EXCELITAS TECHNOLOGIES

OTFI-0275 XLM Plus

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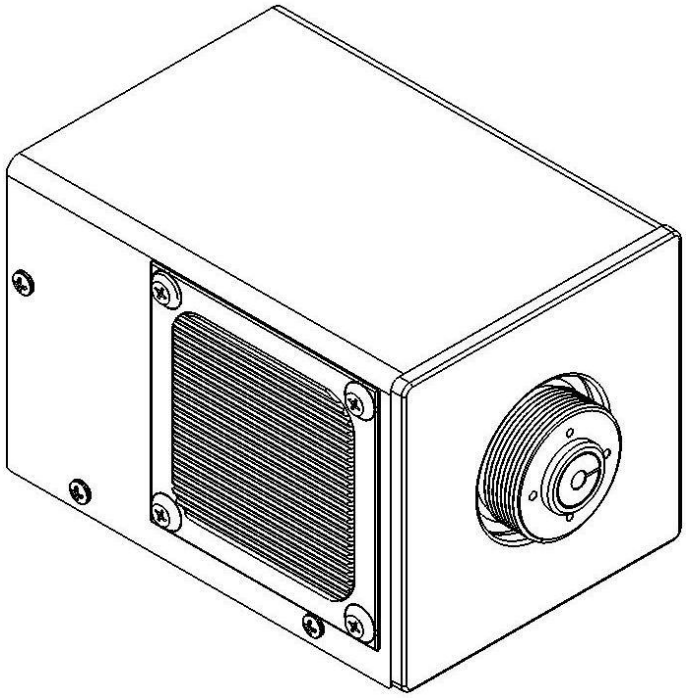
LED Fiber Optic Light Module With Electronics (Firmware 15SW-0001 Revision 03.00) Integration Manual



Thank you for purchasing the OTFI-02X5 LED fiber optic illuminator module. This product is manufactured by Excelitas Technologies, a leader in the design and manufacture of high performance solid state lighting solutions.
To ensure trouble free integration, please read and follow these instructions.

Table of Contents

Introduction and Intended Use

The Excelitas Technologies OTFI-02X5 LED fiber illuminator module with electronics provides high quality white light for fiber optic illumination applications. It contains a high brightness LED (light emitting diode), associated optics to deliver bright illumination from 400 nm to 700 nm, and an integrated electronics driver. It is intended as an alternative to xenon light sources for 1 mm to 6 mm fiber light guides for OEM customer integration into their medical devices.

System Symbol Description

The following table describes the important symbols regarding the safe integration and operation of the OTFI-02X5 light module. These symbols are located throughout the manual. Proper care should be taken when these symbols are identified.

Symbol	Description
	**This symbol indicates critical information regarding safe handling and operation. Serious injury or damage to property could result if these instructions are not followed.**
NOTE:	**This symbol contains important information regarding integration and / or operation of the illuminator module.**

Safety Warnings and Precautions

WARNING DIRECT VIEWING OF EXITING LIGHT CAN BE HARMFUL

Do not look directly into light output port or connected fiber light guide. The light exiting the light output port and at the tip of a connected fiber light guide is of high intensity. Always plug the fiber light guide into the light source before turning on the power and or provide safety interlocks to cut off power to the LED when a fiber light guide is not present.

LED-based products emit light which, in some circumstances, can cause damage to the eye. The potential for injury will depend upon many factors including but not limited to:

- duration of exposure and extent of pupil dilation prior to exposure;

- distance from light source to eye
- wavelength of LED light
- drive current supplied to LEDs
- beam pattern

Buyer must determine the potential for injury and apply all protective measures for safe operation.

WARNING TO PREVENT BURNS

Do not touch the light output port from the light source during or immediately after use to avoid burns.

Do not touch the light output tip of attached light guides during or immediately after use to avoid burns.

Use caution when handling fiber light guides that are or have been in contact with the light source. Although the Fiber Illuminator Module does not emit infrared radiation, the light guide may become hot from light being absorbed at light output port. The light can be absorbed by light guides and by materials placed in the optical path causing light energy to be transferred as heat.

NO USER SERVICEABLE PARTS INSIDE, DO NOT ATTEMPT REPAIRS

In the event the light module should fail please contact Excelitas Technologies for service.

WARNING NEVER DROP OR SUBJECT TO SEVERE IMPACT

Do not drop this equipment or subject it to severe impact as it could compromise the functionality and / or safety of the unit. Should this equipment be mishandled or dropped do not use it.

ATTENTION LENS CLEANING INSTRUCTIONS

To clean the light source output port, turn off the light source and allow it to cool. Use a soft lens cloth to gently wipe the glass lens of the light output port. Do not apply force to the lens when cleaning. It is recommended that the light exit port is not accessible for cleaning by end users. Do not use liquids when cleaning.

ATTENTION MISUSE WILL INVALIDATE SAFETY ASSURANCES

Use of this light module in a manner not in accordance with its intended use will invalidate the safety compliance assurances listed in Table 7 of regulatory compliance standards.

Product Description

The light module delivers high-intensity white light from a LED light source. The light module has an integrated temperature sensor, a heat sink and fan that effectively remove heat generated by the LED resulting in long life operation. The internal mechanical components are designed to maintain precise optical alignment of the optical train. The module includes an aluminum sheet-metal housing with metal fan guards to reduce emissions, universal mounting features for simple integration, and integrated LED driver and controller boards. Electrical connections are provided on the back of the housing.

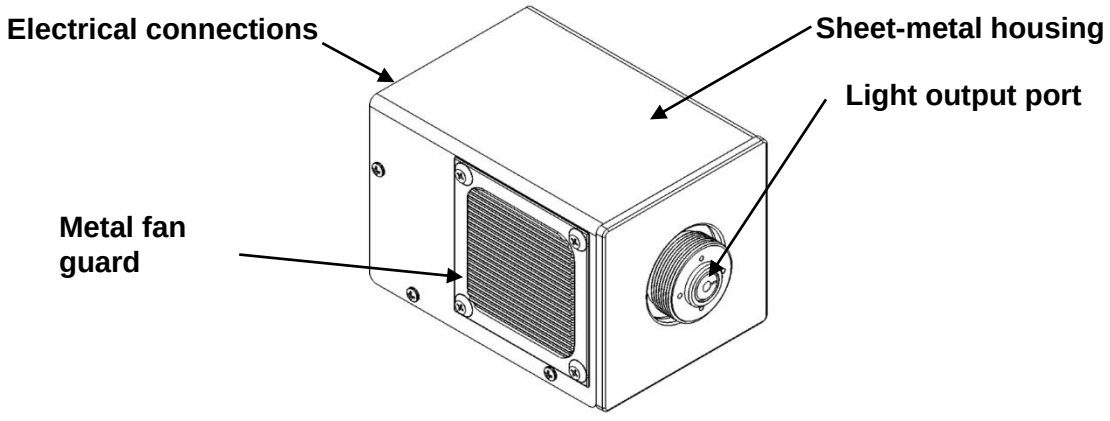


Figure 1

OTFI-02X5 Light module

U.S. and International Patents Pending

Technical Data

Optical Specifications

Parameter	Units	Minimum	Typical	Maximum
Angle of exit light (FWHM)	°		76	
Fiber diameter compatibility	mm	1	5	6

NOTE: Light guides should never come into direct contact with the optic in the light output port. It is recommended that there be a 0.1mm gap between the light output port and the mating fiber.

NOTE: Remove protective caps from the light output port and light guides before turning the light module on.

Electrical Specifications

Parameter	Minimum	Typical	Maximum
Power input, Vdc*	12	--	24
**Maximum and minimum voltage ratings are subject to a ± 5% tolerance.*			

WARNING: REVERSE POLARITY WILL CAUSE DAMAGE TO THE DEVICE.

Observe polarity when connecting the power terminal.

Fiber Illuminator Module Connectors

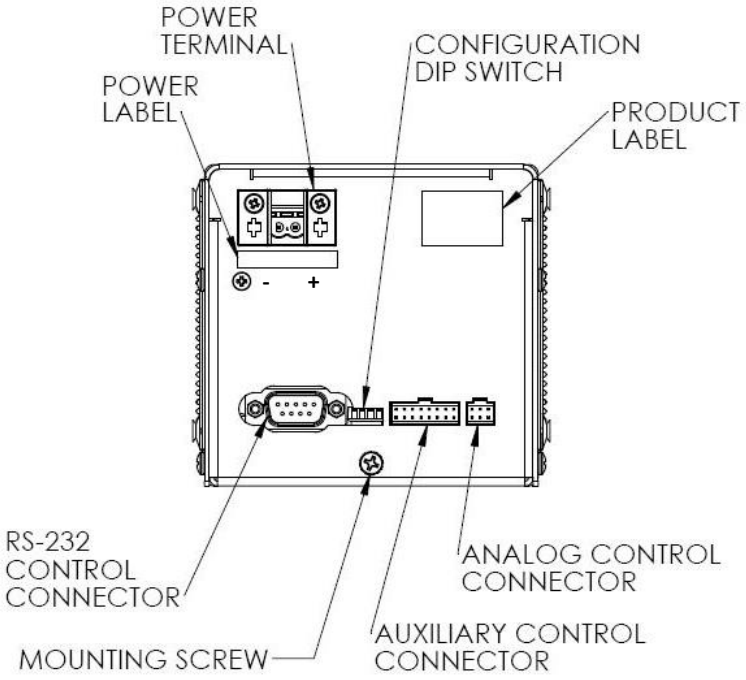


Figure 2 Rear View

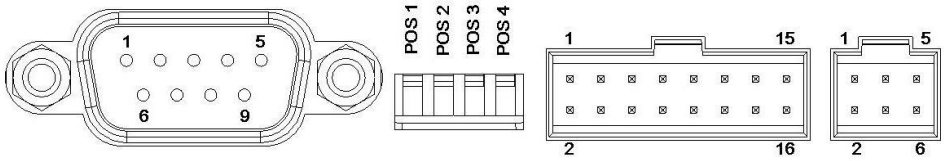


Figure 3 Enlarged view of connectors

Fiber Illuminator Module External Interface

Table 1 Auxiliary Control Connector

Auxiliary Control Connector			Connector Type	
Optional Hardware Control			Molex 90130-3216	
Pin Num	**Signal Name**	**I/O**	**Nominal**	**Description**
1	LED ENBLE IN	input	2-5V	Signal to enable LED Driver. Can be used with LED ENBLE OUT to implement a safety interlock feature.
2	RXD	Input	3.3V	TTL level UART receive signal
3	LED ENABLE OUT	output	12/24 Vdc Open Circuit, 2.5V/5V when connected to pin 1	Signal to enable LED driver. Can be used with LED ENBLE IN to implement a safety interlock feature. LED ENABLE Output voltage is equal to the DC voltage input.
4	TXD	Output	3.3V	TTL level UART transmit signal
5	GND	--	--	Signal ground
6	GND	--	--	Signal ground
7	EXT PWM	Input	3.3V	TTL level signal to control PWM dimming (25,000 Hz Max)
8	EXT. POTENTIOMETER 1	Input	2V	Connect pin 8 to one side of a potentiometer for PWM dimming to adjust Low Level output (Connect pin 8 directly to pin 10 for a Low Level output = 0)
9	STATUS INDICATOR	Output	3V	Output is used to drive a buyer provided LED for power on indication and system status. The output is current limited at 15mA. Flashing indicates an error. See Table 5 for list of error messages.
10	EXT. POTENTIOMETER 2	Input	--	Connect pin 10 to one side of a potentiometer for PWM dimming to adjust Low Level output (Connect pin 8 directly to pin 10 for a Low Level output = 0)
11	GND	--	--	Signal ground
12	GND	--	--	Signal ground
13	LEDON	Output	2V	Provides a signal to indicate the LED is turned on. Can be used to enable an elapsed time indicator
14	MONITOR 1	--	2V	Monitors the high side of the internal digital potentiometer which is used to adjust the LED current
15	OVERTEMP ALERT	Output	3V	Provides a signal indicating over temperature condition. A 1Hz pulsing signal indicates a fan failure or open thermistor. A 2Hz pulsing signal indicates pending over-temperature shutdown. This feature is not available in mode 3.
16	MONITOR 2	--	--	Monitors the low side of the internal digital potentiometer which is used to adjust the LED current.

Table 2 Analog Control Connector

Analog Control Connector			Connector Type	
Analog Dimming Control			Molex 90130-3206	
Pin Num.	**Signal Name**	**I/O**	**Nominal**	**Description**
1	GND	--	--	
2	LED ON/OFF	Input	3.3V	Provides a TTL signal to enable/disable the LED
3	DIMMING SWITCH INPUT 1	Input	Pull up to 3.3V	External encoder switch or up/down switch input to control intensity
4	0-5V	Input	0-5V	0-5VDC input to control the LED intensity
5	DIMMING SWITCH INPUT 2	Input	Pull up to 3.3V	External encoder switch or up/down switch input to control intensity
6	GND	--	--	

Table 3 RS-232 Control Connector

RS-232 Control Connector			Connector Type	
RS-232			DB-9 MALE	
Pin Num.	**Signal Name**	**I/O**	**Nominal**	**Description**
1	NC	--	--	
2	TRANSMIT DATA	Output	± 5.4V	RS-232 transmit signal
3	RECEIVE DATA	Input	± 25V max	RS-232 receive signal
4	NC	--	--	
5	SIGNAL GND	--	--	Signal ground
6	NC	--	--	
7	NC	--	--	
8	NC	--	--	
9	NC	--	--	

Table 4 Mode Configuration Dip Switch Settings

Configuration Mode Dip Switch Setting Position 4 Not Used				
Configuration	Pos 1	Pos 2	Pos 3	Mode Description
Mode 1	0	0	--	Local Control via Rotary Encoder
Mode 2	1	0	--	Local Control via Up/Down Switch
Mode 3	0	1	--	Remote Control via RS-232 Commands
Mode 4	1	1	--	Remote Control via Analog Input Signal
Internal PWM	--	--	0	Internal PWM (Custom Program)
External PWM	0	1	1	External PWM (RS-232 mode only)
0 = dip switch in the “down” position 1 = dip switch in the “up” position -- = any position is acceptable				

System Setup and Operation

Input Power – the Fiber Illuminator Module can be powered from a 12V-24V DC source with a minimum power rating of 100W. The power source can be connected directly to the fiber illuminator module input power terminal; the mating connector is Phoenix Contact p/n 1757019. Observe polarity marking on the Power Terminal when connecting power.

Safety Interlock – the Fiber Illuminator Module is safety interlock enabled through a jumper between pin1 and pin 3 on the Auxiliary Control Connector. This jumper can be replaced with a buyer supplied interlock switch that shorts pin1 and pin 3 when it is safe to turn on the light output.

Status indicator – the power on status can be monitored by connecting a buyer supplied LED to pin 9 (anode) and to pin 11 (cathode) of the Auxiliary Control Connector. The LED will light up when the input voltage is above 11.5V. A flashing LED indicates an error during operation.

Alarm/Alert Output – Except in Mode 3 (Remote RS-232) operation, an alarm/alert signal is provided on pin 15 of the Auxiliary Control Connector. The fan failure alert signal will pulse at a rate of 1Hz to indicate a fan failure and the light output will be reduced to 10% of the maximum output until a different intensity request is received. An over temperature alert signal will be sent when the temperature of the unit is within 2°C of the thermal shutdown temperature equal to 68° C. This signal will pulse at a rate of 2Hz at a 50% duty cycle and the light output will be reduced to a 50% of the maximum output intensity. A pending shut down alert signal will be sent when the temperature is 1°C from the thermal shutdown temperature which is equal to 69°C. This signal will pulse at a rate of 2Hz and at a 50% duty cycle and the light output will be reduced to 10% of the maximum output until a different intensity request is received. When the thermistor reading is 70°C or above, the light source output will be disabled

Optional Low Level Control – When using PWM control, the LED will be switched between a low level current and the programmed current. The default low level current is set to zero with a jumper installed between pin 8 and pin 10 of the Auxiliary Control Connector.
An optional external resistor can be installed between pin 8 and pin 10 of the Auxiliary Control Connector to set the low level current.

Operation Mode Configuration – The Fiber Illuminator Module can be configured to operate in 4 different control modes:

Mode 1 (Manual Rotary Encoder)

The Fiber Illuminator Module is preconfigured for the manual rotary encoder mode operation from the factory. The user is required to provide a quadrature encoder connected to pins 1, 3, and 5 of the Analog Control Connector. The interface diagram using the recommended Honeywell part number 510E1A48F209PC is shown in Figure 4.

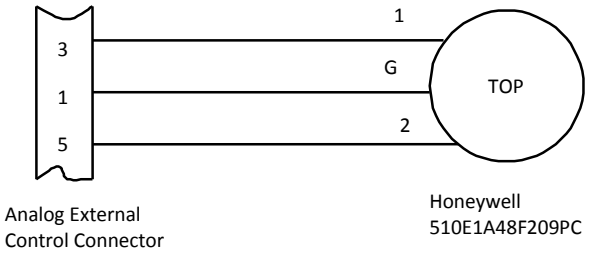


Figure 4 Rotary Encoder Interface Connection

When using manual rotary encoder Mode 1, the intensity of the light output can be controlled by the rotary switch according to the following:

- The rotary switch selects one of the 37 factory preset levels of output intensity, including the OFF position.
- The unit will power up in the intensity level one step above the OFF position.
- The rotary switch input can be an endless rotation type.
- As the light output intensity reaches its maximum or minimum level depending on the direction of rotation, the light output will remain at maximum or minimum until the rotation direction is changed.

Dimming levels for mode 1 are linearized.

Mode 2 (Manual Up/Down)

To operate the Fiber Illuminator Module in the manual up/down switch mode, set the Configuration DIP Switch to Mode 2 according to the Configuration DIP Switch Setting table. The user is required to provide a single pole double throw (momentary) switch or membrane switches connected to pins 1, 3, and 5 of the Analog Control Connector. The interface diagram is shown in Figure 5:

Up/Down Switch Interface Connection

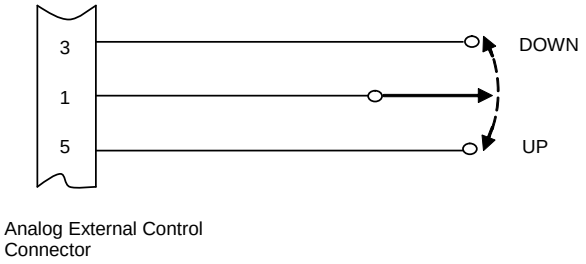


Figure 5 Up/Down Switch Interface Connection

When using the manual up/down Mode 2, the intensity of the light output can be controlled by the up/down switch according to the following:

- The up/down switch selects one of the 37 factory preset levels of output intensity, including the OFF position.
- The unit will power up in the intensity level one step above the OFF position.
- The light intensity will increase to the next level for each momentary press of the Up/Down switch in the “up” position and decrease to the next level for each momentary press in the “down” position.
- If the switch is pressed and held down in the “up” or “down” position for more than 1 sec, the intensity level will continue to increase or decrease until the switch is released.
- As the light output intensity reaches its maximum or minimum level depending on the direction of switch, the light output will remain at maximum or minimum until the direction is changed.
- Dimming levels for mode 2 are linearized.

Mode 3 (Remote RS-232)

To operate the Fiber Illuminator Module in the remote RS-232 mode, set the Configuration DIP Switch to Mode 3 according to the Configuration DIP Switch Setting table. The user is required to provide serial communication through the RS-232 connector or though the UART signals (pins 2, 4, and 5 of the Auxiliary Control Connector).

When remote RS-232 Mode 3 is used, the intensity of the light output can be controlled by commands sent through the serial communication port. In addition, there are other functions that can be accessed through the built in command set. In Mode 3, the fiber illuminator module will power up with no light output until the intensity command is sent. The default intensity duty cycle is set to 100%. The serial command set is described in the following:

Mode 3 Serial Commands

A Glossary is located in Appendix A

The RS-232 serial communication uses the following protocol:
Baud Rate: 19200
Data bits: 8 Bits
Parity: None
Stop Bit: 1
CRC: MODBUS16
Command Data is sent in packet form using serial (hex) data format as show below.

Start Byte	Length	ID	Data Bytes	CRC

Where

Start byte is 0xA5.

Length is the length of the data packet including the start byte and CRC bytes.

ID byte is the requested command

Data bytes are the data associated with the command sent

CRC is a MODBUS16 CRC (2 bytes) low byte followed by high byte

Response Data is received in packet form using serial (hex) data format as show below.

Start Byte	Length	ID	Status	Data Bytes	CRC

Where

Start byte is 0xA5.

Length is the length of the data packet including the start byte and CRC bytes.

ID byte is the requested command echoed back

Status = ACK (for successful receive of message), or
NACK (for unsuccessful receive of message)

Data bytes are the data requested

CRC is a MODBUS16 CRC (2 bytes) low byte followed by high byte

Commands sent to fiber illuminator module from an external terminal

READ_FIRMWARE_VERSION_MSG:

length = 7 bytes (start byte + length + id + control byte + address +16 bit crc)
id = 0x01
control byte = 0xA2
address = 0xEA for low byte of version number
0xEB for high byte of version number

Firmware version number is expressed as a two byte hex number. For example, a version number of "10.11" High byte is 0x0A and Low byte is 0x0B.

READ_PARAMETERS_MSG:

length = 5 bytes (start byte + length + id + 16 bit crc)
id = 0x01

This message requests the Fiber Illuminator Module to send the current parameters. These include input voltage, LED voltage, temperature, LED current, fan running status, error codes.

READ_TEMPERATURE_MSG:

length = 5 bytes (start byte + length + id + 16-bit CRC)

id = 0x03

This message requests the Fiber Illuminator Module to send the current temperature reading in deg C

SET_INTENSITY_RDAC_MSG:

length = 7 bytes (start byte + length + id + intensity (2 bytes) + 16-bit CRC)
id = 0x06
data bytes = intensity (0 to 1023) low byte, high byte

This message requests the Fiber Illuminator Module to set the current level for the LED in Mode 3. Within the range from 0 to 1023, settings 0-5 will disable the light output. Setting 6 provides the minimum light output while setting 1023 provides the maximum output.
Equation to convert intensity setting (6 – 1023) to LED current ILED:
ILED = [(intensity setting ÷ 1024 x 20) ÷ (intensity setting ÷ 1024 x 20 + 7.5) x 2] ÷ 30 ÷ 0.00267

SET_INTENSITY_FREQUENCY_MSG:

length = 7 bytes (start byte + length + id + frequency (2) + 16-bit CRC)
id = 0x07
data bytes = frequency (800 to 25,000Hz) (low byte, high byte)

This message requests the Fiber Illuminator Module to set the intensity PWM frequency. The configuration mode must be set to Serial.

Example: 0xA5, 0x07, 0x07, 0x20, 0x03, crc16 will set the frequency to 800 Hz

The Intensity PWM frequency is programmed as a value from 800 (0320 hex) to 25000 (61A8 hex) representing 800Hz to 25,000Hz.

The Actual PWM Frequency may be slightly off due to rounding in calculating the prescaler registers (TMR and PR).

TMR = 16 for PWM Frequency <= 11KHz
= 1 for PWM Frequency > 11KHz

Based on the PWM Frequency Setting value, the proper prescaler PR is determined by:

PR = 1/Frequency Setting x 1/4 x Fosc x 1/TMR -1
where Fosc = 12Mhz

For example, if the frequency setting is 10000 for 10KHz,

PR = 1/10000 x 1/4 x 12,000,000 x 1/16 – 1 = 17.75 = 17 (decimal dropped)

Using 17 as PR, the actual Intensity PWM frequency can be calculated from:
PWM Frequency = 1/[(PR + 1) x 4 x 1/Fosc x TMR]
= 1/ [(17 +1) x4 x 1/12,000,000 x 16] = 10.416 KHz

SET_INTENSITY_DUTY_CYCLE_MSG:

length = 7 bytes (start byte + length + id + duty cycle + 16-bit CRC)
id = 0x08
data bytes = on time counts (0 to 1023) low byte, high byte

This message requests the Fiber Illuminator Module to set the intensity PWM's on-time.

The programmed PWM on time counts is a value from 0 to 1023 (10 bit resolution max). The default PWM on time is 1023 which is equivalent to 100%.

The PWM duty cycle resolution is dependent on the microprocessor clock frequency (Fosc), the desired PWM frequency (FPWM), and the Prescaler (TMR) used to set the PWM frequency. The PWM Duty Cycle can be calculated based on the following equation:

PWM Duty Cycle = PWM On Time / PWM Period x 100%
Where:
PWM On Time = on-time counts x 1/Fosc x TMR
Fosc = 12MHz
TMR = 16 for PWM Frequency <= 11KHz
= 1 for PWM Frequency > 11KHz

For example, for a PWM frequency of 800Hz, the duty cycle resulted from an on-time setting of "93 (5D hex)" would be:

PWM On Time = 93 x 1/12000000 x 16 = 0.124ms
PWM Period = 1/800 = 1.25ms
PWM Duty Cycle = 0.124ms/1.25ms x 100% = 9.92%

SET_FAN_DUTY_CYCLE_MSG:

length = 7 bytes (start byte + length + id + duty cycle (2 bytes) + 16-bit CRC)
id = 0x09
data bytes (2 bytes)= duty cycle % on (accepted range is 10% to 100% in 10% step)

This message requests the fiber illuminator module to set the fan's duty cycle

Example 0xA5, 0x07, 0x09, 0x0a, 0x00, CRC16 sets the fan to 10%

SET_LED_DRIVER_STATE_MSG:

length = 6 bytes (start byte + length + id + state + 16-bit CRC)
id = 0x0A
state = ON (0x00) or OFF (0x01)

This message requests the fiber illuminator module to enable or disable the LED driver. The configuration must be in Serial Mode.

Example: 0xA5, 0x06, 0x0A, 0x00, CRC16 enables the LED driver (LED turns on).

Messages sent from Fiber Illuminator Module to an external terminal

The fiber illuminator module will only respond to valid messages. It will not respond to an invalid request.

ACK_READ_FIRMWARE_VERSION_MSG:

length = 7 (start byte + length + id + status + data + 16-bit CRC)
id = 0x04
status = ACK or NACK (error detected)
data = firmware version number byte requested

ACK_READ_PARAMETERS_MSG:

length = 18 bytes (start byte + length + id + status +12 data bytes + 16-bit CRC)
id = 0x01
status = ACK
data bytes = vIN (2) + vLED (2) + temp (2) + iLED (2) + fan running status (2) + error bytes (2)

Each parameter contains two bytes (low byte, high byte) in hex value.

Conversion equations are as follows:

- vIN = (hex value)/1024 x 3.3 * 1/0.125 (V)
- vLED = (hex value)/1024 * 3.3 * 1/0.567 (V)
- iLED = (hex value)/1024 * 3.3 x 1/51 * 1/0.00267(A)
- temp is thermistor resistance in Kohm

  Thermistor Value = 18.2 * hex value/(1024 – hex Value)

  Convert thermistor value to temperature using thermistor manufacturer's formula (Murata part number NCP15XH103J03RC).

Fan running status value greater than 10 = fan working

Table 5 Error Bytes

Error Bytes	Description
0b0000000000000001	ERROR_FAN_NOT_RUNNING
0b0000000000000010	ERROR_TEMP_HIGH
0b0000000000000100	ERROR_OVER_TEMP_CONDITION
0b0000000000001000	ERROR_TEMP_PENDING_SHUTDOWN
0b0000000000010000	ERROR_VIN_HIGH
0b0000000000100000	ERROR_VIN_LOW
0b0000000001000000	ERROR_VLED_HIGH
0b0000000010000000	ERROR_BAD_PACKET
0b0000000100000000	ERROR_INVALID_RHEOSTAT_READING
0b0000001000000000	ERROR_I2C
0b0000010000000000	ERROR_EEPROM
0b0000100000000000	ERROR_A-TO-D_CONVERTER
0b0001000000000000	ERROR_WATCHDOG_FIRED
0b0010000000000000	ERROR_STACK_OVERFLOW
0b0100000000000000	ERROR_TEMP_LOW

ACK_READ_TEMPERATURE_MSG:

length = 7 bytes (start byte + length + id + status + temp + 16-bit CRC)

id = 0x03

status = ACK

This message responds by sending the 1 byte temperature in deg C

ACK_SET_INTENSITY_RDAC_MSG:

length = 6 bytes (start byte + length + id + status + 16-bit CRC)
id = 0x06
status = ACK or NACK (error detected)

This message responds by sending an ACK or a NACK for an invalid request

ACK_SET_INTENSITY_FREQUENCY_MSG:

length = 6 bytes (start byte + length + id + status + 16-bit CRC)
id = 0x07
status = ACK or NACK (error detected)

This message responds by sending an ACK or a NACK for an invalid request

ACK_SET_INTENSITY_DUTY_CYCLE_MSG:

length = 6 (start byte + length + id + status + 16-bit CRC)
id = 0x08
status = ACK or NACK (error detected)

This message responds by sending an ACK back after successfully setting the intensity's On-Time. A NACK indicates the setting was invalid and clamped at 0x3ff or 100% on.

ACK_SET_FAN_DUTY_CYCLE_MSG:

start byte = 0xA5
length = 6 (start byte + length + id + status + 16-bit CRC)
id = 0x09
status = ACK or NACK (error detected)

This message responds by sending an ACK back after successfully setting the fan's duty cycle. A NACK indicates the request was invalid.

ACK_SET_LED_DRIVER_STATE_MSG:

start byte = 0xA5
length = 6 (start byte + length + id + status + 16-bit CRC)
id = 0x0A
status = ACK or NACK (error detected)

This message responds by sending an ACK back after setting the LED Driver state. A NACK indicates the request was invalid (not an ON or OFF).

Mode 4 (Remote Analog)

To operate the Fiber Illuminator Module in the remote analog mode, set the Configuration DIP Switch to Mode 4 according to the Configuration Mode DIP Switch Setting in Table 4 . The user is required to provide an analog input single from 0 to 5VDC to pin 4(+) and pin 6(-) of the Analog Control Connector. A 3.3VDC signal needs to be connected to pin 2 of the Analog Control Connector to control the LED On/Off signal.

When remote analog Mode 4 is used, the intensity of the light output can be controlled by the analog input signals according to the following:

- The analog input controls the intensity of the light output in 100 factory preset levels (excluding OFF) according to the analog input voltage.
- The light output is enabled or disabled by the LED On/Off signal. 3.3V enables the output, 0V disables the output.
- The unit will power up at the intensity in accordance with the analog input voltage.

Internal PWM

The Fiber Illuminator Module light output can be modulated using an internally generated PWM signal to obtain the desired output level through an internal lookup table in Modes 1, 2, and 4 or through serial commands in Mode 3. The internal PWM is enabled by setting position 3 of the Configuration DIP Switch to the “down” position.

The internal PWM frequency is programmable between 800Hz and 25KHz, The default setting is 10KHz. The internal PWM duty cycle is programmable between 0% - 100% via RS-232 serial commands, with a resolution dependent on the frequency. The internal PWM default setting is 100%.

External PWM

The Fiber Illuminator Module light output can optionally be controlled using an externally provided PWM signal when operating in the Remote RS-232 Mode. This signal can be connected to pin 7 (+) and pin 6 (-) of the Auxiliary Control Connector. In order to use the external PWM signal, the internal PWM signal must be disabled by setting position 3 of the

Configuration DIP Switch to the “up” position before turning on the unit. When external PWM is selected, the **SET_INTENSITY_DUTY_CYCLE_MSG** command will be ignored.

EMI Considerations

The fiber illuminator module has been designed with consideration given to electromagnetic interference (EMI) concerns. The fiber illuminator module features a sheet metal box enclosure complete with metal fan guards covering the openings required for fan airflow. To maximize these attributes, it is recommended to connect the enclosure to ground. The mounting screw on the rear side of the enclosure can be used for this purpose.

Thermal Specifications

In order to maintain the average 20,000 hours life expectancy of an L70 rating (70% of initial output through 20,000 hours of service), the thermistor temperature must not exceed a maximum of 59°C at a continuous drive current of 18A. This is the most critical thermal consideration and metric.

The fiber illuminator module software provides thermistor temperature monitoring and fan speed control to help minimize the junction temperature of the LED. In Mode 1 (Manual Rotary Encoder), Mode 2 (Manual Up/Down), and Mode 4 (Remote Analog), when the temperature of the LED is below 40°C the fan will run at a low speed setting which is a 40% duty cycle. When the temperature of the LED exceeds 40°C the fan will run at a higher RPM which is a 60% duty cycle. When the fan is operating at high speed and the LED temperature is below 35° C, the fan will revert to the low speed setting. In Mode 3 (Remote RS-232), the monitoring of the thermistor and the control of the fan speed must be set and managed by the OEM customer.

The fiber illuminator module can be operated at thermistor temperatures higher than 59°C using RS232 commands, but with the effect that useful life will be reduced to less than 20,000 hours. The fiber illuminator module features a hardware disable feature at 70°C. In the event that the thermistor exceeds 70°C, power to the LED will be cut off. The unit will however continue to operate in other functions, such as fan and serial communications.

The device must be integrated to ensure sufficient airflow exchange with ambient air to maintain the recommended thermistor temperatures.

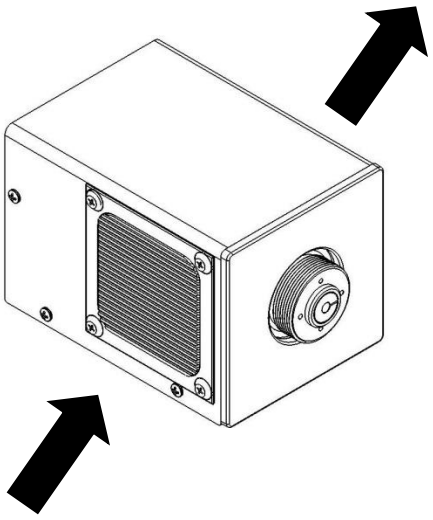
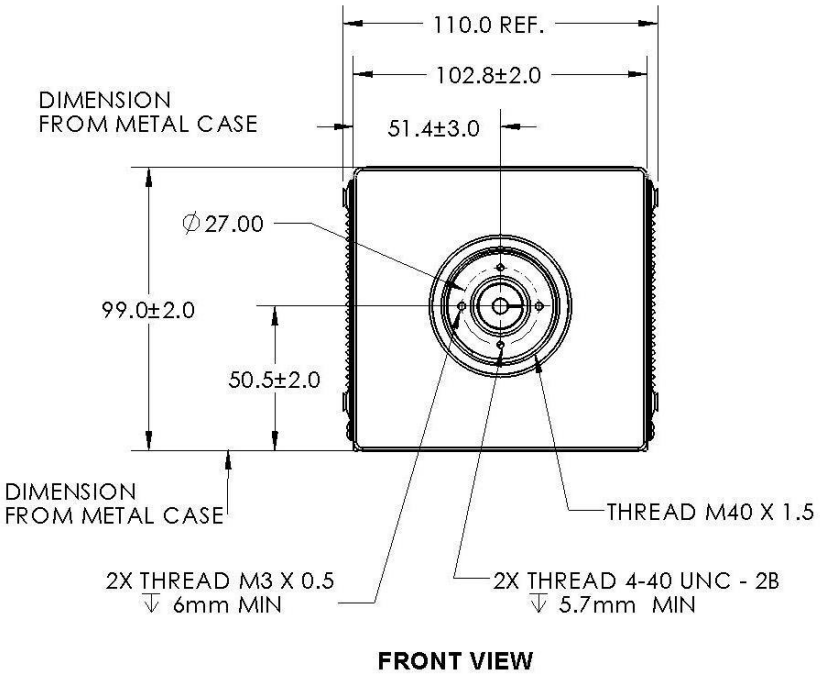
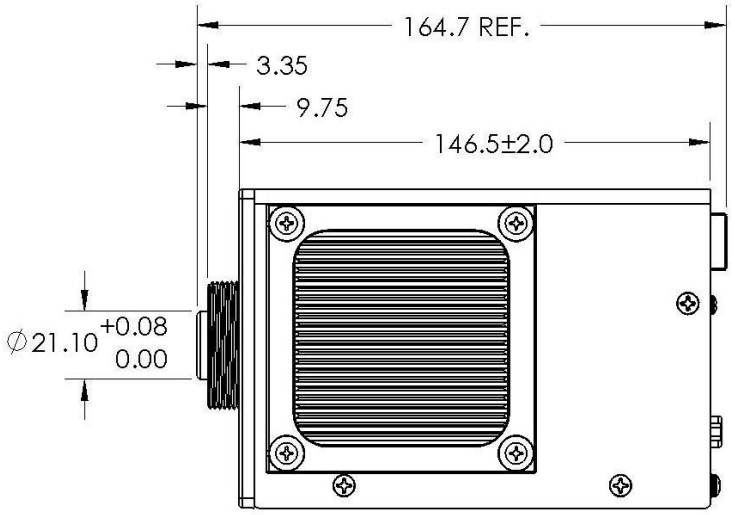


Figure 6 Direction of airflow for internal fan

Mechanical Specifications and Recommended Mounting Instructions

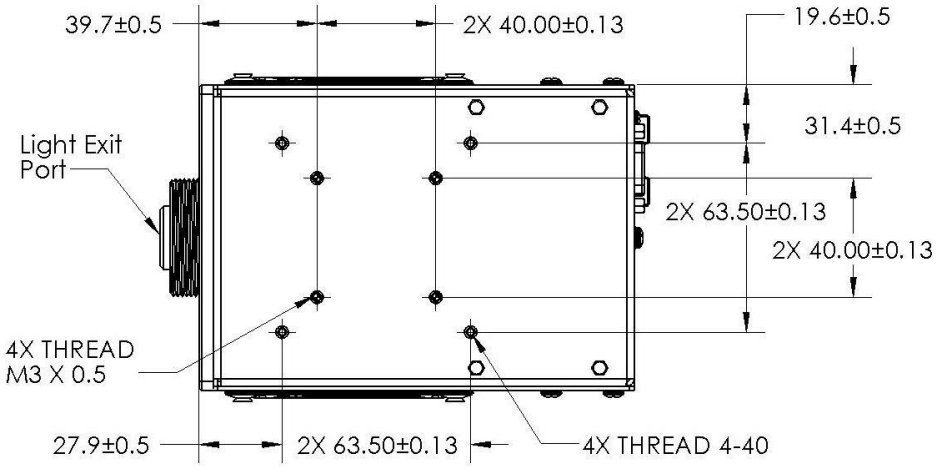


FRONT VIEW



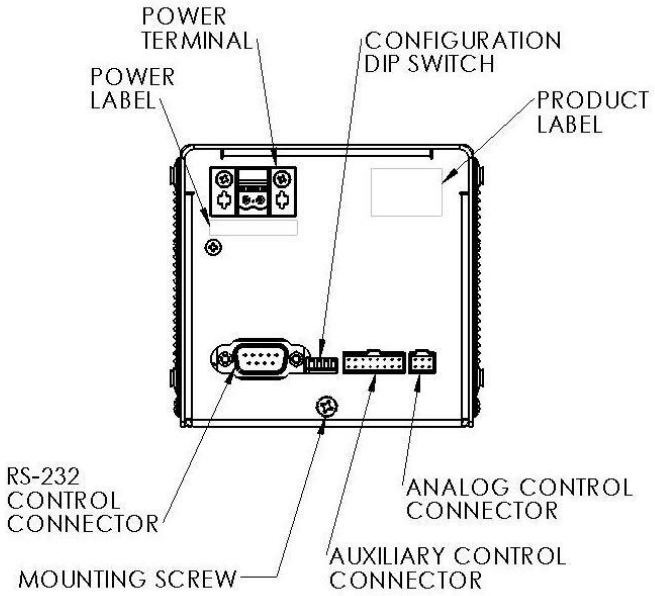
SIDE VIEW

NOTE: units are in millimeters with tolerances of ±0.3 mm unless otherwise noted



BOTTOM VIEW

NOTE: units are in millimeters with tolerances of ±0.3 mm unless otherwise noted



Rear View

For proper alignment to the optical axis of the illuminator, it is recommended to use either the two M3 metric holes or the two 4-40 standard holes as the pilot feature, as pictured in the front view. These holes are located central to the mounting holes on the 27mm bolt-hole circle.

In addition to the mounting holes on the front of the device, it is recommended that support be provided to the module by attaching a bracket to the mounting screw located on the rear side of the module.

It is also recommended that there be a nominal 0.1mm gap between the light exit port and the OEM mating fiber to prevent uncured fiber epoxy transfer to the light guide.

Environmental Specifications

The Product is designed to operate over the following range of environmental conditions:

Table 6 Environmental Operating and Storage Conditions

Ambient Conditions for Operation	Units	Min	Typical	Max
Ambient operating temperature	°C	0	20	+40
Relative Humidity	%			85

Ambient Conditions for Storage	Units	Min	Typical	Max
Storage temperature	°C	-20	25	+65
Relative Humidity	%			85

Depending on the customer-determined fan speed, LED life may be reduced at maximum ambient conditions.

OEM should characterize the fiber illuminator module in the final design with respect to thermistor temperature as described in the Thermal Specifications section on page 21.

Agency Compliance Statement

The fiber optic illuminator module complies with the following standards:

Table 7 Applicable regulatory requirements

Name of standard	*Number, date of standard*
Restriction of Hazardous Substances in Electrical and Electronic Equipment (RoHS)	European Directive 2011/65/EU
Medical electrical equipment - Part 1: General requirements for safety ("2nd Edition")	IEC 60601-1:1988 +A1:1991 +A2:1995
Medical electrical equipment - Part 1: General requirements for safety and essential performance ("3rd Edition")	IEC 60601-1:2005 + CORR. 1 (2006) + CORR. 2 (2007)
Medical electrical equipment - Part 1-2: General requirements for basic safety and essential performance – Collateral standard: Electromagnetic compatibility requirements and test	EN 60601-1-2

Appendix A – Glossary

ACK	Acknowledge – communication handshake message (AA hex)
A-to-D	Analog to Digital
CW	Clockwise
CCW	Counter-Clockwise
CRC	Cyclic Redundancy Check – data integrity checksum
EEPROM	Electrical Erasable Programmable Read Only Memory
FWHM	Full width half max
LED	Light Emitting Diode
NACK	Not Acknowledge – communication handshake message (55 hex)
PWM	Pulse Width Modulation
RPM	Revolutions Per Minute

Limited Warranty

Excelitas Technologies warrants the fiber illuminator module product to be free from defects in material and workmanship and to be in conformance with the written specification for a period of 24 months from date of purchase.

If any defect in material or workmanship or failure to conform to such specification is found, the Purchaser should promptly notify Excelitas Technologies. After a Returned Material Authorization number is assigned by Excelitas Technologies, Purchaser may return the product to Excelitas Technologies, carrying charges prepaid. Products will not be accepted for repair, replacement, credit or refund, without the written authorization of and in accordance with Excelitas Technologies instructions.

Excelitas Technologies shall analyze the failures, making use, when appropriate of technical information provided by Purchaser relating to the circumstances surrounding the failures. At Excelitas Technologies option, we will repair or replace the product found to be defective, and shall return the product carrying charges prepaid. Excelitas Technologies correction of any defects by the grant of credit, replacement or repair shall constitute fulfillment of all of its obligations and liability to the Purchaser hereunder.

Excelitas Technologies is not responsible for damage to its product caused by misuse, neglect, accident, shipping, abuse, maintenance, cleaning procedures, use or attempts to operate above its rated capacity intentionally or that otherwise deviate from the parameters established in the user integration manual and applicable specifications; or to products that have been improperly installed, stored, maintained, repaired or altered by anyone other than Excelitas Technologies; or have had their serial numbers or month and year of manufacture or shipment removed, defected or altered. Any actions cited above shall terminate this Warranty and shall relieve Excelitas Technologies from any further responsibility.

Excelitas Technologies shall not be liable for any incidental, special, or consequential damages in any claim action, suit or proceeding arising under this Warranty or any other part of the agreement of sale

between Excelitas Technologies and the Purchaser, nor shall there be any liability hereunder for claims for labor, loss of profits or good will, repairs or other expenses incidental to replacement.

This warranty does not extend to any system into which a product is incorporated. No other warranty, including warranties of merchantability or fitness for a particular purpose is given with respect to such service or any other service provided by Excelitas Technologies under this Agreement. This warranty applies only to Purchaser and may not be assigned or extended by Purchaser to any of its customers or other users of the Items. Excelitas Technologies will not accept any returns from Purchaser's customers or users of Purchaser's products.

Product specifications are subject to change without notice.

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Document revision history

Rev.	*Description of change*	*ECO*	*Date*	*Prepared*	*Approved*
A	Release to document control	2082	3/21/2013	W. Li	CY
B	Added firmware revision callout and updated fan control	2158	7/19/2013	J. Swayne	WC
C	Added RS232 command to query firmware revision	2172	8/19/2013	J. Swayne	WC
D	Clarified external PWM operation and updated operation on fan speed control	3012	2/6/2014	Wai Choi	JAS
E	Added 3rd edition compliance	3313	6/5/2015	J. Swayne	WL