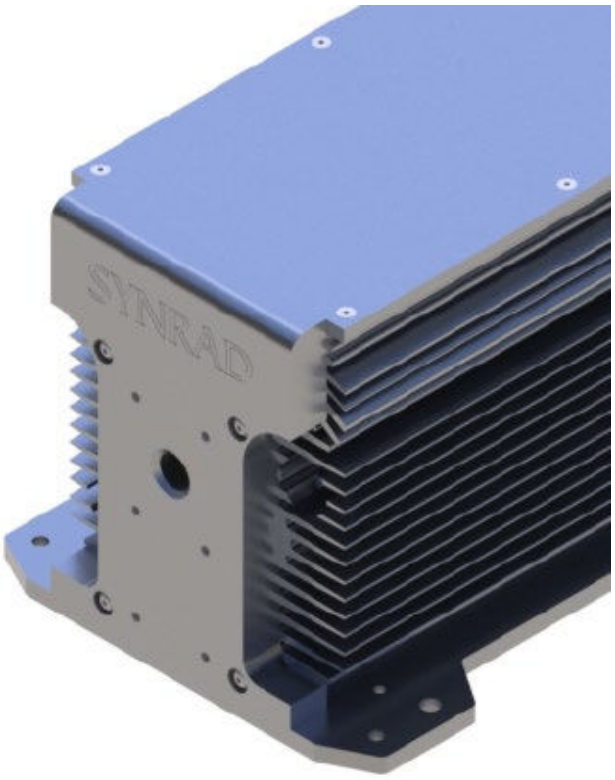
v40 Laser

User Manual



Novanta

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Important Information

For your protection, carefully read these instructions before installing and operating the scan head.
Retain these instructions for future reference.

Novanta reserves the right to update this user manual at any time without prior notification.

If product ownership changes, this manual should accompany the product.

DANGER: Indicates a hazardous situation which, if not avoided, will result in serious injury or death. Its use should be limited to the most extreme situations.

WARNING: Indicates a hazardous situation which, if not avoided, could result in serious injury or death.

CAUTION: Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

Important: Indicates information considered important but not directly hazard related (e.g., security, hygiene, or equipment or property damage).

Safety Labels

DANGER: Laser radiation can cause severe retinal and corneal burns, burns on the skin, and may pose a fire risk. To avoid injury and reduce risk of fire, please follow the control measures and safety guidelines provided by the laser's manufacturer, and those established by your Laser Safety Officer (LSO), Radiation Safety Officer (RSO), or safety department of your business or institution.

ESD Warning
MOVIA scan heads are electrostatic discharge-sensitive devices (ESD). The equipment should remain sealed until the user is located at a proper static control station; improper handling could cause damage to these electronics.

A proper static control station should include:

A soft grounded conductive tabletop or grounded conductive mat on the tabletop.

A grounded wrist strap with the appropriate (1 MΩ) series resistor connected to the tabletop mat and ground.

An adequate earth ground connection, such as a water pipe or AC ground.

Conductive bags, trays, totes, racks, or other storage.

Properly grounded power tools.

Personnel handling ESD items should wear ESD protective garments and ground straps.

Important: Equipment returned to the factory must be shipped in anti-static packaging.

Important: Customers assume all responsibility for maintaining a laser-safe working environment. Original equipment manufacturer (OEM) customers assume all responsibility for CDRH (Center for Devices and Radiological Health) certification.

Customer Support

Before contacting Novanta for assistance, review appropriate sections in the manual that may answer your questions.

After consulting this manual, please contact one of our worldwide offices between 9 AM and 5 PM local time.

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Trademark & Copywrite

Warranty Information

This is to certify that v40 lasers are guaranteed by NOVANTA 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 im-proper maintenance. We request that you examine each shipment within 10 days of receipt and inform NOVANTA of any shortage or damage. If no discrepancies are reported, NOVANTA shall assume the shipment was delivered complete and defect-free.

If, within one year from the date of purchase, any part of the v40 laser should fail to operate, contact the NOVANTA Customer Service department at 1.800.NOVANTA1 (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 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 NOVANTA for evaluation unless otherwise instructed.

If your v40 laser fails within the first 45 days after purchase, NOVANTA will pay all shipping charges to and from NOVANTA when shipped as specified by NOVANTA Customer Service. After the first 45 days, NOVANTA will continue to pay for the costs of shipping the repaired unit or replacement parts back to the customer from NOVANTA. The customer, however, will be responsible for shipping charges incurred when sending the failed unit or parts back to NOVANTA or a NOVANTA Authorized Distributor. In order to maintain your product warranty and to ensure the safe and efficient operation of your v40 laser, only authorized NOVANTA replacement parts can be used. This warranty is void if any parts other than those provided by NOVANTA are used.

NOVANTA and NOVANTA Authorized Distributors have the sole authority to make warranty statements regarding NOVANTA products. NOVANTA 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. NOVANTA 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 NOVANTA 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 NOVANTA, or the use thereof, infringes upon any Patent, foreign or domestic.

Sales, Application & Support

Novanta Sales and Support

NOVANTA® worldwide headquarters are located north of Seattle in Mukilteo, Washington. U.S.A. Our mailing address is:

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Sales & Application

NOVANTA Regional Sales Managers work with customers to identify and develop the best CO2 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 NOVANTA at 1.800. NOVANTA1.

Customer Service

For assistance with order or delivery status, service status, or to obtain a Return Authorization (RA) number, contact NOVANTA at 1. 800.NOVANTA1 and ask to speak to a Customer Service representative, or you can email us by sending a message to customercare@Novanta.com.

Technical Support

NOVANTA 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 Novantatechsupport@ Novanta.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 the NOVANTA web site at http://www.Novanta.com.

EU Headquarters

For assistance in Europe, contact NOVANTA® European subsidiary, NOVANTA Europe, at:

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Getting started

Use information in this section to prepare your v40 laser for operation. The order of information presented in this chapter is the same as the order of tasks that you need to perform. The best way to get your laser ready for operation is to start at Inventory and work your way through Connecting.

This section contains the following information:

- Introduction – introduces the v40 laser, lists important features, and describes nomenclature.
- Unpacking – provides important information about shipping your v40 laser.
- Inventory – displays and describes all components shipped with your laser.
- Mounting – describes how to attach laser components to a mounting surface.
- Connecting – explains how to connect power and control cables as well as cooling connections for water-cooled models.

Introduction

The v40 laser is a small-footprint laser from NOVANTA featuring high power and excellent beam quality. The circular beam provides more accurate cutting and faster processing speeds than competing technologies. With an integrated RF power supply, meaning no external RF cables, the compact laser housing mounts easily to flatbed cutters, robotic arms, or gantry systems making integration into your production line simple and fast.

v40 features include:

- Compact resonator design
- RF power supply integrated into laser chassis
- Built-in “tickle” generator
- Color-coded LEDs mirror user outputs
- “Industrial-strength” ±5–24 VDC inputs and outputs
- Keyswitch fan- or water-cooled models available
- OEM (no Keyswitch/no shutter) air-, fan-, or water-cooled models available

v40 Nomenclature

v40 lasers are divided into two distinct functional categories: Keyswitch and OEM models. In addition to a manual Keyswitch, all Keyswitch-equipped lasers include a manual shutter switch that allows the laser output aperture to be blocked. OEM lasers do not incorporate either a manual keyswitch or shutter assembly since they are primarily designed as components to be integrated into a larger processing system by the Original Equipment Manufacturer (OEM) or System Integrator who bears the responsibility for meeting the appropriate laser safety requirements for Class IV laser systems.

Model numbers

The last three characters in the v40 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 FSV40KFD designates that particular v40 laser as a “D” version, Keyswitch, fan-cooled model. FSV40SAD indicates an OEM, air-cooled v40 laser.

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 NOVANTA.

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

Packaging guidelines

- To prevent equipment damage or loss of small components, use care when removing packaging materials.
- Save all shipping containers and packaging materials, including covers and plugs. Use these specialized packing materials when shipping the laser to another location.
- After unpacking, review the Inventory section and verify that all components are on hand.
- When packing a laser for shipment, be sure to remove all accessory items not originally attached to the laser including beam delivery components, cooling tubing, fittings, etc.
- Refer to the Packaging Instructions drawing in the Technical Reference chapter for information on packaging a v40 for shipment using NOVANTA-supplied packaging 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.
- Do not lift or support the laser using the cooling fittings; lift the laser by the mounting feet or baseplate only.

Inventory

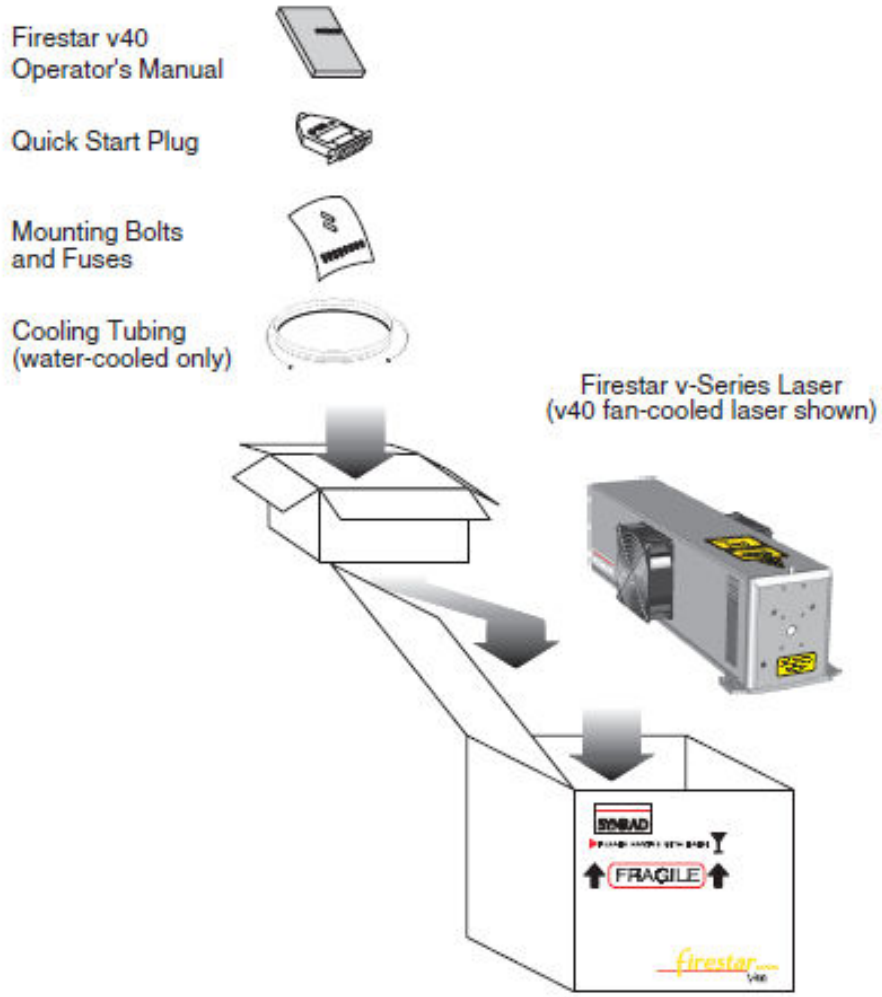


Figure 1-1 v40 shipping box contents.

Table 1-1 v40 ship kit contents.

Shipping Box Contents	Qty
v40 Laser	1
v40 Operator's Manual	1
Spare Fuse (not shown)	2
Mounting Bolts	3
Cooling Tubing (water-cooled only)	1
Quick Start Plug	1
Final Test Report (not shown)	1

Contents description

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

v40 Laser – for cutting, welding, drilling, and marking a wide variety of products and materials.

Quick Start Plug (except SAB models) – connects to 's User I/O connector. Jumpers are built into the plug to enable 's shutter and remote interlock circuits 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" O.D. by 30 feet and must be cut to length.

Mounting Bolts – 1/4–20 × 5/8" bolts fasten to your mounting surface.

v40 Operator's Manual – provides setup, operation, and maintenance information for your v40 laser.

Spare Fuse (not shown) – fast blow 25 A fuse protects 's internal circuitry.

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

Mounting

The Mounting section includes subsections:

- Fastening from above
- Fastening from below

v40's base plate is designed so that the laser is easily mounted to either vertical or horizontal surfaces using only three fasteners. Three ball bearing "feet" pressed into 's base plate eliminate any possible distortion of the laser tube caused by variations in the flatness of the surface on which the laser is mounted. Refer to the v40 package outline drawings in the Technical Reference chapter for mounting locations and dimensions. Read through the mounting sections below to determine which set of mounting holes are required for your application. When mounting v40 lasers, you can choose to fasten from above, into your mounting surface, or from below, into v40's base plate.

Important Note: To allow proper airflow, air- or fan-cooled units must have at least 2.25" (57.2 mm) of unobstructed clearance between the outside edge of the cooling fan and any enclosure or surface.

Caution: Possible Equipment Damage

NOVANTA 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 vertical orientation increases the risk of damage to the laser's output optic.

Fastening from above

To fasten to a mounting surface from above, perform the following steps:

1. Refer to the appropriate outline and mounting drawing for dimensions and then drill and tap three 1/4–20 UNC holes into your mounting surface. These hole locations should correspond to the two slots labeled “A” and the thru hole labeled “B” shown in Figure 1-2.

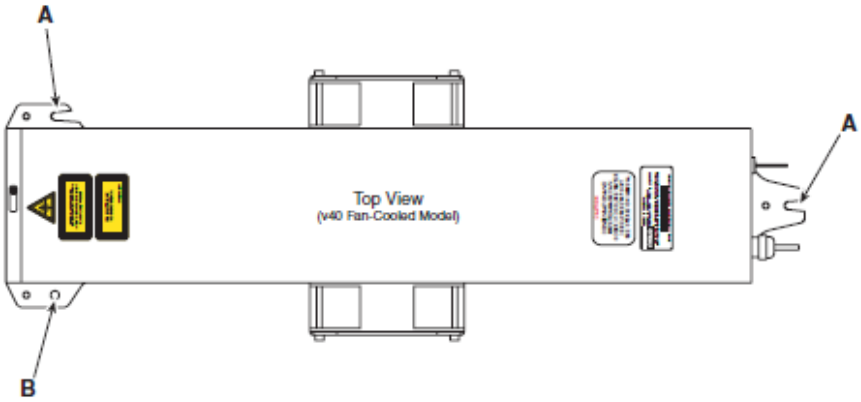


Figure 1-2 Fastening from above

2. Place on the mounting surface so that slots “A” and hole “B” on the base plate line up with the tapped holes in the mounting surface.
3. Insert 1/4–20 × 5/8" UNC capscrews through ’s base plate into the threaded holes of the mounting surface. Turn the screws by hand until the threads engage.
4. Tighten all three capscrews to a torque of 6 ft lbf (8 N m) maximum.

Fastening from below

To fasten to a mounting surface from below, perform the following steps:

1. Refer to the appropriate outline and mounting drawing for dimensions and then drill three 0.261" (6.6 mm) diameter holes into your mounting surface. Hole locations should correspond to the threaded holes labeled “C” shown in Figure 1-3.

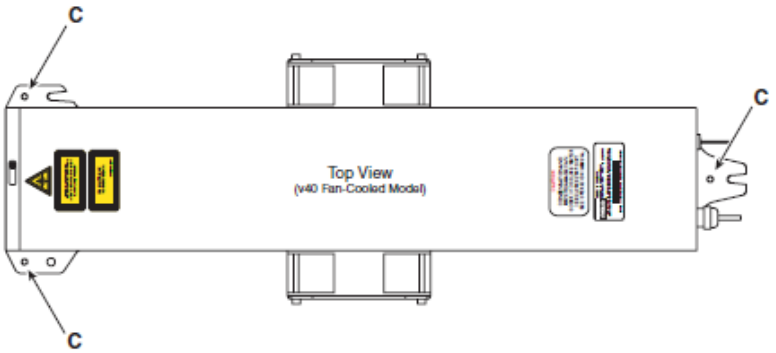


Figure 1-3 Fastening from below

2. Place on the mounting surface so that the threaded holes on the base plate (labeled “C” in Figure 1-3) line up with the holes drilled through the mounting surface.
3. Insert 1/4–20 × 5/8″ UNC capscrews through the mounting surface into the threaded holes of ’s base plate. Turn the screws by hand until the threads engage.
4. Tighten all three capscrews to a torque of 6 ft lbf (8 N m) maximum.

Connecting

The Connecting section includes subsections:

- Water-cooled connections
- OEM air-cooled connections
- Electrical connections
- Control connections

Water-cooled connections

If your v40 laser is fan-cooled, then skip to the Electrical connections section.

Read Guidelines for cutting and installing tubing before installing any cooling tubing and then make sure to connect the cooling system exactly as described for your particular laser.

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 tubing 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.
- 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″ from its end before reconnecting. Trimming the end of the tubing before reconnecting the fitting provides an undisturbed sealing surface.

Laser cooling fittings

If your integrated laser application uses metric cooling tubing, we recommend the installation of 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.

If, for any reason, you must remove and then reinstall the threaded WATER IN and WATER OUT cooling fittings on the laser, do not overtighten them. When installing new fittings, wrap the threads with Teflon tape and then carefully tighten the fittings until they are just snug enough to prevent water leakage.

Chiller preparation guidelines

- You must provide fittings that will adapt the laser's 1/2" O.D. polyethylene cooling tubing to your chiller's Inlet and Outlet ports. These fittings can be either "quick disconnect" or compression type fittings.
- Because 's cooling tubing is specified in inch sizes, the use of metric tubing fittings is discouraged 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

NOVANTA 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 NOVANTA 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. v40 lasers incorporate the following wetted materials in the coolant path—aluminum, 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–22 °C (64 °F–72 °F), then the following steps MUST be taken to reduce the risk of condensation damage.

- Stop coolant flow when the laser is shut down.

- Increase coolant flow by an additional 1.0 GPM (3.8 lpm). Do not exceed a coolant pressure of 60 PSI (4.1 bar).
- Air-condition the room or the enclosure containing the laser.
- Install a dehumidifier to reduce the humidity of the enclosure containing the laser.

Table 1-2 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 but should not exceed 22 °C (72 °F).

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 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 developing inside the laser.

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 tubing connections

To connect cooling tubing, refer to Figure 1-4 and perform the following steps. The numbered items in Figure 1-4 correspond to the step numbers in the following procedure.

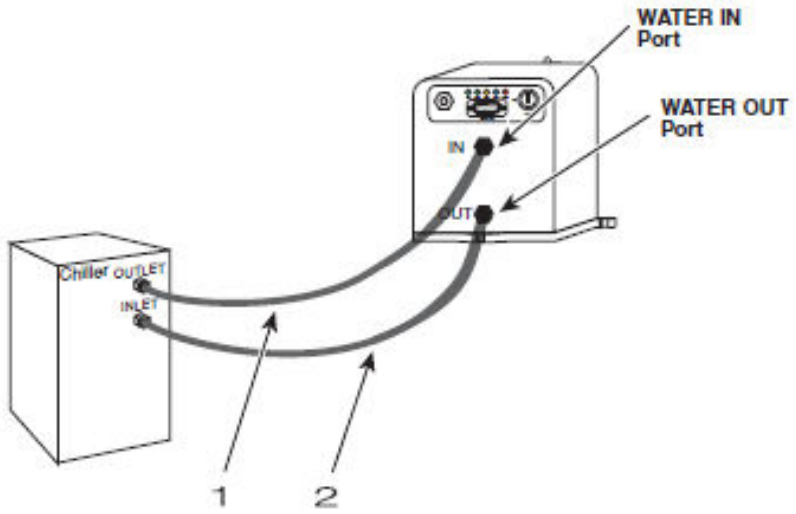


Figure 1-4 cooling connections

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 v40 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 laser.

3. Turn on the chiller and adjust the temperature setpoint to 18–22 °C. Regulate coolant flow to 1.0 GPM (3.8 lpm) at less than 60 PSI (4.1 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.

OEM air-cooled connections (SAB models)

Because v40 OEM air-cooled lasers are shipped without cooling fans, customers must provide some type of air cooling to prevent overheating. NOVANTA recommends an airflow of at least 140 cubic feet per minute for each of the two required fans. Figure 1-5 illustrates the fan placement necessary to keep the laser's heat sink temperature below 45 °C. (113 °F). To provide proper airflow, cooling fans should have a diameter of approximately 4.5–5 inches (114–127 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. Because of the heat generated by internal RF circuitry, establishing significant airflow evenly over the entire surface area of the combined laser/RF chassis is vitally important to the performance and longevity of the laser.

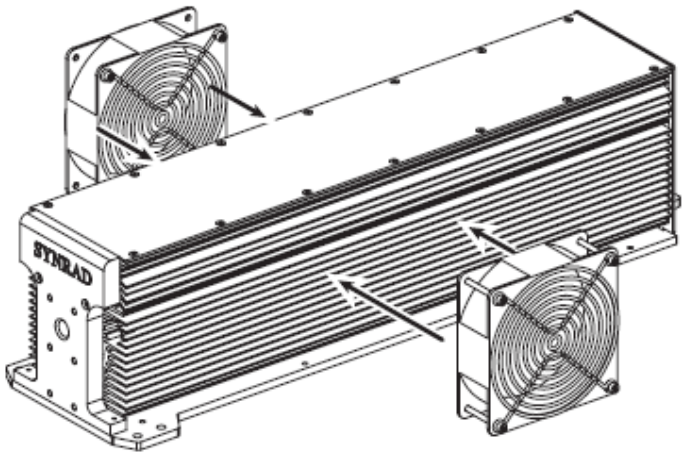


Figure 1-5 Recommended v40 cooling fan locations

Important Note: The air-cooled OEM laser's front plate is not compatible with the fan kit used on fan-cooled v40 lasers. Because a different front plate is required, the factory-supplied fan kit cannot be retrofitted to air-cooled OEM lasers in the field; it must be installed at the factory.

A +24 VDC (1.5 A max.) output to power customer-supplied cooling fans is available from the SAB model's side-mounted DB-9 connector. Refer to DB-9 connections in the Technical Reference chapter for cautions, pinouts, and signal descriptions.

Caution: Possible Equipment Damage

The +24 VDC output described above is not fused or electrically protected. Do not short this pin to ground; the control board will be damaged.

Connecting

NOVANTA recommends side-mounted cooling fans for v40 lasers, but a rear-mounted, single-fan cooling scheme is also feasible. Figure 1-6 illustrates the rear-cooling concept. Please review the guide-lines below to ensure that your implementation provides enough airflow to prevent damage to the laser. The cooling fan must supply at least 300 CFM in order to keep laser and RF heat sink temperatures below 45 °C (113 °F). Note that rear-cooled v40 lasers may experience some performance degradation when compared to the typical side-mounted cooling configuration. Because of the heat generated by 's integrated RF circuitry, establishing significant airflow evenly over the entire surface area of the combined laser/RF chassis is vitally important to the performance and longevity of the laser.

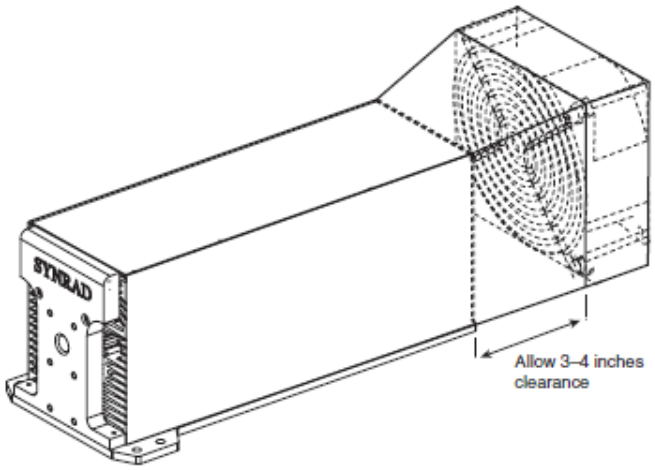


Figure 1-6 Rear-mounted cooling

Guidelines for rear cooling

- The cooling shroud must be designed so that it encloses the full length of both the laser and the cooling fan.
- The shroud must fit snugly against the laser's cooling fins so that cooling air is ducted between the fins and not around them.

- To allow proper heat dissipation, the shroud must be open at the front to allow cooling air to flow away from the laser.
- Allow 3–4" (76–102 mm) of clearance between the front of the cooling fan and the rear of the laser.
- To provide proper airflow, the cooling fan should have a diameter of approximately 4.5–5" (114–127 mm) and must supply an airflow of at least 300 CFM distributed evenly over the length and width of the laser's cooling fins.

Electrical connections

The following procedures describe how to complete electrical connections to both Keyswitch and OEM v40 lasers.

DC power supply

v40 lasers require a DC power supply that provides 30 VDC at 24 A maximum. We recommend the NOVANTA DC-5 DC power supply that supplies 30 VDC at 33 A. AC input requirements for the DC-5 are 90–132 VAC (low range) or 175–264 VAC (high range), single phase (1ø), 15 A max, 47–440 Hz.

To connect the DC-5 power supply for 120 VAC (low range) input, refer to Figure 1-7 and follow the steps listed in the 120 VAC input operation section. If you are connecting the DC-5 for 240 VAC (high range) input, refer to Figure 1-7 and follow the steps listed in the 240 VAC input operation section.

Caution: Possible Equipment Damage

Do not reverse polarity when connecting DC power cables to your DC power source. Reversed DC polarity will damage the laser's internal RF power supply. Carefully follow the directions below to ensure that DC cable leads are properly connected to the correct DC output terminals.

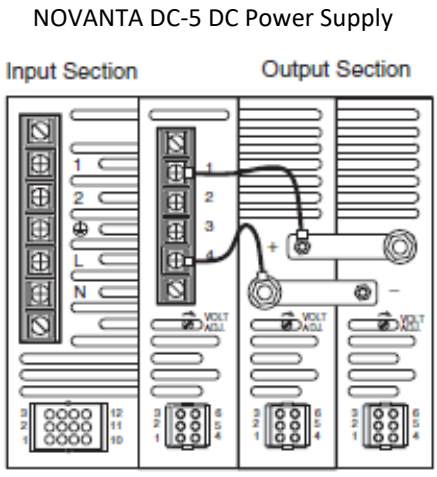


Figure 1-7 DC-5 power supply

Important 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.

120 VAC input operation

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 output section and connect the black (–) DC power cable from the laser to the negative (–) output terminal.
3. Connect the red (+) DC power cable from the laser to the positive (+) 30 VDC output terminal.
4. Locate the 5-pin terminal strip on the power supply's input section, under the protective Snap-On cover.
5. Connect a jumper wire (16 AWG or heavier) between terminals 1 and 2.

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

6. Connect the neutral wire, typically white, from your voltage source to terminal "N" (AC Neutral).
7. Connect the AC hot wire, typically black, from your 120 VAC source to the terminal labeled "L" (AC Line).
8. Connect the ground (earth) wire, typically green, from your AC voltage source to the terminal labeled with the ground symbol.

240 VAC input operation

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 output section and connect the black (–) DC power cable from the laser to the negative (–) output terminal.
3. Connect the red (+) DC power cable from the laser to the positive (+) 30 VDC output terminal.
4. Locate the 5-pin terminal strip on the power supply's input section, under the protective snap on cover.

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

5. Connect one of the two AC hot wires, typically black, from your 240 VAC source to the terminal labeled "L" (AC Line).

6. Connect the other hot wire, typically black or red, from your voltage source to terminal “N” (AC Neutral).
7. Connect the ground (earth) wire, typically green, from your AC voltage source to the terminal labeled with the ground symbol.

Control connections

All control connections to the v40 laser are made through the 15-pin User I/O connector on v40’s rear panel. The User I/O port receives power commands from the NOVANTA’s UC-2000 Universal Laser Controller and also serves as the connection point for auxiliary signals between the laser and any parts handling, automation, or monitoring equipment.

Warning: Serious Personal Injury

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

UC-2000 Universal Laser Controller

NOVANTA recommends the use of a UC-2000 Universal Laser Controller to generate pulse width modulated (PWM) Command signals that control the laser’s output power. To connect a UC-2000 Controller (not included with the v40 laser), perform the following steps:

1. Remove DC power from the laser.
2. Locate the Quick Start Plug in the ship kit.
3. Connect the Quick Start Plug to the User I/O connector on the rear of the laser.
4. Attach the BNC connector on the end of the UC-2000’s Power/Control cable to the BNC connector on the rear of the Quick Start Plug.
5. Connect the miniature DC power plug on the UC-2000’s Power/Control cable to the miniature connector on the cable from the UC-2000’s wall plug transformer.
6. Connect the mini-DIN connector on other end of the UC-2000’s Power/Control cable to the Laser connector on the rear panel of the UC-2000.

Important Note: v40 lasers can be controlled from an alternate user-supplied Command signal source. See Controlling laser power in the Technical Reference chapter for signal descriptions. Refer to User I/O connections in the same chapter for signal specifications and connection details.

Quick Start Plug

The Quick Start Plug is not included with SAB models but may be ordered separately.

Caution: Possible Equipment Damage

Turn off DC power before installing or removing any plug or cable from the User I/O 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.

In order for your v40 laser to properly operate, several input signals must be applied to the DB-15 User I/O connector before lasing is enabled. Remote Interlock (Pin 3) and Shutter Open Request (Pin 10) inputs must be powered before the laser will fire. In applications where v40 is integrated into an automated 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 factory installed shorting jumpers wired into it to enable these inputs. Connect the Quick Start Plug to the User I/O connector when performing initial start-up and testing of your laser.

Caution: Possible Equipment Damage

The Quick Start Plug is intended solely for initial start-up and testing of the laser. Because this plug jumpers Remote Interlock and Shutter Open Request signals, the laser will fire immediately on application of a PWM Command signal. Your integrated control system should provide interlock and shutter signals directly to the DB-15 User I/O connector only after safe operating conditions are established.

For further information about the User, I/O connector, see User I/O connections in the Technical Reference chapter for User I/O pinouts and signal descriptions. See Integrating v40 safety features, also in the Technical Reference chapter, for detailed instructions on integrating v40's keyswitch, shutter, and remote interlock functions with automated control systems. Figure 3-7, Quick Start Plug wiring diagram, also in the Technical Reference chapter shows the Quick Start Plug wiring diagram.

Laser Safety Introduction

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

- 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 v40 laser parts and/or components as they pertain to disposal.
- Additional Safety Information – describes how to find additional information about your v40 laser.
- Compliance – explains in the subsections therein applicable and appropriate regulation information.

 Warning: Serious Personal Injury

This Class 4 CO2 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.

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.

- Warning: Potential & Imminent hazards which, if not avoided, could result in death or serious injury. Alerts operator of serious dangers, hazardous radiation, hazardous voltages, vapor hazard, & reflective dangers.
- Danger: Hazards which, if not avoided, could result in minor or moderate injury. Alerts operator of lifting dangers.
- Caution: Potential hazards or unsafe practices which, if not avoided, may result in product damage. Alerts operator of equipment dangers.
- Important notes & tips: Content specific information and/or recommendations.

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

 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.

 Warning: Serious Personal Injury

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

A CO_2 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.

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.

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.

CO2 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 CO2 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_2 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 affect 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 CO2 laser systems because difluoroethane persists for long time periods over wide areas.

v40 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 Z136.1-2014, 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.

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 NOVANTA® 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.

Thorium Safety

- This laser system incorporates a II-VI Infrared optical component.
- This optical component contains a small amount of thorium fluoride, a type of source material (less than 10% by weight).
- It is exempt from USNRC licensing regulations as an “unimportant quantity of source material” per 10 CFR 40.13(c) (7).
- Shaping, grinding, polishing, or alteration of the optical component is prohibited.
- Use of this optical component in contact lenses, spectacles, or in eyepieces in binoculars or other similar optical instruments is prohibited.

Cleaning optical components is permitted so long as care is taken not to damage the coated surface of the component as sold. This II-VI Infrared requirement only applies to lenses and optics manufactured and distributed by II-VI Infrared. Distributing components or devices that contain lenses and optics manufactured by other companies as if it were manufactured by II-VI Infrared is not in compliance with USNRC distribution requirements.

U.S. distribution of components or devices that contain lenses and optics manufactured by other companies which contain uranium and/or thorium requires a USNRC distribution license. Only II-VI Infrared manufactured lenses and optics which contain thorium are covered by the II-VI Infrared distribution license.

10 CFR 40.13(c) (7) Unimportant quantities of source material.

(7) Thorium or uranium contained in or on finished optical lenses and mirrors, provided that each lens or mirror does not contain more than 10 percent by weight thorium or uranium or, for lenses manufactured before August 27, 2013, 30 percent by weight of thorium; and that the exemption contained in this paragraph does not authorize either:

(i) The shaping, grinding, or polishing of such lens or mirror or manufacturing processes other than the assembly of such lens or mirror into optical systems and devices without any alteration of the lens or mirror; or

(ii) The receipt, possession, use, or transfer of uranium or thorium contained in contact lenses, or in spectacles, or in eyepieces in binoculars or other optical instruments.

Additional laser safety information

The NOVANTA web site https://www.Novanta.com/resources/general_information/lasersafetyresources contain 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 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.

V40 label locations

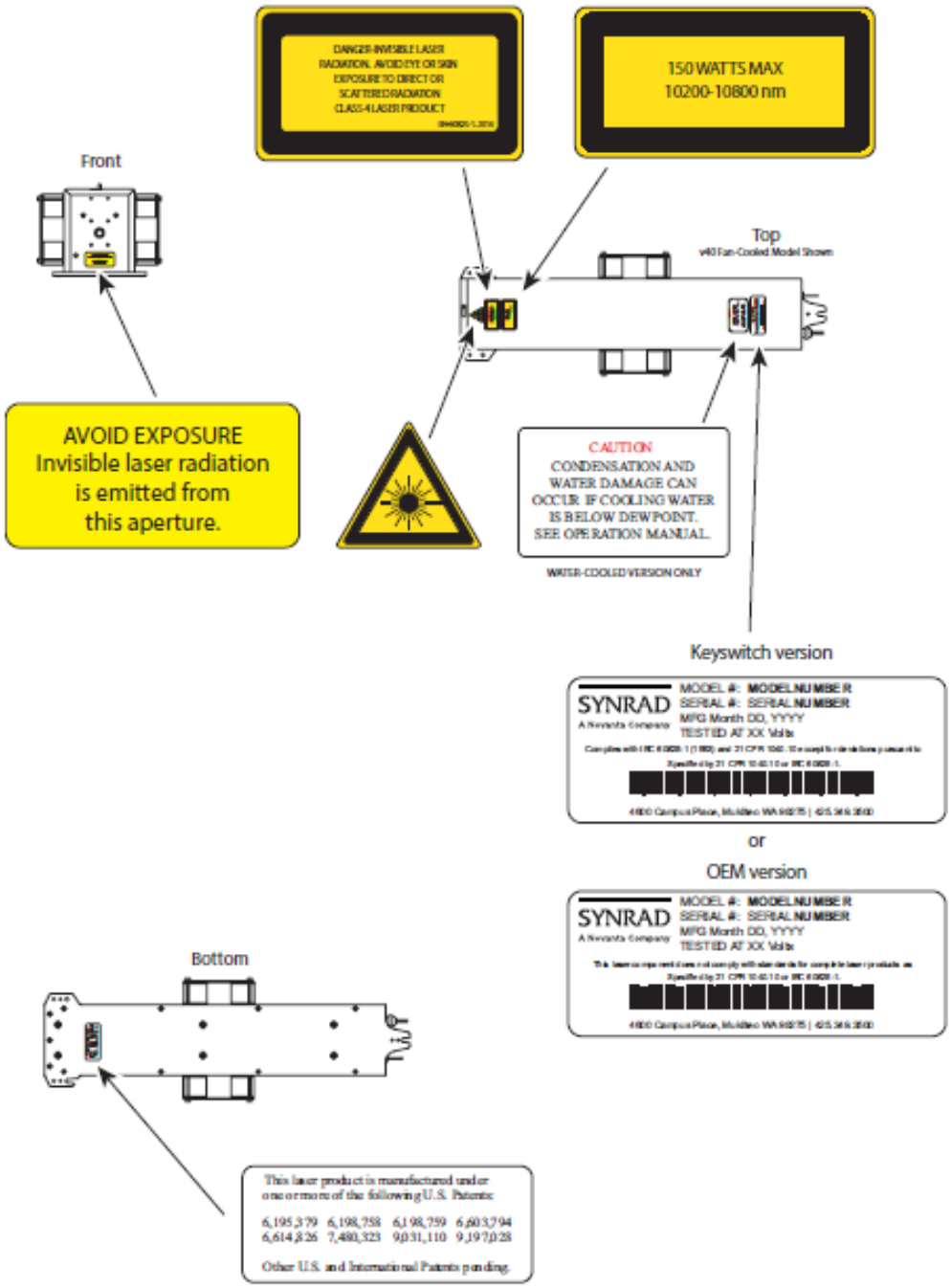


Figure 2-1 V40 Hazard label locations.

Compliance

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

NOVANTA® 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 v40 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, NOVANTA 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. NOVANTA 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 v40 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 Class 4 safety features, located in the following table, which indicate which features are available on v40 lasers, the type and description of the feature, and if the feature is required by CDRH regulations.

OEM Models

v40 OEM lasers are OEM products intended for incorporation as components in laser processing systems. As supplied by NOVANTA, 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.

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, §§C.

NOVANTA® v40 lasers have been tested and found to comply by demonstrating performance characteristics that have met or exceeded the requirements of 47 CFR, §18, §§C for Radiated and Conducted Emissions.

FCC Information to the user

Important 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, NOVANTA has not discovered any significant electrical interference traceable to v40 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.

European Union (EU) requirements RoHS compliance

NOVANTA® v40 lasers meet the requirements of the European Parliament and Council Directive 2015/863/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, 2006/95/EC, the European Norm (EN) document EN 60825- 1:2007 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, As-sociated Hazards, Evaluating Risk, Control Measures, Maintenance of Safe Operation, Incident Reporting and Accident Investigation, and Medical Surveillance.

OEM Models

V40 OEM lasers are OEM products intended for incorporation as components in laser processing systems. As supplied by NOVANTA, 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 60825-1:2004, EN 60204- 1:2016, Safety of Machinery; the Machinery Directive, 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. Table 1, Class 4 safety features, summarizes v40 product features, indicating the type and description of features and whether those features are required by European Union regulations.

Electromagnetic Interference Standards

NOVANTA v40 lasers have demonstrated performance characteristics that have met or exceeded the requirements of EMC Directive 2014/30/EU.

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 v40 lasers, EN 61000- 6-4:2018 defines radiated and conducted RF emission limits while EN 61000-6-2:2016 defines immunity standards for industrial environments.

Table 2-1 Class 4 safety features.

Feature	Location	Description	Required by: CDRH	Required by: EN60825-1	Available on: OEM V40
Keyswitch[1]	Rear Panel Control	On/Off/Reset Key switch 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	Yes
Shutter Indicator	Rear Panel Indicator (Blue)	Illuminates blue to indicate shutter is open.	No	No	Yes
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 p100/150 is actively lasing. Lase LED illuminates when the duty cycle of the command cycle is long enough to produce laser output,	Yes	Yes	Yes
Five second delay	Circuit Element	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.	Yes	No	Yes
Power Fail Lockout[1]	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	Side Panel Connection	Disables RF driver/laser output when a remote interlock switch on an equipment door or panel is opened.	Yes	Yes	Yes
Remote Interlock INT Indicator	Rear panel indicator (Green/Red)	Illuminates green when Remote Interlock circuitry is closed. Illuminates red when interlock circuitry is open.	No	No	No

Over Temperature Protection	Circuit Element	Temperature shutdown occurs if temperature of the laser tube rises above safe operating limits	No	No	Yes
Temp Indicator	Rear panel indicator (Green/Red).	Illuminates green when laser temperature is within operating limits, changing to red when thermal limits are exceeded.	No	No	Yes
Warning Labels	Laser exterior Labels attached to various external housing locations.	Warnings to personnel of potential laser hazards.	Yes	Yes	Yes

1 Not available on v40 OEM lasers

When integrating NOVANTA v40 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, NOVANTA testing program has demonstrated that v40 lasers comply with the relevant requirements of Directive 2014/30/EU, the Electromagnetic Compatibility Directive, as summarized in Table 2 below.

Table 2-2 European Union Directives.

Applicable Standards/ Norms	
2014/30/EU	Electromagnetic Compatibility Directive
2014/35/EU	Low Voltage Directive
2015/863/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	Radiated Emissions Group 1, Class A
EN 61000-6-4	Conducted Emissions Group 1, Class A
EN 61000-6-2	Electrostatic Discharge Immunity
EN 61000-6-2	RF Electromagnetic Field Immunity
EN 61000-6-2	Electrical Fast Transient/Burst Immunity
EN 61000-6-2	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.

Declaration of Conformity

in accordance with ISO / IEC 17050-2:2004

We,

Manufacturer's Name: SYNRAD® A ©Novanta Company

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™ OEM v40 Laser

Model Number: FSv40SxD (*OEM)

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

Applicable Directive(s):	2014/30/EU	Electromagnetic Compatibility Directive
	2014/35/EU	Low Voltage Directive
	(EU) 2015/863	RoHS Directive

Applicable Standard(s):

EN 61010-1:2010	Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements
EN 60825-1-4:2014	Safety of Laser Products (Keyswitch only)
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, *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:

Tim Freni, Quality Manager of SYNRAD

Dated: 7/22/19

European Contact:
Novanta Distribution (USD) GmbH
Parkring 57-59
85748 Garching bei München, Germany

CE

MADE IN THE U.S.A.
900-20976-17 Rev C

Figure 2-2 Declaration Document.

Operation

Use information in this section to familiarize yourself with v40 controls and indicators and to begin operating the laser.

- Keyswitch controls and indicators – displays and describes exterior controls and indicators on Keyswitch-equipped v40 lasers.
- OEM controls and indicators- displays and describes exterior controls and indicators on the OEM v40 lasers.
- Initial start-up – explains how to start your v40 laser while verifying proper operation.

Keyswitch controls and indicators

The Keyswitch controls and indicators section includes subsections.

- OEM v40 front panel
- OEM v40 rear panel

OEM v40 front panel

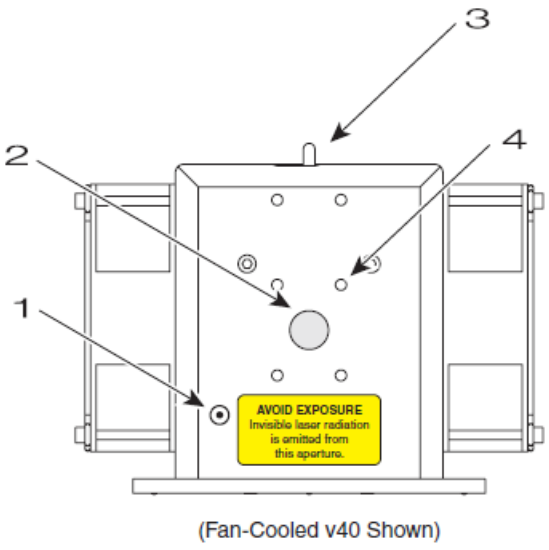


Figure 3-1 OEM v40 front panel controls and indicators.

1 DP POWER Connector – provides a convenient +5 VDC, 50 mA receptacle to power a visible red diode pointer (available from NOVANTA as an optional accessory).

2 Laser Aperture – provides an opening in the v40's front panel from which the beam exits.

3 Shutter Switch – activates a mechanical shutter that opens or closes the laser aperture. Closing the shutter also interrupts RF power to the laser. There is a five-second delay imposed from the time the shutter is opened to the time that PWM Command signals are accepted.

4 Optical Accessories Mounting – provides six threaded holes (8–32 UNC) for mounting optional beam delivery components available from NOVANTA. Because excessive weight may damage the laser, consult NOVANTA before mounting components not specifically designed as options. Refer to package outline drawings in the Technical Reference chapter for mounting hole dimensions.

Important Note: When mounting optical components to v40 lasers, the 8–32 UNC fasteners must extend no further than 0.19" (4.8 mm) into the laser's faceplate

OEM v40 rear panel

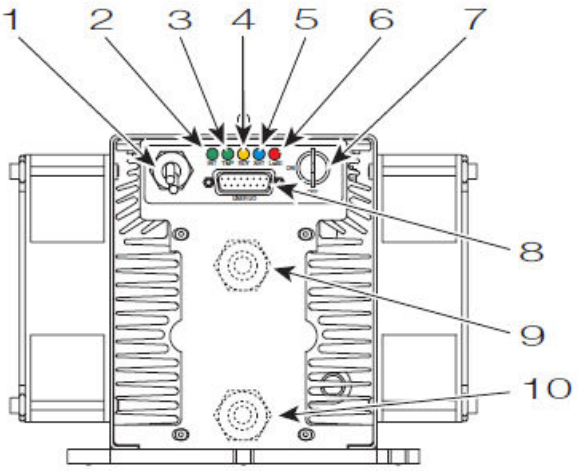


Figure 3-2 V40 OEM v40 rear panel controls and indicators.

1 1 DC Power Cables – receives 30 VDC from the DC power supply. The red (positive) cable contains a replaceable 25A in-line fuse.

2 INT (Remote Interlock) Indicator – illuminates green to indicate that a remote interlock circuit is closed, and that lasing may be enabled. The INT indicator is red, and lasing is disabled if the interlock input is open.

3 TMP (Temperature) Indicator – illuminates green to indicate that laser temperature is within limits and that lasing may be enabled. The TMP indicator is red, and lasing is disabled if the laser's temperature rises above safe operating limits.

4 RDY (Ready) Indicator – illuminates yellow when the laser is enabled, indicating that, after a five-second delay, lasing will begin when a PWM Command signal is applied.

5 SHT (Shutter) Indicator – illuminates blue to indicate that the shutter is Open, and that lasing may be enabled. The SHT indicator is off, and lasing is disabled if the shutter is Closed. When the shutter is switched Open, there is a five-second delay until PWM inputs are recognized.

6 LASE Indicator – illuminates red to indicate that 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.

7 Keyswitch – enables/disables operation of the laser. The laser is enabled when the Keyswitch is turned to the ON position. Turn the Keyswitch OFF to disable lasing.

8 USER I/O Connector – provides a connection point for auxiliary output power as well as input and output signals. Refer to the Technical Reference chapter for pinouts and signal descriptions.

9 WATER IN Port (water-cooled only) – labeled IN, this connection provides the cooling water inlet to 's water-cooling system.

10 WATER OUT Port (water-cooled only) – labeled OUT, this connection provides the cooling water outlet from 's water-cooling system.

OEM controls and indicators

OEM v40 side panel (SAB models)

(Air-Cooled v40 OEM Shown)

Figure 3-3 OEM v40 side panel controls and indicators

1 DB-9 connector – provides a Shutter Switch input as well as auxiliary +5 and +24 VDC outputs. See DB-9 connections in the Technical Reference chapter for connection details.

Initial start-up

The Initial start-up section includes subsections:

- With a UC-2000 Controller
- Without a UC-2000 Controller

Warning: Serious Personal Injury

On v40 OEM lasers, remote interlock (INT) faults are not latched. Clearing the fault condition re-enables the RDY indicator and the laser will fire after the five-second delay provided that the SHT indicator is lit and a PWM Command signal is applied. Because exposure to 10.6 µm CO2 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.

Caution: Possible Equipment Damage

Because of their smaller beam diameter, v40 lasers have significantly higher power densities than previous NOVANTA lasers. This means that even a small amount of contamination on the laser's output coupler can absorb enough energy to damage the optic. Inspect the output coupler periodically for signs of contaminants and carefully clean as required. In dirty environments, purge the output coupler using filtered air or nitrogen to prevent vapors and debris from accumulating on the optical surface.

With a UC-2000 Controller

Before your v40 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.

Danger: Serious Personal Injury

This Class IV laser product emits invisible infrared laser radiation in the 10.6 µm CO2 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.

Initial start-up (continued)

Important Note: When performing the initial start-up sequence, you must first connect the Quick Start Plug or you must provide the required Remote Interlock and Shutter Open Request signals to the User I/O connector. See User I/O connections in the Technical Reference chapter for User I/O pinouts and signal descriptions.

Starting auxiliary equipment

1. Ensure that all personnel in the area are wearing protective eyewear.
2. Place a beam block 24" (61 cm) from the laser aperture to prevent the beam from traveling beyond the work area.
3. On water-cooled systems, turn on the chiller (set between 18 °C–22 °C) and verify it is delivering 1.0 GPM (3.8 lpm) at less than 60 PSI (4.1 bar) of pressure. Examine all cooling connections carefully for leaks.

Caution: Possible Equipment Damage

Inlet cooling water temperature must always be maintained above the dew point to prevent condensation and water damage to your v40 laser.

Important 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.

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.
5. Verify that the laser's Keyswitch (if equipped) is in the OFF position.
6. Turn on the DC power supply.

If the Quick Start Plug is installed, the INT (Remote Interlock) indicator will illuminate green and the SHT (Shutter) indicator will illuminate blue—if the manual Shutter Switch is Open. The TMP (Temperature) indicator will illuminate green if laser temperature is within safe operating limits.

Starting your v40 laser

Important Note: RDY and SHT LEDs denote separate control functions. Although the RDY lamp may light while the SHT LED is Off (Shutter Switch Closed or Shutter Open Request signal missing), no power is applied to the RF boards until both RDY and SHT indicators are illuminated.

1. If the laser has a Diode Pointer installed, remove its aperture dust cover.

2 Place the Shutter Switch (if equipped) in the Open position. The blue SHT (Shutter) indicator will
3 illuminate.
4 Rotate the Keyswitch (if equipped) to the ON position. Verify that the yellow RDY (Ready) lamp illuminates.

Important Note: Each time an OEM laser is powered up or a Keyswitch version is cycled OFF/ON, a five-second delay occurs between the time that RDY and/or SHT indicators illuminate and v40 is permitted to lase.

Warning: Serious Personal Injury

Because of phase differences, external tickle pulses may combine with the internally generated tickle signal causing the LASE LED to flicker during the transition from tickle to lasing. Laser output may occur if the Lase LED flickers.

Important Note: For remote operation (Keyswitch lasers), it is possible to set the Keyswitch to the ON position and use the Remote Reset/Start Request signal (on the User I/O connector) as a remote keyswitch, similar to other NOVANTA laser models.

5 Press the UC-2000's Lase On/Off button. The Lase indicator on the UC-2000 should illuminate.
6 Use the PWM Adj Knob on the UC-2000 to slowly increase power. The LASE LED turns red when PWM signal pulses are long enough to produce laser output (typically 5–10 µs at 5 kHz). The spot where the beam hits the beam block increases in brightness to indicate increased power output.
7 Press the UC-2000's Lase On/Off button to stop lasing. Lase indicators on the UC-2000 and the laser should both turn off.
8 Place 's Shutter Switch (if equipped) in the Closed position.
9 On water-cooled v40 lasers, shut off the chiller or otherwise stop coolant flow through the laser.

Caution: Possible Equipment Damage

Do not flow coolant through the laser for an extended period of time when the laser is shutdown. This causes condensation to form inside the laser which may result in catastrophic damage to internal optics and electronic circuits.

If your v40 laser fails to lase, refer to Troubleshooting in the Maintenance/Troubleshooting chapter for troubleshooting information.

Without a UC-2000 Controller

If you have chosen not to use a UC-2000 to control the laser, follow the procedure below to verify the laser's functionality. Although a tickle signal is not required, you will need to provide PWM Command signals to 's User I/O connector. Refer to User I/O connections in the Technical Reference chapter for connector pinouts and refer to Controlling laser power in the Technical Reference chapter for Command signal descriptions.

Danger: Serious Personal Injury

This Class IV laser product emits invisible infrared laser radiation in the 10.6 µm CO2 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.

Important Note: When performing the initial start-up sequence, you must first connect the Quick Start Plug or you must provide the required Remote Interlock and Shutter Open Request signals to the User I/O connector. See User I/O connections in the Technical Reference chapter for User I/O pinouts and signal descriptions.

Starting auxiliary equipment

1. 1 Ensure that all personnel in the area are wearing protective eyewear.
2. Place a beam block 24" (61 cm) from the laser aperture to prevent the beam from traveling beyond the work area.
3. Connect the output of your PWM controller to PWM Input (Pin 9) on the laser's User I/O connector and connect the ground or return of the controller to PWM Return (Pin 1).
4. Set your PWM controller to a frequency of 5 kHz at +5 VDC and ensure the controller's duty cycle is set to zero percent output (0.0%).
5. On water-cooled systems, turn on the chiller (set between 18 °C–22 °C) and verify it is delivering 1.0 GPM (3.8 lpm) at less than 60 PSI (4.1 bar) of pressure. Examine all cooling connections carefully and verify that they do not leak.

Caution: Possible Equipment Damage

Inlet cooling water temperature must always be maintained above the dew point to prevent condensation and water damage to your laser.

6. Verify that the laser's Keyswitch (if equipped) is in the OFF position, then apply DC power.

If the Quick Start Plug is installed, the INT (Remote Interlock) indicator will illuminate green and the SHT (Shutter) indicator will illuminate blue—if the manual Shutter Switch is Open. The TMP (Temperature) indicator will illuminate green if laser temperature is within safe operating limits.

Starting your v40 laser

v40 RDY and SHT LEDs denote separate control functions. Although the RDY lamp may light while the SHT LED is Off (Shutter Switch Closed or Shutter Open Request signal missing), no power is applied to the RF boards until both RDY and SHT indicators are illuminated.

1. If the laser has a Diode Pointer installed, remove its aperture dust cover.
2. Place the Shutter Switch (if equipped) in the Open position. The blue SHT (Shutter) indicator will illuminate.
3. Rotate the Keyswitch (if equipped) to the ON position. Verify that the yellow RDY (Ready) indicator on the laser illuminates.

Important Note: Each time an OEM laser is powered up or a Keyswitch version is cycled OFF/ON, a five-second delay occurs between the time that RDY and/or SHT indicators illuminate and is permitted to lase.

For remote operation (Keyswitch lasers), it is possible to set the Keyswitch to the ON position and use the Remote Reset/Start Request signal (on the User I/O connector) as a remote keyswitch, like other NOVANTA laser models.

4. Using your PWM controller, slowly increase the duty cycle of the square wave. The LASE indicator illuminates red when PWM signal pulses are long enough to produce laser output (typically 5–10 µs at 5 kHz). The spot where the beam hits the beam block increases in brightness, indicating increased power output.

Warning: Serious Personal Injury

Because of phase differences, external tickle pulses may combine with the internally generated tickle signal causing the LASE LED to flicker during the transition from tickle to lasing. Laser output may occur if the Lase LED flickers.

5. Remove the PWM Command signal from the User I/O connector. The LASE indicator on the laser should turn off.
6. Place 's Shutter Switch (if equipped) in the Closed position.
7. On water-cooled v40 lasers, shut off the chiller or otherwise stop coolant flow through the laser.

Caution: Possible Equipment Damage

Do not flow coolant through the laser for an extended period of time when the laser is shutdown. This causes condensation to form inside the laser which may result in catastrophic damage to internal optics and electronic circuits.

Technical reference

Use information in this section as a technical reference for your v40 laser.

This section contains the following information:

- Technical overview – briefly describes 's v-Series technology and basic optical setup.
- Controlling laser power – explains various aspects of v40 control signals.
- User I/O (Input/Output) connections – describes signals and specifications for the 15-pin User I/O connector.
- DB-9 connections – describes signals and specifications for the SAB model's side-mounted DB-9 connector.
- Integrating safety features – describes how to integrate v40 safety features into your automated control system.
- v40 general specifications – provides specifications for the v40 laser.
- v40 package outline drawings – illustrates laser package and mounting dimensions for Keyswitch and OEM v40 lasers.
- Packaging instructions – illustrates how to package the v40 laser for shipment using NOVANTA-supplied packaging materials.

Technical overview

The Technical overview section includes subsections:

- Laser tube
- Optical resonator
- RF power supply
- Optical setup

Laser tube

v-Series lasers were developed using new technology patented by NOVANTA. This patented "v" technology, based on a combination of free-space and waveguide resonator designs, enables NOVANTA to economically produce a symmetrical laser beam from a small but powerful laser capable of operating for many years with virtually no maintenance. V40's unique extruded aluminum envelope offers excellent heat transfer, long gas life, and low operating costs in contrast to other laser tube technologies. Besides 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. v40 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, v40 lasers have significantly higher power densities than previous NOVANTA lasers. This means that even a small amount of 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.

The output beam, roughly circular as it exits the resonator, transitions to Gaussian-like in mid and far fields three meters and beyond. The internal structure and optics of the resonator combine to produce a Gaussian-like mode quality of TEM00 with an M2 factor ≤ 1.2. As shown in the following figure, beam waist diameter is 2.5 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).

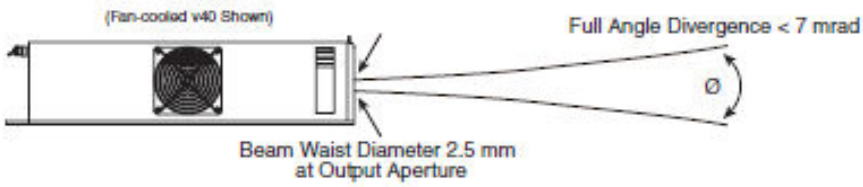


Figure 4-1 v40 beam characteristics

RF power supply

A compact, self-contained RF power supply mounted internally in the laser chassis converts 30 VDC input power into a radio frequency (RF) signal using a crystal-controlled oscillator. The 81.36 MHz RF output from the oscillator is then amplified to obtain approximately 400 watts of RF power. From the amplifier, RF power is routed to the electrode structure in the laser tube where it excites carbon dioxide (CO_2) gas in the tube to produce lasing.

Control circuit

Control circuitry built into the laser interrupts operation if any critical parameter is violated. Switches and sensors on the control board monitor various conditions and parameters that, if exceeded, pose a risk of potential damage to the laser. Additionally, laser operation is interrupted in response to the following conditions: (1) the manual Shutter Switch is closed; (2) the Shutter Open Request input signal is missing; (3) an over temperature condition occurs; (4) the coolant flow rate is too low; (5) the Remote Reset/Start Request signal is enabled; or (6) the Remote Interlock signal is missing.

Optical setup

After selecting a laser for a CO2 laser processing system, the two most important elements to consider are:

1 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.

Delivery optics

Divergence, or expansion, of the laser beam is important for materials processing since a larger beam entering the focusing optic produces a smaller focused spot. Because the laser beam diverges slowly, increasing by four diameters over one meter, this means that for optimum performance the laser should be mounted a distance of 40–60 inches (1.0–1.5 meters) away from the work area and no closer than 30 inches (0.75 meters). Right angle turning mirrors are often used in conjunction with the laser mounting position to obtain this distance. Following figure shows how right-angle turning mirrors in a “flying optics” setup create this longer beam path.

Expander/collimators are optical devices that reduce beam divergence while at the same time increasing beam diameter by a selectable magnification factor. Adding an expander/collimator to the “flying optics” setup shown above would substantially reduce beam divergence and any variance in beam diameter caused by the changing optical path length. 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.

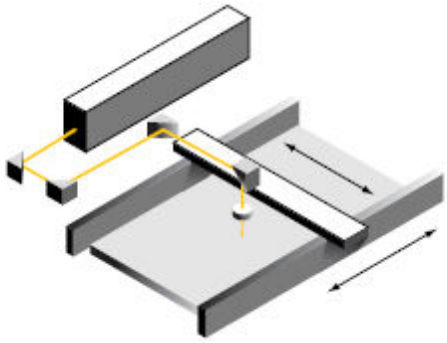


Figure 4-2 “Flying optics” beam path

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 to be processed.

Caution: Possible Equipment Damage

Small amounts of 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. Cleanliness is another important issue affecting performance; a dirty or scratched lens will under perform and exhibit a vastly shortened lifetime. When the application requires air (instead of nitrogen or argon) as an assist gas, use only 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. If compressed shop air is the only choice available, it must be filtered and dried to the specifications shown in Table 3-1.

Table 4-1 Assist gas purity specifications

Assist Gas	Specification
Air	Breathing Grade > 99.9996% purity or better
Air	Compressed- 99.9950% purity or better, water-free; oil filtered to 5 mg/m3 or better; particulate filtered to < 1.0 micron; dried to lower dew point below coolant temperature setpoint.
Nitrogen	High Purity Grade > 99.9500% purity or better

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 NOVANTA UC-2000 Universal Laser Controller to provide PWM Command signals to the v40 laser. If using an alternate method of laser control, thoroughly review this section, controlling laser power, as well as the following section, User I/O connections, for an understanding of the signal requirements necessary to control lasers. For more information about the UC-2000, please consult the UC-2000 Laser Controller Operator's Manual.

Tickle pulse

V40 lasers incorporate a built-in tickle generator, freeing customers from the need to supply tickle pulses between lasing commands. In cases where a 5 kHz, 1 µs tickle pulse is still sent to the laser via a

UC-2000 or other PWM controller, is ignored until the pulse width exceeds approximately 4 microseconds (µs), at which point lasing occurs.

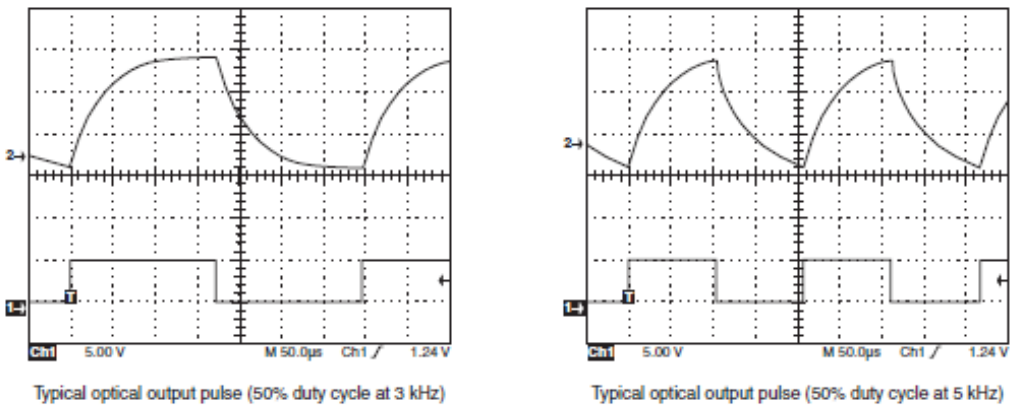
> **Warning: Serious Personal Injury**
>
> Because of phase differences, external tickle pulses may combine with the internally generated tickle signal causing the LASE LED to flicker during the transition from tickle to lasing. Laser output may occur if the Lase LED flickers.

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.

Pulse Width Modulation (PWM)

Pulse Width Modulation, or PWM, controls laser power by varying the duty cycle of '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 ~100 µs; however, the laser cannot precisely follow PWM input signals if the "On" pulse is less than 100 µs in duration. At a constant 50% duty cycle, v-Series 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). Following figure shows representative v40 optical output waveforms at two different PWM frequencies.

Controlling laser power



Typical optical output pulse (50% duty cycle at 3 kHz)

Typical optical output pulse (50% duty cycle at 5 kHz)

Figure 4-3 Representative v40 waveforms

v40 lasers are designed to operate at Command signal base frequencies up to 25 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. When considering Command frequencies at 5 kHz or below, please review Marking/engraving operation later in this section. 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 25 kHz maximum. At 25 kHz, the laser's optical beam response no longer follows the Command input and is very nearly a DC value with just a small amount of ripple present.

Command signal

Warning: Serious Personal Injury

Always use shielded cable when connecting your PWM Command signal source to PWM Input / PWM Return inputs. In electrically 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 9, PWM Input, and Pin 1, PWM Return, of the User I/O connector on the v40 laser 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 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 microseconds (µs). Maximum PWM frequency is 25 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 µs and low for 100 µs, it has a 50% duty cycle; if the amplitude is high for 190 µs and low for 10 µs, it has a 95% duty cycle. Figure below illustrates PWM Command signal parameters while the following table lists PWM signal specifications.

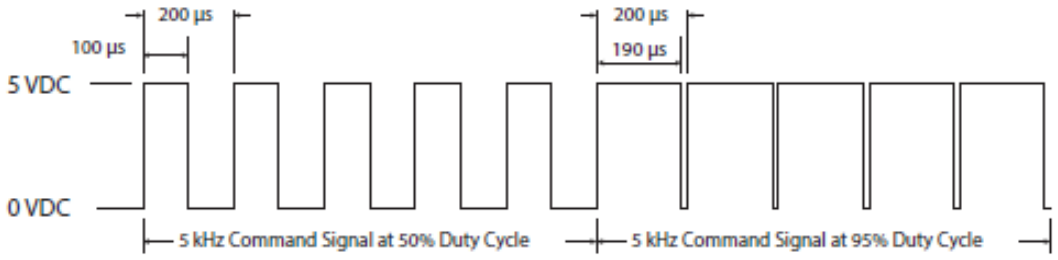


Figure 4-4 PWM Command signal waveform

V40's User I/O PWM input consists of a high-speed PWM input LED with a forward voltage drop (Vf) of 1.5 VDC. The PWM input frequency can range from DC (0 Hz) to 25 kHz. Table 4-2 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 (3 mA)	+5.0 VDC	+6.7 VDC (10 mA), continuous
Frequency Range	0 Hz (DC)	5 kHz	25 kHz
Duty Cycle	0%	— —	100%

Operating modes

External control

In addition to controlling your laser using a UC-2000 Controller, control of 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 a function generator capable of sending PWM pulses at the proper time (gating) and with the proper duty cycle (power).

Analog voltage or current control

Although v40 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 gating and power.

To generate the correct analog voltage 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.

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 will prevent this behavior from occurring.

To operate the laser in CW mode, apply a constant +5 VDC signal to Pin 9, PWM Input, and Pin 1, PWM Return, on the User I/O connector. This constant voltage source forces the internal switching electronics to remain on, providing continuous and uninterrupted laser output power. During CW operation, output power cannot be changed. To adjust output power, refer back to the Pulse width modulation (PWM) section for information about high frequency operation

Important Note: NOVANTA 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. Continuous operation at 99% duty cycle may lead to thermal instability and optical degradation.

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 Universal Laser Controller.

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 input locks the beam off.

Many CO2 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 CO2 gas) is more efficient than a hotter one. The overshoot effect is more pronounced at lower gating frequencies since the gas has a longer time to cool down between Command signal pulses.

Marking/engraving operation

When the delay between the end of one PWM Command signal pulse and the beginning of the next PWM pulse exceeds 200 microseconds (less than or equal to 5 kHz), 's on-board tickle generator sends a tickle pulse to maintain plasma ionization in the tube. Because the on-board tickle generator cannot anticipate when the next PWM Command pulse will arrive, the tickle pulse (which typically lasts for 2–6 µs depending on the laser) can effectively merge with a PWM signal that follows closely afterwards. When the PWM pulse that follows is short, causing the tickle pulse to become a significant fraction of the PWM pulse duration, then the tickle pulse effectively substantially increases the length of the PWM pulse

it has merged with. For subtle marking applications on sensitive, low threshold materials this lengthened PWM pulse may affect mark quality.

While this situation can occur when using PWM Command signal frequencies of 5 kHz and less, it is important to note that it isn't the Command signal frequency itself that is the determining factor but rather this behavior happens only when the off time between PWM pulses exceeds 200 microseconds.

User I/O connections

The User I/O connections section includes subsections:

- User I/O connection summary
- Input/output signals
- Sample I/O circuits

User I/O connection summary

Table below provides a quick reference summary for v40 User I/O connections.

Table 4-3 User I/O pin descriptions

Pin	Function	Description
1	PWM Return	Use this input pin to provide the return side of the PWM Command signal.
2	Remote Reset/Start Request	Apply a positive or negative voltage (±5–24 VDC) with respect to Pin 11, Input Common, to disable the laser. The laser remains disabled while voltage is applied to this pin. Removing voltage from the Remote Reset/Start Request pin causes the laser's RDY indicator to illuminate and begins a five-second countdown after which lasing is enabled.
3	Remote Interlock	Apply a positive or negative voltage (±5–24 VDC) with respect to Pin 11, Input Common, to enable lasing. If your system does not use remote interlock, this pin must be connected to a voltage source in the range of ±5–24 VDC. Refer to Figure 3-7 for a diagram showing how the Remote Interlock input is factory-jumpered.
4	+ 5 VDC Auxiliary Power	This connection provides +5 VDC for driving external inputs or outputs. The +5 VDC Auxiliary Power output can source up to 0.5 A and is protected by a 0.5 A self-resetting fuse. The return (ground) path must be through Pin 12, Auxiliary DC Power Ground.
5	+ 24 VDC Auxiliary Power	This connection provides +24 VDC for driving external inputs or outputs. The +24 VDC Auxiliary Power output can source up to 0.5 A and is protected by a 0.5 A self-resetting fuse. The return (ground) path must be through Pin 12, Auxiliary DC Power Ground.
6	Laser Active	This bi-directional switched output is internally connected to Pin 13, Output Common, when the laser is actively lasing (LASE indicator illuminated red). This output is open (high impedance) when no beam is being emitted (LASE indicator Off).
7	Over Temperature	This bi-directional switched output is internally connected to Pin 13, Output Common, when laser temperature is above safe operating limits (TMP indicator illuminated red). The output is open (high impedance) when laser temperature is within operating limits (TMP indicator green).

Table 4-3 User I/O pin descriptions (continued)

Pin	Function	Description
8	Laser Ready	This bi-directional switched output is internally connected to Pin 13, Output Common, when the laser is enabled (RDY indicator illuminated yellow), indicating that lasing will occur when a PWM Command signal is applied to Pin 9 and Pin 1. When this output is initially switched closed, there is a five-second delay during which lasing is inhibited. This output is open (high impedance) when the laser is disabled (RDY indicator Off).
9	PWM Input	Connect your PWM Command signal (+5 VDC, 5 kHz nominal, 25 kHz max, pulse width modulated) to this input pin to control laser output power. Refer back to Controlling laser power for further information on laser control signals.
10	Shutter Open Request	Apply a positive or negative voltage (±5–24 VDC) with respect to Pin 11, Input Common, to enable lasing. If your system does not supply a Shutter Open Request signal, this pin must be connected to a voltage source in the range of ±5–24 VDC. Refer to Figure 3-7 for a diagram showing how the Shutter Open Request input is factory-jumpered. When a voltage is initially applied to this input, there is a five-second delay during which lasing is inhibited.
11	Input Common	Use this input pin to connect return lines for Remote Interlock, Shutter Open Request, and Remote Reset/Start Request lines.
12	Auxiliary DC Power Ground	This connection provides a ground (earth) connection for +5 and +24 VDC auxiliary power outputs. This pin is the only User I/O pin that is connected to chassis ground. Do not use this pin for grounding if DC power to external I/O circuits is supplied from an external customer-supplied DC power source.
13	Output Common	Use this pin to complete the return path for output connections (Pin 6, 7, 8, 14, or 15). The Output Common line is protected by a 0.25 A self-resetting fuse.
14	Shutter Open	This bi-directional switched output is internally connected to Pin 13, Output Common, when a Shutter Open Request signal is present (SHT indicator illuminated blue), indicating that lasing may be enabled if other operating conditions are met. When this output is initially switched closed, there is a five-second delay during which lasing is inhibited. This output is open (high impedance) when the laser is disabled (SHT indicator Off).
15	Interlock Open	This bi-directional switched output is internally connected to Pin 13, Output Common, when remote interlock circuitry is open (INT indicator illuminated red), indicating that lasing is disabled. The output is open (high impedance) when lasing is enabled (INT indicator green).

Input/output signals

V40's input/output signals are divided into three categories: auxiliary DC power, input signals, and output signals. Signals in each category are fully described in the section below. Figure below illustrates the pin arrangement of the User I/O (15-pin female D-type subminiature) connector on v40 's rear panel.

Important Note: See DB-9 connections later in this section for signal descriptions and pinouts of the SAB model's side-mounted DB-9 connector.

Caution: Possible Equipment Damage

Turn off DC power before installing or removing any plug or cable from the User I/O 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.

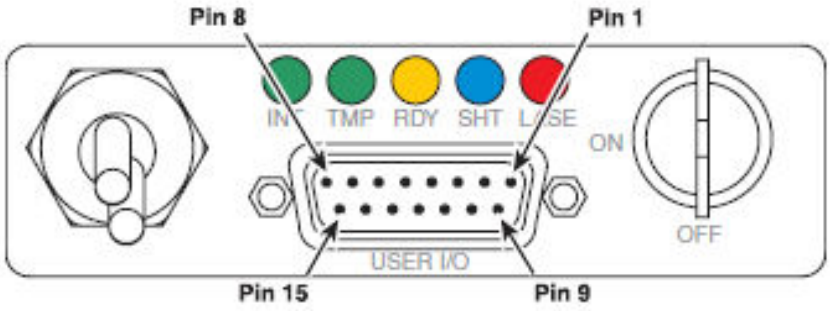


Figure 4-5 User I/O connector pinouts

Auxiliary DC power

V40's User I/O connector provides auxiliary DC power for driving external inputs or outputs connected to the User I/O port. Pin 4, +5 VDC Auxiliary Power, and Pin 5, +24 VDC Auxiliary Power, are protected by self-resetting fuses rated at 0.5 A. Pin 12, Auxiliary DC Power Ground, is connected to chassis ground while all other User I/O pins are floating with respect to chassis ground. Figure below illustrates 's internal DC supply wiring.

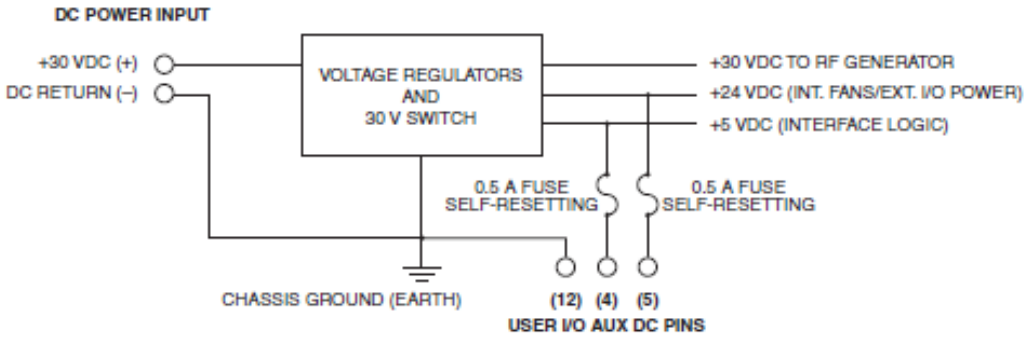


Figure 4-6 Auxiliary power supply wiring

Pin 4 + 5 VDC Auxiliary Power

This connection provides +5 VDC for driving external inputs or outputs. The + 5 VDC Auxiliary Power output can source up to 0.5 A and is protected by a 0.5 A self-resetting fuse. The return (ground) path must be through Pin 12, Auxiliary DC Power Ground.

Pin 5 + 24 VDC Auxiliary Power

This connection provides +24 VDC for driving external inputs or outputs. The + 24 VDC Auxiliary Power output can source up to 0.5 A and is protected by a 0.5 A self-resetting fuse. The return (ground) path must be through Pin 12, Auxiliary DC Power Ground.

Pin 12 Auxiliary DC Power Ground

This connection provides a ground (earth) connection for +5 and +24 VDC auxiliary power outputs. This pin is the only User I/O pin that is connected to the laser's chassis ground. Do not use this pin for grounding if I/O circuits are powered from an external customer-supplied DC power source.

Input signals

A total of four user inputs allow control of v40 lasers. Remote Interlock, Shutter Open Request, and Remote Reset/Start Request inputs are optoisolated and bi-directional, allowing for positive or negative polarity signal inputs. These three signals also share a common return connection, Input Common, which is separate from chassis ground to completely isolate control signals for optimal EMI performance. The fourth input, PWM Input, is optoisolated and has a separate return, PWM Return, to fully isolate PWM signals from the other three user inputs. Note that throughout this manual, input voltage levels are specified with respect to their corresponding return line.

Pin 1 PWM Return

Connect the return side of your PWM Command signal to this pin. Refer to the following table for input circuit specifications.

Pin 2 Remote Reset/Start Request

Apply a positive or negative voltage (±5–24 VDC) with respect to Pin 11, Input Common, to disable the laser. The laser remains disabled while voltage is applied to this pin. Removing voltage from the Remote Reset/Start Request pin causes the laser's RDY indicator to illuminate and begins a five-second countdown after which lasing is enabled. Because all DC power is removed from the laser's RF board when this input is active, no lasing can occur until voltage is removed from Pin 2. Refer to Table 3-4 for input circuit specifications.

Important Note: Note: To prevent operator injury when using Keyswitch-equipped lasers, the Remote Reset/Start Request signal is ignored when the Keyswitch is set to the OFF position. The manually operated Keyswitch must be set to the ON position before the laser can be reset or started from a remote location.

Pin 3 Remote Interlock

Apply a positive or negative voltage (±5–24 VDC) with respect to Pin 11, Input Common, to enable lasing. If your system does not use a remote interlock, this pin must be connected to a voltage source in the range of ±5–24 VDC. Refer to Figure 3-7 for a diagram showing how the Remote Interlock input is factory-jumpered. Because all DC power is removed from the laser's RF board when this input is inactive, no lasing can occur until voltage is applied to Pin 3. Refer to Table 3-4 for input circuit specifications.

On OEM lasers, the Remote Interlock input is not latched. Re-applying a signal to Pin 3 enables the RDY indicator and lasing is possible after the five-second delay, provided that the Shutter Open Request signal is also present (SHT indicator illuminated).

Pin 9 PWM Input

Connect your PWM Command signal (+5 VDC, 5 kHz nominal, 25 kHz max) to Pin 9. This pulse width modulated Command signal controls laser output so that a duty cycle of 50% corresponds to a laser output of approximately one-half rated output power and a duty cycle of 95% corresponds to approximately full output power. Refer to Controlling laser power in this chapter for further information on laser control signals. Connect the PWM signal source return to Pin 1, PWM Return. See the following table for input circuit specifications.

Pin 10 Shutter Open Request

Apply a positive or negative voltage (±5–24 VDC) with respect to Pin 11, Input Common, to enable lasing. If your system does not supply a Shutter Open Request signal, this pin must be connected to a voltage source in the range of ±5–24 VDC. Refer to the figure below for a diagram showing how the Shutter Open Request input is factory-jumpered. When a voltage is initially applied to this input, there is a five-second delay during which lasing is inhibited. Because all DC power is removed from the laser's RF board when this input is inactive, no lasing can occur until voltage is applied to Pin 10. See the following table for input circuit specifications.

Important Note: To ensure optimum laser performance, there is a five-second delay imposed from the time a Shutter Open Request occurs to the time that PWM Command signals are accepted.

Pin 11 Input Common

Use this pin to connect return lines for Remote Interlock, Shutter Open Request, and Remote Reset/Start Request lines. Refer to the following table for input circuit specifications.

Figure below illustrates how Remote Interlock and Shutter Open Request inputs are factory-jumpered on the Quick Start Plug to enable lasing for initial testing and troubleshooting purposes.

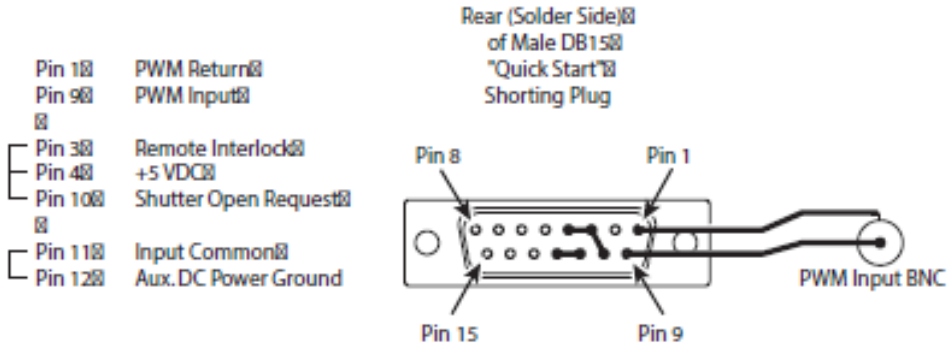


Figure 4-7 Quick Start Plug wiring diagram

The figure on the following page illustrates the input circuit's equivalent internal schematic while Table 3-4 provides v40 input circuit specifications.

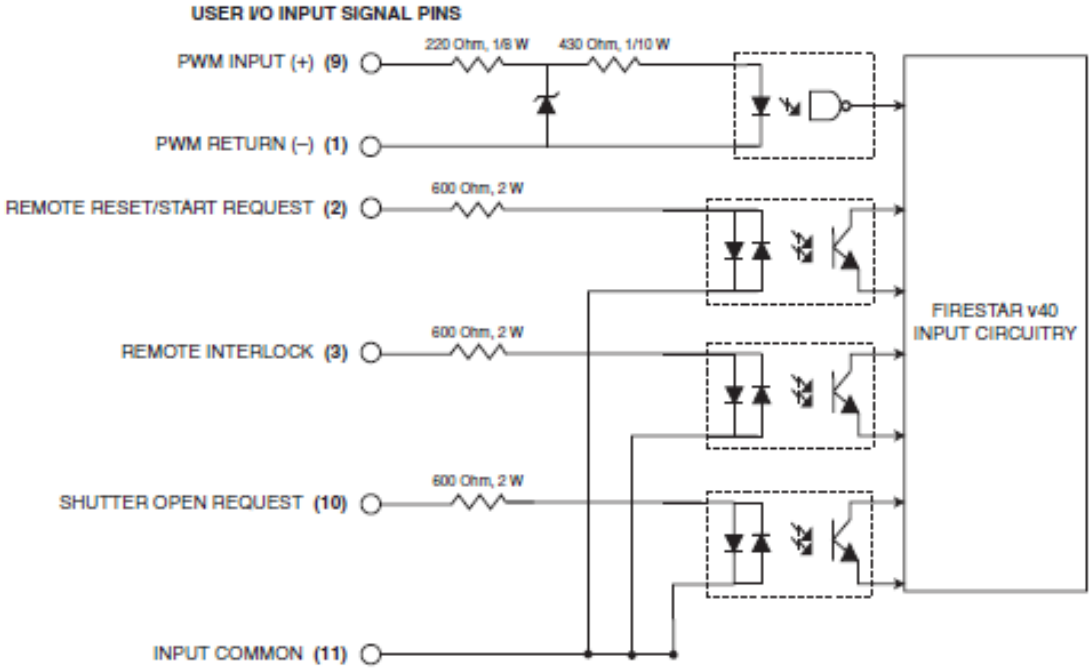


Figure 4-8 Input equivalent schematic

Table 4-4 Input circuit specifications

Input Signal Name	Input Device Type and Specifications
PWM Input	High-speed optoisolator LED (forward voltage drop (Vf) 1.5 VDC) Off state Vmax +0.8 VDC On state Vmin +3.5 VDC @ 3 mA On state (continuous) Vmax +6.7 VDC @ 10 mA Frequency, max. 25 kHz
Remote Reset/Start Request Remote Interlock Shutter Open Request	Bi-directional optoisolator LED (Vf = 1.15 VDC) Off state Vmax < 1.0 VDC On state Vmin ±5.0 VDC @ 7 mA On state (continuous) Vmax ±24.0 VDC @ 40 mA

Note: The Remote Reset/Start Request input must not be sent until Firestar's +5 VDC power supply has stabilized (approximately 200 ms after DC power-up).

Output signals

V40's five user outputs correspond to the status functions described below. Outputs are optoisolated, bi-directional analog switches that allow for high-side or low-side switching. The shared connection, Output Common, is separate from the laser's chassis ground to allow for high-side or low-side switching and to isolate control signals for optimum EMI performance.

V40's optically-isolated outputs are useful for sending laser status to a Programmable Logic Controller (PLC) or computerized control system. Each of the five outputs can source 50 mA at ±24 VDC maximum for a total load of 250 mA. For controlling larger loads, use these outputs to drive a control relay.

Important Note: v40 Laser Ready and Shutter Open output signals denote separate control functions within the laser. Although the Laser Ready output (RDY indicator On) may close while the Shutter Open output is open (SHT LED Off), no power is applied to the RF boards until both Laser Ready and Shutter Open outputs are closed (RDY and SHT indicators illuminated).

Pin 6 Laser Active

This bi-directional switched output is internally connected to Pin 13, Output Common, when the laser is actively lasing (LASE indicator red). This output is open (high impedance) when no beam is being emitted (LASE indicator Off). Refer to Table 3-5 for output circuit specifications.

Pin 7 Over Temperature

This bi-directional switched output is internally connected to Pin 13, Output Common, when laser temperature is above safe operating limits (TMP indicator red). The output is open (high impedance) when laser temperature is within operating limits (TMP indicator green). After an over temperature fault occurs, cool the laser and then cycle DC power to reset the laser. Refer to Table 3-5 for output circuit specifications.

Pin 8 Laser Ready

This bi-directional switched output is internally connected to Pin 13, Output Common, when the laser is enabled (RDY indicator yellow), indicating that lasing will occur when a PWM Command signal is applied to Pin 9 and Pin 1. When this output is initially switched closed, there is a five-second delay during which lasing is inhibited. This output is open (high impedance) when the laser is disabled (RDY indicator Off). Refer to Table 3-5 for output circuit specifications.

Pin 13 Output Common

Use this pin to complete the return (ground) path for any output connection (Pin 6, 7, 8, 14, or 15). The Output Common line is protected by a 0.25 A self-resetting fuse.

Pin 14 Shutter Open

This bi-directional switched output is internally connected to Pin 13, Output Common, when a Shutter Open Request signal is present (SHT indicator blue), indicating that lasing may be enabled if other operating conditions are met. When this output is initially switched closed, there is a five-second delay during which lasing is inhibited. This output is open (high impedance) when the laser is disabled (SHT indicator Off) Refer to the following table for output circuit specifications.

Pin 15 Interlock Open

This bi-directional switched output is internally connected to Pin 13, Output Common, when remote interlock circuitry is open (INT indicator red), indicating that lasing is disabled. The out-

put is open (high impedance) when lasing is enabled (INT indicator green). See the following table for output circuit specifications.

Figure below illustrates the output circuit's equivalent internal schematic and the following table provides v40 output circuit specifications.

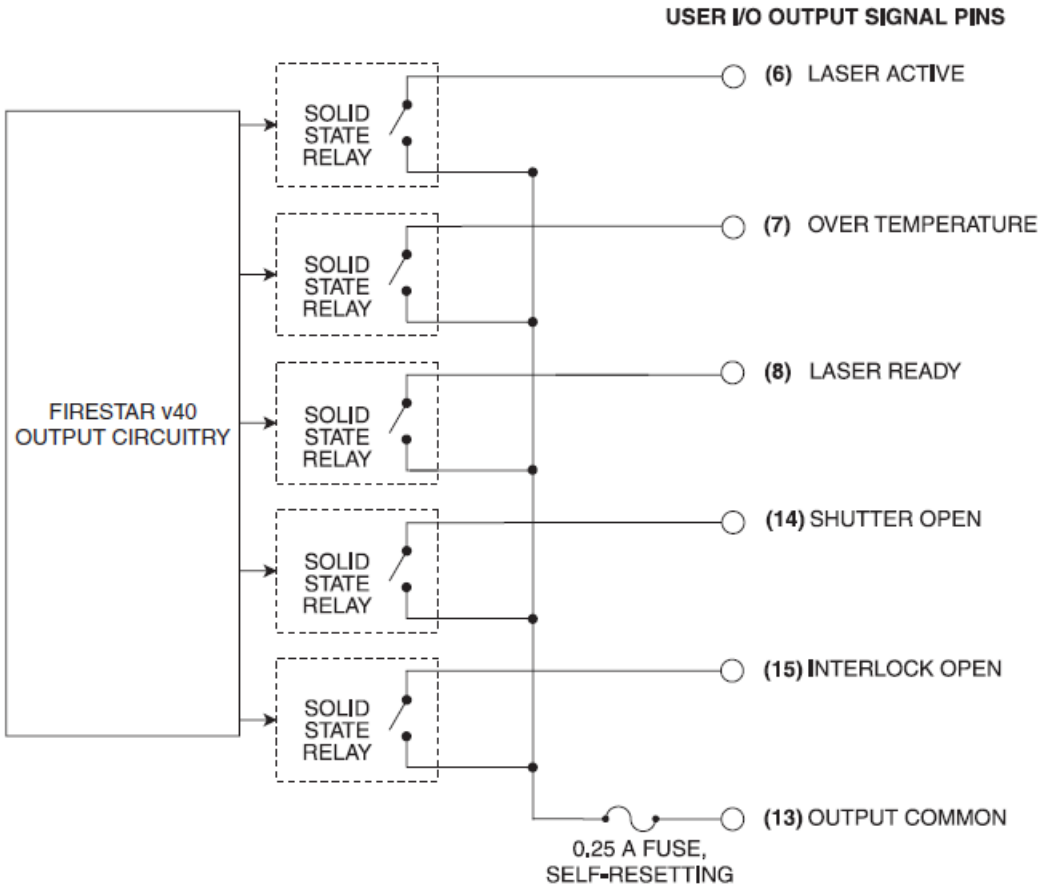


Figure 4-9 Output equivalent schematic

Table 4-5 Output circuit specifications

Output Device	Specifications
Bi-directional CMOS	20 Ohms Rdson 10 MOhms Off Voltage ±24 VDC, max. Current 50 mA, max.

Sample I/O circuits

Sample inputs

Figure below illustrates one method of supplying a Remote Interlock signal using a customer-supplied limit switch. v40's +24 VDC Auxiliary Power output powers the circuit. Note that Pin 4, +5 VDC Auxiliary Power, could have been used instead, depending on circuit voltage requirements.

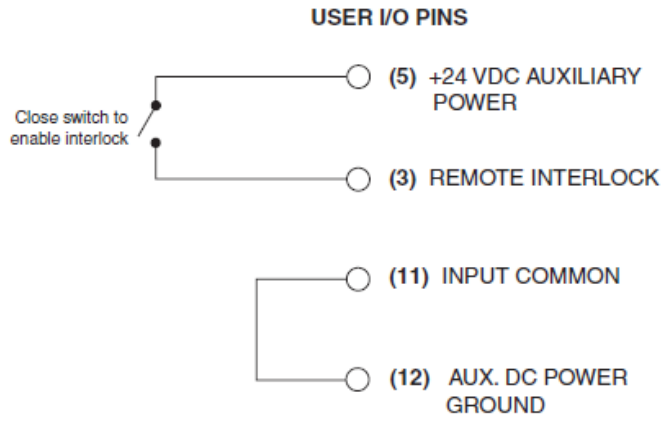


Figure 4-10 Customer-supplied interlock

Figure below shows another variation for supplying a Remote Interlock signal to the laser. In this case, the customer is using a limit switch and supplying a negative voltage to drive 's input circuit.

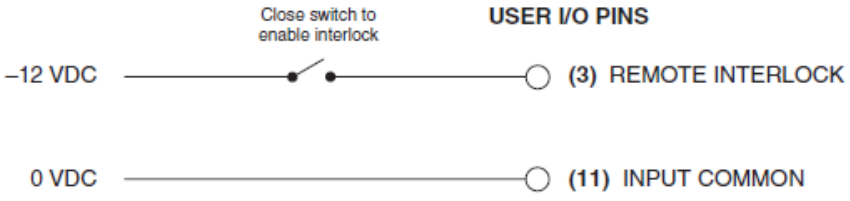


Figure 4-11 Customer-supplied interlock, negative voltage

A Programmable Logic Controller (PLC) can also drive inputs. Figure below shows a typical method for connecting to a PLC output module when only one input is used.

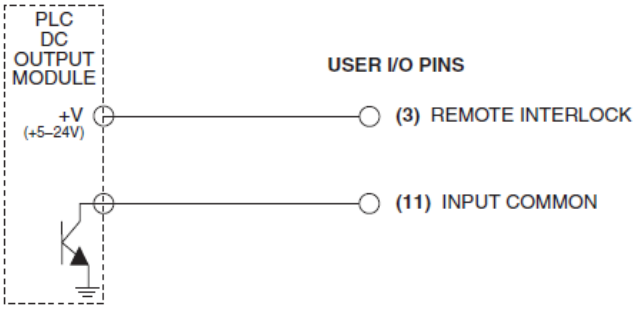


Figure 4-12 PLC driven interlock signal

When multiple PLC outputs are required, connect inputs to the PLC as shown in Figure below. By supplying voltage (+VDC) to Pin 11, Input Common, and pulling individual inputs to ground, each input can be independently activated by the PLC's output module.

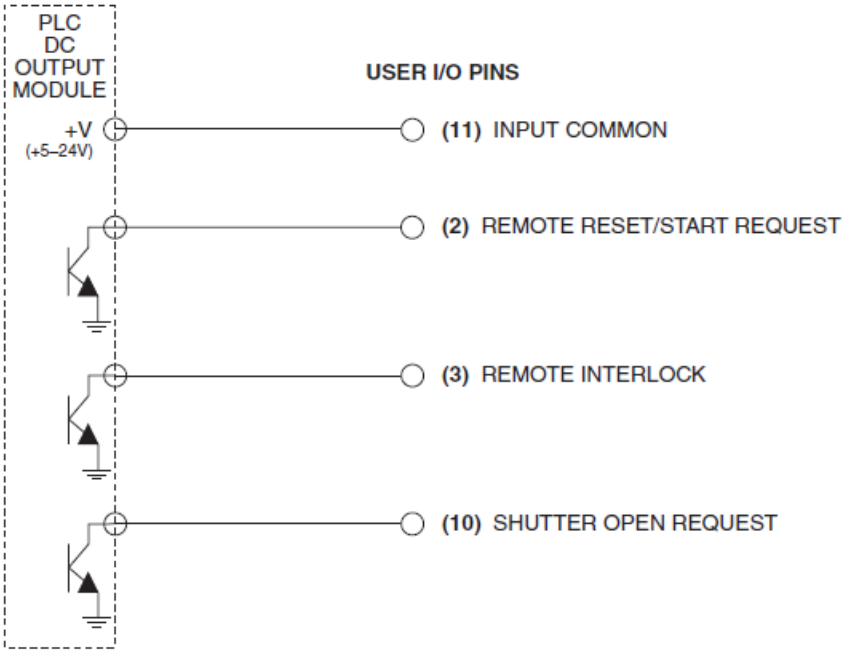


Figure 4-13 Multiple PLC driven inputs

Sample outputs

's optoisolated bi-directional switched outputs can drive small loads (50 mA max), PLC inputs, or relays that can control higher current loads. Figure below illustrates one method of controlling a remote warning lamp using power supplied by 's +24 VDC Auxiliary Power output. Remember to size current-limiting resistor, R1, so that the current draw does not exceed 50 mA.

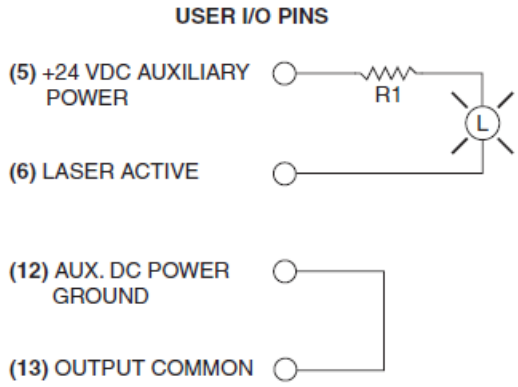


Figure 4-14 output driving warning lamp

Figure below illustrates a method for controlling a higher voltage, higher current load by using a 24 V control relay. Ensure that the relay coil's pull-in current does not exceed 50 mA. A diode or surge suppressor must be installed across the relay coil to prevent voltage spikes from damaging outputs.

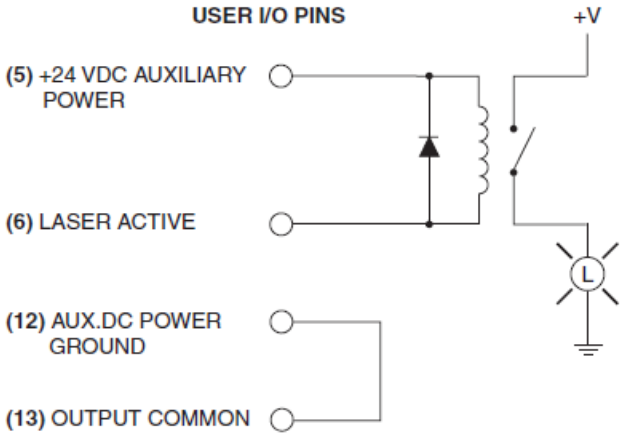


Figure 4-15 output driving relay

Figure below illustrates how 's outputs can drive the DC Input Module of a Programmable Logic Controller (PLC). By supplying voltage (+VDC) to Pin 13, Output Common, each output is independently switched to activate individual PLC inputs.

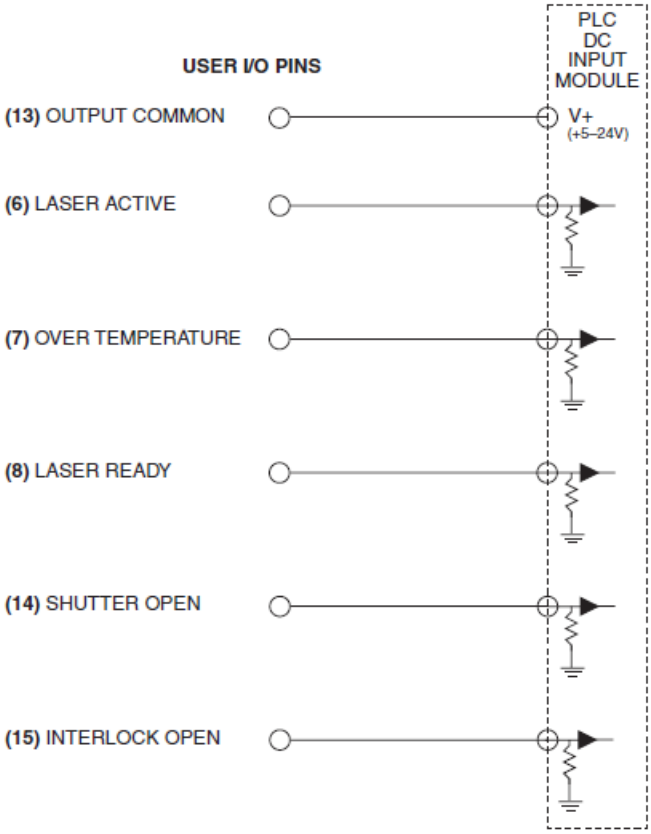


Figure 4-16 output driving PLC input module

DB-9 connections (SAB models only)

The side-mounted DB-9 connector on SAB model lasers provides a Shutter Switch input as well as auxiliary +5 and +24 VDC power. Figure below illustrates DB-9 pinouts.

Caution: Possible Equipment Damage

+5 VDC (Pin 9) and +24 VDC (Pin 4 and Pin 5) voltage outputs are not fused or electrically protected. Do not short these pins; the control board will be damaged.

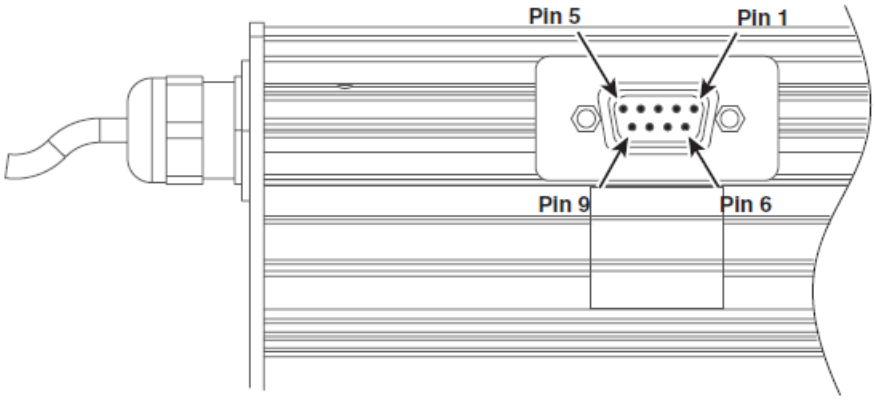


Figure 4-17 DB-9 connector pinouts

Table below describes the function of each pin on the DB-9 connector.

Table 4-6 Side-mounted DB-9 pin descriptions

Pin	Function	Description
1	No Connection	
2	No Connection	
3	DC Power Ground	This connection provides a return (ground) connection for Pin 4 and Pin 5 (+24 VDC Fan Power), and Pin 9 (+5 VDC Auxiliary Power). This pin is the only DB-9 pin connected to chassis ground. Do not use this pin if DC power is supplied from an external customer-supplied DC power source.
4	+ 24 VDC Fan Power	This output provides +24 VDC for driving a customer-supplied cooling fan. The +24 VDC Fan Power output (Pin 4) can source up to 0.75 A max. This pin is not protected or fused; the control board will be damaged if this pin is inadvertently shorted. The return (ground) path must be through Pin 3, DC Power Ground.

Table 4-6 Side-mounted DB-9 pin descriptions (continued)

Pin	Function	Description
5	+ 24 VDC Fan Power	This output provides +24 VDC for driving a customer-supplied cooling fan. The +24 VDC Fan Power output (Pin 5) can source up to 0.75 A max. This pin is not protected or fused; the control board will be damaged if this pin is inadvertently shorted. The return (ground) path must be through Pin 3, DC Power Ground.
6	No Connection	
7	No Connection	
8	Shutter Switch	In Keyswitch models, this input connects to the physical Shutter Switch. Leave this input open to enable lasing. Grounding this pin indicates that the shutter is Closed, which disables lasing. If connecting an external shutter switch to Pin 8, the circuit path must be grounded to Pin 3, DC Power Ground. There is a five-second delay imposed from the time the shutter input is opened to the time that PWM Command signals are accepted.
9	+ 5 VDC Auxiliary Power	This output provides +5 VDC for driving external inputs or outputs. The +5 VDC Auxiliary Power output (Pin 9) can source up to 0.5 A max. This pin is not protected or fused; the control board will be damaged if this pin is inadvertently shorted. The return (ground) path must be through Pin 3, DC Power Ground.

Integrating safety features

The Integrating safety features section includes subsections:

- Keyswitch functions
- Shutter functions
- Remote Interlock functions

V40's User I/O connector allows system integrators or end-users to integrate safety features into their control system. V40's keyswitch, shutter, and remote interlock functions serve to enable or disable DC power to v40's RF drive. Without power, the RF driver cannot supply PWM Command or tickle signals to the resonator, causing the CO2 gas to remain in a zero-energy state. V40 status indicators provide users with a quick visual indication of the laser's operational status. All power to the RF board is removed whenever RDY or SHT indicators are Off. (Laser Ready or Shutter Open outputs open).

Keyswitch functions

Keyswitch lasers

After DC power-up or after a remote interlock fault, the Keyswitch must be toggled to reset the laser and enable the RDY LED, signaling that DC power is applied to the RF driver. Over temperature faults are reset by removing, then reapplying DC power after the laser has cooled.

For Keyswitch lasers used in automated systems, this reset function is provided by the Remote Reset/ Start Request signal via Pin 2 on the User I/O connector. To use this "remote keyswitch" functionality, first place the Keyswitch in the ON position. To reset a fault condition, apply a ±5–24 VDC signal to Pin 2, Remote Reset/Start Request, and Pin 11, Input Common. Removing the signal applies power to the RF driver causing the RDY lamp to illuminate and begins a five-second countdown after which lasing is enabled. The RF driver is disabled as long as a ±5–24 VDC signal is applied to Pin 2.

Your control system can monitor the laser's ready status on the User I/O connector by connecting your system's input to Pin 8, Laser Ready, and Pin 13, Output Common (see output driving PLC input module

Figure 4-16). The Laser Ready output closes when the laser is enabled (RDY LED illuminated yellow), indicating that lasing is possible. The output is open (RDY LED off) when lasing is disabled.

Important Note: A five-second delay occurs between the time the Laser Ready output closes and lasing is enabled.

OEM lasers

On OEM lasers, the RDY LED illuminates on DC power-up (provided that Shutter Open Request and Remote Interlock inputs are enabled) and five seconds later DC power is applied to the RF driver. Over temperature faults are reset by removing and then reapplying DC power after the laser has cooled. Remote interlock faults are not latched; the RDY LED illuminates yellow as soon as the interlock circuit is closed (when the INT LED turns from red to green) and five seconds later lasing is enabled.

Although a Remote Reset/Start Request input is not needed to reset OEM faults, it can be used to inhibit (disable) lasing. Disable the laser by applying a ±5–24 VDC signal to Pin 2, Remote Reset/Start Request, and Pin 11, Input Common. Removing the signal applies power to the RF driver causing the RDY lamp to illuminate and begins a five-second countdown after which lasing is enabled. The RF driver is disabled as long as a ±5–24 VDC Remote Reset/Start Request input is applied.

Your control system can monitor the laser's ready status on the User I/O connector by connecting your system's input to Pin 8, Laser Ready, and Pin 13, Output Common (see prior table).

The Laser Ready output closes when the laser is enabled (RDY LED illuminated yellow), indicating that lasing is possible. The output is open (RDY LED off) when lasing is disabled.

Important Note: A five-second delay occurs between the time the Laser Ready output closes and lasing is enabled.

Shutter functions

A mechanical Shutter Switch is installed on all Keyswitch-equipped lasers. Lasing is enabled when the shutter is Open (SHT LED illuminated blue) and disabled when the shutter is Closed (SHT LED off). The SHT LED illuminates blue to indicate that DC power is applied to the RF driver.

For v40 OEM and Keyswitch-equipped lasers in automated systems, the shutter function is provided by the Shutter Open Request signal via Pin 10 on the User I/O connector. To use this "remote shutter," first place the Shutter Switch (if equipped) in the ON position. Applying a ±5–24 VDC signal between Pin 10, Shutter Open Request, and Pin 11, Input Common, causes the SHT LED to illuminate and sends DC power to the RF driver, enabling lasing after a five-second delay. Removing the Shutter Open Request signal removes DC power from the RF driver, extinguishing the SHT lamp. Lasing remains disabled until a Shutter Open Request signal is applied to Pin 10.

Your control system can monitor the laser's shutter status on the User I/O connector by connecting your system's input to Pin 14, Shutter Open, and Pin 13, Output Common (see Figure 3-16). The Shutter Open output closes when the Shutter Switch is Open, and a Shutter Open Request signal is present (SHT indicator illuminated blue). The output is open (SHT LED off) when the Shutter Switch is Closed, or the Shutter Open Request signal is removed.

Important Note: A five-second delay occurs between the time the Shutter Open output closes and lasing is enabled.

Remote interlock functions

Interlock circuits are often used to disable machinery when a shield, panel, or door is opened. 's remote interlock function allows you to connect into an external remote interlock circuit and prevent lasing by removing DC power from the laser's RF driver boards when the circuit is electrically "open."

Lasing is enabled when a Remote Interlock signal is present (INT LED illuminated green), if RDY and SHT LEDs are illuminated, and disabled when the Remote Interlock signal is removed (INT LED red, RDY LED off). DC power is applied to the RF driver only when the INT LED is green and the RDY LED is yellow (and the SHT LED is illuminated blue). Remote interlock functionality is provided by the Remote Interlock signal via Pin 3 on the User I/O connector.

To use 's remote interlock feature, apply a ±5–24 VDC signal to Pin 3, Remote Interlock, and Pin 11, Input Common. Applying a Remote Interlock signal causes the INT LED to illuminate green and sends DC power to the RF driver, which enables lasing after a five-second delay (provided that the RDY LED is yellow and the SHT LED is blue). Removing the Remote Interlock signal removes DC power from the RF driver, causing the INT LED to turn red and the RDY LED to turn off. Lasing remains disabled until a Remote Interlock signal is reapplied to Pin 3.

Your control system can monitor remote interlock status on the User I/O connector by connecting your system's input to Pin 15, Interlock Open, and Pin 13, Output Common (prior figure). This output is closed when remote interlock circuitry is open (INT indicator illuminated red). The output is open (INT LED green) when interlock circuitry is closed.

v40 general specifications

Table 4-7 v40 general specifications

Parameter Firestar v40		
Output Specifications		
Wavelength†	10.57–10.63 microns	
Power Output [1,2]	40 Watts	
Power Stability [3]	± 5%	
Power Stability [4]	± 3%	
Mode Quality	TEM_{00}, $M^2 \leq 1.2$	
Beam Waist Diameter (at $1/e^2$) [5]	2.5 mm ±0.5 mm	
Beam Divergence, full angle (at $1/e^2$) [5]	< 7.0 mrad	
Ellipticity	< 1.2	
Polarization	Linear, horizontal	
Extinction ratio	> 100:1	
Rise Time	< 100 µs	
Modulation (Optical response)	up to 25 kHz	
Input Specifications		
Power Supply		
Voltage	30 VDC	
Maximum Current	24 A	
Typical	18 A	
Command Input Signal		
Voltage	+3.5 to +6.7 VDC	
Current	10 mA @ +6.7 VDC	
Frequency [6]	DC–25 kHz	
Duty Cycle	0%–100%	
Logic Low State (Vmin–Vmax)	0.0 to +0.8 VDC	
Logic High State (Vmin–Vmax)	+3.5 to +6.7 VDC	
Cooling Specifications	(Air-cooled)	(Water-cooled)
Maximum Heat Load, laser	700 Watts	700 Watts
Minimum Flow Rate	140 CFM per fan	1.0 GPM, < 60 PSI
Rear air-cooled	> 300 CFM	N/A
Coolant Temperature	≤ 40 °C, ambient	18 °C–22 °C

* 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).

4 After two minutes (typical).

5 Measured at laser output.

6 Tested at 5 kHz.

Table 4-7 v40 general specifications (continued)

Parameter	Firestar v40
Environmental Specifications	
Operating Temperature [7]	15 °C–40 °C
Humidity	0–95%, non-condensing
Physical Specifications	
v40, water-cooled	
Length	25.10 in (63.8 cm)
Width	5.62 in (14.3 cm)
Height	6.21 in (15.8 cm)
Weight	24.0 lbs (10.9 kg)
v40, fan-cooled	
Length	24.45 in (62.1 cm)
Width (incl. fans)	8.25 in (20.9 cm)
Height	6.21 in (15.8 cm)
Weight	26.0 lbs (11.8 kg)
v40, air-cooled	
Length	24.45 in (62.1 cm)
Width	6.22 in (15.8 cm)
Height	5.76 in (14.6 cm)
Weight	23.0 lbs (10.4 kg)

* Specifications subject to change without notice.

7 Published specifications guaranteed at a cooling temperature of 22 °C. For air-cooled lasers, some performance degradation may occur in ambient temperatures above 22 °C. Typically output laser power decreases 0.5–1 Watt per degree Celsius increase in ambient temperature.

v40 package outline drawings

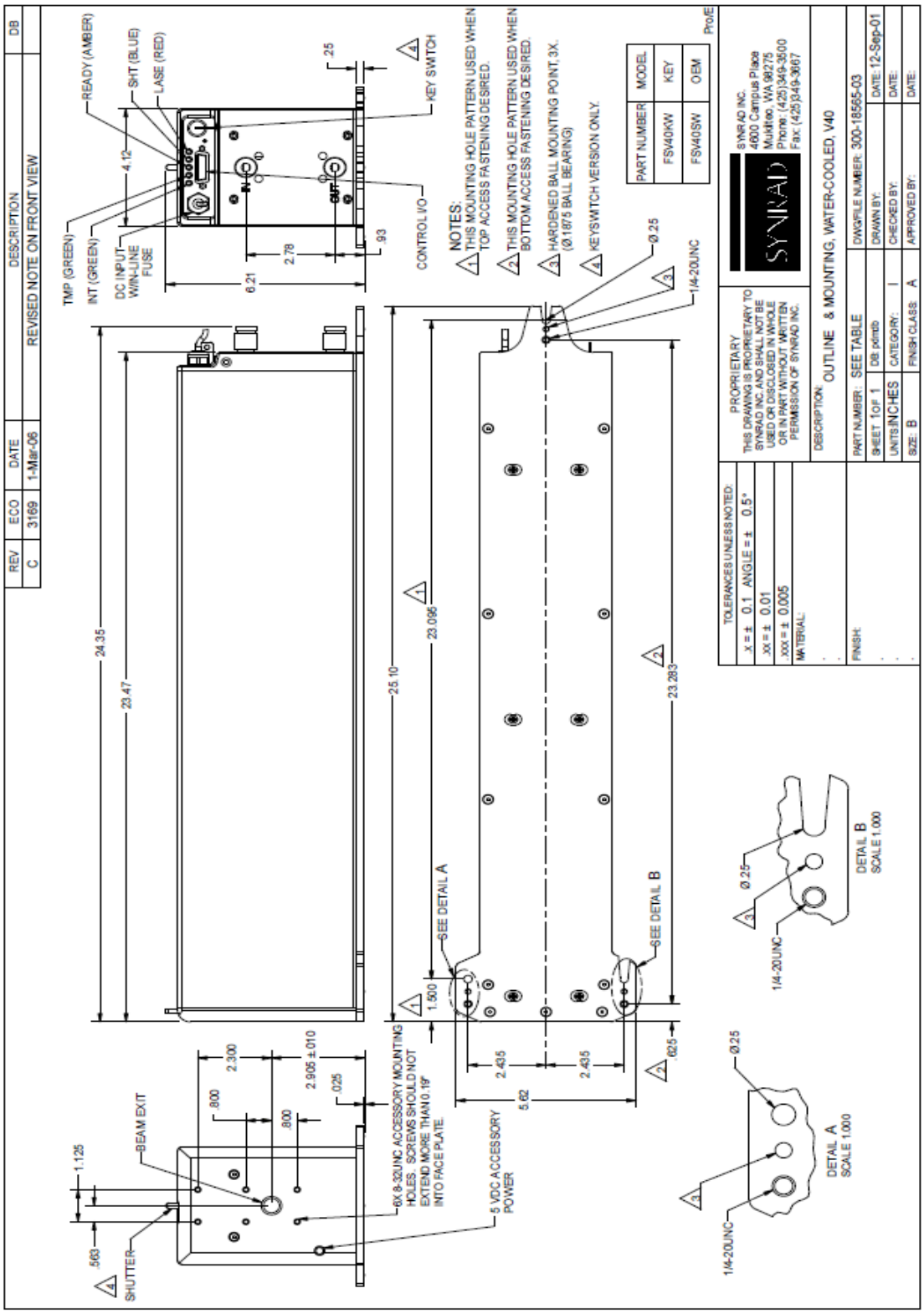


Figure 4-18 Water-cooled v40 package outline and mounting dimensions

v40 package outline drawings (continued)

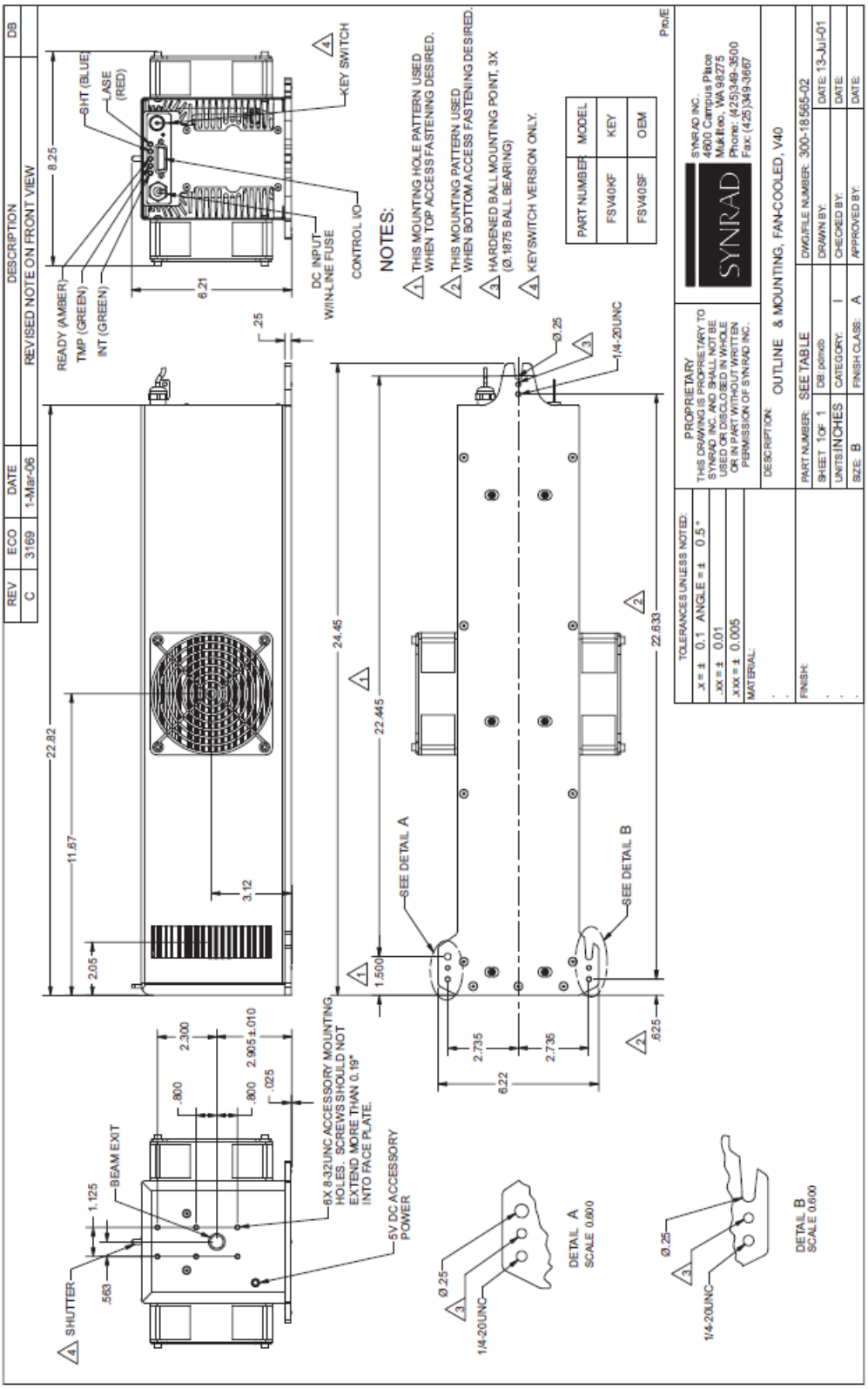


Figure 4-19 Fan-cooled v40 package outline and mounting dimensions

v40 package outline drawings (continued)

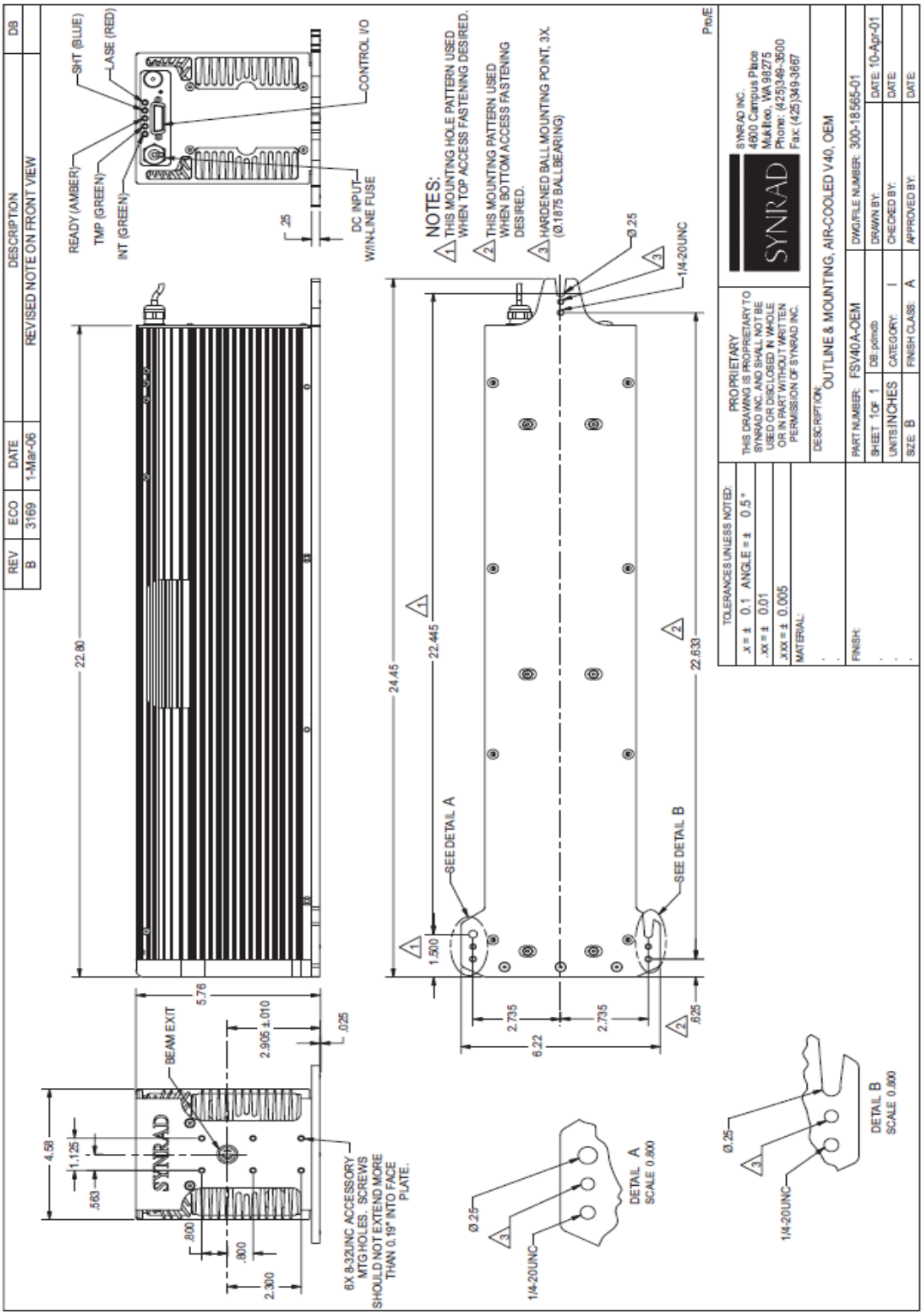


Figure 4-20 Air-cooled v40 (SAB model) package outline and mounting dimensions

V40 packaging instructions drawing

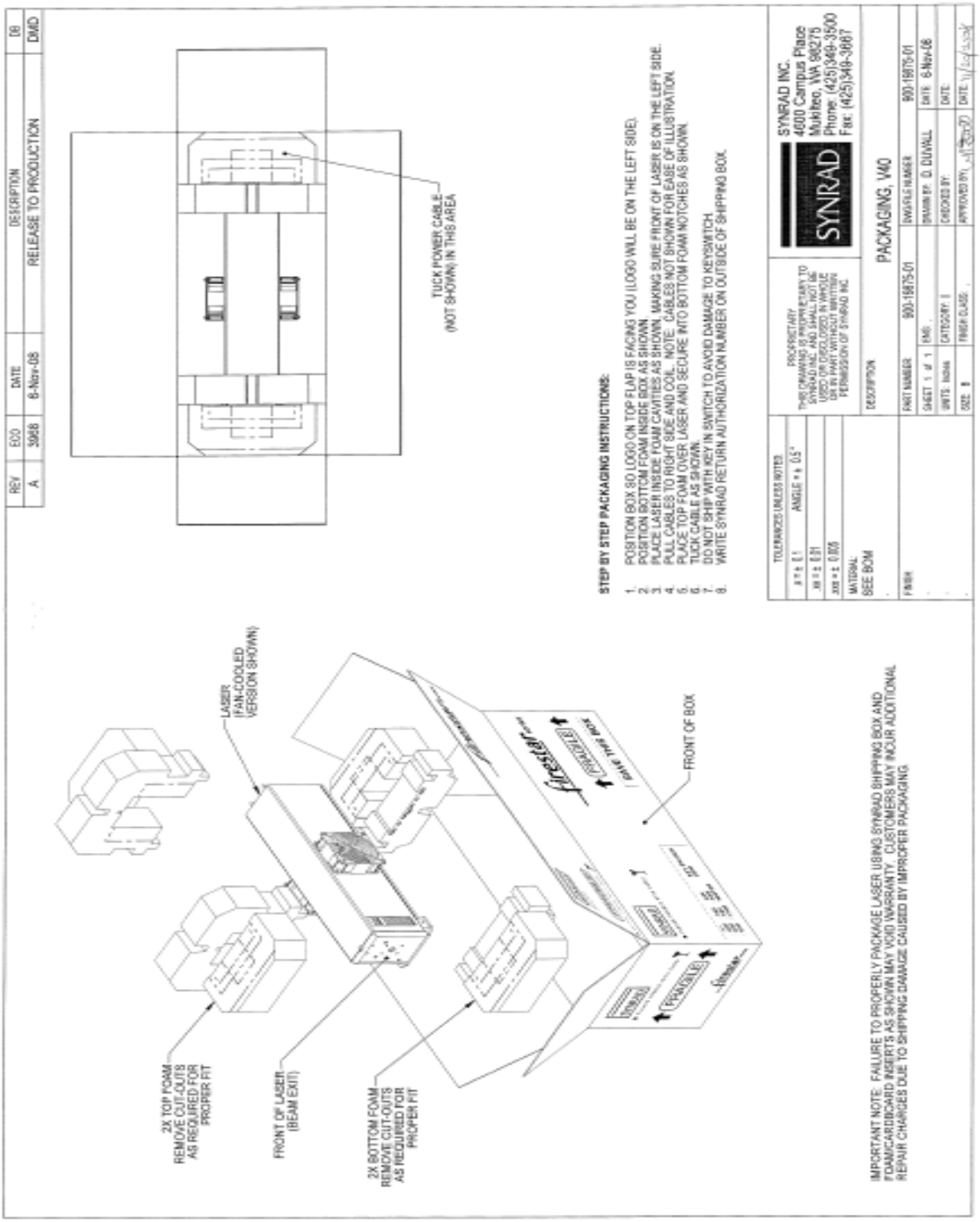


Figure 4-21 v40 packaging instructions

Maintenance & Troubleshooting

This section contains maintenance and troubleshooting information for your v40 laser.

- Maintenance – describes typical v40 maintenance procedures.
- Troubleshooting – explains how to troubleshoot common v40 problems

Caution: Possible Equipment Damage

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

Maintenance

This section includes the following subsections:

- Disabling the v40 laser
- Daily inspections
- Storage/shipping
- Cleaning optical components

Disabling the v40 laser

Before performing any maintenance on your v40 laser, be sure to completely disable the laser by disconnecting the DC Power from the rear panel of the laser.

Daily inspections

Perform the following steps daily to keep your v40 laser in optimum operating condition. Except for the procedures described below, no other service is required or should be attempted.

Caution: Possible Equipment Damage

If you operate the laser in dirty or dusty environments, contact NOVANTA about the risks of doing so and precautions you can take to increase the longevity for the laser system 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. 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.
3. Visually inspect the exterior housing of the laser to ensure that all warning labels are present. Refer to the Laser Safety section for v40 label types and locations.

Storage/shipping

When preparing the 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 less than 29 PSI (while wearing safety glasses!) to remove any residual water. When finished, cap all connectors to prevent debris from entering the cooling system.

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


Important Note: Failure to properly package the laser using NOVANTA-supplied shipping boxes and foam/cardboard inserts as shown in the Packaging instructions may void the warranty. Customers may incur additional repair charges for 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 CO2 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, v40 lasers have significantly higher power densities than previous NOVANTA lasers. This means that even a small amount of 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.

Cleaning guidelines

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.

- Wear latex gloves or finger cots (powder-free) to prevent contamination of optical sur-faces 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.

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.

- Always place optics lens on a tissue or suitable equivalent material for protection; never place optics on hard or rough surfaces.
- It may be necessary to use a cotton ball or fluffed cotton swab instead of a lens wipe to uniformly clean the entire surface of small-diameter mounted optics.
- Before using any cleaning agents, read Safety Data Sheets (SDS) and observe all necessary safety precautions.

Required cleaning materials

The table below 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

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 for contaminants.
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.

Caution: Possible Equipment 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 surfaces if reused.

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 vapors and debris.
5. Gently, and without applying pressure, drag the damp lens wipe across the optical sur-face 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. Use a clean lens wipe on each pass. The wipe will pick up and carry surface contaminants that may scratch optical surfaces or coatings.

6. Carefully examine the optic under suitable lighting. 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.

Caution: Possible Equipment Damage

If acetone is used as a cleaning solvent, a second follow-up cleaning of the optical surface using alcohol is required. Otherwise, solvent residuals could damage your laser!

Important Note: 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.

Troubleshooting

This section includes the following subsections:

- Introduction
- Operational flowchart
- Functional block diagram
- Status LEDs
- Laser faults
- Resetting faults
- Other laser faults
- 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 NOVANTA or a NOVANTA Authorized Distributor for repair information.

To troubleshoot v40 lasers, it is necessary to understand the sequence of events that must happen before the laser can operate. Before attempting any service, we advise you to read the entire troubleshooting guide and review both the operational flowchart and the functional block diagram. Symptoms and possible causes are highlighted by dark print and bullet points throughout this section. Information about each symptom and cause can be found in the paragraphs following each heading.

Caution: Possible Equipment Damage

Attempting repair of a NOVANTA V40 laser without the express authorization of NOVANTA, will void the product warranty.

If troubleshooting or service assistance is required, please contact NOVANTA Customer Service.

Danger: Serious Personal Injury

This Class IV laser product emits invisible infrared laser radiation in the 10.6 µm CO2 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.

Operational flowchart

The flowchart figure below illustrates 's start-up sequence.

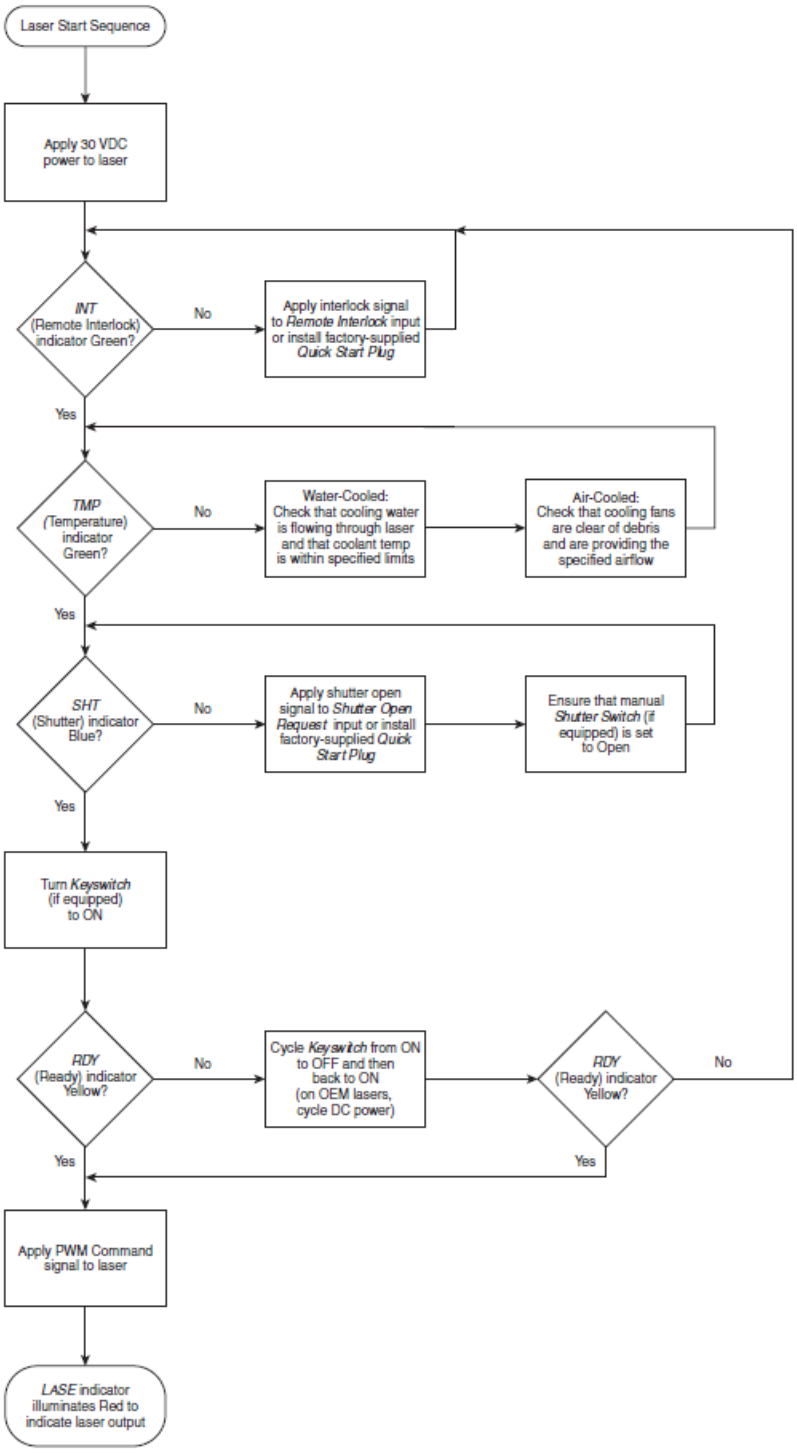


Figure 5-1 v40 operational flowchart.

Functional block diagram

Figure below is a functional block diagram illustrating the v40's control architecture.

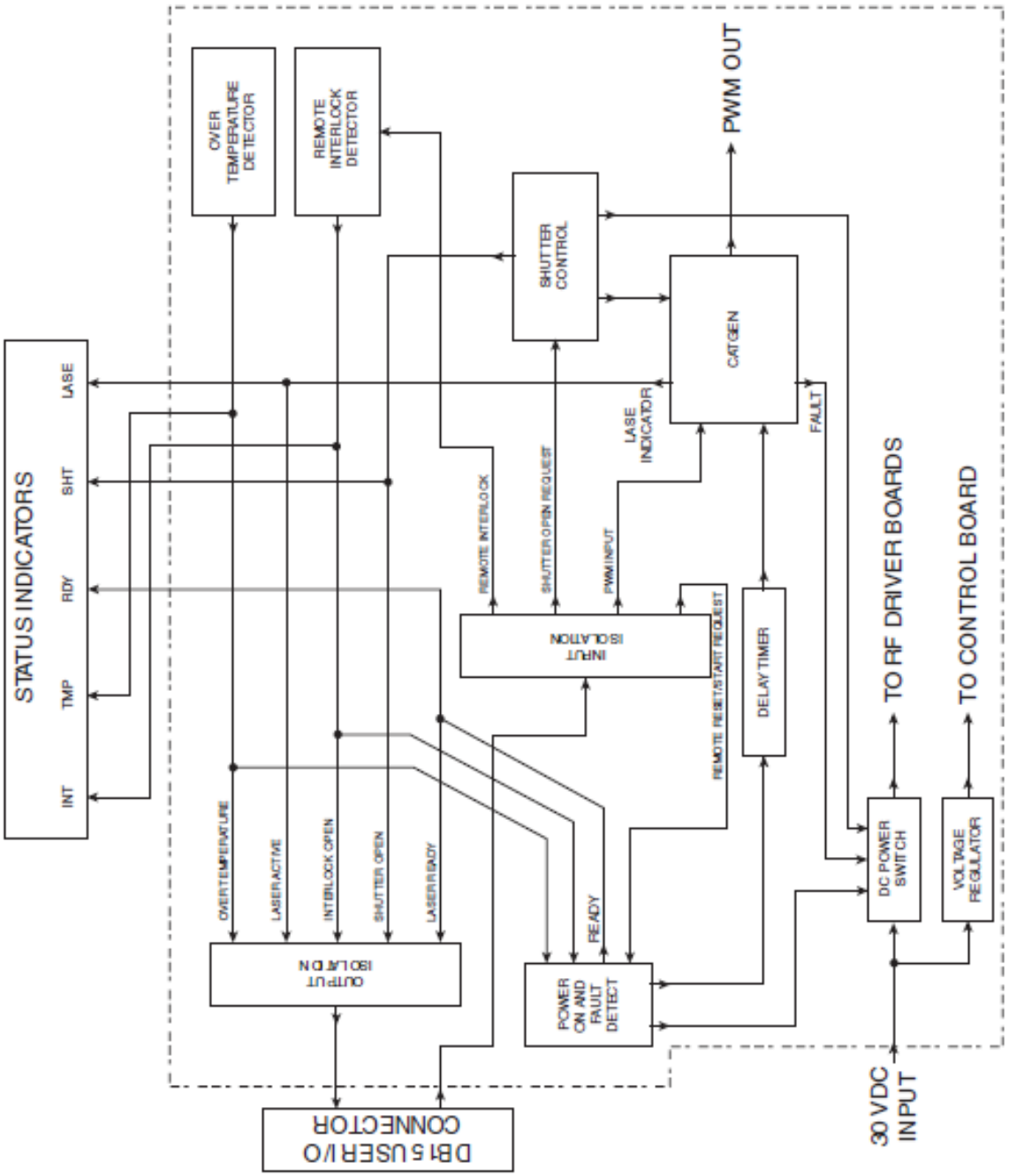


Figure 5-2 v40 functional block diagram

Status LED's

v40 LED indicators, also mirrored as output signals on the User I/O connector, provide status information to the user. Table below shows output signal and LED indicator states during normal and fault conditions. User I/O outputs are Closed when the state indicated by the signal name is True.

Table 5-2 Status signals

LED Indicator	LED Status		Signal Name	User I/O Output Status	
	Normal	Fault		Normal	Fault
INT	Green	Red	Interlock Open	Open	Closed
TMP	Green	Red	Over Temperature	Open	Closed
RDY	Yellow	Off	Laser Ready	Closed	Open
SHT	Blue	Off	Shutter Open	Closed	Open
LASE	Red	Off	Laser Active	Closed	Open

On v40 Keyswitch lasers, the RDY indicator illuminates yellow only when INT and TMP indicators are green and the Keyswitch is cycled from OFF to the ON position. After the RDY indicator illuminates, a five-second delay occurs before is permitted to lase. The SHT LED illuminates blue when a Shutter Open Request signal is applied, and the manual Shutter Switch is set to ON. If the RDY indicator is lit and the shutter is switched from Closed to Open, there is a five-second delay until PWM inputs are recognized. When PWM Command pulses are applied (and are long enough to produce laser output) the LASE LED illuminates red.

On OEM lasers, the RDY lamp illuminates on DC power-up when INT and TMP indicators illuminate green. After the RDY indicator illuminates, a five-second delay occurs before is permitted to lase. The SHT LED illuminates blue when a Shutter Open Request signal is applied. If the RDY indicator is lit and then a Shutter Open Request signal is applied, there is a five-second delay until PWM inputs are recognized. When PWM Command pulses are applied (and are long enough to produce laser output) the LASE LED illuminates red.

Important Note: v40 RDY and SHT indicators (as well as Laser Ready and Shutter Open outputs) denote separate control functions. Although the RDY lamp may light while the SHT LED is Off (Shutter Switch Closed or Shutter Open Request signal missing), no power is applied to the RF boards until both RDY and SHT indicators are illuminated.

Following tables show how 's signal status changes when remote interlock, over temperature, or shutter closed conditions occur.

Table 5-3 Interlock Open condition

LED Indicator	LED Status	Signal Name	Output Signal Status
INT	Red	Interlock Open	Closed
TMP	Green	Over Temperature	Open
RDY	Off	Laser Ready	Open
SHT	Blue	Shutter Open	Closed
LASE	Off	Laser Active	Open

Table 5-4 Over Temperature condition

LED Indicator	LED Status	Signal Name	Output Signal Status
INT	Green	Interlock Open	Open
TMP	Red	Over Temperature	Closed
RDY	Off	Laser Ready	Open
SHT	Blue	Shutter Open	Closed
LASE	Off	Laser Active	Open

Table 5-5 Shutter Open condition

LED Indicator	LED Status	Signal Name	User I/O Output Status
INT	Green	Interlock Open	Open
TMP	Green	Over Temperature	Open
RDY	Yellow	Laser Ready	Closed
SHT	Off	Shutter Open	Open
LASE	Off	Laser Active	Open

Laser faults

v40 lasers version D and above (KFD, SAD, etc.) can indicate four specific fault conditions. In the event of a certain faults, the RDY LED on the laser will blink an error code, pause four seconds, and then repeat the error code. This sequence continues until the fault is corrected and the laser is reset by cycling DC power to the laser.

Table below lists error codes, the corresponding fault condition, and describes any corrective action possible in the field.

Table 5-6 Laser faults

Number of Blinks Ready (RDY) Indicator	Fault Condition	Corrective Action in Field
1 blink	Under Voltage Fault	Verify 30 VDC is measured at the laser under load
2 blinks	Over Voltage Fault	Verify 30 VDC is measured at the laser under load
3 blinks	RF Drive DC Fault	Remove DC power to the laser, wait 30 seconds, and then reapply DC power
4 blinks	PWM Drive Fault	Remove DC power to the laser, wait 30 seconds, and then reapply DC power

Resetting faults

Keyswitch lasers

Remote interlock fault

A remote interlock fault occurs when the Remote Interlock input opens (the INT indicator changes from green to red). To reset a remote interlock fault, close the interlock input (INT indicator changes from red to green) and cycle the Keyswitch from OFF to ON (or apply a ±5–24 VDC Remote Reset/Start Request pulse with the Keyswitch set to ON). When the RDY indicator illuminates, lasing is enabled after a five-second delay.

Over temperature fault

Over temperature faults occur when thermal limits in the laser are exceeded (the TMP indicator changes from green to red). To reset an over temperature fault, lower coolant temperature below 22 °C (water-cooled) or below 40 °C (air-cooled), cycle DC power to the laser, and then cycle the Keyswitch from OFF to ON (or apply a ±5–24 VDC Remote Reset/Start Request pulse with the Keyswitch set to ON). When the RDY indicator illuminates, lasing is enabled after a five-second delay.

Shutter

A closed shutter is not considered a fault condition. When the shutter is opened (or a Shutter Open Request signal is applied), lasing is enabled after a five-second delay provided that the RDY indicator is illuminated yellow.

Under/over voltage fault

An under voltage or over voltage fault occurs when the DC input voltage is below or above preset limits. This fault is indicated by the RDY indicator flashing 1 blink (under voltage) or 2 blinks (over voltage). To reset an under voltage or over voltage fault, ensure that 30 VDC is applied to the laser under full load conditions, cycle DC power off and on, and then toggle the Keyswitch from OFF to ON (or apply a ±5–24 VDC Remote Reset/Start Request pulse with the Keyswitch set to ON). When the RDY indicator illuminates, lasing is enabled after a five-second delay.

RF Drive DC fault

An RF Drive DC fault is indicated by the RDY indicator flashing 3 blinks. Reset the laser by removing DC power to the laser, wait 30 seconds, and then reapply DC power. If the RF Drive DC fault reappears, contact NOVANTA or a NOVANTA Authorized Distributor.

PWM Drive fault

A PWM Drive fault is indicated by the RDY indicator flashing 4 blinks. Reset the laser by removing DC power to the laser, wait 30 seconds, and then reapply DC power. If the PWM Drive fault reappears, contact NOVANTA or a NOVANTA Authorized Distributor.

OEM lasers

Warning: Serious Personal Injury

On v40 OEM lasers, remote interlock (INT) faults are not latched. Clearing the fault condition re-enables the RDY indicator and the laser will fire after the five-second delay provided that the SHT indicator is lit and a PWM Command signal is applied. Because exposure to 10.6 μm CO2 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.

Remote interlock fault

A remote interlock fault occurs when the Remote Interlock input opens (the INT indicator changes from green to red). On OEM lasers, remote interlock (INT) faults are not latched. Re-establish the Remote

Interlock signal input (INT indicator changes from red to green) to enable the RDY indicator and begin lasing after the five-second delay.

Over temperature fault

Over temperature faults occur when thermal limits in the laser are exceeded (the TMP indicator changes from green to red). Beginning with OEM D version v40 lasers, over temperature faults are now latched. To reset an over temperature fault, lower coolant temperature below 22 °C (water-cooled) or below 40 °C (air-cooled) and then cycle DC power to the laser. Once the RDY lamp is lit, lasing is possible after the five-second delay.

Note: Over temperature faults are not latched on earlier OEM v40 lasers. Cool the laser until the TMP indicator changes from red to green. After the RDY lamp lights, lasing is possible after the five-second delay.

Shutter

A closed shutter is not considered a fault condition. When a Shutter Open Request signal is applied, lasing is enabled after a five-second delay provided that the RDY indicator is illuminated yellow.

Under/over voltage fault

An under voltage or over voltage fault occurs when the DC input voltage is below or above preset limits. This fault is indicated by the RDY indicator flashing 1 blink (under voltage) or 2 blinks (over voltage). To reset an under voltage or over voltage fault, ensure that 30 VDC is applied to the laser under full load conditions and then cycle DC power. When the RDY indicator illuminates, lasing is enabled after a five-second delay.

RF Drive DC fault

An RF Drive DC fault is indicated by the RDY indicator flashing 3 blinks. Reset the laser by removing DC power to the laser, wait 30 seconds, and then reapply DC power. If the RF Drive DC fault reappears, contact NOVANTA or a NOVANTA Authorized Distributor.

PWM Drive fault

A PWM Drive fault is indicated by the RDY indicator flashing 4 blinks. Reset the laser by removing DC power to the laser, wait 30 seconds, and then reapply DC power. If the PWM Drive fault reappears, contact NOVANTA or a NOVANTA Authorized Distributor.

Other laser faults

When a laser fault occurs, ’s status LEDs and output signals will reflect a fault condition as indicated in the prior tables. Each Symptom listed below describes a particular fault condition. For each Symptom, specific causes and solutions are described under Possible Causes.

 Warning: Serious Personal Injury

On v40 OEM lasers, remote interlock (INT) faults are not latched. Clearing the fault condition re-enables the RDY indicator and the laser will fire after the five-second delay provided that the SHT indicator is lit and a PWM Command signal is applied. Because exposure to 10.6 µm CO2 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:

- A remote interlock fault is indicated:

INT LED – Red	Interlock Open – Closed
TMP LED – Green	Over Temperature – Open
RDY LED – Off	Laser Ready – Open
SHT LED – Blue	Shutter Open – Closed
LASE LED – Off	Laser Active – Open

Possible Causes:

- No voltage applied to Pin 3 (Remote Interlock) on the User I/O connector.

On systems using remote interlocks, check to see that a positive or negative voltage (±5–24 VDC) is applied to Pin 3, Remote Interlock, with respect to Pin 11, Input Common, on the User I/O connector (refer to User I/O connections in the Technical Reference chapter for details). For systems not using interlocks, connect the factory-supplied Quick Start Plug to the User I/O connector on the laser's rear panel or wire your male DB-15 connector so that Pin 11 (Input Common) is jumpered to Pin 12 (Auxiliary DC Power Ground) and Pin 3 (Remote Interlock) is jumpered to Pin 4 (+5 VDC Auxiliary Power).

Symptom:

- An over temperature fault is indicated:

INT LED – Green	Interlock Open – Open
TMP LED – Red	Over Temperature – Closed
RDY LED – Off	Laser Ready – Open
SHT LED – Blue	Shutter Open – Closed
LASE LED – Off	Laser Active – Open

Possible Causes:

- Water-cooled lasers – Cooling water temperature is above 22 °C (72 °F) or there is inadequate water flow through the laser.

Check that your chiller is maintaining a water temperature between 18 °C–22 °C (64 °F–72 °F) at a flow rate of one gallon per minute (GPM). If water temperature is OK, check the flow rate. The simplest way

to do this, if a flow meter is not available, is to disconnect the cooling tubing from the chiller inlet (or the drain) and run the cooling water for one minute into a five-gallon bucket; you should have close to one gallon. If there is much less than one gallon, check the cooling path for kinked or pinched cooling tubes or check the chiller for a clogged or dirty filter.

- Fan-cooled lasers – 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 140 CFM per fan or at least 300 CFM if rear cooling the laser. To allow for proper airflow, cooling fans must have at least 2.25" (57.2 mm) of unobstructed clearance between the outside edge of the cooling fan housing and any mounting surface or enclosure.

Symptom:

- A shutter closed condition is indicated:

INT LED – Green	Interlock Open – Open
TMP LED – Green	Over Temperature – Open
RDY LED – Yellow	Laser Ready – Closed
SHT LED – Off	Shutter Open – Open
LASE LED – Off	Laser Active – Open

Possible Causes:

- The Shutter Switch (if equipped) is Closed.

If your v40 laser is equipped with a Shutter Switch, slide the switch to the Open position. The SHT indicator will illuminate blue.

- No voltage applied to Pin 10 (Shutter Open Request) on the User I/O connector.

Check to see that a positive or negative voltage (±5–24 VDC) is applied to Pin 10, Shutter Open Request, with respect to Pin 11, Input Common, on the User I/O connector (refer to User I/O connections in the "Technical Reference" chapter for details). If your system does not provide a Shutter Open Request signal, connect the factory-supplied Quick Start Plug to the User I/O connector on the laser's rear panel or wire your male DB-15 connector so that Pin 11 (Input Common) is jumpered to Pin 12 (Auxiliary DC Power Ground) and Pin 10 (Shutter Open Request) is jumpered to Pin 4 (+5 VDC Auxiliary Power).

Symptom:

- Your OEM laser has quit lasing or lasing halted and then restarted. The LASE LED may be Off or On depending on whether PWM Command signals are being applied, but no fault is indicated.

INT LED – Green	Interlock Open – Open
TMP LED – Green	Over Temperature – Open
RDY LED – Yellow	Laser Ready – Closed
SHT LED – Blue	Shutter Open – Closed
LASE LED – Off or On	Laser Active – Open or Closed

Possible Causes:

- An over temperature condition has occurred.

On earlier OEM lasers (v40 versions B and C), over temperature faults are not latched. This means if an over temperature condition occurs, the TMP indicator will turn red, the Over Temperature output will Close, the RDY light goes out, and lasing is disabled. However, if the laser cools down enough to clear the over temp fault, the TMP indicator will change from red to green, the RDY light illuminates, and five seconds later lasing is enabled.

- The remote interlock circuit momentarily opened.

Remote interlock faults are not latched on OEM lasers. This means if an interlock open fault occurs, the INT indicator will turn red, the Interlock Open output will Close, the RDY light goes out, and lasing is disabled. However, if the interlock circuit closes again, the INT indicator will change from red to green, the Interlock Open output will Open, the RDY light illuminates, and five seconds later lasing is enabled.

Symptom:

- There is no output laser beam; all LED status indicators are Off.

Possible Causes:

- No DC voltage is applied, or the laser's in-line fuse has blown.

Ensure that DC power cable connections are tight and verify that +30 VDC is available on the power supply terminals under full load.

Check the in-line fuse on the laser's red DC power cable. Install a Bussman KLK25 or equivalent 25-ampere fast-acting replacement fuse.

Beam delivery optics

Caution: Possible Equipment Damage

Attempting repair of a NOVANTA V40 laser without the express authorization of NOVANTA, will void the product warranty.

If troubleshooting or service assistance is required, please contact NOVANTA Customer Service.

Symptom:

- The laser loses power over time; laser output power must be increased to maintain performance.

Possible Causes:

- Beam delivery optics are coated by vapor residue or debris.

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 CO2 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; preferably by the mounting ring only. If the optic requires cleaning, refer to Maintenance for cleaning instructions. Use only recommended cleaning materials (see first table in this chapter) to prevent scratching delicate optical surfaces.

If the focusing optic is pitted, it must be replaced immediately. Because of the extremely high power density of v40 lasers, pits or debris on the lens surface 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.

Caution: Possible Equipment Damage

A risk of exposure to toxic elements 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 NOVANTA, Inc. or the optics manufacturer for handling instructions.

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