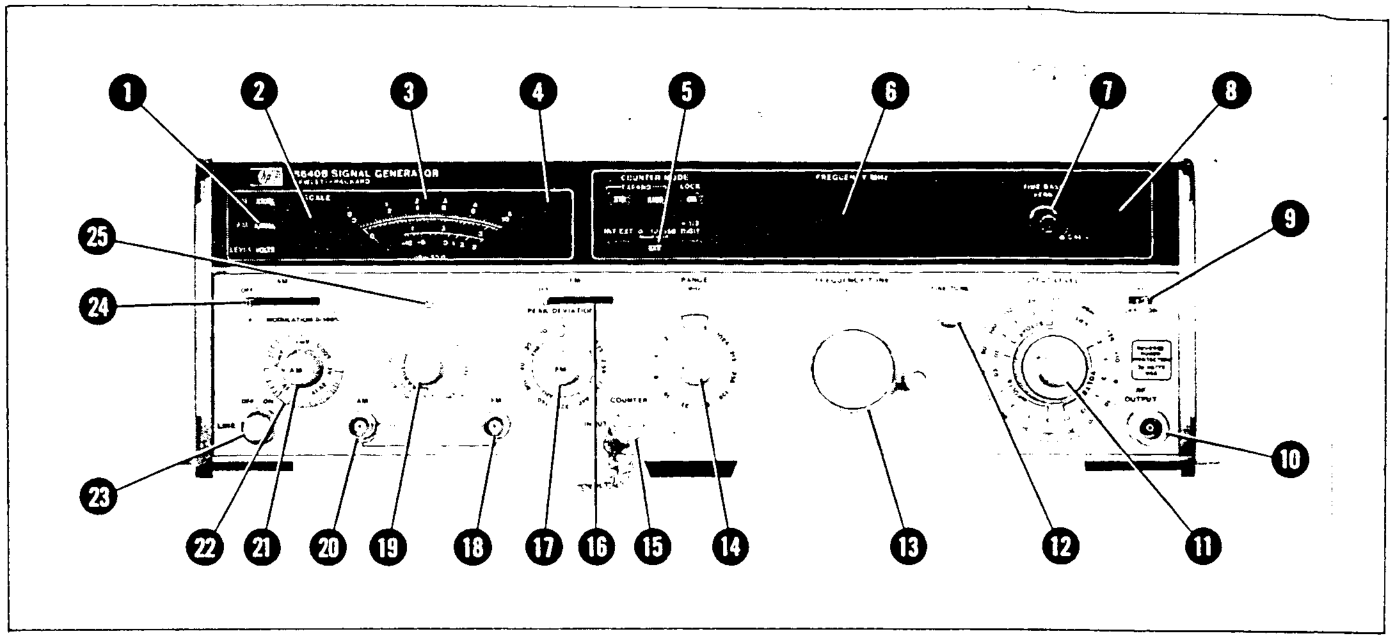
47. MANUAL SCAN. Controls scan in MAN position of SCAN MODE.

48. Log-Linear Mode Switch. Selects LINEAR, 10 dB LOG or 2 dB LOG display modes. To use 2 dB LOG, first find signal using 10 dB LOG; display desired portion in top 16 dB of screen, then switch to 2 dB LOG. Top of screen (LOG REF) remains the same; -70 dB line is now -14 dB (each major division is 2 dB).

NOTE

Do NOT make any VERTICAL GAIN or POSITION adjustments in the 2 dB LOG mode as the front panel calibration will become invalid.

Table B8. HP 8640B Controls, Connectors, and Indicators



Front Panel

1. Meter Function. Interlocked buttons select one of three functions:

AM: meter indicates percent of amplitude modulation.

FM: meter indicates peak frequency deviation.

LEVEL: meter indicates RF output level in Vrms or dBm 50-ohm.

2. SCALE. Annunciator lights to indicate applicable meter scale. Meter scale is automatically selected.

3. Meter. Ranges to one of three linear scales, read according to meter function.

AM X10%: 0-10 scale is read 0-100%.

FM k/MHz: 0-3, 0-5, and 0-10 scales are read in kHz or MHz, depending upon setting of PEAK DEVIATION switch (e.g., with PEAK DEVIATION set to 80 kHz, a meter reading of 7.2 indicates that deviation is 72 kHz).

LEVEL VOLTS: 0-3 and 0-10 scales are read in microvolts, millivolts, or volts depending upon setting of OUTPUT LEVEL controls (e.g., with OUTPUT LEVEL switch set to .03 VOLTS, a meter reading of 2.4 indicates that actual level is 24 mVrms). The -10 to +3 dB scale is read relative to the OUTPUT LEVEL switch dBm scale.

4. Output Problem Annunciators. Lamps light to indicate that modulation or OUTPUT LEVEL settings are causing generator to be uncalibrated.

REDUCE PEAK POWER: indicates a combination of OUTPUT LEVEL and amplitude modulation that exceeds specified limits. This allows 100% AM on all OUTPUT LEVEL ranges except the +20 dBm range. In instruments with the Internal Doubler (Option 002), on the 512-1024 MHz range, the peak envelope power of the carrier may not exceed the maximum level of any OUTPUT LEVEL range.

REDUCE FM VERNIER: indicates that an external FM input level or vernier setting is causing FM deviation to exceed limits.

REDUCE PEAK DEVIATION: indicates PEAK DEVIATION setting is too high for the selected frequency range.

5. COUNTER MODE. Buttons control operation of frequency counter.

EXPAND: X10 expands resolution one digit, moving the decimal point one place to the left; X100 expands resolution two digits, moving the decimal point two places to the left.

NOTE

EXPAND X10 and EXPAND X100 buttons are interlocked so that only one button can be depressed at a time.

LOCK: phase locks Signal Generator to the internal (or to an external) crystal reference. Display indicates lock frequency; loss of lock causes display to blink and indicate actual frequency of Signal Generator.

INT/EXT Source: programs counter to count frequency of Signal Generator (INT) or external input (EXT).

EXT Range: 0-10 or 10-550 selects counter frequency range in MHz when INT/EXT switch set to EXT.

+½ DIGIT: Increases frequency of phase locked generator ½ least significant digit and causes a 5 to appear as a seventh digit on the display. The Signal Generator must be phase locked to initiate +½ DIGIT operation.

6. FREQUENCY MHz. Counter readout indicates RF frequency in MHz. Blinking display indicates loss of phase lock. The OVERFLOW lamp lights to indicate that significant data is not being displayed. Generator cannot be phase locked if an overflow condition is present.

7. TIME BASE VERN. Used as a fine frequency tune when in lock mode to give continuous tuning between lock points (the use of the COUNTER MODE EXPAND X10 control is necessary on some ranges to tune over the full range). When control is not in CAL position, the UNCAL lamp lights to indicate that the counter is uncalibrated.

8. Time Base Adjust. Allows front panel access to time base calibration potentiometer for easy adjustment of internal reference oscillator.

9. RF ON/OFF. Enables or disables the RF output.

NOTE

The RF ON/OFF switch is wired to turn off only the amplitude modulator. This allows the RF Oscillator to remain warmed up, the Auxiliary RF Output to remain on, and the counter and phase lock to remain operating. If it is desirable to switch both the modulator and the RF Oscillator off, the RF ON/OFF function can be easily modified.

10. RF OUTPUT. RF output through Type N female connector. (Connector meets US MIL-C-39012.) 50-ohm ac coupled source impedance.

CAUTION

If not protected by Option 003 (Reverse Power Protection), application of greater than 40 Vdc or +13 dBm of RF power into the output jack of the Signal Generator is likely to cause damage to the output circuits of the instrument.

11. OUTPUT LEVEL. The switch controls a 10 dB step attenuator that sets the output level range. Concentric vernier sets output level within an 18 dB range (the meter indicates actual output).

NOTE

For optimum operation, use the vernier in the top 10 dB of its range.

12. FINE TUNE. Fine frequency control.

13. FREQUENCY TUNE. Coarse frequency control.

14. RANGE. Selects one of ten octave frequency ranges. The eleventh position, 512-1024 MHz/EXT DOUBLER, gives 256-512 MHz at RF OUTPUT, but the FREQUENCY MHz readings and FM meter indications are corrected for use with an RF doubler connected to RF OUTPUT. In Option 002 instrument, the 512-1024 MHz range displays actual RF OUTPUT frequency.

15. COUNTER INPUT. External input to frequency counter; impedance is 50 ohms.

CAUTION

Do not apply a dc voltage or greater than +15 dBm to COUNTER INPUT.

16. FM. Selects frequency modulation and source.

OFF: no FM.

INT: FM by internal oscillator.

AC: FM by external source through FM INPUT jack (greater than 20 Hz, ac + dc less than 5 Vpk).

DC: FM by external source through FM INPUT jack (ac + dc less than 5 Vpk).

CAL: used to calibrate external modulation input (do not use when phase locked).

17. PEAK DEVIATION. Switch and concentric vernier vary FM frequency deviation (as indicated on the meter). Vernier range is from zero to the peak deviation selected by the switch.

18. FM INPUT/OUTPUT. 600-ohm input for external FM; nominally 1 Vpk (0.707 Vrms) required for full peak deviation selected by PEAK DEVIATION switch (never more than 5 Vpk). Output for internal oscillator whenever FM selector is set to INT (600 ohm source impedance); level controlled by AUDIO OUTPUT LEVEL.

19. MODULATION FREQUENCY. Switch selects 400 Hz or 1000 Hz. With Option 001 Variable Modualtion Oscillator (shown), switch also selects multiplier. Vernier, with multiplier, sets frequency from 20 Hz to 600 kHz.

20. AM INPUT/OUTPUT. 600-ohm input for external AM; 1 Vpk (0.707 Vrms) required for 100% modulation (never more than 5 Vpk). Input for pulse modulation (50-ohm); greater than 0.5 Vpk positive pulse required to turn on RF. Output for internal oscillator whenever AM selector is set to INT (600-ohm source impedance): level controlled by AUDIO OUTPUT LEVEL.

NOTE

With the Option 001 Variable Modulation Oscillator, AM OUTPUT and FM OUTPUT are in parallel. Parallel load should be greater than or equal to 600-ohms.

21. MODULATION. Vernier varies amplitude modulation from 0 to 100% (as indicated on the meter).

22. AUDIO OUTPUT LEVEL. Control varies level of signal from AM and/or FM OUTPUT jacks (calibration gives voltage into 600-ohms).

23. LINE. Switch applies or removes AC power. The button is lighted when ON.

24. AM. Selects amplitude modulation and source.

OFF: no AM.

INT: AM by internal oscillator.

AC: AM by external source through AM INPUT jack (greater than 20 Hz, ac + dc less than 5 Vpk).

DC: AM by external source through AM INPUT jack (ac + dc less than 5 Vpk).

PULSE: when selected with no modulation, it disables the RF output; a positive pulse at AM INPUT pulses on the RF.

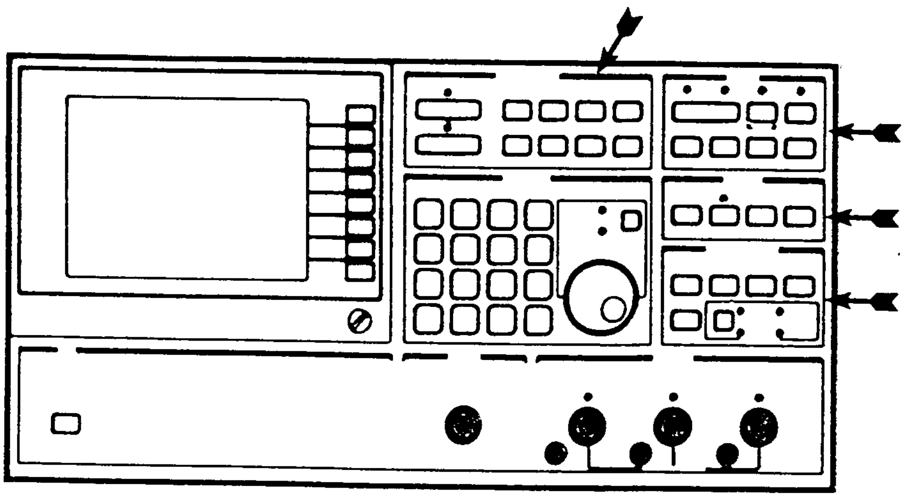
25. Mechanical Meter Zero. Sets meter suspension so that meter indicates zero when power is removed and instrument is in normal operating position.

Table B9. HP 3577A Hardkeys, Softkeys, and Menu Descriptions

This table describes the terms "hardkeys", "softkeys", and "menu" as used with the HP 3577A Network Analyzer. Tables B10 through B14 describe the HP 3577A front panel keys by panel sections. Refer to "OPERATING MANUAL MODEL 3577A NETWORK ANALYZER" by Hewlett-Packard if more detailed information is needed.

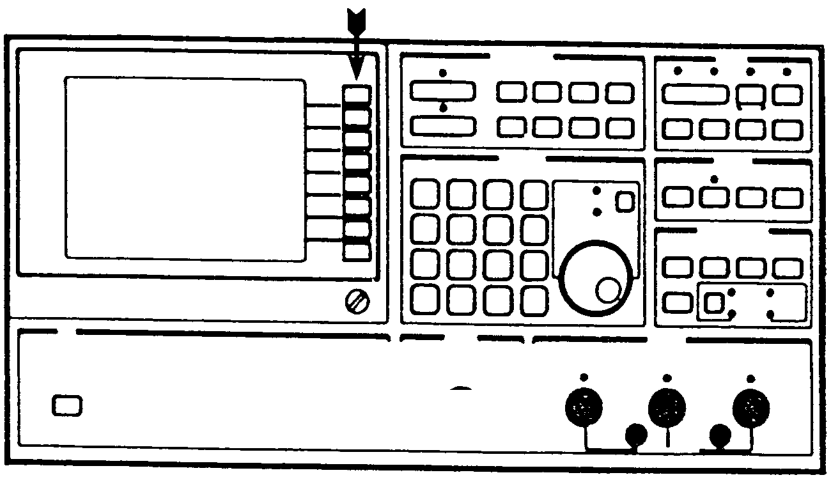
1. HARDKEYS

HARDKEYS refers to all of the keys on the front panel that have command names printed on them. Refer to the figure below for location of hardkeys. Most hardkeys are used to display a menu of softkeys labels. Exceptions to this are the keys in the DATA ENTRY section, the TRIG/RESET key, the LCL key, and the INSTRUMENT PRESET key.



2. SOFTKEYS

The eight keys with no stenciling next to the menu area of the screen are called SOFTKEYS. Refer to the figure below for the location of softkeys.



3. MENU

A menu is a list of softkey labels that is displayed on the CRT next to the column of softkeys. This part of the display is called the MENU AREA. Refer to the figure below for the location of MENU AREA. Menus change whenever a hardkey is pressed or (if a menu is more than one level deep) when certain softkeys are pressed.

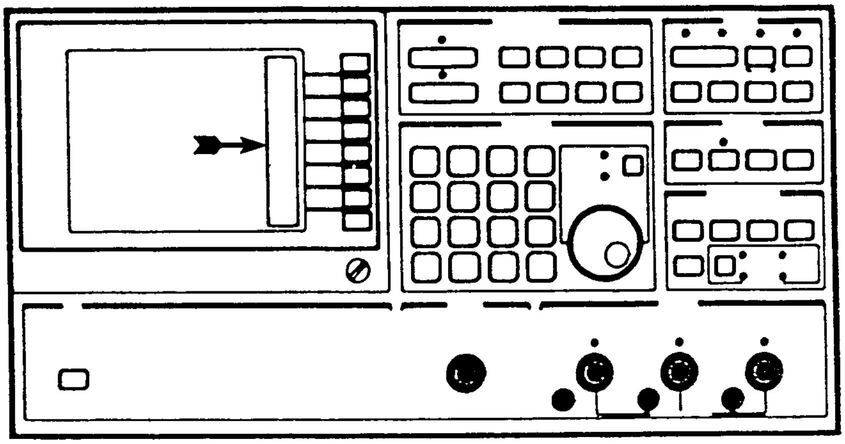
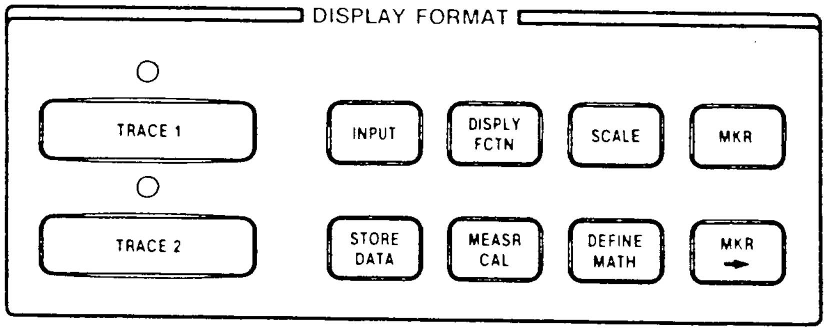


Table B10. HP 3577A Network Analyzer DISPLAY FORMAT Hardkeys



The DISPLAY FORMAT section is one of five front panel sections of the HP 3577A. This section has ten hardkeys which allow the user to define the screen trace, define the graticule scale, read data from the displayed trace, enter data using the position of the marker, store complex data, normalize or do partial or full error correction of one-port measurements, and define three constants and five functions.

1. TRACE 1 or TRACE 2. These hardkeys select Trace 1 or Trace 2 as the active trace. The active trace is indicated by the illuminated LED over either the TRACE 1 or TRACE 2 key and by a bright trace and marker information block on the screen. When the HP 3577A is preset or turned on, trace one is LOG MAGNITUDE and active and trace two is off.

2. INPUT. This hardkey is used to display the menu of softkeys. These softkeys may be used to define the active trace in terms of 1) receiver inputs, 2) data registers (contain stored traces), 3) user defined functions, and 4) user defined complex constants.

3. STORE DATA. There are four registers used to STORE trace DATA. They are called D1, D2, D3, and D4. Store data is in the same form (complex) created by the receivers and stored in trace memory. Therefore, any data register information may be recreated in any of the DISPLAY FUNCTION formats (LOG MAG, PHASE, GROUP DELAY, etc).

4. DISPLAY FCTN. The DISPLAY FCTN hardkey is used to display the menu of softkeys. These softkeys may be used to define the screen trace in terms of how the complex data in trace memory is interpreted (LOG MAG, PHASE, GROUP DELAY., POLAR, etc). If any of the 7 entries in the menu are bright, the trace is on. The trace may be turned off with the bottom softkey.

5. MEASR CAL. This hardkey is used to display the menu of softkeys. These softkeys will help the user calibrate out the effects of measurement hardware inperfections. None of these softkeys functions are operable if the active sweep type is ALTERNATE SWEEP.

6. SCALE. This hardkey is used to display the menu of softkeys. These softkeys may be used to modify the vertical axis scale and value of the reference line. None of the SCALE features require a new measurement sweep

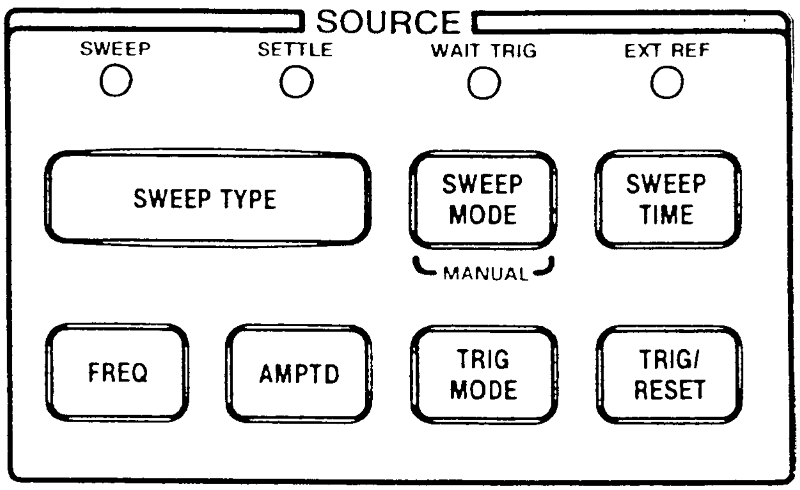
when their values change (unless in Alternate sweep). Each uses data stored in trace memory to reconfigure the screen.

7. DEFINE MATH. This hardkey is used to display the menu of softkeys. These softkeys may be used to define three complex constants and five functions. Constants and functions may be used as terms in USER DEFINED INPUTs or USER DEFINED STOREs. Each component, real and imaginary, of each constant, K1 through K3, may be defined by pressing the appropriate softkey and making a data entry with the numeric keypad.

8. MKR. This hardkey is used to display the menu of softkeys. These softkeys may be used to read data from the displayed trace. The marker (small circle) may be moved to any part of the trace with the knob and the data for that point appears in the MARKER BLOCK above the right half of the graticule. Note that the MARKER imformation is valid even though the trace may be clipped by the upper or lower edges of the graticule.

9. MKR→. This hardkey is used to display the menu of softkeys. Some of these softkeys may be used to enter data corresponding to the position the marker. Others move the marker to points of interest.

Table B11. HP 3577A Network Analyzer SOURCE Hardkeys



The SOURCE section is one of five front panel sections of the HP 3577A. This section has seven hardkeys which control the parameters of the source.

1. SWEEP TYPE. This large hardkey is used to display the menu of softkeys. These softkeys may be used to select from five sweep types (LINEAR FREQUENCY SWEEP, ALTERNATE SWEEP, LOG FREQ SWEEP, AMPTD SWEEP, CW, AND SWEEP DIRECTION UP/DOWN).

2. FREQ. This hardkey is used to display the menu of softkeys. These softkeys are used to modify the frequency parameters. These parameters are START FREQ, STOP FREQ, CENTER FREQ, FREQ SPAN, C FREQ STEP, SWEEP RESOLUTION, or FULL SWEEP.

3. AMPTD. This hardkey is used to display the menu of softkeys. These softkeys may be used to change the signal level of the source output. The HP 3577A source amplitude range is -49 dBm to +15 dBm in .1 dBm steps; the default value at power-on is -10 dBm without test set and +15 dBm with a test set.

4. SWEEP MODE. This hardkey is used to display the softkey menu. These softkeys may be used to select CONTINUOUS, SINGLE, or MANUAL sweeps. The default selection is CONTINUOUS.

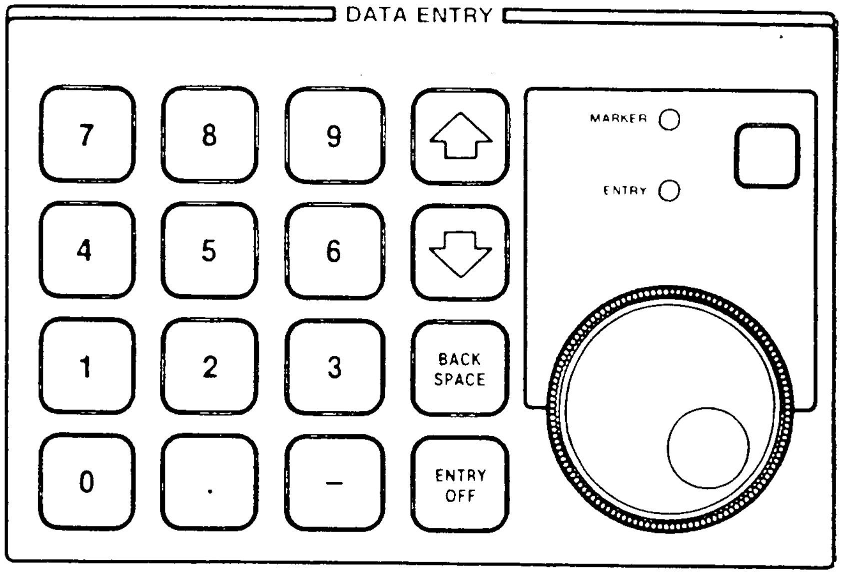
5. TRIG MODE. This is a hardkey to display the menu of softkeys. These softkeys may be used to select the type of triggering used by the HP 3577A to initiate measurement sweeps. The trigger modes are FREE RUN, LINE, EXTERNAL, and IMMEDIATE.

6. SWEEP TIME. This hardkey is used to select measurement times. Immediately after power-on or INSTRUMENT PRESET, the SWEEP TIME for a linear frequency sweep is 1 second. If the SWEEP TYPE is changed to AMPTD SWEEP the default TIME/STEP is 0.050 seconds and the total sweep time depends upon

the STEPS/SWEEP (found in the AMPTD menu). If the SWEEP MODE is changed to MANUAL, the default SAMPLE TIME is 0.050 seconds.

7. TRIG/RESET. This hardkey is used by the operator to either TRIGGER or RESET in preparation for a measurement. This is one of the three hardkeys that do not display a menu. It executes its function immediately when pressed.

Table B12. HP 3577A Network Analyzer DATA ENTRY Hardkeys



The DATA ENTRY section is one of five front panel sections of the HP 3577A. This section has a numeric keybad, increment/decrement (arrow) keys, a BACKSPACE key, ENTRY OFF key, and a knob which are used for entering or modifying data. If new entries are made with the keypad, units must be entered with the softkeys at the right side of the screen before the new entry is complete.

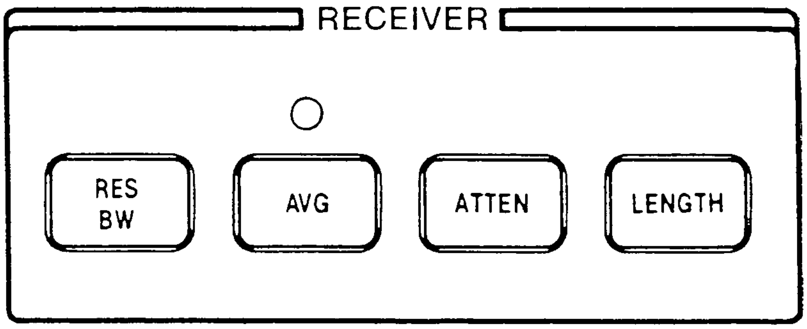
1. BACKSPACE. This hardkey is used to correct data entries for trace arithmetic equations. When the backspace key is pressed, the cursor in the entry block (text in the upper-right corner of the screen) backs up one space, erasing that character.

2. ENTRY OFF. This is used to keep the knob from changing an ENTRY value or to clear the screen of menus and messages. The graticule and all charaters are displayed at low intensity and the trace(s) are bright.

3. KNOB. The KNOB is used in one of two modes: to move the MARKER or for (continuous) ENTRY. It toggles between these two modes when the key above is pressed. Two LEDs, marked MARKER and ENTRY, show which mode the knob is in.

4. INCREMENT/DECREMENT. These two keys are used to increment (up-arrow) or decrement (down-arrow) data for the selected (bright) softkey if it is an item that allows data entry.

Table B13. HP 3577A Network Analyzer RECEIVER Hardkeys



The RECEIVER section is one of five front panel sections of the HP 3577A. This section has four hardkeys which allow the user to control resolution bandwidth, vector averaging, attenuation, impedance, and length for each of the three receiver inputs.

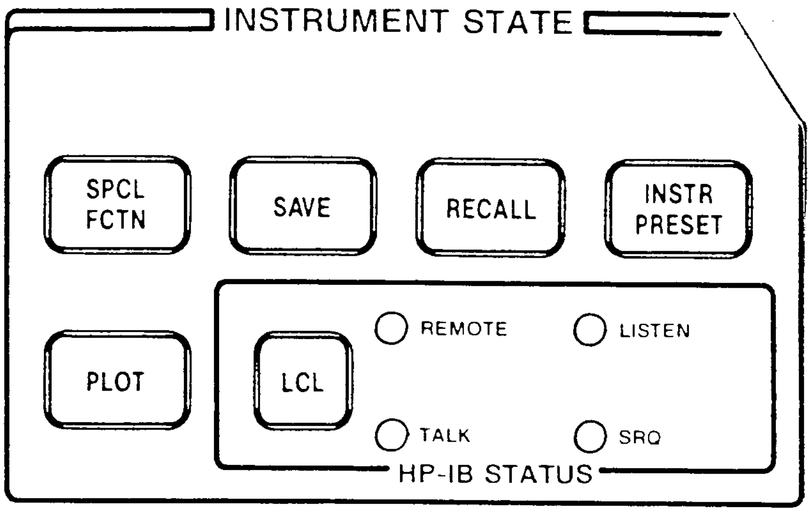
1. RES BW. This hardkey is used to display the menu of softkeys. These softkeys may be used to select one of four resolution bandwidths for the receiver IF. The resolution bandwidths are 1 kHz, 100 Hz, 10 Hz, and 1 Hz.

2. AVE. This hardkey is used to display the menu of softkeys. Selection of any of the numbered softkeys turns on the exponential averaging feature of the HP 3577A. When averaging is on, the LED above the AVE hardkey is illuminated. The number selected by the user from the menu is a weighting factor called N. The larger N is, more noise is reduced. This feature is capable of reducing trace noise as much as 24 dB (N=256).

3. ATTEN. This hardkey is used to display the menu of softkeys. These softkeys may be used to select the input attenuation and input impedance for each of the three receiver channels. Also, the CLEAR TRIP for the receivers is included in this menu.

4. LENGTH. This hardkey is used to display the menu of softkeys. These softkeys may be used to select the electrical length of each of the receiver inputs to compensate for, or simulate cable lengths. Propagation velocity is assumed to be the speed of light.

Table B14. HP 3577A Network Analyzer INSTRUMENT STATE Hardkeys



INSTRUMENT STATE is one of five front panel sections. The hardkeys in this section may be used to SAVE and RECALL instrument state, PRESET the HP 3577A, PLOT what appears on the screen, monitor the HP-IB status of the HP 3577A, or use the SPECIAL FUNCTIONS.

1. SPCL FCTN. This hardkey is used to display the softkey menu. These softkeys may be used for viewing and modifying the HP-IB address, running a CONFIDENCE TEST, turning the beeper on or off, and many service diagnostics.

2. PLOT. This hardkey is used to display the menu of softkeys. These softkeys are used to reproduce the display screen on paper, using an HP-IB plotter. The plotter must be configured to LISTEN ONLY and the HP 3577A must be in the TALK ONLY mode.

3. SAVE. This hardkey is used to display the menu of softkeys. These softkeys may be used to save 5 instrument states. This feature is convenient for saving a complex and/or often-used test configuration and RECALLing it for use at a later time.

4. RECALL. This hardkey is used to display the menu of softkeys. These softkeys may be used to recall 5 SAVEd states or the state of the HP 3577A when it was last turned off (RCL OLD STATE).

5. INSTR PRESET. This is a green hardkey in the INSTRUMENT STATE section. This key resets the values of 3577A parameters to a known state. Immediately after preset or power-on, the HP 3577A parameters are set to their default values.

6. LCL. This hardkey is used to change the HP-IB status of the HP 3577A from REMOTE to LOCAL if the LOCAL LOCKOUT command has not been issued. The

LCL key is part of the HP-IB STATUS block. This block has four LED indicators that show the HP-IB status for REMOTE, TALK, LISTEN, and SRQ. If the REMOTE LED is illuminated, none of the front panel keys have any effect until the LCL key returns to LOCAL control (which extinguishes the REMOTE LED).

APPENDIX C

REPORTING SYSTEM ERRORS

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APPENDIX C

REPORTING SYSTEM ERRORS

The AUTOMATED AN/FRM-19(V) Test System contains internal error detection for program or equipment failures. If an unusual (repeatable) error occurs with no apparent cause it should be reported to NEEACT PAC after thorough investigation of the system hardware and calculator error messages.

NEEACT PAC's Points of Contact:

Terri Hanaoka or Hugh Myers
Commercial: (808) 474-2249
Autovon : 315-430-0111 Ext. 474-2249

Mailing Address:

Commanding Officer
Naval Electronics Engineering Activity, Pacific
Box 130
Pearl Harbor, HI 96860-5170
Attention: Code 323TH or 323HM

Before reporting the error, please do the following:

(1) Have a short description of what happened and what the operator expected to see.

(2) Write the error message displayed or printed (see pages C2 - C11 for Error Codes) and the program line that the calculator stopped at.

(3) Be careful to double check each of the calculator peripherals as thoroughly as possible (individually) and list their device address settings. The MAINT Module may be used to checkout the units.

The responsibility to repair the hardware is as follows:

A. The station's responsibility
   1. Manual AN/FRM-19(V) Test Set
   2. HP 8407A/8412A and HP 3577A Network Analyzer, HP 8600A Digital Marker, HP 8601A Generator/Sweeper, HP 8640B RF Signal Generator, HP 141T/8553B/8552B Spectrum Analyzer
   3. Model 4027B Matrix Systems Matrix Switch
   4. HIA-11HF High Intercept Olektron Amplifier
   5. Model OEM20N2.1-1-1-2-C ACDC Electronics or Model 9006-20 Lambda Electronics 20Vdc/2.1 amp Power Supply

B. The Technical Support Agent's responsibility
   1. All Hewlett-Packard (HP) test equipment contained in the AUTOMATED AN/FRM-19(V) Test Cart
   2. Reverse Polarity Relay Switch

ERROR CODES

An error in a program sets the program line counter to line 0. Press the continue key to continue the program from line 0. Execute the continue command with a line number to continue at any desired line (such as: cont 50).

00	System error.
01	Unexpected peripheral interrupt.
02*	Unterminated text.
03*	Mnemonic is unknown. Mnemonic not found because disk may be down.
04	System is secured.
05	Operation not allowed; line cannot be stored or executed with line number.
06*	Syntax error in number.
07*	Syntax error in input line.
08	Internal representation of the line is too long (gives cursor sometimes).
09	gto, gsb, or end statement not allowed in present context. Attempt to execute a next statement either from keyboard while for/next loop using same variable is executed in program or from program while for/next loop using same variable is executed from keyboard. Attempt to call function or subroutine from keyboard.
10*	gto or gsb statement requires an integer.
11	Integer out of range or integer required; must be from -32768 thru +32767.
12*	Line cannot be stored; can only be executed.
13	ent statement not allowed in present context.
14	Program structure destroyed.
15	Printer out of paper or printer failure.
16	String Variables ROM not present for the string comparison. Argument in relational comparison not allowed.
17	Parameter out of range.
18	Incorrect parameter.

*Press the "RECALL" key to position the cursor at the location of the error.

19 Bad line number.

20 Missing ROM or binary program. The second number indicates the missing ROM. In the program mode, the line number is given instead of the ROM number. Displayed number and missing item:

1	Binary Program	10	Matrix ROM
4	Systems Programming ROM	11	Plotter ROM
6	Strings ROM	12	General I/O ROM
8	Extended I/O ROM	17	Disk ROM
9	Advanced Programming ROM		

21 Line is too long to store.

22 Improper dimension specification.

23 Simple variable already allocated.

24 Array already dimensioned.

25 Dimensions of array disagree with number of subscripts.

26 Subscript of array element out of bounds.
P-number reference is negative.

27 Undefined array.

28 ret statement has no matching gsb statement.

29 Cannot execute line because a ROM or binary program is missing.

30 Special function key not defined.

31 Non-existent program line.

32 Improper data type.
Non-numeric value in for statement or in fts or fti function.

33 Data types do not match in an assignment statement.

34 Display overflow due to pressing a special function key.

35 Improper flag reference (no such flag).

36 Attempt to delete destination of a gto or gsb statement.

37 Display buffer overflow caused by dsp statement.

38 Insufficient memory for subroutine return pointer. Memory overflow during function or subroutine call.

39 Insufficient memory for variable allocation or binary program.
Dimensioned string cannot exceed 32,766 elements.

40 Insufficient memory for operation.
Memory overflow while using for statement or while allocating local p-numbers.

41 No cartridge in tape transport.

42 Tape cartridge is write protected. (Slide record tab to right for recording.)

43 Unexpected Beginning-Of-Tape (BOT) or End-Of-Tape (EOT) marker encountered. Tape transport failure.

44 Verify has failed.

45 Attempted execution of idf statement without parameters or mrk statement when tape position is unknown.

46 Read error in file body.

47 Read error in file head.

48 End-Of-Tape (EOT) encountered before all files were marked.

49 File too small.

50 ldf statement for a program file must be last statement in the line.
get or chain statement should be the last statement in a line.

51 or 52 Memory configuration error for attempted ldm statement. For example, a ROM present when memory was recorded is now not present (see error 20), or attempting to load a memory file recorded on a 9825 into a 9825B.
Memory files are not compatible between the 9825A and 9825B. Only the program portion can be recovered by loading the memory file into the original machine and doing a rcf. This program file can then be loaded into any 9825 with the ldf statement.

53 Negative parameter in cartridge statement.

54 Binary program to be loaded is larger than present binary program and variables have been allocated.

55 Illegal or missing parameter in a cartridge statement.

56 Data list is contiguous in memory for a cartridge statement.

57 Improper file type.

58 Invalid parameter in rcf statement; "SE" or "DB" expected.

59 Attempt to record a program or special function keys which do not exist.

60 Attempt to load an empty file or the null file (type=0).

61 The line referenced in an ldf or ldp statement does not exist. If the line containing the ldf or ldp statement has been overlaid by the load operation, the line number in the display may be incorrect.

62 Specified memory space is smaller than cartridge file size.

63 Cartridge load operation would overlay subroutine return address in program; load not executed.
Disk load operation would overlay gsb return address; load not executed.

64 Attempt to execute ldk, ldf (program file), or ldp during live keyboard statement.
get, chain or getk not allow from live keyboard mode or during an ent statement.

65 File not found.
File specified in the previous fdf statement does not exist.

Default values associated with errors 66 thru 77 when flag 14 is set are explained in the programming chapter of the HP 9825 operating and programming manual.

66 Division by zero.
A mod B, with B equal to zero.

67 Square root of negative number.

68 Tan (n * pi/2 radians).
Tan (n * 90 degrees).
Tan (n * 100 grads).
where n is an odd integer.

69 ln or log of a negative number.

70 ln or log of zero.

71 asn or acs of number less than -1 or greater than +1.

72 Negative base to non-integer power.

73 Zero to the zero power.

74 Storage range overflow.

75 Storage range underflow.

76 Calculation range overflow.

77 Calculation range underflow.

A0 Relational operator in for statement not allowed. No closing apostrophe.

A1 A for statement has no matching next statement.

A2 A next statement encountered without a previous for statement.

A3 Non-numeric parameter passed as a p-number.

A4 No return parameter for a function call.

A5 No functions or subroutines running.
Improper p-number.

A6 Attempt to allocate local p-numbers from the keyboard.

A7 Wrong number of parameters in fts, stf, fti, or itf function. stf or itf parameter must be a string (not a numeric). stf or itf parameter contains too few characters.

A8 Overflow or underflow in fts function.
Overflow in fti function.

A9 String Variables ROM missing for stf or itf functions.

Errors B0 thru B8 may result during the binary disk initialization and disk error recovery routines.

B0 Wrong syntax, argument out of range or variable not properly dimensioned.

B1 More than six defective tracks on the disk.

B2 Verify error. Boots on the disk not identical to boots on the cartridge.

B3 dtrk or tinit not allowed because error information lost or error not d5, d6, d7, or d9.

B4 Attempt to access record for error correction which isn't part of data file.

B5 Improper string length (inconsistent with length given in header).

B6 Not enough space in computer buffer for data item. Item can't be placed in this part of buffer.

B7 Missing Disk or String ROM.

B8 Track still bad after tinit.

C0 Missing General I/O or Extended I/O ROM.

C1 Incorrect number of parameters.

C2 Improper parameter specified.

C3 Wrong parameter type.

C4 Illegal buffer type for bred statement.

C5 Key buffer overflow.

C6 Too large or wrong sign of parameter.

C7 Improper execution of store statement.

C8 Illegal use of kret.

C9 Missing 98036A Interface card.

D0 Improper argument.

D1 Argument out of range.

D2 Improper file size; must be an integer from 1 thru 32767. No lines to store for save or savek.

D3 Invalid file name.

D4 File not found.

D5 Duplicate file name or attempt to copy non-data file to existing file.

D6 Wrong file type.

D7 Directory overflow.

D8 Insufficient storage space on disk.

D9 Verify error. Disk controller detected no read errors, but the data read back doesn't compare with the original. Reprint data. If the problem persists, service the drive, interface or the computer.

DISK IS DOWN (98217A ROM)

UNABLE TO ACCESS DISC CONTROLLER (98228A ROM)
Computer cannot access the disk controller. If control is not restored (e.g., power on) press "RESET" or "STOP" to cancel operation.

d0 Firmware/driver out of synchronization.
Too many defective tracks within it (press "RESET").

d1 All drives in system not powered on.

d2 Door opened while disk being accessed or during dump, load, or copy.

d3 Disk not in drive or no such drive number.
Door open on 9895 drive.

d4 Write not allowed to protected disk.

d5 Record header error (use error recovery routine.)

d6 Track not found (use error recovery routine.)

d7 Data checkword error (use error recovery routine.)

d8 Hardware failure (Press "RESET").

d9 Verify error. Data is readable under normal margins but not under reduced margins. Reprint data. If problem persists, back up disk (new media) or service drive.

E0 General I/O ROM missing.
HP-IB error under interrupt.

E1 Wrong number of parameters.

E2 Improper buffer device or equate table usage.
Multiple-listeners error.
Buffer busy.

E3 Wrong parameter type.

E4 Timeout error.

E5 Buffer underflow or overflow.

E6 Parameter value out of range.

E7 Parity failure.

E8 Improper use of iret statement.
Attempt to DMA with HP-IB.
Buffer or select code is busy.

E9 Illegal HP-IB operation.

F0	File overflow when read or print executed.
F1	Bootstraps not found (98217A ROM) or wrong memory configuration for 98228A Disk ROM (9825T required).
F2	String read but wrong data type encountered.
F3	Attempt to read data item but type doesn't match.
F4	Availability table overflow (repack).
F5	Attempt on end branch from other than running program.
F6	Unassigned data file pointer.
F7	Disk is down; line cannot be reconstructed.
F8	Disk is down and "STOP" pressed.
F9	System error (save files individually and reinitialize).

G1	Incorrect format numbers.
G2	Referenced format statement has an error.
G3	Incorrect I/O parameters.
G4	Incorrect select code.
G5	Incorrect read parameter.
G6	Improper conv statement parameters.
G7	Unacceptable input data.
G8	Peripheral device down.
G9	Interface hardware problem.

M1*	Syntax error.
M2	Improper dimensions. Array dimensions incompatible with each other or incompatible with the stated operation.
M3	Improper redimension specification. New number of dimensions must equal original number; new size cannot exceed original size.
M4*	Operation not allowed. An array which appears to the left of ' cannot also appear on the right.

*Press the "RECALL" key to position the cursor at the location of the error.

M5 Matrix cannot be inverted. Computed determinant = 0.

9872A PLOTTER ROM ERROR CODES

P1 Attempt to store into constant. Occurs when one or more parameters in a dig statement are constants rather than variables.

P2 Wrong number of parameters. Occurs on instructions with numeric-only parameter lists (scl, ofs, plt, iplt, cplt, xax, yax, lim, dig, csiz, line, pen#, and psc). In certain unusual cases where a parameter list contains user-level function calls, an instruction having an incorrect number of parameters may be executed.

P3 Wrong type of parameter or illegal parameter value.

P4 No HP-IB device number specified. Occurs when psc parameter is from 0 thru 14 and an HP-IB card is at the corresponding select code.

P5 Pen control value not from -32768 thru 32767. Hardware transmission error occurs between plotter and computer.

P6 No HP-IB card at specified select code.

P7 axe or ltr statement encountered; 9872 ROM cannot execute them.

P8 Computer "STOP" key cancelled operation. Occurs when the plotter fails to respond for three seconds after the "STOP" key has been pressed.

p0 Transmission error. The calculator has received an illegal ASCII input from the plotter.

p1 Instruction not recognized. The plotter has received an illegal character sequence.

p2 Wrong number of parameters. Too many or too few parameters have been sent with an instruction.

p3 Bad parameter. The parameters sent to the plotter with an instruction are out of range for that instruction.

p4 Illegal character. The character specified as a parameter is not in the allowable set for that instruction.

p5 Unknown character set. A character set out of the range 0 thru 4 has been designated as either the standard or alternate character set.

p6 Position overflow. An attempt to draw a character or perform a cplt that is located outside of the plotters numeric limit of -32768 thru +32767.

Errors generated by write (wrt) and read (red) statements will typically be displayed in the next executed plotter ROM statement. This can be avoided by using an output error command (wrt select code, "OE";) followed by a read statement (red select code, variable) to check for errors after read or write statements that address the plotter.

S0	Invalid set of strings in data list of ldf statement.
S1	Improper argument for string function or string variable.
S2	More parameters than expected for string function or string variable.
S3	Accessing or assigning to non-contiguous string, num function of null string.
S4	Trying to find the value of non-numeric string or null string. Exponent too large. Exponent format invalid (e.g., 1e+ +).
S5	Invalid destination type for string assignment.
S6	Parameter is zero, or negative, exceeded dimensioned size. Invalid sequence of parameters for string variable.
S7	String not yet allocated.
S8	String previously allocated.
S9	Maximum string length exceeded; additional string length must be specified in dim statement.
SPARE DIR.	Printed when the spare disk directory (backup track) automatically replaces the main directory.

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APPENDIX D

REFERENCES

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APPENDIX D

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