

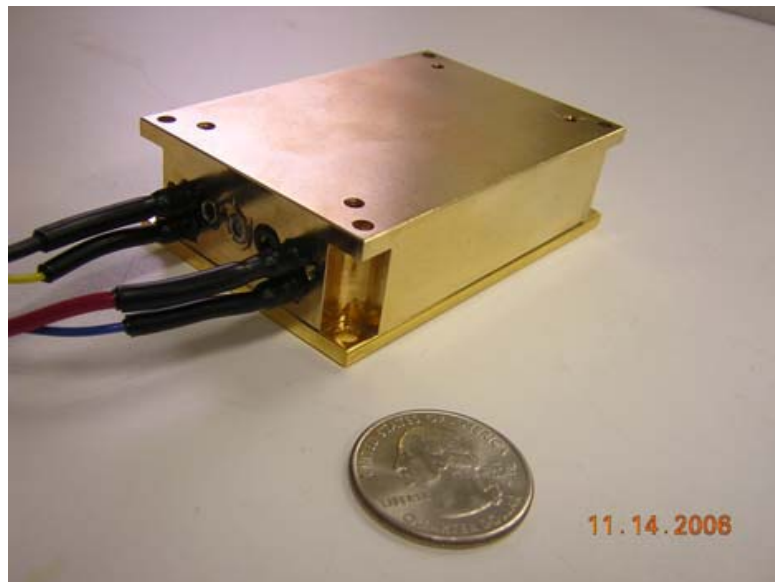
OPERATING MANUAL

Kigre Model # MK88 10Hz

Diode Pumped, Solid State, Er:Glass Laser Transmitter System

YOUR KIGRE MK88 Er:Glass LASER SYSTEM INCLUDES THE FOLLOWING ITEMS:

1. Kigre # MK88, 10Hz TEM₀₀ 1.54um Laser
 2. Kigre # MK830-PS-1.2 Power Supply
 3. AC Cord (with 120VAC, 15A plug)
 4. USB Cable (Style E166307)
 5. MK88 Software CD Version # 1.3.1
 6. MK88-HS-1 Heatsink-Fan Assembly
 7. Operating Manual "MK88 Diode Pumped Solid State (DPSS) Er:Glass Laser Transmitter System"
- Serial # KXXXXXX
Serial # KXXXXXX



**THIS LASER IS DESIGNED TO OPERATE AT 100AMPS,
WHICH IS 55% ON THE CURRENT DIAL**

WHEN CONTACTING KIGRE, PLEASE REFER TO THE SERIAL NUMBERS AND JOB# XX-XXX

PLEASE READ THE ENTIRE OPERATIONS MANUAL TO FAMILIARIZE YOURSELF WITH THIS SYSTEM BEFORE SETTING UP AND/OR OPERATING THE KIGRE LASER. IF YOU HAVE ANY QUESTIONS OR COMMENTS REGARDING THE SAFETY, OPERATION, OR MAINTENANCE OF THIS SYSTEM PLEASE CONTACT OUR CUSTOMER SERVICE DEPARTMENT AT:

KIGRE INC., 100 MARSHLAND RD, HILTON HEAD ISLAND, SC, 29926.
PHONE: 843-681-5800 FAX: 843-681-4559
EMAIL: KIGRE@KIGRE.COM WEB: WWW.KIGRE.COM

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1 SHIPPING AND PACKAGING



Please inspect the shipment **immediately** upon delivery. Check the received goods against the packing list to insure that all items were received. If the shipment is missing items, or is damaged in any way, you will need to contact the freight carrier. You should also contact Kigre's **Customer Service Department** (the address is on the front page) or your local Representative for assistance with your claim.

2 WARRANTY

Unless otherwise specified, all laser power system products manufactured by Kigre are warranted to be free from defects in workmanship and materials for a **period of one (1) year** following delivery of the equipment to the F.O.B. point.

Liability under this warranty is limited to, at Kigre's option, repairing or replacing the part or product which is determined by Kigre to be defective during this warranty period, provided prior authorization for such return has been given by an authorized representative of Kigre and the product is returned, prepaid, to Kigre within thirty (30) days from discovery of the defect. Equipment repaired or replaced under warranty are warranted only for the remaining unexpired portion of the original warranty period.

This warranty does not apply to laser power system products, which upon inspection by Kigre are determined to have been damaged through improper storage or installation, misuse, neglect, accident, or for any cause beyond Kigre's control. Repair or alteration of any part of the laser power system by person other than Kigre authorized personnel immediately voids this warranty.

Buyer assumes all risk and liability for the results obtained by the use of any product delivered hereunder and in no event shall Kigre be held responsible for special or consequential damages or charges. When products manufactured by others are used in conjunction with Kigre equipment, this warranty only extends to the equipment manufactured by Kigre.

This warranty is in lieu of any and all warranties or representations, expressed or implied, and no agreement or understanding affecting this warranty shall be binding upon Kigre unless in writing and signed by an authorized representative of Kigre.

Kigre reserves the right to make changes to its products without incurring the obligation to incorporate such changes in products previously purchased and delivered to the buyer.

3 RETURN PROCEDURE

Your Kigre laser system is designed and constructed to provide years of trouble free service. Should your system require service, return it to our service facility by contacting our **Customer Service Department** for a **Return Material Authorization** number (RMA#). You will need to provide the model and serial number of the damaged equipment and a brief description of the failure. Return shipments should be made prepaid. Kigre will not accept C.O.D. or collect return shipments. Damages caused by inadequate packaging will not be covered under the warranty.

4 SAFETY WARNINGS & LIMITATIONS

4.1 LASER SAFETY WARNING

To maintain “eye-safe” levels, this laser must not be operated above 7.9mJ. Although the eye is less sensitive to the 1.5359 wavelength, proper eye safety must always be used. As with any laser, never look directly at the laser in the beam path. The laser is too small to accept identification or warning labels so the labels are located on the power supply base-plate. All labels conform to United States of America (USA) FDA regulation 21 CFR Ch.1, 1010.3. Only qualified personnel that are trained in solid-state laser applications should operate these systems. The laser should always be operated in a relatively clean environment.



4.2 LASER HANDLING INFORMATION

As with all laser devices, the resonator must be handled carefully. Never touch the optical surfaces of the laser unit. Check the optical surfaces for cleanliness using a microscope and clean only if needed. The optical surfaces should only be cleaned as a corrective action for marked power decrease or poor mode quality and should not be cleaned unless signs of contamination are clearly visible on the optical surfaces. Unnecessary cleaning will only shorten the life span of the optical coating. Handle laser optics with care. A scratch, trace of dirt, or film will diminish the laser's efficiency. Before cleaning optics insure your hands are clean and a clean work surface is available. Place a drop of Methanol in the center of a lens tissue. Place the wet portion of the lens tissue on the optic surface and slowly drag it across the optic. Make a single swipe across the surface of the optic. The lens tissue and optic should be nearly dry before completing the drag. Do not re-use the lens tissue as particles of dust and other contaminants picked up from the surface of the optic may scratch if dragged across with a second swipe. The laser may need to be held in place during this process. Examine the surface of the optic. If streaks or contamination can be seen, repeat the cleaning process using a fresh lens tissue.

The photodiode in the laser is extremely sensitive to static discharge. Always use a grounded wrist strap and follow standard ESD handling procedures when handling the Kigre MK88 laser.



4.3 OUTPUT PULSE TIMING JITTER AND PHOTODIODE FEEDBACK DEVICE

Due to the passive Q-switch design, the laser output pulse will have up to 300uS of jitter with respect to the fire input Command. A high speed InGaAs photodiode is installed in the MK88 laser. The power supply uses this feedback to control the pulsewidth of the pump diodes to insure stable, single-pulse laser output. Kigre recommends using a laser output pickoff detector if timing of the output pulse is critical to your application.

4.4 LASER COOLING INFORMATION

The laser will operate continuously at 10 Hz only with sufficient external cooling capacity of at least 15W. Ambient temperatures are limited by the laser housing temperature, which must stay below +50°C. The exact heatsink requirement will be determined by your repetition rate and duty cycle.

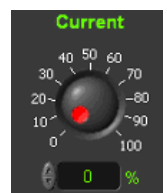


4.5 LASER REPETITION RATE (FIRING RATE) INFORMATION

The laser is "tuned" for optimum performance at 10Hz continuous duty operation. You will find some degradation in the laser's performance if you vary the rep-rate below 10Hz.

4.6 SOFTWARE

The Kigre, Inc. software has been designed to operate with a variety of Kigre, Inc. laser drivers. Therefore, the virtual “GUI” current knob is displayed as a percentage of driver output. Always use a current sensor to calibrate actual amps with the virtual percentage indicated. For the MK830-PS unit, 0% is approximately 30Amps and 100% is approximately 150Amps. The recommended current for most Kigre DPSS lasers is 100Amps, which would therefore correspond to about 55% on the GUI current dial.



4 SAFETY WARNINGS & LIMITS (CONT)

4.7 POWER SUPPLY FANS

The driver will operate continuously at 10 Hz at ambient temperatures up to +50°C. The internal fans will automatically turn on and off as needed. Do not block the intake & exhaust vents on the side panels of the driver.

4.8 GROUNDING

The driver should be connected to earth ground for user safety and proper shielding. Recommended chassis grounding is made via the green wire in the AC cord.



4.9 AC INPUT

The driver can accept 90-250 Volts AC and 50-60 Hz input. The unit will automatically detect the supplied voltage and frequency (auto-switching). Although actual input currents will depend on your AC Source, repetition rate and laser application, the maximum input current for this device is 6A while operating at 30Hz. A Slo-Blo 5 x 20mm fuse is located in the outlet connector on the rear panel. A spare fuse has been supplied in the unlikely event it is needed. Always inspect for faults or other anomalies before replacing a blown fuse. Do not use the device if the fuse keeps tripping and send the unit back to the factory for service if obvious problems, such as a damaged AC cord, can't be resolved.



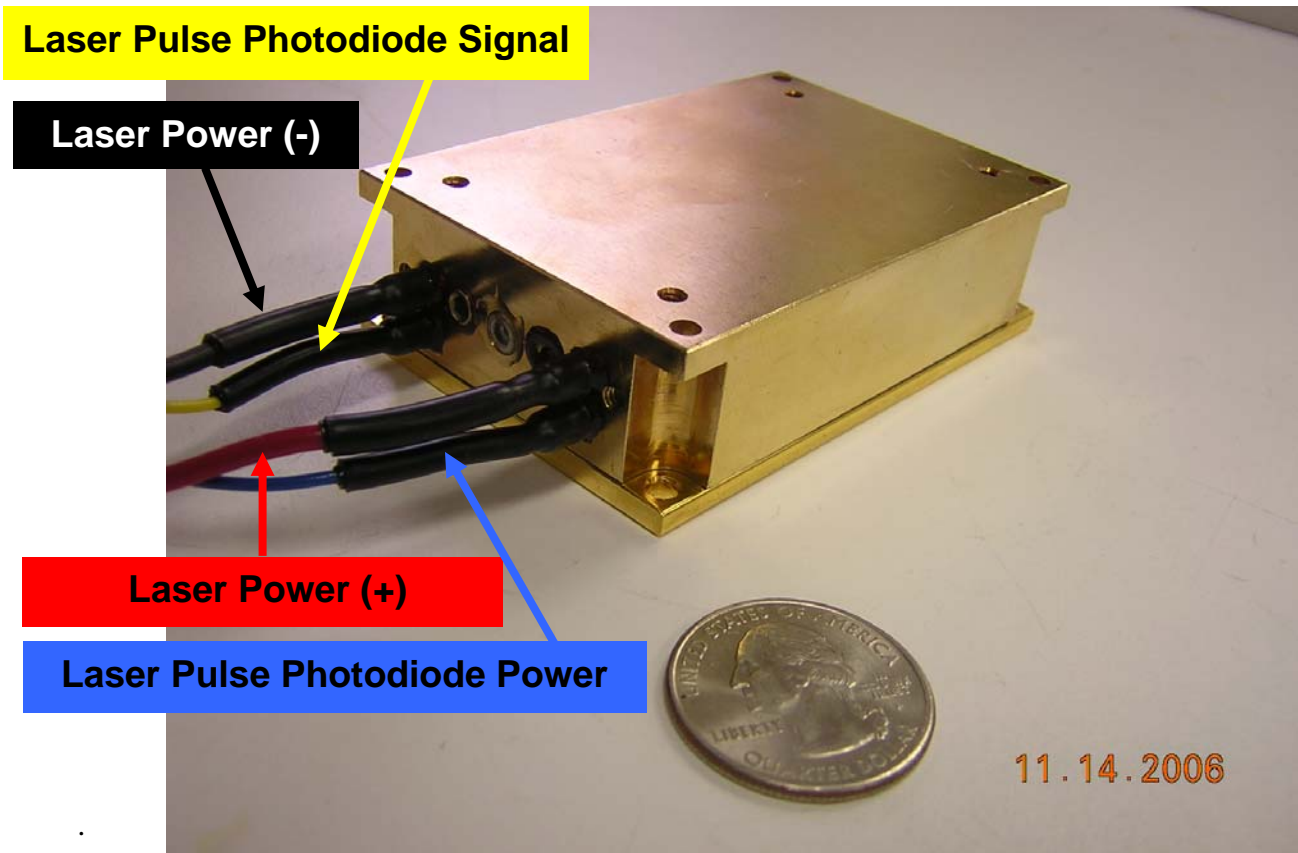
4.10 SERVICE INFORMATION

This system is designed to operate without service for its entire lifetime as rated in the specifications above. Re-alignment and repair should only be attempted by the factory. If you have any questions or comments regarding the safety, operation, or maintenance of this system please contact our customer service department (contact information listed on cover of operations manual).



5 MK-88 LASER SPECIFICATIONS

Wavelength	1.5359 microns
Output energy at 30 Hz	3-4mJ (< 7.9mJ for Class I)
Output mode	TEM ₀₀
Pulse width	7ns +/-2ns, Passive Q-switch
Repetition rate with external cooling*	10 Hz continuous operation
Conductive cooling requirement	15 watts (for continuous duty operation)
Raw beam diameter	0.8mm
Beam divergence	~ 4.2mrad
Beam wander	< 0.5mrad
Weight	514 grams
Laser size	0.85 x 2.0 x 3.0" (22 x 51 x 76 mm)
Temperature range (operating)	- 30 °C to + 50°C
Temperature range (storage)	- 45 °C to + 71°C
Nominal pump diode output energy	1.2J / pulse (typical)
Pump diode array forward voltage (Vf)	8.0V at 100A (typical)
Pump pulsewidth	Approximately 1.5mS (photodiode feedback controlled)
Internal Photodiode:	Hamamatsu # G8376-05 (InGaAs, 0.5mm Ø active area)
Link to Photodiode Datasheet:	http://sales.hamamatsu.com/assets/pdf/parts_G/g8376_series_kird1051e05.pdf



6 MK-830-PS SPECIFICATIONS

AC input voltage:	90-250 Volts AC (Auto-switching)
AC input frequency:	50-60 Hz (Auto-switching)
AC input current:	6A (Slo-Blo 5 x 20mm fuse located on rear panel)
Pump diode current range:	1A – 140A +/- 0.5A
Frequency range:	0.1 – 30 Hz
Laser diode forward voltage range:	0.7 – 16 Volts
External trigger input:	4.5 – 5.5 V, 1.0 – 10mS Pulse into front panel BNC connector. 10Hz MAX. (input resistance is 100K-ohm). Rising edge of input signal fires laser.
Power Supply Weight	4.2Kg (9.3 pounds)
Power Supply Size (H x W x L)	300x261x135 mm (11.8 x 10.3 x 5.3 inches)
Estimated Temperature (operating):	-30C to +50C
Estimated Temperature (storage):	-45C to +71C
Estimated Shock (Mil-Std-810, 516):	70 G, 1.0mS
Estimated Vibration (Mil-Std-810, 514)	10-55-10 Hz swept, 1 min; 762 um peak amp, 2hr, (120cycles)
Power Inlet with Fuseholder:	Qualtek Electronics Corp # 723W-X2/04 (IEC 320 - C14)
Laser connector:	Amphenol # 77TWA7W2S, Female Combo D-sub
Mate to Laser connector:	Amphenol # 717TWA7W2P, Male Combo D-sub
Control connector:	USB 2.0 (backwards compatible to 1.0)

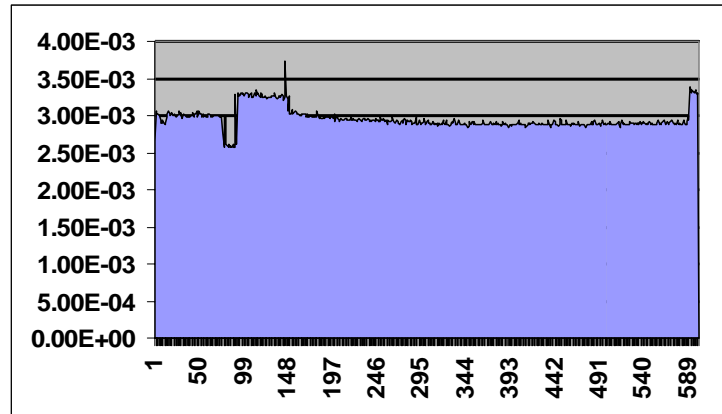


7 SYSTEM INSTALLATION

7.1 MOUNTING THE LASER TO YOUR HEATSINK

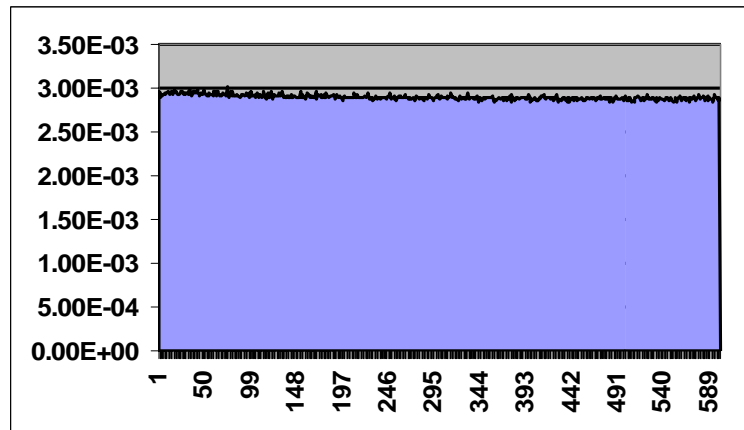
The MK-85, MK-88 and MK-81 laser heads incorporate an exoskeleton optical bench design that is best mounted on a smooth clean flat metal surface. We suggest a 32 Ra micro-inch mounting surface finish specification that is free of burrs, marks or defects larger than 50um. All of the laser head mounting screws should be secured with uniform amount of torque. An example of the laser's output energy performance and stability as influenced by mounting surface defects is shown in the following plots.

Mounting Surface with Defects



MK-81 Output Energy (J) vs. Number of Shots

Smooth Mounting Surface



MK-81 Output Energy (J) vs. Number of Shots

Suggested mounting procedure: (Loctite[®] thread-lock application recommended)

- 1) Loosely “finger” tighten all four screws evenly.
 - 2) Using an X pattern gently tighten the screws a little at a time (about a ¼ turn max).
 - 3) Continue tightening all of the screws a little at a time until the 0.5 in-lb spec is met.
- * Please do not tighten one screw to spec and then tighten another, etc.

Attach the laser to your heat-sink using the four 0.125” mounting holes. A 4-40 screw is preferred. The flatness of the heat-sink mounting surface is very important. Kigre recommends grounding the laser housing for user safety and to improve shielding.

7 SYSTEM INSTALLATION (CONT)

7.2 SUPPLIED MK88-HS-1 HEATSINK-FAN ASSEMBLY (KIGRE # A3916):

- 1) Remove one side of adhesive backing and carefully apply to the Kigre supplied heatsink surface.
- 2) Remove other side of adhesive backing and carefully apply to the *top side* of the laser.
- 3) AC Wall adapter should be plugged into your AC source separately from the MK830-PS unit.

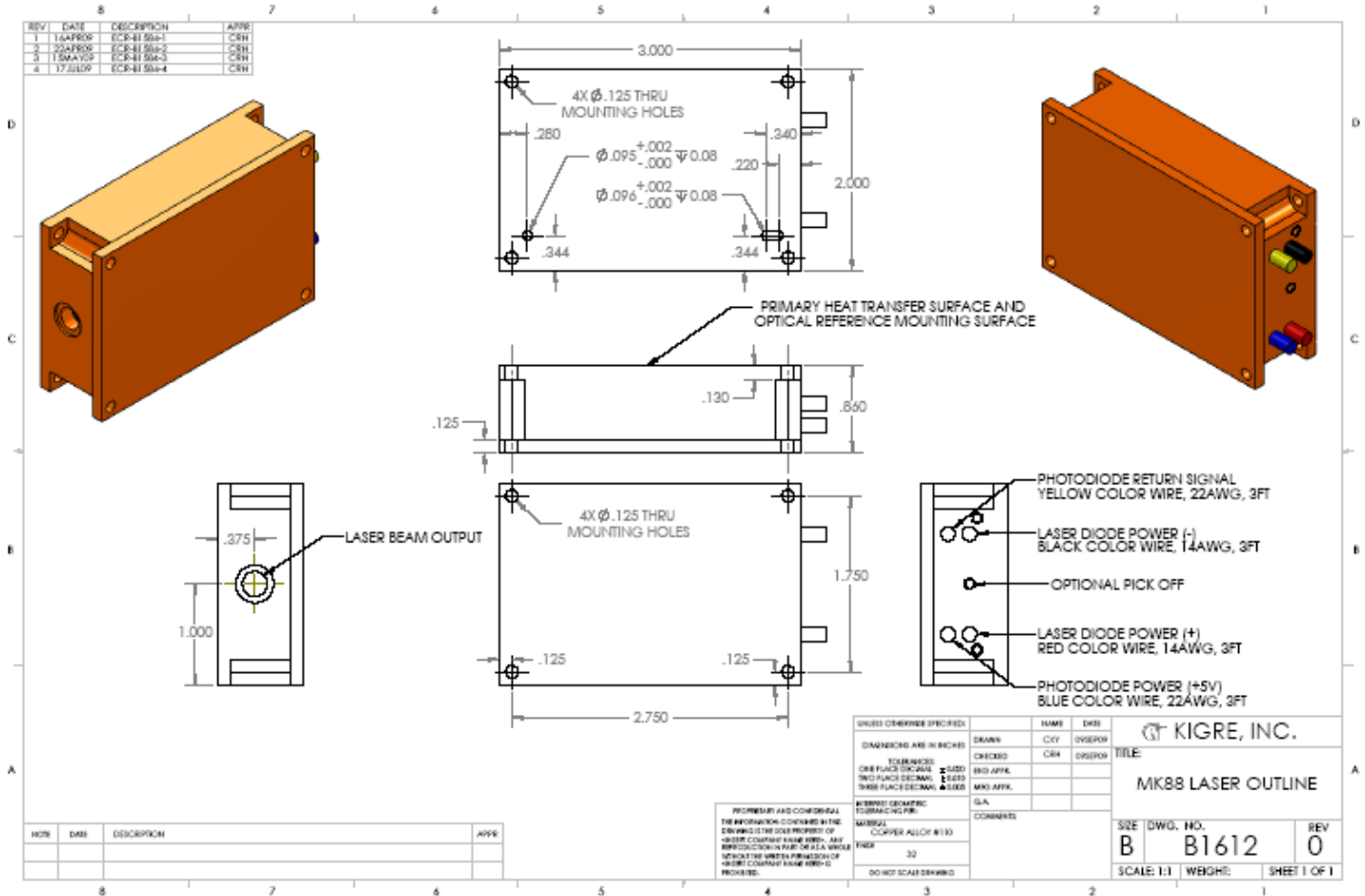
Please note: this heatsink-fan assembly is in addition to the heatsink mounting surface (refer to section 7.1 above).

					NO. NOTES																			
<p>UNLESS OTHERWISE SPECIFIED:</p> <p>DIMENSIONS ARE IN INCHES (EXCEPT WHERE NOTED)</p> <p>TOLERANCES:</p> <p>ONE PLACE DECIMAL ±0.030</p> <p>TWO PLACE DECIMAL ±0.010</p> <p>THREE PLACE DECIMAL ±0.005</p>					NAME	DATE	<p>TITLE:</p> <p style="font-size: 1.2em;">MK88 HEATSINK ATTACHMENT ASSEMBLY</p>																	
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 10%;">REV</td> <td style="width: 10%;">DATE</td> <td style="width: 40%;">DESCRIPTION</td> <td style="width: 10%;">BY</td> <td style="width: 10%;">APPR</td> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> <td> </td> </tr> <tr> <td colspan="5" style="text-align: center;"> <p>PROPRIETARY AND CONFIDENTIAL</p> <p>THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF KIGRE, INC. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF KIGRE, INC. IS PROHIBITED.</p> </td> </tr> </table>					REV	DATE			DESCRIPTION	BY	APPR						<p>PROPRIETARY AND CONFIDENTIAL</p> <p>THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF KIGRE, INC. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF KIGRE, INC. IS PROHIBITED.</p>					DRAWN	22APR10	<p>SIZE</p> <p style="font-size: 1.2em;">A</p>
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<p>INTERPRET GEOMETRIC TOLERANCING PER:</p> <p>MATERIAL</p> <p>FINISH</p> <p>DO NOT SCALE DRAWING</p>					CHECKED	CRH	22APR10	<p>DWG. NO.</p> <p style="font-size: 1.2em;">A3916</p>																
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7 SYSTEM INSTALLATION (CONT)

7.3 LASER BEAM LOCATION:

The laser beam location, with respect to the mounting surface is shown below.



Please note pin function in the above drawing.

DO NOT ATTEMPT TO DE-SOLDER THE FACTORY INSTALLED WIRES, IF APPLICABLE! INTERNAL DAMAGE TO THE HERMETIC SEAL WILL RESULT! TO PREVENT DAMAGE TO THE LASER, YOU MUST INSURE THE LASER DIODE AND PHOTODIODE SIGNALS ARE CONNECTED PROPERLY!

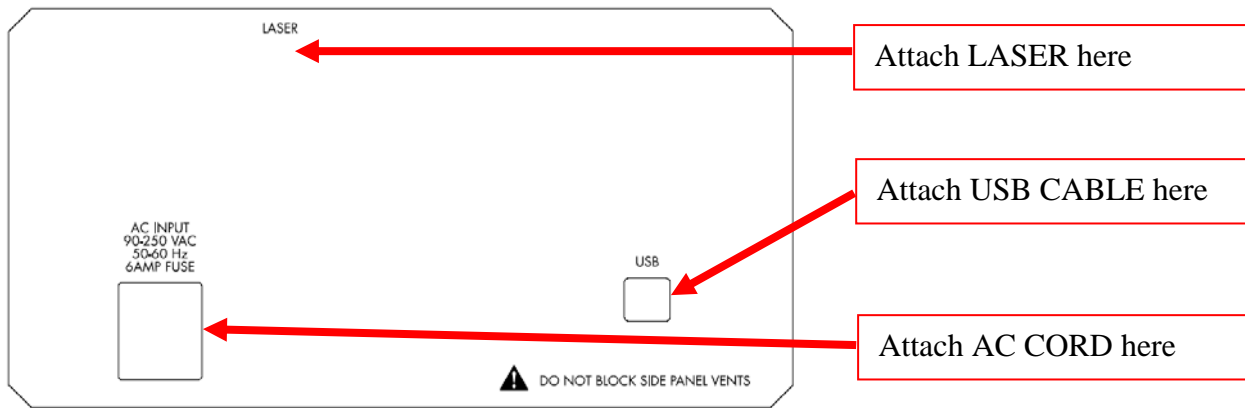


KEEP THE LASER HOUSING BETWEEN -30C AND +50C. MONITOR THE LASER HOUSING TEMPERATURE AS NEEDED TO INSURE THERE IS SUFFICIENT HEATSINKING FOR YOUR APPLICATION.



7 SYSTEM INSTALLATION (CONT)

7.4 POWER SUPPLY SETUP:



Note: The unit is rated for 90-250VAC, 50-60 Hz, 6A (max) input.

The AC Inlet connector is a standard type (IEC 320-C14) often used by computers and other electronics equipment so you may be able to simply replace the cord to accommodate your country's AC outlet standard.

If you prefer to attach a different AC plug on the existing cable: The black wire is AC-L1, the white wire is the AC-L2 (or neutral for 120 systems) and the green wire is the Ground.

Laser connector: Amphenol # 77TWA7W2S, Female Combo D-sub
Mate to Laser connector: Amphenol # 717TWA7W2P, Male Combo D-sub

Pin A1: Laser pump diode current positive (Anode)
Pin A2: Laser pump diode current return (Cathode)
Pin 1: Photodiode power positive
Pin 2: Photodiode signal
Pin 3 & 5: Not used
Pin 4: Chassis ground (used for cable shielding)

8 CONTROL SOFTWARE INSTALLATION

The Kigre MK88 Version # 1.3.1 control software is a ready-made repetition rate generator with current adjustment, burst rate and shot count features.

There are 2 steps to installing this software and initializing the hardware. The first step installs the Kigre *Laser Control Software* and Measurement Computing *InstaCal* USB drivers for the Kigre MK830-PS laser power supply. The second step initializes the MK830-PS to work with your computer.

This installation only needs to be done the first time you use a computer with this Kigre MK88 laser system. If you change computers the complete installation will need to be done again. If you change MK830-PS power supply units you will need to re-run the *InstaCal* software to re-initialize the new power supply. This software works with Microsoft Vista, Windows XP Pro, XP Home, and 98SE (Second Edition) computers that have USB 1.0 or newer support.

STEP 1: INSTALLING THE SOFTWARE:

- 1) Insert the *Kigre "Laser Control Software MK88 V1.3.1" CD* into your computer. If it doesn't auto-run, double-click the *Laser Control Utility 1.3.1 Install.exe* file to begin installation.
- 2) Click "next" to begin.
- 3) Click "next" to accept the default install directory or type in a custom folder name if you prefer.
- 4) Click "next" to accept the NI License agreement.
- 5) Click "next" to start the installation.
- 6) Click "next" to finish the installation.
- 7) Click "next" to install InstaCal.
- 8) Click "next" to accept InstaCal installation folder.
- 9) Click "next" to install the Measurement Computing Corp (MCC) Universal Library.
- 10) Click "next" to begin installing InstaCal.
- 11) Click "finish" to complete the installation process.
- 12) Restart your computer when prompted.

Note: You may be asked to allow script files and/or to install the Microsoft .NET Framework 1.1 Setup if necessary. This is required.

Note: A shortcut to the Kigre *Laser Control Software* should automatically be created on your desktop. You may wish to create a shortcut on your desktop to the *InstaCal* program.

STEP 2: INITIALIZE MK830-PS POWER SUPPLY

- 1) Turn on the MK830-PS power supply.
- 2) Plug in the USB Cable from the MK830-PS power supply to your computer. A new hardware found balloon should verify the new hardware is found and installed (Vista, XP only).
- 3) Open and run the *InstaCal* program to configure the USB board inside the MK830-PS power supply. The program can be found in XP by clicking on the START button and selecting PROGRAMS, MEASUREMENT COMPUTING, INSTACAL. Double-click the *InstaCal* icon to run the program. Select OK to accept plug and play board detection.
- 4) Run the Kigre MK88 Control Software utility.

Note: The Kigre MK88 control software should only be run after the hardware is turned on and the USB cable is connected.

9 CONTROL SOFTWARE OPERATION

The Kigre MK88 Version # 1.3.1 control software is a ready-made repetition rate generator with burst and shot count features.

- 1) Use the cursor or keyboard to set the proper current for your laser. The proper setting is typically 100A, which corresponds to 55% on the current knob.
- 2) Use the cursor or keyboard to set the proper repetition rate for your laser. For Kigre # MK88 lasers the maximum rate is 10Hz. Proper heatsinking of the laser is required.
- 3) Use the cursor or keyboard to set the proper number of shots (burst count) for your application.
- 4) Select START to begin firing the laser and STOP to stop firing the laser. You can stop firing the laser during a burst count-down at any time by pressing the stop button. The software provides a count-down of the remaining number of shots in the burst.

Please note: The TEC Heating, Cooling, and Fault features are not applicable to the MK88 laser.



**THE MK88 LASER IS DESIGNED TO OPERATE AT 100AMPS,
WHICH IS 55% ON THE "CURRENT" DIAL**

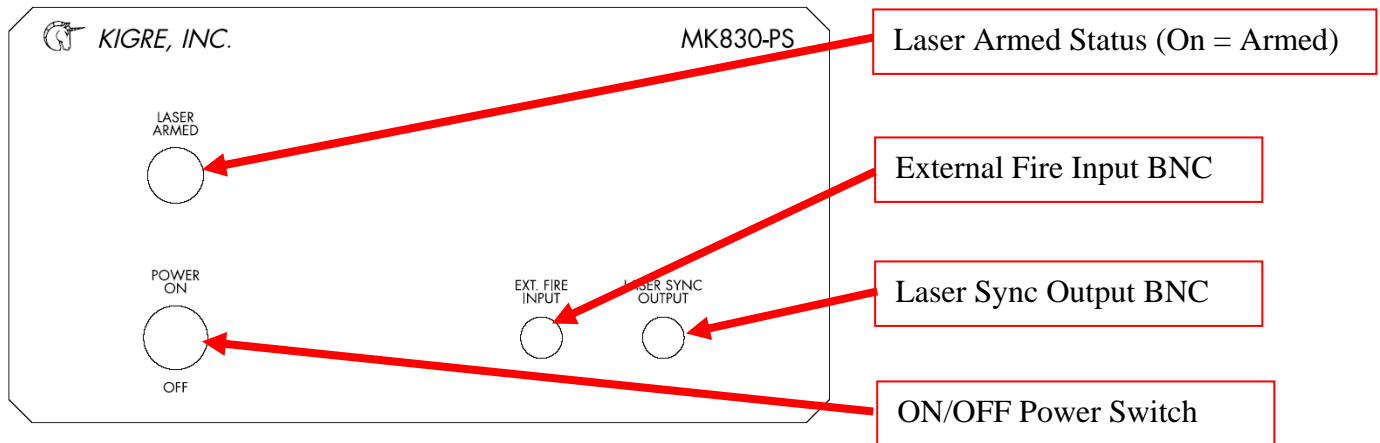
10 F.A.Q. SECTION

1. I get the following error “*the laser is not connector to the system or not configured properly*”:
 - Insure the MK830-PS unit is on and that the green Laser Armed LED is lit.
 - Insure the MK830-PS unit’s DAQ module has been configured. Run InstaCal and verify the DAQ module is recognized.



11 SYSTEM OPERATION

11.1 POWER SUPPLY OPERATION:



The “Laser Sync Output” signal is a 5V, 2mS pulse with the rising edge synchronized with the actual laser output. **The output is intended to drive a 1M-ohm (one mega-ohm) scope input. Never attempt to monitor this signal with a 50-ohm low impedance scope input.**

The “External Fire Input” requires a 5 volt (+/- 0.5V), 1.0–10mS pulse into the front panel BNC connector. Input resistance is 100K-ohm. The laser fire circuit is triggered on the rising edge of this input signal. **Never exceed 10 Hz for the Kigre MK88 laser.**

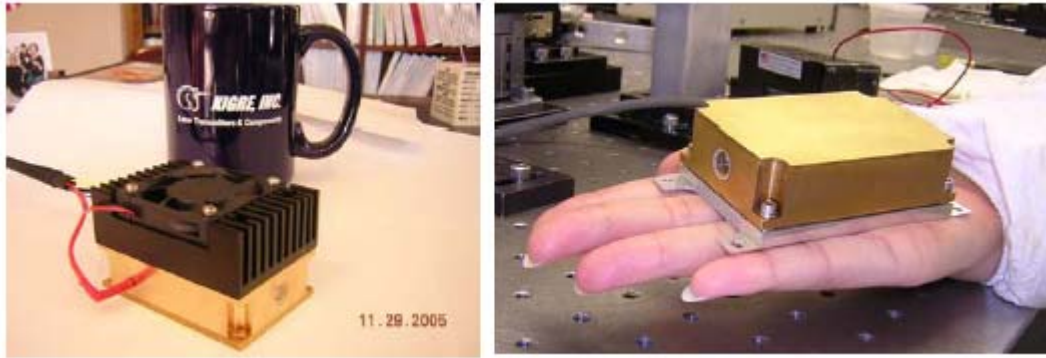
12 OUTPUT TEST VERIFICATION

Use an energy detector, such as the Molectron Energy Max 500 Display and J25 detector shown, to verify laser output performance before installing the system into your unit. Use the Kigre Laboratory Hand Controller (or USB adapter and computer) and supplied AC to DC voltage converter during this initial test. Plug the system into your AC outlet. Move the repetition rate switch to the start position to start firing the laser at 10Hz (5Hz for MK85 systems or 1 Hz for MK81 systems). Move the Rep-Rate switch to the stop position to stop firing the laser. Repeat process as necessary.

The Kigre # MK85, MK88 & MK81 lasers use a passive Q-switch to produce a short pulsewidth, high peak power laser output pulse. The output energy is determined by the Q-switch material and is not user adjustable. Slight variations in output energy are normal and are due to the nature of the passive Q-switch material.



13 ENGINEERING NOTES



Using a fan and heat sink the MK88 laser is typically operated up to its maximum duty cycle. Water cooled baseplates are also acceptable. Active cooling must be used to operate at the maximum duty cycle.

A good method for monitoring the laser's internal temperature is to look at the pump current pulse width. Specifically, this pulse width should not exceed 3 milliseconds. You'll notice that the pump pulse width will increase as the laser heats up. This is due to the loss of efficiency. Once the pump pulse width gets beyond 3mS, the efficiency of the laser drops dramatically and the pump pulse width will rise quickly - indicating an overheated condition. Please do not operate the laser if the pump current pulse width exceeds 3mS.

We suggest the use of a Tektronix model # A622 probe. The probe should be located between the driver and the laser. You can clip on a section of the red wire anywhere in the laser cable.

Datasheet for current probe:

<http://www2.tek.com/cmswpt/psdetails.lotr?ct=PS&ci=13510&cs=psu&lc=EN>

To purchase the probe:

<http://www.alliedelec.com/search/productdetail.aspx?SKU=7000622>

14 OUTPUT TEST DATA



Kigre Transmitter Checkout Sheet

MK-81

MK-84

MK-85

MK88

SAMPLE

Date Tested: 07-20-2010

Program Setting: 2.1D Tester: WLP

Test PS Part #: MK 830-PS-1

Test PS Serial #: K 17108

Test USB/HC Part#: MK 88-0573

Kigre Shock Test: WLP

Test USB/HC Serial #: K 16186

O-scope Part & Serial #: TEKTRONIX TDS 2004 B3 C100801

Energy Meter Part & Serial #: OPHIR VEGA 577149

Detector Part & Serial #: OPHIR 580444

Temp. Test Data: (collect 30 seconds of data) 1Hz 4Hz 5Hz 10Hz

Calibrated energy meter is outside of the temperature chamber.

TEMP (°C)	NUMBER OF SHOTS	MIN ENERGY (mJ)	MAX ENERGY (mJ)	AVERAGE ENERGY (mJ)	PUMP PULSEWIDTH (mS)	ATTACH BURN SAMPLES	SINGLE SHOT BURN SAMPLES
AMBIENT <u>22.5</u>	<u>300</u>	<u>4.35</u>	<u>4.97</u>	<u>4.49</u>	<u>1.13</u>		
<u>30</u>	<u>300</u>	<u>4.36</u>	<u>4.85</u>	<u>4.52</u>	<u>1.14</u>		
<u>40</u>	<u>300</u>	<u>4.23</u>	<u>5.52</u>	<u>4.51</u>	<u>1.17</u>		
<u>50</u>	<u>300</u>	<u>4.04</u>	<u>5.54</u>	<u>4.21</u>	<u>1.20</u>		
<u>20</u>	<u>300</u>	<u>4.11</u>	<u>4.99</u>	<u>4.22</u>	<u>1.11</u>		
<u>10</u>	<u>300</u>	<u>4.19</u>	<u>4.82</u>	<u>4.38</u>	<u>1.10</u>		
<u>0</u>	<u>300</u>	<u>4.34</u>	<u>4.85</u>	<u>4.50</u>	<u>1.07</u>		
<u>-10</u>	<u>300</u>	<u>4.20</u>	<u>4.79</u>	<u>4.54</u>	<u>1.03</u>		
<u>-20</u>	<u>300</u>	<u>4.01</u>	<u>4.75</u>	<u>4.50</u>	<u>1.00</u>		
<u>-30</u>	<u>300</u>	<u>3.64</u>	<u>4.50</u>	<u>4.22</u>	<u>0.99</u>		

Average energy: 4.13 mJ (1.81 ms)

Additional Comments: _____

ATTACH BURN PAPER
SAMPLE TAKEN POST
TEST HERE.
USE ZAP-IT PAPER.

Approved By: [Signature]

Date: 7-20-10

Document Number: 8.2.4.0.F.7

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