



FUSION System Controller User Manual



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Revision History

Revision Date	Rev#	Issued By	Change Details
2023-09-26	A	Carmelo Scaffidi	First release.
2024-04-16	B	Carmelo Scaffidi	Second release. Updated Chapter 3 (Ring Light Connections).
2025-12-22	C	Carmelo Scaffidi	Third release. Updated logo and branding information.

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Preface

The following topics are covered:

- Document Conventions, pg. 9
- List of Acronyms, pg. 10
- Safety, pg. 11
 - Warning Labels, pg. 11
 - Safety Precautions, pg. 11

Document Conventions

The following text conventions are used throughout this document.

Table 1 Document Conventions

Paragraph Format	Indicates
NOTE:	Useful information or helpful tips.
CAUTION:	Information about actions that could cause damage to the system or equipment. Identifies a potentially hazardous situation that could result in minor or moderate personal injury, damage to equipment, or loss of data.
WARNING!	Information that is essential to your safety. Identifies a potentially dangerous situation that could result in serious personal injury or death.
Bold	Noteworthy information.

List of Acronyms

CE	Conformité Européenne
CCW	Counter-clockwise
COM	Communication
CSYNC	Camera Sync
CW	Clockwise
DIO	Digital Input/Output
E-STOP	Emergency Stop
FCC	Federal Communication Commission
IO	Input/Output
LED	Light Emitting Diode
PE	Protective Earth
PWM	Pulse Width Modulation
RMA	Return of Merchandise Authorization

Safety

This section provides guidelines on the use and safety of the Optem® FUSION System Controller, to avoid personal injury or damage to the module.

Warning Labels

Excelitas products have labels affixed to their packaging or enclosures, similar or identical to those shown below.

WARNING! Be sure to read and follow all warning labels.



Electrostatic discharge (ESD) can damage or destroy the product's electronic components. Observe precautions for handling these components (e.g., use anti-static mats, gloves, wrist straps).

Safety Precautions

This section outlines the safety precautions that users must take when operating the Optem® FUSION System Controller.

General Precautions

Observe the following general safety precautions:

- Permit only authorized individuals to operate the Optem® FUSION System Controller.
- Permit only authorized individuals to have access to controlled areas during Optem® FUSION System Controller operation.

ESD Precautions

Handling of this product needs precautions against static electricity because this is a semiconductor product. Please take adequate measures to prevent any static electricity being produced such as the wearing of a wristband or anti-static gloves when handling this product.

Every manufacturing facility in regard to the product (plant, equipment, machine, carrier machine and conveyance unit) should be connected to ground and please avoid the product to be electric-charged.

CHAPTER

1

Introduction

This chapter provides an overview of the Optem® FUSION System Controller, as well as some general product and company information.

The following topics are covered:

- [Optem® FUSION System Controller Description, pg. 14](#)
- [Intended Use, pg. 14](#)
 - [Regulatory Compliance, pg. 14](#)
- [Changes to Excelitas Products, pg. 15](#)
- [Technical Support, pg. 15](#)
- [Limited Warranty Information, pg. 15](#)
 - [Warranty Repair Process, pg. 15](#)

Optem® FUSION System Controller Description

The Optem® FUSION System Controller is designed to control the following devices:

- A stepper motor operated Focus module.
- A stepper motor operated Zoom module.
- LED outputs for camera illumination. This is for LED illuminators which can be 1.5A or 3.0A (bridged).
- Ring Light Illuminator.

Intended Use

NOTE: *Excelitas takes no responsibility for poor performance or malfunction of the system if the conditions described in this section are not met.*

The Optem® FUSION System Controller is intended to be used as a component within a microscopy system such as the Optem® FUSION micro-imaging lens system. The Optem® FUSION System Controller also interfaces with Optem® FUSION Fixed Magnification or Zoom Tube Lenses, and the Optem® FUSION Focus Module.

Regulatory Compliance

The Optem® FUSION System Controller has been tested and certified to comply with the IEC 61326-1:2012/EN 61326-1:2013 Basic Electromagnetic Environment Emissions & Immunity for Measurement, Control, and Laboratory Use Electrical Equipment. It also complies with IEC 61010-1/EN 61010-1:2010/A1:2019 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use.

NOTE: *If the product is modified or changed, the FCC and/or CE approval becomes invalid. In this case, you are responsible for ensuring product conformity.*

Changes to Excelitas Products

Excelitas reserves the right to improve, change, or modify products without incurring any obligations to make changes to previous Excelitas equipment.

Technical Support

For technical support, please contact our Technical Support Team at Inspection@excelitas.com.

Limited Warranty Information

Excelitas Technologies Corp. (“Excelitas”) warrants that the enclosed Excelitas component(s) and related Excelitas accessories (individually a “Product” and collectively the “Products”) will be free from defects in materials and workmanship under normal use and service for a period, beginning from the date of shipment, of twelve (12) months.

Excelitas, at its sole discretion, will repair, replace, or adjust the defective Product, provided that Excelitas' investigation and factory inspection disclose that:

- such defect developed under normal and proper use, and
- the Product is covered under this limited warranty.

Warranty Repair Process

Unless otherwise arranged by Excelitas Technologies Corp., all service and support requests and Return Material Authorization (RMA) requests must be directed to the Excelitas customer support team, who are responsible for conducting preliminary analysis of issues and leading the investigation on all returned Product(s). The Excelitas customer support team, or another Excelitas officer, will issue a RMA number at its discretion if the analysis performed meets the criteria for RMA. This includes Original Warranty claims, Out of Box failures and Post Warranty service requests.

For complete warranty information, limitations, coverage, and process refer to the sales terms and conditions.

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CHAPTER

2

Setting up

This chapter describes how to install and connect the Optem® FUSION System Controller unit. Be sure to read this chapter completely before attempting to install the system.

The following topics are covered:

- [System Components, pg. 18](#)
- [Installing the Controller, pg. 19](#)
 - [Mounting the Controller, pg. 19](#)
 - [Cooling, pg. 20](#)
 - [Space Requirements, pg. 21](#)

System Components

Before beginning, ensure you have all the necessary components, cables, and tools listed in this section.

The following system components are supplied by Excelitas:

- **Optem® FUSION System Controller** – The controller is used to control Excelitas’s LED illuminators, stepper motor motion devices, and a ring light (with external electronics). For connection details, see "[Optem® FUSION System Controller Connections](#)" on page 25.



Figure 1 Optem® FUSION System Controller Unit

- **Optem® FUSION Console Software** – This is provided by Excelitas, and is available by download from the Excelitas website.

The following components must be purchased separately by the end-user:

- **COM cable** – An appropriate cable that connects to the control computer serial port can be purchased from Excelitas. For connection details, see "[PWR/COM/DIO Receptacle and Connector](#)" on page 26.
- **Optem® FUSION System Controller connector kit** – Provides connectors for cabling the following:
 - 24 VDC power supply for the controller (see "[PWR/COM/DIO Receptacle and Connector](#)" on page 26)
 - Digital input/output (see "[PWR/COM/DIO Receptacle and Connector](#)" on page 26)

The connectors are provided without cables because the cable type and length depend on the application and the equipment to which they will be connected.

- **LED illuminator module** – At least one LED illuminator is normally used with the system for illumination. You can purchase the LED illuminator module from Excelitas.
- **Ring Light** – An illuminator using external electronics.
- **Focus module** – A device for motorized Z-axis motion, complete with a stepper motor and limit switches.
- **Zoom module** – A device for motorized zoom motion, complete with a stepper motor and limit switches.
- **Power supply** – A 24 VDC power supply is required.
- **Control computer** – The software for controlling the Optem® FUSION System Controller must be installed on a user-supplied computer. Ensure that the computer has a grounded power cable.

NOTE: *Ensure you have all the components listed above before setting up. If you do not have the necessary components, you can purchase them separately from Excelitas.*

Installing the Controller

This section reviews the installation requirements needed prior to connecting the system. The Optem® FUSION System Controller has a compact design, with minimal integration effort. Most installations can be completed easily by following the instructions provided in this section.

Mounting the Controller

The Optem® FUSION System Controller has two mounting flanges, that can be used to mount the controller onto the system. The controller mounting flanges have four 5 mm mounting slots for standard M4 screws, that are separated by a distance of 80 mm.

The controller can be mounted either horizontally or vertically, to accommodate different conditions. For controller dimensions, see "[Mechanical Dimensions](#)" on page 39.

NOTE: *Excelitas does not supply the screws required to mount the controller onto the system.*

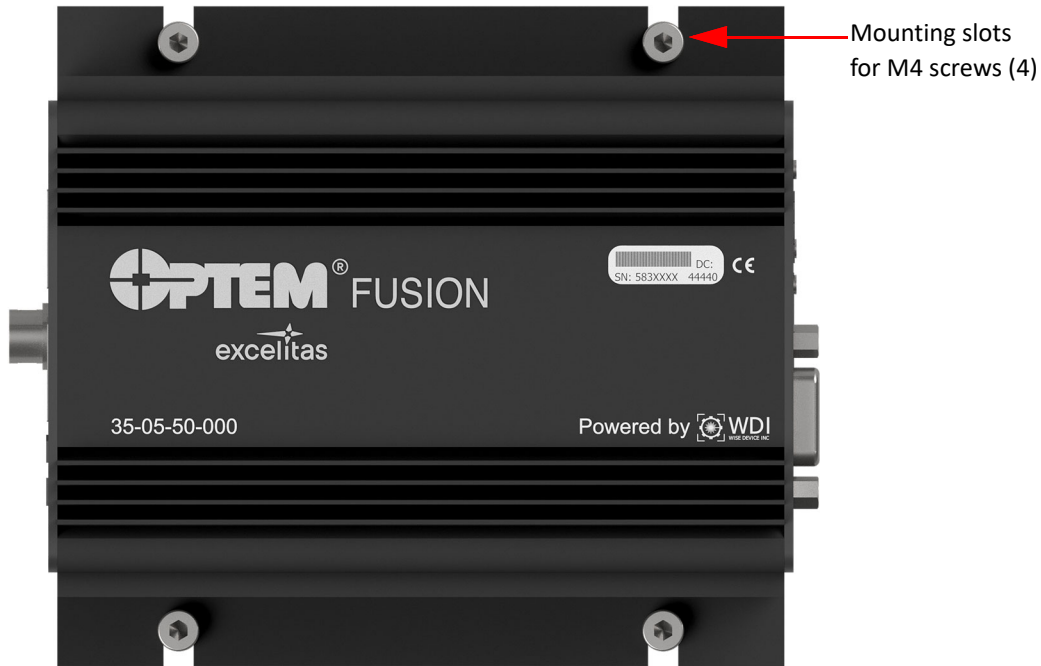


Figure 2 *Optem® FUSION System Controller with Mounting Slots and Screws*

Cooling

The Optem® FUSION System Controller enclosure is used to dissipate heat from the internal electronics for cooling.

Space Requirements

As shown in [Figure 3](#), when you install Optem® FUSION System Controller you must leave approximately 100 mm of clearance at each end of the controller, as work area for cable insertion and removal.



Figure 3 Controller Space Requirements

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CHAPTER

3

Connecting the System

This chapter describes how to connect the system components.

The following topics are covered:

- [System Connections, pg. 24](#)
 - [Optem® FUSION System Controller Connections, pg. 25](#)
 - [PWR/COM/DIO Receptacle and Connector, pg. 26](#)
 - [PWR/COM/DIO Connector Specifications, pg. 27](#)
 - [Recommended USB to RS485 Converter, pg. 28](#)
 - [PWR/COM/DIO Connector Wiring Diagrams, pg. 28](#)
 - [AUX Connection, pg. 30](#)
 - [Axis 1 Stepper Motor Interface Connection, pg. 30](#)
 - [Axis 2 Stepper Motor Interface Connection, pg. 30](#)
 - [Ring Light Connection, pg. 31](#)
 - [Tunable Lens Connection, pg. 31](#)
 - [LED Illuminator Connection, pg. 32](#)
- [Status Indicator, pg. 33](#)

System Connections

This section provides details regarding each component in the Optem® FUSION System Controller system and their respective connections. Most of the components are connected directly through the controller. The Optem® FUSION System Controller system is connected as shown in [Figure 4](#).

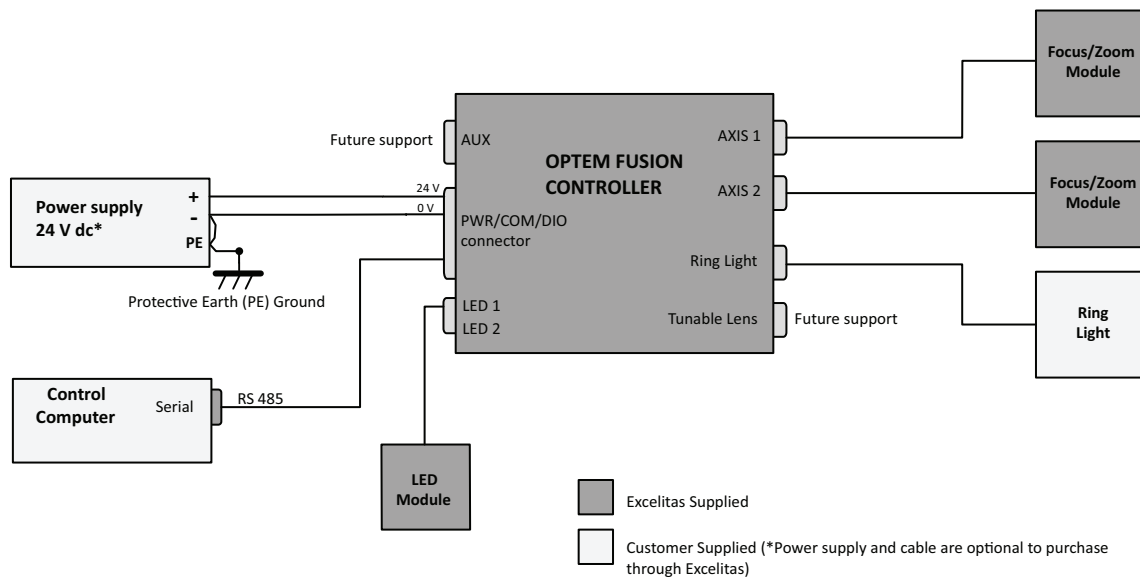


Figure 4 System Connections and Grounding Scheme

The system components must be grounded. The mounting structure can pick up electromagnetic radiation from high power and high frequency sources. If not adequately grounded, the electrical noise and ground shift can degrade the performance of the Optem® FUSION System Controller. Connect the power supply to earth ground before connecting the Optem® FUSION System Controller to the system. We recommend grounding the components closest to where the Optem® FUSION System Controller is mounted.

Optem® FUSION System Controller Connections

This section describes the Optem® FUSION System Controller connections. The Optem® FUSION System Controller is intended to be mounted close to motion modules and LED modules.

- **PWR/COM/DIO connector** – 16-pin connector on the controller for the system’s communication and power input. This connector also has the analog output signal, and all other digital input/output depending on the configuration.
- **AUX** – DR15-HD connector (for future use).
- **LED 1** and **LED 2** – 6-pin connector for two separate LED outputs for illumination.
- **AXIS 1** – 8-pin connector for either the Focus Module interface or the Zoom Module interface.
- **AXIS 2** – 8-pin connector for either the Focus Module interface or the Zoom Module interface.
- **Ring Light** – 4-pin connector for the Ring Light Illuminator controller interface.
- **Tunable Lens** – 6-pin connector for Optotune Lens interface (for future use).

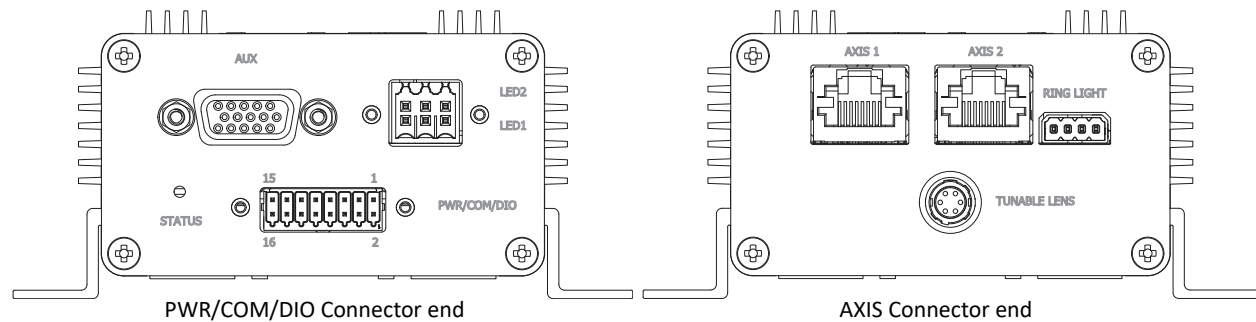


Figure 5 Optem® FUSION System Controller Connections

PWR/COM/DIO Receptacle and Connector

Figure 6 and Table 2 highlight the electrical pin out of the PWR/COM/DIO receptacle and connector.

NOTE: Digital IOs (IO1 to IO5) can be assigned as input sync (trigger) or camera sync, or other signals that may be defined as needed.

NOTE: Mating connector is Phoenix Contact 1844633. *Pin 1 from manufacturer is overwritten as pin 2.

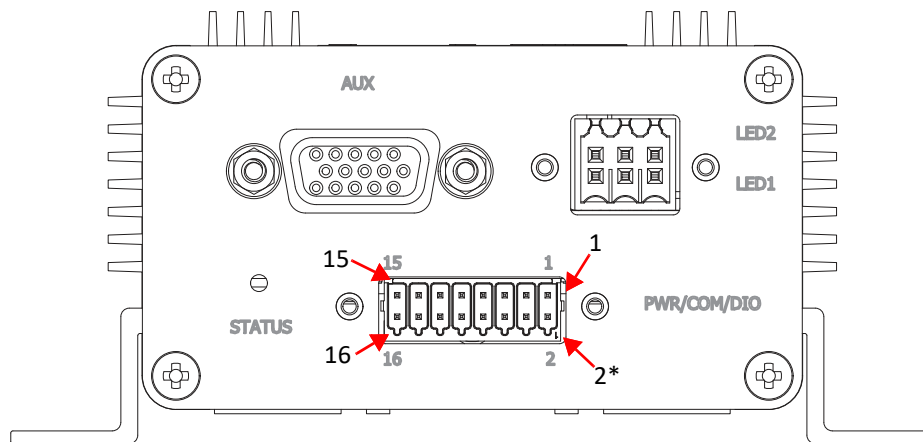


Figure 6 PWR/COM/DIO Receptacle and Connector

Table 2 PWR/COM/DIO Connector Pin Out Description

Pin #	Pin Name	Description	Direction
1, 2	+24V	+24V Power Supply	Supply
3, 4	GND	Power Supply Return	GND
5	Reserved	Reserved	I/O
6	Reserved	Reserved	I/O
7	IO1	Digital Input/Output 1	I/O
8	GND	IOs Return	GND
9	IO3	Digital Input/Output 3	I/O
10	IO2	Digital Input/Output 2	I/O
11	RS485-	Inverting RS485 Receiver Input and Driver Output	I/O
12	RS485+	Non Inverting RS485 Receiver Input and Driver Output	I/O
13	GND	IOs Return	GND

Table 2 PWR/COM/DIO Connector Pin Out Description (continued)

Pin #	Pin Name	Description	Direction
14	IO4/ESTOP	Digital Input/Output 4 or Emergency Stop Input, wired to supply voltage through a mushroom button if configured as input. Actively drive high to enable operation.	I/O
15	IO5-	Inverting Differential IO5 Receiver Input and Driver Output	I/O
16	IO5+	Non Inverting Differential IO5 Receiver Input and Driver Output	I/O

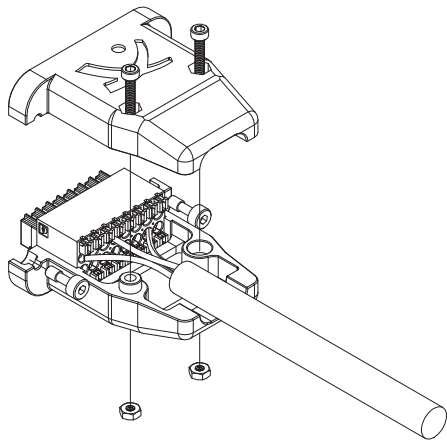
PWR/COM/DIO Connector Specifications

This section provides information for a customer built cable using a connector purchased from Excelitas. It is recommended to use a shielded cable with 24 AWG wire size.

NOTE: *The maximum recommended cable length is 1.8m (6ft).*

Table 3 PWR/COM/DIO Connector Parts List

Item	Qty	Description	Manufacturer	Manufacturer Part #
1	1	Conn, 16 Pos,2.54MM, 2 rows, spring cage, plug	Phoenix Contact	1844633
2	16	Ferrule,#24AWG, uninsulated, 5mm	American Electrical, Inc.	12510025

**Figure 7** *PWR/COM/DIO Connector Housing*

Recommended USB to RS485 Converter

If USB connectivity is desired, it is recommended to use the following USB to RS485 converter to get the best performance and reliability from the product:

- FTDI, Future Technology Devices International Ltd – USB-RS485-WE-1800-BT (1.8m cable)

NOTE: *It is not recommended to use a USB extender for the USB to RS485 converter.*

PWR/COM/DIO Connector Wiring Diagrams

The following diagrams shows the different connections to the PWR/COM/DIO connector on the Optem® FUSION System Controller.

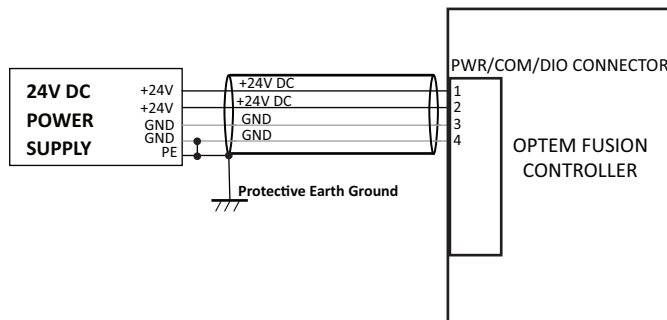
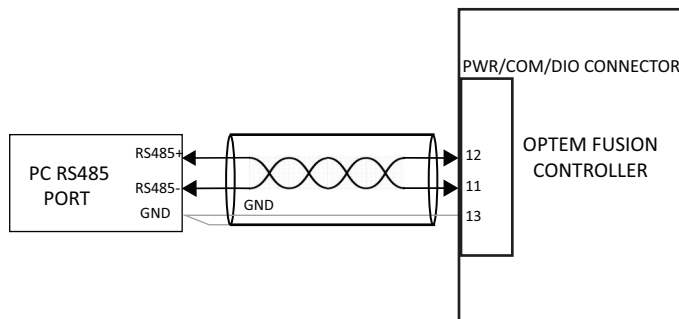


Figure 8 *Power Supply Connections*



NOTE: *The connection to the PC can also be via a USB to RS485 converter.*

Figure 9 *Serial COM Connections*

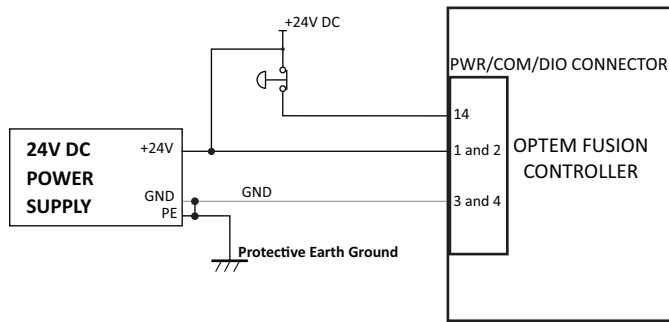


Figure 10 Enable E-stop Connections

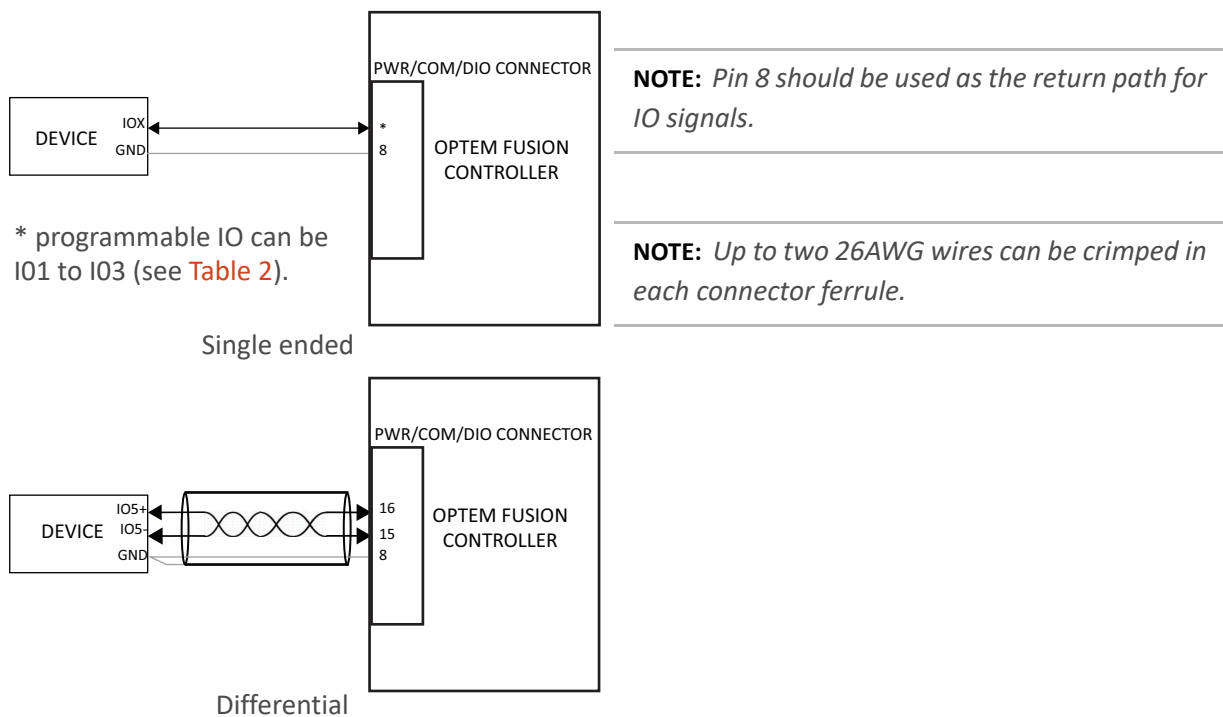


Figure 11 IO signals Connections

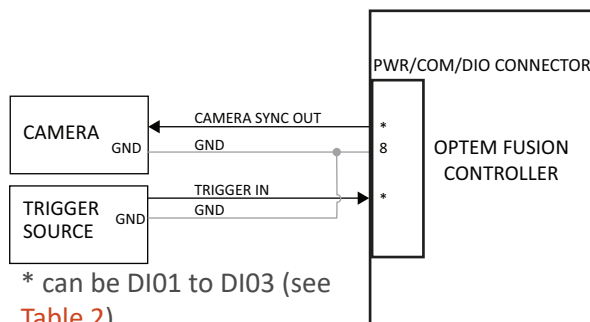


Figure 12 Typical Application for IOs Connections

AUX Connection

This feature is currently not supported.

Axis 1 Stepper Motor Interface Connection

The controller supports a focus module or 7:1 / 12.5:1 zoom products and the option to support custom motorized modules utilizing the RJ-45 connector. For pin connections, see [Table 4](#).

NOTE: The recommended maximum cable length is 1.8 m (6 feet).

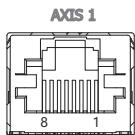


Table 4 Axis 1 Stepper Motor Interface Connector Pin Assignments

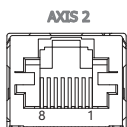
Pin	Signal	Description
1	MCOIL_A+	Motor Coil A+
2	MCOIL_A-	Motor Coil A-
3	POWER_5V	5V Power output
4	HOME/CWLIM	Home Sensor or CW Limit Switch Input ^a
5	LIMIT_CCWLIM	Limit Sensor or CCW Limit Switch Input ^a
6	POWER_GND	Return Ground
7	MCOIL_B+	Motor Coil B+
8	MCOIL_B-	Motor Coil B-

a. Home/Limit switches are software programmable.

Axis 2 Stepper Motor Interface Connection

See "[Axis 1 Stepper Motor Interface Connection](#)" on page 30. For pin connections, see [Table 4](#).

NOTE: The recommended maximum cable length is 1.8 m (6 feet).



Ring Light Connection

The controller supports a Ring Light interface. For pin connections, see [Table 6](#).

NOTE: *The recommended maximum cable length is 1.8 m (6 feet).*

Table 5 Ring Light Connector Parts List

Item	Qty	Description	Manufacturer	Manufacturer Part #
1	1	PTSM 0,5/ 4-P-2,5, printed-circuit board connector	Phoenix Contact	1778858
2	4	Ferrule,#24AWG, uninsulated, 5 mm	American Electrical, Inc.	12510025

RING LIGHT

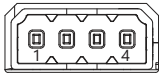


Table 6 Ring Light Connector Pin Assignments

Pin	Signal	Description
1	ANALOG_OUT	Analog output
2	PWM	PWM Output
3	+24V	+24V Power Supply
4	GND	Return GND

Tunable Lens Connection

This feature is currently not supported.

LED Illuminator Connection

The Optem® FUSION System Controller uses an LED driver to supply current to the LEDs for the illumination application. The LED drivers provide a maximum current that can be set between 50 and 1500 mA. The LED driver controls the intensity of the current by pulse width modulation (PWM), or constant current mode. The PWM technique preserves the colour spectrum while adjusting the intensity. The PWM frequency is programmable from 2 Hz to 100KHz such that it is a factor of 100KHz ($100\text{KHz} \div 1 = 100\text{KHz}$, $100\text{KHz} \div 2 = 50\text{KHz}$, $100\text{KHz} \div 3 = 33.3\text{KHz}$, $100\text{KHz} \div 4 = 25\text{KHz}$, $100\text{KHz} \div 5 = 20\text{KHz}$, etc.). The PWM duty cycle range is between 0 and 100% in 0.1% increments. Refer to [Table 8](#) for LED pin assignments.

For most applications, only one LED is used; however, a second LED can be used, for example, to provide illumination from the bottom or in a different colour. For best performance it is recommended to use Excelitas LED illuminators (3.0 A LED illuminator model # 35-07-61-000 or 1.5 A LED illuminator model # 35-07-60-000). Enabling or disabling the LED illuminator is easily done via the Optem® FUSION Console software interface. For details, refer to Chapter 2 of the *MAN-350015 Optem® FUSION Console Reference Manual*.

Table 7 LED Illuminator Connector Parts List

Item	Qty	Description	Manufacturer	Manufacturer Part #
1	1	B2CF 3.50/06/180 SN BK BX, PCB plug-in connector, female plug, 3.50 mm	Weidmuller	1277470000
2	4	Ferrule, #20AWG, insulated, 10 mm	American Electrical, Inc.	11102050

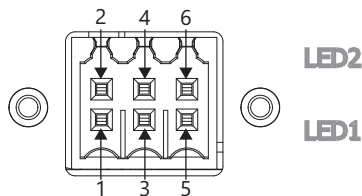


Table 8 LED Connector Pin Assignments

Pin	Signal	Description
1	LED1 Anode	LED1 Anode current output
2	LED2 Anode	LED2 Anode current output
3	NC	Not Connected, do not connect
4	NC	Not Connected, do not connect
5	LED1 Cathode	LED1 Cathode (return)
6	LED2 Cathode	LED2 Cathode (return)

Status Indicator

The Optem® FUSION System Controller status indicator has a single, bi-colour (green and red) status indicator on the PWR/COM/DIO connector end of the controller (outlined in red in [Figure 13](#)). The Optem® FUSION System Controller status indicator will be solid green under normal operation and solid or flashing red under faulty conditions. The flashes occur in patterns, indicating Optem® FUSION System Controller status indicator conditions, as described in [Table 9](#).

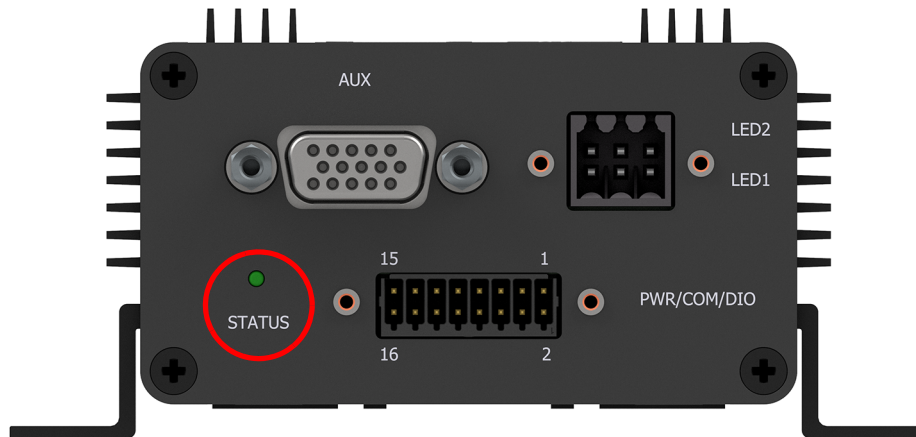


Figure 13 Optem® FUSION System Controller Status Indicator

Table 9 Optem® FUSION System Controller Status Indicator Functions

Colour	Function
Solid green	Normal operation.
Solid orange	Controller is booting. The controller boots in seconds and so this is a very short duration.
Solid red	Controller firmware load failure.
Flashing orange	Firmware upgrade in progress.
Flashing red	Controller error, such as bad CRC or incompatible EEPROM content.

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CHAPTER

4

Specifications and Drawings

The Optem® FUSION System Controller specifications and dimensions are provided in this chapter for your reference.

The following topics are covered:

- Specifications, pg. 36
 - Electrical Specifications, pg. 36
 - Mechanical Specifications, pg. 39
- Mechanical Dimensions, pg. 39
- Environmental Specifications, pg. 40

Specifications

This section provides the specifications for the Optem® FUSION System Controller and the interfaces connected to it.

Electrical Specifications

Table 10 PWR/COM/DIO Connector – Power and Communication Interface

Parameter	Condition	Min	Typical	Max	Units
+24V Power Supply Output					
Supply voltage		21.6	24	26.4	V
Supply power				42	W
Supply Power with Fetura+ module				92	W
Digital Inputs/Outputs IO1, IO2, and IO3					
Input Voltage High (VIH)		2		5.5	V
Input Voltage Low (VIL)		-0.5		0.7	V
Input Resistance			5		KΩ
Output Voltage High (VOH)		4.5	5		V
Output Voltage Low (VOL)		0		0.4	V
Output Impedance			40.2		Ω
Digital Input/Output IO4/ESTOP					
Input Voltage High (VIH)		2.8		28	V
Input Voltage Low (VIL)		-0.5		1	V
Input Resistance			5		KΩ
Output Voltage High (VOH)		4.5	5		V
Output Voltage Low (VOL)		0		0.4	V
Output Impedance			6		KΩ

Table 10 PWR/COM/DIO Connector – Power and Communication Interface (continued)

Parameter	Condition	Min	Typical	Max	Units
RS485					
Differential Driver Output Voltage		2.0		3.3	V
Receiver Differential Threshold Voltage		50	105	200	mV
Differential Termination Resistor			120		Ω
Data rate		9600		921600	bps
Differential input DIO5					
Differential Driver Output Voltage		2.0		3.3	V
Receiver Differential Threshold Voltage		50	105	200	mV

Table 11 Focus Module and Zoom Interfaces

Parameter	Condition	Min	Typical	Max	Units
+5V Power Supply Output					
Supply voltage			5		V
Supply current				20	mA
Stepper Motor Driver MCOIL A+/A- B+/B-					
Output Current				1.2	A RMS
Peak Output Current				2	A
Output Voltage				24	V
Micro stepping		1		256	
Limit Switches Inputs CWLIM, CCWLIM					
Input Voltage High (VIH)		2		5.5	V
Input Voltage Low (VIL)		-0.5		0.7	V
Input Resistance			5		KΩ

Table 12 Illuminator Interface

Parameter	Condition	Min	Typical	Max	Units
Dual Channel LED Driver, Each Channel					
Output Voltage		12.0	14.0	14.5	V
Output Current		0.05		1.5	A
Peak Output Current				2	A
Output Current ripple			15	25	mA
Pulse width		10 ^a			μs
Analog Dimming Range			30:1		
PWM Dimming Range			1000:1 ^a		
PWM Frequency		2		100,000	Hz
Pulse edge position accuracy			1		μs

a. Minimum pulse width can restrict minimum duty cycle, and dimming range, in PWM mode.

Table 13 Ring Light Illuminator Interface

Parameter	Condition	Min	Typical	Max	Units
+24V Power Supply Output					
Supply voltage		21.6	24	26.4	V
Supply current				0.75	A
Analog Output					
Output Voltage		0		10	V
Output Resistance			330		Ω
Voltage Resolution	10-bit DAC		9.8		mV
PWM Output					
Output Voltage High (VOH)		4.5	5		V
Output Voltage Low (VOL)		0		0.4	V
Output Impedance			40		Ω
PWM Frequency			10,000		Hz
PWM Pulse Width		10			μs

Mechanical Specifications

Table 14 Physical Characteristics

Description	Value
Weight	0.43 Kg
Dimensions	See " Mechanical Dimensions " on page 39

Mechanical Dimensions

This section contains the mechanical dimensions of the Optem® FUSION System Controller. All dimensions are in millimeters.

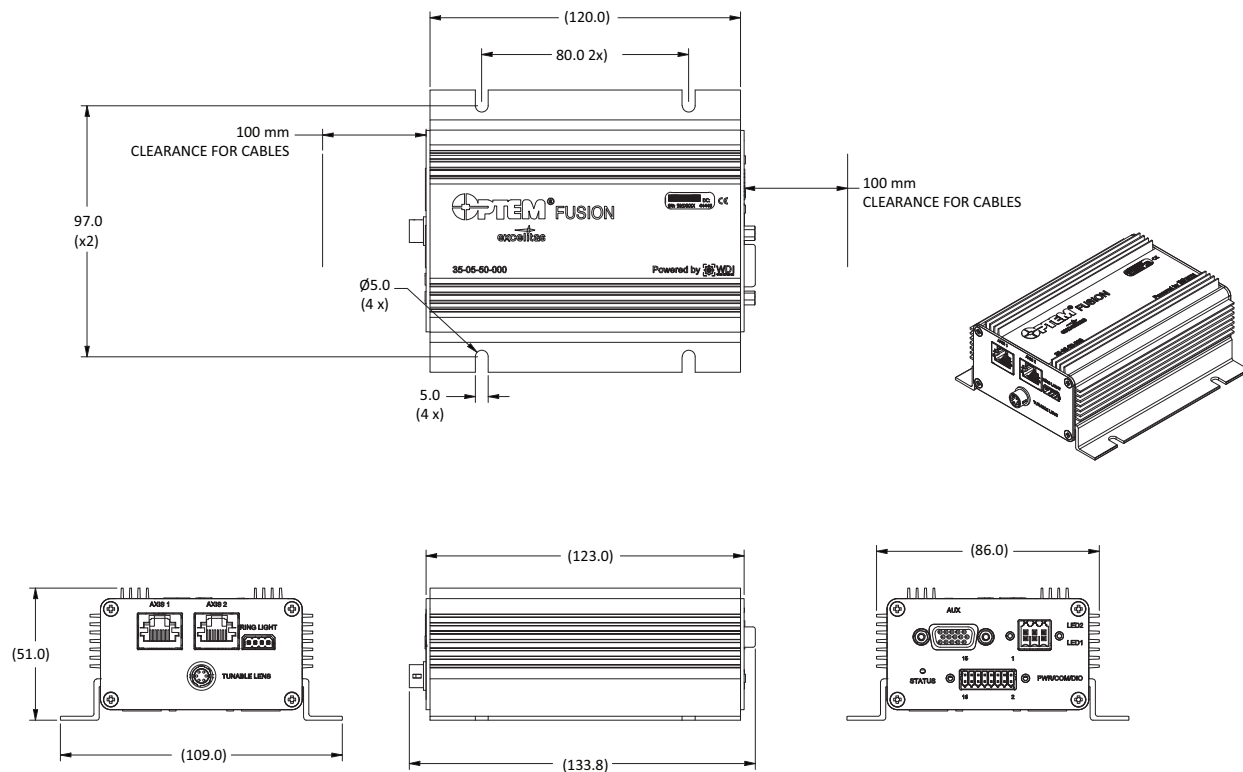


Figure 14 Optem® FUSION System Controller Dimensions

Environmental Specifications

Excelitas takes no responsibility for poor performance or malfunction of the system if the conditions described in this section are not met.

The Optem® FUSION System Controller is intended to be operated and stored under the following conditions:

- 1) In a non-corrosive clean room, laboratory, or factory environment having Class 100,000 (ISO8) or better.
- 2) Operating Environment:
 - The modules shall operate and meet all performance requirements in the operating range 10°C to 40°C, and a humidity range of 10% to 75% non-condensing.
- 3) Non-Operating (Storage) Environment:
 - The modules shall meet all performance requirements after being stored in the non-operating environment from 0°C to 45°C.
- 4) Non-Operating (Transport) Environment:
 - The modules shall meet all performance requirements after being transported in the non-operating environment from -25°C to 70°C. Devices shall not be stored in this range for an extended period of time.

NOTE: *Do not power the Optem® FUSION System Controller until it reaches working temperature.*

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