AMERITEC CORPORATION

MODELS AM5XT AND AM5eXT

Voice/Data Transmission Test Set

INSTRUCTION MANUAL

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Ameritec
CORPORATION

760 ARROW GRAND CIRCLE
COVINA, CALIFORNIA 91722, USA
TEL. 818-915-5441
TELEX 754958
FAX 818-915-7181

For answers to questions, call Ameritec at (818)915-5441 and ask for Technical Assistance.
For additional copies of this manual, order Part Number 18-0022.

AM5XT-BASIC UNITS

The Digital Signal Processor (DSP) board is not installed in the AM5XT-BASIC, as indicated in the last *QUIET* Mode PARAMETER DISPLAY (see Display 6, in ¶7.02).

Because of the absence of the DSP board, the AM5XT-BASIC is *NOT* equipped with the measurements listed below, even though these functions are included on the front panel. The absence of these functions is evident because their function LEDs will not light when the respective Function Enable Keys are pressed.

The functions listed below can be added by contacting Ameritec to order a "factory upgrade of an AM5XT-BASIC to an AM5XT" (Part No. 25-0036).

AM5XT FUNCTIONS *NOT* INCLUDED IN THE AM5XT-BASIC:

ENVELOPE DELAY

INTERMODULATION DISTORTION

PHASE JITTER

AMPLITUDE JITTER

MICRO-INTERRUPTIONS

TRANSIENT TESTS:

Gain Hits

Phase Hits

Dropouts

X-Y PLOTTER (OPTION)

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1. INTRODUCTION

1.01 OVERVIEW

This Instruction Manual describes the operation of the Ameritec Model AM5XT and AM5eXT Voice/Data Transmission Test Sets.

The AM5XT and AM5eXT are micro-processor based test instruments used to measure transmission impairments on 2 and 4 wire telephone lines. The AM5XT measures transmission impairments in accordance with IEEE Standard 743-1984 (Bell Standard 41009).The AM5eXT complies with CCITT recommendations for export.

The instrument also contains a separate full function signal generator able to generate the test tones normally used with the tests.

The instrument contains 4 impedance selections per line, separate DC hold circuits, pulse, MF and DTMF signaling, built-in speaker monitor and talk microphone. Optional features include RS232 remote control port, batteries for cordless portable operation and rack mounting kit for permanent installations.

1.02 UNPACKING

The unit was thoroughly tested and carefully packed before shipment and was in good condition when turned over to the carrier for shipment.

Upon receipt, thoroughly inspect the outside of the shipping container for damage and if damage is noted, immediately contact the carrier. The name of the carrier will be noted on the packing slip which is attached to the outside of the shipping container.

Open the container carefully and compare the contents with the packing slip. Note any damage or shortages. Notify the carrier in the event of damage. Notify Ameritec in the event of shortage.

Save the shipping container for future use in the event that the unit may be returned to the factory.

2. POWER CONSIDERATIONS

2.01 COMMERCIAL POWER

The AM5XT and AM5eXT are powered from commercial 115 VAC or 230 VAC 50/60 Hz power. A rear panel selector switch allows user selection of 115 VAC or 230 VAC.

A detachable 3-wire cord is furnished which mates with a rear panel mounted CCE standard V-type connector. A rear panel-mounted fuse rated at 1/2 A is provided.

The AM5XT and AM5eXT are equipped with a non-volatile memory. Loss of power will cause operation of the unit to cease. However, any front panel configurations previously stored in memory will not be lost.

2.02 OPTIONAL BATTERY PACK

The AM5XT and AM5eXT may be equipped with an optional internal battery pack to allow full cordless (no commercial power) operation.

The power pack consists of two sealed lead acid batterites and associated charging circuitry. The batteries, when fully charged, will power the unit for approximately 5-8 hours.

A low battery indicator is provided in the form of blinking decimal points in the front panel display. Blinking decimal points indicate approximately 1/2 hour of remaining battery operation before recharging is required.

The unit may be operated while the batteries are recharging. Recharging will automatically occur whenever the unit is plugged into commercial AC power, regardless of whether the unit is on or off. Charging will be accomplished faster when the unit power switch is "OFF".

3. PHYSICAL AND FUNCTIONAL DESCRIPTION

3.01 INTRODUCTION

This section illustrates and explains the components of the AM5XT/eXT. Also described are optional equipment and accessories, including the Ameritec AM-47XT Hand-Held Printer, designed to be used with the AM5XT/eXT. The paragraphs in this section are listed below:

3.02 GENERAL

Weight. The AM5XT/eXT weighs 5 pounds without the optional battery pack, and 10 pounds with the battery pack.

Dimensions.
Portable: 8.3"W x 3.5"H x 12.1" D
(210 mm x 89 mm x 307mm)
Rack Mount: 19.0" W x 3.5" H x 12.1" D
(483 mm x 89 mm x 307 mm)

Construction. Electronic components are mounted on four (4) plug-in printed circuit boards, interconnected with harness connectors and housed in a sturdy metal case. If the optional canvas Padded Carrying Case is not ordered, a removeable snap-on cover is supplied to protect the front panel during transport. There are no user-serviceable parts inside the case.

Mounting. A portable unit has a carrying handle and can be stood on any of three (3) possible sides, each of which has rubber feet. When placed on a table, the unit can be set in a tilted position for easier viewing of the front panel; this is done by extending supports located behind the front feet on the front panel side. The 19" Rack Mount kit (85-0076) can be ordered for fixed installations.

3.03 FRONT PANEL NOTES

The Front Panel of the AM5XT is illustrated in Fig. 3-1. See ¶ 3.04 for descriptions of the components called out. See FOLDOUT at the end of this manual for detailed views of the AM5XT and AM5eXT Front Panels.

Front Panel Layout. The AM5XT front panel is a surface approximately 3" (7.5 cm) high by 8" (20.5 cm) wide. It contains switches, keys, LEDs and displays for controlling the unit and indicating its operational status.

Color Coding and Marking. The front panel functions are color coded to tie together associated functions:

GRAY	Store and Recall Keys, normal 2-wire or 4-wire interface select, dialing mode select
BLACK	Pair reversal
GREEN	Send (Transmit, TX) functions
BLUE	Measure (Receive, RX) functions
VIOLET	Auxiliary functions, associated with measure functions

Some of the measure (blue) functions that always work together with certain auxiliary (violet) functions are enclosed with a black border; these are referred to as Function Boxes. See ¶ 9.01 and Fig. 9-2.

Unit Status. After setting up a test, Function LEDs remain on to indicate the function is enabled. The status of the unit can thus be determined at a glance. The Send and Measure functions have prompt-driven DATA and PARAMETER DISPLAYS which are scrolled through to make readings and set parameters.

Keys. All push-button keys are discrete switches, non membrane type, and offer good visual, tactile and audible feedback. All indicators, including the display, are LEDs and should never need replacement.

The unit is controlled by pressing keys arranged along the left and bottom edges of an X-Y matrix of function LEDs:

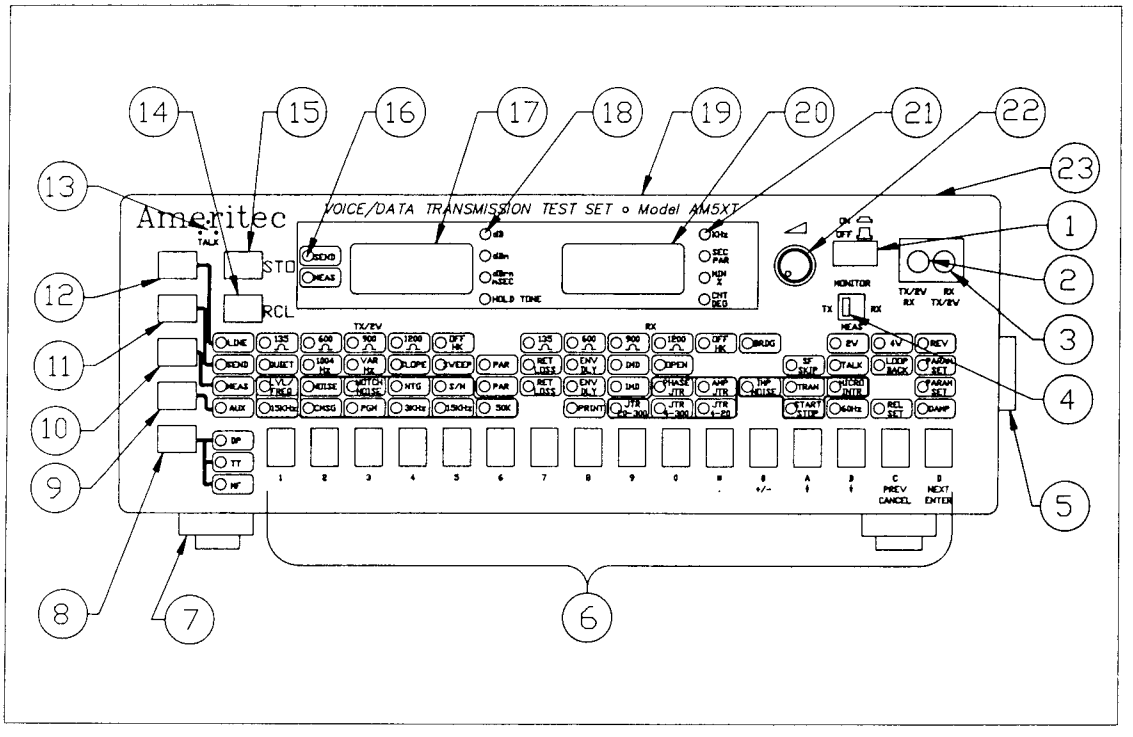


Figure 3-1. *Front Panel Components*

3.03 FRONT PANEL NOTES, continued

Along the *left edge* of the front panel, there are five (5) Keys which are used to select one (1) of the five (5) horizontal rows of operating functions. *LINE*, *SEND*, *MEAS*ure, *AUX*iliary, or Dialing (DP, TT or MF).

> -NOTE-
> Because of space limitation, most of the keys along the left edge are not located directly next to the function rows they control. Carefully follow the color coding which associates a key with the horizontal function row that it enables.

Along the *bottom edge* of the front panel, there are 16 Function Enable Keys referred to as [1], [2], [3], [4], [5], [6], [7], [8], [9], [0], [*], [#], [A], [B], [C], [D]. A Function Enable Key is used to enable the function that is located vertically above it, within the function row that is enabled at the time the key is pressed.

A. For example, press [SEND] key (item 11 in Fig. 3-1); *SEND* LED will light. Then press [7]. Return Loss send function will be enabled (*RET LOSS* LED will light). Then, repeatedly press [7] to step through the three (3) Return Loss send DATA DISPLAYS.
B. When [D] is pressed with either *SEND* or *MEAS* row enabled, the *PARAM SET* LED (green) will light and the PARAMETER DISPLAY(S) will appear, if present. If there is no PARAMETER DISPLAY for the function enabled, the *PARAM SET* LED will not light. When a *PARAM SET* LED is on, the 16 keys along the bottom edge are used to set parameter values.
C. When Dialing Mode (DP, TT, MF) is enabled (using item 8 in Fig. 3-1), pressing a key along the bottom edge will cause the respective digit to be dialed (outpulsed).

See Section 4 for full explanation of key operation.

3.04 FRONT PANEL COMPONENTS

The numbering of the descriptions below corresponds to the numbering of the components in Fig. 3-1.

(1) *Power ON/OFF Push Button.*

-NOTE-
When using AC power, observe CAUTION in ¶ 3.05, before turning on power.

Push button IN to turn power ON. Push button again (button will pop OUT) to turn power OFF.

Button in  = Power ON

Button out  = Power OFF

See Section 2 for power considerations.

(2) *TX/2W Bantam Jack*
For 2-wire circuits (*2W* LED on): Connect the 2-wire pair to this jack. Signals are both transmitted and received over this same pair of contacts.

For 4-wire circuits (*4W* LED on): Connect the send (transmit, TX) pair, over which AM5XT/eXT sends signals.

For reverse (*REV* LED on): This pair becomes the receive pair, RX, over which AM5XT/eXT receives signals.

See Fig. 3-6 for mating cables.

The connections of this jack are the same as screw terminals T and R on the Rear Panel, item 10 in Fig. 3-3.

(3) *RX Bantam Jack*
For 4-wire circuits (*4W* LED on): Connect the receive pair, RX, over which AM5XT/eXT receives signals. For 4-wire reversed (*REV* LED on): This pair becomes the send (transmit, TX) pair, over which AM5XT/eXT sends signals.

For 2-wire reversed (*REV* LED on), signals are both transmitted and received over this pair of contacts.

See Fig 3-6 for mating cables.

The connections of this jack are the same as screw terminals T1 and R1 on the Rear Panel, item 9 in Fig. 3-3.

(4) *Monitor Switch.* Three-position switch used to select the point to which the internal amplifier/speaker is connected.

TX (Transmit): Connects the internal amplifier /speaker to the output of the signal generator.

MEAS (Measure): Connects the internal amplifier/speaker to the output of the receive circuit auto ranging amplifier and associated filters. This considerably increases the volume of the speaker and is useful to monitor low level signals. The signal will always be in an 18 dB range for input signals ranging from -65 to +10 dBm. This setting is particularly useful for audibly monitoring the residual noise in notched noise and S/N ratio measurements.

RX (Receive): Connects the internal amplifier/speaker to the signal being measured. The possibilities are listed below:
- RX (receive) pair of the 4-wire circuit under test
- 2-wire circuit under test
- if measuring 2-wire Return Loss, the receive pair of the Internal Hybrid
- if measuring Noise-to-Ground, the Noise-to-Ground circuit.

(5) *Carrying Handle.* Thick, soft, flexible plastic handle on right panel. Extends for use, retracts against case when not in use. The Carrying Handle is not installed when the 19" Rack Mounting Kit is installed.

(6) *16 Function Enable Keys.* See explanation in ¶ 3.03 under "Keys".

3.04 FRONT PANEL COMPONENTS, continued

⑦ *Rubber Feet* (portable version only). Set of four (4) Rubber Feet on the bottom panel. Behind the front pair of feet are hinged plastic supports that can be swung forward (snap into place) to raise the front and tilt the unit for easier viewing of the Front Panel. In addition, there is a set of four (4) rubber feet on the left panel on which the unit can be conveniently set after transporting with the Carrying Handle (item 5).

⑧ *Dialing Mode Enable Key.* Repeatedly press as necessary to enable desired Dialing Mode, indicated by lighting of respective LED.
DP = Dial Pulse
TT = Touch Tone
MF = Multi-Frequency
See Section 10 concerning Dialing.

⑨ *Auxiliary Function Row Enable Key.* This is referred to as the [AUX] key. Press to enable the Auxiliary Function Row. *AUX* LED will be on when this row is enabled; the Display *MEAS* LED (item 16) will also light. See Section 9 concerning Auxiliary Functions.

⑩ *Measure Function Row Enable Key.* This is referred to as the [MEAS] key. Press to enable the Measure Function Row. *MEAS* LED will be on when this row is enabled; the Display *MEAS* LED (item 16) will also light. See Section 8 concerning Measure Functions.

⑪ *Send Function Row Enable Key.* This is referred to as the [SEND] key. Press to enable the *SEND* Function Row. *SEND* LED will be on when this row is enabled; the Display *SEND* LED (item 16) will also light. See Section 7 concerning Send Functions.

⑫ *Line Function Row Enable Key.* This is referred to as the [LINE] key. Press to enable the Line Function Row. *LINE* LED will be on when this row is enabled. See Section 7 concerning Send Functions.

⑬ *Microphone*, three holes labeled *TALK*. The Microphone is located behind the Front Panel. Speak into the Microphone when in one of the *TALK* modes. See ¶ 7.14 for details.

⑭ *Recall Key*[RCL]. This key is used to recall and execute commands stored in non-volatile memory, either front panel setups or dialed numbers. Up to 40 *front panel setups* can be recalled. See Section 11 for details. Up to 10 *dialed numbers* can be recalled, each with up to 48 digits. Also, the last dialed number can always be recalled and redialed using this key. See ¶ 10.02 and 10.03 for details.

⑮ *Store Key* [STO]. This key is used to store commands in non-volatile memory, either front panel setups or dialed numbers. Up to 40 *front panel setups* can be stored. See Section 11 for details. Up to 10 *dialed numbers* can be stored, each with up to 48 digits. See ¶ 10.02 for details.

⑯ *Display LEDs, SEND and MEASure.* These LEDs indicate what function is being viewed on the Display. One of these LEDs will always be on:

SEND on = enabled Send Function being viewed on the display.

MEAS on = enabled Measure Function being viewed on the display.

The *SEND* Display LED will automatically light when the [SEND] key (item 11) is pressed. The *MEAS* Display LED will automatically light when either the [MEAS] key (item 10) or [AUX] key (item 9) is pressed.

3.04 FRONT PANEL COMPONENTS, continued

(17) *Left LED Display.* This is a red LED display with four (4) 7-segmented characters with floating decimal points. The type or reading (Send Function or Measure Function) is indicated by the LEDs to the left of this display; see item 16. The unit of measurement is indicated by LEDs located to the right of this display. See item 18.

(18) *Units of Measurement LEDs.* Each of these LEDs is labeled with a unit(s) of measurement. One of these LEDs will light, as appropriate, to indicate the unit of measurement for a numerical value displayed in the left display (item 17). The possible units of measurement are explained below.

dB The deciBel (dB) is a logarithmic (base 10) electrical unit used to compare or indicate changes in level. The dB unit is only a relative unit, however, and does not have meaning unless a point of reference is established. Thus the systems of dBm and dBrn were established as described below.

dBm To establish a point of reference in making comparisons in *level* (and *noise* for CCITT standard) measurements in transmission testing, the system of dBm was adopted.

00.0 dBm is defined as the level of *one (1) milliWatt of power,* hence the abbreviation "m" after the dB. Levels of less power than this reference point are negative, -dBm values, and levels of greater power are positive, +dBm values. See Fig. 3-2.

It turns out that 00.0 dBm is a strong level for a telephone line, so most of the level measurements in units of dBm are negative, i.e., less power than the 0.00 dBm reference. For example -10.0 dBm is a typical level at which dialing tones are sent.

dBrn, AM5XT only. The dBrn unit is used in noise level measurements, "rn" meaning relative noise. Note in Fig. 3-2 that the zero reference for noise measurement has been established at -90.0 dBm, an extremely low level for a telephone line. Thus, noise measurements will always be positive (higher level) with respect to the 00.0 dBrn reference.

Absolute and Relative Measurements. An *absolute* level measurement is made in units of *dBm*, as described above. A *relative* measurement is in units of *dB*; a zero point of reference is established at any level, and subsequent level measurements are made *relative* to that level. See ¶ 9.09 for an explanation of how relative measurements are used.

mSEC milli-seconds. One mSEC = one thousandth of a second. Unit of measure in Envelope Delay.

HOLD TONE. This LED will light when a valid Holding Tone is present at the receive port. A valid Holding Tone is required for Notched Noise, S/N Ratio, Phase Jitter, Amplitude Jitter and Transient Tests; this LED must be on for these tests to be valid. A Holding Tone is nominally 1004 Hz; see Table 3-1 for holding tone range specificiations, which depend on the type of measurement.

Table 3-1
Acceptable Holding Tone Ranges

Acceptable Range	Type of Measurement
990 Hz to 1030 Hz	Phase Jitter and Amplitude Jitter
995 Hz to 1025 Hz	All other holding tone tests

(19) *Metal Case.* This is a sturdy aluminum case, painted blue, with a steel rear panel. For portable units, if the optional canvas Padded Carrying Case is not ordered, a removeable snap-on cover is supplied to protect the front panel during transport. For fixed installations, an optional 19" Rack Mounting Kit (installed at the factory) can be ordered.

(20) *Right LED Display.* This is a red LED display with four (4) 7-segmented characters with floating decimal points. The type of reading (Send Function or Measure Function) is indicated by the LEDs on the far left of the display area; see item 16. The unit of measurement is indicated by LEDs located to the right of this display. See item 21.

(21) *Units of Measurement LEDs.* Each of these LEDs is labeled with a unit(s) of measurement. One of these LEDs will light as appropriate to indicate the unit of measurement for a numerical value displayed in the right display (item 20). The possible units of measurement are explained below.

kHz = Kilo-Hertz = 1000 Hertz = 1000 cycles per second.

SEC = Seconds (time)

PAR = PAR (Peak-to-Average Ratio) units. See ¶ 8.08.

MIN = Minutes

% = Percent

CNT = Counts

DEG = Degrees

(22) *Volume Control Knob.* This controls the volume of the speaker, item 23. Turn clockwise to increase speaker volume and turn counter-clockwise (anti-clockwise) to decrease speaker volume.

(23) *Speaker.* This is located on the top of the unit near the front. The speaker is connected to a monitor point determined by the position of the Speaker Monitor Switch, item 4. speaker volume is controlled by the Volume Control Knob, item 22.

-NOTE-

All frequencies are expressed in kHz, not Hz. A common mistake is to try to set a frequency value and enter it as if it were expressed in Hz instead of kHz. For example, enter 1004 Hz as 1.004 kHz (be sure to enter the decimal point between the 1 and the 0). If an attempt were made to enter this as 1004 without the decimal point, the display would default to 120.0 kHz, the maximum possible value for a frequency. Thus if the display "mysteriously" shows 120.0 kHz instead of the value entered, the frequency was entered as if it were in units of Hz. Re-enter the correct value in units of kHz, with a decimal point in the appropriate place.

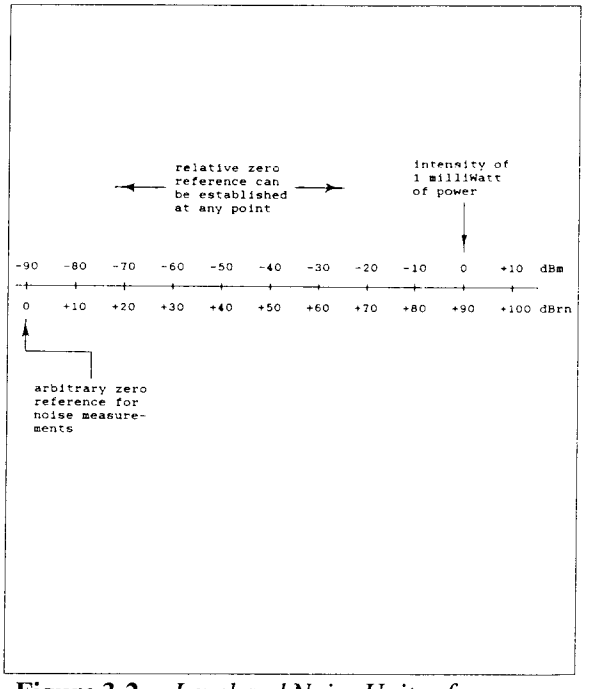


Figure 3-2. *Level and Noise Units of Measurement*

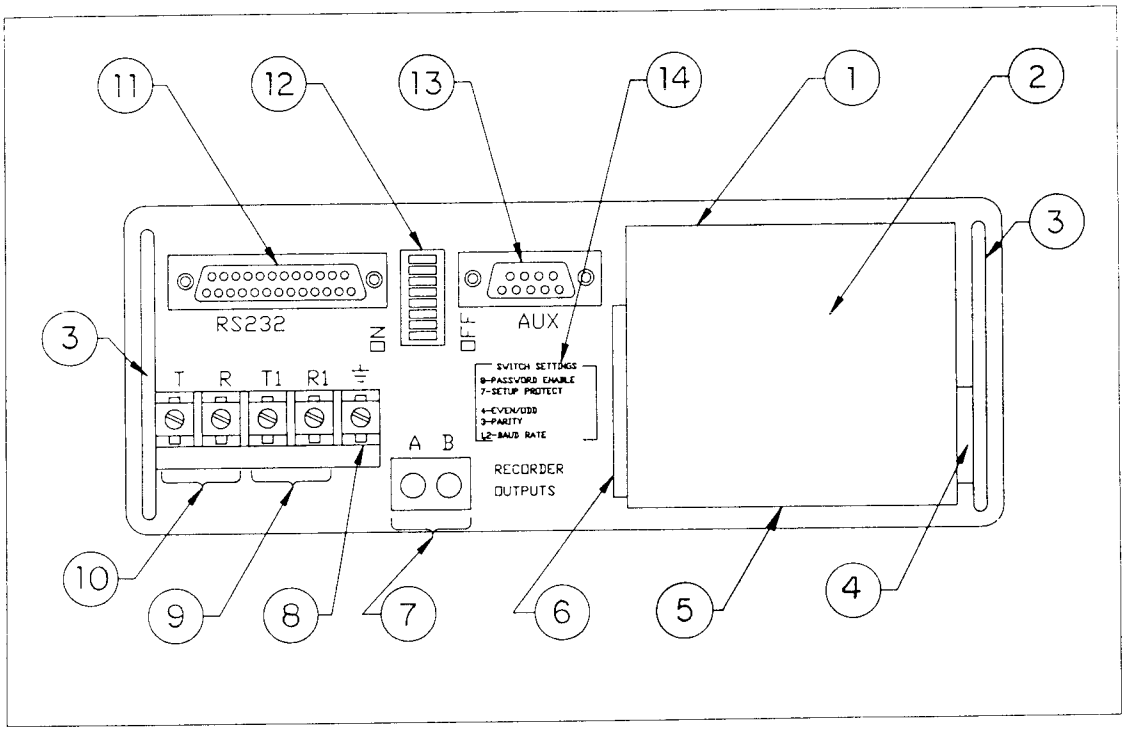


Figure 3-3. *Rear Panel Components*

3.05 REAR PANEL COMPONENTS

① **AC Power Selector Switch,** 115V/230V. Red slide switch. Before plugging in the power cord, set this switch to match the power source to which the power cord is to be connected, either 115 VAC or 230 VAC.

> ***CAUTION***
> ***Observe the CAUTION printed on the back of the unit. When connected to a 230 VAC source, be sure to set this switch to 230V position before turning on the power. Damage to the unit will result if 230 VAC is applied with this switch set to 115 V.***

② **Step-Down Transformer**, part of power supply.

③ **Foot/Guard**, 2 places. The unit can be stood on end, resting on these rubber-coated supports. They protrude to allow clearance for rear panel components and rear-mounted cables.

④ **Fuse Holder,** with slotted cover. Unscrew with common blade screwdriver to inspect/replace the fuse. The fuse is 1/2 amp, 250 V.

⑤ **Identification Label.** With Model Number and Serial Number, attached to the bottom of the step-down transformer. The Serial Number is a six-digit number, coded as follows:
first two digits = week (01 thru 52) of manufacture.
second two digits = year of manufacture
third two digits = identification number (00 thru 99) to distinguish between units.

Example: A unit with Serial Number 118847 was manufactured the 11th week of 1988.

⑥ **Power Plug.** 3-pronged male, for 115 or 230 VAC. Mating power cord is supplied. Be sure Input Power Selector Switch (item 1) is in correct position.

3.05 REAR PANEL COMPONENTS, continued

(7) **Recorder Outputs**, optional. These Bantam Jacks, labeled "A" and "B", are the outputs of the X-Y plotter, Option 25-0045. See ¶ 3.06 and Section 13 for details concerning the plotter function. In general, these contacts are used as follows:

"A" Bantam Jack: Sleeve = ground
Tip = not used
Ring = auxiliary logic output

"B" Bantam Jack: Sleeve = ground
Tip = Plot X or auxiliary logic output
Ring = Plot Y or auxiliary logic output

(8) **Screw Terminal, Ground.** This is the same connection as the Sleeve contacts on the front-panel Bantam Jacks (items 2 and 3 in Fig. 3-1). Use this ground as the reference ground in the Noise-to-Ground test (¶ 8.06).

(9) **Screw Terminals, T1, R1.** These are the same connections as the Tip and Ring of the *right* front-panel Bantam Jack (item 3 in Fig. 3-1. See ¶ 3.04, 3).

(10) **Screw Terminals, T, R.** These are the same connections as the Tip and Ring of the *left* front-panel Bantam Jack (item 2 in Fig. 3-1. See ¶ 3.04, 2).

(11) **RS232 Connector**, optional. 25-pin male DB25, only with units equipped with Option 25-0019. Connector pin assignments are listed in Table 3-2. A printer or terminal can be connected here. This connector is also used to connect the unit in a chain if this is other than the first unit in the chain. See Section 12 concerning RS232 port operation.

-NOTE-
This area is filled with a plastic cover if the unit is not equipped with the RS232 Option.

(12) **8-Switch DIP Switch.** Table 3-1 lists the switch functions and positions. An abbreviated list, item 14, is given on the rear panel.

Switches 1 thru 4 control the operating characteristics of the RS232 port. See section 12 concerning RS232 port operation.

Switches 5 and 6 are not used.

Switch 7 protects/unprotects the front panel setups stored in non-volatile memory. Note that Switch 7 does *not* protect Dialed Numbers stored in non-volatile memory per ¶ 10.02.

Switch 8 controls the remote control password enable.

Table 3-2
RS232 Connector Pin Assignment

PIN		FUNCTION	DIRECTION
2	TD	Transmit Data	From AM5XT/eXT
3	RD	Received Data	To AM5XT/eXT
4	RTS	Request to Send	Not Used
5	CTD	Clear to Send	Not Used
7	GNF	Common	--
9	+V	+ Power (+12 Vdc)	From AM5XT/eXT
10	-V	- Power (-12 Vdc)	From AM5XT/eXT
20	DTR	Data Terminal Ready	Not Used
22	RI	Ring Indicator	Not Used

Table 3-3.
DIP Switch Settings

DIP SWITCH	FUNCTION	CODE
1 & 2	Set Baud Rate	1 OFF, 2 OFF = 300 BAUD 1 ON, 2 OFF = 1200 BAUD 1 OFF, 2 ON = 2400 BAUD 1 ON, 2 ON = 9600 BAUD
3	Parity Enable	ON = PARITY, OFF = NO PARITY
4	Parity Select	ON = EVEN PARITY, OFF = ODD PARITY
5	Not used	--
6	Not used	--
7	Setup Protect	ON = PROTECT; OFF = UNPROTECTED
8	Password Enable	ON = Password required; OFF = password not required

3.05 REAR PANEL COMPONENTS, continued

(13) **Auxiliary (AUX) RS232 Connector,** 9-pin female D-type miniature. This is used to connect to the RS232 port of an auxiliary unit (printer, test access switch, etc.), installed near the AM5XT/eXT, in order to communicate with the auxiliary unit via the main RS232 port of the AM5XT/eXT. Use cable 48-0083 for this function. See ¶12.01 for details. Available pins are listed in Table 3-4.

Table 3-4
Auxiliary RS232 Connector Pin Assignment

Pin		Function	Direction
2	RD	Received Data	To AM5XT/eXT
3	TD	Transmit Data	From AM5XT/eXT
7	GND	Common	--

Baud rate and parity are the same as those of the main RS232 port (set with Switches 1 thru 4 of the DIP switch, item 12).

(14) **List of DIP Switch Settings**. See Table 3-3 for detailed information on settings.

3.06 OPTIONAL EQUIPMENT

This paragraph describes features that can be made a part of the AM5XT/eXT when specially ordered. See ¶ 3.07 and ¶ 3.08 for accessories that can be specially ordered to use with the AM5XT/eXT.

Sealed Lead Acid Batteries and Integral Charger, Option 24-0017. When fully charged, these batteries allow 5 to 8 hours of cordless (no commercial power operation). See ¶ 2.02 for details.

RS232 Port, Option 25-0019. The RS232 Port is required for printouts and external control of the AM5XT/eXT from a terminal or computer. The RS232 Port makes possible additional functions and capabilities that cannot be done with the front panel controls alone. A unit equipped with this option has an RS232 connector (item 11 in Fig. 3-3) on the rear panel. See Section 12 concerning RS232 Port operation.

19" Rack Mounting Kit, Option 85-0076. Order this option if the unit is to be mounted in a 19" relay rack. The Carrying Handle and Rubber Feet are not included when this option is ordered.

3.06 OPTIONAL EQUIPMENT, continued

X-Y Plotter Outputs, Option 25-0045. Voltages are delivered to rear panel Bantam Jacks which are connected to an external plotter for hard copy graph of test results. A unit equipped with this option has two (2) Bantam Jacks (item 7 in Fig. 3-3) on the rear panel. See ¶13.01 for details. This option is not available for an AM5XT-BASIC.

Delete Front Panel, Option 25-0020. RS232 Port, Option 25-0019, must also be ordered. The Front Panel is deleted for exclusive remote control of the unit through the RS232 Port when front panel manual control will never be needed.

Siemens Adaptor, Option 25-0041, for AM5eXT only. This brings the line connections to two (2) 3-socket connectors, designed to mate with lines that are connected with a 3-pronged Siemens-type Banana connector, a standard in some European countries. These connectors are mounted on the bottom of the AM5eXT, flush with the front panel.

3.07 AM-47XT HAND-HELD PRINTER (Optional) (Table 3-5 and Fig. 3-5)

The AM-47XT Hand-Held Printer is designed to be used with an AM5XT or AM5eXT to give a hard copy of the measurements and setups.

Operating Instructions. See ¶ 13.01.

Technical Specifications. See Table 3-5.

Component Locations. See illustration in Fig. 3-5, Page 1.

Connectors, Cables. The connectors are used with the AC Adaptor (70-0029) and the Printer Cable (48-0095), shown in Fig. 3-4; both of these cables are supplied with the AM-47XT.

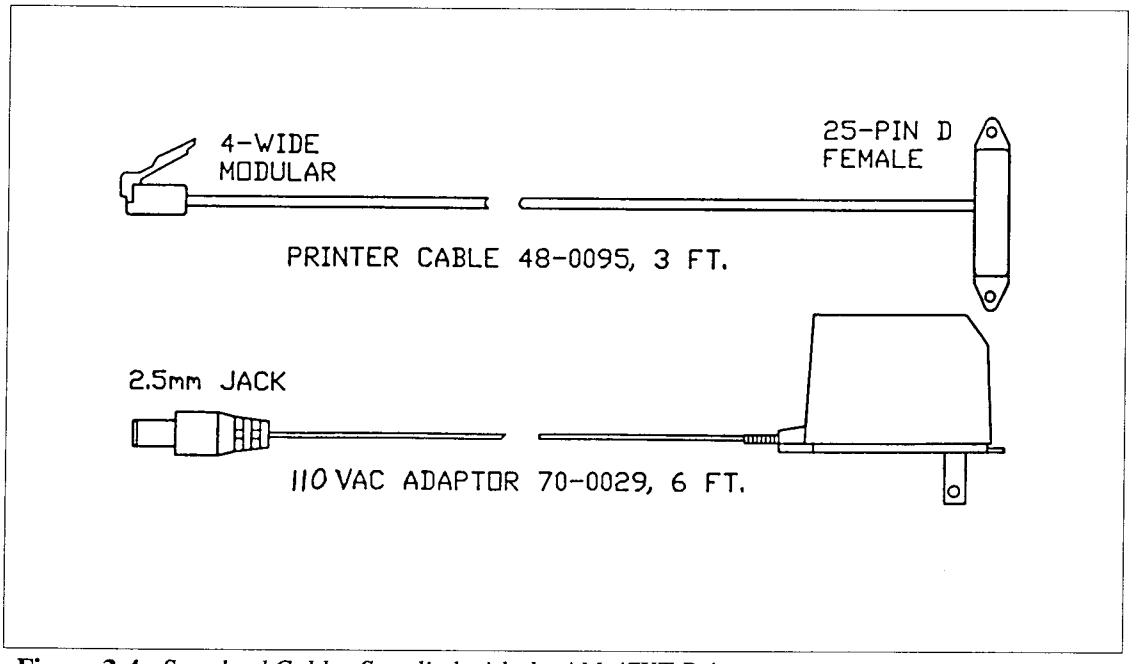


Figure 3-4. *Standard Cables Supplied with the AM-47XT Printer.*

3.07 AM-47XT HAND-HELD PRINTER (Optional), continued

Power. Power is supplied by an internal NiCad battery pack. There is an internal recharging circuit in the printer that operates when the AC Adaptor is plugged in.

Power Switch. See charging instructions in ¶ 13.01 concerning the position of this switch during charging and operation.

2-Position DIP Switch. This is used to set the Baud Rate (300, 1200 or 9600). Settings are indicated in a table on the label above the switches.

> -NOTE-
> Printer Power Switch must be off when changing Baud Rate on the AM47XT. Moving DIP switches with the Printer Power Switch ON does not change the Baud Rate until the Printer is switched OFF and then switched ON again.

LEDs. The LEDs light as described below:

1. The *POWER* LED *lights continuously* when the AC Adaptor is connected and the battery pack is charging (starts charge cycle each time power is turned ON).
2. The *POWER* LED *blinks* when power is ON and the battery pack has been charged.
3. The *SIGNAL* LED *lights* when data is being received from the AM5XT/eXT.

Printing Mechanism. Printing mechanism is dot matrix impact type with replaceable ribbon cartridge. Standard-width adding machine paper is used. The ribbon cartridge and paper roll are housed within the case. The printout is in 40-column format, at a speed of 0.4 lines per second.

Ribbon Cartridge Replacement. (Refer to Figure 3-5). For replacement ribbon cartridges, order Part No. 26-0015.

1. Push up on end of housing (as indicated by arrow) to remove paper roll compartment cover.
2. Observe how ribbon is routed on the old cartridge.
3. Push on end of cartridge as indicated in Figure 3-5 to eject old cartridge.
4. Snap in new cartridge, being careful to insert ribbon correctly.
5. Rotate manual ribbon take-up as indicated by the arrow to apply tension to the ribbon.
6. Re-install compartment cover.

Table 3-5.
AM-47XT

CHARACTERISTICS	SPECIFICATIONS
Input Signal	Serial ASCII RS232 (modified for plot function)
Input Connector	4-Wide Modular Jack
Input Speed	300, 1200 or 9600 Baud with 1500 Character FIFO Buffer
Print Type	6 x 8 Impact Dot Matrix
Paper	2.25"w x 1.8" Dia. Adding Machine Paper (Part No. 26-0014)
Ink Supply	Replaceable Inked Ribbon Cartridge (Part No. 26-0015)
Characters per Line	40
Print Speed	0.4 Lines per Second
Power	Internal NiCad Battery Pack with Built-in Charger
Battery Life	Approximately 7,000 Lines
Charge Time	8 to 14 hours
Size	7.6"L x 3.4"W x 1.9"D
Weight	1.5 lbs.
Cables	Printer Cable (48-0095) and AC Adaptor (70-0029), supplied (cables are illustrated in Fig. 3-4).

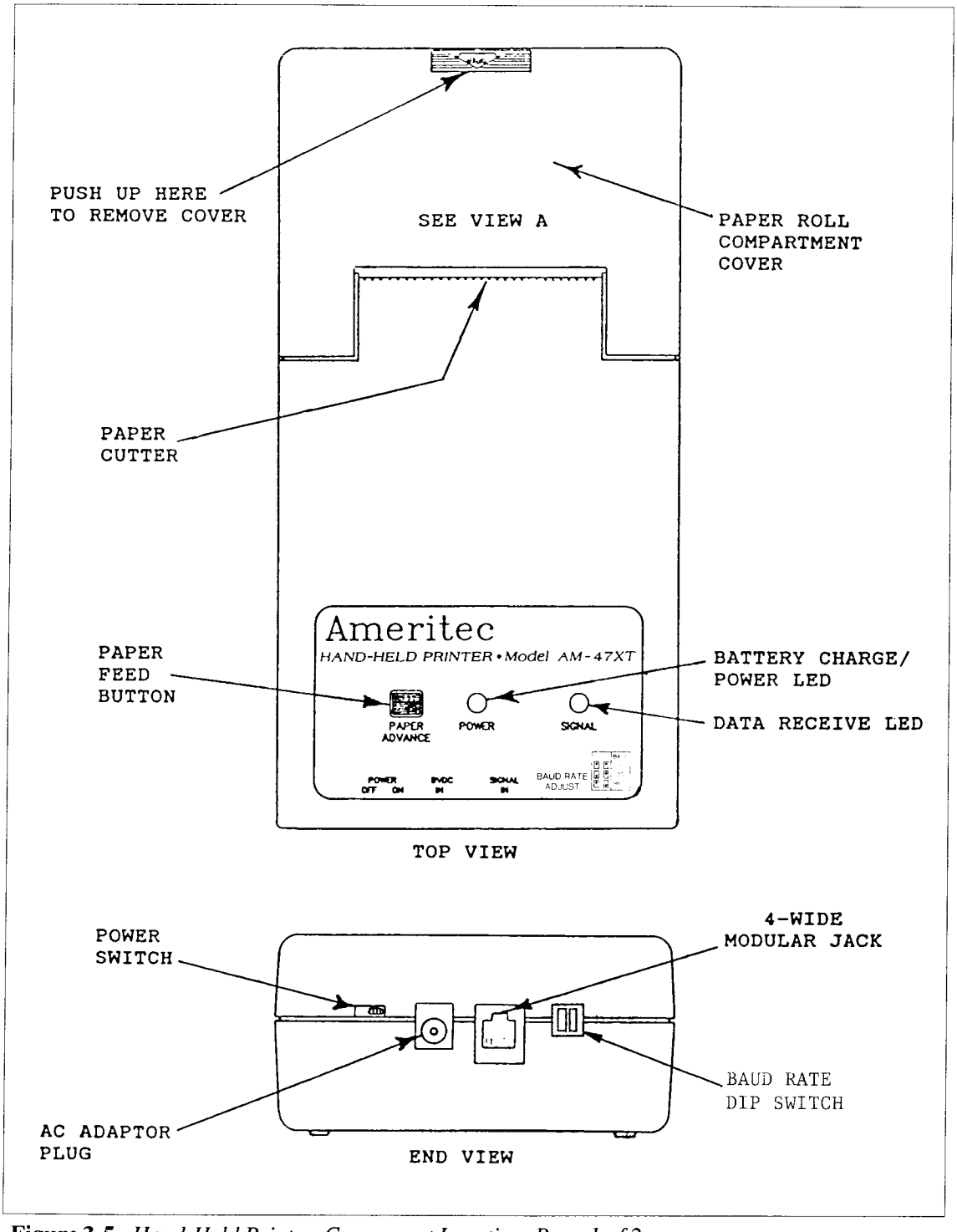


Figure 3-5. *Hand-Held Printer, Component Location, Page 1 of 2.*

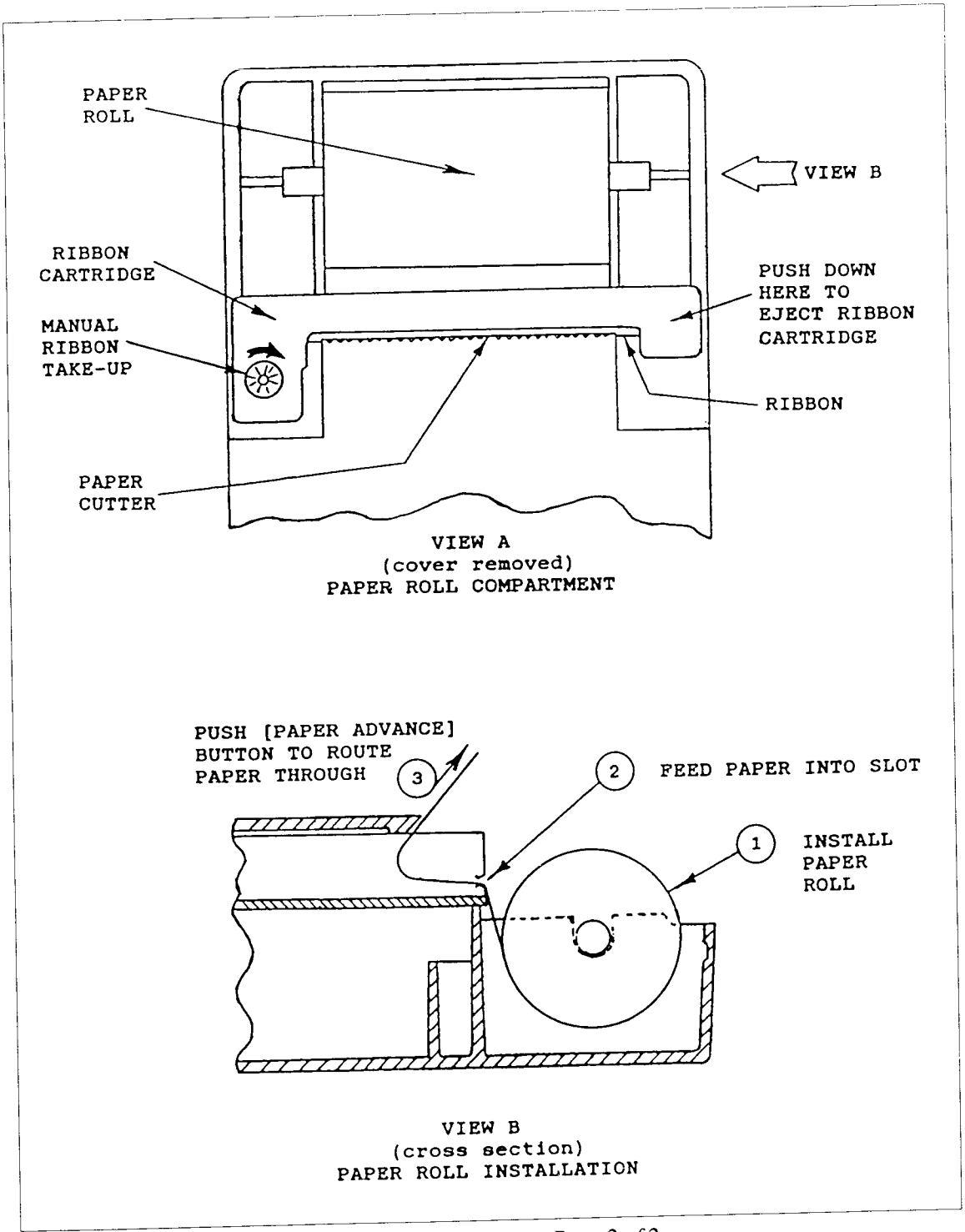


Figure 3-5. *Hand-Held Printer, Component Location, Page 2 of 2.*

3.07 AM-47XT HAND-HELD PRINTER, continued

Paper Roll Installation. (Refer to Figure 3-5.) For additional rolls of paper, order Part No. 26-0014.

1. Push up on end of housing (as indicated by arrow) to remove paper roll compartment cover.
2. Install paper roll in cradle and feed paper into slot.
3. Push [PAPER ADVANCE] button to route paper through printer.
4. Re-install compartment cover.

Self-Test. For a printout of all possible characters, hold down the [PAPER ADVANCE] button and set the POWER switch to ON. Self test printouts will continue to output until [PAPER ADVANCE] button is released.

Charging Considerations. The AM47XT NiCad battery pack is charged through the AC adaptor (70-0029). See Figure 3-8 for connection.

Charging is controlled by a microprocessor that is programmed to run the charging circuitry without sensing the actual charged or discharged state of the battery pack.

With the AC adaptor connected, each time the power is turned ON, the microprocessor assumes the worst case and goes into a full 14-hour charge cycle.

With the AC adaptor connected and the power OFF, the AM47XT is charged with a very low trickle current which takes several days to charge the battery pack.

-NOTE-
The AM47XT is normally charged with the power ON even though many other devices are typically charged with the power OFF.

The AC adaptor can be left continuously connected to the AM47XT. There is no danger of "overcharging" the battery pack.

After the charging cycle, the POWER LED will blink. Also, after the charging cycle, a timer is set which will start the charge cycle again after it is decremented to zero. Each time a line is printed, the timer is decremented a certain amount. If the POWER switch is left ON, the AM47XT can print about 7,000 lines before the timer is decremented to zero and a new charge cycle is initiated.

There are two (2) charging procedures:
1. A normal procedure
2. A procedure if the battery pack is *completely* discharged.

Normal Charging Procedure. Connect AC adaptor (70-0029) as shown in Figure 5-2. Turn POWER switch ON and note POWER LED. If LED lights, unit is charging. If LED does not light, battery pack is completely discharged; go to next charging procedure.

When charging cycle is complete (after about 14 hours), POWER LED will blink.

-NOTE-
Each time power is turned ON with the AC adaptor connected, the AM47XT will go through a complete charging cycle, regardless of the charge of the battery pack.

Charging Procedure When Battery Pack is Completely Discharged. Connect AC adaptor (70-0029) as shown in Figure 5-2. Turn POWER switch ON to verify POWER LED does not light. Turn POWER switch OFF. This will initiate a trickle charge that will charge the battery pack enough to operate the microprocessor-controlled charging circuitry. Leave the POWER switch OFF for about one (1) hour.

Turn the POWER switch ON. The POWER LED will now light continuously, indicating that the full charge cycle has begun. After about 14 hours, the POWER LED will start to blink, indicating that charging is complete.

3.08 ACCESSORIES

The items described in this paragraph are not automatically supplied with the AM5XT/eXT; they must be added to the order per customer request. See ¶ 3.07 concerning the AM-47XT Hand-Held Printer.

Line Cables. Bantam Plug Line Cables are illustrated in Fig. 3-6, along with their lengths and part numbers. Each of these cables can be used for a front-panel line connection, mating to the Bantam Jacks (items 2 and 3, Fig. 3-1) in the upper right-hand corner of the unit.

Padded Carrying Case, Model No. 87-0070B. This case is ideal to protect and carry the AM5XT/eXT and AM-47XT Printer, for example, while field testing. The AM5XT/eXT could be operated without removing it from the case. This case is constructed of green/gray heavy canvas, filled with foam padding. Other features are listed below:

- Case dimensions: approximately 11" long x 5" wide x 13" high (28 cm long x 13 cm wide x 33 cm high).
- Side pocket with individual Velcro-fastened cover flap, designed to carry AM-47XT Hand-Held Printer.
- Hand-carrying strap and padded shoulder-carrying strap.
- Aluminum plate in the bottom to enable case to stand on end.

RS232 Cables. Cables that can be used with the RS232 Option are illustrated in Fig. 3-7, along with their lengths and part numbers. Each of these cables mates to the optional RS232 connector (item 11, Fig. 3-3). See Section 12 for applications that use these cables.

3.09 MASK FEATURE (Optional)

This feature provides eight sets of performance limits (masks) that are applied to Level/Freq and Delay sweep results to determine whether a line is measuring according to its specifications. When the measurement results are within limits, the printer/plotter output is normal. When a measurement result is outside the mask, an indication of the error is recorded on the printer plot.

All units with Version 8 and up software contain this feature. The optional RS232 Port (Part No. 25-0019) is necessary to obtain the printer/plotter and mask feature.

There are eight different performance masks to select from, each with eight different limit specifications. A mask is selected using the "Cond" parameter for Level/Frequency, Envelope Delay or Group Delay measurements. Stored memory recalls 81 to 88 are also reserved for this purpose. Masks are recalled independently from LINE parameters or MEASUREMENT setups.

A printer plot output of a mask specification allows a graphic display of the mask. This plot uses the same scaling parameter as a normal printer plot, so it can be compared with an actual plot of the line under test.

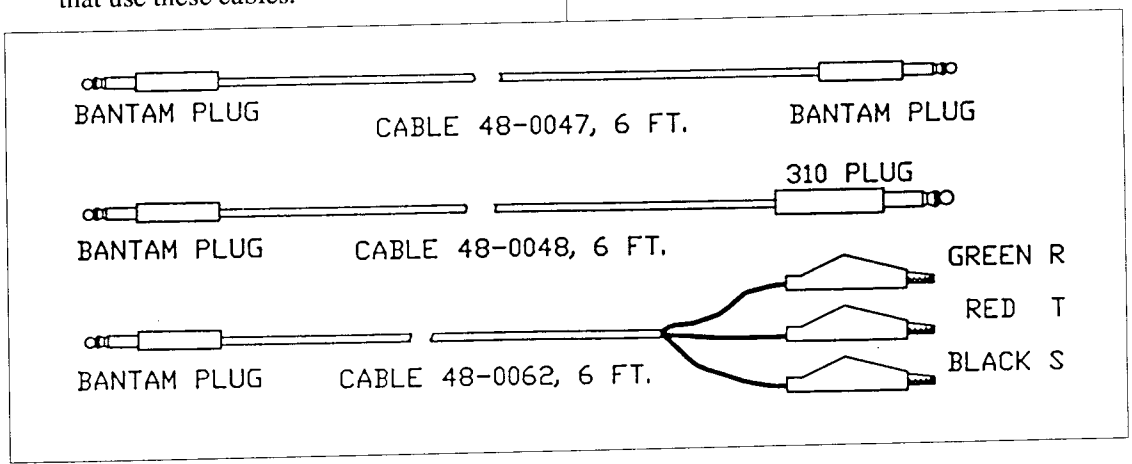


Figure 3-6. *Bantam Plug Line Cables.*

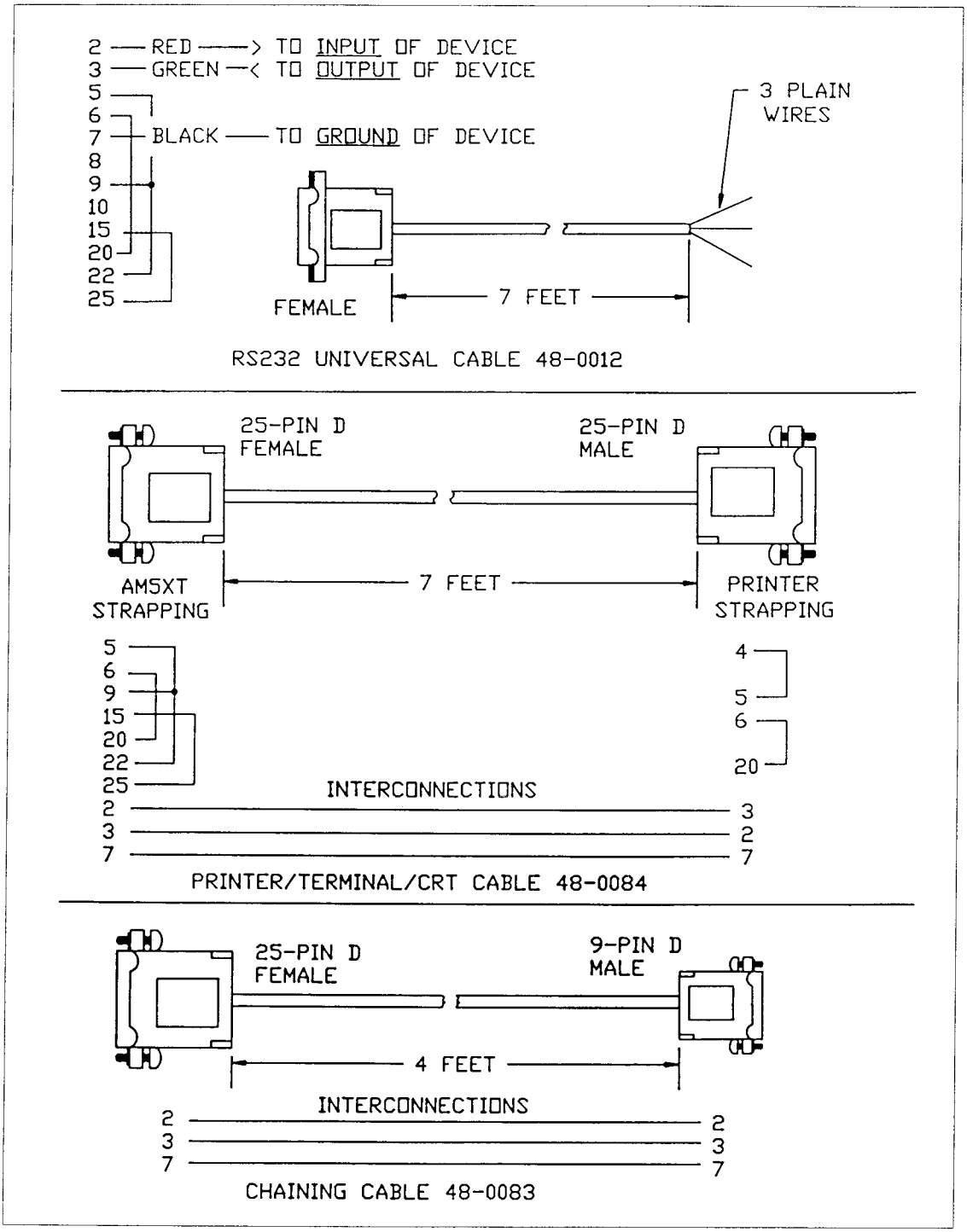


Figure 3-7. *RS232 Cables.*

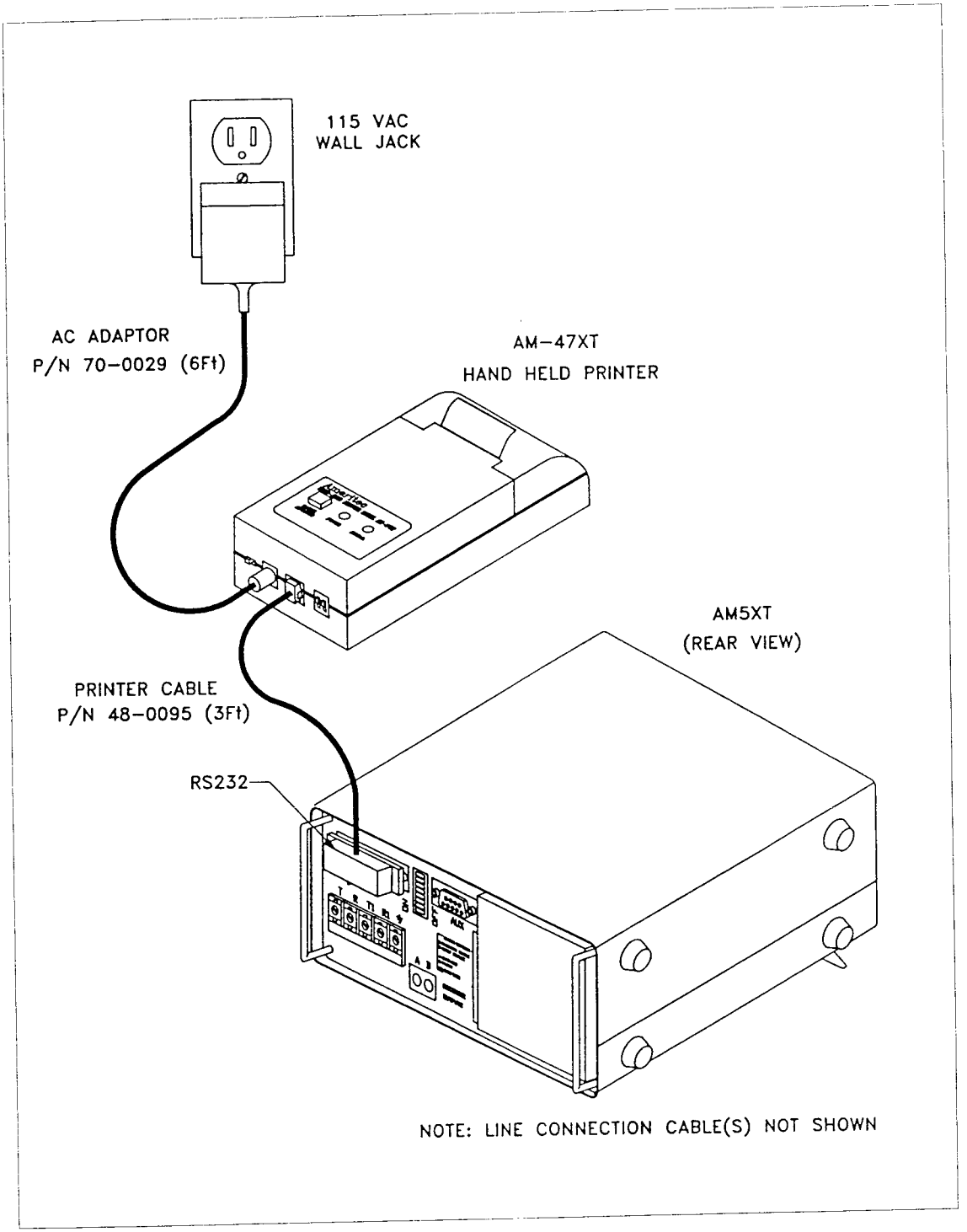


Figure 3-8. *Printer Hookup*

4. SELF-TEST AND OPERATION TECHNIQUES

4.01 INTRODUCTION

This section describes procedures to verify that the AM5XT/eXT is working properly. Refer to foldout at the back of the manual for front panel details. Some important operation techniques are discussed in this section.

4.02 SELF-TEST SETUP

These tests are done with the AM5XT/eXT looped back on itself, not connected to any external equipment. The signals sent (generated) through the Transmit (*TX*) port are routed directly back to the Receive (*RX*) port through a Bantam cable plugged into the front panel jacks or through a pair of wires attached to the rear panel screw terminals (T to T1 and R to R1).

When the AM5XT/eXT is turned on, all LEDs and displays will light for approximately three (3) seconds. Display will then read TEST PASS. The unit will then assume its default configuration

4.03 SWITCH SETUP

Place Monitor Switch in the *TX* (Transmit) mode.

Press LINE key. Turn off BRDG LED by pressing [#]. Verify that unit is set for 600 Ω TX, 600 Ω RX and 4W.

Verify that CMSG (PSHO for AM5eXT) is lit on AUX line.

4.04 QUIET SEND MODE

Press *SEND* key. *SEND* LED will light. Press key [1] to activate QT (Quiet) mode.

Press *MEAS* key. *MEAS* LED will light. Verify that LVL/FREQ LED is lit. Display should read "undr" with units "dBm".

Press key [2] for NOISE. Display should read "undr" with units "dBrn" ("dBm for AM5eXT).

4.05 SEND 1004 Hz

Press *SEND* key. *SEND* LED will light. Press key [2] to send 1004 Hz (at 00.0 dBm).

-NOTE-
Turn volume control up or down as desired to increase or decrease volume of the speaker sound. The speaker is monitoring the 1004 Hz tone being sent.

Press *MEAS* key. *MEAS* LED will light. Press key [1] for LVL/FREQ. Display should read "00.0 ± 1 dBm, 1.004 ± .002 kHz.

Press key [2] for NOISE. Display should read "90.0 ± 1 dBrn" ("01.0 ± 1.0 dBm" for AM5eXT).

Press key [3] for NOTCH NOISE. Note that *HOLD TONE* LED is on (signal being received). Reading on display must be less than 40.0 dBrn and at "1.004 kHz" (-50 dBm for AM5eXT). If left display reads "undr", right display will be blank.

Press key [5] for *S/N* (signal-to-noise ratio). Note that *HOLD TONE* LED is still on. Display should read greater than 50.0 dB (or display read "over") and at "1.004 ± .002 kHz".

Verify that *JTR 20-300* LED is on on *AUX* line.

Press key [0] for *PHASE JTR*. Display should read "PJTr" and "00.0 ± 0.2 " with *DEG* LED lit.

Press key [*] for AMP JTR. Display should read "AJTr" and "00.0 ± .2" with % LED lit.

4.06 SEND PAR

Press *SEND* key. Press key [6] for PAR. Display will read "0.00 dBm" and PAr. Press *MEAS* key. Press key [6] for PAR. Display should read "00.0 ± 1.0 dBm" and "100 ± 2 PAR".

4.07 SEND ENVELOPE DELAY (ENV DLY)

Press *SEND* key. Press [8] for *ENV DLY*. Again press key [8] to display "00.0 dBm" and "rEF".

Press *MEAS* key. Display should read "3.965 ±.010 mSEC" and "1.800 ±.002 kHz".

4.08 SEND IMD

Press *SEND* key. Press key [9] for IMD. Press *MEAS* key. Display should read "00.0 ± .5 dBm" and "4 T". Press key [9]. Display should change to "OVER dB" and "2 4T". Press key [9] again. Display should change to "OVER dB" and "3 4T".

Press *SEND* key. Press key [9]. Display will read "00.0 dBm" and "TEST". Press *MEAS* key. Display should read "30.0 ± .5 dBm" and "3 4T". Press key [9]. Display should read "00.0 ± .5 dBm" and "4T". Press key [9] again. Display should read "20.0 ± .5 dB" and "2 4T". Press key [9] again. Display should read "30.0 ± .5 dB" and "3 4T".

4.09 AUTO CALIBRATE (Up to version 7* only)

The AM5XT/eXT was calibrated at the factory for proper measurement accuracy by loading certain values into internal RAM. RAM is maintained by a small internal "super cap" (1 fared capacitor) with 30-day life. As long as the AM5XT/eXT is connected to commercial power at least once each 30 days *or* if equipped with the internal battery option, the RAM "super cap" will retain its charge indefinitely.

If the unit is *not* equipped with the internal battery option *and* is not connected to commercial power for 30 days or more, the unit will require recalibration. This is easily accomplished in the field. As part of the power-on self-test, the unit will automatically diagnose itself and inform the operator of the need for recalibration.

If during the power-on self-test the display indicates "AUTO CAL?", proceed as follows:

1. Remove all input leads.
2. Press [AUX] key to enter *AUX* mode.
3. Press [#] key.
4. Press [D] key.

The unit will then go through an auto-calibration process wherein the send/receive pairs will be internally looped. The internal signal generator will send 6 different levels at 1004 Hz plus 1 level at PAR while the measurement circuitry calibrates itself. This process takes approximately 30 seconds, following which the unit will revert to normal operation.

4.10 CALIBRATION CHECK (Up to version 7* only)

When desired, the AM5XT/eXT can be forced into auto-calibration any time by entering *AUX* mode and depressing the [#] key and the [ENTER] or [D] key. Make certain that all input leads are disconnected during auto-calibration or erroneous calibration will result.

4.11 CALIBRATION (Version 8* and up)

AM5XT/eXTs with version 8 and up software allow for complete field calibration using only a high accuracy digital voltmeter. Voltmeter must read out in AC Volts RMS and be accurate at 1000 Hz within .4%. Minimum input impedance should be 200 kΩ.

1. Disconnect all input leads from AM5XT/eXT.
2. Connect leads of voltmeter to T1 and R1 either on the front right Bantam jack or rear terminal screws.
3. Press [AUX] key to enter *AUX* mode.
4. Press [#] key. Display will read *AUTO CAL?*
5. Press [D, ENTER] key. Display will read *V1* on left and four dashes on the right. *PARAM SET* LED will light.
6. Enter voltage shown on voltmeter, with decimal. *PARAM SET* LED will blink. Voltage should be larger than 1.200 and smaller than 2.600. Larger or smaller readings cannot be entered. If reading is outside this range, unit must be repaired. Press [D, ENTER] key to enter reading. *PARAM SET* LED will remain on.

*See ¶7.02, Display 5 to determine software installed in the AM5XT/eXT being used.

4.11 CALIBRATION (Version 8 and up), continued.

7. Press [D, Enter] key. Display will read *V2* on left and four dashes on the right.
8. Enter voltage shown on voltmeter, with decimal. *PARAM SET* LED will blink. Voltage should be larger than 0.250 and smaller than 0.450. Larger or smaller readings cannot be entered. If reading is outside this range, unit must be repaired. Press [D, ENTER] key to enter reading. *PARAM SET* LED will remain on.
9. Press [D, ENTER] key. Display will be blank on the left and read *CAL?* on right. *PARAM SET* LED will go out.
10. Disconnect voltmeter from AM5XT/eXT.
11. Press [D, ENTER] key. Unit will begin to calibrate itself. This process takes approximately 4 minutes. After calibration is completed, unit goes to operating mode and is ready for use.

4.12 PARAMETER SET

The Parameter Set mode is used with Send and Measure functions to change/adjust the signal level, variable frequency, and sweep parameters. To enter Parameter Set mode:

1. Press [SEND] or [MEAS] key to enable Send or Measure function row.
2. Press [D].
3. *PARAM SET* LED will light. Press [D] to step to next parameter. Press [C] to step to previous parameter.

It is important to note that the *PARAM SET* LED indicates the state of the values entered/changed:

If the *PARAM SET* LED is ON, then the value displayed is entered into the AM5XT/eXT. The value can be changed with the number keys or in increments with the [▲] and [▼] keys.

If *PARAM SET* LED is BLINKING, then the value displayed has been changed, but not entered. Press [D] to **enter** or press [C] to **cancel** the value and revert to previous value.

If *PARAM SET* LED is OFF, all values have been entered and the user is able to begin testing.

To exit Parameter Set mode, press [SEND] or [MEAS] key again.

4.13 DATA DISPLAYS

Data Displays are accessed by pressing the same key that is used to enable the function. For example, RETURN LOSS has three types of white-noise test tones. Refer to ¶7.08, Displays 1, 2, and 3.

1. Press [SEND] key.
2. Press [7] to select Echo Return Loss (ErL).
3. Press [7] again to select Singing Return Loss - Lo (SrLL).
4. Press [7] again to select Singing Return Loss - Hi (SrLH).
5. Press [7] again to return to Echo Return Loss (ErL).

5. CONNECTION AND CONFIGURATION INSTRUCTIONS

5.01 INTRODUCTION

This section describes the AM5XT/eXT connections and configurations made in preparation for testing. It is divided into the following paragraphs:

5.02 General
5.03 Connectors and Cables
5.04 Line Termination Impedances
5.05 Configurations

In ¶ 5.05, basic operating instructions are given for testing with the Western Electric 829 loopback device and also with Ameritec Responders.

5.02 GENERAL

Low-Level Measurements. Power the AM5XT/eXT with batteries when making a low-level noise measurement. Do *not* use AC power for this test because interference from the AC source can affect the measurement.

Independent Send and Measure Modes. The Send, Measure and Filter modes of the AM5XT/eXT operate independently. Almost any combination of Send, Measure or Filter can be selected. However, depending on the setup, the resulting measurements may or may not be valid.

For example, a 1004 Hz holding tone must be sent for various measure modes and a PAR waveform must be sent when PAR is measured. If the 1004 Hz tone or PAR waveform were not present in the corresponding measurement, the measurement would not be valid. The AM5XT/eXT configuration (see ¶ 5.06) determines in what part of the system the signals need to be sent and measured.

The correct Send, Measure and Filter modes are indicated for each test described in the operating instructions of Sections 7 and 8.

5.03 CONNECTORS AND CABLES

See Fig. 3-2 and Fig 3-3 for illustrations of the AM5XT/eXT connectors and cables. Note that some cables are standard and others are optional. Connect the appropriate cable(s) described in this paragraph according to the desired application.

AC Operation. Connect the power cord (supplied) to the three-pronged connector on the rear panel of the unit. Connect the other end into a standard 115 or 230 VAC wall socket. Note that positioning of the red 115/230 switch near the AC connector on the unit for proper setting.

CAUTION
Severe damage will occur to the unit if set for 115 VAC and connected to the 230 VAC power.

Printer Cables. There are two (2) types of cables used with printers. The 48-0095 is used with the AM-47XT Hand-Held Printer. The 48-0078 is used to connect to most other 25-pin female serial EIA printers. There is also a 48-0083 cable used to connect an EIA Serial ASCII type device to the AUX port of the AM5XT/eXT.

Figure 5-2 shows the connections for the AM-47XT Hand-Held Printer.

See ¶ 13.01 for operating instructions for printing.

Line Connection Cables. There are three (3) Bantam cables illustrated in Fig. 5-1that are used for line connections. Use these cables as required to connect the AM5XT/eXT to 2-wire or 4-wire lines.

-NOTE-
The rear panel screw terminals and Bantam jacks are wired in parallel, resulting in the identical connection by using either type.

CONNECTION AND CONFIGURATION INSTRUCTIONS

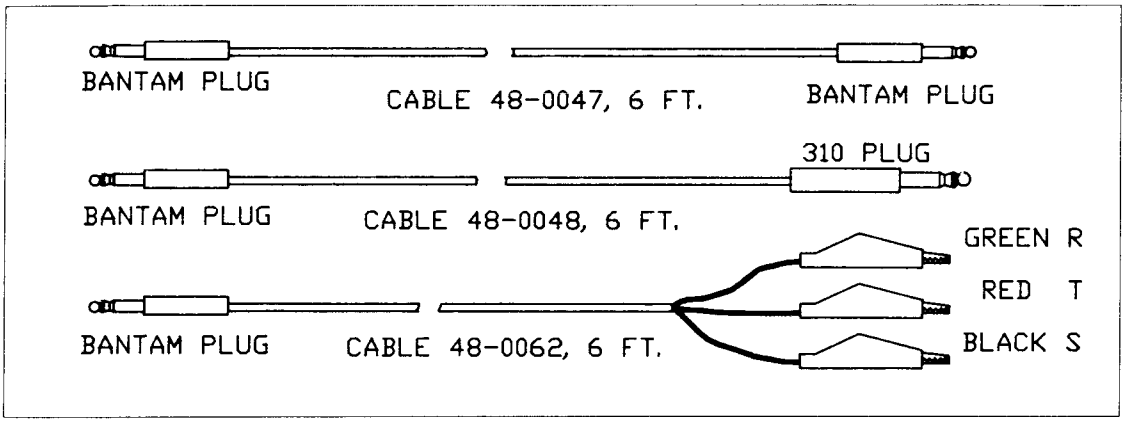


Figure 5-1. *AM5XT/eXT Connection Cables*

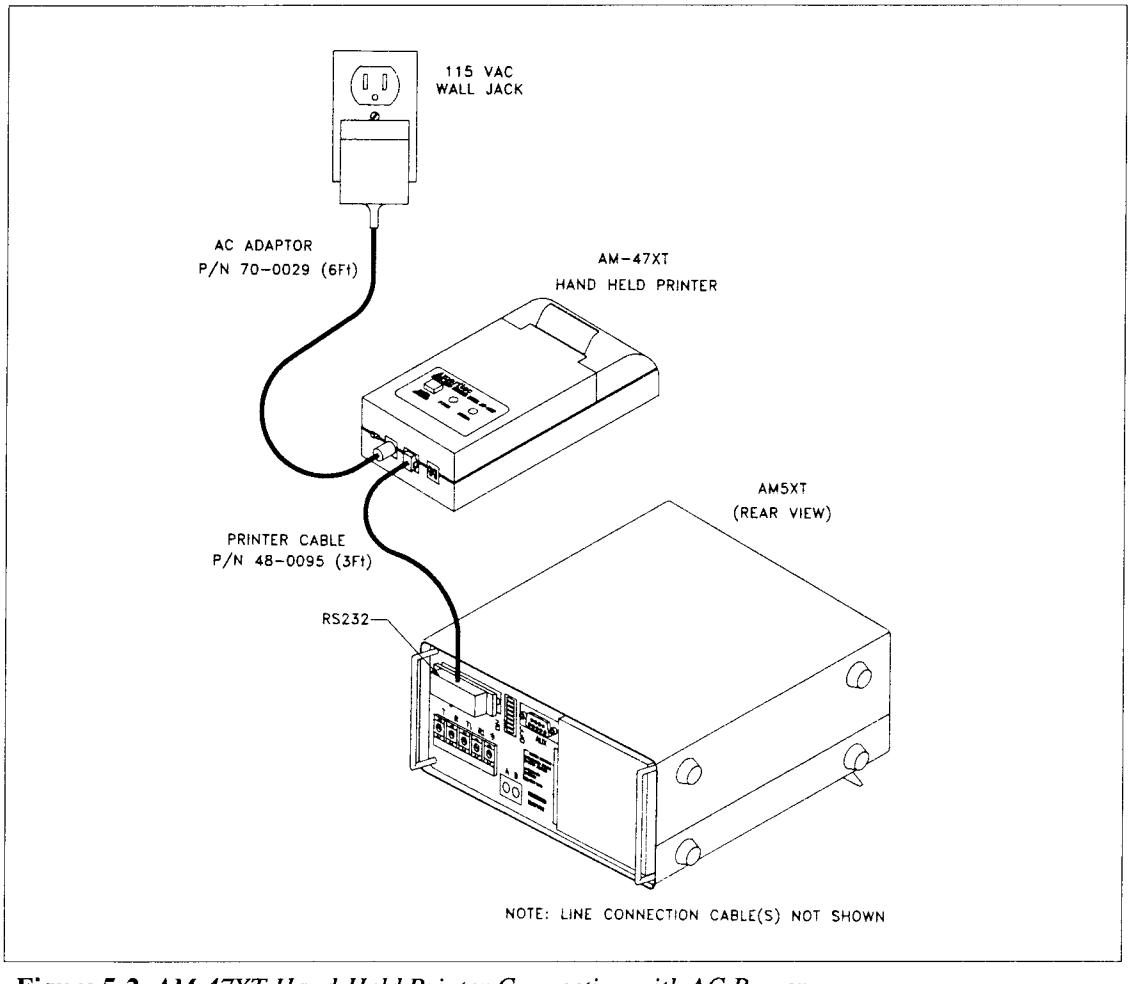


Figure 5-2. *AM-47XT Hand-Held Printer Connection with AC Power*

AM5XT/eXT Interface with Line Connections. The state of the "Line Reverse" LED determines the connection of the AM5XT/eXT internal circuitry to the 2-wire or 4-wire lines. The connections for the different settings are listed below:

2W Connects together the internal measurement circuitry and signal generator across the 2-wire line at the *TX* jack; the signal generator source impedance of 135 (150 for AM5eXT), 600, 900, or 1200 Ω (determined by the line selections) terminates the line in all signal generator modes except *OPEN*.

4W Connects the internal measurement circuitry to the *RX* pair and the internal signal generator to the *TX* pair.

REV Send and receive pairs (as defined above) are reversed.

AM5XT/eXT is Polarity Insensitive. It does not matter which way the Send pair or the Receive pair of contacts are connected. The Send T and R can be interchanged without affecting the measurement. Also the Receive T1 and R1 could be switched without changing the measurement.

5.04 LINE TERMINATION IMPEDANCES

It is important that the line(s) be properly terminated with a matching impedance. This paragraph gives instructions for terminating lines with 135 (150 for AM5eXT), 600, 900 or 1200 Ω impedance.

To terminate the line(s) correctly:

1. Choose either terminate or bridge mode:
   A. Select terminate mode, or
   B. Select bridge mode and terminate the line with some other device (such as a modem) of proper impedance.
2. Set the transmit and receive impedances to match those of the circuit under test.

5.05 CONFIGURATIONS

There are three (3) basic AM5XT/eXT configurations to test 2-wire and 4-wire telephone and data communication lines:

1. End-to-end-- requiring two (2) AM5XT/eXTs.
2. Loopback
3. Testing with responders

This paragraph describes the different configurations, explains how they are used, and discusses the advantages and disadvantages.

-NOTE-
End-to-end and responder testing apply to either 2-wire or 4-wire.
Loopback testing only applies to 4-wire.

End-to-End Testing (Fig. 5-4). Measurements on telephone transmission lines are usually made by applying an appropriate signal at one end of the transmission line and then measuring the results at the other end of the line. This configuration requires a test set at each end of the line and is called "end-to-end" testing. Fig. 5-4 shows a 4-wire end-to-end configuration, making measurements over a telephone network that normally connects two (2) modems. Each AM5XT/eXT both sends and receives signals, sending a signal over the *TX* pair of lines, and measuring the signal received over the *RX* pair of lines.

End-to-end testing can also be done over 2-wire lines. The AM5XT/eXT on one end sends a signal and the AM5XT/eXT on the other end measures the received signal. End-to-end testing is necessary to perform Envelope Delay measurements.

End-to-end testing is the most reliable for characterizing the near-to-far impairments, but it has the disadvantage of requiring two (2) test sets and an operator at each test site.

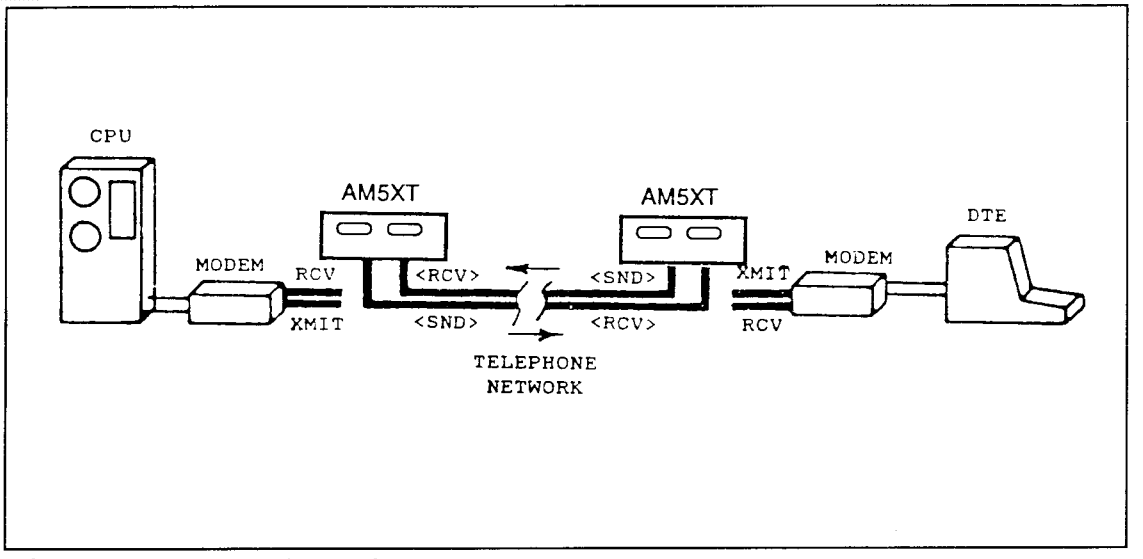


Figure 5-4. *4-Wire End-to-End Testing.*

Loopback Testing. The distant end of a 4-wire transmission line can be looped back (1) manually or (2) with a commandable loopback device such as the Western Electric Model 829. The AM5XT/eXT at the near end sends a signal which travels to the distant end where it makes a U-turn and travels back to the AM5XT/eXT which measures the received signal.

The advantage of this configuration is that it requires only one (1) operator and test set at a central site. Although this method is more convenient and less costly than end-to-end testing, it is also less reliable. The disadvantage is that it does not characterize transmission impairments in each direction. Instead of detecting impairments, a loopback measurement could actually cover them up; an apparently satisfactory loopback measurement may contain impairments in each direction which cancel each other! This method of testing may be useful, however, providing its limitations are recognized.

-NOTE-
A loopback test can *not* be done on 2-wire because signals can not be sent and measured simultaneously on the same pair of lines.

To do a loopback test with a Western Electric Model 829:

1. Connect the AM5XT/eXT at the near end of the 4-wire line under test.
2. Momentarily press "Loop Back" (Send/C) to send a 2713 Hz (or whatever is the necessary loopback tone) tone over the *TX* line. This will trip the distant Model 829 into loopback.
3. Send the desired test signal with the AM5XT/eXT and make the desired measurement of the looped-back signal.
4. After testing is finished, momentarily press "Loop Back" to restore the Model 829 to its normal, transparent state.

Testing with Responders. (Fig. 5-5 and Fig. 5-6). Using multifunction responders has most of the advantages of end-to-end testing with the added advantage of not requiring an AM5XT/eXT at the far end of the system. This configuration is similar to loopback testing except that the responder can generate signals in addition to looping back. Unlike a dedicated loopback device, responders can be used in 2-wire far-to-near testing.

On 4-wire circuits, a DTMF commandable responder, such as the Ameritec Model AM3-4, may be placed permanently at the distant modem where it remains transparent until commanded by DTMF signals sent from the AM5XT/eXT at the central site. In addition to performing loopback, the responder can send various tones. This allows far-to-near tests as well as loopback tests.

Example: 4-wire far-to-near and loopback tests for level and frequency with an Ameritec AM3-4A or AM3-4B Responder:

1. Connect an AM5XT/eXT to the near end of a 4-wire facility and an Ameritec AM3-4A or AM3-4B Responder at the far end. A typical configuration is illustrated in Fig. 5-5.
2. Use AM5XT/eXT "TT" digits to send the appropriate DTMF command sequence to command the responder into milliwatt mode (responder will generate 1004 Hz, 0 dBm signal). Measure received signal and note level and frequency.
3. Use AM5XT/eXT "TT" digits to sent DTMF command sequence to command responder into loopback.
4. Use AM5XT/eXT to send 1004 Hz tone at 0 dBm. Measure loopback received level and frequency.
5. Use AM5XT/eXT "TT" digits to send DTMF command sequence to restore responder to normal.

On a 2-wire network, dial access responders are very useful in measuring far-to-near characteristics. An Ameritec AM3-2C Responder (automatic milliwatt) or AM3-2A Responder can be dialed up over the network path under test using the AM5XT/eXT keypad. It can then be commanded with touch tone from the AM5XT/eXT to make level measurements or send tones. The AM3-2C can perform far-to-near level and frequency, idle channel noise and noise with tone. In addition to the AM3-2C functions, the AM3-2A can also perform far-to-near gain slope and near-to-far level. A typical configuration is illustrated in Fig. 5-6.

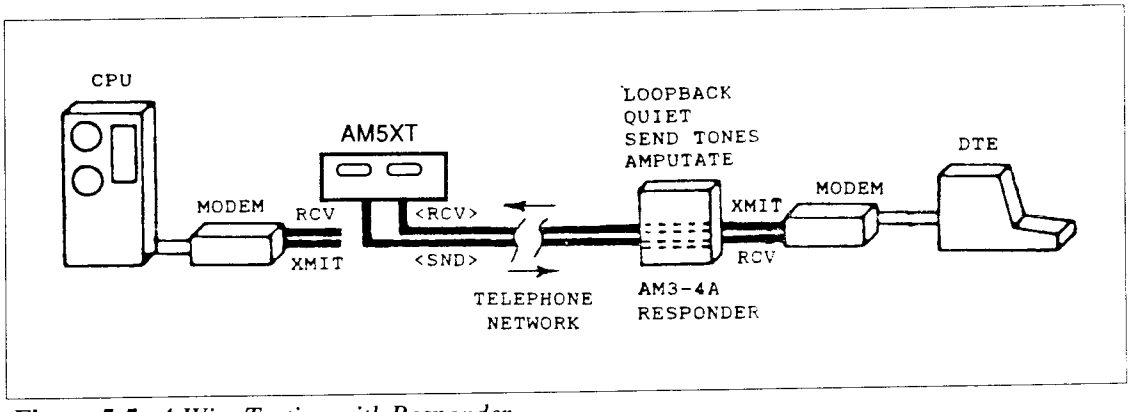


Figure 5-5. *4-Wire Testing with Responder*

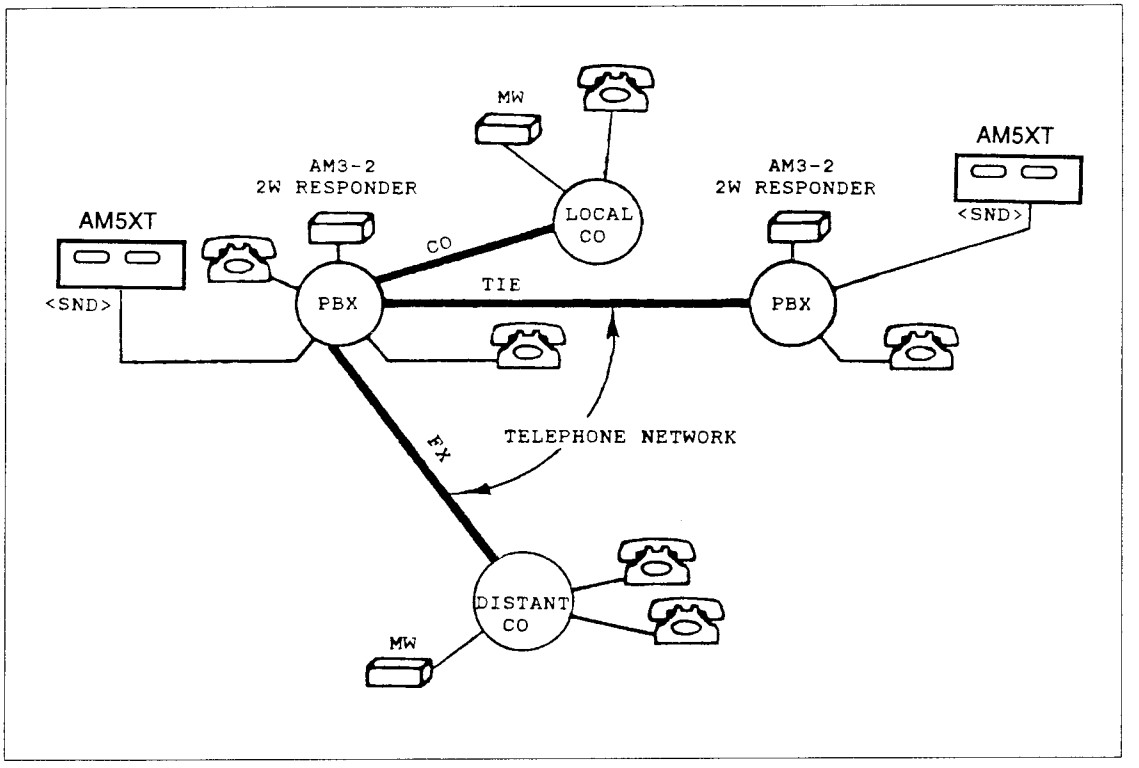


Figure 5-6. *2-Wire Testing with Responder*

6. LINE FUNCTIONS

6.01 INTRODUCTION

LINE Functions determine the condition of the interface of the AM5XT/eXT with the 2 or 4-wire telephone line connected for test.

Some Line Functions are color-coded per the line pair to which the function is applied:

GREEN (*TX/2W*) = 2-wire pair, or 4-wire transmit pair: *T,R*

BLUE (*RX*) = 4-wire receive pair: *T1, R1*

Other Line Functions are color-coded to match the type of connection enabled:

GRAY = 2-wire or 4-wire normal connection

BLACK = 2-wire or 4-wire with connections reversed (*T,R* becomes *T1,R1* and vice versa)

-NOTE-

The color coding of the Line Functions matches the color coding of the labels of the Line Bantam Jacks (see items 2 and 3 in Fig. 3-1).

See Fig. 6-1 for instructions to select desired Line Function.

Unlike the Send and Measure Functions, there are *no displays* associated with Line Functions; the status of the Line Functions is completely determined by the condition of the Line Function LEDs. Also, unlike the Send and Measure Functions, more than one Line Function LED will be on at the same time.

In this section, the Function Enable Key for each Line Function is shown enclosed in a square ☐. For example, [8] *600 Ω* indicates that key [8] is pressed to connect 600 Ω to the receive pair, *RX (T1, R1),* when the line is terminated (*BRDG* LED off).

Paragraphs in this section are listed below:

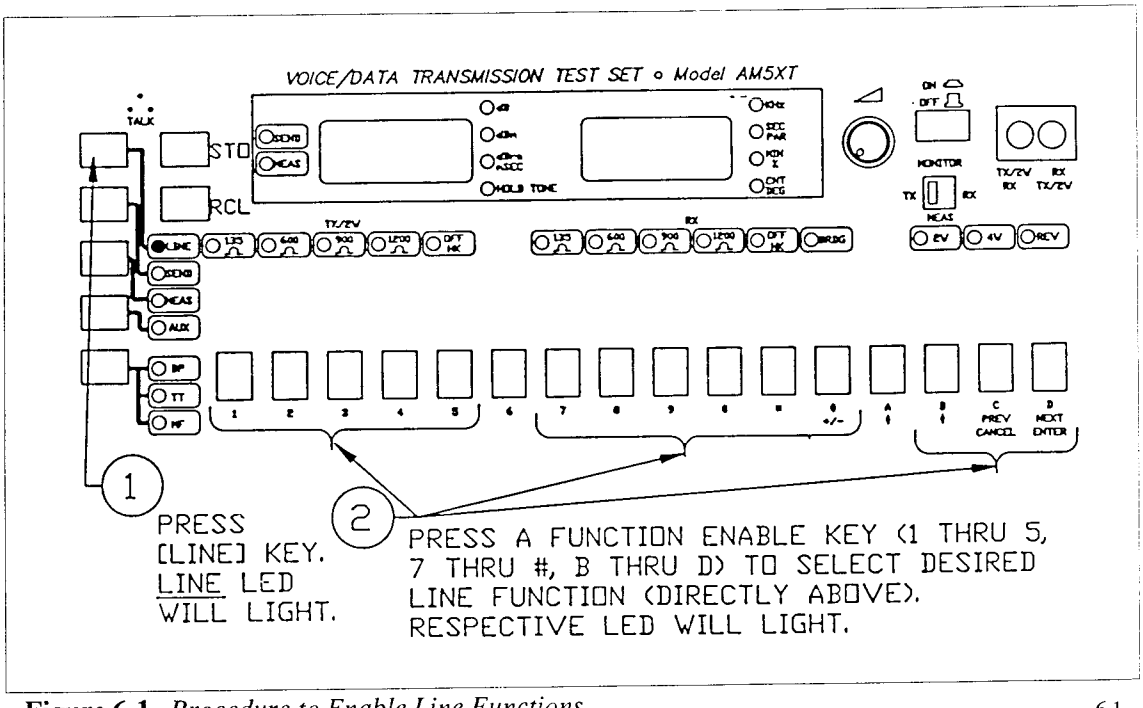


Figure 6-1. *Procedure to Enable Line Functions*

6.02 GENERAL LINE FUNCTION NOTES

-NOTE-
Line functions enabled are stored/ recalled separate from the other front panel functions. See ¶ 11.02.

Line Circuits Block Diagrams. See Fig. 6-2 and 6-3. For reverse (*REV*), note that the *RX (T1, R1)* and *TX (T, R)* pair are reversed, as indicated in the black-background labeling under the front panel Bantam jacks.

Line Impedances. The Transmit Pair, *TX (T,R)*, and Receive Pair, *RX (T1, R1)*, each have four (4) impedances from which to select:

135 Ω (150 Ω for AM5eXT)
600 Ω
900 Ω
1200 Ω

Line Function Enable Keys [1] thru [4] and [7] thru [0] are used to select the line impedances. The LEDs of the selected line impedances will be on.

-NOTE-
The dBm and dBrn readings are always calculated based on the AM5XT/eXT *RX* line impedance selected, even when the *RX* pair is bridged. The internal micro-processor takes the measured voltage and calculates the reading using the formula:

$$dBm = 10 \log \frac{(E^2 \times 1000)}{R}$$

Where: R = selected RX line impedance
E = measured voltage

The receive pair, *RX (T1, R1)*, of a 4-wire circuit under test is terminated with the selected *RX* impedance only when the line is *terminated* (*BRDG* LED off) - see below and ¶ 6.07 concerning the Bridge/Terminate Line Function.

When sending a test tone, the transmit line, *TX/2W (T,R)*, is always terminated because the selected source impedance for the signal generator terminates the line. The transmit line is bridged only when the SEND function is OPEN (signal generator is disconnected). Likewise, a 2-wire line is bridged only when the SEND function is OPEN.

DC Line Hold (On-Hook/Off-Hook). The *TX/2W (T, R)* and *RX (T1, R1)* lines have separate DC hold circuits. The hold circuits are electronic equivalents of a line hold coil. Key [5] is used to connect/disconnect the TX/2W (*T, R*) line hold circuit; key [*] is used to connect/disconnect the RX (*T1, R1*) line hold circuit. With DC hold on (*OFF HK* LED on), the circuit connects a 200 Ω DC path across T and R (or T1 and R1) which presents a high impedance path (>50 kΩ) to AC signals.

Bridge/Terminate. The RX (T1, R1) line pair can be either bridged or terminated, using key [#].

For 4-wire circuits, "terminated" means that the *RX (T1, R1)* line is terminated by the selected AM5XT/eXT *RX* impedance. "Bridged" (not terminated) means that the AM5XT/eXT presents a high impedance (>50 kΩ) to the *RX (T1, R1)* line under test. When in bridged mode, the *RX (T1, R1)* line must be terminated by a device external to the AM5XT/eXT. The TX (T1, R1) line is always terminated unless the SEND function is OPEN.

In 2-wire mode (*2W* LED on), the line will only be bridged when the *OPEN* send mode is enabled, in which case the signal generator is disconnected

-NOTE-
A line under test is terminated by either an external impedance *or* the AM5XT/eXT. Do *not* terminate the line both externally *and* with the AM5XT/eXT.

***2W, 4W, REV* (2-Wire, 4-Wire, Reversed).** Keys [B] and [C] are used to select the type of line (2-wire or 4-wire) connected to the AM5XT/eXT. Key [D] is used to conveniently reverse the connections. When Reversed, *TX/2W (T,R)* becomes *RX (T1, R1)* and vice versa.

6.02 GENERAL LINE FUNCTION NOTES, continued

Line Connections (for normal non-reversed operation).

4-Wire Circuits:

Front Panel Connection:

- Connect the receive pair (over which the AM5XT/eXT receives signals) to the *RX* Bantam jack.
- Connect the send (transmit) pair (over which the AM5XT/eXT sends signals) to the *TX/2W* Bantam jack.

Rear Panel Connection:

- Connect the receive pair (over which the AM5XT/eXT receives signals) to the *T1* and *R1* screw terminals.
- Connect the send (transmit) pair (over which the AM5XT/eXT sends signals) to the *T* and *R* screw terminals.

2-Wire Circuits:

- *Front panel connection:* Connect the pair to the *TX, 2W* Bantam jack.
- *Rear Panel Connection:* Connect the pair to the *T* and *R* screw terminals.

6.03 GENERATOR SOURCE IMPEDANCES (Transmit Pair)

The front-panel labels are color-coded *green* for each of the possible generator source impedances. The choices are listed below, along with their Function Enable Keys:

[1] *135 Ω(150 Ω* for AM5eXT)

[2] *600 Ω*

[3] *900 Ω*

[4] *1200 Ω*

One of the associated LEDs will be on to indicate which of these impedances has been selected for the AM5XT/eXT signal generator. The selected source impedance is connected to the transmit pair, *TX (T,R)*, as indicated in Fig. 6-2 and Fig. 6-3; note that half of the impedance is connected to each side of the line.

When the Send Function is set to *QUIET*, the signal generator is disconnected and the Transmit pair, *TX (T,R)*, is terminated with the selected source impedance. When the Send Function is set to *OPEN*, both the signal generator and the selected generator source impedance are disconnected from the *TX (T, R)* pair.

6.04 [5] *OFF HK* (Send Pair Off-Hook/On-Hook)

OFF HK LED on = off-hook condition with DC path (>50 kΩ AC path) across transmit pair, *TX (T,R)*, equivalent to 200 Ω holding coil.

OFF HK LED off = on-hook condition with holding coil disconnected.

6.05 TERMINATION IMPEDANCES (Receive Pair)

The front-panel labels are color-coded *blue* for each of the possible termination impedances. The choices are listed below, along with their Function Enable Keys:

[7] *135 Ω(150 Ω* for AM5eXT)

[8] *600 Ω*

[9] *900 Ω*

[0] *1200 Ω*

One of the associated LEDs will be on to indicate which of these impedances has been selected for the receive pair, *RX (T1,R1)*.

With *BRDG* LED off (*RX* terminated), the selected termination impedance is connected across the receive pair, *RX (T1,R1)*, as indicated in Fig. 6-2 and Fig. 6-3. With the *BRDG* LED on, RX becomes high impedance (no termination).

With *BRDG* LED on (*RX* bridged) set the RX impedance to the same value as the external termination impedance on the receive pair, *RX (T1,R1)*. This setting is used to tell the AM5XT/eXT microprocessor the value of the external termination impedance so that it can calculate the proper measure reading; the formula is given is in ¶ 6.02 under "Line Impedances".

6.06 [*] *OFF HK* (Receive Pair Off-Hook/On-Hook)

OFF HK LED on = off-hook condition with DC path (>50 kΩ AC path) across receive pair, *RX (T1,R1)*, equivalent to 200 Ω holding coil.

OFF HK LED off = on-hook condition with holding coil disconnected.

6.07 [#] *BRDG* (Receive Pair Bridged/ Terminated)

BRDG LED on = high impedance bridge (>50 k Ω) across receive pair, *RX (T1,R1)*.

BRDG LED off = receive pair, *RX (T1,R1)*, terminated by impedance selected per ¶ 6.05.

In 2-wire mode (*2W* LED on), the measure circuitry is always high impedance, as indicated in Fig. 6-2. A 2-wire line is terminated by the signal generator source impedance.

6.08 [B] *2W* (2-Wire)

This function is color-coded *gray* on the front panel.

2W LED on = transmit pair, *TX (T,R)*, is connected to both the signal generator (send) and the measure (receive) circuits, as shown in Fig. 6-2.

6.09 [C] *4W* (4-Wire)

This function is color-coded *gray* on the front panel.

4W LED on = transmit pair, *TX (T,R)*, is connected to the signal generator
and
receive pair, *RX (T1,R1)*, is connected to the measure (receive) circuitry.

Tone Ringer, Incoming Ring. With this feature enabled, a ringback tone will be heard from the AM5XT/eXT speaker when a ringing voltage appears across the transmit pair, *TX (T,R)*.

To enable the tone ringer, press the appropriate keys on the front panel to enable *4W* and *OPEN*:

1. With *LINE* LED on, press [C]. *4W* LED will light,
2. With *SEND* LED on, press [0]. *OPEN* LED will light.

6.10 [D] *REV* (Reversed)

This function is color-coded *black* on the front panel.

REV LED on = transmit pair, *TX (T,R)*, and receive pair, *RX(T1,R1)*, connections reversed compared to the connections listed in ¶ 6.08 and 6.09. Note labeling with black background under front panel Bantam jacks, which indicates this connection reversal.

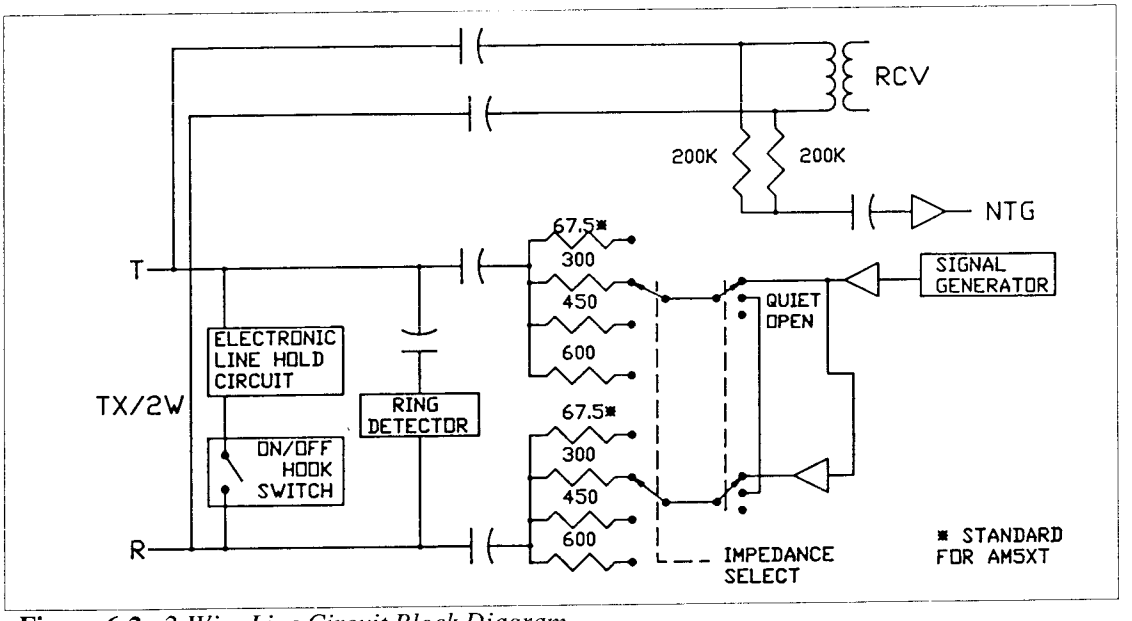


Figure 6-2. *2-Wire Line Circuit Block Diagram*

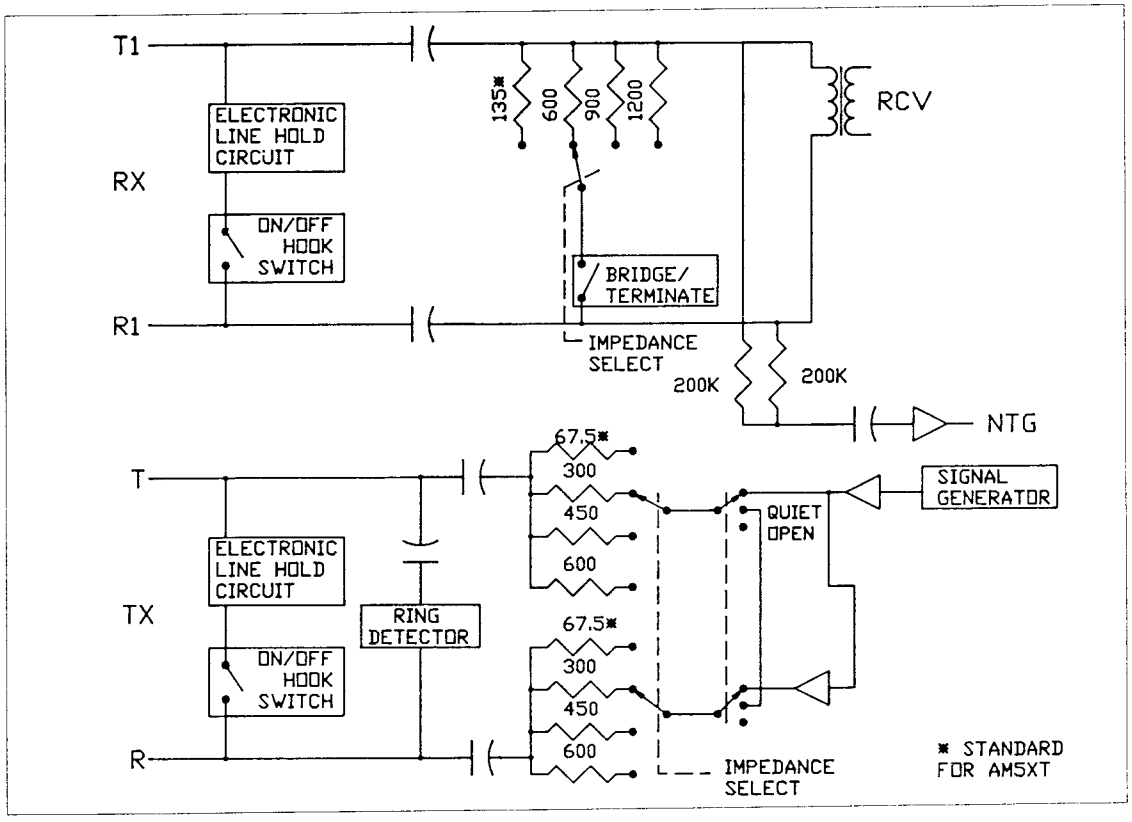


Figure 6-3. *4-Wire Line Circuit Block Diagram*

7. SEND FUNCTIONS

7.01 INTRODUCTION

The AM5XT/eXT contains a highly-flexible signal generator capable of generating a variety of test tones which are applied to the Transmit (TX) pair.

SEND refers to the signal generator condition applied to the TX pair of the line under test. See Fig. 7-1 for instructions to select desired Send Function. Note that **SEND** Functions are color-coded GREEN.

In this section, the paragraph heading for each Send Function shows its Function Enable Key enclosed in a square, [ ]. For example, [1] *QUIET* indicates that key [1] is pressed to select *QUIET* Send mode. DATA and PARAMETER DISPLAY information is given in the right column. Section 4 explains how the DATA and PARAMETER DISPLAYS are accessed and used.

Level Display. There is only one level setting and it is stored in volatile memory. For convenience, the level display which shows this value can be accessed with any SEND function. The level display is always the *first* PARAMETER DISPLAY.

To access the level display:

1. Press [SEND] key.
2. Press any Send Function Enable Key.
3. Press [D] to access Set Level Display (first PARAMETER DISPLAY).

Remember that when the level value is changed, it changes the level for all SEND signals, except for dialed tones (see Display 4 ¶ 7.02 for PARAMETER DISPLAY to set Touch Tone level). When power is turned off, the send level always defaults to 00.0 dBm. The level for dialed tones, however, is stored in non-volatile memory.

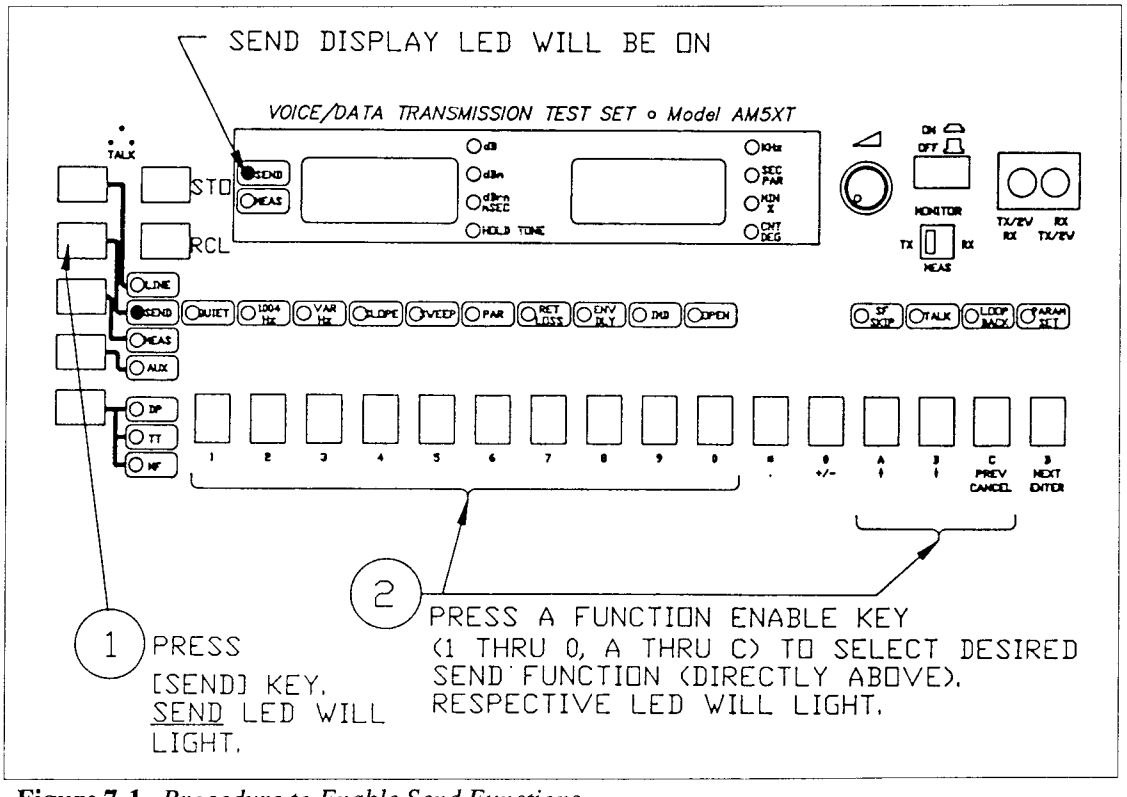


Figure 7-1. *Procedure to Enable Send Functions*

7.02 [1] *QUIET*

The signal generator is disconnected from the TX line and the line is quiet terminated with a passive resistance equal to the TX line impedance selected per ¶6.03.

Miscellaneous PARAMETER DISPLAYS. Parameters are set and information is displayed here that is of a general nature or can not be conveniently implemented elsewhere. Note that these displays are not related to the *QUIET* mode.

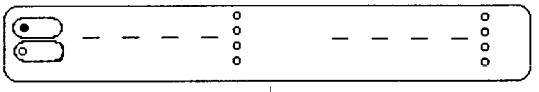
2 Set Level for send functions. Note that Level does not have meaning for *QUIET* mode.

3 Set frequency for Loop Back Tone, sent by pressing [C]. See ¶7.15.

4 Set level for DTMF (Touch Tone) or MF tones dialed. See ¶10.01 concerning dialing.

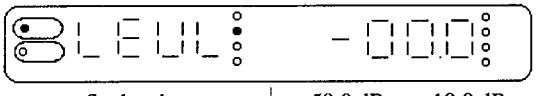
5 & 6 These displays indicate the present software installed.

DATA DISPLAY 1



QUIET display

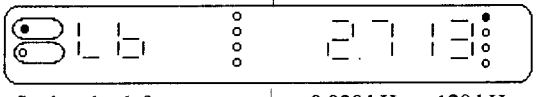
PARAMETER DISPLAYS 2



Set level (for other send functions)

-50.0 dBm to 10.0 dBm (Default = 00.0 dBm)

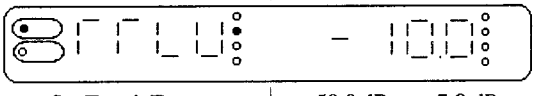
3



Set loopback frequency. (Momentary auxiliary tone)

0.020 kHz to 120 kHz (Factory setting = 2.713 kHz)

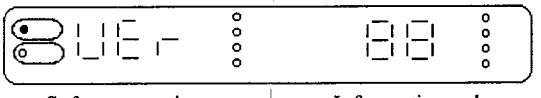
4



Set Touch Tone (and MF) Level

-50.0 dBm to 7.0 dBm (Factory setting = -10.0 dBm)

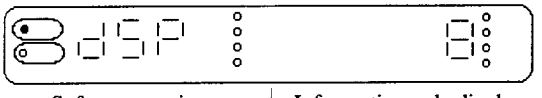
5



Software version of the main unit

Information only display

6



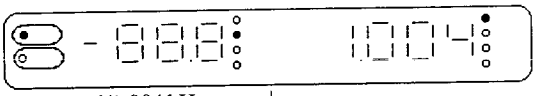
Software version of the Digital Signal Processor (DSP)

Information only display. 255 = DSP not installed (AM5XT BASIC)

7.03 [2] *1004 HZ*

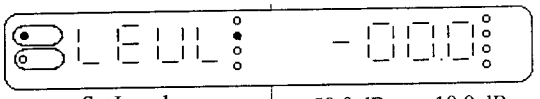
The signal generator outputs a continuous 1004 Hz sine wave to the TX pair. Level is adjustable with the PARAMETER DISPLAY.

DATA DISPLAY



Level/1.004 kHz being sent

PARAMETER DISPLAY

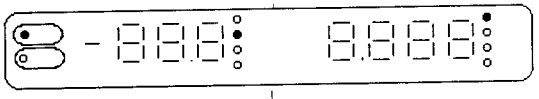


Set Level | -50.0 dBm to 10.0 dBm (Default = 00.0 dBm)

7.04 [3] *VAR HZ (Variable Tone)*

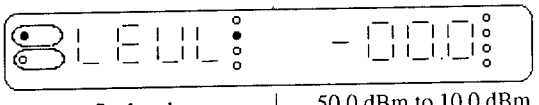
The signal generator outputs a sine wave tone to the TX pair. Level and Frequency are adjustable with the PARAMETER DISPLAYS.

DATA DISPLAY

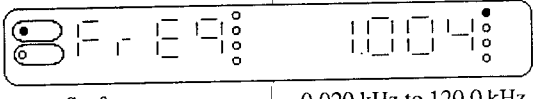


Level/Frequency being sent

PARAMETER DISPLAYS



Set level | -50.0 dBm to 10.0 dBm (Default = 00.0 dBm)



Set frequency | 0.020 kHz to 120.0 kHz (Default = 1.004 kHz)

7.05 [4] *SLOPE*

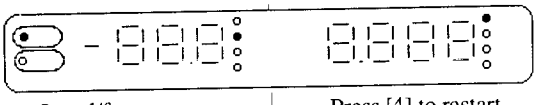
The signal generator outputs:

- AM5XT - 3 tones: 1004 Hz, 2804 Hz and 404 Hz;
- AM5eXT - 4 tones: 1004 Hz, 2004 Hz, 3004 Hz, and 304 Hz in a repetitive cycle.

This sequence of tones is used for multiple-point gain/slope measurements, i.e. a plot of transmission loss versus frequency; at 3 points with the AM5XT, and at 4 points with the AM5eXT.

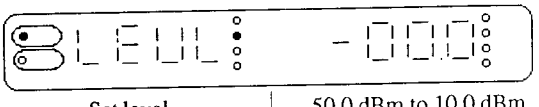
Level and Rate (duration of each tone) are adjustable with the PARAMETER DISPLAYS.

DATA DISPLAY

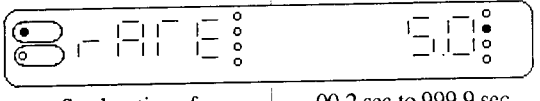


Level/frequency. Steps through tones as set by parameters. | Press [4] to restart sequence at 1.004 kHz.

PARAMETER DISPLAYS



Set level | -50.0 dBm to 10.0 dBm (Default = 00.0 dBm)



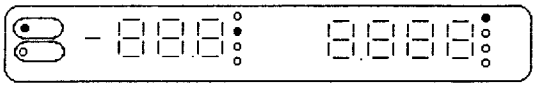
Set duration of each tone | 00.2 sec to 999.9 sec (Default = 5.0 sec)

7.06 [5] *SWEEP*

The signal generator sweeps through a series of frequencies. With factory default parameter settings, the sweep starts at 0.204 kHz and increases in 0.100 kHz steps every 1 second until 5.004 kHz is reached, at which time the sweep starts again at 0.204 kHz.

All parameters are adjustable with the PARAMETER DISPLAYS, including the Level and Delay Time (inserted before and after the sweep sequence).

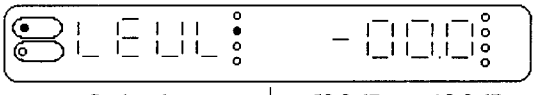
DATA DISPLAY



Level/frequency. Steps through tones as set by parameters.

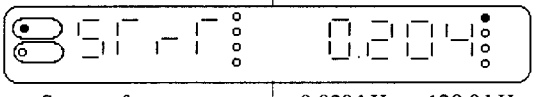
Press [5] to restart sweep sequence.

PARAMETER DISPLAYS



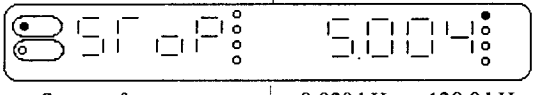
Set level

-50.0 dBm to 10.0 dBm
(Default = 00.0 dBm)



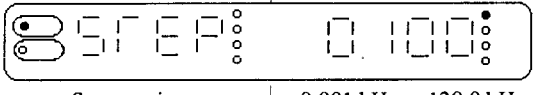
Set start frequency
(Start of sweep)

0.020 kHz to 120.0 kHz
(Default = 0.204 kHz)



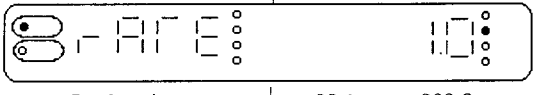
Set stop frequency
(End of sweep)

0.020 kHz to 120.0 kHz
(Default = 5.004 kHz)



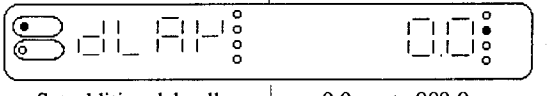
Set step size

0.001 kHz to 120.0 kHz
(Default = 0.100 kHz)



Set duration
of each tone.

00.1 sec to 999.9 sec
(Default = 1.0 sec)



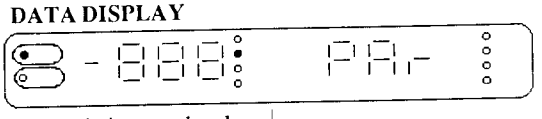
Set additional dwell
inserted before and after
sweep sequence.

0.0 sec to 999.9 sec
(Default = 0.0 sec)

7.07 [6] *PAR (Peak-to-Average Ratio)*

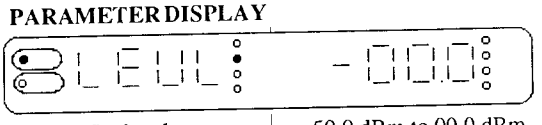
The signal generator outputs 16 specific frequencies simultaneously per Bell 41009 specification. This composite test tone is used for a P/AR (peak-to-average) measurement. The composite Level is adjustable with the PARAMETER DISPLAY.

DATA DISPLAY



P/AR being sent level

PARAMETER DISPLAY



Set level

-50.0 dBm to 00.0 dBm

(Default = 00.0 dBm)

7.08 [7] *RET LOSS (Return Loss)*

The signal generator outputs shaped, white-noise test tones, used in the *Return Loss* measurement mode (¶8.09). Three (3) measurements are made using these tones, each with its characteristic test tone band:

1 • Echo Return Loss (ERL), with white noise test tone band-limited (3 dB points at 560 Hz and 1965 Hz).

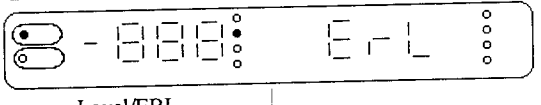
2 • Singing Return Loss LO (SRLL), white noise test tone band-limited to exclude high frequency components (3 dB points at 260 Hz and 500 Hz).

3 • Singing Return Loss HI (SRLH), white noise test tone band-limited to exclude low frequency components (3 dB points at 2200 Hz and 3400 Hz).

Enable the appropriate DATA DISPLAY to send the respective Return Loss test tone.

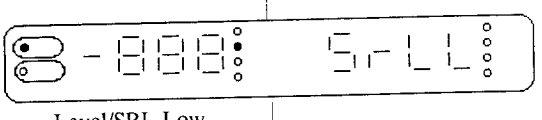
Level is adjustable with the PARAMETER DISPLAY.

DATA DISPLAYS 1



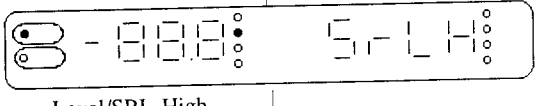
Level/ERL

2



Level/SRL-Low

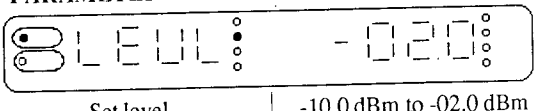
3



Level/SRL-High

4

PARAMETER DISPLAY



Set level

-10.0 dBm to -02.0 dBm

(Default = -02.0 dBm)

FOR AM5XT ONLY

7.09 [8] *ENV DLY (Envelope Delay)*

An Envelope Delay test measures the non-linearities in the phase response of a line. A transmission test set is required at each end of the circuit to be measured.

There are two (2) types of send signals generated with an Envelope Delay test:

1 • A *Sweep* series of carrier frequencies, usually from 200 Hz to 4000 Hz, modulated by 83-1/3 Hz.

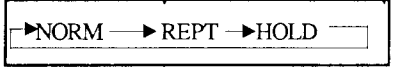
2 • A constant carrier *Reference* Frequency, usually 1800 Hz, also modulated by 83-1/3 Hz.

One or the other of these signals is generated from both the near-end and far-end test set.

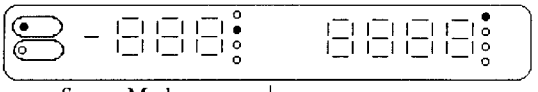
The displays listed are identified by number for ease of reference.

In the *Sweep* Mode (Display 1), the signal generator steps through a series of carrier frequencies. With factory default parameter settings, the sweep starts at 0.200 kHz and increases in 0.100 kHz steps every 3 seconds until 4.000 kHz is reached, at which time the sweep starts again at 0.200 kHz. All parameters are adjustable with the PARAMETER DISPLAYS, including the Level, Reference Frequency and Delay Time (inserted before and after the sweep sequence).

Optional method to select mode: Repeatedly press either [A,↑] or [B,↓] to scroll one-way through these mode-select displays in the order shown below:



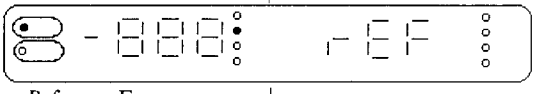
DATA DISPLAYS 1



Sweep Mode. Test signal level/frequency.

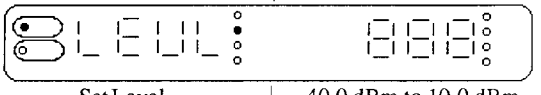
Press [8] twice to restart sweep sequence.

2



Reference Frequency. Level being sent.

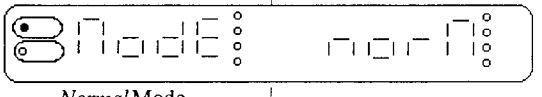
PARAMETER DISPLAYS 3



Set Level.

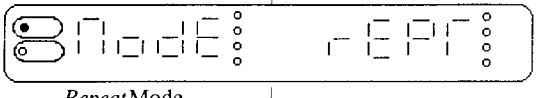
-40.0 dBm to 10.0 dBm. (Default = 0.0 dBm)

4A



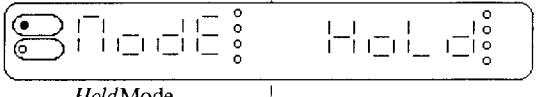
Normal Mode. Press [0] to enable.

4B



Repeat Mode. Press [1] to enable.

4C



Hold Mode. Press [2] to enable.

FOR AM5XT ONLY

7.09 [8] *ENV DLY (Envelope Delay), cont.*

Displays 4A, 4B, and 4C can also be accessed from the Measure Display PARAMETER DISPLAY LIST; see ¶8-10.

-NOTE-
Displays 4A, 4B, and 4C show the three possible selections for the mode parameter; these displays are enabled by pressing keys [0], [1], and [2], respectively, or by using the [▲] or [▼] key.

Normal and Repeat modes are used when Envelope Delay is used on a 4-wire line. The near-end unit is set to *Normal* mode and the far-end unit is set to *Repeat* mode. The near-end unit is used to send the Reference Frequency to the far-end unit, and receive a second (repeat) Reference Frequency from the far-end unit.

In the first test, 4-wire near-to-far, after the Reference Frequency has been zeroed, the near-end unit is put into Sweep mode and the far-end unit sends the Reference Frequency. Envelope Delay is then read on the near-end unit for the line being swept (near-to-far).

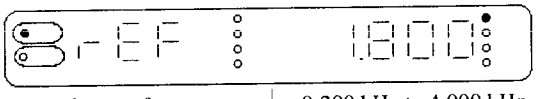
In the second test, 4-wire far-to-near, after the Reference Frequency has been zeroed, the near-end unit sends the Reference Frequency and the far-end unit is put into the Sweep mode. Envelope Delay is again read on the near-end unit for the line being swept (far-to-near).

For an explanation of Hold mode, see **2-Wire Envelope Delay** on page 8-16.

See ¶ 8.10 for Setup and Test Procedures including both Send and Measure functions.

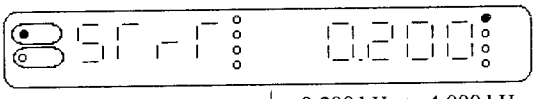
PARAMETER DISPLAYS, continued

5



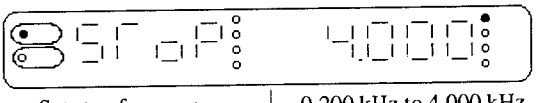
Set reference frequency. | 0.200 kHz to 4.000 kHz (Default = 1.800 kHz)

6



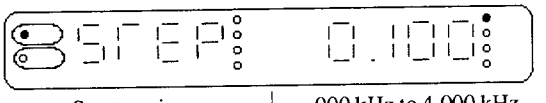
Set start frequency of test signals. | 0.200 kHz to 4.000 kHz (Default = 0.200kHz)

7



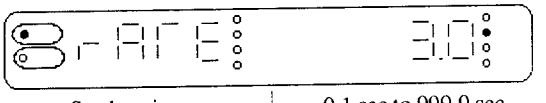
Set stop frequency of test signals | 0.200 kHz to 4.000 kHz (Default = 4.000 kHz)

8



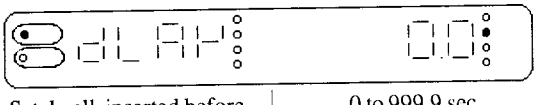
Set step size | .000 kHz to 4.000 kHz (Default = 0.100 kHz)

9



Set duration of each tone. | 0.1 sec to 999.9 sec (Default = 3.0 sec)

10



Set dwell inserted before & after sweep sequence. | 0 to 999.9 sec (Default = 0.0 sec)

FOR AM5eXT ONLY

7.10 [8] *GROUP DLY (Group Delay)*

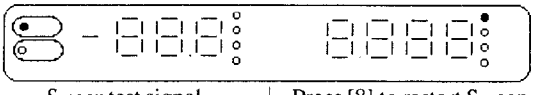
A Group Delay test measures the non-linearities in the phase response of a line. A transmission test set is required at each end of the circuit to be measured. Test signals are generated over a 2-wire circuit from the test set on one end, and the Group Delay is measured on the other end. See ¶8.11 for Measure functions and Test Procedure.

With a Group Delay test, there are two (2) types of send signals which are alternately generated for 120 ms:

- A constant carrier *Reference* Frequency, usually 1800 Hz, modulated by 41-2/3 Hz.
- A *Sweep* series of carrier frequencies, usually from 200 Hz to 20 kHz, also modulated by the 41-2/3 Hz.

The displays listed are identified by number for ease of reference. Display 1 indicates the level and frequency of the *Sweep* carrier frequency being sent at the time. With factory default parameter settings, the *Sweep* starts at 0.200 kHz and increases in 0.100 kHz steps every 3 seconds until 20.00 kHz is reached, at which time the *Sweep* starts again at 0.200 kHz. All parameters are adjustable with the PARAMETER DISPLAYS, including the Level, Reference Frequency and Delay Time (inserted before and after the sweep sequence).

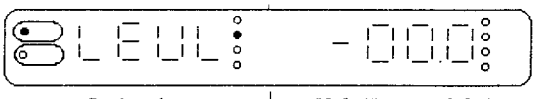
DATA DISPLAY 1



Sweep test signal. Level/Frequency.

Press [8] to restart Sweep sequence

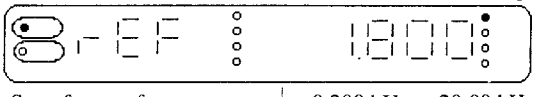
PARAMETER DISPLAYS 2



Set level.

-50.0 dBm to 10.0 dBm (Default = 00.0 dBm)

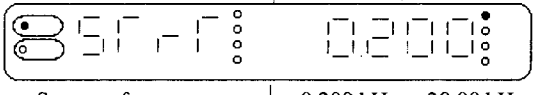
3



Set reference frequency.

0.200 kHz to 20.00 kHz (Default = 1.800 kHz)

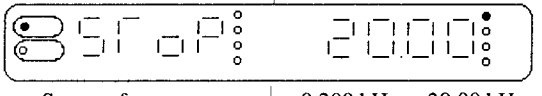
4



Set start frequency of test signals.

0.200 kHz to 20.00 kHz (Default = 0.200 kHz)

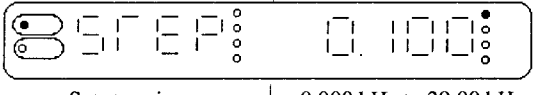
5



Set stop frequency of test signals.

0.200 kHz to 20.00 kHz (Default = 20.00 kHz)

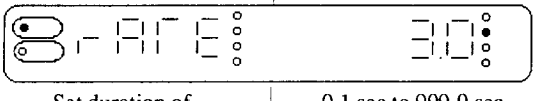
6



Set step size.

0.000 kHz to 20.00 kHz (Default = 0.100 kHz)

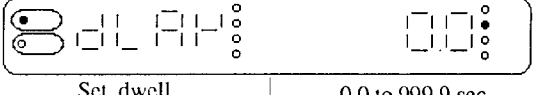
7



Set duration of each tone.

0.1 sec to 999.9 sec (Default = 3.0 sec)

8



Set dwell, inserted before & after sweep sequence.

0.0 to 999.9 sec (Default = 0.0 sec)

7.11 9 *IMD (Intermodulation Distortion*)*

Definition. Intermodulation Distortion is also known as "Non-Linear Distortion" or "4-Tone Test". Intermodulation Distortion is signal component generation that is produced from the transmitted signal and adds to the transmitted signal; these additional signal components are usually undesirable.

Send Signals. Three (3) types of signals are used with the Intermodulation Distortion test; see ¶ 8.12 for Test Procedure which explains how these signals are used.

The Intermodulation Distortion send displays are numbered for ease of reference. The send signals are described below:

1 • *4-Tone Signal.* This test signal is composed of four (4) tones, all at the same level, as described below:
- Two (2) tones are 6 Hz apart, centered at 860 Hz.
- Two (2) tones are 16 Hz apart, centered at 1380 Hz.

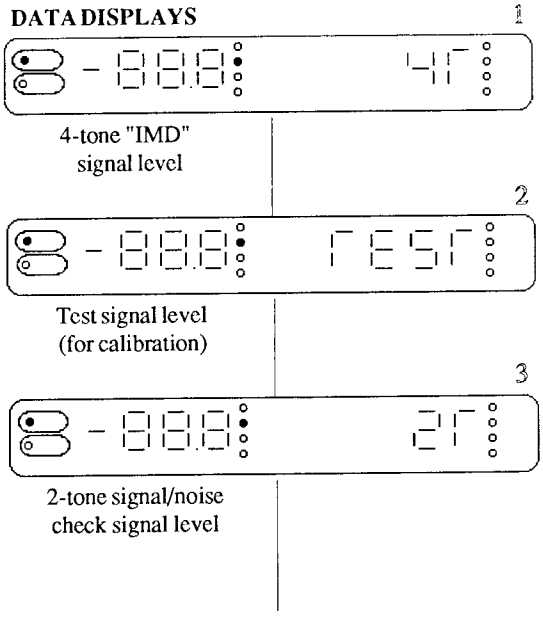
The 4-Tone Signal is sent when Display 1 is enabled.

2 • *Calibration Test Signal.* This is a special signal used to self-test the calibration of the AM5XT/eXT when the unit is looped back on itself (send, TX, connected directly to receive, RX). This signal is composed of the 4-tones listed above, plus additional tones which represent second and third order intermodulation products. The Calibration Test Signal is sent when Display 2 is enabled.

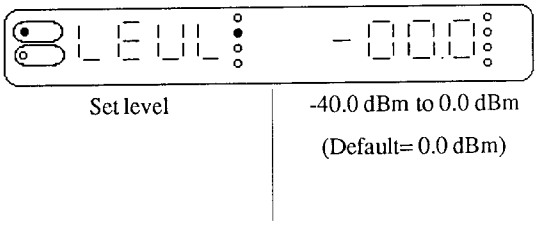
3 • *2-Tone Signal.* This signal is composed of two (2) of the tones listed under *4-Tone Signal* (those centered at 860 Hz). The 2-Tone Signal is sent when Display 3 is enabled.

*Licensed under U.S. Patent #3,862,380

DATA DISPLAYS



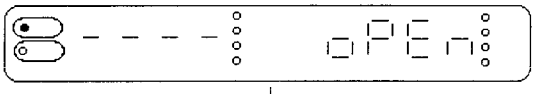
PARAMETER DISPLAY



7.12 [0] *OPEN*

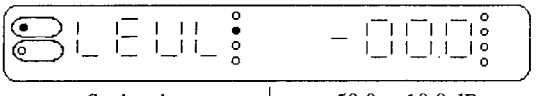
Similar to *QUIET* (¶7.02) mode, but completely disconnects the signal generator from the transmit line; for this mode, the transmit line is *not* terminated by the generator impedance.

DATA DISPLAY



"Open"

PARAMETER DISPLAY



Set level

-50.0 to 10.0 dBm

(Default= 0.0 dBm)

7.13 [A] *SF SKIP (Signaling Frequency Skip)*

SF SKIP is used to avoid sending tones in the "signaling frequency" band to avoid knocking down a long distance dialed circuit. *SF SKIP* is an ON/OFF toggle used in connection with the *VAR HZ, SWEEP* and *ENVELOPE* (or *GROUP) DELAY* modes.

With the *SF SKIP* LED on, the signal generator *cannot* be set to send frequencies in the band 2450 Hz through 2750 Hz (2130 Hz to 2430 Hz for AM5eXT). With the *SF SKIP* LED off, the signal generator is fully variable.

7.14 [B] *TALK*

Instead of the internal signal generator, the *TALK* mode connects a front-panel microphone to the transmit line. This allows the operator to talk to a testing partner at the distant end of the line under test. The *TALK* function will work on wet or dry (no DC voltage) 2- or 4-wire lines. Two (2) modes are available: Full Duplex and Push-to-Talk. Full Duplex in 2-wire mode employs a hybrid to provide hands-free "speaker phone" operation.

Full-Duplex TALK Mode, LED flashes.

1. Press [B] *momentarily* to disconnect the signal generator and connect the built-in microphone to the TX line. The microphone is located behind the three holes labeled TALK in the upper left corner of the front panel.

2. Set the MONITOR switch to RX to enable the speaker.

3. Full Duplex (speaker phone) operation is now enabled. For 2-wire, a hybrid is used to allow Full Duplex operation.

To exit Full Duplex Mode, *momentarily* press [B]; LED will go out.

In some cases audible regenerative feedback may result, especially in the 2-wire mode where the line under test is not impedance matched to the hybrid, and at high volume settings. This may be overcome by using the "push-to-talk" mode, described next.

7.14 [B] *TALK*, continued

Half-Duplex TALK Mode ("Push-to-Talk"), LED continually ON.

Press and *hold* [B] to enable the Push-to-Talk mode. [B] is also used to select the direction of the conversation:

- To speak, hold down [B] to operate the microphone and mute the speaker. The microphone (item 13 in Fig. 3-1) is located behind the three holes labeled TALK in the upper left corner of the front panel.

- To listen, release [B] to disconnect the microphone and enable the speaker (*TALK* LED remains steady on).

To exit Push-to-Talk mode, *momentarily* press [B]; LED will go out.

7.15 [C] *LOOP BACK*

LOOP BACK is a Programmable Momentary Auxiliary Tone intended to trip and restore a 4-wire loopback device such as a Western Electric Model 829.

The frequency and level of this tone is set with a *QUIET* Send mode PARAMETER DISPLAY (Display 3), see ¶7.02. To activate a Model 829, program the frequency for 2713 Hz, the default setting.

Momentarily press [C] to disconnect the present Send mode and send the Auxiliary Tone over the TX pair. The Auxiliary Tone will be applied as long as the [C] key is held down.

Release [C] to automatically restore the previous Send (signal generator) mode.

8. MEASURE FUNCTIONS

8.01 INTRODUCTION

The AM5XT/eXT contains highly versatile detectors and filters which are connected to the receive line (RX) under test. The term MEASURE refers to the detection mode being used in order to detect and display the characteristics of the received signal(s). See Figure 8-1 for instructions to select desired Measure Mode. Note that Measure functions are color-coded BLUE.

In this section, the paragraph heading for each Measure Function shows its Function Enable Key enclosed in a square ☐ . For example, [6] *PAR* indicates that key [6] is pressed to select PAR Measure mode. DATA and PARAMETER DISPLAY information is given in the right column. Section 5 explains how the DATA and PARAMETER DISPLAYS are accessed and used.

Paragraphs in this section are listed next:

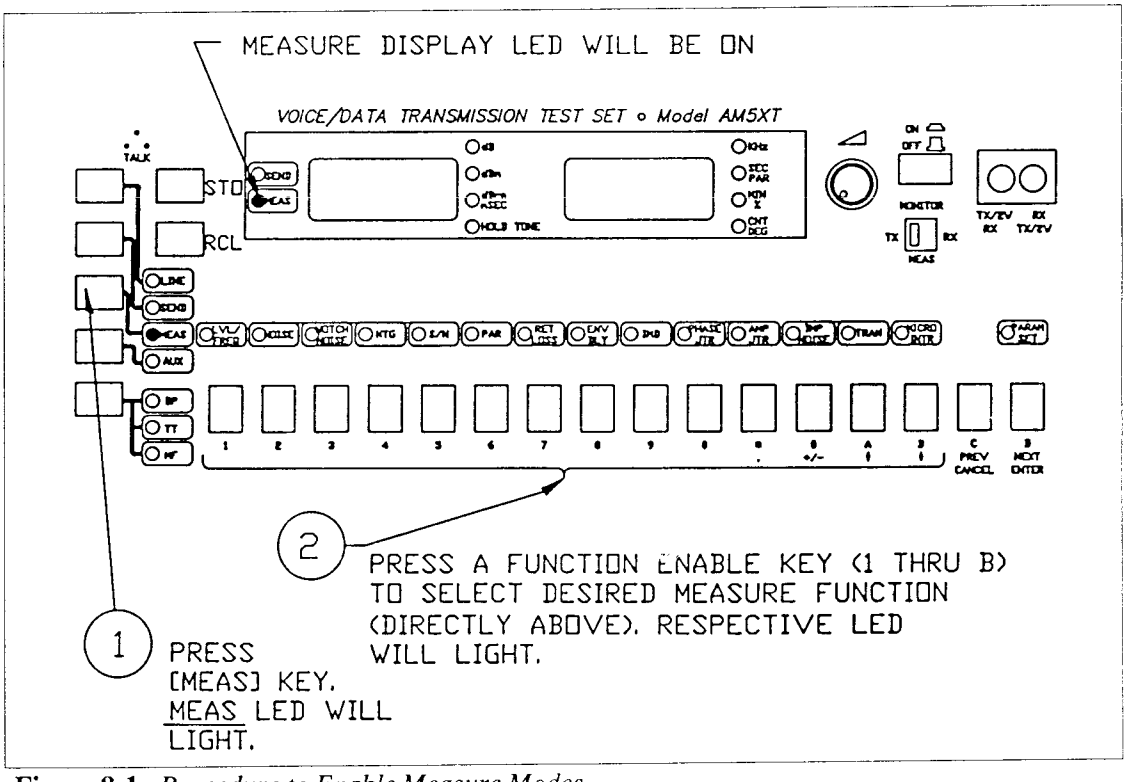
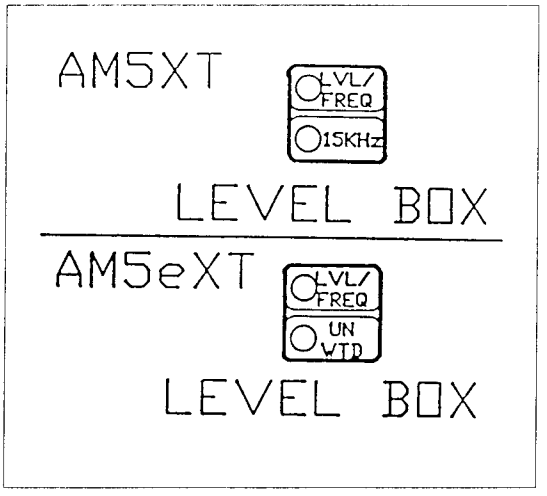


Figure 8-1. *Procedure to Enable Measure Modes*

8.02 [1] *LVL/FREQ (Level/Frequency)*

-NOTE-
There is a dark box around the *LVL/FREQ* and 15 kHz LEDs for AM5XT (*LVL/FREQ* and *UN WTD* LEDs for AM5eXT). This "Level Box" indicates that the 15 kHz (or *UN WTD*) filter is always associated with the Level/-Frequency Measurement. See ¶ 9.02 and 9.03 for descriptions of 15 kHz (AM5XT) and Sound-Unweighted (AM5eXT) low-pass filters, enabled in the Auxiliary Function row, *AUX*.



• **Wide-Band Level/Frequency** (*AUX* filter *not* used). An autoranging amplifier, average detector and frequency counter are connected to the RX pair. A 120 kHz low-pass filter is used, allowing full bandwidth operation. The detected average voltage is converted to dBm by the microprocessor, based upon the impedance selected for the RX line (¶6.02 thru 6.05). To enable this mode:

1. Set *LVL/FREQ* LED "ON"
2. Set *15 kHz* LED "OFF" (AM5XT) or *UN WTD* LED "OFF" (AM5eXT)

• **Narrow-Band Level/ Frequency** (AUX filter used). This is the same as above, except the AUX Function filter in the "Level Box" is enabled (LED "ON"); the filter is a low-pass filter, connected to the front end, effectively eliminating high-frequency components. This mode is useful in making measurements on voice-band circuits where high-frequency components are of no interest. To enable this mode:

1. With MEAS LED on, set *LVL/FREQ* LED "ON".
2. With AUX LED on, For AM5XT, set *15 kHz* LED "ON" (connecting *15 kHz* low-pass filter), or
   For AM5eXT, set *UN WTD* LED "ON" (connecting Sound-Unweighted low-pass filter).

• **Setup.** For end-to-end testing, the transmitted (Send) test tone is applied to the distant-end transmit (TX) circuit. For 4-wire loopback testing, the transmitted (Send) test tone is applied to the near-end transmit (TX) circuit.

8.02 [1] *LVL/FREQ (Level /Frequency), continued*

Enable the appropriate Send Function (Section 7):

- *1004 HZ* for single point loss tests
- *SLOPE* for 3-point (4-point for AM5eXT) gain/slope tests
- *VAR HZ* or *SWEEP* for multi-point frequency response curve tests.

Operation. The AM5XT/eXT measures the resultant signal on the near-end receive pair (RX). Read the voltage and frequency in the DATA DISPLAY.

If the received signal has excessive power-line hum or excessive high-frequency components (in excess of 15 kHz), an erratic display may result.

Connect the appropriate filter(s) to eliminate undesired frequencies and stabilize the display:

1. To eliminate *power-line hum*:
   - Enable the Auxiliary Functions (*AUX* LED "ON").
   - Press [B] to connect the 60 Hz high-pass filter (*60 Hz* LED will light).With the 60 Hz filter connected, frequency components below 60 Hz will be effectively eliminated from the reading. Press [B] again to disconnect the filter from the measurement (*60 Hz* LED will go out).

2. To eliminate *high frequencies*, make a

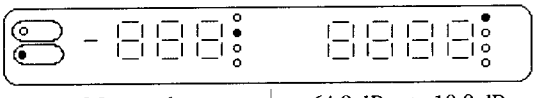
   Narrow-Band Level/Frequency measurement (described above), using the AUX filter.

Rapidly fluctuating readings may be captured as follows:

1. Enable the Auxiliary Functions (*AUX* LED "ON").

2. Press [D] (*DAMP* LED will light) With *DAMP* ON, the display will update at the rate of 2-times per second, half the normal 4-times per second update rate.

DATA DISPLAY 1



Measured Level/Frequency	-64.9 dBm to 10.0 dBm 0.020 kHz to 120.0 kHz

8.02 [1] *LVL/FREQ (Level/Frequency), continued*

Plotting. For plotting a graph of the results through the RS232 port, use PARAMETER DISPLAYS to set:

2. low level limit of the plot
3. high level limit of the plot
4. rate at which lines are printed
5. performance limits for line on printer/plotter

See ¶13.01 for details concerning plotting.

Automatic Tracking Printing Mode. To deliver a printout each time there is a shift in frequency, set RATE parameter to "0". With RATE = 0, there must be a discrete, stable shift in the frequency in order for there to be a printout. If the frequency changes at least 8 Hz (approximately) and stabilizes for about 0.5 sec, there will be a printout. This setting is useful when the Send Function is *SLOPE* (3 or 4 frequency steps) or *SWEEP* (multiple frequency steps).

-NOTE-
Do not set RATE to 0 when the Send source is a continuous (not step) sweep generator. With a continous sweep, no frequency lasts for 0.5 sec, so there would never be a printout with the RATE set to "0".

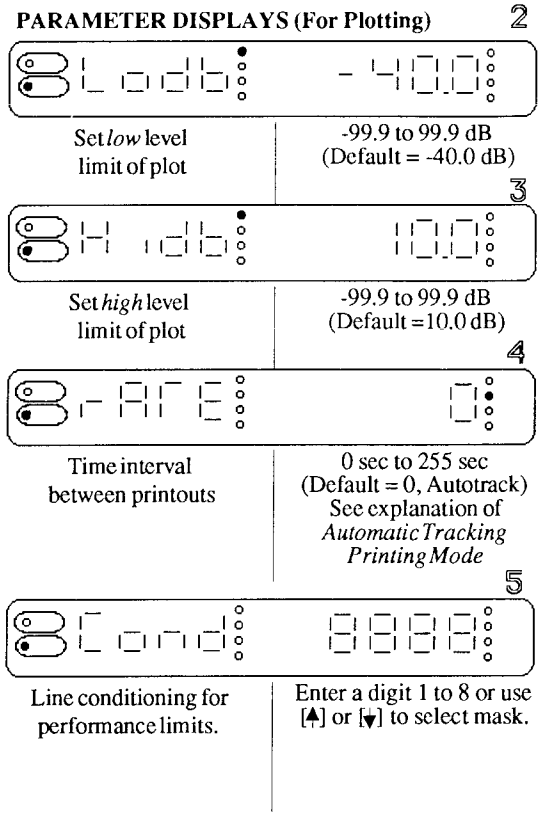
8.03 GENERAL NOISE MEASUREMENT NOTES

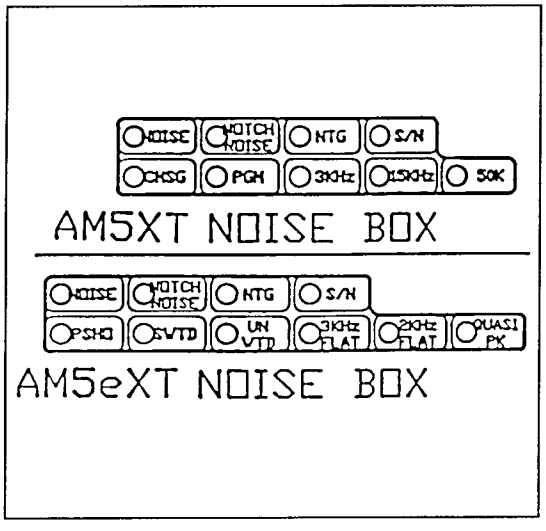
The information discussed here applies to all four (4) types of noise measurements:

- (Idle Channel) NOISE
- NOTCH NOISE
- NOISE-TO-GROUND (NTG)
- SIGNAL-TO-NOISE (S/N) RATIO

-NOTE-
There is a dark box around the function LEDs that are associated with noise measurements, enclosing the noise functions in the *MEAS* row and the noise filters in the *AUX* row. This box is referred to as the "Noise Box".

PARAMETER DISPLAYS (For Plotting)





8.03 GENERAL NOISE MEASUREMENTS NOTES, continued

Noise Measurement with Filter. To set up a noise measurement using a filter:

1. In the Measure Functions row (with *MEAS* LED ON), press the appropriate key to enable the desired noise test (NOISE, NOTCH NOISE, NTG, or S/N); corresponding LED will light.
2. Press [AUX] key, *AUX* LED will light.
3. Press appropriate key, [2] thru [6], to enable desired noise filter. The respective LED will light, indicating that the filter is enabled. Possible filters are listed in Table 8-1.

Table 8-1
NoiseWeighting Filters

KEY	AM5XT	AM5eXT
[2]	C-Message (CMSG)	Psophometric (PSHO)
[3]	Program (PGM)	Sound-Weighted (SWTD)
[4]	3 kHz flat	Sound-Unweighted (UN WTD)
[5]	15 kHz flat	3 kHz flat
[6]	50 kBit	2 kHz flat

No-Filter Noise Measurement. To set up a NO-FILTER noise measurement:

1. In the Measure Functions row (with MEAS LED ON), press the appropriate key to enable the desired noise test (NOISE, NOTCH NOISE, NTG, or S/N); corresponding LED will light.
2. In the Auxiliary (AUX) Functions row, check if a filter is enabled (LED lit). Possible filters are listed in Table 8-1.
3. If a filter is enabled (LED lit), press the same key that was used to enable the filter (with AUX LED ON); its LED will extinguish, indicating that the filter is disabled. Note, therefore, that if the same filter key is pressed repeatedly, it will toggle (alternate) between enabled and disabled as evidenced by the LED turning ON and OFF.

Quasi-Peak Detector, AM5eXT Only. With the AM5eXT, there is a choice of devices to measure the voltage on the receive pair; select either the RMS Detector or the Quasi-Peak Detector.

With the AM5eXT, follow the steps below to make a noise measurement using the Quasi-Peak detector:

1. In the Measure Functions row (with MEAS LED ON), press the appropriate key to enable the desired noise test (NOISE, NOTCH NOISE, NTG, or S/N); corresponding LED will light.
2. Press [AUX] key. *AUX* LED will light.
3. Press [7]. *QUASI PK* LED will light, indicating that the Quasi-Peak Detector is enabled.

For the AM5eXT, the Quasi-Peak Detector is enabled when the *QUASI PK* LED is ON. The RMS Detector is enabled when the *QUASI PK* LED is OFF.

For the AM5XT, all noise measurements are made with the RMS Detector only (there is no *QUASI PK* LED).

Test Setup. Enable the appropriate Send signal (QUIET or 1004 Hz). For end-to-end testing, the Send signal is connected to the distant-end transmit (TX) circuit. For 4-wire loopback testing, the Send signal is applied to the near-end transmit (TX) circuit. When using a responder, command the responder into the appropriate send mode.

Units of Measurement for Noise. For noise measurements, the voltage on the received pair is measured using an RMS Detector (RMS *or* Quasi-Peak Detector with the AM5eXT). This voltage is converted to dBm by the microprocessor, based upon the selected terminate impedance (¶6.02). In the AM5XT, the microprocessor further converts the reading to dBrn in accordance with the formula: dBrn = dBm + 90; for example, -50 dBm = -50 + 90 = 40 dBrn. With the AM5XT, therefore, noise measurements are in units of dBrn; with the AM5eXT, noise measurements are in units of dBm.

8.04 [2] *NOISE (Idle Channel Noise)*

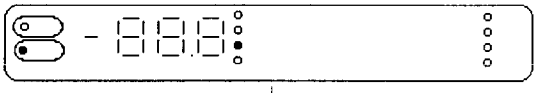
The Idle Channel NOISE test measures the noise, through a selected filter, on a theoretically "quiet" line, i.e., a QUIET terminated circuit without a test signal. See notes in ¶8.03 concerning noise measurements.

Send Function. Set the Send Function to *QUIET* (¶7.02).

Filter Selection. For AM5XT, the usual noise-weighting filter used for Idle Channel *NOISE* measurements is the C-Message filter (key [2]). For AM5eXT, the usual filter used for Notch Noise measurements is the Psophometric filter (key [2]).

In general, any of the filters listed in Table 8-1 can be used.

DATA DISPLAY



Measured noise level
10 to 99 dBrn
-80 to 9 dBm

For AM5XT, units are dBrn; for AM5eXT, units are dBm.

-NOTE-
The right-hand display does not operate during idle channel NOISE measurements.

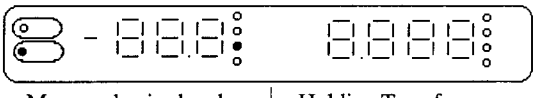
8.05 [3] *NOTCH NOISE (Noise-with-Tone)*

The Notch Noise Test measures the noise, through a selected filter, on a line which has a 1004 Hz tone. The 1004 Hz tone is removed in the measuring circuit through a 1010 Hz "notch" filter, then the residual noise is measured. This test is sometimes referred to as a "noise-with-tone" measurement.

Send Function. Set the Send Function to 1004 Hz (¶7.03)

-NOTE-
In order for the Notch Noise measurement to be valid, the "HOLD TONE" indicator green LED must be ON, indicating that the 1004 Hz tone is present at the proper frequency and level. Acceptable frequency is from 995 Hz to 1025 Hz at a level of greater than -40 dBm. The right hand display will also indicate the frequency of the received tone for further verification.

DATA DISPLAY



Measured noise level,
10 to 99 dBrn
-80 to 9 dBm

Holding Tone frequency

For AM5XT, units are dBrn; for AM5eXT, units are dBm.

8.05 [3] *NOTCH NOISE (Noise-with-Tone), continued*

Filter Selection. For AM5XT, the usual noise-weighting filter used for Notch Noise measurements is the C-Message filter (key [2]). See Fig. 9-2 for a graph of the C-Message filter. For AM5eXT, the usual filter used for Notch Noise measurements is the Psophometric filter (key [2]).

In general, any of the filters listed in Table 8-1 can be used.

8.06 [4] *NTG (Noise -to-Ground)*

Noise-to-Ground is measured by internally summing the signals on the Tip and Ring wires of the receive (RX) line within the AM5XT/eXT, then measuring the noise, through a selected filter, with reference to ground. For the ground reference, use either the ground screw terminal on the rear panel (item 8 in Fig. 3-3) or the sleeve contact of the RX front-panel Bantam Jack,

Send Function. Set the Send Function to QUIET (¶7.02)

Filter Selection. For AM5XT, the usual noise-weighting filter used for Noise-to-Ground measurements is the C-Message filter (key [2]).

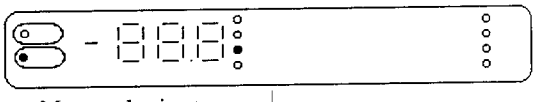
For AM5eXT, the usual filter used for Noise-to-Ground measurements is the Psophometric filter (key [2]).

In general, any of the filters listed in Table 8-1 can be used.

8.07 [5] *S/N (Signal-to-Noise Ratio)*

Signal-to-Noise Ratio Measurement is similar to the notch noise measurement in that a 1004 Hz test tone is expected at the received end. The receive circuit contains an average detector, a 1004 Hz notch filter, a noise-weighting filter, and an RMS detector (RMS *or* Quasi-Peak Detector for AM5eXT).

DATA DISPLAY

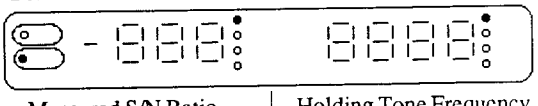


Measured noise-to-ground
40 to 129 dBrn
(-50 to 39 dBm)

For AM5XT, units are dBrn; for AM5eXT, units are dBm.

-NOTE-
The right-hand display does not operate during NTG measurements.

DATA DISPLAY



Measured S/N Ratio,
0 to 60 dB

Holding Tone Frequency

8.07 [5] *S/N (Signal-to-Noise Ratio), cont.*

The measurement is made as follows:

1. The average detector measures the amplitude of the received test tone (primarily 1004 Hz) and the microprocessor keeps this value in memory. This is the "signal" reading.
2. The RMS or Quasi-Peak detector measures the value of the residual noise after the 1004 Hz tone is notched out; this value is also kept in memory by the microprocessor. This is the "noise" reading.
3. The microprocessor computes the difference, in dB, between the value in "1" and the value in "2". This is the Signal-to-Noise Ratio.

Send Function. Set the Send Function to *1004* Hz (¶7.03).

-NOTE-
In order for the Signal-to-Noise measurement to be valid, the "HOLD TONE" indicator green LED must be ON, indicating that the 1004 HZ tone is present at the proper frequency and level. Acceptable frequency is from 995 Hz to 1025 Hz at a level of greater than -40 dBm. The right hand display will also indicate the frequency of the received tone for further verification.

Filter Selection. For AM5XT, the usual noise-weighting filter used for Signal-to-Noise measurements is the C-message filter (key [2]). For AM5eXT, the usual filter used for Signal-to-Noise measurements is the Psophometric filter (key [2]).

In general, any of the filters listed in Table 8-1 can be used.

8.08 [6] *PAR (Peak-to-Average Ratio)*

Definition of P/AR. P/AR (Peak-to-Average Ratio) measurements are made by applying a special 16 tone (PAR) signal at the distant end of the line under test. At the near end, the AM5XT simultaneously measures the peak value and average value of the received test signal. *The Ratio of the Peak value to the Average value of the transmitted signal is arbitrarily assigned a value of 100.*

If the transmission channel were non-dispersive, then the received Peak-to-Average Ratio would also have a value of 100. A typical telephone channel causes smearing or Intersymbol Interference, however, and a value other than 100 is observed.

Table 8-2 shows some typical values which might be used to judge the acceptability of a telephone line to reliably transmit data.

EXAMPLE: If a modem requires a C2 conditioned line and a P/AR of 50 is measured, this line is likely to encounter transmission problems. On the other hand, if a P/AR of 78 is measured, Intersymbol Interference will not present problems.

8.08 [6] ***PAR (Peak-to-Average Ratio), cont.***

Table 8-2
P/AR Requirements of Telephone Lines

CIRCUIT CONDITIONING	TYPICAL P/AR VALUES
Basic Channel	45
C1	48
C2	78
C4	87
C5	95

The P/AR value of the received (distorted) signal is made according to the following formula:

$$P/AR = 100^* (K\ P/Afw - 1)$$

Where P = peak voltage of received signal
Afw = full-wave average of the received signal
K = a constant

The constant K is derived by giving undistorted signal a nominal value of 100. Therefore:

$$K = 2Afwo/Po$$

Where Po = Peak voltage of the undistorted (original) signal
Afwo = full-wave average of the undistorted (original) signal

Therefore:

$$P/AR = 100 * [2(P/Po) / (Afw/Afwo)-1]$$

or

$$P/AR = 100 * [2(Pn/Afwn)-1]$$

Where Pn = normalized peak voltage of the received signal
Afwn = normalized full-wave average of the received signal

Factors Which Affect P/AR. P/AR is most sensitive to envelope delay distortion and return loss problems. To a lesser degree it is affected by attenuation distortion, noise, and nonlinear (intermodulation) distortion. It is basically unaffected by transient phenomena such as impulse noise and phase and gain hits.

Envelope Delay Distortion. There is high correlation between measured P/AR values and values calculated from a plot of envelope delay distortion. In fact, for an envelope delay response containing significant ripples, P/AR is a better indication of the ability of the network to pass data reliably. Return loss problems are a common source of envelope delay ripple.

Effect of Noise. Noise can have a significant effect on a P/AR measurement. For this reason, it is important to measure signal-to-noise ratio (or noise-with-tone) before making a P/AR measurement. If the signal-to-noise ratio is less than 25 dB, then the P/AR reading will be significantly reduced by noise alone.

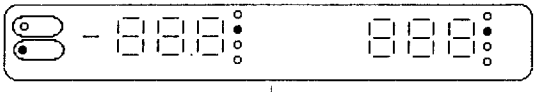
Effect of Nonlinear Distortion. Nonlinear (Intermodulation) Distortion can similarly affect the P/AR reading. The effect depends on whether the second or third order products dominate as the source of distortion. If the third order products dominate, they increase or decrease the P/AR value, depending upon the sign of the added products.

Send Function. Set the Send Function to PAR (¶7.07), a composite wave form per Bell 41009 specifications, made up of 16 specific phase-related frequencies.

8.08 [6] *PAR (Peak-to-Average Ratio), cont.*

Note in the DATA DISPLAY that the left reading is the RMS level of the received P/AR waveform in dBm, and the right reading is the Peak-to-Average Ratio in P/AR units (100 P/AR = value for transmitted signal).

DATA DISPLAY



Measured Level, | P/AR reading 0 to 120 P/AR

8.09 [7] *RET LOSS (Return Loss)*

Definition. Return Loss is the ratio, in dB, of the power incident on a transmission system discontinuity to the power reflected from the discontinuity. It indicates how well the input and output impedances are matched throughout a circuit. Return Loss measurements are made on both 2-wire and 4-wire circuits.

Setup. A test signal is transmitted from the near end while the far end is Quiet terminated. At the near end, the level of the transmitted test tone (TX) is compared with the measured level on the receive line (RX). The difference between the transmit and receive signal is the Return Loss in dB.

Test Signals. Four (4) possible test signals can be transmitted:

- Echo Return Loss (ERL) signal
- Singing Return Loss (SRL) LO signal
- Singing Return Loss (SRL) HI signal
- Sine Wave (VAR HZ) in 200 Hz to 5kHz band, per ¶7.04.

ERL, SRL LO and SRL HI are band-limited white-noise test signals (see ¶7.08).

Since the Return Loss measurement is the ratio between transmitted energy and received energy, the absolute amplitude of transmit energy is somewhat immaterial. The AM5XT/eXT, however, has the ability to generate the ERL, SRL LO and SRL HI waveforms anywhere between -10 dBm and -2 dBm; see ¶7.08.

2-Wire Return Loss. In 2-wire Return Loss measurements, the test signal is applied to the transmit pair (TX) of the internal 4-wire-to-2-wire hybrid, and at the same time the RMS detector measures the energy on the receive pair (RX) of the hybrid. The hybrid balancing impedance is the selected line impedance (¶6.02) in series with the 2.16 uF. If the 2-wire circuit under test is properly terminated and free of send/receive coupling, then very little of the transmitted energy will be returned on the received pair and the Return Loss reading in dB (which is a measure of the transmitted energy versus received energy) will be a large reading.

The AM5XT/eXT may be used as a passive 2-Wire termination (900 Ω in series with 2.16 µf) by selecting 2-Wire Line Mode, Ret Loss Meas Mode and Quiet Send Mode. The 900 Ω, 2.16µf termination is provided only when the unit is in the 2-Wire Line Mode and Return Loss Measure Mode.

4-Wire Return Loss. In 4-wire Return Loss measurements, the internal hybrid is not used; the test waveform and RMS detector are connected directly to the 4-wire transmit (TX) and receive (RX) pairs, respectively. Because most 4-wire circuits have loss or gain circuits in their transmit or receive leg, a correction factor must be used to compensate for this gain or loss in order to provide a meaningful Return Loss measurement. The correction factor is an offset adjustment called TLP (Transmission Level Point). The AM5XT/eXT subtracts the TLP setting from the original reading and then displays the corrected Return Loss measurement.

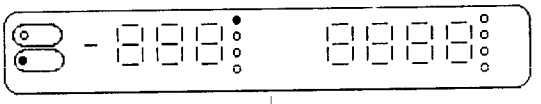
Because of the need to determine and set the value of the TLP, 4-wire Return Loss measurements require a special procedure, as listed below:

1. Send the desired test signal (ERL,SRL LO, SRL HI or sine wave) per ¶7.08 or ¶7.04.
2. Press [D] to enable the *PARAM SET* LED and bring up the TLP parameter prompt.
3. Set the value of TLP to "00.0".
4. Loop back the far end (be sure termination is correct).
5. Press [7] to bring up the Return Loss Data Display.

6. Read and note the loop-around Return Loss on the Data Display. This is the amount of loss (+dB reading) or gain (-dB reading) of the circuit.
7. Repeat Step 2.
8. Set the value of TLP equal to the Return Loss reading in Step 6. Be sure both the sign and the value are the same. Example: If loop-around Return Loss in the 4-wire circuit is -15.0 dB, then set TLP for -15.0 dB.
9. Unloop the 4-wire circuit and Quiet Terminate the far end per ¶7.02.
10. Repeat Step 5.
11. Read the actual Return Loss on the DATA DISPLAY. Note that the AM5XT/eXT automatically uses the TLP setting to adjust the measurement and displays the correct reading.

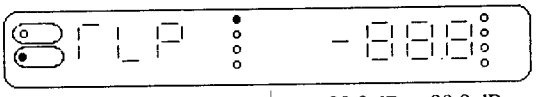
Send Function. Set the Send Function to ERL, SRL LO, SRL HI (¶ 7.08), or VAR HZ (¶ 7.04).

DATA DISPLAY



Measured Return Loss

PARAMETER DISPLAY



Set "TLP"	-99.9 dB to 99.9 dB (Default = 0 dBm)

-NOTE-
The TLP setting can be kept for future use if it is stored as part of a test setup store (see ¶ 5.01).

FOR AM5XT ONLY

8.10 [8] *ENV DLY (EnvelopeDelay)*

An Envelope Delay test measures the non-linearities in the phase response of a line. See ¶7.09 for Send function parameter settings. This test requires a transmission test set at each end of the circuit to be measured. A special procedure must be followed which is outlined below.

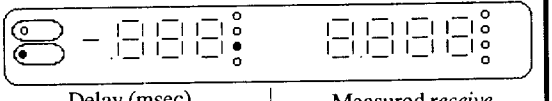
The displays are numbered for ease of reference.

These displays only work in Normal or Hold Mode. "REPT" is displayed in Repeat Mode.

Displays 1, 2 and 3 are selected by repeatedly depressing the *ENV DLY* button while in the *MEAS* mode.

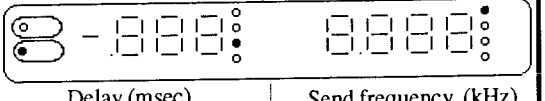
DATA DISPLAYS

1



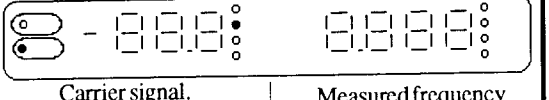
Delay (msec) -3.00 ms to 9.00 ms	Measured *receive* frequency

2



Delay (msec) -3.00 ms to 9.00 ms	Send frequency (kHz) (kHz LED *flashes*)

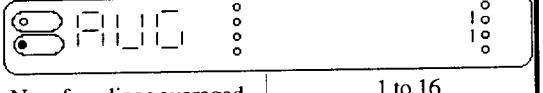
3



Carrier signal. Level (dBm)	Measured frequency (kHz)

4

PARAMETER DISPLAYS



No. of readings averaged for displays 1 and 2. Enter value per display stability. Increase value if display is unstable. Sweep rate of carrier must be reduced as number of average is increased.	1 to 16 (Default = 1)

FOR AM5XT ONLY

8.10 [8] *ENV DLY (Envelope Delay) , cont..*

Optional method to select mode: repeatedly press either [A, ↑] or [B, ↓] to scroll one-way through these mode-select displays in the order shown below:

▶NORM▶REPT▶HOLD

PARAMETER DISPLAYS 5A, 5B, & 5C are identical to the mode select displays 4A, 4B, & 4C included in the Envelope Delay send parameters (¶7.09). They are repeated here for ease of reference.

Plotting. There are additional PARAMETER DISPLAYS used for plotting graphs of the measurements through the RS232 port or XY plotter outputs. These parameters are respectively used to set:

6 Low delay limit of the plot of display 1 or display 2

7 High delay limit of the plot of display 1 or display 2

8 Low level limit of the plot of display 3

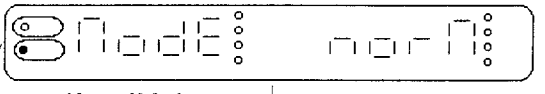
9 High level limit of the plot of display 3

10 Rate at which lines are printed

11 Performance limits for line on printer/plotter.

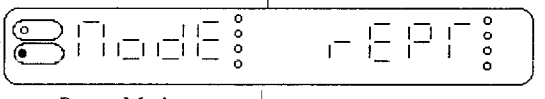
*See explanation on page 8-13 for "Automatic Tracking Printing Mode".

PARAMETER DISPLAYS, continued 5A



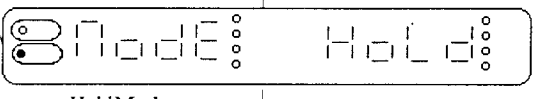
Normal Mode
Press[0] to enable.

5B



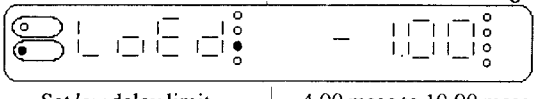
Repeat Mode
Press [1] to enable.

5C



Hold Mode
Press [2] to enable.

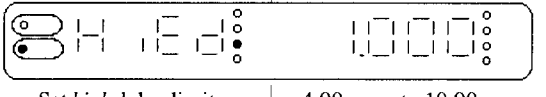
PARAMETER DISPLAYS, For Plotting 6



Set *low* delay limit of Env. Delay plots

-4.00 msec to 10.00 msec (Default = -1.00 msec)

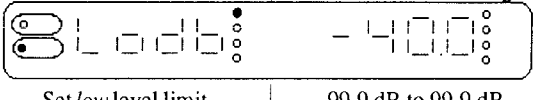
7



Set *high* delay limit of Env. Delay plots

-4.00 msec to 10.00 msec (Default = 1.000 msec)

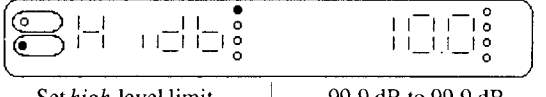
8



Set *low* level limit of level/freq. plot

-99.9 dB to 99.9 dB (Default = -40.0 dB)

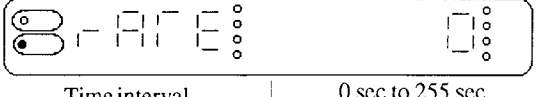
9



Set *high* level limit of level/freq. plot

-99.9 dB to 99.9 dB (Default = 10.0 dB)

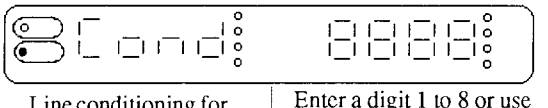
10



Time interval between printouts

0 sec to 255 sec (Default = 0, AutoTrack*)

11



Line conditioning for performance limits.

Enter a digit 1 to 8 or use [▲] or [▼] to select mask.

FOR AM5XT ONLY

8.10 [8] ***ENV DLY (Envelope Delay), continued.***

Automatic Tracking Printing Mode. To deliver a printout each time there is a shift in frequency, set RATE parameter to "0". With RATE = 0, there must be a discrete, stable shift in the frequency to cause a printout. If the frequency changes at least 8 Hz (approximately) and stabilizes for about 0.5 sec, there will be a printout.

4-Wire Setup. Two (2) types of 4-wire Envelope Delay tests can be made:

- Near-to-Far Envelope Delay
- Far-to-Near Envelope Delay

Fig. 8-2 shows the setup to measure both types of 4-wire Envelope Delay.

Control of Far-End AM5XT. There are three (3) ways to control the far-end AM5XT:

- Manually, with a person at the far end controlling the AM5XT. An additional telephone line is used for communication between the people at the near and far-end test sets, or they may use TALK Mode (¶7.14) to communicate through the AM5XT units.

- Use Touch Tone (TT) commands over the line being tested, sent from the near-end AM5XT to RECALL "canned" test setups with the STORE function.

To RECALL a test setup stored in a memory of the far-end AM5XT:

1. In the near AM5XT, enable TT Dialing Mode as explained in ¶10.02.
2. Dial "A" followed by the 2-digit memory location. For example, dial "A01" to recall setup in memory location 01.

- Send commands from the near end to the far end over a separate telephone line to the far-end AM5XT RS232 port. See ¶12.01 concerning RS232 operation.

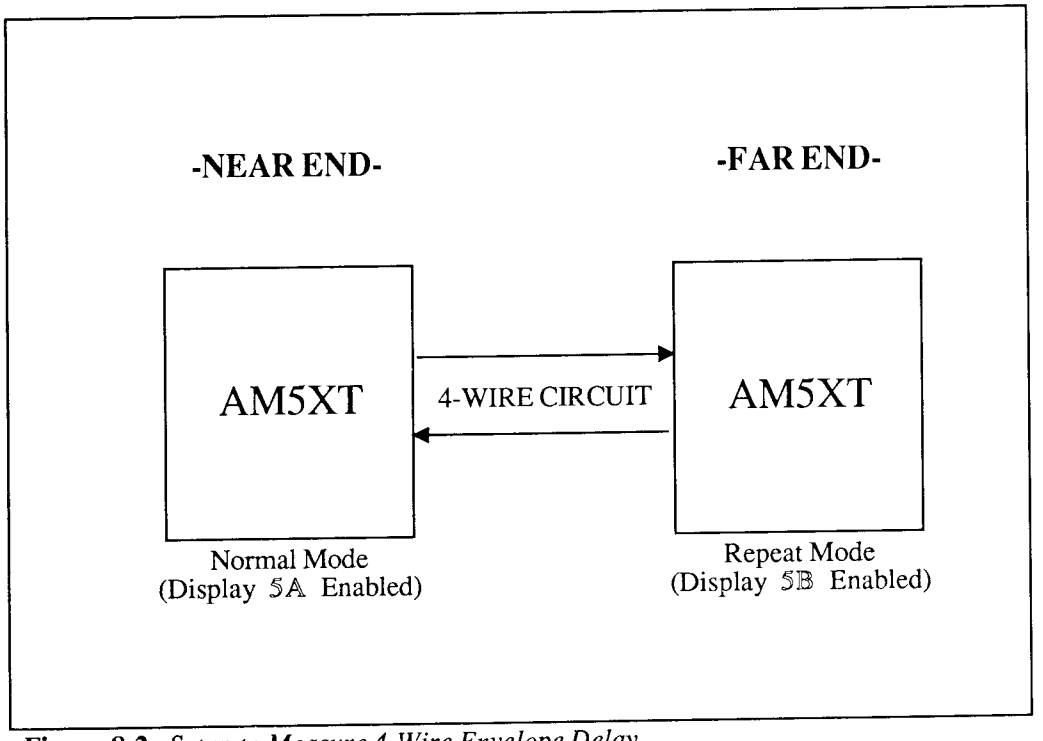


Figure 8-2. *Setup to Measure 4-Wire Envelope Delay*

FOR AM5XT ONLY

8.10 [8] *ENV DLY (Envelope Delay), continued*

Operation. Follow the appropriate procedure outlined below to measure either Near-to-Far or Far-to-Near Envelope Delay.

TEST PROCEDURE

4-WIRE, NEAR-TO-FAR

Summary:

NEAR END

1. Send REFERENCE frequency.
2. Set NORMAL Mode.
3. Enable Measure Display 2 (Delay/Send Freq).
4. Zero to Reference Frequency with REL SET.
5. Send ENV DLY Sweep.
6. Read Envelope Delay on Measure Display 2.

FAR END

1. Send REFERENCE Frequency.
2. Set REPEAT Mode.
3. Enable Measure Display 3 (Level/Freq.).

-NOTE-

Send "Display 1" thru "Display 10" refer to displays shown on pages 7-6 and 7-7. **Measure** "Display 1" thru "Display 11" refer to displays shown on pages 8-11 and 8-12.

Detailed Instructions:

1. On both near and far AM5XT, press [SEND] key and enable Send Function row. Press [8] to enable *ENV DLY*.

   - On near AM5XT, if other than default settings are desired, use PARAM SET to set desired values for the Sweep parameters with Send Displays 6 thru 11. See ¶7.09.

Detailed Instructions, continued:

   - On both near and far AM5XT, if other than default Reference Frequency is desired, use PARAM SET to set desired Reference Frequency with Send Display 5.
   - On both near and far AM5XT, send Reference Frequency by enabling Send Display 2. See ¶7.09.

2. On both near and far AM5XT, press [MEAS] key and enable Measure Function row; press [8] to enable ENV DLY. With PARAM SET, set the near-end AM5XT to NORMAL mode (Measure Display 5A), and set the far-end AM5XT to REPEAT mode (Measure Display 5B). At both ends, press [MEAS] key again to exit PARAM SET.

3. On near AM5XT, press [8] as necessary to enable Measure Display 2 (kHz LED will flash). On far AM5XT, press [8] as necessary to enable Measure Display 3.

4. On near AM5XT, press AUX key then press [C] to enable REL SET (note that *REL SET* LED does not light). The left display of Measure Display 2 will go to "0.000 msec", indicating that the delay measure has been zeroed at the Reference Frequency.

5. On near AM5XT, press [SEND] key to enable Send Function row; press [8] as necessary to enable Send Display 1 (ENV DLY Sweep Mode); see ¶7.09. Leave far AM5XT in Send Reference Frequency.
6. On near AM5XT, press [MEAS] key to enable Measure Display 2 (kHz LED will flash). Read the Envelope Delay in msec.

7. If reading in Step 6 is unstable, increase setting of Measure Display 4 to increase the number of readings AVeraGed before the result is displayed. As the averaging number is increased, the sweep rate must be reduced.

8. If results are to be plotted or printed out, set constraints with Measure Displays 6 thru 11.

FOR AM5XT ONLY

8.10 [8] *ENV DLY (Envelope Delay), continued*

TEST PROCEDURE

4-WIRE, FAR-TO-NEAR

Summary:

NEAR END

1. Send REFERENCE frequency.
2. Set NORMAL Mode.
3. Enable Measure Display 1 (Delay/Rev Freq).
4. Zero to Reference Frequency with REL SET.

6. Read Envelope Delay on Measure Display 1.

FAR END

1. Send REFERENCE Frequency.
2. Set REPEAT Mode.

5. Send ENV DLY Sweep.

-NOTE-
Send "Display 1" thru "Display 10" refer to displays shown on pages 7-6 and 7-7.
Measure "Display 1" thru "Display 11" refer to displays shown on pages 8-11 and 8-12.

Detailed Instructions:

1. On both near and far AM5XT, press [SEND] key and enable Send Function row. Press [8] to enable *ENV DLY*.

   - On far AM5XT, if other than default settings are desired, use PARAM SET to set desired values for the Sweep parameters with Send Displays 6 thru 10 . See ¶7.09.

Detailed Instructions, continued

   - On both near and far AM5XT, if other than default Reference Frequency is desired, use PARAM SET to set desired Reference Frequency with Send Display 5.
   - On both near and far AM5XT, send Reference Frequency by enabling Send Display 2. See ¶7.09.

2. On both near and far AM5XT, press [MEAS] key and enable Measure Function row; press [8] to enable ENV DLY. With PARAM SET, set the near-end AM5XT to NORMAL mode (Measure Display 5A), and set the far-end AM5XT to REPEAT mode (Measure Display 5B). On near end, press [MEAS] key again to exit PARAM SET.

3. On near AM5XT, press [8] as necessary to enable Measure Display 1 (kHz LED will be continuously ON).

4. On near AM5XT, press *AUX* key then press [C] to enable *REL SET* (note that *REL SET* LED does not light). The left display of Measure Display 1 will go to "000.0 msec", indicating that the delay measure has been zeroed at the Reference Frequency.

5. On far AM5XT, press [SEND] key to enable Send Function row; press [8] as necessary to enable Send Display 1 (ENV DLY Sweep Mode); see ¶7.09. Leave near AM5XT in Send Reference Frequency.

6. Read the Envelope Delay in msec.

7. If reading in Step 6 is unstable, increase setting of Measure Display 4 to increase the number of readings AVeraGed before the result is displayed. As the averaging number is increased, the sweep rate must be reduced.

8. If results are to be plotted or printed out, set constraints with Measure Displays 6 thru 11.

FOR AM5XT ONLY

8.10 [8] *ENV DLY (Envelope Delay), continued*

2-Wire Envelope Delay. The ability to make a 2-wire Envelope Delay measurement is an exclusive testing feature, found only in the Ameritec AM5XT. This allows the delay to be measured without using an additional line for a return path.

A phase-locked loop (PLL) generator in the near-end AM5XT is used to "lock on" to the 83-1/3 Hz modulation frequency of the Reference carrier frequency sent from the far end. This establishes a phase reference in the near end AM5XT. The HOLD mode is used in the near AM5XT to "hold" this phase reference so delay can be measured as the far end sweeps the carrier frequency.

The Envelope Delay measurement will drift slightly from the time HOLD Mode is enabled; it will change a maximum of 15 micro-seconds/minute; this is due to the slight instability of the PLL phase reference. The Envelope Delay measurement should, therefore, be made soon after HOLD Mode is enabled. For example, the Envelope Delay measurement must be made within 2 minutes of enabling HOLD Mode (second part of step 7 in procedure) to guarantee no more than 30 micro-seconds of error in the reading.

Setup. Fig. 8-3 shows the setup to measure 2-Wire Envelope Delay.

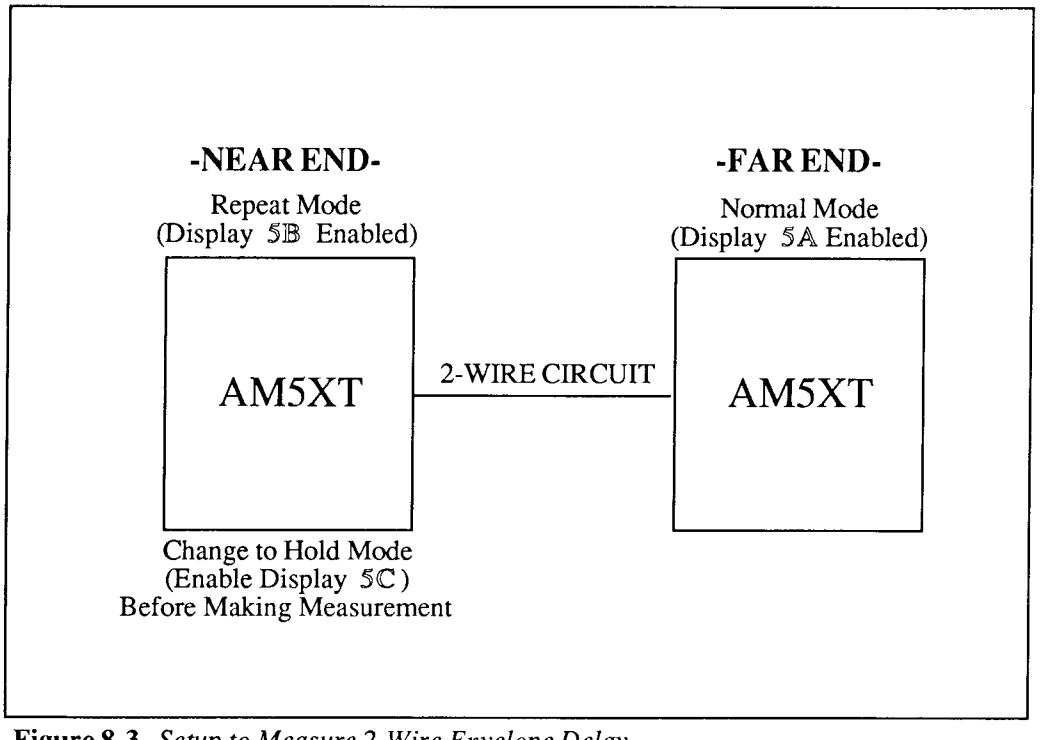


Figure 8-3. *Setup to Measure 2-Wire Envelope Delay*

FOR AM5XT ONLY

8.10 [8] *ENV DLY (Envelope Delay), continued.*

TEST PROCEDURE

2-WIRE, FAR-TO-NEAR

Summary:

NEAR END

1. Set Send to QUIET Mode.
2. Set REPEAT Mode.

5. Wait at least 10 sec.
6. Set Measure HOLD Mode. Enable Measure Display 1 (Delay/Rev Freq).
7. Zero to Reference Frequency with REL SET.

9. Read Envelope Delay on Measure Display 1.

FAR END

3. Send REFERENCE Frequency.
4. Set NORMAL Mode.

8. Send ENV DLY Sweep Mode.

-NOTE-
Send "Display 1" thru "Display 10" refer to displays shown on pages 7-6 and 7-7. **Measure** "Display 1" thru "Display 11" refer to displays shown on pages 8-11 and 8-12.

Detailed Instructions:

1. On near end:
   - Press [SEND] key to enable Send Function Row.
   - Press [1] to enable QUIET Send Mode (¶7.02).

2. On near end:
   - Press [MEAS] key to enable Measure Function row.
   - Press [8] to enable ENV DLY.
   - Use PARAM SET to set Repeat Mode (Display 5B).

Detailed Instructions, continued:

3. On far end:
   - Press [SEND] key and enable Send Function Row.
   - Press [8] to enable ENV DLY (see ¶7.09).
   - Press [8] as necessary to enable Send Display 2 (send Reference Frequency).
   - If other than default Reference Frequency is desired, use PARAM SET to set desired Reference Frequency with Send Display 5.
4. On far end:
   - Use PARAM SET to set NORMAL MODE (Display 5A).

5. Wait at least 10 seconds to allow the Near End Phase Lock Loop (PLL) Generator to "lock on" precisely to the phase of the modulation frequency of the Reference Frequency.

6. On near end:
   - Press [MEAS] key and enable Measure Function Row.
   - Use PARAM SET to set Envelope Delay HOLD Mode (Display 5C).
   - On near end, press [MEAS] key again to exit PARAM SET.
   - Press [8] as necessary to enable Measure Display 1 (Delay/Rev Freq).

7. On near end:
   - Press [AUX] key then press [C] to enable REL SET (note that REL SET LED does not light).
   - The left display of Measure Display 1 will go to "0.000 msec", indicating that the delay measure has been zeroed at the Reference Frequency.

8. On far end:
   - Press [SEND] key and enable Send Function row.
   - Press [8] as necessary to enable Send Display 1(ENV DLY Sweep).
   - If other than default Sweep settings are desired, use PARAM SET to set desired parameter values with Send Displays 6 thru 10. (See ¶7.09).

9. On near end, read Envelope Delay on Measure Display 1.

FOR AM5eXT ONLY

8.11 [8] *GROUP DLY (Group Delay)*

A Group Delay Test measures the non-linearities in the phase response of a line. A transmission test set is required at each end of the circuit to be measured. Test signals are generated over a 2-wire circuit from the test set on one end, and the Group Delay is measured on the other end. See ¶7.10 for Send Functions.

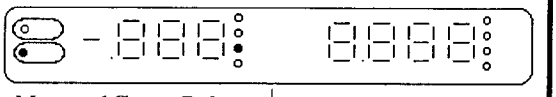
With a Group Delay test, there are two (2) types of send signals which are alternately generated for 120 msec:

- A constant carrier **Reference** Frequency, usually 1800 Hz, modulated by 41-2/3 Hz.
- A **Sweep** series of carrier "test" frequencies, usually from 200 Hz to 20 kHz, also modulated by the 41-2/3 Hz.

The Measure Displays listed are numbered for ease of reference.

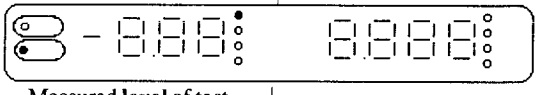
DATA DISPLAYS

1



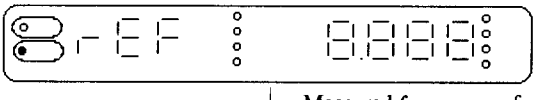
Measured **Group Delay** at indicated test frequency.

2



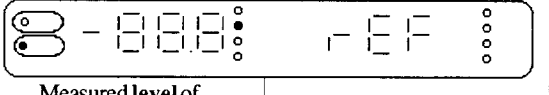
Measured **level** of test signal, at indicated frequency, relative to reference. In other words, the difference between levels: Test level - Reference level.

3



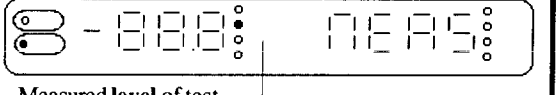
Measured ***frequency*** of reference signal.

4



Measured **level** of reference (ref) signal.

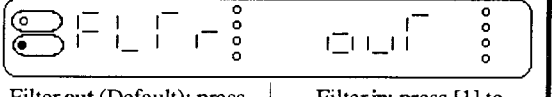
5



Measured **level** of test (meas) signal.

PARAMETER DISPLAYS

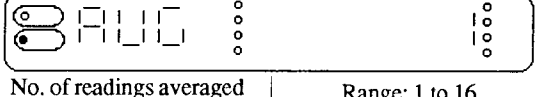
6



Filter **out** (Default): press [0] to disable

Filter **in**: press [1] to enable.

7



No. of readings averaged for display 1. Enter value per display stability. Increase value if display is unstable.

Range: 1 to 16 (Default = 1)

FOR AM5eXT ONLY

8.11 [8] *GROUP DLY (Group Delay)*, cont.

Plotting. There are additional PARAMETER DISPLAYS used for plotting graphs of measurement Display 1 or Display 2 through the RS232 port or XY plotter outputs. These parameters are respectively used to set:

8 *Low* delay limit of the plot of display 1
9 *High* delay limit of the plot of display 1
10 *Low* level limit of the plot of display 2
11 *High* level limit of the plot of display 2
12 *Rate* at which lines are printed
13 Performance limits for line on printer/plotter.

See Section 13 for details and examples concerning plotting.

Automatic Tracking Printing Mode. To deliver a printout-plot each time there is a shift in frequency, set RATE parameter to "0". With RATE = 0, there must be a discrete, stable shift in the frequency to cause a printout/plot. If the frequency changes at least 8 Hz (approximately) and stabilizes for about 0.5 sec, there will be a printout/plot.

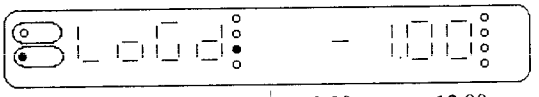
Setup. Group Delay is measured over a 2-wire circuit, generating the composite signals at one end and measuring the Group Delay at the other end.

For 4-wire, a Group Delay measurement is made individually over each pair (TX pair and RX pair). Since the Send and Measure functions of the AM5eXT are independent, both Group Delay measurements could be made simultaneously at both ends of the circuit, each test set measuring the Group Delay of the signals being sent from the opposite end.

Fig. 8-4 shows the setup to measure Group Delay.

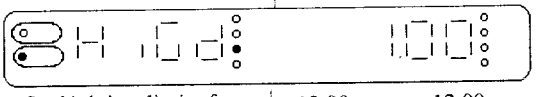
PARAMETER DISPLAYS for Plotting

8



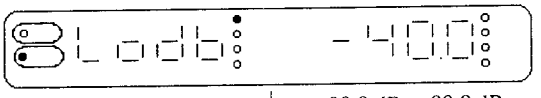
Set *low* time limit of Group Delay plot. | -12.00 msec to 12.00 msec (Default = -1.00 msec)

9



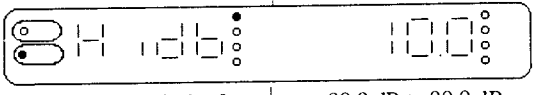
Set *high* time limit of Group Delay Plot. | -12.00 msec to 12.00 msec (Default = 1.00 msec)

10



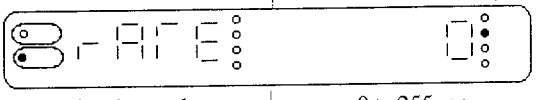
Set *low* level limit of level/freq. plot | -99.9 dB to 99.9 dB (Default = -40.0 dB)

11



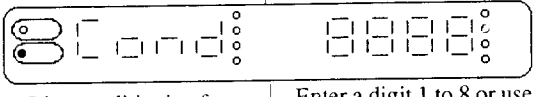
Set *high* level limit of level/freq. plot | -99.9 dB to 99.9 dB (Default = 10.0 dB)

12



Time interval between printouts. | 0 to 255 sec (Default = 0, Autotrack*)

13



Line conditioning for performance limits. | Enter a digit 1 to 8 or use [▲] or [▼] to select mask.

*See explanation of Automatic Tracking Printing Mode.

FOR AM5eXT ONLY

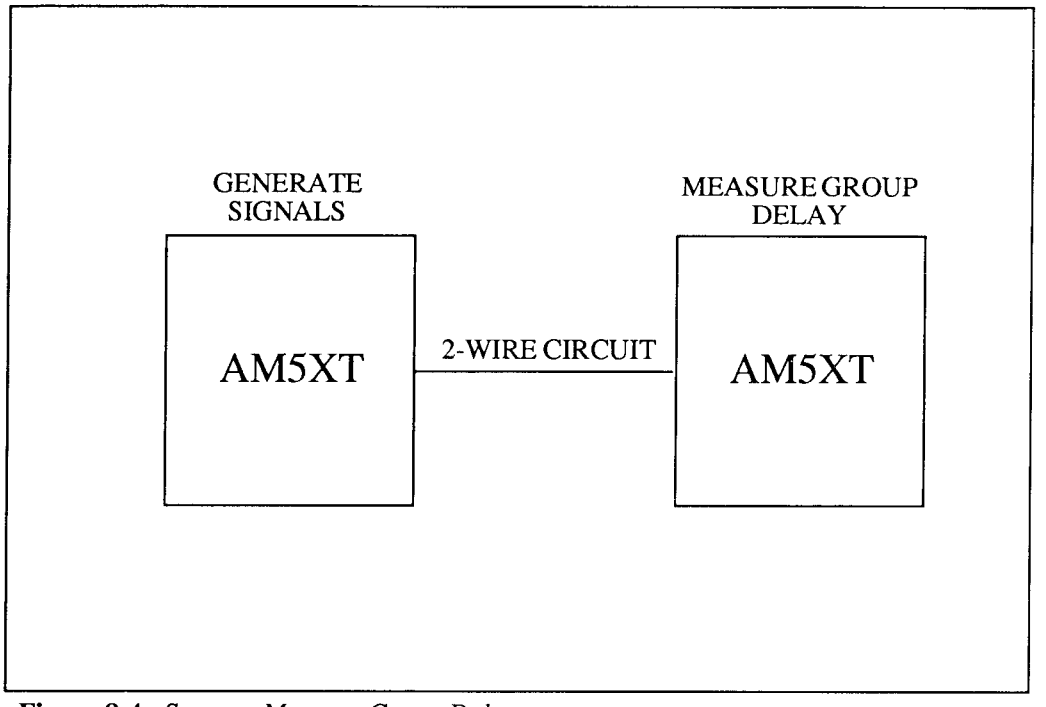


Figure 8-4. *Setup to Measure Group Delay.*

8.11 [8] ***GROUP DLY (Group Delay),* cont.**

Operation. Follow the procedure outlined below:

1. For other than default Send signals, set desired Send signals as indicated in ¶7.10.
   - Set level of Send signals with GROUP DLY Send Display 2.
   - Set Reference Frequency with GROUP DLY Send Display 3.
   - Set Test Signal sweep parameters with GROUP DLY Send Display 4 thru Display 8 .
2. If high-frequency noise is causing interference, enable the high-frequency Filter:
   - Use Measure PARAM SET.
   - Access GROUP DLY Measure Display 6.
   - Press [1].
   - Measure Display 6 will then read "FLTR IN".
3. Repeatedly press [8] as needed to make readings from Measure Display 1 thru Display 5.

-and/or-

4. Print out readings from Measure Display 1 or Display 2 by:
   - Setting the plotting parameters with Display 8 thru Display 13.
   - Pressing [AUX] key and then holding down [8] to initiate the printout.

-NOTE-
If the high-frequency filter is used, set the STOP frequency of the sweep no higher than 4 kHz. The filter introduces 30 microseconds of error to the Group Delay at 4 kHz.

8.12 [9] *IMD (Intermodulation Distortion*)*

Definition. Intermodulation Distortion is also known as "Non-Linear Distortion" or "4-Tone Test". Intermodulation Distortion is signal component generation that is produced from the transmitted signal and adds to the transmitted signal; these additional signal components are usually undesirable.

The Intermodulation Distortion signal is composed of four (4) tones, all at the same level, as decribed below:

Two (2) tones are 6 Hz apart, centered at 860 Hz.

Two (2) tones are 16 Hz apart, centered at 1380 Hz.

Third-order non-linear distortion creates six (6) intermodulation products in a narrow band centered at 1.9 kHz. The power due to these third order intermodulation produces is measured and expressed in dB below the received signal.

Second-order Non-Linear Distortion creates four (4) intermodulation products in each of 2 narrow bands centered at 520 Hz and 2240 Hz. The power in each of these second-order intermodulation bands is also measured. The average of these two second-order distortion powers is expressed in dB below the received signal.

See ¶7.11 for Send Function parameter settings.

The Noise Correction Factor is used to automatically correct the displayed readings of 2nd and 3rd order distortion when a 4-tone signal is received.

The second digit in the right display indicates if the Noise Correction Factor is enabled:

"⊏" = Noise Correction Factor captured
" " (blank) = Noise Correction Factor not determined.

When a 2-tone signal is transmitted for 15 seconds, the receiver will automatically measure backgound noise level and save. Readings are then displayed with the "C" to tell the operator the display reading has been "corrected".

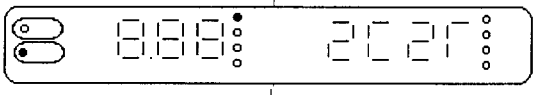
*Licensed under U.S. Patent #3,862,380.

8.12 [9] IMD *(Intermodulation Distortion)*, continued

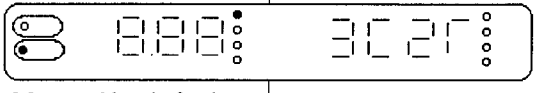
WHEN RECEIVING 2-TONE SIGNAL *AFTER CAPTURING NOISE CORRECTION FACTOR*

DATA DISPLAYS

Measured signal level.



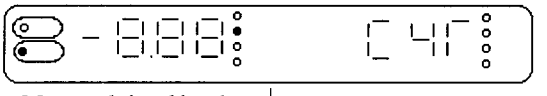
Measured level of noise in 2nd order bands below signal.



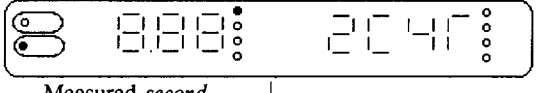
Measured level of noise in 3rd order band below signal.

WHEN RECEIVING 4-TONE SIGNAL *AFTER CAPTURING NOISE CORRECTION FACTOR*

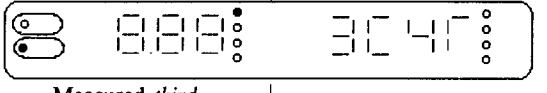
DATA DISPLAYS



Measured signal level.



Measured *second* order level below signal. Measurement has been corrected.



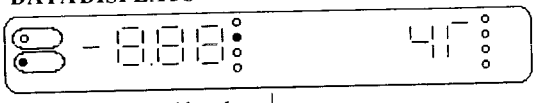
Measured *third* order level below signal. Measurement has been corrected.

8.12 [9] *IMD (Intermodulation Distortion) continued*

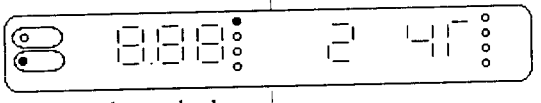
If *IMD* Measure mode is exited to enable another Measure function, the correction factor is lost. When *IMD* mode is enabled again, the absence of the correction factor is indicated by the absence of the "[" in the second digit of the right display, as shown in the displays to the right.

WHEN RECEIVING 4-TONE SIGNAL *WITHOUT* NOISE CORRECTION FACTOR

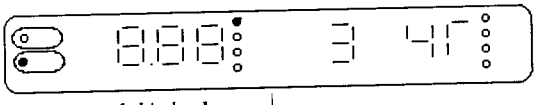
DATA DISPLAYS



Measured signal level



Measured *second* order level below signal. Measurement has *not* been corrected.



Measured *third* order level below signal. Measurement has *not* been corrected.

8.13 [0] *PHASE JTR (Phase Jitter)*

This measurement requires a 1004 Hz nominal Holding Tone. This test measures the peak-to-peak phase variation of the modulation of the holding tone. The bandwidth (range of frequencies) is selected over which the phase jitter is measured. A phase-locked-loop generator locks on the Holding Tone and an average peak-to-peak phase jitter is measured in degrees.

The bandwidth can be set to either:

1. 20 Hz to 300 Hz (default),
2. 4 Hz to 300 Hz, or
3. 4 Hz to 20 Hz.

8.14 [*] *AMP JTR (Amplitude Jitter)*

The test for amplitude jitter is the same as the phase jitter measurement except instead of measuring the variation of the phase, the variation of the amplitude of the modulation is measured. The unit of measurement for the amplitude jitter is average percent peak-to-peak variation.

Because this is an amplitude measuremnt, the phase-locked-loop frequency is not of interest.

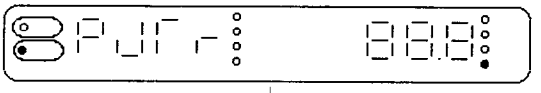
8.15 [#] *IMP NOISE (Impulse Noise without Tone)*

This is a timed study which counts the number of noise pulses that exceed each of three levels (thresholds). No Holding Tone is used for this test.

Three (3) noise thresholds are established: low, middle, and high levels, with an equal interval between them called the "delta". The time over which the run is to be made is the duration.

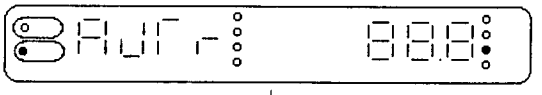
The run is started and a running count is kept of the number of noise pulses that exceed each threshold. The run will automatically stop when the duration time is reached. The test can be stopped manually at any time.

DATA DISPLAY



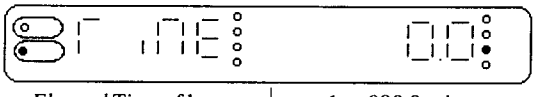
Measured Phase Jitter

DATA DISPLAY

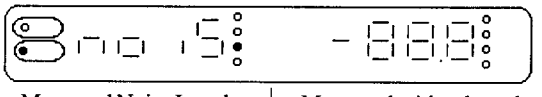


Measured Amplitude Jitter

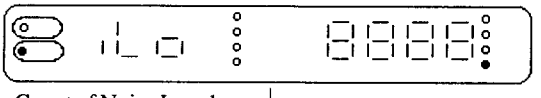
DATA DISPLAYS



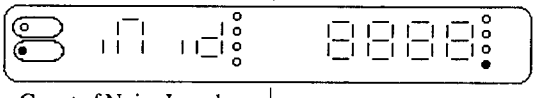
Elapsed Time of last timed study | .1 to 999.9 minutes



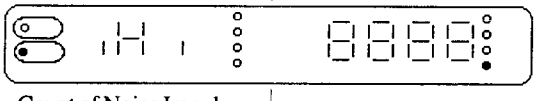
Measured Noise Level | Measured with selected noise-weighting filter.



Count of Noise Impulses exceeding *low* threshold

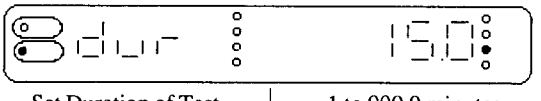


Count of Noise Impulses exceeding *mid* threshold

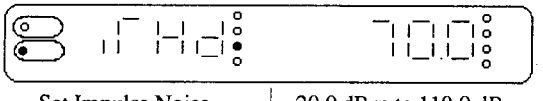


Count of Noise Impulses exceeding *high* threshold

PARAMETER DISPLAYS



Set Duration of Test | .1 to 999.9 minutes (Default = 15.0 minutes)



Set Impulse Noise Low Threshold | 20.0 dBrn to 110.0 dBrn (Default = 70.0 dBrn)

8.15 [#] *IMP NOISE (Impulse Noise without Tone), continued*

The blanking interval is the time after a noise pulse when the counter does not count. The blanking interval for a threshold is started when a pulse exceeds the threshold for the first time. The noise pulse counter does not count during the blanking interval. The purpose of the blanking interval is to minimize the effect of ringing on the count. Without the blanking interval, several counts could be made immediately after the first pulse, due to secondary pulses caused by ringing. The blanking interval allows time for the ringing to die down.

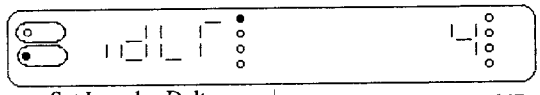
A typical duration time for the study is 15 minutes, although a study of up to 999.9 minutes (16 hours) could be made. Note that only duration, low level threshold, and impulse delta are set.

8.16 [A] *TRAN (Transients)*

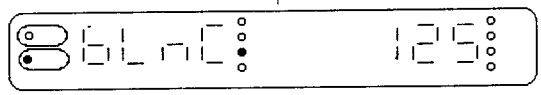
PHASE HITS. A phase hit is a sudden change in the phase of the modulation of a Holding Tone. A threshold of from 5 to 45 degrees is set and the number of phase hits that exceed that threshold during the timed study is counted.

GAIN HITS. A gain hit is a sudden change in the amplitude of the modulation of a Holding Tone. A threshold of 2, 3, 4, or 6 dB is set and the number of gain hits that exceed that threshold during the timed study is counted.

PARAMETER DISPLAYS, continued

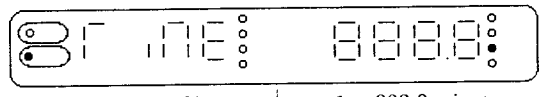


Set Impulse Delta (differential between thresholds) | 2 dB, 3 dB, 4dB or 6dB (Default = 4 dB)

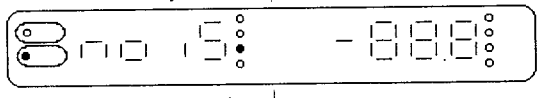


Set Blanking Interval | 1 to 255 msec (Default - 125 msec)

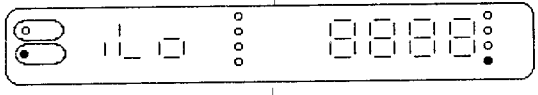
DATA DISPLAYS



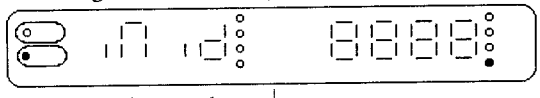
Elapsed Time of last timed study | .1 to 999.9 minutes



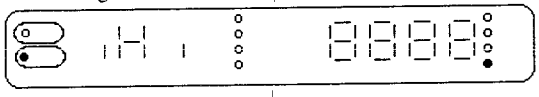
Measured Noise Level



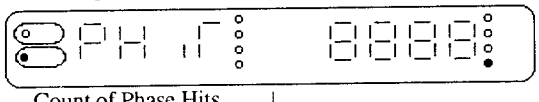
Count of Noise Impulses exceeding *low* threshold



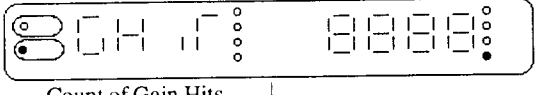
Count of Noise Impulses exceeding *mid* threshold



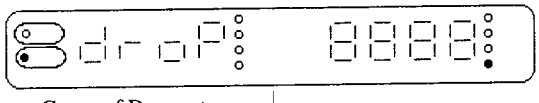
Count of Noise Impulses exceeding *high* threshold



Count of Phase Hits exceeding Phase Hit threshold



Count of Gain Hits exceeding Gain Hit threshold

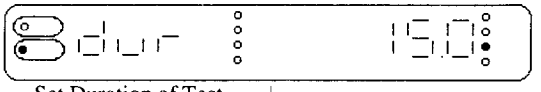


Count of Dropouts

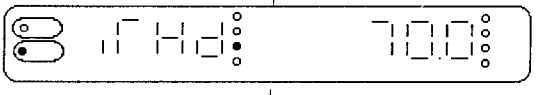
8.16 [A] *TRAN (Transients), continued*

DROPOUTS. A dropout is the loss of Holding Tone. The number of losses of Holding Tone during a timed study is counted. A "loss" of Holding Tone occurs if the Holding Tone level and/or frequency go out of the acceptable range for valid transient measurements, usually a 12 dB reduction in the Holding Tone level as measured at the start of the test.

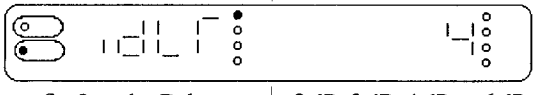
PARAMETER DISPLAYS



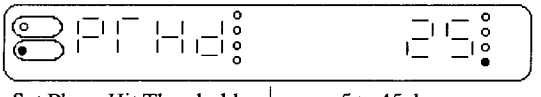
Set Duration of Test — .1 to 999.9 minutes (Default = 15.0 min.)



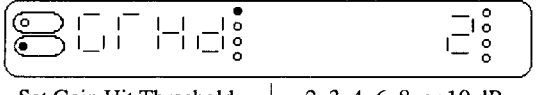
Set Impulse Noise Low Threshold — 20.0 dBrn to 110.0 dBrn (Default = 70.0 dBrn)



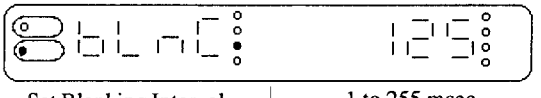
Set Impulse Delta — 2 dB, 3 dB, 4 dB or 6 dB (Default = 4 dB)



Set Phase Hit Threshold — 5 to 45 degrees (Default = 25 deg.)



Set Gain Hit Threshold — 2, 3, 4, 6, 8 or 10 dB (Default = 2 dB)

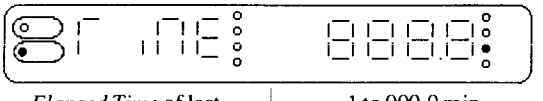


Set Blanking Interval — 1 to 255 msec (Default = 125 msec)

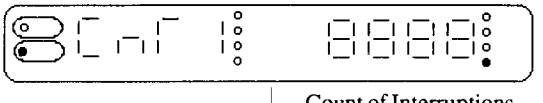
8.17 [B] *MICRO INTR (Micro-interruptions)*

Micro-interrruptions is a test for dropouts that exceed a specified threshold. Duration of test, threshold of interruption, and blanking interval are set and test is started. Five (5) different counts are logged depending on the length of the interruption, and can be displayed during or after the test.

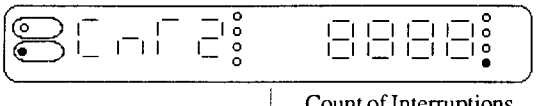
DATA DISPLAYS



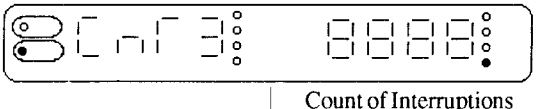
Elapsed Time of last timed study — .1 to 999.9 min



Count of Interruptions lasting 0.3-3.0 msec



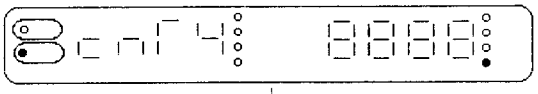
Count of Interruptions lasting 3.0-30 msec



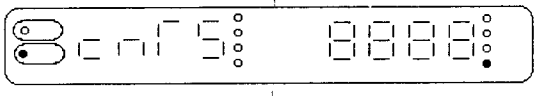
Count of Interruptions lasting 30-300 msec

8.17 B *MICRO INTR (Micro-interruptions), continued*

DATA DISPLAYS, continued

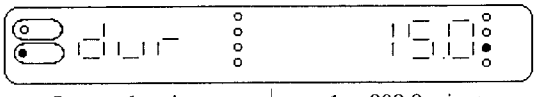


Count of Interruptions lasting 300 msec-1 minute



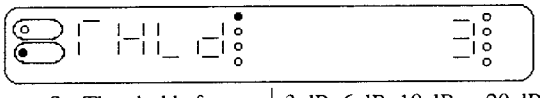
Count of Interruptions lasting > 1 minute

PARAMETER DISPLAYS



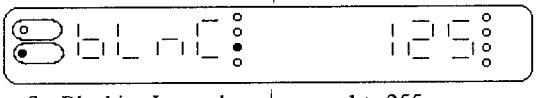
Set test duration

.1 to 999.9 minutes (Default = 15.0 minutes)



Set Threshold of Interruption (in dB's below initial input level)

3 dB, 6 dB, 10 dB or 20 dB (Default = 3 dB)



Set Blanking Interval

1 to 255 msec (Default = 125 msec)

9. AUXILIARY FUNCTIONS

9.01 INTRODUCTION

AUXILIARY Functions are associated with the Measure Functions. See Fig. 9-1 for instructions to select desired Auxiliary Function. Note that Auxiliary Functions are color-coded VIOLET.

In this section, the Function Enable Key for each Auxiliary Function is shown enclosed in a square [ ]. For example, [8] *PRINT* indicates that key [8] is pressed to output information to an external printer.

Function Boxes. Some Auxiliary Functions are only associated with certain Measure Functions; these Auxiliary Functions are enclosed with a black border, together with the Measure Functions with which they are associated. These are referred to as Function Boxes. There are four (4) Function Boxes which are illustrated in Fig. 9-2. Note that the Level Box and Noise Box are different for the AM5XT and AM5eXT; the Jitter Box and Timed Study Box are the same for the AM5XT and AM5eXT. See FOLDOUT at the end of the manual for complete illustrations of the AM5XT and AM5eXT front panels.

Paragraphs in this section are listed below:

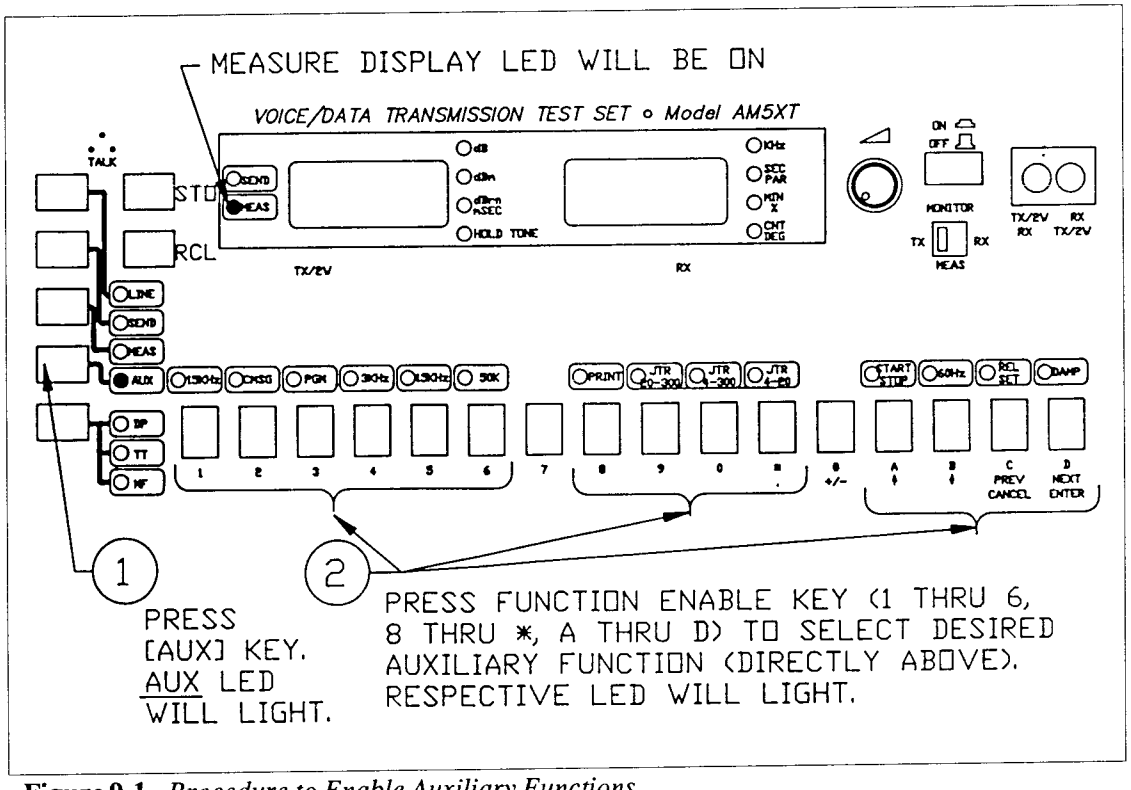


Figure 9-1. *Procedure to Enable Auxiliary Functions*

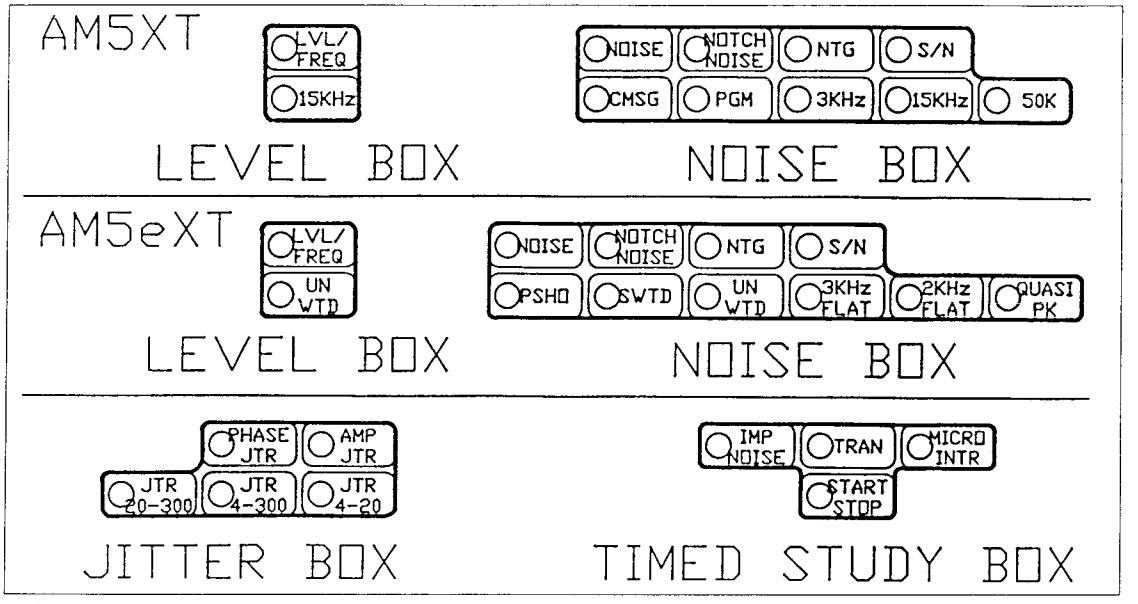


Figure 9-2. *Function Boxes*

9.02 [1] FILTER FOR NARROW-BAND LEVEL/FREQUENCY

This function is part of the Level (Function) Box as shown in Fig. 9-2. It is a low-pass filter, connected to the front end of the measurement circuitry, effectively eliminating high-frequency components. For AM5XT, this is a 15 kHz filter; for AM5eXT, a sound-unweighted filter (30 Hz to 20 kHz).

Enable this filter (LED on) in a Level/Frequency measurement when making measurements on voice-band circuits where high frequency components are of no interest. With this filter enabled, the test is referred to as a "narrow-band level/frequency measurement". See ¶ 8.02 for Level/ Frequency measurement information.

9.03 NOISE WEIGHTING FILTERS

Noise weighting filters are part of the Noise (Function) Box as shown in Fig. 9-2. If a noise measurement is to be made with a noise weighting filter, there are five (5) noise weighting filters from which to choose. Only one (1) of the filters (or none) can be selected for a given noise measurement. The possible filters are listed in Table 9-1.

Table 9-1
Noise Weighting Filters

KEY	AM5XT	AM5eXT
[2]	C-Message (CMSG)	Psophometric (PSHO)
[3]	Program (PGM)	Sound-Weighted (SWTD)
[4]	3 kHz flat	Sound-Unweighted (UNWTD)
[5]	15 kHz flat	3 kHz FLAT
[6]	50 kBit	2 kHz FLAT

The AM5XT filters comply with IEEE STD 743-1984 (formerly Bell 41009) specification. The AM5eXT filters comply with CCITT recommendations.

Table 9-2 and Table 9-3 describe respectively the AM5XT and AM5eXT noise weighting filters and reference the figures that illustrate the filter characteristics.

-NOTE-
In addition to a noise weighting filter, the 60 Hz filter may be connected as desired during the measurement. See ¶ 9.08

Table 9-2
AM5XT Noise Weighting Filters

FILTER	DESCRIPTION	ILLUSTRATION
CMSG (C-Message)	bandpass filter	Figure 9-3
PGM (Program)	bandpass filter	Figure 9-4
3 kHz	low pass filter (3 dB down @ 3 kHz, 12 dB/octave rolloff)	Figure 9-5
15 kHz	low pass filter (3 dB down @ 15 kHz, 12 dB/octave rolloff)	Figure 9-6
50K (50 K Bit)	combination low pass and high pass filter	Figure 9-7

Table 9-3
AM5eXT Noise Weighting Filters

FILTER	DESCRIPTION	CCITT RECOMMENDATION	ILLUSTRATION
PSHO (Psophometric)	band pass filter	CCITT P. 53	Figure 9-8
SWTD (Sound-weighted)	low pass, high pass filter	CCITT J. 16	Figure 9-9
UN WTD (Sound un-weighted)	low pass, high pass filter	CCITT J.16	Figure 9-10.
3 kHz FLAT	bandpass filter	CCITT O. 71	Figure 9-11
2 kHz FLAT	bandpass filter	CCITT O. 71	Figure 9-12

AM5eXT ONLY

9.04 [7] *QUASI PK* (Quasi-Peak Detector Enable)

With AM5eXT noise measurements, there is a choice of devices to measure the voltage on the receive pair; select either the RMS Detector or the Quasi-Peak Detector.

With the AM5eXT, follow the steps below to make a noise measurement using the Quasi-Peak detector:

1. In the Measure Functions row (with *MEAS* LED ON), press the appropriate key to enable the desired noise test (*NOISE*, *NOTCH NOISE*, *NTG* or *S/N*); corresponding LED will light.
2. Press [AUX] key. *AUX* LED will light.
3. Press [7]. *QUASI PK* LED will light, indicating that the Quasi-Peak Detector is enabled.

For the AM5eXT, the Quasi-Peak Detector is enabled when the *QUASI PK* LED is on. The RMS Detector is enabled when the *QUASI PK* LED is off.

-NOTE-
For the AM5XT, all noise measurements are made with the RMS Detector only (there is no *QUASI PK* LED).

9.05 [8] PRINT ENABLE

The print key is used to initiate a printout through the RS232 port. For this print key to operate, the unit must be equipped with the optional RS232 port (Part No. 25-0019) and have a printer connected.

A printout can be made of:

A. The front panel setup together with the present reading(s) of the enabled measurement function, or
B. For Level/Frequency or Envelope Delay (Group Delay for the AM5eXT) tests only: a simultaneous plot and printout of the test results being displayed in the measure display, output periodically at a rate set by the user.

These two (2) types of printout are implemented as outlined below:

Up to Version 7

Printout of Front Panel Setup and Present Measurement(s). This printout is a "snapshot" of the front panel setup and measure reading(s) at the time the print key is pressed. Procedure to obtain this printout is listed below:

1. Press [AUX] key.
2. *Momentarily* press [8].
3. The *PRINT* LED will *not* light during this print mode.

Periodic Printout/Plot of Reading on Measure Display. This printout mode is for Level/Frequency or Envelope Delay (Group Delay for AM5eXT) tests only. Procedure to initiate this printout/plot is listed below:

1. Set the upper and lower limits of the plot and the rate of the printouts/plot; see PARAMETER DISPLAYS "for Plotting" in ¶ 8.02 (Level/Frequency), ¶ 8.10 (Envelope Delay) or ¶ 8.11 (Group Delay).
2. Set *LVL/FREQ, ENV DLY*, or *GROUP DLY* Measurement display to the DATA DISPLAY to be printed/plotted.
3. Press [AUX] key.
4. *Continuously* press [8] for approximately 2 seconds.
5. The *PRINT* LED will flash on/off during this print mode.
6. To exit this print mode, again *continuously* press [8] for approximately 2 seconds; *PRINT* LED will go out.

See Section 13 for information on obtaining hard copies of test results, using a printer and/or x-y plotter. See ¶13.03 for printing/plotting with Version 8 and up.

9.06 JITTER BANDWIDTH SELECT

The three (3) Jitter Bandwidth Weighting Filters are part of the Jitter (Function) Box as shown in Fig. 9-2. When making Phase Jitter or Amplitude Jitter measurements, one (1) of these Bandwidths must be chosen for the test. Therefore, one (1) of the Jitter Bandwidth LEDs will always be on, indicating the Bandwidth selected.

The possible Phase Jitter or Amplitude Jitter Bandwidths are listed in Table 9-4.

9.07 [A] *START STOP* (Timed Study Start/Stop)

The Start/Stop function is part of the Timed Study (Function) Box as shown in Fig. 9-2. It is used to Start/Stop the Timed Study tests enclosed in the Timed Study Box:

IMP NOISE	Impulse Noise (without tone)
TRAN	Transient Tests
	Impulse Noise (with tone)
	Phase Hits
	Gain Hits
	Dropouts
MICRO INTR	Micro Interruptions

Table 9-4
Jitter Bandwidth Weighting Filters

KEY	FILTER	BANDWIDTH
[9]	*JTR 20-300*	20 Hz to 300 Hz (power on default)
[0]	*JTR 4-300*	4 Hz to 300 Hz
[*]	*JTR 4-20*	4 Hz to 20 Hz

9.07 [A] *START STOP* (Timed Study Start/Stop), continued

To start a timed test:

1. Press [AUX] key to turn *AUX* LED on.
2. Press [A], turning on the *START STOP* LED. The LED will flash during the test.

When the *START STOP* LED begins to flash, all the DATA DISPLAYS are reset to zero, ready to start recording the counts during the present test run. See ¶8.15 thru ¶ 8.17 for illustrations of the timed test DATA DISPLAYS.

There are two (2) ways for the *START STOP* LED to stop flashing, indicating the end of the timed test:

A. The LED will stop flashing *automatically* if the DUR (test duration) PARAMETER DISPLAY is set to a value other than 0 (no time out), and the test is left to run the full DUR time.

B. The LED can be *manually* turned off by pressing [A] again (with *AUX* LED on) during the course of the timed test.

9.08 [B] *60 Hz* FILTER

The 60 Hz high-pass filter is meant for temporary insertion to eliminate frequencies 60 Hz or lower. Power line hum due to 50 Hz or 60 Hz components can cause erratic readings on the display. Connect this filter to eliminate power line hum and stabilize the reading on the display.

To connect/disconnect the 60 Hz filter:

1. Press [AUX] key to turn *AUX* LED on.
2. Press [B] to connect the 60 Hz high-pass filter (*60 Hz* LED, green, will light).
3. Press [B] again to disconnect the filter from the measurement (*60 Hz* LED will go out).

9.09 [C] *REL SET* (Relative Measure Zero Set)

All level and noise measurements are normally expresssed as *absolute* values in units of dBm or dBrn. When the *REL SET* LED is set on, the absolute value display of dBm or dBrn (left hand display) will go to "00.0 dB". Once *REL SET* is enabled, all subsequent readings will be relative to the zeroed reading, displayed in units of dB.

-NOTE-
In the Envelope Delay measurement, when *REL SET* is used to zero the delay measure to the Reference Frequency, *REL SET* is a momentary function and its LED does not light.

Absolute and Relative Measurements. Either an Absolute or Relative measurement can be made with any *level or noise measurement*. The choice is made by setting the *REL SET* LED to off (absolute) or on (relative). The use of absolute and relative measurements is outlined below:

A. Normally, the absolute setting (*REL SET* LED off) is used for noise and level measurements.

B. The relative setting (*REL SET* LED on) is used to establish a new zero reference level. This is useful in tests such as frequency response where levels at various frequencies are to be compared with the level at a reference frequency.

To make a relative reading:

1. Start with *REL SET* LED off.
2. When the desired reference point is established, press [C] (with *AUX* LED on) to turn on *REL SET* LED.
3. When *REL SET* LED turns on, the display will read "00.0 dB", meaning that the level or noise reading is now referenced to the reading that was on the display when *REL SET* was enabled.
4. Subsequent readings are now referenced to this new zero reference.
5. To summarize, a reading with the *REL SET* LED on means "relative to the last reading before *REL SET* was enabled".

EXAMPLE: Changing from absolute to relative with a level measurement:

1. With the *MEAS* LED on and *LVL/FREQ* LED on, *REL SET* LED off, a level of "-17.7 dBm" is displayed.
2. [AUX] key is pressed (*AUX* LED lights).

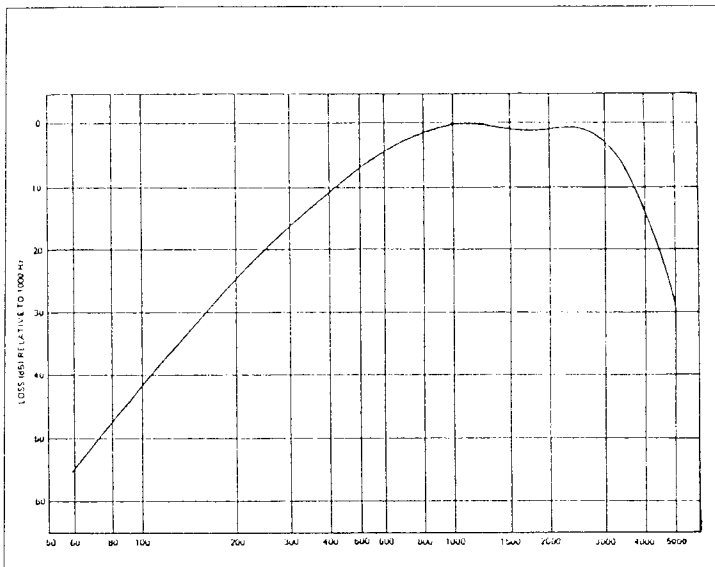
9.09 [C] *REL SET* (Relative Measure Zero Set), continued

3. [C] is pressed (*REL SET* lights).
4. Reading is now "00.0 dB" (note that units are now in dB, not dBm).
5. With *REL SET* LED still on, the reading changes to "-2.3 dB"; this means that the level is -2.3 dB relative to the reading just before *REL SET* was enabled.
6. The absolute reading would be -17.7 + -2.3 = -20.0 dBm.

9.10 [D] *DAMP* (Display Update Select)

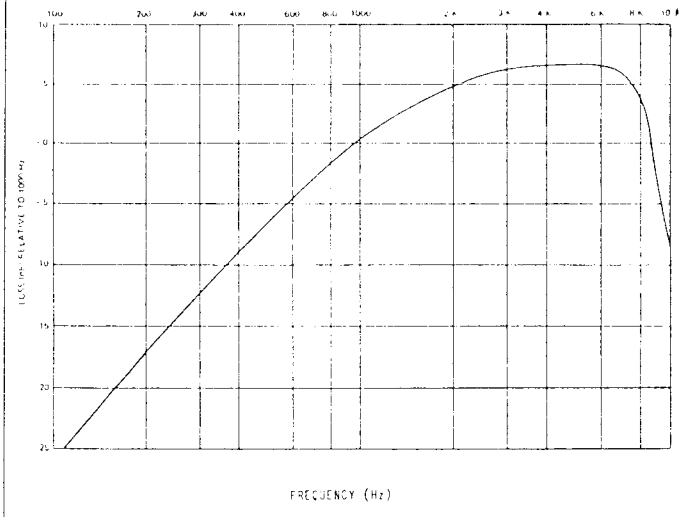
DAMP LED off = Front panel display updated four (4) times each second. This is the normal setting.

DAMP LED on = Front panel display update is slowed down to two (2) updates per second. This setting is useful to capture erratic readings.



Frequency	Design Loss (dB)
60	55.7
100	42.5
200	25.1
300	16.3
400	11.2
500	7.7
600	5.0
700	2.8
800	1.3
900	0.3
1000	0.0
1200	0.4
1300	0.7
1500	1.2
1800	1.3
2000	1.1
2500	1.1
2800	2.0
3000	3.0
3300	5.1
3500	7.1
4000	14.6
4500	22.3
5000	28.7

Figure 9-3. *C-Message Weighting Characteristic.*



Frequency (Hz)	Design Loss (dB) Ref to 1000 Hz
100	26.3
200	17.3
300	12.2
400	9.0
500	6.6
600	4.7
700	3.2
800	2.0
900	0.8
1000	0 Ref
1500	-3.2
2000	-4.8
2500	-5.6
3000	-6.0
4000	-6.5
5000	-6.5
6000	-6.4
7000	-5.8
8000	-4.0
9000	-1.5
10,000	8.5

Figure 9-4. *Program Weighting Characteristic.*

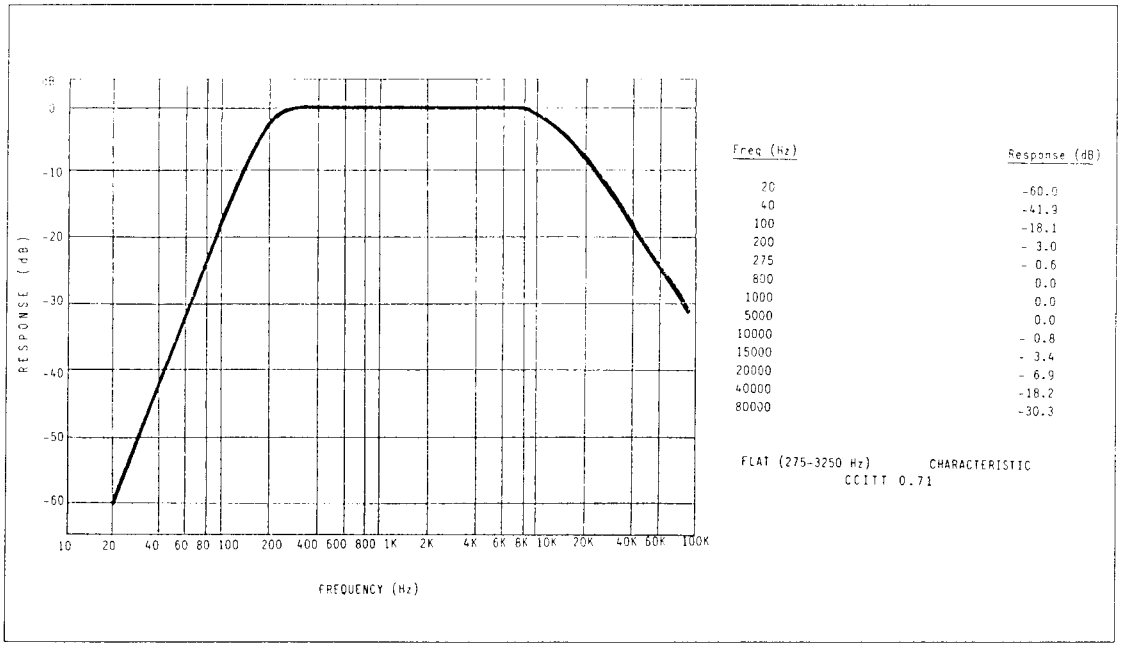


Figure 9-5. *3 KHz Flat Weighting Characteristic.*

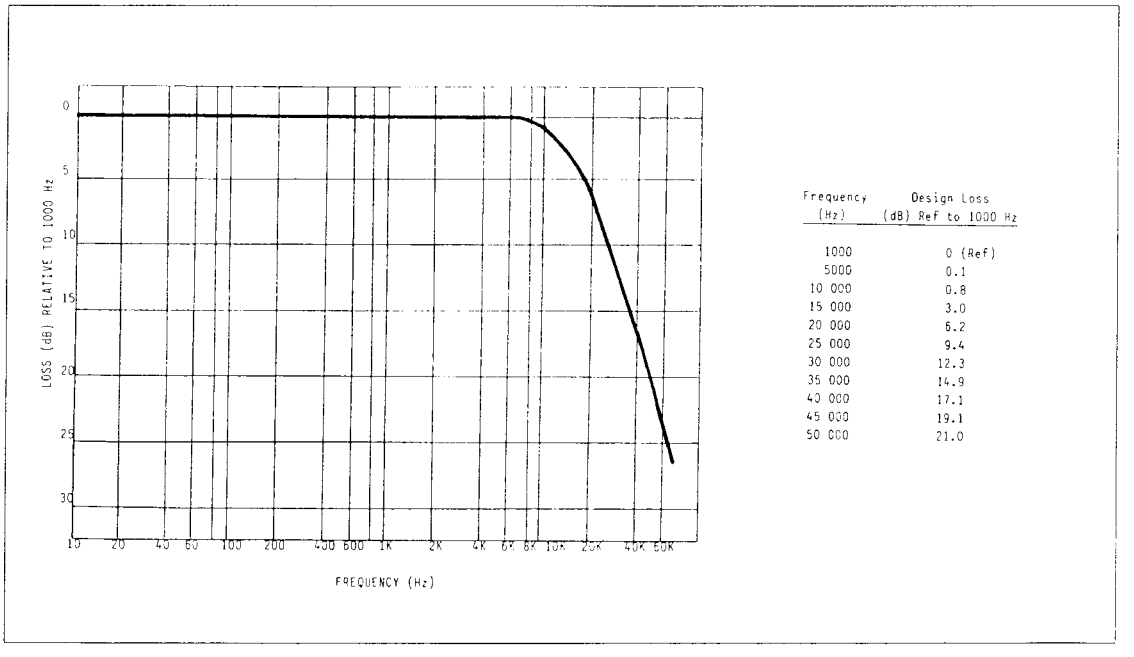
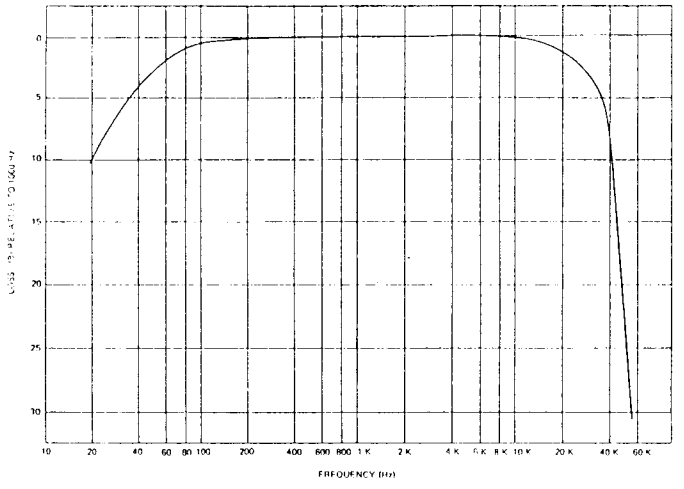
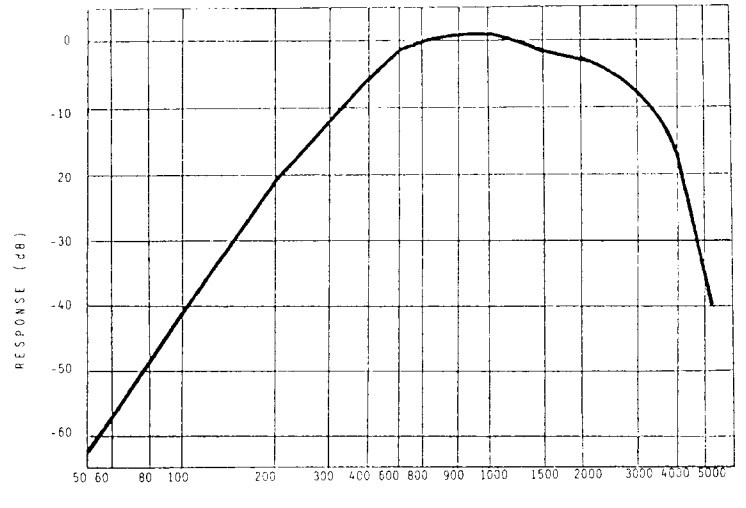


Figure 9-6. *15 KHz Flat Weighting Characteristic.*



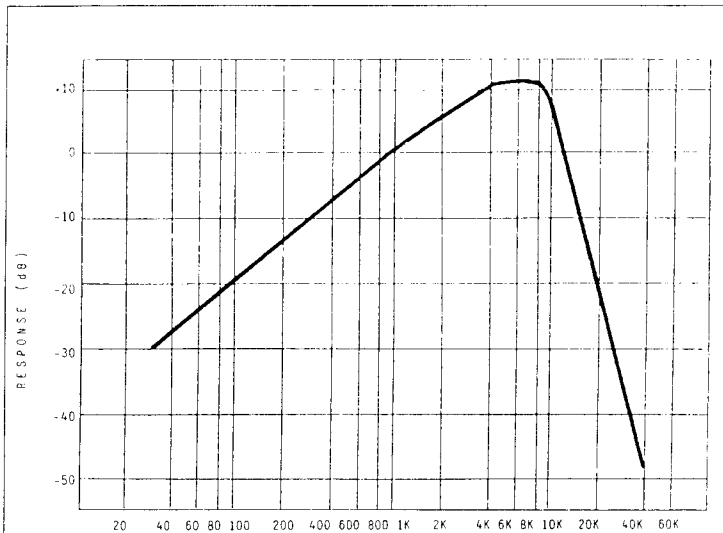
Frequency (Hz)	Design Loss (dB) Ref to 1000 Hz
0	>30
50	2.7
200	0.2
1000	0 (Ref)
5000	0.1
10 000	0.3
15 000	0.7
20 000	1.3
25 000	2.1
30 000	3.3
35 000	5.0
40 000	7.8
45 000	14.0
50 000	>22.0
>55 000	>30.0

Figure 9-7. *50 Kilobit Weighting Characteristic.*



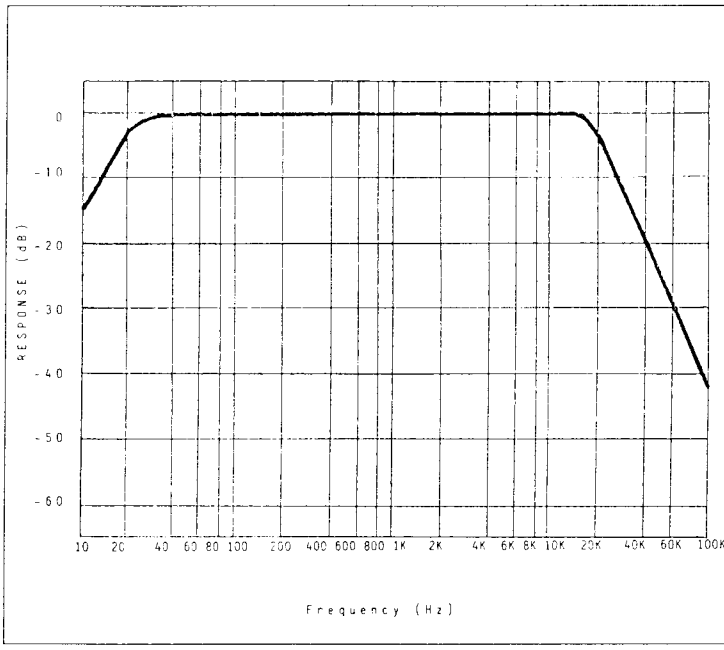
Freq (Hz)	Response (dB)
50	-63.0
100	-41.0
150	-29.0
200	-21.0
300	-10.6
400	- 6.3
500	- 3.6
600	- 2.0
800	0.0
1000	+ 1.0
1200	0.0
1500	- 1.3
2000	- 3.0
2500	- 4.2

Figure 9-8. *Psophometric Characteristic.*



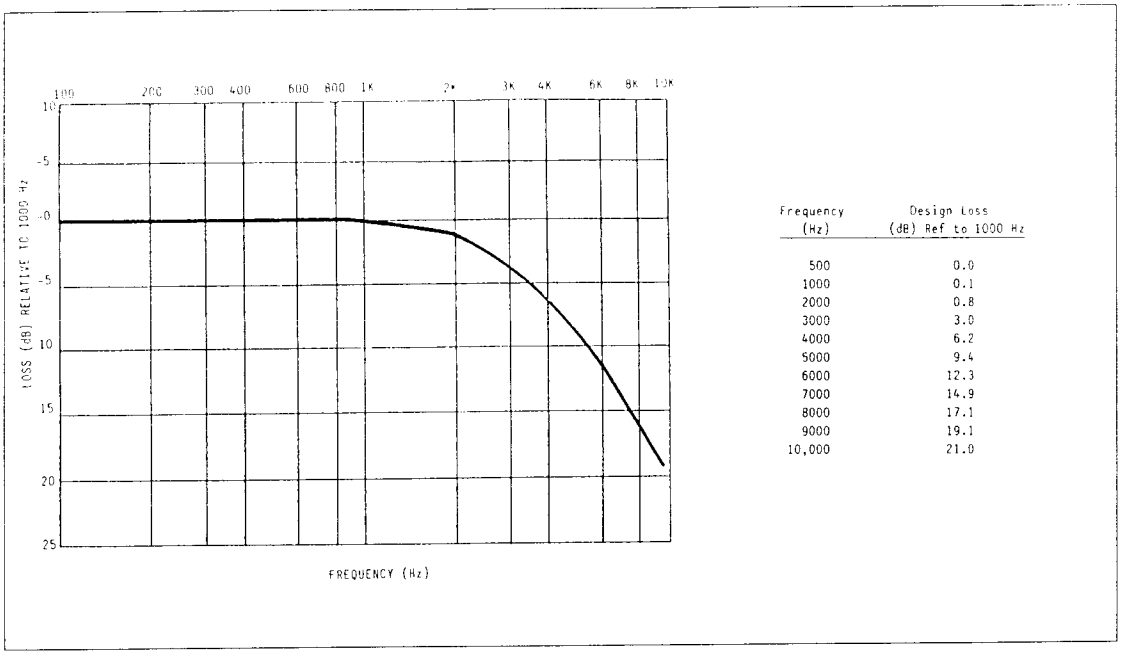
Freq (Hz)	Response (dB)
31.5	-29.9
63.0	-23.9
100	-19.8
200	-13.8
400	- 7.8
800	- 1.9
1000	0
2000	+ 5.6
3150	+ 9.0
4000	+10.5
5000	+11.7
6300	+12.2
7100	+12.0
8000	+11.4
9000	+10.1
10000	- 8.1
12500	0
14000	- 5.3
16000	-11.7
20000	-22.2
31500	-42.7

Figure 9-9. *Sound Weighted Characteristic.*



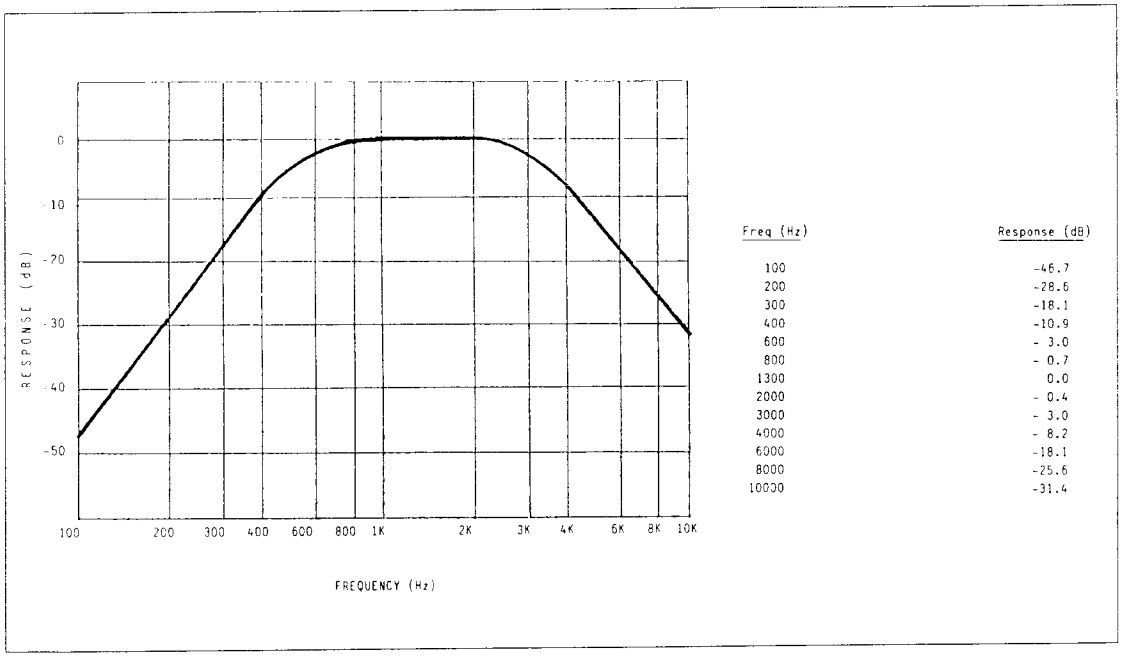
Freq (Hz)	Response (dB)
1	-55.4
2	-43.3
5	-27.3
10	-15.1
15	- 8.0
20	- 3.6
30	- 0.2
45	+ 0.4 (peak)
100	+ 0.1
800	0.0
1000	0.0
6500	-0.05 (valley)
13500	+0.15 (peak)
16000	0.0
22000	- 3.3
40000	-19.3
80000	
100000	-43.9

Figure 9-10 *Sound Unweighted Characteristic.*



Frequency (Hz)	Design Loss (dB) Ref to 1000 Hz
500	0.0
1000	0.1
2000	0.8
3000	3.0
4000	6.2
5000	9.4
6000	12.3
7000	14.9
8000	17.1
9000	19.1
10,000	21.0

Figure 9-11. *3 KHz Flat Characteristic.*



Freq (Hz)	Response (dB)
100	-46.7
200	-28.6
300	-18.1
400	-10.9
600	- 3.0
800	- 0.7
1300	0.0
2000	- 0.4
3000	- 3.0
4000	- 8.2
6000	-18.1
8000	-25.6
10000	-31.4

Figure 9-12. *2 KHz Flat Characteristic.*

10. DIALING

10.01 INTRODUCTION

This section covers the dialing (signaling) capability of the AM5XT/eXT. The AM5XT/eXT can outpulse in any of the three (3) dialing modes listed below:

DP (Dial Pulse)
TT (Touch Tone-DTMF)
MF (Multifrequency)

This section is divided into the following paragraphs.

10.02 MANUAL DIALING

Tone Dialing Level. For tone dialing (TT or MF), follow the procedure below to set the dual-tone composite level.

1) Set Send Function to QUIET mode.
2) Go to QUIET mode Display 4, "TTLV" in PARAMETER DISPLAYS, illustrated in ¶ 7.02.4) Set the parameter for the level desired for the TT/MF tones. Range: -50 dBm to +7 dBm.

-NOTE-
The maximum level for the TT/MF tones is +7 dBm, even though the generator is capable of levels up to +10 dBm for single tones.

Dial Mode Select To select a Dial Mode:

1. Locate the [DP/TT/MF] key in the lower left corner of the front panel.
2. Repeatedly press the [DP/TT/MF] key as necessary until the LED lights next to the desired Dialing Mode.
   DP = Dial Pulse
   TT = Touch Tone (also called DTMF, Dual Tone Multi-frequency)
   MF = Multi-frequency

-NOTE-
Once a Dial Mode (DP, TT or MF) has been selected, it will remain selected unless changed, even when Dialing Mode is exited to go to another mode (*LINE*, *SEND*, *MEAS* or *AUX*). When Dial Mode is enabled, the last selected Dial Mode will still be enabled (if power has been on continuously).

Dialing. To dial (outpulse) a digit:

1. Select the desired Dial Mode per procedure above.
2. Locate the row of 16 keys along the bottom edge of the front panel, labeled (from left to right) 1 thru 0, *, #, A, B, C, D.
3. Press the key associated with the digit to be outpulsed.

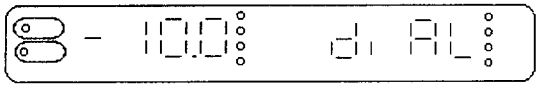
Monitoring Dialing. Note the following:

A. In order to listen to dialing:
   1) Set MONITOR Switch (item 4, Fig. 3-1) to the TX position.
   2) With Volume Knob (item 22, Fig 3-1), adjust speaker sound to comfortable level.

B. For indication of dialing on the display:
   1) Press [SEND] key (display *SEND* LED will light), before entering dialing mode (TT or MF).

10.02 MANUAL DIALING, continued

2) When a key is pressed to dial a digit, the left-hand display will indicate the level outpulsed (for tone dialing) and the right-hand display will read "DIAL" as indicated in the example display below:



10.03 STORAGE OF DIALED NUMBER

Up to ten (10) telephone numbers consisting of up to 48 digits each may be stored in dialed number memory locations 0 thru 9. Dialed number memory is non-volatile, so the numbers stored are retained even if power is turned off. In addition, the last number dialed is automatically stored. See ¶ 10.04 for procedures to recall and speed dial telephone numbers stored in memory.

Storing a Telephone Number:

1. Enter dialing mode and select Dialing Mode DP, TT or MF.
2. Dial the desired number (up to 48 digits).
3. Press [STO].
4. Press any digit 0 thru 9 corresponding to the memory location desired to store the number.
5. Exit dialing mode by selecting any other mode (*LINE, SEND, MEAS* or *AUX*).

Normally the digits are output to the line as step 2 is performed. To avoid actually sending the digits to the line, use the DP dialing mode in step 1 with the transmit line ON HOOK (*OFF HOOK* LED off).

-NOTE-
Only the *number* is stored. The level and Dialing Mode (DP, TT or MF) are *not* stored. For example, a dialed number could be stored while in DP mode and later recalled and speed dialed while in TT mode. See ¶ 10.04 for Speed Dialing.

Clearing a Stored Number:

Before a new number can be stored, the old number must be cleared or the new number will be stored after the sequence for the old number.

1. Exit dialing mode by selecting any other mode (*LINE, SEND, MEAS* OR *AUX*).
2. Enter dialing mode and select Dialing Mode DP, TT or MF.
3. Press[STO].
4. Press digit of memory location you wish to clear.
5. Follow procedure for **Storing a Telephone Number.**

10.04 AUTOMATIC SPEED DIALING

Before speed dialing, manually set the Tone Dialing Level and Dial Mode per instructions in ¶ 10.02, above.

Last Number Automatic Speed Dial. Any time that:

1. dialing mode is entered.
2. a number is dialed (either manually or using the recall function) and
3. dialing mode is exited (to *LINE, SEND, MEAS* or *AUX*),

the number just dialed is automatically stored in the last-number-dialed memory. To dial that number again, follow this procedure:

1. Enter dialing mode and select Dialing Mode DP, TT, or MF.
2. Press [RCL] and then [*].
3. The "last number dialed" will be recalled from memory and speed dialed.

Table 10-1
MF and TT (DTMF) Tone Pairs

KEY	MF TONE PAIRS (Hz)	TT TONE PAIRS (Hz)
[1]	700/900	1209/697
[2]	700/1100	1336/697
[3]	900/1100	1477/697
[4]	700/1300	1209/770
[5]	90/1300	1336/770
[6]	1100/1300	1477/770
[7]	700/1500	1209/852
[8]	900/1500	1336/852
[9]	1100/1500	1477/852
[*] (KP)	1100/1700	1209/941
[0]	1300/1500	1336/941
[#] (ST)	1500/1700	1477/941
[A] (ST3P)	700/1700	1633/697
[B] (STP)	900/1700	1633/770
[C] (ST2P)	1300/1700	1633/852
[D]		1633/941

10.04 AUTOMATIC SPEED DIALING, continued

Recall and Speed Dial of Stored Dialed Number. Any of the telephone numbers stored per ¶ 10.03 may be recalled from memory and speed dialed:

1. Enter dialing mode and select Dialing Mode DP, TT, or MF.
2. Press [RCL].
3. Press the key [0] thru [9] corresponding to the memory location containing the desired telephone number.
4. The telephone number will be recalled from memory and speed dialed.

10.05 DUAL-TONE DIALING FREQUENCIES

TT and MF Dialing Modes outpulse dual-tone signals. The frequencies of these tones are listed in Table 10-1. Note that there is no MF signal on key [D].

10.06 DIAL PULSE (DP) REQUIREMENTS

Unlike tone dialing (TT or MF) which can be done over circuits with or without line battery voltage, Dial Pulse (DP) requires loop current. Dial pulses are output by disconnecting (breaking) and connecting (making) the loop, at 60% break and 40% make. Therefore, Dial Pulse can only be done on a line over which loop current is flowing, such as a 2-wire POT (Plain Old Telephone) line. Dial Pulse cannot be done over dry (no loop current) 4-wire lines.

Observe the procedure below to dial 2-wire Dial Pulse (DP), TT or MF:

1. Press [LINE] key to go to LINE mode.
2. Press [5] to light the OFF HK LED and go off-hook.
3. The line connected to the AM5XT/eXT (at TX/2W jack) should now provide Dial Tone.
4. Adjust the speaker volume (item 22 in Fig. 3-1) to a comfortable level
5. Enter dialing mode and select Dialing Mode DP, TT or MF.

10.06 DIAL PULSE (DP) REQUIREMENTS, continued

6. Dial the number with the appropriate keys along the bottom edge of the front panel.
7. If time-out occurs before dialing is completed, temporarily go back on-hook.

   A. Go to LINE mode
   B. Press [5] to turn off *OFF HK* LED and wait for 2 to 3 seconds.
   C. Press [5] again to turn off the *OFF HK* LED again, then re-enter the dialed number.
8. If a person has been dialed, the operator can talk to the person at the distant end of the line. See ¶7.14 for TALK mode instructions.

10.07 DIALING CONTROLLED THROUGH (OPTIONAL) RS232 PORT

If dialing is controlled through the RS232 port, the following commands can be included in the dialed number string:

A. Go off-hook, then proceed to the next digit.
B. Pause for Dial Tone, then proceed to the next digit.
C. Wait 1 second, then proceed to the next digit.
D. 500 ms hook flash, then proceed to the next digit.

See Section 12 for details.

Note, however, that the dialed number store and recall functions cannot be controlled using the RS232 port.

10.08 REMOTE CONTROL USING TT COMMANDS

-NOTE-
This feature is not enabled in the AM5XT-BASIC because it requires a Digital Signal Processor (DSP) board, not installed in the AM5XT-BASIC.

A far-end AM5XT/eXT can be controlled from a near-end AM5XT/eXT using TT dialing. Observe the following procedure:

1. Manually enter desired front panel setups into memory locations in the unit to be used at the far (remote) site. Store each setup using the procedure below:
   A. Set Rear Panel DIP switch 7 to OFF (open).
   B. Enable desired front panel setup.
   C. Press [STO].
   D. Press the two (2) number keys (00 thru 39) of desired store location of front panel setup.
   E. Press [D] to enter.
2. Install the near and far-end AM5XT/eXTs.
3. To recall a front panel setup previously stored in a memory location of the far-end AM5XT/eXT:
   A. In the near-end AM5XT/eXT, enable TT Dialing Mode.
   B. Press [A].
   C. Press the two (2) number keys (00 thru 39) of desired front panel setup.
   D. The far-end AM5XT/eXT will automatically configure itself to the desired front panel setup.

10.09 TT RESPONDER CONTROL

TT (DTMF)-commandable responders can be controlled with an AM5XT/eXT. Use the AM5XT/eXT to output TT digits per the responder command set to tell the responder to go into any of its possible states. Some possible responder states are:

Quiet termination
Loopback*
Send 1004 Hz (Milliwatt)
Send slope tones
Amputate
Send certain digital bit patterns
Reset to through (transparent) mode

-*NOTE-
A dedicated loopback device is controlled with a momentary auxiliary tone. See ¶7.15.

11. MEMORY CONSIDERATIONS (STORE & RECALL)

11.01 INTRODUCTION

The AM5XT/eXT is equipped with 79 store and recall locations for test set-up and recall of frequently performed measurements. In addition to these, there are also ten locations for storing and recalling telephone numbers of up to 48 digits in length. Finally, there is a "last number dialed" recall memory.

11.02 FACTORY SET DEFAULTS

The unit is shipped with 30 memories loaded with information which may be recalled by the user. This information may be overwritten, if desired, if the SETUP PROTECT DIP switch on the rear panel (#7) is in the OPEN (= off) position. The stored information is protected if the unit is equipped with the optional battery pack (P/N24-0017). If the unit is not equipped with this option, and is left unused for approximately two weeks, the super-cap will discharge, resulting in a loss of memory. The battery pack will prevent this from happening.

Stored memory recalls 00-21 are Factory Default Programs for functions **not** including LINE. Recalls 41 to 44 and 51 to 54 are for LINE functions that are Factory set.

To RECALL (RCL):

1. Press [RCL] key.
2. Press the two number keys of the store location of the desired setup.
3. Unit will immediately configure itself to the recalled setup.

Following is a listing of the 30 stored memories and their intended purpose:

(Recall settings are also listed in the ***Quick Reference Card*** *of Factory Default Programs* [illustrated in Figs. 11-1 and 11-2] which is included with the AM5XT and AM5eXT units.)

RECALL 00	
SEND	OPEN - SF SKIP
MEASURE	LVL/FREQ
AUX	CMSG - JTR 20-300
DISPLAY	SEND - OPEN
PURPOSE	*Power Up Settings*

RECALL 01	
SEND	1.004 kHz @ 0 dBm - SF SKIP
MEASURE	LVL/FREQ
AUX	CMSG - JTR 20-300
DISPLAY	MEAS - dBm
PURPOSE	*Line Loss*

RECALL 02	
SEND	.404 kHz @ 0 dBm - SF SKIP (.304 kHz @ 0 dBm - SF SKIP on AM5eXT)
MEASURE	LVL/FREQ
AUX	CMSG - JTR 20-300
DISPLAY	MEAS - dBm
PURPOSE	*Line Loss*

RECALL 03	
SEND	2.804 kHz @ 0 dBm - SF SKIP (2.004 kHz @ 0 dBm - SF SKIP on AM5eXT)
MEASURE	LVL/FREQ
AUX	CMSG - JTR 20-300
DISPLAY	MEAS - dBm
PURPOSE	*Line Loss*

RECALL 04	
SEND	SLOPE @ 0 dBm - SF SKIP
MEASURE	LVL/FREQ
AUX	CMSG - JTR 20-300
DISPLAY	MEAS - dBm
PURPOSE	*3-Tone Slope (4-Tone Slope on AM5eXT)*

RECALL 05	
SEND	SWEEP @ 0 dBm (204Hz - 3004Hz) - SF SKIP
MEASURE	LVL/FREQ
AUX	CMSG - JTR 20-300
DISPLAY	MEAS - dBm
PURPOSE	*Voiceband Sweep*

RECALL 06	
SEND	QUIET - SF SKIP
MEASURE	NOISE
AUX	CMSG - JTR 20-300
DISPLAY	MEAS - dBrn
PURPOSE	*Idle Channel Noise*

MEMORY CONSIDERATIONS (STORE & RECALL)

RECALL 07	
SEND	1.004 kHz @ 0 dBm - SF SKIP
MEASURE	NOTCH NOISE
AUX	CMSG - JTR 20-300
DISPLAY	MEAS - dBrn - HOLD TONE - kHz
PURPOSE	*Noise with Tone (Notched Noise)*

RECALL 08	
SEND	1.004 kHz @ 0 dBm - SF SKIP
MEASURE	S/N
AUX	CMSG - JTR 20-300
DISPLAY	MEAS - dB - HOLD TONE - kHz
PURPOSE	*Signal-to-Noise Ratio*

RECALL 09	
SEND	QUIET - SF SKIP
MEASURE	IMP NOISE
AUX	CMSG - JTR 20-300
DISPLAY	MEAS - MIN
PURPOSE	*15 min. Impulse Noise w/o Tone*
Note:	Press "A" (START) to start test Press MEAS, continually press "#" (IMP NOISE) to view results

RECALL 10	
SEND	1.004 kHz @ 0 dBm - SF SKIP
MEASURE	TRAN
AUX	CMSG - JTR 20-300
DISPLAY	MEAS - HOLD TONE - MIN
PURPOSE	*15 min. impulse noise with tone + phase & gain hits and dropouts*
Note:	Press "A" (start) to start test, press "MEAS", continually press "A" (TRAN) to view results

RECALL 11	
SEND	RET LOSS (ERL) - SF SKIP
MEASURE	RET LOSS
AUX	CMSG - JTR 20-300
DISPLAY	SEND - dBm
PURPOSE	*Return Loss*
Note:	Press "7" (RET LOSS) to select ERL, SRL-Lo or SRL-Hi. Press "MEAS" to measure the return loss.

RECALL 12	
SEND	PAR @ 0 dBm - SF SKIP
MEASURE	PAR
AUX	CMSG - JTR 20-300
DISPLAY	MEAS - dBm - PAR
PURPOSE	*PAR*

RECALL 13	
SEND	1.004 kHz @ 0 dBm - SF SKIP
MEASURE	PHAS JTR
AUX	CMSG - Jtr 20-300
DISPLAY	MEAS - HOLD TONE -DEG
PURPOSE	*Phase Jitter (20-300 Hz)*

RECALL 14	
SEND	1.004 kHz @ 0 dBm - SF SKIP
MEASURE	AMP JTR
AUX	CMSG - JTR 20-300
DISPLAY	MEAS - HOLD TONE - %
PURPOSE	*Amplitude Jitter (20-300 Hz)*

RECALL 15	
SEND	IMD (2T) - SF SKIP
MEASURE	IMD
AUX	CMSG - JTR 20-300
DISPLAY	MEAS - dBm
PURPOSE	*4 tone intermodulation distortion test*
Note:	This recall should be used in conjunction with, and prior to, recall number 16. First, recall 15 and wait for display to read "C2T" (approx. 5 sec.), then recall 16.

RECALL 16	
SEND	IMD (4T) - SF SKIP
MEASURE	IMD
AUX	CMSG - Jtr 20-300
DISPLAY	MEAS - dBm
PURPOSE	*4-tone intermodulation distortion test*
Note:	Press "9" (IMD) to view 2nd and 3rd harmonics.

FOR AM5XT ONLY

RECALL 17	
SEND	ENV DLY (REF) - SF SKIP
MEASURE	ENV DLY (Mode = NORM)
AUX	CMSG - JTR 20-300
DISPLAY	MEAS - MSEC- kHz
PURPOSE	*Envelope Delay*
Note:	This test should be used with recall numbers 18, 19, 20 & 21. **See ENVELOPE DELAY NOTES.**

RECALL 18	
SEND	ENV DLY (SWEEP .204-3.504kHz)-SF SKIP
MEASURE	ENV DLY (Mode = NORM)
AUX	CMSG - JTR 20-300
DISPLAY	MEAS - MSEC - KHZ (BLINKING)
PURPOSE	*Envelope Delay*
Note:	You are now measuring the near to far envelope delay. (Displaying the delay and send frequencies.)

RECALL 19	
SEND	ENV DLY (REF) - SF SKIP
MEASURE	ENV DLY (Mode = NORM)
AUX	CMSG - JTR 20-300
DISPLAY	MEAS - MSEC - kHz
PURPOSE	*Envelope Delay*

RECALL 20	
SEND	ENV DLY (REF) - SF SKIP
MEASURE	ENV DLY (Mode = REPT)
AUX	CMSG - JTR 20-300
DISPLAY	MEAS - kHz
PURPOSE	*Envelope Delay*

RECALL 21	
SEND	ENV DLY (SWEEP .204-3.504kHz)-SF SKIP
MEASURE	ENV DLY (Mode = REPT)
AUX	CMSG - JTR 20-300
DISPLAY	MEAS - kHz
PURPOSE	*Envelope Delay*

ENVELOPE DELAY NOTES

For measuring delay in the transmit leg, recall "17", dial (TT) "A20" (this recalls #20 in the far end). Press "C" to zero out the reading. Recall #18. This will display the delay in the near-to-far leg.

For measuring delay in the receive leg, recall "17", dial (TT) "A20" (this recalls #20 in the far end). Press "C" to zero out the reading. Recall "19" and dial (TT) "A21" (this recalls #21 in the far end). This will display the delay in the far-to-near leg.

FOR AM5eXT ONLY

RECALL 17	
SEND	GRP DLY (SWEEP .204- 3.504 kHz)-SF SKIP
MEASURE	GRP DLY
AUX	PSHO-JTR 20-300
DISPLAY	MEAS - MSEC - kHz
PURPOSE	*Group Delay*

RECALL 18	
SEND	GRP DLY (SWEEP .204- 3.504 kHz)-SF SKIP
MEASURE	GRP DLY
AUX	PSHO-JTR 20-300
DISPLAY	MEAS - MSEC - kHz
PURPOSE	*Group Delay - Narrow Band*

RECALL 19	
SEND	GRP DLY (SWEEP .204-3.504 kHz)-SF SKIP
MEASURE	GRP DLY
AUX	PSHO-JTR 20-300
DISPLAY	MEAS - dB - kHz
PURPOSE	*Group Delay - Relative Loss - Narrow Band*

RECALL 20	
SEND	GRP DLY (SWEEP .200-20.00 kHz)-SF SKIP
MEASURE	GRP DLY
AUX	PSHO-JTR 20-300
DISPLAY	MEAS - MSEC - kHz
PURPOSE	*Group Delay - Wide Band*

RECALL 21	
SEND	GRP DLY (SWEEP .200-20.00 kHz)-SF SKIP
MEASURE	GRP DLY
AUX	PSHO-JTR 20-300
DISPLAY	MEAS - dB - kHz
PURPOSE	*Group Delay - Relative Loss - Wide Band*

GROUP DELAY NOTES

All group delay measurements are one way, with the path being measured towards the AM5XT/eXT. Both AM5XT/eXT's use the same recalls for each test.

RECALL 41	
LINE	135Ω(150Ω on AM5eXT) TX 135Ω(150Ω on AM5eXT) RX 4W

RECALL 42	
LINE	600ΩTX - 600 ΩRX - 4W

RECALL 43	
LINE	900ΩTX - 900 ΩRX - 4W

RECALL 44	
LINE	1200ΩTX - 1200 ΩRX - 4W

RECALL 51	
LINE	135Ω(150Ω on AM5eXT) TX 135Ω(150Ω on AM5eXT) RX 2W

RECALL 52	
LINE	600ΩTX - 600 ΩRX - 2W

RECALL 53	
LINE	900ΩTX - 900 ΩRX - 2W

RECALL 54	
LINE	1200ΩTX - 1200 ΩRX - 2W

To enter additional stored LINE set-ups, set the unit in the configuration desired using the *LINE* line information. Press "STO", followed by two (2) digits-- 40, 45 to 50, or 55 to 79. Press [D] to "ENTER" and complete the store.

-NOTE-
Remember that if 00-21, 41-44, or 51-54 is entered, the factory default is overwritten with the new configuration.

RECALL 80 (Version 8 and up)
Recalls all set-ups that were active when the unit was powered down.

On Version 8 and up units, recalls 81-88 are for setting performance limits (masks) for use when printing/plotting Level/Frequency and Delay sweep results.

Recalls 81-88 are factory set and cannot be changed from the front panel of the AM5XT/eXT. They can be changed through the RS232 port and stored for use later. See ¶12.09 for Conditioning Mask Definition Format.

11.03 USER ENTERED MEMORIES

It is suggested that the first 22 (00-21) recalls be left intact. In the event that there are operational problems, Ameritec Customer Service can more easily lead the user through tests to determine problems.

To enter additional stored set-ups, set DIP switch number 7, on the rear panel, to its open position. Set the unit in the configuration desired for recall by using the SEND, MEAS and AUX line information. Press "STO" followed by two digits, 22 to 39. Press [D] to "ENTER" and complete the store.

-NOTE-
The keypad mode (*SEND*, *MEAS* and *AUX*) and display selection are also stored. When the setup is recalled, these selections are also recalled.

Ameritec CORPORATION

MODEL AM5XT
WIDEBAND ANALOG/DATA
TRANSMISSION TEST SET

QUICK REFERENCE CARD, IEEE-743 VERSION
FACTORY DEFAULT PROGRAMS

TEST	RECALL #	TRANSMIT
Line Loss	01	1004 Hz, 0 dBm
Line Loss	02	404 Hz, 0 dBm
Line Loss	03	2804 Hz, 0 dBm
3-Tone Slope	04	Slope, 0 dbm
Full Sweep	05	Sweep, 204-3004 Hz, 0 dBm
Idle Channel Noise	06	Quiet Terminated
Notched Noise	07	1004 Hz, 0 dBm
Signal-To-Noise	08	1004 Hz, 0 dBm
Impulse Noise w/out Tone	09	Quiet Terminated
Step Sequence: Recall 09		
	Press "A" to Start Test	
	Press "MEAS"	
	Continually Press "#" to view results	
Impulse Noise w/Tone	10	1004 Hz, 0 dBm
Step Sequence : Recall 10		
	Press "A" to Start Test	
	Press "MEAS"	
	Continually Press "A" to View Results	
Return Loss	11	ERL, -2 dBm
To Select SRL-LO or SRL-HI:		
	Press "SEND"	
	Press "7" To Cycle Thru ERL, SRL-LO and SRL-HI	
	Press "MEAS" to Measure the Return Loss	
PAR	12	PAR, 0 dBm
Phase Jitter	13	1004 Hz, 0 dBm
Amplitude Jitter	14	1004 Hz, 0 dBm
Non Linear Distortion (IMD	15 & 16	4 Tone IMD
Step Sequence: Recall 15 at Transmit Set		
Wait for display to read "C2T" (approx. 10 sec.)		
Recall 16 at Transmit Set		
Press "9" at Receive Set to View 2nd & 3rd Order Distortion.		
Envelope Delay (Master/Normal)	17, 18 & 19	ENV DLY, 0 dBm
Envelope Delay (Slave/Repeat)	20, 21	ENV DLY, 0 dBm
Transmit Leg: Recall 20 at far end		Send Reference (REPT)
Recall 17		Send Reference (NORM)
Press "C"		Rel. Set
Recall 18		Send Sweep, 204 - 3504 HZ
Receive Leg: Recall 20 at far end		Send Reference (REPT)
Recall 17		Send Reference (NORM)
Press "C"		Rel. Set
Recall 21 at far end		Send Sweep, 204 - 3504 HZ (REPT)
Recall 19		Send Reference (NORM)

LINE IMPEDANCE	RECALL # (4W)	RECALL # (2W)
135 Ω	41	51
600 Ω	42	52
900 Ω	43	53
1200 Ω	44	54

Note: (1) 00-39 are recalls for measurement setups.
(2) 40-79 are recalls for line impedance setups.

Figure 11-1. *Quick Reference Card for AM5XT Factory Default Programs*

Ameritec CORPORATION

MODEL AM5eXT
WIDEBAND ANALOG/DATA
TRANSMISSION TEST SET

QUICK REFERENCE CARD, CCITT VERSION
FACTORY DEFAULT PROGRAMS

TEST	RECALL #	TRANSMIT
Line Loss	01	1004 Hz, 0 dBm
Line Loss	02	304 Hz, 0 dBm
Line Loss	03	2004 Hz, 0 dBm
4-Tone Slope	04	Slope, 0 dbm
Full Sweep	05	Sweep, 204-3004 Hz, 0 dBm
Idle Channel Noise	06	Quiet Terminated
Notched Noise	07	1004 Hz, 0 dBm
Signal-To-Noise	08	1004 Hz, 0 dBm
Impulse Noise w/out Tone	09	Quiet Terminated
Step Sequence: Recall 09		
	Press "A" to Start Test	
	Press "MEAS"	
	Continually Press "#" to view results	
Impulse Noise w/Tone	10	1004 Hz, 0 dBm
Step Sequence : Recall 10		
	Press "A" to Start Test	
	Press "MEAS"	
	Continually Press "A" to View Results	
Return Loss	11	ERL, -2 dBm
To Select SRL-LO or SRL-HI:		
	Press "SEND"	
	Press "7" To Cycle Thru ERL, SRL-LO and SRL-HI	
	Press "MEAS" to Measure the Return Loss	
PAR	12	PAR, 0 dBm
Phase Jitter	13	1004 Hz, 0 dBm
Amplitude Jitter	14	1004 Hz, 0 dBm
Non Linear Distortion (IMD)	15 & 16	4 Tone IMD
Step Sequence: Recall 15 at Transmit Set		
Wait for display at Receive Set to read "C2T" (approx. 10 sec.)		
Recall 16 at Transmit Set		
Press "9" at Receive Set to View 2nd & 3rd Order Distortion.		
Group Delay	18, 19, 20 & 21	GRP DLY, 0 dBm
Delay - Narrow Band	18	Sweep, 204 - 3504 Hz
Relative Level - Narrow Band	19	Sweep, 204 - 3504 Hz
Delay - Wide Band	20	Sweep, .200 - 20.00 kHz
Relative Level - Wide Band	21	Sweep, .200 - 20.00 kHz

LINE IMPEDANCE	RECALL # (4W)	RECALL # (2W)
150 Ω	41	51
600 Ω	42	52
900 Ω	43	53
1200 Ω	44	54

Note: (1) 00-39 are recalls for measurement setups.
(2) 40-79 are recalls for line impedance setups.

Rev. 018902

Figure 11-2. *Quick Reference Card for AM5eXT Factory Default Programs*

Memory 22 sweep 204Hz - 5.004KHz
rate 2.5 sec
level 0dB

Memory 23 sweep 204Hz - 5.004KHz
rate .1 sec
level 0dB

12. RS232 COMMMANDS

12.01 INTRODUCTION

In general, the AM5XT/eXT RS232 commands and functions follow the layout of the front panel. All commands that can be executed from the front panel can be executed remotely. All commands start with a "(" and end with a ")". The commands are executed as soon as the ")" is received. Other control characters, such as carriage return <CR> and line feed <LF>, are not required and will be ignored if received. Only characters between the "(" and ")" are processed.

The first letter of the command generally corresponds to the row in the front panel where that function is located. The second character corresponds to the key (0-9, *, #, A-D) for the function being controlled. The commands have exactly the same effect as they would have if entered from the front panel. Front panel controls which act as alternate on/off toggles are remotely controlled using a "+" or "-" in the command to turn that selection on or off.

A few RS232 commands have no front panel counterparts and are exclusive to remote control operation. Their formats do not follow the previously explained guidelines, but are activated using the same command format.

To display a Help Menu, press "?" and a brief explanation of command functions will be displayed. Control commands can be reviewed, if desired, along with display and set parameter instructions.

To display the parameter for a given command, include Pn after the command within the parentheses. To change the parameter for a given command, include Pn = n.n after the command within the parentheses. For example:

(S3)	Sends variable Hz
(S3P1)	Displays parameter 1 (Freq)
(S3P1=n.nnn)	Sends variable Hz and sets parameter 1 (Freq) to n.nnn kHz.

12.02 COMMAND PROTOCOL

Line control commands:

(L)	LINE MODE
(L1)	SENDZ = 135 Ω (150 Ω on AM5eXT)
(L2)	SENDZ = 600 Ω
(L3)	SENDZ = 900 Ω
(L4)	SENDZ = 1200 Ω
(L5+)	SEND OFF HOOK
(L5-)	SEND ON HOOK
(L7)	RCVZ = 135 Ω (150 Ω ON AM5eXT)
(L8)	RCVZ = 600 Ω
(L9)	RCVZ = 900 Ω
(L0)	RCVZ = 1200 Ω
(L*+)	RCV OFF HOOK
(L*-)	RCV ON HOOK
(L#+)	BRIDGE
(L#-)	TERMINATE
(LB)	2 WIRE
(LC)	4 WIRE
(LD+)	REVERSE
(LD-)	NORMAL

The following line control commands can only be executed from the RS232 port, not from the front panel:

(WR+)	Enter "WAIT FOR RING" mode
(WR-)	Terminate "WAIT FOR RING" mode

"Wait for ring" mode causes the RCV pair (if in 4W), or the SND pair (if in 2W), to go on hook and enter a high impedance state, attached only to the ring detector. If in 4W mode, the signal generator is temporarily put in quiet, but the SND pair line holding circuit remains in the state it was in before receiving the command. When a ringing burst is detected (about 500 ms of ringing voltage), the AM5XT/eXT will send the following message:

(RING) <CR> <LF>

> -NOTE-
> <CR> and <LF> are used to represent the ASCII carriage return and line feed characters.

Wait for ring mode is terminated either by the (WR-) command, or by going off hook on that pair.

12.02 COMMAND PROTOCOL, cont'd.

Send control commands:

(S) SEND MODE
(S1) QUIET
P0 = LEVEL, P1 = LBFRQ, P2 = TTLV
(S2) 1004
P0 = LEVEL
(S3) VARIABLE HZ
P0 = LEVEL, P1 = FREQ
(S4) SLOPE
P0 = LEVEL, P1 = RATE
(S5) SWEEP
P0 = LEVEL, P1 = START, P2 = STOP
P3 = STEP, P4 = RATE, P5 = DELAY
(S6) PAR
P0 = LEVEL
(S7) ERL/SRLL/SRLH
(S70) ERL
(S71) SRLL
(S72) SRLH
P0 = LEVEL

AM5XT:
(S8) ENVELOPE DELAY
(S80) ENV DLY SWEEP TEST FREQ
(S81) ENV DLY REF FREQ
P0 = LEVEL, P1 = MODE (0, 1, 2 FOR NORM, REPT, HOLD) , P2 = REF FREQ P3 = START, P4 = STOP, P5 = STEP, P6 = RATE, P7 = DELAY

AM5eXT:
(S8) GROUP DLY
P0 = LEVEL, P1 = REF FREQ, P2 = START, P3 = STOP, P4 = STEP, P5 = RATE, P6 = DELAY

(S9) IMD
(S90) IMD
(S91) IMD TEST
(S92) IMD S/N CHECK
P0 = LEVEL
(S0) OPEN
P0 = LEVEL
(SA+) SF SKIP ON
(SA-) SF SKIP OFF
(SB+) TALK ON
(SB-) TALK OFF
(SC) 2713 HZ FOR 1 SECOND
(SCn) 2713 HZ FOR n SECONDS

Measure Control Commands:

(M) MEASURE MODE
(M1) LEVEL/FREQ
P0 = LODB, P1 = HIDB, P2 = RATE, P3 = COND
(M2) NOISE
(M3) NOTCHED NOISE
(M4) NOISE TO GROUND
(M5) SIGNAL TO NOISE
(M6) PAR
(M7) RETURN LOSS
P0 = TLP
(M9) IMD
(M90) IMD LEVEL
(M91) IMD 2ND ORDER
(M92) IMD 3RD ORDER
(MA) TRANS
(MA0) TRANS TIME
(MA1) TRANS NOISE
(MA2) TRANS LO
(MA3) TRANS MID
(MA4) TRANS HI
(MA5) TRANS PHITS
(MA6) TRANS GHITS
(MA7) TRANS DROPOUTS (TRANS DROP 6DB on AM5eXT)
(MA8) TRANS DROP 10 DB (AM5eXT ONLY)
P0 = DUR, P1 = ITHLD, P2 = DELTA, P3 = PTHLD, P4 = GTHLD, P5 = BLANKING

AM5XT:
(M8) ENVELOPE DELAY
(M80) ENV DLY DLY/MEAS FREQ
(M81) ENV DLY DLY/SEND FREQ
(M82) ENV DLY LEVEL/FREQ
P0 = AVG, P1 = MODE (0, 1, 2 FOR NORM, REPT, HOLD), P2 = LOED, P3 = HIED, P4 = LODB, P5 = HIDB, P6 = RATE, P7 = COND

AM5eXT:
(M8) GROUP DELAY
(M80) GDLY DLY/ FREQ
(M81) GDLY LEVEL/FREQ
(M82) GDLY REF FREQ
(M83) GDLY REF LEVEL
(M84) GDLY MEAS LEVEL
P0 = FILTER (0, 1 FOR FILTER OUT, IN) P1 = AVG, P2 = LOGD, P3 = HIGD, P4 = LODB, P5 = HIDB, P6 = RATE, P7 = COND

12.02 COMMAND PROTOCOL
Measure Control Commands, continued:

(M#0) IMP NOISE TIME
(M#1) IMP NOISE NOISE
(M#2) IMP NOISE LO
(M#3) IMP NOISE MID
(M#4) IMP NOISE HI
P0 = DUR, P1 = ITHLD, P2 = DELTA, P3 = BLANKING
(MB) UINTR
(MB0) UINTR TIME
(MB1) UINTR CNT 1
(MB2) UINTR CNT 2
(MB3) UINTR CNT 3
(MB4) UINTR CNT 4
(MB5) UINTR CNT 5
P0 = DUR, P1 = THLD, P2 = BLANKING

Auxiliary control commands for AM5XT:

(A) AUX MODE
(A1+) LF FILTER IN
(A1-) LF FILTER OUT
(A2) CMSG FILTER
(A3) PGM FILTER
(A4) 3 KHZ FILTER
(A5) 15 KHZ FILTER
(A6) 50 KBIT FILTER
(AF) NO NOISE FILTER
(A8) PRINT
(A8+) PRINT PLOT ON
(A8-) PRINT PLOT OFF
(A9) JITTER 20-300
(A0) JITTER 4-300
(A*) JITTER 4-20
(A#) AUTOCALIBRATE
(AA+) START STUDY
(AA-) STOP STUDY
(AB+) 60 HZ FILTER IN
(AB-) 60 HZ FILTER OUT
(AC+) RELATIVE ON
(AC-) RELATIVE OFF
(AD+) DAMP ON
(AD-) DAMP OFF

Auxiliary control commands for AM5eXT:

(A) AUX MODE
(A1+) LF FILTER IN
(A1-) LF FILTER OUT
(A2) PSOPHOMETRIC FILTER
(A3) SOUND WEIGHTED FILTER
(A4) SOUND UNWEIGHTED FILTER
(A5) 3250 FLAT FILTER
(A6) 2300 FLAT FILTER
(AF) NO NOISE FILTER
(A7+) QUASI PEAK
(A7-) RMS
(A8) PRINT
(A8+) PRINT PLOT ON
(A8-) PRINT PLOT OFF
(A9) JITTER 20-300
(A0) JITTER 4-300
(A*) JITTER 4-20
(A#) AUTOCALIBRATE
(AA+) START STUDY
(AA-) STOP STUDY
(AB+) 60 HZ FILTER IN
(AB-) 60 HZ FILTER OUT
(AC+) RELATIVE ON
(AC-) RELATIVE OFF
(AD+) DAMP ON
(AD-) DAMP OFF

12.03 RESPONSE PROTOCOL

All responses from commands are enclosed in parentheses and terminated by the ASCII <CR> <LF> (carriage return line feed). For ease of interpretation by machine, all fields are fixed width so the fields always start and stop at predefined character positions in the line. The character positions are numbered above the sample output lines.

The following commands are used to read the current setup, or take a measurement remotely. They result in a response from the AM5XT/eXT. Responses are documented below:

Command	Function
(A1)	Read the displays and annunciators
(ACn)	Read the displays and annunciators every n seconds until "(" command is received.
(ALE)	Read line setup
(ASE)	Read send setup
(AME)	Read measure setup
(AAE)	Read auxiliary setup
(AE)	Read line, send, measure and auxiliary setups.

12.03 RESPONSE PROTOCOL, cont'd.

The following commands are for dialing:

Command	Function
(TTxxxxxx)	Dial Touch Tone
(DPxxxxxx)	Dial Dial Pulse
(MFxxxxxx)	Dial Multi Freq

Where: xxxxxx may be a maximum of 48 digits.
"x" may be any dialed digit 1-0, #, *, A, B, C, or D, or "x" may be any of the following 4 coded functions:

- P = pause for dial tone and then proceed to next digit (dial tone is 1 second of continuous energy > 24 dBm).
- \- = wait 1 second and then proced to next digit.
- F = 500 ms on hook flash and then proceed to next digit.
- H = go off hook and then proceed to next digit.

-NOTE-
The dial number store and recall functions cannot be controlled using the RS232 port.

The (A1) command is used to read the contents of the AM5XT/eXT numerical displays, along with the pertinent annunciators. See Figure 12-1 for response from (A1) command.

Characters	Definition
1	"("
2-5	"SEND" or "MEAS" depending on display.
6	space
7-14	Alpha-numeric contents of left display. It is 8 characters long to allow for up to 4 characters and 4 decimal points, though currently there is never more than one decimal point. A "+" sign appears in this field even though it appears as a blank on the front panel display.
15	space
16-22	Left display annunciator. "DBM", "DB", or "DBRN/MS". "HOLD TONE" will appear in character position 41-45.

Characters	Definition
23	space
24-31	Alpha-numeric contents of right display.
32	space
33-39	Right display annunciator. Blanks if no annunciator is on.
40	space
41-45	Holding tone annunciator.
46	Low battery annunciator. Space if off, "*" if on. The front panel low battery indicator is flashing decimal points that will *not* appear on the RS232 displays.
47	")"
48-49	<CR> <LF>

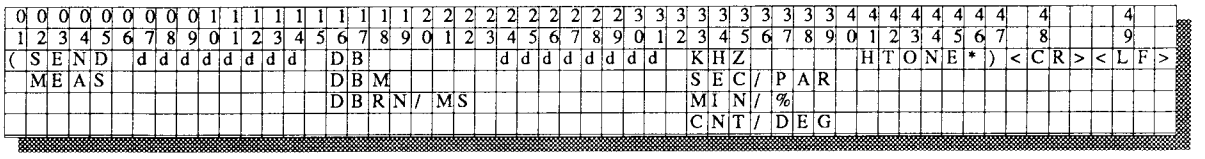


Figure 12-1. *Response from (A1) Command*

12.03 RESPONSE PROTOCOL, cont'd.

The (ALE) command is used to read the status of the AM5XT/eXT line control annunciators. See Fig. 12-2 for response from (ALE) command.

Characters	Definition
1	"("
2-6	"SNDZ="
7-10	Current send impedance, left justified
11	space
12-18	Send pair ON/OFF hook status
19	space
20-24	"RCVZ="
25-28	Current receive impedance, left justified
29	space
30-36	Receive pair ON/OFF hook status
37	space
38-43	Receive pair TERM/BRIDGE status
44	space
45-46	2W-4W mode
47	space
48-50	NOR/REV status
51	")"
52-53	<CR><LF>

```
0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 3 3 3 3 3 3 3 3 4 4 4 4 4 4 4 4 5 5 5       5
1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 1       2
( S N D Z   1 3 5   O N H O O K   R C V Z   1 3 5   O N H O O K   B R I D G E   4W  N O R ) < C R > < L F >
          1 5 0   O F F H O O K           1 5 0   O F F H O O K   T E R M       2W  R E V
          6 0 0                           6 0 0
          9 0 0                           9 0 0
          1 2 0 0                         1 2 0 0
```

Figure 12-2. *Response from (ALE) Command*

12.03 RESPONSE PROTOCOL, cont'd.

The (ASE) command is used to read the status of the AM5XT/eXT send control annunciators and related items. See Figure 12-3 for response from (ASE) command.

Character(s)	Definition
1	"("
2-7	"SMODE="
8-12	Current send mode
13	space
14-17	"LEV="
18-22	Current send level (even if in quiet)
23	space
24-27	"FRQ="
28-34	Current var Hz frequency (even if not sending var Hz), in kHz to 1 Hz resolution.
35	space
36-41	SF skip status
42	space
43-49	Talk status
50	")"
51-52	<CR><LF>

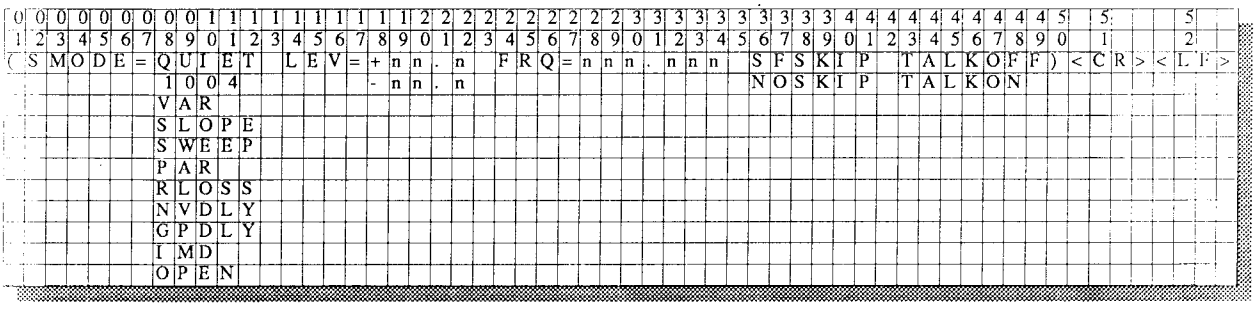


Figure 12-3. *Response from (ASE) Command*

12.03 RESPONSE PROTOCOL, cont'd.

The (AME) command is used to read the status of the AM5XT/eXT measure control annunciators and related items. See Figure 12-4 for response from (AME) command.

Characters	Definition
1	"("
2-7	"MMODE="
8-13	Current measure mode
14	")"
15-16	<CR><LF>

The (AAE) command is used to read the status of the AM5XT/eXT auxiliary control annunciators and related items. See Figure 12-5 for response from (AAE) command.

Characters	Definition
1	"("
2-12	"L/F FILTER="
13-15	Filter IN/OUT status
16	space
17-23	"FILTER="
24-29	Noise weighting filter in use.
30	space
31-34	"JTR="
35-40	Jitter bandwidth selected.
41	space
42-47	"STUDY="
48-52	Timed study STOP/START status.
53	space
54-57	"60 HZ" or "NO60" for 60 Hz filter status.
58	space
59-62	"REL="
63-67	Relative measure zero set "OFF" or with a relative reference level if on.
68	space
69-72	"DAMP" or "NOR" for display update select
73	")"
74-75	<CR><LF>

0	0	0	0	0	0	0	0	0	1	1	1	1	1		1				1		
1	2	3	4	5	6	7	8	9	0	1	2	3	4		5				6		
(	M	M	O	D	E	=	L	V	L	F	R	Q	)	<	C	R	>	<	L	F	>
							N	O	I	S	E										
							N	N	O	I	S	E									
							N	T	G												
							S	/	N												
							P	A	R												
							R	L	O	S	S										
							E	N	V	D	L	Y									
							G	R	P	D	L	Y									
							I	M	D												
							P	H	S	J	T	R									
							A	M	P	J	T	R									
							I	M	P												
							T	R	A	N											
							U	I	N	T	R										

Figure 12-4. *Response from (AME) Command*

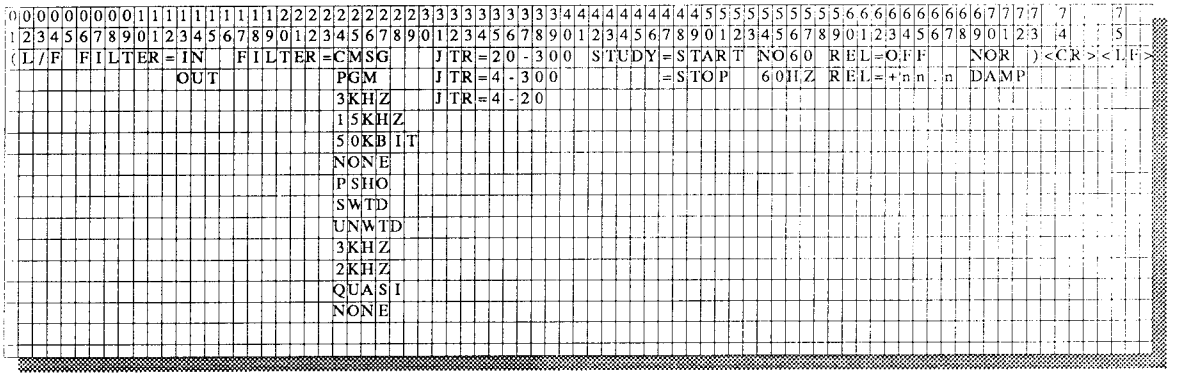


Figure 12-5 *Response from (AAE) Command*

12.03 RESPONSE PROTOCOL, cont'd.

The (AE) command is used to read the entire status of the AM5XT/eXT. It gives the same response as the (ALE), (ASE), (AME), and (AAE) commands, in that order. It gives a complete picture of the AM5XT/eXT setup.

12.04 PASSWORD SECURITY

The following have to do with password security:

(Pxxxx) Logon with password, up to 63 characters. May not include "(", ")", "!", "or ?". Logon is *not* needed if password DIP switch #8 is OFF. After turning password switch ON, unit will remain logged on until 2 minute timeout or (B) command, just as if it had been logged on with a password.

(AXYZxxxx) Set new password with up to 63 characters. May not include "(",")", "!", or "?".

12.05 MISCELLANEOUS COMMANDS

(B)	BYE, logoff.
)	Repeat last command entered.
(Znn)	Store front panel nn.
(Rnn)	Recall front panel nn.
(AY+)	Enable front panel display and keypad.
(AY-)	Disable front panel display and keypad.
(AYK)	Disable front panel keypad
(E+)	Echo ON
(E-)	Echo OFF

12.06 RS232 PORT CONFIGURATION

The operating characteristics of the RS232 port are controlled by DIP switch settings of switches 1-4 on the rear panel. Switches 7 and 8 control front panel setup protect and password.

See **Table 3-2** for RS232 connector pin assignments.

See **Table 3-3** for DIP switch settings.

12.07 AUXILIARY RS232 PORT

A second RS232 port is provided on the rear panel of the AM5XT/eXT in the form of a 9-pin female "D" miniature connector. It is labeled "AUX" port.

It is used to connect to the RS232 port of an "auxiliary unit", such as a printer, test access switch, etc., which may be co-located with the AM5XT/eXT and where it is desired to communicate with the auxiliary device via the main RS232 port of the AM5XT/eXT.

See Table 3-4 for auxiliary RS232 connector pin assignments. The baud rate and parity selection will be the same as that set for the main RS232 port.

12.08 DAISY CHAINING

In normal operation, the ASCII characters received by the AM5XT/eXT are decoded and acted upon by the AM5XT/eXT in accordance with the protocol described in ¶12.02. It is possible to command the AM5XT/eXT to become transparent so that all subsequent ASCII characters received by the AM5XT/eXT RS232 port are sent through to the "AUX" port.

The AM5XT/eXT will respond to a two-character transparent mode command at any time. The command is "!x", where "x" is any character "A" - "Z". An "A" disables transparent mode and activates normal command processing. Any other character puts the unit in the transparent mode. The "!" character is always sent out the "AUX" port when it is received. The character following the "!" is decremented if it is in the range "B" - "Z", then sent out the "AUX" port. In this way, several AM5XT/eXT's can be daisy chained together. "!A" will select the first unit in the chain for command processing. "!B" selects the second unit, "!C" the third unit, etc.

CAUTION

DO NOT daisy chain AM5XT/eXT's together with the baud rate set at 9600. Corruption of data will result.

When in transparent mode, any character received on the RS232 port is sent out the AUX port, and vice versa. When not in transparent mode, nothing is sent out the AUX port (except "!X" commands), and anything received on the AUX port is ignored.

12.09 CONDITIONING MASK DEFINITION FORMAT

The eight (8) performance limits, or masks, that can be used with the printer/plotter can be selected from the AM5XT/eXT front panel or selected and changed remotely via the RS232 port.

The unit has a set of eight (8) masks programmed into it when it is shipped from the factory. To recall the masks from the front panel, press [RCL] and the number key 81-88 that corresponds to the appropriate mask. Remotely, the command is (Rnn), where nn = 81 to 88.

To redefine a mask remotely, enter the following:
(CnN = NAME), where n = 1 to 8 corresponding to masks, and NAME is 4 characters or less.

The masks to be redefined has now been named. Now the limit specifications must be set. The command for defining limits for Level/Frequency is:
(CnLs = FFF.FFF, SLL.L, SHH.H), where

- n = mask to be redefined, 1-8,
- s = limit specification 1-8 within the mask for Level/Frequency,
- FFF.FFF = frequency in kHz, up to 6 digits,
- SLL.L = low level limit in dBm, up to 3 digits and a sign, and
- SHH.H = high level limit in dBm, up to 3 digits and a sign.

The command for redefining limits for Delay is:
(CnDs = FFF.FFF, SLL.LLL, SHH.HHH), where

- n = mask to be redefined, 1-8,
- s = limit specification 1-8 within the mask for Delay,
- FFF.FFF = frequency in kHz, up to 6 digits,
- SLL.LLL = low delay limit in ms up to 5 digits and a sign, and

12.09 CONDITIONING MASK DEFINITION FORMAT, continued

SHH.HHH = high delay limit in ms up to 5 digits and a sign.

To end limit specifications for a mask, enter
(CnLs = *) for Level/Frequency
(CnDs = *) for Delay.

Example:

Bell Standards require the following bandwidth parameter limits:

	ATTENUATION DISTORTION (FREQUENCY RESPONSE) RELATIVE TO 1004 Hz		ENVELOPE DELAY DISTORTION	
Channel Conditioning	Frequency Range (Hz)	Variation (dB)	Frequency Range (Hz)	Variation (μs)
Basic	500-2500 300-3000	-2 to +8 -3 to +12	800-2600	1750

-NOTE-
A (+) means loss with respect to 1004 Hz, and (-) means gain with respect to 1004 Hz. Therefore, (-) means a lower level and (+) means a higher level on the AM5XT/eXT.

Mask 1, in this example, will be for Basic channel conditioning. The name of the mask will be BASE. Enter:

(C1N = BASE).

Next, enter the lowest frequency, the low level limit and the high level limit for the first limit specification. for this example, enter

(C1L1 = 0.3, -12.0, 3.0).

Continue entering the next highest frequency and the corresponding low and high level limits.

(C1L2 = 0.5, -8.0, 2.0)
(C1L3 = 2.5, -12.0, 3.0)
(C1L4 = 3.0, -99.9,99.9)
(C1L5 = *)

The -99.9 and 99.9 in C1L4 indicate no low or high limit for this frequency. The * in C1L5 indicates there are no more limit specifications for this mask (Level/Frequency).

Entering the Delay distortion is similar to the Level/Frequency process. Enter the lowest frequency, low delay limit and high delay limit for the first limit specification. Enter the next highest frequency and the corresponding low and high delay limits. Low and high delay limits are entered in milliseconds (ms).

(C1D1 = 0.8, 0.0, 1.75)
(C1D2 = 2.6, -13.0, 13.0)]
(C1D3 = *)

The -13.0 and 13.0 in C1D2 indicates no low or high delay limit. The * in C1D3 indicates there are no more limit specifications for this mask (Delay).

Mask 1 has now been redefined and stored in recall 81. To recall masks, the command is (Rnn), where nn is 81 to 88.

13. PRINTING AND PLOTTING

13.01 INTRODUCTION

In order for the AM5XT/eXT to give a print-out, the unit must be equipped with the optional RS232 Port (Part No. 25-0019).

To use the AM5XT/eXT with an XY Plotter, the unit must be equipped with the XY Plotter Output option (Part No. 25-0045).

13.02 TYPES OF PRINTOUTS (up to Version 7)

There are two (2) types of printouts:

- Printout of the activated front panel test setup.
- Printout of the test results being displayed in the measure display. This type of printout is possible for the tests listed below:
  1. Level/Frequency
  2. Envelope Delay for AM5XT

  -or-

  Group Delay for AM5eXT.

How to implement each type of printout is discussed below.

Setup. Connect an AM47XT or other appropriate printer to the RS232 port (25-pin D-type connector) on the rear panel.

Be sure the Baud rate is set the same as the Baud rate of the AM5XT/eXT; see Table 3-3 for Baud rate settings for the AM5XT/eXT.

Printout of Front Panel Setup.

1. Press [AUX] key.
2. *Momentarily* press [8].
3. The *PRINT* LED will *not* be ON during this print mode.

Printout of Measurement.

1. Set *LVL/FREQ, ENV DLY,* or *GROUP DLY* Measurement display to the display to be printed/plotted.
2. Set low and high plotting parameters by referring to ¶8.02, 8.10 and 8.11. Refer to the section in these paragraphs titled **Plotting.**
3. Press [AUX] key.
4. *Continuously* press [8] for approximately 2 seconds.
5. The *PRINT LED* will flash ON/OFF during this print mode.
6. To exit this print mode, again *continously* press [8] for approximately 2 seconds; *PRINT* LED will go out.

13.03 TYPES OF PRINTOUTS (Version 8 and up)

There are three (3) types of printouts:

- Printout of the activated front panel test setup.
- Printout of the plot results and measurements being displayed in the measure display. This type of printout is possible for the tests listed below:
  1. Level/Frequency
  2. Envelope Delay for the AM5XT

  -or-

  Group Delay for the AM5eXT.
- Printout of the plot condition mask.

Select low and high plotting parameters and plot condition mask by referring to ¶8.02, 8.03 and 8.11. Refer to the section in these paragraphs titled **Plotting.**

How to implement each type of printout is discussed below.

Printout of Front Panel Setup.

1. Press [AUX] key
2. Press [8, PRINT] key. Display cycles through three (3) print options and one (1) blank option. Release [8, PRINT] key when display reads "PrnT".
3. The *PRINT* LED will be on during this mode.

Printout of Plot Measurement Results.

1. Set *LVL/FREQ, ENV DLY,* or *GRP DLY* Measurement display to the display to be printed/plotted.
2. Set low and high plotting parameters by referring to ¶8.02, 8.10 and 8.11. Refer to the section in these paragraphs

13.03 TYPES OF PRINTOUTS (Version 8 and up), continued

4. Press [8, PRINT] key. Display cycles through three (3) print options and one (1) blank option. Release [8, PRINT] key when display reads "PrnT PLoT".
5. The *PRINT* LED will be flashing during this mode.

Printout of Plot Condition Mask.

1. Press [AUX] key.
2. Press [8, PRINT] key. Display cycles through three (3) print options and one (1) blank option. Release [8, PRINT] key when display reads "PrnT Cond".
3. The *PRINT* LED will be flashing during this mode.

Exiting Print Mode Before Printing.

1. Press [8, PRINT] key. Display will cycle through three (3) print options and one (1) blank option. Release [8, PRINT] key when display is blank.

Exiting Print Mode While Printing.

1. Press [8, PRINT] key. Wait until *PRINT* LED stops flashing, then release [8, PRINT] key.

13.04 XY PLOTTER OPERATION

Start and Stop Frequencies for Plotter Limits.

1. Go to "START" frequency of frequency Sweep by pressing [SEND] key, [SWEEP] key (or [ENV DLY] on AM5XT or [GROUP DLY] on AM5eXT), then [PARAM SET] as necessary.

2. Enter frequency that corresponds to minimum frequency to be plotted.

3. Go to "STOP" frequency of frequency Sweep by pressing [PARAM SET] once.

4. Enter frequency that corresponds to maximum frequency to be plotted.

-NOTE-
When using Automatic Tracking, the send rate on both units must be the same to allow time at the beginning and end of each plot for the pen to catch up with the change in frequencies during the Delay Time.

Set Up Plotter Zero and Scaling.

1. Choose a scale on the plotter which will keep the entire plot on the paper and be convenient to read.

2. Go to low limit of plotting parameter (Lodb, LoEd, or LoGd) by pressing [MEAS] key, [LVL/FREQ] key (or [ENV DLY] on AM5XT or [GROUP DLY] on AM5eXT), then [PARAM SET] as necessary. AM5XT/eXT is now outputting minimum frequency and minimum level or delay to plotter.

3. Adjust "ZERO" controls on plotter to obtain desired location of minimum frequency and minimum level or delay.

4. On AM5XT/eXT, enter value of level or delay that corresponds to the current position of the plotter.

5. Go to high limit plotter parameter (Hidb, HiEd, or HiGd) by pressing [PARAM SET] once. AM5XT/eXT is now outputting maximum frequency and maximum level or delay to plotter.

6. Adjust gain controls on plotter to obtain desired location of maximum frequency and maximum level or delay.

7. On AM5XT/eXT, enter value of level or delay that corresponds to the current location of the plotter.

8. Repeat steps 1 through 7 to minimize the effect of interaction between the zero controls and gains controls on the plotter.

13.04 XY PLOTTER OPERATION, cont.

Choosing Plotting Algorithm.

1. While in Measure Mode, press [PARAM SET] key as necessary to get to "RATE" parameter.

2. For Auto-Track Plotting, enter "0". For Continuous Plotting, enter any number except "0" (up to 255 seconds).

Begin Plot.

1. Press [MEAS] key to display readings to be plotted.

2. Set Reference if relative measurement is desired. Set far end to reference level and frequency. If Envelope Delay, set near end to reference level and frequency also.

3. Press [AUX] key, then [REL SET] key to establish reference level or "0" delay.

4. Start frequency sweep at far end (or applicable end if envelope delay).

5. Wait for plotter to move to first plot point, then lower the plotting pen.

6. Wait for plotter to move to last plot point, then raise the plotting pen.

14. ORDERING INFORMATION

Part No.	DESCRIPTION
AM-5XT	Two- and Four-Wire Voice/Data Analog Transmission Test Set. (North American version)
AM-5eXT	Two- and Four-Wire Voice/Data Analog Transmission Test Set. (World, CCITT version)
Accessories and Options	
AM-47XT	Hand-Held Plotter Printer for AM5XT.
	Includes cable and one roll paper. Requires Option 25-0019.
18-0022	AM5XT/eXT Instruction Manual
25-0019	RS232 Remote Control Port with AUX RS232 Output Port. Required for plotter printer.
24-0017	Sealed Lead Acid Batteries and Integral Charger for AM5XT/eXT.
25-0045	X-Y plotter option for AM5XT/eXT.
25-0036	Field Upgrade Kit to Upgrade an AM5XT-BASIC to an AM5XT.
25-0037	Factory Upgrade of an AM5 to an AM5XT.
25-0041	"Siemens" type banana connections
26-0014	One roll paper for AM-47XT.
26-0015	Ribbon cartridge for AM-47XT
25-0020	Delete front panel (credit)
48-0012	Universal RS232 Cable
48-0047	Bantam (M) to Bantam (M) Input Cable, 6' (two used for 4-wire operation)
48-0048	Bantam (M) to 310 (M) Input Cable, 6' (two used for 4-wire operation)
48-0062	Bantam (M) to Mini-Clip Input Cable, 6' (two used for 4-wire operation)
48-0083	Chaining cable
48-0084	Printer cable (TI type, 25 pin)
48-0095	Replacement cable for AM5XT/eXT to AM-47XT
70-0029	110 VAC Wall adaptor for AM-47XT
85-0076	19" Rack Mounting Kit.
87-0070B	Padded Carrying Case with pouch for AM-47XT

15. WARRANTY AND SERVICE POLICY

Ameritec Corporation warrants that its electronic instrument products are manufactured to the highest commercial standards and are free of any defects in material or workmanship. For a period of one year from shipment, Ameritec will repair without charge to the original purchaser any unit which upon inspection by Ameritec proves to be defective. This warranty is the sole warranty offered by Ameritec and is in lieu of all other warranties express or implied and all other obligations or liabilities including claims of consequential damage.

In the event of malfunction, call or write the Ameritec factory and obtain a return authorization number. Return the unit to Ameritec freight prepaid with a note enclosed listing:

- Return Authorization Number
- Return shipment address
- Name and telephone number of person familiar with the problem
- Brief description of problem

The unit will be repaired and returned freight prepaid for units in warranty and freight collect for out-of-warranty units. A copy of the original Purchase Order must accompany an out-of-warranty repair.

AMERITEC CORPORATION
760 Arrow Grand Circle
Covina, California 91722
U.S.A.

Telephone: (818)915-5441
Telex: 754958
FAX: (818)915-7181

TECHNICAL SPECIFICATIONS
AM5XT, AM5eXT

REVISED 11/23/88

Note: All references to IEEE, refer to IEEE Std. 743-1984

1. Measurements

Level:	(-65 to +10 dBm)
Frequency:	(20 Hz to 120 kHz)
Noise:	(AM5XT, 10 to 100 dBrn) (AM5eXT, -80 to +10 dBm)
Noise with Tone:	(AM5XT, 10 to 100 dBrn) (AM5eXT, - 80 to +10 dBm)
S/N Ratio:	(10 to 50 dB)
Noise to Ground:	(AM5XT 40 to 130 dBrn) (AM5eXT - 50 to +40 dBm)
Impulse Noise:	(3 Level)
Transients:	(Phase Hits, Gain Hits, Interruptions, Impulse Noise)
Micro Interruptions	
Return Loss:	(2 Wire, 4 Wire)
Envelope Delay Distortion:	(AM5XT)
Group Delay:	(AM5eXT)
Phase Jitter	
Amplitude(Gain) Jitter	
P/AR	
Intermodulation Distortion (U.S. Patent 3,862,380)	

2. Send Functions (Signal Generator):

2.1	VAR:	(Variable frequency/level settable by user).
2.1.1	Frequency Range:	20 HZ TO 120 KHz
2.1.2	Frequency Resolution:	a) 10 Hz single stepping 100 Hz automatic repeat stepping
		b) 1 Hz from 20 to 9999 Hz 10 Hz from 10 KHz to 99.99 KHz 100 Hz from 100 KHz to 120 KHZ using 4 digit manualparameter entry.
		c) 1 Hz through the whole range using remote control via RS232 port.

2.1.3 Frequency Accuracy: (Tolerance) ± 0.01 %

2.1.4 Level Range: -50 dBm to +10 dBm for the entire frequency range.

2.1.5 Level Resolution: 0.1 dB through the entire range, any mode of entry.

2.1.6 Level Accuracy: (Tolerance)

	20 Hz	200 Hz	20 kHz	120 kHz
+10 dBm	±.25	±.1	±.25	
-40 dBm	±.5	±.5	±.5	
-50 dBm				

Accuracy is not specified below 400 Hz when using 135 ohm (150 ohm, AM5eXT) termination.

2.2 Signalling Frequencies (SF) Skip:

Frequency range skipped in automatic sweep modes or disallowed in manual entry modes, when SF function is selected, is: 2450 Hz to 2750 Hz (2130 Hz to 2430 Hz AM5eXT).

2.3 Holding Tone:

Used when performing Level/Frequency (when not in VAR mode), Phase/Amplitude Jitter, Noise with Tone or Transients Measurements.

* Frequency 1004 Hz @ <0.1 deg phase jitter.

* Level -50 to +10 dBm

Alternately, the operator can set the desired frequency (e.g. 1020 Hz) using VAR.

2.4 2 KHz Tone

Selected under VAR mode when measuring micro interruptions.

* Frequency 2 KHz

* Level/Range -50 to + 10 dBm

2.5 Slope Tones

Tones generated when measuring gain slope (frequency response).

2.5.1 Fixed Tones:

*	Frequencies	404, 1004, 2804 Hz (AM5XT) 304, 1004, 2004, 3004 Hz (AM5eXT)
*	Dwell	5 seconds per tone default. Operator settable.
*	Level Range	-50 to + 10 dBm

2.5.2 Sweep Mode

Operator settable level, start frequency, stop frequency, frequency step size, step rate, and delay to start of next sweep.

2.6 Return Loss

All signals specified below are band limited noise. The frequency characteristics are indicated in Tables 1, 2, and 3.

* Echo Return Loss (ERL) 560 to 1965 Hz
* Singing Return Loss - Low (SRL-LO) 260 to 500 Hz
* Singing Return Loss - High 2220 to 3400 Hz
* Level - Settable -2 to -10 dBm
* Level Accuracy - $\pm$0.5 dB

2.7 Peak to Average Ratio (PAR):

P/AR Line Spectrum:	Per IEEE 4.6.2.1 See Table 4
P/AR Distortion:	Spurious outputs $\leq$4 kHz >50 dB below component at 1890.625 Hz Spurious outputs >4 kHz >40 dB below component at 1890.625 Hz
Period:	64.0 ms $\pm$0.1%
Level Range:	0 to -40 dBm (true rms)

2.8 Group Delay Transmitter (CCITT 0.81)(AM5eXT)

2.8.1 Reference Signal (Carrier):

* Frequency: 1800 Hz Default, settable 200 Hz to 20 KHz ± 0.5%

2.8.2 Measuring Signal (Carrier):

Sweep

Start Frequency:	200 - 20 kHz
Stop Frequency:	200 - 20 kHz
Step Size:	1 - 9999 Hz
Rate*:	0.1 - 999.9 Sec
Delay Before Start & After Stop:	0.1 - 999.9 Sec

* This is the length of time each measuring carrier will be generated. The finest resolution is 0.24 sec (based on change over frequency). Due to this fact, the AM5eXT will round the entered value to the nearest 0.24 sec.

2.8.3 Modulation Signal

* Frequency: 41.66 Hz ± 0.5%

* Modulation Depth: 0.4 ± 0.05 (40% ±5%)

2.8.4 Identifying Signal:

* Frequency: 166.6 Hz ± 0.5% (derived from modulation frequency)

* Modulation Depth: 0.2 ± 0.05 (20% ±5%)

* Send Duration of Signal: 24 ms (1 cycle of modulation signal)

2.8.5 Change Over Frequency:

Minimum period at which measuring carrier can be changed to a new value.

* Frequency: 4.166 Hz ± 0.5% (derived from modulation frequency)

* Period: 240 ms

2.8.6 Composite Output Signal:

* Level: -40 dBm to +10 dBm (600 ohm)

  Level Accuracy: ±0.3dBm

* Modulation Distortion: (Ratio of RMS value of unwanted sidebands to that of wanted sidebands) < 1%

* Carrier Change-Over Time: (From one carrier to the next) < 100 uS

* Deviation Between Carrier Change Over Point and Envelope Minimum (Fig. 2.8) ≤ ± 0.2 ms

* Harmonic Distortion < 1.0%

* Spurious Distortion < 0.1%

* Maximum Error in Group Delay Measurement Contributed by Generator.

  200 - 400 Hz ± 5 uS
  400 - 600 Hz ± 3 uS
  600 - 20K Hz ± 1 uS

2.9 Envelope Delay Distortion Transmitter (AM5XT):

Frequency Range:	200 - 4000 Hz ± 1 Hz
Level Range:	0 to -40 dBm ± .1 dB
Delay Distortion of Transmitter:	< ± 5 us 600 to 4000 Hz < ± 15 us 200 to 599 Hz
Modulation:	83.333 Hz ± 0.1% 50% ± 5%
Distortion:	83.33, 3 fc + 83.3 Hz at least 52 dB below carrier. Other spurious signals at least 46 dB below carrier. Total distortion at least 43 dB below carrier.

2.10 Non-Linear Distortion (4 Tone)*

Transmitter:

Level Range:	0 to -40 dBm rms
Level Accuracy:	±1 dB
Spectrum:	857,863,1372,1388 Hz at equal (±0.2 dB) levels
Harmonic Distortion:	>35 dB below tone
Background Noise:	Any noise within passband of distortion filters >70 dB below 4 tone signal
Signal/Noise Check:	857,863 Hz pair
Self Check Signal:	
2nd Order	20 ±0.5 dB
3rd Order	30 ±0.5 dB

*U.S. Patent 3,862,380

3. Receive Functions

3.1 Level Measure:

* Range: -64.9 to +10 dBm

* Resolution: 0.1 dB

* Accuracy in dB:

	20 Hz	200 Hz	20 kHz	120 kHz
+10 dBm	±.5	±.2	±.5	
-50 dBm	±1.0	±1.0	±1.0	
-65 dBm				

Notes: At 1004-1020 Hz accuracy is ±0.1 dBm from 0 to -20 dBm. When using 135 ohm (150 ohm, AM5eXT) accuracy is not specified below 400 Hz.

* Noise Protection: Low frequency (60 Hz) switchable in or out. High frequency, 120 KHz low pass always inserted. In addition, 15K Flat(AM5XT) or Sound Unweighted (AM5eXT)filter may be inserted.

* Detector: Average

3.2 Frequency Measure

* Range: 20 Hz to 120 KHz

* Resolution/ Accuracy: 20 Hz to 10 KHz - 1 Hz/±1 Hz
10 KHz to 100 KHz - 10 Hz/±10 Hz
100 KHz to 120 KHz - 100 Hz/± 100 Hz

* Signal Level: -55 to + 10 dBm with S/N ratio >20 dB

3.3 Noise Measure

* Level:
  Noise
    (AM5XT) 10 to 99 dBrn (20-99 dBrn @ 135 ohm)
    (AM5eXT) -80 to +9 dBm, (-70 to +9 dBm at 150 ohm)

  Noise to Ground
    (AM5XT) 40 to 129 dBrn
    (AM5eXT) -50 to +39 dBm

* Resolution: 1 dB

* Accuracy:
  Noise
    (AM5XT) 20 to 99 dBrn, ±1 dB
    10 to 20 dBrn, ±2 dB
    (±1 dB CMSG)
    (AM5eXT) -70 to +9 dBm, ±1 dB
    -80 to -70 dBm, ±2 dB
    (±1 dB PSO)
  Noise to Ground ±1.5 dB

* Filters:
    (AM5XT) C-Message, Program 3 kHz flat, 15 kHz flat, 50 k Bit, 60 Hz
    (AM5eXT) Psophometric (P.53), Sound Wtd. (J.16), Sound Unwtd (J.16), Flat (275 - 3250 Hz) (0.71), Flat (750 - 2300 Hz) (0.71), 60 Hz

* Detector: RMS or Quasi-Peak (J.16) (AM5eXT only) as selected

3.4 Noise With Tone Measure:

* Notch: 995 - 1025 Hz, 50 dB minimum

(Other specifications same as "NOISE MEASURE" above)

3.5 Signal to Noise Measure:

* Signal Range: -40 to +10 dBm

* Noise Range:
    (AM5XT) 10 dBrn to 70 dBrn
    (AM5eXT) -80 to -20 dBm

* Display Range: 10 to 60 dB

* Accuracy:

(AM5XT)	Noise above 20 dBrn, ±1 dB Noise below 20 dBrn, ±2 dB (± 1 dB CMSG)
(AM5eXT)	Noise above -70 dBm, ±1 dB Noise below -70 dBm, ±2 dB (±1 dB PSO)
(Both)	S/N Ratio 0 - 40 dB, ±1 dB S/N Ratio 40 - 45 dB, ±2 dB S/N Ratio 45 - 50 dB, ±3 dB S/N Ratio 50 - 60 dB, ±3 dB*

*(Typical performance, not guaranteed).

3.6 Impulse Noise Measure (3 Level):

	AM5XT	AM5eXT
* Minimum Threshold:	30 dBrn	-60 dBm
* Maximum Threshold:		
135 (150) ohm	112 dBrn	+22 dBm
600 ohm	106 dBrn	+16 dBm
900 ohm	104 dBrn	+14 dBm
1200 ohm	103 dBrn	+13 dBm

* Threshold Difference: 2,3,4,6 dB, Operator Settable

* Threshold Accuracy: ±1 dB

* Study Timer: User settable 0.1 - 999.9 min. or continuous. Default = 15.0 min.

* Max Count: 9999 (each threshold)

* Dead Time: Settable 1-255 ms (125 ms default)

3.7 Impulse Noise with Tone Measure:

See 3.14, Transients

3.8 P/AR Measure:

*	Test Signal:	P/AR Waveform
*	Range:	0 to 120 P/AR units
*	Resolution:	1 P/AR unit
*	Accuracy:	P/AR = 30 to 110 - ± 2 P/AR units P/AR = 0 to 120 - ± 4 P/AR units
*	Signal Level Range:	-40 to 0 dBm (measured with RMS detector)
*	Receive Filter:	2 cascaded bandpass filters Q=2, F=1300 Hz
*	Detectors:	Full Wave Average, Peak and RMS

3.9 Return Loss Measure:

*	Test Signals:	Band limited white noise (ERL, SRL-LO, SRL-HI) or sine wave @ -10 to -2 dBm
*	Range:	0 to 40 dB (2 wire) 0 to 50 dB (4 wire)
*	Resolution:	0.1 DB
*	Accuracy:	±0.5 dB
*	4 Wire Level Compensation (TLP):	+99.9 to -99.9 dB in .1 dB steps
*	Detector:	True RMS

3.10 Group Delay Measure (AM5eXT):

Input Level Range -50 dBm to +10 dBm
(-40dBm for 135/150 ohm)

Delay Measuring Range -12000 to +12000 uS

Delay Measuring Accuracy ±1% of reading
+ errors from table below

Measuring Freq	Additional Error
200 to 400 Hz	50 uS
400 to 600 Hz	15 uS
600 to 20k Hz	5 uS
Amplitude Variation	**Additional Error**
0 to 10 dB	5 uS
10 to 30 dB	10 uS
30 to 50 dB	20 uS

Level Measurement Accuracy

Relative Level Reading (+/-)	Relative Level Accuracy	Absolute Level Accuracy
0 to 10 dB	±0.15dB	±0.25dBm
10 to 30 dB	±0.30dB	+0.30dBm
30 to 40 dB	±0.50dB	+0.50dBm
40 to 50 dB	±1.00dB	±1.00dBm

Frequency Readings ± 1%

3.10.1 Noise Immunity:

A low pass filter to reduce interfering signals above 4 KHz is selectable. The filter meets the following requirements.

Group delay at 2600 Hz relative to 1 KHz <± 5 uS
Group delay at 2800 Hz relative to 1 KHz <± 30 uS

Group delay error <±20 uS in presence of white noise, band limited to 4 KHz, at a level of 26 dB below carrier level and a sweep rate less than 25 Hz/Sec.

The error due to presence of a tone near the reference or measuring signal, when the level of the tone is 26 dB below the signal, will be as follows:

Tone Frequency Deviation from Signal Error

± 150 Hz	≤ 20 uS
± 200 Hz	≤ 2 uS

3.11 Envelope Delay Distortion Receiver (AM5XT)

Measurement Range:	-3000 to +9000 us
Frequency Range:	200 - 4000 Hz
Level Range:	-40 to +10 dBm
Resolution:	1 microsecond
Accuracy:	600 - 4000 Hz, ±5 uS 200 - 599 Hz, ±15 uS
Display Response Time:	<1 second
Repeat Mode Settling Time:	<3 seconds
Signal/Noise Ratio:	Accuracy specifications are met with S/N ratio ≥24 dB
Turnover:	Accuracy is unaffected by interchanging the input leads.
Analog Output:	DC voltages suitable for driving an X-Y recorder are provided.
Drift:	After warm-up the reference zero will not drift by more than 10 microseconds in any 30 minute period.
Repeat Mode:	Both forward reference and return refernce modes are provided.
Hold Mode:	Provides a 2-wire "one way" measurement with drift <15 uS per minute.

3.12 Phase Jitter Measure (IEEE, CCITT 0.91):

* Test Signal: 990-1030 Hz <0.1 Deg Jitter, -40 to +10 dBm
* Jitter Range: 0.0 to 30 Degrees P-P
* Accuracy: ± 5% of Value, ± 0.2 Degrees

* Noise Protection:

  400 Hz high pass, 12 dB/octave
  1800 Hz low pass, 24 dB/octave
  Band limited (250-3500 Hz) white noise down 30 dB from 1 kHz sine wave reads < 4 degrees jitter peak-peak.

* Single Frequency Interference: Per IEEE 4.5.1.7 (no applicable CCITT specification)

* Frequency Weighting:

4-300 Hz	See Table 5.
4-20 Hz	See Table 5.
20-300 Hz	See Table 5.

* Level to Phase Conversion: Per IEEE 4.5.1.8 & CCITT 0.91 2.5

* Amplitude to Phase Conversion: Using a test signal of 1 kHz 10% amplitude modulated the phase jitter reads less than 0.2 Degrees.

* Peak Detector Performance: Per 1EEE 5.4.1.11 & CCITT 0.91

* Demodulated Signals:

Carrier	Provided
Phase Jitter	Provided

* Time to Display Correct Reading:

4-20, 4-300 Hz	25 Seconds
20-300 Hz	4 Seconds

3.13 Amplitude Jitter:

*	Test Signal:	990-1030 Hz <0.1% jitter -40 to +10 dBm
*	Accuracy:	±5% of reading ±0.2 %
*	Measurement Range:	0.0 - 25.0% Peak
*	Noise Rejection:	Per IEEE 4.5.2.5
*	Frequency Weighting Using Two Tone Test Signal of IEEE 4.5.2.6	See Tables 6,7
*	Signal Frequency Interference:	Per IEEE 4.5.2.7
*	Level to Amplitude Jitter Conversion:	Per IEEE 4.5.2.8
*	Phase to Amplitude Jitter Conversion:	Per IEEE 4.5.2.9
*	Measurement Averaging Time:	Per IEEE 4.5.2.10
*	Detector:	Peak-to-Peak Per IEEE 4.5.2.11
*	Time to Display Correct Reading:	20-300 Hz, 4 Seconds 4 -300 Hz, 25 Seconds
*	Demodulated Signal Output:	Provided

3.14 Transients:

Common Requirements

*	Test Signal:	995-1025 Hz, +10 to -40 dBm tone with >20 dB S/N ratio (C-Notch)
*	Blanking Interval:	125 ms factory default 1-255 ms operator settable
*	Qualification Interval: (AM5XT) (AM5eXT)	 3.5-4.39 ms 3.6-4.4 ms
*	Polarity of Input Signal:	Accuracy specifications are met with interchange of input leads.
*	Study Timer:	0.1 to 999.9 minutes accurate to ±0.1%
*	Count Hierachy:	Dropout blocks all counters for duration plus 1 second.
*	Noise Protection for Hit and Dropout Counters:	High pass with cutoff frequency of 400 Hz and 12 dB per octave rolloff plus low pass with cutoff frequency of 1800 Hz and 24 dB per octave rolloff. Satisfies IEEE & CCITT requirements for Single frequency interference, amplitude to phase conversion, phase to amplitude conversion, and hit amplitude and duration limits.
*	Counters	All counters are 4 digit (9999 max.)

* Impulse Noise (3 Level):

	AM5XT	AM5eXT
Minimum Threshold:	30 dBrn	-60 dBm
Maximum Threshold:		
135 (150) ohm	112 dBrn	+22 dBm
600 ohm	106 dBrn	+16 dBm
900 ohm	104 dBrn	+14 dBm
1200 ohm	103 dBrn	+13 dBm
Threshold Difference:	2,3,4,6 dB	
Threshold Accuracy:	±1 dB	
Filters:	See 3.3, Filters	
Counter Independence:	The counters for low, mid and high threshold operate independently and simultaneously as required by input conditions.	

* Phase Hits:

Threshold Range:	5-45 Degrees in 1 Degree Steps
Threshold Accuracy:	±(10% of setting +.5 Degrees)
Single Frequency Interference:	Per IEEE 4.4.4.4 (No Applicable CCITT Spec)
Amplitude to Phase Conversion:	10 dB gain hit will not cause phase hit with 10 Degrees threshold setting.

Loop Recovery
Time (Hit Rate
of Change):

Tested with linear phase change of 100 Degrees and 20 Degrees threshold

Rise Time >50 ms	no count
Rise Time <20 ms	count

Phase Hit Amplitude and Duration Limits:

(AM5XT)

(AM5eXT)

With threshold of 20 degrees and phase hits of 25 degrees

Count All	> 5.0 ms
Count None	< 3.6 ms

* Gain Hits:

Threshold Settings:	2,3,4,6,8,10 dB (AM5eXT does not have 10dB Setting)
Threshold Accuracy:	±0.5 dB (0.2 ms rise time)
Single Frequency Interference:	Per IEEEE 4.4.5.4 (No applicable CCITT Spec)
Phase to Amplitude Conversion:	180 Degrees phase hit shall not count at any threshold

Loop Recovery (Hit Rate of Change)

Test with linear amplitude change of 4 dB in either direction and threshold set to 2 dB.

Rise Time >600 ms:	no count
Rise Time <200 ms:	count

Gain Hit Amplitude
and Duration Limits

(AM5XT)

(AM5eXT)

With threshold of 2 dB
and hits of 3 dB

Count All:	$\geq$ 5.0 ms
Count None:	$\leq$ 3.6 ms

* Interruptions(AM5eXT)

Level Thresholds:	6 dB and 10 dB (10 dB interruption blocks Hit and Impulse counters)
Threshold Accuracy:	$\pm$1 dB
Qualification:	<2.0 ms Ignore >3.5 ms Recognize
Separation:	>4.0 ms to guarantee recognition as separate

* Dropouts(AM5XT)

Threshold:	12 $\pm$1 dB
Single Frequency Interference:	Per IEEE 4.4.6.3 (No applicable CCITT Spec)

* Ancillary Detector-
HCMOS 5v Logic
Outputs: 0=signal above threshold
1=signal below threshold

Loop Recovery
Time (Hit Rate
of Change):

Tested with linear
phase change of 100
Degrees and 20
Degrees threshold

Rise Time >50 ms	no count
Rise Time <20 ms	count

Phase Hit Amplitude
and Duration Limits:

(AM5XT)

(AM5eXT)

With threshold of 20
degrees and phase
hits of 25 degrees

Count All	> 5.0 ms
Count None	< 3.6 ms

* Gain Hits:

Threshold Settings:	2,3,4,6,8,10 dB (AM5eXT does not have 10dB Setting)
Threshold Accuracy:	±0.5 dB (0.2 ms rise time)
Single Frequency Interference:	Per IEEEE 4.4.5.4 (No applicable CCITT Spec)
Phase to Amplitude Conversion:	180 Degrees phase hit shall not count at any threshold

Loop Recovery (Hit
Rate of Change)

Test with linear amplitude
change of 4 dB in either
direction and threshold set
to 2 dB.

Rise Time >600 ms:	no count
Rise Time <200 ms:	count

Gain Hit Amplitude
and Duration Limits

(AM5XT)

(AM5eXT)

With threshold of 2 dB
and hits of 3 dB

Count All:	$\geq$ 5.0 ms
Count None:	$\leq$ 3.6 ms

* Interruptions(AM5eXT)

Level Thresholds:	6 dB and 10 dB (10 dB interruption blocks Hit and Impulse counters)
Threshold Accuracy:	$\pm$1 dB
Qualification:	<2.0 ms Ignore >3.5 ms Recognize
Separation:	>4.0 ms to guarantee recognition as separate

* Dropouts(AM5XT)

Threshold:	12 $\pm$1 dB
Single Frequency Interference:	Per IEEE 4.4.6.3 (No applicable CCITT Spec)

* Ancillary Detector-
HCMOS 5v Logic
Outputs: 0=signal above threshold
1=signal below threshold

3.15 Micro Interruptions (0.62):

*	Test Signal Frequency:	2000 ± 100 Hz
*	Input Level Range:	-30 dB to +10 dB
*	Level Threshold Below Initial Level:	Selectable 3,6,10,20 dB
*	Threshold Accuracy:	± 1 dB @ 3,6,10 dB ± 2 dB @ 20 dB
*	Detector Sensitivity To Interruption Duration:	100% detected if >0.45 ms. 50% detected at 0.3 ms duration
*	Dead Time:	Selectable 1-225 ms or Shortest Possible (as short as 500 uS)
*	Auxiliary Detector Output:	HCMOS 5V logic output 0=signal above threshold 1=signal below threshold
*	Study Timer:	Same as for impulse noise
*	Counters:	5 four Digit Counters based on duration of interruption. CNT1 for 0.3 - 3 ms duration CNT2 for 3 - 30 ms duration CNT3 for 30 - 300 ms duration CNT4 for 300 ms 1 min duration CNT5 for >1 min duration

3.16 Non-Linear Distortion (4 Tone)*

Receiver:

Signal Level:	0 to -40 dBm
Measurement Range:	10 to 65 dB for 2nd and 3rd order products
Resolution:	0.1 dB

Measurement Accuracy:

		DISTORTION READING 10dB	55dB	65dB
RCVR LEVEL	0dBm	+/- 1.0dB	+/- 1.5dB	
	-30dBm	+/- 1.0dB	+/- 2.5dB	
	-40dBm			

(Accuracy not specified for 135/150 ohm if level < -30dBm)

Filter Characteristics:

2nd Order:	503-537,2223-2257 Hz
3rd Order:	1877-1923 Hz Bandwidth test per 0.42, 3.2.4; IEEE 4.6.3.2.4, 4.6.3.2.5
Detector:	RMS
Crosstalk:	Generator does not impact receiver accuracy
Signal/Noise Correction:	Automatic
Spurious Tone Detection:	Provided
Measurement Response Time:	Within 1 dB of final reading 10 seconds
Display Update Rate:	3 seconds

*U.S. Patent 3,862,380

4. General

4.1 Input: 2 or 4 wire transmission line. Separate 135(150), 600, 900 or 1200 ohm selectable terminate impedance or high impedance (50 K-ohm) bridge. Separate DC hold circuits.

4.2 DC Blocking: 200 VDC

4.3 Balance: >90 dB, 50 Hz - 120 Hz: decreasing 6 dB per octave above 120 Hz

4.4 Return Loss:

	150 ohm	600-1200 ohm
20 - 200 Hz	>15dB	>25dB
200 - 20k Hz	>30dB	>40dB
20k - 120k Hz	>30dB	>30dB

4.5 Signalling: Pulse, DTMF (touch tone) or MF (multi-frequency) from full 16 button keypad

4.6 Monitor/Talk: Built-in speaker monitor and microphone with 2/4 wire hybrid for hands free speaker phone or push-to-talk operation

4.7 Power: 115 VAC or 230 VAC 50/60 Hz @ 26 VA. Internal rechargeable battery (sealed lead/acid) optional. Battery charge life approximately 5 hours. Low battery warning at .5 hour remaining.

4.8 Weight:

	Net	Shipping
Basic Unit	5 lbs.	8 lbs.
W/Battery Option	10 lbs.	13 lbs.

4.9 Dimensions: Portable 8.3" W x 3.5" H x 12.1" D
Rack Mt. 19.0" W x 3.5" H x 12.1" D

4.10 Operating: 0 to 40 deg. Celsius
Storage: -40 to +75 deg. Celsius

4.11 Humidity: 10% - 90% non-condensing

4.12 Line Connections: Dual miniature phone jack*. 0.173" dia. on .312" centers (front panel) and screw terminal strip (rear panel).

*Mates with ADC PJ777 or Switchcraft TT253. Commonly known as "Bantam" plug.

4.13 Remote Control Port (optional):

* Type: RS232, ASCII
* Baud Rate: 300, 1200, 2400, 9600 baud switch selectable
* Connection: 25 pin male, D-miniature type
* Parity: Odd, even or none; switch selectable
* Functions: All functions and settings of set may be remotely controlled. All measurements may be remotely accessed

4.14 Auxiliary Port: (furnished with Remote Control Port)

* Type: RS232. ASCII
* Baud Rate: Same as selected for remote control port.
* Connection: 9 pin female, D-miniature type
* Parity: Same as selected for remote control port.

4.15 Store/Recall Functions:

40 user defined unit setups
40 user defined line related setups
10 user defined telephone numbers
(plus last number redialed)

Specifications may be changed without notice.

TABLE 1
ERL FILTER RESPONSE
(FREQUENCY WEIGHTING)

Frequency (Hz)	Relative loss (dB)	Tolerance (dB)
<200	>30.0	---
300	21.8	±2.3
560	3.0	±0.4
750	0.2	±0.2
1000	0.0	±0.1
1500	0.1	±0.2
1965	3.0	±0.4
2400	10.9	±1.2
3000	22.9	±3.0
4000	42.6	±5.0
>5000	>45.0	---

TABLE 2
SRL LOW FILTER RESPONSE
(FREQUENCY WEIGHTING)

FREQUENCY (HZ)	RELATIVE LOSS (dB)	TOLERANCE (dB)
<100	>20	---
120	20	±3.0
200	9.5	±1.1
260	3	±0.5
360	0	±0.2
500	3	±0.5
650	10	±1.2
1000	20	±3.0
>1200	>20	---

TABLE 3
SRL HIGH FILTER RESPONSE
(FREQUENCY WEIGHTING)

FREQUENCY (HZ)	RELATIVE LOSS (dB)	TOLERANCE (dB)
<1000	>30	---
1300	30	±4.0
2000	11.5	±1.3
2200	3	±0.5
2700	0	±0.2
3400	3	±0.5
3700	10.9	±1.3
5700	30	±4.0
>6000	>30	---

TABLE 4
P/AR LINE SPECTRUM

LINE SPECTRUM			LINE SPECTRUM TOLERANCE	
FREQUENCY (HZ)	MAGNITUDE (dB)	PHASE (DEGREE)	LEVEL (±dB)	PHASE (±DEGREE)
140.625	-33.737	-173.73	0.80	5.0
390.625	-15.881	-161.24	0.30	3.0
640.625	-14.556	-143.95	0.20	2.0
890.625	-15.181	-114.31	0.20	0.5
1140.626	-16.303	- 55.37	0.20	0.4
1390.625	-11.937	30.19	0.10	0.4
1640.625	- 3.961	86.41	0.10	0.4
1890.625	- 0.000	113.78	0.00	0.4
2140.625	- 0.438	128.62	0.10	0.4
2390.626	- 3.104	137.78	0.10	0.4
2640.625	- 6.512	144.00	0.20	0.5
2890.625	-10.082	148.52	0.20	1.0
3140.625	-13.658	151.95	0.30	3.0
3390.625	-17.240	154.67	0.30	4.0
3640.625	-20.892	156.87	0.30	5.0
3890.625	-24.722	158.70	0.50	5.0

TABLE 5
(COMBINATION OF IEEE and 0.91 SPECIFICATION)

FREQUENCY DIFFERENCE (HZ)	PHASE JITTER (DEGREES)		
	FREQUENCY BAND (HZ)		
	4 - 300	4 - 20	20 - 300
0.3	<1	<1	XXX
0.4	<1	<1	XXX
0.75	<3	<3	XXX
1.0	<3	<3	XXX
1.5	<8	<8	XXX
2.0	<8	<8	<1
4.0	10.7 ± 1.5	10.7 ± 1.5	XXX
5.0	XXX	XXX	<3
6.0	11.2 ± 1.0	11.2 ± 1.0	XXX
8.0	11.5 ± 0.7	11.5 ± 0.7	XXX
10.0	11.5 ± 0.7	11.5 ± 0.7	<8
12.0	11.5 ± 0.7	11.5 ± 0.7	<10
16.0	11.5 ± 0.7	11.5 ± 0.7	XXX
20.0	11.5 ± 0.7	11.1 ± 1.1	11.5 ± 0.7
33.0	11.5 ± 0.7	<3	11.5 ± 0.7
47.0	11.5 ± 0.7	<1	11.5 ± 0.7
240	11.5 ± 0.7	XXX	11.5 ± 0.7
300	11.1 ± 1.1	XXX	11.1 ± 1.1
500	<3	XXX	<3
700	<1	XXX	<1

XXX = Does NOT APPLY

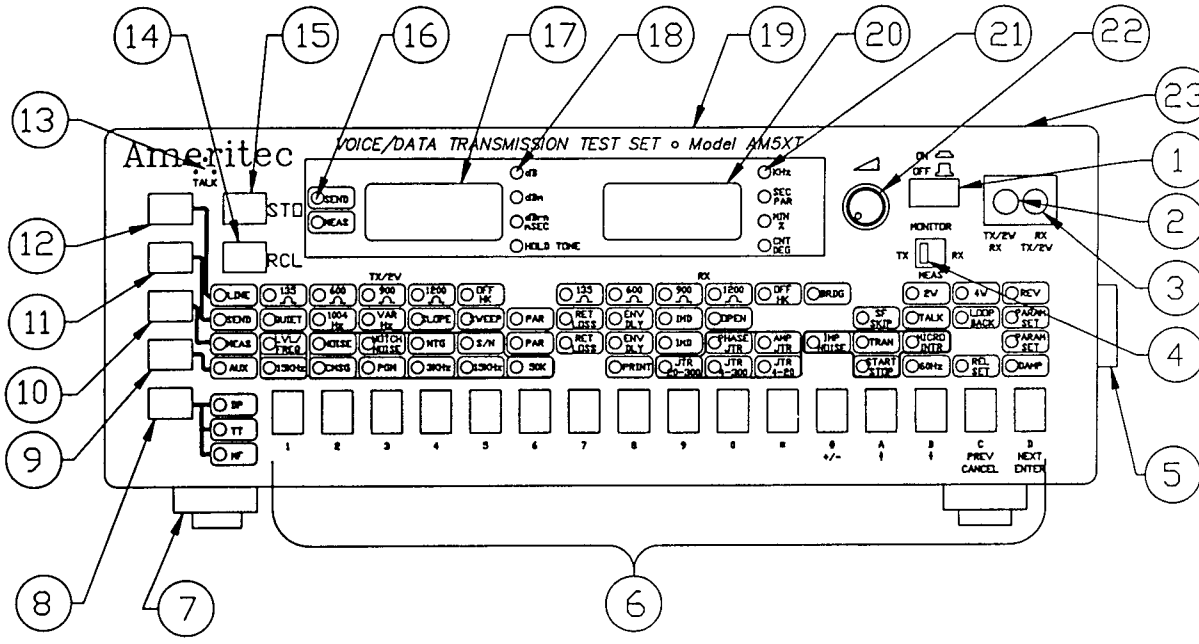
TABLE 6
AMPLITUDE JITTER FREQUENCY WEIGHTING 20 - 300 HZ

FREQUENCY DIFFERENCE (HZ)	AMPLITUDE JITTER READING (%)
2	<0.9
5	<2.6
10	<7.0
20 - 240	9.4 - 10.6
300	8.7 - 10.6
500	<2.6

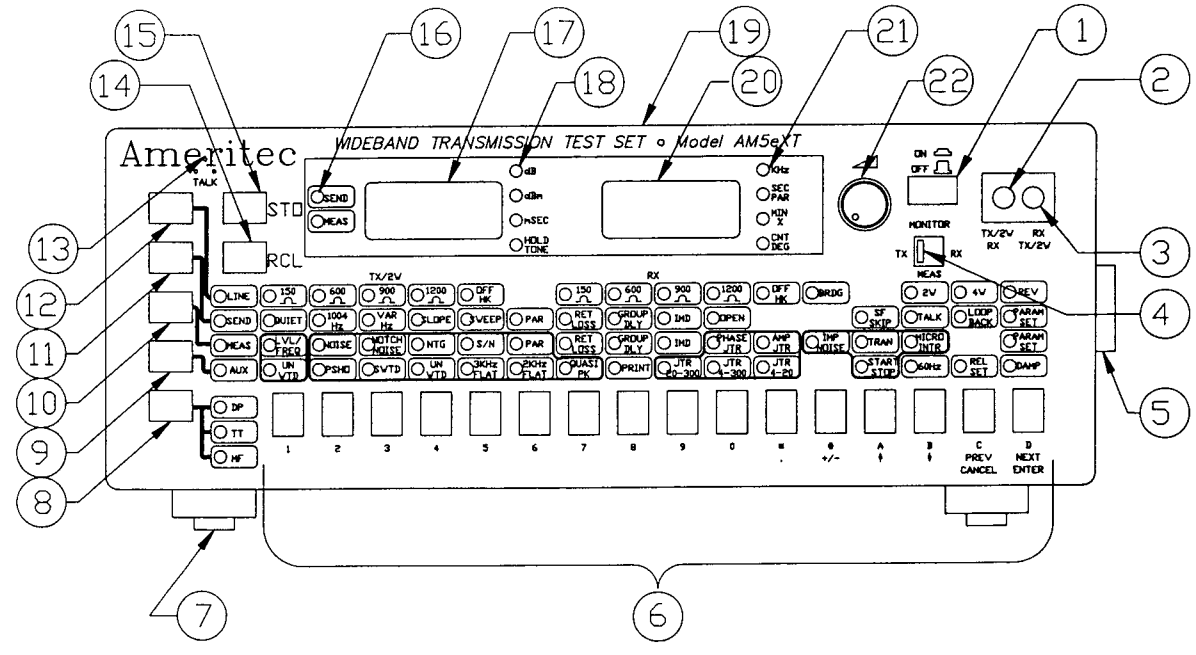
TABLE 7
AMPLITUDE JITTER FREQUENCY WEIGHTING 4 - 300 HZ

FREQUENCY DIFFERENCE (HZ)	AMPLITUDE JITTER READING (%)
0.4	<0.9
1.0	<2.6
2.0	<7.0
4.0	8.0 TO 10.6
8 - 240	9.4 TO 10.6
300	8.7 TO 10.6
500	<2.6

spec.am5 23-nov-88



AM5XT



AM5eXT