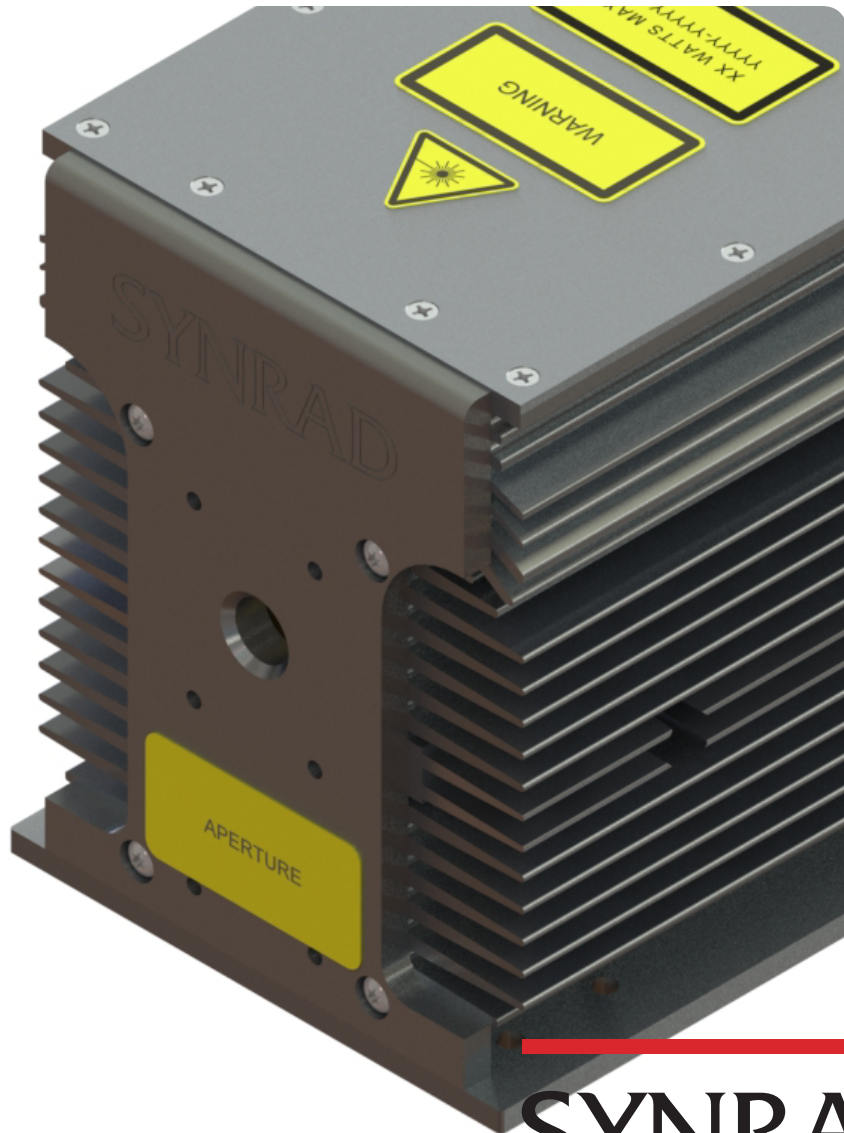


# *firestar* series V30



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# *firestar* series V30

## OEM v30 Operator's Manual

Version 2

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DATE: March 2019

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## Warranty information

This is to certify that v30 lasers are guaranteed by SYNRAD to be free of all defects in materials and workmanship for a period of one year from the date of purchase. This warranty does not apply to any defect caused by negligence, misuse (including environmental factors), accident, alteration, or improper maintenance. We request that you examine each shipment within 10 days of receipt and inform SYNRAD of any shortage or damage. If no discrepancies are reported, SYNRAD shall assume the shipment was delivered complete and defect-free.

If, within one year from the date of purchase, any part of the v30 laser should fail to operate, contact the SYNRAD Customer Service department at 1.800.SYNRAD1 (outside the U.S. call 1.425.349.3500) and report the problem. When calling for support, please be prepared to provide the date of purchase, model number and serial number of the unit, and a brief description of the problem. When returning a unit for service, a Return Authorization (RA) number is required; this number must be clearly marked on the outside of the shipping container in order for the unit to be properly processed. If replacement parts are sent to you, then you are required to send the failed parts back to SYNRAD for evaluation unless otherwise instructed.

If your v30 laser fails within the first 45 days after purchase, SYNRAD will pay all shipping charges to and from SYNRAD when shipped as specified by SYNRAD Customer Service. After the first 45 days, SYNRAD will continue to pay for the costs of shipping the repaired unit or replacement parts back to the customer from SYNRAD. The customer, however, will be responsible for shipping charges incurred when sending the failed unit or parts back to SYNRAD or a SYNRAD Authorized Distributor. In order to maintain your product warranty and to ensure the safe and efficient operation of your Firestar v30 laser, only authorized SYNRAD replacement parts can be used. This warranty is void if any parts other than those provided by SYNRAD are used.

SYNRAD and SYNRAD Authorized Distributors have the sole authority to make warranty statements regarding SYNRAD products. SYNRAD and its Authorized Distributors neither assumes nor authorizes any representative or other person to assume for us any other warranties in connection with the sale, service, or shipment of our products. SYNRAD reserves the right to make changes and improvements in the design of our products at any time without incurring any obligation to make equivalent changes in products previously manufactured or shipped. Buyer agrees to hold SYNRAD harmless from any and all damages, costs, and expenses relating to any claim arising from the design, manufacture, or use of the product, or arising from a claim that such product furnished Buyer by SYNRAD, or the use thereof, infringes upon any Patent, foreign or domestic.

# Service & support information

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## Sales and Applications

SYNRAD Regional Sales Managers work with customers to identify and develop the best CO<sub>2</sub> laser solution for a given application. Because they are familiar with you and your laser application, use them as a first point of contact when questions arise. Regional Sales Managers also serve as the liaison between you and our Applications Lab in processing material samples per your specifications. To speak to the Regional Sales Manager in your area, call SYNRAD at 1.800.SYNRAD1.

## Customer Service

For assistance with order or delivery status, service status, or to obtain a Return Authorization (RA) number, contact SYNRAD at 1.800.SYNRAD1 and ask to speak to a Customer Service representative, or you can email us by sending a message to [customer-care@synrad.com](mailto:customer-care@synrad.com).

## Technical Support

SYNRAD Regional Sales Managers are able to answer many technical questions regarding the installation, use, troubleshooting, and maintenance of our products. In some cases, they may transfer your call to a Laser, Marking Head, or Software Support Specialist. You may also e-mail questions to the Technical Support Group by sending your message to [customercare@synrad.com](mailto:customercare@synrad.com).

## Reference materials

Your Regional Sales Manager can provide reference materials including Outline & Mounting drawings, Operator's Manuals, Technical Bulletins, and Application Newsletters. Most of these materials are also available directly from SYNRAD web site at <http://www.synrad.com>.

## EU headquarters

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# getting started

Use information in this chapter to prepare your OEM v30 laser for operation. The order of information presented in this chapter is the same as the order of tasks that you will need to perform. The best way to get your laser ready for operation is to start at Unpacking and work your way through Connecting.

This chapter contains the following information:

Introduction – introduces the OEM v30 laser, lists important features, and describes Firestar nomenclature.

Unpacking – provides important information about shipping your OEM v30 laser.

Inventory – displays and describes all components shipped with your laser.

Mounting – describes how to attach the OEM v30 laser to a mounting surface.

Connecting – explains how to cool the laser and connect both power and control cables.

# getting started

## Introduction

The Introduction section includes subsections:

- Firestar nomenclature

- Model numbers

The Firestar® v30 laser is designed to provide OEMs a compact, cost-effective 30 W laser package. Although the OEM v30 is part of the Firestar family of lasers, its user interface differs significantly from the standard Firestar interface design. With the exception of the optoisolated PWM input, PWM Positive, all OEM v30 input and output signals operate at 5V logic levels to ensure compatibility and ease of installation when retrofitting the Firestar v30 into existing 30 W laser systems. The OEM v30 control board also differs from other Firestar v-Series models in that it does not incorporate a built-in tickle generator—users should provide a 5 kHz, 1  $\mu$ s tickle pulse between applied PWM signals.

**Important Note:** Firestar OEM v30SxG models do not include a five-second delay function. This means a tickle signal can be applied immediately after the Laser Enable input is activated, effectively eliminating the delay on laser power-up or interlock activation. See Controlling laser power in the Technical Reference chapter for tickle signal specifications and recommended duration prior to lasing.

As with other laser safety requirements, the OEM or system integrator is solely responsible for designing the system to incorporate a five-second delay and any other controls required by relevant laser safety standards for Class 4 laser devices.

**Note:** Although the OEM v30 is part of the Firestar family of lasers, its user interface differs significantly from the standard Firestar interface design. See the Interface connections section in the Technical Reference chapter for details.

The OEM v30 laser is available in either air-cooled (SAG) fan-cooled (SFG), or water-cooled (SWG) configurations

The Firestar OEM v30 laser is an OEM product intended for incorporation as a component in a laser processing system and as such does not comply with 21 CFR, Subchapter J or EN 60825-1 without additional safeguards.

## Firestar nomenclature

Firestar lasers are divided into two distinct functional categories: Keyswitch and OEM models. OEM lasers, like the OEM v30, do not incorporate keyswitch or shutter functions required by CDRH and EN 60825-1 regulations because they are designed as components for integration into larger processing systems by the Original Equipment Manufacturer (OEM) or System Integrator who bears full responsibility for meeting the appropriate laser safety requirements for systems incorporating Class 4 lasers.

## Model numbers

The last three characters in the Firestar model number serve to designate the functional category, cooling method, and model version. The functional category is indicated by either a “K” for Keyswitch or “S” (Switch-less) for OEM models. The next letter indicates the cooling method: “W” for water-cooled units, “F” for fan-cooled units, and “A” for air-cooled lasers (where the customer must provide the proper cooling via fans or blowers). The last letter in the model number indicates the current model version beginning with “B”. For example, the model number FSV30SAG designates the Firestar v30 laser as an OEM, air-cooled, “G” version unit.

# getting started

## Unpacking

The Unpacking section includes subsections:

Incoming inspection

Packaging guidelines

### Incoming inspection

Upon arrival, inspect all shipping containers for signs of damage. If you discover shipping damage, document the damage (photographically if possible), then immediately notify the shipping carrier and SYNRAD, Inc.

The shipping carrier is responsible for any damage occurring during transportation from SYNRAD, Inc. to your receiving dock.

### Packaging guidelines

To prevent equipment damage or loss of smaller components, use care when removing packaging materials.

After unpacking, review the Inventory section and verify that all components are on hand.

Save all shipping containers and packaging materials, including covers and plugs. Use these specialized packing materials when shipping the laser to another location.

When packing a laser for shipment, be sure to remove all accessory items not originally attached to the laser including beam delivery components, connectors, etc.

Refer to the Firestar v30 packaging instructions drawings in the Technical Reference chapter for details on packaging the laser using SYNRAD-supplied shipping materials.

When shipping water-cooled lasers, remember to drain all cooling water from the laser and then cap open fittings to prevent debris from entering the coolant path.

# getting started

## Inventory

SYNRAD CO<sub>2</sub>  
Laser's Manual CD



Quick Start Plug



Cooling Tubing  
(water-cooled only)



Mounting Bolts  
and Fuses



Firestar OEM v30 Laser  
(air-cooled version shown)

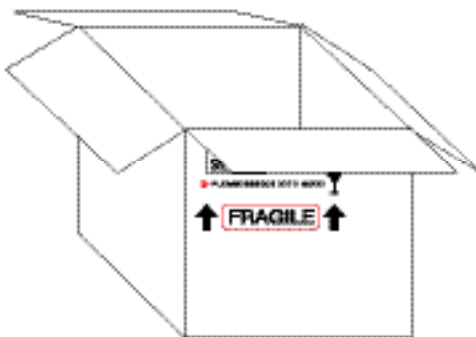
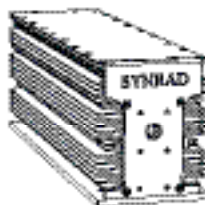


Figure 1-1 Firestar v30 shipping box contents

Table 1-1 lists items included in the Firestar v30 ship kit.

Table 1-1 Ship kit contents

Shipping Box Contents	Qty	Shipping Box Contents	Qty
SYNRAD Firestar OEM v30 Laser .....	1	Mounting Bolts .....	3
SYNRAD CO <sub>2</sub> Lasers Manual CD.....	1	Spare Fuse.....	2
Quick Start Plug (except SA models).....	1	Final Test Report (not shown) .....	1
Cooling Tubing (water-cooled only).....	1		

# getting started

## Inventory

### Contents description

Each item listed in Table 1-1 is described below.

SYNRAD Firestar OEM v30 Laser – for cutting, welding, drilling, and marking a wide variety of products and materials.

SYNRAD CO<sub>2</sub> Lasers Manual CD – contains a Firestar v30 manual that provides setup, operation, and maintenance information for your OEM v30 laser.

Quick Start Plug (except SA models) – connects to the v30's Interface A (DB-9) connector. A built-in jumper enables the v30 for initial start-up and testing.

Cooling Tubing (water-cooled only) – carries cooling water from the chiller to the laser and back. This black polyethylene tubing is 1/2-inch O.D. by 30 feet and must be cut to length.

Mounting Bolts – Three each 1/4–20 × 5/8" UNC capscrews are provided for fastening the Firestar v30 laser to your mounting surface.

Spare Fuse – fast-blow 20 A fuse incorporated into the positive DC power cable protects the laser's internal circuitry. See Troubleshooting in the Maintenance/Troubleshooting chapter for replacement information.

Final Test Report (not shown) – contains data collected during the laser's final pre-shipment test.



# getting started

## Mounting

The OEM v30 base plate is designed so the laser is easily mounted using three 1/4–20 UNC or M6 × 1 ISO fasteners. Three ball bearing “feet” pressed into the base plate eliminate any possible distortion of the laser tube caused by variations in the flatness of the mounting surface. Refer to OEM v30 package outline drawings in the Technical Reference chapter for mounting locations and dimensions.

**Important Note:** To prevent possible distortion of the tube, you must fasten the v30 base plate directly to your mounting surface.

### Caution possible equipment damage

SYNRAD does not recommend mounting lasers in a vertical “head-down” or “tail-down” orientation. If you must mount your laser in this manner, please contact the factory for limitations as a vertical orientation increases the risk of damage to the laser’s output optic.

To fasten the OEM v30 laser to your mounting surface, perform the following steps:

- 1 Refer to the appropriate v30 outline & mounting drawing and drill three holes into your mounting surface that correspond to either the UNC or metric hole pattern.
- 2 Place the v30 laser on the mounting surface so that the threaded holes in the base plate line up with the holes in your mounting surface as shown in Figure 1-2.

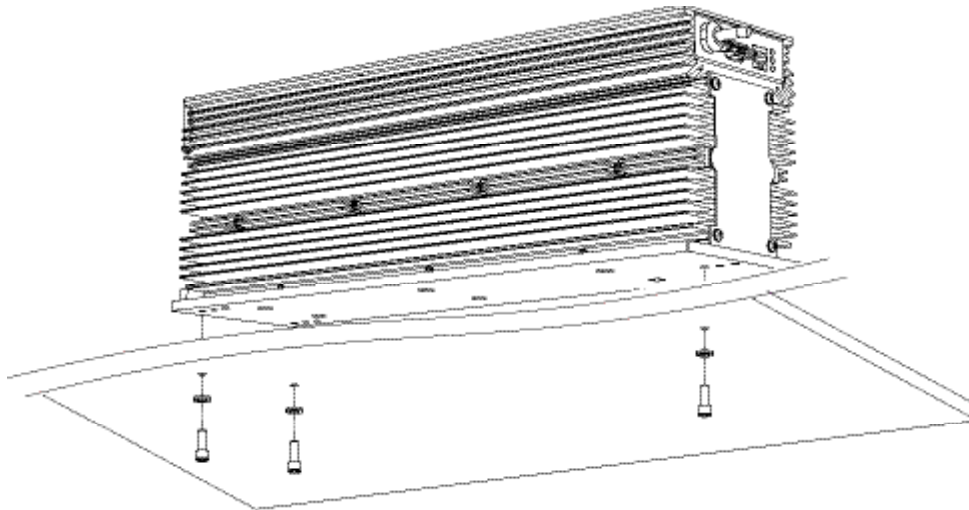


Figure 1-2 OEM v30 mounting locations (1/4–20 fastener locations shown)

**Note:** Mounting bolts must not extend further than 6.0 mm (0.24") into the v30 base plate.

- 3 Insert three M6 × 1 ISO or 1/4–20 UNC capscrews through the mounting surface into the threaded holes of the v30 base plate. Turn the screws by hand until the threads engage.
- 4 Evenly tighten all three capscrews to a maximum torque of 6.1 N m (54 in lb).

# getting started

## Connecting

The Connecting section includes subsections:

Water-cooled connections

Air-cooled connections

Electrical connections

Control connections

Note: If your OEM v30 laser is fan-cooled (an SFG model), then skip ahead to the Electrical connections section. For air-cooled (SAG) lasers, go to the Air-cooled connections section.

## Water-cooled connections

### Cooling fitting adaptors

If your integrated laser application uses metric cooling tubing, you should install tubing adaptors to convert the laser's WATER IN and WATER OUT fittings from 1/2-inch tubing to 12-mm metric tubing. These tubing adaptors are available from many tubing and fitting manufacturers.

## Guidelines for cutting and installing tubing

Cut tubing lengths generously to allow for trimming.

Cut tubing squarely; diagonal cuts may not seal properly. Carefully trim any burrs if the cut is "ragged".

Avoid excessive stress on fittings; create gentle bends when routing tubing close to connectors. Excessive stress from sharp bends will compromise the sealing properties of the fitting.

Never allow the tubing to kink, since kinking severely restricts coolant flow.

Push tubing completely into the fitting, then pull the tubing to verify that it is locked into place.

If tubing must be disconnected from a fitting, first push and hold the tubing slightly into the fitting. Next push the release collet evenly towards the fitting, and then pull the tubing free.

After disconnecting tubing from a fitting, trim 12.7 mm (0.5") from its end before reconnecting. Trimming the end of the tubing before reconnecting the fitting provides an undisturbed sealing surface.

## Chiller preparation guidelines

You must provide fittings to adapt the laser's 1/2-inch O.D. polyethylene cooling tubing to your chiller's Inlet and Outlet ports. These fittings can be "quick disconnect" or compression type fittings.

Because Firestar's cooling tubing is specified in inch sizes, do not use metric tubing fittings unless you have installed the appropriate inch-to-metric tubing adaptors. The use of metric fittings on inch size tubing will lead to coolant leaks or may allow the pressurized tubing to blow-off the fitting.

# getting started

## Connecting Coolants

SYNRAD recommends that the laser's cooling fluid contain at least 90% distilled water by volume. In closed-loop systems, use a corrosion inhibitor/algaecide such as Optishield® Plus or equivalent as required. Avoid glycol-based additives because they reduce the coolant's heat capacity and high concentrations may affect power stability. For SYNRAD lasers, the minimum coolant setpoint is 18 °C (64 °F) so glycol is not necessary unless the chiller is subjected to freezing temperatures. If tap water is used, chloride levels should not exceed a concentration of 25 parts per million (PPM). Install a filter on the chiller's return line and inspect frequently. Firestar OEM v30 lasers incorporate the following wetted materials in the coolant path—nickel-plated brass, copper, acetal, PBT, polyethylene, stainless steel, and Viton®.

Note: DO NOT use de-ionized (DI) water as a coolant. DI water is unusually corrosive and is not recommended for mixed material cooling systems.

## Setting coolant temperature

Choosing the correct coolant temperature is important to the proper operation and longevity of your laser. When coolant temperature is lower than the dew point (the temperature at which moisture condenses out of the surrounding air), condensation forms inside the laser housing leading to failure of laser electronics as well as damage to optical surfaces.

The greatest risk of condensation damage occurs when the laser is in a high heat/high humidity environment and the chiller's coolant temperature is colder than the dew point of the surrounding air or when the system is shut down, but coolant continues to flow through the laser for extended periods of time.

The chiller's temperature setpoint must always be set above the dew point temperature. In cases where this is not possible within the specified coolant temperature range of 18 °C to 22 °C (64 °F to 72 °F), then the following steps **MUST** be taken to reduce the risk of condensation damage.

Air-condition the room or the enclosure containing the laser.

Install a dehumidifier to reduce the humidity of the enclosure containing the laser.

Stop coolant flow when the laser is shut down.

Increase coolant flow by an additional 3.8 lpm (1.0 GPM). Do not exceed a coolant pressure of 414 kPa (60 PSI).

Table 1-2 on the following page provides dew point temperatures for a range of air temperature and relative humidity values. Remember that the laser's coolant temperature must be set above the dew point temperatures shown in the chart; however, for best results and performance, do not exceed a coolant temperature of 22 °C (72 °F).

# getting started

## Connecting

Table 1-2 Dew point temperatures

Dew Point Temperature Chart °F (°C)

Air Temp °F (°C)	Relative Humidity (%)															
	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95
60 (16)	—	—	—	32 (0)	36 (2)	39 (4)	41 (5)	44 (7)	46 (8)	48 (9)	50 (10)	52 (11)	54 (12)	55 (13)	57 (14)	59 (15)
65 (18)	—	—	33 (1)	37 (3)	40 (4)	43 (6)	46 (8)	48 (9)	51 (11)	53 (12)	55 (13)	57 (14)	59 (15)	60 (16)	62 (17)	64 (18)
70 (21)	—	33 (1)	37 (3)	41 (5)	45 (7)	48 (9)	51 (11)	53 (12)	56 (13)	58 (14)	60 (16)	62 (17)	64 (18)	65 (18)	67 (19)	69 (21)
75 (24)	—	37 (3)	42 (6)	46 (8)	49 (9)	52 (11)	55 (13)	58 (14)	60 (16)	62 (17)	65 (18)	67 (19)	68 (20)	70 (21)	72 (22)	73 (23)
80 (27)	35 (2)	41 (5)	46 (8)	50 (10)	54 (12)	57 (14)	60 (16)	62 (17)	65 (18)	67 (19)	69 (21)	71 (22)	73 (23)	75 (24)	77 (25)	78 (26)
85 (29)	40 (4)	45 (7)	50 (10)	54 (12)	58 (14)	61 (16)	64 (18)	67 (19)	70 (21)	72 (22)	74 (23)	76 (24)	78 (26)	80 (27)	82 (28)	83 (28)
90 (32)	44 (7)	50 (10)	54 (12)	59 (15)	62 (17)	66 (19)	69 (21)	72 (22)	74 (23)	77 (25)	79 (26)	81 (27)	83 (28)	85 (29)	87 (31)	88 (31)
95 (35)	48 (9)	54 (12)	59 (15)	63 (17)	67 (19)	70 (21)	73 (23)	76 (24)	79 (26)	81 (27)	84 (29)	86 (30)	88 (31)	90 (32)	92 (33)	93 (34)
100 (38)	52 (11)	58 (14)	63 (17)	68 (20)	71 (22)	75 (24)	78 (26)	81 (27)	84 (29)	86 (30)	88 (31)	91 (33)	93 (34)	95 (35)	97 (36)	98 (37)

To use Table 1-2, look down the Air Temp column and locate an air temperature in Fahrenheit or Celsius (°C values are shown in parentheses) that corresponds to the air temperature in the area where your laser is operating. Follow this row across until you reach a column matching the relative humidity in your location. The value at the intersection of the Air Temp and Relative Humidity columns is the Dew Point Temperature in °F (or °C). The chiller's temperature setpoint must be set above the dew point temperature. For example, if the air temperature is 85 °F (29 °C) and the relative humidity is 60%, then the dew point temperature is 70 °F (21 °C). Adjust the chiller's temperature setpoint to 72 °F (22 °C) to prevent condensation from forming inside the laser.

**Caution**  
possible  
equipment  
damage

Operating the laser at coolant temperatures above 22 °C (72 °F) may result in decreased laser performance and/or premature failure of electronic components.

# getting started

## Connecting Cooling tubing connections

The following procedure will guide you in configuring the most efficient cooling system. Please connect your system exactly as described below.

To connect cooling tubing to your v30 laser, refer to Figure 1-3 and perform the following steps.

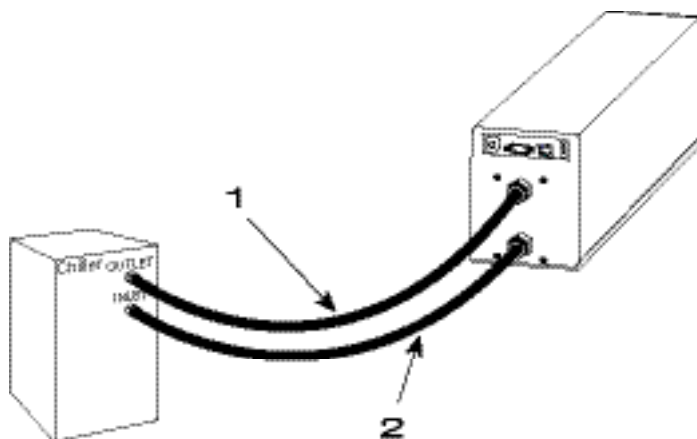


Figure 1-3 OEM v30 cooling connections

- 1 Cut and connect a length of 1/2-inch O.D. polyethylene cooling tubing to fit between the chiller's Outlet port and the upper WATER IN port on the rear of the OEM v30 laser.
- 2 Cut and connect a length of tubing to fit between the lower WATER OUT port on the rear of the laser and the chiller's Inlet port.

### Caution possible equipment damage

Inlet coolant temperature must be maintained above the dew point temperature to prevent condensation and water damage to the v30 laser.

- 3 Turn on the chiller and adjust the coolant temperature setpoint to between 18 °C to 22 °C. Regulate coolant flow to 3.8 lpm (1.0 GPM) at less than 414 kPa (60 PSI) of pressure.
- 4 Closely examine all cooling connections and verify that there are no leaks.

### Caution possible equipment damage

Operating the laser at coolant temperatures above 22 °C (72 °F) may result in decreased laser performance and/or premature failure of electronic components.

# getting started

## Connecting

### Air-cooled connections

#### Side cooling

Air-cooled v30 (SAG) lasers are shipped without cooling fans so customers must provide some type of air cooling to prevent overheating. SYNRAD recommends using two cooling fans rated for at least 4.0 m<sup>3</sup>/min (140 CFM) at a static air pressure of 13.2 mm H<sub>2</sub>O (0.52 in H<sub>2</sub>O). The cooling fans should measure approximately 120 × 120 mm (4.7" × 4.7") and have at least 57.2 mm (2.25") of unobstructed clearance between the outside edge of the fan housing and any mounting surface or enclosure.

The OEM v30 does not provide a voltage output sufficient to power cooling fans, so customers must provide an external power source to drive the selected cooling fans. Because of the heat generated by internal RF circuitry, establishing significant airflow evenly over the entire surface of the combined laser/RF chassis is vitally important to the performance and longevity of the laser.

For free-space mounting (no fan shroud), position the fans symmetrically as shown in Figure 1-4 where they are centered horizontally with the laser chassis and vertically with the heatsink fins. Position both fans so the inside face is no more than 76 mm (3.0") from the v30's heatsink fins.

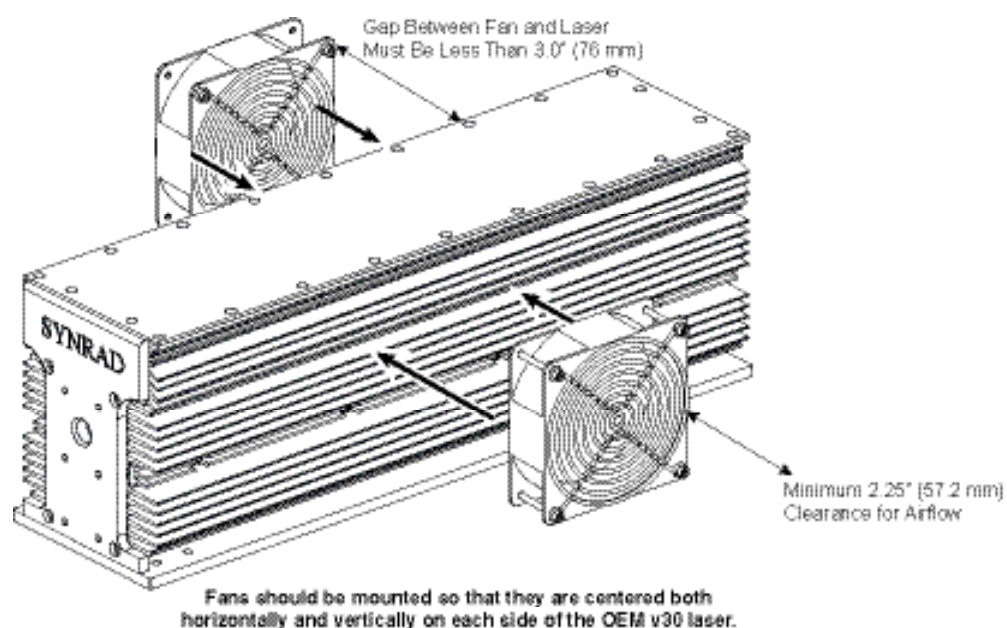


Figure 1-4 Recommended v30 cooling fan locations – free-space cooling

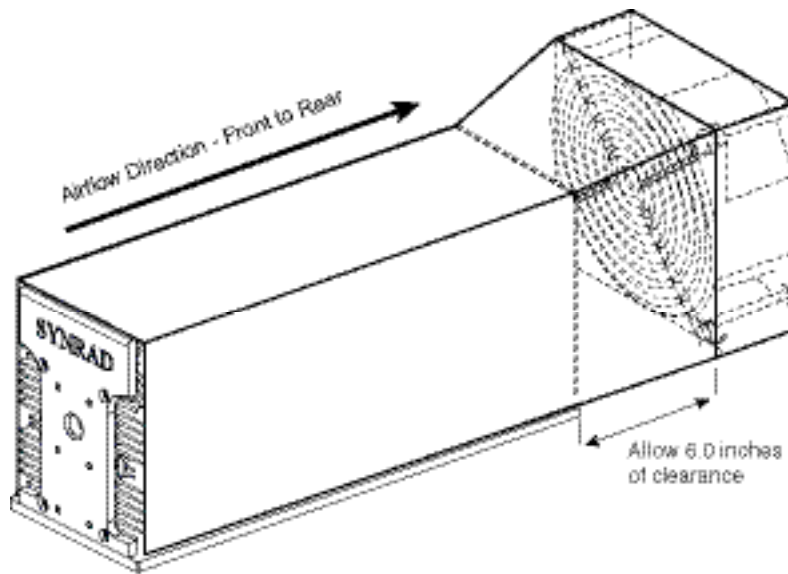
When using a tight-fitting fan shroud designed for side cooling, the cooling fans can be positioned within 5–25 mm (0.20–1.0") of the heatsink fins as long as the same gap is maintained on either side.

#### Rear cooling

A fan shroud designed for rear cooling can be used to minimize the length of the laser installation as shown in Figure 1-5. The shroud should enclose the full length of the laser and cooling fan and must fit snugly against the laser's heatsink fins. Use a fan rated for at least 8.5 m<sup>3</sup>/min (300 CFM) at a static air pressure of 23.9 mm H<sub>2</sub>O (0.94 in H<sub>2</sub>O) and position it approximately 150 mm (6.0") from the rear of the laser.

# getting started

## Connecting



The customer-supplied fan shroud must be designed so that it encloses both the OEM v30 laser and cooling fan.

Figure 1-5 Recommended fan shroud design – rear cooling

### Guidelines for rear cooling

Design the cooling shroud so that it encloses the full length of both the laser and the cooling fan.

Fit the shroud snugly against the laser's heatsink fins so air is ducted between the fins and not around them.

For proper heat removal, open the shroud at the front to direct air flow through the laser.

Use a cooling fan rated for at least 8.5 m<sup>3</sup>/min (300 CFM) at a static air pressure of 23.9 mm H<sub>2</sub>O (0.94 in H<sub>2</sub>O) and position it approximately 150 mm (6.0") from the rear of the laser.

### Electrical connections

The following procedures describe how to complete electrical connections to v30 lasers. OEM v30 DC power cables are manufactured from #12 AWG wire and measure 1 meter (40 inches) in length.

### DC power supply

**Note:** The negative (–) side of the DC input to the laser is internally connected so that the laser chassis serves as DC power ground. You should isolate the laser's DC power supply so that the only grounded connection is at the laser. Alternatively, you can mount the laser chassis on an insulating pad or film in order to electrically isolate the laser when other equipment is grounded to the laser's DC power supply.

# getting started

## Connecting

OEM v30 SAG/SWG lasers require a DC power supply capable of providing 30 VDC at 15 A minimum (24 A peak for a minimum of 0.5 ms) while fan-cooled (SFG) models require 30 VDC at 16 A (24 A peak for a minimum of 0.5 ms). SYNRAD recommends our PS-2, a 30 V, 750 W DC power supply (shown in Figure 1-6). AC input requirements for the PS-2 are 90–264 VAC (auto-ranging); single-phase (1Ø); 10 A max; 47–440 Hz. To connect the PS-2 power supply, refer to Figure 1-6 and perform the following steps:

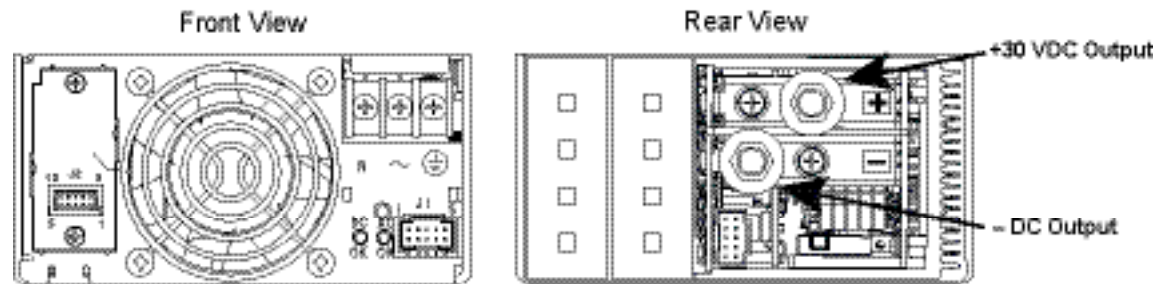


Figure 1-6 PS-2 (Emerson iMP4) power supply

### Caution possible equipment damage

Do not reverse polarity when connecting DC power cables to your DC power source. Reversed DC polarity may damage the v30's internal RF and control board circuitry. Carefully follow the directions below to ensure that DC cable leads are properly connected to the correct DC output terminals.

- 1 Verify that input AC power to the DC power supply is physically locked out or disconnected.
- 2 Locate the 30 VDC output terminals on the power supply's rear (output) section and connect the black (–) DC power cable from the v30 laser to the negative (–) output terminal.
- 3 Connect the red (+) DC power cable from the laser to the positive (+) 30 VDC output terminal.
- 4 On the PS-2's front (input) section, connect the neutral wire from your AC voltage source, typically white, to the terminal labeled "N" (AC Neutral).
- 5 Connect the hot wire from your AC voltage source, typically black, to the "L" (AC Line) terminal.
- 6 Connect the ground (earth) wire from the AC source, typically green, to the terminal labeled with the ground symbol.

Note: Because AC input connections and requirements vary from country to country, customers must provide the appropriately sized AC power cable or wiring.

## Control connections

Complete all control connections to OEM v30 lasers through the Interface A (DB-9) or Interface B (RJ45) connectors on the v30's rear panel. The interface connector receives tickle pulse and PWM Command signals and also serves as the connection point for auxiliary signals between the laser and any parts handling, automation, or monitoring equipment. See the Interface connections section in the Technical Reference chapter for details.



# getting started

## Connecting

**Important Note:** The OEM v30 control board does not incorporate a built-in tickle generator; therefore, an externally-generated 5 kHz, 1  $\mu$ s tickle pulse must be applied between PWM Command signals to achieve optimum laser performance. See Controlling laser power in the Technical Reference chapter for tickle signal descriptions.

**Note:** Use the Interface A (DB-9) connector for new or upgraded installations. Although both interface connectors provide the same functionality, the DB-9 connector contains an additional output, Lase Indicator, to indicate the OEM v30 is actively lasing. Use the Interface B (RJ45) connector only when integrating a v30 into laser systems previously configured for an RJ45 interface.



### **Warning** serious personal injury

The use of the Quick Start Plug bypasses the laser's safety interlock function; potentially exposing personnel in the area to invisible infrared CO<sub>2</sub> laser radiation.

Because this plug jumpers the Laser Enable input signal, the laser will fire immediately on application of a PWM Command signal. Your integrated control system should provide an interlock signal directly to the Interface A (or Interface B) connector only after safe operating conditions are established.

The Quick Start Plug is intended only for initial testing and troubleshooting by qualified personnel. In normal operation, the laser's Laser Enable input should be connected to the machine's safety interlock circuitry.

### **Caution** possible equipment damage

Turn off DC power before installing or removing any plug or cable from the Interface A and Interface B connectors. Ensure that user connections are made to the appropriate pins and that the appropriate signal levels are applied. Failure to do so may damage the laser.

## Quick Start Plug (DB-9 only)

**Note:** The Quick Start Plug is not included with SAG models, but may be ordered separately.

In order for your Firestar v30 laser to properly operate, a +5 VDC voltage input must be applied to the Laser Enable input on the Interface A (DB-9) or Interface B (RJ45) connector before lasing is enabled. In applications where the OEM v30 is integrated into an automated control system and safety interlocks are required, these input signals must be provided by the customer's control system. The Quick Start Plug included in the ship kit has a factory-installed shorting jumper wired to enable the Laser Enable input (see Figure 4-2 in the Technical Reference chapter). Connect the Quick Start Plug to the Interface A (DB-9) connector when performing initial start-up and testing of the laser.

For further information about Interface A and Interface B connectors, see Interface connections in the Technical Reference chapter for connector pinouts and signal descriptions.

# getting started

## Connecting

### UC-2000 Universal Laser Controller



#### **Warning** serious personal injury

Always use shielded cable when connecting your PWM Command signal source to PWM Positive/PWM Negative inputs. In electrical-noisy environments, long lengths of unshielded wire act like an antenna and may generate enough voltage to trigger uncommanded lasing.

For testing, troubleshooting, and basic operation, SYNRAD recommends using a UC-2000 Universal Laser Controller to generate the tickle pulses and pulse width modulated (PWM) Command signals necessary to control laser output power. You may need to refer to Interface connections, in the Technical Reference chapter, for Interface A and Interface B connection details.

To connect a UC-2000 Controller (available separately from SYNRAD), perform the following steps:

#### Interface A (DB-9) connector

- 1 Remove DC power from the laser.
- 2 Connect the UC-2000's Power/Control cable to the Quick Start Plug or fabricate a suitable DB-9 plug so Pin 1, PWM Positive, connects to the center pin of the Power/Control cable's BNC connector and Pin 6, PWM Negative, connects to the shield.
- 3 If the system does not provide an enable input to your DB-9 plug, then jumper Pin 9, Laser Enable, to Pin 5, DC Out.
- 4 Connect the Quick Start Plug or your DB-9 plug to the Interface A (DB-9) connector on the rear of the laser.
- 5 Connect the miniature DC power plug on the UC-2000's Power/Control cable to the miniature connector on the wall plug transformer cable.
- 6 Connect the mini-DIN connector on the other end of the UC-2000's Power/Control cable to the Laser connector on the UC-2000's rear panel.
- 7 Plug the compact transformer into any 100–240 VAC, 50–60 Hz outlet.

Note: OEM v30 lasers can also be controlled from an alternate user-supplied Command signal source. Refer to Controlling laser power in the Technical Reference chapter for control signal descriptions and refer to Interface connections, also in the Technical Reference chapter, for signal specifications and connection details.

#### Interface B (RJ45) connector

- 1 Remove DC power from the laser.
- 2 Fabricate a suitable RJ45 plug so Pin 1, PWM Positive, connects to the center pin of the UC-2000's Power/Control cable's BNC connector and Pin 6, PWM Negative, connects to the shield.

# getting started

## Connecting

- 3 Connect your system's +5V enable input to Pin 7, Laser Enable, on the RJ45 plug.
- 4 Connect your RJ45 plug to the Interface B (RJ45) connector on the rear of the laser.
- 5 Connect the miniature DC power plug on the UC-2000's Power/Control cable to the miniature connector on the wall plug transformer cable.
- 6 Connect the mini-DIN connector on the other end of the UC-2000's Power/Control cable to the Laser connector on the UC-2000's rear panel.
- 7 Plug the compact transformer into any 100–240 VAC, 50–60 Hz outlet.

Note: OEM v30 lasers can also be controlled from an alternate user-supplied Command signal source. Refer to Controlling laser power in the Technical Reference chapter for control signal descriptions and refer to Interface connections, also in the Technical Reference chapter, for signal specifications and connection details.

# Laser Safety

## 2

### Laser Safety Introduction

- Hazard Information – includes equipment label terms and hazards, please familiarize yourself with all definitions and their significance.
- General & Other Hazards – provides important information about the hazards and unsafe practices that could result in death, severe injury, or product damage.
- Disposal – information on your laser parts and/or components as they pertain to disposal.
- Additional Safety Information – describes how to find additional information about your laser.
- Compliance – explains in the subsections therein applicable and appropriate regulation information.

**Note:** Read the entire safety section. This will ensure you are familiar with the hazards and warnings prior to starting.

#### **Warning Serious personal injury**



**This Class 4 CO<sub>2</sub> laser product emits invisible infrared laser radiation in the 9.3–10.6 μm wavelength band.**

**Because direct or diffuse laser radiation can inflict severe corneal injuries, always wear eye protection when in the same area as an exposed laser beam.**

**Do not allow the laser beam to contact a person!**

**This product emits an invisible laser beam that is capable of seriously burning human tissue.**

**Always be aware of the beam's path and always use a beam block while testing.**

# Laser Safety

## Hazard Information

Hazard information includes terms, symbols, and instructions used in this manual or on the equipment to alert both operating and service personnel to the recommended precautions in the care, use, and handling of Class 4 laser equipment.

## Terms

Certain terms are used throughout this manual or on the equipment labels. Please familiarize yourself with their definitions and significance.










Parameter	Description
 	<p><b>WARNING:</b> Potential &amp; Imminent hazards which, if not avoided, could result in death or serious injury.</p> <p>Alerts operator of serious dangers, hazardous radiation, hazardous voltages, vapor hazard, &amp; reflective dangers.</p>
	<p><b>DANGER:</b> Hazards which, if not avoided, could result in minor or moderate injury.</p> <p>Alerts operator of lifting dangers.</p>
	<p><b>CAUTION:</b> Potential hazards or unsafe practices which, if not avoided, may result in product damage.</p> <p>Alerts operator of equipment dangers.</p>
  	<p><b>IMPORTANT NOTES &amp; TIPS:</b></p> <p>Content specific information and/or recommendations.</p>

Figure 2-1 Labeling terms and definitions.

**Warning**  
**Serious personal injury**

For laser systems being used or sold within the U.S.A., customers should refer to and follow the laser safety precautions described American National Standards Institute (ANSI) document Z136.1-2014, Safe Use of Lasers.

For laser systems being used or sold outside the U.S.A., customers should refer to and follow the laser safety precautions described in European Normative and International Electrotechnical Commission documents IEC/TR 60825-14:2014, Safety of Laser Products – §14: A User's Guide.

# Laser Safety

## General hazards

Following are descriptions of general hazards and unsafe practices that could result in death, severe injury, or product damage. Specific warnings and cautions not appearing in this section are found throughout the manual.

### **Warning** **Serious** **personal** **injury**



Do not allow laser radiation to enter the eye by viewing direct or reflected laser energy.

CO<sub>2</sub> laser radiation can be reflected from metallic objects even though the surface is darkened. Direct or diffuse laser radiation can inflict severe corneal injuries leading to permanent eye damage or blindness. All personnel must wear eye protection suitable for CO<sub>2</sub> radiation, e.g. 9.3–10.6 μm when in the same area as an exposed laser beam.

Eye wear protects against scattered energy but is not intended to protect against direct viewing of the beam—never look directly into the laser output aperture or view scattered laser reflections from metallic surfaces.

Enclose the beam path whenever possible. Exposure to direct or diffuse CO<sub>2</sub> laser radiation can seriously burn human or animal tissue, which may cause permanent damage.

This product is not intended for use in explosive, or potentially explosive, atmospheres!

Materials processing with a laser can generate air contaminants such as vapors, fumes, and/or particles that may be noxious, toxic, or even fatal. Safety Data Sheets (SDS) for materials being processed should be thoroughly evaluated and the adequacy of provisions for fume extraction, filtering, and venting should be carefully considered. Review the following references for further information on exposure criteria:

ANSI Z136.1-2014, Safe Use of Lasers, §7.3.

U.S. Government's Code of Federal Regulations: 29 CFR §1910, §§ Z.

Threshold Limit Values (TLV's) published by the American Conference of Governmental Industrial Hygienists (ACGIH).

It may be necessary to consult with local governmental agencies regarding restrictions on the venting of processing vapors.

The use of aerosol dusters containing difluoroethane causes "blooming", a condition that significantly expands and scatters the laser beam. This beam expansion can effect mode quality and/or cause laser energy to extend beyond the confines of optical elements in the system, possibly damaging acrylic safety shielding. Do not use air dusters containing difluoroethane in any area adjacent to CO<sub>2</sub> laser systems because difluoroethane persists for long time periods over wide areas.

# Laser Safety

Laser should be installed and operated in manufacturing or laboratory facilities by trained personnel only. Due to the considerable risks and hazards associated with the installation and operational use of any equipment incorporating a laser, the operator must follow product warning labels and instructions to the user regarding laser safety. To prevent exposure to direct or scattered laser radiation, follow all safety precautions specified throughout this manual and exercise safe operating practices per ANSI Z136.1-2014, Safe Use of Lasers at all times when actively lasing.

Due to the specific properties of laser light, a unique set of safety hazards that differ from other light sources must be considered. Just like light, lasers can be reflected, refracted, diffracted or scattered.



Figure 2-2 Always wear safety glasses or protective goggles with side shields to reduce the risk of damage to the eyes when operating the laser.

A CO<sub>2</sub> laser is an intense energy source and will ignite most materials under the proper conditions. Never operate the laser in the presence of flammable or explosive materials, gases, liquids, or vapors.

**Warning**  
**Serious**  
**personal**  
**injury**

“Caution  - The use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.”



Safe operation of the laser requires the use of an external beam block to safely block the beam from traveling beyond the desired work area. Do not place your body or any combustible object in the path of the laser beam. Use a water-cooled beam dump or power meter, or similar non-scattering, noncombustible material as the beam block. Never use organic material or metals as the beam blocker; organic materials, in general, are apt to combust or melt and metals act as specular reflectors which may create a serious hazard outside the immediate work area.

Always wear safety glasses or protective goggles with side shields to reduce the risk of damage to the eyes when operating the laser.

# Laser Safety

## Disposal

This product contains components that are considered hazardous industrial waste. If a situation occurs where the laser is rendered non-functional and cannot be repaired, it may be returned to SYNRAD® who, for a fee, will ensure adequate disassembly, recycling and/or disposal of the product.

## Other hazards

The following hazards are typical for this product family when incorporated for intended use: (A) risk of injury when lifting or moving the unit; (B) risk of exposure to hazardous laser energy through unauthorized removal of access panels, doors, or protective barriers; (C) risk of exposure to hazardous laser energy and injury due to failure of personnel to use proper eye protection and/or failure to adhere to applicable laser safety procedures; (D) risk of exposure to hazardous or lethal voltages through unauthorized removal of covers, doors, or access panels; (E) generation of hazardous air contaminants that may be noxious, toxic, or even fatal.

## Additional laser safety information

The SYNRAD web site [https://www.synrad.com/resources/general\\_information/lasersafetyresources](https://www.synrad.com/resources/general_information/lasersafetyresources) contains an online laser safety handbook that provides information on (1) Laser Safety Standards for OEM's/System Integrators, (2) Laser Safety Standards for End Users, (3) References and Sources, and (4) Assistance with Requirements.

In addition, the Occupational Safety and Health Administration (OSHA) provides an online Technical Manual located at [http://www.osha.gov/dts/osta/otm/otm\\_iii/otm\\_iii\\_6.html](http://www.osha.gov/dts/osta/otm/otm_iii/otm_iii_6.html) Section III, Chapter 6 and Appendix III are good resources for laser safety information.

Another excellent laser safety resource is the Laser Institute of America (LIA). Their comprehensive web site is located at <http://www.lia.org>.



# Laser Safety

## Laser label locations

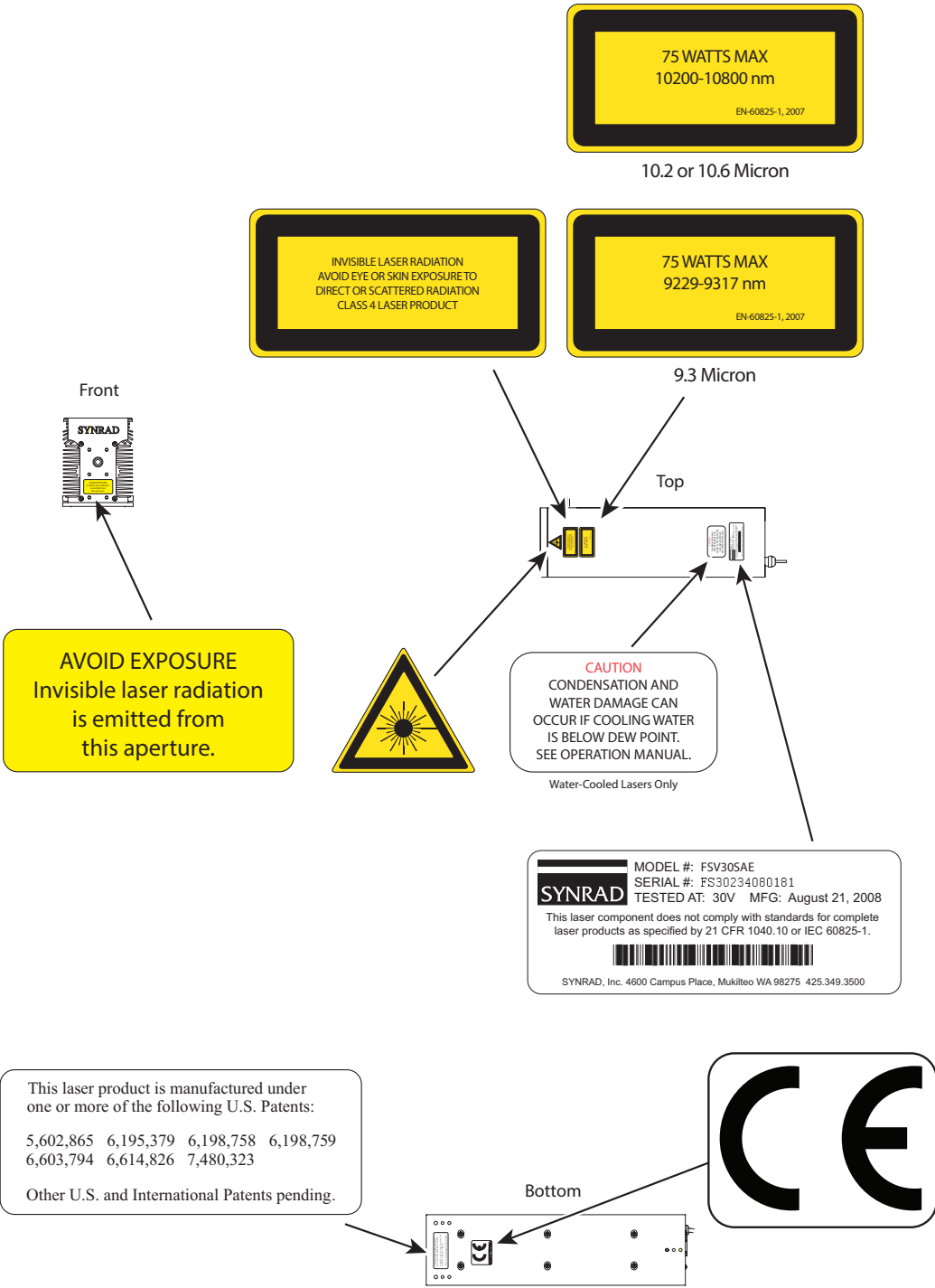


Figure 2-3 Hazard label locations.

# Laser Safety

## Agency compliance

- Center for Devices and Radiological Health (CDRH) requirements.
- Federal Communications Commission (FCC) requirements.
- European Union (EU) requirements.

SYNRAD® lasers are designed, tested, and certified to comply with certain United States (U.S.) and European Union (EU) regulations. These regulations impose product performance requirements related to electromagnetic compatibility (EMC) and product safety characteristics for industrial, scientific, and medical (ISM) equipment. The specific provisions to which systems containing laser lasers must comply are identified and described in the following paragraphs. Note that compliance to CDRH, FCC, and EU requirements depends in part on the laser version selected—Keyswitch or OEM.

In the U.S., laser safety requirements are governed by the Center for Devices and Radiological Health (CDRH) under the auspices of the U.S. Food and Drug Administration (FDA) while radiated emission standards fall under the jurisdiction of the U.S. Federal Communications Commission (FCC). Outside the U.S., laser safety and emissions are governed by European Union (EU) Directives and Standards.

In the matter of CE-compliant laser products, SYNRAD assumes no responsibility for the compliance of the system into which the product is integrated, other than to supply and/or recommend laser components that are CE marked for compliance with applicable European Union Directives.

Because OEM laser products are intended for incorporation as components in a laser processing system, they do not meet all of the Standards for complete laser processing systems as specified by 21 CFR, §1040 or EN 60825-1. SYNRAD assumes no responsibility for the compliance of the system into which OEM laser products are integrated.

## Center for Devices and Radiological Health (CDRH) requirements

Product features incorporated into the design of laser lasers to comply with CDRH requirements are integrated as panel controls or indicators, internal circuit elements, or input/output signal interfaces. Specifically, these features include a lase and laser ready indicators, remote interlock for power on/off, a laser aperture shutter switch, and a five-second delay between power on and lasing. Incorporation of certain features is dependent on the laser version (Keyswitch or OEM). See the following table for Class 4 safety features, indicating which features are available on laser lasers, the type and description of the feature, and if the feature is required by CDRH regulations.

## OEM models

Laser OEM lasers are OEM products intended for incorporation as components in laser processing systems. As supplied by SYNRAD, these lasers do not meet the requirements of 21 CFR, §§J without additional safeguards. In the U.S., the Buyer of these OEM laser components is solely responsible for the assurance that the laser processing system sold to an end user

# Laser Safety

components to ensure that they meet all applicable local laser safety requirements. In cases where the Buyer is also the end-user of the OEM laser product, the Buyer/end-user must integrate the laser so that it complies with all applicable laser safety standards as set forth above.

## Federal Communications Commission (FCC) requirements

The United States Communication Act of 1934 vested the Federal Communications Commission (FCC) with the authority to regulate equipment that emits electromagnetic radiation in the radio frequency spectrum. The purpose of the Communication Act is to prevent harmful electromagnetic interference (EMI) from affecting authorized radio communication services. The FCC regulations that govern industrial, scientific, and medical (ISM) equipment are fully described in 47 CFR, §18, §5C.

SYNRAD® laser lasers have been tested and found to comply by demonstrating performance characteristics that have met or exceeded the requirements of 47 CFR, §18, Radiated and Conducted Emissions.

## FCC information to the user

**Note:** The following FCC information to the user is provided to comply with the requirements of 47 CFR, §18, §5213.

## Interference Potential

In our testing, SYNRAD has not discovered any significant electrical interference traceable to laser lasers.

## System Maintenance

Ensure that all exterior covers are properly fastened in position.

## Measures to Correct Interference

If you suspect that your laser interferes with other equipment, take the following steps to minimize this interference:

- 1 Use shielded cables to and from the equipment that is experiencing interference problems.
- 2 Ensure that the laser is properly grounded to the same electrical potential as the equipment or system it is connected to.

## FCC caution to the user

The Federal Communications Commission warns the user that changes or modifications of the unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

# Laser Safety

## European Union (EU) requirements

### RoHS compliance

SYNRAD® laser lasers meet the requirements of the European Parliament and Council Directive 2014/35/EU on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment that establishes maximum concentration values for certain hazardous substances in electrical and electronic equipment.

### Laser safety standards

Under the Low Voltage Directive, 2014/35/EU, the European Norm (EN) document EN 60825-1:2014 was developed to provide laser safety guidance and includes clauses on Engineering Specifications, Labeling, Other Informational Requirements, Additional Requirements for Specific Laser Products, Classification, and Determination of the Accessible Emission Level. To develop a risk assessment plan/laser safety program for users, see IEC/TR 60825-14:2004 that includes clauses on Administrative Policies, Laser Radiation Hazards, Determining the MPE, Associated Hazards, Evaluating Risk, Control Measures, Maintenance of Safe Operation, Incident Reporting and Accident Investigation, and Medical Surveillance.

### OEM models

OEM lasers are OEM products intended for incorporation as components in laser processing systems. As supplied by SYNRAD, these lasers do not meet the requirements of EN 60825-1 without additional safeguards. European Union Directives state that “OEM laser products which are sold to other manufacturers for use as components of any system for subsequent sale are not subject to this Standard, since the final product will itself be subject to the Standard.” This means that Buyers of OEM laser components are solely responsible for the assurance that the laser processing system sold to an end-user complies with all laser safety requirements before the actual sale of the system. Note that when an OEM laser component is incorporated into another device or system, the entire machinery installation may be required to conform to EN 60825-1; EN 60204-1:2006, Safety of Machinery; the Machinery Directive, EN 2006/42/EC; and/or any other applicable Standards and in cases where the system is being imported into the U.S., it must also comply with CDRH regulations.

In cases where the Buyer is also the end-user of the OEM laser product, the Buyer/end-user must integrate the laser so that it complies with all applicable laser safety standards as set forth above. The following table, Class 4 safety features, summarizes laser product features, indicating the type and description of features and whether those features are required by European Union regulations.

### Electromagnetic interference standards

The European Union’s Electromagnetic Compatibility (EMC) Directive, 2014/30/EU, is the sole Directive developed to address electromagnetic interference (EMI) issues in electronic equipment. In particular, the Directive calls out European Norm (EN) documents that define the emission and immunity standards for specific product categories. For lasers, EN 61000-6-4 defines radiated and conducted RF emission limits while EN 61000-6-2 defines immunity requirements for industrial environments.

# Laser Safety

SYNRAD® laser lasers have demonstrated performance characteristics that have met or exceeded the requirements of EMC Directive 2014/30/EU.

Table 2-1 Class 4 safety features.

Feature	Location / Description	Required by:		Available on:
		CDRH	EN60825-1	OEM Laser
<b>Keyswitch<sup>1</sup></b>	<b>Rear panel control</b> On/Off/Reset Keyswitch controls power to laser electronics. Key cannot be removed from switch in the "On" position.	<b>Yes</b>	<b>Yes</b>	<b>No</b>
<b>Shutter function</b>	<b>Laser control</b> Functions as a beam attenuator to disable RF driver/laser output when closed.	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
<b>Shutter indicator</b>	<b>Rear panel indicator (Blue)</b> Illuminates blue to indicate shutter is open.	<b>No</b>	<b>No</b>	<b>Yes</b>
<b>Ready indicator</b>	<b>Rear panel indicator (Yellow)</b> Indicates that laser has power applied and is capable of lasing.	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
<b>Lase indicator</b>	<b>Rear panel indicator (Red)</b> Indicates that is actively lasing. Lase LED illuminates when the duty cycle of the Command signal is long enough to produce laser output.	<b>No</b>	<b>No</b>	<b>Yes</b>
<b>Five second delay</b>	<b>circuit element</b> Disables RF driver/laser output for five seconds after Keyswitch is turned to "On" or remote reset/start pulse is applied when Keyswitch is in "On" position.	<b>Yes</b>	<b>No</b>	<b>Yes</b>
<b>Power fail lockout<sup>1</sup></b>	<b>circuit element</b> Disables RF driver/laser output if input power is removed then later reapplied (AC power failure or remote interlock actuation) while Keyswitch is in "On" position.	<b>Yes</b>	<b>Yes</b>	<b>No</b>
<b>Remote Interlock</b>	<b>Rear panel connection</b> Disables RF driver/laser output when a remote interlock switch on an equipment door or panel is opened.	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>
<b>Remote Interlock</b>	<b>Rear panel indicator (Green/Red)</b> Illuminates green when Remote Interlock circuitry is closed indicator Illuminates red when interlock circuitry is open.	<b>No</b>	<b>No</b>	<b>Yes</b>
<b>Over temperature</b>	<b>circuit element</b> Temperature shutdown occurs if temperature of the laser protection tube rises above safe operating limits.	<b>No</b>	<b>No</b>	<b>Yes</b>
<b>Temp indicator</b>	<b>Rear panel indicator (Green/Red)</b> Illuminates green when laser temperature is within operating limits, changing to red when thermal limits are exceeded.	<b>No</b>	<b>No</b>	<b>Yes</b>
<b>Warning labels</b>	<b>laser exterior</b> Labels attached to various external housing locations to warn personnel of potential laser hazards.	<b>Yes</b>	<b>Yes</b>	<b>Yes</b>

1 Not available on laser OEM lasers

# Laser Safety

When integrating SYNRAD® laser OEM lasers, the Buyer and/or integrator of the end system is responsible for meeting all applicable Standards to obtain the CE mark. To aid this compliance process, SYNRAD testing program has demonstrated that laser lasers comply with the relevant requirements of Directive 2014/30/EU, the Electromagnetic Compatibility Directive, as summarized in the table below.

Table 2-2 European Union Directives.

Applicable Standards / Norms

2004(2014)/108(30)/EU	Electromagnetic Compatibility Directive
2014/35/EU	Low Voltage Directive
2011/65/EU	RoHS Directive
EN 61010-1:2010	Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements
EN 61000-6-4:2007	Radiated Emissions Group 1, Class A
EN 61000-6-4:2007	Conducted Emissions Group 1, Class A
EN 61000-6-2:2005	Electrostatic Discharge Immunity
EN 61000-6-2:2005	RF Electromagnetic Field Immunity
EN 61000-6-2:2005	Electrical Fast Transient/Burst Immunity
EN 61000-6-2:2005	Conducted RF Disturbances Immunity

After a laser or laser processing system has met the requirements of all applicable EU Directives, the product can bear the official compliance mark of the European Union as a Declaration of Conformity.

# Laser Safety

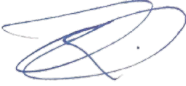

Declaration of Conformity	
in accordance with ISO / IEC 17050-2:2004	
We,	
<b>Manufacturer's Name:</b>	SYNRAD® A ©Novanta Company
<b>Manufacturer's Address:</b>	4600 Campus Place Mukilteo, WA 98275 U.S.A.
Hereby declare under our sole responsibility that the following equipment:	
<b>Product Name:</b>	Firestar™ OEM v30 Laser
<b>Model Number:</b>	FSv30SxG (*OEM)
Conforms to the following Directive(s) and Standard(s):	
<b>Applicable Directive(s):</b>	2014/30/EU                      Electromagnetic Compatibility Directive 2014/35/EU                      Low Voltage Directive 2011/65/EU                      RoHS Directive
<b>Applicable Standard(s):</b>	
EN 61010-1:2010	Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements
EN 61000-6-4:2007	Radiated Emissions, Group 1, Class A
EN 61000-6-4:2007	Conducted Emissions, Group 1, Class A
EN 61000-6-2:2005	Electrostatic Discharge Immunity
EN 61000-6-2:2005	RF Electronic Fields Immunity
EN 61000-6-2:2005	Electrical Fast Transient/Burst Immunity
EN 61000-6-2:2005	Conducted RF Disturbances Immunity
*OEM lasers do not comply with EN 60825-1:2014, <i>Safety of Laser Products</i> . Buyers of OEM laser products are solely responsible for meeting applicable Directives and Standards for CE compliance and marking.	
<b>Corporate Officer:</b>	<b>European Contact:</b>
	Novanta Distribution (USD) GmbH Parkring 57-59 85748 Garching bei München, Germany
_____ Tim Frenj, Quality Manager of SYNRAD	
Dated: 3/4/19	
	 MADE IN THE U.S.A. 900-20976-18 Rev B

Figure 2-4 Declaration Document.

# 3

Use information in this chapter to familiarize yourself with OEM v30 controls and indicators and to begin operating the laser.

This chapter contains the following information:

Controls and indicators – displays and describes exterior controls and indicators on OEM v30 lasers.

Initial start-up – explains how to start your OEM v30 laser while verifying proper operation.



# operation

## Controls and indicators

The Controls and indicators section includes subsections:

OEM v30 front panel

OEM v30 rear panel

## OEM v30 front panel

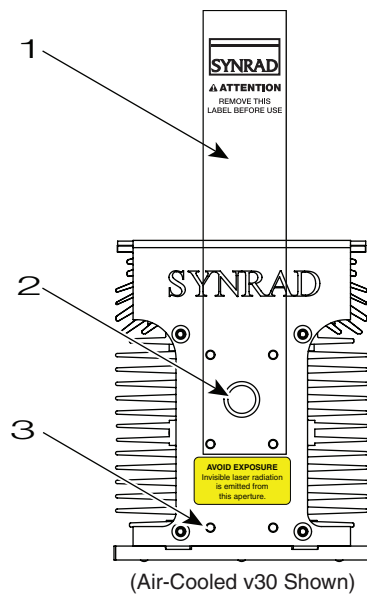


Figure 3-1 OEM v30 front panel controls and indicators

- 1** Aperture Seal – prevents dust from damaging the output coupler during shipping. Remove the red self-adhesive seal before applying power to the laser!
- 2** Laser Aperture – provides an opening in the OEM v30's front panel from which the beam exits.
- 3** Optical Accessories Mounting – provides six threaded holes (8–32 UNC) for mounting optional beam delivery components. Because excessive weight may damage the laser, consult SYNRAD before mounting components not specifically designed as Firestar options. Refer to OEM v30 package outline drawings in the Technical Reference chapter for mounting hole dimensions.

**Note:** When mounting optical components to the OEM v30 laser, excessive fastener length may damage the laser. See the appropriate package outline drawing for important information about accessory mounting hole depth.

# operation

## Controls and indicators

### OEM v30 rear panel

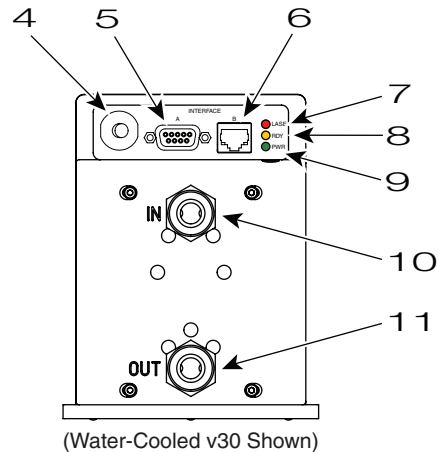


Figure 3-2 OEM v30 rear panel controls and indicators

- 4 DC Power Cables – receives +30 VDC from the DC power supply. The DC power cables are manufactured from #12 AWG wire and measure 1 meter (40 inches) in length. The red (positive) cable contains a replaceable in-line fuse. If fuse replacement is required, replace it with a Cooper Bussmann ABC-20-R, a Littelfuse 314020 or equivalent 20 A, fast-blow fuse.
- 5 Interface A (DB-9) Connector – provides a connection point for auxiliary output power as well as input and output signals. See Interface connections in the Technical Reference chapter for DB-9 interface details and pinouts.
- 6 Interface B (RJ45) Connector – provides a connection point for auxiliary output power as well as input and output signals. See Interface connections in the Technical Reference chapter for RJ45 interface details and pinouts.
- 7 LASE Indicator – illuminates red to indicate that the laser is actively lasing. The LASE indicator is off when tickle pulses are being generated and illuminates red when PWM Command signal pulses are long enough to produce laser output.
- 8 RDY (Ready) Indicator – illuminates yellow when the laser is enabled, indicating that lasing will begin when a PWM Command signal is applied.
- 9 PWR (Power) Indicator – illuminates green when +30 VDC power is applied to the laser.
- 10 WATER IN Port (water-cooled models only) – labeled IN, this connection provides the cooling water inlet to the v30's coolant path.
- 11 WATER OUT Port (water-cooled models only) – labeled OUT, this connection provides the cooling water outlet from the v30's coolant path.

# operation

## Initial start-up

The Initial start-up section includes subsections:

Status LEDs

With a UC-2000 Controller

Without a UC-2000 Controller

## Status LEDs

Three status LEDs on the rear of the OEM v30 laser provide a visual indication of operating status. A green PWR LED illuminates when DC power is applied to the laser. The yellow RDY LED indicates that a Laser Enable signal has been applied and lasing will begin once a PWM Command signal is received. The LASE LED illuminates red to indicate that the PWM Command signal is sufficient to induce laser output.

 **Danger**  
serious  
personal  
injury

This Class 4 laser product emits invisible infrared laser radiation in the 9.3– 10.6  $\mu\text{m}$  CO<sub>2</sub> wavelength band depending on model. Because direct or diffuse laser radiation can inflict severe corneal injuries, always wear eye protection when in the same area as an exposed laser beam. Do not contact the laser beam. This product emits an invisible laser beam that is capable of seriously burning human tissue.

Always be aware of the beam's path and always use a beam block while testing.

 **Warning**  
serious  
personal  
injury

Firestar OEM v30 SxG lasers do not include a five-second delay function. This means a tickle signal can be applied immediately after the Laser Enable input is activated, effectively eliminating the delay on laser power-up or interlock activation.

As with other laser safety requirements, the OEM or system integrator is solely responsible for designing the system to incorporate a five-second delay and any other controls required by relevant laser safety standards for Class 4 laser devices.

**Caution**  
possible  
equipment  
damage

Remove the aperture seal before firing the laser. The self-adhesive seal is installed to prevent dust from entering the laser housing during shipment and installation and must be removed before operation.

# operation

## Initial start-up

### With a UC-2000 Controller

Before your OEM v30 laser is put into service for the first time, its functionality should be verified. Follow this procedure to verify the laser system is operating at optimum performance. For this procedure, use the UC-2000 as a stand-alone controller; do not attempt to control the laser or UC-2000 externally.

**Note:** After applying 30 VDC, but before operating the laser, you must provide a Laser Enable input signal to either the Interface A (DB-9) or Interface B (RJ45) connector. See Interface connections in the Technical Reference chapter for pinouts and signal descriptions.

### Starting auxiliary equipment

- 1 Ensure that all personnel in the area are wearing protective eyewear.
- 2 Remove the red self-adhesive aperture seal from the laser faceplate.
- 3 Place a power meter, or appropriate beam block, 61 cm (24 in) from the laser aperture to prevent the beam from traveling beyond the work area.
- 4 On water-cooled v30's, turn on the chiller (set in the range of 18–22 °C) and verify it is delivering 3.8 lpm (1.0 GPM) at less than 414 kPa (60 PSI) of pressure.

**Note:** If you have not yet operated your UC-2000 Universal Laser Controller, refer to the UC-2000 Laser Controller Operator's Manual for setup and operation instructions before continuing.

- 5 Set the UC-2000 to MANUAL mode, and then set the PWM Adj Knob to provide zero percent output (0.0%). The UC-2000's Lase indicator should be Off.

### Starting your OEM v30 laser

- 1 If the laser has a Diode Pointer installed, remove its aperture dust cover.
- 2 Turn on the +30 VDC power supply. The v30's PWR LED should illuminate green.
- 3 Apply a Laser Enable signal to the appropriate interface connector. The yellow RDY lamp turns on to indicate that lasing is enabled when a PWM Command signal is received.

**Note:** On cold starts, provide five to ten seconds of tickle before sending PWM Commands to the laser.

- 4 Press the UC-2000's Lase On/Off button. The Lase indicator on the UC-2000 should illuminate.
- 5 Use the UC-2000's PWM Adj Knob to slowly increase power. The v30 LASE LED illuminates red when PWM Command pulses are long enough to produce laser output. The spot where the beam hits the beam block should increase in brightness to indicate increased power output.
- 6 Press the UC-2000's Lase On/Off button to stop lasing. LASE indicators on the UC-2000 and the laser should turn off.

If your OEM v30 laser fails to lase, refer to Troubleshooting in the Maintenance/Troubleshooting chapter for troubleshooting information.

# operation

## Initial start-up

### Without a UC-2000 Controller

When not using a UC-2000 to control the laser, follow the steps below to verify laser operation. For all v30 lasers, an externally-generated tickle signal is required for optimum laser performance. Connect the signal generator for both tickle and PWM Command signals to either the Interface A (DB-9) or Interface B (RJ45) connector. Refer to Interface connections in the Technical Reference chapter for connector pinouts and see Controlling laser power in the Technical Reference chapter for tickle and PWM signal descriptions.

**Note:** After applying 30 VDC, but before operating the laser, you must provide a Laser Enable input signal to either the Interface A (DB-9) or Interface B (RJ45) connector. See Interface connections in the Technical Reference chapter for pinouts and signal descriptions.

### Starting auxiliary equipment

- 1 Ensure that all personnel in the area are wearing protective eyewear.
- 2 Remove the red self-adhesive aperture seal from the laser faceplate.
- 3 Place a power meter, or appropriate beam block, 61 cm (24 in) from the laser aperture to prevent the beam from traveling beyond the work area.
- 4 Connect the output of your PWM controller to PWM Positive (Pin 1) on the appropriate interface connector and connect the ground or return of the Controller to PWM Negative (Pin 6).

**Note:** Your controller must provide both tickle and PWM Command signals to the laser. See Controlling laser power in the Technical Reference chapter for tickle and Command signal descriptions.

- 5 Ensure your controller is set to provide a 1  $\mu$ s square wave tickle pulse (at a frequency of 5 kHz) after any 200- $\mu$ s measurement period where a PWM signal is not applied.
- 6 Set your PWM controller to a frequency of 5 kHz and ensure that the controller's duty cycle is set to zero percent output (0.0%).

### Starting your OEM v30 laser

- 1 If the laser has a Diode Pointer installed, remove its aperture dust cover.
- 2 Turn on the +30 VDC power supply. The v30's PWR LED should illuminate green.
- 3 Apply a Laser Enable signal to the appropriate interface connector. The yellow RDY lamp turns on to indicate that lasing is enabled when a PWM Command signal is received.

**Note:** On cold starts, provide five to ten seconds of tickle before sending PWM Commands to the laser.

- 4 Using your PWM controller, apply tickle pulses (a +5 VDC, 5 kHz square wave of 1  $\mu$ s duration). After five to ten seconds, slowly increase the duty cycle of the square wave. The LASE indicator illuminates red when PWM pulses are long enough to produce laser output. The spot where the beam hits the beam block should increase in brightness to indicate increased power output.
- 5 Remove the PWM Command signal from the laser and re-apply tickle pulses every 200  $\mu$ s. The LASE indicator on the laser should turn off.

If your OEM v30 laser fails to lase, refer to Troubleshooting in the Maintenance/Troubleshooting chapter for troubleshooting information.

# technical reference

# 3

Use information in this chapter as a technical reference for your OEM v30 laser.

This chapter contains the following information:

Technical overview – briefly describes v30 technology and basic optical setup.

Controlling laser power – explains various aspects of OEM v30 control signals.

Interface connections – describes signals and specifications for the OEM v30's Interface A (DB-9) and Interface B (RJ45) Input/Output connectors.

OEM v30 general specifications – provides specifications for Firestar OEM v30 lasers.

OEM v30 package outline drawings – illustrates laser package and mounting dimensions for OEM v30 lasers.

OEM v30 packaging instructions – illustrates how to package v30 lasers for shipment using SYNRAD-supplied packaging materials.

# technical reference

## Technical overview

The Technical overview section includes subsections:

OEM v30 laser

Optical setup

## OEM v30 laser

### Laser tube

Firestar® OEM v30 lasers were developed using new technology patented by SYNRAD, Inc. This patented “v” technology, based on a combination of free-space and waveguide resonator designs, enables SYNRAD to economically produce a symmetrical laser beam from a small but powerful laser capable of operating for many years with virtually no maintenance. Firestar’s unique extruded aluminum envelope offers excellent heat transfer, long gas life, and low operating costs in contrast to other laser tube technologies. In addition to being the vessel that maintains the lasing environment, the aluminum tube is also the structural platform that integrates the laser’s optical, electrical, and cooling components.

### Optical resonator

The optical resonator, in conjunction with the electrodes and the gas mixture, generates the laser beam. Firestar v30 optical resonators are comprised of four optical elements: a rear mirror, two turning mirrors, and an output window. These optical elements are fastened to the tube’s exterior and are exposed to its interior through holes in the end caps. O-rings sandwiched between optical elements and each end cap form a gas seal and provide a flexible cushion that allows the slight movement necessary for alignment. All optical elements are aligned and locked into place by factory technicians before the laser is shipped.

#### Caution possible equipment damage

Because of their smaller beam diameter, Firestar v30 lasers have significantly higher power densities than other SYNRAD lasers. This means that any contaminants on the laser’s output coupler (or on any beam delivery optic) can absorb enough energy to damage one or more optics in the beam path. Periodically inspect the laser’s output coupler and all other beam delivery optics for signs of contaminants, and then carefully clean as required. In dirty environments, purge laser optics using filtered air or nitrogen to prevent vapor and debris from accumulating on optical surfaces.

The output beam, roughly circular as it exits the resonator, transitions to a Gaussian-like mode in mid and far fields—three meters (9.8 ft) and beyond. The internal structure and optics of the resonator combine to produce a Gaussian-like mode quality ( $M^2$  factor) of  $\leq 1.2$ . As shown in the following figure, beam waist diameter is 2.5 mm  $\pm$ 0.5 mm at the output aperture and full angle divergence due to diffraction is less than 7 milliradians (a 7 mrad full angle divergence means that beam diameter increases 7 mm over every one meter distance traveled).

# technical reference

## Technical overview

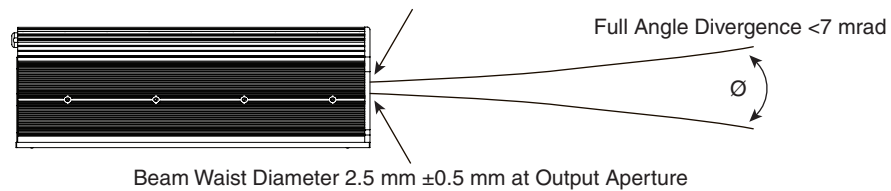


Figure 4-1 OEM v30 beam characteristics

### Internal RF power supply

Firestar OEM v30 lasers are driven by a compact radio frequency (RF) oscillator mounted in the laser chassis. The 30 VDC input voltage is converted into a high-power RF signal using an RF power oscillator. The output from the RF oscillator (nominally at 83.5 MHz) drives the laser directly by exciting carbon dioxide ( $\text{CO}_2$ ) gas in the tube to produce lasing.

### Control circuit

Sensors built into the OEM v30 control board monitor the laser for conditions like under/over voltage, over temperature, and other faults that pose a risk of damage to the laser. Additionally, laser operation is controlled by a Laser Enable input.

### Optical setup

After selecting a laser for a  $\text{CO}_2$  laser processing system, the two most important elements to consider are: (1) beam delivery optics to transmit the beam to the work area; and (2) focusing optics to focus the beam onto the part or material to be processed. Each element is crucial in the development of a reliable laser-based material processing system and each element should be approached with the same careful attention to detail.

### Beam delivery optics

Divergence, or expansion, of the laser beam is important in materials processing since a larger beam entering the focusing optic produces a smaller focused spot. Because the v30 laser beam diverges by 7 mm over each meter of distance traveled, the laser should be mounted a distance of 1.0–1.5 m (40–60 in) away from the work area and no closer than 0.75 m (30 in) for optimum performance. Right angle turning mirrors (beam benders) are often used in conjunction with the laser mounting position to obtain this distance.

Expander/collimators are optical devices that increase beam diameter by a selectable magnification factor while reducing beam divergence at the same time. Adding an expander/collimator substantially reduces beam divergence and any variance in beam diameter caused by the changing optical path length in an XY (“flying optics”) table application. In fixed-length delivery systems where the laser is positioned only one meter away from the focusing optic and a small spot size is required, an expander/collimator is again the best solution to provide the required beam expansion before reaching the focusing optic.

Note: Optical components in the beam path must always be aligned to the actual beam path, not the laser faceplate. Because of slight variations in laser construction, the beam path may not always be centered in, or perpendicular to, the aperture in the faceplate.



# technical reference

## Technical overview

### Focusing optics

When selecting a focusing optic, the primary consideration should be material thickness and any vertical tolerances that occur during final part positioning rather than making a selection based only on minimum spot size. The chosen focal length should create the smallest possible focused spot while providing the depth of field required for the material being processed.

#### Caution possible equipment damage

Any contaminants on the laser's output window (or on any optic in the beam path) can absorb enough energy to damage the optic. Inspect all beam delivery optics periodically for signs of contaminants and carefully clean as required. In dirty environments, purge laser optics using filtered air or nitrogen to prevent vapor and debris from accumulating on optical surfaces.

Optics are fragile and must be handled carefully, preferably by the mounting ring only. Be careful to select optics that are thick enough to withstand the maximum assist gas pressure available for the process. This is especially important in metal cutting applications using high-pressure assist gases.

Cleanliness is another important issue affecting performance and becomes increasingly important as laser power increases. Dirty or scratched lenses will under perform, exhibit a vastly shortened lifetime, and may fail catastrophically.

When the application requires air (instead of nitrogen) as an assist gas, use only breathing quality air available in cylinders from a speciality gas supply company. Compressed shop air contains minute particles of oil and other contaminants that will damage optical surfaces. If compressed shop air is the only choice available, it must be filtered and dried to ISO 8573-1:2010 Class 1, 2, 1 specifications as shown in the following table.

Table 4-1 Assist gas purity specifications

Assist Gas	Typical Purpose	Specification	
Air	Cutting/Drilling	Breathing Grade	$\geq 99.9996\%$ purity; filtered to ISO Class 1 particulate level
Air	Cutting/Drilling	Compressed	Instrument-grade air filtered and dried to ISO 8573-1:2010 Class 1, 2, 1 ( $\leq 10$ 1.0–5.0 $\mu\text{m}$ particles/ $\text{m}^3$ ; $\leq -40$ °F dew point; $\leq 0.01$ mg/ $\text{m}^3$ oil vapor)
Argon	Welding	High Purity Grade	$\geq 99.998\%$ purity; filtered to ISO Class 1 particulate level
Helium	Welding	High Purity Grade	$\geq 99.997\%$ purity; filtered to ISO Class 1 particulate level
Nitrogen	Cutting/Drilling	High Purity Grade	$\geq 99.9500\%$ purity; filtered to ISO Class 1 particulate level
Oxygen	Cutting/Drilling	Ultra Pure Grade	$\geq 99.9998\%$ purity; filtered to ISO Class 1 particulate level

# technical reference

## Controlling laser power

The Controlling laser power section includes subsections:

Control signals

Operating modes

### Control signals

Much of the information provided in this section describes the use of a SYNRAD UC-2000 Universal Laser Controller to provide tickle and PWM Command signals to the v30 laser. If using an alternate method of laser control, thoroughly review this section, Controlling laser power, as well as the following section, Interface connections, for an understanding of the signal requirements necessary to control Firestar lasers. For more information about the UC-2000, please consult the UC-2000 Laser Controller Operator's Manual.

### Tickle pulse

**Important Note:** OEM v30 lasers do not provide internal tickle; therefore, users should provide 1  $\mu$ s duration tickle pulses at a frequency of 5 kHz between applied PWM Command signals. For optimum laser performance, a tickle pulse must be sent at the end of every 200- $\mu$ s interval in which a PWM Command signal was not applied.

Tickle pulses pre-ionize the laser gas to just below the lasing threshold so that a further increase in pulse width adds enough energy to the plasma to cause laser emission. Tickle pulses cause the laser to respond predictably and almost instantaneously to PWM Command signals, even when there is considerable delay (laser off time) between applied Command signals. On cold starts, provide five to ten seconds of tickle before sending PWM Commands to the laser.

The externally-generated tickle pulse requirement is a square wave with an amplitude ranging from logic low (typically 0 V) to logic high (typically 5 V) at a frequency of 5 kHz. A single pulse of 1  $\mu$ s duration must be applied at the end of every 200- $\mu$ s interval in which a PWM Command signal was not applied. See Table 3-9 for complete voltage and current specifications.

### Pulse Width Modulation (PWM)

Pulse Width Modulation, or PWM, controls laser power by varying the duty cycle of the laser's RF amplifiers, which in turn control the time-averaged RF power applied to the laser. Typically, laser output follows the PWM input with a rise and fall time constant of  $\sim$ 100  $\mu$ s; however, the laser cannot precisely follow PWM input signals if the "On" pulse is less than 100  $\mu$ s in duration. At a constant 50% duty cycle, v30 lasers typically reach 90–100% of full optical output when operated at a frequency of 5 kHz and reach 65–80% optical output at 7 kHz. The percentage of optical output increases as duty cycle increases (at a constant PWM frequency) or as PWM frequency decreases (at a constant duty cycle). see the following figure or a representative v30 optical output waveforms at two different PWM frequencies.

OEM v30 lasers are designed to operate at Command signal base frequencies up to 100 kHz; however, the choice of PWM frequency depends on the user's specific application. In the majority of laser applications, the UC-2000's default Command signal frequency of 5 kHz has proven to work well. For high-speed motion applications that cannot tolerate any ripple in the optical beam response but still need adjustable power levels, we recommend the use of higher PWM frequencies, up to 100 kHz maximum.

# technical reference

## Controlling laser power

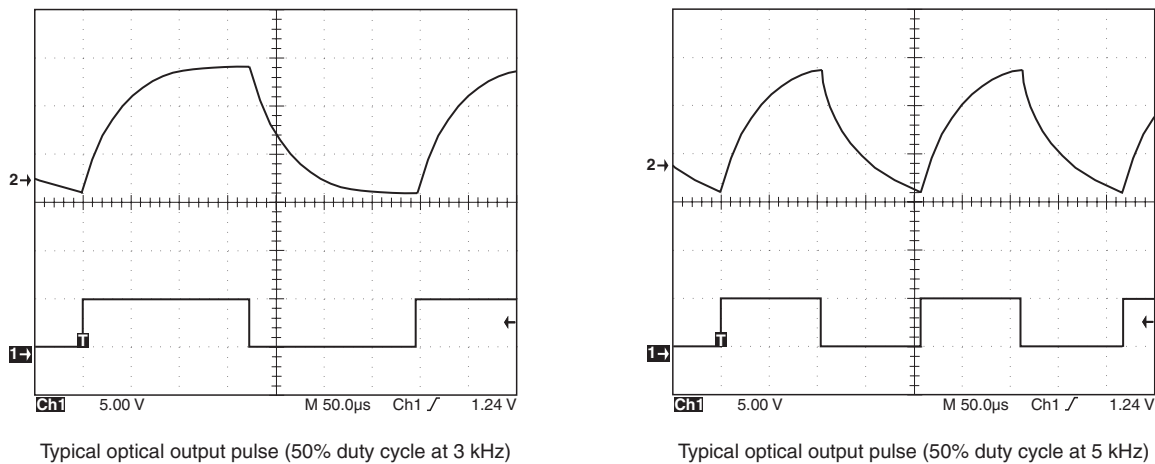


Figure 4-2 Representative OEM v30 waveforms

## Command signal

**Warning**  
serious  
personal  
injury

Always use shielded cable when connecting your PWM Command signal source to PWM Positive/PWM Negative inputs. In electrical-noisy environments, long lengths of unshielded wire act like an antenna and may generate enough voltage to trigger uncommanded lasing.

The modulated Command signal applied between Pin 1, PWM Positive, and Pin 6, PWM Negative, on either interface connector has three basic parameters: signal amplitude, base frequency, and PWM duty cycle. By changing these parameters, you can command the beam to perform a variety of marking, cutting, welding, or drilling operations.

The first Command signal parameter, signal amplitude, is a square wave that is either logic low—corresponding to laser beam off, or logic high—corresponding to beam on. The laser off voltage, typically 0 V, can range from 0.0 V to +0.8 VDC while the laser on voltage, typically 5 V, can range from +3.5 V to +6.7 VDC.

Base frequency, the second parameter, is the repetition rate of the PWM input signal. The standard base frequency is 5 kHz, which has a period of 200  $\mu$ s. Maximum PWM frequency is 100 kHz.

The third Command signal parameter, PWM duty cycle, is the percentage of the period that the Command signal is high. If the Command signal's amplitude (at 5 kHz) is high for 100  $\mu$ s and low for 100  $\mu$ s, it has a 50% duty cycle; if the amplitude is high for 190  $\mu$ s and low for 10  $\mu$ s, it has a 95% duty cycle. The following figure illustrates PWM Command signal parameters while the following table lists PWM signal specifications.

# technical reference

## Controlling laser power

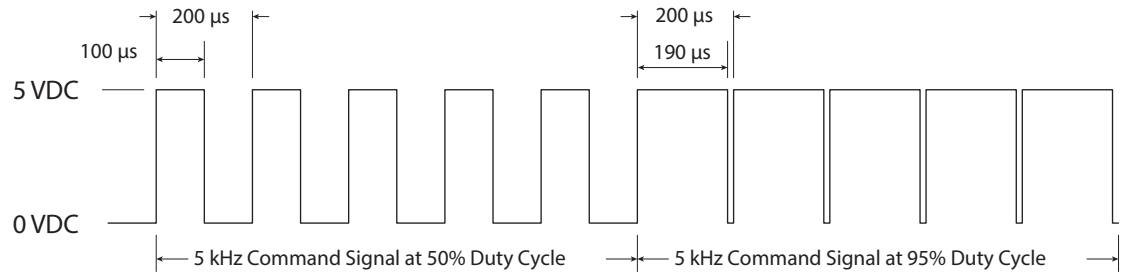


Figure 4-3 PWM Command signal waveform

The v30's PWM input (on either the Interface A or Interface B connector) consists of a high-speed optoisolator LED with a forward voltage drop ( $V_f$ ) of 1.5 VDC. The PWM input frequency can range from DC (0 Hz) to 100 kHz. Table 3-2 provides minimum, maximum, and nominal PWM signal specifications.

Table 4-2 PWM Command signal levels

Laser State	Minimum	Nominal	Maximum
Laser Off	0.0 VDC	0.0 VDC	+0.8 VDC
Laser On	+3.5 VDC (5 mA)	+5.0 VDC (9 mA)	+6.7 VDC (10 mA), continuous
Frequency Range	0 Hz (DC)	5 kHz	100 kHz
Duty Cycle	0%	— —	100%

## Operating modes

### External control

In addition to controlling the OEM v30 laser using a UC-2000 Universal Laser Controller, control of the v30 externally, without a UC-2000, is also possible. The two primary elements of laser control are gating, the ability to turn the laser on and off at the appropriate times, and power, the ability to control the laser's output energy. Both gating and power can be handled by a device such as a personal computer, Programmable Logic Controller (PLC), or function generator capable of providing tickle pulses in addition to sending PWM signals at the proper time (gating) and with the proper duty cycle (power).

### Analog voltage or current control

Although OEM v30 lasers cannot be controlled directly by analog voltage or current signals, this type of control is possible when using the UC-2000 Controller. The Controller is connected normally to the laser and analog voltage or current signals sent to the UC-2000's ANV/C connector then control both laser gating and power.

To generate the correct analog voltage for the UC-2000 Controller from a computer or PLC, a Digital-to-Analog (D/A or DAC) card capable of generating 0 V (laser off) to 10 V (maximum laser power) must be installed. To generate the proper analog current, install a D/A card that can generate 4 mA (laser off) to 20 mA (maximum power). Software able to control your analog output card is required for either configuration.

# technical reference

## Controlling laser power

### Continuous wave (CW)

In some applications, such as high speed marking or cutting, the time constant of the laser and the PWM modulation causes a series of dots that may be visible on the marking surface instead of a “clean” line. Operating the laser in CW mode (or increasing the PWM frequency) will prevent this behavior from occurring.

To operate the laser in CW mode, apply a constant +5 VDC signal to Pin 1, PWM Positive, and Pin 6, PWM Negative, on either the Interface A or Interface B connector. This constant voltage source forces the internal switching electronics to remain on, providing continuous and uninterrupted laser output power. During CW operation; however, output power cannot be changed.

Because most applications require adjustable output power, it is preferable to increase the PWM Command signal frequency (up to 100 kHz) in high-speed applications. Refer back to the Pulse Width Modulation (PWM) section for information regarding high-frequency operation.

**Note:** SYNRAD lasers are designed for maximum performance at a 95% duty cycle. Increasing the maximum PWM percentage beyond 95% greatly increases the laser’s heat load with little or no corresponding increase in laser output power.

## Gated operation

In many marking and cutting applications, the laser is required to pulse, or gate, on and off in synchronization with an external control signal (typically from a computer or function generator operating in the range from DC to 1 kHz). To pulse or gate the laser, connect a signal providing +5.0 VDC pulses to the Gate connector on the rear panel of the UC-2000.

Users who intend to use a gating signal should set the UC-2000’s gate input logic to internal Pull-Down (normally off) mode. This prevents the beam from being enabled unless a high level (+3.5 V to +5.0 VDC) signal is applied to the Gate input connector. In the pull-down (normally off) mode, an asserted logic low signal, short circuit to ground, or an open or disconnected Gate input locks the beam off.

### **Warning** serious personal injury

The UC-2000’s default gate logic is factory set to internal Pull-Up (normally on) mode so that an open (disconnected) Gate input causes the laser to turn on. This functionality allows the user to easily test and verify laser operation prior to integration.

In an integrated system, you should configure the UC-2000’s gate input logic to internal Pull-Down (normally off) mode. This prevents the beam from being enabled unless a high level (+3.5 V to +5.0 VDC) signal is applied to the Gate input connector. In the Pull-Down (normally off) mode an asserted logic low signal, short circuit to ground, or an open or disconnected Gate inputs locks the beam off.

Many CO<sub>2</sub> lasers operating in applications requiring short gating pulses at repetition rates below 500 Hz will exhibit some leading edge overshoot regardless of the PWM frequency. This occurs because a cooler lasing medium (the CO<sub>2</sub> gas) is more efficient than a hotter one. The overshoot effect is more pronounced at lower gating frequencies because the gas has more time to cool between PWM Command signal pulses.

# technical reference

## Interface connections

The Interface connections section includes subsections:

Interface A (DB-9) connector

Interface B (RJ45) connector

Two built-in interface options are available for integrating OEM v30 lasers—a DB-9 and an RJ45 interface connector. The RJ45 (Interface B) connector is useful when integrating v30's into existing integrated laser systems previously configured for an RJ45 interface. For new Firestar OEM v30 installations, use the DB-9 (Interface A) connector. Although both interface connectors provide the same functionality, the DB-9 connector contains an additional output, Lase Indicator, that activates when the v30 is actively lasing.

### Interface A (DB-9) connector

The Interface A (DB-9) connector provides a +5 VDC auxiliary output (DC Out), a PWM input, an enable input, and four status outputs. The user inputs, Laser Enable and PWM Positive/PWM Negative, enable lasing and provide output power control. User outputs indicate v30 ready, lase, over temperature, and input voltage status. PWM inputs are optoisolated; however, all other inputs and outputs operate using standard 5V logic levels (0V – logic low; 5V – logic high). Both inputs and outputs are ESD protected, but are not optoisolated; all input signals sent to the laser must be clean or conditioned by the user.

**Caution**  
possible  
equipment  
damage

Turn off DC power before installing or removing any plug or cable from the Interface A (DB-9) connector. Ensure that user connections are made to the appropriate pins and that the appropriate signal levels are applied. Failure to do so may damage the laser.

Figure below illustrates the pin arrangement of the Interface A (9-pin female D-type subminiature) connector on the OEM v30's rear panel while the following table on the next page provides connection descriptions.

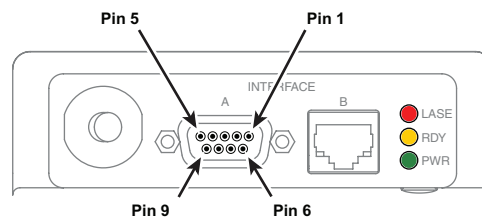


Figure 4-4 Interface A (DB-9) connector pinouts

# technical reference

## Interface connections

Table 4-3 Interface A (DB-9) pin descriptions

Pin	Function	Description
1	PWM Positive input	Use this optoisolated voltage input for tickle and PWM signals referenced to PWM Negative (Pin 6). The tickle signal is a +5 VDC, 1 $\mu$ s pulse at 5 kHz while the PWM Command signal is a +5 VDC, 5 kHz nominal (100 kHz max) pulse width modulated square wave.
2	Laser Ready output	This output is logic high (+5 V) when the laser is ready to lase (RDY indicator illuminated yellow). The output is low (0 V) when the laser is disabled (RDY indicator Off). The Laser Ready output sources 20 mA typical, 40 mA maximum.
3	Lase Indicator output	This output is logic high (+5 V) when the laser is actively lasing (LASE indicator illuminated red). The output is low (0 V) when the laser is not lasing (LASE indicator Off). The Lase Indicator output sources 20 mA typical, 40 mA maximum.
4	Overtemp Fault output	This output is logic high (+5 V) when an over temperature fault condition is detected (RDY indicator flashing continuously). The output is low (0 V) when laser temperature is within normal limits. The Overtemp Fault output sources 20 mA typical, 40 mA maximum.
5	DC Out output	This connection provides a +5 VDC, 250 mA maximum user output voltage referenced to GND (Pin 8). For example, jumper or switch this output to drive the Laser Enable input.
6	PWM Negative input	This input provides the negative, or return, side of the optoisolated tickle/PWM Command signal referenced to PWM Positive (Pin 1).
7	DC Voltage Fault output	This output is logic high (+5 V) if the DC input voltage is under or over voltage limits and the PWR indicator flashes a repeating sequence of 1 blink (under voltage) or 2 blinks (over-voltage). The output is low (0 V) when DC input voltage is within limits. The DC Voltage Fault output sources 20 mA typical, 40 mA maximum.
8	GND	This connection is the ground, or return, point for all signals except PWM Positive.
9	Laser Enable input	When this input is logic high (+5 V), the laser is enabled (RDY indicator illuminates yellow). The laser is disabled when the input is low (0 V). Tickle or PWM signals are applied to the RF circuit immediately after this input goes high.

**Important Note:** When switching +5 VDC to the Laser Enable input on Pin 9 through a switch or relay contact, we highly recommend adding a 100 Ohm, 1/4 watt resistor in series between the switching device and the Laser Enable input.

# technical reference

## Interface connections

### DB-9 input circuitry

The Interface A (DB-9) connector has two user inputs—a PWM input and an enable input. As described in Table 3-3, PWM Positive and PWM Negative are optoisolated to fully isolate PWM Command signals from other inputs and outputs. The Laser Enable input is ESD protected, but is not optoisolated, so this input signal must be conditioned by the user.

Figure below illustrates the input circuit's equivalent internal schematic while the prior table on the following page provides DB-9 input circuit specifications.

<p><b>Warning</b> serious personal injury</p>	<p>Always use shielded cable when connecting your PWM Command signal source to PWM Positive/PWM Negative inputs. In electrically-noisy environments, long lengths of unshielded wire act like an antenna and may generate enough voltage to trigger uncommanded lasing.</p>
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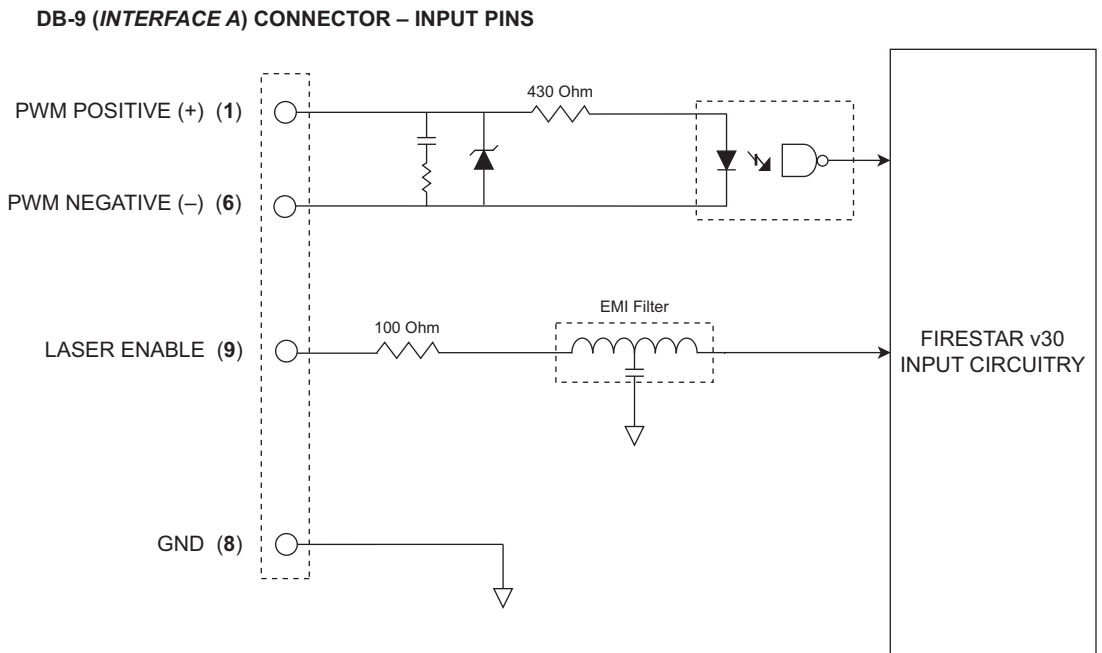


Figure 4-5 DB-9 input equivalent schematic



# technical reference

## Interface connections

Table 4-4 DB-9 input circuit specifications

Input Signals	Input Device Type and Specifications
PWM Positive	High-speed optoisolator LED, forward voltage drop (Vf) 1.5 VDC Off state Vmax +0.8 VDC On state Vmin +3.5 VDC @ 5 mA On state (continuous) Vmax +6.7 VDC @ 10 mA Frequency, max. 100 kHz
Laser Enable	5V logic input buffer Off state Vmax +0.8 VDC On state Vmin +2.0 VDC @ 0.2 mA On state (continuous) Vmax +5.0 VDC @ 0.5 mA

Note: Do not apply a Laser Enable signal until the OEM v30's internal +5 VDC power supply has stabilized (approximately 200 ms after DC power-up).

### Sample input circuits

**Caution**  
possible  
equipment  
damage

The Interface A (DB-9) Laser Enable input is a direct 5V logic input. Do not send a voltage signal to the Laser Enable input (Pin 9) until DC power is applied; otherwise, the control board will be damaged. Observe all 5V logic specifications and precautions when integrating OEM v30 inputs and outputs into your control system.

Figure below illustrates one method of applying the Laser Enable signal using a customer-supplied limit switch or relay contact powered by the OEM v30's DC Out output (+5 V, 250 mA).

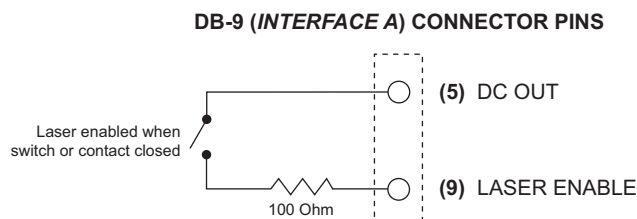


Figure 4-6 OEM v30 powered Laser Enable circuit

# technical reference

## Interface connections

Figure below shows another variation for applying a Laser Enable signal. In this case, the customer is also supplying the voltage necessary to drive the v30's enable circuit.

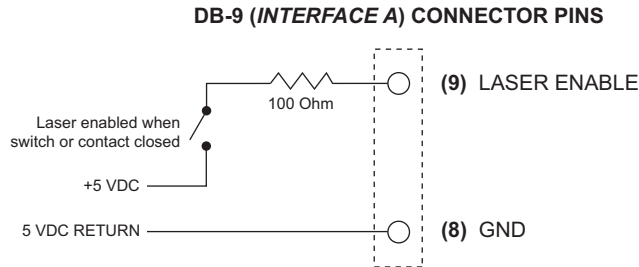


Figure 4-7 Customer powered Laser Enable circuit

Figure below shows an isolated PLC output module switching the Laser Enable signal from a +5 V source.

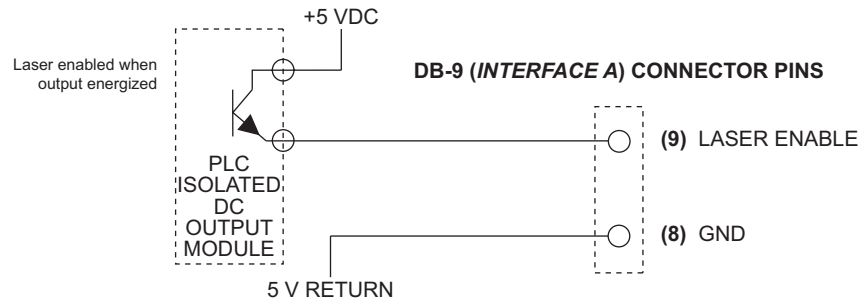


Figure 4-8 PLC switched Laser Enable circuit

### DB-9 output circuitry

The Interface A (DB-9) connector has four user outputs that communicate laser status to the user's control system. As described in Table 4-3, the four outputs, Laser Ready, Lase Indicator, Overtemp Fault, and DC Voltage Fault are ESD protected, but are not optoisolated. The Laser Ready output goes high (+5V) when lasing is possible, otherwise the output is low (0V) when the laser is not ready. Lase Indicator goes high when the PWM signal is sufficient to induce laser output and is low when no beam is being emitted. Overtemp Fault goes high when laser temperature rises above its upper thermal limit; otherwise the output is low. DC Voltage Fault goes high when an under/over voltage condition is sensed; otherwise the output is low when the DC supply voltage is within limits.

Note: OEM v30 outputs are voltage sources. Each output can source only 20 mA typical, 40 mA maximum, to a ground referenced load (the ground reference, GND, is Pin 8). The control board will be damaged if this current limit is exceeded.

The Interface A (DB-9) connector also includes a +5 VDC output voltage source, DC Out. This output can provide a maximum current of 250 mA and is useful for driving the Laser Enable input as described in the DB-9 input circuitry subsection.

# technical reference

## Interface connections

Table below provides DB-9 output circuit specifications while following figure illustrates the output circuit's equivalent internal schematic.

Table 4-5 DB-9 output circuit specifications

Output Signals	Output Device Type and Specifications
Laser Ready	5V logic output buffer
Lase Indicator	On state $V_{min} +4.5 \text{ VDC @ } 50 \text{ mA}$
Overtemp Fault	On state (typical) $+5.0 \text{ VDC @ } 0.5 \text{ mA}$
DC Voltage Fault	Off state $V_{max} +0.8 \text{ VDC}$

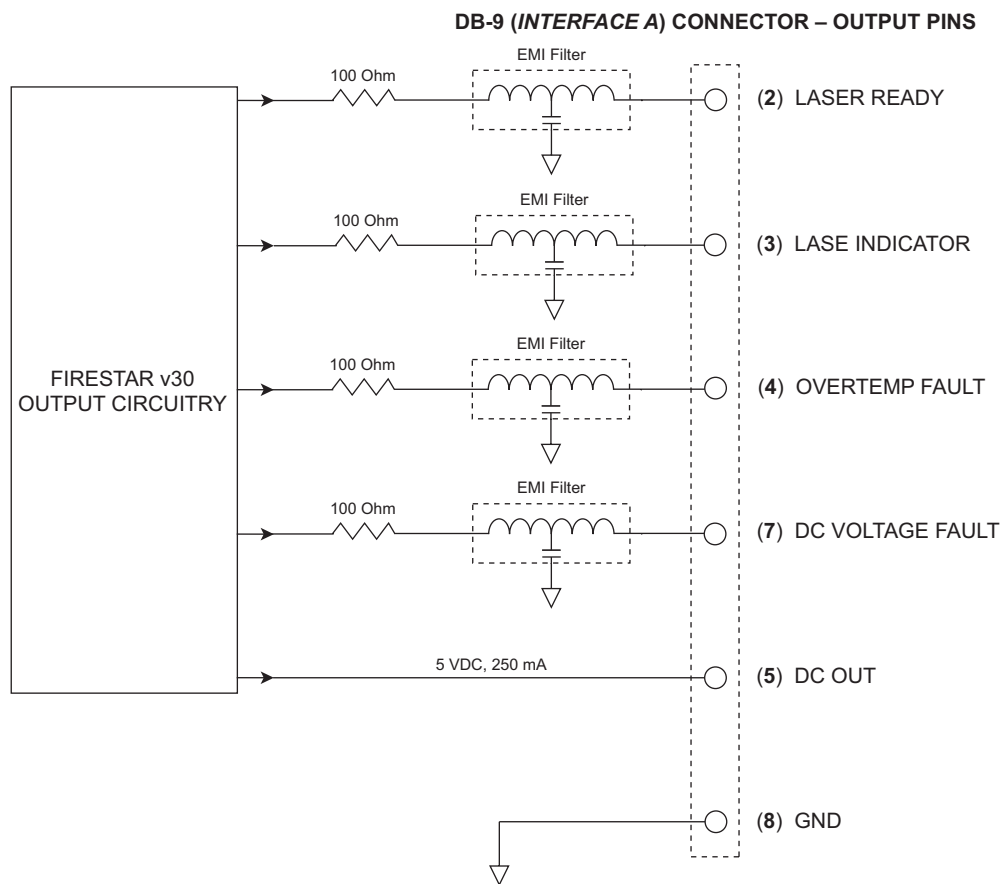


Figure 4-9 DB-9 output equivalent schematic

# technical reference

## Interface connections

### Sample output circuit

You can monitor OEM v30 laser status remotely by connecting one or more outputs to an isolated 5 VDC solid state relay or PLC input module. Figure below illustrates the connections required to monitor the DB-9's Lase Indicator status, or any other DB-9 output, using an isolated 5 VDC input module.

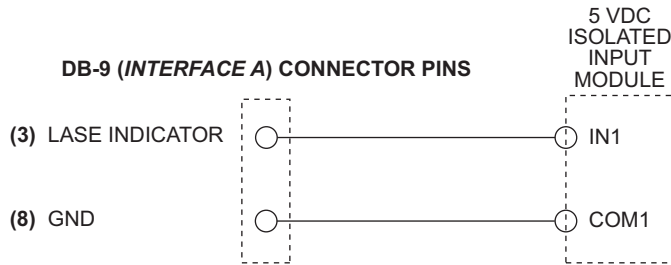


Figure 4-10 Lase Indicator output to PLC input

### Interface B (RJ45) connector

The Interface B (RJ45) connector provides a +15 VDC auxiliary output (DC Out), a PWM input, an enable input, and three status outputs. The user inputs, Laser Enable and PWM Positive/PWM Negative, enable lasing and provide output power control. User outputs indicate v30 ready, over temperature, and input voltage status. PWM inputs are optoisolated; however, all other inputs and outputs operate using standard 5V logic levels (0V – logic low; 5V – logic high). Both inputs and outputs are ESD protected, but are not optoisolated; all input signals sent to the laser must be clean or conditioned by the user.

**Caution**  
possible  
equipment  
damage

Turn off DC power before installing or removing any plug or cable from the Interface B (RJ45) connector. Ensure that user connections are made to the appropriate pins and that the appropriate signal levels are applied. Failure to do so may damage the laser.

Figure below illustrates the pin arrangement of the Interface B (RJ45/8P8C) connector on the OEM v30's rear panel while Table 3-6 on the next page provides connection descriptions.

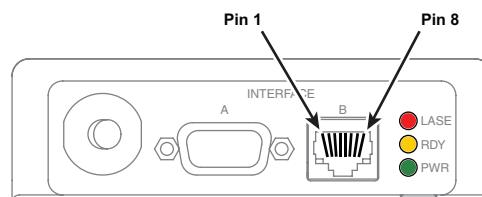


Figure 4-11 Interface B (RJ45) connector pinouts

# technical reference

## Interface connections

Table 4-6 Interface B (RJ45) pin descriptions

Pin	Function	Description
1	PWM Positive input	Use this optoisolated voltage input for tickle and PWM signals referenced to PWM Negative (Pin 6). The tickle signal is a +5 VDC, 1 $\mu$ s pulse at 5 kHz while the PWM Command signal is a +5 VDC, 5 kHz nominal (100 kHz max) pulse width modulated square wave.
2	DC Out output	This connection provides a +15 VDC, 250 mA maximum user output voltage referenced to GND (Pin 8).
3	Laser OK output	This output is logic high (+5 V) when no faults are detected. The output is low (0 V) if a fault occurs (RDY or PWR indicators flashing). The Laser OK output sources 20 mA typical, 40 mA maximum.
4	Temperature OK output	This output is logic high (+5 V) when laser temperature is within operating limits. The output is low (0 V) when an over temperature condition is detected (RDY indicator flashing continuously). The Temperature OK output sources 20 mA typical, 40 mA maximum.
5	Voltage OK output	This output is logic high (+5 V) when DC input voltage is within limits. The output is low (0 V) if the DC input voltage is under or over voltage limits and the PWR indicator flashes a repeating sequence of 1 blink (under voltage) or 2 blinks (overvoltage). The Voltage OK output sources 20 mA typical, 40 mA maximum.
6	PWM Negative input	This input provides the negative, or return, side of the optoisolated tickle/PWM Command signal referenced to PWM Positive (Pin 1). If this pin does not provide a PWM return, it must be connected to GND (Pin 8). The control board will be damaged if this pin is left unconnected.
7	Laser Enable input	When this input is logic high (+5 V), the laser is enabled (RDY indicator illuminates yellow). The laser is disabled when the input is low (0 V). Tickle or PWM signals are applied to the RF circuit immediately after this input goes high.
Important Note:		When switching +5 VDC to the Laser Enable input on Pin 7 through a switch or relay contact, we highly recommend adding a 100 Ohm, 1/4 watt resistor in series between the switching device and the Laser Enable input.
8	GND	This connection is the ground, or return, reference for all RJ45 inputs and outputs.

# technical reference

## Interface connections

### RJ45 input circuitry

The Interface B (RJ45) connector has two user inputs—a PWM input and an enable input. As described in the prior table, PWM Positive and PWM Negative are optoisolated to fully isolate PWM Command signals from other inputs and outputs. The Laser Enable input is ESD protected, but is not optoisolated, so this input signal must be conditioned by the user.

Figure below illustrates the input circuit's equivalent internal schematic while below on the following page provides RJ45 input circuit specifications.

<p><b>Warning</b> serious personal injury</p>	<p>Always use shielded cable when connecting your PWM Command signal source to PWM Positive/PWM Negative inputs. In electrically-noisy environments, long lengths of unshielded wire act like an antenna and may generate enough voltage to trigger uncommanded lasing.</p>
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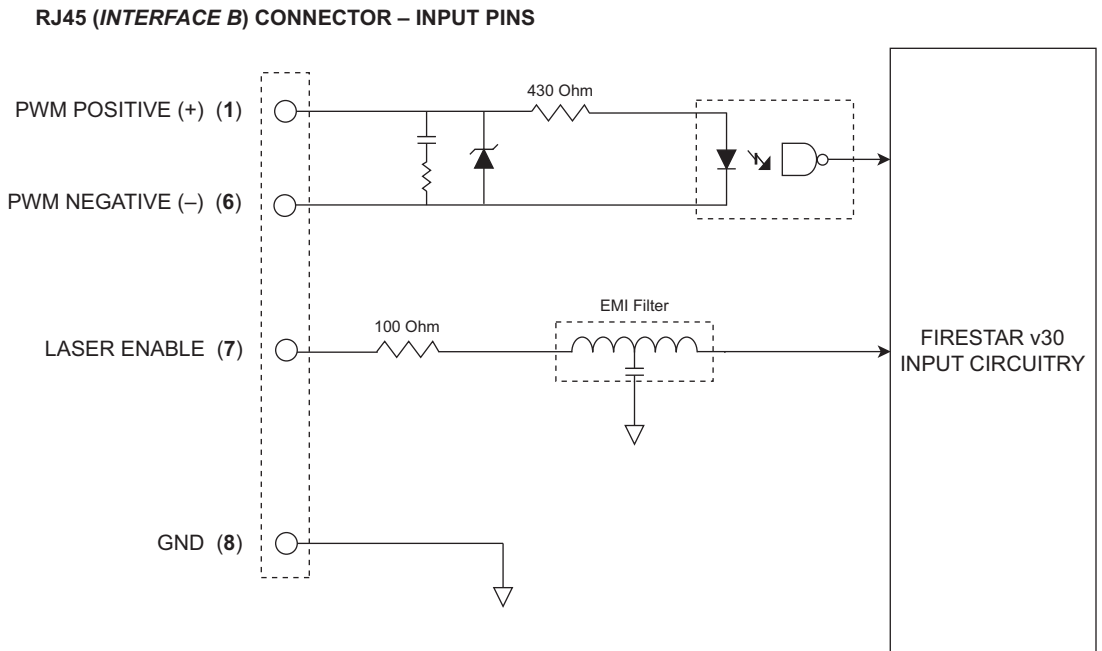


Figure 4-12 RJ45 input equivalent schematic

# technical reference

## Interface connections

Table 4-7 RJ45 input circuit specifications

Input Signals	Input Device Type and Specifications
PWM Positive	High-speed optoisolator LED, forward voltage drop (Vf) 1.5 VDC Off state Vmax +0.8 VDC On state Vmin +3.5 VDC @ 5 mA On state (continuous) Vmax +6.7 VDC @ 10 mA Frequency, max. 100 kHz
Laser Enable	5V logic input buffer Off state Vmax +0.8 VDC On state Vmin +2.0 VDC @ 0.2 mA On state (continuous) Vmax +5.0 VDC @ 0.5 mA

Note: Do not apply a Laser Enable signal until the OEM v30's internal +5 VDC power supply has stabilized (approximately 200 ms after DC power-up).

### Sample input circuits

#### Caution possible equipment damage

The Interface B (RJ45) Laser Enable input is a direct 5V logic input. Do not send a voltage signal to the Laser Enable input (Pin 7) until DC power is applied; otherwise, the control board will be damaged. Observe all 5V logic specifications and precautions when integrating OEM v30 inputs and outputs into your control system.

PWM Negative (Pin 6) must be connected to GND (Pin 8) or it must serve as the return path for the PWM Positive signal.

Figure below shows a method for applying a Laser Enable signal to the RJ45 Interface B connector. In this case, the customer must also supply the +5V voltage necessary to drive the circuit.

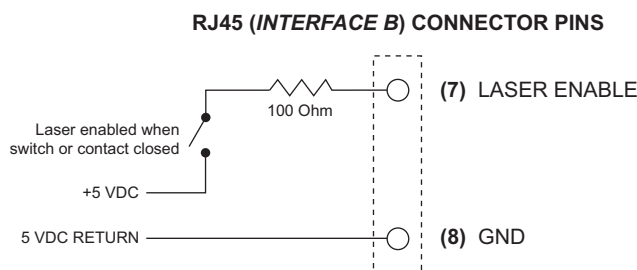


Figure 4-13 Customer powered Laser Enable circuit

# technical reference

## Interface connections

Figure below shows an isolated PLC output module switching the Laser Enable signal from a +5 V source.

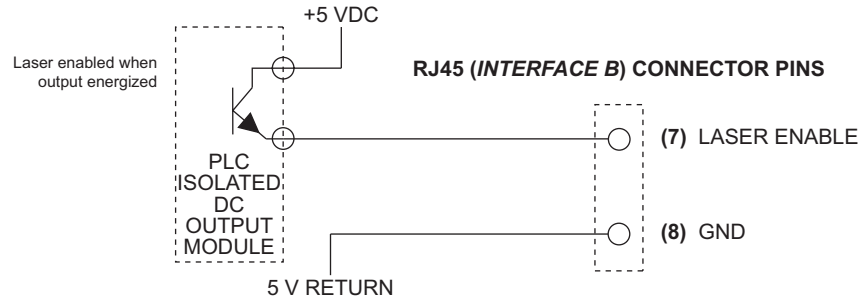


Figure 4-14 PLC switched Laser Enable circuit

### RJ45 output circuitry

The Interface B (RJ45) connector has three user outputs that communicate laser status to the user's control system. As described in Table 3-6, the three outputs, Laser OK, Temperature OK, and Voltage OK are ESD protected, but are not optoisolated. The Laser OK output is high (+5V) when lasing is possible, otherwise the output goes low (0V) when a fault is detected. Temperature OK is high when laser temperature is within limits; otherwise the output goes low if laser temperature rises above thermal limits. Voltage OK is high when the DC supply voltage is within limits; otherwise the output goes low if an under/over voltage condition is sensed.

Note: OEM v30 outputs are voltage sources. Each output can source only 20 mA typical, 40 mA maximum, to a ground referenced load (the ground reference, GND, is Pin 8). The control board will be damaged if this current limit is exceeded.

The Interface B (RJ45) connector also includes a +15 VDC output voltage source, DC Out, that provides a maximum current of 250 mA.

Table below provides RJ45 output circuit specifications while the following figure illustrates the output circuit's equivalent internal schematic.

Table 4-8 RJ45 output circuit specifications

Output Signals	Output Device Type and Specifications
Laser OK	5V logic output buffer
Temperature OK	On state $V_{min} +4.5$ VDC @ 50 mA
Voltage OK	On state (typical) +5.0 VDC @ 0.5 mA Off state $V_{max} +0.8$ VDC



# technical reference

## Interface connections

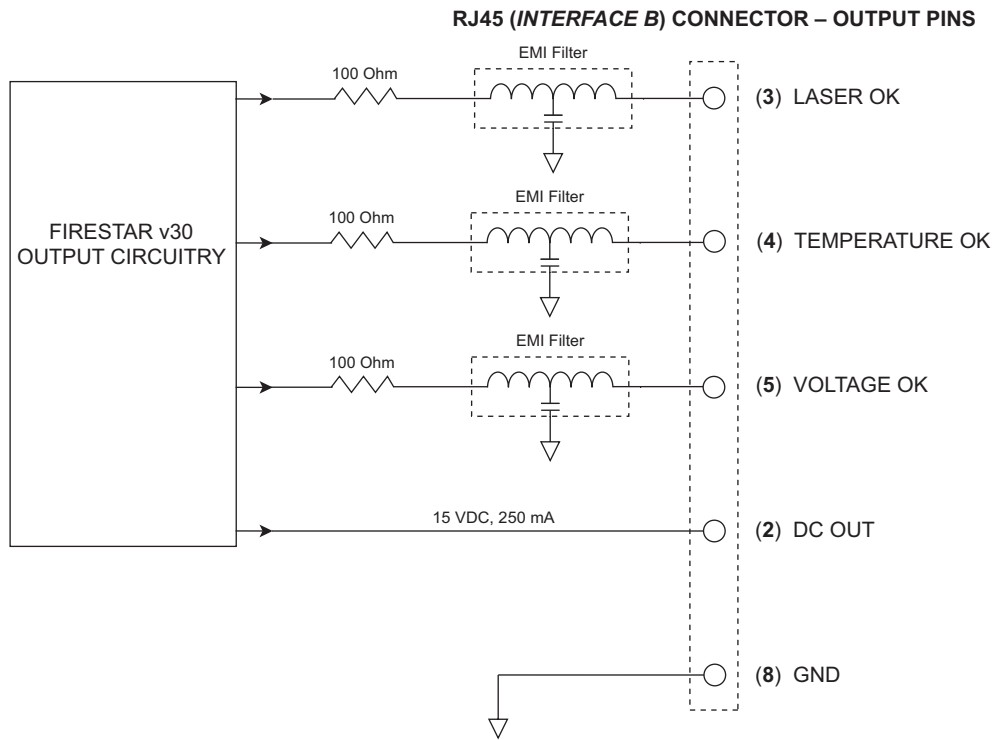


Figure 4-15 RJ45 output equivalent schematic

### Sample output circuit

You can monitor OEM v30 laser status remotely by connecting one or more outputs to an isolated 5 VDC solid state relay or PLC input module. Figure below illustrates the connections required to monitor the RJ45's Laser OK status, or any other RJ45 output, using an isolated 5 VDC input module.

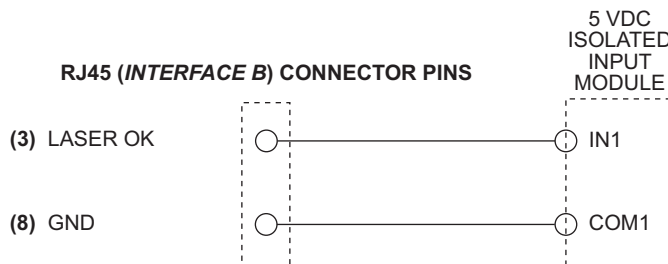


Figure 4-16 Laser OK output to PLC input

# technical reference

## OEM v30 general specifications

Table 4-9 OEM v30 general specifications

Parameter			
Output Specifications	10.6 μm	10.2 μm	9.3 μm
Wavelength, μm	10.57–10.63 <sup>†</sup>	10.20–10.30	9.23–9.31
Power Output, continuous <sup>1,2</sup>	30 W	25 W	20 W
Power Stability <sup>3</sup>	± 5% / ± 3%	± 5% / ± 3%	± 7% / ± 5%
Mode Quality (M <sup>2</sup> )	≤ 1.2	≤ 1.2	≤ 1.2
Beam Waist Diameter, mm (at 1/e <sup>2</sup> ) <sup>4</sup>	2.5 ± 0.5	2.5 ± 0.5	2.5 ± 0.5
Beam Divergence, full angle, mrad	< 7.0	< 7.0	< 7.0
Ellipticity	< 1.2	< 1.2	< 1.2
Polarization	Linear, horiz.	Linear, horiz.	Linear, horiz.
Rise Time	< 100 μs	< 100 μs	< 100 μs
<b>Input Specifications</b>			
<b>Power Supply</b>			
Voltage	30 V ± 2.0 VDC		
Current, max. (air-/water-cooled)	15 A (24 A peak for 0.5 ms min.)		
(fan-cooled)	16 A (24 A peak for 0.5 ms min.)		
<b>Input Signals</b>			
	Tickle Signal	PWM Command Signal	
Voltage (5 V nominal)	+3.5 to +6.7 VDC		+3.5 to +6.7 VDC
Current	10 mA @ +6.7 VDC		10 mA @ +6.7 VDC
Frequency	5 kHz (1 μs duration)		DC–100 kHz
<b>Cooling Specifications</b>			
	(Air-/fan-cooled)	(Water-cooled)	
Maximum Heat Load, laser	450 Watts		450 Watts
Minimum Flow Rate	140 CFM per fan (x2)		1.0 GPM, < 60 PSI
Coolant Temperature	< 40 °C, ambient		18–22 °C
<b>Environmental Specifications</b>			
Ambient Operating Temperature Range <sup>5</sup>	15 °C–40 °C		
Humidity	0–95%, non-condensing		
<b>Physical Specifications</b>			
	(Air-cooled)	(Fan-cooled)	(Water-cooled)
Length	16.79 in (42.65 cm)	16.79 in (42.65 cm)	17.06 in (43.33 cm)
Width	4.58 in (11.63 cm)	4.72 in (11.94 cm)	4.58 in (11.63 cm)
Height	5.76 in (14.63 cm)	6.28 in (15.95 cm)	5.84 in (14.83 cm)
Weight	18.00 lbs ( 8.20 kg)	21.30 lbs ( 9.66 kg)	19.24 lbs ( 8.73 kg)

\* Specifications subject to change without notice. All tests performed at 5 kHz, 95% duty cycle unless otherwise noted.

† Typical. Actual wavelength range may vary from 10.2–10.8 μm.

1 This power level is guaranteed for 12 months regardless of operating hours.

2 Minimum 30 VDC input voltage to obtain guaranteed output power.

3 From cold start (guaranteed) / After two minutes (typical).

4 Measured at laser output.

5 Published specifications guaranteed at a temperature of 22 °C. Some performance degradation may occur in ambient temperatures above 22 °C. For air-cooled lasers, laser power typically decreases 0.5–1% per degree Celsius increase in ambient temperature.



# technical reference

## OEM v30 package outline drawings

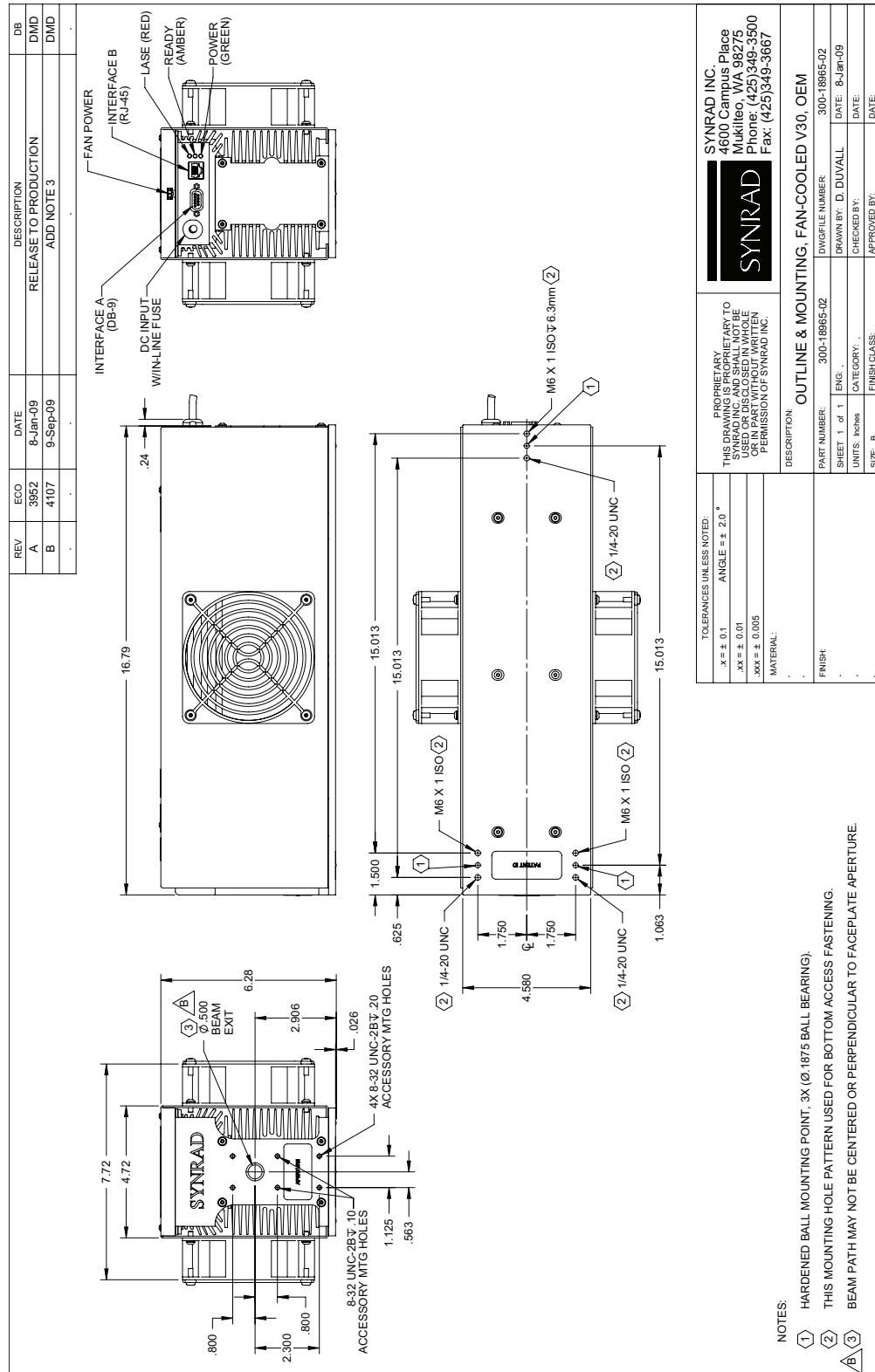


Figure 4-18 OEM v30 fan-cooled package outline and mounting dimensions

# technical reference

## OEM v30 package outline drawings

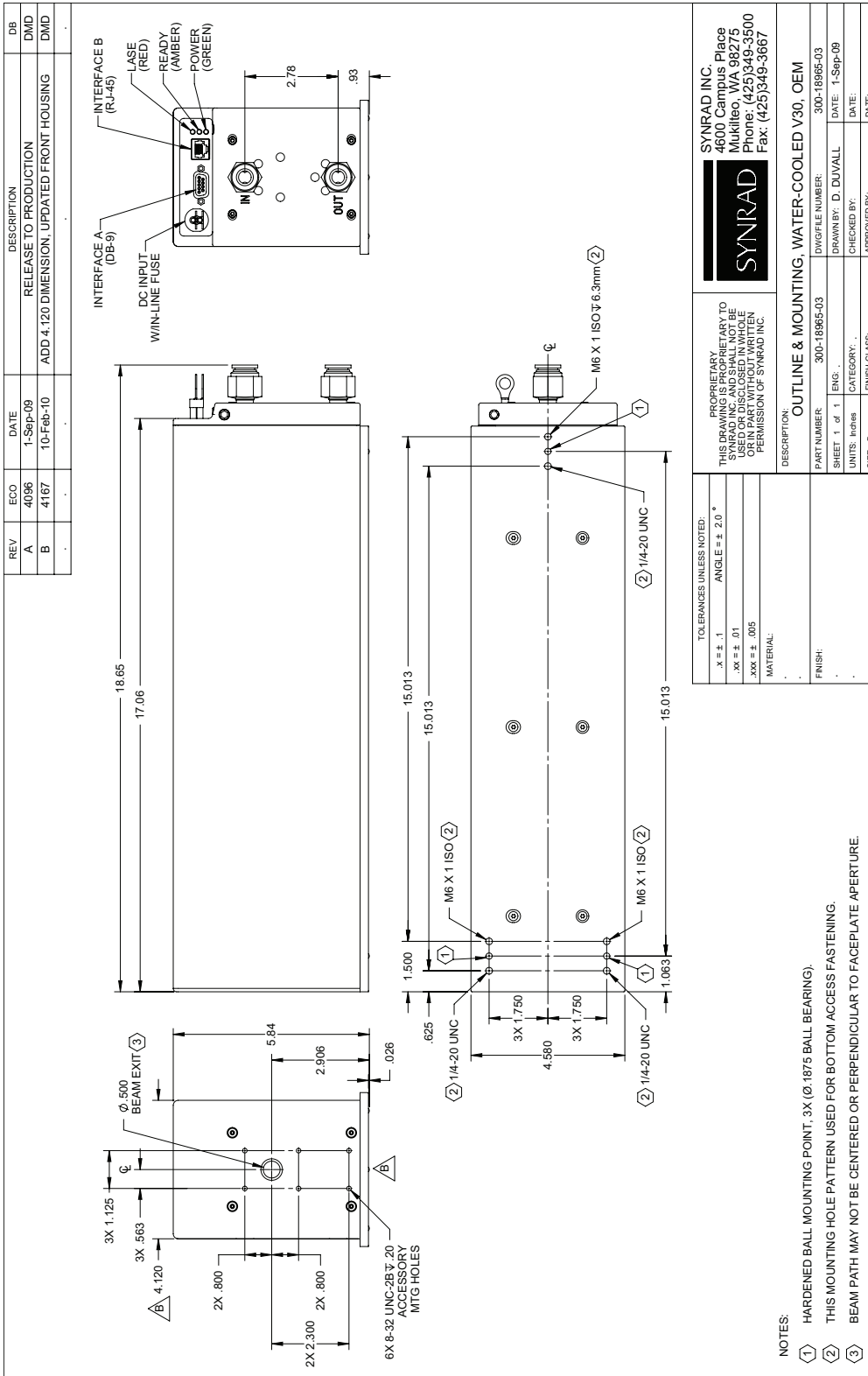


Figure 4-19 OEM v30 water-cooled package outline and mounting dimensions

# technical reference

## OEM v30 packaging instructions

REV	ECO	DATE	DESCRIPTION	DB	DMD
A	4325	26-Apr-11	RELEASE TO PRODUCTION		DMD
B	4564	23-May-12	UPDATE DESCRIPTION		DMD

**STEP BY STEP PACKAGING INSTRUCTIONS:**

1. POSITION BOX SO LOGO ON TOP FLAP IS FACING YOU (LOGO WILL BE ON THE LEFT SIDE).
2. POSITION BOTTOM FOAM INSIDE BOX AS SHOWN.
3. PLACE LASER INSIDE FOAM CAVITIES AS SHOWN, MAKING SURE FRONT OF LASER IS ON THE LEFT SIDE AND TOP OF LASER IS FACING YOU.
4. PULL TOP OF LASER TO THE RIGHT SIDE AS SHOWN.
5. PULL TOP FOAM OVER LASER AS SHOWN.
6. TUCK CABLE AS SHOWN.
7. DO NOT SHIP WITH KEY IN SWITCH TO AVOID DAMAGE TO KEY/SWITCH.
8. WRITE SYNRAD RETURN AUTHORIZATION NUMBER ON OUTSIDE OF SHIPPING BOX.

<p>PROPRIETARY SYNRAD INC. AND SHALL NOT BE USED OR DISCLOSED IN WHOLE OR IN PART WITHOUT WRITTEN PERMISSION OF SYNRAD INC.</p>	<p><b>SYNRAD INC.</b> 4600 Campus Place Mukilteo, WA 98275 Phone: (425)349-3500 Fax: (425)349-3667</p>	<p><b>PACKAGING, V30(V)30</b></p> <p>DESCRIPTION: PART NUMBER: 90D-20277-01 DWG FILE NUMBER: 90D-20277-01 DRAWN BY: D. DUVAL DATE: 26-Apr-11 CHECKED BY: DATE: APPROVED BY: DATE:</p>
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<p>TOLERANCES UNLESS NOTED:          .x# ± # .          .xx ± # .          .xxx ± # .</p>	<p>ANGLE ± # . °</p>	<p>FINISH:          SEE BOM</p>
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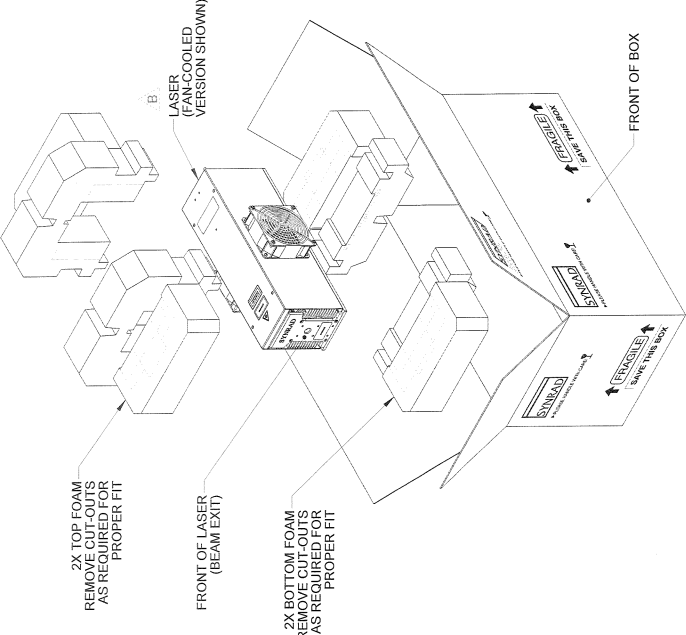
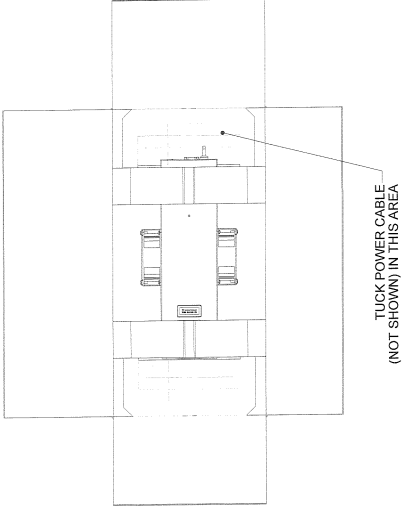
**IMPORTANT NOTE:** FAILURE TO PROPERLY PACKAGE LASER USING SYNRAD SHIPPING BOX AND FOAM CARDBOARD INSERTS AS SHOWN MAY VOID WARRANTY. CUSTOMERS MAY INCUR ADDITIONAL REPAIR CHARGES DUE TO SHIPPING DAMAGE CAUSED BY IMPROPER PACKAGING.

Figure 4-20 OEM v30 air-cooled packaging instructions

# technical reference

## OEM v30 packaging instructions

REV	ECO	DATE	DESCRIPTION	DB
A	3968	6-Nov-08	RELEASE TO PRODUCTION	DMD
B	4564	23-May-12	CHANGE TO FAN VERSION	DMD

**STEP BY STEP PACKAGING INSTRUCTIONS:**

1. POSITION BOX SO LOGO ON TOP FLAP IS FACING YOU (LOGO WILL BE ON THE LEFT SIDE).
2. POSITION CUT-OUTS IN THE CENTER OF THE LASER AS SHOWN. MAKING SURE FRONT OF LASER IS ON THE LEFT SIDE.
3. PLACE LASER INSIDE FOAM CUT-OUTS AS SHOWN. CABLES NOT SHOWN FOR EASE OF ILLUSTRATION.
4. PULL CABLES TO RIGHT SIDE AND COIL. NOTE: CABLES NOT SHOWN FOR EASE OF ILLUSTRATION.
5. PLACE TOP FOAM OVER LASER AND SECURE INTO BOTTOM FOAM NOTCHES AS SHOWN.
6. TUCK CABLE AS SHOWN.
7. DO NOT SHIP WITH KEY IN SWITCH TO AVOID DAMAGE TO KEYSWITCH.
8. WRITE SYNRAD RETURN AUTHORIZATION NUMBER ON OUTSIDE OF SHIPPING BOX.

**TOLERANCES UNLESS NOTED:**

.x ± .01    ANGLE ± .05°  
 .xx ± .01  
 .xxx ± .005

MATERIAL:  
 SEE BOM

FINISH:

PROPRIETARY THIS DRAWING IS PROPRIETARY TO SYNRAD. IT IS NOT TO BE REPRODUCED OR USED OR DISCLOSED IN WHOLE OR IN PART WITHOUT WRITTEN PERMISSION OF SYNRAD INC.

SYNRAD INC.  
 4600 Campus Place  
 McMilliteo, VA 30275  
 Phone: (423)349-3300  
 Fax: (423)349-3667

DESCRIPTION: **PACKAGING, V30, FAN OR PRE-ALIGN /B**

PART NUMBER: 900-19874-01    DWG FILE NUMBER: 900-19874-01  
 SHEET 1 of 1    ENG.    DRAWN BY: D. DUVALL    DATE: 6-Nov-08  
 UNITS: Inches    CATEGORY: I    CHECKED BY: [Signature]    DATE: 5/24/12  
 SIZE: B    FINISH CLASS:    APPROVED BY: [Signature]    DATE: 7/11/12

**IMPORTANT NOTE:** FAILURE TO PROPERLY PACKAGE LASER USING SYNRAD SHIPPING BOX AND THIS BOMBED INSERTS AS SHOWN MAY CAUSE DAMAGE TO LASER. CUSTOMERS MAY INCUR ADDITIONAL REPAIR CHARGES DUE TO SHIPPING DAMAGE CAUSED BY IMPROPER PACKAGING.

Figure 4-21 OEM v30 fan-/water-cooled and pre-aligned packaging instructions

# maintenance/ troubleshooting

# 4

Use information in this chapter to perform maintenance or troubleshoot your Firestar OEM v30 laser.

This chapter contains the following information:

Maintenance – describes typical v30 maintenance procedures.

Troubleshooting – explains how to troubleshoot v30 problems.



# maintenance/ troubleshooting

## Maintenance

The Maintenance section includes subsections:

Disabling the v30 laser

Daily inspections

Storage/shipping

Cleaning optical components

## Disabling the v30 laser

Before performing any maintenance on your Firestar® OEM v30 laser, be sure to completely disable the laser by disconnecting DC power from the laser.

## Daily inspections

Perform the following steps daily to keep your OEM v30 laser in optimum operating condition. Except for the procedures described below, no other service is required or should be attempted.

 **Warning**  
serious  
personal  
injury

A risk of exposure to toxic elements, like zinc selenide, may result when certain optical or beam delivery components are damaged. In the event of damage to laser, marking head, or beam delivery optics, contact SYNRAD, Inc. or the optics manufacturer for handling instructions.

**Caution**  
possible  
equipment  
damage

If you operate your laser or marking head in a dirty or dusty environment, contact SYNRAD about the risks of doing so and precautions you can take to increase the longevity of your laser, marking head, and associated optical components.

- 1 For water-cooled lasers, inspect cooling tubing connections for signs of leakage. Check for signs of condensation that may indicate the cooling water temperature is set below the dew point temperature. Condensation will damage electrical and optical components inside the laser. See Setting coolant temperature in the Getting Started chapter for details on preventing condensation.
- 2 When using compressed air as a purge/assist gas for your beam delivery system, empty water traps and oil separators on each filter and/or dryer between the laser and your compressed air source. Compressed air must meet the gas purity specifications shown in the Technical Reference chapter.

# maintenance/ troubleshooting

## Maintenance

- 3 Inspect beam delivery components for signs of dust or debris and clean as required. When cleaning the optical surfaces of beam delivery components, carefully follow the manufacturer's instructions.
- 4 Visually inspect the exterior housing of the laser to ensure that all warning labels are present. Refer to Figure 1 in the Laser Safety chapter for label types and locations.

## Storage/shipping

When preparing a water-cooled laser for storage or shipping, remember to drain cooling water from the laser. In cold climates any water left in the cooling system may freeze, which could damage internal components. After draining thoroughly, use compressed shop air at no more than 29 PSI (while wearing safety glasses!) to remove any residual water. When finished, cap all cooling connections to prevent debris from entering the cooling system.

When shipping SYNRAD lasers to another facility, we highly recommend that you ship the unit in its original SYNRAD shipping container. If you no longer have the original shipping box and inserts, contact SYNRAD Customer Service about purchasing replacement packaging. Refer to OEM v30 packaging instructions in the Technical Reference chapter for detailed instructions on packaging the laser for shipment.

**Important Note:** Failure to properly package the laser using a SYNRAD-supplied shipping box and foam/cardboard inserts as described in the OEM v30 packaging instructions section may void the warranty. Customers may incur additional repair charges due to shipping damage caused by improper packaging.

## Cleaning optical components

 **Danger**  
serious  
personal  
injury

Ensure that DC power to the laser is turned off and locked out before inspecting optical components in the beam path. Invisible CO<sub>2</sub> laser radiation is emitted through the aperture. Corneal damage or blindness may result from exposure to laser radiation.

**Caution**  
possible  
equipment  
damage

Because of their smaller beam diameter, Firestar lasers have significantly higher power densities than previous SYNRAD lasers. This means that any contamination on the laser's output window (or on any optic in the beam path) can absorb enough energy to damage the optic. Inspect the output window and other beam delivery optics periodically for signs of contaminants and carefully clean as required. In dirty environments, purge laser optics using filtered air or nitrogen to prevent vapor and debris from accumulating on optical surfaces.

# maintenance/ troubleshooting

## Maintenance

Debris or contaminants on the laser's output coupler or external beam delivery components may affect laser processing and lead to damage or failure of the optics and/or the laser. Carefully follow the steps below to inspect and clean the optical components in the beam path. Before beginning the cleaning process, read this entire section thoroughly to ensure that all cleaning materials are available and that each step is completely understood.

**Important Note:** Exercise great care when handling infrared optics; they are much more fragile than common glass materials. Optical surfaces and coatings are easily damaged by rough handling and improper cleaning methods.

## Cleaning guidelines

Wear latex gloves or finger cots (powder-free) to prevent contamination of optical surfaces by dirt and skin oils.

Never handle optics with tools; always use gloved hands or fingers.

Hold optics by the outer edge; never touch the coated surface.

Always place optics on lens tissue for protection; never place optics on hard or rough surfaces.

It may be necessary to use a fluffed cotton swab or cotton ball instead of a lens wipe to uniformly clean the entire surface of small-diameter mounted optics.

Before using cleaning agents, read Material Safety Data Sheets (MSDS) and observe all necessary safety precautions.

## Required cleaning materials

Table 4-1 lists the type and grade of materials required to properly clean optical surfaces.

Table 5-1 Required cleaning materials

Cleaning Material	Requirements
Latex gloves or finger cots	Powder free
Air bulb	Clean air bulb
Ethyl or isopropyl alcohol	Spectroscopic or reagent grade
Acetone	Spectroscopic or reagent grade
Lens wipe (preferred)	Optical (cleanroom) quality
Cotton balls or cotton swabs	High-quality surgical cotton/high-quality paper-bodied

# maintenance/ troubleshooting

## Maintenance

### Cleaning optics

- 1 Shut off and lock out all power to the laser. You must verify that the laser is OFF (in a zero-energy state) before continuing with the optical inspection!
- 2 Visually inspect all optical surfaces in the beam path, including the laser's output coupler, for contaminants.

#### Caution possible lens damage

Do not allow the nozzle of the air bulb to touch the optical surface. Any contact may damage the optic by scratching coatings on the optical surface.

Do not use compressed shop air to blow contamination from the optic. Compressed air contains significant amounts of water and oil that form adsorbing films on the optical surface.

Do not exert pressure on the surface of the optic during cleaning. Optical surfaces and coatings are easily scratched by dislodged contaminants.

Use a new lens wipe on each pass as contaminants picked up by the wipe may scratch the optical surface.

- 3 Remove loose contaminants from the optic by holding a clean air bulb at an angle to the optic and blow a stream of air at a glancing angle across the lens surface. Repeat as necessary.
- 4 Dampen a lens wipe with the selected cleaning agent. Alcohol (least aggressive) is best for initial surface cleaning. Acetone (moderately aggressive) is best for oily residue or minor baked-on vapor and debris.

**Important Note:** If acetone is used as a cleaning solvent, a second follow-up cleaning of the optical surface using alcohol is required to remove any acetone residue.

- 5 Gently, and without applying pressure, drag the damp lens wipe across the optical surface in a single pass. Do not rub or apply any pressure, especially when using a cotton swab. Drag the wipe without applying any downward pressure.

**Note:** Use a clean lens wipe on each pass. The wipe will pick up and carry surface contaminants that may scratch optical surfaces or coatings.

To prevent streaking during the final alcohol cleaning, drag the lens wipe slowly across the surface so that the cleaning liquid evaporates right behind the wipe.

- 6 Carefully examine the optic under a good light. Certain contaminants or damage such as pitting cannot be removed. In these cases the optic must be replaced to prevent catastrophic failure.
- 7 Repeat Steps 4 through 6 as required, removing all traces of contaminants and deposits.

# maintenance/ troubleshooting

## Troubleshooting

The Troubleshooting section includes subsections:

- Introduction
- Operational flowchart
- LED/output signal status
- Laser fault indications
- Resetting faults
- Laser troubleshooting
- Beam delivery optics

## Introduction

This section is designed to help isolate problems to the module level only. Problems on circuit boards or the laser tube are outside the scope of this guide because they are not user-serviceable assemblies; do not attempt to repair them. Contact SYNRAD or a SYNRAD Authorized Distributor for repair/replacement information. To troubleshoot the OEM v30 laser, it is necessary to understand the sequence of events that must happen before the laser can turn on and operate. Before you attempt to perform any service, we advise you to read the entire troubleshooting section and review the operational flowchart on the following page.

 **Danger**  
serious  
personal  
injury

This Class 4 laser product emits invisible infrared laser radiation in the 9.3–10.6  $\mu\text{m}$  CO<sub>2</sub> wavelength band depending on model. Because direct or diffuse laser radiation can inflict severe corneal injuries, always wear eye protection when in the same area as an exposed laser beam. Do not contact the laser beam. This product emits an invisible laser beam that is capable of seriously burning human tissue.

Always be aware of the beam's path and always use a beam block while testing.

**Caution**  
possible  
equipment  
damage

Attempting repair of a SYNRAD Firestar laser without the express authorization of SYNRAD will void the product warranty. If troubleshooting or service assistance is required, please contact SYNRAD Customer Service.

# maintenance/ troubleshooting

## Troubleshooting

### Operational flowchart

The flowchart below illustrates the OEM v30's start-up sequence.

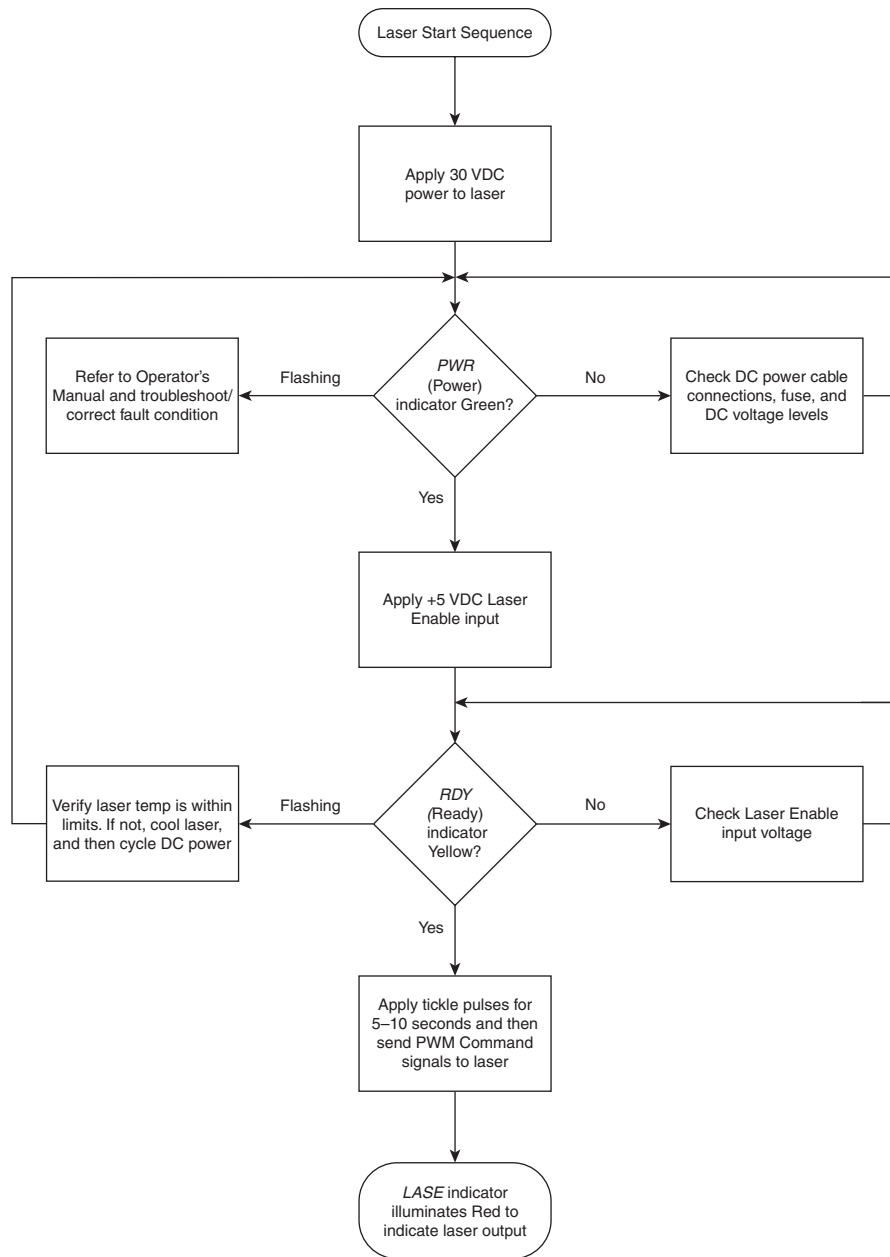


Figure 5-1 Operational flowchart

# maintenance/ troubleshooting

## Troubleshooting

### LED/output signal status

On OEM v30 lasers, the PWR indicator illuminates green on DC power-up. The RDY LED illuminates yellow when a Laser Enable signal is applied after which customer-supplied tickle and PWM Command signals are passed through to the RF driver. When PWM Command pulses are applied (and are long enough to produce laser output) the LASE LED illuminates red.

The v30 LED indicators, in conjunction with Interface A and Interface B outputs, provide status information to the user. Each subsection below shows LED and output signal status changes as various operating and fault conditions occur.

### LED/Interface A (DB-9) output status

Following show how v30 LED and DB-9 output signal status changes as various operating and fault conditions occur.

Table 5-2 Status LED and Interface A (DB-9) output signal overview

LED	LED Status		Output Signal Name	DB-9 Output Status	
	Normal	Fault		Normal	Fault
LASE	Red	--	Lase Indicator	High	--
	--	Off	Lase Indicator	--	Low
RDY	Yellow	--	Laser Ready	High	--
	--	Off	Laser Ready	--	Low
	--	Flashing <sup>1</sup>	Overtemp Fault	--	High
PWR	Green	--	DC Voltage Fault	Low	--
	--	Blinking <sup>1</sup>	DC Voltage Fault	--	High

1 See the Laser fault indications section for details.

Table 5-3 Normal operating condition

LED Indicator	LED Status	Output Signal	DB-9 Output Status
LASE (if tickle applied)	Off	Lase Indicator	Low
LASE (if PWM applied)	Red	Lase Indicator	High
RDY	Yellow	Laser Ready	High
		Overtemp Fault	Low
PWR	Green	DC Voltage Fault	Low

# maintenance/ troubleshooting

## Troubleshooting

Table 5-4 Laser Enable input not connected

LED Indicator	LED Status	Output Signal	DB-9 Output Status
LASE (if tickle applied)	Off	Lase Indicator	Low
LASE (if PWM applied)	Off	Lase Indicator	Low
RDY	Off	Laser Ready Overtemp Fault	Low Low
PWR	Green	DC Voltage Fault	Low

Table 5-5 Over Temperature fault

LED Indicator	LED Status	Output Signal	DB-9 Output Status
LASE (if tickle applied)	Off	Lase Indicator	Low
LASE (if PWM applied)	Off	Lase Indicator	Low
RDY	Flashing <sup>1</sup>	Laser Ready Overtemp Fault <sup>1</sup>	Low High
PWR	Green	DC Voltage Fault	Low

<sup>1</sup> See the Laser fault indications section for details.

Table 5-6 DC Voltage fault

LED Indicator	LED Status	Output Signal	DB-9 Output Status
LASE (if tickle applied)	Off	Lase Indicator	Low
LASE (if PWM applied)	Off	Lase Indicator	Low
RDY	Off	Laser Ready Overtemp Fault	Low Low
PWR	Blinking <sup>1</sup>	DC Voltage Fault <sup>1</sup>	High

<sup>1</sup> See the Laser fault indications section for details.



# maintenance/ troubleshooting

## Troubleshooting

Table 5-7 PWM Sense/Control Board fault

LED Indicator	LED Status	Output Signal	DB-9 Output Status
LASE (if tickle applied)	Off	Lase Indicator	Low
LASE (if PWM applied)	Off	Lase Indicator	Low
RDY	Flashing <sup>1</sup>	Laser Ready Overtemp Fault	Low Low
PWR	Flashing <sup>1</sup>	DC Voltage Fault	Low

<sup>1</sup> See the Laser fault indications section for details.

## LED/Interface B (RJ45) output status

Tables below show how v30 LED and RJ45 output signal status changes as various operating and fault conditions occur.

Table 5-8 Status LED and Interface B (RJ45) output signal overview

LED	LED Status		Output Signal Name	RJ45 Output Status	
	Normal	Fault		Normal	Fault
LASE	Red	--	n/a	--	--
	--	Off	n/a	--	--
RDY	Yellow	--	Laser OK	High	--
	--	Off	Laser OK	--	Low
	--	Flashing <sup>1</sup>	Temperature OK	--	Low
PWR	Green	--	Voltage OK	High	--
	--	Blinking <sup>1</sup>	Voltage OK	--	Low

<sup>1</sup> See the Laser fault indications section for details.

Table 5-9 Normal operating condition

LED Indicator	LED Status	Output Signal	RJ45 Output Status
LASE (if tickle applied)	Off	n/a	--
LASE (if PWM applied)	Red	n/a	--
RDY	Yellow	Laser OK Temperature OK	High High
PWR	Green	Voltage OK	High

# maintenance/ troubleshooting

## Troubleshooting

Table 5-10 Laser Enable input not connected

LED Indicator	LED Status	Output Signal	RJ45 Output Status
LASE (if tickle applied)	Off	n/a	--
LASE (if PWM applied)	Off	n/a	--
RDY	Off	Laser OK Temperature OK	Low High
PWR	Green	Voltage OK	High

Table 5-11 Over Temperature fault

LED Indicator	LED Status	Output Signal	RJ45 Output Status
LASE (if tickle applied)	Off	n/a	--
LASE (if PWM applied)	Off	n/a	--
RDY	Flashing <sup>1</sup>	Laser OK Temperature OK <sup>1</sup>	Low Low
PWR	Green	Voltage OK	High

<sup>1</sup> See the Laser fault indications section for details.

Table 5-12 DC Voltage fault

LED Indicator	LED Status	Output Signal	RJ45 Output Status
LASE (if tickle applied)	Off	n/a	--
LASE (if PWM applied)	Off	n/a	--
RDY	Off	Laser OK Temperature OK	Low High
PWR	Blinking <sup>1</sup>	Voltage OK <sup>1</sup>	Low

<sup>1</sup> See the Laser fault indications section for details.

# maintenance/ troubleshooting

## Troubleshooting

Table 5-13 PWM Sense/Control Board fault

LED Indicator	LED Status	Output Signal	RJ45 Output Status
LASE (if tickle applied)	Off	n/a	--
LASE (if PWM applied)	Off	n/a	--
RDY	Flashing <sup>1</sup>	Laser OK Temperature OK	Low High
PWR	Flashing <sup>1</sup>	Voltage OK	High

<sup>1</sup> See the Laser fault indications section for details.

## Laser fault indications

OEM v30 lasers have the ability to indicate five specific fault conditions. In the event of certain faults, the RDY LED, PWR LED, or both will blink an error code, pause 1/2 second, and then repeat the code. This sequence continues until the fault is corrected and the laser is reset by cycling DC power to the laser.

Table below lists fault codes, the corresponding fault condition, and describes possible corrective actions.

Table 5-14 Laser fault codes

LED	# of Blinks	Fault Condition	Corrective Action in Field
RDY	Continuous	Over Temperature fault	Cool laser and then cycle DC power
PWR	1 blink	Under Voltage fault	Verify 30 V (under load) and cycle DC power
PWR	2 blinks	Over Voltage fault	Verify 30 V (under load) and cycle DC power
PWR	3 blinks	DC Sense fault	Contact SYNRAD Customer Service
RDY/PWR	Continuous	PWM Sense/Ctrl Bd fault	Contact SYNRAD Customer Service

## Resetting faults

### Remote interlock condition

A remote interlock condition occurs when the Laser Enable input opens (the RDY indicator turns off). On OEM lasers, remote interlock conditions are not latched. Re-establish the Laser Enable signal input (RDY LED changes from off to yellow) and begin lasing immediately.

### Over temperature fault

Over temperature faults occur when thermal limits in the laser are exceeded. This fault is indicated by the RDY indicator flashing continuously). To reset an over temperature fault, lower coolant temperature below 22 °C (water-cooled) or 40 °C (air-/fan-cooled) and then cycle DC power. When the RDY LED illuminates without flashing, lasing is enabled.

# maintenance/ troubleshooting

## Troubleshooting

### Under Voltage fault

An under voltage fault occurs when DC input voltage is at or below 20 VDC. This fault is indicated by the PWR indicator flashing 1 blink at 1/2 second intervals. To reset an under voltage fault, ensure that 30 VDC is applied to the laser under full-load conditions and then cycle DC power. When PWR and RDY indicators illuminate, lasing is enabled.

Under voltage faults are typically caused by the DC power supply being unable to properly regulate output voltage under full-load or high inrush current conditions. Improper regulation may be caused by an under-sized DC supply or insufficient AC line voltage to the supply.

### Over Voltage fault

An over voltage fault occurs when DC input voltage is at or above 33 VDC. This fault is indicated by the PWR indicator flashing 2 blinks at 1/2 second intervals. To reset an over voltage fault, ensure that 30 VDC is applied to the laser under full-load conditions and then cycle DC power. When PWR and RDY indicators illuminate, lasing is enabled.

### DC Sense fault

An DC Sense fault is indicated by the PWR indicator flashing 3 blinks at 1/2 second intervals. If this fault occurs, the laser requires service—contact SYNRAD or a SYNRAD Authorized Distributor.

### PWM Sense/Control Board fault

A PWM Sense or control board fault is indicated by both RDY and PWR indicators flashing continuously. If this fault occurs, the laser requires service—contact SYNRAD or a SYNRAD Authorized Distributor.

## Laser troubleshooting

During normal operation or when laser faults occur, OEM v30 status LEDs and output signals annunciate laser status as previously described in Tables 5-2–5-13. This section provides more detailed information for troubleshooting and resolving a variety of laser faults. Each Symptom listed in this section describes a particular fault. For each Symptom, specific causes and solutions are described under Possible Causes.

### Symptom:

The following status LED and I/O states exist:

LASE LED – Off	Lase Indicator – Low (0V)		
RDY LED – Off	Laser Ready – Low (0V)	Laser OK	– Low (0V)
PWR LED – Green			
	Overtemp Fault – Low (0V)	Temperature OK	– High (+5V)
	DC Voltage Fault – Low (0V)	Voltage OK	– High (+5V)

### Possible Causes:

The Laser Enable input is not active.

A +5 VDC Laser Enable signal must be applied between Pin 9, Laser Enable, and Pin 8, GND, on the DB-9 connector (or Pin 7, Laser Enable, and Pin 8, GND, on the RJ45 connector) to enable lasing.

# maintenance/ troubleshooting

## Troubleshooting

In some cases, it is easier to troubleshoot the laser processing system by disconnecting field wiring from the DB-9, or RJ45, connector and then installing the DB-9 Quick Start Plug to verify v30 laser operation. If the laser was not shipped with a Quick Start Plug, you can fabricate one as shown in Figure below.

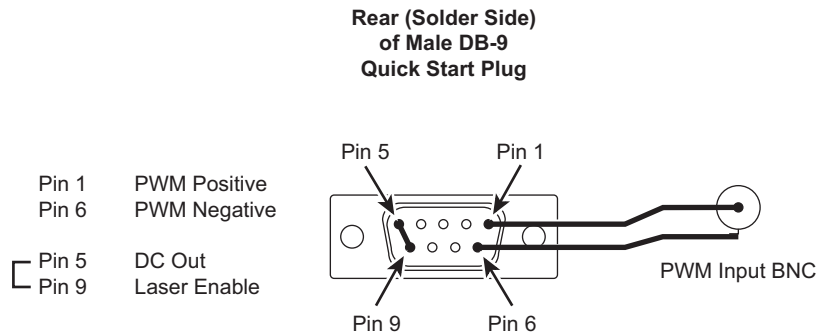


Figure 5-2 DB-9 Quick Start Plug wiring diagram

### Symptom:

The following status LED and I/O states exist:

LASE LED – Off	Lase Indicator – Low (0V)	
RDY LED – Flashing	Laser Ready – Low (0V)	Laser OK – Low (0V)
PWR LED – Green	Overtemp Fault – High (+5V)	Temperature OK – Low (0V)
	DC Voltage Fault – Low (0V)	Voltage OK – High (+5V)

### Possible Causes:

Air-/fan-cooled lasers – an over temperature fault has occurred because cooling fans are not providing adequate airflow to the laser.

Check that all cooling fans are clear of debris and are providing an airflow rate of at least 4.0 m<sup>3</sup>/min (140 CFM) per fan at a maximum static pressure of 13.1 mm H<sub>2</sub>O (0.52 in H<sub>2</sub>O). To allow for proper airflow, cooling fans must have at least 57.2 mm (2.25 inches) of unobstructed clearance between the outside edge of the cooling fan housing and any mounting surface or enclosure.

Water-cooled lasers – an over temperature fault has occurred because coolant temperature is above 22 °C (72 °F) or there is inadequate water flow through the laser.

Check that the chiller is maintaining a coolant temperature between 18 °C–22 °C (64 °F–72 °F) at a flow rate of 3.8 lpm (1.0 GPM). If coolant temperature is OK, check the flow rate. If a flow meter is not available, disconnect the cooling tubing from the chiller inlet (or the drain) and run the coolant for one minute into a one-gallon container; you should have close to one gallon of coolant. If there is much less than one gallon in the container, check the cooling path for kinked or pinched cooling tubes and check the chiller for a clogged or dirty filter.

# maintenance/ troubleshooting

## Troubleshooting

### Symptom:

The following status LED and I/O states exist:

LASE LED – Off	Lase Indicator – Low (0V)		
RDY LED – Off	Laser Ready – Low (0V)	Laser OK – Low (0V)	
PWR LED – 1 blink code			
	Overtemp Fault – Low (0V)	Temperature OK – High (+5V)	
	DC Voltage Fault – High (+5V)	Voltage OK – Low (0V)	

### Possible Causes:

An under voltage fault exists.

An under voltage fault occurs when input voltage drops to 20 VDC or below for more than 420 ms. Check that the DC power supply is supplying +30 VDC under load, has a minimum current capacity of 15 A (air-/water-cooled) or 16 A (fan-cooled), and can sustain a 24 A peak for a minimum of 0.5 ms. After correcting the problem, cycle DC power to reset the fault.

An under voltage condition caused by the DC power supply current-limiting can occur if PWM signals are applied before tube breakdown occurs. On cold starts, verify that tickle pulses are being sent to the v30 OEM laser for a period of five to ten seconds before a PWM signal is applied.

After correcting the problem, cycle DC power to reset the fault.

### Symptom:

The following status LED and I/O states exist:

LASE LED – Off	Lase Indicator – Low (0V)		
RDY LED – Off	Laser Ready – Low (0V)	Laser OK – Low (0V)	
PWR LED – 2 blink code			
	Overtemp Fault – Low (0V)	Temperature OK – High (+5V)	
	DC Voltage Fault – High (+5V)	Voltage OK – Low (0V)	

### Possible Causes:

An over voltage fault exists.

An over voltage fault occurs when input voltage rises to 33 VDC or above for more than 420 ms. Check that the DC power supply is supplying +30 VDC under load. After correcting the problem, cycle DC power to reset the fault.

### Symptom:

The following status LED and I/O states exist:

LASE LED – Off	Lase Indicator – Low (0V)		
RDY LED – Off	Laser Ready – Low (0V)	Laser OK – Low (0V)	
PWR LED – 3 blink code			
	Overtemp Fault – Low (0V)	Temperature OK – High (+5V)	
	DC Voltage Fault – High (+5V)	Voltage OK – Low (0V)	

# maintenance/ troubleshooting

## Troubleshooting

### Possible Causes:

An DC Sense fault has occurred.

If this fault occurs, the laser requires service—contact SYNRAD Customer Service or a SYNRAD Authorized Distributor.

### Symptom:

The following status LED and I/O states exist:

LASE LED – Off	Lase Indicator – Low (0V)		
RDY LED – Flashing	Laser Ready – Low (0V)	Laser OK – Low (0V)	
PWR LED – Flashing			
	Overtemp Fault – Low (0V)	Temperature OK – High (+5V)	
	DC Voltage Fault – Low (0V)	Voltage OK – High (+5V)	

### Possible Causes:

A PWM Sense fault or control board failure has occurred.

If this fault occurs, the laser requires service—contact SYNRAD Customer Service or a SYNRAD Authorized Distributor.

### Symptom:

The power supply is connected and DC voltage is correct, but the following LED and I/O states exist:

LASE LED – Off	Lase Indicator – Low (0V)		
RDY LED – Off	Laser Ready – Low (0V)	Laser OK – Low (0V)	
PWR LED – Off			
	Overtemp Fault – Low (0V)	Temperature OK – Low (0V)	
	DC Voltage Fault – Low (0V)	Voltage OK – Low (0V)	

### Possible Causes:

The 20 A fast-acting fuse has blown.

To replace the fuse, open the inline fuse holder (located on the positive DC power cable) by twisting the upper half 1/4 turn counter-clockwise. Remove the fuse and replace it with a 20 A, 250 V fast-acting fuse (Cooper Bussmann ABC-20-R, Littelfuse 314020, or equivalent).

## Interface A (DB-9)

### Symptom:

The built-in +5 VDC, 250 mA voltage output on Pin 5, DC Out, was accidentally shorted to ground.

### Possible Causes:

In the event that Pin 5, DC Out, is shorted to ground, the OEM v30 laser will not be damaged as the voltage regulator is protected by a current-limiting circuit. Remove the short circuit to re-enable the voltage output.

# maintenance/ troubleshooting

## Troubleshooting

### Interface B (RJ45)

#### Symptom:

The built-in +15 VDC, 250 mA voltage output on Pin 2, DC Out, was accidentally shorted to ground.

#### Possible Causes:

In the event that Pin 2, DC Out, is shorted to ground, the OEM v30 laser will shutdown, but restarts automatically when the short-circuit is removed.

## Beam delivery optics

 **Warning**  
serious  
personal  
injury

The use of aerosol dusters containing difluoroethane causes “blooming”, a condition that significantly expands and scatters the laser beam. This beam expansion can effect mode quality and/or cause laser energy to extend beyond the confines of optical elements in the system, possibly damaging the safety shielding. Do not use air dusters containing difluoroethane in any area adjacent to CO<sub>2</sub> laser systems because difluoroethane persists for long time periods over wide areas.

**Caution**  
possible  
equipment  
damage

If you operate your laser or marking head in a dirty or dusty environment, contact SYNRAD about the risks of doing so and precautions you can take to increase the longevity of your laser, marking head, and associated optical components.

#### Symptom:

The laser appears to lose power over time; laser output power must be increased to maintain previous performance.

#### Possible Causes:

Beam delivery optics are coated by vapor residue or debris.



# maintenance/ troubleshooting

## Troubleshooting

 **Danger**  
serious  
personal  
injury

Ensure that DC power to the laser is turned off and locked out before inspecting optical components in the beam path. Invisible CO<sub>2</sub> laser radiation is emitted through the aperture. Corneal damage or blindness may result from exposure to laser radiation.

Shut down the laser and carefully inspect each optic in the beam delivery path, including the laser's output coupler. Remember that optics are fragile and must be handled carefully. If the optic requires cleaning, then refer back to Maintenance for cleaning instructions. Use only recommended cleaning materials (see Table 4-1) to prevent scratching delicate optical surfaces.

 **Warning**  
serious  
personal  
injury

A risk of exposure to toxic elements, like zinc selenide, may result when certain optical or beam delivery components are damaged. In the event of damage to laser, marking head, or beam delivery optics, contact SYNRAD, Inc. or the optics manufacturer for handling instructions.

If the focusing optic is pitted, it must be replaced immediately. Because of the extremely high power density of Firestar lasers, pits or debris on the lens may absorb enough energy from the focused beam to crack the lens. If this happens, other optics in the beam path may be contaminated or damaged as well.

When the application requires air (instead of nitrogen) as an assist gas, we recommend the use of breathing quality air available in cylinders from a specialty gas supply company. Because compressed shop air contains minute particles of oil and other contaminants that will damage optical surfaces, it must be carefully filtered and dried before use as a purge or assist gas. Refer to Table 3-1, Assist gas purity specifications, in the Technical Reference chapter for filtering and drying specifications.

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