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**ATS 2  
Audio Test Set**

**OPERATING MANUAL**

# **ATS 2 Audio Test Set**

## **OPERATING MANUAL**

### **Warranty Registration**

Thank you for purchasing the ATS 2 Audio Test Set. To provide complete service on your ATS 2, we must have a record of warranty registration. Please take a few moments to complete the warranty registration card in the back of this manual and MAIL IMMEDIATELY. There are also two change of address cards that can be used as required.

## FOREWORD

This manual describes the functions and operation of the Electrodata ATS 2 Audio Test Set. To become fully acquainted with the many features of this versatile device, we recommend that the operator read the entire manual. However, since operation of the ATS 2 is relatively straightforward, the user will be able to run comprehensive tests of phone line quality simply by turning to the Applications Section (Section 3) and following the step-by-step procedures.

This manual also contains an index so that specific information may be located quickly.

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Figure 1 - ATS 2 Audio Test Set

## 1.0 INTRODUCTION

### 1.1 General

The portable hand-held ATS 2 Audio Test Set, shown in Figure 1, is designed to make analog measurements in accordance with IEEE Standard 743-1984 and Bell Publication 41009. It is used for the installation and maintenance of 2-wire or 4-wire leased lines or dial-up circuits and is capable of performing all basic analog transmission measurements plus Impulse Noise, Peak-to-Average Ratio (P/AR) and Signal-to-Noise (S/N) ratio. Manual and auto-dial (DTMF/Pulse) and hold capability combined with integral speaker and microphone allow the ATS 2 to function as a telephone handset.

### 1.2 Functional Description

The ATS 2 consists of both a transmitter and receiver which are operated independently for half-duplex testing or simultaneously for full-duplex testing. A twenty-three key keyboard is used to select send and measure modes and various operating parameters. It is also used to enter transmit levels and frequencies and to enter digits, including A, B, C and D, for either pulse or DTMF dialing. An audible alarm sounds when each key is depressed. There is a two line 32 character alphanumeric display which is used to display the current send or measure mode, current send level and frequency, measured test results and selected operating parameters.

Both a speaker and microphone are located on the upper half of the ATS 2. The speaker is used to monitor tones being sent or received by the Test Set. Two keys are used to adjust the speaker volume level. An additional key is used to connect the speaker to either the send or receive line pairs. The microphone is enabled by a momentary action key to permit communication with a person at the distant end of the transmission line being tested. The ATS 2 will also function as a push-to-talk telephone set on 2-wire dial networks.

Two connectors for attaching the ATS 2 to the line under test, and the hold and reverse keys are also located on the upper half of the Test Set. The connectors consist of both a dual miniature bantam jack and an RJ11C modular phone jack. These connectors are wired in parallel. The reverse key reverses the connection of the send and receive line pairs to the Test Set. The hold key causes a constant DC line holding current to flow in the send line pair.

### 1.3 Physical Description

The ATS 2 Audio Test Set is housed in a sturdy aluminum case. The cover, which is removable, contains a reference guide, and a modular cable assembly with alligator clips for attaching the Test Set to the line under test. A positive latch is provided on the cover to keep the Test Set securely closed when not in use. A jack on the top of the case is provided for both recharging the internal nickel-cadmium batteries and for AC operation using the PS-4 Battery Eliminator/Charger. The ATS 2 comes complete with a four foot long modular cable, this technical manual, a PS-4 Battery Eliminator/Charger and a padded carrying case. Special cables are available from the factory at a nominal charge.

### 1.4 Receiving and Unpacking

The ATS 2 Audio Test Set should be unpacked when received, and visually inspected for any damage. If the Test Set appears to be damaged, and the outside of the shipping container is damaged, contact the carrier and submit a claim. The serial number on the bottom of the Test Set should correspond with the packing list. If there are any problems noted, contact the factory or your sales representative. It is recommended that the Test Set be placed on charge, as described in Section 4.2, before attempting any extended operation. The Test Set may be used while the batteries are being charged.

### 1.5 Send Modes

The ATS 2 has ten send modes including two dial modes. These modes, along with a description of each, are listed below. Diagrams of the send and dial mode setup menus may be found in Appendix A-1 through A-8.

SEND QUIET TERM. - The output is disconnected from the transmitter and terminated in accordance with the impedance and termination selections. This mode is selected by pressing <SEND>, then using the <| > or <| > key until “SEND QUIET TERM.” is displayed.

SEND 1004Hz TONE - A 1004 Hz tone is generated at the level selected. This mode is selected by pressing the <SEND> key, then using the <| > or <| > key until “SEND 1004Hz TONE” is displayed. The ATS 2 will also display the transmit level and frequency on the lower line of the display.

SEND VAR FREQ - A tone is generated at the frequency and level selected. This mode is selected by pressing the <SEND> key, then using the <| > or <| > key until “SEND VAR FREQ” is displayed. The ATS 2 will also display the transmit level and frequency on the lower line of the display

## 1.5 Send Modes (continued)

SEND P/AR SIGNAL - A standardized test signal of 16 tones is generated at the level selected. This mode is selected by pressing the <SEND> key, then using the <| > or <| > key until “SEND P/AR SIGNAL” is displayed. The ATS 2 will also display the transmit level on the lower line of the display.

SEND SLOPE - Three tones (404Hz, 1004Hz and 2804Hz) are transmitted at 10 second intervals at the level selected. This mode is selected by pressing <SEND>, then using the <| > or <| > key until “SEND SLOPE” is displayed. The ATS 2 also displays the transmit level and frequency on the lower line of the display.

SEND AUTO STEP - A tone is generated at the level selected. The starting frequency, step size, end frequency and step dwell time are all selectable. This mode is selected by pressing the <SEND> key, then using the <| > or <| > key until the ATS 2 displays the transmit level and frequency on the bottom line of the display.

MANUAL DIAL - Digits are displayed and dialed as each key is depressed. This mode is selected by pressing the <SEND> key, then using the <| > or <| > key until the ATS 2 displays “MANUAL DIAL”. The ATS 2 also displays the phone number on the bottom line of the display. Depressing the <ENTER> key will re-dial the number displayed.

AUTODIAL - One of 10 pre-programmed numbers is dialed. This mode is selected by pressing the <SEND> key, then using the <| > or <| > key until the ATS 2 displays “AUTODIAL BIN #N”, where N is a number from 0 to 9 representing one of the 10 storage bins contained in the ATS 2. The ATS 2 also displays the phone number stored in the bin on the bottom line of the display. The bin number may be changed by keying in a new number. The displayed number is dialed by pressing <ENTER>.

SEND 2713Hz TONE - A 2713 Hz tone is sent at the preselected level. This mode can be selected when the ATS 2 is at the top of any non-dial setup menu by pressing the <2713> key. The 2713 Hz tone will continue to be transmitted until the key is released.

SEND AUX. TONE - A pre-programmed tone is sent at the pre-selected level. This mode can be selected when the ATS 2 is at the top of any non-dial setup menu by pressing the <AUX> key. This tone will continue to be transmitted until the key is released. The tone is programmed in the setup menu under the “AUXILIARY FREQ.” option.

## 1.6 Measure Modes

The ATS 2 has five measure modes. These modes, along with a description of each, are listed below. Diagrams of the measure mode setup menus may be found in Appendix 1-9 through A-13.

LEVEL/FREQUENCY - The average level (in dBm) and frequency of the input signal are measured and displayed. This mode is selected by pressing <MEAS>, then using the <| > or <| > key until “LEVEL/FREQUENCY” is displayed.

NOISE - The RMS level of the input signal is measured and displayed. The input filter (3 kHz flat, C-Message or C-Notch) is selectable. Level readings are in terms of dB<sub>rn</sub> if the 3kHz filter is used, and dB<sub>nc</sub> for the C-Message and C-Notch filters. This mode is selected by pressing <MEAS>, then using the <| > or <| > key until “NOISE” is displayed. The ATS 2 also displays the type of filter in use and the measured noise level and will display “TONE” if the C-notch filter is in use and a 1004 Hz holding tone is received.

SIGNAL TO NOISE - The receive noise level is compared to the received 1004 Hz signal level and the ratio is displayed in terms of dB. This mode is selected by pressing <MEAS>, then using the <| > or <| > key until “SIGNAL TO NOISE” is displayed. The ATS 2 will also display “TONE” if a 1004 Hz holding tone is received.

P/AR - The peak and average values of the input signal are measured and displayed as a ratio. This mode is selected by pressing the <MEAS> key, then using the <| > or <| > key until “P/AR” is displayed. The ATS 2 will also display the receive level (in dBm) and the peak-to-average ratio (in units) on the bottom line of the display.

IMPULSE - Noise impulses above a selected level are counted. The test duration and input filter (3 kHz flat, C-Message or C-Notch) are selectable. This mode is selected by pressing <MEAS>, then using the <| > or <| > key until the ATS 2 displays “IMPULSE”. The ATS 2 also displays the type of filter, the impulse count and elapsed test time (hours:minutes). The colon (:) in the time display will flash while the test is running. If the C-notch filter is in use, the ATS 2 will display “TONE” whenever a 1004 Hz holding tone is received, and a “TONE LOST” counter may be accessed by pressing the Down Arrow key.

## 1.7 Specifications

### Modes

Send Modes: Quiet termination  
1004 Hz tone  
Variable frequency  
P/AR signal  
Slope tones  
Auto step  
2713 Hz tone (momentary)  
Auxiliary tone (momentary)

Dial Modes: Manual  
Autodial

Measure Modes: Level/Frequency  
Background noise  
Signal to noise  
Impulse noise  
P/AR rating

### Send Modes

Quiet termination Signal generator disconnected from output

Output noise: < 10 dBrn

### Send Frequency

Range: 50 Hz to 5 kHz  
Resolution: 1 Hz  
Accuracy:  $\pm 0.03\%$   
Direct Entry: Numeric keypad  
Stepping:  $\pm 1$ , 10, and 100 Hz  
Fixed frequencies: 1004 Hz, 2713 Hz and programmable auxiliary tone  
Slope tones: 404 Hz, 1004 Hz, and 2804 Hz, 10 seconds per tone  
Auto step: Programmable start, stop, step size and step duration  
P/AR signal: 16 phase related frequencies  
Distortion: 50 Hz to 200 Hz < -50 dB  
200 Hz to 5 kHz < -40 dB  
SF Skip: 2450 Hz to 2750 Hz

## 1.7 Specifications (continued)

		<u>Send Modes</u>
Send Level		
Range:		+10 dBm to -50 dBm (0 dBm maximum for P/AR)
Resolution:		.1 dB
Accuracy		
50 Hz to 200 Hz:		±0.5 dB
200 Hz to 5 kHz		±0.2 dB
1004 Hz		±0.1 dB from 0 to -19 dBm
Direct entry:		Numeric keypad
Stepping:		±.1 and 1 dB
Flatness		
50 Hz to 200 Hz		±.5 dB
200 Hz to 5 kHz		±.2 dB
		<u>Measure Modes</u>
Level/Frequency		
Level range:		+10 dBm to -65 dBm
Resolution:		.1 dB
Accuracy		
50 Hz to 200 Hz		±0.5 dB
200 Hz to 5 kHz		±0.2 dB
1004 Hz		±0.1 dB from 0 to -19 dBm
Detector		averaging
Display modes:		Absolute or relative with respect to input level
Frequency range:		20 Hz to 10 kHz
Resolution:		1 Hz
Accuracy:		±1 Hz
Background noise		
Range:		10 to 99 dBm
Resolution:		1 dB
Accuracy		
20 to 99 dBm		±1 dB
10 to 20 dBm		±2 dB
Filters:		C-Message, 3 kHz flat, C-Notch
Detector:		True RMS
Display modes:		Absolute or relative with respect to input level
Notch filter:		995 to 1025 Hz > 50 dB rejection
Loss of tone:		< -40 dBm

## 1.7 Specifications (continued)

### Measure Modes

#### Signal to noise

Signal range:	+10 dBm to -40 dBm
Noise range:	10 dBm to 90 dBm
Ratio range:	10 to 50 dB
Resolution:	1 dB
Accuracy:	±1 dB
Detector:	Average for level and true RMS for noise
Display modes:	Absolute or relative with respect to current measurement
Notch filter:	995 to 1025 Hz > 50 dB rejection
Loss of Tone:	< -40 dBm

#### Impulse noise

Threshold Range	
w/C-NOT filter:	40 to 100 dBm
w/3kHz, C-MSG filter:	30 to 100 dBm
Resolution:	1 dB
Accuracy:	±1 dB
Count rate:	7 per second
Count timer:	1 to 99 minutes or continuous
Count range:	0 to 9999
Filters:	C-Message, 3 kHz flat, C-Notch
Notch filter:	995 to 1025 Hz > 50 dB rejection
Loss of tone:	< -40 dBm
Loss of tone counter:	0 to 9999

#### P/AR rating

Range:	0 to 120 P/AR units
Resolution:	±1 P/AR unit
Accuracy	
30 to 110 P/AR units:	±2 P/AR units
0 to 120 P/AR units:	±4 P/AR units
Input level range:	0 to -40 dBm
Detector:	Average



## 1.7 Specifications (continued)

	<u>Dial Modes</u>
Manual dial	
Dial method:	DTMF or pulse
DTMF signals:	Full supervisory tone set, including: A, B, C and D
Redial:	Up to last 16 digits
Autodial	
Memory:	10 locations, each capable of holding up to 16 digits
Dial method:	DTMF or pulse
DTMF signals:	Full supervisory tone set, including: A, B, C and D
	<u>General</u>
Input/Output	
Line:	2-wire or 4-wire
Connectors:	RJ11C modular jack and dual miniature phone jack (.173" dia. Mon .312" centers, mates with ADC PJ777 or Switchcraft TT253)
DC blocking:	150 volts
Normal/Reverse Switch:	Reverse send and receive pairs
Hold circuit:	Electronic, 24 ma.
Impedance:	600 or 900 ohms
Termination:	Bridge or terminate
Bridging Loss:	< .2 dB
Return Loss:	> 30 dB
Longitudinal Balance:	> 80 dB at 60 Hz > 70 dB at 540 Hz > 60 dB at 4 Hz Decreasing 6 dB per octave above 4 kHz

## 1.7 Specifications (continued)

### General

#### Power

Batteries:	Rechargeable, nickel-cadmium
Battery life:	7 hours minimum per charge, ½ hour minimum after battery low indication
Recharge time:	4 hours maximum, with unit turned off
AC operation:	115/230 vac, 50/60 Hz
Auto Shut-off:	15 minutes after last key depression

#### Physical

Push-to-talk:	Built-in condenser microphone
Monitor:	Adjustable volume, switchable between send and receive
Display:	2 line by 16 character, LCD
Display update	
Normal:	5 times per second
Damped:	2 times per second
Size:	10"L x 4"W x 2 5/8"H
Weight:	2 1/4 lbs. (1 Kgram)
Operating temperatures:	0E to 50E C
Storage temperature:	-20E C to 90E C
Humidity:	10% to 90% relative humidity non-condensing

## 2.0 OPERATION

### 2.1 General

The ATS 2 Audio Test Set is menu driven to allow the operator to quickly select the desired send or measure mode and various operating parameters. There are two separate menus available. One is for send mode selection and the other for measure mode selection. Each menu is two dimensional. While at the top of either menu, the operator can move horizontally using the left or right arrow keys, to select the desired mode. Once a mode is selected, the operator can move vertically through the menu, using the up and down arrow keys, to display various operating parameters. While an operating parameter is being displayed, the left and right arrow keys are again used to select the desired option.

### 2.2 Lower Panel Keys

The ATS 2 lower panel keyboard, reference 1 in Figure 2, contains twenty-three keys, which are used to select the desired send and measure modes, various operating parameters (including transmit level and frequency), and to control Test Set operation. An audible alarm sounds when each key is depressed.

The keys are divided into control keys and data entry keys by color. The control keys are dark blue and the data entry keys are beige. Each of the keyboard control keys and its function are listed in Table 1.

The data keys labeled 0 through 9 and A, B, C, D, “\*”, and “#” are used to enter digits in the MANUAL DIAL and AUTODIAL modes and numeric values for transmit level and frequency. Ten of these data keys also serve as special function keys. Each of these special keys and its function are listed in Table 2.

### 2.3 Upper Panel Keys

The control keys on the upper half of the ATS 2 along with their function are listed in Table 3.

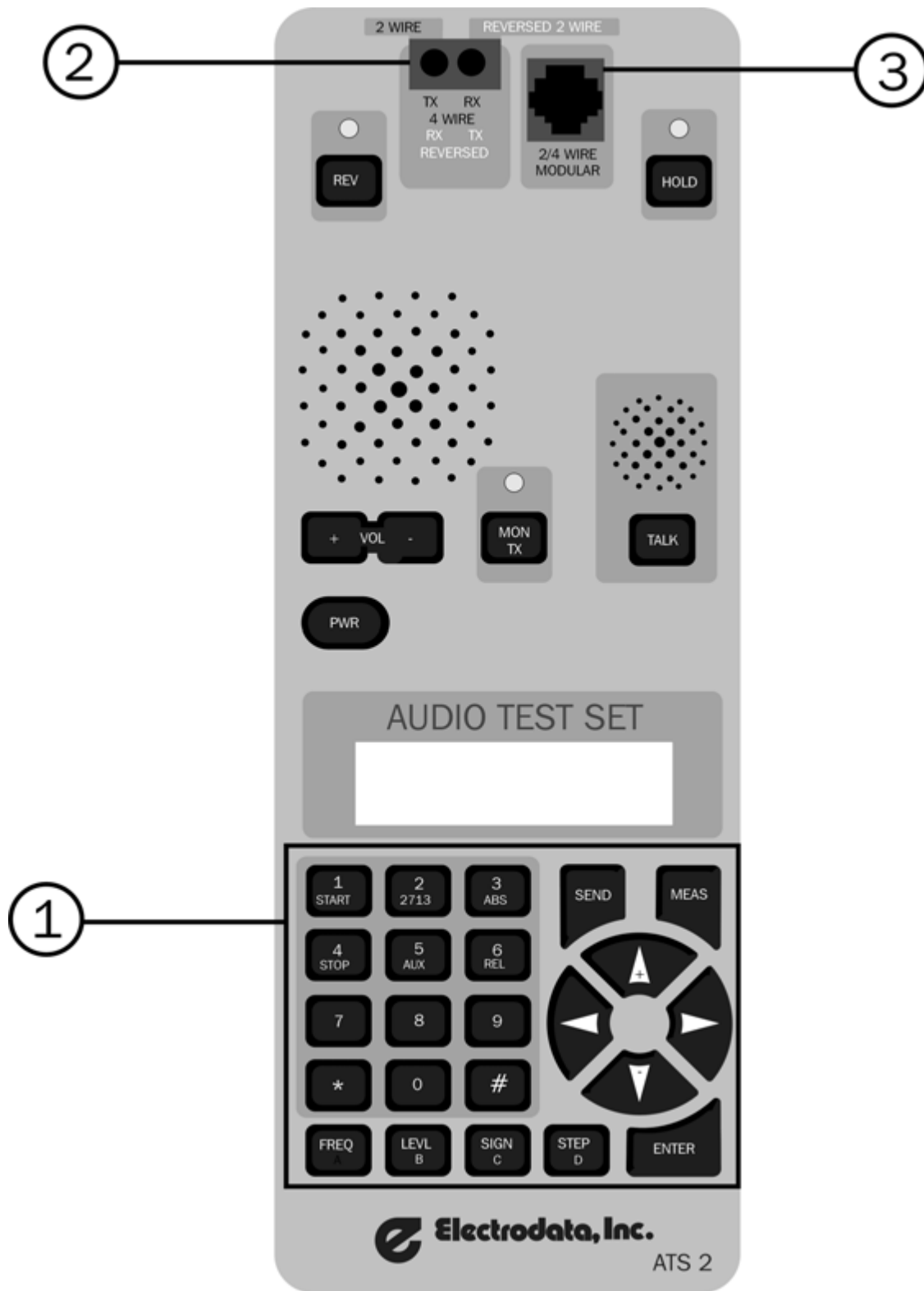


Figure 2 - Front Panel








<u>Key</u>	<u>Function</u>
	Moves the display to the top of the current send mode menu and displays the current send mode and transmit level and frequency if applicable.
	Moves the display to the top of the current measure mode menu and displays the current measure mode and the results of the current measurement.
	Moves the display left through the send or measure mode menus or selects options for various operating parameters.
	Moves the display right through the send or measure mode menus or selects options for various operating parameters.
	Moves the display down through a send mode menu or steps the transmit level or frequency down.
	Moves the display up through a send or measure mode menu or steps the transmit frequency or level up.
	Enters the currently displayed level or frequency or setup value. Dials the currently displayed number (with MANUAL DIAL or AUTODIAL displayed)

Table 1 - Lower Panel Control Keys











<u>Key</u>	<u>Function</u>
	Starts a counting period in the IMPULSE measuring mode. Restarts transmission in the SEND AUTO STEP mode at the START FREQUENCY.
	Stops a counting period in the IMPULSE measure mode.
	Momentarily overrides current send mode with a 2713 Hz tone to actuate remote Western Electric Model 829 Channel Interface Unit
	Auxiliary - Momentarily overrides current send mode with the previously entered AUXILIARY FREQ.
	Absolute - Displays subsequent levels as an absolute value.
	Relative - Displays subsequent levels relative to the value being measured when the key is pressed.
 	Frequency & Level - Allows the transmit frequency or level to be changed using the data keys (0-9) or the up and down arrow keys.
	Changes the sign of a transmit level as it is being entered.
	Manually steps to the next transmit frequency in the SEND SLOPE and SEND AUTO STEP modes.

Table 2 - Lower Panel Special Function Keys







<u>Key</u>	<u>Function</u>
	Power - Turns power on and off to Test Set.
	Reverse - Alternate action (toggle) key. Reverses the transmit and receive line pairs and turns the associated indicator on and off. Indicator is on when the send line pair (TX) is connected to the receiver and receive line pair (RX) is connected to the transmitter.
	Hold - Alternate action (toggle) key. Applies or removes DC holding current from send line pair and turns associated indicators on and off. Indicator is on when a DC holding current is applied to simulate a telephone off-hook condition. This key initiates a comprehensive self-test if held down while turning power on.
	Volume Up/Down - Increases/Decreases the monitor speaker volume level.
	Monitor Transmit - Alternate action (toggle) key. Alternately allows monitoring of the transmit or receive line pairs and turns the associated indicator on and off. Indicator is on when monitoring speaker is connected to the send line pair (TX). In 2-wire operation this key has no effect and the indicator is always on.
	Momentary Switch - While pressed, connects internal microphone to send line pair and mutes the monitoring speaker.

Table 3 - Upper Panel Control Keys

## 2.4 Connectors

There are two line connectors on the ATS 2. Both connectors are connected in parallel and either connector can be used to attach the Test Set to the line under test. The first connector is a dual bantam miniature phone jack, reference 2 in Figure 2. The second connector is an RJ11C modular jack, reference 3 in Figure 2. Both connectors and their interconnection to the line under test are shown in Figure 3.

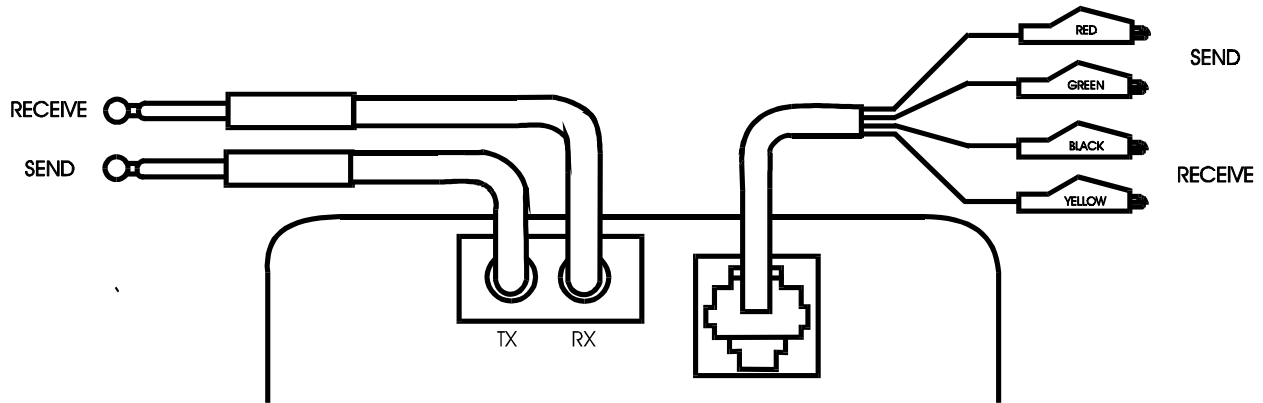


Figure 3 - ATS 2 Line Connections

## 2.5 Operating Parameters

Operating parameters are used to configure the ATS 2 for a particular application. The various operating parameters required for the currently selected measure mode are displayed by depressing the down arrow key. Only those operating parameters that are required for a particular mode will be displayed.

The bottom line of each display will contain the options available for the currently displayed operating parameter. The currently selected option will be flashing. The operator can select one of the other options by depressing either the right or left arrow key as required. Depressing the up and down arrow keys will move the display to other operating parameters in this menu. Depressing the <SEND> or <MEAS> key will move the display to the top of either the send or measure menu displaying the currently selected mode.

The ATS 2 operating parameters and the available options for each parameter are listed below. The locations of these options in the setup menu are diagrammed out in Appendix A-1 through A-13.



## 2.5 Operating Parameters (continued)

IMPEDANCE - Selects the input and output impedance of the ATS 2.

- 600 ohms      The receiver input impedance, when terminated, and transmitter source impedance will be 600 ohms.
- 900 ohms      The receiver input impedance, when terminated, and transmitter source impedance will be 900 ohms.

TERMINATION - Selects either terminated or bridging operation.

- TERM            The receiver is terminated by the resistive impedance selected by the IMPEDANCE operating parameter.
- BRIDGE        The receiver will be unterminated and have an input impedance greater than 25 Kohms.

LINE - Selects either 2-wire or 4-wire operation.

- 4-WIRE        The receiver is connected to the receive pair (RX) and the transmitter is connected to the send pair (TX).
- 2-WIRE        Both the receiver and transmitter are connected to the send pair (TX).

AUTO SHUT-OFF - Selects whether the Test Set should turn off automatically if no key has been depressed within 15 minutes.

- OFF            The ATS 2 will not automatically turn off. It can only be turned off by depressing the <PWR> key.
- ON             The ATS 2 will turn off automatically if no key is depressed within 15 minutes. The ATS 2 defaults to this setting when turned on.

SK SKIP - Determines whether the transmitter should skip over the SF frequency band (2450 to 2750 Hz) while in the SEND VAR FREQ and SEND AUTO STEP modes.

- OFF            The transmitter will not skip over the SF frequency band.
- ON             The transmitter will skip over the SF frequency band to avoid accidental transmission of signaling frequencies.

## 2.5 Operating Parameters (continued)

AUXILIARY FREQ. - Determines the frequency of the tone that be transmitted whenever the <AUX> key is depressed. The desired frequency is entered using the number keys 0 through 9 followed by the <ENTER> key. The value must be between 50 and 5000 Hz.

START FREQUENCY - Determines the start frequency in the SEND AUTO STEP mode. The desired frequency is entered using the number keys 0 through 9 followed by the <ENTER> key. The value must be between 50 and 5000 Hz and less than the END FREQUENCY.

END FREQUENCY - Determines the end frequency in the SEND AUTO STEP mode. The desired frequency is entered using the number keys 0 through 9 followed by the <ENTER> key. The value must be between 50 and 5000 Hz and greater than the START FREQUENCY.

STEP SIZE - Determines the frequency increment for each step in the STEP AUTO STEP mode. The desired step size is entered using the number keys 0 through 9 followed by the <ENTER> key. The value must be less than 4950 Hz.

STEP DWELL TIME - Determines the time interval the transmitter will remain at each frequency in the SEND AUTO STEP mode before stepping to the next frequency. The transmitter may be stepped manually at any time by depressing the <STEP> key.

    NN SEC.                    The transmitter will remain at each frequency for NN seconds. The desired dwell time is entered using the number keys 0 through 9 followed by the <ENTER> key. The value must be between 01 and 99 seconds.

    MANUAL                    The transmitter will only step to the next frequency when the <STEP> key is depressed.

DIAL METHOD - Determines the dialing method to be used in the MANUAL DIAL and AUTODIAL modes.

    PULSE                    The holding current across the send line pair (TX) will be broken (pulse or rotary dialed) at a rate of 10 pps with a 60% break interval

    DTMF                    DTMF tones (touch tones) will be sent on the transmit line pair (TX).

ENTER BIN #N - Allows storage of a telephone number in bin #N for future autodialing. The number is entered in the displayed bin by depressing any of the keys in the 16 character keypad.

## 2.5 Operating Parameters (continued)

DISPLAY DAMPING - Selects the rate at which the display will be updated in the measure modes.

- |     |  |
|-----|--|
| OFF | Display will be updated at a rate of five times a second to display rapidly changing measurements.             |
| ON  | Display will be updated at a rate of two times per second. This is useful for displaying erratic measurements. |

FILTER - Selects the input filter to be used in the NOISE and IMPULSE measuring modes.

- |       |  |
|-------|--|
| 3kHz  | A 3 kHz Flat filter is selected.   |
| C-MSG | A C-Message filter is selected.  |
| C-NOT | A C-Message filter combined with sharp notch filter centered at 1010 Hz is selected. |

THRESHOLD - Selects the input threshold to be used in the IMPULSE measuring mode. The threshold is entered using the number keys 0 through 9 followed by the <ENTER> key. The threshold must be between 40 and 100 dBrn if the C-Notch filter is selected or between 30 and 100 dBrn otherwise.

COUNT PERIOD - Determines the test duration time in the IMPULSE measuring mode.

- |         |   |
|---------|---|
| NN MIN. | The ATS 2 will count impulses above the input threshold for “NN” minutes. The time interval “NN” in minutes is entered using the number keys 0 through 9 followed by the <ENTER> key. The interval must be between 01 and 99 minutes. |
| CONT.   | The ATS 2 will count impulses above the input threshold until the <STOP> key is pressed or another measure mode is selected.  |

## 2.6 Entering or Changing Send Level

The ATS 2 provides two ways to enter or change the current send level in all send modes except MANUAL DIAL and AUTODIAL. The first is by direct entry using the <SIGN> key and the number keys 0 through 9, and the second is by using the up and down arrow key to step the level up or down. The send level can only be changed while the display is at the top of the current send or measure menu. The <SEND> and <MEAS> keys are used to access the top of the menus.

To change the current send level, first press the <LEVL> key. If a send mode is being displayed, the “dBm” in the bottom line of the display will begin flashing. If a measure mode is being displayed, the right seven positions of the top line of the display will be replaced with the current send level with the “dBm” flashing. At this point, the operator can either directly enter the new level or depress the up or down arrow key to step the level up or down. Depressing the <SIGN> key will toggle the sign of the value being entered. If either the up or down arrow key is depressed and held down, the level will step up or down first in .1 dB increments and then in 1 dB increments.

The <ENTER> key is used to return the display to normal operation or terminate direct entry if less than three digits are entered.

## 2.7 Entering or Changing Send Frequency

The ATS 2 provides two ways to enter or change the current send frequency while in the SEND VAR FREQ mode. The first is by direct entry using the number keys 0 through 9 and the second is by stepping using the up and down arrow keys. The send frequency can only be changed while the display is at the top of the SEND VAR FREQ mode menu or at the top of the current measure mode menu. The <SEND> and <MEAS> keys are used to access the top of the menus.

To change the current send frequency, the operator first presses the <FREQ> key. If the send mode is being displayed, the “Hz” in the bottom line of the display will begin flashing. If a measure mode is being displayed, the right six positions of the top line of the display will be flashing. At this point the operator can either directly enter the new frequency or depress the up or down arrow key to step the frequency up or down. If either the up or down arrow key is depressed and held down, the frequency will step up or down first in 1 Hz increments, then in 10 Hz increments and finally in 100 Hz increments.

The <ENTER> key is used to return the display to normal operation or terminate direct entry if a frequency less than 1000 Hz is being entered.

## 2.8 Line Termination Impedance

The ATS 2 calculates input levels by measuring the voltage appearing on the line assuming that it is terminated by either 600 or 900 ohms as selected by the IMPEDANCE parameter. It is important that the line be properly terminated for correct readings. This can be done by the ATS 2 when the TERMINATION parameter is set to TERM or by some other device when the TERMINATION parameter is set to BRIDGE.

Measurements can be made with the ATS 2 on circuits externally terminated with an impedance other than 600 or 900 ohms. To do this, the IMPEDANCE parameter should be set to 600 ohms and the TERMINATION parameter to BRIDGE. The appropriate correction given in Table 4 should be added to all observed level readings.

<u>External Impedance</u>	<u>Correction</u>
1200 ohms	-3.0 dB
150 ohms	6.0 dB
135 ohms	6.5 dB
75 ohms	9.0 dB

Table 4 - External Impedance Corrections

## 3.0 APPLICATIONS

### 3.1 General

This section describes in step-by-step fashion how to use the ATS 2 to thoroughly test a voice frequency communications channel, whether it be a dial-up phone line or a dedicated, 3002-type link. Section 3.2 explains how to monitor a phone channel and determine the presence or absence, and, to some extent, the acceptability of signal. This section applies only to “existing” circuits (i.e. circuits which already have data equipment connected to them and are passing, or at least attempting to pass, data). Sections 3.3 through 3.7 explain how to set up one or two ATS 2's to generate and measure a 1004 Hz test tone in preparation for the more elaborate tests described in Sections 3.8 through 3.14. Tests are described in the logical sequence in which they should be performed. Thus for general testing of existing circuits, the technician may start at Section 3.2 and continue step-by-step through Section 3.14. For testing of new circuits, the procedure begins at Section 3.3. (A “short-cut” test procedure involving the P/AR test is also described in these sections, although its use is not generally recommended).

Also included in this section is a procedure for testing short-haul lines. This procedure may be followed by turning directly to Section 3.15.

The Reference Guide in the lid of the ATS 2 provides a synopsis of the procedures described in the following pages for those who are already familiar with it. Pages 1 through 3 list the keyboard functions common to all modes of operation. Pages 4 through 16 list the various setup menus along with recommended option settings. Page 17 shows 2-wire and 4-wire test configurations and pages 18 through 24 list the various tests and the setup menus that should be used for each test as well as keyboard functions and expected results.

### 3.2 Monitoring Line Activity

The very first step in testing an existing communications channel is to monitor the activity on that channel. In monitoring line activity, the ATS 2 is used to “eavesdrop” on the suspect channel. It will measure and display the frequency and level of received signals and, via the built-in speaker, allow the technician to listen in.

### 3.2 Monitoring Line Activity (continued)

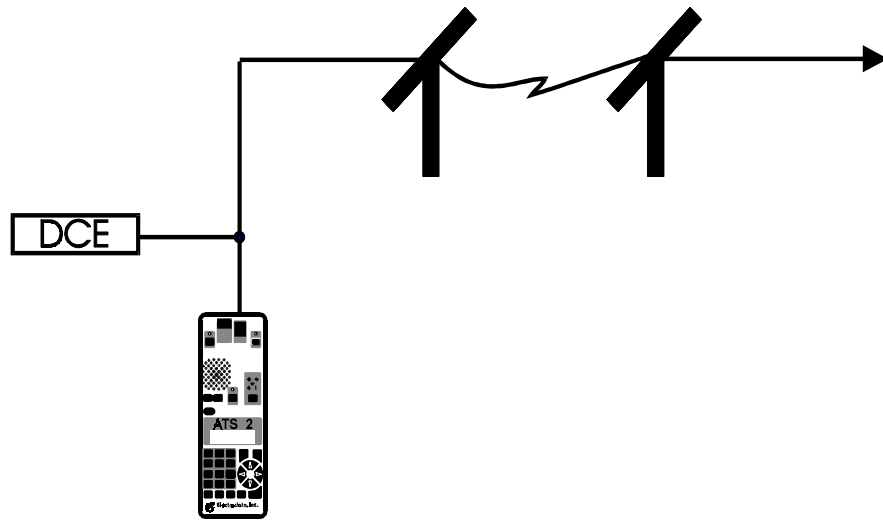


Figure 4 - Bridged Configuration for Line Monitoring

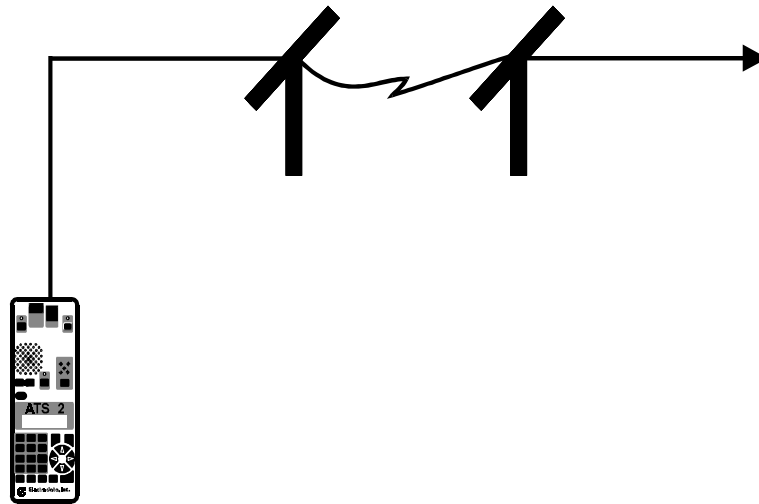


Figure 5 - Terminated Configuration for Line Monitoring

### 3.2 Monitoring Line Activity (continued)

The monitor test can be set up in either of two configurations. The preferred setup is the “bridged” configuration shown in Figure 4. Here the ATS 2 “sees” everything that is happening on the channel, but the data equipment connected to the channel continues to operate as if the ATS 2 were not present. The alternative is the “terminated” configuration shown in Figure 5. In this setup, the data equipment is removed from one end of the line and the ATS 2 is connected in its place. In this situation, the ATS 2 “sees” everything that is coming from the other end of the line, and the line “sees” the ATS 2 as the termination point of the circuit. To run either of these tests, proceed as follows:

1. With the ATS 2 disconnected from the phone line, turn power on by pressing the <PWR> key. The ATS 2 will test itself then jump to the most recently selected Measure mode. If the ATS 2 displays BATTERY LOW at any time, the PS-4 batter eliminator/charger should be connected as described in Section 4.2.
2. If the ATS 2 does not now display “LEVEL/FREQUENCY”, press the <| > or <| > key until it does.
3. Press the Down Arrow key to proceed through the Measure mode setup menu.
4. The ATS 2 now reads “DISPLAY DAMPING” on the top line, and “OFF ON” on the bottom line. This option determines how often the display is updated during a test run. Initially this option should be set to “OFF”; it may later be changed to “ON” if, during the test, the display updates too fast to be readable. The flashing value is the current setting. If necessary, change this setting by pressing the <| > or <| > key.
5. Press the Down Arrow key again to display the “TERMINATION” option. This should be set to “TERM” for the terminated configuration of Figure 5, or to “BRIDGE” for the bridged configuration of Figure 4. Use the <| > or <| > key, if necessary, to change it.
6. When the correct termination has been selected, press the Down Arrow key again to display the “IMPEDANCE” option. This option may be set to either 600 ohms or 900 ohms as indicated by the flashing portion of the display. The impedance should be set to match the line under test, which in all end-user applications will be 600 ohms. As before, use the <| > or <| > key to change the setting, if necessary.
7. Press the Down Arrow key again and set the “LINE” option to “4-WIRE” if a 4-wire 3002-type line is to be monitored, or to “2-WIRE” for monitoring 2 wire circuits, such as dial-up lines.
8. Press the Down Arrow key once more to display the “AUTO SHUT OFF” option. Select “ON” to cause the ATS 2 to automatically shut off if 15 minutes elapse without a key being pressed, or “OFF” to defeat the automatic shut off.



### 3.2 Monitoring Line Activity (continued)

9. The Measure menu is now configured properly (the remaining option, “AUXILIARY FREQ”, will not be used in this test). Press the <SEND> key at this point to bring up the Send mode setup menu.
10. Press the <|> or <|> key until the ATS 2 displays “SEND QUIET TERM.” In this Send mode, the ATS 2's transmitter is shut off.
11. This completes configuration of the Send menu (the remaining options were previously set in the Measure menu). At this point the modular connector on the cable provided with the ATS 2 should be plugged into the receptacle at the top of the test set.
12. If the terminated configuration is to be used, be sure to disconnect any communications equipment from the phone line before connecting the ATS 2.
13. Connect the alligator clips at the other end of the cable to the phone line (see Appendix A-15).
14. If the ‘REV’ or ‘HOLD’ light at the top of the test set is on, press the corresponding key so that the light goes out. For 4-wire testing, press the <MON TX> key, if necessary, to turn off the ‘MON TX’ light.
15. Any signal from the receive side of the line should now be heard through the ATS 2 speaker. Use the VOL Up or VOL Down key to adjust the volume to the desired level.
16. Press the <MEAS> key to display the current measure mode. The ATS 2 will display “LEVEL/FREQUENCY”, along with the two numerical values. The first will be the level of the received signal in dBm; the second will be the frequency of the received signal in hertz (Hz).
17. For a 4-wire 3002-type line, the level reading should generally be between -12dBm and -20dBm. For a 2-wire dedicated line, the level should be about 0 dBm when the local communications equipment is transmitting, and between -12dBm and -20dBm when only the remote equipment is transmitting. On dial-up lines the range is much more nebulous. When the local equipment is transmitting, the range may be between 0 and -12dBm. When only the remote equipment is transmitting, the level should be above the “receiver sensitivity” of the local communications equipment. If the ATS 2 displays “UNDERRANGE” or “OVERRANGE”, the received signal is way out of range. Frequency readings are dependent on the type of communications equipment and the presence or absence of data traffic.
18. If the level and/or frequency readings are changing too fast to be readable, press the Down Arrow key and use the <|> key to change the “DISPLAY DAMPING” setting to “ON”. Then press <MEAS> again to return to the LEVEL/FREQUENCY display.

### 3.2 Monitoring Line Activity (continued)

19. If testing a 4-wire line, press the <REV> key at the top of the unit. The REV light will come on indicating that the transmit and receive pairs have been reversed. You are now listening to the signal on the transmit side of the line and the ATS 2 is displaying its level and frequency. The expected level of a transmit signal should be right around 0 dBm. If the level measured here is -12dBm or lower and the level measured previously was around 0 dBm, it is likely that the TX and RX pairs of the phone line are reversed.
20. For both 2-wire and 4-wire lines, the above process should be repeated at the other end of the line by returning to Step 12.

### 3.3 Test Configurations

In addition to monitoring capability, the ATS 2 has the ability to generate a wide range of test signals that allow a comprehensive set of measurements to be obtained. These tests are described in the following sections.

Before any of these tests can be performed, however, it is necessary to determine whether the line will be tested in an “end-to-end” or “loopback” configuration. In the end-to-end configuration, shown in Figure 6, two ATS 2s are used, one being connected to each end of the line. This method is preferred because results obtained from it can be compared to telephone company specifications (see Appendix A-16) to determine phone line quality. Its disadvantage is that it requires two test sets and two technicians. Loopback testing, on the other hand, requires only one test set and one technician, since signals are transmitted down the line where they are looped back to the transmitting test set, as shown in Figure 7. Results obtained from loopback testing are not reliable enough to compare to specifications, however. Loopback testing cannot be used for 2-wire lines (dial-up lines included), and even in 4-wire testing it is impossible to identify which direction of transmission is the source of the problem. The procedure for establishing an end-to-end test is described in Section 3.4 and a loopback test in Section 3.5. Section 3.6 describes how to set up a multipoint test and dial-up testing is described in Section 3.7.

Appendix A includes a blank Line Analysis Charts, suitable for copying, that can be used to record and graph test results. If the chart is to be used, the circuit number (see Appendix A-20), a description of the section of line to be tested and the test configuration should be included in appropriate sections. A sample of a completed chart is provided in Appendix A-21.

If at any time in the test procedure a line failure is found, you will have the option of continuing the test or stopping at that point, as described in Section 3.14.

For “quick and dirty” phone line testing, the Peak-to-Average Ratio (P/AR) test may be used as described in Section 3.13. Although we do not generally recommend the P/AR test for this application, the procedure may be followed once the test has been set up as described in Sections 3.4 through 3.8.

3.3 Test Configurations (continued)

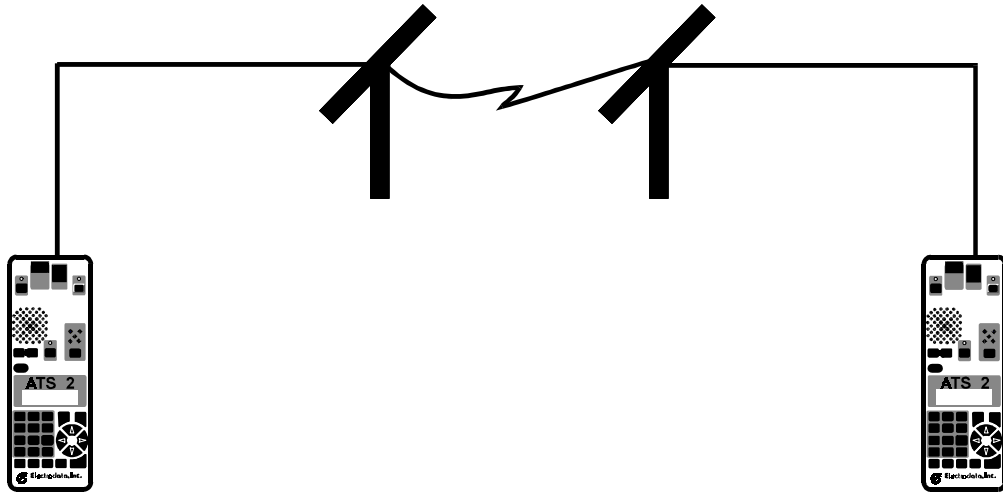


Figure 6 - End-to-End Test Configuration

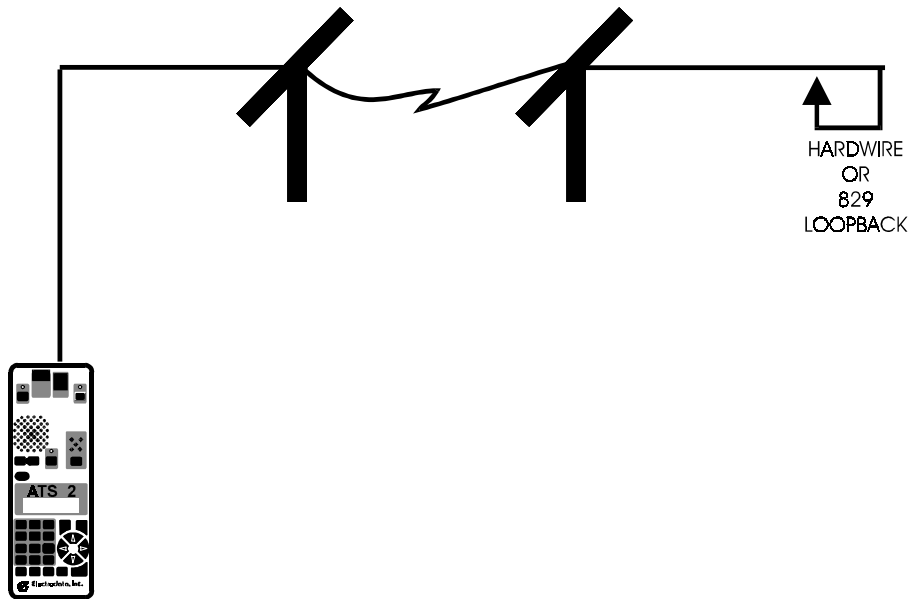


Figure 7 - Loopback Test Configuration

### 3.4 End-to-End Testing

End-to-end testing can be used for both 2- and 4-wire lines. In either case, two test sets are required, one at each end of the line. 2-wire testing must be performed in a half-duplex fashion, with only one unit transmitting at a time. Thus, one unit will be designated as the sending unit and the other as the receiving unit. Once the test is completed in this configuration, the roles of the test sets are reversed and the test is repeated. 4-wire testing, on the other hand, can be full-duplex. In full-duplex testing, each test set is configured to simultaneously send and receive. In either configuration, two Line Analysis Charts should be used, one for each direction of transmission.

Whether a full- or half-duplex test is being run, the technicians at each end of the line may communicate with each other during the test run by using the ATS 2's built-in microphone. When one of the technicians wishes to talk to the other, he holds down the key marked "TALK" and talks into the microphone directly above it. The technician at the other end will hear this through his speaker. When done talking, the <TALK> key should be released so that the other technician may respond. Note that pressing the <TALK> key invalidates the readings displayed on the remote test set.

To set up an end-to-end test, proceed as follows:

1. Disconnect any existing communications equipment from both ends of the telephone channel. Connect an ATS 2 at each end of the line as described in Appendix A-15.
2. Press the <PWR> key on both units to turn power on. The units will come up in the most recently selected Measure mode when the self-test is complete.
3. If the ATS 2 beeps and displays "BATTERY LOW" at this or any subsequent time, connect the PS-4 battery eliminator/charger as described in Section 4.2.
4. Press the <SEND> key on both units to display the current Send mode.
5. For 4-wire testing, use the <| > or <| > key on both units to change the current Send mode to "SEND 1004 Hz TONE" (if not already), then proceed to Step 8.
6. For 2-wire testing, choose one test set to act as the sending unit, and the other to act as the receiving unit. On the sending unit, use the <| > or <| > key, if necessary, to change the current Send mode to "SEND 1004Hz TONE". On the receiving unit, change the current Send mode, if necessary, to "SEND QUIET TERM."
7. On the receiving unit, press the Down Arrow key to display the "TERMINATION" option. If "TERM" is flashing, proceed to Step 8, otherwise use the <| > key to select "TERM."

### 3.4 End-to-End Testing (continued)

8. On both units, press the Down Arrow key to display the “IMPEDANCE” option. This option should be set to match the impedance of the line under test, with choices of 600 or 900 ohms. The flashing value is the current setting for this option. 600 ohms is used for all testing at customer premises. Use the <|> or <|> key, if necessary, to change this setting.
9. On both units, press the Down Arrow key again to display the “LINE” option. Use the <|> or <|> key, if necessary, to change it to the correct setting.
10. On both units, press the Down Arrow key again to display the “AUTO SHUT OFF” option. If set to “ON”, the ATS 2 will automatically shut itself off after 15 minutes of keyboard inactivity. If set to “OFF”, the auto shut off feature is disabled. Use the <|> or <|> key if necessary to change this setting to the desired value.
11. On both units, insure that all LED indicators at the top of the test set are off (except the ‘MON TX’ indicator in 2-wire testing). If not, press the associated key to turn the indicator off.
12. The test sets are now configured to send a 1004 Hz tone over the line. At this point testing may proceed as described in Section 3.8.

### 3.5 Loopback Testing

As explained in Section 3.3, loopback testing can only be used on 4-wire dedicated lines and only as a very general indicator of line quality. A loopback can be established in either of two ways.

One method, the “hardwire” loopback, is to go to the remote site and physically jumper the transmit pair to the receive pair. Two clips leads are required to do this. This method provides more conclusive results than the alternative, but at the cost of requiring a visit to the remote location (which often is not feasible).

The other method can only be used on lines with a Western Electric 829 or equivalent channel interface unit. Here a single test set is connected at one end of the line. The test set sends a tone to the channel interface at the other end of the line instructing it to go into loopback. The channel interface then connects its transmitter to its receiver so that the signal generated by the test set is returned. This is by far the most convenient method of testing since it requires only one technician and one test set and no visits to the remote location. It does require that the line have 829s installed, though.

### 3.5 Loopback Testing (continued)

To set up a loopback test, proceed as follows:

1. If performing a hardwire loopback, jumper the transmit pair to the receive pair at the far end of the phone line.
2. At the local end of the phone line, disconnect any communications equipment and connect the ATS 2 in its place as described in Appendix A-15.
3. Press <PWR> to turn power on. The ATS 2 will test itself then jump to the most recently selected Measure mode menu. If the ATS 2 displays “BATTERY LOW” at this or any subsequent point, connect the PS-4 battery eliminator/charger as described in Section 4.2.
4. Press <SEND> to display the current Send mode.
5. Use the <| > or <| > key, if necessary, to change the Send mode to “SEND 1004Hz TONE”.
6. Press the Down Arrow key to display the “IMPEDANCE” option. This option should be set to match the impedance of the line under test, with choices of 600 or 900 ohms. The flashing value is the current setting for this option. A setting of 600 ohms is used for all testing at customer premises. Use the <| > or <| > key, if necessary, to change this setting.
7. Press the Down Arrow key again to display the “LINE” option and change it, if necessary, to “4-WIRE”.
8. Press the Down Arrow key again to display the “AUTO SHUT OFF” option. If set to “ON”, the ATS 2 will automatically shut itself off after 15 minutes of keyboard inactivity. If set to “OFF”, the auto shut off feature is disabled. Use the <| > or <| > key, if necessary, to change this setting to the desired value.
9. If any of the LED indicators at the top of the test set are on, press the associated key to turn it off.
10. The test set is now configured to send a 1004 Hz tone. Testing may proceed as described in Section 3.8.

### 3.6 Testing Multipoint Circuits

A multipoint circuit is one in which a single master location is connected to two or more slave locations as shown in Figure 8. For testing purposes, it is helpful to think of the multipoint circuit as two or more related point-to-point circuits. For example, the circuit in Figure 8 can be thought of as a circuit running from the master location to slave “A” and a separate, but related, circuit running from the master location to slave “B”. The objective of multipoint testing is to test

### 3.6 Testing Multipoint Circuits (continued)

each of these sub-circuits, or “legs”, without interference from any of the other legs.

To test a multidrop line in an end-to-end configuration, first disconnect all data communications equipment (DCE) from the line, then connect an ATS 2 to the line at the master location and another ATS 2 at the slave “A” location. Testing is then performed on this section of the line. When complete, the ATS 2 is removed from the slave “A” line and moved to the slave “B” line, where the test procedures are repeated. This process continues until each leg has been tested.

The same theory applies to loopback testing. Here a loopback is established at the master location, then testing is performed one at a time from each of the slave locations. In the case of a hardwire loopback, a visit must first be made to the master location to establish the loopback. In the case of 829 tone-activated loopbacks, the loopback may be established remotely from the first slave location. Testing then proceeds one leg at a time until complete, at which time the loopback may be remotely terminated from the last slave location. Thus an 829 tone-activated loopback test requires no visits to the master location.

An alternative, which allows all testing to be performed from the master location, exists in using the 829 tone-activated loopback on multipoint lines, provided that somebody will be available at each of the slave locations to plug in and unplug channel interfaces. In this alternative, the test set is connected at the master location, then the 829 channel interfaces at each slave location except location “A” are unplugged from the AC power outlet. Testing then proceeds on leg “A” until complete, at which time the 829 at location A is unplugged and the 829 at location B is plugged in. This process continues until each leg has been tested (and be sure to plug the 829's back in when done).

Once a leg has been isolated for testing, the test may be set up as described in Section 3.4 for end-to-end testing, or Section 3.5 for loopback testing.

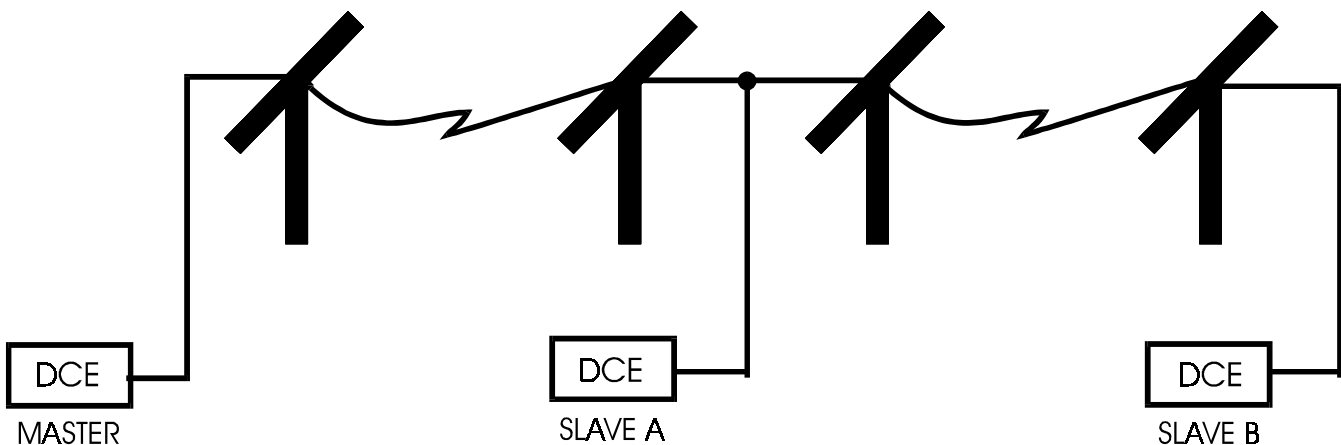


Figure 8 - Multipoint Line with Two Slave Locations

### 3.7 Dial-Up Testing

Dial-up lines are similar to 3002 lines and for the most part will meet the specifications of an unconditioned 3002 channel. The telephone company is under no obligation, however, to insure that it does. Thus resolution of dial-up problems can be difficult (and often impossible). Dial-up testing is also complicated by the 2-wire nature of dial-up lines, which rules out the possibility of loopback testing. Even so, dial-up lines can be tested in an end-to-end fashion to determine basic acceptability.

Before a dial-up line can be tested, a connection between two locations must first be established. This can be accomplished using two ATS 2s, one at the local end to place the call, and the other at the remote end to answer the call. To do so, proceed as follows:

1. Power both ATS 2s on by pressing the <PWR> key. When the internal self test is complete, the ATS 2 will display the most recently selected Measure mode. If the ATS 2 displays “BATTERY LOW” at this or any subsequent time, connect the PS-4 battery eliminator/charger as described in Section 4.2.
2. Press <SEND> on both units to display the current Send mode.
3. On the answering unit, use the <| > or <| > key to change the Send mode to “SEND QUIET TERM”, then press the Down Arrow key to display the “TERMINATION” option. If “TERM” is flashing, proceed to Step 4. Otherwise, press the <| > key to select “TERM”.
4. On the calling unit, use the <| > or <| > key to change the Send mode to “MANUAL DIAL”.
5. On the calling unit, press the Down Arrow key again. The ATS 2 will now display “DIAL METHOD” and “PULSE DTMF”. The flashing value shows the current configuration of the ATS 2. If the flashing value is incorrect, use the <| > or <| > key to change it. This option should be set to match the phone line. If the line is touch-tone, select DTMF. If the line is rotary dial, or if you are unsure, select PULSE.
6. On both units, press the Down Arrow key again to display the “IMPEDANCE” option and press the <| >key, if necessary, to select “600 ohms”.
7. On both units, press the Down Arrow key again to display the “LINE” option and select “2-WIRE”.
8. On both units, press the Down Arrow key again to display the “AUTO SHUT OFF” option. You may instruct the ATS 2 to automatically shut itself off if left unattended by selecting “ON” or you may defeat the automatic shut-off by selecting “OFF”.



### 3.7 Dial-up Testing (continued)

9. This completes configuration of the Send menu (the remaining option will not be used in this test). Disconnect any existing communications equipment from the phone line and connect both ATS 2s using the supplied cable (see Appendix A-15). Make sure that the 'REV' and 'HOLD' lights on both ATS 2s are off. If either is on, press the associated key to turn it off.
10. On the calling unit, press <SEND> so that the ATS 2 again displays "MANUAL DIAL", then press the <HOLD> key so that the HOLD light comes on and the line goes off-hook.
11. Dial tone should now be heard on the calling unit. The volume may be adjusted with the VOL Up or VOL Down key.
12. Key in the phone number for the remote test set from the keypad of the calling unit. You should hear the ATS 2 dialing as you do so.
13. The ring should be heard on both test sets. When heard, press the <HOLD> key on the answering unit to turn the HOLD light on and answer the call by taking the line off-hook.
14. On the calling unit, press the <|> key until the display reads "SEND 1004Hz TONE". This transmits a 1004 Hz tone which should be heard on both ATS 2s.
15. To establish voice communications, press the <TALK> key on one unit and speak into the microphone located directly above it. Release the <TALK> key when done talking so that the remote technician may respond.
16. Testing may now proceed as described in Section 3.8. Note that from here on the calling unit will be referred to as the "sending" unit, and the answering unit as the "receiving" unit.

### 3.8 Insertion Loss and Continuity Testing

This section describes how to measure the frequency and level of a 1004 Hz test tone. This one simple test serves four purposes: it determines whether AC continuity exists, it measures the "insertion loss" characteristic of the line, it provides a general idea of frequency shift and it serves as a reference for future tests.

Before this test can be performed, the procedures in Sections 3.3 through 3.7 should be followed to establish a connection and generate a 1004 Hz test tone. If you plan to use the tone-activated loopback feature of an 829-equivalent channel interface unit, the procedure for establishing the loopback is included in the following steps. The terms "sending unit" and "receiving unit" refer to 2-wire testing. For 4-wire testing, each step should be performed on each test set connected to the line.

### 3.8 Insertion Loss and Continuity Testing (continued)

1. Establish a line connection as described in Section 3.3 through 3.7.
2. On the sending unit, press <SEND> to return to the top of the Send menu, then press <LEVL> to cause the “dBm” indicator in the display to flash. The transmit level may now be keyed in. For dedicated line testing, this level will normally be 0 dBm, which is keyed in as <0> <ENTER>. For dial-up lines, the transmit level should be set to match the transmit level of the communications equipment normally connected to the line. This will be -9 dBm for permissive (RJ11C) type connections, -4 dBm for fixed-loss loop arrangements, or between 0 and -12 dBm for programmable connections. To enter a dial-up level, press the <SIGN> key, if necessary, to change the sign of the displayed level, then key in the desired value and press <ENTER>.
3. On the receiving unit, press the <MEAS> key to display the current Measure mode and use the <| > or <| > key, if necessary, to select “LEVEL/FREQUENCY”.
4. On the receiving unit, press the Down Arrow key to bring up the “DISPLAY DAMPING” option. Use the <| > key, if necessary, to select “OFF”.
5. On the receiving unit, press the down Arrow key again to display the “TERMINATION” option. If “TERM” is flashing, proceed to Step 6. Otherwise press the <| > key to select “TERM”.
6. On the receiving unit, press <MEAS> to return to the top of the Measure menu.
7. If performing an 829 tone-activated loopback test, hold down the <2713> key at this time and release it after 5 seconds. This generates a 2713 Hz tone.
8. The receiving test set should now be picking up the transmitted 1004 Hz tone. If running an 829 tone-activated loopback test and the tone is not picked up, repeat Step 7. When the tone is heard, the 829 has gone into loopback, where it will remain until the <2713> key is pressed again.
9. The VOL Up or VOL Down key can be used to set the speaker volume as desired.
10. If the level and/or frequency are changing too fast to be readable, press the Down Arrow key on the RECEIVING unit to bring up the “DISPLAY DAMPING” option, and use the <| > key to select “ON”. Then press <MEAS> again to return to the LEVEL/FREQUENCY display.

### 3.8 Insertion Loss and Continuity Testing (continued)

11. If the ATS 2 displays “UNDERRANGE” or “OVERRANGE”, the insertion loss of the line is too low or high. On dial-up lines, the level should be higher than the “receiver sensitivity” of the communications equipment which will normally be connected to the line. In all cases, the reading should vary no more than 6 dBm.
12. Regardless of line type, the frequency reading should be 1004 Hz ( $\pm 5$  Hz) and the tone heard through the speaker should be a pure, clear tone, with no discernible background noise. (If noise is heard, it may be measured as described in Sections 3.10 through 3.12).
13. Both the level and frequency readings should be recorded on the Line Analysis Chart. The insertion loss may be calculated by subtracting the receive level from the transmit level. The resulting value should lie between 12 and 20 dB, or between 24 and 40 dB for the hardwire loopback testing. Record this value on the Line Analysis Chart.
14. You may now proceed to Section 3.9 to run a comprehensive test, or to Section 3.13 to run a P/AR test which provides a general idea of line quality.

### 3.9 Frequency Sweeps (Attenuation Distortion Testing)

The insertion loss/continuity test described in the previous section will weed out most phone line problems. The ability of a channel to pass a 1004 Hz tone, however, does not necessarily indicate an acceptable phone line. This section and the sections that follow describe how to make further measurements of phone line acceptability.

The test described in this section is a “frequency sweep”. This test is used to measure the “attenuation distortion” (or “frequency response”) characteristic of the channel. In this test, a range of frequencies covering the voiceband spectrum is generated and measured at the other end. Ideally, each signal, regardless of frequency, should be received at the same level as the 1004 Hz tone measured previously. This never happens in reality, however, and the degree of deviation from this ideal can be used to further determine the quality of the transmission line.

The level readings obtained at each frequency in this test may be plotted on the graph at the left-hand side of the Line Analysis Chart and compared to the specifications shown on page A-17.

Since the measurements obtained in this test will all be referred to the 1004 Hz tone measurement, it is necessary to first set up and run an insertion loss/continuity test as described in Sections 3.3 through 3.8. Once this has been done, the test proceeds as follows (the terms “sending test set” and “receiving test set” in the discussion below refer to 2-wire testing. For 4-wire testing, each step should be performed on each test set connected to the line):

1. Generate and measure a 1004 Hz tone as described in Sections 3.3 through 3.8.
2. On the receiving test set, press the <REL> key. The level reading now becomes 0 and the “dBm” indicator changes to “dB”. From now on, all received levels will be related to the level which was being received at the instant you press the <REL> key. Since a 1004 Hz tone was being received at this time, all future readings will be in reference to the 1004 Hz reading.
3. On the sending unit, press <SEND> then <↑> until the Send mode changes to “SEND AUTO STEP”. This mode will be used to automatically step through a range of frequencies.
4. On the sending unit, press the Down Arrow key to display “SF SKIP” and use the <↑> key if necessary to select “ON”.
5. On the sending unit, press the Down Arrow key again. The ATS 2 now displays the “START FREQUENCY”. From the keypad, key in “304”, then press <ENTER>.
6. On the sending unit, press the Down Arrow key again to display “END FREQUENCY”. Now key in “3304” followed by <ENTER>.
7. On the sending unit, press the Down Arrow key again to display “STEP SIZE”. This time key in “300” then <ENTER>.
8. On the sending unit, press the Down Arrow key again to display “STEP DWELL TIME”. Options for this area a finite number of seconds or “MANUAL”. Press the <↑> key if necessary to select a finite number of seconds, then key in “10” followed by <ENTER>.
9. The sending unit is now configured to automatically step through a range of frequencies from 304 to 3304 Hz in 300 Hz increments every 10 seconds. The SF Skip parameter will cause it to skip over the 2704 Hz frequency, insuring that the remote 829 will not accidentally be taken out of (or put into) loopback and that unwanted signaling frequencies will not be inadvertently generated on dial-up lines. Press <SEND> on the sending unit, then press <START> to begin sending the 304 Hz tone.
10. On the receiving unit, press <MEAS> to display the level and frequency readings. Each time a new frequency is received, the frequency reading will take a second or two to stabilize. Once the display has stabilized, note the level reading for the received frequency. Plot this level on the graph on the left-hand side of the Line Analysis chart with an “X” or a large dot. Note that the dot has already been plotted on the graph showing the 0 dB reading at 1004 Hz. You may also wish to write in each level reading above or below the point on the graph (see Appendix A-21 for an example). If the ATS 2 displays “UNDERRANGE” or “OVERRANGE” at any point, the received signal is way out of specs.
11. If the test is proceeding too fast or too slow, press <SEND> on the sending unit, followed by the Down Arrow key, until the “STEP DWELL TIME” option is again displayed. Then

key in a more appropriate time interval (in seconds) and press <ENTER>. Press <SEND> or <MEAS> to return to the send or measure display, as desired.

12. When all of the frequencies from 304 to 3304 Hz have been generated and their levels recorded, draw a continuous line across the graph to connect the points. Make sure that this line also passes through the 0 dB 1004 Hz point (again see Appendix A-21, if necessary).
13. Compare the graph with the specifications shown on page A-17. Note that some measurements may indicate a line is out of specification for one type of conditioning, but may be satisfactory for others.
14. On the Line Analysis Chart, writer either “acceptable” or “unacceptable” under the “ATTENUATION DISTORTION” heading then proceed to the next section.

### 3.10 C-Message Noise Measurements

Even if a phone channel is within specs in its ability to pass voiceband frequencies, it may still be degraded by noise. Noise itself can be classified into 3 separate categories. One form of noise is present on the line at all times at relatively constant levels. Hiss, crosstalk and stray inductance would be included in this category. This type of noise can be measured by using the “C-message” noise measurement techniques described in this section. The other two forms of noise may be measured by following the “signal-to-noise ratio” and “impulse noise” test procedures described in Sections 3.11 and 3.12.

Before running this test, the operator should test the line for continuity as described in Sections 3.3 through 3.8. Once this has been done, the test may be run as described below. As before, the discussion below refers to a sending unit and a receiving unit. If the loopback test or 4-wire full-duplex test is being run, all steps apply to each test set connected to the line.

1. On the sending unit, press <SEND> to access the top of the Send menu, then use the <| > or <| > key to change the Send mode to “SEND QUIET TERM.”
2. On the receiving unit, press <MEAS> to access the top of the Measure menu, then press <| > until “NOISE” is displayed in the upper left-hand corner.
3. On the receiving unit, press the Down Arrow key to display “FILTER”, then use the <| > or <| > key to select “C-MSG”.
4. On the receiving unit, press <MEAS> again to return to the NOISE display. The C-Message noise level will now be displayed in terms of dBnc (see Appendix A-14). If the display changes too fast to be readable, press the Down Arrow key twice to bring up the “DISPLAY DAMPING” option, then press the <| > key to change it to “ON”. Press <MEAS> to return to the NOISE display.

5. The displayed figure may now be compared to the specifications listed in Appendix A-18. If the ATS 2 displays “OVERRANGE”, the noise level is extremely high and way out of specs. If the ATS 2 displays “UNDERRANGE”, the noise level is very low and is well within specs. Record the C-message noise reading on the Line Analysis Chart. Refer to Appendix A-21 for an example.

### 3.11 Measuring Signal-to-Noise Ratio

Unlike C-message noise measurements, which determine the noise level when no signal is present on the line, the signal-to-noise ratio measurement determines the noise level when signal is present. The signal-to-noise ratio measurement is similar to the C-message noise measurement in that it is affected only by steady state noise. Thus one of the major factors affecting signal-to-noise ratio is “harmonic distortion”.

Assuming that the C-message noise measurement was just performed, this test may be run as follows (otherwise setup a 1004 Hz tone and test for continuity as described in Sections 3.3 through 3.8, then start at Step 2 below):

1. On the sending unit, press <SEND> to access the Send menu, then press <|> to change the Send mode to “SEND 1004Hz TONE”.
2. On the receiving unit, press <MEAS>, then use the <|> key to change the current Measure mode to “SIGNAL TO NOISE”. The receiving unit should now display “TONE” along with the signal-to-noise ratio in terms of dB (see Appendix A-14). If the “TONE” message is not displayed, the 1004 Hz signal is not being received from the transmitter and the signal-to-noise ratio reading is invalid. In this case, reaffirm that the sending unit is set for “SEND 1004Hz TONE” and that its transmit level is correct.
3. If the display on the receiving unit updates too fast to be readable, press the Down Arrow key and use the <|> key to change the “DISPLAY DAMPING” option setting to “ON”. Then press <MEAS> again to return to the SIGNAL TO NOISE display.
4. For dial-up, unconditioned and C-conditioned lines, the signal to noise ratio reading should be 24 dB or greater. For D-conditioned lines, this figure should be 28 dB or greater. If the ATS 2 displays “UNDERRANGE”, the signal-to-noise ratio is less than 10 dB and thus way out of specs.
5. Record the signal-to-noise (S/N) ratio on the Line Analysis Chart and proceed to Section 3.12.

### 3.12 Impulse Noise Measurements

Impulse noise is a sporadic “spike” (e.g., pop or click) of high amplitude. Impulse noise measurements are made in terms of the number of spikes exceeding a specified amplitude over a given time period. Telco specs identify three different amplitude levels, or “thresholds” to be tested

against. Thus, the impulse noise test may need to be run up to three times using three different thresholds. Since the thresholds are determined based on the received 1004 Hz tone level, a 1004 Hz tone must first be generated and measured as described in Sections 3.3 through 3.8.

Since this test must be run up to three times, and since each repetition involves counting spikes over a relatively long period, you may prefer to measure impulse noise only if you have heard pops or clicks through the speaker during the previous tests, or in situations where the phone line has exhibited a high number of sporadic errors.

This test requires that an uninterrupted 1004 Hz tone be generated by the sending unit. Therefore the <TALK> key should not be used on the sending unit while the test is in progress. The test is run as follows:

1. On the receiving test set, press <MEAS>, then use the <| > key to change the current Measure mode to “IMPULSE”.
2. On the receiving test set, press the Down Arrow key until it displays “THRESHOLD”.
3. The impulse threshold must now be calculated and entered on the receiving unit. The value is based on the received 1004 Hz level which should be previously have been recorded on the Line Analysis chart. The threshold will change each of the three times you run through the test. The first time through, add 84 to the 1004 Hz reading. The resulting value will be in terms of dBm (see Appendix A-14) and should be rounded to the nearest integer. Key this value in from the keypad, then press <ENTER>. The second and third times through, add 4 to the previous value. (Example: The received 1004 Hz reading was -16.2 dBm. The first time through, add 84 and round to a value of 68 dBm. Key this in by pressing <6> <8> <ENTER>. The second time through, add 4 to this value to get 72 dBm, and the third time through, add 4 more to get 76 dBm.)
4. On the receiving unit, press the Down Arrow key again to display “COUNT PERIOD”. The test may be run for a finite number of minutes or continuously. The recommendation is for a finite test of 15 minutes. Press the <| > key, if necessary, to select this option, then key in the desired number of minutes followed by <ENTER>. A shorter or longer interval may be selected, but the 15 minute interval will be the easiest to work with and is the minimum interval for telco acceptance.
5. On the receiving unit, press the Down Arrow key again to display the “FILTER” option and set it to “C-NOT”.
6. On the receiving unit, press <MEAS> to return to the IMPULSE display. The ATS 2 should display “TONE” in the lower right-hand corner. If not, the 1004 Hz tone is not being received. Reaffirm that the sending unit is set for “SEND 1004Hz TONE” and that its transmit level is correct.
7. On the receiving unit, press <START> to start the test.

8. The receiving test set will display first the number of received impulses followed by the time interval in hours and minutes. The flashing colon (:) in the display indicates that the test is in progress.
9. When the receiving unit beeps and the colon stops flashing, the test is over. The test may also be stopped manually by pressing <STOP>. For a 15 minute test, the count should not exceed 15 the first time through, 9 the second time and 5 the third time. Otherwise the count should not exceed 1 per minute the first time, 0.6 per minute the second time and 0.33 per minute the third time.
10. On the receiving unit, press the Down Arrow key to read the TONE LOST counter. If this value is non-zero, the 1004 Hz tone was lost during the test and the impulse count is invalid.
11. Record the impulse count, the count period, threshold and tone lost counter values on the Line Analysis Chart. If the impulse count was 0, it is unnecessary to run the test again at a higher threshold and testing may proceed to Section 3.13.
12. If the test is to be run again, return to Step 2.

### 3.13 P/AR Measurements

One other characteristic that adversely affects phone line performance is “phase non-linearity”. This type of distortion can be measured using a technique called the peak-to-average ratio (P/AR test). Although no tariffed specifications exist for acceptable and unacceptable P/AR ratings at this time, they can be evaluated for general acceptability and they are respected by common carriers.

The P/AR test is also affected to some extent by attenuation distortion and background noise (but not impulse noise). Thus, if the P/AR test is to be used to provide strictly an indication of phase non-linearity, the test procedure described in Sections 3.3 through 3.11 should be followed first, to eliminate attenuation distortion and noise as possible sources of trouble. By the same token, though, the P/AR test can be used by itself to provide a general indication of overall phone line quality.

Note, however, that when used in this application, a continuity test must first be performed as described in Sections 3.3 through 3.8. Also note that P/AR results are not nearly as reliable in this application as those obtained from the comprehensive test procedure.

Once the pre-requisites have been met, the test may proceed as follows:

1. On the sending unit, press <SEND> to access the top of the Send mode setup menu and use the <↓> or <↑> key to select “SEND P/AR SIGNAL”.
2. On the receiving unit, press <MEAS> to access the top of the Measure mode setup menu and use the <↓> or <↑> key to select “P/AR”.



3. The receiving unit will now display the received signal level in dBm and the P/AR rating in units. If the display reads “UNDERRANGE” or “OVERRANGE”, the received signal is too weak or strong, respectively, and is way outside of specs.
4. Record the number of P/AR units on the Line Analysis Chart. A value of 100 or higher indicates a perfect line. Ratings of less than 70 to 80 may pose problems for high-speed circuits (4800 bps and up) and ratings below 50 may pose problems for lower speed circuits.

### 3.14 Test Conclusion

If the test procedures described in Sections 3.3 through 3.13 have been followed, you will now have a completed Line Analysis chart and a good idea of the quality of the phone channel. Note, however, that if you have been using the 2-wire test configuration, you will at this point have only tested the line in one direction of transmission. In this case, you will now have to reverse the roles of the sending and receiving test sets and repeat the test procedure in the other direction using a second Line Analysis Chart. To do this, take the test set that was previously the sending unit, press <SEND>, and use the <↑> or <↓> key to change the Send mode to “SEND QUIET TERM.” Then press the Down Arrow key and, if necessary, change the “TERMINATION” option to “TERM”. On what was previously the receiving unit, press <SEND> and use the <↑> or <↓> key to select “SEND 1004Hz TONE”. Then repeat the test procedure starting at Section 3.8.

Also note that if you are testing a multidrop line, it will be necessary to repeat the test procedure on the remaining legs as described in Section 3.6.

If you have been running an 829 tone-activated loopback test, it will be necessary to take the remote 829 out of loopback before disconnecting the ATS 2. To do this, first make sure the “MON TX” light is off. If it is not, press <MON TX> to turn it off. Then use the VOL Up or VOL Down key, if necessary, to adjust the speaker volume to a suitable level. Next hold down the <2713> key and you should hear a high-pitched (2713 Hz) tone come through the speaker. After a few seconds this tone should go away, indicating that the line is out of loopback. Release the key at this time.

The test is concluded by disconnecting the ATS 2s from the line and pressing <PWR> to turn them off, reconnecting any existing communications equipment, plugging all 829 channel interface units back into the wall outlet, and removing all jumpers from the telco line.

If the line was found to be out of specs on one or more parameters, it will now be necessary to contact the phone company. (If the failure was found on a loopback test, it is advisable, although not always necessary, to perform that test again in an end-to-end mode before contacting the phone company). Refer to the designated circuit number when talking to telco employees (see Appendix A-15) and record the names of telco contacts on the Line Analysis Chart.

### 3.15 Testing Short-Haul Lines

Short-haul dedicated lines are entirely different than 3002-type lines in terms of characteristics and testing. There are no tariffed specifications for short-haul lines, so that testing for specific impairments is out of the question. The line can nevertheless be tested using the ATS 2 for general quality and for compatibility with communications equipment in terms of DC coupling (continuity) and loading.

Like 3002 lines, 4-wire short haul lines can be tested in a hardwired loopback or end-to-end configuration. Since short-haul lines generally are not equipped with 829 channel interfaces, this type of loopback is usually ruled out. To perform the test, first configure the test set (s) as described in Sections 3.4 or 3.5. Then proceed as follows (the discussion below refers to a sending unit and a receiving unit. If a 4-wire test is being run, all steps apply to each test set connected to the line):

1. On the sending unit, press <SEND> to return to the top of the Send menu, then press <LEVL> to cause the “dBm” indicator in the display to flash. The transmit level may now be keyed in. Since the impedance of short-haul lines varies widely, it will be impossible to set a precise transmit level. Instead the transmit level can only be roughly approximated. Key in <0> then <ENTER> to set the transmit level to approximately 0 dBm.
2. On the receiving unit, press the <MEAS> key to display the current Measure mode and use the <| > or <| > key, if necessary, to select “LEVEL/FREQUENCY”.
3. On the receiving unit, press the Down Arrow key to bring up the “DISPLAY DAMPING” option. Use the <| > key, if necessary, to select “OFF”.
4. On the receiving unit, press the Down Arrow key again to display the “TERMINATION” option. If “TERM” is flashing, proceed to Step 5. Otherwise, press the <| > key to select “TERM”.
5. On the receiving unit, press <MEAS> to return to the top of the Measure menu.
6. The receiving test set should now be picking up the transmitted 1004 Hz tone. On the receiving unit, hold down the VOL Up or VOL Down key to set the speaker volume as desired.
7. If the level and/or frequency are changing too fast to be readable, press the Down Arrow key on the RECEIVING unit to bring up the “DISPLAY DAMPING” option, and use the <| > key to select “ON”. Then press <MEAS> again to return to the LEVEL/FREQUENCY display.
8. If the ATS 2 displays “UNDERRANGE”, the signal level is too low for the ATS 2 to interpret. Check the sending unit and make sure that it is set for “SEND 1004Hz TONE” and that its transmit level is set correctly. If so, press <REV> on the RECEIVING unit. If a reading is obtained at this point, the transmit and receive pairs of the phone lines were reversed. Otherwise, the transmitted signal is not getting through the phone line.

9. If the received level is in range, record it. Note that there are no specs as to what the receive level should be.
10. On the sending unit, press <SEND> to display the current Send mode, then use the <| > key to change it to “SEND AUTO STEP”.
11. On the sending unit, press the Down Arrow key to display the “SF SKIP” option. Although the SF skip feature is not needed in short-haul line testing, we recommend that it always be left “ON”. Use the <| > or <| > key, if necessary, to change it.
12. On the sending unit, press the Down Arrow key again to display the “START FREQUENCY”. Key in 50, then press <ENTER>.
13. On the sending unit, press the Down Arrow key again to display the “END FREQUENCY”. Key in 5000, then press <ENTER>.
14. On the sending unit, press the Down Arrow key again to display the “STEP SIZE”. Key in 450, then <ENTER>.

### 3.15 Testing Short-Haul Lines (continued)

15. On the sending unit, press the Down Arrow key again to display the “STEP DWELL TIME”. This may be set to a specific time or to “MANUAL”. Press the <| > key, if necessary, to select a specified time interval, then key in 10 followed by <ENTER>.
16. The sending unit is now configured to automatically step through a range of frequencies from 50 to 5,000 Hz in 450 Hz increments. It will generate a new frequency every 10 seconds. Press <SEND> on the sending unit, then press <START> to begin transmitting the 50 Hz tone
17. On the receiving unit, press <MEAS> to return to the “LEVEL/FREQUENCY” display.
18. The receiving unit will now display the receive level and frequencies of the signals generated by the sending unit. Each time a new frequency is generated, the display will take a second or two to stabilize. When the display does stabilize, record the level and frequency. Continue this process until all frequencies from 50 to 5000 Hz have been recorded.

The results of the test may now be analyzed. If the highest level reading was obtained at 50 Hz, and if each level dropped off progressively thereafter, the line is probably DC-coupled. If, however, any of the level readings were higher than the 50 Hz reading or if the 50 Hz reading was “UNDERRANGE”, the line is probably AC-coupled.

If the received level was relatively constant over the 500 to 2750 Hz range, but dropped off rapidly in the 3200 to 4100 Hz range (possibly even going to “UNDERRANGE”) the line is probably loaded (or amplified). If, on the other hand, the received level dropped off gradually all the way up through 5000 Hz, the line is probably unloaded.

For unloaded, unamplified lines, a rough approximation of line length may be made by subtracting the 2750 Hz level reading from the 1850 Hz reading. The result is the approximate length of the line in miles. Note that if a hardwire loopback test is being run, the result should be divided by two to determine the actual circuit length.

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## 4.0 MAINTENANCE

### 4.1 General

The ATS 2 Audio Test Set is a solid state device, highly reliable, and requires no adjustments. The only routine maintenance required is the periodic recharging of the internal batteries as described below.

In case of problems with the Audio Test Set, the self-test program described in Section 4.3 should be run to verify that the ATS 2 is operational. If the Audio Test Set is found to be non-operational, it should be returned to the factory for repair. Return authorization and shipping instructions must be obtained from the factory before returning the Test Set. A note indicating the suspected failure or symptoms and return address should be included with the unit when shipped.

### 4.2 Battery Recharging/AC Operation

The batteries in the ATS 2 Audio Test Set should be recharged when the “BATTERY LOW” status message appears during normal operation. The plug from the PS-4 Battery Eliminator/Charger should be plugged into the jack on the bottom end of the Audio Test Set first. The switch on the bottom of the transformer should be set to either 115 or 230 vac depending on the power source available. The transformer should then be plugged directly into a standard 115 vac outlet or through an adapter into a 230 vac outlet.

The batteries should be charged for at least four hours with the power switch off to assure a full charge. The Audio Test Set can be used while the batteries are being recharged but the recharge time will be longer. The Audio Test Set can be left on charge continuously without damage.

**CAUTION** - Only the Electrodata PS-4 Battery Eliminator Charger should be used with the ATS 2 Audio Test Set. Other battery eliminator/chargers, even though they may have the same connector, are not compatible with the Audio Test Set and may result in damage to the Audio Test Set. Rechargeable batteries are not user-replaceable and replacement should be performed by a qualified service person.

### 4.3 Self-Test Procedure

The ATS 2 contains a short self-test that runs each time the unit is powered on. In addition, the ATS 2 contains a comprehensive self-test which can be run by holding down the <HOLD> key and turning power on. In either case, the ATS 2 will turn on and display “Electrodata, Inc.” on the top line, and the part number and revision level of the software on the bottom line.

On completion of the short self-test, the ATS 2 will beep and display either “SELF TEST PASSED” or “SELF TEST FAILED”. If the self-test fails, charge the batteries as described in Section 4.2, then run the test again. If it still fails, contact the factory or your local Electrodata representative.

The comprehensive self-test consists of 9 sections. The display shows which section is currently being tested. As each test is completed successfully, the ATS 2 will beep twice and proceed to the next section. If, however, a test fails, the ATS 2 will emit a single long beep and display “SELF TEST FAILED” before proceeding. The 9 sections tested by the ATS 2 are as follows:

PROGRAM MEMORY  
DATA MEMORY  
DISPLAY  
LOOPBACK  
3kHz FILTER  
C-MSG FILTER  
C-NOT FILTER  
IMPULSE NOISE  
P/AR

During the DISPLAY test, the ATS 2 will count down from 9 to 1 in each display position. It is up to the operator to verify that this test is successful.

When the entire procedure is complete, the ATS 2 will beep twice and display “SELF TEST COMPLETE”, then return to the most recently selected measure menu.

If an error is encountered during the comprehensive self-test, contact the factory or your local Electrodata representative and explain which section or sections of the test failed.

Always obtain return authorization from the factory before returning equipment for repair.

## 5.0 WARRANTY

The ATS 2 is guaranteed to be free of defects in material and workmanship for a period of one year after receipt by the original purchaser.

Under this Warranty, defective equipment will be either repaired or replaced at the option of Electrodata, Incorporated. Electrodata, Inc. will pay all transportation costs on equipment being returned for Warranty repair when return authorization has been obtained.

Liability under this Warranty extends only to the replacement value of the ATS 2. This Warranty is void if:

1. the ATS 2 has been altered or repaired without written authorization of Electrodata, Inc.; or
2. the ATS 2 is installed or operated other than in accordance with the instructions contained in this manual or Electrodata literature.

After expiration of this Warranty, the ATS 2 may be returned to the factory for repair. Prior to returning any equipment, return authorization and shipping instructions must be obtained from the factory. The customer must pay all transportation costs plus the standard time and material rates in effect at the time of repair.



## APPENDIX

## SEND QUIET TERM Menu

SEND QUIET TERM.

TERMINATION  
TERM BRIDGE

Use term unless monitoring an intact line

IMPEDANCE  
600ohms 900ohms

Set to match line (usually 600)

LINE  
4-WIRE 2-WIRE

Set to match line

AUTO SHUT OFF  
OFF ON

User preference

AUXILIARY FREQ.  
0050Hz

User preference

## SEND 1004Hz TONE Menu

SEND 1004Hz TONE  
-00.0dBm 1004Hz

Leased line: set level to 0 dBm. Dial-up:  
set level to match modem TX level (-9dBm  
with RJ11C jack).

IMPEDANCE  
600ohms 900ohms

Set to match line (usually 600)

LINE  
4-WIRE 2-WIRE

Set to match line

AUTO SHUT OFF  
OFF ON

User preference

AUXILIARY FREQ.  
0050Hz

User preference

## SEND VAR FREQ Menu

<b>SEND VAR FREQ</b> -00.0dBm 0050Hz	Leased line: set level to 0 dBm. Dial-up: set level to match modem TX level (-9dBm with RJ11C jack). Set frequency as desired.
<b>SF SKIP</b> OFF ON	ON
<b>IMPEDANCE</b> 600ohms 900ohms	Set to match line (usually 600)
<b>LINE</b> 4-WIRE 2-WIRE	Set to match line
<b>AUTO SHUT OFF</b> OFF ON	User preference
<b>AUXILIARY FREQ.</b> 0050Hz	User preference

## SEND P/AR SIGNAL Menu

SEND P/AR SIGNAL  
-00.0dBm

Leased line: set level 0dBm. Dial-up: set level to match modem TX level (-9dBm with RJ11C jack).

IMPEDANCE  
600ohms 900ohms

Set to match line (usually 600)

LINE  
4-WIRE 2-WIRE

Set to match line

AUTO SHUT OFF  
OFF ON

User preference

AUXILIARY FREQ.  
0050Hz

User preference

## SEND SLOPE Menu

SEND SLOPE  
-00.0dBm 1004Hz

Leased line: set level to 0 dBm. Dial-up: set level to match modem TX level (-9dBm with RJ11C jack). Frequency controlled by ATS .

IMPEDANCE  
600ohms 900ohms

Set to match line (usually 600)

LINE  
4-WIRE 2-WIRE

Set to match line

AUTO SHUT OFF  
OFF ON

User preference

AUXILIARY FREQ.  
0050Hz

User preference

## SEND AUTO STEP Menu

<b>SEND AUTO STEP</b> -00.0dBm 0050Hz	Leased line: set level to 0 dBm. Dial-up: set level to match modem TX level (-9dBm with RJ11C jack). Frequency controlled by ATS
<b>SF SKIP</b> OFF ON	ON
<b>START FREQUENCY</b> 0050Hz	3002 and dial-up: 0304 Hz Short-haul: 0050 Hz
<b>END FREQUENCY</b> 0050Hz	3002 and dial-up: 3304 HZ Short-haul: 5000 Hz
<b>STEP SIZE</b> 0050Hz	3002 and dial-up: 0300 Hz Short- haul: 0450 Hz
<b>STEP DWELL TIME</b> 10 SEC. MANUAL	10 SEC.
<b>IMPEDANCE</b> 600ohms 900ohms	Set to match line (usually 600)
<b>LINE</b> 4-WIRE 2-WIRE	Set to match line
<b>AUTO SHUT OFF</b> OFF ON	User preference
<b>AUXILIARY FREQ.</b> 0050Hz	User preference

## MANUAL DIAL Menu

<b>MANUAL DIAL</b>	Displays phone number on second line
<b>DIAL METHOD</b> PULSE DTMF	DTMF = touch-tone dial Use PULSE (rotary) when in doubt
<b>IMPEDANCE</b> 600ohms 900ohms	600ohms
<b>LINE</b> 4-WIRE 2-WIRE	2-WIRE
<b>AUTO SHUT OFF</b> OFF ON	User preference
<b>AUXILIARY FREQ.</b> 0050Hz	User preference



## AUTODIAL Menu

AUTODIAL BIN #0	Key in desired bin #. Lower line displays number stored in bin
ENTER BIN #0	Key in desired phone number
   I	
ENTER BIN #9	Key in desired phone number
DIAL METHOD PULSE DTMF	DTMF = touch-tone dial Use PULSE (rotary) when in doubt
IMPEDANCE 600ohms 900ohms	600ohms
LINE 4-WIRE 2-WIRE	2-WIRE
AUTO SHUT OFF OFF ON	User preference
AUXILIARY FREQ. 0050Hz	User preference

## LEVEL / FREQUENCY Menu

<b>LEVEL/FREQUENCY</b> -00.0dBm 1004Hz	Displays measured level and frequency
<b>DISPLAY DAMPING</b> OFF ON	Normally OFF ON to slow down display
<b>TERMINATION</b> TERM BRIDGE	TERM
<b>IMPEDANCE</b> 600ohms 900ohms	Set to match line (usually 600)
<b>LINE</b> 4-WIRE 2-WIRE	Set to match line
<b>AUTO SHUT OFF</b> OFF ON	User preference
<b>AUXILIARY FREQ.</b> 0050Hz	User preference

## NOISE Menu

<b>NOISE C-NOT</b> 50dBn            TONE	Displays current filter and noise level. Displays "TONE" if 1004 Hz holding tone is received and C-NOT filter is used.
<b>FILTER</b> 3kHz C-MSG C-NOT	C-MSG for C-message noise
<b>DISPLAY DAMPING</b> OFF ON	Normally OFF ON to slow down display
<b>TERMINATION</b> TERM BRIDGE	TERM
<b>IMPEDANCE</b> 600ohms 900ohms	Set to match line (usually 600)
<b>LINE</b> 4-WIRE 2-WIRE	Set to match line
<b>AUTO SHUT OFF</b> OFF ON	User preference
<b>AUXILIARY FREQ.</b> 0050Hz	User preference

## SIGNAL TO NOISE Menu

<b>SIGNAL TO NOISE</b> 24dB TONE	Displays S/N ratio TONE must be displayed for reading to be valid
<b>DISPLAY DAMPING</b> OFF ON	Normally OFF ON to slow down display
<b>TERMINATION</b> TERM BRIDGE	TERM
<b>IMPEDANCE</b> 600ohms 900ohms	Set to match line (usually 600)
<b>LINE</b> 4-WIRE 2-WIRE	Set to match line
<b>AUTO SHUT OFF</b> OFF ON	User preference
<b>AUXILIARY FREQ.</b> 0050Hz	User preference

## P/AR Menu

<b>P/AR</b> -00.0dBm 100 UNITS	Displays receive level and P/AR units
<b>TERMINATION</b> TERM BRIDGE	TERM
<b>IMPEDANCE</b> 600ohms 900ohms	Set to match line (usually 600)
<b>LINE</b> 4-WIRE 2-WIRE	Set to match line
<b>AUTO SHUT OFF</b> OFF ON	User preference
<b>AUXILIARY FREQ.</b> 0050Hz	User preference

## IMPULSE Menu

IMPULSE C-NOT 0000 00:00 TONE	Displays filter, impulse count, and time (hours: minutes). Colon flashes while test in progress. TONE displays with C-NOT filter.
TONE LOST CNTR 0000	Displayed with C-NOT filter only.. Displays number of times tone was lost.
THRESHOLD 070dBm	1st run= receive level + 84 2nd run= first value + 4 3rd run= second value + 4
COUNT PERIOD 15 MIN. CONT.	15 MIN.
FILTER 3kHz C-MSG C-NOT	C-NOT
TERMINATION TERM BRIDGE	TERM
IMPEDANCE 600ohms 900ohms	Set to match line (usually 600)
LINE 4-WIRE 2-WIRE	Set to match line
AUTO SHUT OFF OFF ON	User preference
AUXILIARY FREQ. 0050Hz	User preference

## Working with Decibels

The decibel, or “dB”, is a unit of measure of signal power commonly used in the telecommunications world. It is quite different from other more familiar measurements of power such as watts and horsepower.

Unlike the watt, which is an “absolute” unit of measure, the decibel is a “relative” unit of measure. This means that decibels must always be expressed as a relationship. Where it is perfectly fine to refer to a signal level of “10 watts”, it is meaningless to refer to a signal level of “10 dB”. It is meaningful, however, to say that one signal level is 10 dB above another.

Every 10 dB represents a factor of 10, and every 3 dB represents a factor of 2. Thus a signal that is 3 dB below another is actually one-half as strong. A signal-to-noise ratio of 10 dB means that the signal level is 10 times greater than the noise level.

Decibels can be used as an absolute measurement if they are related to a known standard. In telecommunications, it is common to relate decibels to a standard value of 1 milliwatt. Decibels referenced to the milliwatt standard are abbreviated “dBm”. To refer to a signal level as -3dBm is therefore meaningful: the signal level is 3 dB below one milliwatt, or one-half of a milliwatt. A signal level of -10dBm is equal to one-tenth of a milliwatt and a signal level of 0 dBm is equal to 1 milliwatt. The dBm has become the standard unit of measure for telephone signal levels.

Noise measurements, however, are related to the nanowatt and are abbreviated “dBrn”. DBrn can be converted to dBm by subtracting 90, just as dBm can be converted to dBrn by adding 90. For example, -30 dBm is equal to 60 dBrn. 74 dBrn would be equal to -16 dBm. In telephone line testing you will find that most dBm readings are negative numbers (or zero) and most dBrn readings are positive.

When a noise measurement is made using a C-message or C-notch filter (see Appendix A-19), a “c” is added to the “dBrn”. Thus a noise reading of 55 dBrnc signifies a level of 55 dBrn (-35 dBm) measured with a C-MSG or C-NOT filter.

The ATS 2 automatically displays its measurements in the correct format (dB, dBm, dBrn, dBrnc) according to the operation being performed. An additional display of “dBrel” will be used if the <REL> key is pressed while measuring SIGNAL TO NOISE ratio.

## Phone-Line Connections

The ATS 2 is connected to a phone line using a cable with a modular plug on one end and 4 alligator clips on the other. The modular plug is inserted into the RJ11C jack at the top of the ATS 2; the alligator clips are connected to the line.

The ATS 2 is connected to the phone line at the same location as the modem or telephone that will normally use the line. This location is referred to as the “d-marc”. The d-marc itself is usually a small plastic box about 2 inches square with a cover held on by a single screw. To connect the ATS 2 to this box, remove the screw and the cover to expose four or more terminal screws inside. If the cover of the box is marked “TX” and “RX”, make sure you note the positions of these markings before removing it.

A 4-wire dedicated line will have four terminal screws, two for the transmit side of the line and two for the receive. If the transmit (TX) and receive (RX) pairs are marked, connect the red and green clip leads to the transmit pair and the yellow and black leads to the receive pair. If they are unmarked, match the color of the clips to the color of the wires underneath the screw terminals. Since red and green are usually transmit and yellow and black are usually receive, this will generally be correct. (If not, the connections can be reversed internally to the ATS 2 simply by pressing the “REV” key at the top of the test set).

To connect to a 2-wire dedicated line, simply locate the two terminal screws that have wires connected underneath them and connect the red alligator clips to one and the green to the other.

To connect to a dial-up line, you must locate the two wires that carry the data signal (tip and ring). Usually these wires will be solid red and solid green. Find the terminal screws that the wires connect to and clip the red and green alligator clips to them.

For leased lines, a circuit number and a telephone number will usually be attached on or near the d-marc. The telephone number is the number to call and report line troubles. The circuit number should be referred to in all correspondence with the telephone company. Both numbers should be entered on the Line Analysis Chart.



## Line Conditioning and Telco Specs

Your telephone company has standards of acceptability for every dial-up line and 3002 line that leaves its facilities. Communications equipment such as modems and telephones also have minimum requirements for telephone line performance. As long as each phone line performs up to standard and as long as these standards meet the minimum requirements of the communications equipment connected to the line, voice and data transmission will be acceptable.

Sometimes, however, a phone line may fall below telco standards (also known as specifications, or “specs”) and cause problems for the communications equipment. Usually this is caused by some component of the line which has gone defective. In these cases the line can be repaired and brought back up to specs. In other cases, though, the problem may not be due to a defective component, but rather to factors beyond the control of the telephone company. In these cases, the only solution is to put “conditioning” on the line. Conditioning is also called for when the communications equipment connected to the line requires better performance than can be provided by a basic telephone channel.

In conditioning, the telephone company adds circuitry to the phone line to cause it to meet specifications which are tighter than those of the basic channel. Many of these new specifications are subject to FCC or local “tariffs” requiring that the phone company insure that they are met. Although conditioning allows faster and more accurate data transmission, it is fairly expensive and thus seldom used. Note also that conditioning is not done on dial-up lines.

There are two basic types of conditioning. “C” conditioning is used to reduce attenuation distortion and phase non-linearities (see Sections 3.9 and 3.13). “D” conditioning is used to reduce harmonic distortion (see Section 3.11). For each type of conditioning, there are varying levels of performance as well. As this time, C-conditioning is available in levels C1 through C5, while D-conditioning is available in levels D1 and D2.

The following pages list the specifications for basic (unconditioned) 3002 lines as well as C- and D-conditioned lines. Note also that the Line Analysis charts and transparent overlays provided with each ATS 2 can be used to verify compliance with specifications for basic and C-conditioned lines (see Section 3.9).

Attenuation Distortion Limits

Channel Conditioning	Frequency Range (Hz)	Variation† (dB)
Basic	500-2500	+2 to -8
	300-3000	+3 to -12
C1	*1000-2400	+1 to -3
	* 300-2700	+2 to -6
	300-3000	+3 to -12
C2	* 500-2800	+1 to -3
	* 300-3000	+2 to -6
C3 (access line)	* 500-2800	+0.5 to -1.5
	* 300-3000	+0.8 to -3
C3 (trunk)	* 500-2800	+0.5 to -1
	* 300-3000	+0.8 to -2
C4	* 500-3000	+2 to -3
	* 300-3200	+2 to -6
C5	* 500-2800	+0.5 to -1.5
	* 300-3000	+1 to -3

\* These specifications are tariffed

† Relative to 1004 Hz receive signal level

Limits for Other Impairments

1. 1004 Hz loss variation: no more than  $\pm 4$  dB long term (12 dB to 20 dB)  
and no more than  $\pm 3$  dB short term

2. C-message noise (without tone):

<u>Facility miles</u>	<u>Maximum receive noise level</u>
0-50	28 dBrc
51-100	31 dBrc
101-400	34 dBrc
401-1000	38 dBrc
1001-1500	40 dBrc
1501-2500	42 dBrc
2501-4000	44 dBrc
4001-8000	47 dBrc
8001-16000	50 dBrc

3. Signal-to-noise ratio: 24 dB minimum  
(28 dB minimum for D1 and D2 conditioned lines)

4. Impulse noise:

Threshold with respect to 1004 Hz receive level	Maximum counts above threshold allowed in 15 minutes
-6 dB	15
-2 dB	9
+2 dB	5

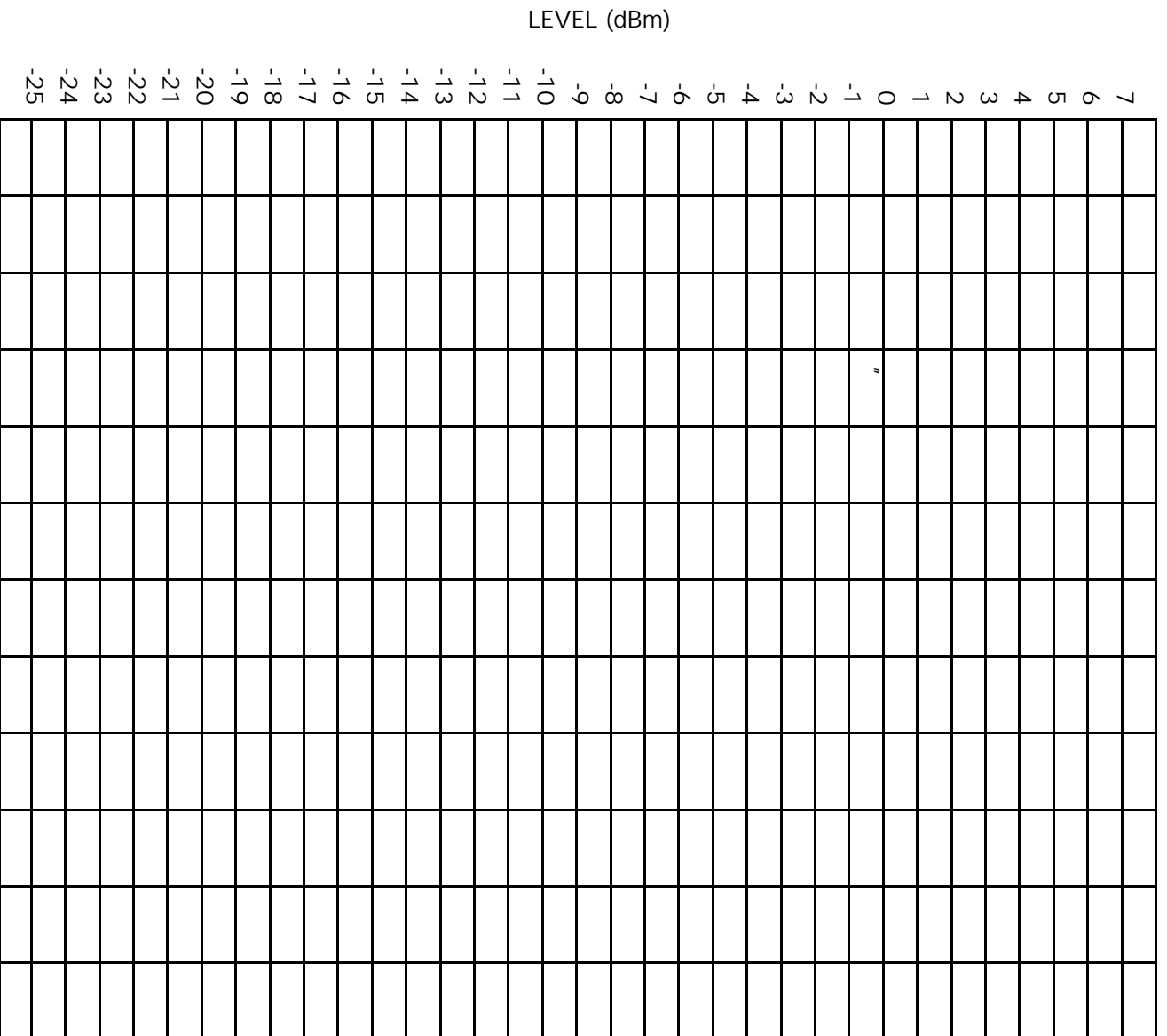
5. Frequency shift:  $\pm 5$  Hz maximum

## Filters

In making meaningful noise measurements on a transmission channel, it is helpful to use a test set whose frequency response characteristics match those of the communications equipment which will normally be connected to the line. For example, if a modem responds only to frequencies between 300 and 3000 Hz, a test set which measures noise levels at 10,000 Hz and higher may provide misleading results, since it can potentially measure noise at frequencies that the modem ignores. The frequency response characteristics of a test set can be changed through the use of “filters”. A filter is an electronic circuit that limits bandwidth and that weighs certain frequencies more heavily than others.

The ATS 2 allows the operator to choose from three types of filters: the 3kHz (flat), the C-MSG (C-message) and the C-NOT (C-notch). As its name implies, the 3 kHz flat filter provides a flat frequency response up to approximately 3 kilohertz. The C-message filter was developed to simulate the frequency response of telephone handsets, and continues to be the standard used by telephone companies for both voice and data. The C-notch filter is the same as the C-message filter with sharp attenuation added at around 1010 Hz. This filters out the 1004 Hz test tone and is useful in measuring noise-with-tone and signal-to-noise ratio.

# LINE ANALYSIS CHART



CIRCUIT #: \_\_\_\_\_

SERVICE #: \_\_\_\_\_

CONTACT: \_\_\_\_\_

DESCRIPTION: \_\_\_\_\_

\_\_\_\_\_

CONFIGURATION: \_\_\_\_\_

DATE: \_\_\_\_\_ TIME: \_\_\_\_\_

RECEIVE 1004 HZ LEVEL: \_\_\_\_\_ dBm

FREQUENCY: \_\_\_\_\_ HZ

INSERTION LOSS: \_\_\_\_\_ dB

ATTENUATION DISTORTION: \_\_\_\_\_

C-MESSAGE NOISE = \_\_\_\_\_ dBrc

S / N RATIO = \_\_\_\_\_

- 1
- 2
- 3

IMPULSE: \_\_\_\_\_ Counts

per \_\_\_\_\_ Minutes

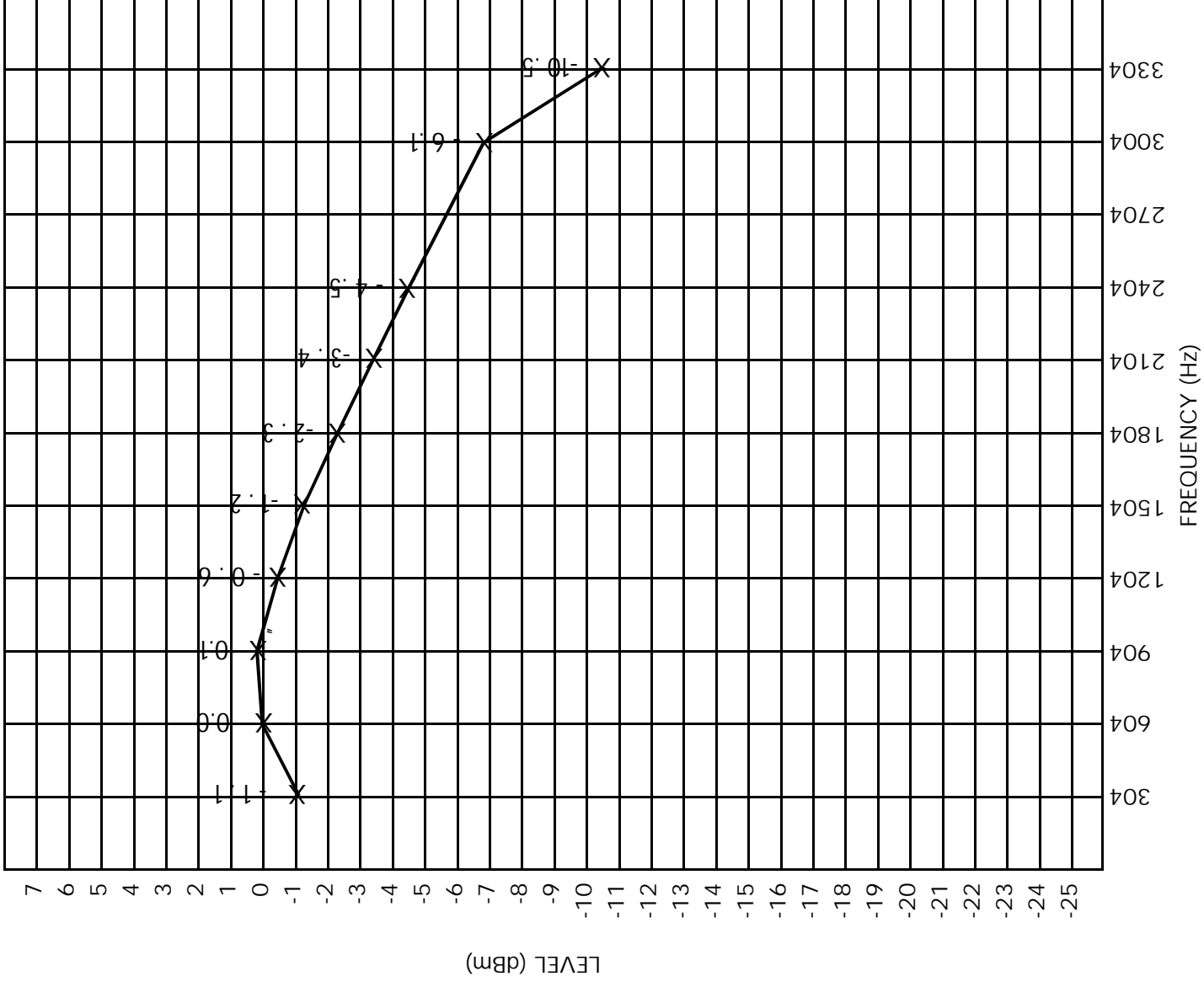
at \_\_\_\_\_ dBrc

-tone LOST: \_\_\_\_\_ Counts

P / AR = \_\_\_\_\_ units

NOTES:

# LINE ANALYSIS CHART



CIRCUIT #: 17443

SERVICE #: 555-1212

CONTACT: \_\_\_\_\_

DESCRIPTION: Cleveland / Bedford Line

\_\_\_\_\_

CONFIGURATION: End to end. Send from Cleveland,

Measure at Bedford.

DATE: 3 / 9 / 96 TIME: 3:30 p.m.

RECEIVE 1004 Hz LEVEL: -14.1 dBm

FREQUENCY: 1004 Hz

INSERTION LOSS: 14.1 dB

ATTENUATION DISTORTION: Unacceptable

C-MESSAGE NOISE = 33 dBmnc

S / N RATIO = 35

IMPULSE: 3 1 0 Counts  
1 2 3

per 15 15 15 Minutes

at 70 74 78 dBm

TONE LOST: 0 0 0 Counts

P / AR = 103 units

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