SPI Lasers

redPOWER

redPOWER

FiberView Control Unit

FVCU

Instructions for Use

Safety Notes

This FiberView Control Unit (FVCU) does not in itself present a hazard but may be used to control **redPOWER** PRISM Fiber Lasers which are potential hazards.

The safety information provided in the Instructions for Use for **redPOWER** PRISM Fiber Lasers must be observed.

Throughout these Instructions for Use warning messages are given in contexts in which a hazard may occur.

General Hazard Information

WARNING: Ensure that all Users are fully aware of all safety implications identified in these Instructions for Use before attempting to install, operate or maintain this FVCU.

WARNING: This FVCU has no safety control functionality and as such all safety functionality, including electrical and laser safety functionality, is the responsibility of the Laser Integrator.

WARNING: Attempts to modify or alter this FVCU or the use of controls or adjustments or performance of procedures other than those specified in these Instructions for Use may render this FVCU unsafe.

Attempts to modify or alter this FVCU or the use of controls or adjustments or performance of procedures other than those specified in these Instructions for Use additionally will invalidate the warranty and may result in patent infringement.

Laser Integrators are not authorized to modify this FVCU.

Electrical Hazard Information

CAUTION: This FVCU must be grounded for safety and to comply with regional electrical codes.

Failure to do so may result in incorrect operation of the FVCU.

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FIGURES

TABLES

1 Structure and Scope of these Instructions for Use

These Instructions for Use for SPI Lasers' **redPOWER®** FiberView Control Unit (FVCU) contain all the information that Users needs to know for its safe and efficient use. This information is important. These Instructions for Use should be read before installing and using the FVCU and made available for reference at the location where the FVCU is being used. Additional or replacement copies are available from SPI Lasers.

These Instructions for Use are divided into the sections below which provide Users with health and safety information before introducing the FVCU and then guiding them through its installation, operation, maintenance and disposal. Lastly it provides other useful information and the FVCU's specifications.

1 Structure and Scope of these Instructions for Use
2 Definition of Symbols and Terms
3 Health and Safety
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5 **redPOWER** FVCU Tour
6 Getting Started
7 Installation
8 Operating Instructions
9 The FVCU and FIberView for Laser Control
10 Basic Control Using Serial Communication
11 Machine Interface Reference
12 Alarm and Warning Messages
13 Maintenance
14 Disposal
15 Specifications
16 General Information
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18 Customer Service

The FVCUs covered by these Instructions for Use have order codes:

$$\text{SP - FVCU - } \begin{matrix}\mathbf{1}\\\mathbf{4}\end{matrix}$$

The order code can be found on a label on the front panel of the FVCU. The last digit indicates whether the FVCU can control one (1), or from one to four (4) PRISM Fiber Laser Modules.

2 Definition of Symbols and Terms

This general warning symbol emphasizes important information needed during installation and operation

This symbol identifies the protective conductor terminal (ground point)

WARNING:	Indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury
	Warnings must be observed to prevent personal injury to yourself and others.
CAUTION:	Indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury
	Cautions must be observed to prevent personal injury and damage to or destruction of equipment or loss of operational effectiveness.
FVCU:	FVCU as used herein means the item that was procured from SPI Lasers.
	This FVCU is not a consumer product and is not to be sold on or made available as such.
Laser Integrator:	Any person, company or organisation who integrates this FVCU into equipment, or any person, company or organisation who uses this FVCU in the form as supplied by SPI Lasers.
	A Laser Integrator is skilled in and understands the integration issues surrounding the use, design and supply of laser products to end users in the end markets which it supplies.
User:	Individuals or organizations that use this FVCU. User includes the Laser Integrator and the end user
Authorised Personnel:	Those who have attended official Training Courses and have been certified as competent.
SPI Lasers:	SPI Lasers UK Ltd.

3 Health and Safety

3.1 General

This section gives information on the hazards which may be encountered during installation, operation and maintenance of this FVCU and steps to reduce the risk. Also included is information on laser and electrical safety compliance. All safety instructions, including those in the Safety Notes and those in other sections of these Instructions for Use, must be followed. Not following safety instructions may constitute a hazard to Users and third parties or cause damage to property and the FVCU.

Only Authorised Personnel who have been instructed in, and fully understand, the necessary safety procedures should operate this FVCU. Access must be restricted to Authorised Personnel.

Any local safety requirements for the operation of this equipment must be complied with.

Throughout the documentation, '**WARNING**', and '**CAUTION**' paragraphs appear. It is the responsibility and duty of all Users who operate and maintain this equipment to fully understand the **WARNING** and **CAUTION** and act in order to reduce or eliminate hazards.

3.2 Intended Use of the FVCU

This FVCU has been designed exclusively for incorporation or integration into other equipment for controlling from one to four SPI **redPOWER** PRISM Fiber Lasers.

Operating the device within the limits of its designated use requires the user to:

- observe the instructions set out in these Instructions for Use and in the PRISM Fiber Lasers Instructions for Use
- install and use this FVCU in compliance with international, national and local regulations regarding laser safety, for example IEC/EN 60825-1 and 21 CFR 1040.10.
- install and use this FVCU in compliance with international, national and local regulations regarding the safety of electrical equipment, for example BS EN 60204
- wire and connect the electrical lines to this FVCU in compliance with international, national and local regulations regarding electromagnetic compatibility (EMC), for example the relevant sections of IEC/EN 61000 and FCC CFR47
- not move this FVCU when it is switched on
- carry out necessary inspection and maintenance work

This FVCU is not intended for controlling lasers other than SPI **redPOWER** PRISM Fiber Lasers.

SPI Lasers cannot be held liable for any damage resulting from use other than the intended use. The risk lies entirely with the User.

3.3 Hazards

3.3.1 Laser Hazards

This FiberView Control Unit (FVCU) does not in itself present a hazard but may be used to control **redPOWER** PRISM Fiber Lasers which are potential hazards.

The safety information provided in the Instructions for Use for **redPOWER** PRISM Fiber Lasers must be observed.

3.4 Compliance

Within the EU, the FVCU is CE marked and is supplied with a Declaration of Conformity. The standards which SPI Lasers declares that the FVCU is in conformity with, and the directives which SPI Lasers declares that the FVCU complies with the requirements of are listed in the Declaration of Conformity.

Within the USA, the FVCU is shipped with an appropriately completed FDA 2877 form.

It is the responsibility of the Laser Integrator to ensure that the integrated laser system conforms with the appropriate standards and complies with the appropriate directives. Nonetheless, many of the electronic and labelling requirements have been incorporated into the FVCU to facilitate compliance.

3.4.1 Europe: WEEE Directive

Figure 1 WEEE Symbol

This symbol indicates that, at end of life, this FVCU should be separately collected from unsorted waste.

3.4.2 Europe: RoHS Directive

This FVCU is in conformity with European RoHS Directive. Compliance is demonstrated through conformance with this standard which is harmonised to the RoHS directive:

- BS EN 50581:2012

3.4.3 Europe: EMC Directive

This FVCU falls outside the scope of the EMC Directive as it is intended exclusively for an industrial assembly operation for incorporation into other apparatus. However SPI Lasers recognises that Laser Integrators may require the integrated laser system to comply with the directive. SPI Lasers has therefore designed for compliance to parts of the standards listed below which are harmonised to the EMC Directive:

- BS EN 50370-1:2005
- BS EN 55011:2009+A1:2010..

3.4.4 USA: CFR Title 47, Federal Communications Commission

This FVCU is designed for compliance with:

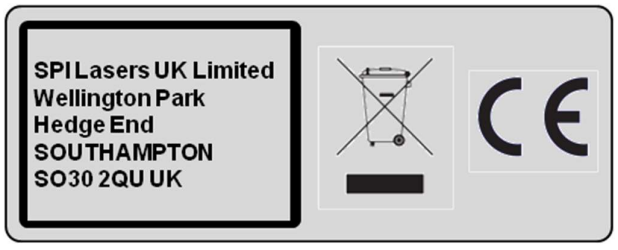
- FCC CFR47: §15.109 Radiated emission limits.

3.5 Labelling

Labels are placed on the rear panel of the FVCU to warn of potential hazards and to provide other useful information.

Table 1 below shows the labels and give their locations.

Table 1 Safety, Explanatory and Compliance and Information Labels

Protective conductor terminal indicator	
Identification	
Address, WEEE and CE label	

4 Document References

Document number	Description
FS-S00131	PRISM Rack Fiber Laser Installation Drawing
SM-S00482	PRISM Fiber Laser Serial Interface Manual
SM-S00499	**redPOWER** Fiber Laser Serial Communications Protocol

These documents may be downloaded by going to 'Customer Login' at the top right of SPI Lasers' home page: www.spilasers.com.

5 redPOWER FVCU Tour

The **redPOWER** FVCU builds on many years of experience of SPI Lasers in designing, developing and supplying control systems for fiber lasers into a wide range of industrial laser processing applications. It gives laser integrators the capability to control fiber lasers in industrial laser machines with maximum output power levels from 300W up to many kilowatts.

5.1 Key Features

The FVCU allows the individual PRISM FL modules to be controlled as a single Fiber Laser either by using the Laser Integrator's interface or by using SPI Laser's FiberView software. The FVCU also takes the inputs from the sensors in the PRISM HPC Module and the individual PRISM FL modules and generates alarm and warning signals and also the pierce detection signal.

- **Pulse Shaping**

  An integrated pulse generator in the FVCU allows precise and accurate control of the laser power over time. When cutting complex features, this allows fine control of laser power. When welding and additive manufacturing, control of the power throughout the process, but particularly at the start and end, can produce dramatic improvements in the quality of the finished part. For example, this can be very evident when welding crack sensitive aluminium alloys, where a controlled cooling of the melt pool will reduce occurrence of cracks and leave a much stronger weld.

  Within the FVCU Parameter Sets are used to define the desired energy output. The FVCU can store up to 50 Parameter Sets in its onboard memory for fast access when switching between Parameter Sets during processing. The Parameter Editor will set up the desired repetition rate, peak power and pulse length, choosing from a library of pulse shapes and waveforms. However, any arbitrary pulse shape can be defined using the Shape Editor. The Shape Editor works graphically to produce and edit dimensionless shapes that are then saved as a particular User Defined pulse shape. This pulse shape can be used in any parameter set, where it is scaled to the peak power and pulse width associated with that pulse shape.

- **Process Cycles**

  Process Cycles are an automation feature implemented in the FVCU that can dramatically reduce the load and complexity needed for the system controller, by transferring a number of control functions directly to the laser controller. They allow a programmed sequence of Parameter Sets to be output using minimal input to control an entire process sequence, for example when a single part has to be processed with different types of spot and seam welds at different positions around the part. Process Cycles are constructed from one or more elements known as Steps. Each Step holds a Parameter Set reference and control

attributes. A Process Cycle can be programmed to execute fully automatically from start to finish, or to require a simple external trigger input / serial command to change between programmed Steps, or any combination of automatic and manual control.

The FVCU has the capacity to store up to 1000 steps which can be grouped into up to 50 Process Cycles. The Process steps can be given meaningful names when being stored within the laser.

- **Pierce Detection**

Pierce detection is an aid in cutting processes. The back reflected light from the work piece is detected in an High Power Combiner (HPC) Module and interpreted to determine when the work piece has been fully pierced. Completion of the pierce is signalled by a output on the Machine Interface and in the FiberView control software. An HPC module is required to implement this feature.

As different materials and processes have different back reflections, the feedback from different process will vary. Therefore a set of configuration parameters are made available to the Laser Integrator in order for them to hone their process.

- **Machine Interface**

The Machine Interface allows total operational integration of the laser into a production line or cell. Options include Power Control, Parameter Selection and Alarm Reporting. The function of each of the seven input and seven output signal lines can be configured by the user. See Section 7.5.6. for more details.

- **Indicators**

Coloured LED indicators are fitted to the front panel to show whether there is DC power, the state of the PRISM Fiber Laser – one of the six states: OFF, STARTING, STANDBY, RAMPING UP, ON or RAMPING DOWN, and whether there is an alarm or warning.

- Power (white, marked '~')

  Indicator is lit if DC power is connected.

- Emission Indicator (yellow, marked with laser warning triangle)

  Indicator is flashing if the PRISM Fiber Laser is in the STARTING state.

  Indicator is lit if the PRISM Fiber Laser is in the STANDBY, RAMPING UP, ON or RAMPING DOWN state.

  Indicator is not lit if the PRISM Fiber Laser is in the OFF state.

- Fault (red, marked '?')

  Indicator is flashing if there is an Alarm condition. The PRISM Fiber Laser will be in the OFF state

  Indicator is lit if there is an active Warning.

  Indicator is not lit when there are no alarms or warnings present.

5.2 Software Tools

SPI Lasers' Graphical User Interface, FiberView, allows Users to control this FVCU over a serial interface. Operation of the FVCU using FiberView is described in Section 9.

6 Getting Started

6.1 Receiving and Inspection

Before installing or operating this FVCU, you should:

- Inspect the shipping container for damage
- Inspect the FVCU for signs of damage
- Confirm that the shipping carton contains all items on the shipping inventory list

Retain all packaging materials until the FVCU has been commissioned. If anything is missing or defective contact SPI Lasers. See Section 16 for contact details.

6.2 Unpacking and Handling

To avoid the risk of personal injury or damage to the FVCU when lifting or moving, follow good manual handling practice.

Figure 2 FVCU in Packing Case

1. Open the packing case and open up the flaps.
2. Remove the FVCU with the foam packing pieces.
3. Remove the cables.
4. Remove the foam packing pieces from the FVCU. Put the packing pieces into the empty packing case and store for future use.

7 Installation

7.1 Safety and Compliance During Installation

Before installation reference should be made to Section 3 regarding laser safety, electrical safety, EMC and compliance. When installed, the FVCU, the PRISM Fiber Laser and the additional equipment required to operate them should not obstruct access to safety devices or impair their operation.

It is recommended that installation is done in the sequence of the following sections, with water connections to the PRISM Fiber Lasers made and checked before electrical connections are made.

7.2 Location and Environment

This FVCU is designed for operation within the environment specified in Table 14. Operating the FVCU beyond the limits of the environmental specification may lead to accelerated component ageing and performance degradation.

This FVCU must not be installed in a corrosive atmosphere. The FVCU must not be exposed to high levels of optical radiation, for instance radiation from materials processing.

This FVCU is sealed against dust and water ingress to IP52 to BS EN 60529:1992+A2:2013 with the exception of the electrical connectors which are rated IP50. The laser integrator should ensure that when installed the FVCU is not likely to be exposed to water, for instance from coolant leaks.

At least 120mm clear space must be provided behind the FVCU to allow the electrical cables to be routed correctly.

7.3 Mounting

The total weight of the FVCU is given in Section 15.4. The width of the FVCU enables it to fitted into a standard 19” rack cabinet.

7.4 FiberView Installation

Insert the medium supplied, which has the FiberView software on it, into the computer which will be used to control the FVCU. Run setup.exe. This will install FiberView and necessary support programs.

Note: Check PC setting as follows: Control Panel – Regional & Language Options – Advanced Tab – Language for non-Unicode Programs. Set this to English in drop down box.

Table 2 Laser Integrator Supplied PC – For Operating FiberView

Parameter	Requirement
Operating System:	Windows 7 and above
Minimum Hardware Specification:	Processor 1GHz
-	Hard drive with 250MB free space
	2GB RAM
	CD Drive
	RS-232 Interface Port or RJ45 Network Port Up to 57,600 Baud.
	Minimum screen resolution 1024 x 768
Interconnect cable connections	RS-232:9-pin D-type, Null Modem (Pins connected 2-3, 3-2, 5-5) Ethernet: Cross-over cable for direct connection to PC, Standard cable for LAN connection.
PC settings Control Panel – Regional & Language Options – Advanced Tab – Language for non-Unicode Programs	English

7.5 Electrical Connections

CAUTION: This FVCU must be grounded for safety and to comply with regional electrical codes.

Failure to do so may result in incorrect operation of the FVCU.

For safe operation of the FVCU the electrical connections given in the following sections need to be made. All electrical connections should use cables of the shortest practical length.

For safety, the FVCU must be connected to an external protective earthing system before any other electrical connections are made. The FVCU is not 'hot pluggable': all electrical connectors should be mated and secured in place before power is applied.

All figures in this section indicate the pin positions when looking at the connector on the rear panel of the FVCU.

To operate a PRISM Fiber Laser using this FVCU a power connection must be made to the PRISM FL Module and to the FVCU, and a control connection must be made from the FVCU

to the PRISM FL Module, and a control connection, which can be serial (Ethernet, RS-232 or RS-485) or analogue and logic, must be made to the FVCU.

The connectors mounted on the rear panel of the FVCU, as shown in Figure 3 with connections to a PRISM FL Module, are described in more detail in Table 3.

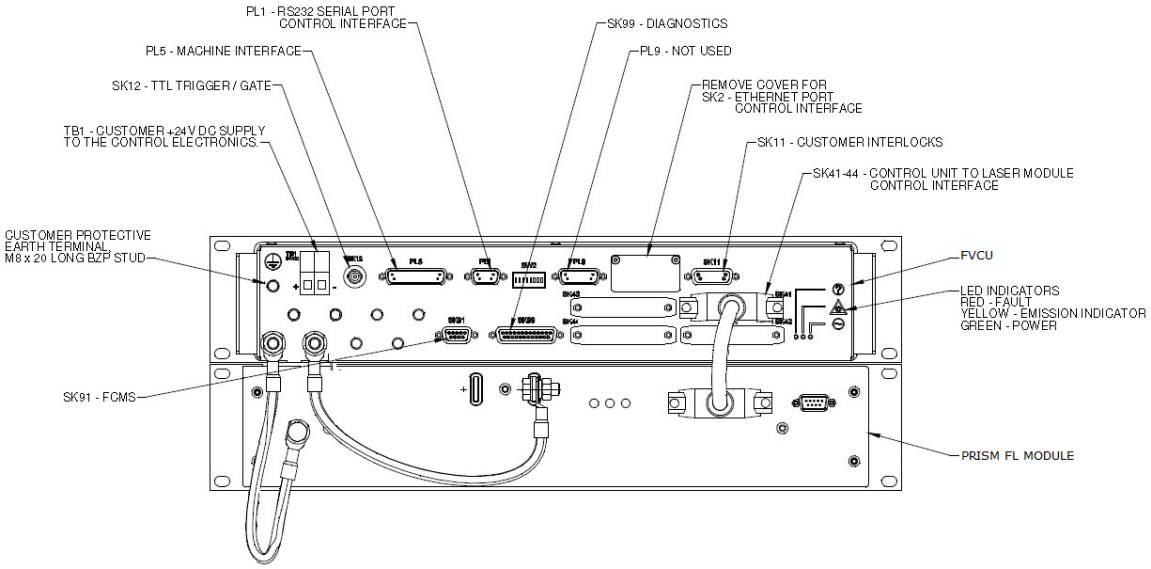


Figure 3 Interface Connectors

Table 3 Interface Connectors

Connector ID	Function	Connector Description	Reference
-	RS-232 and RS-485 (PRISM FL Module)	9-way D-Type male connector	Section 7.5.2
PL1	RS-232 Serial Port Control Interface	9-way D-Type female connector	Section 7.5.4
PL5	Machine Interface	25-way D-Type male connector	Section 7.5.6
PL9	Reserved for future expansion		
SK2	Ethernet	RJ-45	Section 7.5.5
SK11	Software Shutdown	-	Section 7.5.7
SK12	Reserved	-	-
SK41	PRISM FL Module Control Interface	37-way D-type male connector	Section 7.5.3
SK91	Fiber Continuity Monitoring System	9-way D-Type female connector	Section 7.5.8
SK99	SPI Lasers use only	-	-
TB1	Auxiliary Power Supply	Terminal Block	7.5.10
	Protective Conductor (Earth) Terminal	M8 x 20 Stud	Section 7.5.1

7.5.1 Protective Conductor (Earth) Terminal

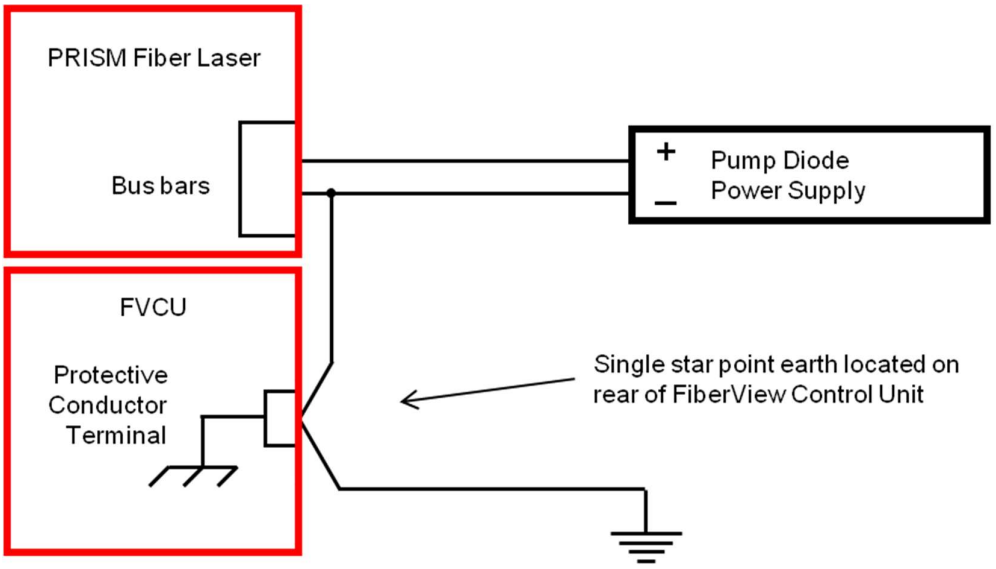


Figure 4 Star Earthing Configuration

The grounding and bonding of the FVCU and PRISM FL Module to a suitable low impedance safety and EMC earth point is necessary to ensure safety in fault conditions and to minimise the effects of electrical noise during normal operation. The FVCU and PRISM FL Module should be connected as shown schematically in Figure 4. The earth connection from the PRISM FL Module to the FVCU should be as short as possible. A longer, missing or incorrect earth connection will increase susceptibility to electrical noise and could impair proper operation.

The protective conductor shall support the maximum short-circuit current of the pump diode PSU.

7.5.2 PRISM FL Module RS-232 and RS-485

The individual RS-232 and RS-485 connector on the PRISM FL Module should not be used when it is controlled by the FVCU.

7.5.3 PRISM FL Module User Interface

The FVCU is supplied with a 1.5m long, 37 way cable to connect to the PRISM FL Module.

7.5.4 PL1 – Serial Port Control Interface

A cable with standard 9-way D-plug is used to connect the FVCU to the system controller or a PC. The interface operates with signal levels defined by the RS-232 specification. The pin-out is shown in Table 4.

Table 4 Serial Port Connections

Pin	RS-232 Connections
2	Receive Data input (RX)
3	Transmit Data Output (TX)
5	Ground

Pin connections are 2-3, 3-2, 5-5, with no other connections necessary. If connection is made directly from a PC to the FVCU a crossover (NULL MODEM) cable should be used

RS-232 is the preferred standard. If longer cable runs are required than allowed for by the RS-232 standard, then an RS-232 to RS-422 converter can be used, but this will be the responsibility of the user.

7.5.5 SK2 - Ethernet

The Ethernet port can be used to connect the FVCU to a LAN or the network port on a single computer. The port uses standard RJ45 connectors. A standard straight through cable is required for connection to a LAN. For direct connection to a PC a cross-over cable needs to be used if the PC network card doesn't support auto cross over detection.

7.5.6 PL5 – Machine Interface

The Machine Interface connection is made through PL5 at the rear of the FVCU, via a 25 way D-Type Plug (male). It consists of seven inputs and seven outputs. Each input/output can be software configured to perform a specific function selected from a list of available functions. The default configuration should be suitable for the majority of applications, but the configurable flexibility allows Laser Integrators to tailor the interface to their application if required.

To prevent operational problems caused by earth loops, the Machine Interface I/O hardware is opto-isolated and requires an external 24V supply, connected as described in section 7.5.6.1, in order for the outputs to function. The configured output functionality is available in both Local and Remote operating modes, although the Machine Interface must be provided with 24V to power the opto-isolation.

Some of the functionality for the input/output is multiplexed depending on the processing mode, for example; the **Laser ON** / **Process Cycle Start** changes functionality depending on whether the FVCU is processing in parameter sets or process cycle mode.

Please read all of this section before using the Machine Interface to be familiar with all its operation.

7.5.6.1 Machine Interface Supply

The Machine Interface must be powered by a power supply in range of +15 to +30V (typically +24V) capable of delivering 200mA. Power is provided by connecting the external supply between PEXT and GNDEXT on the pin allocations shown in Table 5. Two PEXT and GNDEXT connections are provided for convenience. Each pair is linked internally, and normally only one of the pair needs to be connected to the external supply. Nominal load for each input is 5mA. The maximum current capability of each output is 50mA.

7.5.6.2 Default Configuration

Table 5 below shows the default functions for each pin connection on PL5.

Note: the functionality of IN0 – IN6 and also OUT0 – OUT6 can be re-configured using the FiberView control software.

The External Trigger Input (IN6 in default setting) can be reprogrammed similarly to the other Inputs. However, if a Trigger input is required it is recommended to use Pin 16 as the hardware behind this connection is optimised.

The Machine Interface optimised Trigger (IN6) can operate at up to 50kHz. At the maximum frequency the control system will accommodate up to a 50% duty cycle comfortably. However, if one of the other inputs (IN0 – IN5) is used, there will be a maximum operating frequency of 4.7kHz for a 50% duty cycle, beyond which input edges may be missed. This maximum frequency will increase slightly as the duty cycle is reduced.

Note: Do not assign **Laser ON** function (ID2, Table 5) to Trigger Input Pin 16 due to the high speed nature of this input potentially causing internal timing conflicts.

Table 5 PL5 Machine Interface Pin Out

PIN #	I/O	PIN NAME	DEFAULT FUNCTION
1	PEXT	PEXT	External 24 V DC
2	PEXT	PEXT	External 24 V DC
3	I	IN0	**Laser Start**
4	I	IN1	**Laser ON / Process Cycle Start**
5	I	IN3	Unused
6	I	IN5	Unused
7	O	OUT1	**Laser ON / Process Cycle Active**
8	O	OUT3	**Alarm Status**
9	O	OUT5	Unused
10	O	AOUT	Laser Power Analogue Feedback

PIN #	I/O	PIN NAME	DEFAULT FUNCTION
11	AI	AIN+	Analogue Input Demand Positive
12	-	-	-
13	I	COMMON	Digital Input Common Return path
14	GNDEXT	GNDEXT	External 0 V DC
15	GNDEXT	GNDEXT	External 0 V DC
16	I	IN6	Trigger Input (Recommended)
17	I	IN2	**Process Cycle Step**
18	I	IN4	**Alarm Reset**
19	O	OUT0	**Laser STANDBY**
20	O	OUT2	Remote Status
21	O	OUT4	Warning
22	O	OUT6	**Process Cycle Wait**
23	GNDEXT	GNDEXT	External 0 V DC
24	AI	AIN-	Analogue Input Negative
25	-	-	-

Note:

- The two PEXT 24V DC input connections are linked together internally. There is no preference for connecting the 24V DC supply, and it is not necessary to use both.
- The three GND EXT 0V DC input connections are linked together internally. There is no preference for connecting the 0V DC supply, and it is not necessary to use all three.

7.5.6.3 Connection Configurations

The Machine Interface inputs and outputs are provided as sourcing only. Figure 5 below shows the configuration and connection method.

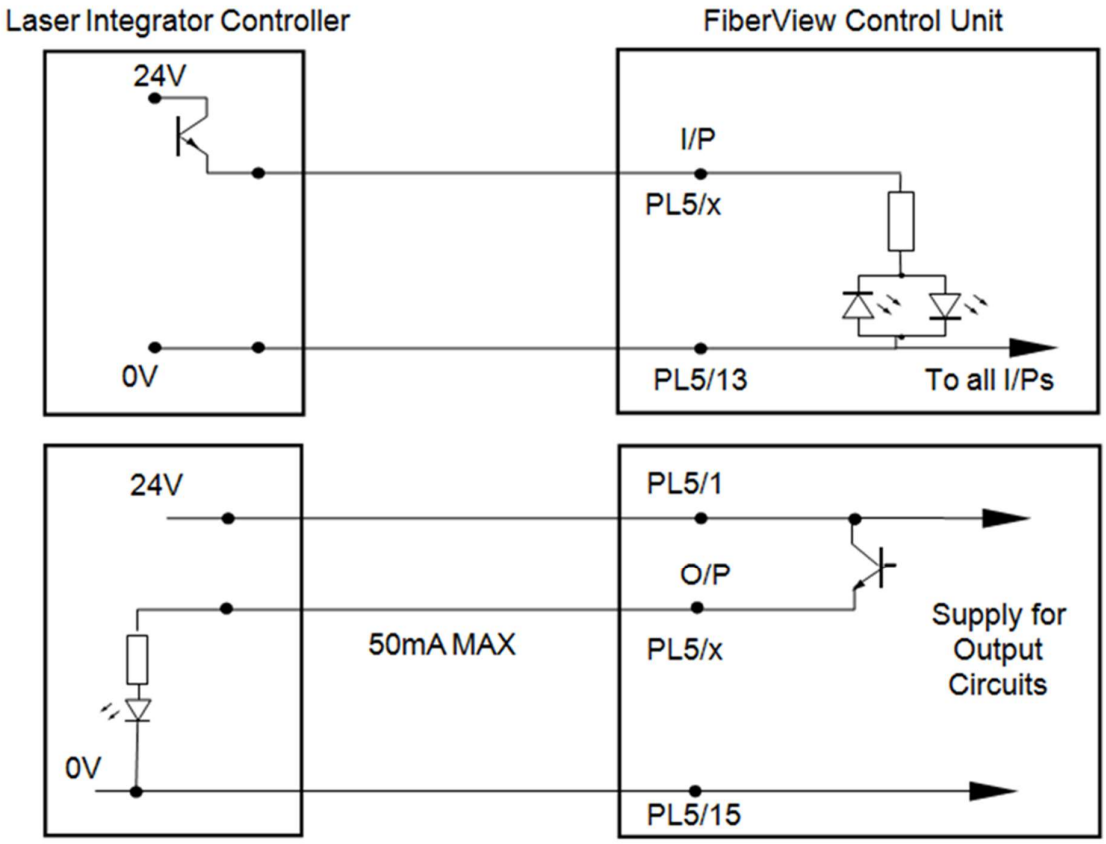


Figure 5 Machine Interface Connections Circuits

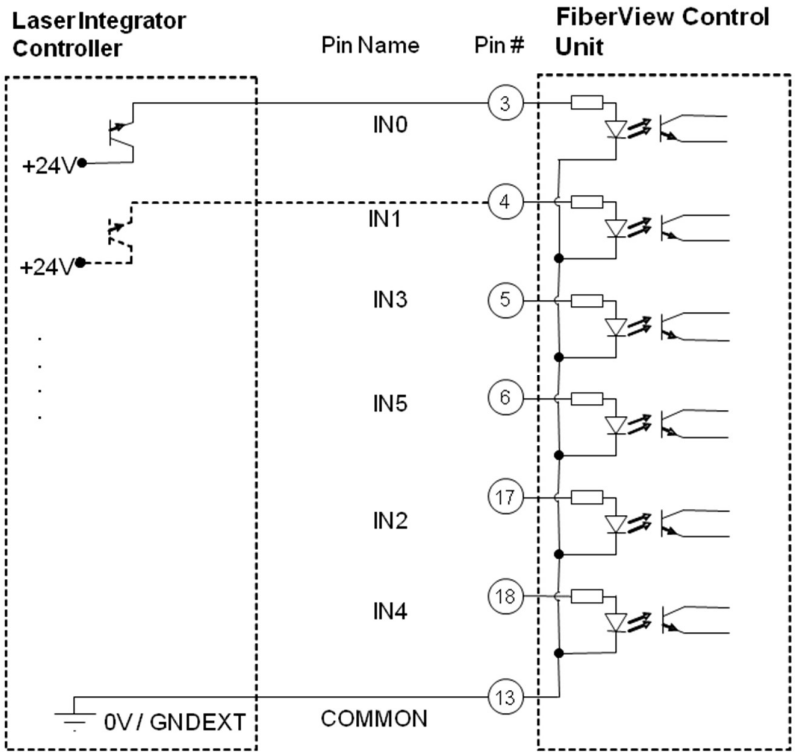


Figure 6 PL5 Programmable Inputs

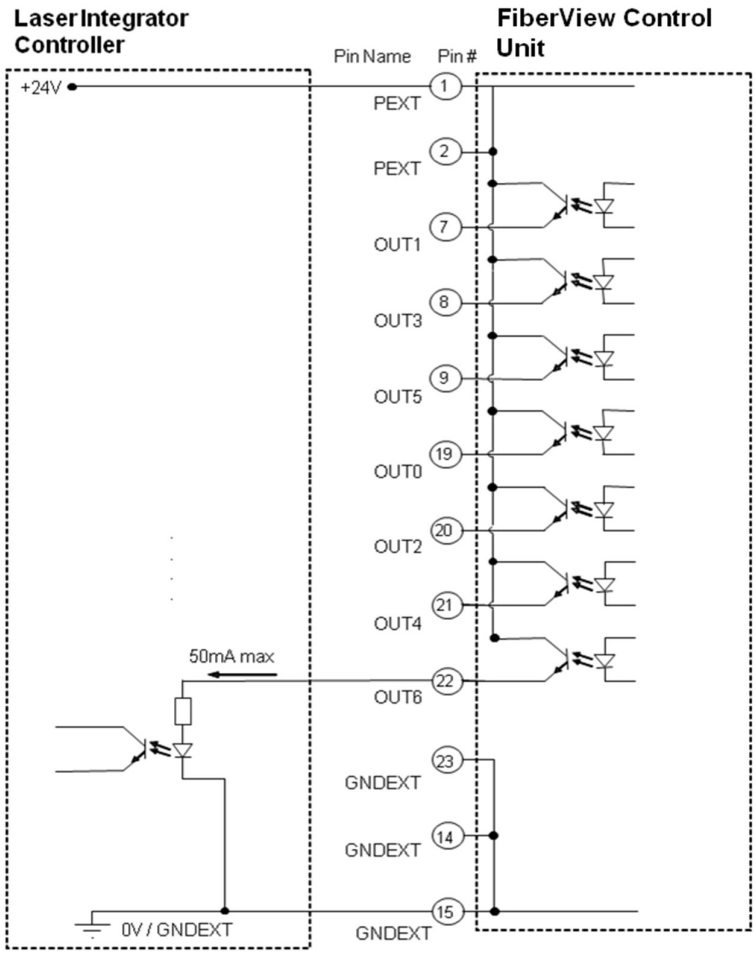


Figure 7 PL5 Programmable Outputs

7.5.6.4 Basic Operation

With the basic connections above, supplying 24V to the inputs will assert them.

In order for the FVCU to be fully controlled through the Machine Interface it is necessary to put it in Remote Control mode via FiberView. This is done by clicking on the control button (silhouette of a Man) on the main FiberView toolbar, which turns into a Cog to indicate that Remote Control is selected. The control status indicator on FiberView will turn red, and the text alongside it will change to REMOTE.

The necessary connections (based on the default configuration) to start using the FVCU in Remote Control mode are:

Laser Start (IN0, Pin 3)

This takes the FVCU from the OFF state to the STANDBY (ready) state.

- If this input is clear when entering Remote Control and the FVCU is in the ON state, the FVCU will go to the OFF state.
- If this input is set when entering Remote Control and the FVCU is in the ON state, it will remain switched to STANDBY.
- Clearing this input while in Remote Control will put the FVCU in the OFF state.

However, if this function is un-configured from the Machine Interface, the FVCU can be started using serial communications or FiberView in Remote or Local Control mode. The Machine Interface would then be used for the **Laser ON** command.

Laser ON (IN1, Pin 4)

This takes the FVCU from the STANDBY state to the ON state. A positive edge is required for this input to act. If the FVCU is not in the STANDBY state the input is ignored.

- If the FVCU is in the ON state, and is put into Remote Control with IN0 set and IN1 set, the state will remain the ON state.

Trigger Source Select

This needs to be defined for one of the Inputs and set to select external Trigger. If it is clear, the internal Trigger will be used. When using external Trigger exclusively, this input needs to be held high continuously. If this function is not defined on the Machine Interface the active parameter set setting is used.

7.5.6.5 Laser Control Inputs

The FVCU can be controlled in Remote Mode by using the inputs on the Machine Interface. Ensure Remote Control Status is true before using any of the inputs. Connection details are shown in Table 5.

Table 6 shows the full list of functions that can be configured to apply to any of IN0-IN6.

Table 6 Laser Inputs

ID	Input Function Description	Notes
0	Not supported	
1	Laser Start	In Remote Control state: False: Takes the FVCU to OFF True: Takes the FVCU from OFF to STANDBY
2	Laser ON / Process Cycle Start	False: Sets FVCU to STANDBY or stops a defined process cycle True: Sets FVCU to ON or starts a defined process cycle (if laser already in STANDBY)

ID	Input Function Description	Notes
3	Trigger / Gate Input Recommended Configuration: Use Input 6.	False: No laser Output. True: Gated Mode: Laser output. Triggered Mode: Laser pulse on rising edge.
4	Trigger Source Select (Internal / External)	False: FVCU runs at pulse rate defined by internal parameters. True: FVCU is Triggered or gated by Trigger Input
5	Process Cycle Step	Advances to next process step on rising edge.
6	Alarm Reset	Resets Alarm condition on rising edge.
7	Strobe	Read parameter set / process cycle data (ID8-ID14) on rising edge.
8	Parameter Set / Process Cycle Select (Bit 0)	Parameter set or Process cycle can be selected using these inputs. Only operational in Remote Control.
9	Parameter Set / Process Cycle Select (Bit 1)	
10	Parameter Set / Process Cycle Select (Bit 2)	
11	Parameter Set / Process Cycle Select (Bit 3)	
12	Parameter Set / Process Cycle Select (Bit 4)	
13	Parameter Set / Process Cycle Select (Bit 5)	
14	Alignment Laser Demand	
15	Scanner Start Input	
16	Safe Mode Recovery Start	
17	Not supported	
18	Low Power Mode Enable	

7.5.6.6 Status Outputs

Status outputs are provided at the Machine Interface. Connection details are shown in Figure 5. Table 7 shows the full list of functions that can be configured to apply to any of OUT0 - OUT6 as shown in Table 5.

Table 7 Laser Status Outputs

ID	Output Function Description	Notes
0	Not supported	Not supported
1	Laser STANDBY	False: FVCU OFF or ON True: FVCU in STANDBY
2	Laser ON / Process Cycle Active	False: FVCU OFF/STANDBY or Process Cycle Stopped True: FVCU ON or Process Cycle Running
3	Remote Control Status	False: LOCAL control Mode True: Remote Control Mode
4	Sync	Synchronised True with duration of laser pulsing.
5	Process Cycle Wait	False: Process cycle running or in Autostep mode. True: Waiting for Process Cycle Step input
6	Processing Mode	False: Normal Mode True: Process Cycles Mode
7	Alarm	False: Alarm not present True: Alarm present
8	Warning	False: Warning not present True: Warning present
9	Not supported	
10	Acknowledge	False: Data not accepted or strobe off True: Data accepted
11	Parameter Set / Process Cycle Selected (Bit 0)	Provides monitor output to confirm parameter set or process cycle selected
12	Parameter Set / Process Cycle Selected (Bit 1)	
13	Parameter Set / Process Cycle Selected (Bit 2)	
14	Parameter Set / Process Cycle Selected (Bit 3)	
15	Parameter Set / Process Cycle Selected (Bit 4)	

ID	Output Function Description	Notes
16	Parameter Set / Process Cycle Selected (Bit 5)	
17	Scanner Start Output	
18	Ready To Start	Connected with no alarms
19	Emission Indicator	
20	Not supported	
21	Safe Mode Recovery Active	
22	Not supported	
23	Not Supported	
24	Not supported	
25	Not Supported	
26	Back reflection warning	True: Back reflection signal above warning level. False: Back reflection signal below warning level.
27	Burn Back / Safe Mode detected	True: Condition detected False: Condition not detected.
28	Laser Over Temperature	True: One of monitored temperatures above Alarm level.
29	Back Reflection Alarm	True: Back reflection signal above alarm level. False: Back reflection signal below alarm level.
30	Not Supported	
31	Not Supported	
32 - 41	Process Cycle Active Step (Bits 0 - 9)	
42	Pierce Detect Flag	True: Completion of pierce detected. False: Completion of pierce not detected.
43	Low Power Mode Enabled	

7.5.6.7 Analogue Input

The waveform applied between Pins 11 and 24 can be used to control the demanded output power. This is referred to as External Power Control (EPC). The Machine Interface needs to have an external power supply connected between Pins 1 or 2 and 14 or 15 for this function to operate. The active pulse shape must also be set into EPC mode using FiberView. (Refer to Section 9.3.7.)

There are two modes for this function:

Absolute Mode: A signal level between 0V and 10V will linearly control the demand level of the active pulse shape between 0% and 100% of the overall demand level.

Relative Mode: A signal level between 0V and 10V will linearly control the demand level of the active pulse shape between 0% and 100% of the set demand level for that pulse shape.

7.5.6.8 Analogue Output

The output on Pin 10 can be used to remotely monitor the output power. This signal is calibrated linearly from 0V to 10V, to read 10V for the rated output power of the FVCU.

The Machine Interface needs to have an external power supply connected for this function to operate.

This signal is either the CW power when in CW mode or a time averaged value when in modulated mode. It is the same value as displayed on the power meter panel of FiberView.

7.5.6.9 Diagnostic Outputs

Diagnostic outputs are grouped into the following:

- Alarms, which stop operation.
- Warnings, which indicate a problem but allow continued operation.

The presence of an alarm or warning is indicated by the transition of the ‘Alarm Status’ or ‘Warning Status’ output from false to true.

Alarm status will remain present until the alarm has been manually reset.

Warning status will remain present until the condition causing the warning has cleared. This may not require manual intervention.

The actual alarm or warning codes can be read remotely, if required, using the Serial Interface.

7.5.7 SK11 – Software Shutdown

For correct operation, the plug supplied fitted into SK11 must not be removed.

7.5.8 SK91 – Fiber Continuity Monitoring System

Warning: The FVCU does not control the pump power supply and has no safety functionality to de-energise or control the pump diodes or the output power.

Failure to provide external safety functionality may result in exposure to harmful levels of radiation

For correct operation, the FCMS monitoring link plug (part number PS-A01980), when supplied with the laser, must be fitted into SK91 and must not be removed.

If FCMS monitoring link plug (part number PS-A01980) has not been supplied, the following instructions must be carried out.

7.5.8.1 Instructions to make FCMS monitoring link plug

It is the responsibility of the Laser Integrator to provide an integrator safety circuit, constructed from components approved to the relevant standards, to make certain that electrical power is removed to ensure laser safety. It is understood that this will be done in a manner certified to the required national and international laws, rules, statutes and standards. This safety circuit must only allow the PRISM FL Module controlled by the FVCU to be enabled when the industrial laser machine into which the FVCU is incorporated is in a state safe for laser emission. It must disable the PRISM FL Module to make the industrial laser machine safe both as required in normal operation and after activation of the E-Stop System.

The integrator safety circuit must include the Fiber Continuity Monitoring System (FCMS) such that if there is no continuity between the FCMS pins the PRISM FL Module is disabled and the industrial laser machine is put in a safe state.

All applicable safety requirements for the intended market must be met prior to allowing the FVCU to enter service as part of an integrated laser system.

SK91 is a 9 way D-type socket which provides access to the fiber continuity monitoring system (FCMS) and BDO over temperature functions incorporated in the PIPA-Q optical connector, BDO. With appropriate monitoring, a fiber break or cable severance, an unmated connector or optical connector over temperature condition can be detected and used to shut down the FVCU. The monitoring and shut down circuits are not included in the FVCU.

The resistance of the circuit depends on the BDO length and is minimum 3, typically 4.5 and maximum 6 ohms per metre. The circuit is insulated from earth (ground) and is only suitable for SELV circuits, maximum 25V AC or 60V DC. The minimum recommended voltage is 5V and minimum current is 10mA, to ensure reliable operation of the temperature switches. The maximum permissible current is 50mA.

Table 8 BDO Integrity Circuit Connections (When Option Specified)

Pin №	I/O	Description
1	-	FCMS
2	-	
3	-	FCMS
4	-	
5	-	
6	-	Must be linked to pin 8
7	-	
8	-	Must be linked to pin 6
9	-	

7.5.9 SK99 – Service Monitor

SK-99 is provided for use by SPI Lasers service personnel only.

7.5.10 TB1 – Auxiliary Power Supply

The 24V DC Auxiliary Power Supply connection is a terminal block. The terminals accept wire of 0.5 mm² - 16 mm², AWG 20 – 6.

7.5.11 Minimum Interface Connections

The minimum hardware connections needed to operate a PRISM FL Module are shown in Table 9.

Table 9 Minimum Interface Connection

PL/SK	PIN #	I/O	FUNCTION
Required for Remote Operation (Default Pin Configuration)			
PL5	1/2	PEXT	External 24Vdc
PL5	14/15	GNDEXT	External 0Vdc
PL5	4	I	**Laser ON**
PL5	3	I	**Laser Start**

A serial interface is also required: either RS-232 on PL1 or Ethernet on SK2).

The serial interface should be connected to a PC which has FiberView software installed.

7.5.12 Connection to Interlock and E-Stop System

WARNING: The FVCU does not control the pump power supply and has no safety functionality to de-energise or control the pump diodes or the output power.

Failure to provide external safety functionality may result in exposure to harmful levels of radiation

It is the responsibility of the Laser Integrator to provide an integrator safety circuit, constructed from components approved to the relevant standards, to make certain that electrical power is removed to ensure laser safety. It is understood that this will be done in a manner certified to the required national and international laws, rules, statutes and standards. This safety circuit must only allow the PRISM FL Module controlled by the FVCU to be enabled when the industrial laser machine into which the FVCU is incorporated is in a state safe for laser emission. It must disable the PRISM FL Module to make the industrial laser machine safe both as required in normal operation and after activation of the E-Stop System.

The integrator safety circuit must include the FCMS such that if there is no continuity between the FCMS pins on SK91 the PRISM FL Module is disabled and the industrial laser machine is put in a safe state.

All applicable safety requirements for the intended market must be met prior to allowing the FVCU to enter service as part of an integrated laser system.

8 Operating Instructions

WARNING: Follow the procedures and instructions described in the following section.

Failure to do so may lead to harmful radiation exposure resulting in personal injury and damage to the equipment.

This section describes the operation of PRISM FL Module using the FVCU. Before proceeding refer to all relevant sections in these Instructions for Use and the Instructions for Use of the PRISM FL Module covering safety, environmental and electrical specifications, component inspection and installation.

In this section the names of electrical connections are given in **bold**.

8.1 Before Operation

8.1.1 Risk Assessment and Checks

- Carry out and implement a risk assessment covering personnel and the environment appropriate to the installation and operation of the integrated laser system.
- Carry out the Risk Assessment and Checks given in the Instructions for Use of the PRISM FL Module
- Ensure the electrical connections are made in accordance with Section 7.4.

8.1.2 User Training

All Users must be officially trained and authorised within their respective organisations. They must also be fully conversant with the following:

- Laser hazards, safety procedures and correct use of related safety equipment.
- Hazards related to the use of Lasers for materials processing, prescribed safety procedures and related equipment.
- The contents of these Instructions for Use, and therefore the safety provisions in them.

8.2 Powering the FVCU Up and Down

Power should be applied to the FVCU and PRISM FL Module in the following sequence:

1. 24V DC Auxiliary PSU. The ‘Run’ status indicators will show green.
2. Allow the 24V DC Auxiliary PSU to stabilise
3. Pump Diode PSUs

4. Allow the Pump Diode PSUs to stabilise

Remove power from the FVCU in the following sequence:

1. Ensure that **Enable**, **Modulate** and **Power Set** are set to 0V and discharged
2. Turn off the Pump Diode PSU
3. Allow the Pump Diode PSU to discharge
4. Turn off the 24V DC Auxiliary PSU
5. Allow the 24V DC Auxiliary PSU to discharge

8.3 Alarms and Warnings

8.3.1 Alarms

When the system detects an alarm condition, the FVCU goes to the OFF state.

Alarm conditions include:

- Optical Fault
- Back reflection detected
- Output Fiber over-temperature
- Supply ‘brown-out’
- Internal over-temperature

In the case of an optical fault, the FVCU enters Safe Mode. In this mode, the FVCU limits the PRISM FL Module to a pre-configured parameter set that will output a low energy, low frequency pulse. This allows checks to be made without making any damage worse.

Optical fault detection needs to be sensitive enough react quickly to minimise damage. However, there may be a potential for false detection of optical faults. In this case, the safe mode recovery routine will get the FVCU out of safe mode and enable all of the PRISM FL Modules.

8.3.2 Warnings

A warning is generated by conditions which are of concern, but do not put the FVCU into the OFF state. Warnings are removed automatically when the condition is removed.

Warning conditions include:

- Back Reflection approaching alarm level
- Temperature(s) approaching alarm level(s)
- FVCU in Safe Mode

9 The FVCU and FiberView for Laser Control

9.1 Overview

FiberView is the Graphical User Interface (GUI) program specifically written for Fiber Lasers with the FiberView Control Unit (FVCU). FiberView is used to monitor and control the Fiber Laser, program parameters and process cycles, alert the User to any maintenance requirements and to aid in fault diagnosis. FiberView is an advanced laser control system offering many features not available in other products. However the protocol for controlling Fiber Lasers is available from SPI Lasers to allow users to integrate control of Fiber Lasers into an overall system controller.

The initial configuration of the Fiber Laser can be set from FiberView, and then the operating parameters selected and internal parameters monitored during operation.. Different levels (Maintenance, Supervisor, and Operator) of access are allowed to the features of the program for control of the Fiber Laser in a production environment.

If the FiberView program is run with no FVCU connected to the PC, then an option is available to run in a simulation mode. This mode is useful for safely familiarising the user with the operation of the program.

9.2 Basic Operation

Launch FiberView. For the normal installation there will be a shortcut on the Desktop to do this, along with the version number if the default install options have been used.

On starting FiberView in its default mode, a dialog box similar to Figure 8 appears. FiberView will automatically search for Fiber Lasers connected via RS-232 and Ethernet (local or network) connections. FiberView displays all the Fiber Lasers with connections to it. Clicking on each connection will show more information. Select the desired connection, and then click on “Connect to Laser …” to enable FiberView to control that Fiber Laser.

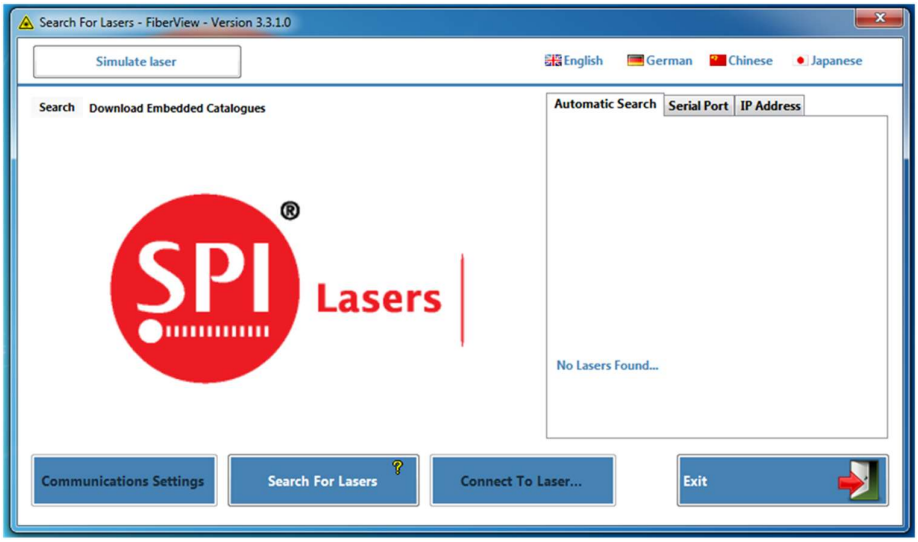


Figure 8 Fiber Laser Connection Dialog

If the Fiber Laser is connected to the computer, but FiberView cannot establish communications with it then

1. Check the correct connection cable is being used, appropriate to the type of serial connection (as in Sections 7.5.4 or 7.5.5).
2. Use the Communications Settings button to check that FiberView is set for the same communication port that the Fiber Laser is connected to, and correct if necessary.
3. Make sure that the communications modules have been correctly installed. Do this by uninstalling FiberView. Then go into the Utilities – Communications Package folder on the FiberView CD. Run the program FLComms110.exe. Then re-install FiberView as described in Section 7.4.

The hardware on the Fiber Laser stores set-up information: e.g. programmed parameter sets, alarm and warning levels, calibration data and configuration. On start-up, FiberView reads this information from the Fiber Laser. Thus one installation of FiberView can be connected to any Fiber Laser, and will know its status and limitations. The information read back from the Fiber Laser is displayed in the Laser Tabs area.

It is possible to have more than one instance of FiberView running on a single PC, with each instance controlling a separate Fiber Laser.

On connecting to a Fiber Laser, FiberView displays its overview screen, similar to Figure 9.

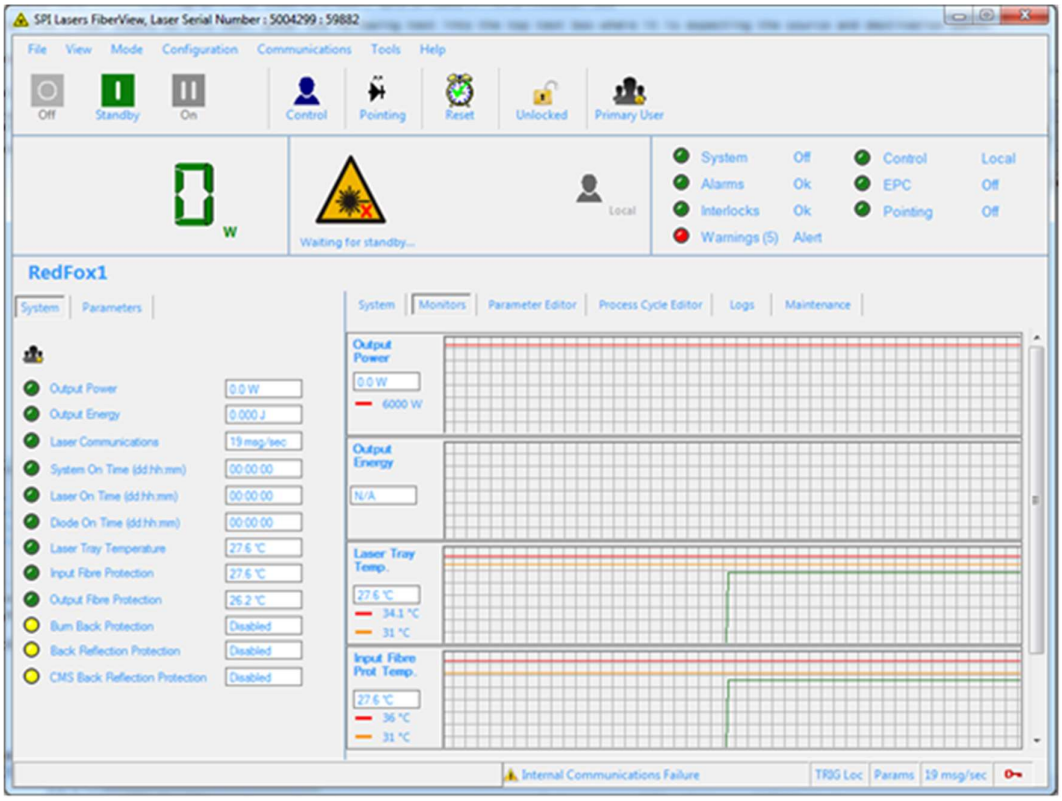


Figure 9 FiberView Overview Screen

The Control Tabs are used to set-up and monitor the Fiber Laser operating parameters.

To configure the operating parameters select the Parameter Editor Control Tab or, on the Menu bar, select: View – Windows – Parameter Set Programming. Here the demand level is set and the output waveform (CW, single sector pulse, sine wave or an arbitrary user defined shape) is determined.

Note: For a CW output, 100% demand is calibrated to deliver the maximum rated power of the Fiber Laser.

Maximum demand setting is 102%. This extra headroom can be used to fine tune the process, or compensate for small variations over time in the processing conditions.

In Single Sector Pulsed Mode a frequency and pulse width are set. In this mode the pump drivers are switched on and off rapidly. The effect is to 'chop' the CW output into a series of pulses.

Returning to the Laser Overview Screen (Monitors Tab, or on the Menu bar select: View – Windows – Laser Overview), will allow the Fiber Laser's conditions to be monitored while it is running.

To operate the Fiber Laser use the buttons in the Tool bar. Click on the green STANDBY Button to enable the Fiber Laser. When the On Button turns black (after a 5s safety delay), click on it to start laser emission.

To turn the Fiber Laser OFF, click the red Off Button, or the green STANDBY Button.

Note: Restarting from STANDBY Mode is faster than from the OFF condition.

9.3 Parameter Sets

9.3.1 Overview

Parameter Sets define the output of the Fiber Laser. This section explains how the different fields of the Parameter Set affect the output. The FiberView Control Module can store up to 50 Parameter Sets in its onboard memory for fast access when switching between Parameter Sets during processing.

Each Parameter Set contains the following information:

Table 10 Parameter Set Attributes

Item	Information
Parameter Set Identification String	a 16 character string giving the Parameter Set an identifying name. (e.g. to store the name of the part the Parameter Set has been developed to process)
Library Shape Reference	the output style: either a Pre–defined shape or a User defined shape
Mean Current Demand	used for CW and Sine Wave output styles
Peak Current Demand	used for Single Sector Pulse, Sine and User Defined Shape output styles
Width	the pulse width duration for the Single Sector Pulse and User Defined Shape output styles, scaled in microseconds, with a maximum duration of 1s
Frequency	maximum frequency that can be set is 50kHz
Ramp Up Time	the time to ramp up from the STANDBY to the ON state, with a maximum of 10s
Ramp Down Time	the time to ramp down from the ON to the STANDBY state, with a maximum of 10s
External Power Control Enable	selects between external analogue control and internal parameter set control for output height. When external control is enabled, the analogue input on the Machine Interface controls the output height
External Power Control Mode	Relative mode sets the external analogue control range between 0 and the relevant height of the active Parameter Set. Absolute mode sets the external analogue control range between 0 and the maximum current demand

Item	Information
External Trigger Source	Selects between internal and external Trigger sources. This is a Local operating mode Trigger source select, and only has a bearing on the output if the Machine Interface Trigger source select function is not configured to an input when in Remote Control
Internal Trigger Select	The output is Triggered from the internal frequency generator at the frequency determined by the active Parameter Set Frequency field
External Trigger Select	When the external Trigger input on the Machine Interface is set, the output response is determined by the External Trigger Mode
External Trigger Mode	Edge Trigger Mode (when this mode is selected, the Fiber Laser will output a Single Pulse or User Defined Shape each time a Machine Interface Trigger input is generated - input transition from CLEAR to SET) Gated Trigger Mode (when this mode is selected, the output will use the active Parameter Set settings when a Machine Interface Trigger input is asserted.) There is no output when the Machine Interface Trigger input is clear. If a pulsed style shape is being used (Single Sector Pulse or User Defined Shape), the frequency of the output is determined by the internal frequency generator.

Parameter Sets can be edited using the Parameter Editor. Select by Parameter Editor Tab, or View – Windows – Parameter Set Programming on Menu Bar.

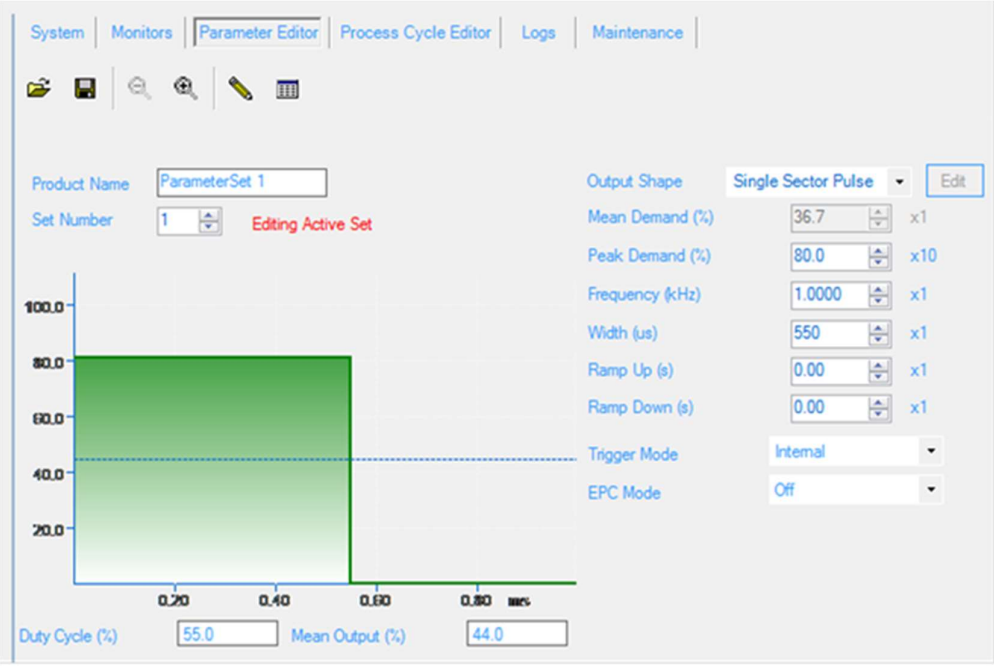


Figure 10 FiberView Parameter Editor

Use the up and down arrows by each parameter to adjust by amount shown as multiplier to right of box.

To adjust the multiplier, right click on it and select desired value from the popup menu.

Alternatively, type the desired value directly into the appropriate parameter box.

9.3.2 Current Demand Level

- Mean Current Demand – used for CW and Sine Wave output styles. Maximum value is 100%.
- Peak Current Demand – used for Single Sector Pulse, Sine and User Defined Shape output styles. Maximum value is 100%.

9.3.3 Frequency

Sets the pulse repetition frequency, in kHz, when operating in Internal Trigger mode. The maximum frequency that can be set is 50kHz.

9.3.4 Width

Sets the pulse width, in µs, for the pulse width duration for the Single Sector Pulse and User Defined Shape output styles. Maximum duration that can be set is 1s.

9.3.5 Ramp Up and Ramp Down

When output is demanded it will linearly increase from 0% to the demanded level over this period. When the output is turned off, its power will decrease to zero over this period.

9.3.6 Trigger Mode

Selecting one of the External Modes allows the FVCU to be controlled by a Trigger signal applied to the Trigger Input (Pin 16) on Machine Control Interface (PL5, section 7.5.6).

- Internal: Output pulses generated at rate set in the parameter editor, using internal function generator.
- External Edge Triggered: One output pulse is generated for each positive going edge on the Trigger inputs. Not for CW mode.
- External Gated: Output is enabled while the Trigger input is held high, and turned off for Trigger input low.

9.3.7 EPC (External Power Control)

Allows the demand level to be controlled by the value of the voltage applied to the Analogue Input (Pins 11 and 24) on the Machine Control Interface (PL5, Section 7.5.6).

The EPC indicator in the Status Indicators area will turn red if EPC is in use for the Active pulse shape.

- Off: Analogue Input level ignored.
- Absolute: An input of 0-10V will control the peak demand for the pulse shape from 0-100%.
- Relative: An input of 0-10V will control the peak demand for the pulse shape from 0% to the maximum value set in the pulse shape parameters.

Note: By setting the pulse shape to CW and using EPC mode, the output of the FVCU can be made to follow any arbitrary externally applied waveform.

9.3.8 User Defined Pulse Shapes

Any arbitrary pulse shape can be defined using the Shape Editor. The Shape Editor works with dimensionless shapes that are then saved as a particular User Defined pulse shape. This pulse shape can be used in any parameter set, where it is scaled to the peak power and pulse width associated with that pulse shape.

The Shape Editor, shown in Figure 11, is accessed from the Parameter Editor tab by either selecting the ‘Pencil’ icon or via menu option View – Shape Editor. Clicking on the Insert button allows a range of features to be added to the Pulse Shape. Any node on the Shape can be selected and dragged to a new position to alter the shape.

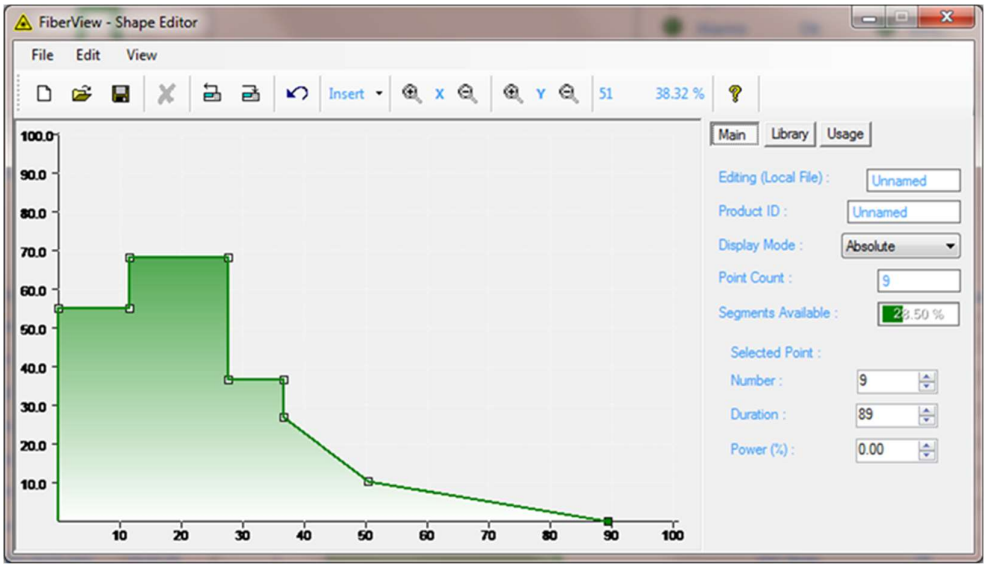


Figure 11 Shape Editor Window

When the shape is completed, click on the “Save to Laser Storage” icon and assign it to a User Defined shape number (which can later be used in any parameter set). A copy of the shape can be saved to disc using the “Save to Local Storage” option.

The ‘Library’ and ‘Usage’ buttons can be used to see which pulse shapes are currently in use by the FVCU.

9.4 Process Cycles

Process Cycles are an automation feature of the FVCU. They allow a programmed sequence of Parameter Sets to be output using minimal input to control an entire sequence, for example when a single part has to be processed with different types of spot and seam welds at different positions around the part. Process Cycles are constructed from one or more elements known as Steps. Each Step holds a Parameter Set reference and control attributes. A Process Cycle can be programmed to execute fully automatically from start to finish, or to require an external input / serial command to change between programmed Steps, or any combination of automatic and manual control.

The FVCU has the capacity to store up to 1000 steps which can be grouped into up to 50 Process Cycles. In this way, for example, a single Process Cycle of 1000 Steps or 50 Process Cycles of 20 Steps can be set up. Any number of Steps can be linked to create a range of Process Cycles, provided that there are no more than 50 Process Cycles and no more than a combined total of 1000 Steps.

Figure 12 shows Steps grouped into Process Cycles. The Process Cycles contain from one to 16 Steps.

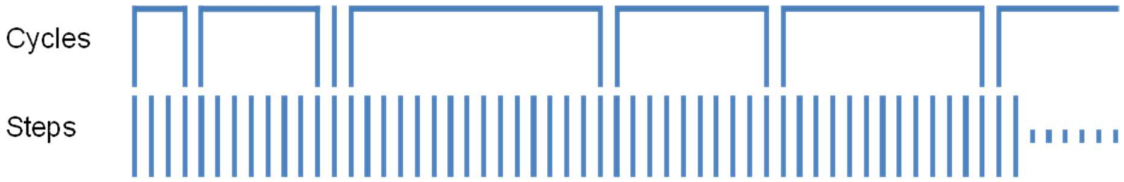


Figure 12 Steps Grouped into Process Cycles

A 16 character name is stored with each active Process Cycle to allow it to be identified. For example, the name of the Process Cycle could be the name of the part the Process Cycle has been developed to process.

Process Cycle Steps determine the sequence of Parameter Sets that are executed, along with their timing and transition type. All of the other information required to specify the output is determined by the Parameter Set.

To edit a Process Cycle select by Process Cycle Tab, or View – Windows – Process Cycle Editor on Menu Bar.

The **Process Cycle Step**s contain the attributes listed in Table 11. The attributes can be assigned to each Step in the Process Cycle editor, shown in Figure 13.

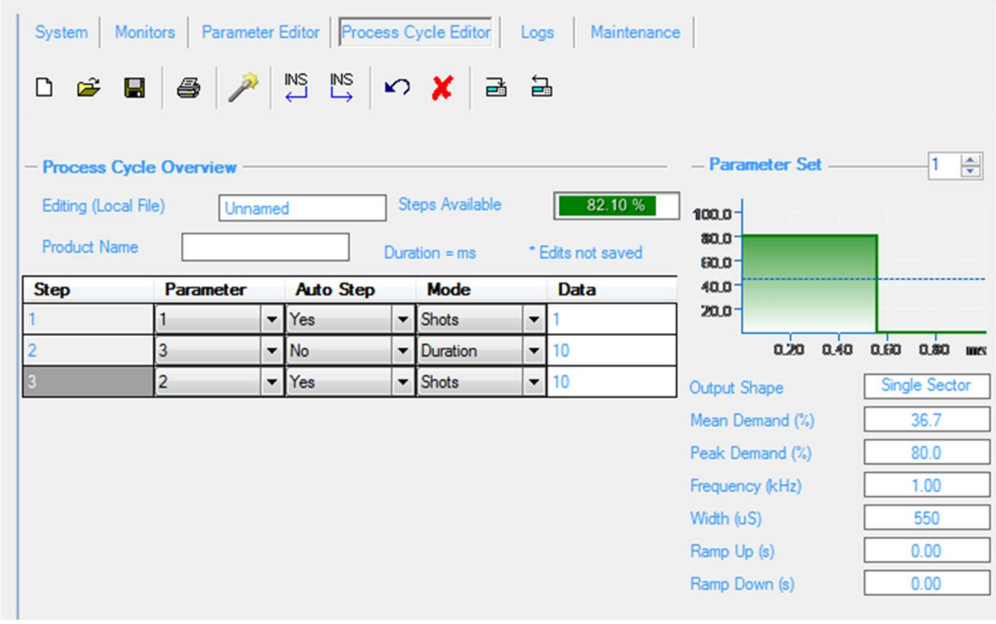


Figure 13 FiberView Process Cycle Editor

Table 11 Process Cycle Step Attributes

Item	Label	Information
Parameter Set Reference	Parameter	This field is used to reference any of the 50 available Parameter Sets
Automatic or manual step transition	AutoStop	This field sets whether the execution will advance onto the next Step automatically, or require a manual Step command
Shots or duration execution	Mode	This field specifies whether the Step duration is measured as a number of pulses or as a timed duration before its execution has completed and the Process Cycle is ready to advance onto the next stage
Number of shots or time period for the step	Data	This field specifies the number of pulses or the time duration of the Step depending on the execution type field of the Step. Range 0 to 10000 milliseconds or pulses. Specifying a value of 0 sets the Step to infinite duration, which overrides the transition type to manual, and outputs the specified Parameter Set until a manual Step command is received

9.5 Other Settings

9.5.1 Alignment Laser

The alignment laser of the FVCU assists in aligning the process tool in the correct position on the work piece. Red light from a low power laser diode is transmitted to the work piece using the same delivery fiber as the main laser output.

The alignment laser can be activated at any time by clicking on the diode icon on the Tool Bar.

The icon changes as shown below to indicate whether the alignment laser is off or on.

Off On

The state of the FVCU is taken into account when activating the alignment laser, as follows:

Laser OFF:

- Clicking the diode icon will start the emission indicator flashing (similarly to the Laser STANDBY command) for 5 seconds. The alignment laser will turn on after the emission time and the emission indicator will be on.
- Turning the alignment laser off will turn off the emission indicator.
- If the alignment laser is on (and so the emission indicator is on) and the Laser STANDBY command is sent the emission indicator will flash again to provide the relevant warning before entering STANDBY.

Laser STANDBY:

- Clicking the diode icon will turn the alignment laser on immediately.
- Turning the alignment laser off will not turn the emission indicator off.

Laser ON:

- The Laser will be emitting, so when the alignment laser is activated its state will be reported as on, but its output will be off. When the Laser enters STANDBY or OFF, the alignment laser output is automatically switched on.
- If the alignment laser is on and the laser is turned OFF the emission indicator will remain on.
- If the laser is commanded to STANDBY after the alignment laser has been commanded on the emission warning time is restarted to provide a full 5 seconds.

If the alignment laser is left on, it will automatically switch off after 30 minutes. This timeout can be disabled in the Laser Settings window by selecting 'Configuration' ' Laser…'. Note that running the alignment laser continuously will reduce its life.

The MCIF can be configured to control the alignment laser.

9.6 Laser alignment brightness adjustment

Warning

By adjusting the brightness of the alignment laser, the Class 2 classification could be changed to Class 3. The user is responsible for using an appropriate power meter to safely monitor the brightness during the adjustment routine.

The brightness will get updated in incremental steps to avoid over brightening.

The laser module will not return a value that would represent the actual brightness and so FiberView has no way of knowing how dim or bright the alignment laser is before, during or after adjustment.

There is no value or graph or other representation to show actual brightness level.

The user interface will not know what the starting level is for the brightness (i.e. it could be already 1 step from its max).

To adjust the alignment laser brightness for FiberView go to the Laser Settings window.

- Configuration->Laser...->***Alignment laser***

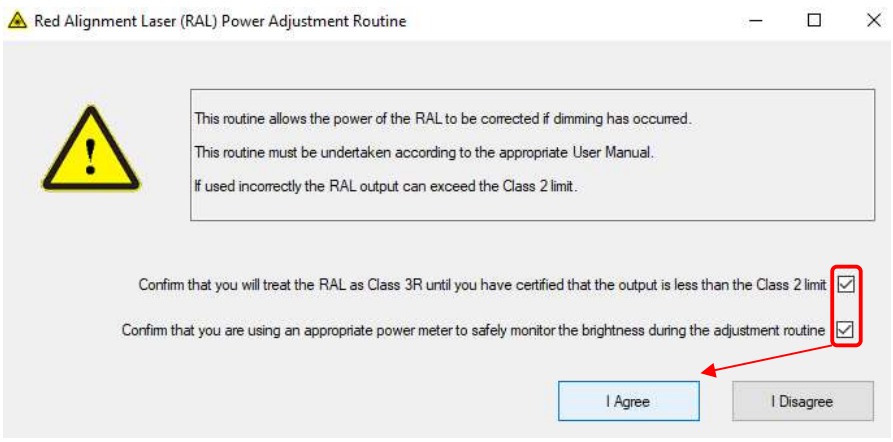
9.6.1 Alignment laser password

Enter a SPI Customer supervisor level password or greater when prompted.

9.6.2 Alignment laser agreement

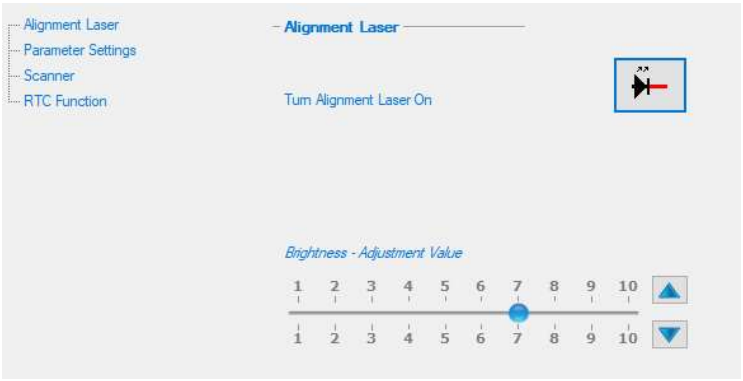
Before proceeding the user must agree to treat the RAL as class 3R until it has been certified that the output is less than the class 2 limit. The user must also agree that an appropriate power meter has been used to measure the output power.

The user must tick both boxes in order for the “I agree” button to be enabled and to be able to continue and adjust the alignment laser.



9.6.3 Alignment laser form

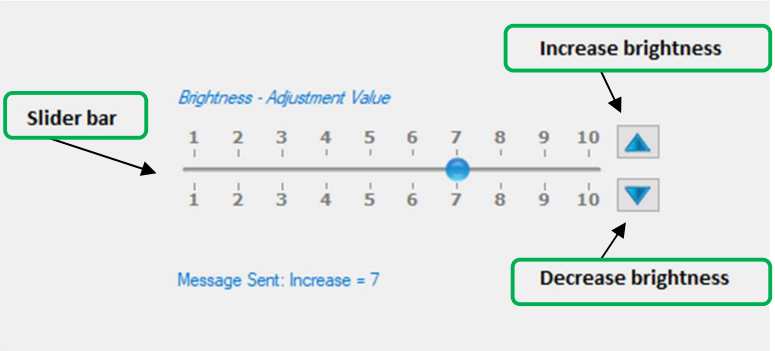
Once the correct password has been entered, the alignment laser form will be shown.



9.6.4 Alignment laser controls

There are 3 controls.

1. A slider bar to select a value between 1 and 10
2. A button with a up arrow on it to increase the brightness
3. A button with a down arrow to decrease the brightness



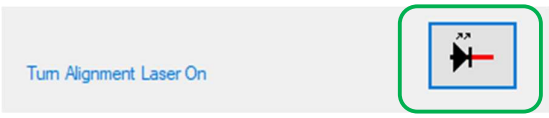
Use the slider bar to select the amount of adjustment required.

Then click either the up or down arrow to send the adjustment command to the laser module.

There will be no response from the laser module directly so all that FiberView can do is confirm that the command has been sent.

9.6.5 Enable alignment controls

The alignment laser needs to be ON for the alignment controls to be enabled. To switch on the alignment laser use the alignment laser ON/OFF button.



9.6.6 Multiple laser modules

FiberView will have only 1 set of new interface controls, as only one laser module can be used for the alignment laser.

9.6.7 Machine Interface

The Machine Interface functions are described in Section 7.5.6. The configuration of the seven outputs and seven inputs can be designated and confirmed by selecting either the Maintenance Tab and then MCIF from its toolbar, or from the Menu bar: View – Windows – Maintenance – Machine Interface.

To alter the configuration use the Menu bar in the Maintenance - Machine Interface window and select Action – Change Configuration. To write the new configuration to the FVCU, select Action – Save Configuration.

The Function for each connection can be selected from the drop down boxes associated with each one.

Note: If an external Trigger Input is to be used on the Machine Interface, it is highly recommended that it be connected to In6, Pin 16. This connection has higher speed hardware associated with it designed for this function.

9.6.8 Interlocks

If there is an error condition on one of the Interlocks check that the linking plug is correctly fitted to SK11.

9.6.9 Alarms and Warnings

If there is an error condition that Triggers an Alarms or Warnings, the corresponding indicator in the Status Indicators Area of the FiberView window will turn red. A list of the Alarm and Warning messages and codes is given in Section 12.

To find more information on which Alarms or Warnings has been activated, hover the mouse over the red indicator and a pop up box will show which Alarm or Warning has been activated. This information is also displayed in the two line status window under the Power output display.

Records of Alarms and Warnings can also be viewed by selecting the Logs Tab or View – Windows – Logs on the Menu Bar, and then clicking ‘Alm’ or ‘Warn’ on the Logs window toolbar.

After clearing the Alarm condition, use the Reset button on the main FiberView Toolbar to reset the indicator status and allow the FVCU to be restarted.

10 Basic Control Using Serial Communication

10.1 Overview

This section explains how to start and stop the FVCU using the serial protocol over either an RS-232 or Ethernet connection.

10.2 Functionality

The FVCU can be in one of six states: OFF, STARTING, STANDBY, RAMPING UP, ON or RAMPING DOWN (see Figure 14).

Three commands can be issued to change the state. (The other states are controlled by the sequencing.)

- Laser OFF
- Laser STANDBY
- Laser ON

The states are described in more detail below.

OFF State

The OFF state is entered under the following conditions:

- Following the application of 24V to the FVCU (TB2)
- Following a Laser OFF command
- Following an Alarm condition

The OFF state is left after receiving a Laser STANDBY command.

STARTING State

When in the OFF state, the STARTING state is entered after receiving a Laser STANDBY command. The STARTING state automatically sequences to the STANDBY state after a fixed time of 5s.

The OFF state is entered if an Alarm condition occurs.

STANDBY State

The STANDBY state is entered under the following conditions

- Following the STARTING state duration after a Laser STANDBY command is received.
- Following the Ramp Down state duration after a Laser STANDBY command is received.

The STANDBY state is left after receiving a **Laser ON** command.

The OFF state is entered if an Alarm condition occurs.

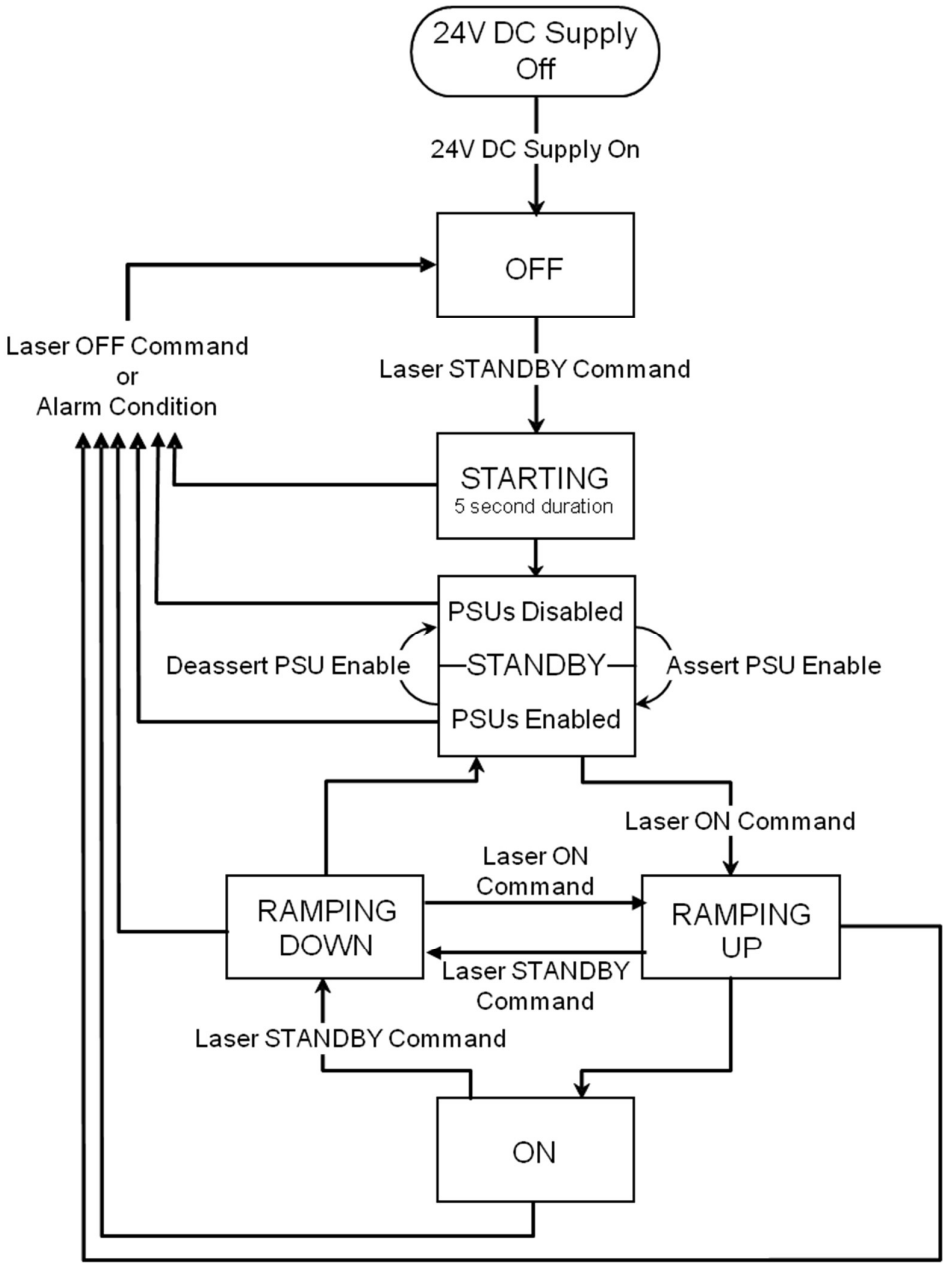


Figure 14 State Transition Diagram

RAMPING UP State

When in the RAMPING DOWN or STANDBY states, the RAMPING UP state is entered after receiving a **Laser ON** command.

When in other states the **Laser ON** command is ignored.

The RAMPING UP State automatically sequences to the ON state after the ramp up duration has elapsed. The ramp up duration is determined by the active parameter set.

The OFF state is entered if an Alarm condition occurs.

ON State

The ON state is entered automatically from the RAMPING UP State after the ramp up duration has elapsed. The ramp up duration is determined by the active parameter set.

The ON state is left after receiving a Laser STANDBY command.

The OFF state is entered if an Alarm condition occurs.

RAMPING DOWN State

When in the RAMPING UP or ON states, the RAMPING DOWN state is entered after receiving a Laser STANDBY command.

The RAMPING DOWN State automatically sequences to the STANDBY state after the ramp down duration has elapsed. The ramp down duration is determined by the active parameter set.

The OFF state is entered if an Alarm condition occurs.

10.3 Protocol Message References

- Set Laser OFF (Control Code 0x00) - Sends a Laser OFF command.
- Set **Laser STANDBY** (Control Code 0x01) - Sends a **Laser STANDBY** command.
- Set **Laser ON** (Control Code 0x02) - Sends a **Laser ON** command.
- Read Laser State (Control Code 0x03) - Requests the state.
- Reset System (Control Code 0x05) - Sends a Reset command. Normally used to reset an Alarm condition when the cause has been cleared.
- Read Zone Status (Control Code 0x50) - Used to retrieve the overall status including the current state.

Refer to SM-S00499, Fiber Laser Serial Communications Protocol, for the exact structure and implementation of the above serial protocol commands.

11 Machine Interface Reference

11.1 Overview

The Machine Interface for the FVCU consists of seven inputs and seven outputs. They are available to Laser Integrators on connector PL5 as shown in Table 5. Each input and output can be configured to perform a specific function selected from a list of available functions. This configuration can be changed to suite the laser's operation. The default configuration should be suitable for the majority of applications, but the configurable flexibility allows laser integrators to tailor the interface to their application if required.

This section describes setting up the Machine Interface on the FVCU using the default configuration. SM-S00499, Fiber Laser Serial Communications Protocol is available to explain how to reconfigure the Machine Interface functionality if the default configuration does not suit the required application.

11.2 Default Input Functionality

11.2.1 Summary

The default configuration of the Machine Interface inputs and outputs is given in Table 12 and Table 13

Table 12 Default Configuration of Machine Interface Inputs

Input Number	Pin on PL5	Function ID	Function Description	Reference
IN0	3	1	**Laser Start**	11.2.2
IN1	4	2	**Laser ON / Process Cycle Start**	11.2.3
IN2	17	5	**Process Cycle Step**	11.2.4
IN4	18	6	**Alarm Reset**	11.2.5
IN6	16	3	Trigger	11.2.6

Table 13 Default Configuration of Machine Interface Outputs

Output Number	Pin on PL5	Function ID	Function Description	Reference
OUT0	19	1	**Laser STANDBY**	11.3.1
OUT 1	7	2	**Laser ON / Process Cycle Active**	11.3.2
OUT 2	20	3	Remote Control	11.3.3

OUT 3	8	7	**Alarm**	11.3.4
OUT 4	21	8	Warning	11.3.5
OUT 5	9	9	Reserved	-
OUT 6	22	5	**Process Cycle Wait**	11.3.6

11.2.2 Laser Start (Input Function ID 1)

- Default connection
  - PL5 pin number 3
  - Input number 0
- Basic Function Description
  - Only operational in Remote Control.
  - Takes the state from OFF to STANDBY under Remote Control
  - Input is edge sensitive in Remote Control.
  - Input is level sensitive when entering Remote Control.
- Detailed Function Description
  - SETting the input sequences the state to the STANDBY state.
  - CLEARing the input switches the state to the OFF state.
  - When switching into Remote Control, the state of the **Laser Start** input is acted upon depending on the state of the FVCU as follows:
    - When the state is OFF, and **Laser Start** input is SET, the state will remain OFF when entering Remote Control. The **Laser Start** input must detect a positive edge to change the state. Alternatively a software command can be issued to sequence the state to the STANDBY state while the input remains SET.
    - When the state is the STANDBY or the ON state, and **Laser Start** input is CLEAR, the state will switch to the OFF state when entering Remote Control. In this case, the **Laser Start** input is level sensitive. While in Remote Control, the only way to sequence the state into the STANDBY state is to SET **Laser Start**.
    - When the state is the STANDBY or the ON state, and the **Laser Start** input is SET, the state will not switch to the OFF state when entering Remote Control. In this case, the state of the **Laser Start** input is level sensitive and the state is also dependant on the **Laser ON** / **Process Cycle Start** input.

- Therefore, care must be taken to ensure the **Laser Start** input (if configured) is in the correct state when entering Remote Control.

- This function has no effect if it is not configured on the Machine Interface.
- This function can be assigned to any of the seven inputs.
- Associated default functions
  - **Laser STANDBY** - Output Function
  - Remote Status - Output Function
- Sequence diagrams:

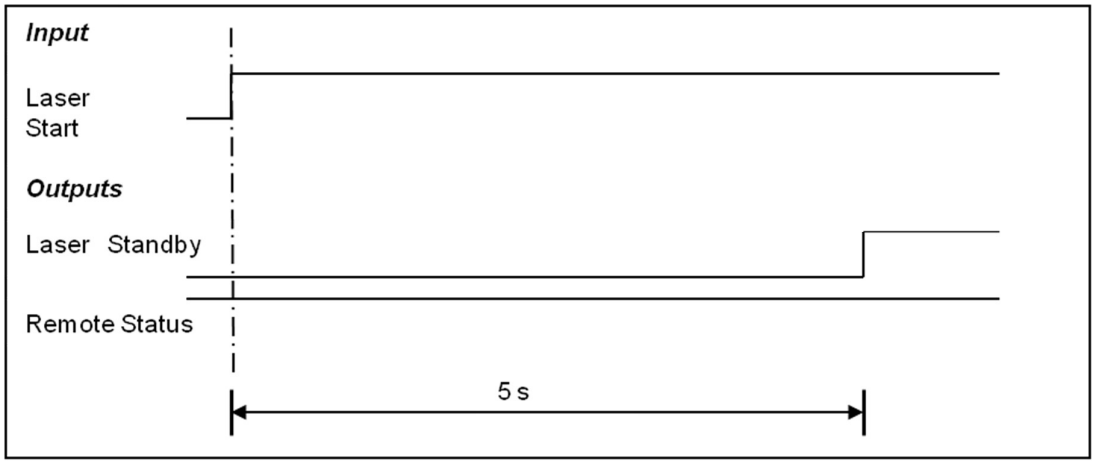


Figure 15 Moving to STANDBY in Remote Control

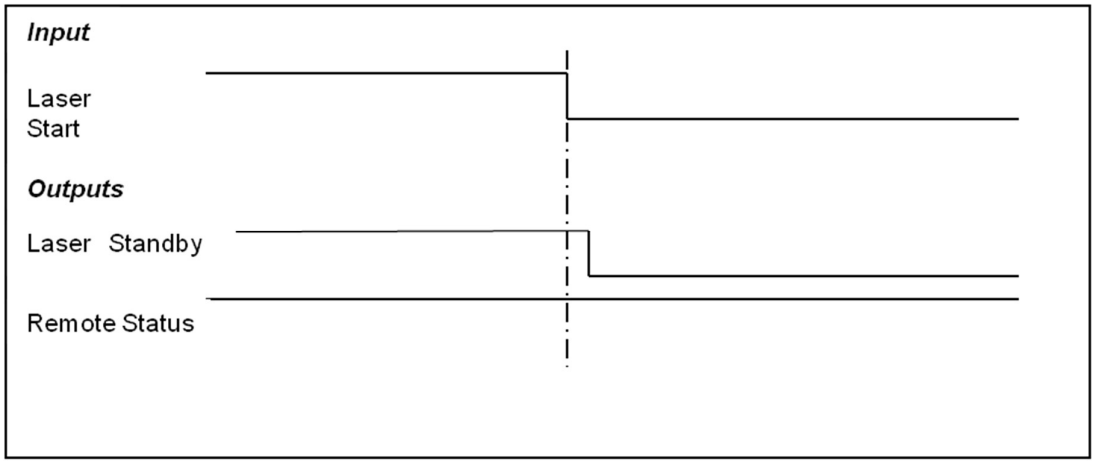


Figure 16 Moving to OFF in Remote Control

Note: There is a small switching delay before the **Laser Start** is acted on (<1ms)

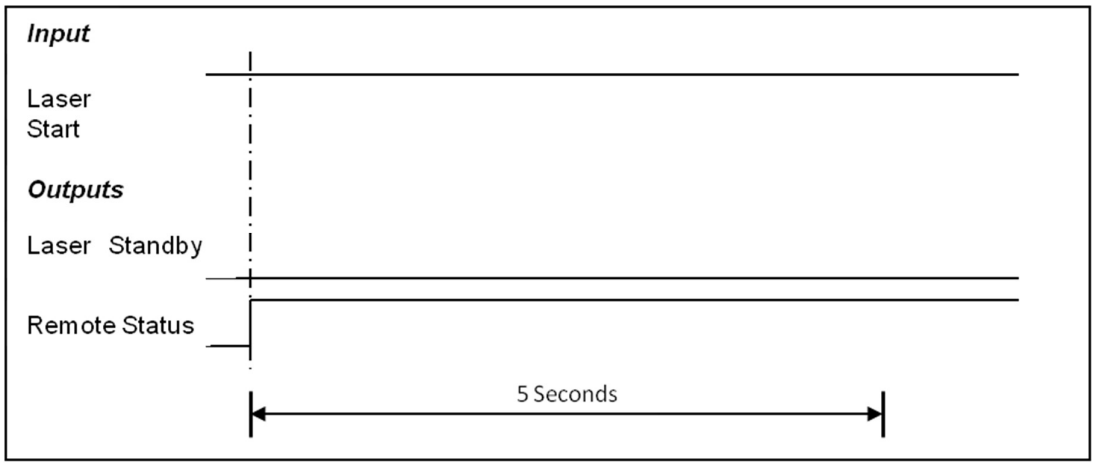


Figure 17 Entering Remote Control (OFF State, Laser Start Set)

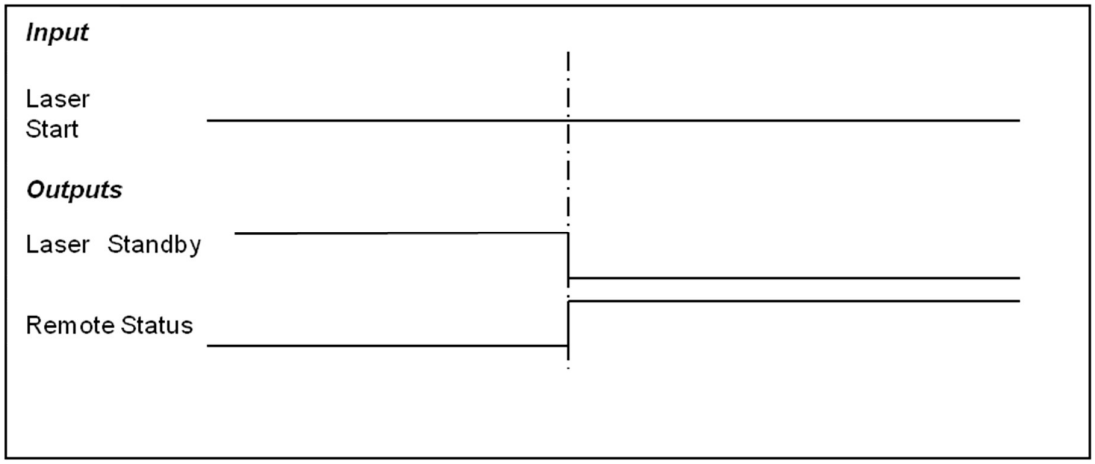


Figure 18 Entering Remote Control (STANDBY or ON State, Laser Start Clear)

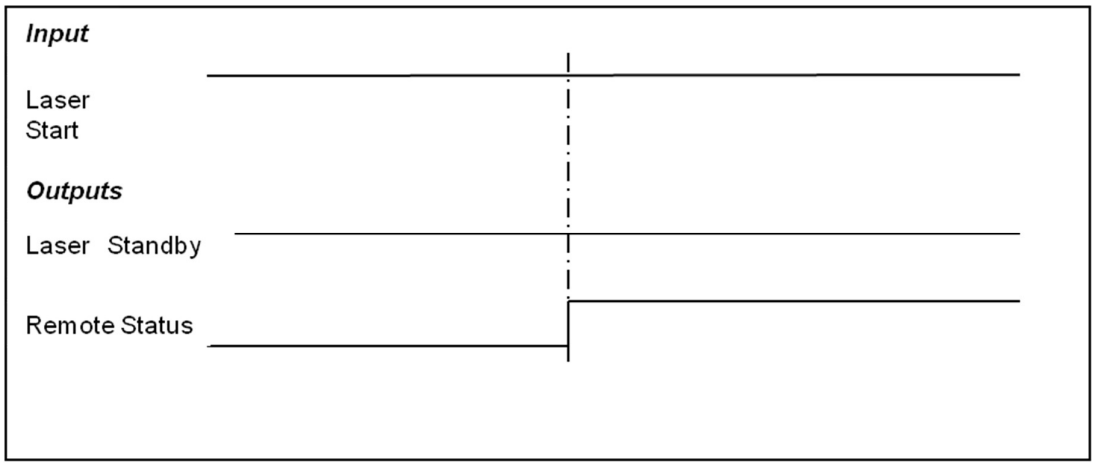


Figure 19 Entering Remote Control (STANDBY or ON State, Laser Start Set)

11.2.3 Laser ON / Process Cycle Start (Input Function ID 2):

- Default connection
  - PL5 pin number 4
  - Input number 1
- Basic Function Description
  - Multiplexed input depending on processing mode.
  - Takes the state from the STANDBY state to the ON state and the ON state to the STANDBY state under Remote Control in parameter set mode.
  - Starts / stops a process cycle under Remote Control in process cycle mode.
  - Input is edge sensitive in Remote Control.
  - Input is level sensitive when entering Remote Control.
  - Only operational in Remote Control.
- Detailed Function Description

a) Parameter Set Operation

- When the FVCU is in Remote Control this input function provides the following action:
  - From the STANDBY state, setting the input changes the state to the ON state or the RAMPING UP state if a ramp up time is configured in the active parameter set.
  - From the ON state, clearing the input changes the state to the STANDBY state or starts the RAMPING DOWN state if a ramp down time is configured in the active parameter set.

- When in the STANDBY state and switching into Remote Control the **Laser ON** input is acted upon depending on the initial state.
    - When the state is the STANDBY state, and the **Laser ON** input is SET, the state will not switch to the ON state when entering Remote Control. In this case the **Laser ON** input is edge Triggered.
    - When the state is the ON state, and the **Laser ON** input is CLEAR, the state will change to the RAMPING DOWN (if any ramp is set) or STANDBY state when selecting Remote Control. In this case the **Laser ON** input is level sensitive.
    - When the state is the ON state, and the **Laser ON** input is SET (and the **Laser Start** input is either not configured or configured and SET), the state will remain the ON state. In this case the **Laser ON** input is level sensitive.
    - When the state is the OFF state, or transitioning to the STANDBY state, and the **Laser ON** input is SET, the state will not transition to the ON state when it enters STANDBY.

b) Process Cycle Operation

- When the FVCU is in Remote Control this input function provides the following action:
    - From the STANDBY state, setting the input starts a Process Cycle.
    - From the Process Cycle Active state, clearing the input stops a Process Cycle. If a ramp down time is set in the Parameter Set linked to the active Process Cycle Step, the ramp down will commence when the Process Cycle Start input is CLEARED and the state will transition to the STANDBY state.
- When in STANDBY and switching into Remote Control the state of the Process Cycle Start input is acted upon depending on the initial state.
    - If the state is the STANDBY state, and the Process Cycle Start input is SET, a Process Cycle will not start when entering Remote Control. In this case the Process Cycle Start input is edge Triggered.
    - If a Process Cycle is active when entering Remote Control it will stop regardless of the Process Cycle Start input condition. If a ramp down time is set in the Parameter Set linked to the active Process Cycle Step, when entering Remote Control the ramp down will commence and the state will transition to the STANDBY state.
    - When the state is the OFF state, or transitioning to the STANDBY state, and the Process Cycle Start input is SET, a Process Cycle will not start when it enters STANDBY.
- Care must be taken to ensure the **Laser Start** and **Laser ON** / **Process Cycle Start** inputs (if configured) are in the correct state when entering Remote Control.
- This function is only operational in Remote Control and when the state is the STANDBY state. If this function is configured and SET, when the STANDBY state is

entered from the OFF state, the state will not transition to the ON state. The configured input must be cycled to provide a leading edge to transition the state to the ON state.

- This function has no effect if it is not configured on the Machine Interface.
- This function can be assigned to any of the seven inputs.
- Associated functions
    - **Laser Start** - Input Function
    - **Laser STANDBY** - Output Function
    - **Laser ON** / **Process Cycle Active** - Output Function
    - Remote Status - Output Function
- Sequence diagrams

a) Parameter Set Operation

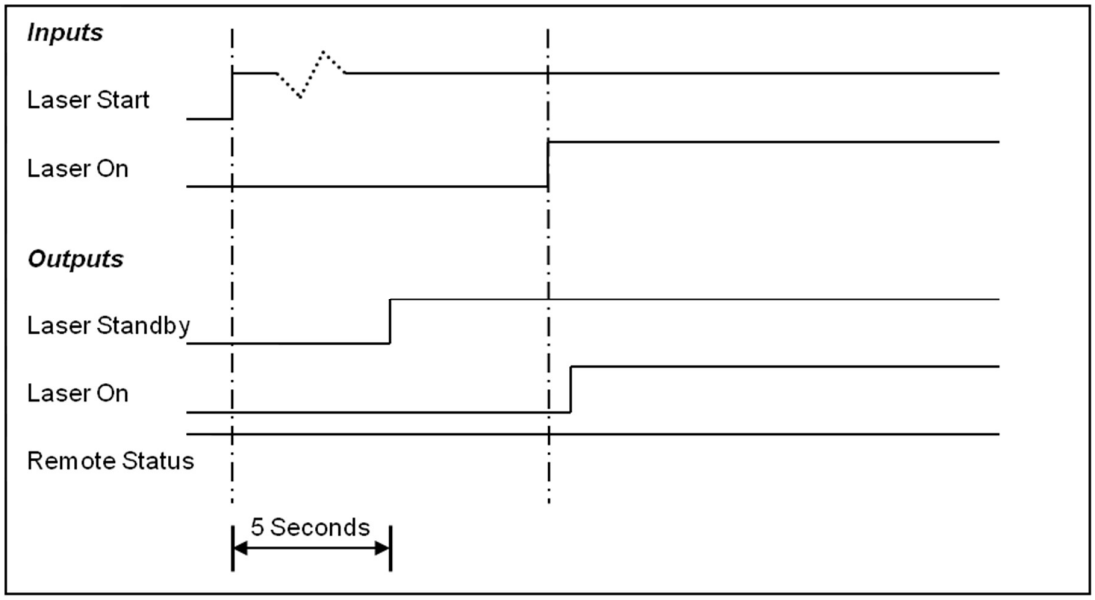


Figure 20 Moving to ON in Remote Control

Note:

The FVCU can be started using a serial protocol message, as long as **Laser Start** is SET.

Laser ON can be asserted at any time to move the state to the ON state as long as the initial state is in STANDBY state.

There is a small switching delay before **Laser ON** is acted on (<1ms) and **Laser ON** status is SET or CLEARED

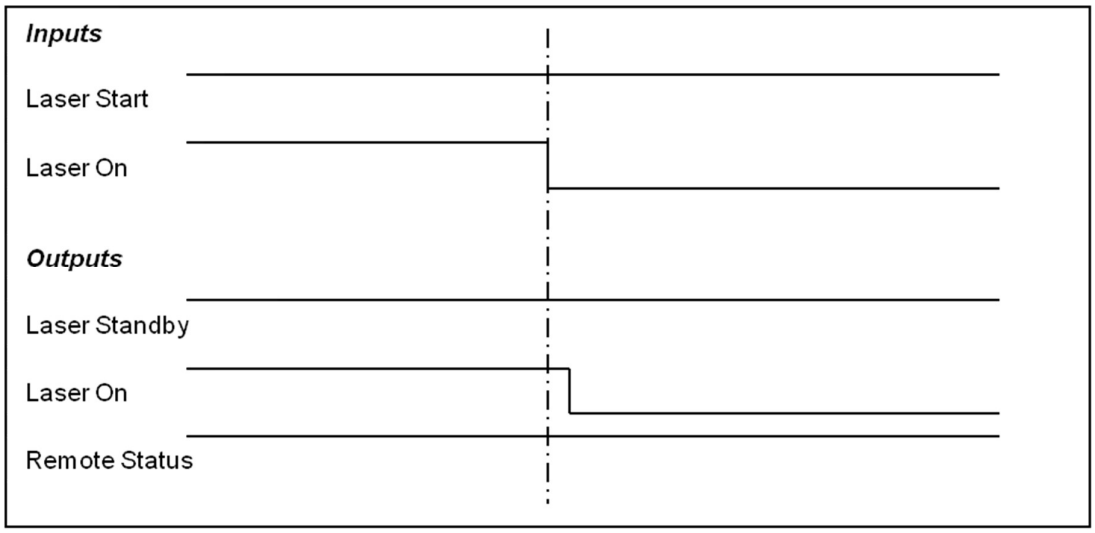


Figure 21 Moving to STANDBY in Remote Control (No Ramp Down Time Configured)

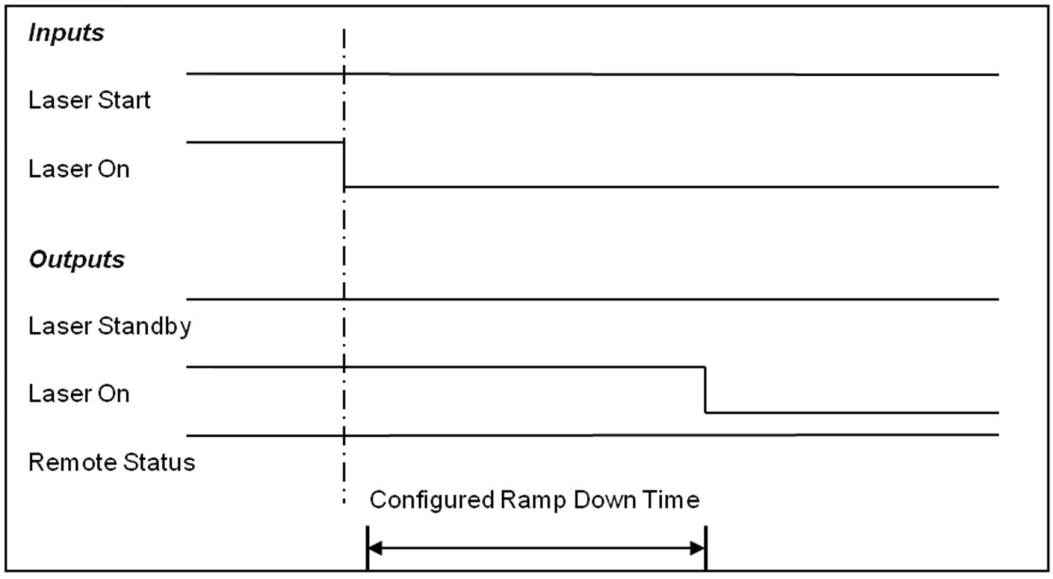


Figure 22 Moving to STANDBY in Remote Control (Ramp Down Time Configured)

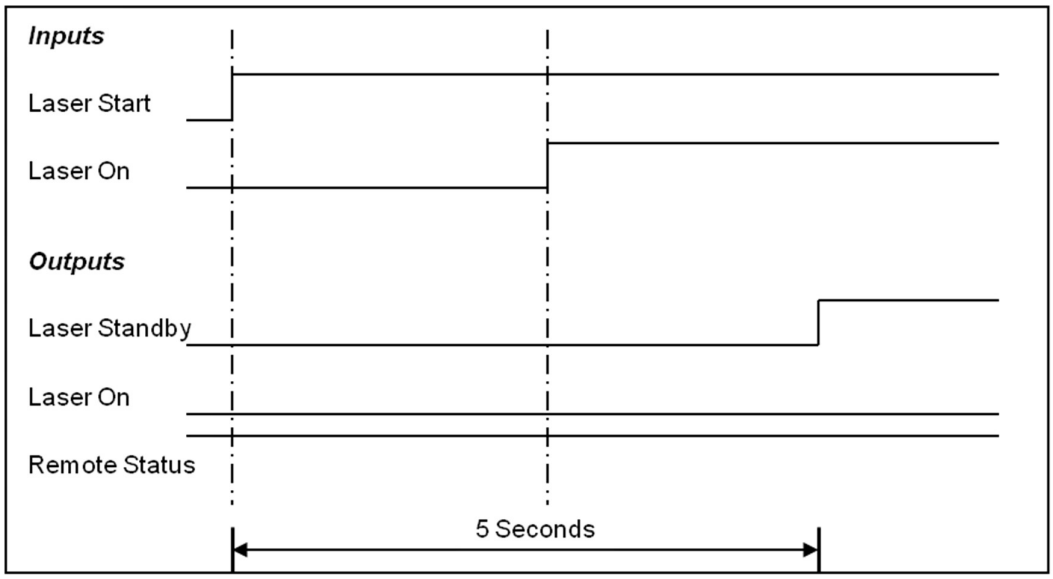


Figure 23 Moving to ON state in Remote Control Before the State has Moved to the STANDBY State

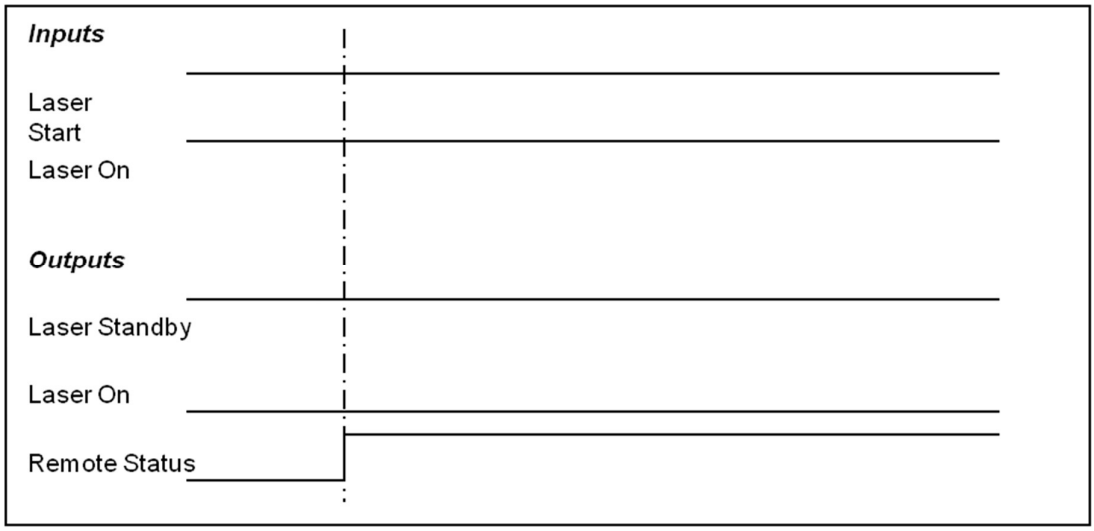


Figure 24 Entering Remote Control (STANDBY State, Laser ON Input Set)

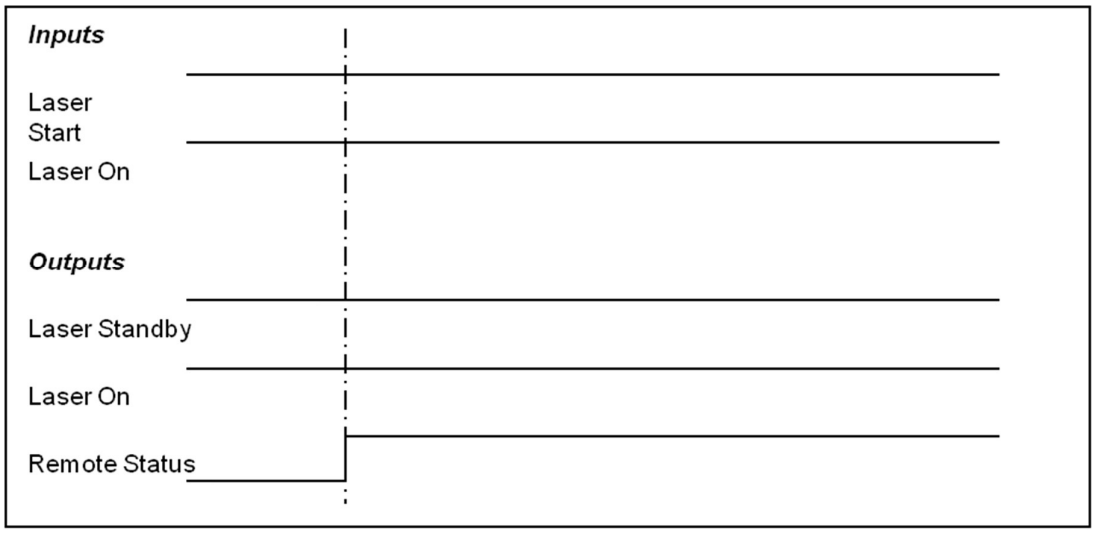


Figure 25 Entering Remote Control
(ON State, Laser ON Input Set)

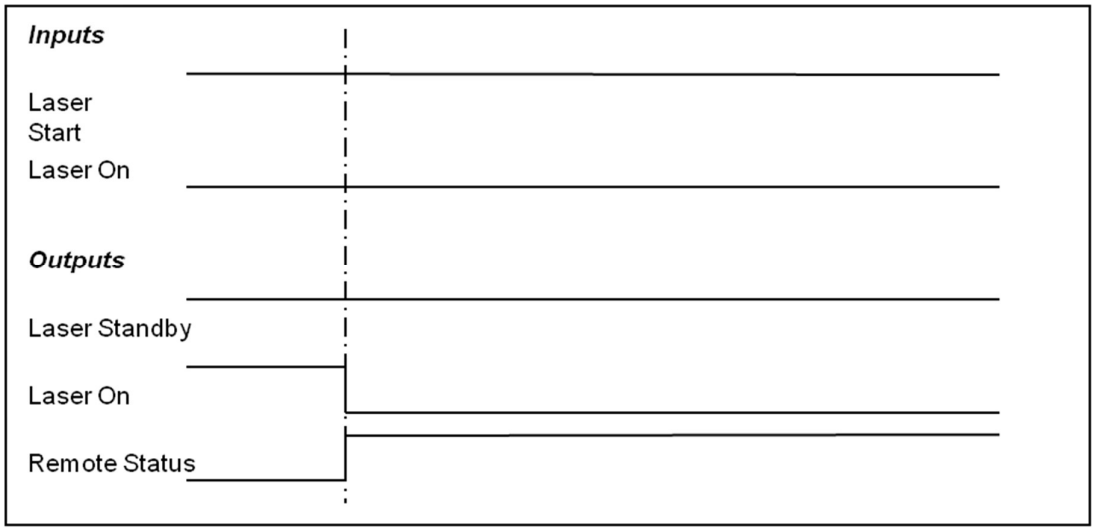


Figure 26 Entering Remote Control
(ON State, Laser ON Input Clear, No Ramp Down Time Configured)

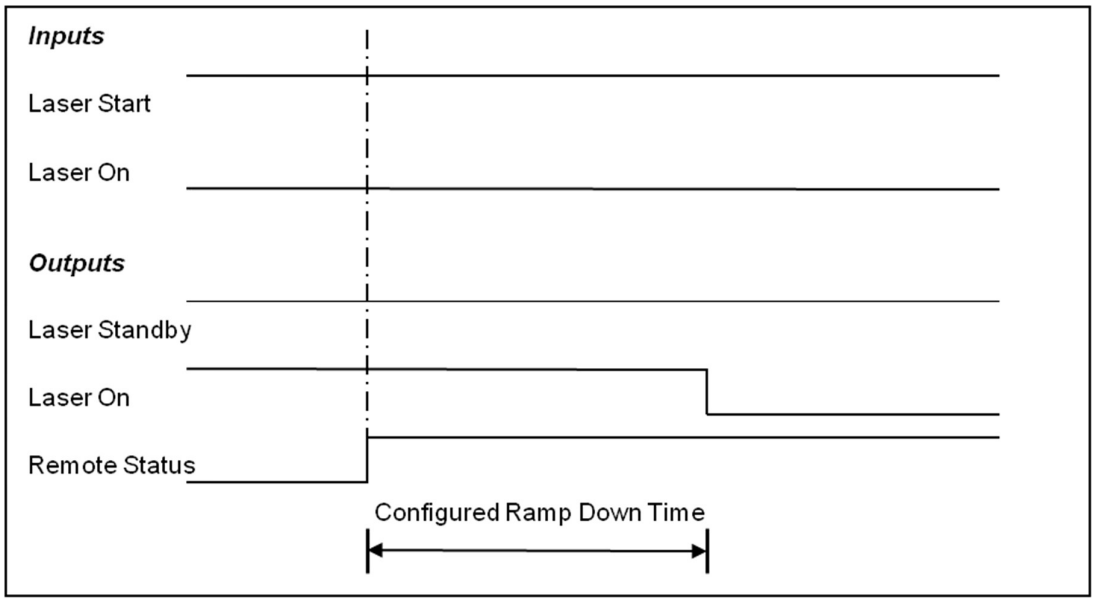


Figure 27 Entering Remote Control
(ON State, Laser ON Input Clear, Ramp Down Time Configured)

b) Process Cycle Operation

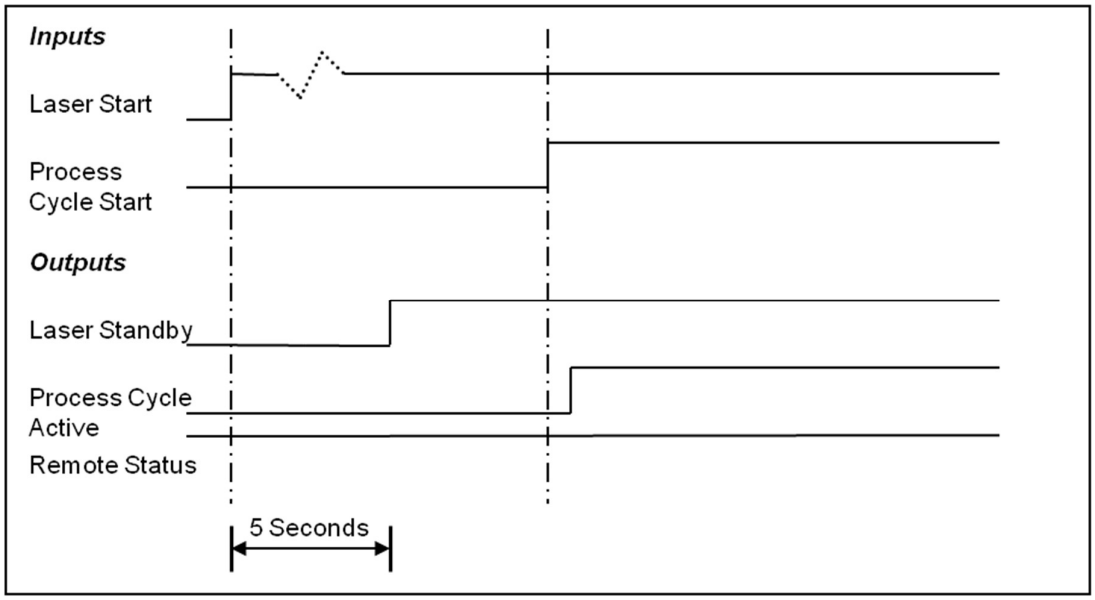


Figure 28 Starting a Process Cycle in Remote Control

Note: The state can be moved to the ON state using a serial protocol message, as long as **Laser Start** is SET.

Process Cycle Start can be asserted at any time to start a Process Cycle as long as the state is the STANDBY state.

There is a small switching delay before **Process Cycle Start** is acted on (<1ms) and **Process Cycle Active** is SET.

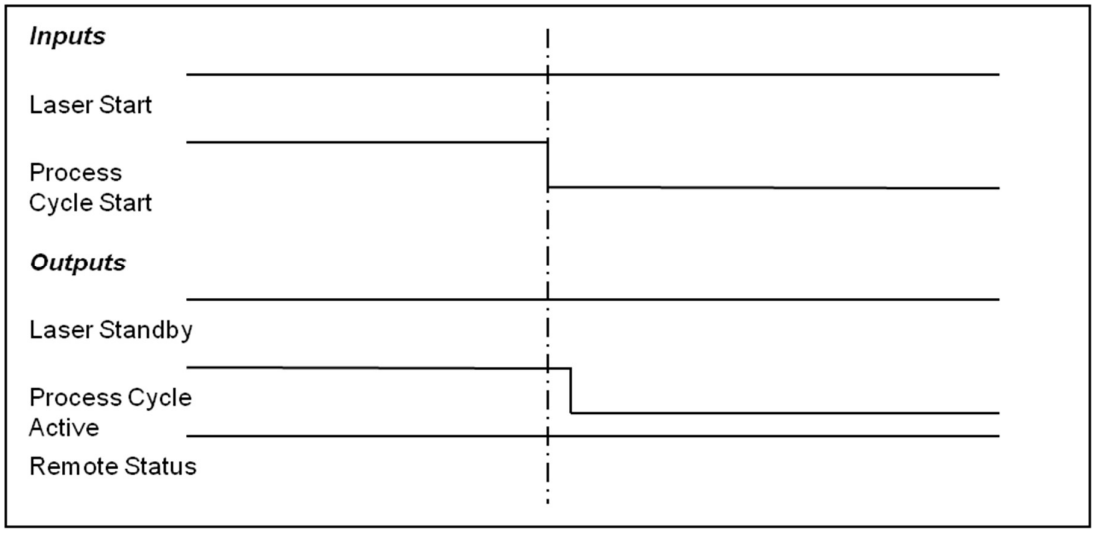


Figure 29 Stopping a Process Cycle in Remote Control (No Ramp Down Time Configured in Active Step Parameter Step)

Note: There is a small switching delay before **Process Cycle Start** is acted (<1ms) and **Process Cycle Active** status is CLEARED.

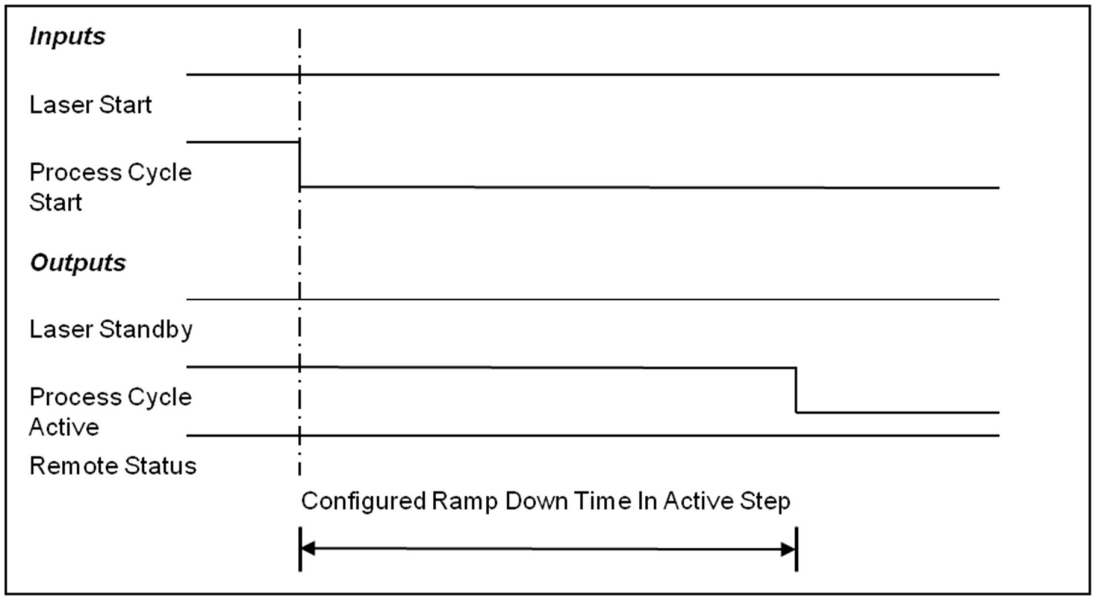


Figure 30 Stopping a Process Cycle in Remote Control (Ramp Down Time Configured in Active Step Parameter Step)

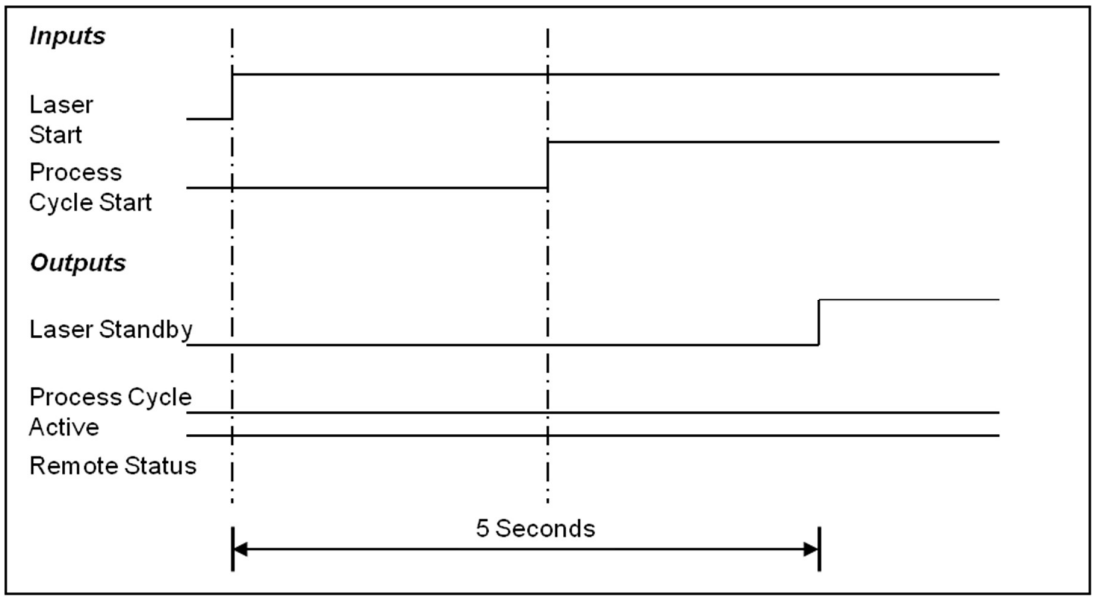


Figure 31 Starting a Process Cycle in Remote Control Before the State has Moved to the STANDBY State

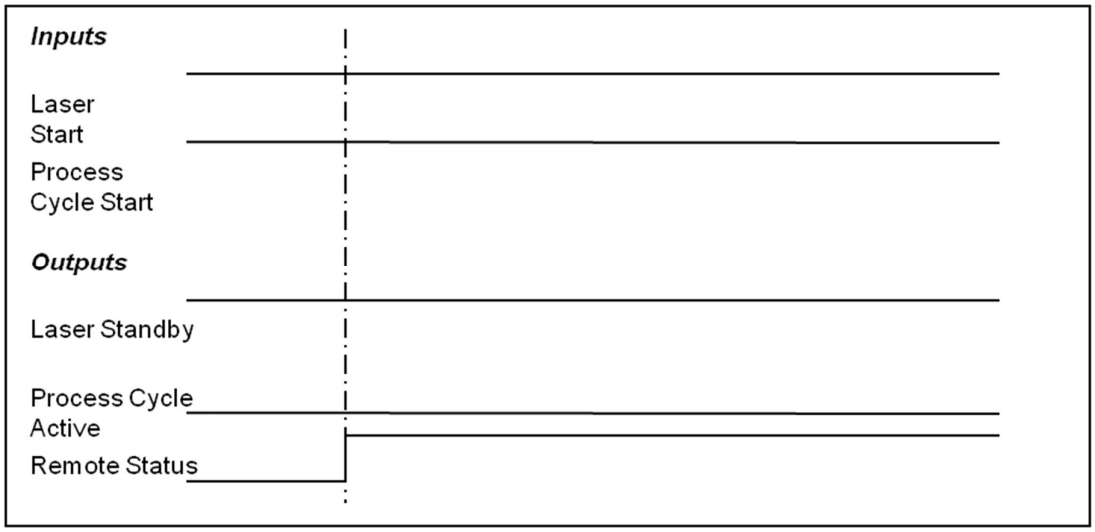


Figure 32 Entering Remote Control (STANDBY State, Process Cycle Start Input SET)

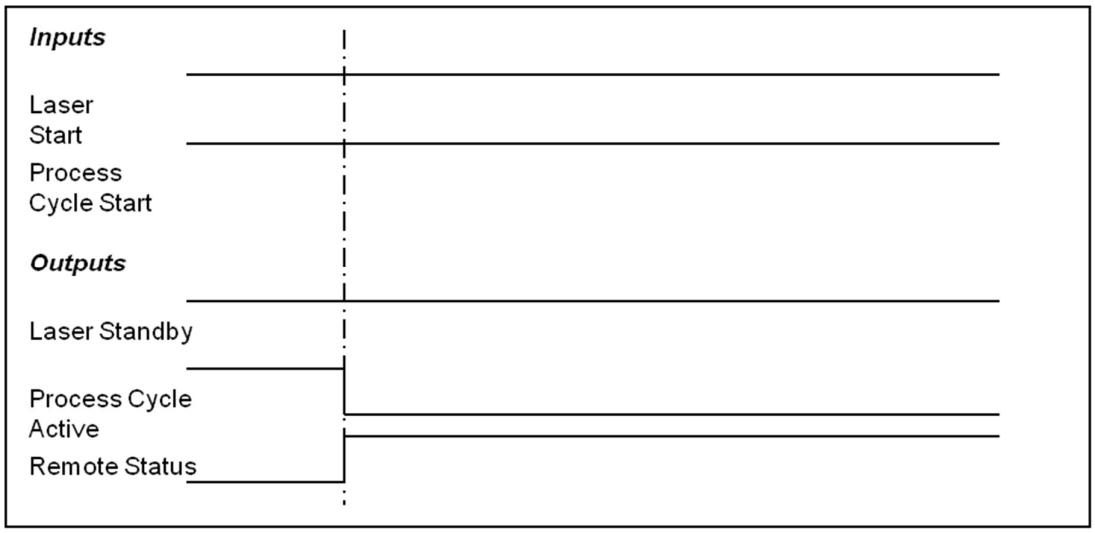


Figure 33 Entering Remote Control (Process Cycle Active, Process Cycle Start Input Set, No Ramp Down Time Configured in Active Step Parameter Step)

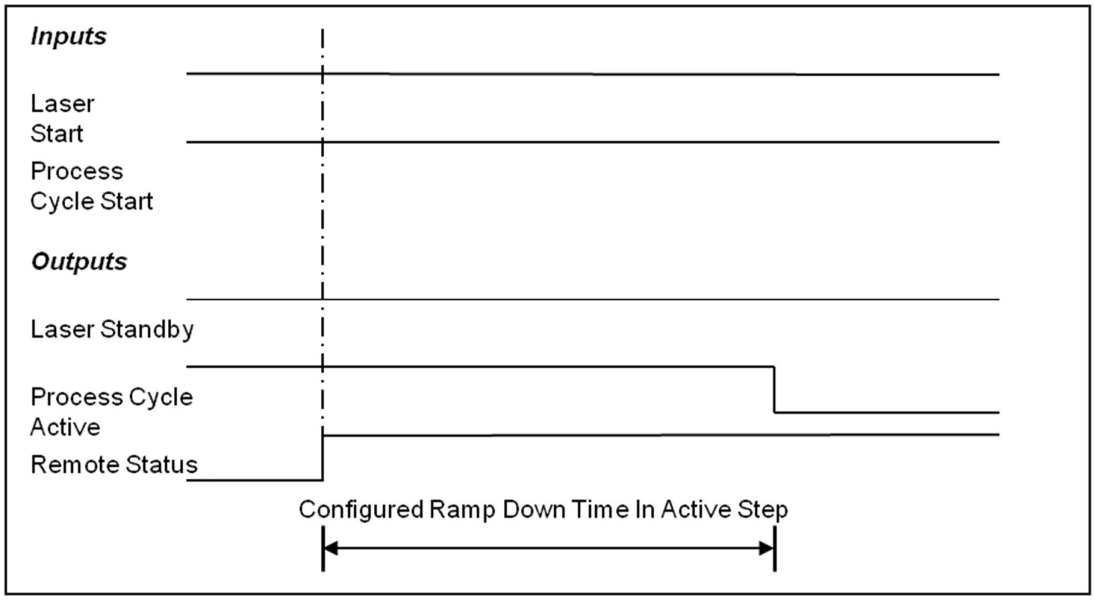


Figure 34 Entering Remote Control (Process Cycle Active, Process Cycle Start Input Set, Ramp Down Time Configured in Active Step Parameter Step)

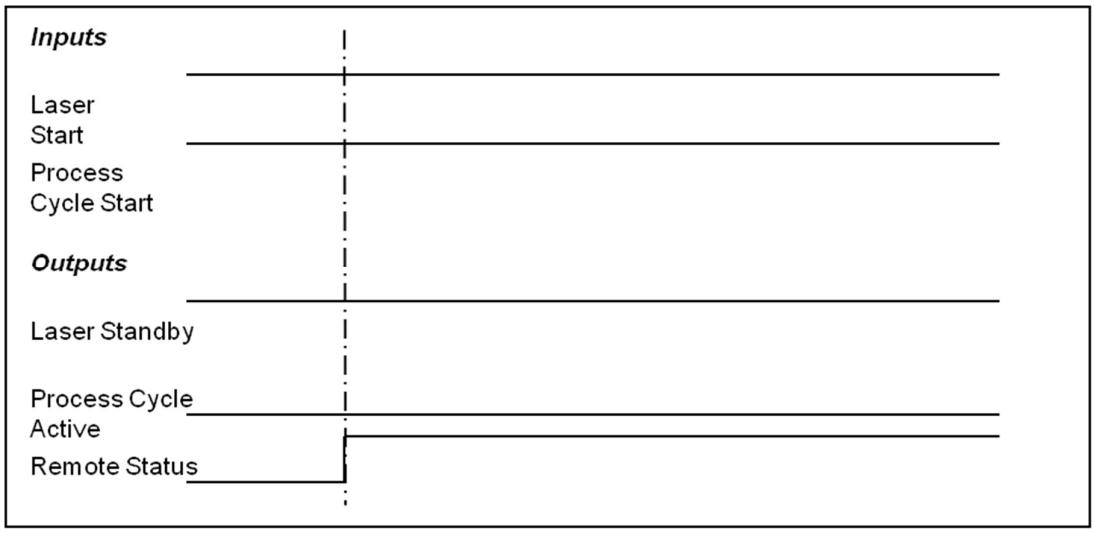


Figure 35 Entering Remote Control (STANDBY State, Process Cycle Start Input Set)

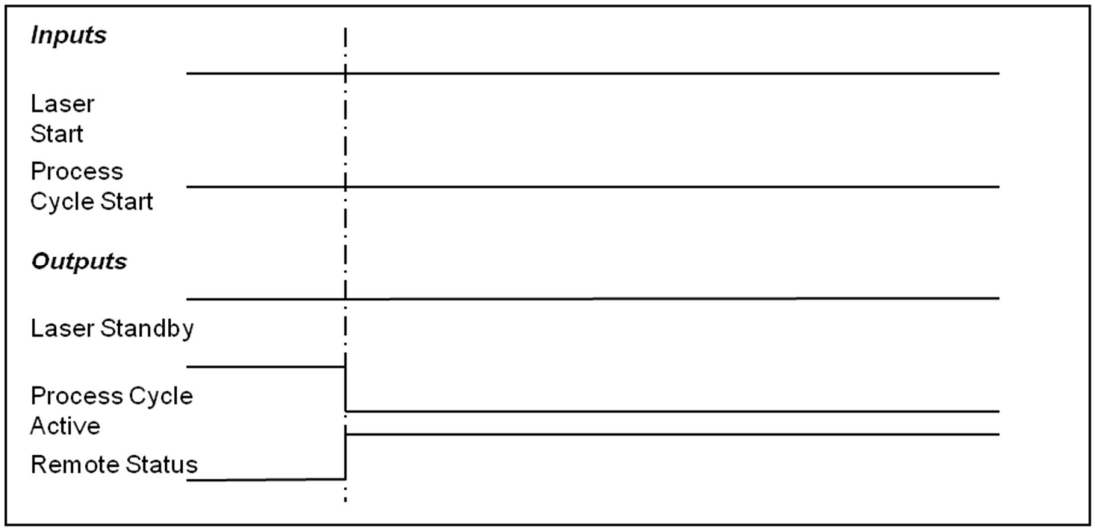


Figure 36 Entering Remote Control (Process Cycle Active, Process Cycle Start Input CLEAR, No Ramp Down Time Configured in Active Step Parameter Step)

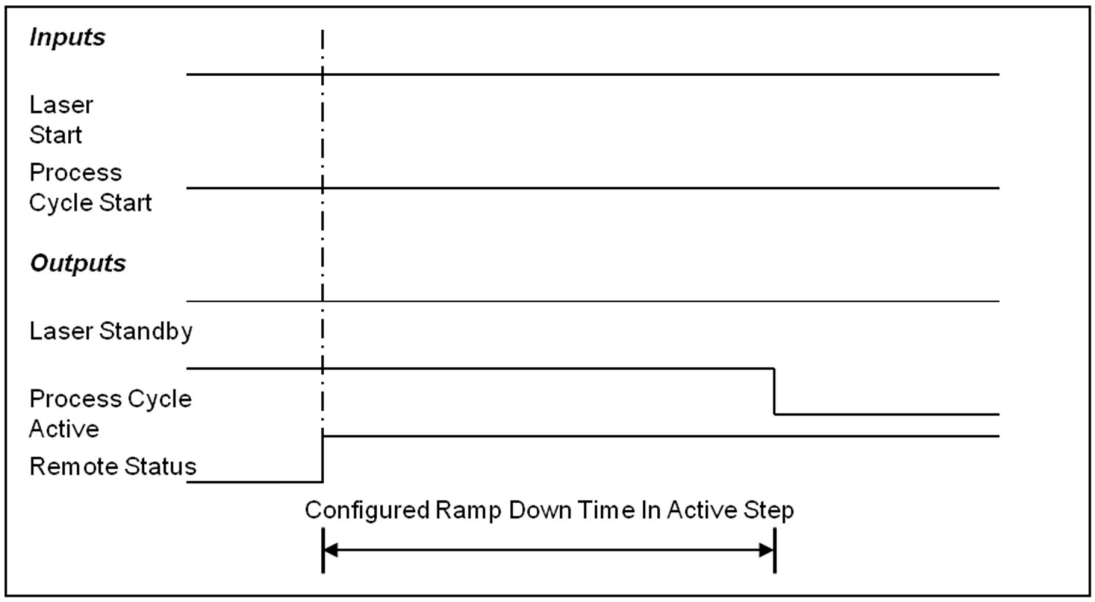


Figure 37 Entering Remote Control
(Process Cycle Active, Process Cycle Start Input CLEAR, Ramp Down Time Configured in Active Step Parameter Step)

11.2.4 Process Cycle Step (Input Function ID 5)

- Default connection
  - PL5 pin number 17
  - Input number 2
- Basic Function Description
  - Only relative to Process Cycle mode.
  - Advance a **Process Cycle Step** once the duration or shots have completed.
  - Input is leading edge sensitive.
  - Only operational in Remote Control.
- Detailed Function Description
  - This input function is used in conjunction with the Process Cycles feature of the FVCU. It is used to advance a Process Cycle on to the next step when the active Process Cycle Step is configured to manual step mode, or the step duration is infinite. The input function becomes active when the step duration (either time or shots) has completed and the step is waiting to advance. The Step input is active from the start of the step execution for steps configured with an infinite duration (duration = 0).

- An output function can be configured on the Machine Interface to indicate that the Process Cycle is waiting for a Step input in order to advance.
- If the function is not configured on the Machine Interface a Process Cycle cannot be advanced using the Machine Interface. In this situation, steps can be advanced using the serial protocol, or steps must be configured to automatically advance.
- This input function is only operational in Remote Control.
- This function can be assigned to any of the seven inputs.
- Associated functions
  - **Laser ON / Process Cycle Start** - Input Function
  - **Laser ON / Process Cycle Active** - Output Function
  - Process Cycle Wait - Output Function

- Sequence diagrams

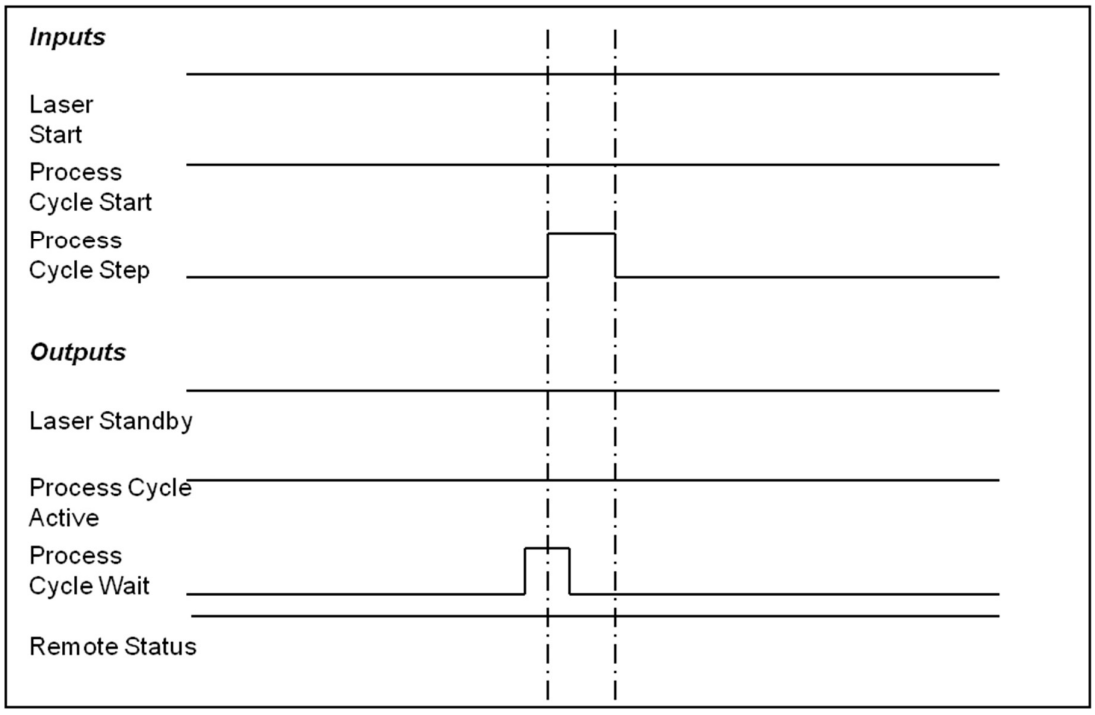


Figure 38 Advancing Process Cycle Steps in Remote Control

Notes:

If a Process Cycle is waiting, it will only advance when it receives a step command.

The **Process Cycle Wait** output will clear once the Step input command has been processed. It is not synchronised with the clearing of the Step input.

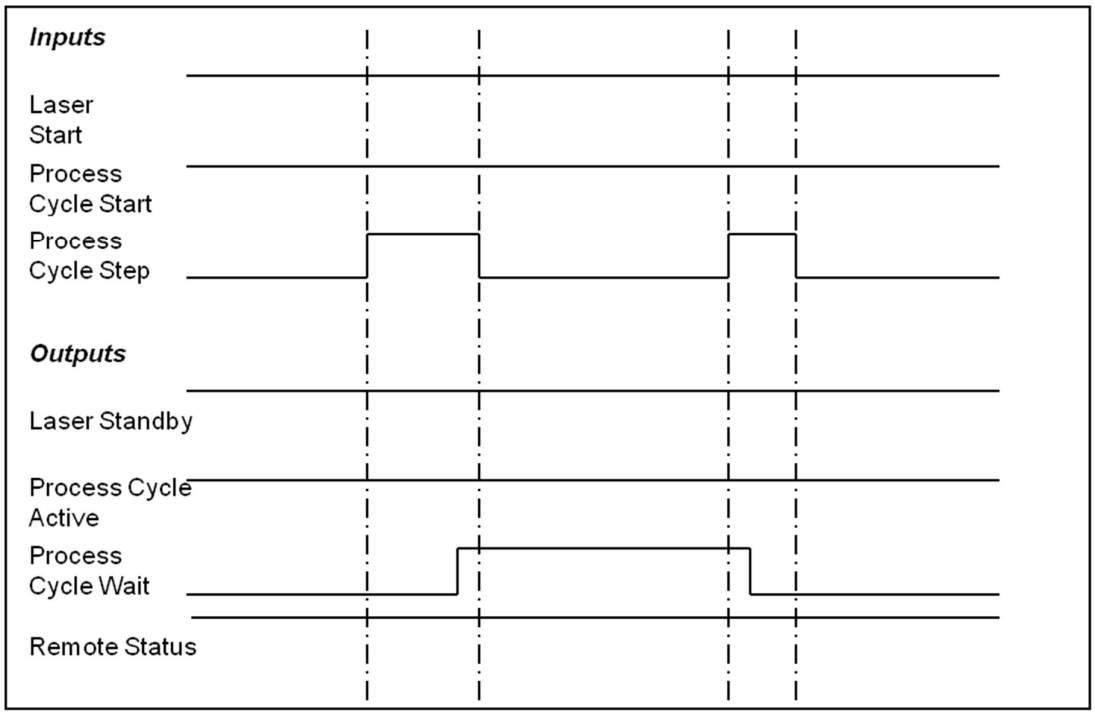


Figure 39 Advancing Process Cycle Steps in Remote Control (Before Process Cycle Wait Is Set)

Note: The second **Process Cycle Step** input advances the process cycle as the leading edge occurs while the Process Cycle is waiting to advance.

11.2.5 Alarm Reset (Input Function ID 6)

- Default connection
  - PL5 pin number 18
  - Input number 4
- Basic Function Description
  - Resets FVCU (normally after an alarm condition has occurred, and the cause has been cleared).
  - Input is leading edge sensitive.
  - Only operational in Remote Control.
- Detailed Function Description
  - This input function allows the FVCU to be reset via the Machine Interface. It Triggers when the input transitions from CLEAR to SET only. The function can be used following an alarm condition, once the fault has been identified and cleared, to clear the latched alarm state.

- Triggering the Alarm Reset function while the state is in the STANDBY or ON state will switch the state to the OFF state.
- An output function can be configured on the Machine Interface to indicate when there is an alarm condition.
- This function is only operational in Remote Control.
- This function can be assigned to any of the seven inputs.
- Associated functions
  - **Alarm** - Output Function
  - **Laser STANDBY** - Output Function

- Sequence diagrams

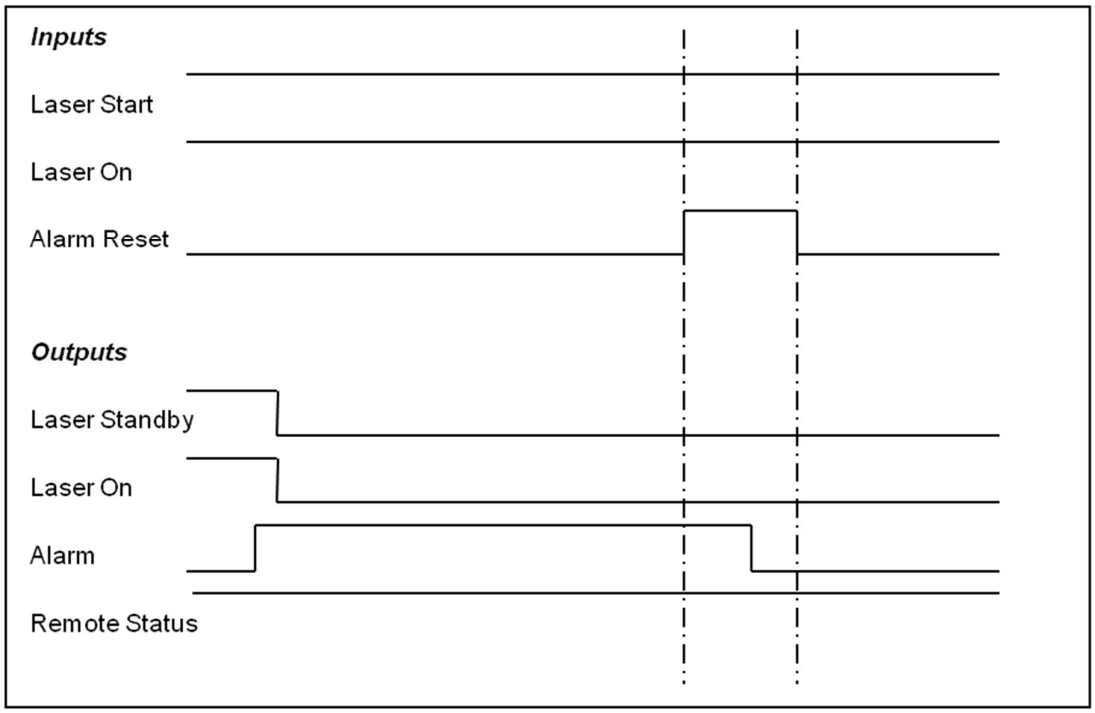


Figure 40 Alarm Reset

Notes:

Alarm condition causes the state to move to the OFF state.

The alarm condition must be cleared before resetting it otherwise the alarm may reoccur following the reset.

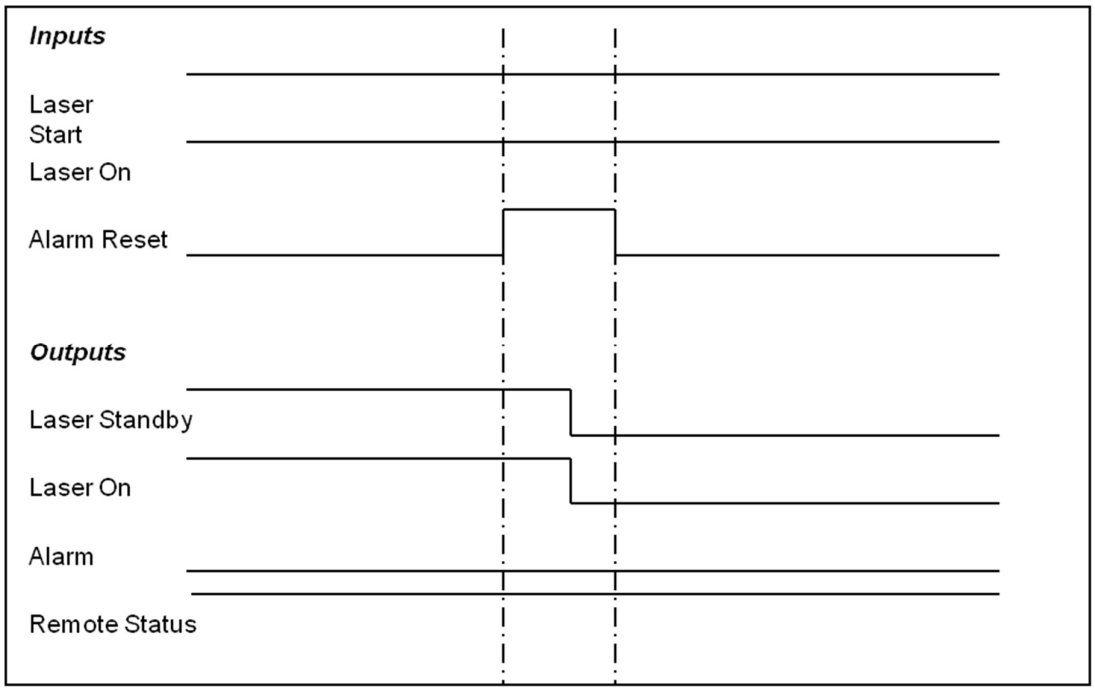


Figure 41 Alarm Reset When in the ON state

11.2.6 Trigger (Input Function ID 3)

- Default connection
  - PL5 pin number 16
  - Input number 6
- Basic Function Description
  - Provides a signal to the FVCU to start output.
  - Configurable for Edge or Gated modes.
  - Input is edge sensitive for Edge Trigger mode.
  - Input is level sensitive for Gated mode.
  - Operational in both Local and Remote Control.
- Detailed Function Description
  - This input function allows the power output to be controlled externally. It has two functions depending on the active Parameter Set settings. It can be configured as a Gate (level sensitive), where power will be output when the input is SET, and stopped when the input is CLEAR, or a Trigger (leading edge sensitive), where a single defined pulse configured in the active parameter set

will be output each time the input is asserted. The output can only be Triggered up to the frequency configured in the active parameter set.

- The input is operational in both Remote and Local Control as follows
- In Local – The Trigger mode is configured using the parameter set configuration.
- In Remote – The Trigger is configured using the Trigger Source Select if this function is configured on the Machine Interface, or the active Parameter Set settings are used if Trigger Source Select is not configured.
- If this function is not configured on the Machine Interface, the external Trigger mode is specified by the active Parameter Set.
- This function can be assigned to any of the seven inputs, although it is recommended to use Input 6, as this input uses higher bandwidth electronics.
- Associated functions
  - Trigger Source Select - Input Function
  - Sync - Output Function

- Sequence diagrams

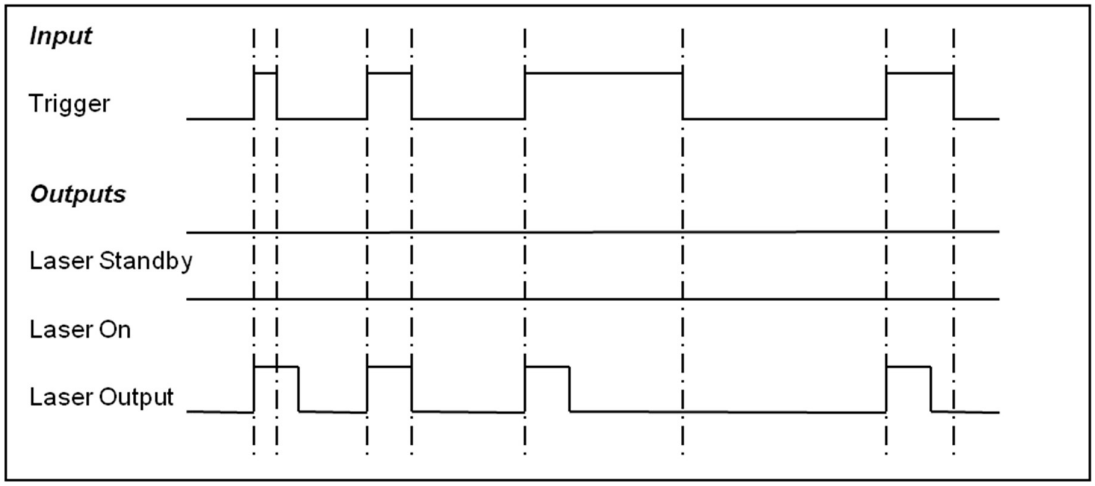


Figure 42 Edge Trigger Operation(Pulsed Output Only)

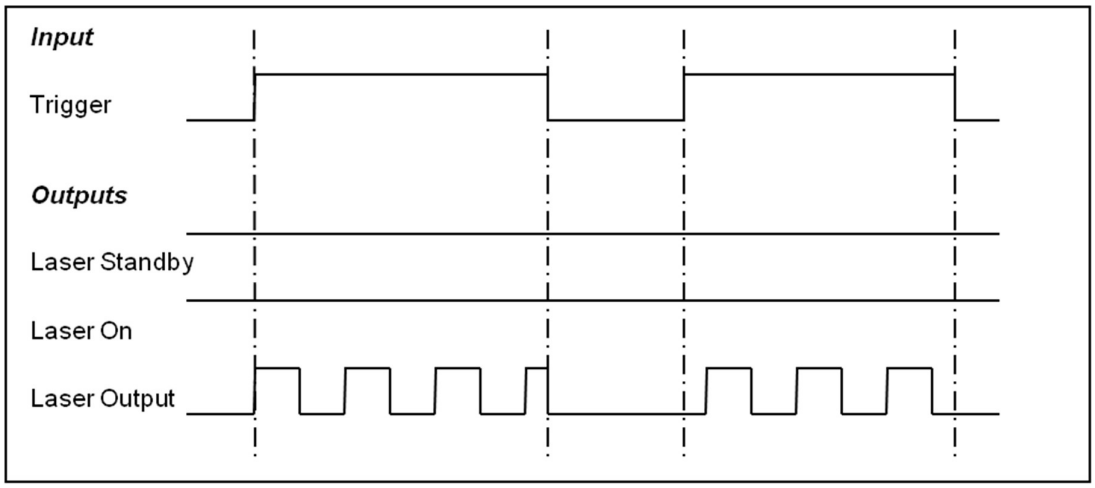


Figure 43 Gated Trigger Operation (Pulsed Output)

Note: Gated Trigger is not synchronised with the output pulses in during Pulsed Output.

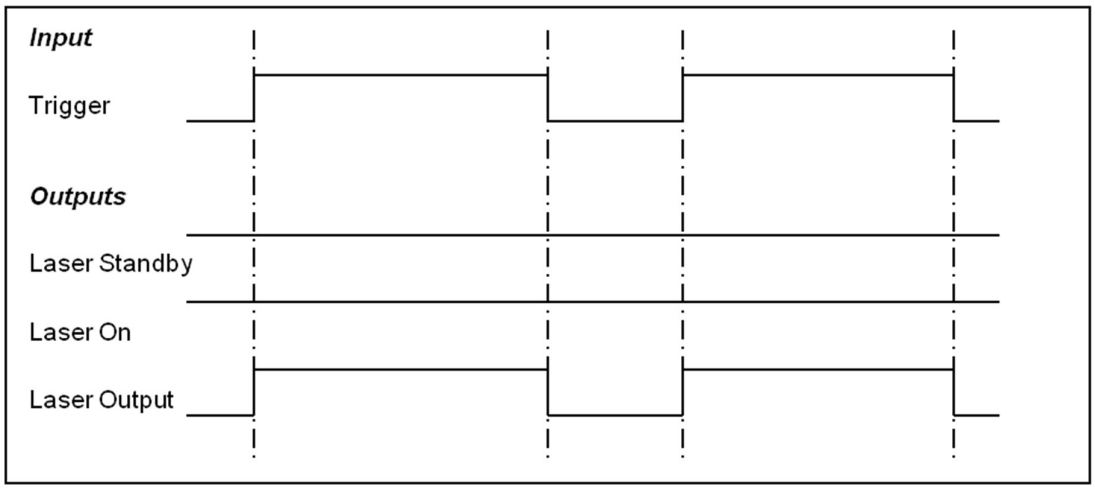


Figure 44 Gated Trigger Operation (CW Output)

11.3 Default Output Functionality

11.3.1 Laser STANDBY (Output Function ID 1)

- Default connection
  - PL5 pin number 19
  - Output number 0
- Basic Function Description
  - SET when the state is the STANDBY state.

- CLEAR when the state is in the OFF state.
- Operational in both Local and Remote Control.

- Detailed Function Description
  - This output function is used to indicate when the state is the STANDBY state. It will not be SET until the emission indication time (5s) has expired, following a **Laser Start** command from either a configured Machine Interface **Laser Start** input function, or a **Laser STANDBY** serial command message.
  - The output function will also be SET when the state is the ON state, or a Process Cycle is active.
  - The output function is CLEAR when the state is the OFF state or STARTING state.
  - This function can be assigned to any of the seven outputs.
  - Associated functions
    - **Laser Start** - Input Function
- Sequence diagrams
  - See Figure 15 to Figure 44 for example functionality.

11.3.2 Laser ON / Process Cycle Active (Output Function ID 2)

- Default connection
  - PL5 pin number 7
  - Output number 1
- Basic Function Description
  - SET when the state is the RAMPING state or the ON state, or a Process Cycle is active.
  - CLEAR when the state is in the STANDBY state or the OFF state.
  - Operational in both Local and Remote Control.
- Detailed Function Description
  - This output function is used to indicate when the state is the ON state or RAMPING state in Parameter Sets mode or a Process Cycle is active in Process Cycle mode.
  - The operation of the function is subtly different depending on whether the FVCU is operating in Parameter Set mode, or Process Cycles mode as follows:

a) Parameter Sets mode:

- This output function will be SET following a **Laser ON** command from either a configured Machine Interface **Laser ON** input function (SET under Remote Control), or a **Laser ON** serial command message.
- When the FVCU is configured to ramp up via the Parameter Set, this function will be SET when the ramp up starts, and remain SET until the state returns to the STANDBY state or moves to the OFF state.
- When the FVCU is configured to ramp down via the Parameter Set, this function will be CLEAR when the ramp down has completed and output has stopped. This output function remains SET for the duration of a configured ramp down time following the issue of a **Laser STANDBY** command either by a configured Machine Interface **Laser ON** input function (CLEARED under Remote Control) or a **Laser STANDBY** serial command message.

b) Process Cycles mode:

- This output function will be SET following a Process Cycle Start command from either a configured Machine Interface Process Cycle Start input function (SET under Remote Control), or a Process Cycle Start serial command message.
- Output function will be CLEAR when a Process Cycle completes, or the Process Cycle is stopped from either a configured Machine Interface Process Cycle Start input function (CLEARED under Remote Control), or a Process Cycle Stop serial command message.
- When a Process Cycle is terminated; if the current step being executed is referencing a Parameter Set with a ramp down time defined, this output function remains SET for the duration of a configured ramp down time following the issue of a Process Cycle Stop command either by a configured Machine Interface Process Cycle Start input function (CLEARED under Remote Control) or a Process Cycle Stop serial command message.
- This function can be assigned to any of the seven outputs.
- Associated functions
    - **Laser ON** / **Process Cycle Start** - Input Function
    - **Laser STANDBY** - Output Function
- Sequence diagrams
    - See Figure 20 to Figure 44 for example functionality.

11.3.3 Remote Control (Output Function ID 3)

- Default connection
    - PL5 pin number 20

- Output number 2

- Basic Function Description
  - SET when in Remote Control.
  - CLEAR when t in Local Control.

- Detailed Function Description
  - This output function is used to indicate whether the FVCU is in Remote or Local control mode. Remote Control indicates that the FVCU is monitoring and being controlled by the Machine Interface inputs. The mode is Local control when the output is CLEAR, and Remote Control when the output is SET.
  - Some or all of the Local control functionality can be utilised when in Remote Control, depending on the Machine Interface input configuration.
  - The mode can only be changed between Remote and Local control via the serial communications interface.
  - This function can be assigned to any of the seven outputs.

- Sequence diagrams
  - See Figure 15 to Figure 42 for example functionality.

11.3.4 Alarm (Output Function ID 7)

- Default connection
  - PL5 pin number 8
  - Output number 3

- Basic Function Description
  - SET when there is in an alarm condition.
  - CLEAR when there is no alarm condition.
  - Operational in both Local and Remote Control.

- Detailed Function Description
  - This output is used to indicate when there is an Alarm condition. It is cleared by issuing an **Alarm Reset** command once the condition causing the alarm has been cleared, from either a configured Machine Interface **Alarm Reset** input function (SET under Remote Control) or an **Alarm Reset** serial command message.
  - This function can be assigned to any of the seven outputs.
  - Associated function
    - **Alarm Reset** - Input Function

11.3.5 Warning (Output Function ID 8)

- Default connection
  - PL5 pin number 21
  - Output number 4
- Basic Function Description
  - SET when there is a warning condition.
  - CLEAR when there is no warning condition.
  - Operational in both Local and Remote Control.
- Detailed Function Description
  - This output is used to indicate when there is a Warning condition.
  - This output function is SET for any warning condition. It is CLEARED when there are no warning conditions.
  - This function can be assigned to any of the seven outputs.

11.3.6 Process Cycle Wait (Output Function ID 5)

- Default connection
  - PL5 pin number 22
  - Output number 6
- Basic Function Description
  - SET during a Process Cycle at the end of a manual transitions step to indicate the Process Cycle is waiting for a Step input in order to continue.
  - CLEAR at any other time.
  - Operational in both Local and Remote Control.
- Detailed Function Description
  - This output is used to indicate when the Process Cycle is waiting for a Step command in order to advance during a Process Cycle execution.
  - The Step command can be issued either by a configured Machine Interface **Process Cycle Step** input function (SET under Remote Control) or a **Process Cycle Step** serial command message.
  - This function can be assigned to any of the seven outputs.
  - Associated functions
    - **Laser ON / Process Cycle Start** - Input Function
    - **Process Cycle Step** - Input Function

- **Laser STANDBY** - Output Function
- **Laser ON / Process Cycle Active** - Output Function

- Sequence diagrams
  - See Figure 38 and Figure 39 for example functionality.

11.4 Protocol Message References

- Set Zone Configuration (Control Code 0x20)
- This command is used to configure the Machine Interface functionality.
- Read Zone Configuration (Control Code 0x21)
- This command is used to read the Machine Interface functionality.
- Set Zone Default Configuration (Control Code 0x22)
- This command is used to set the Machine Interface default functionality.
- Set Control Mode (Control Code 0x42)
  - This command is used to switch between remote and local control. The Machine Interface inputs are enabled when in Remote Control.
- Read Control Mode (Control Code 0x43)
  - This command is used to read the remote / local control mode. The Machine Interface inputs are enabled when in Remote Control mode.
- Read Zone Digital IO Block (Control Code 0x71)
  - This command is used to read the current state of the digital I/O.

Refer to SM-S00499, Fiber Laser Serial Communications Protocol, for the exact structure and implementation of the above serial protocol commands.

12 Alarm and Warning Messages

12.1 Alarm Code Definitions

Each alarm code contains information about the zone, and module associated with the failure. It can be broken down as follows:

Alarm Code = ZMNN

Where

Z is the zone associated with the alarm.

M is the module number to identify devices where there is more than one.

NN is the alarm code identifying the problem.

12.1.1 PRISM FL Module Zone Alarms

Code	Description
8m01	Module Communications Failure
8m02	Temperature 1 Fault
8m03	Temperature 2 Fault
8m04	Temperature 3 Fault
8m05	Temperature 4 Fault
8m06	Temperature 5 Fault
8m07	Temperature 6 Fault
8m08	Snap Switch Faulty
8m09	Memory corruption fault
8m10	Auxiliary Power Supply Low Fault
8m11	Driver Power Supply not Present
8m12	Fiber Failure
8m13	BDO Open
8m14	BDO Short
8m15	Humidity
8m16	Internal Communications Failure

Code	Description
8m17	Unexpected Emission
8m18	Driver Negative Power Supply Failure
8m19	PLC Driver Output Fault

12.1.2 System Zone Alarms

Code	Description
1102	System configuration memory failure. Unknown configuration data loaded. FVCU will not operate. Factory configuration setup required.
1120	Serial communications failure
1123	Ethernet communications failure
1130	HPFL – Combiner base plate - High temperature
1131	High internal optics temperature
1133	HPFL – LCMS Cover Temperature
1160	Serial watchdog timeout
1162	Ethernet watchdog timeout

12.1.3 Control Zone Alarms

Code	Description
2101	Modulation frequency error – Frequency demand out of range
2102	Update error – Attempted parameter update failed
2103	Peak current demand error – Peak current demand out of range
2105	Ramp time error – Ramp timing out of range

12.1.4 Modulator Zone Alarms

Code	Description
3m02	PRISM FL Module fault
3m03	PRISM FL Module communications failure
3m04	PRISM FL Module communications failure

12.1.5 Fiber Zone Alarms

Code	Description
4m01	HPFL – Case
4m02	FCMS fault
4m03	Fiber output housing over temperature
4m04	Power monitor signal out of range
4m05	Excessive peak back reflections detected
4m06	Excessive back reflections detected

12.1.6 Machine Interface Zone Alarms

Code	Description
5101	Configuration memory failure, defaults loaded.

12.1.7 GUI Zone Alarms

Code	Description
6101	Serial communications fault

12.1.8 PSU Zone Alarms

Code	Description
7101	PSU 1 failed
7102	PSU 1 voltage dip detected

12.2 Warning Code Definitions

Each warning code contains information about the zone, and module associated with the failure. It can be broken down as follows:

Warning Code = ZMNN

Where

Z is the zone associated with the warning.

M is the module number to identify devices where there is more than one.

NN is the warning code identifying the problem.

12.2.1 PRISM FL Module Zone Warnings

Code	Description
8m51	PRISM FL Module Disabled
8m52	Temperature 1 Warning
8m53	Temperature 2 Warning
8m54	Temperature 3 Warning
8m55	Temperature 4 Warning
8m56	Temperature 5 Warning
8m57	Temperature 6 Warning
8m58	Calibration Warning
8m59	Therm Fault
8m60	Humidity Warning
8m61	Calibration Failed
8m62	Fan Failed

12.2.2 System Zone Warnings

Code	Description
1102	Unknown Configuration.
1108	Parameter defaults in use.
1120	Serial communications buffer approaching full
1121	Serial communications buffer full. Messages will be rejected until space available.
1122	Ethernet communications buffer approaching full
1123	Ethernet communications buffer full. Messages will be rejected until space available.
1130	High laser tray temperature
1131	High internal optics temperature
1133	High diode tray temperature
1148	Modulator fault detected

Code	Description
1150	Shape data has been reset
1151	Segment data has been reset
1152	Process cycle data reset
1153	Process cycles step data reset

12.2.3 Control Zone Warnings

Code	Description
2101	Ramp up incomplete
2102	Ramp down incomplete
2103	Ramp between parameters incomplete
2104	In safe mode following optical fault detection
2105	Modulation frequency error – Frequency demand out of range
2106	Fiber pierce frequency error – Frequency demand out of range

12.2.4 Fiber Zone Warnings

Code	Description
4m01	LPFL - Burn back protection disabled HPFL - Main power monitor burn back protection disabled
4m02	FCMS circuit broken
4m03	Fiber output housing over temperature
4m04	Back reflection protection disabled
4m05	Excessive back reflections detected

12.2.5 Machine Interface Zone Alarms

Code	Description
5101	Using default Machine Interface configuration

12.2.6 PSU Zone Warnings

Code	Description
7150	PSU not present.
7151	PSU charge fault

13 Maintenance

WARNING: Never attempt to modify internal or external components not covered in this section.

Doing so may lead to serious personal injury, performance degradation and premature failure

The FVCU is designed to be maintenance free. There are no parts or mechanical items within the FVCU that require replacement during the specified operating life of the FVCU. However periodic inspection of the FVCU is recommended.

13.1 Periodic Inspection

The items listed below should be inspected periodically for damage which may affect the safe operation of the FVCU. The frequency of the inspection will depend on the environment in which the FVCU is installed.

- The enclosure
- The electrical connections

13.2 General Cleaning

Occasionally, the outside of the FVCU may require cleaning to assure full and clear visibility of the warning labels. Before cleaning disconnect the FVCU from the power supplies. Clean only with a clean damp cloth and if any labels become displaced contact SPI Lasers immediately for replacements.

14 Disposal

At end of life, this FVCU should be separately collected from unsorted waste with a view to meeting the recovery and recycling targets specified in the appropriate national regulations implementing the WEEE Directive on waste electrical and electronic equipment (WEEE) for a product of its class.

15 Specifications

The following section describes the operating and performance specifications of the FVCU. Included are details of the utilities required for installation and operation. Before attempting to install or integrate the FVCU, please read this section to ensure all requirements are understood.

15.1 Operating Conditions

This FVCU is designed for indoor use and to be safe when operated within the environmental conditions given in Table 14 and at the pump diode supply voltage given in Table 16.

Table 14 Environmental Operating Conditions

Parameter	Value	Units
Temperature (Operating)	5 – 45	°C
Humidity (Operating)	5 – 85 (non-condensing)	% RH
Altitude	<2000	m

This FVCU is sealed against dust and water ingress to IP52 to BS EN 60529:1992+A2:2013 with the exception of the electrical connectors which are rated IP50. The laser integrator should ensure that when installed the FVCU is not exposed to water.

Note that auxiliary equipment is required to operate the FVCU. The environmental operating conditions of the additional equipment must be observed.

This FVCU must not be installed in a corrosive atmosphere.

This FVCU must not be exposed to high levels of optical radiation, for instance laser or other radiation from materials processing.

15.2 Non-Operating Conditions

Table 15 Non-Operating Conditions

Parameter	Value	Units
Temperature (Storage)	0 to +70	°C
Humidity (Storage)	0 – 95 (non-condensing)	% RH

15.3 Utility Requirements

15.3.1 Electrical Requirement

The FVCU is electrically powered. Electrical power for the internal electronics is provided by a DC auxiliary power supply.

Table 16 Electrical Requirements

Parameter	Min	Typ	Max	Units	Note
Auxiliary PSU	22.8	24	25.2	V DC	5A Rated

The power supply should be appropriately approved and protected

15.4 Mechanical Specifications

Table 17 Dimensions and Weight

Parameter	Value	Unit
Height	88	mm
Width	416	mm
Depth	168	mm
Weight	3.2	kg

16 General Information

16.1 Trade Marks

The SPI Lasers logo, SPI, GTWave, **redPOWER** and **redENERGY** are trademarks (registered or applied for) of SPI Lasers in at least one of the United States of America, the United Kingdom, the European Community and China, and in various other territories throughout the world. All other trademarks are the property of their registered owners.

16.2 Software

Any software forming part of this equipment should be used only for the purpose for which it was supplied by SPI Lasers. No changes, modifications or copies (except for producing a necessary back-up copy) shall be undertaken by the User.

SPI Lasers accepts no responsibility for equipment malfunction resulting from any of the above actions.

16.3 Warranties

SPI Lasers makes no warranties, expressed or implied, including and without limitation warranties as to merchantability or fitness for a particular purpose except as expressly set forth in the standard Terms and Conditions of sale.

16.4 Copyright

16.5 Changes

These Instructions for Use are supplied without liability for errors or omissions. SPI Lasers reserves the right to change the information and specifications contained in these Instructions for Use without prior notice.

17 Contact Information

Table 18 Contact Information

UK Head Office and Manufacturing Facility	US Corporate Office	China Office	Korea Office
SPI Lasers UK Limited 6 Wellington Park Hedge End Southampton SO30 2QU UK Tel: +44 (0)1489 779696	**SPI Lasers LLC** 4000 Burton Drive Santa Clara CA 95054 USA Tel: +1 408 454 1169	**SPI Lasers (Shanghai) Co., Ltd.** Room 108, Building 3 No. 7 Guiqing Road Caohejing Hi-tech Park Shanghai 200233 China Tel: +86 (0) 21 6171 9470	**SPI Lasers Korea Ltd.** A-1201 DAEBANG TRIPLAON Business Tower 1682 Jungsan-dong Ilsandong-gu Goyang-si Gyeonggi-do Republic of Korea Tel: +82 31 926 7580
Order Management orders@spilasers.com Tel: +44 (0)1489 779696 - Option 5		**Company Web Site** www.spilasers.com	
Service service@spilasers.com Tel: +44 (0)1489 779696 - Option 2 productsupportasia@spilasers.com Contact your local office number		Or contact your local distributor.	

18 Service

In the unlikely event that the FVCU requires attention outside the scope of the maintenance requirements as detailed in Section 13, contact SPI Lasers for advice on further on-site fault diagnosis and/or return of the FVCU. Contact information is given in Section 16.

When contacting a Customer Centre, please have the following information at hand:

- The order code.
- The serial number.
- The number of accumulated laser hours.
- Typical operating parameters.
- Any other relevant information (e.g. fault codes and descriptions) that would assist in fault diagnosis.

If the FVCU requires fault-diagnosis or servicing or is to be returned to SPI Lasers, it is the system integrator's responsibility to remove the FVCU from the integrated laser system and make it safe and, if the FVCU is to be returned to SPI Lasers, to ensure that all relevant return documentation is in place before shipment. Details of documentation requirements and copies can be obtained where required from SPI Lasers.

Pack the FVCU in the original packaging and include all original accessories and documentation as detailed in the original inventory. The correct and original packaging should be used to prevent damage in transit. If all or part of the original packaging is unavailable, contact SPI Lasers for replacement items. Please take time to complete all return documentation, which can be obtained from SPI Lasers. Accurate details, diagnosis and comments in the documentation reduce turnaround time for repair at SPI Lasers.

On request, SPI Lasers will supply a report detailing faults found and repairs carried out necessary to return the FVCU to full operational specification.