EDFA-B-C 17dBm

SDI optimized Erbium Doped Fiber Amplifier

User manual

Rev. D

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Revision history

Current revision of this document is the uppermost in the table below.

Rev.	Repl.	Date	Sign	Change description
D	C	2015-10-22	OEH	Added notice about fibre cleaning
C	B	2015-10-12	OEH	Corrected dip switch settings
B	0	2014-05-21	OEH	Added LED chapter
0	A	2012-01-11	SHH	Initial revision.
A	-	2008-02-01		Initial revision (not published)

Contents

1 Product overview

The Flashlink EDFA-B-C 17dBm is an erbium doped fiber amplifier with a special control circuit making it better for SDI signals than normal EDFAs. It is a +17dBm booster that is typically used at the beginning or in the middle of a link. At the receiving end of a link, a low power / low noise preamp would typically be needed instead.

The EDFA is unidirectional by nature, but can amplify up to 40 DWDM channels on a single fiber, at 100GHz spacing. Ideal gain flatness is achieved with input power close to the nominal input power.

Various safety measures are implemented, like automatic shutdown if rear lid is opened to access the fiber connectors, or manual shutdown by the use of GPI, GYDA, RS422 or turning the safety key to the “off” position. There is also a reduced output power mode that can be entered with the use of GPI, GYDA or RS422 control.

EDFA can also be directly controlled over RS232, bypassing the Flashlink features. The key, lid, GPI and GYDA/RS422 still operate the shutdown and reduced output power modes, even when using direct RS232 control.

EDFA status is monitored by use of LEDs, GPIO and RS422/GYDA.

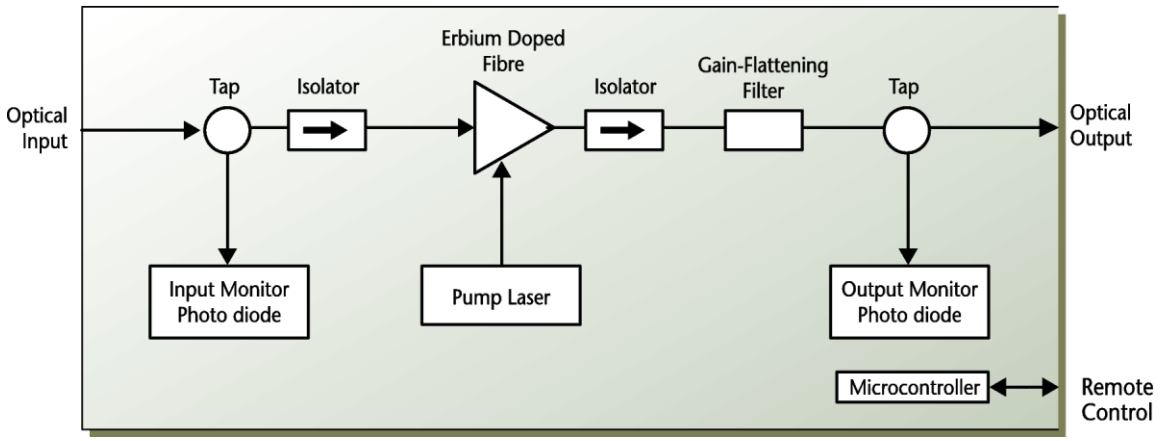

Figure 1: EDFA block diagram

2 Specifications

2.1 Optical Characteristics

Nominal input power	-6dBm
Maximum input power	+4dBm
Minimum input power	-10dBm
Total output power	17dBm +/- 1.5dBm at Pin from -10dBm to 0dBm
Gain flatness	Max. 1.0dB at Pin=-6dBm, Pout=17dBm Max. 5.0dB at Pin from -10dBm to 0dBm
Noise figure	Max. 6.0dB at Pin=-6dBm, Pout=17dBm
Wavelength range	Full C-band, 1529 to 1562nm
Number of DWDM ch.	Min. 40 channels at 100GHz spacing
Polarization dependant gain	Max. 0.5dB
Polarization Mode Dispersion	Max. 0.5ps
Input/Output return loss (pump off)	Min. 35dB

2.2 Power consumption

Maximum power consumption:	<9W (+5V)

2.3 Environmental conditions

Operation temperature range	0°C – 45°C
Operation without damage temperature range	0°C – 55°C

3 Cautions

3.1 Laser Safety

This unit is capable of emitting dangerous levels of light.

DO NOT UNDER ANY CIRCUMSTANCES LOOK AT THE OUTPUT OF THE UNIT OR FIBRE ATTACHED TO THE UNIT!

Containing a Class IIIb assembly, use the utmost case when changing connections, and always turn the unit completely off before inspecting or cleaning any connectors which are attached to the unit's output.

3.2 Fibre Cleaning

It is imperative that the fibre ends of the EDFA are kept clean of dust and dirt, to avoid insertion loss and back reflection. Insertion loss will take away margin from the optical budget, while back reflection will lead to excessive bias currents (due to output power regulation being dependent on power measured at the output, after isolator and gain flattening filter). This also means that for output power testing, the output should be properly terminated with minimal back reflection.

4 Configuration

4.1 Dip switch settings

The dip switches are also documented on the front of the EDFA

The following dip switches change the meaning of the other dip switches:

4.1.1 Common dip switches

Pos	Name	Function OFF	Function ON	Comment
1	G_P	Constant Gain	Constant Power	Fundamental working mode for EDFA.
7	A_M	Autonomous and/or GYDA/DIP control	Manual RS232 control	Set OFF to use the RS232 port in the front of the EDFA to control parameters like function (constant power, gain or drive),
8	OVR	Gyda control	Dip switches active	When ON, only dip switches can change configuration. GYDA can only monitor. To control with GYDA, set to OFF.

4.1.2 Constant power mode

In this mode, dip switches 1 and 8 are set ON, 7 is OFF.

Pos	Name	Function OFF	Function ON	Comment
2	S_T	SDI optimised	Telco optimised	Chooses between signal types present on the fiber. For a low number of SDI signals which might display pathological signals (shifts in average power), set dip ON. For many channels with fast adaptation to varying input levels, set dip OFF.
3	G3	Add 14dBm	Add 10dBm	These dip switches set the output power, from a minimum of +10dBm to a maximum of +17.5dBm (0.5dB step).
4	G3	Add 2dBm	Add 0dBm	
5	G2	Add 1dBm	Add 0dBm	
6	G1	Add 0.5dBm	Add 0dBm	

4.1.3 Constant gain mode

In this mode, dip switches 1 and 7 are set OFF, while 8 is set ON.

Pos	Name	Function OFF	Function ON	Comment
2	S_T	Not used	Not used	No effect in Constant Gain mode.
3	G3	Add 18dB	Add 10dB	These dip switches set the gain, from a minimum of 10dB to a maximum of 25dB (1dB step).
4	G2	Add 4dB	Add 0dB	
5	G1	Add 2dB	Add 0dB	
6	G0	Add 1dB	Add 0dB	

4.2 Status by LED's

The status of the module can be easily monitored visually by the LEDs at the front of the module. The LEDs are visible through the front panel as shown below.

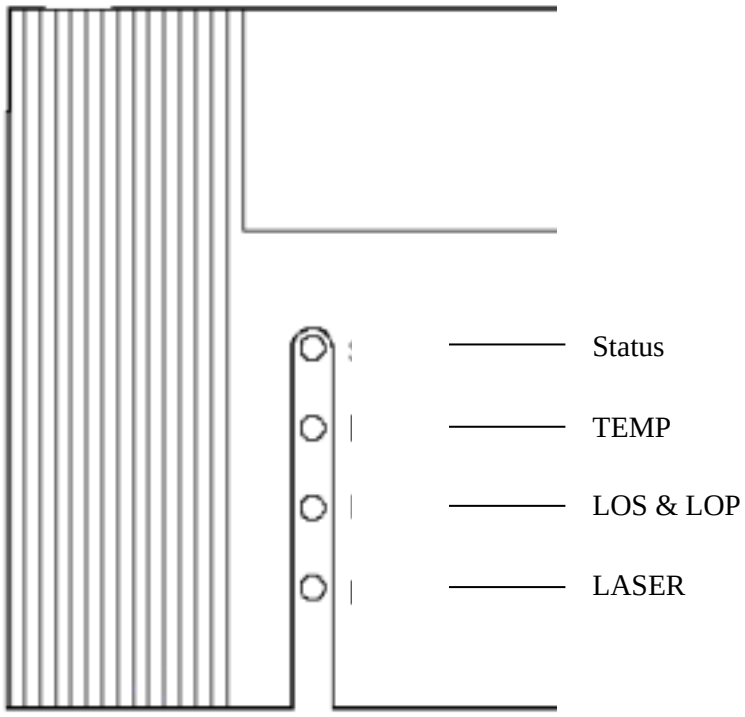

Figure 2: Panel indicator overview (Text not printed on the front panel)

4.2.1 LED status description

The functions of the different LEDs are described in table below.

Diode \ state	Red LED	Yellow LED	Green LED	No light
Status	Module is faulty		Module is OK Module has power	Module has no power
TEMP	Laser temperature alarm	Ambient temperature alarm	Temperature is OK	
LOS & LOP	Loss of input signal	Loss out output signal (mute/bypass)	Signal is OK	
LASER	Laser fail	Laser disabled (mute/bypass)	Laser is OK.	

4.3 GPI

These outputs can be used for wiring up alarms for third party control systems. The GPI outputs are open collector outputs, sinking to ground when an alarm is triggered. The GPI connector is shown in figure 7.

There are two GPI inputs, one for muting output power (power goes to below safe limit) and one for complete disable (same function as key switch, lid and software disable command).

Electrical Maximums for GPI outputs

Max current: 100mA
Max voltage: 30V

EDFA-B-C 17dBm module GPI pinning:

Signal	Name	Pin #	Mode	Direction
STATUS		Pin 1	Open Collector	Output
LOS	Loss of input signal/power	Pin 2	Open Collector	Output
LOP	Loss of output signal/power	Pin 3	Open Collector	Output
TERM	Temperature out of range	Pin 4	Open Collector	Output
LASER	Laser bias current out of range	Pin 5	Open Collector	Output
DIS	DISABLE (completely shut off bias current to the laser).	Pin 6	TTL, 0V = active level	Input
MUTE	MUTE (output power goes below class 1 limits).	Pin 7	TTL, 0V = active level	Input
Ground	0 volt pin	Pin 8	0V.	

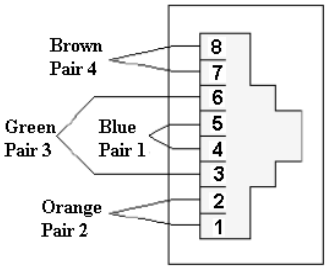

Figure 3: GPI Outlet

4.4 RS232 control

If dip switch 7 (“A_M”) is set OFF (Manual), the GYDA/dip switch control over the EDFA will halt and the RS232 input will be enabled (RS232 output is always on). Bitrate 9600, 8N1 (8 databits, no parity, 1 stop bit). A typical prompt will be “MSA::EDFA>”. When the prompt returns, the module is ready for a new command. There is an option to set the bitrate of the EDFA module to something else than 9600, but this will disable autonomous/GYDA operation until reset back to 9600.

The following table lists the most useful commands (the HELP command will list all commands):

Command	Example response	Comment
GET_STATUS	MODULE:DISABLED DI CONTROL: AGC ALARMS: NORMAL LD: NORMAL	
GET_INFO		
GET_BAUD		Bit rate of serial port.
SET_BAUD [4800,9600, 14400,19200,38400]	OK	
GET_ECHO		
SET_ECHO [ON,OFF]	OK	Echoes characters back to the terminal. Off by default
GET_MODE	MODE: G 18.80 dB	
SET_MODE [P,G,C,M]<value>	OK	Power in dBm, Gain in dB, Current in mA or M***MISSING***
GET_LD_POW		Laser diode power measurement
GET_MPD [1,2,ALL]	MPD1: -1.82 dBm, 6.58E-01 mW MPD2: -8.29 dBm, 1.48E-01 mW	1: input, 2: output
GET_LD_CRNT		Laser diode bias current measurement
GET_ALARM_LD_CRNT		Alarm limit for laser diode bias current
SET_ALARM_LD_CRNT <value,D>		
GET_LD_TEC		Laser diode thermal stabiliser current
GET_TPUMP	TPUMP: 25.47 C	
GET_ALARM_TPUMP_HI	ALARM_TPUMP_HI: 30.00 C	
SET_ALARM_TPUMP_HI <value,D>	OK	
GET_ALARM_TPUMP_LO	ALARM_TPUMP_LO: 20.00 C	
SET_ALARM_TPUMP_LO <value,D>	OK	
GET_TCASE	TCASE: 31.03 C	Ambient temperature
GET_ALARM_TCASE_HI	ALARM_ TCASE_HI: 70.00 C	Upper alarm limit
SET_ALARM_TCASE_HI <value,D>	OK	
GET_ALARM_TCASE_LO	ALARM_ TCASE_LO: 0.00 C	
SET_ALARM_TCASE_LO <value,D>	OK	
GET_LOS_SWD		
SET_LOS_SWD [ON,OFF,CP]		
GET_LOS		Threshold for loss of signal. Input power below this triggers muting of output power.
SET_LOS <value>		
HELP	…	The complete list of commands

4.5 Lid operated switches

If the lid covering the fiber connectors on the backplane should be opened, the EDFA will automatically disable. This is done both by a switch in direct contact with the lid, and by software through the use of an optical sensor.

4.6 Key switch

The key switch in the front of EDFA-B-C 17dBm can be used to disable the EDFA. The key can only be removed when the switch is in the OFF position.

5 Connections

The backplane module EDFA-C1 has 3 connectors (GPI, RX and TX) and a lid covering the optical ports.

To connect or disconnect fiber patch cords to the optical ports, the lid must be opened. This is done by unscrewing the thumb screw and lifting the lid up. Even though opening the lid automatically disables the EDFA, we recommend always disabling the EDFA by turning the key before opening the lid.

The RX port is on the right, TX on the left.

The third port (to the left of the thumb screw) is the GPI port, with pinout as described in chapter 4.3.

6 Operation

6.1 Introduction

The EDFA-B-C 17dBm will typically be used as a midway booster when there are many signals on the fiber, or directly after the transmitter / DWDM multiplexer if there are few signals. The reason for this is that optimum input power on the EDFA for DWDM applications is -6dBm.

A full 40-channel system based on the flashlink DWDM-40C together with 0dBm flashlink transmitters will already have approximately +14dBm[1] at the output, thereby requiring a 20dB attenuator to get +17dBm (just 3dB up) with a flat gain response out of the EDFA-B-C 17dBm.

On the other hand, a narrow band DWDM system (up to 8 channels) will not experience problems with the gain/frequency response of the EDFA-B-C 17dBm, and can therefore directly benefit from the +17dBm output power (compared to the app. +7dBm[1] from 8 channels in a DWDM-8C).

6.2 EDFA theory

Understanding the way the erbium doped fiber amplifier works can lead to easier handling of problems that occur, such as wideband noise, signal dependent noise (bit errors under certain signal conditions) etc.

The pump laser at 1480nm (980nm would be used for a low-noise preamp with low output power) and a short piece of fiber with a small amount of SiO_2 (glass) molecules in the structure replaced by Er_2O_3 are the central elements of an EDFA. The photons at 1480nm emitted from the laser excite electrons belonging to the erbium atoms. The excited state (called 11/2, actually a broad range of sub states and thermic variations in energy) has a limited life span, but if a photon at the appropriate wavelength (energy) comes close to this electron, it will collapse down to the ground state (15/2) with a new photon emitted at the excact same phase and direction as the original photon. If no photon passes by within the life span of the excited state, the electron will collapse by itself, and a photon will be generated at the wavelength matching the energy level, in a random direction. Some of these photons will have a direction along the signal path of the fiber, and will therefore be amplified by other excited electrons at the same energy level. This is called amplified spontaneous emission (ASE) and is the primary source of noise introduced in an EDFA.

6.3 Operation modes

An EDFA can normally be operated in one of three modes: AGC, ACC or APC. The EDFA-B-C 17dBm has dip switch and GYDA settings for two of these, AGC (referred to in this document as “Constant Gain”) and APC (“Constant Power”).

In “Constant Power” mode, the output power is regulated independently of input power. In “Constant Gain” mode, the output power varies with input power.

In addition, there are two different versions of “Constant Power”. For use with a relatively low number of SDI links which might transport a pathological signal[2], there is a special SDI mode. When using this mode, the EDFA should not be used near saturation (full output power). Recommended output power in “SDI optimised Constant Power” mode is +14dBm. There are two reasons for this. First, the regulation loop is slower in this mode, therefore adding or subtracting optical channels from the fiber can lead to bit errors in other channels

[1] Example values, not for performance indications.
[2] Specifically the EQ stressing 19-1 sequence that comes from displaying a uniform purple colour over several whole video lines.

if the overhead is insufficient. Second, an EDFA driven to saturation will not handle long streams of either 0 or 1.

When the number of channels running on the fiber is high and the signals are uncorrelated, the recommended operating mode is “Telco optimised Constant Power”. In this mode, the EDFA will have a very fast regulation loop that ensures error free operation on other channels when one or more channels are added/subtracted from the fiber. For this mode, operation in saturation (full output power) is recommended.

For use as an inline amplifier (not at transmit or receive locations), constant gain mode can be beneficial. In this mode, all channels have roughly the same gain (see gain flatness specification), which makes margins, gain and attenuation trivial to calculate for a system architect. Optimal gain flatness is achieved with a gain of 23dB, corresponding to -6 in / 17dBm out. For lower input power, the output power will be correspondingly lowered, from the definition of “constant gain”.

General environmental requirements for Nevion equipment

1. The equipment will meet the guaranteed performance specification under the following environmental conditions:
   - Operating room temperature range: 0°C to 40°C
   - Operating relative humidity range: up to 90% (non-condensing)

2. The equipment will operate without damage under the following environmental conditions:
   - Temperature range: 0°C to 50°C
   - Relative humidity range: up to 90% (non-condensing)

Product Warranty

The warranty terms and conditions for the product(s) covered by this manual follow the General Sales Conditions by Nevion, which are available on the company web site:

www.nevion.com

Appendix A Materials declaration and recycling information

A.1 Materials declaration

For product sold into China after 1st March 2007, we comply with the “Administrative Measure on the Control of Pollution by Electronic Information Products”. In the first stage of this legislation, content of six hazardous materials has to be declared. The table below shows the required information.

組成名稱 Part Name	Toxic or hazardous substances and elements					
	鉛 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr(VI))	多溴联苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
EDFA-B-C 17dBm	O	O	O	O	O	O
O: Indicates that this toxic or hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement in SJ/T11363-2006. X: Indicates that this toxic or hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement in SJ/T11363-2006.						

This is indicated by the product marking:

A.2 Recycling information

Nevion provides assistance to customers and recyclers through our web site http://www.nevion.com/. Please contact Nevion’s Customer Support for assistance with recycling if this site does not show the information you require.

Where it is not possible to return the product to Nevion or its agents for recycling, the following general information may be of assistance:

- Before attempting disassembly, ensure the product is completely disconnected from power and signal connections.
- All major parts are marked or labeled to show their material content.
- Depending on the date of manufacture, this product may contain lead in solder.
- Some circuit boards may contain battery-backed memory devices.