



15632 Roxford Street
Sylmar, CA 91342-1265
818-986-0000
818-698-0428 fax
www.QPClasers.com

Operating Manual For Ultra-50™ MEDICA High Power Fiber Coupled Module



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1. General information

This document presents some information relevant to the integration of QPC laser modules by OEM laser manufactures.

1.1 U.S. Export control laws compliance

The product and technical data forwarded herewith is EXPORT CONTROLLED. Export of this information in any form is restricted by the Export Administration Act of 1979, as amended in sequence. Refer to Export Administration Regulations *Supplement No. 1 to Part 774, Category 6A005.d.1. Semiconductor lasers* and *Commerce Control List Overview and the Country Chart, Part 738 and Supplement No. 1 to Part 738*.

1.2 Warranty summary

QPC Lasers, Inc warrants that the products that it manufactures and sells will be free from defects in materials and workmanship for a period of one (1) year from the date of shipment from an authorized QPC Lasers, Inc distributor. If a product proves defective within the respective period, QPC Lasers, Inc will provide repair or replacement as described in the complete warranty statement.

Unauthorized service of the laser or any of its parts and accessories voids warranty. To arrange for service or obtain a copy of the complete warranty statement, please contact your nearest QPC Lasers, Inc sales and service office.

Except as provided in this summary or the applicable warranty statement, QPC lasers, inc makes no warranty of any kind, express or implied, including without limitation the implied warranties of merchantability and fitness for a particular purpose. In no event shall QPC lasers be liable for indirect, special, or consequential damages.

1.3 Product End-of-Life Handling



QPC Lasers is committed to protecting the environment. Although the module is not included in the list of devices governed by the WEEE and RoHS EU directives, QPC Lasers will attempt to provide return service and disposal of your used equipment. When you are ready to reclaim the instrument, you must properly transfer it according to local regulations concerning WEEE equipment or ship the instrument to the QPC Lasers recycling center. You may contact QPC Lasers for the recycling center shipping address and instructions.

1.4 Important Safety Information



This product is a Class 4 laser. When energized with a power supply, the laser emits radiation that may be invisible, visible or both. Avoid eye or skin exposure to direct or scattered radiation. Do not allow laser radiation to be directed toward the operator, other people or reflective objects. Radiation from the laser is potentially harmful.

Failure to follow instructions may result in serious injury or fire. Before energizing with a power supply, be sure that radiation from the laser or from optical fibers connected to it will be safety

contained and resulting heat will be removed. Do not open or modify this product in any way; it has no customer serviceable assemblies or parts. Consult ANSI Z136.1 (Standard For Safe Use of Lasers) for general safety guidance including eye protection using properly selected laser safety glasses.

Consult the test report that accompanies each laser for the maximum optical power, wavelength(s), and beam divergence of the product as well as the current and voltage from the power supply that result in the rated optical power. Consult the test report to determine if red visible laser light may be emitted from this product in addition to invisible laser radiation. If red laser light is to be viewed, always avoid direct eye exposure and always use eye protection to reduce eye exposure to laser radiation at all wavelengths to safe levels.

1.5 Background on Laser Diode Modules

Simple procedures and precautions allow trouble-free use of QPC laser diode modules. Care is required because all laser diode modules have common sensitivities.

- Polished optical output windows and fiber tips can be ruined by mechanical contact, condensed moisture or contaminants.
- Laser diodes are sensitive to electrostatic discharge (ESD), over-currents and reverse-currents.
- Mounting surfaces of laser diode modules are carefully machined to allow intimate contact with a cooling plate. Thermal contact may be ruined by scratches, dents, particulates, loose fasteners, over-tightened fasteners or a poor surface condition on the cooling plate.
- Mechanical distortion of laser modules can cause micron-level optical misalignments that reduce optical output.

2. Module installation

2.1 Unpacking and Handling Laser Modules

When removing the device from its packaging and at any other time during handling, the following procedures should be followed:

1. ESD protection procedures:

Each person handling or within twelve (12) inches of unprotected ESDS devices shall be grounded using wrist straps that shall:

- Provide a continuous electrical path from the user directly to ESD ground.
- Have an integral resistance at the wrist band end of the grounding wire that will limit current to less than 0.5 mA through that specific path to ground at the highest power supply voltage that may be encountered.
- Be worn by operators handling unprotected ESDS devices when seated.

2. Open the protective bag in a clean environment.



3. When removing a component from its box, use gloves or finger cots.
4. Do not allow anything to contact the output window or fiber tip
5. Do not scratch or dent the mounting surface or its edges.
6. Unless explicitly stated otherwise in the product specifications, removing the lid from the body of the module may result in serious degradation of performance and shall void the product's warranty.

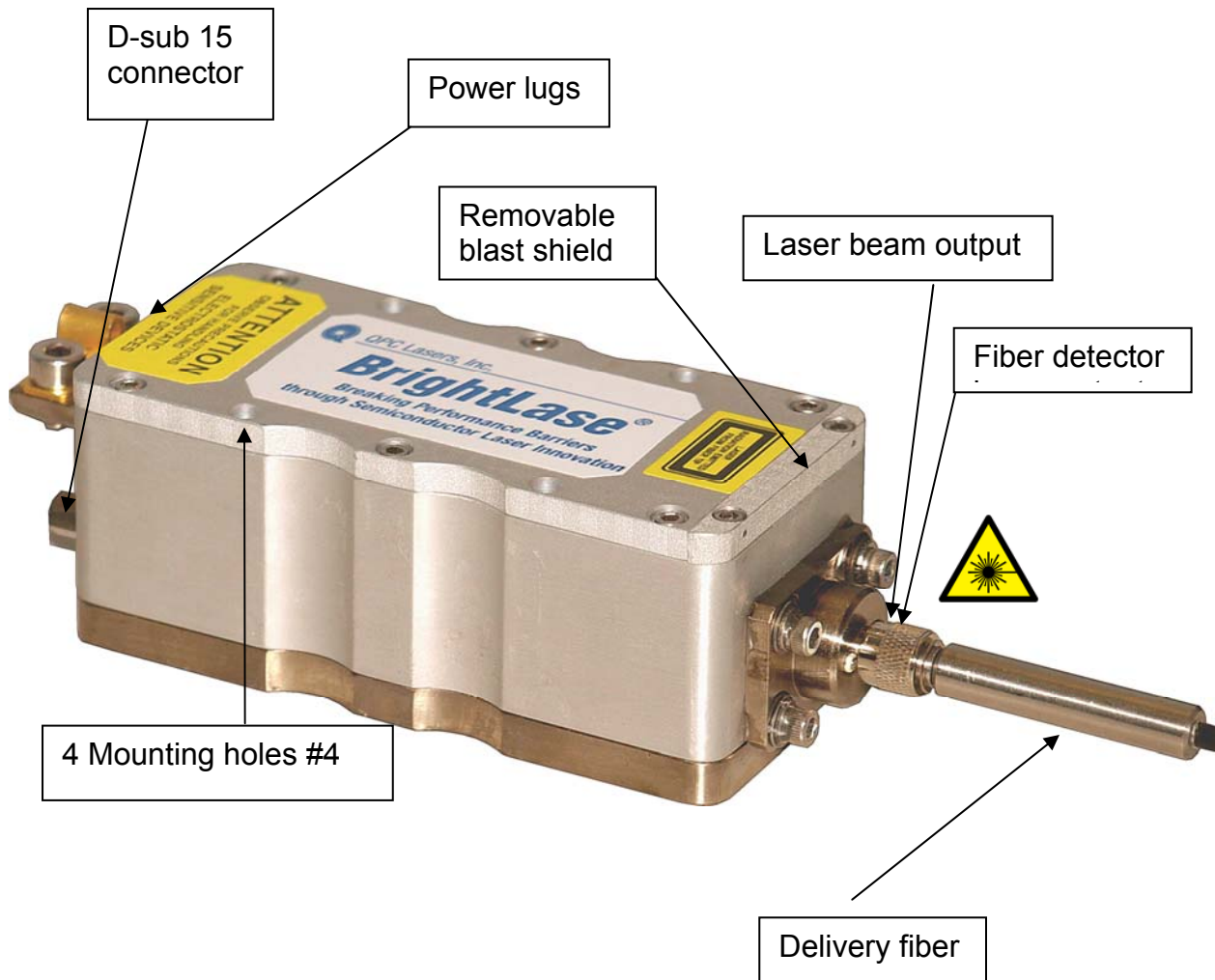


Figure 1: Ultra-50™ MEDICA electrical and cooling connections

2.2 Installation of Laser Modules

1. Be sure that all power supplies are turned off.
2. Align mounting holes of the module with those of the cold plate before inserting screws, in order to avoid scratching the cold plate with the screw tips. The mounting surface should be free of scratches, dents, particles and contaminants. It should have surface finish (Ra) of 32 micro-inches or finer and flatness of a few parts per thousand or better. Avoid denting or scratching the surfaces when the module base is installed on the cold plate.
3. If the cooling plate has poor surface conditions that cannot be improved, then a graphite thermal pad, an indium thermal pad, or thermal grease may be tried. However, specified performance may still not be met and the lifetime of the module may be greatly reduced.
4. Fasten the module to the cooling plate using steel screws and lock washers.
5. Mounting screws should be fastened with seven (7) inch-pounds (0.8 Newton-meter) of torque. Gradually tighten the screws in rotation, to help maintain alignment.
6. Remove the shorting bar from the cathode and anode electrical connections.
7. Connect the current leads to the module while maintaining correct polarity.
8. See sections on accessories for details about installation and operation of external items

3. Operation of Laser Modules

1. Before applying current, connect the free end of the fiber cable safely, connect the current leads and make sure that the cooling plate is temperature-controlled.
2. While connecting or disconnecting the current source, the current must be set to zero. The power supply must be free of transients (from any source, including line voltage) that may cause excessive currents even for micro-seconds. Loose connections or intermittent shorts must be avoided.
3. The specified operating power should not be exceeded by more than 5% and only for brief periods.
4. To avoid moisture condensation on the module and fiber cable, the ambient dew point should not be allowed to fall near or below the temperature of the cooling plate. The laser should be operated at a base plate temperature of 20°C unless otherwise specified.



4. Maintenance of Optical Surfaces

1. Contact with an optical window on the module or with the polished end of the fiber cable must be avoided.
2. If dust settles on these surfaces, blow with dry gas to clean.
3. During storage, retain in place any connector caps shipped with the product.



5. Fiber management

1. Carefully remove protective cap from fiber and retain for future use.
2. Attach the fiber end to a SMA type mounting fixture.
3. Insure that the fiber from the module is not stressed or stretched at any time.
4. Insure the fiber is not coiled during operation not flexed near the SMA connector at any time.
5. If cleaning is required use clean, dry compressed air to gently remove any dust or contaminants.

6. Specifications

6.1 Module specifications

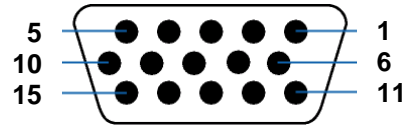
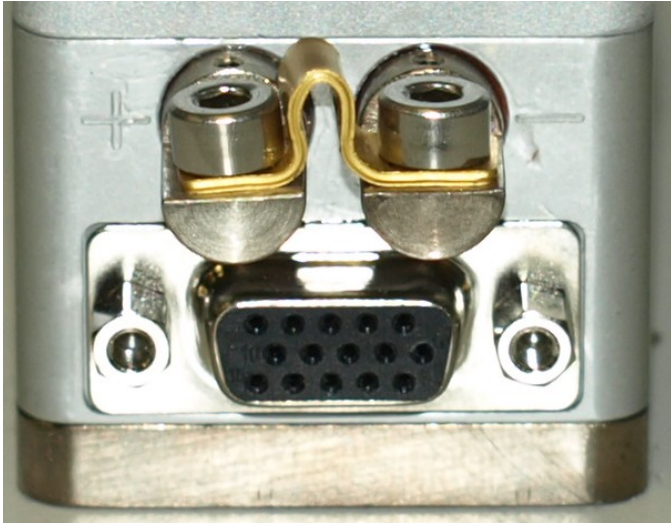
	6808-M000	6008-M002	6009-M002	6010-M000
Output power	≥15 W	≥50 W	≥50 W	≥30 W
Operating current	<30 A	<80 A	<80 A	<68 A
Operating voltage	<1.9 V	<1.9 V	<1.6 V	<1.8 V
Center wavelength	808 nm	808 nm	976 nm	1064 nm
Wavelength tolerance	± 10 nm	± 3 nm	± 3 nm	± 10 nm
Spectral width (FWHM)	<5 nm	<5 nm	<5 nm	<8 nm
Wavelength temperature coefficient	<0.3 nm/°C	<0.3 nm/°C	<0.3 nm/°C	<0.3 nm/°C
Fiber core diameter (nominal)	400 μm	400 μm	400 μm	200 μm
Fiber NA (nominal)		0.22	0.22	0.22
Fiber length	1 m	1 m	1 m	1 m
Fiber output connector	SMA	SMA	SMA	SMA
Operating/Test temperature	20° C	20° C	20° C	20° C
Internal thermistor	NTC 10K Ω	NTC 10K Ω	NTC 10K Ω	NTC 10K Ω
Module size (L x W x H)			88x40x36	
Aiming beam wavelength			635±5nm	
Aiming beam power			>1 mW	
Aiming beam electrical parameters	35 mA, ~2.5V DC (voltage regulated power supply)			

	6013-M000	6014-M000	6015-M000	6017-M000
Output power	≥14 W	≥14 W	≥15 W	≥7 W
Operating current	<55A	<55A	<60A	<40A
Operating voltage	<1.4 V	<1.5 V	<1.5 V	<1.3V
Center wavelength	1380 nm	1470 nm	1532 nm	1710 nm
Wavelength tolerance	± 10 nm	± 10 nm	± 10 nm	± 20 nm
Spectral width (FWHM)	<12 nm	<12 nm	<12 nm	<20 nm
Wavelength temperature coefficient	0.3 nm/°C	0.35 nm/°C	0.35 nm/°C	0.4 nm/°C
Fiber core diameter (nominal)	400 μm	400 μm	400 μm	400 μm
Fiber NA (nominal)		0.22	0.22	0.22
Fiber length	1 m	1 m	1 m	1 m
Fiber output connector	SMA	SMA	SMA	SMA
Operating/Test temperature	20° C	20° C	20° C	20° C
Internal thermistor	NTC 10K Ω	NTC 10K Ω	NTC 10K Ω	NTC 10K Ω
Module size (L x W x H)			88x40x36	
Aiming beam wavelength			635±5nm	
Aiming beam power			>1 mW	
Aiming beam electrical parameters	35 mA, ~2.5V DC (voltage regulated power supply)			

Note: Other configurations (power, wavelength, fiber core size) are available upon request.

Other wavelengths available include 640nm, 1210nm, 1920nm.

6.2 15-pin D-sub connector assignment (TIA option outside of module)



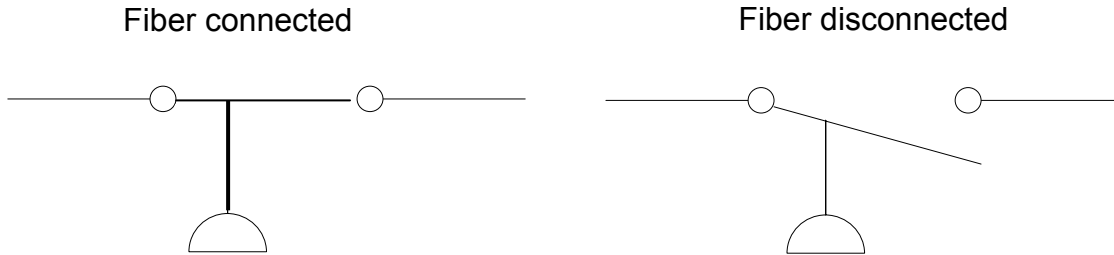
- Pin numbering on the female connector:

Pin number	Assignment
1	Fiber detection sensor
2	Fiber detection sensor
3	To Aiming beam power supply “+”
4	To Aiming beam power supply “-”
5	Monitor Photodiode “+”
6	Monitor Photodiode “-”
7	Optional secondary MPD
8	Optional secondary MPD
9	Not used
10	Optional secondary thermistor
11	Option TBD
12	Option TBD
13	Option TBD
14	Thermistor
15	Thermistor

Table 1: Pin assignment for 15-pin D-sub connector of Ultra-50™ Medica series.

7. Fiber detector

When the output fiber is removed, the electrical connection between pin#1 and pin#2 from the 15-pin Sub-D connector at the rear of module will become open. That action can be used to trigger an interlock or an alarm.



Make sure that the laser is turned off before removing the fiber

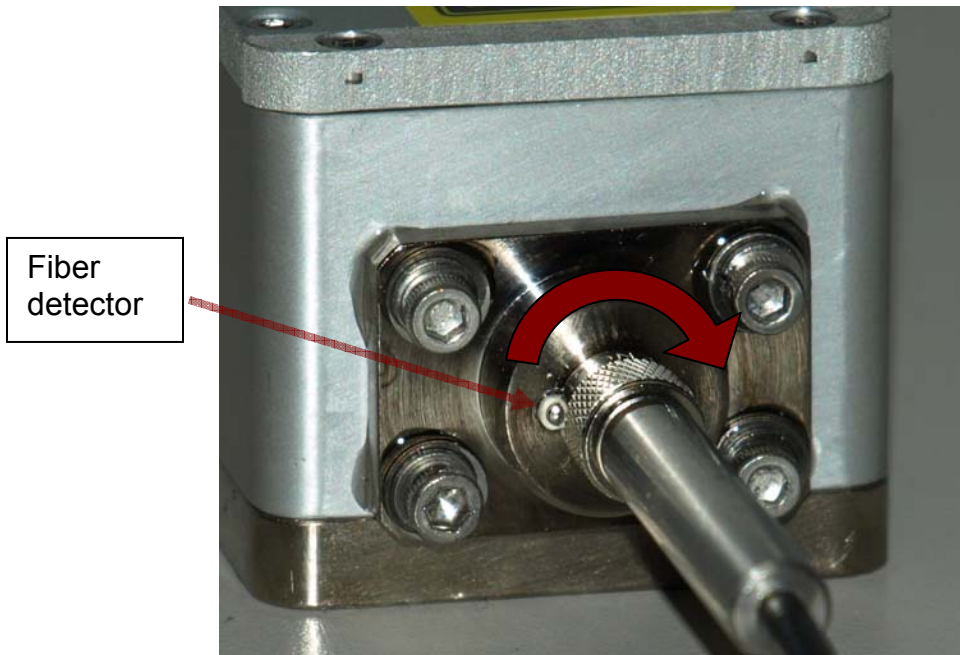


Figure 2: Fiber detection sensor

8. Module dimensions

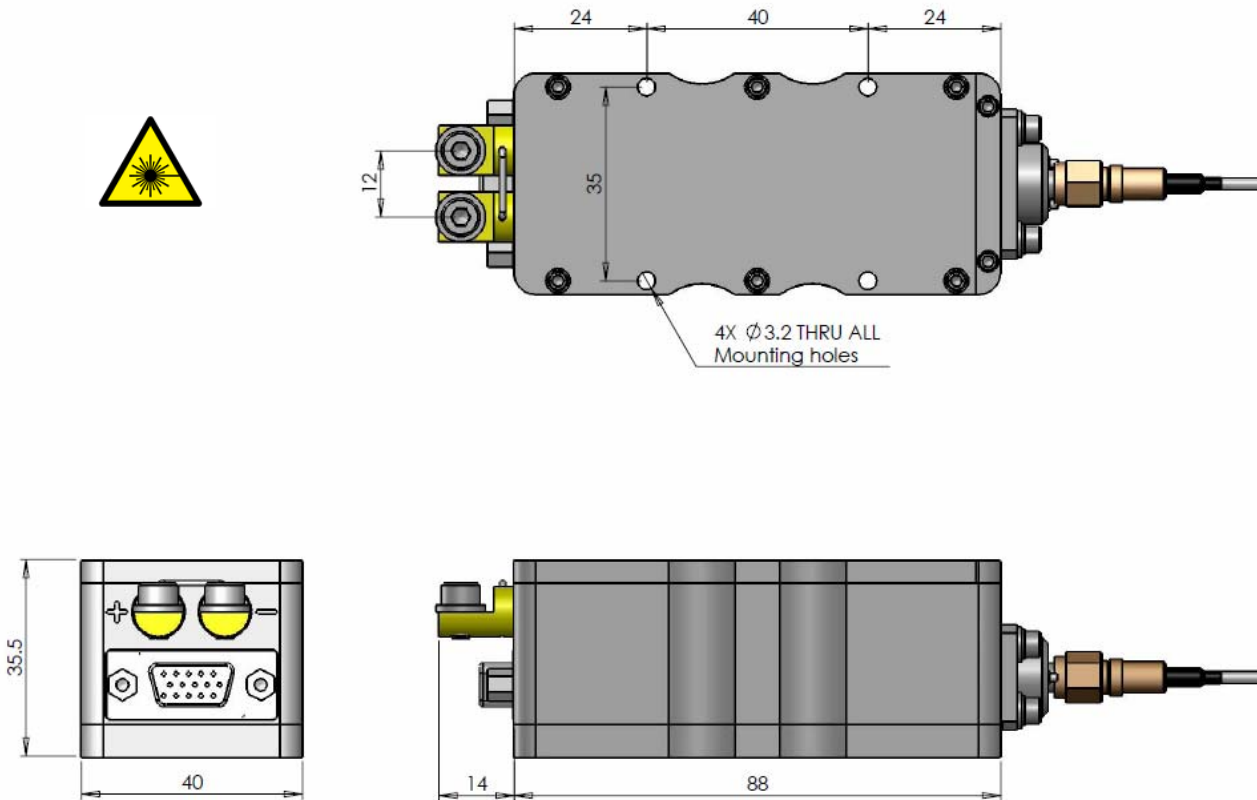








Figure 3: Ultra-50™ MEDICA Module dimensions (units are all in mm)

9. List of related laser products from QPC

Part #	Description	
9903-0001	Ultra-therm™ Thermoelectric Cooler	
9902-0001	Ultra-therm™ Water-cooled chiller	
9900-0001	0-3V Trans-impedance amplifier board	
6xxx-xxxx B1/4 6xxx-xxxx B1/4	Ultra-drive™ Benchtop series of laser systems	
6xxx-xxxx-O1/4 6xxx-xxxx-O1/4	Ultra-drive™ OEM series of laser systems	

 **Note:** None of QPC's accessories have parts that are serviceable by our customers. Please contact QPC in case of malfunction or if maintenance is needed.

10. Thermistors

Two thermistors are installed (second thermistor is optional) inside the Ultra-50™ **MEDICA** module to monitor accurately the base plate temperature of the laser diodes.

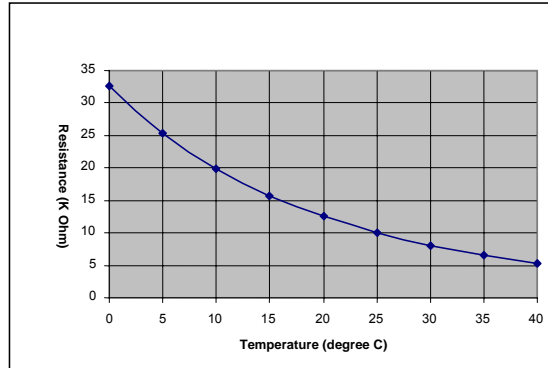


Figure 4: R-T curve of built-in thermistor



11. Aiming beam

This product is a Class 4 laser. Always follow all safety instructions in this manual regarding laser radiation hazards including the viewing of red laser light. Avoid direct eye exposure to red laser light. See safety information in section 1.4.



Use precautionary ESD measures when handling the leads of the aiming beam laser.

1. Make sure that all power supplies are turned off
2. A voltage-regulated, surge free DC power supply with at least 3V compliance voltage is required to power the aiming beam laser.
3. Insure fiber is secure in its mounting fixture and protective cap is removed.
4. Turn on the DC power supply and set voltage to zero.
5. Connect the anode lead for the aiming beam laser diode to the anode of the power supply, repeat for cathode lead.

Parameter	Value
Wavelength	635nm typ., 640nm max
Output power	> 1mW and < 5mW
Power stability	< 5% variation
Operating voltage (DC)	2V-5V (2.6V typical)
CW Operating Current	40mA typ., 50mA max.
Operating Temperature	Same as module
Storage Temperature	Same as module

Table 2: Specifications for red aiming beam

12. Trans-impedance amplifier (TIA) board (Option P/N: 9900-0001)

The TIA board for MPD takes two sources of photodiode current and converts and amplifies to voltage signal. The Converter requires two power supply delivering +15 and -15V DC and gives a voltage output of up to 3 VDC. The board dimensions are 45 mm x 60 mm x 12 mm. Power supplies are not provided by QPC.

The board is located outside of the module housing.

Parameter	Value
Output voltage at maximum power	+3V DC \pm 0.1V
Supply voltage	-15, 0, +15V
Linearity of output voltage	\pm 15% (20-100% of output power)
Offset	minimal offset drift \pm 10mV

Table 3: Specifications for MPD current-voltage conversion board

The voltage converters are calibrated to work with a matching laser module. Please refer to the documentation for the serial numbers of the board and laser module.



Pin Number	Assignment	Circuit Board Assignment
5	Photodiode (1) +	IN1 (2)
6	Photodiode (1) -	IN1 (1)
7	Photodiode (2) +	IN2 (2)
8	Photodiode (2) -	IN2 (1)

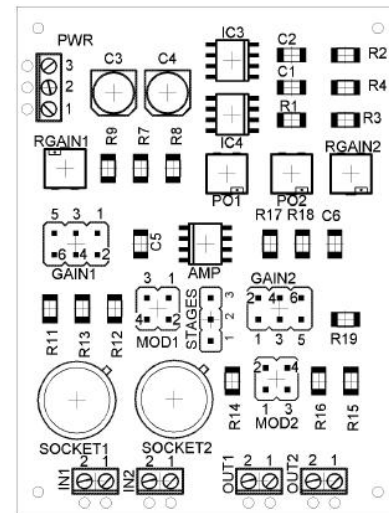


Table 4: Pin assignment for MPD board

- Connection:

1. Connect voltage output leads to screw terminals OUT1 and OUT2. Right pin (1) is the output and left pin (2) equals to ground.
2. Connect the power supply to screw terminal PWR. Use top terminal (3) for negative, middle (2) for GND, and bottom terminal (1) for positive voltage. NOTE: Applying operating voltage with a wrong polarity will destroy the board.
3. Connect the leads from photodiodes to terminals IN1 and IN2. Connect as specified in the following table



13. Ultra-Therm Thermoelectric cooler (Option P/N: 9903-0001)

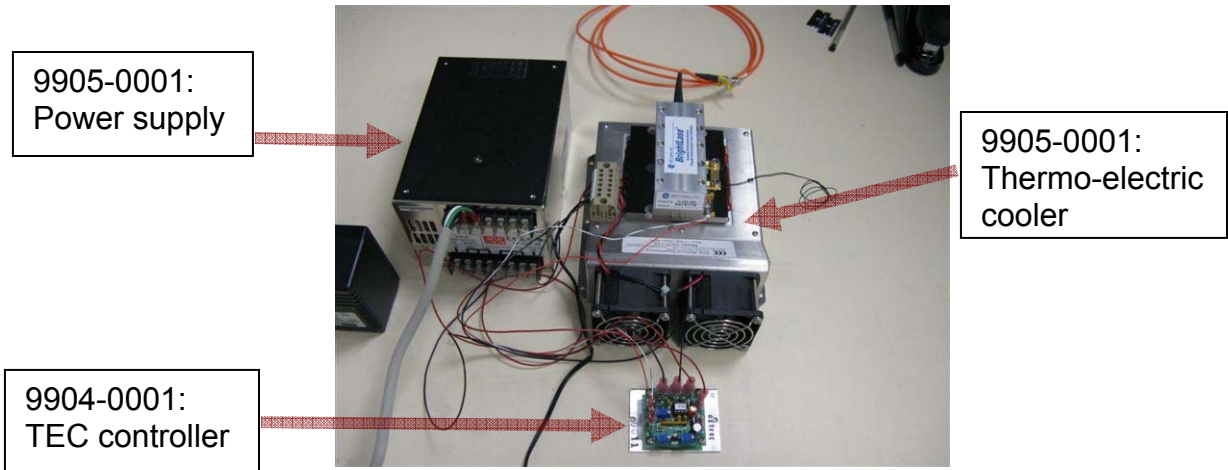


Figure 5: TEC assembly including power supply and feedback electronics

13.1 Overview

QPC’s cooling module uses four high efficiency TEC modules in conjunction with a heat exchanger and two cooling fans to dissipate a maximum thermal load of 110W. It is a high performance cooling module designed for OEM applications for laser products, medical equipments and semiconductor processing. When coupled with the temperature controller unit (9904-0001), the module functions as a highly stable cooling unit for QPC’s Ultra-50 series laser module.

13.2 Specifications

Parameter	Value
9903-0001: Thermo-electric cooling module	
Physical dimensions (mm) (LxWxH)	215 x 163.5 x 69.8
Maximum heat dissipation at 20C	110W
Cooling Fan rated voltage (VDC)	24
9904-0001: TEC controller	
Physical dimensions (mm) (LxWxH)	69.8 x 50.8 x 38.0
Thermistor input	NTC 15kOhm
Power Supply requirements	48V, 10A maximum

Additional option:

9905-0001	TEC controller power supply
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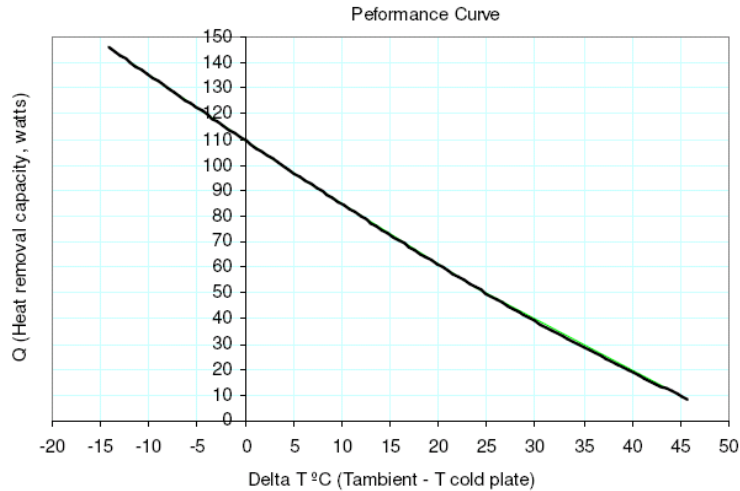


Figure 6: Heat dissipation versus ambient temperature

13.3 Operation

- a. The proportional and integral tuning has been completed during initial component testing. If adjustments are required after delivery, refer to the TEC controller manual for detailed instruction.
- b. The set temperature is adjusted by using the potentiometer marked R7 on the controller board. It is preset to maintain the module temperature at 20C at the operating current and output power.
- c. Turn on the cooling fan power supply before activating the main temperature controller power supply. It is advisable to adopt a first on last off procedure to insure optimal lifetimes for the TEC modules. The cooling fans are oriented to direct the airflow from the back of the module to the front. Insure that there are no obstructions placed immediately in front of the cooling module that could restrict the airflow. The fans can be rotated to draw air from the front and expel behind the module with a slight degradation in cooling efficiency.
- d. Power up the main controller power supply.
- e. Monitoring the Ultra-50 module temperature is done by measuring the resistance of the base mounted 10k thermistor with an ohmmeter.
- f. The Ultra-50 module temperature should stabilize to approximately 20C after a few minutes.
- g. Once the temperature is stable, the Ultra-50 module may be powered up and set to desired output.
- h. If adjustments to the module temperature are required, counterclockwise rotation of the R7 potentiometer screw will decrease the temperature and conversely if an increase in module temperature is needed.
- i. When powering down, turn off the Ultra-50 first, then the power supply to the TEC controller and finally the cooling fan power supply.

14. Ultra-Therm™ Water-cooled chiller (Option P/N: 9902-0001)

14.1 Overview

This high purity chiller is intended for use with QPC's Ultra-50 MEDICA high power fiber-coupled laser modules. The chiller module utilizes an efficient refrigeration unit coupled to a compact stainless steel heat exchanger. This refrigerant-to-water heat exchanger (brazed plate design) removes the heat from the recirculating water (process coolant) loop. The compressor is operated in a continuous run mode for optimum reliability and accurate temperature control of the process coolant. The chiller units are fabricated with premium materials contacting the process coolant. These premium materials minimize the possibility of contaminating the heat source and increase overall system reliability.

The rack-mount configuration offers many user friendly features to minimize maintenance efforts. Monitoring and reporting of critical performance parameters (i.e. process coolant flow / level, compressor over-temperature, & process coolant temperature alarm) are available features. The units utilize magnetically coupled centrifugal or magnetically coupled sliding vane style pumps that offer quiet and near vibration free operation and maximum lifetime, with no periodic maintenance required.

14.2 Specifications

Parameter	Value
Model Number	9902-0001
Cooling Capacities	800 W
Heat Dissipation	Dissipate heat to ambient air via fan
Process Coolant Temperature Range	5-35°C
Ambient Temperature Range	15-35°C
Process Coolant Temperature Stability	±0.1°C
Input Power Requirements	100, 120, 200, 208, 230 Volts AC 50 or 60 Hz, Single phase
Full Load Amperage (typical)	3.5 Amps @ 120, 1.8 Amps @ 230 VAC
Weight	49-55 dry lbs, 22-25 kg
Cabinet Dimensions (WxDxH)	435 mm x 438 mm x 221 mm
Communications (RS-485)	Optional Feature: Serial communications

Table 5: Specifications of Ultra-Therm™ water-cooled chiller (P/N: 9902-0001)

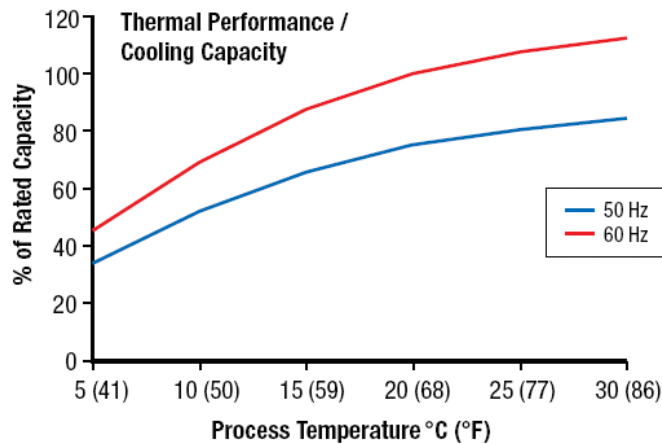


Figure 7: Thermal performance of QPC's Ultra-Therm™ water-cooled chiller

14.3 Integration

- Preparation of chiller



Make sure that the chiller and laser are tuned off for the next steps:

1. A field selectable transformer is available, located in the back of the chiller. This option allows voltage inputs of 100, 120, 200, 208, & 230 / 50-60 Hz. Insert the appropriate plug into the circuit.
2. Access the tank lid via the fill cover at the top of the cabinet & use the funnel provided to fill the process water tank. Fill the tank ½" from bottom of tank neck.
3. Remove cover to view full mark on tank. Over filling will cause excessive tank pressure & leaking will result. Fill the chiller module using only high quality distilled or deionized water. Longer running operation without maintenance can be obtained by mixing 15% of glycol with 85% de-ionized water.
4. Adjust the setting flow rate. Remove first the black plastic cap at the back of the chiller. Modify switch #5, 6, 7, and 8 ONLY as shown in diagram to obtain proper flow rate.
5. If voltage is 120V/60Hz, select 0.75 gallons/mn. Pressure should be <10 psi during operation. If voltage is 230V/50Hz, select 1.1 gallons/mn.



Do not control flow rate with an external valve, the positive displacement pump model pdm will increase pressure to maintain constant flow rate which can damage the pump and the chiller

6. Attach instant tube fitting provided by QPC to chiller's inlet and outlet. Note the direction of the process coolant flow. The bulkhead fitting marked "Supply" is the process water pump discharge
7. Insert the rigid tubing provided by QPC into connectors on chiller and module. Push the tubing inside the connector and make sure that connections are secure.

- Operation of the chiller

1. Energize the “PUMP” switch on the front panel to circulate the process coolant. Note that the condenser fan and the digital controller are energized at this time. The system heater will be energized if the “Actual” process water temperature is below the “Set” value selected on the front panel display.
2. Energize the “COOL” switch also located on the front panel. This switch energizes the system compressor. The “Actual” process coolant temperature is the upper of the two displays and provides the real-time process coolant temperature in °C or °F w/ 0.1° resolution. To access the “Set” process coolant temperature value, press the “Up” or “Down” arrow keys marked ▲ / ▼ until the new desired set value (bottom displayed temperature) is reached. Let go of the “Set Key” and the new set point is entered.
3. Do not operate in ambient temperature above 35°C.



14.4 Dimensions

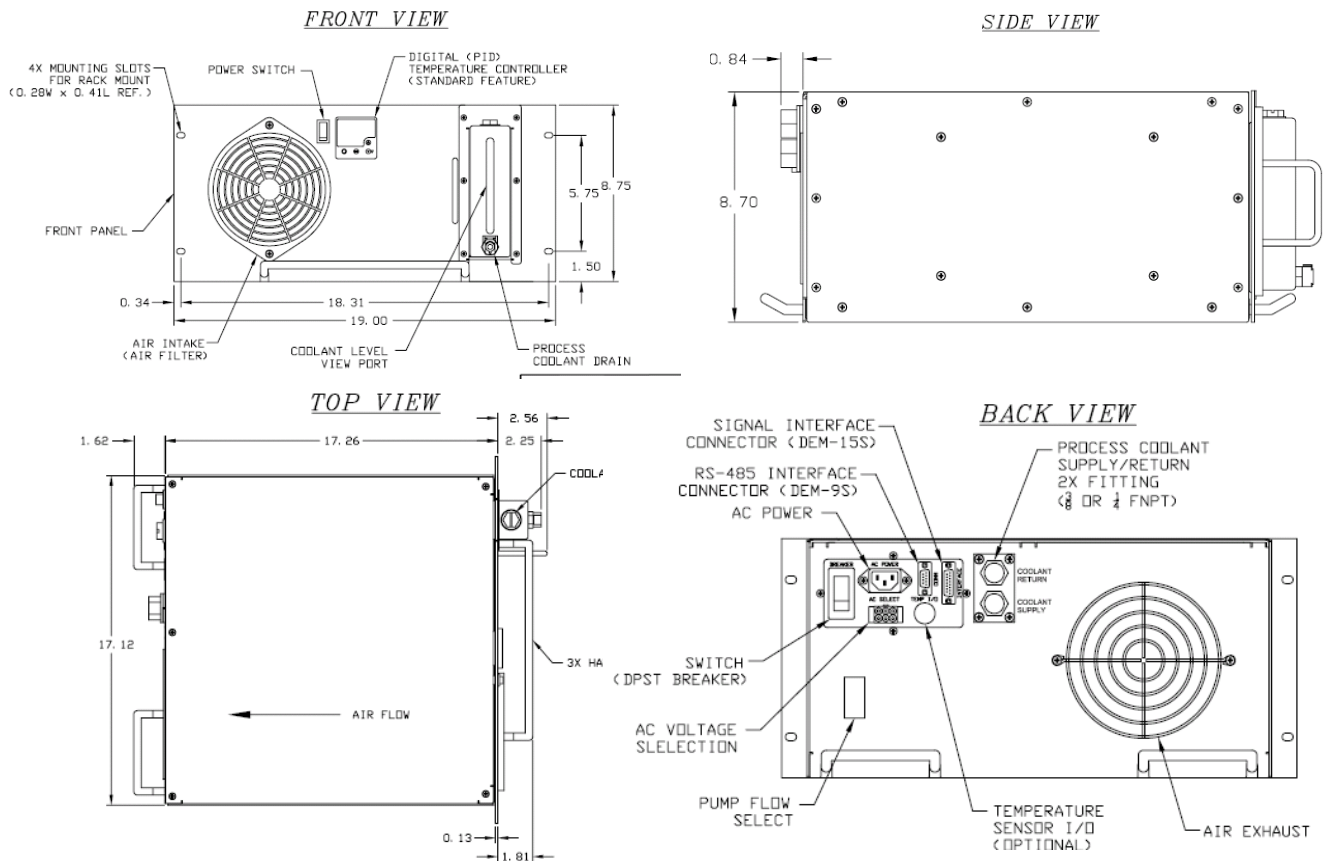


Figure 8: Water-cooled chiller controls and dimensions

Note: A custom water-cooled plate designed for the Ultra-50™ MEDICA is also available upon request.

15. STANDARD TERMS AND CONDITIONS OF SALE

1. LIMITS OF AGREEMENT. The terms and conditions as set forth herein as well as any additional terms and conditions that may appear on the face hereof shall constitute the entire agreement between Quintessence Photonics Corporation ("Seller") and Buyer. Seller will not be bound by any terms of Buyer's order that are inconsistent with the terms herein. Acceptance by Buyer of these terms may be made either (a) by written acceptance, or (b) by receipt by Buyer of delivery of any products described on the face of this Form ("Products") and failure by Buyer to return the Products within five (5) days following such delivery. The Agreement shall not be modified except in writing, signed by the parties hereto. No waiver by Seller of any default or provision hereof shall be deemed a waiver of any subsequent default or provision.

2. PRODUCTS PROVIDED AND PRICE.

- (a) Unless otherwise provided on the front of this form, products furnished hereunder shall be newly manufactured products but may contain components which have been previously used in other product units. Any such previously used components have been disassembled, reprocessed and reassembled, as appropriate, and meet or exceed the Seller's specifications for newly manufactured components.
- (b) The price of all Products unless otherwise specifically stated on the face hereof is F.O.B. carrier, at the place of manufacture or warehouse location, which is the address set forth on the face hereof, exclusive of insurance cost. The cost of packaging for normal domestic shipment is included in the invoiced price. Where special domestic or export packaging is specified, involving greater expense, a charge will be made to cover such extra expense.
- (c) Prices and orders do not include Federal, State or local excise, sales, use or other taxes now or hereinafter enacted, which are applicable to the Products sold hereunder or this transaction (excluding only taxes based on Seller's income), which tax or taxes will be added by Seller to the sales price when Seller has the legal obligation to collect the same and will be invoiced to and paid by Buyer, unless Buyer provides Seller with a proper tax exemption certificate. In the event Seller is required to pay any such tax, fee or charge at the time of sale or thereafter, the Buyer shall reimburse Seller therefore.
- (d) Prices quoted are for the Products and services described on the face hereof only and do not include technical data, proprietary rights of any kind, patent rights, qualification, environmental or other than Seller's standard tests unless expressly agreed to in writing by Seller.
- (e) Unless otherwise stated by Seller in writing, all quotations are firm for, and expire, sixty (60) days after date thereof and constitute offers.

3. PAYMENT TERMS.

- (a) Unless otherwise stated on the front of this form, the terms of the sale are net 30 from date of invoice. Seller reserves the right to require alternative payment terms, including, without limitation, sight draft, letter of credit or payment in advance. All payments shall be made to seller at its principal office Sylmar, California, or such other office as designated on the face hereof. Interest accrues on overdue invoices at the rate of one and one-half percent (1 ½%) per month, but not more than the amount allowed by law, on the unpaid balance from the original due date of the invoice. Payment shall not be withheld for delay in installation if at Buyer's request nor for delay in delivery of required documentation unless a separate price is stated therefore, and only to the extent of the prices stated.
- (b) All orders are subject to, and the obligation of Seller to make deliveries is subject to, the right of the Seller as provided in paragraph 11, to require of the Buyer payment of all or any part of the purchase price in advance of delivery or to make shipment C.O.D. If the Buyer fails to make advance payment when requested by Seller, or if the Buyer is or becomes delinquent in the payment of any sum due Seller (whether or not arising out of this order) or refuses to accept C.O.D. shipment, then Seller shall have the right, in addition to any other remedy to which it may be entitled in law or equity, to cancel the sales order, refuse to make further deliveries, and declare immediately due and payable all unpaid amounts for goods previously delivered to the Buyer. Partial shipments made under any order shall be treated as a separate transaction and payment thereof shall be made accordingly. However, in the event of any default by Buyer, Seller may decline to make further shipments without in any way affecting its rights under such order.
- (c) Seller reserves a purchase money security interest in the Products sold hereunder and the proceeds thereof, in the amount of the purchase price. In the event of default by Buyer on any of its obligations to Seller, Seller will have the right to repossess the goods sold hereunder without liability to Buyer. In such event, Buyer agrees to make the Products available to Seller so that Seller can repossess them without a breach of the peace. This security interest will be satisfied by payment in full. A copy of the invoice may be filed with appropriate authorities at any time as a financing statement and/or chattel mortgage to perfect Seller's security interest. Buyer shall cooperate fully with Seller to execute such other documents and to accomplish such filings and/or recordings thereof as Seller may deem necessary for the protection of Seller's interests in the Products furnished hereunder.

4. TRANSPORTATION AND RISK OF LOSS.

- (a) Unless otherwise agreed to in writing by Seller, all transportation shall be at the expense of Buyer, Seller reserving the right to ship Products freight collect and to select the means of transportation and routing. Unless otherwise advised, Seller may insure to full value of the Products or declare full value thereof to the transportation company at the time of delivery and all such freight and insurance costs shall be for Buyer's account. Risk of loss or damage shall pass to Buyer upon delivery of the Products to the transportation company at the FOB point, whether or not installation is provided by or under supervision of Seller.
- (b) Seller may at its option obtain insurance for its Products covering their delivery to Buyer and Buyer agrees to reimburse Seller for the cost of providing such insurance. If Buyer has not been notified of the existence of insurance coverage and provides its own insurance for such shipment Seller will waive its insurance charge.
- (c) Confiscation or destruction of, or damage to Products shall not release, reduce or in any way affect the liability of Buyer therefore. Notwithstanding any defect or nonconformity, or any other matter, such risk of loss shall remain in Buyer until the Products are returned at Buyer's expense to such places as Seller may designate in writing. Buyer, at its expense, shall fully insure Products against all loss or damage until Seller has been paid in full therefore, or the Products have been returned, for whatever reason, to Seller.

5. SHIPMENT.

Seller will attempt to meet shipment schedules. However, any shipment quotation or forecast on an order acknowledgment is only an estimate of the time required to make shipment and Seller will not assume liability, consequential or otherwise, because of any delay or failure to deliver all or any part of any order for any reason, including its active or passive negligence. Seller reserves the right to allocate inventories and current production in any way it deems desirable.

6. INSPECTION AND ACCEPTANCE.

The Buyer shall have the right to inspect the goods upon tender of delivery. Failure of the Buyer to inspect the goods and give written notice to the Seller of any alleged defect or nonconformity within thirty (30) days after tender of delivery shall constitute an irrevocable acceptance by Buyer of the goods delivered to him, provided the goods for which Seller agrees in writing to provide installation by its personnel, shall be deemed accepted by Buyer upon completion by Seller of its applicable acceptance tests or execution of Seller's acceptance form by Buyer. Notwithstanding the foregoing, use of any such goods by Buyer, its agents, employees or licensees, for any purpose after delivery thereof, shall constitute acceptance of the goods by Buyer.

7. RETURNS.

The Products may not be returned to Seller without first obtaining Seller's consent. The request for return *for repair and/or credit* must be filed with Seller and shall include purchase order number, approximate date shipped and any and all other Quintessence Photonics Corporation Page 2 of 2 Standard Terms and Conditions identifying numbers (such as invoice number, date of invoice, P.O. numbers, etc.). Each request for return of Products for credit should state the type and quantity of goods, the part numbers and the reasons for the return. If return authorization is granted, Products shall be returned in a clean, well packaged condition. No credit allowance on defectives will be made and no replacement for defectives will be shipped in any event, unless the alleged defectives are, among other things, established to Seller's satisfaction after suitable testing and inspection by Seller.

8. TERMINATIONS.

Any order for a standard Product with a published price accepted by Seller and terminated by Buyer prior to shipment, shall be subject to a termination charge of not less than ten percent (10%) of the order value to cover costs of processing and order handlings. Termination thereof within thirty (30) days before shipment shall be subject to a written acceptance by Seller and termination charge of not less than twenty-five percent (25%) of the order value; thereafter no such order may be terminated except by mutual agreement in writing. No order for nonstandard products or products without a published price may be terminated by Buyer except by mutual agreement in writing. Terminations by mutual agreement are subject to the following conditions:

- (a) Buyer will pay, at applicable contract prices, for all Products which are completely manufactured and allocable to Buyer at the time of Seller's receipt of notice of termination;
- (b) Buyer will pay all costs, direct and indirect, which have been incurred by Seller with regard to Products which have not been completely manufactured at the time of Seller's receipt of notice of termination, plus a pro rata portion of the normal profit on the contract;
- (c) Buyer will pay a termination charge on all other Products affected by the termination. Seller's normal accounting practices shall be used to determine costs and other charges. To reduce termination charges, Seller will divert completed parts, material or work-in-progress from terminated contracts to other customers whenever, in the Seller's sole discretion, it is practicable to do so. In the event of a termination, Buyer will have no rights in partially completed goods.

9. LIMITED WARRANTY—LIMITATION OF REMEDIES.

- (a) Except as otherwise specified herein, Seller warrants the Products:
 - (1) To be free from defects in material and workmanship for a period of time and under such conditions as specified in Seller's warranty for the individual Product, or for three (3) months from shipment if a warranty for an individual Product is not specified, and
 - (2) To perform in the manner and under the conditions as specified in Seller's warranty for the individual Product or for three (3) months from shipment if a warranty for an individual product is not specified.
- (b) This warranty is the only warranty made by Seller with respect to the Products and no representative or person is authorized to bind Seller for any obligations or liabilities beyond the warranty in connection with the sale of Seller's goods. This warranty is made to the original purchaser only at the original location and is nontransferable, and may only be modified or amended by a written instrument signed by a duly authorized officer of Seller. Major sub-systems manufactured by other firms but integrated into Seller's system are covered by the original manufacturer's warranty and Seller makes no warranty, express or implied regarding such sub-systems. Goods or parts which are replaced or repaired under this warranty are warranted only for the remaining unexpired portion of the original warranty period applicable to the specific product.
- (c) These remedies are available only if Seller is notified in writing by Buyer promptly upon discovery of the defect, and in any event within the warranty period for the individual Product, Seller's examination of such goods discloses to Seller's satisfaction that such defects actually exist and the goods have not been (i) repaired, worked on, or altered by persons not authorized by Seller so as, in Seller's sole judgment, to injure the stability reliability, or proper operation of such goods; (ii) subject to misuse, negligence or accident; or (iii) connected, installed, used or adjusted otherwise that in accordance with the instructions furnished by Seller.
- (d) All Products which Buyer considers defective shall be returned to Seller's office as designated on the face hereof transportation costs prepaid and borne by Buyer (unless otherwise provided on the face hereof). The risk of loss of the goods shipped or delivered to Seller's plant for repair or replacement will be borne by Buyer.

- (e) If it is found that any Product has been returned without cause and is still serviceable, Buyer will be notified and the Product returned at Buyer's expense. In addition, a charge for testing and examination may, in Seller's sole discretion, be made on Products so returned.
- (f) THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES (EXCEPT FOR SPECIFIC WRITTEN PRODUCT PERFORMANCE GUARANTEES) WHETHER WRITTEN, ORAL OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, AND SHALL BE THE BUYER'S SOLE REMEDY AND SELLER'S SOLE LIABILITY ON CONTRACT OR WARRANTY OR OTHERWISE FOR THE PRODUCT.

10. SELLER'S RIGHTS TO SUBCONTRACT.

Seller may subcontract any portion of the work on any item subject to this Agreement, but Seller's obligations and rights hereunder shall not thereby be limited or affected.

11. BANKRUPTCY OR INSOLVENCY OF BUYER.

If the financial conditions of the Buyer at any time is such as to give Seller, in its judgment, reasonable grounds for insecurity concerning Buyer's ability to perform its obligations under this agreement. Seller may (a) by notice in writing to Buyer, cancel this agreement, without judicial intervention or declaration of default of Buyer and without prejudice to any right or remedy which may have accrued or may accrue thereafter to Seller, (b) require full or partial payment in advance and suspend any further deliveries for continuance of the work to be performed by Seller until such payment has been received or (c) make shipments C.O.D.

12. PROPRIETARY RIGHTS.

The sale of the Products hereunder to Buyer shall in no way be deemed to confer upon Buyer any right, interest or license in any patents or patent applications or design copyrights the Seller may have covering the Products. Seller retains for itself all proprietary rights in and to all designs, engineering details, and other data and materials pertaining to any Products supplied by Seller and to all discoveries, inventions, patents and other proprietary rights arising out of the work done by Seller in connection with the Products or with any and all Products developed by Seller as a result thereof, including the sole right to manufacture any and all such Products. Buyer warrants that it will not divulge, disclose, or in any way distribute or make use of such information, and that it will not manufacture or engage to have manufactured such Products.

13. EQUAL OPPORTUNITY.

Seller certifies that it has developed and has on file affirmative action programs as required by the rules and regulations of Executive Order 11246, as amended and 41 C.F.R. Chapter 60-2.2, issued by the Department of Labor. In addition, Seller is in full compliance with section 503 of the Rehabilitation Act of 1973 and section 402 of the Vietnam Era Veterans Readjustment Assistance Act of 1974.

14. ERRORS.

Stenographic and clerical errors are subject to correction.

15. APPLICABLE LAW; JURISDICTION AND VENUE.

This agreement will be governed by the laws of the State of California. The California state courts will have exclusive jurisdiction and venue over any dispute arising out of this agreement, and Buyer hereby consents to the jurisdiction of such courts.

16. LIMITATION OF LIABILITY.

- (a) Seller will not be liable for any loss, damages or penalty resulting from delay in delivery of the Products when such delay is due to causes beyond the reasonable control of Seller, including without limitation, supplier delay, force majeure, act of God, labor unrest, fire, explosion or earthquake. In any such event, the delivery date will be deemed extended for a period equal to the delay.
- (b) SELLER'S LIABILITY UNDER, FOR BREACH OF, OR ARISING OUT OF THIS AGREEMENT AND/OR SALE WILL BE LIMITED TO REPAIR OR REPLACEMENT OF ANY DEFECTIVE PRODUCTS OR A REFUND OF THE PURCHASE PRICE OF THE PRODUCTS, AT SELLER'S SOLE OPTION, AS SET FORTH IN PARAGRAPH 9 ABOVE. IN NO EVENT WILL SELLER BE LIABLE FOR COSTS OF PROCUREMENT OF SUBSTITUTED PRODUCTS BY BUYER, NOR WILL SELLER BE LIABLE FOR ANY SPECIAL, CONSEQUENTIAL, INCIDENTAL OR OTHER DAMAGES INCLUDING WITHOUT LIMITATION LOSS OF PROFIT WHETHER OR NOT SELLER HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH LOSS HOWEVER CAUSED, WHETHER FOR BREACH OR REPUDIATION OF CONTRACT, BREACH OF WARRANTY, NEGLIGENCE OR OTHERWISE. THIS EXCLUSION INCLUDES ANY LIABILITY THAT MAY ARISE OUT OF THIRD PARTY CLAIMS AGAINST BUYER. THE ESSENTIAL PURPOSE OF THIS PROVISION IS TO LIMIT THE POTENTIAL LIABILITY OF SELLER ARISING OUT OF THIS AGREEMENT AND/OR SALE.

17. SUBSTITUTIONS AND MODIFICATIONS.

Seller will have the right to make substitutions and modifications at the specifications of Products sold by Seller, provided that such substitutions or modifications will not materially affect overall Product performance.

18. ATTORNEY'S FEES AND COSTS.

Reasonable attorney's fees and costs will be awarded to the prevailing party in the event of litigation involving the enforcement or interpretation of this agreement.