



PCM-7700

Pulsed Current Source

Operation Manual



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Manual Document 7650-0015, Rev. A03

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Safety

- Always refer to the safe operating section of the manual for your model of the PCM-7700 system.
- Do not open the cover of the PCM-7700. There are no user-serviceable parts inside. Opening the cover exposes you to shock and voids the factory warranty.
- Do not install, handle, or remove the output cables or laser diode while the PCM-7700 is operating. Allow at least 10 minutes after powering down before handling the output cable or laser diode.
- Do not use this device in a manner not specified by the manufacturer.
- Allow sufficient space around this device for air circulation. Cooling air enters the rear of the chassis and exits the front of the chassis.
- Do not use where liquids are present or in corrosive environments. Clean this instrument by wiping with a dry or damp cloth.

WARNING

Risk of lethal electric shock. Do not open the cabinet of this device. Do not touch the output or laser diode while it is operating. This device produces LETHAL levels of electric current, both inside its cabinet and at its output.

DO NOT OPERATE THIS DEVICE UNLESS ANOTHER PERSON, CAPABLE OF RENDERING FIRST AID OR RESUSCITATION, IS PRESENT.

SAFE AND PROPER OPERATION OF THIS DEVICE IS THE RESPONSIBILITY OF THE USER.

Directed Energy, Inc. (DEI) provides information on its products and associated hazards, but it assumes no responsibility for the after-sale operation and safety practices.

Safe Operating Area

This section contains Safe Operating Area (SOA) graphs for all PCM-7700 models.

IMPORTANT: Do not operate the instrument outside of the Safe Operating Area!

Although the PCM-7700's external triggering system allows it to operate outside the Safe Operating Area, such operation will result in permanent damage to the PCM-7700, the laser diode, or both.

Below the line of each graph represents operating parameters for which the instrument functions safely and all pulse specifications are met.

Here is an example of how to use the SOA graph to calculate maximum pulse width:

Assume the laser is rated at 25 V 200 W, the pulser is a PCM-7700-48, and the desired pulse is 200 A at 1 Hz.

According to the PCM-7700-48 SOA graph, at 25 V the maximum output power is 170 W.

In this case the instrument (170 W), not the laser diode (200 W), is the limiting factor. If the diode rating were 100 W instead, you would use the laser's maximum power and not the SOA value in the next step.

Find the maximum duty cycle:

$$\text{power} = \text{voltage} * \text{current} * \text{duty_cycle}$$

Re-arranging the equation:

$$\text{duty_cycle} = \text{power} / \text{voltage} * \text{current}$$

$$\text{duty_cycle} = 170 \text{ W (SOA graph)} / [25 \text{ V (laser forward voltage)} * 200 \text{ A}] = 0.034$$

Find the period:

$$\text{period} = 1 / \text{frequency} = 1 / 1 \text{ Hz} = 1.00 \text{ s}$$

Find the maximum pulse width:

$$\text{maximum pulse width}^* = \text{period} * \text{duty_cycle} = 1.00 \text{ s} * 0.034 = 34 \text{ ms}$$

*The absolute maximum pulse width should never exceed 50 milliseconds, even in single shot operation.

In the above example the pulse width will need to be 34 ms or less for the instrument to operate in the Safe Operating Area (SOA).

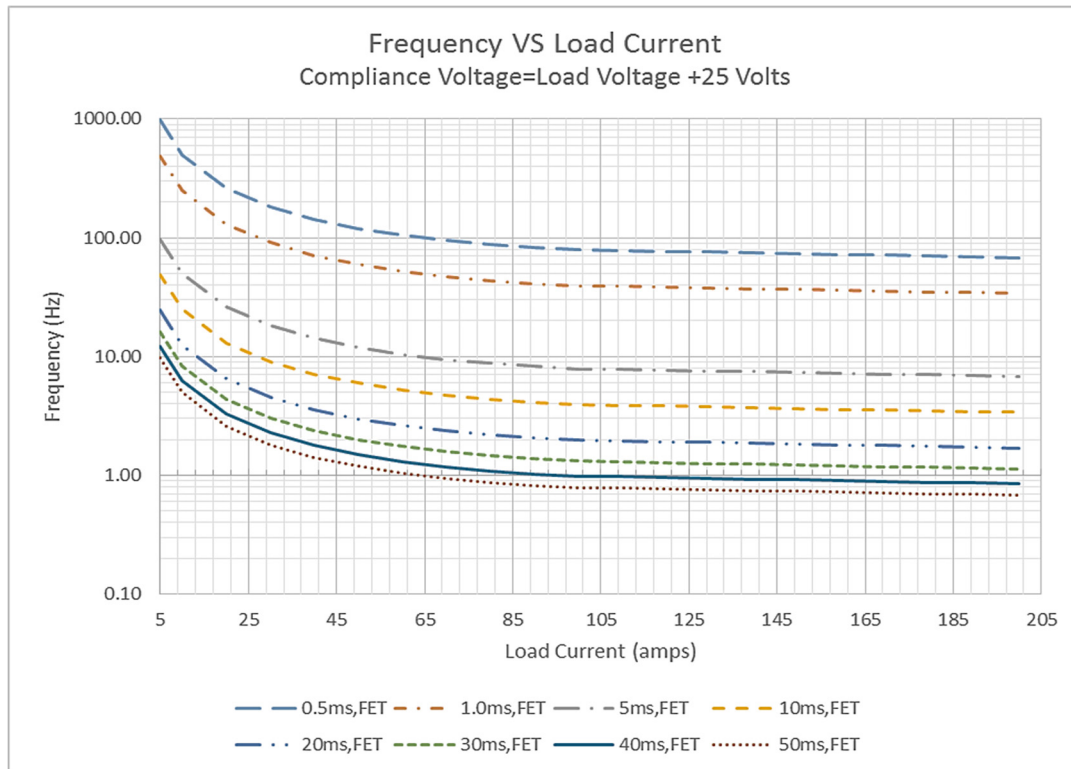
To calculate the maximum pulse width for a single-shot pulse, use 1 Hz as the pulse frequency. Remember, the output pulse width should never exceed 50 milliseconds.

❖ Safe Operating Area Graphs

IMPORTANT: Do not operate the instrument outside of the Safe Operating Area!

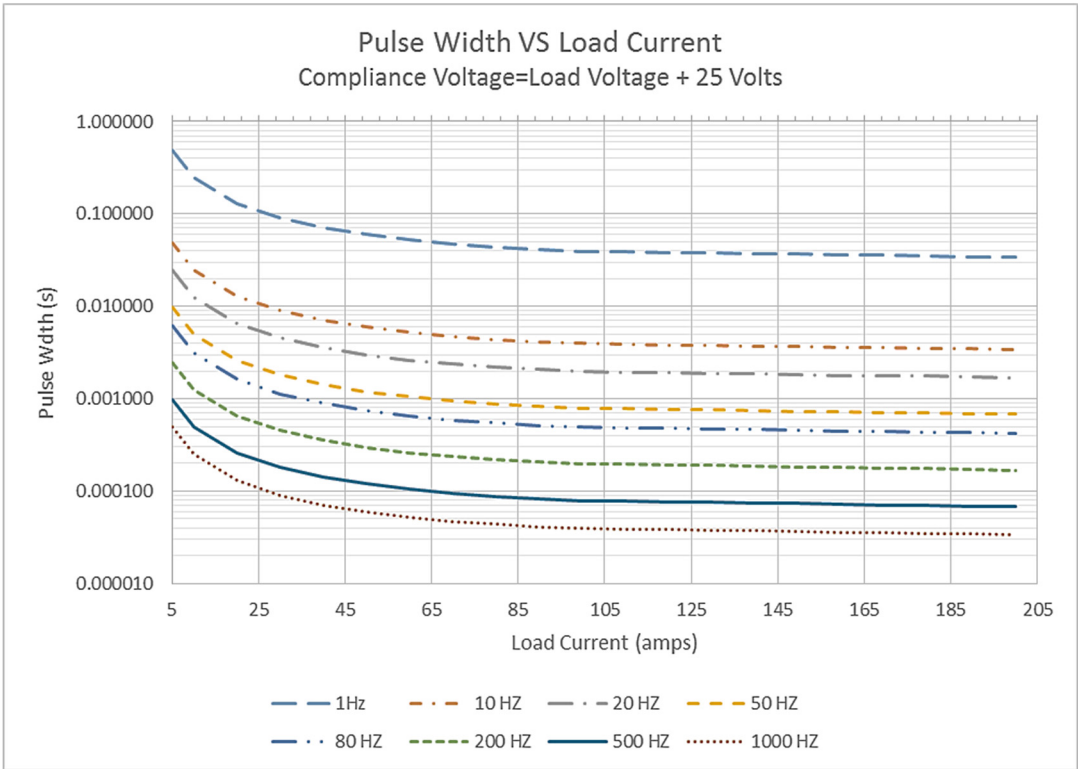
Although the PCM-7700's external triggering system allows it to operate outside the Safe Operating Area, such operation will result in permanent damage to the PCM-7700, the laser diode, or both.

The Safe Operating Area is below the line of each graph. Only operate the instrument in this Safe Operating Area.

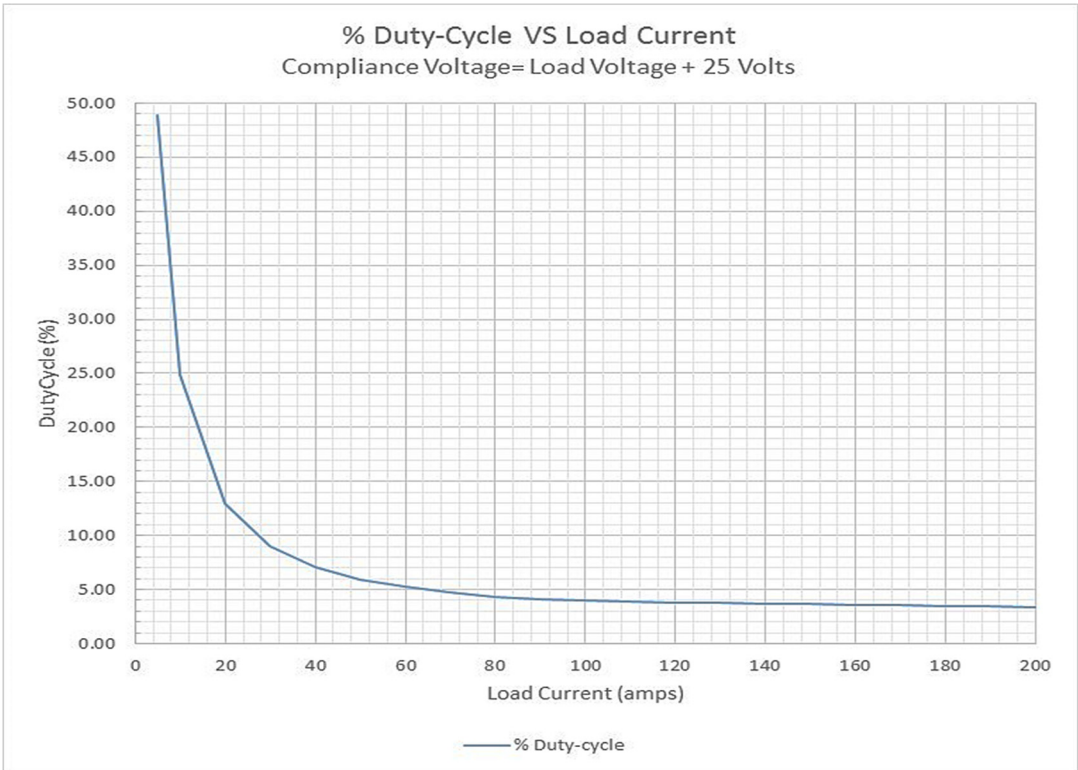


PCM-7700-48

The Safe Operating Area is below the line of each graph. Only operate the instrument in this Safe Operating Area.

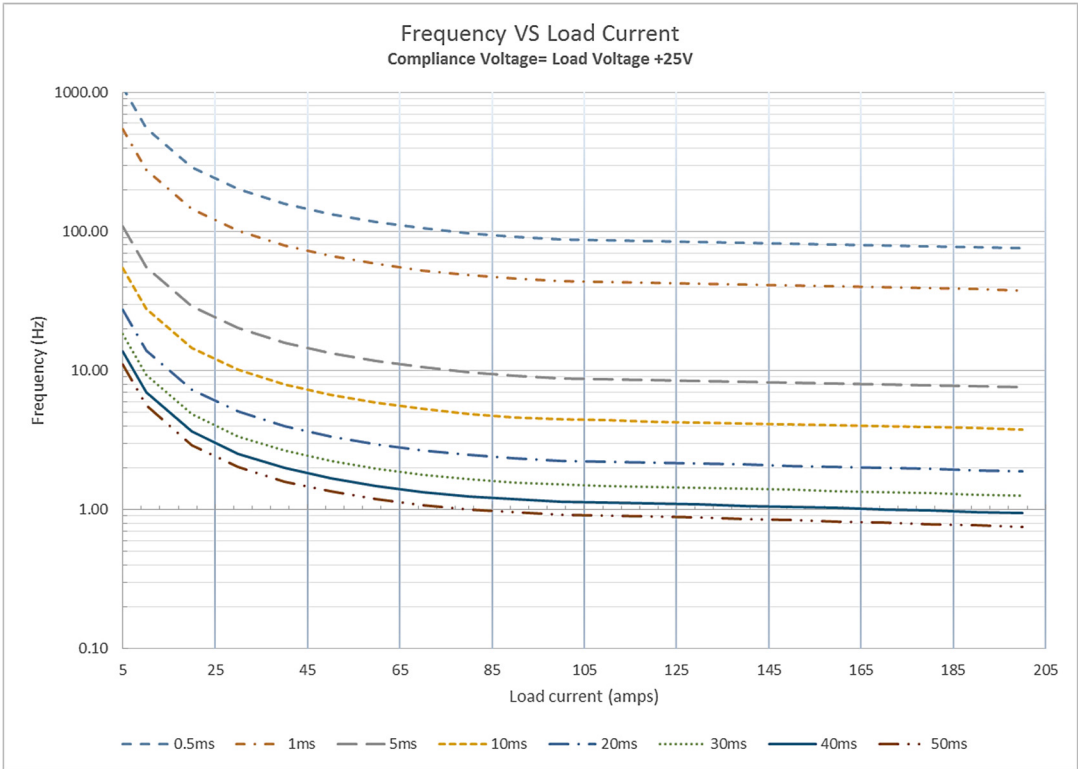


PCM-7700-48

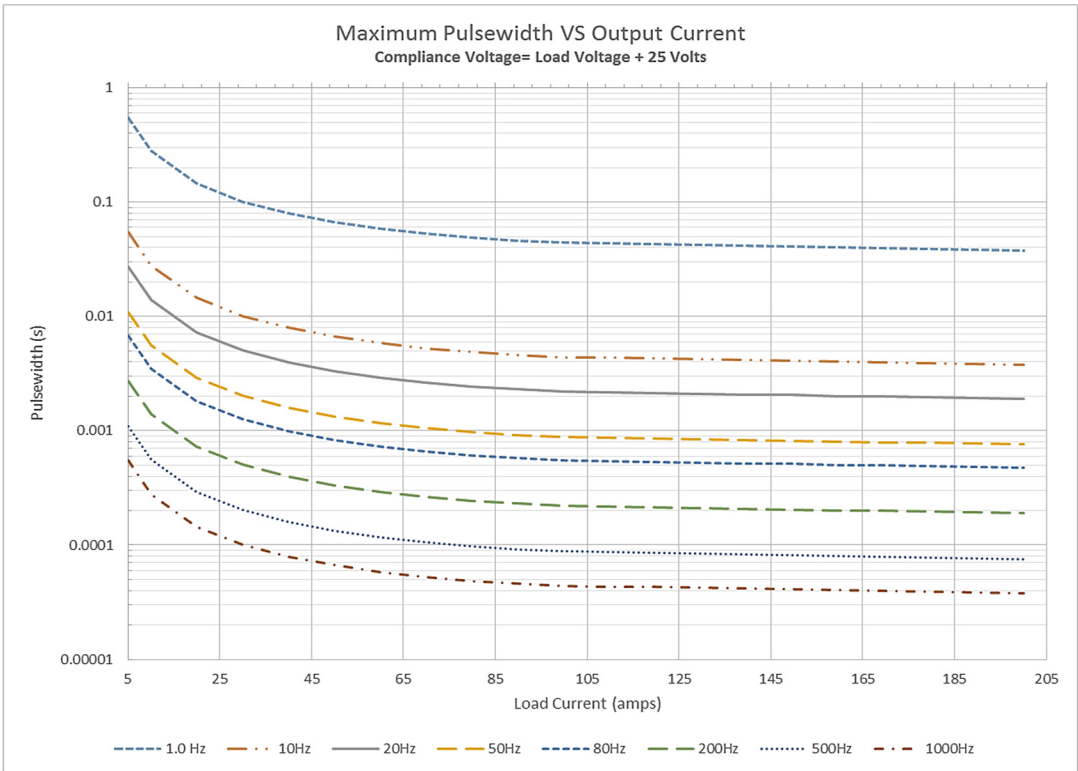


PCM-7700-48

The Safe Operating Area is below the line of each graph. Only operate the instrument in this Safe Operating Area.

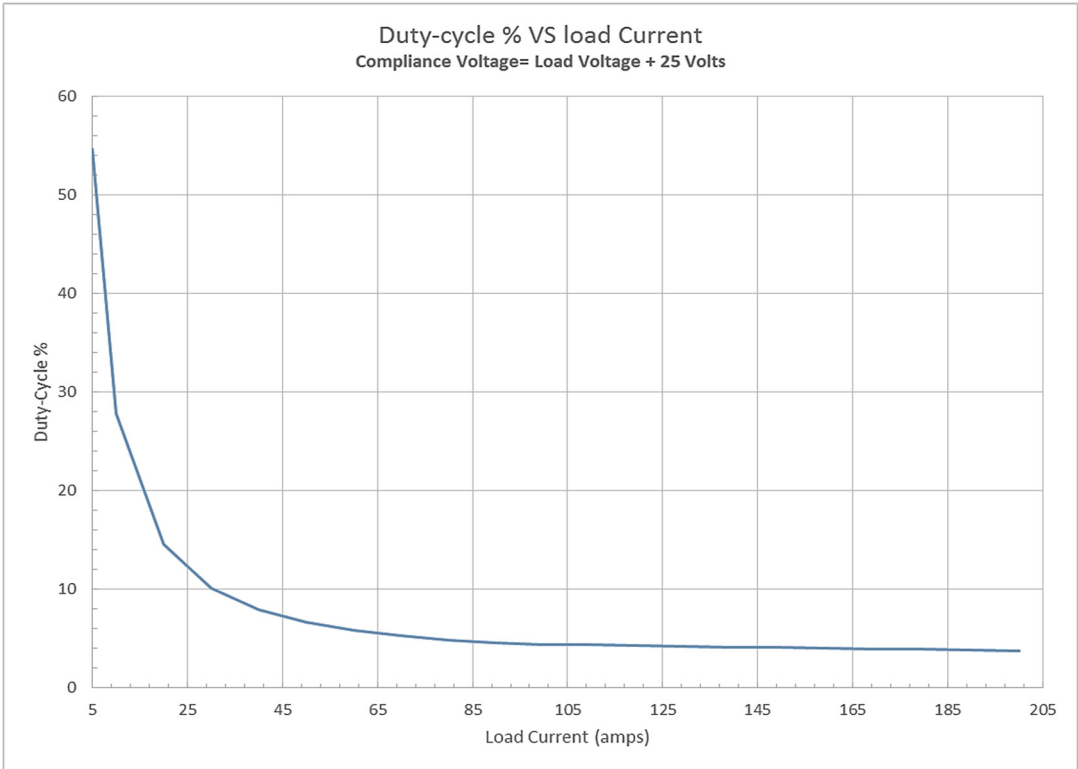


PCM-7700-EX



PCM-7700-EX

The Safe Operating Area is below the line of each graph. Only operate the instrument in this Safe Operating Area.



PCM-7700-EX

Introduction

❖ Description

The PCM-7700 is an air-cooled, high-power current source designed to drive laser diodes, bars, and arrays. The output current can be set from 5 A to 200 A. The load voltage for the PCM-7700-48 is 0 V to 25 V, and for the PCM-7700-EX is 0 V to 25 V. The pulse width is from 500 μ s to 50 ms with a pulse repetition rate of single-shot to 1 kHz.

There is a convenient front panel DB-15 connector with the trigger, current monitor, voltage monitor, current setpoint, and enable connections.

The included evaluation board has all the necessary controls for the user to begin testing immediately. The evaluation board has the trigger, current monitor, voltage monitor, current setpoint, and enable connections easily accessible with BNC cables. The impedance of the trigger input is 50 Ω .

The PCM-7700 output current maybe set with a potentiometer on an included evaluation board, or an analog voltage via a BNC connection on the evaluation board. You must remove the potentiometer if using the analog voltage on the BNC connector. The current may also be set directly through pin 6 of the DB-15 connector on the front of the system.

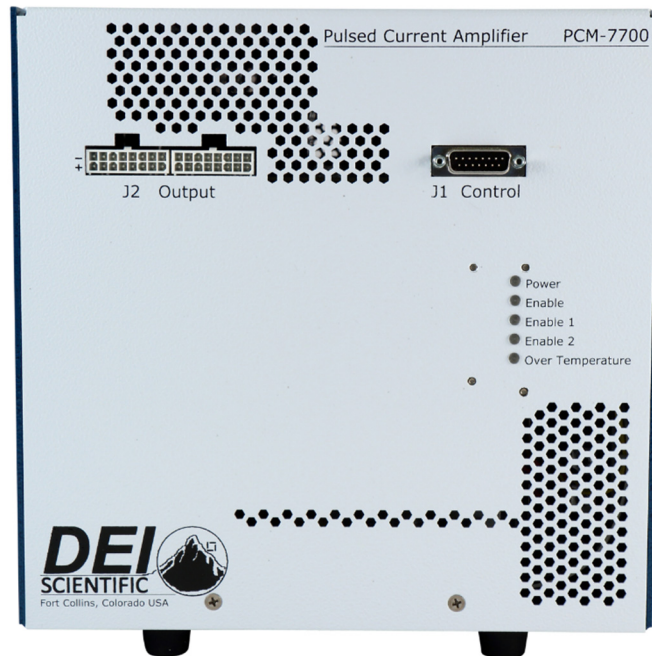
The instrument may be controlled in digital control mode or analog control mode. Digital control mode uses a DC voltage, with the pulse width defined by the trigger input. Analog control mode uses a varying analog voltage to set the output current. Either mode of operation requires the user to ensure the instrument is never operated outside of the SOA curves.

The laser diode or load is connected to the PCM-7700 through two twisted-pair cables designed to preserve the fidelity of high-speed current pulses.

Colored LEDs on the front of the instrument provide immediate visual confirmation of the system status.

The PCM-7700-EX requires an external power supply of 0 V to 50 V, (there is a 25 V overhead voltage, so it is always the load voltage + 25 V). The external system has a 1 meter cable supplied to connect to an external power supply. One end of the cable has a 4 position rectangular housing connector to connect to the PCM-7700-EX. The second end of the cable has no connector, allowing the customer to install the type of connector needed for the external power supply.

❖ Front Panel Features



Power

The **Power** LED is lit when the PCM-7700 power is on. The power switch is located on the rear of the unit.

Enable Mode

The **ENABLE** LED is lit when the PCM-7700 output current is enabled. The PCM-7700 can be enabled only when the Enable 1 and Enable 2 parameters have been met.

Enable 1

The **ENABLE 1** LED is lit when the PCM-7700 first parameter is enabled.

Enable 2

The **ENABLE 2** LED is lit when the PCM-7700 second parameter is enabled.

Over Temperature

The **Over Temperature** LED is lit when the PCM-7700 is in an over-temperature condition. This condition disables the output of the PCM-7700 system.

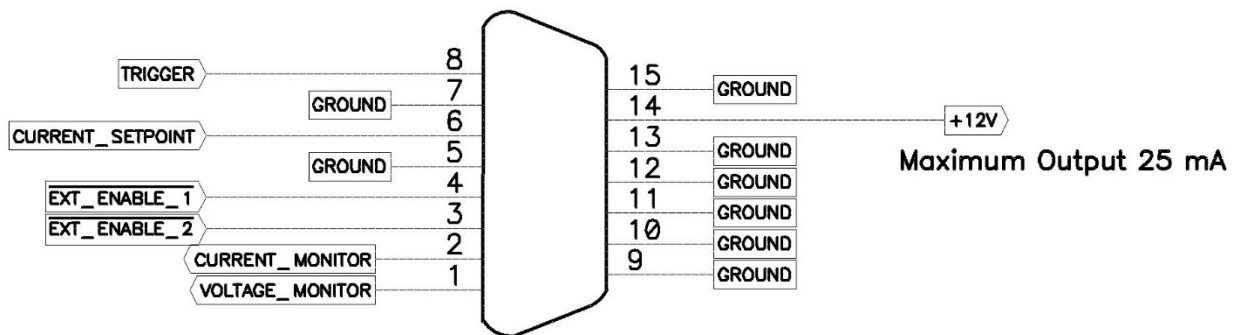
If the **Over Temperature** fault occurs, the instrument is operating outside the Safe Operating Area (SOA). Damage to the PCM-7700 or to the laser/load may occur.

J1 Control DB-15 Connector

Connector J1 has the following pin connections for controlling the PCM-7700:

- Pin 1, Voltage Monitor, 1 M Ω termination, 60 mV/V. Example: 30 V on the output causes 1.800 V (typical) to appear on the Voltage Monitor pin.
- Pin 2, Current Monitor, 50 Ω termination, 5 mV/A. Example: 200 A on the output causes 1.000 V (typical) to appear on the Current Monitor pin.
- Pin 4, External Enable 1: Ground this pin to enable.
- Pin 3, External Enable 2: Ground this pin to enable.
- Pin 6, Current Setpoint, 10 k Ω , 0 V to 10 V.
 - 0.000 V = 0 A output
 - 10.000 V = 200 A output
- Pin 8, Trigger input, 50 Ω termination impedance, single-shot to 1 kHz.
 - 0 V = output off
 - 5 V = output on
 - Trigger pulse width
 - Digital control mode, 500 μ s to 50 ms.
 - Analog control mode, 0 to ∞ ms.
- Pin 14, +12 V output, maximum 25 mA. This is used for the included evaluation board.
- Pin 5, 7, 9, 10, 11, 12, 13, 15: Ground connection.

J1 Control Connector



J2 Output

This connector has the following pin connection for the output of the PCM-7700 system.

- 2 connectors: Amp 1-770974-0
- Pin 1 through 8 = Out –
- Pin 9 through 16 = Out +

❖ Rear Panel Features



Power Cord Connector

The power entry receptacle is a type IEC 320 C-14 grounding equipment power connector.

On-Off Power Switch

This switches power of the PCM-7700 on and off.

❖ Accessories Included

AC Power Cord

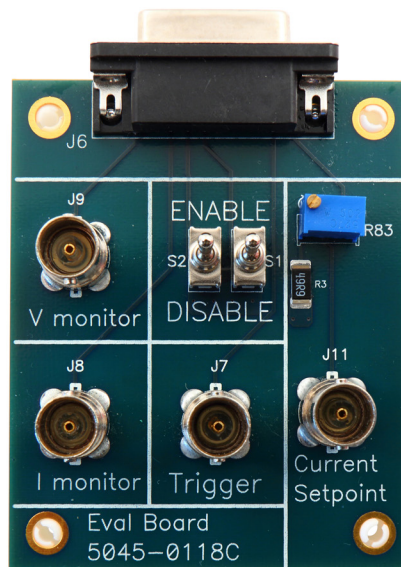
Factory-supplied power cord, type IEC 320-C-13 grounding equipment power cord.

Twisted-Pair Output Cables

The factory-supplied output cables transfer output current pulses to an external device. Two twisted-pair cables fit the socket on the front panel of the PCM-7700; an Amp 770583-1 connector is supplied on the user end.

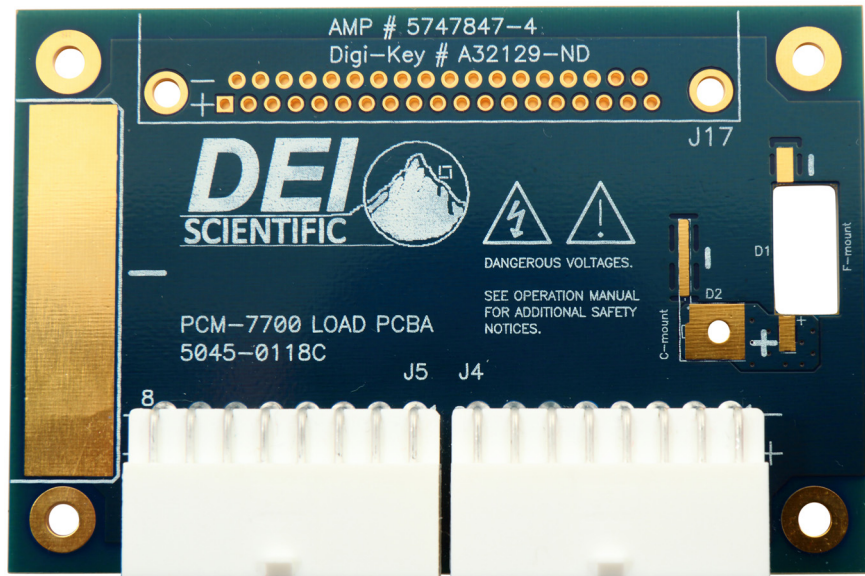
Evaluation Board

The evaluation board provides convenient connections to all of the available signals, allowing the user to utilize the system upon receipt. This includes such functions such as monitoring the output current and voltage, using a trigger source to set the frequency and pulse width, and connecting an analog signal that sets the current output.



Output Interface Board

The output interface board has connectors for the twisted-pair output cables. The customer can put a load on this interface board.



Interfacing the Load to the Output Cable

The output of the PCM-7700 uses two Amp 1-770974-0 connectors that are connected to two twisted-pair cables. One set of these output cables is included with every system. The user may order additional output cables if needed.

The recommended method of interfacing to a load is by designing a simple, two-layer printed circuit board (PCB). This interface board must have very low resistance, and more importantly, very low inductance to ensure that the droop and overshoot specifications are met. To reduce the inductance, use very wide copper planes on the top and bottom layers with no copper inner planes. PCBs thinner than 0.070 inches perform best in reducing inductance. Copper thickness should be 2 ounces or more to reduce resistance.

DEI recommends soldering your laser directly to the interface PCB without any additional cables or wire. If wires are absolutely necessary, they should be as short as possible and twisted if longer than 3 cm. Wires and cabling from an interface board to the laser will increase inductance, which increases overshoot. DEI can design a custom interface board for you at a nominal cost; please contact customer support for a quotation.

The two photos on the next page show an interface board created for a laser used in the DEI lab. The top of the board has solid copper from the stripline to the laser's positive terminal. The bottom of the board has solid copper plane everywhere the positive plane is, plus additional copper to connect to the negative side of the laser. The bottom copper is connected to the top of the board using as many vias as possible (over 400 in this case). Using multiple vias reduces both inductance and resistance. The laser is mounted in the center of the PCB, but it may be mounted anywhere on the board.

Why are we trying so hard to reduce resistance?

Resistance in the output path turns electrical energy into unnecessary heat. Designers spend a lot of time and effort removing as much heat as possible from their systems, thus resistance is an unwanted parameter.

Why are we trying so hard to reduce inductance?

Inductance in the output path can cause voltage overshoot on the rising and falling edges of the output pulse. The overshoot voltage is defined by the following fundamental equation:

$$V = L * di / dt$$

Assume we wish to generate a 200 A pulse with a 16 μ s rise time and a voltage overshoot of less than 10 V. What is the maximum allowable inductance in the output path?

$$L = V / (di/dt) = 10 \text{ V} / (200 \text{ A} / 0.000016 \text{ s}) = 800 \text{ nH}$$

It is easily seen that with high currents and fast rise times, voltages can increase rapidly if inductance is not kept as low as possible. While we are more concerned about current overshoot than voltage overshoot, the overall result is that the current pulse can be affected by undesirable inductance in the output path.

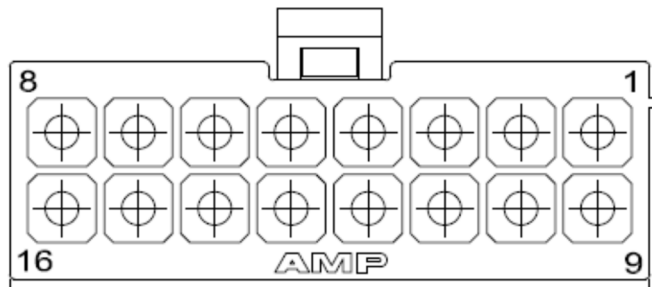
❖ Description

These output cables are 1 meter in length of twisted-pair sets and consists of two male Amp 770583-1 connectors at each end.

❖ Connector pinouts

The two male Amp connectors interface with the instrument and have the following pinout on each connector:

- Pins 1 through 8: negative (–) output
- Pins 9 through 16: positive (+) output



Amp 770583-1 connector looking from the back of the connector down.

❖ Enable pinouts

The PCM-7700 requires that pins 3 and 4 of the DB-15 be connected to ground or 0 V to satisfy an enable function that determines the readiness for output of the PCM-7700.

Operation

❖ Safety

Follow the safety guidelines. DO NOT PROCEED WITHOUT UNDERSTANDING AND OBSERVING THESE GUIDELINES.

❖ Requirements

Make sure the PCM-7700:

- Is connected with the proper cables and termination impedance
- Has its output cable connected to a load or output device of the proper polarity
- Is powered up
- Has all faults cleared

❖ Setup

1. Make sure the PCM-7700 has been OFF for at least ten minutes when connecting or disconnecting the current output connector.
2. Make the laser diode connection with the correct polarity. If necessary, review the output cable for polarity specifications.
3. Make the external trigger connection:
 - a. External Trigger, at DB-15 pin 8, or the BNC on the evaluation board.
 - b. 50 Ω termination impedance
 - c. Single shot to 1 kHz
 - d. 0 V = output off
 - e. 5 V = output on
4. Make the control voltage source connection:
 - a. Control voltage at DB-15 pin 6, or the BNC on the evaluation board.
 - b. 10 k Ω termination impedance
 - c. 0 V to 10 V, 0.000 V = 0 A output, 10.000 V = 200 A output
5. Connect an oscilloscope to the current monitor if desired.
 - a. Current monitor at DB-15 pin 2, or the BNC on the evaluation board.
 - b. 50 Ω termination
 - c. 5 mV / A
6. Connect an oscilloscope to the voltage monitor if desired.
 - a. Voltage monitor at DB-15 pin 1, or the BNC on the evaluation board.
 - b. 1 M Ω termination
 - c. 60 mV / V
7. Connect the AC power cord to the rear of the PCM-7700.

❖ Power Up

1. Verify the external trigger is disabled.
2. Verify the control voltage is disabled.
3. Turn on the AC power switch on the rear of the PCM-7700 system. The instrument powers up in about 3 seconds.
4. After a few seconds, the PCM-7700 power LED will light.

❖ Set the Output Current and Enable the PCM-7700

1. Set the output current between 5 A and 200 A by applying a voltage of 0 V to 10 V to the control input. Use either the evaluation board or a direct connection to the DB-15.
2. Enable the external control voltage source.
3. Set the external trigger for the desired frequency and pulse width. The frequency should be from a single shot to 1 kHz. The pulse width should be between 500 μ s and 50 ms.
4. Enable the external trigger source.
5. Set the external enable 1 pin to ground or 0 V, or place switch S1 on the evaluation board in the Enable position.
6. Set the external enable 2 pin to ground or 0 V, or place switch S2 on the evaluation board in the Enable position.
7. View the current monitor and voltage monitor for the correct output.

❖ View Status Information on the PCM-7700

1. There are 5 LEDs on the front panel that indicate status conditions.

❖ Power Down

1. Disable the unit by placing 5 V on the external enable inputs (pins 1 and 2), or place the switches on the evaluation board in the disable position.
2. Disable the external trigger and external control voltage source.
3. Turn the power OFF by using the AC power switch on the rear of the instrument.

Warranty and Service

❖ Warranty

Directed Energy, Inc. (DEI) warrants equipment it manufactures to be free from defects in materials and factory workmanship under conditions of normal use, and agrees to repair or replace any standard product that fails to perform as specified within one year after date of shipment to the original owner. OEM, modified, and custom products are warranted, as stated above, for ninety (90) days from date of shipment to original owner. This Warranty shall not apply to any product that has been:

- I. Repaired, worked on, or altered by persons unauthorized by DEI in such a manner as to injure, in DEI's sole judgment, the performance, stability, or reliability of the product;
- II. Subjected the product to misuse, neglect, or accident; or
- III. Connected, installed, adjusted, or used otherwise than in accordance with instructions furnished by DEI.

DEI reserves the right to make any changes in the design or construction of its products at any time, without incurring any obligation to make any change whatever in units previously delivered.

DEI's sole obligation, and buyer's sole remedies, under this agreement shall be limited to a refund of the purchase price, or at DEI's sole discretion, to the repair or replacement of products in kind that prove, to DEI's satisfaction, to be defective, when returned to the DEI factory, transportation prepaid by the buyer, within the warranty period. DEI shall in no way be liable for damages consequential or incidental to defects in its products, for failure of delivery in whole or in part, for injuries resulting from its use, or for any other cause.

Returns must be preauthorized and accompanied by a DEI return authorization number.

The foregoing states the entire warranty extended by DEI, and is given and accepted in lieu of 1) any and all other warranties, expressed or implied, including but not limited to the implied warranties of merchantability and fitness for any particular purpose and 2) any obligation, liability, right, claim or remedy in contract or tort.

❖ Factory Service and Support

For more information about your instrument or for an operation problem, please contact the factory:

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Notes
