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# **FCC Part 24E Transmitter Certification**

## **Test Report**

**FCC ID: LB41900CDMA**

**FCC Rule Part: CFR 47 Part 24 Subpart E**

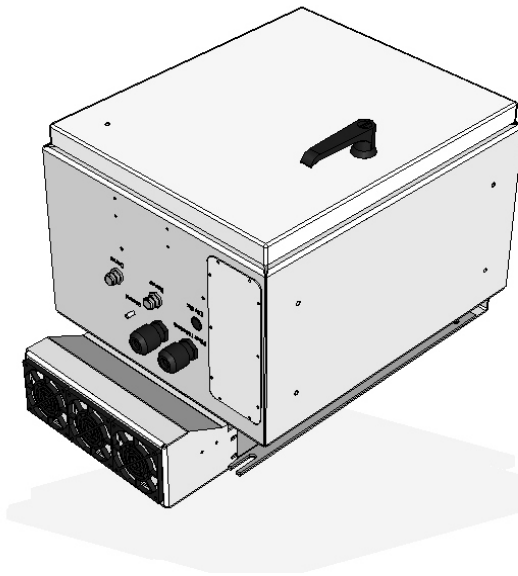
**ACS Report Number: 06-0458-24E**

Manufacturer: EMS Wireless  
Equipment Type: PCS Bi-Directional Repeater  
Tradename: MirrorCell<sup>®</sup> II  
Model: CDM1912-739

## **Manual**

# Operator's Manual

## MirrorCell<sup>®</sup> II Repeater CDM 812, CDM1912 Series



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## **Disclaimer**

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## WARNINGS, CAUTIONS, AND GENERAL NOTES



### 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 B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This Class B digital apparatus meets all requirements of the Canadian Interference Causing Equipment Regulations. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Cet appareillage numérique de la classe B répond à toutes les exigences de l'interférence canadienne causant des règlements d'équipement. L'opération est sujette aux deux conditions suivantes: (1) ce dispositif peut ne pas causer l'interférence nocive, et (2) ce dispositif doit accepter n'importe quelle interférence reçue, y compris l'interférence qui peut causer l'opération peu désirée.

Installation should be made per ANSI/NFPA 70, the National Electrical Code(NEC), Article 810 specifically for clearances from power and lighting conductors, mounting and grounding.

The screen of the coax cable must be connected to earth(grounded) at the entrance to the building. This should be done in accordance with applicable National Electrical Code(NEC) installation codes. In the U.S., this is required by Section 820.93 of the National Electrical Code, ANSI/NFPA 70.

### RF Exposure

In accordance with FCC requirements of human exposure to radiofrequency fields, the server and donor radiating elements shall be installed such that a minimum separation distance of 118 cm and 49 cm, respectively, is maintained between the radiating element and the general population.

### IC Requirements

The Manufacturer's rated output power of this equipment is for single carrier operation. For situations when multiple carrier signals are present, the rating would have to be reduced by 3.5 dB, especially where the output signal is re-radiated and can cause interference to adjacent band users. This power reduction is to be by means of input power or gain reduction and not by an attenuator at the output of the device.

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## 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. EMS Wireless 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, or need help with installation and using of the system, please contact the EMS Wireless Customer Support Department.



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## 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 EMS *Wireless*' Customer Support department. Service will be rendered according the EMS *Wireless*' warranty and repair policy. The product shall not be returned without contacting EMS *Wireless* and obtaining a return authorization number from the Customer Service department

When returning a product for service, include the following information: Owner, Model Number, Serial Number, Return Authorization Number (obtained in advance from EMS *Wireless* Customer Support Department), service required and/or a description of the problem encountered.

## Warranty and Repair Policy

The EMS *Wireless* Quality Plan includes product test and inspection operations to verify the quality and reliability of our products.

EMS *Wireless* 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

EMS *Wireless* warrants to the original purchaser all standard products sold by EMS *Wireless* 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 EMS *Wireless*. During the warranty period, EMS *Wireless*' obligation is limited to repair or replacement of any product that EMS *Wireless* 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 EMS *Wireless* 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 EMS *Wireless* 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 EMS *Wireless*. EMS *Wireless* Customer Support 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 EMS *Wireless* Customer Support prior to returning any device. Advise EMS *Wireless* Customer Support of the model, serial number, and the discrepancy. The device shall then be forwarded to EMS *Wireless*, transportation prepaid. Devices returned freight collect or without authorization may not be accepted.**
- b. Prior to repair, EMS *Wireless* Customer Support will advise the customer of EMS *Wireless* 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 the customer does not authorize non-warranty repairs, 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 EMS *Wireless*. Customer approval is also necessary for any removal of certain parts, such as connectors, which may be necessary for EMS *Wireless* 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

**EMS Wireless' 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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**EMS Wireless 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 CDM 812, CDM1912 Series Repeaters:

1. Use electrostatic discharge (ESD) precautions when dealing with the modules within the repeater so that units are not damaged.
2. Opening or removing any module voids the warranty.



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## 1.0 Introduction

This fully featured repeater is designed primarily for large outdoor use (several miles radius of coverage, depending on terrain), or for indoor use with medium sized buildings (100,000 to 200,000+ square feet [10,000 to 20,000 square meters]). The repeater is contained in a weatherproof outdoor NEMA 4 enclosure, as shown in Figure 1. It may be used as a simple and inexpensive alternative to a base station (BTS). The block diagram in Figure 2 shows a typical outdoor installation.

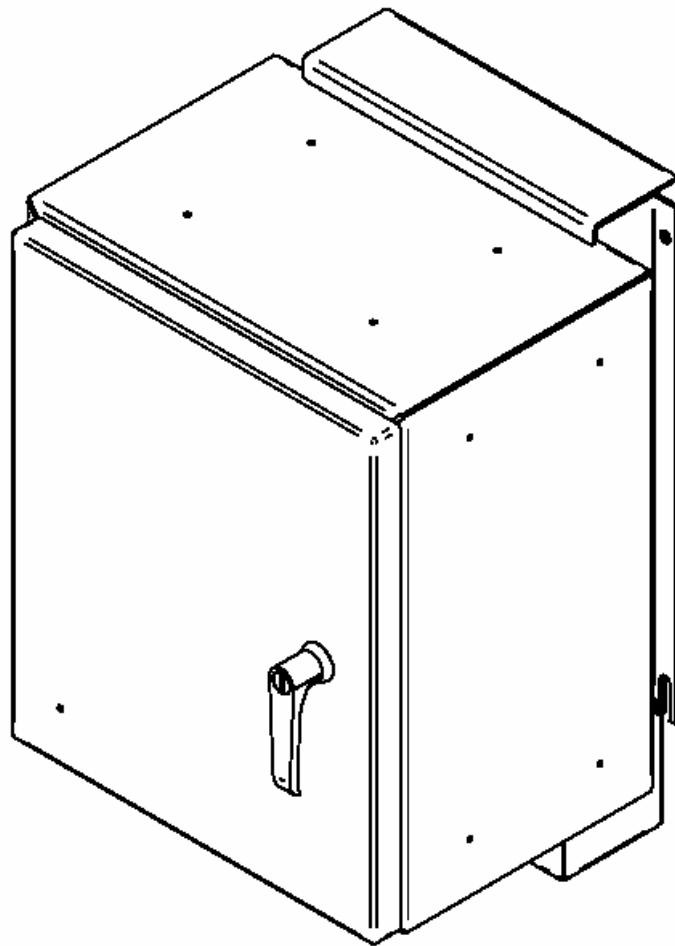


Figure 1: MirrorCell® II Repeater Exterior View

Additionally, it can be configured with a variety of bandpass filters, so it can be band or channel selective. For example, the repeater can pass just one channel, a few adjacent channels (i.e. approximately 4.5 MHz for 3 adjacent CDMA channels), or a full 15 MHz PCS band. This gives the carrier great flexibility to choose exactly which signals are repeated. For even more flexibility, two separate (non-adjacent) passbands within the same 800 or 1900 MHz band may be specified. For example, at 1900 MHz, E Band (UL: 1885 - 1890 MHz) and C2 Band (UL: 1895 - 1902.5 MHz) can be repeated using one MirrorCell II™. At 800 MHz, one repeater can pass the A and A'' sub-bands (UL: 824 - 835 MHz), and also pass the A' sub-band (UL: 845.0 - 846.5 MHz), while rejecting the competitor's B sub-band (UL: 835 - 845 MHz).

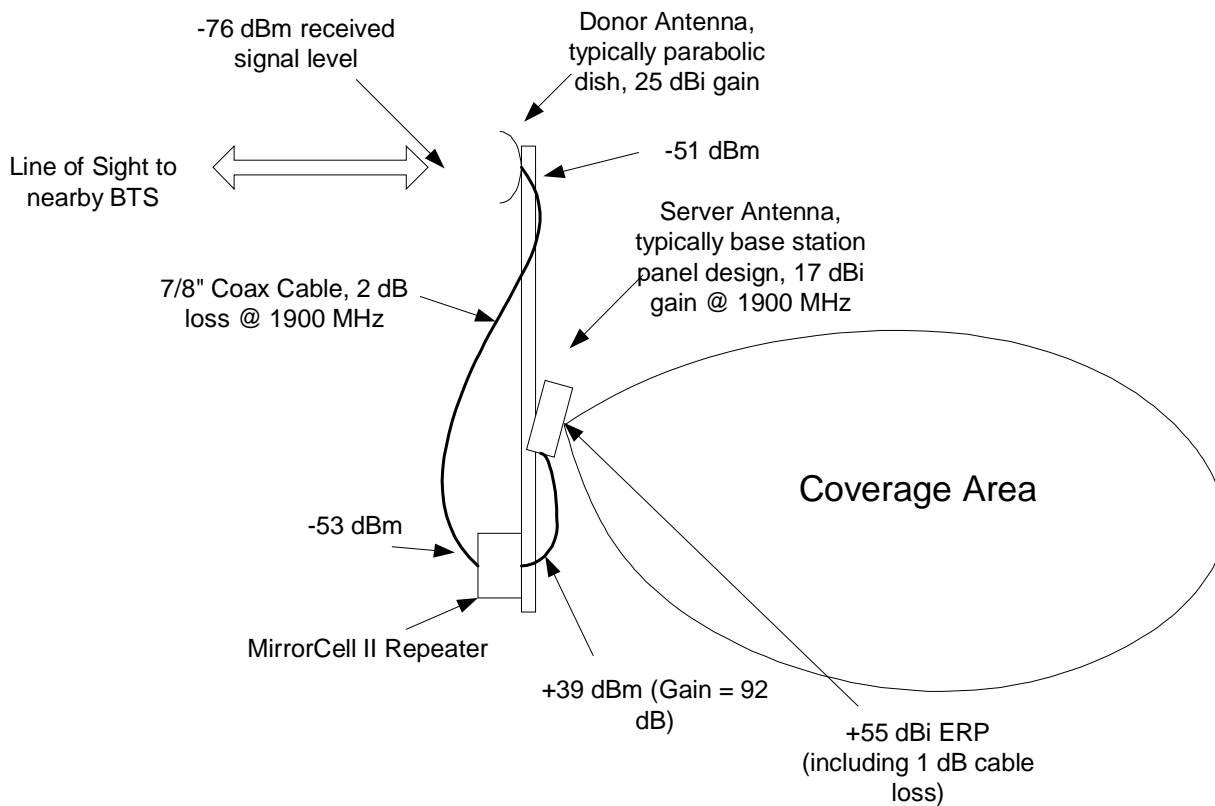


Figure 2: Typical Outdoor MirrorCell® II Repeater System Design

An alternate use of this repeater is for indoor applications. The MirrorCell<sup>®</sup> II makes great economic sense for buildings that are too large for the EkoMini repeater, but too small to justify a fiber optic DAS (Distributed Antenna System). One MirrorCell II can cover most typical buildings up to approximately 200,000 square feet using ½" coax and several power dividers feeding approximately eight indoor server antennas. Figure 3 shows a typical example. Also, directional couplers with varying levels of coupling values may be used to tailor the power delivered to each building floor for optimal coverage.

The MirrorCell<sup>®</sup> II has these features:

- 90 – 95 dB gain in a range of models with up to three composite RF output power levels available.
- Output power level may be incremented in one dB steps over a 30 dB range, either automatically with built-in software, or manually with software commands.
- An optional battery back-up unit is available to maintain repeater operation for several hours during AC power interruptions
- Receive diversity is available as an option.



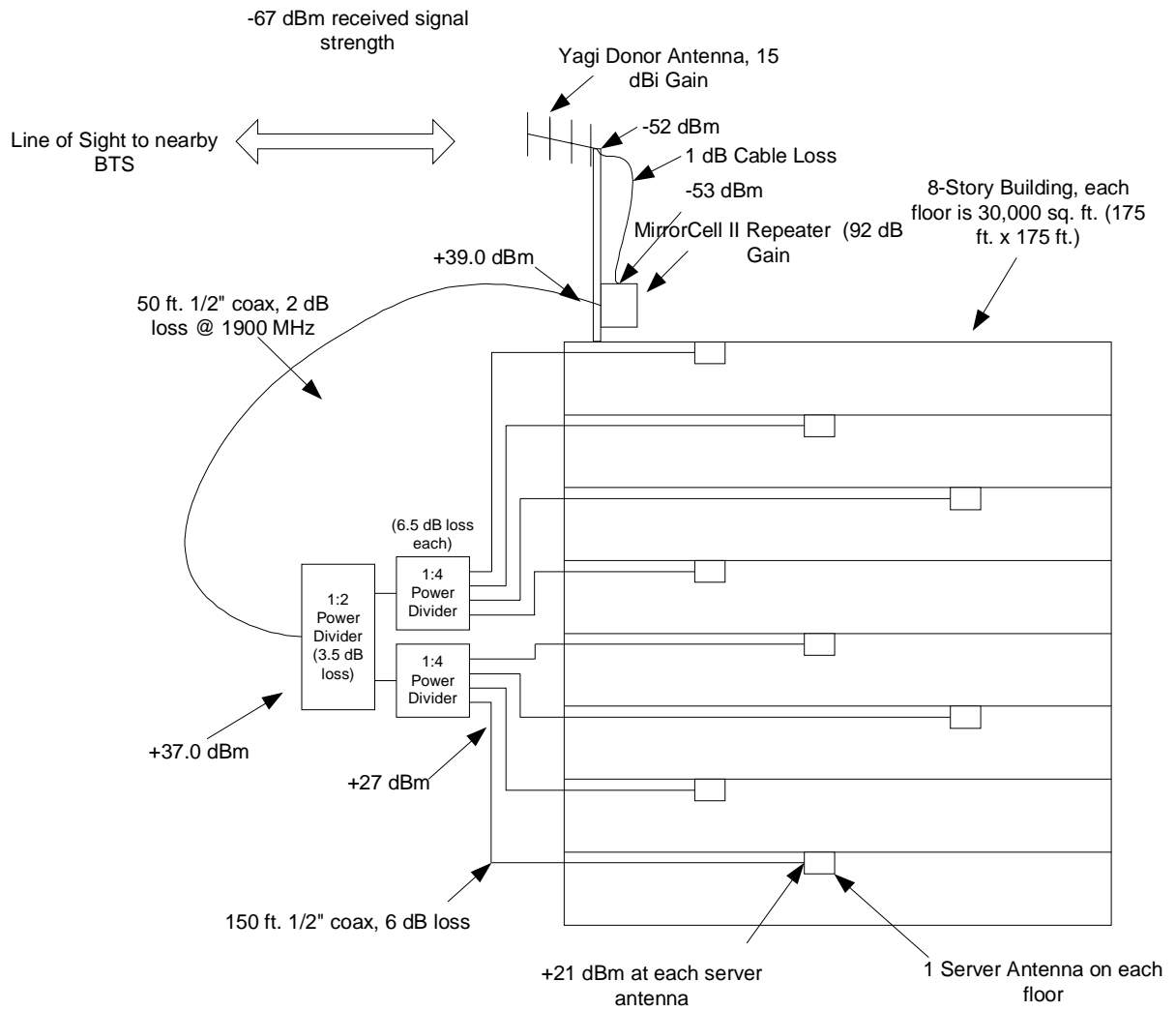


Figure 3: MirrorCell® II Indoor Installation Example

## 2.0 Available Options

The MirrorCell® II repeater is available for all Cellular 800 MHz bands (A, B, A+B, and SMR) and PCS 1900 MHz bands (A – F). In addition, all available options are shown in Table 1 below:

Single channel or sub-band
Two non-adjacent channels or sub-bands
+36 dBm (4 watts) composite RF output power (PCS only)
+39 dBm (8 watts) composite RF output power
+43 dBm (20 watts) composite RF output power
Wired Telephone Line Interface with Modem for Remote Alarming
Wireless (CDMA) Data Modem for Remote Alarming
IPWMM Modem
120 - 260 VAC/50-60 Hz Operation
24 VDC Operation
Battery Back-up MPP-100 (External Unit) – non UL Approved
Battery Back-up MPP-200 (External Unit) – UL Approved
DIN 7-16(f) Donor/Server Antenna Connectors (Type N(f) is standard)
Receive Diversity, 1900 MHz Units
Receive Diversity, 800 MHz Units

Table 1: Available MirrorCell® II Options

## 3.0 Installation Guidelines

### 3.1 Outdoor Site Selection

When the MirrorCell® II is used outdoors, site selection is one of the most critical decisions affecting the overall performance of the repeater system. A repeater should be located where it can receive a sufficient *line of sight* signal from the donor site to maximize the repeater's performance. For example, supposing a 1900 MHz MirrorCell® II has +39 dBm power output specification with a gain of 92 dB. Then, an input signal level at the donor input connector (after the donor antenna and coax cable) of greater than or equal to -53 dBm (composite power) is required for +39 dBm output:  $-53 \text{ dBm} + 92 \text{ dB gain} = +39 \text{ dBm}$ .

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

- The roof of a building adjacent to the desired coverage 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

### 3.2 Donor and Server Antenna Selection

Proper selection of the repeater's donor and server antennas is crucial in designing the repeater system. The most important parameter to be concerned with is *antenna isolation*. This is a measure of the ability of the donor and server antennas to avoid receiving each other's signals. Remember, the repeater is simultaneously transmitting and receiving on each of the uplink and downlink frequency bands. For this to happen successfully, the two antennas must be well isolated from each other, or excessive signal levels from one antenna will be received by the other antenna. This sets up a feedback loop, and oscillation begins. An example of this is shown in Figure 4 below:

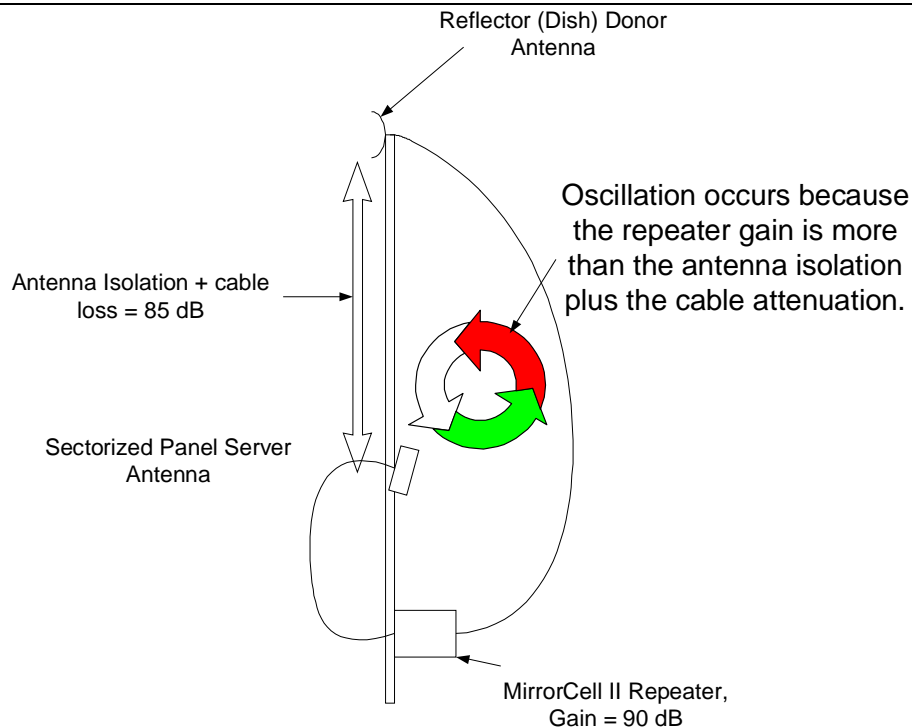


Figure 4: Example of Repeater Oscillation

Good antenna characteristics, especially front-to-side and front-to-back ratio, help to provide proper isolation between the server and donor antennas. Proper antenna mounting location is also a key to achieving adequate antenna isolation.

*The isolation between antennas must be at least 10 – 15 dB greater than the gain setting of the repeater or the repeater could go into oscillation. Antenna isolation limits the amount of repeater gain that can be used. Therefore, if the isolation is 90 dB, the repeater gain should be set no higher than 80 dB to ensure proper operation.*

Antenna isolation can be approximately estimated with a few calculations. Please refer to the **EMS Wireless** application note “Antenna Isolation Calculations” for details. Also, a small chart titled “Isolation Examples” shows four example installations using specific antenna models, with the resulting calculated isolation for each.

The donor antenna selection is critical in the design of a properly functioning repeater system because it provides the majority of the required front-to-side ratio. The donor antenna is typically a high gain antenna, with excellent sidelobe and backlobe suppression. Microwave dish (reflector) antennas with vertical and horizontal beam widths of less than 15° are ideal candidates for the donor antenna. This is because the repeater should only re-transmit signal from one base station, generally chosen

because it has adequate signal strength and enough unused capacity to accommodate the repeater system.

In many urban environments, base stations are physically close together. The donor antenna must have a narrow beamwidth so it receives and transmits signal to only the desired BTS. Microwave dish antennas also provide the recommended front-to-back ratio of more than 25 dB to help achieve the required antenna isolation.

Even better donor antenna front-to-side ratio is available with “high performance” or “ultra high performance” reflector antennas. These models have a metal shroud extending out from the face of the reflector. The inside of the shroud is covered with microwave absorbing material to suppress side radiation. The best performance models extend the shroud and use the highest quality absorbing material. Unfortunately, this increases the wind loading of the antenna and requires a heavier duty support structure. The trade-off is extremely high front-to-side ratio (frequently 40-55 dB), which allows close physical spacing between the donor and server antenna. This close physical spacing (sometimes less than 40 feet) is excellent in areas with stringent zoning requirements that limit the structure height.

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

The installer should use these specific ways to achieve proper isolation:

- Use high gain, directional antennas with low sidelobes. This means the front-to-side ratio should be better than 25dB. Also, use antennas with excellent antenna front to back ratio.
- Point the donor and server antennas opposite each other; i.e., at 180° from each other, and ensure that the antennas have minimal backlobe radiation.
- Physically separate the antennas, either vertically or horizontally.
- Use external shielding, such as wire mesh or a grounded metal plate placed between the antennas. Reflector antenna manufacturers sell ice shields, normally used to prevent ice from falling on the antennas during winter weather. They can also be used to enhance isolation because they are metallic fence or mesh material. The isolation can be frequently improved by about 10 to 20 dB by using an ice shield.

For indoor installations, achieving adequate isolation is still important, but somewhat easier to achieve. This is because the donor and server antennas are physically separated by the building material, which is normally quite lossy to RF. This is especially true if the donor antenna is placed on a building roof that has a metallic layer. In most of these installations, inexpensive yagi donor antennas can be used. The server antenna(s) are frequently ceiling mount designs with most of the radiation directed down toward the building floor. This further enhances the isolation.

### **3.3 Antenna Mounting and Isolation Measurements**

Use the following steps to mount the donor antenna.

1. Mount donor antenna at the initial desired location. *A visual line of sight path to the BTS is critical for a strong, stable donor signal that is a constant level over a long period of time.*
2. Measure the received signal strength from the donor site. The amount of power the repeater can produce is dependent on this signal level.
3. If greater signal strength is needed, try raising the donor antenna's height, or use a higher gain antenna, if possible.
4. Measure the RF channel strength received at the donor antenna and verify that the proper base station sector is being received. The RF channel of the desired base station should be at least 15dB higher than any of the other received RF carriers. This can be measured using a spectrum analyzer. If necessary, the donor antenna should be oriented until the desired RF channels are 15dB greater than any others received. If this cannot be achieved, use an antenna with higher gain. This means the antenna beamwidth is narrower, which requires greater precision to physically orient the antenna toward the donor site. But, the donor signal will be higher, and the antenna will be more effective rejecting unwanted signals.

Then, isolation measurements should be made to ensure proper operation of the repeater. Isolation measurement can be accomplished easily by following the procedure outlined below, as illustrated in Figure 5.

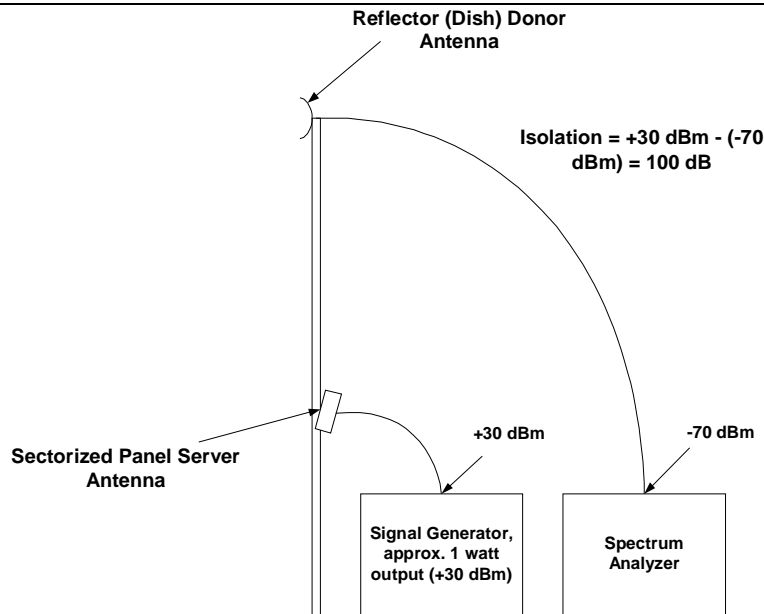


Figure 5: Antenna Isolation Measurement Set-up

1. Mount the server antenna at the initially chosen location to obtain the desired coverage.
2. Inject a known signal within the bandwidth of operation into the server antenna. An unused channel within the band should be used. The signal should be at least 1 watt to allow for an accurate measurement of isolation. If a 1 watt (+30 dBm) test source is not available, the repeater and a low-power signal generator can be used in series to generate a signal of sufficient strength. The repeater will add approximately 60 – 90 dB of gain, depending upon the repeater model, and how much attenuation is added to the repeater.
3. Connect a signal measurement device, such as a spectrum analyzer, to the donor antenna. Measure the received signal level. The RF power difference between the output of the signal generator and the input to the spectrum analyzer is the antenna isolation. (Note that the gain of each antenna is not used in the calculation.) This test should be done once using downlink frequencies and once using uplink frequencies. Generally both measurements will be similar, but as much as 10 dB difference can occur. The final result should be the lower of the two measured values.

*Antenna isolation should 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. Although isolation can be approximately calculated, an actual measurement is strongly recommended in most applications.*

The repeater gain must be set to at least 10 dB below the measured isolation. For example, if the measured antenna isolation is 90dB, the repeater gain should be set for no more than 80 dB.

### 3.4 Repeater Mounting

These recommendations should be followed for best repeater performance:

- The repeater should be mounted so the heatsink avoids direct sunlight. This will help improve the lifetime of the repeater.
- *The repeater must be mounted upright* so that the connectors are on the underside. This will help prevent a buildup of moisture inside the repeater.
- The repeater is equipped with N female (optionally, DIN 7-16) antenna connectors. Connectors are located at the bottom of the unit.
- 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.
- Ensure that adequate room is allowed for the opening and closing of the repeater door. See the specification table for dimensions of the repeater.

### 4.0 Repeater Set-up

- Refer to the Installation Guide for instructions on mounting and connecting power to the MirrorCell II.
- Connect the Donor antenna to the "Donor" port on the MirrorCell<sup>®</sup> II.
- Connect the Server antenna to the "Server" port on the MirrorCell<sup>®</sup> II.
- ***DO NOT TURN THE POWER ON UNLESS BOTH DONOR AND SERVER PORTS ARE TERMINATED!*** Turn the MirrorCell<sup>®</sup> II on with the power switch located on the inside bottom of the repeater cabinet, shown in Figure 6 below.



Power Switch

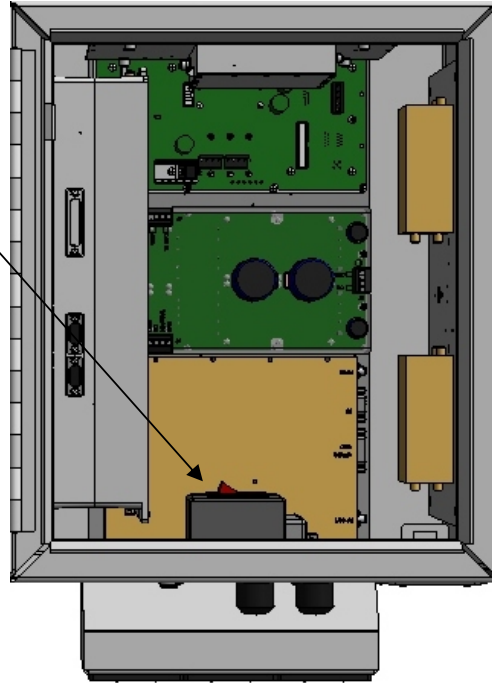


Figure 6a: Repeater Power Switch Location, A/C Version

Power Switch

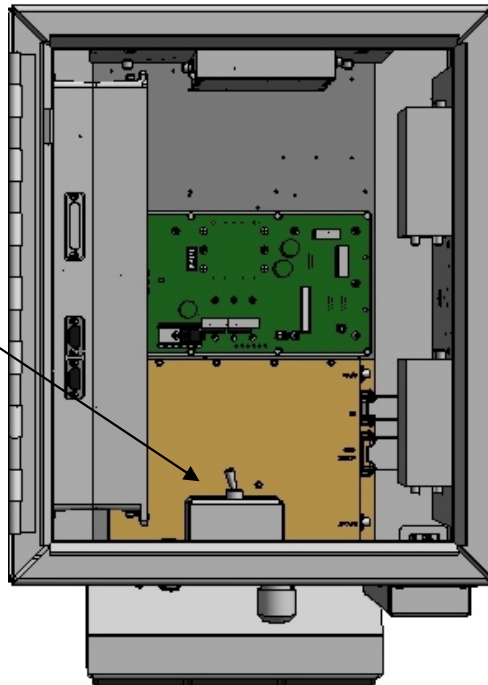


Figure 6b: Repeater Power Switch Location, DC Version

- Connect a laptop computer with a terminal emulator program (i.e., HyperTerminal, ProComm, etc.) to the MirrorCell® II RS232 port with a DB9 straight-through serial cable, as shown in Figure 7 below. The male connector is attached to the repeater port and the female connector is attached to the laptop's RS232 serial port.

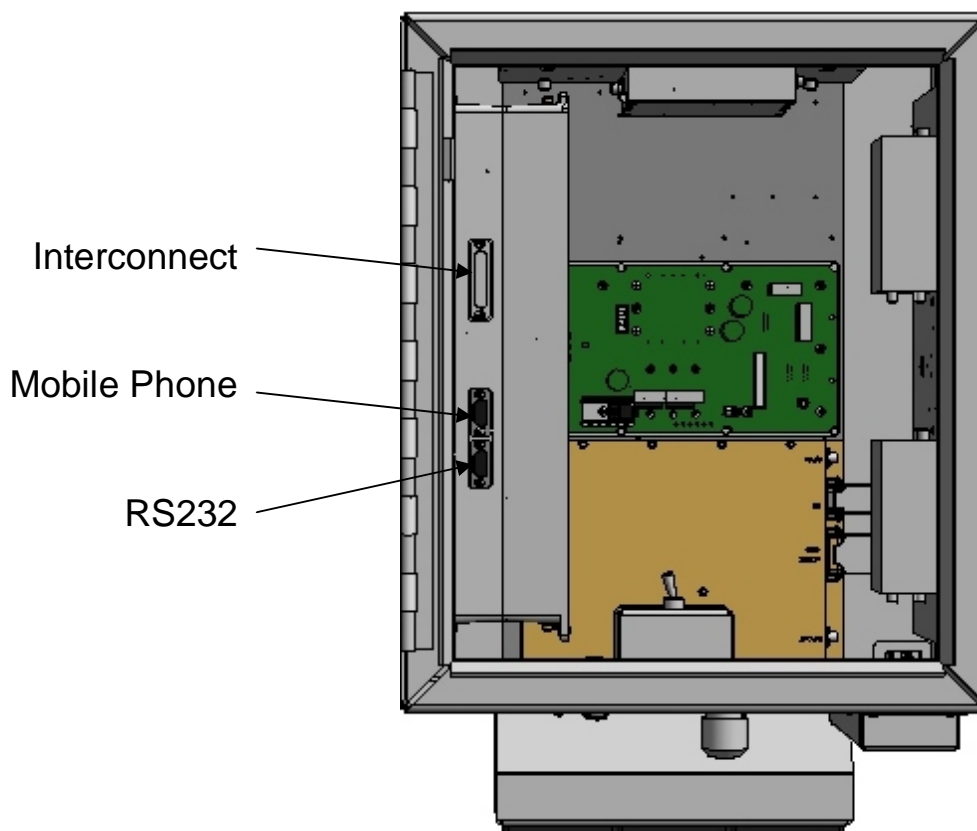


Figure 7: RS232 Port Location

- Start the terminal program with settings 9600-8-N-1 and initialize the login by pressing 'enter'. *Details of the terminal program configuration are shown in Appendix A of this Operator's Manual.* Login to the repeater with your username and password. The default username and password are "USERNAM1" and "PASSWRD1" respectively, without the quote marks. Note that all software commands are CASE SENSITIVE. *Section 6 of this Operator's Manual details*

*all the software commands available in the repeater.*

- Type 'STATUS' and press 'enter' to verify the current repeater settings. Also, the 'STATUS' command can be used after every software parameter is changed to verify the current setup. The screen should appear similar to Figure 8 below.

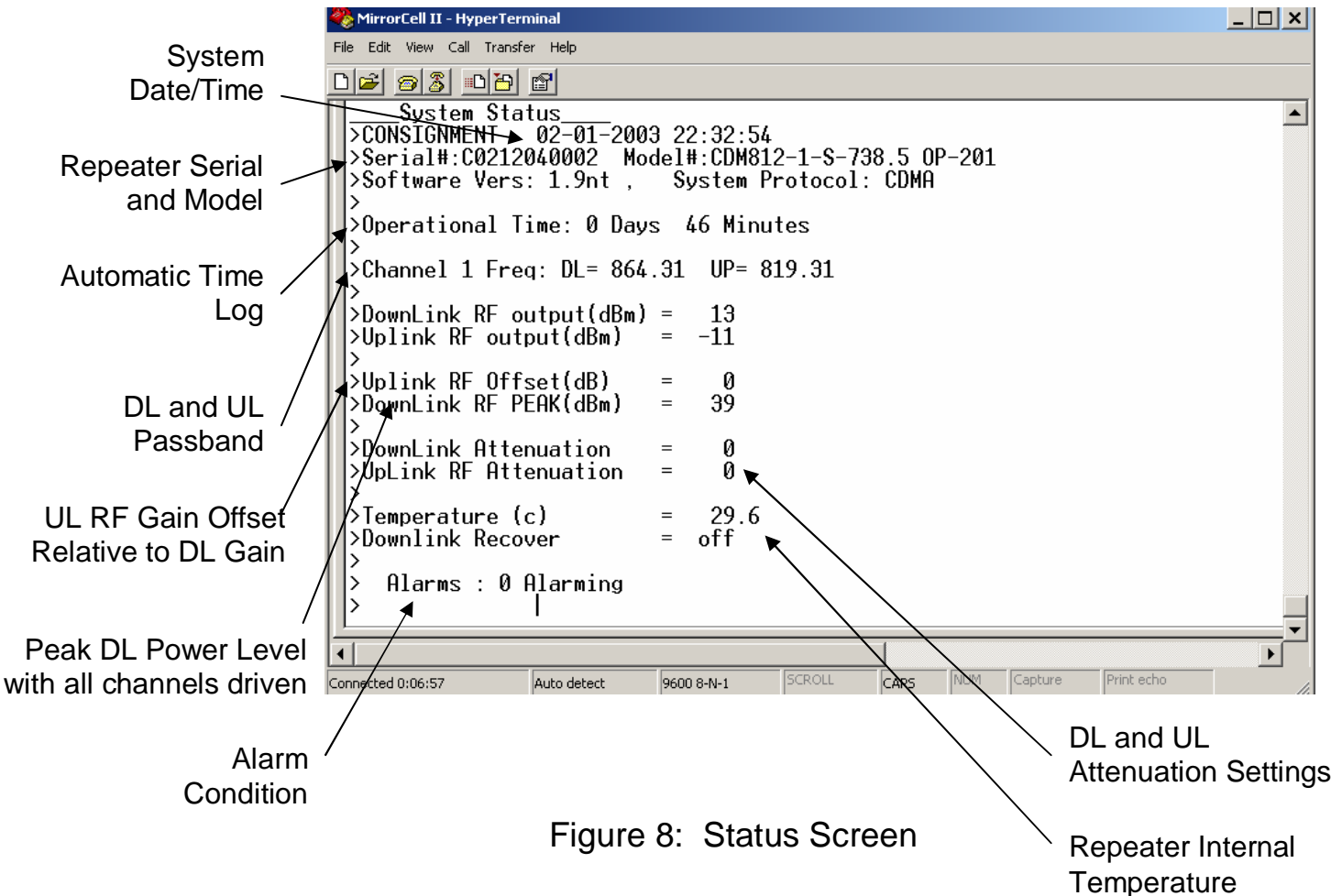


Figure 8: Status Screen

- The UL and DL passband center frequencies are normally preset at the factory. However, they can be changed by the user, if, for example, the user requires greater attenuation of adjacent out of band frequencies.
- To set the peak limit for the unit type 'SET PEAK #', where '#' is any number between 18 and the repeater's maximum rated output power in dBm plus 1. (Example: To limit the peak power to +27 dBm, type 'SET PEAK 28'.) The default factory setting is the repeater's maximum rated output power plus 1. If maximum power is desired, then skip this step.

- The automatic setup can be started by typing 'RESTART'. The repeater will go through the setup routine to achieve the peak limit output power as set above. This can take up to a minute to complete and will display a message when it is complete.
- *A complete list of alarms and their respective alarm code numbers is shown in Appendix B.*
- *The use of external alarms for the MirrorCell II is detailed in Appendix C.*

### Important Notes:

- The MirrorCell<sup>®</sup> II repeater will attempt to set itself to the PEAK limit output power setting using its available gain. If input (donor) signal is insufficient to reach the output power PEAK setting with the repeater's available gain, the repeater will remain set using the maximum gain to an output power level of

$$(\text{INPUT SIGNAL LEVEL}) + (\text{REPEATER MAX GAIN}) = (\text{OUTPUT POWER LEVEL})$$

- If the repeater is to be moved from its current location to a new location, it is recommended that you manually set the attenuation values to maximum (30 dB) before turning it off.
- Ensure that all RF connections remain watertight and mechanically secure.

## 5.0 System Optimization

The repeater uses highly selective Surface Acoustic Wave (SAW) bandpass filters, which have a group delay of 3 microseconds. Since the propagation delay of free space is 5.4 microseconds per mile, the delay is "equivalent" to somewhat more than ½ mile of free space propagation.

The neighbor lists of the donor base station and the base stations surrounding the area served by the repeater may need to be adjusted after the repeater is installed. For example, in Figure 9, a repeater extends the coverage of BTS1 to a new area. BTS1 is now a neighbor with BTS4 and BTS5, whereas without the repeater, BTS1 is a

neighbor 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.

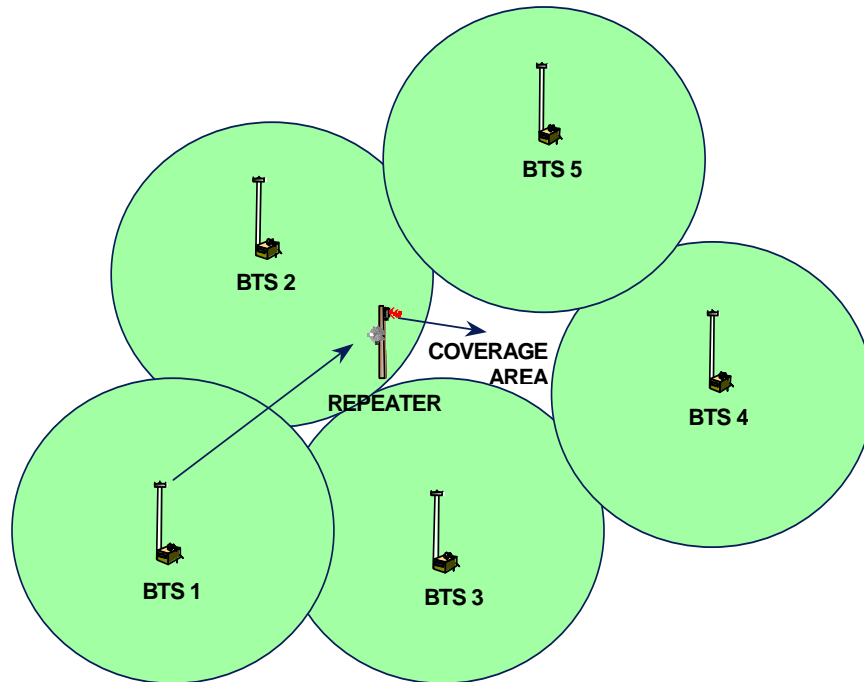


Figure 9: Neighbor List Changes with Repeater Operation

## 6.0 Detailed Software Commands

### 6.1 User Names and Passwords

The repeater login sequence begins by asking for Username and Password. The MirrorCell II allows for four different user names and passwords, each of which has different authorities. The default login parameters are shown in Table 2 below.

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

Table 2: User Names and Passwords

**Note:** The Usernames and Passwords should be changed during installation.

For example, to change a Username and Password:

```
SET UID# [username] <enter>  
SET PWD# [password] <enter>
```

## 6.2 Basic Commands

The basic repeater commands are listed below.

- STATUS Displays Status Screen
- RESTART Begin Auto Setup Process
- MODEM Displays Modem Configuration Parameters
- GET PASSWORD Displays a list of User Names and Passwords (USRS 1 and 2)
- LOGOUT Exits or Logs off repeater
- EXIT Exits or Logs off repeater
- GET LOG Displays Log
- ALARMS Displays List of Current alarms and Trigger timestamp
- ALARM # Displays Alarm #'s Parameters (1-20)
- LIST ALARMS Displays a list of all alarms their assigned number and status
- NEED UPDATES Logs user off terminal and Dial out to MUM to get all settings for the site. Used when replacing a unit in the field, or repeater parameters has already been setup at the MUM

## 6.3 "Set" Commands

The "Set" Commands allow the user to change specific parameters that define the repeater operation:

- SET UL OFFSET Up Link Gain Offset (0-16)
- SET DLPOWER Desired Down Link Power Setting (17-36)
- SET PROTOCOL System Technology (CDMA, AMPS, GSM)
- SET PEAK Maximum Down Link Output Power (18-42)
- SET PWD# Password for User ID # (8 alpha-numeric)

- 
- SET UID# User Name for User ID # (8 alpha-numeric)
  - SET DT Date in mm/dd/yy format
  - SET TM Time in 24hr format hh:mm:ss
  - SET ID Unit ID or Name
  - SET MUMNUMBER Phone Number to Dial to MUM when Report Active
  - SET UNTNUMBER Phone number of the Mirror Cell Unit.
  - SET REPORT Report Alarms (ON or OFF)
  - SET ALARM # Alarm # active or disabled (ON or OFF)
  - SET HB PERIOD Time between Expected Contact 0=HB off (0-999)minutes
  - SET ALRM RTRY Number of retries to send alarms. (0-100)
  - SET ALRM INTV Minutes between Alarm report retries.
  - SET DL FREQ # (Freq) Sets down link center frequency of the band pass
  - SET UP FREQ # (Freq) Sets uplink center frequency of the band pass
  - SET DL ATTN # Sets down link attenuation to a specified level
  - SET UL ATTN # Sets up link attenuation to a specific level

The example below shows how to set the repeater DL and UL passband center frequencies (this example assumes that OPT-2 offering two non-adjacent operating bands has been installed):

Example >set dl freq 1 1975.00  
>set up freq 1 1895.00  
  
>set dl freq 2 1947.50  
>set up freq 2 1867.50

*Note: 'SET UL ATTN #' and 'SET DL ATTN' commands override the auto setup feature and allows the repeater to be set up outside of the RF detected power range of the repeater. Peak power limit will still function properly at the lowest usable level of detection (+18 dBm typical). The user may wish to disable down link power detect alarm which will be on constantly due to no RF detected.*

*The RF detector has typically a dynamic range of detection of 23 dB and factory is calibrated in the factory for a RF power range of +17 to +40 dBm. The software look up table for the RF detector gives the unit a very accurate means of measuring average RF output power, typically +/-1 dB across the power range. Greatest accuracy is in the higher power ranges between +30 to +40 dBm.*

The following “set” command example illustrate a typical log in session:

### Command Examples

```
>set ul offset 2
>set dlpower 34
>set protocol CDMA
>set peak 37
>set PWD2 pass2
>set UID2 user2
>set dt 20/02/01
>set dt 02/20/01
>set tm 11:47:00
>set id unit123
>set mumnumber 9876543211
>set untnumber 1234567890
>set report on
>set alarm 1 off
>set hb period 21
>set alm rtry 2
>set alm intv 5
```

## 7.0 Technical Description

### General Description

The block diagram in Figure 10 shows the major components of the MirrorCell® II.



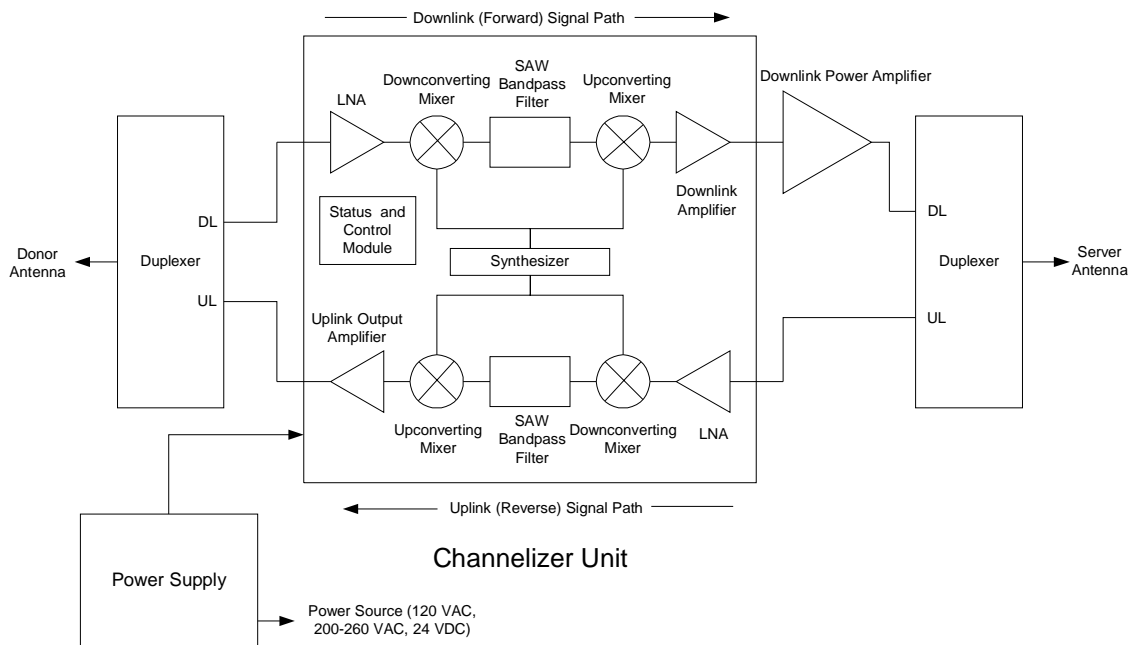


Figure 10: Block Diagram of MirrorCell® II Repeater

The five major modules include: The Channelizer Module, the downlink power amplifier, power supply, duplexers, and the status and control module (contained within the Channelizer). Built-in software adjusts and controls the repeater gain and other functions.

An internal view of the repeater with the major components identified is shown in Figure 11.

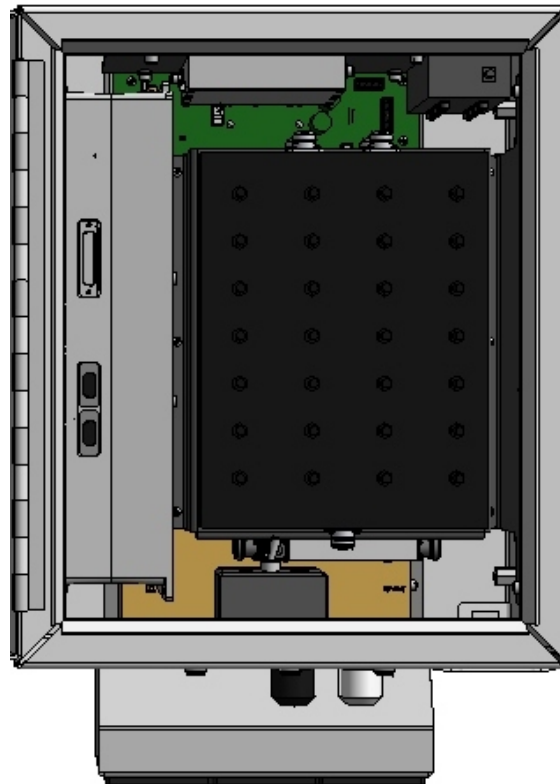
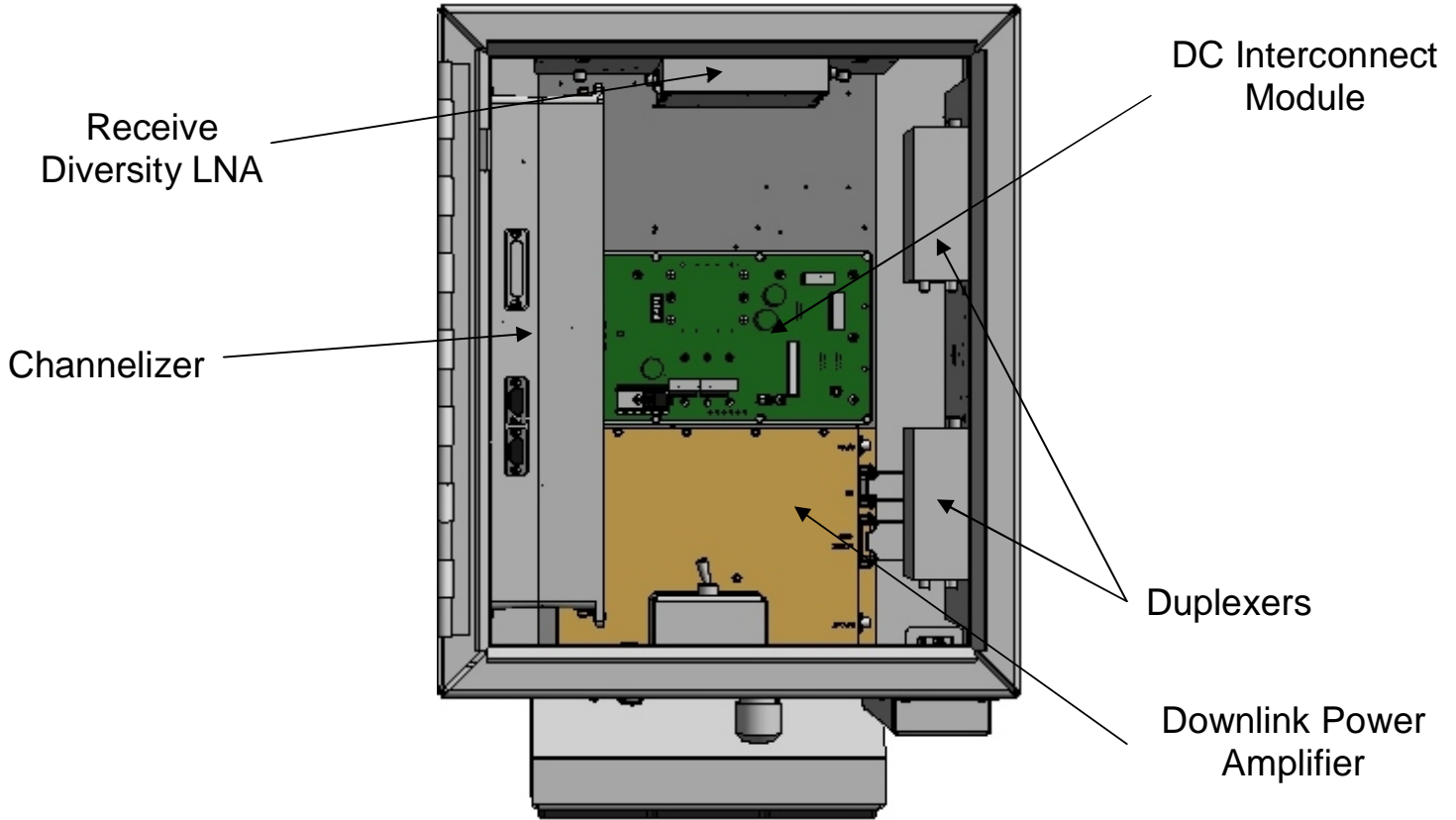


Figure 11: MirrorCell® II Internal View

The repeater is enclosed in an aluminum case with rear mounted cooling fins. Aluminum offers a lightweight design with good heat conduction and weatherproof protection. The housing conforms to the NEMA (weather-proof) standard. Per the NEMA 4 specification, the enclosure will withstand 65 PSI (pounds per square inch) pressure salt water spray on all four sides with no leakage to the inside.

The unit is cooled with electric fans that are cycled depending on the internal temperature of the unit. Forced air from the fans is directed between cooling fins on the rear of the cabinet, which enhances the MTBF by as much as 100%.

The transmit and receive antenna ports are standard N-type (DIN 7-16 optional) located on the underside of the repeater.

## 7.2 Channelizer Module

The primary reference frequency for the MirrorCell® II repeater is provided by a 20 MHz temperature stabilized crystal oscillator. This basic reference frequency is used by the PLL to generate the local oscillator (LO) frequency. The 20 MHz frequency accuracy is 5 ppm. All internally generated frequencies are locked to this basic oscillator. The same LO frequency is used for both the up converter and down converter, ensuring no difference in the input and output frequencies.

The downlink and uplink paths in the channelizer module each consist of an LNA, a down-converting mixer with a low side Local Oscillator that produces a 140 MHz Intermediate Frequency (IF). Then, SAW (Surface Acoustic Wave) filters, an up-converting mixer, and a post amplifier complete the circuit. The channelizer module also includes power level control functionality. Note that the uplink path includes the power amplifier in the Channelizer unit, while the downlink path has the power amplifier external to the channelizer.

## 7.3 Downlink Power Amplifier

The downlink power amplifier may have output power levels as shown in Table 1. The power amplifiers are designed to meet industry standards regarding Adjacent Channel Power Ratio (ACPR) and spectral re-growth.

## 7.4 Power Supply Module

The power supply is designed for an input voltage of 120 VAC, 200-260 VAC, or +24 VDC, depending on the option. A surge suppression filter is included for voltage transient protection on the A/C powered models.

## 7.5 Duplexer Filters

The uplink and downlink RF signals are separated and combined with duplexers operating in the appropriate frequency bands. The duplexers are constructed with comb-line cavity bandpass filters, which provide excellent isolation against out-of-band signals.

## 7.6 Status and Control Module

The status and control module, contained within the channelizer, enables monitoring and control of the repeater. This module determines the status of the Channelizer and identifies failure conditions. When a failure condition is identified, an alarm is issued. When this occurs, the module sends a message to a PC over a serial data link (modem). Also, the optional MUM software program, which is installed on a remote computer, can monitor these alarms, and query the repeater on a pre-determined schedule.

## 7.7 Automatic Software-Driven Gain Control

A key feature of the MirrorCell<sup>®</sup> II repeater is the automatic software-driven gain control, or more simply, Automatic Set-up. This allows “plug and play” operation with little or no user intervention. When Automatic Set-up is initialized, built-in software adjusts the internal attenuators in the uplink and downlink signal paths within the Channelizer module. *Note that the UL and DL gains are generally equal to ensure a balanced path, unless the user manually changes them or the uplink signal is too high.* For most applications, the automatic software sequence will set an appropriate gain value without manual intervention.

The following software sequence is used:

- The repeater gain and attenuator settings can be reset by using the ‘RESTART’ software command, as described in section 4. This re-starts the software sequence and initiates Automatic Set-up.

- When Automatic Set-up is initiated, variable attenuators are immediately set at their maximum values of 30 dB. Thus, the UL and DL gain is 30 dB below the specified value. This prevents the repeater from exceeding its maximum power output specification in non-ideal installation situations.
- A power sensor measures the downlink signal level at the server output. If this level is below the maximum output specification, or 'PEAK' level, the software removes UL and DL attenuation in 1 dB steps until one of two things occurs:
  - The 'PEAK' level is achieved. In this case, the donor signal is sufficient for the repeater to achieve its 'PEAK' setting without using its full gain.
  - All the attenuation is removed. In this case, the donor signal is too low for the repeater to achieve its 'PEAK' setting with its available gain.
- If the donor signal level increases later (i.e. more channels are added), causing the repeater to exceed its 'PEAK' setting, the software will automatically add attenuation to keep the repeater within specification.
- If the donor signal level decreases later, the repeater will *not* remove attenuation to boost the repeater output to its original level. That is, *the software will only add attenuation, but never remove it.* This action differentiates this control system from simple AGC systems. Normally, a base station and a handset already have a power control system in place. The repeater gain does not continuously change to maintain its 'PEAK' setting, as this would fight and defeat the BTS power control function.

## 8.0 Technical Specifications

The MirrorCell<sup>®</sup> II specifications are divided into RF (Table 3), Electrical (Table 4) Mechanical (Table 5), and Environmental (Table 6), shown below.

Parameters	Uplink	Downlink
<b>Frequency – Models:</b>		
800 MHz:		
Cellular A (A'' + A)	824 – 835 MHz	869 – 880 MHz
Cellular B (B + A' + B')	835 – 849 MHz	880 – 894 MHz
Cellular AE (A'' + A + A' [Excludes B])	824 – 835 MHz, 845 – 846.5 MHz	869 – 880 MHz, 890 – 891.5 MHz
Cellular BE (B + B' [Excludes A'])	835 – 845 MHz, 846.5 – 849 MHz	880 - 890 MHz, 891.5 – 894 MHz
Cellular Full Band	824 – 849 MHz	869 – 894 MHz
Public Safety	821 – 824 MHz	866 – 869 MHz
ESMR	806 – 821 MHz	851 – 866 MHz
ESMR Full	806 – 824 MHz	851 – 869 MHz
1900 MHz:		

PCS A	1850 – 1865 MHz	1930 – 1945 MHz
PCS B	1870 – 1885 MHz	1950 – 1965 MHz
PCS C	1895 – 1910 MHz	1975 – 1990 MHz
PCS D	1865 – 1870 MHz	1945 – 1950 MHz
PCS E	1885 – 1890 MHz	1965 – 1970 MHz
PCS F	1890 – 1895 MHz	1970 – 1975 MHz
Bandwidth of Bandpass	800 MHz Models: 200 kHz – 14 MHz 1900 MHz Models: 200 kHz – 15 MHz	800 MHz Models: 200 kHz – 14 MHz 1900 MHz Models: 200 kHz – 15 MHz
Composite Output Power Maximum Limit	+23dBm +/- 1 dB (200 mW)	+33 dBm +/- 1 dB (2W) +36 dBm +/- 1 dB (4W) (1900 MHz only) +39 dBm + 0.5/-1.0 dB (8W) +43 dBm + 0.5/-1.0 dB (20W)
Gain at Minimum Attenuation: 800 MHz:  1900 MHz: +36 dBm (4W) option +38.5 dBm (7W) option +43 dBm (20W) option	(see next page) 90 dB Nominal for any power output option  90 dB Nominal 92 dB Nominal 95 dB Nominal	(see next page) 90 dB Nominal for any power output option  90 dB Nominal 92 dB Nominal 95 dB Nominal
Gain Range	30 dB	30 dB
Gain Flatness	2.5 dB pk to pk	2.5 dB pk to pk
Gain Change over temperature	+/- 2 dB	+/- 2 dB
Gain Step Size	1 +/- 0.5 dB	1 +/- 0.5 dB
Gain change over BW	+/- 2 dB	+/- 2 dB
Number of Carriers	Single or Multiple	Single or Multiple
Noise Figure at Maximum Gain 800 MHz: 1900 MHz:	<5 dB <5 dB	<6.5 dB <6.5 dB
Spurious Output	FCC/IC	FCC/IC
Number of Bandpasses or Channels	1 or 2, depending on option	1 or 2, depending on option
Signal Electrical Delay	3 μsec (Typical)	3 μsec (Typical)
Connectors	N(f) Standard, DIN 7-16 Optional	N(f) Standard, DIN 7-16 Optional
Mean Time Between Failures (MTBF)	75,000 hours	75,000 hours

Table 3: MirrorCell® II RF Specifications

RF Output Power	Current and Power Requirement		
	120 VAC Power Option	220 VAC Power Option	24 VDC Power Option
+36 dBm (4W) (1900 MHz only)	3.0 amps	1.6 amps	10.5 amps
+39.0 dBm (8W) 800 and 1900 MHz	3.0 amps	1.6 amps	10.5 amps
+43 dBm (20W) 800 and 1900 MHz	4.0 amps	2.2 amps	14.5 amps

Table 4: MirrorCell® II Electrical Power Specifications

Parameter	Specification
Housing, (WxHxD)	15 x 24 x 14 inches (38.1 cm x 61 cm x 35.6 cm)
Weight	49 pounds (22.3 kg)
Housing Material	Aluminum, off-white paint color
Cooling	Convection/Forced Air

Table 5: MirrorCell® II Mechanical Specifications

Parameter	Specification
Operating Temperature	-25° to 50° C.
Storage Temperature	-40 to 75° C
Enclosure	NEMA 4 (Weatherproof)

Table 6: MirrorCell® II Environmental Specifications

## 9.0 Troubleshooting, Maintenance and Parts Replacement

### 9.1 Troubleshooting:

A chart of troubleshooting procedures is shown in Table 7 below.

PROBLEM	POSSIBLE CAUSE	SOLUTION
LED Power Supply Module is not lit	<ol style="list-style-type: none"> <li>Unit not turned on</li> <li>No power to unit</li> <li>Module failure</li> <li>Input AC or DC wiring is faulty.</li> </ol>	<ol style="list-style-type: none"> <li>Plug in/turn on unit</li> <li>Restore power to unit</li> <li>Replace module</li> <li>Rewire/repair power source to repeater.</li> </ol>
LED on power supply module is lit but cannot login to the repeater	<ol style="list-style-type: none"> <li>Software emulation program is not set properly</li> <li>Software emulation program is not working properly</li> <li>Cables not functioning properly</li> <li>Bad Channelizer</li> </ol>	<ol style="list-style-type: none"> <li>Verify program is set properly</li> <li>Verify program is working properly; replace if necessary</li> <li>Replace cable</li> <li>Replace Channelizer module</li> </ol>
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	<ol style="list-style-type: none"> <li>Receiving too low of a signal from donor site</li> <li>Gain not set correctly</li> </ol>	<ol style="list-style-type: none"> <li>Verify adequate signal is received; adjust donor antenna if necessary</li> <li>Reset gain</li> </ol>
Receiving sufficient signal strength but too much interference to make a call	Repeater goes into oscillation because of insufficient antenna isolation	<ol style="list-style-type: none"> <li>Improve antenna isolation: <ul style="list-style-type: none"> <li>Further separate antennas</li> <li>Mount a shield between antennas</li> </ul> </li> <li>Reduce repeater gain</li> </ol>



## Table 7: Troubleshooting Procedures

### **9.2 Maintenance**

The MirrorCell<sup>®</sup> II does not require preventative maintenance.

### **9.3 Parts Replacement**

In case of repeater failure, EMS *Wireless* recommends you send back the entire repeater for repair, and mount a spare repeater in its place.

## Appendix A: 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 Hyper-terminal. 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 A-1.

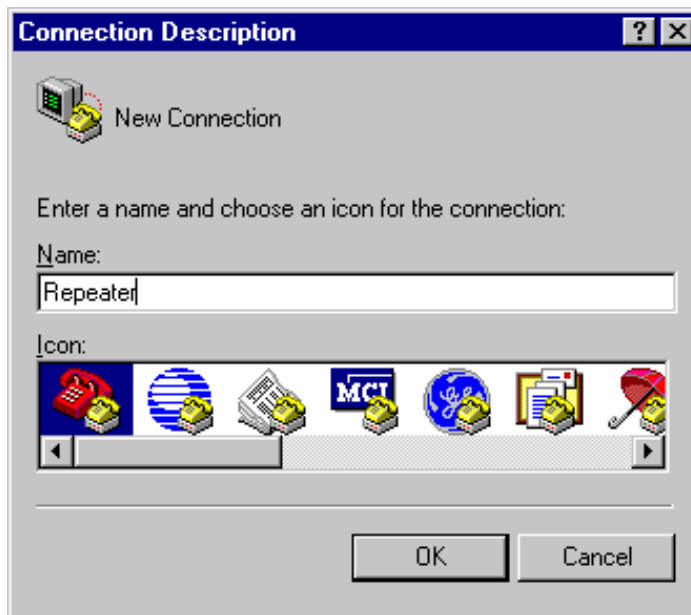


Figure A-1: HyperTerminal Connection Description Window

4. For a direct connection to the repeater, choose "Direct to Com X" in the drop down box. See Figure A-2.



Figure A-2: HyperTerminal Screen for Direct Connection

5. For remote connection via modem, enter the number you wish to dial and choose to connect using “Standard Modem” as in Figure A-3.



Figure A-3. HyperTerminal Screen for Modem Connection

6. After clicking OK, you will need to choose "Port Settings." Select:

- Bits per Second: 9600
- Data bits: 8
- Parity: None
- Stop bits: 1

The port settings will be the same for direct connection and remote connection. For a direct connection to the repeater, make sure flow control is set to "None". See Figure A-4 below.

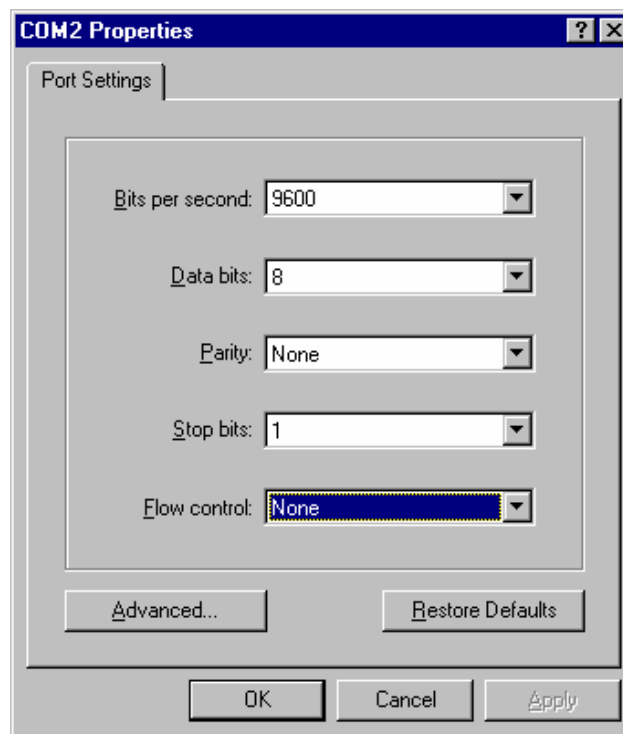


Figure A-4: Port Settings for Modem Connection

The MirrorCell<sup>®</sup> II will auto answer on the 2<sup>nd</sup> ring. Once the modems handshake and a session is started it may be necessary to press the <enter> key to initiate login sequence.

## Appendix B: Alarm Table

A complete list of alarms is shown in Table B-1 below.

**Table B-1: Repeater Alarms**

<b>Alarm Number</b>	<b>Alarm Name</b>	<b>Alarm Status</b>
1	SynthLock Uplink	on
2	SynthLock DownLink	on
3	OverTemp	on
4	Fan Alarm	on
5	AmpDownLink	on
6	AmpUplink	on
7	Low Output Pwr DL	on
8	Power AC	on
9	Batt Power DC	off
10	Low V DC Input	on
11	OverDrive Uplink	on
12	Com Alarm, Heartbeat	off
13	External 1	on
14	External 2	on
15	External 3	on
16	External 4	on
17	Intrusion	on
18	S Param Change	off
19	Invalid Logins	on
20	OverDrive DL	on

## Appendix C: External Alarms

Other pieces of equipment can be alarmed by connecting relay outputs into the external alarms of the MirrorCell II. An alarm condition will be generated when the open collector input is pulled to common ground. The input has a very weak pullup resistor in circuit. The external alarm inputs can be physically connected either on the alarm terminal-strip as pictured in figure C-1 or directly to the DC Distribution board on the labeled jumper. The software should be configured to not alarm any external alarm not physically connected to the repeater. The software alarms for the external alarms are in order and number 13 to 16. Alarm 9 corresponds to the Batt Backup alarm input and is used to alarm BBU systems attached to the repeater.

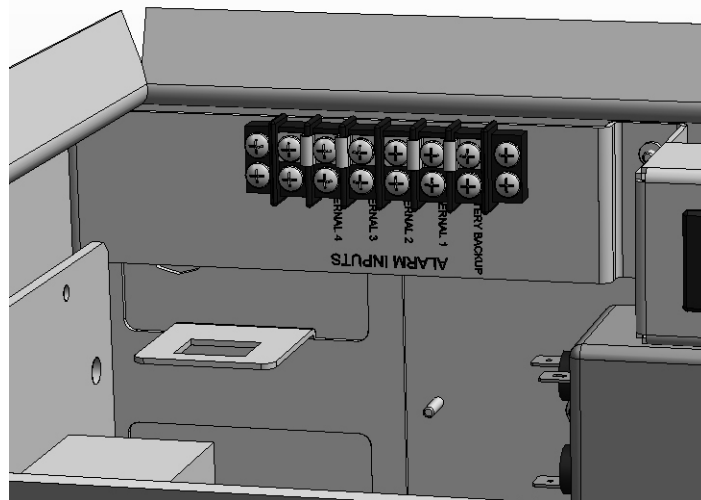


Figure C-1