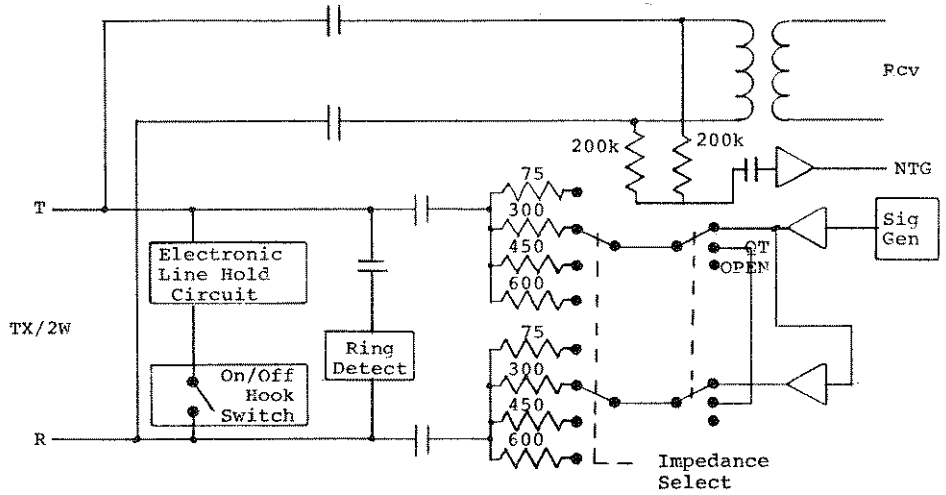
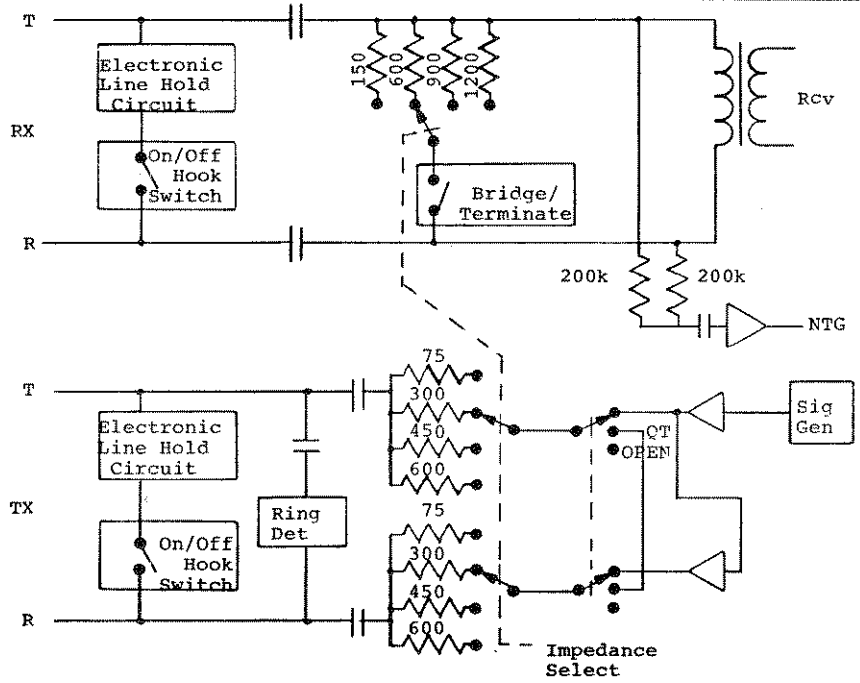
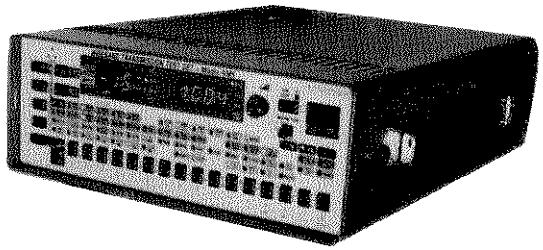


2 WIRE

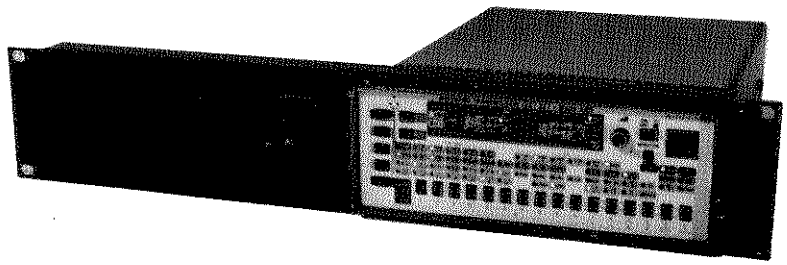


4 WIRE

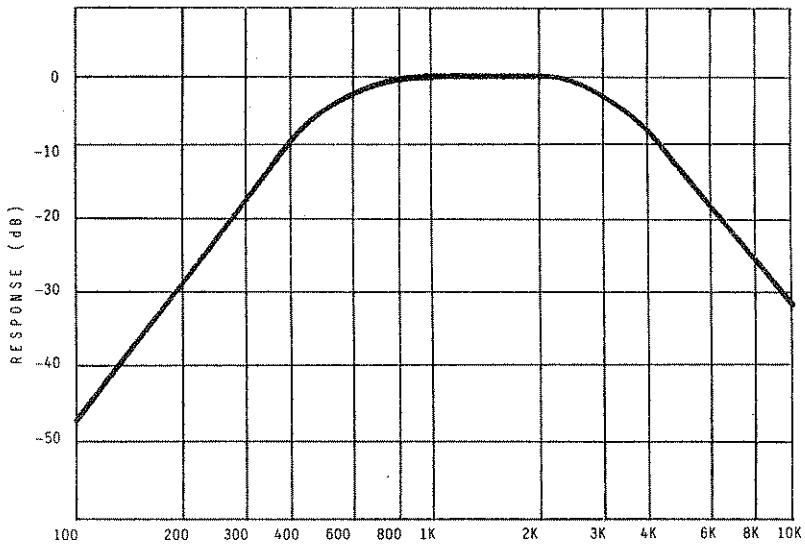
Simplified Line Circuit Block Diagram FIGUPE 8



MODEL AM5



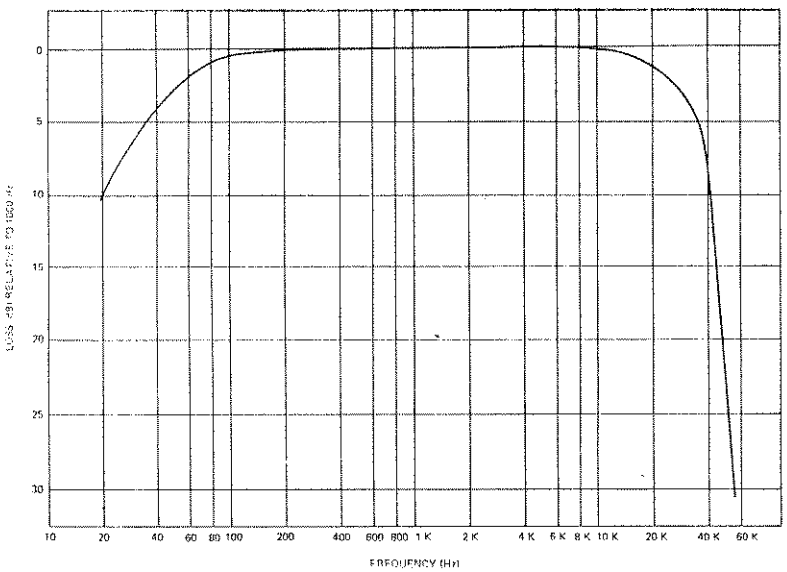
MODEL AM5
WITH RACK MOUNT ADAPTOR



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

FLAT (750-2300) CHARACTERISTIC
CCITT 0.71

FIGURE 7A

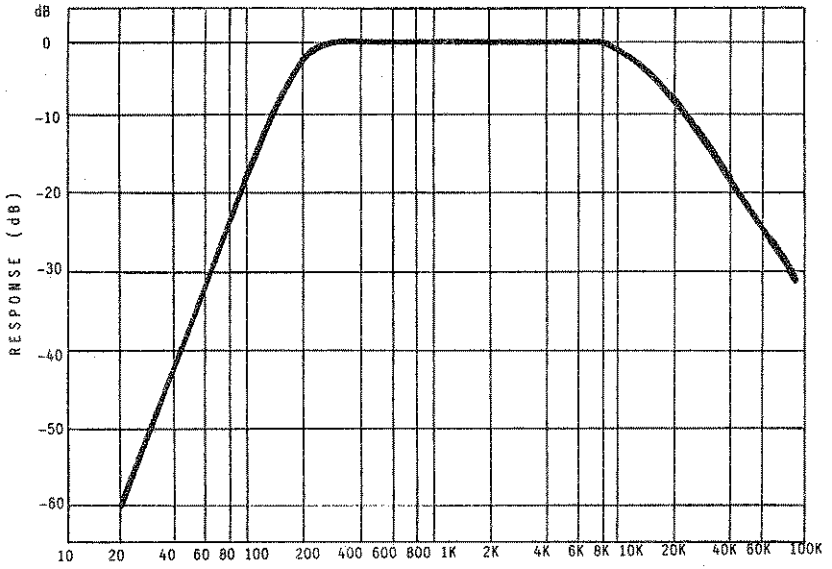


Frequency (Hz)	Design Loss (dB) Ref to 1Q00 Hz
0	>30
50	2.7
200	0.2
1000	0 (Ref)
5000	0.1
10 000	0.3
15 000	0.7
20 000	1.3
25 000	2.1
30 000	3.3
35 000	5.0
40 000	7.8
45 000	14.0
50 000	>22.0
>55 000	>30.0

50 Kilobit Weighting Characteristic

Figure 7

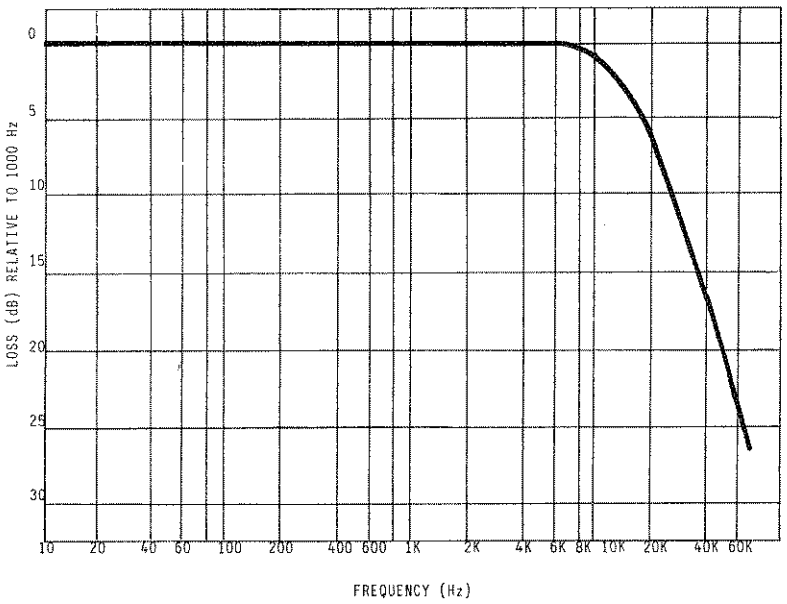
TABLE OF CONTENTS



Freq (Hz)	Response (dB)
20	-60.0
40	-41.9
100	-18.1
200	- 3.0
275	- 0.6
800	0.0
1000	0.0
5000	0.0
10000	- 0.8
15000	- 3.4
20000	- 6.9
40000	-18.2
80000	-30.3

FLAT (275-3250 Hz) CHARACTERISTIC
CCITT 0.71

FIGURE 6A

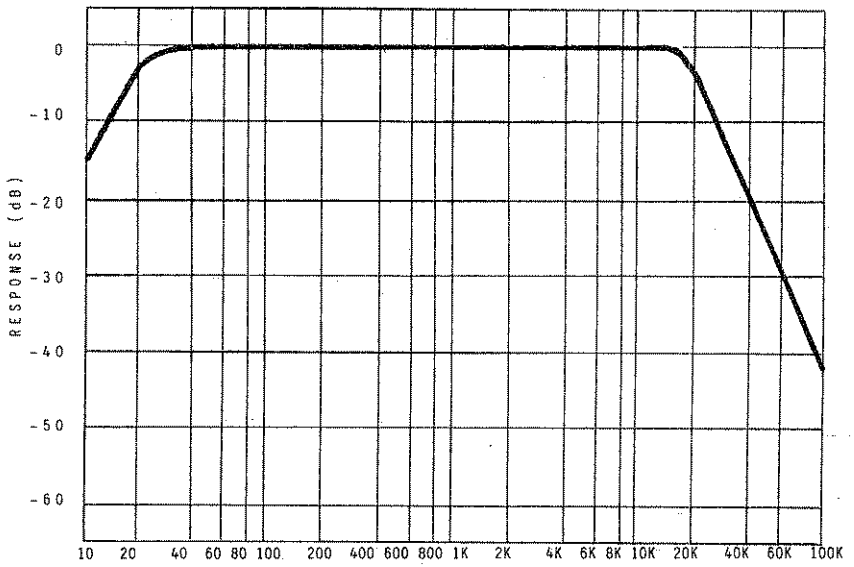


Frequency (Hz)	Design Loss (dB) Ref to 1000 Hz
1000	0 (Ref)
5000	0.1
10 000	0.8
15 000	3.0
20 000	6.2
25 000	9.4
30 000	12.3
35 000	14.9
40 000	17.1
45 000	19.1
50 000	21.0

15 KHz Flat Weighting Characteristic

Figure 6

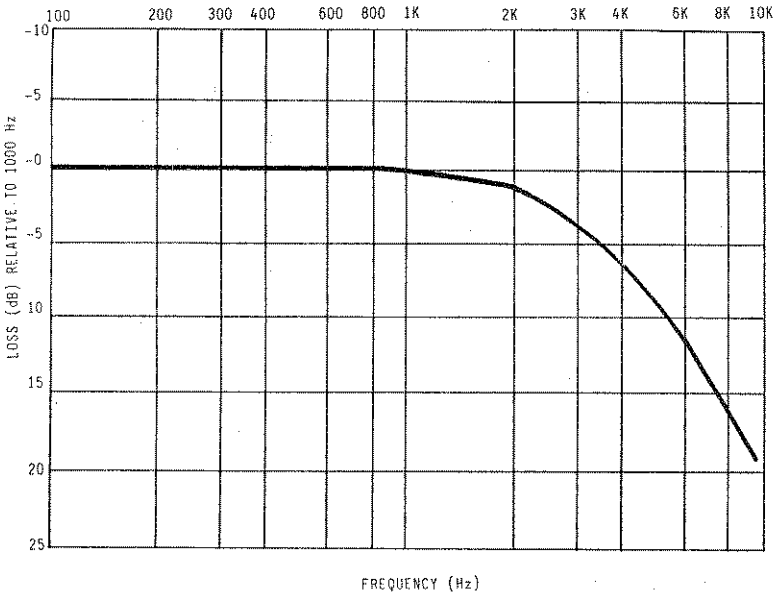
ILLUSTRATIONS



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

SOUND UNWEIGHTED CHARACTERISTIC
CCITT J.16

FIGURE 5A



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

3 KHz flat Weighting Characteristic

Figure 5

I. INTRODUCTION

This Instruction Manual describes the operation of the Ameritec Model AM5 Wideband Transmission Test Set.

The Model AM5 is microprocessor based test instrument used to measure transmission impairments on 2 and 4 wire telephone lines in accordance with IEEE Standard 743-1984 (Bell Standard 41009). An export version complying with CCITT recommendations is also available and is designated Model AM5E.

The instrument contains measurement circuitry able to measure:

Level	(-65 to +10 dBm)
Frequency	(20 Hz to 110 kHz)
Noise	(10 to 100 dBrn)
Noise with Tone	(10 to 100 dBrn)
Signal to Noise-Ratio	(10 to 50 dB)
Noise to Ground	(40 to 130 dBrn)
Impulse Noise	(3 level)
2 & 4 Wire Return Loss	
P/AR	

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

II. INSTALLATION

A. 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.

B. POWER

The AM5 is 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 power 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 Model AM5 is 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.

C. OPTIONAL BATTERY PAK

The Model AM5 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 batteries and associated charging circuitry. The batteries, when fully charged, will power the unit for approximately 8 - 12 hours.

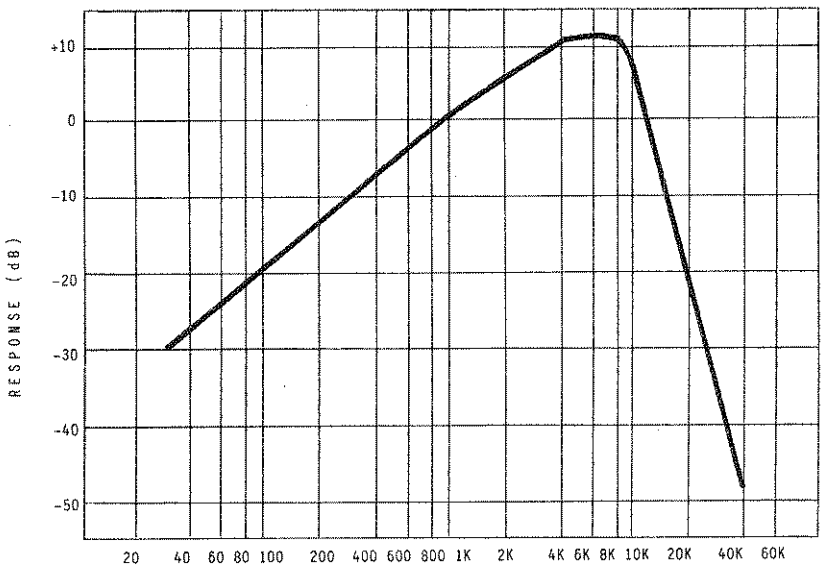
A low battery indicator is provided in the form of blinking decimal points in the front panel display. Blinking decimal points indicate approximately one hour of remaining battery operation before recharging is required.

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."

D. INPUT CONNECTIONS

Connection of the 2 or 4 wire telephone line to be tested may be made to front panel or to the rear panel of the unit.

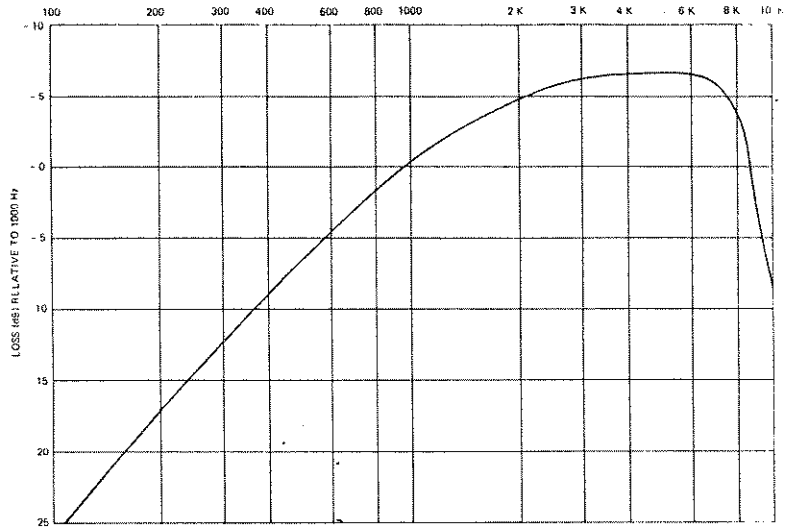
The front panel contains a dual bantum (miniature) telephone line jack which will accept two .173" diameter x .781" long phone plugs spaced .312" apart. The telephone pair (T&R or A&B wires) are connected to the tip and ring of each plug. The sleeve connection of the plug is used only in noise to ground (NTG) measurements. The left jack is normally used for connection of the TX (transmit) or send pair of a 4 wire circuit or the single pair of a 2 wire circuit. The right jack is normally used for connection of the RX (receive) pair of a 4 wire circuit.



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

SOUND WEIGHTED CHARACTERISTIC
CCITT J.16

FIGURE 4A



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 (NOTE 2)

PROGRAM WEIGHTING CHARACTERISTIC

Figure 4

The rear panel contains a barrier terminal strip composed of 5 screw terminals. These terminals are connected in parallel with the front panel jacks and may be alternately used in lieu of the front panel jacks. Connections are from left to right T&R (Transmit), T&R RX (receive) and signal ground.

E. RS232 (REMOTE CONTROL) PORT

Connection to the optional RS232 port and its operation are described in Section V of this Manual.

III. CONTROLS AND INDICATORS

A. FRONT PANEL LAYOUT (see Figure 1)

The AM5 front panel is a surface approximately 3" high by 8" wide. It contains all of the switches and LED's for controlling the unit and displaying its operational status.

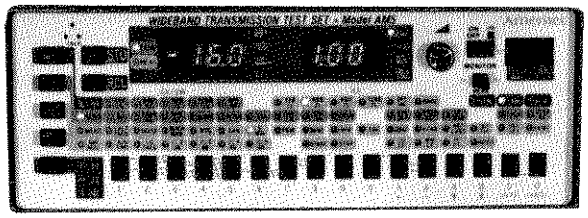
All unit conditions are simultaneously displayed and the status of the unit can be determined by a glance. It is not necessary to step through a menu nor decode unusual indicators to determine unit status.

All push button switches are discrete switches, not membrane type, and offer good visual, tactile and audible feedback. All indicators are LED's and should never need replacement.

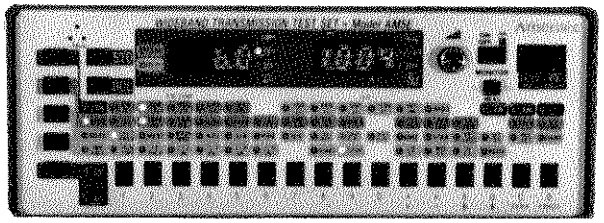
Control of the unit is accomplished by activation of push buttons arranged around the edge of an X Y matrix of LED's.

There are 5 push buttons along the left edge of the front panel which allow selection of horizontal rows of operating categories (LINE, SEND, MEASURE, IMPULSE NOISE and SIGNALING [MF, DP, TT]).

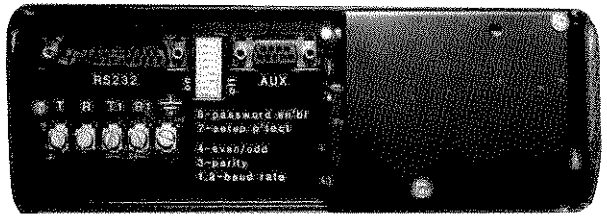
There are 16 push buttons along the bottom edge of the front panel which correspond to vertical columns and allow selection of function within the category.



FRONT PANEL LAYOUT AM5



FRONT PANEL LAYOUT AM5E



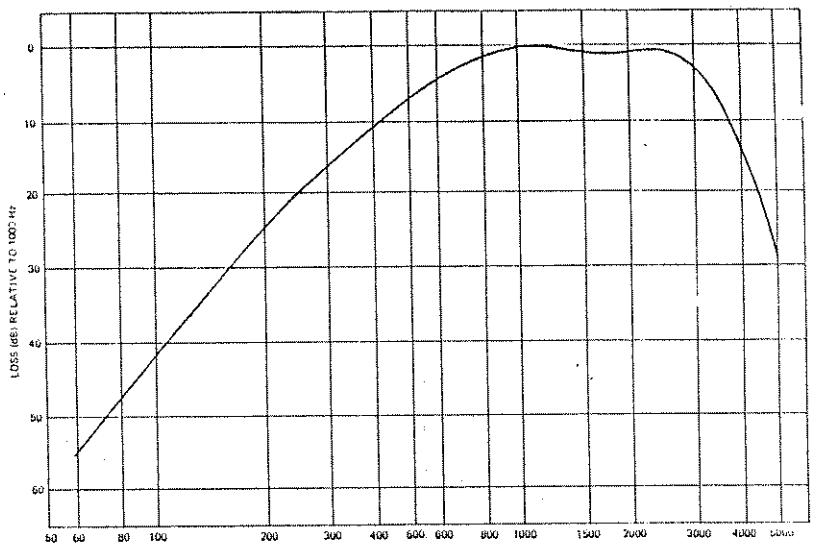
REAR PANEL LAYOUT

FIGURE 1

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

PSOPHOMETRIC CHARACTERISTIC
CCITT P.53

FIGURE 3A



FREQUENCY (HZ)

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

C-MESSAGE WEIGHTING CHARACTERISTIC

Figure 3

1. "Line" Category

"Line" refers to the 2 or 4 wire telephone line connected to the AM5 for test.

a. 150 OHM, 600 OHM, 900 OHM, 1200 OHM (color coded green): refers to the source impedance of the internal signal generator which is connected to the transmit (send) pair. There is one exception:

(i) When the signal generator is in OPEN, it is not connected to the line.

b. OFF HK, on hk (green): OFF HOOK places a DC path across T&R of the transmit (send) pair equivalent to a 200 ohm holding coil. On hook removes the path.

c. 150 OHM, 600 OHM, 900 OHM, 1200 OHM (blue): Refers to the termination impedance applied across T&R of the receive pair when in the terminate (not BRIDGED) mode. In BRIDGE the impedance selection affects measure levels.

d. OFF HK, on hk (blue): OFF HOOK places a DC path across the T&R of the receive pair equivalent to a 200 ohm holding coil. On hook removes the path.

e. BRDG, Terminate (blue): BRIDGE causes the measure circuitry to be high impedance bridged (>50K ohm) across the T&R of the receive pair. Terminate (not bridged) causes the receive line to be terminated by the impedance selected by the 150 ohm, 600 ohm, 900 ohm, 1200 ohm switches. In 2W mode the measure circuitry is always in a high impedance state. The line termination is provided by the signal generator (send) impedance.

f. 2W: Causes the transmit pair to be connected to both the signal generator (send) and the measure (receive) circuits.

g. 4W: Causes the transmit pair to be connected directly to the signal generator and the receive pair to be connected directly to the measure circuits.

h. REV: Causes the transmit and receive connections to be reversed.

A simplified block diagram of the line circuits is illustrated in Figure 8.

2. "Send" category

Send refers to the signal generator condition applied to the transmit pair of the line under test.

a. QT (quiet) — Causes the signal generator to send no signal. The transmit pair is simply terminated in the selected impedance.

b. 1004 HZ — Causes the signal generator to apply a 1004 Hz tone to the transmit pair. The level may be varied from -50dBm to +10dBm.

c. VAR (variable) HZ — Causes the signal generator to apply a tone to the transmit pair at whatever frequency was last set up for this mode. The level may be varied from -50dBm to +10dBm. The frequency may be varied from 20 Hz to 110 kHz.

d. SLOPE (AM5) — Causes the signal generator to apply a 5 second tone of 1004 Hz followed by 5 second tones of 2804 Hz and 404 Hz and the sequence will then repeat. The level may be varied from -50 dBm to +10 dBm.

d1. SLOPE (AM5E) — Causes the signal generator to apply a 5 second tone of 1004 followed by 5 second tones of 2004, 3004 and 304 Hz and the sequence will then repeat. The level may be varied from -50 dBm to +10 dBm.

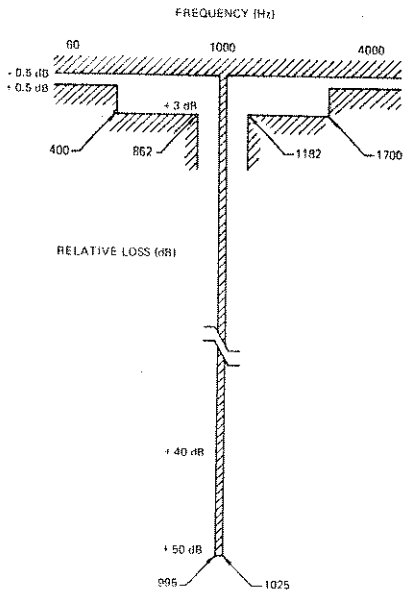
d2. SLOPE - SWEEP Secondary Mode — Causes the signal generator to sweep repeatedly in accordance with parameters previously set into the A, B, C and D memory locations where:

A = low frequency	(kHz)
B = high frequency	(kHz)
C = frequency step size	(kHz)
D = dwell time at each step	(Sec)

This mode is entered by depressing "SLOPE" button twice. (Associated LED will blink.) (See Section F. 4 for parameter settings.) The level may be varied from -50 dBm to +10 dBm.

e. P/AR — Causes the signal generator to generate 16 specific frequencies simultaneously in accordance with Bell 41009 specification. This test tone is used in connection with the P/AR (peak to average ratio) measurement. The composite level may be set between -40 dBm and 0 dBm.

f. ERL, SRL LO and SRL HI — These test tones are shaped white noise signals used in connection with the "return loss" measurement mode to measure "echo return loss," "singing return loss LO," and "singing return loss HI." The level may be set between -10 dBm and -2 dBm.



1010 Hz Notch Filter

Figure 2

7. If existing low threshold setting is acceptable, depress "ENTER" (to exit "LO THLD"). If new low threshold value is desired, enter desired value by direct numeric entry or by using up/down buttons. Depress "ENTER" to enter new value and to exit "LO THLD."

6. Select desired "DELTA DB."

9. Depress "START" to begin study (start LED will blink while study is in progress).

10. While study is in progress, the number of counts in the "LO, Mid & HI" registers as well as elapsed study time may be observed. Depression of "NOISE" button will allow observation of received noise level as well as study time remaining.

K. IMPULSE NOISE WITH TONE MEASUREMENT

1. Set "SEND" for "1004 HZ."

2. Select "MEAS" and select "NOTCH NOISE" and select desired filter "C-Msg, PGM, 3 kHz, 15 kHz or 50 k" (AM5); "Psho, Sound Wtd, Sound Unwtd, Flat 3250, Flat 2300 (AM5E).

3. Select "IMP NOIZ" and confirm that "HOLD TONE" indicator is on indicating receipt of 1004 Hz hold tone.

4. All other steps are same as impulse noise measurement described above.

g. OPEN

Similar to QT (quiet) mode but causes the signal generator to be totally disconnected from the transmit line so that the transmit line is <u>not</u> terminated by the generator impedance.

h. LVL SET

Level set allows the signal level of the test tone selected above to be set to the desired level. Once selected, a green LED will come on and while this green LED is on the level may be stepped up or down in 1 dB steps using the UP ARROW or DOWN ARROW buttons or the level may be directly entered using the numeric buttons followed by depression of the "enter" button. LVL SET also enables the STO and RCL buttons to be used to store or recall one of ten user settable levels by pushing STO or RCL followed by a number 0-9.

The last level selected for the signal generator will apply if the "send" selection is changed to a new tone selection, except that the generator will not generate a tone level outside that allowed for a particular tone. For example: If the operator attempts to select a send level of 0 dBm for "ERL," the unit will send -2 dBm as this is the value closest to that selected and is still within the allowable send limit for this tone.

i. FREQ SET

Frequency Set is used to set the frequency which will be sent by the "VAR HZ" mode.

Once selected, a green LED will come on and while the green LED is on the frequency may be stepped up or down in 100 Hz steps using UP ARROW or DOWN ARROW buttons or the frequency may be directly entered using the numeric buttons followed by depression of the "enter" button. FREQ SET also enables the STO and RCL buttons to be used to store or recall one of ten user settable frequencies by pushing STO or RCL followed by a number 0-9.

Note that the frequency is displayed (and must be entered) in units of kHz. For example: 1004 Hz is entered as 1.004 kHz.

j. SF SKIP

SF SKIP is an ON/OFF toggle used in connection with the VAR HZ mode. With SF SKIP on (LED on) the VAR HZ mode can <u>not</u> be varied into the frequency band 2450 Hz through

2750 Hz (2130 to 2430 Hz for AM5E). With SF SKIP off the VAR HZ mode is fully variable. SF SKIP (on) is used to avoid sending of tones in the "signaling frequency" band to avoid knocking down a long distance dialed circuit.

k. TALK — TALK connects a front panel located microphone to the transmit line in lieu of the internal signal generator. 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 modes are available. "Push to talk" and "full duplex." Full duplex in 2 wire mode employs a hybrid to provide hands free "speaker phone" operation.

l. 2713 HZ (Labeled "AUX TONE" on AM5E) — This control is a momentary action button which when depressed causes the send tone to be overridden and a 2713 Hz tone sent in its stead. This control is used to activate W.E. Model 829 loopback devices which may be employed on 4 wire lines.

3. "Measure" Category

Measure applies to the detectors and filters which are applied to the receive line under test to measure and display various parameters.

a. LVL/FREQUENCY: Wide Band — Causes an auto ranging amplifier, average detector and frequency counter to be connected to the receive pair. The detected average voltage will be converted to dBm by the microprocessor based upon the impedance selected for the receive line and will be displayed in the left hand numeric display in units of dBm. The frequency will be displayed in the right hand numeric display in units of kHz. In this measurement mode, a 120 kHz lo pass is employed.

a1. LVL/FREQUENCY: Narrow Band (Secondary Mode) — As above, but employs a 15 kHz lo pass filter. This mode entered by depressing LVL/FREQ button twice. (Associated LED will blink.)

The following descriptions cover the various noise measurements, with various filters, which can be performed by the AM5. Noise measurements are made in the AM5 using an RMS detector. The AM5E allows either a RMS or peak detector (secondary mode) to be used.

G. P/AR MEASUREMENTS

1. Set "SEND" for "PAR."
2. Set "MEAS" for "PAR" (display will indicate received P/AR value in units of P/AR and also received level of PAR test signal in dBm).

H. 2 WIRE RETURN LOSS MEASUREMENTS

1. Set "SEND" for ERL, SRL LO or SRL HI" as desired.
2. Set "MEAS" for "RET LOSS" (display will indicate return loss in dBm).

I. 4 WIRE RETURN LOSS MEASUREMENTS

1. Set "SEND" for "ERL, SRL LO or SRL HI" as desired.
2. Loop distant end of 4 wire circuit under test while maintaining proper termination impedance.
3. Set "MEAS" for "RET LOSS" and note dB reading (loop around loss will result in a positive dB reading; loop around gain will result in a negative reading).
4. Select "TLP SET" and direct numeric enter the return loss value obtained in Step 3. Depress ENTER to enter value and exit "TLP SET."
5. Restore the distant end of the 4 wire circuit and note return loss reading.

J. IMPULSE NOISE MEASUREMENTS

1. Set "SEND" for "QT" (quiet).
2. Select "MEAS" and select "NOISE" and select desired filter "C-Msg, PGM, 3 kHz, 15 kHz or 50 k" (AM5); "Psho, Sound Wtd, Sound Unwtd, Flat 3250, Flat 2300 (AM5E).
3. Select "IMP NOIZ."
4. Select "RUN TIME" (display will indicate the current run time in minutes).
5. If existing run time setting is acceptable, depress "ENTER" (to exit "RUN TIME"). If new run time value is desired, enter desired value by direct numeric entry or by using up/down buttons. Depress "ENTER" to enter new value and to exit "RUN TIME."
6. Select "LO THLD" (display will indicate the current low threshold in dBrn (AM5) or dBm (AM5E)).

2. Set "MEAS" for "NOISE" (display will indicate measured RMS noise in dBrn (AM5) or dBm (AM5E)). Depress "NOISE" again to select Quasi-Peak detector (AM5E, NOISE indicator blinks).

3. Select desired filer "C-Msg, PGM, 3 kHz, 15 kHz or 50 k" (AM5); "Psho, Sound Wtd, Sound Unwtd, Flat 3250, Flat 2300 (AM5E).

4. Depress and hold "60 HZ" button to reduce effects of 50/60 Hz noise.

D. **NOTCH NOISE MEASUREMENTS** (Noise With Tone)

1. Set "SEND" for "1004 HZ".

2. Set "MEAS" for "NOTCH NOISE" (display will indicate measured RMS noise in dBrn (AM5) or dBm (AM5E) and frequency of received (1004 Hz) holding tone in kHz). Depress "NOTCH NOISE" a second time to select Quasi-Peak detector (AM5E, NOTCH NOISE blinks).

3. Select desired filter "C-Msg, PGM, 3 kHz, 15 kHz or 50 k" (AM5); "Psho, Sound Wtd, Sound Unwtd, Flat 3250, Flat 2300 (AM5E).

4. Verify that "HOLD TONE" indicator is on (measurement is otherwise invalid).

5. Depress and hold "60 HZ" button to reduce effect of 50/60 Hz noise on measurement.

E. **NOISE TO GROUND MEASUREMENT**

1. Set "SEND" for "QT" (quiet).

2. Set "MEAS" for "NTG" (display will indicate measured RMS noise to ground in dBrn (AM5) or dBm (AM5E)). Depress "NTG" a second time to select Quasi-Peak detector (AM5E, NTG blinks).

3. Select desired filter "C-Msg, PGM, 3 kHz, 15 kHz or 50 k" (AM5); "Psho, Sound Wtd, Sound Unwtd, Flat 3250, Flat 2300 (AM5E).

4. See 5. above.

F. **SIGNAL TO NOISE RATIO MEASUREMENT**

1. Identical to NOTCH NOISE measurement except set "MEAS" for "S/N" (display will indicate S/N ratio in dB and frequency of received (1004 Hz) holding tone in kHz).

b. NOISE: Sometimes referred to as idle channel noise measurement as it measures the noise, through a selected filter, on a theoretically "quiet" line. Results are displayed in the left hand display in units of dBrn (AM5) or dBm (AM5E).

c. NOTCH NOISE: Sometimes referred to as noise with tone measurement as it measures the noise, through a selected filter, on a line which has a 1004 Hz tone. This tone is removed in the measuring circuit through a 1010 Hz "notch" filter (see Figure 2) and the residual noise is measured. Results are displayed in the left hand display in units of dBrn (AM5) or dBm (AM5E), while at the same time the right hand display indicates the frequency of the 1004 Hz tone.

Note: In order for the notch noise measurement to be valid, the "holding tone" indicator LED must be on indicating that the 1004 Hz tone is present at the proper frequency and level.

d. NTG (Noise to Gnd): Is measured by internally commoning the tip and ring wires of the receive line (within the AM5) and measuring the noise, through a selected filter, with reference to ground. Results are displayed in the left hand display in dBrn (AM5) or dBm (AM5E).

e. S/N (Signal to Noise Ratio): This measurement is similar to the notch noise measurement except that both the 1004 Hz test tone signal level is measured as well as the residual noise after the 1004 Hz tone is notched out. The resulting ratio of signal to noise is calculated by the microprocessor and expressed in dB and is displayed in the left hand display. The right hand display indicates the frequency of the 1004 Hz tone. The "HOLD TONE" indicator must also be on for this measurement to be valid.

e1. NOISE FILTERS:

A variety of filters are available for use in making the noise measurements described above. In the AM5 unit these filters comply with IEEE STD 743-1984 (formerly Bell 41009) specification. These are shown on the front panel as slightly smaller rectangle labels. These include:

C MSG (C Message) A bandpass filter

(See Figure 3)

PGM (Program)	A bandpass filter (See Figure 4)
3 KHZ	A low pass filter (3dB down @ 3kHz, 12dB/octave rolloff (See Figure 5)
15 KHZ	A low pass filter (3dB down @ 15 kHz, 12 dB/octave rolloff (See Figure 5)
50 K (50 K Bit)	A combination low pass and high pass filter (See Figure 6)
60 HZ	A high pass filter designed for temporary insertion to eliminate frequencies 60 Hz or lower.

In the AM5E unit the available filters comply with appropriate CCITT recommendations. These include:

PSHO (Psophometric)	A band pass filter See Figure 3A	CCITT P.53
WTD (Sound weighted)	A lo pass, hi pass filter See Figure 4A	CCITT J.16
UNWTD (Sound not weighted)	A lo pass, hi pass filter See Figure 5A	CCITT J.16
3 KHZ	A bandpass filter See Figure 6A	CCITT 0.71
2 KHZ	A bandpass filter See Figure 7A	CCITT 0.71

Any <u>one</u> of the above filters (except 60 Hz) may be associated with any <u>one</u> of the noise measurements for a given test. The 60 Hz filter may be temporarily added to the measurement as desired.

f. P/AR: Causes the receive line to be connected to detectors which simultaneously detect the peak and average value of the P/AR Test waveform. The resultant ratio is displayed as a value from 0 to 120 P/AR units with 100 equal to a perfect P/AR reading (no degradation of the P/AR waveform. The left hand display indicates the RMS level of the received P/AR waveform in dBm.

VIII. <u>MEASUREMENTS QUICK REFERENCT LIST</u>

A. ABSOLUTE LEVEL OR FREQUENCY MEASUREMENTS

1. Set "SEND" for "1004 HZ" or "VAR HZ" (display will indicate <u>send</u> level in dBm and frequency in kHz).
2. If "VAR HZ" is selected, use "FREQ SET" to select desired frequency in kHz.
3. Use "LVL SET" to select desired send level in dBm.
4. Set "MEAS" for "LVL/FREQ" (display will indicate <u>measured</u> [received] level in dBm and frequency in kHz).

<u>Variations</u>

a. For narrow band LVL/FREQ measurements (using 15 kHz low pass filter), depress "LVL/FREQ" a second time (associated LED blinks).

b. To eliminate 50/60 Hz components from measurement, press and hold "60 HZ" button.

B. RELATIVE LEVEL MEASUREMENTS (3 Point Gain Slope or Frequency Response)

1. Set "SEND" for "SLOPE" if making 3 point gain slope measurements, or

1a. Set "SEND" for "SLOPE SWEEP" (slope-secondary mode selected by second depression of "SLOPE" button) if making frequency response measurements.

2. If "SLOPE SWEEP" selected, set sweep parameters (3 second dwell recommended to allow measurements to stablize).
   Store A = low frequency
   Store B = high frequency
   Store C = frequency step size
   Store D = dwell time
3. Select "SF SKIP" if desired.
4. Set "MEAS" for "LVL/FREQ" (display will indicated <u>measured</u> [received] level in dBm and frequency in Hz.
5. When desired REF frequency is displayed (usually 1004 Hz) depress "REL SET" to zero the level reading so that all subsequent level readings are in dB REL (relative to the level at 1004 Hz).

C. NOISE MEASUREMENTS (Idle Channel Noise)

1. Set "SEND" for "QT" (quiet).

VII. WARRANTY

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 pruchaser 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.

SERVICE POLICY

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.

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Covina, CA 91722 USA
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TELEX: 754958

g. RET LOSS (Return Loss): Causes the transmitted test tone level (ERL, SRL LO, SRL HI, or sine wave) to be compared with the measured level on the receive line with the resultant differences displayed on the left hand display in dB. Either 2 wire or 4 wire return loss measurements may be made. In 2 wire mode the test waveform is transmitted on the send pair of the internal 4 wire to 2 wire hybrid. At the same time the RMS detector is connected to the receive pair of the hybrid and the difference in sent level versus received level is displayed in dB.

In 4 wire mode the internal hybrid is not used and the test waveform and RMS detector are connected respectively, directly to the 4 wire send and receive pairs. On 4 wire circuits an offset adjustment called TLP (Transmission Level Point) is subtracted from the reading to compensate for gain or loss in the 4 wire circuit under test.

h. SET TLP (Transmission Level Point): Allows an offset factor to be introduced to the return loss received signal when making return loss measurements on 4 wire circuits. This offset factor is used to compensate for the loss or gain which may be present in the 4 wire circuit. The TLP factor may be set from -99.9 dB to +99.9 dB and is subtracted from the return loss reading obtained on the 4 wire circuit in a loopback condition. For this reason, 4 wire return loss measurements are a 2 step process:

Step 1 While sending ERL, SRL LO or SRL HI and with TLP set for zero (00.0 dB), loop the 4 wire circuit at the distant hybrid point (maintain proper termination) and measure return loss. The return loss reading will indicate in dB the amount of loss (+dB reading) or gain (-dB reading) on the circuit. This step is for the purpose of measuring the loss of the path and is in preparation to making an actual return loss measurement.

Step 2 Set TLP to equal return loss reading obtained in Step 1 (be sure to enter TLP value in dB with the same sign as obtained in Step 1), unloop the 4 wire circuit, restore

its normal termination, and note the new return loss reading.

SET TLP also enables the STO and RCL buttons to be used to store or recall one of ten user settable TLP's by pushing STO or RCL followed by a number 0 - 9.

i. REL SET (Relative Set On, Off): All level and noise measurements are normally expressed as absolute values of dBm or dBrn. Depression of the relative set button will cause the absolute value display of dBm or dBrn in the left hand display to be zeroed. Once "set" all subsequent readings will be relative to the zeroed reading, and will be displayed in units of dB.

j. DAMP (On, Off): The front panel display is normally updated 4 times each second. DAMP on will cause the display update rate to be slowed to 2 updates per second and is useful in capturing eratic readings.

4. IMP NOIZ (Impulse Noise) Category

Impulse Noise is a measurement of the number of test signal amplitude transients (noise pulses) which exceed 3 preset thresholds over a preset time interval.

The first (lowest) of the 3 level thresholds is normally entered directly in dBrn. The 2nd (middle) and 3rd (highest) thresholds are established by selecting a delta of 2, 3, 4 or 6 dB. For example, a low threshold of -50 dBrn and a delta of 3 dB would result in level thresholds of -50 dBrn (low), -53 dBrn (mid) and -56 dBrn (hi).

A run time (in minutes) is selected and the test is started. The test is normally run with a 1 kHz test tone and notch noise and C message (or psophometric) receive filters. Depression of the IMP NOIZ button will cause the measure category to default to notch noise and C MSG (or psophometric) unless some other noise mode or filter is first selected.

a. RUN TIME Allows the operator to set the time interval, in minutes, during which impulses will be counted. Depression of the RUN TIME button will cause an associated green LED to come on and the right hand display to indicate the time in minutes. While the green LED is on, the operator may enter, via the numeric buttons, the number of minutes desired from 000.1 to 999.9, or the UP ARROW or DOWN ARROW buttons may be used to step the time up or down in 1 minute

PARITY	Odd, even, none switch selectable
FUNCTIONS	All functions and settings of set may be remotely controlled. All measurements may be taken remotely.

AUXILIARY 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.

STORE/RECALL FUNCTIONS:

10 user defined complete unit setups
10 user defined frequencies
10 user defined levels
10 user defined TLP's
10 user defined impulse timers
10 user defined impulse thresholds
10 user defined telephone numbers
(plus last number redialed)

Specifications may be changed without notice.

GENERAL

INPUT:	2 or 4 wire transmission line. Separate 150, 600, 900 or 1200 ohm selectable terminate impedances or high impedance (50 K-ohm) bridge. Separate DC hold circuits.
DC BLOCKING:	200 VDC
BALANCE:	>90 dB, 50 Hz - 120 Hz; decreasing 6 dB per octave above 120 Hz
RETURN LOSS:	>30 dB (>15 dB, 20 Hz - 400 Hz using 150 ohm)
SIGNALING:	Pulse, DTMF (touch tone) or MF (multi-frequency) from full 16 button keypad
MONITOR/TALK:	Built in speaker monitor and microphone with 2/4 wire hybrid for hands free speaker phone operation
POWER:	115 VAC or 230 VAC 50/60 Hz @ 20 VA. Internal rechargeable battery (sealed lead/acid) optional. Battery charge life approximately 5 hours. Low battery warning at 1 hour remaining.

WEIGHT:

	Net	Shipping
Basic Unit	5 lb.	8 lb.
With Battery Option	10 lb.	13 lb.

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

OPERATING TEMPERATURE:	0 to 50 deg. Celsius
STORAGE TEMPERATURE:	-40 to 75 deg. Celsius
LINE CONNECTIONS:	Dual miniature phone jack* .173" dia.on .312" centers (front panel) and screw terminal strip (rear panel) * Mates with ADC PJ777 or Switchcraft TT253.

REMOTE CONTROL PORT:

TYPE	RS232, ASCII
BAUD RATE	300, 1200, 2400, 9600 baud switch selectable
CONNECTION	25 pin male, D-miniature type

steps. An entry of 0 (zero) will cause the study time interval to be continuous.

Run time also enables the STO and RCL buttons to be used to store or recall one of ten user settable times by pushing STO or RCL followed by a number 0 - 9.

b. LO THLD (Threshold): Allows the operator to set the value of the lowest level threshold. Depression of this key will cause an associated green LED to come on. While the LED is on, the low level threshold may be directly entered as a numeric value from 30 dBrn to 100 dBrn (-60 to +10 dBm) in .1 dB resolution or the or buttons may be used to step the low threshold up or down to the desired value in 1 dB steps. Once the desired value is displayed, it may be entered by depression of the ENTER button. LO THLD also enables the STO and RCL buttons to be used to store or recall one of ten user settable thresholds by pushing STO or RCL followed by a number 0 - 9.

c. DELTA 2dB — Causes the mid and hi level thresholds to be established in increments of 3 dB above that selected for the low threshold.

d. DELTA 3dB — Causes the mid and hi level thresholds to be established in increments of 3 dB above that selected for the lo threshold.

e. DELTA 4dB — Causes the mid and hi level thresholds to be established in increments of 4 dB above that selected for the lo threshold.

f. DELTA 6dB — Causes the mid and hi level thresholds to be established in increments of 6 dB above that selected for the lo threshold.

g. START — Depression of the start button will cause the Lo, Mid and Hi impulse counters to be reset to zero and will cause the previously selected run time to begin while the counters accumulate impulses which exceed the previously selected Lo, Mid and Hi thresholds. An associated red LED will continue to blink while the test is in progress. The left hand display will display Lo, Mid or Hi counts or noise as selected by the LO CT, MID CT, HI CT or NOISE buttons. The right hand display will display a countdown of the run time in minutes. If the run time has been set to

zero (continuous), the right hand display will count up, showing the elapsed time of the study.

h. STOP — Causes the study to stop. While stopped, the Lo, Mid and Hi counters will retain the counts accumulated since study start and may be viewed in the left hand display.

i. LO CT (Low Count) — Displays value of lo counter in left display and minutes elapsed into study in right display.

j. MID CT (Mid Count) — Displays value of mid counter in left display and minutes elapsed into study in right display.

k. HI CT (Hi Count) — Displays value of hi counter in left display and minutes elapsed into study in right display.

l. NOISE — Displays received noise level in left display and minutes remaining in study in right display.

5. (SIGNALING) DP, TT, MF Category

Selection of any of the 3 available signaling methods, DP (dial pulse), TT (touch tone-DTMF) or MF (multifrequency) is accomplished by repeated depression of the DP, TT, MF button until the red LED associated with the desired signaling mode is lit. When any of the 3 signaling select LED's is lit, depression of any of the 16 buttons along the bottom edge of the front panel will cause the associated digit 0-9, #, *, A-D) to be outpulsed.

Once a signaling method has been selected, it will remain selected even though one of the other category buttons may have been selected in the meantime. Returning to the DP, TT, MF category will cause the last selected signaling mode to be reselected.

6. Miscellaneous

a. STO (Storage) Function: Allows up to 10 front panel configurations to be stored in non volatile internal memory for later recall. Also used to store for later recall, up to ten each of the following:

Transmit (signal generator) level
Signal generator, VAR Hz mode, frequency
Return loss TLP
Impulse noise run time
Impulse noise low threshold

THRESHOLD ACCURACY	Above 40 dBrn (-50 dBm) - ±0.5 dB Below 40 dBrn (-50 dBm) - ±1.0 dB
TIMER	User settable 0.1 - 999.9 min. or continuous. Default = 15.0 min.
MAX COUNT	9999 (each threshold)
DEAD TIME (AM5)	143 msec
(AM5E)	125 msec

IMPULSE NOISE WITH TONE MEASURE:

NOTCH FILTER	1010 Hz, 50 dB min.
TONE LEVEL	+10 to -40 dB
THRESHOLD ACCURACY	Above 50 dBrn (-40 dBm) - ±0.5 dB Below 50 dBrn (-40 dBm) - ±1.0 dB

(Other specifications same as "IMPULSE NOISE" above)

P/AR MEASURE:

RANGE	0 to 120 PAR units
RESOLUTION	1 PAR unit
ACCURACY	PAR = 30 to 110 - ±2 PAR units PAR = 0 to 120 - ±4 PAR units
SIGNAL LEVEL RANGE	-40 to 0 dBm (measured with RMS detector)
DETECTORS	Average, Peak and RMS

RETURN LOSS MEASURE:

RANGE	0 to 40 dB (2 wire) 0 to 50 dB (4 wire)
TEST SIGNALS	Band shaped white noise (ERL, SRL-LO, SRL-HI) or sine wave
SEND LEVEL	-10 dBm to -2 dBm (sine wave -10 to +10 dBm)
RESOLUTION	0.1 dB
ACCURACY	±0.5 dB
4 WIRE LEVEL COMPENSATION (TLP)	+99.9 to -99.9 dB in .1 dB steps
DETECTOR	RMS

NOISE MEASURE:

RANGE	(AM5)	10 to 100 dBrn, (20 to 100 dBrn at 150 ohm)
	(AM5E)	-80 to +10 dBm, (-70 to +10 dBm at 150 ohm)
RESOLUTION		1 dB
ACCURACY	(AM5)	20 to 100 dBrn - ±1 dB, 10 to 20 dBrn - ±2 dB
	(AM5E)	-70 to +10 dBm - ±1 dB, -80 to -70 dBm - ±2 dB
FILTERS	(AM5)	C-Message, Program, 3 kHz Flat, 15 kHz Flat, 50 kBit, 60 Hz
	(AM5E)	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	(AM5)	RMS
	(AM5E)	RMS or Quasi-Peak (J.16) as selected

NOISE WITH TONE MEASURE:

NOTCH	1010 Hz, 50 dB minimum

(Other specifications same as "NOISE MEASURE" above)

SIGNAL TO NOISE MEASURE:

SIGNAL RANGE		-40 to +10 dBm
NOISE RANGE	(AM5)	10 to 70 dBrn
	(AM5E)	-80 to -20 dBm
RATIO RANGE		10 to 50 dB
ACCURACY		Noise above 20 dBrn (-70 dBm) - ±1 dB Noise below 20 dBrn (-70 dBm) - ±2 dB S/N Ratio 0 - 40 dB - ±1 dB S/N Ratio 40 - 45 dB - ±2 dB S/N Ratio 45 - 50 dB - ±3 dB

IMPULSE NOISE MEASURE (3 level):

THRESHOLD RANGE	30 to 100 dBrn (-60 to +10 dBm)
THRESHOLD DIFFERENCE	2, 3, 4, 6 dB

Dialed telephone numbers (up to 48 digits each)

b. RCL (Recall) Function: Recalls any of the stored functions.

c. ON, OFF: Switches power to the unit on/off.

d. MONITOR: Consists of a 3 position selector switch (TX, RX, MEAS), a volume control and an internal amplified speaker.

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

ii. RX (Receive) Connects the internal speaker/amplifier to the signal being measured, which will be either the RX (receive) pair of the 4 wire circuit under test, the 2 wire circuit under test, the receive pair of the internal hybrid if measuring 2 wire return loss, or the noise to ground circuit if measuring noise to ground.

iii. MEAS (Measure) Connects the internal speaker/amplifier to the output of the receive circuit auto ranging amplifier and associated filters. This signal will always be in an 18 dB range for input signals ranging from -65 to +10 dBm.

IV. OPERATION

A. POWER ON SELF TEST

Upon activation of the power ON/OFF switch to the ON position, power will be applied to the unit and the unit will automatically undergo a self test.
All front panel LED's will be bright for approximately 3 seconds to allow observation that all lamps are operating.

The internal microprocessor will then execute a routine where memory and operating circuits are tested. If successful, the numeric display will display the message "TEST PASS" for approximately 3 seconds after which the unit will assume its default configuration.

B. DEFAULT CONFIGURATION

Following the power-on self test sequence, the unit will assume the following configuration:

4 wire normal (not reversed) line connection
Send Pair: 600 ohm, ON HOOK with signal generator OPEN, SF SKIP on.

Receive Pair: 600 ohm, ON HOOK, bridged, with measuring circuit displaying LEVEL and FREQUENCY.

Note: If the power-on self test sequence determines that the calibration data in RAM has been lost, then an automatic calibration sequence will be offered (display will indicate "auto cal?"). If this occurs, remove all test leads which may be connected to the front or rear panel RX and TX connections and depress the "ENTER" button. The unit will then automatically calibrate itself. This process takes approximately 40 seconds.

C. "LINE" CONFIGURATIONS

The 2 or 4 wire line connected to the AM5 may be terminated and signaled upon in a variety of ways.

A simplified block diagram of the "Line" circuits is shown in Figure 8.

1. IMPEDANCE SELECTION

Four different impedance selections (150 ohm, 600 ohm,900 ohm, 1200 ohm) are provided for the TX (Transmit) line and the same selection of impedances is separately provided for the RX (Receive) line.

With "Line" category enabled, TX impedances are selected by buttons 1, 2, 3 or 4. Rx impedances are selected by buttons 7, 8, 9 or 0. An associated LED will indicate the selected impedances. **NOTE:** The impedance selection described above is also used by the internal microprocessor in computing dBm and dBrn readings for the display as measurements are actually made in volts (E) and then converted to dBm based upon the selected impedance (R) in accordance with the formula: $dBm = 10 \log (\frac{E2}{R} \times \frac{1000}{})$. The circuit under test will actually be terminated by the AM5's internal impedances only when in not "BRIDGED" (terminate) mode.
When in 2 wire mode and with the signal generator selected to send a test tone (not "QUIET" or "OPEN"), it is not possible to bridge the line as the signal generator source impedance effectively terminates the line.

2. DC LINE HOLD (On Hook/OFF HOOK)

Both TX and RX lines are provided with separate DC hold circuits. The hold circuits are electronic equivalents of a line hold coil. With DC hold on ("OFF HOOK" selected), the circuit provides a 200 ohm DC path across T&R while at the same time providing a high impedance path (>50 K ohms) to AC frequencies.

While in the "Line" category, On Hook/OFF HOOK (line hold off/on) may be selected for the TX line by depression of

ACCURACY:

LEVEL

	20Hz	50Hz	200Hz	20kHz	60kHz	110kHz
+10dBm	±0.8	±0.3	±0.1	±0.3	±1.0	
-40dBm	±0.8	±0.4	±0.3	±0.8	±1.0	
-50dBm						

Notes: When using 150 ohm, accuracy is not specified below 400 Hz
P/AR, ERL, SRL-LO, SRL-HI, accuracy is ±0.5 dB

FREQUENCY ±0.01%

RECEIVER

LEVEL MEASURE:

RANGE -64.9 to +10 dBm

RESOLUTION 0.1 dB

ACCURACY

	20Hz	50Hz	200Hz	20kHz	60kHz	110kHz
+10dBm	±0.8	±0.3	±0.2	±0.4	±1.5	
-40dBm	±0.8	±0.8	±0.4	±0.8	±2.0	
-50dBm	±1.5	±1.5	±0.8	±1.5	±3.0	
-65dBm						

Notes: At 1004 Hz accuracy is ±0.1 dBm from 0 to -20 dBm
When using 150 ohm, accuracy is not specified below 400 Hz

NOISE PROTECTION: Low frequency (60 Hz) switchable in or out
High frequency, 120 kHz low pass or 15 kHz low pass (Secondary Mode) always inserted

DETECTOR: Average

FREQUENCY MEASURE:

RANGE: 20 Hz to 110 kHz

RESOLUTION/ ACCURACY:
20 Hz to 10 kHz - 1 Hz/±1 Hz
10 kHz to 100 kHz - 10 Hz/±10 Hz
100 kHz to 110 kHz - 100 Hz/±100 Hz

LEVEL: -55 to +10 dBm, S/N ratio >20 dB

VI. TECHNICAL SPECIFICATIONS

STANDARD	(AM5)	IEEE 743-1984 (Bell 41009)
	(AM5E)	CCITT
MEASUREMENTS		Level (-65 to + 10 dBm) Frequency (20 Hz to 110 kHz) Noise (10 to 100 dBrn) Noise with Tone (10 to 100 dBrn) S/N Ratio (10 to 50 dB) Noise to Ground (40 to 130 dBrn) Impulse Noise, 3 level P/AR 2W Return Loss 4W Return Loss

SIGNAL GENERATOR MODES

VAR HZ		20 Hz to 110 kHz steppable in 100 Hz steps or direct settable with 4 digit resolution. 1 Hz from 20 - 9,999 Hz, 10 Hz from 10,000 - 99,990 Hz, 100 Hz from 100,000 - 110,000 Hz (1 Hz from 20 - 110,000 Hz by remote control only), -50 to +10 dBm.
SF SKIP	(AM5)	2450 - 2750 Hz
	(AM5E)	2130 - 2430 Hz
REF TONE		1004 Hz -50 to +10 dBm
SLOPE - 3(4) TONES	(AM5)	404 Hz, 1004 Hz, 2804 HZ - 5 sec per tone
	(AM5E)	300, 1004, 2000, 3000 Hz - 5 sec per tone
SLOPE - SWEEP (Secondary Mode)		Operator settable Lo and Hi frequency end points, step size (Hz), and step dwell time (sec).
P/AR		Simultaneous 16 phase related frequencies per Bell 41009, -50 dBm to 0 dB
ERL, SRL-LO SRL-HI		Band shaped white noise (ERL 560 - 1965 Hz, SRL-LO 260 - 500 Hz, SRL-HI 2200 - 3400 Hz), -10 dBm to -2 dBm

button "5". RX On Hook/OFF HOOK is selected by button "*". These buttons act as toggles.

3. BRIDGE/terminate

Button "#" in the "Line" category is a toggle which selects "BRIDGE" or "terminate" conditions for the RX line.

In 2 wire mode, the line will only be bridged if the generator is set to "QUIET" or "OPEN" while bridge is selected.

Terminate means that the line is terminated by the AM5 with the impedance selected by the impedance selector controls. Bridged (not terminated) means that the AM5 is high impedance (50 K ohms) connected to the line under test and in this case the line should be terminated by a device external to the AM5.

A line under test should typically be terminated by an external impedance or the AM5 but not both.

4. 2W, 4W, REV SELECTION

This set of 3 controls in the "Line" category is used to select the line type corresponding to the type of line (2 wire, or 4 wire) connected to the AM5 as well as to provide a convenient method of "reversing" the TX and RX pair on 4 wire circuits without actually having to unplug and replug the connection.

On 4 wire circuits, connect the receive pair (the pair on which the AM5 will receive signals) to the RX jack. Connect the send or transmit pair (the pair on which the AM5 will send signals) to the TX jack.

On 2 wire circuits connect the pair to the TX jack.

D. SIGNAL GENERATOR (SEND) OPERATION

The AM5 contains a highly flexible signal generator capable of generating a variety of test tones for application to the TX (Transmit) pair.

1. QUIET

The generator may be set to a "quiet" mode (Button #1) wherein the generator is disconnected from the TX line and the line is "quiet" terminated by a passive resistive termination.

2. OPEN

Open (Button 9) causes the signal generator to be disconnected from the TX line and the line to be left open.

3. **VAR HZ**

The generator may be set to VAR HZ mode (Button #3) where it may be caused to generate any frequency from 20 Hz to 110 kHz with 1 Hz resolution and any level from -50 dBm to +10 dBm with 0.1 dB resolution. Both a direct selection method as well as a sweep up or sweep down mode are provided for both level (1 dB steps) and frequency 100 Hz steps) selection.

4. **SF SKIP**

An SF Skip mode is provided (Button "A") which, if selected, will prevent the VAR HZ generator from generating any frequency in the frequency range 2450 Hz through 2750 Hz (2130 Hz to 2430 Hz for AM5E).

5. **PRESET TONES**

Seven preset "frequently used" test tones are provided. These are:

a. 1004 Hz (Button 2) — Generates a continuous 1004 Hz sine wave.

b. SLOPE 3 (or 4) TONE (Button 4) — Generates a 1004 Hz sine wave for 5 seconds immediately followed by a 2804 Hz sine wave for 5 seconds immediately followed by a 404 Hz sine wave for 5 seconds. This sequence repeats indefinitely while in this mode and is used for 3 point gain slope measurements (a plot of transmission loss versus frequency at 3 points). In the AM5E, 4 tones at frequencies 1004, 304, 2004 and 3004 Hz are provided.

c. SLOPE-SWEEP (Second depression of Button 4) — A second depression of the "SLOPE" button will cause the associated red LED to flash indicating that the signal generator is in the SLOPE-SWEEP mode. In this mode the generator will sweep from lo to hi frequency limits in steps and dwell time set into the A, B, C, and D memory locations. See page 32 for setting A, B, C, D parameters.

d. P/AR (Button 5) — Generates a phase related 16 sine wave test tone used for the peak to average ratio (P/AR) measurement.

e. ERL (Button 6) — A white noise test tone band limited (3 dB points at 560 Hz and 1965 Hz)

Pin #		Function	Direction
2	RD	Received Data	To AM5
3	TD	Transmit Data	From AM5
7	GND	Common	--

The baud rate and parity selection will be the same as that set for the main RS232 port.

In normal operation, ASCII characters received by the AM5 are decoded and acted upon by the AM5 in accordance with the protocol described in paragraph IX B above. It is possible to command the AM5 to become transparent so that all subsequent ASCII characters received by the AM5 RS232 port are sent through to the AM5 "AUX" port.

The AM5 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 AM5 into 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 "A"-"Z", then sent out the AUX port. In this way, several AM5'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. 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.

When echo is turned on, the AM5 echoes back ALL characters when it is not in transparent mode. When echo is turned off, the AM5 does not echo anything. The only thing it will send are responses to the (A.. series of commands.

G. RS232 PORT CONFIGURATION

The operating characteristics of the RS232 port are controlled by switch settings of switches 1-4 on the rear panel dip-switch. Switches 7 and 8 control front panel setup protect and password.

Switch	Function	Code
1 & 2	Sets baud rate	1 open, 2 open = 300 baud
		* 1 on, 2 open = 1200 baud
		1 open, 2 on = 2400 baud
		1 on, 2 on = 9600 baud
3	Enables parity	* 3 on = parity
		3 open = no parity
4	Selects parity	* 4 on = even parity
		4 open = odd parity
5	Not used	--
6	Not used	--
7	Setup protect	* on = protect
		open = unprotected
8	Password enable	on = password required
		* open = password not req'd

* Indicates factory settings

The RS232 port is a male "D" miniature connector. The following pins are available for use:

Pin #		Function	Direction
2	TD	Transmit Data	From AM5
3	RD	Received Data	To AM5
4	RTS	Request to Send	From AM5
5	CTS	Clear to Send	To AM5
7	GND	Common	--
9	+V	+ Power (+12 VDC)	From AM5
10	-V	- Power (-12 VDC)	From AM5
20	DTR	Data Terminal Ready	From AM5
22	RI	Ring Indicator	To AM5

H. AUXILIARY RS232 PORT

A second RS232 port is provided on the rear panel of the AM5 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 A an "auxiliary unit," such as a printer, test access switch, etc., which may be co-located with the AM5 and where it is desired to communicate with the auxiliary device via the main RS232 port of the AM5. The following pins are available for use:

and used for the echo return loss measurement.

f. SRL/LO (Button 7) — A white noise test tone band limited to exclude high frequency components (3 dB points @ 260 Hz and 500 Hz) and is used to make singing Return Loss - Lo measurements.

g. SRL-HI (Button 8) — A white noise test tone band limited to exclude low frequency components (3 dB points @ 200 Hz and 3400 Hz) and is used to make singing Return Loss - Hi measurements.

6. LEVEL SET

Level set (Button "*") may be used to set the transmit level of any send (signal generator) function within the following limits:

Function	Power Up Default	Minimum Setting	Maximum Setting
Quiet	-	-	-
1004 Hz	00.0 dBm	-50.0 dBm	+10.0 dBm
VAR Hz	00.0 dBm	-50.0 dBm	+10.0 dBm
Slope	00.0 dBm	-50.0 dBm	+10.0 dBm
P/AR	00.0 dBM	-40.0 dBm	00.0 dBm
ERL	-02.0 dBm	-08.8 dBm	-02.0 dBm
SRL/LO	-02.0 dBm	-08.0 dBm	-02.0 dBm
SRL/HI	-02.0 dBm	-08.0 dBm	-02.0 dBm
2713 Hz	00.0 dBm	-50.0 dBm	+10.0 dBm

It should be noted that the AM5 contains a single tone generator and that, if set to a certain level in a given function and then switched to a new function, it will send that same level of the new function (or the level nearest within its min/max limits).

For example: If the generator is set for 1004 Hz at a level of -20.0 dBm and is then switched to ERL, it will send -10.0 dBm as that is the level within the ERL min/max limits closest to -20.0 dBm.

To set level, depress the level set button ("0"). The associated green LED will come on indicating that the level set function is active and ready to accept a numeric input (direct level set using the numeric buttons) or a sweep input UP ARROW or DOWN ARROW buttons.

For direct level entry, enter a number corresponding to the desired level. It is not necessary to enter insignificant zeros. For example, a level of "-07.0" may be entered as

"-7"; a level of "+09.3" may be entered as "9.3". Once the desired level has been entered in the display, it may be executed by depression of the "enter" ("C") button. If a mistake is made, depress "cancel" ("D") button, reselect "level set" and proceed.

If the level has been stepped up or down using the UP ARROW ("A") or DOWN ARROW ("B") buttons and the CANCEL buttonis depressed, the level set function will be deselected. However, the level will remain at the level last displayed.

7. FREQUENCY SET

Frequency Set (Button "#") is used only in conjunction with the VAR HZ mode to select or store a signal generator frequency or in conjunction with the SLOPE-sweep mode to define the parameters of the frequency sweep.

To preset or set a frequency for the signal generator VAR HZ mode, proceed as follows:

Go to the SEND category and depress the FREQ SET button. Note that the associated green LED will come on and the right hand numeric display will indicate the VAR HZ mode current frequency setting (readings are in kHz).

Use the UP ARROW or DOWN ARROW buttons to move the frequency up or down to the desired new frequency (note that the frequency will move in 100 Hz steps). When the desired frequency is reached, the FREQ SET mode may be exited by pressing the cancel button.

OR

Direct frequency selection may be accomplished by entry of the desired frequency (in kHz) using the numeric buttons and the decimal point button. When the desired frequency has been entered in the display, press the ENTER button and the VAR HZ mode will assume the new frequency. Direct entry will allow frequencies to be entered in 1 Hz steps from 0.020 to 9.999 kHz, in 10 Hz steps from 10.00 to 99.99 kHz and in 100 Hz steps from 100.0 to 110.0 kHz.

Note that if SF SKIP is on it will not be possible to set the signal generator for frequencies between 2450 and 2750 Hz (AM5) or 2130 and 2430 Hz (AM5E).

8. TALK

Momentary depression of the talk button ("c") will disconnect the signal generator from the TX line and will connect a built-in microphone in its stead. With the monitor switch set to RX, the speaker will be operational and full duplex (speaker phone) operation is possible. A hybrid is employed

Character(s)	Definition
1	"("
2-6	"TIME="
7-11	Time interval to be used for next study started.
12	space
13-17	"THLD="
18-22	Low impulse threshold to use for next study started.
23	space
24-29	"DELTA="
30	Delta threshold to use for next study started.
31	space
32-36	Impulse study start/stop status.
37	space
38-42	"DISP="
43-47	Currently selected impulse noise display mode.
48	")"
49-50	<CR><LF>

Response to (AE) command:

The (AE) command is used to read the entire status of the AM5. It gives the same response as the (ALE), (ASE), (AME), and (AIE) commands, in that order. It gives a complate picture of the AM5 setup.

D. PASSWORD SECURITY

The following have to do with password security:

(P----)	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.
(AXYZ----)	Set new password
(B)	Logoff. Unit will also auto log off after 2 minutes without receiving any command.

E. FRONT PANEL LOCKOUT

(AY+)	Enable front panel display and keypad
(AY-)	Disable front panel display and keypad
(AYK)	Disable front panel keypad

F. MISCELLANEOUS COMMANDS

(Zn)	Store front panel setup n
(Rn)	Recall front panel setup n
(E+)	Enable echo
(E-)	Disable echo

50	")"
51-52	<CR><LF>

Response from (AME) command:

```
00000000011111111112222222222333333333344444444445555555555 5   6
12345678901234567890123456789012345678901234567890123456789 9   0
(MMODE=LVLFRQ FILTER=CMSG    60HZ TLP=-nn.n REL=-nn.n NOR )<CR><LF>
      NOISE          PGM     NO60                 OFF   DAMP
      NNOISE         3KHZ
      NTG            15KHZ
      S/N            50BIT
      PAR
      RETLOS
```

The (AME) command is used to read the status of the AM5 measure control annunciators, and related items.

Character(s)	Definition
1	"("
2-7	"SMODE="
8-13	Current measure mode.
14	space
15-21	"FILTER="
22-27	Current noise filter selected.
28	space
29-32	Current 60 Hz filter status.
33	space
34-37	"TLP="
38-42	Current TLP reference level +/-nn.n
43	space
44-47	"REL="
48-52	Relative display mode, gives relative reference level if relative is on.
53	space
54-57	Norman/damp status.
58	")"
59-60	<CR><LF>

Response from (AIE) command:

```
000000000111111111122222222223333333333444444444 4   5
123456789012345678901234567890123456789012345678 9   0
(TIME=nnn.n THLD=nnn.n DELTA=2 START DISP=LOW  )<CR><LF>
                              3 STOP       MID
                              4            HIGH
                              6            NOISE
```

The (AIE) command is used to read the status of the AM5 impulse noise control annunciators, and related items.

in 2 wire mode which allows full duplex operation in 2 wire mode as well. This mode of operation is indicated by the talk LED blinking.

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

Push to talk is accomplished by depressing and holding the talk button. Push to talk mode is indicated by the talk LED being steady on. With the talk button held depressed, the microphone will operate but the speaker will be muted. Releasing the talk button (talk LED remains steady on) will disconnect the microphone and unmute the speaker for listening.

"Push to talk" mode may be exited by momentary depression of the talk button (talk LED will go out).

NOTE: When operating the unit under remote control via the optional RS232 port, the unit must be in push to talk mode in order for the built-in ring detector to detect and signal, out the RS232 port, the receipt of ringing.

9. 2713 HZ (AUX)

Depression of this button ("D") will cause the signal generator to be overridden and for 2713 Hz to be applied to the line for however long the button is held depressed. Release of the button will automatically restore the last signal generator mode. This function is typically used to trip and restore Bell Model 829 loop back devices found on some 4 wire circuits.

E. MAKING MEASUREMENTS

Most analog transmission measurements are made by applying a test tone of a certain type to the distant end of a transmission line pair and then measuring the test tone signal at the near end. For this reason, a test set is usually employed at each end of the circuit under test. A field technician or far end technician will normally operate the distant test set while the near end test set is operated by personnel within the switching center or data center at which the line under test terminates. An alternate to this scheme is to use remotely controlled responders at the distant end of the circuit under test. Ameritec Model AM3-2A two-way responders and AM3-4A and 4B four-wire responders are suitable for this purpose and may be controlled by the TT (DTMF) signaling in the AM5.

Simple loop back devices, such as the Bell Model 829, may be found on the distant end of 4 wire circuits. The Model AM5 is compatible with these units as it is able to generate the 2713 Hz test tone necessary to control this type of loop back device.

1. LEVEL AND FREQUENCY MEASUREMENT

TRANSMITTER SETTING: 1004 Hz for single point loss tests, SLOPE for 3 point gain slope tests, VAR HZ or SLOPE-SWEEP for multi point frequency response curve tests.

The transmitted test tone is applied to the distant end transmit circuit or the near end transmit circuit of a looped back 4 wire circuit while the receive pair measures the resultant signal on the near end receive pair. With measure category LEVEL/FREQUENCY (button 1) selected, the left hand display will indicate the level of the received signal in dBm while the right hand display indicates the frequency of the received signal in kilo hertz. The front end receiver will accept signals in the range of 20 Hz to over 100 kHz. If the received signal has excessive power line hum or excessive high frequency components (in excess of 110 kHz), an erratic display may result. This may be corrected in two ways:

a. A second depression of the level/frequency button (button 1) will introduce a 15 kHz low pass filter to the front end and effectively eliminate high frequency components.

   This mode will be indicated by a slow blinking of the red LED associated with the level/frequency button. This mode is useful in making measurements on voice band circuits where high frequency components are of no interest.

b. Power line hum contribution can be determined by momentary depression of the 60 Hz button (button *). A 60 Hz high pass filter will be introduced while this button is held depressed and will effectively eliminate frequency components below 60 Hz from the reading. Release of the button will remove the filter from the measurement. Level measurements are made using an average detector and a 120 kHz low pass filter is also used.

Rapidly fluctuating readings may be captured by depression of the DAMP switch (button D). With DAMP on, the display will update at the rate of 2 times per second, half the normal 4 times per second update rate.

2. NOISE MEASUREMENTS

TRANSMITTER SETTING: QUIET terminated.

Noise measurements are normally made on a quiet terminated circuit and are usually referred to as idle channel noise (noise without a test signal). The voltage on the received pair is measured using a RMS detector (RMS or Quasi-Peak on AM5E). This voltage is converted to dBm by the microproces-

Characters(s)	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>

Response from (ASE) command:

```
000000000111111111122222222223333333333444444444 5    5
123456789012345678901234567890123456789012345678901 1    2
(SMODE=QUIET LEV=-nn.n FRQ=nnn.nnn NOSKIP TALKOFF)<CR><LF>
      1004                          SFSKIP TALKON
      VAR
      SLOPE
      PAR
      ERL
      SRLL
      SRLH
      OPEN
```

The (ASE) command is used to read the status of the AM5 send control annunciators, and related items.

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) +/-nn.n
23	space
24-27	"FRQ="
28-34	Current var Hz frequency (even if not sending var Hz), in kHz to 1 Hz resolution, nnn.nnn.
35	space
36-41	SF skip status.
42	space
43-49	Talk status.

MDCNT
HICNT

The (A1) command is used to read the contents of the AM5 numeric displays, along with the pertinent annunciators.

Character(s)	Definition
1	"("
2-5	"SEND" or "MEAS" depending on display space
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 as a "+" sign in this field even though it appears as a blank on the front panel display. Typical displays appear as "123.4 ", "+04.3 ", "-64.9 ", "OVER ".
15	space
16-20	Left display annunciator. Note that in the case of displaying impulse noise counts the front panel annunciator is simply "COUNTS", but the RS232 format identifies which of the three counts is being displayed.
21	space
22-29	Alpha-numeric contents of right display.
30	space
31-33	Right display annunciator. Blanks if no annunciator is on.
34	space
35-39	Holding tone annunciator.
40	Low battery annunciator. Space if off, "*" if on. Note that the front panel low battery indicator is flashing decimal points. The extra decimal points will NOT appear on the RS232 displays.
41	")"
42-43	<CR><LF>

Response from (ALE) command:

```
000000000111111111122222222223333333333444444444455 5    5
123456789012345678901234567890123456789012345678901 2    3
(SNDZ=150  ONHOOK  RCVZ=150  ONHOOK  TERM   2W NOR><CR><LF>
     600              600
     900              900
     1200             1200
```

The (ALE) command is used to read the status of the AM5 line control annunciators.

sor based upon the selected terminate impedance. In the Model AM5 the microprocessor further converts the reading to dBrn in accordance with the formula: dBrn = dBm + 90. For example: -50 dBm = 40 dBrn. The normal filter used for noise measurements is the C Message filter (button 6) and is depicted in figure 4. Any one of four other filters may alternately be selected. These are program (button 7), 3 kHz flat (button 8), 15 kHz flat (button 9), and 50 kBit (button 0). The AM5E provides psophometric, sound weighted, sound unweighted, flat (275 - 3250 Hz) and flat (750 - 2300 Hz), respectively.

The right hand display will not operate during noise measurements.

3. NOTCH NOISE (Notch With Tone) MEASUREMENT

TRANSMITTER SETTING: 1004 Hz

Notch noise measurements are identical to noise measurements with the exception that a 1010 Hz notch filter is introduced to the receive detector circuit. The notch filter removes the 1004 Hz test tone from the received signal and allows the display to indicate residual noise. Like the noise measurement, the C Message filter is most often used with notch noise measurements (or psophometric). However, any of the above-mentioned filters may alternately be selected.

In order for this measurement to be valid, the received signal must contain the 1004 Hz test tone. An indicator is provided near the right hand display and is labeled "HOLD TONE." It is a green LED and it will be on whenever the received signal contains a 995 Hz to 1025 Hz tone at a level of greater than -40 dBm. The right hand display will also indicate the frequency of the received tone for further verification.

4. SIGNAL TO NOISE RATIO MEASUREMENT

TRANSMITTER SETTING: 1004 Hz

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 followed by the 1004 Hz notch filter and noise weighing filter followed by a RMS detector. The first detector measures the amplitude of the received test tone (primarily 1004 Hz) and the microprocessor maintains this value in memory. The second detector (following the notch filter) measures the value of the residual noise and this value also is kept in memory by the microprocessor. The microprocessor computes the ratio of signal to noise and displays the resultant reading in the left hand display in dB. The hold tone indicator near the right hand display must

be on for this measurement to be valid. The right hand display will display the frequency of the received tone for further verification.

The C Message (or psophometric) filter is normally used with this measurement, however, any of the other filters may be alternately selected.

5. **P/AR (Peak to Average Ratio) MEASUREMENT**

TRANSMITTER SETTING: P/AR (A composite wave form made up of 16 specific phase related frequencies)

P/AR (Peak to Average Ratio) measurements are made by applying a special 16 tone signal at the distant end of the line under test. At the near end the AM5 is used to simultaneously measure 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 will also have a value of 100. A typical telephone channel does cause smearing or Intersymbol Interference and so a value other than 100 would be observed. Table 1 shows some typical values which might be used to judge the acceptability of a telephone line to transmit data reliably. For example: If a modem requires a C2 conditioned line and you measure P/AR of 50, then you know you are going to have difficulties. On the other hand, a value of 78 indicates that Intersymbol Interference will not trouble you.

TABLE 1

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 following commands are for dialing:

Command	Function
(TTXXX...X)	dial Touch Tone
(DPXXX...X)	dial Dial Pulse
(MFXXX...X)	dial Multi Freq

Where: XXX...X 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 (dialtone is 1 second ofcontinuous energy > 24 dBm)
\- = wait 1 second and then proceed 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 dialed number store and recall functions cannot be controlled using the RS232 port.

The following commands are used to read the current setup, or take a measurement remotely. They result in a response from the AM5. Responses are documented below:

Command	Function
(A1)	read the display and annunciators
(ALE)	read line setup
(ASE)	read send setup
(AME)	read measure setup
(AIE)	read impulse setup
(AE)	read line, send, measure and impulse setups

All responses from commands are enclosed in parenthesis and terminated by an 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.

C. **RESPONSE PROTOCOL**

Response from (A1) command:

```
0000000001111111111222222222233333333334 4   4
1234567890123456789012345678901234567890 1 2   3
(SEND ddddddddDB    dddddddd            )<CR><LF>
 MEAS         DBM           KHZ HTONE*
              DBRN          PAR
              LOCNT         MIN
```

Measure control commands:

Command	Function
(M)	select measure mode
(M1)	level/frequency (wideband)
(M1+)	level/frequency (15 kHz bandwidth)
(M1-)	level/frequency (wideband)
(M2)	noise
(M3)	notched noise
(M4)	noise to ground
(M5)	signal/noise
(M6)	CMSG filter
(M7)	PGM filter
(M8)	3 kHz filter
(M9)	15 kHz filter
(M0)	50 kBit filter
(M*+)	60 Hz filter IN
(M*-)	60 Hz filter OUT
(M#)	PAR
(MA)	return loss
(MBnnn.n)	set TLP
(MBZn)	store TLP n
(MBRn)	recall TLP n
(MC+)	relative ON
(MC-)	relative OFF
(MD+)	damp ON
(MD-)	damp OFF

Impulse noise study control commands:

Command	Function
(I)	select impulse mode
(I1nnn.n)	set timer
(I1Zn)	store timer n
(I1Rn)	recall timer n
(I2nnn.n)	set threshold
(I2Zn)	store threshold n
(I2Rn)	recall threshold n
(I3)	delta 2 dB
(I4)	delta 3 dB
(I5)	delta 4 dB
(I6)	delta 6 dB
(I8)	start
(I9)	stop
(I*)	display low count
(I#)	display mid count
(IA)	display mid count
(IB)	display noise

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

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.

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 network's ability to pass data reliably. Return loss problems are a common source of envelope delay ripple.

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.

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.

6. RETURN LOSS MEASUREMENT

a. TWO-WIRE RETURN LOSS

TRANSMITTER SETTING: ERL, SRL LO, SRL HI or VAR HZ

Two-wire return loss measurements are made by applying one of three white noise test signals or a sine wave in the 200 - 5

kHz band to the transmit pair of an internal 4 wire to 2 wire hybrid, while at the same time measuring the energy on the received pair of the hybrid. The hybrid balancing impedance is the selected line impedance in series with 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. As the return loss measurement is the ratio between transmitted energy and received energy, the absolute amplitude of transmit energy is somewhat immaterial, however, the AM5 has the ability to generate the ERL, SRL LO and SRL HI wave forms anywhere between -10 and -2 dBm.

b. **FOUR-WIRE RETURN LOSS**

TRANSMITTER SETTING: ERL, SRL LO, SRL HI or VAR HZ

Four-wire return loss measurements are a two-step process due to the fact that most 4 wire circuits employ loss or gain circuits in their transmit leg or receive leg. This gain or loss must be compensated for in order to provide a meaningful return loss measurement. This is accomplished by presetting into the Model AM5 a factor, called TLP (transmission level point), to offset the loop around gain in the 4 wire circuit. Proceed as follows:

a. Loop back the distant end of the 4 wire circuit (maintaining proper termination) and measure the loop around return loss of the 4 wire circuit under test.

b. Set TLP equal to the return loss measured in Step a. For example: If loop around return loss in the 4 wire circuit is -15 dB, then set TLP for +15. Restore the distant end of the 4 wire circuit to its normal termination and measure return loss. This reading will be the actual return loss.

7. IMPULSE NOISE MEASUREMENTS

Model AM5 will measure 3 level impulse noise on either a (NOISE), (NOTCH NOISE) or (NOISE TO GROUND basis). Any of the available filters may be used in connection with the 3 impulse noise measuring modes. Making an impulse noise measurement, it is first necessary to select one of the three noise measure categories along with an associated filter. Once having selected this, then select IMPULSE NOISE, then select and enter the following parameters:

RUN TIME: Should be entered in minutes to define the time base during which the impulse noise study will run.

"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 500ms of ringing voltage), the AM5 will send the following message:

(RING) <CR> <LF>

Note: <CF> <LF> is used in this document to represent the ASCII carriage return and linefeed characters.

Wait for ring mode is terminated either by the (WR-) command, or by going off hook on that pair.

Send control commands:

Commands	Function
(S)	select send mode
(S1)	quiet
(S2)	1004
(S3)	variable Hz
(S4)	slope tones
(S5)	par
(S6)	erl
(S7)	srll
(S8)	srlh
(S9)	open circuit
(S*nnn.n)	set level
(S*Zn)	store level n
(S*Rn)	recall level n
(S#nnn.n)	enter frequency kHz (1 Hz resolution .020-110.000 kHz)
(S#Zn)	store frequency n
(S#Rn)	recall frequency n
(SA+)	SK skip ON
(SA-)	SK skip OFF
(SC+)	talk mode ON
(SC-)	talk mode OFF
(SD)	send 2713 Hz for 1 second
(SDn)	send 2713 Hz for n seconds

Note: "n" represents a single digit 0-9. "nnn.n" represents a freeformat number with an optional decimal point, such as "1.004", "2", ".45" or "100.104".

V. REMOTE CONTROLS

A. OPERATION

In general, the AM5 RS232 commands follow the layout of the front panel. 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 and line feed, are not required but will be ignored if received. Only characters between the "(" and ")" are processed.

The first letter of the command generally corresponds to the row on 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 remote controlled using a "+" or "-" in the command to turn that selection on or off.

A few RS232 commands have no front panel counterparts, so their formats do not follow the above guidelines.

B. COMMAND PROTOCOL

Line control commands:

Commands	Function
(L)	select line mode
(L1)	sendz=150 ohms
(L2)	sendz-600 ohms
(L3)	sendz-900 ohms
(L4)	sendz-1200 ohms
(L5+)	send off hook
(L5-)	send on hook
(L7)	rcvz=150 ohms
(L8)	rcvz=600 ohms
(L9)	rcvz=900 ohms
(L0)	rcvz=1200 ohms
(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

LOW THRESHOLD: Is the value in dBrn which defines the lower amplitude threshold of the impulse noise measurement.

DELTA 2, DELTA 3, DELTA 4, DELTA 6 dB: Select any one of these four settings to define the increment between the low and mid threshold and the mid and hi threshold. For example: a selection of DELTA 3 dB will set the mid threshold 3 dB above the low threshold and the hi threshold 3 dB above the mid threshold.

For noise and noise to ground impulse noise measurements, make sure that the line under test is quiet terminated at the distant end. For notch noise impulse noise measurements, make sure that a 1004 Hz test signal is applied to the distant end of the pair under test.

To start the test, depress the Start button. The red LED associated with the Start button will begin blinking indicating that the impulse noise study is in progress and at the same time the right hand display will indicate a count down of the number of minutes remaining in the study, or count up elapsed time if the study interval is continuous. The left hand display will display the counts representing noise impulses that have exceeded either the low, mid or hi thresholds, depending upon whether the LOW, MID or HI count counter is selected. Selection of the NOISE display (button B) will indicate the RMS value of the noise appearing on the line under test. When the elapsed time counter has counted down to zero, the impulse noise study will stop and the LOW, MID and HI counters will contain the number of noise impulses, that occurred during the study, which exceeded the respective thresholds.

F. STORAGE OF PARAMETERS

1. FRONT PANEL SET UP STORE/RECALL

Complete front panel configuration set ups may be stored in any one of ten memory locations for later recall. To utilize this feature, merely select the desired front panel configuration and then depress the STO (store) button followed by depression of any one of the numeric buttons 0 through 9. (Note: The rear panel "setup protect" dip switch #7 must be "off" whenever changing stored parameters.) The display will then indicate "stor all?" If you wish to store the indicated front panel set up in the selected memory location (0 through 9), merely depress the ENTER button (button C). To undo the store command, depress CANCEL button (button D).

Recall of front panel set ups is accomplished by depressing the RCL (recall) button followed by the memory location 0 through 9 containing the desired front panel set up.

Note: Front panel "store" and "recall" will operate only if the following functions are not selected: DP, TT or MF, LVL SET, FREQ SET, RUN TME, LO THLD, SET TLP. If any of the above are selected, the STO and RCL have a different function as described in Section B below.

a. **"CANNED" (factory supplied) FRONT PANEL SET-UPS**

As supplied from the factory, the AM5 will be programmed for the following set-ups:

	TX PAIR	RX PAIR
RCL1	600 ohm, 1004 Hz @ 0.0 dBm	600 ohm, Terminate, 4W LVL/Freq
RCL2	600 ohm Slope @ 0.0 dBm	600 ohm, Terminate, 4W LVL/Freq
RCL3	600 ohm 1004 Hz @ 0.0 dBm	600 ohm, Terminate, 4W NotchNoise, C-Msg(or Psho)
RCL4	600 ohm 1004 Hz @ 0.0 dBm	600 ohm, Terminate, 4W S/N Ratio, C-Msg (or Psho)
RCL5	600 ohm P/AR @ -16 dBm	600 ohm, Terminate, 4W P/AR
RCL6	600 ohm 1004 Hz @ 0.0 dBm	600 ohm, Terminate, 4W NotchNoise, C-Msg(or Psho) Impulse Noise, 15 min. Run Time, 67 dBm Lo Thld, 4 dBm Delta
RCL7	150 ohm 82.0 kHz @ -16 dBm	150 ohm, Terminate, 4W LVL/Freq
RCL8	150 ohm 82.0 kHz @ -16 dBm	150 ohm, Terminate, 4W Noise, 50 kHz
RCL 9	150 ohm 28.0 kHz @ -16 dBm	150 ohm, Terminate, 4W LVL/Freq
RCL0	600 ohm ERL @ -8 dBm	600 ohm, Terminate, 4W Return Loss

These factory set-ups are protected from accidental change by means of a rear panel switch. Dip switch #7 will normally be in the "ON" position. While in this position, the "STO" function will not operate nor will the corresponding remote control command operate and it is not possible to erase or change the front panel set-ups.

MEMORY	PARAMETERS	RANGE	GRANULARITY	FACTORY DEFAULT
A	LO FREQ	.020 kHz to 110 kHz	-	.204 kHz
B	HI FREQ	.020 kHz to 110 kHz	-	4.004 kHz
C	FREQ STEP	.020 kHz to 109.980 kHz	1 Hz	.100 kHz
D	DWELL TIME	1/4 Sec to 9999 Sec	256 Msec	1 Sec

To change any of the parameters in memory:

1. Select "FREQ SET" mode (associated green LED on).
2. Enter desired value in kHz or seconds.
3. Depress "ENTER".
4. Select "FREQ SET" mode (associated green LED on).
5. Depress "STO" and the approriate memory location (A, B, C, or D).
6. Repeat for each of the parameters.

G. **AUTO CALIBRATE**

The unit was calibrated at the factory for proper measurement accuracy by loading certain values into internal RAM memory. RAM memory is maintained by a small internal battery with 30-day life. As long as the AM5 is connected to commercial power at least once each 30 days or if equipped with internal battery option and batteries are charged, the RAM battery will retain charge indefinitely.

If unit is not equipped with 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 and, in fact, the unit will automatically diagnose itself and inform the operator of the need for recalibration as part of the power on self test.

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

1. Remove all input leads.

2. Press "ENTER."

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 5 different levels @ 1004 Hz plus 1 level @ PAR while the measurement circuitry calibrates itself. This process takes approximately 30 seconds following which the unit will revert to normal operation.

If desired, the unit may be forced into "AUTO CALIBRATE" at any time by entering "IMP NOIZ" mode and depressing the "D" button followed by depression of the "ENTER" button. Make certain that all input leads are disconnected during "AUTO CALIBRATION" or erroneous calibration will result.

Next, exit the dialing mode by selecting any other line category (LINE, SEND, MEASURE or IMP NOIZ).

Method B: Storage of a number not yet dialed. (This method allows a number to be stored without actually signaling it out on the TX PAIR.)

First, enter the dialing mode by selecting DP, TT or MF.

Next, depress "STO" followed by depression of any digit 0 through 9 corresponding to the memory location desired to store the number.

Next, dial the desired number (up to 48 digits).

Next, exit the dialing mode by selecting any other line category.

Last Number Redial:

Any time that dialing mode is entered, a number is dialed (either manually or using the recall function) and then dialing mode is exited, that number will be stored in the last number dialed memory. To dial that number again, follow this procedure:

First, enter dialing mode and toggle to the desired signaling type (DP, TT or MF).

Next, depress "RCL" and "*". The "last number dialed" number will be recalled from memory and speed dialed.

Dialed Number Recall(speed dial):

Any of the stored telephone numbers may be recalled from memory and speed dialed.

First, enter dialing mode and select the desired signaling type (DP, TT or MF).

Next, depress "RCL" followed by the digit (0-9) corresponding with the memory location containing the desired telephone number.

4. SLOPE-SWEEP PARAMETER STORAGE

In SLOPE-SWEEP mode the AM5 signal generator will automatically sweep between a low and high frequency limit at step sizes and dwell times previously stored in memory. The four parameters associated with this mode, LO FREQ, HI FREQ, FREQ STEP, and DWELL TIME, are stored in memory locations A, B, C, and D, respectively. The parameters have the following range:

By moving switch #7 to the off position, the "STO" function will be made operational and the factory set-ups may be altered to the operator's preference.

It is recommended that switch #7 be returned to the "ON" position once the desired front panel set-ups are obtained so as to protect them from accidental change.

2. MISCELLANEOUS PARAMETER STORE/RECALL

Up to 10 values of each of the following parameters may be stored in memory for later recall:

Any signal generator transmit level (LVL SET)

Any signal generator, "VAR HZ", Frequency (FREQ SET)

The TLP reference level used for 4 wire return loss (SET TLP)

The impulse noise measurement timer (RUN TIME)

The impulse noise measurement low level threshold (LO THLD)

To store a value in memory, select the desired function (this will be indicated by the associated green LED on). Next, select the desired value using either direct numeric entry or the UP ARROW or DOWN ARROW controls.

Note: If up arrow or down arrow buttons are used, the value displayed in the numeric display is automatically ready for storage. If direct numeric entry is used, the "ENTER" button must be depressed and the function reselected (associated green LED on) before storage can take place.

With the function selected, the associated green LED On, and the desired value displayed, depress the "STO" button followed by a numeric button 0 through 9 corresponding to the desired memory storage location.

Special Note: While it is possible to enter a wide range of signal generator level values into memory, the signal generator actual transmit levels are limited to a specific range depending upon the signal generator function selected. For example, ERL signals may only be output in the range -10 to -2 dBm. Therefore, if a value is recalled from memory and is outside the allowed range for the function selected, then the generator will generate the level at its limit closest to the value recalled. For example, if in ERL signal generate and a value of -20 dBM is recalled, the generator will actually go to -10 dBM as that is the level within its range closest to the recalled value.

Similarly, if in VAR HZ mode with SF SKIP on, the signal generator will not generate any recalled frequency in the SF SKIP band (2450 Hz - 2750 Hz) or 2130 Hz - 2430 Hz for AM5E but rather will go to the allowed value closest to the recalled value. The stored values are not affected by these adjustments.

a. **"CANNED" (factory supplied) MISCELLANEOUS PARAMETERS**

As supplied from the factory, the miscellaneous memory will have the following values in memory:

LVL SET	VALUE	TYPICAL USE
1	-50.0 dBm	
2	-40.0 dBm	
3	-29.0 dBm	Co to CXR data
4	-23.0 dBm	
5	-16.0 dBm	Co to CXR voice
6	- 8.0 dBm	Customer trunk transmit
7	- 6.0 dBm	Co to Customer data
8	0.0 dBm *	Customer data transmit
9	+ 7.0 dBm	Co to customer CXR
0	+10.0 dBm	

FREQ SET	VALUE
1	50 Hz
2	404 Hz
3	1004 Hz *
4	1200 Hz
5	2400 Hz
6	2804 Hz
7	4800 Hz
8	28 kHz
9	82 kHz
0	110 kHz

SET TLP (Ret Loss Mode)	VALUE
1	0.0 dB *
2	+16.0
3	-16.0
4	+23.0
5	-23.0
6	+ 7.0
7	-7.0
8	+10.0
9	-10.0
0	--

RUN TIME (Imp Noiz Mode)	VALUE
1	1 min
2	5 min
3	10 min
4	15 min *
5	30 min
6	60 min
7	2 hr (120 min)
8	8 hr (480 min)
9	12 hr (720 min)
0	00 min (continuous)

LO THLD (Imp Nois Mode)	VALUE
1	10 dBrn
2	20 dBrn
3	30 dBrn
4	40 dBrn
5	50 dBrn
6	60 dBrn
7	70 dBrn *
8	80 dBrn
9	90 dBrn
0	100 dBrn

Note: AM5E uses dBm units of measurement.

* Indicates power on default settings.

Rear panel dip switch #7 will also protect the miscellaneous stored values when in the on position. Turn switch to the OPEN (off)position if it is desired to change any of the stored values.

3. **DIALED TELEPHONE NUMBER STORE/RECALL**

Up to ten telephone numbers consisting of up to 48 digits each may be stored in memory, plus the last number dialed may also be recalled.

Stored telephone numbers provide a "speed dial function" to the unit in that the entire stored number is automatically dialed upon recall.

There are two methods of storing numbers:

Method A: Storage of a number just dialed.

First, enter the dialing mode by selecting DP, TT or MF.

Next, dial the desired number (up to 48 digits).
Next, depress "STO" followed by depression of any digit 0 through 9 corresponding to the memory location desired to store the number.