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Corning 926 EDFA Module Controller

Introduction

This document specifies the electrical circuit for controlling the 926 EDFA module.

Description

The electrical circuit is built on printed circuit board which matches physical dimensions of the 926 EDFA optical gain block. The controller has three electrical connectors:

- Two 11-pins headers. They are used for direct interfacing with optical module.
- One 50-pins connector. It is located on the opposite side of the and is used as the interface to the host controller. This is a standard 2mm ejector header from Samtec (ETH series for 50 wires flat cable).

The controller has also four optical power monitors (PIN diodes), all of them pigtailed with a single mode fiber and SC optical connectors.
The circuit is ready to be used with 926 module equipped with two laser pumps.
There is an option of using a third laser pump with 926 gain block. However, this laser is not part of 926 assemblies and the circuit for driving this laser has to be build separately. This laser driver can be built in the same way as the drivers already implemented on the board. In this situation all control signals are available on flat cable connector and the third laser will be fully under control of the local microprocessor.

The host system can set one of the following modes of operation for both stages of amplification:

1. Constant output power mode. In this case the laser pump current has such value that the output optical power is kept constant.
2. Constant gain mode. The controller maintains constant ratio between optical output and input powers.
3. Constant pump laser power mode. Regardless of other signals, constant optical pump power is maintained.
4. Constant laser current mode. In this mode of operation constant current is forced through laser pump.

The target values for any of the modes of operation are set by the host system. It is the responsibility of the host system to set the target values which are within the limits of the amplifier specification. In no case laser current will exceed the preset maximum value (230 mA for the first stage) which is set by the microprocessor during the initialization phase. In the case of microprocessor malfunction the driver is designed in such way that the laser current cannot exceed absolute maximum value (400 mA for the first stage).

For the constant output power mode and constant gain mode, optical input power has to be within some limits. For example, if optical input power drops below threshold value, the amplifier will not be able to deliver the required optical output power. In this case the laser current will reach its preset limit and the alarm signal will be sent to the host system.

For very fast changes of optical input power the controller reaches new steady state within 30 to 40us.

The unit requires +5V and can operate constantly at ambient temperature of 50C. Both, the laser driver and the TEC driver are very efficient and do not require heat sinks. Thickness of the assembled board is limited by the size of connectors and optical monitor diodes.

Communication

Communication with the module is under control of the host system. The controller signals its status by setting six output lines. These signals can be read any time by the host system. The host system can also, at any time, shut down lasers, or reset the controller.

All parameters monitored by the controller can be read through a serial communication channel. Through the serial channel, the host system can change mode of the operation or target values. Standard ASCII characters are used for encoding.

There are three possible communication links:

- RS232 TTL signal level.
- SPI (Motorola Serial Peripheral Interface)
- I2C interface.

Additionally there are four logic inputs:

- SHD – unconditional all pump lasers shutdown.
- EXRST – reset controller.
- BKGD, VFP two pins for flash programming (software upgrade) and debugging.

The controller has six output signals to signal various conditions which can be read by the host system:

- Two flags AL0, AL1 signal different states of the controller.
- DGR line is set (logic1) if initialization function was successfully executed.
- DYELL line is set in the case of not service affecting alarms.
- DRED signals serious service affecting alarm condition.
- The last signal R is set if microprocessor was internally reset and it operates in its default state and may require attention of the host system.

All three signals DGR, DYELL, DRED have LED drive capability and can be also used for direct driving front panel indicators.

The following are the signals monitored by the controller.

- Laser current.
- Laser optical output power.
- TEC current. (including direction)
- Laser temperature (resistance of the thermistor)
- Supply voltage for analog circuit. (*)
- Voltage of the laser cathode. With GND reference (*)
- Voltage of the error amplifier for the temperature controller. (*)

The values of the above parameters are measured for every pump laser.
Additionally the controller monitors:

- Optical input power to the first stage.
- Optical output power of the first stage.
- Optical input power to the second stage.
- Optical output power of the second stage.
- +5V supply voltage.
- Locally regulated laser pumps supply voltage. (*)
- The board (ambient) temperature.

Signals with (*) are only used internally and can be read by special debugging commands.

Calibration

It is almost impossible to have reasonable accuracy of the measurements assuming typical values of the optical parameters which can often vary by tens or even hundreds percent.
The Corning 926 EDFA Module controller was designed in such way that calibration process can be fully automatic.
Calibration will require the following instruments with GPIB capability:

- Optical signal source.
- Optical attenuator.
- Optical power meter.
- Personal computer.
- Optical splitters (50/50)

The general idea is to interface a PC to the controller with optical gain block and measurements instruments. By applying a known optical power as input to the EDFA, we can measure the output voltage of the sensing circuit. The gain of that circuit is controlled digitally (by means of setting a digital potentiometer). The total transfer function of output voltage as a function of input optical power can be easily found. Similar measurements can be done for the output power and for the second stage.

In order to characterize the laser pump we should know at least one point of the following characteristics:

- Optical output power as function of the laser current.
- Laser monitor diode current as function of the laser current.

The threshold current for the laser can be measured or supplied as initial data. In the case when the current limit for the pump laser is below the absolute maximum, the operating value of that limit should be also entered as initial data.

We provide an interface board to facilitate the calibration process. This board has a mating 50 pins header to be connected through flat cable to the controller. It has also simple terminals for connecting a power supply. It converts low voltage RS232 signals to the standard values.

The controller has EPROM memory for storage of the calibration data. After all measurements are done and verified, the EPROM memory should be locked for further writing. This should be done by removing the write enable resistor.

During reset and initialization procedure the controller reads the content of the EPROM and sets some of its operational parameters. Part of memory is reserved for the data which is passed to the host system. These data may include, for example, manufacturer serial number, system parameters (such as noise figure degradation if input optical power is out of specification) and/or any other information. System related data can also be entered during the calibration procedure.