# SYSTEM 8000 OPERATING MANUAL

## Fiberoptic Interfacility Links for Satellite Earth Stations

- System 8400 Remote RF Signal Monitor Links
- System 8500 Fiberoptic Data Links
- System 8600 70/140 MHz Transmit / Receive Links
- System 8700 L-Band Transmit / Receive Links
- System 8800 C/X-Band Transmit / Receive Links
- System 8900 Ku-Band Transmit / Receive Links

MAN-8000 Rev E


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**Disclaimer**

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This manual describes the System 8000 Fiberoptic Interfacility Links for Satellite Earth Stations, Model Numbers:

System 8400 Remote RF Signal Monitor Links
System 8500 Fiberoptic Data Links
System 8600 70/140 MHz Transmit/Receive Links
System 8700 L-Band Transmit/Receive Links
System 8800 C/X-Band Transmit/Receive Links
System 8900 Ku-Band Transmit/Receive Links

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Ortel, A Division of Emcore
Alhambra, California, 91803, USA

**Warnings, Cautions and General Notes**

**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 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 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.

## CAUTION

## Before replacing a failed plug-in, remove the four screws of the Status and Control plug-in (SCP) and gently pull it out slightly so that it is no longer plugged into its socket. This turns the SCP off.

**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 Customer Service.

**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, return the product to Ortel for evaluation in accordance with Ortel's warranty policy.

When returning a product for service, include the following information: owner, model number, serial number, return authorization number (obtained in advance from Ortel's Customer Service Dept.), service required and/or a description of the problem encountered.

**Warranty and Repair Policy**

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

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

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 one (1) year from date of shipment from Ortel. During the warranty period, Ortel's obligation, at our option, is limited to repair or replacement of any product that Ortel proves to be defective. This warranty does not apply to any product, which has been subject to alteration, abuse, improper installation or application, accident, electrical or environmental over-stress, negligence in use, storage, transportation, or handling.

2. **Specific Product Warranty Instructions**

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

   This warranty is the only warranty made by Ortel and is in lieu of all other warranties, expressed or implied, except as to title, and can be amended only by a written instrument signed by an officer of Ortel. Ortel sales agents or representatives are not authorized to make commitments on warranty returns.

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

   a. Return authorization shall be received from the Ortel Customer Service 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.

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

This fiberoptic laser transmitter contains a class IIIb laser product as defined by the U.S. 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).

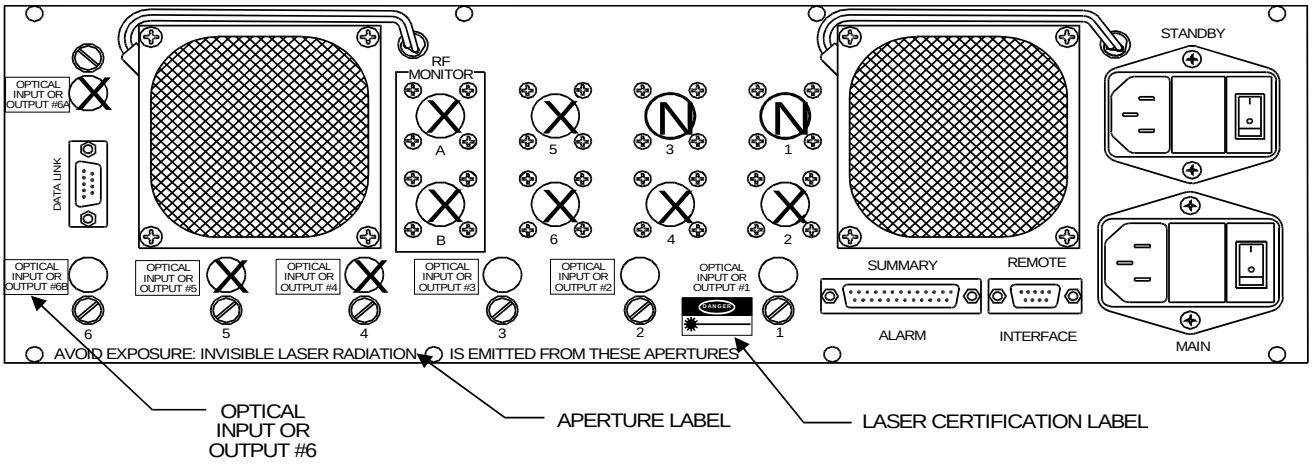
The Ortel laser products are used in optical fiber communications systems for radio frequency and microwave frequency analog fiberoptic links. In normal operation, these systems are fully enclosed and fully shielded by the hermetically sealed laser metal package. Laser bias current is limited by the internal control circuitry. The transmitters are coupled to glass fiber and have 1310 nm optical output wavelength with typically 0.5 to 12 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.

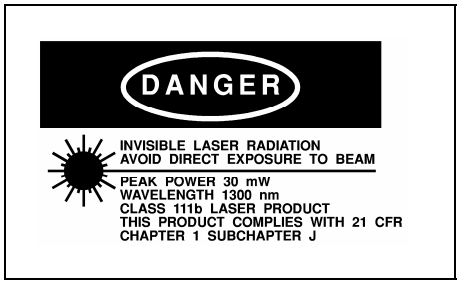
Since there is no human access to the laser output during system operation, no special operator precautions are necessary when fiber is connected to the transmitter and receiver. During installation, service, or maintenance, the service technician is warned, however, to **take precautions, which include not looking directly into the fiber connector or the fiber that 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 the laser transmitter.** Return it to Ortel for service and repair. Contact the Ortel Customer Service Department for a return authorization if service is necessary.

**Disclaimer**

Every attempt has been made to make this material complete, accurate, and up-to-date. Users are cautioned, however, that Ortel 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

# LIST OF FIGURE PAGE

# LIST OF ABBREVIATIONS AND DEFINITIONS:

**GENERAL**

| | |
|---|---|
| **Automatic Switching** | This is the mode of operation in which the Fiberoptic (FO) System automatically switches to a redundant powered standby fiberoptic link in case the primary link that carries the signal fails. The system should be reset to the default primary FO path after it is repaired. The system does not automatically switch back to the primary FO path if the standby path fails even if the primary path is functional. |
| **Auto Off** | This disables automatic redundancy switching of the FO system and gives the user direct control of the RF switch positions. The RF switches can be controlled manually from the Monitor and Control System or locally at the chassis Status and Control plug-in. If left in this mode of operation, the FO System will not automatically switch to a standby path upon link failure. |
| **Default Configuration** | Configuration that utilizes the primary fiberoptic links and automatic redundancy-switching mode of operation. |
| **External Switching** | Synonymous with Auto Off. |
| **FO** | Fiberoptic |
| **Interfacility Link** | A link between the Antenna Site and the Control Center. |
| **Lockout** | This is a feature on the chassis Status and Control plug-in that locks out remote computer control. |
| **Primary FO Link** | The fiberoptic (FO) link that is designated to carry the signal transmission when all the links are operational. |
| **Redundant FO Link** | This is synonymous with the term Standby FO Link |
| **Standby FO link** | The powered FO link that backs up the primary FO link in case of failure. |
| **C/IM3** | Ratio of 2-tone carrier to third order intermodulation distortion. |
| **CNR** | Carrier -to- Noise Ratio |
| **D/C** | Downconverter |
| **GND** | Ground |
| **HPA** | High Power Amplifier |
| **IIP3** | Input Third Order Intercept Point |
| **IP3** | Third Order Intercept Point |
| **KPA** | Klystron Power Amplifier |
| **LED** | Light emitting diode |
| **LNA** | Low Noise Amplifier |
| **LHCP** | Left-Hand Circular Polarization |

| | |
|---|---|
| **NF** | Noise Figure = 173.8 + ($RF_{in}$ - $SNR_{output}$) dB |
| **NC** | No Connection |
| **PC** | Personal Computer |
| **RHCP** | Right-Hand Circular Polarization |
| **RSU** | Redundancy Switching Unit |
| **SATCOM** | Satellite Communication |
| **SN** | Serial Number |
| **SNR** | Signal-to-Noise Ratio |
| **SFDR** | Spur-Free Dynamic Range=2/3[($RF_{in}$)+(C/IM3)/2+173.8-NF]dB-$Hz^{2/3}$ where $RF_{in}$ is the RF input power per tone. |
| **TOI** | Third Order Intercept Point |
| **U/C** | Upconverter |
| **VS** | Voltage Sum |

**FIBEROPTIC LINK TERMS**

| | |
|---|---|
| **FO** | Fiberoptic |
| **FO Tx** | Fiberoptic Transmitter |
| **FO Rx** | Fiberoptic Receiver |
| **HOPA** | High Optical Power Alarm. In the FO Rx, this alarm indicates that the received optical power is too high and may damage the photodiode. |
| **LASER TEMP** | Laser Temperature Alarm. This is the LED display for the alarm on the FO Transmitter plug-ins. |
| **LOPA** | Low Optical Power Alarm. In the FO Rx, this alarm indicates that the received optical power is too low and the performance may be degraded. When activated, the red "OPT PWR LO" message will illuminate on the FO Receiver plug-in LED display. |
| **LSRIM** | Laser Current Monitor. This monitors the DC bias current of the laser in units of mA. |
| **LSR PWR LO** | Optical Power Low Alarm. This is displayed on the front panel of the FO Data Link plug-in when the laser output is below an internally set threshold. |
| **OPTA** | Optical Power Alarm. This alarm indicates that the laser optical power is unstable. When activated, the red "OPT PWR LO" message will illuminate on the FO Transmitter plug-in display. |
| **OPT PWR LO** | Optical Power Low Alarm that is displayed on the front panel of the FO Transmitter and Receiver plug-ins. |
| **OPT PWR HI** | Optical Power High Alarm that is displayed on the front panel of the FO Receiver plug-ins. |
| **NO DATA** | Warning displayed on the front panel of the FO Data Link plug-in to indicate that no data is being |

transmitted.

**PD** Photodiode

**PDIM** Photodiode Current Monitor. For the FO Tx, this is the photodiode that measures the optical power out of the back facet of the laser (XPDI); for the FO Rx, this is the optical power received by the photodiode in the FO Rx (RPDI). The PDIM is in units of mA.

**PDIM1** Photodiode Current Monitor. For the laser module in the FO Data Link Tx, this is the photodiode that measures the optical power out of the back facet of the laser. The PDIM1 is in units of mA.

**PDIM2** Photodiode Current Monitor. This is the input optical power received by the photodiode module. The PDIM2 is in units of mA.

**PD PWR LO** Received Photodiode Current Low Alarm. This is diplayed on the front panel of the FO Data Link plug-in when the received photodiode current is too low.

**RFPA** RF Power Alarm. This alarm indicates that the RF power has dropped below the threshold that has been set by the user.

**RFPM** RF Power Monitor. This monitors the RF power after the internal input gain control for the FO Tx and after the output gain control for the FO Rx.

**RF PWR LO** RF Power Low warning which is displayed on the front panel of the FO Transmitter and Receiver plug-ins.

**RPDI** This is the same as PDIM for the FO Rx. It is the optical power received by the photodiode in the FO Rx. The RPDI is in units of mA.

**TEIM** Thermoelectric Cooler Current Monitor. This monitors the DC current drawn by the TE cooler to maintain stable temperature for the laser over the FO System operating temperature. The TEIM is in units of A with no current drawn at 25°C.

**TEMP** Temperature sensor that gives the internal temperature of the FO plug-ins.

**TMPA** Temperature Alarm that indicates that the laser temperature is unstable.

**XPDI** This is the same as PDIM for the FO Tx. It is the photodiode current that measures the optical power out of the back facet of the laser. XPDI is in units of mA.

## MONITOR AND CONTROL TERMS

**M&C** Monitor and Control system. This is a user-supplied computer system that monitors and controls the operation of the antenna and control room sites. The M&C communicates with the Ortel Fiberoptic System via the remote interface serial port.

**SCP** Status and Control Plug-in. This is the plug-in that provides status and controls the automatic redundancy switching of the chassis. It contains a microprocessor that communicates to the other plug-ins installed in the chassis via the backplane. It also communicates with the M&C via the remote interface serial port on the back of the chassis.

**CTS** Clear To Send. This is an RS-232 input to the Status and Control Plug-in. It is not used and may be left open (not connected to anything).

**DSR** Data Set Ready. This is an RS-232 input to the Status and Control Plug-in. When the M&C system is able to receive data via the RS-232 interface, it should put this line into the active state (approximately +9 volts). Conversely, when the M&C system is busy and cannot receive data, it should put this line into the inactive state (approximately -9 volts). The Status and Control Plug-in will monitor this line before each transmission and only transmit data when it is in the active state.

**DTLK** Fiberoptic Data Link Transceiver plug-in

**DTR** Data Terminal Ready. This is an RS-232 output from the Status and Control Plug-in. When this signal is in the active state (approximately +9 volts) the Status and Control Plug-in can receive serial data via the RS-232 interface. When this signal is inactive (approximately -9 volts), the Status and Control Plug-in is busy and cannot receive data. Note that if the 'ENQ' character used to determine the FO System readiness is executed and if the 'ACK' character is received, then the DTR signal will never enter the 'busy' state.

**EAROM** This is an acronym for Electrically Alterable Read Only Memory. In this document it indicates the non-volatile memory devices used to store configuration and calibration information.

**IICC** Inter-Integrated Circuit Clock. This is a bi-directional serial data bus.

**IICD** Inter-Integrated Circuit Data. This is a bi-directional serial digital bus.

**ID1** Identifier Number 1. This identifies the plug-ins (Model Number, Description, etc).

**ID2** Identifier Number 2. This identifies the plug-ins (Model Number, Description, etc).

**ID3** Identifier Number 3. This identifies the plug-ins (Model Number, Description, etc).

**kps1** The calibration coefficient for the +15 volt power supply. This coefficient is stored in the non-volatile memory on the chassis.

**kps2** The calibration coefficient for the -15 volt power supply. This coefficient is stored in the non-volatile memory on the chassis.

**kps3** The calibration coefficient for the +5 volt power supply. This coefficient is stored in the non-volatile memory on the chassis.

**$kpdi_u$** The calibration coefficient for the photodiode current monitor for a plug-in. The 'u' subscript specifies the plug-in. The coefficient is stored in the non-volatile memory in the designated plug-in.

**$klsi_u$** The calibration coefficient for the laser bias current monitor for a plug-in. The 'u' subscript specifies the plug-in. The coefficient is stored in the non-volatile memory in the designated plug-in.

**$ktei_u$** The calibration coefficient for the thermoelectric cooler current monitor for a plug-in. The 'u' subscript specifies the plug-in. The coefficient is stored in the non-volatile memory in the designated plug-in.

**$krfp_u$** The calibration coefficient for the RF power monitor for a plug-in. The 'u' subscript specifies the plug-in. The coefficient is stored in the non-volatile memory in the designated plug-in.

**$ktmp_u$** The calibration coefficient for the temperature sensor in a plug-in. The 'u' subscript specifies the plug-in. The coefficient is stored in the non-volatile memory in the designated plug-in.

**ops1** The calibration offset for the +15 volt power supply. This offset is stored in the non-volatile memory on the chassis.

**ops2** The calibration offset for the -15 volt power supply. This offset is stored in the non-volatile memory

| | |
|---|---|
| | on the chassis. |
| **ops3** | The calibration offset for the +5 volt power supply. This offset is stored in the non-volatile memory on the chassis. |
| **opdi$_u$** | The calibration offset for the photodiode current monitor for a plug-in. The 'u' subscript specifies the plug-in. The offset is stored in the non-volatile memory in the designated plug-in. |
| **olsi$_u$** | The calibration offset for the laser bias current monitor for a plug-in. The 'u' subscript specifies the plug-in. The offset is stored in the non-volatile memory in the designated plug-in. |
| **otei$_u$** | The calibration offset for the thermoelectric cooler current monitor for a plug-in. The 'u' subscript specifies the plug-in. The offset is stored in the non-volatile memory in the designated plug-in. |
| **orfp$_u$** | The calibration offset for the RF power monitor for a plug-in. The 'u' subscript specifies the plug-in. The offset is stored in the non-volatile memory in the designated plug-in. |
| **otmp$_u$** | The calibration offset for the temperature sensor in a plug-in. The 'u' subscript specifies the plug-in. The offset is stored in the non-volatile memory in the designated plug-in. |
| **RTS** | Request To Send. This is an RS-232 output from the Status and Control Plug-in. It is not used in this system and may be left open (not connected to anything). |
| **RX+** | Differential Receive Data |
| **RX-** | Differential Receive Data |
| **RXD** | Receive Data. This is an RS-232 input to the Status and Control Plug-in. The serial data transmitted by the M&C system is sent on this signal line. The data rate is fixed at 9600 baud. |
| **RXDM** | Single End Receive Data |
| **TXD** | Transmit Data. This is an RS-232 output from the Status and Control Plug-in. The serial data transmitted by the Status and Control Plug-in is sent on this signal line. The data rate is fixed at 9600 baud with no parity, one start bit, 8 data bits, and 1 stop bit (10 bitsper word). |
| **TX+** | Differential Output Data |
| **TX-** | Differential Output Data |
| **TXDM** | Single End Send Data |
| **TXRX+** | RS-485 Differential Data Bus |
| **TXRX-** | RS-485 Differential Data Bus |

# CHAPTER 1 - INTRODUCTION

This manual gives information about the installation, performance and maintenance of the Ortel System 8000 Fiberoptic Interfacility Links for satellite earth stations. The entire manual should be read and understood before beginning installation and operation.

## SYSTEM APPLICATION

The Ortel Fiberoptic (FO) system provides two-way signal transmission via optical fiber cable between an Antenna Site and the Control Center in a satellite earth station. Figure 1-1(a) schematically illustrates the application of the Ortel FO systems in the earth station. The Ortel FO system connects the combined upconverter outputs to the high power amplifiers (HPA) in the SATCOM uplink, and it connects the low-noise amplifiers (LNA) to the downconverters in the SATCOM downlink, transmitting at L-Band, C-Band, X-Band and Ku-Band frequencies with more than 500 MHz bandwidth. The remote RF Signal Monitor link takes the full 500 MHz bandwidth signal to be transmitted by the antenna and returns it back to the Control Center for verification that the uplink signal meets specifications and levels. This monitor signal is taken at the antenna from the coupled test ports for each polarization of the uplink signal. The Fiberoptic Data Link is a full duplex link providing a fiberoptic path to interconnect the Monitor and Control terminals.

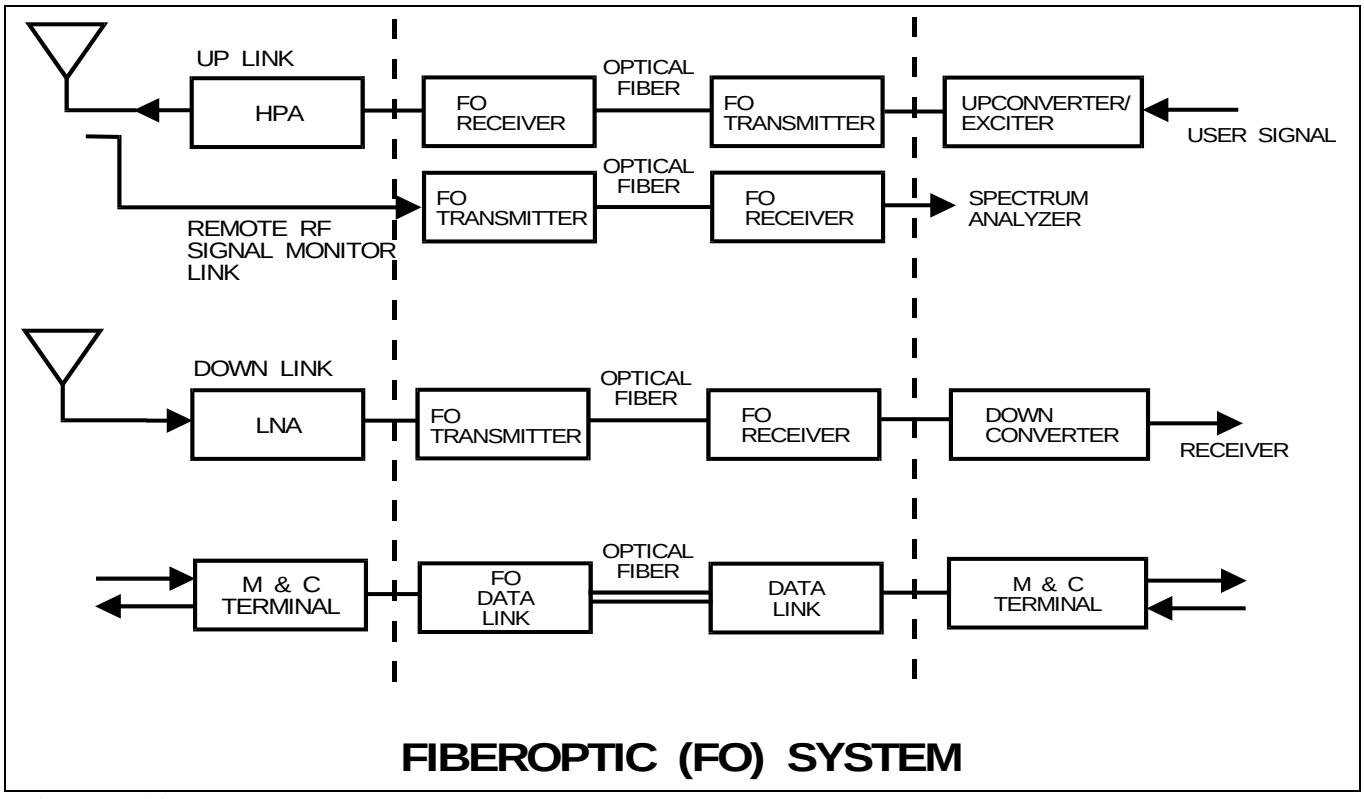



**Figure 1-1(a)**
The Ortel System 8700 (L-Band), System 8800 (C / X-Band) and System 8900 (Ku-Band) transmit uplink and downlink signals between the Antenna Site and the Control Center. The RF Signal monitor link (System 8400) remotely measures the quality of the uplink signal. The Fiberoptic Data Link (System 8500) interconnects M&C terminals.

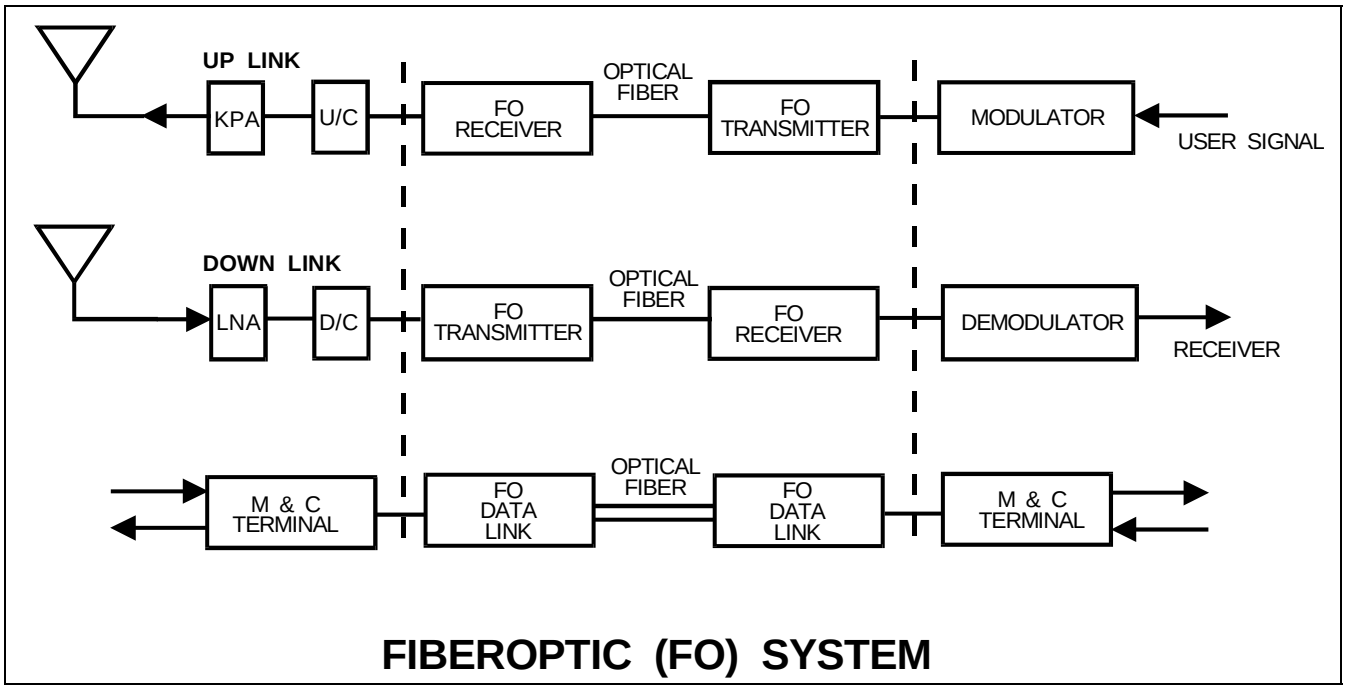



**Figure 1-1(b)**
The Ortel Fiberoptic System 8600 transmits 70/140 MHz uplink signals between the Antenna Site and the Control Center

## FIBEROPTIC THEORY OF OPERATION

The basic elements of a fiberoptic link consists of a laser module, an optical fiber and a photodiode. Light that is emitted by the laser is received and detected by the photodiode. Figure 1-2 is a block diagram of the FO link and its modulation characteristics. The input RF signal modulates the laser's output light. The laser diode emits coherent light at 1310 nm wavelength when biased above a threshold current. To take advantage of the inherent linearity of the laser diode, the DC operating current of the laser is set at the middle of the light versus current curve as shown in Figure 1-2.

The Ortel transmitter uses a feedback network in the laser bias circuit to maintain constant average optical power. A monitor photodiode within the laser module assembly senses the optical power emitted by the laser, providing information for the feedback network. Because the laser diode performance is temperature dependent, a thermoelectric (TE) cooler is used to regulate the laser's operating temperature at approximately $22^{o}$ C over the temperature range of the FO system operation.

At the other end of the link, the photodiode receives the modulated optical signal from the optical fiber. The photodiode demodulates the signal and reproduces the original RF signal. Overall link bandwidth is determined by the response of the laser, amplifiers and the photodiode. Dynamic Range in a fiberoptic link is limited by laser and amplifier noise and by distortion, which limits the maximum RF power.

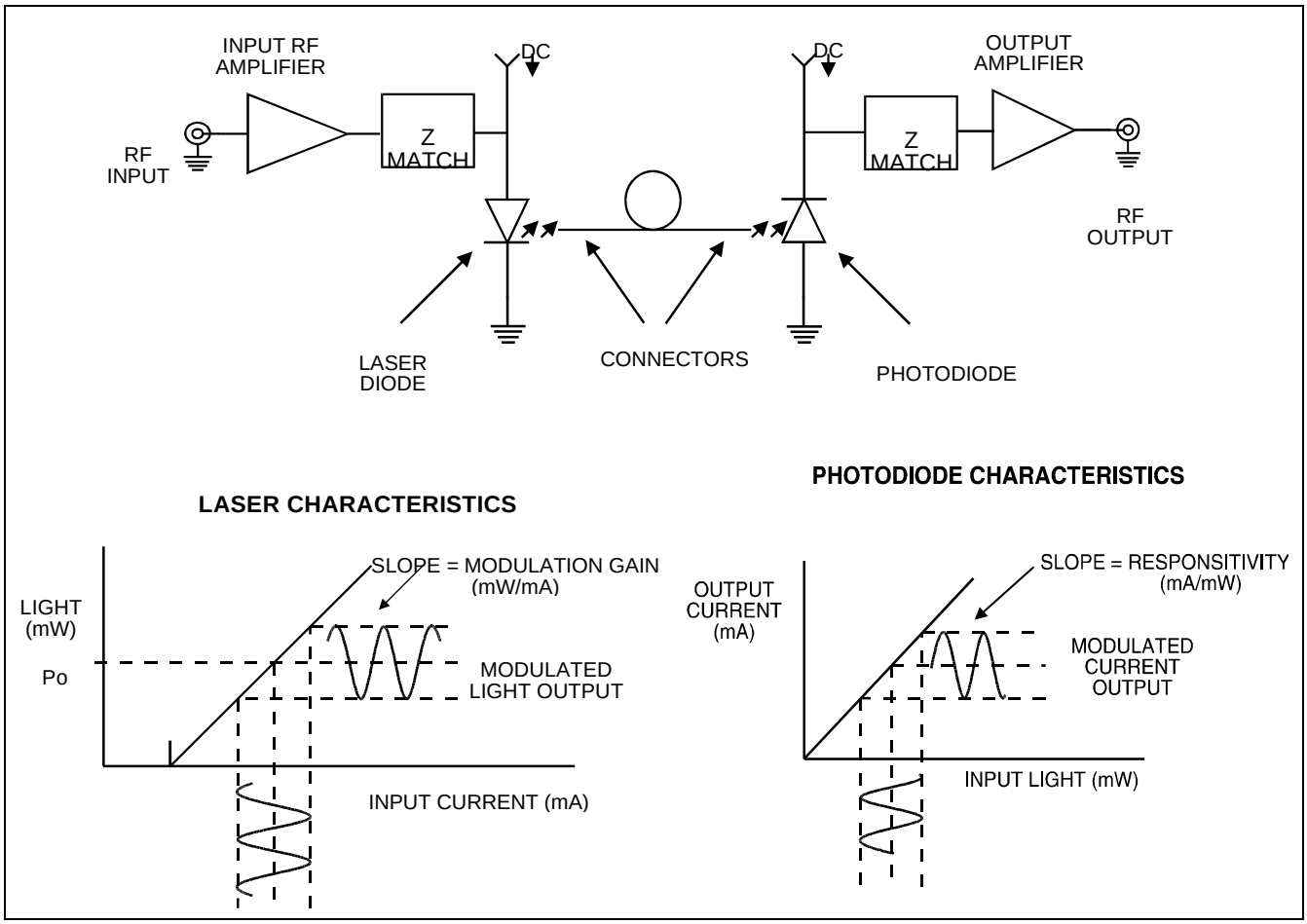



**Figure 1-2**
Block diagram of the analog fiberoptic links and its characteristics.

## SYSTEM DESCRIPTION

The Ortel FO system consists of at least two 5.25 inch high, 19 inch wide rack-mountable chassis. Each chassis can hold Main and Standby power supplies, a Status and Control plug-in (to communicate with the user's Monitor and Control System via the remote serial interface) and six FO Transmit and Receive plug-ins. The remote interface is specified as RS-232 or RS-485 in the customer purchase order. The FO plug-ins function to transmit/receive SATCOM interfacility uplink and downlink signals over single-mode optical fiber at 1310 nm wavelength and to remotely monitor the RF uplink signal. The FO system has two methods of control: 1) remote control with the user's Monitor and Control (M&C) System through the remote interface serial data port located on the rear panel of the chassis or 2) local control at the chassis Status and Control plug-in front panel. The FO System can operate in two redundancy switching modes: 1) Automatic or 2) Auto Off. In the automatic switching mode, a powered standby FO link is switched into use upon failure of the primary FO link. For the 1:2 redundant configuration (1 standby FO link to backup two primary FO links), the user's M&C System is needed to provide automatic redundancy switching. Automatic switching can be disabled remotely through the M&C System or locally at the chassis Status and Control plug-in front panel. In the "Auto Off" switching mode of operation, the automatic switching mode is disabled, and the user can directly control the positions of the RF switches either locally or remotely through the M&C System to dictate which FO links are

"in use" and which are "idle". A summary alarm which activates a contact switch closure upon failure of any component in that chassis is provided through a 25-pin D-connector at the rear panel of the chassis. Any plug-in can be removed and replaced with a spare plug-in while the chassis is powered. The chassis fans can also be replaced while the chassis is powered.

The Ortel System 8000 can include the following parts at the line replaceable unit (LRU).
The FO Transmitter plug-in consists of a laser module; preamplifiers to achieve the optimum RF level to the laser module, analog control and monitor circuitry (bias, stabilization and monitoring), and a digital interface to the Status and Control plug-in through the chassis backplane. The Ortel FO system can include several different FO Transmitter plug-ins, which perform distinctly different functions for an uplink, downlink, RF Signal Monitor link and Fiberoptic Data Link. These FO Transmitter plug-ins are different from each other and are therefore not interchangeable. For the 70/140 MHz and L-Band systems, the uplink FO Transmitter/Receiver plug-ins are identical to those of the downlink. For the C, X and Ku-Band systems, there are three FO Transmitter plug-ins: FO Uplink Transmitter, FO Downlink Transmitter and FO RF Signal Monitor Transmitter plug-ins. The Fiberoptic Data Link includes a laser module and a photodiode module in a single plug-in for full duplex transmission of M & C data via optical fiber. The Fiberoptic Data Link requires two singlemode optical fibers. The model numbers for these plug-ins are listed in Figure 1-3.

The FO Receiver plug-in consists of a photodiode module, post-amplifiers to achieve the proper RF output levels, analog control and monitor circuitry, and a digital interface to the Status and Control plug-in through the chassis backplane. Corresponding to the FO Transmitter plug-ins listed above, in each frequency band, the Ortel FO system can include three FO Receiver plug-ins: FO Uplink Receiver plug-in, FO Downlink Receiver plug-in, and FO RF Signal Monitor Receiver plug-in. These FO Receiver plug-ins are not interchangeable. The L, C, X and Ku-Band FO Receiver plug-ins contain a variable gain post-amplifier. The 70/140 MHz FO Receiver plug-in contains a fixed gain post-amplifier.

| PARTS LIST | MODEL/PART NUMBER | |
|---|---|---|
| Chassis | 8001A | |
| Power Supply (PS) | Main | Standby |
| | 8009A | 8009B |
| Status and Control Plug-In (SCP) | RS-232 | RS-485 |
| | 8010B-232 | 8010B-485 |
| Data Link | RS-232 | RS-422 |
| | 8501A-RS232 | 8501A-RS422 |
| Chassis Mainframe (includes PS & SCP) | 8000A | |
| Accessory Kit (-xx is optical attenuator value) | 8050A-xxx | |
| Operating Manual | 8070A | |
| Installation Computer Disk (OC8000) | 1160-001 | |
| Chassis Fan | 115 VAC | 230 VAC |
| | 5328-002 | 5328-001 |

| PLUG-IN | TRANSMITTER | | | | RECEIVER | | |
|---|---|---|---|---|---|---|---|
| 70/140 MHz | Standard | Hi Perf <40Km | Hi Perf 40-65Km | 50 Ω | Standard | Hi Gain | Lo Gain |
| | 8603A | -001 | -002 | -050 | 8604A | -001 | -002 |
| L-Band | Up/Down Link | | | | Up/Down Link | | |
| | 8710A | | | | 8720A | | |
| C-Band | Up | Down | RF Mon | | Up | Down | RF Mon |
| | 8810A | 8810B | 8483A | | 8820A | 8820B | 8820A |
| X-Band | Up/Down Link | | | | Up/Down Link | | |
| | 8850A | | | | 8860A | | |
| Ku-Band | Up | Down | RF Mon | | Up | Down | RF Mon |
| | 8910A | 8910B | 8493A | | 8920A | 8920B | 8920A |

**Figure 1-3**
System 8000 model and part numbers

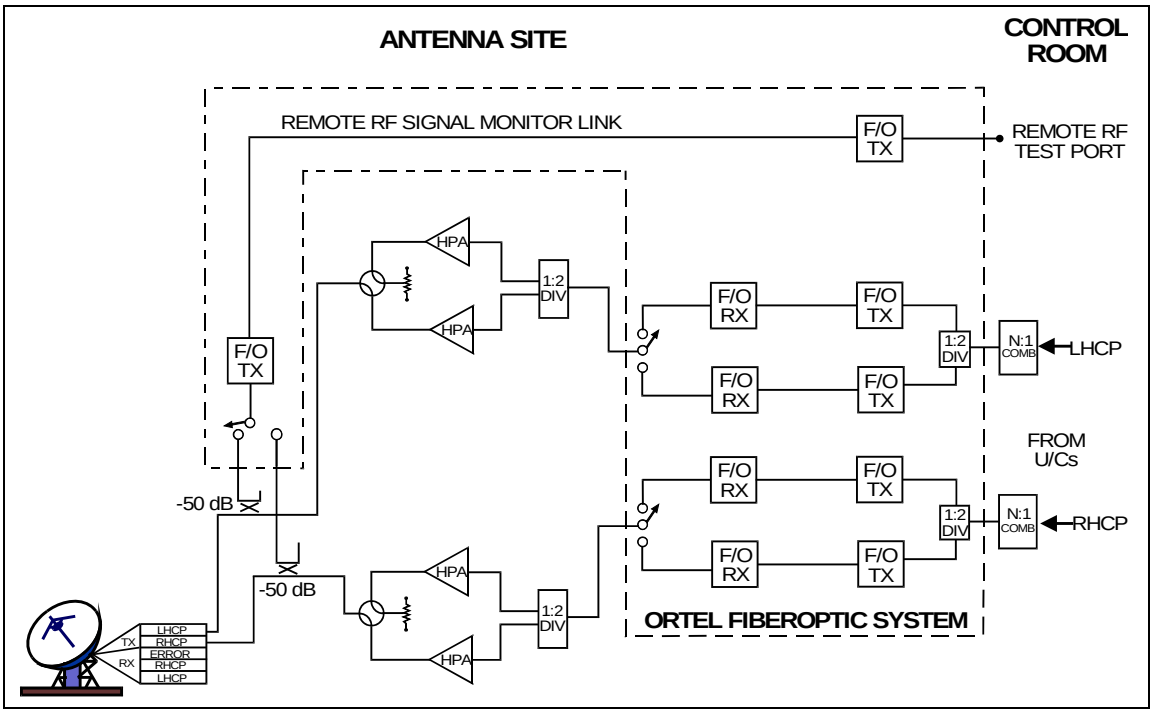
For the 70/140 MHz FO system (System 8600), three fixed gain post-amplifiers are available. There are standard gain (8604A), high gain (8604A-001) and low gain (8604A-002) FO Receivers. The different gains are available so that the total link insertion loss can be designed near transparency (0 dB gain) for a wide range of lengths from 0 to 65 km. For distances over 10 km, the FO Transmitter plug-in needs to have higher power and higher performance (8603A-001 and 8603A-002). The recommended combinations of FO Transmitter and Receivers for the distance/optical loss budgets are given in Figure 1-4. The optical loss budgets are determined using a typical optical fiber loss specification at 1310 nm of 0.4 dB/km plus 1 dB for losses from optical connectors.

| Optical Loss Budget | Typical Distance | FO Transmitter/FO Receiver |
|---|---|---|
| 1 to 5 dB | 0 to 10 km | 8603A and 8604A |
| 5 to 13 dB | 10 to 30 km | 8603A-001 and 8604A-002 |
| 11 to 19 dB | 25 to 45 km | 8603A-001 and 8604A |
| 17 to 27 dB | 40 to 65 km | 8603A-002 and 8604A-001 |

**Figure 1-4**
System 8600: 70/140 MHz recommended transmitter/receiver combinations for link applications from 0 to 65 km.

Each FO system is factory configured for the user's requirement (redundancy, uni-directional or bi-directional). Hence, the plug-in positions in the chassis are fixed and not interchangeable. As instructed later in Chapter 3 (Installation), the chassis configuration should be compared with the configuration sheet provided and with the user's purchase order. A fiberoptic link refers to one FO Transmitter connected to one FO Receiver through a single length of optical fiber. Each FO Transmitter must be connected to the correct mating FO Receiver in the companion chassis for the system to function correctly. The "primary" FO link is the link designated to carry the signal when all the links are functioning properly; the "standby" FO link is a powered standby link to back up a primary FO link in case of failure.

An interfacility link is defined as a link between the Antenna Site and the Control Center. Figure 1-5 shows how an interfacility link can have two fiber optic links (one primary and one standby) to achieve 1:1 redundancy or three FO links to provide 1:2 redundancy.



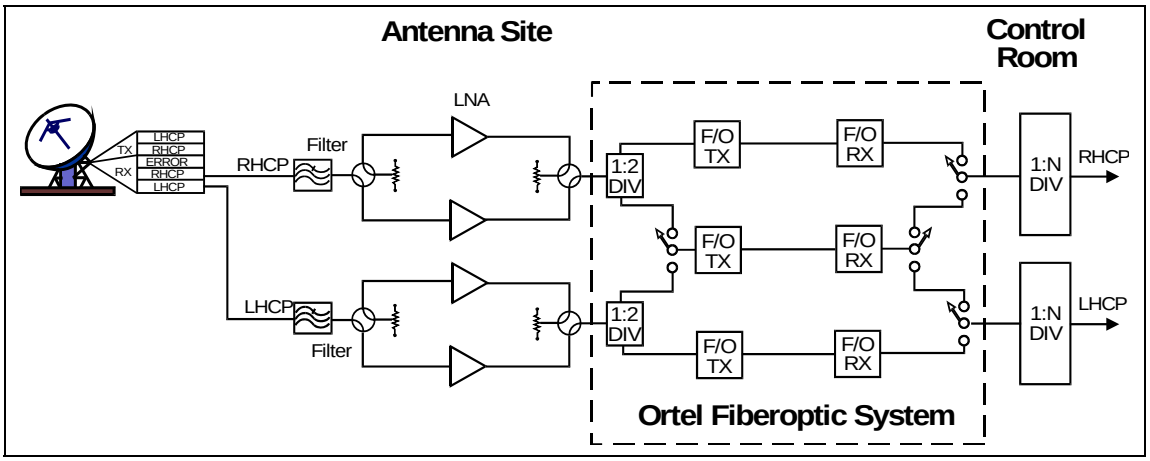




**Figure 1-5**
Earth Station Transmit System with 1:1 redundant fiberoptic links and Receive System with 1:2 redundant fiberoptic links for two interfacility links (LHCP and RHCP).

The 70/140 MHz system (System 8600) is available in the 1:1 redundancy configuration, but not the 1:2 configuration. The use of the 70/140 MHz FO System is shown in Figure 1-6.

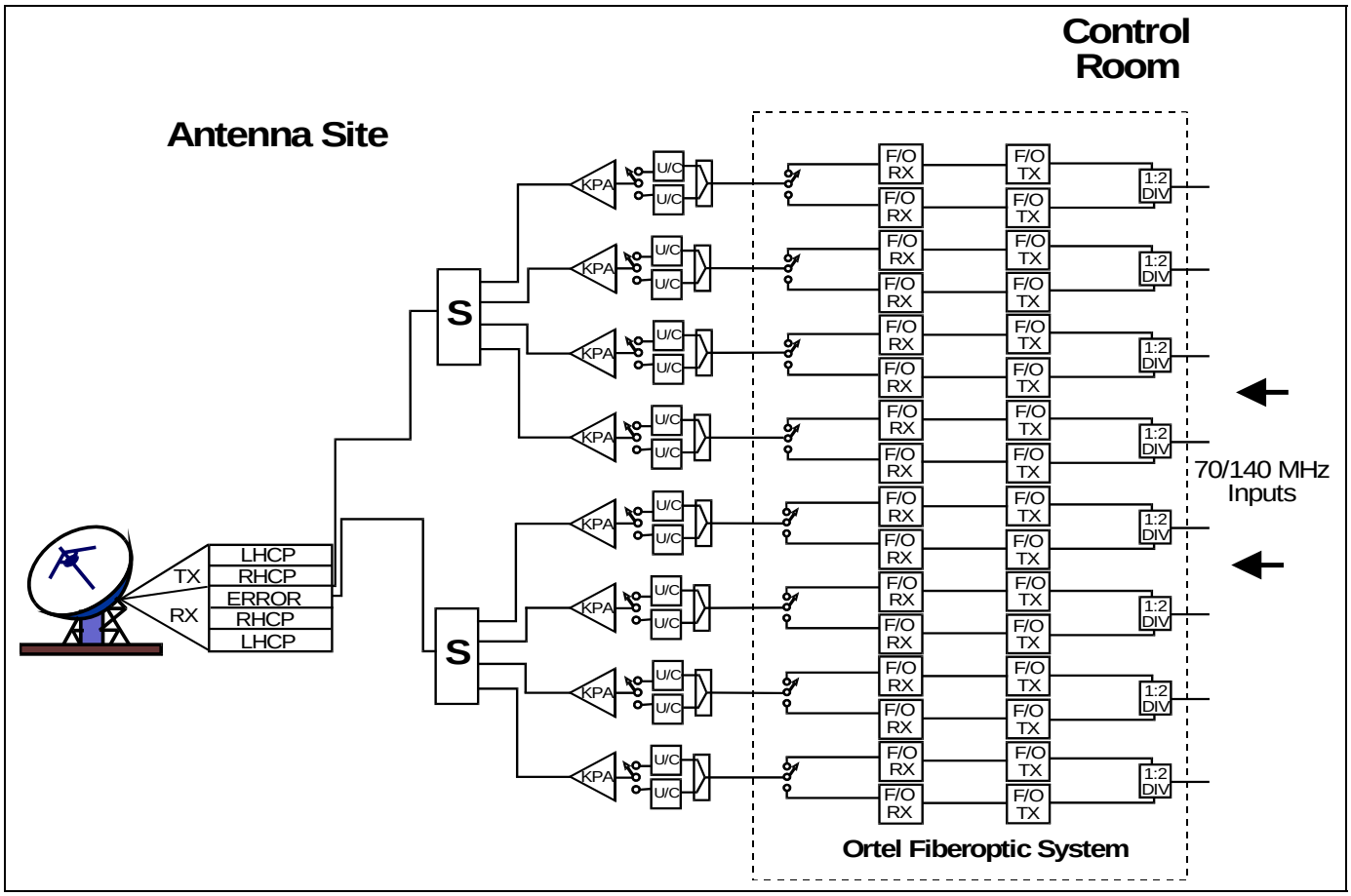



**Figure 1-6**
Earth Station Transmit System with Klystrons and 1:1 Redundant 70/140 MHz Fiberoptic Links.

The Control Center chassis are defined as the chassis that are located in the Control Center. They contain the Uplink FO Transmitter, the Downlink FO Receiver and the FO RF Signal Monitor Receiver plug-ins. The Antenna Site chassis are defined as the chassis that are located at the Antenna Site. They contain the Downlink FO Transmitter, the Uplink FO Receiver and the FO RF Signal Monitor

Transmitter plug-ins. Figure 1-7 shows the plug-ins that can be found at the Control Center and those that can be found at the Antenna Site.
The RF input to the FO system is at the rear panel of the chassis, through RF connectors which connect to the internal redundancy switching unit and from there to the inputs of the fiberoptic transmitter plug-ins. The output from the FO Transmitter is an optical signal from an FC/APC optical bulkhead connector located at the chassis rear panel. The optical output connects to the user-supplied 1310 nm wavelength single-mode optical fiber cable. Any optical connector in the fiberoptic link path must have an optical return loss >55 dB in order to minimize adverse optical reflections back into the laser. Angle-polished optical connectors (such as the FC/APC) satisfy this requirement. At the remote end of the link, the user's optical fiber cable interfaces with the fiberoptic receiver through an FC/APC bulkhead optical connector located at the rear panel of the chassis. The microwave output from the FO Receiver goes through the redundancy switching unit to the RF connector at the rear panel of the chassis. This RF output connects to the user's equipment. Figure 1-8 is an example of a configuration sheet showing the chassis layout.

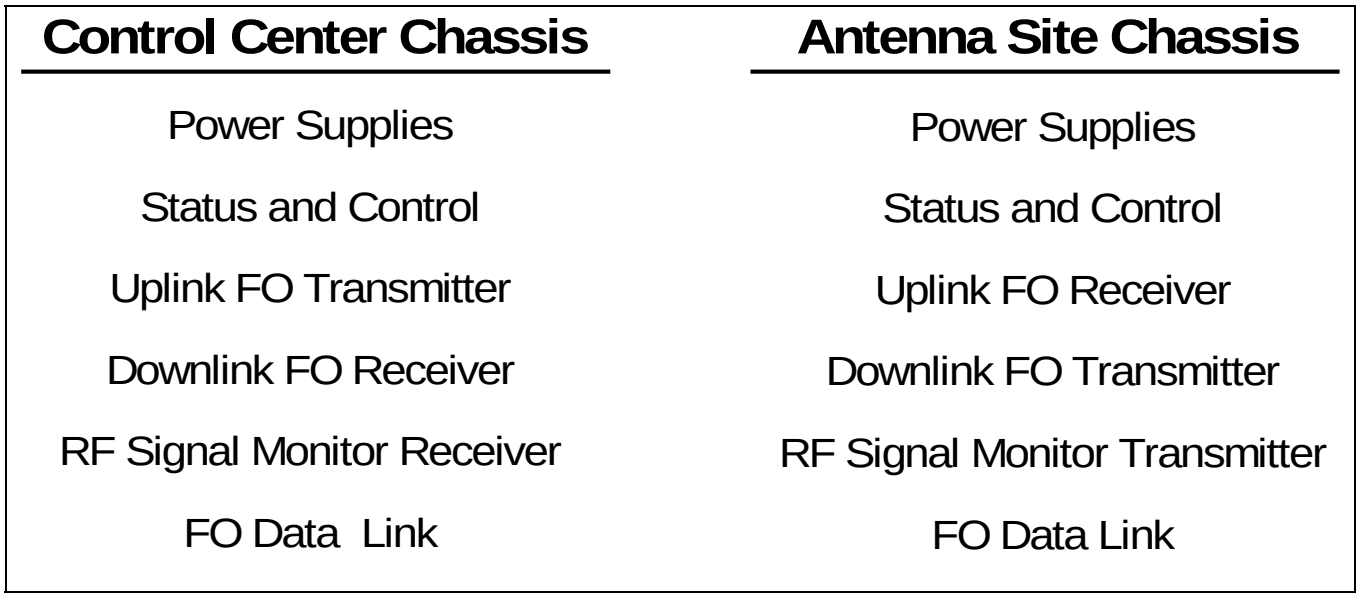



**Figure 1-7**
Plug-ins that are found in the Control Center chassis and the Antenna Site chassis.

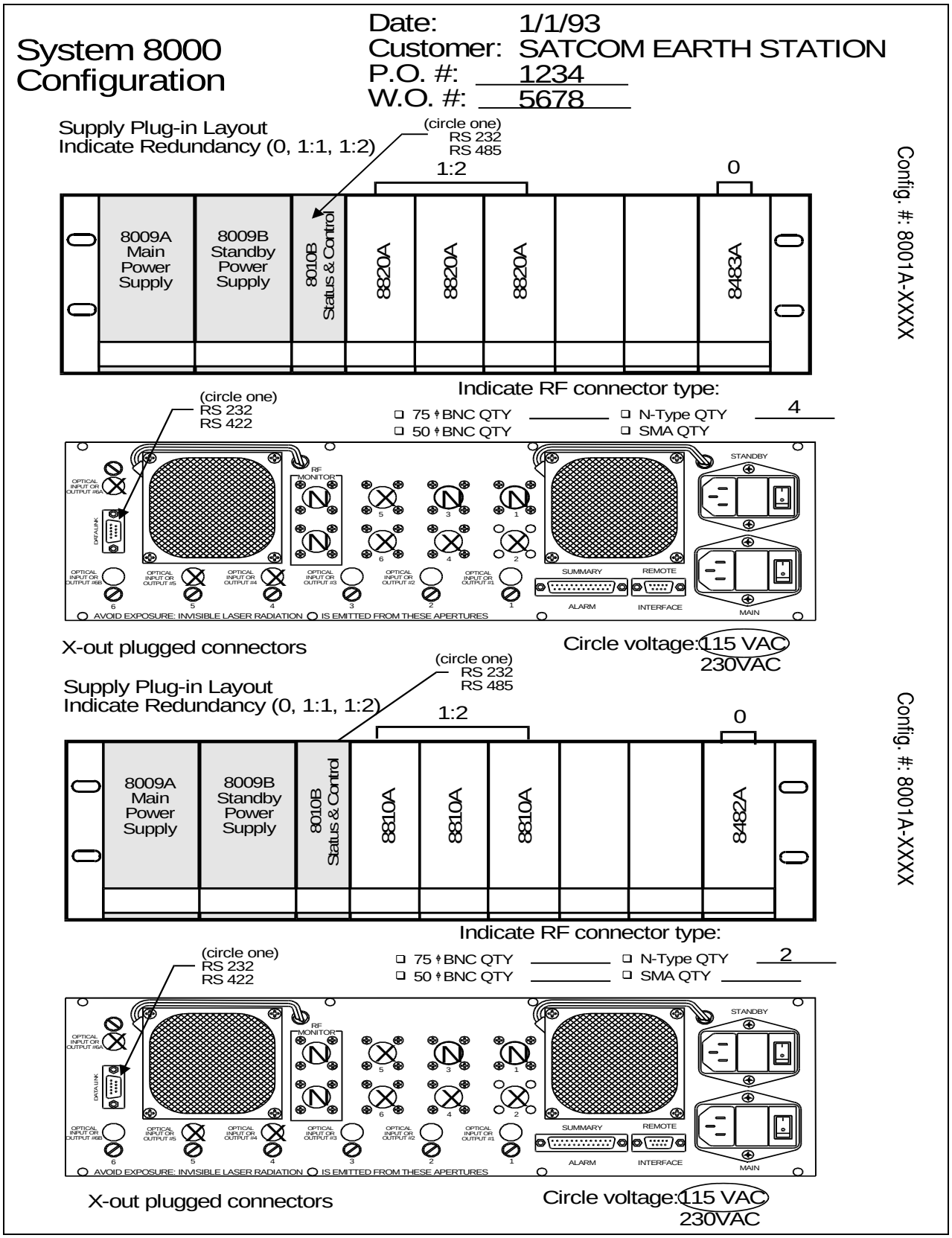



**Figure 1-8**
Sample configuration sheet for chassis

## CONTENTS OF SHIPMENT

The following are delivered items per the customer purchase order:

1) Chassis
2) Power Supplies
3) Status and Control Plug-ins
4) FO Plug-ins
5) Accessory Kit.

The following items are included in the delivery even though they are not specified as line items in the customer purchase order:

1) One FC/APC fiber optic jumper cable for each FO Transmitter plug-in
2) System 8000 Installation Computer Disk
3) Test data package
4) Operating Manual (one per chassis).

## REQUIRED EQUIPMENT FOR INSTALLATION AND OPERATION

For installation of the Ortel FO System, the user needs the following equipment:

1) Power cords to connect the FO System to a source of AC power. The AC power inlet connector at the FO System chassis rear panel is an international IEC320 connector.
2) RF power meter with sensors able to detect RF levels from -12 dBm to -60 dBm
3) RF signal source
4) IBM PC or equivalent computer (minimum is IBM 286 with 4MEG RAM) with two serial interfaces and a 3.5 inch floppy disk drive.
5) Serial cables to interface the System 8000 chassis (remote interface) to the computer used for installation. The System 8000 remote interface is either RS-232 or RS-485 as specified in the purchase order. The user may need an RS-485/RS-232 converter for proper interface to a PC.

The FO System includes a 3.5 inch disk formatted for the IBM PC standard or equivalent computer to be used for installation. The installation program is an executable file that runs in the Microsoft Disk Operating System (MS-DOS) Version 3.1 or higher.

Not essential, but useful for diagnostics are:

1) RF spectrum analyzer
2) Optical power meter.

The user needs to supply the following for operation:

1) M&C System for remote operation
2) Angle-polished FC/APC connectorized optical fiber cable. If fiber distribution boxes are used, then they should contain either angle-polished connectors specified for return loss >55 dB or fusion splices. Flat polished connectors anywhere along the optical fiber path will degrade the system performance. One optical fiber cable is required for each Transmitter and Receiver plug-in pair. Two optical fibers are needed for each FO Data Link (System 8500).
3) Optical attenuators to ensure that the FO Receivers are not damage by excessive (>2 mA) received optical power.

The user's M&C System polls the FO System to obtain status information. The user's M & C System is also needed for achieving automatic redundancy switching for the 1:2 redundant configuration. The Ortel Fiberoptic System remote serial interface can be specified as RS-232 or RS-485. RS-232 cables with 9-pin D-connectors that connect the Ortel Fiberoptic System (specified with RS-232 interface) to an IBM PC or equivalent computer are supplied in the Ortel System 8000 Accessory kit (Model 8050A-xx needs to be ordered). If the user's M&C System is not RS-232 or the pin assignments are not compatible with the Ortel System, then the user needs to supply a serial cable and/or a converter box that will interface his M&C System to the Ortel FO System. The pin assignments are provided in Chapter 2. The user supplies equipment to utilize the chassis summary alarm output that is a contact closure upon failure of any component in the chassis. The power requirement for each FO chassis is 150 W. The AC power inlet connector at the FO System rear panel is an international IEC320 connector.

## ORGANIZATION OF THE MANUAL

The manual is divided into several chapters. Safety precautions given in the preface to this manual should be understood. "Caution" calls attention to a procedure or practice, which, if ignored, may result in personal damage or in 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. This first chapter gives a system overview and definition of the Ortel FO Interfacility Link System for Satellite Earth Stations. The second chapter describes the system, including the various redundancy switching configurations, the response of the FO system to various component failures, the layout of the various plug-ins in the chassis, and the chassis rear panel (optical and electrical connectors). Detail description and specifications for each plug-in, including the FO Transmitter/Receiver plug-ins, the power supply plug-ins and the Status and Control plug-in are provided in Chapter 2. Chapter 2 also specifies the software interface between the Ortel FO System and the user's M & C system. It gives the serial link commands that the Ortel FO System (Status and Control plug-in) needs to receive through the remote interface from the user's M&C System in order to control and monitor the FO System. Instructions for installing the FO System are given in Chapter 3. The "Installation" computer disk included with the FO System is used for installation. Once installed, the FO System is fully operational. Finally, maintenance, testing and troubleshooting procedures are given in Chapter 4. Also described are measurements to verify the FO link specifications. Flow charts to aid in troubleshooting the FO System are also found in Chapter 4.

# CHAPTER 2 - SYSTEM DESCRIPTION AND SPECIFICATIONS

## SYSTEM CONFIGURATIONS

The system redundancy configurations for two interfacility signal transmission links (for example LHCP and RHCP) are shown in Figure 2-1. The 1:1 redundant system includes power dividers and switches to provide a 1:1 redundant fiberoptic (FO) link for the RHCP path and another 1:1 redundant fiberoptic link for the LHCP path. The 1:2 redundant configuration includes power divider and switches to provide a single redundant powered standby fiberoptic link for two paths (RHCP and LHCP). The 1:2 redundancy configuration is available for L, C, X and Ku-Band systems, but not for the 70/140 MHz system. Finally, in the non-redundant configuration, the fiberoptic links are independent. Redundant switching can be performed outside of the Ortel FO system (for example, before the upconverters and after the HPAs) in the non-redundant configuration. In addition to the FO uplinks and downlinks, the system configuration may include a FO RF Signal Monitor link to bring a sample of the uplink signal to be transmitted by the antenna back to the Control Center for verification that the uplink

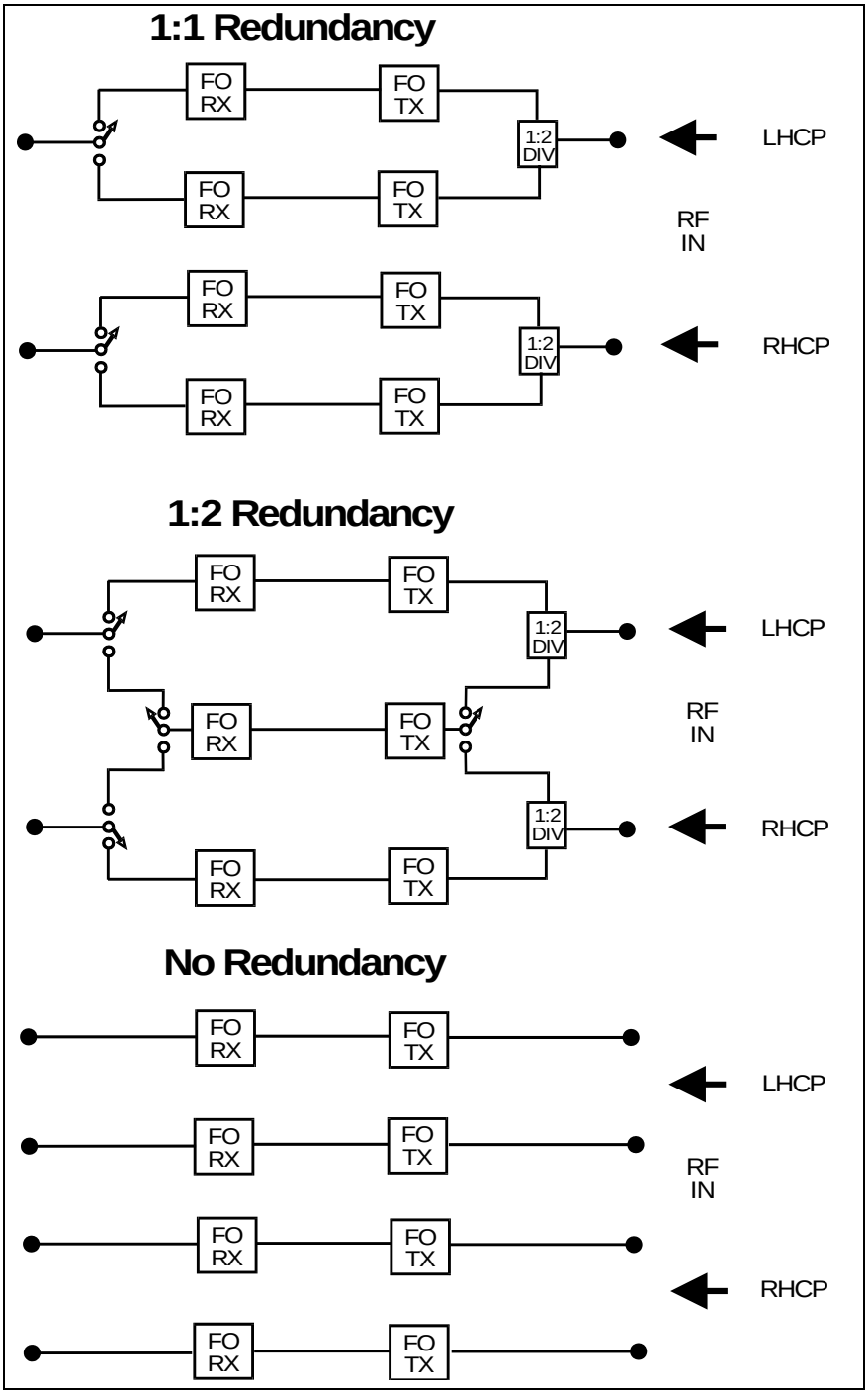



**Figure 2-1**
Available redundancy schemes

signal meets specifications and RF levels. For this purpose, the earth station needs a FO RF Signal Monitor Transmitter plug-in at the RF test ports of the Antenna Site and a FO RF Signal Monitor Receiver plug-in at the Control Center. This link was schematically illustrated previously in Figures 1-1 and 1-5. The Ortel System 8400 C, X and Ku-Band RF Signal Monitor links accept two RF inputs (such as RHCP and LHCP). A switch internal to the FO RF Signal Monitor Transmitter plug-in selects the signal path to monitor. The switch is controlled through the remote interface by supplying the proper commands to the FO System from the user's Monitor and Control (M&C) System. The L-Band RF Signal Monitor link accepts one RF input. The output of the FO RF Signal Monitor link is at the Control Center chassis, at the front panel connector of the FO RF Signal Monitor Receiver plug-in. There are RF Signal Monitor links for L, C, X and Ku-Bands, but not for 70/140 MHz.

As a separate link, the Fiberoptic Data Link provides a full duplex fiberoptic link using two optical fibers to transmit M&C data between the antenna and control room sites.

The Status and Control plug-in enables monitor and control of all the plug-ins in the FO chassis. It permits automatic redundancy switching or manual (Auto Off) switching modes of operation as explained later in the Status and Control plug-in section of this chapter. The FO System can be controlled remotely through the user's M&C System or locally at the chassis.

## CHASSIS (MODEL 8001A)

Figure 2-2 shows the components in the chassis. The chassis supports and interconnects the various system components, and interfaces to the user's electrical equipment. The chassis fits a standard 19 inch rack and is 3U (5.25 inches) high. The chassis contains power dividers and RF switches (in the redundancy switching configuration) and a relay for the summary alarm that closes a contact when an alarm from any component in the chassis activates. It also contains the backplane (shown in Figure 2-3) that distributes power to all the plug-ins and interfaces the plug-ins with the inputs/outputs to the chassis. Each FO chassis is factory configured with the appropriate power dividers and RF switches for the user's requirement (redundancy, uni-directional or bi-directional). Hence, the plug-in positions in the chassis are fixed and not interchangeable.

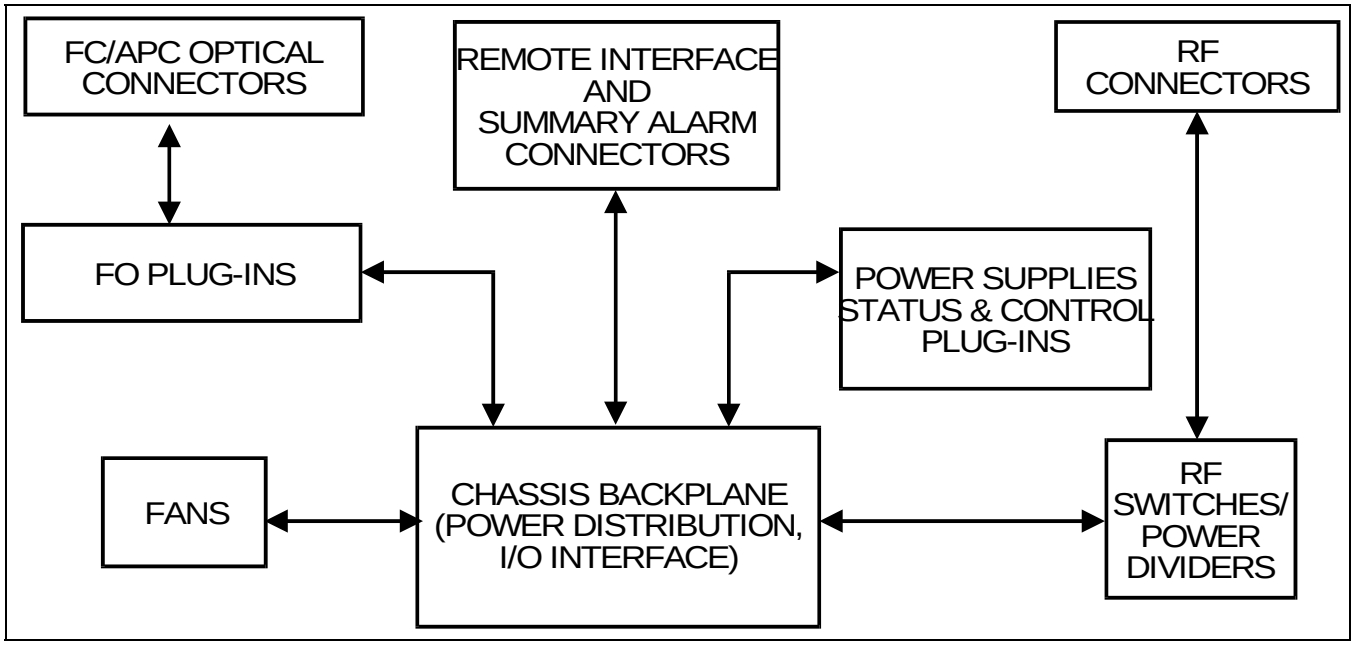



**Figure 2-2**
Block diagram of chassis hardware

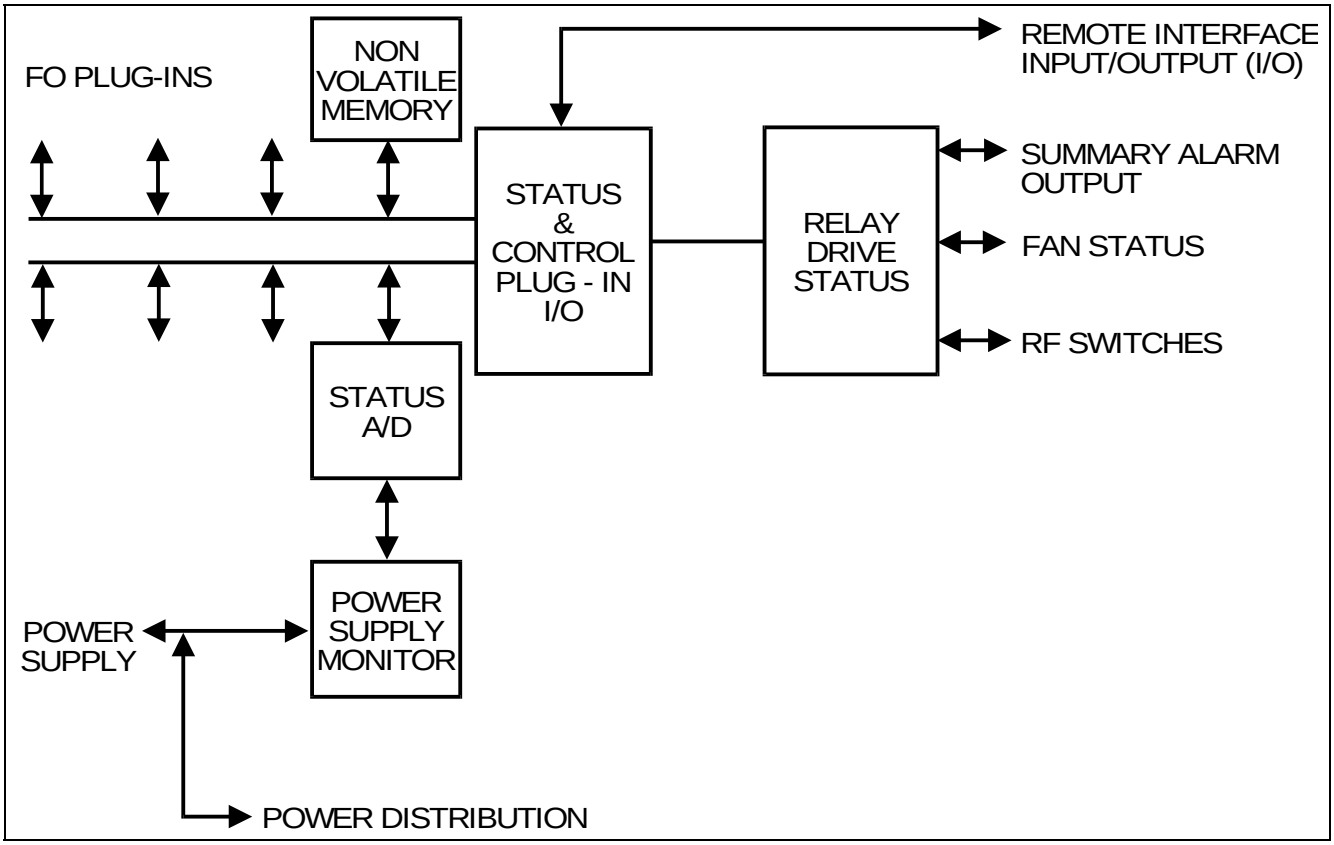



**Figure 2-3**
Chassis backplane block diagram

An example of the rear panel of a chassis is shown in Figure 2-4. Redundant fans, located in the back of the chassis, remove heat generated by the equipment. Each fan can be replaced while the chassis power remains on. Ventilation holes are at the sides of the chassis. The user can stack equipment directly above and below the FO System chassis. For redundancy, there are two independent power on/off switches and two independent power cords connected to the two separate power supplies. The AC power inlet connector at the FO System rear panel is an international IEC320 connector. The optical connections are at FC/APC female bulkheads that provide optical output/input from/to the FO Transmitter/Receiver plug-ins. The RF connectors are female bulkheads that provide RF input/output to/from the system.

All plug-ins provide alarm and monitor information that is transmitted via the remote serial interface (9 pin D-connector on each chassis rear panel). The serial interface is either RS-232 or RS-485 as specified in the purchase order. The alarms for each plug-in are also indicated on the front panel of each plug-in by an LED display. Warnings and alarms that are not displayed on the front panel but are transmitted to the user's M&C System include: the warning that the FO System automatic redundancy switching is disabled (Auto Off) and the warning that the standby rather than primary FO link is in active use.

Figure 2-5 is an example of how a chassis can be filled. Each chassis holds a main and standby power supply and a chassis Status and Control plug-in. There are six slots available to hold FO Transmitter and Receiver plug-ins.

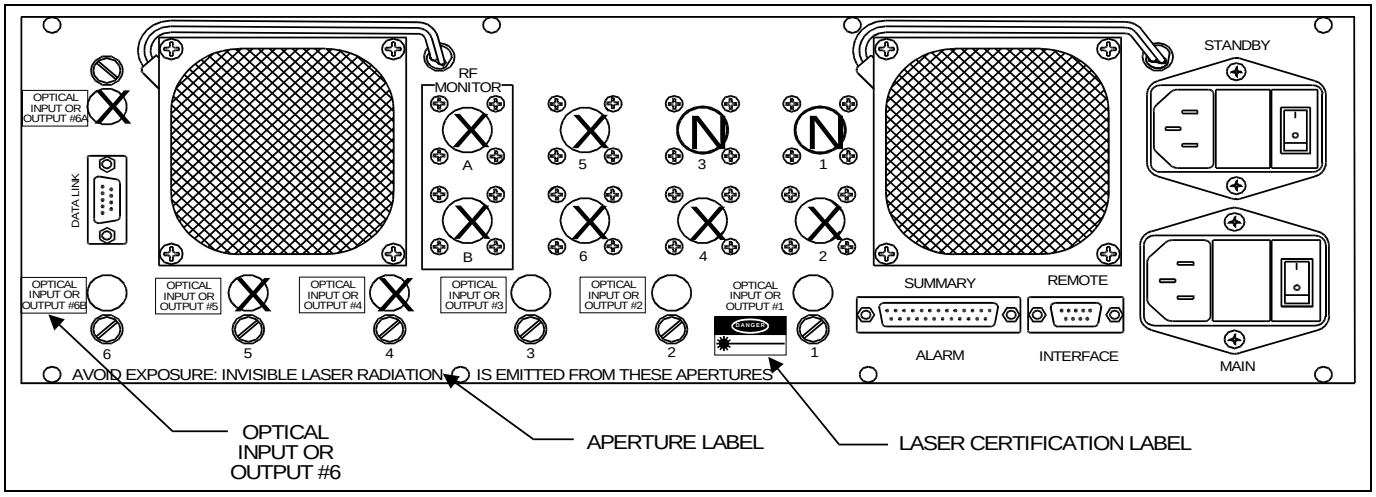



**Figure 2-4**
Chassis Rear Panel

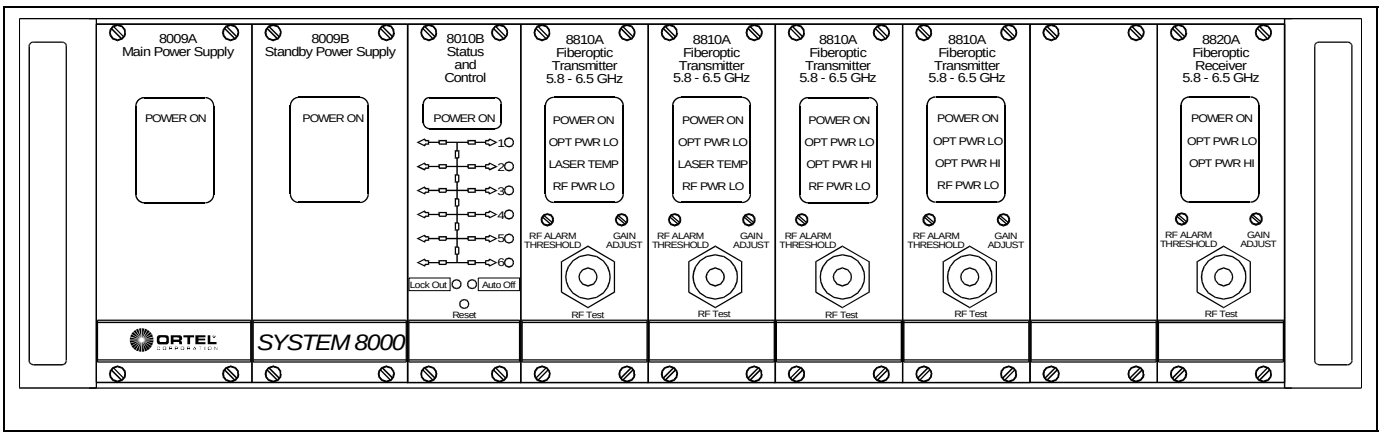



**Figure 2-5**
Front view of a typical system configuration

The layout of the plug-ins in the chassis follows the guidelines illustrated in Figure 2-6. Starting from the left side of the chassis, the first position is held by the main power supply, followed by the standby power supply, and then the Status and Control plug-in. The remaining six slots are filled depending upon the specific system configuration. The 1:2 FO links are to the left, followed by the 1:1 redundant links and then followed by the non-redundant links. The primary FO links are the links designated to carry the signals when all the links are operational; the standby links are powered backup links for the primary links in case of failure. For a 1:2 redundant system, the standby FO link is between the two primary FO links. For a 1:1 redundant system, the primary FO link is in the slot to the left of the standby FO link. In linking a FO Transmitter plug-in to a FO Receiver plug-in, the mating plug-in pairs are in the exact corresponding slots in the companion chassis. As instructed and described later (Chapter 3), the chassis configuration should be compared and verified with the configuration sheets shipped along with the FO System.

The FO system interfaces with the user's M&C System through the 9-pin D-connector remote interface serial port. The user's M&C System can then receive the status for each plug-in and control the redundancy switching unit. Finally, the chassis summary alarm indicates when any alarm within the chassis has been activated. The output is a 25-pin D-connector. Figure 2-7 gives the pin assignments and the specifications for the electrical and optical connectors on the rear panel of the chassis. There are power fuses at the rear panel of the chassis to protect the equipment. The chassis dimensions are also provided in Figure 2-7. Any plug-in or chassis fan can be removed and replaced with a spare while the chassis is powered. This minimizes system interruption.

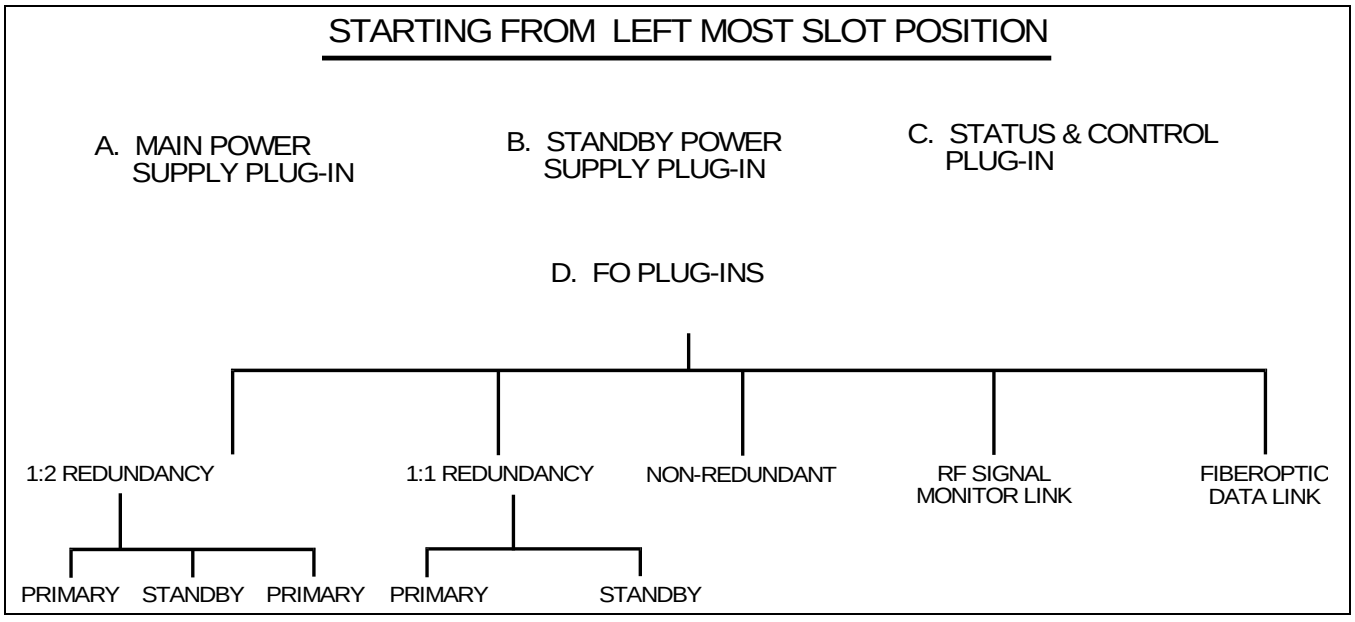



**Figure 2-6**
Plug-in hierarchy in the chassis.

## SUMMARY ALARM

The summary alarm consists of two contacts, one of which is normally open and the other normally closed. Upon failure of any component in the chassis, the contacts change from being normally open (or normally closed) to closed (or open), respectively. The output connector is a 25-pin D-connector at the rear panel of the chassis. The pin outs of the connector are given in Figure 2-7.

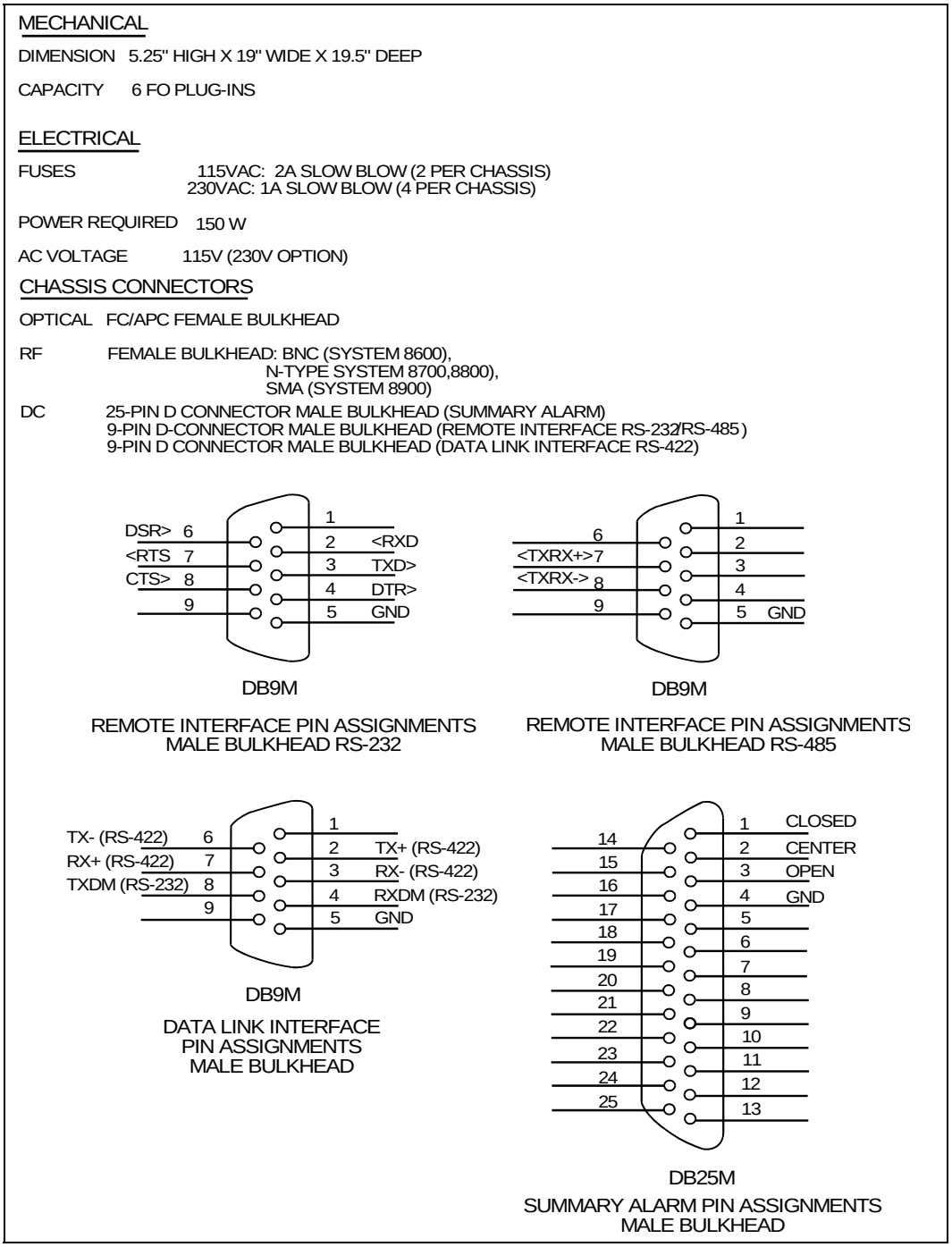



**Figure 2-7**
Chassis specifications and pinouts of connectors

## POWER SUPPLIES (MODELS 8009A/B)

There is a main (Model 8009A) and a standby (Model 8009B) power supply for each chassis. The specifications for the power supplies are given below in Figure 2-8.

| PARAMETER | SPECIFICATION |
|---|---|
| Output Voltage/Load Maximum | +15 V / 6 A<br>+ 5 V/ 10 A<br>-15 V/0.5A |
| Available Continuous Power | 150 W at 40°C |
| Input Voltage | 90 to 132 VAC<br>180 to 264 VAC |
| Input Frequency | 50 to 60 Hz |
| Operating Temperature<br>Storage Temperature | 0 to 50°C<br>-20 to 65°C |
| Overload Protection | Each output is current limited |
| Dimensions | 5.25 in. high, 2.2 in. wide, 18 in. deep |

**Figure 2-8** Power Supply Specifications

The pin assignments for the power supplies are given below. There are pins for AC inputs, DC outputs (±15 V and 5 V), grounding and for a failure alarm. A drawing of the connector is given in Figure 2-9.

| Pin No. | Description |
|---|---|
| 4 | AC HI |
| 6 | AC GND |
| 8 | AC LOW |
| 10 | +5 V |
| 12 | +5 V |
| 14 | +5 V |
| 16 | GND |
| 18 | GND |
| 20 | GND |
| 22 | GND |
| 24 | -15 V |
| 26 | +5 VS |
| 28 | ALARM |
| 30 | +15 V |
| 32 | +15 V |

Connector: DIN 41612, Type H

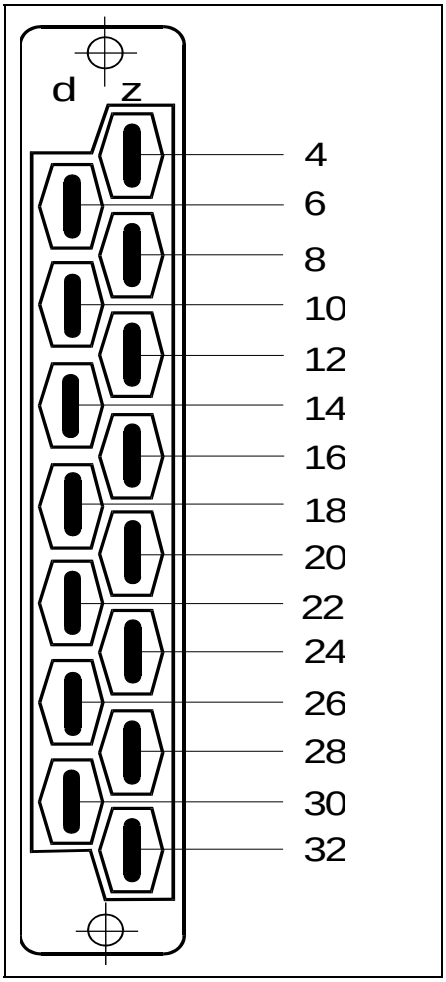



**Figure 2-9** Drawing of the power supply connector.

The power harness connection to the chassis backplane as viewed from the front of the chassis is given below.

| | | |
|---|---|---|
| +5V Main Power Supply | +5V Standby Power Supply | GND |
| $V_{out}$ | GND | -15V Main Power Supply |
| 15V Main Power Supply | +15V Standby Power Supply | -15V Standby Power Supply |

**Figure 2-10**
Chassis backplane power harness matrix (viewed from front of chassis).

# FO TRANSMITTER AND RECEIVER PLUG-INS

Each FO link includes a FO Transmitter plug-in and a FO Receiver plug-in. For L, C, X and Ku-Bands, the FO uplink connects the combined upconverter outputs to the HPA via optical fiber. The FO downlink connects the LNA to the downconverters via optical fiber. For 70/140 MHz, the FO link connects the modulator outputs to the upconverters via optical fiber in the uplink; it connects the downconverters to the demodulators in the downlink.

The general link block diagram is given in Figure 2-11. It includes a variable gain pre-amplifier, fiberoptic link, and a post-amplifier. For L, C, X and Ku-Bands, the gain of the post-amplifier is variable; for the 70/140 MHz system, the post-amplifier gain is fixed. Power dividers and RF switches in the redundancy switching unit are represented by 4 dB loss and 4 dB noise figure at the front end and by 2 dB loss and 2 dB noise figure at the output. These are shown in Figure 2-11.

Figure 2-13 to 2-16 provide typical gain, noise figure and output third order intercept (TOI) values for the FO System components. The L, C, X and Ku-Band performance specifications are for a fiberoptic link that has a 6 dB optical fiber loss budget.

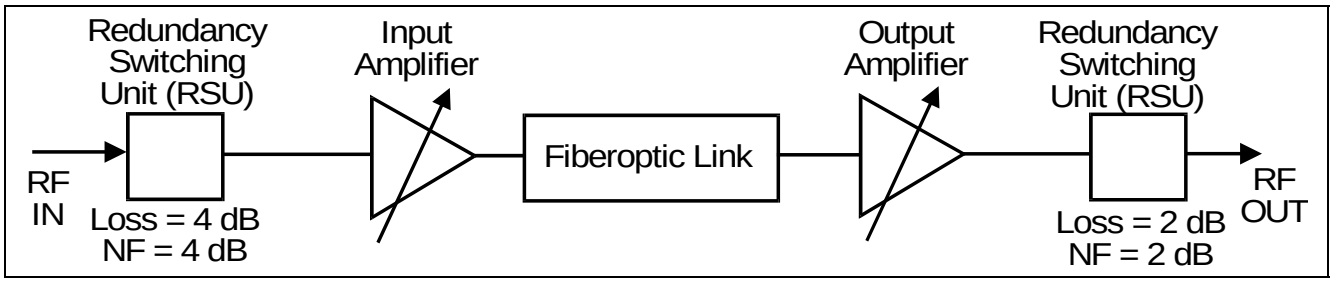



**Figure 2-11**
Block diagram of System 8000 Link

The performance specifications for the System 8000 links are given in Figures 2-17 to 2-20.

| Parameter | Input Amp | | FO Link 8603A | Output Amp | FO System (w/o RSU) | |
|---|---|---|---|---|---|---|
| | Min Gain | Max Gain | | 8604A | Min Gain | Max Gain |
| **Gain** | 12 dB | 21 dB | -33-2X(Opt Loss) dB | 21 dB | -2X(Opt Loss)dB | 9-2X(Opt Loss)dB |
| **NF @ 0 km**<br>**NF @ 10 km** | 17 dB | 8 dB | 45 dB<br>59 dB | 4 dB | 34 dB<br>47 dB | 25 dB<br>38 dB |
| **TOI @ 0km,0.5 Opt Loss**<br>**TOI @ 10km,5dB Opt Loss** | 30 dBm | 30 dBm | -1 dBm<br>-11 dBm | 26 dBm | 15 dBm<br>7 dBm | 15 dBm<br>7 dBm |

Absolute Max RF Input at max input gain setting: -5dBm. 1:1 Automatic Redundancy Switching Unit is optional.

**Figure 2-12(a)**
70/140 MHz IF Link: Model 8603A Tx and 8604A (0 to 10 km)

| Parameter | Input Amp | | FO Link 8603A-001/8603A-002 | | | | | | Fixed Output Amp | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Min Gain | Max Gain | | | | | | | 8604A-002 | 8604A | 8604A-001 |
| Gain | 12 dB | 21 dB | -10-2X(Opt Loss) dB | | | | | | 9 dB | 21 dB | 33 dB |
| NF | 17 dB | 8 dB | 10km | 30km | 25km | 45km | 40km | 65km | 4 dB | 4 dB | 4 dB |
| | | | 48dB | 55dB | 54dB | 59dB | 57dB | 71dB | | | |
| TOI | 30dBm | 30dBm | 26-2X(Opt Loss) dBm | | | | | | 26dBm | 26dBm | 26dBm |

Absolute Max RF Input at max input gain setting: -5dBm. 1:1 Automatic Redundancy Switching Unit is optional.

**Figure 2-12 (b)**
70/140 MHz IF Link: Model 8603A-001 TX and 8604A-002 RX (10-30 km) or 8604A RX (25-45 km), Model 8603A-002 TX and 8604A-001 RX (40-65 km)

| Parameter | Input Amp | | FO Link | Output Amp | | FO System (w/o RSU) | |
|---|---|---|---|---|---|---|---|
| | Min Gain | Max Gain | | Min Gain | Max Gain | Min Gain | Max Gain |
| Gain | 15 dB | 30 dB | -22 dB | 0 dB | 15 dB | -7 dB | 23 dB |
| Noise Figure | 17 dB | 8 dB | 48 dB | 13 dB | 7 dB | 34 dB | 19 dB |
| Output TOI | 28 dBm | 31 dBm | 8 dBm | 16 dBm | 27 dBm | 3 dBm | 19 dBm |

Absolute Max RF Input at max input gain setting: -15dBm. 1:1 or 1:2 Automatic Redundancy Switching Unit is optional

**Figure 2-13**.
Model 8710A/8720A L-Band System (6 dB Optical Loss Budget)

| Parameter | Input Amp | | FO Link | Output Amp | | FO System (w/o RSU) | |
|---|---|---|---|---|---|---|---|
| | Min Gain | Max Gain | | Min Gain | Max Gain | Min Gain | Max Gain |
| Gain | 3 dB | 13 dB | -23 dB | 7 dB | 17 dB | -13 dB | 7 dB |
| Noise Figure | 23 dB | 15 dB | 43 dB | 16 dB | 10 dB | 42 dB | 31 dB |
| Output TOI | 24 dBm | 24 dBm | 1 dBm | 20 dBm | 24 dBm | 5 dBm | 14 dBm |

Absolute Max RF Input at max input gain setting: 5 dBm. 1:1 or 1:2 Automatic Redundancy Switching Unit is optional

**Figure 2-14(a)**
Model 8810A/8820A C-Band Uplink System (6 dB Optical Loss Budget)

| Parameter | Input Amp | | FO Link | Output Amp | | FO System (w/o RSU) | |
|---|---|---|---|---|---|---|---|
| | Min Gain | Max Gain | | Min Gain | Max Gain | Min Gain | Max Gain |
| Gain | 12 dB | 27 dB | -23 dB | 0 dB | 10 dB | -11 dB | 14 dB |
| Noise Figure | 26 dB | 14 dB | 43 dB | 16 dB | 10 dB | 34 dB | 19 dB |
| Output TOI | 24 dBm | 24 dBm | 1 dBm | 14 dBm | 20 dBm | -2 dBm | 7 dBm |

Absolute Max RF Input at max input gain setting: -10 dBm. 1:1 or 1:2 Automatic Redundancy Switching Unit is optional

**Figure 2-14(b)**.
Model 8810B/8820B C-Band Downlink System (6 dB Optical Loss Budget)

| Parameter | Input Amp | | FO Link | Output Amp | | FO System (w/o RSU) | |
|---|---|---|---|---|---|---|---|
| | Min Gain | Max Gain | | Min Gain | Max Gain | Min Gain | Max Gain |
| **Gain** | 20 dB | 30 dB | -43.1dB | 8 dB | 20dB | -1.5 dB | 11 dB |
| **Noise Figure** | 18 dB | 10 dB | 55 dB | 8 dB | 6 dB | 36 dB | 25. dB |
| **Output TOI** | 26 dBm | 25 dBm | -14 dBm | 15 dBm | 21 dBm | -7 dBm | -3 dBm |

Absolute Max RF Input at max input gain setting: -15 dBm. 1:1 or 1:2 Automatic Redundancy Switching Unit is optional

**Figure 2-15**
Model 8850A/8860A X-Band System (6 dB Optical Loss Budget)

| Parameter | Input Amp | | FO Link | Ouptut Amp | | FO System (w/o RSU) | |
|---|---|---|---|---|---|---|---|
| | Min Gain | Max Gain | | Min Gain | Max Gain | Min Gain | Max Gain |
| **Gain** | 20 dB | 30 dB | -37 dB | 8 dB | 18 dB | -9 dB | 11 dB |
| **Noise Figure** | 18 dB | 10 dB | 55 dB | 8 dB | 6 dB | 36 dB | 25 dB |
| **Output TOI** | 26 dBm | 25 dBm | -8 dBm | 15 dBm | 21 dBm | -5 dBm | 4 dBm |

Absolute Max RF Input at max input gain setting: -15 dBm. 1:1 or 1:2 Automatic Redundancy Switching Unit is optional

**Figure 2-16(a)**
Model 8910A/8920A Ku-Band Uplink System (6 dB Optical Loss Budget)

| Parameter | Input Amp | | FO Link | Ouptut Amp | | FO System (w/o RSU) | |
|---|---|---|---|---|---|---|---|
| | Min Gain | Max Gain | | Min Gain | Max Gain | Min Gain | Max Gain |
| **Gain** | 15 dB | 30 dB | -37 dB | 8 dB | 18 dB | -14 dB | 11 dB |
| **Noise Figure** | 22 dB | 11 dB | 55 dB | 8 dB | 6 dB | 42 dB | 25 dB |
| **Output TOI** | 26 dBm | 25 dBm | -8 dBm | 15 dBm | 21 dBm | -5 dBm | 4 dBm |

Absolute Max RF Input at max input gain setting: -15 dBm. 1:1 or 1:2 Automatic Redundancy Switching Unit is optional

**Figure 2-16 (b)**

Model 8910B/8920B Ku-Band Downlink System (6 dB Optical Loss Budget)

| PARAMETER | 70/140 MHz<br>8603A/8604A, Options-001, -002, -050 | |
|---|---|---|
| Passband | 50 to 180 MHz | |
| Optical Loss (OpL) | 0 to 27 dB | |
| Nominal RF Input at Max Gain | -22 dBm | |
| Link Gain<br>(minus 6 dB with RSU) | 8603A/8604A<br>8603A-001/8604A002<br>8603A-001/8604A<br>8603A-002/8604A-001 | 0 to 9dB - 2X(OpL)<br>11 to 20dB-2X(OpL)<br>23 to 32dB-2X(OpL)<br>35 to 44dB-2X(OpL) |
| Flatness | $\pm$0.25 dB/40 MHz | |
| Gain Slope | 0.02 dB/MHz | |
| Gain Stability (constant temp) | $\pm$0.15 dB/24 hrs | |
| Noise Figure<br>at Max Input Gain<br>(add 4 dB with RSU) | 8603A | 8603A-001/8603A-002 |
| | 25 dB (1km)<br>38 dB (10km) | 28 dB (10km)<br>34 dB (25km)<br>37 dB (40km)<br>52 dB (65km) |
| Third Order Distortion | C/I = 60 dB (at max input gain<br>& $RF_{input}$ = -27 dBm/tone) | |
| Group Delay<br>Linear<br>Parabolic | 1 nsec<br>0.05 nsec/MHz<br>0.015 nsec/MHz$^2$ | |
| Input / Output Impedance | Standard | Option-050 |
| | 75 Ω | 50 Ω |
| Input / Output VSWR | 1.3:1/1.3:1 | |
| RF Connector | BNC | |
| Optical Fiber | 1310 nm, singlemode | |
| Optical Connector | FC/APC | |
| Absolute Max RF Input at Max Gain | -5 dBm | |
| Temperature Range | 0$^o$C to 50$^o$C, operating<br>-20$^o$C to 60$^o$C, storage | |
| Dimensions | 5.25" high, 1.8" wide, 18" deep | |

Spur-Free Dynamic Range (SFDR) = 2/3[$RF_{in}$ + (C/IM3)/2 + 173.8 - NF] dB-Hz$^{2/3}$. $RF_{in}$ is the input power per tone.
C/IM3 is the ratio of carrier to third order intermodulation distortion.

**Figure 2-17** Performance Specifications for System 8600 (70/140 MHz) Links

| PARAMETER | L-Band 8710A/8720A |
|---|---|

| | |
|---|---|
| Passband | 950 to 1750 MHz |
| Optical Loss (OpL) | 6 dB |
| Nominal RF Input at Max Gain | -30 dBm |
| Link Gain<br>(minus 6 dB with RSU) | -10 to 20 dB |
| Flatness | $\pm$0.2 dB/48 MHz<br>$\pm$1 dB/500 MHz |
| Gain Slope | 0.02 dB/MHz |
| Gain Stability (constant temp) | $\pm$0.15 dB/24 hrs |
| Noise Figure<br>at Max Input Gain<br>(add 4 dB with RSU) | 20 dB |
| Spur-Free Dynamic Range* | 96 dB-Hz$^{2/3}$ |
| Group Delay<br>Linear<br>Parabolic | 0.5 nsec<br>0.02 nsec/MHz<br>0.01 nsec/MHz$^2$ |
| Input / Output Impedance | 50 Ω |
| Input / Output VSWR | 1.5:1/1.5:1 |
| RF Connector | N-Type |
| Optical Fiber | 1310 nm, singlemode |
| Optical Connector | FC/APC |
| Absolute Max RF Input at Max Gain | -15 dBm |
| Temperature Range | 0$^o$C to 50$^o$C, operating<br>-20$^o$C to 60$^o$C, storage |
| Dimensions | 5.25"X1.8"X18" |

* Spur-Free Dynamic Range (SFDR) = 2/3[$RF_{in}$ + (C/IM3)/2 + 173.8 - NF] dB-Hz$^{2/3}$. $RF_{in}$ is the input power per tone. C/IM3 is the ratio of carrier to third order intermodulation distortion.

**Figure 2-18** Performance Specifications for System 8700 (L-Band)

| PARAMETER | C-Band Uplink 8810A/8820A | C-Band Downlink 8810B/8820B |
|---|---|---|
| Passband | 5.845 to 6.425 GHz | 3.6 to 4.2 GHz |
| Optical Loss | 6 dB | 6 dB |
| Nominal RF Input at Max Gain | -15 dBm | -30 dBm |
| Link Gain (minus 6 dB with RSU) | -13 to 7 dB | -11 to 14 dB |
| Flatness | $\pm$0.2 dB/48 MHz<br>$\pm$0.7 dB/500 MHz | $\pm$0.2 dB/48 MHz<br>$\pm$0.7 dB/500 MHz |
| Gain Slope | 0.02 dB/MHz | 0.02 dB/MHz |
| Gain Stability (constant temp) | $\pm$0.15 dB/24 hrs | $\pm$0.15 dB/24 hrs |
| Noise Figure at Max Input Gain (add 4 dB with RSU) | 32 dB | 20 dB |
| Spur-Free Dynamic Range* | 98 dB-Hz$^{2/3}$ | 96 dB-Hz$^{2/3}$ |
| Group Delay<br>Linear<br>Parabolic | 0.5 nsec<br>0.02 nsec/MHz<br>0.01 nsec/MHz$^2$ | 0.5 nsec<br>0.02 nsec/MHz<br>0.01 nsec/MHz$^2$ |
| Input / Output Impedance | 50 Ω | 50 Ω |
| Input / Output VSWR | 1.35:1/1.35:1 | 1.35:1/1.35:1 |
| RF Connector | N-Type | N-Type |
| Optical Fiber | 1310 nm, singlemode | 1310 nm, singlemode |
| Optical Connector | FC/APC | FC/APC |
| Absolute Max RF Input at Max Gain | 5 dBm | -10 dBm |
| Temperature Range | 0°C to 50°C, operating<br>-20°C to 60°C, storage | 0°C to 50°C, operating<br>-20°C to 60°C, storage |
| Dimensions | 5.25"high, 1.8"wide, 18"deep | 5.25"highX1.8wide"X18"deep |

Spur-Free Dynamic Range (SFDR) = 2/3[$RF_{in}$ + (C/IM3)/2 + 173.8 - NF] dB-Hz$^{2/3}$. $RF_{in}$ is the input power per tone. C/IM3 is the ratio of carrier to third order intermodulation distortion.

**Figure 2-19 (a)** Performance Specifications for System 8800 C-Band Links

| PARAMETER | X-Band<br>8850A/8860A |
|---|---|
| Passband | 7.250 to 8.400 GHz |
| Optical Loss | 6 dB |
| Nominal RF Input<br>at Max Gain | -30 dBm |
| Link Gain<br>(minus 6 dB with RSU) | -15 to 5 dB |
| Flatness | $\pm$ 0.25 dB/48 MHz<br>$\pm$0.75 dB/500 MHz |
| Gain Slope | 0.02 dB/MHz |
| Gain Stability (constant temp) | $\pm$0.15 dB/24 hrs |
| Noise Figure at Max Input Gain<br>(add 5 dB with RSU) | 28dB |
| Spur-Free Dynamic Range* | 92 dB-Hz$^{2/3}$ |
| Group Delay<br>Linear<br>Parabolic | 0.5 nsec<br>0.02 nsec/MHz<br>0.01 nsec/MHz$^2$ |
| Input / Output Impedance | 50 Ω |
| Input / Output VSWR | 1.35:1/1.35:1 |
| RF Connector | N-Type |
| Optical Fiber | 1310 nm, singlemode |
| Optical Connector | FC/APC |
| Absolute Max RF<br>Input at Max Gain | -15 dBm |
| Temperature Range | 0$^o$C to 50$^o$C, operating<br>-20$^o$C to 60$^o$C, storage |
| Dimensions | 5.25"high, 1.8"wide, 18"deep |

* Spur-Free Dynamic Range (SFDR) = 2/3[$RF_{in}$ + (C/IM3)/2 + 173.8 - NF] dB-Hz$^{2/3}$.
$RF_{in}$ is the input power per tone. C/IM3 is the ratio of carrier to third order intermodulation distortion.

**Figure 2-19 (b)** Performance Specifications for System 8800 X-Band Links

| PARAMETER | Ku-Band Uplink 8910A/8920A | Ku-Band Downlink 8910B/8920B |
|---|---|---|
| Passband | 14 to 14.5 GHz | 10.95 to 12.75 GHz |
| Optical Loss | 6 dB | 6 dB |
| Nominal RF Input at Max Gain | -30 dBm | -30 dBm |
| Link Gain (minus 6 dB with RSU) | -9 to 11 dB | -14 to 11 dB |
| Flatness | ±0.2 dB/48 MHz<br>±0.7 dB/500 MHz | ±0.2 dB/48 MHz<br>±0.7 dB/500 MHz |
| Gain Slope | 0.02 dB/MHz | 0.02 dB/MHz |
| Gain Stability (constant temp) | ±0.15 dB/24 hrs | ±0.15 dB/24 hrs |
| Noise Figure at Max Input Gain (add 5 dB with RSU) | 25 dB | 25 dB |
| Spur-Free Dynamic Range* | 94 dB-$Hz^{2/3}$ | 94 dB-$Hz^{2/3}$ |
| Group Delay<br>Linear<br>Parabolic | 0.5 nsec<br>0.02 nsec/MHz<br>0.01 nsec/$MHz^2$ | 0.5 nsec<br>0.02 nsec/MHz<br>0.01 nsec/$MHz^2$ |
| Input / Output Impedance | 50 Ω | 50 Ω |
| Input / Output VSWR | 1.35:1/1.35:1 | 1.35:1/1.35:1 |
| RF Connector | SMA | SMA |
| Optical Fiber | 1310 nm, singlemode | 1310 nm, singlemode |
| Optical Connector | FC/APC | FC/APC |
| Absolute Max RF Input at Max Gain | -15 dBm | -15 dBm |
| Temperature Range | 0°C to 50°C, operating<br>-20°C to 60°C, storage | 0°C to 50°C, operating<br>-20°C to 60°C, storage |
| Dimensions | 5.25"high, 1.8"wide, 18"deep | 5.25"highX1.8"wideX18"deep |

* Spur-Free Dynamic Range (SFDR) = $2/3[RF_{in} + (C/IM3)/2 + 173.8 - NF]$ dB-$Hz^{2/3}$. $RF_{in}$ is the input power per tone. C/IM3 is the ratio of carrier to third order intermodulation distortion.

**Figure 2-20** Performance Specifications for System 8900 Ku-Band Links

## RF SIGNAL MONITOR LINK: FO TRANSMITTER AND RECEIVER PLUG-INS

The pin assignments and exterior characteristics of the FO Transmitter and FO Receiver plug-ins for the RF Signal Monitor link are the same as those for the FO uplink/downlink transmitter and receivers with the following exceptions. The RF Signal Monitor Transmitter has no preamplifier, RF test port, RF gain adjust, or RF Alarm threshold adjust as found for the uplink/downlink Transmitter plug-ins. As a result, there is no pin assignment for these features (RF power monitor or alarm) for the RF Signal Monitor Transmitter. The nominal input to the RF Signal Monitor link is 5 dBm. The RF Signal Monitor Receiver is the same as the uplink Receiver. The C and Ku-Band RF Signal Monitor links can accept two RF signals (such as RHCP and LHCP signals) for remote monitoring. A switch internal to the FO RF Signal Monitor Transmitter plug-in (located at the Antenna Site) allows selection of the RF signal to be monitored. The switch position can be remotely controlled by the user's Monitor and Control System.

| PARAMETERS | C-Band 8483A/8820A | Ku-Band 8493A/8920A |
|---|---|---|
| Passband | 5.845 to 6.425 GHz | 14 to 14.5 GHz |
| Optical Loss Budget | 6 dB | 6 dB |
| Link Loss | 10 to 20 dB | 15 to 25 dB |
| Flatness | ±0.2 dB/48 MHz<br>±0.7 dB/500 MHz | ±0.2 dB/48 MHz<br>±0.7 dB/500 MHz |
| Nominal Input Power | 5 dBm | 5 dBm |
| Noise Figure | 48 dB | 55 dB |
| Input TOI | 30 dBm | 28 dBm |
| Typical Input 1dB Compression Point | 18 dBm | 18 dBm |
| Gain Stability (constant temp) | ± 0.15 dB/24 hrs | ± 0.15 dB/24 hrs |
| Input / Output Impedance | 50 Ω | 50 Ω |
| Input / Output VSWR | 1.35:1 | 1.35:1 |
| RF Connector | N-Type | SMA |
| Optical Fiber | 1310 nm, singlemode | 1310 nm, singlemode |
| Optical Connector | FC/APC | FC/APC |
| Absolute Max RF Input | 18 dBm | 18 dBm |
| Temperature Range | 0°C to 50°C, operating<br>-20°C to 60°C, storage | 0°C to 50°C, operating<br>-20°C to 60°C, storage |
| Dimensions | 5.25" X 1.8" X 18" | 5.25" X 1.8" X 18" |

**Figure 2-21** Performance Specifications for System 8400 RF Signal Monitor Links

For the FO Uplink/Downlink Transmitter plug-ins, the pin assignments that interface with the chassis backplane are given below.

**FO UPLINK/DOWNLINK TRANSMITTER PLUG-IN PIN ASSIGNMENTS**

70/140 MHz: Model 8603A, Model 8603A-001, Model 8603A-002
L-Band: Model 8710A
C-Band: Model 8810A, Model 8810B
X-Band: Model 8850A, Model 8860A
Ku-Band: Model 8910A, Model 8910B

| Pin No. | Description |
|---|---|
| 1A | GND |
| 1B | GND |
| 1C | GND |
| 2A | +5 V |
| 2B | +5V |
| 2C | +5V |
| 3A | GND |
| 3B | GND |
| 3C | GND |
| 4A | -15 V |

5A PDIM: Photodiode (PD) Current Monitor - measures the optical power out of the laser facet. The normal range is 0.3 to 2 mA and the level should remain stable.

5B LSRIM: Laser DC Current Monitor - DC bias current of the laser. The normal range of this monitor is 50 - 100 mA. Anything higher indicates possible laser lifetime degradation. Anything lower indicates circuit malfunctions.

5C TEIM: TE Cooler Current Monitor - DC current drawn by the TE cooler to maintain the laser temperature. The maximum DC current drawn by the TE cooler is 1.6 A. The reference is 25$^{o}$C with no current drawn.

6A RFPM: RF Power Monitor - measures the RF power immediately prior to the laser module, after the input gain control. The RF power is in unit of measure dBm.

9A OPTA: Optical Power Alarm - sinks current if photodiode current monitor (PDIM) detects that the laser power has drifted more than 5% from its setpoint. When activated, the red "OPT PWR LO" illuminates at the front panel LED display of the plug-in.

9B TMPA: Temperature Alarm - sinks current if the laser diode temperature as measured by the TE cooler current monitor (TEIM) is unstable, deviating from its initial setpoint by more than 2$^{o}$C.

9C RFPA: RF Power Alarm - sinks current if the RF power (monitored by RFPM) drops below that set by the RF Power threshold adjustments at the plug-in front panel.

| | | |
|---|---|---|
| 13A | IICC: | Inter-Integrated Circuit Clock. This is a bi-directional serial data bus. |
| 13B | IICD: | Inter-Integrated Circuit Data. This is a bi-directional serial digital bus. |
| 14A | ID1: | Identifier Number 1. This identifies the plug-ins (Model Number, Description, etc). |
| 14B | ID2: | Identifier Number 2. This identifies the plug-ins (Model Number, Description, etc). |
| 14C | ID3: | Identifier Number 3. This identifies the plug-ins (Model Number, Description, etc). |
| 15A | +15 V | |
| 15B | +15 V | |
| 15C | +15 V | |
| 16A | GND | |
| 16B | GND | |
| 16C | GND | |

Connector: DIN 41612, Type C/2. A drawing of this connector is given in Figure 2-22.

For the FO Uplink/Downlink Receiver plug-ins, the pin assignments which interfaces with the chassis backplane are:

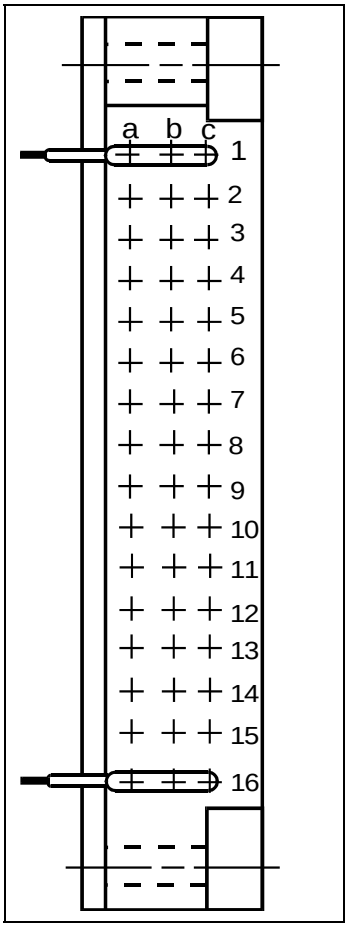



**Figure 2-22**
Drawing for the connector for the FO plug-ins.

## FO UPLINK/DOWNLINK RECEIVER PLUG-IN PIN ASSIGNMENTS

70/140 MHz: Model 8604A, Model 8604A-001, Model 8604A-002
L-Band: Model 8720A
C-Band: Model 8820A, Model 8820B
X-Band Model 8850A, Model 8860A
Ku-Band: Model 8920A, Model 8920B

| Pin No. | Description |
|---|---|
| 1A | GND |
| 1B | GND |
| 1C | GND |
| 2A | +5 V |
| 2B | +5V |
| 2C | +5V |
| 3A | GND |
| 3B | GND |
| 3C | GND |
| 4A | -15 V |
| 5A | PDIM: Photodiode (PD) Current Monitor - measures the optical power received by the photodiode. Depending upon the link length, the normal range is 0.2 to 2 mA. |
| 5C | RFPM: RF Power Monitor - measures the RF power after the output gain control of the FO Receiver. The RF power is in unit of measure dBm. |
| 9A | LOPA: Low Optical Power Alarm - sinks current when the received optical power corresponds to a DC photocurrent monitor below 0.2mA. |
| 9B | HOPA: High Optical Power Alarm - sinks current when the received optical power corresponds to a DC photodiode current monitor (PDIM) above 2 mA. |
| 9C | RFPA: RF Power Alarm - sinks current when the RF power drops below that set by the RF Power threshold adjustments at the front panel of the plug-ins. |
| 13A | IICC: Inter-Integrated Circuit Clock. This is a bi-directional serial data bus. |
| 13B | IICD: Inter-Integrated Circuit Data. This is a bi-directional serial digital bus. |
| 14A | ID1: Identifier Number 1. This identifies the plug-ins (Model Number, Description, etc). |
| 14B | ID2: Identifier Number 2. This identifies the plug-ins (Model Number, Description, etc). |
| 14C | ID3: Identifier Number 3. This identifies the plug-ins (Model Number, Description, etc). |
| 15A | +15 V |
| 15B | +15 V |
| 15C | +15 V |
| 16A | GND |

16B GND
16C GND

Connector: DIN 41612, Type C/2. A drawing for this connector is given in Figure 2-21.

For the RF Signal Monitor Transmitter plug-in, the pin assignments are:

**RF SIGNAL MONITOR TRANSMITTER PLUG-IN PIN ASSIGNMENTS**

C-Band: Model 8483A
X-Band: Model 8850A
Ku-Band: Model 8493A

| Pin No. | Description |
|---|---|
| 1A | GND |
| 1B | GND |
| 1C | GND |
| 2A | +5 V |
| 2B | +5V |
| 2C | +5V |
| 3A | GND |
| 3B | GND |
| 3C | GND |
| 4A | -15 V |
| 5A | PDIM: Photodiode (PD) Current Monitor - measures the optical power out of the laser facet. The normal range is 0.3 to 2 mA, and the level should be stable. |
| 5B | LSRIM: Laser DC Current Monitor - DC bias current of the laser. The normal range of this monitor is 50 - 100 mA. Anything higher indicates possible laser lifetime degradation. Anything lower indicates circuit malfunctions. |
| 5C | TEIM: TE Cooler Current Monitor - DC current drawn by the TE cooler to maintain the laser temperature. The maximum DC current drawn by the TE cooler is 1.6 A. The reference is 25$^{o}$C with no current drawn. |
| 6A | MONR: Monitor Switch Position - gives the position (A or B) of the switch that selects the RF signal path (RHCP or LHCP) to be returned to the Control Center for monitoring. |

| | | |
|---|---|---|
| 9A | OPTA: | Optical Power Alarm - sinks current if photodiode current monitor (PDIM) detects that the laser power has drifted more than 5% from its setpoint. When activated, the red "OPT PWR LO" message will illuminate at the front panel LED display of the plug-in. |
| 9B | TMPA: | Temperature Alarm - sinks current if the laser diode temperature is unstable, deviating from its initial setpoint by more than $2^{o}C$. |
| 13A | IICC: | Inter-Integrated Circuit Clock. This is a bi-directional serial data bus. |
| 13B | IICD: | Inter-Integrated Circuit Data. This is a bi-directional serial digital bus. |
| 14A | ID1: | Identifier Number 1. This identifies the plug-ins (Model Number, Description, etc). |
| 14B | ID2: | Identifier Number 2. This identifies the plug-ins (Model Number, Description, etc). |
| 14C | ID3: | Identifier Number 3. This identifies the plug-ins (Model Number, Description, etc). |
| 15A | +15 V | |
| 15B | +15 V | |
| 15C | +15 V | |
| 16A | GND | |
| 16B | GND | |
| 16C | GND | |

Connector: DIN 41612, Type C/2. A drawing for this connector is given in Figure 2-21.

For the FO RF Signal Monitor Receiver plug-in, the pin assignments that interface with the chassis backplane are:

**RF SIGNAL MONITOR RECEIVER PLUG-IN PIN ASSIGNMENTS**

C-Band: Model 8820A
X-Band: Model 8860A
Ku-Band: Model 8920A

| Pin No. | Description |
|---|---|
| 1A | GND |
| 1B | GND |
| 1C | GND |
| 2A | +5 V |
| 2B | +5V |
| 2C | +5V |
| 3A | GND |
| 3B | GND |
| 3C | GND |
| 4A | -15 V |

5A PDIM: Photodiode (PD) Current Monitor - measures the optical power received by the

photodiode. Depending upon the link length, the normal range is 0.2 to 2 mA.

| | | |
|---|---|---|
| 9A | LOPA: | Low Optical Power Alarm - sinks current when the received optical power corresponds to a DC photocurrent monitor below 0.2mA. |
| 9B | HOPA: | High Optical Power Alarm - sinks current when the received optical power corresponds to a DC photodiode current monitor (PDIM) above 2 mA. |
| 13A | IICC: | Inter-Integrated Circuit Clock. This is a bi-directional serial data bus. |
| 13B | IICD: | Inter-Integrated Circuit Data. This is a bi-directional serial digital bus. |
| 14A | ID1: | Identifier Number 1. This identifies the plug-ins (Model Number, Description, etc). |
| 14B | ID2: | Identifier Number 2. This identifies the plug-ins (Model Number, Description, etc). |
| 14C | ID3: | Identifier Number 3. This identifies the plug-ins (Model Number, Description, etc). |
| 15A | +15 V | |
| 15B | +15 V | |
| 15C | +15 V | |
| 16A | GND | |
| 16B | GND | |
| 16C | GND | |

Connector: DIN 41612, Type C/2. A drawing for this connector is given in Figure 2-22

## FIBEROPTIC DATA LINK

Fiberoptic Data Link Plug-in Model 8501A (Option-001)

A Fiberoptic Data Link transmits serial data (such as from M&C terminals) between remote sites via singlemode optical fiber. Each datalink is bi-directional requiring two singlemode fibers between the Control Center and the Antenna site. A Fiberoptic Data Link requires; two Fiberoptic Data Link plug-ins, (Model 8501A), one in the chassis at the Control Center and the other in the chassis at the Antenna site as shown in Figure 2-23. Each Fiberoptic Data Link plug-in contains both a laser module and a photodiode module as shown in Figure 2-24 for bi-directional use. The serial input data (RS-422 or optional RS-232) modulates the laser and is then transmitted via an optical fiber as a modulation on the optical carrier. At the remote Fiberoptic Data Link plug-in, the optical signal is detected with a photodiode and demodulated to provide the serial data as an output through an RS-422 serial port (RS-232 is optional).

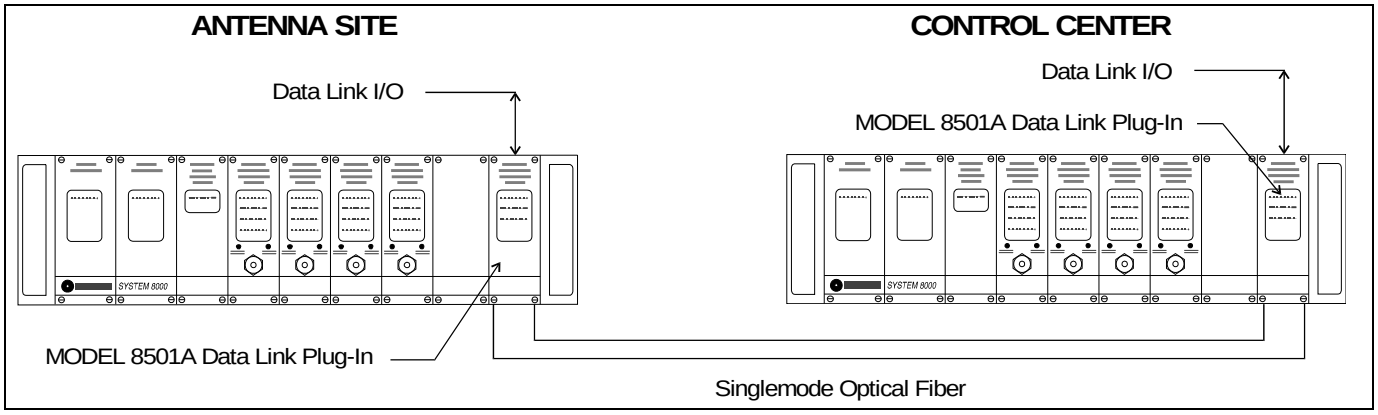



**Figure 2-23**
Fiberoptic Data Link transmits serial data between the Control Center and the Antenna site.

Each chassis includes an input and output serial port (9-pin D - connectors) located at the chassis rear panel. Each Fiberoptic Data Link plug-in fits in the rightmost slot (Slot 6) of the designated chassis. The optical output (from the laser module) is through the lower optical connector of the Data Link plug-in. The optical input (to the photodiode module) is through the upper connector.

The Fiberoptic Data Link front panel LED display indicates the following status and alarm information. The specifications are given in Figure 2-25:

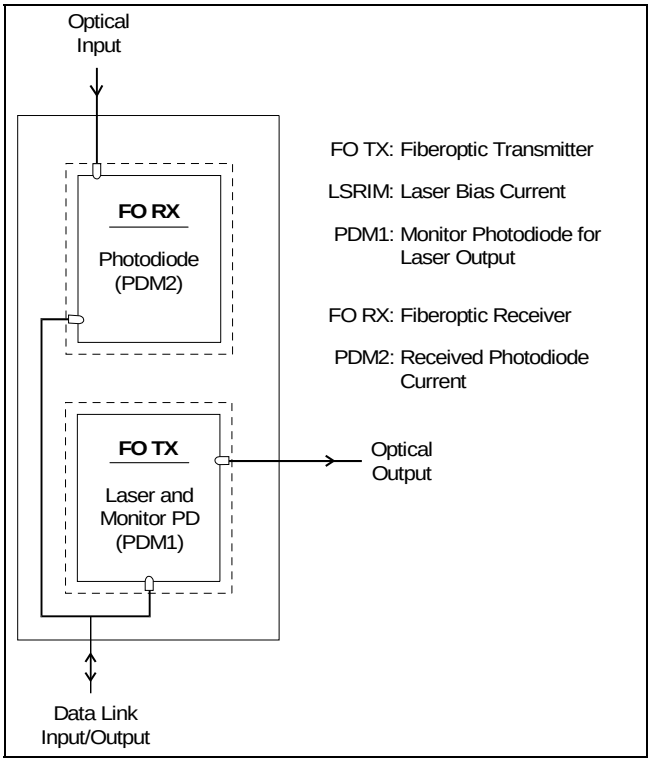



**Figure 2-24**
Fiberoptic Data Link Plug-in (Model 8501A) Block diagram.

| INDICATOR | LED COLOR | STATUS & ALARM |
|---|---|---|
| Power On | Green | Power to Plug-in |
| LSR PWR LO | Red | Laser Output Power Low |
| PD PWR LO | Red | Received Optical Power Low |
| NO DATA | Yellow | No Data Transmitted or Received |

| | |
|---|---|
| **ELECTRICAL PARAMETERS** | |
| Bit-Error Rate (BER) | $<10^{-9}$ |
| Serial Data Interface | RS-422 |
| Option-001 | RS-232 |
| Operating Mode | Asynchronous, Full Duplex |
| Input/Output (I/O) Logic Levels | Differential I/O Range: $\pm$1 to $\pm$6 V (Balanced & Terminated 120 Ω) |
| RS-232 (Option-001) | Single-ended I/O Range: $\pm$ 4 to $\pm$ 12 V (Unbalanced & Non-Terminated) |
| Data Signal Rate | 200 kbps |
| RS-232 (Option-001) | 19.2 kbps |
| **OPTICAL PARAMETERS** | |
| Wavelength | 1310 $\pm$ 30 nm |
| Fiber Type | 9/125 µm singlemode |
| Connector | FC/APC |
| Optical Loss Budget | 6 dB |
| **ABSOLUTE MAXIMUM RATINGS** | |
| Operating Temperature | 0°C to +50°C |
| Storage Temperature | -20°C to +65°C |
| Power Requirements | 6 W |
| Plug-in Dimensions | 5.25 in. high, 1.8 in. wide, 18 in. deep |

**Figure 2-25**
Fiberoptic Data Link Specifications

| Pin No. | Description |
|---|---|
| 1A | GND |
| 2A<br>2B<br>2C | +5 V<br>+5 V<br>+5 V |
| 3A<br>3B<br>3C | DIGITAL GND<br>DIGITAL GND<br>ANALOG GND |
| 4A | -15 V |
| 5A<br>5B | TX+: Differential Output Data<br>TX-: Differential Output Data |
| 6A<br>6B<br>6C | TXDM: Single End Send Data<br>RXDM: Single End Receive Data<br>RX+: Differential Receive Data |
| 7A | RX-: Differential Receive Data |
| 8A | PDIM1: Photodiode (PD) Current Monitor - measures the optical power out of the laser back facet. The normal range is 0.3 to 2 mA and the level should remain stable. This is a laser monitor photodiode, not the photodiode used to receive the Fiberoptic Data Link signal. |
| 8B | LSRIM: Laser DC Current Monitor - DC bias current of the laser. The normal range of this monitor is 50 to 100 mA. Anything higher indicates possible laser lifetime degradation. Anything lower indicates circuit malfunctions. |
| 8C | PDIM2: Photodiode (PD) Current Monitor - measures the optical power received by the Fiberoptic Data Link photodiode. Depending upon the link length, the normal range is 0.2 to 2 mA. |
| 13A<br>13B | IICC: Inter-Integrated Circuit Clock. This is a bi-directional serial data bus.<br>IICD: Inter-Integrated Circuit Data. This is a bi-directional serial data bus. |
| 14A<br>14B<br>14C | ID1: Identifier Number 1. This identifies the plug-ins (Model Number, Description, etc.).<br>ID2: Identifier Number 2. This identifies the plug-ins (Model Number, Description, etc.).<br>ID3: Identifier Number 3. This identifies the plug-ins (Model Number, Description, etc.) |
| 15A<br>15B<br>15C | 15 V<br>15 V<br>15 V |
| 16A | GND |

**Figure 2-26**
Fiberoptic Data Link plug-in, pin assignments that interface to the chassis backplane.

Connector: DIN 41612, Type C/2. A drawing of this connector is given in Figure 2-22.

The 9-pin D-connector at the chassis rear panel for input/output for the FO Data Link is shown in Figure 2-27.

**STATUS AND CONTROL PLUG-IN (MODEL 8010B)**

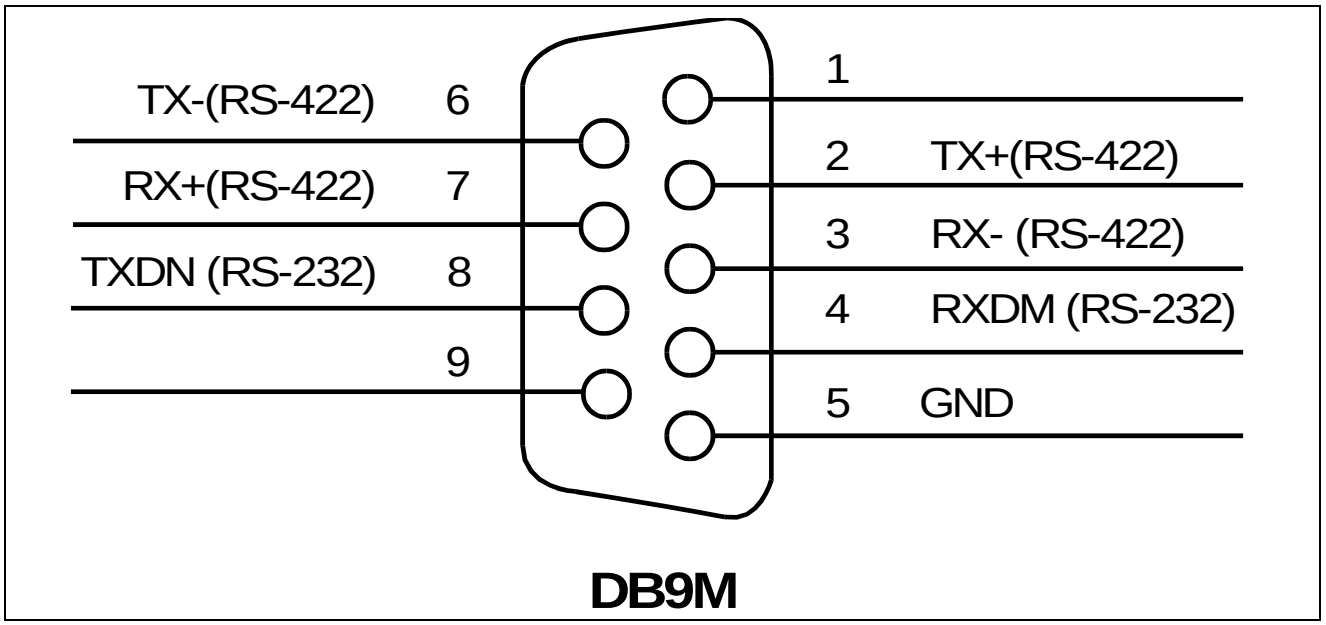



**Figure 2-27**
Data Link Interface pin assignments male bulkhead

The Status and Control plug-in provides both local and remote monitor and control of the Ortel FO System. Locally, recessed switches at the front panel of the Status and Control plug-in dictate the redundancy switching configuration. Computer monitor and control is via the remote interface port at the chassis rear panel as shown in Figures 2-4 and 2-7. The Status and Control plug-in includes the following features:

1) Automatic redundancy switching for backing up a primary fiberoptic link path with a fully powered standby fiberoptic link (in FO Systems containing a Redundancy Switching Unit (RSU))

2) Manual switching of the RSU (Auto Off)

3) Remote control through the serial port (RS-232 or RS-485) at the chassis rear panel

4) Local control using the recessed switches at the Status and Control plug-in front panel

5) Display of the RF switch configuration at the front panel of the plug-in

6) Generation of the status and alarm information concerning each plug-in within the chassis.

## Before replacing a failed plug-in, remove the four screws of the Status and Control plug-in (SCP) and gently pull it out slightly so that it is no longer plugged into its socket. This turns the SCP off.

Figure 2-28 illustrates the Status and Control Plug-in. The plug-in front panel has a Power On indicator, recessed switches for local control of the six possible FO plug-ins in the chassis, an LED display to indicate the RF input/output paths to/from the FO plug-ins, a recessed manual Master Reset switch to locally reset the entire chassis to the default configuration (automatic redundancy switching, use of the primary FO links, alarms reset), a recessed switch and indicator for disabling Automatic Redundancy Switching (Auto Off) and a recessed switch for locking out computer control (Lockout).

The front panel LED display shows the direction of the signal with the RF input/output to the left of the display and the optical

input/output to the right of the display. For a FO Transmitter plug-in, the arrow at the left of the display is unlit while the one at the right is lit to indicate that the direction of the signal is from an RF input to an optical output. For a FO Receiver plug-in, the arrow at the right is unlit while the one to the left of the display is lit to indicate that the signal is from an optical input to an RF output. RF power divider and RF switch configurations for the chassis are displayed by the LED bars. For example, a power divider would be shown as an input green LED bar and two green output LEDs bars. Paths defined by unlit LEDs are not available RF paths.

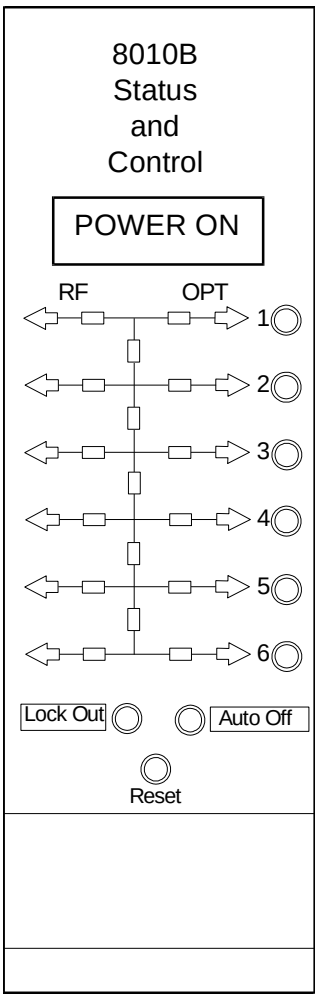



**Figure 2-28**
Front panel display of Status & Control Plug-in. Colored LEDs indicate the direction & status of RF signal paths

**AUTO/MANUAL REDUNDANCY SWITCHING**

The redundancy switching unit (RSU) functions of the Status and Control plug-in will now be described. Non-redundant FO Systems do not contain an RSU (RF switches and power dividers). Hence, this section describing auto/manual redundancy switching does not apply.
The Status and Control plug-in features:

1) Automatic or Manual redundancy switching selection.

2) If the system is using the standby path, a warning is activated

3) A local reset capability so that the FO System can be returned to the default redundancy switching configuration and to reset the alarms. The default redundancy switching configuration uses the primary FO link path and selects the automatic redundancy switching mode.

**1. Automatic Redundancy Switching**

The Automatic Redundancy Switching feature minimizes link downtime by automatically switching over to an "Idle" powered standby link if the primary fiberoptic link fails. The 1:1 and 1:2 redundancy switching configurations are shown in Figure 2-1. The response of the automatic redundancy switching to alarms is shown in Figure 2-29 and is as follows. The primary fiberoptic paths are the default configurations. Resetting the configuration returns the system to the default configuration and to the automatic redundancy switching mode of operation. When an alarm is detected by the Status and Control plug-in, the RF switch is activated to put the standby path in use. For example, in the 1:1 redundancy configuration, RF signal is divided to both FO Transmitters (there is a power divider and not a switch) as shown in Figure 2-1. In this case, power to the defective laser will be turned off (OPT PWR LO will be displayed at the FO Transmitter plug-in front panel).

The FO Receiver in the primary path would receive no optical power, activating the "OPT PWR LO" alarm, and the automatic switching unit in the chassis will then switch to the standby FO Receiver. If the standby path is non-operational or already in use, then the system will not switch. In the 1:2 redundant configuration, if the standby path is already in use, then failure of the second primary path does not activate any switching. An alarm will be activated to notify the user that a failure has occurred.

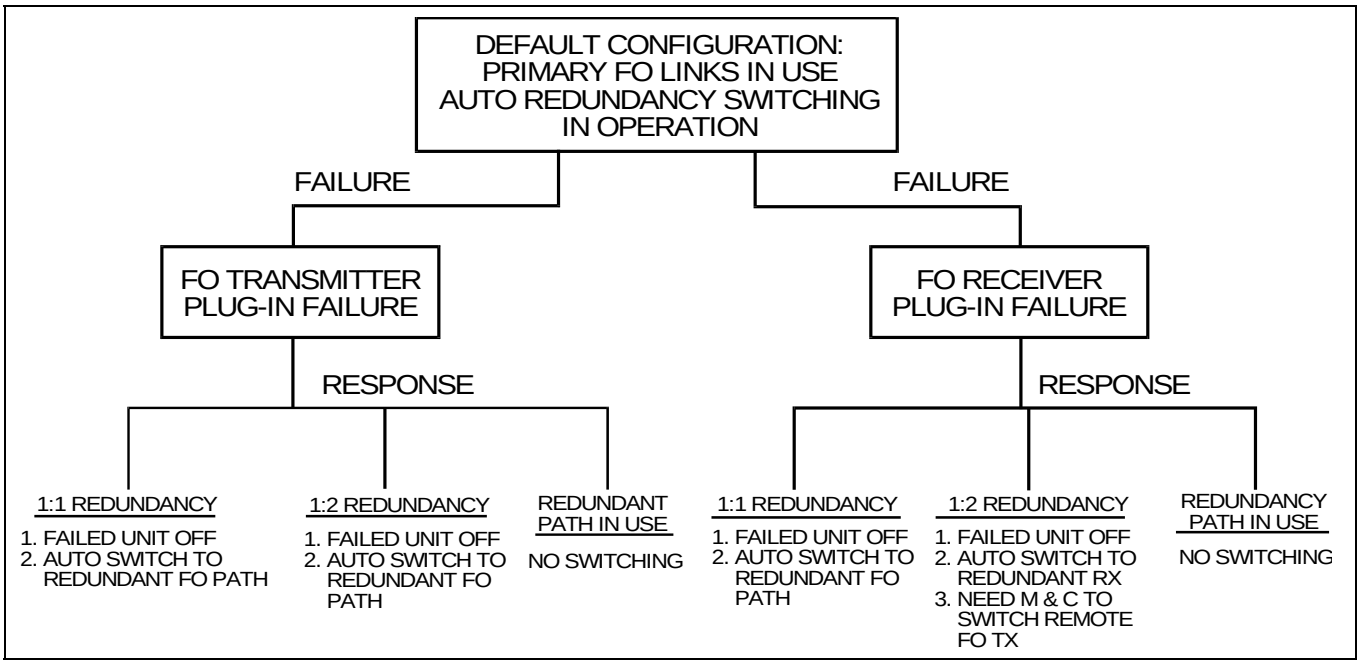



**Figure 2-29**
Response of the redundancy switching unit upon plug-in failure

| DESCRIPTION OF FAILURE | FO TRANSMITTER (TX) PLUG-IN LED ALARMS | | | FO RECEIVER (RX) PLUG-IN LED ALARMS | | | FO SYSTEM RESPONSE |
|---|---|---|---|---|---|---|---|
| | OPT PWR LO | LSR TMP | RF PWR LO | OPT PWR LO | OPT PWR HI | RF PWR LO | |
| LASER PWR LOW | X | | | X | | X | FO TX OFF:AUTO SWITCH TO STANDBY FO LINK |
| LASER TEMP UNSTABLE | | X | | | | | FO TX OFF:AUTO SWITCH TO STANDBY FO LINK |
| TX RF PWR LOW | | | X | | | X | WARNING TO USER'S M&C SYSTEM |
| RX OPT PWR LOW | | | | X | | X | AUTO SWITCH TO STANDBY FO RX;NEEDED M&C TO SWITCH TO STANDBY FOR TX |
| FIBER BREAK | | | | X | | X | AUTO SWITCH TO STANDBY FO RX;NEEDED M&C TO SWITCH TO STANDBY FO TX |
| RX OPT PWR HIGH | | | | | X | | WARNING TO USER'S M&C SYSTEM |
| RX RF PWR LO | | | | | | X | WARNING TO USER'S M&C SYSTEM |
| STANDBY PATH IN USE | | | | | | | WARNING TO USER'S M&C SYSTEM |
| AUTO OFF | | | | | | | WARNING TO USER'S M&C SYSTEMS |

**Figure 2-30** Various failures and the resulting Fiberoptic System response

Figure 2-30 describes the various failures and warnings, the alarms that would be activated in the FO Transmitter and FO Receiver plug-ins in that FO link path, and the response of the automatic redundancy switching unit.

1) If the laser fails (OPT PWR LO), then at the FO Transmitter plug-in, the optical alarm activates. At the FO Receiver plug-in, low light would be detected (activating an alarm) and a warning that the RF signal is low. The FO Transmitter plug-in would be turned off and if 1:2 redundant configuration, the standby FO Transmitter plug-in would be switched into active use. At the FO Receiver plug-in chassis, the standby FO Receiver plug-in would be switched into active use.

2) If the TE cooler at the FO Transmitter plug-in fails (LASER TEMP), then the temperature alarm activates. The FO laser would be turned off and, if 1:2 redundant configuration, the standby transmitter plug-in switched into active use. At the FO Receiver plug-in, low light would then be detected, and the FO Receiver plug-in would be switched into active use.

3) If the RF Power is low at the FO Transmitter or at the output of the FO Receiver plug-in, then a yellow warning light will be displayed at the plug-ins and a warning activated.

4) If the photodiode fails or if there is a break in the optical fiber cable, then at the FO Receiver, the low optical power alarm activates. At the FO Receiver plug-in chassis, the standby FO Receiver plug-in would be switched into active use. For a 1:1 redundant configuration, this automatically permits active use of the standby link. However, for a 1:2 configuration, the user-supplied M&C System is needed to switch the FO Transmitter to the standby path. The user is responsible for supplying the message to the FO system to automatically switch to the standby FO transmitter in the 1:2 configuration. Otherwise, there will be total loss of signal.

5) If the optical power received by the FO Receiver is in excess of 2 mW, then a yellow warning light will be displayed at the plug-in and a warning activated.

6) If a fan in the chassis fails, then a warning will be activated.

7) If the standby FO path is in active use, a warning will be activated to indicate this configuration. After correcting a defective

primary path, the FO System can be reset to the default primary configuration and the alarms reset.

8) If the redundancy switching is in the manual mode of operation, a warning will be activated and indicated on the front panel of the Status and Control plug-in. Resetting the FO System returns it to the automatic redundancy switching mode of operation.

### 2. Manual Redundancy Switching (Auto Off)

Manual switching can be computer-controlled through the remote interface or it can be locally implemented at the front panel of the Status and Control plug-in. "Auto Off" disables automatic switching, giving the user direct manual control of the RF and FO paths. Locally, at the Status and Control plug-in, as shown in Figure 2-28, the user can toggle the "Auto Off" switch to alternate between Automatic and Manual Redundancy Switching. The yellow LED display shows when the mode of operation of the chassis is manual (Auto Off). Manual switching through computer control is via the software commands to the FO System. The software commands are given later in the Software interface section to this chapter. The RF switches are controlled to allow the selected FO path to be "In Use". The relevant commands include the selection of the "Redundant (Standby) FO Paths", "Auto Off (External Switching)" and the "Relay" Switch positions. Locally, the Status and Control plug-in front panel will show the RF switch positions with the LED display. When the system is in the manual switching mode of operation, the system will not automatically switch to a standby link in case of failure of the primary link. Hence the user must pay special attention to the actual paths "In Use". To enable automatic redundancy switching, choose auto switching in the definition of the system configuration or reset the system to the default configuration (automatic redundancy switching and primary links).

## REMOTE/LOCAL CONTROL

The FO System can be controlled remotely or locally. Control includes powering the laser on/off and controlling the RF switch position. Remote and Local Control applies to both non-redundant FO Systems and those that contain a Redundancy Switching Unit (RSU).

### 1. Remote Control

The Status and Control computer control interface port is located at the 9-pin remote interface D-connector at the rear panel of the chassis. A complete description of the software commands between the Status and Control plug-in and the user's Monitor and Control System is described later in this chapter.

### 2. Local Control and Remote Lockout (Lockout)

The local redundancy switching control for a chassis is through recessed switches at the Status and Control plug-in front panel. In Local Control, the FO System will execute a local command from the front panel of the Status and Control plug-in. The computer control can be locked out, if desired, by pressing the recessed switch at the lower section of the Status and Control plug-in indicated by "Lockout" as shown in Figure 2-28.

The recessed switches next to the LED display of the Status and Control plug-in refer to the FO plug-ins in Slots 1 to 6. If the Slot contains a FO Transmitter plug-in, then pressing the recessed switch toggles the laser power between on and off; if the Slot contains a primary FO Receiver plug-in, then pressing the recessed switch toggles the RF switch position. If the FO Receiver plug-in is a standby unit, then the recessed switch has no effect. If there is no RF switch (for example, a non-redundant link), then pressing the recessed switch for a FO Receiver plug-in has no effect. The response of the system to switching is displayed in the LED display of the Status and Control plug-in. The green LEDs show the RF paths; the yellow LEDs show the paths that are available upon appropriate RF switching. In summary, pressing the recessed switches on the front panel of the Status and Control plug-in has the following effects:

| PLUG-IN TYPE | RECESSED SWITCH FUNCTION |
|---|---|
| FO Transmitter | Laser Power On/Off |
| Primary FO Receiver (System with RSU) | RF Switch Toggle |
| Standby FO Receiver (System with RSU) | No Effect |
| Primary FO Receiver (Non-Redundant System) | No Effect |

The RESET brings the chassis back to the system default configuration: automatic redundancy switching configuration, use of the primary FO links and alarms reset.

Examples of the local control logic are given in Figure 2-31. In a 1:1 redundancy switching configuration (Figure 2-1), a power divider splits input RF power to two FO transmitter plug-ins. The Status and Control plug-in LED display shows green lighted paths to each FO transmitter plug-in as shown in Figure 2-31(a). At the FO receiver chassis, the RF switch selects the primary FO link path (Slot 1) as shown by the green LED display in Figure 2-31(b). Slot 2 is the Standby FO path and is indicated by the yellow LEDs. If the recessed switch corresponding to the primary FO Transmitter plug-in (Slot 1) is pressed, then that turns the FO transmitter plug-in off. The front panel display of the FO Transmitter plug-in shows "OPT PWR LO". The Status and Control

plug-in LED display to that FO plug-in remains green (Figure 2-31(a)) because the LED shows the RF power divider not the status of the defective FO Transmitter plug-in (the status of the FO Transmitter plug-in is shown on its own front panel). If the system is in the automatic redundancy switching mode of operation, then at the FO receiver chassis, the system automatically switches to the standby path (Slot 2) as shown by the Status and Control LED display of Figure 2-31(c).

Pressing the recessed switch again turns the FO Transmitter plug-in back on. At the FO Receiver chassis, the standby FO path (Slot 2) remains in use. To reset the FO Receiver chassis to the primary path (Slot 1), the recessed switch corresponding to the FO Receiver (Slot 1) must be pressed. This toggles the RF switch so that Slot 1 changes from being "idle" to "in use". Pressing the Status and Control plug-in Master Reset resets the entire chassis to the default configuration. If the standby FO path (Slot 2) is in use and the primary FO path is defective (Slot 1), then pressing the recessed switch at the FO Receiver plug-in (Slot 1) will toggle the RF switch to go back to Slot 1, but then it will automatically return to Slot 2 if the system is in the automatic mode of operation.
As a second example, consider a 1:2 redundancy configuration in Slots 1, 2 and 3 of a pair of chassis. At the FO Transmitter chassis, the default switch position is such that RF power from Input #1 goes through a switch and power divider to both FO Transmitter plug-ins in Slots 1 and 2 as shown in Figures 2-1 and displayed in Figure 2-32(a). The RF power from Input #3 goes to the Slot 3 FO Transmitter. There is a yellow LED between the RF Input #3 and FO Transmitter #2 to indicate the presence of an RF switch between the plug-ins. The recessed switches toggle the corresponding FO Transmitters between laser power on and off. At

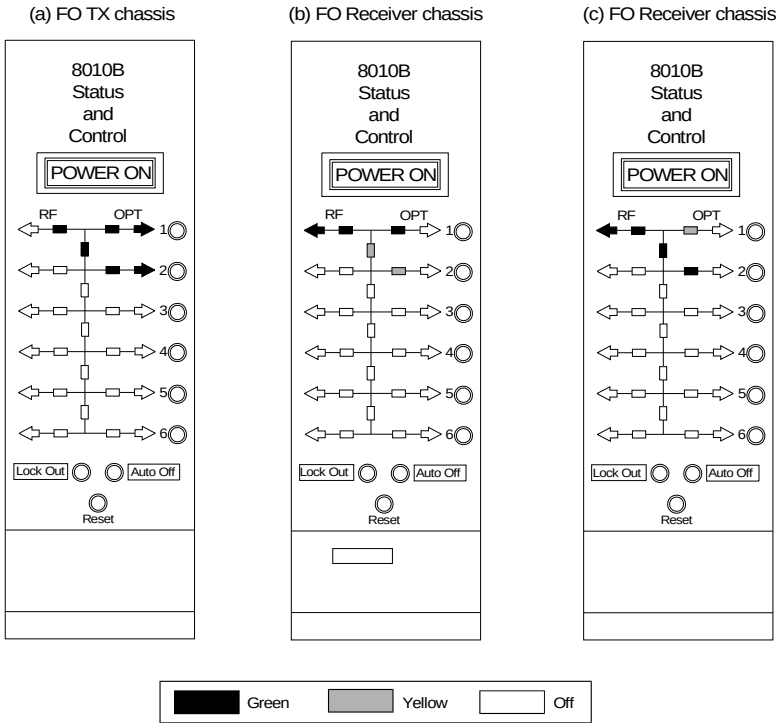



**Figure 2-31**
LED display showing RF paths at FO Transmitter & Receiver chassis for a 1:1 Redundant System

the FO Receiver chassis, the RF paths are through the primary links (Slots 1 and 3) as shown in Figure 2-32(b).

The yellow LEDs show that FO Receiver #2 is "Idle". If the recessed switch corresponding to Slot 3 is pressed to turn off that FO Transmitter, then the RF switch would automatically switch so that RF power from Input #3 goes through the standby link (Slot 2). At the FO Receiver chassis, the redundant FO Receiver (Slot 2) would then switch to being in use as shown in Figure 2-32(c). Pressing the recessed switches at the FO Receiver chassis has the following response: Switch 1 toggles the RF switch between plug-ins in Slots 1 and 2; similarly Switch 3 toggles the RF switch between Slots 2 and 3; Switch 2 at the receiver is inactive. In the 1:2 configuration, there is no direct control of the RF switch at the FO Transmitter chassis; the recessed switches turn the FO Transmitter on/off. However, the RF switch at the FO Transmitter can be indirectly toggled by sequentially turning the Power "Off" to FO Transmitter #3 and then turning the Power back "On" to Transmitter #3 and then turning the power "Off" to Transmitter #1.

**RESET**

The "RESET" control at the front panel directly resets the microprocessor and reconfigures the redundancy switching configuration and all alarms back to the default configuration. After performing operations using the local switching control, the operator should verify the state of the system. In particular, the user should check that the redundancy switching is in the automatic mode and that the chassis containing the FO receiver plug-ins is not inadvertently left with the standby paths in use. The system will not automatically switch back to the primary path if the standby path fails even if the primary path is functional. A simple way to reset the system is to press the chassis "Reset" switch on the Status and Control plug-in at each chassis. This resets the redundancy switching configuration to the automatic mode and use of the primary FO links and resets the alarms.

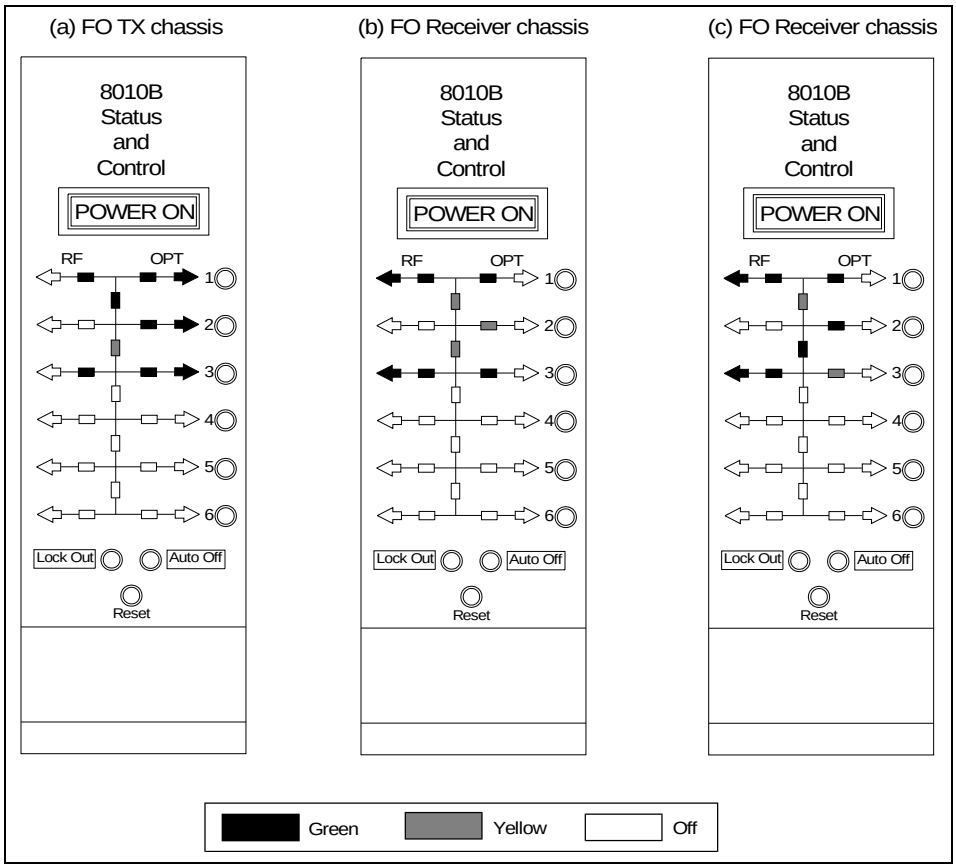



**Figure 2-32**
LED display showing RF paths at FO Transmitter & Receiver chassis for a 1:2 Redundant System

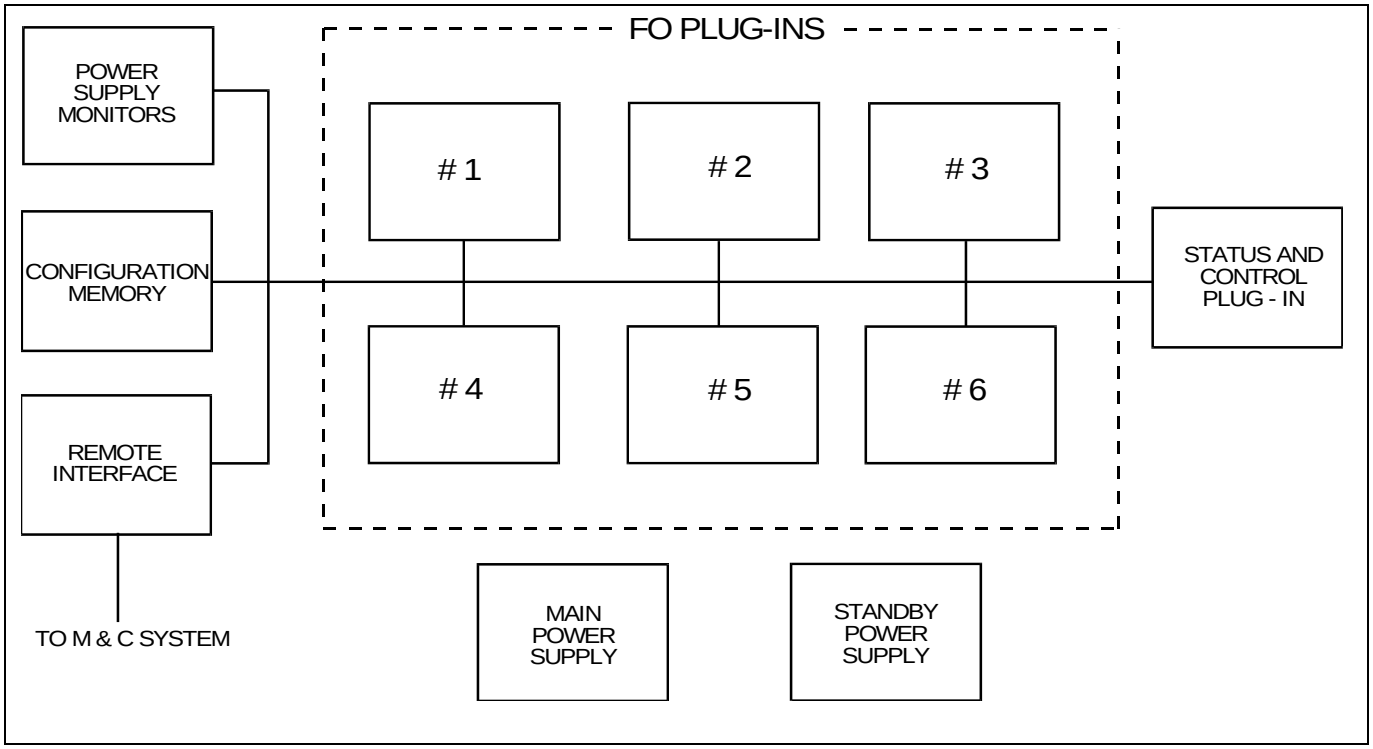



**Figure 2-33**
Interface of Status and Control plug-in with other components in the FO system

**STATUS AND ALARM INFORMATION**

Figure 2-33 shows how the Status and Control plug-in interfaces with the other components in the FO System. Figure 2-34 is a block diagram of the Status and Control plug-in, showing the functions of the components within the plug-in.

Remote control, status and alarm reporting is through the remote interface serial port (9-pin D-connector) at the rear panel of the chassis. Figure 2-35 gives the input/output pins for the RS-232 serial data cable. The interface to an IBM PC Standard computer is also shown.

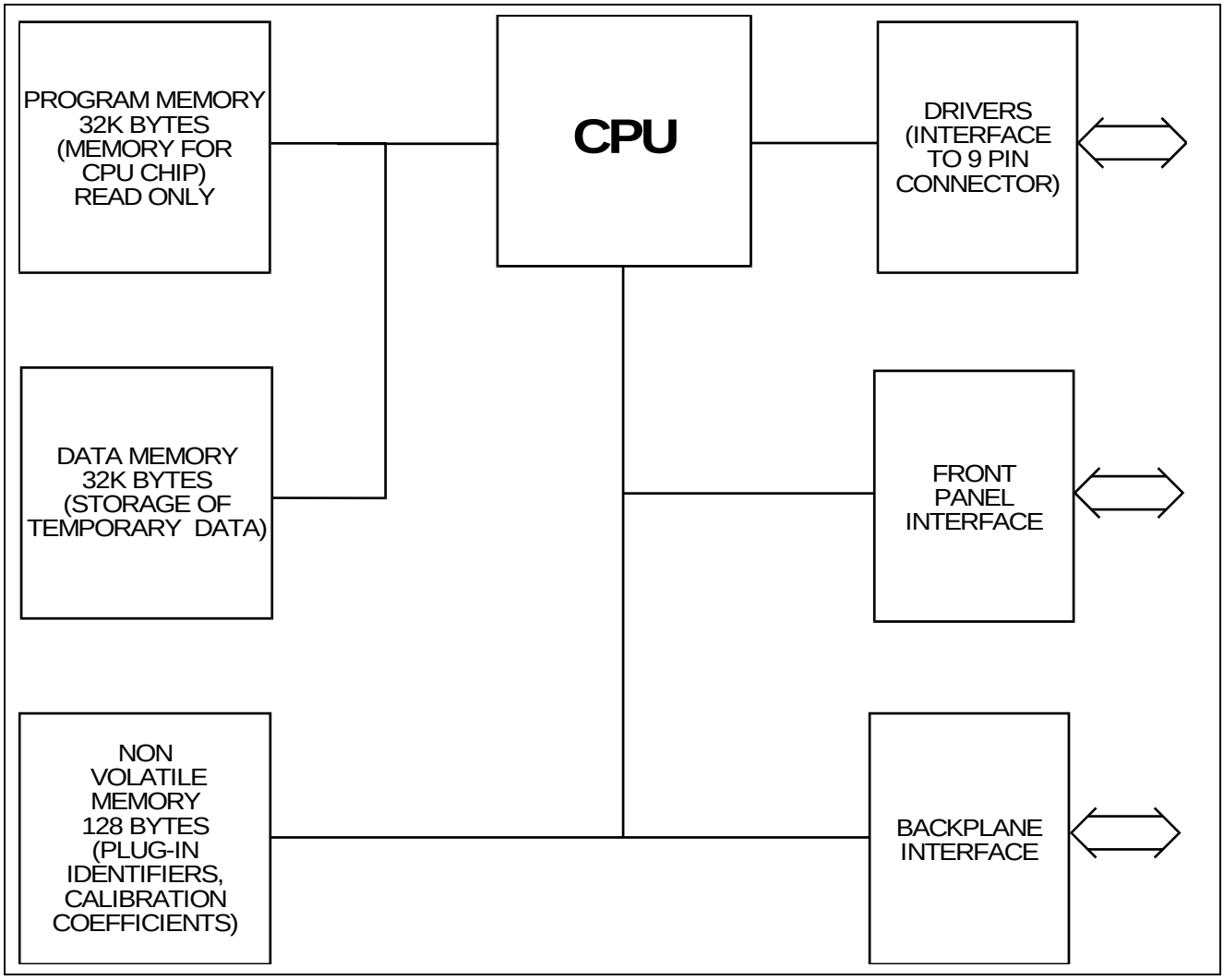



**Figure 2-34** Block diagram of Status and Control plug-in

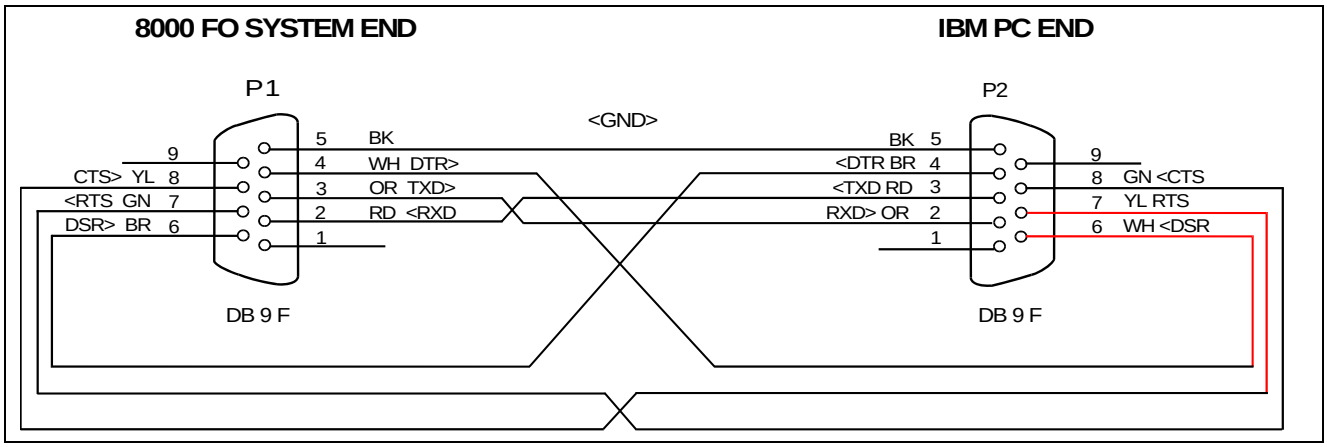



**Figure 2-35** The serial data cable for the Ortel Fiberoptic System RS-232 interface.

8000 FO SYSTEM END IBM PC END

| Notes: | | |
|---|---|---|
| 1. <and> indicate direction of signal flow<br>2. This is a 'null modem' cable<br>3. Female connectors on both ends | DSR<br>CTS<br>RTS<br>RXD<br>TXD<br>DTR | Data Set Ready<br>Clear To Send<br>Request To Send<br>Receive Data<br>Transmit Data<br>Data Terminal Ready |

**MONITOR AND ALARM INDICATORS**

The Status and Control plug-in provides the status for the following conditions for the various plug-ins and the purpose of each indicator:

| Plug-in | Status Indicators | Purpose of Monitor |
|---|---|---|
| Power Supplies: | Power On | Indicates power to plug-in |
| Status and Control: | Power On | Indicates power to plug-in |
| FO Up/Down Transmitter | Power On | Indicates power to plug-in |
| | PD Current Monitor (PDIM) | Laser optical output (0.3 to 1.2 mA) |
| | Laser DC Current Monitor (LSRIM) | Current drawn by laser (50 to 100 mA) |
| | TE Cooler Current Monitor (TEIM) | Laser temperature stability (-1 to 1.6 A) |
| | RF Power Monitor (RFPM) | Monitors internal amplifier functionality |
| FO Up/Down Receiver | Power On | Indicates power to plug-in |
| | PD Current Monitor (PDIM) | Received optical signal (0.2 to 2 mA) |
| | RF Power Monitor (RFPM) | Monitors internal amplifier functionality |
| FO RF Signal Monitor Transmitter | Power On | Indicates power to plug-in |
| | PD Current Monitor (PDIM) | Laser optical output (0.3 to 1.2 mA) |
| | Laser DC Current Monitor (LSRIM) | Current drawn by laser (50 to 100 mA) |
| | TE Cooler Current Monitor (TEIM) | Laser temperature stability (-1 to 1.6 A) |
| | Switch Position (MONR) | Specifies the selected RF input |
| FO RF Signal Monitor Receiver | Power On | Indicates power to plug-in |
| | PD Current Monitor (PDIM) | Received optical signal (0.2 to 2mA) |
| FO Data Link | Power On | Indicates power to plug-in |
| | PD Current Monitor (PDIM1) | Laser optical output (0.3 to 1.2 mA) |
| | Laser DC Current Monitor (LSRIM) | Current drawn by laser (50 to 100 mA) |
| | TE Cooler Current Monitor (TEIM) | Laser temperature stability (-1 to 1.6 A) |
| | PD Current Monitor (PDIM2) | Received optical signal (0.2 to 2 mA) |
| | Data Monitor (DATA) | Received signal |
| Status and Control | System Status Display | Specifies the FO paths in use or idle |

**Figure 2-36** Plug in Monitor Information

The Status and Control plug-in provides an alarm for the following conditions for the various plug-ins as provided in Figure 2-37. On the plug-in LED display, a red alarm indicates a failure requiring immediate switching to a standby path (standby power supply or standby FO link path); a yellow alarm is a warning that should be checked.

| Plug-in | Alarm Indicators | Failure |
|---|---|---|
| Power Supplies | +15 V FAULT (red)<br>-15 V FAULT (red)<br>+5 V FAULT (red) | Power supply failure/Replace plug-in<br>Power supply failure/Replace plug-in<br>Power supply failure/Replace plug-in |
| FO Up/Down Transmitter | OPT PWR LO (red)<br>LASER TEMP (red)<br>RF PWR LO (yellow) | Laser degradation/Replace plug-in<br>TE cooler failure/Replace plug-in<br>RF signal low/Check cause |
| FO Up/Down Receiver | OPT PWR LO (red)<br>OPT PWR HI (yellow)<br>RF PWR LO (yellow) | Loss of optical signal/Replace plug-in or fiber<br>Excess optical signal/Check cause & adjust<br>RF signal low/Check cause |
| FO RF Signal Monitor Transmitter | OPT PWR LO (red)<br>LASER TEMP (red) | Laser degradation/Replace plug-in<br>TE cooler failure/Replace plug-in |
| FO RF Signal Monitor Receiver | OPT PWR LO (red)<br>OPT PWR HI (yellow) | Loss of optical signal/Replace plug-in or fiber<br>Excess optical signal/Check cause & adjust |
| FO Data Link | LSR PWR LO (red)<br>PD PWR LO (red)<br>NO DATA (yellow) | Laser degradation/Replace plug-in<br>Loss of optical signal/Replace plug-in or fiber<br>Data signal low/Check cause |
| Status and Control | Fan<br>Auto Off (yellow)<br>Remote Lockout (yellow)<br>Redundant Path in Use | M&C Warning/Check Fan/Replace<br>Warning/Automatic switching disabled<br>Warning/Computer control disabled<br>M&C Warning/May have no backup path |

**Figure 2-37**
Plug-in Alarm Information

The Monitor & Control (M&C) warnings for the automatic redundancy switching off (Auto Off) and computer control lockout (Lockout) are displayed locally on the chassis Status & Control plug-in.

| COMPONENT | PIN ASSIGNMENT | MONITOR | ALARM | LED COLOR |
|---|---|---|---|---|
| POWER SUPPLY | | POWER ON | | GREEN |
| | 10A, 10B, 10C | | +5 V FAULT | RED |
| | 12A | | -15 V FAULT | RED |
| | 23A, 23B, 23C | | +15 V FAULT | RED |
| FO UPLINK AND DOWNLINK TRANSMITTER PLUG-INS | | POWER ON | | GREEN |
| | 5A | PD CURRENT mA 0.3 TO 2A | | USER'S M&C |
| | 5B | LASER CURRENT 50-100 mA | | USER'S M&C |
| | 5B | TE CURRENT -1 TO 1.6 A | | USER'S M&C |
| | 6A | RF POWER | | USER'S M&C |
| | 9A | | OPT PWR LO | RED |
| | 9B | | LASER TEMP | RED |
| | 9C | | RF PWR LO | YELLOW |
| FO UPLINK AND DOWNLINK RECEIVER PLUG-INS | | POWER ON | | GREEN |
| | 5A | PD CURRENT mA 0.2 TO 2 mA | OPT PWR LO | USER'S M&C |
| | 5C | RF POWER | | USER'S M&C |
| | 9A | | OPT PWR LO | RED |
| | 9B | | OPT PWR HI | YELLOW |
| | 9C | | RF PWR LO | YELLOW |
| FO RF SIGNAL MONITOR TRANSMITTER PLUG-INS | | POWER ON | | GREEN |
| | 5A | PD CURRENT 0.3 TO 2 mA | | USER'S M&C |
| | 5B | LASER CURRENT 50 TO 100 mA | | USER'S M&C |
| | 5C | TE CURRENT -1 TO 1.6 A | | USER'S M&C |
| | 6A | SWITCH POSITION | | USER'S M&C |
| | 9A | | OPT PWR LO | RED |
| | 9B | | LASER TEMP | RED |
| STATUS & CONTROL | | POWER ON | | GREEN |
| | | AUTO OFF | | YELLOW |
| | | LOCK OUT | | YELLOW |
| FIBEROPTIC DATA LINK | | POWER ON | | GREEN |
| | 5A | MONITOR PD (PDIM1) 0.3 TO 2 mA | | |
| | 5B | LASER CURRENT 50 TO 100 mA | | USER'S M&C |
| | 9A | PD CURRENT (PDIM2) 0.2 TO 2 mA | | |
| | | | LSR PWR LO | RED |
| | | | PD PWR LO | RED |
| | 5 TO 7 | | NO DATA | YELLOW |
| CHASSIS | | RF SWITCH POSITION | | USER'S M&C |
| | | | FAN | USER'S M&C |
| | | | STANDBY PATH IN USE | USER'S M&C |

**Figure 2-38**
Monitor and alarm descriptions for the various components in the fiberoptic system.

Figure 2-38 summarizes the status and alarms, the pin assignment on the Status and Control plug-in and the color of the LED display on the FO plug-ins. The pin assignments between the Status and Control plug-in and the chassis backplane are given below in Figure 2-39.

| Pin No. | Description |
|---|---|
| 10A | +5V |
| 10B | +5V |
| 10C | +5V |
| 11A | GND |
| 11B | GND |
| 11C | GND |
| 12A | -15 V |
| 14A | TXD: Transmit Data Serial Bus. The data transmitted by the FO System. |
| 14A | RXD: Receive Data Serial Bus. The data received by the FO System. |
| 14B | GND: Ground |
| 14C | IICC: Inter-Integrated Circuit Clock. This is a bidirectional serial data bus. |
| 21B | IICD: Inter-Integrated Circuit Data. This is a bidirectional serial digital bus. |
| 23A | +15V |
| 23B | +15V |
| 23C | +15V |

**Figure 2-39** Status and Control plug-in pin assignments

Connector: DIN 41612, Type M.
Dimensions 5.25 in. high, 1.6 in. wide, 19.5 in. deep

The chassis address can be set with the DIP switch located on the SCP circuit board. The settings are described in the following section on software interface.

# SOFTWARE INSTALLATION AND OPERATION

This is a walk through of configuring a system 8000 chassis using the system 8000 "systest.exe" software. This example assumes the software will be run from the DOS prompt and the software is loaded on a fixed disk drive (ex. *c*:\8000, or whatever letter is assigned to the fixed disk drive) if the software is being run from a ORTEL supplied 3.5 "diskette, or equivalent, substitute the appropriate drive letter designation (ex. ***a***:\ 8000).

1. Insure you are in the system 8000 directory (ex. If the system 8000 files are in the 8000 directory.) :
   a.) Type "cd\8000"
   Assuming the software is being run from a fixed disk drive designated as drive ***c:*** , the computer display should now read :
   c:\8000>
   b.) Type "systest.exe"
   At this time the system 8000 software should be visibly loading on the computer display. A message may be displayed stating the following :

   *Reading Configuration Data"*
   * If configuration data is not available, the message:
   "*using default value"* will also be displayed.

   After the message window is gone from the display the system 8000 software is running and ready to be configured.

| File | Operation | Setup | Options | Window | Help |
|---|---|---|---|---|---|

2. At the top of the System 8000 software-interface is the "control menu". The control menu will be visible from all system 8000 user interface modes, (setup, configuration, etc.). A wise first step in chassis configuration is to insure that software chassis configuration corresponds with plug-ins installed in the chassis. To do this press and hold the "Alt" key (this activates the "control" menu), while the "Alt" key is pressed press and release the "S" key (this activates the "Setup" menu).
   a.) Press and hold the "Alt" key while pressing and releasing the "S" key. At this time the "Setup" menu should be displayed.
   b.) Press and release the "A" key. This displays the "Allow InIt." (allow initialization) option. Select "Yes", then select "OK"
   c.) Repeat step 2a.
   d.) Press and release the "C" key. This accesses the system 8000 chassis configuration utility. The "Reading Configuration data" message will be briefly displayed. When this message is gone the chassis configuration utility is ready for use. The computer display should resemble the illustration on page 3-10 figure 3-6 of the System 8000 Operating Manual.
   e.) Verify that corresponding plug-in identifiers agree with plug-ins physically located in the chassis. If this is the case, select "OK" at the bottom of the configuration menu. Message windows will be displayed saying the following:
   "Updating configuration";
   "Sending Redundancy Reset Command"; and
   "Reading Configuration Data".
   When these messages are no longer displayed. The System 8000 "System Status" Display will be running. If this is the case, the plug-ins are correctly configured, go to step 4.
   f.) If this is not the case, (plug-ins are not reading correctly, new plug-ins have been added or removed from chassis, or plug-ins are not reading at all.), proceed with chassis configuration, and/or plug-in configuration listed below in step #3.

3. Repeat Steps 2a.) and 2b.)
   The "System Configuration" program can now be configured for proper operation.
   a.) Press and hold the "Alt" key while pressing and releasing the "1" key. Use the up and down arrows, "_" "↓", to select the correct plug-in type.
   b.) Press the "Tab" key to configure plug-in redundancy status. If the chassis is configured for redundancy select 1 : 1 or 1 : 2. If the chassis is not configured for redundancy select "None".
   c.) Press the "Tab" key again to configure the plug-in as a "Primary" or "Redundant" link according to site requirements.

d.) Repeat Step 3a.) through 3c.) for each additional plug-in location in the chassis, if there is no plug-in a particular chassis slot, enter "None".

e.) On the left side of the "System Configuration" display are 'site specific', 'user definable' information and settings. This information is dependent on End User requirements, and system configuration. Initial values should be set to the following guidelines:

| | |
|---|---|
| Facility Name: | *User Definable* |
| Date / Time: | *User Definable* |
| Optical Loss: | System Dependent |
| Location msg.: | *User Definable* |
| Chassis SN: | System Dependent |
| SCP serial: | System Dependent |
| SCP Model: | System Dependent |
| SCP user msg.: | *User Definable* |
| Chassis Loc.: | System Dependent |

| Default Settings: | | | |
|---|---|---|---|
| Local Lockout | * | OFF | |
| | | ON | |
| Auto Redundancy | * | OFF | (*off* for no redundancy) |
| | | ON | (*on* for redundant units) |
| Async msgs | * | OFF | |
| | | ON | |

f.) At the bottom of each plug-in column of the system configuration window, the plug-in model # and Serial # are displayed. If their is no display, or something other than the plug-ins model # or serial # is displayed, further plug-in configuration is required. If this is the case skip step # 3g, and refer to step # 4 for more details.

g.) At this time the data in the "System configuration" window should be correctly entered. Press "Enter" to accept the entered configuration values.

4 . The "System Status" window should now be displayed. Some of the information displayed in the top right corner of the "System Configuration" window is displayed in the top left corner of the "System Status" window. Plug-in status is played in the lower half of the window. Plug-in status should reflect actual values. If this is not the case, and all zeros, or ASCII character set, dashed lines, or if no serial and/or model number was displayed in step 3f.), proceed as follows to configure each individual plug-in. Selections from Menu Bar can be made by pressing the "Alt" key with the designated red colored letter where necessary.

a.) Press and hold the "Alt" key while pressing and releasing the "S" key.

b.) Press and release the "s" key. This accesses the plug-in selection utility.

c.) Use the "_" , or "↓" arrow keys to select the desired plug-in type, and press "*Ente"*

d.) Repeat step 4a.).

e.) Press and release the "t" key. This accesses the plug-in setup utility. The computer will first display the *"Reading Unit Data"* message and then display the plug-in setup utility. Or use arrow Down to go to "Setup unit" menu and press "Enter". Steps F through N should be completed before you press "Enter".

f.) Press and hold the "Alt" key while pressing and releasing the "I" key. This will initialize the plug-in to Ortel default values. Do not press "Enter" until you get to step "l".

g.) Press "Alt" press and release the "t" key. This accesses the plug-in type. Select the proper plug-in type as in step "c" using arrows.

h.) While pressing the "Alt" key Press and release the "S" key and enter the plug-in serial number.

i.) Press the "Tab" key, or "m" key to enter the plug-in model number.

j.) Press the "Tab" key, or "U" key to enter the user message. (This is a *user definable* input).

k.) Press the "Tab" key, or "T" key to select the Plug in type. Use the "_", or "↓" arrow keys to select the "unit type".

l.) "Coeff", and "Offset" values are predetermined by default. The RF Power Coeff. + Offset values are set to a default value, however using the rf- power input level as a reference, the user may wish to modify these variables to reflect specific site signal level conditions.
m.) Press the "*Enter*" key. The plug-in is now configured for operation.
n.) Repeat steps 4a-n for additional plug-ins as required.

5. At this point the chassis should be configured correctly.
   a.) In the "System Status" window information in the upper left corner of the display reflects the user input. The plug-in status information in the lower half of the display should correctly reflect the Chassis plug-in status such as Alarms.
   b.) Press and hold the "Alt" key, while pressing and releasing the "s" key. Then press and release the "c" key. Them "System Configuration" menu should now list the plug-in model and serial number values at the lower area of the display. This step can be used as quick check for configuration.
   c.) Press "*Enter*".

6. The System 8000 Chassis should now be correctly configured.

# Key Stroke Summary

## INITIALIZE SYSTEM 8000 SOFTWARE:

| | | |
|---|---|---|
| Type: | C: | Change to the drive where the System 8000 software |
| Press: | Enter | is located . |
| Type: | CD\ 8000 | Changes to the DOS directory where the |
| Press: | Enter | Syst. 8000 software is located |
| Type: | Systest | Starts the systest.exe |
| Press: | Enter | software program . |

## VERIFY CHASSIS CONFIGURATION:

| | | |
|---|---|---|
| Press and Hold: | Alt (key) | Display |
| Press and Release: | S (key) | " Setup " menu |
| Press and Release: | C (key) | Display 8000 configuration utility. |

## CONFIGURE CHASSIS: (A)

(If not already in configuration utility)

| | | |
|---|---|---|
| Press and Hold: | Alt (key) | Display |
| Press and Release: | S (key) | " Setup " menu |
| Press and Release: | A (key) | Allow Initialization |
| Press and Release: | _ (or) ¯ (key) | Select " Yes " |
| Press and Release: | Enter | Accept selection |

# CONFIGURE CHASSIS: (B)

(If already in configuration utility)

## Configure Plug – ins for Chassis (B):

| | | |
|---|---|---|
| Press and Hold: | Alt (key) | This selects plug - in # 1 |
| Press and Release: | 1 (key) | (select additional plug - ins as required ) |
| Press and Release: | _ (or) ↓ (key) | Select plug - in type |
| Press and Release: | Tab (key) | Move to next window |
| Press and Release: | _ (or) ¯ (key) | Select Redundancy |
| Press and Release: | _ (or) ¯ (key) | Select Primary or Redundant |
| Press and Hold: | Alt (key) | Enter |
| Press and Release: | F (key) | Facility name |
| Press and Hold: | Alt (key) | Enter date and time |
| Press and Release: | D (key) | of configuration . |
| Press and Hold: | Alt (key) | Enter system optical |
| Press and Release: | p (key) | budget requirement . |
| Press and Hold: | Alt (key) | User definable |
| Press and Release: | m (key) | comment |
| Press and Hold: | Alt (key) | Enter chassis |
| Press and Release: | S (key) | serial number |
| Press and Hold: | Alt (key) | Enter Status and control |
| Press and Release: | C (key) | serial number |
| Press and Hold: | Alt (key) | Enter status and control |
| Press and Release: | e (key) | model number |
| Press and Hold: | Alt (key) | User definable |
| Press and Release: | u (key) | message |
| Press and Hold: | Alt (key) | Enter chassis location |
| Press and Release: | h (key) | System / Site Dependent |
| Press and Hold: | Alt (key) | Set Local Lockout |

## Configure Plug – ins for Chassis (B):

| | | |
|---|---|---|
| Press and Release: | o (key) | Default is Off |
| Press and Hold: | Alt (key) | Set redundancy option |
| Press and Release: | R (key) | System dependent |
| Press and Hold: | Alt (key) | Set Async. messages |
| Press and Release: | A (key) | Default is Off |
| Press and Release: | Enter (key) | Chassis is configured. |

The System 8000 chassis is now correctly configured for normal operation .

# SOFTWARE INTERFACE TO USER'S M&C SYSTEM

This section describes the communication commands via the serial link (known as "Remote Interface") between the Ortel FO System Status and Control plug-in (SCP) and the user-supplied Monitor and Control (M&C) System. The following describe the commands that the user's M&C System must send in order to control and monitor the Ortel FO System. The user's M&C System polls the FO System to obtain status information.

The serial link interface can be either RS-232 or RS-485 (as specified in the purchase order). If the interface is RS-485, then each FO System chassis is addressable using the Dual Inline Package (DIP) switch located on the SCP circuit board and a multidrop serial cable can be used. This section gives the messages and commands for both the RS-232 and RS-485. A 120 ohm bus terminating resistor is provided on the SCP and should be used whenever the chassis is at one end of the RS-485 bus. The termination is connected whenever the jumper plug located near the DIN connector on the SCP is installed (the jumper plug is factory installed). To disconnect the terminating resistor, simply remove the jumper plug. If the FO System is RS-232, then 'Address' is factory set to the single character hex FF. For a Remote Interface that is RS-485, the chassis 'Address' assignment made using the DIP switch is given in Figure 2-40. On the DIP switch, the 'Off' position refers to the '1' bit setting; the 'On' position refers to the '0' bit setting.

| Address (hex) | DIP Switch Setting 1 2 3 4 5 6 7 8 | Address (hex) | DIP Switch Setting 1 2 3 4 5 6 7 8 | Address (hex) | DIP Switch Setting 1 2 3 4 5 6 7 8 |
|---|---|---|---|---|---|
| 20 | 0 1 0 0 0 0 0 0 | 40 | 0 0 1 0 0 0 0 0 | 60 | 0 1 1 0 0 0 0 0 |
| 21 | 0 1 0 0 1 0 0 0 | 41 | 0 0 1 0 1 0 0 0 | 61 | 0 1 1 0 1 0 0 0 |
| 22 | 0 1 0 0 0 1 0 0 | 42 | 0 0 1 0 0 1 0 0 | 62 | 0 1 1 0 0 1 0 0 |
| 23 | 0 1 0 0 1 1 0 0 | 43 | 0 0 1 0 1 1 0 0 | 63 | 0 1 1 0 1 1 0 0 |
| 24 | 0 1 0 0 0 0 1 0 | 44 | 0 0 1 0 0 0 1 0 | 64 | 0 1 1 0 0 0 1 0 |
| 25 | 0 1 0 0 1 0 1 0 | 45 | 0 0 1 0 1 0 1 0 | 65 | 0 1 1 0 1 0 1 0 |
| 26 | 0 1 0 0 0 1 1 0 | 46 | 0 0 1 0 0 1 1 0 | 66 | 0 1 1 0 0 1 1 0 |
| 27 | 0 1 0 0 1 1 1 0 | 47 | 0 0 1 0 1 1 1 0 | 67 | 0 1 1 0 1 1 1 0 |
| 28 | 0 1 0 0 0 0 0 1 | 48 | 0 0 1 0 0 0 0 1 | 68 | 0 1 1 0 0 0 0 1 |
| 29 | 0 1 0 0 1 0 0 1 | 49 | 0 0 1 0 1 0 0 1 | 69 | 0 1 1 0 1 0 0 1 |
| 2A | 0 1 0 0 0 1 0 1 | 4A | 0 0 1 0 0 1 0 1 | 6A | 0 1 1 0 0 1 0 1 |
| 2B | 0 1 0 0 1 1 0 1 | 4B | 0 0 1 0 1 1 0 1 | 6B | 0 1 1 0 1 1 0 1 |
| 2C | 0 1 0 0 0 0 1 1 | 4C | 0 0 1 0 0 0 1 1 | 6C | 0 1 1 0 0 0 1 1 |
| 2D | 0 1 0 0 1 0 1 1 | 4D | 0 0 1 0 1 0 1 1 | 6D | 0 1 1 0 1 0 1 1 |
| 2E | 0 1 0 0 0 1 1 1 | 4E | 0 0 1 0 0 1 1 1 | 6E | 0 1 1 0 0 1 1 1 |
| 2F | 0 1 0 0 1 1 1 1 | 4F | 0 0 1 0 1 1 1 1 | 6F | 0 1 1 0 1 1 1 1 |
| 30 | 1 1 0 0 0 0 0 0 | 50 | 1 0 1 0 0 0 0 0 | 70 | 1 1 1 0 0 0 0 0 |
| 31 | 1 1 0 0 1 0 0 0 | 51 | 1 0 1 0 1 0 0 0 | 71 | 1 1 1 0 1 0 0 0 |
| 32 | 1 1 0 0 0 1 0 0 | 52 | 1 0 1 0 0 1 0 0 | 72 | 1 1 1 0 0 1 0 0 |
| 33 | 1 1 0 0 1 1 0 0 | 53 | 1 0 1 0 1 1 0 0 | 73 | 1 1 1 0 1 1 0 0 |
| 34 | 1 1 0 0 0 0 1 0 | 54 | 1 0 1 0 0 0 1 0 | 74 | 1 1 1 0 0 0 1 0 |
| 35 | 1 1 0 0 1 0 1 0 | 55 | 1 0 1 0 1 0 1 0 | 75 | 1 1 1 0 1 0 1 0 |

| Address (hex) | DIP Switch Setting 1 2 3 4 5 6 7 8 | Address (hex) | DIP Switch Setting 1 2 3 4 5 6 7 8 | Address (hex) | DIP Switch Setting 1 2 3 4 5 6 7 8 |
|---|---|---|---|---|---|
| 36 | 1 1 0 0 0 1 1 0 | 56 | 1 0 1 0 0 1 1 0 | 76 | 1 1 1 0 0 1 1 0 |
| 37 | 1 1 0 0 1 1 1 0 | 57 | 1 0 1 0 1 1 1 0 | 77 | 1 1 1 0 1 1 1 0 |
| 38 | 1 1 0 0 0 0 0 1 | 58 | 1 0 1 0 0 0 0 1 | 78 | 1 1 1 0 0 0 0 1 |
| 39 | 1 1 0 0 1 0 0 1 | 59 | 1 0 1 0 1 0 0 1 | 79 | 1 1 0 0 1 0 0 1 |
| 3A | 1 1 0 0 0 1 0 1 | 5A | 1 0 1 0 0 1 0 1 | 7A | 1 1 1 0 0 1 0 1 |
| 3B | 1 1 0 0 1 1 0 1 | 5B | 1 0 1 0 1 1 0 1 | 7B | 1 1 1 0 1 1 0 1 |
| 3C | 1 1 0 0 0 0 1 1 | 5C | 1 0 1 0 0 0 1 1 | 7C | 1 1 1 0 0 0 1 1 |
| 3D | 1 1 0 0 1 0 1 1 | 5D | 1 0 1 0 1 0 1 1 | 7D | 1 1 1 0 1 0 1 1 |
| 3E | 1 1 0 0 0 1 1 1 | 5E | 1 0 1 0 0 1 1 1 | 7E | 1 1 1 0 0 1 1 1 |
| 3F | 1 1 0 0 1 1 1 1 | 5F | 1 0 1 0 1 1 1 1 | 7F | 1 1 1 0 1 1 1 1 |

DIP switch position 'off' represents the '1' bit; switch position 'on' represents the '0' bit.

**Figure 2-40** Chassis Address using the DIP switch located on the Status and Control plug-in.

Messages sent to a FO System chassis must be formatted in the following manner:

| STX | Address | Data | ETX | CKSUM |
|---|---|---|---|---|

where:

STX is the framing character (hex 02) used to indicate the start of a message.

Address is a single character in the range hex 20 through hex 7F, which is the unique address of the chassis that is to process the message. If the remote interface is RS-232, then the Address is a single character hex FF.

Data is a variable length string of characters containing the actual command and data to be processed by the chassis. The exact content of these strings are listed in the following section.

ETX is the framing character (hex 03) used to indicate the end of a message.

CKSUM is a single character checksum used to validate the message before it is processed. The checksum character is the exclusive OR of all the message characters (STX, Address, Data, ETX).

The chassis will acknowledge the receipt of a message by transmitting the following message if the received message was recognized and contained a valid chesksum:

| | | | | |
|---|---|---|---|---|
| STX | Address | ACK | ETX | CKSUM |

If the received message was not recognized, contained invalid or improperly formatted data, or contained a bad checksum, the chassis will transmit the following message:

| | | | | |
|---|---|---|---|---|
| STX | Address | NAK | ETX | CKSUM |

The 'Address' portion of both of these response messages will contain the assigned address character of the chassis that transmitted the message. It is the responsibility of the M&C system to verify that the proper chassis responded to the message. If the 'NAK' message is transmitted, the M&C System can obtain detailed information as to the type of error by using the 'SYST?' query command.

If the message requires the FO System chassis to transmit data, it will first transmit the ACK message followed by the response message formatted as indicated below. The requested data will be in the 'Data' field of the message.

| | | | | |
|---|---|---|---|---|
| STX | Address | Data | ETX | CKSUM |

The 'Address' portion of this message will contain the assigned address character of the chassis transmitting the message.

To ensure that the receive buffers in each chassis do not overflow, the M&C System should wait for the ACK or NAK response after sending each message.

For each command shown below, the string enclosed in single quotes (') represent the exact command string (or keystroke) to be sent. The single quote characters are not part of the strings and should not be sent. Strings not shown below and strings having invalid parameters are ignored but will cause a NAK response to be sent. Strings having parameters that are outside their valid ranges are ignored. Indicated selector values are always transmitted as digit characters (i.e. the selector 0 is transmitted as the ASCII character '0' (hex 30)). Parameter values have the form snnnnnn where s is the sign character (' ', '+' or '-'), n is a digit ('0'..'9' or a decimal point '.').

If a command mnemonic is not recognized, the 'command not recognized' bit in the status word is set. If the format of the command is invalid or the parameters (if any) are not formatted correctly or are out of range, the 'command syntax error' bit is set in the extended status word. If the received checksum is in error, the 'checksum error' bit is set in the extended status word. These three bits are reset whenever the status is read (see 'SYST?' command).

The Status and Control Plug-in continually interrogates all the plug-ins in the chassis and maintains a record of their current state. When the appropriate query command is received from the M&C, the Status and Control Plug-in will transmit the requested status information. Bit coded bytes of status information and binary bytes are transmitted as pairs of hexadecimal digits.

The FO System will return a status record upon command (SYST?). Except when the 'asynchronous message' bit is set, the FO System is a 'slave' device in that it only responds when it receives a query from the M&C. If the 'asynchronous message' bit is set (see 'MODE' and 'SYST?'), then the Status and Control will asynchronously transmit a message (see 'ALRM', 'WARN' and 'SEND') to inform the M&C System that an alarm has been detected. The M&C System can then query the FO System for the exact cause of the alarm. The default state is for the 'asynchronous message' bit to be off so that no asynchronous message is transmitted. The aysnchronous message flag can be toggled in the Setup/Configuration Menu of the "OC8000" installation program. The data rate is fixed at 9600 baud with no parity, one start bit, 8 data bits and 1 stop bit (10 bits per word).

The format for the serial interface output of the Status and Control Plug-in is shown below. When an alarm or warning condition is first detected, if the 'asynchronous message' bit is set, then the SCP will asynchronously transmit a message (see 'ALRM', 'WARN' and 'SEND' below) to inform the M&C that an alarm has just been detected. The M&C can then interrogate the Status and Control Plug-in to determine the exact cause of the alarm.

**'ALRM"x..x"'** One or more alarms have been detected.

This message is sent asynchronously whenever an alarm condition is first detected. When the alarm is detected, in addition to transmitting this message, the Status and Control Plug-in will perform any enabled automatic actions, which have been defined as the alarm response. Thus, the recovery of the system from alarm conditions is not dependent on M&C intervention except in the case of the 1:2 redundant configuration when the FO transmitter needs to be automatically switched to the redundant path by the M&C system commands. The cause of the alarm is coded in the "x..x" string which will be one of these (the " is part of the message string):

| | |
|---|---|
| "Un.DIG.FAIL" | This is generated by a hardware failure within the plug-in in slot # n (n = 1 to 6). These slots are the six that are to the right of the SCP. The device which implements the communication between the plug-in in slot #n and the Status and Control Plug-in has failed to respond and is probably defective. |
| "Un.DN.RX.LOP" | The low optical power alarm in the downlink receiver in slot n has been activated. |
| "Un.DN.TX.OPP" | The optical power alarm in the downlink transmitter in slot n has been activated. |
| "Un.DN.TX.TEMP" | The temperature alarm in the downlink transmitter in slot n has been activated. |
| "Un.UP.RX.LOP" | The low optical power alarm in the uplink receiver in slot n has been activated. |
| "Un.UP.TX.OPP" | The optical power alarm in the uplink transmitter in slot n has been activated. |
| "Un.UP.TX.TEMP" | The temperature alarm in the uplink transmitter in slot n has been activated. |
| "Un.MON.TX.OPP | The optical power alarm in the RF signal monitor transmitter in slot n has been activated. |
| "Un.MON.TX.TEMP | The temperature alarm in the RF signal monitor transmitter in slot n has been activated. |
| "Un.MON.RX.LOP" | The low optical power alarm in the RF signal monitor receiver in slot n has been activated. |
| "Un.LINK.LLP | The low optical output alarm (from the laser module) in the Data Link in slot n has been activated. |
| "Un.LINK.LOP | The low optical received power alarm (from the received photodiode module) in the Data Link in slot n has been activated. |
| "BACK.DIG.FAIL" | The digital interface on the chassis backplane has failed. |
| "MAIN.+15.FAIL" | The main +15 volt supply is outside its limits (13.5 V to 16.5 V). |
| "MAIN.-15.FAIL" | The main -15 volt supply is outside its limits (-13.5 V to -16.5 V). |
| "MAIN.+5.FAIL" | The main +5 volt supply is outside its limits (4.0 V to 6.0 V). |
| "STBY.+15.FAIL" | The standby +15 volt supply is outside its limits (13.5 V to 16.5 V). |
| "STBY.-15.FAIL" | The standby -15 volt supply is outside its limits (-13.5 V to -16.5 V). |
| "STBY.+5.FAIL" | The standby +5 volt supply is outside its limits (4.0 V to 6.0 V). |

**'CALKuc?'** Read a calibration coefficient.

This command is used to read the value of a calibration coefficient string. The 'c' digit selects the coefficient to be read while the 'u' digit selects the plug-in. The returned string will be in the form:

csnnnnnn

where the letter 'c' indicates that the value has been calibrated, 's' is either blank (to indicate a positive number) or a '-' (to indicate a negative number), and 'n' is a digit (from 0 to 9) or a decimal point (.). The string 'nnnnnn' contains the numeric value of the coefficient. Note that one of the 'n' characters may be a decimal point ('.'). The command retrieves the specified calibration coefficient from non-volatile memory. The selected coefficient is transmitted exactly as it was set. The first character of the returned string will be a 'D' if the coefficient contains the default value or a 'C' if the coefficient contains a loaded string.

The 'u' plug-in selector values are:

| | |
|---|---|
| SCP | u = '0' |
| Plug-in #1 | u = '1' |
| Plug-in #2 | u = '2' |
| Plug-in #3 | u = '3' |
| Plug-in #4 | u = '4' |
| Plug-in #5 | u = '5' |
| Plug-in #6 | u = '6' |
| Chassis | u = '7' |

The 'c' coefficient selector values are:

For Status and Control Plug-in:

| | |
|---|---|
| '0' | This is a spare coefficient which is not used |

For Plug-ins #1 through #6:

| | |
|---|---|
| '0' | kpdi (monitor photodiode current in laser module) |
| '1' | klsi (laser bias current) |
| '2' | ktei (thermoelectric current) |
| '3' | krfp (RF power) |
| '4' | kpdid (received photodiode current) |

For Chassis:

| | |
|---|---|
| '0' | kps1a (primary +15V power supply) |
| '1' | kps2a (primary -15V power supply) |
| '2' | kps3a (primary +5V power supply) |
| '3' | kps1a (standby +15V power supply) |
| '4' | kps2a (standby -15V power supply) |
| '5' | kps3a (standby +5V power supply) |

**'CALOuo?'** Reads a calibration offset.

This command is used to read the value of a calibration offset string. The 'o' digit selects the offset to be read while the 'u' digit selects the plug-in. The returned string will be in the form:

osnnnnnn

where the letter 'o' indicates that a calibrated offset has been provided, 's' is either blank (to indicate a positive number) or a '-' (to indicate a negative number), and 'n' is a digit (from 0 to 9) or a decimal point (.). The string 'nnnnnn' contains the numeric value of the coefficient. Note that one of the 'n' characters may be a decimal point ('.'). The command retrieves the specified calibration offset from non-volatile memory. The selected offset is transmitted exactly as it was set. The first character of the returned string will be a 'D' if the offset contains the default value or a 'C' if the offset contains a loaded string.

The 'u' plug-in selector values are:

| | |
|---|---|
| SCP | u = '0' |
| Plug-in #1 | u = '1' |
| Plug-in #2 | u = '2' |
| Plug-in #3 | u = '3' |
| Plug-in #4 | u = '4' |
| Plug-in #5 | u = '5' |
| Plug-in #6 | u = '6' |
| Chassis | u = '7' |

The 'o' offset selector values are:

For Status and Control Plug-in:

| | |
|---|---|
| '0' | This is a spare offset which is not used |

For Plug-ins #1 through #6:

| | |
|---|---|
| '0' | opdi (monitor photodiode current in laser module) |
| '1' | olsi (laser bias current) |
| '2' | otei (thermoelectric current) |
| '3' | orfp (RF power) |
| '4' | opdid (received photodiode current) |

For Chassis:

| | |
|---|---|
| '0' | ops1a (primary +15V power supply) |
| '1' | ops2a (primary -15V power supply) |
| '2' | ops3a (primary +5V power supply) |
| '3' | ops1a (standby +15V power supply) |
| '4' | ops2a (standby -15V power supply) |
| '5' | ops3a (standby +5V power supply) |

**'DCFGaabbccddee'** Define the system configuration.

This command is used to designate the system configuration. This information is stored in the non-volatile memory contained on the chassis backplane. This command is ignored if the 'ALLOWINI' flag is not set.

The 'aa' byte is a pair of hexadecimal digits bit coded as follows:

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
|---|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | 0 | - | Slot #1 is not used |
| - | - | - | - | - | - | 1 | - | Slot #1 contains a plug-in |
| - | - | - | - | - | 0 | - | - | Slot #2 is not used |
| - | - | - | - | - | 1 | - | - | Slot #2 contains a plug-in |
| - | - | - | - | 0 | - | - | - | Slot #3 is not used |
| - | - | - | - | 1 | - | - | - | Slot #3 contains a plug-in |
| - | - | - | 0 | - | - | - | - | Slot #4 is not used |
| - | - | - | 1 | - | - | - | - | Slot #4 contains a plug-in |
| - | - | 0 | - | - | - | - | - | Slot #5 is not used |
| - | - | 1 | - | - | - | - | - | Slot #5 contains a plug-in |
| - | 0 | - | - | - | - | - | - | Slot #6 is not used |
| - | 1 | - | - | - | - | - | - | Slot #6 contains a plug-in |

The 'bb' byte is a pair of hexadecimal digits bit coded as follows:

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
|---|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | 0 | - | Slot #1 is a redundant plug-in |
| - | - | - | - | - | - | 1 | - | Slot #1 is a primary plug-in |
| - | - | - | - | - | 0 | - | - | Slot #2 is a redundant plug-in |
| - | - | - | - | - | 1 | - | - | Slot #2 is a primary plug-in |
| - | - | - | - | 0 | - | - | - | Slot #3 is a redundant plug-in |
| - | - | - | - | 1 | - | - | - | Slot #3 is a primary plug-in |
| - | - | - | 0 | - | - | - | - | Slot #4 is a redundant plug-in |
| - | - | - | 1 | - | - | - | - | Slot #4 is a primary plug-in |
| - | - | 0 | - | - | - | - | - | Slot #5 is a redundant plug-in |
| - | - | 1 | - | - | - | - | - | Slot #5 is a primary plug-in |
| - | 0 | - | - | - | - | - | - | Slot #6 is a redundant plug-in |
| - | 1 | - | - | - | - | - | - | Slot #6 is a primary plug-in |

The 'cc' byte is a pair of hexadecimal digits bit coded as follows:

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
|---|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | 0 | - | Slot #1 is used as 1:1 redundancy |
| - | - | - | - | - | - | 1 | - | Slot #1 is used as 1:2 redundancy |
| - | - | - | - | - | 0 | - | - | Slot #2 is used as 1:1 redundancy |
| - | - | - | - | - | 1 | - | - | Slot #2 is used as 1:2 redundancy |
| - | - | - | - | 0 | - | - | - | Slot #3 is used as 1:1 redundancy |
| - | - | - | - | 1 | - | - | - | Slot #3 is used as 1:2 redundancy |
| - | - | - | 0 | - | - | - | - | Slot #4 is used as 1:1 redundancy |
| - | - | - | 1 | - | - | - | - | Slot #4 is used as 1:2 redundancy |
| - | - | 0 | - | - | - | - | - | Slot #5 is used as 1:1 redundancy |
| - | - | 1 | - | - | - | - | - | Slot #5 is used as 1:2 redundancy |
| - | 0 | - | - | - | - | - | - | Slot #6 is used as 1:1 redundancy |
| - | 1 | - | - | - | - | - | - | Slot #6 is used as 1:2 redundancy |

The 'dd' byte is a pair of hexadecimal digits bit coded as follows:

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
|---|---|---|---|---|---|---|---|---|
| - | - | - | 0 | - | - | - | - | Asynchronous message transmissions are off |
| - | - | - | 1 | - | - | - | - | Asynchronous message transmissions are on |
| - | - | 0 | - | - | - | - | - | Control Center chassis |
| - | - | 1 | - | - | - | - | - | Antenna Site chassis |
| - | 0 | - | - | - | - | - | - | Local lockout off (Local control allowed) |
| - | 1 | - | - | - | - | - | - | Local lockout on (Local control not allowed) |
| 0 | - | - | - | - | - | - | - | Manual redundancy switching (Auto Off) |
| 1 | - | - | - | - | - | - | - | Automatic redundancy switching |

The 'ee' byte is a pair of hexadecimal digits bit coded as follows:

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
|---|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | 0 | - | Slot #1 is not configured for redundancy |
| - | - | - | - | - | - | 1 | - | Slot #1 is configured for redundancy |
| - | - | - | - | - | 0 | - | - | Slot #2 is not configured for redundancy |
| - | - | - | - | - | 1 | - | - | Slot #2 is configured for redundancy |
| - | - | - | - | 0 | - | - | - | Slot #3 is not configured for redundancy |
| - | - | - | - | 1 | - | - | - | Slot #3 is configured for redundancy |
| - | - | - | 0 | - | - | - | - | Slot #4 is not configured for redundancy |
| - | - | - | 1 | - | - | - | - | Slot #4 is configured for redundancy |
| - | - | 0 | - | - | - | - | - | Slot #5 is not configured for redundancy |
| - | - | 1 | - | - | - | - | - | Slot #5 is configured for redundancy |
| - | 0 | - | - | - | - | - | - | Slot #6 is not configured for redundancy |
| - | 1 | - | - | - | - | - | - | Slot #6 is configured for redundancy |

Note that the values of the 'cc' and 'ee' bytes work together to determine the actual redundancy mode of each slot.

**'DCFG?'** Read the system configuration.

This commands returns the four bit coded bytes that specify the system configuration. Each byte is returned as a pair of hexadecimal digits (see 'DCFGab' for the coding).

**'INIDc?'** Report identification string.

This returns the specified identification string as selected by the 'c' character. These strings are stored in the firmware PROM and cannot be changed by the user. All strings are 20 characters long.

F: Manufacturer name.
M: Model number.
R: Firmware revision.

**'MODEms'** Specify an operating mode.

This command is used to set specific operating modes. The 'm' character selects the mode to change and the 's' digit specifies the state. Note that the 'ALLOW INIT' flag must be set in order for this command to be effective. The available combinations for 'm' and 's' are:

| m | s | |
|---|---|---|
| 'A' | '0' | Auto redundancy OFF |
| 'A' | '1' | Auto redundancy ON (Default) |
| 'L' | '0' | Local lockout OFF (Default) |
| 'L' | '1' | Local lockout ON |
| 'S' | '0' | Asynchronous messages OFF (Default) |
| 'S' | '1' | Asynchronous messages ON |

**'MODEm?'** Report an operating mode.

This command causes a single digit to be returned ('0' or '1') which indicates the current state of the selected mode parameter. See 'MODEms' for the selectors.

**'MONRup'** Select the input to be used by the FO RF Signal Monitor Transmitter.

This command will cause the FO RF Signal Monitor Transmitter in slot 'u' to use the input specified by the 'p' character ('A' or 'B'). The 'CMDERR' flag will be set if the specified plug-in is not a FO RF Signal Monitor Transmitter.

**'MONRu?'** Transmit the current FO RF Signal Monitor Transmitter input selection.

This command will transmit the current input selection for the FO RF Signal Monitor Transmitter in slot 'n'. A single character 'A' or 'B' will be transmitted. The 'CMDERR' flag will be set if the specified plug-in is not an FO RF Signal Monitor Transmitter.

**'MSGSumx..x'** Set a message string.

Set the specified message string in the specified plug-in. The message string itself is defined by the 20 character string represented by 'x..x'. The 'm' character selects the string while the 'u' character selects the plug-in. This command is ignored if the message is too short or the 'ALLOW INIT' flag is not set.

The 'u' plug-in selector values are:

SCP u = '0'
Plug-in #1 u = '1'
Plug-in #2 u = '2'
Plug-in #3 u = '3'
Plug-in #4 u = '4'
Plug-in #5 u = '5'
Plug-in #6 u = '6'
Chassis u = '7'

The 'm' message selector values are:

'I': The installation dat message ('u' must be '7').

'L': Optical loss message ('u' must be '7').

'M': Model number (user loaded - this can be different from the firmware model number retrieved using the 'INID' command).

'S': Serial number.

'U': User message. This can be any 20 character string.

**MSGSum?'** Send message string.

Transmit the selected message string. 'm' and 'u' select the message and plug-in as in the 'MSGSmux..x' command. The selected 20 character string will be transmitted.

**'RELYns'** Set RF switch position.

The RF switch selected by the 'n' digit is set to the position specified by the 's' character. The 'n' digit can have the values '1' through '3' while the 's' character is either 'A' or 'B'. This command is ignored unless the 'ALLOW INIT' flag is set.

IT IS THE RESPONSIBILITY OF THE USER TO ENSURE THAT THE SPECIFIED RF SWITCH STATE IS VALID. DATA LOSS WILL RESULT IF A RF SWITCH IS SWITCHED TO AN UNUSED OR INOPERATIVE PLUG-IN!

For testing purposes, the switch selector character 'S' may be used to access the summary alarm relay. Setting this relay to position 'B' turns on the alarm.

**'RELYn?'** Report the RF switch position.

This command will return a single character ('A' or 'B') that corresponds to the current position of the selected RF switch. The 'n' digits ('1' to '3') selects the RF switch in a chassis. The RF switch assignments for the 1:2 and 1:1 redundancy configurations are given in Figure 2-41. The 'S' specifies the summary alarm relay.

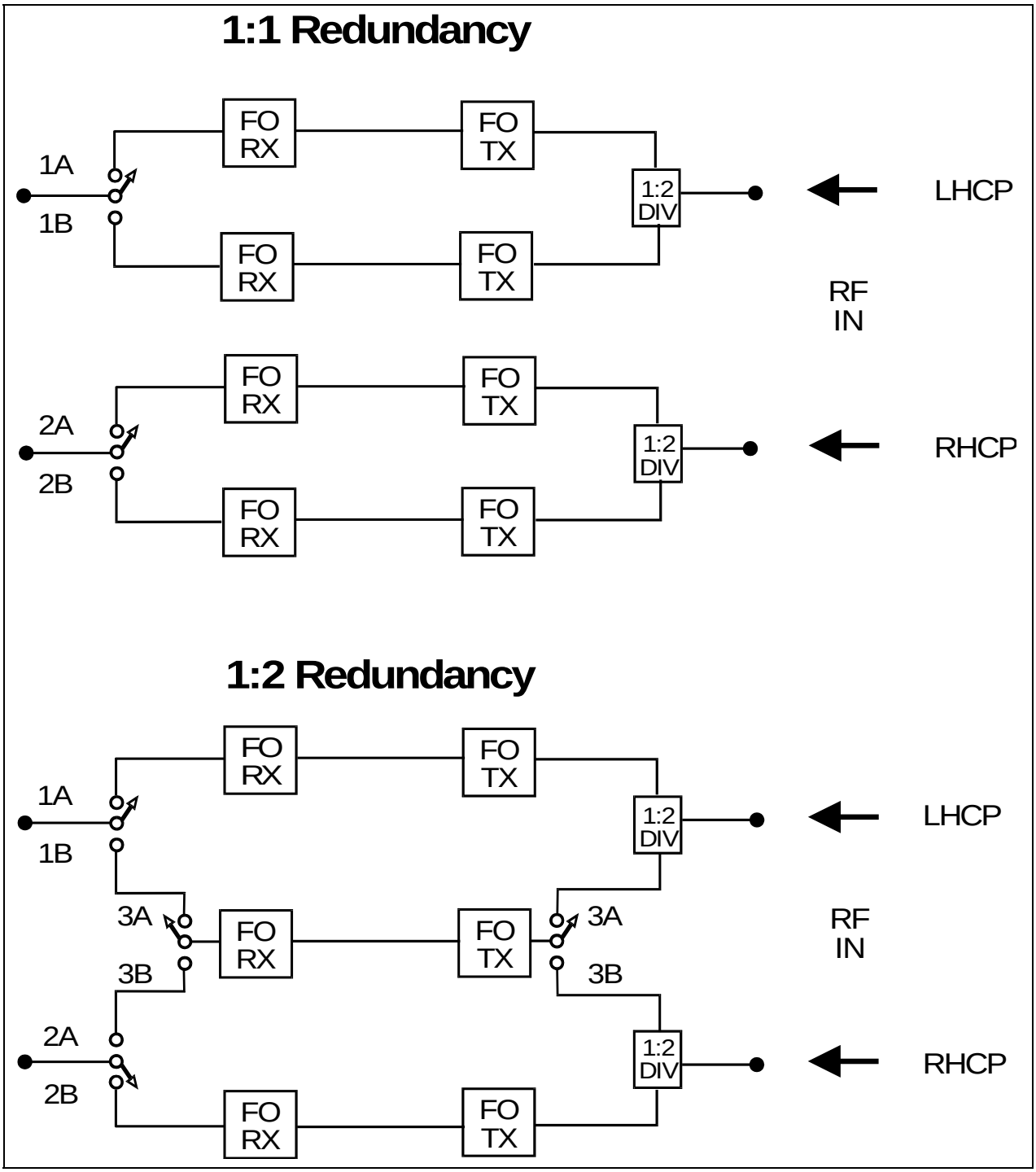



**Figure 2-41**
RF Switch Assignments for the 1:2 and 1:1 Redundancy Switching Configuration.

**'RSETA'** System reset of alarms.

This command will put the system into the 'reset' state which is defined as follows:

The summary alarm is reset
The power supply alarms are reset
The fan alarms are reset.
The 'ALLOW INIT' flag is cleared ('Allow Init' is reset to "No" to disallow configuration changes).
The configuration EAROMS of all plug-ins are read.

**'RSETR'** System reset of redundancy switching configuration.

This command will put the system into the 'reset' state which is defined as follows:

Automatic redundancy switching is active.
Primary signal paths selected.
The configuration EAROMS of all plug-ins are read.

**'SEND"m..m"'** Send a message to the companion chassis.

The message enclosed within the " characters should be sent by the M&C to the companion chassis (e.g. if this is an uplink transmitter, send the message to the uplink receiver to which the fiber optic links connect). If the "Asynchronous messages" bit is set, then this message is emitted asynchronously by the Status and Control Plug-in when an alarm condition occurs which causes some automatic switching of redundant plug-ins. In some configurations, an associated switching MUST occur in the companion plug-in to prevent loss of data. To simplify the job of the M&C, the Status and Control Plug-in initiating the switching generates the appropriate message; the M&C only needs to transmit the message. An associated 'ALRM' message will also be emitted to indicate the cause of the alarm.

**'STATue'** Establish the state of a particular plug-in.

This sends the command byte 'e' to plug-in 'u'. The 'u' selector must be in the range '1' through '6'. The command byte 'e' is coded as follows:

'0': Turn off the plug-in's power
'1': Turn on the plug-in's power.

**'STATu?'** Report status of the specified plug-in.

This command will return the status record 'aabbccddeeffgghhii' for the plug-in that is in the specified slot. The status information is formatted as indicated below. Not all byte positions are meaningful for all types of modules. The bytes that are not used for a particular module will contain the value $00. Each returned byte is coded as a pair of hexadecimal digits.

aa The type of module:

00: No plug-in is installed or plug-in is nonfunctional
01: FO uplink transmitter
02: FO uplink receiver
03: FO downlink transmitter
04: FO downlink receiver
05: FO monitor transmitter
06: FO monitor receiver
07: FO data link transmitter

bb The bit coded coefficient calibration flags:

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
|---|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | - | 0 | KPDI is the default |
| - | - | - | - | - | - | - | 1 | KPDI is the calibrated value |
| - | - | - | - | - | - | 0 | - | KLSI is the default |
| - | - | - | - | - | - | 1 | - | KLSI is the calibrated value |
| - | - | - | - | - | 0 | - | - | KTEI is the default |
| - | - | - | - | - | 1 | - | - | KTEI is the calibrated value |
| - | - | - | - | 0 | - | - | - | KRFP is the default |
| - | - | - | - | 1 | - | - | - | KRFP is the calibrated value |
| - | - | - | 0 | - | - | - | - | KPDId is the default |
| - | - | - | 1 | - | - | - | - | KPDId is the calibrated value |

cc The bit coded offset calibration flags:

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
|---|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | - | 0 | OPDI is the default |
| - | - | - | - | - | - | - | 1 | OPDI is the calibrated value |
| - | - | - | - | - | - | 0 | - | OLSI is the default |
| - | - | - | - | - | - | 1 | - | OLSI is the calibrated value |
| - | - | - | - | - | 0 | - | - | OTEI is the default |
| - | - | - | - | - | 1 | - | - | OTEI is the calibrated value |
| - | - | - | - | 0 | - | - | - | ORFP is the default |
| - | - | - | - | 1 | - | - | - | ORFP is the calibrated value |

dd A bit coded byte that contains the alarm information (if any) for the plug-in:

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
|---|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | - | 1 | Optical power low alarm is on (FO Rx) |
| - | - | - | - | - | - | 1 | - | Optical power high alarm is on (FO Rx) |
| - | - | - | - | - | 1 | - | - | RF power low alarm is on (FO Rx) |
| - | - | - | - | - | - | - | 1 | Optical power low alarm is on (FO Tx) |
| - | - | - | - | - | | 1 | - | Laser temperature alarm is on (FO Tx) |
| - | - | - | - | - | 1 | - | - | RF power low alarm is on (FO Tx) |
| - | - | - | - | - | - | - | 1 | Laser power low alarm is on (FO Data Link) |
| - | - | - | - | - | - | 1 | - | Optical power low alarm is on (FO Data Link) |
| - | - | - | - | - | 1 | - | - | No data alarm is on (FO Data Link) |
| - | - | - | - | 1 | - | - | - | Always high |
| - | 0 | - | - | - | - | - | - | Monitor transmitter 'A' input selected |
| - | 1 | - | - | - | - | - | - | Monitor transmitter 'B' input selected |
| 1 | - | - | - | - | - | - | - | The plug-in is disabled (power is off) |
| 0 | - | - | - | - | - | - | - | The plug-in is enabled (power is on) |

ee A pair of hexadecimal digits that contain the photodiode current value for the plug-in. The actual current is obtained using the equation:

$$I = ee * kpdi + opdi$$

ff A pair of hexadecimal digits that contain the laser bias current. The actual current is obtained using the equation:

$$I = ff * klsi + olsi$$

gg A pair of hexadecimal digits that contain the thermoelectric cooler current level. The actual current is obtained using the equation:

I = gg * ktei + otei

hh A pair of hexadecimal digits that contain the RF power. The actual power is obtained using the equation:

I = hh * krfp + orfp

ii A pair of hexadecimal digits that are always 00 (reserved for future use).

The actual content of the eeffgghh bytes is plug-in type dependent. The chart below shows the values in each byte for each type of plug-in.

| | **XMTR** | **RCVR** | **DTLK** |
|---|---|---|---|
| **ee** | Monitor photodiode current | Received photodiode current | Monitor photodiode current in laser |
| **ff** | Laser bias current | 0 | Laser bias current |
| **gg** | Thermoelectric cooler current | Temperature sensor voltage | Received photodiode current |
| **hh** | RF power detector voltage | RF power detector voltage | 0 |

**'SYST?'** Return the system status information.

This command will cause the Status and Control Plug-in to return the status record 'aabbccddeeffgghhiijjkkllmmnnoo' where each letter pair represents a pair of hexadecimal digits. The coding is:

aa This bit coded byte indicates which plug-ins are in the signal path as determined by the position of the RF switches on the backplane:

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
|---|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | 0 | - | Slot #1 is NOT in the signal path |
| - | - | - | - | - | - | 1 | - | Slot #1 is in the signal path |
| - | - | - | - | - | 0 | - | - | Slot #2 is NOT in the signal path |
| - | - | - | - | - | 1 | - | - | Slot #2 is in the signal path |
| - | - | - | - | 0 | - | - | - | Slot #3 is NOT in the signal path |
| - | - | - | - | 1 | - | - | - | Slot #3 is in the signal path |
| - | - | - | 0 | - | - | - | - | Slot #4 is NOT in the signal path |
| - | - | - | 1 | - | - | - | - | Slot #4 is in the signal path |
| - | - | 0 | - | - | - | - | - | Slot #5 is NOT in the signal path |
| - | - | 1 | - | - | - | - | - | Slot #5 is in the signal path |
| - | 0 | - | - | - | - | - | - | Slot #6 is NOT in the signal path |
| - | 1 | - | - | - | - | - | - | Slot #6 is in the signal path |
| 1 | - | - | - | - | - | - | - | One or more standby paths are in use |

bb This bit coded byte contains additional system information:

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
|---|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | - | 0 | RF switch 1 is in position 'A' |
| - | - | - | - | - | - | - | 1 | RF switch 1 is in position 'B' |
| - | - | - | - | - | - | 0 | - | RF switch 2 is in position 'A' |
| - | - | - | - | - | - | 1 | - | RF switch 2 is in position 'B' |
| - | - | - | - | - | 0 | - | - | RF switch 3 is in position 'A' |
| - | - | - | - | - | 1 | - | - | RF switch 3 is in position 'B' |
| - | - | 0 | - | - | - | - | - | Fan 1 alarm off |
| - | - | 1 | - | - | - | - | - | Fan 1 alarm on |
| - | 0 | - | - | - | - | - | - | Fan 2 alarm off |
| - | 1 | - | - | - | - | - | - | Fan 2 alarm on |
| 0 | - | - | - | - | - | - | - | Summary alarm off |
| 1 | - | - | - | - | - | - | - | Summary alarm on |

cc This bit coded byte contains error information:

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
|---|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | - | 1 | Most recent EAROM update failed |
| - | - | - | - | - | - | 1 | - | $I^2C$ bus error |
| - | - | - | - | - | 1 | - | - | Command not recognized |
| - | - | - | - | 1 | - | - | - | Parameter stack error |
| - | - | - | 1 | - | - | - | - | Command syntax error |
| - | - | 1 | - | - | - | - | - | An alarm condition exists |
| - | 1 | - | - | - | - | - | - | A warning condition exists |
| 1 | - | - | - | - | - | - | - | Front panel $I^2C$ error |

Note that all these error bits are cleared when read by this command.

dd This bit coded byte shows any errors in the I/O to the plug-ins in the chassis or the backplane:

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
|---|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | 1 | - | Slot 1 I/O error |
| - | - | - | - | - | 1 | - | - | Slot 2 I/O error |
| - | - | - | - | 1 | - | - | - | Slot 3 I/O error |
| - | - | - | 1 | - | - | - | - | Slot 4 I/O error |
| - | - | 1 | - | - | - | - | - | Slot 5 I/O error |
| - | 1 | - | - | - | - | - | - | Slot 6 I/O error |
| 1 | - | - | - | - | - | - | - | Backplane I/O error |

ee This bit coded bytes show any EAROM errors:

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
|---|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | - | 1 | SCP EAROM error |
| - | - | - | - | - | - | 1 | - | Slot 1 EAROM error |
| - | - | - | - | - | 1 | - | - | Slot 2 EAROM error |
| - | - | - | - | 1 | - | - | - | Slot 3 EAROM error |
| - | - | - | 1 | - | - | - | - | Slot 4 EAROM error |
| - | - | 1 | - | - | - | - | - | Slot 5 EAROM error |
| - | 1 | - | - | - | - | - | - | Slot 6 EAROM error |
| 1 | - | - | - | - | - | - | - | Backplane EAROM error |

ff This bit coded byte shows any ADC or DAC errors:

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
|---|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | 1 | - | Slot 1 ADC/DAC error |
| - | - | - | - | - | 1 | - | - | Slot 2 ADC/DAC error |
| - | - | - | - | 1 | - | - | - | Slot 3 ADC/DAC error |
| - | - | - | 1 | - | - | - | - | Slot 4 ADC/DAC error |
| - | - | 1 | - | - | - | - | - | Slot 5 ADC/DAC error |
| - | 1 | - | - | - | - | - | - | Slot 6 ADC/DAC error |
| 1 | - | - | - | - | - | - | - | Backplane ADC/DAC error |

gg This bit coded byte shows the coefficient calibration flags:

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
|---|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | - | 0 | KPSA1 is the default |
| - | - | - | - | - | - | - | 1 | KPSA1 is the calibrated value |
| - | - | - | - | - | - | 0 | - | KPSA2 is the default |
| - | - | - | - | - | - | 1 | - | KPSA2 is the calibrated value |
| - | - | - | - | - | 0 | - | - | KPSA3 is the default |
| - | - | - | - | - | 1 | - | - | KPSA3 is the calibrated value |
| - | - | - | - | 0 | - | - | - | KPSB1 is the default |
| - | - | - | - | 1 | - | - | - | KPSB1 is the calibrated value |
| - | - | - | 0 | - | - | - | - | KPSB2 is the default |
| - | - | - | 1 | - | - | - | - | KPSB2 is the calibrated value |
| - | - | 0 | - | - | - | - | - | KPSB3 is the calibrated value |
| - | - | 1 | - | - | - | - | - | KPSB3 is the calibrated value |

hh This bit coded byte shows the offset calibration flags:

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
|---|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | - | 0 | OPSA1 is the default |
| - | - | - | - | - | - | - | 1 | OPSA1 is the calibrated value |
| - | - | - | - | - | - | 0 | - | OPSA2 is the default |
| - | - | - | - | - | - | 1 | - | OPSA2 is the calibrated value |
| - | - | - | - | - | 0 | - | - | OPSA3 is the default |
| - | - | - | - | - | 1 | - | - | OPSA3 is the calibrated value |
| - | - | - | - | 0 | - | - | - | OPSB1 is the default |
| - | - | - | - | 1 | - | - | - | OPSB1 is the calibrated value |
| - | - | - | 0 | - | - | - | - | OPSB2 is the default |
| - | - | - | 1 | - | - | - | - | OPSB2 is the calibrated value |
| - | - | 0 | - | - | - | - | - | OPSB3 is the calibrated value |
| - | - | 1 | - | - | - | - | - | OPSB3 is the calibrated value |

ii This bit coded byte shows the power supply alarms:

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
|---|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | - | 1 | Main +15 V alarm is on |
| - | - | - | - | - | - | 1 | - | Main +5 V alarm is on |
| - | - | - | - | - | 1 | - | - | Main - 15 V alarm is on |
| - | - | - | - | 1 | - | - | - | Standby +15 V alarm is on |
| - | - | - | 1 | - | - | - | - | Standby +5 V alarm is on |
| - | - | 1 | - | - | - | - | - | Standby - 15 V alarm is on |

jj This is the bit coded status byte for plug-in in Slot 1:

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
|---|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | - | 1 | Optical power low alarm is on (FO Rx) |
| - | - | - | - | - | - | 1 | - | Optical power high alarm is on (FO Rx) |
| - | - | - | - | - | 1 | - | - | RF power low warning is on (FO Rx) |
| - | - | - | - | - | - | - | 1 | Optical power low alarm is on (FO Tx) |
| - | - | - | - | - | - | 1 | - | Laser temperature alarm is on (FO Tx) |
| - | - | - | - | - | 1 | - | - | RF power low warning is on (FO Tx) |
| - | - | - | - | 1 | - | - | - | Always high |
| - | 0 | - | - | - | - | - | - | RF Signal Monitor Tx Input A is selected |
| - | 1 | - | - | - | - | - | - | RF Signal Monitor Tx Input B is selected |
| 1 | - | - | - | - | - | - | - | The plug-in is disabled (OFF) |
| 0 | - | - | - | - | - | - | - | The plug-in is enabled (ON) |

kk This is the bit coded status byte for plug-in in Slot 2 (see jj byte).

ll This is the bit coded status byte for plug-in in Slot 3 (see jj byte).

mm This is the bit coded status byte for plug-in in Slot 4 (see jj byte).

nn This is the bit coded status byte for plug-in in Slot 5 (see jj byte).

oo This is the bit coded status byte for plug-in in Slot 6:

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
|---|---|---|---|---|---|---|---|---|
| - | - | - | - | - | - | - | 1 | Optical power low alarm is on (FO Rx) |
| - | - | - | - | - | - | 1 | - | Optical power high alarm is on (FO Rx) |
| - | - | - | - | - | 1 | - | - | RF power low warning is on (FO Rx) |
| - | - | - | - | - | - | - | 1 | Optical power low alarm is on (FO Tx) |
| - | - | - | - | - | - | 1 | - | Laser temperature alarm is on (FO Tx) |
| - | - | - | - | - | 1 | - | - | RF power low warning is on (FO Tx) |
| - | - | - | - | - | - | - | 1 | Laser output low alarm is on (DTLK) |
| - | - | - | - | - | - | 1 | - | Received optical power low alarm is on (DTLK) |
| - | - | - | - | - | 1 | - | - | No data warning is on (DTLK) |
| - | - | - | - | 1 | - | - | - | Always high |
| - | 0 | - | - | - | - | - | - | RF monitor XMTR using input A |
| - | 1 | - | - | - | - | - | - | RF monitor XMTR using input B |
| 1 | - | - | - | - | - | - | - | The plug-in is disabled (OFF) |
| 0 | - | - | - | - | - | - | - | The plug-in is enabled (ON) |

**'TYPEue'** Set the plug-in type.

The plug-in specified by the 'u' digit is set to be type 'e'. The coding of the 'e' character is:

'0': No plug-in is installed or plug-in is nonfunctional
'1': FO uplink transmitter
'2': FO uplink receiver
'3': FO downlink transmitter
'4': FO downlink receiver
'5': FO monitor transmitter
'6': FO monitor receiver
'7': FO Data Link transceiver

**'TYPEu?'** Read the plug-in type.

The single digit type code from the plug-in specified by the 'u' digit is transmitted. The coding is that same as for the 'TYPEue' command.

**'VOLT?'** Read the power supply voltages.

The 6 power supply voltage readings are returned. Each voltage is a single pair of hexadecimal digits and corresponds to the voltage of one of the power supplies as indicated below.

aa This byte contains the voltage of the primary +15V power supply. The range of 0.0 to 15.99 volts can be measured. The actual power supply voltage is obtained using the equation:

V = aa * kps1a + ops1a

where kps1a and ops1a are the previously loaded calibration coefficient and offset. The nominal value of kps1a is 0.0627. The nominal value of ops1a is 0.0000.

bb This byte contains the voltage of the primary -15V power supply. The range of 0.0 to -15.99 volts can be measured. The actual power supply voltage is obtained using the equation:

V = bb * kps2a + ops2a

where kps2a and ops2a are the previously loaded calibration coefficient and offset. The nominal value of kps2a is -0.0627. The nominal value of ops2a is 0.0000.

cc This byte contains the voltage of the primary +5V power supply. The range of 0.0 to 5.99 volts can be measured. The actual power supply voltage is obtained using the equation:

V = cc * kps3a + ops3a

where kps3a and ops3a are the previously loaded calibration coefficient and offset. The nominal value of kps3a is 0.0235. The nominal value of ops3a is 0.0000.

dd This byte contains the voltage of the standby +15V power supply. The range of 0.0 to 15.99 volts can be measured. The actual power supply voltage is obtained using the equation:

V = dd * kps1b + ops1b

where kps1b & ops1b are the previously loaded calibration coefficient & offset. The nominal value of kps1b is 0.0627. The nominal value of ops1b is 0.0000.

ee This byte contains the voltage of the standby -15V power supply. The range of 0.0 to -15.99 volts can be measured. The actual power supply voltage is obtained using the equation:

V = ee * kps2b + ops2b

where kps2b and ops2b are the previously loaded calibration coefficient and offset. The nominal value of kps2b is -0.0627. The nominal value of ops2b is 0.0000.

ff This byte contains the voltage of the standby +5V power supply. The range of 0.0 to 5.99 volts can be measured. The actual power supply voltage is obtained using the equation:

V = ff * kps3b + ops3b

where kps3b and ops3b are the previously loaded calibration coefficient and offset. The nominal value of kps3b is 0.0235. The nominal value of ops3b is 0.0000.

**'WARN"x..x"'** One or more warning conditions have been detected.

This message is sent asynchronously whenever a warning condition is first detected. The cause of the warning is coded in the "x..x" string which will be one of these (the " is part of the message string). Warnings do not initiate automatic redundancy switching but should be checked.

| | |
|---|---|
| "FAN1.FAIL" | This is generated when a failure is detected in cooling fan # 1. |
| "FAN2.FAIL" | This is generated when a failure is detected in cooling fan # 2. |
| "REDUN.LNK" | This is generated when one or more standby paths are in use. |
| "Un.UP.RX.HOP" | This is generated when the uplink receiver plug-in in slot n signals a 'high optical power' condition. |
| "Un.DN.RX.HOP" | This is generated when the downlink receiver plug-in in slot n signals a 'high optical power' condition. |
| "Un.UP.TX.LRFP" | This is generated when the uplink transmitter plug-in in slot n signals a 'low RF power' condition. |
| "Un.DN.TX.LRFP" | This is generated when the downlink transmitter plug-in in slot n signals a 'low RF power' condition. |
| "Un.UP.RX.RFP" | This is generated when the uplink receiver in slot n signals an "RF power low" warning. |
| "Un.DN.RX.RFP" | Same as "Un.UP.RX.RFP" except it refers to a downlink receiver. |
| "Un.MON.RX.HOP | High optical power warning from the RF signal monitor receiver. |
| "Un.MON.RX.RFP | RF power warning from the RF signal monitor receiver. |
| "Un.LINK.ND" | No data warning from the FO Data Link transceiver. |

**'XFUNuf'** Execute the specified function for the specified plug-in

The function specified by the 'f' character is executed in plug-in 'u'.

The 'u' plug-in selector values are:

| | |
|---|---|
| SCP | u = '0' |
| Plug-in #1 | u = '1' |
| Plug-in #2 | u = '2' |
| Plug-in #3 | u = '3' |
| Plug-in #4 | u = '4' |
| Plug-in #5 | u = '5' |
| Plug-in #6 | u = '6' |
| Chassis | u = '7' |

The 'f' function selectors are:

'A' Set the 'ALLOW INIT' flag. The plug-in selector MUST be '0' or CMDERR bit will be set.

'C' Clear the 'ALLOW INIT' flag. The plug-in selector MUST be '0' or the CMDERR bit will be set.

'I' Initialize the parameters for the specified plug-in to their default values. This command only works if the 'ALLOW INIT' flag is set. The 'CMDERR' bit is set if 'ALLOW INIT' is not set.

'P' Force the specified unit to use its primary path. The specified unit should be configured as 'Redundant'. The redundant unit will be switched out of the signal path as though an alarm condition existed in it. The unit's companion primary unit will be switched into the signal path. This command is provided for test and diagnostic purposes.

'R' Force the specified unit to use its redundant path. The specified unit should be configured as 'Primary'. The primary unit will be switched out of the signal path as though an alarm condition existed in it. The unit's companion redundant unit will be switched into the signal path. This command is provided for test and diagnostic purposes.

'T' Execute a self test and master reset of the Status and Control plug-in processor. The plug-in selector MUST be '0' or the CMDERR bit will be set. This is equivalent to cycling the power on the Status and Control plug-in and will initialize all settings to their power on defaults. Any diagnostic errors will be reported in the system status information (see 'SYST?'). No additional commands should be sent until the message 'READY' is received. The default settings are:

ALLOW INIT flag is cleared
Automatic redundancy switching enabled
Redundancy forcing disabled (see 'P' and 'R' above)
Primary paths selected
All alarms are reset
The EAROMS of all plug-ins are read

'U' Update the EAROM. The current parameter settings will be permanently stored in the non-volatile memory of the plug-in. The EAROM error flag for the selected memory will be cleared if the update was successful or set if the update was unsuccessful. The 'ALLOW INIT' flag must be set to enable this operation.

**SYSTEM 8000 ACCESSORY KIT (Model 8050A-xx)**

The Ortel System 8000 Accessory Kit provides items that are important for installing the FO System. The Kit includes the following:

1) Kit for cleaning optical connectors. Cotton swabs saturated with cleaning solution and compressed air. Optical connectors should be cleaned prior to every connection.

2) Four connectorized (FC/APC connectors) optical attenuators with loss values "-xx" dB as specified in the Accessory kit model number. The optical attenuators are used during FO System pre-installation setup when the FO Transmitters and Receivers are co-located. They simulate the loss due to the actual fiber optical cable, and are not intended for permanent installation in the earth station system. A 6 dB optical attenuator (Model 8050A-06 simulates the typical loss for a 15 km long optical fiber and is the standard optical loss budget for the System 8700, 8800 and 8900. No optical attenuator is needed to simulate <1 km lengths for the System 8600 70/140 MHz links (Model 8050A-00).

3) Fiberoptic jumper cable adapter: FC/PC optical connector to FC/APC optical connector. This jumper is useful for adapting to fiberoptic test equipment (such as an optical power meter) which commonly accepts an FC/PC connector. This adapter should not be installed in the FO System because the optical reflections from the FC/PC connector can degrade the system performance.

4) Light Card to Detect 1310 wavelength light from the laser diode, providing quick visual verification of laser light output.

5) Two 10 feet long RS-232 cables to connect the Ortel FO System to a IBM PC or equivalent computer with two serial RS-232 ports for use during installation of the FO System.

6) Two chassis fuses: 2 A Slow Blow and 1 A Slow Blow (2 each).

7) Trim pot adjustment tool for setting the gain control and the RF threshold alarm at the front panel of the FO plug-ins.

The layout of the Accessory Kit is shown in Figure 2-42

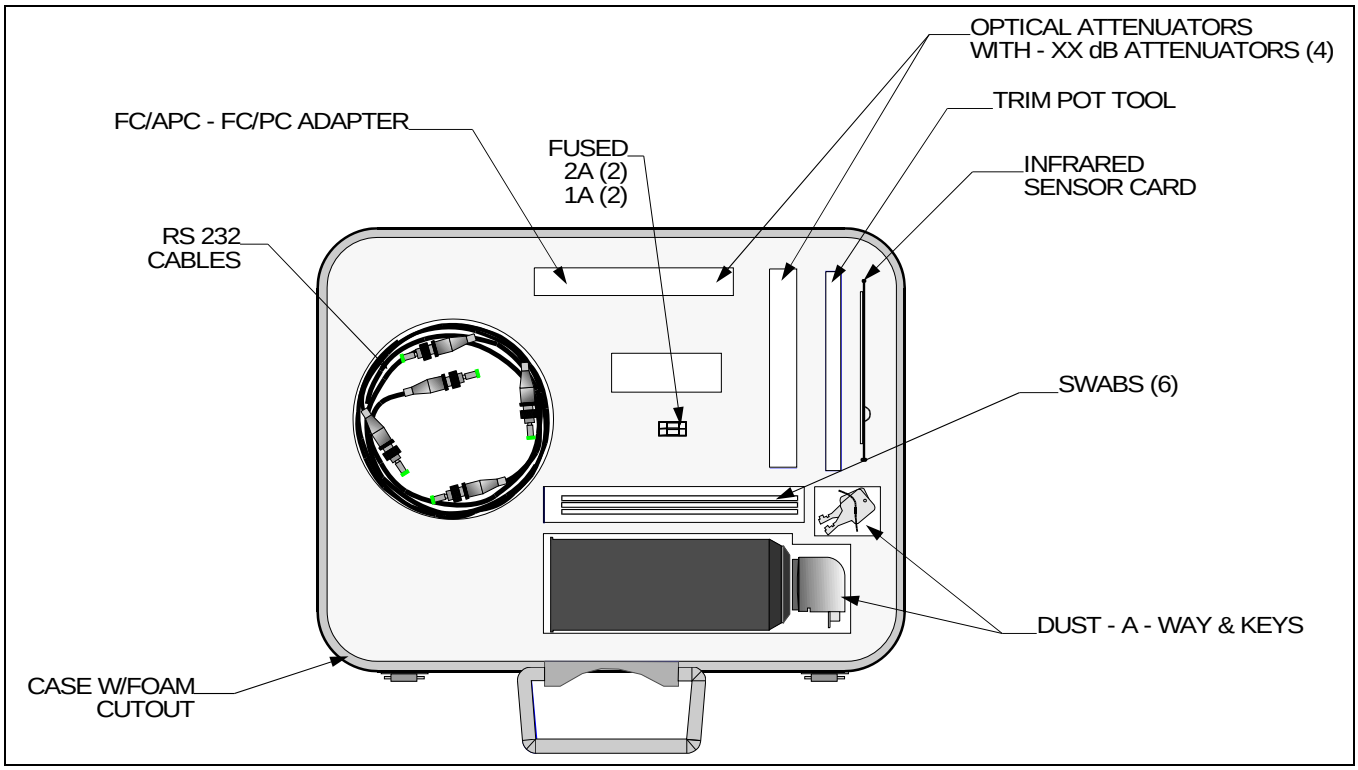



**Figure 2-42**
Layout of System 8000 Accessory Kit Model # 8050A-XX

# CHAPTER 3 - INSTALLATION

## 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 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 power to the not perform any FO System. Incorrect AC power can damage the FO System and cause injury to the user.

Throughout this chapter, there are "Caution" warnings. "Caution" calls attention to a procedure or practice, which, if ignored, may result in damage to the system or system component. Do 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 immediately.

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

## CONTENTS OF SHIPMENT

Each chassis should already be configured, containing the appropriate plug-ins in the chassis. All internal connections between the plug-ins have been made at the factory. The user only supplies external connections to interface with his equipment. Verify that the configuration of the chassis agrees with the purchase order for the equipment. An example of the configuration sheet, which shows the layout of the plug-ins in the chassis and the rear panel, is shown in Figure 3-1.

The following are delivered items per the customer purchase order:

1) Chassis
2) Power Supplies
3) Status and Control Plug-ins
4) FO Plug-ins
5) Accessory Kit.

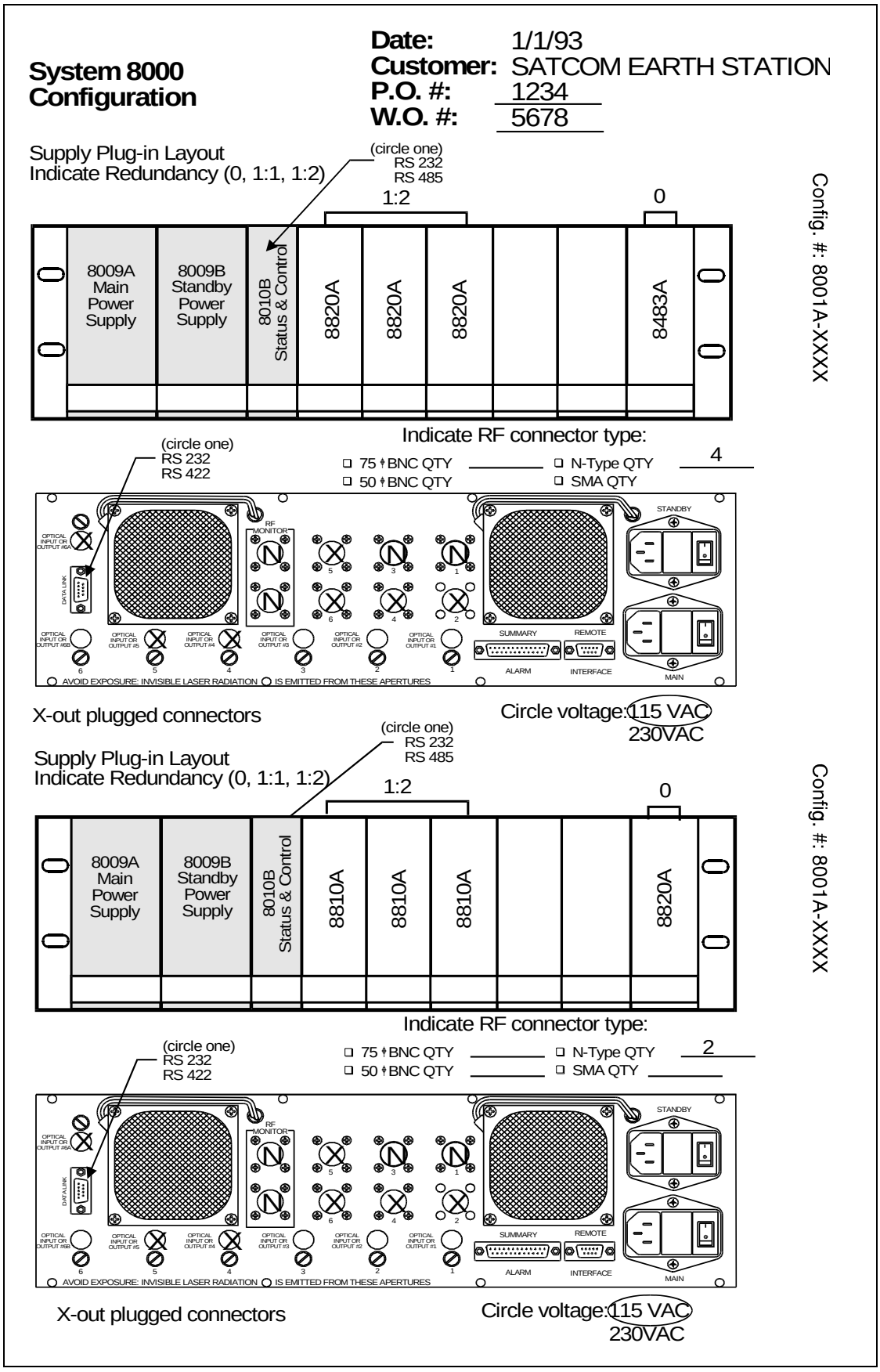



**Figure 3-1**
Sample configuration of chassis

The following items are included in the delivery even though they are not specified as line items in the customer purchase order:

1) One FC/APC fiber optic jumper cable for each FO Transmitter plug-in
2) System 8000 Installation Computer Disk
3) Test data package
4) Operating Manual (one per chassis).

## REQUIRED EQUIPMENT FOR INSTALLATION AND OPERATION

For installation of the Ortel FO System, the user needs the following equipment:

1) Power cords to connect the FO System to a source of AC power. The AC power inlet connector at the FO System chassis rear panel is an international IEC320 connector.
2) RF power meter with sensors able to detect RF levels from -12 dBm to -60 dBm
3) RF signal source
4) IBM PC or equivalent computer (minimum is IBM 286 with 4MEG RAM) with two serial interfaces and a 3.5 inch floppy disk drive.
5) Serial cables to interface the System 8000 chassis (remote interface) to the computer used for installation. The System 8000 remote interface is either RS-232 or RS-485 as specified in the purchase order. The user may need an RS-232/RS-485 converter for proper interface to a PC.

The FO System includes a 3.5 inch disk formatted for the IBM PC standard or equivalent computer to be used for installation. The installation program is an executable file that runs in the Microsoft Disk Operating System (MS-DOS) Version 3.1 or higher.

Not essential, but useful for diagnostics are:

1) RF spectrum analyzer
2) Optical power meter.

The user needs to supply the following for operation:

1) M&C System for remote operation
2) Angle-polished FC/APC connectorized optical fiber cable. If fiber distribution boxes are used, then they should contain either angle-polished connectors specified for return loss >55 dB or fusion splices. Flat polished connectors anywhere along the optical fiber path will degrade the system performance. One optical fiber cable is required for each Transmitter and Receiver plug-in pair. Two optical fibers are needed for each FO Data Link (System 8500).
3) Optical attenuators to ensure that the FO Receivers are not damage by excessive (>2 mA) received optical power.

**SYSTEM PRE-INSTALLATION VERIFICATION AND SET-UP**

## Caution:
## Do Not connect RF power input/output or optical input/output to the chassis until directed to do so by the following procedures. The FO Transmitter or FO Receiver may be damaged by high RF or optical inputs.

The following pre-installation verification and set-up should be performed with all the chassis in one location. Optical attenuators can be used to simulate the optical fiber for this set-up. For example, a 15 km fiber with connectors typically has 6 dB of optical attenuation. Optical attenuators are available in the Ortel System 8000 Accessory kit.

1. The AC power connector at the FO System chassis rear panel is an international IEC320 connector and the AC power supply specifications were given in Chapter 2. The total power requirement for a single chassis is 150 W. The Ortel FO System has already been factory-configured for the user's AC voltage (115 V or 230 V) as specified in the purchase order for the FO System. Ensure that the appropriate AC power source is supplied to the Ortel FO System.

   Connect the power cables from both the main and standby power supplies to a source of AC power. Do not turn the power on yet.

### Caution:
### Do Not connect the optical input to the FO Receiver plug-ins until directed to do. The FO Receiver plug-in may be damaged by high optical inputs. Maximum operating optical power is 2 mW. Do Not look directly at the end of an optical connector which emits laser light!

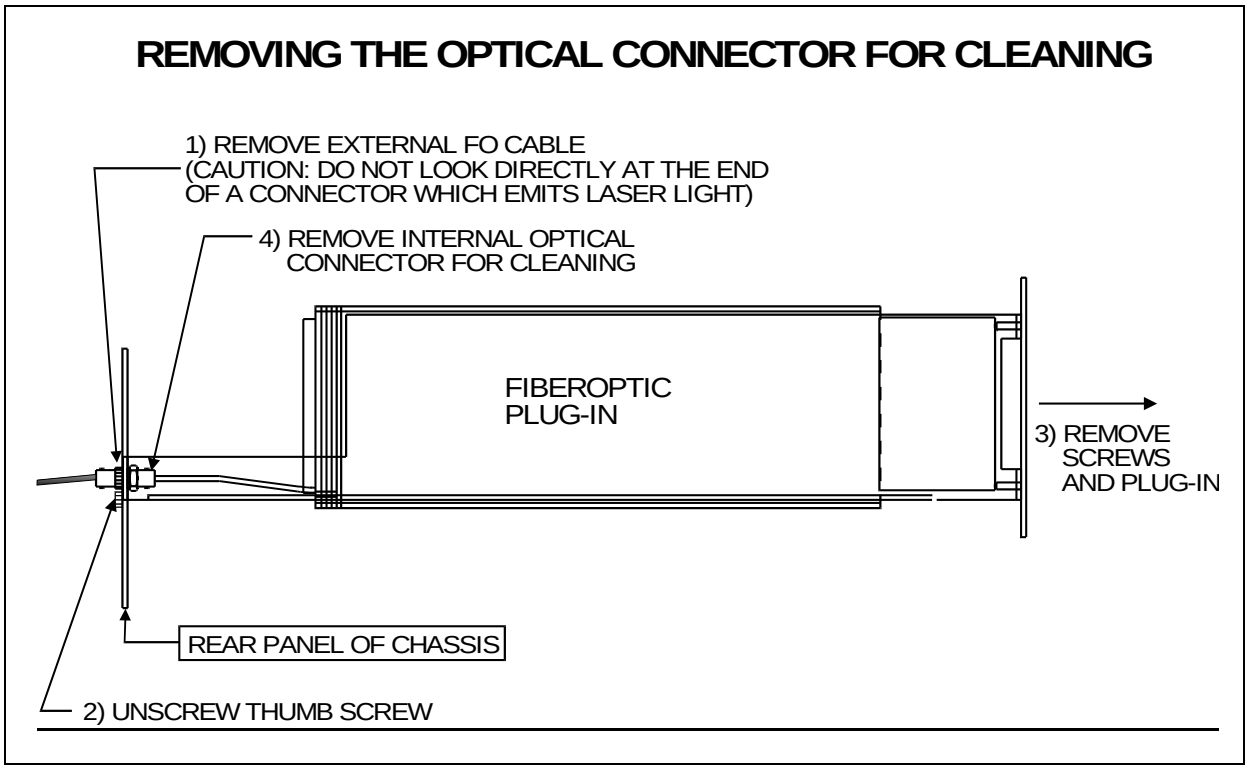



**Figure 3-2**
Removing the Optical Connector for Cleaning.

2. Optical connections will now be made to the FO Transmitter plug-ins. The configuration sheet shows the System configuration and the interconnections. Optical attenuators should be used to simulate the optical fiber. Optical attenuators with values specified by the customer are provided in the Ortel Accessory kit. The optical connectors used in this system are the standard FC/APC connectors for 1310 nm singlemode fiber which specify an optical return loss of >55 dB. For optimum performance, the tips of the optical connectors must be very clean. A cleaning kit is provided in the Ortel Accessory kit. The bulkhead optical connectors in the Ortel FO System chassis were cleaned prior to shipment and should not need further cleaning. However, the connectors from the optical fiber or the optical attenuator should be cleaned before connecting to the chassis. 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 (in cans supplied in the System 8000 Accessory Kit). The optical output connections from the FO Transmitter plug-ins can now be made.

## Caution:
## Be careful not to over tighten connectors!
## Optical Connectors should be finger tightened only!

If it becomes necessary to clean the optical connector from a FO Transmitter or Receiver plug-in, the plug-in must be removed from the chassis (as shown in Figure 3-2). First, disconnect the optical fiber cable from the chassis. Do not look directly at the end of an optical connector, which emits laser light! Then, remove the thumbscrew at the rear panel of the chassis, which holds the plug-in to the chassis. Remove the four screws at the front panel of the plug-in, which hold it to the chassis. Gently pull the plug-in out from the chassis. The bulkhead optical connector, located at the back of the plug-in, is now exposed. Disconnect the optical connector from the bulkhead feedthrough. The ferrule tip can now be cleaned as described above.

3. The system is now ready for optical connection to the FO Receivers. The FO Receiver plug-in mate to a FO Transmitter plug-in is in the companion chassis in the exact corresponding slot as the FO Transmitter plug-in. After cleaning the optical cable connectors, connect the FO cable to the mating FO Receiver plug-ins. The received optical power at FO Receiver should not exceed 2 mW; hence, sufficient optical attenuation is needed in both the actual and simulated links in order not to exceed this value. If the received photocurrent at the FO receiver exceeds 2 mA, a warning will be given at the FO plug-in front panel LED display and to the M&C system.

4. Now, switch on both power supplies at each chassis. Upon turning the power on, the FO System configuration is set to the default configuration: RF switch settings are directed to the primary FO links and the mode of switching is automatic. After a moment, the green "power on" LED displays should light on all the plug-ins. There should be no red alarms illuminated. If the yellow "OPT PWR HI" warning is illuminated at any FO Receiver plug-in, remove the optical fiber cable to that unit and insert addition optical attenuation. The warning means that the FO Receiver photocurrent exceeds 2 mA, which could damage the unit. Because no RF cable is connected, the yellow "RF PWR LO" warning will be illuminated for both the FO Transmitter and Receiver plug-ins.

5. Next, using serial interface cables (RS-232 cables are provided in the System 8000 Accessory kit), connect a pair of companion chassis to the two serial ports of an IBM or equivalent computer. Insert the Ortel System 8000 Installation Disk. In the Microsoft Disk Operating System (MS-DOS), the Ortel System 8000 Installation program is an executable file. In the A:> prompt, type "OC8000". The computer program displays the System Status for one of the chassis. An example of the display is given in Figure 3-3. The display gives information about the FO plug-ins (Slots 1 to 6). The displays show the FO plug-in type (for example Uplink Transmitter), the redundancy configuration (the RF switch assignments for the redundancy switching configurations are given in Figure 3-4), whether it is a primary or standby link and the status of the plug-ins (whether the RF switch is in the position to make the FO plug-in "in use" or "idle"). The display also shows the status monitoring levels, which chassis is being shown (the Control Center or the Antenna Site chassis) and the chassis serial number. The date and the optical loss for the link can be entered by the user as explained below in the System Configuration Setup. To toggle the System Status display between the two chassis, press the computer keyboard function key "F6" or go to the Program Menu at the top of the computer display by pressing the F10 function key and in the "Options" Menu, select "Comm Port". Other commands used in the "OmC8000" program are listed in Figure 3-5

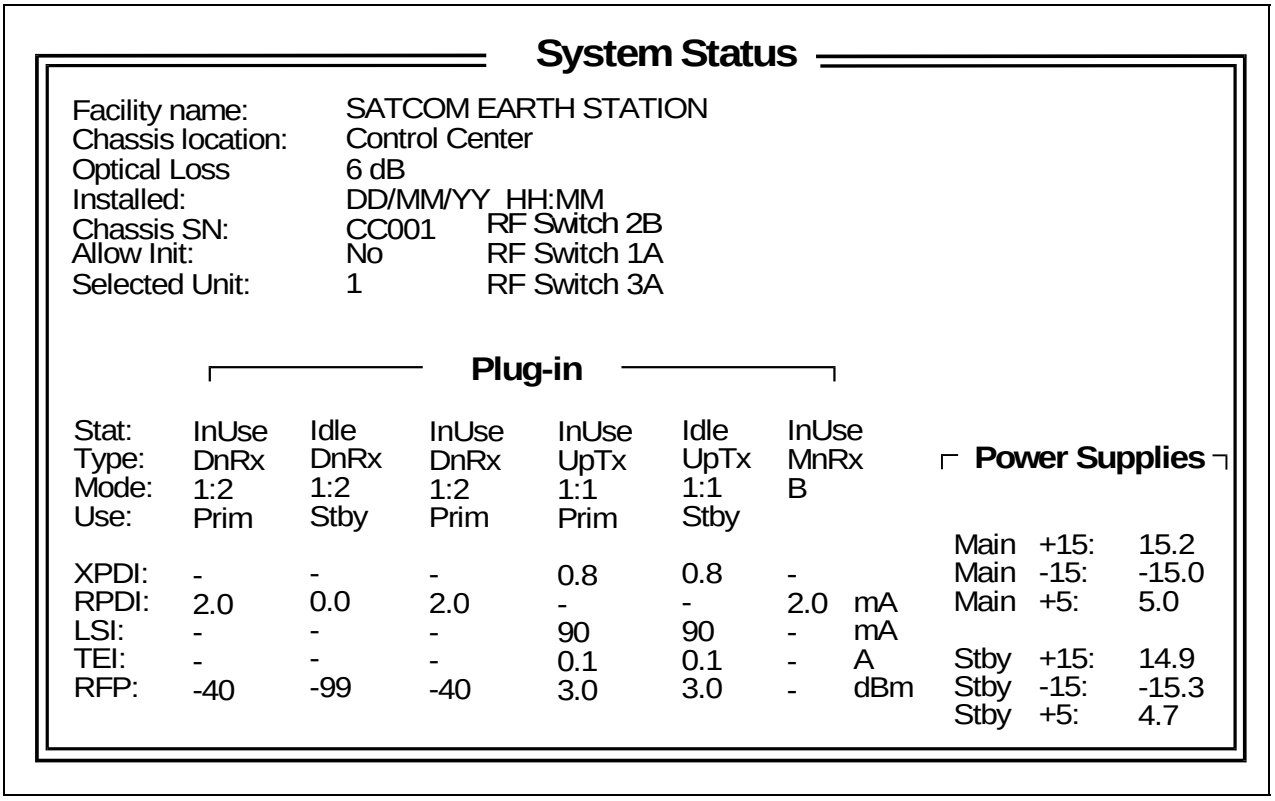



**Figure 3-3**
An example of computer display showing the Fiberoptic System Status for the chassis that goes into Control Center.

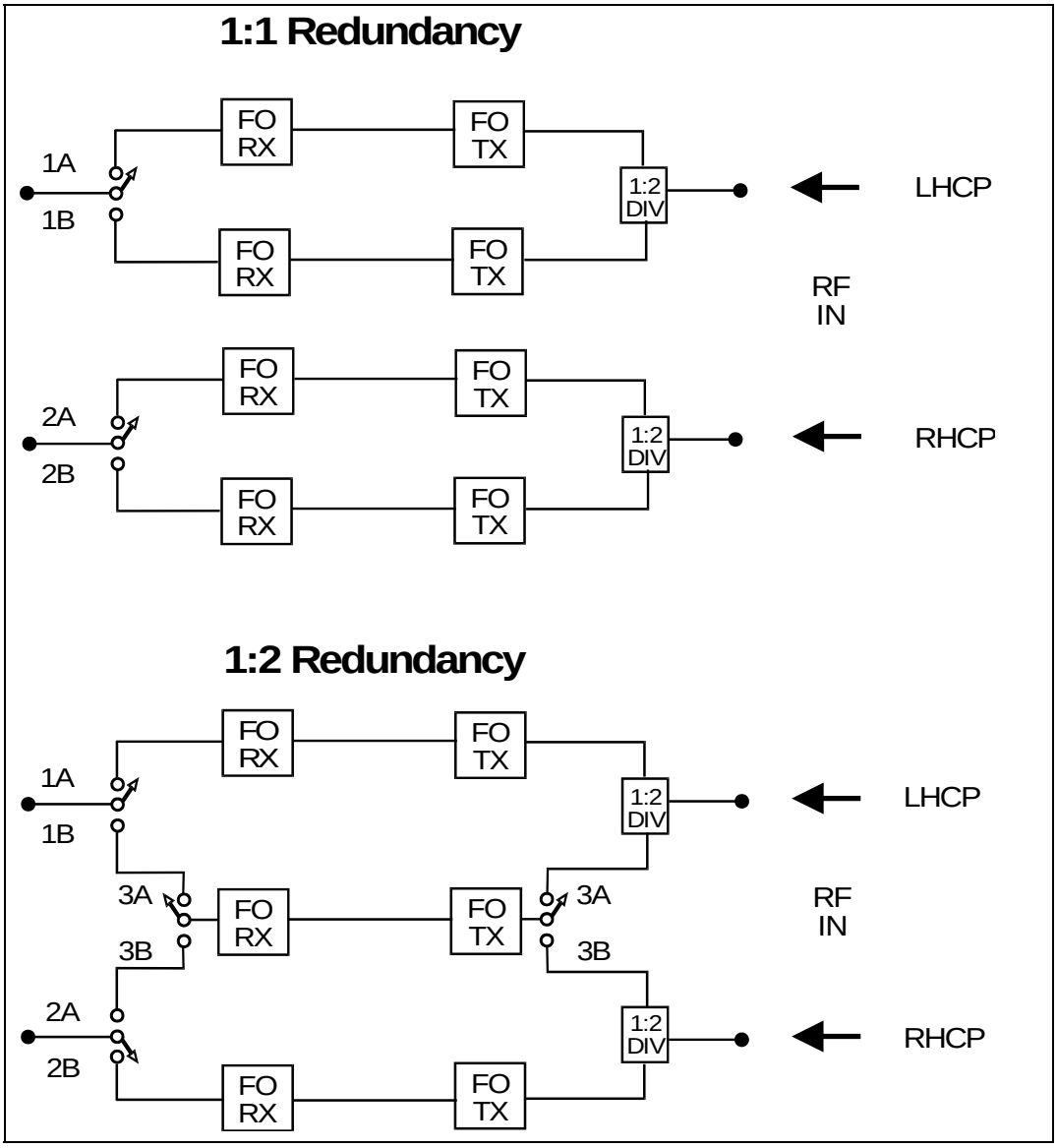



**Figure 3-4**
Switch Assignments for the 1:2 and 1:1 Redundancy 1:1 Redundancy Switching Configuration

| COMMAND | FUNCTION |
|---|---|
| OC 8000 | Runs Installation Program |
| F1 | Help |
| F6 | Toggles System Status Display Between Chassis |
| F10 | Brings up Program Menu (at top of screen) |
| ESC | Cancels Function & Returns to Previous Screen |
| Alt 'Highlighted Letter' | Jumps to Category Indicated by the 'Highlighted Letter" |
| Tab | Moves Cursor around Screen. |
| Enter | Completes Function and Returns to System Status Display |
| File/Save | Saves System Status Information in Current File. |
| File/Save As | Saves System Status Information in User Named File |
| File/Print | Prints System Status Display |
| File/Exit | Exits OC 8000 Installation Program and Resets System to Primary FO Links, Automatic Redundancy Switching and Resets Alarms |
| Operation/Redundant FO Path | Forces RF Switching to All Redundant Paths (Operation/Resets to Return to Primary FO links) |
| Operation/Reset Redundancy | Resets the Chassis to the Primary FO Links and Automatic Redundancy Switching |
| Operation/Reset Alarms | Resets the Summary and Power Supply Alarms and Resets 'Allow Init' to 'NO' |
| Operation/Unit Status | Gives the Status of the Selected Plug-in and Selects the Power ON/OFF. (Need to Select Unit in Setup/Select Unit to alter the Unit Status Settings) |
| Setup/Allow Init. | Allows Changing the System Configuration. |
| Setup/Configuration | Displays the System Configuration for Configuration Changes. |
| Setup/Monitor Input | Selects the A/B Input to the FO RF Signal Monitor Transmitter Plug-in. |
| Setup/Relays | Selects the RF Switch Position of the FO Transmitter and Receiver Plug-ins for Redundancy Switching. |
| Setup/Select Unit | Selects the Plug-in to Configure. |
| Setup/Select Unit | Shows the Setup of the Selected Plug-in, its Serial Number and its Description. |
| Options/Comm Port | Selects the Computer Communication Port (Identical to F6). |
| Options/Comm Port | Rewrites the System Status Display to Show Updated System Configuration. |

**Figure 3-5**
Summary of commands used by the Ortel System 8000 Installation computer program to perform various functions

Now, information such as the date and optical loss can be entered by the user. Go to the program Menu (F10) and in the "Setup" Menu, select "Allow Init". Then choose "Yes" and press "Enter". This allows the user to change settings on the System Configuration Display. After enabling initialization, go to the System Configuration display by going to the program "Setup" Menu and select "Configuration". The "System Configuration" as shown in Figure 3-6 will now display. The user can now change the following System Configuration information: Facility Name, Date, Optical Loss, User Message, Local Lockout On/Off, Automatic Redundancy Switching On/Off, and Asynchronous Message On/Off. Other information such as the plug-in configuration, Model and Serial Numbers, and chassis location cannot be changed by the user. Verify that the configuration agrees with the System configuration sheet supplied with the equipment and with the purchase order. Verify that the equipment location is correct. To exit the System Configuration Display and save the changes, move the cursor to the "ok" position and press "Enter". The user may now wish to disallow changes to the System Configuration by going to the program "Setup" Menu. Select "Allow Init" and choose "No". After pressing "Enter", the System Status screen will display showing the new information that the user has supplied.

The System Status Display should now show the status of each plug-in. The received photodiode currents should be between 0.2 and 2 mA. Optimum performance is achieved with high-received optical power. However, the FO receiver can be damaged by excess optical power. A warning at the FO Receiver front panel display will illuminate if the received current is in excess of 2 mA. If the received photocurrent exceeds 2 mA, disconnect the optical input to the receiver and add optical attenuation to reduce the photocurrent to 2 mA. A failure alarm will activate and initiate switching to the standby FO path if the received optical power drops below 0.2 mA.

**Caution:**
**Be sure that RF power inputs to the FO Transmitter Plug-ins do not exceed the following absolute maximum power levels. The laser modules may be damaged by a higher-level RF input. The nominal operating RF input power levels should be 10 to 20 dB below these absolute maximum levels.**

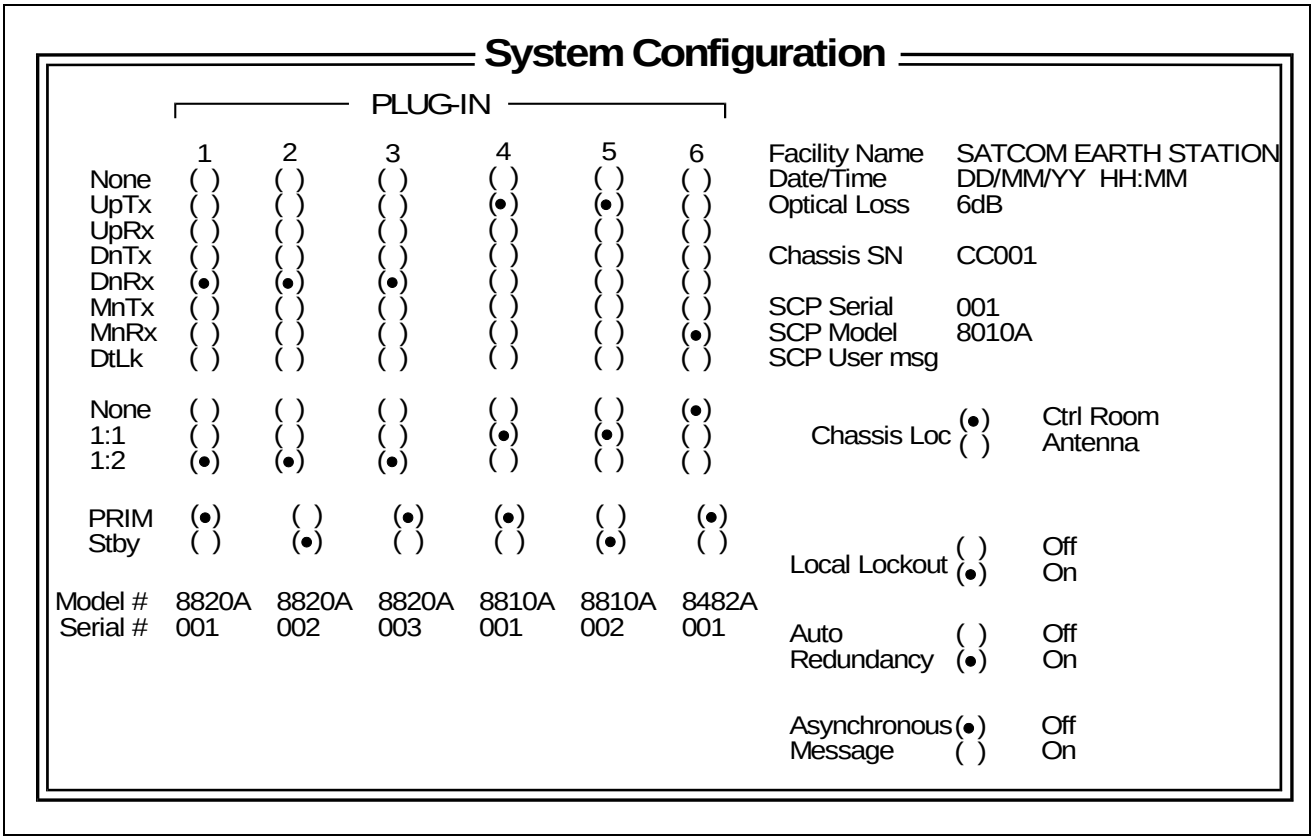



**Figure 3-6**
A sample data sheet showing the System Configuration for the chassis that goes into the Control Center.

| Plug-in | Absolute Max RF Input at Max Gain Setting |
|---|---|
| 70/140 MHz (8603A) | -5 dBm |
| L-Band (8710A) | -15 dBm |
| C-Band Up (8810A) | +5 dBm |
| C-Band Down (8810B) | -10 dBm |
| X-Band (8850A) | -15 dBm |
| Ku-Band (8910A or 8910B) | -15 dBm |
| RF Monitor (8400) | +18 dBm |

6. The system is now ready for RF connections, RF gain adjustment, and RF Alarm threshold adjustment. The gain adjustment located at the front of each plug-in sets the preamplifier or post-amplifier gain. The RF Alarm threshold adjustment for each FO plug-in, which determines the RF level at which the RF Power Low warning alarm, will activate has been preset at the factory for the minimum RF level. Verify that all of these adjustments are fully adjusted counter-clockwise for the 70/140 MHz, C, X and Ku-Band plug-ins and clockwise for the L-Band plug-ins. Ensure that the RF input levels to the Ortel System 8000 do not exceed the power specifications.

7. Connect a user-supplied RF input to the first FO Transmitter plug-in and connect a power meter to the RF test port at the front of the FO Transmitter. The user-supplied RF input should represent the maximum total input power expected for actual use. The RF test port at the front panel of the FO uplink/downlink transmitter plug-ins measures the RF level internal to the FO Transmitter (just prior to the laser module). The RF test ports are calibrated to be -20 dB from the actual RF level. The RF gain adjust at the front panel of the FO Transmitter plug-in sets the preamplifier in the FO Transmitter so that at the maximum expected total RF input level into the FO Transmitter plug-in, the laser would be modulated with the optimum level for achieving high carrier to noise ratio and low intermodulation distortion. The RF level into the laser module (after the preamplifier) is close to 0 dBm. Depending upon the user's requirement, the system can be adjusted to trade-off better carrier to noise at the expense of linearity. For example, if the FO Transmitter gain adjustment is increased, then the carrier to noise and noise figure improve but the intermodulation distortion increases due to the higher modulation. The user must also avoid exceeding the absolute maximum RF ratings when making these gain adjustments. Figure 3-7 gives nominal levels read at the test ports which sets the preamplifier gain for achieving high carrier to noise and low distortion for many applications.

| Plug-in | Nominal RF Input at Min Gain | Nominal RF Input at Max Gain | Power at Transmitter Test Port |
|---|---|---|---|
| 70/140 MHz (8603A) | -13 dBm | -22 dBm | -23 to -17 dBm |
| L-Band (8710A) | -15 dBm | -30 dBm | -23 to -17 dBm |
| C-Band Uplink (8810A) | -5 dBm | -15 dBm | -23 to -17 dBm |
| C-Band Downlink (8810B) | -15 dBm | -30 dBm | -23 to -17 dBm |
| X-Band (8850A) | -15 dBm | -30 dBm | -23 to -17 dBm |
| Ku-Band Uplink (8910A) | -20 dBm | -30 dBm | -23 to -17 dBm |
| Ku-Band Downlink (8910B) | -15 dBm | -30 dBm | -23 to -17 dBm |

**Figure 3-7**
FO Transmitter plug-in gain adjustment that gives high carrier to noise and low distortion for many application.

8. The RF Alarm threshold can now be set. Reduce the user-supplied RF input level to 10 dB below the minimum expected signal level that would be supplied to the Ortel FO System. Then increase the RF Alarm threshold adjustment until the yellow warning "RF Power Low" on the front of the plug-in lights up. The computer display will provide the value of the RF Alarm threshold in the System Status line "RFP". The warning will not activate unless the RF signal drops 10 dB below the minimum expected RF signal level. In operation, this alarm could indicate failure of the internal amplifiers if the M&C system shows that there is no loss of RF signal into the FO system.

9. Now, adjustments can be made at the companion FO Receiver plug-in. First, the RF Alarm threshold of the FO receiver plug-ins should be set. To set the RF Alarm threshold, keep the RF input level to FO system at 10 dB below the minimum expected signal level (as in the previous step). Then increase the RF Alarm threshold until the yellow warning "RF PWR LO" on the front of the FO Receiver plug-in lights up. The computer System Status display provides the value of the RF Alarm threshold in the line "RFP".

10. The gain adjustment of the FO Receiver plug-in can be set (the 70/140 MHz FO Receiver plug-in has a fixed gain post-amplifier, and no adjustment is needed). Connect a power meter to the FO Receivers test port. The test port is calibrated so that it is -20 dB from the actual output from the FO Receivers. Supply an RF input level to the FO System so that it represents the total input power expected for actual use. Adjust the gain control at the front of the FO Receiver plug-in until the RF output from the system is appropriate for interfacing with the user's equipment (such as the satellite receiver or HPA). If desired, the user can also connect the actual RF output located at the FO System chassis rear panel to the user-supplied equipment (such as a spectrum analyzer, power meter, or satellite down converter/receiver) for further diagnostics.

11. Similar connections and adjustments need to be made for the remaining FO paths including any shelf spares. The simplest way to select the standby FO path is to turn the power off to the Primary FO path. Go to "Setup/Select Unit" to select the FO plug-in to turn "Off". Then go to "Operation/Unit Status" to turn the Power "Off". This will force the Standby FO path to be "In Use." Both chassis containing the FO Transmitter and FO Receiver plug-ins must be switched in this manner. Another method is to manually select the RF switch positions. This technique requires the user to pay special attention to the exact switch positions but does not require that any FO plug-ins be turned off. In the program menu (F10), go to the "Setup" Menu and select "Relays" and choose the configuration according to the RF switch assignments given in Figure 3-4. The RF switch positions for both chassis containing the FO Transmitter and Receiver must be selected. A final way to select the standby FO paths is to turn off all the primary FO link transmitter and receiver plug-ins. This will force the RF switches to all the standby paths but will activated red alarms for all the primary FO links. To choose the standby FO links, go to the "Operation" Menu and choose "Redundant FO Path". Then make connections and adjustments as described above in Steps 5 to 9. To return to the primary paths, reset both chassis by going to the "Operation" Menu and "Reset Redundancy". The alarms can be reset with "Operation"/"Reset Alarms".

12. The Fiberoptic Data Link needs no adjustment.

13. The RF Signal Monitor link (located in the chassis to the right of the FO Uplink/Downlink Plug-ins) has no adjustment. The nominal total RF input power to this link is 5 dBm. This input must be set externally, using fixed attenuators if necessary.

14. After completing this setup, both chassis should be reset to the default configuration: primary FO links and automatic redundancy switching configuration by going to the program menu (F10) and "Operation" Menu and "Reset Redundancy". Exiting the "OC8000" program also resets the System to the default configuration. The System Status display can be printed by going to the "File" Menu and selecting "Print." The System Status can also be saved in a file that the user names by going to the "File" Menu and selecting "Save As". To obtain all the System Status information, the user must toggle to both chassis (using the keyboard function key F6). The Ortel System 8000 is now ready for installation. Keep the RF and optical connectors clean with a protective cover before transporting the equipment to the installation site.

## MECHANICAL INSTALLATION

Install each chassis in a standard NEMA 19-inch rack using four screws. The racks must have shelves to support the chassis. The chassis cannot be mounted by the front panel screws alone. Ventilation holes at the sides of the chassis and fans at the back of the chassis should not be blocked. The Control Center chassis go to the Control Center and the Antenna Site chassis go to the Antenna Site. RF and optical cables should be neatly placed and labeled. Power cords need to be secured to avoid inadvertently disconnecting them from the sockets.

## ELECTRICAL AND OPTICAL INSTALLATION

Following the mechanical installation, the system is ready for installation and operation.

1. Connect power cables from both the main and standby power supplies to sources of AC power. Before connecting the optical cables to the chassis, clean the connectors on the fiber optic cables as described earlier in the pre-installation section. Verify the System configuration and connect the optical cables to the connectors at the rear panels of the companion chassis. Turn on both power supplies. After a moment, the green "power on" LED displays should light on all the plug-ins. There should be no red LED alarm illuminated. If the red "OPT PWR LO" alarm remains on, the fiber optic cable must be checked for continuity. The yellow "OPT PWR HI" warning should be off, otherwise remove the optical cable and add optical attenuation. Because no RF cable is connected, the yellow "RF PWR LO" warning will illuminate for both the FO Transmitter and Receiver plug-ins.

2. Next, connect a user-supplied IBM PC Standard or equivalent computer to the remote interface port at the back of the Transmitter chassis. Insert the Ortel System 8000 Installation Disk. In the Microsoft Disk Operating System (MS-DOS) and A:> prompt, type "OC8000". The program will display the System Status.

**Caution:**
**The FO Receiver plug-in may be damaged by optical high inputs. Maximum operating optical power is 2 mW.**

3. Connect the RF input/output connectors at the rear panels of the chassis to the earth station system. If necessary, fine tune the RF gain adjustment using a power meter at the FO plug-in front panel test ports. The RF Alarm threshold should not need adjustment. Its level is set so that the threshold is approximately 10 dB below the minimum expected RF signal level.

4. For the RF Signal Monitor Link, connect the RF inputs to the appropriate connectors at the rear panel of the chassis located at the Antenna Site. The nominal RF input for the FO RF Signal Monitor link is 5 dBm. The inputs go through a switch internal to the FO RF Signal Monitor Transmitter plug-in (located at the Antenna Site) to select the signal (such as RHCP or LHCP) to be monitored. The switch can be remotely controlled through the user's Monitor and Control (M&C) System. The RF output of the Signal Monitor Link can be monitored through the rear panel or the test port at the front panel RF connector of the FO Signal Monitor Receiver plug-in located in the chassis at the Control Center. The output of the link can then be connected to a spectrum analyzer to remotely monitor and verify levels of the uplink signal.

5. Verify that all alarms and warnings are off, that the status levels are in the normal operating range as given in Figure 2-36 and that the default Primary FO links are "In Use". Check and print out the System Status for the chassis at both the Antenna and Control Center Sites. The System Status can be saved at any time to a file chosen by the user.

6. Connect the data signal (RS-422 or RS-232) to be transmitted via the Fiberoptic Data Link to the 9-pin D-connector at the chassis rear panel.

7. The electrical and optical installation is now complete. Exit the installation program by going to the "File" Menu and selecting "Exit". The system will automatically reset the redundancy switching to the default configuration upon exiting the program. The default configuration selects the primary FO link path and the automatic redundancy switching mode of operation. The Summary and Power Supply alarms will also be reset and the System will disallow System Configuration changes ("Setup/Allow Init" will be reset to "No").

8. Disconnect the computer and connect the user-supplied M&C System to the Ortel FO Transmitter and Receiver chassis. The

Remote Interface port (specified as RS-232 or RS-485 in the purchase order) at the rear panel of the FO System chassis interfaces to the user's M&C System allowing him to monitor the status of the FO System. RS-232 cables with 9-pin D-connectors which connect the Ortel Fiberoptic System to an IBM PC or equivalent computer are supplied in the Ortel System 8000 Accessory kit and schematically shown in Figure 2-34. If the user's M&C pin assignments are not compatible with this or the user interface is RS-485, then the user needs to supply a cable which will interface his M&C System to the Ortel FO System. The pin assignments for the 9-pin D-connector at the rear panel of the Ortel FO System chassis were given earlier in Figures 2-7. Warnings and alarms will be transmitted to the user's M&C System. For the 1:2 redundant configuration, the user's M&C System must provide the appropriate commands to automatically switch the FO transmitter to the standby path upon failure of the FO Receiver. Failure of the user's M&C System to automatically switch the FO transmitter to the standby path in the event of a failure will result in a total loss of signal.

9. Connect the user's alarm sensor to the FO System Summary Alarm Output using the 25-pin D-connector at the FO System chassis rear panel. The pin outs of the connector were given in Figures 2-7. This will inform the user if there is a failure within the chassis. Once the Summary Alarm is activated, the Summary Alarm relay switch remains in the activated alarm position. The Summary Alarm is reset by going to the "Operation" Menu and selecting "Reset Alarms".

10. The installation is now complete. The FO System should now be ready for full operation.

# CHAPTER 4 - MAINTENANCE, TESTING AND TROUBLESHOOTING

This chapter describes maintenance, performance verification and troubleshooting of the Ortel System 8000 Fiberoptic System.

## MAINTENANCE

The system normally operates without operator intervention. However, it is the user's responsibility to utilize the monitor and alarm outputs provided. Monitoring these outputs and logging readings periodically will provide an early warning that maintenance is required to avoid system failure or degradation. If any item fails, the line replaceable unit (plug-in) should be replaced and the system restored to the default configuration (the primary FO link path and the automatic redundancy switching mode of operation). A plug-in can be removed and replaced with a spare while the chassis is powered to minimize system interruption.

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

After installation of the user's Monitor and Control (M&C) System, it is best to perform any maintenance, testing and troubleshooting through the user's M&C System. However, the Ortel FO System permits the user to view the status of the FO System during operation by disconnecting the user's M&C System and then connecting a IBM PC standard or equivalent computer to the remote interface port at the rear panel of the FO System chassis. Insert the Ortel System 8000 Installation Computer Disk. In the Microsoft Disk Operating System (MS-DOS) A:> prompt, type "OC8000". This will then display the real-time status for the FO System (chassis and plug-ins). Figure 3-3 is an example of the computer display. If the "Pre-installation or Installation" Status were saved, those values can be compared with the current values. During this time, when the user's M&C System is disconnected, certain functions (such as automatic switching control in the 1:2 redundancy switching configuration) will be disabled. After exiting this computer program, the system will automatically reset to the Primary FO links, clear the alarms and reset the system to the automatic redundancy switching configuration.

## PLUG-IN REPLACEMENT

1. If a primary FO plug-in fails, the standby FO link is forced into use. The plug-ins of the failed FO link are automatically turned off although power is still provided to display the alarms at the front panel of the plug-ins. Just before replacing a failed plug-in, remove the four screws of the Status and Control plug-in (SCP) and gently pull it out slightly so that it is no longer plugged into its socket. This turns the SCP off. To replace the failed plug-in, disconnect the optical fiber cable from the plug-in. Do not look directly at the end of an optical connector which emits laser light. Then, remove the thumbscrew at the rear panel of the chassis, which holds the plug-in to the chassis. Remove the four screws at the front panel of the plug-in, which hold it to the chassis. Gently pull the plug-in out from the chassis.

2. Gently slide the replacement plug-in into the chassis slot. The optical connector of the replacement plug-in should already be clean. Otherwise, it needs to be cleaned as described in Chapter 3 and Figure 3-7 before inserting it into the chassis. Align and tighten the thumbscrew at the chassis rear panel and then the ones at the front panel. Clean and reconnect the optical cable to the FO plug-in. Push the Status and Control plug-in back into its socket and tighten the screws.

3. To turn the unit on, first select the chassis containing the FO Transmitter plug-in (using the F6 function key). Go to the "Setup" Menu and "Select Unit". Select the Slot (1 to 6) that contains the replacement unit. Then go to the "Operation" Menu and "Unit Status". Move the cursor to the Power On/Off position and select "On" to turn the FO Transmitter plug-in on. Repeat this procedure for the FO Receiver plug-in by going to the chassis containing the replacement FO Receiver plug-in (using the F6 function key). Again go to the "Operation" Menu and "Unit Status". Move the cursor to the Power On/Off position and select "On". Check the System Status Display to verify that the levels are within the ranges specified in Figure 2-36 for both the FO Transmitter and FO Receiver plug-ins. Go to the "Setup" Menu and "Reset Alarms" to clear the alarm indicators.

4. If the FO Transmitter and Receiver plug-in RF gain adjustment and RF alarm threshold adjustment have not been previously set, then they must be set at this time. Connect an RF power meter to the FO Transmitter plug-in front panel test port to measure the RF level internal to the FO Transmitter (just prior to the laser module). The RF test port is calibrated to be -20 dB from the actual RF level that goes into the laser module. Adjust the gain at the FO Transmitter front panel for the appropriate RF level (it should adjusted to be identical to the other plug-ins in active use). The RF alarm threshold should now be adjusted so that the alarm does not activate unless the RF signal drops at least 10 dB below the normal operating RF level. Similarly, at the FO Receiver plug-in, connect an RF power meter to the FO Receiver test port and adjust the RF gain and alarm threshold until the level is appropriate. A more detail description for setting up the FO Transmitter and Receiver plug-in gain level is given in Chapter 3.

5. The FO Transmitter and FO Receiver plug-ins should now be fully functional as shown in the System Status Display. The repaired FO link still remains "Idle" rather than "In Use", meaning that the System does not automatically switch back to the Primary FO link once the Standby FO link is switched to "In Use" even though the Primary FO link has been repaired. To reset the RF switches back to the Primary FO links, the simplest method is to go to the "Operation" Menu and "Reset Redundancy". This must be performed for both chassis containing the FO Transmitter and FO Receiver plug-ins. The alarms (such as the Summary Alarm and the Power Supply Alarms) need to be separately reset by going to the "Operation" Menu and "Reset Alarms". If the "OC8000" Installation program is used, then exiting the program automatically resets the redundancy switching configuration to all primary FO links and resets the alarms. If this is not desired, then the user's M&C System program should be used during maintenance and repair to prevent unintentional reset of the System. RF switches can also be toggled locally at the chassis by pressing the recessed switches at the Status and Control plug-in front panel. Pressing the recessed switches has the results shown in Figure 4-1.

| **Plug-in Type** | **Recessed Switch Function** |
|---|---|
| FO Transmitter | Laser Power On/Off |
| Primary FO Receiver (system with RSU) | RF Switch Toggle |
| Standby FO Receiver (system with RSU) | No Effect |
| Primary FO Receiver (non-redundant system) | No Effect |

**Figure 4-1**
Response of RF switch in RSU when recessed switch at Status and Control plug-in front panel are pressed.

6. After the Primary FO link has been repaired, the user can choose to continue to use the standby FO link. The Summary Alarm indicating failure of the Primary FO link can be cleared by going to the "Operation" Menu and "Reset Alarms". When convenient, it is recommended to reset the system to the Primary FO links because failure of the Standby FO link will NOT automatically switch the System back to the Primary FO link even though the Primary FO link has been repaired. Reset the System to the Primary FO links by going to "Operation" and "Reset Redundancy".

7. To replace a Power Supply or Status and Control plug-in, remove the four screws at the front panel of the plug-in that hold it to the chassis. Gently slide the plug-in out and insert a replacement plug-in into the chassis slot. Tighten the screws that hold the plug-in to the chassis. Clear the alarms by going to the "Operation" Menu and "Reset Alarms". When a replacement Status and Control plug-in is inserted or if both Power Supplies are replaced (causing the power to the System to be Off and turned On again), then the System will automatically Reset to the default condition: Primary FO links and automatic redundancy switching and the alarms will reset.

8. To replace the chassis fan, disconnect the power cable that is attached to the fan. Remove the four screws that hold the fan to the chassis. Install a replacement fan. Tighten the screws that hold the fan to the chassis and reconnect the power cable to the fan. To clear the alarms, go to the "Operation" Menu and "Reset Alarms".

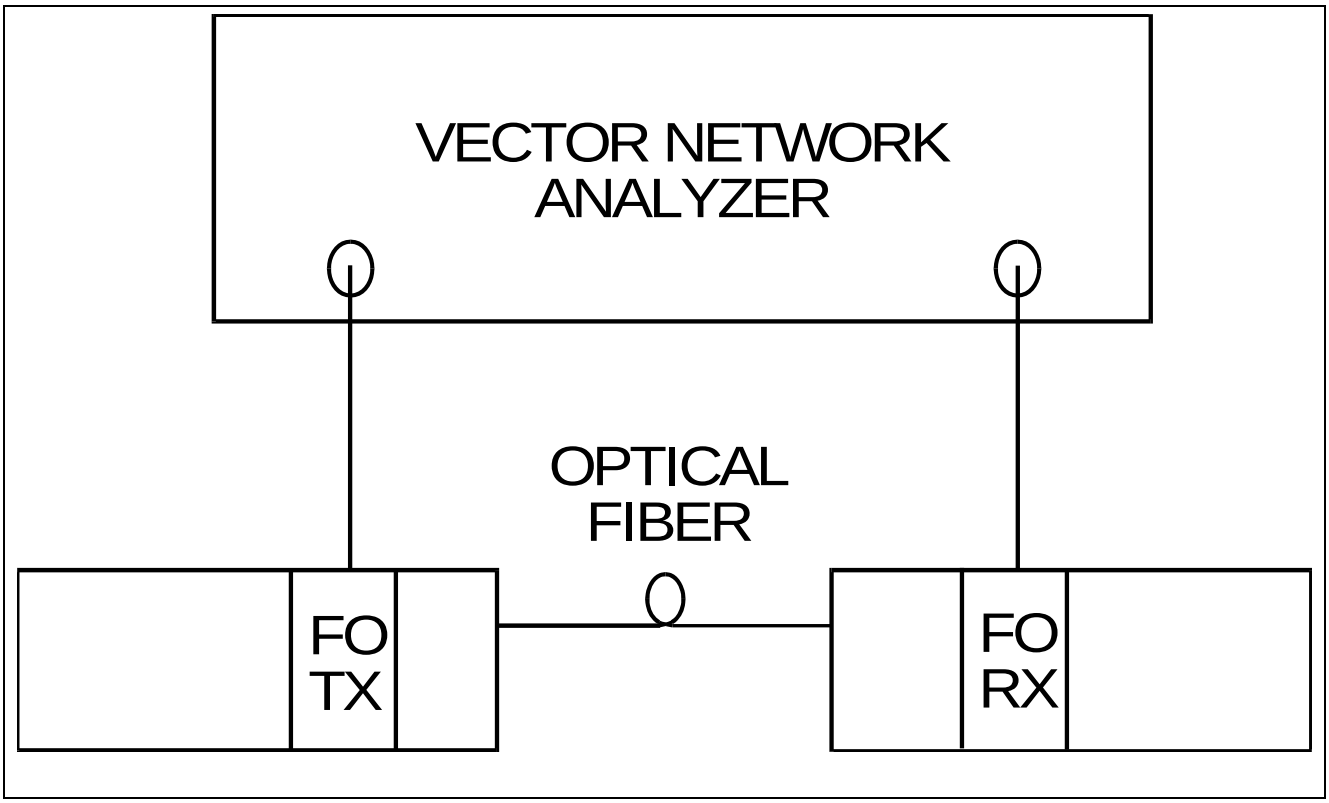



**Figure 4-2**
Setup to measure the Fiberoptic System gain, flatness, gain slope, VSWR and group delay.

## TESTING

This section contains information and procedures for performing tests to verify the specifications and functionality of the system. It describes how to test the Redundancy Switching Unit (RSU) and how to verify the specifications of the individual uplink, downlink and RF Signal Monitor fiberoptic links. The testing described in this section assumes that the FO chassis are collocated.

The user must select the appropriate RF switch positions to test the desired fiberoptic link by using the Ortel System 8000 Installation Computer program or pressing the recessed switches at the Status and Control plug-in front panel. The RF switch positions are shown in Figure 2-39. An alternative way to force the RF switches from the primary to the standby FO paths is to turn off the primary FO transmitter and receivers. To force use of the standby FO links, go to the "Operation" Menu and "Select "Redundant FO path". This will activate red alarms for the primary paths and force use of the standby paths. The system can be reset to the primary paths by going to the "Operation" Menu and "Reset Redundancy" for both chassis.

To verify the performance specifications of the individual fiberoptic links, the following describes the measurement methods.

1) Total Gain, Flatness, Gain Slope

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 at the back of the chassis which contains the FO Transmitter plug-in to be tested. Connect the FO Receiver plug-in RF output at the back of the appropriate chassis to Port 2 of the network analyzer. The $S_{21}$ measurement parameter provides gain, flatness, and gain slope over the frequency bandwidth of interest. These values can then be compared to the performance specifications given in Chapter 2.

2) 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 1.35:1 corresponds to a 16.54 dB return loss.

3) Group Delay

These measurements are made using a vector network analyzer. Set up the measurement as described above for measuring amplitude response (gain). The group delay measurement function gives the group delay as a function of frequency. The network analyzer measures phase change within a frequency step and computes the group delay. This measurement provides the peak-to-peak group delay over the bandwidth of interest. The linear and parabolic group delays are computed from this measurement by calculating the derivative and second derivative of the group delay as a function of frequency.

4) Noise Figure

The noise figure (NF) is defined as:

$$NF = 10 \log(SNR_{input}/SNR_{output}),$$

where SNR is the signal-to-noise ratio at the input/output of the system under test. If the input signal is thermal noise, the noise figure can be determined by measuring the signal-to-noise level at the output of the system and the input signal level $RF_{in}$.

The noise figure is given by:

$$NF = 173.8 + (RF_{in} - SNR_{output}) \text{ dB},$$

where $RF_{in}$ is in units dBm and the SNR is in units dB-Hz.

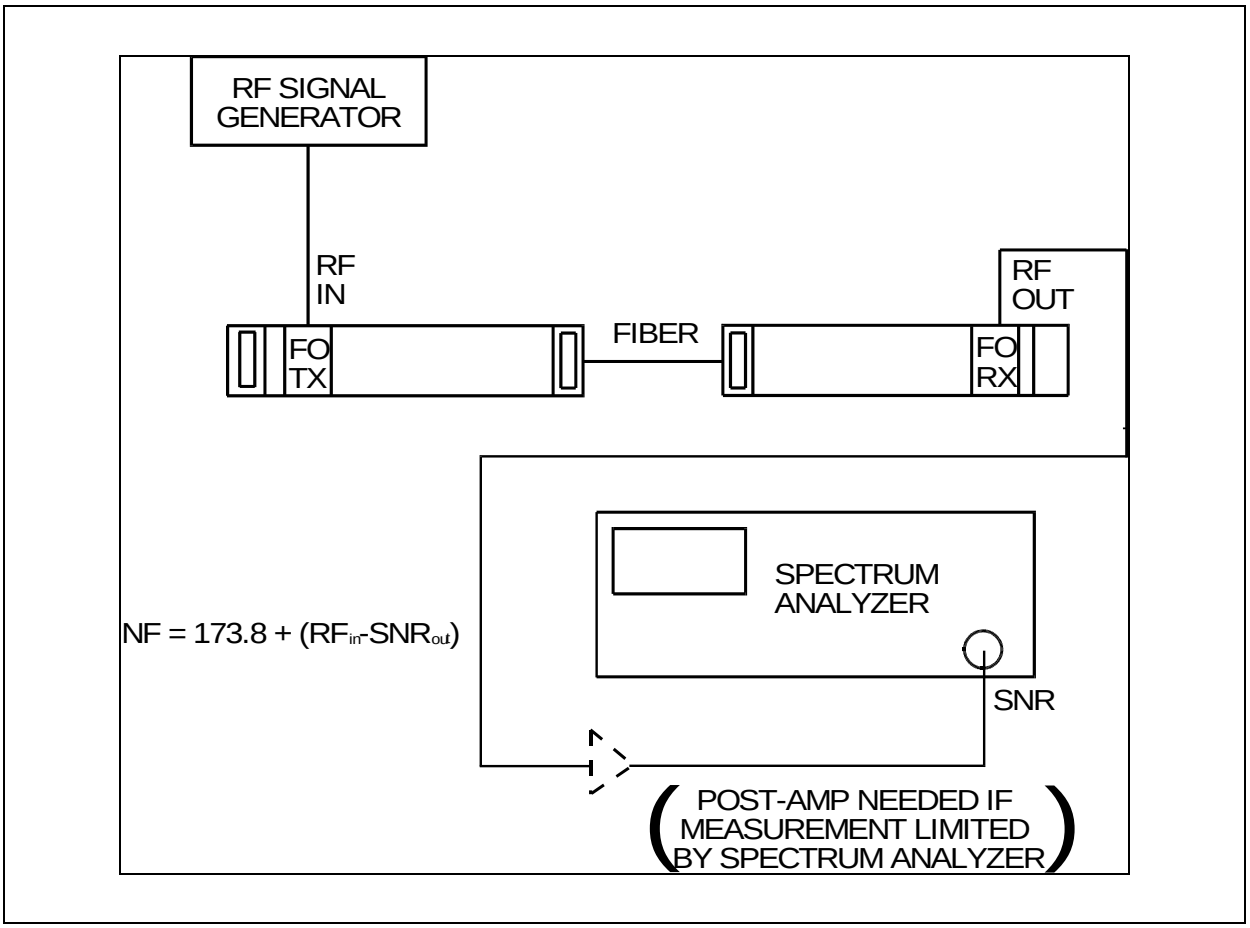



**Figure 4-3**
Setup for measuring noise figure

Generally, for measuring the noise figure of amplifiers, noise figure meters are used. However, when the expected noise figure is 20 dB or higher, such as for fiberoptic link systems, conventional noise figure meter techniques are not used because noise figure meters require noise sources which are several dB higher than the device under test. Instead, we describe below the technique that we use to determine the system noise figure. The approach conservatively determines the FO System noise figure because it assumes that all of the contribution to the measured noise is due to the FO System and none is due to the signal source generator.

To measure noise figure for the fiberoptic link, 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. Ensure that the signal level does not exceed the maximum RF input level rated for the FO plug-in to be tested. The SNR of the signal generator should also be measured to ensure that it is not limiting the noise figure measurement. Then connect the signal generator to the input of the FO link and an RF spectrum analyzer to the RF output of the link as shown in Figure 4-3.

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. Calculate the output signal to noise ratio (SNR). The SNR and RF input values can now be inserted in the NF equation above to compute the Noise Figure of the fiberoptic link.

The noise contribution from the spectrum analyzer should be measured to ensure that it does not limit this measurement. This is simply done by measuring the spectrum analyzer noise floor when it is terminated into a matched load (usually 50Ω). If the noise level after the fiberoptic system is below the spectrum analyzer noise floor, then it is necessary to add a post-amplifier after the fiberoptic link to enable measurement above the spectrum analyzer noise floor.

If a clean signal generator is not available, one can use the following alternate technique. Measure the total gain of the FO link. Then, terminate the input to the FO link with a 50 ohm load and measure the output noise level. The noise figure is then given by:

NF = 173.8 - (Gain - Output Noise) dB,

where NF and Gain are in units dB and Output Noise is in units dBm/Hz. Similar to the previous technique, if the spectrum analyzer noise limits the measurement, then a post-amplifier after the FO link must be used. The gain in the above noise figure calculation must then include the post-amplifier gain.

5) Linearity Test - 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 link (at the chassis containing the FO Transmitter). 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 >80 dBc for 0 dBm RF output tones in order to negligibly affect the measurements. The RF output from the fiberoptic link (at the chassis containing the FO Receiver) may need to be filtered before inputting to a spectrum analyzer.

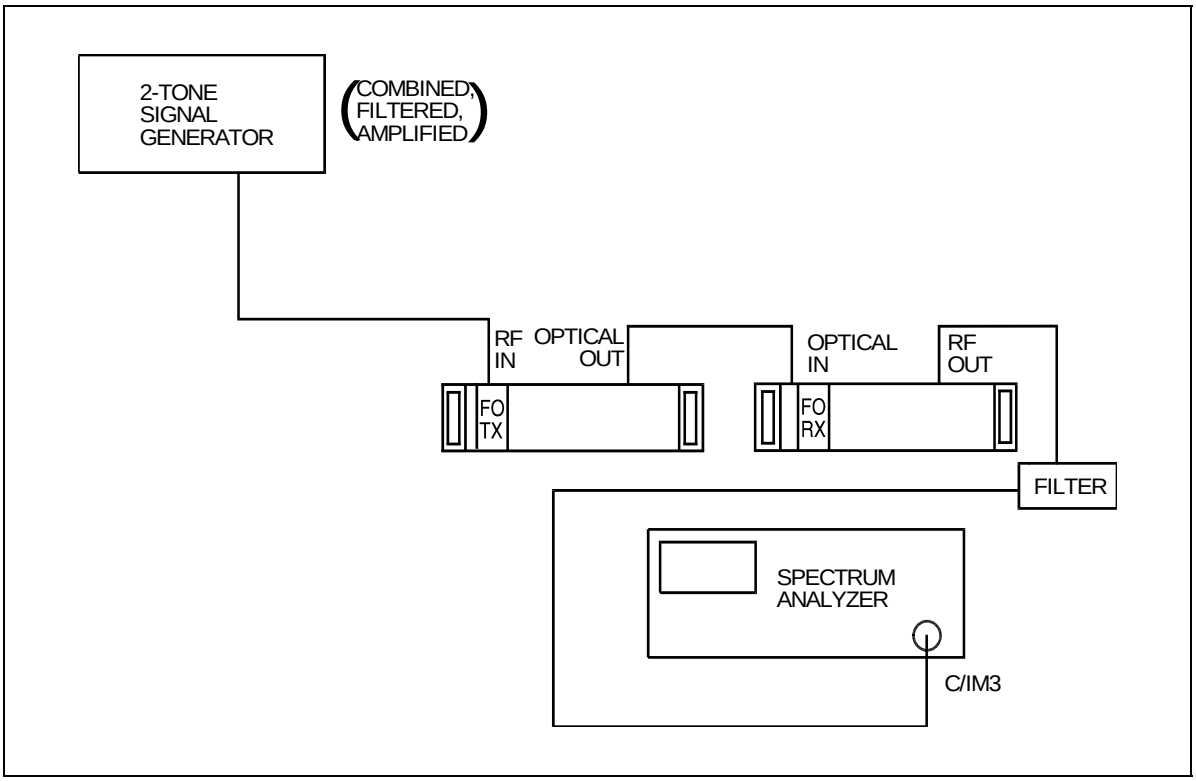



**Figure 4-4**
Setup for measuring two-tone linearity.

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/IM3) in units dB. From the C/IM3, one can then compute the input third order intercept (IIP3). The input IIP3 is given by:

$$IIP3 = RF_{input} + (1/2)(C/IM3) \text{ dBm},$$

where $RF_{input}$ is the power per tone in units dBm and C/IM3 is in units dB.

The third order spur-free dynamic range (SFDR) is the input signal range where the output signal is above the noise level and the third order distortion product is below the system noise level. It is given by:

$$SFDR = 2/3 \text{ (IIP3} + 173.8 - NF) \text{ dB-Hz}^{2/3}$$

$$SFDR = 2/3[(SNR_{output}) + (C/IM3)/2] \text{ dB-Hz}^{2/3}$$

$$SFDR = 2/3[RF_{in} + (C/IM3)/2 + 173.8 - NF] \text{ dB-Hz}^{2/3}$$

where IIP3 is the input third order intercept point, NF is the noise figure, C/IM3 is the ratio of the carrier to the third order intermodulation distortion level and $RF_{in}$ is the RF input per tone.

6) Redundancy Switching Unit (RSU)

To test the proper functioning of the RSU and alarms, the user can toggle the RF switches between the "primary" and the "standby" FO paths by entering the program "OC8000" and in the "Operation" Menu choose "Redundant FO path". Both FO companion chassis need to be connected to the computer for this test. The RSU can also be tested by the user creating a failure (for example by disconnecting the fiber optic cable) to verify that the fiberoptic system switches to the standby FO path. The "System Status" display of the computer program shows the plug-ins that are "in use" and those that are "idle" (indicating the positions of the RF switches) and the performance levels of each plug-in in the chassis. The user can verify which FO path is being used by observing the changes in the RF output level as the gain adjustment at the front panel of the selected FO plug-in is altered. The RSU can also be tested locally at the chassis by pressing the recessed switches at the front panel Status and Control plug-in front panel. The response of the switches are given in Figure 4-1.

**TROUBLESHOOTING**

System failure or degradation is indicated by communication to the user's M&C System, by the FO System Summary Alarm output, and locally by the LED displays on the equipment. Troubleshooting comprises some basic steps:

1. Check the user's M&C System to obtain the alarm information, the status levels and the RF switch positions (deduced from the plug-ins that are "in-use" and those that are "idle"). A summary of the monitor information for each plug-in is given in Figure 4-5. A summary of the alarm information is given in Figure 4-6.

| Component | Status Indicators | Purpose of Monitor |
|---|---|---|
| Chassis | System Status Display | Computer display of status |
| Power Supply | Power On | Indicates power |
| Status and Control | Power On<br>RF Switch Configuration | Indicates power<br>Shows RF switch positions |
| FO Up/Down Transmitter | Power On<br>Monitor Photocurrent (PDIM)<br>Laser DC Current (LSRIM)<br>TE Cooler Current (TEIM)<br>RF Power Monitor (RFPM) | Indicates power<br>Laser stability (0.3 to 2mA)<br>Laser bias (50 to 100mA)<br>Laser temp stability (-1 to 1.6A)<br>Pre-amp functionality |
| FO Up/Down Receiver | Power On<br>Received Photocurrent (PDIM)<br>RF Power Monitor (RFPM) | Indicates power<br>Received optical signal (0.2 to 2mA)<br>Post-amp functionality |
| RF Signal Monitor Transmitter | Power On<br>Monitor Photocurrent (PDIM)<br>Laser DC Current (LSRIM)<br>TE Cooler Current (TEIM)<br>RF Switch Position | Indicates power<br>Laser stability (0.3 to 2mA)<br>Laser bias (50 to 100mA)<br>Laser temp stability (-1 to 1.6A)<br>Input selection thru computer |
| RF Signal Monitor Receiver | Power On<br>Received Photocurrent (PDIM) | Indicates power<br>Received optical signal (0.2 to 2mA) |
| FO Data Link | Power On<br>Laser Monitor Current (PDIM1)<br>Laser DC Current (LSRIM)<br>TE Cooler Current (TEIM)<br>Received Photocurrent (PDIM2)<br>Data Signal | Indicates power<br>Laser stability (0.3 to 2mA)<br>Laser bias (50 to 100mA)<br>Laser temp stability (-1 to 1.6A)<br>Received optical signal (0.2 to 2mA)<br>Indicates data signal present |

**Figure 4-5**
**Summary of the monitor information from each plug-in**

| Component | Alarm Indicators | Failure |
|---|---|---|
| Power Supply | +15 V FAULT<br>- 15 V FAULT<br>+ 5V FAULT | Power supply failure/replace<br>Power supply failure/replace<br>Power supply failure/replace |
| FO Up/Down Transmitter | OPT PWR LO (red)<br>LASER TEMP (red)<br>RF PWR LO (yellow) | Laser degradation/Replace plug-in<br>TE cooler failure/Replace plug-in<br>RF signal low/Check cause |
| FO Up/Down Receiver | OPT PWR LO (red)<br>OPT PWR HI (yellow)<br>RF PWR LO (yellow) | Loss of optical signal/Replace plug-in or fiber<br>Excess optical signal/Check cause & adjust<br>RF signal low/Check cause |
| RF Signal Monitor Transmitter | OPT PWR LO (red)<br>LASER TEMP (red) | Laser degradation/Replace plug-in<br>TE cooler failure/Replace plug-in<br>RF signal low/Check cause |
| RF Signal Monitor Receiver | OPT PWR LO (red)<br>OPT PWR HI (yellow) | Loss of optical signal/Replace plug-in or fiber<br>Excess optical signal/Check cause & adjust |
| FO Data Link | LSR PWR LO (red)<br>PD PWR LO (red)<br>NO DATA (yellow) | Laser degradation/Replace plug-in<br>Loss of optical signal/Replace plug-in or fiber<br>No data signal/Check cause |

**Figure 4-6**
Summary of Alarm Information from each component

2. If the DC levels (OPT PWR LO, LASER TEMP) for the fiberoptic systems are normal (within specifications and similar to previous values), but the RF power at the FO Transmitter is low, then check the RF signal input to the Fiberoptic System to see if the problem lies upstream of the Fiberoptic System.

3. If the RF signal input to the system is normal but the RF power at the FO Transmitter is low (RF PWR LO), then remove the faulty plug-in and replace it with a spare. Reset the system to operation. A plug-in can be removed and replaced with a spare plug-in while the chassis is powered. This minimizes system interruption.

4. If the RF power at the FO Transmitter is normal but is low at the FO Receiver, replace the FO Receiver with a spare. Reset the system to normal operation.

5. If the DC level at the FO Transmitter is abnormal, replace the faulty FO Transmitter. Restore the system to normal operation.

6. If the DC level at the FO Transmitter is normal, but the FO Receiver indicates optical power received is low, then replace the FO Receiver with a spare and/or check the continuity of the optical fiber cable.

7. After the faulty fiberoptic link is corrected, the Fiberoptic System should be reset to the Default Configuration: primary fiberoptic link in active use and automatic redundancy switching mode of operation.

8. Contact Ortel to return apparently failed plug-ins for repair. Plug-ins must be repaired only by qualified, factory-trained personnel.

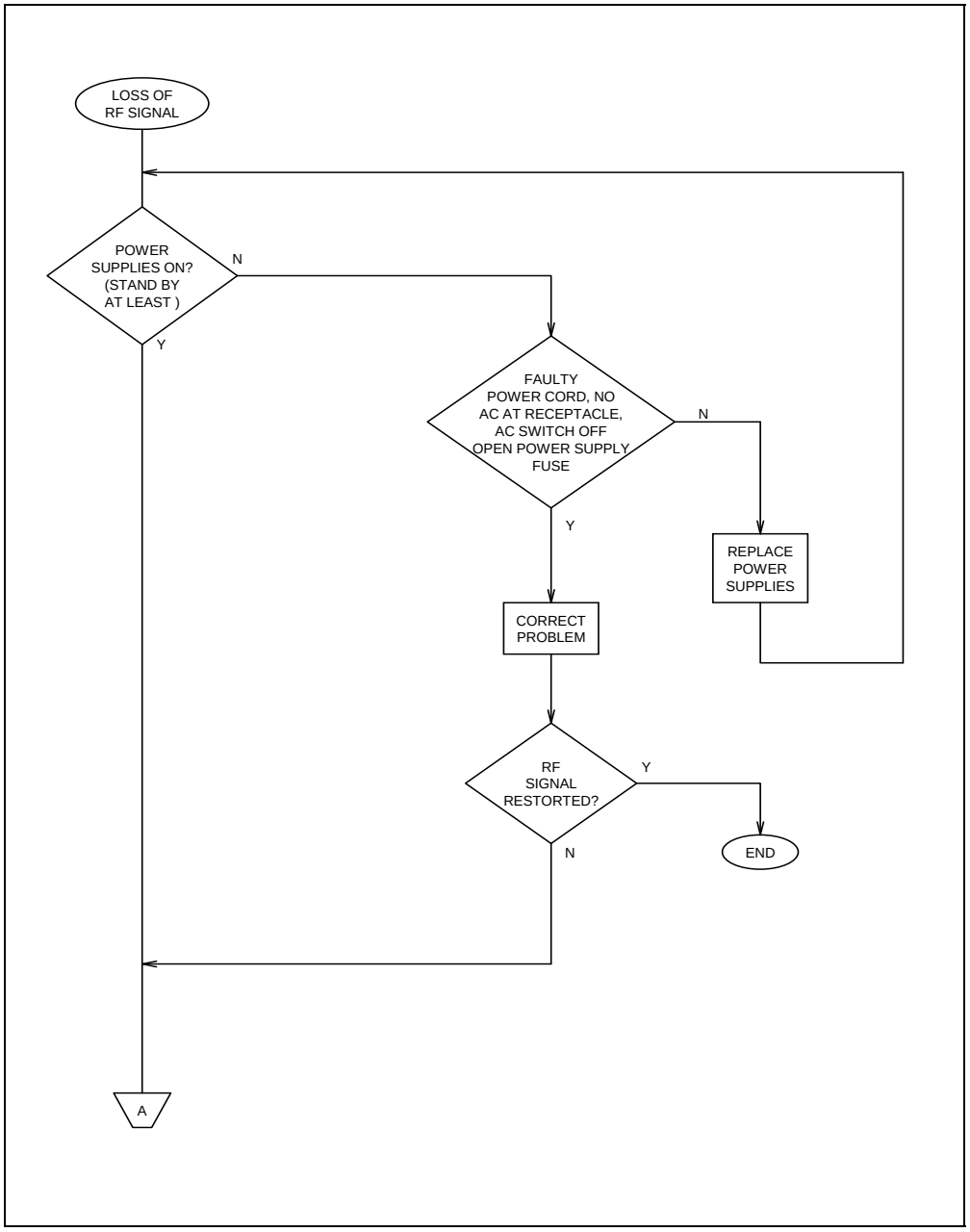



**Figure 4-7**
Flow Charts for troubleshooting FO System

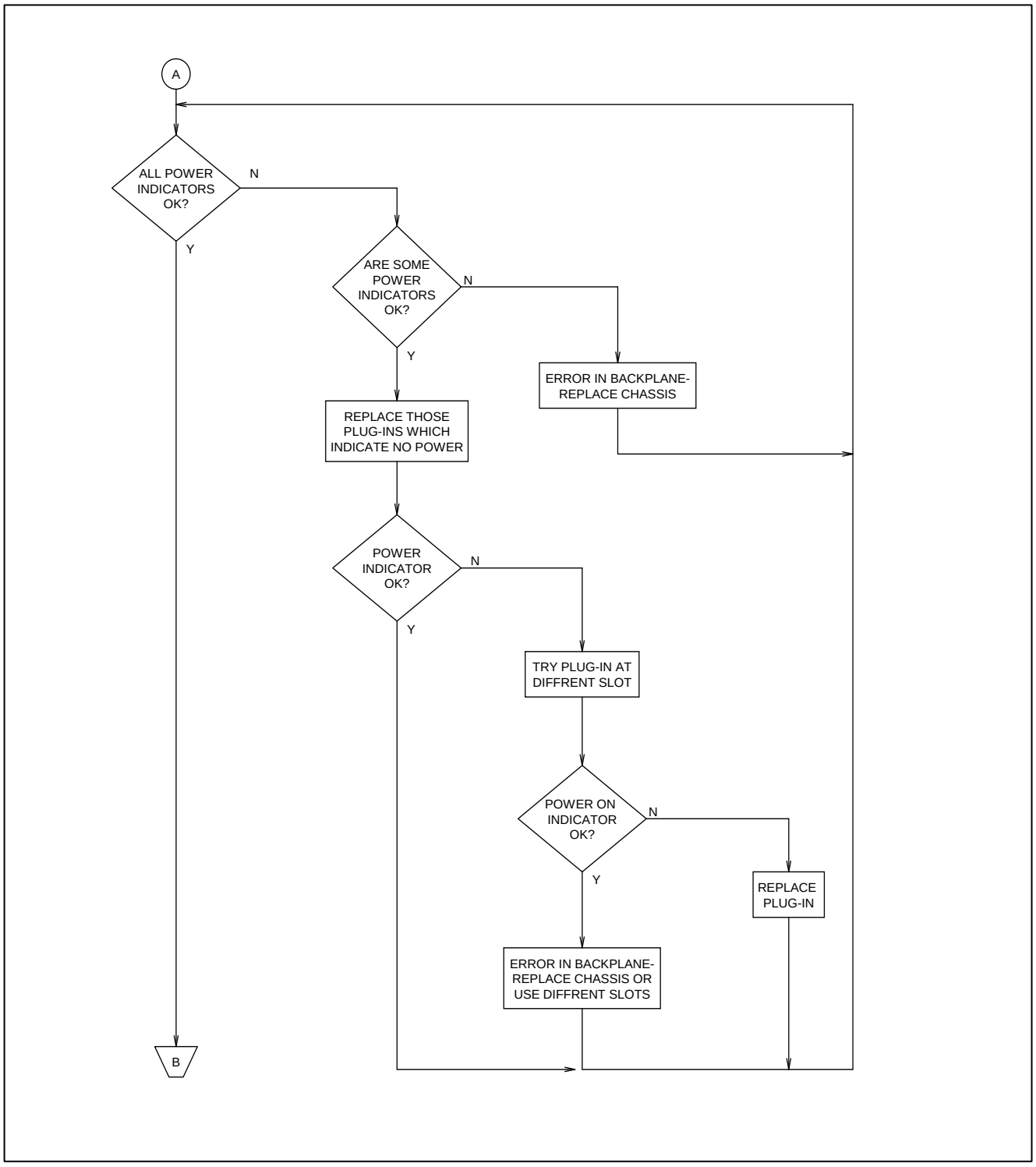



**Figure 4-7(b)**
Flow Charts for troubleshooting FO System

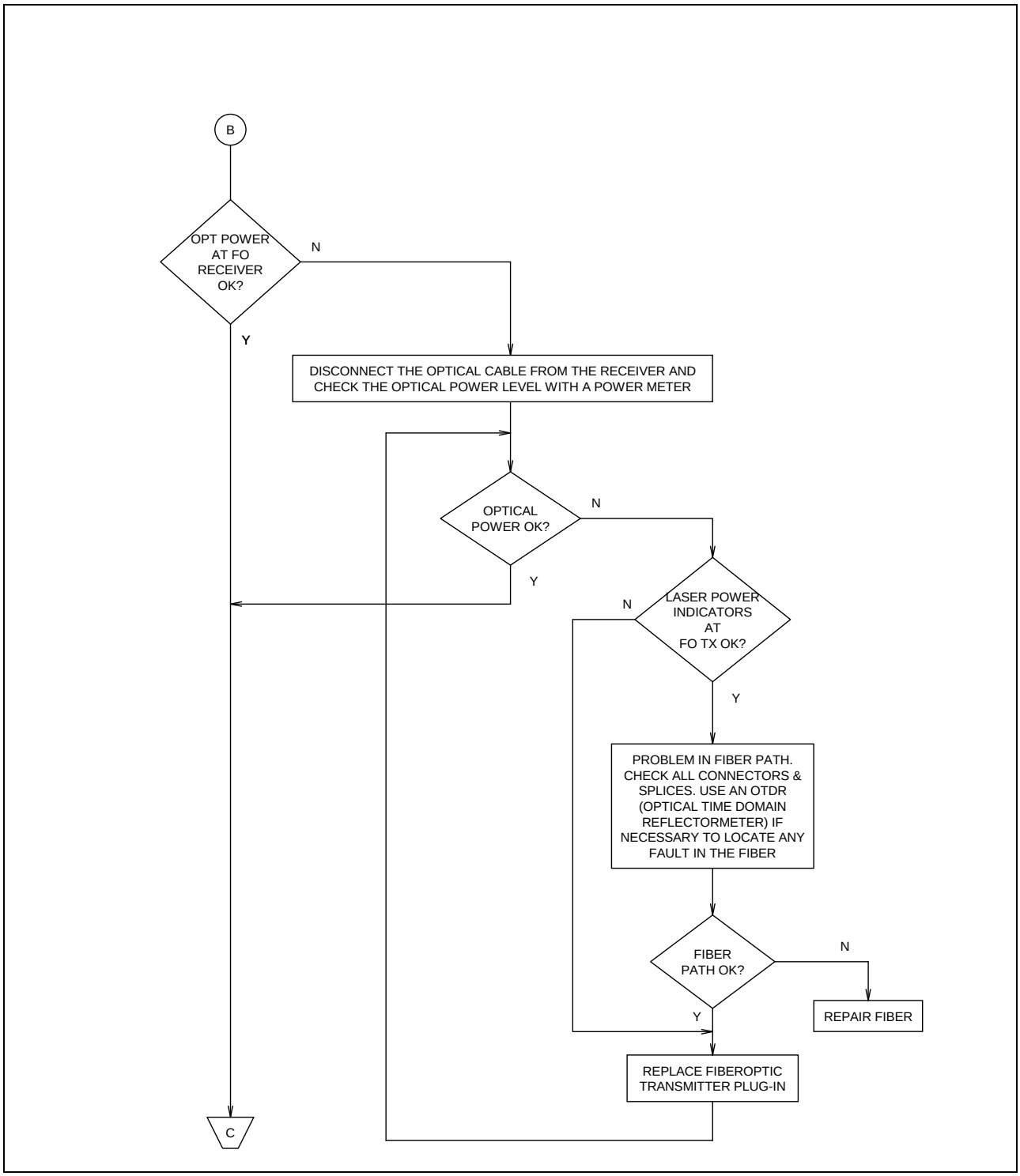



**Figure 4-7(c)**
Flow Charts for troubleshooting FO System

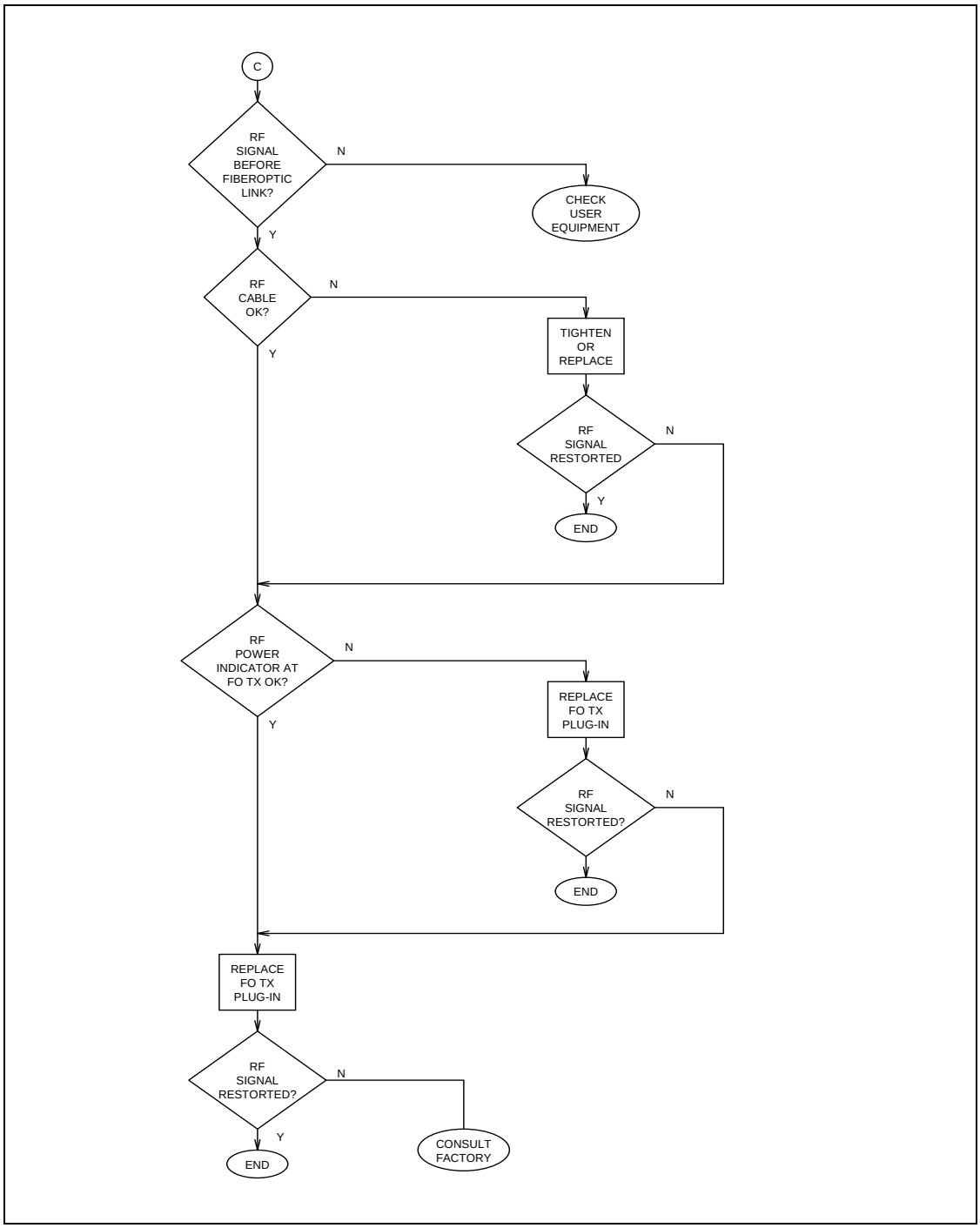



**Figure 4-7(d)**
Flow Charts for troubleshooting FO Systems

# Fan Alarm Adjust

**Description**

The System 8000 Fan Alarm is designed to alarm the user of a possible malfunction of a Fan blower motor through the M&C system and through the Ortel Supplied Software. The dual fans give the chassis a better cooling and redundancy in case one fan goes out.
If a fan stops running or is known to be defective the user is advised to replace the fan by removing the four mounting screws and buy an equivalent fan from a near by hard ware store or call the factory for replacement as soon as possible.
Periodic inspection of fans and uninterrupted air flow in the area of the chassis is highly recommended.

**Issue**
The system 8000 fan alarm circuit is factory adjusted according to specified user supplied AC voltage. On occasion, the AC supply voltage could exceed or be below the specified voltage where by making a false alarm to be triggered. In such an incident the user have access to adjust the proper setting using the following procedure.

**Fan Alarm chassis level DC adjustment:**
The user should have a DVM with an insulated probe around the side of tip. If the probe is not well insulated: an electric tape can be used to insulate the probe leaving the very end of the probe tip. This will avoid unwanted grounding by the user while probing the test points.

1. Locate the fan alarm board on the left side of the chassis next to the main power supply.
2. Ground the negative probe of the volt meter to the chassis ground.
3. Measure the two test points which can be accessed from the side panel of the chassis. Each test point is a monitor point for each fan motor. Each test points should read roughly 2.6V, if that is not the case adjust the pot adjacent to the test point to be equal to 2.6V. Now the Fan Alarm on the display should clear.