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SECTION Pages

SECTION 1: DESCRIPTION

1.1 GENERAL

Lic engineering CO_2 laser power supply will produce very high voltage up to 50-100KV and high currents up to a few thousand mA under certain conditions. This is sufficient voltage and current to kill people. A little careless operation or mishandling may cause a fatal accident.

In order to avoid any such accidents and to ensure the long life designed into this power supply, it is important that all instructions be followed.

1.2 DESCRIPTION

Incorporating the **BALLASTLESS** and **SUPER PULSE** technologies, Lic engineering CO_2 laser power supply can operate without requiring ballast resistors in H.V. lines of the laser head. As a result, total electrical efficiency of the laser system will increase 20-30% compared to a conventional type power supply using the ballast resistors.

Lic engineering CO_2 laser power supply also can generate very high peak laser power called "Super Pulse" in pulse mode. In this mode, the peak height of laser output power becomes more than 4 times to 10 times higher than CW power.

This **BALLASTLESS** and **SUPER PULSE** technologies were developed early 1980's by Lic engineer.

Lic power supply uses a "**resonant mode switching technology**" to minimize a switching loss as well as components size.
This makes Lic engineering products efficient, compact, and reliable.

1.3 SPECIFICATIONS

1.3.1 AC INPUT

100V, 120V, 208V, 220V, 360V, 480V AC Center Voltage: +/- 10%, Single and Three phase, 47-63Hz.

Note: Other voltage ranges are also available by request.

1.3.2 OUTPUT POWER

50W/80W Continuously in CW mode:	CPZ-50P/80PD
600W/1000W Continuously in CW mode:	CPF-CNF-600/1000P/PD
1700W/2500W Continuously in CW mode:	CSF-1700/2500P/PD
3500W Continuously in CW mode:	CSF-3500P/PD
25KW/50KW Continuously in CW mode:	CSF-25000/50000S/MLT

1.3.3 STRIKING VOLTAGE

25KV-50KV, depending on the unit ordered.

1.3.4. OPEN CIRCUIT VOLTAGE

When no loads are connected to outputs of the power supply, the unit is capable of producing extreme high voltage 3-4 times higher than its striking voltage.

To avoid any such dangerous conditions, it is very important to confirm that all high voltage and floating outputs are connected firmly to correct loads before producing high voltage.

Note:
Open circuit protection protects only (center) H.V. outputs and does not protect a floating output in dual discharge configuration. In certain circumstances, the floating output may attain very high voltage unless the load is connected properly to the power supply.

1.3.5 OPERATING VOLTAGE

5KV to 40KV, depending on the unit ordered.

1.3.6 OPERATING CURRENT

Maximum allowable current:
50mA to 15 amps, depending on the unit ordered.

Minimum stable current:
As a general rule, the laser head current tends to be unstable at low current level. The lowest stable current depends on the characteristic of the specific laser head.

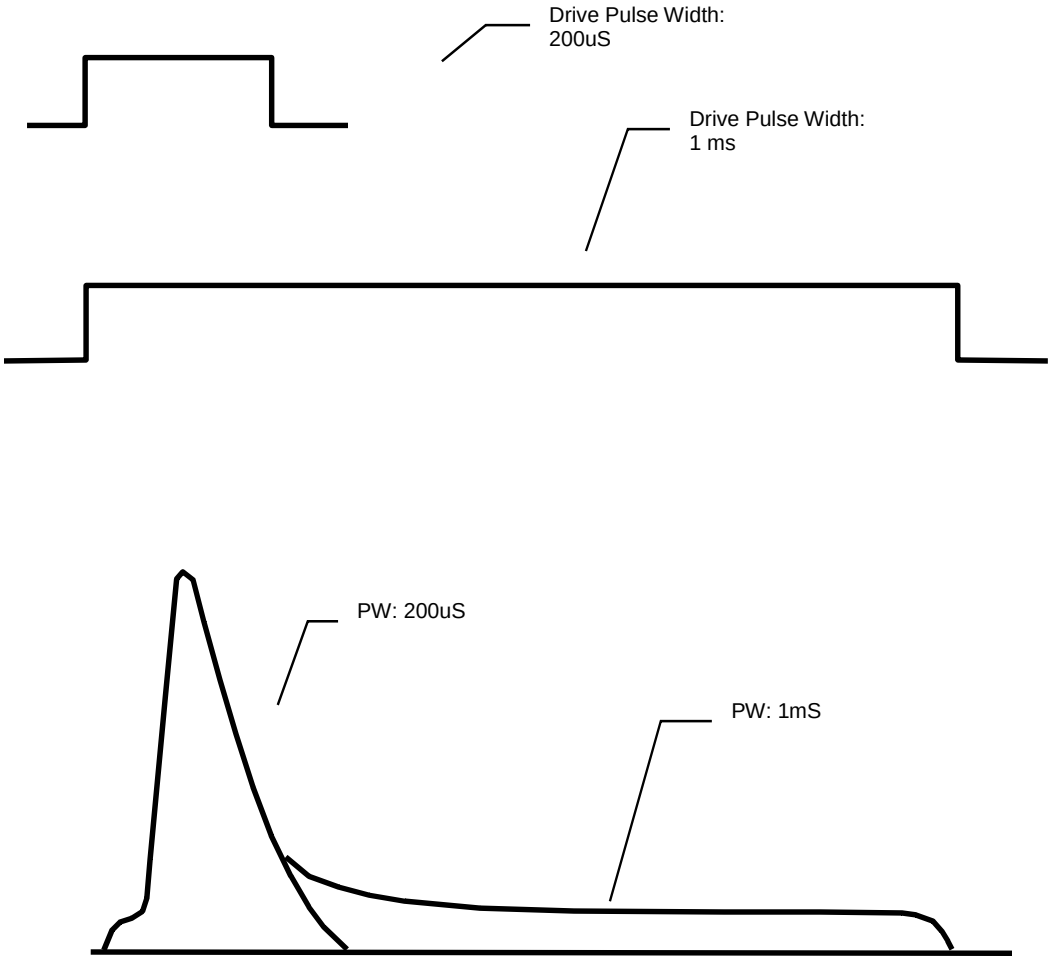
1.3.7 PULSE RATE

Up to 2KHz to 4(5)KHz, Lic's CO2 power supply can generate the Super Pulse. As the repetition rate increases, however, the peak height of the laser power will generally be decreased.

1.3.8 PULSE WIDTH

The minimum pulse width is 100uS to 300uS depending on the unit ordered and DC for the maximum. The output current shape is not a rectangular but a kind of exponential curve as shown below. First part of the pulse rises quickly to its maximum, then it decays gradually with the exponential curve. The high peak part of the pulse will last between 100uS and several hundred microseconds, depending on the pulse width setting. When the pulse width is set at 1msecond, for example, the tail part of the pulse is much lower than its peak height as shown in FIG-1.

SECTION 1: DESCRIPTION



SUPER PULSE WAVE FORM
(FIG-1)

1.3.9 PEAK POWER

At least 3-4 times higher laser power should be obtained without any adjustment with Lic's power supply and 8-10 times higher laser power should be obtained with an optimum adjustment for certain laser tubes. However, the peak power greatly depends on the specific laser head characteristics. To obtain the maximum peak output power, the laser head current must be optimized.

1.3.10 AVERAGE OUTPUT POWER IN PULSE MODE

Adjusting pulse conditions by either increasing pulse width or pulse repetition rate will produce an average output power close to CW power.

1.3.11 EFFICIENCY

85% to 97 % depending on the unit ordered.

1.3.12 LINE or LOAD REGULATION

- **CPP-series (custom made units):**
  Highly stable, precise version with a pre-regulator attached:
  +/- 0.1% for 10% change of line voltage or load impedance change. Contact factory for detail.

- SPSIII/CSF-25000/50000:
  +/- 0.5% for 10% change of line voltage or load impedance change.

- Normal CSF-series:
  +/- 2% for 10% change of line voltage or load impedance change.

1.3.13 PROTECTION CIRCUIT

The protection circuits consist of **Over Current, Over Voltage,** and **Over Temperature** as follows.

Over Current Protection Circuit:
protects the unit against (1) direct or indirect short of H.V. outputs, (2) Any electrical disturbances induced by external or internal noises, (3) Overload caused from improper load (too low or too high impedance).
Most of Lic's products are equipped with (1) Primary over current , and (2) Secondary over current protection circuit. When the protection circuit detects these fault conditions, the unit will be shut off instantaneously, sending FAULT signal to external.

Over Voltage Protection:
protects the unit against over voltage of H.V. output. When the circuit detects the over voltage condition, the unit will be shut off instantaneously, sending FAULT signal to external.

Note:
Open circuit protection protects only H.V. outputs and does not protect a floating output in dual discharge configuration(Refer to Fig-2). In certain circumstances, the floating output may attain very high voltage unless the load is connected properly to the power supply.

Over temperature protection:

detects a base temperature on which main switching devices and other power semiconductors are mounted. In case flowing cooling water is insufficient, stopped, or its temperature is not cold enough, this protection circuit will be activated.

Note:
To restart the power supply from the fault condition, use RESET signal. Refer to RESET signal at SECTION 1.4.4 for detail.

1.3.14 LEAKAGE CURRENT

55uA typical for CPF-600/1000. Based on UL(BRH) standard.
For other units, please contact to Lic.

1.3.15 OPERATING TEMPERATURE

Cooling water temperature:	below 25C
Ambient temperature:	below 40C

1.3.16 WATER FLOW REQUIRED

CPF-600/1000:	gallon per minutes
CSF-1700/2500/3500:	gallon per minutes
CSF-25000/50000:	gallon per minutes

1.3.17 STORAGE TEMPERATURE

-55C to 70C

1.3.18 DIMENSIONS(LxWxH inch)

CPZ-50/150:	5.7(L) x 1.9(W) x 1.3(H) inch
CPZ-300:	7.7(L) x 1.9(W) x 1.3(H) inch
CPF-600/1000:	11.4(L) x 3.70(W) x 2.05(H) inch
CNF-600P:	11.4(L) x 3.70(W) x 2.65(H) inch
CSF-1700/2500/3500:	13.4(L) x 8.8(W) x 2.1(H) inch
CSF-25000:	19.2(L) x 12.5(W) x 3.4(H) inch
CSF-50000:	21.7(L) x 14.5(W) x 5.7(H) inch

1.4.19 WEIGHT(Lb.)

CPZ-50/150:	2.1lb
CPZ-300:	2.7lb
CPF-600/1000:	5.6lb
CSF-1700/2500/3500:	19lb
CSF-25000:	34.5lb
CSF-50000:	60.7lb

SECTION 1: DESCRIPTION

1.4 CONTROL SIGNAL

Lic's CO2 laser power supplies use 9, 12, and 25 signals to control and monitor the power supply. These signals are completely isolated from an internal main AC line and **GND line is connected to system ground(earth GND).** In the following chapter, only 12 signals are described. The remaining signals will be explained in a separate MANUAL attached with a specific unit. The control signals are **active-high logic** as described below:

1.4.1 LASER signal (INPUT) for all model

Laser signal controls output(s) of the power supply to be either ON or OFF. In Pulse mode, a modulated pulse train will be inputted. Whenever LASER is high, the power supply will produce a high voltage from its output.

CAUTION:
If LASER signal is high during starting period of the power supply, high voltage output will appear suddenly as soon as READY comes. This could be dangerous under certain conditions. To prevent such accidental high voltage, **keep LASER off before applying AC power to the power supply.**

1.4.2 CW/Pulse signal(INPUT) for CPZ-series, and CSF-25000/50000 only

This signal is used to select either CW mode or Pulse mode. When this is high, the unit operates in CW mode, and when it is low, the unit operates in Pulse mode. While the unit is operating, do not change this signal. It may cause a FAULT condition.

1.4.3 POWER signal (INPUT) for all models

Analog signal to control laser head current both in CW and Pulse mode. Even in Pulse mode, the POWER signal will control an average H.V.. pulse current.

1.4.4 RESET signal(INPUT) for all models except CPZ-series

To reset an activated protection circuit and to recover from the fault condition, this signal must be on and then off. The unit starts to restore not at the rising edge of RESET signal(ON edge) but the falling edge(OFF edge). If the fault is
caused by a temporary reason (that is, the fault reason is already removed before sending RESET), the unit will be restored to a previous operating condition **as soon as RESET signal comes to the OFF edge.**
But the fault condition exists, the unit may operate for a short time until protection circuits detect the fault condition again. If the unit keeps showing a fault after several resets, do not try resetting again. This could harm the unit.

CAUTION:
The power supply will produce sudden high voltage **as soon as RESET signal comes to off edge**.

1.4.5 SIMMER signal (INPUT) as Options

Analog signal to control simmer current both in CW and Pulse mode. As soon as this signal is input, the unit will generate an H.V. output controlled by SIMMER level.

CAUTION:
Even if the LASER is off, H.V. current will flow in this mode unless SIMMER signal is zero.
Be aware that the unit will create sudden H.V. when AC power is applied.

1.4.6 READY signal (OUTPUT) for all models except CPZ-series

Indicates that the power supply is ready to use. When internal main voltage is settled, this signal comes to high.

1.4.7 FAULT signal (OUTPUT) for all models except CPZ-series

Indicates that OVER CURRENT, OVER VOLTAGE or OVER TEMPERATURE protection circuits inside the unit are activated.
When the protection circuits detect a fault condition, the unit stops operation instantaneously, sending this signal to external.

1.4.8 HV1 signal (OUTPUT) as Options

Output signal to monitor the laser head current. This signal is proportional to a real laser head current.

1.4.9 HV2 and HV3 signal (OUTPUT) as Options

Output signals to monitor the laser head voltages. These voltages are proportional to a real laser head voltage.

1.5 INTERFACE

1.5.1 +5VDC

+5V DC power source is included in all the units except CPZ-series**. Do not use this +5V DC power for an external circuit.** There is no capacity to drain and if 5V DC is disturbed by an external circuit, the power supply cannot maintain a stable operation.

1.5.2 Output & Input Signal Condition

SECTION 1: DESCRIPTION

CPZ-series:

1-1). POWER (Input)
10K ohm impedance
1-2). LASER (Input)
1K ohm impedance
1-3). S.P (Input)
4.7K ohm impedance

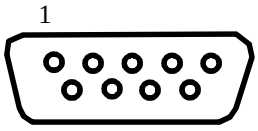
CPF- ,CNF-, CPP-, & CSF-series:

2-1). POWER (Input)
10K ohm impedance
2-2). SIMMER (Input)
Infinity impedance.
2-3). LASER, RESET (Input)
4.7K ohm impedance
2-4). FAULT, READY (Output)
4.7K ohm pull up resistor
2-5). H.V.1-H.V.3 (Output)
100 ohm impedance

1.5.3. Pin assignment.

CPZ-Series / D-SUB, 9 PIN:

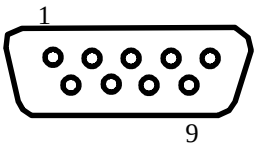
1: NC
2: +5V DC
3: GND
4: LASER
5: S.P
6: NC
7: POWER
8: NC
9: NC



D-Sub 9P
Male

CPF- ,CNF-, CPP-, & CSF-series / D-Sub 9P:

1: RESET
2: +5V DC
3: GND
4: LASER
5: CW/PULSE
6: READY
7: POWER
8: FAULT
9: SIMMER

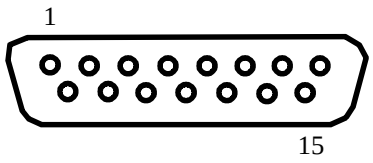


D-Sub 9P
Male

SECTION 1: DESCRIPTION

CPF- ,CNF-, CPP-, & CSF-series / D-Sub 15P:

1: RESET	9: READY
2: +5V DC	10: POWER
3: GND	11: FAULT
4: LASER	12: SIMMER
5: CW/PULSE	13: AGND
6: H.V. 1	14: NC
7: H.V. 2	15: NC
8: H.V. 3	



D-Sub 15P
Male

Section 2. Installation

2.0 INSTALLATION

2.1 GENERAL

After unpacking, general inspection and preliminary check-out 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 directly:

Lic engineering
3735 Coffey Ln.
Santa Rosa, CA 95403 USA
Tel: (707) 575 8821
Fax: (707) 526 3905
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) Check water inlet & outlet for bending.

2.3 OIL FILLING (for 25KW/50KW OEM products only)

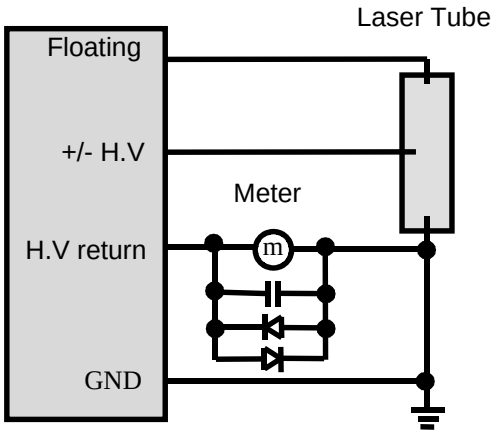
Loosen all screws on the top cover of H.V. container(oil container). Pull up whole body of the power supply from the H.V. container with care (not to damage oil seal). Pour the insulating oil supplied with a separated oil can into the H.V. container up to the line marked. When the oil level reaches the marked line, slowly put the whole power supply back to the H.V. container. Be careful that no H.V. components touch the open edge of H.V. container. Tighten all the screws for the top cover of H.V. container.

2.4 OUTPUT WIRE CONNECTIONS

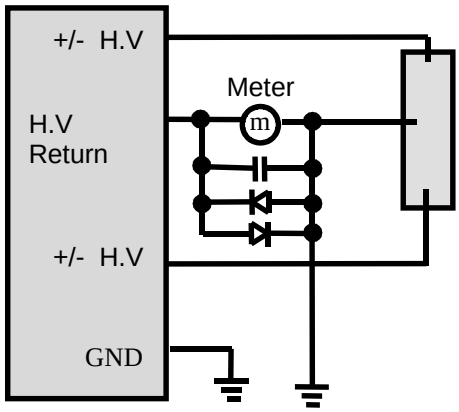
Refer to the following wiring diagram of Fig-10.

Section 2. Installation

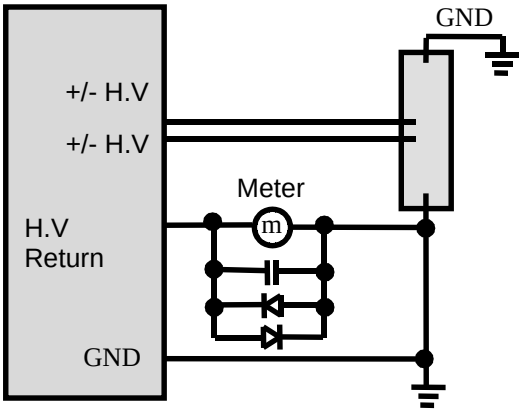
(1). Center +/- High Voltage, One GND, One Floating



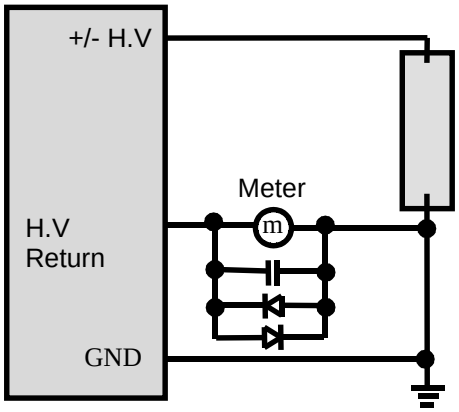
(2). Center GND, Both end High Voltage



(3). Dual High Voltage One GND



(4). Single Discharge, One High Voltage, One GND



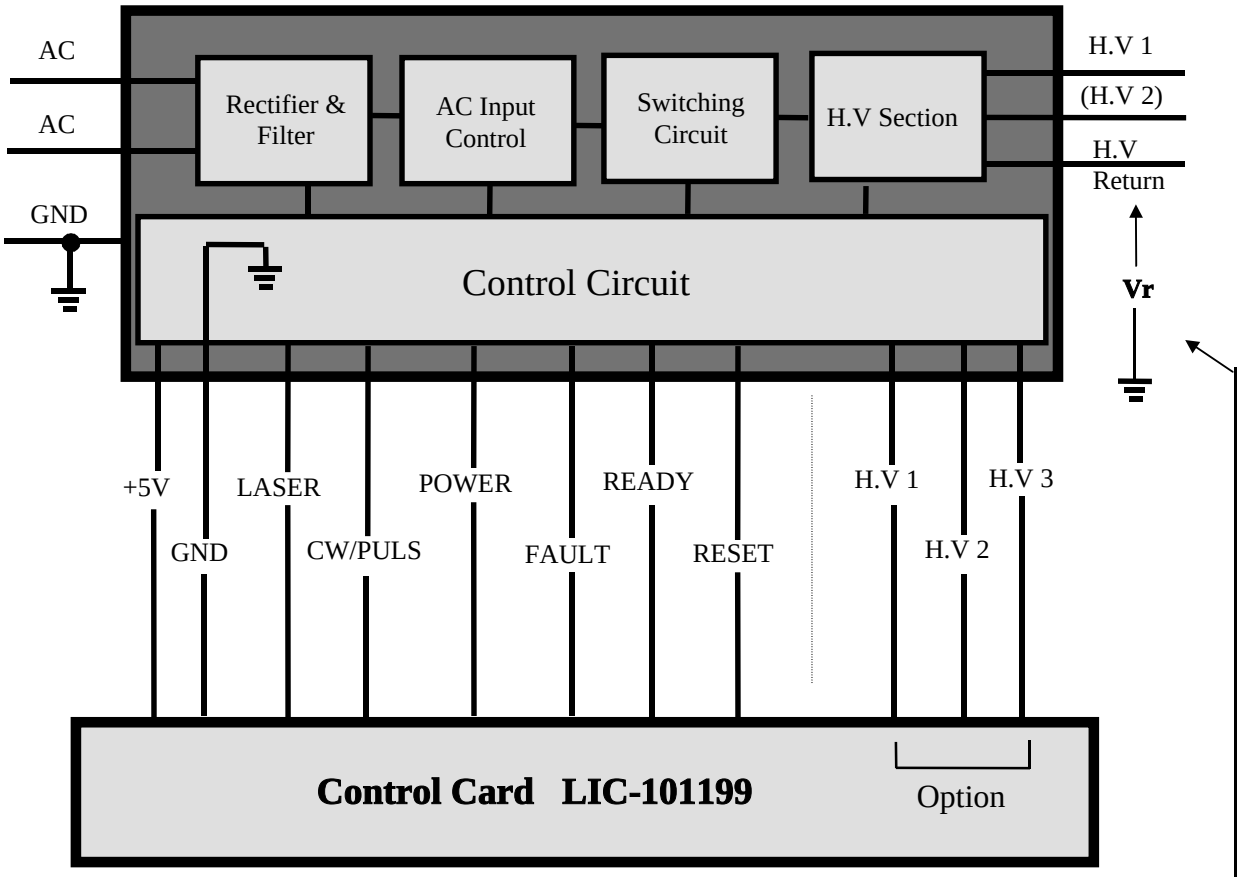
Section 2. Installation

Output Configuration
(FIG-2)

CAUTION:
Do not put a resistor in a H.V. **return line.** H.V. **return line potential must be less than 1 V reference to GND in order for the error amplifier inside the unit to work properly**

2.5 CONTROL SIGNAL CONNECTION

2.5.1 CPZ - /CPF - CNF- /CPP- /CSF - Series



Vr: Return line potential
This potential should be less than
1V.

Control Signal Connection
(FIG-3)

Section 2. Installation

2.6 WATER LINE CONNECTION

Connect cooling water lines to the power supply firmly. After connecting the line, apply the maximum water pressure that is expected in that line. Confirm there is no water leakage at the connections. Lic's power supply does not require much water to flow. The cooling water is completely isolated from the internal circuits of the power supply, and the electrical potential is ground level.

2.7 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:

100/115/208/220/240/360/380/440/480V, Single/Three phase, +/- 10%

Section 3. Operation

3.0 OPERATION

3.1 PREPARATION

3.1.0 PRECAUTION

1). Shut off the unit
Do not shut off AC line voltage while the power supply is running. This could cause damage to the power supply.

2). Discharging capacitor bank
Once AC voltage is applied to the power supply, there is stored energy in a capacitor bank of primary circuit. This energy is discharged through a resistor, and it takes about 1-5 minutes.

3.1.1 DUMMY LOAD

Note:
USING DUMMY LOAD FIRST HELPS CUSTOMERS LEARN EASY, SAFE OPERATION AND AVOID UNEXPECTED ACCIDENTS.

If the customer is the first to operate this type of power supply, it is recommended to use a dummy load prior to operating with the actual laser head. The resistance value of the dummy load should be close enough to the value of the minimum impedance of customer's laser head (operating voltage at maximum current divided by the maximum operating current). Also the wattage of the dummy should be as high as the expected maximum output power of the power supply.

3.1.2 LOAD CONDITION

Each unit is adjusted at Lic's factory to match each customer's specified laser head impedance. This should be verified before connecting the power supply to the laser head.

3.2 STARTING IN CW MODE

3.2.1 WITHOUT SIMMER

STEP 1. CONTROL UNIT ON

Customer's control unit power on. Switch LASER signal off, SIMMER off, CW/Pulse signal to CW, and POWER signal to zero.

STEP 2. AC POWER ON

Turn AC power of the power supply on. Confirm READY will come on in 10-30 seconds.

Section 3. Operation

STEP 3. STARTINGH.V.

Turn LASER on. Watching H.V. current, gradually increase POWER signal. With dummy load, the H.V. current should be controlled smoothly from zero to its maximum. When an actual laser head is connected, however, the H.V. current will generally be unstable at low current.

Note:
If H.V. current does not start to flow in spite of certain level of POWER signal, or FAULT comes, or there are unusual sounds or odors detected, take AC line off immediately from the unit.
Refer to TROUBLE SHOOTING in SECTION 4.4.
If it seems difficult to locate the problem, contact Lic directly:

3.2.2 WITH SIMMER

CAUTION:
Even LASER is off, H.V. current will flow in this mode unless SIMMER signal is zero.
Be aware that the unit will create sudden H.V. when AC power is applied.

STEP 1. CONTROL UNIT ON

Customer's control unit power on. Turn LASER signal off, switch CW/Pulse signal to CW, SIMMER SW to off, and POWER & SIMMER levels to zero.

STEP 2. AC POWER ON

Turn AC power of the power supply on.
Confirm READY will come on in 10-30 seconds.

STEP 3. STARTING SIMMER

Turn SIMMER SW on. Watching H.V. current, gradually increase SIMMER level.
With dummy load, the H.V. current should be controlled smoothly from zero to its maximum.
When an actual laser head is connected, however, the H.V. current will generally be unstable at low current.

STEP 4. STARTING MAIN DISCHARGE

Turn LASER on. Watching H.V. current, gradually increase POWER signal.

Section 3. Operation

3.3 STARTING THE UNIT IN PULSE MODE

Note:
Prior to starting Super Pulse, make sure that the unit operates without problems in CW mode.
The power supply may produce certain sounds in Pulse mode. This is because a repetition rate of input pulse is in an audible frequency range and high voltage components in the power supply are mechanically vibrated by strong pulse currents. Such sounds are normal and not harmful to the unit. Even in CW mode, the power supply may produce small sounds at very low current caused by a pulsing current(discontinued current).

3.3.1 WITHOUT SIMMER

STEP 1. CONTROL UNIT ON

Customer's control unit power on. Switch LASER signal off, SIMMER off, CW/Pulse signal to PULSE, and POWER signal to zero.

STEP 2. AC POWER ON

Turn AC power of the power supply on. Confirm READY will come on in 5-30 seconds.

STEP 3. STARTING H.V.

Turn LASER on. Watching H.V. current, gradually increase POWER signal. With dummy load, the H.V. current should be controlled smoothly from zero to its maximum. When an actual laser head is connected, however, the H.V. current will generally be unstable at low current.

3.3.2 WITH SIMMER

STEP 1. CONTROL UNIT ON

Power customer's control unit on. Turn LASER signal off, switch CW/Pulse signal to PULSE, SIMMER SW to off, and POWER & SIMMER level to zero.

STEP 2. AC POWER ON

Turn AC power of the power supply on. Confirm READY will come in 5-30 seconds.

STEP 3. STARTING SIMMER

Turn SIMMER SW on. Watching H.V.

current, gradually increase SIMMER level.

With dummy load, the H.V. current should be controlled smoothly from zero to its maximum. Set the desired simmer level.

STEP 4. STARTING MAIN DISCHARGE

Turn LASER on. Watching H.V. current, gradually increase POWER signal.

3.4 TURN THE UNIT OFF

STEP 1. LASER off
STEP 2. SIMMER off (if applicable)
STEP 2. Turn AC line off

Section 4. Maintenance

4.0 MAINTENANCE

4.1 GENERAL

Lic's CO_2 laser power supply contains potentiometers that are set at Lic's factory. Do not try to adjust these potentiometers. **There are no user-serviceable parts in Lic'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 PERIODIC SERVICING

OIL FILLING AND CHANGE (for OEM unit only)
Periodically check oil color and oil level of H.V. container. If the oil color becomes dark brown, it is the time to replace the oil. If the oil level is too far below the line on the container, add oil. In both case, follow the steps described in the Installation section.
Oil type: Shell Diala AX

4.3 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.

4.4 TROUBLE SHOOTING

4.4.1 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.

4.4.2 FAULT COMES ON

1). Check head impedance.
Check laser head impedance. If the impedance is too low, the power supply may be tripped by the over current protection circuit.

If the laser head impedance is too high, the over voltage protection may be activated.
If customer uses a gas flow type laser, check the gas pressure and gas flow rate of the laser system.

2). Check cooling water flow rate and temperature.
If water flow rate is too low, or the temperature is over 25C, the power supply may be tripped by an over temperature protection.

3). Check high voltage, floating and its return lines if there is no open circuit. Check if there are no unusual sounds detected at start up time.

4.4.3 OUTPUT DOES NOT APPEAR

1). Confirm READY is active, LASER is on, and POWER signal has certain voltage levels.

2). Check AC power and all control signals condition.

4.4.4 ODORS OR UNUSUAL SOUNDS

If odors or unusual sounds are detected, turn LASER off, and take AC power off immediately. Contact Lic.

Note:
The power supply may produce certain sounds in Pulse mode. This is because a repetition rate of input pulse is in an audible frequency range and high voltage components in the power supply are mechanically vibrated by strong pulse currents. Such sounds are normal and not harmful to the unit. Even in CW mode, the power supply may produce small sounds at very low current caused by a pulsing current (discontinued current).

Section 5. Warranty

5.0 WARRANTY

5.1 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 a unit, or any portion thereof, Lic must be consulted to avoid unnecessary shipping.
If return of the units are deemed necessary, a Return Authorization Number "RAN" will be assigned. This number must be recorded on the outside of the shipping container.

Contact:

Lic engineering
3735 Coffey Lane
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