



INSTRUMENT REPAIR SERVICE
14120-D SULLYFIELD CIRCLE
CHANTILLY, VA 22021
(703) 378-0600

OPERATING AND SERVICE MANUAL

4935A Transmission Impairment Measuring Set

SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed 2314A.

For additional important information about serial numbers, see INSTRUMENTS COVERED BY MANUAL in Section I.

WARNING

Power switch does not turn off AC power and some DC power circuits.

© COPYRIGHT HEWLETT-PACKARD COMPANY/COLORADO TELECOMMUNICATIONS DIVISION 1982
5870 Centennial Blvd., P.O. Box 7050, Colorado Springs, CO 80933
ALL RIGHTS RESERVED

MANUAL PART NO. 04935-90013
MICROFICHE PART NO. 04935-90014

Printed APR 1983
PRINTED IN U.S.A.

WARNING**SAFETY**

If this instrument is to be energized via an autotransformer for voltage reduction, make sure the common terminal is connected to the earthed pole of the power source.

BEFORE SWITCHING ON THIS INSTRUMENT, the protective earth terminals of this instrument must be connected to the protective conductor of the (mains) power cord. The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by use of an extension cord (power cable) without a protective conductor (grounding).

Make sure that only fuses with the required rated current and of the specified type (normal blow, time delay, etc.) are used for replacement. The use of repaired fuses and the short-circuiting of fuse holders must be avoided.

Whenever it is likely that the protection offered by fuses has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

GROUNDING

Any interruption of the protective (grounding) conductor (inside or outside the instrument) or disconnecting the protective earth terminal can make this instrument dangerous. Intentional interruption is prohibited.

HIGH VOLTAGE

Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible and, when inevitable, should be carried out only by a skilled person who is aware of the hazard involved.

Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

Adjustments and service described herein are performed with power supplied to the instrument while protective covers are removed. Energy available at many points, if contacted, result in personal injury.

CAUTION**LINE VOLTAGE**

BEFORE SWITCHING ON THIS INSTRUMENT, make sure instrument requirements match the voltage of the power source.

GROUNDING

BEFORE SWITCHING ON THIS INSTRUMENT, ensure that all devices connected to this instrument are connected to the protective (earth) ground.

BEFORE SWITCHING ON THIS INSTRUMENT, ensure that the line power (mains) plug is connected to a three-conductor line power outlet that has a protective (earth) ground. (Grounding one conductor of a two-conductor outlet is not sufficient.)

IEC SYMBOLS

The following is a list of key IEC symbols used by Hewlett-Packard. All symbols are normally applied adjacent to the device requiring the symbol. They shall not be placed on removable parts likely to be detached or lost.



Instruction Manual symbol: If necessary, to preserve the apparatus from damage it is necessary for the user to refer to the instruction manual, then shall the apparatus be marked with this symbol (IEC 348:16a).



Terminal devices fed from the interior by live voltages that may be dangerous when connecting to or disconnecting from those devices shall be marked with the flash shown when the voltage exceeds 1 KV. The flash shall be red (IEC 348:18c).



Earth Terminals. If the use of this symbol for the protective earth terminal is not permitted by National Standards, it may be modified, for example, by being placed inside a circle (IEC 348:18a).



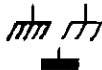
AC current (IEC 117-1, symbol No. 3).



DC current (IEC 117-1, symbol No. 2).



AC or DC current (IEC 117-1, symbol No. 8).



Frame or chassis connection. The hatching may be completely or partly omitted if there is no ambiguity. If the hatching is omitted, the line representing the frame or chassis shall be thicker (IEC 117-1, symbol No. 87).

A

Ampere (IEC 117-4, symbol No. 356).

V

Volt (IEC 117-4, symbol No. 357).

VA

Voltampere (IEC 117-4, symbol No. 358).

W

Watt (IEC 117-4, symbol No. 360).

Wh

Watt-hour (IEC 117-4, symbol No. 361).

VAh

Voltampere-hour (IEC 117-4, symbol No. 362).

Hz

Hertz (IEC 117-4, symbol No. 365).



Capacitor, normally closed. In order to avoid confusion with the symbol for a capacitor, the distance between the horizontal (as drawn here) lines should be at least equal to the length of those lines (IEC 117-3, symbol No. 215.2).

In addition the following describes the use of Warnings, Cautions and Notes used in HP Automatic Test System Manuals.

Warnings, cautions and notes. (All) Warnings and cautions shall precede the text to which each applies but notes may precede or follow applicable text depending on the material to be highlighted. Warnings, cautions, and notes shall not contain procedural steps nor shall they be numbered. When a warning, caution, or note consists of two or more paragraphs, the heading WARNING, CAUTION, NOTE, shall not be repeated above each paragraph. If it is ever necessary to precede a paragraph by both a warning and a note, or a caution and a note, etc. they shall appear in the sequence as noted, namely, warnings, cautions, notes. Such inserts in the text shall be short and concise and be used to emphasize important and critical instructions.

WARNING

An operating procedure, practice, etc. which, if not correctly followed, could result in personal injury or loss of life.

CAUTION

An operating procedure, practice, etc. which, if not strictly observed, could result in damage to, or destruction of, equipment.

NOTE: An operating procedure, condition, etc. which it is essential to highlight.

Health hazards precaution data. (All) When hazardous chemicals or adverse health factors, in the environment or use of the equipment cannot be eliminated, appropriate precautionary requirements shall be included.

TABLE OF CONTENTS

Section	Title	Page	Section	Title	Page
I. GENERAL INFORMATION			IV. PERFORMANCE TESTS		
1-1.	Introduction	1-1	4-1.	Introduction	4-1
1-3.	General Description	1-1	4-3.	Equipment Required	4-1
1-5.	Instrument Identification	1-1	4-5.	Test Record	4-1
1-7.	Specifications	1-1	4-7.	Self Check	4-1
1-9.	Safety Considerations	1-4	4-9.	Performance Verification	4-1
1-12.	Related Manuals	1-4	4-12.	Performance Tests	4-2
1-14.	User Repair	1-4	4-13.	Transmitter Flatness at +10 dBm .	4-2
1-16.	Options and Accessories	1-4	4-14.	Transmitter Flatness at -40 dBm .	4-4
1-19.	Warranty	1-4	4-15.	Receiver Accuracy at +11 dBm	
1-21.	Recommended Test Equipment	1-4		and -40 dBm	4-8
1-23.	Battery Operation (Options 001		4-16.	Autorange Test	4-10
	and 003)	1-6	4-17.	Filter Tests	4-11
1-26.	Charging the Batteries	1-6	4-18.	Impulse Noise DAC Test	4-14
1-29.	Operating Temperature	1-6	4-19.	Count Limit Test	4-16
1-31.	Storage Temperature	1-7	4-20.	Termination Impedance Test	4-17
1-34.	Memory Effect	1-7	4-21.	Hold Tone Dropout Detector Test	4-19
			4-22.	Hold Circuit Test	4-20
			4-23.	Distortion Test	4-21
			4-24.	P/AR Test	5-25
			4-25.	Noise-to-Ground (Standard and	
				Option 001)	4-26
II. INSTALLATION			V. ADJUSTMENTS/CALIBRATIONS		
2-1.	Introduction	2-1	5-1.	Introduction	5-1
2-3.	Initial Inspection	2-1	5-3.	Safety Considerations	5-1
2-6.	Preparation For Use	2-1	5-5.	Equipment Required	5-1
2-7.	Power Requirements	2-1	5-6.	Instrument Access	5-1
2-9.	Line Voltage Selection	2-1	5-9.	Adjustment Locations	5-1
2-10.	Power Cable	2-2	5-11.	Adjustments	5-2
2-13.	Operating Environment	2-2	5-13.	+5 V, +14 V, and -14 V Power	
2-16.	Storage and Shipment	2-2		Supply Adjustments	5-3
2-17.	Environment	2-2	5-14.	A3 Receiver Gain Adjustments	5-4
2-20.	Instrument Packaging	2-2	5-15.	Detector Adjustments	5-5
			5-17.	Notch Filter Adjustments	5-7
			5-18.	A13 P/AR Filter and Latch	
				Adjustments (Options 002 and 003) .	5-8
			5-19.	Output Level and Transmit	
				Monitor Loop Adjustments	5-9
			5-20.	Hold Circuit Adjustments	5-10
III. OPERATION			VI. REPLACEABLE PARTS		
3-1.	Operation	3-1	6-1.	Introduction	6-1
3-3.	Self Check	3-1	6-3.	Replaceable Parts List	6-1
3-5.	Error Messages	3-1	6-5.	Ordering Information	6-1
3-7.	Operating Instructions	3-6			
3-10.	Measurement Principles	3-17			
3-12.	Input-Output Switching	3-17			
3-19.	Level and Frequency Measurements .	3-18			
3-21.	1000 Hz Loss	3-18			
3-24.	Frequency Shift	3-18			
3-26.	Attenuation Distortion	3-18			
3-30.	SF Skip	3-19			
3-32.	Message Circuit Noise Measurements	3-19			
3-40.	Noise Measurements	3-22			
3-42.	Noise-with-Tone (Notched Noise)	3-22			
3-45.	Signal-to-Noise Measurement	3-22			
3-48.	Signal Frequency Interference	3-24			
3-52.	Impulse Noise	3-24			
3-55.	Noise-to-Ground Measurement	3-25			
3-59.	Peak-to-Average Ratio Measurement .	3-25			
			VII. MANUAL CHANGES		
			7-1.	Introduction	7-1
			7-3.	Manual Changes	7-1
			7-6.	Manual Change Instructions	7-1

TABLE OF CONTENTS (Cont'd)

Section	Title	Page	Section	Title	Page
VIII. SERVICE					
8-1	General Information	8-1	8-168.	Disassembly	8-29
8-8.	How Measurements are Made	8-3	8-169.	Remove Case	8-29
8-10.	Level and Frequency	8-4	8-171.	Receiver Board/Shield Plate/ Battery Charger Board Disassembly	8-29
8-13.	Noise	8-4	8-173.	Switchboard/Front Panel Removal	8-30
8-16.	Noise-with-Tone	8-4	8-175.	Transmitter Board Removal	8-30
8-19.	Signal-to-Noise	8-5	8-177.	Reassembly	8-30
8-22.	Impulse Noise	8-5	8-179.	Power Supply Troubleshooting	8-33
8-26.	Noise-to-Ground (Standard and Option 001)	8-6	8-181.	Minimum Core Troubleshooting Procedure	8-34 8-35
8-29.	Peak-to-Average Ratio: P/AR (Options 002 and 003)	8-6	8-186.	Display Troubleshooting	8-36
8-32.	Frequency Measurement	8-6	8-189.	Control Troubleshooting	8-36
8-34.	Level Measurement	8-7	8-190.	Troubleshoot Keyscan/Interrupt Circuitry	8-36
8-38.	How to Compute Frequency and Level Measurement	8-8	8-192.	Control and Counting Section Troubleshooting	8-36
8-39.	Level Calculation Example	8-8	8-194.	Transmitter Troubleshooting	8-37
8-42.	Control Theory of Operation	8-11	8-196.	Transmit Clock Generator	8-37
8-44.	Microprocessor to Instrument	8-11	8-200.	Transmitter Signature Analysis Procedure	8-37
8-45.	System Latches	8-11	8-202.	Digital-to-Analog Conversion	8-39
8-48.	Instrument to Microprocessor	8-12	8-204.	Filter and Signal Select Circuitry	8-40
8-51.	Operator to Microprocessor	8-12	8-207.	Output Amplifier	8-42
8-52.	Keyboard Interrupt	8-12	8-210.	Transmit Monitor	8-43
8-54.	Receiver Impedance Switches	8-12	8-212.	Receiver Troubleshooting	8-43
8-57.	Microprocessor to Operator	8-13	8-217.	Setup	8-44
8-58.	Displays	8-13	8-219.	Overall Transmit Monitor Test	8-44
8-60.	Instrument to Operator	8-13	8-222.	Transmit Monitor Signal	8-44
8-62.	Monitor Amp	8-13	8-225.	Noise Filter	8-45
8-64.	Beep Generator	8-13	8-227.	Simplified Autorange Check	8-45
8-66.	Operator to Instrument	8-13	8-229.	Detector Select	8-46
8-68.	Miscellaneous Circuitry	8-13	8-232.	Inputs from Front Panel/Notch Filter/25 dB Amp/Tone Dropout Signal Path	8-47
8-73.	Receiver Theory of Operation	8-15	8-235.	Input Transformer	8-47
8-76.	I/O Switching/Hold Circuits/ Termination	8-16	8-237.	Noise-to-Ground Input Path (noise-to-ground units only)	8-47
8-80.	Input Select/Notch Filter/ 25 dB Amp	8-17	8-239.	Tone Dropout Signal Path	8-47
8-85.	Noise Filter Circuitry	8-17	8-242.	Notch Filter	8-47
8-97.	Level Detectors	8-19	8-246.	Noise Filters	8-48
8-100.	Impulse Noise Detectors	8-19	8-248.	Autorange	8-48
8-102.	Transmitter	8-19	8-250.	Detector Troubleshooting	8-48
8-104.	Test Signal Generation Method	8-20	8-252.	Impulse Noise Circuitry	8-48
8-113.	Circuit Description	8-21	8-254.	Charger Board Troubleshooting Procedure	8-50 8-50
8-126.	Power Supply Theory	8-23	8-255.	Charge Circuitry/Charge Inhibit Circuitry	8-50
8-128.	AC Line Supplies	8-23	8-257.	Relay Drive Circuitry, Low Voltage Inhibit Circuitry	8-50
8-131.	Regulators	8-24	8-261.	Inhibit Circuitry AC and Low Voltage	8-51
8-139.	Charger Board Theory of Operation	8-25	8-263.	Delay and Relay Drive Circuitry	8-51
8-141.	Battery Charging	8-26	8-265.	AC and Low Voltage Inhibit Troubleshooting	8-52
8-144.	Power Source Selection	8-26	8-267.	Service Aids	8-53
8-146.	Relay Drive Circuitry	8-26			
8-148.	Inhibit Circuit	8-27			
8-153.	Maintenance	8-28			
8-155.	Periodic Maintenance	8-28			
8-157.	Failure Maintenance	8-28			
8-159.	Component Replacement	8-28			
8-164.	Soldering	8-28			
8-166.	Cleaning	8-28			

TABLE OF CONTENTS (Cont'd)

Section	Title	Page	Section	Title	Page
8-268.	Service Selection of Input/Notch Filter/25 dB Amp.....	8-53	8-278.	Procedure	8-54
8-270.	Procedure	8-53	8-279.	Hand Selection of A3C57 and A3C160 (A13C57 and A13C160 for P/AR units) for Desired Frequency Response ...	8-55
8-272.	Service Selection of Noise Filters by Hand.....	8-54	8-282.	Hand Selection of C57 and C160 .	8-55
8-274.	Procedure	8-54	8-283.	Filters: Response of Each Stage.....	8-56
8-276.	Service Selection of Autorange Gain for Service.....	8-54			

LIST OF ILLUSTRATIONS

Figure	Title	Page	Figure	Title	Page
1-1.	Model 4935A Transmission Impairment Measuring Set	1-0	5-1.	Hold Circuit Adjustment	5-1
1-2.	Charge Acceptance at Various Temperatures	1-6	6-1.	Exploded View Case and Covers	6-4
1-3.	Temperature-Capacity Relationships-Sealed Cells at C Rate Discharge	1-7	6-2.	Exploded View Assemblies and Cables	6-5
2-1.	Line Voltage Selection	1-2	6-3.	Exploded View Battery Option	6-7
3-1.	Front and Rear Panel Controls/Connectors/Indicators	3-2	7-1.	A2 Switch Board Component Locator	7-5
3-2.	Measurements	3-6	7-2.	A5 Charger Board Component Locator	7-6
3-3.	Input-Output Switching	3-17	7-3.	Partial A5 Charger Board Schematic	7-6
3-4.	Level and Frequency Measurements	3-18	7-4.	A14 Transmitter Board Component Locator	7-7
3-5.	Message Circuit Noise Measurements	3-19	7-5.	Partial A4 and A14 Schematic	7-8
3-6.	C-Message Weighting Characteristic	3-20	7-6.	A14 P/AR Transmitter Board Component Locator	7-8
3-7.	3 kHz Flat Weighting Characteristic	3-20	7-7.	A4 Transmitter Board Component Locator	7-9
3-8.	Program Weighted Filter	3-21	7-8.	Partial Power Supply Schematic	7-10
3-9.	15 kHz Flat Filter	3-21	7-9.	A13 P/AR Receiver Board Component Locator	7-11
3-10.	50 kBit Filter.....	3-22	7-10.	A3 Receiver Board Component Locator	7-12
3-11.	C-Message Weighting with Notch Characteristic	3-23	7-11.	A3 Receiver Board Schematic (Sheet 1 of 2)	7-13
3-12.	Signal-to-Noise Measurement	3-23	7-12.	A3 Receiver Board Schematic (Sheet 2 of 2)	7-14
3-13.	Impulse Noise Waveform Representation ..	3-24	8-1.	4935A Main Block Diagram	8-1
3-14.	Noise-to-Ground Related to Message Circuit Noise	3-25	8-2.	Voltage-to-Frequency Conversion Characteristics	8-7
3-15.	P/AR Transmit Signal Frequency Spectrum	3-26	8-3.	Voltage-to-Frequency Conversion Output ...	8-8
3-16.	P/AR Transmit Signal Envelope	3-26	8-4.	Frequency and Level Measurement Timing .	8-9
4-1.	Transmitter Flatness Test at +10 dBm	4-2	8-5.	Control Circuitry Block Diagram	8-11
4-2.	Transmitter Flatness Test at -40 dBm	4-4	8-6.	Receiver Block Diagram	8-14
4-3.	Receiver Test at +11 dBm and -40 dBm	4-8	8-7.	Switchboard Block Diagram	8-15
4-4.	Autorange Test	4-10	8-8.	Input-Output Switching	8-16
4-5.	Filter Tests	4-11	8-9.	Filter Block Diagram	8-17
4-6.	Impulse Noise DAC Test	4-14	8-10.	Autorange Block Diagram	8-18
4-7.	Count Limit Test	4-16	8-11.	Stair-step Sinewave	8-20
4-8.	Termination Impedance Test	4-17	8-12.	Transmitter Block Diagram	8-21
4-9.	Hold Tone Dropout Detector Test	4-19	8-13.	Power Supply Block Diagram	8-23
4-10.	Hold Circuit Test	4-20	8-14.	Charger Board Block Diagram	8-25
4-11.	Distortion Test	4-21	8-15.	Inhibit Circuit	8-26
4-12.	-40 dBm Distortion Test	4-22	8-16.	Relay Drive Circuit	8-26
4-13.	Filter Circuits	4-23	8-17.	Instrument Troubleshooting	8-32
4-14.	P/AR Test	4-25			
4-15.	Noise-to-Ground Test	4-26			

LIST OF ILLUSTRATIONS (Cont'd)

Figure	Title	Page	Figure	Title	Page
8-18.	Stair-step Sinewave	8-39	8-29.	Receiver Board Schematic Diagram (Sheet 1 of 2)	8-69
8-19.	P/AR Signal Frequency Spectrum	8-41	8-30.	Receiver Board Schematic Diagram (Sheet 2 of 2)	8-71
8-20.	P/AR Transmit Signal Envelope	8-42	8-31.	A4 Transmitter Board Component Locator	8-72
8-21.	20 Hz Waveform	8-43	8-32.	A14 Transmitter Board Component Locator	8-73
8-22.	Transmit Monitor Test Output	8-44	8-33.	Transmitter Board Schematic Diagram (Sheet 1 of 2)	8-73
8-23.	4935A Signal Flow Block Diagram	8-63	8-34.	Transmitter Board Schematic Diagram (Sheet 2 of 2)	8-75
8-24.	Front Panel Schematic Diagram	8-65	8-35.	A5 Charger Board Component Locator	8-76
8-25.	A2 Switch Board Component Locator	8-66	8-36.	Charger Board Schematic Diagram	8-77
8-26.	Switch Board Schematic Diagram	8-67			
8-27.	A3 Receiver Board Component Locator	8-68			
8-28.	A13 Receiver Board Component Locator	8-69			

LIST OF TABLES

Table	Title	Page	Table	Title	Page
1-1.	Specifications	1-2	7-1.	Manual Changes	7-1
1-2.	Recommended Test Equipment	1-5	8-1.	Measurements Summary	8-3
1-3.	List of Parts Used for Performance Tests	1-5	8-2.	Noise Amplification	8-5
2-1.	HP Plug Styles	2-3	8-3.	Reference Signatures	8-38
4-1.	Transmitter Flatness at +10 dBm	4-3	8-4.	Wideband Filter Response	8-40
4-2.	Transmitter Flatness at -40 dBm	4-5	8-5.	5 kHz Low Pass Filter Response	8-40
4-3.	Abbreviated Transmitter Flatness	4-7	8-6.	Output Select MUX	8-41
4-4.	Receiver Accuracy Test Table	4-9	8-7.	Transmit Monitor Test	8-43
4-5.	Abbreviated Receiver Accuracy Test Table	4-9	8-8.	A3U1B Voltages	8-49
4-6.	Autorange Test	4-10	8-9.	TP3 Voltages	8-49
4-7.	C-Message Filter Test	4-11	8-10.	Hand Selection of Noise Filters	8-54
4-8.	3 kHz Flat Filter Test	4-12	8-11.	Autorange States	8-5
4-9.	15 kHz Flat Filter Test	4-12	8-12.	Hand Selection of C57 and C160	8-56
4-10.	Program Filter Test	4-12	8-13.	4935A C-Message Filter	8-57
4-11.	50 kBit Filter Test	4-13	8-14.	4935A 3 kHz Flat Filter	8-57
4-12.	Notch Filter Test	4-13	8-15.	4935A 15 kHz Flat Filter	8-57
4-13.	Impulse Noise DAC Test	4-15	8-16.	4935A Program Filter	8-57
4-14.	Filter Circuit Parts List	4-23	8-17.	4935A 50 kBit Filter	8-58
4-15.	Abbreviated Distortion Test	4-24	8-18.	4935A Notch Filter	8-58
4-16.	P/AR Filter Responses	4-25	8-19.	4935A P/AR Filter	8-58
6-1.	Reference Designation and Abbreviations	6-2	8-20.	4935A 150 kHz Low Pass Filter	8-58
6-2.	Manufacturer Code List	6-8	8-21.	4935A 110 kHz Low Pass Filter	8-59
6-3.	Replaceable Parts	6-9	8-22.	Bell 41009 C-Message Filter	8-59
			8-23.	Bell 41009 3 kHz Flat Filter	8-60
			8-24.	Bell 41009 15 kHz Flat Filter	8-60
			8-25.	Bell 41009 Program Filter	8-60
			8-26.	Bell 41009 50 kBit Filter	8-61
			8-27.	Bell 41009 P/AR Filter	8-61
			8-28.	Bell 41009 Notch Filter	8-61

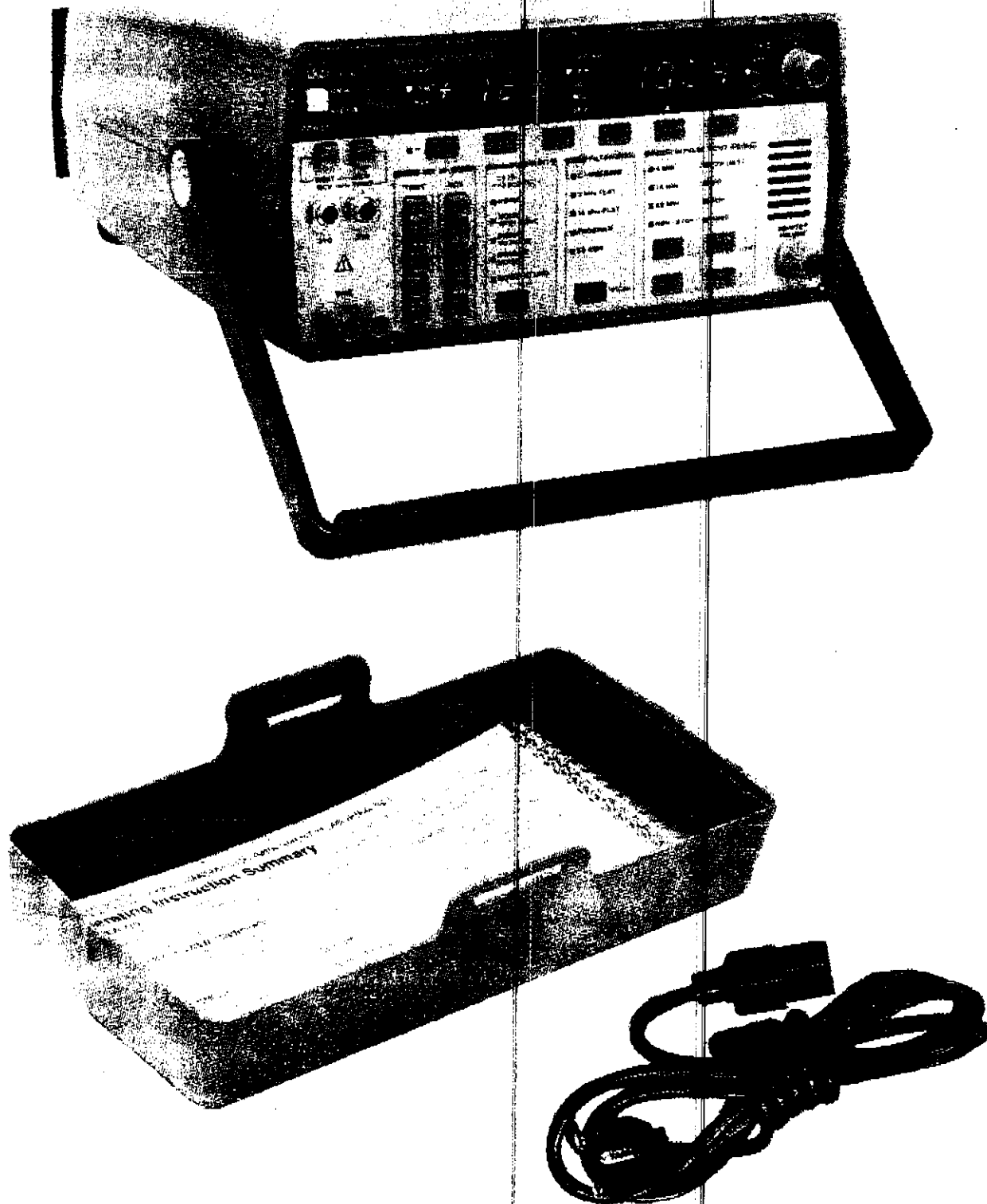


Figure 1-1. Model 4935A Transmission Impairment Measuring Set

SECTION I GENERAL INFORMATION

1-1. INTRODUCTION

1-2. This Operating and Service manual contains information to install, operate, maintain, and service the HP Model 4935A Transmission Impairment Measuring Set (TIMS). Figure 1-1 shows the HP Model 4935A with cover and power cord. The manual is divided into eight major sections which provide the following information:

SECTION I. GENERAL INFORMATION. Provides identification, specifications, related manuals, and user-repair information.

SECTION II. INSTALLATION. Contains unpacking and inspection information, power requirements, packaging, and storage instructions.

SECTION III. OPERATION. Includes an explanation of controls, connectors, indicators, and an automatic self check procedure. Describes measurement principles and front panel instructions for making each measurement.

SECTION IV. PERFORMANCE TESTS. Gives test procedures required to verify that the instrument's performance is in accordance with the specifications.

SECTION V. ADJUSTMENTS. Provides adjustment and calibration procedures.

SECTION VI. REPLACEABLE PARTS. Lists and identifies the instrument assemblies and replaceable parts.

SECTION VII. MANUAL CHANGES. Contains information to backdate the manual for instruments with earlier serial numbers.

SECTION VIII. SERVICE. Includes theory of operation, troubleshooting procedures, flowcharts, component locators, and schematic diagrams.

1-3. GENERAL DESCRIPTION

1-4. HP Model 4935A is a Transmission Impairment Measuring Set (TIMS) which measures wideband data and voice impairments. The frequency range over which measurements are made is 20 Hz to 110 kHz, in steps of 1, 10, 100, 1000, or 10,000 Hz. There are four permanently stored, fixed frequencies -404, 1004, 2804, and 2713 Hz. Any other four frequencies may be temporarily assigned and stored by the user.

1-5. INSTRUMENT IDENTIFICATION

1-6. A 10 character serial number (0000A0000) is inscribed on the rear panel. The first four digits and the letter are the serial prefix. The serial prefix will change only if changes are made to the instrument; a Manual Change Sheet will be included with the manuals of any instruments affected. The last five numbers form the serial suffix which is unique to each instrument.

1-7. SPECIFICATIONS

1-8. Instrument specifications are listed in Table 1-1.

Table 1-1. Specifications

TRANSMITTER			RECEIVER																																																			
Frequency			Frequency																																																			
Frequency Range 20 Hz to 110 kHz			Frequency Range 20 Hz to 110 kHz																																																			
	Resolution	Accuracy		Resolution	Accuracy																																																	
20-99,999 Hz	1 Hz	$\pm .005\%$ of output frequency	20-9,999 Hz	1 Hz	± 0.5 Hz																																																	
100-110 kHz	10 Hz	$\pm .012\%$ of output frequency	10-110 kHz	10 Hz	± 5 Hz																																																	
Store and Recall Functions																																																						
SK Skip . . . At power up skips a band from 2450-2750 Hz																																																						
Frequencies At power up F1 is 404 Hz																																																						
F2 is 1004 Hz																																																						
F3 is 2804 Hz																																																						
F4 is 2713 Hz																																																						
Level			Level																																																			
Range -40 to +13 dBm			Range -60 to +13 dBm																																																			
Resolution 0.1 dB			Resolution 0.1 dB																																																			
Flatness (in dB)			Accuracy (in dB)																																																			
<table border="1"> <thead> <tr> <th colspan="6">FREQUENCY, Hz</th> </tr> <tr> <th>20</th> <th>200</th> <th>15k</th> <th>80k</th> <th>85k</th> <th>110k</th> </tr> </thead> <tbody> <tr> <td colspan="6" style="background-color: black;">[Shaded Area]</td> </tr> <tr> <td>±1.0</td> <td>±0.2</td> <td>±0.5</td> <td>±0.5</td> <td></td> <td></td> </tr> </tbody> </table>			FREQUENCY, Hz						20	200	15k	80k	85k	110k	[Shaded Area]						±1.0	±0.2	±0.5	±0.5			<table border="1"> <thead> <tr> <th colspan="6">FREQUENCY (Hz)</th> </tr> <tr> <th>20</th> <th>50</th> <th>200</th> <th>15k</th> <th>60k</th> <th>85k</th> <th>110k</th> </tr> </thead> <tbody> <tr> <td colspan="6" style="background-color: black;">[Shaded Area]</td> </tr> <tr> <td>±1.0</td> <td>±0.5</td> <td>±0.2</td> <td>±0.5</td> <td>±0.5</td> <td></td> </tr> </tbody> </table>			FREQUENCY (Hz)						20	50	200	15k	60k	85k	110k	[Shaded Area]						±1.0	±0.5	±0.2	±0.5	±0.5	
FREQUENCY, Hz																																																						
20	200	15k	80k	85k	110k																																																	
[Shaded Area]																																																						
±1.0	±0.2	±0.5	±0.5																																																			
FREQUENCY (Hz)																																																						
20	50	200	15k	60k	85k	110k																																																
[Shaded Area]																																																						
±1.0	±0.5	±0.2	±0.5	±0.5																																																		
Distortion: (in dB from fundamental)			Receiver accuracy not specified below 500 Hz when using 135Ω termination.																																																			
(Includes harmonics, spurious and background noise within a filter with a 3 dB bandwidth of 4 kHz or 4 f ₀ , whichever is greater.)			At 1004 kHz accuracy is ±0.1 dB from -20 to +13 dBm.																																																			
<table border="1"> <thead> <tr> <th colspan="4">FREQUENCY (Hz)</th> </tr> <tr> <th>30 Hz</th> <th>100 Hz</th> <th>4k</th> <th>110k</th> </tr> </thead> <tbody> <tr> <td colspan="4" style="background-color: black;">[Shaded Area]</td> </tr> <tr> <td></td> <td>-55</td> <td>-50</td> <td></td> </tr> <tr> <td></td> <td>-50</td> <td>-40</td> <td></td> </tr> </tbody> </table>			FREQUENCY (Hz)				30 Hz	100 Hz	4k	110k	[Shaded Area]					-55	-50			-50	-40		<p><i>Cross talk: >78 dB isolation @ 4 kHz, decreasing 6 dB per octave above 4 kHz.</i></p>																															
FREQUENCY (Hz)																																																						
30 Hz	100 Hz	4k	110k																																																			
[Shaded Area]																																																						
	-55	-50																																																				
	-50	-40																																																				
At 1004 Hz, 0 dBm, THD using a 4 kHz filter is more than 65 dB down from the fundamental.																																																						
Message Circuit Noise			Message Circuit Noise																																																			
Transmitter is quiet terminated			Range (@ 600Ω and 900Ω) 0 to 100 dBm																																																			
			@ 135Ω lower limit is 7 dB higher																																																			
			Resolution 1 dB																																																			
			Accuracy ± 1 dB from 10 to 100 dBm																																																			
			± 2 dB from 0 to 10 dBm																																																			
			Filters C-Message, 3 kHz Flat, 15 kHz Flat, Program, 50 kBit																																																			
Specifications describe the instrument's warranted performance. Supplemental characteristics shown in shaded areas or in italics are intended to provide information useful in applying the instrument by giving typical, but non-warranted performance parameters.																																																						

WARNING**SAFETY**

If this instrument is to be energized via an autotransformer for voltage reduction, make sure the common terminal is connected to the earthed pole of the power source.

BEFORE SWITCHING ON THIS INSTRUMENT, the protective earth terminals of this instrument must be connected to the protective conductor of the (mains) power cord. The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by use of an extension cord (power cable) without a protective conductor (grounding).

Make sure that only fuses with the required rated current and of the specified type (normal blow, time delay, etc.) are used for replacement. The use of repaired fuses and the short-circuiting of fuse holders must be avoided.

Whenever it is likely that the protection offered by fuses has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

GROUNDING

Any interruption of the protective (grounding) conductor (inside or outside the instrument) or disconnecting the protective earth terminal can make this instrument dangerous. Intentional interruption is prohibited.

HIGH VOLTAGE

Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible and, when inevitable, should be carried out only by a skilled person who is aware of the hazard involved.

Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

Adjustments and service described herein are performed with power supplied to the instrument while protective covers are removed. Energy available at many points, if contacted, result in personal injury.

CAUTION**LINE VOLTAGE**

BEFORE SWITCHING ON THIS INSTRUMENT, make sure instrument requirements match the voltage of the power source.

GROUNDING

BEFORE SWITCHING ON THIS INSTRUMENT, ensure that all devices connected to this instrument are connected to the protective (earth) ground.

BEFORE SWITCHING ON THIS INSTRUMENT, ensure that the line power (mains) plug is connected to a three-conductor line power outlet that has a protective (earth) ground. (Grounding one conductor of a two-conductor outlet is not sufficient.)

IEC SYMBOLS

The following is a list of key IEC symbols used by Hewlett-Packard. All symbols are normally applied adjacent to the device requiring the symbol. They shall not be placed on removable parts likely to be detached or lost.



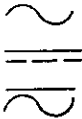
Instruction Manual symbol: If necessary, to preserve the apparatus from damage it is necessary for the user to refer to the instruction manual, then shall the apparatus be marked with this symbol (IEC 348;16a).



Terminal devices fed from the interior by live voltages that may be dangerous when connecting to or disconnecting from those devices shall be marked with the flash shown when the voltage exceeds 1 KV: The flash shall be red (IEC 348;18c).



Earth Terminals. If the use of this symbol for the protective earth terminal is not permitted by National Standards, it may be modified, for example, by being placed inside a circle (IEC 348;18a).



AC current (IEC 117-1, symbol No. 3).



DC current (IEC 117-1, symbol No. 2).



AC or DC current (IEC 117-1, symbol No. 8).



Frame or chassis connection. The hatching may be completely or partly omitted if there is no ambiguity. If the hatching is omitted, the line representing the frame or chassis shall be thicker (IEC 117-1, symbol No. 87).

A Ampere (IEC 117-4, symbol No. 356).

V Volt (IEC 117-4, symbol No. 357).

VA Voltampere (IEC 117-4, symbol No. 358).

W Watt (IEC 117-4, symbol No. 360).

Wh Watthour (IEC 117-4, symbol No. 361).

VAh Voltamperehour (IEC 117-4, symbol No. 362).

Hz Hertz (IEC 117-4, symbol No. 365).



Contactor, normally closed. In order to avoid confusion with the symbol for a capacitor, the distance between the horizontal (as drawn here) lines should be at least equal to the length of those lines (IEC 117-3, symbol No. 215.2).

In addition the following describes the use of Warnings, Cautions and Notes used in HP Automatic Test System Manuals.

Warnings, cautions and notes. (All) Warnings and cautions shall precede the text to which each applies but notes may precede or follow applicable text depending on the material to be highlighted. Warnings, cautions, and notes shall not contain procedural steps nor shall they be numbered. When a warning, caution, or note consists of two or more paragraphs, the heading WARNING, CAUTION, NOTE, shall not be repeated above each paragraph. If it is ever necessary to precede a paragraph by both a warning and a note, or a caution and a note, etc, they shall appear in the sequence as noted, namely, warnings, cautions, notes. Such inserts in the text shall be short and concise and be used to emphasize important and critical instructions.

WARNING

An operating procedure, practice, etc, which, if not correctly followed, could result in personal injury or loss of life.

CAUTION

An operating procedure, practice, etc, which, if not strictly observed, could result in damage to, or destruction of, equipment.

NOTE: An operating procedure, condition, etc, which it is essential to highlight.

Health hazards precaution data. (All) When hazardous chemicals or adverse health factors, in the environment or use of the equipment cannot be eliminated, appropriate precautionary requirements shall be included.

TABLE OF CONTENTS (Cont'd)

Section	Title	Page	Section	Title	Page
VIII. SERVICE					
8-1	General Information	8-1	8-168.	Disassembly	8-29
8-8.	How Measurements are Made	8-3	8-169.	Remove Case	8-29
8-10.	Level and Frequency	8-4	8-171.	Receiver Board/Shield Plate/ Battery Charger Board Disassembly	8-29
8-13.	Noise	8-4	8-173.	Switchboard/Front Panel Removal ..	8-30
8-16.	Noise-with-Tone	8-4	8-175.	Transmitter Board Removal	8-30
8-19.	Signal-to-Noise	8-5	8-177.	Reassembly	8-30
8-22.	Impulse Noise	8-5	8-179.	Power Supply Troubleshooting	8-33
8-26.	Noise-to-Ground (Standard and Option 001)	8-6	8-181.	Minimum Core Troubleshooting	8-34
8-29.	Peak-to-Average Ratio: P/AR (Options 002 and 003)	8-6	8-183.	Procedure	8-35
8-32.	Frequency Measurement	8-6	8-186.	Display Troubleshooting	8-36
8-34.	Level Measurement	8-7	8-189.	Control Troubleshooting	8-36
8-38.	How to Compute Frequency and Level Measurement	8-8	8-190.	Troubleshoot Keyscan/Interrupt Circuitry	8-36
8-39.	Level Calculation Example	8-8	8-192.	Control and Counting Section Troubleshooting	8-36
8-42.	Control Theory of Operation	8-11	8-194.	Transmitter Troubleshooting	8-37
8-44.	Microprocessor to Instrument	8-11	8-196.	Transmit Clock Generator	8-37
8-45.	System Latches	8-11	8-200.	Transmitter Signature Analysis Procedure	8-37
8-48.	Instrument to Microprocessor	8-12	8-202.	Digital-to-Analog Conversion	8-39
8-51.	Operator to Microprocessor	8-12	8-204.	Filter and Signal Select Circuitry ..	8-40
8-52.	Keyboard Interrupt	8-12	8-207.	Output Amplifier	8-42
8-54.	Receiver Impedance Switches	8-12	8-210.	Transmit Monitor	8-43
8-57.	Microprocessor to Operator	8-13	8-212.	Receiver Troubleshooting	8-43
8-58.	Displays	8-13	8-217.	Setup	8-44
8-60.	Instrument to Operator	8-13	8-219.	Overall Transmit Monitor Test ..	8-44
8-62.	Monitor Amp	8-13	8-222.	Transmit Monitor Signal	8-44
8-64.	Beep Generator	8-13	8-225.	Noise Filter	8-45
8-66.	Operator to Instrument	8-13	8-227.	Simplified Autorange Check	8-45
8-68.	Miscellaneous Circuitry	8-13	8-229.	Detector Select	8-46
8-73.	Receiver Theory of Operation	8-15	8-232.	Inputs from Front Panel/Notch Filter/25 dB Amp/Tone Dropout Signal Path	8-47
8-76.	I/O Switching/Hold Circuits/ Termination	8-16	8-235.	Input Transformer	8-47
8-80.	Input Select/Notch Filter/ 25 dB Amp	8-17	8-237.	Noise-to-Ground Input Path (noise-to-ground units only)	8-47
8-85.	Noise Filter Circuitry	8-17	8-239.	Tone Dropout Signal Path	8-47
8-97.	Level Detectors	8-19	8-242.	Notch Filter	8-47
8-100.	Impulse Noise Detectors	8-19	8-246.	Noise Filters	8-48
8-102.	Transmitter	8-19	8-248.	Autorange	8-48
8-104.	Test Signal Generation Method ..	8-20	8-250.	Detector Troubleshooting	8-48
8-113.	Circuit Description	8-21	8-252.	Impulse Noise Circuitry	8-48
8-126.	Power Supply Theory	8-23	8-254.	Charger Board Troubleshooting	8-50
8-128.	AC Line Supplies	8-23	8-255.	Procedure	8-50
8-131.	Regulators	8-24	8-257.	Charge Circuitry/Charge Inhibit Circuitry	8-50
8-139.	Charger Board Theory of Operation ..	8-25	8-259.	Relay Crive Circuitry, Low Voltage Inhibit Circuitry	8-50
8-141.	Battery Charging	8-26	8-261.	Inhibit Circuitry AC and Low Voltage	8-51
8-144.	Power Source Selection	8-26	8-263.	Delay and Relay Drive Circuitry	8-51
8-146.	Relay Drive Circuitry	8-26	8-265.	AC and Low Voltage Inhibit Troubleshooting	8-52
8-148.	Inhibit Circuit	8-27	8-267.	Service Aids	8-53
8-153.	Maintenance	8-28			
8-155.	Periodic Maintenance	8-28			
8-157.	Failure Maintenance	8-28			
8-159.	Component Replacement	8-28			
8-164.	Soldering	8-28			
8-166.	Cleaning	8-28			

TABLE OF CONTENTS (Cont'd)

Section	Title	Page	Section	Title	Page
8-268.	Service Selection of Input Notch Filter/25 dB Amp.....	8-53	8-278.	Procedure	8-54
8-270.	Procedure	8-53	8-279.	Hand Selection of A3C57 and A3C160 (A13C57 and A13C160 for P/AR units) for Desired Frequency Response ...	8-55
8-272.	Service Selection of Noise Filters by Hand.....	8-54	8-282.	Hand Selection of C57 and C160 ..	8-55
8-274.	Procedure	8-54	8-283.	Filters: Response of Each Stage.....	8-56
8-276.	Service Selection of Autorange Gain for Service.....	8-54			

LIST OF ILLUSTRATIONS

Figure	Title	Page	Figure	Title	Page
1-1.	Model 4935A Transmission Impairment Measuring Set	1-0	5-1.	Hold Circuit Adjustment	5-1
1-2.	Charge Acceptance at Various Temperatures	1-6	6-1.	Exploded View Case and Covers.....	6-4
1-3.	Temperature-Capacity Relationships-Sealed Cells at C Rate Discharge	1-7	6-2.	Exploded View Assemblies and Cables	6-5
2-1.	Line Voltage Selection	1-2	6-3.	Exploded View Battery Option	6-7
3-1.	Front and Rear Panel Controls/Connectors/Indicators	3-2	7-1.	A2 Switch Board Component Locator.....	7-5
3-2.	Measurements	3-6	7-2.	A5 Charger Board Component Locator	7-6
3-3.	Input-Output Switching	3-17	7-3.	Partial A5 Charger Board Schematic	7-6
3-4.	Level and Frequency Measurements	3-18	7-4.	A14 Transmitter Board Component Locator	7-7
3-5.	Message Circuit Noise Measurements	3-19	7-5.	Partial A4 and A14 Schematic.....	7-8
3-6.	C-Message Weighting Characteristic.....	3-20	7-6.	A14 P/AR Transmitter Board Component Locator	7-8
3-7.	3 kHz Flat Weighting Characteristic.....	3-20	7-7.	A4 Transmitter Board Component Locator	7-9
3-8.	Program Weighted Filter	3-21	7-8.	Partial Power Supply Schematic.....	7-10
3-9.	15 kHz Flat Filter	3-21	7-9.	A13 P/AR Receiver Board Component Locator	7-11
3-10.	50 kBit Filter	3-22	7-10.	A3 Receiver Board Component Locator	7-12
3-11.	C-Message Weighting with Notch Characteristic	3-23	7-11.	A3 Receiver Board Schematic (Sheet 1 of 2)	7-13
3-12.	Signal-to-Noise Measurement	3-23	7-12.	A3 Receiver Board Schematic (Sheet 2 of 2)	7-14
3-13.	Impulse Noise Waveform Representation ..	3-24	8-1.	4935A Main Block Diagram	8-1
3-14.	Noise-to-Ground Related to Message Circuit Noise	3-25	8-2.	Voltage-to-Frequency Conversion Characteristics	8-7
3-15.	P/AR Transmit Signal Frequency Spectrum ..	3-26	8-3.	Voltage-to-Frequency Conversion Output ...	8-8
3-16.	P/AR Transmit Signal Envelope	3-26	8-4.	Frequency and Level Measurement Timing ..	8-9
4-1.	Transmitter Flatness Test at +10 dBm	4-2	8-5.	Control Circuitry Block Diagram	8-11
4-2.	Transmitter Flatness Test at -40 dBm	4-4	8-6.	Receiver Block Diagram	8-14
4-3.	Receiver Test at +11 dBm and -40 dBm ...	4-8	8-7.	Switchboard Block Diagram	8-15
4-4.	Autorange Test	4-10	8-8.	Input-Output Switching	8-16
4-5.	Filter Tests	4-11	8-9.	Filter Block Diagram	8-17
4-6.	Impulse Noise DAC Test	4-14	8-10.	Autorange Block Diagram.....	8-18
4-7.	Count Limit Test	4-16	8-11.	Stair-step Sinewave	8-20
4-8.	Termination Impedance Test	4-17	8-12.	Transmitter Block Diagram	8-21
4-9.	Hold Tone Dropout Detector Test	4-19	8-13.	Power Supply Block Diagram.....	8-23
4-10.	Hold Circuit Test	4-20	8-14.	Charger Board Block Diagram	8-25
4-11.	Distortion Test	4-21	8-15.	Inhibit Circuit	8-26
4-12.	-40 dBm Distortion Test	4-22	8-16.	Relay Drive Circuit.....	8-26
4-13.	Filter Circuits	4-23	8-17.	Instrument Troubleshooting	8-32
4-14.	P/AR Test	4-25			
4-15.	Noise-to-Ground Test	4-26			

LIST OF ILLUSTRATIONS (Cont'd)

Figure	Title	Page	Figure	Title	Page
8-18.	Stair-step Sinewave	8-39	8-29.	Receiver Board Schematic Diagram (Sheet 1 of 2)	8-69
8-19.	P/AR Signal Frequency Spectrum	8-41	8-30.	Receiver Board Schematic Diagram (Sheet 2 of 2)	8-71
8-20.	P/AR Transmit Signal Envelope	8-42	8-31.	A4 Transmitter Board Component Locator	8-72
8-21.	20 Hz Waveform	8-43	8-32.	A14 Transmitter Board Component Locator	8-73
8-22.	Transmit Monitor Test Output	8-44	8-33.	Transmitter Board Schematic Diagram (Sheet 1 of 2)	8-73
8-23.	4935A Signal Flow Block Diagram	8-63	8-34.	Transmitter Board Schematic Diagram (Sheet 2 of 2)	8-75
8-24.	Front Panel Schematic Diagram	8-65	8-35.	A5 Charger Board Component Locator	8-76
8-25.	A2 Switch Board Component Locator	8-66	8-36.	Charger Board Schematic Diagram	8-77
8-26.	Switch Board Schematic Diagram	8-67			
8-27.	A3 Receiver Board Component Locator	8-68			
8-28.	A13 Receiver Board Component Locator	8-69			

LIST OF TABLES

Table	Title	Page	Table	Title	Page
1-1.	Specifications	1-2	7-1.	Manual Changes	7-1
1-2.	Recommended Test Equipment	1-5	8-1.	Measurements Summary	8-3
1-3.	List of Parts Used for Performance Tests	1-5	8-2.	Noise Amplification	8-5
2-1.	HP Plug Styles	2-3	8-3.	Reference Signatures	8-38
4-1.	Transmitter Flatness at +10 dBm	4-3	8-4.	Wideband Filter Response	8-40
4-2.	Transmitter Flatness at -40 dBm	4-5	8-5.	5 kHz Low Pass Filter Response	8-40
4-3.	Abbreviated Transmitter Flatness	4-7	8-6.	Output Select MUX	8-41
4-4.	Receiver Accuracy Test Table	4-9	8-7.	Transmit Monitor Test	8-43
4-5.	Abbreviated Receiver Accuracy Test Table	4-9	8-8.	A3U1B Voltages	8-49
4-6.	Autorange Test	4-10	8-9.	TP3 Voltages	8-49
4-7.	C-Message Filter Test	4-11	8-10.	Hand Selection of Noise Filters	8-54
4-8.	3 kHz Flat Filter Test	4-12	8-11.	Autorange States	8-5
4-9.	15 kHz Flat Filter Test	4-12	8-12.	Hand Selection of C57 and C160	8-56
4-10.	Program Filter Test	4-12	8-13.	4935A C-Message Filter	8-57
4-11.	50 kBit Filter Test	4-13	8-14.	4935A 3 kHz Flat Filter	8-57
4-12.	Notch Filter Test	4-13	8-15.	4935A 15 kHz Flat Filter	8-57
4-13.	Impulse Noise DAC Test	4-15	8-16.	4935A Program Filter	8-57
4-14.	Filter Circuit Parts List	4-23	8-17.	4935A 50 kBit Filter	8-58
4-15.	Abbreviated Distortion Test	4-24	8-18.	4935A Notch Filter	8-58
4-16.	P/AR Filter Responses	4-25	8-19.	4935A P/AR Filter	8-58
6-1.	Reference Designation and Abbreviations	6-2	8-20.	4935A 150 kHz Low Pass Filter	8-58
6-2.	Manufacturer Code List	6-8	8-21.	4935A 110 kHz Low Pass Filter	8-59
6-3.	Replaceable Parts	6-9	8-22.	Bell 41009 C-Message Filter	8-59
			8-23.	Bell 41009 3 kHz Flat Filter	8-60
			8-24.	Bell 41009 15 kHz Flat Filter	8-60
			8-25.	Bell 41009 Program Filter	8-60
			8-26.	Bell 41009 50 kBit Filter	8-61
			8-27.	Bell 41009 P/AR Filter	8-61
			8-28.	Bell 41009 Notch Filter	8-61

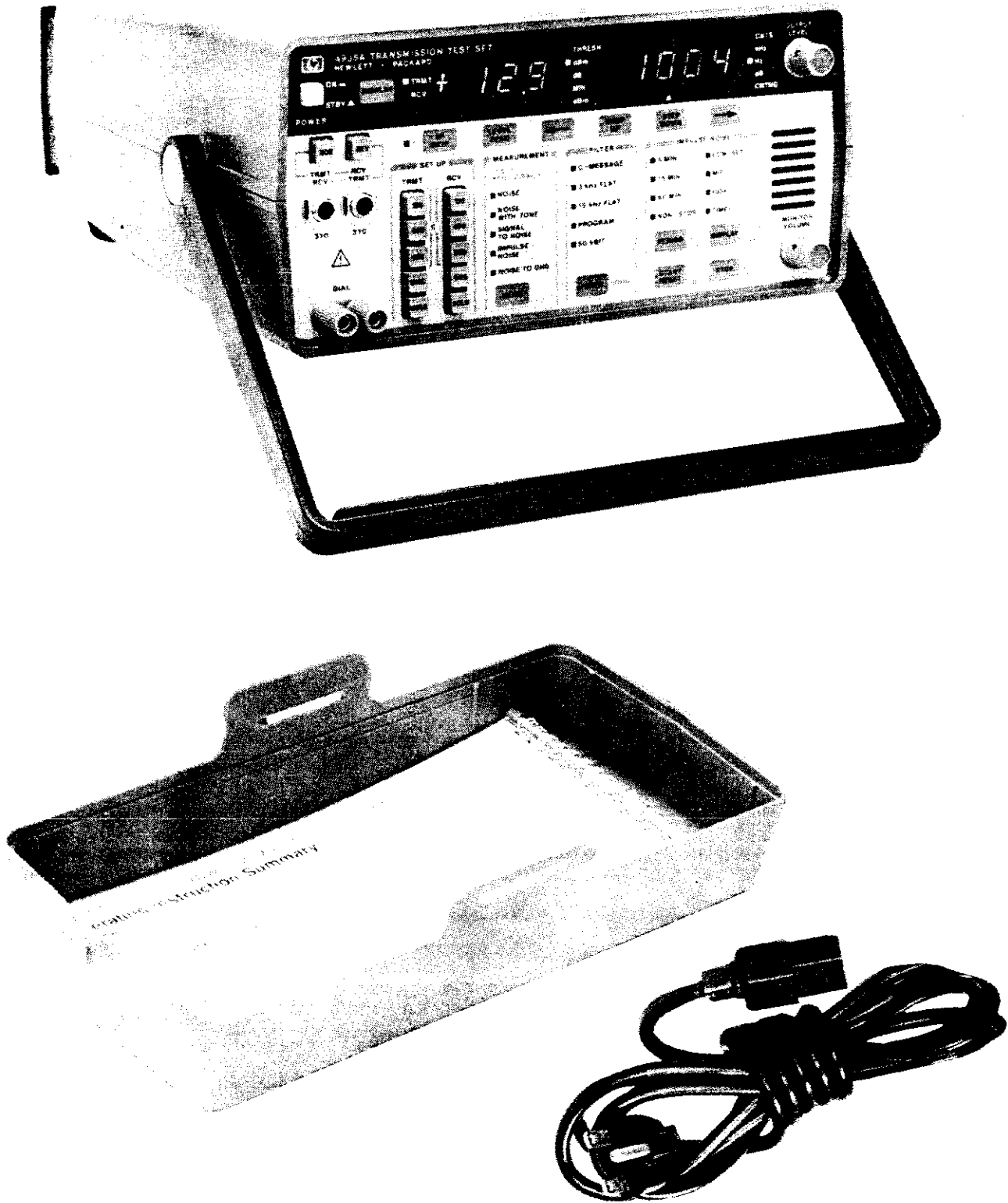


Figure 1-1. Model 4935A Transmission Impairment Measuring Set

SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION

1-2. This Operating and Service manual contains information to install, operate, maintain, and service the HP Model 4935A Transmission Impairment Measuring Set (TIMS). Figure 1-1 shows the HP Model 4935A with cover and power cord. The manual is divided into eight major sections which provide the following information:

SECTION I. GENERAL INFORMATION. Provides identification, specifications, related manuals, and user-repair information.

SECTION II. INSTALLATION. Contains unpacking and inspection information, power requirements, packaging, and storage instructions.

SECTION III. OPERATION. Includes an explanation of controls, connectors, indicators, and an automatic self check procedure. Describes measurement principles and front panel instructions for making each measurement.

SECTION IV. PERFORMANCE TESTS. Gives test procedures required to verify that the instrument's performance is in accordance with the specifications.

SECTION V. ADJUSTMENTS. Provides adjustment and calibration procedures.

SECTION VI. REPLACEABLE PARTS. Lists and identifies the instrument assemblies and replaceable parts.

SECTION VII. MANUAL CHANGES. Contains information to backdate the manual for instruments with earlier serial numbers.

SECTION VIII. SERVICE. Includes theory of operation, troubleshooting procedures, flowcharts, component locators, and schematic diagrams.

1-3. GENERAL DESCRIPTION

1-4. HP Model 4935A is a Transmission Impairment Measuring Set (TIMS) which measures wideband data and voice impairments. The frequency range over which measurements are made is 20 Hz to 110 kHz, in steps of 1, 10, 100, 1000, or 10,000 Hz. There are four permanently stored, fixed frequencies -404, 1004, 2804, and 2713 Hz. Any other four frequencies may be temporarily assigned and stored by the user.

1-5. INSTRUMENT IDENTIFICATION

1-6. A 10 character serial number (0000A00000) is inscribed on the rear panel. The first four digits and the letter are the serial prefix. The serial prefix will change only if changes are made to the instrument; a Manual Change Sheet will be included with the manuals of any instruments affected. The last five numbers form the serial suffix which is unique to each instrument.

1-7. SPECIFICATIONS

1-8. Instrument specifications are listed in Table 1-1.

Table 1-1. Specifications

TRANSMITTER			RECEIVER																																																																																																		
Frequency			Frequency																																																																																																		
Frequency Range 20 Hz to 110 kHz			Frequency Range 20 Hz to 110 kHz																																																																																																		
	Resolution	Accuracy		Resolution	Accuracy																																																																																																
20-99,999 Hz	1 Hz	= .005% of output frequency	20-9,999 Hz	1 Hz	±0.5 Hz																																																																																																
100-110 kHz	10 Hz	± .012% of output frequency	10-110 kHz	10 Hz	±5 Hz																																																																																																
Store and Recall Functions																																																																																																					
SK Skip . . . At power up skips a band from 2450-2750 Hz																																																																																																					
Frequencies At power up F1 is 404 Hz																																																																																																					
			F2 is 1004 Hz																																																																																																		
			F3 is 2804 Hz																																																																																																		
			F4 is 2713 Hz																																																																																																		
Level			Level																																																																																																		
Range -40 to +13 dBm			Range -60 to +13 dBm																																																																																																		
Resolution 0.1 dB			Resolution 0.1 dB																																																																																																		
Flatness (in dB)			Accuracy (in dB)																																																																																																		
<table border="1"> <thead> <tr> <th colspan="6">FREQUENCY, Hz</th> </tr> <tr> <th>20</th> <th>200</th> <th>15k</th> <th>60k</th> <th>85k</th> <th>110k</th> </tr> </thead> <tbody> <tr> <td colspan="6" style="background-color: black;">Output Level (dBm)</td> </tr> <tr> <td colspan="6" style="background-color: black;">+13</td> </tr> <tr> <td colspan="6" style="background-color: black;">+10</td> </tr> <tr> <td colspan="6" style="background-color: black;">0</td> </tr> <tr> <td colspan="6" style="background-color: black;">-40</td> </tr> <tr> <td colspan="2" style="background-color: black;">±1.0</td> <td colspan="2" style="background-color: black;">±0.2</td> <td colspan="2" style="background-color: black;">±0.5</td> </tr> </tbody> </table>			FREQUENCY, Hz						20	200	15k	60k	85k	110k	Output Level (dBm)						+13						+10						0						-40						±1.0		±0.2		±0.5		<table border="1"> <thead> <tr> <th colspan="6">FREQUENCY (Hz)</th> </tr> <tr> <th>20</th> <th>50</th> <th>200</th> <th>15k</th> <th>60k</th> <th>85k</th> </tr> </thead> <tbody> <tr> <td colspan="6" style="background-color: black;">Input Level (dBm)</td> </tr> <tr> <td colspan="6" style="background-color: black;">+13</td> </tr> <tr> <td colspan="6" style="background-color: black;">-40</td> </tr> <tr> <td colspan="6" style="background-color: black;">-60</td> </tr> <tr> <td colspan="2" style="background-color: black;">±1.0</td> <td colspan="2" style="background-color: black;">±0.5</td> <td colspan="2" style="background-color: black;">±0.2</td> </tr> <tr> <td colspan="2" style="background-color: black;">±0.5</td> <td colspan="2" style="background-color: black;">±0.5</td> <td colspan="2" style="background-color: black;">±0.5</td> </tr> </tbody> </table>			FREQUENCY (Hz)						20	50	200	15k	60k	85k	Input Level (dBm)						+13						-40						-60						±1.0		±0.5		±0.2		±0.5		±0.5		±0.5	
FREQUENCY, Hz																																																																																																					
20	200	15k	60k	85k	110k																																																																																																
Output Level (dBm)																																																																																																					
+13																																																																																																					
+10																																																																																																					
0																																																																																																					
-40																																																																																																					
±1.0		±0.2		±0.5																																																																																																	
FREQUENCY (Hz)																																																																																																					
20	50	200	15k	60k	85k																																																																																																
Input Level (dBm)																																																																																																					
+13																																																																																																					
-40																																																																																																					
-60																																																																																																					
±1.0		±0.5		±0.2																																																																																																	
±0.5		±0.5		±0.5																																																																																																	
Distortion: (in dB from fundamental)			Receiver accuracy not specified below 500 Hz when using 135Ω termination.																																																																																																		
(Includes harmonics, spurious and background noise within a filter with a 3 dB bandwidth of 4 kHz or 4 f ₀ , whichever is greater.)			At 1004 kHz accuracy is ±0.1 dB from -20 to +13 dBm.																																																																																																		
<table border="1"> <thead> <tr> <th colspan="4">FREQUENCY (Hz)</th> </tr> <tr> <th>30 Hz</th> <th>100 Hz</th> <th>4k</th> <th>110k</th> </tr> </thead> <tbody> <tr> <td colspan="4" style="background-color: black;">Output Level (dBm)</td> </tr> <tr> <td colspan="4" style="background-color: black;">+13</td> </tr> <tr> <td colspan="4" style="background-color: black;">+10</td> </tr> <tr> <td colspan="4" style="background-color: black;">0</td> </tr> <tr> <td colspan="4" style="background-color: black;">-40</td> </tr> <tr> <td colspan="2" style="background-color: black;">-55</td> <td colspan="2" style="background-color: black;">-50</td> </tr> <tr> <td colspan="2" style="background-color: black;">-50</td> <td colspan="2" style="background-color: black;">-40</td> </tr> </tbody> </table>			FREQUENCY (Hz)				30 Hz	100 Hz	4k	110k	Output Level (dBm)				+13				+10				0				-40				-55		-50		-50		-40		<p><i>Cross talk: >78 dB isolation @ 4 kHz, decreasing 6 dB per octave above 4 kHz.</i></p>																																																														
FREQUENCY (Hz)																																																																																																					
30 Hz	100 Hz	4k	110k																																																																																																		
Output Level (dBm)																																																																																																					
+13																																																																																																					
+10																																																																																																					
0																																																																																																					
-40																																																																																																					
-55		-50																																																																																																			
-50		-40																																																																																																			
At 1004 Hz, 0 dBm, THD using a 4 kHz filter is more than 65 dB down from the fundamental.			<p>Message Circuit Noise</p> <p>Range (@ 600Ω and 900Ω) 0 to 100 dBm</p> <p>@ 135Ω lower limit is 7 dB higher</p> <p>Resolution 1 dB</p> <p>Accuracy ± 1 dB from 10 to 100 dBm</p> <p style="text-align: right;">±2 dB from 0 to 10 dBm</p> <p>Filters C-Message, 3 kHz Flat, 15 kHz Flat, Program, 50 kBit</p>																																																																																																		
<p>Message Circuit Noise</p> <p>Transmitter is quiet terminated</p>																																																																																																					
<p>Specifications describe the instrument's warranted performance. Supplemental characteristics shown in shaded areas or in italics are intended to provide information useful in applying the instrument by giving typical, but non-warranted performance parameters.</p>																																																																																																					

1-9. SAFETY CONSIDERATIONS**CAUTION**

Before applying power, make sure that the rear power input module is set to the line voltage in use and that the correct fuse is installed.

1-10. Whenever internal circuits are exposed, caution must be used. Observe all warnings and cautions marked on the instrument or listed in the procedures.

1-11. When using AC power for test equipment, the chassis must be connected to earth ground. When the power button is on STBY (standby), AC and DC voltages are present in the instrument. To completely power down, disconnect the AC power cord from the 4935A. The batteries in options 001 and 003 provide continuous power to 4935A circuits; follow the disassembly procedures in Section VIII, Service to access the instrument.

WARNING

Power switch does not turn off AC power and some DC circuits.

1-12. RELATED MANUALS

1-13. Operating information is summarized on a card in the instrument cover.

1-14. USER REPAIR

1-15. Internal repairs to the instrument should be done by authorized repair shops only. For assistance, contact the nearest Hewlett-Packard Sales and Service Office listed at the rear of this manual.

1-16. OPTIONS AND ACCESSORIES

1-17. Options available are:

Option 001: Adds a rechargeable battery pack.

Option 002: Adds P/AR (Peak/Average Ratio) measurement in place of Noise-to-Ground.

Option 003: Adds P/AR (Peak/Average Ratio) measurement in place of Noise-to-Ground and a rechargeable battery pack.

1-18. Accessories available are:

15513A	Test cord w/310 male at both ends
18132A	19" Rack Mount Adapter
18134A	Soft-pack Carrying case
18161A	Ladder Bracket
04955-30014	Diagnostic Service Kit

1-19. WARRANTY

1-20. Instrument warranty is as listed on the inside of the front cover.

Battery warranty is 1 year.

1-21. RECOMMENDED TEST EQUIPMENT

1-22. Recommended test equipment is listed in Table 1-2. Equipment with equivalent characteristics may be used.

Table 1-2. Recommended Test Equipment

INSTRUMENT	CRITICAL SPECIFICATIONS	RECOMMENDED MODEL	USE*
AC CALIBRATOR	OUTPUT LEVEL 1mV TO 10V FREQUENCY: 20 Hz TO 110 kHz ACCURACY 0.1% @ ≥ 7 mV	FLUKE 5200A OR EQUIVALENT	P,T
OSCILLOSCOPE	>15 MHz BANDWIDTH A VS B CAPABILITY	HP 1741A	P,A
MULTIMETER	AC AND DC FUNCTIONS AC VOLTS: 10V MAX TO 1000V DC VOLTS: .1 TO 1000V BALANCED INPUT	HP 3455A	P,A,T
DIGITAL MULTIMETER	DC CURRENT: 1AMP MAX	HP 3468A	P,A,T
DUAL OUTPUT POWER SUPPLY	-12 AND -12V @ 0 TO 0.2A	HP 6234A	P
DUAL RANGE DC POWER SUPPLY	0-50 Vdc @ 0 TO 2A	HP 6218A	P,T
AUDIO ANALYZER	INPUT VOLTAGE RANGE 50mV-300V BANDWIDTH 500 kHz FILTER 30 kHz	HP 8903A	P
COUNTER	RANGE: AC COUPLED 30 Hz TO 100 MHz SENSITIVITY: 10 mV TO 100 MHz	HP 5315A	P

*P = PERFORMANCE TESTS

A = ADJUSTMENTS

T = TROUBLESHOOTING

Table 1-3. List of Parts Used for Performance Tests

PART NUMBER (IF APPLICABLE)	DESCRIPTION
1698-3447	135 Ω 1% RESISTOR
0698-8240	398 Ω 1% RESISTOR
0698-7408	600 Ω .1% RESISTOR
0698-6344	900 Ω .1% RESISTOR
HP 11095A	TERMINATION, 600 Ω BNC-TO-BNC
1250-0781	BNC-TEE FEMALE
1251-3757	BNC TO TYPE 310 POMONA NO. 2798 OR EQUIVALENT BNC TO DUAL BANANA JACK POMONA NO. 1296 DUAL BANANA COMPONENT CARRIER POMONA NO. 1330-ST
04935-60014	DIAGNOSTIC SERVICE KIT

1-23. BATTERY OPERATION (Options 001 and 003)

1-24. Nickel-Cadmium batteries enable the 4935A to be used in areas removed from AC power. Typical operating time is 3 hrs when fully charged. The batteries are trickle-charged whenever the instrument is connected to an AC source and the POWER switch is in STBY.

1-25. Regular discharge-charge cycles are recommended to maintain battery capacity. The instrument should be operated until batteries are discharged (instrument stops working) then recharged, at least every 30 days. Normal recharge time is about 14 hours. Typical battery life under normal operating conditions should be at least 100 charge-discharge cycles.

NOTE

Batteries do not charge when 4935A is operating from an AC source.

1-26. Charging the Batteries

1-27. The internal battery pack consists of three rechargeable battery packs (+6V, +15.6V and -15.6V). These provide typically three hours of continuous use without recharging. To recharge the battery packs, connect the 4935A to an AC power source and press power switch to STBY (the batteries will not charge with the POWER switch in ON). Normal recharge time is about 14 hours.

1-28. The batteries may be charged at temperatures between 5°C and 40°C (41°F and 104°F), but have greater charge capacity if charged between 5°C and 25°C (41°F and 77°F). At temperatures above 25°C the charge acceptance falls off as shown in Figure 1-2. For example, a cell charged at 45°C accepts about 60-70% of its rated capacity. Temperatures below 5°C cause pressure to build up within the cell as it is charged, which could result in venting of the cell. This results in a permanent degradation of the battery capacity due to loss of electrolyte.

1-29. Operating Temperature

1-30. Normal operating temperature of the 4935A with batteries (options 001 and 003) should be between -20°C and +40°C. However, there will be a loss of capacity when operating at the extremes. At low temperatures, the batteries cannot fully discharge even if they were fully charged at room temperature. At high temperatures, this same effect takes place to a lesser degree, in addition to the problem of charge acceptance previously mentioned. Figure 1-3 illustrates this effect.

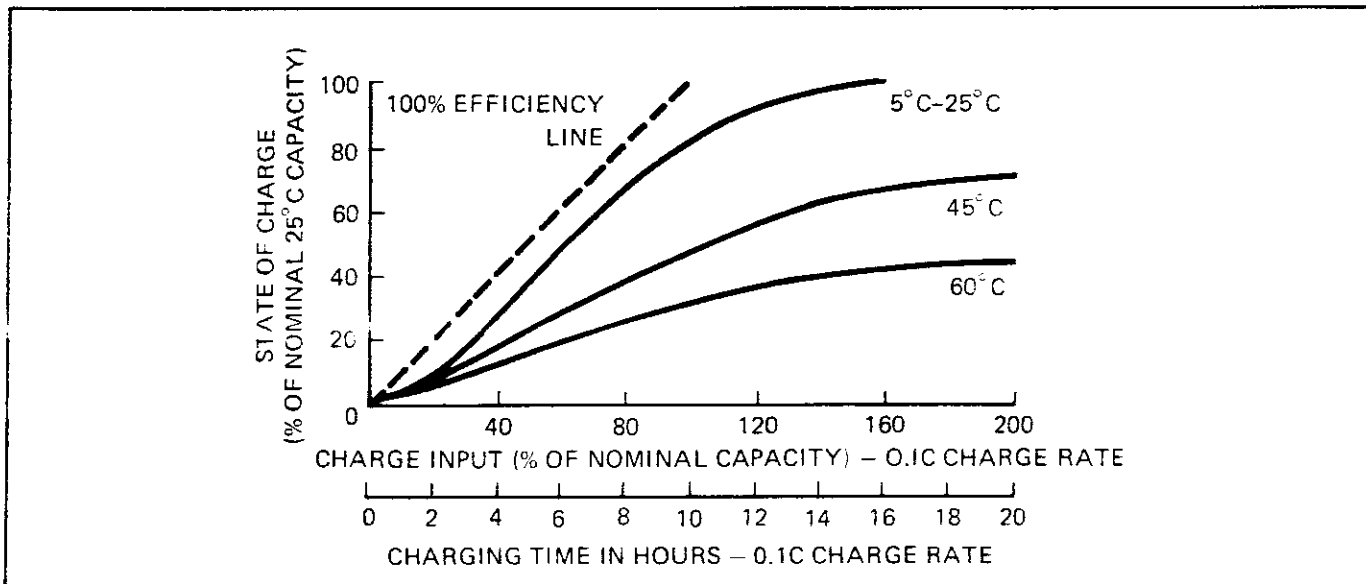


Figure 1-2. Charge Acceptance at Various Temperatures