OPERATING MANUAL

ORTEL MIRRORCELL® SERIES 5800

FOR AMPS/GSM

IN-BUILDING FIBEROPTIC RF

DISTRIBUTED ANTENNA SYSTEM

User's Manual

ORTEL CORPORATION

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ORIGINAL

G:\EDC\DOCSRLSD\MAN\5800AMPS-GSM\5800
Rev. A November 19, 1997

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 his 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. This entire manual should be read and understood before beginning installation and operation.

CAUTION

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

Electrostatic Sensitivity

ESD = ELECTROSTATIC DISCHARGE SENSITIVE DEVICE

Observe electrostatic precautionary procedures.

Semiconductor laser transmitters and receivers provide highly reliable performance when operated in conformity with their intended design. However, a semiconductor laser may be damaged by an electrostatic charge inadvertently imposed by careless handling.

Static electricity can be conducted to the laser chip from the center pin of the RF input connector, and through the DC connector pins. When unpacking and otherwise handling the transmitter, follow ESD precautionary procedures including use of grounded wrist straps, grounded workbench surfaces, and grounded floor mats.

If You Need Help

If you need additional help in installing or using the system, need additional copies of this manual, or have questions about system options, please contact:

Ortel's Customer Service Dept.
2015 W. Chestnut Street, Alhambra, CA 91803, USA
(818) 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 Customer Service Department. Service will be rendered according to Ortel's warranty and repair policy. The product shall not be returned without contacting Ortel 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 Ortel Corporation's Customer Service Dept.), 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 optoelectronic components.

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. 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 Department prior to returning any device. Advise the Ortel Customer Service Department 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.

EXCEPT AS EXPRESSLY PROVIDED HEREIN, ORTEL MAKES NO WARRANTY OF ANY KIND, EXPRESSED OR IMPLIED, WITH RESPECT TO ANY GOODS, PARTS AND SERVICES PROVIDED IN CONNECTION WITH THIS AGREEMENT INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. ORTEL SHALL NOT BE LIABLE FOR ANY OTHER DAMAGE INCLUDING, BUT NOT LIMITED TO, INDIRECT, SPECIAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF OR IN CONNECTION WITH FURNISHING OF GOODS, PARTS AND SERVICE HEREUNDER, OR THE PERFORMANCE, USE OF, OR INABILITY TO USE THE GOODS, PARTS AND SERVICE.

Ortel will not be responsible for loss of output or reduced output of optoelectronic devices if the customer performs chip mounting, ribbon bonding, wire bonding, fiber coupling, fiber connectorization, or similar operations. These processes are critical and may damage the device or may affect the device's output or the fiber output.

Ortel test reports or data indicating mean-time-to-failure, mean-time-between-failure, or other reliability date 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.

This fiberoptic laser transmitter contains a class IIIb laser product as defined by the US Department of Health and Human Services, Public Health Service, Food and Drug Administration. This laser product complies with 21 CFR, Chapter I, Subchapter J of the DHEW standards under the Radiation Control for Health and Safety Act of 1968. The laser module certification label is located on the equipment enclosure and it also shows the required **DANGER** warning logotype (as shown below).

The Ortel laser products are used in optical fiber communications systems for radio frequency and microwave frequency analog fiberoptic links. In normal operation, these systems are fully enclosed and fully shielded by the hermetically sealed laser metal package. Laser bias current is limited by the internal control circuitry. The transmitters are coupled to glass fiber and have 1310 nm optical output wavelength with typically 0.5 to 20 mW output depending on the model. The optical radiation is confined to the fiber core. Under these conditions, there is no accessible laser emission and hence no hazard to safety or health.

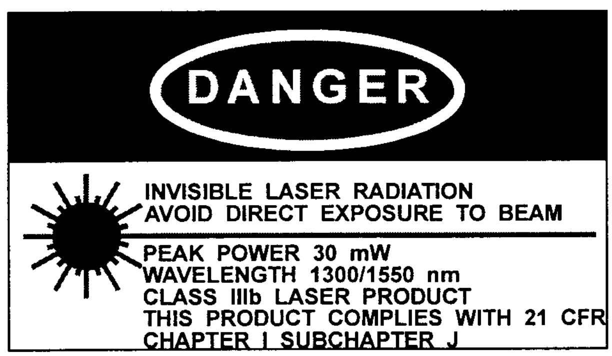
Since there is no human access to the laser output during system operation, no special operator precautions are necessary when fiber is connected to the transmitter and receiver. During installation, service, or maintenance, the service technician is warned, however, to **take precautions which include not looking directly into the fiber connector or the fiber which is connected to the fiber connector before it is connected to the fiberoptic receiver. The light emitted from the fiberoptic connector or any fiber connected to the connector is invisible and may be harmful to the human eye. Use either an optical power meter or an infrared viewer or fluorescent screen for optical output verification. All handling precautions as outlined by the FDA and ANSI Z136.2 and other authorities of class IIIb lasers must be observed.**

Do not attempt to modify or to service this Product. Contact the Ortel Corporation Customer Service Department for a return authorization if service or repair is necessary.

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.

DETAIL OF LASER CERTIFICATION LABEL



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LIST OF ABBREVIATIONS AND DEFINITIONS

FO	Fiberoptic
FC/APC	Type of angle polished optical connector
CDPD	Cellular Digital Packet Data
C/I	Ratio of 2-tone carrier to third order intermodulation distortion.
CNR	Carrier-to-Noise Ratio
GND	Ground
HPA	High Power Amplifier
HUB	Fiberoptic equipment at the base station: chassis with power supply, Transceiver plug-ins, and RF Power Splitter/Combiner plug-ins
ID	Identification number
IIP3	Input Third Order Intercept Point=RF_{in}+(C/I)/2
IP3	Third Order Intercept Point
LED	Light emitting diode
LNA	Low Noise Amplifier
NF	Noise Figure = 173.8 + (RF_{in} - SNR_{output}) dB
NA	Not applicable
NC	No Connection
PBX	Private Branch Exchange
SN	Serial Number
SNR	Signal-to-Noise Ratio
SFDR	Spur-Free Dynamic Range=2/3[(RF_{in})+(C/I)/2+173.8-NF]dB-$Hz^{2/3}$ where RF_{in} is the RF input power per tone.
TOI	Third Order Intercept Point

CHAPTER 1 INTRODUCTION AND APPLICATION

OUTLINE OF MANUAL

This manual describes the Ortel MirrorCell Series 5800 In-Building Fiberoptic RF Distributed Antenna System, provides the product specifications, and describes the methods used to measure the system performance. The first chapter describes the in-building application of the MirrorCell Series 5800 system. The second chapter describes the system, the components and features. The third chapter gives the specifications for the overall system and for each line replaceable component in the system. Chapter 4 describes how to measure the performance of the system.

The first section of this manual provides information for engineering design purposes. Installation, maintenance and troubleshooting can be found in Chapters 5, 6, and 7.

APPLICATION

The Ortel MirrorCell Series 5800 system can be used in a building to send radio signals over optical fiber to many different locations such as an office area, a conference room or a lobby. The signal is fed to local antennas at each location. By distributing the RF signal to many antennas located throughout the building, a fiberoptic distributed antenna system can provide uniform coverage throughout the building.

The fibers typically emanate from a source point (small base station) in the building. These fibers run from that source point, piping the signal to many fiberoptic antennas throughout the building as shown in Figure 1-1.

One of the key advantages of a fiberoptic RF distribution system is that it separates the issues of coverage and capacity. In an alternative system that covers a building by distributing radio base stations, one must add a base station in that area when faced with the problem of poor coverage in one section. Thus, capacity is added to a section which might not need it. Similarly, when faced with a capacity problem in a portion of the building, one would need an additional base station regardless of whether additional coverage is required. Coverage and capacity are two separate problems. With a fiberoptic RF distribution system, there are separate solutions to the two separate problems. For poor coverage, an additional fiberoptic antenna is added; for an area with insufficient capacity, more base station transceivers are added. In this way, equipment and channels are most efficiently used, and the entire system is more economical. Not only can the fiberoptic RF distribution system be used to create uniform coverage throughout the entire building, including stairwells, elevator shafts and garages, regardless of the size and construction, but it enables centralization of the equipment. In the fiberoptic RF distribution system, the bulky equipment (such as the base station transceivers, filters, and power supplies) are located in an equipment room, while the antennas are strategically placed for coverage. This factor is especially significant in buildings where aesthetics are key, since it is easier to conceal a small fiberoptic antenna than several radios.

The ability to centrally locate the PBX with base stations (voice and CDPD) is critical to economically offering combined wireless office services such as cellular wireless PBX and CDPD applications within the building. Centralized equipment has many advantages, including serviceability and adaptability to new standards (such as digital cellular). These advantages are especially apparent when the RF distribution system is shared by multiple services like cellular voice and CDPD. Since the fiberoptic antennas cover the entire cellular band and are format independent, they are capable of sending any type of signal throughout the building, whether analog, digital or CDPD, and they can send them all simultaneously. Because the capacity is determined by the base station equipment, not the antennas, once a building is wired for RF distribution via fiberoptics, capacity and new services can be added without any changes visible to the customer.

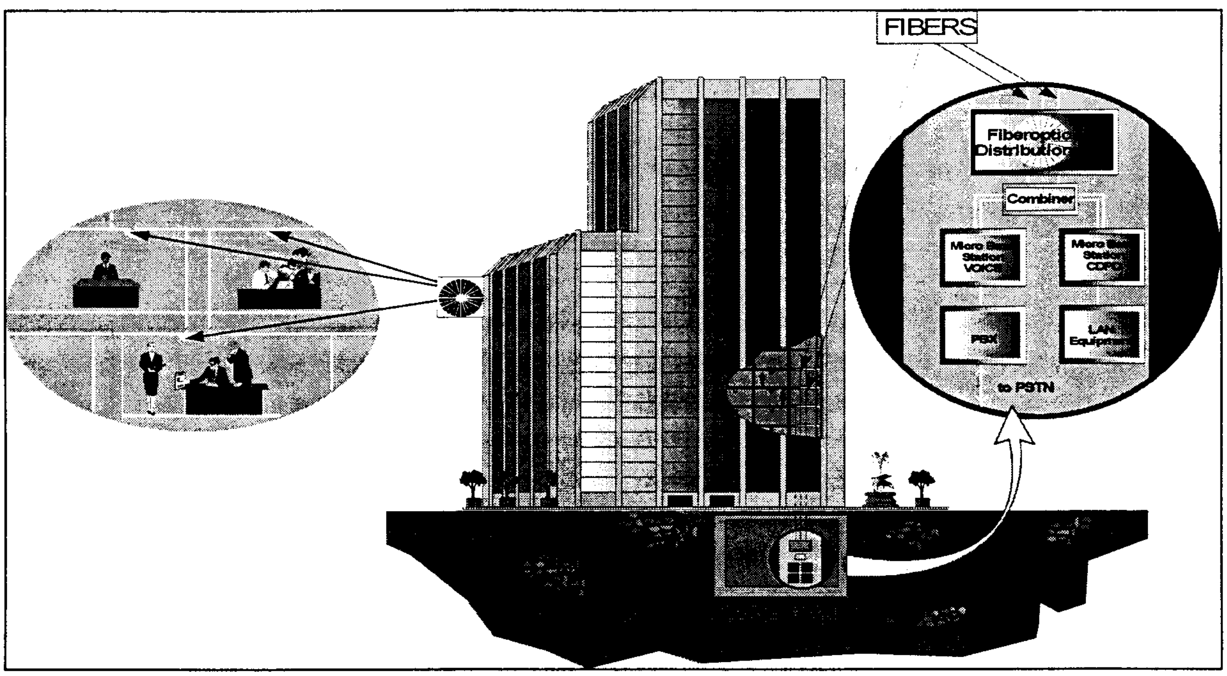


Figure 1-1 In-Building Fiberoptic RF Distribution System

CHAPTER 2 SYSTEM DESCRIPTION

SYSTEM COMPONENTS

The MirrorCell Series 5800 In-Building Distributed Antenna System is a Fiberoptic RF Distribution system designed to provide cellular coverage throughout a building or campus of buildings. The Fiberoptic System uses small Fiberoptic Antennas that are similar in size to conventional smoke detectors and are typically mounted to a ceiling to provide coverage to a sector of the building. These antennas are connected by optical fibers to an RF Distribution Hub, which provides the interface to the cellular system through connection to either a base station or a repeater. The Fiberoptic Antennas, placed strategically throughout the building, create uniform coverage. Because the attenuation of fiber is negligible, the Hub and cellular equipment can be located anywhere in the building without concern for the distance between the Hub and the Fiberoptic Antennas.

The MirrorCell Series 5800 consists of an RF Distribution Hub and up to 16 Fiberoptic Antenna units. As shown in Figure 2-1, at the Hub, the MirrorCell Series 5800 interfaces with the Cellular System (a base station or a repeater) and converts the cellular signals to or from optical signals. At the Antenna units, the MirrorCell Series 5800 converts the optical signals to and from cellular signals for interface with the mobile user. Optical fiber cables connect the Hub to the Antenna units. The system provides bi-directional signal transmission between the Hub and the Antenna units via fiberoptics. The downlink signal is the path from the Hub to the Antenna units. The downlink cellular signal enters the Hub and is split to several Fiberoptic Transceivers that convert the RF signal to an optical signal. The signal is sent along optical fiber to the Fiberoptic Antennas, where the Antenna unit's photodiode converts it to RF again. The RF signal is then amplified and fed to the Antenna for transmission. The uplink path is the signal from the Antenna units to the Hub. The uplink signal is received at the Antenna and amplified before the Antenna unit's laser diode converts the signal to an optical signal for transmission to the Hub. At the Hub, the optical signal is converted to RF and combined with the signals from other Fiberoptic Antennas. In this way, all Fiberoptic Antennas that are served from a Power Splitter/Combiner pair appear to the Base Station as one Antenna. It is also possible to have multiple splitter/combiner pairs and configure a building as multiple cells.

The optical fiber cable that links the Hub to the Antenna units can be as long as 2 km to provide the user flexible placement of the Antenna units for optimum coverage and capacity handling. Any optical connector inserted in the MirrorCell Series 5800 (such as through a patch panel) must have an optical return loss greater than 55 dB (for example tight fit FC/APC optical connectors). Otherwise optical reflections can degrade overall system performance. The total optical reflection back to the laser module must be less than -40 dB. The cable can also contain two wires to supply power from the Hub to the Antenna units. For 18 AWG copper wire, the maximum length is 45 m. Other user requirements are given in Chapter 3.

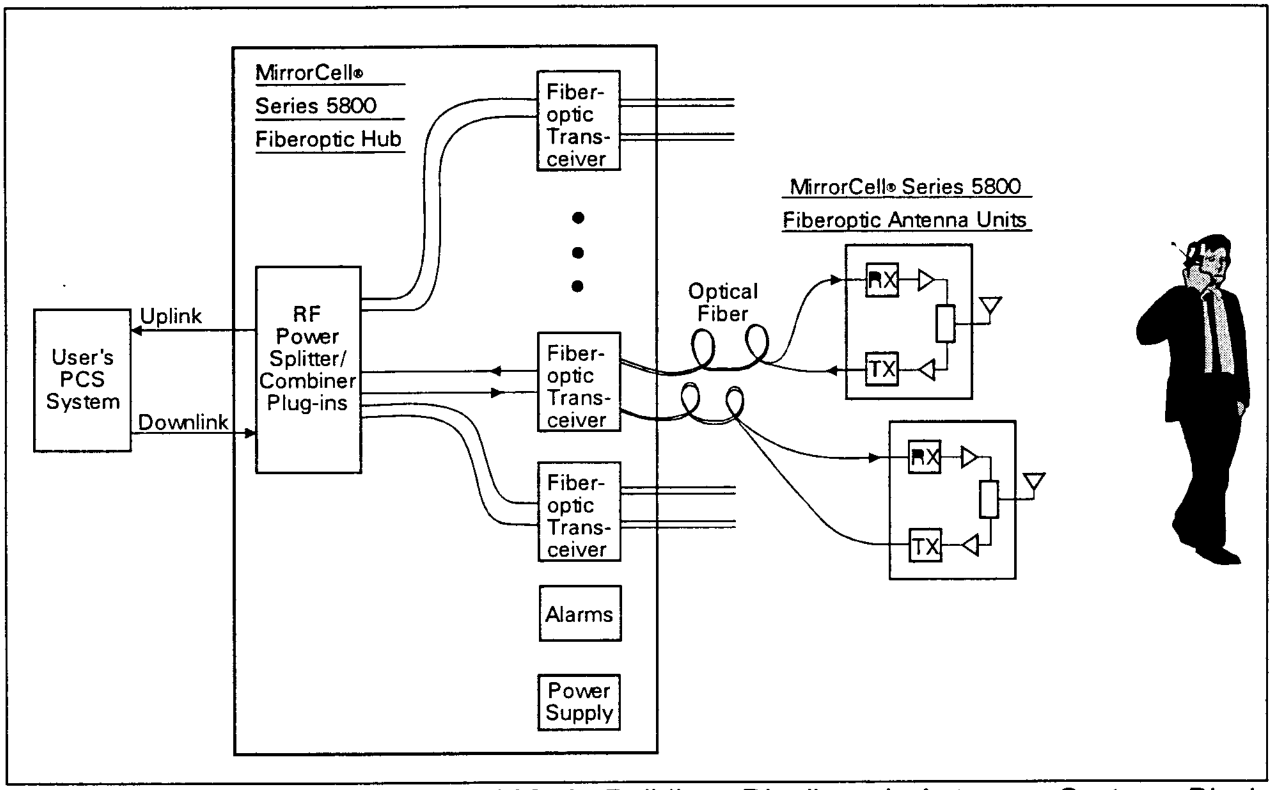


FIGURE 2-1 MirrorCell Series 5800 In-Building Distributed Antenna System Block Diagram

The MirrorCell Series 5800 consists of a chassis with a built-in power supply, RF Power Splitter plug-ins, Transceiver plug-ins and RF Power Combiner plug-ins. Figure 2-2 gives the MirrorCell Series 5800 parts list at the line replaceable unit (LRU).

Figure 2-2
MirrorCell Series 5800 model number

DESCRIPTION	MODEL NUMBER		
	AMPS	**GSM**	**BROADBAND**
Chassis with Built-in Power Supply	5899A	5899A	5899A
Transceiver Plug-in	5821A	5821B	5821C
RF Power Splitter Plug-in			
Two 1-way	5831A	5831B	5831C
Two 2-way	5832A	5832B	5832C
One 4-way	5834A	5834B	5834C
One 8-way (double wide)	5838A	5838B	5838C
RF Power Combiner Plug-in			
Two 1-way	5841A	5841B	5841C
Two 2-way	5842A	5842B	5842C
One 4-way	5844A	5844B	5844C
One 8-way (double wide)	5848A	5848B	5848C
Antenna Unit	5851A	5851B	5851C
Blank Front Panel	5891A	5891A	5891A

A chassis can hold up to two single wide (or one double wide) RF Power Splitter plug-ins, two single wide (or one double wide) RF Power Combiner plug-ins and eight Transceiver plug-ins as shown in Figure 2-3. Each Transceiver plug-in provides bi-directional signal transmission between each of two Antenna units as shown in Figure 2-4. The RF Power Splitter plug-in distributes the downlink Cellular signal to each Transceiver plug-in the chassis. The RF Power Combiner plug-in combines the uplink signal from each Transceiver plug-in in the chassis for output to the user's Cellular System (Base Station or Repeater).

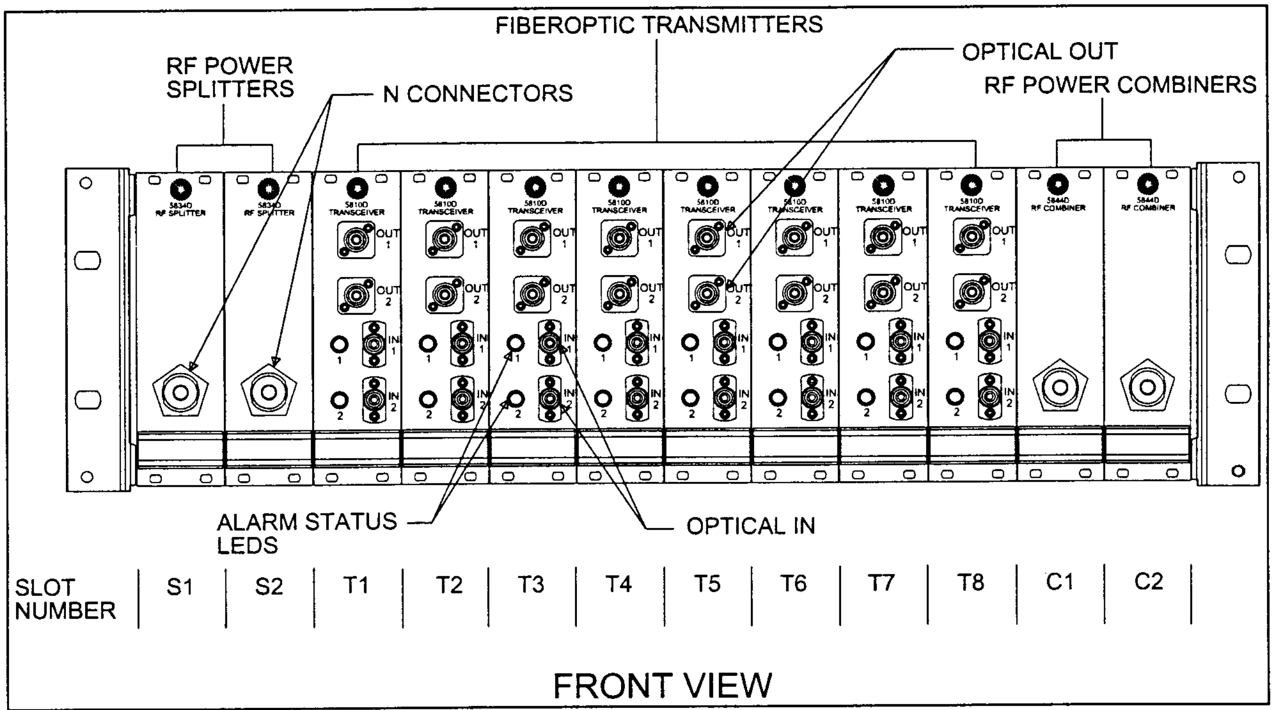


FIGURE 2-3 MirrorCell Series 5800 Hub Chassis containing RF Power Splitter, Transceiver and RF Combiner Plug-ins.

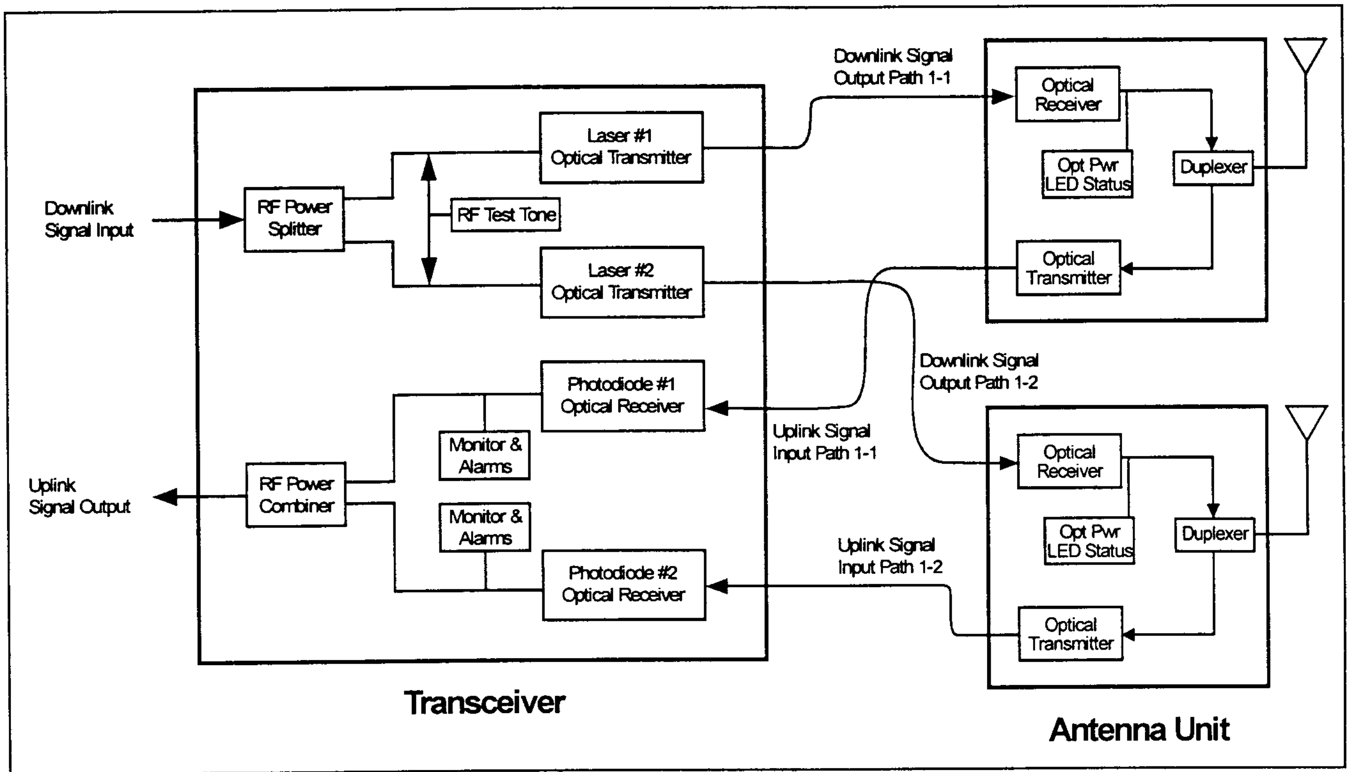


FIGURE 2-4 Block Diagram of Transceiver Plug-In and Antenna Unit

For verification of system functionality, there are alarm outputs located at the rear panel of the chassis (Figure 2-5) and LED indicators at both the Transceiver plug-ins and the Antenna units. At the Antenna unit, the LED indicates whether optical power is being received for the downlink path as shown in Figure 2-4. In a Transceiver plug-in, there are two LED's, one for each of the two round trip signal paths for that plug-in. Each LED indicates the continuity of an RF test tone for the entire path, sent from the Transceiver plug-in (downlink signal) to the Antenna Unit and back to the Transceiver plug-in (uplink signal). The status of each round trip path is monitored, and alarm outputs are available at the chassis. A summary alarm will indicate a failure in any path. The DIP switch can be used to prevent a signal path that isn't being used from tripping the alarm.

In addition to the built-in chassis power supply, inputs are provided so that the user can hook up a redundant power supply to back up the primary built-in power supply or battery. The MirrorCell Series 5800 automatically switches to the backup power source in case the primary supply fails. The primary power supply is monitored and alarm outputs are available at the chassis. Upon repair of the primary power supply, the system automatically switches back to the built-in chassis power supply.

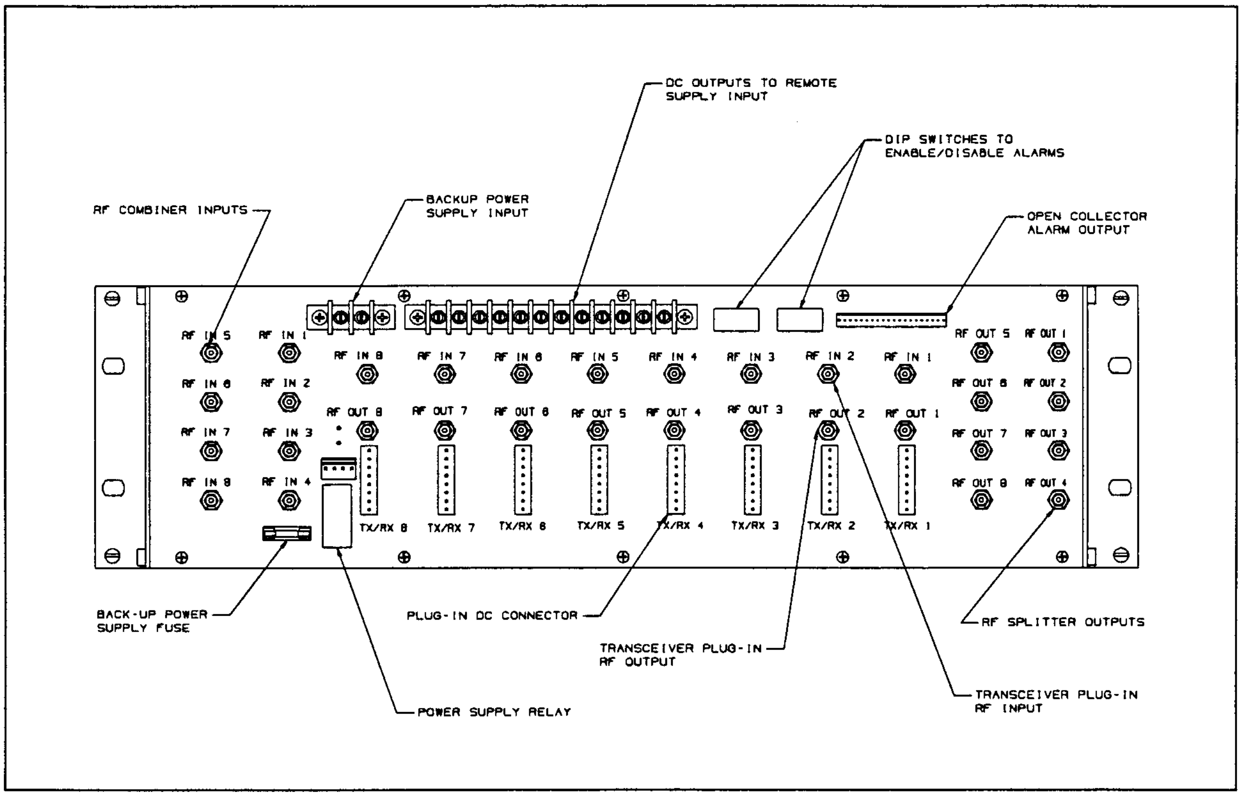


FIGURE 2-5 Rear View of MirrorCell Series 5800 Chassis

CHAPTER 3 SPECIFICATIONS

LINK SPECIFICATIONS

For specifying performance levels in Figure 3-1, each fiberoptic link is defined between the Hub (N-Type connectors on the Power Splitter/Combiner plug-ins) and the antenna connection on the Antenna unit. The link specifications are given in Figure 3-2. The user's downlink cellular signal connects to the input of the MirrorCell Series 5800 RF power splitter, and the RF output is at the Antenna unit for broadcast. In the other direction, the uplink signal from the mobile user is received by the MirrorCell Series 5800 RF Antenna unit and transmitted to the Hub chassis. The RF output from the Mirror XCell Series 5800 uplink is at the RF power combiners at the Hub. The uplink signal is then received by the Cellular System.

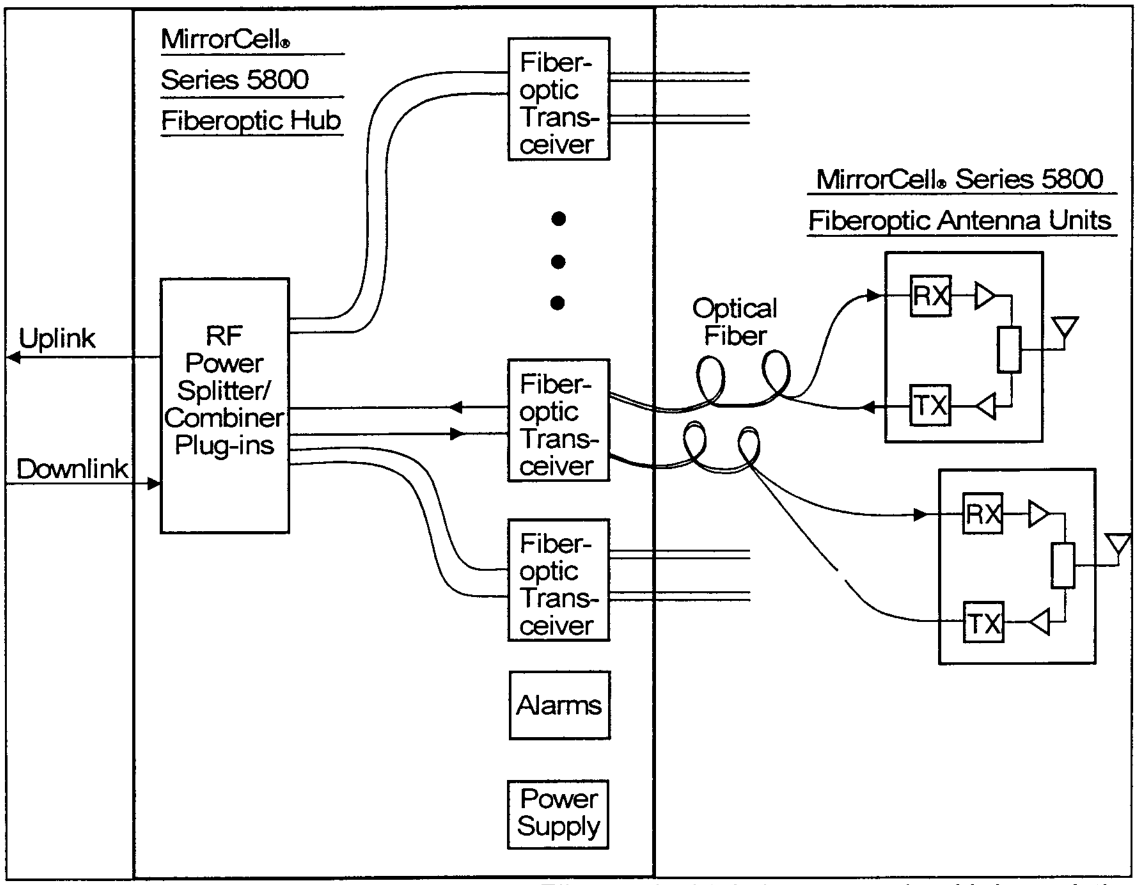


FIGURE 3-1 MirrorCell Series 5800 Fiberoptic Link between the Hub and the antenna unit.

The performance levels shown in Figure 3-2 are for an optical loss budget of 2 dB, which is the typical optical path loss for 2 km optical fiber and a pair of optical connectors. Optical reflection back to the laser must be low. The total optical reflection back to the laser module in the Transceiver plug-in or Antenna unit must be less than -40 dB. Otherwise, the overall system performance may be degraded. Figure 3-3 shows requirements that the user must satisfy for proper operation of the MirrorCell Series 5800 system. Figure 3-4 is a table which provides a guide for the user to set up his Downlink signal levels. It gives the nominal RF power per channel that the user can provide to the input of the Fiberoptic Downlink System.

Figure 3-2A

PERFORMANCE PARAMETER	DOWNLINK SPECIFICATION		
Version	**AMPS**	**GSM**	**Broadband**
Frequency Response	869MHz - 894MHz	935MHz- 960MHz	800 MHz - 960MHz
Operating Composite RF Input to RF PWR Splitter	+12 dBm	+12 dBm	+12 dBm
Operating Composite RF Output from Antenna unit	+7 dBm	+7 dBm	+9 dBm
RF Link Loss (at 25°C)	5 dB ± 2 dB	5 dB ± 2 dB	3 dB ± 2 dB
RF Gain Variation over Temperature	± 2.0 dB	±2.0 dB	± 2.0 dB
Response Flatness	± 2 dB	± 2 dB	± 2 dB
Output Carrier to Noise (single tone)	> 64 dB (30 KHz BW) Pout=+4 dBm	> 56 dB (200 KHz BW) Pout=+4 dBm	> 64 dB (30 KHz BW) Pout=+6 dBm
Output Carrier to Intermodulation (2 tones)	> 48 dB $P_{out/tone}$ = +4 dBm	> 48 dB $P_{out/tone}$ = +4 dBm	> 48 dB $P_{out/tone}$ = +6 dBm
Spur Free Dynamic Range	64 dBm $Hz^{2/3}$ (30 KHz)	58 dBm $Hz^{2/3}$ (200 KHz)	64 dBm $Hz^{2/3}$ (30 KHz)

Figure 3-2B

PERFORMANCE PARAMETERS	UPLINK SPECIFICATION		
Version	**AMPS**	**GSM**	**Broadband**
Frequency Response	824MHz - 849MHz	890MHz - 915MHz	800 MHz - 960MHz
Operating RF Input power to Antenna	-105 to -40 dBm	-97 to -40 dBm	-105 to -40 dBm
RF Link Gain (at 25°C)	-3 dB ± 2 dB	-3 dB ± 2 dB	0 dB ± 2 dB
Gain Variation over Temperature	± 2 dB	± 2 dB	± 2 dB
Response Flatness	± 2 dB	± 2 dB	± 2 dB
Output Carrier to Noise (single tone, P_{in} = -45 dBm) Uplink C/N spec. is for **one** antenna operating	> 66 dB (30 KHz BW)	> 58 dB (200KHz BW)	> 69 dB (30 KHz BW)
Output Carrier to Intermodulation (2 tones)	> 50 dB $P_{in/tone}$ = -45 dBm	> 50 dB $P_{in/tone}$ = -45 dBm	> 50 dB $P_{in/tone}$ = -48 dBm
Spur Free Dynamic Range (with Dynamic Range Enhancement)	77 dB (30 Khz)	72 dB (200 Khz)	77 dB (30 Khz)

Figure 3-3
User requirements for operation of MirrorCell Series 5800

PARAMETER	USER REQUIREMENT
Max Composite RF Input (damage level)	30 dBm (downlink) -10 dBm (uplink)
Max Optical Fiber Length	2 km
Optical Fiber	9/125 mm (core/clad) 1310 nm, singlemode
Optical Connectors	FC/APC Singlemode,tight fit
Optical Return Loss	≥ 40 dB
Number of Optical Fibers	Two per Antenna unit
Chassis AC Power (factory configured)	90 to 135 VAC or 184 to 264 VAC 50 to 60 Hz
Backup Power Supply (Optiona1)	+12 VDC ± 0.5 V, 8.5 A max load Ripple < 170 mV pp
Antenna DC Power	12 VDC ± 1 V at 0.5 A Ripple: <170 mV p-p, freq >300 Hz <300 mV, freq <300 Hz
Rack	Chassis: 3U high, 19" wide, 13.9" deep 1U (1.75") air space above and below each chassis
Antenna Unit	Do Not Paint Antenna Unit decorative cover
Temperature Performance to Full Spec Operating Storage Relative Humidity Operating Short Term	 5°C to 40°C 0°C to 50°C -20°C to 65°C 20 to 55% 10 to 80% (not exceeding 0.024 lbs water/dry air)
Max Length Wires to Supply DC Power to Antenna Units from chassis, @ 11.5Vdc	<300 m with 10 AWG Copper Wire <120 m with 14 AWG Copper Wire <45 m with 18 AWG Copper Wire

Figure 3-4
Downlink RF power per channel input to the Fiberoptic System as a function of number of channels.

NUMBER RF CHANNELS	USER'S NOMINAL INPUT TO FIBEROPTIC DOWNLINK SYSTEM
1	12 dBm/ch
2	9 dBm/ch
4	6 dBm/ch
8	3 dBm/ch
16	0 dBm/ch
n	12 - [10log(n)] dBm/ch

CHASSIS, POWER SUPPLY, ALARMS (MODEL 5899A)

The chassis with a built-in power supply is part of the Hub. Figure 3-5 is a sketch of the chassis. It supports and interconnects the various system plug-ins, and interfaces to the user's electrical equipment. The chassis fits into a standard 19 inch rack, is 3U (5.25 inches) high, 13.5 inches deep. Each chassis requires 1U (1.75 inches) of air space above and below it for thermal dissipation. Figure 3-6 summarizes the chassis and power supply specifications

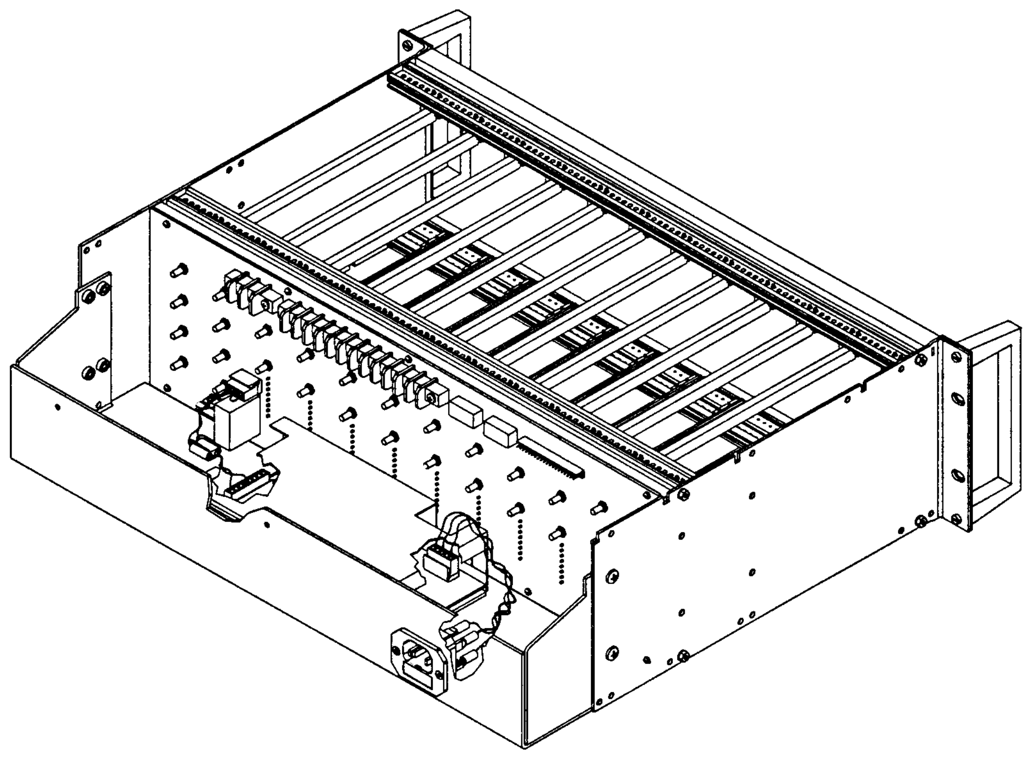


Figure 3-5 Sketch of chassis, showing the Power Supply mounted in the back, behind the chassis backplane.

Figure 3-6
Model 5899A Chassis and Power Supply specifications

PARAMETER	SPECIFICATION
Input Voltage (factory configured)	90 to 135 VAC or 184 to 264 VAC
Input Frequency	50 to 60 Hz
Output Voltage	+12 VDC ± 0.5 V
Maximum Load	8.5 A
Available Continuous Power	100 W at 50°C
Efficiency	78%
Noise Spikes	<170 Mv p-p
AC Power Plug	North America Nema 5-15P
17-pin Molex Power Output to 6 Antenna Units	12 VDC ± 0.5 V
2-pin Molex Power Input for Backup Power Supply	12 VDC ± 0.5 V (8.5 A max load, <170 mV pp ripple)
18-pin Molex Alarms Output	Open Collector Outputs: No Alarm—withstands 15 V Alarm—sinks 20 mA
Alarms Enable/Disable	On/Off DIP Switches
Dimensions	5.25" high, 19" wide, 13.9" deep
Temperature Range Performance to Full Spec Operating Storage	 5°C to 40°C 0°C to 50°C -20°C to 65°C

The chassis can accommodate 8 Transceiver plug-ins, 2 single-wide Power Splitter plug-ins and 2 single-wide Power Combiner plug-ins as shown in Figure 3-7. A Power Splitter plug-in can go into either of the two slots on the left-hand side of the chassis (designated S1 and S2); a Power Combiner plug-in can go into either of the two slots on the right-hand side (designated C1 and C2). The Transceiver plug-ins can fill any of the eight middle slots (designated T1 to T8). Slot numbering begins from the left-hand side as viewed from the front of the chassis. Transceiver Slot Number 1 is the third slot from the left edge of the chassis (T1). The Power Splitter in Slot S1 divides the cellular signal to Transceiver plug-ins in Slots T1 through T4; similarly, the Power Splitter in Slot S2 divides the cellular signal to Transceiver plug-ins in Slots T5 through T8. The Power Combiner plug-in in Slot C1 is linked to Transceiver plug-ins in Slots T1 to T4; the Power Combiner plug-in in Slot C2 is linked to the Transceiver plug-ins in Slots T5 through T8.

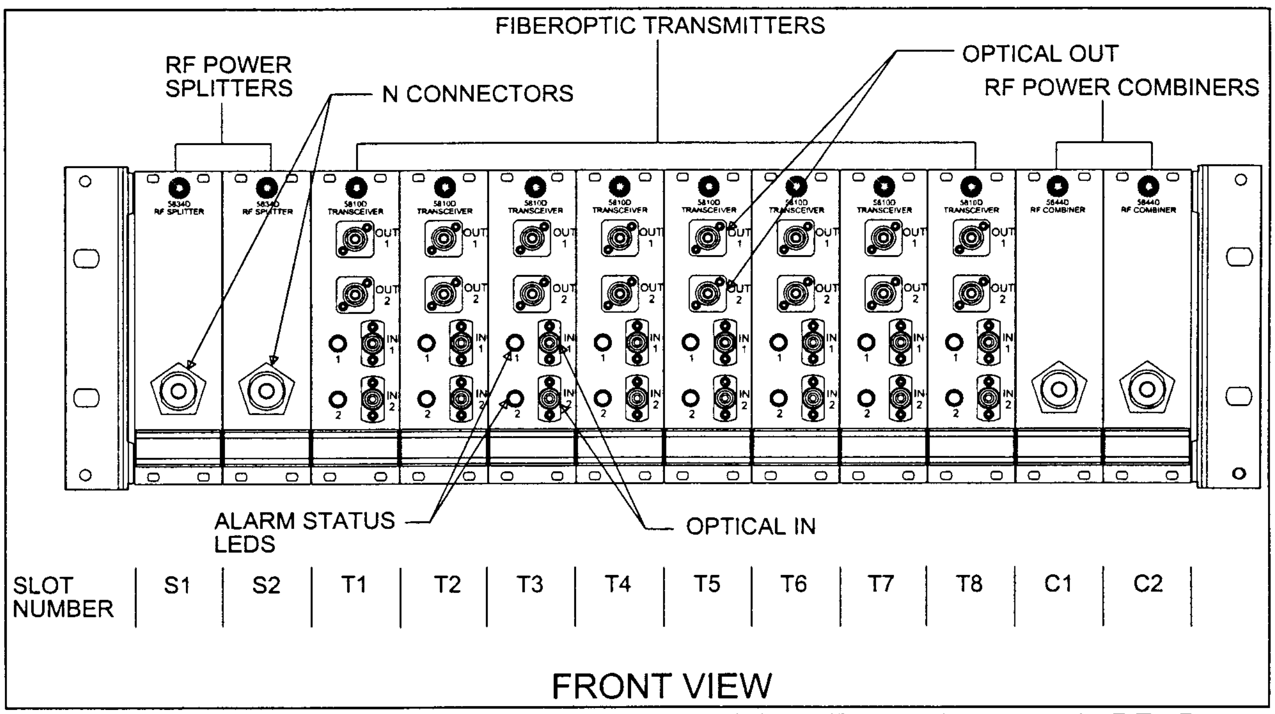


Figure 3-7 MirrorCell Series 5800 Hub containing Transceivers and RF Power Splitter/Combiner plug-ins.

Figure 3-8 shows a rear view of a populated chassis. The power supply is mounted at the back of the chassis and has a hardwired AC power cord. The chassis backplane distributes power to all the plug-ins and connects the RF signal between the Transceiver plug-ins and the Power Splitter/Combiner plug-ins via SMB blindmate connectors. The backplane RF connections are made at the factory. The backplane also has several other connectors and switches. Figure 3-8 shows the DC power input connector for powering the MirrorCell Series 5800 with a backup power supply, the DC power output connector for powering up to 6 remote Antenna units, the alarms output connector, and the DIP switches for individually disabling the Transceiver plug-in alarms. Figure 3-9 gives the pinouts for the chassis backplane connectors.

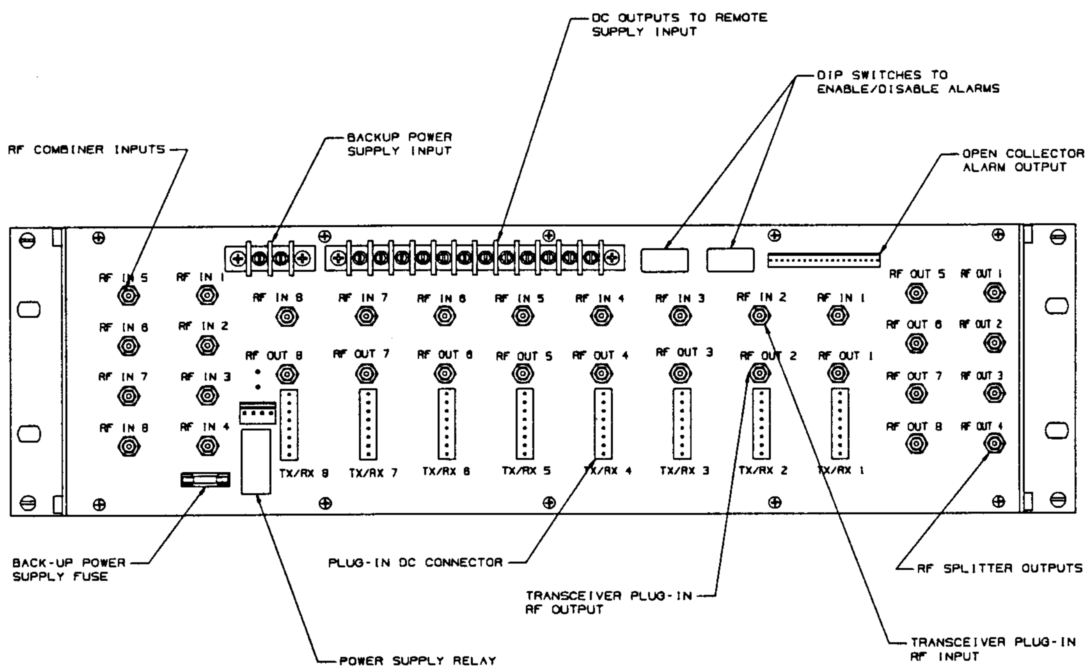


Figure 3-8 Rear view of Chassis showing RF input/output, DC power connectors, alarm connectors and alarm switches.

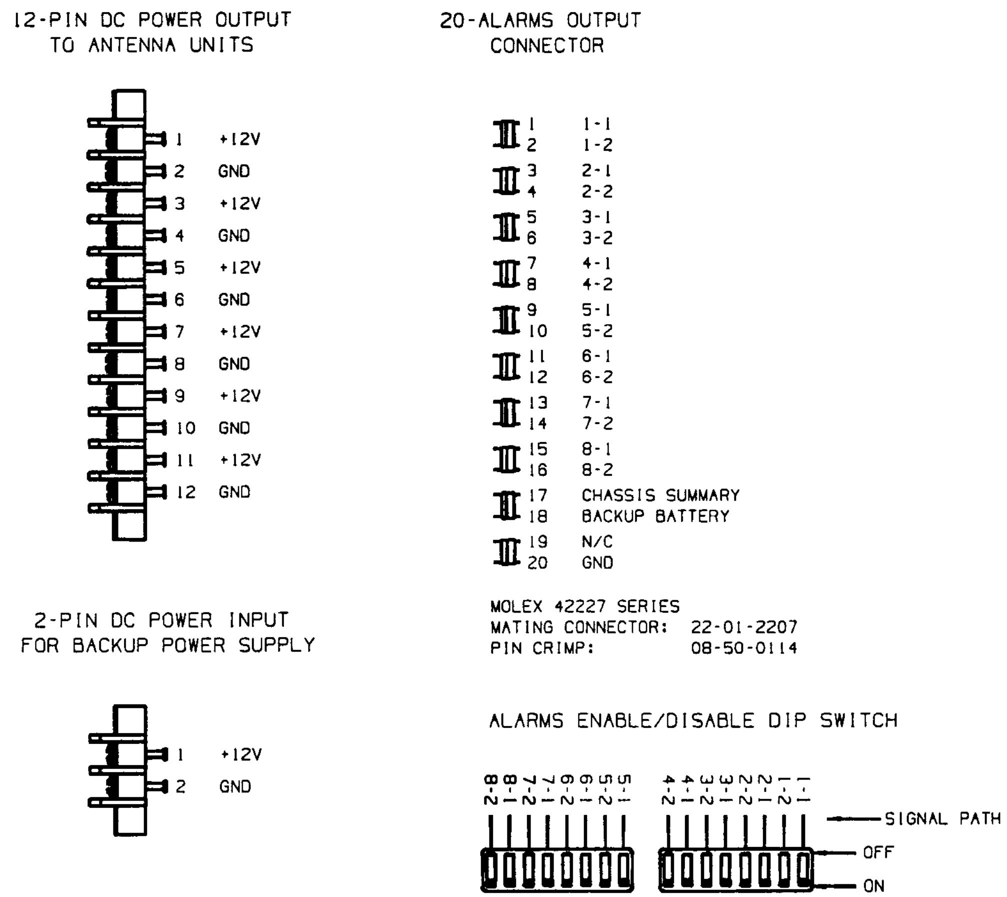


Figure 3-9 Chassis backplane connectors and switch pinouts.

In reference to the DIP switch numbering scheme, the signal path and alarm designated as "4-2" refers to the second signal path in the Transceiver plug-in in Slot T4. The chassis alarm connector provides open collector alarm outputs for each of the 16 signal paths from 1-1 to 8-2. A summary alarm output is provided which sums all the transceiver alarm outputs together. If any transceiver has a failure, then the summary alarm will indicate failure. The alarm enable/disable switch for any signal path that is not hooked up should be turned "off" in order not to activate the chassis summary alarm, indicating system failure.

In reference to the alarm output connector, the primary power supply, the Transceiver plug-ins and the chassis summary status are monitored and alarmed. The alarm outputs are open collector outputs such that under normal conditions, when there is no alarm, there is no collector current flow and the output can withstand 15 V. When there is an alarm, the open collector outputs are capable of sinking 20 mA. Figure 3-10 shows a typical circuit which can monitor the alarm status by measuring the open collector voltage. When there is no alarm, the monitor voltage is 15 V; when there is an alarm, the monitor voltage is 0 V. The open collector outputs can also be wired to drive relays for Form C-contact closure switches.

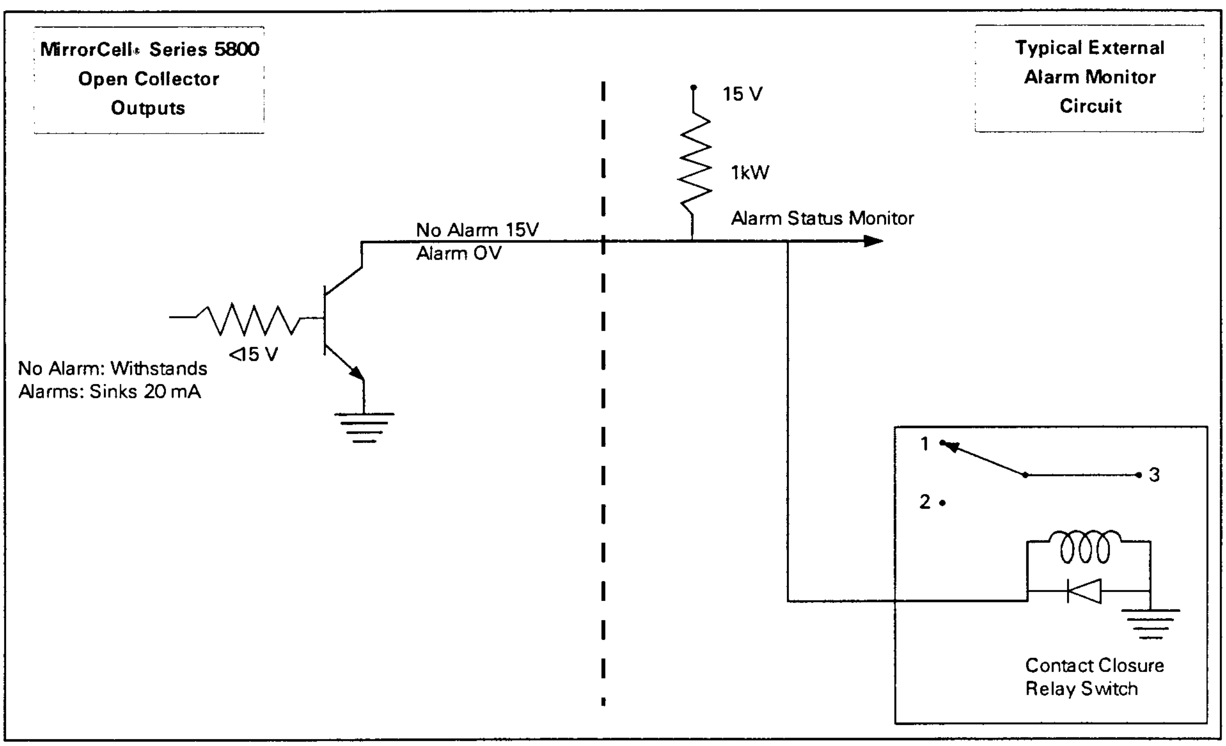


FIGURE 3-10 MirrorCell Series 5800 alarms and open Collector outputs can be externally monitored or connected to a contact relay switch circuit.

TRANSCEIVER PLUG-INS (MODEL 5821A/B/C)

Each Model 5821A/B/C Transceiver plug-in provides bi-directional signal transmission (uplink and downlink) between the Hub and two Antenna units. The major components in the Transceiver plug-in are shown in Figure 3-11. For the downlink path, the Transceiver plug-in contains two laser modules to feed two Antenna units. An RF test tone to determine system continuity is sent from the Transceiver plug-in along the Downlink Cellular signals. The Transceiver plug-in also contains two photodiode modules to receive the uplink signals from the two Antenna units. The RF test tones originally sent along the downlink and received by these two photodiodes in the return path are monitored and alarmed. The transceiver plug-in contains a 3-dB RF power combiner to combine the two uplink signals from the two photodiode modules.

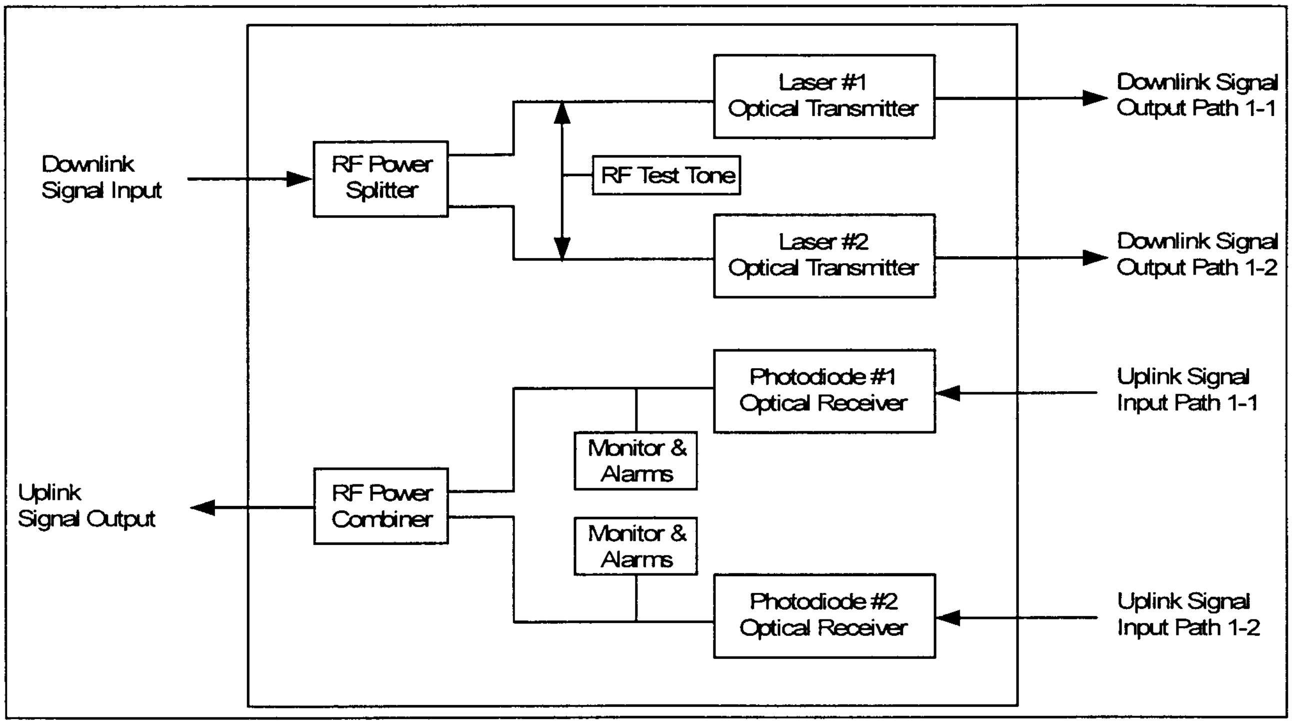
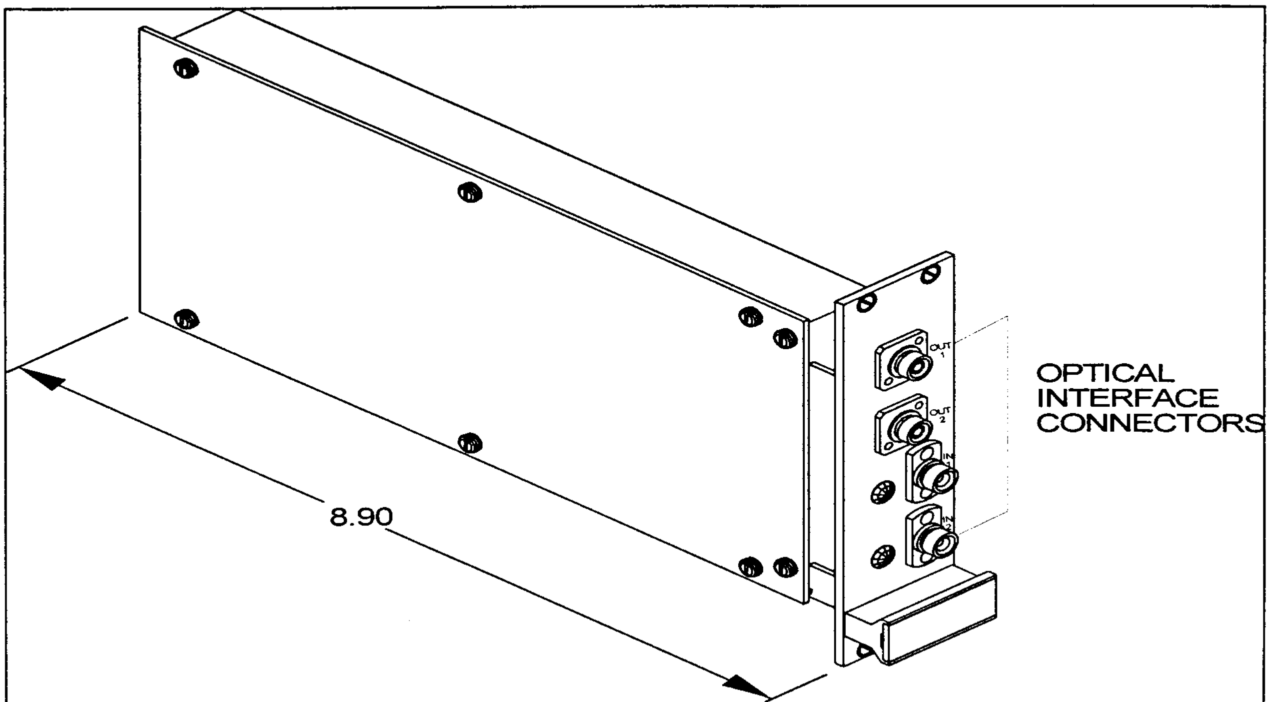


FIGURE 3-11 Major Components in Transceiver Plug-in.

Figure 3-12 illustrates the Transceiver plug-in and provides the pin assignments. Figure 3-13 shows the specifications.



Transceiver Rear Panel
DC Connector Pinouts

Pin	Description
1	Power GND
2	+12Vdc
3	N/C
4	N/C
5	Alarm 1
6	N/C
7	Alarm 2
8	Power GND

FIGURE 3-12 Sketch of Transceivers plug-in and DC connectors pinout.

Figure 3-13
Model 5821A/B/C Transceiver plug-in specifications

PARAMETER	SPECIFICATIONS
Passband Model 5821A (AMPS) Model 5821B (GSM) Model 5821C (Broadband)	 824 to 894 MHz 890 to 960 MHz 800 to 960 MHz
Impedance	50 W
Input/Output VSWR	<1.5:1
RF Connector (rear panel)	SMB Blindmate
Optical Connector (front panel)	FC/APC tight fit
Wavelength	1310 nm $\pm$ 30 nm, singlemode
Optical Output Power (at $I\text{-}I_{th}$ = 40 mA)	 0.75 mW +/- 0.15
LED Indicators	Green: RF functionality Red: Signal Degradation >5 dB
Dimensions H x W x D	3.95" x 1.4" x 8.9"/100.3 x 35.6 x 223.1mm
Weight	1 lb./0.5kg
DC Power Requirement	12 V $\pm$ 1 V at 0.5 A, <170 mV pp ripple
Max Composite RF Input	20 dBm (damage level)
Temperature Range Performance to Full Spec Operating Storage	 5°C to 40°C 0°C to 50°C -20°C to 65°C

ANTENNA UNIT (MODEL 5851A/B/C)

Each Antenna unit located in the coverage area provides bi-directional signal transmission (uplink and downlink) between a mobile user and the Base Station Hub. The major components of the Antenna unit are shown in Figure 3-14. The downlink signal from the Hub is received by the Antenna unit's photodiode for broadcast by the built-in antenna. The Antenna unit also receives signals from the mobile user and then transmits the uplink signal back to the Hub.

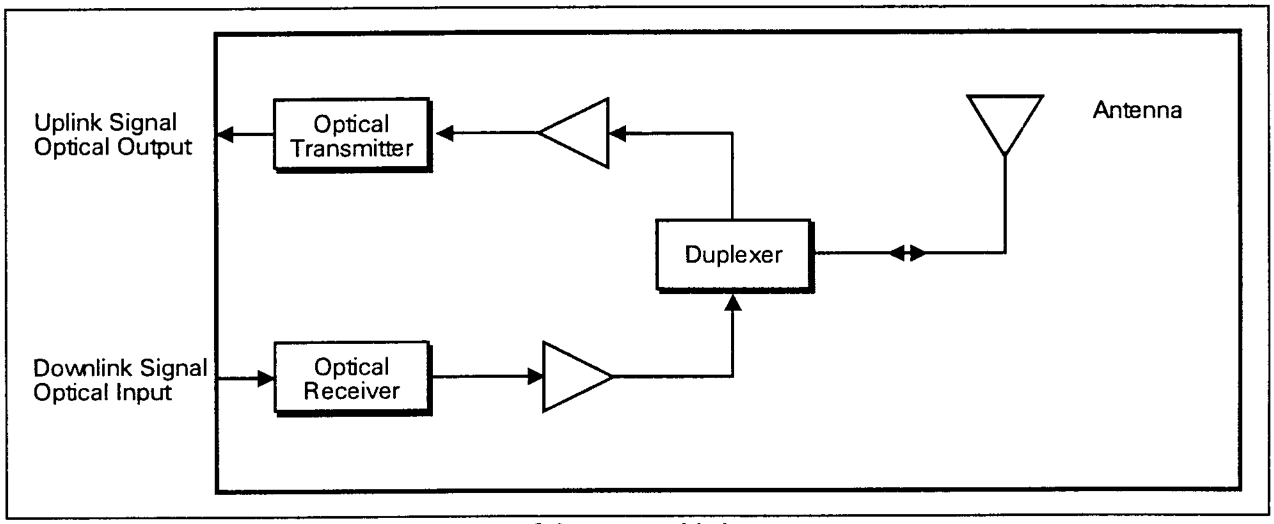


FIGURE 3-14 Block diagram of Antenna Unit

Figure 3-15 is a sketch of the Antenna unit and provides the pin assignments for DC input power connector. The Antenna RF connector and the Antenna itself are optional. For installation, the Antenna unit includes a decorative cover and a mounting plate. The specifications for the Antenna unit (excluding the Antenna itself) are given in Figure 3-16.

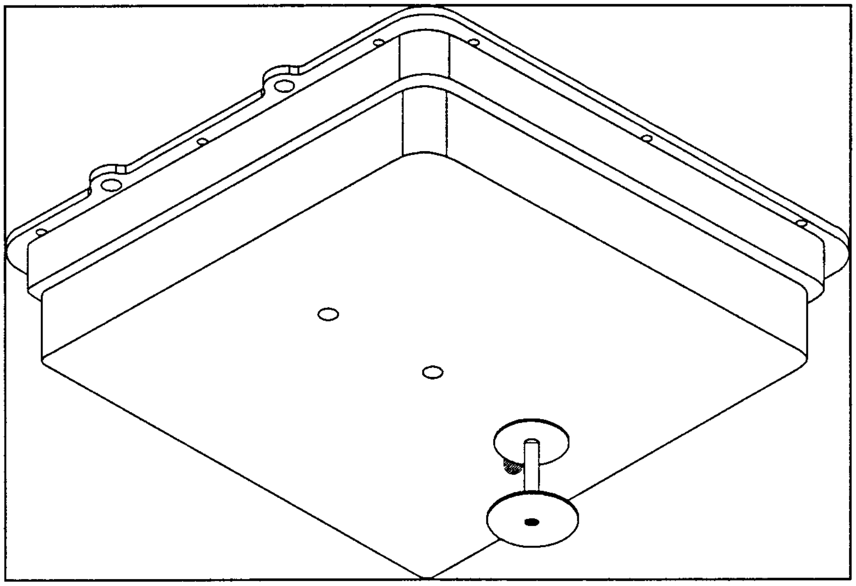


FIGURE 3-15 Sketch of Antenna Unit and DC Connector Pinout.

Figure 3-16
Model 5851 A/B/C Antenna unit specifications

PARAMETER	SPECIFICATIONS
Passband Model 5851A (AMPS) Model 5851B (GSM) Model 5851C (Broadband)	 824 to 894 MHz 890 to 960 MHz 800 to 960 MHz
Optical Connectors	FC/APC tight fit
Wavelength	1310 nm ± 30 nm, singlemode
Optical Output Power (at $I\text{-}I_{th}$ = 40 mA)	0.75 mW +/- 0.15
Optical Return Loss	> 40 dB
LED Indicators	Green: Optical Power Received Red: No Optical Power Received
External DC Power Supply Requirement	12 V ± 1 V at 0.5 A (Max Ripple: <170 mV pp @ >300 Hz, < 500 mV pp @ < 300 Hz)
Dimensions	6.8"L X 6.8"W X 2.7"D/168x168x69mm
Weight	1.5 lb./0.7kg
Max Composite RF Input	20 dBm (damage level)
Temperature Range Performance to Full Spec Operating Storage	 5°C to 40°C 0°C to 50°C -20°C to 65°C

RF POWER SPLITTER/COMBINER PLUG-INS (MODELS 583x A/B/C AND 584x A/B/C)

The MirrorCell Series 5800 RF Power Splitter and Combiner plug-ins are located at the Hub. The RF Power Splitter plug-ins take the user's downlink signal and splits it into several paths for distribution to different Antenna units. The input to the Power Splitter plug-in is at the front panel for easy access to the Cellular System. The outputs are distributed to the various Transceiver plug-ins via the factory-made RF connections at the chassis backplane. The signal then is transmitted to the Antenna units. In the reverse path, the uplink signals from the various Antenna units are received by the Transceiver plug-ins and routed to the RF Power Combiner plug-ins via the chassis backplane. The RF outputs from the Power Combiner plug-ins are at the front of the chassis for transmission to the Cellular System.

The following RF Power Splitter/Combiner plug-ins are available:

Model 5831A/B/C	Two 1-way Splitter (single-width)
Model 5832A/B/C	Two 2-way Splitter (single-width)
Model 5834A/B/C	One 4-way Splitter (single-width)
Model 5838A/B/C	One 8-way Splitter (double-width)
Model 5841A/B/C	Two 1-way Combiner (single-width)
Model 5842A/B/C	Two 2-way Combiner (single-width)
Model 5844A/B/C	One 4-way Combiner (single-width)
Model 5848A/B/C	One 8-way Combiner (double-width)

The various configurations are illustrated in Figure 3-17. A single chassis can hold two single wide (or one double wide) Power Splitter plug-ins and two single wide (or one double wide) Power Combiner plug-ins. The Power Splitter plug-ins fit into the two left hand slots of the chassis; the Power Combiner plug-ins fit into the two right hand slots of the chassis.

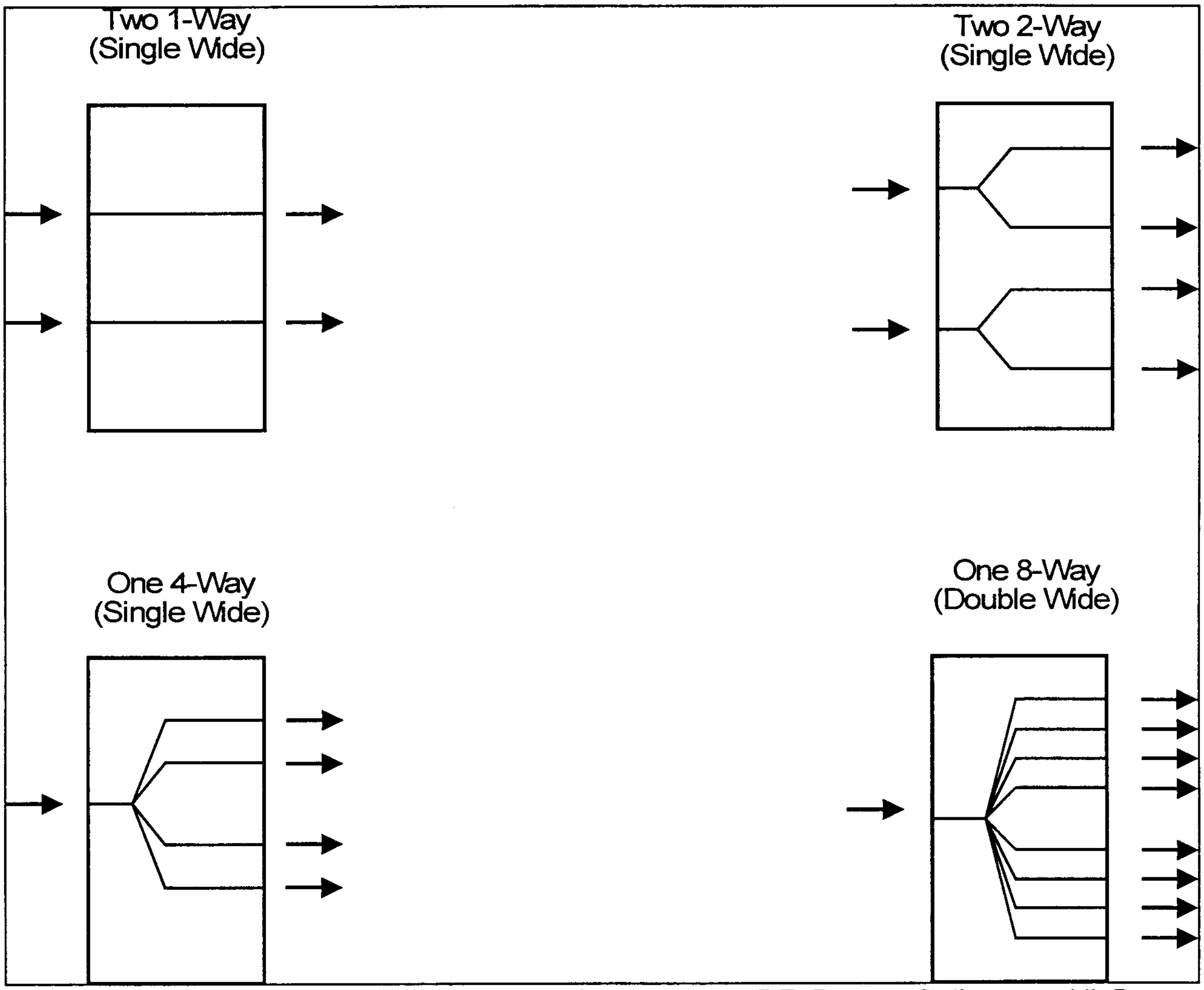


FIGURE 3-17 Illustration of MirrorCell Series 5800 RF Power Splitters. All Power Splitter/Combiners have the same insertion loss.

The Splitter/Combiner plug-ins have been designed to give a fixed insertion loss regardless of the number of splits. The specifications for the plug-ins are given in Figure 3-18 and a sketch is given in Figure 3-19.

Figure 3-18
RF Power Splitter/Combiner specifications (Models 583x A/B/C and 584x A/B/C)

PARAMETER	RF POWER DIVIDER	RF POWER COMBINER
Passband Models 583xA and 584xA (AMPS) Models 583xB and 584xB (GSM) Models 583xC and 584xC (Broadband)	 824 to 894 MHz 890 to 960 MHz 800 to 960 MHz	 824 to 894 MHz 890 to 960 MHz 800 to 960 MHz
Impedance	50 W	50 W
VSWR	1.5:1 (input)	1.5:1 (output)
RF Connectors Input Output	 N-Type (front) SMB Blindmate (rear)	 SMB Blindmate (rear) N-Type (front)
Insertion Loss	9.8 dB $\pm$ 0.5 dB	9.8 dB $\pm$ 0.5 dB
Dimensions H x W x D (single width)	3.95" x 1.4" x 8.9" 100.3 x 35.6 x 223.1mm	3.95" x 1.4" x 8.9" 100.3 x 35.6 x 223.1mm
Weight (single width)	1 lb.	1 lb.
Max Composite RF Input	30 dBm (damage level)	N/A
Temperature Range Performance to Full Spec Operating Storage	 5°C to 40°C 0°C to 50°C -20°C to 65°C	 5°C to 40°C 0°C to 50°C -20°C to 65°C

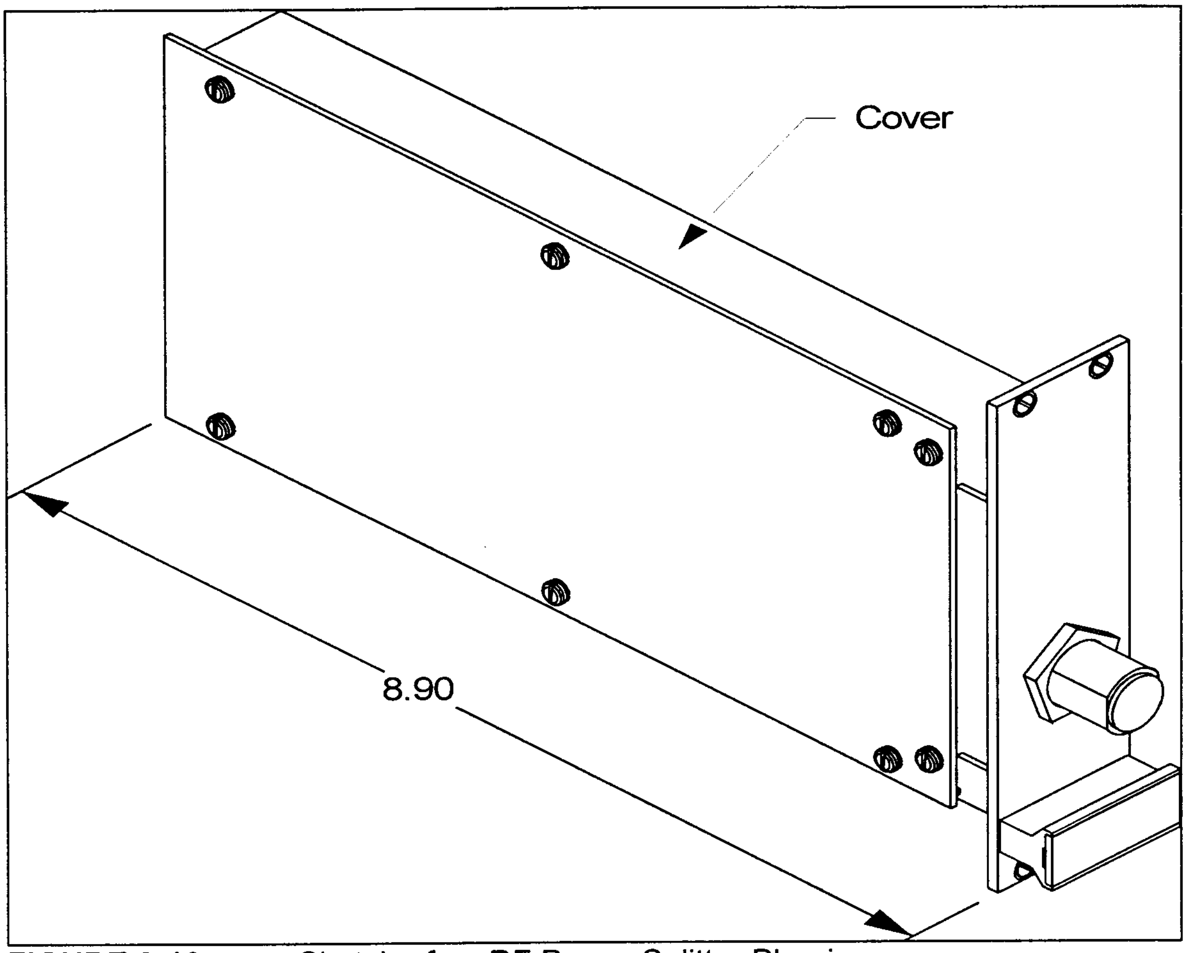


FIGURE 3-19 Sketch of an RF Power Splitter Plug-in.

CHAPTER 4

PERFORMANCE TESTING

This chapter describes methods for measuring the performance of the MirrorCell Series 5800 Fiberoptic System.

Caution
Do Not look directly at the end
of an optical connector which emits laser light!

The testing described in this section assumes that the MirrorCell Series 5800 is tested in a laboratory, with the Hub and Antenna units collocated. A spool of fiber can simulate the actual fiber length.

The MirrorCell Series 5800 link test specifications are given in Figure 4-1.

Figure 4-1
Test specifications for MirrorCell Series 5800.

PARAMETER	DOWNLINK	UPLINK
Passband: AMPS GSM Broadband	 869 to 894 MHz 935 to 960 MHz 800 to 960 MHz	 824 to 849 MHz 890 to 915 MHz 800 to 960 MHz
RF Loss (at 25°C)	5 dB ± 2 dB	3 dB ± 2 dB
Response Flatness	± 2 dB	± 2 dB
Gain Variation over Temp	± 2 dB	± 2 dB
Output Carrier to Noise: AMPS GSM Broadband (P_{out}/tn = 6dBm)	(P_{out}/tn = 4 dBm) >64 dB (30 kHz BW) >56 dB (200 kHz BW) >64 dB (30 kHz BW)	(P_{in}/tn = - 45 dBm) >66 dB (30 kHz BW) >58 dB (200 kHz BW) >69 dB (30 kHz BW)
2-Tone Output Carrier to 3rd Order Intermod	>48 dB (P_{out}/tn = 4 dBm for Amps, GSM, = 6 dBm for BB	>50 dB (P_{in}/tn = -45 dBm Amps, GSM = -48 dBm, Broadband
Propagation Delay	<0.5 ms (RF) + 5 ms/km,typ (fiber)	<0.5 ms (RF) + 5 ms/km,typ (fiber)
Input/Output VSWR	<1.5:1	<1.5:1
Test Conditions	Optical Budget = 2 dB Optical Reflections < - 40 dB Downlink RF In/Out: N-Connector of Power Splitter Plug-in/Antenna Connection on Antenna Unit Uplink RF In/Out: Antenna Connection on Antenna Unit/N-Connector on Power Combiner Plug-in Transceiver 5°C to 40°C and Antenna at 25°C or Antenna at 5°C to 40°C and Transceiver at 25°C	

GAIN, FLATNESS, GAIN VARIATION

These measurements are made using a network analyzer as shown in Figure 4-2. After calibrating the network analyzer with the necessary RF cables, connect Port 1 of the network analyzer to the RF input to the MirrorCell Series 5800 and Port 2 to the RF output. For the Downlink, the RF input is at the N-Connector of the front panel of the RF Power Splitter plug-in and the output is at the Antenna Unit RF connector (excluding the Antenna itself). For the uplink, the RF input is at the Antenna unit RF connector (excluding the Antenna unit itself) and the RF output is at the N-Connector of the RF Power Combiner plug-in front panel. The S_{21} measurement parameter provides gain and flatness over the frequency bandwidth of interest. The gain variation with temperature can be measured by inserting the units in an oven and measuring the change in the system gain as the temperature is varied.

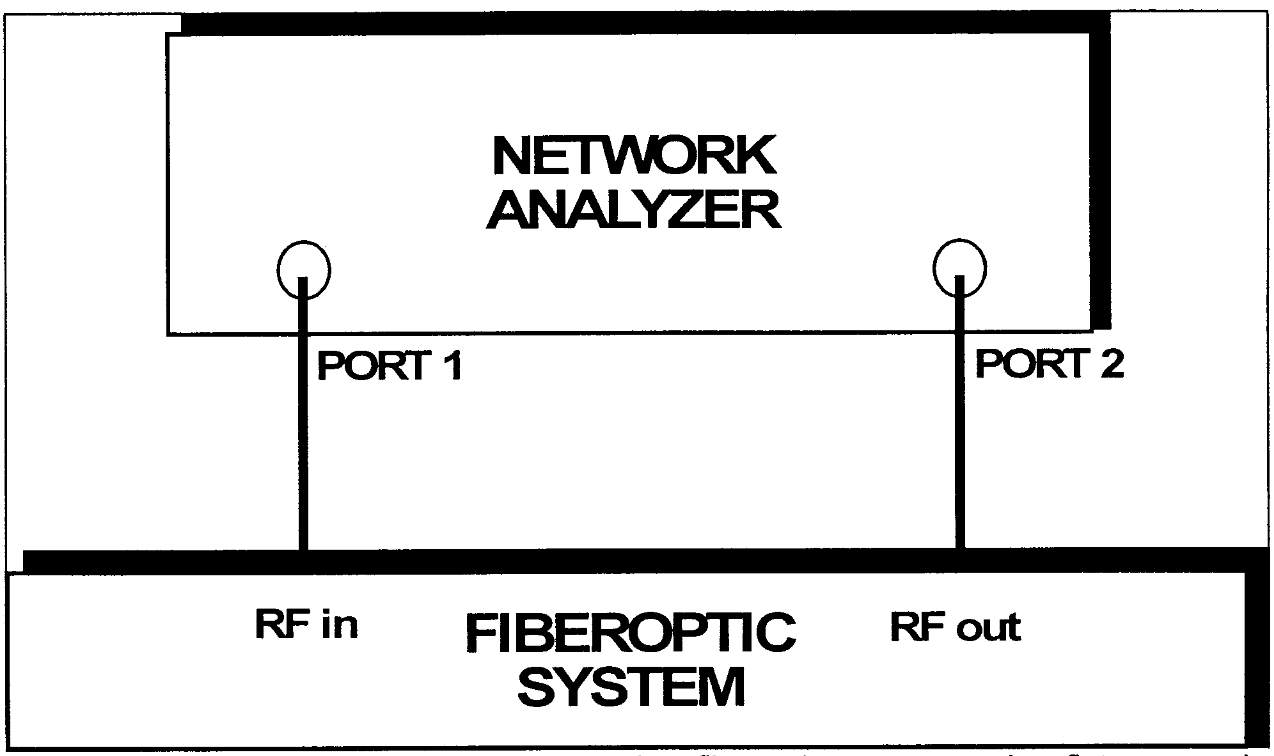


FIGURE 4-2 Setup to measure the fiberoptic system gain, flatness, gain variation, VSWR and propagation delay.

INPUT/OUTPUT VSWR

These measurements are made using a network analyzer. Set up the measurement as described above for measuring amplitude response (gain). The S_{11} and S_{22} measurement parameters provide the input and output return loss of the fiberoptic link. This can then be translated to input/output VSWR. A VSWR of 1.5:1 corresponds to a 14 dB return loss.

PROPAGATION DELAY

These measurements are made using a vector network analyzer. Set up the measurement as described above for measuring amplitude response (gain). The delay measurement function gives the propagation delay as a function of frequency. The fiber spool must be removed for measuring the propagation delay of just the RF portion.

The typical time delay for fiber is 5 ms/km, given by:

$$T = n/c = 1.5/(0.3 \text{ km/ms})$$

where n is the refractive index of glass and c is the speed of light.

OUTPUT CARRIER TO NOISE

To measure the output carrier to noise, one needs a signal generator that puts out a clean tone at the frequency of interest. Measure the output of the signal generator with a power meter and adjust the signal source to the appropriate output level. Ensure that the signal level does not exceed the maximum RF input level rated for the units to be tested. The Carrier to Noise (CNR) of the signal generator should also be measured to ensure that it is not limiting the measurement.
Then connect the signal generator to the input of the Fiberoptic (FO) system to be tested and an RF spectrum analyzer to the RF output as shown in Figure 4-3. For the Downlink, the RF input is at the front panel of the RF Power Splitter plug-in and the output is at the Antenna Unit RF connector (excluding the Antenna itself). For the uplink, the RF input is at the Antenna unit RF connector (excluding the Antenna unit itself) and the RF output is at the RF Power Combiner plug-in front panel.

Set the spectrum analyzer to the center frequency of interest. Measure the signal level. Then measure the noise by setting the ATTEN to 0 dB so that the noise contribution from the spectrum analyzer is minimum. Activate the noise density measurement and the marker to measure the noise level in dBm/Hz. If the spectrum analyzer does not have a noise density measurement feature, then the user must determine the output noise level from the spectrum analyzer resolution bandwidth (BW). The CNR in a 1 Hz BW is the difference between the signal level and the noise level. Calculate the output CNR in a 30 kHz BW:

$$CNR(30\ kHz) = CNR\ (1\ Hz) - 44.8\ dB.$$

The noise contribution from the spectrum analyzer should be measured to ensure that it below that of the fiberoptic system. This is simply done by measuring the spectrum analyzer noise floor when it is terminated into a matched load (usually 50W). If the noise level is the same without as it is with the fiberoptic system, then it is necessary to add a post-amplifier after the fiberoptic link to enable measurement above the spectrum analyzer noise floor.

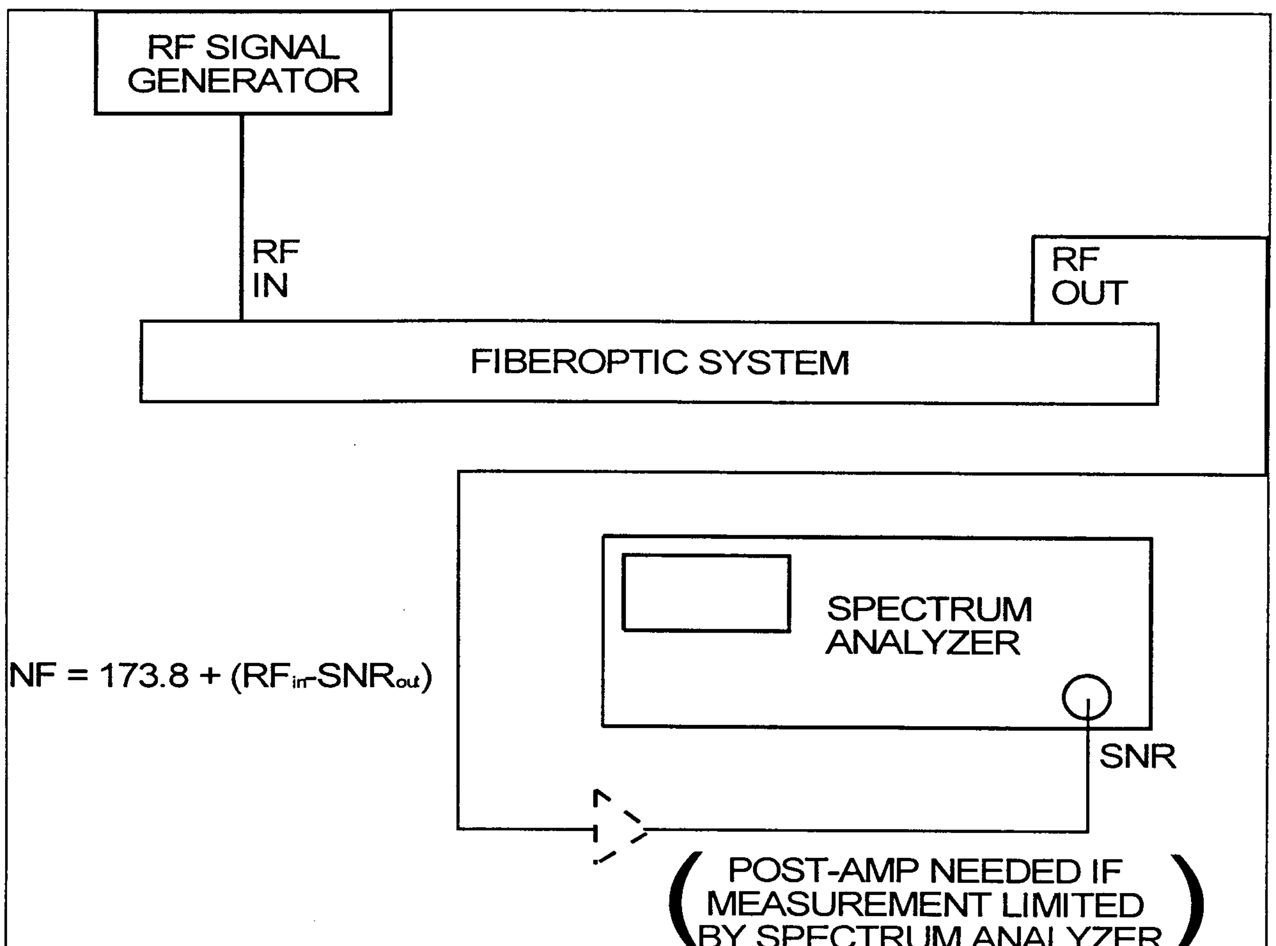


FIGURE 4-3 Setup for measuring carrier to noise.

LINEARITY - TWO CARRIERS

For this test, the measurement setup is shown in Figure 4-4. A two-tone signal generator is connected to the RF input to the fiberoptic system. The two-tone signal generator must provide two clean tones. The ratio of the carrier to third order distortion of the signal generator should be >70 dBc for 0 dBm RF output tones in order to negligibly affect the measurements. The RF output from the fiberoptic link may need to be filtered before inputting to a spectrum analyzer to prevent distortion contributions from the spectrum analyzer.

With an RF filter, the filter first needs to be adjusted to allow the carrier (tone) signal to be measured by the spectrum analyzer. Then, the filter should be adjusted to remove the two tones while allowing passage of the third order intermodulation distortion product. The frequency of the third order intermodulation product is at $2f_1 \pm f_2$, where f_1 and f_2 are the frequencies of the two tones. The third order intermodulation distortion can now be measured by the spectrum analyzer and compared to the carrier. The linearity performance is given by the amount the third intermodulation product is below the carrier: (C/I) in units dB.

From the C/I, one can then compute the input third order intercept (IIP3). The input IIP3 is given by:

$$IIP3 = RF_{input} + (1/2)(C/I) \text{ dBm},$$

where RF_{input} is the power per tone in units dBm and C/I is in units dB.

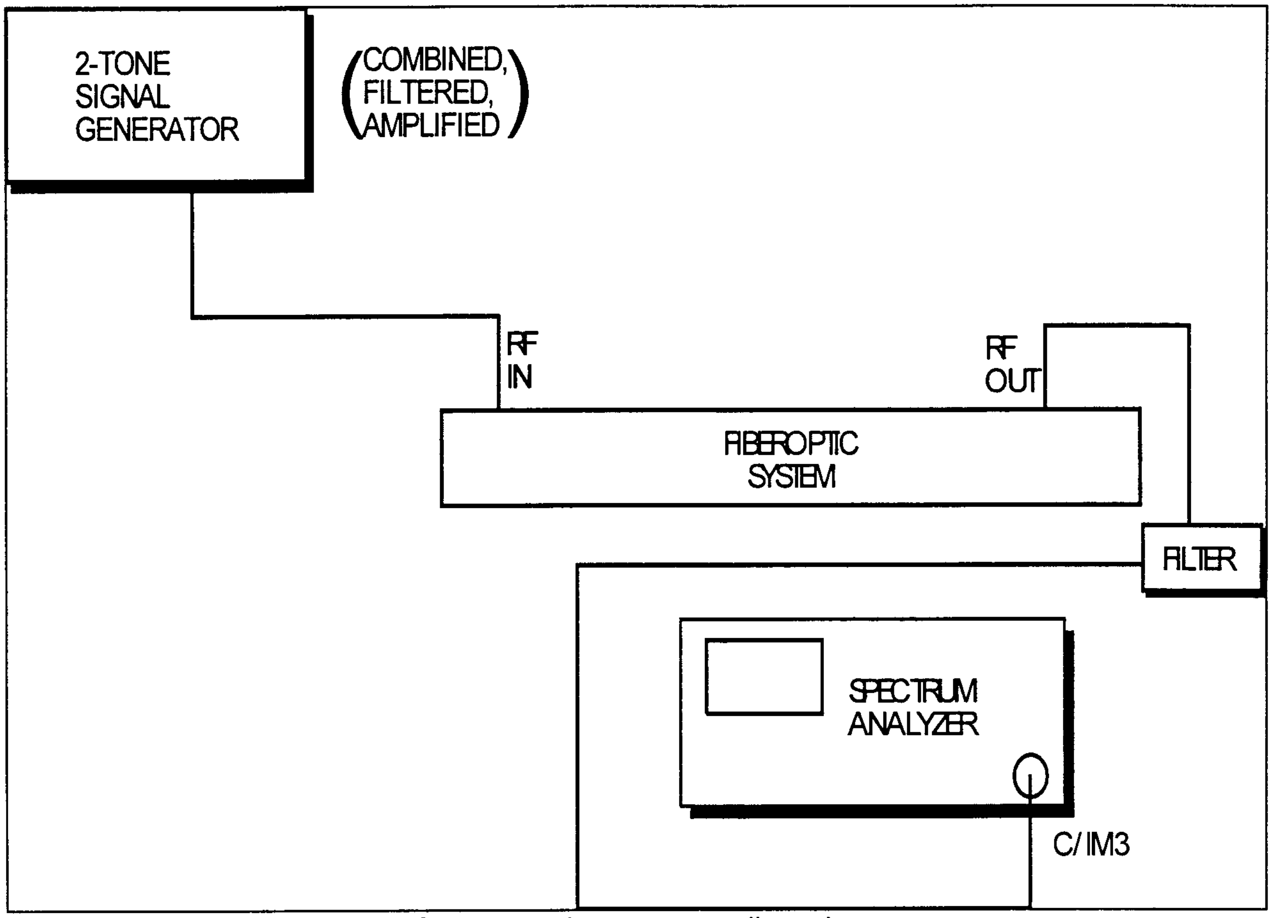


FIGURE 4-4 Setup for measuring two-tone linearity

CHAPTER 5 INTRODUCTION

OUTLINE OF MANUAL

Chapters 5-7 describe the installation, maintenance and troubleshooting of the MirrorCell Series 5800 Fiberoptic RF In-Building Distributed Antenna System. Chapter 5 describes the contents of the shipment and what the user needs for installation. The sixth chapter provides step by step instructions for installing the MirrorCell Series 5800 system and verifying the system functionality. Chapter 7 provides maintenance and troubleshooting guidelines for the system.

SAFETY TO PERSONNEL

Before installing the equipment, the entire manual should be read and understood. Safety precautions were discussed in the preface to this manual. The Ortel MirrorCell Series 5800 Fiberoptic (FO) System contains a Class IIIb laser as defined by the U.S. Department of Health and Human Services, Public Health Service, Food and Drug Administration. Do not look directly at the end of an optical connector which emits laser light. In addition, the user needs to supply the appropriate AC and DC power to the MirrorCell 5800 FO System. Incorrect AC or DC power can damage the FO System and cause injury to the user.

Throughout this manual, there are "Caution" warnings. "Caution" calls attention to a procedure or practice, which, if ignored, may result in injury or damage to the system or system component. Do not perform any procedure preceded by a "Caution" until the described conditions are fully understood and met.

SAFETY TO EQUIPMENT

Unpack the system carefully, thoroughly inspecting the equipment to assure that no damage has occurred in shipment. If damage is found, notify the responsible carrier and Ortel Corporation immediately.

Carefully check the contents of the shipment against the shipping list. Notify Ortel Corporation if there is an apparent discrepancy.

CONTENTS OF SHIPMENT

The shipment should contain the following items as listed on the customer purchase order:

1) Chassis with Built-in Power Supply
2) RF Power Splitter Plug-ins
3) RF Power Combiner Plug-ins
4) Transceiver Plug-ins
5) Antenna Units (with mounting flange, decorative cover and hardware).
6) User's Manual
7) Quick Tips for 5800.

The MirrorCell Series 5800 model/part numbers are given in Figure 5-1.

Figure 5-1
MirrorCell Series 5800 model numbers *

DESCRIPTION	MODEL NUMBER		
	AMPS	GSM	BROADBAND
Chassis with Built-in Power Supply	5899A	5899A	5899
Transceiver Plug-in	5821A	5821B	5821C
RF Power Splitter Plug-in			
Two 1-way	5831A	5831B	5831C
Two 2-way	5832A	5832B	5832C
One 4-way	5834A	5834B	5834C
One 8-way (double wide)	5838A	5838B	5838C
RF Power Combiner Plug-in			
Two 1-way	5841A	5841B	5841C
Two 2-way	5842A	5842B	5842C
One 4-way	5844A	5844B	5844C
One 8-way (double wide)	5848A	5848B	5848C
Antenna Unit	5851A	5851B	5851C
Blank Front Panel	5891A	5891A	5891A

* Additional Models may become available. Contact your local Sales representative.

CHAPTER 6 INSTALLATION

PRE-INSTALLATION REQUIREMENTS

An example of a system layout is shown in Figure 6-1. The part of the MirrorCell Series 5800 that contains the chassis and plug-ins is known as the Hub and is located at the Building Base Station. The Hub interfaces with the user's Cellular System. The Antenna units are distributed in the building and typically mounted on the ceiling. Optical fiber cables connect the Hub to the Antenna units. The chassis is typically powered at the wall AC outlet. The Antenna units are powered by +12 VDC (the chassis can power up to 6 Antenna units).

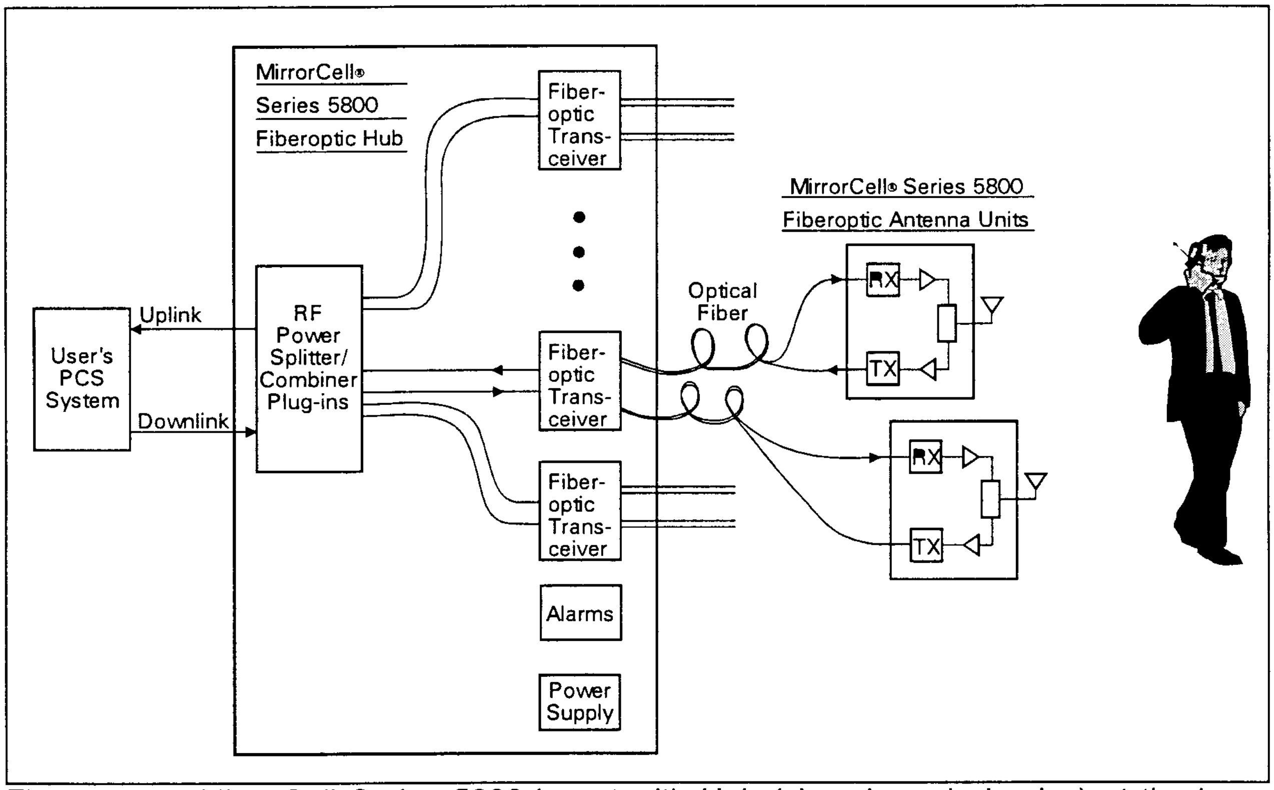


Figure 6-1 MirrorCell Series 5800 layout with Hub (chassis and plug-ins) at the base station and the Antenna units distributed throughout the building.

In this section, we provide instructions for organizing the system layout before installation. The installer or operator must make sure that certain requirements have been met before beginning installation. In addition, the chassis must be configured with the plug-ins inserted in the correct slots, all cables must be labeled, and the entire system configuration must be documented. Steps for this pre-installation set-up are given below.

1. Ensure that the requirements given in Figure 6-2 are met. The table in Figure 6-2 includes the user requirements for the optical fiber cable, absolute maximum RF input to the MirrorCell Series 5800 system and the DC and AC power requirements. Two optical fibers are required for each Antenna unit; each Transceiver plug-in can connect to two Antenna units. Typically, a small hole in the ceiling tile is made to feed the optical and electrical cables to the antenna unit. Angle-polished FC/APC connectorized optical fiber cable must be installed in the building. Any optical connector used between the Hub and the Antenna units should be an angle-polished connector specified for return loss >55 dB. Fusion splices to connect fibers are also suitable. Flat polished connectors anywhere along the optical fiber path will degrade the system performance.

2. The customer must provide the following equipment for installation:

   (a) Optical connector cleaning kit: cotton swabs, alcohol, dust-free compressed air
   (b) Crimping tool, mating connectors, and pin crimps for the DC electrical connectors and alarm outputs at the chassis backplane

3. Not essential, but useful for diagnostics are the following equipment:

   (a) RF power meter
   (b) Optical power meter
   (c) Spectrum analyzer

Figure 6-2
User requirements for operation of MirrorCell Series 5800

PARAMETER	USER REQUIREMENT
Max Composite RF Input (damage level)	30 dBm (downlink) 20 dBm (uplink)
Max Optical Fiber Length	2 km
Optical Fiber	9/125 µm (core/clad) 1310 nm, singlemode
Optical Connectors	FC/APC, tight fit
Optical Return Loss	> 40 dB
Number of Optical Fibers	Two per Antenna unit
Chassis AC Power (factory configured)	90 to 135 VAC or 184 to 264 VAC 50 to 60 Hz
Backup Power Supply (Optional)	+12 VDC ± 0.5 V, 8.5 A max load Ripple < 170 mV pp
Antenna DC Power	12 VDC ± 1 V at 0.5 A Ripple: <170 mV, freq. >300 Hz <300 mV, freq. <300 Hz
Rack	Chassis: 3U high, 19" wide, 13.5" deep 1U (1.75") air space above and below each chassis
Antenna Unit	Do not paint antenna unit decorative cover.
Temperature Performance to Full Spec Operating Storage Relative Humidity Operating Short Term	 5°C to 40°C 0°C to 50°C -20°C to 65°C 20 to 55% 10 to 80% (not exceeding 0.024 lbs water/dry air)
Max Length Wires to Supply DC Power to Antenna Units	<300 m with 10 AWG Copper Wire <120 m with 14 AWG Copper Wire <45 m with 18 AWG Copper Wire

Figure 6-3
MirrorCell Series 5800 component layout in the building.

HUB ID				
HUB LOCATION				
TRANSCEIVER		ANTENNA SN	ANTENNA LOCATION	ANTENNA DC POWER LOCATION
SN	Path ID			
	T1-1			
	T1-2			
	T2-1			
	T2-2			
	T3-1			
	T3-2			
	T4-1			
	T4-2			
	T5-1			
	T5-2			
	T6-1			
	T6-2			
	T7-1			
	T7-2			
	T8-1			
	T8-2			

4. Before beginning installation, document the layout of the system in the building using the table in Figure 6-3. Each chassis can hold a total of 8 Transceiver plug-ins in Slots T1 through T8, starting from the left-hand side of the chassis, following the two RF Power Splitter plug-in slots (see Figure 6-4). Slot T1 is the third single wide (1.4 inch wide) slot from the left-hand edge of the chassis. Each Transceiver plug-in distributes signals to and from two separate Antenna units. Hence, the signal paths are identified as follows: T3-2 corresponds to signal #2 from the Transceiver plug-in in Slot T3. The table associates each signal path with a specific Transceiver plug-in (by serial number and its position in the chassis) and with a specific Antenna unit (by serial number and its location in the building). The table also documents the location of the DC power source for each Antenna unit. Each chassis can provide DC power for as many as 6 remote Antenna units.

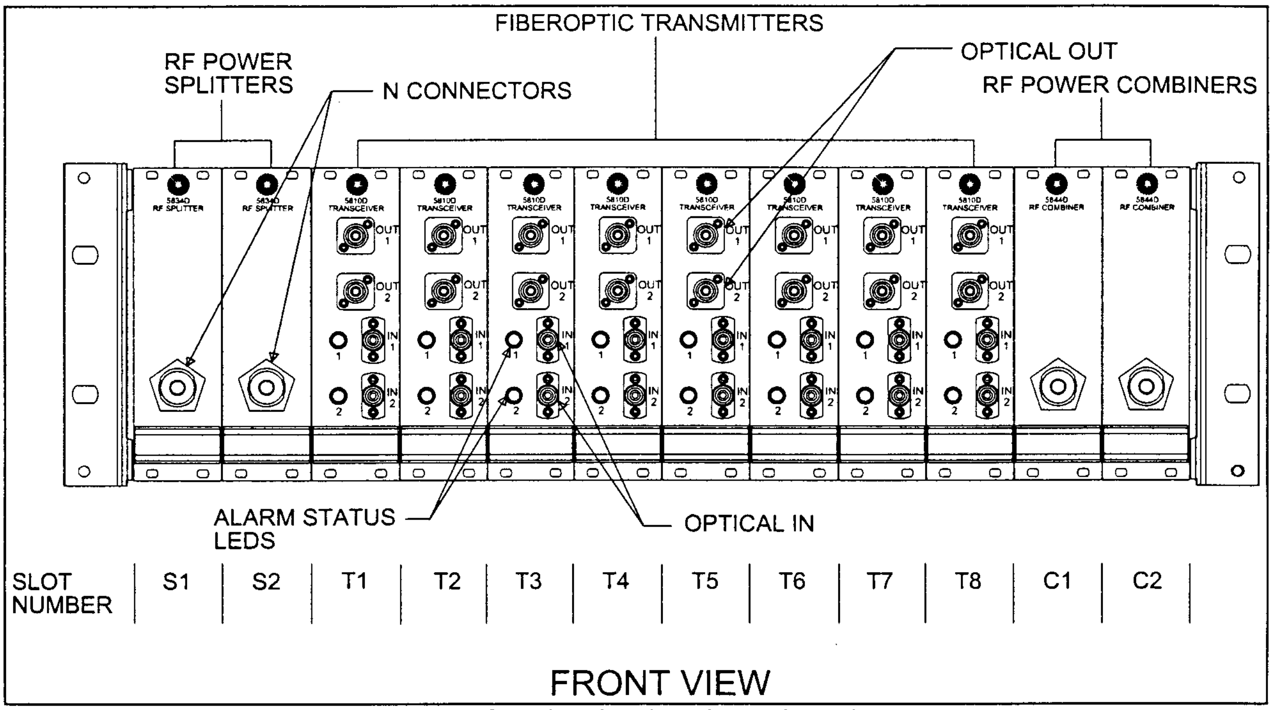


Figure 6-4 Numbering scheme for plug-in slots in a chassis.

Figure 6-5 shows the available Power Splitter configurations. The RF Power Splitter plug-ins are on the left-hand side of the chassis, and the RF Power Combiner plug-ins are on the right-hand side of the chassis as shown in Figure 6-4. There are two possible slots for the Power Splitters: S1 and S2, starting from the left of the chassis. Similarly, at the right side of the chassis, there are two slots for the Power Combiner plug-ins: C1 and C2, numbering from the left of the chassis. The Power Splitter plug-in in S1 is linked to the Power Combiner plug-in in C1; similarly, the Power Splitter in S2 is paired with the Power Combiner plug-in in C2. Look at the numbering scheme at the chassis rear panel (also shown in Figure 6-6). A single wide Power Splitter plug-in in Slot S1 is linked with the Transceiver plug-ins in T1, T2, T3 and T4. The single wide Power Splitter plug-in in S2 is linked with the Transceiver plug-ins in T5, T6, T7 and T8. One double wide 8-way Power Splitter plug-in (Model 5838A/B/C) is connected to all 8 Transceiver plug-in in the chassis. A single wide 1-way Power Splitter plug-in (Model 5831A/B/C) in Slot S1 is linked to Transceiver plug-ins in Slots T1 and T3; similarly, the same Power Splitter plug-in in Slot S2 is linked to Transceiver plug-ins in slots T5 and T7.

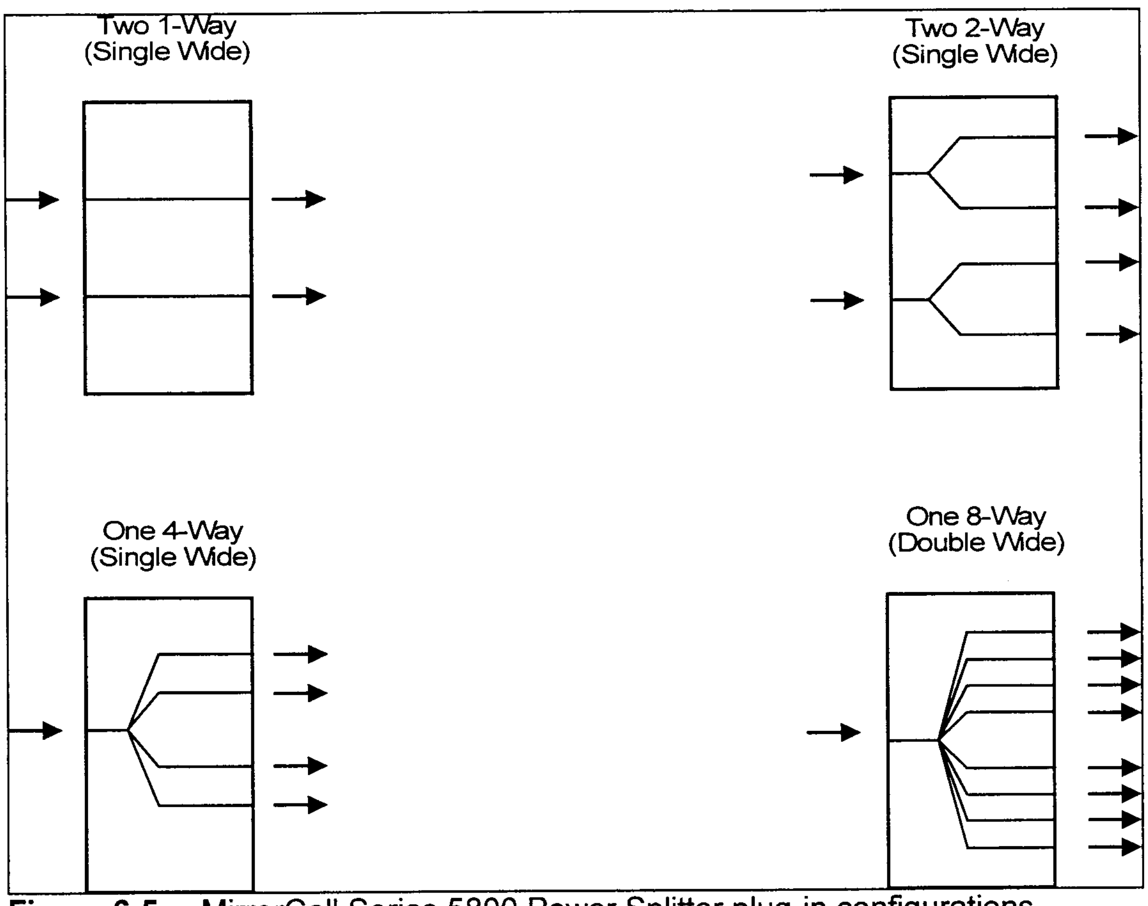


Figure 6-5 MirrorCell Series 5800 Power Splitter plug-in configurations.

5. After documenting the system layout using the table in Figure 6-3, gently insert the plug-ins into the chassis along the guide rails. Blind-mate RF connectors interface the plug-ins to the chassis backplane.

6. The RF connections at the rear of the chassis have been wired at the factory. Notice at the rear panel of the chassis that the RF connectors at the RF Power Splitter/Combiner plug-ins are numbered from 1 to 8 (Figure 6-6). These numbers are associated with the Transceiver plug-ins from 1 to 8. For example, the RF output #3 of a Power Splitter plug-in is connected to the RF input of the Transceiver in slot T3. Similarly, the RF output of the Transceiver in T3 is connected to the RF input #3 of the Power Combiner plug-in. All the RF connections at the chassis rear panel have been made at the factory, and all chassis slots are available for use.

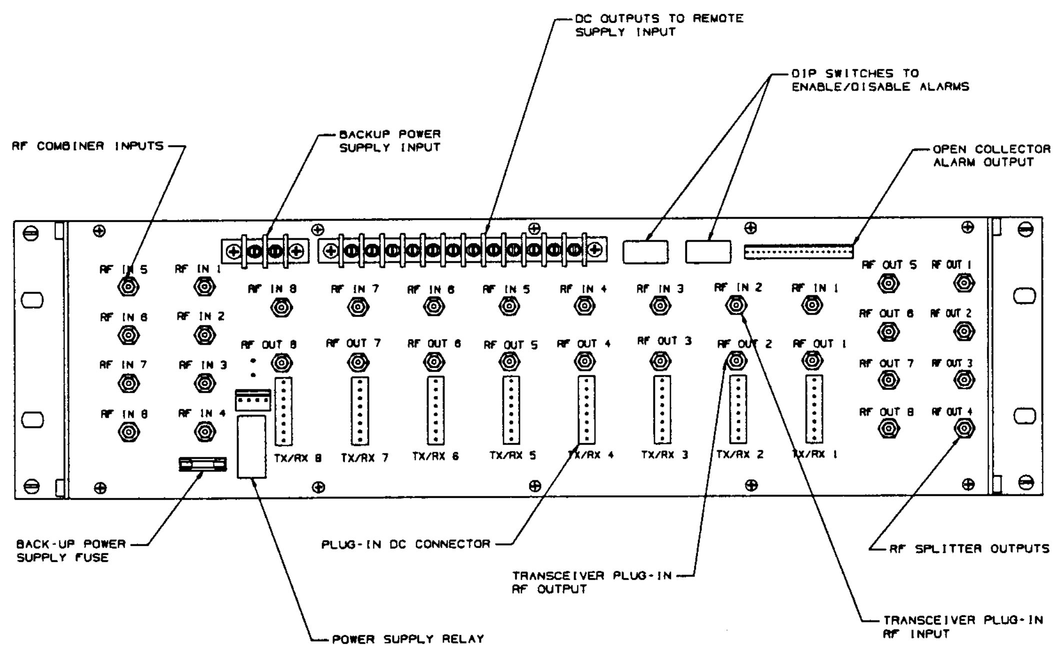


Figure 6-6 Rear panel of chassis showing how the RF Power Splitter/Combiner RF connectors are associated with the Transceiver plug-ins.

7. Label all the optical cables to identify the signal path and connection. It is important to record which optical cable goes to each Antenna, so if an alarm is received, the problem Antenna can be located. The optical cables should be tested to verify that the optical loss is less than 2dB.

ANTENNA UNIT INSTALLATION

Figure 6-7 shows an exploded view of the Antenna unit to be installed onto a ceiling tile. There are three major parts to be mounted: the mounting flange, the Antenna unit and the decorative cover.

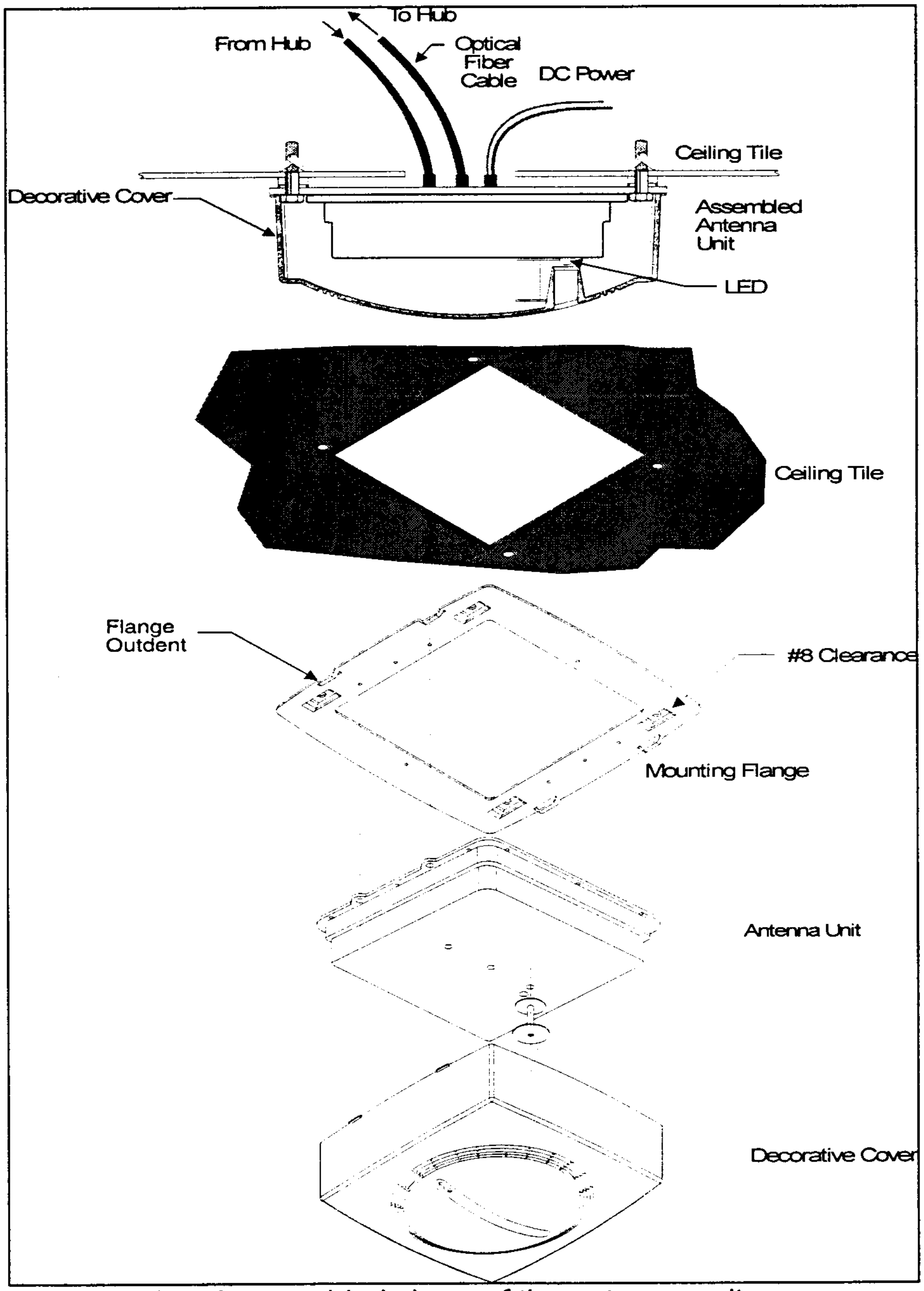


Figure 6-7 Exploded and assembled views of the antenna unit.

1. The Antenna unit must be mounted in a suitable location to maintain the operating environmental temperature of 5 to 40°C.

2. First, use the mounting flange as a template to cut the proper openings in the ceiling tile for the mounting screws and for the optical and electrical wires. Verify that the optical and electrical wires are labeled. Then pull the appropriate optical and electrical wires out from the ceiling.

3. Attach the mounting flange to the ceiling at the four corners. As shown in Figure 6-7, there are four #8 clearance holes at the corners of the flange for mounting to the ceiling. Use the necessary hardware (nuts, bolts, lock washers, screws, anchors, etc.) to ensure a secure attachment to the specific ceiling.

4. Next, check that the Antenna unit is assembled with an Antenna. The RF port (a user specified option) on the Antenna unit can be used for attaching the user's own antenna and for RF testing.

5. Optical and electrical connections can now be made before mounting the Antenna unit to the flange. The optical and electrical cable should already be accessible to the Antenna unit through the hole in the ceiling. Optical connections will now be made to the Antenna unit. The optical connectors used in this system are the standard FC/APC connectors for 1310 nm singlemode fiber which specify a return loss of >55 dB. **For optimum performance, the tips of the optical connectors must be cleaned just prior to making the connection.** To clean the connector, gently wipe the tip of the ferrule with a cotton swab moistened with alcohol, then blow the ferrule dry using dust-free compressed air. The optical connections to the Antenna unit can now be made. The optical connectors should all have been labeled to indicate the specific connection: which Antenna unit and whether it is an optical input or output.

6. DC electrical connections can be made through the terminal block on the Antenna unit, using customer supplied lugnuts for a #6 screw (0.138" dia.). The polarity of the DC power for the Antenna unit is labeled on the Antenna unit. Ensure that the DC polarity supplied to the Antenna unit is correct. To attach the ceiling electrical wires that are from the DC power source, strip away approximately 0.4 inch of the insulation from the electrical wires. Ensure that the wiring is correct before connecting to the Antenna unit.

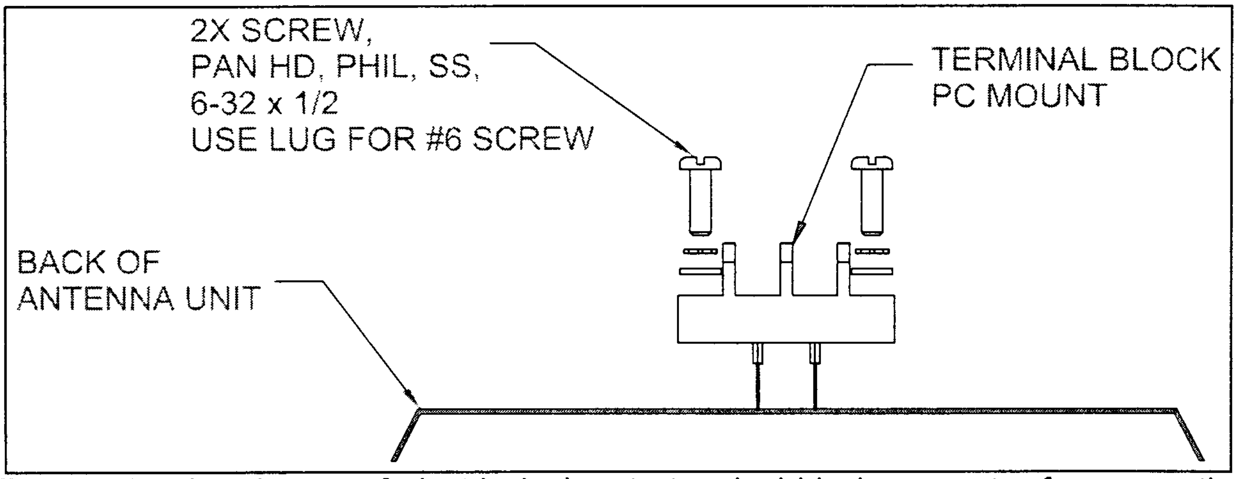


Figure 6-8 Attachment of electrical wires to terminal block connector for connection to Antenna unit.

CAUTION

Incorrect DC Voltage supply can damage the Antenna unit

7. Place a protective cap over any optical connector that is not being used. This is essential since dirty or scratched connectors will impair future performance of those signal paths.

8. Attach the Antenna unit to the mounting flange stand-offs at the four sides of the Antenna unit. Mount the Antenna unit so the unit's LED indicator is oriented in the user's desired direction.

9. Orient the decorative cover so that the small hole on the face of the cover is over the Antenna unit's LED. Snap the decorative cover over the mounting flange.

CAUTION

Do Not Paint the Decorative Cover

HUB INSTALLATION

The Hub consists of a chassis with a built-in power supply, Transceiver plug-ins, RF Power Splitter and RF Power Combiner plug-ins. Figure 6-4 shows an example of a populated chassis.

1. Put the chassis in a suitable location to maintain the operating environmental temperature (5° to 40°C). The MirrorCell Series 5800 Hub can be mounted in a standard 19 inch rack using four screws and guide rails. Each chassis must have 1U (1.75 inches) of air space above and below it for thermal dissipation.

2. Ensure that the appropriate AC power source is supplied to the chassis. Plug the chassis power plug into a source of AC power. The MirrorCell Series 5800 unit is now powered "ON".

3. Optical connections will now be made to the FO Transceiver plug-ins. The optical connectors used in this system are the standard FC/APC connectors for 1310 nm singlemode fiber which specify a return loss of >55 dB. **For optimum performance, the tips of the optical connectors must be cleaned just prior to making the connection.** To clean the connector, gently wipe the tip of the ferrule with a cotton swab moistened with alcohol, then blow the ferrule dry using dust-free compressed air. The optical connections to the Transceiver plug-ins can now be made. The optical connectors should all have been labeled to indicate the specific Antenna that it is being connected to.

4. Place a protective cap over any optical connector that is not being used. This is essential since dirty or scratched connectors will impair future performance of those signal paths.

5. The system is now ready for RF connection. Figure 6-9 gives the nominal RF input levels that the user provides to the Downlink Fiberoptic System as a function of the number of channels. Check the Downlink power levels and adjust according to the table in Figure 6-9 before connecting to the Fiberoptic System. Connect the downlink Cellular signal to the N-Connectors of the MirrorCell Series 5800 RF Power Splitter plug-ins located to the left of the chassis. Similarly, the uplink Cellular signal from the Fiberoptic System is located at the N-Connectors of the RF Power Combiner plug-ins. Connect these to the user's uplink cellular receiver.

6. Connect the alarm monitoring outputs to the user's monitoring system. The chassis rear panel connectors and pinouts are shown in Figure 6-10. The MirrorCell Series 5800 alarm outputs are open collector outputs such that under normal conditions, when there is no alarm, there is no collector current and the output can withstand 15 V. When there is an alarm condition, the open collector outputs are capable of sinking 20 mA.

7. At the rear of the chassis, switch the DIP switches to the "ON" position for those signal paths that are active. If a switch is in the "OFF" position, then the summary alarm output will not respond to a failure of the corresponding signal path.

8. If a standby power supply is available, connect it to the 2-pin Molex connector at the chassis rear panel. The standby power supply should be capable of providing 12 VDC and 8.5 A for maximum loading. Ensure that the polarity is correct to avoid damaging the system.

Figure 6-9
Downlink RF power per channel input to the Fiberoptic System as a function of number of channels.

NUMBER RF CHANNELS	USER'S NOMINAL INPUT TO FIBEROPTIC DOWNLINK SYSTEM
1	12 dBm/ch
2	9 dBm/ch
4	6 dBm/ch
8	3 dBm/ch
16	0 dBm/ch
n	12 - [10log(n)] dBm/ch

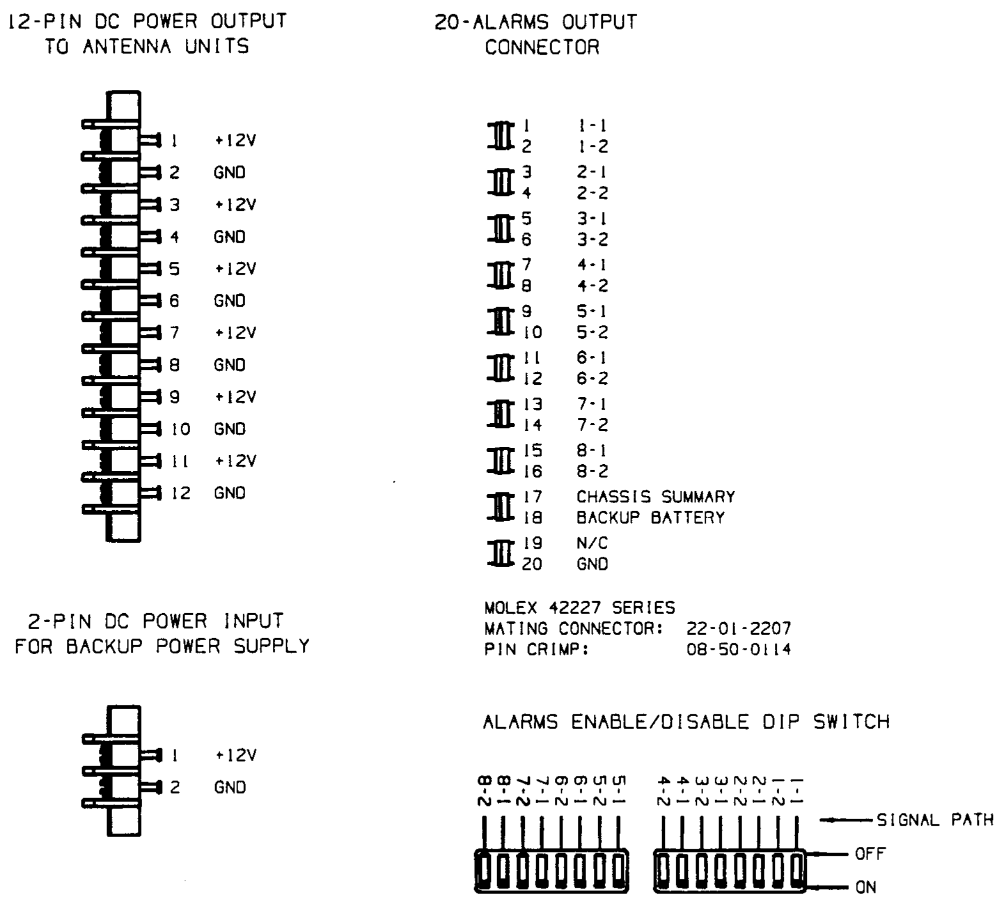


Figure 6-10 Chassis Rear panel connectors and switch pinouts

The table in Figure 6-11 summarizes the normal conditions for the MirrorCell Series 5800 system.

Figure 6-11
Normal operating condition of the MirrorCell Series 5800

LOCATION	ITEM	NORMAL CONDITION
Transceiver Plug-in	LED's for signal paths #1 and #2	Green
Antenna Unit	LED	Green
Chassis Rear Panel	DIP Switch Positions	"ON" (down position) for each active signal path
Chassis Rear Panel	Open Collector Alarm Outputs	No Alarm: withstands 15 V
Throughout System	Unused Optical Connectors	Covered with protective caps

SYSTEM VERIFICATION

The MirrorCell Series 5800 system is now ready for verification of system functionality. If a problem is encountered, go to Troubleshooting section of Chapter 7.

1. Check that all the LED's are green. There are two alarm LED's for each Transceiver plug-in. They are associated with signal paths #1 and #2 of that Transceiver. The LED at the Transceivers indicate the status of the round-trip RF signal path starting from the Transceiver plug-in, along the downlink signal path, to the Antenna unit and back to the Transceiver plug-in along the uplink signal path.

2. Verify that the LED indicator on each Antenna unit is green. This LED indicates that the Antenna unit is receiving DC light from the Transceiver plug-in along the downlink path.

CHAPTER 7

MAINTENANCE AND TROUBLESHOOTING

This chapter describes the maintenance and troubleshooting of the Ortel MirrorCell Series 5800 system.

GENERAL MAINTENANCE

CAUTION

Do Not look directly at the end
of an optical connector which emits laser light!

The system normally operates without operator intervention. If any unit fails, the line replaceable unit (Antenna unit or plug-in) should be replaced and the system restored. A failed unit can be removed and replaced with a spare while the rest of the system is operating.

One of the most important requirements is to maintain clean, undamaged optical interfaces. Any optical connector which is not used must be covered with a protective cap. There are four optical connectors for each Transceiver plug-in and two optical connectors for each Antenna unit. These connectors are internal to the units and not field serviceable. To ensure that the internal connectors are not inadvertently damaged, just prior to mating an external optical fiber connector to a Transceiver or Antenna unit, the external connector should be cleaned as described below. The connectors on the Transceiver plug-in and Antenna units cannot be cleaned in the field.

OPTICAL CONNECTOR CLEANING

1. It is very important to maintain clean, scratch-free optical connectors. Whenever an optical cable is removed, place a protective cap over the optical connector at both the cable end and at the Transceiver or Antenna unit.

2. To clean an optical connector, gently wipe the tip of the ferrule with a cotton swab moistened with alcohol, then blow the ferrule dry using dust-free compressed air.

3. The optical connectors for the Transceiver plug-ins and the Antenna units are internal, and cannot be cleaned in the field.

TRANSCEIVER PLUG-IN REPLACEMENT

1. A Transceiver plug-in is associated with two Antenna units. If a Transceiver plug-in is removed to be replaced, it will temporarily shut down two signal paths. To replace a Transceiver plug-in, check that the four optical cables in front are labeled and then disconnect them. Loosen the two screws at the front panel of the plug-in that hold it to the chassis. Gently pull the plug-in out from the chassis. The plug-in RF connectors are blind-mates located on the chassis backplane.

2. Gently slide the replacement plug-in into the chassis slot. Align and tighten the front panel screws. The optical connector of the replacement plug-in should already be clean. Clean the connectors of the optical fiber as described above and before reconnecting them to the plug-in.

3. Check that the LED's are green at the Transceiver plug-in and at the two Antenna units associated with the Transceiver plug-in.

4. Check that the open collector alarm at the Hub has reset to indicate that there is no failure in the signal path. The open collector output withstands 15 V under a "No Alarm" condition.

ANTENNA UNIT REPLACEMENT

1. If an Antenna unit is removed to be replaced, it will temporarily shut down the signal path. To replace the Antenna unit, snap the decorative cover off of the Antenna unit by slightly squeezing the sides of the decorative cover near the tabs which hold it to the mounting flange that is attached to the ceiling (Figure 6-7). Carefully hold onto the Antenna unit which is attached to optical fiber cables and DC power cables above the ceiling. Then, at the four sides of the Antenna unit, remove the screws that hold it to the stand-offs of the mounting flange (Figure 6-7). Check that the cables are labeled, and then remove the cables from the unit.

2. Connect the DC cable to the replacement Antenna unit. Clean the optical fiber connector, check the label on the cable, and connect it to the Antenna unit. Repeat for the other optical fiber cable.

3. Orient the decorative cover so that the small hole on the face of the cover is over the Antenna unit's LED, and snap it over the mounting flange.

4. Check that the LED's are green at the Antenna unit and then at the associated Transceiver plug-in.

5. Check that the open collector alarm at the Hub has reset to indicate that there is no failure in the signal path. The open collector output withstands 15 V under a "No Alarm" condition.

POWER SPLITTER/COMBINER PLUG-IN REPLACEMENT

1. A Power Splitter or Combiner plug-in can be associated with as many as all 16 signal paths. If a Power Splitter or Combiner plug-in is removed to be replaced, it will shut down all the signal paths that are associated with it.

2. Before replacing a Power Splitter or Combiner plug-in, check that all the RF cables are labeled at the front of the plug-in. These N-type cables interface with the user's cellular system. The RF blindmate connectors at the rear of the chassis interface with the Transceiver plug-ins in the chassis. Notice that at the rear panel (Figure 7-1), the RF connectors are numbered from 1 through 8 for the Power Splitter and Combiner plug-ins. These numbers are associated with the Transceiver plug-ins in Slots T1 through T8 as shown in Figure 7-2. For example, at the rear of the chassis, the RF output #3 from the Power Splitter plug-in connects to the RF input to Transceiver #3, located in Slot T3. Similarly, at the rear of the chassis, the RF output from Transceiver #3 connects to the RF input #3 from the Power Combiner plug-in. The rear RF connections have all been made at the factory.

3. Now remove the RF cables at the front of the RF Power Splitter/Combiner plug-in, loosen the screws at the front panel which hold the plug-in to the chassis, and gently slide the plug-in out.

4. Gently slide in the replacement plug-in. Tighten the front panel screws and reconnect the RF cables.

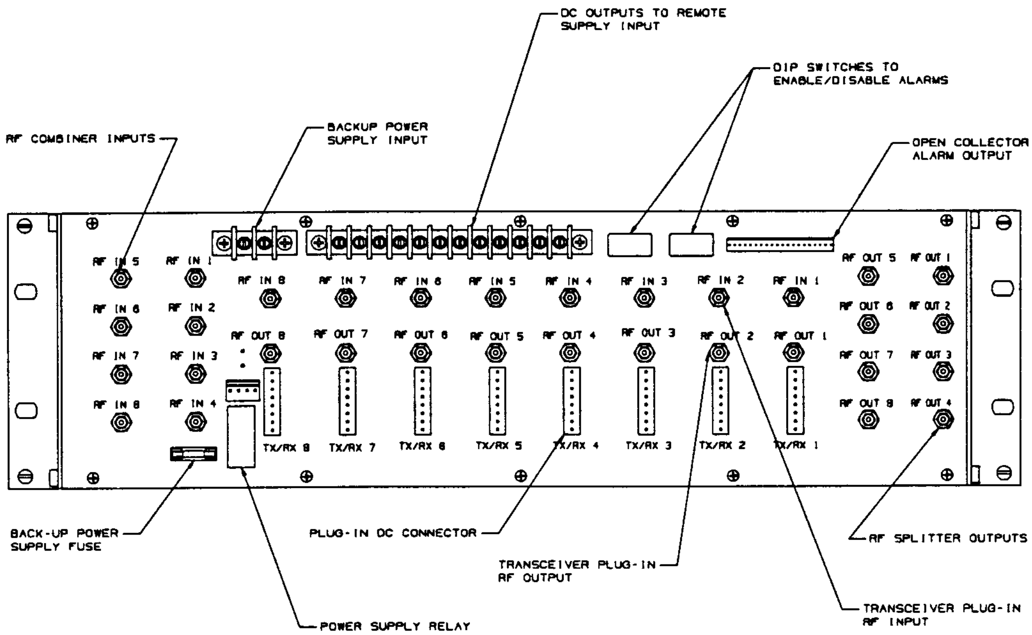
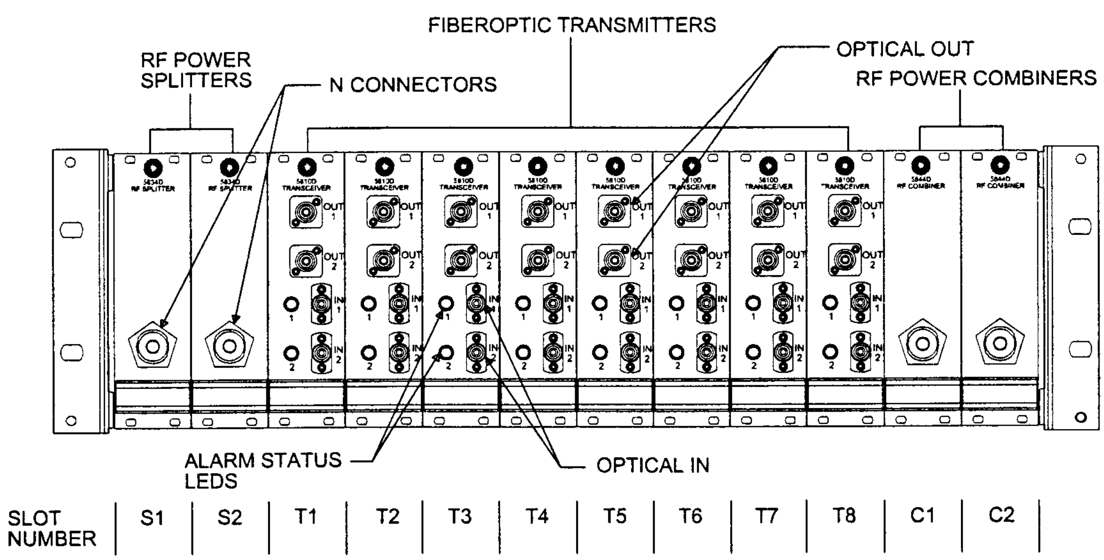


Figure 7-1 Rear panel of chassis showing how the RF Power Splitter/Combiner RF connectors are associated with the Transceiver plug-ins



FRONT VIEW

Figure 7-2 Numbering scheme of plug-in slots in a chassis.

TROUBLESHOOTING

System failure is indicated by red LED's, one located at each Antenna unit and two located at each Transceiver plug-in. The LED located at the Antenna unit indicates the status of the DC light received by the Antenna unit via the downlink signal path. The LED located at the Transceiver plug-in indicates the status of the round-trip RF signal from the Transceiver plug-in via the Downlink path to the Antenna unit and back from the Antenna unit via the Uplink path to the Transceiver plug-in. If the Antenna unit LED is red, then the Transceiver plug-in LED will also be red, but not vice versa. Failure as displayed by a red LED at the Transceiver plug-in is also indicated by an open collector output current at the alarm connector at the rear panel of the chassis at the Hub. The open collector outputs provide status for each signal path from 1-1 to 8-2, one for the power supply and one chassis summary alarm.

Troubleshooting comprises some basic steps. The table in Figure 7-3 give the normal operating condition of the MirrorCell Series 5800 system. The table in Figure 7-4 provides information about the alarms, failures and course of action. Finally, Figure 7-5 provides flow charts to aid in troubleshooting.

Figure 7-3 Normal operating condition of the MirrorCell Series 5800

LOCATION	ITEM	NORMAL CONDITION
Transceiver Plug-in	LED's for signal paths #1 and #2	Green
Antenna Unit	LED	Green
Transceiver or Antenna Unit	Optical Output Power	0.7 mW ± 0.14 mW
Chassis Rear Panel	DIP Switch Positions	"ON" (down position) for each active signal path
Chassis Rear Panel	Open Collector Alarm Outputs	No Alarm: withstands 15 V
Throughout System	Unused Optical Connectors	Covered with protective caps

Figure 7-4 Summary of alarm information for the MirrorCell Series 5800

COMPONENT	INDICATOR	MEANING	POSSIBLE CAUSES
Power Supply	Open Collector Output Alarm: sinks 20 mA	Failure of chassis power supply	Power supply failure, alarm error
Transceiver Plug-in	Red LED and Open Collector Output Alarm	Failure of RF signal path: from Transceiver plug-in to Antenna unit and back to Transceiver plug-in	Transceiver plug-in failure, Antenna unit failure, optical connector dirty or damaged, optical fiber cable damaged, alarm error
Antenna Unit	Red LED and Open Collector Output Alarm	Failure to detect DC light in downlink path	Transceiver plug-in failure, Antenna unit failure, optical connector dirty or damaged, optical fiber cable damaged, alarm error
Transceiver Plug-in or Antenna Unit	LED's Unlit	LED not functional	Transceiver or Antenna unit failure, no DC power to unit

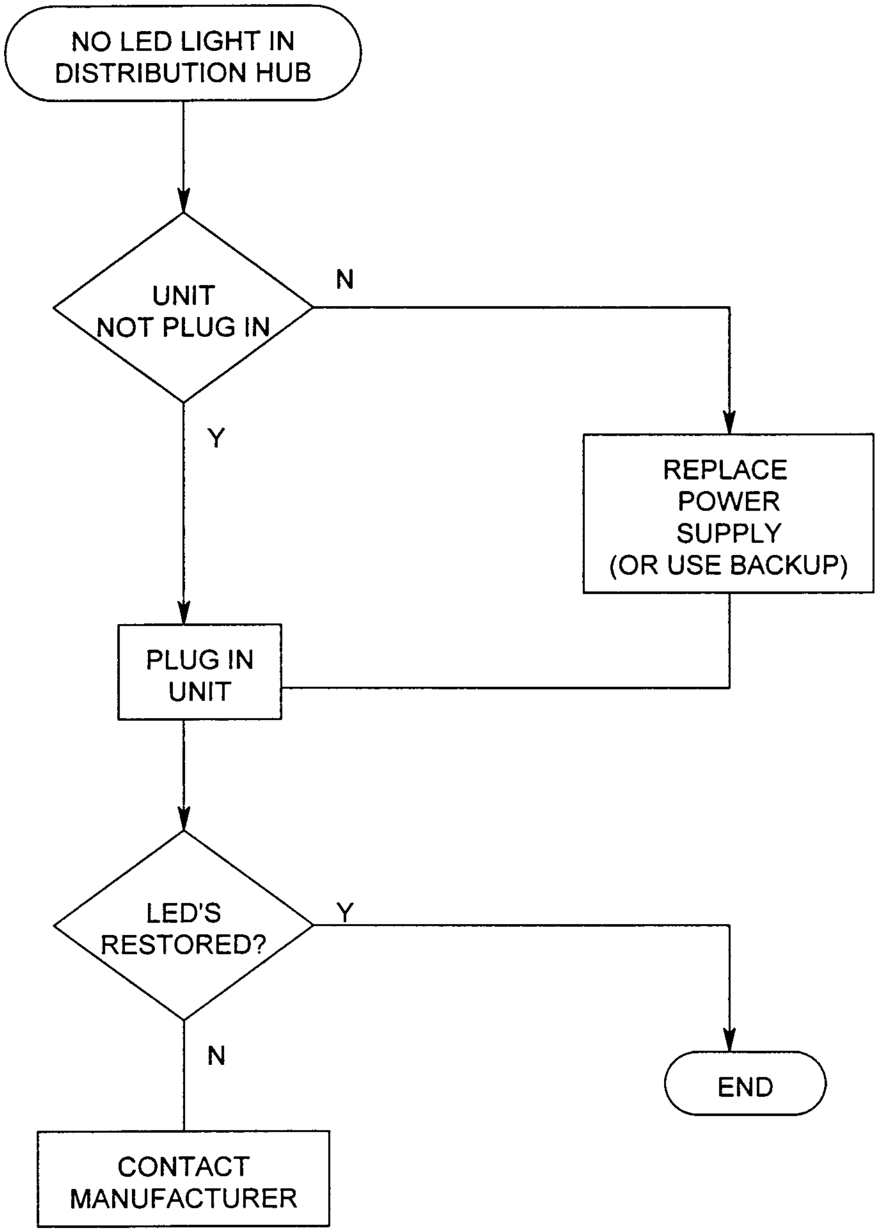


Figure 7-5A Flow chart for troubleshooting the MirrorCell Series 5800

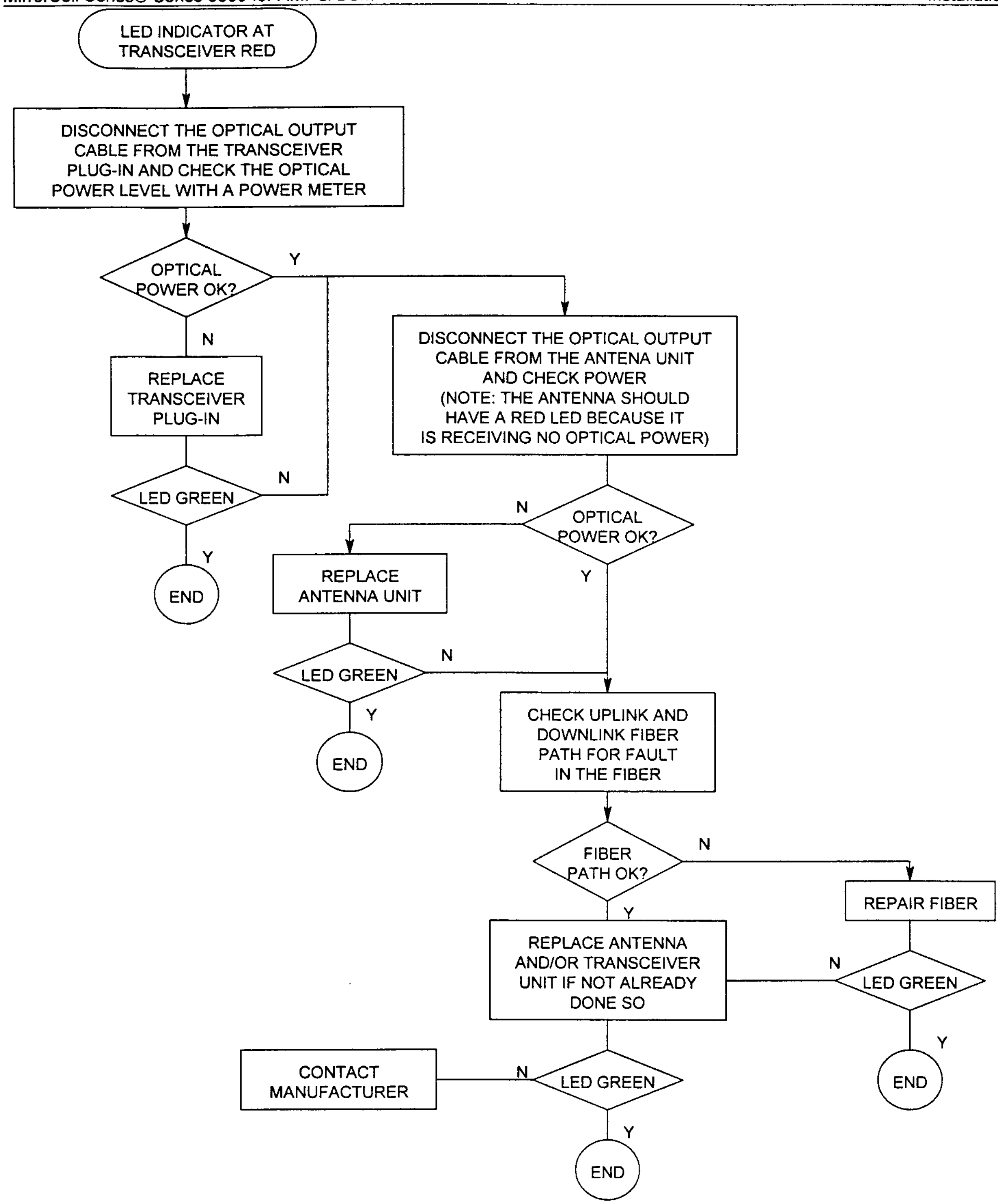


Figure 7-5B Flow chart for troubleshooting the MirrorCell Series 5800.