

# *firestar* series V30



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## reference guide

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## Firestar OEM v30E Reference Guide

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## Warranty information

This is to certify that Firestar® OEM v30 lasers are guaranteed by SYNRAD, Inc. 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, Inc. 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 Firestar OEM 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 Firestar OEM v30 laser fails within the first 45 days after purchase, SYNRAD, Inc. 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 OEM v30 laser, only authorized SYNRAD replacement parts can be used. This warranty is void if any parts other than those provided by SYNRAD, Inc. are used.

SYNRAD, Inc. and SYNRAD Authorized Distributors have the sole authority to make warranty statements regarding SYNRAD products. SYNRAD, Inc. 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, Inc. 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.

## Trademark/copyright information

SYNRAD and Firestar are registered trademarks of SYNRAD, Inc.

All other trademarks or registered trademarks are the property of their respective owners.

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# Hazard information

Hazard information includes terms, symbols, and instructions used in this manual or on the equipment to alert 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.

**⚠ Danger:** Imminent hazards which, if not avoided, will result in death or serious injury.

**⚠ Warning:** Potential hazards which, if not avoided, could result in death or serious injury.

**⚠ Caution:** Potential hazards or unsafe practices which, if not avoided, may result in minor or moderate injury.

**Caution:** Potential hazards or unsafe practices which, if not avoided, may result in product damage.

**Important Note:** Important information or recommendations concerning the subject under discussion.

**Note:** Points of particular interest for more efficient or convenient equipment operation; additional information or explanation concerning the subject under discussion.

## 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.

**⚠ Danger**  
serious  
personal  
injury

This Class 4 laser product emits *invisible* infrared laser radiation in the 10.6  $\mu\text{m}$   $\text{CO}_2$  wavelength band.

Do not allow laser radiation to enter the eye by viewing direct or reflected laser energy.  $\text{CO}_2$  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 10.6  $\mu\text{m}$   $\text{CO}_2$  radiation when in the same area as an exposed laser beam. Eyewear 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  $\text{CO}_2$  laser radiation can seriously burn human or animal tissue, which may cause permanent damage.

**⚠ Danger**  
serious  
personal  
injury

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

## Hazard information (cont.)

### **Warning**

serious  
personal  
injury

U.S. customers should refer to and follow the laser safety precautions described in the American National Standards Institute (ANSI) Z136.1-2007 document, *Safe Use of Lasers*. Procedures listed in this Standard include the appointment of a Laser Safety Officer (LSO), operation of the product in an area of limited access by trained personnel, servicing of equipment only by trained and authorized personnel, and posting of signs warning of the potential hazards.

European customers should appoint a Laser Safety Officer (LSO) who should refer to and follow the precautions described in EN 60825-1, 2007—*Safety of Laser Products*.

### **Warning**

serious  
personal  
injury

Materials processing can generate air contaminants such as vapors, fumes, and/or particles that may be noxious, toxic, or even fatal. Material Safety Data Sheets (MSDS) 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 Z136.1-2007, *Safe Use of Lasers*, section 7.3.

U.S. Government's *Code of Federal Regulations*: 29 CFR 1910, Subpart 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.

### **Warning**

serious  
personal  
injury

Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

### **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 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.

### **Caution**

possible  
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.

## Hazard information (cont.)

Firestar® v30 lasers 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 Z136.1-2007 at all times when actively lasing.

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 heat source and will ignite most non-metallic materials under the proper conditions. Never operate the laser in the presence of flammable or explosive materials, gases, liquids, or vapors.

The use of controls or adjustments or performance of procedures other than those specified herein may result in exposure to hazardous *invisible* laser radiation, damage to, or malfunction of the laser. Severe burns will result from exposure to the laser beam.

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.

## Other hazards

The following hazards would be 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.

## 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, Inc. who, for a fee, will ensure adequate disassembly, recycling, and/or disposal of the product.

## Additional laser safety information

The SYNRAD web site (<http://www.synrad.com/LaserFacts/lasersafety.html>) contains an online laser safety handbook that provides information on (1) Laser Safety Standards for OEM's/System Integrators including product classification, product housing, product features, and other CDRH requirements; (2) Laser Safety Standards for End Users including Class 1 installations, Class 4 installations, laser hazards, ANSI Standard, U.S. State requirements, and OSHA; (3) References and Sources including CDRH, ANSI/OSHA; 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.laserinstitute.org>.

# OEM v30 label locations

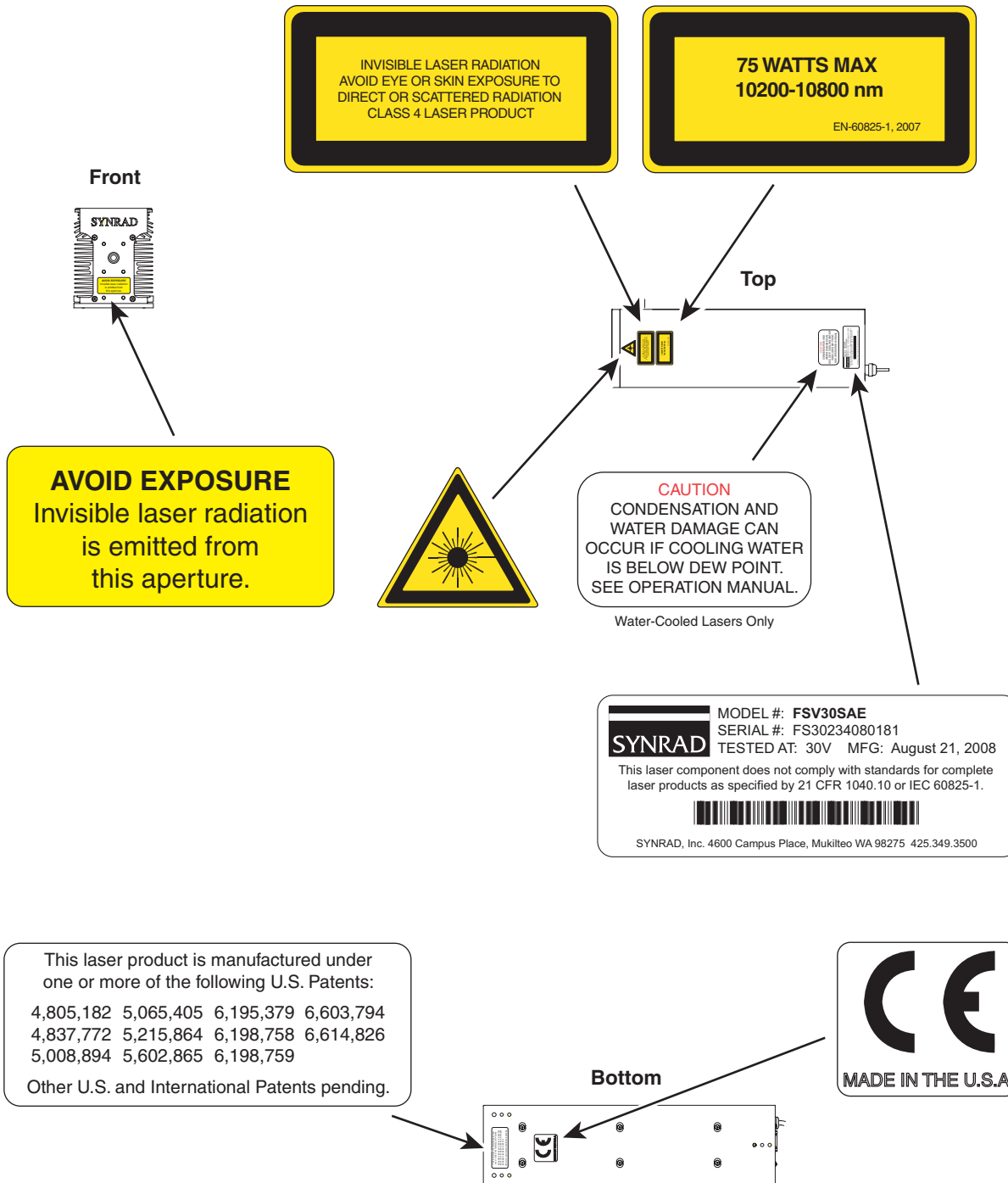


Figure 1 Firestar OEM v30 label locations

## Agency compliance

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 Firestar OEM v30 lasers must comply are identified and described in the following paragraphs.

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, Inc. 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, Part 1040 or EN 60825-1. SYNRAD, Inc. assumes no responsibility for the compliance of the system into which OEM laser products are integrated.

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

Firestar v30 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, Subchapter 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 complies with all laser safety requirements before the actual sale of the system. Under CDRH regulations, the Buyer must submit a report to the CDRH prior to shipping the system. In jurisdictions outside the U.S., it is the sole responsibility of the Buyer of these OEM 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.

To aid in the development of integrated v30 systems see Table 1, *Class 4 safety features*. The table indicates which features are available on OEM v30 lasers, the type and description of the feature, and if the feature is required by CDRH regulations.

## 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 was 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, Part 18, Subpart C.

SYNRAD's Firestar OEM v30E lasers have been tested and found to comply by demonstrating performance characteristics that have met or exceeded the requirements of 47 CFR, Part 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, Part 18, Section 213.

### Interference Potential

In our testing, SYNRAD, Inc. has not discovered any significant electrical interference traceable to Firestar OEM v30 lasers.

## Agency compliance (cont.)

### System Maintenance

Ensure that all exterior covers are properly fastened in position.

### Measures to Correct Interference

If you suspect that your Firestar OEM v30 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 OEM v30 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.

## European Union (EU) requirements

### RoHS compliance

SYNRAD Firestar OEM v30 lasers meet the requirements of the European Parliament and Council Directive 2002/95/EC on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment, as amended by Decision 2005/618/EC establishing maximum concentration values for certain hazardous substances in electrical and electronic equipment.

### Laser safety standards

Under the Low Voltage Directive, 2006/95/EC, the European Norm document 60825-1 was developed to protect persons from laser radiation by imposing requirements upon manufacturers of laser products to provide an indication of laser radiation; to classify laser products according to the degree of hazard; to require both user and manufacturer to establish procedures so that proper precautions are adopted; to ensure adequate warning of the hazards associated with accessible radiation through signs, labels, and instructions; to improve control of laser radiation through protective features; and to provide safe usage of laser products by specifying user control measures.

SYNRAD's OEM v30 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, *Safety of Machinery*; the Machinery Directive EN 2006/42/EC; and/or any other applicable Standards. 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.

To aid in the development of integrated v30 systems see Table 1, *Class 4 safety features*. The table indicates which features are available on OEM v30 lasers, the type and description of the feature, and if the feature is required by European Union regulations.

## Agency compliance (cont.)

**Table 1** Class 4 safety features

Feature	Location/Description	Required by:		Provided on OEM v30
		CDRH	EN60825-1	
Keyswitch	Rear panel control On / Off/Reset Keyswitch controls power to laser electronics. Key cannot be removed from switch in the “On” position.	Yes	Yes	No
Shutter function	Laser control Functions as a beam attenuator to disable RF driver/laser output when closed.	Yes	Yes	No
PWR (Power) indicator	Rear panel indicator (Green) Illuminates green to indicate DC power is applied.	No	No	Yes
RDY (Ready) indicator	Rear panel indicator (Yellow) Indicates that laser has power applied and is capable of lasing.	Yes	Yes	Yes
LASE indicator	Rear panel indicator (Red) Indicates that Firestar is actively lasing. LASE LED illuminates when the duty cycle of the Command signal is long enough to produce laser output.	Yes	Yes	Yes
Five second delay	Firestar circuit element Disables RF driver/laser output for five seconds after Laser Enable signal is applied.	Yes	No	Yes
Power fail lockout	Firestar circuit element 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.	Yes	Yes	No
Remote Interlock	Rear panel connection Disables RF driver/laser output when a remote interlock switch on an equipment door or panel is opened.	Yes	Yes	No
Over temperature protection	Firestar circuit element Temperature shutdown occurs if temperature of the laser tube rises above safe operating limits.	No	No	Yes
Warning labels	Firestar exterior Labels attached to various external housing locations to warn personnel of potential laser hazards.	Yes	Yes	Yes

## Electromagnetic interference standards

The European Union’s Electromagnetic Compatibility (EMC) Directive, 2004/108/EC, 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 OEM v30 lasers, EN 55011 and CISPR:11 define radiated and conducted RF emission limits while the generic Standards EN 61326 and EN 50082-1 define immunity requirements published by the International Electromechanical Commission (IEC).

SYNRAD’s Firestar OEM v30E lasers have demonstrated performance characteristics that have met or exceeded the requirements of EMC Directive 2004/108/EC.

## Agency compliance (cont.)

When integrating SYNRAD's OEM v30 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's testing program has demonstrated that OEM v30 lasers comply with the relevant requirements of 2004/108/EC, the Electromagnetic Compatibility Directive, as summarized in Table 2 below.

**Table 2** European Union Directives

### Applicable Standards/Norms

2004/108/EC	Electromagnetic Compatibility
2006/95/EC	Low Voltage Directive
2002/95/EC	RoHS Directive (amended 2005/618/EC)
EN 61010-1:2001	Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1:General Requirements
CISPR 11:2003-03	Conducted and Radiated Emissions Group 1, Class A
EN 61000-4-2:1995+A1:1998 +A2:2001	Electrostatic Discharge Immunity
EN 61000-4-3:2002+A1:2002	RF Electromagnetic Fields Immunity
EN 61000-4-4:1995+A1:2001 +A2:2001	Electrical Fast Transient/Burst Immunity
EN61000-4-6:1996+A1:2001	Conducted RF Disturbances Immunity

After a product has met the requirements of all applicable EU Directives, the product can bear the official compliance mark of the European Union as shown in Figure 2.



**Figure 2** European compliance mark

# Declaration of Conformity

## Declaration of Conformity

in accordance with ISO / IEC 17050-2:2004

We,

**Manufacturer's Name:** SYNRAD, Inc.

**Manufacturer's Address:** 4600 Campus Place  
Mukilteo, WA 98275  
U.S.A.

hereby declare under our sole responsibility that the following equipment:

**Product Name:** Firestar v30 Laser

**Model Number:** FSV30SxE (OEM\*)

conforms to the following Directive(s) and Standard(s):

**Applicable Directive(s):** 2004/108/EC Electromagnetic Compatibility Directive  
2002/95/EC RoHS Directive (amended by 2005/618/EC)

**Applicable Standard(s):** EN 61010-1:2001 Safety Requirements for Electrical Equipment  
for Measurement, Control, and Laboratory  
Use - Part 1: General Requirements

CISPR 11:2003-03 Conducted and Radiated Emissions  
Group 1, Class A

EN 61000-4-2:1995  
+A1:1998 +A2:2001 Electrostatic Discharge Immunity

EN 61000-4-3:2002  
+A1:2002 RF Electromagnetic Fields Immunity

EN 61000-4-4:1995  
+A1:2001 +A2:2001 Electrical Fast Transient/Burst Immunity

EN 61000-4-6:1996  
+A1:2001 Conducted RF Disturbances Immunity

\*OEM lasers do not comply with EN 60825-1:2007, *Safety of Laser Products*. Buyers of OEM laser products are solely responsible for meeting applicable Directives and Standards for CE compliance and marking.

**Corporate Officer:**



Dave Clarke, President of SYNRAD, Inc.

**European Contact:**

Synrad Europe  
Münchener Straße 2A  
D-82152 Planegg  
Germany

Dated 25 September 2008



MADE IN U.S.A.

# Introduction

Although the OEM v30 laser is part of the Firestar v-Series family, its user interface differs significantly from the standard v-Series interface design. With the exception of the optoisolated PWM input (*PWM Positive*), all OEM v30 inputs and outputs operate at 5V logic levels to ensure compatibility and ease of installation when retrofitting the Firestar v30 into existing 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 **must** provide a 5 kHz, 1 μs tickle pulse between applied PWM signals.

The OEM v30 laser is available in air-cooled (SAE), fan-cooled (SFE), or water-cooled (SWE) 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.

# Inventory

## Ship kit

Table 3 lists items included in the v30 ship kit.

**Table 3** Ship kit contents

Shipping Box Contents	Qty	Shipping Box Contents	Qty
SYNRAD Firestar OEM v30 Laser.....	1	Firestar OEM v30 Reference Guide .....	1
Quick Start Plug (except SA models).....	1	Spare Fuse .....	2
Cooling Tubing (water-cooled only).....	1	Final Test Report .....	1
Mounting Bolts .....	3		

## Ship kit contents

Each item listed in Table 3 is described below:

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

Quick Start Plug (except SA models) – connects to the v30’s *Interface A* connector. A jumper built into the plug 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 – 1/4–20 UNC bolts fasten the laser to your mounting surface.

*Firestar OEM v30 Reference Guide* – provides setup, operation, and maintenance information for your v30 laser.

Spare Fuse – fast-blow 20 A fuse protects the Firestar v30’s internal circuitry.

Final Test Report – contains data collected during the laser’s final pre-shipment test.

## Mounting

The OEM v30 base plate is designed so that the laser can be easily mounted using only 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. See OEM v30 outline and mounting drawings later in this document for mounting dimensions.

**Note:** To maintain proper airflow, the OEM v30 must have at least 2.25" (57.2 mm) of unobstructed clearance between the outside edge of the cooling fans and any enclosure or surface.

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

- 1 Refer to the v30 outline and mounting diagram and drill three holes into your mounting surface that correspond to either the UNC or metric base plate bolt pattern.
- 2 Place the v30 on the mounting surface so that the threaded holes on the base plate line up with the holes in your mounting surface.
- 3 Insert three 1/4–20 UNC or M6 × 1 capscrews through the mounting surface into the corresponding 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 value of 54 in lb<sub>f</sub> (6.1 N m) maximum.

## Cooling connections

If your OEM v30 laser is fan-cooled (an SFE model), then skip ahead to the *Electrical connections* section. For air-cooled 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. Tubing extends into the fitting approximately 7/8 of an inch (22.2 mm).
- If tubing must be disconnected from a fitting, first push and hold the tubing slightly into the fitting. Next push the white fitting ring evenly towards the fitting, and then pull the tubing free.
- After disconnecting tubing from a fitting, trim 1/2" (12.7 mm) from its end before reconnecting. Trimming the end of the tubing before reconnecting the fitting provides an undisturbed sealing surface.

## Cooling connections (cont.)

### 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.

### Coolants

SYNRAD recommends that the laser's cooling fluid contain at least 90% water (distilled or tap) by volume. In closed-loop systems, use a corrosion inhibitor/algaecide such as Optishield® Plus or equivalent. 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. In applications where biocides containing chlorides are used, concentrations should not exceed 25 parts per million (PPM). Maintain a coolant pH level above 7.0. We recommend the installation of a filter on the chiller's return line, especially in areas where water hardness is a problem. Firestar OEM v30 lasers incorporate the following wetted materials in the coolant path—brass, copper, Delrin®, PBT, polyethylene, stainless steel, and Viton®.

### 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 1.0 GPM. Do not exceed a coolant pressure of 60 PSI.

Table 4 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).

#### **Caution**

possible  
equipment  
damage

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

# Cooling connections (cont.)

**Table 4** 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
<b>60 (16)</b>	— (0)	— (2)	— (4)	32 (5)	36 (7)	39 (8)	41 (9)	44 (10)	46 (11)	48 (12)	50 (13)	52 (14)	54 (15)	55 (16)	57 (17)	59 (18)
<b>65 (18)</b>	— (1)	— (3)	33 (4)	37 (6)	40 (8)	43 (9)	46 (11)	48 (12)	51 (13)	53 (14)	55 (15)	57 (16)	59 (17)	60 (18)	62 (19)	64 (20)
<b>70 (21)</b> (1)	— (3)	33 (5)	37 (7)	41 (9)	45 (11)	48 (12)	51 (13)	53 (14)	56 (16)	58 (17)	60 (18)	62 (18)	64 (19)	65 (21)	67 (22)	69 (23)
<b>75 (24)</b> (3)	— (6)	37 (8)	42 (9)	46 (11)	49 (13)	52 (14)	55 (16)	58 (17)	60 (18)	62 (19)	65 (20)	67 (21)	68 (22)	70 (23)	72 (24)	73 (25)
<b>80 (27)</b>	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)
<b>85 (29)</b>	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 (29)
<b>90 (32)</b>	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 (32)
<b>95 (35)</b>	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)
<b>100 (38)</b>	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)

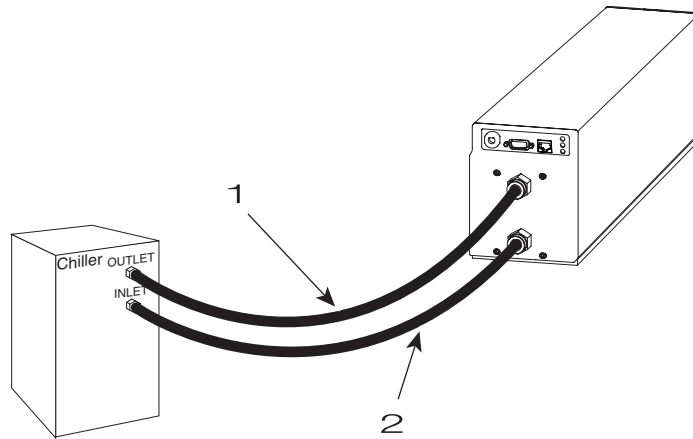
To use Table 4, look down the *Air Temp* column and locate an air temperature in Fahrenheit or Celsius (°C values are shown in parentheses) that corresponds to the air temperature in the area where your laser is operating. Follow this row across until you reach a column matching the relative humidity 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.

## Cooling connections (cont.)

### 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 3 and perform the following steps.



**Figure 3** OEM v30 cooling connections

- 1 Cut and connect a length of 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 cooling water temperature must always be maintained above the dew point to prevent condensation and water damage to your Firestar laser.

- 3 Turn on the chiller and adjust the temperature setpoint to 18 °C to 22 °C. Regulate coolant flow to 1.0 GPM at less than 60 PSI (4.14 bar) of pressure.
- 4 Closely examine all cooling connections and verify that there are no leaks.

#### **Caution**

possible  
equipment  
damage

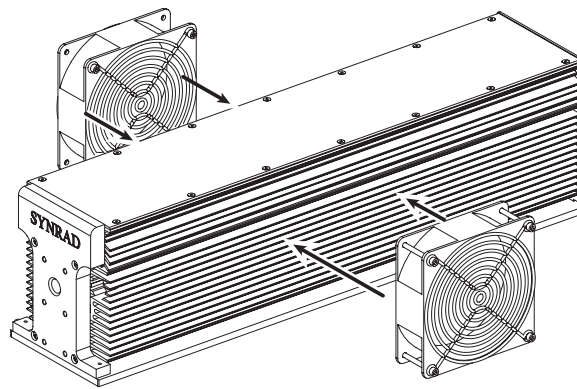
Operating the laser at coolant temperatures above 22 °C (72 °F) may result in decreased performance and/or premature failure of electronic components.

## Cooling connections (cont.)

### Air-cooled connections (SA models)

Air-cooled v30 (SA) lasers are shipped without cooling fans. To prevent overheating and keep laser/RF heatsink temperatures below 45 °C (113 °F), customer must provide two 140 CFM cooling fans rated for a static air pressure of 0.94 inches of water (23.9 mm H<sub>2</sub>O) and mount them as shown in Figure 4. Cooling fans should have a diameter of approximately 4.7 × 4.7" (120 × 120 mm) and have at least 2.25" (57.2 mm) of unobstructed clearance between the outside edge of the fan housing and any mounting surface or enclosure.

OEM v30 SA lasers do not provide a voltage output sufficient to power cooling fans; users must provide an external power source appropriate for 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.



Fans should be mounted so that they are centered both horizontally and vertically on each side of the OEM v30 laser.

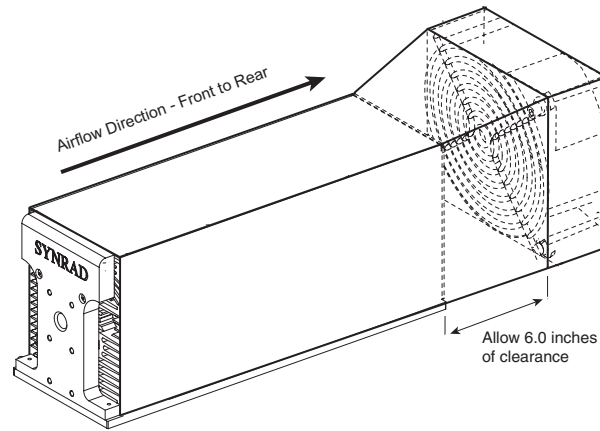
**Figure 4** Recommended v30 cooling fan locations

SYNRAD recommends side-mounted cooling fans for OEM v30 lasers, but rear-mounted, single-fan cooling is possible. Figure 5 illustrates the rear-cooling concept. Review the guidelines listed below to ensure that your integration provides enough air flow to prevent damage to the laser. The fan must supply at least 300 CFM to prevent overheating. A rear-cooled laser may experience some performance loss when compared to a typical side-mounted cooling configuration.

### 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 cooling fins so that 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.
- Allow three to four inches of clearance between the front of the cooling fan and the rear of the laser.
- Use a cooling fan rated for a least 300 CFM at a static air pressure of 0.94 inches of water (23.0 mm H<sub>2</sub>O) and position it approximately 6.0" (15 cm) from the rear of the laser.

## Cooling connections (cont.)



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

Figure 5 Rear-mounted cooling

## Electrical connections

### DC power supply

The air-cooled v30 (SA) laser requires a DC power supply capable of providing 30 VDC at 15 A (24 A peak for a minimum of 0.5 ms) while fan-cooled (SFE) lasers require 30 VDC at 16 A (24 A peak for a minimum of 0.5 ms). We recommend the SYNRAD PS-2 a 30 V, 750 W DC power supply (shown in Figure 6). AC input requirements for the PS-2 power supply are 90–264 VAC (auto-ranging); single phase (1Ø); 10 A maximum; 47–440 Hz. To connect the PS-2 power supply, refer to Figure 6 and perform the following steps:

**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.

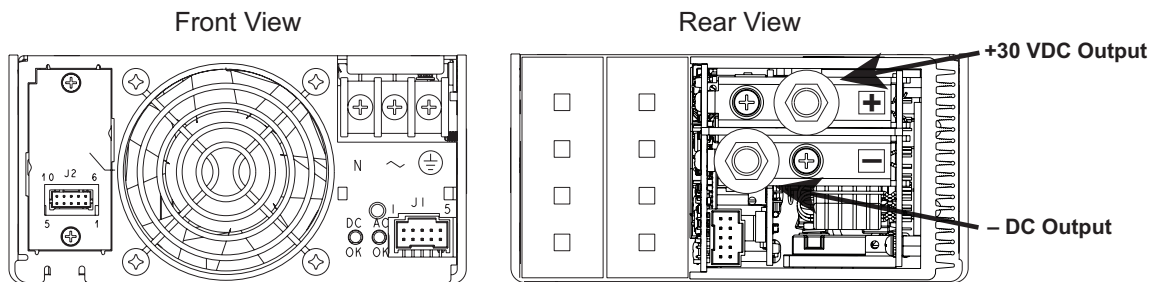


Figure 6 PS-2 (Emerson iMP4) power supply

## Electrical connections (cont.)

- 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 supply'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 the OEM v30 laser 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. Refer to the Technical Reference section for specific details about the OEM v30 user interface.

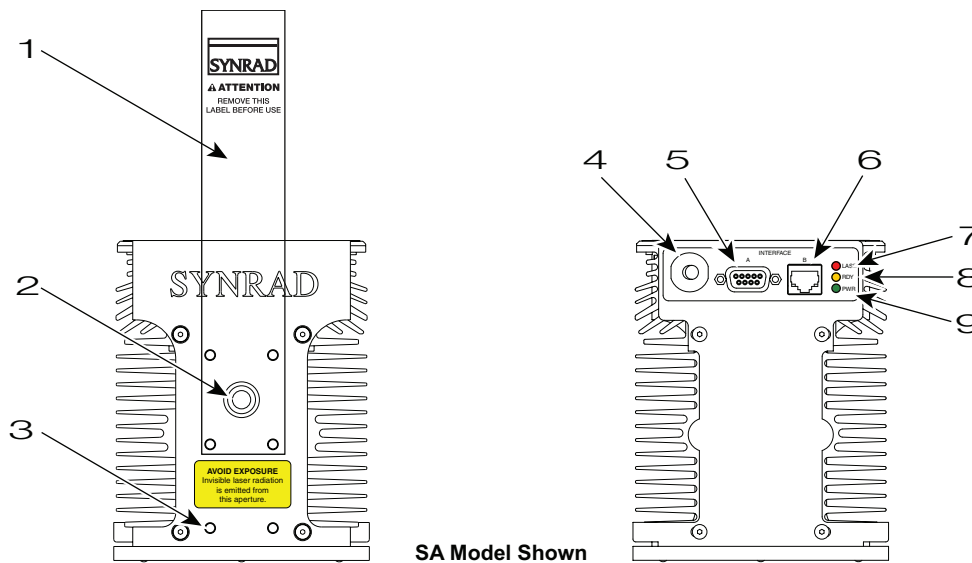
The OEM v30 control board differs from other Firestar v-Series models in that it does **not** incorporate a built-in tickle generator. If you are not using a SYNRAD UC-2000 Universal Laser Controller to operate the laser, you **must** provide a 5 kHz, 1  $\mu$ s tickle pulse between applied PWM signals.

Refer to the *Firestar v40 Operator's Manual* and see *Controlling laser power* in the Technical Reference chapter for tickle signal descriptions. A PDF version is available from our web site at: <http://www.synrad.com/Products/manuals.htm>.

 **Warning**  
serious  
personal  
injury

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

# Controls and indicators



**Figure 7** OEM v30 controls and indicators

- 1 Aperture Seal – prevents dust from damaging the output coupler during shipping. Remove the red self-adhesive label before applying power to the laser.
- 2 Laser Aperture – provides an opening in Firestar’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 available from SYNRAD. Because excessive weight may damage the laser, consult SYNRAD before mounting components not specifically designed as Firestar options. Refer to the Firestar OEM v30 package outline drawings for mounting hole dimensions.

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

- 4 DC Power Cables – receives 30 VDC from the DC power supply. The cables are manufactured with #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 Bussman ABC20 or a Littelfuse 314020 fuse.
- 5 *Interface A* (DB-9) Connector – provides a connection point for auxiliary output power as well as input and output signals. Refer to the Technical Reference section 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. Refer to the Technical Reference section for RJ45 8-8 interface details and pinouts.
- 7 *LASE* Indicator – illuminates red to indicate that the OEM v30 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* Indicator – illuminates yellow when the laser is enabled, indicating that lasing will begin when a Command signal is applied.
- 9 *PWR* Indicator – illuminates green when +30 VDC power is applied to the laser.

# Operation

## Status LEDs

Three status LEDs 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 that, after a five-second delay, lasing will begin once a PWM Command signal is received. The *LASE* LED illuminates red to indicate that the PWM signal is sufficient to induce laser output.

## Start-up

 **Warning**  
serious  
personal  
injury

On Firestar OEM v30 lasers, DC voltage faults are not latched. Clearing a DC voltage fault (under- or over-voltage) will restore normal operation and lasing is possible after the five-second delay provided that the Laser Enable input signal is high. Because exposure to 10.6  $\mu\text{m}$  CO<sub>2</sub> laser radiation can inflict severe corneal injuries and seriously burn human tissue, the OEM or System Integrator must ensure that appropriate safeguards are in place to prevent unintended lasing.

 **Danger**  
serious  
personal  
injury

This Class 4 laser emits *invisible* infrared laser radiation in the 10.6  $\mu\text{m}$  CO<sub>2</sub> wavelength band. Since 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.

**Note:** After applying 30 VDC, but before operating the laser, you must provide a *Laser Enable* signal to the appropriate *Interface A* (DB-9) or *Interface B* (RJ45) connector.

- 1 If you have not already done so, remove the red self-adhesive aperture seal from the front of the laser.
- 2 Ensure that all personnel in the area are wearing protective eyewear.
- 3 Place a beam block 24 inches from the laser aperture to prevent the beam from traveling beyond the work area.

**Note:** If you are using a UC-2000 to control the v30 laser, refer to the *UC-2000 Laser Controller Operator's Manual* for setup and operation instructions before continuing.

If you are not using a UC-2000 to control the laser, you must provide tickle and PWM Command signals to control power output. Refer to the *Firestar v40 Operator's Manual* and see *Controlling laser power* in the Technical Reference chapter for tickle and PWM Command signal descriptions. A PDF version is available from our web site at <http://www.synrad.com/Products/manuals.htm>.

- 4 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.

If not using a UC-2000, ensure that your PWM controller is set to zero percent output (0.0%).

## Operation (cont.)

- 5 Turn on the +30 VDC power supply. The *PWR* LED should illuminate green.
- 6 If the laser has a Diode Pointer installed, remove its aperture dust cover.
- 7 Apply a *Laser Enable* signal to the appropriate *Interface Connector*. The yellow *RDY* lamp turns on to indicate that, after a five-second delay, lasing is enabled when a PWM Command signal is received.
- 8 Press the UC-2000's *Lase On/Off* button. The *Lase* indicator on the UC-2000 should illuminate.
- 9 Use the *PWM Adj Knob* on the UC-2000 Controller 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, indicating an increasing power output.

If you are not using a UC-2000 to control the laser, apply tickle pulses (a +5 VDC, 5 kHz square wave of 1  $\mu$ s duration) between *PWM Positive* (Pin 1) and *PWM Negative* (Pin 6) on the appropriate DB-9 or RJ45 connector. After five to ten seconds, slowly increase the PWM duty cycle of the square wave. 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, indicating an increasing power output.

- 10 Press the UC-2000's *Lase On/Off* button to remove the PWM Command signal from the laser. The *LASE* LED turns off. If your v30 laser fails to lase, refer to the Troubleshooting section for troubleshooting information.

If you are not using a UC-2000 to control the laser, remove the PWM Command signal from the laser and re-apply tickle pulses every 200  $\mu$ s. If your v30 laser fails to lase, refer to the Troubleshooting section.

## Technical reference

### v30 interface connectors

Two built-in interface options are available for integrating the OEM v30—a DB-9 and an RJ45 8-8 interface connector. The RJ45 connector (*Interface B*) is useful when integrating a v30 into existing integrated laser systems previously configured for an RJ45 interface. Use the DB-9 connector (*Interface A*) for new Firestar installations. Although both interface connectors provide the same functionality, the DB-9 connector contains an additional output, *Lase Indicator*, that activates when the OEM v30 is actively lasing.

The v30's PWM input (*PWM Positive*) is optoisolated, however all other inputs and outputs operate using standard 5V logic levels (0 V – logic low; 5 V – logic high). 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. Signals for each interface connector, A or B, are described below.

**Important Note:** Do not connect both *Interface A* and *Interface B* connectors at the same time as this will damage the laser's control board. Wire only one interface into your control system.

**Note:** OEM v30 outputs are voltage sources. They can provide only 20 mA typical, 40 mA maximum, to a ground referenced load. **The control board will be damaged if this current maximum is exceeded.** For either connector, *Interface A* or *Interface B*, the ground reference (GND) is Pin 8.

### Interface A connector (DB-9)

The DB-9 *Interface A* connector provides a +5 VDC auxiliary output (*DC Out*), two inputs, and four status outputs as described in Table 5. Two user inputs, *Laser Enable* and *PWM Positive*, enable lasing and provide output power control.

Apply a +5 V signal to the *Laser Enable* input to enable lasing (after a five-second delay). Connect your PWM Command signal (+ 5 VDC, 5 kHz nominal) between *PWM Positive* and *PWM Negative* inputs to control laser power. There is no internal tickle signal generated by the OEM v30 control board. Users **must** provide a 5 kHz, 1  $\mu$ s tickle pulse between applied PWM Command signals.

## Technical reference (cont.)

**Note:** You must connect a *Laser Enable* signal to Pin 9 before applying a PWM Command signal to Pin 1, *PWM Positive*, and Pin 6, *PWM Negative*. Configure your control system to provide a *Laser Enable* signal only after all other safe operating conditions are met.

### 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—the control board will be damaged. Observe all 5V logic specifications and precautions when integrating Firestar OEM v30 inputs and outputs into your control system.

The DB-9 *Interface A* connector provides four 5V logic level outputs to communicate laser status to the control system. *Laser Ready* goes high when lasing is possible; the output is low when the laser is not ready. *Lase Indicator* goes high when the PWM signal is sufficient to induce laser output; the output is low when no beam is being emitted. *DC Voltage Fault* goes high after sensing an under/over voltage condition; the output is low when the DC supply voltage is within limits. *Overtemp Fault* goes high when laser temp rises above its upper thermal limit; otherwise, the output is low.

**Note:** When an over temperature condition occurs, cool the laser below its over temperature threshold and then cycle DC power to restore normal operation.

**Table 5** Interface A (DB-9) pinouts

Pin	Name	Function
1	<i>PWM Positive</i>	Optoisolated input for PWM and tickle signals. Reference Pin 1 to <i>PWM Negative</i> (Pin 6).
2	<i>Laser Ready</i>	Logic output high when Ready to lase; low if not ready. The <i>Laser Ready</i> output sources 20 mA typical, 40 mA maximum.
3	<i>Lase Indicator</i>	Logic output high when Lasing; low if not lasing. The <i>Lase Indicator</i> output sources 20 mA typical, 40 mA maximum.
4	<i>Overtemp Fault</i>	Logic output high when over temperature condition detected; low if temp OK. The <i>Overtemp Fault</i> output sources 20 mA typical, 40 mA maximum.
5	<i>DC Out</i>	Pin 5 provides a +5 VDC, 250 mA maximum, user output voltage.
6	<i>PWM Negative</i>	Negative side of optoisolated PWM Command signal. Reference Pin 6 to <i>PWM Positive</i> (Pin 1).
7	<i>DC Voltage Fault</i>	Logic output high when DC input is under/over voltage limits; low if DC input OK. The <i>DC Voltage Fault</i> output sources 20 mA typical, 40 mA maximum.
8	<i>GND</i>	Ground pin for all DB-9 input/output signals except <i>PWM Positive</i> .
9	<i>Laser Enable</i>	Logic input. Enables laser when high; disables laser when low. A five-second delay is invoked after this pin goes high. <i>Laser Enable</i> must be high before <i>PWM Positive</i> can fire the laser.

**Note:** When switching +5 VDC to the *Laser Enable* input (DB-9, 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 (cont.)

### Interface B connector (RJ45)

The RJ45 8-8 *Interface B* connector provides a +15 VDC auxiliary output (*DC Out*), two inputs, and three status outputs (Table 6). Two user inputs, *Laser Enable* and *PWM Positive*, enable lasing and provide output power control.

Apply a +5 V signal to the *Laser Enable* input to enable lasing (after a five-second delay). Control power by connecting a PWM Command signal (+5 VDC, 5 kHz nominal) between *PWM Positive* and *PWM Negative* (or *GND*) inputs. The OEM v30 does not generate a tickle signal so customers **must** provide a 5 kHz, 1  $\mu$ s tickle pulse between applied PWM signals.

**Note:** You must send a *Laser Enable* signal to Pin 7 before applying a PWM Command signal. Configure your control system to provide a *Laser Enable* signal only after all other safe operating conditions are met.

#### 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—the control board will be damaged. Observe all 5V logic specifications and precautions when integrating Firestar 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.

On the RJ45 connector, three 5V logic level outputs are available to communicate laser status to the control system. *Laser Ok* is high when lasing is possible; the output goes low when a fault is detected. *Voltage Ok* is high when the DC supply voltage is within limits; low after sensing an under/over voltage condition. *Temperature Ok* is high when laser temperature is within limits; low if laser temperature rises above its thermal limit.

**Note:** When switching +5 VDC to the *Laser Enable* input (RJ45, 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.

**Table 6** Interface B (RJ45 8-8) pinouts

Pin Name	Function
1 <i>PWM Positive</i>	Optoisolated input for PWM/tickle signals. Reference to <i>PWM Negative</i> (Pin 6) or <i>GND</i> (Pin 8).
2 <i>DC Out</i>	Pin 2 provides a +15 VDC, 250 mA maximum, user output voltage.
3 <i>Laser Ok</i>	Logic output high when no faults detected; low if laser fault. The <i>Laser Ok</i> output sources 20 mA typical, 40 mA maximum.
4 <i>Temperature Ok</i>	Logic output high when temperature within limits; low if over temperature condition detected. The <i>Temperature Ok</i> output sources 20 mA typical, 40 mA maximum.
5 <i>Voltage Ok</i>	Logic output high when DC supply voltage within limits; low if DC input is under/over voltage. The <i>Voltage Ok</i> output sources 20 mA typical, 40 mA maximum.
6 <i>PWM Negative</i>	Negative side of optoisolated PWM Command signal. Reference Pin 6 to <i>PWM Positive</i> (Pin 1) or <i>GND</i> (Pin 8). If this input does not provide a PWM return, it <b>must</b> be connected to <i>GND</i> (Pin 8). The control board will be damaged if this pin is left unconnected.
7 <i>Laser Enable</i>	Logic input. Enables laser control when high; disables laser when low. A five-second delay is invoked after this pin goes high. <i>Laser Enable</i> must be high before <i>PWM Positive</i> can fire the laser.
8 <i>GND</i>	Ground (return) pin for RJ45 input/output signals.

# Firestar OEM v30 general specifications

**Table 7** Firestar OEM v30 specifications

Parameter	Firestar OEM v30		
<b>Output Specifications</b>			
Wavelength <sup>†</sup>	10.57–10.63 microns		
Power Output, continuous <sup>1,2</sup>	30 Watts		
Power Stability <sup>3</sup>	±5%		
Power Stability <sup>4</sup>	±3%		
Mode Quality	$M^2 \leq 1.2$		
Beam Waist Diameter (at $1/e^2$ ) <sup>5</sup>	2.5 mm ±0.5 mm		
Beam Divergence, full angle (at $1/e^2$ ) <sup>5</sup>	< 7 mrad		
Ellipticity	< 1.2		
Polarization	Linear, horizontal		
Rise Time	< 100 µs		
<b>Input Specifications</b>			
Power Supply			
Voltage	30 ±2.0 VDC		
Current, max. (air-/water-cooled)	15 A (24 A peak for 0.5 ms minimum)		
(fan-cooled)	16 A (24 A peak for 0.5 ms minimum)		
Input Signals			
Tickle Signal	PWM Command Signal		
Voltage	+3.5 to +6.7 VDC (5V nominal)		
Current	10 mA @ +6.7 VDC		
Pulse Duration	1 µs		
Frequency	5 kHz		
<b>Cooling Specifications</b>			
	(Air-cooled)	(Water-cooled)	
Maximum Heat Load, laser	450 Watts	450 Watts	
Minimum Flow Rate	140 CFM per fan (×2)	1.0 GPM, < 60 PSI	
Coolant Temperature	< 40 °C, ambient		
<b>Environmental Specifications</b>			
Operating Temperature <sup>6</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.

† 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) at 95% duty cycle.

4 After two minutes (typical) at 95% duty cycle.

5 Measured at laser output.

6 Published specifications guaranteed at a temperature of 22 °C. Some performance degradation may occur in ambient temperatures above 22 °C. Typically, laser output power decreases 0.5–1% per degree Celsius increase in ambient temperature.

# OEM v30 package outline drawings

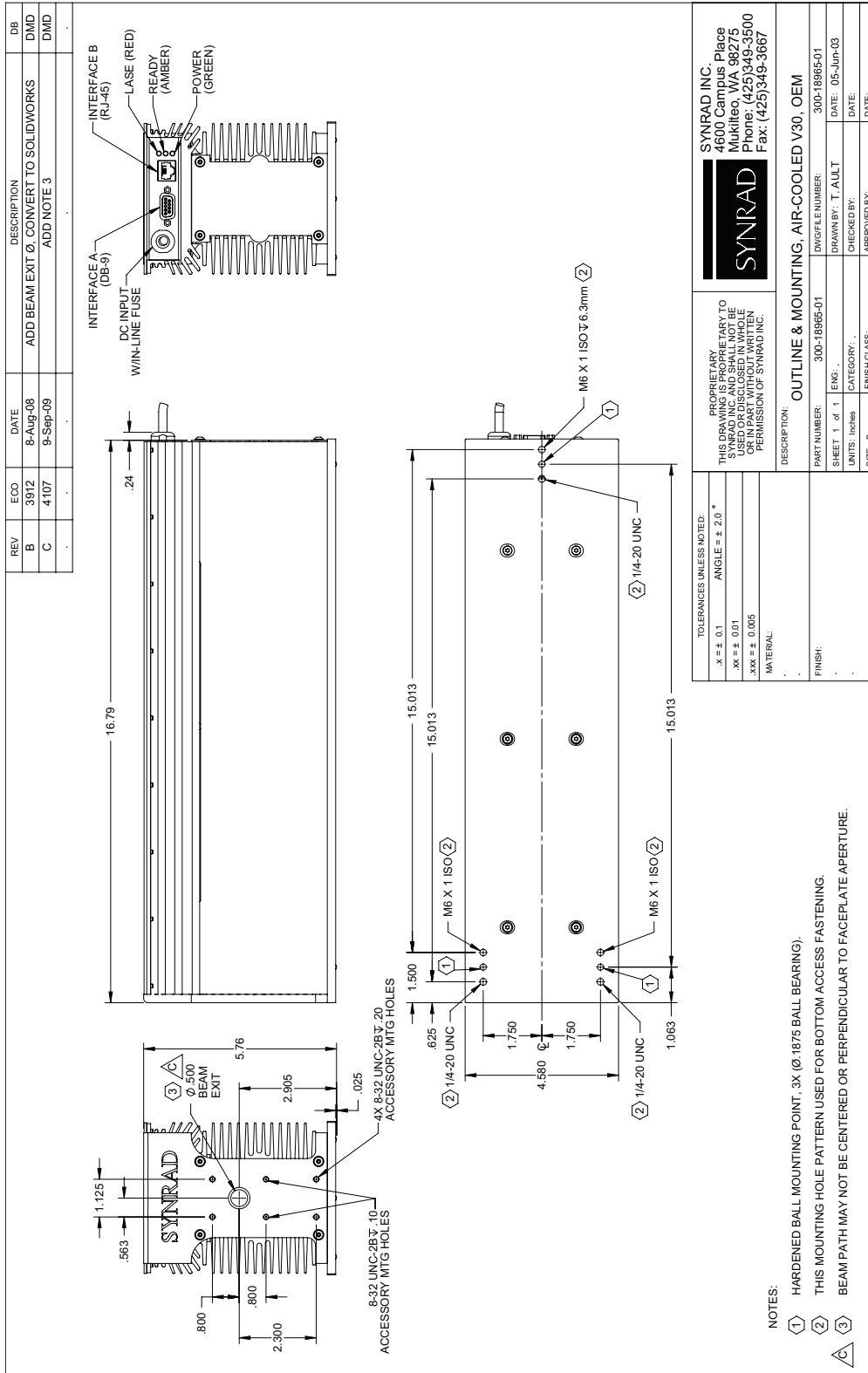


Figure 8 OEM v30 air-cooled package outline and mounting dimensions

# OEM v30 package outline drawings (cont.)

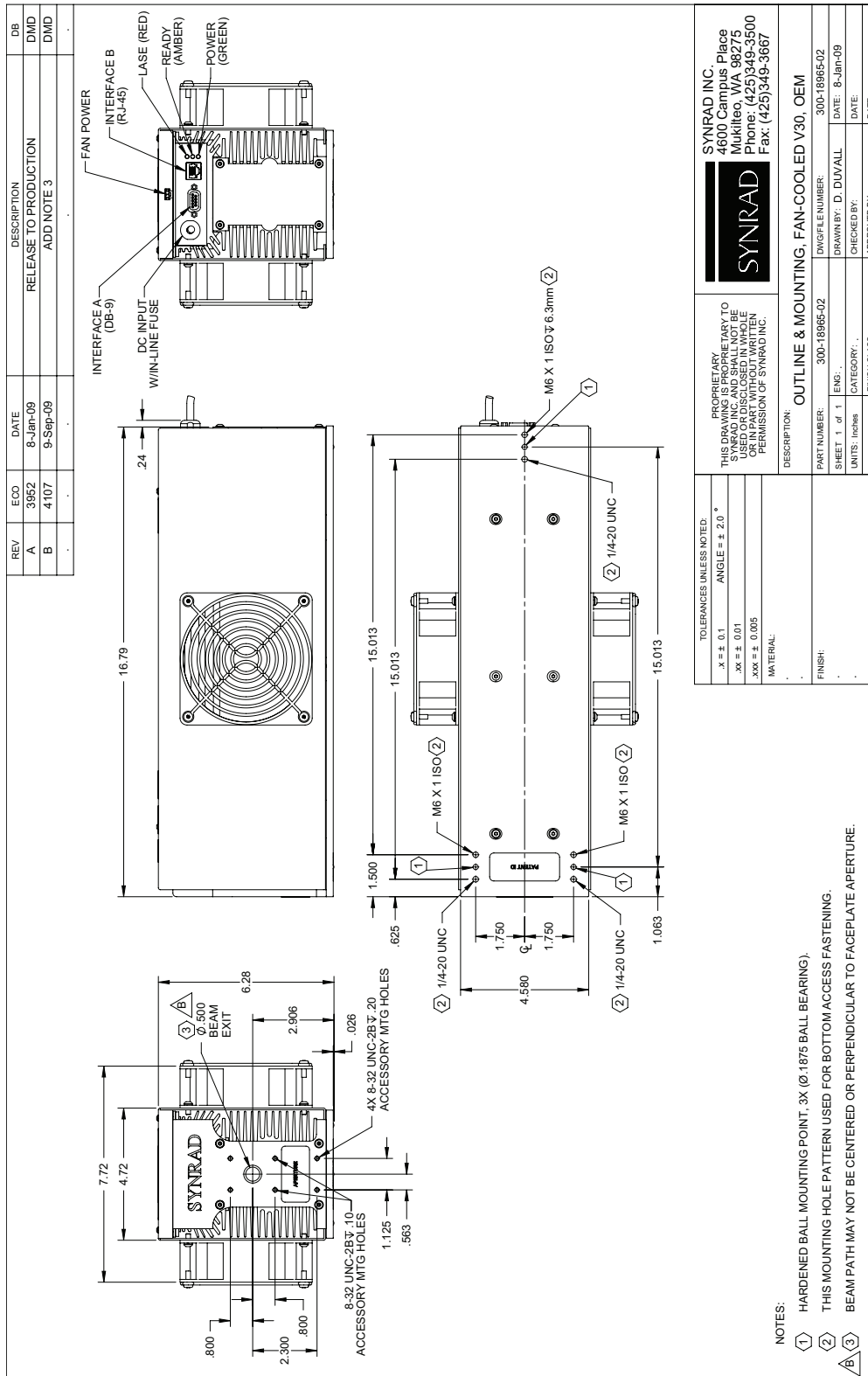


Figure 9 OEM v30 fan-cooled package outline and mounting dimensions



# Troubleshooting

This section is designed to help isolate Firestar OEM v30 lasers problems to the board level only. Problems on circuit boards or the laser tube are not within 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 or replacement information.

**⚠ Danger**  
serious  
personal  
injury

This product emits *invisible* infrared laser radiation in the 10.6 μm CO<sub>2</sub> wavelength band. Direct or diffuse laser radiation can inflict severe corneal injuries and can seriously burn human or animal tissue. Service personnel troubleshooting Firestar lasers should be thoroughly trained in laser safety practices and electronic service techniques before attempting repairs.

**Caution**  
possible  
equipment  
damage

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

## Status indications

OEM v30 LED indicators in conjunction with *Interface A* (DB-9) or *Interface B* (RJ45) outputs provide status information to the user. Table 8 and Table 9 show OEM v30 output signal and LED indicator states during normal and fault conditions for DB-9 and RJ45 connectors respectively.

**Table 8** Interface A (DB-9) status signals

LED Indicator	LED Status		DB-9 Signal Name	DB-9 Signal Status	
	Normal	Fault		Normal	Fault
LASE (Red)	On	Off	Lase Indicator	High	Low
RDY (Yellow)	On	Off	Laser Ready	High	Low
RDY (Yellow)	On	Flashes	Overtemp Fault	Low	High
PWR (Green)	On	Flashes	DC Voltage Fault	Low	High

**Table 9** Interface B (RJ45) status signals

LED Indicator	LED Status		RJ45 Signal Name	RJ45 Signal Status	
	Normal	Fault		Normal	Fault
LASE (Red)	On	Off	—	—	—
RDY (Yellow)	On	Off	Laser Ok	High	Low
RDY (Yellow)	On	Flashes	Temperature Ok	High	Low
PWR (Green)	On	Flashes	Voltage Ok	High	Low

# Troubleshooting (cont.)

## Error codes

Firestar OEM v30 lasers have the ability to indicate various laser faults by flashing *RDY* and *PWR* indicators. For OEM v30 lasers manufactured after October 1, 2011, certain faults are annunciated by the *PWR* LED blinking an error code, pausing 1/2 second, and then repeating the error code. This sequence continues until the fault is corrected and the laser is reset by cycling DC power. Table 10 lists error codes, the corresponding fault condition, and describes possible corrective actions.

**Table 10** Firestar v30 error codes

LED	# of Blinks	Fault Condition	Corrective Action in Field
<i>RDY</i>	Off		
<i>PWR</i>	1 blink	Under-Voltage fault	Verify 30 VDC (measured at laser under load)
<i>RDY</i>	Off		
<i>PWR</i>	2 blinks	Over-Voltage fault	Verify 30 VDC (measured at laser under load)
<i>RDY</i>	Off		
<i>PWR</i>	3 blinks	DC Sense fault	Remove DC power, wait 30 seconds, and then re-apply power.
<i>RDY</i>	Continuous		
<i>PWR</i>	On	Over temperature fault <sup>1</sup>	Cool laser and then cycle DC power.
<i>RDY</i>	Continuous		
<i>PWR</i>	Continuous	PWM Sense fault	Remove DC power, wait 30 seconds, and then re-apply power.

1 An over temperature fault is indicated if the Overtemp Fault output is high (+5 V). If the Overtemp Fault output is low, then a control board failure may have occurred.

## Laser faults

When a fault occurs, status LEDs and output signals reflect faults as indicated in Table 8, Table 9, or Table 10. Each Symptom listed below describes a particular fault and specific causes and solutions are described in the Possible Causes section.

### Symptom:

- The *RDY* indicator is Off. The *PWR* LED is green and the *LASE* LED is Off. On the *Interface A* (DB-9) connector, all outputs (Lase Indicator, Laser Ready, DC Voltage Fault, and Overtemp Fault) are Low. On the *Interface B* (RJ45) connector, the Laser Ok signal is Low while Voltage Ok and Temperature Ok outputs are High.

### Possible Causes:

- No Laser Enable input signal is present.

A 5V logic level Laser Enable signal must be applied to enable lasing. On the *Interface A* (DB-9) connector, apply the enable signal between Pin 9 and Pin 8. On the *Interface B* (RJ45) connector, apply the enable signal between Pin 7 and Pin 8.

### Symptom:

- The *RDY* LED is flashing. The *PWR* LED is green and the *LASE* LED is Off. On the *Interface A* (DB-9) connector, Lase Indicator, Laser Ready, and DC Voltage Fault, outputs are Low, but the Overtemp Fault output is High. On the *Interface B* (RJ45) connector, the Voltage Ok signal is High while Laser Ok and Temperature Ok outputs are Low.

### Possible Causes:

- An over temperature fault exists.

## Troubleshooting (cont.)

Cool the v30's temperature to below 40 °C (air-/fan-cooled) or 22 °C (water-cooled) and then cycle DC power to the laser. For air-/fan-cooled units, verify that cooling fans are free of debris and providing the proper airflow; for water-cooled units, check that the chiller is maintaining the correct coolant temperature and flow rate.

### Symptom:

- The *RDY* indicator is flashing. The *PWR* LED is green and the *LASE* LED is Off. On the *Interface A* (DB-9) connector, all outputs (Lase Indicator, Laser Ready, DC Voltage Fault, and Overtemp Fault) are Low. On the *Interface B* (RJ45) connector, the Laser Ok signal is Low while Voltage Ok and Temperature Ok outputs are High.

### Possible Causes:

- A control board failure has occurred.

Contact SYNRAD or a SYNRAD Authorized Distributor.

 **Warning**  
serious  
personal  
injury

On Firestar OEM v30 lasers, DC voltage faults are not latched. Clearing a DC voltage fault (under- or over-voltage) will restore normal operation and lasing is possible after the five-second delay provided that the Laser Enable input signal is high. Because exposure to 10.6  $\mu\text{m}$  CO<sub>2</sub> laser radiation can inflict severe corneal injuries and seriously burn human tissue, the OEM or System Integrator must ensure that appropriate safeguards are in place to prevent unintended lasing.

### Symptom:

- The *PWR* indicator blinks once, pauses 1/2 second and repeats. Both *RDY* and *LASE* LEDs are Off. On the *Interface A* (DB-9) connector, Lase Indicator, Laser Ready, and Overtemp Fault outputs are Low, but the DC Voltage Fault output is High. On the *Interface B* (RJ45) connector, the Temperature Ok signal is High while the Laser Ok and Voltage Ok outputs are Low.

### Possible Causes:

- An under-voltage fault exists.

Check that the DC power supply is supplying +30 VDC under load and that its current capacity is 15 amperes or greater (air-/water-cooled) or 16 amps or greater (fan-cooled) with a peak current capacity of 24 A for a minimum of 0.5 ms.

- An under-voltage condition exists (DC power supply is current-limiting) because PWM signals were applied before tube breakdown occurred.

On a cold start, verify that tickle pulses are being sent to the v30 laser for a period of five to ten seconds before a PWM signal is applied.

### Symptom:

- The *PWR* indicator blinks twice, pauses 1/2 second and repeats. Both *RDY* and *LASE* LEDs are Off. On the *Interface A* (DB-9) connector, Lase Indicator, Laser Ready, and Overtemp Fault outputs are Low, but the DC Voltage Fault output is High. On the *Interface B* (RJ45) connector, the Temperature Ok signal is High while the Laser Ok and Voltage Ok outputs are Low.

### Possible Causes:

- An over-voltage fault exists.

Check that the DC power supply is supplying +30 VDC under load.

## Troubleshooting (cont.)

### Symptom:

- The *PWR* indicator blinks three times, pauses 1/2 second and repeats. Both *RDY* and *LASE* LEDs are Off. On the *Interface A* (DB-9) connector, *Lase Indicator*, *Laser Ready*, and *Overtemp Fault* outputs are Low, but the *DC Voltage Fault* output is High. On the *Interface B* (RJ45) connector, the *Temperature Ok* signal is High while the *Laser Ok* and *Voltage Ok* outputs are Low.

### Possible Causes:

- A DC Sense fault has occurred.

Remove DC power from the laser, wait 30 seconds, and then re-apply DC power. If the fault fails to clear, contact SYNRAD or a SYNRAD Authorized Distributor.

### Symptom:

- Both *PWR* and *RDY* indicators are flashing. The *LASE* LED is Off. On the *Interface A* (DB-9) connector, all outputs (*Lase Indicator*, *Laser Ready*, *DC Voltage Fault*, and *Overtemp Fault*) are Low. On the *Interface B* (RJ45) connector, the *Temperature Ok* and *Voltage Ok* outputs are High while the *Laser Ok* signal is Low.

### Possible Causes:

- A PWM Sense fault has occurred.

Remove DC power from the laser, wait 30 seconds, and then re-apply DC power. If the fault fails to clear, contact SYNRAD or a SYNRAD Authorized Distributor.

## DB-9 connector

### Symptom:

- The built-in +5 VDC, 250 mA voltage output on Pin 5, *DC Out*, has been 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.

## RJ45 connector

### Symptom:

- The built-in +15 VDC, 250 mA voltage output on Pin 2, *DC Out*, has been 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 once the short-circuit is removed.

## Beam delivery optics

### 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.

## Troubleshooting (cont.)

**⚠ 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 lens. 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 to the *Firestar v40 Operator's Manual* and use only recommended cleaning materials to prevent scratching delicate optical surfaces.

**⚠ Caution**  
possible  
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 laser application requires air (instead of nitrogen or argon) as an assist gas, use breathing quality air available in cylinders from a welding supply company. Compressed shop air contains minute particles of oil and other contaminants that will damage optical surfaces and must be carefully filtered and dried before use as a purge or assist gas.

**⚠ 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 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.

**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.

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