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Operating Manual

50mW C-Band EDFA with GPIB and RS232 Interface

(Version 1.1 Dec 2007)



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Introduction

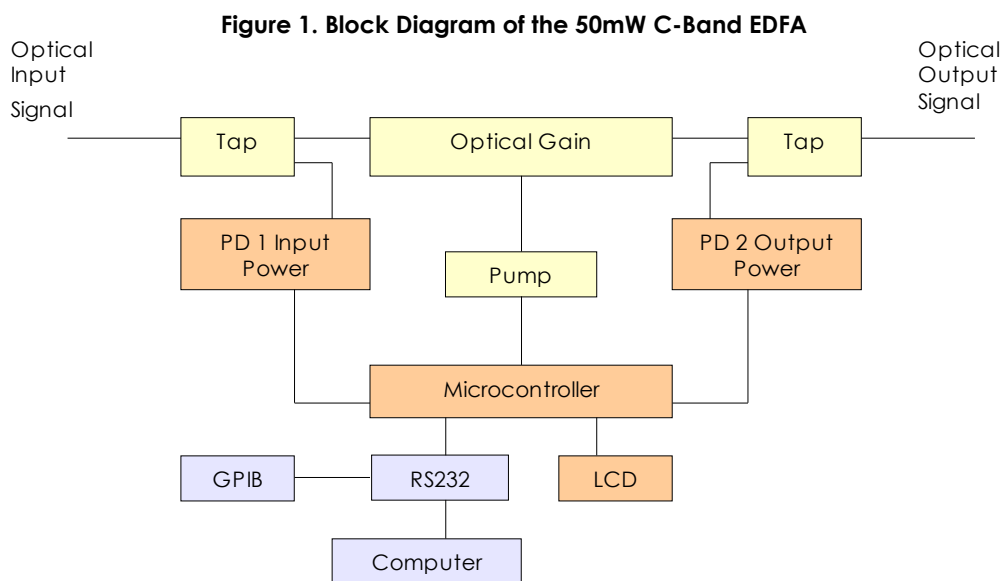
This manual describes the functionality and operation of a C-band Erbium-doped fiber amplifier (EDFA), capable of amplifying radiation in the spectral range of 1530 to 1570nm up to 17dBm (50mW) of spectral intensity. The optical input and output are polarization-insensitive single-mode fibers.

The unit comprises two main parts: The fiber gain module and the control system. The fiber gain module includes Erbium-doped fiber pumped by one or two fiber-coupled pump lasers of 980nm emission wavelength.

The control system is driven by a microcontroller and ensures that the gain module always works at optimum performance levels. During remote control the three typical modes of EDFA-operation can be selected: Automatic current control, power control or gain control. In each of these modes the control system monitors optical input and output power and the pump laser's temperature, and it drives the pump laser's current according to the specified mode. These parameters can also be transmitted through a serial communications port (RS-232) or GPIB-port connected to an external computer.

This EDFA features a low noise figure, stable output power, and excellent environmental stability. The features make it an ideal optical amplifier to meet the following application requirements:

- DWDM Networks
- CATV
- Optical Add / Drop and Cross Connects
- Pre-amplification or Booster Amplification
- LANs and MANs
- Test equipment and instrumentation



Safety precautions

The EDFA should only be operated by qualified personnel who reviewed this manual before installing and applying the module.

CAUTION: Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

CAUTION: Even without any optical input signal the optical output is emitting radiation if the front panel's "Enable" switch is in position "On".

LASER SAFETY:

This product contains laser diodes of class 3B. To ensure continued safety, do not remove any covers or attempt to gain access to the inside of the product. When the amplifier is operating, the output power of light with wavelengths in the invisible range exceeds 17 dBm. To avoid damaging your eyes, please DO NOT look into the output port of the EDFA directly.



1. Description of Controls and Displays

1.1 EDFA Front Panel



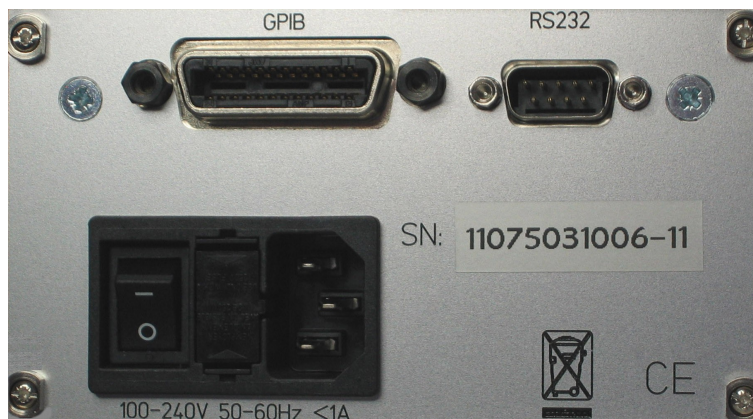
Optical interface: SC/UPC adapters "IN", "OUT" with corresponding LED indicators signaling low input level ("LOS") and output emission present ("Active") .

Electrical power supply: The LED indicator "Power" is signaling that the unit is in operation.

Optical power control: Switch "Enable" is controlling the pump laser operation; potentiometer "Adjust" is controlling the pump laser current; display "Pump Power [%]" is indicating the pump laser output power in percentage of maximum rated output power.

Remote interface: The LED "Remote" is signaling that EDFA operation is remotely controlled via RS232 or GPIB and that the front panel controls are locked; switch "Local" is unlocking front panel controls again.

1.2 EDFA Rear Panel



Mains input: The mains input is combined with a fuse housing and the mains switch.

Remote interface: An external computer can be connected either via GPIB cable or RS232 cable.

2. Installation

Power Installation



- Ensure that the unit is switched off at both the mains switch and the 'Enable' switch (mains switch at the rear panel and the 'Enable' switch at the front panel in position „Off“) and use a standard IEC mains connector for mains input at the rear panel to connect the EDFA to the power supply. A fuse F1A 250V is pre-installed for operation at 240 V ac.

Optical Connection



- Standard fiber handling and cleaning procedures should be followed.
- Be sure that the optical interfaces of the patch cords used are correct for the EDFA.
- Connect customer-supplied fiber patch cords to the SC/UPC optical ports.

Powering of the EDFA

- Turn on the mains switch on the rear panel. The front panel LEDs will light. Move the 'Enable' switch to the ON position. The EDFA will be in the normal working state.
- Turn off the EDFA by moving the 'Enable' switch to the OFF position, then turn off the mains switch.

3. Operation

3.1 Manual Operation

When the power supply is present and the mains switch is turned on, the green 'Power' LED on the front panel goes on. After power-on the EDFA is in manual operation mode.

Use the 'Enable' switch to turn on and off the EDFA pump lasers. Emission is indicated by a red 'Active' LED on the front panel (Caution: Don't look directly into any output connector!). Use the 'Adjust' control to regulate the pump laser's current (cw rotation increases pump current). The pump laser's output power is indicated on the LCD display, given in percentage of its maximum output power.

During manual operation the EDFA runs in ACC mode, i.e. the control system stabilizes the pump laser's current against the current reference given by the 'Adjust' control.

The manual mode is left and the front panel controls become locked if certain commands (see chapter 3.2.3) are sent via the RS232/GPIB interface. This is indicated by a blue 'Remote' LED.

The green 'Power' LED will blink if an error (Temperature or Range Error) occurs during operation. Main cause for temperature error is an ambient temperature over the specified value. Main cause for range error is a wrong parameter sent during remote operation or the end-of-life of the pump laser diode(s). Light is still emitted from the EDFA's output but neither output value nor stability are guaranteed. Call service if errors don't disappear at normal conditions.

If the EDFAs input power drops below -25dBm, the red 'LOS' LED will go on. Normal operation of the EDFA is not affected by this event.

Table 1. LED Indicators

LED	color	on	flashing	off	comments
Power / Error Status	green	Power supply on	Error present (Temperature or Range Error)	Power supply off	Read error status through RS232 interface
LOS	red	Loss of input signal	-	Input signal present	Read error status through RS232 interface
Active	red	EDFA emission on	-	EDFA emission off	
Remote	blue	EDFA control via serial interface	-	Manual EDFA control (front panel)	Several RS232 interface commands change this status

3.2 Remote Operation

After poweri-on the EDFA is automatically enabled for manual operation via the front panel controls. Nonetheless commands can be sent and are accepted by the microcontroller control system via the serial interface (RS232 or GPIB). All commands not related to EDFA parameter changes (power or current) can be used without loss of local front panel control. Commands related to EDFA parameter changes shift the EDFA state into 'Remote', indicated by the blue 'Remote' LED. The front panel controls are now inactive and locked. Manual control can be attained again by pressing the 'Local' button.

During local operation the EDFA is confined to ACC mode (automatic current control). During remote operation it can be commanded to run in either ACC, APC or AGC mode. The particular mode is not indicated on the front panel. Nonetheless the LCD display always is indicating the actual pump laser power value.

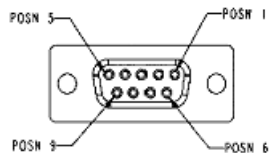
CAUTION:

During remote operation it is possible to run the EDFA in a state of pump laser current(s) above 100% (watch LCD display for pump powers >100% and watch Range Error status). This is not recommended because it will result in a reduced lifetime of the pump laser(s).

3.2 Remote Operation via RS232

3.2.1 Serial connection to the EDFA

Figure 4. Pin description 9-pin sub-D connector



2 – TX 3 – RX 5 – gnd

Use a standard 1:1 serial cable with DB9 female-female connectors for a connection to a PC.

After power-on reset the device adjusts its serial interface parameters to 9600 baud and 8,N,1. No handshake is used. Assure that the PC's terminal software uses the same parameters. The device will send a "hello" message including the version number of its firmware. Receiving the hello message confirms that the reset was successful and that serial communication works well. Change the serial baud rate by typing baud XXXX with XXXX = baud rate in hexadecimal, e.g. sending baud 9600 increases the baud rate to 38400. The maximum baud rate depends on the type and length of cable used.

3.2.2 Command structure

The device is controlled by sending simple commands based on the ASCII character set. In case of misspelling a command or in case of using an unknown command, an error message ("Sorry?") is the response. All command parameters (either a Byte XX or a Word XXXX) have to be hexadecimal numbers.

During typing of a command typing errors can be corrected by using the backspace key (ASCII code \$08). Commands are accepted after sending the carriage return key (ASCII code \$0D). Commands can also be terminated with both carriage return (0D) and line feed (0A) because the line feed character will be ignored.

In response the device produces a new line on the terminal by sending the codes carriage return (\$0D) and line feed (\$0A).

If the command generates one or more response lines, each line again is terminated by \$0D, \$0A.

3.2.3 Command Summary

Table 2. Command Summary

Command Syntax	Function
Serial interface	
hello	Display firmware version number
baud XXXX	Change baud rate to \$XXXX
echo off	No echo of input characters
echo on	Echo input characters
General commands	
help	Display list of commands
ophour	Display 1/10 operating hours
sernb	Display the device's serial number
Operation commands	
acc XX	Enter ACC mode with \$XX=current (in %)
agc XX	Enter AGC mode with \$XX=gain (in dB)
apc XX	Enter APC mode with \$XX=power (in %)
edfa off	Switch off EDFA pump lasers
edfa on	Switch on EDFA pump lasers
Status Alarm commands	
getlos	Read Loss of Signal alarm status (00=o.k., 01=alarm)
gettemp	Read Temperature Error status (00=o.k., 01=error)
getrange	Read Range Error status (00=o.k., 01=error)

Attention: All *operation commands* listed in the table are causing the EDFA to enter 'Remote' operation status and to lock the front panel controls.

3. Alphabetical list of commands

Command: acc XX

Function:

Enter ACC mode with XX=current in % (XX = \$00 to \$64)

Explanation:

Choose ACC (automatic current control) mode of the EDFA. The pump laser's current can be set between 0% and 100% of its maximum value.

Response:

none

Command: agc XX

Function:

Enter AGC mode with XX=gain in dB (XX = \$00 to \$1E)

Explanation:

Choose AGC (automatic gain control) mode of the EDFA. The pump laser's current is automatically controlled to achieve a difference (gain) between input and output power signal of the EDFA of 0 to 30 dB. In case of high input powers the actual gain is limited by saturation. Watch the front panel LCD display for pump laser output power limitation.

Response:

none

Command: apc XX

Function:

Enter APC mode with XX=power in % (XX = \$00 to \$64)

Explanation:

Choose APC (automatic power control) mode of the EDFA. The EDFAs output power can be set between 0% and 100% of its maximum value.

Response:

none

Command: baud XXXX (default XXXX = \$2580)

Function:

Change the baud rate.

Explanation:

Change the baud rate to \$XXXX baud. Typical values are

9600 baud	\$2580
14400 baud	\$3840
19200 baud	\$4800
38400 baud	\$9600

Response:

none

Command: echo off

Function:

No echo of input characters

Explanation:

Stop echoing input characters via the serial interface.

Response:

none

Command: echo on (default)

Function:

Echo input characters

Explanation:

Echo input characters via the serial interface.

Response:

none

Command: edfa off

Function:

Switch off EDFAs pump laser(s).

Explanation:

If the EDFA emission is switched off, the red front panel 'Active' LED will turn off.

Response:

none

Command: edfa on

Function:

Switch on EDFAs pump laser(s).

Explanation:

If the EDFA emission is switched on, the red front panel 'Active' LED will light up.

Response:

none

Command: getlos

Function:

Read Loss of Signal alarm status.

Explanation:

The red front panel LED 'LOS' will turn on, if the input signal strength drops below -25 dBm.

Response:

00 – No alarm

01 – Input signal strength below -25 dBm

Command: getrange

Function:

Read Range Error status.

Explanation:

On error the pump laser(s) maximum current is exceeded.

Response:

00 – No range error

01 – Range error present

Command: gettemp**Function:**

Read Temperature Error status.

Explanation:

On error the pump laser's TECs cannot keep the laser(s) within the specified range.

Response:

00 – No temperature error

01 – Temperature error present

Command: help**Function:**

Display list of commands.

Response:

Several lines of ASCII character text.

Command: ophour**Function:**

Display 1/10 operating hours.

Response:

A line with hex number XXXX.

Command: sernb**Function:**

Display serial number of the device.

Response:

A line with hex number XXXX.

3.3 GPIB Operation

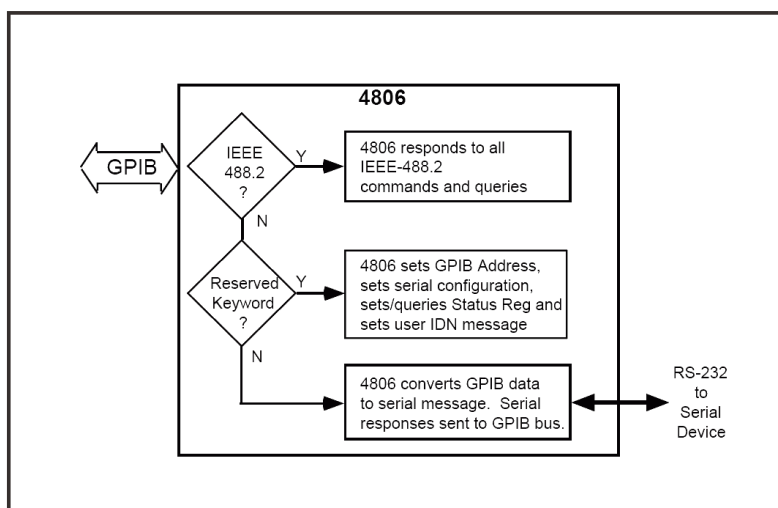
This device is equipped with a built-in GPIB – RS232 converter which converts external GPIB commands into RS232 format. The converted commands are subsequently handled by the serial interface described in section 3.2. Commands and their responses sent to the EDFA via GPIB thus are identical to the ones sent via RS232.

The converter card is a 4806 model from ICS Electronics. The default GPIB address is 4. The PDF-manual for this card is provided with each EDFA..

All commands via GPIB have to be terminated with a line feed (0A). To send valid commands to the EDFA these have to be terminated with carriage return (0D) and line feed (0A).

After sending a command to the EDFA always read the buffer of the converter card which carries the command echo and the device response. Otherwise communication problems can occur.

Figure 5. Command processing scheme



4. Technical Specifications

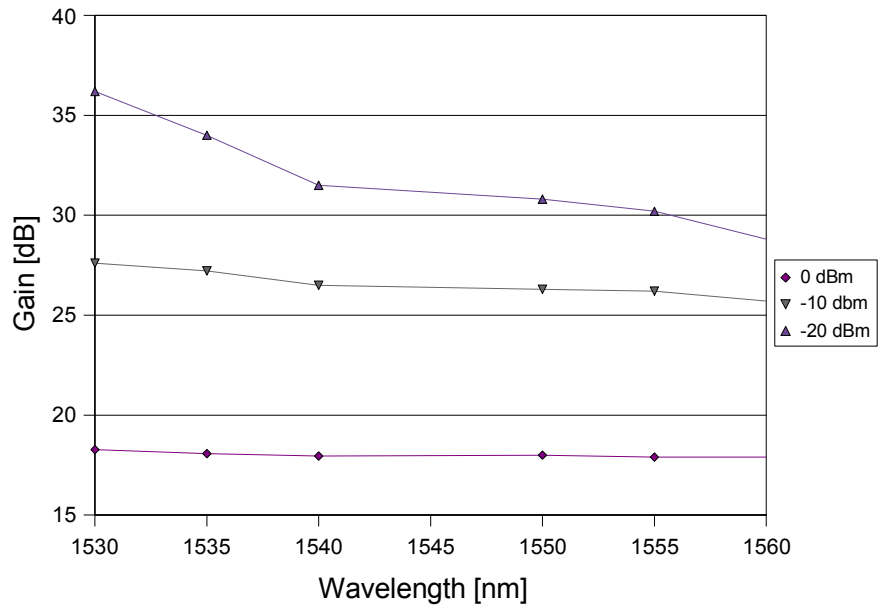
Table 3. Technical Specifications

Parameter	Units	Specification
Power supply		
Supply voltage	Volts AC	100 - 240 @ <1A
Frequency	Hz	50 - 60
Power Consumption	W	< 50
Optical specifications		
Output power	dBm	17dBm@0dBm in
Fiber type	μm	SM 9/125
Optical connector		SC/UPC
Wavelength Range	nm	1530 – 1565
Noise Figure	dB	5 - 6
Signal Gain	dB	> 25dB@-10dBm in
Pump wavelength	nm	980
Pump Leakage to I/O	dBm	< -15 dBm
Input / Output Return Loss	dB	60
Input/Output Isolation	dB	40/40
Polarization Sensitivity	dB	0.07
Loss of Input Power	dBm	< -25dBm
Others		
Module size	mm	210 x 290x 95
Weight	kg	2 kg
Operating temp. range	°C	0 – 40
Storage temp. range	°C	-40 – 85
Relative Humidity	%	5 - 95 (Noncondensing)

Test Report

s/n 11075033006-11

Gain spectrum:



Noise figure: 5,5 @ 0dBm input, 1550 nm