FiberdriveÔ Laser Module

Application Note

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BLUE SKY RESEARCH

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1 INTRODUCTION

1.1 General

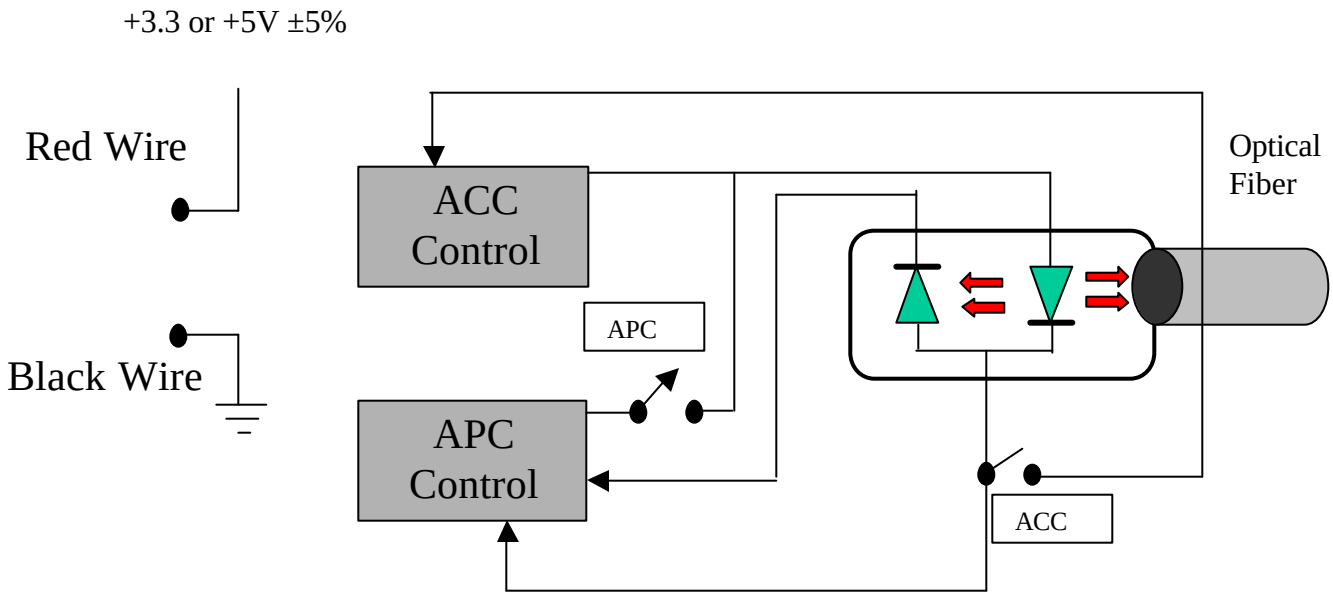
The applications for high quality visible red laser diodes continue to increase. In order to satisfy markets such as spectroscopy, fluorescence, and alignment, a high quality laser beam in a user-friendly package is required. The Fiberdrive™ marries Blue Sky Research's Circulaser™ diode with integrated electronics to make a complete module that is extremely easy to implement in your system design.

The Fiberdrive package contains all the circuitry to run the laser in one of two modes: under APC, automatic power control, or ACC, automatic current control. The electrical interface is reduced to a simple DC power supply requirement. Users can reconfigure the Fiberdrive to either one of these two modes of operation. The optical interface is a fiber pigtail for delivering the beam where it is needed.

This application note covers all aspects of how to set up and use the Fiberdrive. If you are unsure of any aspects of your Fiberdrive module, please read this whole application note before operation.

1.2 Block Diagram

The standard Fiberdrive laser module integrates optics and electronics as shown below.



The laser diode and a back facet monitor PIN diode are contained in a hermetically sealed can. BSR's proprietary optics focus the front facet laser power onto a single mode optical fiber. When desired the fiber can be polarization maintaining fiber, or PMF. When PMF is used, the polarization of the laser is aligned to the slow axis of the PMF so that an extinction ratio, ER, greater than 15 dB can be achieved at the fiber output.

The rear facet output falls on a PIN monitor diode. When placed in APC mode, the APC control electronics monitors the current out of the PIN. It constantly adjusts the laser output to maintain a constant current reading. If the module is in the ACC mode, the APC control is deactivated, and the laser will be driven under a constant current. As described in Section 2.2, you can go back and forth between APC and ACC modes by moving a jumper or through the circuit board pin connections.

Both the constant Pout level in the APC mode, and the constant current level in the ACC mode, are controlled with a single 10kO POT. This trimpot is available through the small hole drilled in the top surface of the module. The module is also available with circuit board pins on the bottom. Adjustment to the current levels can be made via varying the voltage on SET pin #4. The electrical power connection to the outside is a simple DC interface. The module is designed to be run off of a 3.3V or a 5V DC supply.

2 OPERATION OF THE APC AND ACC MODES OF LASER CONTROL

2.1 General

The Fiberdrive is a complete module that is designed to operate the laser diode in either of two modes. One mode is Automatic Power Control (APC), and the other is Automatic Current Control (ACC). You can adjust the exact power out or adjust the laser bias current. The module includes protection circuitry to prevent damage to the laser diode. The output power from the module may vary differently over time and temperature depending on the mode chosen.

2.2 Shifting Between APC and ACC Modes

Going back and forth between the APC and the ACC modes is easy. Accessible through the rectangular hole in the top of the module is a two pin jumper. The jumper can be on either the two pins silk-screened "APC" or the two pins marked "ACC". To go back and forth, simply turn off the power supply to the module, and using a pair of sturdy tweezers, move the jumper to the desired two pins.

If your module has circuit board pins, the jumper is not included. In the pinouts (Section 3.1.5), pin#6 is the APC pin and pin #7 is the ACC pin. To enable each mode, connect that pin to pin #8.

NOTE: *To prevent ESD damage to the module, a properly grounded wrist strap should be worn whenever moving or touching the jumper.*

NOTE: *When going from the APC to the ACC mode, first turn the output power level all the way down in the APC mode. This will prevent any current damage upon power up in the ACC mode.*

NOTE: *If circuit board pins #6 and #7 are both connected to pin #8, this will result in a short circuit. There will be no power output from the laser, but the module will not be damaged.*

2.3 APC Mode

The most commonly used mode is APC. In this mode, an internal feedback loop in the Fiberdrive constantly monitors the back facet monitor current and tries to keep it to a steady value. The value is preset in the factory to achieve the typical power out for that particular Fiberdrive's specification within 5%. The value may be changed by turning the trimpot available through the small hole in the top of the module, or by varying the voltage on the SET pin #4. Turning the trimpot counterclockwise increases the targeted amount of photocurrent and thus the power out into the fiber will increase. Increasing the SET pin voltage from 0 to a maximum of 1.2V will achieve the same effect.

Most applications require a steady state output power. In the APC mode this can be achieved with excellent stability over time, if the environmental temperature is not changing. There is no temperature control inside the Fiberdrive module. Thus the laser diode needs approximately 10 to 15 minutes to come to a steady state operating temperature. After that the power stability with time is typically <0.2% over the short term and <0.5% over a full 24 hours. Testing this parameter is discussed in Section 4.3.

If the module is used in APC mode, and the temperature of the module is varied, the output power will change. The change arises from two factors. First, the laser threshold slope efficiency (mW/mA) changes with temperature. Diodes like to be cold, so as the device heats up this slope rolls over and more current is needed to maintain a given facet output power. Most of this effect can be compensated for in the APC mode. If the temperature is too high though, the current limiting features of the circuitry will turn on and there will not be sufficient current to maintain the output power. This may occur if the laser diode temperature goes over 40°C or 50°C depending on the model.

The second factor affecting power output is the laser to fiber mechanical coupling. Certain alignment tolerances are on the order of 1µm. Thermal changes cause coupling changes that affects the power output. This cannot be compensated for with the APC mode, because the laser to back facet monitor pathway is not affected like the front facet pathway. The change in power

output as the temperature is varied is sometimes referred to as the tracking error, TE, and is typically about 25% for the Fiberdrive from 0-40°C.

2.4 ACC Mode

In the ACC mode, the Fiberdrive simply maintains a set level of bias current to the laser diode. Again you can set this value of current by adjusting the trimpot through the hole in the top of the module, or the voltage on pin #4. Turning the trimpot counterclockwise increases the bias current to the laser, or increasing the voltage on pin #4 has the same effect.

> **NOTE:** *Care must be used in this mode as it is possible to overdrive the bias current to the laser if the trimpot is turned too far.*

The ACC mode can be useful for laser diagnostics and other testing. Long term degradation of the laser diode may be monitored by watching the power output under ACC mode. Assuming the temperature is held steady, any changes to power output in this condition will be dominated by changes in the laser diode itself.

Changing the temperature of the module under ACC mode will change the power output. Both influences of changing the laser's slope efficiency and changing the package coupling will be apparent. The difference in the power output changes between the APC and the ACC mode, as the temperature is varied, is due to the change in the laser's slope efficiency. Thus the overall power out change will be higher in the ACC mode.

3 IMPLEMENTATION

3.1 General

This section covers many of the physical and operational things you need to consider when using the Fiberdrive Module.

3.1.1 Initial Inspection

As the unit has sensitive electro-optic diodes, please wear an anti-static wrist strap and work in an electrostatic discharge (ESD) Class I controlled area. Inspect the shipping container for any indication of excessive mechanical shock to the contents, and inspect the contents to ensure that the shipment is complete. Do not discard the original shipping container and packing material. These are required whenever the equipment is to be transported.

Next, visually inspect the unit, including the strain relief and the electrical connection, for structural damage that may have occurred during shipping. Immediately inform Blue Sky Research and, if necessary, the carrier if the contents of the shipment are incomplete, if the unit or any of its components are damaged or defective, or if the unit does not otherwise pass the initial inspection. In the event of carrier responsibility, BSR will allow for the repair or replacement of the unit or component while a claim against the carrier is being processed.

3.1.2 Returning Shipments to Blue Sky Research

BSR will only accept returns for which an approved Return Material Authorization, (RMA), has been issued by BSR sales personnel. This number must be obtained prior to shipping any material back to BSR. The owner's name and address, the model number and full serial number of the unit, the RMA number, and an itemized statement of claimed defects must be included with the return material.

3.1.3 Packaging

Returned material must be shipped in its original shipping container and packing material. If these are not available, ask BSR customer service personnel to provide packaging instructions.

Typical packaging guidelines are as follows:

1. Wear an anti-static wrist strap and work in an ESD controlled Class I area.
2. Pack the unit in a reliable shipping container.
3. Use enough shock-absorbing material (10 to 15 cm or four to six inches on all sides) to cushion the unit and prevent it from moving inside the container.
4. Seal the shipping container securely.
5. Clearly mark FRAGILE on its surface.
6. Always provide the model and serial number of the unit and, if necessary, the RMA number on any accompanying documentation.

3.1.4 Mounting the Fiberdrive on a PCB

Care must be taken when installing the Fiberdrive module on a PCB. Component mounting onto a PCB must be in accordance with ANSI/IPC-A-610, Section 2. To mount the Fiberdrive on a PCB:

1. Screw the module to the PCB (using ordinary M2 screws in the 2 mm holes drilled in the flanges).
2. Torque the fasteners to approximately 15 to 20 oz/in. (The value stated is a guideline; actual values are determined by user-specific installation practices).
3. If your unit comes with the electrical pins on the bottom, solder the connector pins directly to the PCB (245° soldering for ≤5 s).

3.1.5 Heatsinking

Laser diodes in the visible range exhibit lifetimes that vary greatly with junction temperature. Lifetime may be reduced by factor or 5 or more in going from 25°C to 50°C. The laser diode in the Fiberdrive is already heatsinked internally to a large metallic block. No other heatsinking is necessary in normal operation. However, if you are running extended periods in temperatures above 35°C, and you want to maximize system lifetime, it is a good idea to mount the Fiberdrive on a heatsink. Thermal grease should be used in-between to increase conductance. As an alternative, convection air can be circulated over the Fiberdrive in the direction of the fins on the package body.

BSR recommends that maximum performance and lifetime in harsh conditions can be achieved by using the FiberTec™ module. This module is the same as the Fiberdirve, but also includes a thermo-electric cooler for the laser. Thus the laser junction temperature can remain constant even though the package is in a warm ambient environment. For more information on the FiberTec, please visit the Blue Sky Research website or contact your local sales representative.

3.1.6 Connector Pin Assignments

If your Fiberdrive has two rows of connector pins on the bottom, they are assigned as follows.

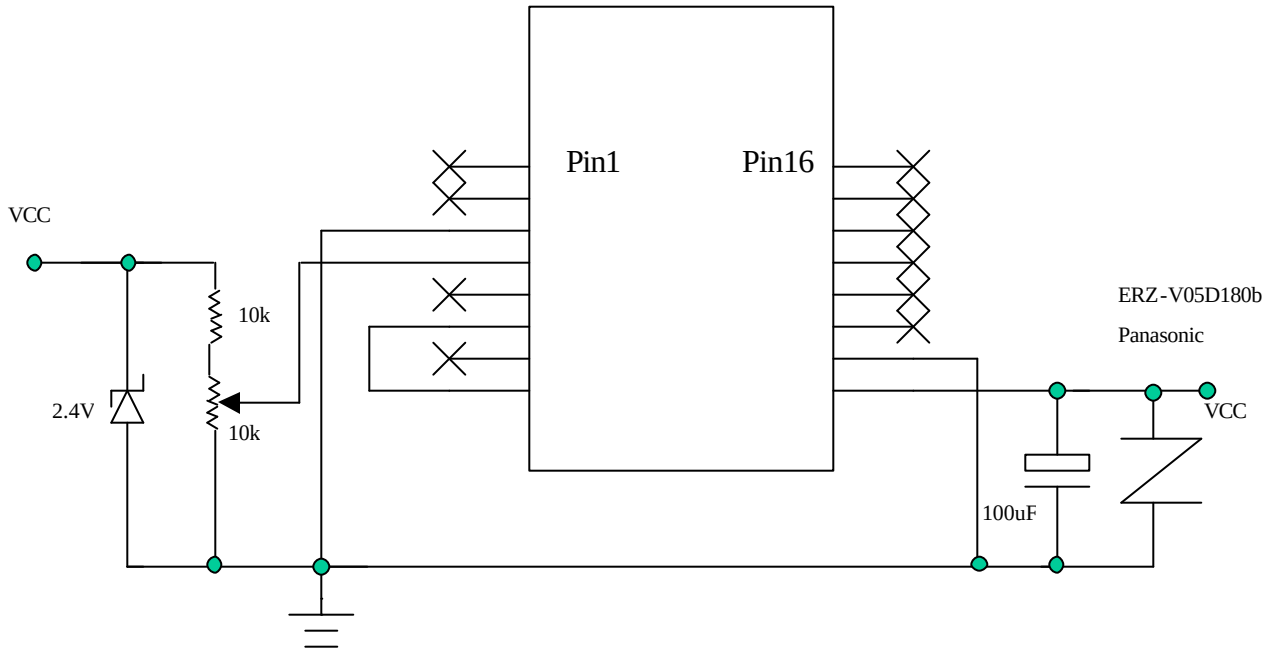
Pin No.	Name	Type	Description
1	NC	Passive	No connection
2	NC	Passive	No connection
3	GND	Active	Ground
4	set	Analog input	Constant current or constant power setting , Max 1.2V
5	RS*	Active	Reserved
6	APC	Active	Connect to Pin 8, Module function Automatic Power Control.
7	ACC	Active	Connect to Pin 8, Module function Constant Current Control.
8	CC	Active	Control Common
9	VCC	Power	+3.3 or +5 V+/- 5%
10	GND	Active	Ground
11	RS*	Active	Reserved
12	RS*	Active	Reserved
13	RS*	Active	Reserved
14	NC	Passive	No connection
15	NC	Passive	No connection
16	NC	Passive	No connection
			*RS pin should not be grounded. These are used in the FiberTec module. Pin #11 is the temp set pin and pins #5,12, and 13 readout TEC voltage, temperature lock, and alarm.

When looking at the bottom of the Fiberdrive with the fiber pigtail exiting to your left, pin#1 is in the upper left-hand corner for the two rows, and pin #16 is in the lower left-hand corner. The pins labeled 'Reserved' should not be grounded. The mode of the Fiberdrive can be changed by connecting either pin #6 or pin #7 to pin #8.

3.1.7 Making Power and Pin Connections

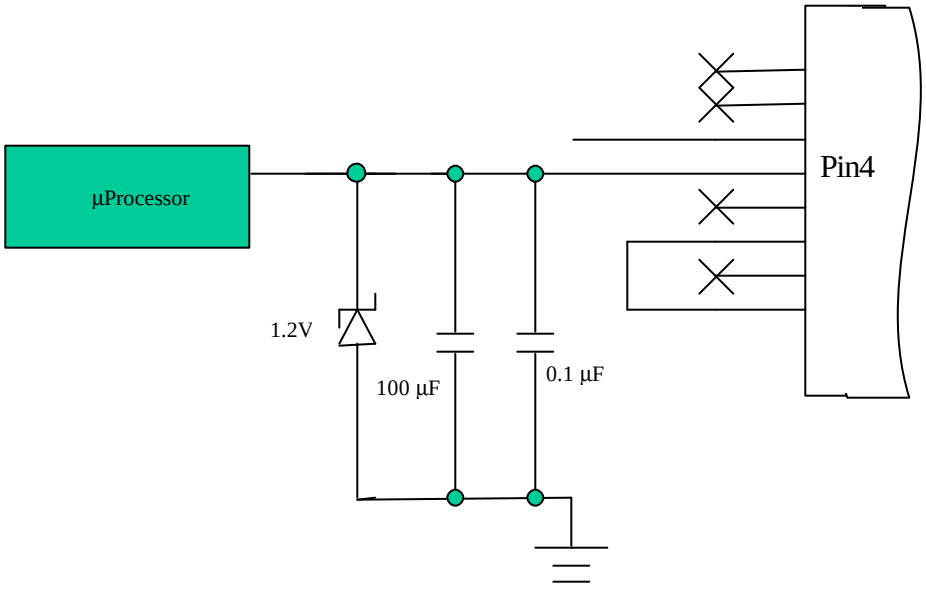
Electrical connection is made to a DC power supply through the red and black wires. Connect the red wire to the positive terminus. The black goes to the negative or GND terminus. The wires can be clipped as needed and mechanically attached or soldered for the connection. Take care not to pull excessively on the wires. The power supply should be +3.3V or +5V ±5% depending on the model number. For models with circuit board pins, power is brought to pin #9 and GND to pin #3.

When using a lab bench power supply no special precautions are needed upon power up other than to keep the voltage and current settings within proper ranges. While there is protection circuitry inside the Fiberdrive module, a slow start-up circuit is a good idea when using the pin connections on a circuit board. As shown below a large capacitor and a surge protector will reduce noise and help protect the module.



The above diagram shows the Fiberdirve in APC mode. To convert to ACC mode, remove the connection between pin #6 and pin #8, and connect pin #7 to pin #8.

The circuit on pin #4 is a way to manually adjust the voltage that's sets the power output or the current output, depending on the mode of operation. The Zener diode provides protection from overdriving this input. In actual system use however, the input is usually controlled through a microprocessor as shown below.



3.1.8 Making Optical Connections

While the tensile strength of fiber is high, it can easily be damaged by excessive bending and kinking. Treat the pigtail as you would a piece of fine crystal. Make sure that you never pick up the Fiberdrive by the pigtail, but always grasp the body of the device. If there is a connector on the end of your pigtail, it should be cleaned with a lint-free tissue and isopropyl alcohol before every mating. (See Technical Note: How to Handle and Clean Optical Fiber and Connectors)

3.2 Operation

Use sturdy tweezers to set the jumper, available through the rectangular hole in the top of the module, in either APC or ACC mode. Alternatively, connect either pin #6 (APC), or pin#7 (ACC) to common pin #8. Turn on the power supply. The desired power output in either mode is set by placing the fiber optic output into a power meter. Turn the trimpot available through the small hole in the top of the module. Turning the trimpot clockwise decreases the current and the power setting, and turning it counterclockwise will increase the power and current settings. The bias current is limited in APC mode so that turning the trimpot excessively in the counterclockwise direction will not damage the laser. Alternatively, the power out may also be adjusted by varying the voltage on the SET pin #4. Raising the voltage will increase the power out in both modes. To prevent damage to the device, the maximum voltage on this pin should not exceed 1.2V.

Before using the module in an application or experiment, a warm-up time of 10-15 minutes is recommended for best steady state operation.

NOTE: *To prevent ESD damage to the module, a properly grounded wrist strap should be worn whenever moving or touching the jumper.*

NOTE: *When going from the APC to the ACC mode, first turn the output power level all the way down in the APC mode. This will prevent any current damage upon power up in the ACC mode.*

NOTE: *If circuit board pins #6 and #7 are both connected to pin #8, this will result in a short circuit. There will be no power output from the laser, but the module will not be damaged.*

NOTE: *When switching the jumper just push the jumper onto the pins far enough to make good contact. Pushing the jumper all the way down makes it difficult to switch it at a later time.*

4 TESTING DATA SHEET PARAMETERS

You can easily verify several parameters of operation for your Fiberdrive Module

4.1 Measuring Power Output, Pout

The output power, Pout, of the Fiberdrive may be confirmed running either in the APC or ACC mode. Simply attach the connector of the pigtail to an appropriately calibrated optical power meter. Before connecting you should always properly clean the connector tip. Power up the Fiberdrive and adjust the current with either the trimpot or pin #4. At room temperature you should be able to go well past the minimum rated value in the data sheet.

4.2 Wavelength and Linewidth

It is not possible to determine the exact wavelength and linewidth with a typical power meter as their detectors are broadband with no filter involved. Wavelength and linewidth can be determined with an optical spectrum analyzer rated for visible wavelengths. The OSA acts as a sensitive monochromator. If you test with an OSA, remember that the wavelength is quite dependent on temperature – the laser shifts to longer wavelengths at higher temperatures. The module should be temperature stabilized before taken any spectral measurements. It is best to test this in the ACC mode. In the APC mode, the bias current can change, which in turn can vary the laser's chip temperature and thus vary the reading.

4.3 Output Power Stability

Output power stability is usually defined in terms of short-term and long-term time periods of one hour and 24 hours respectively. Verification of the stability must be done in the APC mode. The values on the data sheet were determined by temperature stabilizing the Fiberdrive inside a controlled oven. A rough measure of stability may be determined on the bench top, but the unit

should be allowed to temperature stabilize for 15 minutes prior to the test. It is also very important that once the test begins, the fiber not be disturbed. Because of the high stability in the Fiberdrive family, movements of the pigtail can alter the readings on the power meter greater than the stability of the module itself.

4.4 Tracking Error

In applications where one is trying to have a constant stable output power, the tracking error of a laser module may become important. The tracking error, TE, is usually concerned with the output power variations over temperature. Variations occur because the feedback circuit is looking at the power out of the rear laser facet, but the actual used power is coming out of the front laser facet into the fiber. The mechanical coupling of the rear facet to its photodiode monitor is much more stable than the front facet coupling to the optical fiber. The output coupling may change while the backfacet monitor current remains constant. The percentage change in output power is the TE.

To measure the TE of your Fiberdrive module, place the device in the APC mode and let the power output stabilize at a reference temperature. Its preferable if this is done inside an oven. Then you can vary the temperature while monitoring the output power. The power variation from the reference power is your TE. For the Fiberdrive its typically about 25% over the full temperature range. If a more accurate stability over temperature is required in actual use, we suggest that the output power be monitored with a fiber tap coupler. Using a 1% tap coupler will cost very little useable power and allow a feedback loop to reduce the TE to 5% or less.

5 CONCLUSION

This note was intended to provide a brief overview of how to use the Blue Sky Research Fiberdrive laser module. As BSR has a policy of continuous process and quality improvement over time, some of the information contained here may be subject to change. For further updates, please contact the Technical Support Group at Blue Sky Research, Milpitas, CA at 1(408)941-6068.

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