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LDI-820

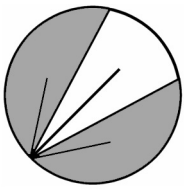
Laser Diode Driver

USER'S MANUAL

WARNING

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

The use of optical instruments with these products will increase eye hazard.



LASER
DRIVE
INC.

Last Revision: November 2000
Part Number: 636-00005-00 Rev 00

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Section 1

User Safety

1.1 Ground The Power Supply

To minimize shock hazard, the power supply must be connected to an electrical ground. The power supply is equipped with a three-conductor AC power cable which must be plugged into an approved three-contact electrical outlet.

1.2 Verify Line Voltage Selector Setting

Before connecting the line cord, verify that the line voltage setting in the power module agrees with local line voltage. (See Section 6.6)

1.3 Removing The Cover

WARNING:
DANGEROUS VOLTAGES EXIST INSIDE THE POWER SUPPLY, EVEN WITH THE POWER SWITCHED OFF. ONLY QUALIFIED SERVICE PERSONNEL SHOULD REMOVE THE COVER.

1.4 Servicing

There are no user replaceable parts inside the power supply. Refer all servicing to qualified personnel. (See Section 9)

1.5 FCC Compliance

THIS EQUIPMENT GENERATES, USES, AND CAN RADIATE RADIO FREQUENCY ENERGY AND IF NOT INSTALLED AND USED IN ACCORDANCE WITH THE INSTRUCTION MANUAL, MAY CAUSE INTERFERENCE TO RADIO COMMUNICATIONS. IT HAS BEEN TESTED AND FOUND TO COMPLY WITH THE LIMITS FOR A CLASS A COMPUTING DEVICE PERSUANT TO SUBPART J OF PART 15 OF FCC RULES, WHICH ARE DESIGNED TO PROVIDE REASONABLE PROTECTION AGAINST SUCH INTERFERENCE WHEN OPERATED IN A COMMERCIAL ENVIRONMENT. OPERATION OF THIS EQUIPMENT IN RESIDENTIAL AREAS IS LIKELY TO CAUSE INTERFERENCE, IN WHICH CASE, THE USER, AT HIS OWN EXPENSE, WILL BE REQUIRED TO TAKE WHATEVER MEASURES MAY BE REQUIRED TO CORRECT THE INTERFERENCE.

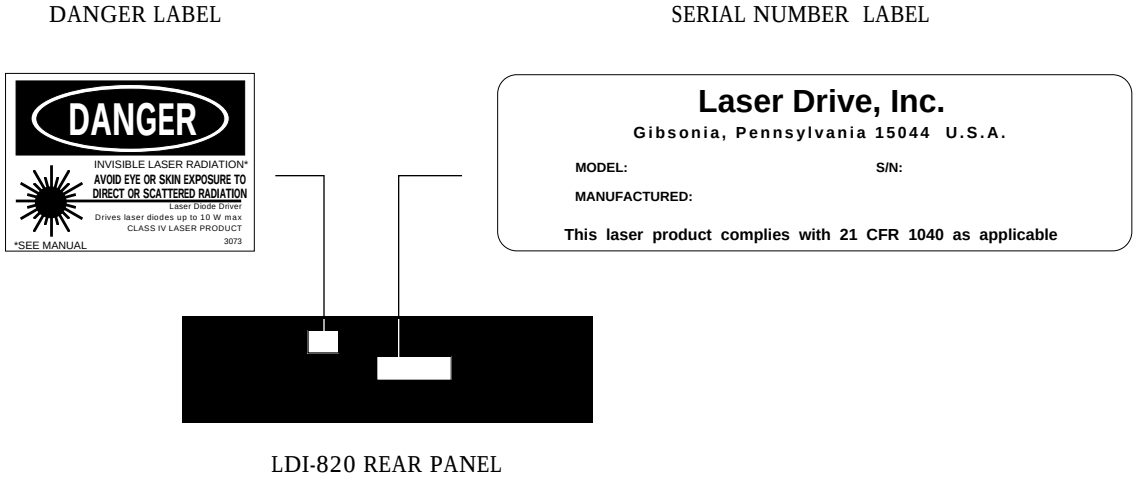
1.6 Laser Safety Warnings

The laser light emitted from laser diodes is invisible and may be harmful to the human eye. Avoid looking directly into the laser diode or into the collimated beam along its optical axis when the device is in operation.

Operating a laser diode outside of its maximum ratings may cause device failure or a safety hazard.

See the laser specifications for additional information.

Figure 1.1 CDRH Safety Labels



Section 2

Initial Inspection and Turn On

2.1 Unpacking Your LDI-820 Power Supply

Upon receipt, carefully inspect the shipping container for damage. Carriers will not accept claims for damage unless all shipping materials are saved.

2.2 Setting the Line Voltage and Selecting a Fuse and Power Cord

See Section 6.6 for a description of the power module. Verify that the line voltage selector and fuse are set properly. If the power cord we shipped is incorrect for your area, either contact LDI or obtain the correct cord locally.

2.3 Initial Turn On

READ THIS MANUAL BEFORE CONNECTING A LASER DIODE TO THE LDI-820

Refer to Section 8 for cw and quasi-cw operating procedures.

CAUTION:
LASERS MAY BE DAMAGED BY IMPROPER SETTING OF THE CURRENT LIMIT AND BIAS CONTROLS OR BY IMPROPER USE OF THE ANALOG INPUT. SEE SECTIONS 5 & 8. CHECK THE LINE VOLTAGE SELECTOR AND FUSE BEFORE CONNECTING POWER.

The remote interlock jumper must be installed in the rear panel terminal strip. It is installed when shipped. If it is not in place, the LDI 820 will display INTERLOCK OPEN and the unit will be inoperable.

Section 3

Product Description

The LDI-820 is a high current general purpose laboratory laser diode driver. CW or quasi-cw laser diodes, LED's or similar devices requiring up to 10 amps drive current may be safely operated and controlled with the LDI-820. Optical power or current control mode, transient suppression, diode protection circuits, set-up mode, overcurrent limit and full thermoelectric cooler control are provided.

The driver features multi-character alpha-numeric display of all key operating functions, error messages, and automatic self-test. Operator command is required for laser turn-on. Embedded microprocessor based logic prohibits illegal commands and prevents inadvertent faulty set-up. Highly stabilized analog circuits provide final laser drive.

A unique single knob control is combined with function switches for setting of operating parameters. The lighted alpha-numeric display allows observation of function and value. The single large control knob permits easy operator interface, even in darkened laboratory environments and the analog "feel" so useful in fine adjustments.

An internal pulse generator allows operation of quasi-cw devices or digital modulation of cw laser diodes. External triggering, and external modulation inputs are provided.

The thermoelectric cooler controller operates the TEC option on all SDL laser diodes, or may be used to control external TEC devices. This controller is calibrated for use with 10 kΩ thermistors and provides up to 5A at 10V.

This driver meets the requirements of 21 CFR 1040.10 laser safety regulations.

Section 4
Specifications

Current Control Mode

Average/Peak Current Range	0.05 to 9.95 A
Average/Peak Current Resolution	0.01 A
Average Current Accuracy	± 0.02 A + 1% of reading
Peak Current Accuracy	± 0.03 A + 2% of reading, for frequency >10 Hz
Analog Input[1]	
Scale Factor (Accuracy)	1V/A, 10 V Full Scale (± 0.03 A + 2% of reading)
Input Impedance	20 kΩ nominal
Bandwidth	25 kHz typical
Transition Times	12 µsec typical
Maximum Output Voltage	4 V at connector, 3 V end of cable
Noise	20 mA p-p @ laser connector typical

Power Control Mode

Average/Peak Power Range	0.01 to 2 W
Average/Peak Power Resolution	0.002 W (0.002 setpoint)
Average Power Accuracy	± 0.002 W + 2% of reading
Peak Power Accuracy	± 0.01 W + 3% of reading (0.02 W if MPD ≤ 0.5)
Analog Input	
Scale Factor (Accuracy)	2 V/W, 4 V Full Scale (± 0.01 W + 3% of reading)
Input Impedance	20 kΩ nominal
Bandwidth	25 kHz typical
Transition Times	10 µsec typical
Maximum Output Voltage	4 V at connector, 3 V end of cable
Noise	5 mW p-p @ laser connector typical (10 mW if MPD ≤ 0.5)

Monitor Photodiode

Control Range	0.1 to 20 µA/mW (mA/W)
Two Internal Ranges[2]	0.1 to 0.50 and 0.52 to 20 µA/mW
Resolution	0.02 µA/mW
Maximum Input Current	10 mA

Current Limit

Range	0.25 to 10 A
Resolution (Accuracy[3])	0.01 A (± 0.02 A + 1% of reading)

Temperature Control[6]

Actual/Setpoint Range	-20 to 40 °C
Reading Range	-25 to 50 °C
Resolution (Accuracy[4])	0.1 °C (± 1 °C)
Maximum Voltage Drive	10.5 V at connector, 10 V end of cable
Maximum Current Drive	5 A
TEC Drive Limit Range	0 to 10 V
Resolution (Accuracy)	0.01 V (± 0.02 V + 2% of setting)

Pulse Generator

Amplitude & Baseline	
Range & Resolution	same as Current/Power Modes
Current Accuracy	add 1% to basic reading error
Power Accuracy	add 1% to basic reading error
Width Range	10 µsec to 0.3 sec
Resolution (Accuracy)	5 µsec (± 2 µsec + 0.1% of setting)
Repetition Rate Range	1 to 1000 Hz, single pulse & ext. trig
Resolution	≤ 10 Hz
Accuracy	±0.1%
Pulse Rise Time	10 µsec (typical)

Monitor Outputs

Output Impedance:	<1000 Ω
Current Scale Factor (Accuracy)	1V/A, 10 V Full Scale (±0.03 A + 2% of reading)
Power Scale Factor (Accuracy)	5 V/W, 10 V Full Scale (± 0.005 W + 2% of reading)

Remote Interlock

Open Circuit Voltage	5 V ± 10%
Short Circuit Current	< 2 mA
Threshold	< 1 V enables drive, > 3 V disables

Remote Trigger Switch

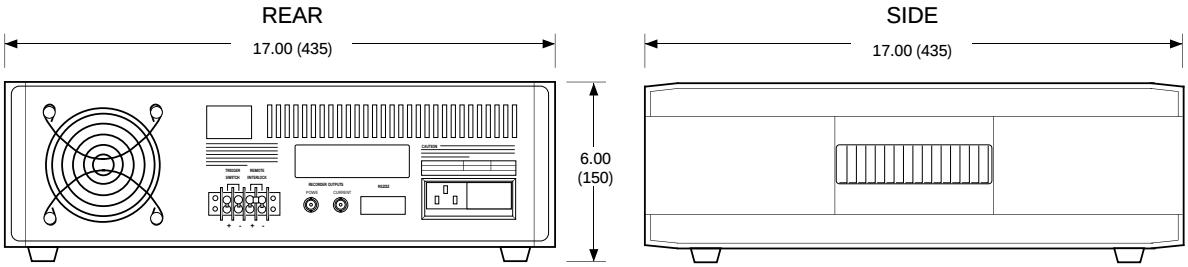
Open Circuit Voltage	5 V ± 10%
Short Circuit Current	< 2 mA
Threshold	switch closure or < 1V triggers single pulse if enabled on front panel, switch opening or > 3 V re-arms.

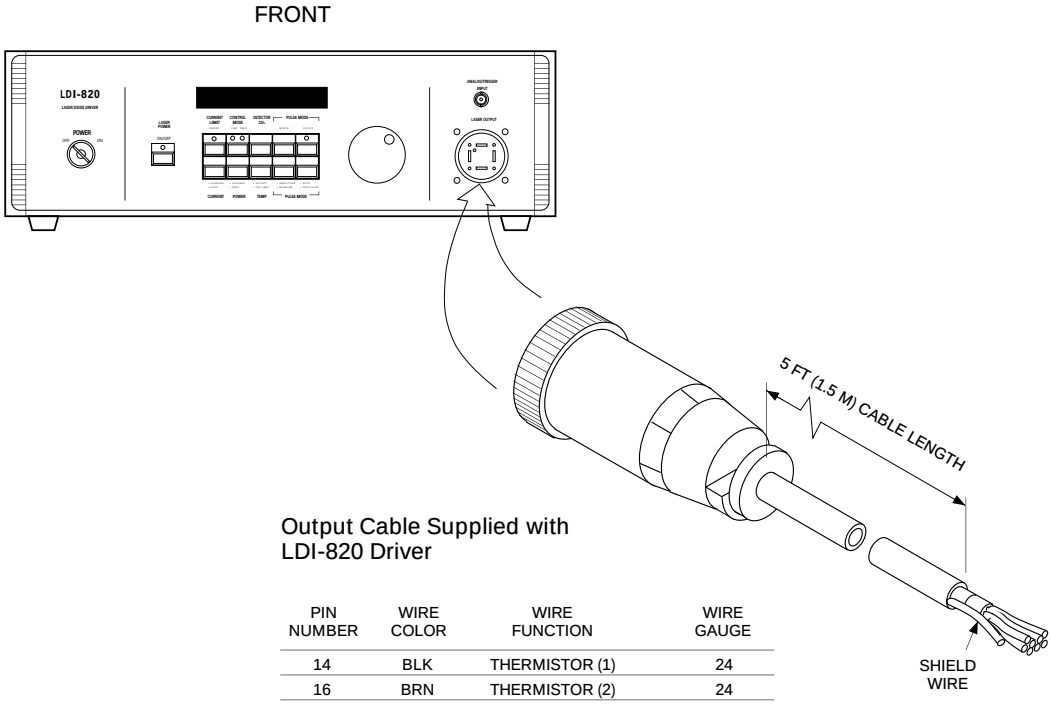
General

Operating Temperature	10 to 40 °C, noncondensing
Storage Temperature	-40 to 75 °C
Power	100, 120, 220, 240 VAC +5%, -10% 48 to 66 Hz 270 W maximum @ 120 VAC 300 VA maximum @ 120 VAC
Size (H x W x D)	6" x 17" x 17" (155mm x 435mm x 435mm)
Weight	26 lb. (12 kg)

Notes

1. The sum of bias and analog currents will limit at the current limit setting
2. Offset increases for Monitor Photodiode calibration < 0.52 µA/mW
3. Total error between displayed current limit and displayed average current in current limit mode may be as high as the sum of the accuracies for these two values.
4. The thermistor presently used by LDI has a ±5% tolerance at 25 °C, ±8% at -10 °C, and ±6% at 30 °C. Corresponding temperature errors are ±1.2, ±1.5, and ± 1.5 °C.
5. The LDI-820 is designed to apply a negative bias to the laser diode Cathode Lead while the Anode Lead is at ground.
6. Temperature control is unipolar for cooling.





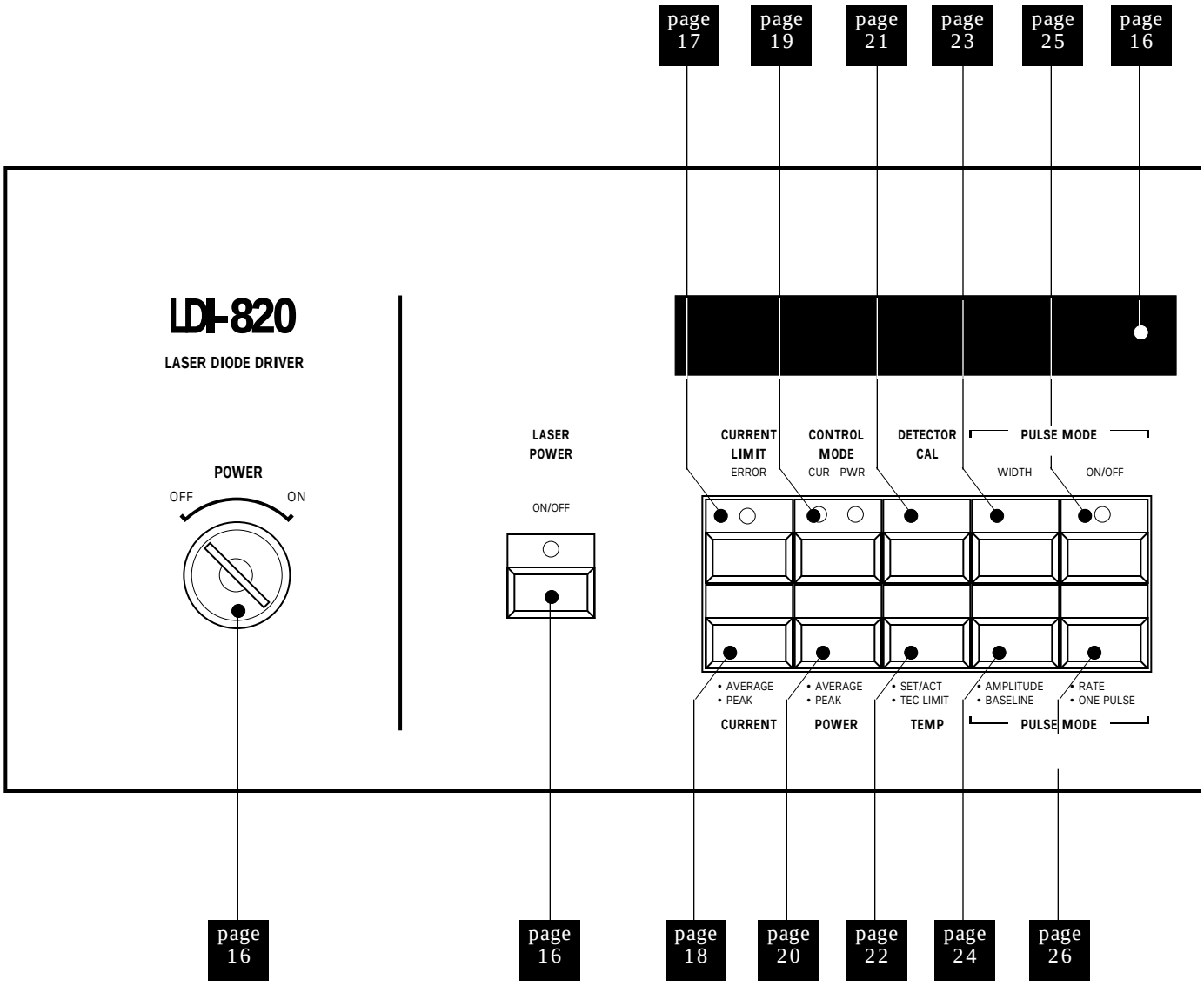
Output Cable Supplied with
LDI-820 Driver

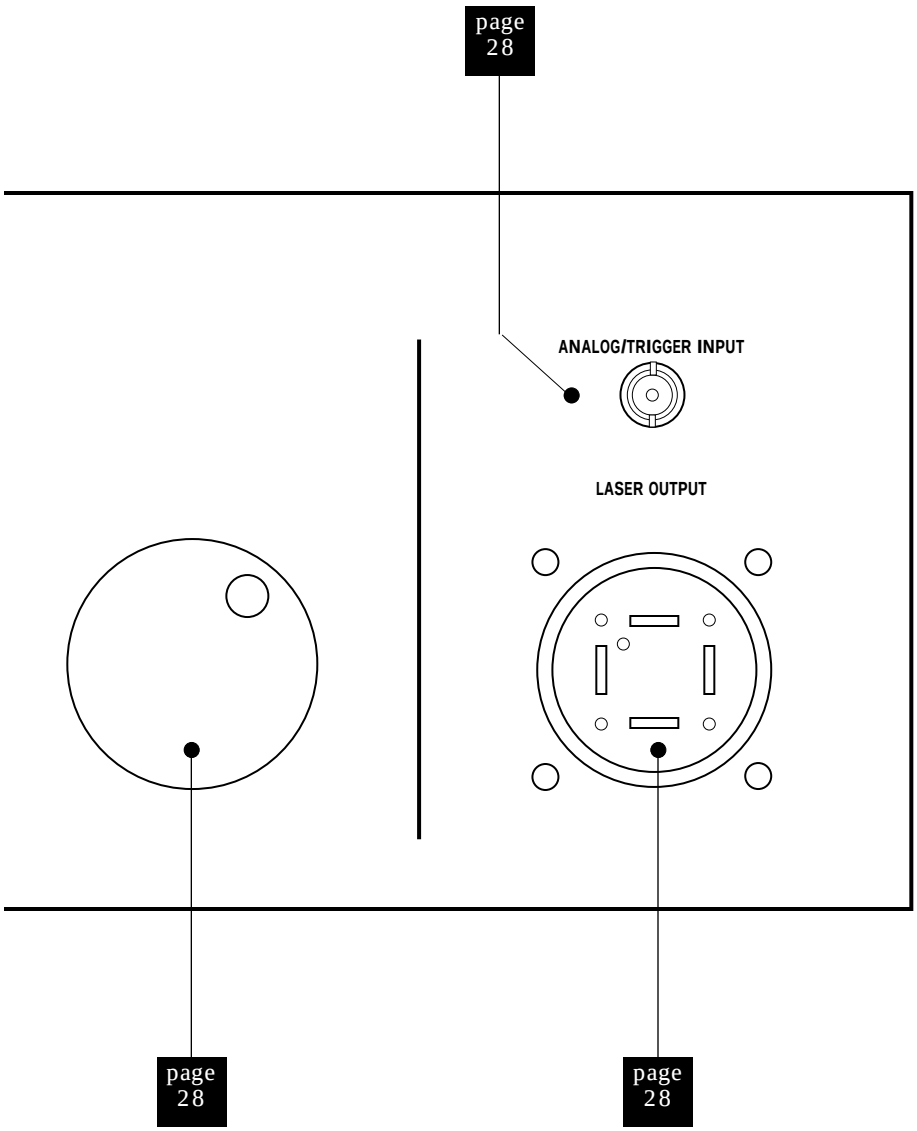
PIN NUMBER	WIRE COLOR	WIRE FUNCTION	WIRE GAUGE
14	BLK	THERMISTOR (1)	24
16	BRN	THERMISTOR (2)	24
1	RED	LASER ANODE (+)	16
10	ORN	LASER CATHODE (-)	16
15	YEL	TEC (+)	16
7	GRN	TEC (-)	16
3	BLU	MPD ANODE (-)	24
2	VIO	MPD CATHODE (+)	24
4	SHIELD	DRAIN	SHIELD

Section 5

LDI-820 Front Panel Description

This section describes the operation of each front panel feature. The descriptions match the panel layout pictured here from left to right. Reading this section is an excellent way to become familiar with the operation of the LDI-820.




page 28
ANALOG/TRIGGER INPUT
LASER OUTPUT
page 28
page 28

5.1 Main POWER Switch

This switch controls the line power. It is a locking switch, with the key removable only in the "OFF" position. The LASER POWER key (button) is a more convenient way to switch power to the laser diode. An automatic self-test is performed at power on. This test will not damage a laser if one happens to be connected. After the self-test, the LDI-820 will automatically switch to the current limit function.

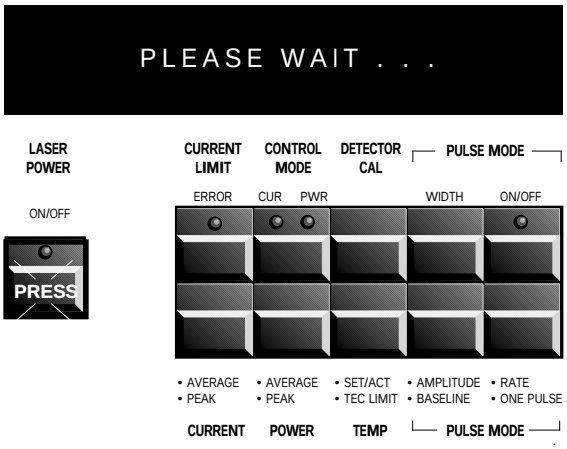
5.2 Display

The 20 character display indicates the parameter being displayed, its value and its units. Informative and error messages are also displayed.



5.3 **LASER POWER** (ON/OFF)

This key (button) toggles between laser ON and laser OFF. The light in the key lights when the laser is ON. When switching from OFF to ON, the light blinks for about 5 seconds before the laser actually switches on. This delay is provided to comply with safety requirements. If a laser is not connected to the output connector, the LASER POWER control will not switch ON and if the laser becomes disconnected, the LASER POWER control will switch off. Pressing any key during the 5 second wait will cancel the delay and return to laser OFF.

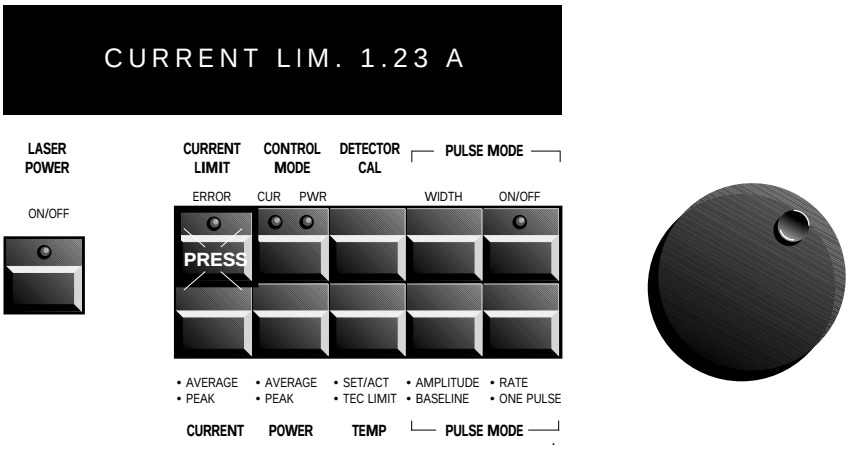


CAUTION: DO NOT SWITCH THE LASER POWER ON WITHOUT FIRST CHECKING CURRENT LIMIT, DETECTOR CAL, AND ALL DRIVE LEVELS.

Function Keys
This group of 10 keys controls the functions of the LDI-820. The top row is conventional. The bottom row of keys each access 2 functions. The most common function appears the first time a lower key is pressed and then the two functions listed on the panel under each key alternate each time the key is subsequently pressed. An exception to the rule for the lower row of keys is the pulse rate key. It is used for selecting pulse rate and producing single pulses but the two functions do not toggle.

5.4 **CURRENT LIMIT** (ERROR)

This key sets the display and knob to show and adjust the current limit value. Drive current for both the setup load and laser diode will not exceed the value shown on the display. CURRENT LIMIT responds to the instantaneous current value, including analog inputs and pulses. The light in the CURRENT LIMIT key lights whenever the LDI-820 is in current limit (typically, the error indication occurs about 100 mA before full current limiting.) Although the current limit setting will display "0", the actual current is not specified to track the current limit setting below 0.25 A.

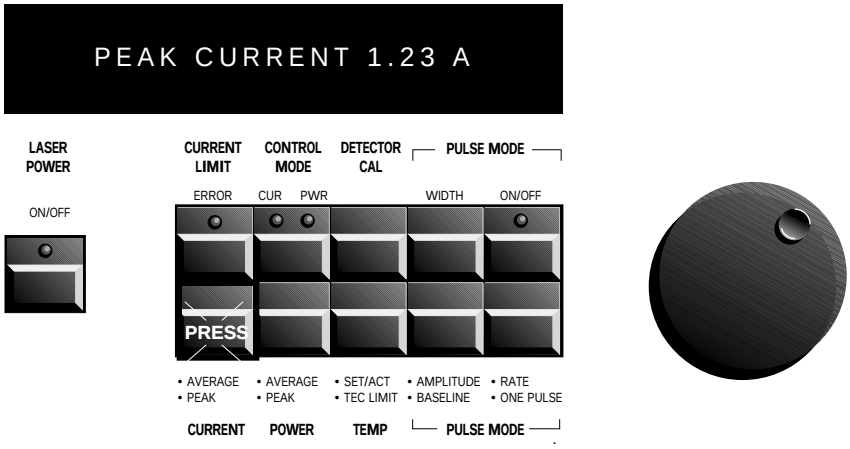


It is good practice to always check CURRENT LIMIT prior to operating a laser diode. A suggested initial setting for CURRENT LIMIT is the rated operating current for the laser. After verifying correct operation, the current limit may be raised slightly to allow operation at rated current without current limiting.

CAUTION: THE CURRENT LIMIT VALUE SHOULD BE CHANGED WHEN CHANGING LASERS.

5.5 CURRENT (AVERAGE and PEAK)

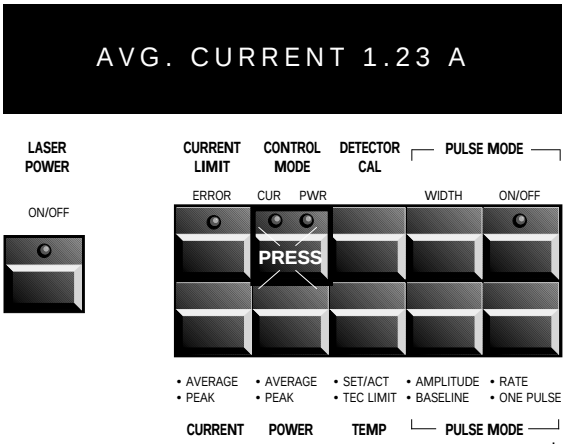
This key sets the display and knob to show and adjust the laser operating current. The display shows the actual average current (not the same as pulse baseline in pulse mode, which shows the setpoint). This value is affected by the knob, analog input and pulse drive. Remove other drives to see the effect of the internal setpoint alone. When in power control ("PWR") or PULSE mode, the average current is displayed but may not be adjusted. Some analog input and pulse drive conditions will result in an unstable average reading due to the averaging time constant. When the LDI-820 is switched on, the current setpoint is the same as when power was switched off. The setpoint for average current is independent from the pulse mode baseline current setpoint.



If the display is already showing current, the CURRENT key may be pressed a second time to observe peak current. Peak current is the peak value of the actual current. When the PULSE MODE is OFF, using the knob affects average current even though viewing peak current. When the PULSE MODE is ON, the knob has no effect. Below about 10 Hz, the peak reading becomes jittery. If it is desired to operate a laser to some peak current, the built-in pulse generator may be used to set the baseline and peak values.

5.6 CONTROL MODE (CUR and PWR)

This key alternates between current (CUR) and power (PWR) control modes. The lights in the key indicate which mode is active. The power mode may only be entered when the laser is on and a monitor photodiode (MPD) is connected to the LDI-820. This rule was imposed because when the laser is OFF, no MPD signal is available to the control circuitry and proper setting of the control cannot be verified.



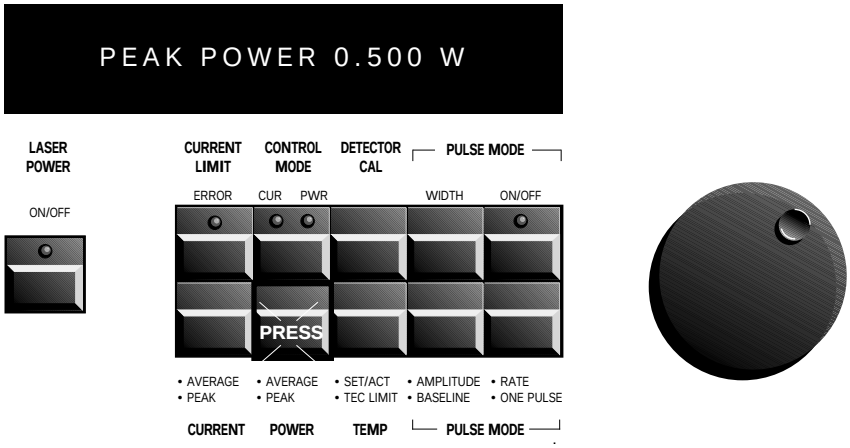
Each time the laser is switched ON (automatically into current mode first), the AVERAGE POWER setpoint is set to 0. If the laser power is switched OFF while in the power control mode, the LDI-820 will remain in power mode until any key except LASER POWER is pressed (to turn the laser back ON). This allows the laser to be switched ON and OFF without having to restore power control mode settings each time. The power indicator in the key blinks to indicate this special condition and the power setpoints are not cleared. When the LDI-820 main power is switched ON, the control mode will be set to current control. If the control mode is switched when the laser power is ON, the setpoints for the new mode (both BASELINE and AMPLITUDE in pulse mode) will retain their last values.

CAUTION:

DO NOT CHANGE CONTROL MODES WHILE A LASER IS ON IF THE OPERATING CONDITIONS FOR THE MODE TO BE ENTERED ARE NOT VALID FOR THE LASER CONNECTED TO THE LDI-820. SET THE DETECTOR CALIBRATION VALUE AS DESCRIBED ON PAGE 21 BEFORE SWITCHING TO POWER CONTROL MODE.

5.7 POWER (AVERAGE and PEAK)

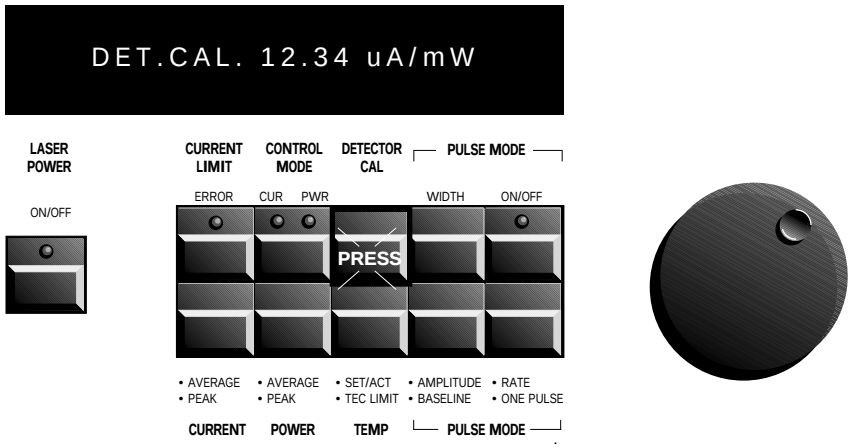
This key sets the display and knob to show and adjust laser power. The display shows the actual average power (not the same as pulse baseline in pulse mode, which shows the setpoint.) This value is affected by the knob, analog input and pulse drive. Remove other drives to see the effect of the internal setpoint alone. When in current control ("CUR") or PULSE mode or when the laser is not ON, the power is displayed but may not be adjusted. Some analog input and pulse drive conditions will result in an unstable average reading due to the averaging time constant. Power control mode may only be entered when the laser is ON and a monitor photodiode (MPD) is connected. When the LDI-820 is switched on, the power setpoint is initialized to 0. The setpoint for average power is independent from the pulse mode BASELINE power setpoint.



If the display is already showing power, the POWER key may be pressed a second time to display peak power. Peak power is the peak value of the actual power. When PULSE MODE is OFF, using the knob affects average power even though viewing peak power. When the PULSE MODE is ON, the knob has no effect. Below about 10 Hz, the peak reading becomes jittery. If it is desired to operate a laser to some peak power the internal pulse generator may be used to set the baseline and peak values.

5.8 DETECTOR CAL

This key sets the display and knob to show and adjust the calibration number for the monitor photodiode (MPD). The units used are µA/mW (or, equivalently, mA/W) and the number is found on data sheets which accompany lasers. The calibration number adjusts the LDI-820 to match variations in MPD gain from one laser to another. When the LDI-820 is first switched ON, DETECTOR CAL will be the same as when power was switched OFF. DETECTOR CAL may only be adjusted when not in power (PWR) control mode.



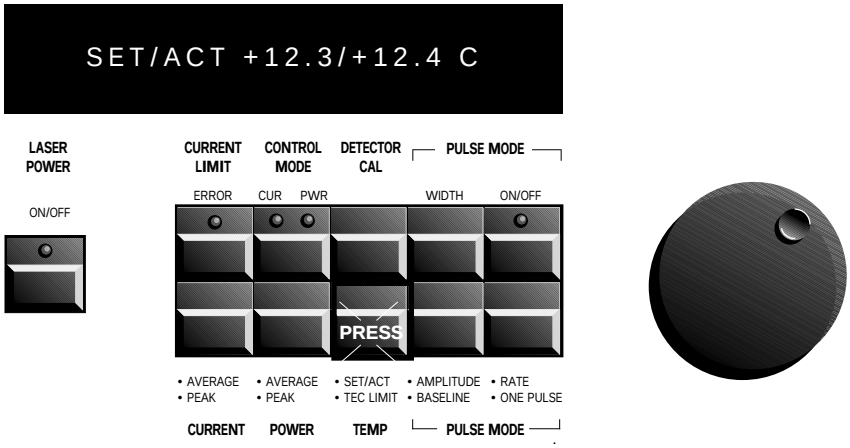
Proper use of DETECTOR CAL is essential when driving a laser in power control mode. For instance, if the true detector calibration for a laser connected to the LDI-820 is 5 µA/mW and DETECTOR CAL is set to 10 µA/mW, when the LDI-820 is switched to power control the laser will emit double the indicated power unless stopped by the current limit. A good procedure is to first run the laser in current mode (after setting DETECTOR CAL to the data sheet value while the laser drive is still off). Set the current to a value for which the power may be read from the data sheet and compare the displayed power value with the data sheet value. If the DETECTOR CAL setting is much smaller (about 1/2 of actual) than the actual value, the LDI-820 may oscillate or overshoot when in power control mode. If you use a custom monitor photodiode, limit MPD current to less than 10 mA (less than 5 mA recommended).

CAUTION:

IF THIS CONTROL IS IMPROPERLY SET, THE LASER DIODE MAY BE DRIVEN TO CURRENT LIMIT OR THE LDI-820 MAY OSCILLATE WHEN POWER CONTROL IS SELECTED. ALWAYS SET DETECTOR CAL BEFORE SWITCHING A LASER ON.

5.9 TEMP (SET/ACT and TEC LIMIT)

This key sets the display and knob to show and adjust the thermoelectric cooler setpoint and to show the actual temperature. Both setpoint and actual are displayed simultaneously. When the LDI-820 is first powered ON the setpoint will be the same as when power was switched OFF. If no thermistor is detected, the message "OPEN" will be displayed instead of the normal display. If a shorted thermistor is detected, "SHORT" will be displayed. TEC drive voltage limit will be set to zero for either error condition (the stored value for TEC limit will not be affected). The thermoelectric cooler drive circuit is active whether the laser is ON or OFF.



If the display is already showing the two temperatures, the TEMP key may be pressed a second time to display the maximum drive voltage which will be applied to the thermoelectric cooler. This limit varies for different laser products. For SDL lasers the limits are:

SDL-2352-H1	4.5 Volts
SDL-2300 Series "P" packages	8.0 Volts

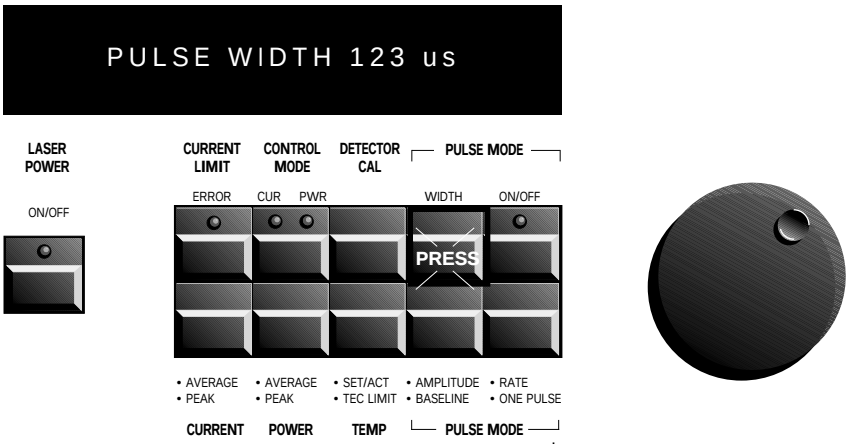
When the LDI-820 is first powered on, the voltage limit will be the same as when power was switched off.

CAUTION:
IF USING THE LDI-820 WITH A SPECIAL THERMOELECTRIC COOLER, VERIFY THE VOLTAGE LIMIT SETTING. OBSERVE THE ACTUAL TEMPERATURE DISPLAY FOR SIGNS OF THERMAL OSCILLATION.

THE LASER AND/OR THERMOELECTRIC COOLER MAY BE DAMAGED IF THE VOLTAGE LIMIT IS SET INCORRECTLY.

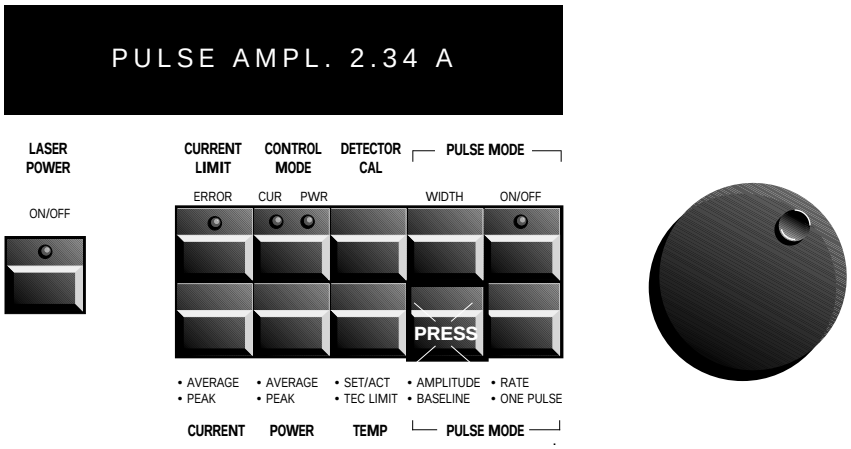
5.10 **PULSE MODE** (WIDTH)

This key sets the display and knob to show and adjust the width of the drive pulses. The maximum PULSE WIDTH setting is limited to 95% duty cycle. When the LDI-820 is first powered ON, the pulse width will be the same as when power was switched OFF.



5.11 **PULSE MODE** (AMPLITUDE and BASELINE)

This key sets the display and knob to show and adjust the amplitude of the pulse drive. The pulsed amplitude will be set either in amps or watts, depending on the setting of CONTROL MODE. The laser drive will pulse from the BASELINE value to the BASELINE plus the pulse AMPLITUDE value.



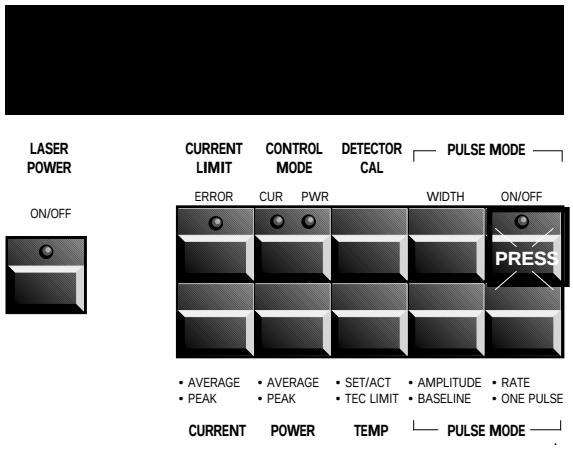
If the display is showing the pulse amplitude already, the key may be pressed a second time to set the pulse BASELINE value. The BASELINE will also be set in the units matching the control mode.The BASELINE values (current and power) are independent from the average value setpoints.

When the LDI-820 is first powered on, the AMPLITUDE and BASELINE values for current will be the same as when electrical power was switched off. The BASELINE and AMPLITUDE for power are set to zero each time power control mode is entered. The special mode which allows switching the laser off without losing setpoints applies here too (See Section 5.6).

Pulse AMPLITUDE and BASELINE values in the display are setpoints, not measured values. The values in the display do not include the effects of external inputs.

5.12 **PULSE MODE** (ON/OFF)

This key turns the pulse mode OFF and ON. The light in the key is on when the pulse mode is ON. Pulse AMPLITUDE, WIDTH, and RATE are all associated with this key. When the LDI-820 is first powered ON, the pulse mode will be the same as when power was switched OFF. An important thing to remember is that all the setpoints for pulse mode are independent from the average current and power setpoints.

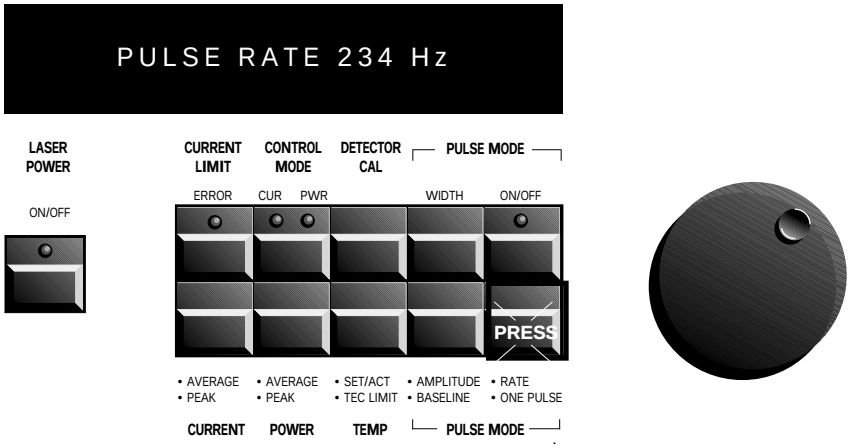


CAUTION:
WHEN THE PULSE MODE IS SWITCHED OFF, THE FUNCTION OF THE ANALOG/TRIGGER INPUT SWITCHES FROM TRIGGER (IF IN SINGLE PULSE MODE) TO INPUT. THIS MAY APPLY HIGH DRIVE LEVELS TO THE LASER DIODE. THE CURRENT WILL BE LIMITED TO THE CURRENT LIMIT VALUE.

WHEN THE PULSE MODE IS SWITCHED, DRIVE CONDITIONS ARE ALSO SWITCHED. USE CAUTION WHEN SWITCHING PULSE MODE WITH LASER POWER ON.

5.13 PULSE MODE (RATE and ONE PULSE)

This key sets the display and knob to show and adjust the width of the pulse rate. The maximum pulse rate setting is limited to 95% duty cycle. Above about 300 Hz, the actual output does not change every 1 Hz, although the display does. The output step size increases from about 0.3 to 1% as the rate increases from 300 to 1000 Hz.



or . . .



or . . .



If the rate is adjusted to 1 Hz, then about 1/2 turn more counterclockwise, the single pulse mode is enabled. Subsequently, each time the pulse rate key is pressed, a single pulse will be produced and will be indicated on the display.

The ANALOG/TRIGGER INPUT switches from INPUT to TRIGGER and the rear panel TRIGGER switch is activated. Triggering frequency is limited to 1 Hz from the PULSE RATE button or TRIGGER switch input, but is limited only by pulse overrun from the front panel TRIGGER INPUT. Because of hardware limitations, the actual pulse width does not respond to changes in single pulse mode when the front panel TRIGGER INPUT is used. Pressing the RATE key or triggering from the rear panel will update the pulse width.

If other keys are pressed while in the ONE PULSE mode, the appropriate function will be displayed and may be adjusted as usual. Pressing the RATE key will produce a pulse and return the display to "ONE PULSE READY". The RATE and rear panel inputs cause a "*****PULSE*****" to be displayed, but the front panel input does not. To exit the one pulse mode, turn the knob about 1/2 turn clockwise.

When the LDI-820 is first powered ON, the pulse rate is the same as when power was switched OFF. Note that while the knob is being used to adjust the pulse rate, missing and extra output pulses may occur.

CAUTION:
WHEN THE SINGLE PULSE MODE IS SWITCHED OFF, THE FUNCTION OF THE ANALOG/TRIGGER SWITCHES TO ANALOG INPUT AND ANY APPLIED SIGNAL AFFECTS THE DRIVE LEVEL.

5.14 Control Knob

The knob is used to adjust all settings. About 8 to 12 revolutions are required to scan from zero to full scale. In some cases, for instance viewing peak current while in pulse mode, the knob has no effect. The previous sections detail when the knob is "locked out."

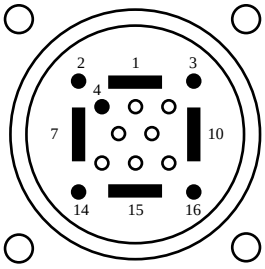
5.15 ANALOG/TRIGGER INPUT

This BNC connector allows adding modulation to the values set by the LDI-820 controls except when in single pulse mode. Full scale is 10 V (10 A or 2W). In single pulse mode this connector allow external triggering. Trigger threshold is 1.5 V nominal. The shell of the BNC is referred to safety ground.

CAUTION:
THE ANALOG INPUT MAY OVERDRIVE THE LASER IF EXCESSIVE VOLTAGE IS APPLIED. CURRENT LIMIT WILL PROTECT THE LASER IF SET PROPERLY. READ THE PULSE RATE SECTION ON PAGE 21 BEFORE USING THE ANALOG/ TRIGGER INPUT IN SINGLE PULSE MODE.

5.16 LASER OUTPUT

This multi-pin connector allows connecting the output cable or optional heat-sinks to the LDI-820. It carries laser drive, thermoelectric cooler drive, monitor photodiode and thermistor signals. The matching plug installs with the large polarizing key "up". The output cable color code is shown below.



Note that heavy gauge (16 AWG) wire is used to minimize voltage drops in the cable. Short lengths (4 inches, 10 cm) of 20 AWG wire may be used to make a transition from the cable conductors to the laser pins. Because high currents are generated by the LDI-820, cable inductance is also important. Energy stored in cable inductance during a pulse must be absorbed. Use of short cables and reverse protection diodes (1N5818, 1A Schottky) is strongly recommended.

Pin Number	Wire Color	Function	Wire Gauge
14	Black	Thermistor Lead 1	24
16	Brown	Thermistor Lead 2	24
1	Red	Laser Anode (0 V)	16
10	Orange	Laser Cathode (negative)	16
15	Yellow	T.E. Cooler Positive Lead (positive)	16
7	Green	T.E. Cooler Negative Lead (0 V)	16
3	Blue	Monitor Photodiode Anode (negative)	24
2	Violet	Monitor Photodiode Cathode (0 V)	24
4	Shield	Drain	-

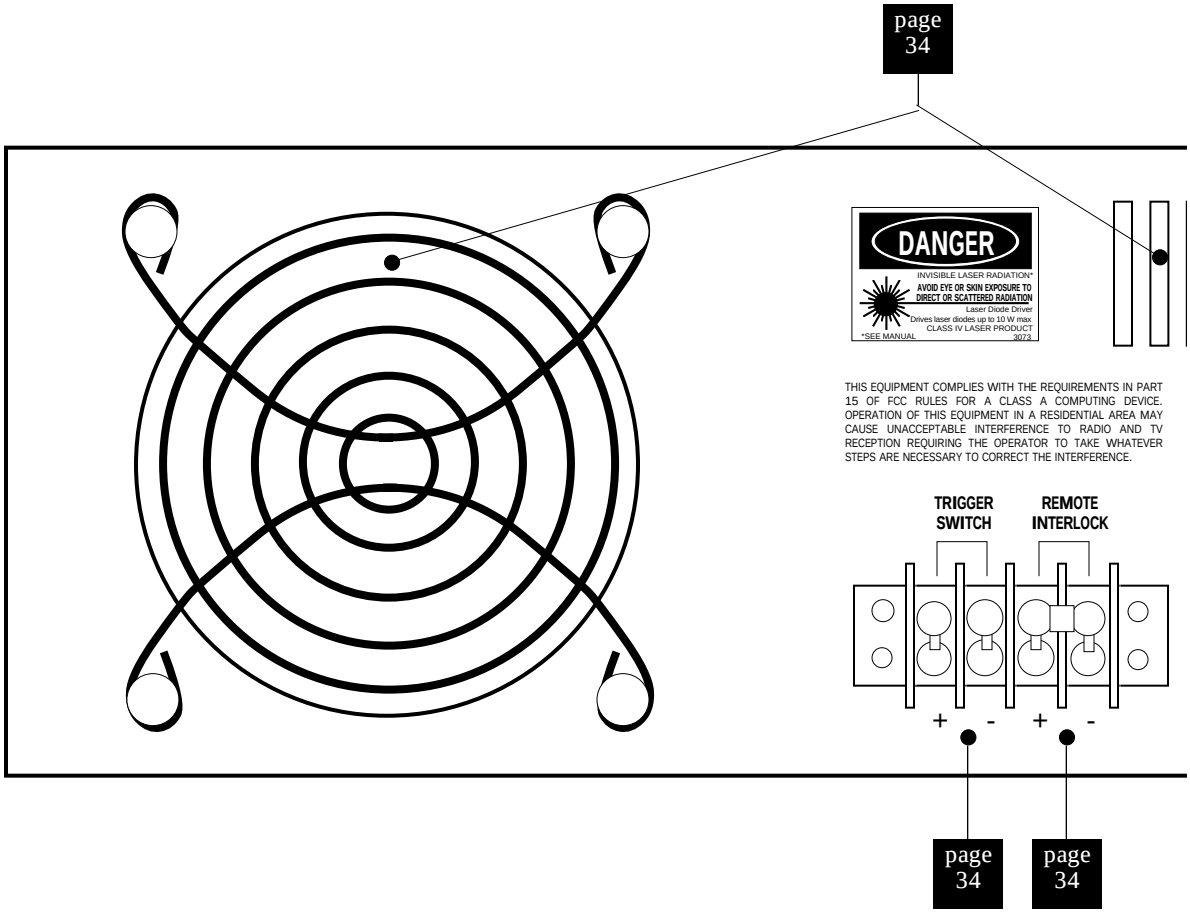
Comments in parentheses refer to the polarity of the voltage on a wire. The overall cable shield may be connected to the laser anode lead or the laser package (case). The monitor photodiode shield should not be connected (It is connected at the front panel).

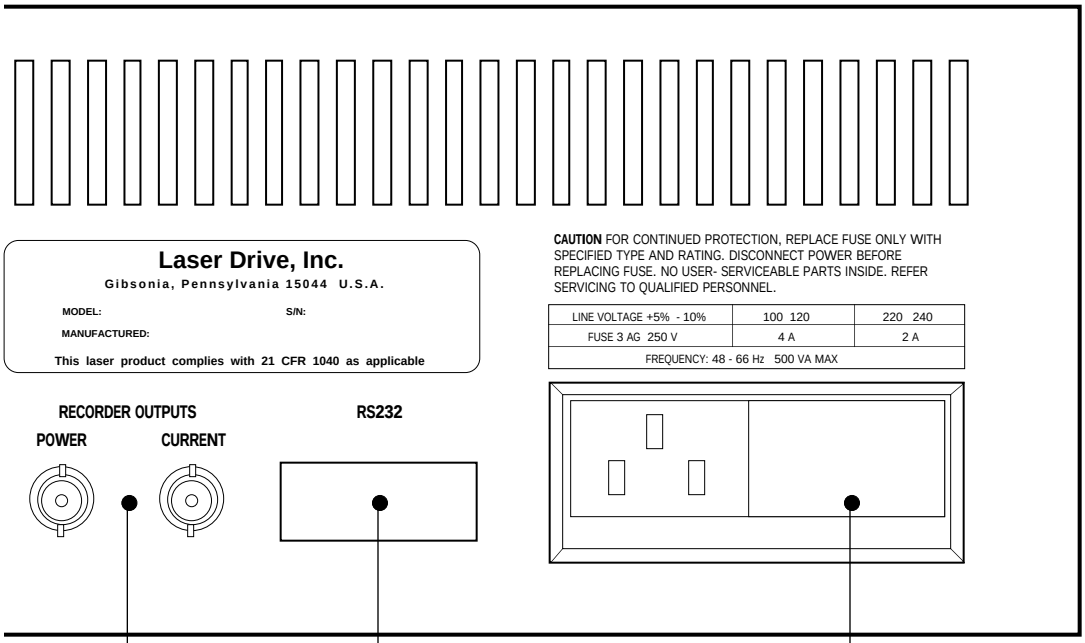
Section 6

LDI-820 Rear Panel Description

This section describes the operation of each rear panel feature. The descriptions match the panel layout pictured here from left to right.

Reading this section is an excellent way to become familiar with the operation of the LDI-820.





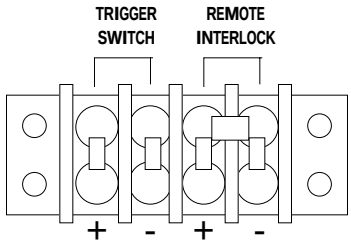
page 35
page 35
page 35

6.1 Fan and Intake Slots

The fan pulls air through the intake slots, over the internal components and heatsink, then exhausts it through the fan guard. If dust build-up is seen on the intake slots or fan, it may indicate a similar build-up internally. Remove the top cover (remove the two screws at the rear of the top cover and slide it back) and check for dust. Vacuum or blow dust out of unit. Note that some units have only 3 screws holding the fan guard. The lower outboard screw is omitted from these units.

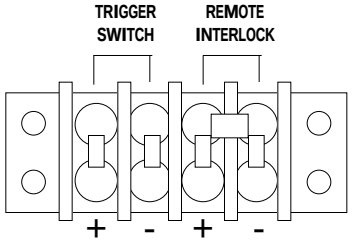
6.2 TRIGGER SWITCH

These two terminals on the terminal strip may be connected to a switch. When in single pulse mode, each time the switch is closed a pulse will be generated. The switch may be a remote foot or hand switch. The "-" terminal is connected to safety ground.



6.3 REMOTE INTERLOCK

These two terminals on the terminal strip are provided to comply with safety requirements. They must be jumpered for normal operation. If it is desired to use the interlock feature, remove the jumper and replace it with a circuit (for example, a door switch) which will be closed in the normal position. If the switch is opened when the laser drive is ON, the laser drive will switch OFF. The laser will not switch on when the interlock closes again until the front panel LASER POWER control is pressed.. The "-" terminal is connected to safety ground.



6.4 RECORDER OUTPUTS

These two BNC connectors allow monitoring the laser drive current and output power (if the laser is equipped with a monitor photodiode). Both signals are designed to be used with high impedance measuring equipment. Both signals also follow the pulse and modulation drive signal components. If these signals are used with an X-Y recorder, be sure the bandwidth of the recorder is adequate.

POWER: This BNC output provides a voltage proportional to the monitor photodiode signal. Assuming the DETECTOR CAL is set correctly, the scale factor is 5 V/W.

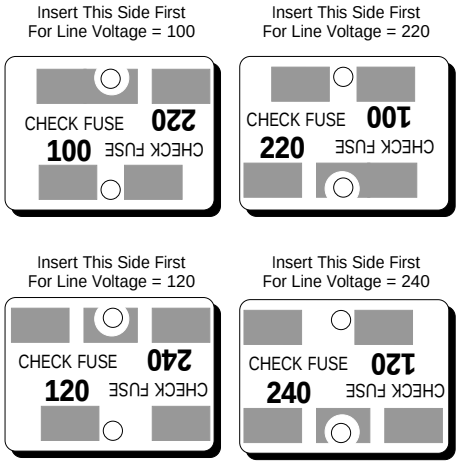
CURRENT: This BNC output provides a voltage proportional to the current flowing through either the internal load or laser diode. The scale factor is 1 V/A.

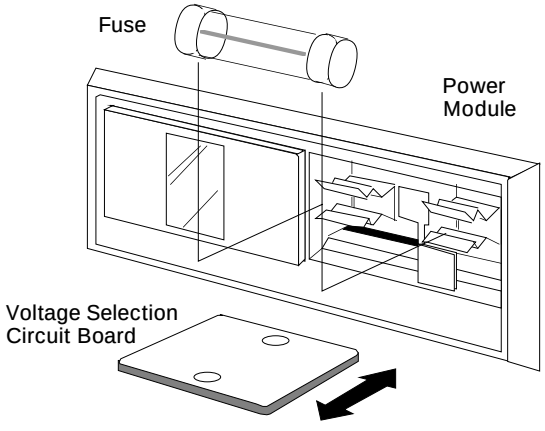
6.5 RS-232 (An option not yet available)

6.6 Power Module

The power module allows changing line cords to match local outlets, holds the main line fuse and allows matching line voltage to one of 4 choices by removing and repositioning a small circuit board in the module. Use a pair of pliers to extract the voltage selecting circuit board if it needs to be changed.

WARNING:
VERIFY THAT THE LINE VOLTAGE SELECTION AND FUSE ARE CORRECT FOR YOUR INSTALLATION BEFORE APPLYING POWER TO THE UNIT. MAKE ALL REQUIRED CHANGES WITH POWER REMOVED FROM THE UNIT.





Section 7

Calibration Procedure, Error Messages and Self Test

7.1 Calibration Procedure

NOTE: This laser diode driver is calibrated at the factory prior to shipment. Opening the chassis will invalidate the warranty. Before attempting service or calibration, contact LDI.

The LDI-820 is calibrated using constants in non-volatile storage. To calibrate the LDI-820, the top cover must be removed and the calibration jumper (JMP2) must be removed. The top cover is removed by unscrewing the two screw near the top edge of the rear panel and sliding the top cover rearward. Perform the calibration only if the LDI-820 passes self test and after it has been on at least 1/2 hour. When JMP2 is removed, the LASER POWER and PULSE ON/OFF keys are used to control the calibration process. The front panel knob is used to adjust the display to match an independently measured value in some steps.

CAUTION:
IF PERFORMED IMPROPERLY OR WITH EQUIPMENT THAT DOES NOT MEET SPECIFICATION, THESE PROCEDURES WILL ADVERSELY AFFECT THE PERFORMANCE OF THE LDI-820.

DO NOT CONNECT A LASER TO THE LDI-820 DURING CALIBRATION. MAKE NO CONNECTION TO ANALOG/TRIGGER INPUT DURING CALIBRATION.

Calibration proceeds in the order below. To skip a calibration step, press the PULSE MODE - ON/OFF key. To update a particular calibration constant and proceed to the next step, press the LASER POWER key when the present step is completed. If trouble occurs during a calibration step press the PULSE MODE - ON/OFF key to avoid updating a constant with bad information. If an offset voltage exceeds 50 mV or a gain error exceeds 20% (uncorrected), a calibration error will result.

Step 1: Main Voltage Reference

Display shows "VOLT. CAL D.DDD." Connect a voltmeter capable of measuring 10 V to an accuracy of 3 mV, high to TP 2 and low to TP 1. Adjust the front panel knob until the display matches the value read on the external meter. (nominally 9 V). To update the stored calibration constant, press the LASER POWER key. To skip this step or exit without updating, press the PULSE MODE - ON/OFF key.

Step 2: Average Current Offset

Display shows "CURRENT OFS. DDD." Connect an ammeter capable of measuring 100 mA to an accuracy of 1 mA to the external laser cable, high to orange and low to red. Adjust the front panel knob until the display matches the value read on the external meter (nominally 100 mA). To actually change the stored value, press the LASER POWER key. To skip this step or exit without updating, press the PULSE MODE - ON/OFF key.

Step 3: Change Meter Range
Display shows “SWITCH TO 10A RANGE!” To avoid blowing a meter fuse or damaging a meter, you must change ranges now. Press the LASER POWER key when you are ready to proceed.

Step 4: Average Current Gain
Display shows “CURRENT GAIN D.DDD.” Connect an ammeter capable of measuring 10 A to an accuracy of 10 mA to the external laser cable, high to orange and low to red (same as previous step). Adjust the front panel knob until the display matches the value on the external meter (nominally 9 A). To actually change the stored value, press the LASER POWER key. To skip this step or exit without updating, press the PULSE MODE - ON/OFF key.

Step 5: Current Limit Offset and Gain
This routine executes automatically. The current limit offset and gain are adjusted to match the average current values. Nothing appears in the display.

Step 6: Average Power Offset
This routine executes automatically. The average power offset is adjusted. Nothing appears in the display.

Step 7: Average Power Gain
Display shows “POWER GAIN D.DD.” Connect an ammeter capable of measuring 10 mA to an accuracy of 10 μA, high to TP 3 and low to TP 1. Adjust the front panel knob until the display matches the value on the meter (nominally 3 mA).

When calibration is complete, the message “CALIBRATION COMPLETE” appears in the display. Remember to replace the calibration jumper. If a calibration number exceeds maximum value, "CALIBRATION ERROR" will be displayed. After calibration, the pulse mode will be off.

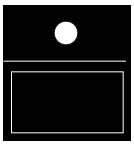
7.2 Error Messages

Error messages are displayed on the main display. The CURRENT LIMIT key also includes an indicator which lights if current limit occurs.

CALIBRATION ERROR

This error indicates that the number needed to calibrate a function exceeds the maximum allowed value. It can occur only during calibration. Check for errors in the calibration setup or hardware problems in the LDI-820.

CURRENT LIMIT ERROR



There is no displayed message for this error. The indicator in the CURRENT LIMIT key blinks. The indication continues for about one second after the error is removed so that it will be visible even for transient current limiting. The error indication typically occurs 100 mA before the actual current limit. Reduce the current or power setpoint or external modulation to correct the current limit error.

HEATSINK

This error indicates the internal heatsink has overheated. The laser drive and thermoelectric cooler voltage will be set to 0 and the laser power will be switched OFF. The error message will remain until the heatsink cools 5° below the trip temperature. When the heatsink cools, the thermoelectric cooler will be switched back on. The laser power must be restored manually. Nominal trip temperature is 65 °C.

INTERLOCK OPEN

This message occurs when the interlock circuit is opened. The interlock terminals are on the rear panel and are jumpered when the LDI-820 is shipped. (The terminals may be used to implement remote control of laser power for safety reasons.) If the interlock circuit is opened, the laser power is switched OFF. To proceed, the interlock circuit must be closed and then the laser power must be switched back ON manually.

LASER OFF

This message occurs when an attempt is made to switch from current to power control modes when the laser power is OFF. The error occurs because the laser power cannot be measured or set unless the laser is ON.

LOW LINE	This message occurs when the power line voltage drops to a level insufficient for proper circuit operation. The drive level will be set to 0 and the laser power will be switched OFF. To resume operation the main power switch must be switched OFF, then back ON.
NO LASER	This message occurs when an attempt is made to switch laser power from OFF to ON with no laser connected.
NO MPD	This message occurs when an attempt is made to switch from current to power control modes when no monitor photodiode is connected.
OPEN SHORT	These messages refer to the thermistor used to sense the temperature of an external laser. They are only displayed when the TEMP key is pressed. Both errors indicate that the thermoelectric cooler circuit will not be able to function correctly. The voltage limit of the thermoelectric cooler driver will be set to 0 volts until the error is corrected.

7.3 Self Test

The self test is performed each time the LDI-820 is switched ON. It tests over 90% of the LDI-820. The test is divided into several sections. Error messages show if a test fails. The tests take about 15 seconds to perform. Self test may fail if a signal is connected to the ANALOG/TRIGGER INPUT during the test.

Test 1

This test exercises the digital portion of the LDI-820. An attempt to display the following error messages will be made, but if the digital test has failed, the result may be unpredictable.

The error messages will read:

"DIG. ROM" - failed ROM test (checksum)
"DIG. RAM" - failed RAM test
"UNCALIBRATED" - the LDI-820 calibration data is missing

Test 2

This test turns on the front panel LED's for one second. No error messages are displayed.

Test 3

This tests the main ADC and DAC together by generating voltages with the DAC and reading them with the ADC.

The error message is:

"MAIN DAC"

Test 4

This tests the variable gain power feedback amplifier and power peak detector by applying a test current and varying the power feedback DAC settings.

The error messages are:

"POWER MODE" and "PEAK POWER"

Test 5
This tests the operation of the current control mode, current limit and current peak detector. First, the current setpoint is set to 10 A and current limit is set to 0 and 8 amps. Actual current is measured to determine whether current limit is working. The current limit signal line is checked. The peak current reading is tested. Next, current limit is set to 10 A and the current setpoint is set to 0 and 8 amps.

Error messages are:

"CURRENT LIMIT," "CURRENT MODE," and "PEAK CURRENT"

Test 6
This tests the pulse generator by setting the output to 10 A and varying pulse rate and width. The pulse width is first set to 500 µsec and the rate to 1 kHz, then the settings are changed to 2 msec and 100 Hz. Average and peak reading are taken.

Error message is:

"PULSE MODE"

Test 7
This tests the thermoelectric cooler. The voltage limit is kept below the stored value to avoid damaging a thermoelectric cooler if one is connected.

Error message is:

"TEC"

Test 8
This tests the heatsink sensor.

Error message is:

"HEATSINK SENSOR"

The self test will exit if any test fails. To use the LDI-820 even though self test failed, press any key.

Section 8

Operating Instructions

These operating instructions present the sequence of events to be followed when assembling the LDI-820 driver, heatsink and laser diode for operation in the continuous wave (cw) and quasi-cw modes. Please read through this section prior to assembly. If there are any questions about the use of this driver power supply, please contact LDI applications engineering for assistance.

WARNING
READ THIS MANUAL BEFORE CONNECTING A LASER DIODE TO THE LDI-820 DRIVER. LASERS MAY BE DAMAGED BY IMPROPER SETTING OF THE CURRENT LIMIT AND BIAS CONTROLS OR BY IMPROPER USE OF THE ANALOG INPUT. REVIEW SECTION 5 FOR THE PROPER SETTING OF THESE CONTROLS.

On a table grounded for electrostatic discharge protection (ESD), gather the LDI-820 Laser Diode Driver, heatsink and the laser diode. The test data shipped with the laser diode is required for set up and should be kept within reach too.

8.1 Preliminary Set-up Procedure

Step 1: Selecting The Heatsink/Head

The correct heatsink to use is the LDI-820-P or LDI-820-H matched to the laser diode package that has been purchased. For example, the SDL-2362-P1, 1 watt cw laser diode should be mounted onto the LDI-820-P heatsink. Thus, the letter "P" suffix on the heatsink is consistent with the "P1" designation on the laser diode. The purpose of the heatsink is to conduct and dissipate the heat coming from the laser diode package, including the thermoelectric cooler, if included.

Step 2: Interconnecting Heatsink and Laser Diode

Using ESD protection equipment and procedures, including a grounded wrist-strap, remove the laser diode from the packaging material (refer to the "Laser Diode Operator's Manual and Technical Notes," Section 3.0, provided with SDL's lasers). SDL laser diodes have conductive material across the pins for ESD protection. Keep this material in place until the laser is secured to the heatsink. With the correct mounting bolts, specific to the laser diode package, fasten the laser package directly to the end of the heatsink. Thermal conducting grease is not recommended because it can migrate and short the "C" and "H" laser packages thus causing an apparent power supply malfunction. The "P" packaged devices require that four mounting bolts be tightened securely. Be certain that all bolt holes are used to ensure proper heat conduction from the laser to the heatsink. The P1 package has two additional threaded holes for mounting accessories such as lenses and filters. The "P1" and "P2" packaged laser diodes can now be electrically connected to the 9-pin socket on the heatsink (remove the conductive material from the leads).

Step 3: Connecting The Laser Driver To The AC Line

Verify that the power module on the back of the LDI-820 is set for the correct line voltage (refer to Section 6.6). Turn the driver key switch to the OFF position. Plug the AC cord into the outlet.

Step 4: Plugging the Heatsink Cable Into the Front Panel Laser Output Connector

This is a large diameter (1.75"/45 mm), multi-pin plug with several polarizing keys. The largest of these keys is to be aligned in the "up" position (a small "+" sign can be seen on the outside surface of the plug). First, gently slide the connector into the mating panel socket, then follow with a full clockwise twist until a snap is felt. The connector is now properly seated. If this action does not occur smoothly, twist the movable portion of the plug until it seats on the socket, then again try twisting a full turn clockwise. It should not be necessary to force the connectors together.

Step 5: Preparing To Energize The Laser Diode

Review Section 2.0 of the "Laser Diode Operator's Manual and Technical Notes," Safety (SDL) and 21 CFR 1040.10 Compliance before proceeding further.

CAUTION

POINT THE LASER AWAY FROM ANY PERSON WHO MAY BE IN THE AREA. FOR MEASUREMENT PURPOSES THE LASER DIODE CAN BE POINTED INTO A POWER METER SUCH AS AN INTEGRATING SPHERE WITH A CALIBRATED DETECTOR.

PUT ON LASER SAFETY GOGGLES FOR USE WITH GaAlAs LASERS BEFORE PROCEEDING.

Find the main power key switch on the left side of the front panel and turn it to the ON position. The display will show that self testing is occurring. After the words "SELFTEST DONE" appear on the display, set CURRENT LIMIT. While referring to the test data sent with the laser diode, set the current limit by turning the control knob to the value shown for "I at XXXX mW" on the data sheet. For example, the SDL-2362-P1 might require that the operating current for 1 Watt cw (I at 1000 mW) be set to 1.60 amperes. Therefore, the current limit should also be set to 1.60 amperes initially, to prevent accidental damage to the laser diode. Should the current limit not be set, it is possible to apply too much current until causing irreversible, catastrophic damage.

If a monitor photodiode is included with your laser, push the DETECTOR CAL button and set the displayed value to that shown on the laser test data sheet as "Monitor Gain". These units are in microamperes per milliwatts (μA/mW).

Finally, if the laser diode has an internal thermoelectric cooler, push the button labeled TEMP and adjust the knob to display "+25/+25 C" or as close to this as possible. This will set the same temperature as the laser diode factory test. Push the CURRENT button and adjust to display "AVG. CURRENT 0 A".

8.2 Continuous Wave (CW) Operating Procedure

After completing Steps 1-5 of the Preliminary Set-up Procedure, push the LASER POWER on/off button below the display. There will be a delay of approximately 5 seconds, then the LDI-820 will be connected to the laser diode. The applied current should display 0 amperes as the display shows "AVG. CURRENT 0 A". The "CUR" LED should be glowing. Turn the knob slowly clockwise while watching the AVG. CURRENT reading increase to about 50% of the rated operating current (about 0.8 A for the SDL-2362-P1). If either an internal detector or external power meter is being used, this would be an ideal point to check the optical output power.

To check power with the internal monitor photodiode, push the lower button labeled: POWER, •AVERAGE, •PEAK. One push will display peak power. Correlate the operating current with the output power at this 50% current point by checking the Light vs. Current (L/I) curve on the test data sheet. If there is a severe disagreement between the test data and that displayed, turn off the laser diode and recheck the recommended set up condition.

If operating conditions are as expected, continue to increase AVG. CURRENT until reaching the recommended operating current (1.98 A for our example laser diode). If possible, recheck laser output power to confirm agreement with the test data. Now the laser can be switched on and off to full power by pushing the LASER POWER switch. Whenever a different laser diode is used with the LDI-820, the current limit set up procedure must be repeated.

8.3 Pulsed (Quasi-cw) Operating Procedure

The term "quasi-cw" (QCW) is defined as that mode of operation where the laser diode on-pulse-width is greater than or equal to one microsecond. Laser diodes manufactured for cw operation can also be operated in the QCW mode, whereas those laser diode designated for QCW operation can only be operated in that mode. Operating a QCW laser in the cw mode could induce catastrophic damage.

Short pulse operation (< 10 μs pulse width) is not possible with the LDI-820 unless an adaptation is made near the laser diode to insert an RF circuit such as a "BIAS TEE". Often, the RF bias circuit must be optimized for the particular laser diode and desired range of modulation frequencies. A typical RF bias circuit is discussed in the "Laser Diode Operator's Manual and Technical Notes". Low duty cycle (< 1%), short pulse (≤100 ns) operation is achievable with separate power supplies available from other manufacturers.

Before operating in the pulse mode, be sure to read Steps 1-5 of the Preliminary Set-up Procedures if you have yet to do so. Also, for reliable quasi-cw operation, please refer to the absolute maximum pulse conditions on the test data sheet supplied with your laser diode.

Typical Applications of Quasi-cw Laser Diodes

- Pyrotechnic Initiation
- Opthalmological Treatment
- Photo-Medical Procedures
- Solid-State Laser Pumps
- Illumination

Pyrotechnic initiation with laser diodes is typically a thermal process where the diode is pulsed on for 100 μs to10 ms at a rate of less than 1 to 10 pulses per second. Often, the laser diode has a fiber optic pigtail used to route the beam to the pyrotechnic/explosive material. A typical scenario includes the delivery of a 10 mJ pulse; 1 watt for 10 ms, at 1 pps (1% duty factor); to a material optimized for use with the GaAlAs laser emission wavelengths (nominally 800 nm to 840 nm). The Quasi-cw operating procedures outlined in ths section instruct the user on how to set up the laser diode for these conditions.

Step 1

Set the CURRENT LIMIT to the value shown on the test data sheet. A typical current for the QCW, 1 W, SDL-2260-H2 is 1.8 A. This is accomplished by turning the control knob until the display reads CURRENT LIMIT 1.8 A.

Step 2

Adjust the pulse width to 10 ms (in this example) by pushing the WIDTH button and turning the control knob until "10 ms" is displayed.

Step 3

Adjust the pulse rate to the desired frequency of 1 Hz by pushing the PULSE MODE button: • RATE, • ONE PULSE. Turn the control knob until "1 Hz" is displayed, or . . . push the button again and turn the control knob counterclockwise to display "ONE PULSE READY".

Step 4
Set the desired pulse current by pushing the PULSE MODE button: AMPLITUDE and adjusting the knob to about 10% less current than required to achieve 1 watt. In our example where the laser emits 1 watt at 3 amperes, the pulse amplitude setting would be 2.7 A.

If the pulse amplitude is first set to the same value as current limit in Step 1 above, the CURRENT LIMIT ERROR light will flash indicating that the current limit circuit is taking effect. To avoid pulse distortion, the 10% margin between these two current set points is required. For lower power levels, a correspondingly lower pulse amplitude would be set up in this step. Read the test data sheet, L/I curve, to find the lower current level for lower required power.

Step 5
Activate the PULSE MODE of operation by pushing the ON/OFF button located nearest to the control knob. Now, it is possible to test the set points with the internal dummy load, before energizing the laser. It is suggested that an oscilloscope be connected to the rear panel CURRENT BNC connector. This will permit the pulse current to the laser to be monitored at a 1V/A scale factor. The emitted optical power is a replica of the drive current pulse.

If in the single pulse mode, try pushing the ONE PULSE button to display "***PULSE*** ". This might also be a good time to test a remote mechanical trigger switch connected to the rear panel (ref. Section 6.2, "Trigger Switch"). The laser diode can also be electronically triggered with a TTL pulse of at least 1.5 V applied at the ANALOG/ TRIGGER INPUT BNC connector (ref. Section 5.15, ANALOG/TRIGGER INPUT).

If all functions are acceptable, proceed to Step 6 below. If all functions are not acceptable, recheck the current limit and peak current set points discussed in Step 4 above. If error messages are displayed refer to either Section 7 "Error Messages" or LDI for assistance.

Step 6
Energize the laser by pushing the LASER POWER, ON/OFF button. If the pulse rate has been set to > 1 Hz, the laser diode will begin operation immediately after the 5 second delay. If set to the single pulse mode, either manual or electronic triggering is required before the laser will emit.

8.4 Other Modes Of Operation

Other conditions where more intricate operation is desired include:

1. Non-return-to-zero operation (cw with pulse added)
   [ref. Section 5.11, PULSE AMPLITUDE and BASELINE]

2. Complex quasi-cw operation (polynomial function pulse)
   [ref. Section 5.15, ANALOG/TRIGGER INPUT]

3. Temperature tuning wavelength (change set temperature)
   [ref. Section 5.9, TEMP (SET/ACT and TEC LIMIT)]

   Note: The TEC drive is active whether the laser is on or off.

4. Constant power operation (power control mode)
   [ref. Section 5.6, CONTROL MODE CUR and PWR]

Each of these operating modes, as well as others, are made possible by the LDI-820. Section 5 of this manual discusses both set-up and operation of 16 front panel features while Section 6 discusses the rear panel aspects.

Section 9
Service

WARNING
DANGEROUS VOLTAGES ARE PRESENT IN THIS PRODUCT EVEN WHEN THE POWER SWITCH IS OFF. ONLY EXPERIENCED SERVICE PERSONNEL SHOULD ATTEMPT REPAIRS.

USE A LOW POWER SOLDERING IRON AND ROSIN CORE FLUX ONLY.

If it is necessary to remove a plug from a pc board-mounted socket, do so by slowly rocking and pulling the plug. Excessive force can break the pc boards.

WARNING
DO NOT REMOVE THE SAFETY GROUND WIRE FROM THE FRONT OR REAR PANEL.

Main Board Jumpers:

JMP 1 Internal/External laser, not installed for external laser

JMP 2 Run/calibrate, installed to run

JMP 3 Run/test current loop, installed to run. Used for trouble shooting the output stage.

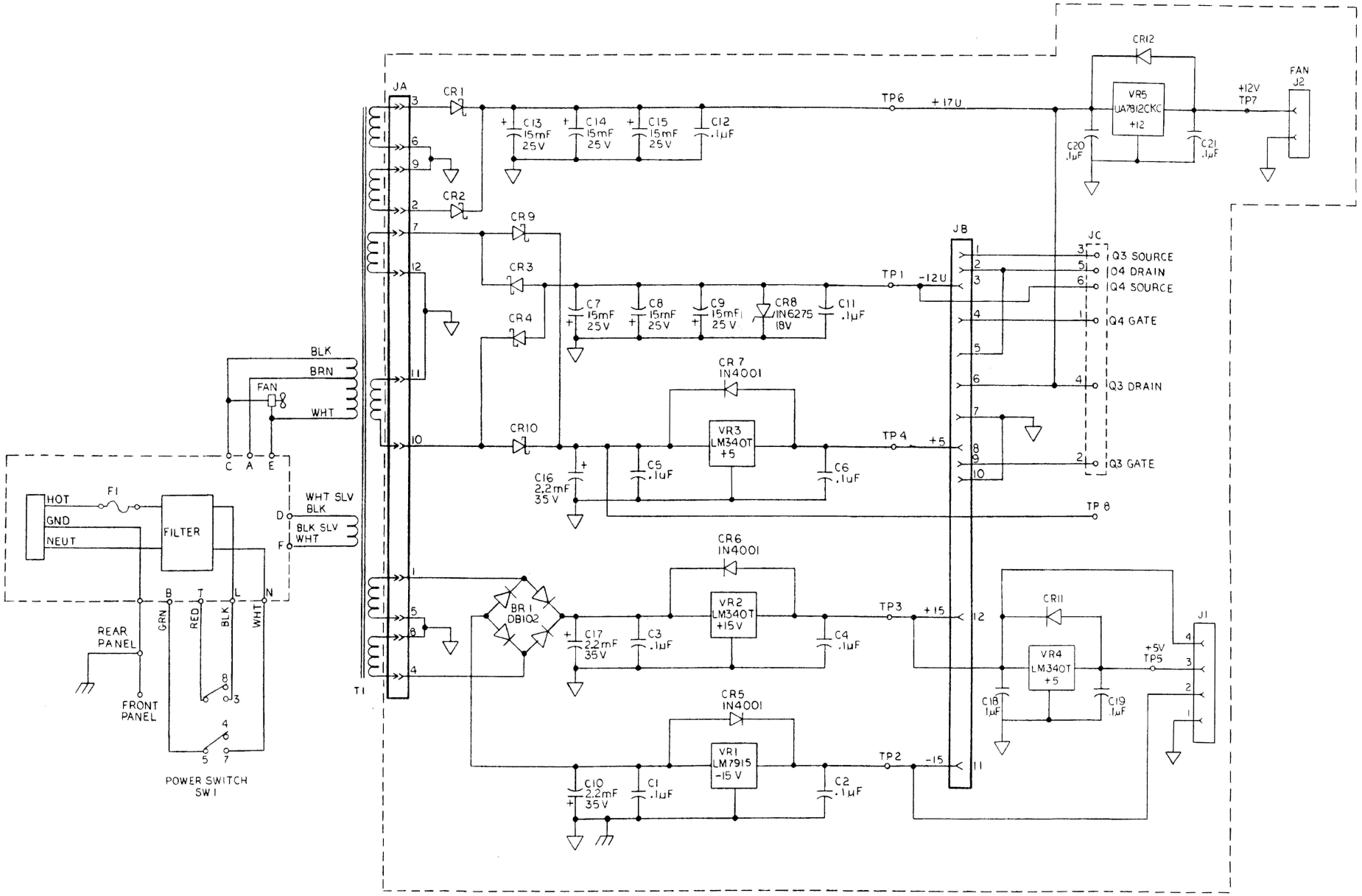
JMP 4 Test processor/run, not installed to run

Section 10
Parts List

(A complete part list will be available at a later date.)

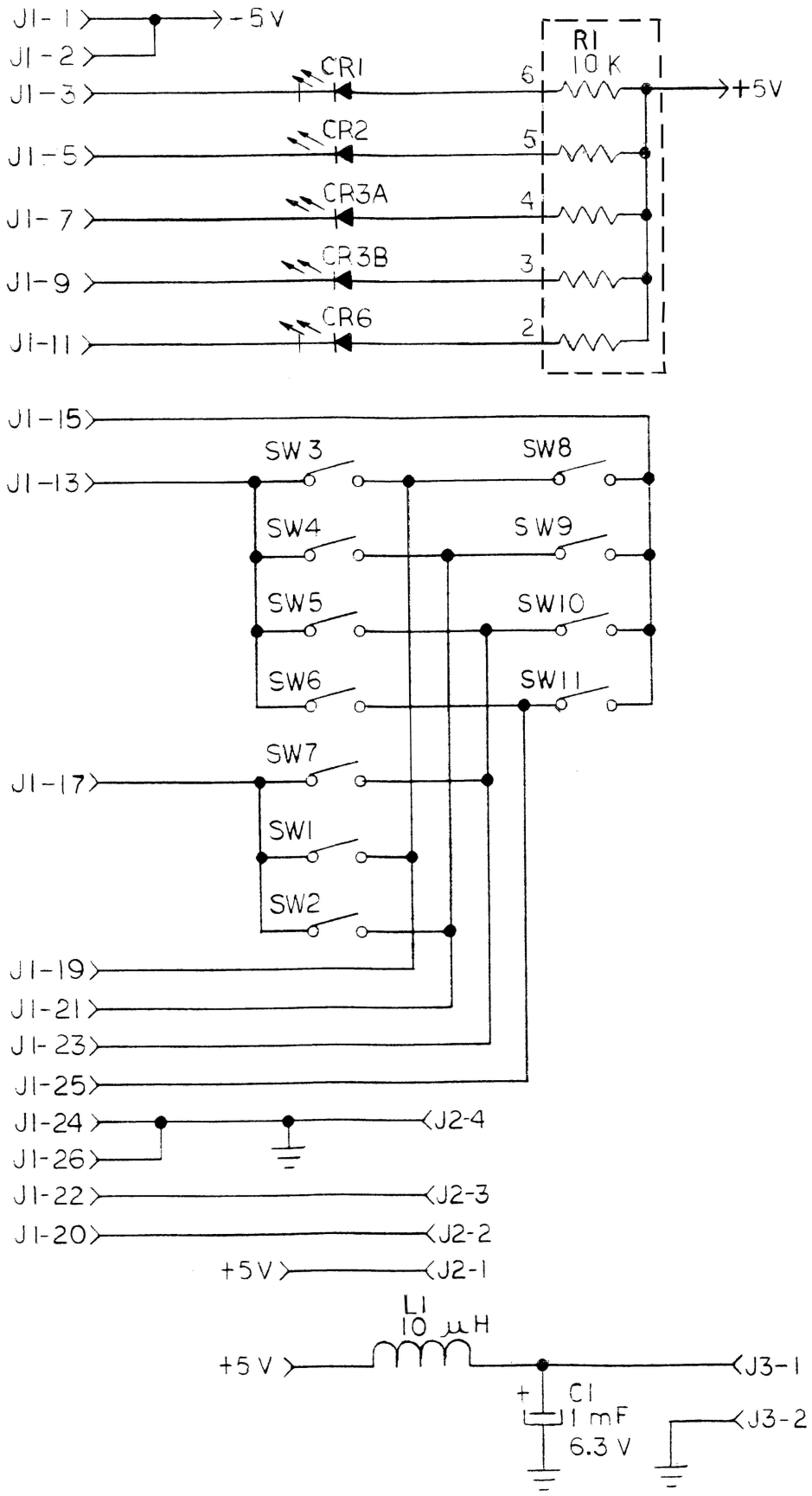
Section 11

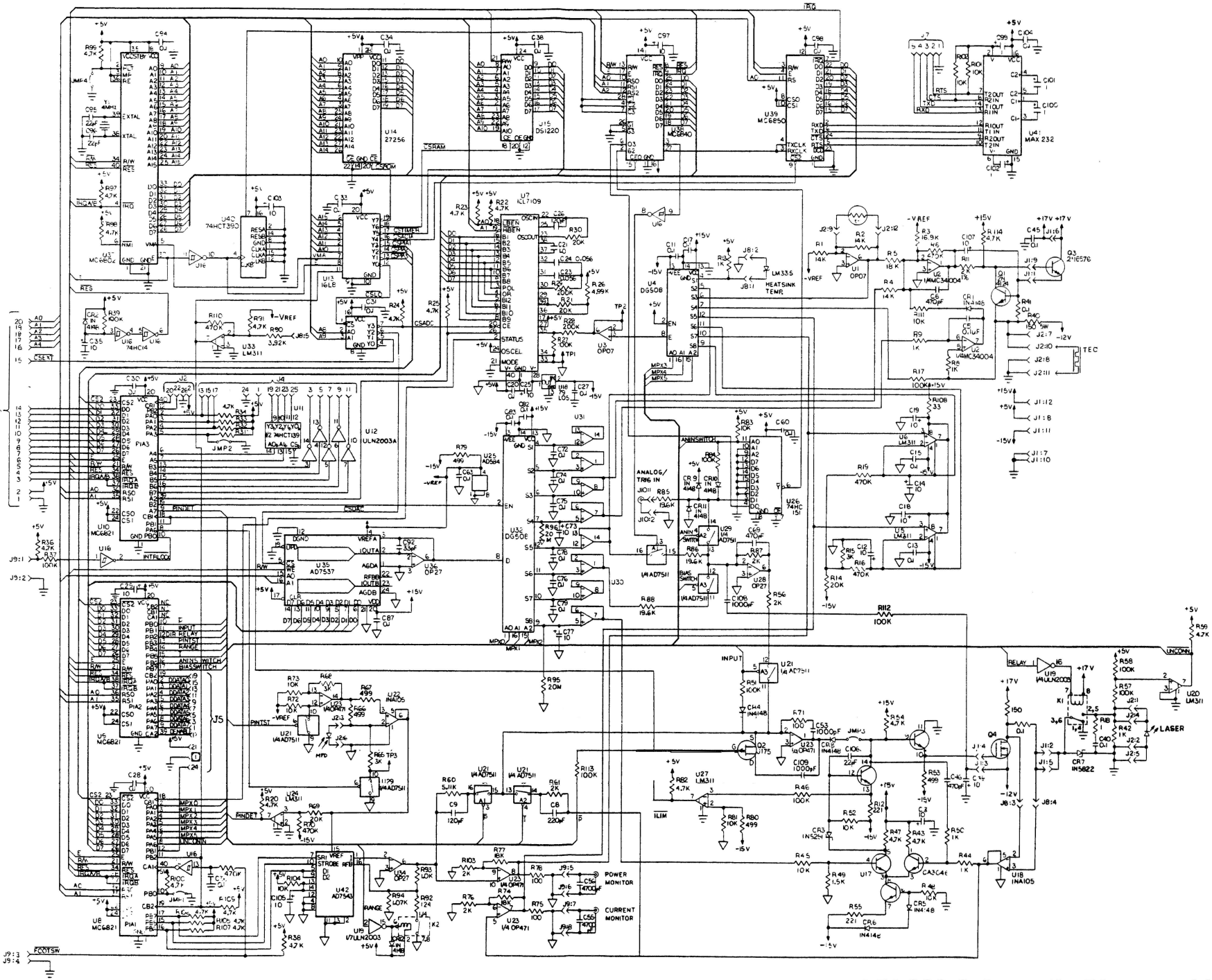
Schematic Diagrams



LDI-820 Schematic Diagram 11.1
POWER SUPPLY

LDI-820 Schematic Diagram 11.2
FRONT BOARD





LDI-820 Schematic Diagram 11.3
MAIN BOARD

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