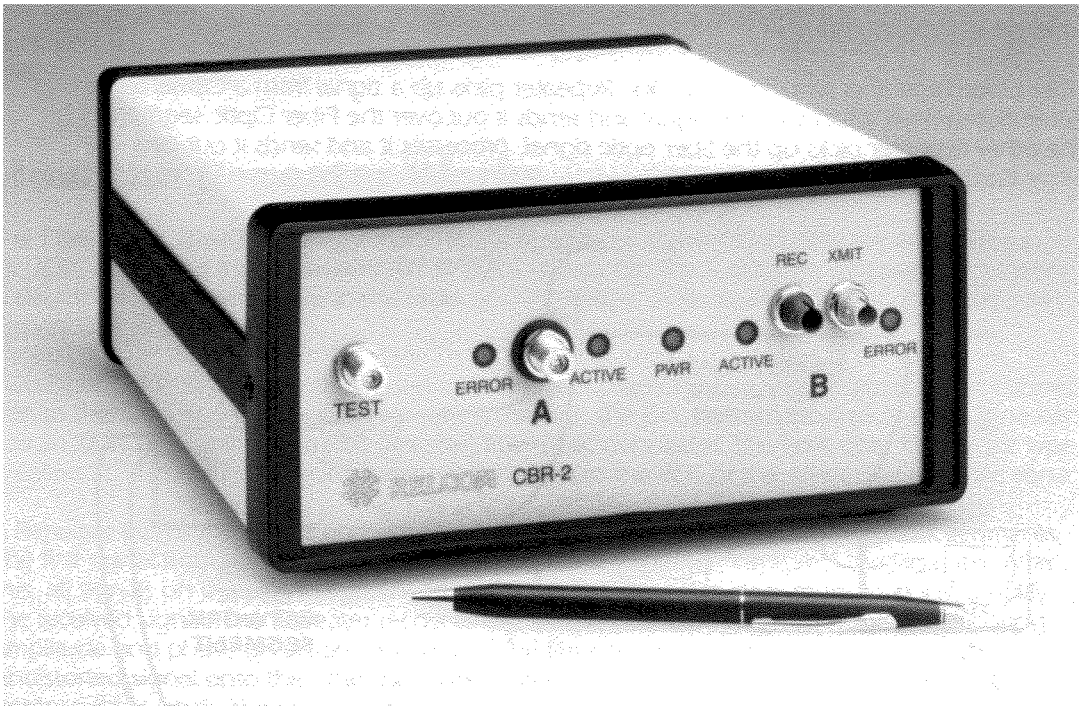
Operating Manual

5 Mbit/s Carrier-band to Fiber Optic Repeater

Model CBR-2
Model CBR-3



Relcom Inc.
INDUSTRIAL LAN | WIRING COMPONENTS AND TESTERS

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500-375 Repeater Manual Rev. A.0

Purpose of a Repeater

A Repeater is used to extend the distance covered by a network or to add more stations to the network. It overcomes limits on the length of a network or the number of stations imposed by electrical characteristics. A single network can be expanded, or small networks can be joined by adding Repeaters. When networks are expanded or joined, each of the smaller networks becomes a Segment of the larger network. Each segment has the same limits on length and number of stations as a single network without a Repeater.

Fiber Optic Repeaters work in pairs. One Repeater picks up a signal from a Carrier-band network segment, processes the signal and sends it out over the Fiber Optic segment. The other Repeater picks up the fiber optic signal, processes it and sends it out over the other Carrier-band network segment.

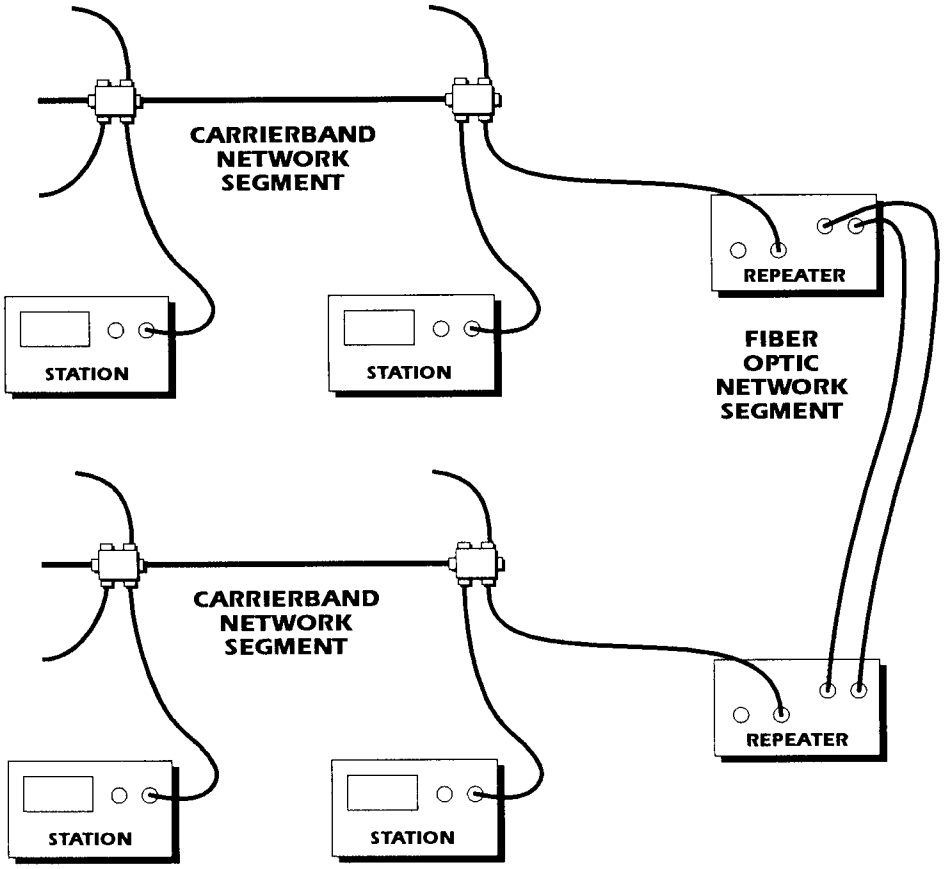

Figure 1. Fiber Optic Repeater and Network Segments

Fiber optic repeaters are useful for several reasons: They can span long distances. Since fiber optics do not conduct electricity, the fiber optic repeaters eliminate ground current problems, are immune to lightning strikes, and do not pick up noise.

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Two types of Fiber Optic Repeaters are described in this manual:

1. The CBR-2 is intended for applications where the fiber optic segment is less than 2 km in length or a passive star coupler is used with few ports and very short spurs.

2. The CBR-3 is intended for applications where the fiber optic segment is up to 8 km in length or a passive star coupler is used with many ports or long spurs.

This manual applies to both types of Repeaters. The difference between the CBR-2 and CBR-3 Repeaters is in the wavelength (color) of the light transmitted and is described in the Specifications section.

How the Repeater Works

The Fiber Optic Repeaters are intended to work with the Carrier-band network as defined in the IEEE 802.4 and the equivalent ISO 8802/4 standards. The Carrier-band network operation is described in Relcom's Carrier-band Network Handbook.

Two Fiber Optic Repeaters are needed to connect Carrier-band network segments. The connection to the Carrier-band network segment is through the F connector labeled A. Each Repeater has an XMIT (Transmit) and a REC (Receive) fiber optic connector. The fiber optic connector type is called ST. The XMIT of one Repeater is connected to the REC of the other one and vice versa.

A Repeater listens for signals on both the Carrier-band and the Fiber Optic network segments. The first signal from one of the segments to reach the Repeater "captures" the Repeater. After this, all signals on the other segment are ignored. The Repeater does more than just amplify the received signal. The Repeater recovers digital data from the received signals, eliminating amplitude and phase distortions and noise. The Repeater then transmits a full strength, undistorted signal onto the other network segment. When a reception and subsequent retransmission ends, the Repeater momentarily blanks both inputs to ignore residual signal reflections on the cable. Then the Repeater listens again for a signal on both network segments.

The Repeater is designed to minimize the time required to receive, process and retransmit signals. Transmit delay time through the Repeater is less than 600 nanoseconds and should be added to the cable delay to determine the slot_time of the network.

When the Repeater detects an error condition in the incoming signal, it turns the ERROR light next to the corresponding connector momentarily ON. If the end delimiter is subsequently detected, the E bit is set in the transmitted end delimiter to indicate that the data in the frame was in error. If no end delimiter is detected before the received signal fades (a “runt” frame), the ERROR light is also turned ON momentarily

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Topologies

Networks with repeaters can be configured in many different ways. The only caveat is that the overall system must not loop back on itself. Although figure 1 shows the Repeater connected at the ends of the trunk cable segments, the Repeater can be connected to any tap on a Carrier-band network segment. More than two segments can be connected using Repeaters. The diagram below shows a linear string of Repeaters connecting several network segments together

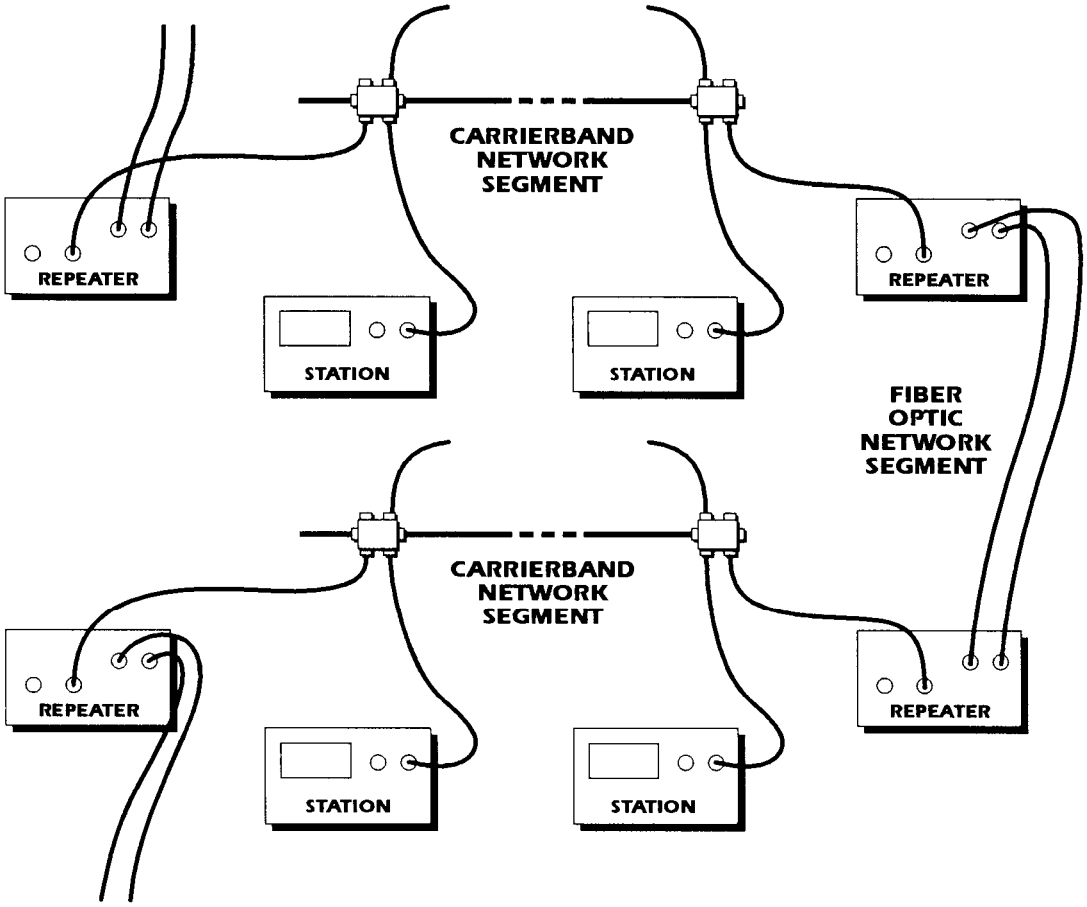

Figure 2. Linear String of Repeaters

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Fiber Optics can also be branched using a device called a Star Passive Coupler. The coupler receives optical signals from any of its input ports and sends them out on all of the transmit ports. The coupler is a totally optical device and does not require an external power source. See Relcom's Guide to Industrial Fiber Optics for guidance regarding couplers.

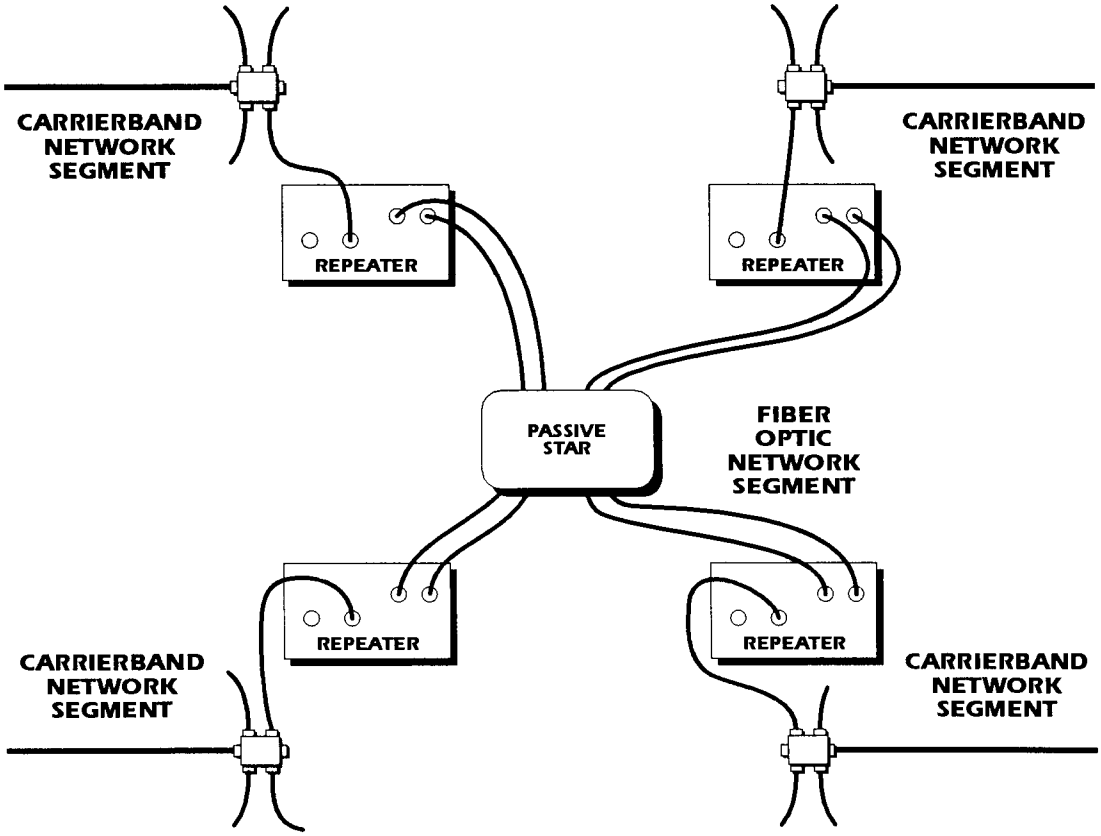

Figure 3. Passive Star Configuration

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When multiple Repeaters are used in a system, ensure that Repeaters and network segments do not get connected in such a way as to create a circular path as shown below. This will cause signal interference and the network will not work.

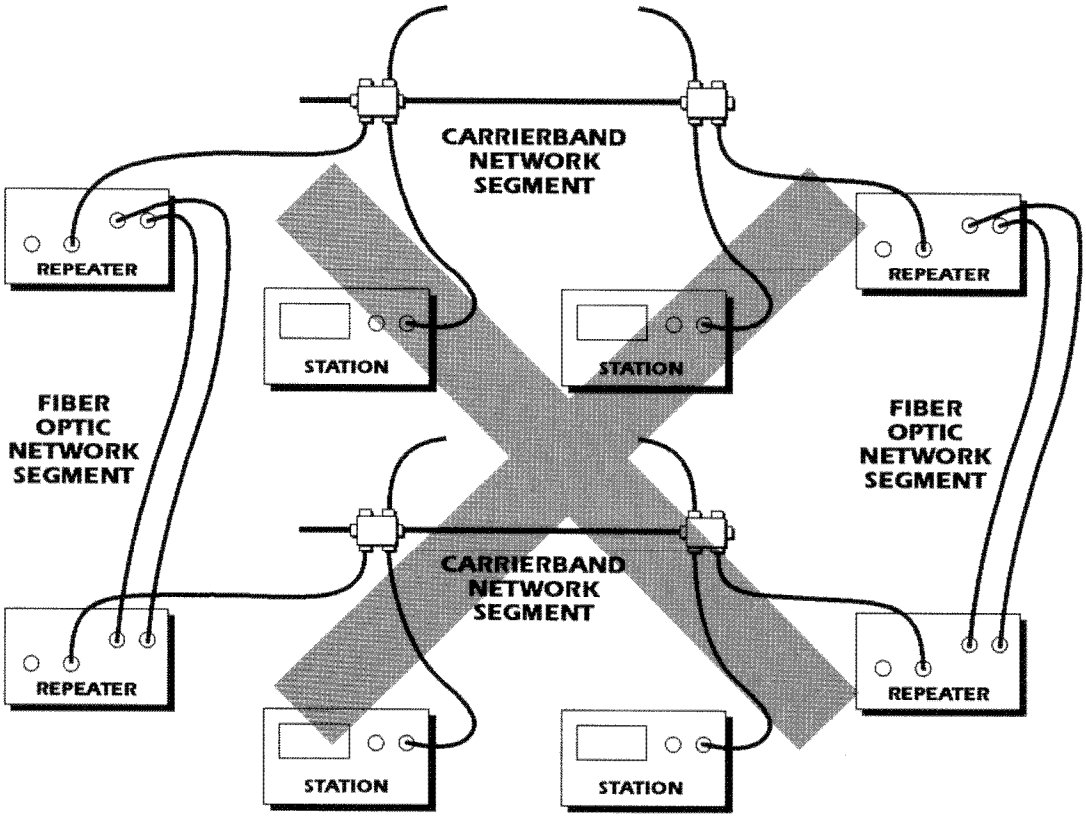

Figure 4. Cross Connected Configuration - DO NOT USE!!

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Network System Considerations

The following discussion assumes some familiarity with the operation of the Carrier-band network. If not, please refer to Relcom's Carrier-band Network Handbook, Section 4.

The Repeater is "transparent" to stations on the network segments. No protocol modification to the stations is necessary. All the stations work as if they were on one long trunk cable. There is, however a network parameter, slot_time, that may have to be increased in each network station.

Slot Time

Slot_time is the maximum time any station needs to wait for a response from any other station on the network. Slot_time is defined as:

Slot_time {(2 x Path_delay + Station_delay + Safety_margin)/0.2 +7}/8

The delays are in microseconds. The delay is divided by 0.2 to make the delay in terms of bit times. (At 5 Mbits/sec. the period of one bit is 0.2 microseconds). The "+7}/8" makes the slot_time in terms of bytes (or octets as they are known in LAN terminology).

Here is a sample calculation of slot_time:

Assume that the station delay, the time between when a station receives a frame and when it responds, is 5 microseconds.

Assume that the trunk cable length of each Carrier-band network segment is 400 meters. If the cable delay for RG-11 cable is 4 nanoseconds/meter then the path_delay is 4 x 400 or 1.6 microseconds on each carrier-band segment.

Assume the two Carrier-band segments are separated by 2 km of fiber optic cable. Assume that the delay of fiber optic cable is 5 nanoseconds/meter; then, the path delay of the fiber cable is 5 x 2000 or 10 microseconds.

The transit delay time through each Repeater is 400 nanoseconds or 0.4 microseconds.

Let the safety margin be 0.5 microseconds.

Slot_time = {(2 x [1.6 + 0.4 + 10 + 0.4 + 1.6] + 5 + 0.5)/0.2 +7}/8

= 22 (rounded up)

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Power

The Repeater is powered from an AC or DC power source depending on the option chosen.

AC power requirements are 120/240 Vac, 50/60 Hertz, 15W. The power cord connection to the Repeater is a standard IEC 320 plug. Different types of power cords can be used to adapt to various types of power sources.

DC power requirements are 24 Vdc, 15W.

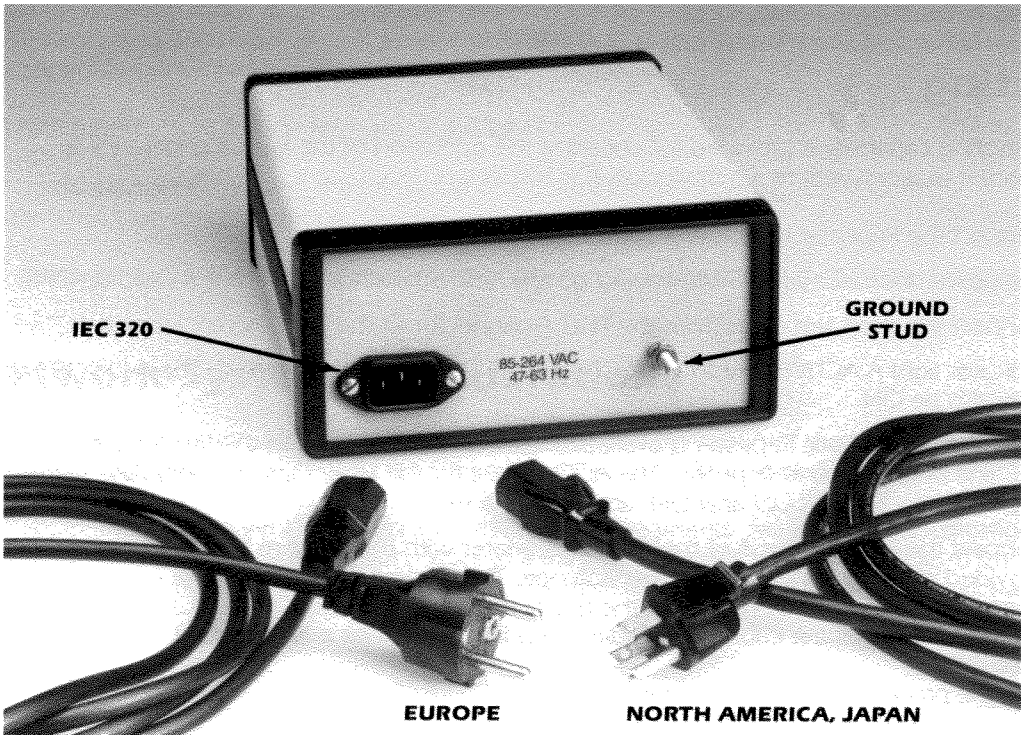

Figure 5. AC Power plugs

Grounding

For Repeaters with serial numbers 200 and higher, both F-connectors are grounded to the Repeater's case for reducing RFI emissions.

The Repeater's case is connected to the front panel TEST F-connector, to the mains ground connection of the AC power plug and to the stud on the back panel of the Repeater. The grounding stud is 1/4 inch.

Testing

A self-testing capability is provided for checking the operation of the Repeater before it is connected to a network or if a malfunction is suspected.

1. Connect the Repeater to a power source.

The power indicator light, PWR, should be ON. The other indicator lights should be OFF

2. Connect the short test cable from the TEST F-connector to the F-connector labeled A.

Indicator light A ACTIVE should blink ON and OFF about once a second. The A ERROR light may also be ON.

3. If another Fiber Optic Repeater is available, connect the XMIT line of the first Repeater to the REC line on the second Repeater. The ACTIVE light for the Fiber Optic input on the second Repeater should be ON.

4. Connect the F-connector A of the second Repeater with the 75 ohm terminated cable provided with the Repeater to an oscilloscope. The second Repeater will put out signal bursts. The peak-to-peak voltage of the bursts should be between 3.0 and 3.9 Volts. (Keep in mind that the cable gives a direct reading and is not a 10:1 probe.)

Repeat the procedure with the Repeaters reversed.

There is no built-in provision for testing the Fiber Optic input or output other than to connect two Repeaters back-to-back and use the TEST signal to check the operation of the Fiber Optic ports as described above.

The Repeater's optical power output can be measured with an optical power meter. The average optical output from the XMIT connector is the same whether the Repeater is transmitting or not. The measured output of the Repeater depends on the size of the fiber used and should be greater than listed below:

Fiber size	50/125	62.5/125	100/140
CBR-2 Output	-21 dBm	-17 dBm	-11.6 dBm
CBR-3 Output	--	-20 dBm	--

The values listed here are minimum values that take into account temperature variations and emitter aging. Under normal conditions the outputs should be 2-3 dBm higher

If these tests do not produce the specified results, the Repeater(s) may be defective and should be returned for repair

THERE ARE NO USER ADJUSTMENTS OR REPAIRS TO BE MADE INSIDE THE REPEATER EXCEPT AS NOTED ABOVE FOR SELECTING THE GROUNDING OPTION.

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Installation

The Repeater is connected to segments of the Carrier-band network like any other station through a drop cable and a tap. The following should be considered when installing a Repeater:

Place the Repeater where its indicator lights can be seen. This will help identify and isolate network problems if they occur

While the Repeater is fully enclosed, it is not waterproof. Install the Repeater in a dry place.

The Repeater operates at temperatures between -20 and +65 degrees Centigrade (-4 to 150 degrees F). However, do not install the Repeater in places where it will be heated by other equipment or where there is no airflow.

A rack mounting kit for the Repeater is available.

For guidance about installing the carrier-band segment of the network, see Relcom's Carrier-band Network Handbook.

For guidance about the fiber optic segment of the network, see Relcom's Guide to Industrial Fiber Optics.

For DC Repeaters (CBR-2DC, CBR-3DC) it is important to note that this device is considered to have a permanent connection to the power supply, in order to comply with CSA and UL requirements, a readily accessible disconnect device is required between the power connections on the Repeater and its power source. This shall be provided during the installation of the unit in a manner to comply with local regulations.

For both AC and DC Repeaters, users are warned not to disconnect power to the Repeater while the circuit is alive unless the location is known to be non-hazardous.

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Troubleshooting

During normal Repeater operation, the PWR light is ON, the two ACTIVE lights are ON and OFF intermittently and the ERROR lights may blink occasionally. If not, check the following list of symptoms and possible corrections:

1. The PWR light is OFF

Check the power cord and the power source.

2. An ACTIVE light is ON indicates that data is being received from that network segment. Normally the ACTIVE light shows differing levels of brightness indicating the relative amount of data received from the corresponding segment. If the light is solidly OFF, no data is being received. The causes may be:

The Repeater is disconnected from the network segment. Check the network wiring.

None of the stations on the network segment are transmitting.

The signal to the Repeater is too low. Check the signal level with the Carrier-band Tester.

The Repeater is defective. Check the Repeater with the test procedures.

3. If the ERROR indicator light blinks ON the Repeater has received a frame with an error. The ERROR light should blink ON no more than once every 20 seconds. This corresponds to a bit error rate of 10^{-9} or one bad bit received for one billion sent. If the ERROR light blinks ON more frequently:

There may be excessive noise on the network segment. Use the Carrier-band Tester to determine the noise level.

The Repeater may be receiving a signal that is too low. This may be a result of improper network design, failure in the cables or taps, or some station not transmitting at a sufficiently high signal level.

The Repeater detects two types of errors.

a. If the Repeater detects a start delimiter of a frame but no end delimiter before the received signal drops below threshold.

b. If the Repeater detects three consecutive "highs" or three consecutive "lows" within a bit cell. These are violations of the data encoding used in carrier-band.

The Repeater does not check frame CRCs or other types of network errors. The ERROR indicator lights are only a diagnostic aid for pointing to a segment that may be generating more than the expected number of errors.

4. If both ERROR lights are ON continuously, even if the Repeater is disconnected from the network segments, the Repeater has detected that it has an internal problem and has disconnected itself from the network segments.

To reset the Repeater, disconnect the power and reconnect it again. If both ERROR lights come ON again, the Repeater is defective.

THERE ARE NO USER ADJUSTMENTS OR REPAIRS THAT CAN BE PERFORMED ON THE REPEATER. IF THE REPEATER DOES NOT WORK PROPERLY, RETURN IT TO RELCOM FOR REPAIR OR REPLACEMENT.

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Specifications

DATA RATE	5 M bits/sec
TRANSIT DELAY	0.6 microseconds max. (one Repeater)
REPEATER CASCADE	16 Repeaters

Carrier-band

INPUT SIGNAL POWER	+10 to +66 dBmV
CONNECTOR	F-type with gold center contact, female

Fiber optic

FIBER SIZE	50/125	62.5/125	100/140
CBR-2 TRANSMITTER OUTPUT (AT END OF 30-YEAR LIFE) + TEMPERATURE RANGE	-21.0 dBm minimum	-17.0 dBm minimum	-11.6 dBm minimum
CBR-3 TRANSMITTER OUTPUT (AT END OF 30-YEAR LIFE) + TEMPERATURE RANGE	_	-20.0 dBm minimum	_
OPTICAL CONNECTOR TYPE	ST		
CBR-2 RECEIVER OPTICAL POWER RANGE	-26 dBm (1.6 µW) minimum (for BER < 10^{-9}) -8 dBm maximum (160 µW)		
CBR-3 RECEIVER OPTICAL POWER RANGE	-29 dBm (1.3uW) minimum (for BER < 10^{-9}) -11 dBm maximum (79 µW)		
PEAK EMISSION WAVELENGTH	CBR-2 820nm CBR-3 1300nm		
FIBER OPTIC CABLE BANDWIDTH REQUIREMENT	35 MHz minimum		

General

POWER REQUIREMENTS	AC option: 120/240 VAC, 50/60 Hz, 15W DC option: 24 VDC, 15W
POWER CONNECTOR	AC option: IEC 320 DC option: screw terminal block
STORAGE TEMPERATURE	-20 to +80° C
OPERATING TEMPERATURE (AFTER 30-MINUTE WARM-UP)	-20° to +65° C
EMI (ELECTROMAGNETIC INTERFERENCE)	EN 61326, Class A
ESD (ELECTROMAGNETIC DISCHARGE)	IEC 61000-4-2
SIZE	19 x 20 x 9 cm (7.5" x 8" x 3.5")
WEIGHT	1.4 Kg (3 Lbs.)

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Agency Approval

CBR-2AC and CBR-3AC: CSA, FM

CBR-2DC and CBR-3DC: CSA, FM

Models and Accessories

CBR-2AC	Carrier-band to Fiber Optic Repeater, 820 nm, AC Power
CBR-2DC	Carrier-band to Fiber Optic Repeater, 820 nm, DC Power
CBR-3AC	Carrier-band to Fiber Optic Repeater, 1300 nm, AC Power
CBR-3DC	Carrier-band to Fiber Optic Repeater, 1300 nm, DC Power
CBR-A001	Test Cable
CBR-A002	Scope Probe Cable with Termination
CBR-A003	North American, Japan Type Power Cord
CBR-A004	Continental Europe Type Power Cord
CBR-A005	Rack Mount Kit

Warranty

Relcom, Inc. warrants the Repeater 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 Repeater has been disassembled, modified or used for purposes other than those described in this manual.

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

Before utilizing the Repeater, the user should determine its suitability for the intended use. The user assumes all risks 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 Repeater without notice and with 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 questions or suggestions, please contact:

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