Operating Manual

Carrier-band Network Monitor

Model CBM-1

Relcom Inc.
INDUSTRIAL LAN | WIRING COMPONENTS AND TESTERS

2221 Yew Street
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500-347 Rev. 0

Installation

This equipment may be connected to mains/line voltages of 85-265Volt AC at 47-63Hz. The power consumption is less than 20 Watts. Power is attached to the unit through a standard IEC-325 power receptacle. There is no voltage selection device, this unit uses a universal input power supply.

There are no special mounting requirements for this product.

The unit has a tilt handle which can be used to elevate either the front or rear of the unit to allow better visibility of the front panel during operation.

There are no means to electrically disconnect this device from the mains/line supply other than to remove the mains plug. The input is fused with a self-resetting solid state device that requires no user intervention for proper operation.

Controls and Connectors

Front Panel Controls/Connectors

The Controls for the unit are membrane switches. The PWR switch is a soft switch - the microprocessor controls the internal solid state switch. All other switches are in a matrix scanned by the microprocessor for control of the unit.

There are two front panel connectors which are 75 Ohm BNC style connectors. The signal to be applied to these connectors is a standard IEEE-802.4 (IEC-8802.4) token bus signal of a level not to exceed +70 dBmV.

The display is a 20 character X 4 line LCD with an electroluminescent backlite panel.

Normal instrument operation, settings and control is accomplished through the use of the display and front panel keys.

Rear Panel Connections

The rear panel has four Connectors. A power connector, an RS-232 connection, and two BNC's for observation of signals. These are described below:

- Power Connector - IEC-325 style. Input is 85-265 Volts AC between 47 and 63 Hz. The power consumption is less than 20 Watts.
- RS-232 Connector- 9 pin "D" plastic. This connector provides for communication to the unit with baud rates from 300 to 9600 Baud. The connection can be used to control the unit with appropriate software, and is used to upgrade the Flash version of the unit when an upgrade is necessary. This connector and associated circuitry can be electrically isolated with the appropriate installed option for ground sensitive applications.
- TRIG Connector- BNC connector. Provides an output signal that is of" a duration of approximately 5 microseconds, and with an amplitude of approximately 5 Volts. The signal is from +5 Volts to ground and the falling edge is generated upon detection of the final end delimiter of a recognized signal.

This signal is meant to drive a coax cable (50-75 Ohms) into a normal oscilloscope 1M Ohm input. This signal is driven by an approximately 75 Ohm source and if terminated in 75 Ohms, will result in about 1/2 the amplitude stated above.

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SIG. LEV. Connector- BNC connector. Provides an output signal that is either:

1. A logarithmic representation of the applied input signal of about 10 dB per 100mv with 0 dBmV being near ground potential. Useful for checking signal levels, reflections, and noise sources, or

2. An output signal representative of the applied input signal amplified by 20 dB to allow checking for distortion and noise.

This signal is meant to drive a coax cable (50-75 Ohms) into a normal oscilloscope 1M Ohm input. This signal is also driven by a 75 Ohm source and if terminated in 75 Ohms, will result in 1/2 the amplitude stated above.

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INTRODUCTION

The CBM-1 Monitor is a network diagnostic and maintenance tool for the IEEE 802.4 (ISO 8802-4) token bus carrier-band network operating at 5 Mbit/s. It is used to observe network operation and make measurements while the network is active. The Monitor complements Relcom's CBT-702000 Tester that is used to install and check the network wiring system when the network is not operating. The Monitor is a passive network device that examines network activity but does not interfere with the networks operation in any way. It is a valuable management and maintenance tool for critical control networks that have to operate continuously. The Monitor is used to:

- List all the stations* active on the network's logical ring and note the stations that join or leave the network.
- Measure the signal level of each station and display its current and low signal level values.
- Measure the reflections on the network that indicate wiring problems.
- Measure the noise caused by external sources or grounding problems.

These measurements verify good network operation or alert maintenance personnel about deteriorating network conditions so that steps can be taken to prevent network downtime or to help determine what has failed.

The Monitor can optionally be connected through an RS-232 interface to either a local PC or through a modem to a remote PC. The Monitor software program on the PC can control the Monitor, display network measurements. save them and compare them to previous measurements.

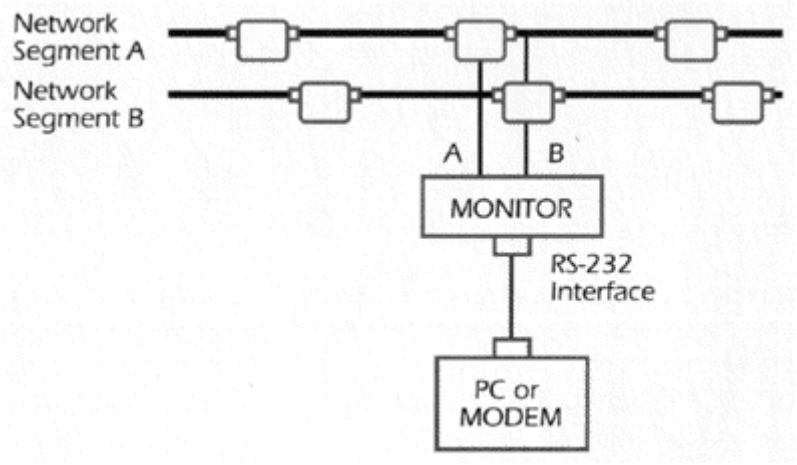

Figure 1. Monitor Measures Two Network Segments

* "Stations" are also called "nodes" or "devices."

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OPERATION*

The Monitor is controlled from the front panel:

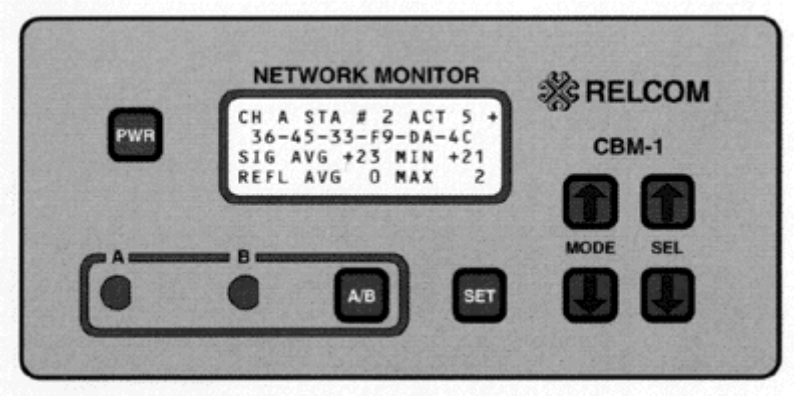

Figure 2. Front Panel

Pressing the Monitor's PWR switch turns the Monitor either ON or OFF. The PWR switch has to be held for a little while. This prevents accidental contact from activating the switch. After power is turned on, the Monitor performs a self-check and momentarily indicates its status on the display:

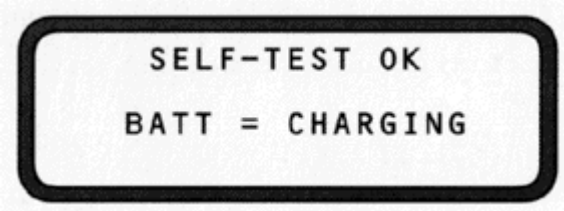

Figure 3. Power-up Test

Line 1 shows if the self-test is OK or if the Monitor is defective. (See Error Messages)

Line 2 blank

Line 3 indicates the remaining battery capacity. (See "Battery" in the Appendix)

Line 4 blank

After the momentary display, the Monitor enters the All Station mode and begins to look for signals on input connector A. Once network signals have been found, the Monitor begins to acquire a list of all the stations participating in token passing on the network and makes signal and noise measurements.

Pressing the A/B switch toggles which of the A or B inputs is selected for measurement and display.

*The Monitor operation discussion assumes some knowledge of how the token passing bus network works. For a quick introduction, see the Network Operation Overview section.

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OPERATING MODES

The MODE switch selects one of the Monitor; operating modes. Push the MODE switch down to get the next mode below. Push the MODE switch up to get the next mode above.

Pushing the SET switch while in any one of the measurement modes will switch the Monitor to its Status and Setting mode. When in the status and setting mode, pushing the SET switch puts the Monitor back to the measurement mode it was previously in.

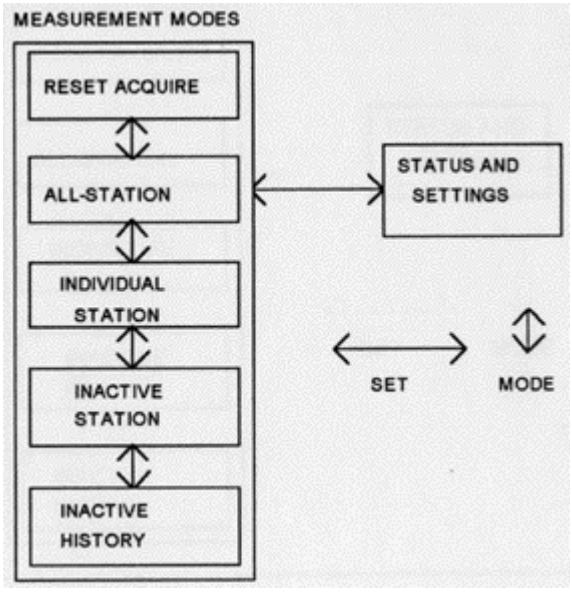

Figure 4. Mode Selection

All-Station Mode

When the All-Station mode is first entered after powering up or after reset, the Monitor looks for stations active on the network on channel A. During this time, the display shows:

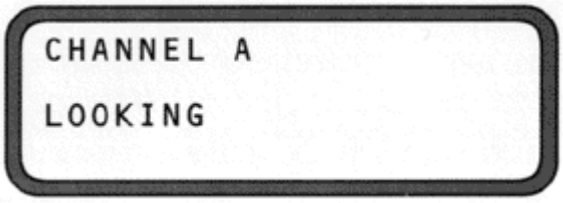

Figure 5. Display While Looking

If the Monitor cannot find any stations, it will display:

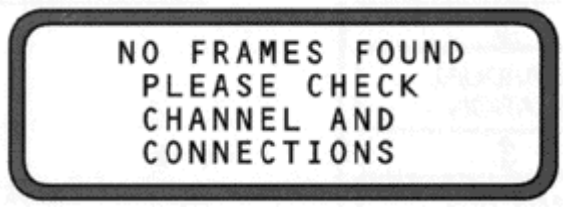

Figure 6. Display if Not Connected to Network

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If there are stations operating on the network, the Monitor shows that it is acquiring stations:

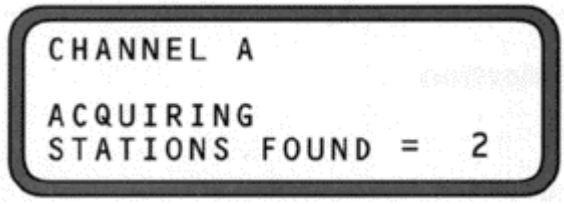

Figure 7. Display While Acquiring Stations

After the Monitor has found all the stations, it displays a summary of its findings. The Monitor keeps making measurements and updating the display:

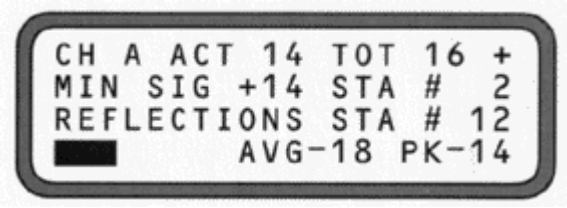

Figure 8. Display of All-Station Mode

Line 1 shows:

The network segment being measured, A or B.

The number of stations currently active in the logical ring.

Most stations found on the logical ring during this measurement session. If the Active count is less than the Total station count, one or more stations have left the logical ring.

The "+" sign is a changing symbol that indicates that the Monitor is actively making measurements and updating the display.

Line 2 shows the minimum signal and which station has this level. The minimum signal should be greater than + 10.

Line 3 shows if the Monitor detects a reflection and the station where it shows up the most. The amount of reflection can be examined by going to that station in the Individual Station mode. See the Reflection section for details.

Line 4 shows the Noise level on the network wiring. The noise measurement is displayed in two ways. The bar graph shows the noise level as a moving bar. The bar has a rapid rise time and a slow decay so that noise bursts can be observed. Line 4 also shows the average noise level and the peak noise levels numerically. The average noise should be less than -10.

Pressing the A/B switch changes the network segment being measured and displayed.

NOTE: The signal reflection and noise measurements are particular to the place on the network where the Monitor is attached. If the Monitor is attached to a different place, the measurements are likely to be different.

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Stand-Alone Station Measurement

The Monitor can make measurements on a stand-alone station before it is attached to the network. This is useful to see that the station has an adequate signal level, the station has a recognizable frame and the station's address will not conflict with other stations' addresses already on the network. In this test, the station is connected directly to the Monitor.

A Stand-Alone station measurement is made when the Monitor cannot find token frames during the All-Station measurement. In that case the Monitor detects one station attempting to make contact with other stations. The Stand-Alone Station display will show:

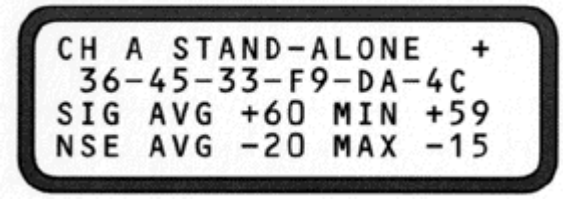

Figure 9. Display of Stand-alone Mode

Line 1 shows the network segment examined and that only one station has been found. The "+" sign is a changing symbol that indicates that the Monitor is actively making measurements and updating the display.

Line 2 shows the address of the station. (See Appendix A for the different types of address displays).

Line 3 shows the signal level of the station. A signal output of +60 dBmV and above will show as +60. This level is adequate for attaching a station to the network.

Line 4 shows the maximum noise and the average noise generated by the station. The average noise should be less than -15.

When the station is attached directly to the Monitor, the Monitor cannot measure the station's signal level because it is too high. The Monitor only gives an indication that there is a high signal output. To make a more exact measurement of a station's signal level, connect the station and the Monitor to the drop ports of a tap.

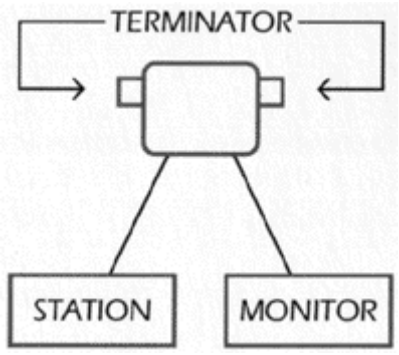

Figure 10. Precise Signal Measurement Configuration

Be sure the two trunk ports of the tap are terminated. The tap attenuates the station's signal level by 40 dB. If the station transmits at +64 dBmV, for example, the Monitor's measurement will be +24 dBmV.

Note: The only front panel control that is operational during the Stand-alone measurement mode of operation is the power switch. All other controls are disabled. The only exit from this mode is by waiting for a timeout condition indicated by the display showing the "LOOKING" message. To

do this, the input signal must be disconnected from the front panel for a period of time exceeding the selected timeout value.

Reset Acquire Mode

This mode of operation is provided to allow a quick method to clear all measurements and re-acquire the station list. It resets all stored measurements for the selected channel. When troubleshooting cable problems, high noise peaks, low signal levels, and possible reflections may cause unusual out-of-range readings. Re-acquiring the channel gives a more realistic view of possible changes in the system.

Individual Station Mode

After the Monitor has acquired all the stations on the network, the Individual Station Mode provides information about a specific station:

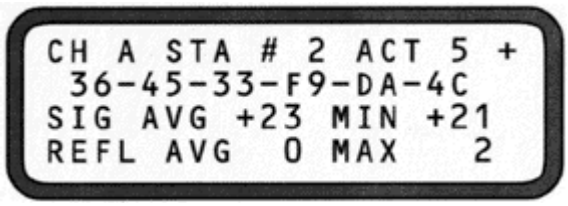

Figure 11. Display of Individual Station Mode

Line 1 shows the network segment, A or B, followed by the Station Number. The Station Number is a number that the Monitor assigns to each station that the Monitor has detected on the network. The station with the highest network address is "1 ;' the station with the next lower address is "2;' etc. This station numbering is for user convenience so that a station can be identified by a single number rather than by the much longer network address.

Line 1 also shows the number of stations active on the network at the time this mode was entered.

A changing symbol indicates that the Monitor is actively making measure-merits on the selected station and updating the display. This is shown by the "+" sign above.

Line 2 shows the stations address.

Line 3 shows the present signal level and the lowest signal level recorded during this measurement session.

Line 4 shows the present reflection level and the highest reflection level recorded during this measurement session. The reflection number should be less than 3. (For a detailed discussion, see Reflection below)

To examine other stations, push the SELect switch. If the lower SELect switch is pushed, the next lower addressed station is displayed. If the upper SELect switch is pushed, the next higher addressed station is displayed.

The station display "wraps'.' Pushing the upper SELect switch when the highest address station is displayed will get the lowest address station.

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Inactive Station Mode

A station is called inactive if at one time it was part of the logical ring but now cannot be detected. In the All-Station mode this shows up as less stations active now than the total detected in the network. To find out which stations are inactive, push the Mode down switch twice to get to the Inactive Station Mode.

Figure 12. Display of Inactive Station

Line 1 shows that station 2 on channel A is inactive.

Line 2 shows the station's address.

Line 3 shows the past/current signal average and minimum.

Line 4 shows the past/current average and maximum reflection.

If the station becomes active and rejoins the network the "+" on the right side of the display changes.

The list of inactive stations can be scrolled by the SELect switches.

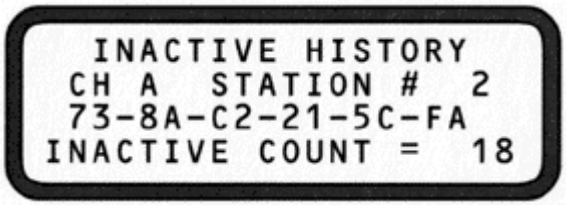

Figure 13, Display of Inactive History

Line 2 shows that station 5 on channel A is being displayed.

Line 3 shows the station's address.

Line 4 shows that the station has left the logical ring 18 times.

The inactive station history and all the other Monitor's current measurements can be cleared by pushing the Set switch and selecting the Clear option.

Inactive Station mode works like the Individual Station mode in that the Monitor tries to detect communication from the selected station and display its signal and reflection. If the station is inactive, the last measurement results are displayed:

By pushing the Mode down switch, the Monitor displays the inactivity history of the selected station. This is useful for long-term monitoring of intermittent problems.

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LOOSE CONNECTION DETECTION

Defective or loose wiring can cause stations to drop off the network and come back on intermittently. To help locate these types of problems, the Monitor provides audio and visual indications:

- When a station leaves the logical ring, the Monitor sounds a long beep and slowly blinks the backlight of the display two times.
- When a station enters the logical ring, the Monitor sounds a short beep and blinks the display backlight two short times.

The wiring problem can often be located by shaking the wiring and listening for the beeps or watching for the display to blink.

SIGNAL VIEWING

Signal from a selected station can be examined with an oscilloscope when the Monitor is in Individual Station mode. The signal is available on the connector labeled SIG. LEV. on the back of the Monitor. A negative going trigger is generated on the TRIG connector each time the selected station's token frames end delimiter is detected. A digital oscilloscope is recommended so that the signal can be examined before as well as after the trigger.

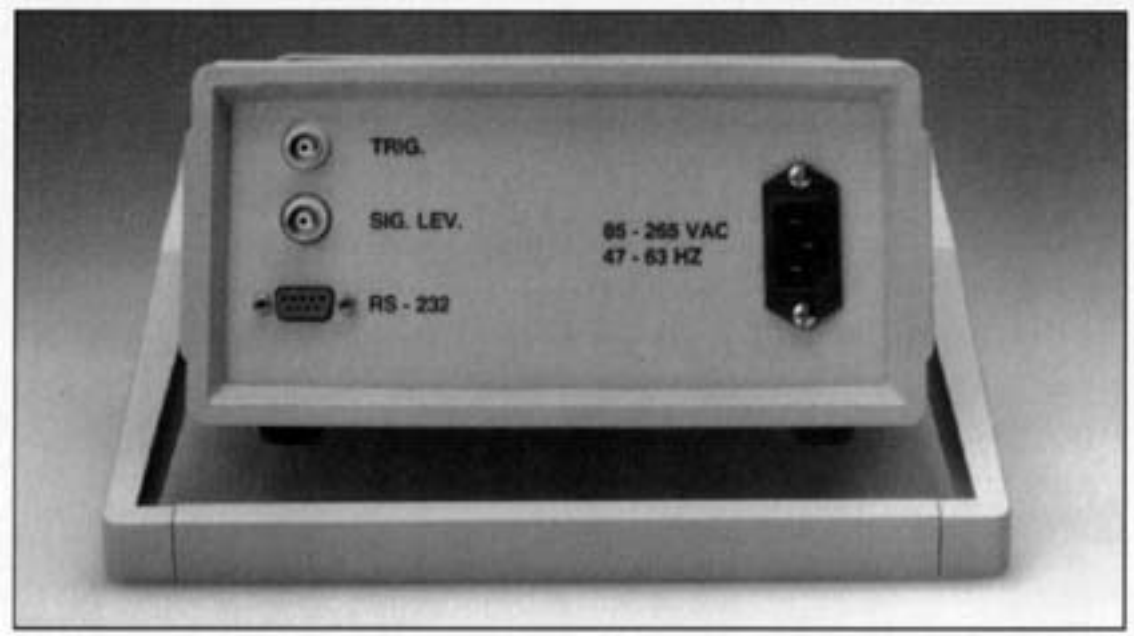

Figure 14. Back of Monitor

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The signal at the SIG. ‘s can be one of two types selectable in Status and Settings:

- Input The signal received by the Monitor is amplified by 20 dB so that it resembles the signal on the trunk cable. This is useful for looking at the reflections and noise at the end of a frame or at distortions of the signal. For example:

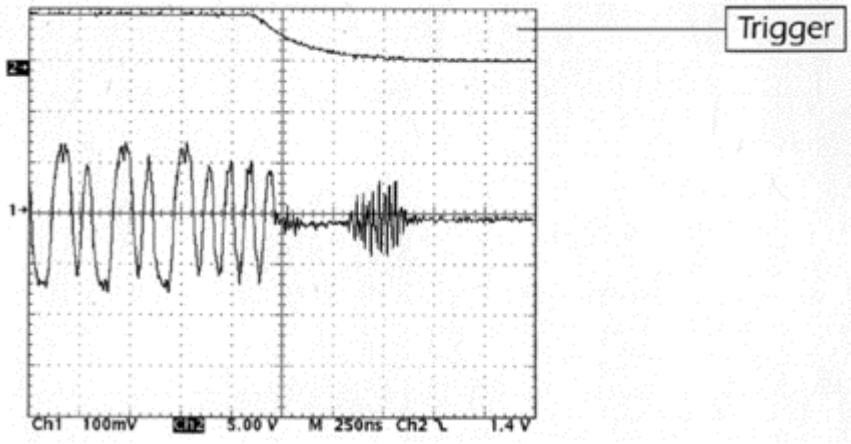

Figure 15. Input Signal

The oscilloscope should be set to 100 mV/div, and 200 ns/div. The trigger should be on the falling edge.

- LogAmp shows the signal envelope. The envelope level is logarithmic. Each 13 mV variation on the oscilloscope screen represents about] dB of signal variation. This makes noise appear to be larger than it really is. For example, if the signal is, say, 15 dBmV and the noise is -20 dBmV, the display would look like:

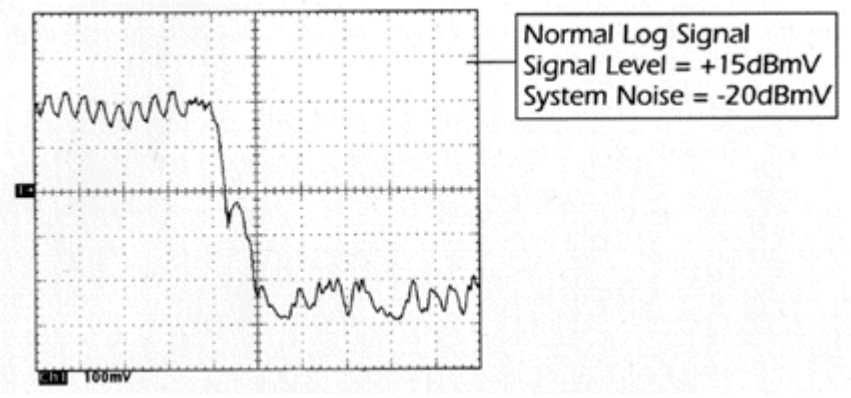

Figure 16. LogAmp Signal

The scope settings should be 100 mV/div and 2 us/div. The trigger should be on the falling edge.

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REFLECTION

Normally, when a station stops transmitting a frame, the signal from the station dies out quickly. If there is a cable system fault, there is a residual signal (a reflection). This may be caused by a cable fault, a bad terminator or an unterminated tap. In the All Station mode the Monitor looks for this signal after a station has stopped transmitting. If the Monitor can detect the reflection, the Ail Station display will show the station after whose transmission this residual signal is most detectable.

To get an indication about the severity of the reflection, go to the Individual Station mode and select that station. The 4th line of the display shows the current reflection level and the maximum reflection level measured. Reflection severity is shown as dBs above 0 dBmV. Reflections below 3 are not important. Reflections greater than that should be examined with a scope.

To look at reflections, put the Monitor in the Individual Station mode and select the station after whose transmission the reflection is to be examined. Connect an oscilloscope to the SIG. LE--'s. connector and trigger (negative going edge) from the TRIG. connector of the Monitor.

Normally, when there are no reflections, the signals look like the ones shown in Figure 15 and Figure 16.

If there is a trunk cable discontinuity such as a loose trunk terminator, it will cause a reflection, that is, an echo. Consider this example:

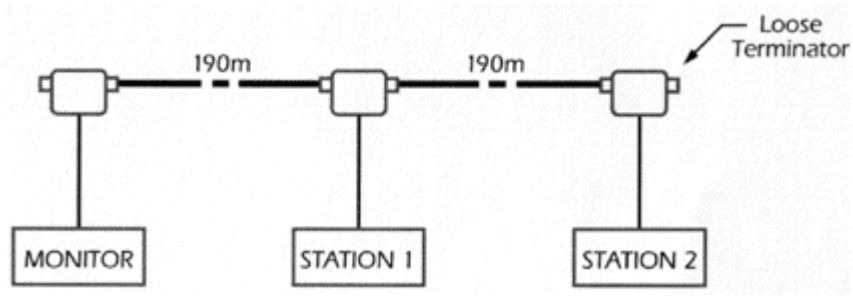

Figure 17. Example Network

Two stations are on a network as shown in Figure 17. At station 2, the trunk cable terminator is loose. When the Monitor triggers the scope after station 1 transmission, the signal and reflection look like that shown in Fig. 18.

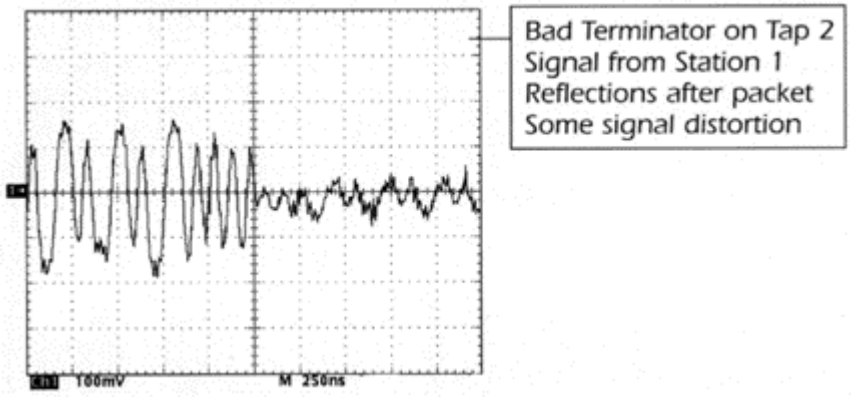

Figure 18. Signal and Reflection From Station 1

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When the Monitor triggers the scope after Station 2's transmission, the signal and reflection look like that shown in Fig. 19.

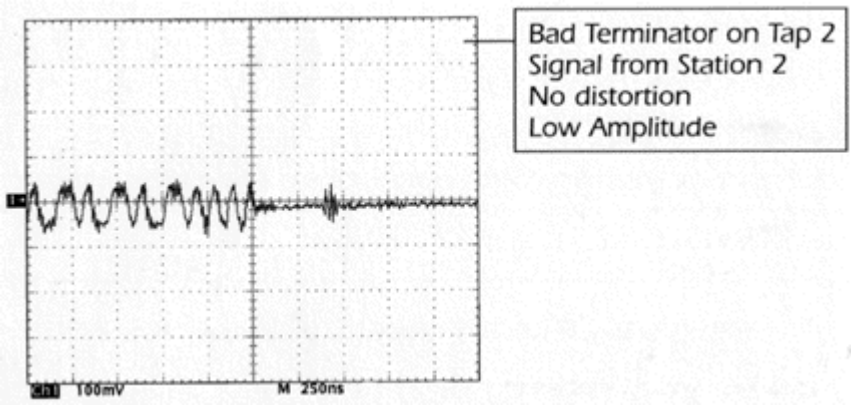

Figure 19. Signal and Reflection From Station 2

Note that the signal from Station 2 is much smaller than that from Station 1 because of cable attenuation. Also note that the reflection at Station 2 cannot be seen because the discontinuity, the loose terminator, is at Station 2.

The duration of the reflection indicates the distance the selected station is from the discontinuity. The station furthest from the cause of the reflection is the one that shows the greatest duration of the reflection. The location of the discontinuity can be estimated from the length of the signal reflection. Consider the LogAmp signal from Station 1:

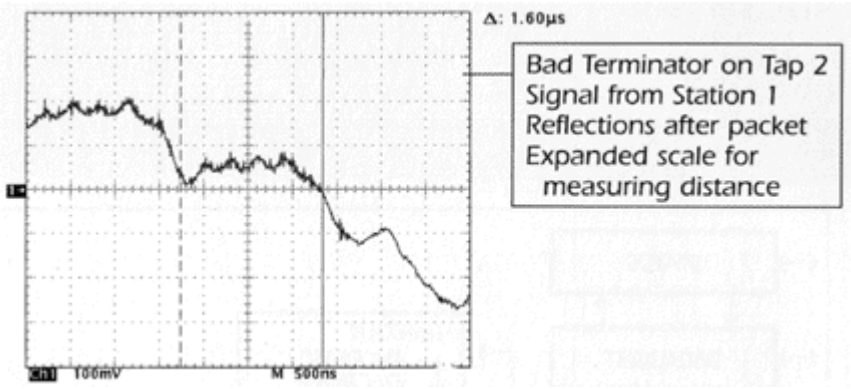

Figure 20. LogAmp Signal of Station 1.

In Figure 20, the signal does not drop off but has a step that is about 1600 nanoseconds long. This is caused by a reflection. Signal travels on the cable about one meter in 4.5 ns. Since the reflection is a result of a signal traveling to the discontinuity and back, divide the reflection time by 2. In this example, the distance to the discontinuity is 800 ns away. Divide 800 ns by 4.5 ns/meter to get a distance of 178 meters.

If a station is selected for viewing that is closer to the discontinuity, the length of the reflection time will get shorter If a station that is further from the discontinuity is selected, the reflection will be longer. If a station past the discontinuity is selected, no reflection is seen. Using these facts, the direction and possible location of the discontinuity can be determined.

Note: In the LogAmp mode, the fall time of the LogAmp is relatively slow and, even with perfect cable, the signal will have a "bump" as shown in Figure 16. While this may appear as an indication

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of a reflection, it is really more than 20 dB down from the signal level and should not be considered.

There are some things that should be kept in mind when using the Monitor to look for reflections:

The Monitor cannot determine if there is a problem in the drop cable to any station. Drop cable problems will show up at the Monitor as a lower than expected signal from a station.

The Monitor will not show reflections from a station that is beyond the discontinuity. For this reason, it is a good practice to make periodic network measurements from both ends of the trunk cable. Reflection problems that are not visible from one end may be visible from the other.

The Monitor cannot "see" through repeaters to measure station signal levels or reflections. All the stations beyond a repeater will have the same signal level and reflection measurement because it is the repeater's output that is being measured when stations beyond the repeater are recognized.

STATUS AND SETTING MODE

When the Monitor is in any one of the measurement modes and the SET switch is pushed, the Status and Setting displays are brought up. The MODE switches scroll the choices. The SELect switches select a choice for the particular setting. The settings are listed below:

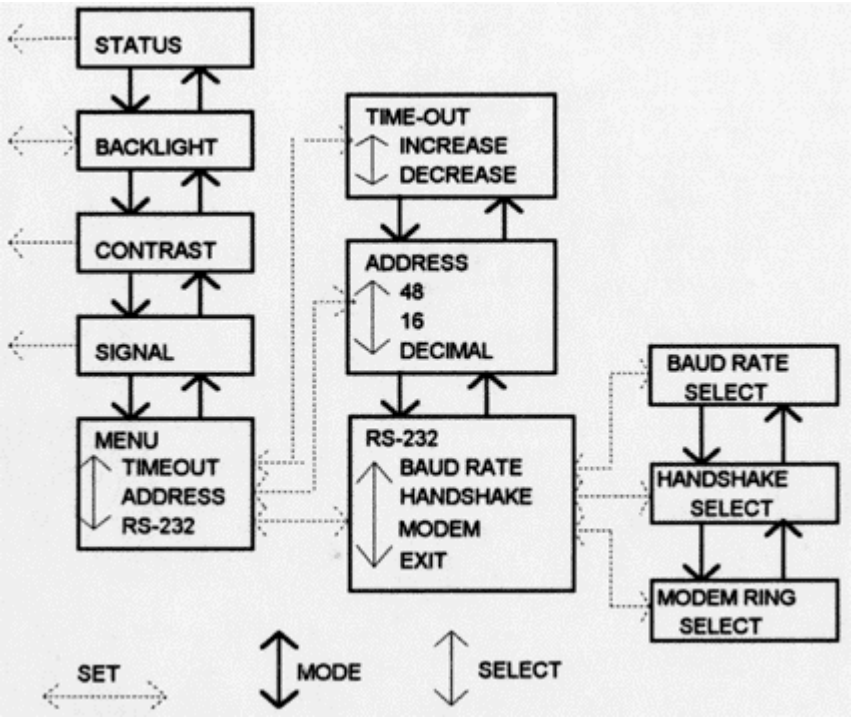

Figure 21. Status and Setting Selection

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The most often used items are directly accessible by pushing the SET and MODE switches:

- Status: The status display shows the status of the Monitor:

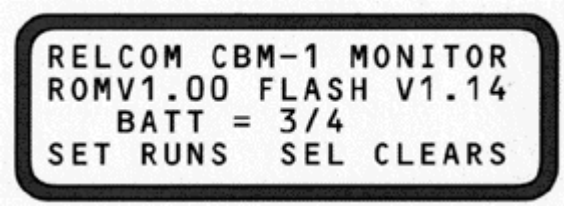

Figure 22. Status Display

Line 2 shows ROM and Flash firmware version.

Line 3 indicates the remaining battery capacity. (See "Battery" in the Appendix)

Line 4 allows the Monitor to be cleared: Pressing the SELect switch clears the Monitor of any previously acquired data and Marts a new acquisition sequence. Pressing the SET switch restarts network measurements.

- Backlight: The display backlight can be turned ON or OFF. The backlight uses considerable amount of power and will decrease battery life by about 50%. If the Monitor is plugged into a power source, this power usage is of no consequence.
- Contrast: The LCD display contrast can be changed to make the display easier to read in different light conditions or viewing angles.
- Signal: The signal sent to the back panel connector can be either the amplified signal received at the input to the Monitor or the log amp signal envelope. (See Signal Viewing above)

Less often used Monitor settings are accessible from a menu:

- Timeout: Normally, when the Monitor is in the All-Station mode and is scanning the network to get a list of all the stations, it will wait for 0.3 seconds to receive a signal from a particular station that needs to be acquired and measured. If that station is not found in that time, the station is listed as missing. In very large network or some types of dual redundant networks, this default wait time may be too short. The Delay option allows the wait time to be increased. The range is from 0.1 to 25 seconds.
- Address: The address display format can be selected. See Addressing in the Appendix.

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If the Monitor is used with a PC, either directly or through a modem, the RS-232 interface conventions have to be selected:

- Baud Rate: If the Monitor is to work with a PC or a modem through its RS-232 interface, the Monitor's data rate must match the data rate capabilities of these devices. Normally the baud rate is set at 9600.
- Handshake: The Monitor can use the XON/XOFF signal handshake to interact with a modem or a PC over the RS-232 interface. The default mode is NONE
- Modem Status: This item in the RS-232 Menu screen shows the current status of modem operation. It shows NONE, ON, or FAIL.
- Modern #Rings: The Monitor when connected to a Modem can set the modem to answer on a set number of rings. When zero is selected, Modems do not answer. The number of rings ranges from 0 (none) to 254. The unit is shipped set to 0.

Timeout, Address, Baud rate, Modem number of rings, and Handshake settings are saved in the Monitors non-volatile memory and are used as default settings the next time the Monitor is powered up.

The Monitor returns to the operating modes by pressing the SET switch as shown in the figure above.

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USING THE MONITOR EFFECTIVELY

The Monitor can provide early warning if network problems are developing. This capability is only effective if the normal network operation is known.

The way to determine the normal network operation is to perform a network audit and establish a baseline for good operation. Once the audit information has been gathered, regular network monitoring results can be compared against the audit data that show trends or point out significant deviations.

To perform an audit, make a list of all the stations on the network starting from one end of the network. Write in the address of each station. If a dual redundant network is used, leave two rows for each station. Write in the location of where the station is connected to the network. This can be a tap number and a drop port number or some other designation. For example:

STATION	#	ADDRESS	LOCATION	END 1 SIGNAL	END 2 SIGNAL
Contr1		30C72976B2C5	A 1-2		
			B 1-2		
Contr2		30CF087D23A6	A 3-1		
			B 3-1		
PLC1		30C37B29E573	A 5-2		
			B 5-2		
PLC2		30C9F167AC2	A 5-1		
			B 5-1		

END 1 AT TAP #: _____ PORT #: _____

NOISE: _____ REFLECTION: _____ AT STAT. # _____

END 2 AT TAP #: _____ PORT #: _____

NOISE: _____ REFLECTION: _____ AT STAT. # _____

Connect the Monitor to the drop port of a tap as close as possible to the first station (End 1) and note the tap number and port of the tap. Select the Monitor port A or B and wait for the Monitor to scan the network.

- Verify that the Monitor has found all the stations on the list.
- Note the Noise and the Reflection from the All-Station display.

Examine each station. Record the station number assigned to each station by the Monitor. This is an aid to identifying each station. Note the signal level.

Repeat the same procedure by attaching the Monitor to a tap as close as possible to the last station on the list (End 2).

Examine the data:

- Signal levels of stations nearest to the network end being measured should be higher than those stations further away. All signal levels should be greater than + 10.
- Noise should be less than -1 0. If not, there is noise getting on the network.
- The Noise measurements on both ends of the network should have the similar values. If the noise values are not similar, the Monitor can be used to find what part of the network is the noisiest and provide a clue to the source of the noise. The noise could come from an external source or from a station that does not turn off its transmitter completely.

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- Reflection should be less than 3. The greater the reflection, the higher the number.
- The Current and Low signal level measurements of each station should be within 2 dB of each other. If not, clear the measurement and make the measurement for that station again. Unequal values indicate that something is causing the variation. This may be a loose connector or noise.

If the network appears to be operating correctly, date and save the data sheet. At a later time, repeat the network measurements and compare with the results of a previous measurement. This historical data can be used to recognize network wiring or station degradation. These problems can be corrected before they disable the network.

The manual network audit and performance comparisons described above is performed automatically by the Monitor Software that runs on a local or remote PC and gets the data directly from the Monitor.

COMPUTER ENHANCED OPERATION

The Monitor's utility can be enhanced by using it with a PC computer. The Monitor's RS-232 interface connects it to a PC or through a modem over a telephone to a remote PC. The Monitor Software in the PC can do the following:

Control the Monitor and display measurement results on the PC computer screen.

Show signal and noise measurements as a strip chart.

Perform the routine network maintenance measurements, compare the results with the baseline values, warn about deteriorating network conditions and generate a report.

Store measurement results on disk or incorporate them into other programs such as spreadsheets or word processors.

The Monitor's RS-232 interface can be electrically isolated as an option. This is useful in situations where the network cabling ground cannot be connected to the RS-232 signal ground. The isolation option, if implemented, is shown on the serial number tag on the back of the instrument as CBM-1, opt 01.

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APPENDIX A. ADDRESS DISPLAY FORMATS

The carrier-band network is used in different ways in various control systems. Some networks use 48-bit addresses; others use 16-bit address. Of those that use the 48-bit addressing, some interpret the address in the Ethernet style and others interpret it as a decimal number. The options for the address display format can be selected in the Setting mode.

48-bit Ethernet Format

Station addresses have 48 bits. The bits are transmitted in the order left to right and interpreted as least significant bit of each byte first. These bits are represented in a more compact form by the Monitor shown in the example below. The sequence:

0000 1111 0111 0100 1010 1000 0011 0110 1110 1110 1101 1001

is displayed as F0-2E-15-6C-77-9B.

48-bit Decimal Format

Some control system vendors use locally assigned 48-bit addresses. This is designated by the first 01 bits in the address. The subsequent bits represent addresses from 0 to 128 in decimal. In the example bit stream below, the least significant bit starting from the left is sent first.

0110 1001 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000

The decimal address is represented by this bit-stream is displayed as 37.

16-bit

Networks using 16-bit addresses are represented as in the Ethernet conventions above. The sequence:

0000 1111 0111 0100

would be displayed as F0-2E.

APPENDIX B. BATTERY

The Monitor's battery is charged when the Monitor is plugged into AC power. If the Monitor is not turned on, the battery charges in about 4 hours. If the Monitor is turned on during charging, the battery charges in about 20 hours. If the display backlight is turned on during charging, the battery may not charge at all.

A fully charged battery will power the Monitor for about 2.5 to 5 hours depending on the age of the battery, the temperature and the use of the display backlight. The remaining battery life is shown on the Status display as a fraction of full charge.

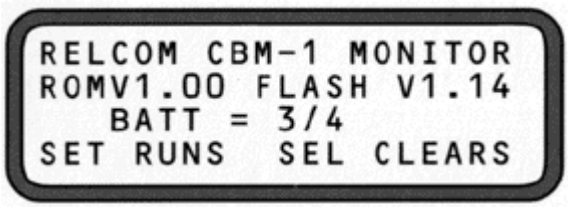

Figure B1, Status Display

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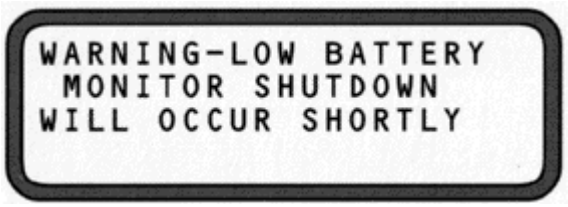

Figure B2. Low Battery Message

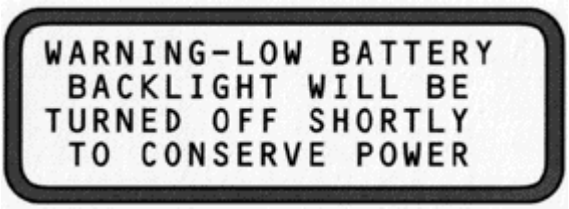

Figure B3. Low Battery Backlight Warning

When the battery is exhausted, the Monitor turns itself off. Before shutting itself off, the Monitor will flash the display for about 10 minutes about once a minute:

If the battery is low and the display backlight is on, the Monitor will flash:

APPENDIX C. ERROR MESSAGES

The following are fatal errors in the Monitor. There are no user service functions or adjustments inside the Monitor. Do not attempt to fix the problem. Call the factory and make arrangements for return and repair: 503-357-5607.

- Self-test errors on power-up

The microprocessor has detected memory errors and cannot operate reliably. Some functions of the Monitor may operate correctly but others may not. If you want to use the Monitor temporarily, recognizing that its operation is questionable, press the SELect Down key and then press the Mode Up key.

- Unable to power down

The microprocessor cannot shut off the power. This is an unrecoverable failure in the power circuits.

APPENDIX D. NETWORK OPERATION OVERVIEW

This overview provides a summary of the carrier-band network technology so that the Monitor can be used more effectively. For a more detailed description, write or call for Relcom's free Carrier-band Handbook.

The carrier-band network uses a shared cable system that lets stations -computers, controllers and PLCs - send signals to each other. The main cable is called the trunk cable. Taps are used to get signals from the station onto the trunk and to get signals from the trunk to the other stations. The cables connecting the taps with the stations are called drop cables. Taps have 2 or more drop ports or connections to stations. For the cable system to work properly, both ends of the trunk cable must have a terminator. The terminator absorbs signals traveling on the trunk cable so that the signal does not reflect from the end and travel back on the trunk cable.

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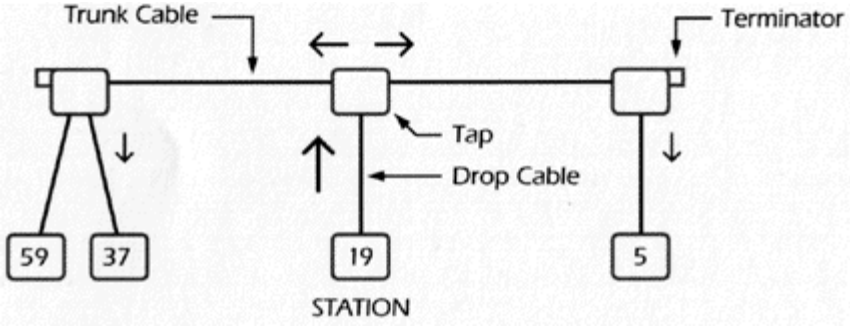

Figure D1. Bus Network Diagram

When a station transmits, it sends out a high signal level. While going through the tap to the trunk cable, the signal is attenuated, that is, it gets smaller. As the signal travels on the trunk cable, it also is attenuated. When the signal goes from the trunk cable through a tap to the drop cable, it is again attenuated. This is shown by the arrows on in the figure above.

Signal level is measured in units called dBmV. A station transmits between 63 and 66 dBmV. When going through a tap, the signal is reduced by 20 dB. Thus, getting a signal onto the trunk cable and getting it off the trunk cable reduces the signal by 40 dB. The receiving station needs at least 10 dBmV of signal to receive properly. This leaves 63 - 20 - 20 - 10 = 13 dB of signal that can be attenuated by the trunk and drop cables.

The stations take turns at using the shared cable system. Only one station has the right to transmit at any given time. When a station is ready to give up its transmission rights, it sends a short message called a token, to another station granting it the right to transmit. Each station has an address that uniquely identifies the station. The token is sent from a station with a higher address to a station with the next lower address. The lowest addressed station sends the token to the highest addressed station. In this way, the token travels on a "logical" ring among all the stations on the network.

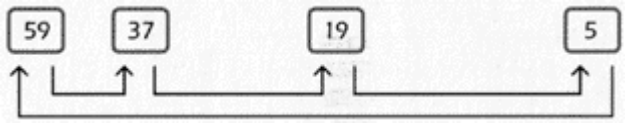

Figure D2. Token Passing Sequence

Messages are sent in frames, a burst of transmission followed by silence of about 10 microseconds. The contents of a frame are shown in the diagram below. The sequence of transmission is from left to right. Each frame, including the token, has a destination address (the station to which the message is intended) and a source address (the address of the sending station).

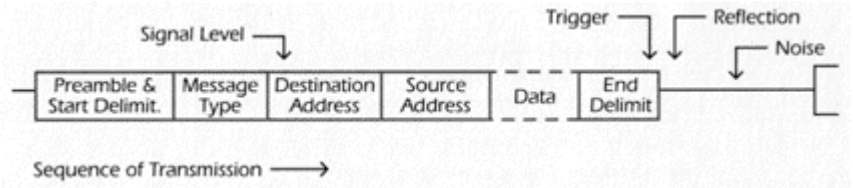

Figure D3. Frame Structure

The Monitor uses the addressing information in the following way: When the Monitor recognizes a token frame, it also gets the source address of that frame. From this the Monitor is able to make a list of all the devices active on the network. The Monitor measures the signal level at the point

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shown above and associates the measured signal level with the particular station in its list. From this information, the Monitor can display, for example, the station with the lowest signal level.

The oscilloscope trigger is generated when the Monitor detects the end delimiter, a unique signal sequence that indicates the end of a frame. A short time after the end delimiter, the Monitor measures the signal remaining on the network to detect reflections. About 5 microseconds, after the end of the frame, when any reflection has died down and before another message starts, the Monitor measures any noise on the network.

APPENDIX E. MEASUREMENT SUMMARY

Shown below are the measurements that indicate good network operation. If the network measurements are not as they should be, see the following pages for possible explanations.

All Station Mode

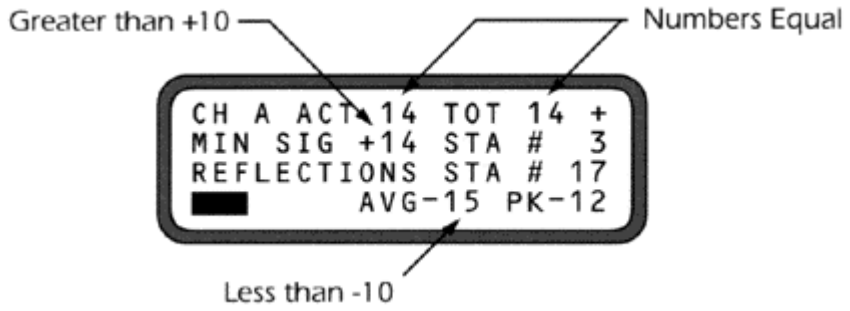

Figure El. All Station Mode Normal Display Stand-alone Mode

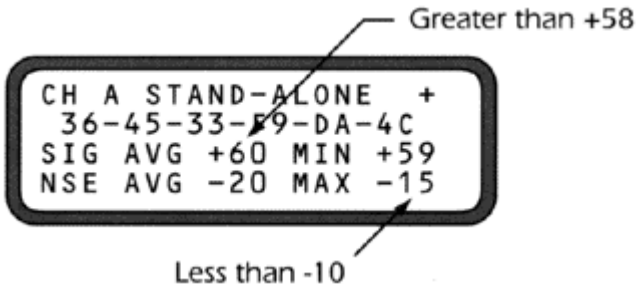

Figure E2. Stand-alone Mode Normal Display

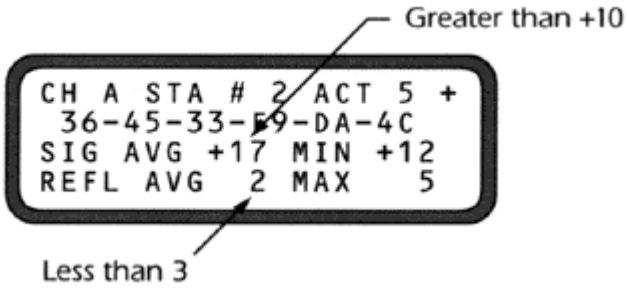

Figure E3. Individual Station Mode Normal Display

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All Station Mode Error Conditions

Shown below are network problems that are detected in the All Station mode.

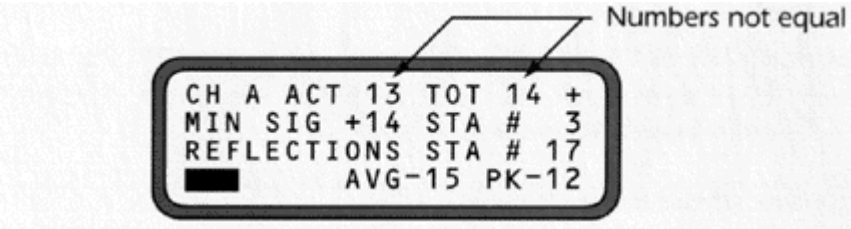

Figure E4, All Station Error Display

A difference between currently active stations and the total station detected indicates that at one time 14 stations were active but now one station has dropped out of the logical ring. Go to the Inactive Station mode to see which station has dropped out.

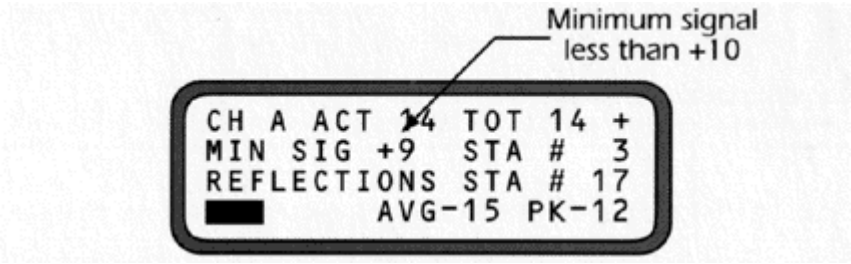

Figure E5. All Station Error Display

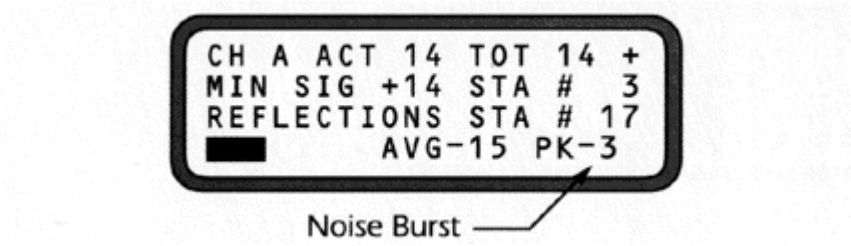

Figure E6, All Station Error Display

A peak noise figure that is well above the average indicates that a large noise burst was detected on the network. Watch the noise bar to see it occasionally gets big showing a noise burst. Try to relate the noise burst timing with other events such as motor start-up, welder operation or other potential noise-causing events.

A minimum signal below + 10 indicates that the station shown is does not provide enough signal output. Go to the Individual Station mode and bring up the indicated station, #3 in this example, to monitor the station.

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Stand-alone Error Conditions

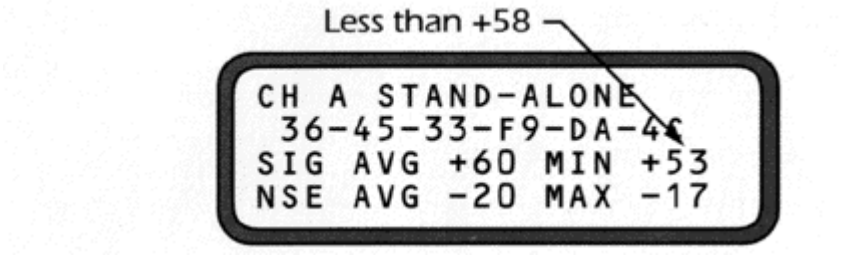

Figure E7. Stand-alone Error Display

A minimum signal of less than +58 indicates that the stand-alone station being tested does not put out enough signal. The probable cause is a bad modem in the station.

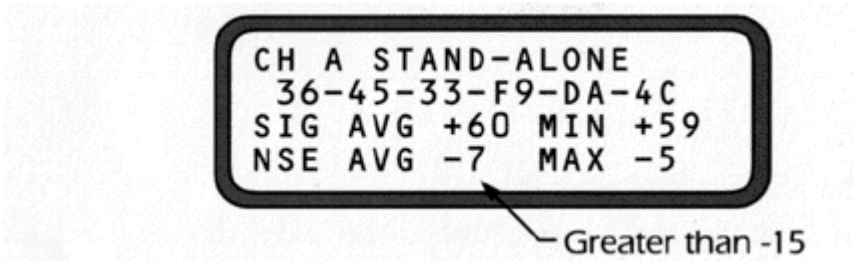

Figure E8. Stand-alone Error Display

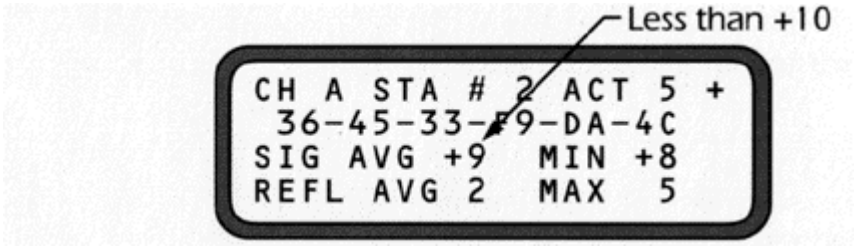

Figure E9. Individual Station Error Display

A signal level below + 10 indicates that the station is not transmitting enough signal, there is something wrong with the station's drop cable, the trunk cable to the station is defective or the cable system is too large.

A noise figure greater than -15 indicates that the station is not shutting down its transmitter completely between transmissions, the station is radiating noise or the test is being conducted in a very noisy electrical environment.

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Individual Station Mode Error Conditions

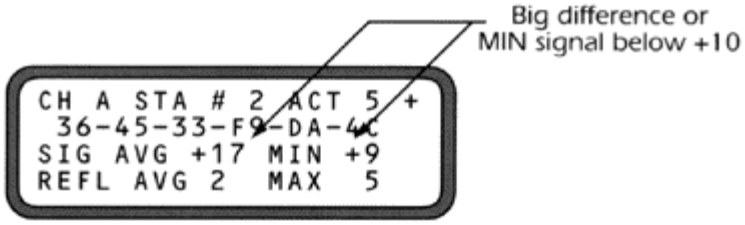

Figure E10. Individual Station Error Display

A big difference between the average signal and the minimum signal indicates that the station is not putting out a consistent signal level. This may be caused by a loose cable or by a defective modem in the station.

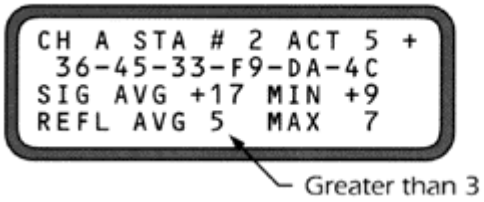

Figure E11. Individual Station Error Display

A reflection number above 3 indicates that there may be reflections on the network. See the Reflection section for details of how to use a scope with the Monitor to observe reflections.

APPENDIX F.

ACCESSORIES (Included with the Monitor):

4 Probe Cables	Precision 75 W cables with BNC connectors, 1.5m (5 ft.)long for connecting the Monitor to the network and to an oscilloscope.
2 Connector Adapters	BNC to F-type connector adapters.
Power Cord	IEC-325 to North America/Japan or Europe plugs
Carrying Case	A nylon case with a pouch for carrying cables, other accessories and the Operation Manual.
Operation Manual	

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OPTIONS:

PC Monitor Software	CBM-1S01	Software for operating the Monitor from a local or remote PC.
RS-232 Cable	CBM-1A001	1.5m (5 Ft.) cable with 9 pin connectors on both ends.
25-pin to 9-pin adapter	CBM-1A002	DB25 female to DB9 male.

SPECIFICATIONS, CBM-1

Size	22 x 22 x 29 cm (8.75" x 4.25" x 11.25"
Weight	3.3 kg (7.25 lb.)
Display	4 lines x 20 characters. Display area 7.5 x 2.5 cm. Character height 4.75 mm.
Switches	Membrane type with tactile and audio feedback.
Power	85-265 VAC, 47-63 Hz through IEC 325 plug, 20 W maximum.
Signal measurement range	+0 to +60 dBmV
Noise measurement range	-20 to +55 dBmV
Battery Operation	At least 2.5 hours from fully charged battery.
Operating Temperature	0 to 40□□C
Operating Altitude	Up to 2000 m.
Relative Humidity & Temperature	90% RH @ 25□ C
Immunity/Susceptibility Derating	Noise measurement sensitivity may be reduced to -10 dBmV within fields containing frequencies of 20-80MHz at levels of 3V/m.

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WARRANTY

Relcom Inc. warrants the Monitor to perform as described in this manual under normal use for a period of ONE YEAR after delivery to the original purchaser. This warranty does not apply if the Monitor has been disassembled, modified or used for purposes other then those described in this manual.

Upon verification of any defect, Relcom Inc. shall, at its option, repair or replace the defective unit.

Before using the Monitor, the user should determine its suitability for the intended use. The user assumes all risk and liability whatsoever in connection with such use. In no event does Relcom Inc. assume liability for incidental or consequential damages.

This warranty is the extent of the obligation or liability assumed by Relcom Inc. and no other warranty or guarantee is either expressed or implied.

Relcom Inc. reserves the right to make design changes to the Monitor without notice and no obligation to make the same or similar changes to units previously manufactured.

All statements in this manual are based on information believed to be reliable. Relcom Inc. is not, however, responsible for any errors or omissions. If you have any questions or suggestions, please contact:

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