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COHERENT

Innova™ 90

ION LASERS

Laser Products Division 3210 Porter Drive P.O. Box 10321 Palo Alto, CA (415) 493-2111

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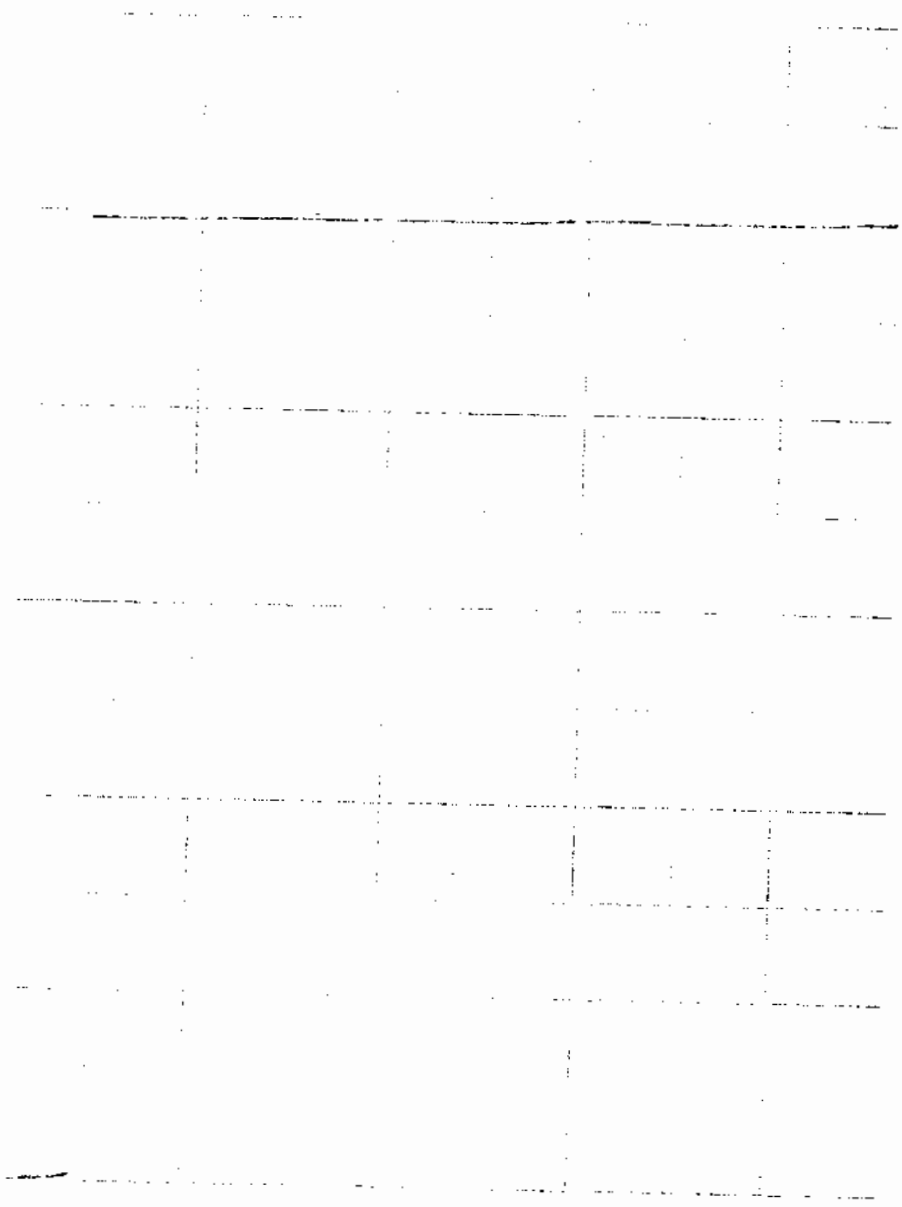
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DATE: 12-26-84

TESTED BY: G.R.

LIGHT REGULATION STABILITY TEST

SYSTEM TYPE	90-5 U.V.	BEGINNING TUBE I	29.0
POWER SUPPLY NO.	1114	HOT PRESSURE	190#
TUBE NO.	30489	OUTPUT POWER	2.0W
HEAD NO.	1099	WAVELENGTH	514.5
CUSTOMER	COULTER	FINAL TUBE I	29.0



1.0 EQUIPMENT AND SPECIFICATIONS

1.1 PURPOSE

The INNOVA™ 90 Series Ion Lasers are designed for a broad range of applications requiring reliable continuous wave light across the broad spectrum from ultraviolet through visible to infrared. Using a compensated Invar resonator and the metal/ceramic tube design, the INNOVA 90 Lasers are the ideal tool for applications in research, medicine, and industry. State-of-the-art electronics provide exceptional performance and convenience of operation.

1.2 DESCRIPTION

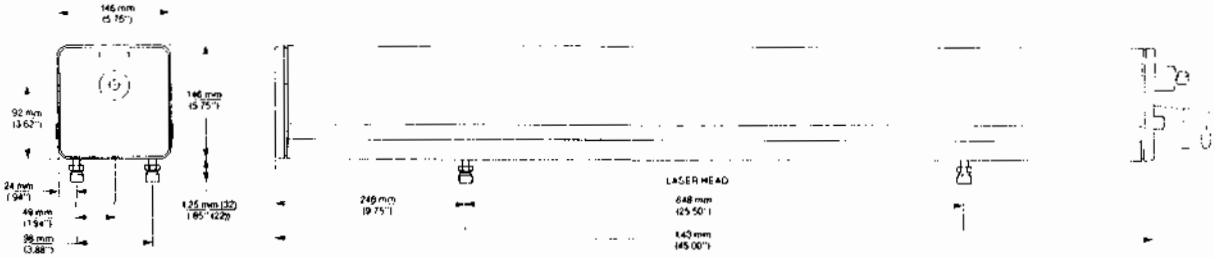
1.2.1 Models

Coherent's INNOVA 90 Ion Lasers are available in five models: four argon models (INNOVA 90-2, 90-3, 90-4, and 90-5), which operate in the 351.1-528.7 nm band and develop maximum power outputs of 2, 3, 4, and 5 watts, respectively; and a krypton model (INNOVA 90K), which operates in the 350.7-799.3 nm band and develops 800 mW maximum. Weights and dimensions are the same for all five models. Specifications and dimensions are listed in Tables 1.1 through 1.4, with outline drawings of all units illustrated in Figure 1.1.

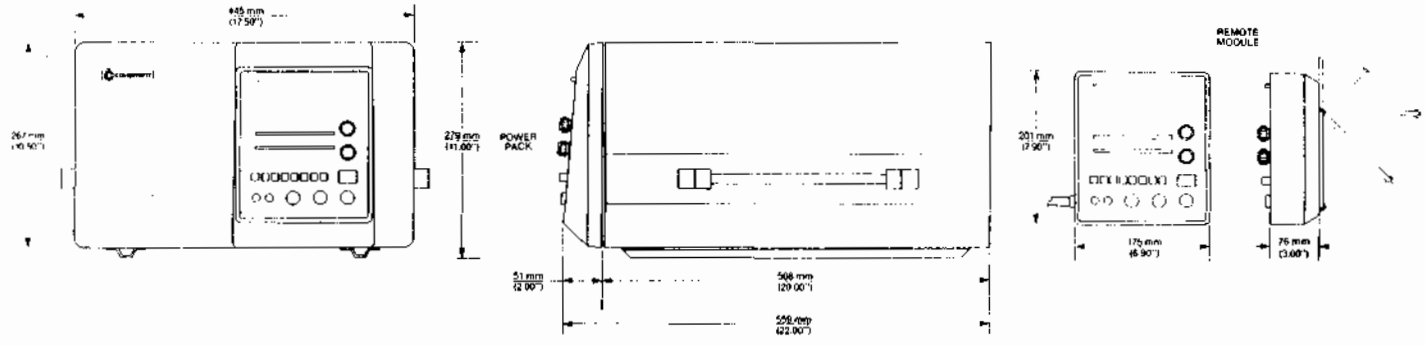
Each INNOVA 90 comprises four major functional units: the laser head, the plasma tube within the laser head, the power supply, and the control electronics. The laser head and power supply are always separate units, but there are three configurations for placement of the control electronics, as explained in 1.2.4.

1.2.2 Laser Head

The laser head houses the plasma tube, the axial field magnet, the resonator structure, various electrical components, and all optical controls and adjustment devices used to operate the laser. (The uses of the latter are fully described in Sections 4 and 6.) The INNOVA resonator design uses solid one-piece Invar rods in an "L"-shaped frame. This construction reduces frequency and amplitude jitter to a minimum. All mechanical features are designed to operate with either argon or krypton tubes. A combination cooling water/power cable umbilical extends from the laser head to the power supply (see Sections 3.4 and 3.5).



LASER HEAD



POWER SUPPLY **REMOTE MODULE**

Figure 1.1 Innova 90 Ion Laser, Outline Drawings

1.2.3 Plasma Tube

The plasma tube generates the gain for the laser light. To function effectively, it must withstand current densities of 700A/cm^2 and dissipate heat at over 200 watts per linear centimeter. To dissipate the heat and achieve low temperature operation, the INNOVA 90 plasma tube features CoolDisk™ construction, in which a unique tungsten-ceramic combination and an internal gas return enable the tube to handle higher discharge currents while producing greater power output and reliability. The basic design uses tungsten disks, secondary recirculation holes, and a ceramic tube wall. In addition, the rigid ceramic feed-throughs and hard seal Brewster windows give the tube a sturdy, contamination free design. Thus, the best materials available are used to provide the highest performance and most reliable tube in existence.

1.2.4 Control Electronics

The control electronics provide all of the electronic controls used to operate the laser and fault indicators. The form, function, and operation of all electronic and control indicators are fully described in Section 4 of this manual.

Three possible control electronics configurations can be supplied:

a. The control electronics are contained in a remote module; in this arrangement, the INNOVA 90 comprises three separately housed units, as shown in Figure 1.2. Using optional cables, the remote module can be placed as far as 12.2 m (40 ft)from the laser head.

b. The control electronics are an integral part of the power supply, with the control panel appearing on the power supply front. In this arrangement, the INNOVA 90 comprises only two separately housed units, as shown in Figure 1.3.

c. The control of the laser is achieved by a customer supplied computer, via a parallel TTL logic interface.

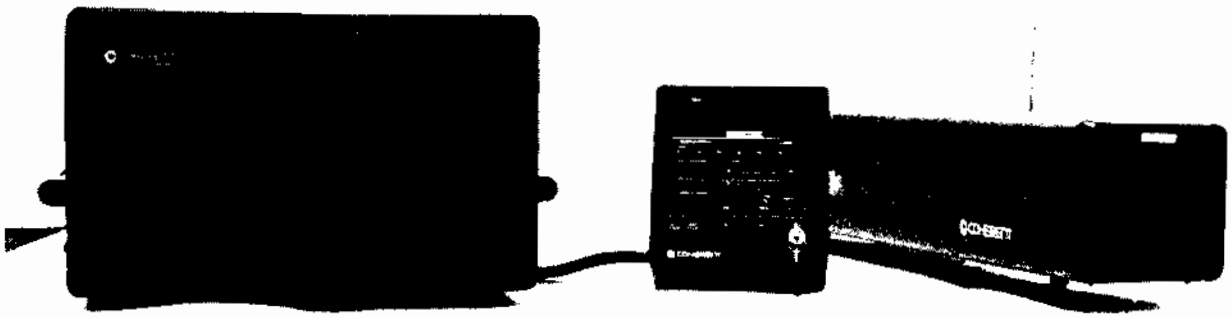


Figure 1.2 INNOVA 90 Series Ion Laser System with Separate Remote Module.

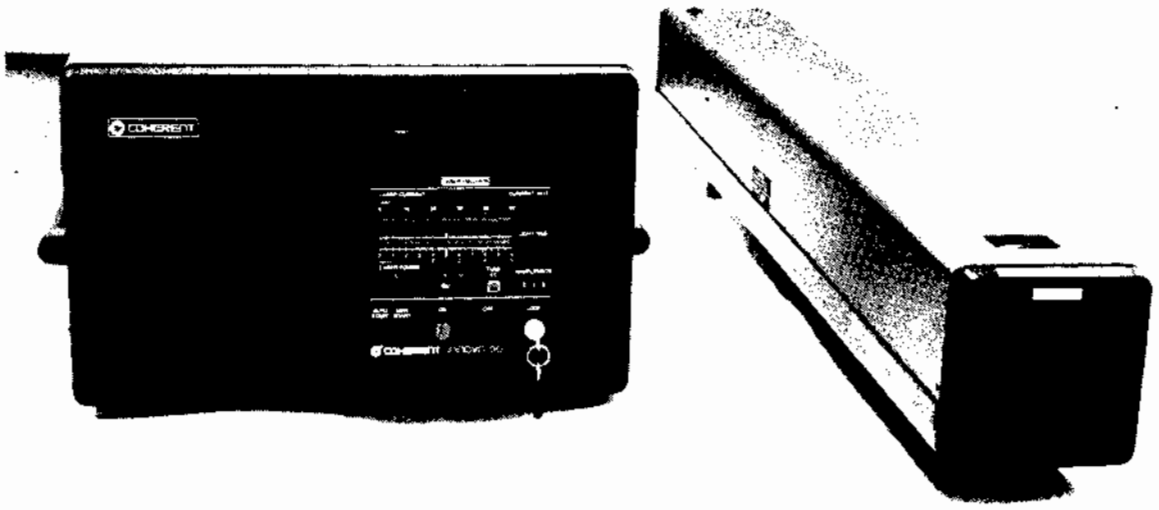


Figure 1.3 INNOVA 90 Series Ion Laser System with Combination Control Module/Power Supply.

1.2.5 Power Supply

The power supply performs three functions:

a. It provides all operating power required by the laser head and control electronics.

b. It interfaces the laser head with the cooling water source.

c. It interfaces the control electronics with the laser head.

Its rear panel mounts: the cooling water source input and return connectors, the primary power input cable, and the water and electrical connectors for the umbilical cable that extends to the power supply from the laser head. The umbilical cable detaches from the power supply for easy transportation and storage. The power supply rear panel also mounts: the external safety interlock connector (see Section 2.2, item 10), the connector required for remote control of the laser or the output to a computer interface, and access to all fuses (see Section 8.2.1).

1.3 Optional Accessories

The INNOVA lasers are supplied with Model 934 wavelength selector, light regulation, and the remote control module as standard equipment. Available options follow.

1.3.1 Model 923 Etalon

This temperature stabilized, solid etalon provides stable single frequency operation. It mounts inside the sealed intracavity space with easy external adjustments. The etalon is used in conjuction with the 934 wavelength selector and provides a single frequency output power at 50% of the values specified in Table 1.4 for 514.5 nm and 488.0 nm lines of argon and 676.4 nm and 647.1 nm lines of krypton lasers.

1.3.2 Optional Optics

Additional optics (mirrors) are available for both argon and krypton lasers. These optics provide laser operation at other than standard lines and in other than standard mode. A summary of the optics is given in Section 9-1 on page 9-1.

Note: Guarantee of spec powers at lines requiring additional optics, (such as UV, violet, IR, etc.) is available only if the option is ordered at the time of the original purchase.

1.3.3 External Light/Current Regulation

This option allows external light and current regulation of a laser via two 0-5V analog signals to two BNC connectors on the back of the power supply. This option, in contrast to the full computer interface, leaves the control module intact. Only the light and current regulation are externally controllable. (Refer to Section 4.2.4)

1.3.4 Rack Mounting

Rack mounting allows the INNOVA 90 power supply to be mounted in a standard 19" laboratory rack. This option provides sliding rack mounts replacing handles.

1.3.5 Control Electronics/Computer Interface

The INNOVA can be supplied with full controls located in the power supply or a computer interface. These options are described in more detail in Section 1.2.4.

TABLE 1.1 SYSTEM PARAMETER SPECIFICATIONS

Bore Configuration:	Tungsten disk with one piece ceramic envelope
Plasma Tube Cooling:	Conductively water cooled
Resonator Construction:	Thermally compensated Invar rod structure
Cavity Configuration:	Flat high reflector, long radius output coupler
Output Polarization:	100:1 Electric Vector Vertical
Cavity Length:	1093 mm (43.03 in) 1135 mm (44.68 in) with Model 934
Excitation:	Current Regulated DC.
Input Voltage:	208 ±10% Vac 50 or 60 Hz 3 phase with ground (either wye or delta)
Maximum Input Current:	45 Amperes per phase*
Maximum Tube Discharge Current:	
90-4, 90-5, 90-K	40 Amperes
90-2, 90-3	32 Amperes for systems built prior to October 15, 1982; 35 Amperes for systems built after October 15, 1982.
Cooling Water	
Flow Rate:	8.5 liters (2.2 gallons) per minute (minimum)
Incoming Temperature:	30° C (86° F) maximum
Pressure:	Minimum 1.76 kg/cm^2 (25 psi) Maximum 3.52 kg/cm^2 (50 psi)

* Models 90-4, 90-5, or 90-K with high field on the magnet.

ABOVE SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

TABLE 1.2 PERFORMANCE PARAMETER SPECIFICATIONS

Beam Diameter(1):	1.5 mm at $1/e^2$ points
Beam Divergence(1):	0.5 mrad at $1/e^2$ points
Long Term Power Stability (2):	Current Regulation ±3% Light Regulation ±0.5%
Optical Noise (3) (4):	In Current Regulation 0.2% rms In Light Regulation 0.2% rms

---

(1) Beam diameter and divergence measured at 514.5 nm at the output coupler. The beam waist diameter is 1.2 mm and is located 140 cm behind the output coupler.

(2) Maximum peak variation (over any 30-minute period after 2-hour warm-up).

(3) Measurement is made with wide band photodiode driving resistive load. The noise voltage is measured with an rms voltmeter with 10 Hz-2 MHz bandwidth. Specification for 514.5 nm at specified output power.

(4) For 90-K laser, the noise is 0.3% in both regulation modes and it is measured at 647.1 nm at specified output power.

ABOVE SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

TABLE 1.3 DIMENSIONS

	LASER HEAD	POWER SUPPLY	REMOTE MODULE
Height	146 mm(5.75 in)	267 mm(10.5 in)	76 mm(3.0 in)
Width	146 mm(5.75 in)	445 mm(17.5 in)	178 mm(7.0 in)
Length	1190 mm(47.00 in)	559 mm(22.0 in)	203 mm(8.0 in)
Weight	44.5 kg(98 lb)	57.6 kg(126 lb)	.91 kg(2.0 lb)

TABLE 1.4 OUTPUT POWER (TEM_{00}) SPECIFICATIONS

Wavelength[1] (nm)	Output Power for Each Model (mW)				
	90-2	90-3	90-4	90-5	90-K
All Lines[2]	2000	3000	4000	5000	800[3]
799.3/793.1					30[3]
752.5					100[3]
676.4					120
647.1					500
568.2					150[3]
530.9					200[3]
528.7	100[3]	150[3]	200[3]	350[3]	
520.8					70[3]
514.5	800	1400	1700	2000	
501.7	100	200	300	400	
496.5	300	400	500	600	
488.0	700	1000	1300	1500	
482.5					30[3]
476.5	300	400	500	600	
476.2					50[3]
472.7	-	60	120	200	
465.8	-	50	100	150	
457.9	150	200	250	350	
454.5	-	-	50[3]	120[3]	
406.7-415.4					150[3,4]
351.1-363.8			100[3,4]	200[3,4]	
350.7-356.4					150[3,4]

1. Single line powers for argon lasers are specified at 514.5 and 488.0 nm only. Other powers indicated are nominal. Firm specifications at other wavelengths are available with special testing. Single line krypton lasers are specified at 676.4 and 647.1 only.

2. All line performance in argon lasers consists of 514.5 through 457.9 lines; for krypton consists of 647.1 through 476.2 lines.

3. Special optics and testing are required. Testing is available only at time of original purchase.

4. Powers with high magnetic field.

ABOVE SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

2.0 LASER SAFETY

2.1 SAFETY INSTRUCTIONS

The laser is a unique light source and exhibits characteristics which are different from conventional light sources. Its safe use depends on the user becoming aware of these characteristics and treating the instrument accordingly. The high-energy output of the beam passing directly into the eye can cause serious damage with the possible loss of vision. Because it remains coherent, the beam might also cause damage to the eyes if contacted indirectly from reflective surfaces. Many light sensitive elements can be damaged by direct exposure to the beam; e.g., the light-sensing element in video cameras, photomultipliers or photodiodes. The energy of the beam is intense enough to ignite volatile substances from some distance. For these reasons and others, the user is advised to follow the precautions below.

(1) Do not use the laser in the presence of inflammables or explosives; these include volatile substances such as alcohol, gasoline, solvents and ether.

(2) Limit access to the laser to those using the equipment. Keep the equipment out of the hands of inexperienced and untrained personnel.

(3) Never look directly into the laser light source or at scattered laser light from any reflective surface. Never sight down the beam into the source.

(4) Maintain experimental setups at low heights to prevent inadvertent beam-eye encounter at eye level.

(5) As a precaution against accidental exposure to the output beam or its reflection, those using the laser should wear safety glasses as required.

(6) Avoid all direct exposure to the laser light. The intensity of the beam can easily cause flesh burns or ignite clothing.

(7) Use laser in an enclosed room. Laser light will remain collimated over large distances, and therefore, presents a potential hazard.

(8) Post warning signs in the area of the laser beam to alert those present.

(9) Advise all those using the laser of these precautions; keep others out. It is good practice to operate the laser in a room with the door clearly marked and/or interlocked with the laser.

WARNING

Ultraviolet light is dangerous and invisible. The ultraviolet output from this laser, when operated in the ultraviolet mode, can cause severe eye and skin damage. Take precautions to avoid any exposure.

Laser users must ascertain that the glasses they are using provide adequate protection. For the visible argon ion laser, The American Optical Laser Spectacle No.598 or equivalent provide protection. For the visible krypton ion laser, Type FR6-P1-BG18-GBS-120 safety glasses from Fred Reed Optical Co., 120 Bryn Mawr, S.E., P. O. Box 1336 Alburquerque, New Mexico 87103, provide protection. For ultraviolet light, Laser-Gard B Series Broad Spectrum Goggles from Glendale Optical Co., 130 Crossway Park, Woodbury, L.I., N.Y. 11797 provide protection. Safety eye glasses which reject many laser wavelengths are available. Glasses can present a hazard as well as a benefit. While they protect the eye from potentially damaging exposure some also reject the beam thereby preventing the user from seeing it. Thus, one might expose the skin to beam burn without seeing it happen.

ELECTRICAL SAFETY

The INNOVA Ion Laser is operated by dc power rectified directly from a 208 volt, three-phase, power line. The voltages are sufficient to give a lethal shock and high currents are involved. Every portion of the electrical system, including the printed circuit cards, should be assumed to be at a dangerous voltage level. Specifically, the printed circuit boards, the interior of the control module, and the interior of the laser head are at a potential of -150 Vdc with respect to ground, when the system is turned on.

The laser head and the power supply are equipped with safety interlocks on the access covers; removing the covers to these high-voltage enclosures turns off the system. Neither component should be opened during operation. Disconnect power before opening the power supply.

WARNING

If the laser head cover is off while the laser is operating, assume all metal parts of the tube (except the resonator rods and magnet cover) are at "high voltage." Protective coverings may have been removed, thus exposing high potential parts.

WARNING

Be especially careful to avoid touching the high voltage starter leads. The gas fill system, located under the magnet, is at -150 Vdc potential. Touching the fill system can be LETHAL.

2.2 BRH Compliance

The following features incorporated in the instrument give conformity to United States Government requirements 21 CFR Subchapter J as administered by the Bureau of Radiological Health (BRH).

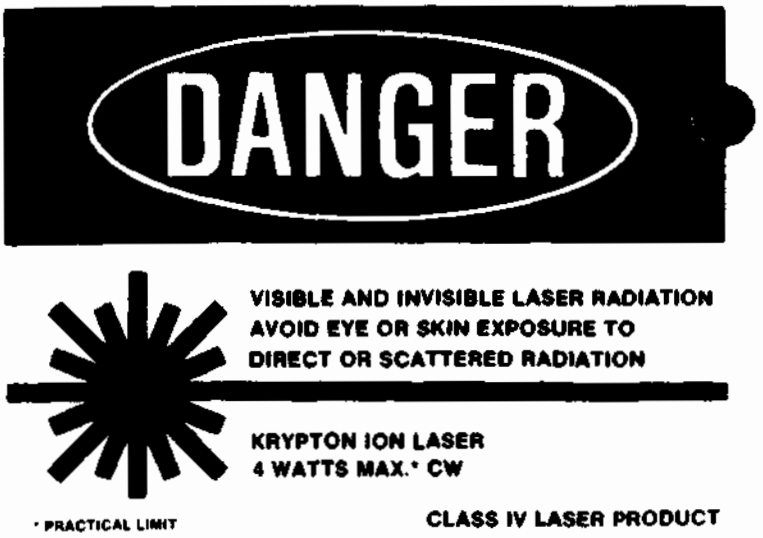
(1) KEY CONTROL: The instrument cannot be turned on until the SYSTEM SWITCH has been activated. Its operation and function are described in Section 4.1.1. The instrument cannot be operated unless the key is in place in the locked switch.

(2) LASER RADIATION EMISSION INDICATOR: The appropriately labeled lights on both the controller and laser head are turned on approximately 30 seconds before laser emission can possibly occur. The indicator is described in Sections 4.1 and 4.2. White lights are used so a spectral region of eye sensitivity exists regardless of the type of safety glasses wh

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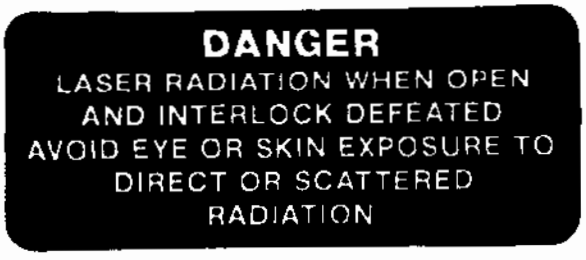


(5) MAXIMUM RADIANT POWER: The maximum laser powers, as indicated by these labels, are 12 watts for an argon unit and 2 watts for a krypton unit. In single line operation, using the Model 934 Wavelength Selector, the maximum power will never exceed twice the specified power given in Section 1.2.2. These lasers operate only in the cw mode.

(6) APERTURE LABEL: On the top of the output end bezel of the laser is this label:



(7) DEFEATABLE INTERLOCKED PROTECTIVE HOUSING LABELS: This label is on each side of the fixed bottom portion of the laser housing.



(8) LASER COVER INTERLOCKS: At each end of the laser head are interlocks that turn the laser off when the cover is being removed. The power supply cover, fuse compartment cover and passbank cover are also equipped with interlocks for the operators' safety.

(9) BEAM SHUTTER: The beam shutter completely blocks the laser beam when closed and prevents human access to laser radiation above the limits of Class 1 radiation. Opening the shutter releases the full power of the laser beam and precautions against exposure must be taken.

(10) EXTERNAL INTERLOCK CONNECTOR: The rear panel of the power supply mounts an external interlock (EXT INTERLOCK) connector consisting of a receptacle and plug such that the system turns off when the plug is removed. This connector is described in Sections 3.5.3 and 4.1.3. Remote interlocking is provided by wiring a switch into the circuit via this plug.

(11) CONTROLS AND ADJUSTMENTS: Front panel controls and their functions for the instruments are listed in Sections 4.1.

WARNING

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

(12) AVOIDANCE OF UNNECESSARY EXPOSURE: With the beam shutter closed and with the cover in place and fastened, human access to radiation is within the limits of Class 1. Operate with the cover removed and interlocks defeated **only** when necessary for maintenance or service by experienced personnel. After maintenance has been performed, turn the unit off, replace the cover, and resume normal laser operations.

NOTE

Labels shown in (4), (6) and (7) do not generally appear on units delivered to countries other than the United States. The laser radiation emission indicator on the laser head (2) and the beam shutter (9) may or may not be included in units for export only. Such units carry the label FOR EXPORT ONLY.

3.0 INSTALLATION

CAUTION

All installations of the INNOVA 90 Series Ion Lasers must be performed only by an authorized service representative of Coherent Inc. Refer to Section 11.4 for a list of Coherent Sales and Service Offices.

3.1 UTILITY REQUIREMENTS

The following utilities must be available before the installation of the INNOVA 90 Series laser system can be started.

3.1.1 Electrical Requirements

(1) Four-wire system: 208 Vac±10%, 3-phase with ground, 50/60 Hz, at 45 amperes per phase input current. The 3-phase input power may be either Wye or Delta connected with the fourth wire to building ground.

(2) Main disconnect, located in the same room as the system and wired to the above power. This item is not supplied by Coherent.

(3) Power cable consisting of:

Four No. 6 wires extending from main disconnect to laser power supply. A 2.9-meter (9.5-foot) cable, hard-wired from the power supply rear panel but without a connector on the free end, is supplied by Coherent with the laser.

3.1.2 Cooling Water Requirements

(1) Minimum cooling water flow rate of 8.3 liters (2.2 gallons) per minute.

(2) Minimum pressure 1.8 kg/cm^2 (25 psi), maximum 50 psi (3.5 kg/cm^2).

(3) Minimum pressure drop of 1.8 kg/cm^2 (25 psi) with laser connected and water flowing.

(4) Maximum inlet temperature 35° C (95° F).

(5) Water quality of hardness less than 150 parts per million (8.8 grains per gallon). Particle size less than 200 microns in diameter. For areas where water hardness is above these levels, water treatment is required. (Contact Service, Section 11)

(6) 5/8" garden hose for connection from water inlet to laser, with male coupler available for coupling to laser power supply (per Section 3.4). Not supplied by Coherent.

(7) 5/8" garden hose for connection from laser to drain, with female coupler available for coupling to laser power supply (per Section 3.4). Not supplied by Coherent.

3.2 UNPACKING

The INNOVA 90 ion laser is shipped in two crates, one for the power supply and one for the head. If a separate remote module is shipped, it is packed with the head.

While unpacking the INNOVA 90, verify against the packing list that all items have been received, carefully inspect each shipping container, and note any damage. All INNOVA containers are shipped with a rough handling indicator affixed to their side. This indicator should be inspected upon receipt. If the indicator bar is red, the container has received handling which may have damaged the contents. This should be noted on the bill of lading. Coherent is not liable for damage in transit. Damage should be reported at once to the shipping carrier and to the Coherent Service Department (see Section 11.4). Save all containers and packing material; they will be required if it becomes necessary to return the equipment to Coherent. Remove the laser head cover and inspect the interior (especially the laser tube) for visible shipping damage. Remove the four foamed plastic shipping blocks: one beneath the reservoir, one under the pump-out valve, one on top of the magnet, and the one block on top of the resonator.

3.3 PRIMARY POWER CONNECTION (See Section 3.1.1)

Attach an appropriate connector to the four-conductor power cable extending from the power supply, or connect the cable directly to the primary power line switch. Connect the green wire to ground. The three phase wires may be connected in any order. If a longer cable is required, use the following procedure to connect a cable to the power supply:

(1) Invert the power supply and remove the bottom cover. (See Figure 3.1.)

(2) Remove the cable which came with the power supply and pass the new cable through the clamp on the rear panel.

(3) Connect the three phase wires to the main contactor in any order. No specific phase order is required.

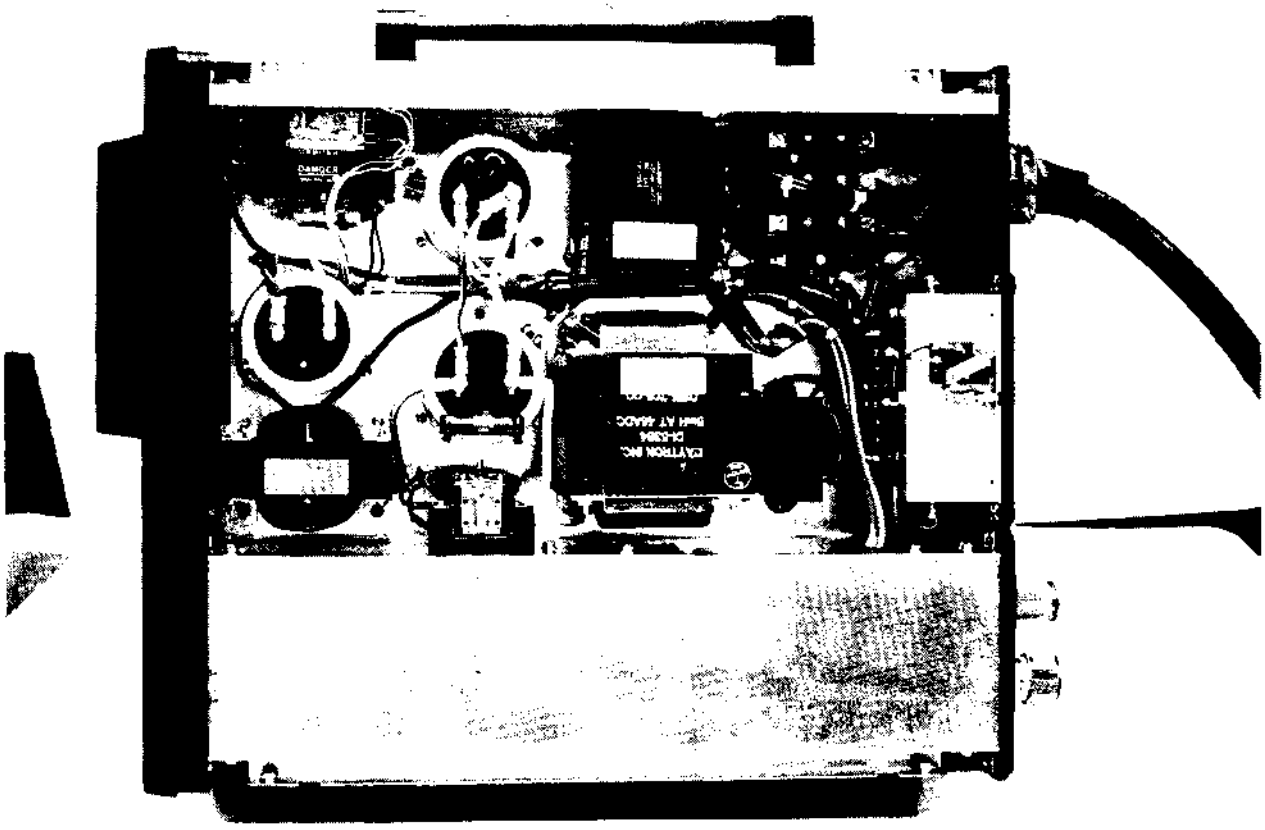


Figure 3.1 Power Supply Power Cable Connections

WARNING

Make certain the chassis is adequately grounded to avoid shock hazard to laser operators.

(4) Connect the ground wire to the chassis with the screw provided. Use a ring lug on the ground wire to insure good contact.

(5) Replace the cover and turn the power supply over to the normal position.

3.4 WATER HOSE COUPLING (See Section 3.1.2 and Figure 3.2.)

The water system should be filtered to guard against particles greater than 200 microns in diameter. A filter (Coherent P/N 124-189) is shipped with the laser.



Figure 3.2 Power Supply Rear Panel

CAUTION

Be careful to carry out the water hose coupling instructions exactly as stated. Damage could result if either pair of hoses were attached to the wrong pair of water couplers.

Couple the water hoses using the following procedure:

(1) The combination power-water cable extending from the laser head includes two water hoses. Couple these hoses to the hose couplers marked TO LASER and FROM LASER on the rear panel of the power supply. The hose couplers are arranged so that each hose mates only with the correct coupler.

(2) Couple the water filter to the WATER IN coupler on the rear panel of the power supply.

(3) Couple a 5/8" hose (not supplied) from the cooling water source (refer to Section 3.1.2) to the water filter.

(4) Couple a 5/8" hose from the rear panel coupler marked DRAIN to the proper drain.

(5) Check for kinked hoses.

(6) Turn on the water and correct any leaks.

3.5 CONTROL CONNECTIONS (See Sections 3.1.1 and 3.3)

3.5.1 Laser Head/Power Supply Interconnections

The combination power-water cable extending from the laser head includes three electrical cables, each terminated with a connector. These connectors are to be plugged into their mating receptacles, J101, J102 and J103 on the rear panel of the power supply (Figure 3.2). Make sure each connector is fully inserted, then tighten the retaining ring. The connectors will only fit into their appropriate receptacles; misconnection is not possible.

3.5.2 Remote Module Connector

If the control electronics are contained in a separate remote control module (refer to Section 1.2.4), the captive cable extending from the remote module must be plugged into the REMOTE connector on the power supply rear panel. If the control electronics are integral to the power supply, the REMOTE connector is not used.

3.5.3 External Interlock Connector

The EXT INTERLOCK receptacle on the rear panel of the power supply is provided with a mating plug in place. When shipped, this plug is jumpered so that the system is ready for operation as long as the plug is in place. If the plug is not in place, the system will not operate.

If it is desired, the EXT INTERLOCK circuit may be used to shut off laser discharge when a person enters a designated restricted area (refer to Section 2.2, item 10). The jumper within the EXT INTERLOCK plug must be replaced by a connection to a door switch or similar device.

4.0 CONTROLS AND OPERATIONS

4.1 CONTROLS AND INDICATORS

NOTE

This section contains brief tabulated descriptions of every control and indicator (pages 4-5 through 4-11). It is advisable to become familiar with the functions of controls and indicators before attempting to turn on the laser.

4.1.1 Control Module Controls and Indicators

The controls and indicators on the control panel are illustrated in Figure 4.1 and are described in Table 4.1.

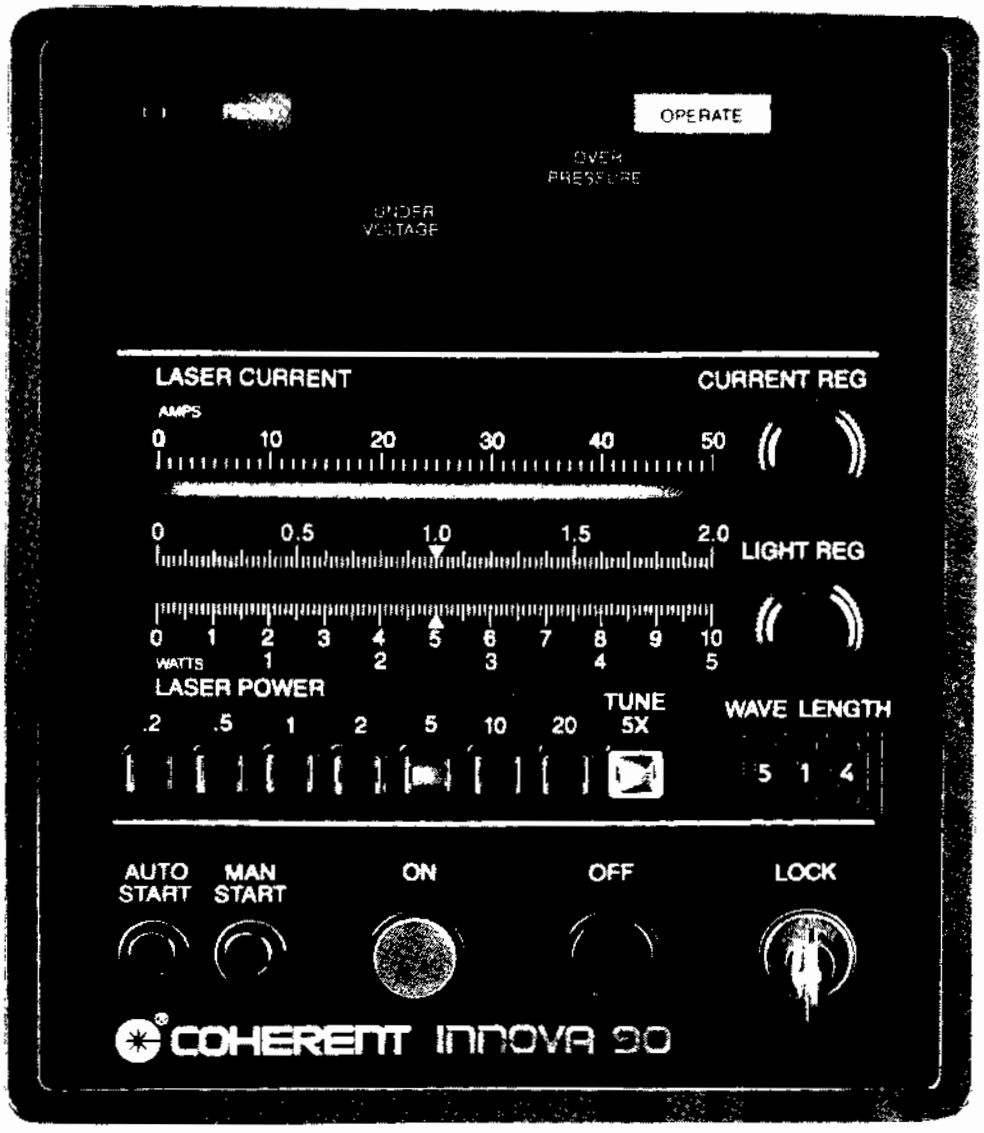


Figure 4.1 Control Panel

Table 4.1 Innova 90 Control Panel Controls and Indicators

Control/Indicator	Description	Function
LOCK switch (key)	Two-position switch controlled by a key. Key can not be removed when switch is on.	1. Applies 24 Vac to the protective interlock circuit. 2. Illuminates following lights: LASER EMISSION, OPERATE, and green light beside either AUTO START or MAN START switch. FAULT and WATER FLOW lights momentarily illuminate each time LOCK switch is activated.
ON switch	Pushbutton switch.	Provided all interlocks are closed: 1. Energizes entire power supply. 2. Illuminates START DELAY indicator and initiates 30-second warm-up cycle.
START DELAY indicator	Illuminated words.	When illuminated, indicates 30-second warm-up is in progress; laser is ready for manual or automatic start-up when this indicator extinguishes.
OFF switch	Pushbutton switch.	Turns off three-phase primary power to laser by opening main contactor.
AUTO START switch	Pushbutton electrical switch and green light; switch is mechanically linked to MAN START switch.	Illuminates its green light and places laser in automatic start mode. In this mode, ionization automatically occurs 30 seconds after ON switch is pressed. At that time, lasing occurs if beam shutter is open. AUTO to MAN mode changeover can be made during lasing to set up for next start.

Table 4.1 (continued)

Control/Indicator	Description	Function
MAN START switch	Pushbutton electrical switch and green light; switch is mechanically linked to AUTO START switch.	Illuminates its green light and places laser in manual start mode. In manual mode, ionization requires two step sequence: (1) 30-second warm-up commenced by ON switch must be completed; (2) MAN START switch must be pressed. At that time, lasing occurs if beam shutter is open. AUTO to MAN mode changeover can be made during lasing to set up for next start.
Power range selectors	Seven pushbutton switches marked .2, .5, 1, 2, 5, 10, and 20.	Sets the upper limit of laser output power, and calibrates power meter for selected range; selected switch displays green when depressed.
TUNE 5X selector	Pushbutton switch.	To facilitate fine optical tuning, converts LASER POWER WATTS indicator to sensitive peak power indicator by locating peak of power indication to center of display and magnifying power changes by a factor of five.
WAVE LENGTH calibrator	Three digital indicators, counted up or down by pushbuttons above and below each digit.	Calibrates power meter to an accuracy of 5% for selected visible frequency. The calibration does not hold in the UV mode.
LASER CURRENT AMPS indicator	Neon bar graph display calibrated to indicate laser tube current from 0-50 amperes in 1.0 ampere increments.	Indicates laser tube current.

Table 4.1 (continued)

Control/Indicator	Description	Function
LASER POWER WATTS indicator	Neon bar graph display calibrated to indicate: 0-20 watts.	Indicates laser power within selected power range.
CURRENT REG control	Rotary knob.	Sets tube current to desired level. Illuminated green light indicates laser is operating in current regulation mode. See Section 4.2.3.
LIGHT REG control	Rotary knob.	Presets operating level (output power) of the laser. Current will automatically increase or decrease (within system constraints) to maintain this level. Illuminated green light indicates laser is operating in light regulation mode. See Section 4.2.3.
OPERATE indicator	Illuminated word.	When illuminated, indicates laser is ready for normal start-up and operation.
FAULT indicator	Illuminated word.	When illuminated, indicates detection of one or more system faults.
RESET control	Illuminated word and pushbutton switch.	When illuminated, indicates illuminated fault. Indicators will not turn off until reset button is pressed, after faults are corrected.
LASER EMISSION indicator	Illuminated words.	Illuminates when key is switched to the on position.

Table 4.1 (continued)

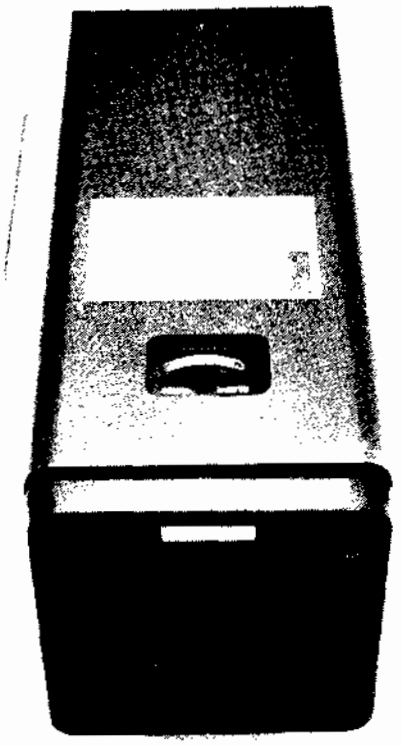
Control/Indicator	Description	Function
OVER VOLTAGE indicator	Illuminated words.	When system shuts down and this light is illuminated, indicates passbank voltage has exceeded maximum level.
UNDER VOLTAGE indicator	Illuminated words.	When illuminated, indicates passbank voltage has dropped below minimum level.
OVER PRESSURE indicator	Illuminated words.	When illuminated, indicates gas pressure inside tube is above normal operating range.
UNDER PRESSURE indicator	Illuminated words.	When illuminated, indicates gas pressure inside tube is below normal operating range. If pressure continues to decrease, laser will shut down.
WATER FLOW indicator	Illuminated words.	When illuminated, indicates cooling water flow rate is insufficient for laser operation (less than 2.2 gal./min.).
WATER TEMPERATURE indicator	Illuminated words.	When illuminated, indicates cooling water temperature is too high for laser operation (return water has exceeded 71°C/160°F.). Laser will shut down.
OVER CURRENT indicator	Illuminated words.	When illuminated, indicates tube current is too high for laser operation.
PASSBANK TEMP indicator	Illuminated words.	When illuminated, indicates passbank temperature is too high for laser operation. Laser will shut down.

Table 4.1 (continued)

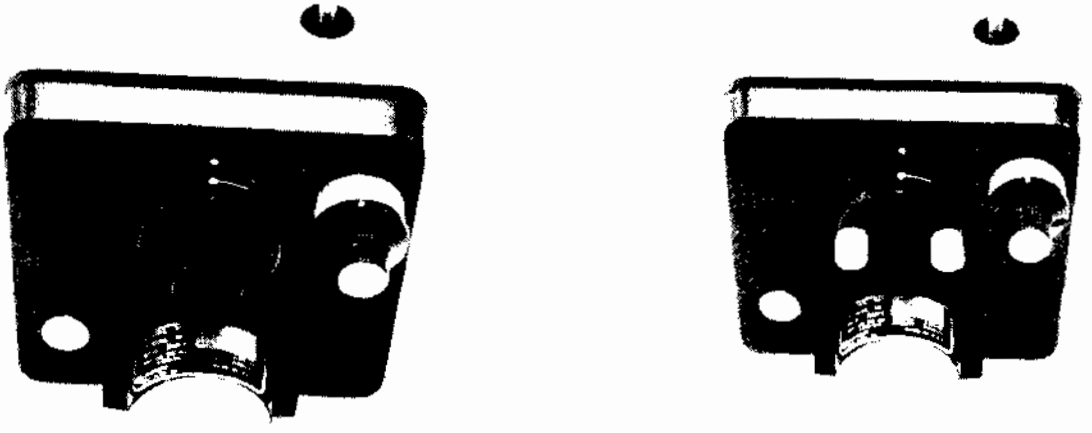
PASSBANK TRANSISTOR indicator	Illuminated words.	When illuminated, indicates one or more passbank transistors have failed. Laser will function normally with up to two failed transistors, but will cease operation if three or more transistors have failed.
FUSE indicator	Illuminated word.	When illuminated, indicates failure of one or more LINE FUSE(s) (refer to Section 8.2.1.1).
COVER indicator	Illuminated word.	When illuminated, indicates cover open on laser head or power supply.

4.1.2 Laser Head Controls

The controls on the laser head are illustrated in Figure 4.2 and are described in Table 4.2.



FRONT VIEW



REAR VIEW

Figure 4.2 INNOVA Head

Table 4.2 Innova 90 Laser Head Controls and Indicators

Control	Description	Function
Horizontal control	Rotatable adjustment knob on laser head rear panel.	Rotates the high reflector horizontally about a vertical axis of rotation.
Vertical control	Rotatable adjustment knob on laser head rear panel.	Rotates the high reflector vertically about a horizontal axis of rotation. Collar of knob is calibrated in nanometers to permit specific wavelength selection during single line laser operation.
Multiline mirror holder	Removable bayonet-mounted holder for multiline high reflector.	Multiline laser operation (see Section 4.2.4).
Model 934 Wavelength Selector mirror holder	Removable bayonet-mounted holder for a prism and high reflector.	Single line laser operation (see Section 4.2.4).
High reflector mirror mount pin	Metal pin protruding up from top rear of laser head cover.	Pull to rock high reflector mounting plate (see Section 6.3.1).
Beam shutter	Recessed lever on top front of laser head cover, marked CLOSE and OPEN.	In CLOSE position blocks lasing action by interrupting intracavity beam. In OPEN position, permits lasing.
Aperture control	Rotary control recessed into front top of laser head cover, marked on rim: 0, 12 through 1.	Selects size of output aperture. Position 0 gives largest aperture; aperture size decreases from position 12 to 1 (see Section 4.2.6).
LASER EMISSION indicator	Illuminated words.	When illuminated, indicates KEY switch is in the on position and the ON button has been depressed.

4.1.3 Power Supply Controls and Connectors

The power supply controls and connectors are all located on the power supply rear panel; they are illustrated in Figure 4.3 and described in Table 4.3.

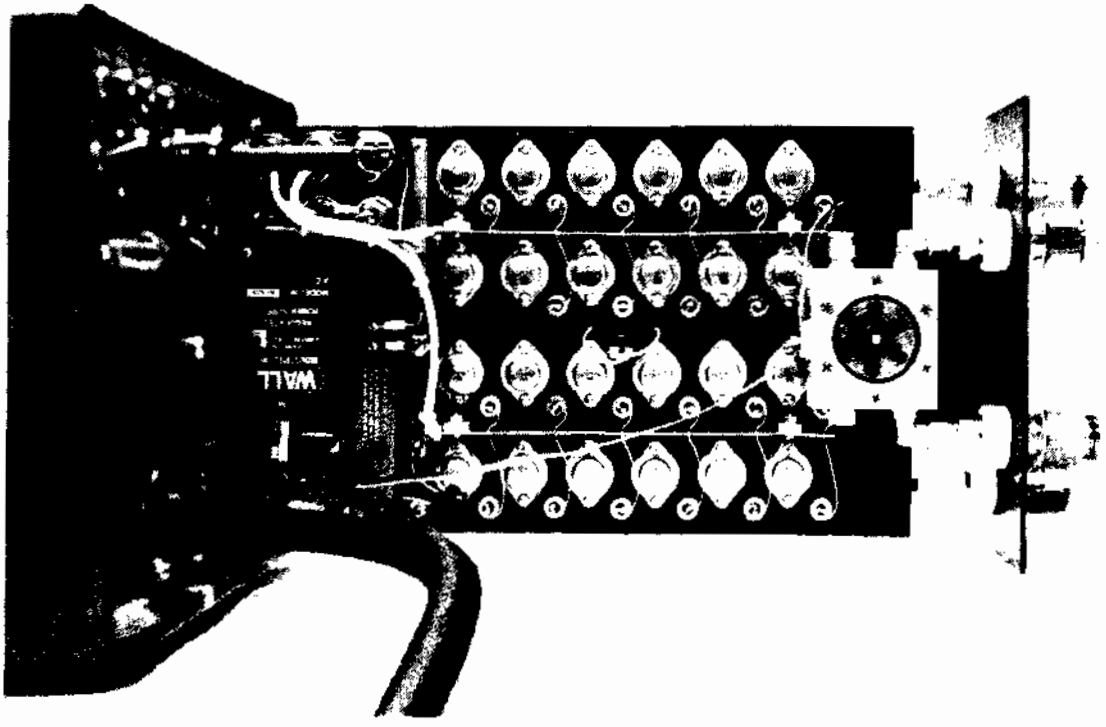


Figure 4.3 Power Supply, Rear Panel and Passbank

Table 4.3 Innova 90 Power Supply Controls and Connectors

Control	Description	Function
STANDBY connector	BNC receptacle, coupled through opto-isolators to tube current control circuit.	Permits remote control of laser to hold output power steadily at minimum level. +5 Vdc at STANDBY connector holds passbank current to minimum; 0 Vdc restores current to operating level.
CURRENT CONTROL (optional)	BNC connector, coupled through isolation amplifiers to current control circuit.	Permits remote control of laser in current control mode operation, using 0-5 Vdc signal (refer to Section 4.3).
LIGHT CONTROL connector (optional)	BNC connector, coupled through isolation amplifier to light control circuit.	Permits remote control of laser in light control mode operation using 0-5 Vdc signal (refer to Section 4.3).

CAUTION

Turn off laser by pressing OFF switch before changing the position of the UV switch. The UV switch position must not be changed while laser is in operation.

UV switch	Two-position toggle switch.	Selects to UV or VISIBLE light output position. Functions by switching tube magnet from low to high field. Do not change the switch position while laser is operating (refer to Section 6.2.2).
EXT INTERLOCK connector	Four-pin receptacle with mating plug.	Permits on-off interlocking of laser to remote switch (refer to Sections 2.2(10), 3.5.3, and 4.1.3). Removing mating plug shuts down laser.
REMOTE connector	50-pin ribbon cable receptacle.	Receives remote control module cable or customer supplied control electronics cable (refer to Section 3.5.2).

Table 4.3 (continued)

Control	Description	Function
Connectors J101, J102, and J103	Four-pin, 12-pin, and four-pin receptacles, respectively.	Receive power and control circuit cables from laser head (refer to Section 3.5.1).
CONTROL XFMR 1 AMP fuse	3AG (1/4 x 1 1/4 x 250 V)	Fuses 24-volt interlock system (refer to Section 8.2.1.2).
208 VAC fuses 3 Amp	3AG (1/4 x 1 1/4 x 250 V) quantity 2	Fuse system power supply, filament, and starter circuit (refer to Section 8.2.1.2).
TO LASER hose connector	Male garden hose connector.	Connects hose supplying water to laser head (refer to Section 3.4).
FROM LASER hose connector	Female garden hose connector.	Connects hose carrying return water from laser head (refer to Section 3.4).
TO DRAIN hose connector	Male garden hose connector.	Connects hose carrying return water to drain (refer to Section 3.4).
WATER IN hose connector	Female garden hose connector.	Connects hose supplying water from water source (refer to Section 3.4).
POWER cable	Heavy duty, factory-connected cable.	Applies three-phase, 208-Vac primary power (refer to Section 3.3) and chassis ground.
Fuse compartment marked DANGER	Recessed compartment with removeable cover.	Houses three 70-ampere primary power fuses (refer to Section 8.2.1.1).
LED fuse fault indicators	24 LED's mounted on passbank transistor panel in power supply pull out drawer.	Indicate passbank transistor failures when in test mode (refer to Section 8.2.2.1).
RUN/TEST switch	Two-position toggle switch.	Disables main power supply. (Refer to Section 8.2.2.1) Allows operation of passbank transistor fault LED's.

4.2 OPERATION

CAUTION

Before turning on, make sure the beam will be properly handled as it emerges from the laser; use a beam stop, such as a power meter, to ensure the beam will be blocked. Personnel in the area should be wearing proper eye protection. The turn-on and power maximizing procedures which follow assume the laser is set up for either visible or UV operation, aligned and ready for operation. If this is not the case, consult Sections 6.2 and 6.3 before commencing. It is particularly important that the UV switch (refer to Table 4.3 and Section 6.2.2) not be changed during laser operation.

4.2.1 Turn-On Procedure

(1) Make sure water and primary power are turned on to the system; if not, refer to Sections 3.3 and 3.4.

(2) Turn on LOCK switch, and observe the white LASER EMISSION light on the control panel comes on. The FAULT light and WATER FLOW light also come on, but only for a half-second while the system is verifying water flow, after which these lights extinguish and the OPERATE light illuminates.

(3) Select MANUAL or AUTO START. A green light above the selected switch will indicate which start method has been chosen.

(4) Adjust the WAVELENGTH calibrator indicators to the operating wavelength. If broadband operation is desired, choose 514 nm for argon or 500 nm for krypton systems. For high field operation UV see Section 6.2.2.

(5) Using the power range selector pushbuttons, select the desired power range.

(6) Depress the ON switch, and observe the START DELAY indicator come on for 30 seconds.

(7) If MANUAL START has been selected press the MANUAL START button again; otherwise, proceed to next step.

(8) If it is not already open, set the beam shutter on the laser head to OPEN position, and observe the LASER POWER WATTS and the LASER CURRENT AMPS displays. Both will be illuminated and the green light beside one will be on, indicating which regulating mode is in effect.

CAUTION

Prior to closing the shutter when lasing in the light regulation mode, the CURRENT REG control should be set slightly higher than the LIGHT REG control to eliminate large changes in current when the shutter is closed. However, the shutter may be used during either light or current regulation.

(9) Maximize the power output by carrying out the procedures listed in Section 4.2.2, page 4-17.

4.2.2 Maximizing Output Power

(1) Preselect the laser power range display so that the laser is in current regulation at maximum current.

(2) Adjust the laser head horizontal control for maximum LASER POWER WATTS indication.

(3) Adjust the laser head vertical control for maximum LASER POWER WATTS indication.

(4) Press the TUNE 5X selector and observe (1) the LASER POWER WATTS display reaches only to the center of the scale and, (2) the displays of power changes are now approximately five times greater than previously.

(5) Repeat steps (2) and (3) above.

(6) Release the TUNE 5X selector; the LASER POWER WATTS display now indicates true power.

NOTE

Once power is maximized at a given wavelength, the output power range selectors on the remote module can be changed without remaximizing the power.

4.2.3 Synopsis of Light and Current Regulation

The INNOVA 90 has independent light and current regulation with an automatic crossover circuit. The mode of regulation is automatically switched over to the mode requiring the lower current. A green light to the right of the CURRENT/LIGHT REG controls indicates which is the governing mode of regulation. System operation involves the interaction of three controls, the CURRENT REG control, the LIGHT REG control, and the power range selectors, as described on the following page.

4.2.3.1 Light Regulation Mode

The LIGHT REG control, when in light control, will adjust laser output power from minimum power to the maximum permitted by the selected power range on the LASER POWER WATTS scale. The LIGHT REG control always requires full counterclockwise to full clockwise rotation (three revolutions) to go from mimimum power to maximum scale — regardless of which power range selector is governing the power. Clockwise rotation of the LIGHT REG control will elevate the LASER POWER WATTS indication to the maximum set by the power range selector that was pushed, but no higher.

4.2.3.2 Current Regulation Mode

The CURRENT REG control, when in current control, will adjust the laser tube current from 5 amperes (for Argon, 10 A for Krypton) up to maximum current permitted within the power range in which the laser is being operated (the minimum current for UV high field operation is 25 A). As the current is increased, laser power increases, but never beyond the power range maximum. When the laser power reaches full scale, the system switches over to light regulation.

4.2.3.3 Power Range Selectors

The power range selection pushbuttons set the scale of the LASER POWER WATTS indicator and fix the maximum laser output. If the LASER POWER WATTS indicator is full scale, the system will always be in light regulation. The power range selection pushbuttons can be operated to conveniently change laser output power, as discussed in the examples below.

4.2.3.4 Examples of Current and Light Regulation

To illustrate how the controls function two control settings are listed below. Remember: (1) The mode of regulation is determined by which mode requires the lower current and, (2) there are three controls affecting the

mode of regulation --- CURRENT REG, LIGHT REG and the RANGE SELECTION buttons.

Current Control

1. LIGHT REG control full clockwise.

2. Power range selected to be above maximum power output at which laser is to be operated.

3. CURRENT REG control will adjust current from threshold to full current.

Light Control

1. CURRENT REG control full clockwise.

2. Power range selected to be just above maximum power output at which laser is to be operated.

3. Rotation of the LIGHT REG control will adjust the output power across the full range of the scale, up to the maximum output power.

In practice, it is recommended that the INNOVA 90 be run in light regulation with the current regulation set just above the light regulation. This setting allows the user to take full advantage of the cross-over electronics. If the laser shutter were closed or the laser detuned, tube current would rise only to the point set by current regulation. This will allow the laser to remain more stable and prolong tube life by eliminating unnecessary high current excursions.

4.2.4 Remote Control Operation

The INNOVA 90 can be operated by remote control through the use of the STANDBY, CURRENT CONTROL, and LIGHT CONTROL connectors on the power supply rear panel (refer to Table 4.13). Such operation is particularly useful for control of the laser with a computer via a digital to analog converter. Procedures for remote operation are given in the following three paragraphs.

4.2.4.1 Remote Current Regulation (Optional)

1. Connect a remote control 0 to +5 Vdc signal source to the CURRENT CONTROL BNC connector on the power supply rear panel.

2. Turn the CURRENT REG control maximum counter-clockwise.

3. Turn the LIGHT REG control maximum clockwise.

4. Push the selector switch to the range that will include maximum expected power.

5. Laser tube current can now be controlled by varying the remote control signal between 0 and +5 Vdc. The + 5 Vdc corresponds to the maximum current.

4.2.4.2 Remote Light Regulation (Optional)

1. Connect the remote control 0 to +5 Vdc signal source to the LIGHT CONTROL BNC connector on the power supply rear panel.

2. Turn the LIGHT REG control maximum counterclockwise.

3. Turn the CURRENT REG control maximum clockwise.

4. Select maximum power range desired by pushing range switch selector.

5. Laser light output can now be controlled by varying the remote control signal between 0 and +5 Vdc. The 5 Vdc corresponds to the maximum power output for the selected range.

4.2.4.3 Mixed Mode Remote Regulation (Optional)

1. Connect separate remote control 0 to +5 Vdc signal sources to both the CURRENT CONTROL and the LIGHT CONTROL BNC connectors on the power supply rear panel.

2. Turn both the CURRENT REG and LIGHT REG controls maximum counterclockwise.

3. The laser will now operate in either the current control mode or the light control mode, depending on the voltage levels and the power range selector pushbutton that has been selected. This operation is completely analogous to manual operation described in Section 4.2.3.

4.2.4.4 Remote Standby Control

1. Connect a remote control source capable of being switched to either 0 or +5 Vdc to the STANDBY BNC connector on the power supply rear panel.

2. When +5 Vdc is applied to the STANDBY connector, laser current will be held to the minimum level. When 0 Vdc is applied, the laser can be operated in any normal mode, i.e., manual or remote, current or light regulation.

4.2.5 Wavelength Selection

Wavelength selection is dependent on the type of rear mirror holder. The INNOVA 90 can be operated with either of two types of rear mirror holders: a multiline mirror holder which produces operation in the all lines, or the Model 934 Wavelength Selector which produces operation in the single line. Both types are shipped with the laser, and each can be readily exchanged for the other, as described in the following section.

Both the multiline mirror holder and wavelength selector are bayonet-mounted. When an exchange is made, the optics remain aligned and the laser should lase immediately. Thus, this design eliminates the need to perform a lengthy grid pattern search to obtain lasing after the mirror holders are changed.

NOTE

Make sure there is a mirror in the holder before attempting to lase.

In addition to the wavelength selector, an optional etalon accessory (the Model 923) is available which provides single-frequency (single longitudinal mode) operation (see Section 4.3).

4.2.5.1 Installation or Removal of Multiline Mirror Holder

For multiline (all-lines) operation, the multiline mirror holder should be used. When switching from single line operation to multiline operation, peak the output at 488.0 nm for argon systems and 647.1 nm for Krypton systems. Remove the wavelength selector. Insure that the multiline holder has a clean mirror, and install the holder into the rear bezel. Lasing should occur immediately without further adjustment. The multiline mirror holder has been prealigned at the factory and its adjustment screws locked in place. The wavelength calibrator indicators located on the control panel should be set to read 488 nm* for multiline argon operation and at 500 nm for multiline krypton operation.

To remove the multiline mirror holder (see Figure 4.4), rotate it 1/8 of a turn counterclockwise and pull straight back. To insert the multiline mirror holder, align the white dot on the rear plate of the laser head with the white dot on the forward edge of mirror holder. Push the mirror holder into the laser head dust cover until it stops. Then, turn the mirror holder clockwise until it locks into position. The white dot on the rear bezel will align with the white dot on the multiline holder when in the correct rotational position.

*514.5 nm for units manufactured prior to February 14, 1983.

To remove the mirror only, for replacement or cleaning, unscrew the large knurled nut in the center of the holder. The mirror can then be withdrawn without removing the rest of the multiline mirror holder assembly from the laser head end plate. (For cleaning and optic handling instructions, refer to Section 6.1.1.)

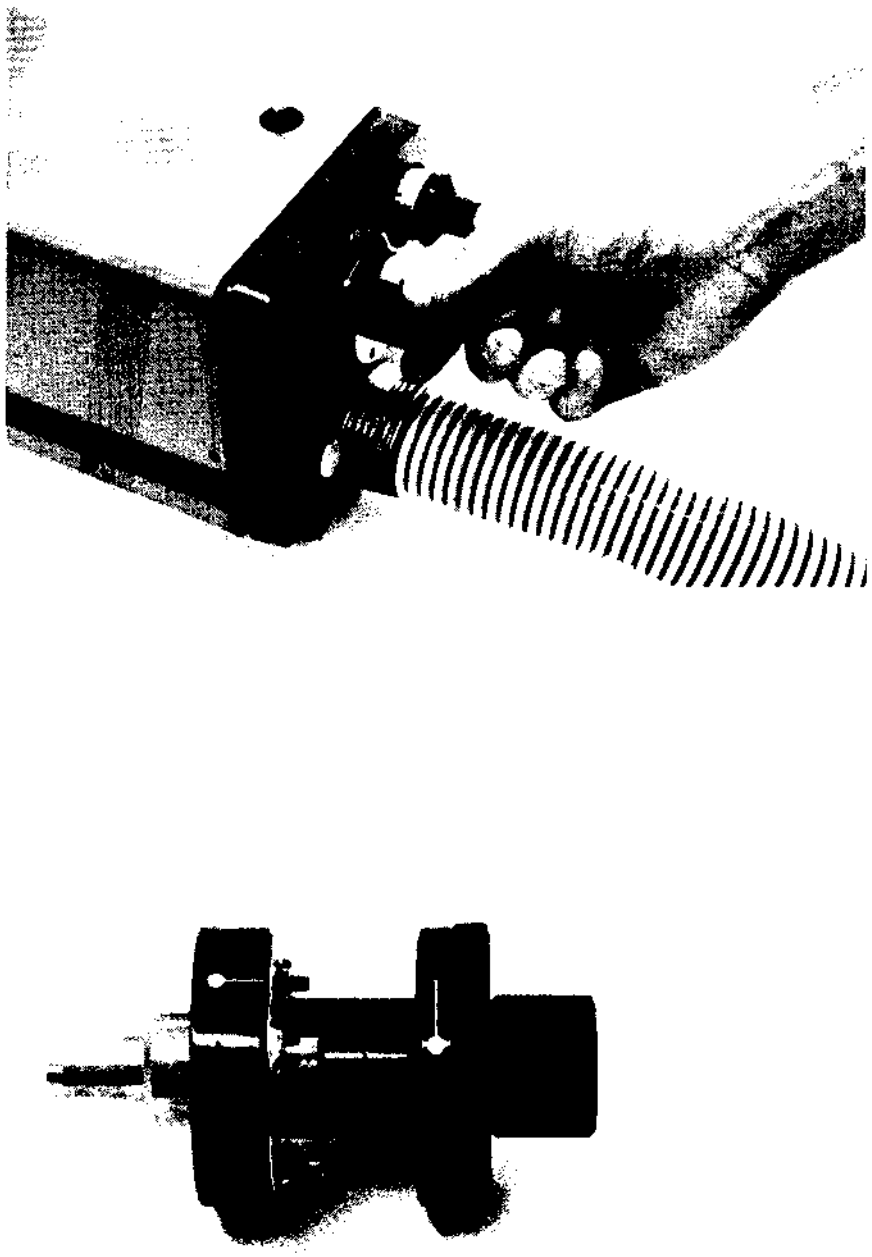


Figure 4.4 Multiline Mirror Holder

4.2.5.2 Installation or Removal of Model 934 Wavelength Selector for Changes to and from Single Line Operation

For single line operation, install the Model 934 Wavelength Selector. The vertical control (see Figure 4.2) can then be used to scan the laser through individual wavelengths. (For finer, single frequency operation, refer to the optional etalon described in Section 4.3.)

To insert the wavelength selector, align the white dot on the rear plate of the laser head with the white dot on the forward edge of wavelength selector. Push the selector into the laser head dust cover until it stops. Then, turn the selector clockwise until it locks into position. The white dots on the bezel and the mirror holder will align over each other when the mirror holder is in the correct rotational position. To remove the wavelength selector (see Figure 4.5), rotate it 1/8 of a turn counterclockwise and pull straight back.

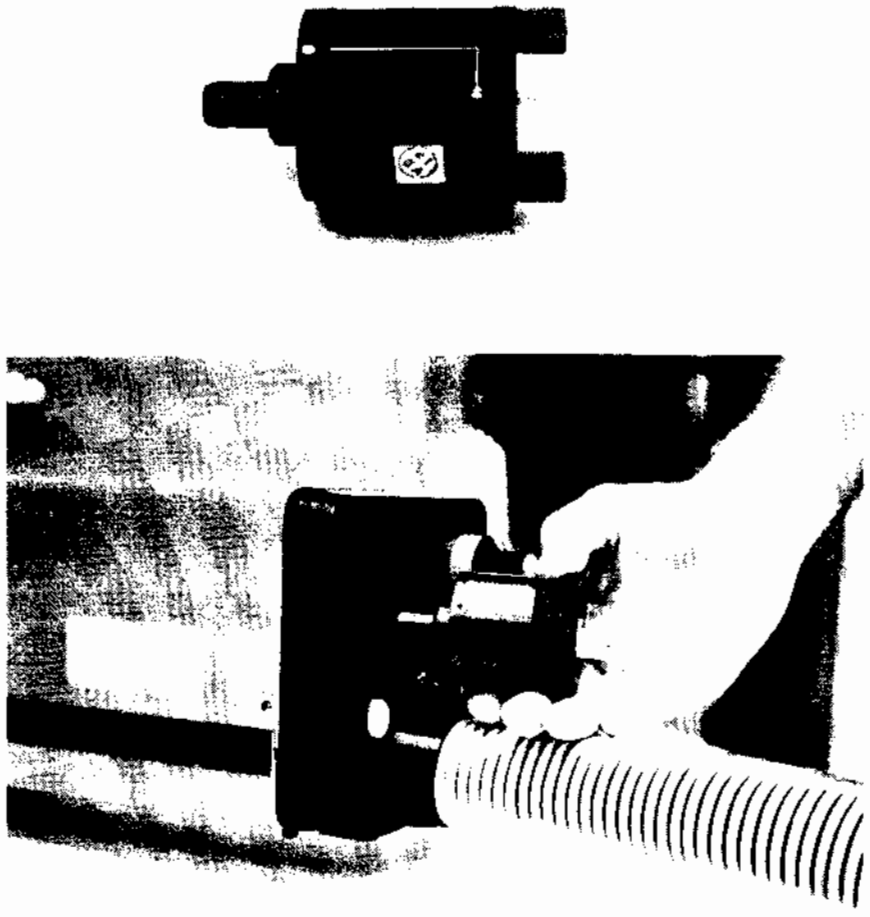


Figure 4.5 Inserting Model 934 Wavelength Selector

4.2.6 Aperture Assembly

The Aperture wheel is located on the front of the laser head just behind the shutter. There are 12 graded holes in the intracavity aperture and a large hole used for alignment. The holes are marked along the rim of the Aperture Wheel; hole 0 is the large alignment hole, the remaining holes decrease in size as the wheel is rotated from position 12 down to position 1. The aperture is used to force the laser to run in a single transverse mode (see Section 5.3.3). Short wavelengths require smaller holes than longer wavelengths for optimum TEM_{00} performance. For highest Gaussian power output, use the largest hole that still maintains TEM_{00}. For highest output power when mode quality is unimportant, use the large alignment hole which will allow the laser to run in a higher order transverse mode. Aperture adjustment is discussed in Sections 5.3.3 and 8.2.4.

Table 4.4. Aperture Hole Sizes

Aperture Holder	Diameter (mm)
0 (Open)	3.97
12	2.79
11	2.71
10	2.64
9	2.58
8	2.53
7	2.49
6	2.44
5	2.37
4	2.26
3	2.18
2	2.08
1	1.99

4.3 INSTALLATION OF MODEL 923 ETALON ASSEMBLY

This installation procedure pertains only to lasers equipped with an etalon option.

NOTE

The Model 923 Etalon may require cleaning before installation. For cleaning instructions, refer to Section 6.1.5.

4.3.1 Single Frequency Operation on 514.5 nm (Argon) or 647.1 nm (Krypton)

The following procedure requires a Coherent Model 240 laser Spectrum Analyzer, a Model 251 Controller and an oscilloscope.

To install the Model 923 Etalon and operate in the single frequency (single longitudinal) mode, proceed as follows:

(1) Operate the laser with the Model 934 Wavelength Selector installed (Section 4.2.5.2) and set the vertical control to 514.5 nm for an argon laser or 647.1 nm for a krypton laser.

(2) Adjust for maximum power output and select an aperture setting for TEM_{oo} mode operation. Record the TEM_{oo} power level.

(3) Turn off the laser by pressing the OFF switch.

(4) Remove the laser head cover.

(5) Refer to Figure 4.6 and locate the etalon holder.

(6) On the forward plate of the etalon holder, release the two knurled nuts and lift out the dummy spacer which sits within the holder when the etalon is not in use.

(7) Prior to installing the etalon assembly, clean the etalon as described in 6.1.5.

(8) Place the etalon in the holder, with the eight-pin connector facing up (refer to Figure 4.8).

(9) On the bottom of the laser head near the etalon holder, locate an eight-conductor ribbon cable with the a female connector that mates to the connector on the etalon and connect the cable to the etalon. The connectors are designed so only the proper orientation of the connector is possible.

(10) Tighten the two knurled nuts until the etalon is snugly held within the holder.

(11) Install head cover interlocks, turn on the laser, and allow a warm-up until the output power stabilizes at a steady level. This will take about 15 minutes.

(12) Align Spectrum Analyzer:

A. Insert Beam Splitter in output beam.

B. Connect ramp driver to side BNC jack of analyzer.

C. Connect output of analyzer to scope.

D. Connect scope trigger from ramp driver to scope.

E. Alignment of Spectrum Analyzer: With the beam passing through the center of the beam splitter, look for a bright reflected spot. The beam splitter can be rotated and the Spectrum Analyzer rotated to bring the reflected spot onto the incident beam spot. Then use the angular adjustment for final adjustment.

F. Adjust analyzer for maximum display on scope using angular adjust screws. Insure that analyzer is not saturated (saturation indicated by flattened peak of wave form). If saturation is observed, insert a beam splitter into output beam from laser. Place analyzer beam splitter into the reflected beam and re-align analyzer.

(13) Adjust Etalon for peak single frequency:

A. Allow Etalon to warm-up (modes will stop marching across scope). Tweak rear mirror mount for maximum power.

B. Using a 9/64 Allen wrench, adjust Etalon tip angle to normal incidence (called 'Flash') - both horizontal and vertical adjustment (see Figure 4.7). This is done by removing the cover from the prism wavelength selector and the prism cover plate protecting the prism and observing the reflected dots on the ceiling. Adjust the Etalon angle so that the dots superimpose upon each other. The best indication of flash is that the modes dance erratically on the scope.

C. Turn the vertical adjustment screw ¼ turn clockwise off of flash. <u>This is standard tilt</u>. Adjust rear mirror for maximum power.

D. Adjust aperture for TEM_{00} mode. At this point, the display may or may not show single frequency. At low output power the laser can operate at two frequencies. That cannot be reduced to a single frequency by reducing the aperture - go to next step if low power and two frequencies.

E. With the vertical adjustment screw ¼ turn off flash clockwise and the laser operating TEM_{00}, record the output power. Adjust the heater control (located on the temperature control board, see Figure 4.9) ½ turn in either direction and allow the heater to stabilize. After the oven has stabilized (approx. 5 min.) record the output power. If the output power of the second measurement is higher, continue turning the potentiometer in the same direction. If not, turn the potentiometer in the opposite direction. Record the output power after each adjustment. When a peak in the etalon band pass is noted, smaller adjustments (¼ turn) in the potentiometer will be required to center the band pass of the etalon over the gain curve. Approximately 3.6 turns are required to move one etalon free spectral range.

F. Typical single frequency output power is 50% of the TEM_{00} power recorded in step 2.

NOTE

The etalon oven temperature control circuit is precisely adjusted at the factory for 514.5 nm operation in an argon laser or 647.1 nm operation in a krypton laser, and no further adjustment is normally required in the field for single frequency operation at those wavelengths. However, if single frequency operation on some other wavelength is desired, the etalon oven temperature may require adjustment, as outlined below.

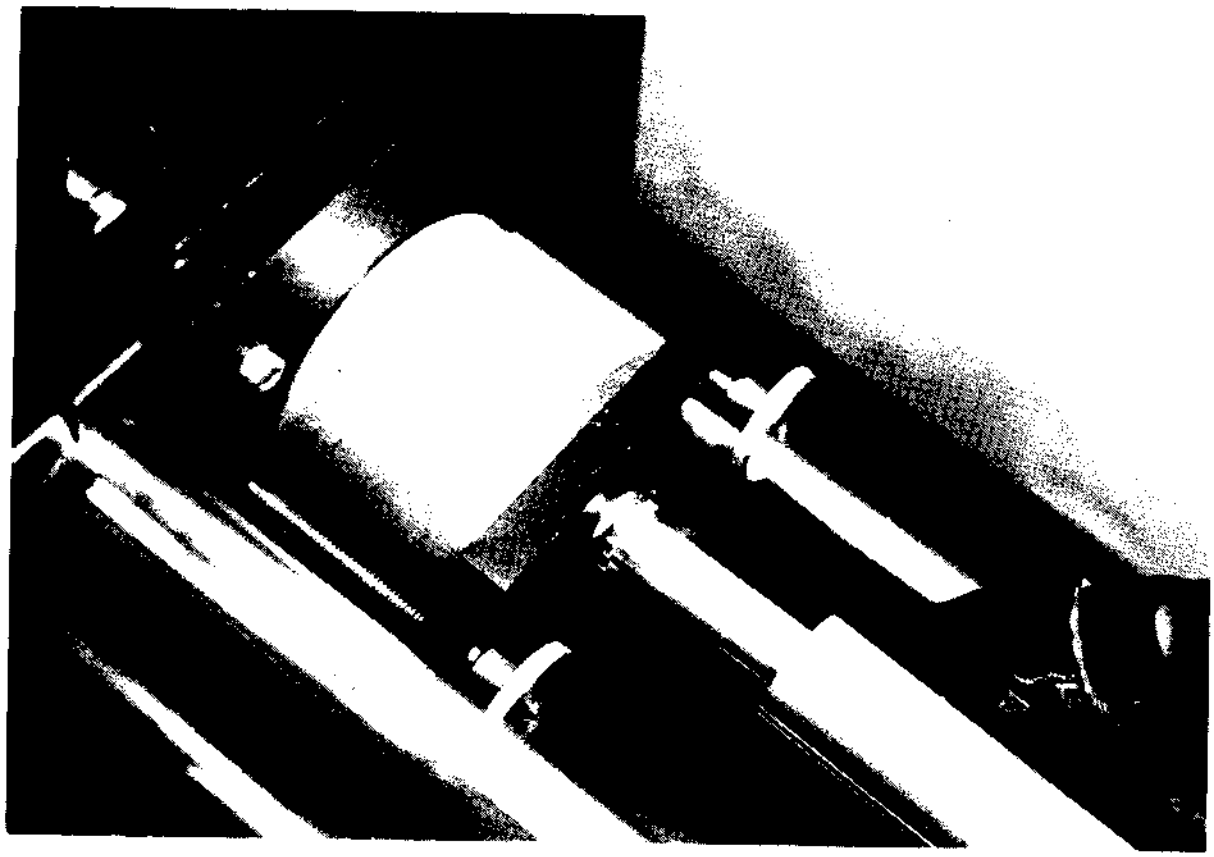


Figure 4.6 Holder for Model 923 Etalon, with Dummy Etalon Installed

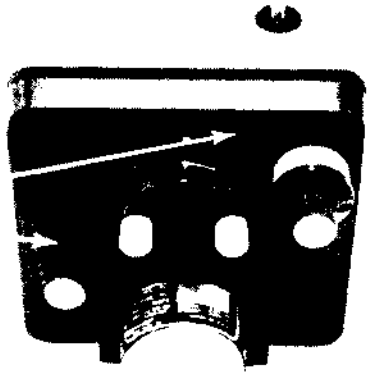
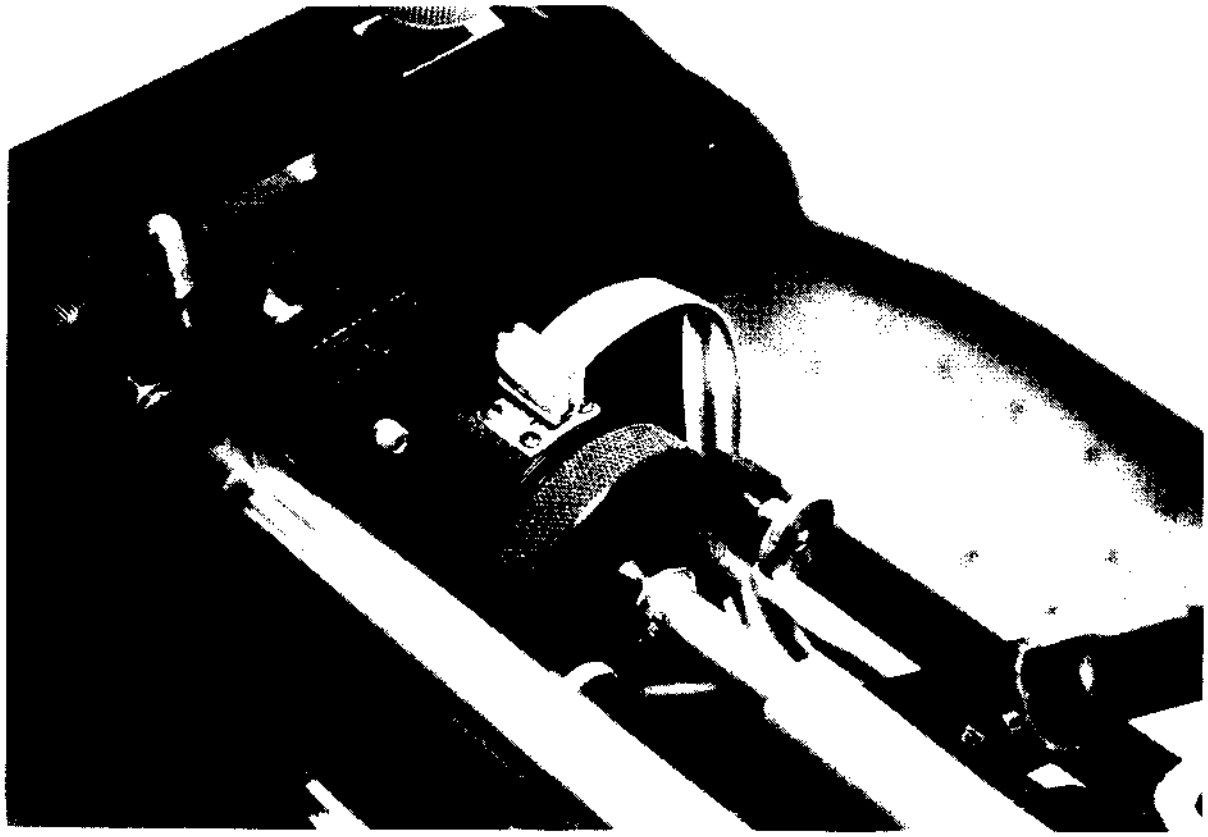


Figure 4.7 Etalon Tilt Adjustment Screws



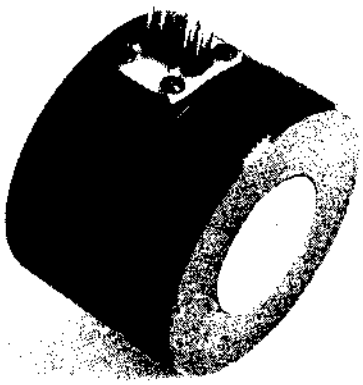


Figure 4.8 Model 923 Etalon

4.3.2 Single-Frequency Operation on Wavelengths Other Than 514.5 nm (Argon) or 647.1 nm (Krypton)

To operate in the single-frequency (single longitudinal) mode at other than 514.5 nm for argon or 647.1 nm for krypton, the Model 923 Etalon is adjusted in two major steps: First, the etalon is aligned for maximum power at either 514.5 nm or 647.1 nm; then after tuning to a new line, the output is optimized by adjusting etalon temperature. With the Model 934 Wavelength Selector installed (Section 4.2.5.2) proceed as follows:

(1) Follow the procedure descirbed in section 4.3.1 Single Frequency Operation at 514.5 nm (Argon) or 647.1 nm (Krypton). The purpose in setting the etalon up in the above high gain lines is to simplify the alignment required when single frequency operations of lower gain lines is desired.

(2) Moving the vertical adjustment of the wavelength selector, select the desired wavelength. If a different optic set is required the optics should be changed and aligned at this time. Do not adjust the etalon tilt at this time.

(3) Peak for maximum power at the desired wavelength (See section 4.2.2 Maximizing Output Power).

(4) The laser should now be operating single frequency. To maximize single frequency output follow the procedure as described in section 4.3.1 13E. If problems are encountered go through the complete alignment procedure in section 4.3.1.

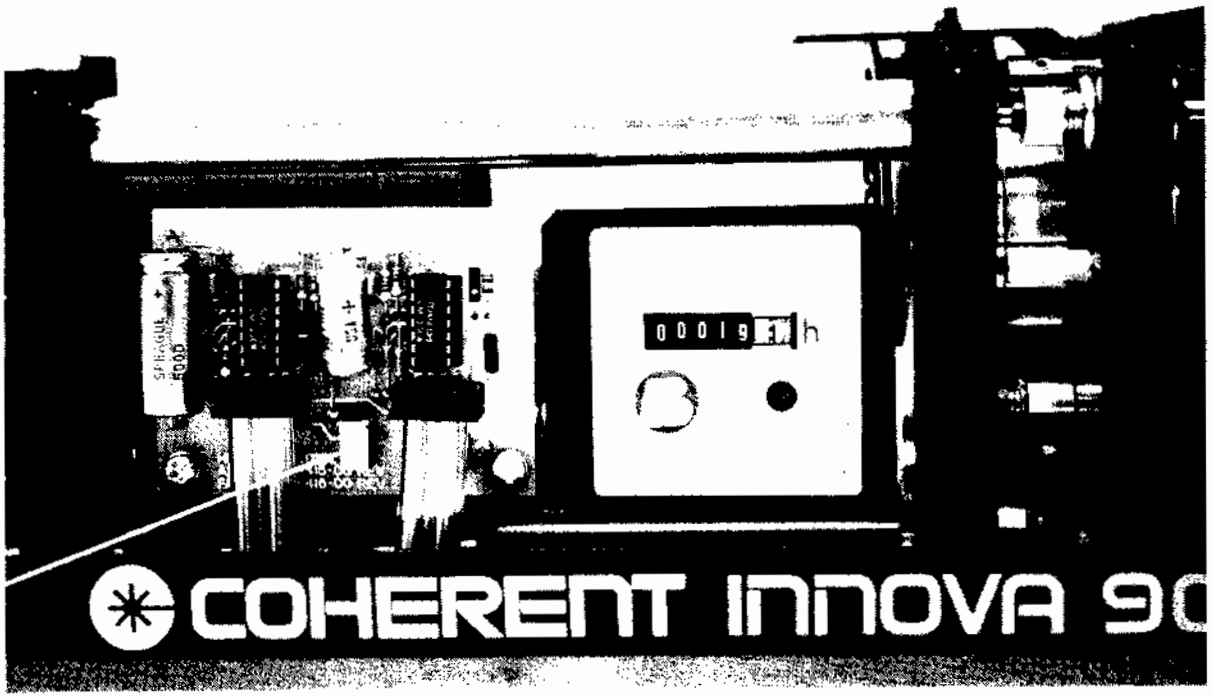


Figure 4.9 Etalon Oven Temperature Adjustment Potentiometer

5.0 THEORY OF OPERATION

5.1 THE NOBLE GAS ION LASERS

Argon and Krypton ion lasers constitute one of the most important classes of lasers. These lasers produce reliable high power in cw operation on a multitude of lines across the visible and in the near ultraviolet and infrared. As a result, cw ion lasers have found applications in fields as diverse as retinal surgery, high resolution spectroscopy and newspaper platemaking. In this section of the manual the theory of laser operation in noble gases is discussed. Subsequent sections cover the design of the ion laser tube, resonator and optics.

In all noble gas ion lasers, laser action occurs between highly excited energy levels in either singly or doubly ionized atoms. The principal excitation mechanism is electron impact in high current dc discharges. Atoms are ionized in one collision, and subsequent excitation to a highly excited state occurs via subsequent collisions. The ions then relax, cascading to lower states with many possible relaxation routes. A simplified energy level diagram for Argon II is shown in Figure 5.1, and several important transitions are labeled.

The natural lifetime of the upper laser levels is 5 nanoseconds. The populations of the lower laser levels rapidly decay to the ground state. The energy separation of the lower laser levels and the ion-ground state is 14 eV. The ground state ions rapidly recombine to form neutral atoms. The rapid depopulation of the lower laser levels minimizes the competition between different laser transitions. (Note that two ion energy levels act as the lower states to all major Ar II laser transitions.) Because line competition is a small effect, single line selection by intracavity prism yields similar power to extracavity line selection. Intracavity line selection has become the standard, principally because it is more convenient in nearly all applications. Note, however, that the blue lines 496.5 nm and 472.7 nm share the same upper level and do, therefore, strongly compete.

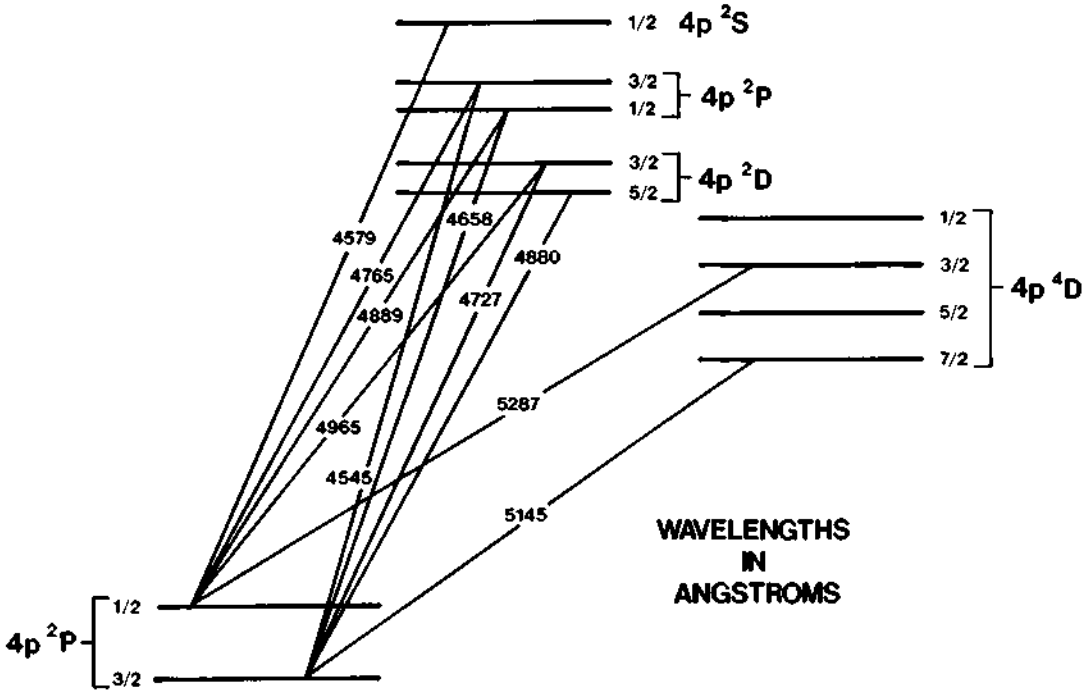


Figure 5.1 Energy Level Diagram Showing Major Laser Transitions in Argon II

The majority of the lasing transitions of the noble gas lasers have low gains. Typically, the optimum output transmission is approximately 5%, lower transmission figures are necessary for some weak lines. The main exception is the blue argon line at 488.0 nm. The spontaneous emission intensity and gain-to-power ratio for this line are almost an order of magnitude greater than for any other ion laser transition. The high gain makes 488.0 nm laser operation easy and very tolerant of changes in the laser's Q. However, this has a negative effect on obtaining either single frequency or mode-locked operation on this line. This is because secondary frequencies or secondary pulses will readily reach laser threshold.

Ion laser lines are typically 4 GHz wide. This width, which encompases some 20 or so longitudinal modes, is the sum of several different processes. The principal broadening mechanisms are inhomogeneous-Doppler broadening and Zeeman splitting. There is however a considerable residue of homogeneous broadening due to the transition's natural lifetimes. Conversion to single frequency operation, achieved by inserting an etalon, is quite efficient; typically over 50%.

5.2 PLASMA TUBE

The INNOVA series lasers feature a plasma tube of a unique design. Any laser tube must meet numerous demanding requirements. It must contain and confine to the laser axis an arc discharge with current densities of 700 amperes per square centimeter. Secondly, heat must be efficiently transferred from the laser bore. Thirdly, this heat must be carried to the cooling water. Fourthly, the tube must be vacuum tight and have electrically insulating walls. Fifth, provision must be made to keep the gas pressure uniform, at the level which gives highest output.

The CoolDisk™ construction of the plasma tube confines the arc with tungsten disks. Heat generated by the plasma is conducted rapidly from the disks, through the high-conductivity ceramic envelope, and into the cooling water. Tungsten is chosen as the disk material both because of its resistance to heat (its melting temperature is 3500°C) and because it is exceptionally resistant to damage by sputtering. Because heat is rapidly conducted away from the bore into the cooling water, temperatures internal to the tube are low — 200°C. The use of perforated disks creates internal gas return paths which have a high conductance for gas flow because the disks stay cool. These disks allow free circulation of the gas within the tube. This free circulation counteracts the gas pumping effects which form a strong pressure gradient within the laser discharge. Because each peripheral hole is smaller than the laser bore, the discharge will always be confined to the laser axis.

The metal/ceramic construction of the laser tube ensures great mechanical strength and ruggedness. The vacuum envelope is formed out of a single, seamless and jointless cylinder of alumina ceramic. This ceramic has extraordinary strength, high thermal conductivity, is an excellent dielectric/insulator and is well suited for high vacuum. The cylinder end pieces are metallic with ceramic insulated inserts where the cathode leads enter the tube. Brewster windows are made of crystalline quartz. This material has unmatched transparency and resistance to damage and color center formation. All ion laser discharges produce intense ultraviolet radiation which cause rapid deterioration of amorphous window materials. The crystalline quartz windows are bonded with a hard glass seal to crystalline quartz stems. These stems are, themselves, bonded to the metal tube "headers" with compliant seals.

Although the CoolDisk tubes have very low sputter rates, gas clean up does occur slowly. To offset this gradual reduction in gas pressure, the INNOVA lasers incorporate an Autofill™ system. The pressure is measured and, when the pressure drops, a known volume of gas from a high pressure reservoir is added.

5.3 RESONATOR

The INNOVA Series ion lasers all have resonators made of the low expansion metal, Invar. Three Invar rods mounted in an L-shaped configuration run the length of the laser. The excellent rigidity of Invar keeps the laser in good alignment, even under conditions of exceptional vibration. While Invar has a higher thermal expansion coefficient than silica (used in other resonator designs) this does not affect the stability of the INNOVA Series ion laser since the rods are thermally compensated. Each rod has aluminum end-pieces. The aluminum pieces are re-entrant: thus, as the temperature increases and the Invar expands outward, the aluminum pieces also expand — inward. The aluminum outer pieces thermally compensate each rod. The individual compensation of the rods eliminates angular misalignment, should one rod reach a different temperature from the others. Additional thermal protection is provided by the solenoid. The magnet on the laser tube is cooled with water flowing both between it and the laser tube, and also by water flowing around the solenoid's circumference. This action reduces the amount of heat escaping from the magnet to the resonator.

The INNOVA 90 Series resonators are kinematically mounted to the case of the laser head. The purpose of this mounting system is to prevent thermal or mechanical stresses applied to the case from causing the laser to become misaligned. The mounting system consists of a conical steel bearing, towards the front of the laser, and a transverse flex plate towards the rear. The use of a conical bearing allows the resonator to move on both horizontal and vertical planes. The transverse flex plate uses a steel plate as a stiff retaining spring. The combined system provides excellent stress isolation between the laser case and the resonator.

5.3.1 Intracavity Optics

The INNOVA ion lasers use two mirrors. The output couplers are concave with radii of curvature of 2 to 10 meters; the high reflectors are flat. Ion laser optics are one-half inch diameter mirrors with hard dielectric, multi-layer coatings.

5.3.2 Wavelength Selector

For applications where single wavelength operation is required, an intracavity prism assembly (Model 934) is used. The wavelength selector assembly has a bimetallic design. This provides compensation against temperature changes, compensating in both angular alignment and laser length. This combination is important for the stability of the laser output and, in single frequency operation, for stability of the laser optical path length.

5.3.3 Aperture

For control of the laser's transverse mode structure and beam quality, an adjustable aperture is provided in all INNOVA 90 Series lasers. The aperture limits the diameter of the laser beam and so prevents higher order modes (which have larger beam diameters) from reaching laser threshold. The aperture wheel has twelve mode control apertures with diameters between 2.0 mm and 2.8 mm. The last hole, 4.0 mm in diameter, is provided for ease of acceptable multimode laser operation; it often increases the laser output power. (Adjustment of the aperture is discussed in Sections 4.2.6, and 8.2.4.)

5.3.4 Etalon

For applications requiring narrow laser linewidth, an optical intracavity etalon is available. The Model 923 is a solid etalon; air-spaced etalons of the same finesse have higher walk-off losses and hence reduced laser powers. The etalon is oven-stabilized and fine wavelength tuning is provided by temperature control. (Also see Sections 4.3, 5.5 and 5.6.3.)

5.3.5 Light Pick-Off

A beamsplitter following the output coupler mirror samples the output beam. The picked-off beam is incident through a diffuser on a photocell. The photocell provides a signal proportional to the output power. The signal is used for two purposes in the INNOVA Series ion lasers. Firstly, it is this signal which is used to measure the output power. Secondly, this signal is used in the light regulation mode. In light regulation control the voltage generated at the photocell is compared with a steady reference voltage. Should the power output of the laser change for any reason, the variation is detected by the regulation electronics. An error signal is then generated which leads to a change in discharge current to compensate for the output variation. The light regulation mode leads to improved long-term output stability and to diminished amplitude noise. For both applications, the operation of the photocell must be stable and controlled. In the INNOVA lasers, the photocell is sealed to prevent dust, dirt and stray room light from affecting the accuracy of the detector. Additionally, the photocell is mounted inside a temperature-controlled oven. Oven stabilization is necessary to provide long-term uniformity and accuracy .

5.4 POWER SUPPLY

5.4.1 Rectifier-Filter

The power supply is designed to operate directly from the power mains using 208 Vac ±10%, 3-phase, 50 or 60 Hz, fused at 70 amperes per phase. The power ON switch activates a contactor which applies power to a three-phase full wave rectifier circuit. The dc output of the rectifier is fed through an LC filter to the laser tube. A "soft-start" circuit is used in the filter to reduce the current surge to the capacitors at turn-on. The output of the filter is also used to drive the tube magnet.

5.4.2 Passbank

The passbank assembly, connected in series with the laser tube, consists of a water-cooled copper heat sink, current regulating circuit board, system power supply board, and the water flow sensor. A driver transistor and 23 transistors in parallel provide tube currents of 5 to 35 amperes for 90-2 and 90-3, 5 to 40 amperes for Innova 90-4 and 90-5, 10 to 40 amperes for Innova 90-K, and 25 to 40 amperes when the laser is operated in high field.

Each transistor is mounted in a socket and fused at 4 amperes. A transistor failure circuit, located in the current regulator board, senses a blown fuse and activates the PASSBANK TRANSISTOR light on the control module. At the same time an LED on the current regulator board will light to indicate which transistor has failed.

The supply is designed to operate with no degradation in performance with two blown fuses (i.e., with the loss of two passbank transistors). If a third fuse fails, the power supply will shut down and cannot be restarted until the transistors and fuses are replaced. The RUN/TEST switch on the current regulator enables the operator to determine which transistors require replacement without powering up the main power supply. (Use of the RUN/TEST switch is discussed in Section 8.2.2.2).

5.4.3 Light and Current Regulator

The current regulator uses operational amplifiers to control the drive current to the passbank transistors. A sample of the passbank current is fed back to the input of the operational amplifiers where it is summed with the signal from the LIGHT REG/CURRENT REG control to provide closed-loop regulation of the laser tube current. A circuit in the signal line from the LIGHT REG/CURRENT REG control provides for automatic crossover between light and current regulation. The laser will automatically operate in the regulation mode requiring the lower current.

5.4.4 Power Meter

Light output for the laser is sampled by means of a beam splitter and photocell located in the laser head. The output of the photocell is fed back to the light regulator board which is located in the control module. Maximum gain of the input stage to the light regulator is controlled by push button switches on the control panel. The regulator then sets the maximum light power out when operating in the light regulation mode. The next stage of the light regulator along with the thumb wheel provides for wavelength compensation of the light regulator. A portion of this signal along with a signal from the light regulator control is fed into the summing input of an operational amplifier. The output is inverted and routed, along with the signal from the current regulation control, to the current regulator board on the passbank.

The signal at the output of the wavelength compensation amplifier is also used to drive the gas discharge display of the power meter. A 15-kHz clock drives a three-phase generator which is used to light adjacent segments on the display. It also drives a ramp generator. The length of the ramp is equivalent to a full scale indication on the display. A comparator is used to compare the laser output to the level of the ramp control. When the output of the comparator changes state, the display is turned off. Therefore, the display is a direct indication of the power level.

5.4.5 Interlocks

The interlock system is powered from an auxiliary transformer that is activated as soon as the system key switch is turned on. In addition to the standard cover interlocks (passbank drawer, head, power supply, and fuse covers) there is a waterflow sensing circuit that opens the interlock circuit should water flow decrease below 2.0 gpm (7.7 pm). Thermostats monitor the passbank temperature and water temperature. These open the interlock system when the temperature exceeds 71°C (160°F).

The interlock system is used to protect the power supply from a number of fault conditions: Passbank over voltage, tube over current, and tube under pressure. Sensing currents are used to detect these faults and open the interlock circuits. This will cause the main contactor to open and prevent it from being pulled back in until the fault is corrected. These circuits only function when the tube is started (ionized).

Each of the interlock sense circuits utilizes an optical coupler, the output of which will turn on an indicator lamp in the control module. The lamp illuminates the front panel to indicate to the operator what interlock is causing the problem. A RESET switch on the front panel allows the operator to reset all of the indicator lights after correction of a fault, and also in case a light turns on due to external transients.

5.4.6 Remote Control

(1) STANDBY — The STANDBY function allows the operator to reduce the laser to minimum output power. When 5 Vdc is applied to the STANDBY BNC on the rear panel, two optical couplers are turned on. The secondary side of the couplers shunt the light and current regulator signals to B-. This causes the current regulator on the passbank assembly to regulate the tube current to approximately 5A (25A in high magnetic field and 10A in krypton lasers).

(2) Remote LIGHT CONTROL and CURRENT CONTROL (Optional) —Remote light or current control is carried out by applying 0 to 5 Vdc to the LIGHT CONTROL or CURRENT CONTROL BNC connectors on the rear panel of the power supply. The control circuits of the standard system are referenced to B-(-150V). Isolation is required to permit control by an external circuit referenced to ground. Special isolation amplifiers are available that provide full control of the laser by a 0 to 5 volt input at the input of the desired function. During remote light control, the control panel LIGHT REG knob should be rotated fully counterclockwise; during remote current control, the control panel CURRENT REG knob should be rotated fully counterclockwise.

5.4.7 Autofill

An ion laser operates with an intense glow discharge, which accelerates ions into the walls of the plasma tube where they are buried, causing a drop in pressure. This gas must be replaced or performance will deteriorate. To replenish the lost gas, the INNOVA uses a two-valve refill system which meters gas into the tube in precise 10-millitorr increments. This resolution allows pressure to be maintained to within 3% of optimum. The gas reservoir, located on the underside of the tube magnet, has sufficient volume for many thousands of hours of tube operation. The fill system, precise and completely automatic, has no user-controlled operations.

Tube pressure is maintained by sensing the tube voltage. The signal from this parameter is fed into the summing junction of an operational amplifier. Normally, any change in the tube voltage signal will have an equal and opposite change in the tube current signal. The result is that the output of the operational amplifier remains constant. If the tube pressure changes, this will be reflected as a change in the tube voltage without a corresponding change in tube current and the output of the operational amplifier will change. The output of the operational amplifier is the bottom end of a voltage divider string. The signal at the other end is obtained from B+. As the tube voltage changes, the voltage at the center of the divider will change. This voltage is applied, through an amplifier, to a comparator. When the tube requires a fill, the voltage drops below a preset limit and the comparator changes state.

After a delay of approximately 10 seconds, a second comparator changes state and pulls in the "ready" relay. This activates the "ready" solenoid and starts the fill timer. After a delay of 2 to 3 minutes the "fill" relay is pulled in and the fill solenoid is activated. A

signal is also fed back to reset the first comparator. If the fill was sufficient to change the tube voltage back to its preset value, the input of the first comparator would remain above the fill set point and the fill system would shut down. If the fill is not sufficient, the timing cycle will begin again and produce another fill. A counter counts the number of fills. If one fill is sufficient, the counter is reset. If for some reason the tube voltage continues going back through the set point, the counter will shut the fill system down after nine fills.

The signal used to start the fill system is also used to provide certain diagnostic information. Indicator lights on the front panel will light if for some reason the tube becomes over-pressured. A light will also light for a low pressure condition. In addition, if the tube pressure falls to an under-pressure condition, the signal would cause the fault relay to drop out and the system would shut off.

5.4.8 Starter

The laser can be started either manually or automatically by pushing the appropriate push button on the control module. When the ON switch is activated, the main contactor is pulled in. This turns on the 15V system power supply and starts a 30-second START DELAY timer. This allows the cathode heater to reach operating temperature before the start circuit can be activated. During this period of time an indicator lamp on the control panel lights to indicate the start delay. At the end of the time delay, the timer turns on an optical SCR which puts halfwave rectified 208 Vac to the auto/manual switch. In the auto mode, the switch is normally closed and the voltage is applied directly to the start circuit. In the manual mode, the switch is a momentary push button and voltage is applied to the start circuit when the switch is closed.

The starter circuit is composed of two parts: the starter module in the power supply and the spark gap/coil assembly located in the tube head. At the end of the warm up start delay, the voltage from the manual/auto start switch is applied to the starter module. In the module an SCR applies the voltage at a 50/60 Hz (dependent on local power availability) rate to the pulse transformer. The secondary drives a one-half wave rectifier. The output of the rectifier is fed through a cable (within the combination power-water cable connecting the laser head to the power supply) from the power supply to the spark gap/coil

6.0 OPTICS AND ALIGNMENT

6.1 OPTICAL CLEANING

The units are shipped with hemostats, a small medicine-dropper, bottles of methanol and acetone, and a limited supply of lens tissue. Upon receipt of this manual, it is recommended that the laser user obtain a large bottle of reagent grade methanol plus a large box of Kodak lens tissues. Though less commonly used, reagent grade acetone might also be obtained.

Laser optics should be handled with utmost care; the slightest scratch, trace of dirt, or film will severely diminish laser's efficiency. Before cleaning optics, make sure one's hands are thoroughly clean and that a clean soft surface, over which to clean the optics, is available.

It is advisable that the laser be operating with monitored power output prior to cleaning. By doing this, improvements in laser performance can be quantitively measured at each step.

6.1.1 Multiline Mirror Cleaning

Before cleaning, terminate laser action by closing the beam shutter. Clean only one mirror at a time to facilitate returning to laser action.

Unscrew the knurled cap from the multiline mirror holder and slide out the mirror assembly. Use the following procedure to clean the optic:

(1) Blow any dust or dirt particles that may scratch the optic during the cleaning process off the optic using clean dry air.

(2) Place a drop of methanol in the center of a tissue. Hold the mirror assembly in one hand and place the wet portion of the tissue on the optic surface and drag it across, as shown in Figure 6.1. The tissue and optic should be dry before the optic reaches the end of the tissue.

(3) Examine the surface of the optic in different lights for streaks of film. If streaks remain, repeat the process using a fresh tissue.



Figure 6.1 Cleaning Optics Using the Drop Drag Method

NOTE

On the side of each Coherent optic is a small arrow. This arrow denotes which side must point toward the laser cavity.

(4) Re-insert the high reflector being careful not to scratch the mirror surface.

(5) Re-establish lasing and peak rear adjustments for maximum power.

NOTE

If power has decreased, reclean the optic.

6.1.2 Output Coupler Cleaning

CAUTION

Be careful not to drop the beamsplitter when performing the next step. The beamsplitter can easily fall out of the output coupler mirror holder.

(1) Remove the output coupler mirror holder and beam pick-off assembly. Slide the sensor pick-off out of the output coupler holder.

(2) Reverse the mirror in its holder to first clean the outer surface. When removing the mirrors from holders, always grasp them by the outer edge; never touch either optical surface.

(3) Follow the cleaning procedure as outlined in section 6.1.1.

(4) Change the output coupler to its normal orientation and clean as before.

(5) Reinsert the output coupler assembly with the slot-key down.

6.1.3 Beam Pick-Off Cleaning

Another cleaning technique is used for the beam pick-off and other optical surfaces that are not easily accessible. This technique may also be used to clean a more contaminated optic.

(1) Fold a tissue into a pad 1 cm wide, being careful not to touch the area that will be in contact with the optic.

(2) Grasp the pad with clean hemostats as shown in Figure 6.2.

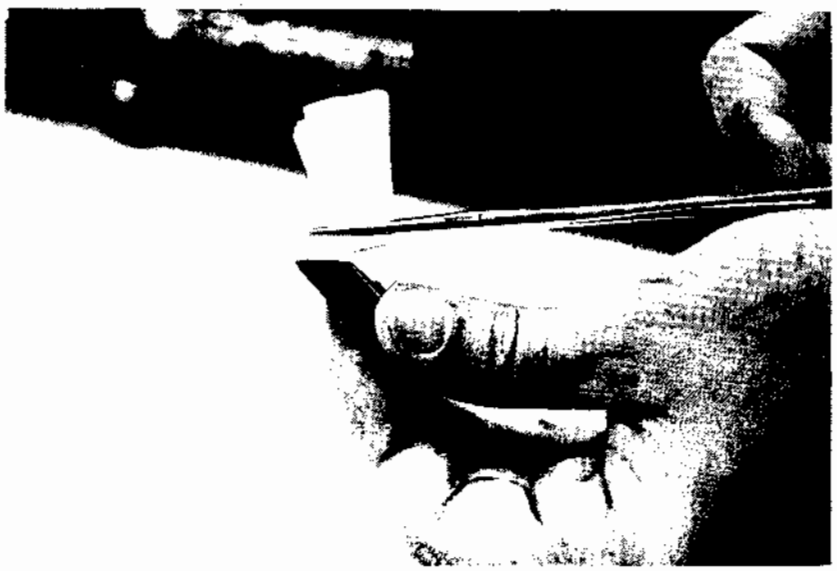


Figure 6.2 Cleaning Using Hemostats and Tissue Pad

(3) Place a few drops of methanol on the pad and shake off the excess.

(4) Make a single wipe across the optical surface. Do not re-use the tissue.

(5) Perform the same procedure on the inside surface using a fresh tissue.

(6) Reinstall the beam pick-off assembly with the key-pin down.

(7) Re-establish lasing and peak front and rear controls as necessary. A small "walk-in" may be required (see Section 6.3.3).

6.1.4 Wavelength Selector Cleaning

(1) Remove the wavelength selector (Figure 6.3) as described in Section 4.2.5.2.

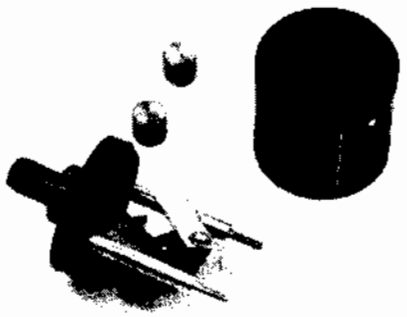


Figure 6.3 Wavelength Selector

(2) The cover can be removed for cleaning by removing two knurled nuts at the rear of the dust cover. The entire cover is now removed by pulling straight back.

(3) There is a small metal plate covering the prism to stop dangerous reflections. To clean the prism, loosen the screw and rotate the plate out of the way.

(4) Clean the prism using the procedure described in Section 6.1.3. Replace the safety cover.

(5) Remove the high reflector by sliding the spring clip to the side. Grasp the optic by its edge and put it in the line mirror holder for convenient cleaning.

(6) Clean the optic using the procedure outlined in Section 6.1.1.

(7) Reassemble the wavelength selector.

6.1.5 Optional Model 923 Etalon Cleaning

(1) As shown in Figure 6.4, the front of the etalon housing is a large knurled collar; unscrew this collar from the housing.

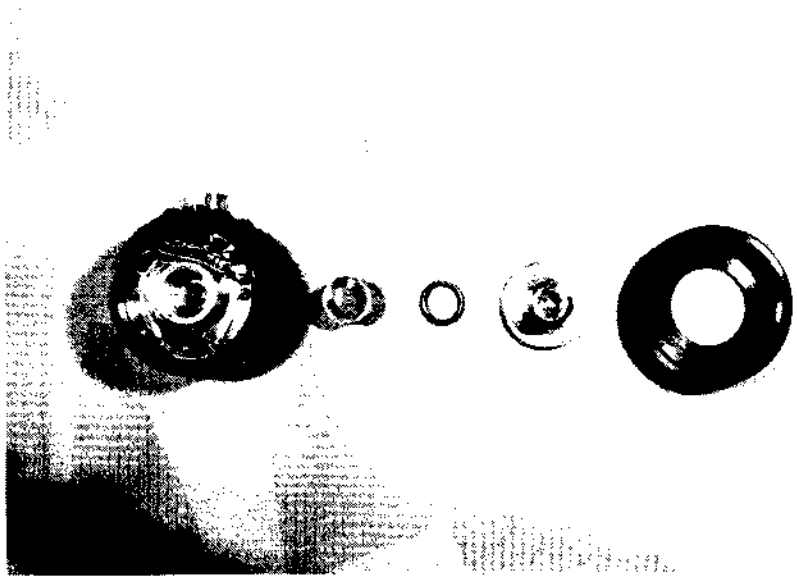


Figure 6.4 Disassembly of Model 923 Etalon for Cleaning

(2) Lift out the spacer from the center of the housing; the spacer has a shaft that protrudes down into the center cylindrical column of the housing.

(3) An O-ring is now exposed, sitting on top of the optic; remove this O-ring by carefully inverting the holder and catching the O-ring with the free hand.

(4) The optic is now exposed; remove it, taking care not to touch the optic surface with bare hands.

(5) Clean the optic, using the procedures of Section 6.1.1, steps (1) through (4).

(6) Replace the optic in the holder by carrying out the above steps in reverse.

6.1.6 Brewster Window Cleaning (Figure 6.5)

Special care should be exercised when cleaning Brewster windows. A careless scratch on the window surface may degrade performance to such an extent that the tube will need to be replaced. The Brewster windows are in a sealed cavity and will rarely need to be cleaned.

WARNING

Always clean the windows with the electrical power off. Extremely high current sources may be exposed very near the Brewster window which may cause serious shock to the operator or, if grounded, may result in tube destruction.

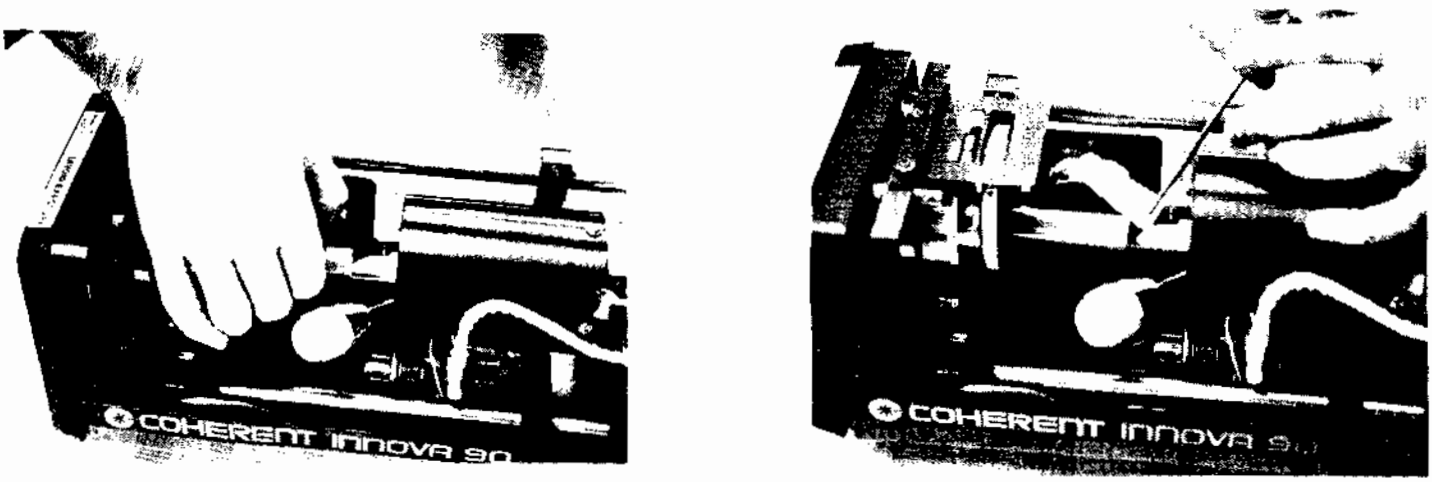


Figure 6.5 Brewster Window Cleaning

(1) Turn the laser electrical power off.

(2) Remove head cover.

(3) Slide the metal dust shield toward the mirror mount to expose the Brewster window.

(4) To clean the Brewster windows (Figure 6.5), use the hemostat and tissue pad technique described in section 6.1.3.

(5) Always wipe the windows with a smooth continuous motion. Wipe in the correct direction, as follows: On the front window, wipe from TOP to BOTTOM. Never wipe the front window from bottom to top as chips can be broken from the sharp bottom edge of the window and dragged across the Brewster surface, possibly scratching it. On the rear window, wipe from BOTTOM to TOP, because this window is installed "upside down". Several wipes, each with a new tissue, will be necessary. On the first wipe use very little pressure, to remove any dust particles from the window. On subsequent wipings use 0.2Kg (7 oz) of force.

(6) After cleaning the window, wait about 15 seconds to allow vapors to escape before sliding the dust shield back in place.

(7) After cleaning the Brewster windows, replace the head cover.

6.2 CHANGING OPTICS

When changing optics, always insure that the replacement optics are clean before installing. Also, be sure that the polished mirror optic seat is clean; it may be cleaned with a cotton swab and methanol. Any dust on the mirror seat will cause the optic to seat improperly, making initial lasing more difficult.

All Coherent optics are designed with a 30 min. wedge in the optics. When changing output couplers, the position of the output beam will move, as the orientation of the wedge is changed. This is important in systems where the realignment of the output beam is required to an optical system. The wedge orientation can be checked by noting the position of the weak satellite beams. If the satellite beams are always located in the same relative position to the primary output (for example in the horizontal plane and to the right hand side of the beam) then the position of the output beam is reproduced.

6.2.1 Visible to Visible

(1) Align the laser for maximum power. If the power output is below normal, the mirrors may need to be "walked-in", see Section 6.3.3.

(2) Cease laser action by closing the laser shutter.

(3) Remove the mirrors and replace them with freshly cleaned mirrors for the desired wavelength region.

(4) Open the laser shutter. If laser action is taking place, first peak the laser power using the rear mirror vertical and horizontal controls. Then maximize power by the final resonator adjustment (walking-in) described in Section 6.3.3.

(5) If lasing action does not occur with small adjustments to the vertical and horizontal rear mirror adjustments, use the vertical search procedure as described in section 6.3.1.

6.2.2. Visible to UV Procedure (High Field Operation)

This method is applicable to the UV generation of the argon Innova and UV and Violet operation of the krypton Innova.

(1) Tune the laser for maximum power, using the all-lines optic holder.

(2) Turn laser off.

WARNING

When switching the tube magnetic field, the laser must be turned off.

(3) To operate the laser in UV, the tube magnetic field must be changed to high field. Change the magnetic field switch located on the rear panel of the power supply from the VIS to UV position.

(4) Turn laser on.

(5) Change the optics as described in Section 6.2. It will be necessary to place a fluorescent target, such as a white business card, in front of the beam to detect laser action.

Due to the limitations of silicon photodetectors, the power meter is not calibrated or guaranteed for UV operation. However, using the calibration point supplied with the Test Data Sheet (shipped with the laser), the WAVELENGTH setting on the control panel can be set to give a reasonably accurate reading of UV output power.

6.3 MIRROR ALIGNMENT

Three types of mirror alignment are described, each method remedies a different type of mirror misalignment. The first procedure, Vertical Search, is the alignment technique most often required. The second, Coarse Mirror Alignment, is rarely required, as the front mirror is usually well enough aligned to allow the simpler Vertical Search procedure to be used. The third procedure, Maximizing the Mirror Alignment, is used whenever the front mirror (output coupler) is not in perfect alignment with the tube.

6.3.1 Vertical Search Procedure

This procedure (Figure 6.6) is used whenever the high reflector (near optic) is misaligned to the point that the laser does not lase. It is assumed that the front mirror is in alignment with the tube. The object of the procedure is to rapidly scan the rear mirror through a grid of possible positions, to find the one position where the mirrors are aligned.

(1) Turn the laser on and set at full current, i.e., set both CURRENT REG and LIGHT REG controls fully clockwise, and select the 20-watt range on the LASER POWER control.

(2) Turn the vertical tuning knob of the rear (high reflector) mirror mount clockwise several turns to tip the mirror forward.

(3) Pull the high reflector mirror mount pin, located on the top of the laser head, back and forth while tuning the horizontal mirror adjustment knob slowly in one direction. If no flash of laser radiation is seen, turn the knob in the opposite direction while wobbling the mirror in the vertical direction. (This forms a search pattern for the mirror alignment needed to produce laser emission).

(4) When a flash of laser radiation appears, slowly turn the vertical mirror adjustment counterclockwise until the laser action is continuous.

CAUTION

If the front optic was changed or cleaned and the output power did not return to normal, the front optic may be misaligned to the tube bore. If this is the case, proceed to Section 6.3.3.

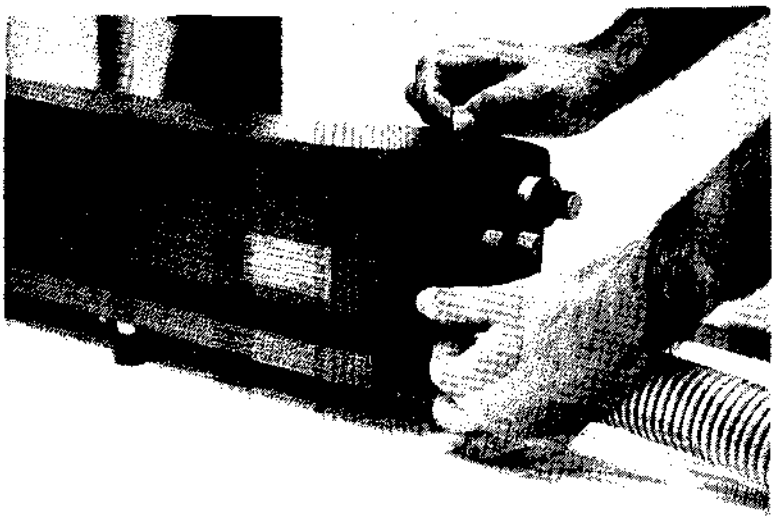


Figure 6.6 Vertical Search Procedure

6.3.2 Coarse Mirror Alignment

If the front and rear mirrors have become completely misaligned to themselves and to the tube, it may be necessary to follow this procedure to find optical alignment. Use this procedure only if the Vertical Scan procedure will not initiate laser action.

(1) Clean and install the front mirror. Remove the rear mirror and have the laser head cover removed, with interlocks defeated.

(2) Turn on the laser at maximum current and fully open the aperture.

(3) Put a white card behind the rear bezel. Slowly pull back on the front mirror plate to achieve vertical movement while slowly turning the horizontal adjusting screw with a 1/8" allen wrench. There are holes in the front bezel that make the screws accessible. At some point, where the mirror is perfectly normal to the laser bore, there will be a movement of light on the white card. It will be a purple color due to the ionized glow of the inert gas, so the movement will be hard to see, since the total image on the card will be the same color.

(4) When a spot is seen that moves as the front mirror is moved, stop rocking the mirror mount and align the two allen screws until the spot is at its brightest. The mirror reflection does not have to be centered in the light passing through the opening in the rear mirror mount. When the image is brightest, the mirror is aimed straight down the bore.

(5) Clean and install the rear mirror. Rock and scan the rear mirror as was done with the front mirror. The only difference is that the horizontal place can be scanned by tuning the lower knob. It will not be necessary to move the mirror plate with allen screws since both horizontal and vertical controls are geared to knobs on the rear bezel.

(6) When the laser suddenly flashes, stop tuning the horizontal knob and adjust the vertical knob until the lasing is sustained. Then proceed to Section 6.3.3.

6.3.3. Maximizing the Mirror Alignment

Lasing indicates the mirrors are parallel. It does not guarantee the mirrors are aimed straight down the bore. Maximum power can only be realized when a major alignment ("walk-in") is performed to align the mirrors to the bore. The aperture should be at the "0" setting for this procedure.

NOTE

Dirty or scratched windows and mirrors will make alignment difficult since one cannot tell if the power has increased because of proper alignment, or because the beam has moved away from a dirt spot on the window.

To align the mirrors to the bore, or "walk-in" the laser (Figure 6.7), proceed as follows:

(1) Turn one of the front mirror screws with the 1/8" allen wrench until the power drops to one half.

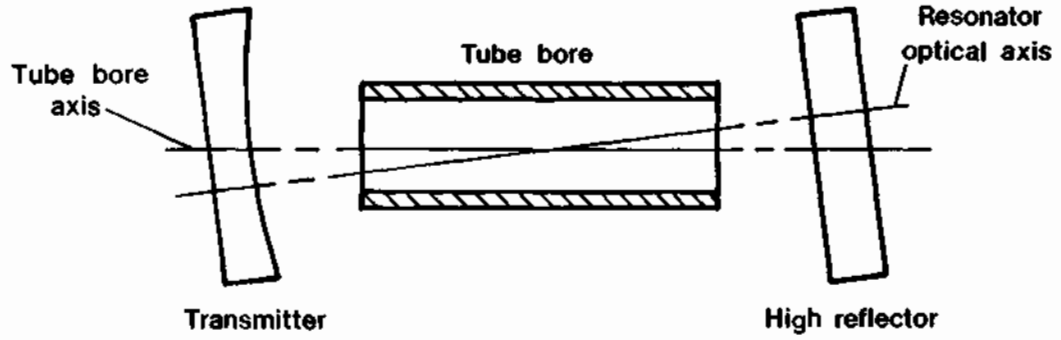
(2) Peak the laser again by turning the rear mirror tuning knobs until the power is again maximized.

(3) If the maximum power is now higher than before, make further corrections in the same direction.

(4) If the power has decreased, turn the front mirror screw the other way.

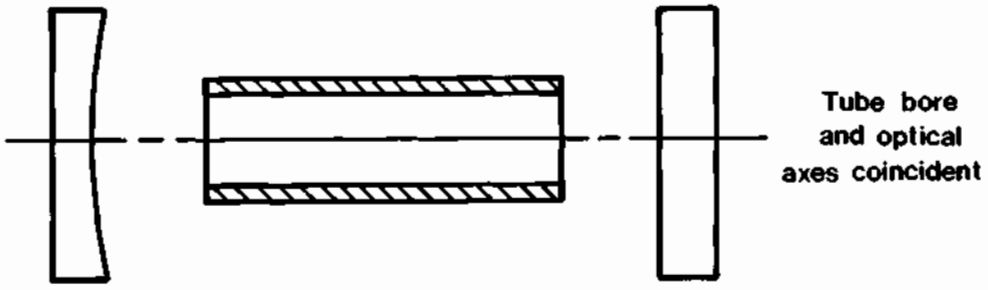
(5) When the power is optimized, turn the other front mirror screw and repeat the trial and error adjustments until the laser is at its maximum power.

(6) When both adjusting screws can no longer be corrected for more power, the mirrors are aligned.



IMPROPERLY ALIGNED RESONATOR

Shown above, in exaggerated form, is an operating laser with its output mirror improperly aligned and maximum power obtained by high reflector mirror adjustment only. Here the optical and tube axes are not coincident. Final resonator alignment, and maximum power obtainable by resonator alignment alone, is achieved by adjusting the two mirrors to make these axes coincide. This is done by a walking procedure in which small changes are made alternatively in the two horizontal and two vertical adjustments.



PROPERLY ALIGNED RESONATOR

Figure 6.7 Aligning Mirrors to the Bore

8. Turn the wavelength selector until continuous lasing occurs. Adjust this adjustment for peak power.

9. Adjust the multiline holder vertical and horizontal adjustments for maximum power. These two adjustments are interactive and you may have to go back and forth between the two adjustments several times to achieve maximum power.

NOTE

From time to time while performing Steps 10 and 11, it may be necessary to repeak the multiline holder horizontal, to maintain a high laser power output.

10. Observe the new reading on the wavelength selector. Slowly rotate the wavelength selector toward the reading recorded in Step 7 above. Notice the laser power decreases.

11. Before lasing stops, repeak the multiline holder vertical adjustment to achieve maximum power.

12. Repeat Steps 10 and 11 until wavelength selector is back to the original reading as recorded in Step 7 above.

13. Peak both horizontal and vertical multiline holder adjustments to achieve maximum multiline power.

14. Fine adjustment can be achieved at this point by adjusting the mirror plate horizontal and vertical adjustments.

15. Unit is set up for crossover between multiline and single line operation.

7.0 TROUBLESHOOTING

7.1 FAULT INDICATORS

To aid troubleshooting, the INNOVA series ion lasers are equipped with eleven automatic fault indicators. Located on the upper control panel, these indicators show the causes of most system failures, as follows:

Fault Indicator	Cause of System Failure
FAULT	One or more system faults has been detected.
OPERATE	System is ready for operation; no faults are present.
OVER VOLTAGE	Excessive passbank voltage.
UNDER VOLTAGE	Passbank voltage dropped below minimum value.
OVER PRESSURE	Excessive gas pressure inside tube resulting in high operating voltage.
UNDER PRESSURE	Insufficient gas pressure inside tube resulting in low operating voltage.
WATER FLOW	Insufficient cooling water flow rate.
WATER TEMPERATURE	Cooling water temperature too high.
OVER CURRENT	Excessive tube current.
PASSBANK TEMP	Passbank is overheated.
PASSBANK TRANSISTOR	Failure of one or more passbank transistors.
FUSE	LINE FUSE has failed.
COVER	Laser head cover open or power supply cover is open.

The fault indicators are operational whenever the LOCK switch is turned on. Each time a system fault is detected, both the FAULT indicator and the indicator showing the particular fault(s) are illuminated. If the RESET indicator is illuminated, press the RESET switch after all faults have been corrected. The fault indicator will turn off and the OPERATE light will illuminate. The laser can then be turned on by following the normal start-up procedure.

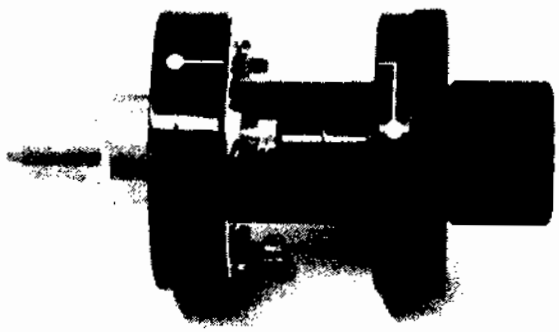


Figure 6.8. Multiline Mirror Holder, Top View

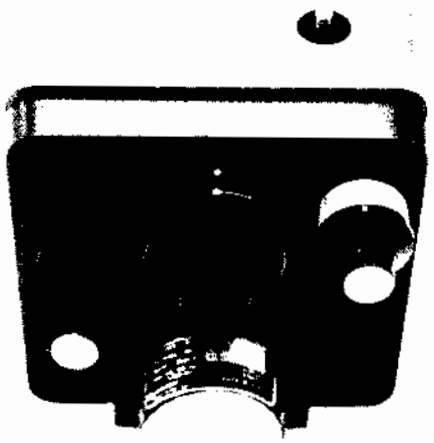


Figure 6.9. Multiline Mirror Holder, End View with Holder Installed

(7) Check the centering of the aperture as described in Section 8.2.4.

6.3.4 Aligning the Multiline Mirror Holder

CAUTION

During the following procedure, do not change the rear horizontal or vertical laser adjustments until told to do so. If those adjustments are prematurely moved, start over with Step 1.

1. Install the wavelength selector and align the unit in accordance with the procedures in Section 6.3.

2. After the laser is fully aligned and "walked in", remove the wavelength selector and install the all lines holder (See Fig. 6.8 and 6.9). Make sure the multiline holder has the proper high reflector installed. Turn the rear vertical mirror knob to read 488 nm for argon lasers or 500 nm for krypton lasers.

3. If lasing occurs, proceed to Step 13. If lasing does not occur, proceed to the next step.

4. Using a 7/64" allen wrench, turn the multiline holder vertical adjustment one-half turn counter clockwise.

NOTE

The horizontal and vertical adjustments on the multiline holder are very coarse. A very small turn will make a large change in optic alignment.

5. Rock the rear mirror plate pin back and forth while making very small turns in one direction on the all lines holder horizontal adjustment. The 7/64" allen wrench will be required for this adjustment. If no flash is observed, turn the multiline holder horizontal adjustment in the opposite direction.

6. When a flash is observed, stop turning the all lines horizontal adjustment and cease rocking the rear mirror plate pin.

7. Record the wavelength reading on the mirror plate vertical adjustment knob.

7.2 TROUBLESHOOTING GUIDE

	Fault	Cause
1.	START light goes out in 30 seconds but tube does not ionize.	a. Control Module not plugged into rear panel. b. Unit in MAN START. c. Starter is defective. d. Tube is over pressurized.
2.	COVER light goes on when key lock is turned on.	An interlocked cover is open.
3.	WATER FLOW light is on.	Less than 8 liters (2.2 gallons) per minute water flow.
4.	WATER TEMP light is on.	Drain water temperature is above 71°C/160°F.

Remedy

a. Connect J101 on the rear panel.

b. Push MAN START or AUTO START.
c. Call Service Representative.
d. Call Service Representative.

Check all possible interlocks:
a. Top cover on power supply.
b. Bottom cover on power supply.
c. Fuse cover on power supply.
d. Passbank cover on power supply.
e. Laser head cover.

a. Kinked hose.
b. Obstruction in water line.
c. Clogged filter.
d. Obstructed drain.
e. Water not turned on.

a. All of problems in (3).
b. Input water temperature above 30°C/86°F.

Fault	Cause
5. OVER VOLTAGE light is on.	Passbank voltage has exceeded 140 volts.
6. UNDER VOLTAGE light is on.	Passbank voltage less than 10 volts.
7. OVER CURRENT light is on.	Current has exceeded 40 amperes.
8. OVER PRESSURE light is on.	Tube voltage is greater than upper limit.
9. UNDER PRESSURE light is on.	Auto fill test point indicates low tube voltage.
10. FUSE light is on.	A blown line fuse.
11. PASSBANK TEMP light is on.	Passbank temperature has exceeded 160° F.

Remedy

Call Service Representative.

Call Service Representative.

Call Service Representative.

a. Turn on power supply (in manual start only). Operate for six (6) minutes.
b. Depress manual start. If over pressure light is still on turn off unit for 15 minutes.
c. Repeat A and B five times. If light still comes on call Service Representative.

Call Service Representative.

a. Disconnect power cable from power source.
b. Replace defective fuse. (see 8.2.1)
c. Reconnect power cable and turn on the power supply.
d. If fuse light illuminates again, call Service Representative.

a. Check water flow.
b. Check water temperature; must be less than 30°C/86°F.

Fault	Cause
12. PASSBANK TRANSISTOR light is on.	If system is still operating, one or two transistors have shorted. If three are shorted, the system will shut down.
13. Output is unstable when using wavelength selector.	a. Stabilizing bar is loose.
	b. Contaminated prism.
	c. Loose prism.
	d. Loose mirror.
	e. Absorption by mirror.
14. Output is dramatically reduced when smaller aperture settings are used.	Aperture is misaligned.

Remedy

Replace transistors per section 8.2.2

a. Tighten spring loaded screw that secures metal spacer in wavelength selector assembly until firm and then back-off 1/12 turn.
b. Clean prism. Replace if necessary; surface of prism may be damaged.
c. Remount with double adhesive tape.
d. Check seat that mirror rests on. Tighten spring clip that holds mirror in position.
e. Clean mirror. Replace if necessary.

Align aperture per section 8.2.4.

7.3 UTILITY BOARD SERVICE TEST POINTS

CAUTION

The INNOVA electrical circuitry is referenced to B- (-150 Vdc) DO NOT use grounded test equipment. Use isolated test equipment such as most battery powered instruments. When using isolated test equipment, the chassis of the equipment may be at high voltage potential.

The Utility Board is found under the top cover of the power supply. There are two printed circuit boards in the aluminum board rack. The upper board is the Utility Board and the lower board is the Interface Board. The board rack can be raised to the vertical position by unscrewing the two long black finger screws located on the outside corners of the rack.

7.3.1 Tube Voltage

The tube voltage is measured between test points TP36(+)(B+) and TP16(-)(collectors).

Nominal tube voltage is 235 Vdc at 40 amperes (for 90-4, 5, K) or 225 Vdc at 35 amperes (for 90-2, 3).

7.3.2 System Power Supply ±15 Vdc

The power supply used to provide power for the logic and regulator circuits is ±15 Vdc and rated at 400 mA.

The +15 Vdc supply is measured between TP53(+) and TP44 (return/B-) on the Utility Board.

The -15 Vdc supply is measured between TP52(-) and TP44 (return/B-) on the Utility Board.

8.0 MAINTENANCE

WARNING

Circuits in the laser head and power supply operate at high voltages. **THESE HIGH VOLTAGES ARE LETHAL.** Use **EXTREME CAUTION** whenever operation without head or power supply cover is required. If operation of the laser is not required, disconnect the main power before removing covers.

8.1 PREVENTIVE MAINTENANCE

8.1.1 Electrical Inspection

NOTE

Condensation may occur on the passbank when the temperature of the passbank is below the dew point. Since the passbank is located in an isolated drawer, the condensed water will run harmlessly to the bottom of the drawer where it will evaporate.

Electrical connections should be checked to insure that they are making good contact and that the insulation, especially on the cathode and anode leads, is in good condition. Look for any small objects (screws, etc.) that may have accidentally fallen into the head or power supply; they may cause mechanical obstruction or electrical failure.

8.1.2 Optical Inspection and Cleaning

CAUTION

Continual cleaning of optical surfaces shortens the optic's useful life and increases the possibility of scratching the optic during cleaning. Keep the laser cavity sealed to prevent contamination of the cavity optics, and always store extra optics in the sealed containers provided.

In the event of marked power loss, the optical surfaces should be checked to insure that they are free from surface contaminants and damage. Examine the optic in different lights for films, streaks, or dust particles. If the optic is dirty, clean the optic as described in section 6.1.

8.1.3 Water System Inspection and Cleaning

8.1.3.1 Water Hose Inspection

Periodically, check the water hoses and water connections for wear and leaks. Replace worn hoses to avoid serious and potentially hazardous flooding of the laser compartment or laboratory.

8.1.3.2 Water Filter Replacement

The quality of the local water will determine the frequency of water filter replacement; experience will be the best guide. If the water contains many particulates, the filter may need to be changed as often as once a week. If the filter clogs, the system will shut down due to lack of water flow. It is best to replace the filter before this occurs.

If a Coherent water filter assembly (P/N 124-189) is in use, replace the filter with P/N 2603-0016.

8.1.3.3 Water Flow Indicator Inspection and Cleaning

The water flow indicator (Figure 8.1) is a fail safe device that reliably senses whether the water flow is adequate to cool the laser. It is located on the left side of the passbank drawer and can be seen when the drawer is pulled out.

Some water sources will cause algae to grow around the pump impeller. Eventually, such growth will restrict water flow and the laser's protection circuit will be activated. To avoid an untimely shutdown of the laser, periodically inspect the impeller and clean it if necessary. Use the following procedure:

(1) Disconnect laser power.

(2) Disconnect and drain the hoses from the water inlet and output. If the power supply is raised above the head, there will be less water to drain.

(3) Unscrew the four passbank drawer thumb screws and slide out the passbank.

(4) Remove the six Phillips screws from the clear plastic face plate of the flow indicator.

(5) Clean the flow indicator wheel.

(6) Make sure the O-Ring is in good condition and free of debris.

(7) Replace the cover plate, reconnect water lines and check for leaks.

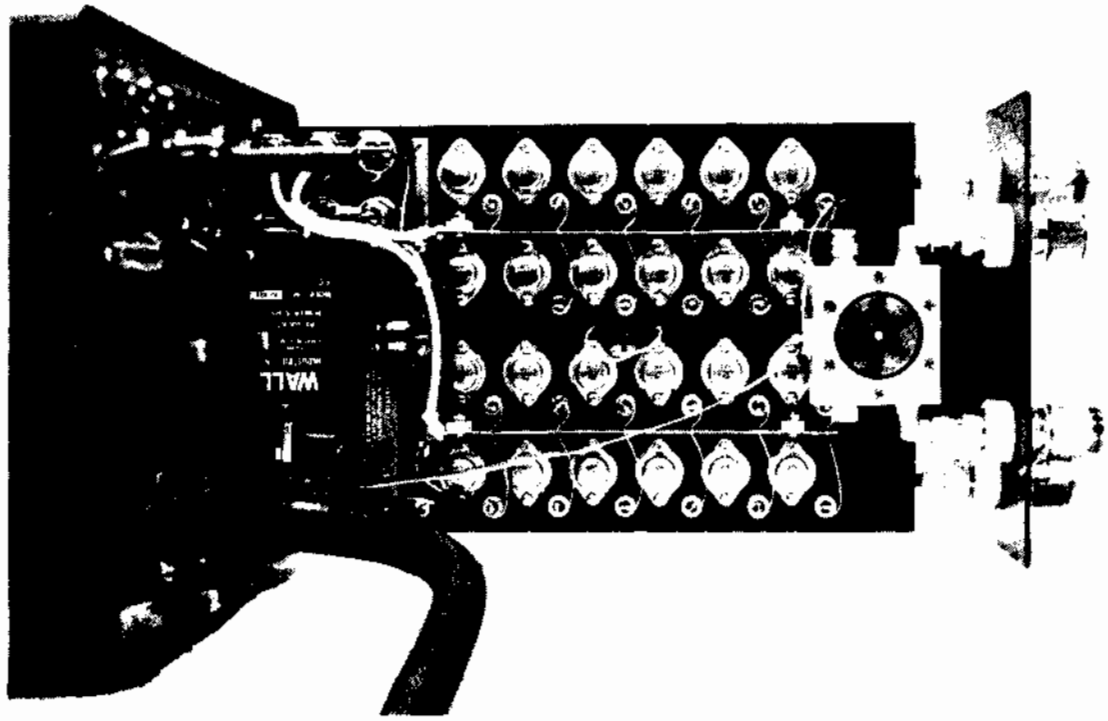


Figure 8.1 Passbank Drawer Showing Water Flow Indicator

8.2 CORRECTIVE MAINTENANCE

8.2.1 Fuses

8.2.1.1 Main Line Fuses

WARNING

> The LINE FUSES are normally protected by a cover (not shown in Figure 8.2) marked DANGER. Disconnect main power to the power supply before removing this cover. Keep cover in place except when changing fuses.

There are three main line fuses, one for each phase; all three are special short-time-lag semiconductor type, 70 ampere, 700 volt fuses, Coherent P/N 5110-0004. As shown in Figure 8.2, they are located on the rear panel of the power supply, labelled LINE FUSE. These fuses protect the rectifier circuit. Failure of one of these fuses is indicated by the FUSE light on the control panel. In the event of a failure of a LINE FUSE, faulty rectifiers or filter capacitors should be suspected. Normally, these fuses are beneath a protective cover.

CAUTION

> Replace LINE FUSES only with the type specified above. Ordinary power fuses may permit rectifier failure before they blow.

8.2.1.2 208 Volt System Fuses

Also shown in Figure 8.2 are the three system fuses mounted on the rear panel of the power supply. Two of these fuses, labelled 208 VAC 3 AMP, are 3 ampere, 250 volt, slow blow, Coherent P/N 5110-0021. These two are the "housekeeper" fuses that protect the system power supply, the filament, and the starter circuit. A failure of either of these fuses will cause the system to shut down. With such a failure, the LASER EMISSION and OPERATE light will be on, but when the ON button is pushed, the main contactor will close only momentarily.

The third system fuse, marked CONTROL XFMR 1 AMP, is a 1 ampere, 250 volt, slow blow, Coherent P/N 5110-0175. It protects the 24 volt interlock system. Failure of this fuse will disable all electrical functions of the laser and cause all the control panel indicators to black out.

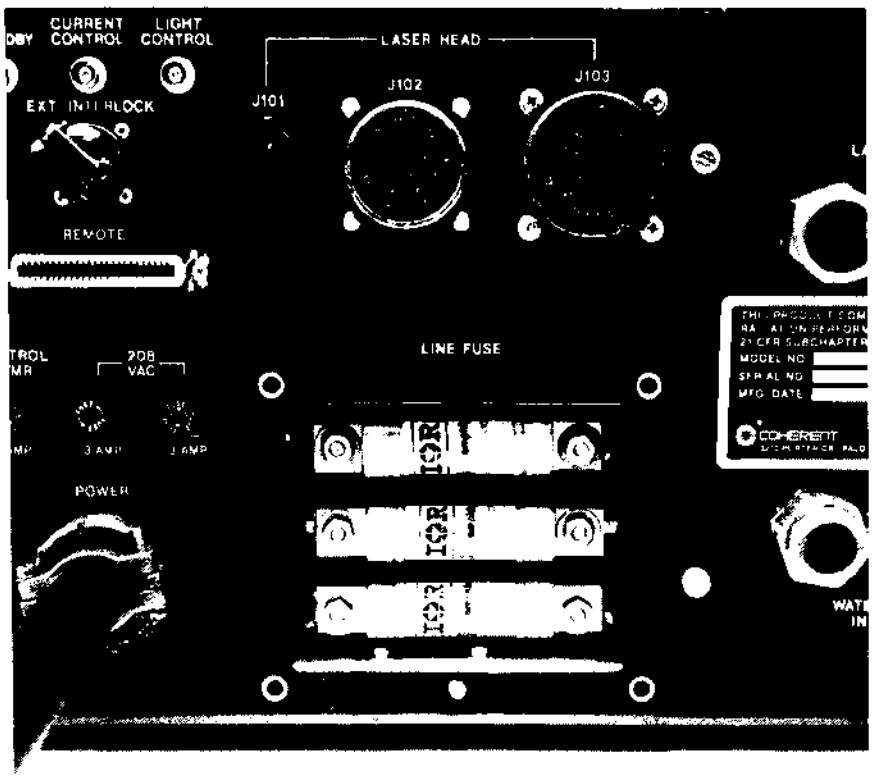


Figure 8.2 Power Supply Rear Panel with Line Fuse Cover Removed

8.2.2 Passbank Transistor Replacement

8.2.2.1 Passbank Functional Operation.

The INNOVA passbank will operate without degradation of performance even though as many as two pass transistors are shorted. Each emitter is fused with a 4-ampere fuse. When a transistor shorts, the fuse blows and disconnects the transistor. A light emitting diode (LED) on the passbank then lights to indicate which transistor and fuse is defective. In addition, the PASSBANK TRANSISTOR light on the control

module turns on to indicate a transistor has failed. The power supply may be operated indefinitely with two transistors blown. If a third transistor fails, the power supply will shut off and cannot be started until the transistors are replaced.

8.2.2.2 Transistor Replacement Procedure.

(1) Loosen the thumb screws holding the passbank drawer in the chassis and carefully slide it out until the TEST-RUN switch on the top of the current regulator board located on the right side of the passbank drawer is clear of the chassis, as shown in Figure 8.3.

(2) Switch the TEST-RUN switch to the TEST position and turn on the KEY switch on the control module. The LED's associated with the blown transistors will light. Turn off the KEY switch. Disconnect the line cord from the wall plug.

(3) Remove the screws holding the defective transistors in their socket and carefully remove the transistors.

(4) Inspect the area under the transistor for metal filings and other material. Check to confirm that the beryllium oxide disk is not cracked. If it is cracked, replace it. Clean the area if necessary and coat both sides of the new disc with Wakefield Thermal Grease No. 120-8 or equivalent.

(5) Replace transistors only with type 2N6259. Coat the bottom of the transistors with the Wakefield Thermal Grease No. 120-8. Carefully install in socket. Replace screws, being sure that the shoulder washers are properly installed.

(6) Tighten screws <u>evenly</u> and torque to 6 inch-pounds (6.90 cm-kg).

(7) Locate the fuse associated with each transistor that was blown and replace it with a 4-ampere fuse, Littlefuse Part No. 275004. Fuses are located on bifurcated terminals near each transistor, as shown in Figure 8.3.

(8) Check the 2.7 ohm emitter resistor associated with the transistor that has been changed for possible short to ground. Check collector for short to ground. If in good order, reconnect the line cord, turn on LOCK switch. No LED's should be on.

(9) Turn off LOCK switch. Turn TEST-RUN switch to RUN position. If the TEST-RUN switch is left in the test position, the PASSBANK TEMP fault indicator will illuminate when power is applied to the system. Carefully push passbank into the chassis and tighten screws. Power supply is now operational.

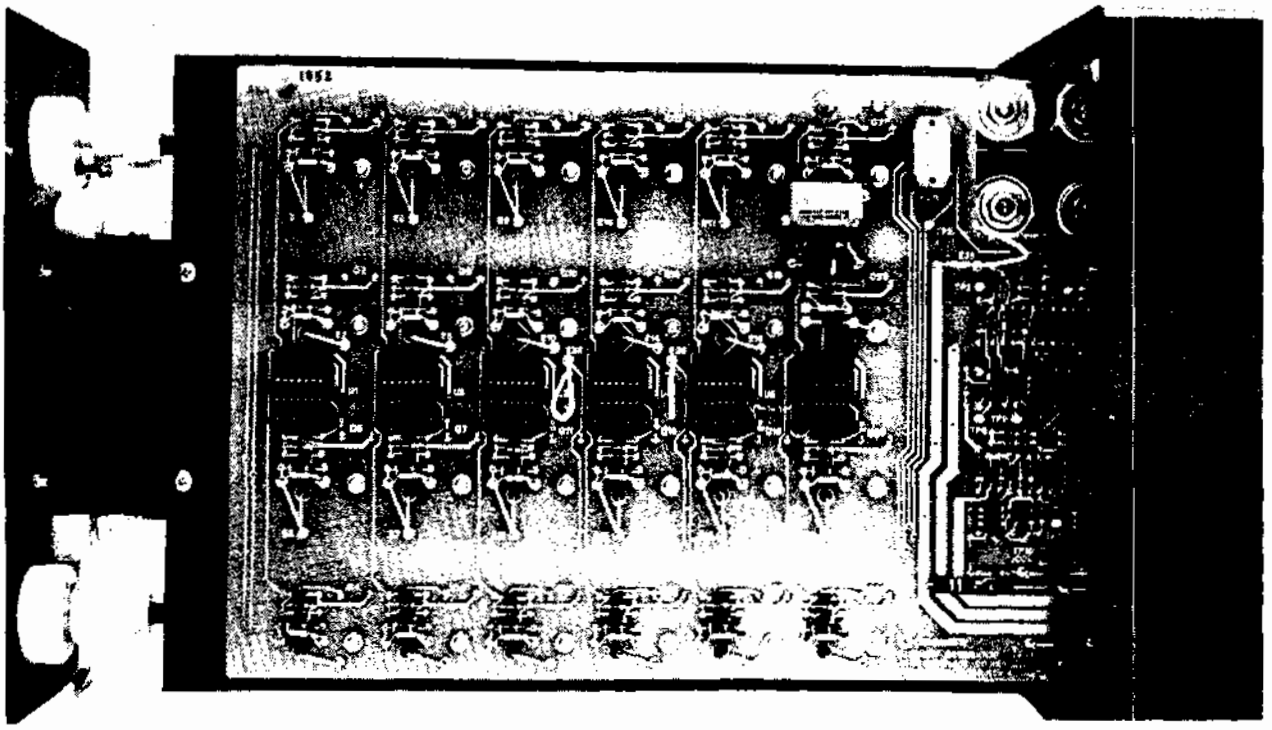


Figure 8.3 Current Regulator Board with TEST-RUN Switch

8.2.3 Tube Alignment Procedure

Tube realignments must be performed by authorized Coherent Service Representatives (refer to Section 11.4). The tube is aligned to the resonator at the factory and should not have to be realigned unless it has been removed or the tube is being replaced.

8.2.4 Aperture Alignment Procedure

The aperture should not require realignment unless the aperture adjustment screws have been moved or the tube position in the resonator has been changed. To check the alignment, rotate the aperture from the largest to smallest hole while observing power output. The output should decrease gradually as smaller and smaller aperture holes are used. If the aperture is misaligned, output power will drop dramatically as smaller aperture holes are chosen, and, at some point, the aperture disk will completely occlude the output beam and lasing will cease.

Refer to Figure 8.4. The aperture uses a three point positioning system. The lower point is a spring-loaded screw enabling all adjustment to be made with the two Allen screws located on the top of the aperture, just behind the front bezel.

Realign the aperture as follows:

(1) Turn laser off.

(2) Remove head cover.

(3) Install interlock defeats on the front and rear bezel.

(4) Turn on laser and set at full current in current regulation.

(5) Open the aperture to the largest hole setting marked "O".

(6) Walk-in the optics using the procedure found in Section 6.3.3.

(7) Using a 5/64 Allen wrench, adjust the two Allen screws for maximum power.

(8) Perform steps 6 and 7 until no further increase in power is observed. This is done to insure that the beam is aligned within the bore as well as the aperture. The aperture may be aligned to the beam while the beam is misaligned to the tube (See Figure 6.7).

(9) Step down the aperture setting to the hole size that produces a TEM_{00} beam. Carefully adjust the aperture adjustment scews to maximize power.

(10) Check for gradual power decrease as aperture is rotated from the largest hole to the smallest.

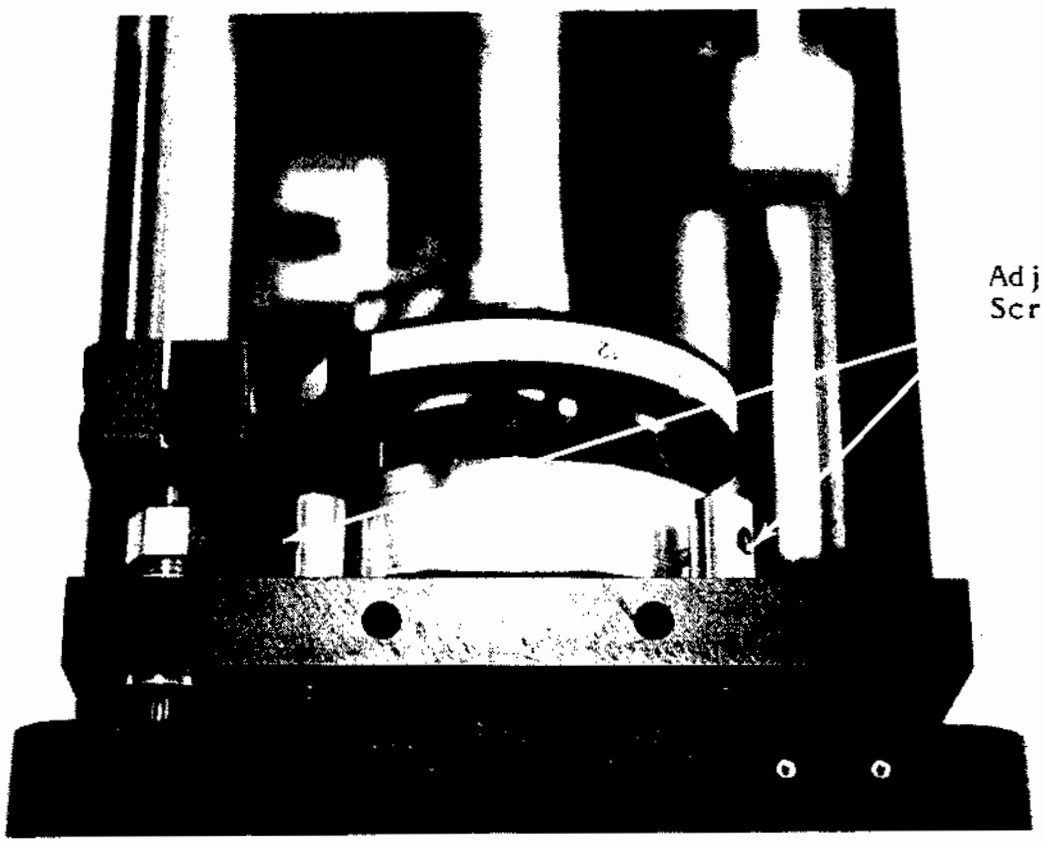


Figure 8.4 Aperture, Showing Allen Screws Used for Adjustment

Section 10.0 **SCHEMATICS** 10-1

0155-732-00E Resistor Module

0155-717-00A Control Panel

0155-466-00C Display Driver

0155-462-00A Light Regulator

0155-424-00B Utility P.C.Board

0155-479-00A Interface P.C.Board

0155-475-00B ±15V System Power Supply

0155-710-00B Power Pack

0155-409-00A Current Regulator P.C.Board Assembly

0155-661-00A Ion Starter

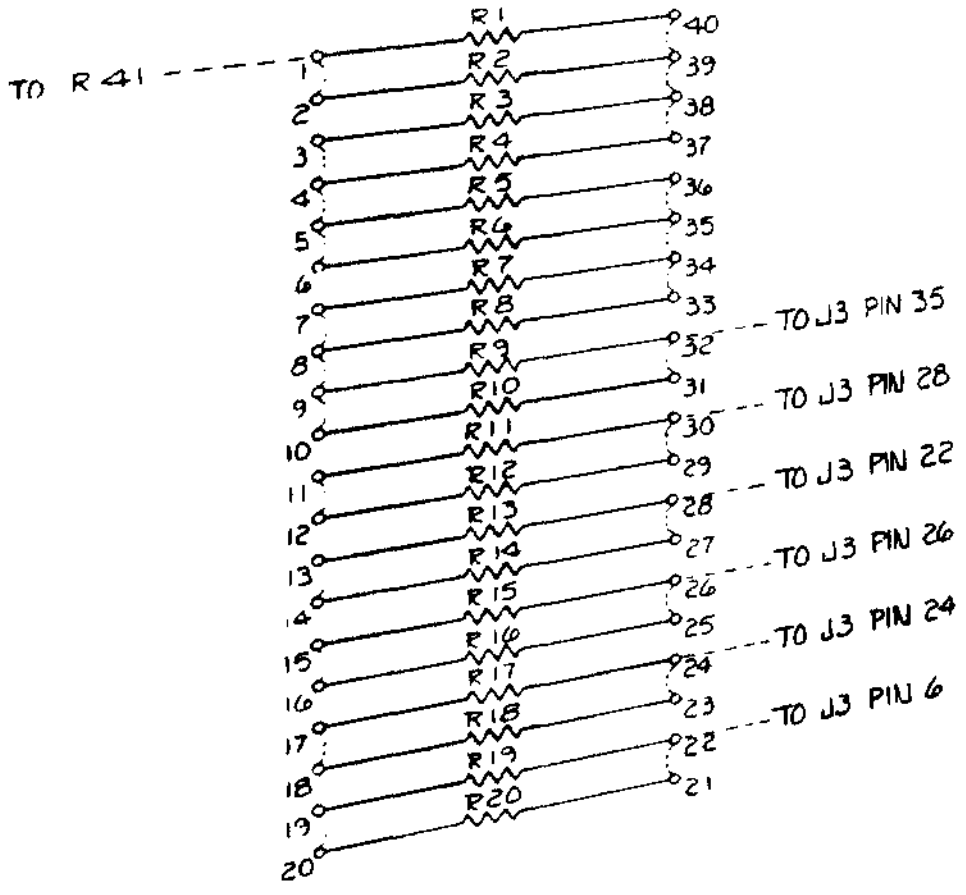
0155-417-00B Heater Controls

0155-711-00E Laser Head

NOTES

1. DASHED LINES INDICATE CONNECTIONS ON 0155-780-00 LIGHT REGULATOR P.C. ASSEMBLY.
2. ALL RESISTORS ARE ± 1% 1/4 W.
3. LOT NO. MATCHES LOT NO. OF LIGHT PICKOFF ASSEMBLY 0155-508-00.

DO NOT SCA



PIN 20 TO PIN 35	PIN 16 TO PIN 31	PIN 16 TO PIN 31
PIN 18 TO PIN 31	PIN 14 TO PIN 35	PIN 14 TO PIN 35
PIN 12 TO PIN 39	PIN 12 TO PIN 39	PIN 12 TO PIN 39
PIN 8 TO PIN 16	PIN 8 TO PIN 18	PIN 8 TO PIN 18
PIN 4 TO PIN 14	PIN 4 TO PIN 20	PIN 4 TO PIN 20
10.5Ω	10.5Ω	10.5Ω
10.5Ω	10.5Ω	10.5Ω
OPEN	OPEN	OPEN
54.9Ω	47.5Ω	47.5Ω
OPEN	OPEN	OPEN
137Ω	124Ω	121Ω
OPEN	OPEN	OPEN
205Ω	200Ω	200Ω
OPEN	OPEN	OPEN
249Ω	255Ω	255Ω
OPEN	OPEN	8.87Ω
11.5Ω	1.0Ω	8.87Ω
OPEN	OPEN	OPEN
18.7Ω	21.5Ω	21.0Ω
12.1Ω	OPEN	16.2Ω
12.1Ω	11.0Ω	16.2Ω
OPEN	OPEN	OPEN
27.4Ω	17.4Ω	17.8Ω
OPEN	OPEN	OPEN
15.0Ω	23.2Ω	23.2Ω
LOT NO. 10	09	08

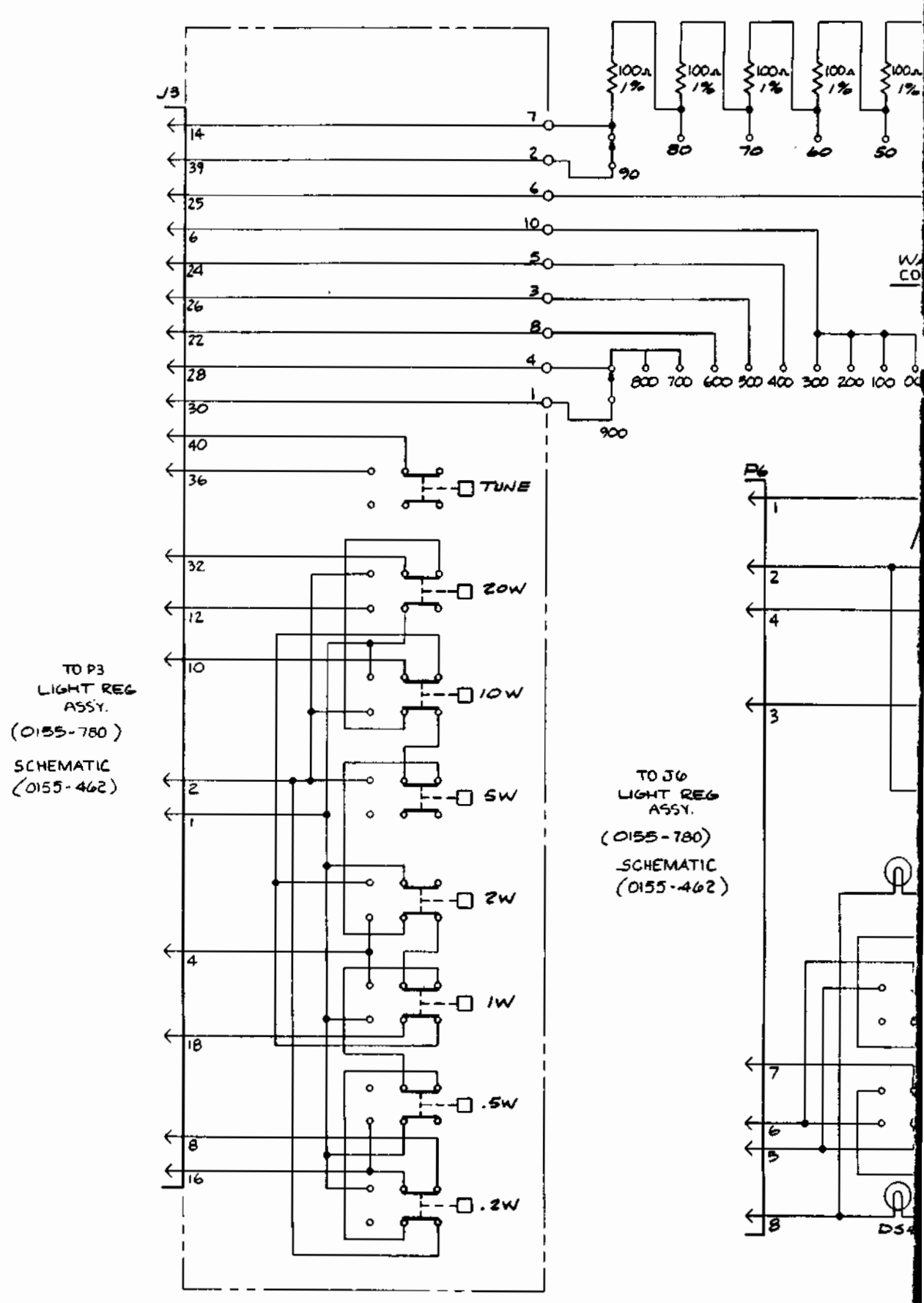
LE DRAWING

RELEASE, NO CHANGE

PIN 20 TO PIN 35	PIN 16 TO PIN 31	PIN 18 TO PIN 35	PIN 16 TO PIN 31	PIN 16 TO PIN 31	PIN 19 TO PIN 39	PIN 19 TO PIN 33	PIN 16 TO PIN 32	CONN-ECTOR
PIN 18 TO PIN 31	PIN 14 TO PIN 35	PIN 16 TO PIN 31	PIN 14 TO PIN 35	PIN 14 TO PIN 35	PIN 16 TO PIN 34	PIN 18 TO PIN 32	PIN 14 TO PIN 35	
PIN 12 TO PIN 39	PIN 12 TO PIN 39	PIN 12 TO PIN 39	PIN 12 TO PIN 39	PIN 12 TO PIN 39	PIN 12 TO PIN 39	PIN 12 TO PIN 39	PIN 12 TO PIN 39	
PIN 8 TO PIN 16	PIN 8 TO PIN 18	PIN 8 TO PIN 14	PIN 8 TO PIN 18	PIN 8 TO PIN 18	PIN 8 TO PIN 14	PIN 8 TO PIN 16	PIN 8 TO PIN 18	
PIN 4 TO PIN 14	PIN 4 TO PIN 20	PIN 4 TO PIN 20	PIN 4 TO PIN 20	PIN 4 TO PIN 20	PIN 4 TO PIN 18	PIN 4 TO PIN 14	PIN 4 TO PIN 19	CONN-ECTOR
10.5Ω	10.5Ω	10.5Ω	10.5 Ω	10.5 Ω	10.7 Ω	43.2 Ω	10.5 Ω	R20
10.5Ω	10.5Ω	10.5Ω	10.5 Ω	10.5 Ω	10.7 Ω	10.0 Ω	10.5 Ω	R19
OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	R18
54.9Ω	45.3Ω	47.5Ω	46.4Ω	45.3 Ω	71.5 Ω	48.7 Ω	47.5 Ω	R17
OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	R16
133Ω	121Ω	93.1Ω	124 Ω	118 Ω	115 Ω	118 Ω	118 Ω	R15
OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	R14
205Ω	205Ω	150Ω	205 Ω	205 Ω	165 Ω	178 Ω	200 Ω	R13
OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	R12
243Ω	249Ω	205 Ω	261 Ω	261 Ω	215 Ω	215 Ω	255 Ω	R11
15.8Ω	OPEN	0.931Ω	7.35Ω	OPEN	OPEN	43.2 Ω	15.8 Ω	R10
15.8Ω	10.2Ω	0.931Ω	14.7Ω	13.7 Ω	18.7 Ω	10.0 Ω	15.8 Ω	R9
OPEN	OPEN	14.0Ω	OPEN	OPEN	11.3 Ω	OPEN	OPEN	R8
21.5Ω	30.1Ω	14.0Ω	24.3 Ω	18.2 Ω	11.3 Ω	15.8 Ω	12.7 Ω	R7
OPEN	5.62Ω	3.01Ω	19.1 Ω	OPEN	5.75Ω	127 Ω	OPEN	R6
12.4Ω	5.62Ω	3.01Ω	19.1 Ω	13.3 Ω	5.75Ω	10.0 Ω	13.7 Ω	R5
OPEN	OPEN	19.6Ω	OPEN	OPEN	20.0Ω	OPEN	OPEN	R4
18.2Ω	14.0Ω	19.6Ω	20.5Ω	21.5 Ω	20.0Ω	20.5 Ω	13.7 Ω	R3
OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	OPEN	R2
17.4Ω	24.9 Ω	32.4Ω	19.6 Ω	17.4 Ω	30.9 Ω	12.7 Ω	27.5 Ω	R1
07	06	05	04	03	02	01	LOT NO. 00	

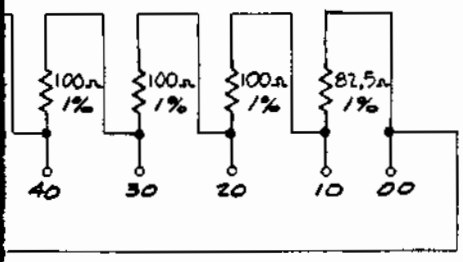
Schematic, Resistor Module
0155-732-00E

NOTES


J3
14
39
25
6
24
26
22
28
30
40
36
32
12
10
2
1
4
18
8
16
7
2
6
10
5
3
8
4
1
100Ω 1%
100Ω 1%
100Ω 1%
100Ω 1%
100Ω 1%
80
70
60
50
90
800 700 600 500 400 300 200 100
900
TUNE
20W
10W
5W
2W
1W
.5W
.2W
TO P3 LIGHT REG ASSY. (0155-780) SCHEMATIC (0155-462)
TO J6 LIGHT REG ASSY. (0155-780) SCHEMATIC (0155-462)
P6
1
2
4
3
7
6
5
8
DS4

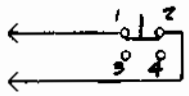
Ed Charg

RELEASE, NO CHANGE



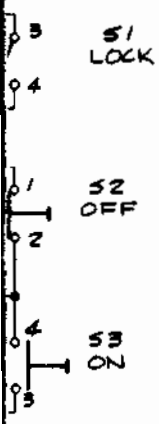
AVELENGTH
MPENSATION

TO J4
DISPLAY
ASS'Y.
(0155-464)
SCHEMATIC
(0155-466)

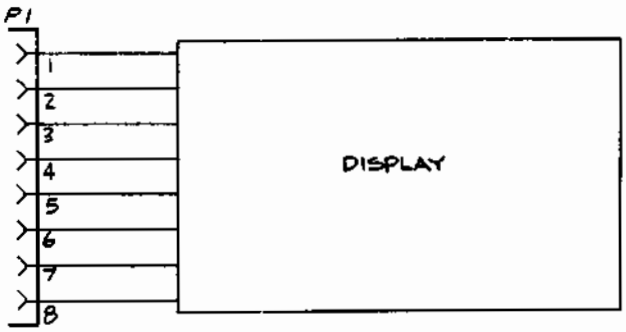


S6
RESET

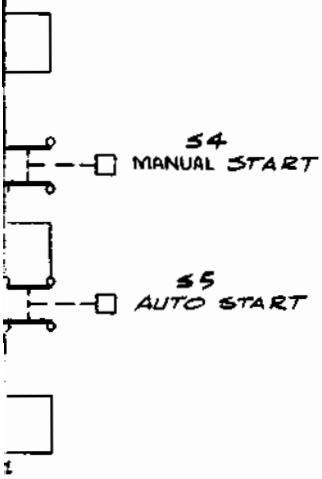
00



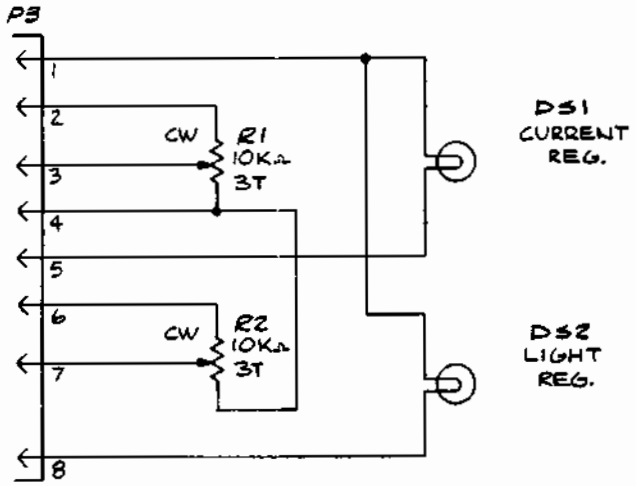
TO J1
DISPLAY ASSY.
(0155-464)
SCHEMATIC
(0155-466)



DS3



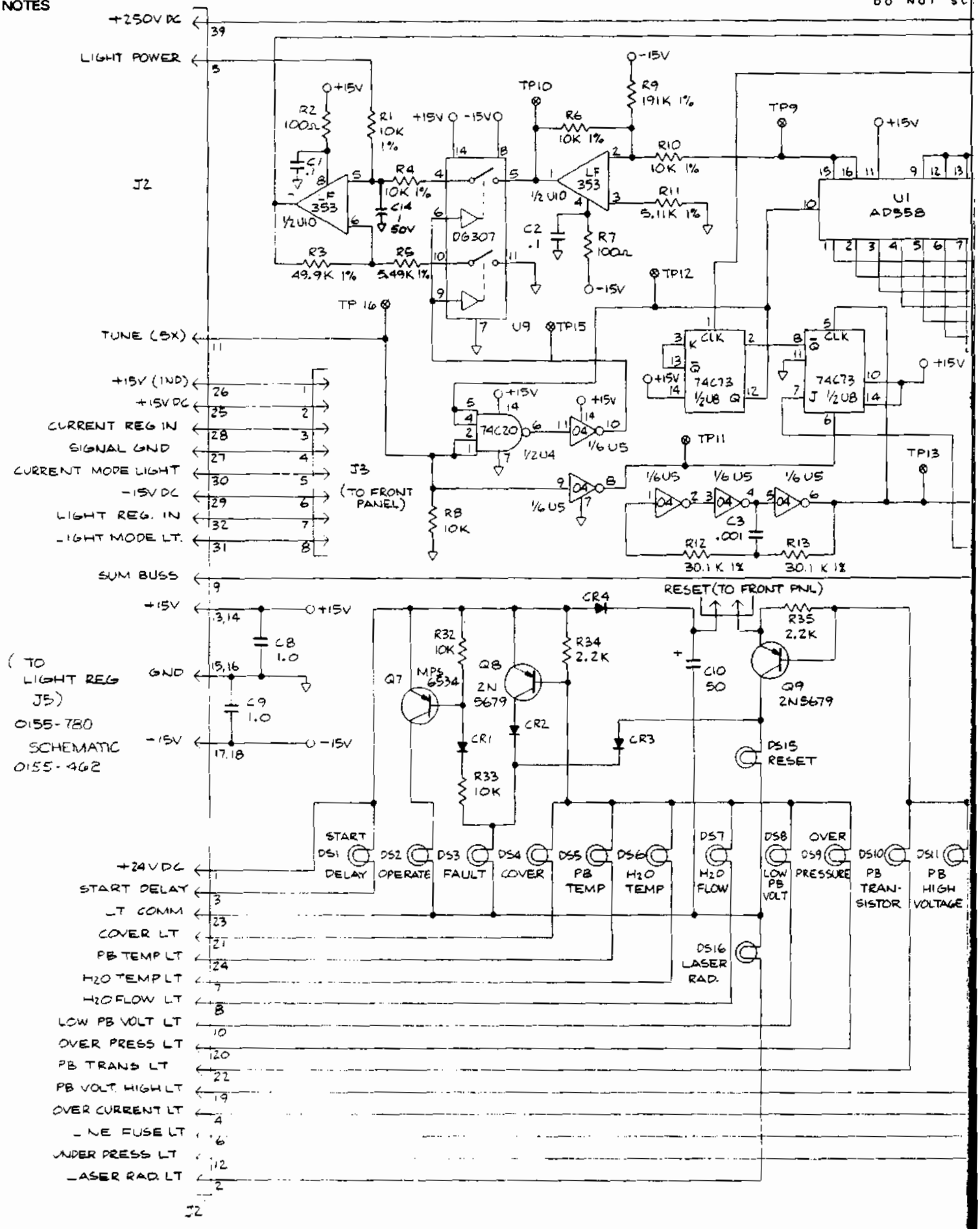
TO J3
DISPLAY ASS'Y.
(0155-464)
SCHEMATIC
(0155-466)

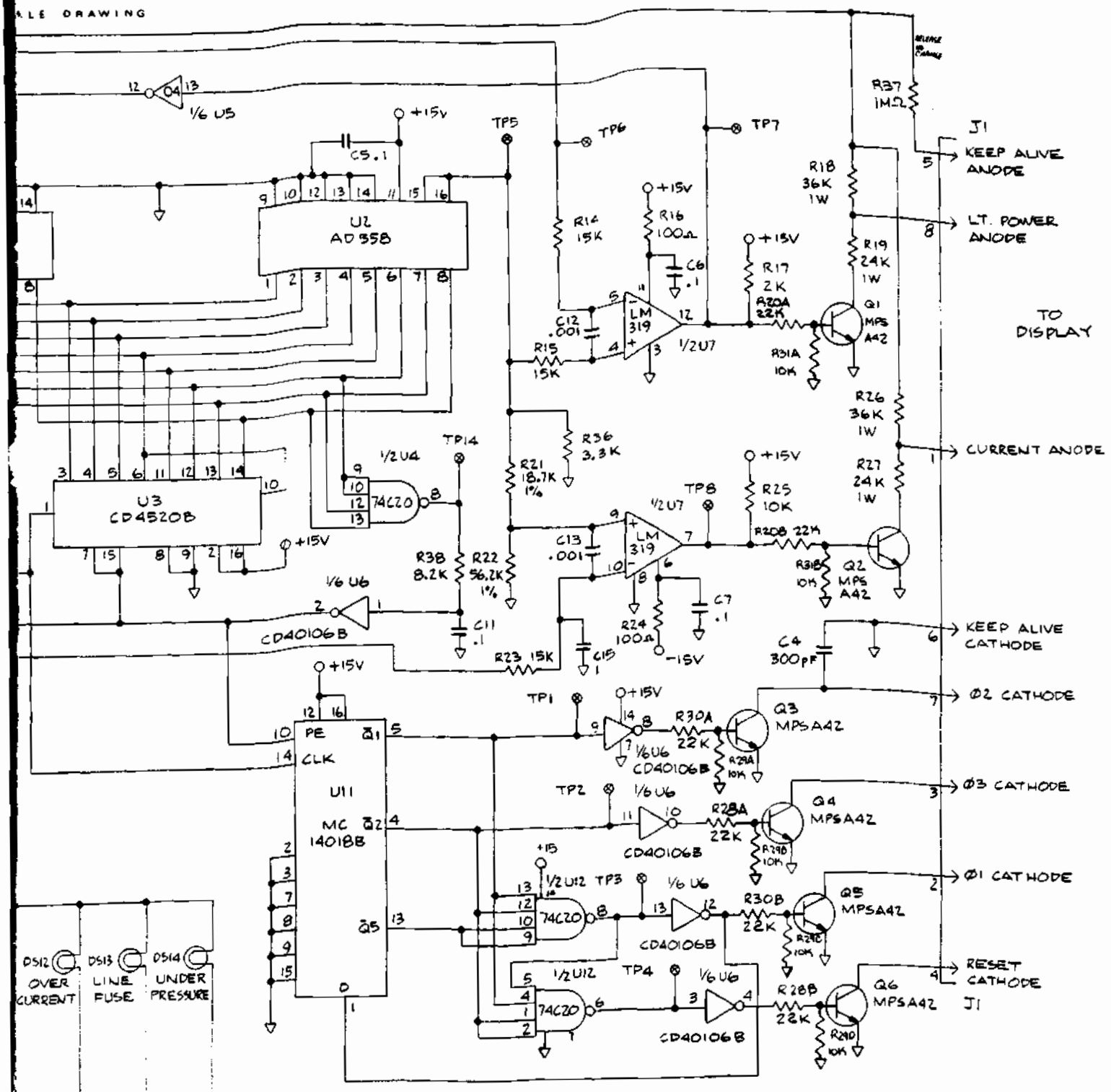


Schematic, Control Panel
#0155-717-00-A

NOTES

DO NOT SC



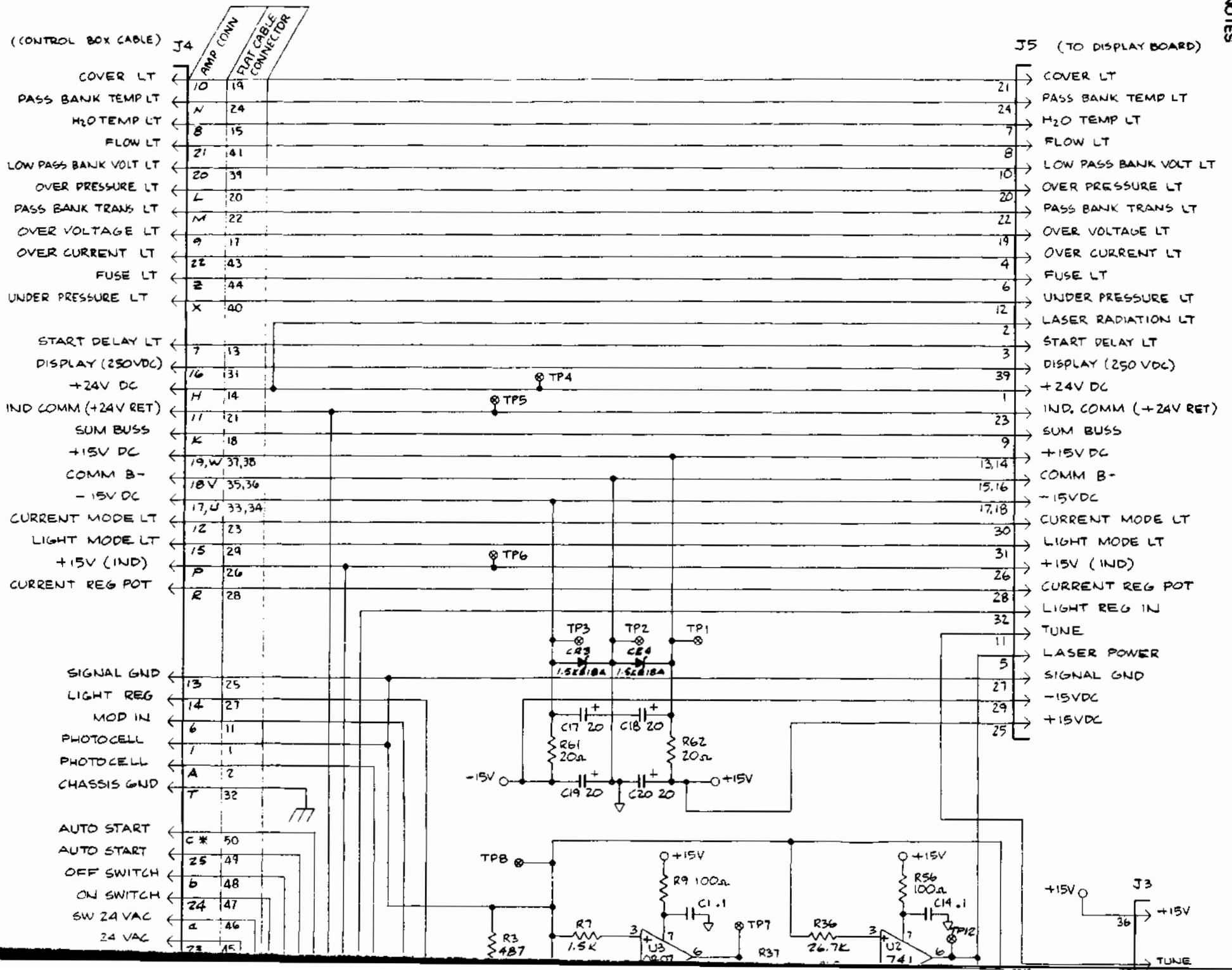


NOTES: UNLESS OTHERWISE SPECIFIED:

1. ALL RESISTORS ARE 1/4 W, 5%, EXPRESSED IN OHMS.
2. ALL CAPACITANCE IN MICROFARADS.
3. ALL DIODES ARE IN4148.

LAST USED	NOT USED
C15	
CR4	
R38	
U12	
Q9	
TP14	
L16	
DS16	
J3	

Schematic, Display Driver
0155-466-00C


(CONTROL BOX CABLE)
J4
AMP CONN
FLAT CABLE CONNECTOR
J5 (TO DISPLAY BOARD)
NOTES
COVER LT
PASS BANK TEMP LT
H2O TEMP LT
FLOW LT
LOW PASS BANK VOLT LT
OVER PRESSURE LT
PASS BANK TRANS LT
OVER VOLTAGE LT
OVER CURRENT LT
FUSE LT
UNDER PRESSURE LT
LASER RADIATION LT
START DELAY LT
DISPLAY (250VDC)
DISPLAY (250 VDC)
+24V DC
IND COMM (+24V RET)
IND. COMM (+24V RET)
SUM BUSS
+15V DC
COMM B-
-15V DC
CURRENT MODE LT
LIGHT MODE LT
+15V (IND)
CURRENT REG POT
LIGHT REG IN
TUNE
LASER POWER
SIGNAL GND
LIGHT REG
MOD IN
PHOTOCELL
PHOTOCELL
CHASSIS GND
AUTO START
AUTO START
OFF SWITCH
ON SWITCH
SW 24 VAC
24 VAC
TP1
TP2
TP3
TP4
TP5
TP6
TP7
TP8
TP12
C17 20
C18 20
C19 20
C20 20
C1 .1
C14 .1
R61 20Ω
R62 20Ω
R9 100Ω
R56 100Ω
R3 487
R7 1.5K
R36 26.7K
R37
+15V
-15V
J3
TUNE

Power supply

phases -

Picofuse on pass bank looks like resist w/ white

---

opto isolater

---

fuse light

Switch boxes.

Q9 transistor

Utility Board

~~DW~~ DW utility BOARD

OC11

OC12 — fuse light

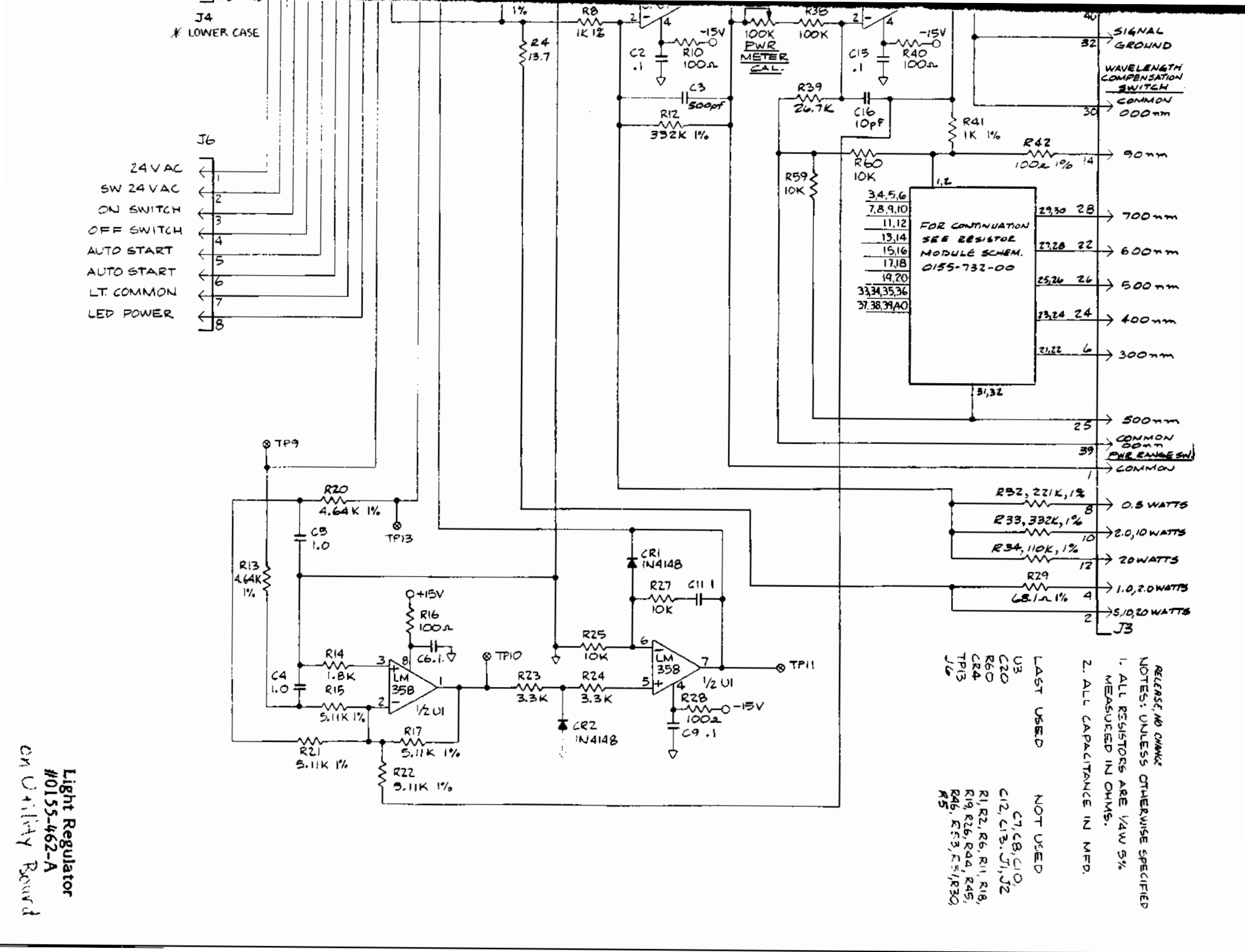
OC13

Q11 - could have been turned on. Have heat damaged.

Back of power supply

- Short out each bank.

remove multiple from + make sure all screws on fuses & wires



RELEASE, NO CHANGE

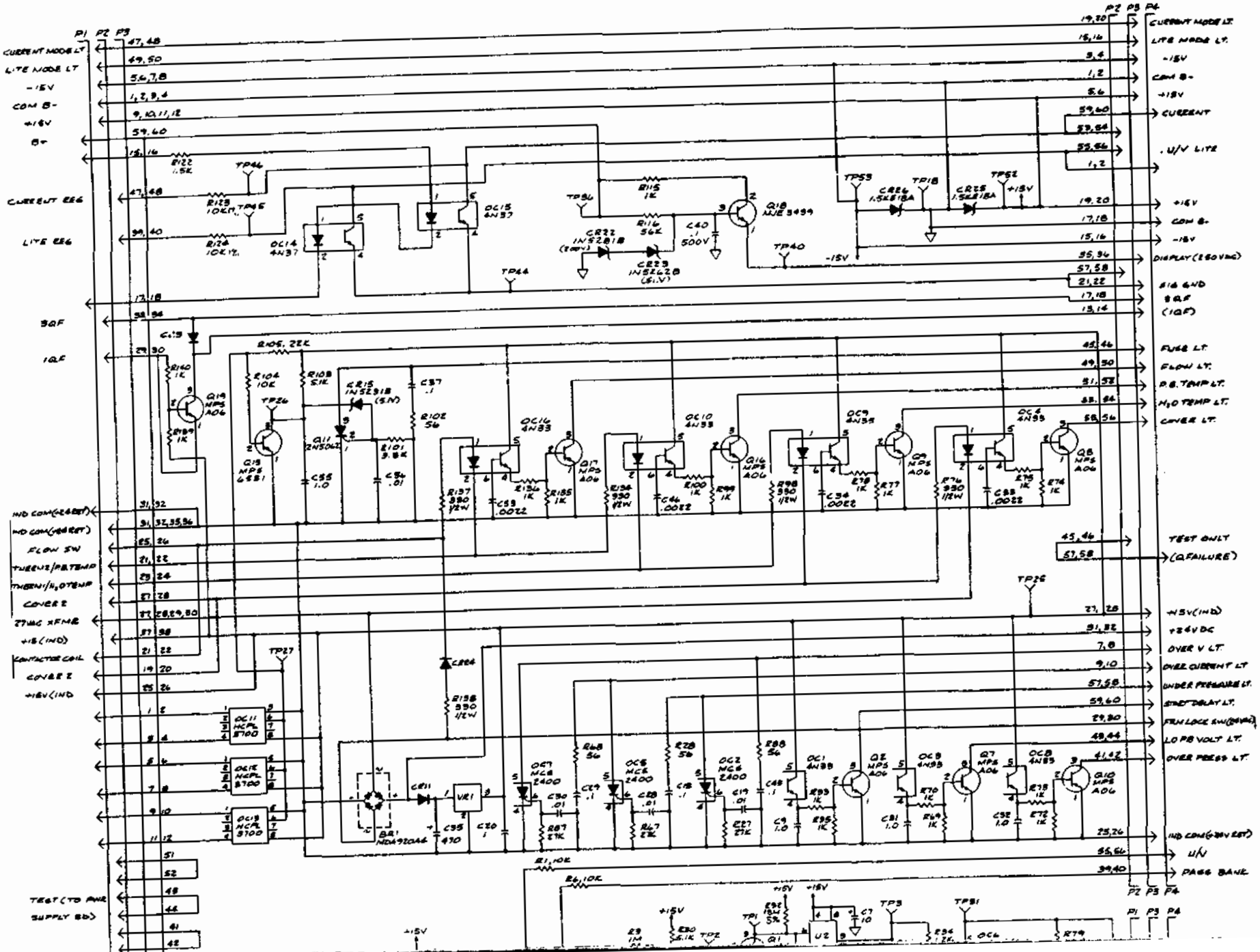
NOTES: UNLESS OTHERWISE SPECIFIED

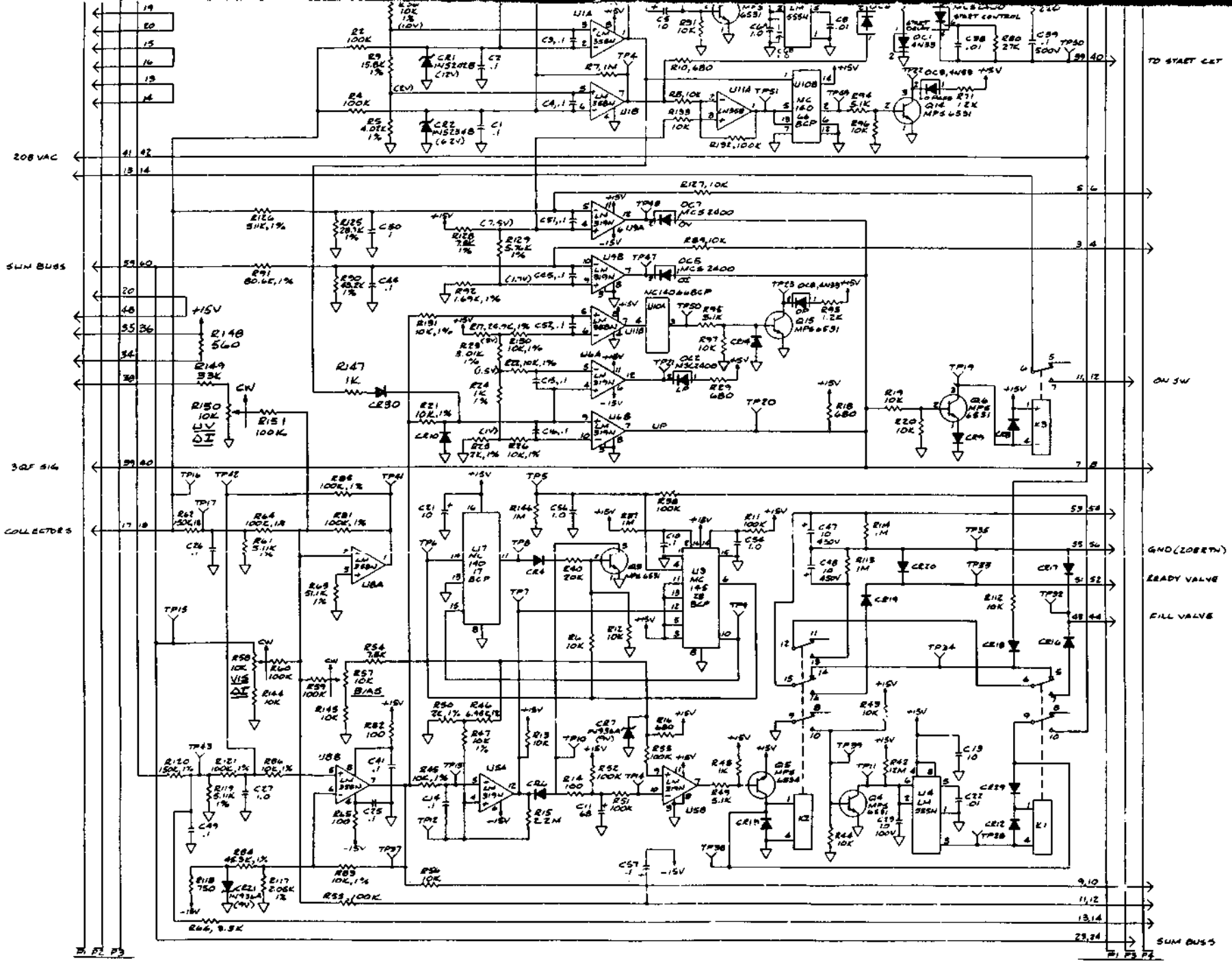
1. ALL RESISTORS ARE 1/4W 5%
   MEASURED IN OHMS.
2. ALL CAPACITANCE IN MFD.

LAST USED
U3
C20
R60
CR4
TP13
J6

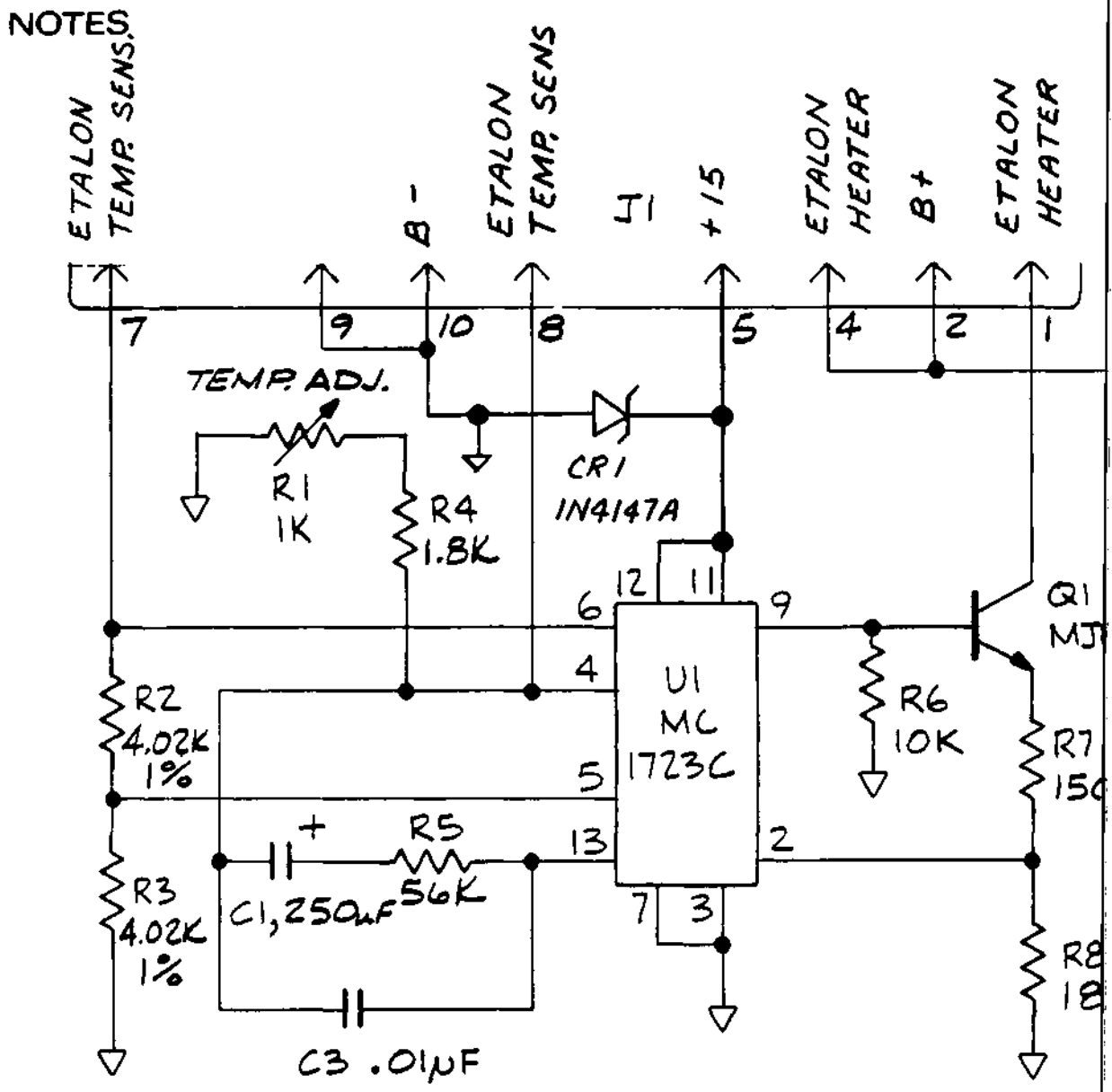
NOT USED
C7, C8, C10, C12, C13, J1, J2
R1, R2, R6, R11, R18, R19, R26, R44, R45, R46, R53, R54, R30, R5

Light Regulator
#0155-462-A
CPU Utility Board


P1 P2 P3
CURRENT MODE LT
LITE MODE LT
-15V
COM B-
+18V
B+
CURRENT REG
LITE REG
SQF
IQF
IND COM(GREEN)
IND COM(RED)
FLOW SW
TWENTY2/PB TEMP
TWENTY1/H2O TEMP
COVER
27VAC XFMR
+15(IND)
CONTACTOR COIL
COVER
+18V(IND)
TEST(TO PWR SUPPLY BD)
P2 P3 P4
CURRENT MODE LT.
LITE MODE LT.
-15V
COM B-
+18V
CURRENT
U/V LITE
+18V
COM B-
-15V
DISPLAY(250VDC)
SIG GND
SQF
(IQF)
FUSE LT.
FLOW LT.
P.B. TEMP LT.
H2O TEMP LT.
COVER LT.
TEST FAULT
(Q FAILURE)
+15V(IND)
+24VDC
OVER V LT.
OVER CURRENT LT.
UNDER PRESSURE LT.
START DELAY LT.
FAN LOCK SW(REAR)
LO PB VOLT LT.
OVER PRESS LT.
IND COM(+30V RET)
U/V
PASS BAND

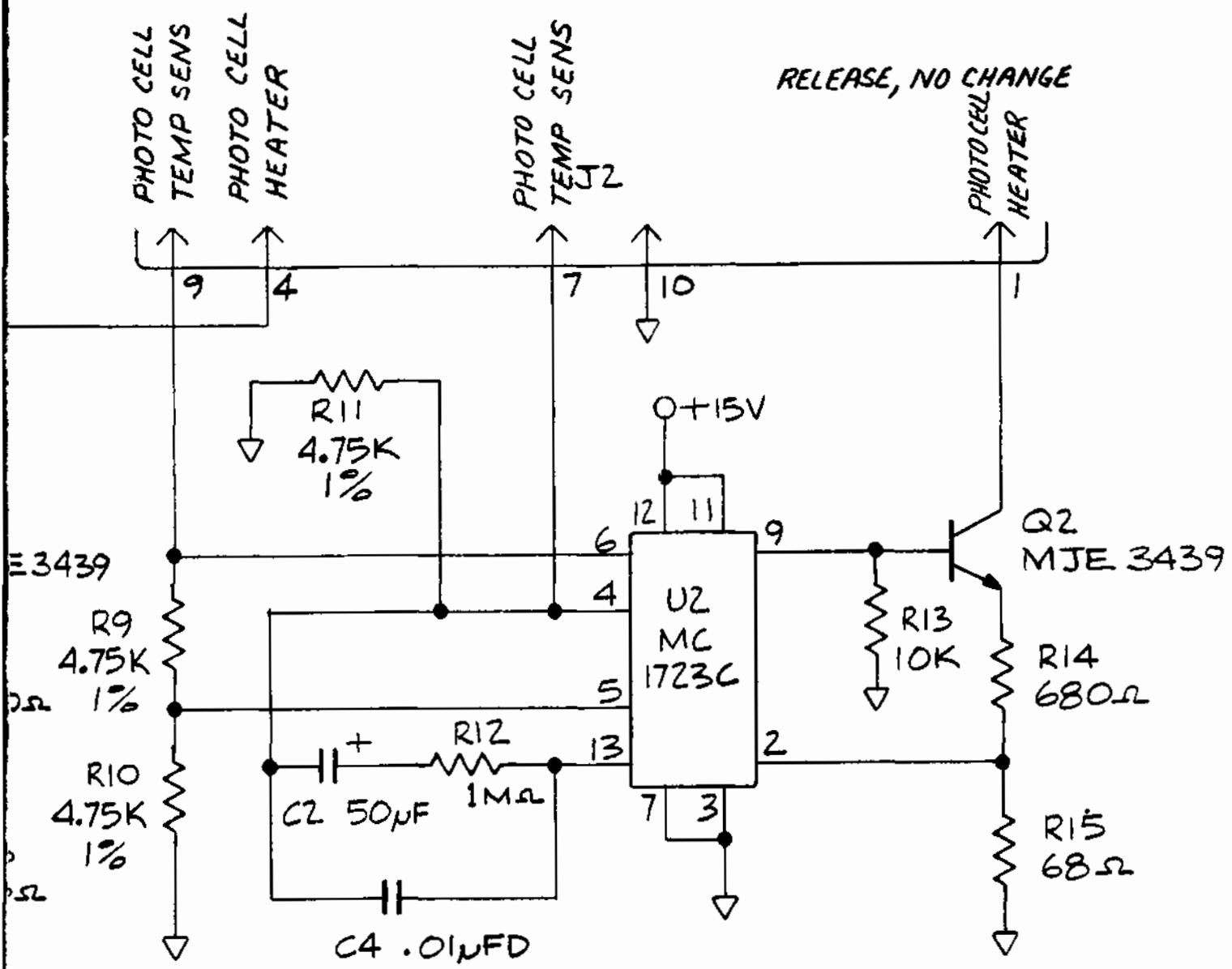


Schematic, Utility P.C. Board
#0155-424-00-B

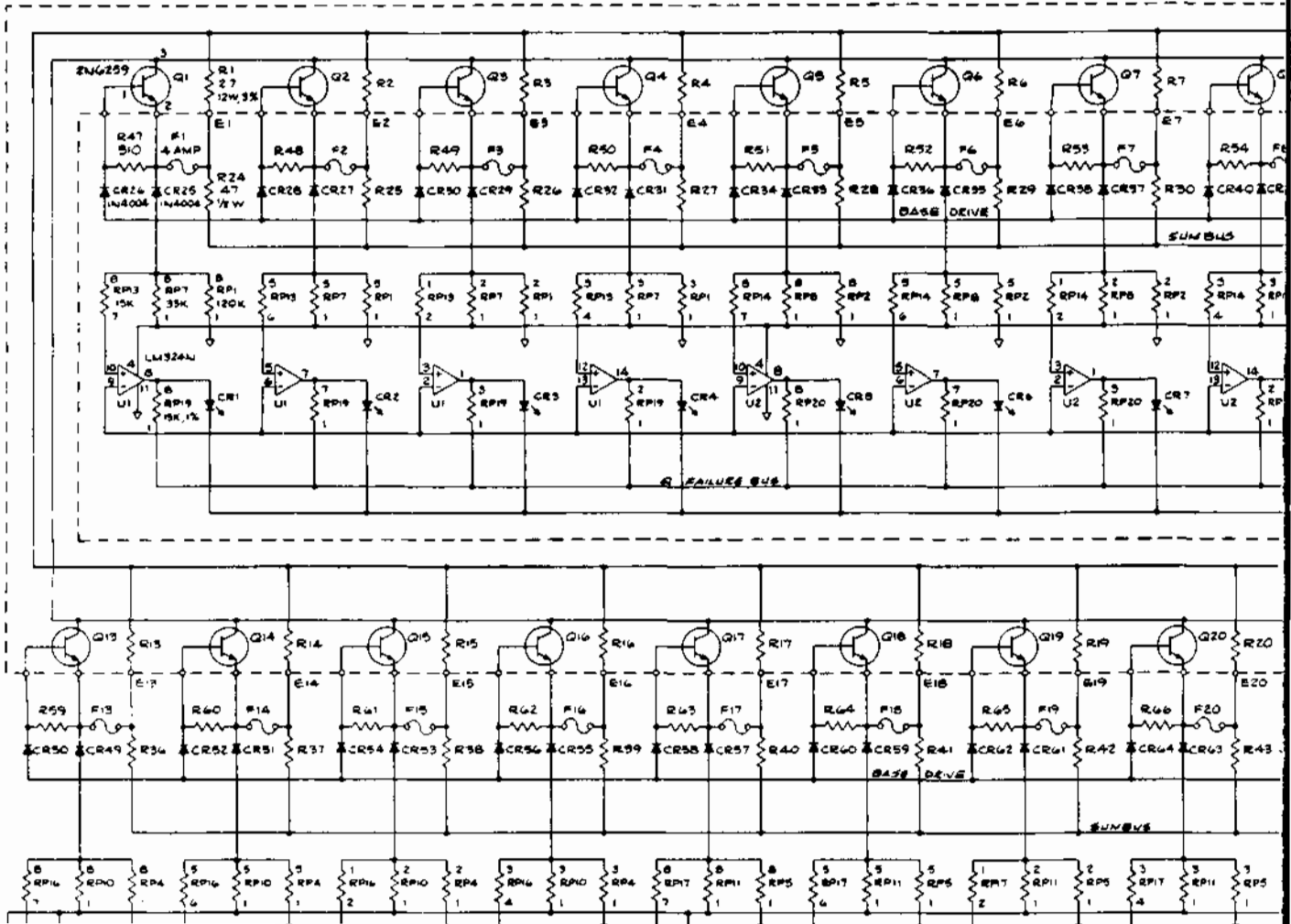


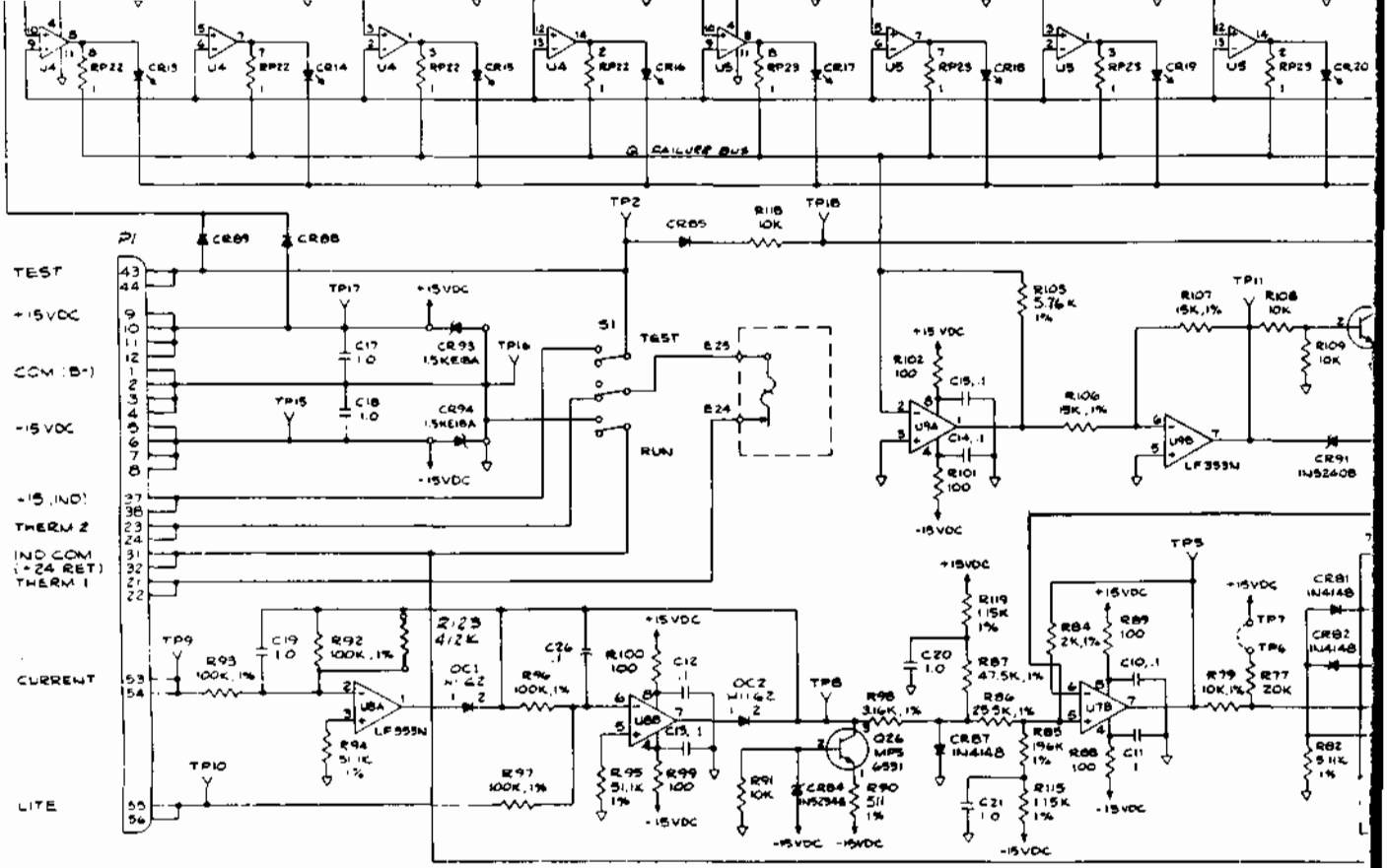
NOTES:

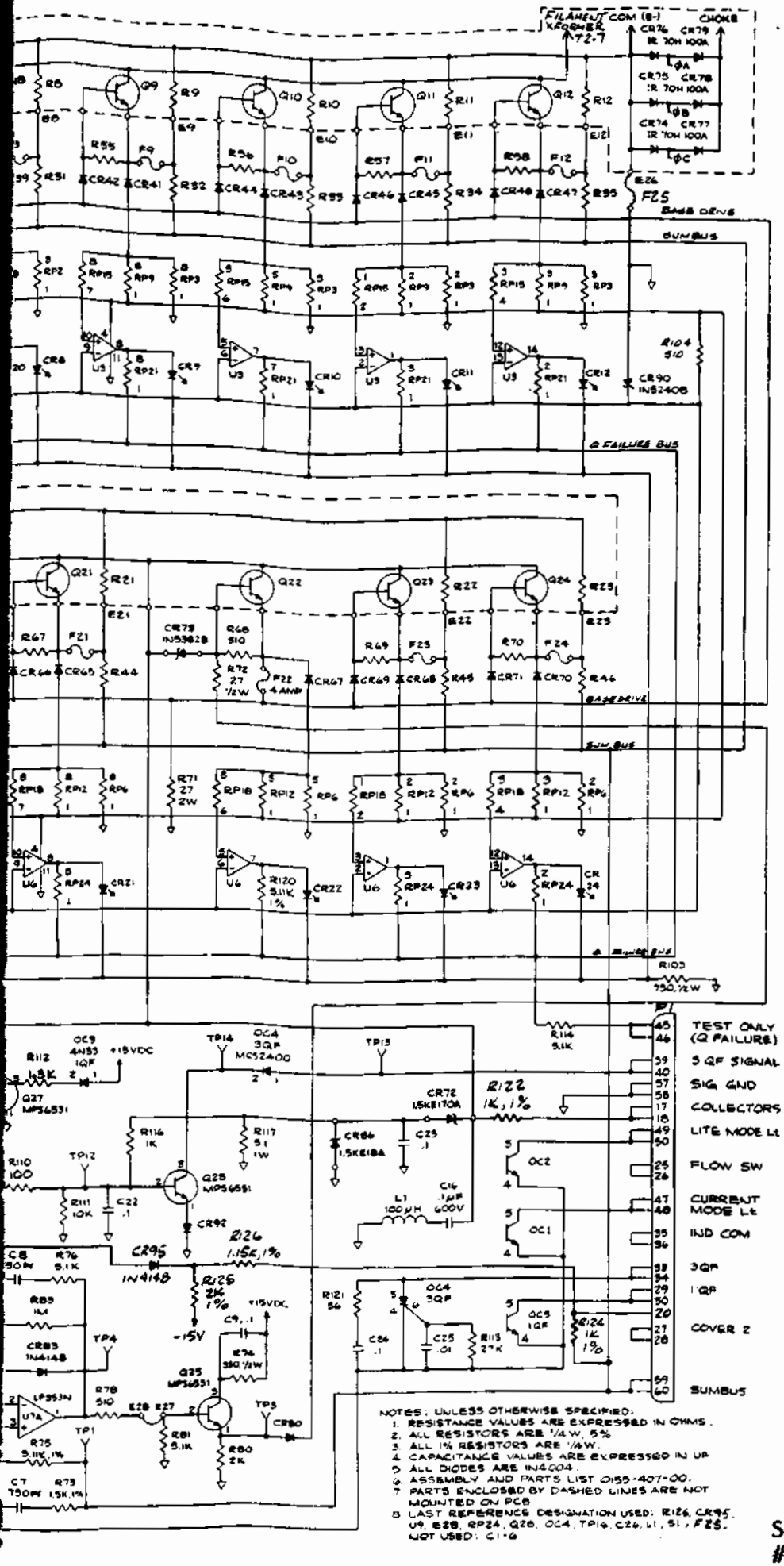
1. ALL RESISTANCE IS IN OHMS 1/4W 5%
2. ALL CAPACITANCE IS IN MICROFARAD



Schematic, Heater Controls
#0155-417-00-B

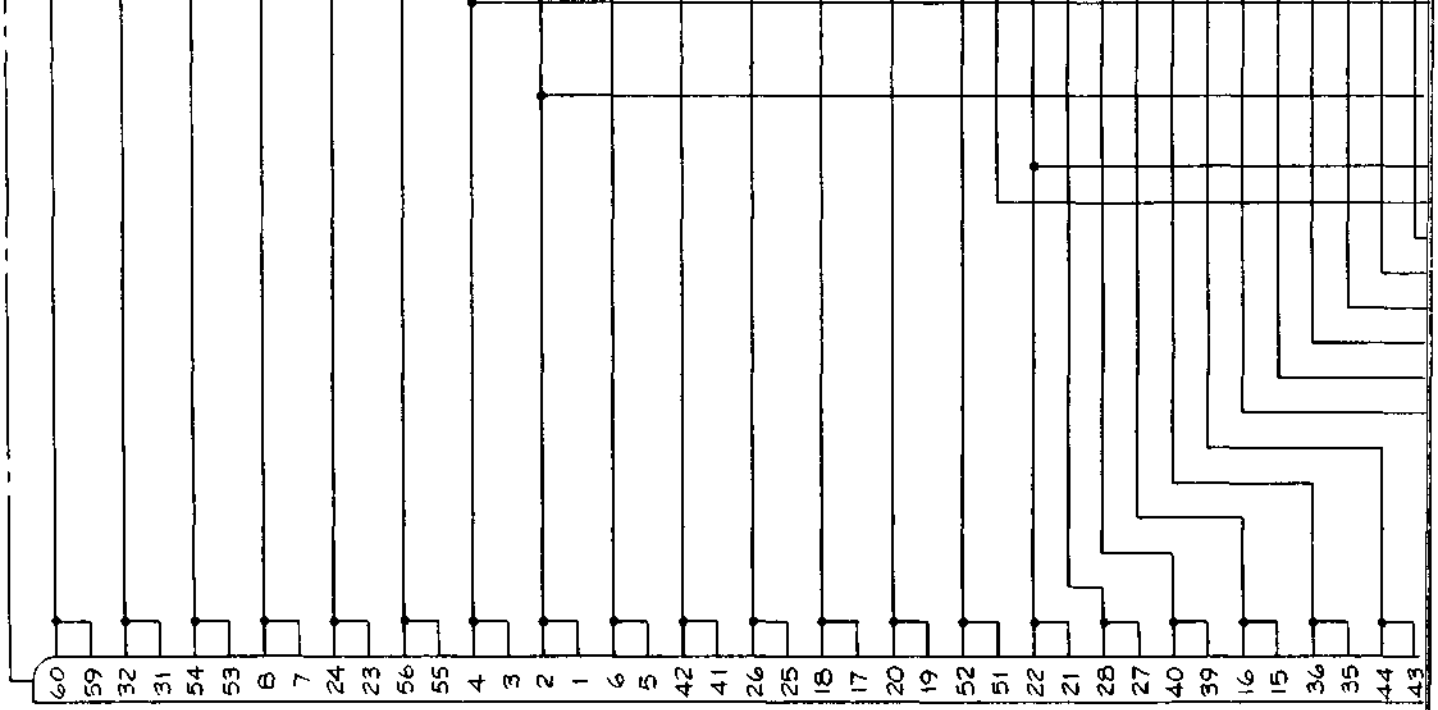

2N6259
Q1
R1
2.7
12W,5%
Q2
R2
Q3
R3
Q4
R4
Q5
R5
Q6
R6
Q7
R7
E1
E2
E3
E4
E5
E6
E7
R47
510
F1
4 AMP
R24
47
½W
R48
F2
R49
F3
R50
F4
R51
F5
R52
F6
R55
F7
R54
CR26
1N4004
CR25
1N4004
CR28
CR27
R25
CR30
CR29
R26
CR32
CR31
R27
CR34
CR33
R28
CR36
CR35
R29
CR38
CR37
R30
CR40
BASE DRIVE
SUM BUS
RP3
15K
RP7
33K
RP1
120K
RP13
RP7
RP1
RP15
RP7
RP1
RP14
RP8
RP2
RP14
RP8
RP2
RP14
RP16
LM324N
U1
U2
RP19
15K,1%
RP19
RP20
CR1
CR2
CR3
CR4
CR5
CR6
CR7
R FAILURE BUS
Q13
R13
Q14
R14
Q15
R15
Q16
R16
Q17
R17
Q18
R18
Q19
R19
Q20
R20
E13
E14
E15
E16
E17
E18
E19
E20
R59
F13
R60
F14
R61
F15
R62
F16
R63
F17
R64
F18
R65
F19
R66
F20
CR50
CR49
R36
CR52
CR51
R37
CR54
CR53
R38
CR56
CR55
R39
CR58
CR57
R40
CR60
CR59
R41
CR62
CR61
R42
CR64
CR63
R43
BASE DRIVE
SUM BUS
RP16
RP10
RP4
RP6
RP10
RP4
RP7
RP11
RP5
RP17
RP11
RP5
RP17
RP11
RP5


FAILURE BUS
P1
TEST
+15VDC
COM (B-)
-15VDC
+15 IND
THERM 2
IND COM (+24 RET)
THERM 1
CURRENT
LITE
CR89
CR88
TP2
CR85
R118 10K
TP18
TP17
TP16
TP15
C17 1.0
C18 1.0
CR93 1.5KE18A
CR94 1.5KE18A
S1
TEST
RUN
E25
E24
TP9
TP10
R93 100K, 1%
C19 1.0
R92 100K, 1%
2123 4122K
OC1
OC2
R96 100K, 1%
R97 100K, 1%
C26 .1
R100 100
C12 .1
C13, 1
R95 51.1K 1%
R99 100
R94 51.1K 1%
R98 3.16K, 1%
Q26 MPS 6591
CR84 IN5248
R90 511 1%
R91 10K
C20 1.0
R119 1.15K 1%
R87 47.5K, 1%
R86 25.5K, 1%
CR87 IN4148
R85 196K 1%
C21 1.0
R115 1.15K 1%
R84 2K, 1%
R89 100
C10, .1
C11 1
R88 100
TP5
TP7
TP6
CR81 IN4148
CR82 IN4148
R79 10K, 1%
R77 20K
R82 5.11K 1%
R102 100
C15, .1
C14, .1
R101 100
R105 5.76K 1%
R106 15K, 1%
R107 15K, 1%
TP11
R108 10K
R109 10K
CR91 IN52408
LF353N



NOTES: UNLESS OTHERWISE SPECIFIED:
1. RESISTANCE VALUES ARE EXPRESSED IN OHMS.
2. ALL RESISTORS ARE 1/4 W, 5%
3. ALL 1% RESISTORS ARE 1/4W.
4. CAPACITANCE VALUES ARE EXPRESSED IN UF
5. ALL DIODES ARE IN4004.
6. ASSEMBLY AND PARTS LIST 0155-407-00.
7. PARTS ENCLOSED BY DASHED LINES ARE NOT MOUNTED ON PCB
8. LAST REFERENCE DESIGNATION USED: R126, CR95, U9, E28, RP24, Q26, OC4, TP16, C26, L1, S1, FZ5.
NOT USED: C1-6

Schematic, Current Regulator PCB Assy.
#0155-409-00-A

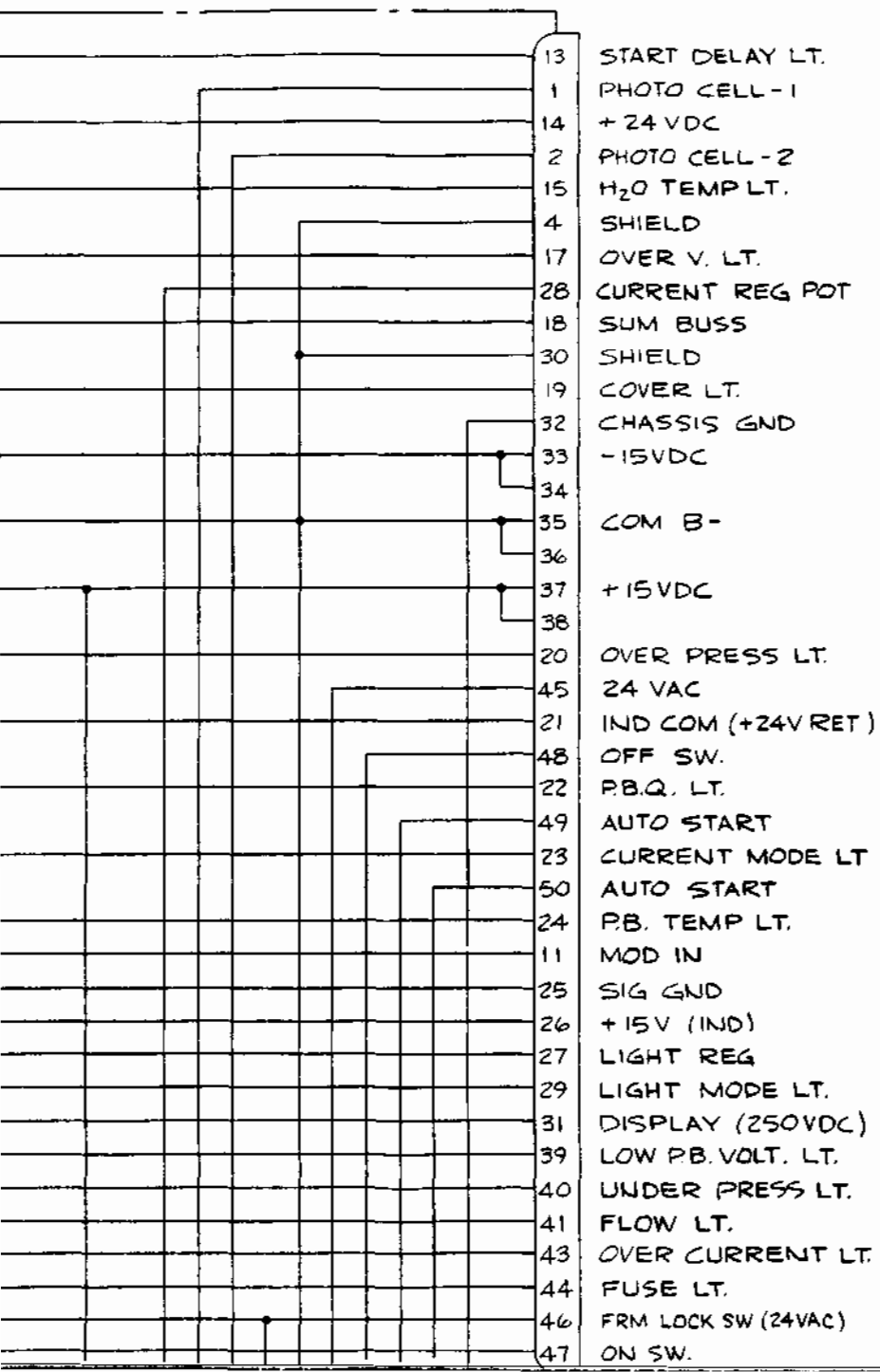


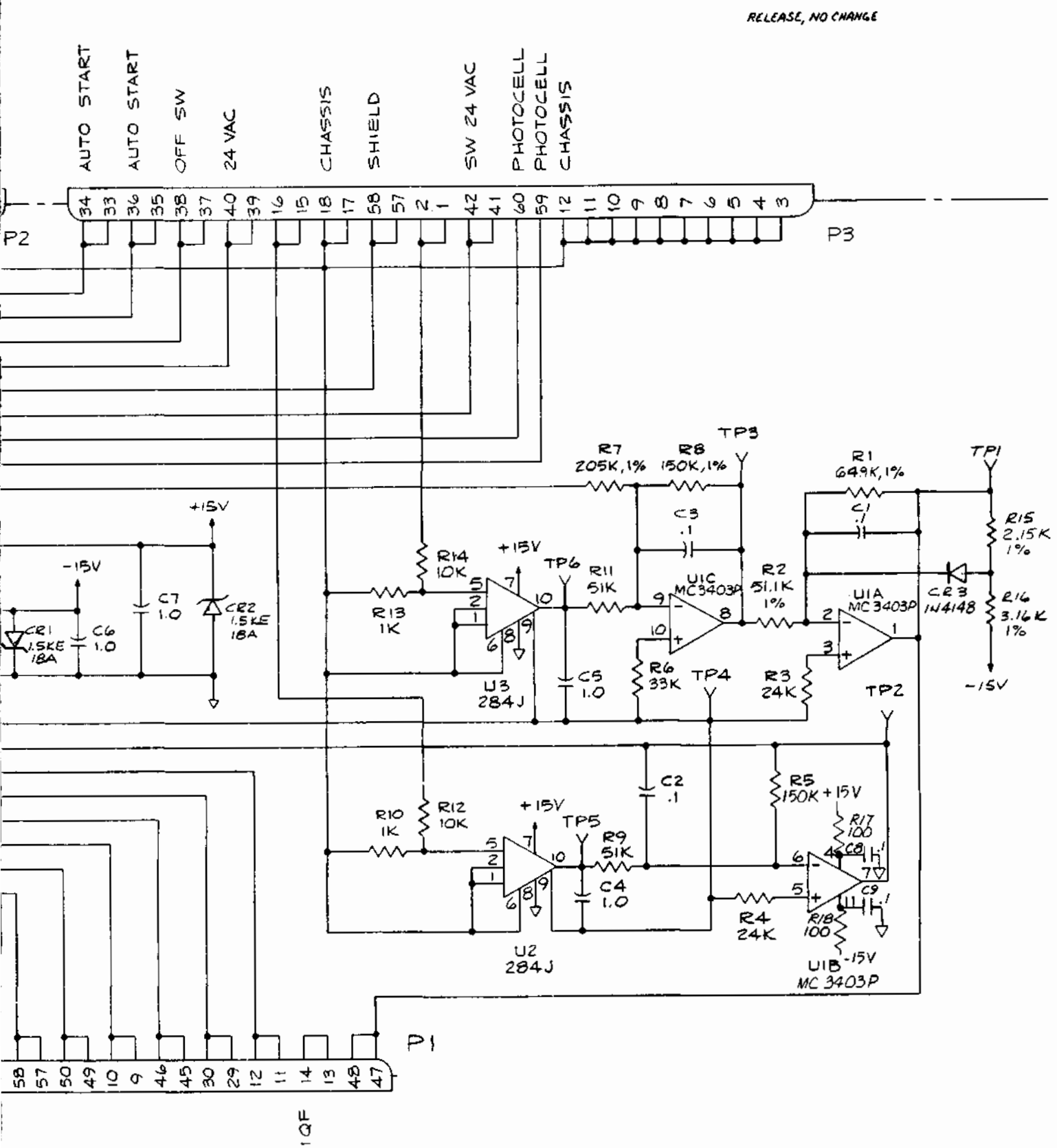
NOTES: UNLESS OTHERWISE SPECIFIED:

1. ALL RESISTORS ARE 1/4 W, 5%.
2. ALL 1% RESISTORS ARE 1/4 W.
3. RESISTANCE VALUES ARE EXPRESSED IN OHMS.
4. CAPACITANCE VALUES ARE EXPRESSED IN UF.
5. ASSEMBLY AND PARTS LIST 0155-422-00

LAST USED:

U3
R16
C7
TP6
P3
CR3


13 START DELAY LT.
1 PHOTO CELL - 1
14 + 24 VDC
2 PHOTO CELL - 2
15 H_2O TEMP LT.
4 SHIELD
17 OVER V. LT.
28 CURRENT REG POT
18 SUM BUSS
30 SHIELD
19 COVER LT.
32 CHASSIS GND
33 - 15VDC
34
35 COM B-
36
37 + 15VDC
38
20 OVER PRESS LT.
45 24 VAC
21 IND COM (+24V RET)
48 OFF SW.
22 P.B.Q. LT.
49 AUTO START
23 CURRENT MODE LT
50 AUTO START
24 P.B. TEMP LT.
11 MOD IN
25 SIG GND
26 + 15 V (IND)
27 LIGHT REG
29 LIGHT MODE LT.
31 DISPLAY (250VDC)
39 LOW P.B. VOLT. LT.
40 UNDER PRESS LT.
41 FLOW LT.
43 OVER CURRENT LT.
44 FUSE LT.
46 FRM LOCK SW (24VAC)
47 ON SW.

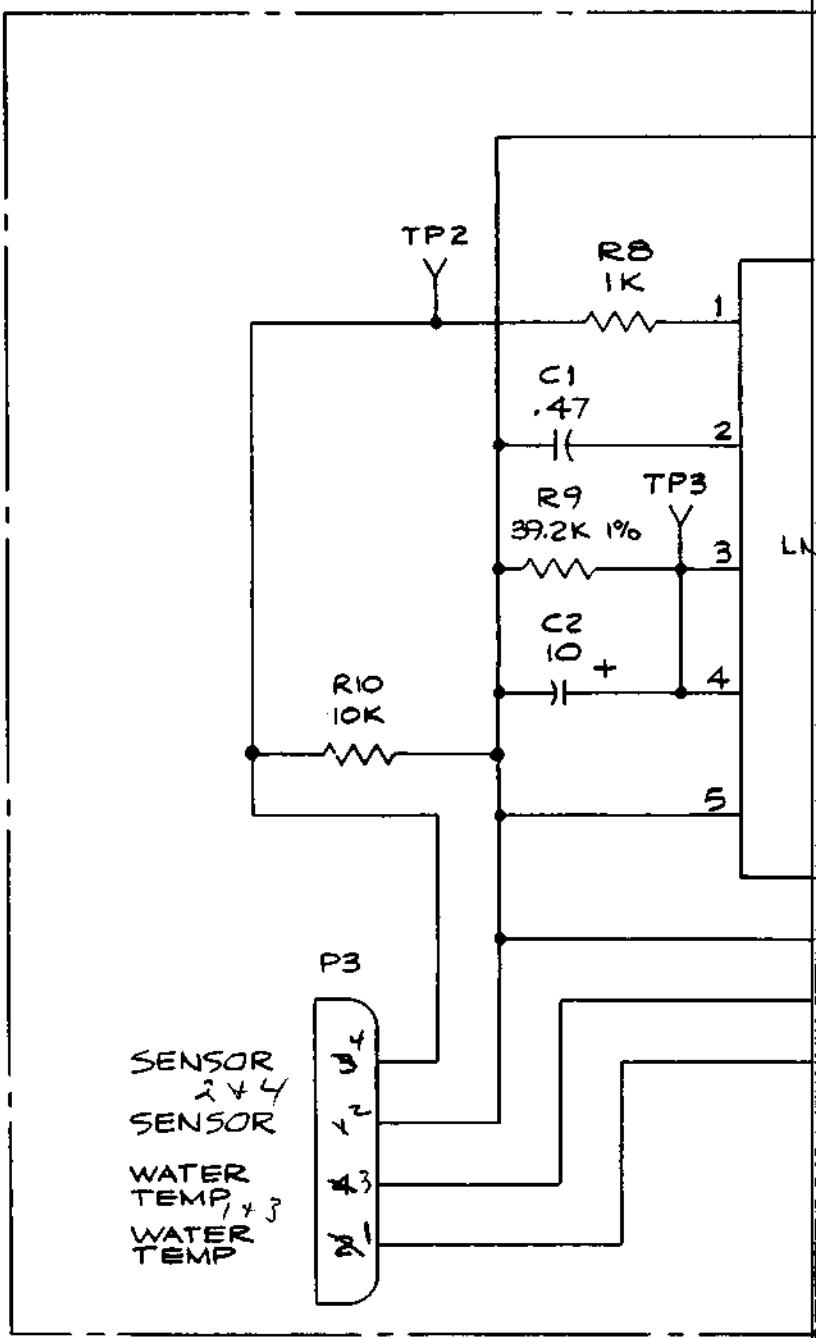


Schematic, Interface PCB
#0155-479-00-A

NOTES

LAST USED:

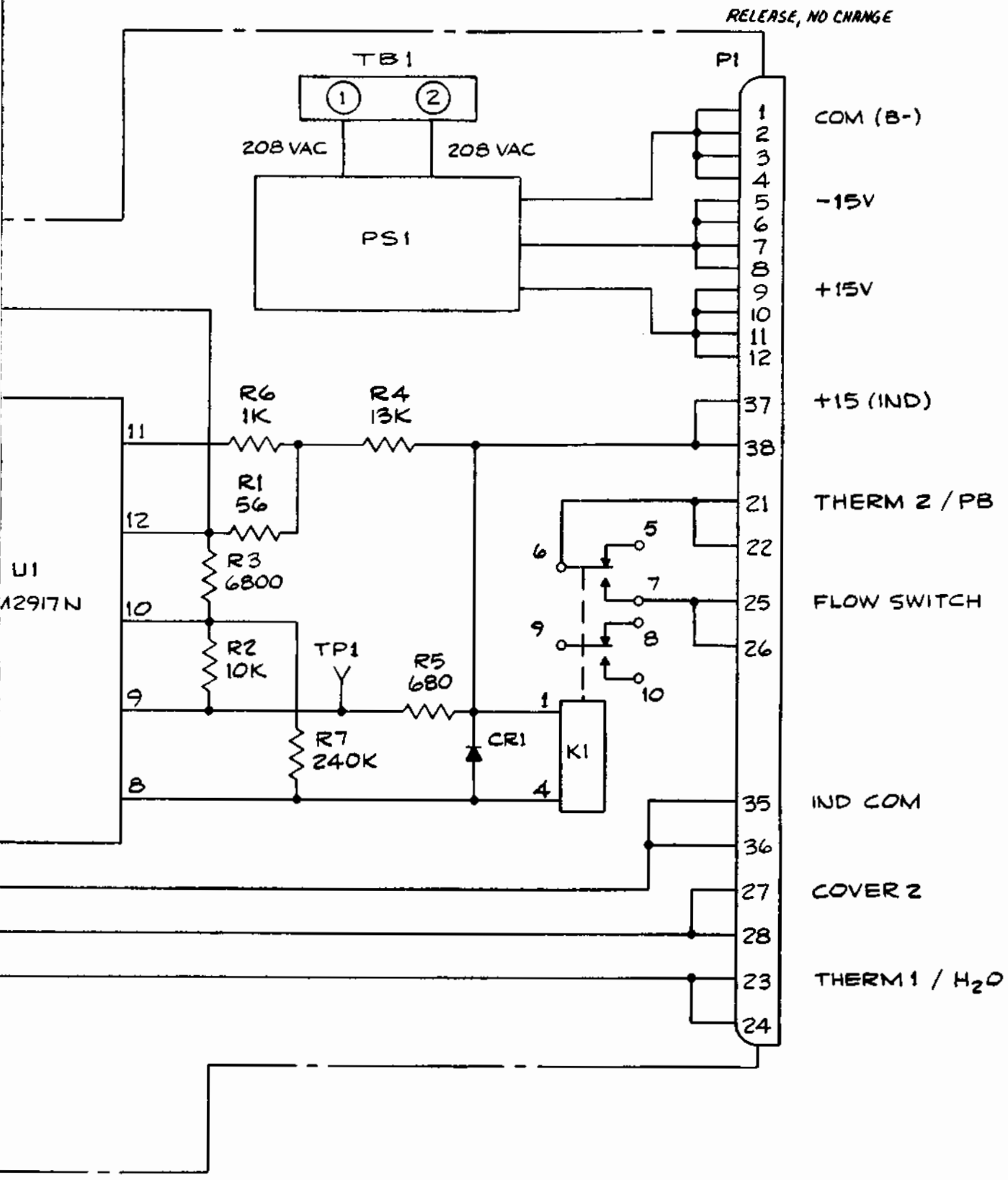
U1	P51
R10	TB1
CR1	
K1	
C2	
TP3	
P3	



LM2917N = freq. to voltage converter

NOTES; UNLESS OTHERWISE SPECIFIED:

1. RESISTANCE VALUES ARE EXPRESSED IN
2. ALL RESISTORS ARE 1/4 W, 5%.
3. CAPACITANCE VALUES ARE EXPRESSED I
4. ASSEMBLY AND PARTS LIST 0155-473-C
5. ALL DIODES ARE IN4004.



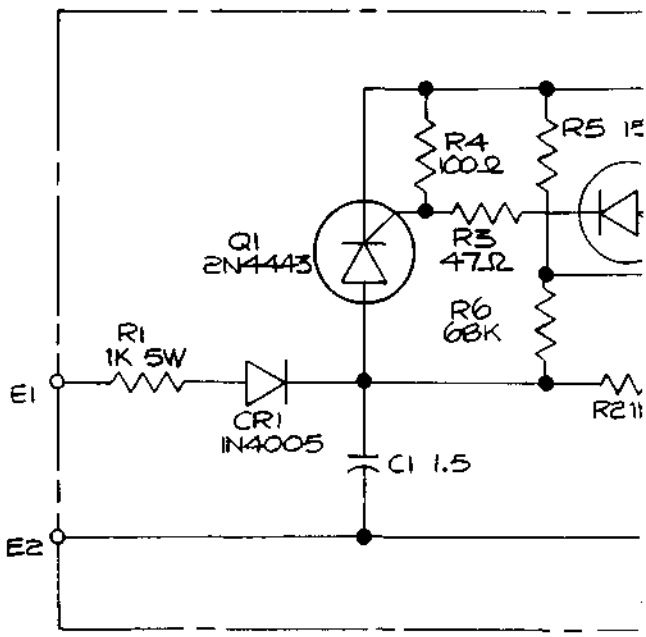
OHMS.

N 4F.
00.

Schematic, + 15V System Power Supply
#0155-475-00-B

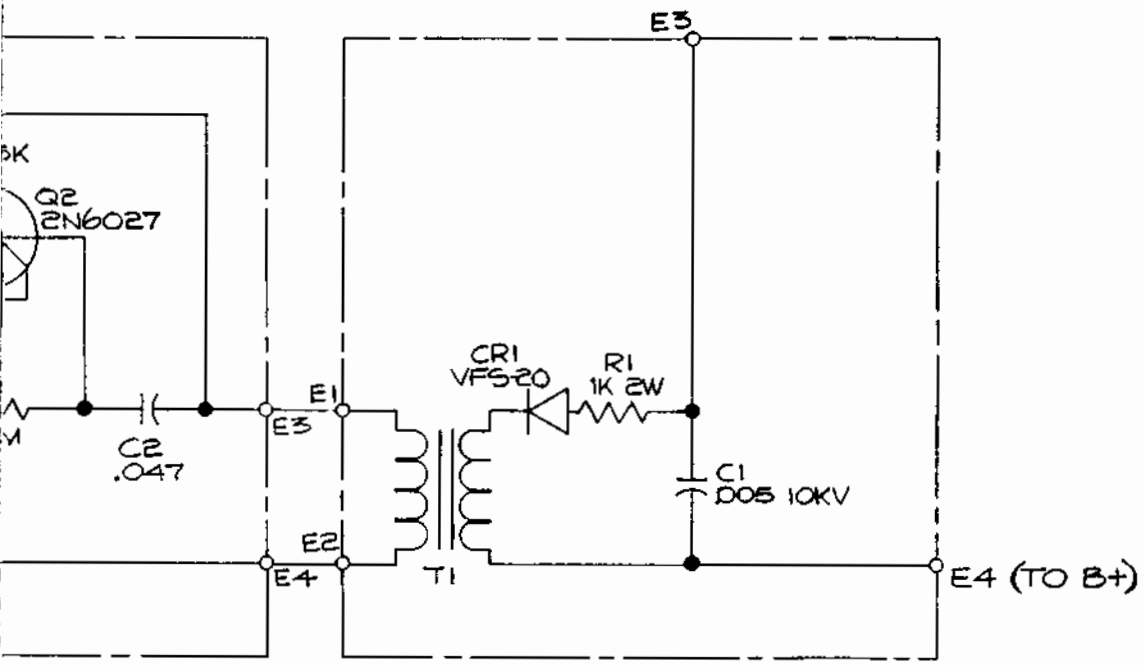
NOTES

1. REF STARTER FINAL ASSY 0155-439-00.
2. ALL RESISTOR VALUES IN OHMS.
3. ALL RESISTORS $\frac{1}{4}$W., EXCEPT AS NOTED.
4. CAPACITANCE VALUES ARE μfd.



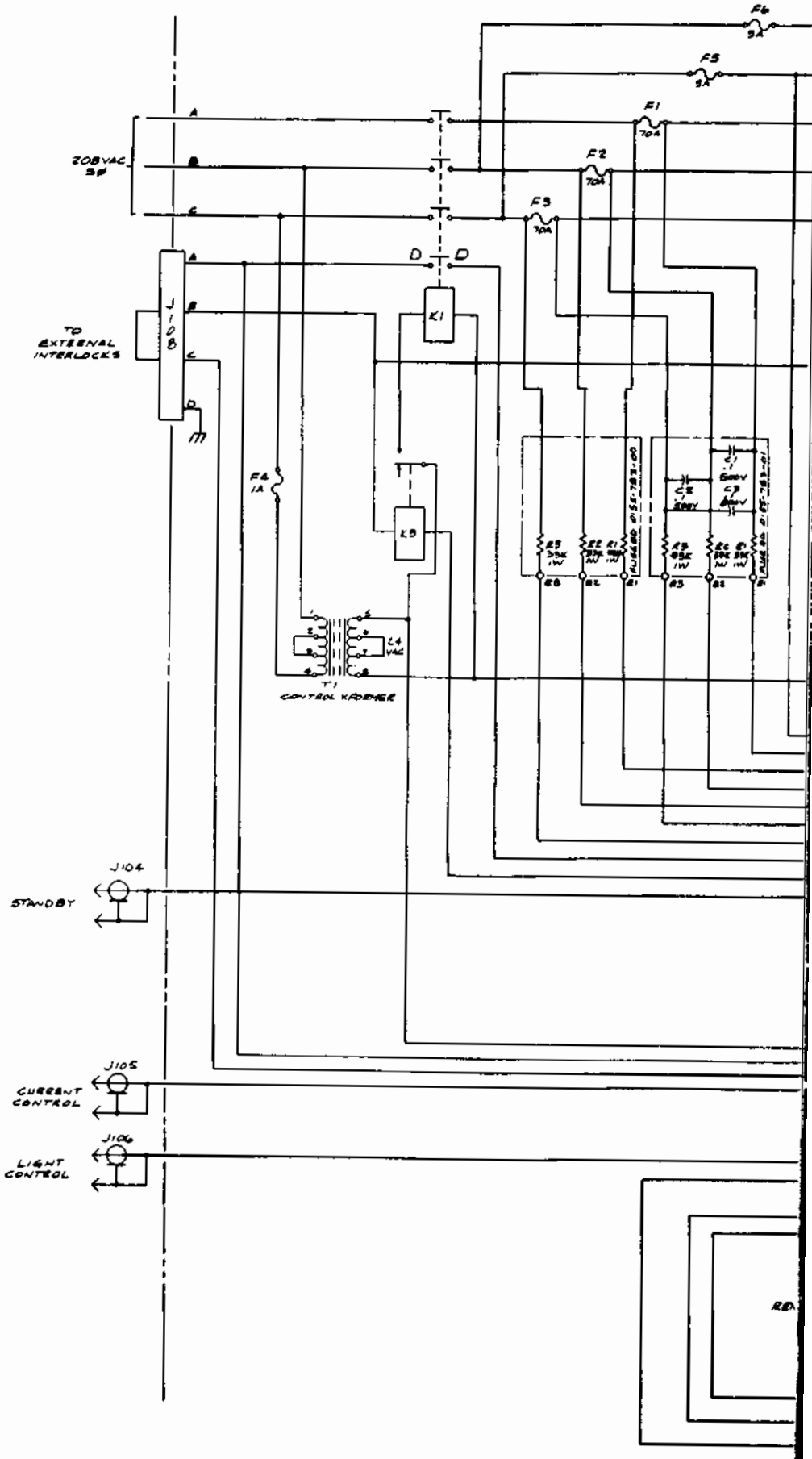
STARTER P.C. ASSY
0155-444-00

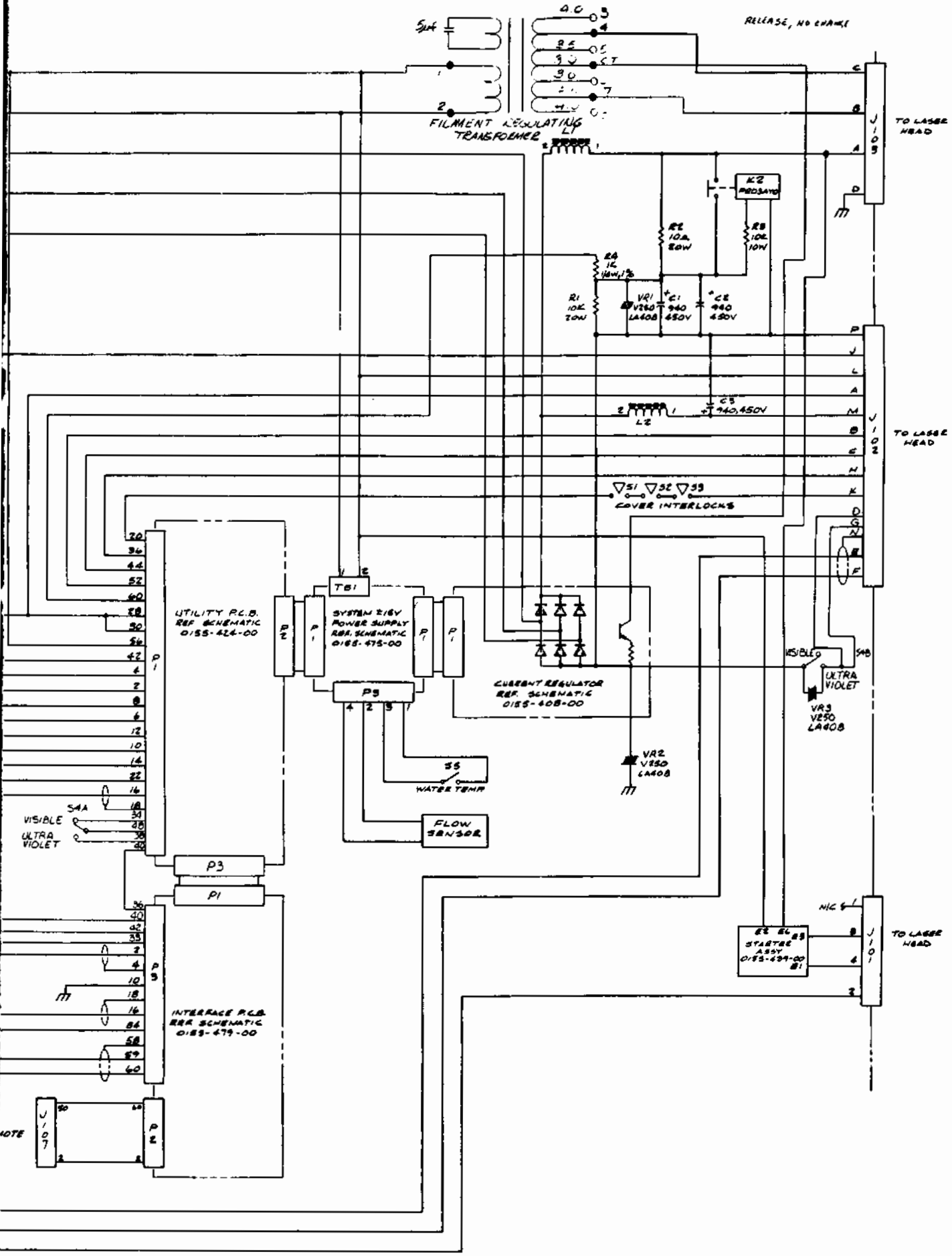
RELEASE, NO CHANGE



STARTER MODULE
0155-443-00

Schematic, Ion Starter
#0155-661-00-A

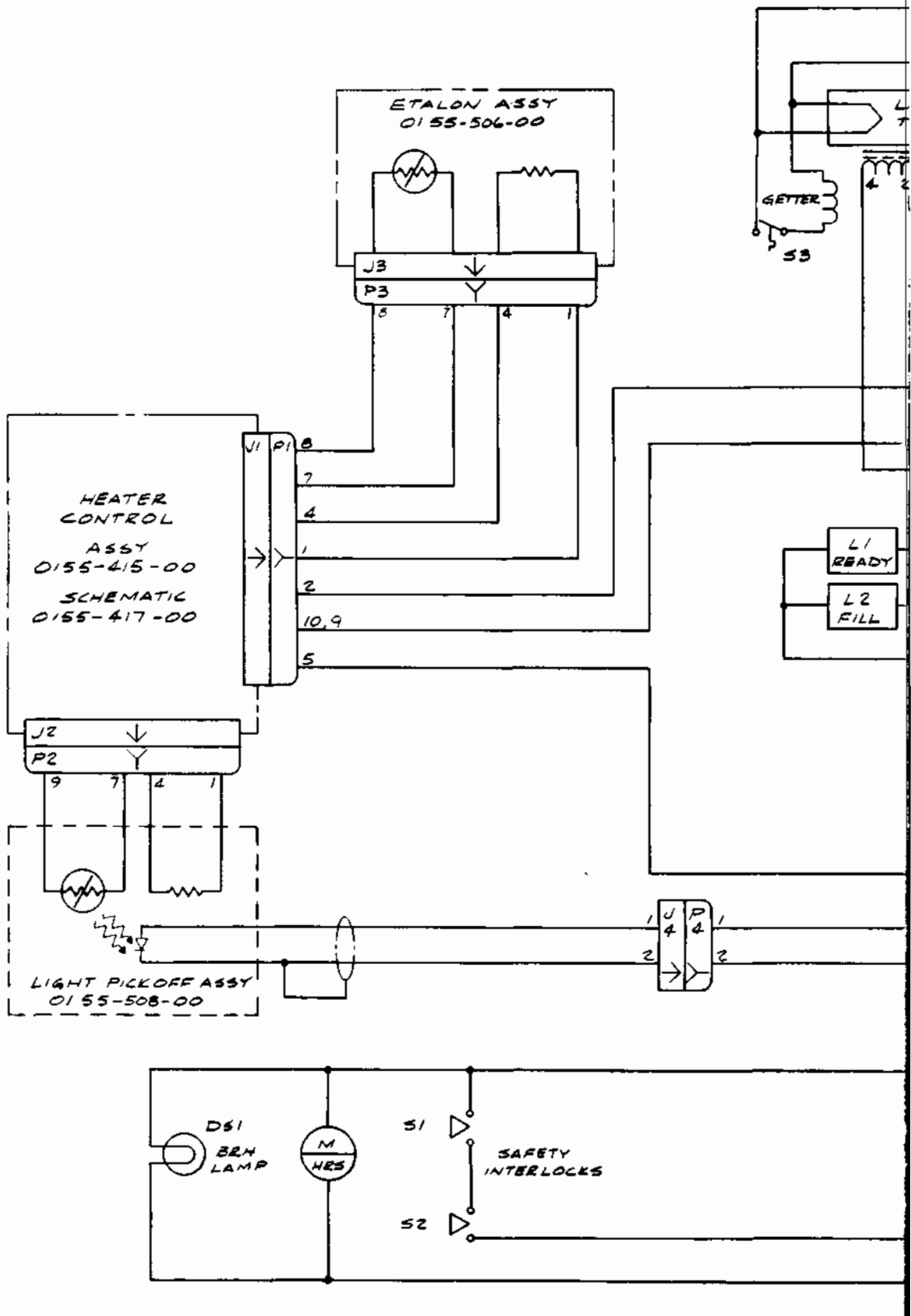

F6
9A
F5
9A
F1
70A
F2
70A
F3
70A
208VAC
3Ø
A
B
C
D
D
J108
TO EXTERNAL INTERLOCKS
K1
K3
F4
1A
T1
CONTROL XFORMER
J104
STANDBY
J105
CURRENT CONTROL
J106
LIGHT CONTROL



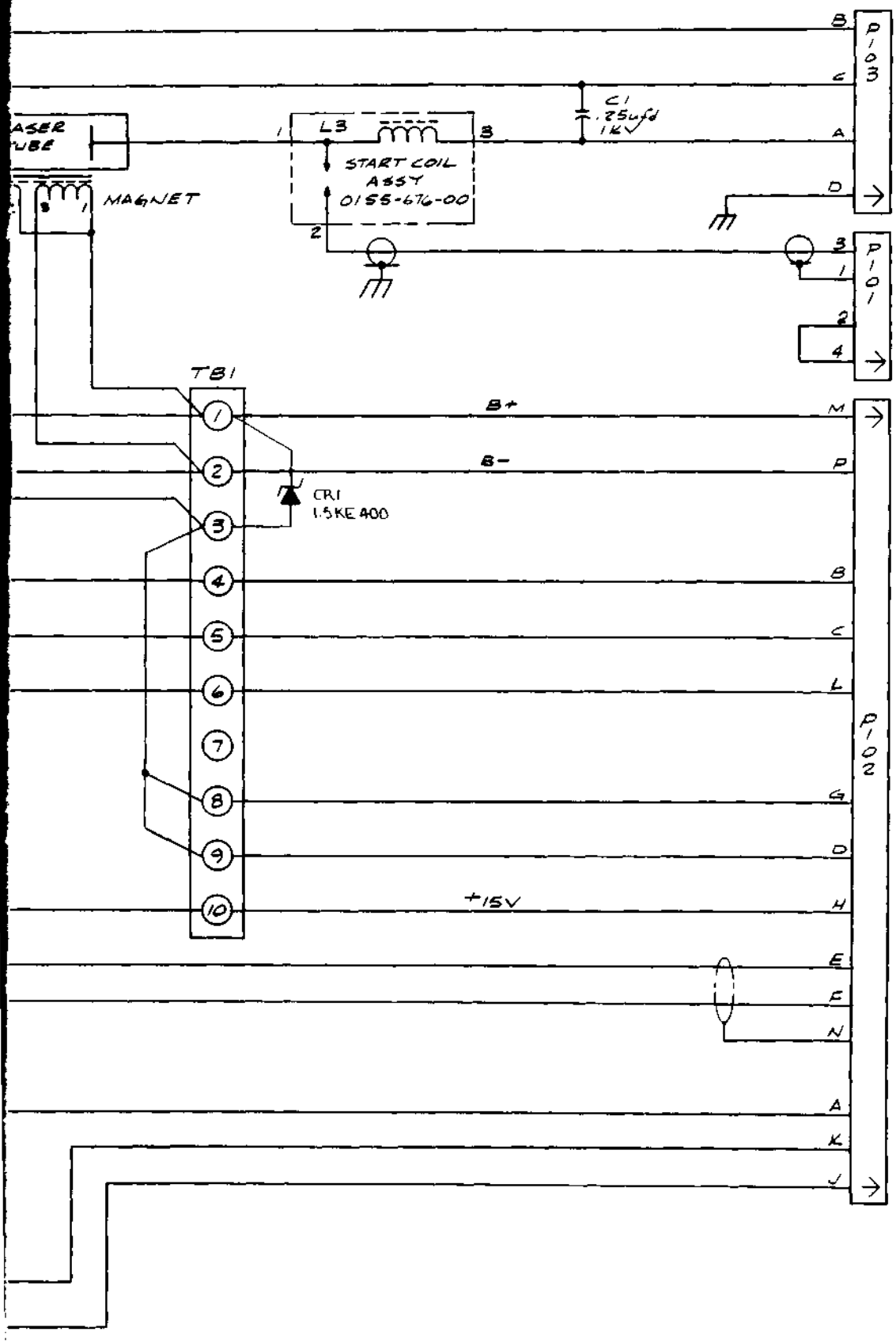
Schematic, Power Pack
#0155-710-00-B

NOTES

DO NO


ETALON ASSY
0155-506-00
J3
P3
8
7
4
1
GETTER
S3
HEATER
CONTROL
ASSY
0155-415-00
SCHEMATIC
0155-417-00
J1
P1
8
7
4
1
2
10,9
5
L1
READY
L2
FILL
J2
P2
9
7
4
1
LIGHT PICKOFF ASSY
0155-508-00
J
4
P
4
1
2
DS1
BRN
LAMP
M
HRS
S1
SAFETY
INTERLOCKS
S2

T SCALE DRAWING



RELEASE, NO CHANGE

FOR CONTINUATION
SEE SYSTEM SCHEMATIC
0165-718-00

Schematic, Laser Head
0155-711-00E

CUSTOMER SERVICE

11.1 WARRANTY

COHERENT warrants to original purchaser only and at original location only that the product will be free from defects in material and workmanship for a period of time and under such conditions as specified in COHERENT's data for that product. Exact warranty period is provided in the sales contract. or for twelve (12) months from delivery if a warranty for the individual product is not specified. Major subsystems manufactured by other firms but integrated into COHERENT's system are covered by the original manufacturer's warranty.

Any internal power supply adjustments or modifications without the express permission of the factory will void the warranty. Customer-caused damages are non-warranted; damages due to misuse, negligence, or accident are non-warranted. (Installation and adjustments other than those stated in the "Installation" and "Operation" sections of this manual void all warranties. Unauthorized repair also will void warranties.) The liability is limited to the replacement or repair at COHERENT's plant or purchaser's place of business, all at the option of COHERENT.

RETURNS AND ADJUSTMENTS

Warranty claim must be made promptly after occurrence of circumstances giving rise thereto and must be received within the applicable warranty period by COHERENT. In no case more than 30 days should elapse after discovery of defect. Such claims should include the product serial number, the date of shipment, and a full written description of the circumstances giving rise to the claim.

Before any products are returned for repair and/or adjustment, authorization from COHERENT for the return and instructions as to how and where these products should be shipped must be obtained. Any product or component returned for examination and/or warranty repair shall be sent insured prepaid via the means of transportation specified by COHERENT. COHERENT reserves the right to reject any warranty claim on any item that has been shipped by non-acceptable means of transporation. When any product is returned for examination and inspection, or for any other reason, Buyer and its shipping agency shall be responsible for all damage resulting from improper packing or handling, and for loss in transit, notwithstanding any defect or non-conformity in the product. In all cases, COHERENT

has sole responsibility for determining the cause and nature of failure, and COHERENT's determination with regard thereto shall be final.

If it is found that COHERENT's product has been returned without cause and is still serviceable, Buyer will be notified and the product returned at Buyer's expense; in addition, a charge for testing and examination may, at COHERENT's discretion, be made on products so returned.

In all cases, COHERENT has sole responsibility for determining the cause and nature of failure, and COHERENT's determination with regard thereto shall be final.

WATER COOLED PRODUCTS

COHERENT does not warrant any of its water-cooled products against contingent or subsequent damage resulting from negligence in providing the required water-cooling or from unexpected events which cause the required water-cooling to be interrupted during operation of the equipment. Many COHERENT water-cooled products include protective devices designed to deactivate the product in the event that water service has not been provided or that water service has been interrupted. However, COHERENT's liability in the event of a protective device failure is limited to repair or replacement of the protective device and does not extend to subsequent damages to the rest of the COHERENT product.

PLASMA TUBE WARRANTY

COHERENT's warranty applies only to undamaged plasma tubes when the plasma tube is excited by the appropriate COHERENT exciter. This warranty does not cover cleaning of contaminated optics and adjustments of the reflectors.

11.2 PLASMA TUBE RETURNS AND EXCHANGES

All laser plasma tubes replaced on a warranty basis must be returned insured prepaid via the means of transportation specified by COHERENT to COHERENT, 3210 Porter Drive, Palo Alto, California. In the event of a warranty replacement, the replacement tube assembly will be shipped to the customer, freight collect, with no additional charges, including installation. All laser

plasma tubes must be carefully packed in the shipping containers provided by COHERENT prior to returning them to the factory. COHERENT does not assume responsibility for tubes broken in shipment due to improper packaging or handling.

THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES, WHETHER WRITTEN, ORAL OR IMPLIED AND SHALL BE BUYER'S SOLE REMEDY AND COHERENT'S SOLE LIABILITY ON CONTRACT OR WARRANTY OR OTHERWISE FOR THE PRODUCT, COHERENT DISCLAIMS ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR PURPOSE. IN NO EVENT SHALL COHERENT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTAL DAMAGES ARISING OUT OF OR IN CONNECTION WITH THE USE OF PERFORMANCE OF THE GOODS DELIVERED HEREUNDER.

11.3 SERVICE INFORMATION

If you have a problem with your system that requires the aid of a trained service engineer please do not hestitate to call the Coherent Service department in you area. We would like to insure your system is functioning properly as soon as possible; frequently a service engineer can solve an apparent problem over the phone.

Before calling Coherent Service, please have the following information available:

System Model_____

System Serial Number_____

Head_____

Tube_____

Power Supply_____

(1) What Fault light (if any) was illuminated at the time of malfunction?_____

(2) Could the fault light be reset by the Reset switch?____

(3) At what point did the failure occur?
- a. System turn on
- b. At tube start
- c. During operation
- d. System turn off

(4) What were the symptoms of the malfunction?

11.4 SALES AND SERVICE OFFICES

Coherent Around The World

Coherent is the leading manufacturer of ion, dye and carbon dioxide lasers for medical, scientific and industrial uses. These products are designed for the highest performance and reliability and reflect Coherent's continuing dedication to excellence in engineering. Coherent's subsidiaries and agents throughout the world provide comprehensive technical support and service for all Coherent products.



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Palo Alto, CA 94304

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Palo Alto, CA 94303

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Telex 34-8304

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Telex 37-7394

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King of Prussia, PA 19406
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Phone Service (215) 337-1750
Telex 84-6179

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Mississauga, Ontario L4V 1J2
Phone (416) 678-1500
Telex 06-968769

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Coherent GmbH
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6074 Roedermark 2
Ober-Roden
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Phone 06074-9140
Telex 841-4197785

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Coherent Scientifique S.A.
52, Avenue de l'Europe
78160 Marly Le Roi
Phone (3)9162660
Telex 842-698000

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Cambridge Science Park
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Cambridge CB4 4BH, England
Phone (0223)68501
Telex 851-817466

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2544 En the Hague
The Netherlands
Phone 70-210101
Telex 844-31528

Sweden
Saven AB
Strandgaten 3
S-185 00 Vaxholm
Phone 764-31580
Telex 854-12986

Switzerland
GMP S.A.
Case Postale 277
CH-1010 Lausanne
Phone 021-333328
Telex 845-24423

Italy
Laser-Optronic S.R.L.
Via Teocrito, 50
20128 Milano
Phone (02) 25-51-904
Telex 843-335516

Australia
Varian Pty. Ltd.
679/701 Springvale Road
Mulgrave, Victoria 3170
Phone (03)-560-7133
Telex 790-38109

Israel
Landseas (Israel) Ltd.
38 King George Street
Box 23011
Tel-Aviv 61230
Phone 299091-4
Telex 922-342216

Brazil
Techno Laser
Sistemas e Equipamentos Ltd.
Rua Frederico Chopin 226
01454 Sao Paulo - SP
Phone 210-9117
Telex 391-1123600

India
Scientific Instruments
Marketing Co.
208, First Floor
Ajmeri Gate
Delhi 110006

Japan
Rikei Corporation
Shinjuku-Nomura Building
1-26-2 Nishi Shinjuku
Shinjuku-ku, Tokyo 160
Phone (03)345-1411
Telex 781-J24208

Taiwan R.O.C.
Superbin Company, Ltd.
6/F, 230-3, Sec.4, Jan Ai Road
Taipei, Taiwan
Phone (02)-705-4205
Telex 785-21206

Singapore
Laser Electronics S.E.A. Pte. Ltd.
24 Sunshine Terrace
Singapore 1953
Phone 2846473
Telex 786-33555

People's Republic of China
Global Technology Inc.
901 West Victoria St., Unit F
Compton, CA 90220
Phone (213) 635-7106
TWX (910) 346-6347

Korea
Wooyang Trading Company
Chunwoo Yackpum Building
12-12, Bongik-Dong, Chongro-Ku
Seoul
Phone 742-4645,46
Telex 787-K23231 Ext. 2804

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