Operator's Manual

MirrorCell® Select
CDMA Repeater

Model CDR1901

ORTEL® CORPORATION

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Disclaimer

Every attempt has been made to make this material complete, accurate, and up-to-date. Users are cautioned, however, that Ortel Corporation reserves the right to make changes without notice and shall not be responsible for any damages, including consequential, caused by reliance on the material presented, including, but not limited to, typographical, arithmetical, or listing errors.

Ortel Corporation
Alhambra, California, 91803, USA

August 6, 1996

WARNINGS, CAUTIONS, AND GENERAL NOTES

This product conforms to FCC Part 15, Section 21. Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Note: **This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at their own expense.**

Safety Considerations

When installing or using this product, observe all safety precautions during handling and operation. Failure to comply with the following general safety precautions and with specific precautions described elsewhere in this manual violates the safety standards of the design, manufacture, and intended use of this product. Ortel Corporation assumes no liability for the customer's failure to comply with these precautions.

WARNING

WARNING Calls attention to a procedure or practice which, if ignored, may result in damage to the system or system component. Do not perform any procedure preceded by a WARNING until described conditions are fully understood and met.

If You Need Help

If you need additional copies of this manual, or have questions about system options, please contact Ortel's Sales Department.

Ortel's Sales Dept.
2015 W. Chestnut St., Alhambra, CA 91803-1542, USA
(626) 281-3636 or (800) 362-3891.

If you need additional help installing or using the system, please contact Ortel's Technical Support at (800) 627-7147 or (626) 281-3636.

Service

Do not attempt to modify or service any part of this product other than in accordance with procedures outlined in this Operator's Manual. If the product does not meet its warranted specifications, or if a problem is encountered that requires service, notify Ortel's sales department. Service will be rendered according the Ortel's warranty and repair policy. The product shall not be returned without contacting Ortel and obtaining a return authorization number from the Sales department

When returning a product for service, include the following information: Owner, Model Number, Serial Number, Return Authorization Number (obtained in advance from Ortel Corporation's Customer Service Department), service required and/or a description of the problem encountered.

Warranty and Repair Policy

The Ortel Corporation Quality Plan includes product test and inspection operations to verify the quality and reliability of our products.

Ortel uses every reasonable precaution to ensure that every device meets published electrical, optical, and mechanical specifications prior to shipment. Customers are asked to advise their incoming inspection, assembly, and test personnel as to the precautions required in handling and testing ESD sensitive opto-electronic components. Physical damage to the external surfaces voids warranty.

These products are covered by the following warranties:

1. General Warranty

   Ortel warrants to the original purchaser all standard products sold by Ortel to be free of defects in material and workmanship for the duration of the warranty period of one (1) year from date of shipment from Ortel. During the warranty period, Ortel's obligation, at our option, is limited to repair or replacement of any product that Ortel proves to be defective. This warranty does not apply to any product which has been subject to alteration, abuse, improper installation or application, accident, electrical or environmental over-stress, negligence in use, storage, transportation or handling.

2. Specific Product Warranty Instructions

   All Ortel products are manufactured to high quality standards and are warranted against defects in workmanship, materials and construction, and to no further extent. Any claim for repair or replacement of a device found to be defective on incoming inspection by a customer must be made within 30 days of receipt of the shipment, or within 30 days of discovery of a defect within the warranty period.

   This warranty is the only warranty made by Ortel and is in lieu of all other warranties, expressed or implied, except as to title, and can be amended only by a written instrument signed by an officer of Ortel.

Ortel sales agents or representatives are not authorized to make commitments on warranty returns.

In the event that it is necessary to return any product against the above warranty, the following procedure shall be followed:

a. **Return authorization shall be received from the Ortel Customer Service prior to returning any device. Advise the Ortel Customer Service of the model, serial number, and the discrepancy. The device shall then be forwarded to Ortel, transportation prepaid. Devices returned freight collect or without authorization may not be accepted.**

b. **Prior to repair, Ortel Customer Service will advise the customer of Ortel test results and will advise the customer of any charges for repair (usually for customer caused problems or out-of-warranty conditions).**

   If returned devices meet full specifications and do not require repair, or if non-warranty repairs are not authorized by the customer, the device may be subject to a standard evaluation charge. Customer approval for the repair and any associated costs will be the authority to begin the repair at Ortel. Customer approval is also necessary for any removal of certain parts, such as connectors, which may be necessary for Ortel testing or repair.

c. **Repaired products are warranted for the balance of the original warranty period, or at least 90 days from date of shipment.**

3. Limitations of Liabilities

Ortel's liability on any claim of any kind, including negligence, for any loss or damage arising from, connected with, or resulting from the purchase order, contract, or quotation, or from the performance or breach thereof, or from the design, manufacture, sale, delivery, installation, inspection, operation or use of any equipment covered by or furnished under this contract, shall in no case exceed the purchase price of the device which gives rise to the claim.

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Ortel test reports or data indicating mean-time-to-failure, mean-time-between-failure, or other reliability data are design guides and are not

intended to imply that individual products or samples of products will achieve the same results. These numbers are to be used as management and engineering tools, and are not necessarily indicative of expected field operation. These numbers assume a mature design, good parts, and no degradation of reliability due to manufacturing procedures and processes.

Handling the CDR1901

1. Use ESD precautions when dealing with the modules within the CDR 1901 so that units are not damaged.
2. Opening any module voids the warranty.
3. Modules cannot be "hot-swapped" (removed while unit is in operation). Disconnecting any component within the CDR 1901 when powered can damage or destroy the equipment and will void the warranty. Unit must not be operating when modules are removed for replacement.

TABLE OF CONTENTS

LIST OF FIGURES

1 GENERAL INFORMATION

The CDR1901 is a channel-selective CDMA repeater, designed to be fully compliant with "Personal Base Station – Base Station Compatibility Requirements for 1.8 to 2.0 GHz Code Division Multiple Access (CDMA) Personal Communications Systems" ANSI J-STD-008 specifications. Separate modules are used for each channel in both the transmit and receive directions. Each module selects a channel in a given direction (transmit or receive) and amplifies it. Standard output power is 2W (33 dBm) with an option for 4W (36 dBm).

The repeater is outfitted with one channel for each radio frequency path. The frequency and amplification of each channel can be individually controlled. The monitoring and control of the system occurs with a direct connection to a laptop computer or via a wireline option for remote access by modem.

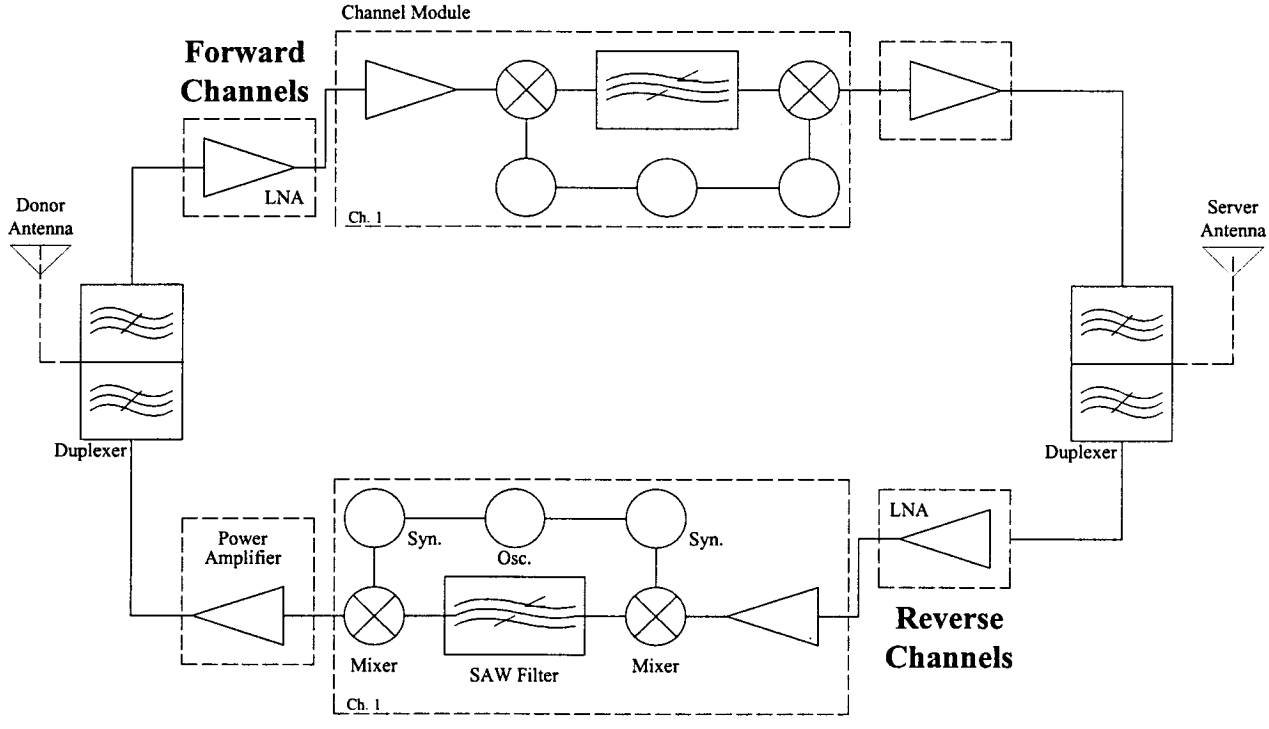

Figure 1. Block Diagram of the CDR1901 repeater.
The CDR1901 consists of several modules: the duplexer, LNA (Low Noise Amplifier), Channel Module (also known as Channelizer), and Power Amplifier. The reverse and forward directions consist of similar modules.

A receive diversity option is available for the repeater. (See Figure 2.) Receive diversity improves the performance of CDMA networks using repeaters. Two antennas are deployed on the server side of the repeater, to allow for spatial receive diversity. The signals from these antennas are combined, amplified, filtered, and then sent to a single donor antenna. The improved signal that is sent back to the donor site is accomplished without introducing additional noise or delay to the system.

Other benefits of using receive diversity include a reduced E_b / N_o, on an average of 1dB, and reduced mobile transmit power of 1 – 2 dB. The reduced E_b / N_o improves capacity of the donor site and minimizes cell site shrinkage. Reduced mobile transmit power has the benefits of increased phone battery life and increased coverage area for the repeater.

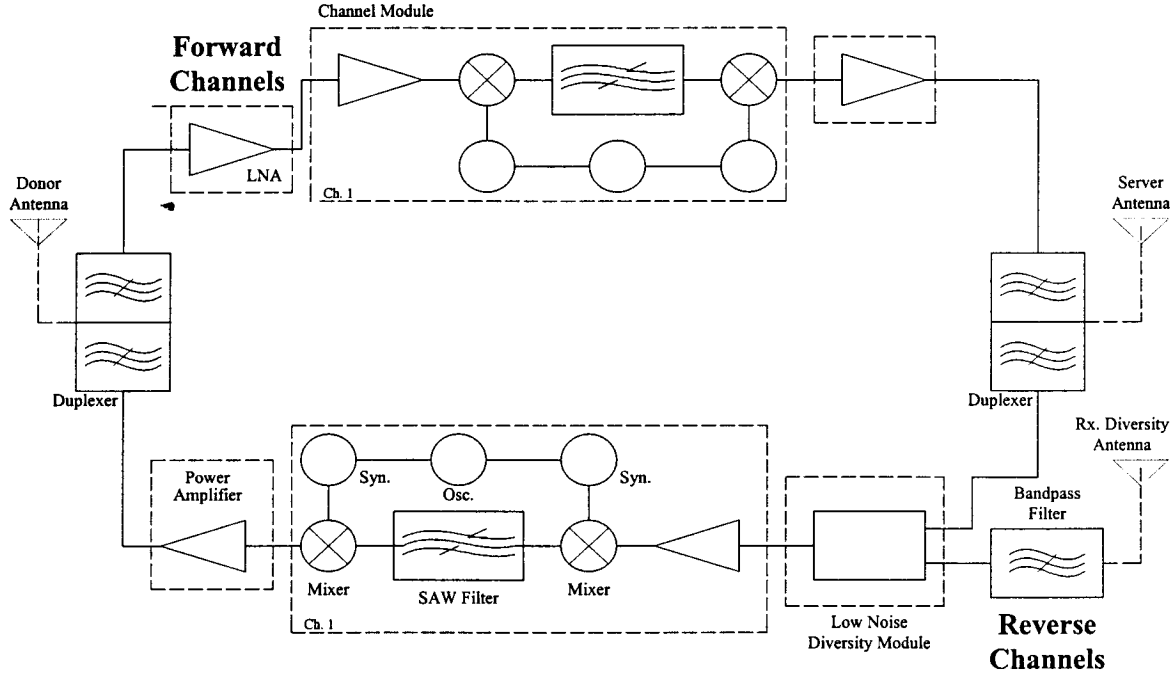

Figure 2. Block Diagram of the CDR1901 repeater with receive diversity.
When using receive diversity, two server antennas are needed. The modules are similar to those in the standard CDR1901, with the addition of a bandpass filter on the receive diversity antenna and a low noise diversity module.

The primary frequency stabilization for the CDR1901 CDMA repeater is provided by the 10 MHz temperature stabilized crystal oscillator, which provides a temperature compensated basic reference frequency for the PLL that provides the local oscillator frequency. The basic settable frequency accuracy is 5 ppm. All internally generated frequencies are locked to this basic oscillator. The same LO

frequency is used for both the upconverter and downconverter, ensuring no difference in the input and output frequencies.

An aluminum case houses the repeater. Cooling fins for the amplifier are located on the rear of the unit. The choice of aluminum as the case material gives a lightweight design with good heat conduction and weatherproof protection. The housing conforms to NEMA 3R/ IP32 standards.

The transmit and receive antenna ports are 7/16" standard, with the option of N-type connectors, located on the underside of the repeater. The external connections on the bottom of the repeater are protected from unauthorized access with a cover, which can be opened only from the inside of the repeater.

For plugable equipment, the socket-outlet shall be installed near the equipment and shall be easily accessible.

This product is Listed by Underwriters Laboratories, Inc. Representative samples of this product have been evaluated by UL and meet applicable UL standards and requirements.

This product is also authorized to bear the Canadian Standards Association (CSA) mark.

Various options on the CDR1901 repeater may not be approved for UL and/or CSA marking. In such a case, there will be no UL and/or CSA labels on the unit.

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2 DESCRIPTION OF MAJOR MODULAR COMPONENTS

2.1 Channel Modules

Each channel module consists of a preamplifier, a baseband downconverter with SAW (Surface Acoustic Wave) filters, a baseband upconverter, and a post amplifier. The module includes power level control functionality.

2.2 Power Amplifiers

The power amplifiers are designed for an output power of 2W (33dBm) with an option for 4W (36dBm). The power amplifiers are designed to meet the ANSI J-STD-008 and IS-95 standards for spectral regrowth.

2.3 Power Supply Module

The power supply is designed for an input voltage of 105 – 130 VAC. Options for 230 VAC and 24 VDC are available. In addition, the AC input is equipped with a surge suppression filter.

2.4 Duplex Filter

The transmit and receive antennas are combined with duplex filters operating in the PCS frequency band. The filter consists of comb-line cavity bandpass filters, which provide excellent isolation against out-of-band signals.

2.5 Status and Control Module

The status and control module enables monitoring and control of the repeater. This module determines the status of all channel modules and identifies all failure conditions. When an alarm occurs, the module can send a message to a PC over a serial data link. The PC connection is over a serial port through an RS232 interface to a VT-100 series terminal. The status and control module sends and receives channel and amplification data on the addressed channel modules when connected to a modem.

Monitoring and control is possible through the MirrorCell Element Manager (MEM) using a modem connection. The MEM is not accessible with a direct hard-line connection to the status and control module.

2.6 LNA Module

The LNA (Low Noise Amplifier) module consists of a low noise amplifier to provide the initial gain for a good noise figure.

2.7 Low Noise Diversity Receive Module

For the receive diversity option, this module combines signals received from both server antennas. It also provides the initial gain for a good noise figure.

2.8 Mechanical Drawing of the CDR1901 Repeater

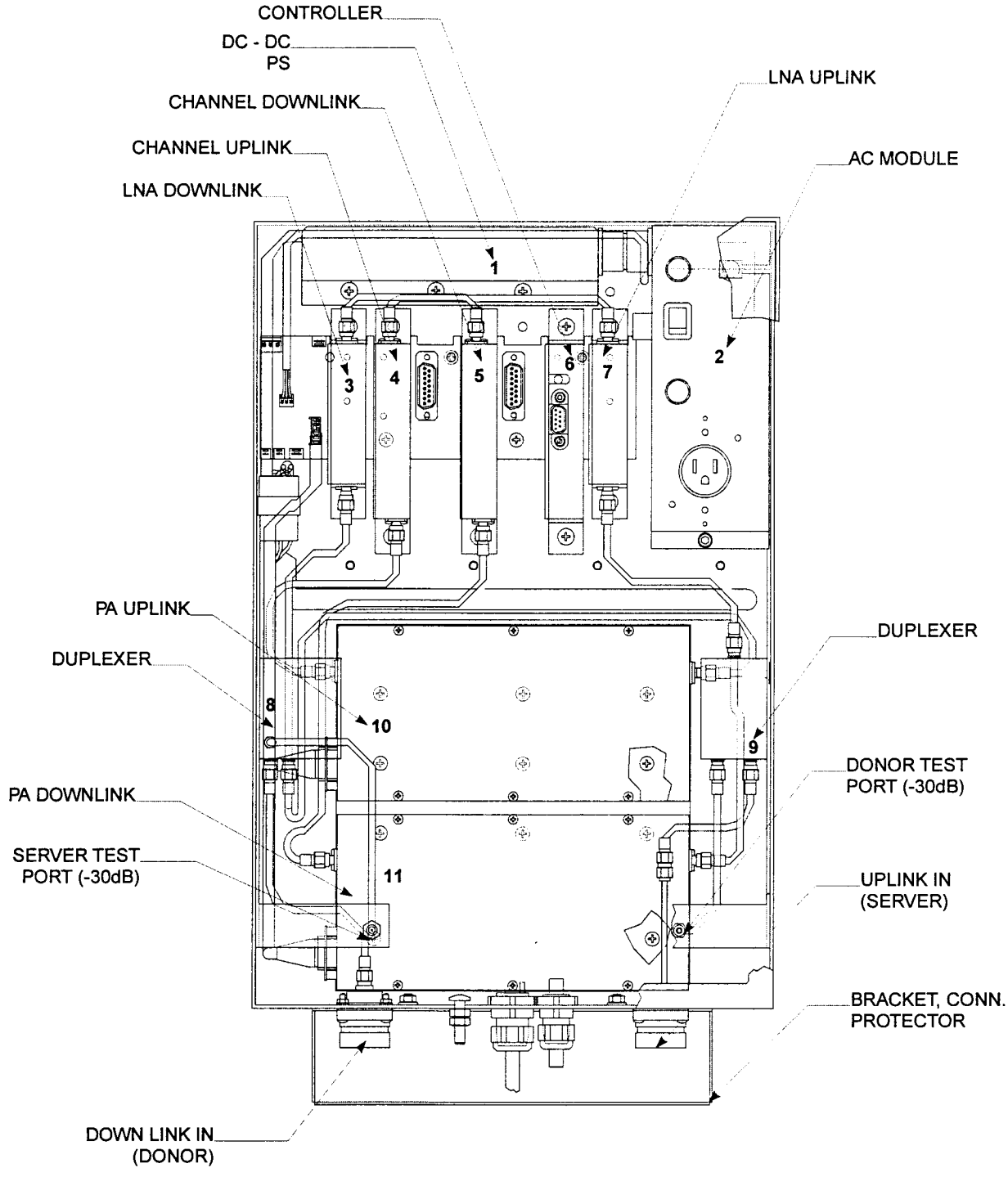

Figure 3. Mechanical drawing of the CDR1901 repeater.

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3 SPECIFICATIONS

3.1 RF Specifications

	REVERSE LINK	FORWARD LINK
Frequency	See Section 4.3	See Section 4.3
Channel Bandwidth	1.25 MHz	1.25 MHz
Output Power Limit: 33dBm 36dBm	24 dBm ± 1 dBm 24 dBm ± 1 dBm	33 dBm ± 1 dBm 36 dBm ± 1 dBm
Noise Figure at max gain Noise Figure at min gain Noise Figure with diversity	≤6.5 dB ≤6.5 dB ≤6.5 dB	≤8 dB N/A ≤8 dB
Gain at max setting: 33dBm Gain at max setting: 36dBm	85 dB nominal 88 dB nominal	85 dB nominal 88 dB nominal
Spectral Regrowth @ max gain: ±885kHz (30kHz BW) ±1.25 MHz, 12.5kHz integration BW Out of Band (1MHz)	 <-45 dBc <-13 dBm <-13 dBm	 <-45 dBc <-13 dBm <-13 dBm
Spectral Regrowth @ min gain: ±885kHz (30kHz BW) ±1.25 MHz, 12.5kHz integration BW Out of Band (1MHz)	 N/A N/A <-13 dBm	 <-45 dBc <-13 dBm <-13 dBm
Return Loss (Donor & Server ports)	>14 dB	>14 dB
Signal Delay	11 usec, typ.	11 usec, typ.
Connectors	7/16" Female N-Female, optional	7/16" Female N-Female, optional
Impedance	50 ohm	50 ohm
Flatness over 1.25 MHz	2.5 dB p-p	2.5 dB p-p
Gain change over channel range	±1.5 dB	±1.5 dB
Variation of gain over temperature	±3 dB	±3 dB
Digital Attenuator	0 to 30 dB 2 dB steps	0 to 30 dB 2 dB steps
Digital Attenuator Error at 30dB	<±2.5 dB	<±2.5 dB
Donor/Server Test Ports	-30 dB ± 5 dB	-30 dB ± 5 dB

3.2 Mechanical Specifications

Housing (W x H x D)	12 x 17.9 x 9.5 inches
Housing, with metal cover and anchorable feet	15.2 x 19.9 x 11.8 inches
Weight	47 ± 2 pounds, completely loaded
Housing Material	Aluminum
Primary Power	105 - 130 VAC, 1.8 A, 50 - 60 Hz 230 VAC, optional 24 VDC, optional
Connection Panel	Protected against unauthorized access
Color	Gray (painted)
Cooling	External Convection No ventilation slots

3.3 Environmental Specifications

EMI	Meets specifications for influx of an electromagnetic field of 10 V/m between 100 kHz – 1 GHz, excluding band of operation
Operating Temperature	-25 to 50° C. Also conforms to Bellcore specification GR-63-CORE, section 5.1.2
Storage Temperature	-40 to 75° C
Weather Resistance	Enclosure: NEMA 3R / IP32 rated
Shipping	Conforms to Bellcore specification GR-63-CORE, sections 5.3 and 5.4.3

3.4 Other Specifications

FCC ID	LB41901CDMA
Canada	CSA: LR110026 IC: 2778 331 126
UL	E177038

4 CHANNEL AND FREQUENCY PLAN

The PCS frequencies are divided into six different groups called bands. These bands are labeled A, B, C, D, E, and F. Each band consists of two sets of frequencies: one set for transmit (forward) and one for receive (reverse). The transmit frequencies range from 1850 MHz – 1910 MHz; receive frequencies range from 1930 MHz – 1990 MHz. The order of the bands (in ascending frequency) is A D B E F C. These frequencies are divided as follows.

4.1 Frequency Bands

Band Designator	Reverse Frequency	Forward Frequency
A	1850 - 1865 MHz	1930 - 1945 MHz
B	1870 - 1885 MHz	1950 - 1965 MHz
C	1895 - 1910 MHz	1975 - 1990 MHz
D	1865 - 1870 MHz	1945 - 1950 MHz
E	1885 - 1890 MHz	1965 - 1970 MHz
F	1890 - 1895 MHz	1970 - 1975 MHz

Figure 4. PCS Frequency Bands
The PCS frequencies are divided into six different bands, labeled A through F.

4.2 Channel Plan

The frequencies for each band are organized by channel numbers. Each channel number consists of a pair of frequencies: one frequency for the forward direction and one for the reverse direction. The frequencies corresponding to a particular channel can be calculated using the formulas in the following table.

Channels	Channel Number	Center Frequency (MHz)
Reverse	$0 \leq N \leq 1199$	1850.000 + 0.050 N
Forward	$0 \leq N \leq 1199$	1930.000 + 0.050 N

Figure 5. Frequency and Channel Number Calculation.
The frequencies for a particular PCS CDMA channel number can be calculated using these formulas.

4.3 Preferred Set of Channel Numbers

To optimize performance and minimize possible interference issues, Ortel recommends using the following channel sets for each band. These sets of channel numbers are based on recommendations listed in section 2 of ANSI J-STD-0008, "Personal Station – Base Station Compatibility Requirements for 1.8 to 2.0 GHz CDMA Personal Communications Systems."

A BAND		
CHANNEL	FORWARD (MHz)	REVERSE (MHz)
25	1931.25	1851.25
50	1932.50	1852.50
75	1933.75	1853.75
100	1935.00	1855.00
125	1936.25	1856.25
150	1937.50	1857.50
175	1938.75	1858.75
200	1940.00	1860.00
225	1941.25	1861.25
250	1942.50	1862.50
275	1943.75	1863.75

Figure 6. Preferred Set of Channel Numbers for A Band.
The listed channels are 1.25 MHz apart and allow for a guard band on either side of the block of frequencies.

B BAND		
CHANNEL	FORWARD (MHz)	REVERSE (MHz)
425	1951.25	1871.25
450	1952.50	1872.50
475	1953.75	1873.75
500	1955.00	1875.00
525	1956.25	1876.25
550	1957.50	1877.50
575	1958.75	1878.75
600	1960.00	1880.00
625	1961.25	1881.25
650	1962.50	1882.50
675	1963.75	1883.75

Figure 7. Preferred set of Channel Numbers for B Band.
The listed channels are 1.25 MHz apart and allow for a guard band on either side of the block of frequencies.

C BAND		
CHANNEL	FORWARD (MHz)	REVERSE (MHz)
925	1976.25	1896.25
950	1977.50	1897.50
975	1978.75	1898.75
1000	1980.00	1900.00
1025	1981.25	1901.25
1050	1982.50	1902.50
1075	1983.75	1903.75
1100	1985.00	1905.00
1125	1986.25	1906.25
1150	1987.50	1907.50
1175	1988.75	1908.75

Figure 8. Preferred Set of Channel Numbers for C Band.
The listed channels are 1.25 MHz apart and allow for a guard band on either side of the block of frequencies.

D BAND		
CHANNEL	FORWARD (MHz)	REVERSE (MHz)
325	1946.25	1866.25
350	1947.50	1867.50
375	1948.75	1868.75

Figure 9. Preferred Set of Channel Numbers for D Band.
The listed channels are 1.25 MHz apart and allow for a guard band on either side of the block of frequencies.

E BAND		
CHANNEL	FORWARD (MHz)	REVERSE (MHz)
725	1966.25	1886.25
750	1967.50	1887.50
775	1968.75	1888.75

Figure 10. Preferred Set of Channel Numbers for E Band.
The listed channels are 1.25 MHz apart and allow for a guard band on either side of the block of frequencies.

F BAND		
CHANNEL	FORWARD (MHz)	REVERSE (MHz)
825	1971.25	1891.25
850	1972.50	1892.50
875	1973.75	1893.75

Figure 11. Preferred Set of Channel Numbers for F Band.
The listed channels are 1.25 MHz apart and allow for a guard band on either side of the block of frequencies.

5 ATTENUATION CONTROL OF THE AMPLIFIER

The MirrorCell Select CDMA repeater offers 30dB of user-settable attenuation to customize the desired output of the repeater. The amplifier can be attenuated in 2dB steps, from 0dB to 30dB. Ortel recommends that you start with 30dB of attenuation and slowly decrease attenuation, thereby increasing output power, in order to ensure the repeater transmits only the desired amount, and not more. This will help to reduce interference caused by too much output power.

The following table is a guideline for setting the attenuation.

Attenuation (dB)	Nominal Gain Setting (dB) 33dBm Output	Nominal Gain Setting (dB) 36dBm Output
0	85	88
2	83	86
4	81	84
6	79	82
8	77	80
10	75	78
12	73	76
14	71	74
16	69	72
18	67	70
20	65	68
22	63	66
24	61	64
26	59	62
28	57	60
30	55	58

Figure 12. Attenuation Control of the Amplifier.
The gain of the repeater can be set via the amount of attenuation added to the signal path. Note that the gain of the standard 2W (33dBm) repeater is 85dB while the gain of the 4W (36dBm) repeater is 88dB.

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6 DESCRIPTION OF THE CONTROL MODULE

6.1 General

The repeater is equipped with a status & control module, which allows the monitoring and control of various parameters such as channel number, attenuation, temperature, status of door, etc., either with a local terminal or via OMC. The communication interface between the local terminal and the control module is set up as a self-explanatory menu for simple manual control and monitoring. This way, the parameters can be easily read off of and set up from the display.

6.2 Settings

The physical interface to the control module consists of a VT-100 series terminal connected to the repeater. Specifically, you will need a laptop computer with a terminal emulation program, such as ProComm or HyperTerminal, connected to the repeater via a DB9 straight-through serial cable with a male connector for the repeater side and a female connector to hook up to the computer's RS232 serial port.

The communication format must be set in the terminal emulation program:

- 9600 baud
- 8 bit
- 1 stop bit
- No parity
- No flow control (flow control = none)

6.3 Login via Local Maintenance Terminal (LMT)

When the PC is connected to the repeater, the login sequence is activated by user-input keystrokes. (See Section 7.6 in the Installation chapter for greater detail.) The login sequence begins by asking for Username and Password. Different user accounts have different authorities. The default login parameters are:

User Name	Password	Authority
USERNAM1	PASSWRD1	read/write
USERNAM2	PASSWRD2	read/write
USERNAM3	PASSWRD3	read only
USERNAM4	PASSWRD4	read only

Note: The Usernames and Passwords should be changed during installation. See Section 7.6, step 6.

For example, to change the second Username and Password:

SET UID2 ORTEL <enter>
SET PWD2 Alhambra <enter>

For more information, see section 6.10.3.

The control module logs the number of failed login attempts. If this number exceeds the user-defined maximum (ILA, default = 8), then future login attempts will be blocked. The false login count is decreased by one each hour. This means you must wait one hour after reaching the maximum number of failed login attempts before a single login can be initiated.

6.4 Commands

The control module does not differentiate between upper- and lower case characters. Command attributes and parameters can be viewed in the tables in section 6.10.

Available commands:

- **ADDRESS** Gives information about current address configuration.
- **CLEAR** Clears the display.
- **CLOCK** Displays a real-time clock.
- **HELP** Displays a quick overview of commands.
- **LOG** Shows the alarm log.
- **LOGOUT** Ends the work session.
- **STATUS** Displays the RF parameters (channel number, attenuation, etc.), as well as peripheral parameters (current draw, status of door).
- **SYSTEM** Shows system data (number of messages).
- **SET, GET** These commands allow the monitoring and control of the repeater's parameters.

All user editable parameters and current status of the repeater can be accessed using the GET and SET commands. Refer to section 6.10 for the format of the different attributes.

Note: The command field must be completely used; otherwise an error results.

Two parameters are writable only, not readable; these are Username and Password. See table 6.10.6.

The syntax for the GET command is:

GET [Attribute] <enter>

For example, to get the status of the forward path amplifier chains:

GET AMD <enter>

The syntax for the SET command is:

SET [Attribute] [Format] <enter>

Where all entries must be separated by a blank space. For example, to set the channel number for the repeater's channel 1:

SET CHA X YYY <enter>

where X = channel within the repeater and YYY = the CDMA channel number. The channel can be set only to channels within your system's band of operation.

6.5 Quick Commands

Three quick commands are available with the function keys:

- F1: Help Menu
- F2: Shows a list of the last ten entered commands
- F3: Shows the Status screen.

6.6 Command Log

The control module stores the last ten commands that have been entered. The F2 button brings up these commands. Use the up and down arrow keys to read off these stored commands. The right and left arrow keys can then be used, along with backspace and clear, to edit the commands as needed.

6.7 Configuring the External Alarms

The external alarms can be configured active-low or active-high, so the alarm is given in either the absence or presence of applied power. For configuration, use the following command:

SET EXT BC <enter>

where B refers to pin 1 and C refers to pin 2.
B or C = 0 means the absence of voltage is normal,
B or C = 1 means the presence of voltage is normal.
The alarms are laid out so that pin 1 is read from EX1 and pin 2 is read from EX2.

6.8 LED Indicators

The LEDs on the control module are tri-colored, where the illuminated colors mean:

- GREEN: Repeater is functioning properly
- AMBER: User is logged in to the control module
- RED: Repeater is not functioning properly

Note: Depending on the alarm configuration, the door alarm may go off a number of seconds after the door has been opened; in this case, the LED will change from Amber to Red.

6.9 Communication via DataCall

To establish a connection to the repeater, use a standard communication software package, such as HyperTerminal (which comes standard with Windows 95) or ProComm Plus. (See section 7.8 for setup instructions for HyperTerminal.) When a modem connection is established with the repeater, the command and parameter access is the same as when you are logged in directly to the repeater.

6.10 Command Attributes

Note: Write access to the parameters shown in each table is valid only if you have logged in with a read-and-write access password.

6.10.1 Channel Assignment Parameters

Designation	Attribute	Read	Write	Format	Comments
Attenuation Downlink (Forward)	ATD	X	X	N MM	N is the repeater channel number, MM is the amount of attenuation between 0 and 30 in 2dB steps.
Attenuation Uplink (Reverse)	ATU	X	X	N MM	N is the repeater channel number, MM is the amount of attenuation between 0 and 30 in 2dB steps.
Channel Information	CHA	X	X	N MMM	N is the repeater channel number, MMM is the actual CDMA channel number.
Channel limits	CHL	X		XXX YYY	XXX is the minimum CDMA channel number. YYY is the maximum CDMA channel number.
Output level Downlink (Forward)	LVD	X	X	N MM	N is the repeater channel number, MM is the RF output power limiting point. For 33dBm output: 27, 30, 33dBm; For 36dBm output: 30, 33, 36dBm. Set MM to "1" to disable the amplifier to turn off the repeater.
Output level Uplink (Reverse)	LVU	X	X	N MM	N is the repeater channel number, MM is the RF output power limiting point: 27, 30, 33dBm; NOTE: due to low output power from the mobile, reverse path power rarely exceeds 20dBm. Set MM to "1" to disable the amplifier to turn off the repeater.

6.10.2 Status Parameters

Designation	Attribute	Read	Write	Format	Comments
Amplifier downlink status	AMD	X		BB	First digit: channel 1 status Second digit: channel 2 status 0 is OK 1 is ERROR - is channel not installed
Amplifier uplink status	AMU	X		BB	First digit: channel 1 status Second digit: channel 2 status 0 is OK 1 is ERROR - is channel not installed
Status of communication Channelizers to Controller	COM	X		XYZW	X is status of communication with channelizer 1 UL (reverse) Y is status of communication with channelizer 2 UL (reverse) Z is status of communication with channelizer 1 DL (forward) W is status of communication with channelizer 2 DL (forward) 0 is OK 1 is ERROR - is channel not installed
Door status	DOO	X		B	0 = closed; 1 = opened
External pin 1 status	EX1	X		B	Status of external pin 1 0 is OK 1 is ERROR
External pin 2 status	EX2	X		B	Status of external pin 2 0 is OK 1 is ERROR
Power 1 status	PW1	X		B	Status of Power 1 0 is OK 1 is ERROR
Power 2 status	PW2	X		B	Status of Power 2 0 is OK 1 is ERROR
Synthesizers downlink	SZD	X		BB	First digit: channel 1 status Second digit: channel 2 status 0 is OK 1 is ERROR
Synthesizers uplink	SZU	X		BB	First digit: channel 1 status Second digit: channel 2 status 0 is OK 1 is ERROR
Temperature	TEM	X		B	0 indicates operating within limits 1 indicates operating out of limits

6.10.3 Communication Parameters

Designation	Attributes	Read	Write	Format	Comments
Addresses	ADD	X	X	N XXXXX..X up to 15 digits	These addresses are used when the repeater is configured for SMS. These are phone numbers to which the repeater reports messages; Up to four numbers are allowed: N = Selector ($1 \leq N \leq 4$)
Address of OMC	ASC	X	X	NNNN..NN Up to 15 digits	For DataCall, address to dial for the OMC. For SMS, address of Short Message Service Center (SMSC)
Communication Device	DEV	X	X	MMM	MMM = DTC for DataCall or remote VT-100 series login capability. MMM = SMS enables SMS MMM = NUL disables Communication.
Main Address	MAD	X	X	N $1 \leq N \leq 4$	Used when configured for SMS. Main address is the selector of one of the four addresses from ADD. This is the address to which alarms, heartbeat information, and traffic reports will be sent.
Modem Connect Time	MCT	X	X	NN	30 to 90 seconds; the time the repeater waits for the modem connection to be established. Valid only when configured for DataCall.
Message Numbers	MSG	X	X	N MMMMMM	N = Selector ($1 \leq N \leq 4$) Number of messages sent from the repeater.

6.10.4 Security Parameters

Designation	Attribute	Read	Write	Format	Comments
OMC to Repeater Password	ORP		X	XXXXXXXX	Up to 8 characters Password used for OMC to login to the repeater
Passwords	PWD		X	N XXXXXXXX	Password up to 8 characters long N = Selector ($1 \leq N \leq 4$)
Repeater to OMC Password	ROP		X	XXXXXXXX	Password up to 8 characters long Password for repeater to login to OMC
User-ID	UID		X	N XXXXXXXX ($1 \leq N \leq 4$)	Password up to 8 characters long N = Selector ($1 \leq N \leq 4$) User-ID 1 and 2: read and write User-ID 3 and 4: read only

6.10.5 Heartbeat Parameter

Designation	Attribute	Read	Write	Format	Comments
Repetition Cycle Alarm	RCH	X	X	NNNN 0 to 1440	Interval between heartbeat messages to OMC in minutes. Setting RCH to 0 disables heartbeat. When setting this parameter, a heartbeat will be sent out as soon as possible (ie, when user logs out if currently logged in)

6.10.6 Miscellaneous Parameters

Designation	Attribute	Read	Write	Format	Comments
Date	DAT	X	X	DDMMYY	
Hardware version number	HWV	X		CC..CC (max 120 characters)	Hardware version of the controller.
Invalid login attempts	ILA	X	X	CC (2 digits)	Number of consecutive invalid login attempts before an alarm is generated. The number is independent of the User-ID.
Timeout for LMT	LMT	X	X	NN (2 digits)	Time after user is automatically logged out when no activity is detected.
Maximum Gain	MGA	X		GG (2 digits)	GG = maximum gain of the repeater.
Number of channels	NCH	X		N ($1 \leq N \leq 4$)	Number of channels installed in the repeater.
Repeater information	RIN	X		CC..CC (max 120 characters)	Miscellaneous repeater information.
Serial Number	SNO	X		CC..CC (max 37 characters)	Textual description of repeater and controller serial numbers.
Software version number	SWV	X		CC..CC (max 120 characters)	Version of software in controller.
Time	TIM	X	X	HHMMSS	24 hour clock.
Vendor name	VND	X		CC..CC (max 120 characters)	Vendor information.

6.11 Alarms and Alarm Configuration

6.11.1 Overview

The MirrorCell Select CDMA repeater can send alarms to an Operations and Maintenance Center or to the MirrorCell Element Manager (MEM), both referred to as the OMC in this document, via a DataCall (modem connection). For each alarm sent, an end of alarm will also be sent when the end of alarm condition is detected. This does not include VLI, LGO, CLR, and ILI alarms. By default, the repeater requires an acknowledgement of each alarm sent. When using SMS, all letters must be capitalized.

Each alarm source can be individually configured. The software has the capability to enable or disable the requirement to acknowledge particular alarms (not including VLI, LGO, CLR, and ILI alarms), and the capability to configure different threshold for particular alarms. In addition, if a particular alarm condition arises which causes the alarm to toggle between OK and ERROR, the software has the capability to adjust the Minimum Alarm Repetition (MAR) time and the Maximum Number of Repetitions (MNR). This will keep the repeater from blocking the communication interface with a series of Alarm/End of Alarm notifications. (See section 6.11.7.2, "Minimum Alarm Repetition Time" for more information on this feature.)

6.11.2 Alarm Formats

Each alarm source has additional parameters sent with the alarm to the OMC, such as the severity of the alarm, the class of alarm, alarm attributes, and in some cases a textual description of the alarm. The message formats of the alarms sent to the repeater are described in the table below. These message formats apply to DataCall communications.

Message Field	Format	Description
Repeater ID	XX-YY-ZZZZ	ID of the repeater generating the message.
Message number	NNNNN	Number of the message from the repeater.
Message type	ALARM	Indicates either an alarm or end of alarm.
Date	DDMMYY	Day, month, and year of when the alarm was detected.
Time	HHMMSS	Hour, minute, and second when the alarm was detected.
Argument	SZU, SZD,...	Code for the alarm source; refer to section 6.11.3 for a description of the alarm sources within the repeater.
Severity	CC	An abbreviation for the severity of the alarm. CR = Critical MA = Major MI = Minor WA = Warning CL = Cleared Depending on the alarm source, the alarm has different severity classifications. When an end of alarm is sent, the severity is CL. See section 6.11.3 for the severity of the different alarms.
Class	CC	Abbreviation for the kind of alarm. CO = Communication alarm EN = Environmental alarm QS = Quality of service alarm PR = Processing alarm EQ = Equipment alarm See section 6.11.3 for the severity of the different alarms.
Parameter	C	The attribute for the different alarms. 1 = Error 0 = OK See section 6.11.3 for the severity of the different alarms.
Additional Information	CC..CC	Some alarm messages contain additional information for the alarms sent.

Example of an alarm format: (the message fields are separated with blanks)

17-42-4711 00023 ALARM 250697 145135 DOO CR EQ 1

The above alarm indicates a door alarm from repeater 17-42-4711; CR means it is critical; and the 1 means it is an error condition.

6.11.3 Alarm Attributes

The following table provides a description of each of the alarm sources within the repeater and the corresponding severity levels and class. In the parameter field, X = 0 means the attribute if OK, and X = 1 means the attribute is in error. Some of the attributes have the capability to report "-" which indicates the piece of equipment that would normally report this alarm is not installed. For example, in a two channel repeater with only one channel installed, certain alarms for channel 2 will indicate "-".

Alarm attribute	Severity Alarm/End	Class	Parameter	Description and notes
SZU	CR/CL	EQ	XX	Synthesizer uplink (reverse) UL1 and UL2 status reported.
SZD	CR/CL	EQ	XX	Synthesizer downlink (forward) DL1 and DL2 reported.
AMU	CR/CL	EQ	XX	Uplink amplifier chain for UL1 and UL2.
AMD	CR/CL	EQ	XX	Downlink amplifier chain for DL1 and DL2.
TEM	CR/CL	EQ	XX	Temperature alarm.
DOO	CR/CL	EQ	XX	Door alarm.
PW1	CR/CL	EQ	XX	Power 1 alarm.
PW2	CR/CL	EQ	XX	Power 2 alarm.
EX1	WA/CL	EN	XX	Alarm from external pin 1.
EX2	WA/CL	EN	XX	Alarm from external pin 2.
COM	WA/CL	EN	XYZW	Communication between controller and channelizers. The order is: X: UL1, Y: UL2, Z:DL1, W: DL2.
VLI	WA	EN	[Username]	Valid login alarm; an alarm that someone has logged in successfully to the repeater. Username is the username logged in. **NOTE**: no end of alarm message sent.
LGO	WA	EN	[Username]	Sent to indicate that Username has logged out from the repeater. **NOTE**: no end of alarm message sent.
CLR	MI	EN		Sent to indicate that changes were made by the last person logged in to the repeater. **NOTE**: no end of alarm message sent.
ILI	CR	EN	[Username]	Sent when the maximum number of failed login attempts is exceeded. [Username] is the last person attempting to login. **NOTE**: no end of alarm message sent.

6.11.4 Acknowledgment of Alarms

In the case of DataCall communications, the alarm is considered to be acknowledged when the repeater has logged in to the OMC and reports the alarm.

Message Field	Format	Description
Repeater ID	XX-YY-ZZZZ	ID of the repeater that the message is intended for.
Message number	NNNNN	Message number from the OMC.
Command	ACT	Indicates that the message will perform an action.
Argument	ACK	Indicates that an acknowledgment is expected.
Argument	MMMMM	Message number of the alarm/end alarm message sent by the repeater.

An example of an alarm acknowledgment message, with message fields separated by blanks:

17-42-4711 00242 ACT ACK 00023

This message indicates an acknowledgment of alarm number 00023 from repeater 17-42-4711.

6.11.5 Alarm Retransmission

If the repeater fails to send an alarm, or of it does not receive an acknowledgment of the alarm, the repeater will attempt to resend the alarm after a user-configurable time interval. The repeater will continue to try to resend the alarm for a user-configurable number of times, or until the repeater receives an acknowledgment of the alarm.

The command/attribute for setting the time interval between retransmissions (Repetition Cycle Alarm) is:

SET RCA XXX <enter> (0<XXX<999 minutes)

The command/attribute for setting the maximum number of repetitions, MNR, is:

SET MNR XX <enter> (0<XX<99 repetition)

6.11.6 Alarm Configuration

Each alarm source is associated with a specific configuration string. This string provides the operator with the possibility to individually configure each alarm. The program has the capability to enable or disable each alarm, the capability to disable the requirement to acknowledge certain alarms (not including VLI, LGO, CLR, and ILI alarms), and the capability to configure different thresholds for particular alarms.

The command to set the alarm string is:

SET ALA [ALARMSOURCE] [ALARMSTRING] <enter>

The following tables describe the alarm string format and the default threshold values for each of the alarms.

6.11.6.1 Alarm String Format

Field Number	Format	Description and Notes
1	X	Determines if the alarm source is enable/disabled X = 0 Alarm is enabled X = 1 Alarm is disabled
2	Y	Determines whether the alarm needs acknowledgment Y = 0 Alarm requires acknowledgment from the OMC Y = 1 Alarm does not require acknowledgment from OMC **NOTE:** This attribute is not used by VLI, LGO, CLR, or ILI
3	E	Shows how alarm is to be calculated/measured E = 1 Evaluate both thresholds E = 2 Evaluate lower threshold E = 3 Evaluate upper threshold E = 4 Ignore limit thresholds (for digital signals such as the door). **NOTE:** This attribute is only an indication of how the alarm parameters are calculated. Changing this will not affect the measurements; ie, the calculation is hard coded.
4	LLL	Lower threshold value
5	UUU	Upper threshold value
6	TTT	Time in seconds for the alarm/measurement to be out of limits before an alarm is triggered.

6.11.6.2 Alarm Threshold Values

Alarm Code	Send	Ack	Eval	Lower	Upper	Seconds	Comments
SZU	0	0	4	000	000	001	
SZD	0	0	4	000	000	001	
AMU	0	0	2	020	000	001	
AMD	0	0	2	020	000	001	Set for LVD = 33 dBm
TEM	0	0	3	000	060	005	Threshold in ° C
DOO	0	0	4	000	000	030	
PW1	0	0	1	090	110	005	Threshold in % of normal
PW2	0	0	1	090	110	005	Threshold in % of normal
EX1	0	0	4	000	000	001	
EX2	0	0	4	000	000	001	
COM	0	0	4	000	000	001	
VLI	0	0	4	000	000	000	
LGO	0	0	4	000	000	000	
CLR	0	0	4	000	000	000	
ILI	0	0	4	000	000	000	

Example of an alarm string custom configuration, with message fields separated by blanks:

SET ALA PW1 0 0 1 80 120 5 <enter>

will customize the thresholds for the PW1 alarm. It will enable the alarm, require acknowledgment, set the lower threshold to 80, set the upper threshold to 120, and require the attribute to be out of limits for 5 seconds before an alarm is generated. The alarm evaluator remains in the default value (1).

Note: The threshold for the AMD alarm depends upon the output power. The default of "20" is based on a peak output power of 33dBm. For peak output power of 30, set AMD to 17. For peak output power of 27, set AMD to 14.

6.11.7 Miscellaneous Alarm Configuration Parameters

6.11.7.1 Configuring the External Alarms

The external alarms can be configured active-low or active-high. Use the following command to configure these alarms:

SET EXT BC <enter>

B refers to pin 1, read from EX1, and C refers to pins 2, read from EX2.
B, C = 0 means that no voltage is an OK condition
B, C = 1 means that a high voltage is an OK condition.

Note: The write access to these parameters is valid only if you are logged in with a read-and-write access password, or if you are sending an SMS message with read and write access.

Designation	Attribute	Read	Write	Format	Comments
External alarm pin configuration	EXT	X	X	BC	B, C = 0 Alarm active low. B, C = 0 Alarm active high.
Repetition cycle alarm	RCA	X	X	NNN 3 digits	Amount of time the repeater waits before retransmitting unconfirmed alarm
Minimum alarm repetition time	MAR	X	X	NN 2 digits	NN is from 0 to 99 minutes.
Maximum number of repetitions	MNR	X	X	NN 2 digits	Maximum number of RCA attempts.

6.11.7.2 Minimum Alarm Repetition Time

This command has been introduced for the case where an alarm is toggling between OK and ERROR. In this state, the repeater should not continuously call the OMC with the new alarm detected for the same fault condition and potentially block the communication between the repeater and the OMC. Typically the MAR should be set to a minimum of two or three times the amount it takes for the repeater to dial up and report the alarm. MAR is expressed in minutes, and the default value is 3.

Note that the first error will always be detected within the normal threshold time. Only the repeated alarms will be blocked. If numerous alarms are received at the OMC, the operator must be able to send a message to disable the particular alarm at the repeater until service of the repeater can be performed.

For example, to set Minimum Alarm Repetition:

SET MAR 5 <enter>

This will set the alarm repetition time to 5 minutes.

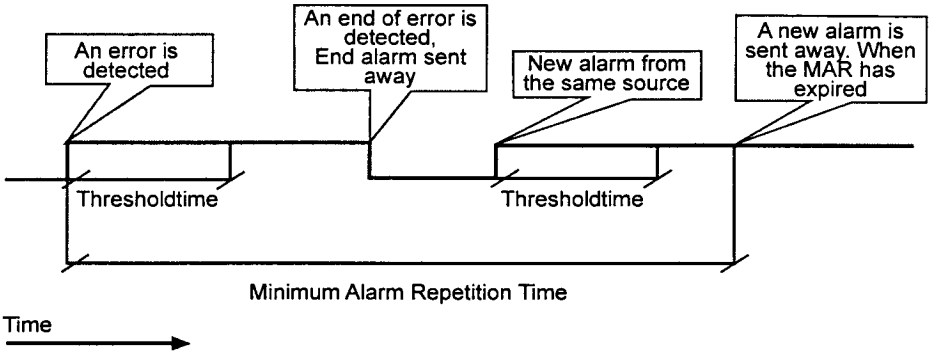

Figure 13. Minimum Alarm Repetition time.
The above figure shows how repetitive alarms are blocked by the MAR attribute.

6.12 Heartbeat Message Format

Field	Format	Description
Repeater ID	XX-YY-ZZZZ	
Message no.	NNNNN	
State	STATE	Incoming heartbeat
Date	DDMMYY	
Time	HHMMSS	24 hour clock
NCH	N	Number of channels
CHA 1	NNN	If channel is not installed, number is replaced by '-' Length of attribute depends on channel number (ie, CDMA channel 100)
CHA2	NNN	If channel is not installed, number is replaced by '-' Length of attribute depends on channel number (ie, CDMA channel 100)
Reserved for future use	- -	Two dashes separated by a space
ATU1	NN	If channel is not installed, number is replaced by '-' (dash)
ATU2	NN	If channel is not installed, number is replaced by '-' (dash)
Reserved for future use	- -	Two dashes separated by a space
ATD1	NN	If channel is not installed, number is replaced by '-' (dash)
ATD2	NN	If channel is not installed, number is replaced by '-' (dash)
Reserved for future use	- -	Two dashes separated by a space
LVU1	NN	If channel is not installed, number is replaced by '-' (dash)
LVU2	NN	If channel is not installed, number is replaced by '-' (dash)
Reserved for future use	- -	Two dashes separated by a space
LVD1		If channel is not installed, number is replaced by '-' (dash)
LVD2		If channel is not installed, number is replaced by '-' (dash)
Reserved for future use	- -	Two dashes separated by a space
SZU	BB	If status not available, replaced by '-'
SZD	BB	If status not available, replaced by '-'
AMU	BB	If status not available, replaced by '-'
AMD	BB	If status not available, replaced by '-'
COM	BBBB	If status not available, replaced by '-'
TEM	B	State of temperature
DOO	B	State of door
PW1	B	State of power 1
PW2	B	State of power 2
EX1	B	State of external pin 1
EX2	B	State of external pin 2
RCH	NNNN	Repetition cycle heartbeat
RCA	NNN	Repetition cycle alarm
MNR	NN	Maximum number of alarm repetitions.

7 INSTALLATION OF THE CDR1901

7.1 Shipment Contents

- Repeater
- Operator's manual
- Wall mount brackets
- Keys for repeater's locks
- "Quick Tips"

7.2 Site Selection

Site selection for the repeater is one of the most critical decisions affecting the overall performance of the repeater system. A repeater must be located where it can receive a sufficient signal from the donor site in order to maximize the repeater's performance. For the 33dBm output repeater, an input signal strength at the donor input connector (after the donor antenna and coax cable) of greater than or equal to –52dBm is required for a 33dBm output: -52dBm + 85dB gain = 33dBm. For the 36dBm output repeater, an input signal strength of greater than or equal to –52dBm is required for a 36dBm output: -52dBm + 88dB gain = 36dBm.

Examples of repeater and accompanying antenna locations include, but are not limited to:

- the roof of a building adjacent to the affected area with the antennas mounted to the penthouse or building sides
- the top of a hill that is obstructing the donor site's coverage, with the antennas pipe-mounted at ground level
- a water tower with antennas mounted at the top
- an existing utility pole, with equipment and antennas mounted below any existing power lines
- a newly installed pole or tower.

For more detailed information on site selection, as well as antenna selection and placement, please see Ortel's Application Note: "Integrating MirrorCell Select Repeaters into a CDMA Network."

7.3 Antenna Selection

Proper selection of the repeater's donor and server antennas is crucial in designing the repeater system. Good antenna characteristics help to provide proper isolation between the server and donor antennas, which helps to prevent feedback.

The donor antenna selected for use with a CDR1901 is critical in the design of a properly functioning repeater system. Since in CDMA systems all of the base stations transmit the same frequency, the donor antenna selected must be capable of receiving only the desired base station. Microwave dish antennas with vertical and horizontal beamwidths of less than 15° are ideal candidates for the donor antenna. Microwave dish antennas also provide the recommended front-to-back ratio of greater than or equal to 25dB to help achieve the required antenna isolation.

The server antenna should provide the desired coverage and also provide the recommended the recommended front-to-back ratio of 25dB. Many different types of antennas will work as a server, such as panel antennas, Yagi antennas, and, for indoor applications, Omni-directional antennas.

The isolation between antennas must be at least 10dB greater than the gain setting of the repeater or the repeater could go into oscillation. Specific ways to achieve proper isolation include:

- using high gain, directional antennas with good front-to-back ratios (≥25dB)
- pointing the donor and server antennas opposite each other; ie, at 180° from each other
- physical separation of the repeater's donor and server antennas
- external shielding, such as wire mesh or a grounded metal plane.

Antenna isolation limits the amount of gain to which the repeater should be set. Therefore, if isolation is less than 95dB, the repeater cannot be set to the maximum of 85dB, in the 33dBm-output model. For the 36dBm-output model, and isolation is at least 98dB is required to use the full 88dB of gain.

The table in Figure 14 is a guideline as to how far apart antennas need to be placed in order to achieve the desired isolation. These figures assume the donor and server antennas are pointing 180° apart and are based on the following formula.

Vertical separation: $I(dB) = 28 + 40 \log (D/\lambda)$
Horizontal separation: $I(dB) = 22 + 20 \log (D/\lambda) - (G_d + G_s)$

I = Isolation (dB)
D = Distance between donor and server antennas (feet)
λ = Wavelength (feet)
G_d = Gain of donor antenna in direction of server antenna
G_s = Gain of server antenna in direction of donor antenna
(valid for G_d, G_s < 10dB)

Note that this table is only a guideline and does **not** substitute for measuring the isolation. See section 7.4.2 for procedures to measure isolation.

Antenna Separation (ft.)	Vertical Isolation (dB)	Horizontal Isolation (dB)
10	79.4	47.7
25	95.3	61.7
50	107.4	67.7
100	119.4	71.2
150	126.5	75.7

Figure 14. Vertical and Horizontal Antenna Isolation at 1900 MHz.
Antenna isolation increases the further apart the antennas are mounted. As this table shows, vertical separation provides better isolation than horizontal separation.

7.4 Antenna Mounting

7.4.1 Donor Antenna

Use the following steps to mount the donor antenna.

1. Mount donor antenna at initially desired location.
2. Measure the received signal strength from the donor site. The amount of power the repeater can produce is dependent on this signal level. Note whether the donor is loaded or unloaded, as this will affect the amount of power needed. The tables in Figures 15 and 16 show received signal strength measured after the donor antenna into the repeater when using the full gain of the repeater.

Received Signal Strength at Donor Antenna Port	Max. Output Power/Channel at Server Antenna Port for Standard Repeater
-52dBm	33dBm
-55dBm	30dBm
-65dBm	20dBm
-75dBm	10dBm

Figure 15. Received Signal Strength vs. Output Power for Standard Repeater.
The output of the repeater is dependent upon the received signal strength at the donor antenna port and the amount of gain used. For example, when the repeater's full 85dB of gain is used, with a received signal strength of –65dBm, the maximum output the repeater can provide is 20dBm.

Received Signal Strength at Donor Antenna Port	Max. Output Power/Channel at Server Antenna Port for 36dBm-option Repeater
-52dBm	36dBm
-55dBm	33dBm
-65dBm	23dBm
-75dBm	13dBm

Figure 16. Received Signal Strength vs. Output Power for 36dBm Repeater.
The output of the repeater is dependent upon the received signal strength at the donor antenna port and the amount of gain used. For example, when the repeater's full 88dB of gain is used, with a received signal strength of –65dBm, the maximum output the repeater can provide is 23dBm.

3. If a greater signal strength is needed, try raising the donor antenna's height, or use a higher gain antenna, if possible.
4. Measure the pilot tone strength received after the donor antenna and verify that the proper base station sector is being received. The pilot tone of the desired base station should be at least 15dB higher than any of the other received pilot tones. If this is not the case, the donor antenna should be adjusted until the desired pilot tone is 15dB greater than any other received pilot tones. (Note that this requires a CDMA signal measurement device.)

7.4.2 Server Antenna Mounting and Isolation Measurements

Isolation measurements should be taken to ensure proper operation of the repeater. Measurement of isolation can be accomplished easily by following the procedures, as illustrated in Figure 17.

1. Mount server and donor antennas at initially chosen location to obtain desired coverage.
2. Inject a known signal within the bandwidth of operation into the donor antenna. An unused channel within the band should be used. The signal should be at least 1W in order to allow for an accurate measurement of isolation. The repeater and a low-power signal generator can be used in series to generate a signal of sufficient strength. The repeater will 55dB – 85dB of gain (or 58dB – 88dB for the 36dB-output repeater), depending upon how much attenuation is added to the repeater.
3. Connect a signal measurement device, such as a spectrum analyzer, to the server antenna. Measure the received signal level. The difference between the signal input to the donor antenna and the received signal measured after the server antenna is the antenna isolation. (Note that the gain of the antenna is not used in the calculation.)

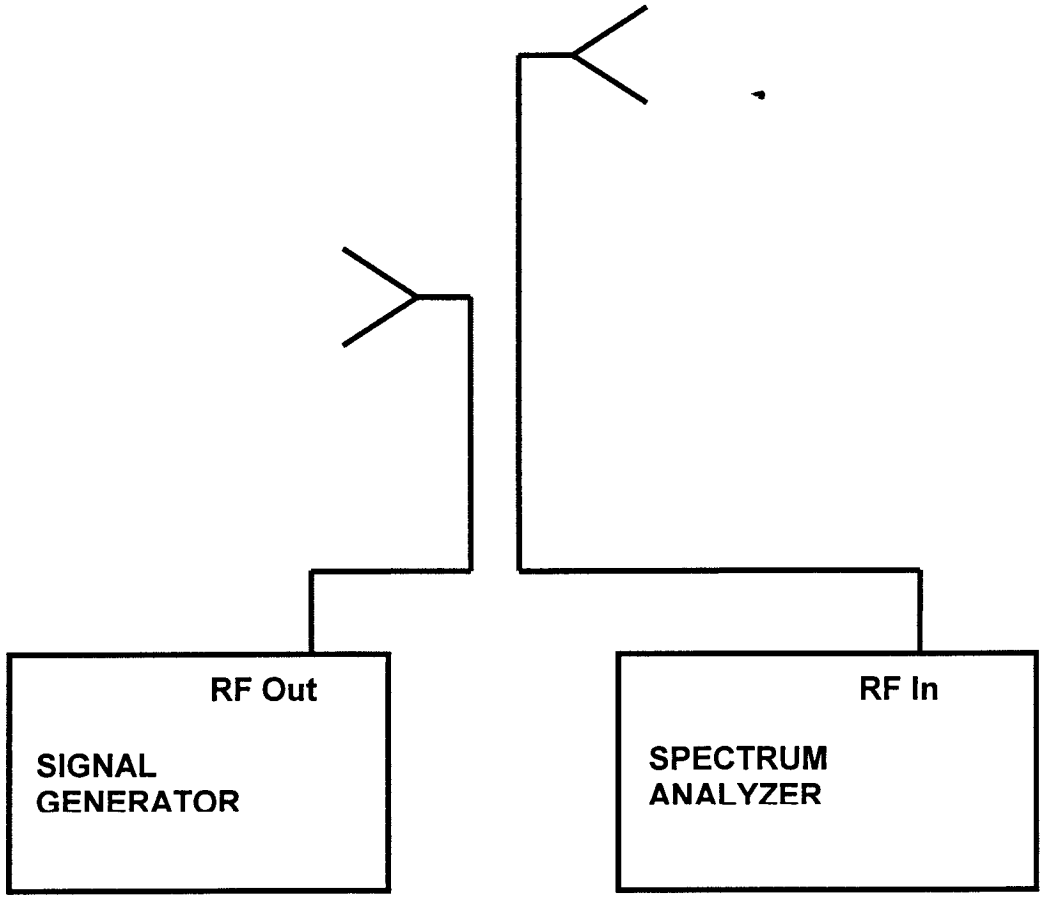

Figure 17. Isolation Measurement Setup.
Antenna isolation can be measured once the donor and server antennas have been mounted at their initially desired location. Isolation measurement is important in properly setting up a repeater.

4. The repeater gain can be set to at least 10dB below the figured measured above. (The antenna isolation must be at least 10dB greater than the repeater gain.) For example, if the antenna isolation measured is 90dB, the repeater gain should be set for no more than 80dB.
5. If isolation is not great enough (ie, if more gain is required), you can try either of the following:
   a. Separate the antennas by a greater distance. (See the tables in Figures 15 and 16 for separation distances with expected isolation.)
   b. Mount some type of external shielding between the antennas, such as a mesh screen, an ice shield, or grounded metal plate.

7.5 Repeater Mounting and Installation

The following recommendations should be adhered to for enhanced repeater performance.

1. The repeater comes standard with wall mount brackets as shown in Figure 18. The brackets attach to the repeater with eight M8x1.25 thread bolt screws, included in the shipment.
2. The repeater should be mounted so the heatsink avoids direct sunlight. This will help improve the lifetime of the repeater.
3. Mount the repeater upright so that the connectors are on the underside. This will help prevent a buildup of moisture inside the repeater.
4. The repeater is equipped with 7/16" DIN (or N-type as an option) antenna connectors. Connectors are located at the bottom of the unit. A protective cover is included with the repeater to prevent unauthorized access to the connectors. The cover can be installed or removed only from the inside of the unit.
5. Ensure that adequate room has been allocated for the bending radius of the cables. Refer to the cable manufacturer's specifications for the allowable cable-bend radius.
6. Ensure that adequate room is allowed for the opening and closing of the repeater door. See Figure 18 for dimensions of the repeater.

7.5.1 Repeater Dimensions

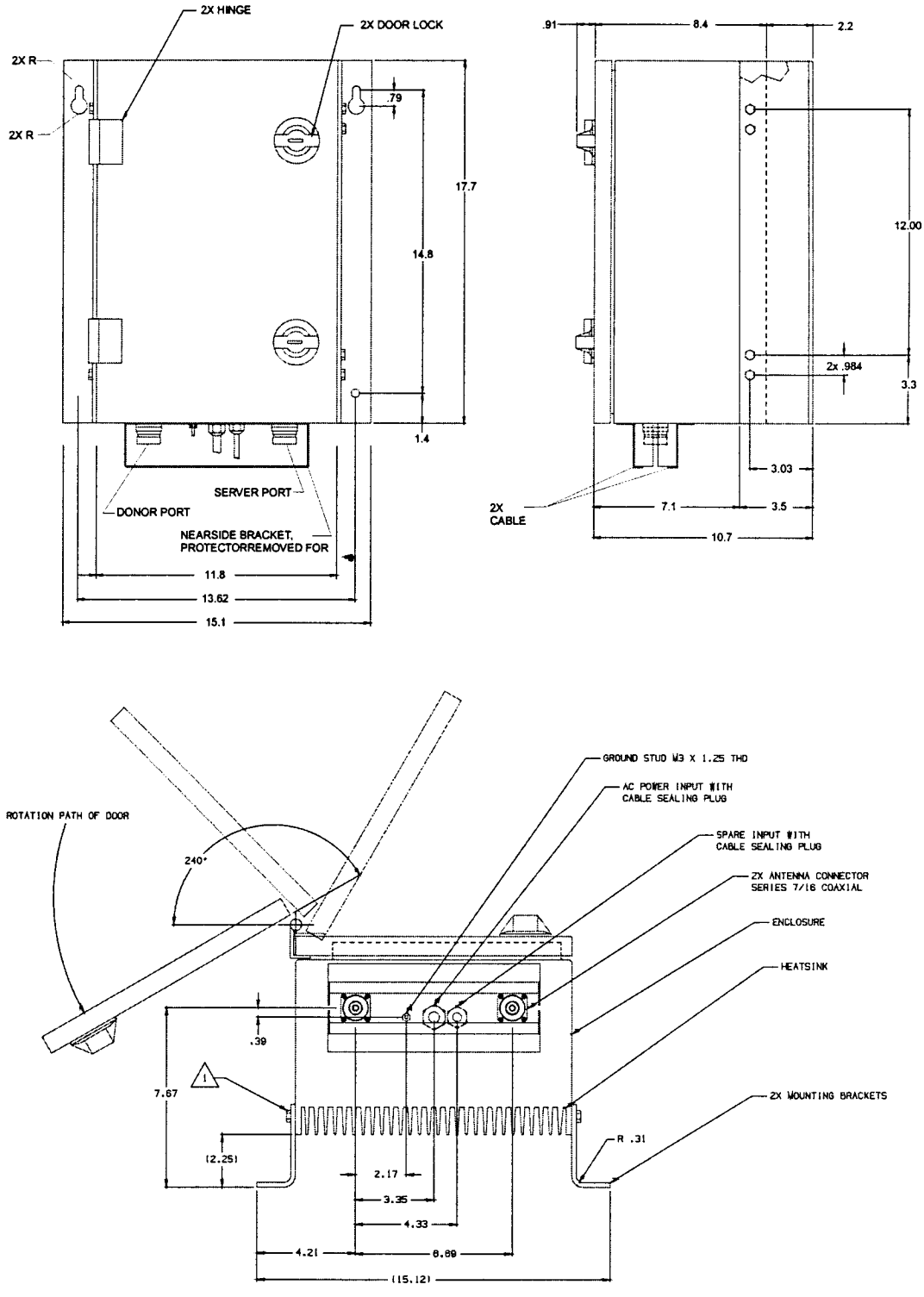

Figure 18. Repeater Dimensions, shown in inches.

7.5.2 Pole Mounting of the Repeater

Figure 19 shows a method of pole mounting for the repeater. This can be accomplished using brackets, "unistrut," and appropriately sized U-bolts.

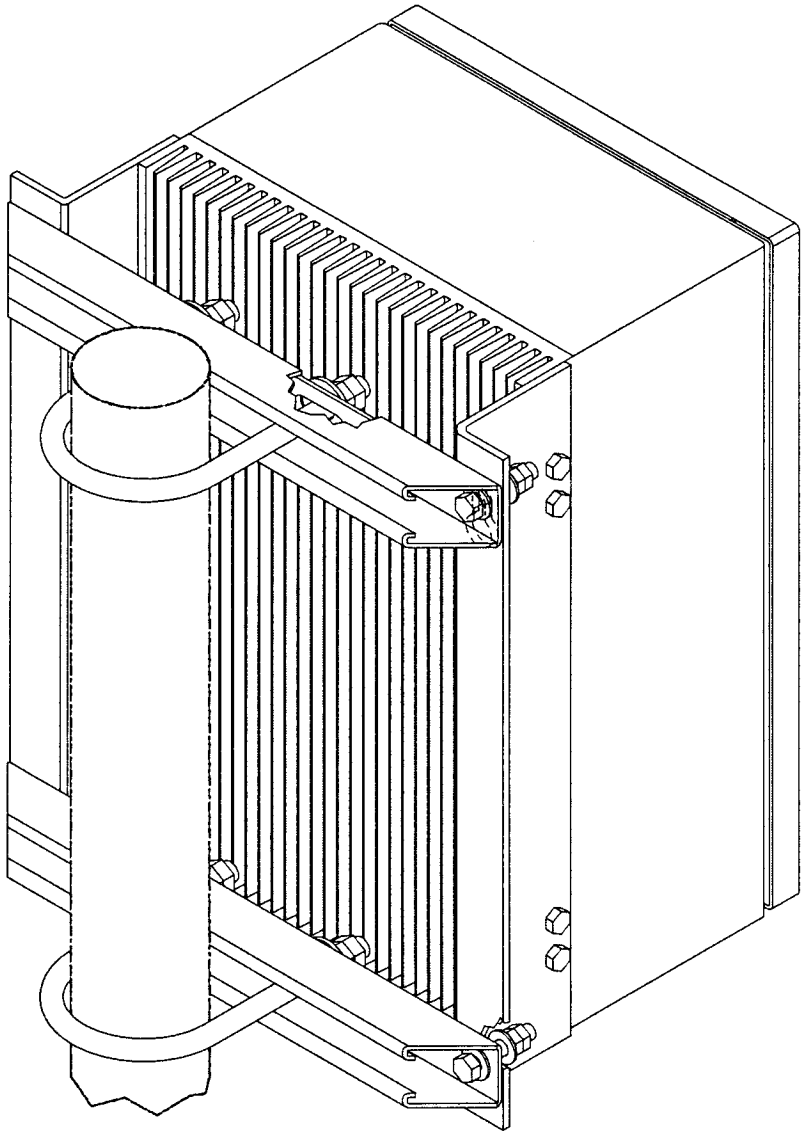

Figure 19. Pole Mounting the Repeater.
Mount the repeater onto a pole by attaching "unistrut" to the repeater's wall-mounting brackets and attaching an appropriately sized U-bolt to the "unistrut."

7.6 Repeater Set-up and Turn-on

The MirrorCell CDR1901 can be configured locally through an RS-232 port and a laptop computer. Once the repeater is configured, it can be controlled using an optional telephone line interface.

The following is a step-by-step procedure for configuring the repeater.

WARNING!
DO NOT TURN ON THE POWER UNLESS THE REPEATER IS CONNECTED TO ANTENNAS OR ATTENUATORS ON BOTH OUTPUT PORTS!

1. Connect the computer using an RS232 serial port with a DB9 male connector (on cable end for the repeater) to the status and control module in the repeater.
2. Us a terminal emulation program, such as ProComm or HyperTerminal, set to:
   - VT-100 series terminal emulation
   - 9600 baud
   - 8 bit
   - 1 stop bit
   - no parity
   - no flow control (flow control = none).
3. Turn the repeater on; press any key on the computer to initialize the login screen.

Note: Login may take several seconds if the repeater is in active communications mode. To bypass sending all of the alarms, press ENTER as soon as the date and time appear on the screen.

4. For assistance, use the following function keys. See Section 6.10 for a complete table of available commands.
   - F1: List of available commands
   - F2: List of last 10 commands; use arrow to get to desired command
   - F3: Shows Status screen.

5. Login to the repeater using one of the following default Usernames and Passwords. The control module does not differentiate between upper and lower case letters. Do not use the number pad on the keyboard to input numbers.

User Name	Password	Authority
USERNAM1	PASSWRD1	read/write
USERNAM2	PASSWRD2	read/write
USERNAM3	PASSWRD3	read only
USERNAM4	PASSWRD4	read only

6. Change the default Username and Password. Each Username and Password can have a maximum of eight characters. For example, to change the second Username and Password, enter the following two commands.

SET UID 2 [newname] <enter>

SET PWD 2 [password] <enter>

7. To see the current status of repeater setup and configuration, type STATUS <enter>. See Figure 20 for a Status screen display. Note that, even if parameters shown on the screen are changed, the screen readout remains the same until STATUS is retyped.
8. Next, set the channel frequency. For example:

SET CHA X YYY <enter>

X = Channel 1 within the repeater
YYY = CDMA channel number for the repeater's channel 1 (can be set to only channels within your system's band.)

SET CHA 1 175 <enter>

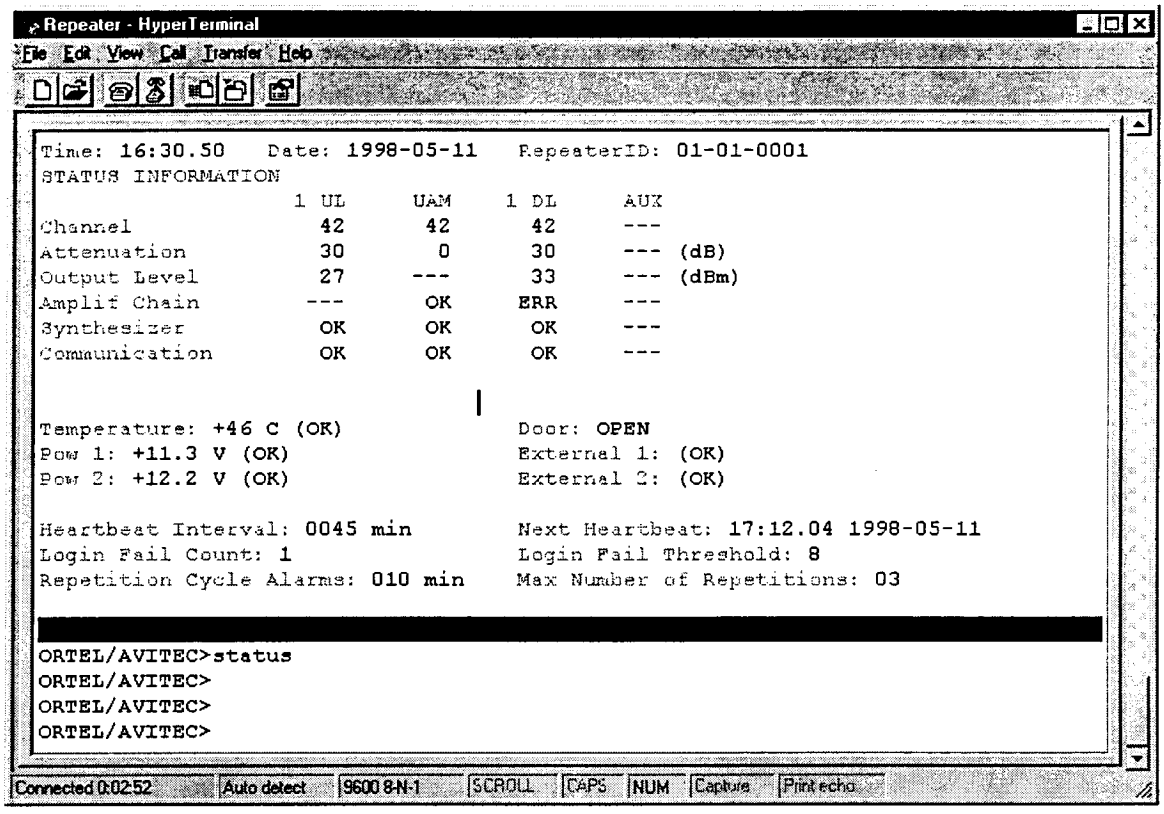

Figure 20. Status Screen for the CDR1901.
The Status screen shows many important monitoring and alarm parameters for the CDR1901.

9. Set the attenuation levels of 0 – 30dB as follows. For the uplink (reverse path) attenuation in channel 1:

SET ATU X YY <enter>

X = Channel 1 within the repeater

YY = Uplink attenuation level for channel 1.

SET ATU 1 10 <enter>

sets the reverse attenuation level for the repeater's channel 1 to 10dB. Now, the repeater's reverse gain will be 85 – 10 = 75dB, for the standard repeater.

For the downlink (forward path) attenuation in channel 1:

SET ATD X YY <enter>

X = Channel 1 within the repeater

YY = Downlink attenuation level for channel 1.

SET ATD 1 10 <enter>

sets the forward path attenuation level for the repeater's channel 1 to 10dB. Thus, the repeater's forward path gain will be 85dB – 10dB = 75dB.

Note: Although the attenuation values for forward and reverse can be set differently, path imbalances may occur when doing so.

Note: In order to transmit the lowest needed power, the initial setup attenuation should be set for maximum (30dB). Then, attenuation levels can be reduced until the desired output power is achieved. This reverse attenuation should then be set equal to the forward attenuation to maintain path balance.

10. Set the peak levels at which the repeater should transmit in the uplink (reverse) and downlink (forward) directions. Forward peak levels for the standard repeater are 27dBm, 30dBm, and 33dBm. Forward peak levels for the 36dBm repeater are 30dBm, 33dBm, and 36dBm. Reverse peak levels for both the standard and 36dBm repeaters are 27dBm, 30dBm, and 33dBm. Note that due to low output power from the mobile, reverse path power rarely exceeds 20dBm.

    To set the peak level in the reverse path:

    SET LVU X YY <enter>

    X = Repeater's channel 1

    YY = Reverse maximum transmit level.

    SET LVU 1 27 <enter>

To set the peak level in the forward path:

SET LVD X YY <enter>

X = Repeater's channel 1

YY = Forward maximum transmit level.

SET LVD 1 30 <enter>

Typing STATUS will show that the channel number and gain settings have been changed. The repeater now should be configured for operation.

11. The repeater should be turned off before connecting it to the antennas. Once connected, the repeater can be turned on. The output power of the repeater should be monitored on the test port. The test ports are 30dB couplers; thus if an output power of 33dBm (2W) is desired, the power measured at the test port should be 3dBm. The attenuation of the repeater should be decreased until the desired output power is achieved.

7.7 Optimization

Now that the repeater is providing the desired output power, the system needs to be optimized. The search window and neighbor lists of the donor base station should be reviewed. Verify the pilot search window parameters are properly set to compensate for filter group delays in the repeater. The repeater uses highly selective Surface Acoustic Wave (SAW) filters, which have a group delay of 11 microseconds. Since the propagation delay of free space is 5.4 microseconds per mile, the delay is "equivalent" to two miles of free space propagation.

The search window of the donor base station may need to be increased depending on the distance from the repeater to the donor base station. For example, if the repeater is 3 miles from the donor base station, and the desired coverage area of the repeater is 2 miles (for a total of 5 miles):

(5 miles) * (5.4 μsec/mile) + 11 μsec (delay in the repeater) = 38 μsec

The donor BTS pilot search window would need to be at least 38 microseconds for call activation to take place.

The neighbor lists of the donor base station and the base stations surrounding the area served by the repeater need to be adjusted. For example, in Figure 21 a repeater extends the coverage of BTS1 to a new area. BTS1 is now neighbors with BTS4 and BTS5, whereas without the repeater, BTS1 is neighbors with just BTS2 and BTS3. Thus BTS4 and BTS5 must be added to BTS1's neighbor list, and BTS1 must be added to BTS4's and BTS5's neighbor lists. A drive test of the coverage area should be performed to verify the final setup.

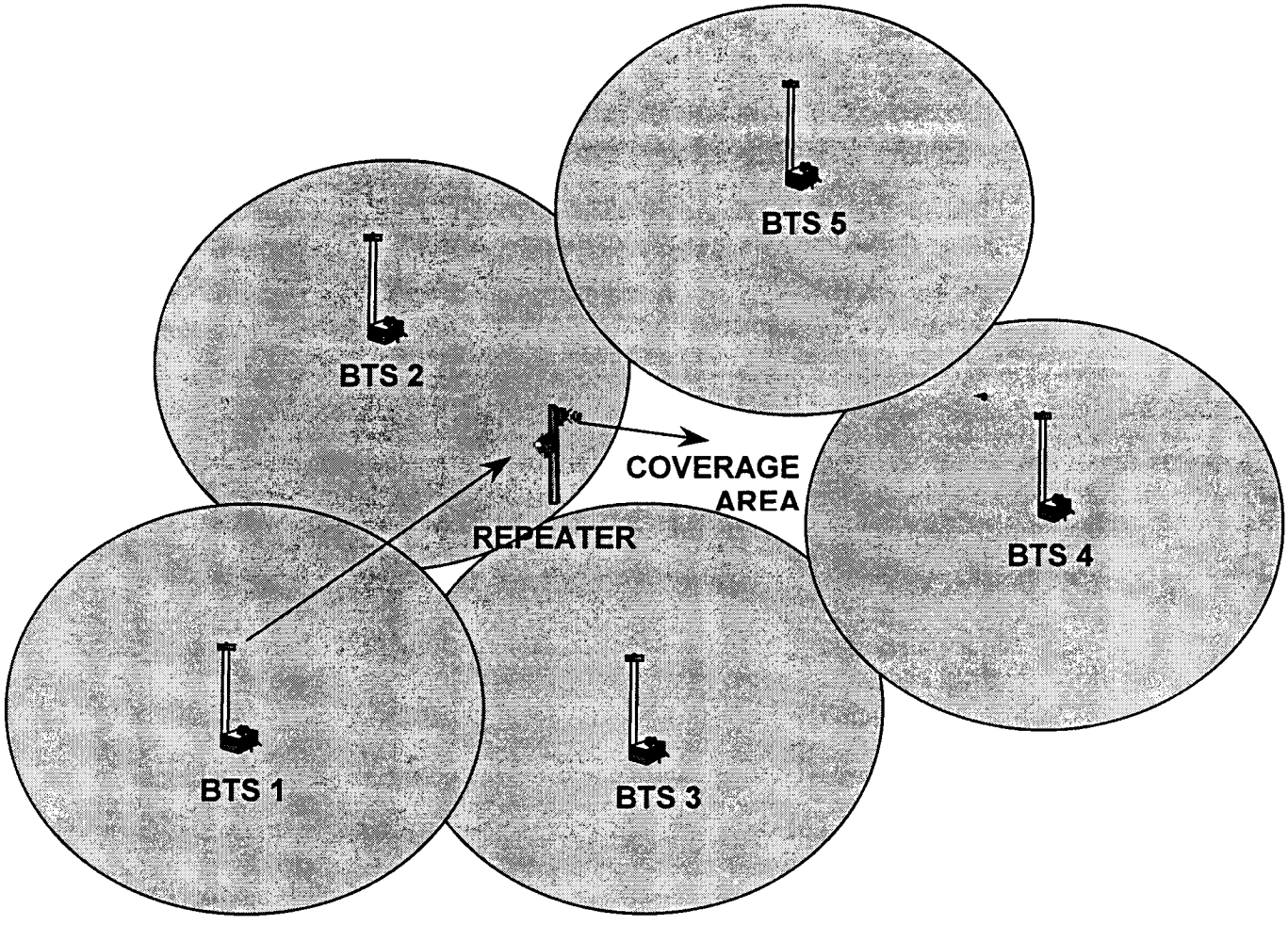

Figure 21. Neighbor List Changes.
Neighbor list changes may need to be implemented when adding a repeater into a system.

7.8 HyperTerminal Configuration

HyperTerminal may be used for terminal emulation when using remote control of the repeater. Use the following steps for setting up HyperTerminal.

1. In the Start menu, open the Programs folder. Go to the Accessories folder in the Programs folder.
2. Choose Hyperterminal. In that folder, choose HyperTerminal.
3. A dialog box will ask you to name the session. Use any name you choose. Select the icon showing the two telephones. See Figure 22.

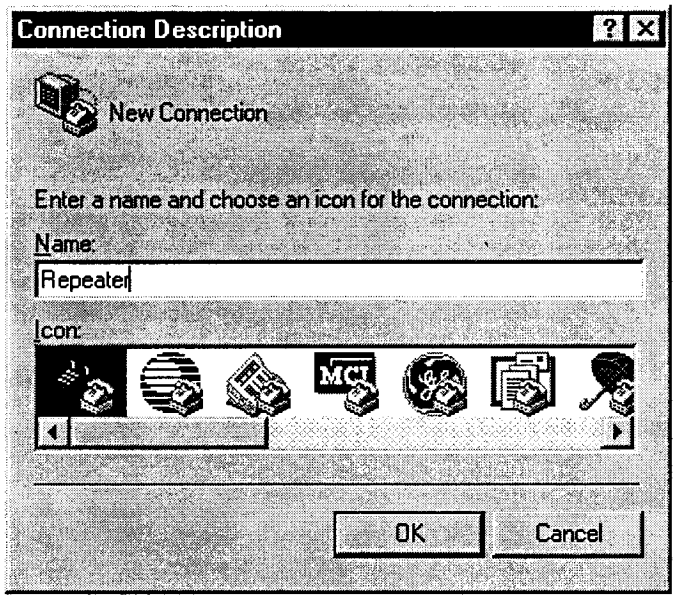

Figure 22. Connection Description in HyperTerminal.

4. For a direct connection to the repeater, choose "Direct to Com X" in the drop down box.

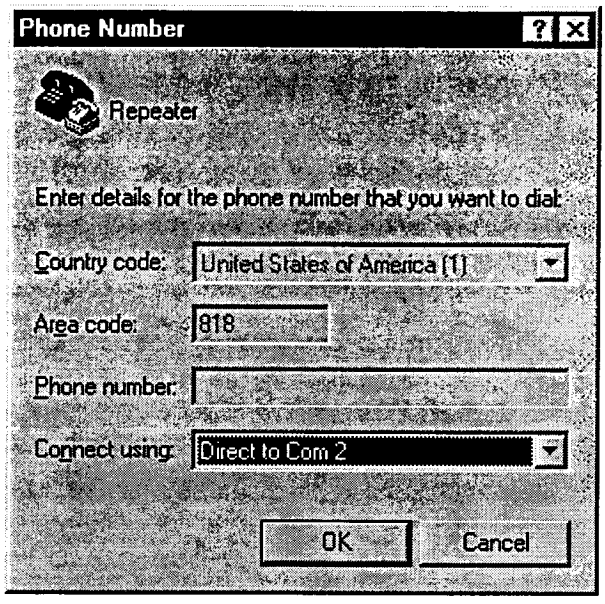

Figure 23. HyperTerminal Screen for Direct Connection.

For remote connection via modem, enter the number you wish to dial and choose to connect using "Standard Modem."

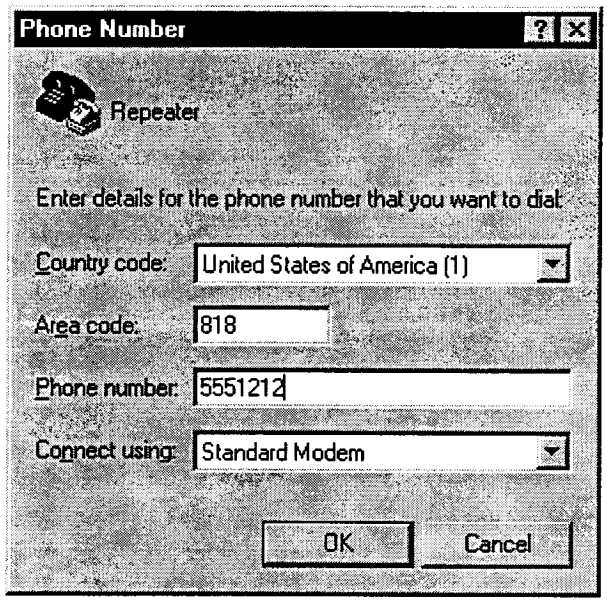

Figure 24. HyperTerminal Screen for Modem Connection.

5. After clicking OK, you will need to choose "Port Settings." Select:
   - Bits per Second: 9600
   - Data bits: 8
   - Parity: None
   - Stop bits: 1

   "Flow control" selection will depend on whether you are using a direct connection to the repeater or a remote connection. For a direct connection, choose "None." For a remote connection choose "Hardware." Click OK.

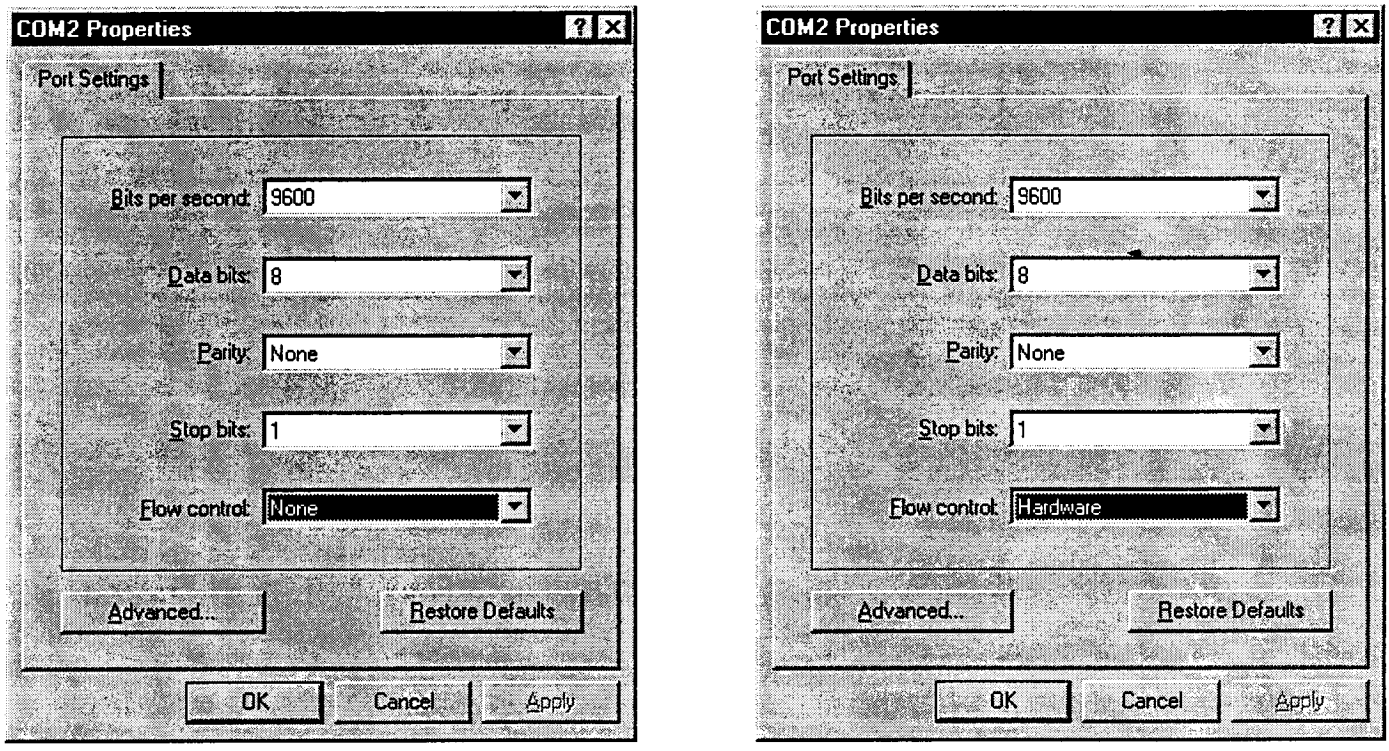

Figure 25. Port Settings for Direct Connection and Remote Connection.
The port settings will be the same for direct connection and remote connection, except for the flow control. For a direct connection to the repeater, make sure flow control is set to "None." For remote connection, set flow control to "Hardware."

7.9 Configuration for Remote Operation

The CDR1901 MirrorCell repeater is designed to report alarms and be configurable using DataCall capabilities. The repeater can be configured for remote operation using the following procedures.

1. The wireline interface with modem must be installed in the repeater.
2. Any existing alarm messages (from factory testing and initialization) should be cleared before activating the repeater. First check the existing alarm log, then clear the log. This can be done at any time during the setup procedure.

   LOG <enter>

   CLEAR LOG <enter>

3. The proper communication mode must first be enabled before communications can begin. For DataCall messaging:

   SET DEV DTC <enter>

4. The phone number to which the repeater will report alarms must be programmed into the repeater, using the following command:

   SET ASC [phone number] <enter>

5. Set the maximum number of times (Maximum Number of Repetitions) the repeater will attempt to resend an unacknowledged message to the predetermined phone number:

   SET MNR xx <enter>

   where xx = number of retries.

6. Set the amount of time the repeater should wait (Repetition Cycle Alarm) for an acknowledgment before resending the messaging, preset at 10 minutes.

   SET RCA xxx <enter>

   where xxx is the number of minutes to wait between each retry.

7. To set the Repeater's ID number:

   SET RID xx-yy-zzzz <enter>

   where x, y, and z are digits.

8. The threshold for Illegal Login Attempts tells how many times a false password can be attempted before the systems locks out any further attempts. This is preset at 8. To reset the value,

   SET ILA xx <enter>

9. The external alarms can be configured active low or active high, so that the alarm is given in either the presence or absence of applied power.

   SET EXT BC <enter>

   Where B, read from EX1, refers to pin 1 and C, read from EX2, refers to pin 2.

   B, C = 0 means the absence of voltage is OK

   B, C = 1 means the presence of voltage is OK

7.10 Configuration for MEM Setup

In order to use the MirrorCell Element Manager (MEM) certain parameters must be adjusted for proper communications between the MEM and the repeater. Follow these steps to configure the repeater.

1. Turn on power to the repeater.
2. Login to the repeater using a read-and-write password.
3. Set the address code to blank. This will disable the sending of alarms to the MEM. The MEM will configure the correct address.

   SET ASC <enter>

4. Set the communications type to DataCall/modem connection.

   SET DEV DTC <enter>

5. If necessary, set the MEM to Repeater password. This information **must** be forwarded to the person doing the MEM installation.

   SET ORP [password] <enter>

6. The repeater is now set-up for MEM operation.

7.11 Troubleshooting

PROBLEM	POSSIBLE CAUSE	SOLUTION
LED on Status & Control (S&C) module is unlit.	1. Unit not turned on. 2. No power to unit. 3. S&C module failure. 4. Power supply failure.	1. Plug in/turn on unit. 2. Restore power to unit. 3. Replace S&C module. 4. Replace power supply.
LED on S&C module is lit but cannot login to the repeater	1. Software emulation program is not set properly. 2. Software emulation program is not working properly. 3. Cables not functioning properly. 4. Bad S&C module.	1. Verify program is set properly. 2. Verify program is working properly; replace if necessary. 3. Replace cable. 4. Replace S&C module.
Poor reverse signal quality; forward signal quality looks fine.	Excessive noise contribution to BTS because gain set too high.	Reduce repeater gain setting.
Output power too low on forward link.	1. Receiving too low of a signal from donor site. 2. Gain not set correctly.	1. Verify adequate signal is received; adjust donor antenna if necessary. 2. Reset gain.
Receiving sufficient signal strength but too much interference to make a call.	Repeater goes into oscillation because of insufficient antenna isolation.	1. Improve antenna isolation: • Further separate antennas • Mount a shield between antennas. 2. Reduce repeater gain.

7.12 Maintenance

Ortel's MirrorCell CDR1901 does not require preventative maintenance.

7.13 Parts Replacement

In case of repeater failure, Ortel recommends you send back the entire repeater for repair, and mount a spare repeater in its place. However, if you would rather make the repair yourself, the following modules can be replaced on the repeater.

WARNING!
TURN OFF REPEATER AND DISCONNECT POWER FROM THE REPEATER BEFORE REMOVING ANY MODULES!

- Status & Control Module
- Uplink (reverse) channelizer
- Downlink (forward) channelizer
- Uplink power amplifier
- Downlink power amplifier
- LNA, uplink
- LNA, downlink

WARNING!
DO NOT INSERT CHANNEL MODULES OR POWER AMPLIFIER INTO THE WRONG POSITION!