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Instruction Manual

**High Power, High Speed, High Current
Laser Diode Driver/Pulse Generator**

**Models: LWG-XXXX/QCW/HP/USB, LDG-XXXX/QCW
USG-XXXX/QCW/USB**



**This manual contains Operating, Safety, and
Maintenance information and subjects to change without notice.**

Rev.1.5

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Safety Precaution

Do not use this product in any manner not specified by the manufacturer. The protective features of this product may be impaired if it is used in a manner not specified in the operation instructions.

Before Applying Power

Verify that all safety precautions are taken. Make all connections to the unit before applying power.

Ground the Instrument

To minimize shock hazard, the instrument chassis and cover must be connected to an electrical ground. The instrument must be connected to the AC power mains through a grounded power cable, with the ground wire firmly connected to an electrical ground (safety ground) at the power outlet. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury.

Fuses and/or Circuit Breaker

Only fuses with required rated current, voltage, and specified type (normal blow, time delay, etc.) should be used. Do not use repaired fuses or short-circuited fuse holders. To do so could cause a shock or fire hazard. If circuit breaker is activated, take a careful inspection and don't repeat the breaker on/off.

Do Not Operate in an Explosive Atmosphere

Do not operate the instrument in the presence of flammable gases or fumes.

Do Not Remove the Instrument Cover

Only qualified, service-trained personnel who are aware of the hazards involved should remove instrument covers. Always disconnect the power cable and any external circuits before removing the instrument cover.

Do Not Modify the Instrument

Do not install substitute parts or perform any unauthorized modification to the product. Return the product to LIC Engineering factory for service and repair to ensure that safety features are maintained.

1.1

GENERAL

High Power, High Speed, High Current Laser Diode Driver/Pulse Generator, LWG-XXXX/QCW/HP/USB & USG-XXXX/QCW/USB has 4 functions in 1 unit. Digital Scope, Pulse Generator, Spectrum Analyzer and LD Driver are combined in one unit. There is no more need of this equipment to test and measure the customer's laser diode and specific load.

The unit is designed to drive a laser diode/customer's specific load in CW, QCW (Quasi Continuous Wave), Precise Control Mode, and Normal Pulse mode. It has a *built-in high efficient Capacitor Charging Power Supply* and communicates closely with the output current/voltage to keep a stable constant current to the customer's load.

The unit has achieved QCW high power up to **2KV/10KA** (depends on model specified), and fastest rise time of **500ps-50us** (depends on model specified). Special made stripline enables the distance from the unit to a laser diode 1m (standard), or 2m (optional) keeping the rise time of 500ps-15ns & the minimum pulse width of 5ns.

The unit uses an isolated USB interface so that user can control the LD driver through user's PC control screens.

Optional tablet PC can be used as a customer's remote control terminal & monitor scope.

The isolated USB interface is isolated from the user's computer as well as from the LWG-XXXX/QCW/HP/USB & USG-XXXX/QCW/USB unit. This ensures the highest noise immunity even in the harsh industrial environment.

The unit uses a high speed current sensing device to sense and display in real time. **Output current is sampling and regulated every micro-second.** This technique guarantees the precise constant current control for customer's wide range of Laser Diodes.

1.2

DESCRIPTION

The high current/high speed/high power laser diode drivers LWG-XXXX/QCW/HP/USB & LDG-XXXX/QCW/HP use a **Dual Voltages & Controls** to realize the high speed and the precise current control at the same time. **Vd & Vi value adjustment** (optional) ensures the precise constant current control. This is a unique feature of LIC's LD drivers.

The unit has an **Output Voltage Selection feature (optional)** to maximize the output power at very low output voltage. With this function, it can maintain **100% of rated output power even at 30% of rated output voltage.**

The unit contains the complete protection circuits to protect the unit against any potential risks and damages. These protection circuits and software detect total 9 faults which are described later in this manual.

The load current is sensed with an ultra-small inductance and high power resistor that accuracy is +/- 1%. To minimize the inductance, this unit uses the same technology that has been used for our LSP-series high speed LD Drivers.

High power pulsed laser diode driver, LWG-XXXX/QCW/HP/USB, USG-XXXX/QCW/USB & LDG-XXXX/QCW/HP use a ***built-in a high efficient Capacitor Charging Power Supply***. The capacitor charging power supply uses a high frequency zero-current switching to minimize a switching loss and achieve high conversion efficiency in a small body (up to **10KW CW Power** with air cooled, and **25KW** with water cooled). This zero-current switching technology has been used for LIC's products since 1986.

The built-in capacitor charging power supply plays an important role for the LD Driver applications because the output current requires a constant current for a wide range of the output power. Refer to 1.9 Capacitor Charging Power Supply for detail.

1.3.0 SPECIFICATIONS OF LWG-XXXX/QCW/HP/USB, USG-XXXX/QCW/USB & LDG-XXXX/QCW

1.3.1 AC INPUT

100V (Less than 1.0KW CW Power), 120V (Less than 1.0KW CW Power), 208V, 220V, 230V, 240V: +/- 10%, Single and Three phase, 47-63Hz.

Note: Other voltage such as 380V, 480V ranges are also available by request.

1.3.2 CW OUTPUT POWER

From 200W to 25KW (Depends on the model names)

1.3.3 MAX. OUTPUT VOLTAGE

Up to 2KV (User selectable from 10V to 2KV)

1.3.4. OUTPUT CURRENT

Up to 10KA in QCW mode (User selectable).

1.3.5 OUTPUT POLARITY

Positive (Standard).

1.3.6 OUTPUT RISE TIME

LNS-XXXX-QCW-HP: 500ps-15ns (depends on the unit ordered.)

LWG/USG/LDG-XXXX-QCW: 100ns-50us (depends on the unit ordered.)

1.3.7 MAXIMUM & MINIMUM PULSE REPETATION RATE

Minimum:	Single Shot, or 0.01Hz
Maximum:	1MHz (depends on the unit ordered)
Steps:	0.01Hz
Time base:	50PPM crystal oscillator

*Note: In QCW mode, the pulse rate is limited by the average power and the current droop specified.

Refer to 3.1.1 Average Power and Pulse Setting for detail.

1.3.8 MAXIMUM & MINIMUM PULSE DUTY

Minimum:	1%
Maximum:	100% (depends on the model number)
Steps:	1%

***Note:**

In QCW mode the maximum pulse width is limited by 1). average power specified and 2). current droop specified.

Refer to 3.1.0 Current Droop and 3.1.1 Average Power and Pulse Setting for detail.

1.3.9 PROTECTION CIRCUIT & FAULT SIGNALS

There are total of 9 fault reasons that the unit ceases the operation. When the protection circuit detects those fault conditions, the unit shuts off instantaneously indicating with FAULT light.

Over Current Protection (1) for internal power supply:

Protects the internal power supply against (1) direct or indirect output short condition, (2) Any electrical disturbances induced by external or internal noises, (3) Overload caused from improper load, or pulse setting.

Over Current Protection (2) for output Switch:

The protection circuit for the output switch **activates in 100ns**. This response time is required to protect the switch against huge output power (the maximum peak pulse power reaches to 1MW!!). The load current is however, several hundred ns to several us delay time after the protection circuit is activated.

Over temperature protection:

Detects a base temperature on which main switching devices and other power semiconductors are mounted. When the base temperature reaches to setting level, the protection circuit activates and the unit ceases the operation.

Over load protection:

LWG-XXXX/QCW/HP/USB, USG-XXXX/QCW/USB & LDG-XXXX/QCW/HP adjust its average power automatically when pulse setting changes, and stays always within the pre-determined average power. When, however, the pulse setting exceeds the predetermined average power (by external pulse setting, for example), the over load protection activates to protect the internal power supply against an over load condition.

This over load is calculated as a product of pulse width and pulse frequency.

Pulse Width Protection:

When the setting pulse width, or an external pulse width exceeds a predetermined value, this protection circuit activates.

Pulse Frequency Protection:

When the setting pulse frequency, or an external pulse frequency exceeds a predetermined value, this protection circuit activates.

Vd Value:

When setting Vd value exceeds a calculated value based on presetting pulse conditions, this protection circuit activates. The calculation is based on the product of Vd value & LD current, and Pulse on time. If this fault happens, adjust one of the following values.

- 1). Reduce Vd value
- 2). Reduce setting current
- 3). Reduce pulse width

Interlock Input:

This is an additional safety feature. Unless this input is closed, the unit keeps fault condition.

This input can be used as a remote switch as well and the cable length can be several meters from the unit. This input is isolated with an optical isolator.

Note:

To restart the unit from the fault condition, use RESET signal. Refer to RESET signal at SECTION 1.4.4 for detail.

1.3.10 OPERATING TEMPERATURE

Ambient temperature: +10 to 40C

1.3.11 OUTPUT CONNECTORS/TERMINALS

Main Output: AMP.7TWC8W8SMP3V4R, or
Screw Terminals, or
Direct Stripline from rear panel

1.3.12 EXTERNAL PULSE INPUT BNC 1K Ohm impedance

1.3.13 DIMENSIONS (WxDxH inch)

Below 1KW (Air cooled):	13"(W) x 10"(D) x 4"(H)
Up to 2KW (Air cooled):	17"(W) x 13.0"(D) x 5.0"(H) excluding handle
Up to 10KW (Air cooled):	17.0"(W) x 13.0"(D) x 7.0"(H) excluding handle
Up to 10KW (USG-XXXX, Air cooled):	17.0"(W) x 21.7"(D) x 9.7"(H) excluding handle
Up to 25KW (water cooled):	17.0"(W) x 17.5"(D) x 10.5"(H) excluding handle

1.3.14 WEIGHT (Lb.)

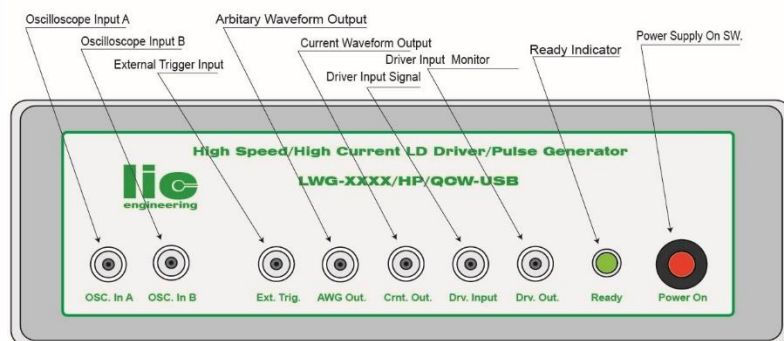
Up to 2KW CW:	Less than 21 lb
Up to 10KW CW:	Less than 55 lb
Up to 25KW CW:	75 lb (Water Cooled)

1.4 FRONT & REAR PANELS

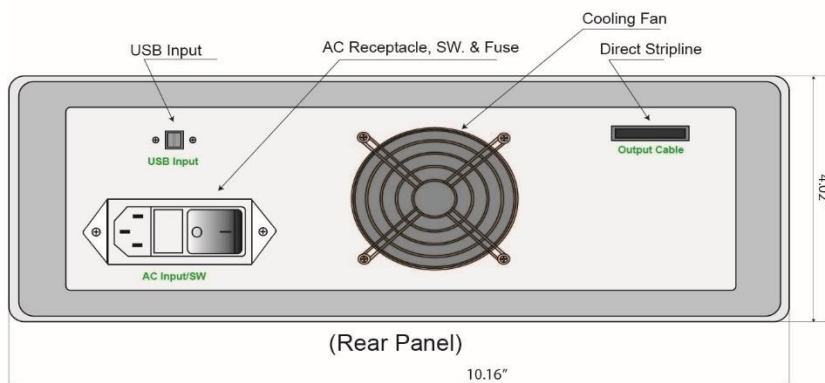
1.4.1 Below 500W Models (High Speed Model)

Front & Rear Panel of LWG-XXXX/QCW/HP/USB & LDG-
XXXX/QCW-HP-USB
(High Speed Model)





(Front Panel)



(Rear Panel)



Top View

1.4.2 Up to 10KW Models



(LWG-XXXX/QCW/USB)

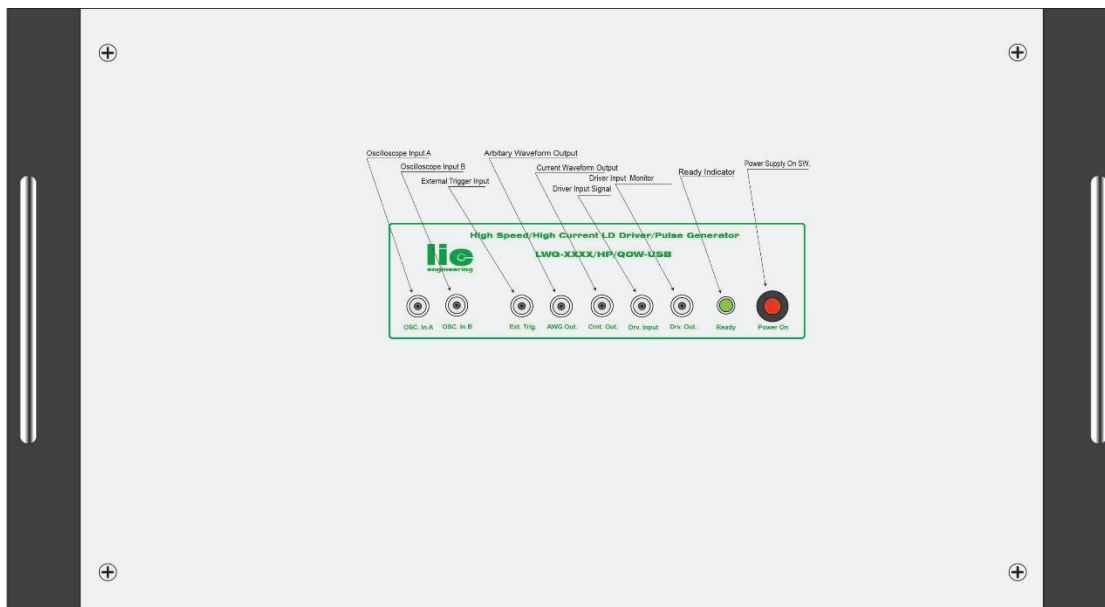


(USG-XXXX/QCW/USB)

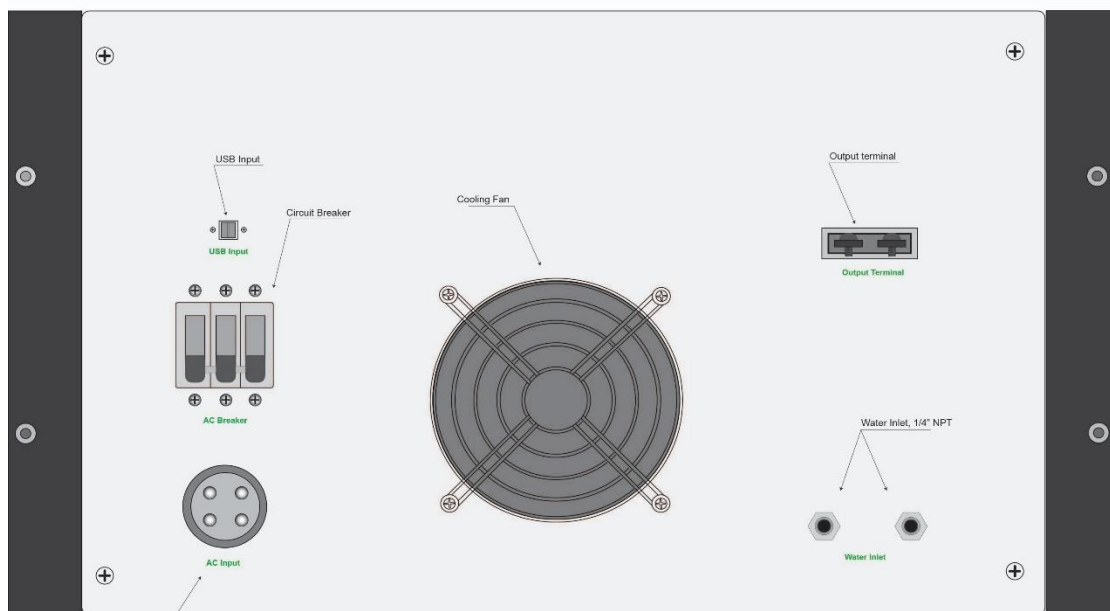


(LDG-XXXX/QCW/USB)

1.4.3 Up to 25KW Models



(Front Panel)



(Rear Panel)

**Front & Rear Panel of LWG-XXXX/QCW/HP/USB &
LDG-XXXX/QCW/QCW-USB
(Up to 25KW)**

1.5 EXPLANATION OF FRONT & REAR PANELS

1.5.1 Ready indicator (Yellow)

Indicates the unit is ready for operation.

1.5.2 Power Supply SW.

When an AC breaker located on a rear panel is turned on, the unit still stays off. Only when Power Supply SW. is pushed, the internal power supply for LD driver is energized that is indicated by a Ready indicator is lighted.

For safety purpose, the output is disabled even if a mechanical Output On/Off SW. stays on position after when the unit is accidentally powered off, and then turned on. To resume the operation, just push this SW again.

1.5.3 Current Monitor

50 ohm BNC output is used to monitor the real time output current. The attenuation ratio is 5mV/A-10mV/A depends on the specification selected.

The load current is sensed with an ultra-small inductance and high power resistor of which accuracy is $\pm 1\%$ and its inductance is far below $0.1nH$.

To minimize the inductance, the unit uses the same technology that has been used for our LSP-series high current sensing technology for long time.

Note *): The oscilloscope input have to be terminated with a 50 ohm to receive a correct waveform of the current.

1.5.4 Drive (Monitor) Signal Output

This is the output signal to activate/deactivate the output switch. With this Signal, user can synchronize the LD current gate time to user's external device.

1.5.5 External Trigger Input

External pulse condition should not exceed the pulse set that is specified when the unit is ordered. If the pulse set exceeds the predetermined values, the unit ceases the operation indicating Fault condition. This is activated by one of the following protection circuit:

Pulse Frequency Protection, Pulse Width Protection, and Over Load Protection.

Interface condition is TTL/CMOS, 5V/1Kohm.

1.5.6 Arbitrary Waveform Output

This is the output signal from the arbitrary pulse generator. This output is usually connected to the Drive Input Signal.

Caution: Arbitrary Waveform Generator Setting

For most applications, the arbitrary pulse generator should be set to the following condition:

- 1). Voltage setting: maximum of 2V
- 2). Waveform: Square waveform

1.5.7 Driver Input Signal

This is the input signal to drive the Laser Diode Driver. This input is usually connected to Arbitrary Waveform Output.

1.6 Rear Panel

1.6.1 USB Input

USB input is ground-isolated both from a user's PC system and LWG-XXXX/QCW/HP/USB & USG-XXXX/QCW/USB LD driver control circuit. This ensures for high noise immunity even in harsh industrial environment. The USB speed is USB 2.0 standard.

1.6.2 Cooling fan

Fan speed is controlled by internal device temperature. As the device temperature increases, the fan speed increases.

1.6.3 AC Circuit Breaker

This is used as a power switch as well as an emergency cut off switch. To use the unit, first turn this breaker on. If by some reason the internal safety features do not work, this circuit breaker shut off the AC power from a user's power line.

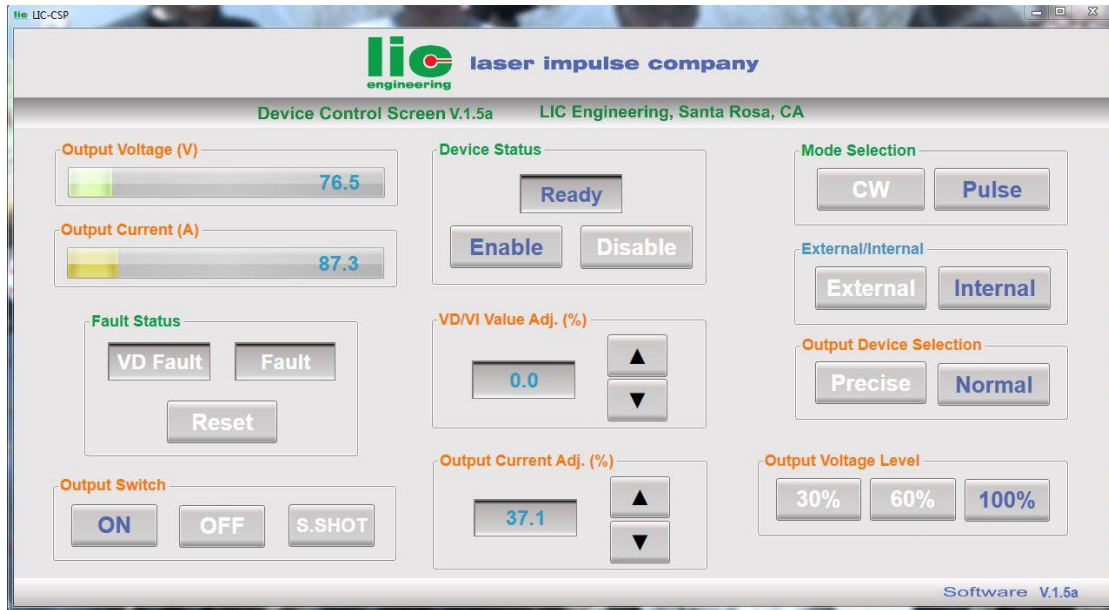
1.6.3 Output Terminal/Direct Stripline

To connect a load to the unit, a special made transmission line, or screw terminal is used. For a high speed output, the direct stripline is used. The stripline is designed to carry a high current without destroying the fast rise time pulse shape. One side of the strip line is just open to the load to connect by soldering/screws.
See 2.3 section for detail.

1.6.4 Water Inlet for 25KW model

Water inlet is 1/4" NPT connector. Required water flow is 5 liter/minute minimum and the water pressure is 3kg/cm² minimum required.

1.7 Control Screen



Device Control Screen

1.7.1 READY

It indicates when the LD driver is ready for operation. When the unit is ready, the READY indicator is lighted.

It doesn't come to a ready status only turning AC beaker located on the rear panel. After pressing Power On button, the unit will be ready status in 10-30 seconds.

1.7.2 Enable/Disable

Pressing Enable/Disable button enables/disables the device (energizing /disarms the device).

When the unit is powered on, it automatically turns to Enable mode after Ready comes. To change the following operating mode however, Disable button must be pressed before the change. Otherwise, it can't be changed: A pop up note is displayed saying: "Press Disable button before changing this selection".

Disable required before change:

- 1). Output Level Selection

1.7.3 Output Device Mode-Precise/Normal Mode (Optional)

This toggles the operating mode either in Precise, or Normal mode. It can be toggled only when Output Switch is OFF state. If either button is pressed while Output Switch signal is ON, a pop up note is displayed saying: "Turn off Output Switch before changing this button".

When Precise button is selected, the second output device is activated to control the output current precisely. With this mode the output current is regulated every micro-seconds so that LD current is very stable and clean. This function is called “**Dual Device Control**” and this is the unique feature of LIC Engineering LD Driver.

When this function is activated, Vd value must be entered in VD/VL Selection windows.

With this mode Vd value is critical to avoid over heating of the control devices. If the setting value is not correct, Vd Fault may be displayed. If this happens, please adjust any of the following values:

Adjusting values when Vd Fault happens:

- 1). Reduce Vd value, or
- 2). Reduce setting current, or
- 3). Reduce pulse width

When Normal mode is selected, the output current can be at the fastest speed.

Note: Some models don't have this function.

1.7.4 Output Level Selection (Optional)

To select this button, Disable button must be pressed before the change. Otherwise, it can't be changed: A pop up note is displayed saying: “Press Disable button before changing this selection”. Default is 30% level.

This button selects the output voltage range of the charging power supply to maximize the output power.

When a regular charging power supply is used, the maximum available output power is decreased as the output voltage is lowered.

This function compensates this problem.

Example: A 40V maximum voltage with 5KW power supply is used.

When 30% of the output voltage is selected, for example, the maximum output voltage is 14V. When a regular power supply is used, the available output power is usually less than 1KW.

With this function, the charging power supply still can supply 100% of rated output power: 5KW at 14V.

Note: Some models don't have this function.

1.7.5 VD/VL Value Selection (Optional)

When Precise button is selected, the second output device is activated to control the output current precisely.

This function is called “**Dual Voltages & Controls**” and a LIC's unique feature.

VD Value:

When this function is activated, Vd value must be entered in VD/VL Selection windows.

Vd value is the maximum LD voltage that is connected to the output terminal of the unit. The unit calculates the minimum output voltage between the minimum and maximum of the LD current and outputs the minimum output voltage. When Output Switch is activated, the unit again calculates the V.I.T product of the device. Where, V is the device voltage, I is the device current, and T is the conduction time. If this value is beyond the safe operating area, the unit becomes Fault condition by displaying "VD Fault". If this happens, please adjust any of the following values:

Adjusting values when Vd Fault happens:

- 1). Reduce Vd value, or
- 2). Reduce setting current, or
- 3). Reduce pulse width

If high pulsing speed is required, turn to Normal mode.

VL Value:

VI value is the compensating voltage for high speed & high current output pulse. When a high speed unit is purchased, VI value is activated instead of Vd value.

There is certain overvoltage is required to overcome the LD inductance at high speed/high current condition. It is expressed as:

$VI = L \cdot dI / dT$, where VI is a required voltage to overcome LD inductance, L is LD inductance, dI is LD current per dT time, and dT is the rise time of the pulse. Example: $L = 5nH$, $dI = 100A$, $dT = 5ns$, then 100V output voltage is required.

A customer can see this effect by adjusting VI value. Connect a current monitor output to an oscilloscope and watch the rise time of the output pulse. As VI value is increased the rise time of the pulse is improved. Too much VI value causes an overshoot of the pulse. Adjust this value to get the optimum rise time of the pulse.

Note: Some models don't have this function.

1.7.6 CW/PULSE

This changes the operating mode either in CW, or Pulse. It can be toggled only when Output Switch is OFF state. If either button is pressed while Output Switch signal is ON, a pop up note is displayed saying: "Turn off Output Switch before changing this button".

When PULSE button is pressed, the control screen goes to a **pulse setting screen** (See section 1.8. Pulse Setting Screen) and a user can set any pulse combinations. If a user set a pulse combination that is not designed for the unit purchased, a FAULT indicator is highlighted.

Refer to FAULT for detail.

When the system starts, the mode is in CW mode and CW indicator is highlighted.

1.7.7 Output Current Adj.

This adjusts the actual output current and a user can set a desired output current by pressing and drag a mouse, or just enter numeral numbers by a keyboard.

This adjustment is a percentage to the maximum output current and reflects directly to the Output Current/Voltage indicators described below.

1.7.8 Output Current Display

The bar graph and numeral numbers in the box show the actual output current flowing to the load. It samples every micro-seconds in real time to display the actual load current. The current is sensed with a precise & high speed current sensing device.

1.7.9 Output Voltage Display

This shows an actual output voltage of the LD driver. Whenever a user changes the LD current, the output voltage indicator shows the output voltage corresponding to the setting output current. The bar graph and numeral numbers in the box show the actual output voltage.*1)

Note*1): The LD driver is a constant current source. The output current is sensed and its signal is feed backed to an error amplifier in real time to maintain the constant current. This causes the output voltage fluctuation all the time whenever the unit is operated. This fluctuation is normal and necessary to maintain the constant LD current.

1.7.10 FAULT



It indicates the LD driver is in fault condition. There are many safety features built in the unit to protect the unit against damage and these protection circuits generate FAULT when the fault condition is detected. The fault conditions are as follows:

- 1). O.C:
Indicates Load Over Current
- 2). O.V:
Indicates Load Over Voltage
- 3). Temp.:
Indicates Power Supply's Over Temperature
- 4). Pulse D.:
Indicates Pulse Duty Fault
- 5). Pulse W.:
Indicates Pulse Width Fault
- 6). Pulse F.:
Indicates Pulse Frequency Fault
- 7). Wtdg Timer:
Indicates Watchdog Timer Fault
- 8). Narrow P.:
Indicates Narrow Pulse Fault
When the pulse interval is more than the one specified, this fault comes.
- 9). Interlock.:
Indicates Interlock Fault
- 10). E Stop:
Indicates Interlock Fault
- 11). P.S:
Power Supply Fault (including Power Supply Over Current, Over Temperature, etc)
- 12). O SW.:
Indicates Output Switch Over Current
- 13). Vd:
Indicates Vd values fault
- 14). NC:
Not connected

After removing the fault conditions, press RESET button.
The unit resumes the operation.

1.7.11 Vd Fault

When Precise button is selected, the second output device is activated to control the output current precisely.
When this function is activated, Vd value must be entered in VD/VL Selection windows.

Vd value is the maximum LD voltage that is connected to the output terminal of the unit. The unit calculates the minimum output voltage between the minimum and maximum of the LD current and outputs the minimum output voltage. When Output Switch is activated, the unit again calculates the V.I.T product of the device. Where, V is the device voltage, I is the device current, and T is the conduction time. If this value is beyond the safe operating area, the unit becomes Fault condition by displaying "VD Fault". If this happens, please adjust any of the following values:

Adjusting values when Vd Fault happens:

- 1). Reduce Vd value
- 2). Reduce setting current
- 3). Reduce pulse width

1.7.12 RESET

To reset the unit from the fault condition, this button is pressed. If there is fault condition exists, pressing RESET doesn't recover the unit. First remove the fault condition, and then press RESET.

1.7.13 ON/OFF/S.SHOT Output Switch

Output Switch OFF state is required before the following changes:

- 1). CW/Pulse Selection
- 2). Output Device Selection
- 3). Output Voltage Level Selection

This button controls LD driver output both in CW and Pulse mode. Pressing ON enables the LD driver to send the output current. Once ON button is pressed, it stays on until OFF button is pressed.

In Pulse mode, the on time is not synchronized with the setting pulse. To synchronize to the pulse, go to PULSE mode and use Run/Stop button on pulse setting screen, and/or an external trigger. The detail is explained in a separate pulse setting manual.

S.SHOT (Single Shot) enables the output current while a mouse left button is pressed and disables when the mouse button is released. This works both in CW and Pulse mode, but again it is not synchronized with the setting pulse in Pulse mode. To synchronize a single shot to the setting pulse, go to pulse setting screen, and use a single shot available in the screen.

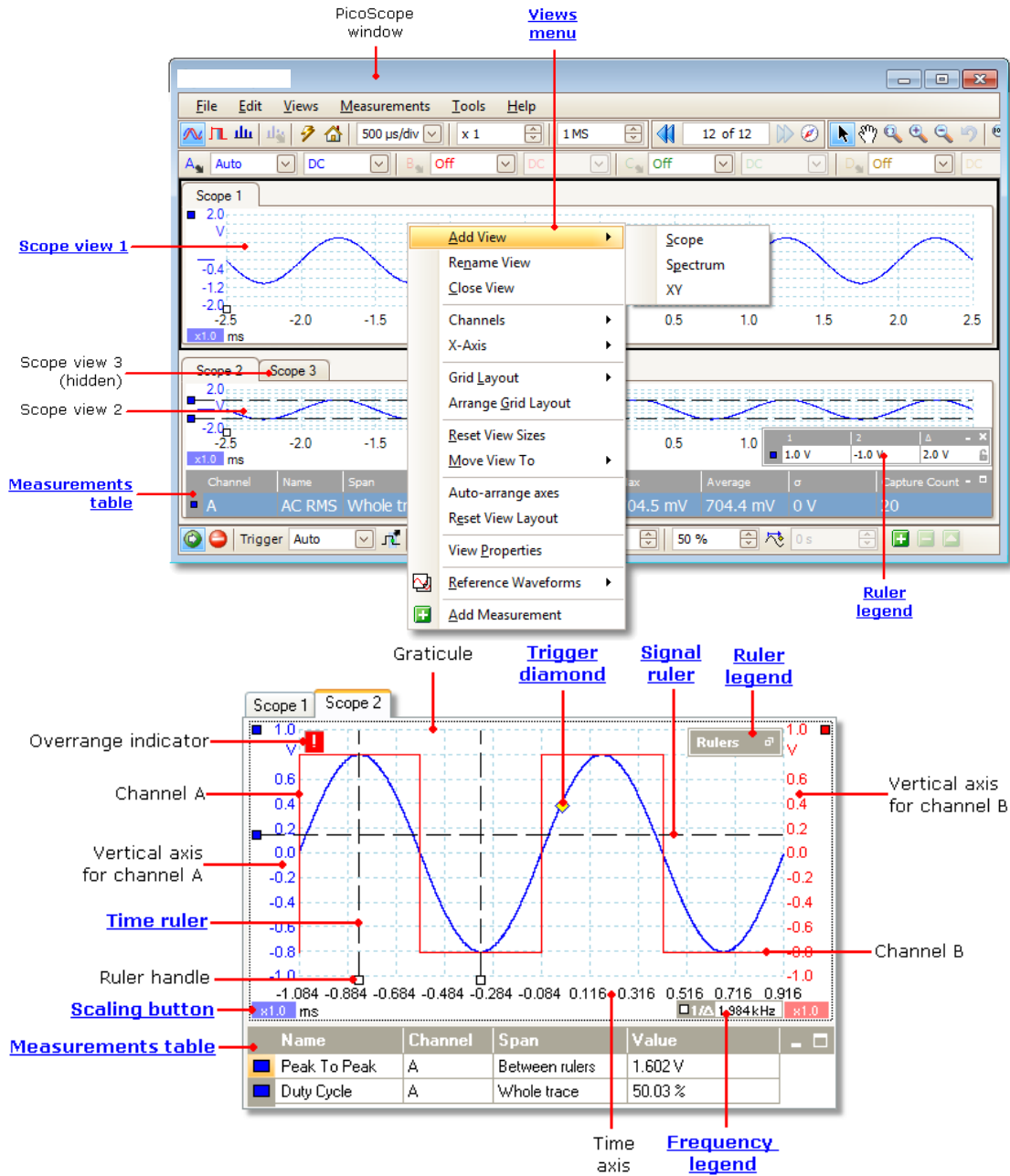
1.7.14 Internal / External Switch

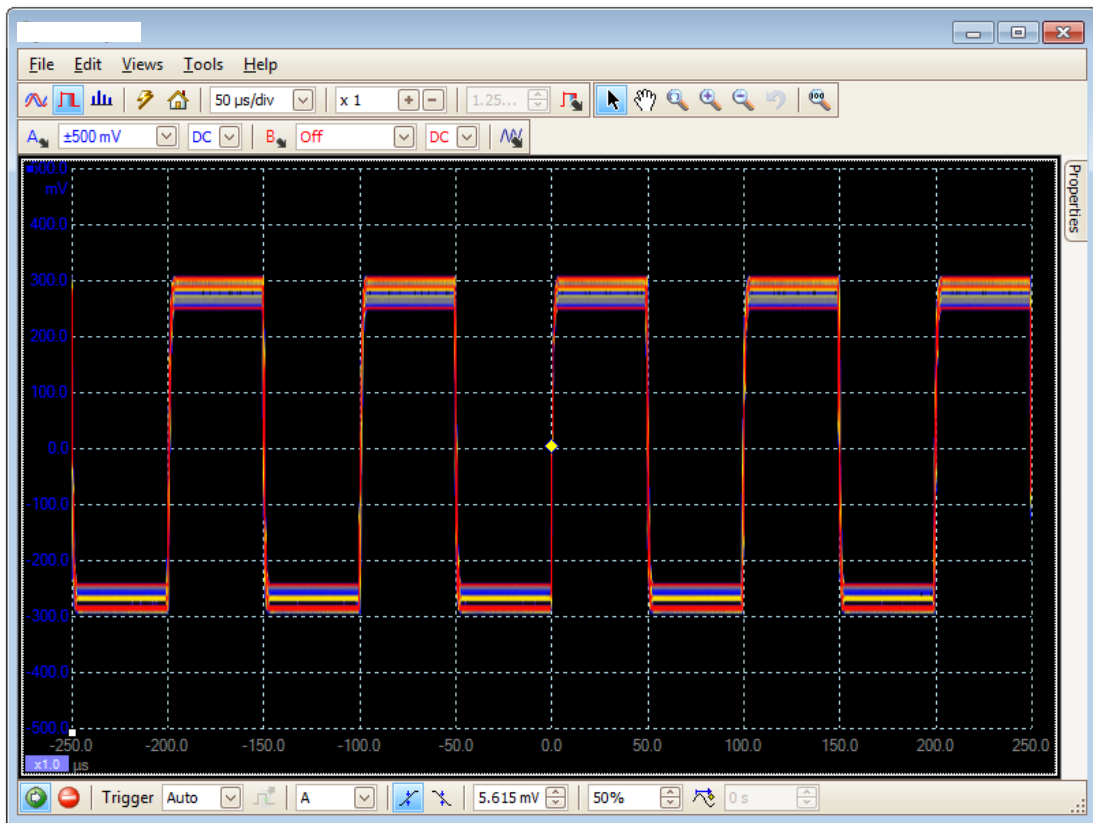
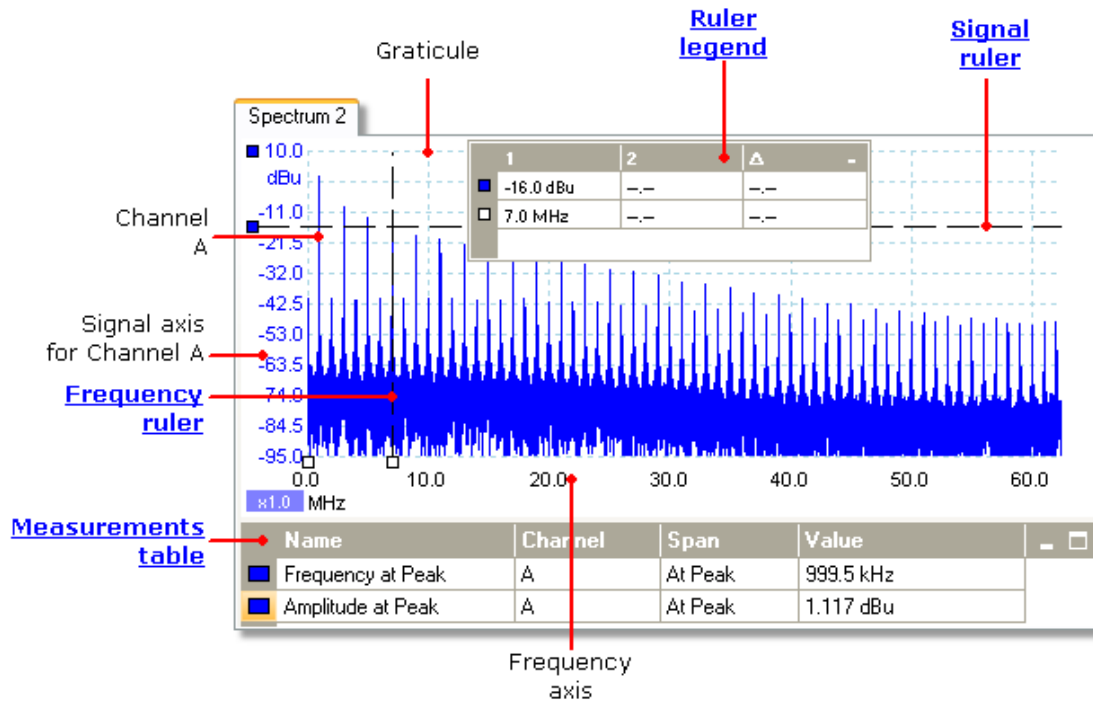
This button toggles the drive signal between internal signal or external signal. When the external input is connected the customer's signal source, this button has to be switched to external.

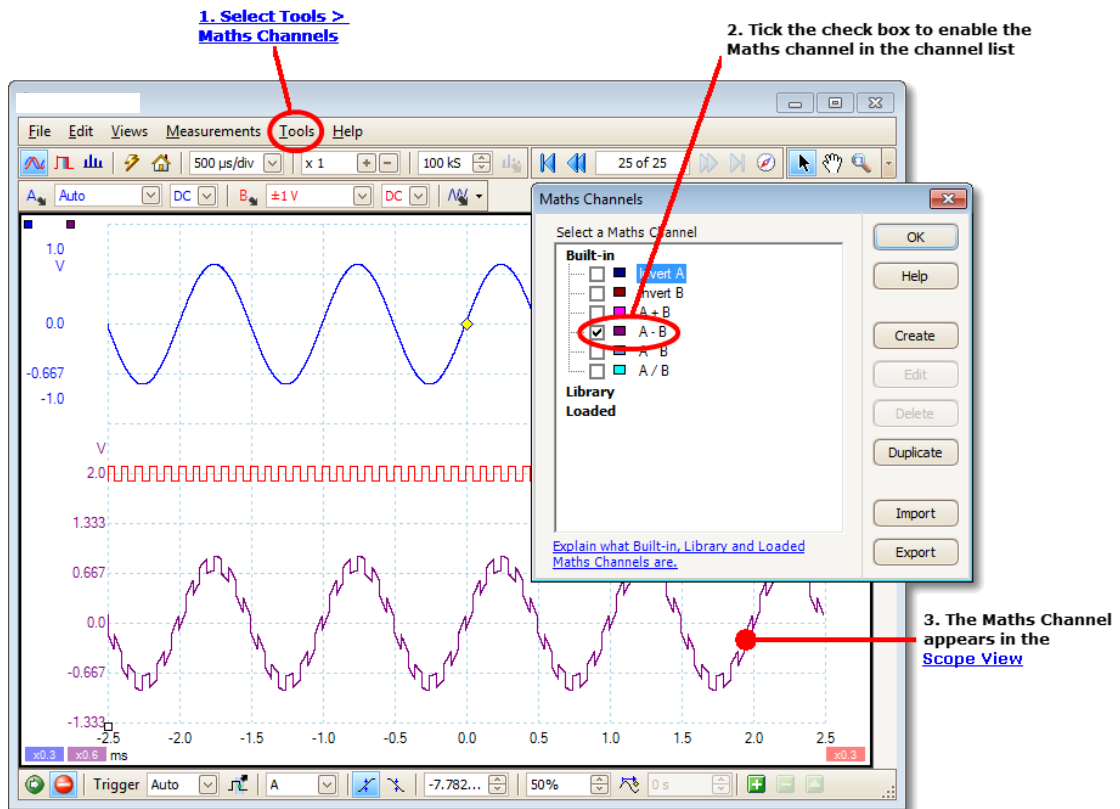
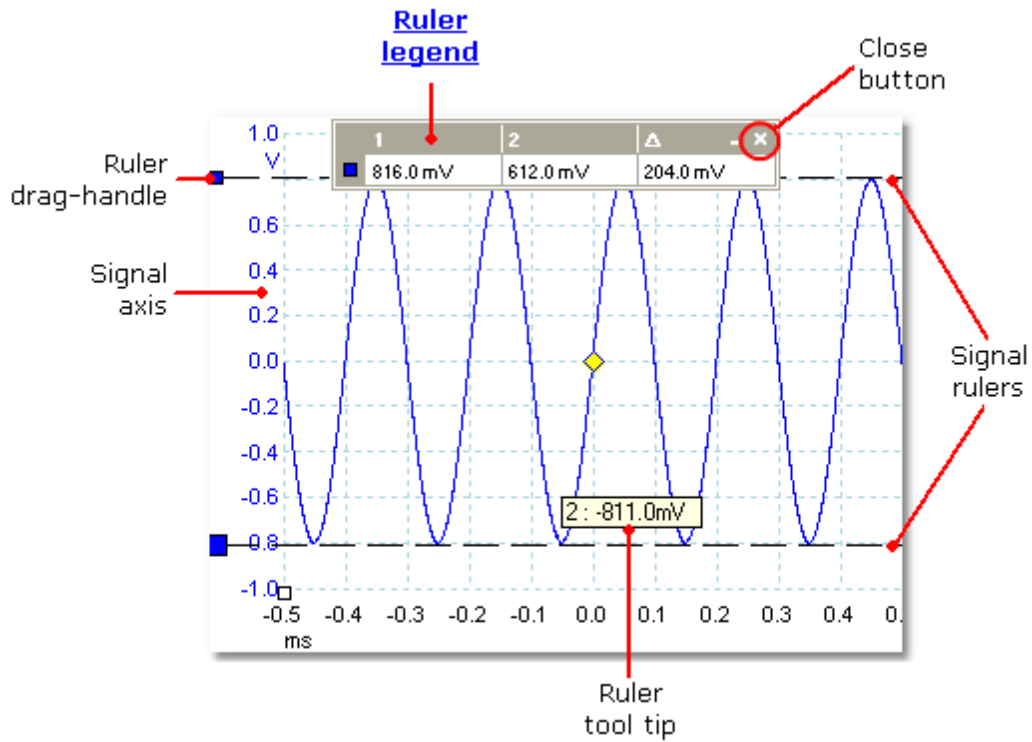
1.8 LWG-Scope

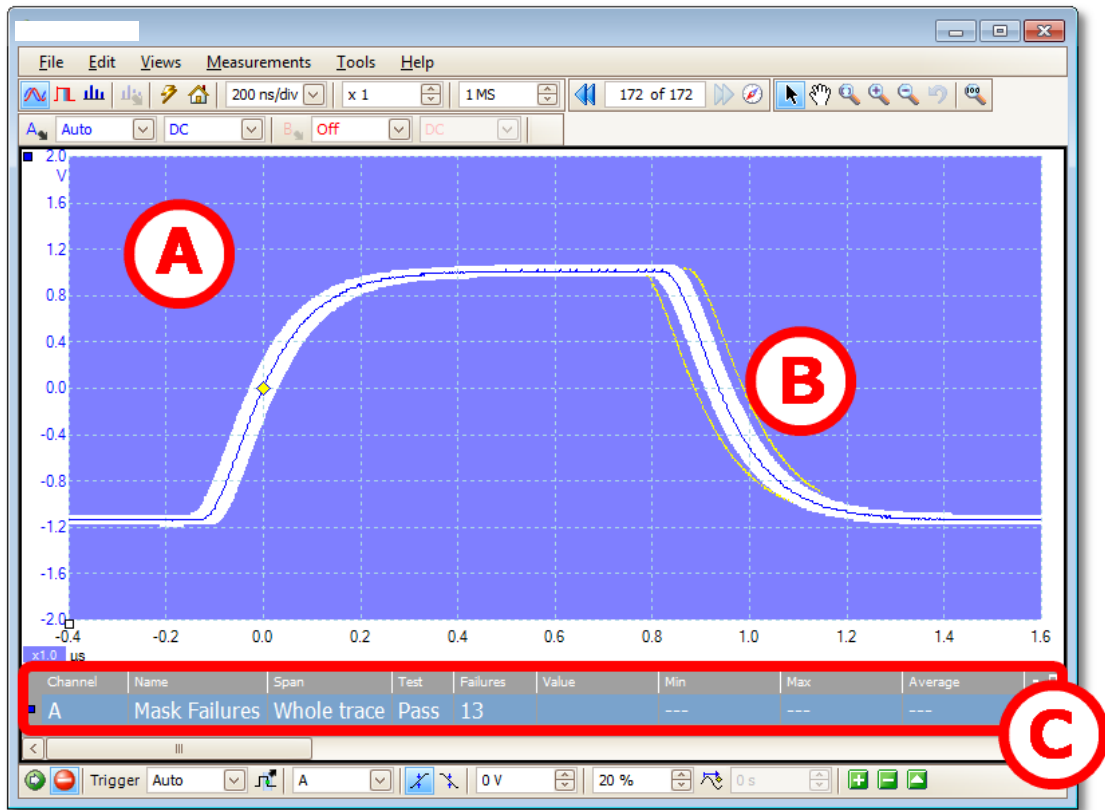
The detail of this screen and how to use the scope and set the pulse combination are explained in a separate manual. Refer to [LWG-Scope](#) Manual in LIC Engineering Website at:

<http://www.licengine.com/manuals.php>

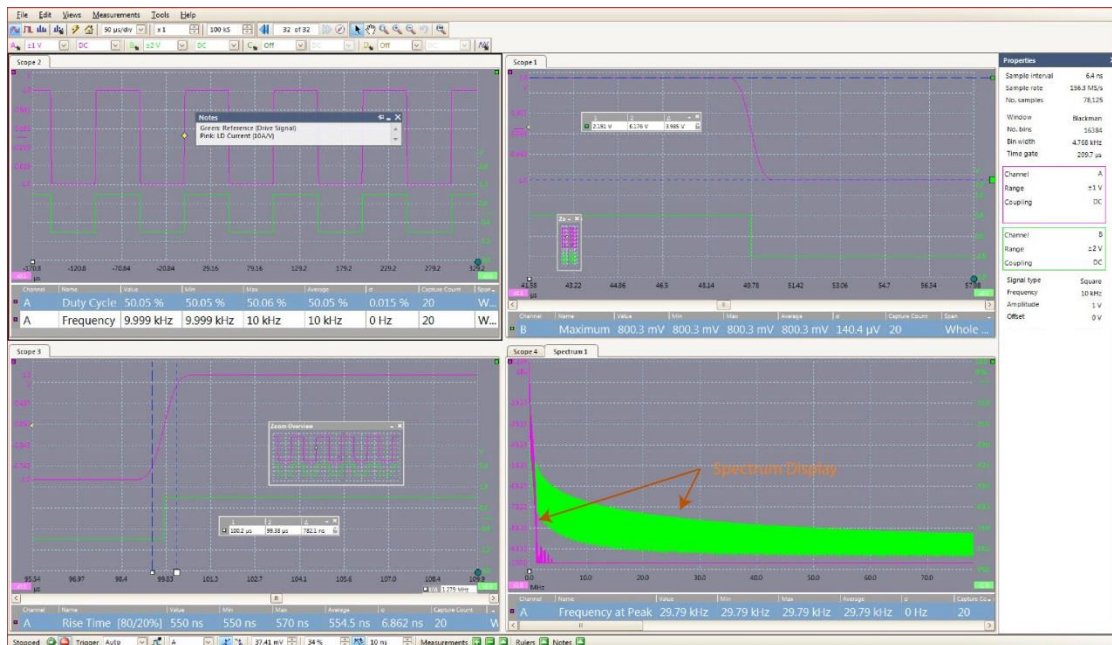


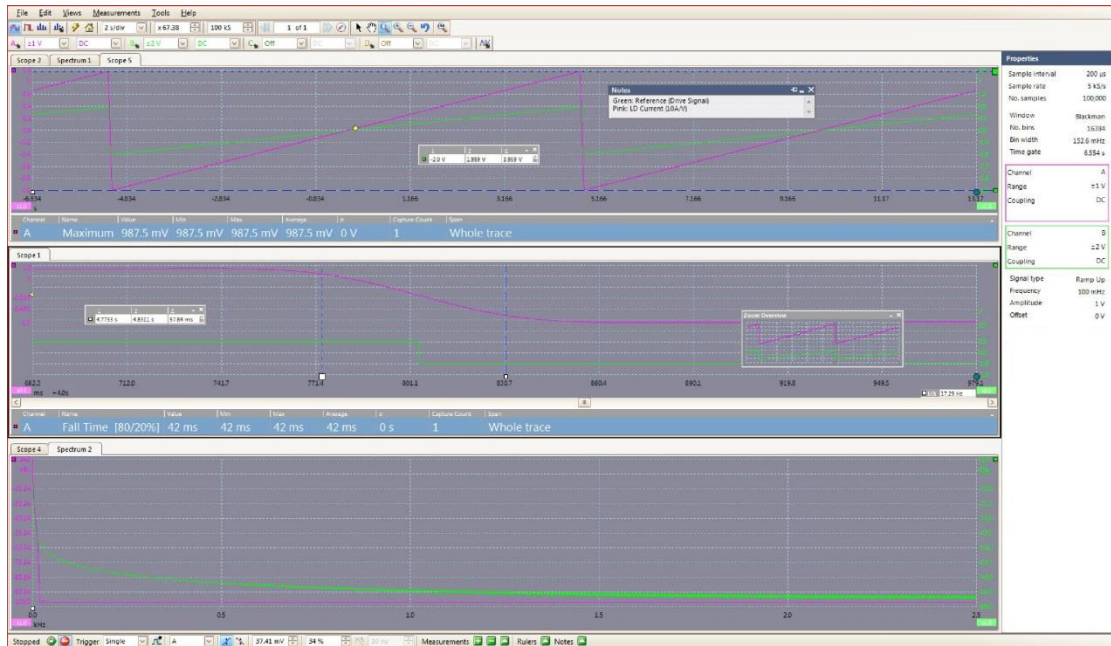






LWG Scope Screen Basic





LWG Scope Screen Samples

1.8.2 Scope & Pulse Setting Specification

Note:

There are many scope versions available with LWG-XXXX/QCW/HP/USB & LDG-XXXX/QCW/QCW/HP-USB LD Drivers.

The standard rise time and its bandwidth are as follows:

Rise Time /Bandwidth: 5.8ns/60MHz 3.5ns/100MHz 1.75ns/200MHz

As an option you can select the following versions:

Bandwidth/Rise Time: 35ns/10MHz 0.7ns/500MHz 29ps/12GHz (Sampling Scope)

Oscilloscope — Vertical (analogue channels)				
Model				
Bandwidth (-3 dB)	60 MHz	100 MHz	200 MHz	250 MHz
Rise time (calculated)	5.8 ns	3.5 ns	1.75 ns	1.4 ns
Input channels	2			
Vertical resolution	8 bits			
Enhanced vertical resolution	12 bits			
Input ranges (full scale)	±50 mV to ±20 V in 9 ranges			
Input sensitivity	10 mV/div to 4 V/div (10 vertical divisions)			
DC accuracy	±3% of full scale			
Input characteristics	1 MΩ ±1% in parallel with 13 pF ±1 pF			
Input type	Single-ended, BNC connector			
Input coupling	Software selectable AC/DC			
Analogue offset range 50 mV to 200 mV ranges 500 mV to 2 V ranges 5 V to 20 V ranges	±250 mV ±2.5 V ±20 V			
Overvoltage protection	±100 V (DC + AC peak)			
Oscilloscope — Horizontal				
Maximum sampling rate (single shot) Ch A or B Ch A or B + 1 Digital port (MSO only) 1 or 2 Digital ports (MSO only) All other combinations	500 MS/s 500 MS/s 500 MS/s 250 MS/s			1 GS/s 500 MS/s
Maximum sampling rate (repetitive signals)	2.5 GS/s	5 GS/s	10 GS/s	10 GS/s
Maximum sampling rate (continuous streaming mode)	10 MS/s in PicoScope software. PC-dependent using SDK .			
Buffer memory# A models B/MSO models	4 MS 8 MS	16 MS 32 MS	64 MS 128 MS	256 MS 512 MS
Buffer memory (streaming)	100 MS in PicoScope software. All available memory with SDK.			
Waveform buffer	Up to 10,000 waveforms			
Timebase ranges	2 ns/div to 5000 s/div	1 ns/div to 5000 s/div	500 ps/div to 5000 s/div	100 ps/div to 5000 s/div
Timebase accuracy	±50 ppm			±2 ppm ±1 ppm/year
Sample jitter	< 5 ps RMS			

Dynamic Performance (analogue channels, typical)		
Crosstalk	Better than 400:1 up to full bandwidth (equal voltage ranges)	
Harmonic distortion	< -50 dB at 100 kHz full scale input	
SFDR	52 dB	
ADC ENOB	7.6 bits	
Noise	180 µV RMS (on most sensitive range)	
Bandwidth flatness	(+0.3 dB, -3 dB) at scope input, from DC to full bandwidth	
Trigger (main features)		
Trigger modes	None, auto, repeat, single, rapid (segmented memory)	
Maximum pre-trigger capture	Up to 100% of capture size	
Maximum post-trigger delay	Up to 4 billion samples	
Trigger re-arm time	< 2 µs on fastest timebase	< 1 µs on fastest timebase
Maximum trigger rate	Up to 10,000 waveforms in a 20 ms burst	Up to 10,000 waveforms in a 10 ms burst
Trigger (analogue inputs)		
Source	Ch A, Ch B	
Trigger types	Rising, falling	
Advanced triggers	Edge: rising, falling or dual edge with adjustable hysteresis Window: signal enters or exits a user-defined voltage range Pulse width: a negative or positive pulse is wider or narrower than a set width, or inside/outside a range of widths Window pulse width: signal is inside or outside a voltage range for a set time Dropout: signal does not cross a voltage threshold for at least a set time Window dropout: signal does not enter or exit a voltage range for at least a set time Interval: time between two edges is greater or less than a set time, or inside/outside a time range Logic: arbitrary logic state of Channels A, B and EXT matches a user-defined pattern Runt pulse: signal crosses one voltage threshold and returns without crossing the other	
Trigger sensitivity	Digital triggering provides 1 LSB accuracy up to full bandwidth of scope. ETS mode: Typical 10 mV p-p, at full bandwidth	

Trigger (digital inputs – MSO models only)				
Source	D15 to D0			
Trigger types	Combined level and edge			
Advanced triggers	Data pattern (adjustable grouping)			
Trigger (logic)				
Source	Ch A, Ch B, D15 to D0			
Trigger types	AND, NAND, OR, NOR, XOR, XNOR of analogue and digital inputs			
External Trigger Input (A/B models only)				
Trigger types	Edge, pulse width, dropout, interval, logic, delayed			
Input characteristics	1 MΩ±1% in parallel with 13 pF ±1 pF			
Input type	Front panel BNC connector			
Bandwidth	60 MHz	100 MHz	200 MHz	250 MHz
Voltage range	±5 V, DC coupled			
Overvoltage protection	±100 V (DC + AC peak)			
Function Generator (all models)				
Standard output signals	Sine, square, triangle, DC voltage			
All models	Ramp, sinc, Gaussian, half-sine, white noise, <u>PRBS</u>			
B/MSO models				
Standard signal frequency	DC to 1 MHz			
Output frequency accuracy	±50 ppm			±2 ppm
Output frequency resolution	< 0.01 Hz			
Output voltage range	±2 V with ±1% DC accuracy			
Amplitude flatness	< 0.5 dB to 1 MHz, typical			
SFDR	> 60 dB, 10 kHz full scale sine wave			
Connector type	Front panel BNC with 600 Ω output impedance			
Overvoltage protection	±10 V			
Sweep modes	Up, down, dual with selectable start/stop frequencies and increments			
Arbitrary Waveform Generator (B/MSO models only)				
Update rate	20 MS/s			100 MS/s
Buffer size	8 kS	8 kS	16 kS	32 kS
Resolution	12 bits (output step size approximately 1 mV)			
Standard signal frequency	DC to 1 MHz			
Bandwidth	> 1 MHz			
Rise time (10 to 90%)	< 100 ns			

Spectrum Analyser				
Frequency range	DC to 60 MHz	DC to 100 MHz	DC to 200 MHz	DC to 250 MHz
Display modes	Magnitude, peak hold, average			
Window types	Rectangular, Gaussian, triangular, Blackman, Blackman–Harris, Hamming, Hann, flat-top			
Number of FFT points	Selectable from 128 to 1 million in powers of 2			
PC Requirements				
Minimum	Processor: 1 GHz Memory: 512 MiB Free disk space: 32-bit: 600 MB, 64-bit: 1.5 GB Operating system: 32- or 64-bit edition of Microsoft Windows XP (SP3), Vista, Windows 7 or Windows 8 (not Windows RT) Ports: USB 2.0 compliant port			
Recommended	Processor: 2 GHz Pentium IV processor, or equivalent Memory: 256 MiB (XP) / 1 GiB (Vista, Windows 7 and 8) Operating system: 32- or 64-bit edition of Microsoft Windows XP (SP3), Vista, Windows 7 or Windows 8 (not Windows RT) Ports: USB2.0 or USB3.0 compliant port. All models will work in USB2.0 mode when connected to a USB2.0 port. The 3207A/B will operate in USB3.0 mode when connected to a USB3.0 port.			
Software				
	Capture modes: oscilloscope, spectrum and persistence. Channel maths: calculate the sum, difference, product, inverse or create your own custom function using standard arithmetic, exponential and trigonometric functions. Mask limiting testing: pass/fail, failure count, total count. Serial Decoding: decode data from a serial bus such as I ² C. Automated measurements Scope mode: AC RMS, true RMS, cycle time, DC average, duty cycle, falling rate, fall time, frequency, high pulse width, low pulse width, maximum, minimum, peak-to-peak, rise time and rising rate. Spectrum mode: frequency at peak, amplitude at peak, average amplitude at peak, total power, total harmonic distortion (THD % and THD dB), total harmonic distortion plus noise (THD+N), spurious-free dynamic range (SFDR), signal+noise+distortion to signal+noise ratio (SINAD), signal to noise ratio (SNR) and intermodulation distortion (IMD). Export data formats: comma separated values (CSV), tab delimited (TXT), Windows bitmap (BMP), graphics interchange format (GIF), portable network graphics (PNG), MATLAB 4 format (MAT).			
Linux drivers	32-bit drivers			
Software development kit	Includes drivers and example code for various programming languages including C, Excel and LabVIEW. Download SDK			

Language Support		
Software		Full support for: English, Deutsch, Español, Français, Italiano Menus and dialogs only for: 中文 (简体), 中文 (繁體), Čeština, Dansk, suomi, Ελληνικά, Magyar, 한국어, 日本語, Norsk, Polski, Português, română, Русский, Svenska, Türkçe
Documentation User's guide Programmer's guide Quick Start Guide		English, Français, Deutsch, Italiano, Español, 中文 English English, Français, Deutsch, Italiano, Español
General		
Data sheet		English, 中文 (简体), Deutsch, Español, Français, Italiano
Additional hardware (supplied)		2 x oscilloscope probes in probe case 2 packs of TA139 test clips (MSO models only) TA136 digital cable (MSO models only) USB 2.0 cable USB 3.0 cable (PicoScope 3207A/B only) User manuals Software CD-ROM
PC interface		USB 2.0USB 3.0
Power requirements		Powered from USB port
Safety approvals		Designed to EN 61010-1:2010
EMC approvals		Tested to EN61326-1:2006 and FCC Part 15 Subpart B

1.9 CAPACITOR CHARGING POWER SUPPLY

High Power Laser Driver, LWG-XXXX/QCW/HP/USB, USG-XXXX/QCW/USB & LDG-XXXX/QCW/HP contain a high efficient and powerful capacitor charging power supply. This type of power supply is designed to charge a capacitor load efficiently. It works at full power condition regardless the load is shorted (at the beginning of charging), heavy or light.

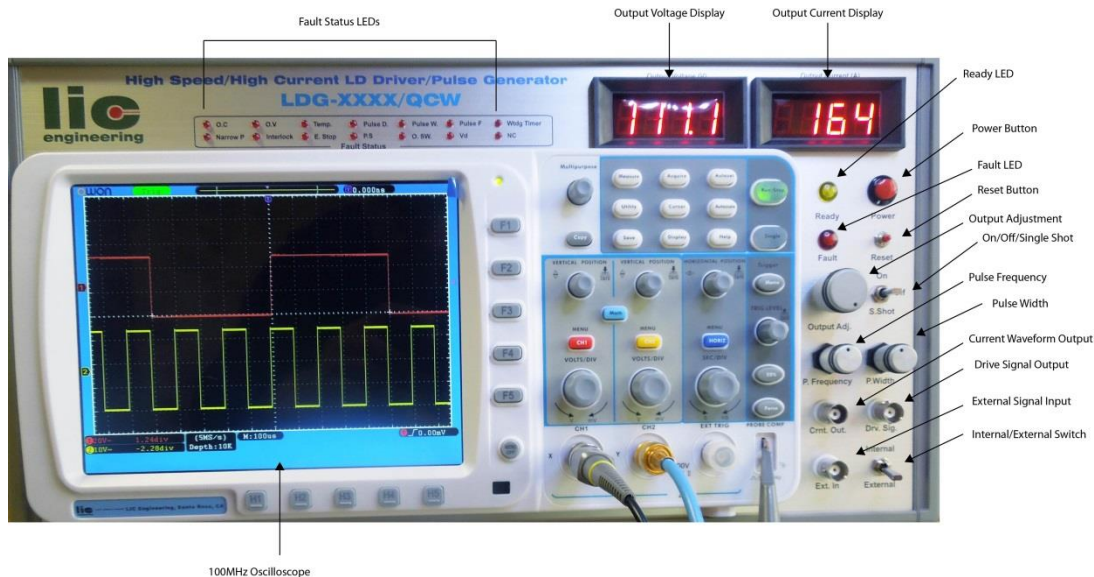
If a normal DC power supply is used for this purpose, it may create several problems such as:

- 1). *DC power supply may be tripped by an over current fault.*
- 2). *There may be no feedback loop formed between the charging power supply and the capacitor bank, so the accurate and real time setting/adjustment is difficult.*
- 3). *It takes a long time to charge up because the charging process is very inefficient.*
- 4). *It may need an extra series resistor to avoid an over load condition and this causes a fair amount of heating loss.*
- 5). *It may be difficult to decrease the output voltage in short time since the capacitor bank is so huge.*

In LWG-XXXX/QCW/HP/USB, USG-XXXX/QCW/USB & LDG-XXXX/QCW/HP unit, there is a feedback loop formed between the huge output capacitor bank and the capacitor charging power supply to regulate the output current accurately.

LWG-XXXX/QCW/HP/USB, USG-XXXX/QCW/USB & LDG-XXXX/QCW/HP use **the double switching technology** that is charging and discharging the output voltage efficiently at the same time. Combined with the precise current tacking system, user can set the current (increasing and decreasing) precisely regardless the output is in heavy or no load at all.

1.10 LDG-XXXX/QCW Control Panel



1.10.1 Output Voltage Display

3-1/2 digit LED indicator shows the charging voltage of the capacitor bank. This value may fluctuate during operation to supply the constant current to the load.

1.10.2 Output Current Display

3-1/2 digit LED indicator shows the peak load current.

1.10.3 Power Button

After AC breaker placed on rear panel is turned on, press this button and a DC main circuit in the unit is energized in 10 seconds.

1.10.4 Ready Indicator

After pressing Power On button, the unit will be ready status in 10 seconds. When this LED lights on, it indicates the unit is energized and ready to use.

1.10.5 Fault Indicator

It indicates the LD driver is in fault condition. There are many safety features built in the unit to protect the unit against damage and these protection circuits generate FAULT when the fault condition is detected. The fault conditions are as follows:

- 1). O.C:
Indicates Load Over Current
- 2). O.V:
Indicates Load Over Voltage
- 3). Temp.:
Indicates Power Supply's Over Temperature
- 4). Pulse D.:

Indicates Pulse Duty Fault

5). Pulse W.:
Indicates Pulse Width Fault

6). Pulse F.:
Indicates Pulse Frequency Fault

7). Wtdg Timer:
Indicates Watchdog Timer Fault

8). Narrow P.:
Indicates Narrow Pulse Fault
When the pulse interval is more than the one specified, this fault comes.

9). Interlock.:
Indicates Interlock Fault

10). E Stop:
Indicates Interlock Fault

11). P.S:
Power Supply Fault (including Power Supply Over Current, Over Temperature, etc)

12). O SW.:
Indicates Output Switch Over Current

13). Vd:
Indicates Vd values fault

14). NC:
Not connected

After removing the fault conditions, press RESET button.
The unit resumes the operation.

1.10.6 Reset Button

To reset the unit from the fault condition, press this button. If there is fault condition exists, pressing RESET doesn't recover the unit. First remove the fault condition, and then press RESET.

1.10.7 Output Adjustment

This adjusts the load current and the adjustment is reflected to the "Output Current" display in real time.

1.10.8 On/Off/Single Shot

This switch controls LD driver output both in CW and Pulse mode. Switching ON enables the LD driver to send the output current. In Pulse mode, the on time is not synchronized with the setting pulse. To synchronize to the pulse, go to PULSE mode and use Run/Stop button on pulse setting screen, and/or

an external trigger. The detail is explained in a separate pulse setting manual.

S.SHOT (Single Shot) enables the output current on while the switch is pressing and disables the output current when the switch is released. This works both in CW and Pulse mode, but again it is not synchronized with the setting pulse in Pulse mode. To synchronize a single shot to the setting pulse, go to pulse setting screen, and use a single shot available in the screen.

1.10.9 Pulse Frequency Adj.

This adjustment controls the pulse frequency of the internal pulse generator and works in "Internal Trigger Mode" setting.

1.10.10 Pulse Width Adj.

This adjustment controls the pulse width of the internal pulse generator and works in "Internal Trigger Mode" setting.

1.10.11 Current Waveform Output

This is the output signal from a current detector output equipped in the unit. Most of LDG-XXXX/QCW unit outputs the load current with the rise time less than 100ns.

However, sometimes the current monitor output is NOT exactly the same as original load current.

To compare the original current with the detector's waveform, a reference sensing resistor is enclosed in the unit.

1.10.12 Drive Signal Output

This is the output signal to activate/deactivate the output switch of the unit. With this signal, user can synchronize the LD current gate time to user's external device.

1.10.13 External Trigger Input

External pulse condition should not exceed the pulse set that is specified when the unit is ordered. If the pulse set exceeds the predetermined values, the unit ceases the operation indicating Fault condition. This is activated by one of the following protection circuit:

Pulse Frequency Protection, Pulse Width Protection, and Over Load Protection.

Interface condition is TTL/CMOS, 5V/1Kohm.

1.10.14 External/Internal Switch

This button toggles the drive signal between internal signal or external signal. When the external input is connected the customer's signal source, this switch has to be switched to external.

Don't change this switch while the unit is running.

2.0 INSTALLATION

2.1 GENERAL

After unpacking, general inspection and preliminary checkout procedures should be performed to ensure that the unit is in proper working order. If it is determined that the unit has been damaged, the carrier should be notified immediately. Contact LIC Engineering directly:



122 Calistoga Rd. Suite 210
Santa Rosa, CA 95409 USA
Tel: (707) 327-2705

Web: www.licengine.com, email: info@LicEngine.com

2.2 INSPECTION

Check for damage incurred during shipment as follows:

1) Inspect unit case for cracking, bending, and other obvious signs of damage.

2.3 OUTPUT STRIPLINE CONNECTIONS

Connect the stripline to the load (Laser Diode) using a soldering iron, or screws.

The physical distance between the load and tip of the stripline must be as short as possible.

Do not use any extra wires to connect between the strip line and a Laser Diode.

USING SUCH EXTRA WIRES WILL INCREASE A RISE AND FALL TIME DRAMATICALLY.

Formula is $T_{rise-time} = L \cdot di / V_o$,
where V_o : the maximum output voltage of the unit, di : Current increment within the time of $T_{rise-time}$, L : Total inductance (LD-pin inductance plus internal lead wire inductance, plus external lead wire inductance).

Example 1):

500A load current, Total inductance=100nH, and Output voltage =50V, then, the fastest rise time T is only 1 μ s.

Example 2):

500A load current, Total inductance=100nH, Output Voltage =300V, then the fastest rise time will be: 170ns-200ns.

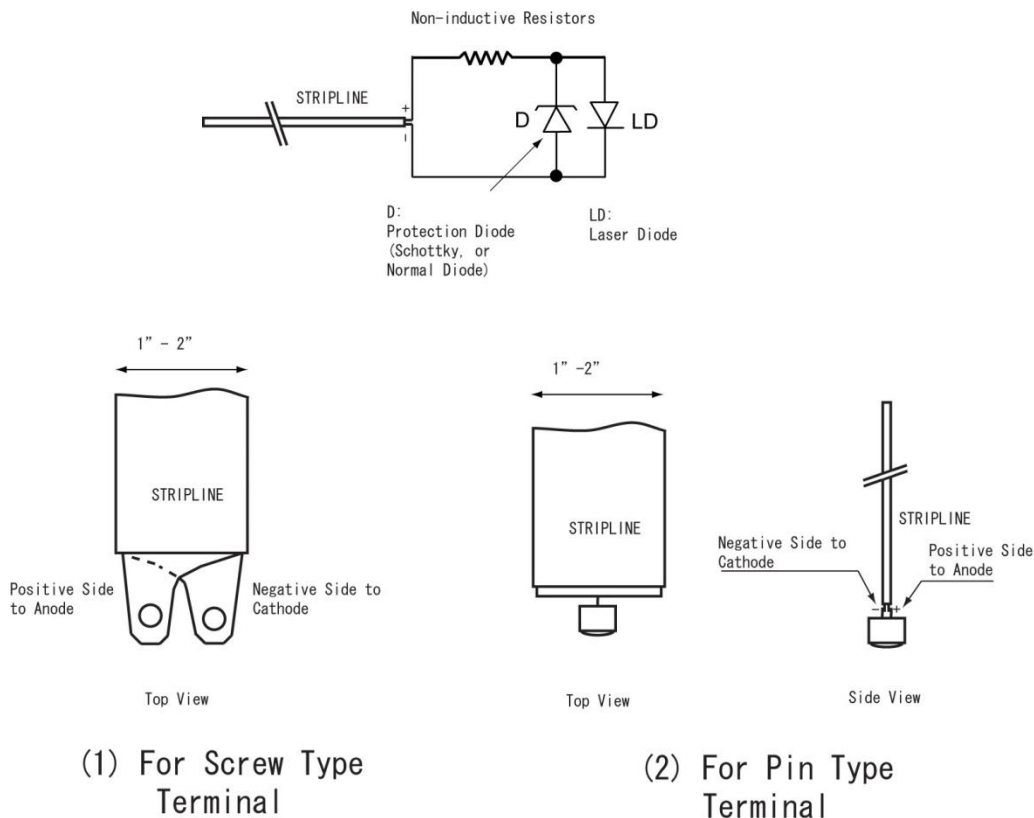
Refer to 3.1.3 RISE TIME, LOAD IMPEDANCE, AND OUTPUT VOLTAGE

THE FORWARDING VOLTAGE OF CONNECTED LD MUST BE CLOSE TO THE OUTPUT VOLTAGE SPECIFIED WHEN THE UNIT IS ORDERED. IF THE LD VOLTAGE IS MUCH LOWERED THAN THE VALUE SPECIFIED, THE RISE TIME OF OUTPUT CURRENT BECOMES SLOW. IN THIS CASE, THE SERIES RESISTOR CAN BE CONNECTED AS SHOWN IN THE FOLLOWING PICTURE. THIS SERIES RESISTORS SHOULD BE VERY LOW INDUCTANCE TYPE AND MUST SATISFIE THE EXPECTED PEAK CURRENT, VOLTAGE AND AVERAGE POWER.

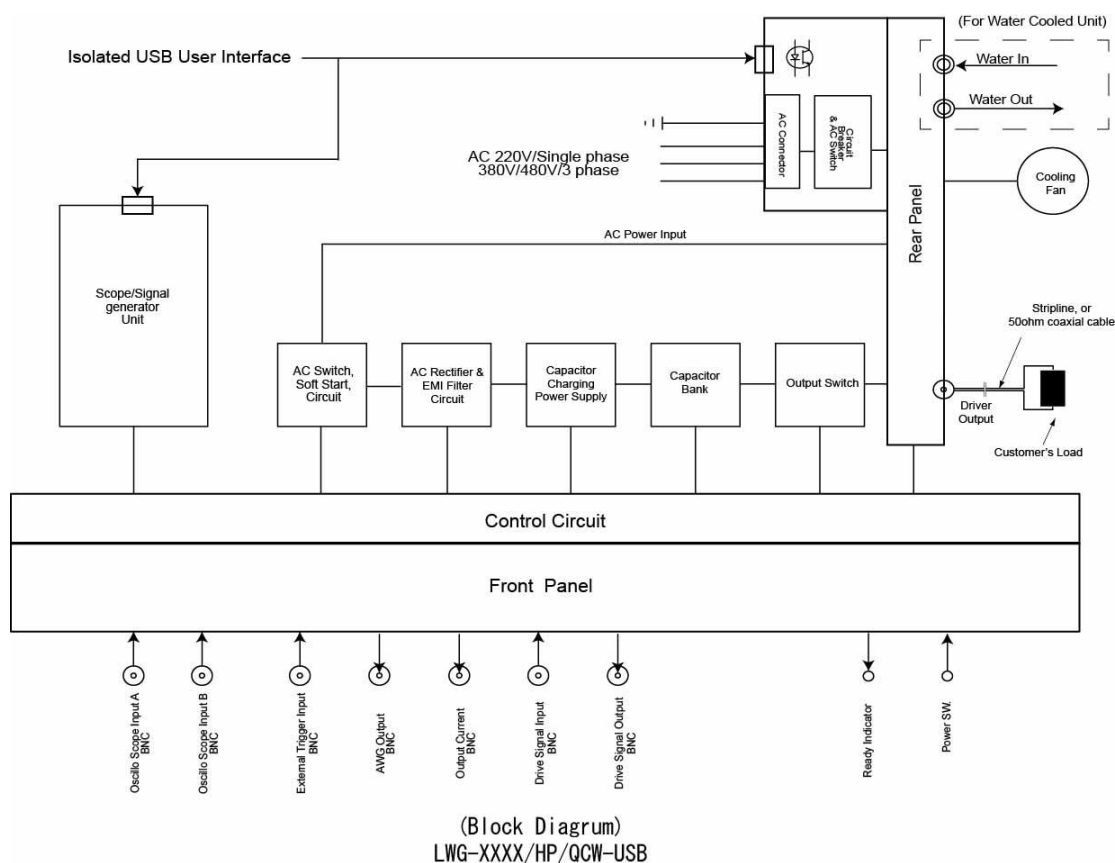
Refer to 3.1.3 RISE TIME AND LOAD IMPEDANCE, OUTPUT VOLTAGE for detail.

Contact factory if user cannot find such resistors. LIC Engineering has a wide range of non-inductive resistor of which power ranges from 5W (air cooled) to 5KW (water cooled).

To protect user's LD from a reverse current, it is good idea to use a protection diode connected in parallel with the LD as follows. The reverse current will increase when the load inductance is increased. Check with a current monitor waveform if the reverse current is within safe area.



2.3 Block Diagram of the unit



2.4 AC LINE CONNECTION

Confirm AC GND(Earth GND) is connected to the power supply GND.
Confirm that AC line voltage is proper for the unit ordered, and AC power to the unit is still off. The standard center voltages are:
100/115/208/220, Single phase/three phase, +/- 10%

3.0 OPERATION

3.1 PREPARATION & PRECAUTION

3.1.1 CURRENT DROOP

In QCW mode, the output current decays by the time for the given pulse width. The percentage of this current deduction is decided by A). The value of the capacitor bank, B). Pulse width, and C). The load impedance.

The formula is $d = Pw \times 100 / C \times Z_d$ (%),
 where d =current droop (%), Pw =Pulse width(seconds), and Z_d =load impedance (ohm: LD voltage (V)/ LD current (A))

Example 1):

LD current =200A, LD voltage is 100V, $C=0.25(F)$, $Pw=5msec$,
 $d = 5 \times 10^{-3} \times 100 / 0.25 \times 100 / 200 = 4\%$

Example 2):

LD current =500A, LD voltage is 50V, $C=0.25(F)$, $Pw=5msec$,
 $d = 5 \times 10^{-3} \times 100 / 0.25 \times 50 / 500 = 20\%$

LD-XXXX-XX has the maximum C in the capacitor bank of 0.5 (Farads).

To improve the current droop, there are several ways:

1). Select the biggest capacitor bank.

Cons: The unit becomes expensive.

2). Decrease LD current, or Pulse Width.

Cons: Pulse width/LD current is limited.

3). Connect a resistor in series with LD.

Cons: Has to prepare the special resistor and the power loss at the series resistor.

3.1.2 AVERAGE POWER AND PULSE SETTING.

In QCW mode, both Pulse Width and Pulse Rate are limited by an average power of the unit.

Assume the ordered unit is 5KW average power, the maximum pulse width is 5ms, LD voltage is 100V, and the maximum load current is 1KA, then the maximum pulse rate of this unit is 10Hz.

$P_{average} = 5KW = 10^3(A) \times 100(V) \times 5 \times 10^{-3}(s) \times F(Hz)$, so
 $F = 5 \times 10^3 / 10^3(A) \times 100(V) \times 5 \times 10^{-3}(s) = 10Hz$.

Even if user attempt to increase the pulse rate, the unit automatically decrease the pulse rate to limit the average power within the power ordered to protect the capacitor charging power supply of the unit.

Or, If user attempt to increase the pre-determined pulse width, the unit becomes Fault condition.

3.1.3 RISE TIME AND LOAD IMPEDANCE, OUTPUT VOLTAGE

As a general rule, the rise time is increased when LD voltage is lowered and LD current is increased, or load impedance is lowered.

Example 1):

LD Current =500A-1KA, Output Voltage =50V, then the fastest rise time will be: 1us-2us.

Example 2):

LD Current =500A-1KA, Output Voltage =300V, then the fastest rise time will be: 100ns-200ns.

As seen above, using higher output voltage unit has a great effect to the rise time improvement. There are two reasons to do so.

1. Overcoming the inductance:

As described in 2.3 OUTPUT STRIPLINE CONNECTION, there is certain amount of Output voltage is required to overcome the inductance that exists between the end of stripline and user's LD. This inductance L is the total of 1). LD-pin inductance plus 2). LD-internal lead wire inductance, plus 3). External lead wire inductance.

Example 1):

LD current =500A, Rise time required = 200ns, Total inductance L=100nH, Then, the required Output voltage to overcome this inductance V_{required} is: $V_{\text{required}}=250V$,

Notice this voltage is used only for the inductance. If user's LD voltage is 50V, total voltage output voltage required from the unit is 300V.

2. Series Resistor:

As seen in the Example before, Increasing a load impedance is an easy choice to improve the rise time.

However, there are Pros and Cons for the higher voltage unit:

Pros:

1) Can improve the rise time dramatically.

Cons:

1) Unit becomes expensive.

2) There are certain heating loss at the series resistor.

3) Has to prepare a low inductance, high peak current, and high power resistor.

3.1.4 PRECAUTION

1). Do not shut off AC line voltage while the power supply is running. This is not a good manner from the safety point of view.

2). Confirm that Cur./Vol. Adj. is set to adequate level before turning Output SW. ON

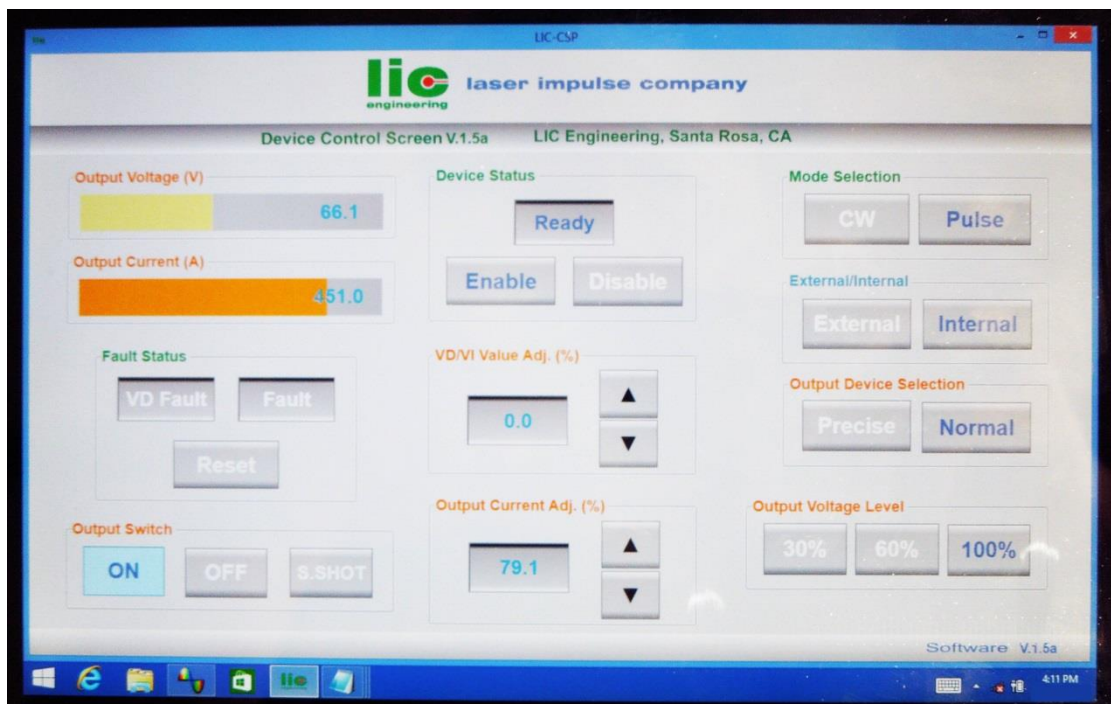
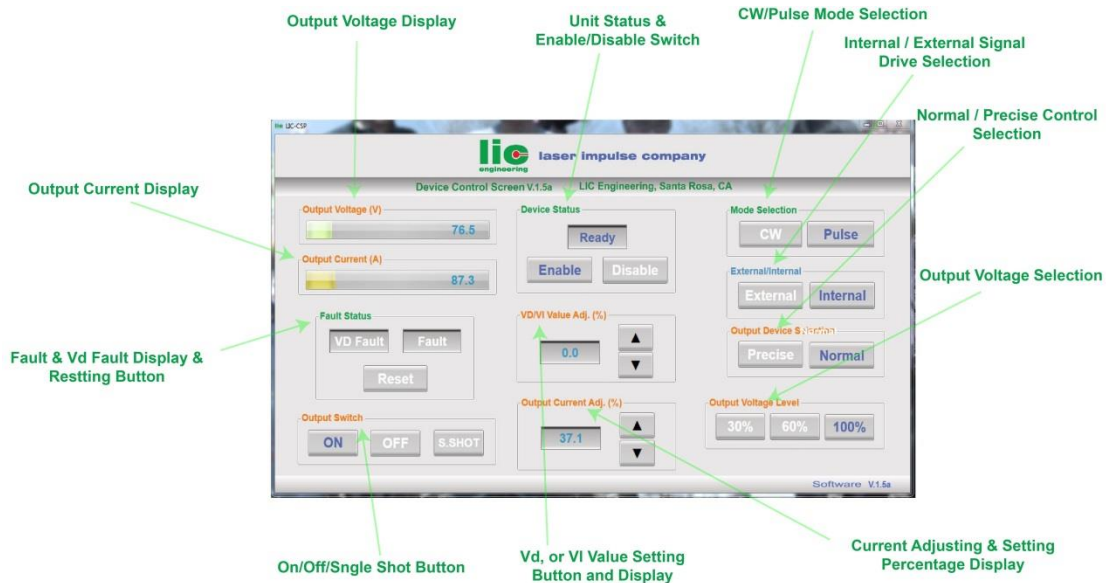
3) Don't change Internal/External SW. while the unit is running.

4) Don't change Rise Time selection while the unit is running.

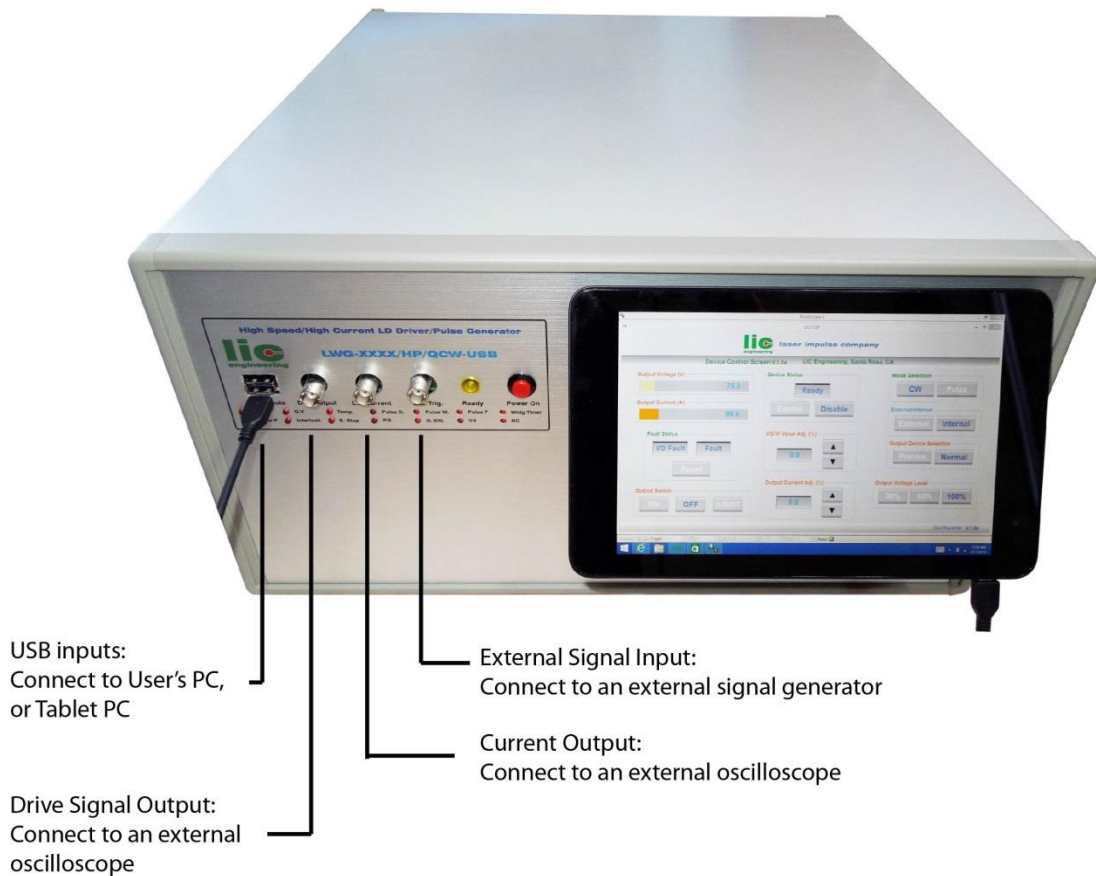
3.2 STARTING IN CW, or PULSE MODE for LWG-XXXX/QCW/USB & USG-XXXX/QCW/USB

For the digital scope/arbitrary wave generator/Spectrum analyzer, please refer to the separate manual of [LWG-Scope](#) Manual in LIC Engineering Website at:

<http://www.licengine.com/manuals.php>



3.2.1 Using Tablet PC



STEP 1. CONNECT BNC CABLES AS SHOWN ABOVE

Note 1:

If an internal oscilloscope of the unit is used, the BNC cables are not necessary to connect.

Current output is connected to channel A & Drive output signal is connected to channel B of the internal scope.

Note 2: The LD driver is a constant current source. The output current is sensed and its signal is feed backed to an error amplifier in real time to maintain the constant current. This causes the output voltage fluctuation all the time whenever the unit is operated. This fluctuation is normal and necessary to maintain the constant LD current.

- STEP 2. Connect Tablet PC to the unit with a USB-USB micro cable attached.
- STEP 3. Connect AC input to user's AC line. Check AC voltage values and line phase if they are matched to the unit ordered.
- STEP 4. Connect user's LDs (Laser Diodes) to the output of the unit. Check the polarity.
- STEP 5. Turn AC power on. Confirm Tablet PC communicates with the unit.
- STEP 6. Push **Power On** Button on the front panel of the unit.
- STEP 7. Confirm **Ready** lamp on in 10 seconds.
- STEP 8. Double click "LIC-CSP" icon on the desktop of Dell PC.
- STEP 9. Select mode: **CW**, or **Pulse**.

Note: Some models are Pulse only. In this case the mode selection doesn't affect anything on the operation.

- STEP 10. Select **External trigger**, or **Internal trigger**.
- STEP 11. External trigger: Go to STEP 12.
Internal trigger: Go to STEP 13.
- STEP 12. External Trigger:
Connect an external signal generator and set the desired pulse combinations.

Note 1: The signal output must be 3V-5V range at 1Kohm load.

Note 2: Depends on the signal conditions the unit detects the fault conditions. The pulse combination must be within the specification of the unit ordered.

- STEP 13. Internal Trigger:
According to the Pico Scope Setting Guide, set the desired pulse combinations.

Note 1: In the signal generator window, select "Arbitrary Waveform, (AWG)".

Note 2: Select "Squire Waveform" and set the pulse frequency and duty cycle desired.

Note 3: Depends on the signal conditions the unit detects the fault conditions. The pulse combination must be within the specification of the unit ordered.

Note 4: **Change the cycle number to 1**. If this number is not 1, the generated frequency is not the same as the frequency set at the signal generator.

Note 5: Leave amplitude min. -0.50 and max. 0.50 (as the default values) in the arbitrary waveform window.

Note 6: Leave the amplitude 2V and offset 0V (as the default values) in the signal generator window.

STEP 14. Select **Normal/Precise** mode.

Note: Some models are Normal Mode only. In this case the mode selection doesn't affect anything on the operation.

STEP 15. Push **Reset** button if there are any faults come.

Note: Depends on the installation conditions, some fault signals light on.

STEP 16. Push **Enable** Button.

STEP 17. Push **Output On** button.

STEP 18. Increase output current by pushing **Output On** button until desired level.

Note: Output current & voltage are displayed on the Output Voltage & Output Current Level Meters.

3.2.2 Using User's PCs

STEP 1. Install a Screen Control Software CD labeled "LIC-CSP" into user's PC.

Note: Just copy & past "LIC-CSP" on desktop of user's PC.

STEP 2. Connect user's PC to the unit with a USB male – USB male cable.

STEP 3. Go to STEP 3. Of 3.2.1 Using Tablet PC.

3.2.4 PRECISE MODE & VD/VL VALUES

Note: Some units don't feature these functions. Check with the unit ordered.

When Precise button is selected, the second output device is activated to control the output current precisely. With this mode the output current is regulated every micro-seconds so that LD current is very stable and clean. This function is called “**Dual Device Control**” and this is the unique feature of LIC Engineering LD Driver.

When this function is activated, Vd value must be entered in VD/VL Selection windows.

With this mode, Vd value is critical to avoid over heating of the control devices. If the setting value is not correct, Vd Fault may be displayed. If this happens, please adjust any of the following values:

Adjusting values when Vd Fault happens:

- 1). Reduce Vd value, or
- 2). Reduce setting current, or
- 3). Reduce pulse width

When Normal mode is selected, the output current can be at the fastest speed.

3.2.5 VD/VL VALUE SELECTION & Vd FAULT

When Precise Button is selected, Vd value must be entered in VD/VL Selection windows.

Vd value is the maximum LD voltage that is connected to the output terminal of the unit. The unit calculates the minimum output voltage between the minimum and maximum of the LD current and outputs the minimum output voltage. When Output Switch is activated, the unit again calculates the V.I.T product of the device. Where, V is the device voltage, I is the device current, and T is the conduction time. If this value is beyond the safe operating area, the unit becomes Fault condition by displaying “VD Fault”. If this happens, please adjust any of the following values:

Adjusting values when Vd Fault happens:

- 1). Reduce Vd value, or
- 2). Reduce setting current, or
- 3). Reduce pulse width

If high pulsing speed is required, turn to Normal mode.

VL Value:

VI value is the compensating voltage for high speed & high current output pulse. When a high speed unit is purchased, VI value is activated instead of Vd value.

There is certain overvoltage is required to overcome the LD inductance at high speed/high current condition. It is expressed as:

$VI = L \cdot dI / dT$, where VI is a required voltage to overcome LD inductance, L is LD inductance, dI is LD current per dT time, and dT is the rise time of the pulse. Example: $L = 5nH$, $dI = 100A$, $dT = 5ns$, then 100V output voltage is required.

A customer can see this effect by adjusting VI value. Connect a current monitor output to an oscilloscope and watch the rise time of the output pulse. As VI value is increased the rise time of the pulse is improved. Too much VI value causes an overshoot of the pulse. Adjust this value to get the optimum rise time of the pulse.

3.2.6 OUTPUT LEVEL SELECTION

This is the unique feature of LIC Engineering products.

As the nature of power supply, available maximum output power is decreased as the output voltage is decreased. By selecting the output voltage which is the required maximum voltage for customer's LD voltage, the charging power supply is able to maximize the output power at that output voltage.

Example: A 40V maximum voltage with 5KW power supply is used as an example.

When 30% of the output voltage is selected, for example, the maximum output voltage is 14V. When a regular power supply is used, the available output power is usually less than 200W-500W.

With this function, the charging power supply still can supply 100% of rated output power: 5KW at 14V.

To select this button, Disable button must be pressed before the change. Otherwise, it can't be changed: A pop up note is displayed saying: "Press Disable button before changing this selection". Default is 30% level.

3.2.7 FAULT REASONS

There are many safety features built in the unit to protect the unit against damage and these protection circuits generate FAULT when the fault condition is detected. The fault conditions are as follows:

- 1). O.C:
Indicates Load Over Current
- 2). O.V:
Indicates Load Over Voltage
- 3). Temp.:
Indicates Power Supply's Over Temperature
- 4). Pulse D.:
Indicates Pulse Duty Fault
- 5). Pulse W.:
Indicates Pulse Width Fault
- 6). Pulse F.:
Indicates Pulse Frequency Fault
- 7). Wtdg Timer:
Indicates Watchdog Timer Fault
- 8). Narrow P.:
Indicates Narrow Pulse Fault
- 9). Interlock.:
Indicates Interlock Fault
- 10). E Stop:
Indicates Interlock Fault
- 11). P.S:

Power Supply Fault (including Power Supply Over Current, Over Temperature, etc)

12). O SW.:

Indicates Output Switch Over Current

13). Vd:

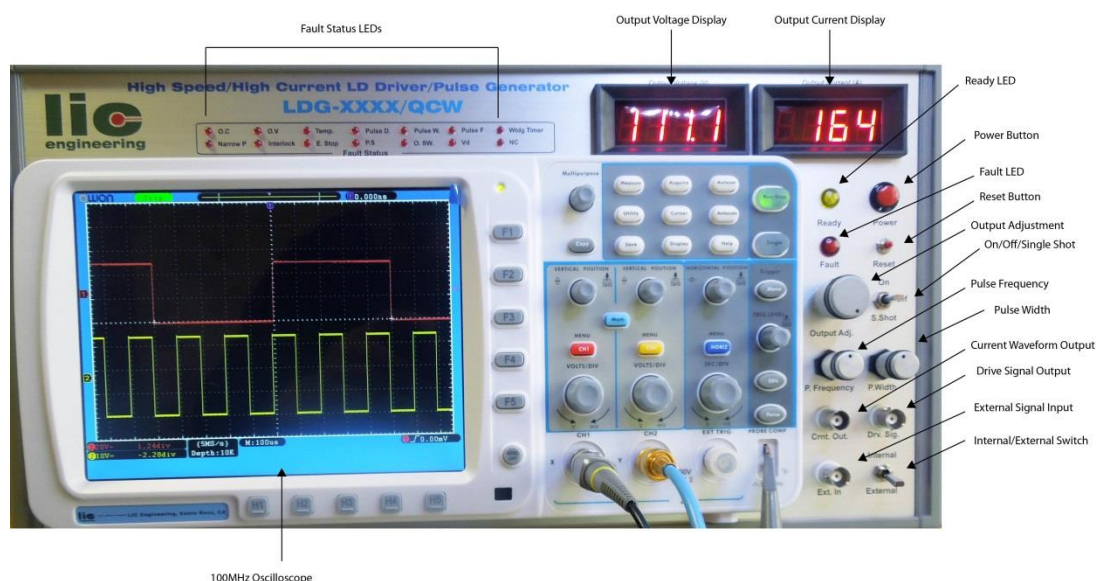
Indicates Vd values fault

14). NC:

Not connected

After removing the fault conditions, press RESET button. If there is no fault condition exists, the unit resumes the operation.

3.3 STARTING IN CW, or PULSE MODE for LDG-XXXX/QCW



- STEP 1. Connect AC input to user's AC line. Make sure that AC voltage and three/single phase are matched to the unit ordered.
- STEP 2. Connect user's LDs (Laser Diodes) to output terminals of the unit. Check the polarity.
Refer to 2.3

OUTPUT STRIPLINE CONNECTIONS

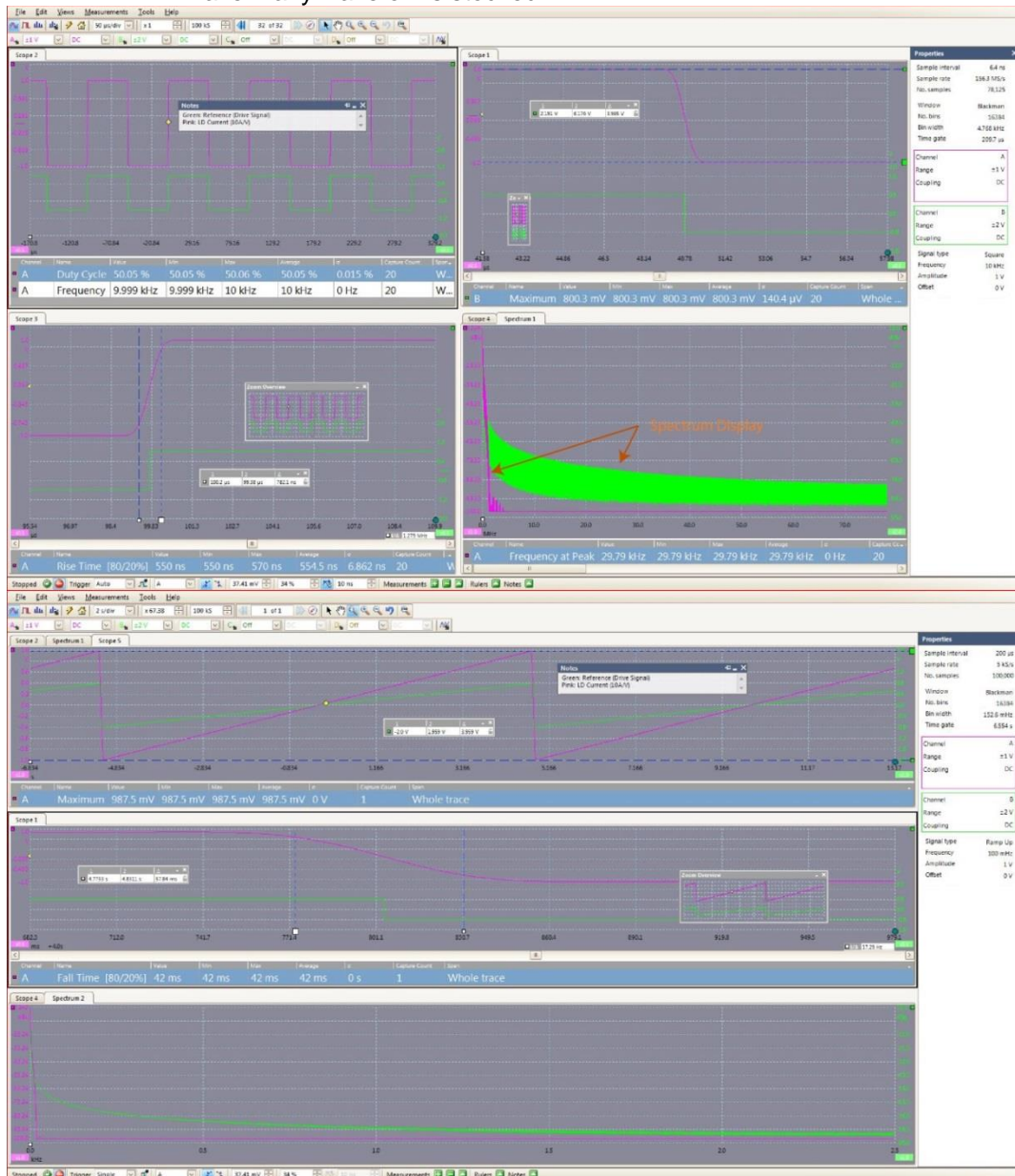
- STEP 3. Turn AC power for the unit on.
- STEP 4. Turn the **AC breaker** on the back panel of the unit on.
- STEP 5. Push **Power** Button on the front panel of the unit.

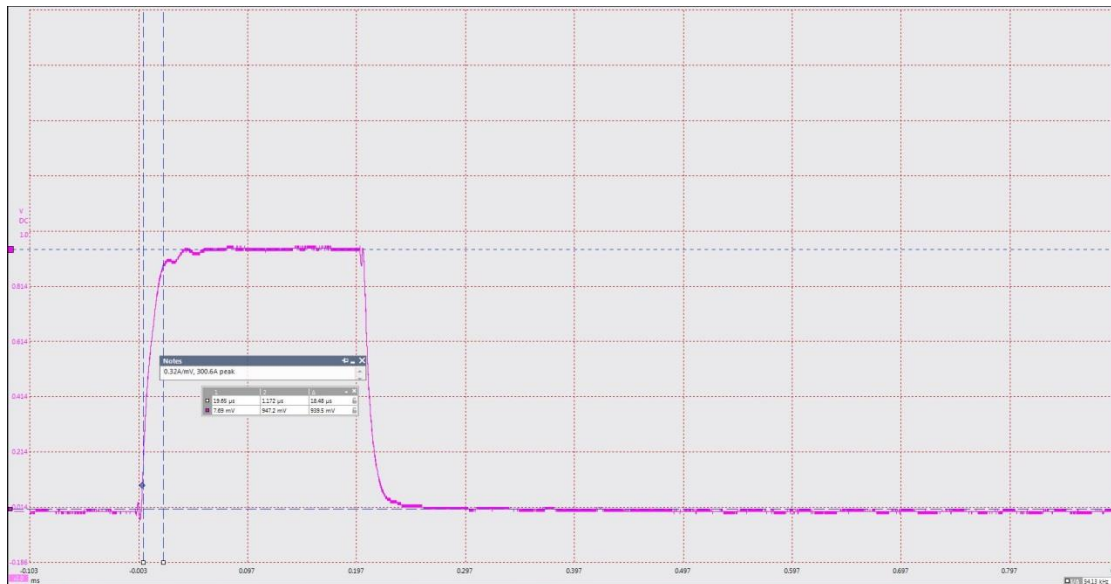
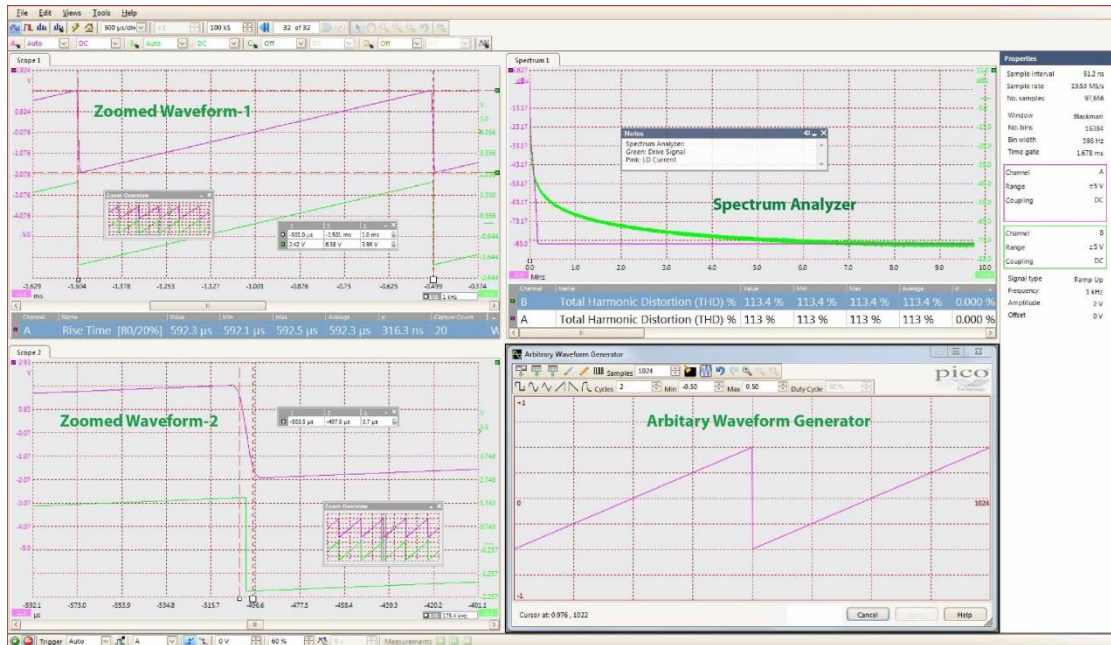
- STEP 6. Confirm **Ready** lumps on in 10 seconds.
- STEP 7. Select mode: **CW**, or **Pulse**.
Note: Some models are Pulse only. In this case the mode selection does not affect anything on the operation.
- STEP 8. Select **External** trigger, or **Internal** trigger.
- STEP 9. External trigger: Go to 10). Internal trigger: Go to 11).
- STEP 10. External Trigger:
Connect an external signal generator and set the desired pulse combinations.
- Note 1: The signal output must be 3V-5V range at 1Kohm load.
Note 2: Depends on the signal conditions the unit detects the fault conditions. The pulse combination must be within the specification of the unit ordered.
Note 3: If no pulse is generated, "Narrow P." fault will come.
- STEP 11. Internal Trigger:
Set the desirable pulse combination by changing pulse rate & pulse width.
- Note 1: Depends on the signal conditions the unit detects the fault conditions. The pulse combination must be within the specification of the unit ordered.
Note 2: If no pulse is generated, "Narrow P." fault will come.
- STEP 12. Select **Normal/Precise** mode.
Note: Some models are Normal Mode only. In this case the mode selection does not affect anything on the operation.
- STEP 13. Push **Reset** button if there are any faults come.
- Note 1: Depends on the installation conditions, some fault signals light on. Check each fault reason and push the Reset button after the fault reason is removed.
Note 2: If no pulse is generated, "Narrow P." fault will come.
- STEP 14. Push **Output On** button.
- STEP 15. Increase output current by adjusting Output Current Adj. until desired level.

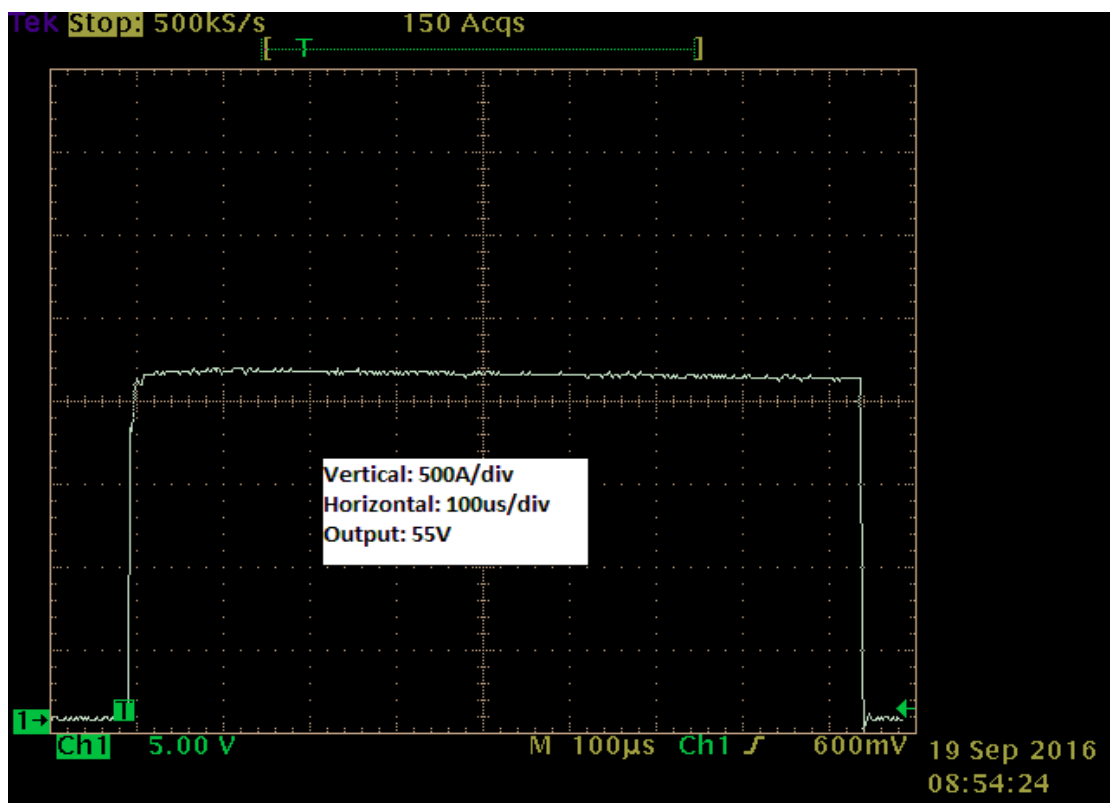
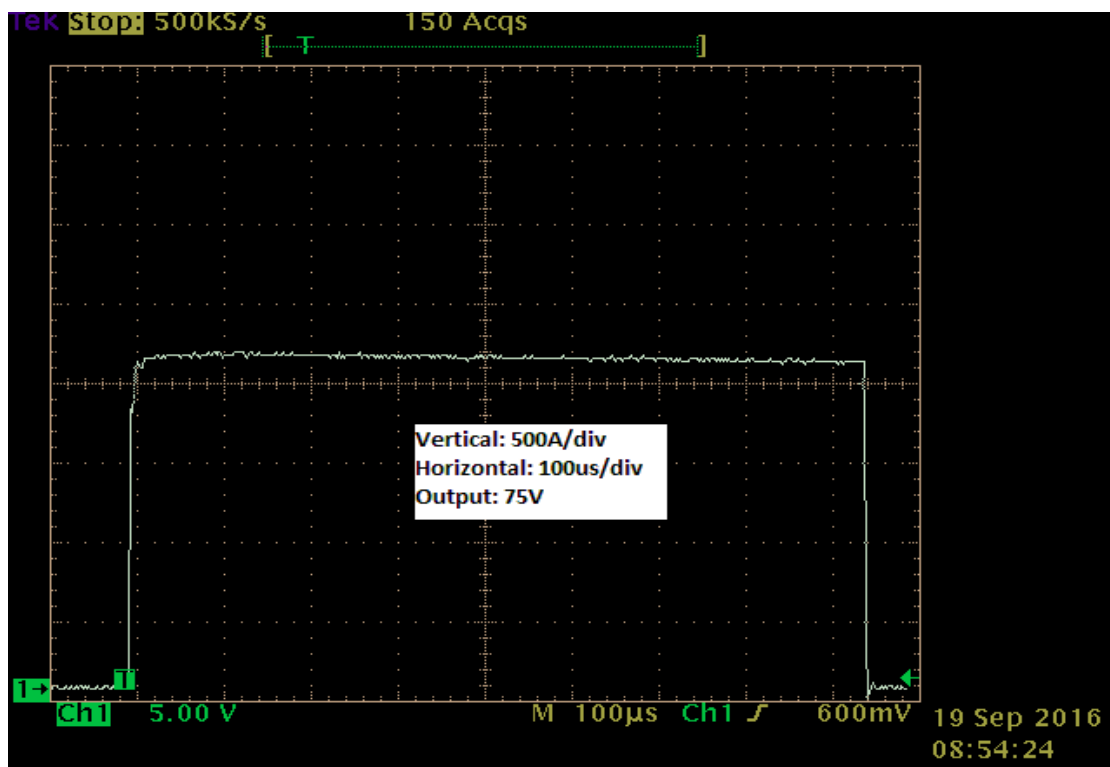
STEP 16. Output current & voltage are displayed on the Output Voltage & Output Current Level Meters on the front panel.

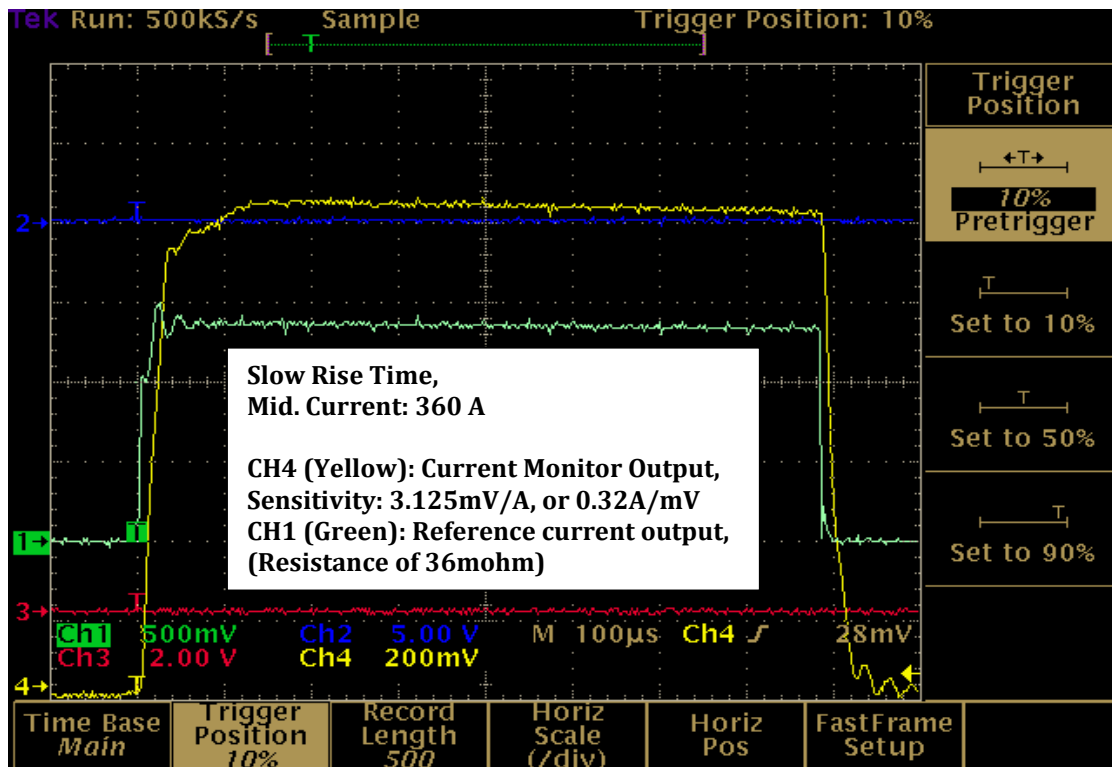
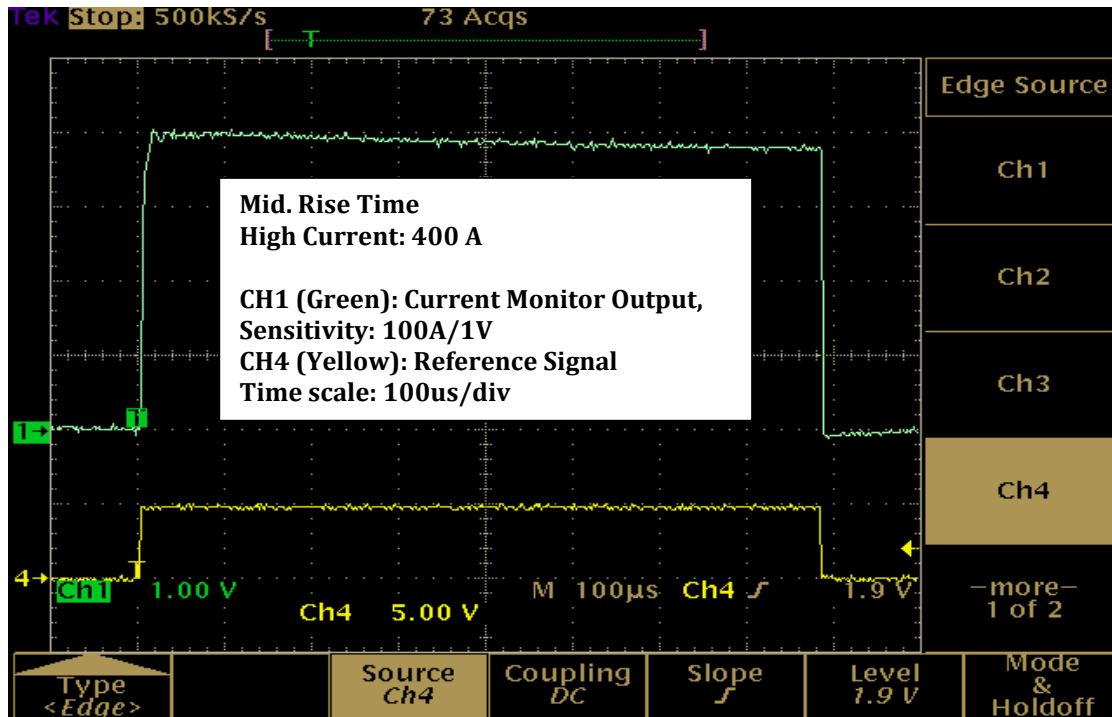
3.4 SAMPLE WAVEFORMS

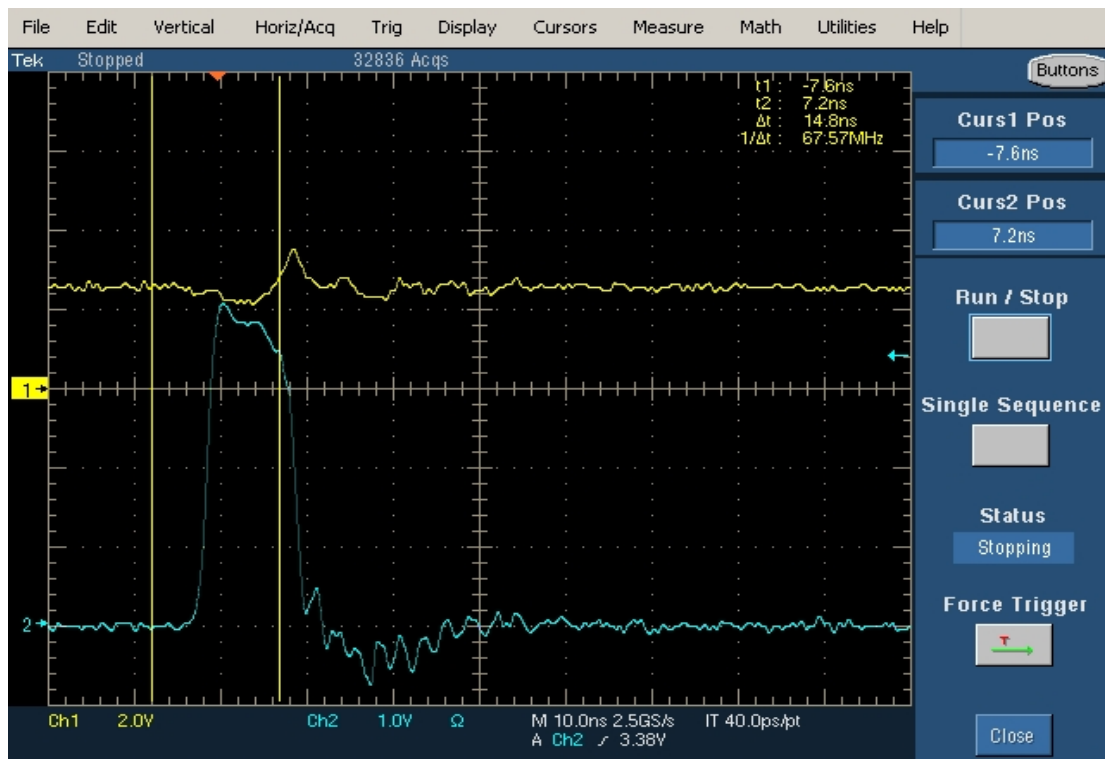
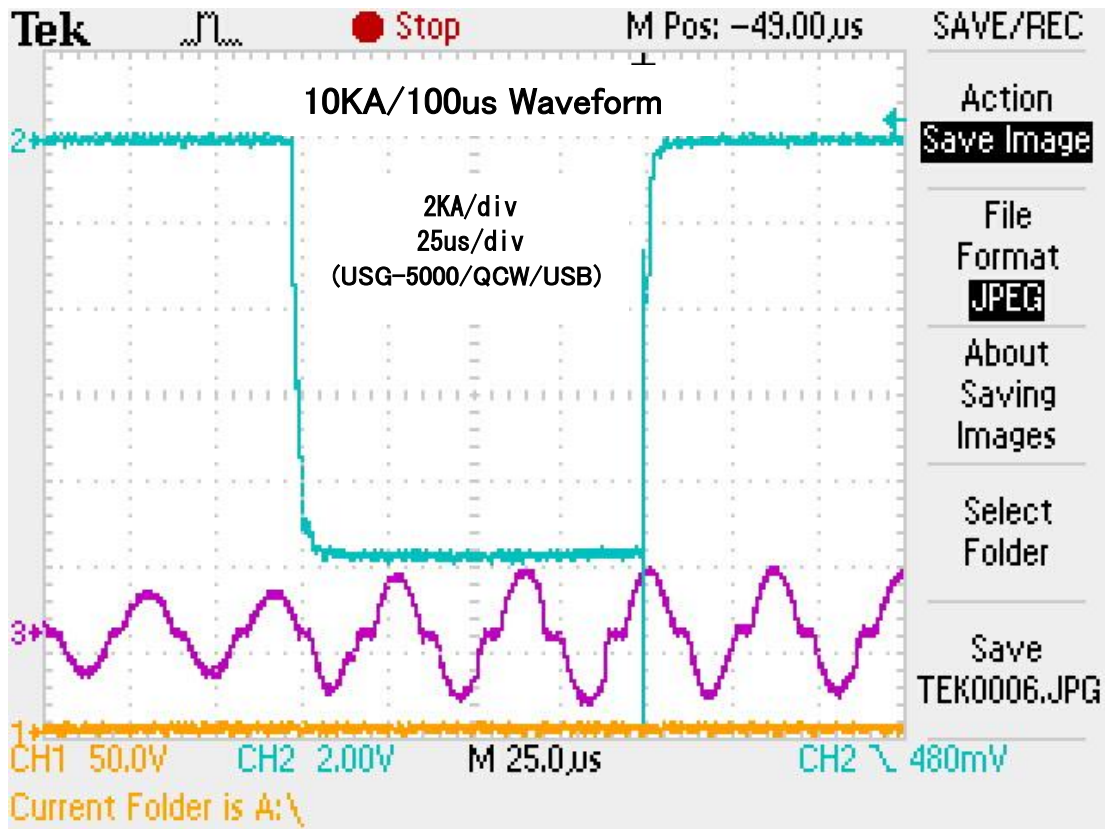
Note: If user want to see other waveforms, please contact to factory. We have many waveforms stocked.

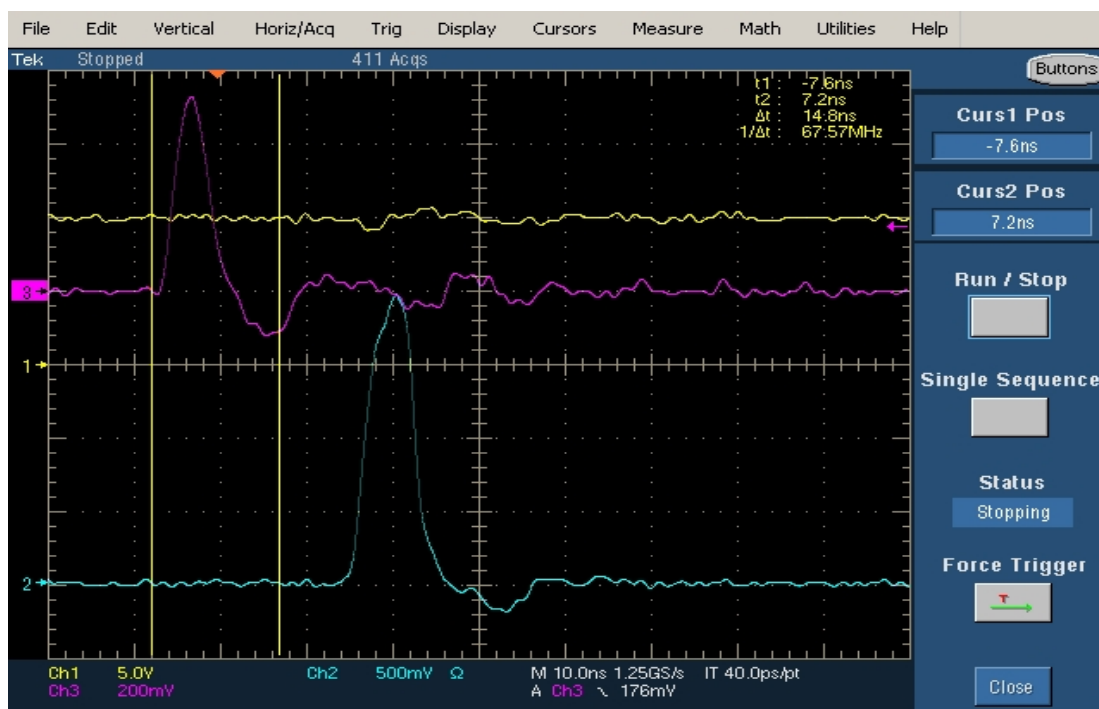


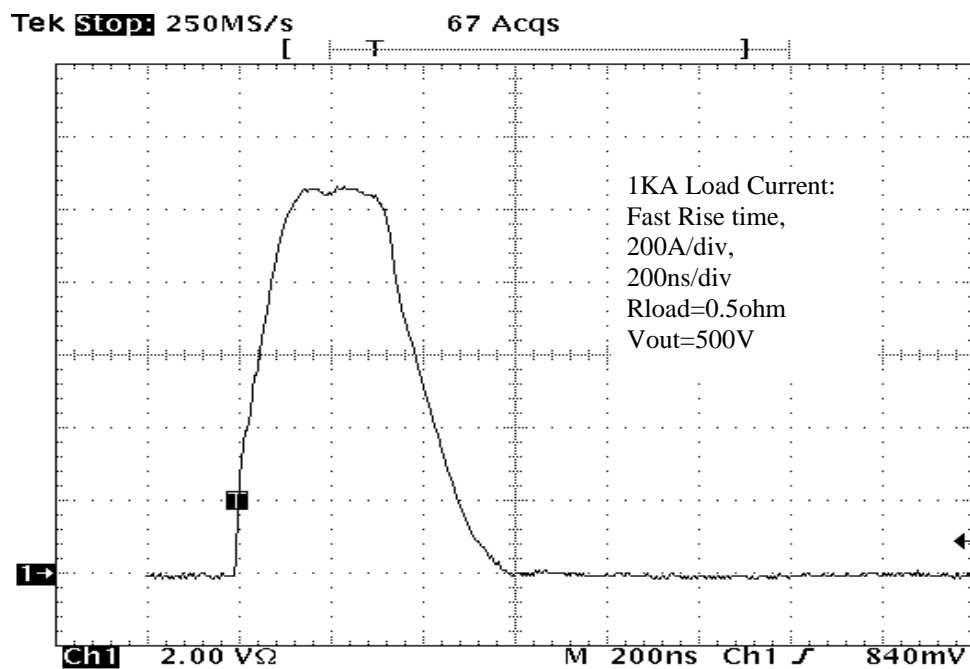
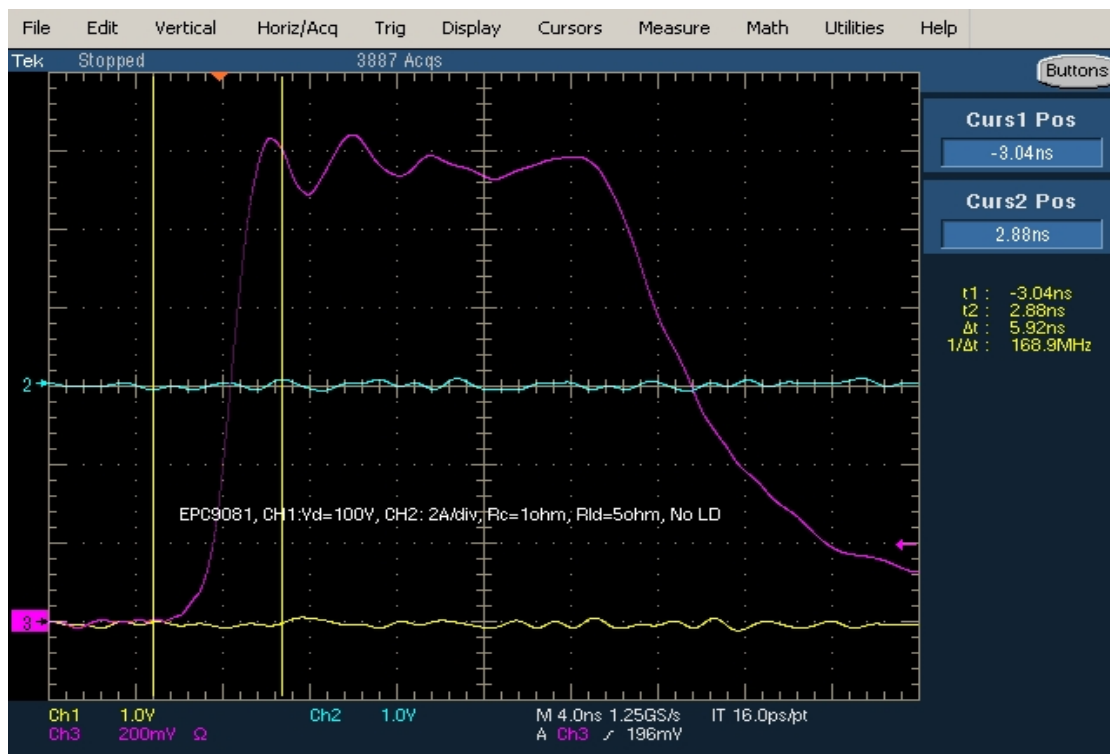


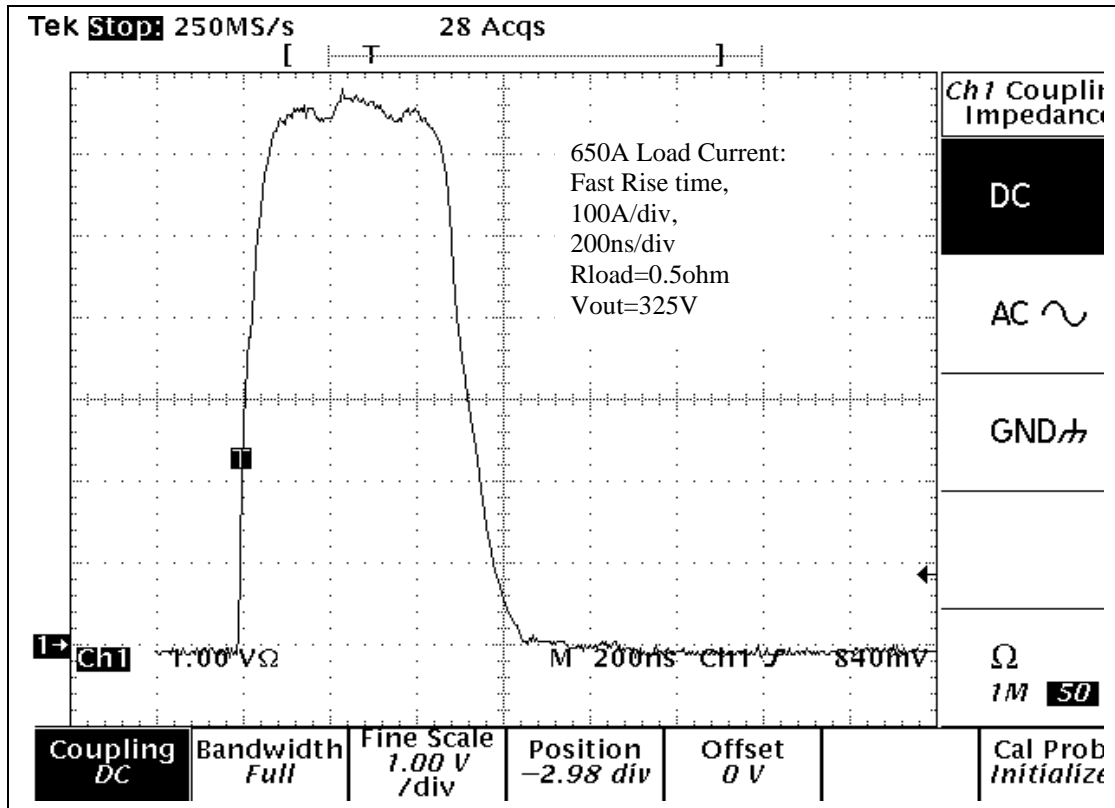


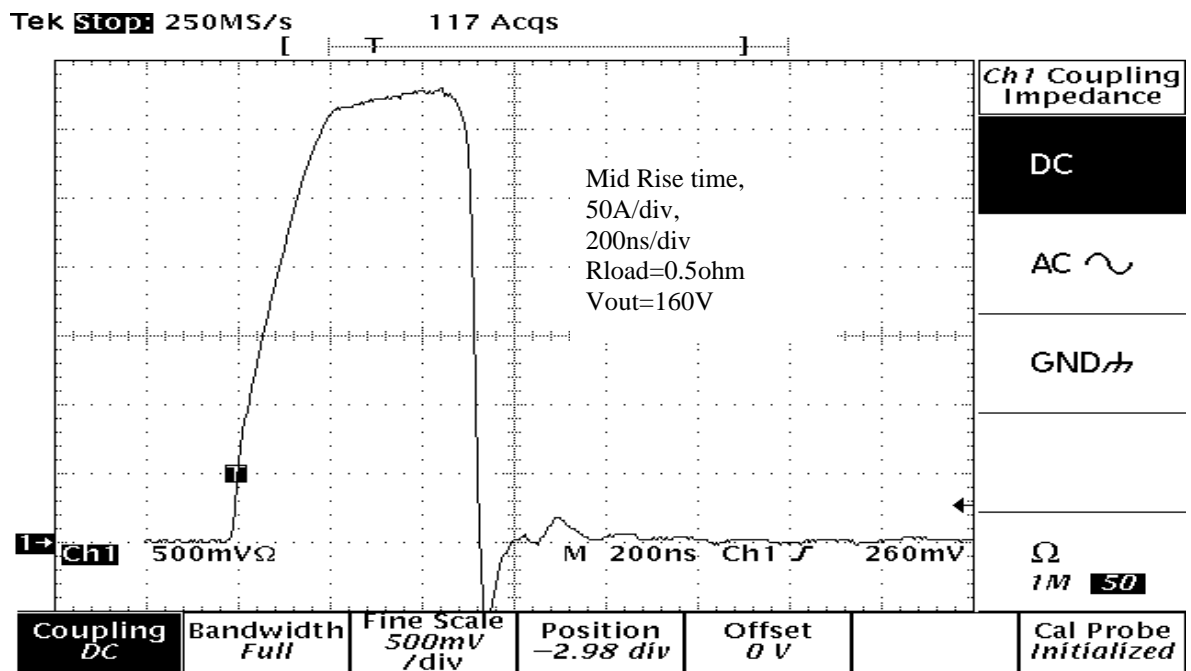
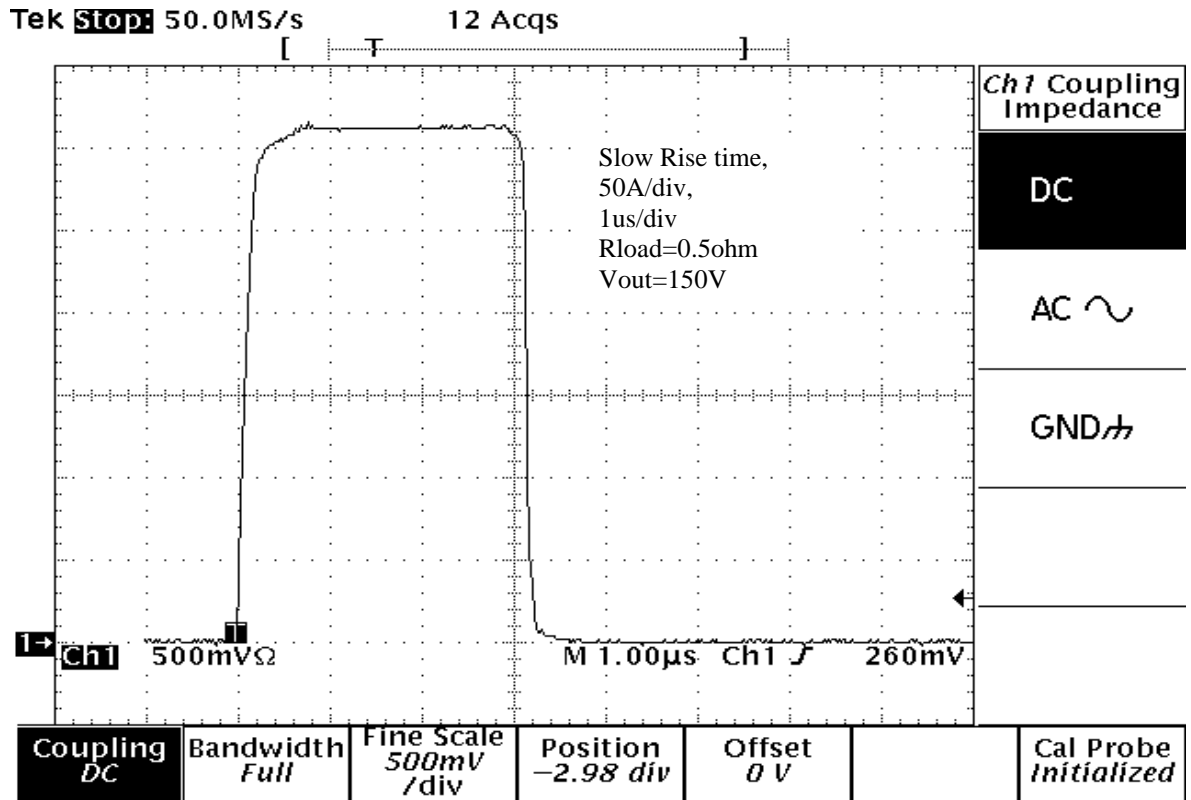












4.0

MAINTENANCE

4.1 GENERAL

LIC Engineering's laser power supply contains potentiometers that are set at LIC Engineering's factory. Do not try to adjust these potentiometers. ***There are no user-serviceable parts in LIC Engineering's products.*** IF USER ATTEMPTS TO OPEN, ADJUST, MODIFY, OR REPAIR THE PRODUCTS, THEN LIC ENGINEERING CAN NO LONGER BE RESPONSIBLE FOR THE SAFE OPERATION OF THE UNIT, AND THE WARRANTY SHALL BE IMMEDIATELY VOID.

4.2 CAUTION

- 1). DO NOT ALLOW THE UNIT TO BE IN OPEN CIRCUIT.
- 2). DO NOT ALLOW THE UNIT TO BE SHORT CIRCUIT.
- 3). DO NOT ATTEMPT TO OPEN, MODIFY OR ADJUST ANY PARTS OF THE POWER SUPPLY.
- 4). DO NOT MECHANICALLY SHOCK.
- 5). KEEP WATER OR MOISTURE FROM THE UNIT EXCEPT IN-/OUTLET OF THE UNIT.
- 6). DO NOT MISUSE, OVERUSE, OR ABUSE THE UNIT.

4.3 TROUBLE SHOOTING

4.3.1 NOT READY SIGNAL COMES ON

CAUTION:

IF READY DOES NOT ON APPEAR WITHIN 60 SECONDS AFTER TURNING ON AC POWER OF THE UNIT, SWITCH AC POWER OFF IMMEDIATELY TO AVOID DESTROYING INTERNAL COMPONENTS.

- 1). Confirm that LASER and POWER signals stay at ground level.
- 2). Check all signal conditions including DC power line.

4.3.2 FAULT COMES ON

- 1). Check if Cur. Adj. is not set at the maximum. In certain case the first edge of the peak current is detected by an over current protection circuit.

4.3.3 OUTPUT DOES NOT APPEAR

- 1). Confirm READY is active, On/Off SW. is on, and Cur. Adj. signal has certain voltage levels.
- 2). Check Remote Interlock terminal (back side of the unit) is shorted.

4.3.4 ODORS OR UNUSUAL SOUNDS

If odors or unusual sounds are detected, turn AC Power off immediately. Contact LIC Engineering.

5.0 WARRANTY

LIC Engineering warrants its products against all defects in materials and workmanship to the original using purchaser for a period of one year from the date of delivery to the original purchaser.

During this period, LIC Engineering will repair or replace its products if defective free of charge. This warranty applies only when the products are properly installed, maintained and used for the intended purpose, and only to the original purchase/user of the products, and only so long as the products are used in the country to which it was originally shipped by LIC Engineering, or by an authorized distributor.

Any shipping charge incurred shall be paid by the purchaser/user of the products.

This warranty is null and void if the user attempts to service the products (other than performing the maintenance described in the Instruction Manual), or if service is performed by people who are not trained and authorized to do so by LIC Engineering.

THE EXPRESS WARRANTY ABOVE IS THE SOLE WARRANTY OBLIGATION OF LIC ENGINEERING AND THE REMEDY PROVIDED ABOVE IS IN LIEU OF GUARANTEES, OR WARRANTIES--ORAL OR WRITTEN, EXPRESS OR IMPLIED-- INCLUDING WITHOUT LIMITATION WARRANTY OR MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

LIC ENGINEERING HAS NO LIABILITY WHATSOEVER FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGE ARISING OUT OF ANY DEFECT, IMPROPER USE, OR UNAUTHORIZED SERVICE OR REPAIR.

5.2

RETURN OF THE UNITS

Prior to return of the unit or any portion thereof, LIC Engineering must be consulted to avoid unnecessary shipping.

If return of the units is deemed necessary, a Return Authorization Number "RAN" will be assigned. This number must be recorded on the outside of the shipping container.

Contact:



122 Calistoga Rd. Suite 210
Santa Rosa, CA, USA
Tel: (707) 327-2705
email: info@LicEngine.com