1 Link Description

1.1 Cautions and Warnings

Throughout this manual, these terms appear which highlight the care that should be exercised to ensure personal safety and proper operation of the equipment.

WARNING: *Warning statements identify conditions or practices that could result in injury or loss of life.*

CAUTION: *Caution statements identify conditions or practices that could result in damage to this product or other property.*

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 aoccur 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.

CAUTION: *any modifications to this device not expressly authorized by Repeater Technologies, Inc. could void the user's authority to operate this device.*

1.2 General Description

The OFFICECELL Fiberoptic Distributed Antenna System provides extended coverage of cellular and PCS networks throughout buildings and campus environments. The Hub Shelf is the HUB SHELF which is a 3U (5.25 inch) high, 19 inch wide rack-mounted chassis. The HUB SHELF holds up to 8 HUB TRANSCEIVER Plug-Ins. The Hub Shelf is located in a communications equipment room in the building and is connected to the cellular/PCS base station or repeater via hardline connection. The Hub Shelf may

also be connected to the radios of a wireless PBX. Each Hub Shelf is configured with up to eight HUB TRANSCEIVER plug-in cards. Each card is connected to up to two Remote Transceivers. The REMOTE TRANSCEIVER Units are distributed throughout the building as necessary to provide coverage. The Remote Transceivers are mounted, generally, above the suspended ceiling but may be mounted near the ceiling inside the room if need be. The aesthetic and low-profile design of the Remote Power Supply makes it relatively unobtrusive. The plastic cover may even be removed and/or painted to match the décor. Each REMOTE TRANSCEIVER is connected to Hub Shelf via two singlemode optical fibers. Each REMOTE TRANSCEIVER has one RF port which is connected to a user-supplied indoor coverage antenna. This port may also be routed through an N-way RF splitter to provide coverage from a number N antennas for the one Remote Transceiver. This reduces the output power and sensitivity at that Remote Transceiver but, in some cases, this could be the most cost-effective way to provide unifirm coverage. The REMOTE TRANSCEIVER is powered by +12 to 24 VDC which can be supplied by the customer or by the Remote Power Supply. This is a universal AC power supply with battery backup and is installed with the REMOTE TRANSCEIVER on a wall mounting bracket supplied with the unit. If DC power is supplied by the customer, it can be distributed from a power supply at the Hub location using the conductor pairs in a composite fiber/conductor cable. The DC connector utilized at the Remote Transceiver can accommodate up to 14 AWG wire.

The OFFICECELL design is very versatile but certain options are available that target specific signal types and applications. In addition to the single band versions, there is an 800 MHz/1900 MHz dual band and a GSM900/GSM1800 dual band option. There is also a high power 800MHz and GSM900 option. This option provides a +22 dBm single carrier output for GSM900 or, for 800 MHz, 10 carriers of IS-136 at +10 dBm/carrier or +12 dBm for single carrier CDMA. The system performance is specified for 4 dB optical loss.

OFFICECELL installation and setup is very simple. First, standard telcom grade singlemode fiberoptic cable that is most suitable for the site is installed. The cable installer can terminate the cable on site easily with the OptoClip optical connectors. The Plug-Ins and Remote Transceivers of a given type are completely interchangeable. The OptoClip plugs directly into the Remote Transceiver at one end. The other end plugs into an optical patch panel or directly into the Hub Shelf via an OptoClip-to-SC/UPC adapter. If the patch panel is used, OptoClip-to-SC/UPC jumpers must be used to connect the HUB SHELF to the patch panel. Built-in optical loss compensation automatically equalizes the gain in both the transmit and receive paths so the transmit RF power is known for a given input RF power and the receive path sensitivity is optimized. The only adjustment available is a manual setting for the static transmit power at the Remote Transceiver which may be used to optimize coverage, if necessary. This is a one time adjustment during set up.

1.2.1 Basic Principles

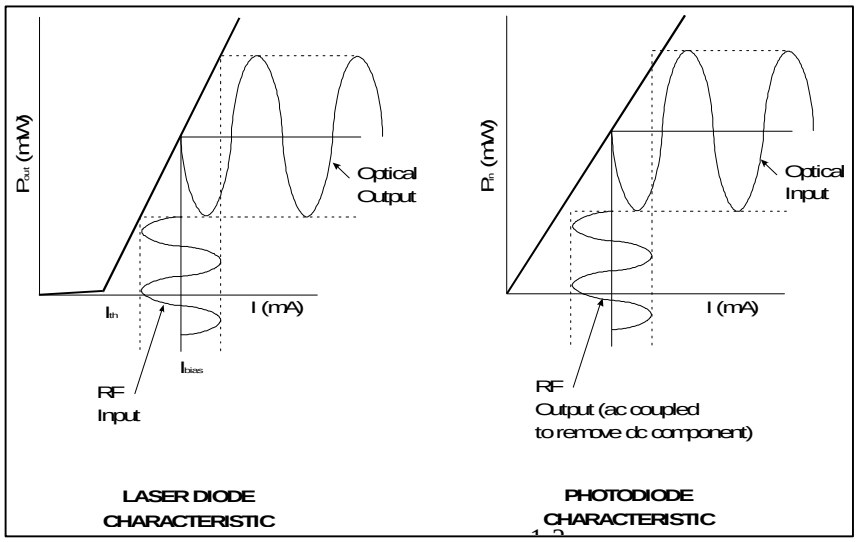


Figure 0. Laser diode and photodiode characteristics illustrating the

The OFFICECELL operation is based on an analog RF fiberoptic link. The principles are illustrated in Figure 1. Input RF signals are converted to light by direct intensity modulation of a semiconductor laser. This modulated light is transmitted over optical fiber and detected by a semiconductor PIN

photodiode. The photodiode converts optical power to electrical current. This current is AC coupled and passed through a load to recover the RF signal.

The basic RF loss in this link is determined by the inefficiencies of the conversions of RF to optical and back. The fiber also contributes an RF loss equal to twice the optical loss. This is because the photodiode converts optical *power* to electrical *current* and RF power is proportional to the square of the current. So, for 1 km of fiber with a loss of 0.4 dB/km (this is typical at 1310 nm wavelength) the optical loss is 0.4 dB and the contribution to the RF loss is 0.8 dB. In a real installation, two optical connectors will add approximately 0.5 dB of optical loss.

The laser and, to a much lesser degree, the photodiode, add noise and distortion to the RF signal. This RF performance is characterized just as any RF link in terms of dB loss, noise figure, third order intercept, etc.

The fiber path itself can contribute noise and distortion. In the OFFICECELL, the laser used is a Fabry-Perot (FP) laser instead of a Distributed Feedback (DFB). The DFB has a single spectral component. The FP laser has multiple spectral components which can contribute noise and distortion for longer fiber runs. For the distances used in the OFFICECELL, this effect is not significant. Also, optical backscattering back into the laser from less than perfect connections can cause additional noise and distortion. The FP lasers used in the OFFICECELL are much less sensitive to this than are DFB lasers. DFB lasers are also considerably more expensive. However, if optical reflections are severe enough from a bad connection, the resulting optical reflection may cause performance degradation. To minimize this, SC/UPC optical connectors with a return loss > 50 dB are used at the Hub Shelf and OptoClip connectors with a return loss of > 60 dB are used at the Remote Transceiver. Following standard practices in cleaning of the removable optical connectors (see procedure outlined below) will keep the connections in spec and will avoid the problems of performance degradation.

1.2.2 Functional Description

The OFFICECELL Fiberoptic Antenna System connects to the mobile coverage RF ports of a repeater or

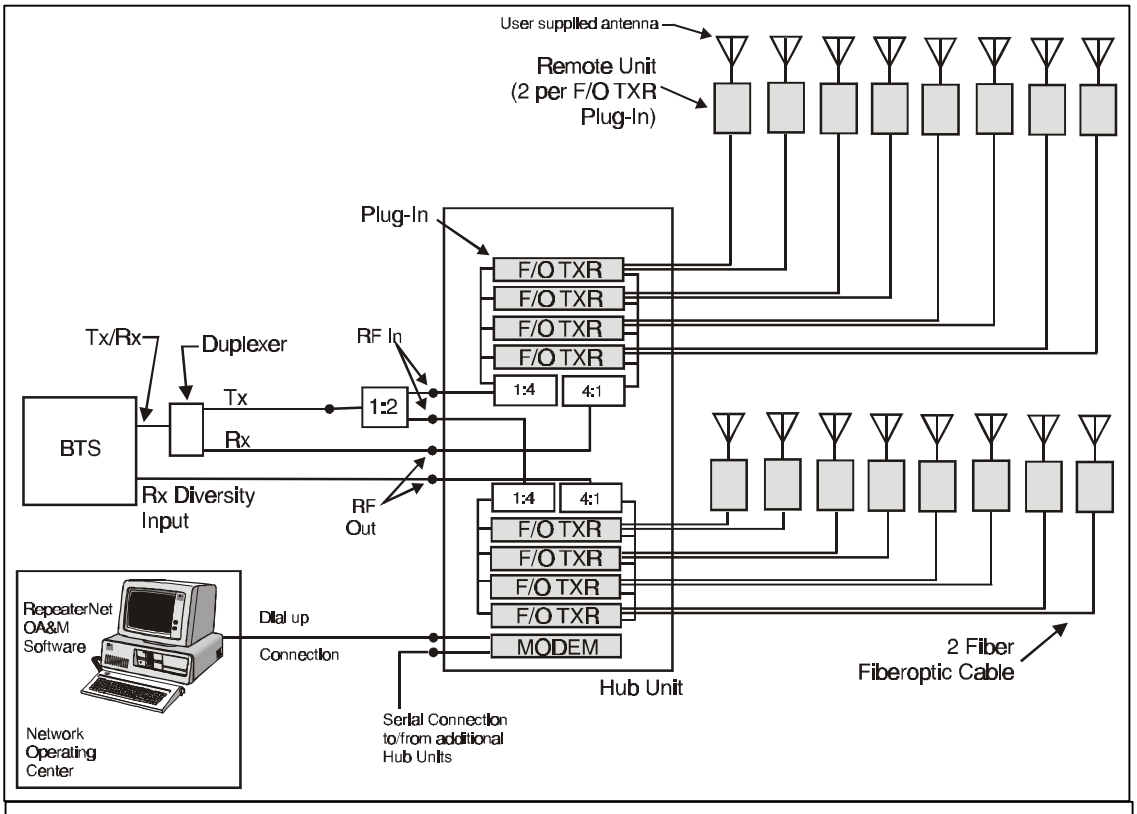


Figure 2. System Block Diagram

base station as an extended coverage antenna. The Hub Shelf mounts in a standard 19 inch rack close to the repeater or base station transmit and receive RF ports. These RF connections are made via the RF connectors on the rear panel. Inside the chassis, the transmit signal is split and routed to the Hub Transceiver Plug-Ins. Each plug-in is a fiberoptic transceiver. The Hub Shelf holds up to eight plug-ins. Each plug-in interfaces with up to two Remote Transceivers by way of fiberoptic connections on the Hub Shelf rear panel.

The HUB TRANSCEIVER Plug-Ins are connected to the Remote Transceivers via singlemode fiber at 1310 nm wavelength. Separate fibers are needed for the transmit and receive signals. SC/UPC optical connectors (SC/PC snap-in connectors with an “ultra-polish”) are used at the Hub Shelf. These connectors are used because they are compatible with the optical blindmate connectors used on the HUB TRANSCEIVER Plug-Ins. The bulkhead connectors are polished to a return loss of > 50 dB.

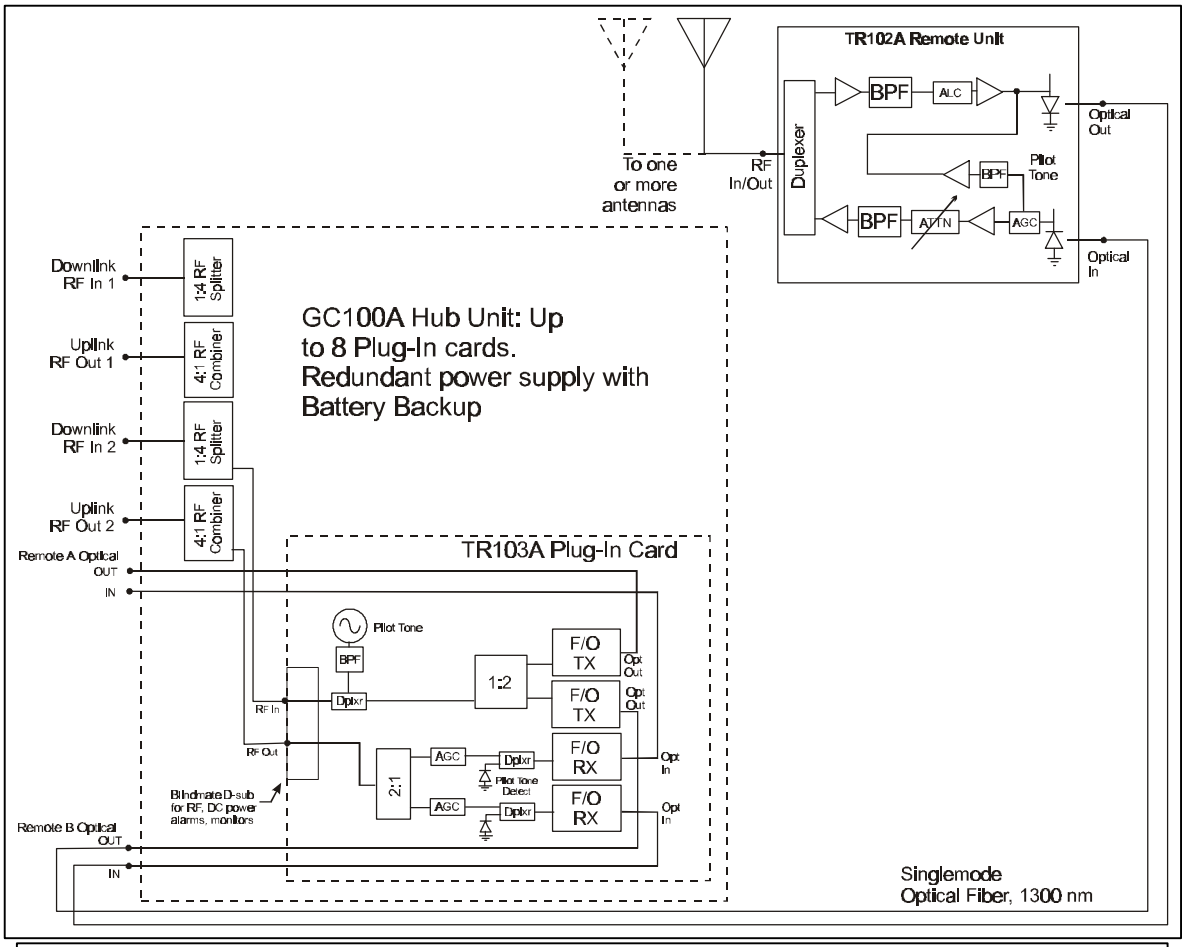


Figure 3. OfficeCell RF Path Block Diagram.

The Remote Transceiver is a fiberoptic transceiver that connects to an external indoor coverage antenna. Depending on coverage and cost requirements, an RF splitter may be used to connect the Remote Transceiver to two or more antennas. The Remote Transceiver uses field-installable OptoClip II optical connectors. The Remote Transceiver optical output is the green connector. The REMOTE TRANSCEIVER units are generally mounted above the false ceiling on a bulkhead or post. Each REMOTE TRANSCEIVER is connected to an indoor coverage antenna by way of a customer-supplied flexible RF cable. Some indoor antennas are available with flexible RF cable pigtails and an SMA

connector termination. These units are distributed throughout the building or campus as necessary to get full coverage. After installation, the transmit power from each Antenna Unit may be adjusted manually by way of an potentiometer on the unit. This is potentiometer indented in 2 dB steps. This is a one time adjustment. For dual band units, there is a separate adjustment for each band.

Several versions of the REMOTE TRANSCEIVER are available that are optimized for specific formats such as DAMPS, GSM900, GSM1800, etc. Dual band versions are available; one providing simultaneous coverage for GSM900 and GSM1800 and one for PCS1900 and 800 MHz. In these versions, a single RF port feeds a dual band antenna.

The block diagram of the OFFICECELL Fiberoptic Antenna System is shown in Figures 2 and 3. The input transmit RF signal is split eight ways in the Hub Shelf. Each of these signals is routed to a Hub Transceiver Plug-In where it is split in two and each path modulates the optical output of a solid state laser diode. This optical output is routed through a singlemode optical fiber to one Remote Transceiver. The photodiode in the REMOTE TRANSCEIVER detects this optical signal and outputs a proportional electrical current. This current is ac coupled and passed through a load to recover the RF signal. The RF signal is amplified, filtered and output to the antenna. The output RF signal path includes a variable attenuator to adjust the output level for optimum coverage. The RF subcarrier is detected at the photodiode output. This level is used by the transmit AGC to set the downlink gain. The subcarrier is also amplified and inserted into the uplink path. This signal is detected at the Hub Shelf Plug-In for the uplink AGC and Node Function Alarm. A failure of any amplifier in the downlink path in the Remote Transceiver, shuts off the subcarrier in the return path which, in turn, triggers the Node Function Alarm at the Hub.

The receive or uplink RF signal from the antenna is filtered and amplified then routed to the Remote Transceiver laser. A fast ALC is included in this path which prevents RF overdrive damage to the laser while recovering fast enough to minimize blocking for TDMA and GSM signals. The laser output in the Remote Transceiver is then modulated by the receive RF signal and is transmitted through another singlemode optical fiber back to the Hub Shelf Plug-In. Each of the two photodiodes in the Hub Transceiver

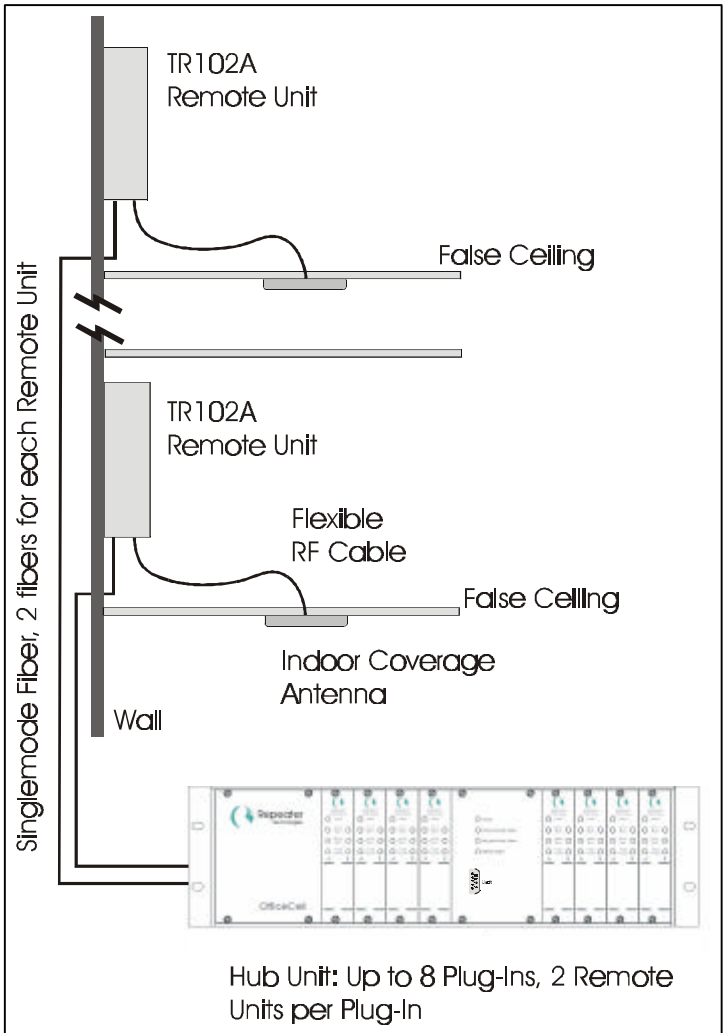


Figure 4. The Remote Transceivers are normally mounted above the false ceiling but may be mounted in the room. Each Remote Power Supply is connected to the Hub Shelf via 2 singlemode fibers. The Remote Power Supply is connected to a user-supplied antenna via flexible RF cable. The Remote Transceivers may be powered using the optional universal Remote Power Supply with battery backup, or using a central power supply that distributes DC power along with the fiber over a composite

Plug-In recovers the RF signals from each of two Remote Transceivers. The pilot tone on each signal is split off and detected. This is used for the Node Function alarm. This LED is normally green and turns red if the pilot tone is not detected. This alarm also appears at the Hub Shelf rear panel DB37 connector as a TTL level critical alarm. It would also be reported to the NOC or service technician by the modem card depending on how the user configured the system alarms.

The receive RF signal from each photodiode is combined in the HUB TRANSCEIVER Plug-In. These combined outputs are combined again in the and output to the rear panel RF uplink connectors. The Hub Shelf is divided into two halves. The RF signals from each half are combined and routed to separate rear panel N connectors. The combined uplink signals from one half can be routed to the BTS main receive port while the other RF output is routed to the BTS receive diversity port. This method provides an overall 3 dB system sensitivity improvement compared to routing all of the uplink signals into one receive port (see Figure 2). Alternatively, both outputs may be combined and routed to a single BTS receive port.

1.3 Specifications

Description

This specification defines the uplink and downlink performance of the OfficeCell Fiberoptic Antenna System. The terminal equipment consists of the Remote Transceiver and the Hub Transceiver Plug-In. The latter is installed in the Hub Shelf. This system meets and exceeds the requirements for GSM900, GSM1800 and GSM1900 Class M3 micro-BTS as well as IS-136 TDMA and IS-95 CDMA for wireless PBX, in-building and campus coverage applications.

There are four frequency options for the OfficeCell: 850 MHz (AMPS), GSM900, GSM1800 and PCS1900. There are two downlink output power options: the P1 power option meets GSM 900 micro-BTS M3 requirements and is available for the 850MHz and 900MHz versions only. The P2 power option meets micro-BTS M3 requirements for 1800MHz and 1900MHz. For 850MHz and 900MHz, the High Power meets GSM micro-BTS power class M1 requirements and IS-136 in-building requirements for +20 dBm composite power. All of these system standards specifications are met for optical loss of up to 4 dB.

RF Parameters (up to 4 dB optical loss)

Uplink

Frequency Range	850 MHz	824 - 849 MHz
	GSM900	890 - 915 MHz
	GSM1800	1710 - 1785 MHz
	PCS1900	1850 - 1910 MHz
Amplitude Flatness		
824 – 849, 890 - 915 MHz; Full band		± 1.5 dB
	(Any 15 MHz band)	± 1.0 dB
1710 – 1785, 1850 - 1910 MHz; Full band		± 2.5 dB
	(Any 15 MHz band)	± 1.0 dB
Noise Figure		≤ 13 dB
	Low Noise Option	≤ 7 dB
Input Third Order Intercept (IIP3), 2 carriers, -43 dBm/carrier		≥ -15 dBm
	Low Noise Option	≥ -25 dBm
Link Gain (with external 20 dB attenuator; 30 dB attenuator with Low Noise Option)		
824 - 915 MHz		4 ± 1 dB
1710 - 1910 MHz		4 ± 1 dB
Uplink Input ALC		
Input RF Threshold		- 25 dBm
Low Noise Option		-35 dBm
Range		30 dB
Response Time		< 5 µsec w/o ringing
Gain Stability		± 1 dB
Input/Output Impedance		50 Ω
Input/Output VSWR		≤ 2 : 1

Downlink

Frequency Range	850 MHz	869 - 894 MHz
	GSM900	935 - 960 MHz
	GSM1800	1805 - 1880 MHz
	PCS1900	1930 - 1990 MHz

Amplitude Flatness

869 – 894, 935 - 960 MHz; Full band	± 2.5 dB
(any 15 MHz band)	± 1.0 dB
1805 – 1880, 1930 - 1990 MHz; Full band	± 2.5 dB
(any 15 MHz band)	± 1.0 dB
Output Noise	≤ -92 dBm/Hz
Output Third Order Intermodulation Product	
(Interfering CW carrier 30 dB below main carrier, for single carrier at max output power)	≤ -38 dBm
2 Equilevel Carriers at +17 dBm/carrier	≤ -42 dBc

Output Power, Maximum (dBm)

	Std	Single Carrier	2 Equilevel Carriers (Power/Carrier)
P1	GSM	+14	+5
	IS-136	+12	+9
	CDMA	+4	+1
P2	GSM	+22	+13
	IS-136	+20	+17
	CDMA	+12	+9

Output Power Range ≥ 12 dB user adjustable (in 2 dB increments at TR102 Remote Transceiver)

Input Power Threshold for Input Power Protect 8.5 to 11.5 dBm
Attenuation Step for Input Power Protect 10 dB

Gain at Maximum Output Power (output attenuator set at min)
- Output Power Option P1 2 ± 1 dB
- Output Power Option P2 14 ± 1 dB

Gain Stability ± 1 dB
Input/Output Impedance 50 Ω
Input/Output VSWR ≤ 2 : 1

General
Loop back Carrier Frequency 99 MHz ± 10 MHz

Optical Parameters
Wavelength 1310 ± 20 nm
Output Power
- Remote Transceiver 1.8 mW
- Hub Transceiver Plug-In 1.8 mW

Optical Connector
- Hub Shelf SC/UPC, > 50 dB return loss
- Remote Transceiver Optoclip II®, > 55 dB return loss

Fiber Singlemode

Absolute Maximum Ratings
RF Input Power
- Uplink +5 dBm

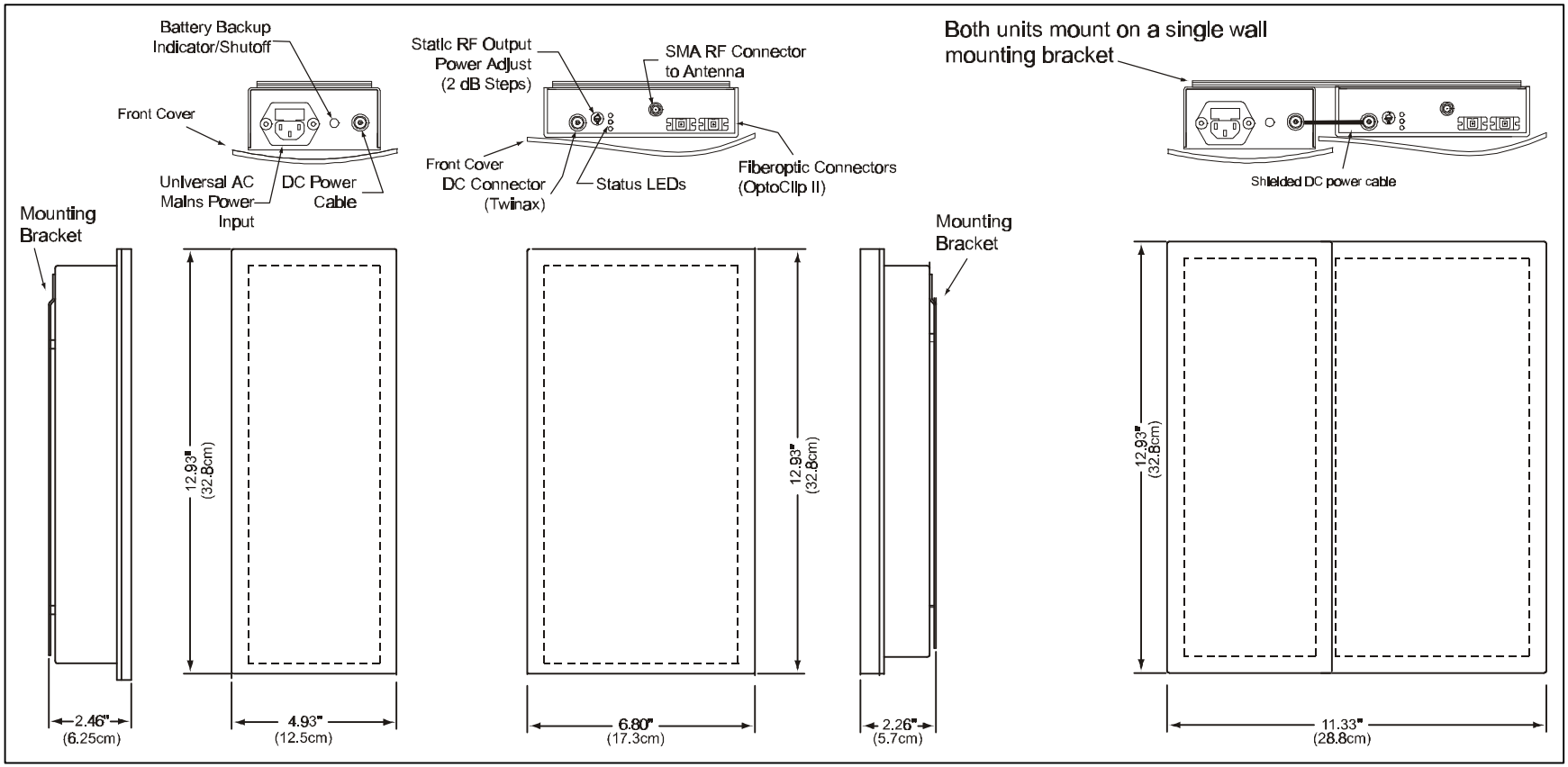
Low Noise Option	-5 dBm
Downlink	+26 dBm total
Photodiode Input Optical Power	+2.3 mW

Electrical

Remote Transceiver	+12 V to +24 V, 12 W (single band), 20 W (dual band)
Remote Power Supply	100 to 240 VAC, 47 – 63 Hz
Hub Transceiver Plug-In	6 W
Hub Shelf	100 - 240 VAC, 47 - 63 Hz

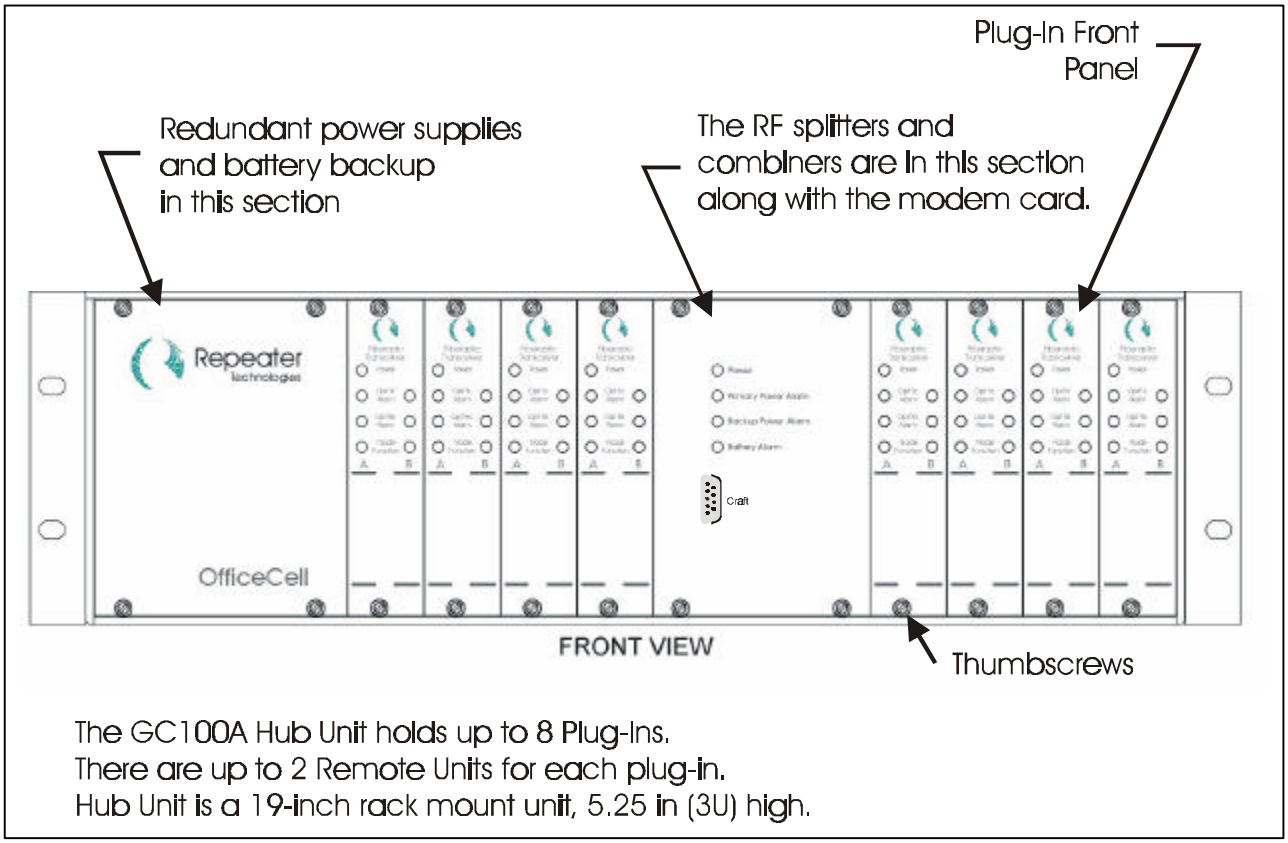
Mechanical

Remote Transceiver — See outline drawing below

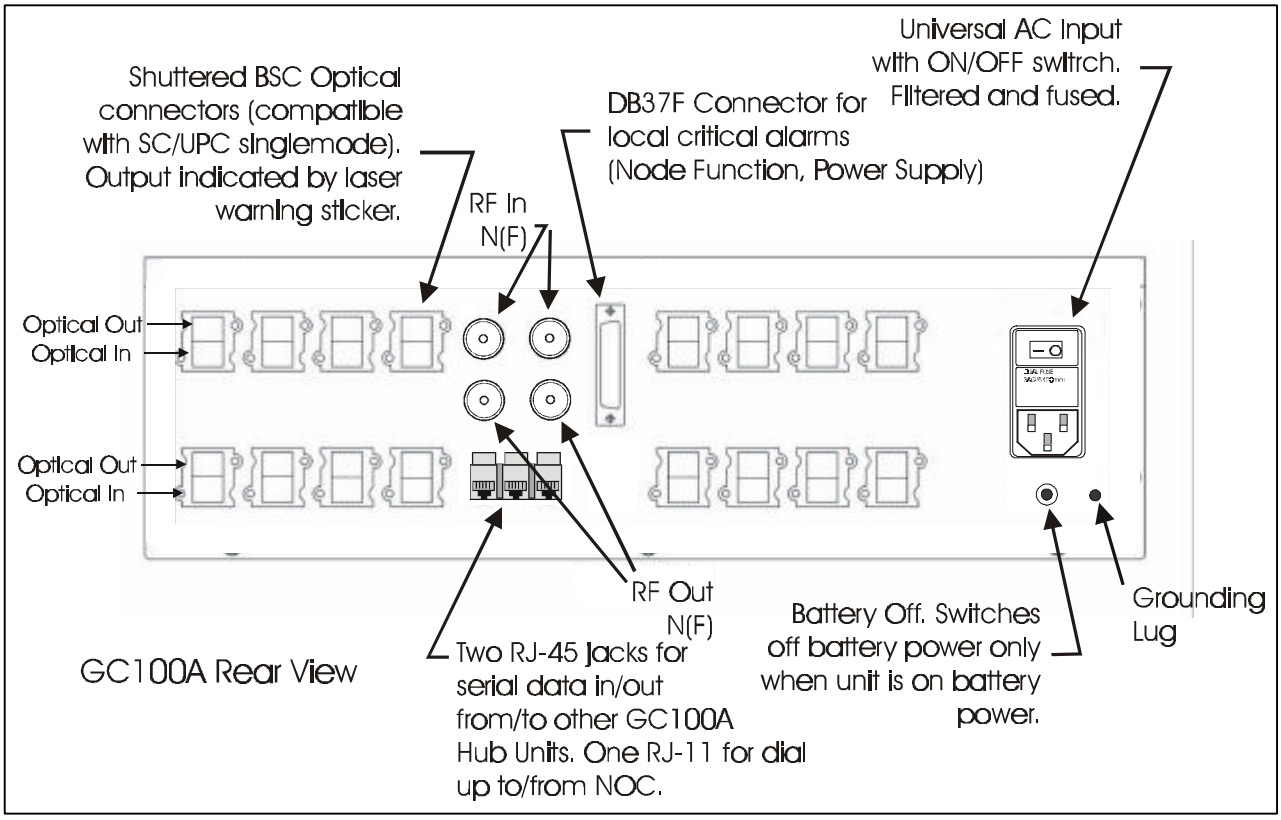


Hub Shelf Plug-In (HUB TRANSCEIVER) Plug-in card with 5.06” H x 1.2” W front panel for HUB SHELF Chassis.

Hub Shelf (HUB SHELF) 19”, 3U (5.25”) H, 15.75” D rack mount



The GC100A Hub Unit holds up to 8 Plug-Ins.
There are up to 2 Remote Units for each plug-in.
Hub Unit is a 19-inch rack mount unit, 5.25 in (3U) high.


Shuttered BSC Optical connectors (compatible with SC/UPC singlemode). Output indicated by laser warning sticker.
RF In N(F)
DB37F Connector for local critical alarms (Node Function, Power Supply)
Universal AC Input with ON/OFF switch. Filtered and fused.
Optical Out
Optical In
Optical Out
Optical In
RF Out N(F)
Grounding Lug
Battery Off. Switches off battery power only when unit is on battery power.
Two RJ-45 jacks for serial data in/out from/to other GC100A Hub Units. One RJ-11 for dial up to/from NOC.
GC100A Rear View

Alarms and Monitors

Remote Transceiver

Description
Power On (Green LED)
Laser Optical Power Low Alarm (active if laser output < 90% of factory set point: Red Front panel LED)
Received Optical Power Low Warning (active if optical loss > 4.2 dB: Yellow front panel LED)
Transmit Amplifier Failure Alarm (active if any amplifier in transmit path fails as detected by bias current: Red LED. Also causes shutoff of subcarrier in uplink path which triggers Node Function Alarm at plug-in.)

Hub Transceiver Plug-In

Node Function (loopback carrier detect: Front panel LED; normally Green, Red if RF subcarrier level drops more than 10 dB)
Received Optical Power Low Warning (active if optical loss > 4.2 dB: Yellow front panel LED, normally OFF)
Laser Optical Power Low Alarm (active if laser optical output power drops 10%): Red Front panel LED, normally OFF)

Hub Shelf

LEDs

Power On (Green, Normally ON)
Main Power Alarm (Red Front panel LED; normally OFF)
Backup Power Alarm (Red Front panel LED; normally OFF)
Battery Alarm (Yellow front panel LED, active if battery backup charge is low; normally OFF)

Alarms, Rear Panel DB-37 (See Table)

Critical Alarms: these include all Node Function Alarms and the Main and Backup Power Supply Alarms.
Summary Contact Closure Alarm: active if any alarm is active in chassis or plug-ins.

RepeaterNet

Any critical alarm prompts the system to dial up Remote Power Supply NOC. This is configured at installation with a laptop computer via the front panel Craft interface. Dial up connection is made with RJ-11 interface on rear panel. The system may also be polled through dial up connection to get status of all alarms and warnings.

Craft Interface (Front Panel)

Used to set up RepeaterNet interface. Includes setting telephone number of master Hub Shelf as well as the NOC or service pager. Also

configures Hub Shelf as master or slave. Master provides dial up connection for itself and daisy-chained slave units. Connection to slave units via RJ-45 jacks on rear.

DB-37 Pin	Signal name	Type	Sense
1	1-A Node Function Alarm	TTL	Active Low
2	2-A Node Function Alarm	TTL	Active Low
3	3-A Node Function Alarm	TTL	Active Low
4	4-A Node Function Alarm	TTL	Active Low
5	5-A Node Function Alarm	TTL	Active Low
6	6-A Node Function Alarm	TTL	Active Low
7	7-A Node Function Alarm	TTL	Active Low
8	8-A Node Function Alarm	TTL	Active Low
9	Master P.S. Alarm	TTL	Active Low
10	Battery Alarm	TTL	Active Low
11	n.c.		
12	n.c.		
13	n.c.		
14	n.c.		
15	RTN		
16	RTN		
17	RTN		
18	n.c.		
19	n.c.		
20	1-B Node Function Alarm	TTL	Active Low
21	2-B Node Function Alarm	TTL	Active Low
22	3-B Node Function Alarm	TTL	Active Low
23	4-B Node Function Alarm	TTL	Active Low
24	5-B Node Function Alarm	TTL	Active Low
25	6-B Node Function Alarm	TTL	Active Low
26	7-B Node Function Alarm	TTL	Active Low
27	8-B Node Function Alarm	TTL	Active Low
28	Back-up Power Supply Alarm	TTL	Active Low
29	n.c.		
30	n.c.		
21	n.c.		
32	n.c.		
33	n.c.		
34	Summary Alarm N.C.	Relay contact	Connect to Common if O.K.
35	Summary Alarm Common	Relay contact	
36	Summary Alarm N.O.	Relay contact	Open if O.K.
37	n.c.		

Environmental

Operating (ETSI EN 300 019-1-3)

Temperature Range	+5 to +45°C
Rate of Temperature Change	0.5 °C/minute
Relative Humidity	5 to 85% RH, non-condensing

Storage and Transportation
(ETSI 300 019-1-1 STORAGE, class 1.2)
(ETSI 300 019-1-2 TRANSPORTATION, class 2.3)

Temperature Range	-40 to +70°C
Rate of Temperature Change	0.5°C/minute
Relative Humidity	10 to 100%

Vibration (Storage)

PARAMETER	FREQUENCY RANGE	SEVERITY		DURATION
	(Hz)	Vel; mm/s	Accel; m/s^2	
Sinusoidal	5 – 62	5.0		3x5 sweep cycles
Sinusoidal	62 - 200		2	3x5 sweep cycles

Vibration Test (Transportation)

PARAMETER	FREQUENCY RANGE	SEVERITY		DURATION
	(Hz)	ASD: m^2/s^3	Rolloff: dB/oct	
Random	5 – 20	0.96		3 x 10 mins
Random	20 - 500		-3	3 x 10 mins

Shock Test (Transportation)

PARAMETER	SHOCK SPECTRUM	SEVERITY		DURATION
	(Hz)	Accel: m/s^2	Number	ms
Shock (m≤100kg)	Half Sine	400	500 in each of 6 directions or 1000 in normal attitude	6

Drop Test (Transportation)

PARAMETER	MASS	DROP HEIGHT	NUMBER OF DROPS
	(kg)	(m)	
Free Fall	< 30	0.5	1 on each face or 2 in normal attitude
Free Fall	30 - 40	0.4	1 on each face or 2 in normal attitude
Free fall	40 - 50	0.3	1 on each face or 2 in normal attitude

Regulatory	UL, CSA, FCC Type Acceptance for 800 MHz and PCS versions. CE Mark for GSM900 and GSM1800 versions