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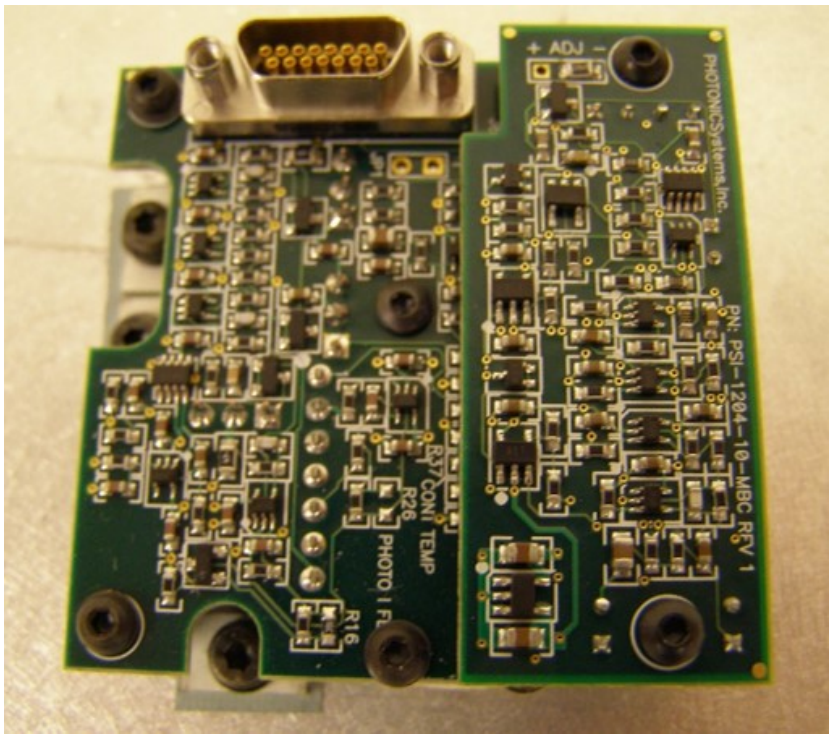
PSI-2450 INTEGRATED CONTROLLER

PSI-2400-10 LASER DIODE CONTROLLER & PSI-1204-10 MODULATOR BIAS CONTROLLER

USER GUIDE

Revision B



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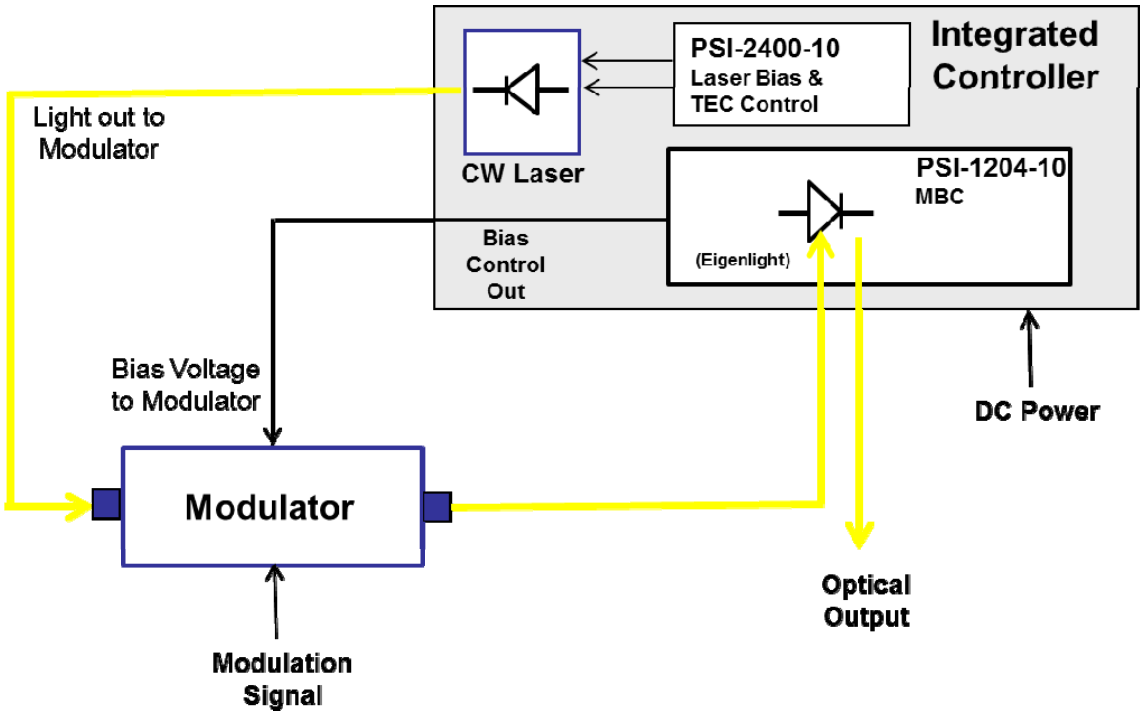
1 DOCUMENT SCOPE

This document describes basic setup and operation of the PSI-2450 Integrated Controller consisting of the PSI-2400-10 Laser Diode Controller (LDC) motherboard and PSI-1204-10 Modulator Bias Controller (MBC) daughterboard. The PSI-2450 Integrated Controller provides the electronic circuitry needed to control a CW laser diode and an optical modulator used to construct an externally modulated photonic transmitter. The laser diode, optical modulator, and photodiode (tap monitor) components required to build the photonic transmitter are supplied by the user.

The PSI-2400-10 LDC provides DC power and control of the CW laser diode light source commonly used in externally modulated transmitters. Power and control is provided for the laser's thermo-electric cooler, laser bias and back-facet photodetector optical power monitor. An integrated optical coupler/feedback photo detector (or Eigenlight tap monitor) also provides a simple means to close the modulator control feedback loop.

The PSI-2400-10 also offers a host socket for the PSI-1204-10 modulator bias controller. When used together, these features allow the board to fully control the laser as a stable light source and electro-optic Mach-Zehnder modulator for either laboratory or field applications.

The block diagram shown below illustrates a typical application of the Integrated Controller (PSI-2400-10 LDC and PSI-1204-10 MBC)



The PSI-2400-10 LDC and PSI-1204-10 have been designed and tested to operate over a wide operating temperature range of -40 to +85°C.

2 PSI-2400-10 LASER DIODE CONTROLLER BOARD

2.1 Overview

The PSI-2400-10 LDC motherboard provides the required circuitry to control a semiconductor laser diode light source and a host socket for the PSI-1204-10 MBC. To control the laser diode, the PSI-2400-10 LDC allows the user to set the optical output power level and the laser's temperature setting.

The LDC board offers feedback mechanisms for accurately monitoring laser power through the laser's internal back facet photodetector. This provides stable optical output power over system lifetime and operating temperature range. Also included is a high accuracy controller for the laser diode thermo-electric cooler (TEC) incorporated in the laser module. By changing fixed resistor values on the PSI-2400-10 LDC, the user may adjust precise optical power and laser temperature operating points which the will maintain over the device operating lifetime and operational temperature range.

2.2 Features and Specifications

The PSI-2400-10 LDC offers the following features:

- Simple control of common 14-pin butterfly laser diode packaged devices
- TEC control over wide temperature range of -40 to 85°C
- Back-facet photo detector laser power control
- Direct interface with PSI-1204-10 MBC for externally modulated systems
- Direct interface with modulator output optical power monitor (Eigenlight tap monitor typical)
- Adjustable optical power output by trimming fixed resistor values

Typical operating specifications for the controller are shown in the table below.

Parameter	**Value**	**Units**
Laser pin-out	See Laser Diode Pin-out	
Laser diode forward voltage	2.5 (Max)	Volts
Laser diode operating forward current range	750 (Max)	mAmps
Back-facet laser monitor photodiode dark current	200 (Max)	nAmps
Back-facet laser monitor photodiode current	0.1 to 2.5	mAmps
Thermo-electric controller operating current	-1 to +1.7 (Max)	Amps
Thermo-electric controller operating voltage	-3.0 to +4.5 (Max)	Volts
TEC thermistor resistance @ 25*C	8 to 12K, user adjust	Ohms
TEC temperature lock/Thermistor to hold	Thermistor to hold within ± 0.1%	Ohms
Laser optical power set point locked	± 1%	mWatt
DC supply voltage	±6 @ 1600mA max ±12 @ 20mA max	Volts
DC power supply pin-out	See I/O Connections	
Operating temperature range	-40 to +85	°C

2.3 Laser Diode Pin-out Assignment

The PSI-2400-10 LDC board has been designed to work with a number of CW laser diode manufacturers using a common butterfly style package. For development and environmental testing purposes however, the 1782 Emcore laser diode series (e.g. part number 1782B-NM-100-xx-FC-PM) was used where the "xx" is the ITU channel number. Whichever laser diode is used, please verify that the laser package pin-out is compatible with the table shown below.

Pin #	Connection	Pin #	Connection
1	Thermistor	8	Case Ground
2	Thermistor	9	Case Ground
3	Laser Cathode (-)	10	NC
4	Monitor Diode Anode (-)	11	Laser Anode (+) GND
5	Monitor Diode Cathode (+)	12	Laser RF (NC on board)
6	TEC (+)	13	Laser Anode (+) GND
7	TEC (-)	14	NC

2.4 PSI-2400-10 Input and Output Connections

Signal and DC power connections are made through connector J6, a 15-pin female Micro-D connector located on the PSI-2400-10 LDC printed circuit board. The manufacturer of this connector is Norcomp Inc. with part number 380-015-213L001. This connector should be compatible with Norcomp and other manufacturers of Micro-D mating connectors.

J6 Pin #	*Connection*
1	+12 Volts (20mA max)
2	-12 Volts (20mA max)
3	-6 Volts (1600mA max)
4	+6 Volts (1600mA max)
5	Laser Enabled (Disabled = ground)
6	MBC Reset (Reset = ground)
7	Bias Locked (ground = Locked open collector)
8	Dither Out to Modulator
9	+/- 12 Volt Ground
10	+/- 6 Volt Ground
11	-6 Volts (1600mA max)
12	+6 Volts (1600mA max)
13	+/- 6 Volt Ground
14	Ground
15	Dither Out Ground to Modulator

2.5 Installation and Set-up

Unless purchased as a complete assembly with the laser diode soldered to the appropriate location on the PSI-2400-10 printed circuit board and mounted on a heat sink cooling plate, there is additional assembly required. Along with the laser diode, the PSI-2400-10 LDC printed circuit board requires the installation of three transistors in TO-220-3 style packages mounted on to a heat-sink cooling plate.

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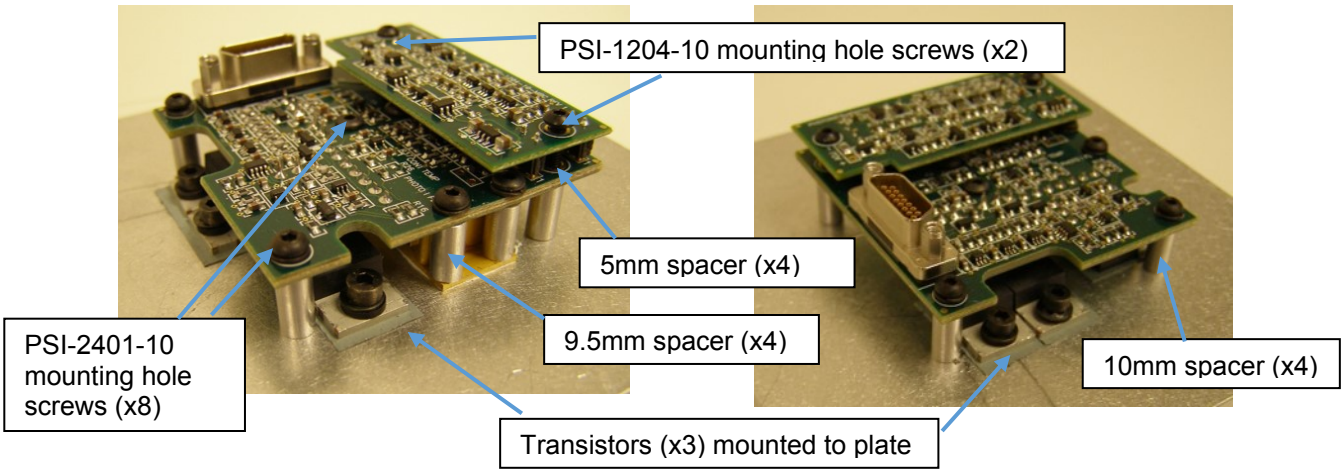
The three transistors mount to the user's heat-sink cooling plate with screws and nylon shoulder washers. The transistors must be placed on the insulating mounting pads, which keep the transistors electrically isolated from the mounting plate. The top side of the transistor has a nylon shoulder washer placed to it before securing with the mounting screws. The user supplied laser should also be secured to this plate; heat sink compound should be applied to the bottom surface of the laser prior to fastening it to the aluminum plate. The laser also needs to be soldered to the control board.

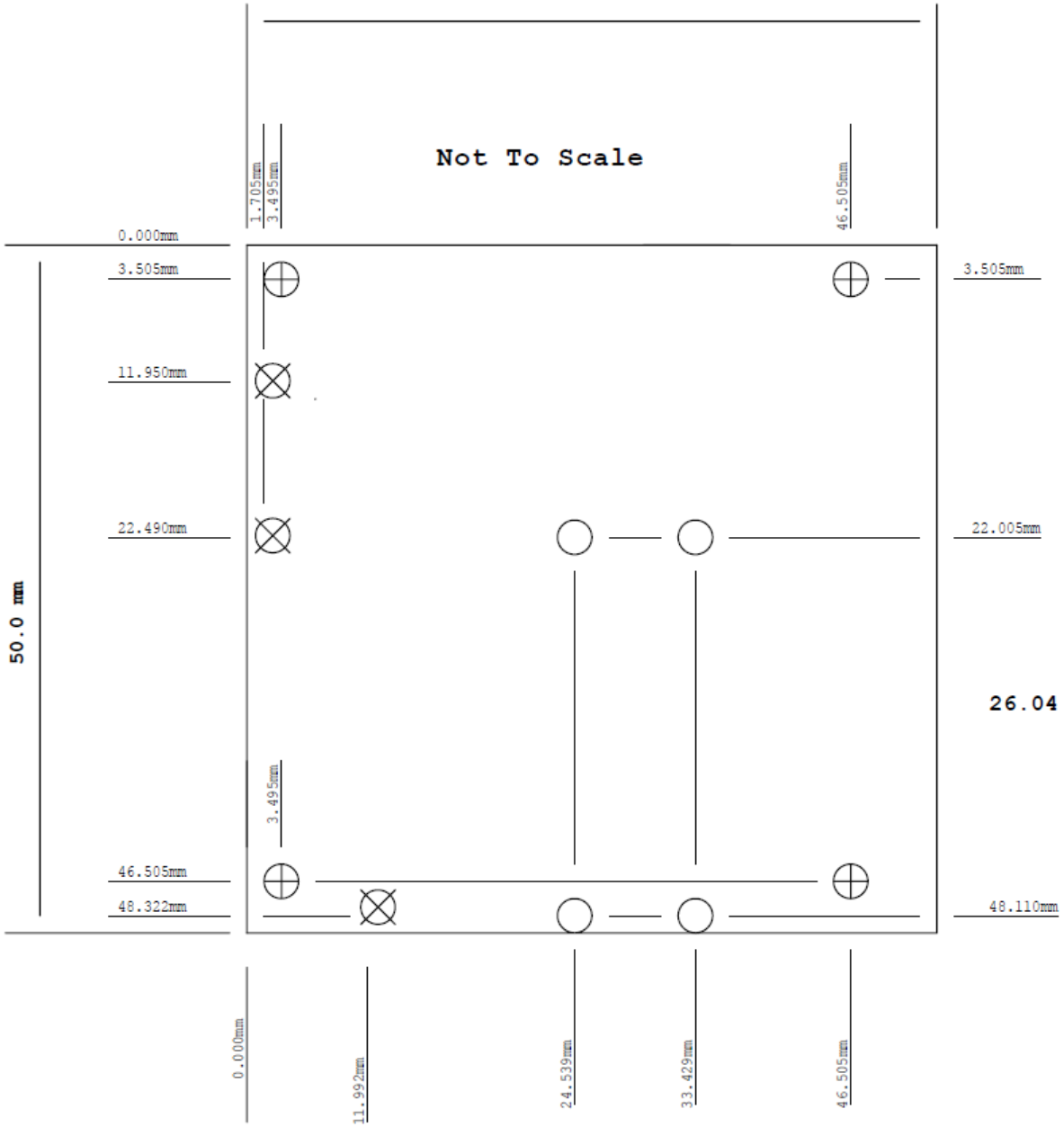
The items listed in the below table are the recommended mounting hardware accessories required to assemble the integrated controller printed circuit board, laser diode, and transistors on to an appropriate cooling plate.

Item Description	Qty	Note
Spacer: 4.5mm OD 2.5mm ID length 10mm	4	Between 4 corner mounting holes on PCB and cooling plate
Spacer: 4.5mm OD 2.5mm ID length 9.5mm	4	Between laser diode flange and PCB mounting holes
Spacer: 4.5mm OD 2.5mm ID length 5.0mm	2	Between mounting hole of PSI-1204-10 MBC PCB and PSI-2400-10 LDC PCB
Button Allen Head Socket Cap Screw, 2.5mm x .45mm x 16mm	8	
Button Allen Head Socket Cap Screw: 2.5mm x .45mm x 22mm	2	Longer screws used between PSI-1204-10 MBC PCB and PSI-2400-10 LDC PCB
M2.5 split washers	9	4 corners and the 2 outside laser screws, not the 2 in the middle of the controller board
Washer Shoulder #4 Nylon: (Keystone Electronics PN 3049)	3	For transistors
Thermal Interface Pad: (t-Global Technology PN DC0011/07-TI900-0.12)	3	Required under transistors

Pictures of the recommended mounting configuration on to a cooling plate is shown below:



The below drawing indicates the recommended cooling plate mounting hole location and tap size information:



Note: All holes tapped 2.5mm x .40mm

2.6 Setting Laser Power, Temperature and Max Current Resistors

The latest revision of the PSI-2400-10 LDC eliminates the use and ease of setting the laser output optical power and laser temperature TEC setting using potentiometers. Based upon customer

requirements, the current LDC design uses fixed resistor values to set the laser output power, the laser temperature TEC set point, and the laser maximum current setting.

Therefore, the below procedure is for trimming the laser power resistor (R26) and trimming of the laser temperature/wavelength set point resistor (R37) and also includes a table of resistor values for setting the maximum laser current resistor (R16).

The temperature and power settings are dependent on each other, a change in one setting will affect the other. The best way to establish the correct values for temperature and optical power is to install two adjustable resistors by using #30 wire to the pads of R26 and R37. The range of values will be from 3K to 1Meg. The recommended approach for adjusting these pots is to half the error of temperature and power and repeat until both the wavelength and power are within the desired specification. Once the two adjustable resistors are set to the final values, unsolder the #30 wires from the printed circuit board and measure the value of the adjustable resistors using a DVM. Solder 0603 resistors of the same values measured on the potentiometers on to the circuit board at the correct R26 and R37 locations.

The maximum laser current is set by resistor R16. Listed below are the values for R16 to set the maximum current the laser can be driven to:

600 mAmps = R16 = 14.3K
500 mAmps = R16 = 20.0K
400 mAmps = R16 = 33.2K
300 mAmps = R16 = 100K
265 mAmps = R16 = open

2.7 Tap Monitor Photodiode

PSI recommends the use of a tap monitor photodiode part number SR141A-1-15 selected for 5-15 mA/Watt (ideally 7-11mA/Watt) sensitivity manufactured by EigenLight Corporation (www.eigenlight.com). The standard data sheet for this device has been attached as an addendum. When selecting the Eigenlight tap monitor photodiode, one must consider the maximum photodiode input current is 160uA at QUAD.

3 PSI-1204-10 MODULATOR BIAS CONTROLLER BOARD

3.1 Overview

The PSI-1204-10 modulator bias controller daughterboard provides precise control of a Mach-Zehnder electro-optic modulator. This controller accurately prevents bias point drift from a user preset QUAD+ or QUAD- modulator transfer function point. The PSI-1204-10 MBC mounts on to the PSI-2400-10 LDC motherboard to form the Integrated Controller.

The PSI-1204-10 MBC operates by adding a very small amplitude dither signal to the DC bias applied to an optical modulator. This dither signal is later detected as a portion of the light output from the modulator under control through a photodiode or tap monitor (e.g. Eigenlight) located on the PSI-2400-10 LDC board. The MBC maintains a constant modulator bias point by continuously adjusting the bias voltage to a predetermined user selected QUAD+ (normal) or Quad- set point.

3.2 Features and Specifications

The PSI-1204-10 LDC offers the following features:

- QUAD+ or QUAD- bias point settings
- Dither based bias control

- Compatible with most optical modulators
- Low operating current: <15mA typical
- Wide operating temperature range: -40° to +85° C

Typical specifications of the PSI-1204-10 MBC are shown below.

Parameter	Value	Units
Modulating Signal	Analog small signal	
Modulators Supported	Mach-Zehnder	
Bias Point Setting	+Quad or -Quad, user selects	
Modulator/Bias-T Load Capacitance	<0.1	µF
Output DC Bias Port Impedance	100	Ω
Output DC Bias Voltage	0.3 less than supply voltages	V
Dither Frequency	1	kHz
Dither Amplitude - set by resistor values to accommodate different Vpi of modulator	20 to 200; user defined	mVpp
Photodiode monitor current at Quad +/-	150	µA
Bias Point Error@Quad+ or Quad - point, 5 to 150ua photodetector current	±3 @ 1% dither of Vpi	degrees
Dynamic Range of Controller Input Signal (maximum) - includes photodiode selection and optical power total range	15	dB
Reset	Automatic and Manual	

3.3 PSI-1204-10 Input and Output Connections

All input and output signal are made through connections on the PSI-2400-10 LDC motherboard. For reference only, the below lists the various connectors and signals between the PSI-1240-10 MBC daughterboard and PSI-2400-10 LDC motherboard.

Connector	Pin	Function	Description
J1	1	Photodiode	Cathode
	2	Photodiode	Anode
J2	1	+12 Volt	+12V
	2	Gnd	Ground +/- 12Volts
	3	-12 Volt	-12V
	4	Reset	Ground = Reset
J3	1	+Modulator	Photo diode anode (analog ground)
	2	Ground Modulator	Provides internally generated bias voltage for photodetector cathode.
J4	1	Locked	Ground = Controller Locked (open collector)
	2	Quad +/-	Open = Q+, Ground = Q- (24K pull up to +5V on LDC board)

3.4 Modulator Transfer Function Selection (QUAD+ or QUAD-)

The PSI-1204-10 is normally set-up for QUAD+ operation. By adding a jumper wire on JP1, the MBC can be configured for QUAD- operation as shown in the table below.

Bias Point Mode	Jumper JP1
Quad +	No
Quad -	Yes

3.5 MBC Reset

The PSI-1204-10 includes an automatic reset function which will engage if the bias point approaches the controller's power supply rail. In certain situations, it may be desirable to reset the modulator bias point manually which can be accomplished when the MBC is installed on the LDC motherboard by connecting pin 6 of connector J6 on the LDC to ground.

3.6 PSI-1204-10 MBC Trim Procedure

The trim procedure for the modulator controller consist of installing a single 0805 or 0603 resistor R19, after a 10 minute or longer warm up period. The purpose of the trim is to reduce the drift of the controller to less than +/- 5mV per minute, when there is no optical power to the Eigenlight photodiode. The point to be measured is the DC control point and ground on the optical modulator. The measurement can be made using a DVM with a resolution of 1mvolt or less.

The method will be to measure for 1 minute and trim for a change of less than plus or minus 5mvolts during the one minute time. Using the controller reset line can assist in this procedure. Reset the controller (momentarily connect the reset line to ground, and remove), this will reset the output voltage to less than 5mVolts of ground. Measure and record the voltage change after 1 minute, this change is the voltage that is to be set to less than +/- 5 mvolts.

The adjustment is made by way of a trim resistor R19. The controller has marked in silk screen the following "+", "Adj", and "–" next to 3 pads with a hole in each one on the printed circuit board. The "+"is the internal +5 volt supply. The "–" is the -5 volt internal supply. The center pad will be one side of the trim resistor. The opposite side of the trim resistor will be placed on the "+" or "-" pad. For example, if the output voltage is drifting in the plus direction, the R19 resistor will be placed between the "–" and the center pad. The resistor value will be within the range of 500K and 30K. (Note greater than a 500K trim would cause less than a 5 mvolt drift change and smaller than a 30K resistor indicates a problem with the controller or setup.) A pot or a decade box can be used to find the proper trim value, small wires can be place in the pad holes for temporary connection of the temporary adjustable resistor. After finding the trim value of R19 remove the temporary wires and solder the resistor in place.