LINEMASTER™

OPERATOR'S MANUAL

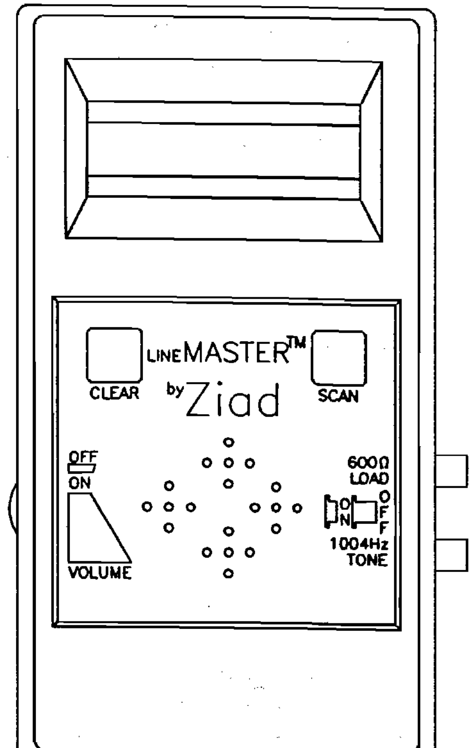

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TABLE OF CONTENTS

SECTION 1: GENERAL

1.1 Introduction

The Linemaster is a compact, portable line monitoring device. It is connected in parallel to a telephone line or trunk pair and bridges that pair with an extremely high DC resistance/AC impedance, which makes the device virtually "invisible". The primary function of the Linemaster is the monitoring of line activity via Ziad's, exclusive **DIGIT DISPLAY** feature. This feature captures and displays the values of all pulse and tone dialed digits, including percent break, pulses per second and interdigit time (pulse), or on-time, off-time and dB level (tones). The **DIGIT DISPLAY** also monitors the line status (on-hook, off-hook), zero volt or wink intervals and non-DTMF voice band tones.

The Linemaster contains an amplified audio monitor with volume control, which provides easier monitoring than conventional butt-sets, particularly when prolonged use is required.

A switchable 600 ohm load is built into the unit to allow for precise dBm measurements or to simply terminate the line to verify a "live" pair. Lastly, a switchable 1004Hz tone generator is built into the unit.

1.2 Unpacking the Unit

Each Linemaster is shipped from the factory in a corrugated carton that contains an inner case made of high-impact double walled plastic. This foam lined plastic case is designed to be used as a permanent carrying case for the unit. The Linemaster is a complex, microprocessor based, electronic device and should be treated with care. We strongly suggest that the unit be kept in its carrying case when not in use.

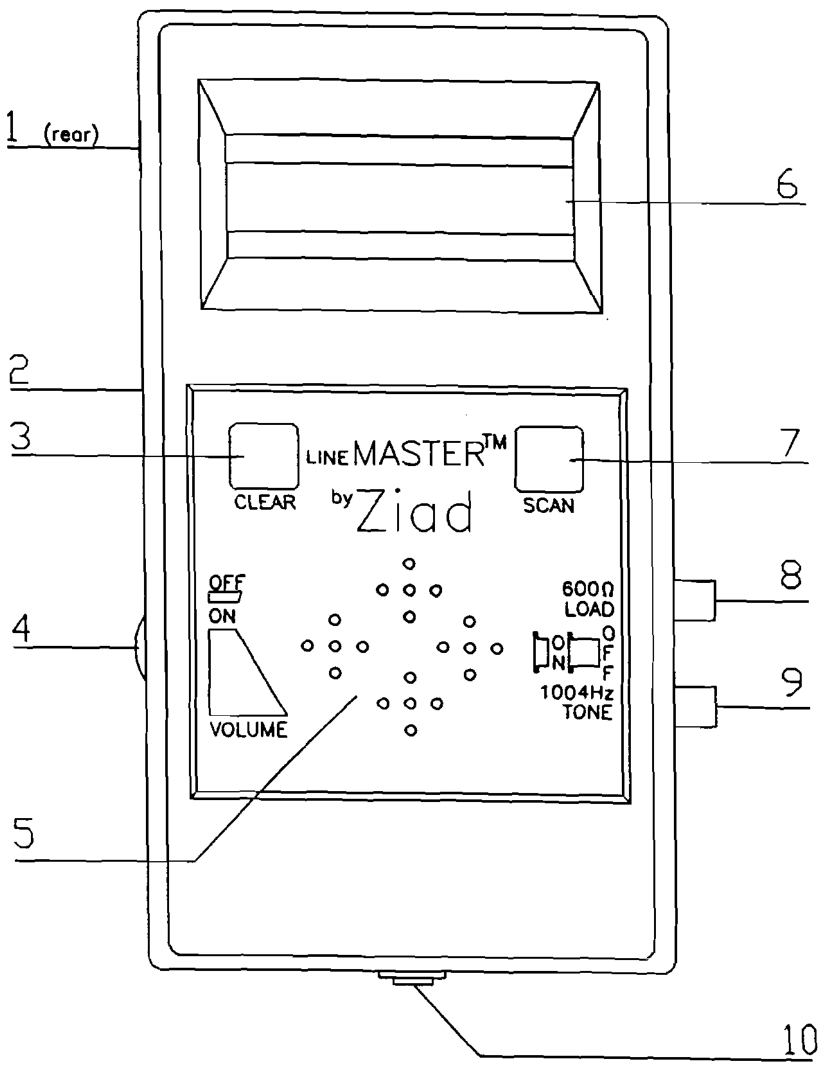
1.3 Installing the Batteries

The battery compartment is located on the back of the unit, directly behind the display. To remove the lid, slide it upward as indicted by the arrow located on the battery lid.

When installing batteries, be sure that the polarity symbols (+ and -) on the batteries match those embossed on the bottom of the battery compartment. Turn power on unit to see that it operates properly. If not, remove the batteries promptly as they could become damaged if left in the incorrect position for an extended period of time.

When replacing batteries in the future, use only high quality alkaline cells. These cells have lower impedance than conventional cells and will guarantee better operation of the Linemaster's sensitive audio circuits.

NEVER leave discharged batteries in the Linemaster for prolonged periods of time, they may leak and damage the unit. If lengthy storage of the unit is required, remove the batteries regardless of age or charge.



1 - Battery Compartment & Tilt Stand

2 - DC Power Jack

3 - Clear Key

4 - ON/OFF/VOLUME Control

5 - Loudspeaker

6 - Liquid Crystal Display (LCD)

7 - Scan Key

8 - 600 Ohm Load Switch

9 - 1004 Hz Tone Switch

10-RJ-11 Receptacle

Figure 1

SECTION 2: BASIC OPERATION

2.1 Power-On Sequence

Before turning on the unit, acquaint yourself with the location of each item shown in Figure 1. Once you have done this, turn the Linemaster on by rotating the thumbwheel (ON/OFF/VOLUME) control down or counter-clockwise. You should hear an immediate "click" from the thumbwheel control which indicates the "ON" position has been reached. You need not rotate the control any further at this point. As soon as power is applied to the unit, the sign-on messages will appear on the Liquid Crystal Display (LCD). There are two messages, each lasting one second each. These messages are as follows:

1.	LineMASTER™ by Ziad, Inc.	2.	BATTERY SUPPLY IS OKAY

If these messages are not displayed immediately, press the CLEAR key. If the unit still fails to produce the sign-on messages, check the batteries for proper installation and repeat the above steps.

2.2 Battery Low Indication

If the second of the two sign-on messages appears as "BATTERY SUPPLY IS LOW" instead of "BATTERY SUPPLY IS OKAY" as previously described, this is an indication that the batteries have discharged sufficiently to trip a circuit within the Linemaster which creates the above message. This will occur when the battery voltage has dropped to approximately 4.75 VDC. The unit should continue to operate for some time after the first appearance of the message.

To view battery status at any time without turning the Linemaster "OFF" and "ON" again, simply press and hold the SCAN key, press and release the CLEAR key, then release the SCAN key. This will generate the sign-on messages as previously described. This two-key sequence can also be used to reset the microprocessor at any time. Although this should rarely be needed, certain functions may cause "brown-out" problems when the unit is in the "low battery" state. Symptoms of this condition would be the failure of the CLEAR key to reset the display or failure of the LCD to change displays when various modes are selected.

2.3 Audio Monitor

The audio monitor is automatically switched on when the ON/OFF/VOLUME control is moved to the ON position. Volume may then be controlled by either up or down rotation, as desired. This feature allows monitoring of line activity in a hands-free state and has ample volume to be heard up to 10 feet. However, to achieve this level of volume, the internal amplifier is NOT top-end limited and is capable of reproducing very loud tones at levels that could cause hearing damage if the speaker is placed directly to the ear. Therefore, this type of usage is NOT recommended.

2.4 Mode Selections

Immediately following the BATTERY SUPPLY IS OKAY/LOW message, the Linemaster will allow you to select several modes of operation. The first option is between TIMING & dB or WRAPAROUND modes (The features provided by each mode will be discussed in Sections 4 and 5). Selection of the desired mode is accomplished by depressing the SCAN key to toggle between modes, while the CLEAR key is used to enter the displayed selection and to move to the next display.

Since the TIMING & dB mode is the most commonly used feature, this is the default feature and is automatically displayed. If you do not need to change this mode, the Linemaster will time-out in 6 seconds, skip the second mode selection and proceed to the main Digit Display function. If you wish to change the second mode selection, you must depress the CLEAR key to proceed to the next display.

The second option is between off-hook threshold levels of CPE, which is less than 22 VDC and CO which is less than 44 VDC. The procedure to change this option and proceed to the next display is identical to the first selection option above.

2.5 600 Ohm Load

The Linemaster has a built-in, switchable 600 ohm load which has several uses. The primary use would be to terminate a line or trunk in order to read dB as dBm. To use the load for this function, use some other device that is capable of dialing (butt-set, etc.) to reach the desired test tone. At this point, simply depress the 600 ohm load switch to the "IN" position and disconnect the device used for dialing. The dB meter of the Linemaster can now be used to read the level of the tone, which can now be expressed as true dBm. this switch can also be used to answer a ringing line for the same purpose. In either case, be sure that the sole termination of the line is the 600 ohm load of the Linemaster. If this load is placed in parallel with another terminating device (PBX, key system, dialer, butt-set, etc.) the load presented will equal something less than 600 ohms and the reading taken by the Linemaster will not be an accurate dBm reading.

Another use for this load is to "pull dial tone" for the purpose of looking for "live" pairs. The combination of the 600 ohm load and the audio monitor allows the Linemaster to be used hands-free for this function.

The electrical components of this load are strictly resistive (per AT&T technical specification) and as such exhibit the same DC resistance and AC impedance. In addition, a resistive 600 ohm load will remain a constant value regardless of frequency. However, some caution is required when using this load to prevent damage due to excessive heat dissipation. The maximum power handling capacity of this load is six (6) watts, which is so excessive for the typical use of the Linemaster that it was considered unnecessary to fuse this link. Even a momentary connection to a 48 VDC power supply without any series resistance will not harm the load. However, prolonged connection to this type of voltage source could damage other internal components of the Linemaster that are in proximity to the load, including possible case meltdown. As with all test equipment, it is best to know what is on the other end of a pair of wires before you terminate them.

2.6 Test Leads

The Linemaster comes equipped with test leads that have miniature alligator clips on one end and an RJ-11 male plug on the other end. The RJ-11 male plugs into the RJ-11 receptacle on the bottom of the Linemaster case. The leads are industry standard coded, with the red lead representing ring or battery and the green lead representing tip or ground. Any other type of modular jack cords may be used with the Linemaster, however, if polarity is important to your application, you should be aware that some modular cords are reversing.

2.7 AC Power Transformer (Optional)

A 120V AC wall-mounted power transformer is available for this unit. The transformer can be used with the batteries installed or in place the batteries. The AC wall-mounted power transformer plugs into any conventional 120V AC receptacle and into the available DC power jack located on the left side of the unit directly above the rotary ON/OFF/Volume control.

SECTION 3: OFF-HOOK THRESHOLD

3.1 General

Before advancing to the features provided by the **DIGIT DISPLAY**, it is important that you understand how the Linemaster determines the line status (on-hook or off-hook) and also captures dial pulses by using a simple voltage comparison.

Most telephone switching systems supply a talk battery within the range of 45-55 VDC. If loop extenders are added, this may increase to as much as 85 VDC. In all of these cases, the telephone instrument only needs 5-6 VDC for adequate operation. The remaining voltage is dropped across the internal resistance of the switching system and the copper wire pair that connect this system to the telephone. The only important component of this equation is the amount of current flowing in the complete loop. Most single-station telephones require at least 20mA for satisfactory operation. Therefore, the amount of voltage that a switch provides is mainly dependent upon the average distance between the switch and the telephone. Once this is understood, it is easy to see why most switches that are located in heavily populated urban areas supply the 45-55 VDC needed for loops of four miles or less, while switches that provide service to rural areas may need loop extenders for loops of up to eight miles, while small town switches and PBX's need only 24 VDC supplies for loops up to 1000 feet.

If a voltage meter is placed across a typical telephone pair, the voltage read in the on-hook state will be the entire supply of the switch due to the fact that the telephone is providing an open in parallel with the meter. When the telephone closes the loop, causing current to flow, the line is now considered off-hook and the voltage read across the line depends entirely on where you are located in the loop. If the supply of a certain switch is 48 VDC and the meter is placed at the point where the outside plant wiring is connected to the switch, the reading taken could be as high as 36-40 VDC due to the fact that the meter is in parallel with the entire loop external to the switch, including the telephone. On the other hand, if the meter is placed directly across the phone at the customer location, the reading could be as low as 5 VDC since only the small resistance of the telephone is in parallel with the meter.

The Linemaster uses exactly this technique to determine the on-hook/off-hook status of the line and to capture dial pulses, which are nothing more than a rapid pattern of on-hook and off-hook transitions called break and make cycles. However, since the Linemaster was designed for use at the switch site, as well as, the customer location, the voltage reference that is compared to the line voltage must be adjustable. This is accomplished by selecting the proper mode option as previously described in Paragraph 2-3.

3.2 CPE vs. CO Settings

As previously described, the Linemaster allows two voltage reference selections. The first option is called CPE (Customer Premise Equipment) which would be used when the Linemaster is located at the end of a loop which is the farthest point from the switch. The reference for this option is 22 VDC. This means that the on-hook voltage must be greater than 22 VDC, while the off-hook voltage must drop below this reference. Since most Linemasters will be used for this application, this option is programmed as the default value and will be selected automatically upon power-up of the unit.

The second option is called CO (Central Office) which would be used when the Linemaster is located at the switch site. The reference for this option is 44 VDC. This means that the on-hook voltage must be greater than 44 VDC, while the off-hook voltage must drop below this level. This option must be selected manually upon power-up of the unit.

Should you wish to change this option after initial selection, you may do so without removing power from the unit by using the two key reset sequence described in Paragraph 2-2. This will reset the options to their defaults.

SECTION 4: DIGIT DISPLAY: TIMING & dB MODE

4.1 Liquid Crystal Display (LCD)

The display consists of two (2) rows of sixteen (16) characters each. Each character is made up of a five by seven dot matrix which provides greater resolution than many LCD's and also allows the use of the full range of standard typewritten characters. This makes the Linemaster's display easy to read and understand.

There are, however, two areas that the LCD is less than perfect. First, the LCD tends to be difficult to read in very bright light, such as sunlight, or in very dim light. Secondly, the LCD is very sensitive to the cold. If the temperature falls below 32 degrees F, you will notice that the display may appear darker that normal when the unit is turned on. As the display warms to room temperature, the normal contrast will return. You should not be overly concerned about exposing the LCD to the cold, as damage would occur only if exposed to temperatures below -40 degrees F for a prolonged period of time.

4.2 Display Format and Operation

As mentioned in Paragraph 4-1, the LCD consists of two (2) rows of sixteen (16) characters per row. The first character of the top row (left) is a location which display one of three special characters. Figure 2 depicts these three characters as they appear in dot matrix form. The first two characters are called Line Status characters with the first example showing the on-hook state and the second example showing the off-hook state. These characters resemble a telephone with the handset moving up and down to indicate line status. As mentioned in Section 3, this character is controlled by a comparison of the voltage across the line with and internal voltage reference that is set by the CPE/CO selection option.

Figure 2

The third character is called Zero Volt and is present in the first space when zero volts of potential exists across the test leads. This symbol will appear when the test leads are not connected to anything, or on idle ground start trunks. This character may also be displayed at other places in a call record, as will be discussed in Section 4-4.

The unique thing about the first space of the top row, in addition to the previously discussed fact that only three characters are ever displayed there, is that those three characters will erase and replace each other in the same space. This behavior will not occur in any other space on the display, since the purpose of the remainder of the display is to capture and retain data about each event that occurs during the progression of a call.

The operation of the display is very similar to a typewriter, with each event character filling the next space to the right. The display cursor (a small line under the character) is left under the last character. This continues until all thirty-one (31) spaces are full, at which point the display software will ceases the accumulation of data and will not "wrap around" or "write over" previously displayed data.

There is one last item that should be mentioned concerning the operation of the display. As you begin to familiarize yourself with the DIGIT DISPLAY, you will notice that each event character is not written to the display until it has finished. This is due to the collection of timing data that will be explained in the next paragraph.

4.3 Event Parameters

Using the example once again of the event characters being written to the display as if they were being typed on a typewriter, imagine that the display software could keep track of the amount of time that each key was held down and the amount of time that elapsed from the point where the last key was released until the next key is pressed. This is exactly what the display software captures for the first fifteen (15) event characters that fill the top row of the LCD. The bottom row is used to display the parameters in three different formats, depending on the type of character that the cursor is sitting under. By using the SCAN key (see Paragraph 4-6), you can view the parameters for each top row character on a space-by-space basis.

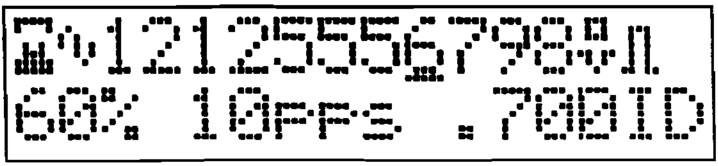


Figure 3

Figure 3 shows a completed call record that consists of fourteen (14) event characters which follow the off-hook status indication and filled spaces 2 through 15 of the top row. If you will notice, the cursor is displayed under the character "6". This means that the information associated with this character is displayed on the bottom row of the LCD . In the case of the "6", the format of the bottom row indicates that this character was transmitted by rotary dial pulse. Had this "6" been transmitted in DTMF, the format of the bottom row would be much different in appearance, as Figure 4 demonstrates.

The information that is captured for rotary dial pulse is: the % of break; (which is the percent of the time the line was broken during on complete break/make cycle), the pulses-per-second (PPS); (which is the number of complete pulse cycles that can be transmitted in one second), and the interdigit time; (which is the time that has elapsed from the end of break period of the sixth pulse of the "6", to the beginning of the break period of the next rotary dial pulse character, or the beginning of an entirely new event). The range of the interdigit timer is 0.001 to 9.9 seconds. In Figure 3, the interdigit time is displayed as .700ID which equals 700/1000th of a second, or 700 milliseconds. NOTE: In the case of a rotary dial pulse "1", the break time is displayed in milliseconds since % of break and PPS can not be calculated for a single break.

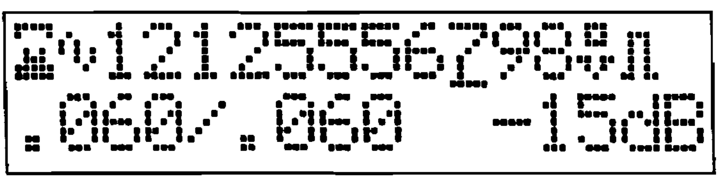


Figure 4

Figure 4 shows the same call record as Figure 3 but the cursor is now under the "7". Once again, the format of the bottom row indicates what method was used to transmit the character, which in the case of the "7", was DTMF.

The information captured for DTMF is: the on/off time; (which is the amount of time that the tone was present on the line, followed by the elapsed time from the end of this tone to the beginning of the next DTMF tone or the beginning of and entirely new event), and the dB level or the tone. The range of the on/off timer is 0.001 to 9.9 seconds. In the above example, both the on and the off times are displayed as .060, which equals 60/1000th of a second, or 60 milliseconds. The range of the dB function is -30 dB to 0 dB (relative) and is displayed in 1dB steps.

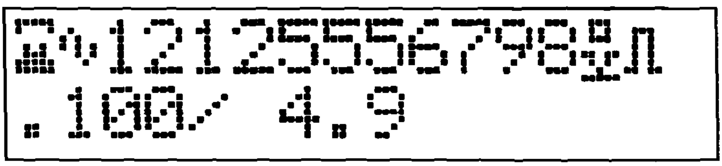


Figure 5

Figure 5, once again, shows the same call record as Figures 3 and 4 but the cursor is now under one of the Linemaster's custom characters, known as the Zero Volt Interval. Since the character is not a tone, no dB level is displayed. Therefore, the only information that can be captured is: the on/off time; (which is the amount of time the Zero Volt Interval was present, followed by the elapsed time between the end of the event and the beginning of the next). The range of the timer is 0.001 to 9.9 seconds. In the above example, the event is displayed as lasting .100, which equals 100/1000th of a second, or 100 milliseconds, while the off time is displayed as 4.9 and is read as 4.9 seconds.

Although many different terms have been used in this section, all of which mean different things depending on the context in which they are used, it is interesting to note that, from an electrical standpoint, the terms "make cycle", "interdigit time", "DTMF off-time" and custom character "off-time" are all identical in function and simply mean that there is a stable DC voltage dropped across the test leads of the Linemaster that is below the off-hook threshold and has no appreciable AC components.

4.4 Custom Characters

As previously mentioned, any character that has a numerical value of 0-9 is a dialed digit that was transmitted in either rotary dial pulse or DTMF. The difference can be determined by the format of the bottom row parameter display. In addition, the DTMF characters *, #, A, B, C, and D are displayed exactly as they appear on the keypad. The other five (5) characters that may appear on the display are custom characters that were created especially for the Linemaster. Each of these characters is created by a specific event that occurs during typical telephone line usage. The definition of each character and the associated event that creates it is as follows:

This is called the **LINE STATUS ON-HOOK.** This occurs whenever the line voltage rises above the OFF-HOOK threshold for at least 150 milliseconds and will continue to be displayed until replaced with one of the next two characters. This character will only be displayed in the first space of the top row.

This is called the **LINE STATUS OFF-HOOK.** This occurs whenever the line voltage falls below the OFF-HOOK threshold for at least 100 milliseconds and will continue to be displayed until replaced by either the ON-HOOK version of this character or the next character. This character will only be displayed in the first space of the top row.

This is called the **ZERO VOLT INTERVAL.** This occurs whenever there is less than 3 volts of potential across the line for at least 50 milliseconds. This character may be present in the first space of the top row if the display has been cleared (see Section 4-7) and the test leads are not connected to anything or are connected to an idle ground start trunk. This character may also be present in any other space on the display which will indicate that the telephone switch battery has been removed from the line. This occurs regularly on most switches just before dial tone is generated or as the call is switched after completion of dialing. This is not the same as the break cycle of a rotary dial pulse which occurs when the line voltage rises above the OFF-HOOK threshold, though no current will flow during either event. The bottom row parameter for this event is shown in Figure 5, with the on-time indicating the length of the event (usually 50-150 milliseconds).

This is called the **LONG PULSE INTERVAL.** The criteria for this event is the same as the LINE STATUS ON-HOOK (above) but it is displayed in the call record at the point where it occurs. This character is usually created by a hook-flash or a legitimate ON-HOOK which may last any length of time. In this second case, you will only see this character if you do not clear the display before a new OFF-HOOK occurs, due to the fact that characters are not displayed until an event ends. The bottom row parameter for this event is shown in Figure 5, with the on-time indicating the length of the event. Frequently, this time will be shown with an up-arrow in front of 9.9 seconds, since this is the limits of the timer.

This is called the **IN-BAND TONE INDICATOR.** The criteria for this event is the presence of any non-DTMF tone on the line for at least 500 milliseconds, that is between 300-3000 Hz and has a level of at least -24 dB which does not fluctuate more than 3 dB. This character is usually created by dial tone or ring back. In this second case, the software will not allow consecutive characters of this type to be displayed next to each other. Instead a single character will be shown but as soon as the first tone has ended, the on/off time of the bottom row parameter will begin to toggle back-and-forth with each new ring. This feature keeps the display from being filled with ring-back signals. The format for the bottom row parameter is the same as for DTMF, as shown in Figure 4, with the on/off time indicated for the last cycle only.

4.5 CLEAR Key

This key has several uses that have already been described in Section 2. However, the primary function of this key is to clear the display of all data that was captured for the last call record. Simply press this key once and the display will be cleared except for the first space of the top row which always indicates the current line status.

4.6 SCAN Key

Until now, the DIGIT DISPLAY has been discussed in terms of "real time". While it is true that this feature operates with only a slight delay that is caused by the need to wait for timing data, many events simply occur too fast to allow the bottom row of parameters to be adequately reviewed. By using the SCAN key, you can review previously stored data during the progress of a call or after completion.

As described, the cursor rests under the last character that is displayed, with the bottom row of the display indicating the parameters for this individual character. The SCAN key moves the cursor one space each time it is depressed, moving left to right. Upon reaching the last space of the top row it will move to the first space of the bottom row and then return to the second space of the top row, at which time the parameters for that character will re-appear on the bottom row. If the display is not completely full, the cursor will skip all empty spaces for faster return. If you use the SCAN key while a call is still in progress, you will notice that new characters are written to the display in proper sequence, but the cursor will remain where you placed it, with the new parameters for that character displayed on the bottom row of the LCD. The parameters associated with these new characters that are displayed during the SCAN process have not been lost but have been placed into memory. To view these parameters, simply move the cursor under each character and they will appear on the bottom row.

As you may have noticed, the complete cursor cycle around the LCD seemed to stop on the fist space of the bottom row without reason. If you will recall, the complete cycle is only required if the display is completely full. Up until now, we have discussed this top row as displaying events characters and the bottom row displaying event parameters only. While this is true for the first fifteen (15) characters (full top row), the bottom row serves a second purpose should a sixteenth character be created. If this occurs, the bottom row will begin to display event characters until full (16 characters). However, no parameters are capture for these bottom row characters. This is why the cursor stops at the first space on the bottom row. Since these characters have no parameters associated with them, there is no need for the cursor to move under each one. Instead, it simply stops at the first space and displays the entire row of characters before returning to the top row.

4.7 dB Meter

As previously described, the **DIGIT DISPLAY** mode indicates the dB level of DTMF and other in-band tones, which are displayed in 1 dB steps. Since this display mode is in real time, tones can only be sampled for level at one point in time, due to the fact that their eventual length is unknown. Therefore, accuracy suffers somewhat when extremely fast readings are required. For more accurate readings of tones that have longer duration, or are constant, use the **dB METER** function of the Linemaster.

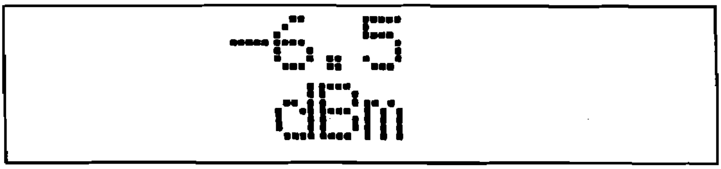


Figure 6

The **DIGIT DISPLAY** and **dB METER** functions are interactive, which means you may move from one function to another without losing any data. The **DIGIT DISPLAY** will continue to collect and store events while you are in the **dB METER** mode, which can be reviewed via the **SCAN** key upon returning to **DIGIT DISPLAY**.

To access the **dB METER** function, depress and hold the **SCAN** key for two (2) seconds. Figure 6 indicates the format of this display which will read tones from -40 dB to +6 dB in 0.5 dB steps. As mentioned in Paragraph 2-4, the term "dBm" refers to a reading taken across a precise 600 ohm load, such as that built into the Linemaster. If a reading is taken across an unknown load, then this must be considered as "dBr" (relative), even though the Linemaster is displaying the dBm indication.

SECTION 5: DIGIT DISPLAY: WRAPAROUND MODE

This mode was included at the request of certain customers who needed to monitor long streams of data that are transmitted in DTMF, such as memory "dumps" from dialers or call records from payphones, etc. Upon selection of this mode option (see Paragraph 2-3) you will note that the display appears the same as the Timing & dB mode when cleared. However, as event characters begin to fill the top row of the display, no event parameters are displayed on the bottom row. When the top row is full, the bottom row is used for event characters, which is typical of the Timing & dB mode. The big difference between the two modes occurs when the bottom row is full. At this point, the display performs a "line feed", which moves all characters from the bottom row to the top row (this act also erases the custom hook-status character from the first space of the top row). Now characters are written to the bottom row only, with each full line creating another line feed.

The display may be cleared at anytime by using the CLEAR key. The SCAN key serves no purpose in this mode and the dB meter be can not be accessed.

SECTION 6: 1004 HZ TONE GENERATOR

This function is activated by depressing the lower of the two push button switches located on the right side of the unit (see Figure 1). When the button is depressed, it will lock in the ON position and the tone will be heard through the loudspeaker. The volume at which the tone is heard depends on the setting selected by the ON/OFF/VOLUME control, which controls the "playback" volume only. The level at which the tone is broadcast on the line is NOT controlled and is preset at the factory to 0 dBm (+/- 0.15 dBm).

When using the unit to broadcast this tone, the 600 ohm load should be in the OFF position to allow the receiving unit to terminate the line with a similar 600 ohm load. The reading taken by the receiving unit can be expressed as "dB of loss" (i.e., a reading of -3.5 dBm equates to 3.5 dB of loss on the circuit). Should the sending unit be in the dB meter mode, any reading taken will be irrelevant due to the fact that the total load resistance is unknown (i.e., the 600 ohm load of the receiving plus *n* feet of cable equals ?).

This tone source may be used on "dry pairs" or DC loops with the same results. However, on DC loops, the battery source should not present a load to the line or the load value must be a known value. In the latter case, a thorough knowledge of Ohms Law and the dB scale will be necessary to calculate a meaningful reading.

To de-activate this feature, depress the push button switch slightly, which will cause it to release to the OFF position.

SECTION 7: SPECIFICATIONS

7.1 Electrical Characteristics

1. DC resistance - Monitor (600 ohm load-out)	> 1.7M ohms
2. AC impedance - Monitor (600 ohm load-out)	> 1.7M ohms
3. DC resistance - 600 ohm load-in	600 ohms +/- 1%
4. AC impedance - 600 ohm load-in	600 ohms +/- 1%
5. Ringer Equivalency	0.0 dB

7.2 Digit Display Function

1. Min. DTMF receive time	40 mS
2. Min. DTMF receive level	-30 dBm
3. Max. DTMF receive level	0 dBm
4. Max. Twist	+/- 10 dB
5. Max. Frequency Deviation	+/- 1.5% or -2 Hz
6. DTMF display On/Off time range	30 mS to 9.9 S
7. Min. Dial Pulse receive rate	5 PPS
8. Max. Dial Pulse receive rate	20 PPS
9. Min. Dial Pulse receive break %	50%
10. Max. Dial Pulse receive break %	75%
11. Min. Dial Pulse receive interdigit time	100 mS
12. Min. In-Band tone presence	300 mS
13. Min. In-Band tone level	-30 dBm
14. Max. In-Band tone fluctuation	2 dB or less
15. Min. Long Pulse (hookflash) presence	150 mS
16. Min. Zero Volt (wink) presence	50 mS
17. Off-Hook/Dial Pulse threshold	Software selectable for 22 VDC (CPE) or 44 VDC (CO)

7.3 dB Meter

1. Calibration	dBm if across 600 ohm load
2. Scale	-40 dB to +6 dB
3. Display Increments	0.5 dB steps
4. Accuracy	+/- 0.5 dB

7.4 1004 Hz Tone Generator

1. Frequency	1004Hz - precise
2. Level	0 dBm across 600 ohm load +/- 0.15 dBm

7.5 Physical

1. Size	7.0" x 3.9" x 1.4"
2. Weight	16 oz
3. Case Material	High Impact ABS
4. Test Leads	4' with mini-alligator clips
5. Battery Type	1.5 VDC "AA" type (4 req'd)
6. Carrying Case	Double wall, foam lined polyethylene

Specifications subject to revision without notice
All specifications at 20 degrees C (68 degrees F)

WARRANTY

NOTWITHSTANDING ANY PROVISION OF ANY AGREEMENT THE FOLLOWING IS EXCLUSIVE:

Ziad, Inc. warrants each instrument it manufacturers to be free from defects in material and workmanship under normal use and service for the period of 180 days from the date of purchase. This warranty extends only to the original purchaser. This warranty shall not apply to fuses, disposable batteries or any other product or parts which have been subject to misuse, neglect, accident or abnormal conditions of operations.

In the event of failure of a product covered by this warranty, Ziad, Inc. will repair and calibrate an instrument returned to an authorized service facility within 180 days of the original purchase provided the warrantor's examination discloses to its satisfaction that the product was defective. The warrantor may, at its option, replace the product in lieu of repair. With regard to any instrument returned with 180 days of the original purchase, said repairs or replacement will be made without charge. If the failure has been caused by misuse, neglect, accident, or abnormal conditions of operations, repairs will be billed at a nominal cost. In such case, an estimate will be submitted before work is started, if requested.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS OR ADEQUACY FOR ANY PARTICULAR PURPOSE OR USE. ZIAD, INC. SHALL NOT BE LIABLE FOR ANY SPECIAL INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER IN CONTRACT, TORT, OR OTHERWISE.

If any failure occurs, the following steps should be taken:

1. Notify Ziad, Inc., or nearest service facility, giving full details of the difficulty, and include the model number, type number, and detail number.

2. On receipt of the Return Merchandise Authorization (RMA), forward the instrument, transportation prepaid. Repairs will be made at the service facility and the instrument returned, transportation prepaid.

SHIPPING TO MANUFACTURER FOR REPAIR OR ADJUSTMENT:

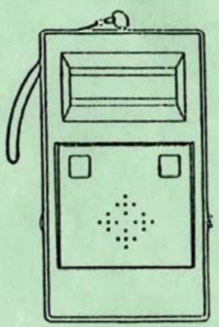
All shipments of Ziad, Inc. instruments should be made via United Parcel Service or "Best Way" prepaid. The instrument should be shipped in its original packing carton, or if not available, use any suitable container that is rigid and of adequate size. If a suitable container is not used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT TO ORIGINAL PURCHASER:

The instrument should be thoroughly inspected immediately upon original delivery to purchaser. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument is damaged in any way, a claim should be filed with the carrier immediately. Final claim and negotiations with the carrier must be completed by the customer.

LINE MASTER™

OPERATOR'S MANUAL



Ziad INC

262 HANOVER ST.
COLUMBUS, OHIO 43215
614-464-1900

TABLE OF CONTENTS

(Rev.-A 4/88)

SECTION 1 - GENERAL

1-1 Introduction

The Linemaster is a compact, portable line-monitoring device. It is connected in parallel to a telephone line or trunk pair and bridges that pair with an extremely high DC resistance/AC impedance, which makes it virtually "invisible." The primary function of the Linemaster is the monitoring of line activity via Ziad,'s exclusive DIGIT DISPLAY feature. This feature captures and displays the values of all tone and pulse dialed digits, including on/off time and dB levels (for tones) or % break, pulses-per-second and interdigit tone (for pulses). The DIGIT DISPLAY also monitors the line status (on-hook/off-hook), zero volt or wink intervals and non-DTMF voice band tones.

The Linemaster also contains an amplified audio monitor with volume control, which provides easier monitoring than conventional butt-sets, particularly when prolonged use is required.

A switchable 600 Ohm load is also built-in to the unit to allow for precise dBm measurements or to simply terminate the line to verify a "live" pair.

1-2 Unpacking the Unit

Each Linemaster is shipped from the factory in a corrugated carton that contains an inner carton made of high-impact double-wall plastic. This foam lined plastic case is designed to be used as a permanent carrying case for the unit. The Linemaster is a complex, microprocessor based, electronic device and should be treated accordingly. We strongly suggest that the unit be kept in its carrying case when not in use. Also included with each Linemaster is one set of batteries, type AA alkaline and this manual. Please check to make sure all items were shipped with the unit before proceeding.

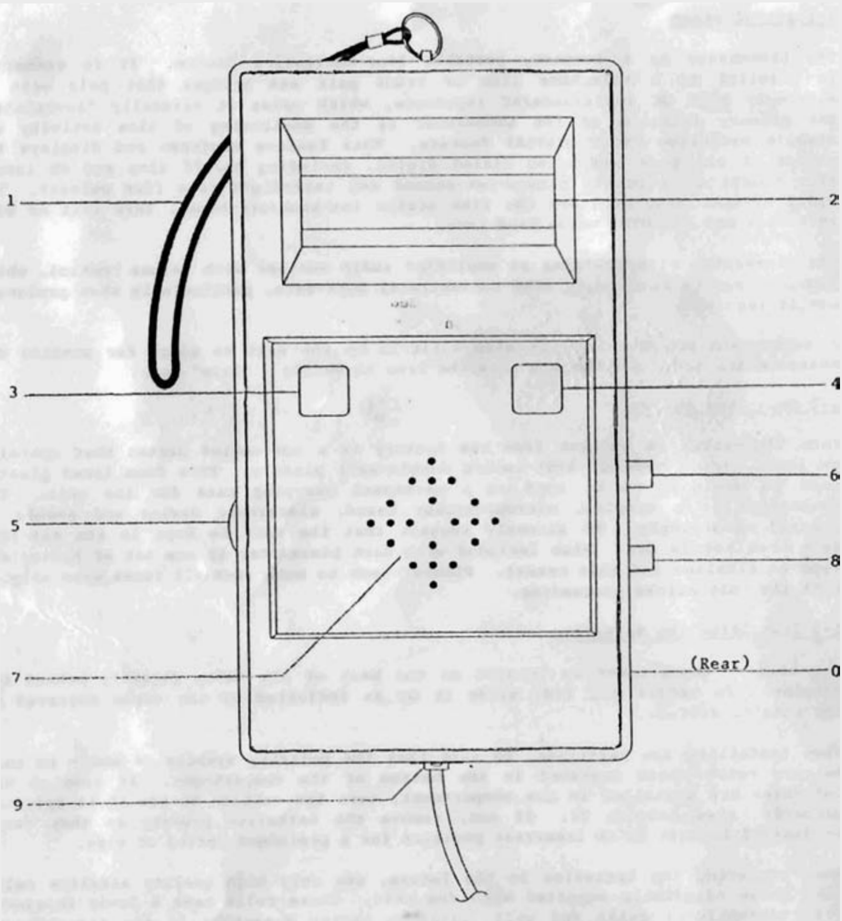
1-3 Installing the Batteries

The battery compartment is located on the back of the unit, directly behind the display. To remove the lid, slide it up as indicated by the arrow engraved on the outside surface.

When installing the batteries, be sure that the polarity symbols (+ and - on each battery match those engraved in the bottom of the compartment. As soon as the batteries are installed in the compartment, turn the unit on to see if it operates properly (See Section 2). If not, remove the batteries prompty as they could be damaged if left in an incorrect position for a prolonged period of time.

When replacing the batteries in the future, use only high quality alkaline cells like those originally supplied with the unit. These cells have a lower impedance than conventional cells and will guarantee better operation of the Linemaster's sensitive audio circuits. In addition, alkaline cells are generally cheaper on a per-hour basis.

Never leave discharged batteries in the Linemaster for prolonged periods of time as they may leak and damage the unit. If lengthy storage of the Linemaster is required, remove the batteries regardless of age or charge.



1. Hanger Strap
2. Liquid Crystal Display (LCD)
3. Clear Key
4. Scan Key
5. On-Off/Volume Control
6. 600 Ohm Load Switch
7. Loudspeaker
8. 1004 HZ Tone Switch
9. RJ-11 Jack (Female)
0. Battery Compartment & Tilt Stand

SECTION 2 - BASIC OPERATION

2-1 Power-On Sequence

Before turning the Linemaster on, take several minutes to acquaint yourself with the location of each item shown in Figure 1. Once you have done this, turn the Linemaster on by rotating the thumbwheel **ON-OFF/VOLUME** control, located on the left side of the unit (display facing you), down or counter-clockwise. You should immediately hear a positive "click" from the thumbwheel control which indicates the **ON** position has been reached. You need not rotate this control any further at this point. As soon as power is applied to the unit, the sign-on messages should appear on the Liquid Crystal Display (LCD). There are two (2) messages in all, lasting one (1) second each. These messages will appear as follows:

LineMASTER™ ⟶ BATTERY SUPPLY
by Ziad, Inc. IS OKAY

If these messages are not displayed immediately, depress the **CLEAR** key. If the unit still fails to produce the sign-on messages, check the batteries for proper polarity and repeat the above steps.

2-2 Battery Low Indication

If the second of the two sign-on messages appears as "BATTERY SUPPLY IS LOW" instead of "BATTERY SUPPLY IS OKAY" as previously described, this is an indication that the batteries have discharged sufficiently to trip a circuit within the Linemaster which creates the above message. This should occur when the battery voltage has dropped to approximately 4.75 VDC. The unit should continue to operate for some time after the first appearance of this indication. While no absolute guarantee can be given as to the actual time left in the batteries, nor the accuracy of the meter functions in the low battery state, experience to date has shown that the majority of units will continue to exhibit more than enough accuracy for telecommunications testing with as low as 4.2 VDC. The time required to discharge from 4.75 to 4.2 VDC varies with the use of the Linemaster's features but should be in the 4 to 6 hour range. The largest consumption of current is associated with the audio monitor. For longer battery life, select the lowest volume possible for each application.

To view the battery status at any time without turning the Linemaster OFF and ON again, simply press and hold the **SCAN** key, press and release the **CLEAR** key, then release the **SCAN** key. This will generate the sign-on messages as previously described. This two-key sequence can also be used to re-set the microprocessor at any time. Although this should rarely be needed, past experience has demonstrated some "brown-out" problems as certain functions are selected which require more current from batteries that are already in the "low battery" state. Symptoms of this condition would be the failure of the LCD to change displays when various modes are selected, or the failure of the **CLEAR** key to re-set the display.

2-3 Audio Monitor

The Audio Monitor is automatically switched on when the **ON-OFF**/Volume control is moved to the On position. Volume may then be controlled by either up or down rotation as desired. This feature allows for monitoring of line activity in a hands-free mode and has ample volume to be heard up to 10 feet or more. However, to achieve this level of volume, the internal amplifier <u>is not</u> top-end limited and is capable of reproducing very loud tones at levels that could cause hearing damage if the speaker is placed directly to the ear. Therefore, this type of useage <u>is not</u> recommended.

2-4 Mode Selections

Immediately following the BATTERY SUPPLY IS OKAY/LOW message, the Linemaster will allow you to select several modes of operation. The first selection option is between TIMING & dB or WRAPAROUND modes. (The features provided by each mode will be discussed in detail in later sections). Selection of the desired mode is accomplished by depressing the SCAN key to toggle between modes, while the CLEAR key is used to enter the displayed selection and to move to the next display. This procedure can be graphically represented as follows:

```
DISPLAY MODE:  1  SCAN    (Change)    DISPLAY MODE:  2
TIMING & dB      <----------->        WRAPAROUND
   |                                     |
CLEAR  (enter)                         CLEAR  (enter)
   |                                     |
   v                                     v
Second Selection Option                Second Selection Option
```

Since the TIMING and dB mode is the most commonly used feature, this is already selected as a default value and is automatically displayed. If you do not need to change this mode, the Linemaster will timeout in 6 seconds, skip the second mode selection display and proceed to the main Digit Display function. If you do not wish to change TIMING & dB to WRAPAROUND but wish to change the second mode selection, you must depress the CLEAR key to progress to the display.

The second selection option is between off-hook threshold levels of CPE, which is less than 22 VDC and CO which is less than 44 VDC. The procedure to change this option and proceed to the next display (main Digit Display function) is identical to the first selection option above. This procedure can be graphically represented as follows:

```
Threashold:  CPE   SCAN  (change)     Threshold:  CO
OFFHOOK      22V  <----------->       OFFHOOK     44V
   |                                     |
CLEAR  (enter)                         CLEAR  (enter)
   |                                     |
   v                                     v
Digit Display                          Digit Display
```

2-5 600 Ohm Load

The Linemaster has a built-in, switchable 600 Ohm load which has several uses. The primary use would be to terminate a line or trunk in order to read dB as dBm. To use this load for this function, use some other device that is capable of dialing (Butt-set, etc.) to reach the desired test tone. At this point, simply move the 600 Ohm load switch to the IN position and disconnect the device used for dialing. The dB meter of the Linemaster can now be used to read the level of the tone, which can now be expressed as true dBm. This switch can also be used to answer a ringing line for the same purpose. In either case, be sure that the sole termination of the line is the 600 Ohm load of the Linemaster. If this load is placed in parallel with another terminating device (PBX, key system, dialer, Butt-set, etc) the load presented to the line will equal something less than 600 Ohms and the reading taken by the Linemaster will not be an accurate dBm reading.

Another use for this load is to "pull dial tone" for the purpose of looking for "live" pairs. The combination of the 600 Ohm load and the audio monitor allows the Linemaster to be used hands-free for this function.

The electrical components of this load are strictly resistive (per AT&T technical specifications) and as such exhibit the same DC resistance and AC impedance. In addition, a resistive 600 Ohm load will remain a constant value regardless of frequency. However, some caution is required when using this load to prevent damage due to excessive heat dissipation. The maximum power handling capacity of this load is 6 watts, which is so excessive for the typical use of the Linemaster that it was considered unnecessary to fuse this link. Even a momentary connection to a 48 VDC power supply without any series resistance will not harm the load. However, prolonged connection to this type of voltage source could damage other internal components of the Linemaster that are in proximity to the load, including possible case meltdown. As with all test equipment, it is best to know what is on the other end of a pair of wires before you terminate them.

2-6 Test Leads

The Linemaster comes equipped with test leads that have miniature alligator clips on one end and an RJ-11 male plug on the other end, which plugs into the RJ-11 female jack on the bottom of the Linemaster case. The leads are industry standard coded, with the red lead representing ring or battery and the green lead representing tip or ground. Any other type of modular jack cords may be used with the Linemaster, however, if polarity is important to your application, you should be aware that some modular cords are reversing and should plan accordingly.

SECTION 3 - Off-Hook Threshold

3-1 General

Before advancing to the features provided by the **DIGIT DISPLAY**, it is important that you understand how the Linemaster determines the line status (on or off-hook) and also captures dial pulses by using a simple voltage comparison.

Most telephone switching systems supply a talk battery within the range of 45-55 VDC. If loop extenders are added, this may increase to as much as 85 VDC. In all of these cases, the telephone instrument only needs 5 or 6 VDC for adequate operation. The remaining voltage is dropped across the internal resistance of the switching system and the copper wire pair that connects this system to the telephone. The only important component of this equation is the amount of current flowing in the complete loop. Most single-station telephones require at least 20mA for satisfactory operation. Therefore, the amount of voltage that a switch provides is mainly dependent upon the average distance between the switch and the telephone. Once this is understood, it is easy to see why most switches that are located in heavily populated urban areas supply the 45-55 VDC needed for loops of four (4) miles or less, while switches that provide service to rural areas may need loop extenders for loops of up to eight (8) miles, with small town switches and PBXs needing only 24 VDC supplies for loops of 1000 feet or so.

If a voltage meter is placed across a typical telephone pair, the voltage read in the on-hook state will be the entire supply of the switch due to the fact that the telephone is providing an open in parallel with the meter. When the telephone closes the loop, causing current to flow, the line is now considered off-hook and the voltage read across the line depends entirely on where you are located on the loop. If the supply of a certain switch is 48 VDC and the meter is placed at the point where the outside plant wiring is connected to the switch, the reading taken could be as high as 36-40 VDC due to the fact that the meter is in parallel with the entire loop external to the switch, including the telephone. On the other hand, if the meter is placed directly across the phone at the customer location, the reading could be as low as 5 VDC since only the small resistance of the telephone is in parallel with the meter.

The Linemaster uses exactly this technique to determine the on-hook/off-hook status of the line and to capture dial pulses, which are nothing more than a rapid pattern of on and off-hook transitions called break and make cycles. However, since the Linemaster was designed for use at the switch site as well as the customer location, the voltage reference that is compared to the line voltage must be adjustable. This is accomplished by selecting the proper mode option as previously described in Paragraph 2-3.

3-2 CPE vs. CO Settings

As previously described, the Linemaster allows two voltage reference selections. The first option is called **CPE** (Customer Premise Equipment) which would be used when the Linemaster is located at the end of a loop which is the farthest point from the switch. The reference for this option is 22 VDC. This means that the on-hook voltage must be greater than 22 VDC, while the off-hook voltage must drop below this reference. Since most Linemasters will be used for this application, this option is pre-programmed as the default value and will be selected automatically upon power-up, unless changed.

The second option is called **CO** (Central Office) which would be used when the Linemaster is located at the switch site. The reference for this option is 44 VDC. This means that the on-hook voltage must be greater than 44 VDC, while the off-hook voltage must drop below this option. This option must be selected upon power-up of the unit.

Should you wish to change this option (or the Timing & dB/Wraparound) after initial selection, you may do so without removing power from the unit by using the two-key reset sequence described in Paragraph 2-2. This will re-set options to their default values.

SECTION 4 - DIGIT DISPLAY - TIMING & dB Mode

Note: If you are already familiar with Ziad's PHD Telecommunicator, you will find this entire section to be an exact duplication of the PHD manual, with the the following exception:

1) When the display is clear and one of the three custom characters (on-hook, off-hook or zero volt) is present in the first space of the top row, the name of that character is displayed as a message across the top row ("on-hook", "off-hook", or "Zero Volt"). At the same time, the bottom row is used to provide a line polarity indication ("Normal Polarity" or "Reverse Polarity"). These messages appear each time the display is cleared and are erased when the first event character is written to the display.

2) The dB **BARGRAPH** of the PHD has been replaced in the Linemaster with a **dB** meter. The differences are explained in detail in a later section.

4-1 LCD (Liquid Crystal Display)

This display consists of two (2) rows of sixteen (16) characters each. Each character is made up of five (5) by seven (7) dot matrix which provides for greater resolution than many LCDs and also allows the use of the full range of standard typewritten characters, which makes it easy to read and understand. Several of the other digit analyzers on the market use a seven (7) segment display which is basically limited to the characters 1 through 0. As an example of the disadvantages of this type display, consider that the DTMF character "#" must be displayed as a "C". By contrast, the Linemaster displays all DTMF characters exactly as they appear on the telephone keypad. In fact, the LCD used in the Linemaster is so versatile that it contains five (5) custom characters that were created specifically for the unit. These will be described in detail in a later paragraph in this same section.

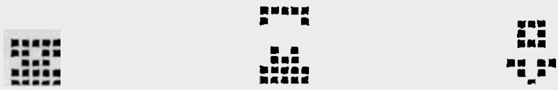
There are, however, several things that make LCDs in general, less than perfect. First, they tend to be slightly difficult to read in very bright light, such as sunlight, or in very dim light. Even in correct lighting, the angle of the light to the display may cause a glare, while the angle of the display to you may cause it to appear rather dark. Although there is no total cure for this problem, the Linemaster employs some new technology in photochemically treated plastics in the display cover window, which helps a great deal.

The second problem involves the LCD's sensitivity to cold. If you leave the Linemaster in your car overnight and the temperature falls below 32°F, you will notice that the display may appear darker than normal when the unit is turned on. As the display warms up to room temperature, the normal contrast will return. You should not be concerned about exposing the LCD to cold, as damage would occur only if exposed to a temperature below -40°F for a prolonged period of time.

4-2 Display Format and Operation

As mentioned in paragraph 4-1, the LCD consists of two (2) rows of sixteen (16) characters each. The first space of the top row (left) is special and the three (3) characters that appear in this space behave somewhat differently from other characters in other spaces. Figure 2 depicts these three characters as they appear in true dot matrix form. The first two examples are collectively called the Line Status character with the first example showing the on-hook state and the second example showing the off-hook state. As you can see, this character resembles a telephone with the handset moving up and down to indicate line status. As mentioned in Section 3, this character is controlled by a comparison of the voltage across the line with an internal voltage reference that is set by the CPE/CO selection option.

Figure 2



The third character is called Zero Volt and is present in the first space when zero volts of potential exists across the test leads. This will occur when the test leads are not connected to anything, or on idle ground start trunks. This character may also be displayed at other places in a call record, as will be discussed in a later paragraph.

The unique thing about the first space of the top row, in addition to the previously discussed fact that only three characters are ever displayed there, is that those three characters will erase and replace each other in the same space. This behavior will not occur at any other space on the display, since the purpose of the remainder of the spaces is to capture and retain data about each event that occurred during the progression of a call.

The operation of this display is very much like a typewriter, with each event character filling the next space to the right. The display cursor (a small line under the character) is left under the last character that was displayed, until the next event creates the next character. This continues until all thirty-one (31) spaces are full, at which point the display software will cease the accummulation of data and will not "wrap around" or "write over" previously displayed data.

There is one last item that should be mentioned concerning the operation of the display. As you begin to familiarize yourself with the DIGIT DISPLAY, you will notice that each event character is not written to the display until it has finished. This is due to the collection of timing data that will be explained in the next paragraph.

4-3 Event Parameters

Using the example once again of the event characters being written to the display as if they were being typed on a typewriter, imagine that the display software could keep track of the amount of time that each key was held down and the amount of time that elapsed from the point where the last key was released until the next key was pressed. This is exactly what the display software captures for the first fifteen (15) event characters that fill the top row of the LCD. The bottom row is used to display these parameters in three different formats, depending on the type of character that the cursor is sitting under. By using the SCAN key (see paragraph 4-6), you can view the parameters for each top row character on a space-by-space basis.

Figure 3

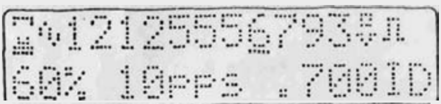


Figure 3 shows a completed call record that consists of fourteen (14) event characters which follow the off-hook status indication and fill spaces 2 through 15 of the top row of the LCD. If you will notice, the cursor is under the character 6. This means that the information associated with this character is currently displayed on the bottomm row of the LCD. In the case of the 6, the format of the bottom row indicates that this character was transmitted in rotary dial pulse. Had this 6 been transmitted in DTMF, the format of the bottom row would be much different in appearance, as the next example (Figure 4) will demonstrate.

The information that is captured for rotary dial pulse is: % of break, which is the % of the time the line was broken during one complete break/make cycle, the pulses-per-second, which is the number of complete pulse cycles that can be transmitted in one second, and the interdigit time, which is the time that elapsed from the end of the break period of the sixth pulse of the 6, to the beginning of the break period of the next rotary dial pulse character, or the beginning of an entirely new event character. The range of the interdigit timer is .001 to 9.9 seconds. In the above example, this time is displayed as .700, which equals 700/1000ths of a second, or 700 milliseconds. Note: In the case of a rotary dial pulse 1, the break time is displayed in milliseconds since % break and PPS cannot be calculated for a single break.

Figure 4

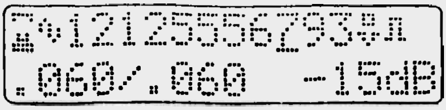


Figure 4 shows the same call record as Figure 3 but the cursor is now under the 7. Once again, the format of the bottom row indicates what method was used to transmit the character, which in the case of the 7, was DTMF.

The information that is captured for DTMF is: on/off time, which is the amount of the time that the tone was present on the line, followed by the elapsed time from the end of this tone to the beginning of the next DTMF tone or the beginning of an entirely new event, and the dB level of the tone. The range of the on/off timer is .001 to 9.9 seconds. In the above example, both the on and the off times are displayed as .060, which equals 60/1000ths of a second, or 60 milliseconds. The range of the dB function is -30 to OdB (relative) and is displayed in 1dB steps.

Figure 5

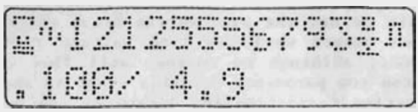
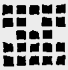


Figure 5, once again, shows the same call record as Figures 3 and 4 but the cursor is now under one of the LM's custom characters, known as the Zero Volt Interval. Since this character is not a tone, no dB level is displayed. Therefore, the only information that can be captured is: on/off time, which is the amount of time that the Zero Volt Interval was present, followed by the elapsed time between the end of the event and the beginning of the next. The range of this timer is .001 to 9.9 seconds. In the above example, the event is displayed as lasting .100, which equals 100/1000ths of a second, or 100 milliseconds, while the off time is displayed as 4.9 and is read as 4.9 seconds.

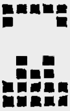
Although many different terms have been used in this section, all of which mean different things depending on the context in which they are used, it is interesting to note that, from an electrical standpoint, the terms "make cycle", "interdigit time"," DTMF off-time" and custom character "off-time" are all identical in function and simply mean that there is a stable DC voltage dropped across the test leads of the LM that is below the off-hook threshold and has no appreciable AC component.

4-4 Custom Characters

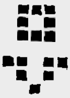
As previously mentioned, any character that has a numerical value of 1-0 is a dialed digit that was transmitted in either rotary dial pulse or DTMF. The difference can be determined by the format of the bottom row parameter display. In addition, the DTMF characters *, #, A,B,C and D are displayed exactly as they appear on the keypad. The other five (5) characters that may appear on the display are custom characters that were created especially for the LM. Each of these characters is created by a specific event that occurs during typical telephone line usage. The definition of each character and the associated event that creates it is as follows:



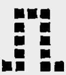
This is called the LINE-STATUS-ON-HOOK. This occurs whenever the line voltage rises above the OFF-HOOK threshold for at least 150 milliseconds and will continue to be displayed until replaced with one of the next two characters. This character will only be displayed in the first space of the top row.



This is called the LINE-STATUS-OFF-HOOK. This occurs whenever the line voltage falls below the OFF-HOOK threshold for at least 100 milliseconds and will continue to be displayed until replaced by either the ON-HOOK version of this characater (above) or the ZERO VOLT INTERVAL (next). This character will only be displayed in the first space of the top row.



This is called the ZERO VOLT INTERVAL. This occurs whenever there is less than 3 volts of potential across the line for at least 50 milliseconds. This character may be present in the first space of the top row if the display has been cleared (See 4-7) and the test leads are not connected to anything or are connected to an idle ground start trunk. This character may also be present at any other space on the display which will indicate that the telephone switch battery has been removed from the line. This occurs regularly on most switches just before dial tone is generated or as the call is switched after completion of dialing. This is not the same as the break cycle of a rotary dial pulse which occurs when the line voltage rises above the OFF-HOOK threshold, although no current will flow during either event. The bottom row parameter for this event is shown in Figure 5, with the on-time indicating the length of the event (usually 50-150 milliseconds).



This is called the LONG PULSE INTERVAL. The criteria for this event is the same as the LINE STATUS ON-HOOK (above) but it is displayed in the call record at the point where it occurred. This character is usually created by a hook-flash or a legitimate ON-HOOK which may last any length of time. In this second case, you will only see this character if you do not clear (see paragraph 4-7) the display before a new OFF-HOOK occurs,due to the fact that characters are not displayed until an event ends. The bottom row parameter for this event is shown in Figure 5, with the on-time indicating the length of the event. Frequently this time will be shown with an up-arrow in front of 9.9 seconds, since this is the limit for this timer.

This is called the IN BAND TONE INDICATOR. The criteria for this event is the presence of any non-DTMF tone on the line for at least 500 milliseconds, that is between 300-3000 HZ and has a level of at least -24dB which does not fluctuate more than 3dB. This character is usually created by dial tone or ring back. In this second case, the software will not allow consecutive characters of this type to be displayed next to each other. Instead, a single character will be shown but as soon as the first tone has ended, the on-off time of the bottom row parameter will begin to toggle back-and-forth with each new ring. This feature keeps the display from being filled with ring-back signals. The format for the bottom row parameter is the same as for DTMF, as shown in Figure 4, with the on-off time indicated for the last cycle only.

4-5 CLEAR KEY

This key has several uses that have already been described in Section 2. However, the primary function of this key is to clear the display of all data that was captured for the last call record. Simply press this key once and the display will be erased except for the first space of the top row which always indicates the current line status.

4-6 SCAN KEY

Until now, the DIGIT DISPLAY has been discussed in terms of "real time." While it is true that this feature operates with only a slight delay that is caused by the need to wait for timing data, many events simply occur too fast to allow the bottom row parameters to be adequately reviewed. By using the SCAN key, you can review previously stored data during the progress of a call or after completion.

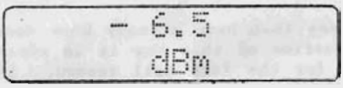
As previously described, the cursor rests under the last character that is displayed, with the bottom row of the LCD indicating the parameters for this character. The SCAN key moves the cursor one space each time it is depressed, moving left to right. Upon reaching the last space of the top row, it will move to the first space of the bottom row and then return to the second space of the top row, at which time the parameters for that character will re-appear on the bottom row. If the display is not completely full, the cursor will skip all empty spaces for a faster return. If you use the SCAN key while a call is still in progress, you will notice that new characters are written to the display in proper sequence, but the cursor will remain where you placed it, with the parameters for that character displayed on the bottom row of the LCD. The parameters associated with these new characters that are displayed during the SCAN process have not been lost but have been placed in memory. To view these parameters, simply move the cursor under each character and they will appear on the bottom row.

As you may have noticed, the complete cursor cycle around the LCD seemed to stop on the first space of the bottom row without reason. If you will recall, this complete cycle is only required if the display is "completely full." Up until now, we have discussed this top row as displaying event characters and the bottom row as displaying event parameters only. While this is true for the first fifteen (15) characters (full top row), the bottom row serves a second purpose should a sixteenth (16th) character be created. If this occurs, the bottom row will begin to display event characters until full (16 characters). However, no event parameters are captured for these bottom row characters. This is why the cursor only stops at the first space of the bottom row. Since these characters have no parameters associated with them, there is no need for the cursor to move under each one. Instead, it simply stops at the first space and displays the entire row of characters before returning to the second space of the top row.

4-7 dB Meter

As previously described, the Digit Display mode indicates the dB level of DTMF and other in-band tones, which are displayed in 1 dB steps. Since this display mode is in real time, tones can only be sampled for level at one point in time, due to the fact that their eventual length is unknown. Therefore, accuracy suffers somewhat when extremely fast readings are required. For more accurate readings of tones that have longer durations, or are constant, use the dB meter function of the Linemaster.

Figure 6



The Digit Display and dB meter functions are interactive, which means you may move from one function to another without losing any data. The Digit Display will continue to collect and store events while you are in the dB meter mode, which can be reviewed via the SCAN key upon returning to Digit Display

To access the dB meter function, depress and hold the SCAN key for 2 seconds. Figure 6 indicates the format of this display which will read tones from -40 to + 6 dBm in .5dB steps. As mentioned in paragraph 2-4, the term "dBm" refers to a reading taken across a precise 600 Ohm load, such as that built in to the Linemaster. If a reading is taken across an unknown load, then this must be considered as "dBr" (relative), even though the Linemaster is displaying the dBm indication.

To exit this mode and return to Digit Display, simply depress the SCAN key normally.

SECTION 5 - DIGIT DISPLAY - WRAPAROUND

This mode option was included at the request of certain customers who need to monitor long streams of data that are transmitted in DTMF, such as memory "dumps" from dialers or call records from payphones, etc. Upon selection of this mode option (see paragraph 2-3) you will note that the Digit Display appears the same as the Timing & dB mode when cleared. However, as event characters begin to fill the top row of the display, no event parameters are displayed on the bottom row. When the top row is full, the bottom row is used for event characters, which is also typical of the Timing & dB mode. The big difference between the two modes occurs when the bottom row is full. At this point, the display performs a "line feed", which moves all characters from the bottom row to the top row (this act also erases the custom hook-status character from the first space of the top row). New characters are written to the bottom row only, with each full line creating another line feed.

The display may be cleared at anytime by using the **CLEAR** key, but the SCAN key serves no purpose in this mode, nor can the dB meter be accessed.

SECTION 6 - 1004 HZ TONE GENERATOR

This function is activated by depressing the lower of the two push-button switches located on the right side of the unit as shown in Figure 1. When the button is depressed, it will lock in the **ON** position and the tone will be heard through the Loudspeaker. The volume at which the tone is heard depends on the setting selected by the **ON-OFF/VOLUME** control, which controls the "playback" volume only. The level at which the tone is broadcast on the line <u>is not</u> controlled and is pre-set at the factory to OdBm (+ or -.15 dBm).

When using your unit to broadcast this tone, the 600 Ohm load should be in the **OFF** position to allow the receiving unit to terminate the line with a similar 600 Ohm load. The reading taken by the receiving unit can be expressed as "dB of loss" (i.e., a reading of -3.5dBm equates to 3.5dB of loss on the circuit). Should the sending unit be in the dB meter mode, any reading taken will be irrelevant due to the fact that the total load resistance is unknown (i.e., the 600 Ohm load of the receiving unit + "x" feet of cable = ?).

This tone source may be used on "dry pairs" or DC loops with the same results. However, on DC loops, the battery source should not present a load to the line or the load must be a known value. In the latter case, a thorough knowledge of Ohms Law and the dB scale will be necessary to calculate a meaningful reading.

To de-activate the feature, depress the push-button switch slightly, which will cause it to release to the **OFF** position.

7-1 **Electrical Characteristics**

1. DC resistance - Monitor (600 Ohm load-out)	Greater than 1.7M Ohms
2. AC impedance - Monitor (600 Ohm load-out)	Greater than 1.7M Ohms
3. DC resistance - 600 Ohm load-in	600 Ohms + or -1%
4. AC impedance - 600 Ohm load-in	600 Ohms + or -1%
5. Ringer Equivalency	0.0B

7-2 **Digit Disiplay Function**

1. Min. DTMF receive time	40ms
2. Min. DTMF receive level	-30dBm
3. Max. DTMF receive level	OdBm
4. Max. Twist	+ or -10dB
5. Max. Frequency Deviation	+ or -1.5% + or -2 HZ
6. DTMF display On/Off time range	30ms to 9.9 sec.
7. Min. Dial Pulse receive rate	5 PPS
8. Max. Dial Pulse receive rate	20 PPS
9. Min. Dial Pulse receive break %	50%
10. Max. Dial Pulse receive break %	75%
11. Min. Dial Pulse receive interdigit time	100ms
12. Min. In-Band tone presence	300ms
13. Min. In-Band tone level	-30dBm
14. Max. In-Band tone fluctuation	2dB or less
15. Min. Long Pulse (hookflash) presence	150ms
16. Min. Zero Volt (wink) presence	50ms
17. Off-hook/Dial Pulse threshold	Software selectable for 22 VDC (CPE) or 44 VDC (CO)

7-3 **dB Meter**

1. Calibration	dBm if across 600 Ohm load
2. Scale	-40 to +6 dB
3. Display increment	.5 dB steps
4. Accuracy	1% of full scale

7-4 **1004 hz Tone Generator**

1. Frequency	1004 HZ - Precise
2. Level	OdBM across 600 Ohm load + or -.15dBm

7-5 **Physical**

1. Size	7.0" x 3.9" x 1.4"
2. Weight	16oz.
3. Case Material	High impact ABS
4. Test Leads	4' with mini-alligator clips
5. Battery Type	1.5 VDC AA type (4)
6. Carrying Case	Double wall, foam lined polyethylene

Specifications subject to revision without notice

All specifications at 20° C (68°F)

WARRANTY

Notwithstanding any provision of any agreement the following warranty is exclusive.

Ziad, Inc. warrants each instrument it manufactures to be free from defects in material and workmanship under normal use and service for the period of 90 days from date of purchase. This warranty extends only to the original purchaser. This warranty shall not apply to fuses, disposable batteries or any product or parts which have been subject to misuse, neglect, accident or abnormal conditions of operations.

In the event of failure of a product covered by this warranty, Ziad, Inc. will repair and calibrate an instrument returned to an authorized Service Facility within 90 days of the original purchase provided the warrantor's examination discloses to its satisfaction that the product was defective. The warrantor may, at its option, replace the product in lieu of repair. With regard to any instrument returned within 90 days of the original purchase, said repairs or replacement will be made without charge. If the failure has been caused by misuse, neglect, accident, or abornal conditions of operations, repairs will be billed at a nominal cost. In such case, an estimate will be submitted before work is started, if requested.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS OR ADEQUACY FOR ANY PARTICULAR PURPOSE OR USE. ZIAD, INC. SHALL NOT BE LIABLE FOR ANY SPECIAL INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER IN CONTRACT, TORT, OR OTHERWISE.

If any failure occurs, the following steps should be taken:

1. Notify Ziad, Inc., or nearest Service facility, giving full details of the difficulty, and include the model number, type number, and serial number.

2. On receipt of the Return Merchandise Authorization, forward the instrument, transportation prepaid. Repairs will be made at the Service Facility and the instrument returned, transportation prepaid.

SHIPPING TO MANUFACTURER FOR REPAIR OR ADJUSTMENT

All shipments of Ziad, Inc. instruments should be made via United Parcel Service or "Best Way" prepaid. The instrument should be shipped in the original packing carton, or if not available, use any suitable container that is rigid and of adequate size. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT TO ORIGINAL PURCHASER

The instrument should be thoroughly inspected immediately upon original delivery to purchaser. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument is damaged in any way, a claim should be filed with the carrier immediately. Final claim and negotiations with the carrier must be completed by the customer.