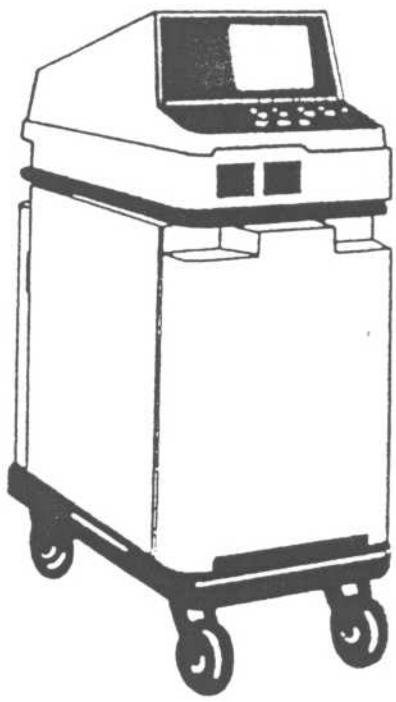
Model 800 Series
Microscopic & Fiberoptic
Surgical Laser System



Service and Maintenance Manual

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800 SYSTEM LABS

LAB 1

USING SYSTEM 800 SERVICE SCREENS

INTRODUCTION

This lab will review some of the key features in the 800 service screens that were earlier demonstrated by your instructor. It is essential that you know how to access and utilize the screen features in order to observe system performance and troubleshoot system errors. The purpose of this lab is to give you hands-on practice on some of the screen commands previously discussed.

OBJECTIVES

Upon completion of this lab you should be able to perform the following:

1. Know and access the System Setup Screen features

2. Know the purpose and meaning of each of the new displays on each of the service screens.

3. Be able to manually power up the laser using the service screen commands.

4. Be able to access and manipulate the features of each of the screens to check or alter power and current outputs.

5. Be able to look up and interpret system status information regarding temperature and interlock readings, and error and power log recordings.

PROCEDURE

First power up the laser by pressing the Standby button. This will bring the laser into it's 3 1/2 minute warmup cycle. After the warmup cycle, the laser will be in Standby applications mode.

Before you begin accessing the service screens, lets first take a look at some new (compared to the 700) features in the applications mode. On the 800 control panel you will notice a SYSTEM SET UP button. This allows the user to access the System Setup screen which provides some basic tone volume adjustments and diagnostics features. Familiarize yourself with this screen and it's functions by performing the following:

EXERCISE 1: System Setup Screen

Step 1: Activate the following buttons displayed on the screen and note what happens.

This Screen is before Software Rev 3.7.1

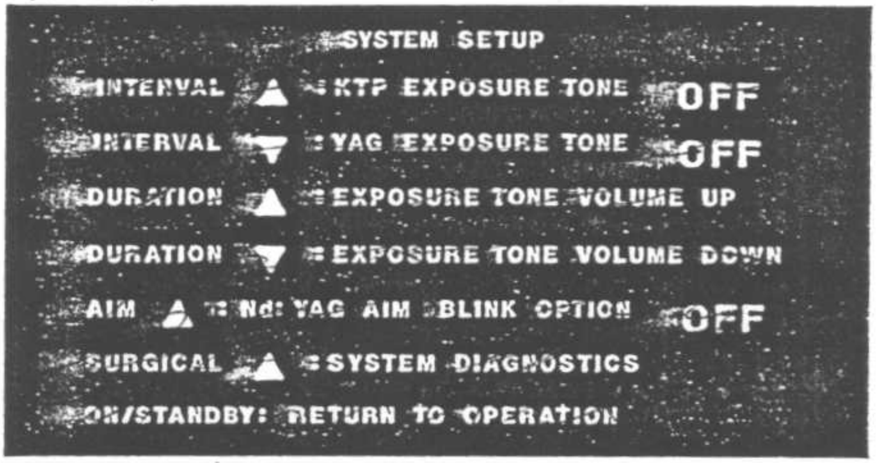
New Screen afte S.W. Rev. 3.7

system Setup

ur. ▲ Summary

tim ▲ Configuration

Dur. ▲ Diagnostics



INT UP	Causes KTP Exposure Tone feature to toggle ON and OFF.
INT DN	Causes YAG Exposure Tone feature to toggle ON and OFF.
DUR UP	Causes volume of the exposure tone to increase.
DUR DN	Causes volume of the exposure tone to decrease.
AIM UP	Toggles the Blink option of the YAG aim beam.
SUR UP	Causes coded system diagnostic messages to be printed on the CRT display, (if any such messages are currently stored in the battery-backup RAM).
STNDBY	Causes the SYSTEM SETUP screen to be erased and restores the previous screen.

EXERCISE 2: Service Mode and Screen 1A

To begin, first enter the service mode. Remember you must first install a service jumper (J18), then press simultaneously SURG. PWR DN, INT UP, and REPEAT(or S3 on the Electronics Board). This will bring you into the Main Menu: Screen 0: Service Screens Menu. This menu is the same as in the 700 series with the exception of a few added screens. Lets proceed by opening Screen 1A: Laser ON/OFF and Interlocks (SUR UP).

In this exercise you will become familiar with manually powering up the laser and interpreting system status information in screen 1A. There are three ways you can power up a laser: Standby button in Applications Mode, Aim Up - "Turn Laser On" (screen 1A) in Service Mode, and the manual power up procedure (overiding the startup software) in Service Mode.

Step 1: Before you can manually power up the laser , you must first power down the laser. Perform the following in screen 1A:

(1) Firmly press SUR UP button, this will open R1 & R2 contactors. The pump and ALE will shut off and the system will stop lasing.

Step 2: To manually power up the system , in order, select the buttons listed in the chart on the next page. Note the status information after each of the commands have been selected.

800 MANUAL LASER POWER Up

1. Service Screen 0: Laser ON/OFF & Interlocks

2. Screen 1A: (SUR UP)Relay OPN/CLS: Closes relays
   Status: LPS01 RLY changes from 0 to 1
   status: LPS02 RLY changes from 0 to 1

Before continuing make sure the RF driver is Off
RF ON/OFF = 0 RF LO/HI = 0
NOTE:
You do not want the system to start Q-switching before the laser has been in operating current (I OP) mode for at least 30 seconds. Q switching prior to warm up of the KTP crystal can cause damage to the crystal.

3. (SUR DN)Lsps EN/DIS: Enables lamp power supply
   status: LPS01 RLY drops back to a 0
   status: LPS02 RLY is still a 1
   status: LPS EN* changes from a 0 to 1
   status: ALE reading = Approx. 5 amps simmer
   status: LCUR = Approx. 5 amps
   status: LPS RDY* changes from a 0 to 1

4. (DUR UP)I OP: Brings ALE current from simmer to operating current.
   status: I OP reading = Approx. 25 amps
   status: ALE reading = Approx. 25 amps

5. (REPEAT)LO RF: Turns the Q-switch on in Low Rf mode.
   status: Changes from CW to Low Rf.
   status: RF ON/OFF changes from a 0 to 1

6. (STNDBY)HI RF: Causes system to Q-switch in High RF mode.
   status: KTP Surg. reading goes up
   status: RF LO/HI* changes from a 0 to 1

Some of the features in Screen 1A include the I SIM, I OP, I MAX current displays and temperature and interlock displays.

Step 3: Lets first take a look at the added temperature displays. In the lower right corner four temperatures are displayed. They are the Endostat, Microbeam, Water and PCB temperatures. If any of these temperatures are out of range, the computer will display a hard fault in service mode or a warning message in applications mode if the fault is not too serious. If a fault 1 error is displayed, a temperature interlock (TMP ILK, WTR ILK, OPN ILK) switch is activated and the system will shut down. When these switches are activated, the 0 reading will change to a 1. The sequence of temperature errors that can occur are as follows:

120 degrees = Type 3: Will display warning in Appts. mode
140 degrees = Type 1: hard fault, system shuts down.
150 degrees = Type 1 hard fault, system shuts down.

Actual temperatures are displayed only in service mode, screen 1A.

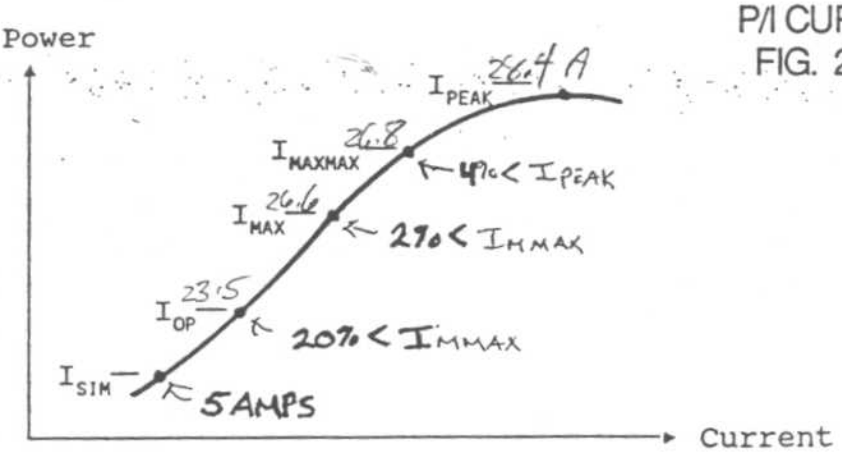
STEP 4: Next take a look at the current displays. The I SIM, I OP, and I MAX are the current values that are used to operate the laser and are determined during warmup. The approximate values that these readings represent are as follows:

I SIM = 5 AMPS (min. lamp current)
I OP = 25 AMPS (Approximate operating current for KTP)
I MAX = 30 AMPS (Approximate max. operating current)

These values are approximate and are referenced to a software I MAX MAX AND I PEAK value. Another way to represent the relationship between these values is by looking at a power to current or P/I curve which is shown on the next page.

EXERCISE 3: P/I CURVE AND CURRENT CONTROLS

The power to current relationship is displayed in the upper right hand corner of Screen 5A (KTP Manual Current Control). Based upon the the power and current data displayed, you could draw your own P/I curve. This curve would enable you to see how well the laser is performing based upon its current to power ratio.



P/I CURVE
FIG. 2.1

Step 1: Go to Screen 5A by first returning to the Main Menu (press READY). Now press SUR DN, this will bring you into the KTP Power/Current Curve Screen. Look at the current and power values displayed in the upper right corner and complete the following questions.

1. Find and write down the following current values:
   I MMAX= 26.8A
   I MAX = 26.6A
   I OP = 23.5A

2. Approximately at what current value does the curve reach a Peak current? 28.4A

3. Draw a P/I curve based on the values displayed in the lower left and upper right of the screen. Label your I SIM, I OP, I MAX., I MMAX, I PEAK and the roll off point on your curve.

Step 6: Now increase the current (INT UP) and observe the ALE, LCUR readings and the KTP beam intensity. Also notice the Surg. Detector reading. You should see these values increasing as you increase the current. Now decrease the current. The readings should now all decrease.

EXERCISE 4: SHUTTERS, DETECTORS & DEVICES

Step 1: Return back to the Main Menu (READY) and select the: Lasers, Shutters, Detectors (AIM UP), this will put you into Screen 2A. Note that the IN and OUT status signals are now called DRW and SW. DRW refers to the signal sent to the solenoid and SW shows wether the switch is open or closed.

Step 2: The Surgical Detector has three gain ranges: X1, X10 and X60. Press the Aim DN button to change the Detector gain range. Go to the X1 gain. Now increase the KTP power, (INT UP). What was the maximum power the system could go to in this gain? Count 150 SURG WATTS 20.5

Step 3: Now go to X10 and increase power until the system reaches a maximum and repeat this step for X60. Record the power and count readings for the maximum setting.
X10 Max. Power Count 255 SURG WATTS 3.5
X60 Max. Power Count 230 SURG. WATTS 520mW
Which gain would be used for the lowest power usage? X60

Step 4: Return back to the Main Menu and select Attachments and ESF, Screen 3. In this screen you can open and close the shutters, test and also disable the eye safety filter, and other areas such as delivery devices and footswitch operation.

Step 5: Select (DUR UP) BEAM SWITCH. This feature allows you to select the endostat or microbeam output. Selecting this command tests the operation of the Coupler Select Mirror Pair. Press (DUR UP) again to return to the previous coupler position.

Step 6: Open and close the different shutters, noting the DRV and SW status signals. Why does the SW Display read either a 01 or 10 display, but not normally 11? 11 is a fault

If SW displayed 11, what would that indicate? Fault

Step 7: Next, attach an eye safety filter(If not already) and check the operation of this filter by pressing INT UP. Observe the filter opening and closing. Note again the status signals for ESF -DRV &SW.

Step 8: In the lower left hand corner of the screen you will see signature resistance and count values that correspond to certain delivery devices. When no device is attached, the system will display a count of 255 and ENDO & uBM PLUG = 0. The laser you are now working on has a device cheater plug connected (J19 electronics board). Disconnect the plug and reconnect the original J19 plug. Record the readings: ENDO SR1 = 255 ENDO SR2 = 254 ENDO PLUG Ø
Attach a 600mm fiber and record the following readings:
ENDO SR1= 76 ENDO SR2= 25 ENDO PLUG 1

Step 9: In the middle bottom column, there are footswitch signals that allow you to check the footswitch operation. Slowly press the footswitch and observe FTSW and RAW signals. The SUR RAW 1 and SURG RAW signals show the incoming footswitch signals. The computer checks these signals by comparing them. If they do not compare, there will be a difference in reading (0 & 1 instead of 0 & 0) and a Footswitch redundancy Failure (SO 44) will be displayed in applications mode.

EXERCISE 5: MODULATION MODE

Step 1: Return to the Main Menu and go into the Special Tests Screen 7. The Clock and Date Set Screen is being skipped because there are no changes to this screen. (Note: if you enter the Clock and Date Set Screen, the data in the Error Log and Power Log will be erased.)

Step 2: The key feature to Screen 7 is the Current Modulation, which is one of the new additions to the 800 model. Press INT UP to enter this screen (Screen 9).

NOTE:
In this screen there is the Modulation ON or OFF feature. When turning on the modulation mode, the Q-switch turns off and the system begins modulating the ALE currents from 5 amps to about 30 amps at 83 Hz and at a 50% duty cycle. This range of current, which averages about 17 amps, produces enough power out for the Aim beam but does not heat up the operating room as much since the lamp is being run at a much lower average current level.

Step 3: **Before** you select Modulation On (AIM DN), make sure the Surgical Attenuator is at minimum attenuation (MAX power). To do this, first select Modulation OFF (AIM UP). and go into high RF Q-switch operation. Record the following readings:

ALE count = 120 ALE cur = 23.5A
LCUR count = 124 LCUR (amps) = 24.7A
SURG count = 121 SURG (power) = 26.7

Step 4: To cycle the Attenuator, either Inc. Power (Attn) INT UP or Dec Power (Attn) INT DN would be selected. When in the Modulation mode, these commands also allow you to adjust the modulation current. Only the high end of the current can be adjusted, the low value (I SIM) is fixed. Notice when you go into the Modulation mode, the screen changes because the Set up, Repeat and STNDBY disappear from the display.

Step 5: Go into Modulation mode (AIM DN). Record the following readings:

ALE count = 168 ALE cur = 17-18A
LCUR count= 102 LCUR (amps) = 20A
SURG count= 118 SURG (power) = 15A

Your LCUR readings should have dropped in relationship to the ALE reading. Explain why this happened. One dependent on the othe

Step 6: Turn Modulation off and rotate the Attenuator until SURG power reaches a maximum reading. Record this value. SURG = 16.6. The SURG. Detector reading should be equal to approx. 20 watts. (At I op & High RF). Note Iop value. 24.7A

Step 7: Return back to Screen 7 (READY) and select Error log screen. This screen keeps a log of the time and error that happened in the laser. Return back to Screen 7.

Step 8: Now select the the power log screen. Record the last power & current displayed in this screen.

KTP 23.3 Watts at 26.4 Lamp Current
YAG 78.1 Watts at 34.1 Lamp Current

Step 9: Return back to the main service screen menu.

This concludes the lab on the 800 service screens. To review the concepts of this lab complete the following questions on the next page.

REVIEW

1. At what temperature will the system submit a Type 1 fault causing system shut down? 140°F

2. If RAW 1=0, and RAW 2 =1, what is the system fault? Raw 1 + Raw 2

3. What buttons would you have to push to get from the Main Menu to the Current Modulation Control Screen? IN + UP IN + UP

4. Which screen would you have to go to if you wanted to find out the P/I curve of the laser? 5A

5. What does the P/I curve tell you about the laser performance?

Yag Rod + Lamp Performance

6. I SIM, I OP, I MAX and I MAX MAX currents are based on what reference current? Peak Power

7. List the gain ranges and their approximate power limits for the Surgical Detector. X1 20 KTP/60W Yag X10 3.5 Yag X60 580mW

8. What happened to the LCUR Value when you put the system into Modulation mode? Explain. Went down

9. When you increased the the INC POWER (KTP) screen 2A, why did not the LCUR or ALE current increase? Which power increased and why? KTP increased do to Surgical Antuartor.

ERROR LOG

Decoding for PP:

	KTP Watts	YAG Watts		KTP Watts	YAG Watts		KTP Watts	YAG Watts
00	0.05	5.	16	0.50	25.	32	5.0	--
01	0.06	6.	17	0.60	30.	33	6.0	--
02	0.07	7.	18	0.70	35.	34	7.0	--
03	0.08	8.	19	0.80	40.	35	8.0	--
04	0.09	9.	20	0.90	45.	36	9.0	--
05	0.10	10.	21	1.0	50.	37	10.0	--
06	0.12	11.	22	1.2	55.	38	11.0	--
07	0.14	12.	23	1.4	60.	39	12.0	--
08	0.16	13.	24	1.6	--	40	13.0	--
09	0.18	14.	25	1.8	--	41	14.0	--
10	0.20	15.	26	2.0	--	42	15.0	--
11	0.25	16.	27	2.5	--	43	16.0	--
12	0.30	17.	28	3.0	--	44	17.0	--
13	0.35	18.	29	3.5	--	45	18.0	--
14	0.40	19.	30	4.0	--	46	19.0	--
15	0.45	20.	31	4.5	--	47	20.0	--

Decoding for D:

	KTP Secs	YAG Secs
0	--	0.1
1	--	0.2
2	--	0.5
3	0.10	1.0
4	0.20	2.0
5	0.50	3.0
6	1.00	4.0
7	CONT	5.0
8	--	10.0
9	--	CONT

Decoding for I:

	KTP Secs	YAG Secs
0	0.10	0.10
1	0.50	0.50

Decoding for E:

	KTP Mode	YAG Mode
0	SINGLE	SINGLE
1	REPEAT	REPEAT

Decoding for W:

K	KTP
Y	YAG

Decoding for S:

F	Laser Off
N	Laser On
L	Laser Warmup
S	Standby
S	Standby
R	Ready – Aim
R	Ready – Aim
E	Ready – Exposure
W	Wavelength Switching
C	Calibration
1	Type 1 Fault
2	Type 2 Fault
5	Watchdog Fault
B	Beam Dump
M	Menu Setup

The format for the error log is as follows:

XX/YY EEEE PP DIEWS

Where			
	XX	:	Day
	YY	:	Month
	EEEE	:	Error Code
	PP	:	Power Level
	D	:	Duration Level
	I	:	Interval Level
	E	:	Exposure Level
	W	:	Wavelength
	S	:	System Status

LAB 2

DETECTOR & CAL POD SET-UP FOR THE 800 LASER

INTRODUCTION

This lab covers detector set-up and Calibration Pod and adjustment procedures which are necessary to obtain quality laser output for the 800 surgical laser system. Before starting this lab, you must first be familiar with the service screens (prerequisite: lab 1) and have read or been trained on the laser resonator. Do not continue with this lab until you have first meet this prerequisites.

NOTE: Before beginning this lab, make sure that KTP and YAG laser, the second train , the fiber interface assembly and endo fiber are completely aligned.

OBJECTIVES

Upon completion of this lab you should be able to perform the following:

1. Effectively access and use the service screens to set up and observe power readings for detector calibrations.

2. Calibrate the Surgical and Safety detectors.

3. Set-up and calibrate the Aim Detector to reach desired power output.

4. Calibrate and check throughput of the Cal. Pod.

PROCEDURE

Our first lab exercise will involve zeroing all the detectors and calibrating the Surgical and Safety detectors. The Surgical and Safety Detectors must be calibrated before the Aim Detector, because these two detectors track each other by comparing each other's power output. If there is a substantial difference between their output reading (+/- 33% or more) the computer will print an error message (Exposure Fault) and immediately drop the Safety Shutter arm in place to prevent an exposure. The tracking between these two detectors serves as a safety backup for ensuring correct power outputs.

Before beginning this lab you will need the following tools:

Material/equipment required:

* DVM
* Alignment Aperture
* Set of allen wrenches
* Sheet of lens tissue paper
* Beam block
* Delivery device cheater plug
* Safety glasses
* Known good Endo fiber
* Power Meter

Step 1. KTP DETECTOR CALIBRATION

a. Turn laser key switch on and place in service mode. To place in service mode, simultaneously press surg. power down, interval up, and repeat, or press S-3 on the Electronics card. This will bring you to Screen 0: Service Screens Menu (main menu). Go to Service Screen 1A and manually power up the system. If you do not remember this procedure, refer to your notes from Lab 1. Setup the system to **Iopp current and Low RF.** Block the KTP beam after the Surgical Attenuator.

b. Next you will zero all the detectors. Before we begin, make sure the system is in KTP mode, not in YAG.

c. Perform zero adjustment for the KTP Surgical Detector as follows: Set up voltmeter at a 300 mv scale to measure DC voltage, then connect leads between TP3 (ground) and TP1.

1) Adjust pot VR1 for zero to +/- 0.002 V on meter. (This zeros the detector output.)

2) Connect meter to TP3 and TP2.

3) Adjust pot VR3 for zero to +/- 0.002 V. (This zeros the output amplifier stage.)

d. Repeat the steps in exercise c for the KTP Safety Detector.

e. Repeat the steps in exercise c for the KTP Aim Detector.

f. Now that you have zeroed the detectors, next you will check for the accuracy of the Detector gain ranges. Place a calibrated power meter after the Safety Shutter location (in the open space). Remove beam block at the Surgical Attenuator. Set the system to High RF, keeping the current at the lopp range (you should still be in Screen 1A).

g. Go to main menu (screen 0) by pressing READY. Next select Shutters and Detectors screen (aim up). This will put you into screen 2A. Raise all the shutters.

h. Set the Detector gain range for 1 (Aim Down). Open Surgical Attenuator for Max. KTP power (Int Up). Record the power reading shown on the meter. Watts _______

i. Check the Surgical Detector power reading on the screen by looking at SURG = ____. Compare this reading with the power reading on the meter. Record both readings below:

Screen reading SURG = _______

Meter reading= _______

j. Adjust VR4 on the Surgical Detector until the power readings match.

k. Place beam block in front of Endo Coupler Assembly. Remove the power meter. Keep all shutters raised.

l. Now adjust ~~VR4~~ VR2 on the ~~Safety~~ Surgical Detector until power readings match the Surgical Detector readings. Compare the two readings on the screen and record them:

SURG = ______

SFTY = ______

The counts should be within +/- 5. The SFTY can be equal to but never higher then the SURG counts.

m. Next you must make sure that both detectors are linear. To do this, press INT down and observe the two readings on the screen. Both readings should go down simultaneously. Keep going down until you have reached a minimum or zero reading. Make sure that both readings are decreasing at the same rate. If readings decreased at a different rate, the detectors may be nonlinear and errors could occur. In order for the detectors to be considered nonlinear, the readings must be more than +/- 5 counts or +/- 33% off.

n. Now check to make sure the detectors track in the lower gain range. Set gain range to 10 and increase and decrease KTP power. Both detectors should still track.

Step 2. AIM DETECTOR SET UP (This step is optional. If you do not have a low power meter, skip this step and step 3, which also requires a low power meter. Proceed to step 4)

a. Stay in KTP mode. Return to Screen 0 and then go to Special Tests screen (interval up). Now go to the Current Modulation screen (interval up).

b. Rotate the Surgical Attenuator to maximum power (Int. up). Now go to current modulation (Aim down). Note that this operation mode is a new feature for the 800 systems and is not present on the earlier models.

c. At this point, you can either increase (Int. up) or decrease (Int. down) high modulation current level to get 8-10 watts on the Surgical Detector. Make sure you do not increase current above rolloff which should be between the range of 17-20 amps. Refer to the LCUR reading on the screen to check this current range.

d. Return to the main menu (ready twice). Go to the Shutter and detector screen (aim up). Drop the Exposure and Calibration shutters (surg. down, aim up). Lower the light valve voltage on the Aim detector to zero (Duration Down). Now unplug the two white wires from the light valve that connect to the shutter PCB. Also remove the cable from the this board.

e. Next remove the Aim detector PCB. Remove foam and gasket, polarizer (plastic piece) and the IR filter (Glass) from the detector body (watch your eyes).

f. Back off spring plunger and remove aperture. Do this by loosening the 2 side screws on the detector body; remove aperture.

g. Loosen the bolt (located at the side of the unit) which holds the detector body to the detector stand (use a 9/64 Ball driver).

h. Put the glass IR filter back in place and put a piece of lens tissue paper over the detector body.

i. Slightly rotate the detector body on the stand to center beam in the detector bore. Look at the beam brightness from the top of the detector. Observe the beam brightness through the tissue paper. Place the detector at the brightest spot. Remove the glass filter.

j. Tighten the bolt. Replace the aperture and spring plunger. Adjust the two top screws located on the aperture until the aperture is centered with the beam: make sure spring plunger exerts tension on aperture. Once again using lens tissue, position aperture to get brightest beam.

k. Replace the IR and polarizer filter, foam gasket and detector board. Plug in the detector power cable.

l. Hook up DVM to TP2 and TP3. Go to screen 2A (use either interval up or interval down) and adjust the Surgical attenuator to get 2 volts out put.

m. Go to the two screws on the Aim detector and fine adjust the aperture to maximize voltage on DVM.

n. Next connect an endo fiber to the system. Open the Surgical Attenuator for max. power (minimum attenuation).

o. Open the Safety Shutter and adjust the light valve voltage from the screen to get 3.5 mw as read at distal end of the fiber with low power meter. (As LV voltage decreases transmission increases).

p. Now adjust the gain on the Aim Detector board (VR4) to get 3.8 mw on the screen. If it is not possible to get 3.8 mw on screen, rotate the detector body clockwise for more light, counter clockwise for less, and then realign the aperture and try again. Go to applications and test the Aim operation at the various Aim and Power levels.

Step 3. LOW POWER MODE (KTP only)

a. Next we will adjust the surgical detector for the low power mode. First, go to lopp, high RF (Screen 1A, DUR UP).

b. Go to main menu and select the shutters and detectors screen. Next, adjust the Surgical Attenuator until you see 8 watts at the Surgical Detector.

c. Close Calibration Shutter. Go to 60X gain by depressing " Detector Gain" until 60X is attained. This reading can only be seen at the Safety Detector. The Surgical Detector will be at a 3X gain range.

d. Open the Safety and Exposure Shutters (if not already open). **Do not** open the Calibration shutter. Increase KTP power. You should see the 60X power range go to about 583 mw at the Safety and about 11.67 watts at the Surgical Detector. Place the low power meter after the Safety Shutter (this blocks light from entering the Safety) and note the reading. This reading should be close to what the Safety read (+/- 10%) at about 583 mw max. If readings are substantially off, perform step e.

e. Adjust VR2 on the Safety Detector so that readings match your meter readings.

Step 4. YAG Detector Calibration

CAUTION : Safety glasses must be worn since the 1064 is not visible to the human eye.

a. Go to YAG operation and repeat the steps for detector zeroing and Calibration for the YAG Detectors. When you have finished setting up the YAG Surgical and Safety detectors, proceed onto to the next section of this lab.

Step 5. CALIBRATION OF THE CAL POD

a. Attach the delivery device cheater or old endo-stat. Zero the cal pod board (YAG and KTP). To zero the Cal Pod first remove the black plate on the rear of the cal pod. This is done by removing the four screws that secure the rear metal plate to the cal pod. Now remove plate. Place the negative probe from the Fluke meter into TP3 and the positive probe into TP1. Adjust VR1 to obtain 0.00mv on a 300mv scale on your meter. Now move the positive probe to TP2. Adjust VR2 to obtain 0.00mv. Move positive probe to TP4. Adjust VR3 for reading of 0.00mv. The cal pod is now zeroed.

b. In KTP, go to Calibration Screen (screen 4A). Power should be .8 watts on the screen (this level is set automatically). Place a beam block in front of the coupler assembly.

c. Raise the Exposure and Safety shutters. Adjust VR2 on the KTP Safety Detector to get 150 counts (+/- 20 counts) on the screen.

d. Place cal pod on the resonator plate in the KTP beam path, behind the Safety Shutter location. Adjust VR4 on the Cal Pod so the screen reads 150 counts or equal to the Safety Detector count reading.

e. Next go to YAG mode. Power should be 16 watts on the Surgical Detector (set automatically).

f. Raise the Exposure and Safety shutters. Adjust VR2 on the YAG Safety Detector to get approximately 150 counts (+/- 20 counts) on the screen.

g. Place Cal Pod on resonator plate in YAG beam path, behind the Safety Shutter location. Adjust VR5 on the cal pod so the screen reads 150 counts (+/- 20 counts) or equal to the YAG Safety Detector counts.

h. Next switch back to KTP mode. Remove Cal Pod from the resonator plate, install snout and position fiber in the Cal Pod.

i. Press REPEAT. "Throughput" should read between 80-90%; note the value.

j. Switch wavelength, open the Safety Shutter. Press REPEAT again. Read "throughput". Adjust VR2 on the YAG Safety Detector and press REPEAT until throughput matches that found in KTP.

This concludes the lab on the 800 detector set up and calibration procedures. To review the concepts of this lab complete the following review questions.

REVIEW

1. Why must you first calibrate the Surgical and Safety Detectors before setting up the Aim Detector? To check Cal to verify proper power.

2. List the three main steps performed for setting up the Surgical and Safety Detectors. zero them.

3. If the detector reading does not match the meter reading during either the 1 or 10 gain range, which pot would you adjust to correct this? VR 4

4. List the errors that would be displayed if the KTP detectors did not track within +/- 33%. Befor S.W. 3.7 after S.W 3.7 20%
   5032 S/32

5. Explain how you would check for "detector tracking".
   vary Power up + down in All Gain ranges.
   X1 + X10

6. Which detector in KTP and YAG is used as a reference for setting up the CAL POD?

LAB 3

800 ELECTRONIC CONTROL BOARD

INTRODUCTION

In this lab you will locate and check key test points on the Electronics (PCB) board. These test points will help you become more familiar with how the control signals from this PCB effect various system operations. We will not go down to component level troubleshooting, for this would be impractical for a six layer board that usually would not be repaired at a customer site. By checking key test points, however, you can more effectively isolate the fault to board level.

OBJECTIVES

Upon completion of this lab you should be able to perform the following:

1. Be able to check low voltages and setup the PCB +5volt reference

2. Measure voltage readings off the PCB drivers

3. Check and adjust the temperature sense circuits

4. Check KTP heater circuit

5. Check the ALE control circuit

6. Check the modulation and light valve circuit

7. Check timing functions and CRT control signals

8. Remove and install the Electronics board

PROCEDURE

You will need the following items to perform the steps in the coming lab exercises:

- DVM with hook end leads
- IC clip
- Oscilloscope
- Electronics Board Schematics (sheets 1-13)
- Service cheater plugs (J18 & J19)
- Low Voltage Test Box

EXERCISE 1: Checking LVPS & PCB Voltages

Step 1: Hook up a low voltage test box at the J2 connector and measure the low voltage values with a DVM. Record your readings: 5v= 5.0 15v=14.95 -15v=-14.99 12v=11.96 24v=23.98 Which voltage reading does not have it's own adjustment pot on the low voltage power supply? 12 V

Step 2: Next you will check the PCB 5V Reference. This is not the same as the 5v LVPS that you just measured. The 5v Reference is a crucial value in which many of the digital electronic functions are based on. Here is an example of what happens when this 5v Reference is not set correctly:

When signature resistor readings are supposed to read 255 counts, but they only read 245, this could be due to the Reference being off. (It can also be due to electronic component tolerances being off). In the Software scheme, this 5v is equivalent to 255 counts and 0 volts is 0 counts. The software bases everything on 255 counts (8 bit counter), so if the 5v is 5.6, then the scale is extended and each count has a higher voltage value which will throw everything off. You will notice the counts dropping below 255. Conversely, if the 5v reference is set at 4.6, then each count has a lower voltage to the count ratio. You will not however, see the counts increase beyond 255, due the the DAC 8-bit counter limit of 255 counts.

For werid Shutter problems Check 12v Reg. 15.0vdc to 12vdc.

Check the 5v Reference by connecting the DVM, - Probe to TP19 and the + Probe to U64, Pins 11 or 12. The DVM must read 5v. If not, adjust pot VR3 until it reads 5v. If the volatge will not adjust to 5v, and the LVPS has already been checked, the PCB is most likely bad. Referance Excatly 5.0vdc

Step 3: Next you will measure the voltages at the drivers located at the far right edge of the PCB. Connect the DVM - Probe to TP19 and +Probe to collector (far right, bottom leg) of each of the drivers. Do this with extreme caution so you don't short out any of the drivers. Record the voltage (DC) readings in the spaces below, starting with the top driver first. Refer to Electronic PCB schematic sheets 9 & 10 for reference.

QH1 KTP SFTY Shutter = ? -.033 to +.688 vdc
QH3 &4 Output Coup.Beam Motor Drive = Q3 5.08 to -4.44 Q4 +5.0 to + 4.0
QH5 &6 Laser Mirror Motor Q5 5.08 Q6 ~~-5.08 to -4.43 vdc~~
QH7 &9 " " Motor Q7 +4.98 5.08 to -4.43 vdc Q9 +5.01 to
QH8 YAG SFTY Shutter= -.021 to +.671 vdc.
QH10 Calibration Shutter Driver= -.034 to +.647 vdc.
QH11 Exposure Shutter Driver= +.001 to +.678 vdc
QH12 E.S.F Driver= +.032 to +.691 vdc.
QH13 Spare shutter Driver (J24 Not Used)=
QH14-17 Surg. Atten. Stepper Motor= Q14 ~~[illegible]~~ -.014 to -.0 Q15 -.012 to -.004 Q16 -.012
~~NOTE: There are no QH 18-20 drivers~~= Q17 Same
QH21 K2 Relay= +.044 to -.048
QH22 (3rd from bottom SH 12) KTP Heater= +.212 to +.280 vdc
AR4-12volt regulator= -11.98
AR2 -5v regulator= -5.08
AR3(2nd from bottom) +12v CRT= +11.70 vdc
AR5(Bottom) +12v System Control +11.88 vdc.

EXERCISE 2: Checking Temperature Sensor Circuits.

Refer to pages 8-5, 8-6 and the Electronics Board diagram in your manual to help locate the temperature circuits that will be discussed in this section.

Step 1: Go to service screen 1A and look at the temperatures displayed in the lower right corner of the screen. These readings are setup at the Laserscope factory and need not be reset. When installing a new PCB, you should verify that the temperature that the system is initially setup for represents the true operating temperature (+/4 degree F).

Step 2: When the system is first turned on, the temperature will read whatever the approx. room temperature is. The PCB and water temperature will rise several degrees the longer the laser remains on. A digital temperature probe can be used to check the PCB temp. at TU1. This reading can be compared with the screen display. There are four pots; VR4, VR5, VR11 and VR8 which can be adjusted if the new PCB is off in it's temperature settings.

EXERCISE 3: Checking the KTP Heater Circuit

The KTP Heater Circuit together with the water cooling system ensures temperature stability for the KTP crystal. The cooling system keeps the crystal from getting to hot. The heater circuit keeps the crystal within the proper temperature range. The thermister on the KTP crystal mount provides temperature feedback (via J20) to the heater circuit which basically acts as a comparator circuit with an ON and OFF switch. The U149 (op-amp) and the U144 (comparator) monitors the voltage drop across the VR7 resistor reference(750 ohms), which is effected by the crystal temperature, and compares it to the reference KTP voltage, 2.98volts. As the crystal temperature rises, the resistor value decreases, thus causing a change in the voltage drop which is picked up by the U149 device. The difference between the ref.voltage and VR7 voltage drop goes through the op-amp and comparator and then either turns on or off QH 22 driver which acts as a switch turning on and off the heater on the KTP unit. The voltage and pot setup for this circuit is done at the factory. To check the KTP Heater Circuit, perform the following: (schematic ref. sheet 12)

Step 2: Measure the reference voltage for the KTP Heater circuit. If this voltage is incorrectly setup, the reference for the 750 ohm reading will be off. Before you make your measurement, turn off the laser, then turn the key switch on. Next, disconnect the J20 heater plug. Now make your voltage reading from RR19 in reference to ground (TP7). Voltage reading=2,985 vdc

Step 3: Your reading should be 2.98volts. If not, adjust the VR6 pot until you read 2.98v at RR19.

Step 4: Next plug J20 back in and bring the laser into full lasing mode. Connect the DVM meter across TP 15 &16 and measure the resistance. The reading should be approx. 750 ohms. If your reading is off,adjust VR7 until you read 750 ohms.

EXERCISE 4: Checking the ALE Control Circuit

In this section of the lab you will check some of the control signals that originate off the PCB and is used to turn on the ALE supply. You will check the following three areas that pertain to the K2 contactor and ALE control:

* K2 relay control circuit
* ALE enable circuit
* LPSRDY (Ready) return signal

(Use schematic sheet 12 for reference)

Step 1: Go to service screen 1A, turn off the K3 and K2 relays. Hook up the DVM, -probe to TP7 and +probe to relay U134 pin8. You should read +24v. Now close K1 & K2 relays (SUR UP). Notice what happens to the output of pin 8. It should drop to low (approx. 0 volts). If the U134 & U133 malfunctioned, the system would be unable to close the K2 relay, which in turn would prevent the 208ACV from reaching the ALE, causing a LO52 error. 24.06 +

Step 2: If pin 8 does not go to ground, check to see if U134 is shorted by doing the following: Turn the system completely off. Set the DVM to the ohms scale and measure between pins 14 &8. They should read open. Now turn the keyswitch ON, the reading should be 60 ohms or less., but more than 0.

Step 3: Measure and record the readings for the following locations: U132 pin 4=5.Ø U136 pin 5=5.Ø
Now select LSPS En (SUR DN) and measure these locations again: U132 pin 4=.025 U136 pin 5=.038
Note how the LSPENON (pin 4) dropped to a low and then the LPSRDY (ready) also changed states when the ALE was turned on. Compare these readings with the status signals displayed in service screen 1A.

EXERCISE 5: Checking the Modulation Circuit

In this section of the lab you will check the Modulation control circuit by measuring the 83hz pulse with an oscilloscope (O-Scope). (reference: sheet 7)

Step 1: Turn the laser completely ON and go into service screen 9. Make sure that Modulation is in the OFF mode. Connect the O-scope to CR 57 diode (Anode Side).

Step 2: Turn the Modulation ON and observe the waveform displayed on the O-Scope. It should look like a distorted square wave at approx. 83hz. If you do not see anything on the display, check your O-Scope for correct settings.

Step 3: To check the origin of the Modulation control signal, connect the O-scope to U73, pin 13. You should see the 83hz waveform. The U73 chip is a Programmable Interval Timer Device that is also used to setup the clock frequency for the Light Valve.

EXERCISE 6: Checking the Light Valve Circuit

You will check the Light Valve operation in two areas; the the Light Valve voltage readings on the PCB Exposure shutter and the main PCB, and the clock frequency on the main PCB.

Step 1: Disconnect either the KTP or YAG Light Valve leads (small white wires) from the Exposure Shutter PC and connect your DVM to the terminals where the leads had been previously connected. Set the DVM to the AC volt scale.

Step 2: Go to service screen 2A. Increase the Light Valve voltage (DUR UP). Notice the increase in the DVM reading. Decrease the voltage. The reading should decrease. If the system displays a Light Valve error, first check these voltages and the connections going to the valve assembly. If the voltages are OK but the Valve does not change in appearance, the valve or connections are faulty.

Step 3: If there are no signals reaching the Exposure Light Valve PC, then the main PCB has to be checked. To check the Light Valve voltage on the PCB (Ref. sheet 9), connect the DVM (ACV scale) to test points TP1 & TP2 (located at the far right mid section of the board). Increase and decrease the Light Valve voltage again in screen 2A and note the readings on the main PCB test points.

If the Light Valve voltage was stuck in maximum or stuck at zero, then VR2 may be open or shorted. Also, if you are unable to bring the light valve voltage down to zero, adjust VR 2 until you read zero volts on TP1 and TP2 +/- 1/2 volt.

Step 4: To check the clock frequency for the Light Valve (Sheet 5), connect an O-Scope to U47 pin 13 (lightvalve switch signal). You should see a 83Hz signal. Without this signal, the Light Valve circuit will not work.

EXECISE 7: Observing CRT, Character Generator and Keyboard Control Errors

In this section of the lab your instructor will demonstrate some control errors that effect the CRT display and Keyboard operation..

Step 1: The following CRT controller (U28) faults will be induced into the system, make a note of the displayed symptoms.

1) Horizontal Sync fault
2) Vertical Sync fault
3) Read/Write fault

Step 2: Next, your instructor will induce a Character Generator fault.

Step 3: The last fault induced will demonstrate a faulty Keyboard Interface Component.

800 Preventative Maintenance Procedure

This procedure will outline what should be done at a scheduled customer preventative maintenance call. It will ask that certain information be recorded and that several functional and system tests be run and that they successfully pass.

- Customer Information -

Site Name ____________________ System Type/SN ____________
Site # ____________________ Clock Hours ____________
PM @ 6 Month ______ @ 12 Month ______

- Initial Check -

A. Before performing any maintenance, first verify the current status of the system. Do this by turning on the system in the application mode and letting the system go through a complete warm-up cycle. Next, calibrate and record all transmission percentages for all delivery devices; in addition to this, ramp power up to maximum for all delivery devices and record max power available.

KTP ENDO TRANSMISSION	______%	MAX POWER	______W
uBEAM TRANSMISSION	______%	MAX POWER	______W
YAG ENDO TRANSMISSION	______%	MAX POWER	______W

B. Verify the system power readings with an external power meter. If they are within 10% of each other, make no adjustments. If not, follow system protocol. Calibrate a 600 micron fiber to perform this test.

KTP	____1W	____5W	____10W	____MAX W
YAG	____10W	____20W	____40W	____MAX W

- Water System Maintenance -

A. Turn system off. Remove side panel to allow access to the water compartment.

B. Remove the D.I. filter and canister. Place a bucket under the vacated filter location. Turn system on and go into service mode screen 1a. Close the relay. Water will be pumped into the bucket. When the water is reduced to a mixture of water and air, open the relay. Refill the reservoir and repeat the process until the old water is drained from the system.

C. Replace D.I. and particle filters with new filters. Refill the reservoir with new de-ionized water. Record the resistivity.

Water Resistance ____M Ohms

- NOTE - **RUNNING THE SYSTEM WITH NO WATER OR A WATER/AIR MIXTURE FOR ANY LENGTH OF TIME CAN CAUSE SEVERE PUMP DAMAGE.**

- Arc Lamp Check -

A. Turn system off and completely de-energize. Open the lamphousing and inspect the lamp for visual integrity. If there is a burn area at the anode or a white film at either end, replace the lamp. Check the power log and determine if to maintain adequate power the A.L.E. has substantially increased current output. If this is the case, replace the lamp. Record the lot # of the new lamp.

Lot # ________

B. If you did not replace the lamp at the six month check, replace it at the 12 month check.

Lot # ________

- Service Call Protocol -

A. Follow the field protocol and check the integrity of all mounts, cables, optics, etc.

Visual Inspection __________ OK

B. Check LVPS for correct operating voltages.

______5v ______+15v ______-15v ______24v

C. Check 5 volt reference.

______5v

D. See if max KTP and YAG powers can be adjusted any higher. Record max powers at the surgical detector.

KTP ______ W (Iopp) YAG ______W

E. Verify the detectors track and are linear.

KTP SAFETY ______ counts KTP SURGICAL ______ counts
YAG SAFETY ______ counts YAG SURGICAL ______ counts

Perform this check at the maximum power available in each wavelength.

F. Remove endo coupler lens and clean with acetone. Install and re-align. Check calibration with a 600u fiber.

KTP Endo ______% ______W max
uBM ______% ______W max

YAG Endo ______% ______W max

G. Check the calibration of the Cal-Pod versus an external power meter. Calibrate with a 600u fiber.

KTP ______1W ______5W ______10W ______MAX W
YAG ______10W ______20W ______40W ______MAX W

H. Go into service mode and enter into the power log. Record the last two previous power levels and the dates on which they were recorded.

KTP 1. ______W ______Date 2. ______W ______Date
YAG 2. ______W ______Date 2. ______W ______Date

I. Check the error log for any multiple faults; investigate these errors to make sure they have been resolved. Note any faults that you might be concerned about.

____

____

____

- Error Detection Operation -

A. Go into Apps and verify the following faults:

	ERROR MESSAGE
1. Hold Exp shutter open (KTP and YAG)	______________
2. Hold Exp shutter closed (KTP and YAG)	______________
3. Hold Cal shutter open (KTP and YAG)	______________
4. Hold Cal shutter closed (KTP and YAG)	______________
5. Hold Saf shutter open (KTP and YAG)	______________
6. Hold Saf shutter closed (KTP and YAG)	______________
7. Hold Beam Mirror down	______________
8. Hold Beam Mirror up	______________

9. Block KTP Surg det (adjust power) ____________
10. Block KTP Saf det (make exposure) ____________
11. Block YAG Surg det (adjust power) ____________
12. Block YAG Saf det (make exposure) ____________
13. Disconnect 2nd flow swtch status ____________
14. ESF recognized ____________
15. ESF disconnected ____________
16. ESF defeated,connect ____________
17. ESF defeated, connect and attached ____________
18. ESF not attached ____________
19. ESF malfunction ____________

- NOTE - CLEAR ERROR LOG AFTER COMPLETING TESTS.

- System Configuration -

A. Make sure all current FCOs have been installed. List any incomplete FCOs. ____________________

B. Record all pertinent s/n's of the system components.

PCB ________ QSW DRIVER ________ ALE ________ LVPS ______

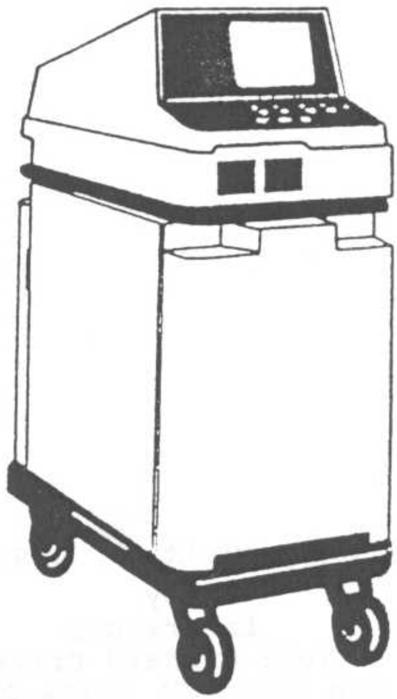
HENE PS ________ SOFTWARE REV ________

- System Tests -

A. Run the unit through an entire service auto system test.
____________ OK

B. Check all ESFs and Derms, etc.

Model 800 Series
Microscopic & Fiberoptic
Surgical Laser System



Service and Maintenance Manual

LASERSCOPE®

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KTP Service Jumpers
1-4-7-10

T A B L E   O F   C O N T E N T S

Section 1 **INTRODUCTION**

1.1 READER AUDIENCE....................................1-1
1.2 USES OF THE MANUAL.................................1-1
1.3 COMBO MODELS.......................................1-1
1.4 EXTERNAL VIEW......................................1-2

Section 2 **SAFETY**

2.1 PROTECTION OF PATIENTS, OPERATING ROOM PERSONNEL..2-1
2.2 AUTOMATIC INGERLOCKS...............................2-2
2.3 PRECAUTIONS TO OBSERVE DURING SERVICING...........2-2

Section 3 **SERVICING OVERVIEW**

3.1 BLOCK DIAGRAM......................................3-1
3.2 FACILITY CONNECTIONS...............................3-1
3.3 OPERATING ROOM ACCESSORIES.........................3-1
3.4 LASER CONSOLE......................................3-3
3.5 ACCESS FOR SERVICING...............................3-4
3.6 SERVICE PHILOSOPHY.................................3-4
3.7 TOOLS AND EQUIPMENT................................3-5
3.8 SPARE PARTS..3-5

Section 4 **OPERATOR USE**

4.1 SYSTEM OPERATING MODES.............................4-1
4.2 SUMMARY OF OPERATION IN APPLICATION MODE..........4-3

Section 5 **DELIVERY DEVICES & ACCESSORIES**

5.1 CONNECTION TO LASER CONSOLE........................5-1
5.2 DETECTION OF DEVICE TYPE...........................5-1
5.3 DEVICES CONNECTING TO ENDOSTAT LASER APERATURE....5-1
5.4 DEVICES CONNECTING TO MICROBEAM LASER APERATURE...5-1
5.5 CALIBRATION OF DELIVERY DEVICES....................5-2
5.6 EYE SAFETY FILTERS.................................5-2
5.7 SYSTEM TEST DEVICE INSTRUCTIONS....................5-3
5.8 REFERENCES FOR FURTHER INFORMATION.................5-4
5.9 DELIVERY DEVICE SIGNATURE RESISTANCE VALUES.......5-5

Section 6 **SYSTEM DESCRIPTION**

6.1 LASER BEAM PATHS...................................6-1
6.2 SYSTEM MODES OF OPERATION..........................6-15

Section 7 **SERVICE** MODE

7.1 CAPABILITIES 7-1
7.2 ACCESSING SERVICE MODE 7-1
7.3 SERVICE SCREEN 0.................................. 7-2
7.4 SERVICE SCREEN 1.................................. 7-3
7.5 SERVICE SCREEN 2.................................. 7-4
7.6 SERVICE SCREEN 3.................................. 7-5
7.7 SERVICE SCREEN 4.................................. 7-6
7.8 SERVICE SCREEN 5.................................. 7-7
7.9 SERVICE SCREEN for SET CLOCK 7-8
7.10 SERVICE SCREEN 7 7-9
7.11 POWER LOG (subordinate Screen from Service Screen 7) 7-10
7.12 ERROR LOG (Subordinate Screen from Service Screen 7) 7-11
7.13 REPEATABILITY TEST (Subordinate Screen from Service Screen 7) 7-12
7.14 MANUAL TESTS (Subordinate Screen from Service Screen 7) 7-13
7.15 CONSUM. ENDOSTATS (Subordinate Screen from Service Screen 7) 7-15
7.16 AUTOMATIC TESTS (Subordinate Screen from Service Screen 7) 7-16
7.17 CURRENT MODULATION CONTROL (Subordinate Screen from Service Screen 7) 7-17
7.18 SERVICE SCREEN 8 7-18

Section 8 ELECTRONICS

8.1 PHYSICAL LAYOUT 8-1
8.2 AC POWER CIRCUIT 8-1
8.3 ELECTRONICS CARD 8-2
8.4 LAMP POWER SUPPLY (A.L.E. POWER SUPPLY) 8-8
8.5 LOW VOLTAGE POWER SUPPLY 8-9
8.6 RF DRIVER 8-11
8.7 CRT 8-13
8.8 SMART LOAD DEVICE 8-15

Section 9 **CALIBRATION OF CAL POD**

9.1 PROCEDURE 9-1

Section 10 **LASER & OPTICS**

10.1 SUMMARY OF LASER ALIGNMENT 10-1
10.2 METERS AND SPECIAL EQUIPMENT REQUIRED 10-1
10.3 KTP LASER ALIGNMENT 10-5
10.4 KTP SECOND TRAIN ALIGNMENT 10-8
10.5 KTP DETECTOR ALIGNMENT 10-10

10.6	LOW POWER MODE ADJUSTMENT (KTP only)	10-14
10.7	COMPUTER ALIGNMENT (Microbeam & Endostat)	10-15
10.8	YAG LASER ALIGNMENT	10-18
10.9	YAG SECOND TRAIN ALIGNMENT	10-19
10.10	YAG DETECTOR ALIGNMENT	10-19
10.11	YAG FIBER ALIGNMENT	10-21
10.12	He-Ne LASER ALIGNMENT	10-22
10.13	TROUBLESHOOTING GUIDE	10-21
10.14	REPLACEMENT AND ALIGNMENT PROCEDURES	10-23
10.15	REPLACEMENT OF LAMP	10-26
10.16	REPLACEMENT OF ROD	10-28
10.17	REPLACEMENT OF LAMP HOUSING	10-29
10.18	REPLACEMENT AND CLEANING OF Q SWITCH	10-30
10.19	REPLACEMENT OF KTP CRYSTAL	10-32
10.20	INSPECTION, CLEANING, REPLACEMENT OF OPTICS	10-34
10.21	PROCEDURES CROSS REFERENCE	10-36

Section 11 **COOLING SYSTEM**

11.1	PURPOSE	11-1
11.2	FACILITY REQUIREMENTS	11-1
11.3	PHYSICAL LAYOUT	11-1
11.4	DESCRIPTION OF OPERATION	11-1
11.5	COMPUTER CONTROL AND TEMPERATURE MONITORING	11-4
11.6	OTHER COMPUTER INTERLOCKS	11-4
11.7	ROUTINE MAINTENANCE	11-5

Section 12 **SYSTEM ADDITIONS & CHANGES**

12.1 WILL BE ADDED WHEN AVAILABLE

Section 13 **ERROR MESSAGES & CODES**

13.1	AUTOMATIC MONITORING	13-1
13.2	FORMAT OF ERROR MESSAGES	13-1
13.3	INDEX OF FAULTS BY PROBLEM CODES	13-2
13.4	TYPE 1 FAULTS	13-4
13.5	TYPE 2 FAULTS	13-13
13.6	TYPE 3 FAULTS	13-92
13.7	CALIBRATION FAULTS	13-93

Appendix A **INSTALLATION**

Appendix B **SCHEMATICS & OTHER DRAWINGS**

Section 1

I N T R O D U C T I O N

1.1 READER AUDIENCE

The information contained in this service manual is intended for use by Laserscope service engineers and by those individuals who have completed the Laserscope biomedical training course at the factory site.

The owner/operator is not authorized to remove any of the fixed covers or modules from the system, except as described in the operation manual for the completion of routine maintenance tasks. Removal of any of these covers or modules will be considered unauthorized modification or misuse of the instrument and will void Laserscope's warranty. Laserscope will not be liable for problems arising from repairs made by unauthorized personnel.

1.2 USES OF THE MANUAL

This manual is a comprehensive tool that serves as a reference or as a guide in troubleshooting any of the various systems or sub-systems employed by the Model 800 Series. Sections of this manual identify and describe the major assemblies, summarize their operation, point out fault conditions, discuss troubleshooting steps, and list requirememts for periodic maintenance.

As product up-grades and revisions are made for increased safety, higher performance and greater user convenience, addendums will be made available to keep this manual up to date.

1.3 COMBO MODELS

The model designations for instruments in the 800 Series are listed below:

Model 801	KTP laser only, with two laser apertures, (one for Endostat fibers and one for Microbeam micromanipulator)
Model 802	KTP laser only, with one laser aperture for Endostat fibers
Model 803	KTP and YAG lasers, with two laser apertures, (one for Endostat fibers and one for Microbeam micromanipulator)
Model 804	KTP and YAG lasers, with one laser aperture for Endostat fibers

Note that no version of the 800 series is available with YAG laser only.

The power rating for the KTP laser is 24 Watts at the head, and for the YAG laser it is 60 watts at the head. Actual power to the tissue depends on the delivery device transmission percentage and will vary with every procedure.

1.4 EXTERNAL VIEW

The Model 800 Series consists of a laser console and delivery devices (Endostat fibers or Microbeam micromanipulator) that users connect to the console. Figure 1-1 and Figure 1-2 show front views of the console. Note air intakes on the left side panel.

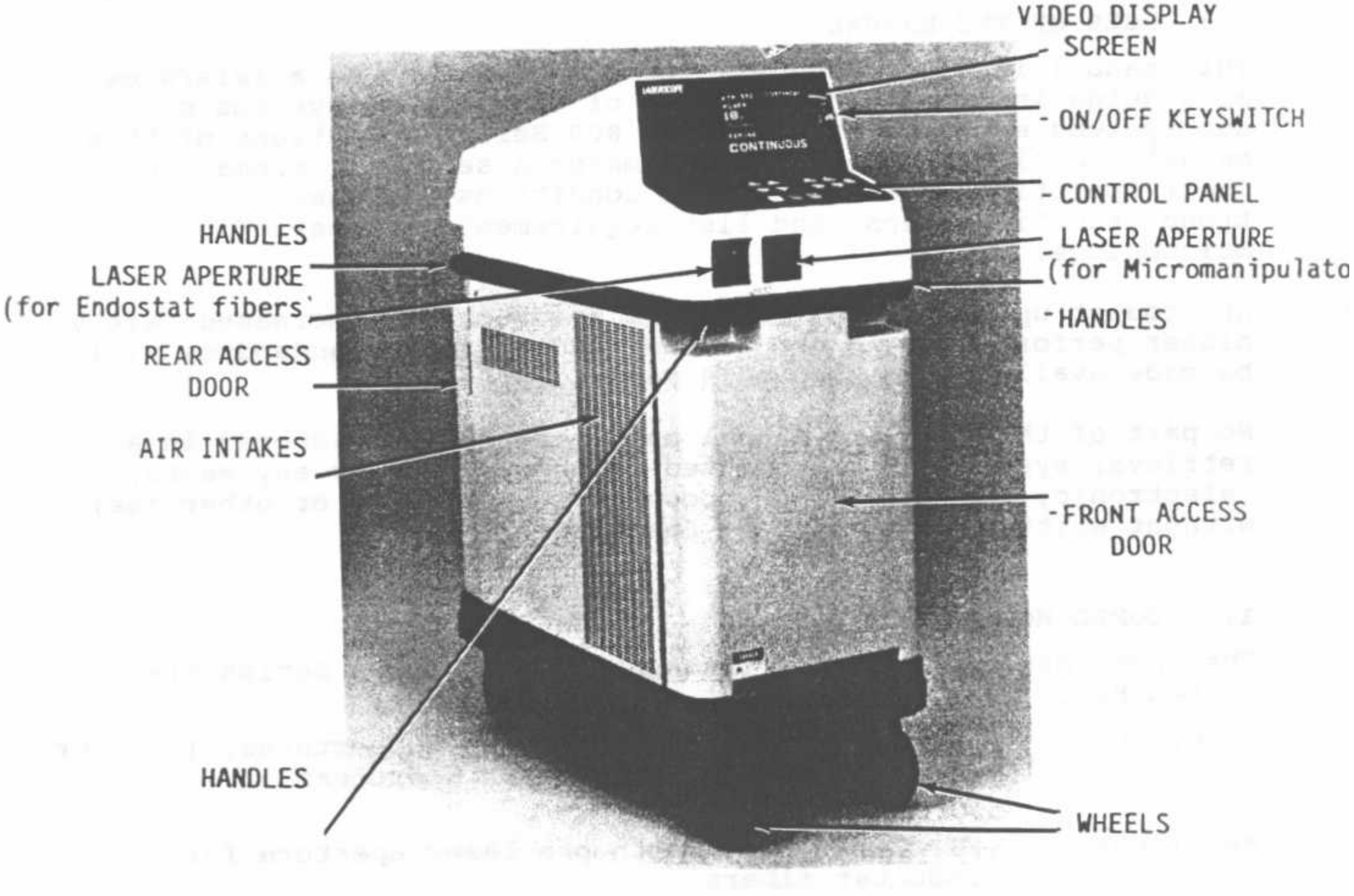


Figure 1-1. Front View of Laser Console

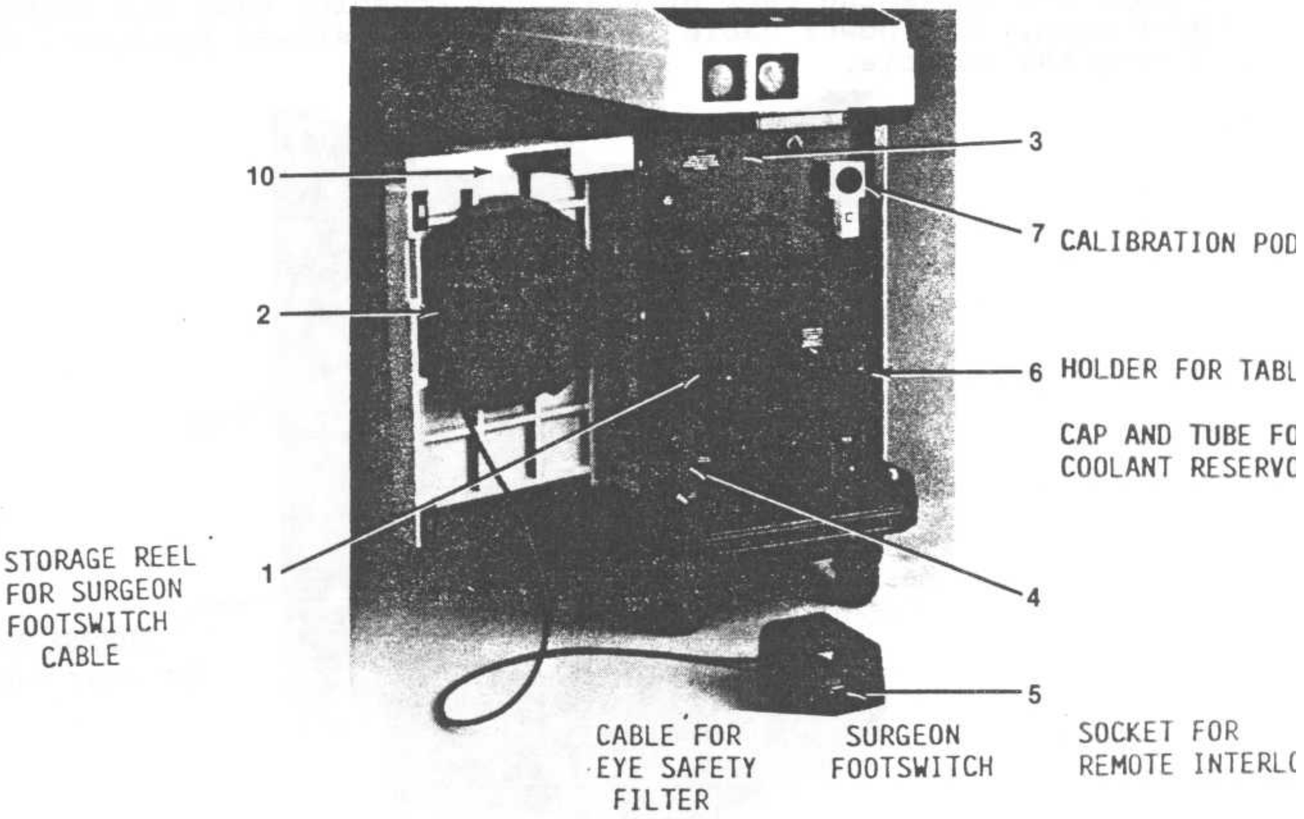


Figure 1-2. Front View with Access Door Open

The handles and wheels are provided for positioning and moving the console. The front wheels are fully castered. The access door is hinged and allows access to the coolant reservoir and to a storage compartment for the eye safety filter cable, table mount assembly, calibration pod, footswitch and cable, and remote interlock connector. The laser aperture for the micromanipulator is provided only on Model 801 and Model 803.

Figure 1-3 shows the rear of the laser console, with the access door open. The power cable is shown in the stowed position, for moving the console.

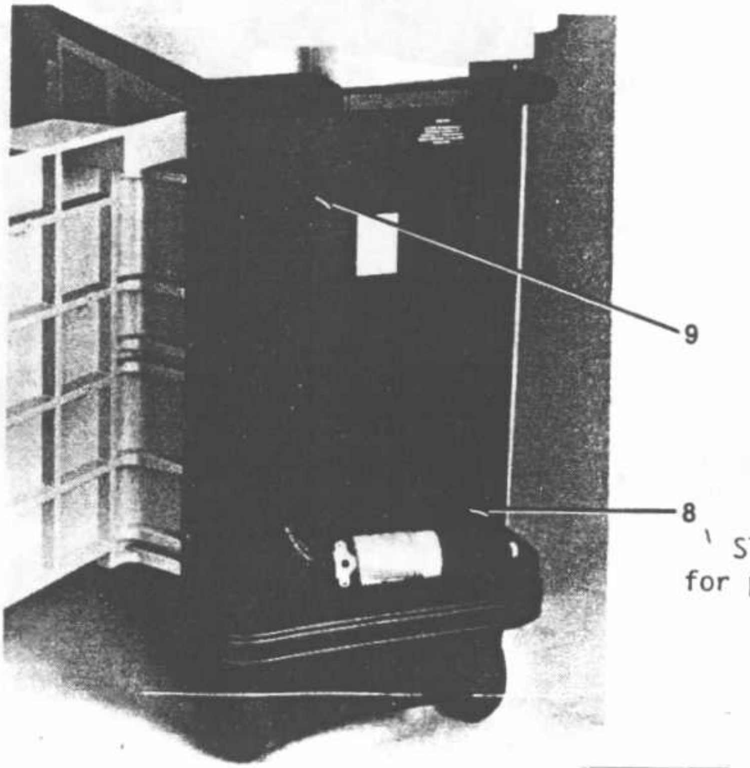


Figure 1-3. Rear View With Access Door Open

Figure 1-4 shows the rear of the console after the power cable has been uncoiled from the storage area.

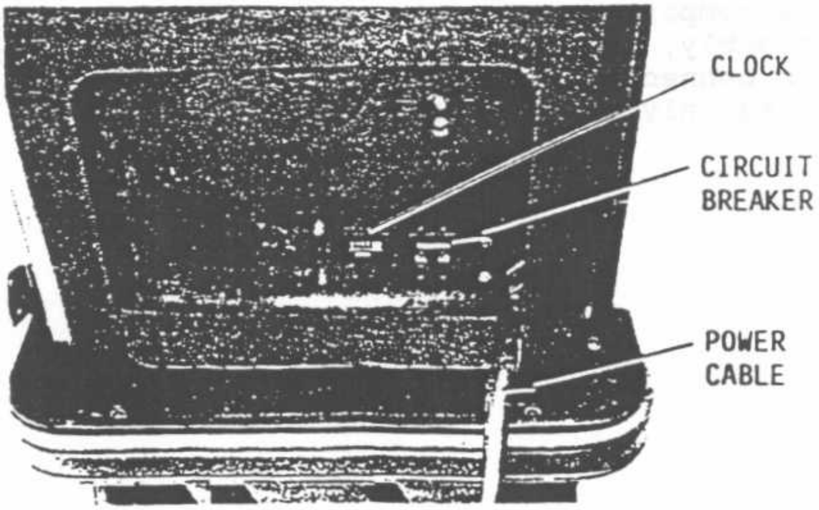


Figure 1-4. Closeup View of Rear Storage Area

S A F E T Y

CAUTION: Laser light from the Model 800 Series presents a severe eye hazard and a potential for burns or fire.

2.1 PROTECTION OF PATIENTS AND OPERATING ROOM PERSONNEL

During operating room procedures the laser light emerges from the console at a laser aperture and then passes through a delivery device (Endostat fiber or micromanipulator) before reaching the patient. Low intensity light is called the aim beam; high intensity light, (produced when the surgeon presses the footswitch), is called the surgical beam.

CAUTION: The aim beam(s) may be viewed by an unprotected eye, but never view the surgical beam directly or by reflection.

Safety features incorporated into the Model 800 Series include:

- An automatic circuit breaker switches the system off completely in the event of an electrical overload.
- An interlock socket can be connected to the operating room doors so that the surgeon's footswitch will be disabled if the doors are opened accidentally.
- The key for the ON/OFF Keyswitch can only be removed when the switch is in the OFF positon. (This prevents someone from removing the key without first turning off the system.)
- An on-board microprocessor continuously monitors the status of the system, and displays messages on the video screen with appropriate user prompts.
- The laser beam cannot be emitted unless an appropriate delivery device has been attached to a laser aperature.
- The console cover panels contain all dangerous laser radiation within the console. This prevents human exposure to the laser beam except through a correctly attached delivery device.
- Only one wavelength of laser radiation can be transmitted at a time through the delivery devices; the color of the aim beam identifies the wavelength. When the 532 nm wavelength has been selected, both the aim beam and the surgical beam are green. When the 1064 nm wavelength has been selected, the aim beam is visible red and the surgical beam is invisible infrared. No 532 nm light can be emitted while the 1064 nm wavelength has been selected.

For your reference, the pages from the Operator Manual that describe operating room hazards and precautions are reproduced at the end of this section.

2.2 AUTOMATIC INTERLOCKS

Besides continuous monitoring of system status and displaying of user prompt messages during operating room procedures (as already mentioned above), the microprocessor also monitors various internal system functions to insure safe operation. For example, laser beam power is monitored to verify that the actual power delivered to the patient stays (within a tight tolerance) at the power value selected by the surgeon.

If an internal fault is detected, it is reported by a specific PROBLEM message on the video display screen and the system is automatically returned to Standby Status (or in some cases to OFF Status). After a system interlock fault, the user (or a service engineer) must correct the cause of the fault before the system can be returned to ON Status.

For details about categories of faults and listings of the various PROBLEM messages, refer to Section 13 of this manual.

2.3 PRECAUTIONS TO OBSERVE DURING SERVICING

Applying AC power to the system after removing cover panels will expose you to high voltages. At such times practice common sense when placing hands inside the cabinet and do not allow foreign objects to fall inside.

> *** WARNING *** When servicing the system do not wear jewelry (such as rings, chains, etc.), or clothing items (such as a neck tie, etc.), that might pass into the laser beam line.

After hinging open the upper portion of the laser console, operating the system will expose you to laser beams that would otherwise be contained within the cabinet. At such times, always wear the special optical safety glasses provided in the Laserscope toolkit for service engineers.

(From SAFETY Section in OPERATOR MANUAL)

■ Hazards and Precautions

The principal hazards are eye injury, burns, ignition of flammable materials, and reflection of the beam from instruments.

Eye Injury

Visible light and near infrared laser energy passes through the transparent components of the eye (the cornea, lens, aqueous and vitreous humor) and is focused on the retina at the back of the eye. This light can therefore cause an accidental retinal burn, the degree of damage depending on the power of the beam, the amount of focusing carried out by the lens, and the duration of the exposure. Suitable precautions against eye injury include safety eyewear of the correct type for the laser being used for the operating room staff, and where appropriate, for the patient. For full details see **"The Surgeon and Other Operating Room Personnel"** on page 1.3 and **"Eye Protection with the KTP/YAG Laser"** on page 10.17.

Burns

Accidental irradiation of tissue other than the target tissue will result in a laser burn, and this is true regardless of the wavelength of the laser being used. Surrounding the target area with moist drapes or saline-soaked patties, and keeping them moist, will greatly reduce this hazard.

Ignition of Flammable Materials

Ignition of flammable materials falls into two categories: ignition of drapes or towels around the target area; or ignition of flammable liquids or gases in or near the target tissue. Keeping drapes moist should prevent their catching fire, and keeping the target area clear of dry swabs and patties will also help. When preparing the patient, be sure to use a non-flammable prepping solution. Anesthetic gases should also be of the non-flammable variety, and **using a foil-wrapped endotracheal tube will help prevent airway fires**. For full details, see **"Anesthesia Considerations with the KTP/532 Laser"** on page 10.13. Care and precision in aiming and firing the laser is of paramount importance.

(From SAFETY Section in OPERATOR MANUAL)

Vapor Plume

There is considerable controversy on the subject of the viability of material ejected from the laser treatment site into the vapor plume. Laserscope suggests that a smoke evacuator or in-line filter be used to capture the plume whenever possible and that the plume be regarded as a source of active biological material by the O.R. personnel. Consult the literature for the most up to date opinions on this subject.

Reflection of the Beam from Instruments

Unless the instrument being used is brand new and flat, the reflection from it is likely to be diffuse rather than specular, and thus slightly less hazardous. In any case, all personnel in the O.R. should be wearing protective glasses or goggles if within the nominal hazard zone. See page 10.17 for more information. Care in aiming the beam is the greatest preventive measure.

■ The Operating Room

The area in the hospital or clinic where the laser is used should be clearly labeled at all entrances with warning signs when the laser is actually in use. The sign should indicate the laser being used. Figure 1-1 shows an example of a sign suitable for use with the KTP/532 Surgical Laser, and Figure 1-2 a sign suitable for use with the KTP/532 Surgical Laser equipped with the Nd:YAG module.

The system console is provided with an interlock socket which can be connected to a door switch. This will automatically switch off the laser in the event of the door's being opened during a procedure. Personnel present in the room should be limited to those essential to the procedure and authorized observers. Appropriate protective eyewear should be available for all attending personnel as described fully in the next section and in Section 10.

Some operating rooms have large picture windows so that non-vital personnel may view the surgery from outside. When KTP/532 laser surgery is being performed (either 532 nm or 1064 nm) it is very unlikely that a laser beam would present any hazard at that distant location. If the hospital laser safety officer would like to provide extra protection anyway, a sheet of transparent orange plastic may be mounted over the window. This will block stray 532 nm laser radiation from the treatment site, still allow viewing into the O.R. and will clearly delineate which O.R. is being used for laser surgery. No additional protection is required for the laser operating at 1064 nm, for viewing beyond 4 feet from the tissue.

(From SAFETY Section in OPERATOR MANUAL)

Figure 1-1
Warning Sign for KTP/532 laser operating at 532 nm only

Figure 1-2
Warning Sign for KTP/532 laser with the Nd:YAG module operating at 532 nm and 1064 nm

The Surgeon and Other Operating Room Personnel

Each wavelength of light (i.e., each type of laser: CO_2, Nd:YAG, Argon, or KTP/532) requires protection matched to that wavelength. Since the KTP/532 laser emits light at 532 nm (a bright green light) or with optional Nd:YAG module, 1064 nm (invisible infrared), only Laserscope approved eyewear should be worn. Only authorized personnel should be allowed in the operating or treatment room, and should, when appropriate, wear suitable protective eyewear, designed for use at 532 nm and 1064 nm. Goggles for other lasers may not provide sufficient protection.

Shielding is measured in Optical Densities, "OD", where the higher the number, the more protection is provided. The eyewear listed below is designed to meet the requirements set forth in ANSI standard Z136.3-1988 for viewing diffuse light reflected from tissue irradiated by the KTP/532 laser.

(From SAFETY Section in OPERATOR MANUAL)

1. Orange Plastic Glasses (OD = **3 at 532 nm ONLY**) (Part Number 10-0470)

2. **Dual Wavelength Plastic Glasses** (OD = 3 at both 532 nm and 1064 nm) (Part Number 10-0790)

3. Amber Goggles (OD = 4 at both 532 nm and 1064 nm) (Part Number 10-0780)

4. "Clear" Dual Wavelength Goggles (OD = 5 at both 532 nm and 1064 nm) (Part Number 10-0380) which block out the 532 nm and 1064 nm wavelengths but do not mask the natural pigmentation of the tissue under treatment.

5. Endoscope and Microscope Automatic Eye Safety Filters (OD = 5 at both 532 nm and 1064 nm) (Automatic Endoscope Eye Safety Filter Part Number: 10-0430, Automatic Microscope Eye Safety Filters are available for many kinds of operating microscopes, contact Laserscope for part numbers) all utilize a filter which blocks out the 532 nm and 1064 nm wavelenghts but do not mask the natural pigmentation of the tissue under treatment.

For more information on Eye Protection, see **"Eye Protection for the KTP/532 Laser"** on page 10.17.

IMPORTANT NOTE **The unit is switched on with a keyswitch. It is recommended that the keys be assigned to one or two keyholders, who should make the keys available for scheduled procedures only, thus preventing unauthorized use of the system.**

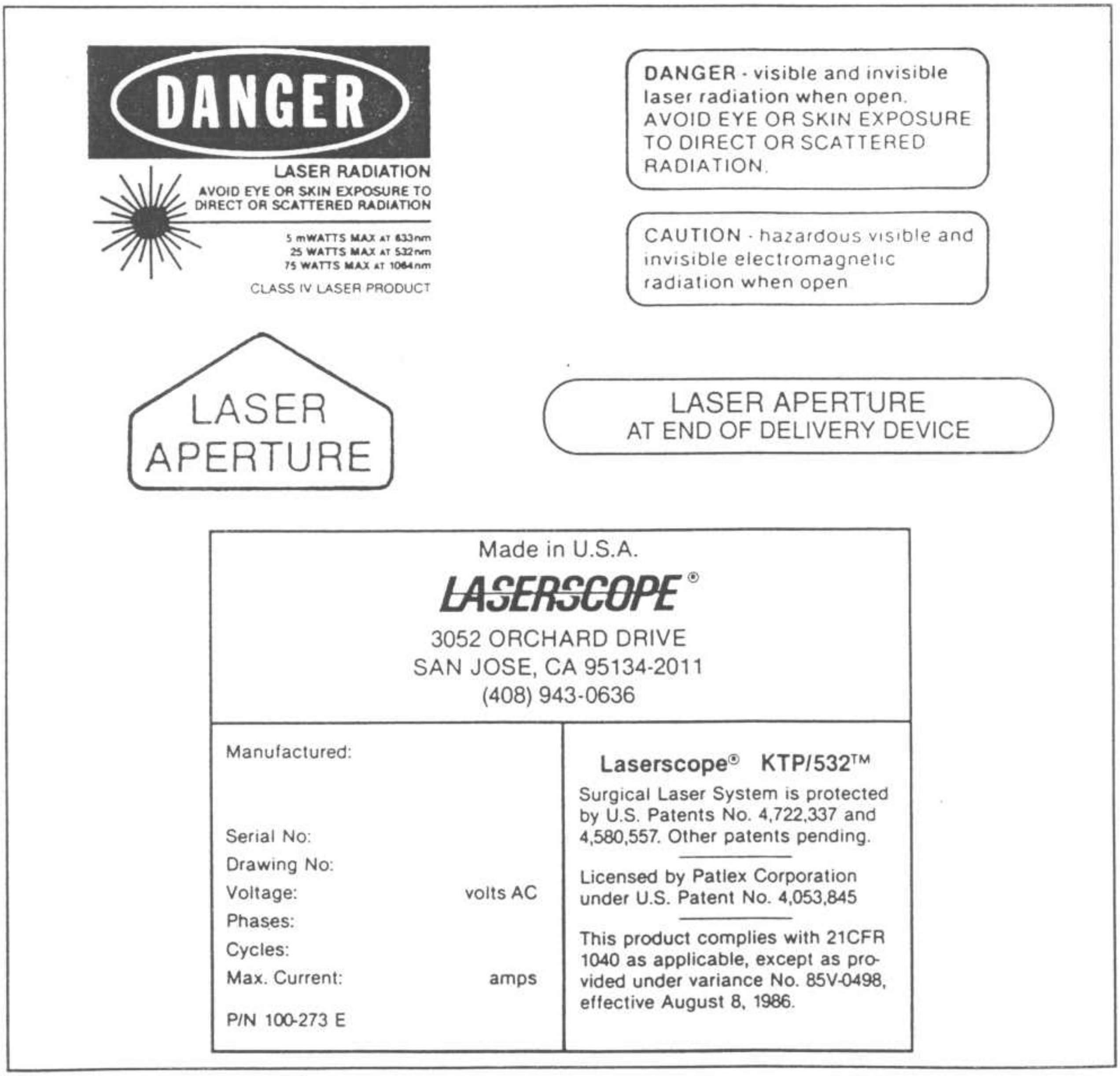
■ The Patient

Patient safety is primarily assured by a well-trained surgical staff and a well-laid-out operating room. Patient education is also important. Moistened towels, where appropriate, should be used to prevent accidental irradiation of any tissue other than the target tissue. Suitable protective eyewear should be worn by the patient during procedures when the patient is not anesthetized. Alternatively, the patient may be protected by a drape barrier. If the patient is anesthetized, the eyelids should be taped shut and then covered with the gauze pads.

(From SAFETY Section in OPERATOR MANUAL)

Safety Existing safety regulations (Chapter I, 21 CFR 1040.10, 1040.11) require that lasers have certain safety features and that certain labels be affixed to a surgical laser unit identifying its manufacturer and the class or classes of radiation produced, in addition to any laser apertures from which access to any laser or collateral radiation is possible. Figure 1-3 shows the required labels.

In addition to the possible hazard of accidental laser burns of the eye and the skin, there is an associated electrical hazard such as is found with any piece of electrical equipment.. Accordingly, care must be taken when connecting or disconnecting the system from the power receptacle.



Section 3

S E R V I C I N G   O V E R V I E W

3.1 BLOCK DIAGRAM

Section 1 of this manual showed external views of the laser console and identified the console parts that are normally accessible to operators. The block diagram in Figure 3-1 provides details about cables and other connections that have to be made when setting up the laser console in the operating room and preparing for surgery.

3.2 FACILITY CONNECTIONS

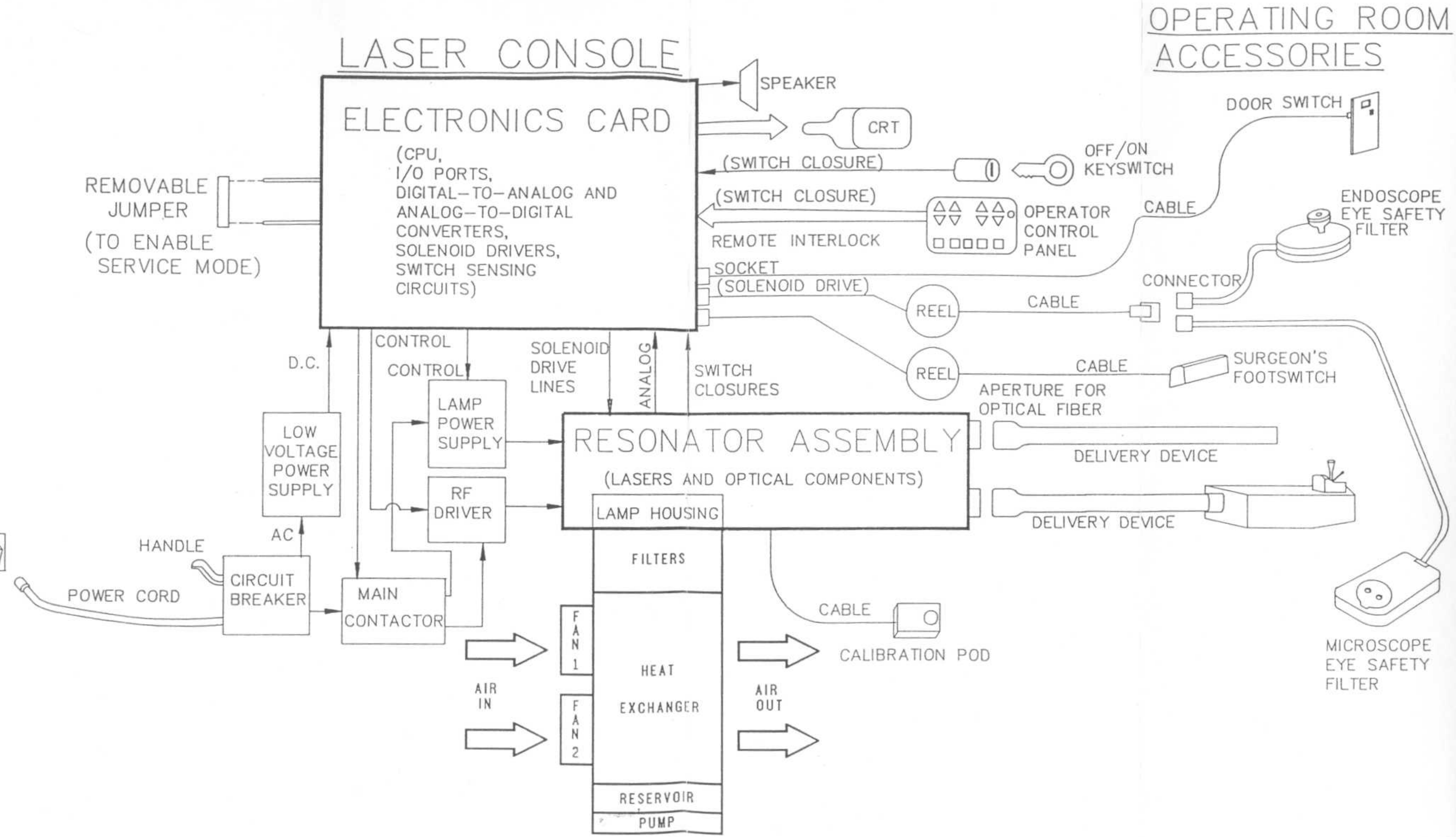
From the hospital facility the laser console requires AC power. De-ionized or distilled water should also be readily available through the hospital laboratory or central supply. The AC power recepticle must provide 208 VAC at 50 amps from a 60 Hz, single phase source. For further details about the power requirements, refer to the Laserscope **Installation Requirements**, (publication number 104-2050), which is included in Appendix A of this manual.

3.3 OPERATING ROOM ACCESSORIES

The accessory that transmits the laser energy from the console to the target tissue is called a delivery device. The most frequently used devices are optical fibers called Endostats. For surgery under a microscope, a micromanipulator device called a Microbeam is used. At the laser console the connection point for the delivery device is called a laser aperture. Because laser light presents a severe eye hazard, to protect the surgeon from the surgical beam an Eye Safety Filter accessory is normally connected to the laser console also. For more details about delivery devices and eye safety filters, refer to Section 5 of this manual.

Also connecting to the laser console through a cable is the Surgeon's Footswitch. During surgical procedures the surgeon presses the footswitch when he or she wants to turn on the surgical beam.

On the laser console a Remote Interlock Socket is provided for a cable from the operating room door. If this cable is installed, the Surgeon's Footswitch will be disabled in the event that someone makes an unauthorized entry into the operating room.



LASER CONSOLE
ELECTRONICS CARD
(CPU,
I/O PORTS,
DIGITAL-TO-ANALOG AND
ANALOG-TO-DIGITAL
CONVERTERS,
SOLENOID DRIVERS,
SWITCH SENSING
CIRCUITS)
SPEAKER
CRT
(SWITCH CLOSURE)
OFF/ON
KEYSWITCH
(SWITCH CLOSURE)
OPERATOR
CONTROL
PANEL
REMOTE INTERLOCK
SOCKET
(SOLENOID DRIVE)
REMOVABLE
JUMPER
(TO ENABLE
SERVICE MODE)
D.C.
CONTROL
CONTROL
SOLENOID
DRIVE
LINES
ANALOG
SWITCH
CLOSURES
LOW
VOLTAGE
POWER
SUPPLY
LAMP
POWER
SUPPLY
RF
DRIVER
RESONATOR ASSEMBLY
(LASERS AND OPTICAL COMPONENTS)
LAMP HOUSING
FILTERS
HEAT
EXCHANGER
RESERVOIR
PUMP
FAN 1
FAN 2
AIR
IN
AIR
OUT
HANDLE
AC
CIRCUIT
BREAKER
POWER CORD
MAIN
CONTACTOR
CABLE
CALIBRATION POD
OPERATING ROOM
ACCESSORIES
DOOR SWITCH
CABLE
ENDOSCOPE
EYE SAFETY
FILTER
CONNECTOR
REEL
CABLE
REEL
CABLE
SURGEON'S
FOOTSWITCH
APERTURE FOR
OPTICAL FIBER
DELIVERY DEVICE
DELIVERY DEVICE
MICROSCOPE
EYE SAFETY
FILTER

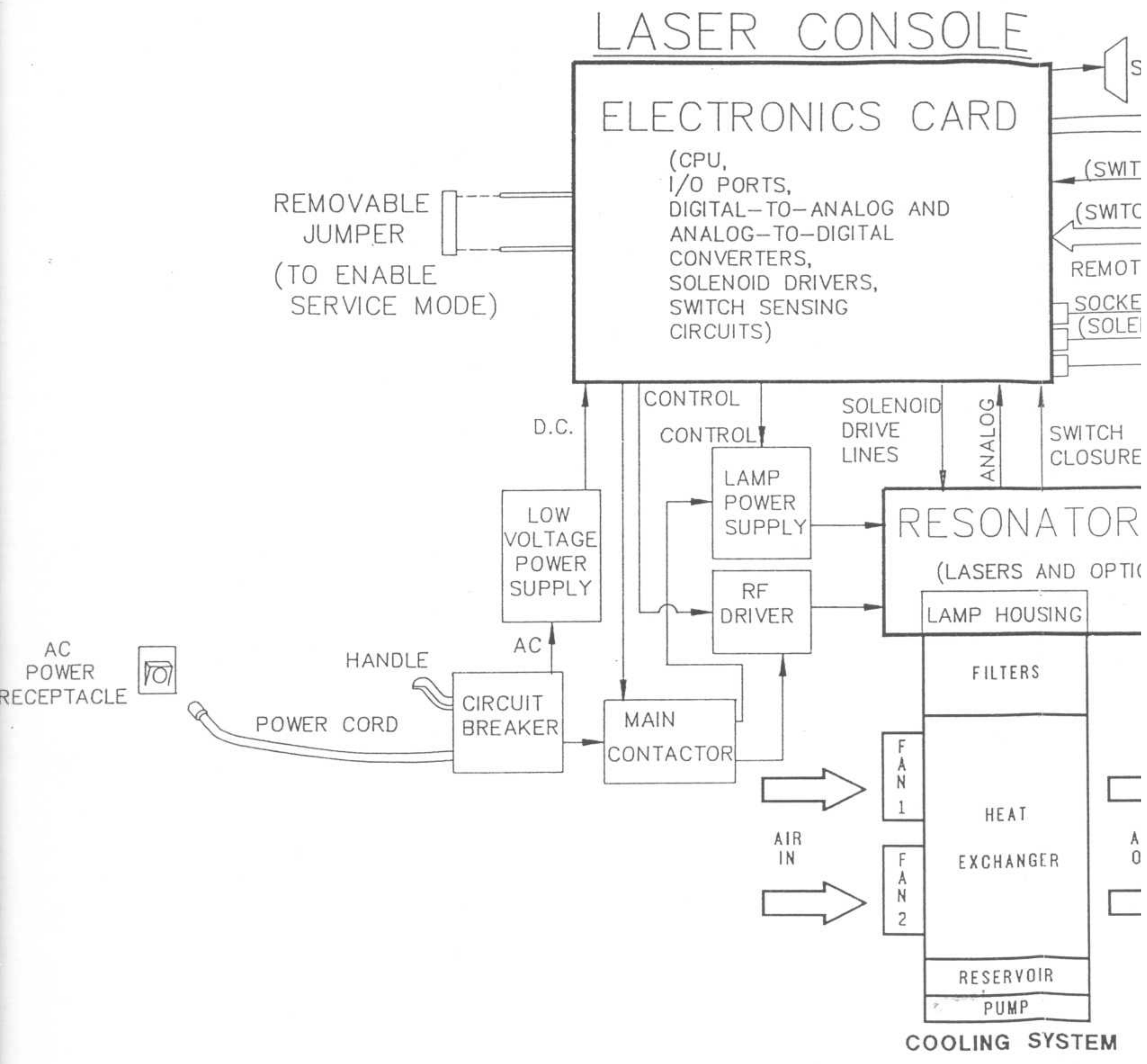
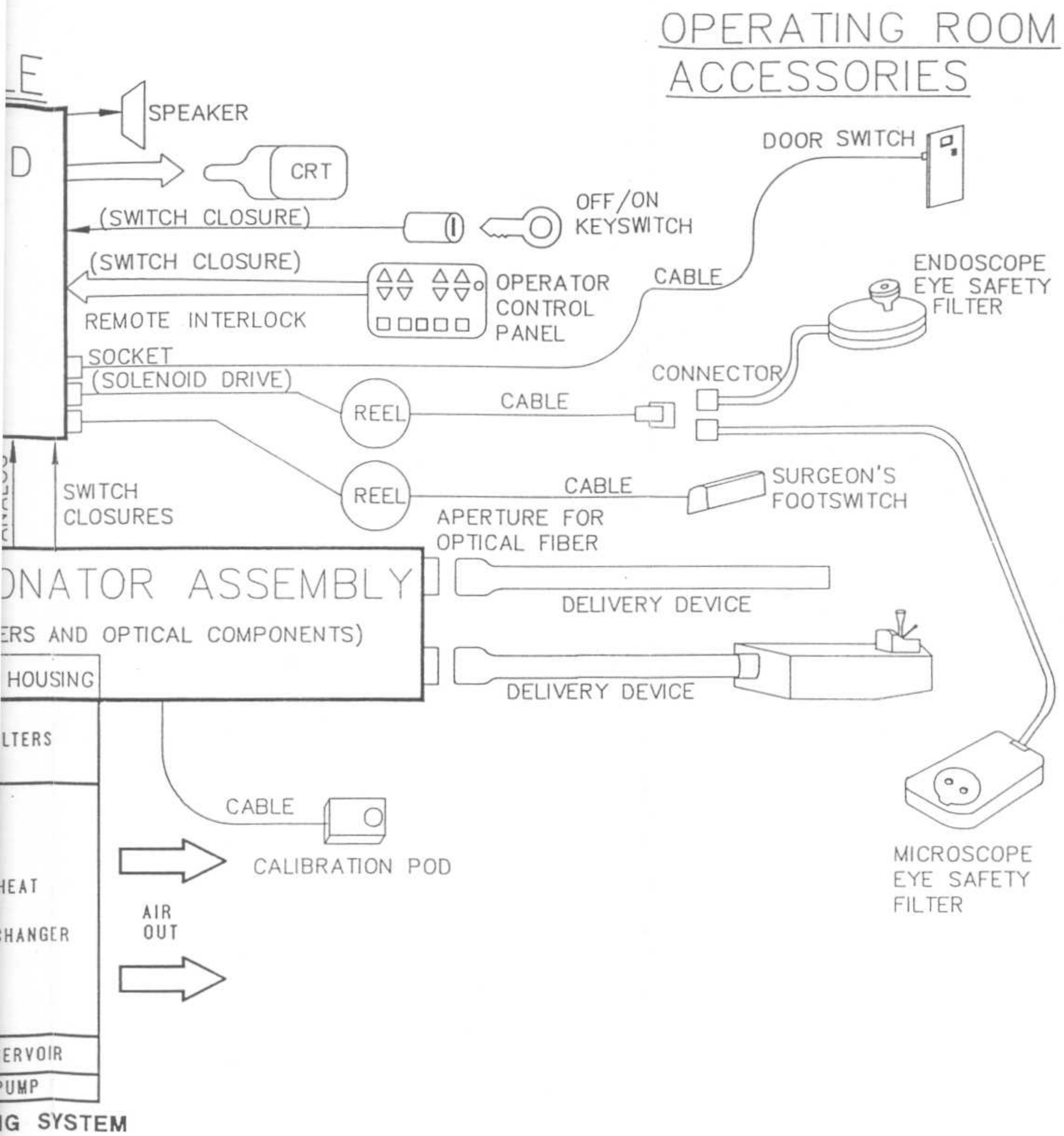


FIGURE 3–1. SYSTEM E



YSTEM BLOCK DIAGRAM

3.4 LASER CONSOLE

The block diagram in Figure 3-1 identifies major components inside the laser console and indicates their interconnections. The main controlling element is a microprocessor-based computer on the Electronics Card. Software for the computer is resident in EPROMs that also are mounted on the Electronics Card.

3.4.1 AC Power Circuit

After the power cord has been plugged into the AC power receptacle, the operator has to open the rear access door and raise the lever on the Circuit Breaker. The low voltage power supply turns on and provides DC power to the Electronics Card after the keyswitch has been activated.

3.4.2 Electronics Card

The computer has I/O Ports that interface to a CRT (Video Display Screen), an Operator Control Panel fitted with membrane buttons, various switch closure sensing circuits, solenoid driver circuits, Digital-to-Analog Converters (D/A) and Analog-to-Digital Converters (D/A). For more details about the Electronics Card, refer to Section 8 of this manual.

3.4.3 System Status OFF

The CRT remains dark until the operator inserts the key into the keyswitch and turns it from OFF to ON. After that, the computer begins to execute an initialization sequence and causes a drive circuit on the Electronics Card to energize the Main Contactor. AC power passes through the contactor to the RF Driver and the Lamp Power Supply, (also called the A.L.E. Power Supply). The outputs from the Lamp Power Supply and RF Driver are controlled by the computer and are initially kept off. Also a message is printed on the video display screen that reports "System Status OFF" and prompts the operator to press the ON/STANDBY button on the control panel.

3.4.4 Laser Powering Up Sequence

After the operator presses the ON/STANDBY button, the computer performs a powering up sequence during which the Lamp Power Supply and RF Driver are turned on. Provided that the powering up sequence is successful, the computer then causes the Lamp Power Supply to drive the lamp with a constant "simmer" current and changes the message on the video display screen to report "System Status ON." At the same the computer energizes a relay that connects AC power to a pump motor in the cooling system, so that heat generated by the lamp will be dissipated to the room air.

3.4.5 Resonator Assembly

This is a flat metal plate where the 532 nm KTP and 1064 nm YAG laser beams are generated. (KTP is the chemical abbreviation for Potassium Titanyl Phosphate, and YAG is the abbreviation for Yttrium Aluminum Garnet.) Precisely positioned on this plate are a YAG rod, Helium Neon laser, a KTP crystal, and various other optical components. The YAG laser (optional) is excited by light from a krypton arc lamp that is mounted beside the YAG rod in a water-cooled lamp housing. Current for the lamp comes from the lamp power supply; the amount of current is controlled by the computer. The RF Driver, (also controlled by the computer), provides the drive for the Q Switch, which is a component in the KTP beam path. The laser beams are brought out to laser apertures at the front of the console. For more details about the lasers and optics, refer to Section 10.

3.4.6 Cooling System

Heat generated inside the lamp housing and on the resonator plate is dissipated to the room air by a cooling system that consists of two large fans that blow room air against the heat exchanger in a closed circulating water arrangement. A reservoir in the system holds approximately 2 gallons of de-ionized water or distilled water. A motor-driven pump forces the water to circulate from the reservoir to the heat exchanger and filters, then through a cavity in the lamp housing and back to the reservoir. For more details about the Cooling System, refer to Section 11.

3.4.7 Calibration Pod

This component is permanently connected to the laser console. It is required for calibrating the delivery devices to compensate for laser beam power losses during transmission from the laser aperture to the patient. For details about its use, refer to Section 3 in the Operator Manual.

3.5 ACCESS FOR SERVICING

Components inside the laser console can be accessed by hinging the top of the cabinet off to one side, and by removing cover panels (one behind the front access door and one on each side). The panels are fitted with releases that require a special tool.

3.6 SERVICE PHILOSOPHY

This manual is designed for on-site maintenance, troubleshooting and repair under a philosophy of "swap-out" of suspect modules and replacement with known-to-be-good modules, (rather than a philosophy of "repair down to the component level").

To implement this approach, the design of the Model 800 Series includes the following built-in features for service support:

- Software-based self-tests that are performed periodically during operation of the system.

- Plain english error messages on the CRT that report problems and internal fault conditions. (For more details about error messages, refer to Section 13.)
- Various automatic software interlocks that avoid dangerous operating conditions and prevent damage to internal components.
- A Service Mode of operation under which the service engineer can take control of the system and exercise the various internal components independently. (For more details about Service Mode, refer to Section 7.)
- Automatic Error Log and Power Log. (Under this software feature data about fault occurrences and laser power usage is automatically recorded in non-volatile memory for later examination and analysis. For more details, refer to section 7.)

3.7 TOOLS AND EQUIPMENT

To support servicing, Laserscope provides a set of special tools for use with the Model 800 Series. These include a tool for removing the cover panels, a power meter for measuring laser beam power, and safety glasses for protection from laser radiation. Optical filters and fixtures are also supplied for laser alignment and testing.

3.8 SPARE PARTS

The spare parts include various optical and electronic component replacements. When parts are needed beyond these, call the Laserscope Service Department.

Section 4

O P E R A T O R   U S E

4.1 SYSTEM OPERATING MODES

If the system has been stowed, the operator has to roll the laser console to the operating room site, connect the power cord to the wall plug, and raise up the lever on the circuit breaker. (For a summary of installation requirements, as well as a step-by-step hookup procedure, refer to Section 3 in the Operator Manual.)

Software for the microprocessor that controls the system is resident in EPROMs inside the laser console. The software puts the system in the Application Mode of operation once the keyswitch has been activated. The indication of this to the operator is the message "SYSTEM STATUS OFF" that appears on the video display screen.

Another available mode of operation is called Service Mode. To change from Application Mode to Service Mode, the service engineer must install a service jumper on the main electronics board and then perform a special procedure. For details about Service Mode, refer to Section 7.

During operation in Application Mode, an operator interacts with the system by observing the video display screen and pressing buttons on the control panel, and a surgeon manages the delivery device and presses the footswitch. (For more about delivery devices, refer to Section 5.)

Besides SYSTEM STATUS, user information on the display screen can include: the wavelength currently selected, beam parameters, calibration data on devices attached or calibrated, and step-by-step instructions for operation of the system. From the control panel the operator can select the 532 nm or 1064 nm wavelength and adjust the following: power of the surgical beam, intensity of the aim beam, exposure duration, exposure interval and repeat.

Figure 4-1 shows the layout of buttons on the control panel and gives the abbreviated designations used in this manual. The button labels on the control panel refer to functions the buttons have during Application Mode. (In Service Mode the functions are different and are described in Section 7.) An audible tone is heard at the laser console when the button press is recognized.

During Applications Mode the buttons have these functions:

SUR UP Increases the surgical power of the laser.

SUR DN Decreases the surgical power of the laser.

AIM UP Increases the intensity of the aim beam.

AIM DN Decreases the intensity of the aim beam.

DUR UP Increases the exposure duration of the surgical beam.

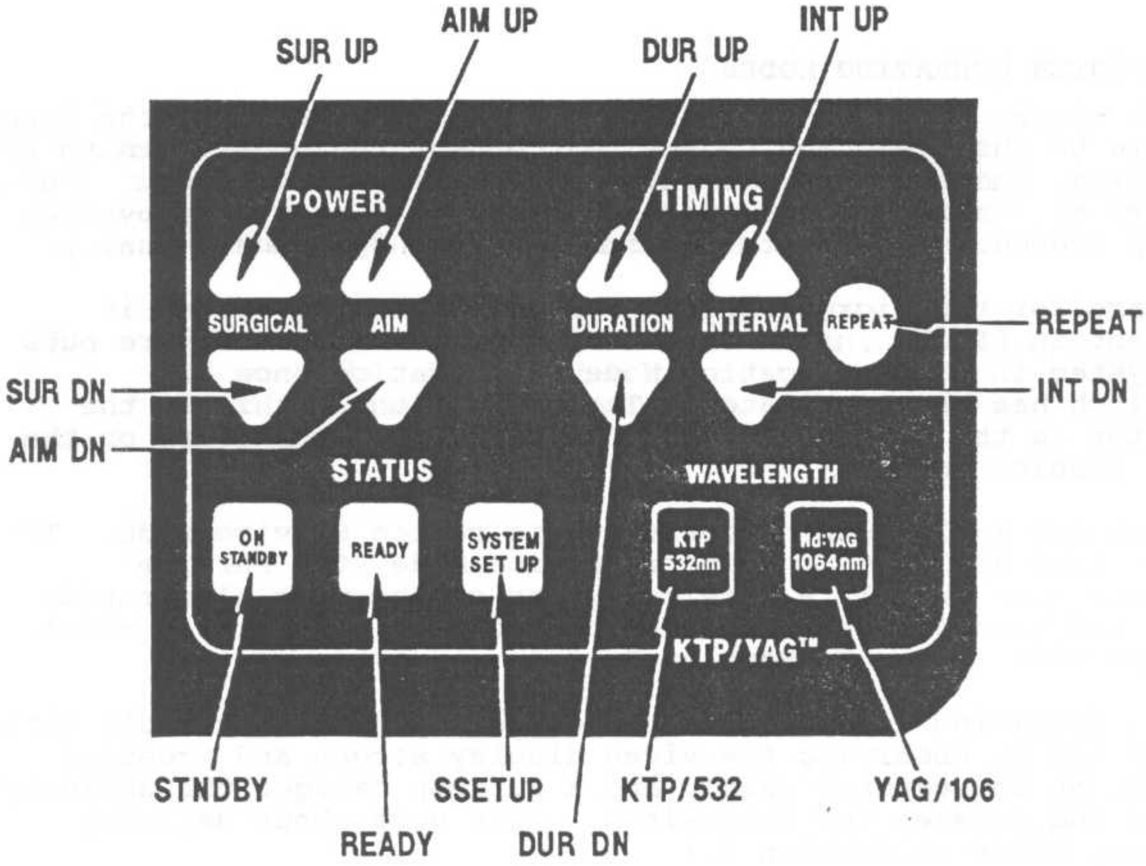


Figure 4-1. Control Panel

DUR DN Decreases the exposure duration of the surgical beam.

INT UP Increases the interval between exposures in the multiple exposure REPEAT setting.

INT DN Decreases the interval between exposures.

REPEAT Places the laser in and out of REPEAT mode. When in REPEAT and the footswitch is depressed, the system will deliver repeated exposures with the chosen interval.

STNDBY Changes the System Status to ON (where the laser is powering up), or to STANDBY (where the laser is operating but the beam cannot be emitted).

READY Changes the System Status from STANDBY to READY; the aim beam is activated and the surgical beam is made available to irradiate the target tissue at the indicated settings when the footswitch is depressed.

SSETUP Brings the System Setup screen onto the CRT display, (see Figure 4-2).

KTP/532 Selects the 532 nm wavelength.

YAG/106 Selects the 1064 nm wavelength.

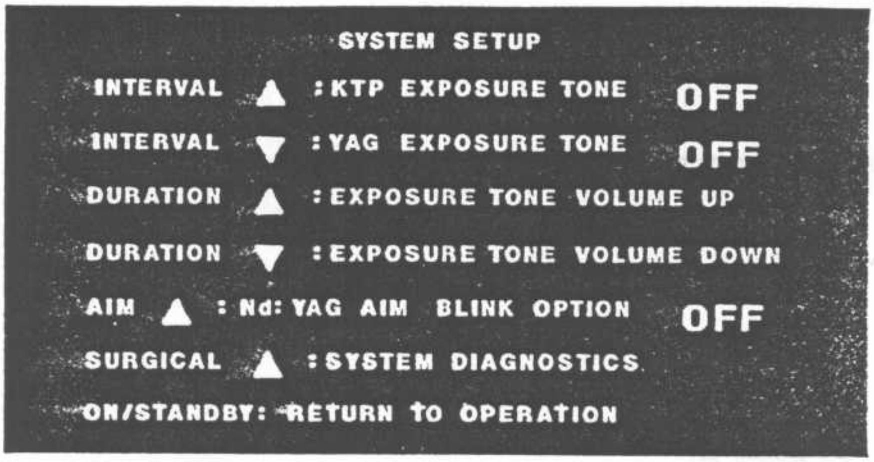


Figure 4-2. Screen for System Setup

INT UP	Causes KTP Exposure Tone feature to toggle ON and OFF.
INT DN	Causes YAG Exposure Tone feature to toggle ON and OFF.
DUR UP	Causes volume of the exposure tone to increase.
DUR DN	Causes volume of the exposure tone to decrease.
AIM UP	Toggles the Blink option of the YAG aim beam.
SUR UP	Causes coded system diagnostic messages to be printed on the CRT display, (if any such messages are currently stored in the battery-backup RAM).
STNDBY	Causes the SYSTEM SETUP screen to be erased and restores the previous screen.

4.2 SUMMARY OF OPERATION IN APPLICATION MODE

Figure 4-3 shows a simplified diagram of the program logic for Application Mode. For detailed operator procedures, refer to Chapter 3 in the Operator Manual.

After an operator turns the keyswitch from OFF to ON, the program performs several internal start-up tests, then reports System Status OFF on the video display screen. Pressing the REPEAT button at this time will cause a line to appear at the bottom of the screen that states the current software revision level. The systems remains at System Status OFF until the operator presses the STNDBY button.

As soon as STNDBY is pressed, the System Status changes to ON, the krypton arc lamp is turned on and a "POWERING UP" message is added at the bottom of the screen. After the system reaches its normal operating temperature, (which takes about 3 1/2 minutes), the System Status is changed to STANDBY. Also "KTP" appears in the top left corner of the screen. On systems having both 532 nm

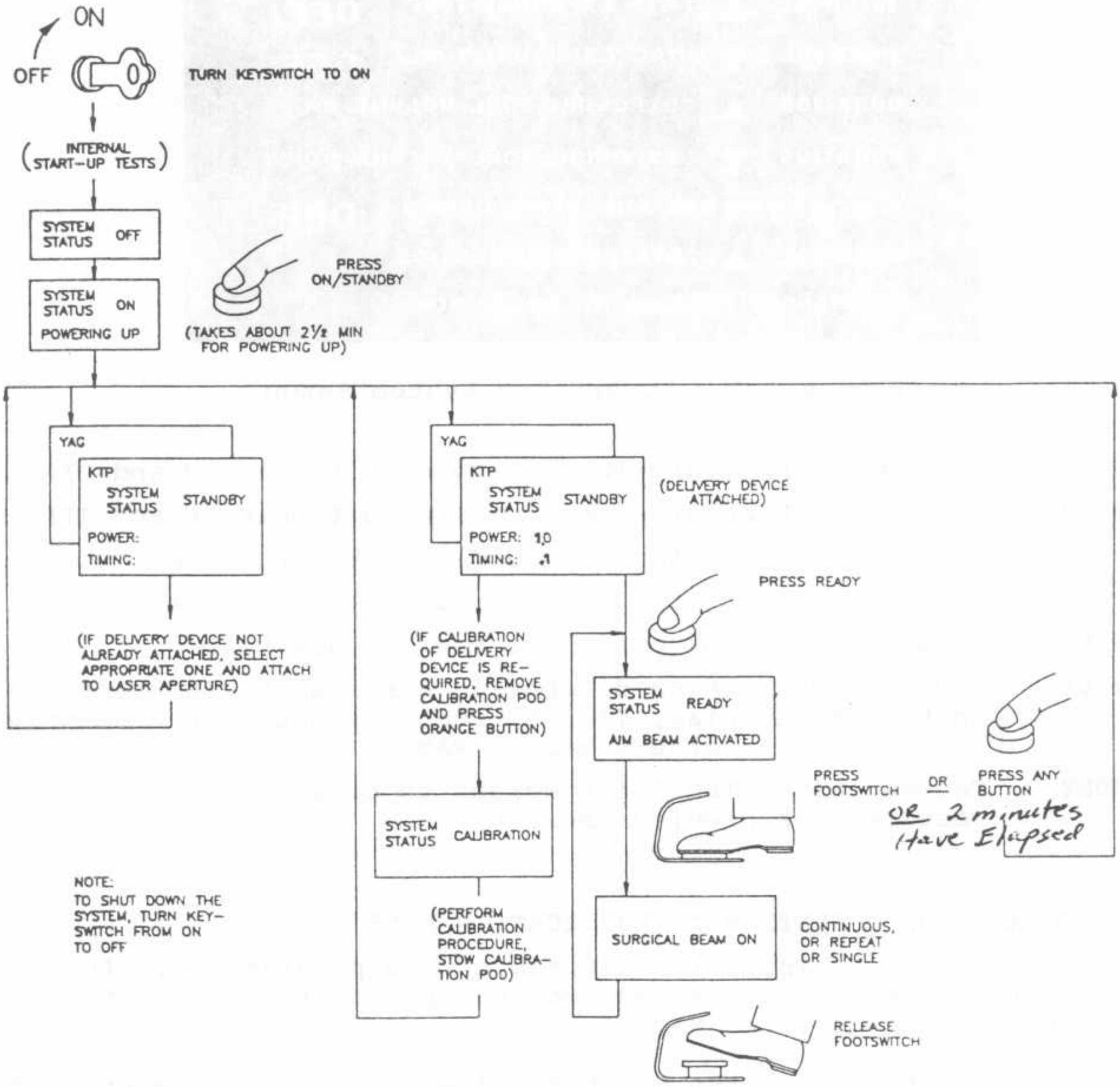


Figure 4-3. Program Logic in Application Mode

and 1062 nm laser output, pressing the YAG/106 button will cause "YAG" to replace "KTP" on the screen. (On systems having only 532 nm output, pressing the YAG/106 button has no effect.)

If no values appear under "POWER" and "TIMING" on the STANDBY screen, it means that the operator needs to attach a delivery device to the laser aperture. When a device is attached, the default values appear under "POWER" and "TIMING", and the word

"UNCALIBRATED" will appear at the middle of the screen. The desired laser beam parameters may be selected from the control panel at this time.

If calibration is required, the operator has to open the front access door on the laser console and remove the Calibration Pod from its holder. Then the operator presses the orange button on the pod and performs the calibration procedure. After completion of the procedure, the System Status changes from CALIBRATION back to STANDBY, and the operator can replace the pod in its holder.

The system remains in STANDBY until the operator presses the READY button. Doing this changes the System Status to READY and causes the aim beam to emerge from the delivery device.

After aiming the aim beam as desired, the surgeon presses the footswitch to turn on the surgical beam. The System Status changes back to READY after the surgical beam turns off (footswitch is released).

To return from System Status READY to System Status STANDBY, the operator presses any button. To shut down the system, the operator turns the keyswitch from ON to OFF.

If the system is in ready with no exposures after 2 minutes, machine goes to standby.

Section 5

D E L I V E R Y   D E V I C E S   &   A C C E S S O R I E S

5.1 CONNECTION TO LASER CONSOLE

The laser beams generated inside the cabinet are brought out to connection points called laser apertures. On all models in the 800 Series the laser aperture at the extreme left front of the laser console is for Endostat fiber delivery devices. Additionally, on Models 801 and 803 a second laser aperture is provided for Microbeam micromanipulator delivery devices.

YAG 1064 nm wavelength is only available at the Endostat laser aperture; KTP 532 nm wavelength is available at both apertures.

5.2 DETECTION OF DEVICE TYPE

On each delivery device the cable connector has a built-in set of "signature" resistors whose resistance values uniquely define the type of delivery device. Pins on the mating socket at the laser aperture connect these resistors to a resistance sensing interface circuit on the Electronics Board. This arrangement makes it possible for the computer to detect when a delivery device has been connected and to identify the type of device.

A Model 800 Series safety feature prevents laser beams from reaching a laser aperture if no delivery device is connected.

Only one delivery device can be connected at a time. If the computer senses that an operator has connected a second device, an error message will be printed on the video display screen. Laser beams will not be allowed to reach the laser apertures until the operator disconnects one of the devices.

5.3 DEVICES CONNECTING TO ENDOSTAT LASER APERTURE

5.3.1 Disposable Fibers

These are the most common delivery devices used with the Model 800 Series. Laserscope fibers are offered in various lengths and with core diameters ranging from 300 microns to 600 microns. (NOTE: Unlike earlier Laserscope systems, the computer on the Model 800 Series is not programmed to accept reusable fibers.)

5.3.2 Dermastat

This is a hand-held, non-contact delivery device for dermatologic applications (such as treatment of skin lesions). A separate calibration pod insert is also included.

5.4 DEVICES CONNECTING TO MICROBEAM LASER APERTURE

5.4.1 Microbeam Micromanipulator

This delivery device attaches to a microscope and allows the surgeon to perform precise incision or vaporization of small tissue areas with minimal damage to surrounding structures. Only the KTP 532 nm wavelength is available and an eye safety filter is always used. The surgeon can adjust the focus and the spot size (from 0.2 mm to over 2.0 mm when using a 250 mm objective lens). The Microbeam delivers the laser energy coaxial to the viewing path and a joystick mechanism is provided for moving the beam. The joystick has a variable tension adjustment that allows the surgeon to set it to a desired feel.

5.4.2 Ophthostat

This is a hand-held probe for post-vitrectomy photocoagulation. It is designed for use with an operating microscope and eye safety filter. A separate calibration pod insert is also included.

5.5 CALIBRATION OF DELIVERY DEVICES

Because some light is lost during transmission of the laser beam through the fiber in the cable, the beam power available at the patient end of the delivery device will be less than the beam power displayed on the screen. When setting power for the surgical beam, the computer therefore assumes some percentage of loss and adjusts the beam power upward to compensate for the loss.

After reaching System Status STANDBY, the computer initially treats the delivery device as "uncalibrated" and assumes some specific default calibration factor, (typically 85%). Also the word UNCALIBRATED will appear near the bottom of the video display screen.

For most delivery devices the operator has the option of either using the device "uncalibrated," (which means the number of watts stated on the screen represents an approximation of the actual power available at the patient end of the device), or performing a device calibration procedure.

To change the System Status to CALIBRATION, the operator removes the Calibration Pod from its storage location and presses the orange button on the pod. After that, the operator performs the steps called out on the video display screen. These steps vary according to the type of delivery device.

5.6 EYE SAFETY FILTERS

In this manual, the section on safety pointed out that laser light presents a severe eye hazard and cautioned that the surgical beam should never be directly or indirectly viewed by the unprotected eye. The precautionary measure for the surgeon to use is an eye safety filter, and the other operating room personnel to wear safety eyewear of the correct type for the laser wavelength being produced.

Laserscope offers an Endoscope Eye Safety Filter and a Microscope Eye Safety Filter as accessories for the Model 800 Series. Each has a cable that connects to the laser console at the eye safety filter receptacle. These are "active" filters: the computer sends signals to move the filter into the viewing path when the surgical beam is turned on, and to move the filter out of the path after the surgical beam is turned off.

5.7 SYSTEM TEST DEVICE INSTRUCTIONS

A SYSTEM TEST DEVICE is located on the inside front door. This test device allows you an optional method of pre-testing the laser system before surgical use (before a patient is brought into the room). To use this device perform the follwing procedure:

1. Turn the Laser on. Attach the **SYSTEM TEST DEVICE** to the Optic Coupler by inserting and turning a 1/4 turn until it locks. The laser will "beep", indicating the device has been attached.

2. Follow the setup instructions on the special menu.

3. To test the eye safety filter, it must be connected to the **Optic Coupler** and attached to the **SYSTEM TEST DEVICE.** If not testing the eye safety filter, it must be disconnected to proceed.

4. To start the test, press **READY.**

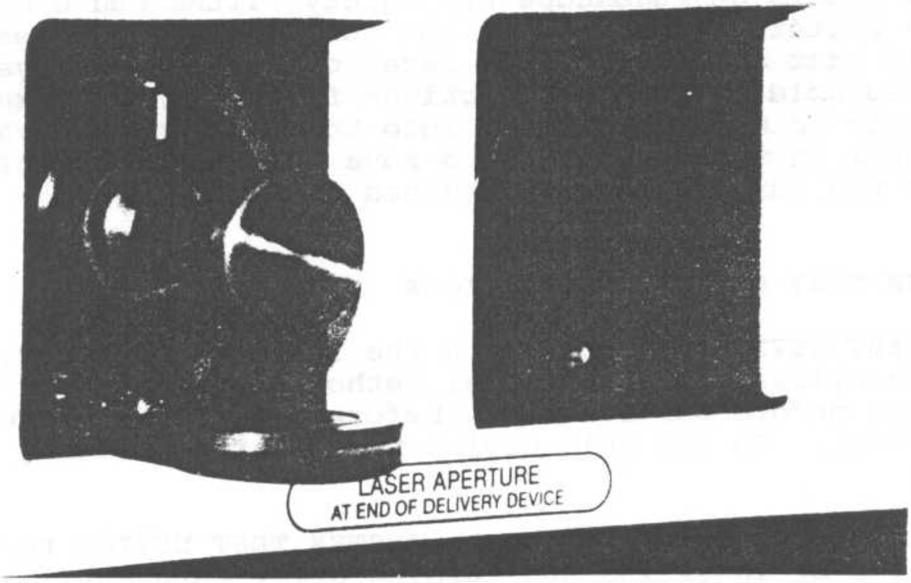
5. Step on the footswitch once (the test will start and finish in three minutes).

6. To terminate the test before completion, press any keys on the control panel or disconnect the **TEST DEVICE.** The screen will tell you if no fault occurred before the interruption.

7. Results will be displayed on the screen if the test finishes non-interrupted.

8. Remove the **SYSTEM TEST DEVICE** from the OPtic Coupler and store inside the recepticle located on the inside front door of the laser console. The Laser is now ready for operation.

9. You may turn the Laser off or remain in **STANDBY** until ready for use.



System Test Device

5.8 REFERENCES FOR FURTHER INFORMATION

5.8.1 Operator Manual

Section 4 describes Endostat fibers in more detail, Section 5 describes the Microbeam, Section 6 covers the Dermastat and Ophthostat, Section 3 gives procedures for calibration of delivery devices.

5.8.2 Laserscope KTP/532 LASER ACCESSORIES (catalog)

This sales publication shows photographs, lists specifications and describes uses of the various delivery devices; eye safety filters and other accessories are also included.

5.8.3 Resource Manual

Section 4.4 gives a detailed discussion of eye safety.

5.9 DELIVERY DEVICE SIGNATURE RESISTANCE VALUES

Each delivery device is recognized by its own "particular signature." This signature is a pair of resistors, (called signature resistors), whose particular signature value can be recognized by the system when the delivery device is inserted into the system at the laser aperture.

5.9.1 Handpieces and Their Values

Shown below is a list of handpieces and their corresponding signature resistor values.

HANDPIECE		SR2	SR1
Microbeam		0 - 9	0 - 9
600 micron	Endostat	20 - 29	71 - 80
400 micron	Endostat	71 - 80	20 - 29
300 micron	Endostat	71 - 80	71 - 80
200 micron	Endostat	0 - 9	122 - 131
Ophthostat		122 - 131	122 - 131
Consumable	Endostat	20 - 29	20 - 29
Dermastat,	1 mm	45 - 54	45 - 54
Dermastat,	2 mm	45 - 54	71 - 80

The following example shows how to read this table.

Suppose that the delivery device is a 400 micron Endostat. From the table you can see that the value for SR2 should be between 71 and 80 counts, and that the value for SR1 should be between 20 and 29 counts.

All signature resistors are mounted on the OCTR PCB, (which is on the corner of the base plate). If there is a problem with a delivery device being recognized by the system, the most likely trouble cause will be the shorting bars on the connected device.

Section 6

S Y S T E M   D E S C R I P T I O N

6.1 LASER BEAM PATHS

6.1.1 Introduction

The Laser system can be divided into several subsystems. These are the YAG rod and lamphousing, the KTP laser and the YAG laser. In addition, there is the subsystem with all the components from the KTP laser output to the fiber couplers, which is usually referred to as the KTP second train. Similarly, the subsystem with all the components from the YAG laser to fiber coupler is referred to as the YAG second train. A brief description of these subsystems is given below, followed by the various modes of operation of the entire laser system.

6.1.2 YAG Rod and Lamp Housing

Figure 6-1 shows a simplified view of the YAG rod and the lamp housing, with some of the optical components near the lamp housing on the base plate.

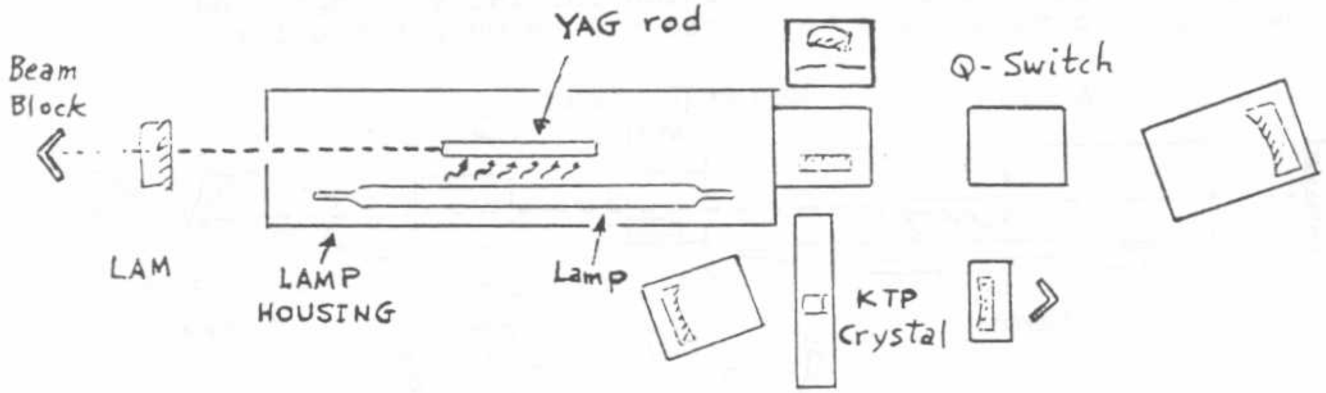


Figure 6-1.

No current flows through the lamp while the System Status is OFF. As soon as the ON/STANDBY button is pressed, the system goes into a powering up sequence (which is described later). When completed, the system will be in KTP mode of operation, with a simmer current (I_{SIM}) of about 5 amps passing through the krypton arc lamp. Inside the lamp housing, the light from the lamp is focussed from the lamp into the YAG rod. Most of the light from the krypton arc lamp is concentrated at a few wavelength bands in the near infrared. Some of these so-called spectral bands emitted from the lamp match the absorption bands of the YAG rod. This match between the emission bands of krypton arc lamp and absorption bands of the YAG rod makes this lamp an efficient pump source for YAG.

The light absorbed by the YAG rod will excite the Neodymium ions in the rod, and cause the rod to act as a light amplifier for the

1064 nm infrared wavelength. This means that the light at 1064 nm that enters the excited YAG rod at one end, will exit stronger at the other end. In a typical YAG laser this gain can be from 20% to 30%. As shown in Figure 6-1 above, some of the amplified light emerges from one end of the rod and strikes the LAM (Long Arm Mirror), which is a high reflecting mirror at 1064 nm that reflects nearly all of the light back into the YAG rod. (The small portion of light, about 0.2%, that does manage to pass through the mirror is absorbed by the beam block behind the mirror.) The light reflected back into the YAG rod is amplified again, and then goes through the KTP or YAG laser as described below, and returns through the YAG rod where it is again amplified. This process is repeated as the light is propagated back and forth, and the 1064 nm light continues to be amplified, untill the gain of the YAG rod becomes saturated.

6.1.3 KTP Laser

The 1064 nm light that emerges from the end of the YAG rod, (see Figure 6-2), travels past the Wavelength Select Mirror, (whose initial position is out of the light path as shown in the diagram), through the Q switch, (which initially is open and allows light to pass), and on to the 532 nm Output Coupler.

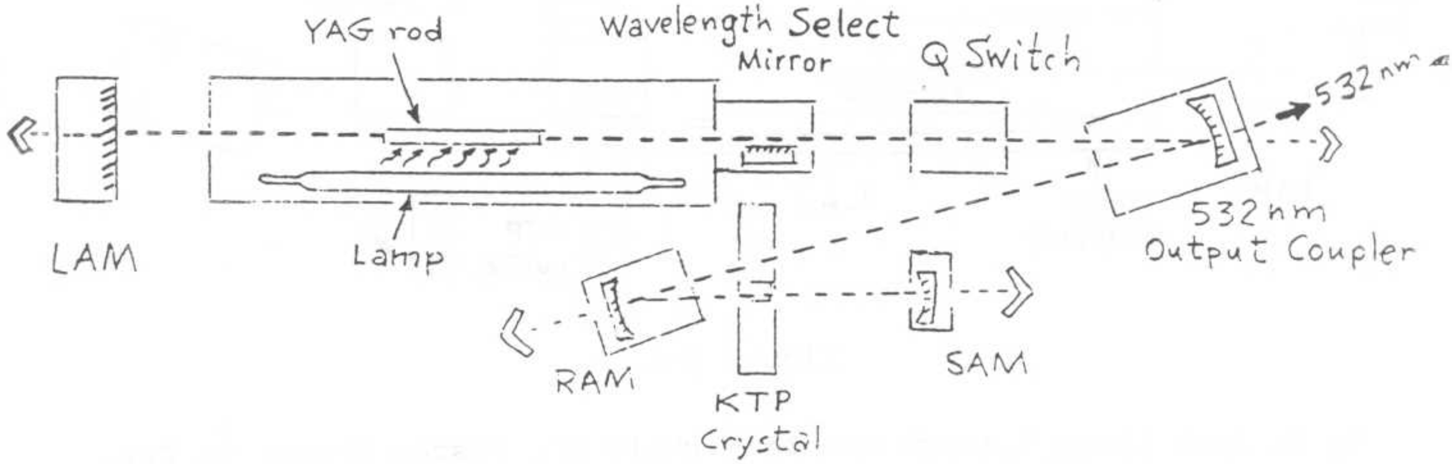


Figure 6-2.

Nearly all the 1064 nm light is reflected off the Output Coupler and reaches the RAM (Relay Arm Mirror), which is another high reflecting mirror at 1064 nm. After that, the 1064 nm light passes through the KTP crystal and strikes the SAM, (Short Arm Mirror), where it is again reflected and retraces the same path back to the YAG rod. (The small portion of 1064 nm light that passes through these mirrors is absorbed by beam blocks.) The returning light is further amplified by the YAG rod, until eventually the gain of the YAG becomes saturated. This entire arrangement is called a laser resonator because the 1064 nm light resonates back and forth over the light paths between the mirrors and through the YAG rod.

As 1064 nm light passes through the KTP crystal, a process called Second Harmonic Generation (SHG) causes the conversion of a small portion of this 1064 nm light to a visible green wavelength at 532 nm. (Note that the KTP crystal only converts some of the light to visible green but does not amplify it.) The green light that emerges from the KTP crystal also reflects off the SAM and passes back through the KTP crystal. The 1064 nm light that propagates through the KTP with the 532 nm light now generates more 532 nm light that adds to the 532 nm light generated on the first pass. All this 532 nm light reflects off the RAM and reaches the 532 nm Output Coupler. This output coupler mirror is highly transmissive for 532 nm light and highly reflective for 1064 nm light. As a result, 532 nm light passes through the mirror and goes on to the next optical components (which are collectively referred to as the "KTP secondary train"), while 1064 nm light is reflected back into the resonator.

The Q Switch is an optical switch that can be closed to block the laser light. If this happens, the 1064 nm light is prevented from oscillating in the resonator and consequently no green light is generated, but the lamp is still on and gain builds up in the YAG rod and energy is stored in the YAG rod. When the Q Switch is subsequently opened, all the energy stored in the Yag rod is dumped in the laser resonator, causing a large pulse of 1064 nm light in laser. The KTP crystal conversion of infrared to visible green is non-linear. This means, for example, that if the infrared power produced in the resonator is doubled, it produces a quadrupling of the amount of green light, and consequently the peak KTP power is increased considerably by Q Switching the laser. This Q Switching process (opening and closing) is repeated at rate of 25 kHz, and the average 532 nm light produced increases considerably. The effect of Q Switching can be quantified as follows. With the Q Switch left open, the continuous wave (CW) KTP power is about 5 watts. But with Q Switching, the average KTP power reaches 24 watts. From these numbers it can be seen that the Q Switch allows a much more efficient conversion of infrared to visible green.

The Q Switch is controlled by the RF Driver. NO RF means the Q Switch is off and the YAG laser runs in its normal, continuous wave mode. When driven by LOW RF without the Q Switch turning on or off, the Q Switch scatters only some of the infrared light and consequently looks like a <u>lossy</u> element in the laser, and partially turns the laser off. Consequently, the amount of conversion to green light is very low and the KTP output power is only a fraction of a watt. This is the RF state used for turning the green output to a low level. When driven by HIGH RF and with the Q Switch turning on and off at 25 kHz, the average KTP output power is high. This 532 nm light goes on to the KTP second train.

6.1.4 YAG Laser

To switch the system over to YAG operation, the operator presses the YAG/1064 button. The details of the wavelength switching process are described later, but essentially the Wavelength Select Mirror moves in place, as shown in Figure 6-3.

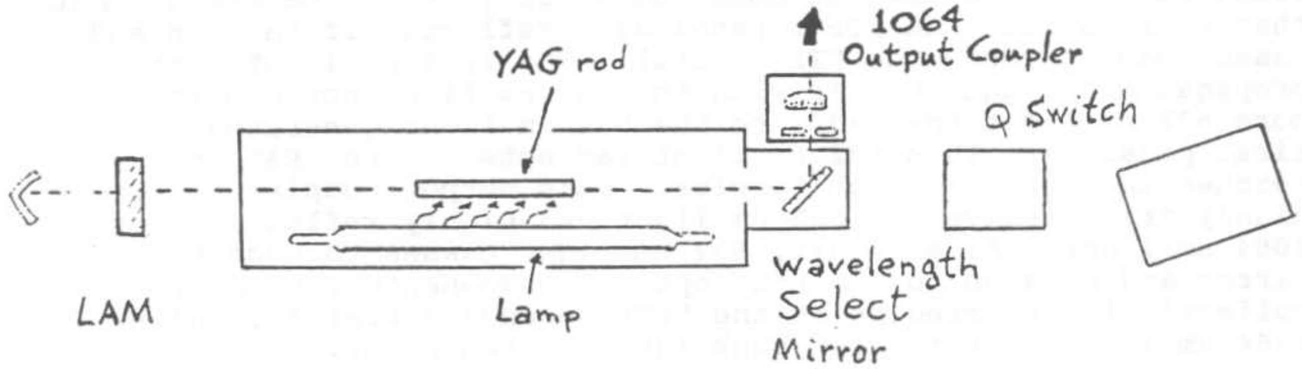


Figure 6-3.

With this mirror in place, the 1064 nm light is reflected towards the 1064 nm Output Coupler and a new resonator is formed for the YAG laser consisting of the LAM, Wavelength Select Mirror and 1064 Output Coupler. The 1064 nm light bounces back and forth between these mirrors and is amplified in the YAG rod. This causes 1064 nm light to build up inside the resonator. The Output Coupler allows about 12% of the 1064 nm light in the resonator to pass through and propagate towards the YAG second train components. The 1064 nm power output from the laser is controlled by adjusting the lamp current.

The output coupler assembly has an adjustable aperture in addition to the mirror. This aperture limits the maximum spot size of the beam that passes through and also defines where it emerges from the coupler. The second surface of the Output Coupler Mirror is curved, and helps to collimate the beam.

NOTE: The flat surface of the Output Coupler has the mirror coating and the curved surface is AR coated. Make sure that the mirror is installed with the flat surface towards the YAG rod.

With the Wavelength Select Mirror in place for YAG operation, no 1064 nm light passes through to the KTP part of the resonator beyond this mirror, and thus no light at 532 nm is produced by the KTP. This means that only KTP or YAG output can be produced at any one time. KTP and YAG outputs can NEVER be produced at the same time.

6.1.5 KTP Second Train

All the components from the 532 nm Output Coupler to the fiber couplers are called the KTP Second Train. Some of the components in the second train are shown in Figure 6-4.

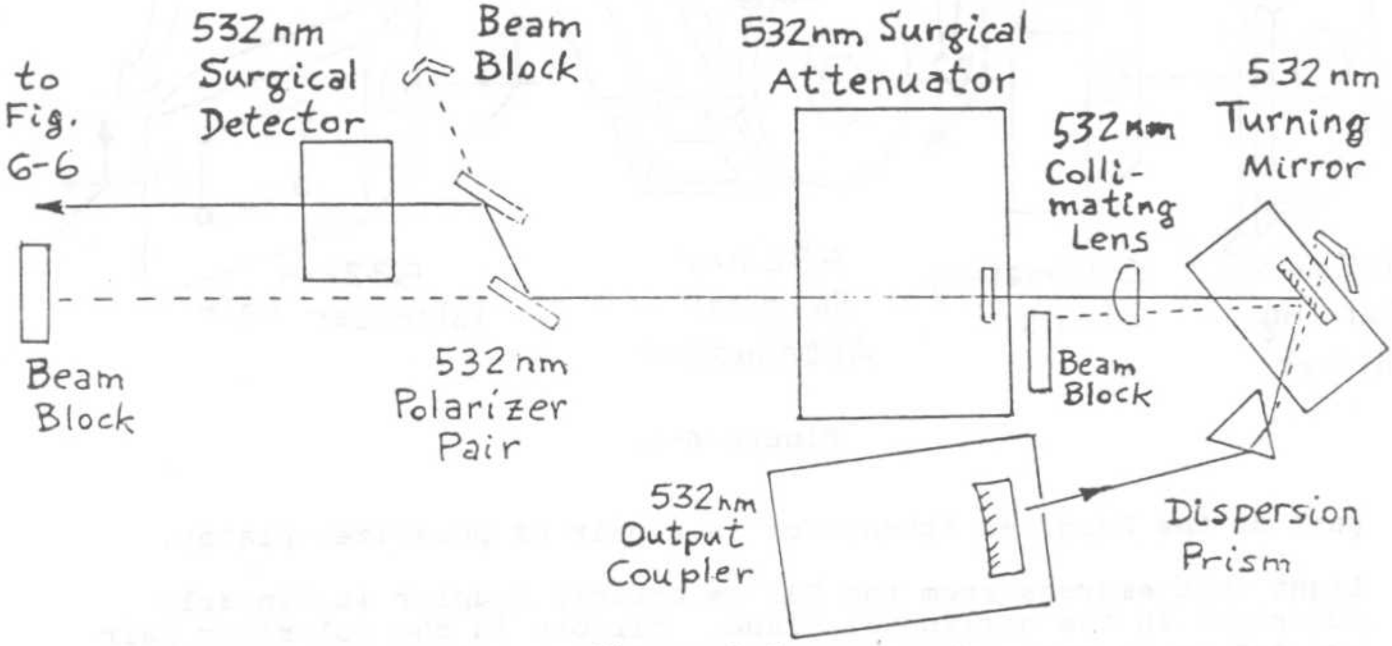


Figure 6-4.

The first component the 532 nm light sees after passing through the 532 Output Coupler, is the Dispersion Prism. A small amount of 1064 nm light passes through the 532 nm Output Coupler, and is coaxial with the 532 nm light. While passing through the Dispersion Prism, the 1064 nm light is not bent as much as 532 nm light. This means that after the prism, the 1064 nm and the 532 nm light are no longer coaxial and as shown in Figure 6-4, the 1064 nm light is absorbed by a beamblock and the 532 nm light continues on down the KTP Second Train. This means that NO 1064 nm light can pass down the KTP Second Train and go into the fiber with the 532 nm light.

From the Dispersion Prism, the 532 nm light is reflected by the 532 nm Turning Mirror and then passes through the 532 nm Collimating Lens which collimates the 532 nm light into a beam of approximately constant diameter through the rest of the components in the KTP Second Train.

The next component in the light path is called the 532 nm Surgical Attenuator. The first part of this assembly consists of a half-wave plate mounted in a circular disk, driven by a stepper motor (see Figure 6-5). The shaft of the stepper motor is fitted with a rubber wheel that presses against the edge of the circular disk and rotates the disk when the motor shaft turns. The second

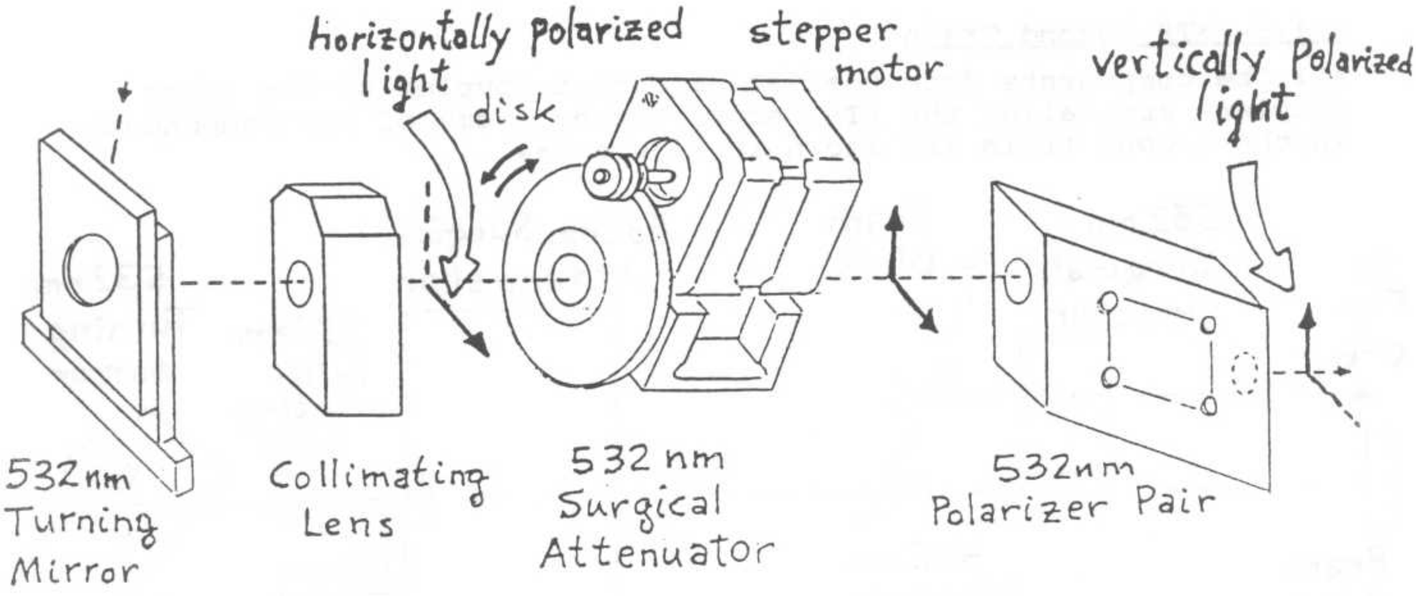


Figure 6-5.

part of the Surgical Attenuator is a pair of polarizer plates.

Light that emerges from the 532 nm Optical Coupler is linearly polarized in the horizontal plane. Mirrors in the polarizer pair are set up in such a way that both will transmit the horizontally polarized component of the light and reflect the vertically polarized component. In conjunction with the polarizing pair the minimum and maximum KTP power levels can be set.

When the half-wave plate is in place, it rotates the polarization of the horizotally polarized light from the laser, and the light emerges from the half-wave with components horizontally and vertically polarized. The vertically polarized light now passes through the Polarizer Pair and continues down the KTP Second Train. The amount of vertically polarized light emerging from the half-wave plate depends on the rotation of this plate (see Figure 6-5), and determines the amount of light propagating down the KTP Second Train. The angle by which the polarization is rotated is twice the angle by which the wave plate is rotated. This means that to rotate the polarization by 90 degrees from horizontal to vertical requires 45 degrees of rotation by the wave plate. This arrangement makes it possible for the computer to control the power output by driving the stepper motor to rotate the half-wave plate to an orientation that produces a desired attenuation, and 45 degrees of rotation is required to go from minimum to maximum attenuation.

Vertically polarized light from the Polarizer Pair goes to the 532 nm Surgical Detector where a small amount of the light is picked off and directed onto a light sensor. The output of the light sensor goes to an Analog-To-Digital (A/D) converter circuit on the Electronics Board where the computer determines the power in the beam at the surgical detector. A digital feedback signal can be sent to the surgical attenuator by the computer to form a control loop for adjusting attenuation. The 532 nm Surgical Detector has three gain ranges. They are set by the computer according to the output power measured at the detector: X1=0-35W, X10=0-3.5W, and X3=0-11W.

After the Surgical Detector, the path of the 532 nm light passes through the optical components shown in Figure 6-6. This illustration shows all the shutters in the KTP Second Train.

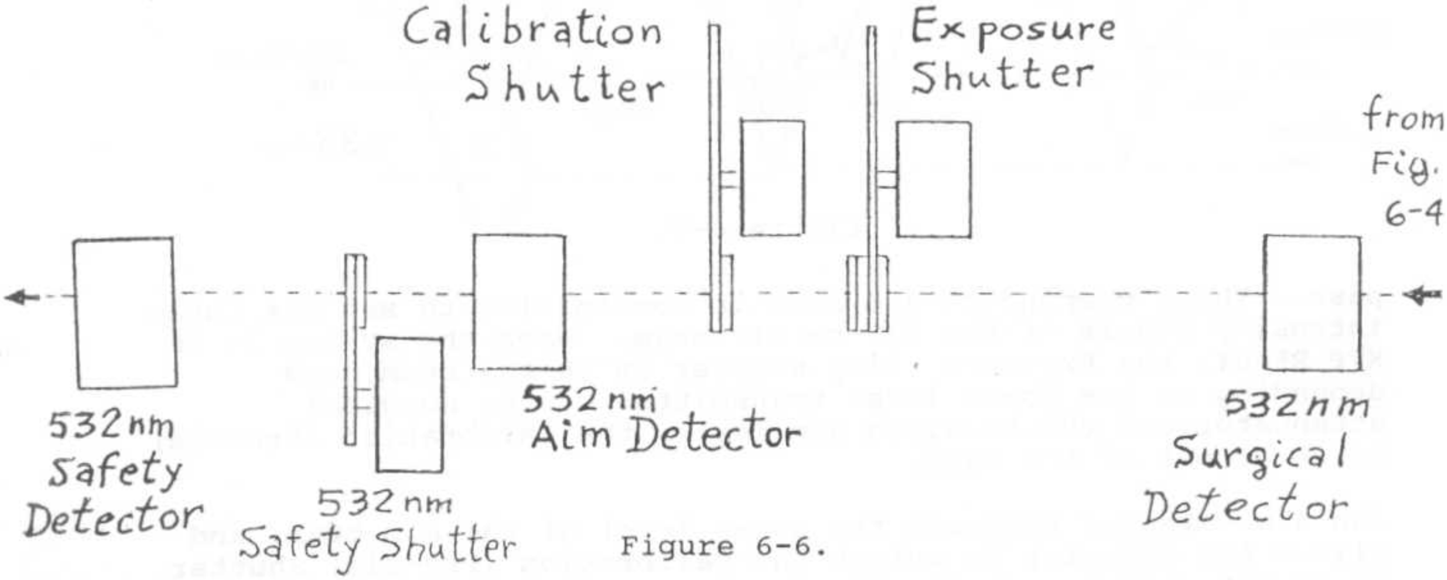


Figure 6-6.

The shutters consist of solenoids and attached "arms" that move in and out of the light path under computer control. Figure 6-7 shows a perspective view of these components and indicates the light path for the 532 nm. For later reference, the 1064 nm and 633 nm (He Ne laser) light paths are also shown.
For the Exposure Shutter and Calibration Shutters, note that the ends of the arms lie in the paths of both 532 nm and 1064 nm light, but that a separate Safety Shutter is provided for each wavelength. On the resonator plate the shutters are all mounted at an angle from the vertical, so that light reflected off the arms will be directed into light wells cut into the surface of the plate. (On models before the Combo, the component comparable to the present Exposure Shutter was called the Aim Shutter, and the one comparable to the Calibration Shutter was called the Pre-Aim Shutter.)

The 532 nm side of the Exposure (Aim) Shutter is fitted with a computer-controlled light valve and an attenuator that allows 5% of the light to pass. The 532 nm side of the Calibration Shutter is fitted with the same attenuator that allows 5% of the light to

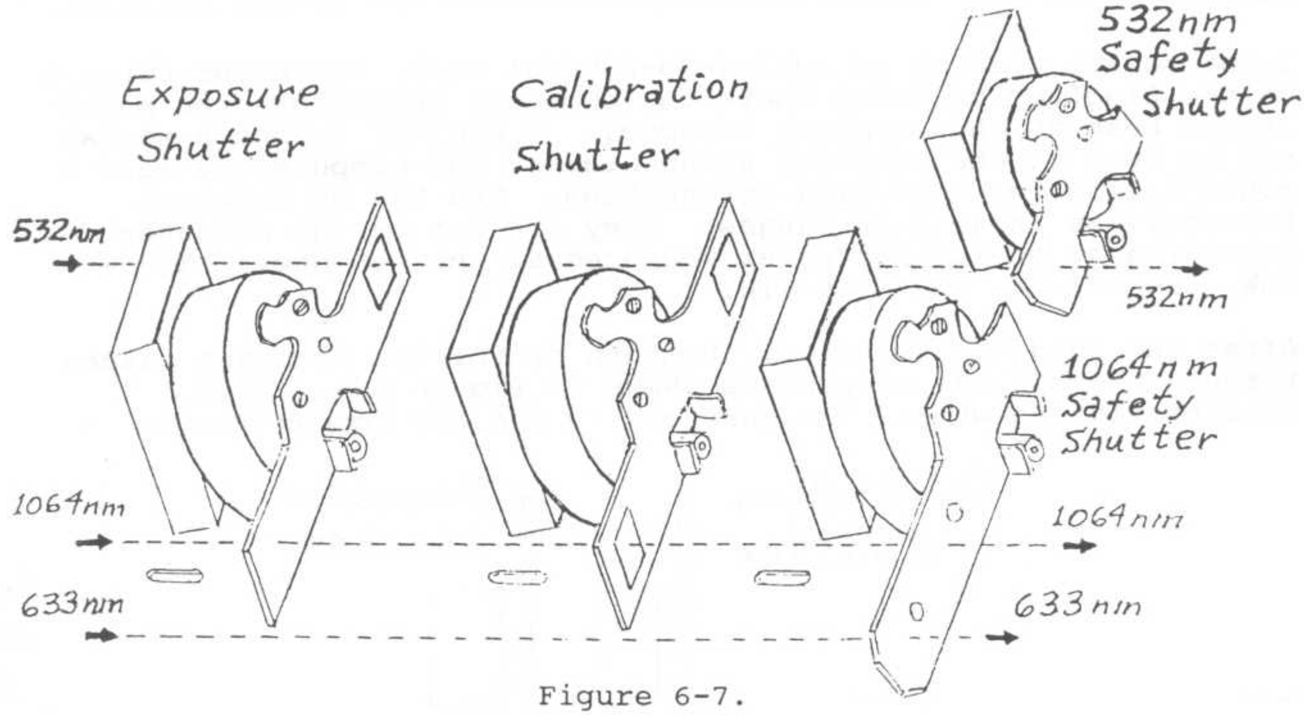


Figure 6-7.

pass. These components are used in combination to set the three intensity levels of the 532 nm aim beam. When the system is in KTP READY, the Exposure (Aim) Shutter is in the beam, and depending on the power level transmitted by the surgical attenuator and the required aim level, the Calibration (Pre-aim) is in or out of the beam.

The Aim Detector measures the power level of the aim beam, and allows the computer to select the Calibration (Pre-aim) Shutter in or out, and to set the light valve level to determine the correct aim level. For the Aim Detector, as with the Surgical Detector, a small amount of light is tapped off. The only design differences are that the Aim Detector has a small adjustable aperture that has to be positioned in the light path and no light diffuser is used. The purpose of the adjustment is to center the beam on the aperture, and make the aim beam accept approximately the same amount of light as it goes through the delivery device fiber when the aim beam is on. In Standby Mode the computer uses the Aim Detector output to set the voltage applied to the light valve so that the aim beam will be produced at the level desired by the surgeon. But in Ready Mode the Aim Detector is put in a "servo closed loop" by adjusting the HIGH modulation current.

The computer also causes the Calibration Shutter to drop into the light path during calibration of a fiber delivery device. With the Surgical Attenuator set for about .8 W KTP and 16 W YAG at the Surgical Detector output, this determines the light level required for calibration.

The next component in the KTP Second Train is the 532 nm Safety Shutter. The computer causes the arm on this shutter to drop into the beam to block the beam while the System Status is OFF, ON or STANDBY. The arm is fitted with an aluminum reflector that deflects high power beams down into a beam trap. (This is a slot cut in the shutter mounting plate. The plate under the shutters is water cooled because of the amount of power to be dissipated: as much as 20 watts for 532 nm and 60 watts for 1064 nm.)

The next component in the 532 nm beam path is the 532 nm Safety Detector, which has four possible gains: X1, X10, X60 and about X500. The purpose of this Safety Detector is to act as a safety backup for the 532 nm Surgical Detector. When producing a surgical beam with the Safety Shutter out, the computer samples the output from the Safety Detector and compares it to the setting on the Surgical Detector. If the two detectors do not agree within a tolerance of +/- 33%, the computer immediately causes the Safety Shutter arm to drop in place to prevent the exposure and prints an error message on the video display screen.

Between the Safety Shutters and the Safety Detector, a space has been left on the resonator plate so that a power meter or the Calibration Pod can be precisely inserted in the beam paths.

Figure 6-8 shows the final components in the 532 nm beam path.

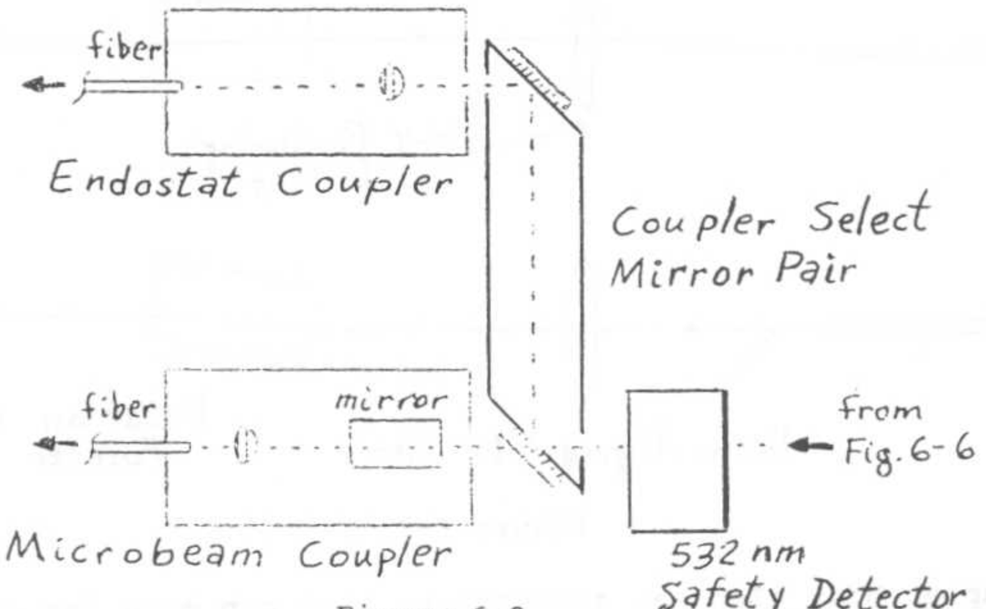


Figure 6-8.

The Coupler Select Mirror Pair consists of a motor connected to a hinged assembly that contains a pair of mirrors. When the motor is de-energized, the assembly remains in the horizontal position and the mirrors deflect the beam to the Endostat fiber laser aperture. When the computer energizes the motor, the assembly is moved out of the beam path and the 532 nm light passes directly to the Microbeam Coupler. Adjustments are provided on the Coupler Select mirror Pair to change the orientation of the two mirrors, so that the 532 nm beam can be precisely aligned into the Endostat Coupler.

The Microbeam Coupler consists of the following components: the coupler body, a focusing lens and a pointer plate. The focusing lens is mounted in the coupler body, and the pointer plate is mounted behind the coupler body.

The pointer plate consists of a round glass bar which can be rotated about two axes (X and Y) at right angles to the beam. These rotational adjustments are used to make the axis of the beam and the axis of the fiber parallel to one another, (see Figure 6-9 below).

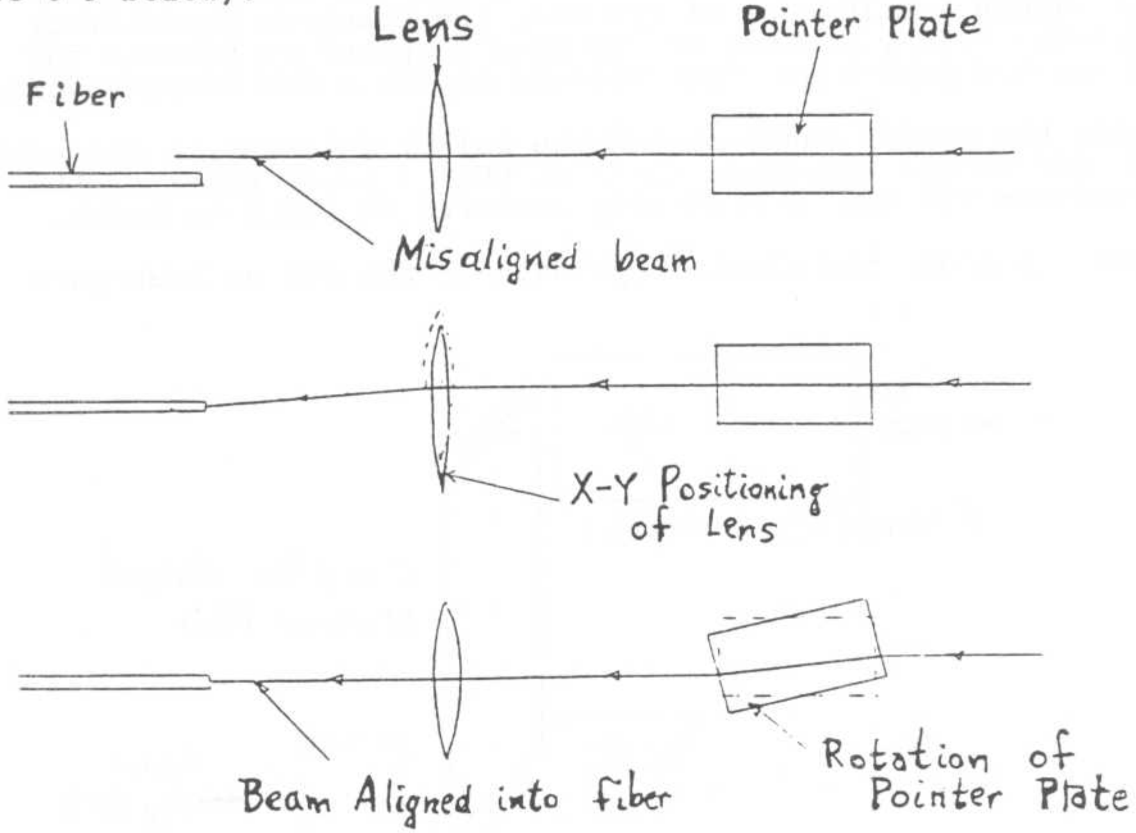


Figure 6-9.

The coupler body also has adjustments that can move the coupler in the X and Y directions at right angles to the beam. These adjustments are used to align the coupler body so that its axis is coaxial with the axis of the beam from the pointer plate.

The lens in the coupler body is used to focus the beam size down to a size that will be small enough, (i.e., down to a size acceptable to the fiber diameter).

The Endostat coupler also has a lens that focuses the spot size to fit into a fiber. As for the Microbeam Coupler, the lens can be adjusted in X , Y and Z to position the beam and focus the spot on the fiber. The angular adjustment on the Coupler Select Mirror Pair now steers the beam in X and Y directions before entering the lens, and adjusts the angle of the beam going into the fiber. Similar to the Microbeam Coupler above, the lens and the Coupler Select Mirror Pair provide the independent adjustment of beam position and beam angle at the fiber.

6.1.6 YAG Second Train

Figure 6-10 shows some of the initial components in the the YAG Second Train after the infrared light emerges from the 1064 nm Output Coupler.

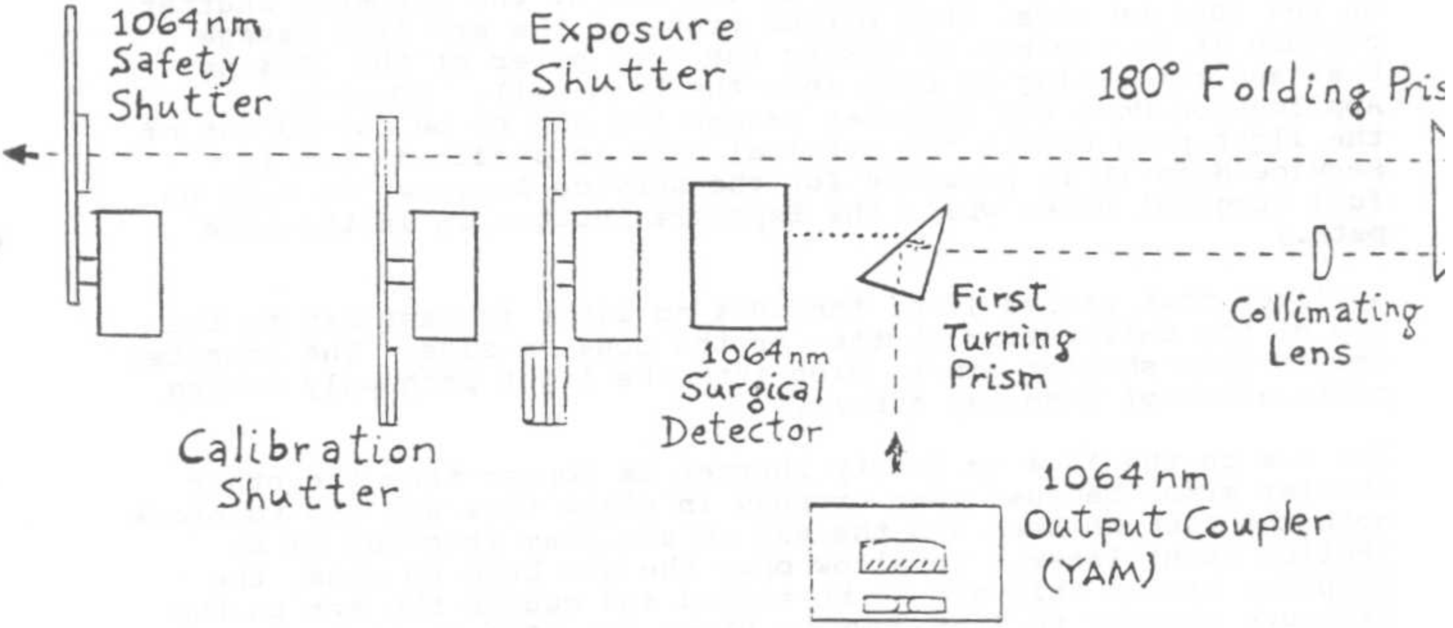


Figure 6-10.

The first component in the light path is the First Turning Prism. All the light that enters the first surface is turned 90 degrees by total internal reflection at the second "long" surface and then passes out of the prism through its third surface. A very small portion of the light is reflected internally from the third surface and the angle of reflection is such that this light then passes out of the prism through the long surface and reaches the 1064 nm Surgical Detector.

The function and internal design of the 1064 nm Surgical Detector are much like those of the 532 nm Surgical Detector, except that the X3 gain is not used. Another difference is that the mirror in this detector mount reflects all the light into the detector. Note also that the 1064 nm detector is mounted in an upright position on the resonator plate, while the 532 nm detector is mounted at an angle, making it easy to identify these detector mounts on the resonator plate.

After emerging from the First Turning Prism, the 1064 nm light beam goes to a Collimating Lens that collimates the beam down the rest of the beam path.

Next the beam passes through the 180 degrees Folding Prism, which by total internal reflection turns the beam around by 180 degrees towards the fiber couplers. (The long surface of this prism has an Anti-Reflection coating.)

The next components in the beam path are the Exposure Shutter and Calibration Shutter (mentioned previously in the description of the 532 nm beam path), and the 1064 nm Safety Shutter. A dielectric mirror is fastened to the arm of the Exposure Shutter on the 1064 nm side. This mirror protects the arm from damage because it is capable of taking the full power of the 1064 nm beam and reflecting it down into the beam well. (During Application Mode the computer causes the arm to be raised out of the light path before the surgical beam is produced, but in Service Mode it is possible for the Service Engineer to turn on full surgical power while the Exposure Shutter is in the beam path.)

A filter that passes 1% of the 1064 nm light is fastened to the arm of the Calibration Shutter on the 1064 nm side. The computer causes this shutter arm to drop into the light path only during calibration of Endostat fibers.

The arm on the 1064 nm Safety Shutter is longer than the other shutter arms, because when dropped in place this arm has to block both the 1064 nm beam and the 633 nm aim beam from the He Ne (Helium Neon) laser. To allow only the aim beam to pass, the computer causes this arm to be raised and causes the arm on the Exposure Shutter to drop down to block the 1064 nm light beam. To allow both the aim beam and the surgical beam to pass, the computer also raises the arm on the Exposure Shutter.

Figure 6-11 shows the final components in the 1064 nm beam path. The Second Turning Prism performs the same functions as the First Turning Prism: turn the beam by 90 degrees and pick off a small portion of the light for a Safety Detector. As was the case with operation in KTP, the purpose of this detector is to act as a safety backup for the Surgical Detector. When producing a surgical beam, the computer samples the output from the Safety Detector and compares it to the setting on the Surgical Detector. If the settings do not agree within a specific tolerance of +/- 33% the computer immediately causes the Safety Shutter arm to

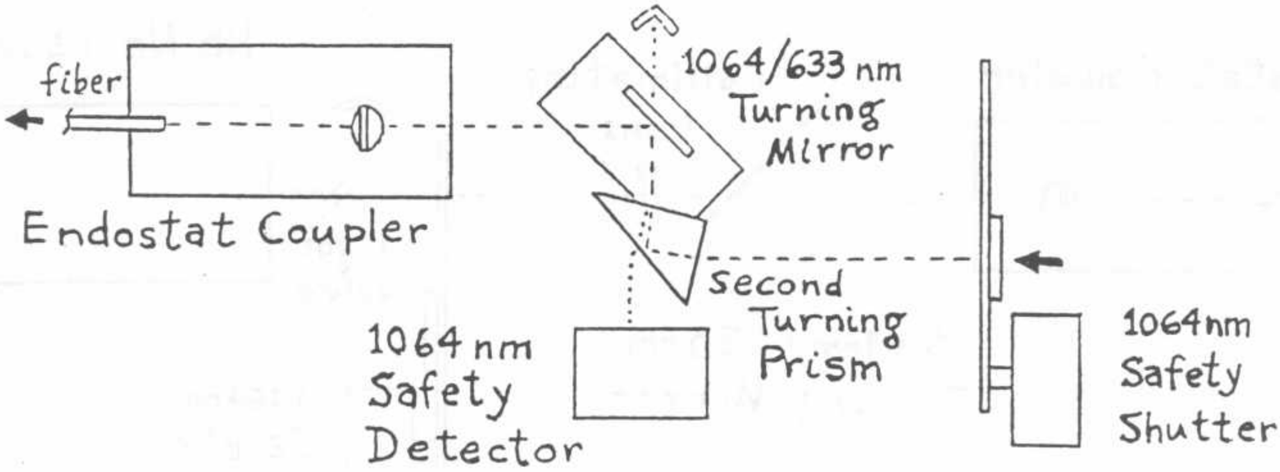


Figure 6-11.

drop in place to prevent the exposure and prints an error message on the video display screen.

The 1064/633 nm Turning Mirror has the optical properties that it is a high reflector for the 1064 nm wavelength and high transmitter of the 633 nm wavelength produced by the He Ne laser. (Any 1064 nm light that manages to pass through the mirror is absorbed by a beam block.) Besides turning the 1064 nm light path by 90 degrees, the Turning Mirror also combines the two beams of different wavelengths.

The 1064 nm beam goes next to the Endostat Coupler. (During operation in YAG, the Coupler Select Mirror Pair mentioned in the description of the KTP Second Train, is kept out of the 1064 nm beam path.) For alignment of the Endostat coupler in YAG, adjustment of the 1064 nm/633 nm Turning Mirror controls the X and Y positioning of the beam on the fiber. However, no provision is made for angular adjustment of the 1064 nm beam on the fiber because it was found that it is not necessary. Also, when the Endostat Coupler lens is adjusted to focus the 532 nm beam on the fiber, it is properly positioned to focus the 1064 nm spot on the fiber, and no further adjustment is required.

6.1.7 Helium-Neon Laser

This laser produces a visible red aim beam that is used when operating in YAG. Because the infrared 1064 nm surgical beam is invisible to the human eye, the He Ne aim beam is necessary because it is the surgeon's only visual indication of the YAG beam path. The helium neon laser is turned on when the System Status changes to ON, and is left on all the time. The beam path is shown in Figure 6-12.

After emerging from the laser, the 633 nm light passes through a light valve identical to the valve mounted on the arm of the Exposure Shutter. The computer controls the light valve to set the level of beam intensity desired by the surgeon. The computer

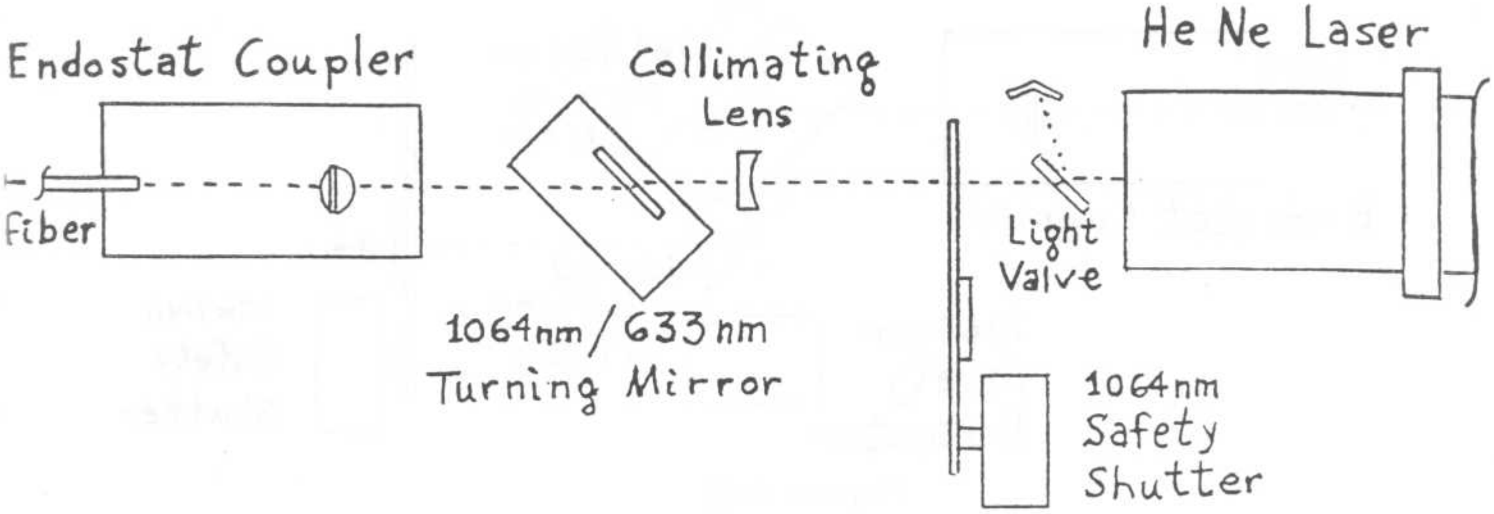


Figure 6-12.

can also cause the aim beam to blink by turning the valve on and off. After the light valve, the 633 nm light passes through a collimating lens that can be adjusted in X and Y for aligning the aim beam. Next the beam passes through the 1064 nm/633 nm Turning Mirror where it is coupled with the 1064 nm beam (as described earlier). Finally the 633 nm light passes through the Endostat Coupler and is focussed into the fiber. The X and Y adjustment of the 633 nm collimating lens described above is used to align the 633 nm beam into the fiber. Note that the Endostat Coupler lens, and 1064/633 nm Turning Mirror which have been used to align the 532 nm and 1064 nm beams each into the fiber, are not disturbed to align the 633 nm beam into the same fiber.

NOTE: The Endostat Coupler, Microbeam Coupler, 532 nm collimating lens, 1064 nm collimating lens, 633 nm collimating lens, and YAM aperture all have X and Y positioning on the lens mounts. Unlike other places on the resonator assembly where the X and Y refer to horizontal and vertical adjustments, here the two adjustments are at 45 degree angles to the horizontal and vertical.

6.1.8 System Alignment

If the system is aligned in the correct order, all the alignments are decoupled. This means that if a certain part of the system has been aligned, alignment of the next part of the system will not disturb the previous alignment. The correct alignment sequence is:

1. 532 nm beam into Microbeam Coupler with pointer plate and coupler lens.
2. 532 nm beam into Endostat Coupler with Coupler Select Mirror Pair and coupler lens.

3. 1064 nm beam into Endostat Coupler with 1064 nm Turning Mirror only.
4. 633 nm beam into Endostat with 633 nm Collimating Lens only.

This alignment sequence always has to be done in this order. For more details, refer to Section 10 of this manual.

6.2 SYSTEM MODES OF OPERATION

For the entire laser system to perform its various functions, certain modes of operation have to be defined for the components and the sub-systems. For the components, we have to define the modes of operation for the Q-Switch driver and the lamp power supply (also referred to as the ALE). The sub-systems we have to consider are the KTP laser system and the YAG laser system.

6.2.1 Q-Switch Driver

There are three modes of operation for the Q-Switch Driver:

RF off — The drive signal to the Q-Switch is off and there is no loss to the 1064 nm light in the laser.

RF low — The drive signal to the Q-Switch is at a low level and the loss in the Q-Switch partially turns the laser off.

RF on — The drive signal to the Q-Switch is turned on full and modulated at 25 KHz to Q-Switch the laser and obtain maximum output at 532 nm.

The RF drive levels for RF low and RF on are adjusted with two pots on the Q-Switch driver. See Section 8 of this manual for more details. Two control lines from the computer are used to set the various modes of the Q-Switch driver.

Note that we are using the terminology "RF off", "RF low" and "RF on" to define the various modes of the Q-SWITCH DRIVER. These modes are NOT the same as "NO RF", "LOW RF" AND "HIGH RF". These modes are laser SYSTEM modes.

6.2.2 Lamp Power Supply (ALE)

For operation in both KTP the YAG ALE is always in current-enabled mode. (The pots for adjusting SIMMER current and FULL current are not used.)

For operation in YAG two current levels are defined: YAG LOW current and YAG OPERATING current. The low current is usually set at 11 A and the operating current is set at the level required to obtain the desired YAG output power. Thus for the YAG laser, the output power is determined by the lamp current. The two current levels are set by the computer.

6.2.3 KTP Laser System Operating Sequences

The operator can select two operating conditions for the KTP laser. These are the KTP STANDBY and KTP READY; they are selected by pressing the STBY or READY buttons as described in Section 4. Within each of these two operating conditions, various system modes are defined. These modes can either be selected by the operator or are determined by the computer. Table 6.1 gives all the system modes of operation for KTP and also gives the action required by the operator to enter any of the modes of the system.

The KTP STANDBY/NO RF mode of operation is the system default condition. This means that from any state, the system will always return to STANDBY/NO RF a given period of some time.

LASER SYSTEM MODES		ACTION REQUIRED	A L E	Q-SW.	EXP.	CAL.	KTP.	KTP.
SCREEN DISPLAY	SYSTEM MODES	TO ENTER MODE	POWER SUPPLY	DRIVER	(AIM) SHUTTER	PRE-AIM SHUTTER	SAFETY SHUTTER	SURG. ATTEN.
KTP STBY	NO RF - IDLE	PRESS STBY BUTTON	KTP SIMMER (5A)	RF OFF	IN	IN	IN	PRESET
	LOW RF	SYSTEM TRANSITION STATE	KTP	RF LOW	IN	IN	IN	PRESET
	HIGH RF	SYSTEM TRANSITION STATE	KTP	RF ON	IN	IN	IN	PRESET
	POWER ADJUST	PRESS POWER UP OR DOWN BUTTON	KTP OPERATING	RF ON	IN	IN	IN	ADJUST
	AIM ADJUST	PRESS AIM UP OR DOWN BUTTON	KTP MODULATION	RF OFF	IN	IN/OUT	IN	PRESET
	CALIBRATION SET UP	PRESS BUTTON ON CAL POD	KTP OPERATING	RF ON	OUT	IN	IN	SET TO 0.8 W
	CALIBRATION	PRESS BUTTON ON CAL POD AGAIN	KTP OPERATING	RF ON	OUT	IN	OUT	PRESET TO 0.8W
KTP READY	AIM	PRESS READY BUTTON	KTP MODULATION	RF OFF	IN	IN/OUT	OUT	PRESET
	SURGICAL HIGH	PRESS FOOTSWITCH (POWER >.5W)	KTP OPERATING	RF ON	OUT	OUT	OUT	PRESET
		PRESS FOOTSWITCH (POWER <.5W)	KTP OPERATING	RF ON	OUT	IN	OUT	PRESET
	SURGICAL LOW	PRESS FOOTSWITCH (IN PULSE MODE)	KTP OPERATING	RF LOW	IN	OUT/IN	OUT	PRESET

NOTE For shutter position, "IN" denotes shutter in the beam path and "OUT" denotes shutter out of the beam path.

TABLE 6-1. MODES OF OPERATION FOR KTP LASER SYSTEM

6.2.4 YAG Laser System Operating Sequences

The operator can select two operating conditions for the YAG laser. These are the YAG STANDBY and YAG READY; they are selected by pressing the STBY or READY buttons as described in Section 4. Within each of these two operating conditions, various system modes are defined. These modes can either be selected by the operator or are determined by the computer. Table 6-2 gives all the system modes of operation for YAG and also gives the action required by the operator to enter any of the modes of the system.

The YAG LOW POWER mode of operation is the system default condition. This means that from any state, the system will always return to STANDBY/LOW POWER after a pre-set time.

LASER SYSTEM MODE			ACTION REQUIRED	A L E POWER SUPPLY	EXP.	CAL.	YAG. SAFETY
SCREEN DISPLAY	SYSTEM MODES		TO ENTER MODE		SHUTTER	SHUTTER	SHUTTER
YAG STBY	YAG LOW POWER	CW	PRESS STANDBY BUTTON	YAG LOW	IN	OUT	IN
	POWER ADJUST		PRESS POWER UP OR DOWN BUTTON	YAG OPERATING ADJUST	IN	OUT	IN
	AIM ADJUST /CW		PRESS AIM UP OR DOWN BUTTON	YAG LOW	IN	OUT	IN
	AIM /BLINK		PRESS BLINK BUTTON	YAG LOW	IN	OUT	IN
	CALIBRATION SET UP		PRESS BUTTON ON CAL POD	YAG OPERATING SET 16 W	IN	IN	IN
	CALIBRATION		PRESS CAL POD BUTTON AGAIN	YAG OPERATING (16 W)	OUT	IN	OUT
YAG READY	AIM /CW/BLINK		PRESS READY BUTTON	YAG LOW	IN	OUT	OUT
	SURGICAL HIGH		PRESS FOOTSWITCH	YAG OPERATING	OUT	OUT	OUT
	SURGICAL LOW		PRESS FOOTSWITCH (PULSE REP MODE)	YAG OPERATING	IN	OUT	OUT

NOTE
For shutter position, "IN" denotes shutter in the beam path, and "OUT" denotes shutter out of the beam path.

Table 6-2. Modes Of Operation For YAG Laser System

S E R V I C E   M O D E

7.1 CAPABILITIES

Besides software for controlling operation during treatment of patients, the computer program for the Model 800 Series also includes special diagnostic software that can assist you in locating system faults. When running under the software for treating patients, the Model 800 Series is said to be in Applications Mode and the operation is as described in the Operator Manual. When running under the diagnostic software, the Model 800 Series is said to be in Service Mode, and the operation will be different in the following ways:

- The CRT will display special Service Screens instead of the screens shown in the Operator Manual
- The buttons on the control panel will have effects that are different from those described in the Operator Manual
- The usual responses to many faults are overridden for troubleshooting purposes. However, some of the interlocks are still checked, to prevent either damage to the system or to keep a potential safety hazard from being created.

Within Service Mode you can individually exercise various components such as shutters and detectors, adjust laser output, and perform certain other special functions.

7.2 ACCESSING SERVICE MODE

Before entering Service Mode you have to install a jumper on the Electronics Card, specifically in receptacle J18. This jumper is intentionally <u>not</u> included with the system when shipped from the factory, so that it can only be installed by authorized service personnel. Remember that you are responsible for removing the jumper after completing the servicing.

With the jumper in place, two methods are available for putting the Model 800 Series in Sevice Mode. The only personnel told how to do this will be Laserscope service engineers or factory certified biomedical technicians.

To enter Service Mode from the Control Panel, simultaneously press the following three buttons: Surgical Power Down, Interval Up, and the Repeat. If the cabinet is open, the other method for entering Service Mode is to press a special pushbutton switch located on the Electronics Card (S3 near the center of the card).

The first screen that appears in Service Mode is called Service Screen 0 and is described below. From this screen you press the ON/STANDBY button to exit back to Applications Mode.

7.3 SERVICE SCREEN 0

This is the first screen to appear in Service Mode and serves as a "Main Menu." The left side of the screen has a list of the buttons on the Control Panel, and the right side of the screen explains the actions that result from pressing the buttons. The second line shows the software revision level along with the current date and time.

```
Screen 0   Service Screens Menu

Rev. 2.1   06/15/90   11:14:58

KTP/532   Select KTP   Status:  KTP
YAG/106   Select YAG

SUR UP    Laser ON/OFF and Interlocks

SUR DN    KTP Power vs Current Curve

AIM UP    Laser, Shutters, Detectors

AIM DN    Attachments and ESF

DUR UP    Calibration

DUR DN    Clock and Date Set

INT UP    Special Tests

INT DN    Fiber Temperature Control

STNDBY    Exit
```

Typical Screen 0

The KTP/532 button and YAG/106 button act as toggles. If the Status is KTP, pressing YAG/106 changes the status to YAG. If the status is YAG, pressing KTP/532 changes the status to KTP.

Pressing the ON/STANDBY button causes an exit from Service Mode and returns the system back to the Applications Mode.

Pressing any of the other buttons brings up a new service screen. For example, pressing SUR UP changes the display from Screen 0 to Screen 1, (which is described next).

NOTE: The abbreviation ESF stands for Eye Safety Filter.

7.4 SERVICE SCREEN 1

There are two versions of this screen, one for KTP and one for YAG. Screen 1A will appear if the status on Screen 0 had been KTP, and Screen 1B will appear if the status had been YAG.

```
Screen 1A  KTP Laser ON/OFF & Interlock

SUR UP  Relay OPN/CLS    LPS RDY*  0
SUR DN  Lsps EN/DIS      LPS01 RLY 0
                         LPS02 RLY 0
AIM UP  Turn Laser On    LPS EN*   0
AIM DN  I SIM
                         ALE =000 00.0A
DUR UP  I OP             LCUR=060 11.7A
DUR DN  I MAX
                         RF ON/OFF 0
INT UP  Inc Power(Curr)  RF LO/HI* 0
INT DN  Dec Power(Curr)
                         SURG=000 00.0W
SETUP   RF OFF           SFTY=000 00.0W
REPEAT  LO RF
STNDBY  HI RF            I SIM=07.0A DAC
                         I OP =25.0A DAC
READY   Main Menu        I MAX=30.0A DAC
YAG/106 Select YAG
           TMP ILK  0 TMP END=037 069F
INT FLW 1  WTR ILK  0 TMP MB =027 069F
WTR LVL 0  OPN ILK  0 TMP WTR=020 061F
RMT ILK 0  KEY OFF  0 TMP PCB=117 074F
```

Typical Screen 1A

```
Screen 1B  YAG Laser ON/OFF & InterlocK

SUR UP  Relay OPN/CLS    LPS RDY*  0
SUR DN  Lsps EN/DIS      LPS01 RLY 0
                         LPS02 RLY 0
AIM UP  Turn Laser On    LPS EN*   0
AIM DN  Turn Laser Off
                         ALE =000 00.0A
DUR UP  LOW CURRENT      LCUR=060 11.7A
DUR DN  MAX CURRENT

INT UP  Inc Power(Curr)
INT DN  Dec Power(Curr)
                         SURG=000 00.0W
READY   Main Menu        SFTY=000 00.0W
KTP/532 Select KTP



           TMP ILK  0 TMP END=037 069F
INT FLW 1  WTR ILK  0 TMP MB =027 069F
WTR LVL 0  OPN ILK  0 TMP WTR=020 061F
RMT ILK 0  KEY OFF  0 TMP PCB=117 074F
```

Typical Screen 1B

This screen is used to turn the laser on in incremental steps, or to have the sequence automatically initiated by the microprocessor. Power (Current) can also be adjusted from this screen.

To return back to the Main Menu, (Service Screen 0), press the READY button.

The following comments apply to Screens 1A, 1B and several of the other service screens:

The current values of parameters (such as current, power, temperature) will appear after the equal (=) signs and be followed by a final letter that represents the units of measurement: A for Amps, W for Watts, F for degrees Fahrenheit. (In cases where an additional three digits appear immediately after =, those digits represent the DAC count.)

For switches and relays, a value of 1 means OPEN and 0 means CLOSED.
For RF ON/OFF, a value of 0 means OFF and 1 means ON.
For RF LO/HI*, a value of 0 means LO and 1 means HI.

7.5 SERVICE SCREEN 2

There are two versions of this screen, one for KTP and one for YAG. Screen 2A will appear if the status on Screen 0 had been KTP, and Screen 2B will appear if the status had been YAG.

```
Screen 2A  KTP Laser,Shutters,Detectors

SUR UP  KTP SFTY SHT     DRV=11  SW=01

SUR DN  EXP(AIM) SHT     DRV=11  SW=01

AIM UP  CAL(PAIM)SHT     DRV=00  SW=01

AIM DN  DET GAIN         Gain=1
                         SURG=000 00.0W
INT UP  INC POWER(KTP)   Gain=1
                         SFTY=000 00.0W
INT DN  DEC POWER(KTP)
                         ALE =000 00.0A
DUR UP  INC LV VOLTAGE

DUR DN  DEC LV VOLTAGE   LitV=000 00.0V

SSETUP  AIM ON/OFF       AIM =000 00.0mV

STNDBY  BEAM SWITCH      DRV=0   SW=01
        LASER SWITCH     DRV=0   SW=01

READY   MAIN MENU   YAG/106  Select YAG
```

Typical Screen 2A

```
Screen 2B  YAG Laser,Shutters,Detectors

SUR UP  YAG SFTY SHT     DRV=00  SW=01

SUR DN  EXP SHUTTER      DRV=00  SW=01

AIM UP  CAL SHUTTER      DRV=00  SW=01

AIM DN  DET GAIN         Gain=1
                         SURG=000 00.0W
INT UP  INC POWER(YAG)   Gain=1
                         SFTY=000 00.0W
INT DN  DEC POWER(YAG)
                         ALE =000 00.0A
DUR UP  INC LV VOLTAGE   LCUR=060 11.7A

DUR DN  DEC LV VOLTAGE   LitV=041 08.0V

SSETUP  BLINK He-Ne
REPEAT  AIM LEVEL        LO
        BEAM SWITCH      DRV=0   SW=01
        LASER SWITCH     DRV=1   SW=10

READY   MAIN MENU   KTP/532  Select KTP
```

Typical Screen 2B

This screen is used to cycle the shutters and detectors, and to set up the light valve. Power can be adjusted by current (YAG) and attenuation (KTP).

On the three lines for shutters, DRV=00 SW=01 means shutter is not being driven and the shutter switches indicate dropped position; DRV=11 SW=10 means shutter is being driven and shutter switches indicate raised position.

On the lines for Beam Switch and Laser Switch, DRV=0 and SW=01 means the motor is not being driven and the switch indicates the inactive position; DRV=1 SW=10 means motor is being driven and the switch indicates the active position.

There are 3 gain changes available in KTP: x1, x10 and x60. At the gain of x60, the surgical power display (in watts) will be 20 times more than the safety power display. The setup for x60 should be SFTY SHT and EXP SHUTTER energized and CAL SHUTTER de-energized.

There are only 2 gain changes available in YAG: x1 and x10.

7.6 SERVICE SCREEN 3

NOTE: The abbreviation ESF stands for Eye Safety Filter.

```
Screen 3   Attachments and ESF

SUR UP   KTP SFTY SHT     DRV=00* SW=01

SUR DN   YAG SFTY SHT     DRV=00* SW=01

AIM UP   EXP(AIM) SHT     DRV=00  SW=01

AIM DN   CAL(PAIM) SHT    DRV=00  SW=01

DUR UP   BEAM SWITCH      DRV=0  SW=01

DUR DN   LASER SWITCH     DRV=1   SW=10

INT UP   ESF              DRV=00  SW=1111
INT DN   ESF UNARMED    SW SHOULD BE=0 1
READY    MAIN MENU          ESF FLT*=-

ENDO SR1   255   AIM FTSW* 0  WTCH FLT* 0
ENDO SR2   255   SUR FTSW* 0  EXP FLT * 0
ENDO PLUG 0      SUR RAW1* 0  KTP PWR * 0
uBM SR1    255   SUR RAW2* 0  YAG PWR * 0
uBM SR2    500   CAL INIT* 0  OVER DUR* 0
uBM PLUG   0     SFTY FLT* 1  UNDR INT* 0
```

Typical Screen 3

This screen can be used to cycle shutters and ESFs. Also, with the laser off (but system on and in Service Mode), the wavelength select mirror can be toggled along with the beam switch.

On the line beginning with "INT UP ", DRV=00 means the Eye Safety Filter is <u>not</u> being driven and DRV=11 means that it is. (The second digit refers to the "Park" current.) The four digits after SW refer to two pairs of redundant switches, (one pair for reporting the position of the moving optical component, and one pair for reporting that the filter assembly is properly attached to the microscope, where applicable.) Redundant switches are used to provide an additional margin of safety.

After ESF FLT*=, a 0 means no fault, a 1 means one or more faults, and a - means this feature not currently selected.

On the line beginning with "INT DN ", ESF UNARMED means the ESF feature has not been selected and ESF ARMED means the feature is selected. After SW SHOULD BE the 0 and 1 values ought to match with the corresponding values on the line just above.

On the lines near the bottom of the screen, the values after ENDO and uBM represent the signature resistances currently being measured at the otuput couplers.

The remaining entries near the bottom of the screen report various faults: 0 means <u>no</u> faults, and 1 means one or more. There are 2 more additional signals = SUR RAW1 and SUR RAW2. They are redundant signals for the SUR FTSW. That is, all three signals should be the same at all times.

7.7 SERVICE SCREEN 4

There are two versions of this screen, one for KTP and one for YAG. Screen 4A will appear if the status on Screen 0 had been KTP, and Screen 4B will appear if the status had been YAG.

```
Screen 4A   KTP Calibration

SUR UP   KTP SFTY SHT     DRV=00*  SW=01

SUR DN   EXP(AIM) SHT     DRV=11   SW=10

         CAL(PAIM) SHT    DRV=00   SW=01

AIM DN   BEAM SWITCH      DRV=0    SW=01

INT UP   INC POWER(KTP)   SURG=000 00.0W

INT DN   DEC POWER(KTP)   SFTY=000 000mW

REPEAT   GET THRUPUT      CAL =000 000mW

SSETUP   GET OFFSET       THRUPUT=000%

READY    MAIN MENU     YAG/106  Select YAG

ENDO SR1 =255         uBM SR1 =255
ENDO SR2 =255         uBM SR2 =255
ENDO PLUG=0           uBM PLUG=0
```

Typical Screen 4A

```
Screen 4B   YAG Calibration

SUR UP   YAG SFTY SHT     DRV=*00  SW=01

SUR DN   EXP SHUTTER      DRV=11   SW=10

         CAL SHUTTER      DRV=00   SW=01

         BEAM SWITCH      DRV=0    SW=01

INT UP   INC POWER(YAG)   SURG=000 00.0W

INT DN   DEC POWER(YAG)   SFTY=000 000mW

REPEAT   GET THRUPUT      CAL =000 000mW

SSETUP   GET OFFSET       THRUPUT=000%

READY    MAIN MENU     KTP/532  Select KTP

ENDO SR1 =255         uBM SR1 =255
ENDO SR2 =255         uBM SR2 =255
ENDO PLUG=0           uBM PLUG=0
```

Typical Screen 4B

This screen is used solely for calibration. See Section 9 for more details.

7.8 SERVICE SCREEN 5

There are two versions of this screen, one for KTP and one for YAG. The screen shows you data for the Power/Current curve that is obtained from the laser now installed in the system. Also this screen provides you with a way to ramp current up and down via the front panel, versus setting the Lamp Power Supply (A.L.E.) manually for each setting.

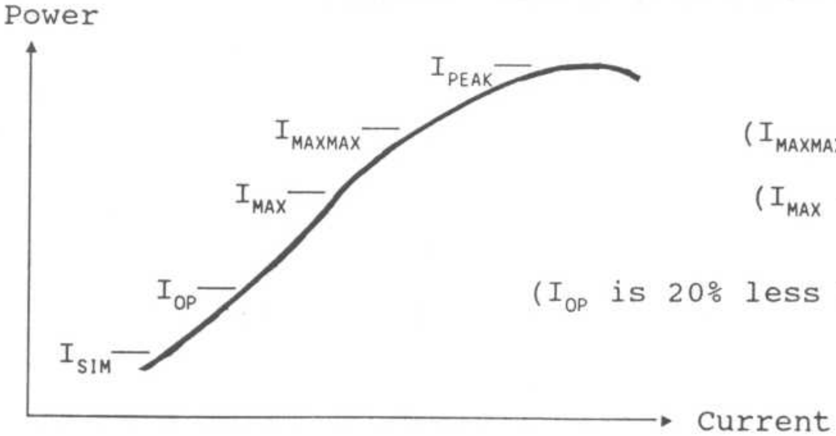
```
Screen 5A  KTP Power/Current Curve
                                POWER-W ALE-A
SUR UP   Set I SIM              23.3    29.6
SUR DN   Set I OP               23.6    28.4
AIM UP   Set I MAX              23.8    28.0
                                23.4    27.4
AIM DN   I SIM                  23.4    27.0
DUR UP   I OP                   22.6    26.4
DUR DN   I MAX                  21.9    26.8
                                21.4    26.0
INT UP   Inc Power(Curr)        21.0    25.6
INT DN   Dec Power(Curr)        20.0    25.2
                                19.9    24.5
SETUP    RF OFF                 19.2    23.9
REPEAT   LO RF
STNDBY   HI RF
READY    Main Menu
YAG/106  Select YAG
         DAC      ALE
I SIM =05.4A   05.0A            ALE =116 22.7A
I OP  =24.5A   22.9A            LCUR=125 24.5A
I MAX =28.4A   26.4A            SURG=000 00.0W
I MMAX=29.2A   27.2A            RF ON/OFF 1
I PEAK=30.3A   28.8A            RF LO/HI* 1
```

Typical Screen 5A

```
Screen 5B  YAG Power/Current Curve
                                POWER-W ALE-A
KTP/532  Select KTP             57.4    35.8
SUR DN   Set I OP               58.3    34.3
AIM UP   Set I MAX              56.4    34.1
                                53.1    33.1






         DAC      ALE
I MIN =15.6A   15.0A            PWR=066 03.3W
I MAX =36.8A   35.0A            PWR=124 58.3W
```

Typical Screen 5B

Using data shown on the screen, by hand you can draw the P/I curve (see below).



(I_{MAXMAX} is 4% less than I_{PEAK})

(I_{MAX} is 2% less than I_{MAXMAX})

(I_{OP} is 20% less than I_{MAXMAX} (KTP Mode))

(I_{SIM} is 5 Amps)

All percentages are referrring to POWER, not current level.

7.9 SERVICE SCREEN for SET CLOCK

From this screen you can change the settings of the computer calendar and clock by pressing buttons on the Control Panel. The numerical values assigned to the buttons are shown on the screen according to their relative positions on the panel, (see below).

```
SET CLOCK

            06/15/90   11:27:59

Confirm each answer with an ENTER

   Year:00


** Press EXIT to quit **


Keys assignment:


 0    2       4   6
                     8
 1    3       5   7

    9    <ENTER>    <EXIT>
```

SUR UP	**0**
SUR DN	**1**
AIM UP	**2**
AIM DN	**3**
DUR UP	**4**
DUR DN	**5**
INT UP	**6**
INT DN	**7**
REPEAT	**8**
STNDBY	**9**
READY	**<ENTER>**
SSETUP	**<EXIT>**

Typical Screen for Set Clock

Upon entering this screen, only the choice for "Year" is shown. After typing in two numbers for the year and pressing <ENTER>, the choice for "Month" will appear. A new choice will appear each time you press <ENTER>, in the following sequence:
Year, Month, Date, Hour(24hr), Minute, Second.

7.10 SERVICE SCREEN 7

By pressing any of the buttons listed on this screen you can bring up a corresponding subordinate new screen. These new screens are described one at time on the pages following this one.

Exiting from one of the subordinate screens brings you back to this screen, and exiting from this screen takes you back to Service Screen 0.

Screen 7	Special Tests
SUR UP	Power Log - KTP or YAG
SUR DN	Error Log - System or Device
AIM UP	Stability Test
AIM DN	Manual Tests
DUR UP	Enable/Disable Consummable Endo
DUR DN	Automatic Tests
INT UP	Current Modulation
INT DN	Resonator Bring Up Test
READY	Main Menu

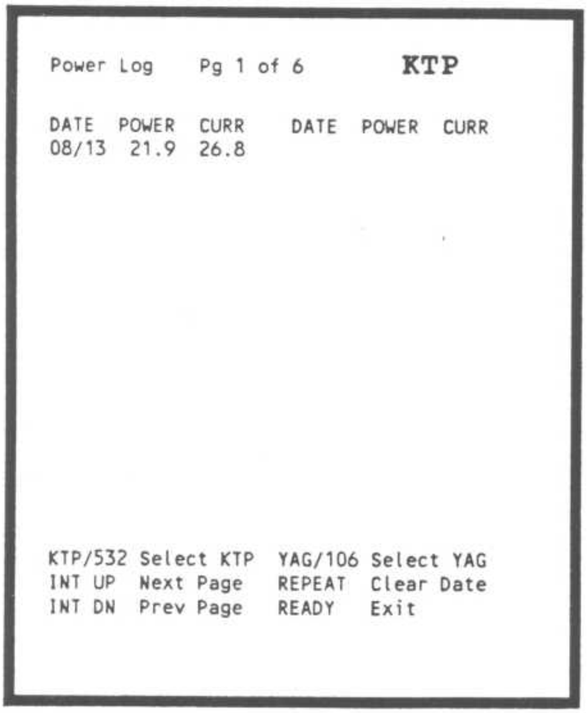
Screen 7

7.11 POWER LOG (Subordinate Screen from Service Screen 7)

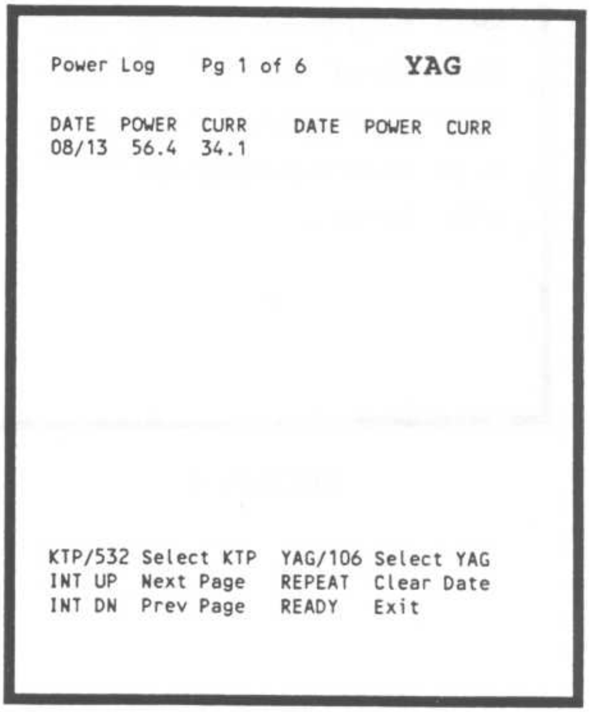
To reach this screen, press the SUR UP button from Screen 7. There are two versions of this screen, one for KTP and one for YAG. The screen for KTP will appear if the status on Screen 0 had been KTP, and the screen for YAG will appear if the status on Screen 0 had been YAG. To change from KTP to YAG, press the YAG/106 button. To change from YAG to KTP, press the KTP/532 button.

The Power Log data can occupy up to six screens; each screen is called a "page." Page 1 is the first page shown. To scroll through the pages, press the INT UP button to advance to the next page, and press the INT DN button to move back to the previous page. A Power Log entry is made every time the system is turned on.

To return to Service Screen 7, press the READY button.



Typical Screen for KTP



Typical Screen for YAG

7.12 ERROR LOG (Subordinate Screen from Service Screen 7)

To reach this screen, press the SUR DN button from Screen 7. There are three versions of this screen: External System Errors, Internal System Errors, and Delivery Device Errors. (External System Errors are errors that are reported on the screen during Application Mode; Internal System Errors are errors that are saved in the error log but <u>not</u> reported on the screen.)

The screen for External System Errors appears first. To change to the screen for Internal System Errors, press the SUR DN button; to change to the screen for Device Errors, press the AIM UP button; to change back to the screen for External System Errors, press the SUR UP button.

Each error log can occupy up to six screens; each screen is called a "page." Page 1 is the first page shown. To scroll through the pages, press the INT UP button to advance to the next page, and press the INT DN button to move back to the previous page.

To return to Service Screen 7, press the READY button.

```
External System Error Log    Pg 1 of 6

DATE  CODE                DATE  CODE
07/21 S033 __ ___KL
07/21 S051 40 101KR




SUR UP  Ext Sys Err SUR DN  Int Sys Err
AIM UP  Device Err
INT UP  Next Page   REPEAT  Clear Data
INT DN  Prev Page   READY   Exit
```

Typical Error Log Screen

On screens for the External System Error Log, the first line starts with "External System Error Log."

"On screens for the Internal System Error Log, the first line starts with "Internal System Error Log."

On screens for the Delivery Device Error Log, the first line starts with "Delivery Device Error Log."

7.13.1 STABILITY TEST (Subord. Screen from Service Screen 7)

To reach this screen, press the AIM UP button from Screen 7. There are two versions of this screen, one for KTP and one for YAG. The screen for KTP will appear if the status on Screen 0 had been KTP, and the screen for YAG will appear if the status on Screen 0 had been YAG.

Press the SYS SETUP button to start the test, press the STANDBY button to end the test, and press the READY button to return back to Service Screen 7.

```
Stability Test                KTP
                              LPS RDY*  0
                              LPS01 RLY 0
                              LPS02 RLY 0
                              LPS EN*   0

                              ALE =000 00.0A
                              LCUR=060 11.7A

                              RF ON/OFF 0
                              RF LO/HI* 0

                              SURG=000 00.0W
SETUP      Start test         SFTY=000 00.0W
STANDBY    End test
READY      Exit               I SIM=07.0A DAC
                              I OP =25.0A DAC
                              I MAX=30.0A DAC

           TMP ILK  0 TMP END=037 069F
INT FLW 1  WTR ILK  0 TMP MB =027 069F
WTR LVL 0  OPN ILK  0 TMP WTR=020 061F
RMT ILK 0  KEY OFF  0 TMP PCB=117 074F
```

Typical Screen for KTP

```
Stability Test                YAG
                              LPS RDY*  0
                              LPS01 RLY 0
                              LPS02 RLY 0
                              LPS EN*   0

                              ALE =000 00.0A
                              LCUR=060 11.7A

                              RF ON/OFF 0
                              RF LO/HI* 0

                              SURG=000 00.0W
SETUP      Start test         SFTY=000 00.0W
STANDBY    End test
READY      Exit               I SIM=  . A DAC
                              I OP =  . A DAC
                              I MAX=  . A DAC

           TMP ILK  0 TMP END=037 069F
INT FLW 1  WTR ILK  0 TMP MB =027 069F
WTR LVL 0  OPN ILK  0 TMP WTR=020 061F
RMT ILK 0  KEY OFF  0 TMP PCB=117 074F
```

Typical Screen for YAG

7.13.2 RESONATOR BRING UP TEST(Subord. Screen from Serv.Screen 7)

Save as above, except use **INT DOWN** to select the test. At the end of the resonator bring up test, the automatic system test will be enabled and cycled through until the SYS SETUP key is pressed during the APPS RUN.

7.14 MANUAL TESTS (Subordinate Screen from Service Screen 7)

To reach this screen, press the AIM DN button from Screen 7. From this subordinate screen you can select any one of several manual tests, then turn that test on and off as desired. Two versions of the screen are available. The initial screen is for KTP; to change to the YAG screen press the YAG/106 button.

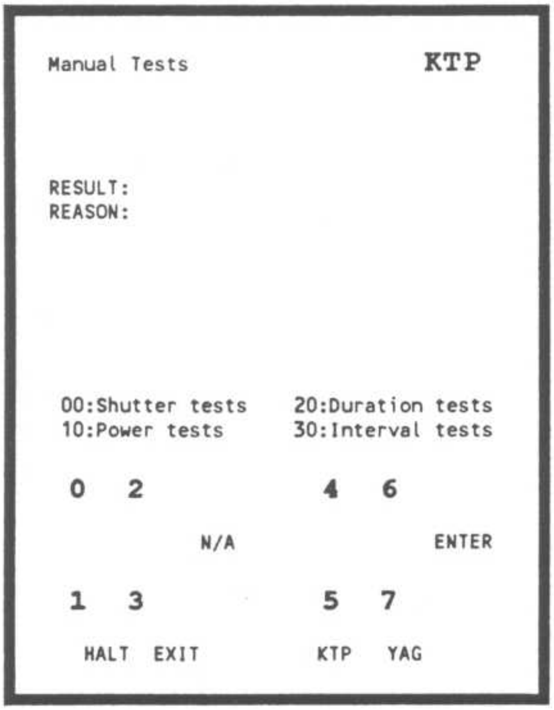
Tests are divided into four categories: Shutter, Power, Duration and Interval, (see numbers on the screen).

To select a test, type in a 2-digit test number by pressing the appropriate buttons on the Control Panel. Numerical values are assigned to the buttons according to their relative positions on the panel, (see illustrations below). As you type in the test number it will appear on the second line of the screen. (Note that only octal numbers, 0 through 7, can be entered.) If you make a mistake, just type in another number and it will overwrite the old number. After you have selected the number you want, press the REPEAT button (which acts as an <ENTER> button).

To see a list of tests in a given category, type the first digit for that category, then type in a zero and press <ENTER>. For example, to see a list of Shutter Tests, type 00 and press <ENTER>, (see second illustration below).

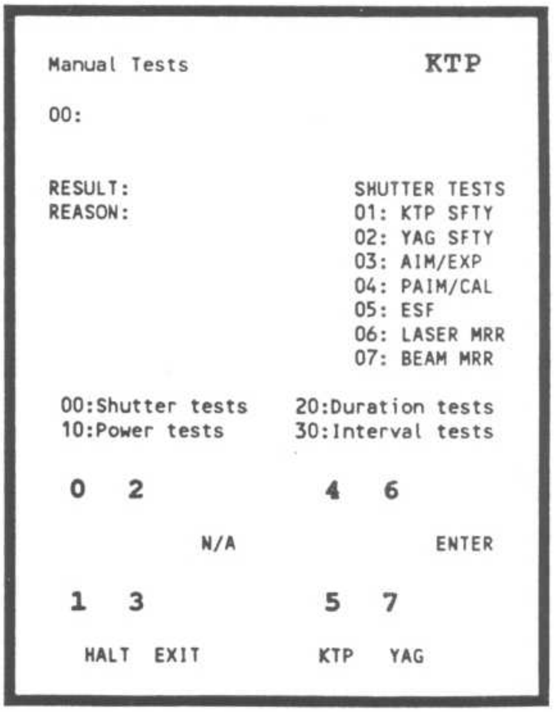
To halt the selected test, press the ON/STANDBY button.

To return to Service Screen 7, press the READY button.



Manual Tests Screen for KTP

Test #



List of Shutter Tests

The test result is shown on the screen as either "passed" or "failed," and the reason for failure is listed either as "laser is ON" or "-not received."

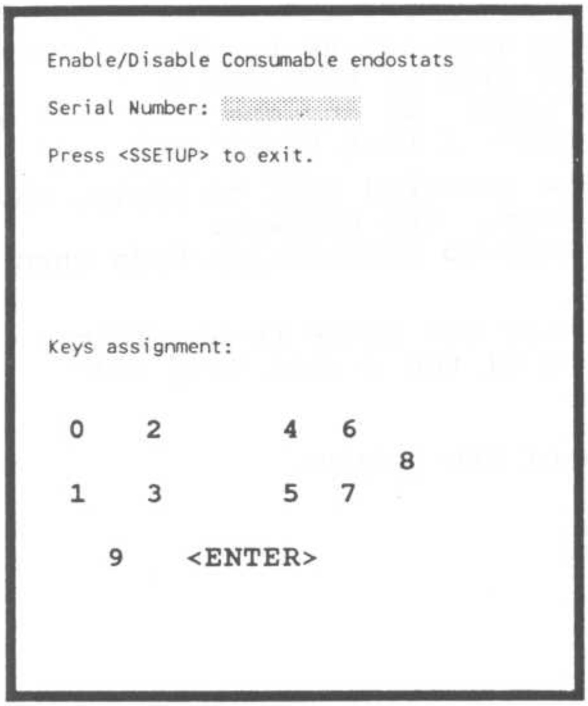
7.14.1 List of Manual Tests

SHUTTER TESTS (Test 01 through Test 07)

01: KTP SFTY	Toggle KTP safety shutter, (solenoid #49), at 10 Hz for 30 min.
02: YAG SFTY	Toggle YAG safety shutter, (solenoid #48), at 10 Hz for 30 min.
03: AIM/EXP	Toggle AIM/EXP shutter, (solenoid #51), at 10 Hz for 30 min.
04: PAIM/CAL	Toggle PAIM/CAL shutter, (solenoid #50), at 10 Hz for 30 min.
05: ESF	Toggle Eye Safety Filter at 5 Hz for 30 min.
06: LASER MRR	Toggle LASER mirror, (solenoid #35), at 2 Hz for 30 min.
07: BEAM MRR	Toggle BEAM mirror, (solenoid #37), at 1 Hz for 30 min.

7.15 CONSUM. ENDOSTATS (Subordinate Screen from Serv. Screen 7)

To reach this screen, press the DUR UP button from Screen 7. Although the software for Application Mode only allows disposable Endostat delivery devices, from this screen it is possible to alter the software to allow consumable Endostats also. To do this, you will first need to obtain a special serial number from the factory. The numerical values assigned to the buttons are shown on the screen according to their relative positions on the panel, (see below).



Screen for Consum. Endostats

SUR UP	0
SUR DN	1
AIM UP	2
AIM DN	3
DUR UP	4
DUR DN	5
INT UP	6
INT DN	7
REPEAT	8
STNDBY	9
READY	<ENTER>

Press the SSETUP button to exit back to Service Screen 7.

7.16 AUTOMATIC TESTS (Subordinate Screen from Service Screen 7)

To reach this screen, press the DUR DN button from Screen 7. From this subordinate screen you can select any one of three types of automatic tests. After the test starts, you are allowed to abort it if desired.

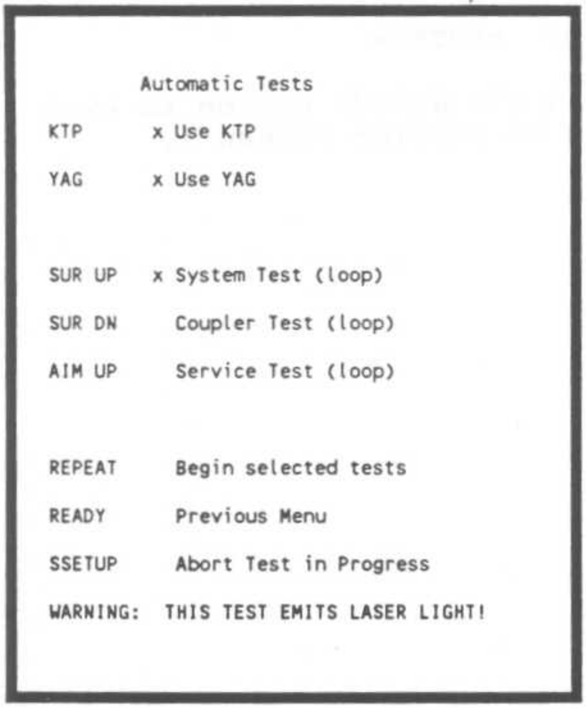
Pressing the KTP/532 button causes the "X" after KTP to toggle on and off. Likewise pressing the YAG/106 button causes the "X" after YAG to toggle on and off. The presence of an "X" means that this wavelength will be tested. The test can be performed on a single wavelength, or on both wavelengths.

The SUR UP, SUR DN and AIM UP buttons also act as toggles to turn the "X" on and off. However only one type of test can be selected at any one time. In other words, at any one time only a single "X" can appear for the selection of test type.

Pressing the REPEAT button causes the selected test to begin, and pressing SSETUP causes it to be aborted. The software automatically changes from Service Mode to Application Mode when running these tests.

The System Test normally takes at least two hours to complete; the Service Test is a shorter version of the System Test and takes only about 20 minutes.

Note the warning line at the bottom of the screen.



Screen for Automatic Tests

7.17 CURRENT MODULATION CONTROL (Subord. Screen from Screen 7)

To reach this screen, press the INT UP button from Screen 7. From this subordinate screen you can turn the current modulation on and off, as well as alter the system operation in several other ways.

*Modulation ON (83 h2) Q Switch OFF
*In Modulation ON Q-Switch control LOCKED OUT and display of RF goes away.
*Modulation ON will only work with current Modulation Control and Shutter, detectors

```
Screen 9   Current Modulation Control

SUR UP   Relay OPN/CLS     LPS RDY*  0
SUR DN   Lsps EN/DIS       LPS01 RLY 0
                           LPS02 RLY 0
AIM UP   Modulation OFF    LPS EN*   0
AIM DN   Modulation ON
                           ALE =000 00.0A
DUR UP   I OP              LCUR=060 11.7A
DUR DN   I MAX
                           RF ON/OFF 0
INT UP   Inc Power(Attn)   RF LO/HI* 0
INT DN   Dec Power(Attn)
                           SURG=000 00.0W
SETUP    RF OFF            SFTY=000 00.0W
REPEAT   LO RF
STNDBY   HI RF             I SIM=07.0A DAC
                           I OP =25.0A DAC
READY    Main Menu         I MAX=30.0A DAC

           TMP ILK  0 TMP END=037 069F
INT FLW 1  WTR ILK  0 TMP MB =027 069F
WTR LVL 0  OPN ILK  0 TMP WTR=020 061F
RMT ILK 0  KEY OFF  0 TMP PCB=117 074F
```

Typical Screen 9

7.18 SERVICE SCREEN 8

There are two versions of this screen, one for KTP and one for YAG. Screen 8A will appear if the status on Screen 0 had been KTP, and Screen 8B will appear if the status had been YAG.

From this screen you can enable or disable the automatic monitoring of fiber temperature at the output couplers by pressing the SSETUP button. The selection you make will remain in effect after you change from Service Mode to Application Mode.

As was the case with Service Screens 2A and 2B, from these two screens you can also drop and raise the shutters, increase or decrease the laser power, and change the positions of the Beam Switch and Laser Switch.

```
Screen 8A  KTP Fiber Temperature Control

SUR UP   KTP SFTY SHT      DRV=00* SW=01

SUR DN   EXP(AIM) SHT      DRV=00  SW=01

AIM UP   CAL(PAIM)SHT      DRV=00  SW=01

AIM DN   DET GAIN          Gain=10
                           SURG=000 00.0W
INT UP   INC POWER(KTP)    Gain=10
                           SFTY=000 00.0W
INT DN   DEC POWER(KTP)
                           ALE =000 00.0A
SSETUP   CPLR ENABLED
              COUNTS    in C      in F
ENDO TEMP:     041      02.0      071.

MB TEMP:       030      02.0      069.

STNDBY   BEAM SWITCH       DRV=0   SW=01
         LASER SWITCH      DRV=0   SW=01

READY    MAIN MENU    YAG/106   Select YAG
```

Typical Screen 8A

```
Screen 8B  YAG Fiber Temperature Control

SUR UP   KTP SFTY SHT      DRV=00* SW=01

SUR DN   EXP(AIM) SHT      DRV=00  SW=01

AIM UP   CAL(PAIM)SHT      DRV=00  SW=01

AIM DN   DET GAIN          Gain=1
                           SURG=000 00.0W
INT UP   INC POWER(YAG)    Gain=1
                           SFTY=000 00.0W
INT DN   DEC POWER(YAG)
                           ALE =000 00.0A
SSETUP   CPLR ENABLED          224 43 9
              COUNTS    in C      in F
ENDO TEMP:     041      02.0      071.

MB TEMP:       030      02.0      069.

STNDBY   BEAM SWITCH       DRV=0   SW=01
         LASER SWITCH      DRV=1   SW=10

READY    MAIN MENU    KTP/532   Select KTP
```

Typical Screen 8B

NOTE: Be sure to ENABLE the fiber temperature feature before leaving the Service Mode. This feature should be ENABLED during normal operation.

Section 8

E L E C T R O N I C S

8.1 PHYSICAL LAYOUT

Section 3 of this manual described the "swap-out" maintenance philosophy adopted for the Model 800 Series and the Service Mode to aid troubleshooting to a "suspect" module or major component.

The major AC components are a Circuit Breaker, Isolation Transformer, three Power Contactors, three Fans and a Pump Motor.

The electronics modules consist of the Electronics Card, Low Voltage Power Supply, Lamp Power Supply (also known as A.L.E. Power Supply), and RF Driver. To access these modules, open the front access door on the laser console and open the top cover. Remove the side panel.

8.2 AC POWER CIRCUIT

Drawing number 0107-2310 shows the AC wiring diagram and identifies the major components. These components are activated in the following sequence after the AC power cord is plugged in and an operator turns on the system.

8.2.1 Circuit Breaker, Isol. Transformer, Low Volt. Power Sply.

After an operator plugs the AC Power Cord into the wall outlet and moves the lever on the Circuit Breaker to the ON (fully up) position, AC power is coupled through the Isolation Transformer and applied to the Low Voltage Power Supply.

8.2.2 Keyswitch

This switch is mounted on the console and has two sets of contacts which perform two different functions. From the Low Voltage Power Supply a +24 VDC output for energizing Contactor K1 is routed in series through a safety interlock chain that includes a set of contacts on the keyswitch. This means that the +24 VDC can not be made available to energize Contactor K1 until after the operator turns the Keyswitch ON.

8.2.3 Contactor K1

After this contactor has been energized, AC power from the isolation transformer passes through the contacts and is applied to the Helium Neon Laser Power Supply and to three cooling fans.

- Fan #1 and Fan #2: Two large fans mounted in front of the heat exchanger in the water cooling system.
- Fan #3: A small fan mounted inside the cabinet in a position that pulls air in beneath the control board, then blows the air against the baffles and over the low voltage power supply.

Contactor K2 and Contactor K3

The contacts of K2 provide the path for AC power to the Lamp Power Supply (A.L.E. Power Supply), and also to an Elapsed Time

Digital Time Indicator (which is mounted next to the Circuit Breaker at the rear of the cabinet). The contacts of K3 provide the path for AC power to the pump motor in the cooling system.

Energizing of K2 and K3

After the Keyswitch has been turned on and the operator has pressed the STANDBY button, the computer initiates the powering up sequence. During this time the computer activates an LPS01 signal that energizes a small DPST relay on the Electronics Card. After that relay has been engergized, the computer can then activate an LPS02 signal that energizes another small DPST relay. The contacts of this second relay provide a path to +24 VDC for energizing Contactor K2. Before logically enabling the A.L.E. power supply, the computer removes the LPS01 signal and the first relay de-energizes. Contactor K3 is a separate relay that is controlled by almost the same logic signal from the computer as for K2, so that K3 picks at the same time that K2 picks. The main difference in function between K2 and K3 is that if some part of the safety interlock chain opens up, the computer will de-energize K2 (to remove power from the A.L.E.), but will leave K3 energized (so that the pump will continue to circulate the water in the cooling system). The two large fans are controlled by K1 and will keep running also.

Safety Interlock Chain

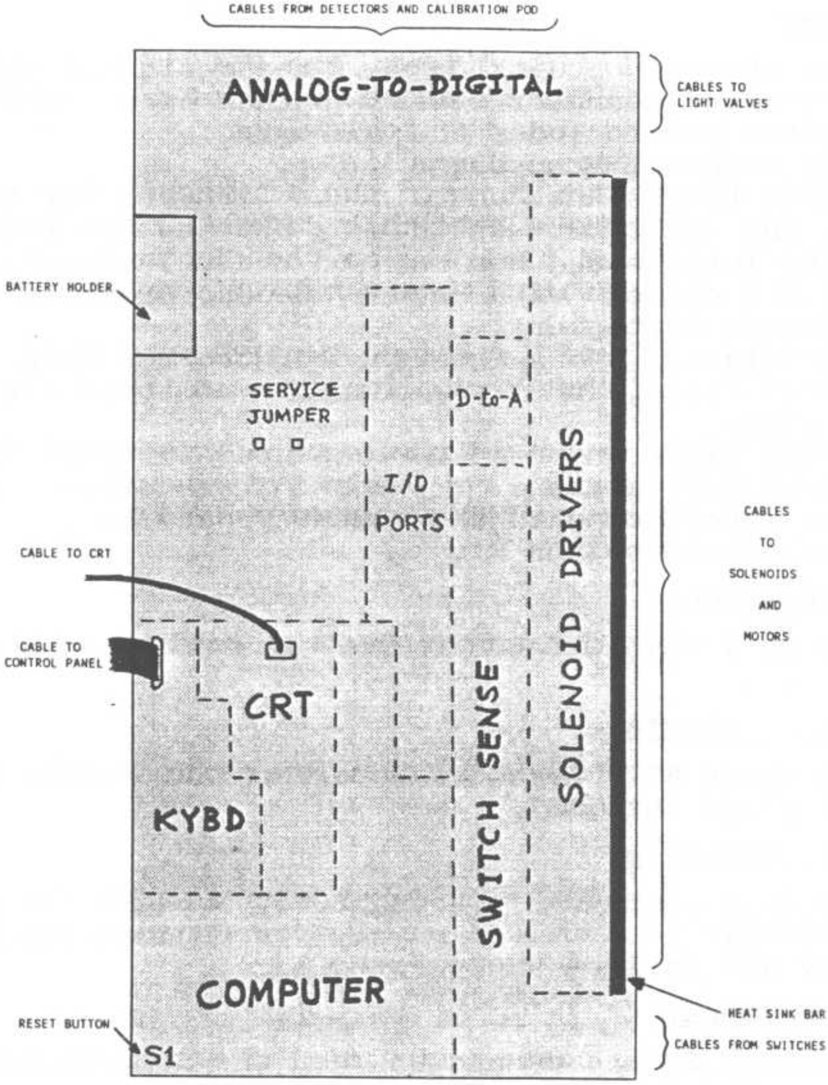
To provide an additional margin of safety a serial interlock chain is formed through the contacts of four switches:

- Keyswitch - A second set of contacts that open if the operator turns the switch off.
- Two Water Level Switches - Mounted inside the reservoir in the cooling system; contacts open if water level gets too low. 1st level will indicate a type 3 fault. 2nd level will issue type 1 fault shutting system down.
- Over-temperature Switch - Mounted on water manifold of cooling system; contacts open if temperature exceeds 140°F.
- Spare Interlock Switch - Presently not used, so contacts closed all the time.

Any interruption in this interlock chain will cause the small DPST holding relay to de-energize, with the result that the +24 volts to K2 will be removed, K2 will de-energize and power will be removed from the A.L.E. Power Supply. Even if the interruption is only momentary and the interlock chain is restored, the DPST holding relay still cannot energize again until the computer performs the LPS01 and LPS02 signal sequence all over again.

8.3 ELECTRONICS CARD

The assembly diagram and schematic diagram are included at the end of this section. Figure 8-1 shows the general arrangement of circuitry. The computer portion is at the bottom left corner, the analog interface is along the top, the solenoid drivers and switch sensing are along the right side.



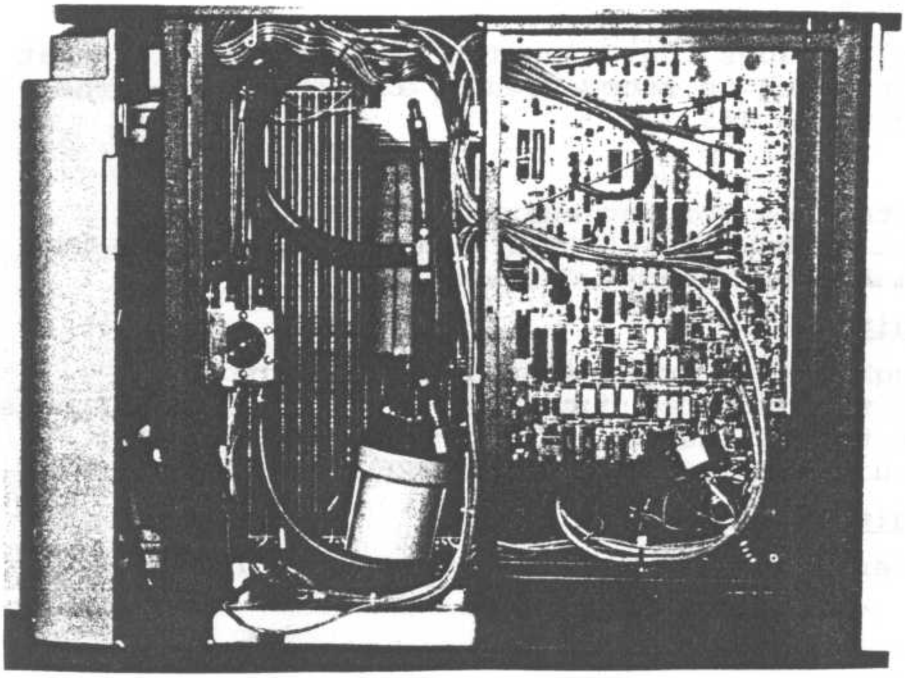


Figure 8-1.

Electronics Card

8.3.1 Computer

Except for the absence of disk drives, the design of the microprocessor-based computer resembles that of a desktop personal computer and includes the following:

- 80186 CPU (Central Processing Unit).
- Five 27C256 EPROMs that contain the firmware for the CPU program, and one 27C256 EPROM that defines the fonts for displaying letters and numerals on the CRT screen.
- Two 6264 RAM chips, (with battery backup provided by two on-board size AA batteries).
- Clock oscillator, 8259A Interrupt Controller chip, and a "watch dog" circuit that periodically monitors for correct program flow.
- 8254 System Timer and 8254 Duration and Interval Timer.
- Data Select Multiplexers, Tri-State Transceivers and other chips for interfacing to the computer data bus.
- RESET pushbutton switch S1.

8.3.2 CRT Interface

The main chip is a 6545 CRT Controller; the cable from the CRT plugs into J15.

8.3.3 Keyboard Interface

The main chip is an 8279 Keyboard Interface; the cable from the control panel plugs into JK1.

8.3.4 Serial Interface

The main chip is a 16459 UART which provides an RS-232 port at J19. (This circuit is provided mainly for engineering purposes at the factory and is left unconnected.)

8.3.5 Service Jumper

Contacts of Switch S3 are connected when the Service Jumper is installed to enable Service Mode.

8.3.6 Speaker Circuit

An LM555 Timer chip provides the drive for an audio speaker that sounds when a button press is recognized by the computer. The speaker cable connects to JA3.

8.3.7 I/O Ports

The Input/Output interface for the address and data bus are provided at I/O Port 1 through I/O Port 4, which are implemented with 8255A Programmable Peripheral Interface chips.

8.3.8 A-to-D Circuits

After passing through signal conditioning circuits on the resonator assembly, the detector outputs and other analog signals that come in at the top of the card are converted to digital information by circuits implemented with AD7226 and AD7502 chips.

8.3.9 D-to-A Circuits

These circuits convert the data bus digital outputs to the appropriate analog signals for driving the Lamp Power Supply (A.L.E. Power Supply) and RF Driver.

8.3.10 Solenoid Drivers

These drivers amplify the digital outputs from the data bus to the current levels needed for energizing the shutter solenoids on the resonator assembly. Note that a heat sink is mounted along this side of the board.

8.3.11 Battery Holder

Two size AA batteries are inserted in this holder to provide backup power for the RAM chips after AC power is turned off.

8.3.12 Switch Sensing Circuits

These circuits monitor the status (open or closed) of various switches. Some of the switches monitered include: ON/OFF keyswitch, water flow switch, two water level switches in the cooling system and remote interlock cable to operating room door. The switch data status is sent to the data bus and is used to indicate the operational state or potential errors that may be present.

8.3.13 Temperature Sensor Circuits

There are four temperature sense circuits on the electronics card. They monitor the Endostat Coupler, Microbeam Coupler, Water and PCB temperatures. The PCB temperature sensor (thermal transducer located at TU1) acts as an on board thermometer for the electronics card. All four temperature circuits are adjustable and are calibrated in the factory. During calibration, the PCB temperature is used as a reference temperature for checking and matching the calibration settings for the Endo and Microbeam sensors. These three temperature readings should agree within about +/- 4 F. The water temperature sensor is set up for 75 degrees F which is based on a standard ambient room temperature. The water temperature rises during machine use. If the water temperature exceeds safe temperature levels, the system will issue warning messages and will shut down when temperatures reach 140 degrees F.

Because these circuits are already adjusted at the factory, additional adjustments will seldom be required. The temperature sense circuits should only be checked when a system is being installed, a electronics card has been replaced or the system is displaying temperature error codes.

To check temperature sense circuits, perform the following steps:

1. Turn on the system, go to Service Mode and select Service Screen 1A or 1B (Laser ON/OFF & Interlocks).

2. At the bottom right corner of the screen note the temperature readings after **TMP END=, TMP MB=** and compare them to the **TMP PCB=** reading. If readings are more than ±4 degrees F off, minor adjustments need to be done to the variable resistors that correspond to the temperature sense circuits that are displaying the incorrect reading. Below is a description of each of the variable pots. Their board locations are shown in Figure 8-2 on the next page.

VR04 for Endostat Coupler temperature sensor
VR05 for Microbeam Coupler temperature sensor
VR11 for PCB Board temperature sensor
VR08 for water temperature sensor

3. Since this PCB temperature acts as a reference reading, first check to make sure this reading is accurate. To check the PCB temperature perform the following steps:

a. Check actual temperature of the thermal transducer. If the system has been off for a while, the temperature reading should be approximately set to 75 degrees F. When the system has been on for a while, the PCB temperature reading will go up. To check the temperature take a thermometer and place it directly on the transducer (TU1-small metallic unit). Measure and compare temperature reading with the displayed **TMP PCB=**.

b. If these two readings differ more than +/- 4 degrees F, adjust the VR11 Pot until the displayed PCB screen reading matches the temperature displayed on the thermometer.

4. After you have checked the PCB temperature, check to make sure that the Endostat and Microbeam Coupler match the PCB reading. If readings differ more than +/- 4 F, adjust Pots VR04 and VR05 until readings are within range to the PCB temperature.

5. Next check the water temperature reading. If the system has been operating for a while, this reading will be higher than 75 degrees F. To make sure that the displayed screen reading reflects the actual water temperature, perform the following steps.

a. Using a thermometer, first check the water temperature by placing the thermometer in the reservoir water tank.

b. Compare this temperature reading with the **TMP WTR=** reading displayed on the screen. If these readings differ more than +/-4 degrees F, adjust Pot VR08 until you can match readings as close as possible.

If you are unable to get temperature readings close to matching displayed readings, the electronics board may be faulty.

8.3.14 Replacement of Electronics Card

If it becomes necessary to replace the card, perform the following procedure.

1. Move panel to gain access to the card.

2. Disconnect all the cables that plug into the card.

3. Loosen and remove the fasteners that hold the card to the frame, then remove the card.

4. Place the new card in position and attach the fasteners that hold the card to the frame.

5. Re-connnect the cables that were removed earlier.

(TOP)

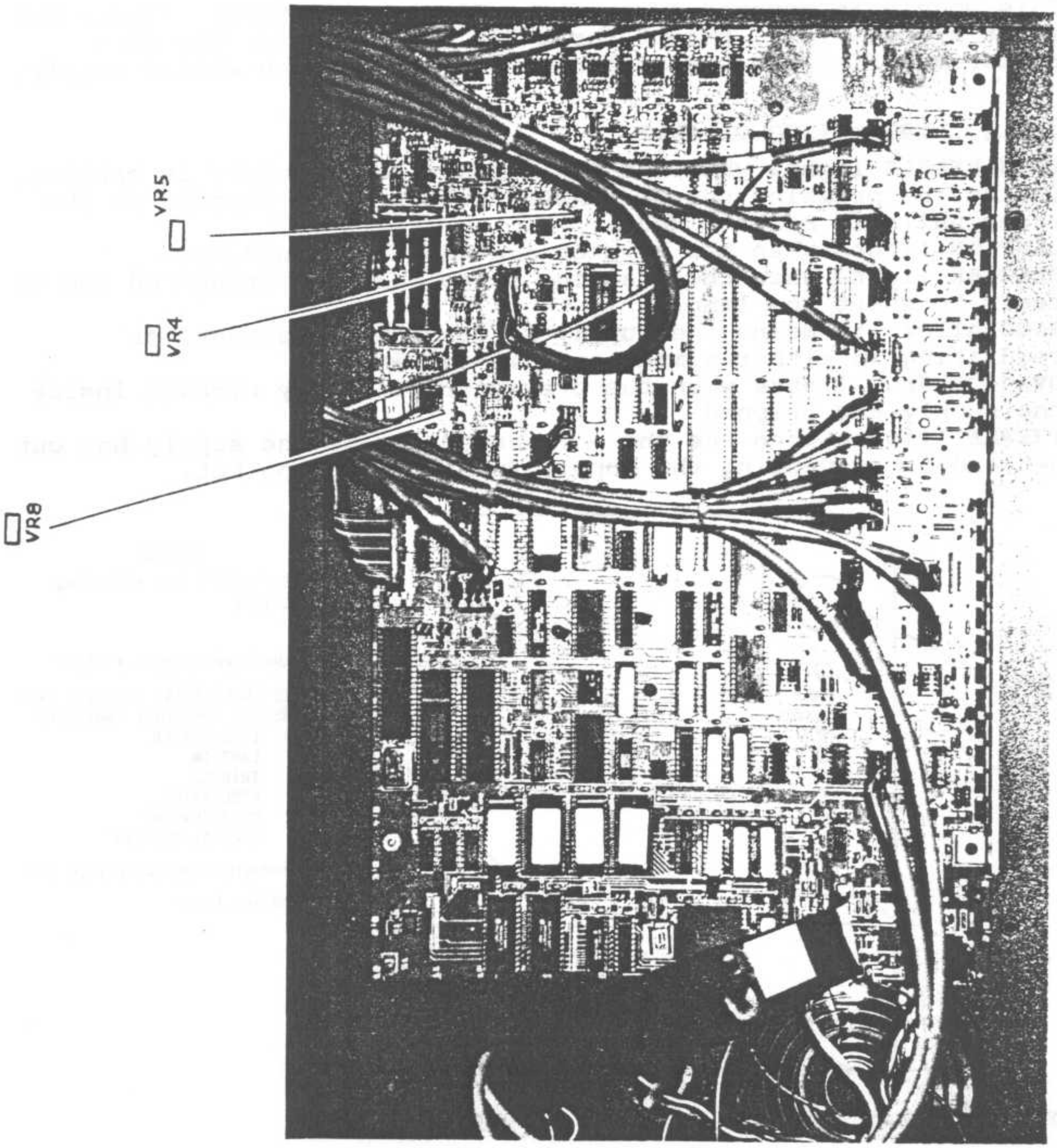


Figure 8-2. Temperature Adjustment Points on Electronics Card

8.4 LAMP POWER SUPPLY (A.L.E. POWER SUPPLY)

This module is mounted next to the Electronics Card. Figure 8-3 shows a rear view. Except for a few basic checks, the only recourse during troubleshooting is to replace the entire supply.

8.4.1 Description of LEDs

LVPS ENABLE lights when the Low Voltage Power Supply is enabled, (either by pressing the ON/STANDBY button or by turning on the laser while in Service Mode).
LAMP ON lights when the krypton arc lamp is turned on.
TRIGGER lights when the starting pulse has been triggered and is ready to start the lamp.
REGULATION lit means the supply is conducting current, or regulating in either simmer or full current.
OVER-CURRENT lights when the over-current safety circuit inside the supply has tripped.
THERMAL lights when the thermal sensor inside the supply has cut out and is preventing the supply from running too hot.

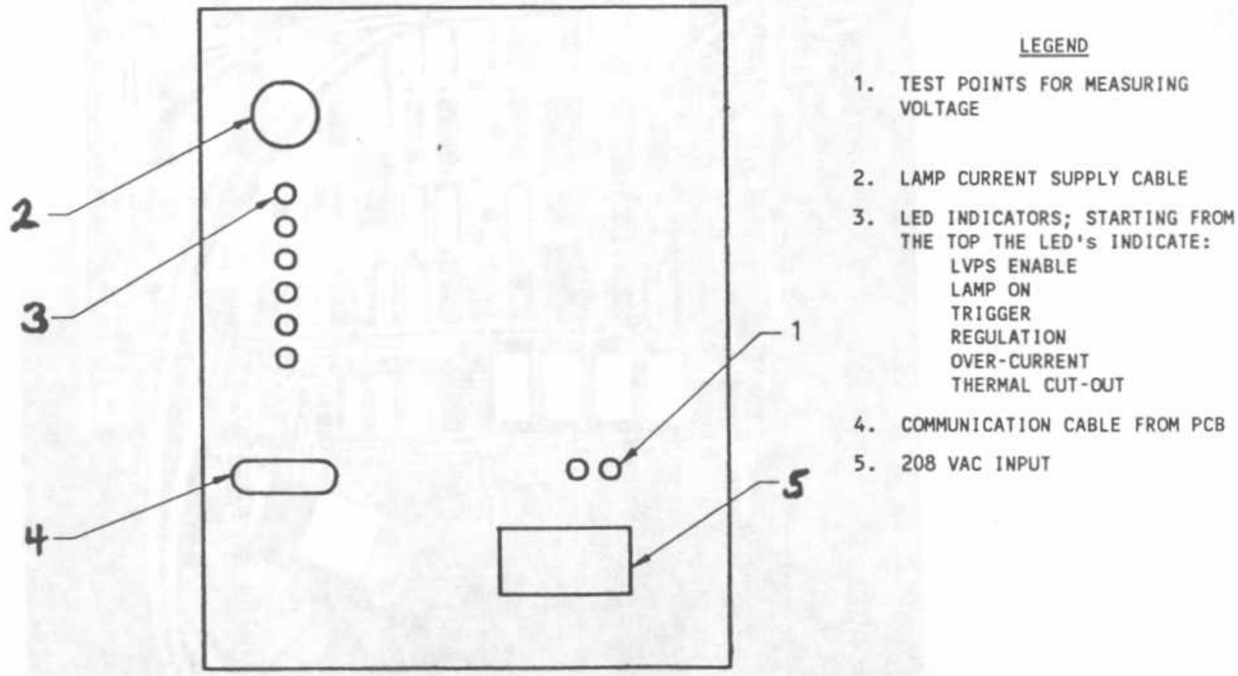


Figure 8-3. Rear of Lamp Power Supply

8.5 LOW VOLTAGE POWER SUPPLY

This module provides the following DC voltages: +5 v, +15 v, +24 v and -15 v. Adjustment pots for each of these voltages are available on the rear of the cabinet, (see Figure 8-4). The adjustment procedure is given below. Note that the voltages must be measured at the Electronics Card with a Fluke (or equivalent) voltmeter, and <u>not</u> at the terminals on the power supply cabinet. The voltages should be set exactly at their specified values.

1. System should be on. Open access door for the Electronics Card.
2. Find the connector housing J2 on the Electronics Card; J2 is located at the very bottom, near the left corner.
3. Locate TP18. This is a small wire loop located just above J2. Place the ground probe from the voltmeter on TP18.
4. Place the positive probe on pin #2 of J2. This is the +5 volt line and it should read exactly 5.00 Volts. If not, adjust the 5v pot on the power supply cabinet, (see drawing in Figure 8-4 for location of this pot).
5. Move the positive probe to pin #6. The reading should be +15 volts. If not, adjust the +15v pot on the power supply cabinet.
6. Move the positive probe to pin #7. Look for -15v. If not, adjust the -15 pot on the power supply cabinet.
7. Move the positive probe to pin #9. Look for 24v. If not, adjust the +24v pot on the power supply cabinet.

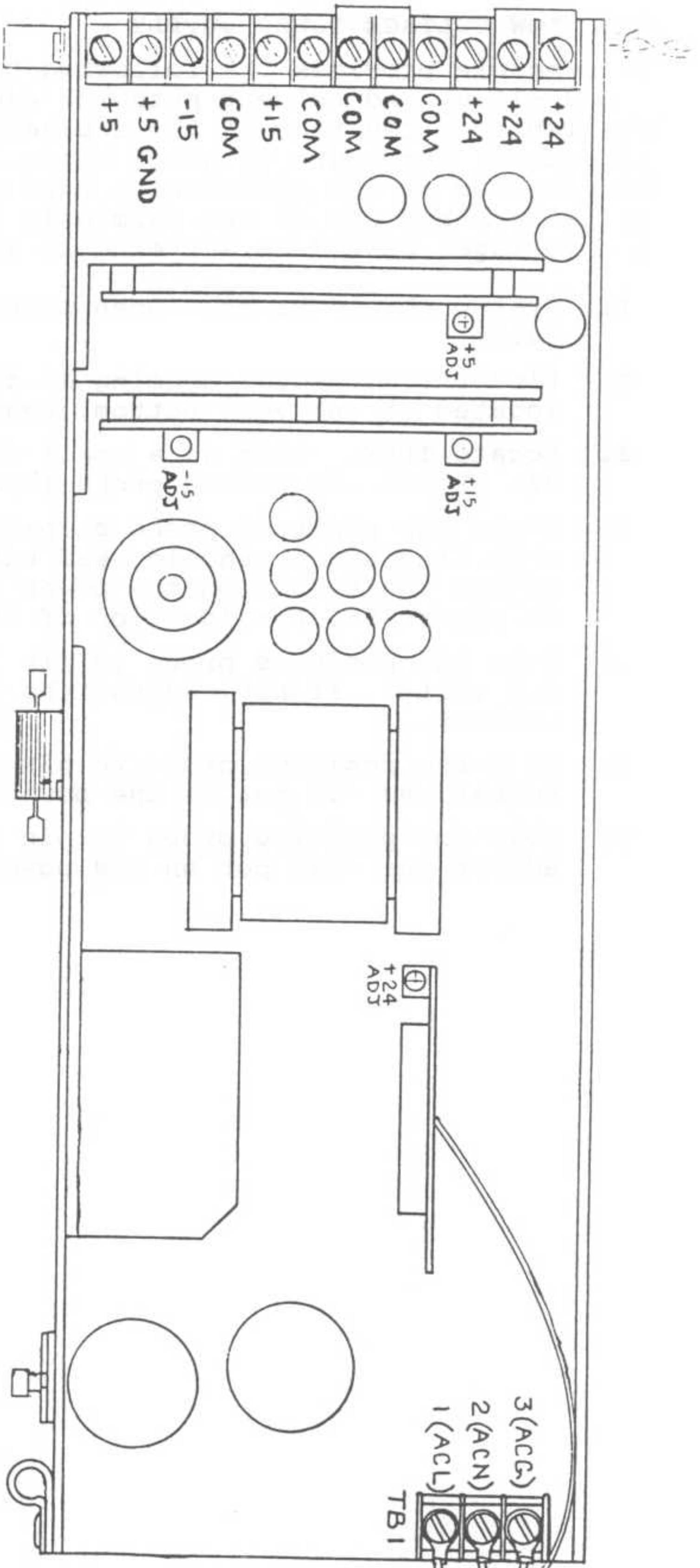


Figure 8-4. Cabinet on Low Voltage Power Supply

8.6 RF DRIVER

When operating in KTP, the RF Driver is used to turn the Q Switch on and off. (The Q Switch is a an optical component on the Resonator Assembly; its function is described in Section 6 of this manual.) The RF Driver is not used when operating in YAG.

Over the data bus the computer sends digital signals that are converted by the D-to-A to the appropriate analog inputs for the RF Driver. Three output levels are available from the RF Driver: Off, Low RF and High RF.

8.6.1 Physical Replacement of RF Driver

Perform the following procedure:

1. Turn system off. Disconnect cables from old RF Driver assembly, then remove mounting screws and lift assembly out of the console.
2. Install new RF Driver assembly and tighten mounting screws.
3. Install cable (0105-3440) that connects between Electronics Card and RF Driver. Reconnect 24v line from Low Voltage Power Supply to RF Driver.

8.6.2 Adjustment of RF Driver Output

Perform the following procedure. You will need an IR power meter and the Service Mode jumper.

1. Install the Service Mode jumper, (if not already installed).
2. Turn on the system, (if not already on), and bring up Service Mode (in KTP).
3. Hinge up the console cover to gain access to the resonator plate, then remove beam block behind LAM mount and place a power meter in this location.
4. Go to KTP full current and Low-RF, then note the IR output at the LAM mount. It should be around 300 to 500 milliwatts, (with HR LAM).
5. Go to High-RF, then note the IR output at the LAM mount. It should be equal to the Low-RF level. If it is not, adjust the "RF LOW" pot on the panel of the RF Driver to get an IR output equal to the reading obtained in the previous step, (#4). (Figure 8-5 shows the locations of pots on the RF Driver panel.)
6. Switch back and forth from Low-RF to High-RF, and make sure that the IR output at the LAM is consistent.
7. Go to High-RF, then place the power meter in the slot between the surgical attenuator and the polarizer mount. Note the power level; it should be around 24 watts. If it is not, back OFF Gate Pot several turns counter clockwise, then cautiously adjust the "GATE" pot on the RF Driver for a maximum 532 nm output power. **CAUTION:** This adjustment

should be done with great care.

8. Turn system off. Then replace beam block behind the LAM.

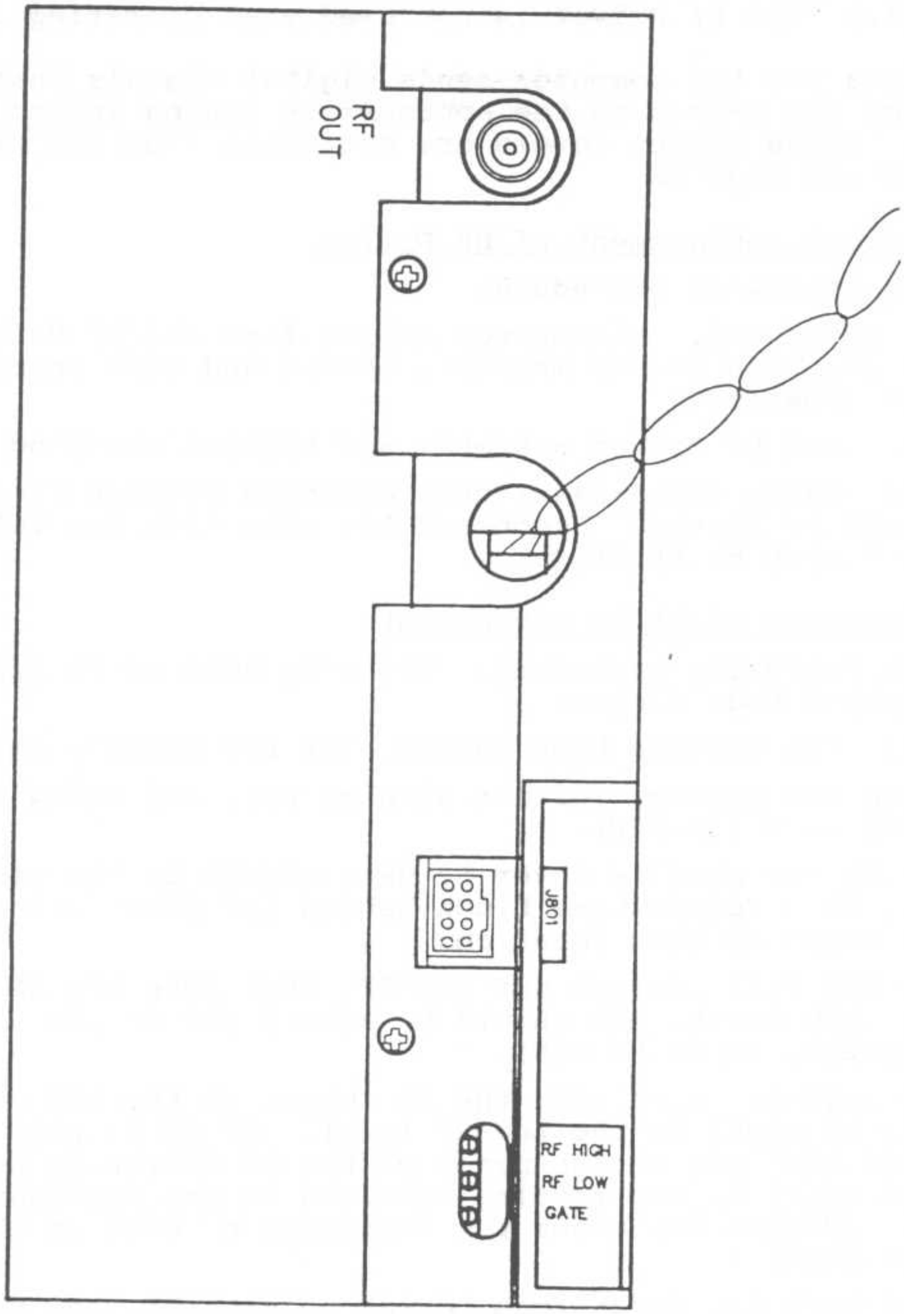


Figure 8-5. Panel on RF Driver

8.7 CRT

The Model 800 Series uses a black and white CRT which receives its video drive signals from the Electronics Card. Specifications for the CRT include regulatory agency compliance with UL and CSA.

The setup procedure for the CRT has checks for size, brightness, synchronization, focus, and contrast. Figure 8-6 identifies the adjustment points and shows their locations on the CRT board.

> *** NOTE *** This procedure only needs to be done if the video display has problems. The procedure is performed at the factory, but normally is not required in the field.

8.7.1 Size Check

a. Horizontal: if necessary to readjust horizontal width, reset width coil (L2) to proper width.
b. Vertical: if necessary to readjust vertical height, reset height control (R38) to proper height. Some interaction between the vertical linearity (R48) control and the size control may require additional readjustment of both controls to achieve proper size and linearity.

8.7.2 Brightness Check

a. If necessary, increase remote brightness control to maximum.
b. Raster lines should be visible at this time. If not, increase setting on master brightness control R52 for visible raster lines.
c. Reset remote brightness control to normal viewing. If no remote brightness control exists, adjust master control for proper viewing brightness.

8.7.3 Synchronization Check

a. Vertical:
  1. Vary vertical hold control (R34) to both ends of the control's range. Non-synchronous roll of screen should occur. Readjust control to lock in screen.
b. Horizontal:
  1. Increase brightness level so that raster lines are visible.
  2. Disable horizontal synchronization pulse.
  3. Screen should roll; readjust horizontal hold control (R18) until a single vertical bar is visible on the screen, and stop adjustment.
  4. Re-enable horizontal sync pulse; video should now be stable.
  5. Adjust video centering control (R19) so that video is centered on screen.
  6. Reset brightness controls to normal viewing level.

CONTROL DESIGNATIONS

R18	Horizontal Oscillator
R19	Horizontal Video Centering
R63	Contrast
L2	Width Coil
R52	Brightness
R48	Vertical Linearity
R34	Vertical Hold
R38	Vertical Size
R28	Focus

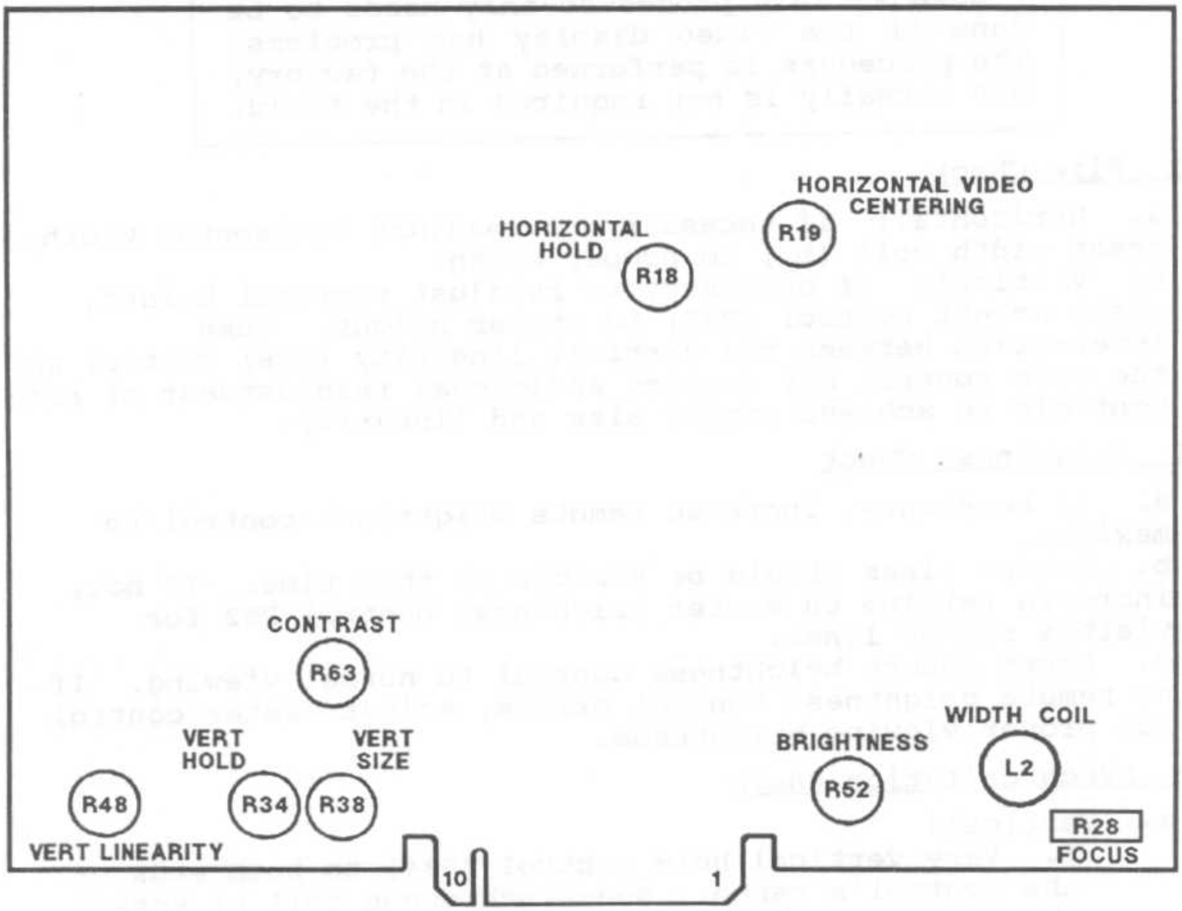


Figure 8-6. Component Side of CRT Board

8.7.4 Focus Check

a. If necessary, adjust focus control (R28) for best overall focus on screen. A compromise may be required between center focus and corner focus.

8.7.5 Contrast Check

a. With brightness control adjusted to normal level, adjust contrast control (R63) to desired video gain.

8.8 SMART-LOAD DEVICE

The Smart-Load Device, mounted onto the Low Voltage Power Supply, acts as a backup load. The LVPS references itself to the 24 volt power supply, thus the 5, -15 and +15 volt supplies are also referenced to the 24v supply in the LVPS. When the RF drive is cycled from ON to OFF, the load on the 24v supply may not remain constant without a Smart-Load, thus causing problems. To provide load stability, the Smart-Load turns itself ON when the RF drive is OFF, and turns itself OFF when the RF driver is ON, thus ensuring that there is a constant load on the 24v line.

When a LVPS is a suspected problem, there is a sequence of steps that can be taken to eliminate any other possibilities.

1. Disconnect the multi-colored cable from J-1 on the control board (Lower right hand corner).
2. Turn circuit breaker and key switch on unit to on position.
3. With DVM, measure output voltages directly on LVPS (refer to Fig. 8-3 for voltage test points).
4. If voltage are good, the problem could possibly be the control board. Try changing the control board replace the cable going into J-1 on new board. Go to step 6.
5. If voltages measured on the LVPS are not good, then the LVPS is the problem.
6. If by changing the control board you get the system to function properly, (check voltages on control board and check 5v reference) you then need to check the smart-load.
7. Put probes from DVM into TP-3 and TP-1 on smart-load PCB (refer to Fig. 8-5 for test points).
8. Cycle the RF driver (in service mode) from no RF to low RF to high RF. Output voltage on DVM should never drop below 2.5 volts. There will be some change between the three different states.
9. If voltages are above 2.5 volts, smart load is ok. If voltages is below 2.5 (for any of the three states) replace SMART-LOAD.

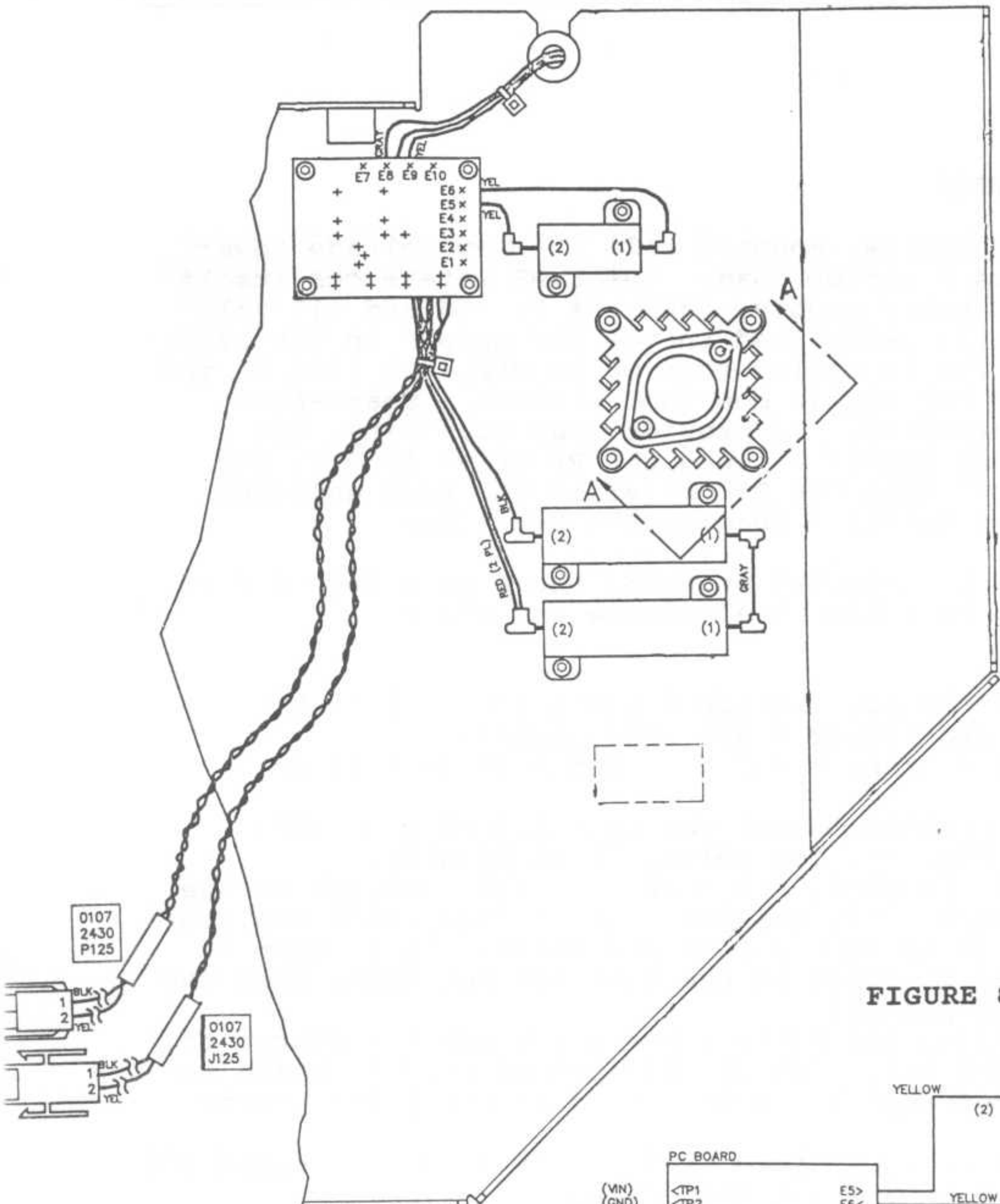
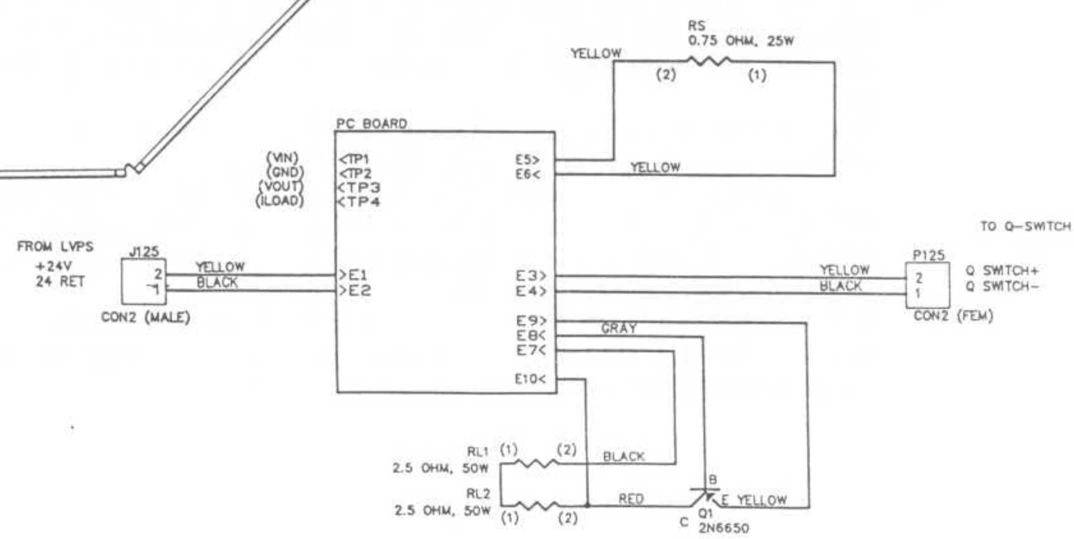


FIGURE 8.7 SMART-LOAD DEVICE



Section 9

CALIBRATION OF CAL POD

9.1 EQUIPMENT REQUIRED

This section of the manual gives the set up and calibration procedure for the Calibration Pod (Cal-Pod). You will need a voltmeter such as Fluke 75/77 (or equivalent), a beam block, and the delivery device cheater or an old Endostat.

NOTE: This procedure assumes that system is turned on and that the detectors on the resonator assembly are aligned and adjusted.

9.2 ZERO THE CAL-POD

1. Attach the delivery device cheater or old Endostat.
2. On the back of the Cal-Pod loosen and remove the four screws that hold the rear metal plate to the Cal-Pod body. Then remove the plate.
3. Place the Fluke meter negative probe into TP3 and the positive probe into TP1. Then adjust VR1 to obtain 0.00 mv on the 300 mv scale of the meter.
4. Move the positive probe to TP2 and adjust VR2 to obtain 0.00 mv.
5. Move the positive probe to TP4 and adjust VR3 to obtain 0.00 mv. The Cal-Pod is now zeroed.

9.3 CALIBRATION IN KTP

6. Put the system in Service Mode and go to Service Screen 4A, (KTP Calibration). On the screen the calibration power (**CAL**) should be 0.8 watts. (This power level is set automatically.) Place a beam block in front of the coupler assembly.
7. Raise the Exposure Shutter and the KTP Safety Shutter. Then adjust VR2 on the KTP Safety Detector to get 150 counts on or the closest count attainable.
8. Place the Cal-Pod on the resonator plate in the KTP beam path, behind the KTP Safety Shutter location. Then adjust VR4 on the Cal-Pod to match the KTP Safety Detector count.

9.4 CALIBRATION IN YAG

9. Press the YAG/106 button to change to YAG mode, (Service Screen 4B). Power at the YAG Surgical Detector should be 16 watts, (which is set automatically).
10. Raise the Exposure Shutter and the YAG Safety Shutter. Then adjust VR2 on the YAG Safety Detector to get 150 counts or the closes count attainable.
11. Move Cal-Pod on resonator plate into YAG beam path, behind

YAG Safety Shutter location. Then adjust VR5 on the Cal-Pod to match the YAG Safety Detector count.

12. Press KTP/532 button to change to KTP mode. Remove Cal-Pod from resonator plate, install snout on Cal-Pod, then position fiber in Cal-Pod.

13. Press REPEAT button and note value after **THRUPUT=**. It should read between 80% and 90%.

14. Press the YAG/106 button to change to YAG mode and then open the YAG Safety Shutter. Press REPEAT to read the "throughput." If necessary, adjust VR2 on the YAG Safety Detector and press REPEAT again, until the throughput in YAG matches the throughput found in KTP.

Section 10

L A S E R & O P T I C S

10.1 SUMMARY OF LASER ALIGNMENT

Figure 10-1 shows a general flow diagram of the full system alignment sequence for KTP and YAG. Note that the sequence starts with four sections of KTP alignment, followed by a similar four sections of YAG alignment, then ends with the He-Ne Laser alignment. You will need to perform all steps in the sequence when a new laser system is aligned, or after major repair work that has caused the system to be misaligned.

For most situations in the field, you will not need to perform the full sequence shown in the flow diagram. The procedures for component replacement and troubleshooting will indicate where in the sequence to begin. However, from that point onward you will need to perform all remaining steps up to the end.

Figure 10-2 shows the beam path and optical components for KTP alignment, and Figure 10-3 shows the beam path and optical components for YAG alignment.

10.2 METERS AND SPECIAL EQUIPMENT REQUIRED

To perform the full sequence of alignment you will need the following equipment items.

- IR Viewer
- IR Card
- Alignment Aperture (P/N 105-_____)
- 98% R LAM Mirror (P/N ___________)
- Laser Power Meter, ...
- Multimeter, such as Fluke 75/77
- 100 micron Microbeam alignment fiber (P/N _________)
- 300 micron Endostat alignment fiber (P/N _________)
- 600 micron Endostat alignment fiber (P/N _________)
- Beam block
- Safety glasses
- Service key
- Delivery device cheater plug
- Set of bald Allen wrenches
- Lens tissue paper

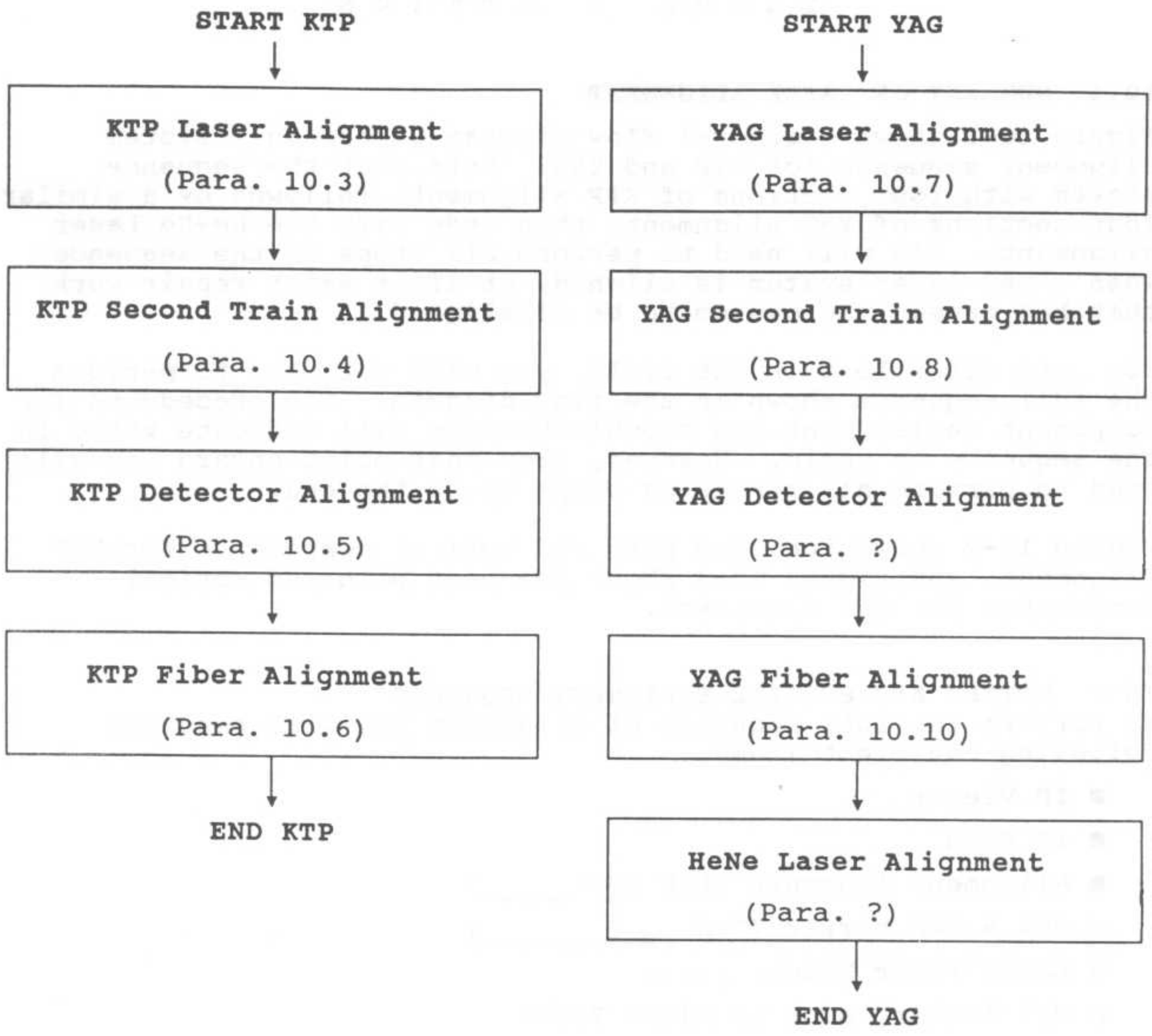


Figure 10-1. Flow Diagram for Full Laser Alignment Procedure

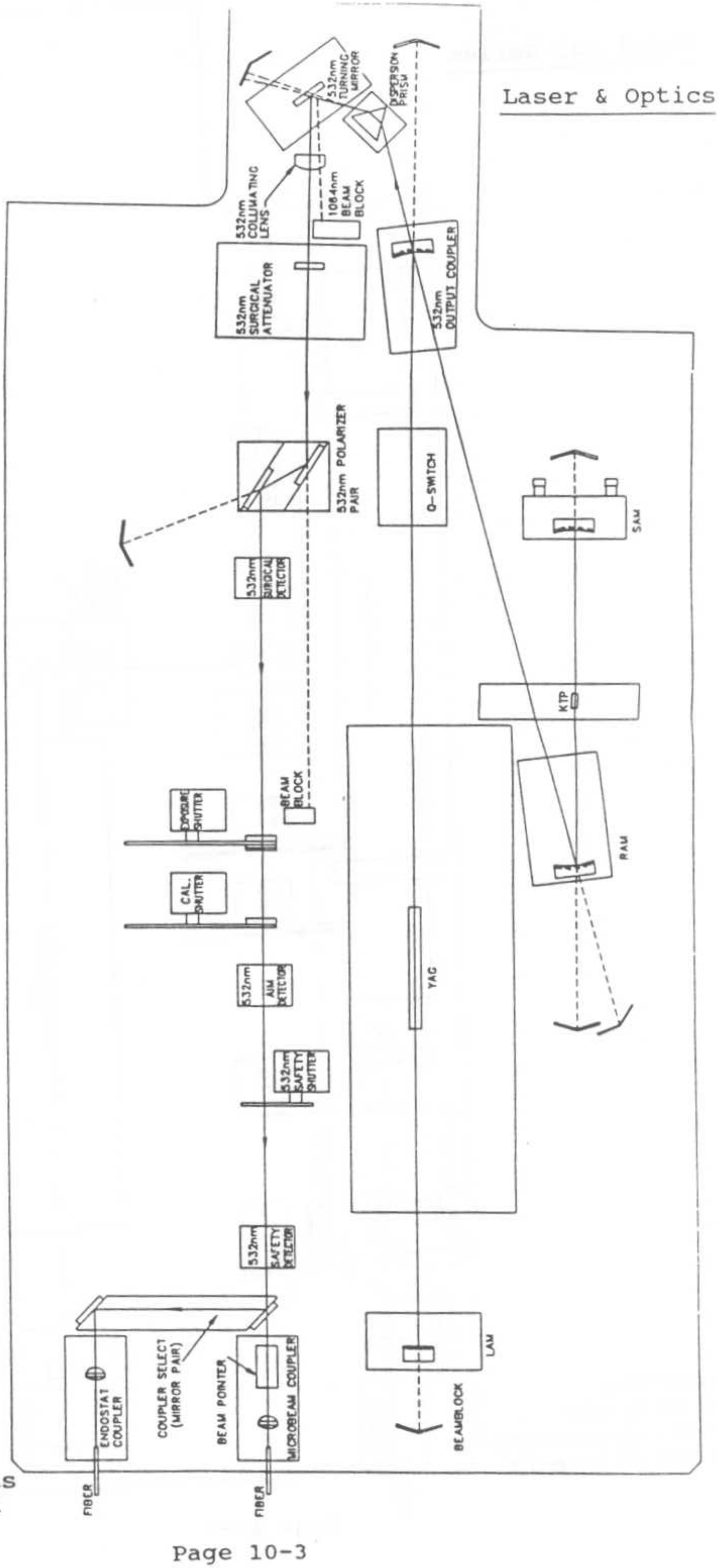


Figure 10-2.
Beam Path and
Optical Components
for KTP Alignment

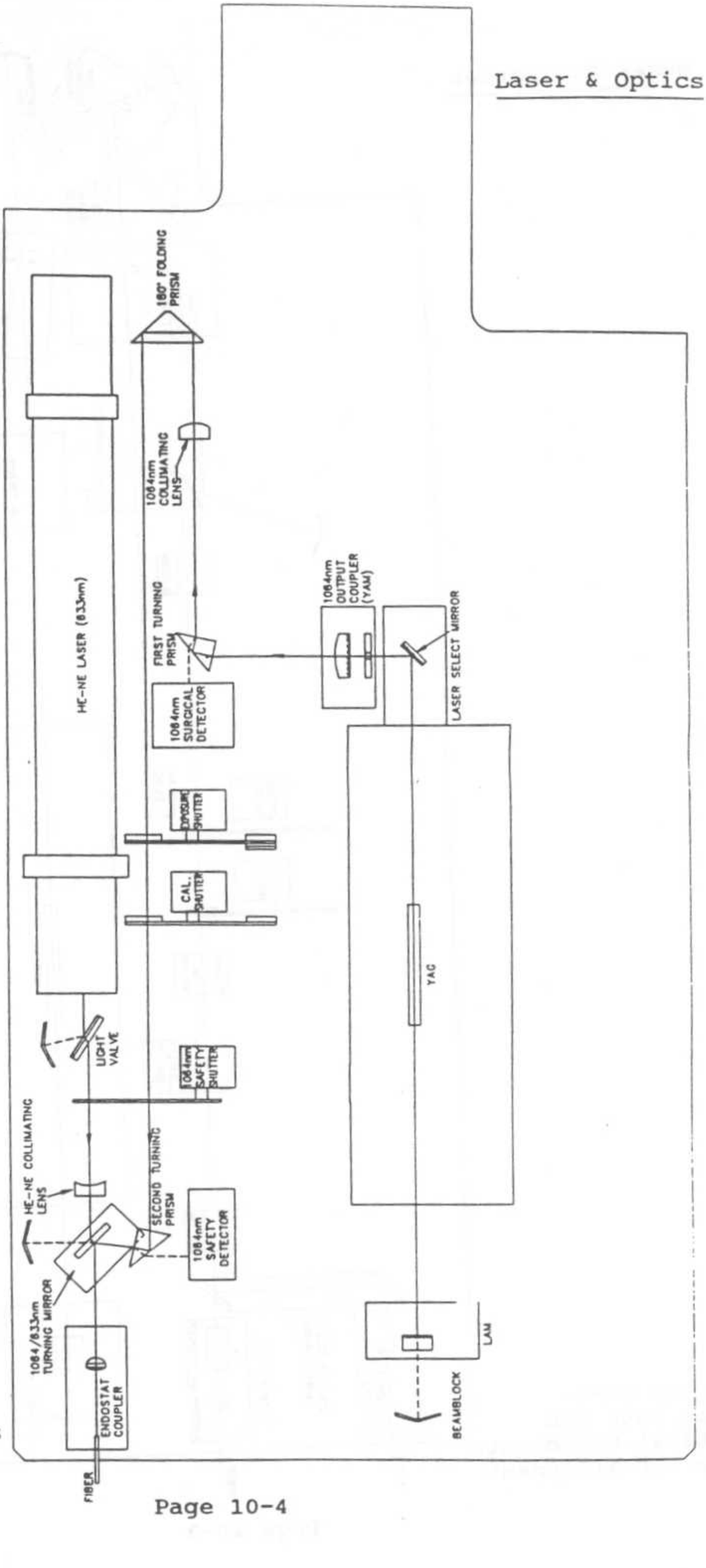


Figure 10-3.
Beam Path and
Optical Components
for YAG Alignment

10.3 KTP LASER ALIGNMENT, (Figure 10-2)

10.3.1 Put system in Service Mode, select KTP (if not already selected), then go to Service Screen 1A (KTP Laser ON/OFF) and turn laser ON.

10.3.2 Go to Service Screen 5 (KTP Manual Current Control), then set ALE lamp current to simmer.

10.3.3 Remove Q-Switch and KTP crystal mount from resonator. Do not disconnect water cooling lines.

10.3.4 Note that LAM mount is fixed, so no LAM adjustment is required. Replace HR LAM (99.8% R) with 98% R LAM.

Go to Screen 5A and turn ALE I OP up to 25 AMPS.

> **WARNING:** With a 98% LAM, more than 20 W of output power at 1064 nm can exit from the LAM. To prevent this beam from being a hazard, output from the LAM under these conditions must always be blocked with a power meter or beam block. Note that there is no permanent plate on the frame to prevent this beam from going into the room.

10.3.5 Place IR card, (or power meter on 1 Watt scale), behind LAM and adjust SAM until laser comes on. This can be done by rocking the SAM mount with a small flat-blade screwdriver next to the upper adjustment screw about the vertical axis. Adjust the mirror mount about the horizontal axis with a 9/64 ball driver in the lower adjustment screw. Watch for flash and then peak laser output power at LAM.

10.3.6 With power meter behind LAM, peak the laser output by adjusting SAM only. About 20 W output power should be obtainable. Record this power level.

10.3.7 Q-Switch installation: Block beam at LAM or SAM. Install Q-Switch square to the beamline. Make sure Q-Switch driver is in No RF mode. Connect BNC cable to Q-Switch. Unblock the beam.

Go to low RF mode. Dip the Q-Switch as follows: Carefully rotate Q-Switch around dowel pin in mounting plate until a minimum output power condition is found at the LAM. Bolt Q-Switch firmly in place. Go to No RF mode and observe sharp increase in output power. If not, dip Q-switch again. Confirm that laser is in No RF mode. Peak output power again with SAM and measure leakage through LAM. The ratio of LAM output power with and without Q-Switch is the Q-Switch power retention. This should be larger than 90%. (Alternatively, power loss at LAM when installing Q-Switch should be less than 2 to 3 watts.)

10.3.8 Go to SIMMER mode. Block beam at LAM. Install KTP crystal mount. Plug heater connector into crystal mount. On main board, measure thermistor resistance at test points 15 and 16 and adjust pot VR 7 until thermistor resistance is 750 ± 10 ohms.

10.3.9 Remove front cover from crystal mount. Place a white card in resonator next to SAM mount. A greenish, bright spot, (due to lamp light coming from the YAG rod), will be seen on card. Adjust KTP crystal in X and Y direction until crystal is centered on this beam due to pump light. Confirm that laser is in No RF mode. Remove white card and beam block. A bright green beam should be visible. Center KTP crystal on this beam.

10.3.10 Place power meter in KTP second train in slot between surgical attenuator and polarizer mount. Adjust SAM for maximum IR leakage at LAM. Adjust KTP angle adjments for maximum green. Peak SAM again for maximum LAM leakage. Repeat several times.

10.3.11 Peak KTP angle and SAM for maximum CW KT2P power. Repeat peaking 532 nm output until no further increase appears. **NOTE:** Sometimes a KTP crystal will show two peaks for 532 nm output, so always make sure that the strongest peak has been selected. (The strongest peak should be around 3.0 watts or above.)

10.3.12 Make sure beam is going through center of KTP crystal. Observe crystal while wearing KTP safety glasses. Position of beam can usually be clearly seen. To do the final x y adjustment of KTP crystal, go to Low RF mode, observe thermistor resistance and adjust x y to get maximum resistance. Observe the beam position in crystal while making this adjustment to make sure laser beam does not hit the edge of crystal.

10.3.13 Replace 98% R LAM with 99.8% R. Peak KTP and SAM to get maximum cw 532 nm power. This should be greater than 4.0 watts.

10.3.14 Go to High RF mode. Laser is now Q-Switched. Very carefully make small adjustments to KTP and SAM to peak KTP power.

> **WARNING:** In High RF, the KTP crystal is vulnerable to damage if adjustments are made to it. For this reason, do not adjust the crystal temperature or crystal position while in High RF. Make only small adjustments to the crystal angle while in High RF, and do this carefully without reducing green output power very much.

> **NOTE:** On certain lasers, the KTP angular alignment is different for CW versus the angular alignment for Q-switched operation. This would be evident by first peaking the laser in CW and setting the KTP angle and SAM for maximum CW power. Then you would set the SAM angle for maximum Q-switched power. In most cases the adjustment is very minute and even in some cases there is no difference. However, on certain lasers this adjustment can be substantial.

The Model 800 Series incorporates a current modulated mode that responds in a similar manner to CW mode for KTP angle adjustments. In cases where lasers that require large adjustments of the KTP angle in Q-switched mode can cause a problem in the modulated mode, use the following alternate alignment procedure.

> **NOTE:** This procedure is only used if 8 to 10 watts of modulated power is not obtainable; otherwise use the standard procedure.

If you find it is not possible to attain 8 to 10 watts at the Surgical Detector in Modulation Mode, and if there are no other optical problems (such as burnt optics, etc.), it may be necessary to adjust the KTP angle to a compromised position between modulated and Q-switched.
To do this, change to Service Mode and go to Service Screen 7, (Special Tests). Then press INT UP to select Current Modulation Control, (Service Screen 9). While alternately pressing AIM UP and AIM DN to toggle the Current Modulation OFF and ON, adjust the KTP angle and the SAM to obtain 8 to 10 watts modulated and an acceptable Q-switched power. The preferred modulation current should fall between current levels of 17 to 22 Amps. Q-switched power should not degrade more than a watt.

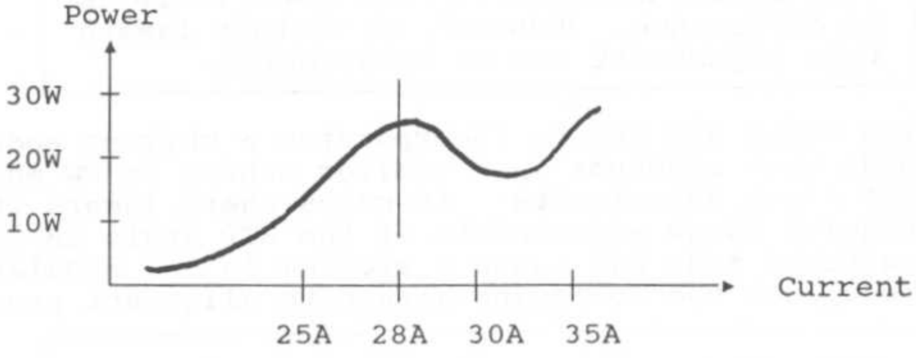
10.3.15 Adjust High RF for maximum 532 nm output. Turn "GATE" pot on Q-switch counter-clockwise several turns slowly adjust pot clockwise until maximum 532 output is obtained. This is measured with a power meter at the Folding Mirror.

10.3.16 Adjust Low RF as follows: With laser in High RF, measure and record IR leakage through LAM. Then go to Low RF, and adjust "LOW RF" on Q-switch driver until LAM leakage is the same as for Hi RF mode.

10.3.17 Check crystal temperature: it should be 750 ±50 ohms.

Do not make temperature adjustments in High RF, (see warning above). Refer to Section 8 for the procedure on checking and adjusting the KTP crystal temperature.

10.3.18 In Screen IA, adjust ALE current to obtain 24W +/- 2 watts. This should be below 35 amps. Also do not adjust the current higher than the first peak. For example, do not adjust the laser peak past 28 amps. Note the Power-Current diagram below.



10.3.19 Turn laser off. Install all beam tubes and crystal mount cover.

10.3.20 Turn laser on. Allow laser to warm up for a minute and do final small adjustment on KTP angle and SAM to peak KTP output.

* * * The KTP first train Laser Alignment is now complete. * * *

10.4 KTP SECOND TRAIN ALIGNMENT

10.4.1 Turn system on, put it in Service Mode, then select KTP (if not already selected). Go to Service Screen 1A, select I OP and low RF.

10.4.2 Remove 532 nm Turning Mirror, then adjust Dispersion Prism for minimum deviation at 532 nm. (This is where the beam coming out of the prism has the least amount of angular displacement from the input beam.) Replace Turning Mirror.

10.4.3 Remove 532 nm Collimating Lens. Set polarizer mount square on baseplate.

10.4.4 Install alignment aperture in KTP alignment fixture (just ahead of 532 nm Safety Detector). Block beam after alignment fixture. (In front of Fiber Interface Assy.)

10.4.5 Go to Service Screen 3, (Attachments and ESF). Connect a device cheater at J19 on the Electronics Card. Then raise all shutters.

10.4.6 Adjust 532 nm Turning Mirror so that beam first goes through center of hole in polarizer mount, and then adjust Turning Mirror so that beam hits center of alignment aperture. (The beam at the alignment aperture will be quite large.)

10.4.7 Install 532 nm Collimating Lens and adjust X and Y position until beam goes through center of alignment aperture. Check to see that beam is not clipped going through polarizer mount.

10.4.8 Place power meter in open space behind 532 nm Safety Shutter.

10.4.9 Remove 532 nm Surgical Attenuator.

10.4.10 Go to High RF mode for laser.

10.4.11 Adjust angle of 532 nm Polarizer Pair until light leakage through polarizers as measured on power meter is a minimum, without any clipping of the beam in the polarizer mount. This leakage should be approximately 150 mW or less. (If it is not, rotate the output coupler.)

10.4.12 Re-install 532 nm Surgical Attenuator. Loosen two screws that clamp the stop plate on the Surgical Attenuator. Rotate half waveplate through 360 degrees while looking at power meter. Note that power will peak four times, 90 degrees apart. Set waveplate where maximum power is observed.

10.4.13 Loosen two screws that hold Surgical Attenuator and tilt attenuator to obtain maximum green power.

10.4.14 Turn the Surgical Attenuator about 90 degrees counter-clockwise and then adjust until minimum power is observed on power meter. This should be less than 150 mW.

10.4.15 Rotate stop plate on Surgical Attenuator clockwise until it hits pin. Lock in place by tightening two screws on the stop plate.

10.4.16 Rotate Surgical Attenuator clockwise until it hits stop. Power meter should read more than 20 W.

10.4.17 Close 532 nm Safety Shutter, and move power meter to slot behind Surgical Attenuator. Read power level at this position.

10.4.18 Calculate the difference between power readings obtained in the previous two steps, (Steps 10.3.15, 10.4.16 and 10.4.17). This is the loss in polarizers and should be less than 2.0 W.

10.4.19 If polarizer loss is more than 2.0 W, repeat Steps 10.4.11 through 10.4.18 until the following two conditions are met: Minimum power transmission is less than 150 mW and power loss of maximum power transmission is less than 2.0 W.

10.4.20 Go to Low RF, then move power meter back to slot behind

Safety Shutter.

10.4.21 Go to Service Screen 2A, (KTP Laser, Shutters, Detectors). Press INT UP button to increase power, then observe that power does increase. Press INT DN button to decrease power, then observe that power does decrease. If this is not the case, half-waveplate is set in wrong quadrant and you will have to correct it, as follows:

Set waveplate manually to maximum transmission. Loosen stop plate on attenuator and rotate so that other end of stop is against pin. Now rotate waveplate in new quadrant to obtain minimum transmission, and fasten stop plate in place against stop for this position. Confirm minimum transmission of 150 mW, losses less than 2.0 W and correct rotation for power adjustment from service screen.

10.4.22 Go to Low RF mode, remove power meter and confirm that beam is going exactly through hole in alignment aperture. If not, adjust 532 nm Collimating Lens to do this.

10.4.23 The external train for 532 nm is now aligned. Good alignment can be recognized as follows:

- The beam goes through the collimating lens and waveplate close to the center.
- The beam is not clipped anywhere in polarizer mount and is close to center of hole going into polarizer mount.
- The beam goes exactly through the alignment aperture.
- At the alignment aperture, the beam is usually somewhat elliptical with the minor axis in horizontal plane and the major axis vertical. The beam size in the vertical direction is usually a little larger than the hole in the alignment aperture.

10.4.24 Remove the alignment aperture, and confirm that all components in 532 nm external beamline are fastened.

* * * The KTP Second Train Alignment is now complete. * * *

10.5 KTP DETECTOR ALIGNMENT

10.5.1 Turn laser on and place in Service Mode. Doing this will bring you to Screen 0: Service Screens Menu (main menu).

10.5.2 Before performing the next step to zero the detectors, make sure the system is in KTP mode, (not in YAG). Block the KTP beam at the Folding Mirror.

10.5.3 Perform zero adjustment for the KTP Surgical Detector: Set voltmeter at a 300 mv scale to measure DC voltage, then connect leads between TP3 (ground) and TP1.

a. Adjust pot VR1 for zero to ±0.002 V on voltmeter. (This zeros the detector output.)
b. Connect meter to TP3 and TP2.
c. Adjust pot VR3 for zero to ±0.002 V on voltmeter. (This zeros the output amplifier stage.)

10.5.4 Repeat Step 10.5.3 for KTP Safety Detector.

10.5.5 Repeat Step 10.5.3 for KTP Aim Detector.

10.5.6 From main menu, (Service Screen 0), press the SUR DN button to go to Service Screen 5A, (KTP Power/Current Curve). Make sure you are in I_{OPP} (by pressing DUR UP) and Low RF (by pressing REPEAT). Next press STNDBY to go to High RF.

> **CAUTION**
> If you enter High RF mode directly without first activating Low RF, you run the risk of sending a giant pulse through the KTP crystal, which could damage or burn out the optical coating.

10.5.7 Go back to main menu, then press AIM UP to select Service Screen 2A, (KTP Lasers, Shutters & Detectors).

10.5.8 Place a calibrated power meter at the Safety Shutter location. Open Surgical Attenuator for maximum power, then note reading on the power meter.

10.5.9 Check the Surgical Detector power reading on the screen by looking at SURG=XXX. Compare reading on the screen with reading on the power meter. If they don't match, adjust VR4 on the Surgical Detector until the power readings match.

10.5.10 Place beam block in front of Endostat Coupler Assembly. Raise all shutters and remove the power meter.

10.5.11 Now adjust VR4 on the Safety Detector until Safety Detector power reading (and counts) matches Surgical Detector power reading (and counts). The counts should agree within ±5 counts. The SFTY counts can be equal to, but never higher than, the SURG counts.

10.5.12 Next you must make sure that both detectors are linear. To do this, press INT DN to decrease power and observe the two readings on the screen. Both readings should go down simultaneously and also should decrease at the same rate. Keep decreasing the power until you reach a minimum or zero reading. If readings decreased at a different rate, the detectors may be non-linear and errors could occur. In order for the detectors to be considered non-linear, the readings must be more than ±5 counts or ±30% off. A non-linear condition can also be caused during low power levels when polarizers are misaligned.

> **CAUTION**
> Safety glasses must be worn since the 1064 nm wavelength is not visible to the human eye.

10.5.13 While adjusting power up to about 20 W and down to 3.0 W, make sure that the surgical and safety detectors track within ± 5 counts.

10.5.14 Go to "10X Gain" on Service Screen 2A, then adjust power from 3.0 W to 0.5 W. Confirm that the surgical and safety detectors track to within ± 5 counts.

This completes calibration of the 532 nm Surgical and 532 nm Safety Detectors.

> **NOTICE:** If, on a system that has been previously calibrated, the surgical and safety detectors track within ± 5 counts over the entire range from 0.5 to 20 W, they should not be recalibrated (even if they do not quite agree with the power meter reading). Most likely, these detectors will be more accurate than the power meter.

10.5.15 An alternative method of calibrating the detectors is to remove the Microbeam Coupler and Beam Pointer, and put a calibrated power meter in that position. Then both detectors can be calibrated while reading the power on the meter. This method is usefull when the power meter is too large to fit in the power meter slot on the resonator plate.

10.5.16 Next the Aim Detector will be set up. Press the READY button to return to main menu, (Service Screen 0), then press INT UP to go to Service Screen 7, (Special Tests). From Service Screen 7 press INT UP to select Current Modulation, (Service Screen 9).

10.5.17 From Service Screen 9 press INT UP to rotate the Surgical Attenuator until you obtain maximum power. After doing that, press AIM DN to turn on Current Modulation. Note that this operation mode is a new feature for the Model 800 systems and was not available on earlier models.

10.5.18 Obtain 8 to 10 watts at the Surgical Detector, by on earlier models.

10.5.18 Obtain 8 to 10 watts at the Surgical Detector, by either pressing INT UP to increase the high modulation current level or pressing INT DN to decrease it, (whichever is appropriate). Make sure you don't increase current above rolloff, (current should be in the range between 17 to 20 amps). Refer to the LCUR reading on the screen to check this current range.

10.5.19 Press the READY button twice to return to the main menu. Then press AIM UP to go to Service Screen 2A, (KTP Lasers, Shutter, Detectors). Press SUR DN to drop the Exposure Shutter and press AIM UP to drop the Calibration Shutter so both shutters are in the beam path. Press DUR DN to lower the light valve voltage to zero.

> **NOTE:** If Detector Assy. is being replaced proceed to steps 10.5.20 through 10.5.26.
> If Detector is just being re-aligned, perform the following:
> 1. Remove the Dectector PCB & Foam.
> 2. Adjust the aperture so it is centered on the beam.
> 3. Put foam and board back on.
> 4. Proceed to step 10.5.27 and continue.

10.5.20 Remove the Aim Detector PCB. Remove the foam and gasket, polarizer (plastic piece) and the IR filter (Glass) from the detector body. CAUTION: Watch your eyes.

10.5.21 Back off spring plunger and remove aperture. Do this by loosening the two side screws on the detector body, then removing the aperture.

10.5.22 Use a 9/64 Ball driver to loosen the bolt, (located at side of the unit), that holds the detector body to the detector stand.

10.5.23 Put the glass IR filter back in place and put a piece of lens tissue paper over the detector body.

10.5.24 Slightly rotate the detector body on the stand to center the beam in the detector bore.

10.5.25 Tighten the bolt that holds the detector body to the detector stand. Replace the aperture and spring plunger. Adjust the two top screws on the aperture until the aperture is centered with the beam; make sure the spring plunger exerts tension on the aperture. Once again, repeat the lens tissue procedure to position the aperture to get the brightest beam.

10.5.26 Reassemble the IR and polarizer filter, foam gasket and detector board. Then plug the detector power cable back in.

10.5.27 Hook the DVM to TP2 and TP3. From Service Screen 2A press the INT UP or INT DN button, (as appropriate), to obtain a reading of 2 volts on the DVM.

10.5.28 On the Aim Detector, go to the two top screws on the aperture and fine adjust the aperture position to maximize the voltage reading on the DVM.

10.5.29 Connect an Endostat fiber to the Endostat Coupler. Then press INT UP to open the Surgical Attenuator to obtain maximum power (minimum attenuation).

10.5.30 Press SUR UP to open the Safety Shutter. Place a low power meter at the distal end of the fiber. Press DUR UP or DUR DN, (as appropriate), to adjust the light valve voltage to obtain a reading of 3.5 milliwatts on the power meter. (As the light valve voltage decreases, the transmission through the fiber increases.)

10.5.31 Adjust VR4 on the Aim Detector board, (gain adjust), to obtain an AIM reading on the screen equal to 3.8 milliwatts. If it is not possible to obtain 3.8 milliwatts on the screen, rotate the Aim Detector body clockwise for more light, or counter-clockwise for less light, just as you did in step 10.5.24. Then realign the aperture and try again. Go to Application Mode and test Aim operation at various Aim and Power levels.

10.6 LOW POWER MODE ADJUSTMENT (KTP only)

10.6.1 In the next steps you will adjust the Surgical Detector for the low power mode. Press READY to return to the main menu, (Service Screen 0), then press SUR UP to go to Service Screen 1A, (KTP Laser ON/OFF & Interlock). From Screen 1A press DUR UP to go to I_{OPP} and press STNDBY to go to High RF.

10.6.2 Press READY to return to the main menu, (Service Screen 0), then press AIM UP to go to Service Screen 2A, (KTP Laser, Shutters, Detectors). From Screen 2A press INT UP or INT DN, (as appropriate), to obtain a reading of 8 watts at the Surgical Detector.

10.6.3 Press AIM UP to close (drop) the Calibration Shutter. Go to 60x Surgical Detector gain by pressing AIM DN until Gain=60 shows on the screen.

10.6.4 Attach delivery device cheater plug at connector J19 on Electronics Card. Press SUR UP to open (raise) the Safety Shutter and press SUR DN to open the Exposure

Shutter. **DO NOT** open the Calibration Shutter.

10.6.5 Adjust VR2 on the Surgical Detector so that the number of counts displayed for the Surgical Detector on the screen matches the number of counts displayed for the Safety Detector.

10.7 COUPLER ALIGNMENT

10.7.1 Turn system on and put it in Service Mode, then select KTP (if not already selected). Go to Service Screen, select full current and HIGH RF.

10.7.2 Place power meter in slot behind 532 nm Safety Detector.

10.7.3 Go to Service Screen 2A, (KTP Laser, Shutters, Detectors), and from that screen close 532 nm Safety Shutter, Exposure Shutter and Calibration Shutter. Adjust 532 nm Surgical Attenuator for approximately 100 mW at power meter.

10.7.4 Set Coupler Select Mirror Pair (beam switch mirror pair) in UP position, so that KTP beam goes into Microbeam Coupler).

10.7.5 MICROBEAM ALIGNMENT

10.7.5.1 Set the pointing plate (beam pointer) about normal to beam path.

10.7.5.2 Put 100 micron alignment microbeam cable into coupler. Remove power meter.

10.7.5.3 If some light comes out of the fiber, proceed to the next step. If not, place a piece of lens tissue between pointing plate and microbeam coupler to scatter beam.

10.7.5.4 Point output of 100 micron cable at a piece of paper, wall or other suitable screen. (Usually, just a faint amount of light will be transmitted through the fiber.)

10.7.5.5 Adjust X and Y position of coupler lens until bright beam is observed through fiber. If lens tissue had been placed in fiber coupler during a previous step, remove tissue now.

10.7.5.6 Project output from fiber on wall and observe any cladding light from the fiber output. (Cladding light can be observed as a bright ring around the normal output from the fiber.) Adjust X and Y position of lens to minimize the cladding light. (If beam gets too bright for visual inspection, put the Calibration Shutter down to attenuate the beam, and adjust Surgical Attenuator to get a suitable light level.)

10.7.5.7 Adjust the pointing plate (beam pointer) to minimize the divergence of the beam from fiber. Do this by making the spotsize from the fiber as small as possible. As the cladding light appears, adjust the lens in X and Y to minimize the cladding light. Repeat this a few times, using the pointing plate to get the smallest spotsize and the lens X-Y position to minimize the cladding light.

10.7.5.8 Adjust Z position of focussing lens as follows: Turn Z adjust knob in any direction and observe if cladding light gets brighter or dimmer. After each Z adjustment, adjust lens in X and Y to minimize cladding light. Find position where cladding light is just faintly visible, then adjust Z position of lens in direction to make cladding light disappear. Keep going until cladding mode is just faintly visible again. Then adjust lens halfway between these two positions to eliminate cladding light. This focusses the beam on the fiber with minimum spotsize.

10.7.5.9 Put alignment aperture on end of fiber. This restricts the output from fiber to 100 degrees.
NOTE: If fixture is not available, use Microbeam instead.

10.7.5.10 Put output from fiber through alignment aperture into power meter. Do fine adjustment of pointing plate and lens X, Y and Z position by getting maximum power into power meter. Put output of fixture (or Microbeam) onto wall. Minimize cladding light, if present.

10.7.5.11 Remove alignment aperture (or Microbeam).

10.7.5.12 Measure power at laser with power meter in slot after Safety Shutter, and measure fiber output. Calculate fiber transmission. This should be 85% or higher. If not, inspect and clean ends of fiber and repeat. Calculate Microbeam transmission; it should be 70%.
*** NOTE *** If you can't achieve 70%, check the coupler lens; it might be installed backwards.

10.7.5.13 This completes Microbeam coupler alignment. Remove 100 micron cable.

10.7.6 ENDOSTAT ALIGNMENT

10.7.6.1 With laser still in KTP mode, adjust Surgical Attenuator for maximum attenuation at 532 nm Safety Shutter.

10.7.6.2 Put 300 micron alignment fiber into Endostat coupler.

10.7.6.3 Move Coupler Select Mirror Pair (beam switch mirror pair) down to direct beam into Endostat coupler.

10.7.6.4 If some light is visible through fiber, adjust Endostat coupler lens in X and Y to get maximum light through fiber.

If no light is visible through fiber, place piece of lens tissue ahead of Endostat coupler and observe faint light through fiber. Then adjust X and Y position of lens to get maximum light through fiber, and afterwards remove lens tissue.

10.7.6.5 Project output from fiber onto wall or suitable screen, then adjust lens X and Y position to minimize cladding light. Adjust angle of coupler select mirror pair mount to minimize size of center bright spot from fiber. Adjust lens X-Y position to remove cladding light. Repeat these adjustments until a minimum center spotsize is obtained without any cladding light.

10.7.6.6 Point output of fiber into power meter. Make fine adjustments of coupler (X, Y, Z) and mirror beam to maximize power. Remove power meter. Check for cladding light, and make small adjustments to minimize it.

Find two positions of lens where cladding light is just faintly observable, and adjust lens position halfway in between.

This completes the Endostat alignment.

WARNING: Note that in the above procedures, the alignment of each coupler is independent. Never use the 532 nm Turning Mirror at the laser output to do alignment into the fibers. This will align or misalign the beam into both couplers, as well as misalign the beam into the detectors.

CAUTION

Safety glasses must be worn since the 1064 nm wavelength is not visible to the human eye.

10.8 YAG LASER ALIGNMENT, (Figure 10-3)

* **NOTE** * If using a power meter that is calibrated for 532 nm, remember to add in the calibration factor for power readings.

10.8.1 Turn system on and put it in Service Mode, then select YAG (if not already selected), and turn laser on. Go to Service Screen 2B, (YAG Laser, Shutters, Detectors), and from that screen adjust lamp current to about 25 Amps.

10.8.2 Confirm that Wavelength Switch Mirror (laser select mirror) is in the down position.

10.8.3 Remove two screws from top of 1064 nm Output Coupler mount and remove aperture.

10.8.4 Place IR card at 1064 nm Output Coupler. Place power meter between 1064 nm Collimating Lens and 180 degrees Folding Prism.

10.8.5 Adjust the 1064 nm Output Coupler mirror mount to get the laser to come on. This can be done by rocking the mirror mount with a flat-blade screwdriver next to the upper adjustment screw about the vertical axis. Adjust the mirror mount about the horizontal axis with a 9/64 ball driver in the lower adjustment screw and watch for flash.

10.8.6 After first laser flash is observed on the IR card, remove IR card and peak laser output on power meter positioned after 1064 nm Collimating Lens.

10.8.7 Increase current to 35 Amps. Peak laser and adjust current for 60 W output. Peak laser at approximately 60 W output. Record this current level. It should be less than 40 Amps.

10.8.8 Lower current and confirm that laser threshold is between 10 and 14 Amps. Adjust laser to about 10 W output.

10.8.9 Install aperture in Output Coupler mount and adjust in X and Y until maximum output is obtained.

10.8.10 Go to current level previously determined in Step 10.7.7 for approximatly 60 W output. Adjust aperture for maximum output. This should be between 55 W and 60 W. Adjust current for 60 W output.

10.8.11 Switch wavelengths between KTP and YAG a few times, and confirm that 60 W output is obtained every time. If not, realign 1064 nm Output Coupler and aperture until 1064 nm output is stable when wavelength is switched.

* * * This completes the YAG laser alignment. * * *

NOTE: Because the LAM mount is fixed, alignment of the YAG and KTP laser are independent; alignment of one does not affect the other.

10.9 YAG SECOND TRAIN ALIGNMENT

10.9.1 Turn system on and put it in Service Mode, then select YAG (if not already selected), and turn laser on. Go to Service Screen 2B, (YAG Laser, Shutters, Detectors), and from that screen adjust YAG output power to about 5 to 10 W.

10.9.2 Put alignment aperture in 1064 nm Collimating Lens mount. Put beam block at Endostat coupler.

10.9.3 Loosen screws on First Turning Prism and rotate prism until beam lines up vertically with the aperture. (Use IR viewer to view beam.) Note that prism can only adjust beam in horizontal direction on aperture. In vertical direction, beam should be within 1/4 inch of the aperture.

10.9.4 Lock prism in place. Move alignment aperture to alignment fixture after 1064 nm Safety Shutter.

10.9.5 Go to full power (60 W), then move Calibration Shutter into beam.

10.9.6 Adjust 1064 nm Collimating Lens in X and Y direction to align beam exactly with alignment aperture.

NOTE: The Second Turning Prism is not adjustable.

* * * This completes alignment of the YAG external train. * * *

10.10 YAG DETECTOR ALIGNMENT

10.10.1 Turn laser on and place in Service Mode, (by pressing S-3 on the Electronics Card or by simultaneously pressing the SUR DN, INT UP and REPEAT buttons). Doing this will bring you to Screen 0: Service Screens Menu (main menu).

10.10.2 Before performing the next step to zero the detectors, make sure the system is in YAG mode, (not in KTP). Block the KTP beam at laser output, before the First Turning Prism.

10.10.3 Perform zero adjustment for the YAG Surgical Detector: Set voltmeter at a 300 mv scale to measure DC voltage, then connect leads between TP3 (ground) and TP1.
   a. Adjust pot VR1 for zero to ±0.002 V on voltmeter. (This zeros the detector output.)
   b. Connect meter to TP3 and TP2.
   c. Adjust pot VR3 for zero to ±0.002 V on voltmeter. (This zeros the output amplifier stage.)

10.10.4 Repeat Step 10.9.3 for YAG Safety Detector.

10.10.5 From main menu, (Service Screen 0), press the SUR DN button to go to Service Screen 5B, (YAG Power/Current Curve).

10.10.6 Go back to main menu, then press AIM UP to select Service Screen 2B, (YAG Lasers, Shutters & Detectors).

10.10.7 Place a calibrated power meter at the Safety Shutter location. Go to 60 watt output.

10.10.8 Check the Surgical Detector power reading on the screen by looking at SURG=XXX. Compare reading on the screen with reading on the power meter. If they don't match, adjust VR4 on the Surgical Detector until the power readings match.

10.10.9 Place beam block in front of Endostat Coupler Assembly. Raise all shutters and remove the power meter.

10.10.10 Now adjust VR4 on the Safety Detector until Safety Detector power reading (and counts) matches Surgical Detector power reading (and counts). The counts should agree within ±5 counts. The SFTY counts can be equal to, but never higher than, the SURG counts.

10.10.11 Next you must make sure that both detectors are linear. To do this, press INT DN to decrease power and observe the two readings on the screen. Both readings should go down simultaneously and also should decrease at the same rate. Keep decreasing the power until you reach a minimum or zero reading. If readings decreased at a different rate, the detectors may be non-linear and errors could occur. In order for the detectors to be considered non-linear, the readings must be more than ±5 counts.

10.10.12 While adjusting power up to about 60 and down to 5.0 W, make sure that the surgical and safety detectors track within ± 5 counts.

10.10.13 Go to "10X Gain" on Service Screen 2B, then adjust power from 3.0 W to 0.5 W. Confirm that the surgical and safety detectors track to within ± 5 counts.

This completes calibration of the YAG Surgical and YAG Safety Detectors.

NOTICE: If, on a system that has been previously calibrated, the surgical and safety detectors track within 3 counts over the entire range from 50 to 60W they should not be recalibrated (even if they do not quite agree with the power meter reading). Most likely, these detectors will be more accurate than the power meter.

* * This completes calibration of the Detectors. * * *

> **NOTE:** On a system that has been previously calibrated, if the Surgical Detector and Safety Detector track within ± 3 counts over the entire range from 5 to 60 W, they should not be recalibrated, even if they do not quite agree with the power meter reading. Most likely, these detectors will be more accurate than the power meter.

10.11 YAG FIBER ALIGNMENT

10.11.1 Turn system on and put it in Service Mode, then select YAG (if not already selected), and turn laser on. Go to Service Screen 2B, (YAG Laser, Shutters, Detectors), and from that screen set YAG output power to about 5 to 10 W.

10.11.2 Confirm that Coupler Select Mirror Pair (beam switch mirror pair) is up (parallel to base plate), and that YAG beam can go into Endostat coupler. Install 300 micron alignment fiber in Endostat port.

10.11.3 Move Exposure Shutter and 1064 nm Safety Shutter out of beam path. Leave Calibration Shutter in beam path.

10.11.4 Project fiber output onto suitable screen and see with IR viewer if any 1064 nm light comes out. If not, put lens tissue ahead of coupler to scatter beam. Faint output at 1064 nm should exit fiber.

> **WARNING:** The Endostat Coupler has previously been aligned for 532 nm, using the Coupler Select Mirror Pair and the X, Y and Z adjust on the coupler lens. Do not touch the X, Y, or Z adjustments on the lens or the Coupler Select Mirror Pair while performing the YAG alignment, because doing that would destroy the 532 nm alignment.

10.11.5 Adjust the 1064 nm/633 nm Turning Mirror to get bright 1064 nm output from fiber. (If lens tissue had been used during a previous step, remove tissue now.)

10.11.6 Adjust 1064 nm/633 nm Turning Mirror to get maximum 1064 nm output from fiber. Minimize cladding light while projecting fiber output on wall. Repeat until beam is maximized and with cladding light minimized.

* * * This completes the YAG fiber alignment. * * *

10.12 He-Ne LASER ALIGNMENT

10.12.1 Turn system on and put it in Service Mode, then select YAG (if not already selected). Go to Service Screen 2B, (YAG Laser, Shutters, Detectors), and from that screen set He-Ne AIM LEVEL to HIGH. (There should be no voltage on the He-Ne light valve.)

10.12.2 Install 300 micron fiber in Endostat Coupler. Confirm that the Coupler Select Mirror Pair (beamswitch mirror pair) is up.

10.12.3 Adjust He-Ne Collimating Lens in X and Y to get maximum 633 nm light through fiber.

> **WARNING:** Do not adjust X, Y or Z position on the Endostat Coupler lens. Doing this would destroy the previous KTP and YAG alignment of the Endostat Coupler.

10.12.4 Remove 300 micron fiber and replace it with 600 micron fiber. With 10 mW power meter, measure 633 nm output from fiber. This should be between 2 and 4 mW.

10.12.5 If 4 mW not obtained in previous step, loosen two screws that hold He-Ne laser in position and rotate laser to get 4 mW out. Adjust 633 nm Collimating Lens each time to get maximum 633 nm output.

10.12.6 If 4 mW cannot be obtained, remove the plate from He-Ne light valve mount and remove plastic polarizer sheet. Put plate back in place. Adjust He-Ne output to get 4 +0/-1 mW output. Confirm that MED aim level for He-Ne is 1.5 to 0.3 mW and Low level is 0.3 to 0.01 mW.

10.12.7 Reinstall 300 micron fiber and adjust 633 nm Collimating Lens for minimum cladding light. Make sure He-Ne laser is fastened in place.

* * * This completes the He-Ne alignment. * * *

10.13 TROUBLESHOOTING GUIDE

The following pages show flow diagrams for the most common resonator problem: "low power." The diagrams, one for KTP and one for YAG, are expressed in simplified terms. Starting at the top of a diagram, you are asked to make a check or inspection. Based on the result, you then decide whether to go on to the next item on the diagram, or to go to the replacement procedures.

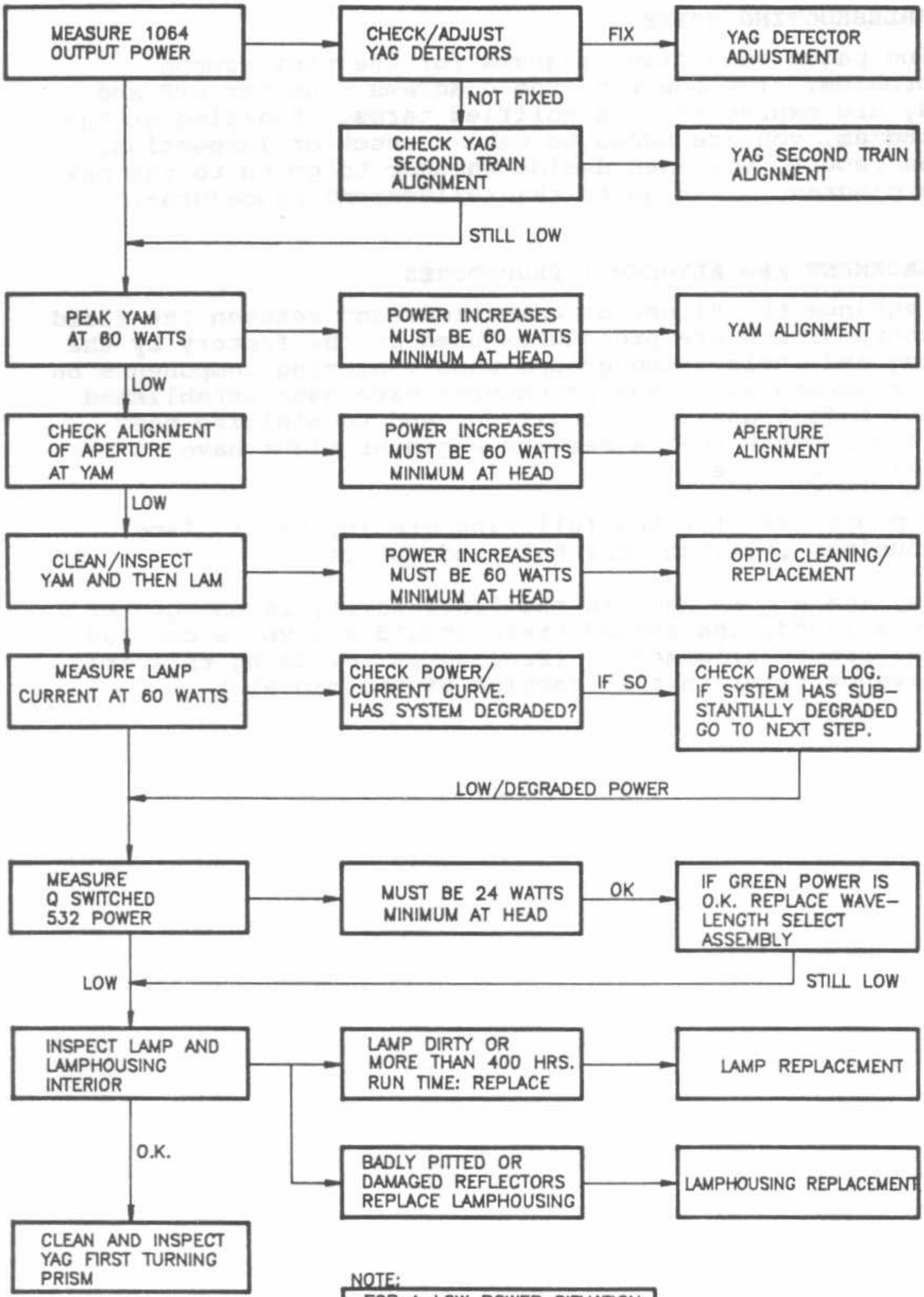
10.14 REPLACEMENT AND ALIGNMENT PROCEDURES

To greatly enhance the "lines of communication" between the field and the factory, there are procedures used at the factory by the manufacturing and engineering groups when replacing components on the resonator assembly. These procedures have been established to ensure the safest possible conditions and to minimize the amount of re-alignment that a service engineer might have to do at the installation site.

Replacement procedures for the following are included: lamp, rod, lamp housing, Q-Switch, crystal, and optics.

NOTE: Anytime a component in the laser cavity is changed or re-aligned, the second train should always be checked for proper alignment. (Procedures for doing this are given earlier in this section of the manual.)

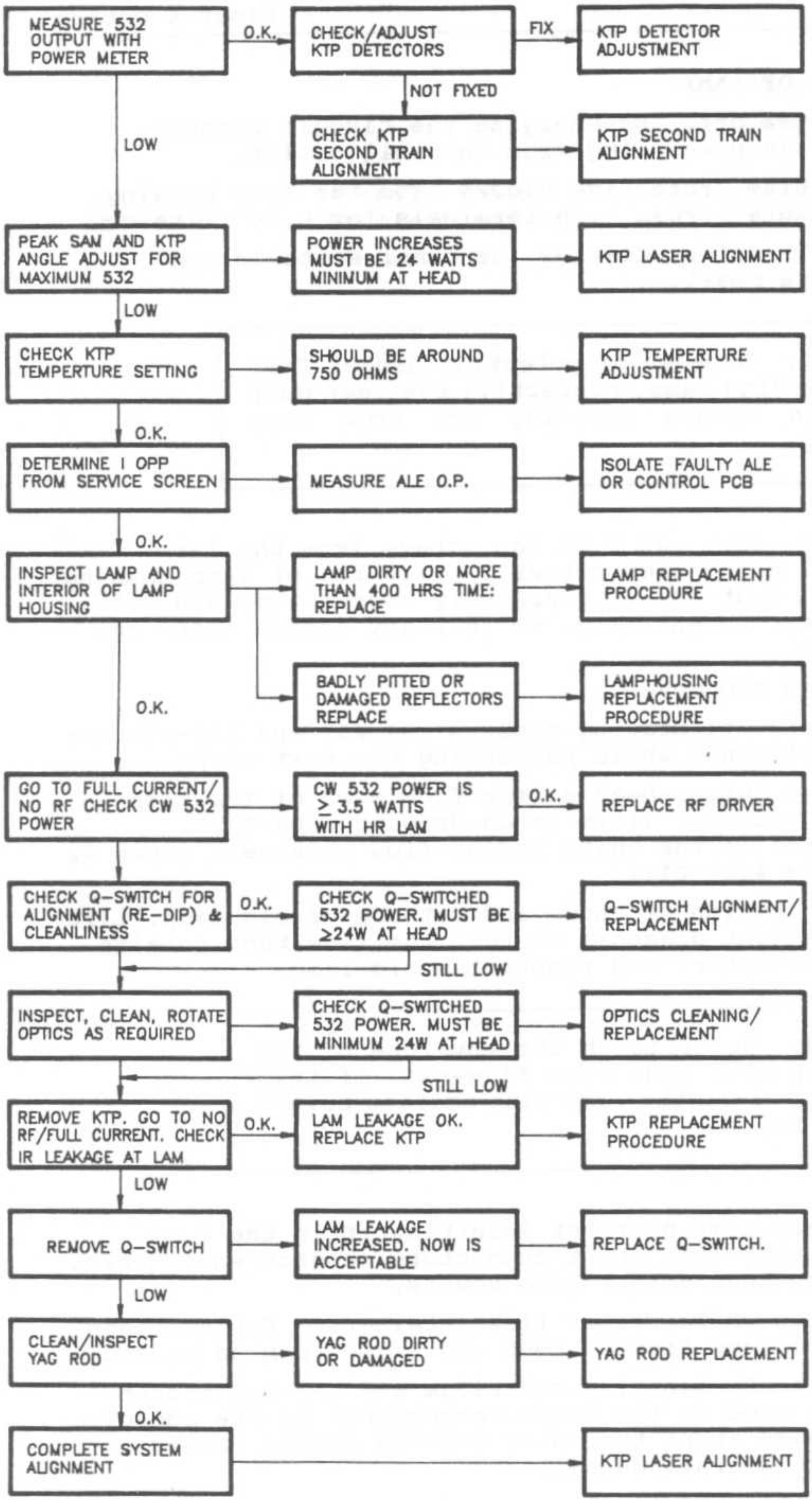
Flow Diagram for "Low Power – YAG/1064"



NOTE:

FOR A LOW POWER SITUATION, THIS FLOW CHART ASSUMES A PROPERLY WORKING COOLING SYSTEM. ENSURE PROPER RESERVOIR WATER LEVEL, OPERATIONAL FANS, AND NO BLOCKAGES TO AIR FLOW CHANNELS

Flow Diagram for "Low Power – KTP/532"



NOTE:

FOR A LOW POWER SITUATION, THIS FLOW CHART ASSUMES A PROPERLY WORKING COOLING SYSTEM. ENSURE PROPER RESERVOIR WATER LEVEL, OPERATIONAL FANS, AND NO BLOCKAGES TO AIR FLOW CHANNELS.

10.15 REPLACEMENT OF LAMP

10.15.1 Turn system off. De-energize the circuit breaker. Remove main power plug from the wall outlet.

10.15.2 Remove white protective blocks from the lamp housing, then measure across both terminals for 0.00 volts dc.

10.15.3 Put on KTP Safety Glasses (or other suitable eye protective gear).

> **WARNING:** Because of potential danger from an exploding lamp, protective eye gear must be worn before removing top from lamp housing.

10.15.4 Remove the four .25 X 20 cap screws from the lamp housing (one in each corner). Lift top of lamp housing slightly, (but DO NOT completely remove top) and let housing sit momentarily, so that any excess water can drain out.

10.15.5 Remove the top cover.

NOTE: Refer to drawing numbers 104-232 and 104-017 for visual reference while performing the next steps.

10.15.6 Remove two button-head screws from each of the lamp mount connectors, (item #5 on drawing #104-232). Remove each of the white teflon flow retainers (item #2 on drawing #104-017).

10.15.7 Note orientation of anode and cathode of old lamp. Lift lamp at slight diagonal so that the flow tube remains in the reflector, and remove the old lamp.

> **CAUTION:** Never touch the envelope of the new lamp with your bare fingers. If this happens, clean the lamp with acetone before installing it.

10.15.8 Install new lamp by first inserting it in the flow tube. Attach lamp mount connectors on each end. Screw two button-head screws into mounts.

10.15.9 Replace two white teflon flow retainers. Replace lamp housing top and tighten four .25 X 20 cap-head screws.

10.15.10 Replace the De-ionizing cartridge and the 0.2 micron filter located in the water compartment of the console. (For details about the water cooling system, refer to Section 11 of this manual.)

10.15.11 Plug main power cable into wall outlet. Energize Breaker and turn keyswitch on. Change from Application Mode to Service Mode, then go to Service Screen 1A, (KTP Laser ON/OFF & Interloc). Close contactor. Watch for water leaks.

10.15.12 After verifying that there are no water leaks, open and close the contactor several times to bleed the air out the lines.

10.15.13 Bring the system up. You should only need to perform minor alignment of the SAM to optimize the laser. (If system alignment is necessary, refer to the procedures given earlier in this section.) Check second train alignment.

10.16 REPLACEMENT OF ROD

10.16.1 Turn system off. De-energize breaker. Remove main power plug from the wall outlet.

10.16.2 Remove LAM mount from baseplate of resonator assembly. Remove laser select mirror assembly.

10.16.3 Loosen and remove seal nuts located on each end of the lamp housing. (These are shown as item #29 on drawing #104-017).

10.16.4 Insert a plastic plug into the end of the rod on the Q-Switch side. While being careful not to lose any of the spacers or o-rings used to insure water integrity of the rod, grip the rod on the LAM side and pull straight forward.

10.16.5 Install plastic plug on the new rod assembly.

10.16.6 Insert the new rod with the plastic end going into the lamp housing first. (Doing this prevents water from getting on the rod face). Place the rod in the lamp housing and space it evenly on both sides.

10.16.7 Remove the plastic plug. Tighten the seal nuts on each side.

10.16.8 Plug main power cable into wall outlet and energize the circuit breaker. Turn keyswitch on. Change from Application Mode to Service Mode, then go to Service Screen 2A, (KTP Laser, Shutters, Detectors). Close the contactor and watch for water leaks.

10.16.9 After verifying that there are no water leaks, open and close the contactor several times to bleed the air out of the lines.

10.16.10 Re-install the LAM and re-install the laser select mirror assembly.

10.16.11 Perform the procedure for KTP Laser Alignment, starting at paragraph 10.3 and continuing with the KTP Laser, Second Train Alignment, YAG Laser, and YAG Second Train Alignment.

10.17 REPLACEMENT OF LAMP HOUSING

NOTE: Because the lamp housing will very rarely fail in the field, you should only perform this procedure after all other troubleshooting techniques have failed to correct the problem.

10.17.1 Turn system off. De-energize breaker. Remove main power plug from the wall outlet.

10.17.2 Remove hose clamps and hoses from the lamp housing. (These are located beneath the base plate.)

10.17.3 Remove laser select mirror. Remove LAM beam tube.

10.17.4 Remove white protective blocks on the lamp housing cover. Check for 0.0 volts.

10.17.5 Remove the lamp power supply (A.L.E.) current cable.

10.17.6 Remove four 8-32 caphead screws located in the corners of the lamp housing. Gently pull up on the lamp housing. (Some water may leak out of the bottom fittings, so exercise caution). Lift the lamp housing out of the base plate.

10.17.7 Install the new lamp housing and re-install the laser select mirror assembly.

10.17.8 Replace four 8-32 caphead screws in corners of the lamp housing.

10.17.9 Replace beam tubes.

10.17.10 Re-connect the lamp power supply (A.L.E.) current cable.

10.17.11 Re-connect hose clamps and hoses to the lamp housing.

10.17.12 Perform the procedure for KTP Laser Alignment, (paragraph 10.3).

10.18 REPLACEMENT AND CLEANING OF Q SWITCH

REPLACEMENT

10.18.1 Turn system off.

10.18.2 Remove the KTP mount and disconnect the BNC cable from the Q-Switch.

10.18.3 Remove the cap-head screw from the Q-Switch mount. Lift up and remove the Q—Switch.

10.18.4 Turn system on. Go to Service Mode and select Service Screen 1A.

10.18.5 Go to Simmer and no RF mode.

10.18.6 Place a power meter behind LAM. (Note that a 98% mirror will have more IR leakage than an HR mirror.)

10.18.7 Go to Full Current.

10.18.8 Peak the SAM for maximum IR power at the LAM. Record this power reading.

10.18.9 Go to Simmer. Loosely bolt new Q—Switch to mount. (The Q—Switch should sit square to the mount, with the top of the Q—Switch flush with the top of the mount.) Install BNC cable.

10.18.10 Go to Full Current and Low RF.

10.18.11 "Dip" the Q—Switch to obtain a minimum reading at the LAM. (The Q—Switch should be parallel with the baseplate and not be angled.) Tighten the caphead screw.

10.18.12 Go to NO RF, (remain at Full Current). Peak the SAM and record the IR power at the LAM.

10.18.13 Calculate the Q-Switch insertion loss. This is defined as: IR power at the LAM without the Q Switch, versus IR power at the LAM with the Q Switch. The Q Switch insertion loss should be no more than 2 or 3 watts. (For more details, refer to KTP Laser Alignment, paragraph 10.3.)

10.18.14 Go to Simmer. Install KTP crystal mount. Perform KTP Laser Alignment as per paragraph 10, starting at 10.3.8.

NOTE ABOUT CLEANING: Oftentimes dust particles can accumulate on the optical surface of the Q Switch and cause minor burns. Most of the time these burns can be cleaned off, but if they can't the Q Switch will have to be replaced.

CLEANING

10.18.16 Turn the system off.

10.18.17 Disconnect BNC cable from the Q Switch, then remove Q Switch.

10.18.18 While being careful not to touch any optical surfaces, remove side covers from the Q-SW.

10.18.19 Fold a piece of lens tissue to conform to the size of the optical surface, then insert the tissue into a pair of hemostats. Saturate the tissue with acetone, (DO NOT use isopropyl alcohol), and shake off the excess acetone. Lightly drag the tissue along the surface of the glass and make sure that no film residue is left on the surface. Repeat these steps for both sides of the Q Switch.

10.18.20 Replace the side covers.

10.18.21 Re-install the Q Switch on the base plate. Re-connect the BNC cable. "Dip" the Q Switch as described in steps 10.18.11 through 10.18.13.

10.18.22 Perform the procedure for KTP Laser Alignment, (paragraph 10.3).

NOTE: AFTER REMOVING THE Q SWITCH FOR REPLACEMENT OR CLEANING, ALWAYS PERFORM THE PROCEDURE FOR KTP LASER ALIGNMENT.

10.19 REPLACEMENT OF KTP CRYSTAL

10.19.1 Turn the system on. Go to Service Screen 1A, (KTP Laser ON/OFF & Interloc). From the Service Screen select NO RF and SIMMER current.

10.19.2 Remove beam tube from LAM mount. Block the beam in front of the LAM.

10.19.3 Remove the two 8-32 cap-head screws that fasten the KTP mount to the base plate.

10.19.4 Remove front cover from the KTP assembly and note locations of screws inside, (see illustration below).

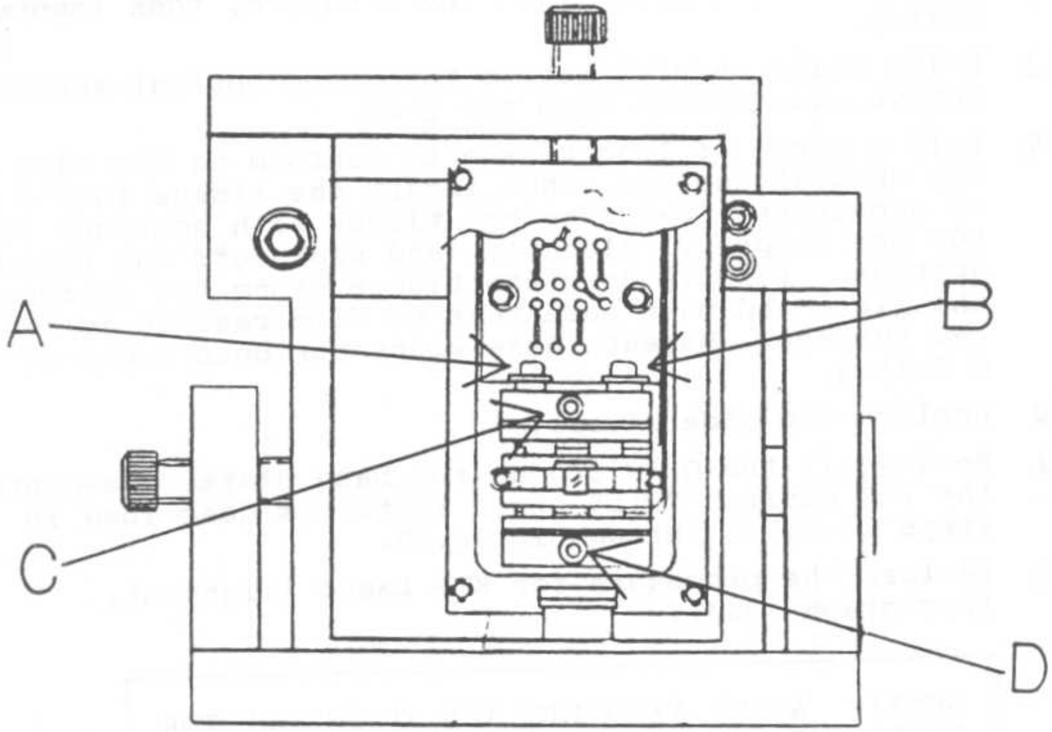


Figure 10-4. View of KTP Mount, (with cover removed)

10.19.5 Alternately loosen screws A and B, until the springs are no longer compressed and the washers sit freely on top of the springs. The crystal is held in place by a clamp that consists of two halves. Loosen screw D until the two halves split apart.

> **CAUTION:** Because the crystal is not restrained by any means other than the clamp, exercise extreme care when removing the clamp.

10.19.6 Carefully place ends of tweezers around sides of the crystal, then extract and remove it from the assembly.

10.19.7 Place the old crystal in a protective plastic holder and return it to the factory for analysis. Also include all pertinent system information and a list of the failure modes.

10.19.8 Grasp new crystal with tweezers and inspect it for cleanliness.

> **NOTE:** In the field this must be done with extreme care, because microscopic particles can not readily be seen with the naked eye.

10.19.9 If cleaning is necessary, obtain acetone (spectroscopic grade only) and cotton tip applicators, then proceed as follows:

Place several drops of acetone on the end of the applicator and then shake off the excess. Using a mimimum of pressure, swab across the surface of the crystal only once and then discard the applicator.

Inspect the crystal surface very carefully, and repeat the above steps until the crystal is clean.

10.19.10 The new crystal will have an arrow marked on one side. Use the tweezers to place the the new crystal into the grooves in the clamping assembly; make sure the arrow is on the bottom side and pointing towards the rod. Place the crystal in far enough so that the crystal face is beyond the bevel cut on the clamping assembly.

10.19.11 Alternately tighten screws A and B until they are tight. Tighten screw C until it is snug, then back off a quarter of a turn.

10.19.12 Replace the front cover on the KTP assembly.

10.19.13 Re-install the beam tubes and bolt the KTP assembly to the base plate.

10.19.14 Perform the procedure for KTP Laser Alignment, (paragraph 10.3). Also check the KTP Second Train Alignment, (paragraph 10.4).

NOTE: There is an engineering change that incorporates the KTP crystal, clamping assembly and thermistors as part of the back face plate assembly. After the cooling block has been removed from the KTP, with this change you can remove the old plate and put right in a new plate that will contain the new KTP.

10.20 INSPECTION, CLEANING AND REPLACEMENT OF OPTICS

In a laser system the optical coatings will sometimes degrade over a period of time. This can cause two major problems: low power and/or a noisy or unstable laser. It does not take much time or effort to inspect and clean these optics in the Model 700 Series, because the mounts for the optics are extremely rigid. This means that when an optic is removed, cleaned and then put back, it should be close to 100% aligned.

**** NOTE:** Only work with one optic at a time.

To **INSPECT** an optic, perform the following steps:

10.20.1 Turn system on. Change from Application Mode to Service Mode, then go to Service Screen 1A or 1B, (KTP or YAG Laser ON/OFF & Interloc).

10.20.2 For KTP, select NO RF and SIMMER current; for YAG, select LOW current.

10.20.3 Remove the suspect optic and closely examine it under a strong light. Mark the top edge of the optic so there is a reference to show how it was seated. You have to turn it at different angles, because coatings will sometimes develop "bleached-out" spots that are extremely difficult to see.

If the optic has bleached spots or a blatantly burnt spot on the surface, you can try to clean it and then rotate it in its holder so that the laser beam passes through a new spot on the optic. But if the bleached spots or burn are in a position where the beam will always pass through it, you must change the optic.

To **CLEAN** the optic, perform the following steps:

10.20.4 While being careful not to touch the coating on either side of the optic, remove it and keep it in its holder.

> **CAUTION:** If you touch the coating on either side of an optic, oil from your hand will be absorbed into the coating and eventually destroy it or cause low power.

10.20.5 Obtain Kodak Lens Cleaning tissue and some spectroscopic acetone. (DO NOT use isopropyl alcohol or any other cleaning solutions, as they will leave a film on the optic.)

Hold a sheet of the lens tissue by one corner and put a drop of acetone in the center of the sheet. Drag the sheet across the surface of the optic, then discard the sheet.

Inspect the optic, and if more cleaning is necessary, repeat the above steps with a new sheet of tissue.

To **REPLACE** the optic, perform the following steps:

10.20.6 Put the optic back into the mount on the base plate.

10.20.7 From the Service Screen, monitor the power.

10.20.8 If any alignment is performed, it should be done only with the optic that was previously removed. If the optic is in a fixed mount, any aligment can be done with the SAM or the YAG output coupler.

Refer to the paragraphs for KTP Laser Alignment (10.3), KTP Second Train Alignment (10.4), YAG Laser Alignment (10.8), and YAG Second Train Alignment (10.9).

NOTE 1: Damaged optics should only be rotated as a temporary measure when new optics are not available.

NOTE 2: When cleaning optics, never apply pressure to the coating. Cleaning should only consist of dragging the wet-with-acetone tissue across the optical surface.

10.21 PROCEDURES CROSS REFERENCE

Given below is a list of all optical components, together with references to the corresponding procedures needed for completing the alignment.

Major components, (such as rod, lamp, lamp housing, Q Switch and KTP mount), have separate detailed replacement procedures.

To replace other components, remove the hold-down screws, take out the old component, and then install the new component. For any subsequent optical alignment, refer to the appropriate procedure/alignment steps.

Component Name and Paragraph Reference to Procedure

LAM - INSPECTION, CLEANING AND REPLACEMENT OF OPTICS, (10.20)

Rod - REPLACEMENT OF ROD, (10.16)

Lamp - REPLACEMENT OF LAMP, (10.15)

Lamp Housing - REPLACEMENT OF LAMP HOUSING, (10.17)

Wavelength Select Mirror Ass'y. - YAG Laser Alignment, (10.8)

Q Switch - REPLACEMENT AND CLEANING OF Q SWITCH, (10.18)

KTP Output Coupler - INSPECTION, CLEANING AND REPLACEMENT OF OPTICS, (10.20)

RAM - INSPECTION, CLEANING AND REPLACEMENT OF OPTICS, (10.20)

SAM - INSPECTION, CLEANING AND REPLACEMENT OF OPTICS, (10.20)

KTP Crystal - REPLACEMENT OF KTP CRYSTAL, (10.19)

KTP Dispersion Prism - KTP SECOND TRAIN ALIGNMENT, (10.4)

KTP Turning Mirror - KTP SECOND TRAIN ALIGNMENT, (10.4)

KTP Collimating Lens - KTP SECOND TRAIN ALIGNMENT, (10.4)

Retarder - KTP SECOND TRAIN ALIGNMENT, (10.4)

Polarizer - KTP SECOND TRAIN ALIGNMENT, (10.4)

KTP Surgical Detector - KTP DETECTOR ALIGNMENT, (10.5)

KTP Aim Detector - KTP DETECTOR ALIGNMENT, (10.5)

KTP Safety Detector - KTP DETECTOR ALIGNMENT, (10.5)

Exposure Shutter - (no alignment necessary)

Calibration Shutter - (no alignment necessary)

KTP Safety Shutter - (no alignment necessary)

Microbeam Coupler Ass'y. - KTP FIBER ALIGNMENT, (10.7)

Beam Pointing Ass'y. - KTP FIBER ALIGNMENT, (10.7)

Coupler Select Ass'y. - KTP FIBER ALIGNMENT, (10.7)

Endostat Coupler Ass'y. - KTP FIBER ALIGNMENT, (10.7)

YAG Output Coupler - YAG LASER ALIGNMENT, (10.8)

YAG Power Mode Adjustment (KTP) - (10.6)

First Turning Prism - YAG SECOND TRAIN ALIGNMENT, (10.9)

YAG Collimating Lens - YAG SECOND TRAIN ALIGNMENT, (10.9)

180 Degrees Turning Prism - (no alignment necessary)

YAG Surgical Detector - YAG DETECTOR ALIGNMENT, (10.10)

YAG Safety Detector - YAG DETECTOR ALIGNMENT, (10.10)

YAG Safety Shutter - (no alignment necessary)

Second Turning Prism - (no alignment necessary)

YAG/He-Ne Folding Mirror - YAG FIBER ALIGNMENT, (10.11)

He-Ne Collimating Lens - He-Ne LASER ALIGNMENT, (10.12)

He-Ne Light Valve - He-Ne LASER ALIGNMENT, (10.12)

He-Ne Laser - He-Ne LASER ALIGNMENT, (10.12)

Section 11

C O O L I N G   S Y S T E M

11.1 PURPOSE

Section 3 of this manual pointed out that air intakes on the left side of the Model 800 Series cabinet have to be kept unobstructed so that room air can be drawn inside. The reason for this requirement is that the krypton arc lamp on the resonator assembly generates considerable heat which has to be dissipated to the outside air. The cooling system for doing this consists of two large fans that blow room air against the heat exchanger in a closed circulating water arrangement.

Along with dissipating heat, the cooling system also maintains the temperature of the YAG rod within a narrow range, (95°F ± 5°F), while laser beams are being generated. Because the optical efficiency of a laser decreases as its operating temperature increases, limiting the temperature variation of the YAG rod is important because it helps keep the power level of the surgical beam more uniform.

11.2 FACILITY REQUIREMENTS

Laserscope document 104-2050, "Installation Requirements for KTP/532 Surgical Laser System," gives full details about the amount of free space clearance required in front of the air intakes. (A copy is included in Appendix A of this manual.)

11.3 PHYSICAL LAYOUT

A coolant reservoir tube and cap are located behind the front access door to the laser console. The cooling system is filled with about 2 U.S. gallons of de-ionized water. To gain access to other components in the water cooling system, remove the right side panel. Figure 11-1 identifies the main components and shows their approximate locations inside the cabinet. (This illustration is adapted from drawing no. 107-026.)

11.4 DESCRIPTION OF OPERATION

The schematic of the cooling system in Figure 11-2 shows the plumbing connections and has arrows to indicate the direction of water flow. During system operation the pump is turned on to force water to circulate out of the reservoir, through the heat exchanger (which resembles the radiator in an automobile) and the water manifold, and back to the reservoir. Connections on the water manifold route water to the lamp housing and several optical components on the resonator.

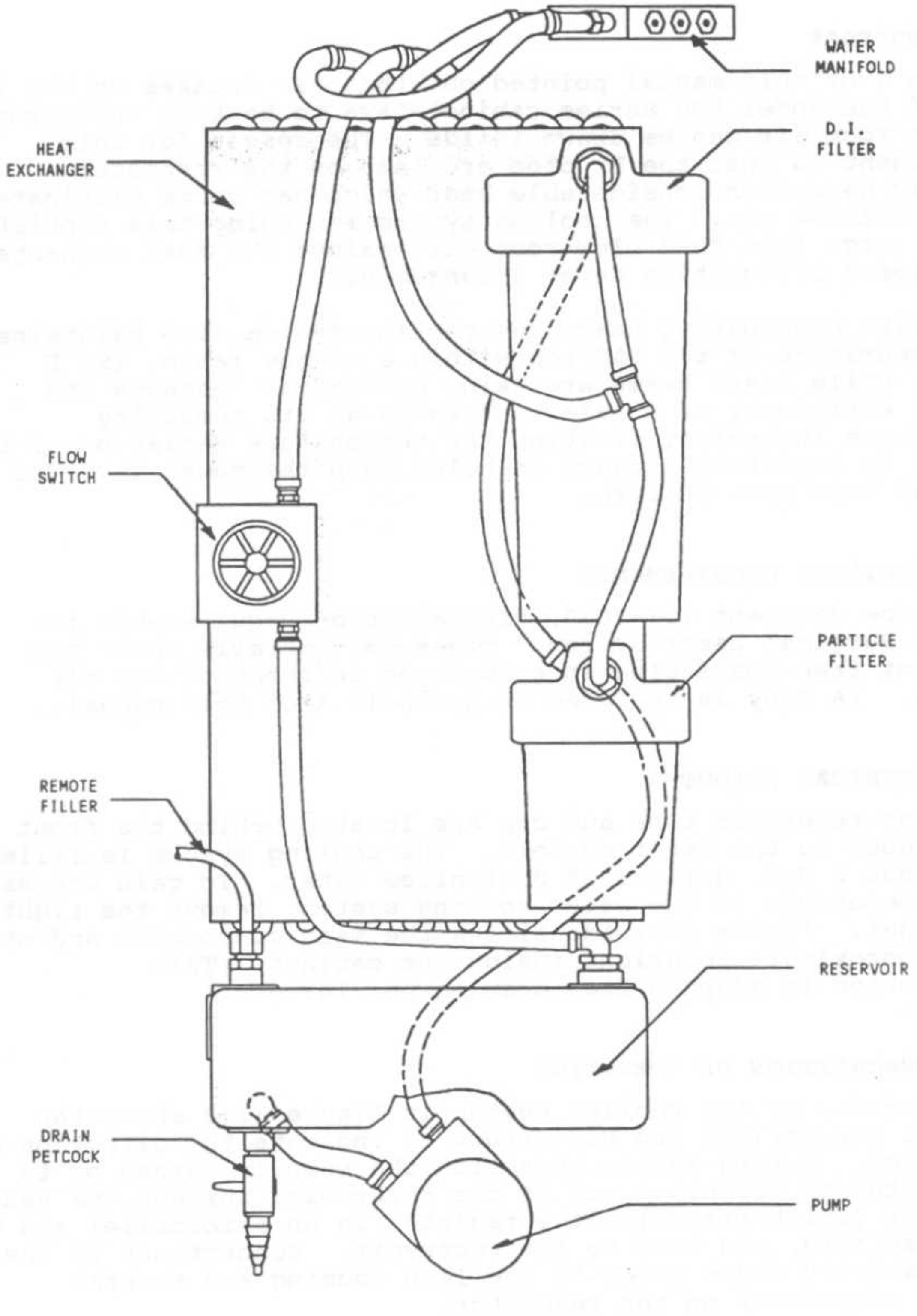


Figure 11-1. View of Cooling System

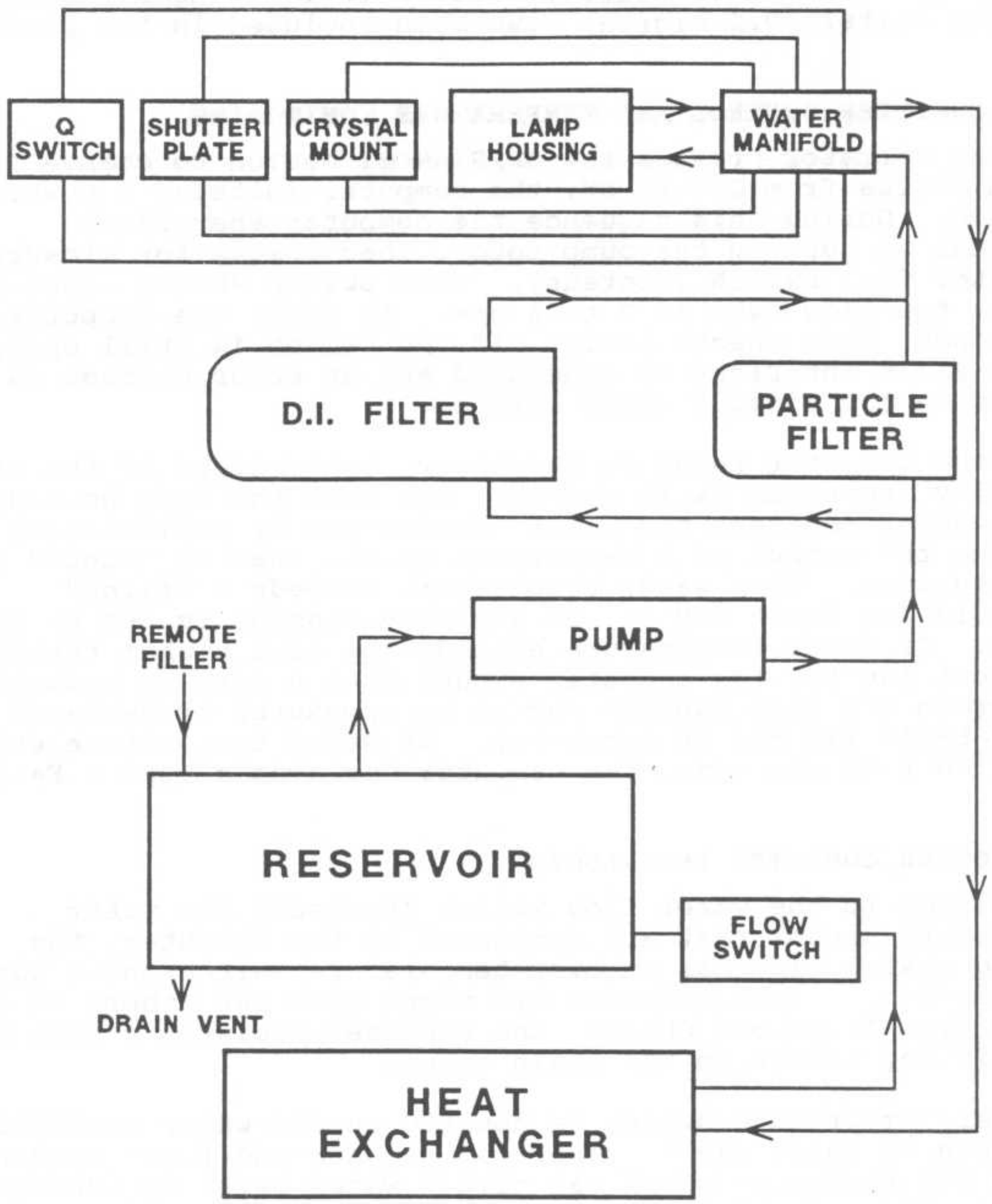


Figure 11-2. Schematic of Cooling System

The lamp is mounted inside a cavity in the lamp housing, and de-ionized water absorbs heat from the lamp as it flows through the cavity. The heated water then flows through the heat exchanger and transfers its heat to the room air, which is forced against the heat exchanger by two large fans behind the air intakes.

Because the de-ionized water comes in direct contact with the lamp while the lamp is conducting current, the water must have a resistivity greater than 500K ohms and be free of contaminants.

To maintain this water quality, both a de-ionizing cartridge and a micron filter (0.2 micron) have been included in the plumbing.

11.5 COMPUTER CONTROL AND TEMPERATURE MONITORING

After an operator presses the ON/STANDBY button to change the System Status from OFF to ON, the computer initates a powering-up sequence. During this sequence the computer energizes a contactor to turn on the pump motor, then checks for closure of the water flow switch (Proteus). This switch should close as long as the flow rate is 2 to 3 gpm. If open, the computer waits 10 seconds, then checks again. If the switch is still open, a Type 1 Fault interlock is generated and an error message is printed on the video display screen.

After the computer turns on the laser, temperature of the water gradually increases as it absorbs heat from the lamp housing. The computer monitors the water temperature by periodically checking the output of a temperture sensor that is mounted inside the reservoir. When water temperature exceeds a "first" threshold (at about 120°F), an advisory message is put on the screen. If water temperature exceeds the next higher threshold (at about 130°F), the computer either puts a warning message on the screen (if this happens during an exposure) or declares a Type 2 Fault (if not in exposure). If water temperature exceeds about 140°F at any time, the computer declares a Type 1 Fault.

11.6 OTHER COMPUTER INTERLOCKS

In addition to the water flow switch (Proteus) and water temperature sensor that are monitored by the computer, the cooling system also has an over-temperature switch and a water level switch. These switches are wired with two others in a series type Interlock Chain; the computer declares a Type 1 Fault if any switch in the chain opens.

The over-temperature switch is mounted on the water manifold and will open at about 140°F. There is an arm and float mechanism inside the reservoir which can give 2 water level indications. When the first level is reached, a type 3 fault occurs. When the second level is reached, a type 1 fault (LO30) ocurs and the system shuts down.

Table 11-1. Cooling System Maintenance Schedule

Action Item	Frequency	Procedure
Change water	If lamp fails to light	Drain water by opening petcock at bottom of reservoir. Close petcock, then pour about 2 U.S. gallons of de-ionized water down the remote filler tube.
Change De-ionizing Cartridge	If resis-tivity of DI water is less than 500K ohms, or new lamp is installed	Remove side panel, remove old cartridge, install new cartridge
Change Micron Filter	If resis-tivity of DI water is less than 500K ohm or new lamp is installed	Remove side panel, remove old filter, install new filter.

NOTES:

1. 2 U.S. Gallons = 1.6 Imperial Gallons
2. 2 U.S. Gallons = 7.57 liters

Section 12

S Y S T E M   A D D I T I O N S   A N D   C H A N G E S

12.1

A P P E N D I X   A

INSTALLATION

800 INSTALLATION REPORT

MODEL________ SYSTEM S\N________ INSTALL DATE________

CUSTOMER____

1. Visually inspect system for any damage that might have occurred during shipment. Open top cover and remove dust cover and side panels. Check to make sure the integrity of the system is intact. If not O.K., please briefly describe any fixes that were needed.

____

____

____

2. Verify line voltage with fluke meter. Please indicate hospital's power source and what setting the multi-tap transformer is set at:

208______ 220______ 240______ 380______ AT______amps.

3. Open front access door and remove filler cap from filler port. Fill with de-ionized or sterile water. Measure the waters resistivity and log down,______M ohms. (ACCEPTABLE DI WATER SHOULD BE ABOVE .5MEG.). Now go into service, screen 1A,and close relay(surg-up) to activate water pump. Add any extra water that was lost from water filing the flow paths. Once water has been running, check cooling system for any leaks. If leaks are found, please describe briefly:

____

____

____

4. Once water is filled check all the temperatures, these settings should be set to ambient room temp. If you have a external thermometer, check the P.C.B. temp. at the thermal transducer(This should be about 75 degrees). Now check the water temp. at the breather port. Lastly check the couplers temp. in reference to the P.C.B. temp. Log down the settings and indicate any adjustments you might have done:

TEMP ENDO_______
TEMP MB _______
TEMP PCB _______
TEMP WATER______

____

____

NOTE: DO NOT RESET THE REAL TIME YET, BECAUSE THIS WILL ERASE ALL THE ERROR AND POWER LOG MEMORY.

5. Now turn laser off and back on and start the laser up. Let the laser go through a complete warm up cycle and then attach a 300u fiber. Calibrate the throughput for KTP and YAG, and check to see the max. power attainable. Document the following:

	FINAL TEST	INITIAL CHECK
KTP	______%	______%
	______watts	______watts
YAG	______%	______%
	______watts	______watts

6. Go back into the service screens and list again the WATER and PCB temps. ______PCB ______WATER

NOTE: If the calibration readings are 10% less than final test data, you should then go into the resonator and troubleshoot what the cause is. Try to keep Iop lasing periods to minimum to prevent the water temp. from getting to hot.(Make sure water temp stays between 80 and

100 degrees) Once you get the laser back to maximum, make sure to document all the adjustments you had to make.(SAM,KTP,YAM AND SECOND TRAIN) Please be descriptive and also indicate the following:

	FINAL TEST	CURRENT LEVEL
KTP:	______W Ipeak_____A	______W Ipeak_____A
	______W Immax_____A	______W Immax_____A
	______W Imax______A	______W Imax______A
	______W Iop_______A	______W Iop_______A
	______W Isim_____A	______W Isim_______A
	______W CW at LAM	______W CW at LAM
	______W hi/low rf	______W hi/low rf
	______KTP temp	______W KTP temp
YAG:	______W Imax_____A	______W Imax______A
	______W Imin_____A	______W Imin______A
	______W (CW/Imax)lam	______W (CW/Imax)lam

____
____
____
____

7. Now check the power log and document 2 previous power readings:
KTP 1.______ 2.______
YAG 1.______ 2.______

8. Check the accuracy of display power verse your external power meter reading. Use KTP and check the following levels at______%:
______1.0W
______5.0W
______10W
______MAX

9. Repeat step 6 for YAG, check the following levels at ______%:
______5.0W
______10W
______30W
______MAX

10. Check the aim levels in KTP by cycling from lo, medium, and high at different power levels. ______O.K.

11. Check aim levels in YAG by cycling from lo, medium, high and blink. ______O.K.

NOTE:If there is a need to adjust calibration at any of the detectors, please describe any adjustments made and indicate the detector.(surgical,safety,aim and cal-pod)

____
____
____

12. Go into the modulation screen, in the service mode. Increase power to max using, Inc power(ATTN). Then turn modulation on and increase power to 10 watts, again using Inc power(CURR). Now note down the L Curr ______A.

13. Check the error log for any existing faults and document along with reason of what created them and why it should not happen again. Be sure to check internal and external logs.

____

____

____

NOTE: Once all checks out, clear any messages in the logs. Do this by resetting the real time.

14. Run a system auto test and log down any fault occurrences and any repairs needed.

____

____

____

15. Record system clock hours _______HRS

16. Put all covers back on, make sure all cheaters have been removed. Let laser cool down and then manually test laser, use all mode and power settings on control panel while test firing at random settings.

17. Summarize briefly on how the installation went and how the laser is working. Be sure to add any comments that would help the 800 series.

____

____

____

____

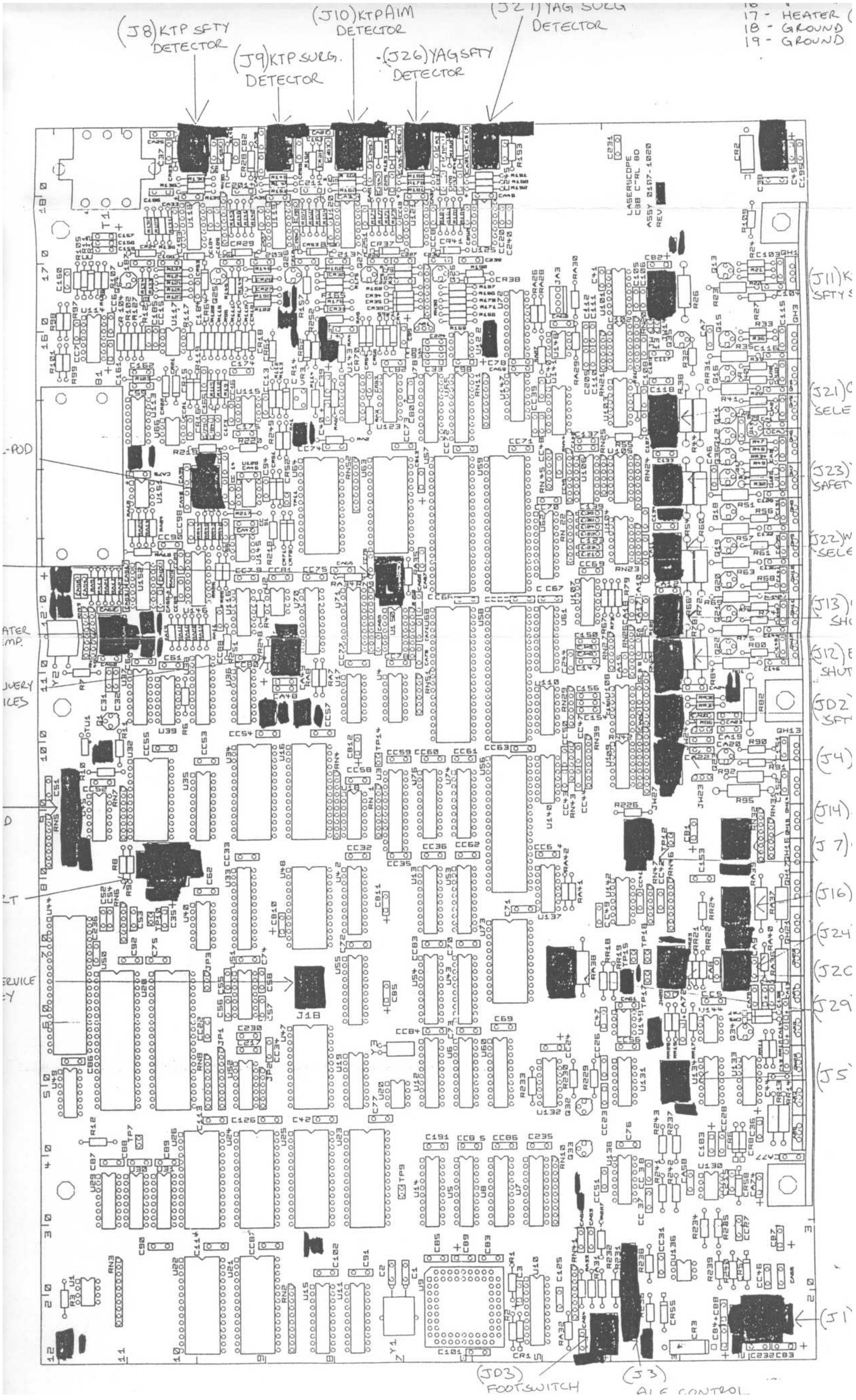
____

____

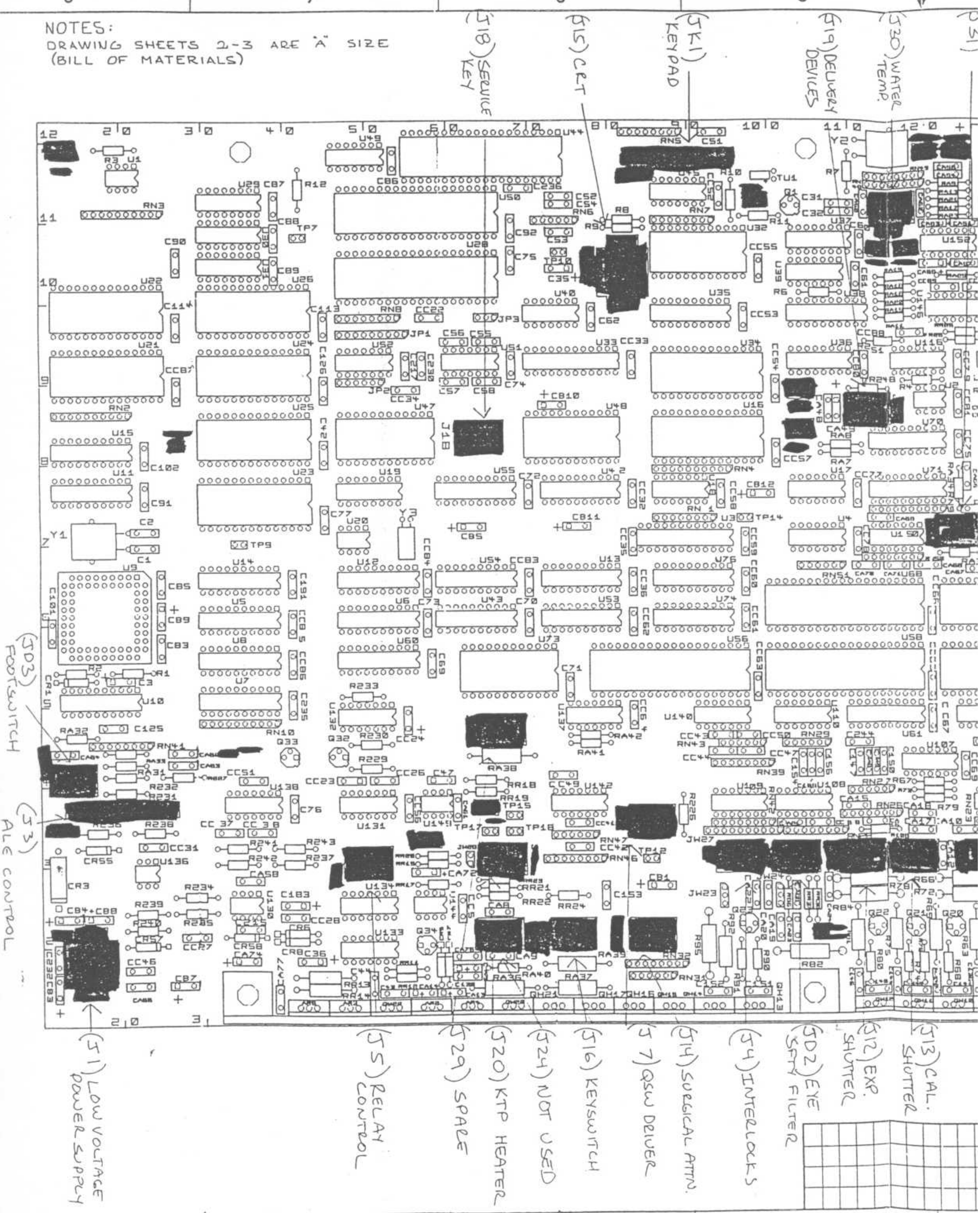
A P P E N D I X   B

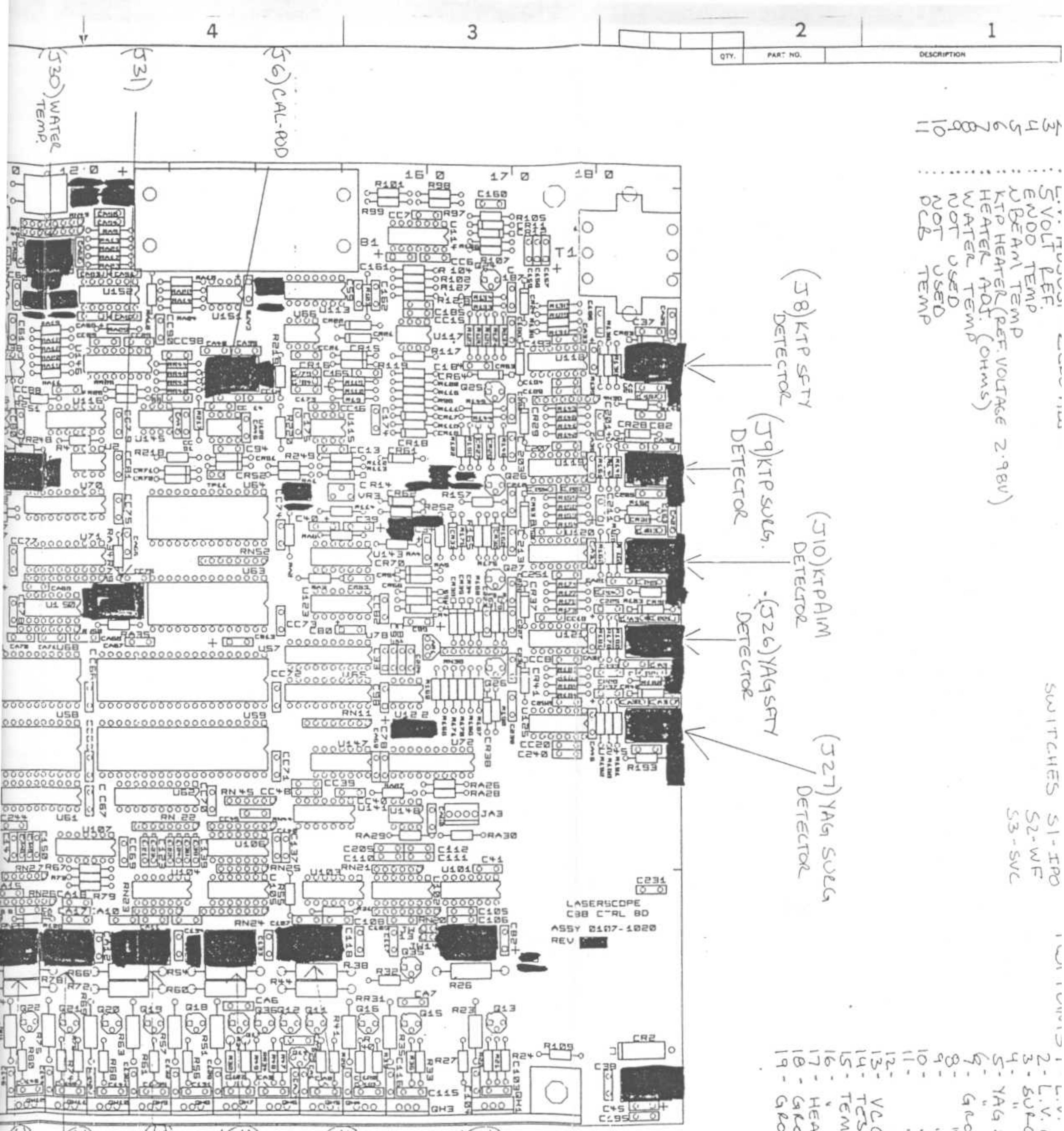
SCHEMATICS AND OTHER DRAWINGS

17 - HEATER (
18 - GROUND
19 - GROUND



NOTES:
DRAWING SHEETS 2-3 ARE "A" SIZE
(BILL OF MATERIALS)

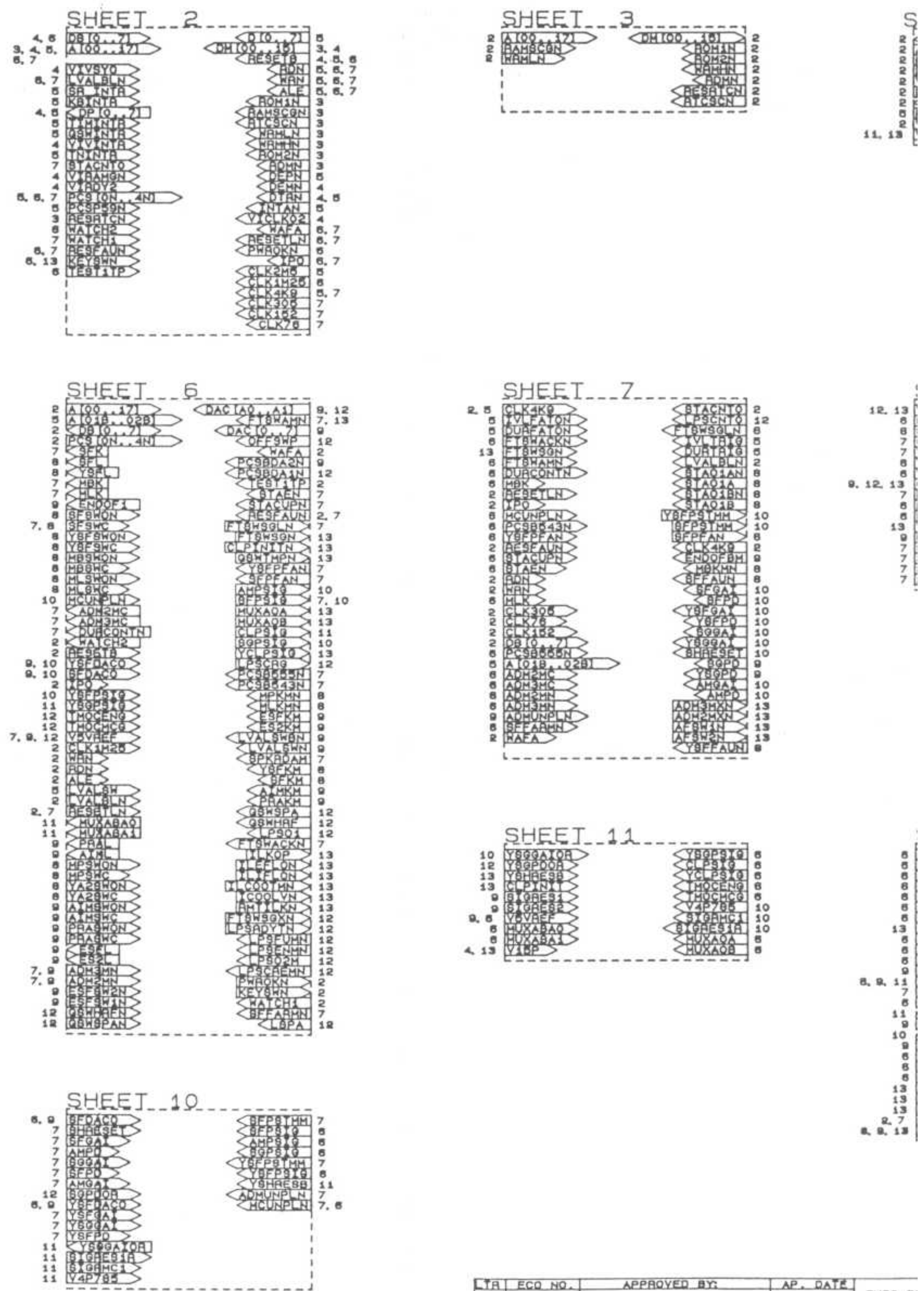




QTY.
PART NO.
DESCRIPTION
(J30) WATER TEMP.
(J31)
(J6) CAL-POD
(J8) KTP SFTY DETECTOR
(J9) KTP SURG. DETECTOR
(J10) KTP AIM DETECTOR
(J26) YAG SFTY DETECTOR
(J27) YAG SURG DETECTOR
(J12) EXP. SHUTTER
(J13) CAL. SHUTTER
(J22) WAVELENGTH SELECT
(J23) YAG SAFETY SHUTTER
(J21) COUPLER SELECT
(J11) KTP SFTY SHUTTER
4 5 VOLT REF.
5 ENDO TEMP
6 UBEAM TEMP
7 KTP HEATER (REF. VOLTAGE 2.98V)
8 HEATER ADJ. (OHMS)
9 WATER TEMP
10 NOT USED
11 NOT USED
OCB TEMP
SWITCHES S1-IPO
S2-WF
S3-SVC
2 - L.V. GROUND
3 - SURG POW SIGNAL +
4 - " -
5 - YAG SURG POW SIG +
6 - " -
7 - GROUND
13 - VCC
14 - TEST 1
15 - TEMP SIG (KTP) -
16 - " +
17 - HEATER (NOT USED)
18 - GROUND
19 - GROUND
LASERSCOPE
CB8 C-RL BD
ASSY 0107-1020
REV
DO NOT SCALE DRAWING
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
BREAK ALL SHARP CORNERS
ASSEMBL
CB8 C
D 0107-1020

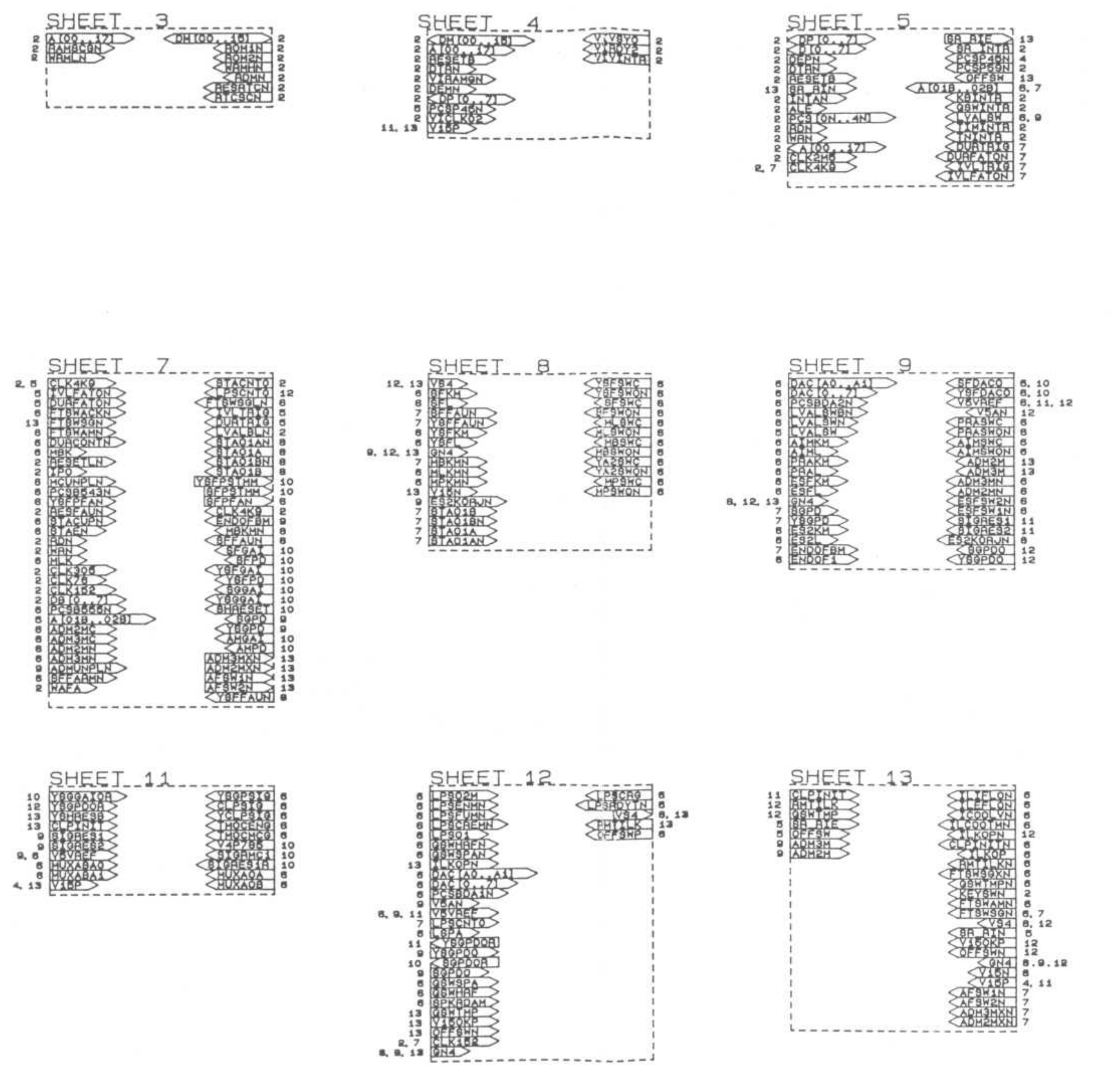
NOTE 1. FILE: CB01A

NOTE 2. UNLESS OTHERWISE SPECIFIED RESISTANCE IS IN OHMS, 1/4 W 5%



LTR	ECO NO.	APPROVED BY:	AP. DATE

MODEL	NEXT ASSY.	APPROVED BY:	AP. DATE
70X			



LTR	ECO NO.	APPROVED BY:	AP. DATE

MODEL	NEXT ASSY.	APPROVED BY:	AP. DATE	CHECKED BY:	DRAWN BY:
70X					PHIL PETERS

LASERSCOPE
3052 ORCHARD DRIVE
SAN JOSE CA 95134-2011

Title: SCH., 107-102, - SHEET TO SHEET

Size	Document Number	REV
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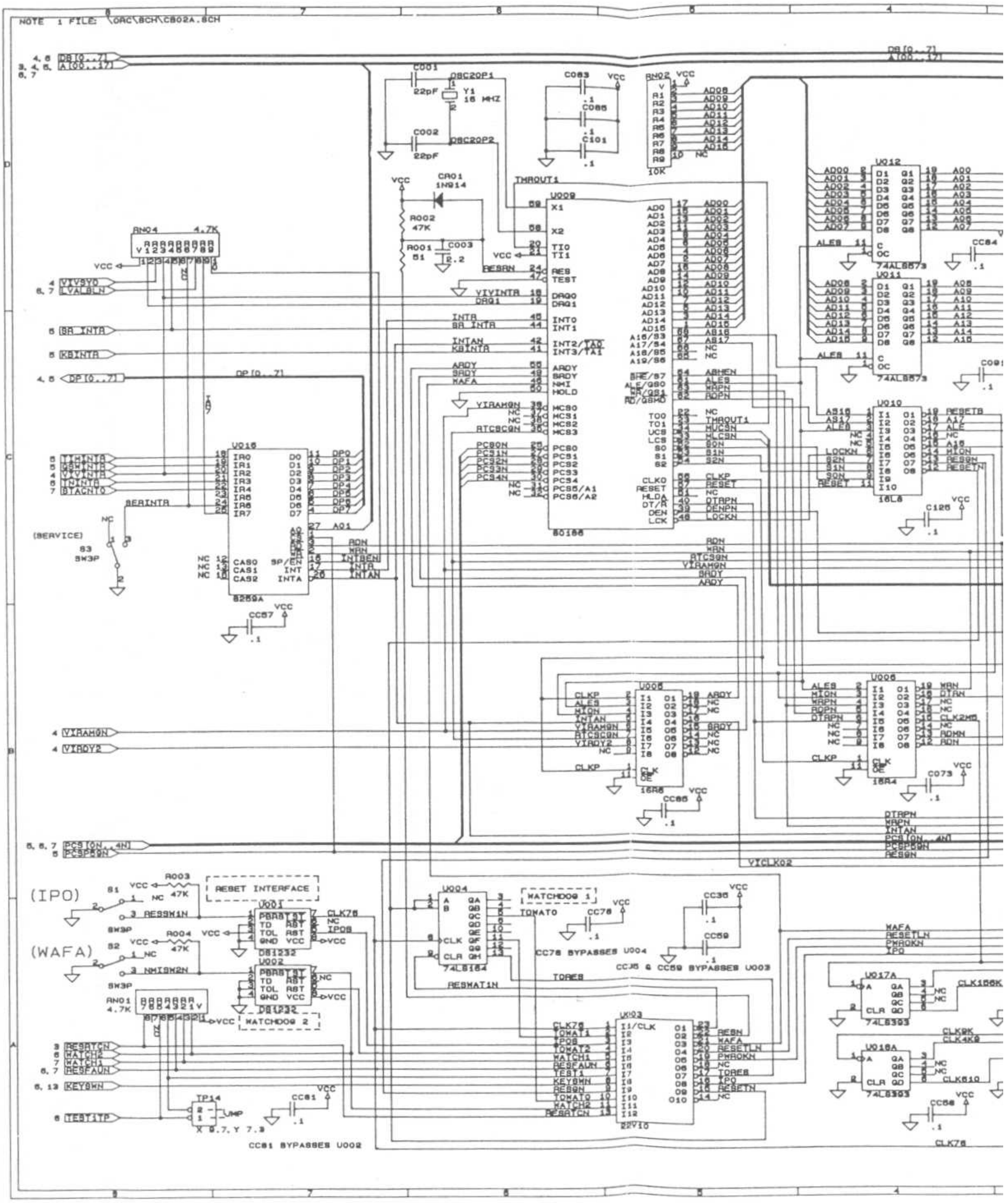
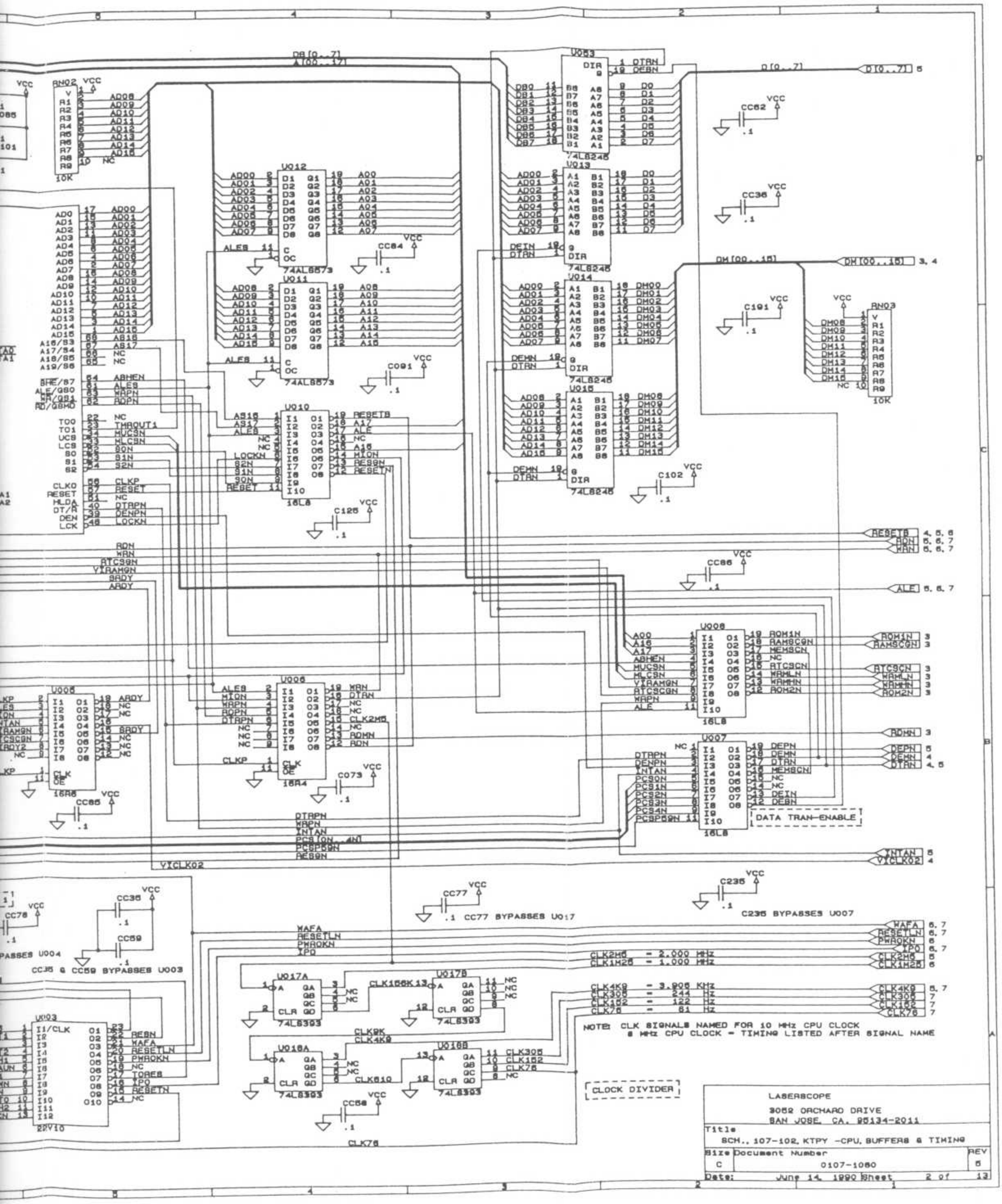
Date: June 14, 1990 Sheet 1 of 13

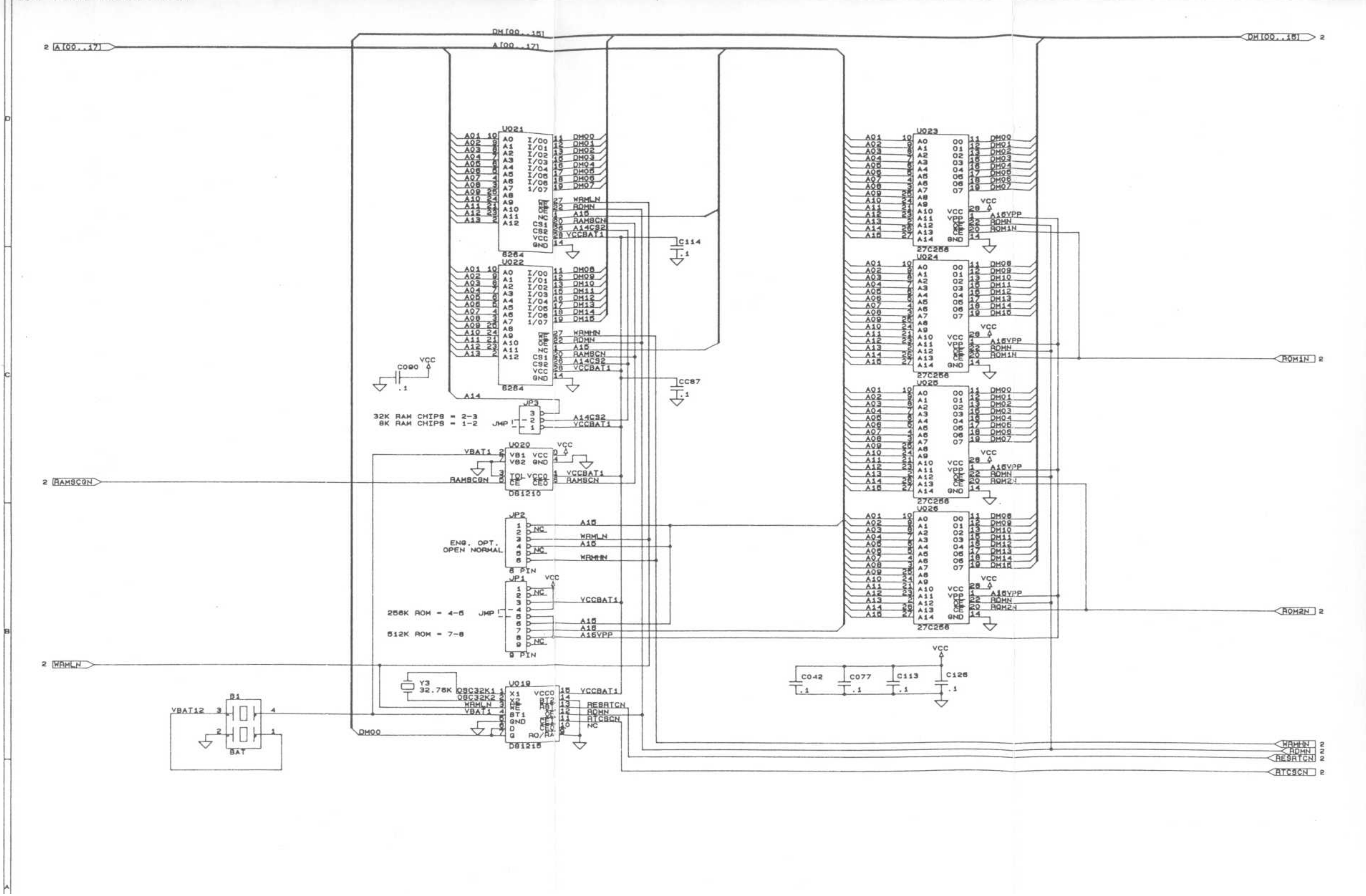


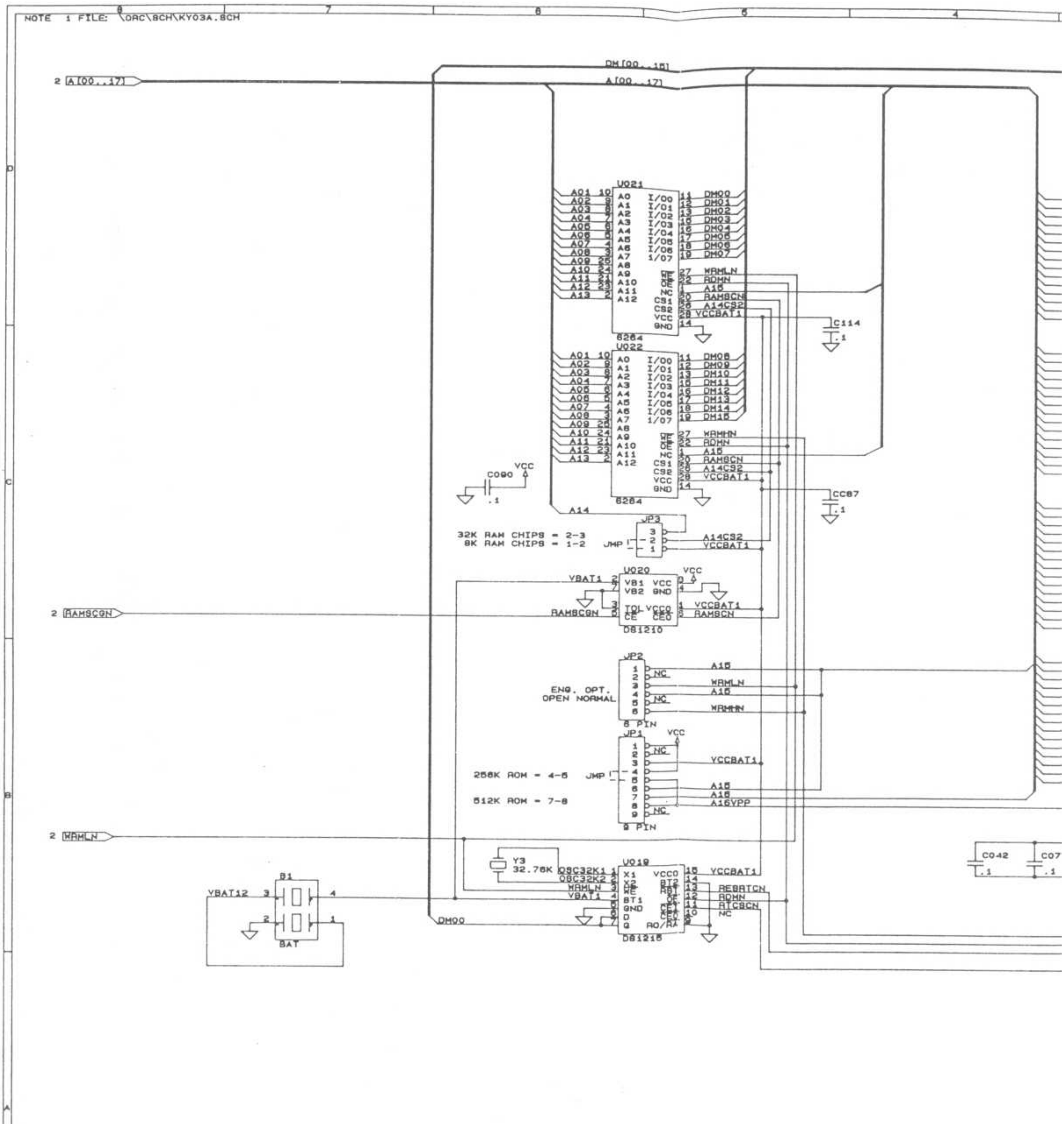
NOTE 1 FILE: \ORC\SCH\CS02A.SCH
RESET INTERFACE
WATCHDOG 1
WATCHDOG 2
(SERVICE)
(IPO)
(WAFA)
80186
8259A
74ALS573
16L8
16R8
16R4
74LS164
DS1232
22V10
74LS393
Y1 16 MHZ
CC81 BYPASSES U002
CC76 BYPASSES U004
CC35 & CC59 BYPASSES U003



NOTE: CLK SIGNALS NAMED FOR 10 MHz CPU CLOCK
8 MHz CPU CLOCK - TIMING LISTED AFTER SIGNAL NAME
CLOCK DIVIDER
DATA TRAN-ENABLE
CC77 BYPASSES U017
C235 BYPASSES U007
CC35 & CC59 BYPASSES U003
LASERSCOPE
3052 ORCHARD DRIVE
SAN JOSE, CA. 95134-2011
Title
SCH., 107-102, KTPY -CPU, BUFFERS & TIMING
Size C
Document Number 0107-1060
REV 5
Date: June 14, 1990 Sheet 2 of 13

NOTE 1 FILE: \ORC\SCH\KY03A.SCH

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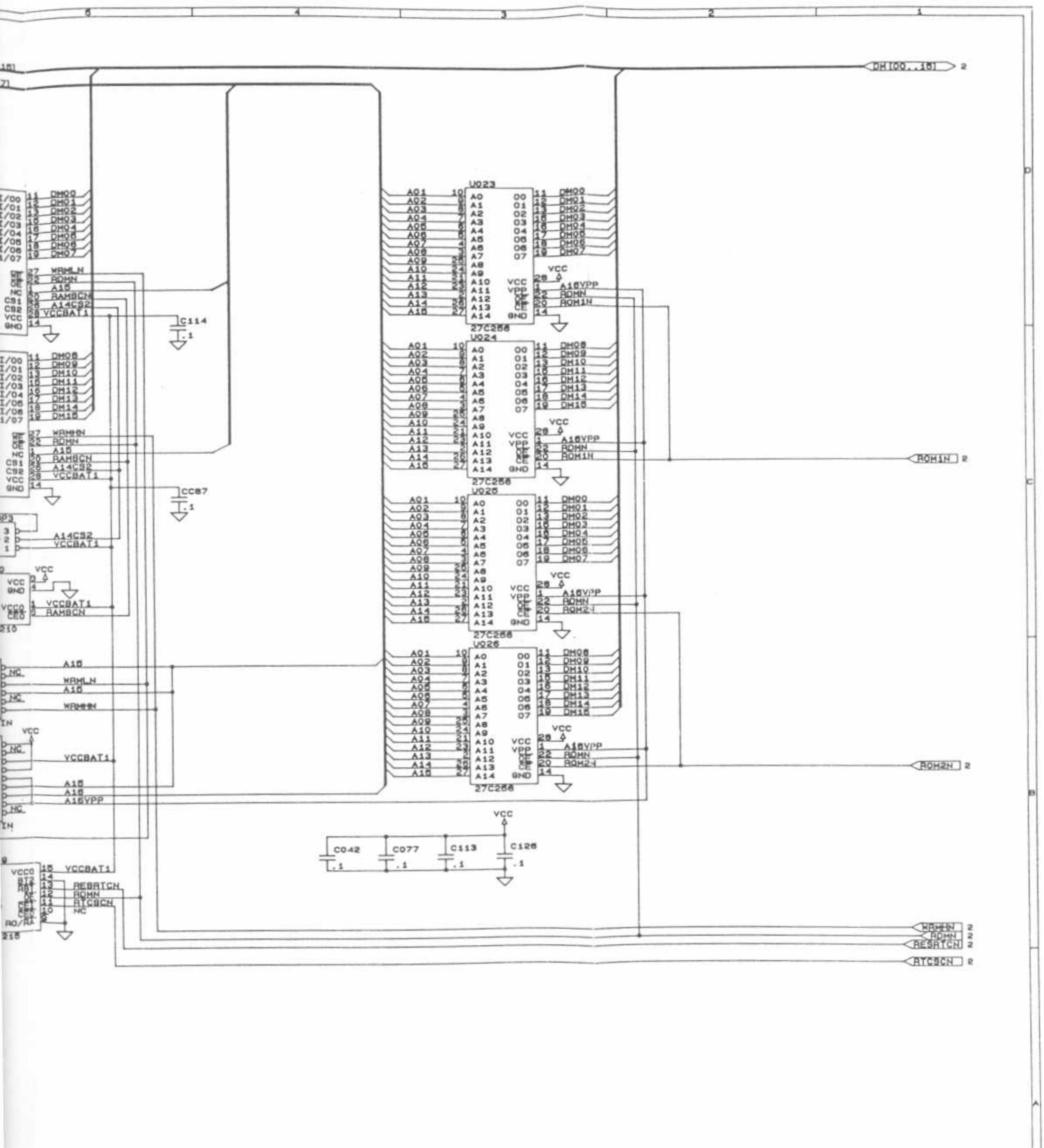
2 A[00..17]
DM[00..15]
A[00..17]
U021
6264
U022
6264
C114
CC87
C090
VCC
32K RAM CHIPS = 2-3
8K RAM CHIPS = 1-2
JP3
A14CS2
VCCBAT1
U020
DS1210
2 RAMSCGN
JP2
ENG. OPT.
OPEN NORMAL
6 PIN
JP1
256K ROM = 4-5
512K ROM = 7-8
9 PIN
A16VPP
2 WRMLN
Y3
32.76K
U019
DS1216
B1
BAT
VBAT12
C042
C07



LASERSCOPE

3052 ORCHARD DRIVE
SAN JOSE, CA. 95134-2011

Title	SCH.. 107-102, - RAM, EPROM & RTC	
Size	Document Number	REV
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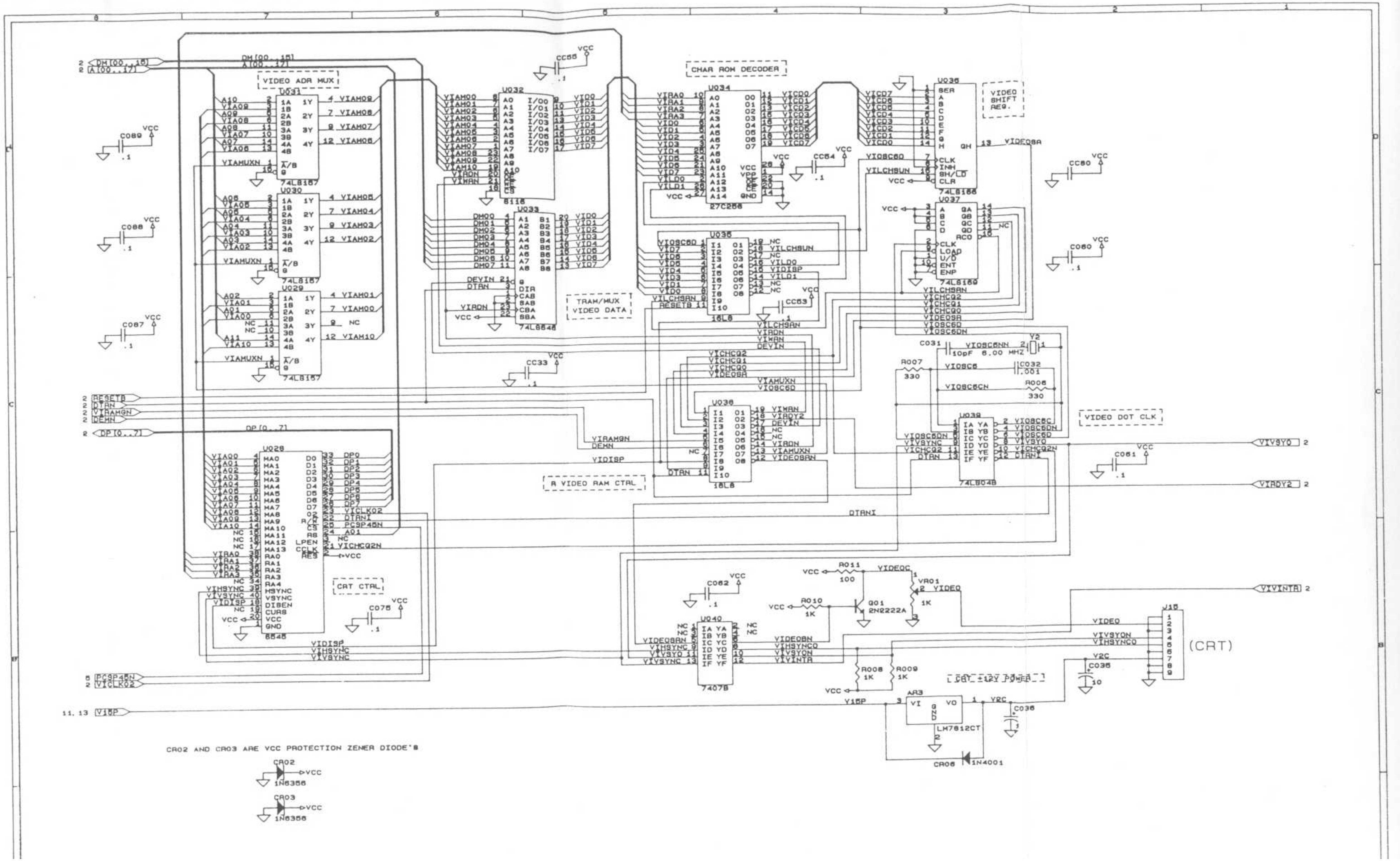
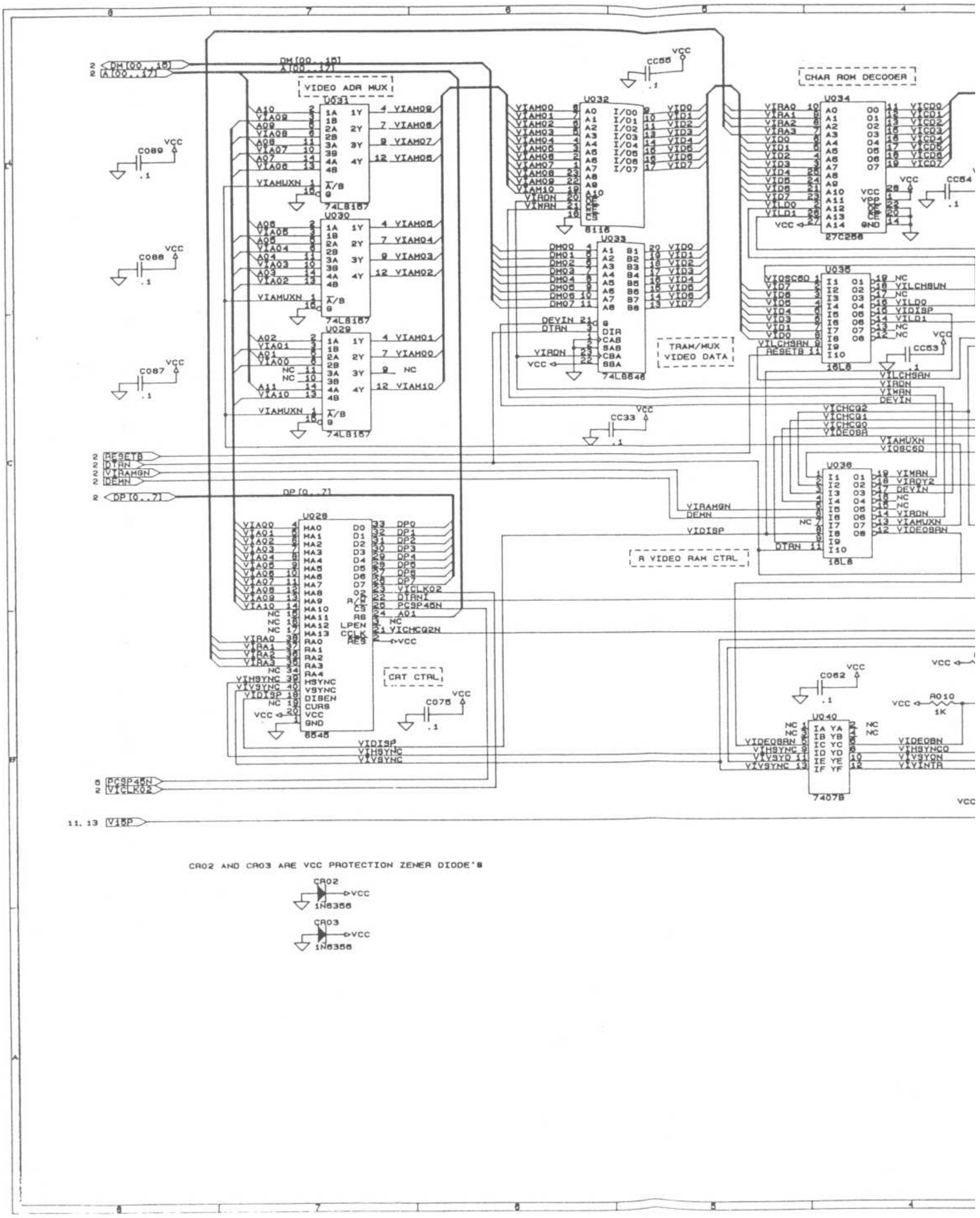
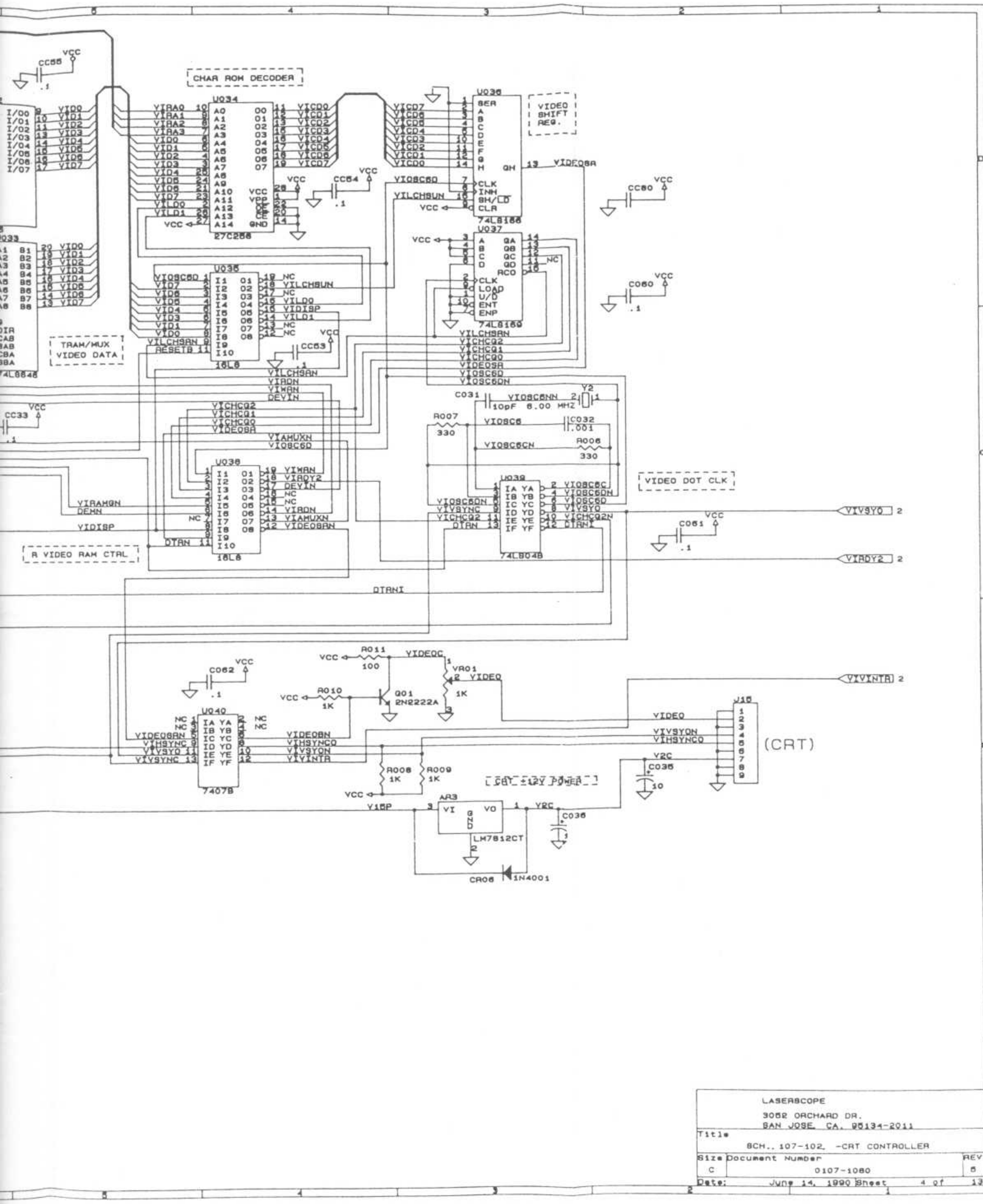
Date:	June 14, 1990 Sheet 3 of 13	

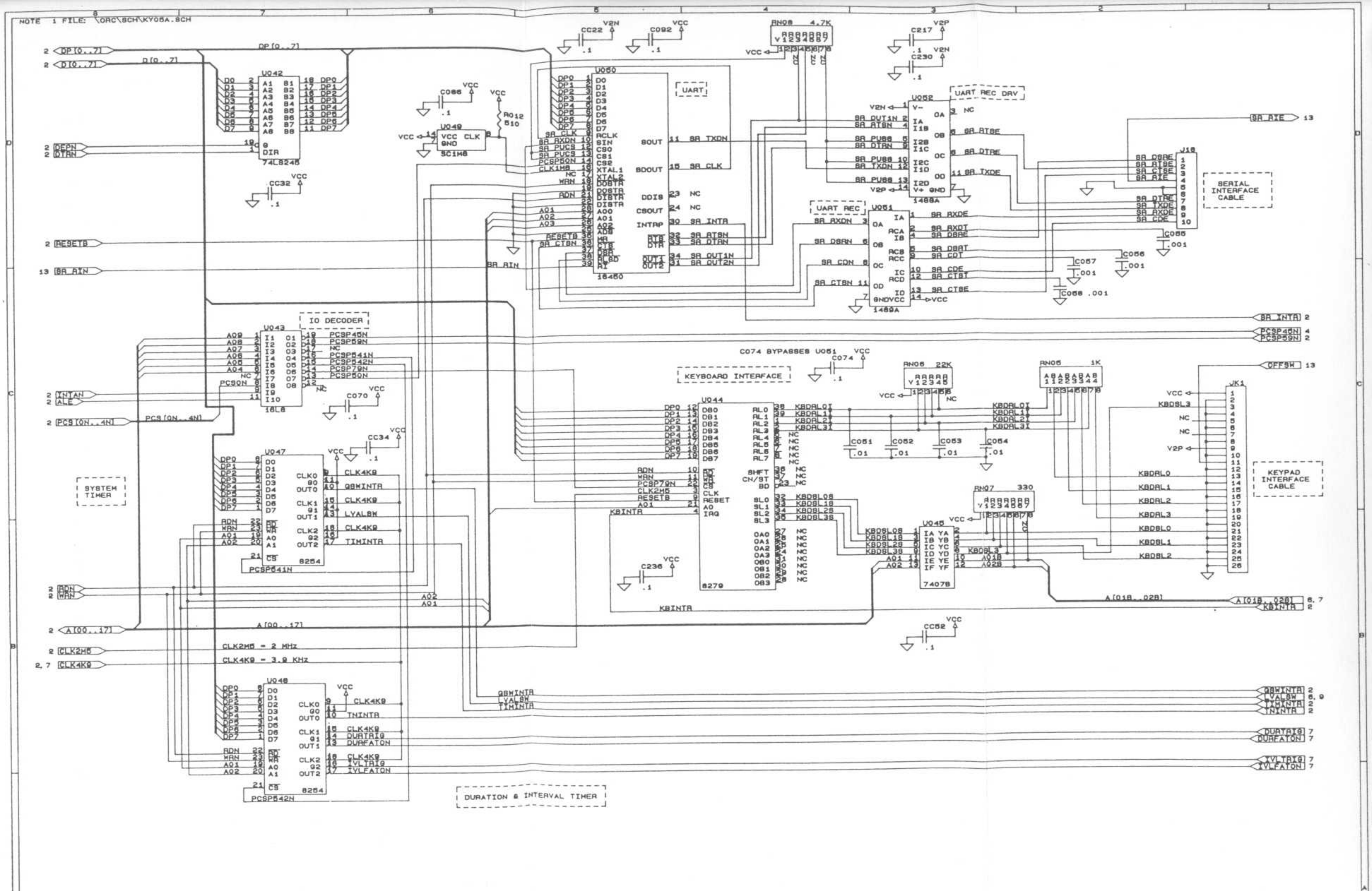

VIDEO ADR MUX
U031 74LS157
U030 74LS157
U029 74LS157
U032 6116
U033 74LS646
TRAM/MUX VIDEO DATA
CHAR ROM DECODER
U034 27C256
U035 16L8
VIDEO SHIFT REG.
U036 74LS166
U037 74LS169
U038 16L8
R VIDEO RAM CTRL
U028 6845
CRT CTRL
U039 74LS04B
VIDEO DOT CLK
Y2 6.00 MHZ
U040 7407B
Q01 2N2222A
AR3 LM7812CT
CRT +12V POWER
CR06 1N4001
J15
(CRT)
CR02 AND CR03 ARE VCC PROTECTION ZENER DIODE'S
CR02 1N6356
CR03 1N6356

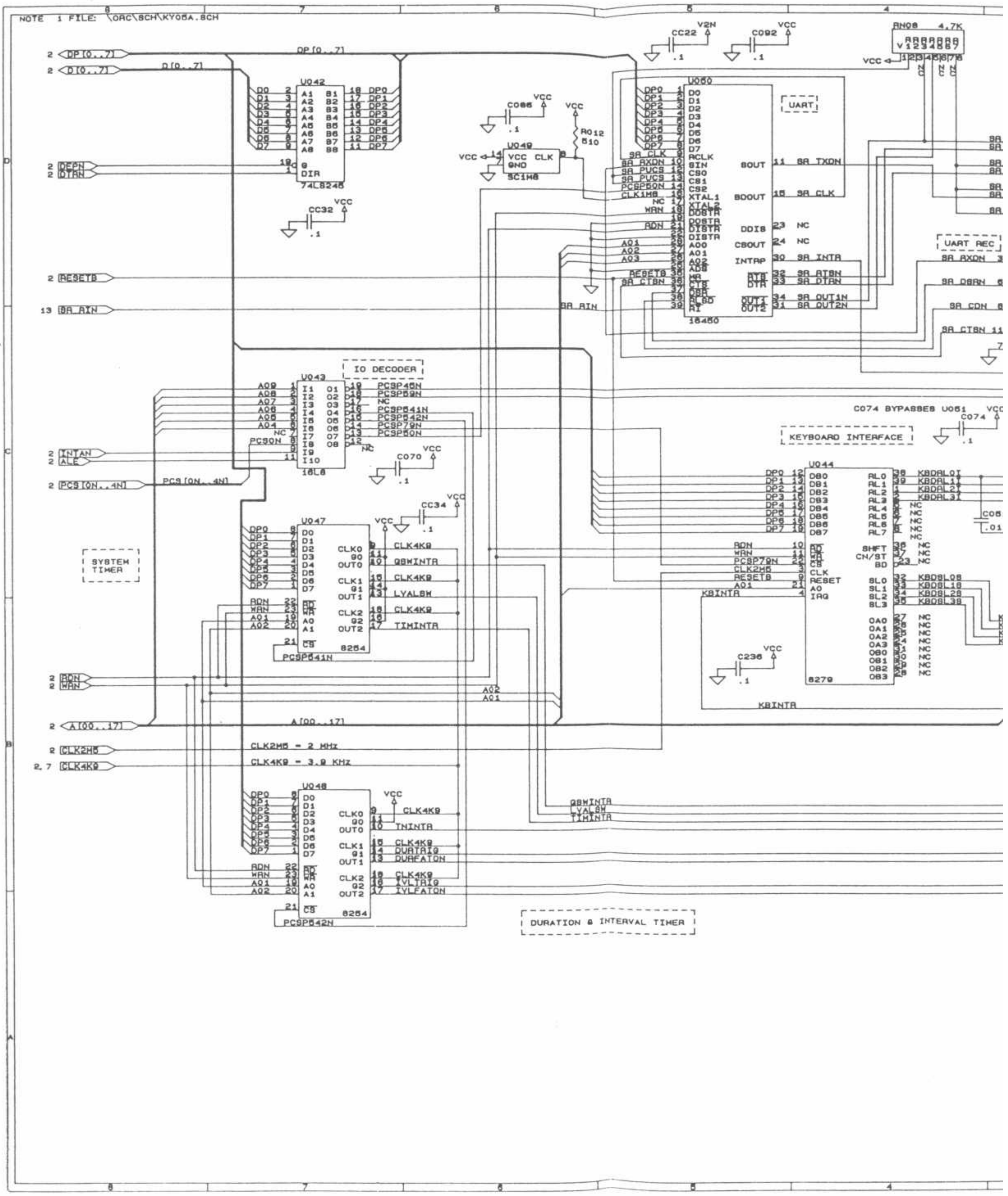


VIDEO ADR MUX
U031
74LS157
U030
74LS157
U029
74LS157
U032
6116
U033
74LS646
TRAM/MUX VIDEO DATA
CHAR ROM DECODER
U034
27C256
U035
16L8
U036
16L8
R VIDEO RAM CTRL
U028
6845
CRT CTRL
U040
7407B
CR02 AND CR03 ARE VCC PROTECTION ZENER DIODE'S
CR02
1N6356
CR03
1N6356

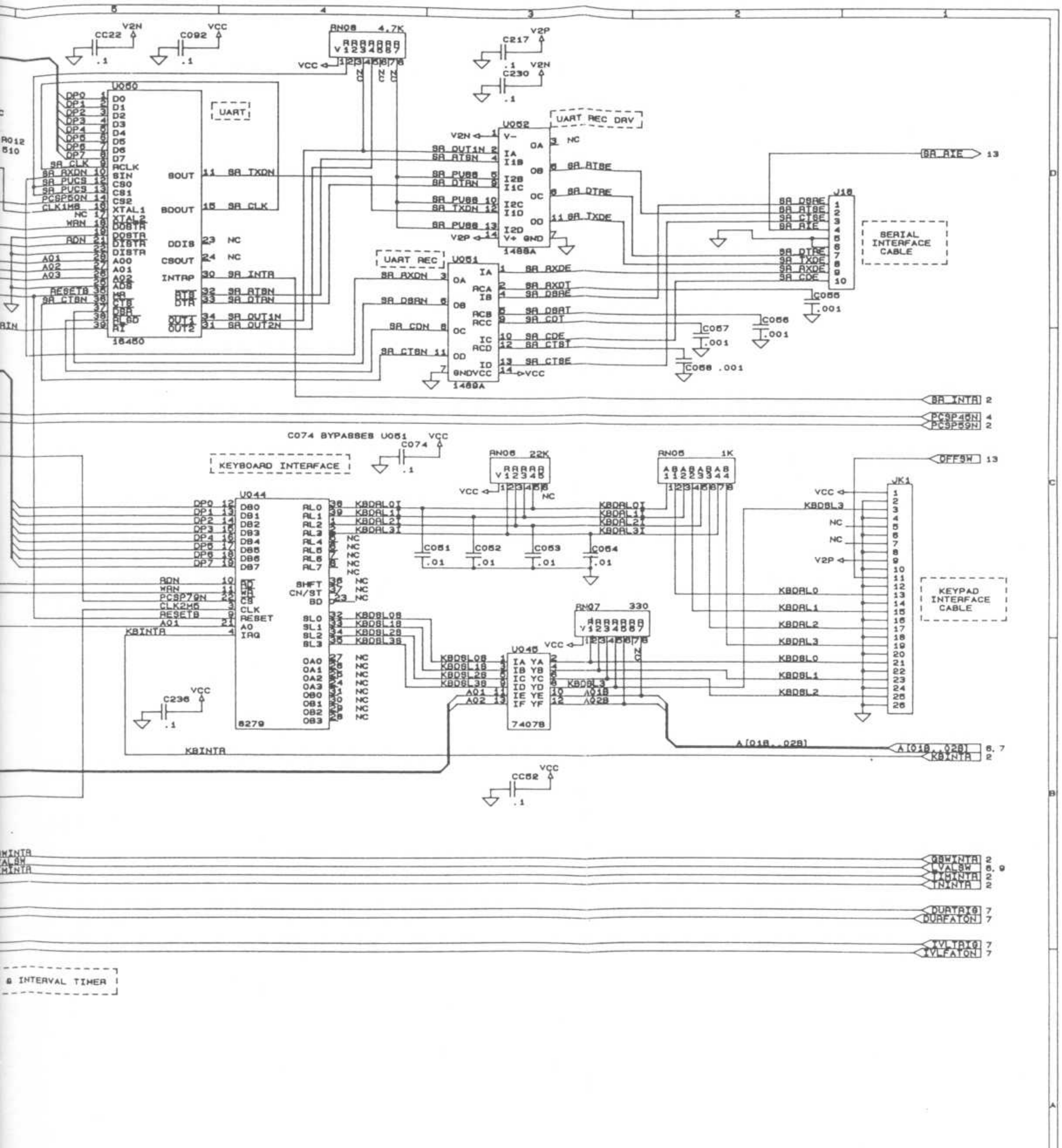


CHAR ROM DECODER
VIDEO SHIFT REG.
TRAM/MUX VIDEO DATA
R VIDEO RAM CTRL
VIDEO DOT CLK
CRT +12V POWER
(CRT)
LASERSCOPE
3052 ORCHARD DR.
SAN JOSE, CA. 95134-2011
Title
SCH., 107-102, -CRT CONTROLLER
Size C
Document Number 0107-1080
REV 5
Date: June 14, 1990 Sheet 4 of 13


NOTE 1 FILE: \ORC\SCH\KY05A.SCH
U042
74LS245
U049
SC1H8
U050
16450
UART
UART REC DRV
U052
1488A
U051
1489A
UART REC
J18
SERIAL INTERFACE CABLE
U043
16L8
IO DECODER
U047
8254
SYSTEM TIMER
C074 BYPASSES U051
KEYBOARD INTERFACE
U044
8279
RN06 22K
RN05 1K
RN07 330
U045
7407S
JK1
KEYPAD INTERFACE CABLE
CLK2M5 = 2 MHz
CLK4K9 = 3.9 KHz
U048
8254
DURATION & INTERVAL TIMER

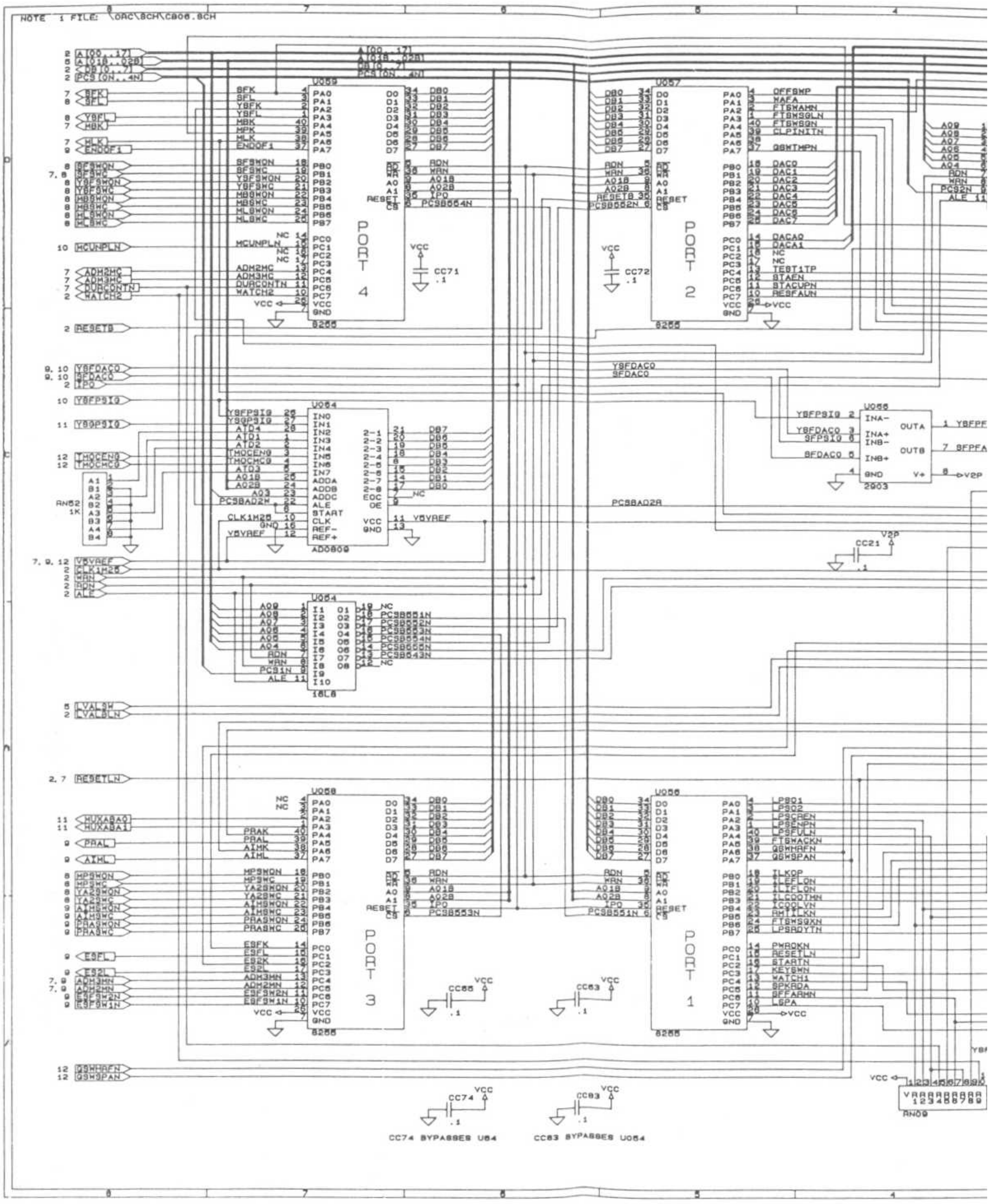


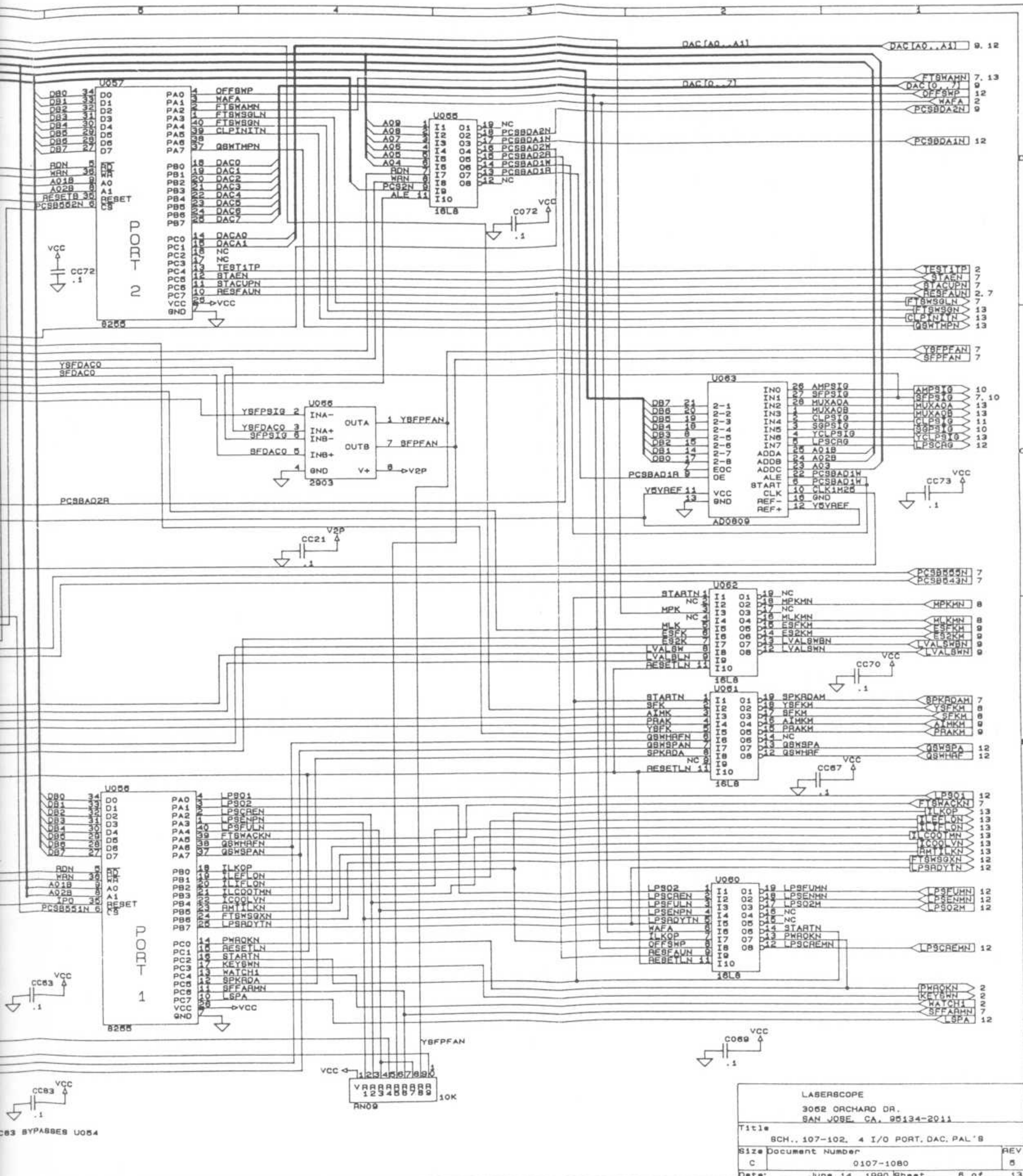
NOTE 1 FILE: \ORC\SCH\KY05A.SCH
DP[0..7]
D[0..7]
DEPN
DTRN
RESETB
SR RIN
INTAN
ALE
PCS[0N..4N]
RDN
WRN
A[00..17]
CLK2M5
CLK4K9
CLK2M5 = 2 MHz
CLK4K9 = 3.9 KHz
U042
74LS245
CC32
C086
U049
SC1M8
R012
510
CC22
V2N
C092
RN08
4.7K
U060
UART
16450
SR TXDN
SR CLK
SR INTR
SR RTSN
SR DTRN
SR OUT1N
SR OUT2N
UART REC
SR RXDN
SR DSRN
SR CDN
SR CTSN
IO DECODER
U043
16L8
PCSP45N
PCSP59N
PCSP541N
PCSP542N
PCSP79N
PCSP50N
C070
SYSTEM TIMER
U047
8254
CC34
CLK4K9
QSWINTR
LYALSW
TIMINTR
PCSP541N
C074 BYPASSES U061
C074
KEYBOARD INTERFACE
U044
8279
KBDRL0I
KBDRL1I
KBDRL2I
KBDRL3I
KBDSL0S
KBDSL1S
KBDSL2S
KBDSL3S
KBINTR
C236
U048
8254
TNINTR
DURTRIG
DURFATON
IVLTRIG
IVLFATON
PCSP542N
DURATION & INTERVAL TIMER

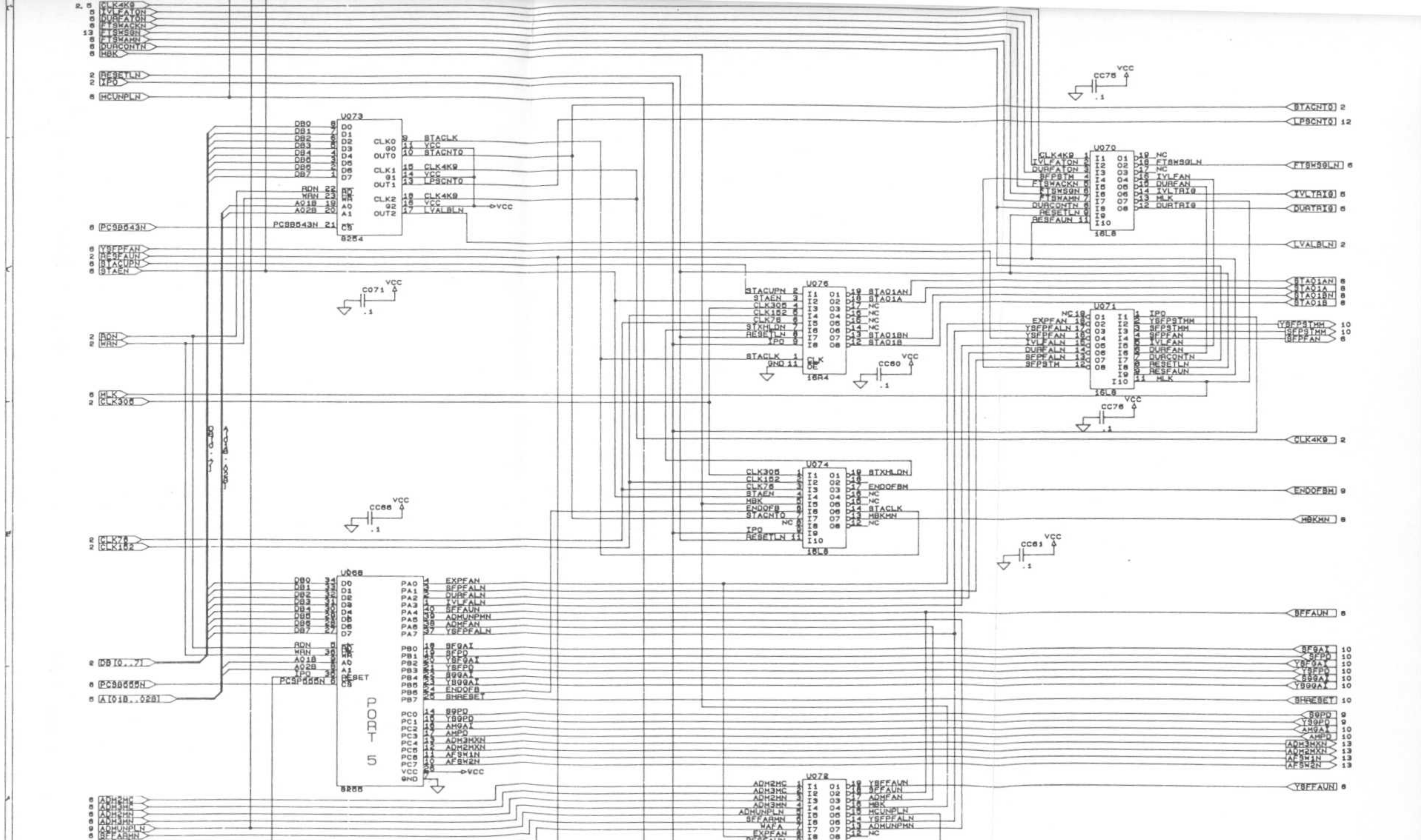


LASERSCOPE
3052 ORCHARD DR.
SAN JOSE, CA. 95134-2011

Title	SCH., 107-102, -KBD CTRL, TIMERS, UART
Size: C	Document Number: 0107-1060	REV: 5
Date:	June 14, 1990	Sheet 5 of 13

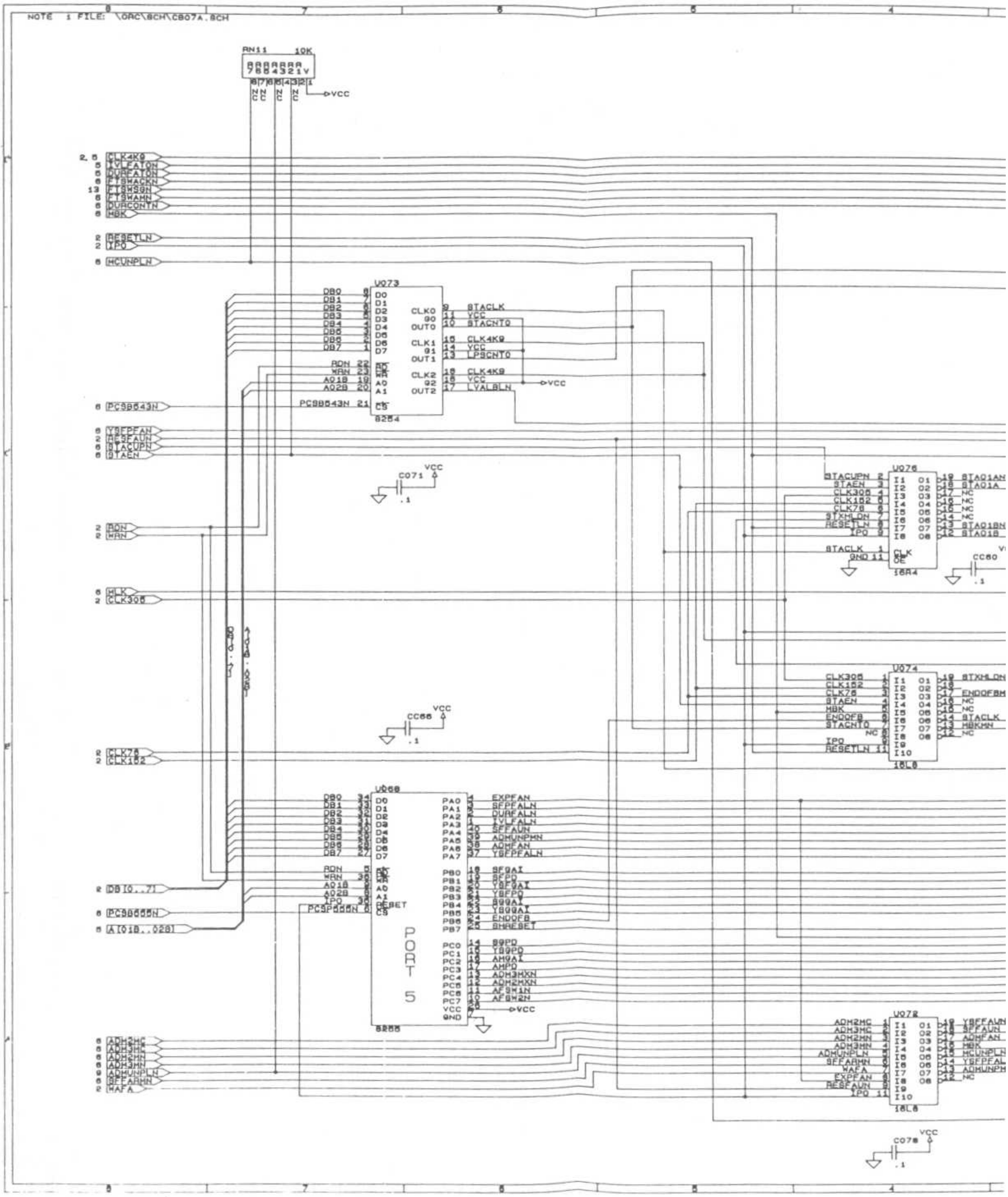

NOTE 1 FILE: \ORC\SCH\C806.SCH
PORT 4
PORT 2
PORT 3
PORT 1
U059
U057
U058
U056
U064
U054
U066
8255
AD0809
16L8
2903
RN52 1K
RN09
CC71 .1
CC72 .1
CC68 .1
CC63 .1
CC21 .1
CC74 .1
CC83 .1
CC74 BYPASSES U64
CC83 BYPASSES U054
RESETB
RESETLN
YSFDACO
SFDACO
IPO
YSFPSIG
YSGPSIG
V5VREF
CLK1M25
WRN
RDN
ALE
LVALSW
LVALSLN
QSWHAFN
QSWSPAN
PCS8AD2N

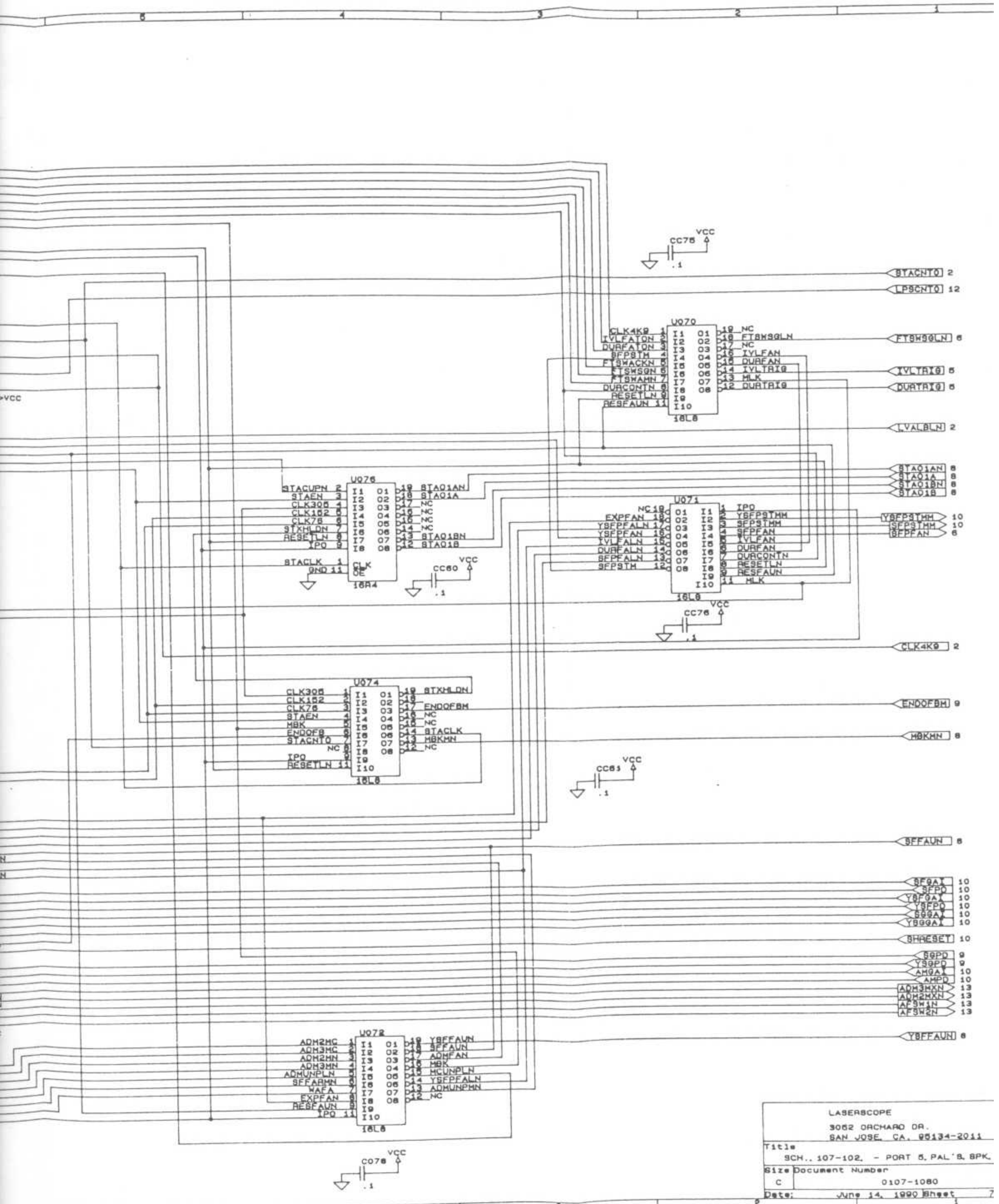

U057
8255
PORT 2
U065
16L8
U066
2903
U063
AD0809
U062
16L8
U061
16L8
U056
8255
PORT 1
U060
16L8
RN09
10K
CC63 BYPASSES U054
LASERSCOPE
3052 ORCHARD DR.
SAN JOSE, CA. 95134-2011
Title
SCH., 107-102, 4 I/O PORT, DAC, PAL'S
Size C
Document Number 0107-1080
REV 5
Date: June 14, 1990
Sheet 6 of 13



LASERSCOPE
3052 ORCHARD DR.
SAN JOSE, CA. 95134-2011

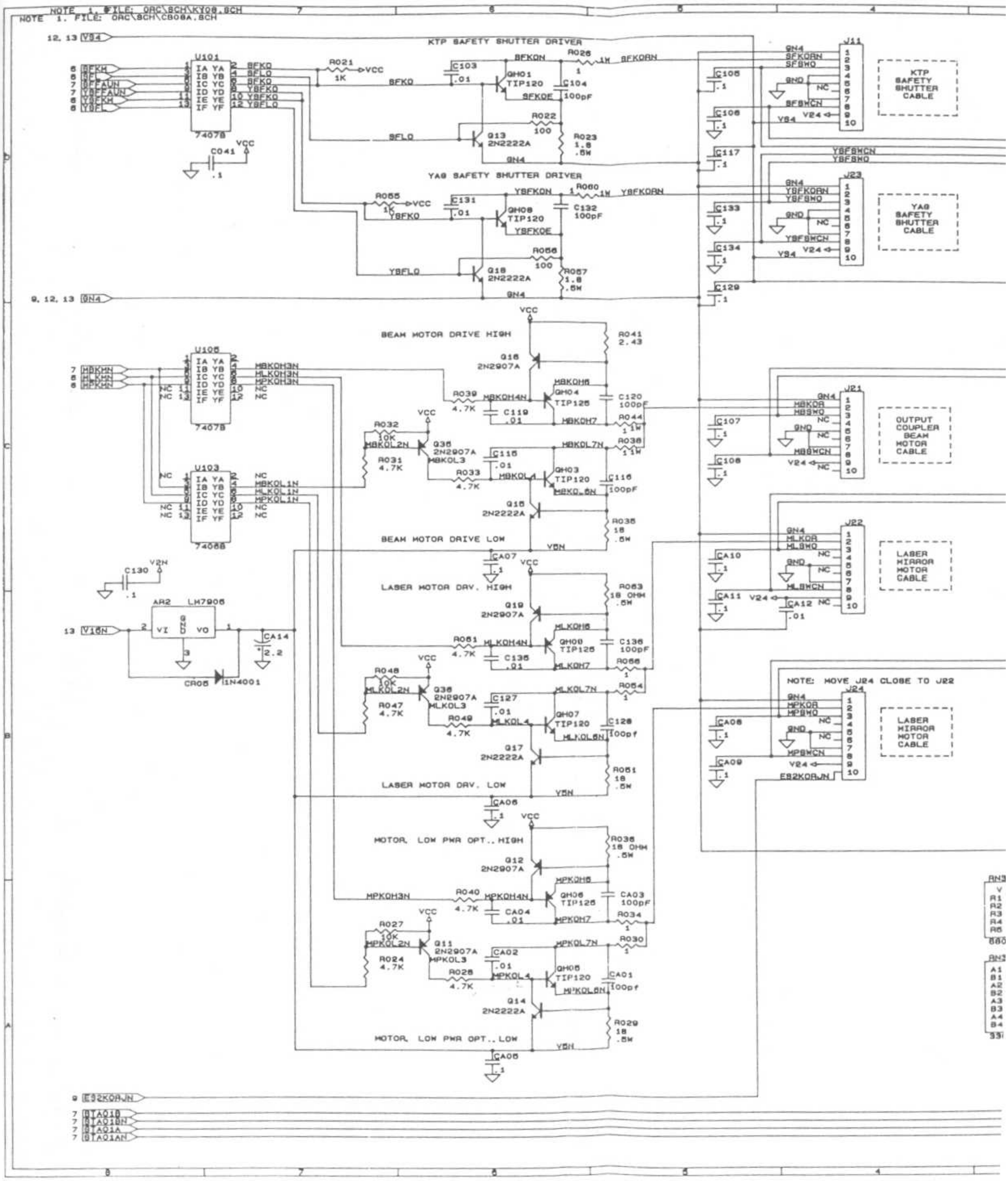
Title: SCH., 107-102, - PORT 5, PAL'S, SPK, MISC.		
Size: C	Document Number: 0107-1080	REV: 5
Date: June 14, 1990	Sheet 7 of 13	

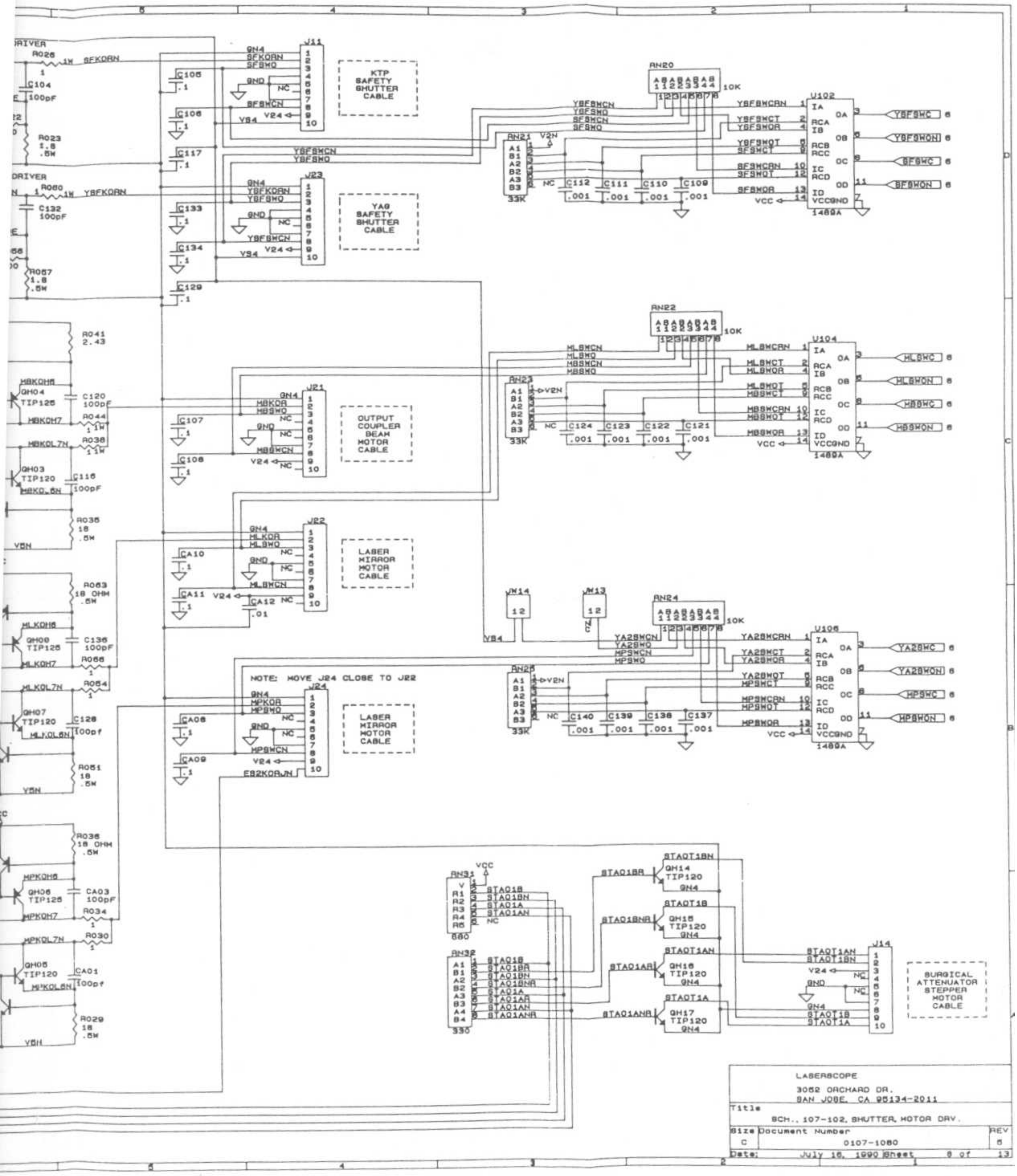

NOTE 1 FILE: \ORC\SCH\C807A.SCH
RN11 10K
U073
8254
U068
PORT 5
8255
U076
16R4
U074
16L8
U072
16L8
CLK4K9
IVLFATON
DURFATON
FTSWACKN
FTSWSGN
FTSWAMN
DURCONTN
HBK
RESETLN
IPO
HCUNPLN
PCS8543N
YSFPFAN
RESFAUN
STACUPN
STAEN
RDN
WRN
HLK
CLK308
CLK78
CLK152
DB[0..7]
PCS8855N
A[01B..02B]
ADH2HC
ADH3HC
ADH2HN
ADH3HN
ADHUNPLN
SFFARMN
WAFA
STACLK
STACNT0
LPSCNT0
LVALBLN
C071
CC66
CC60
C078
VCC
EXPFAN
SFPFALN
DURFALN
IVLFALN
SFFAUN
ADHUNPMN
ADHFAN
YSFPFALN
SFGAI
SFPD
YSFGAI
YSFPD
S99AI
YS99AI
ENDOFB
SHRESET
S9PD
YS9PD
AM9AI
AMPD
ADH3HXN
ADH2HXN
AFSH1N
AFSH2N
STA01AN
STA01A
STA01BN
STA01B
STXHLDN
ENDOFBM
HBKMN
YSFFAUN
SFFAUN
ADMFAN
HCUNPLN
YSFPFAL
ADHUNPM

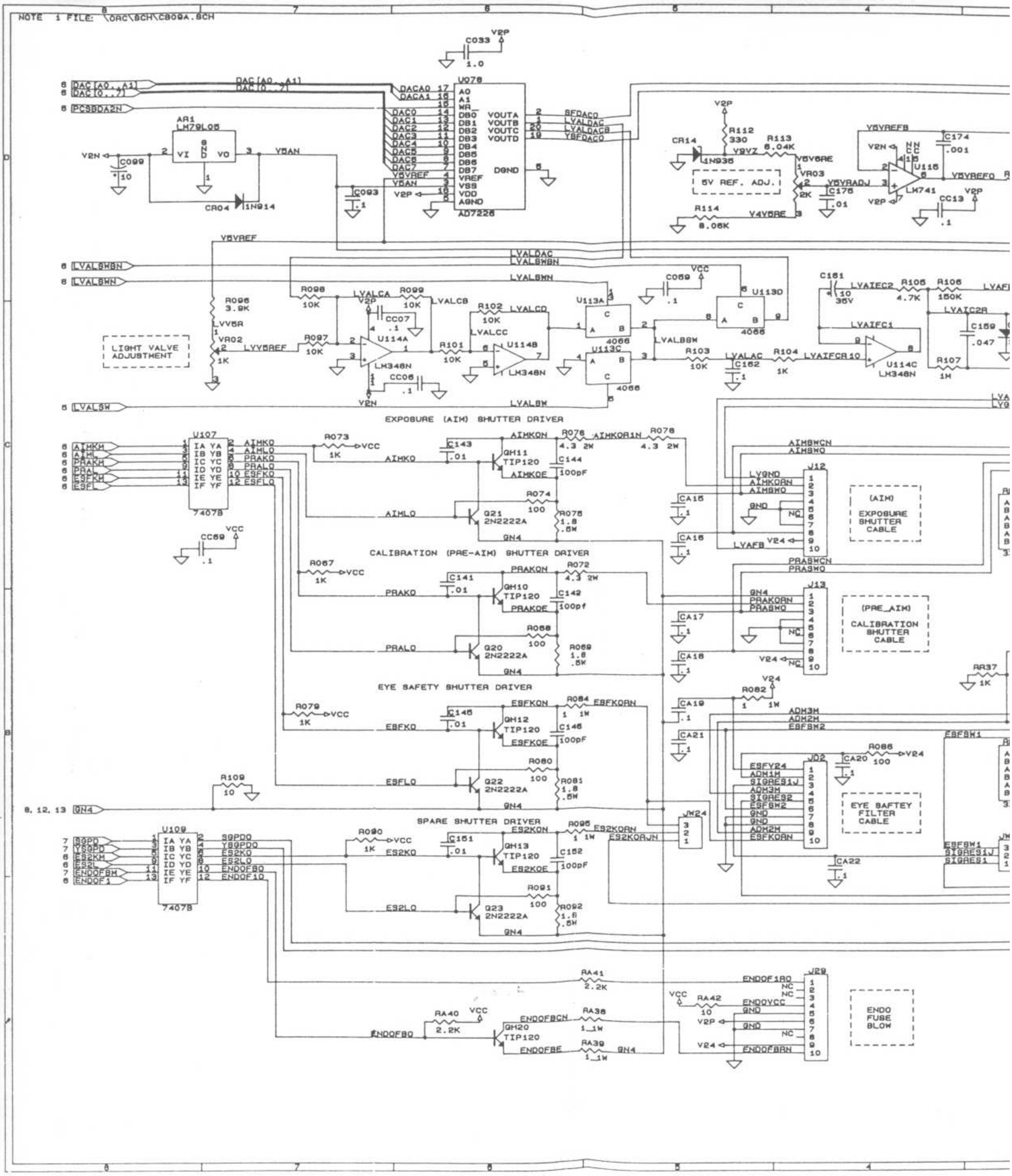


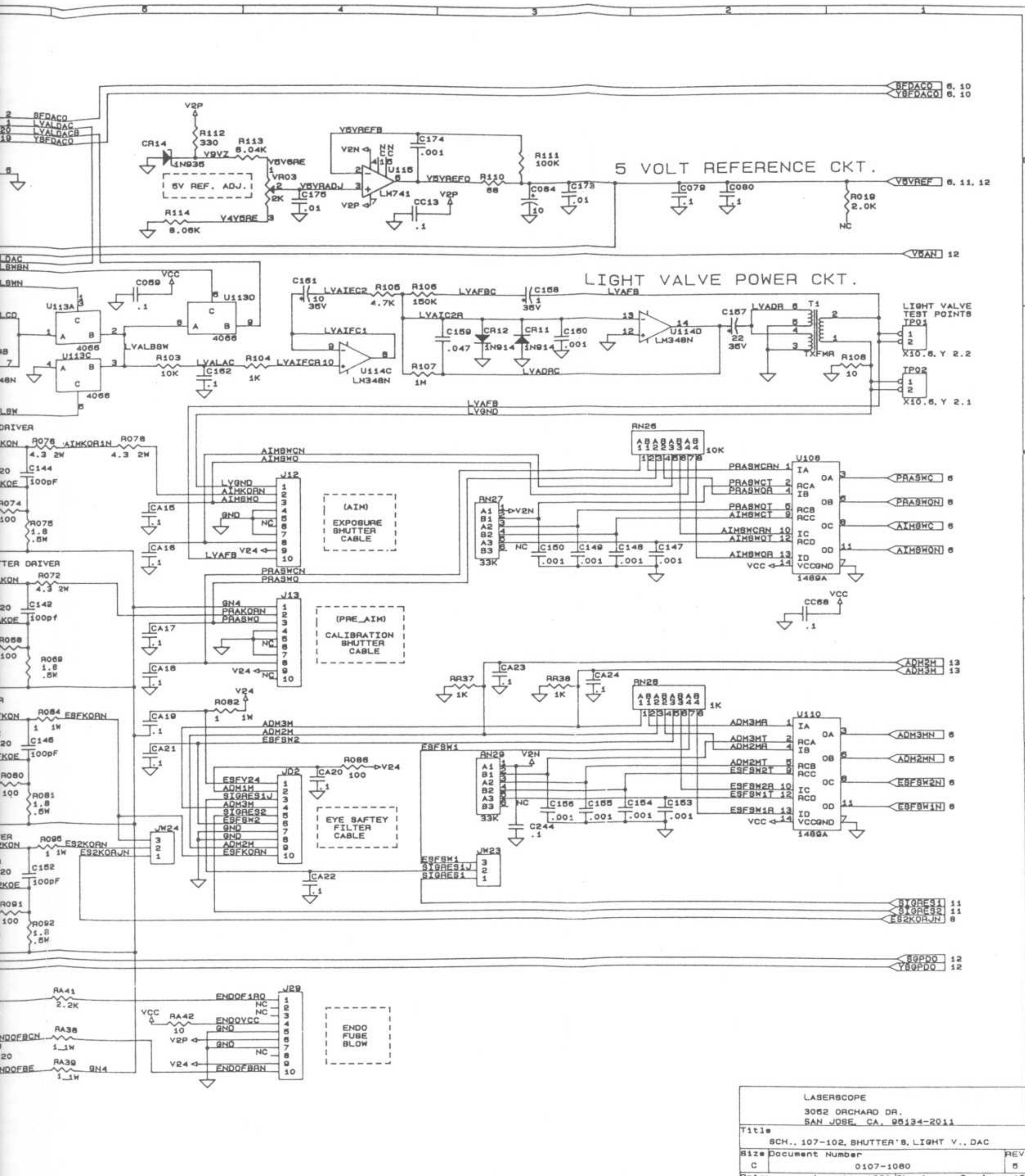
LASERSCOPE
3052 ORCHARD DR.
SAN JOSE, CA. 95134-2011

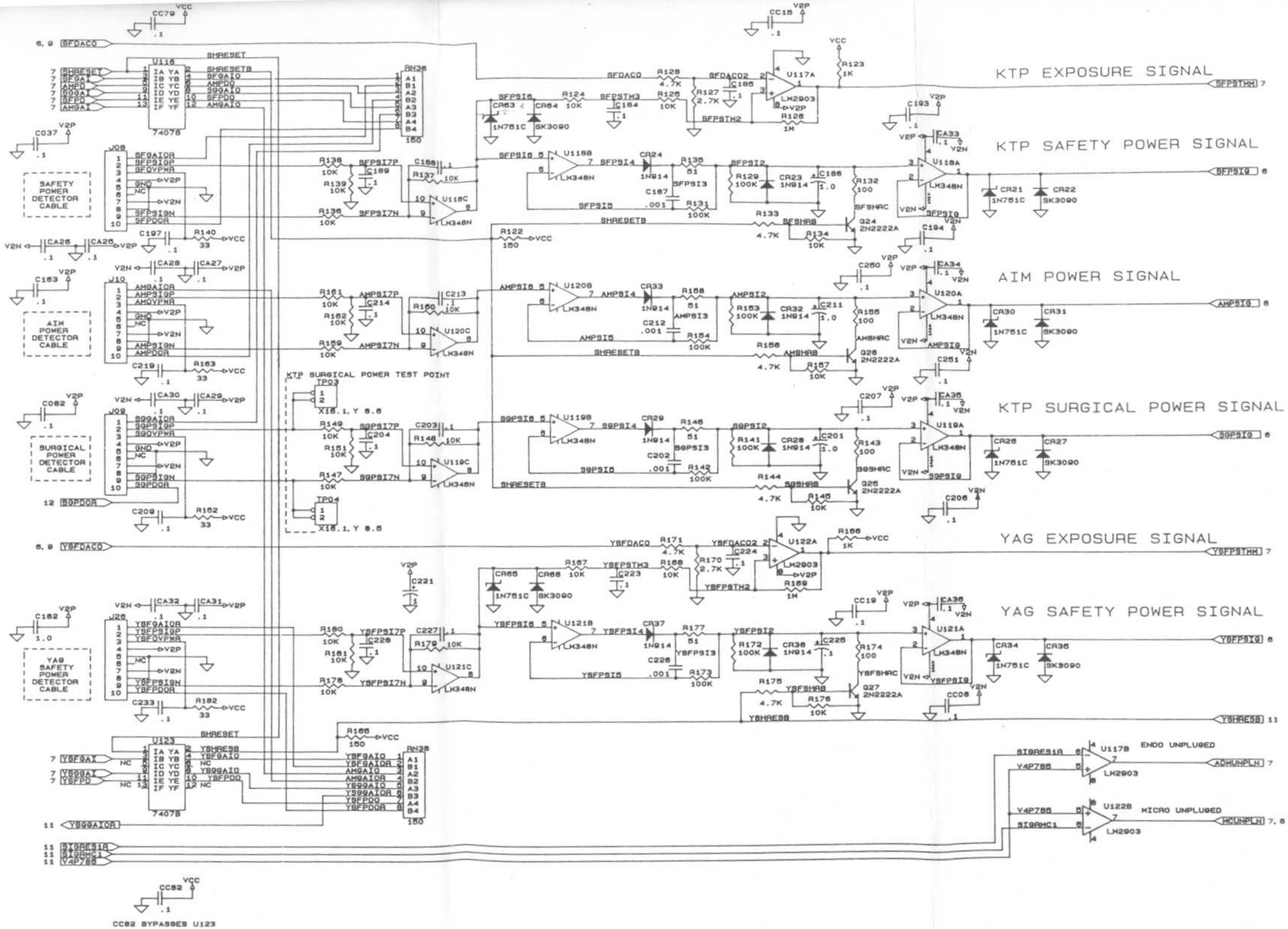
Title	SCH., 107-102, - PORT 5, PAL'S, SPK.
Size	Document Number
C	0107-1080
Date:	June 14, 1990 Sheet 7


NOTE 1. FILE: ORC\SCH\KY08.SCH
NOTE 1. FILE: ORC\SCH\CB08A.SCH
KTP SAFETY SHUTTER DRIVER
YAG SAFETY SHUTTER DRIVER
BEAM MOTOR DRIVE HIGH
BEAM MOTOR DRIVE LOW
LASER MOTOR DRV. HIGH
LASER MOTOR DRV. LOW
MOTOR, LOW PWR OPT.. HIGH
MOTOR, LOW PWR OPT.. LOW
KTP SAFETY SHUTTER CABLE
YAG SAFETY SHUTTER CABLE
OUTPUT COUPLER BEAM MOTOR CABLE
LASER MIRROR MOTOR CABLE
NOTE: MOVE J24 CLOSE TO J22
U101 7407B
U105 7407B
U103 7406B
AR2 LM7906
CR06 1N4001

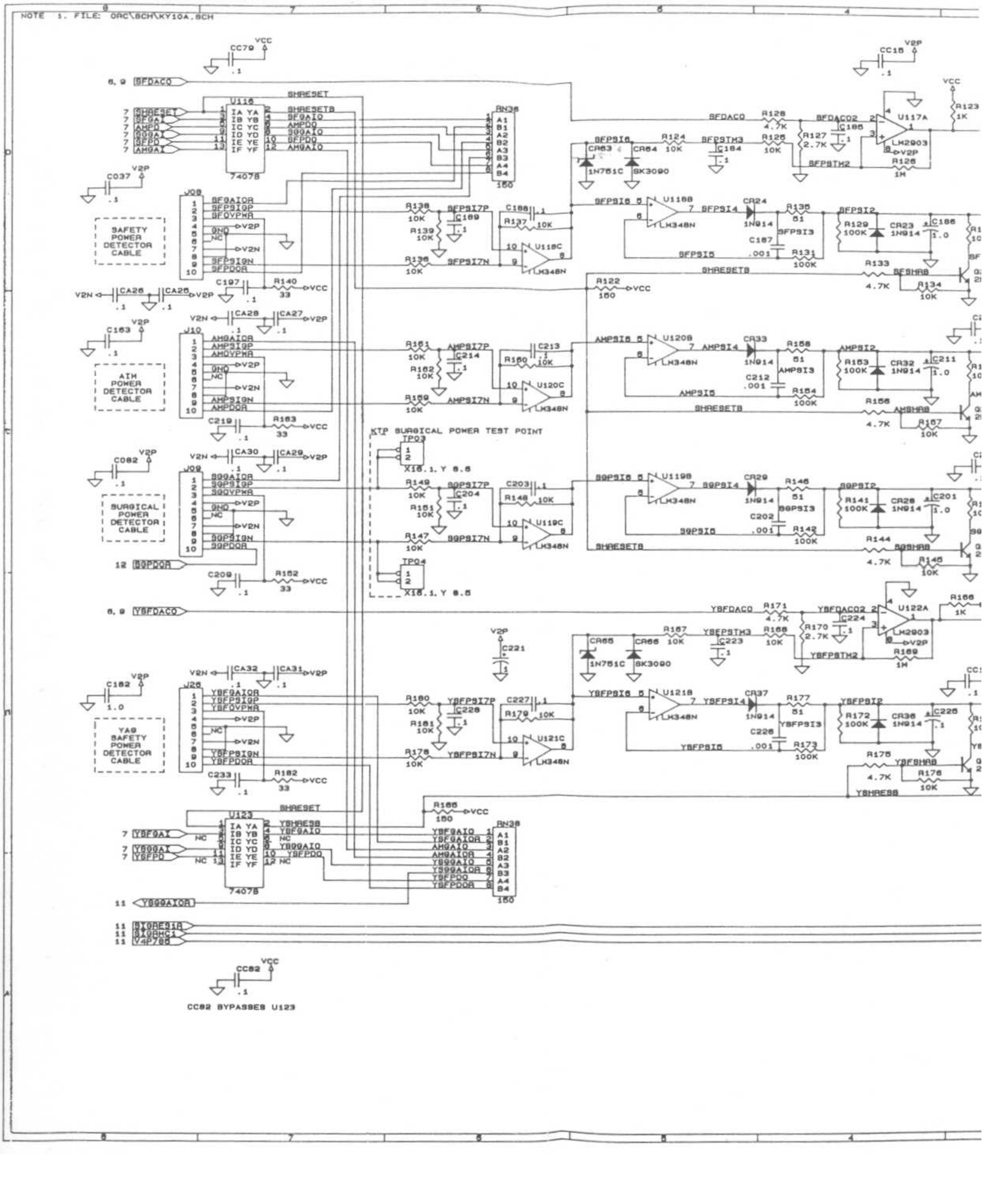

KTP SAFETY SHUTTER CABLE
YAG SAFETY SHUTTER CABLE
OUTPUT COUPLER BEAM MOTOR CABLE
LASER MIRROR MOTOR CABLE
NOTE: MOVE J24 CLOSE TO J22
LASER MIRROR MOTOR CABLE
SURGICAL ATTENUATOR STEPPER MOTOR CABLE
J11
J23
J21
J22
J24
J14
RN20
RN21
RN22
RN23
RN24
RN25
RN31
RN32
U102
U104
U106
1489A
JW14
JW13
QH14 TIP120
QH15 TIP120
QH16 TIP120
QH17 TIP120
QH04 TIP125
QH03 TIP120
QH08 TIP125
QH07 TIP120
QH06 TIP125
QH05 TIP120
LASERSCOPE
3052 ORCHARD DR.
SAN JOSE, CA 95134-2011
Title
SCH., 107-102, SHUTTER, MOTOR DRV.
Size C
Document Number 0107-1080
REV 5
Date: July 16, 1990 Sheet 8 of 13


NOTE 1 FILE: \DAC\SCH\C809A.SCH
EXPOSURE (AIM) SHUTTER DRIVER
CALIBRATION (PRE-AIM) SHUTTER DRIVER
EYE SAFETY SHUTTER DRIVER
SPARE SHUTTER DRIVER
LIGHT VALVE ADJUSTMENT
5V REF. ADJ.
(AIM) EXPOSURE SHUTTER CABLE
(PRE_AIM) CALIBRATION SHUTTER CABLE
EYE SAFTEY FILTER CABLE
ENDO FUSE BLOW
U078 AD7226
AR1 LM79L05
U107 7407B
U109 7407B
U113A 4066
U113C 4066
U113D 4066
U114A LM348N
U114B LM348N
U114C LM348N
U115 LM741
J12
J13
JD2
J29
JW24
QH10 TIP120
QH11 TIP120
QH12 TIP120
QH13 TIP120
QH20 TIP120
Q20 2N2222A
Q21 2N2222A
Q22 2N2222A
Q23 2N2222A

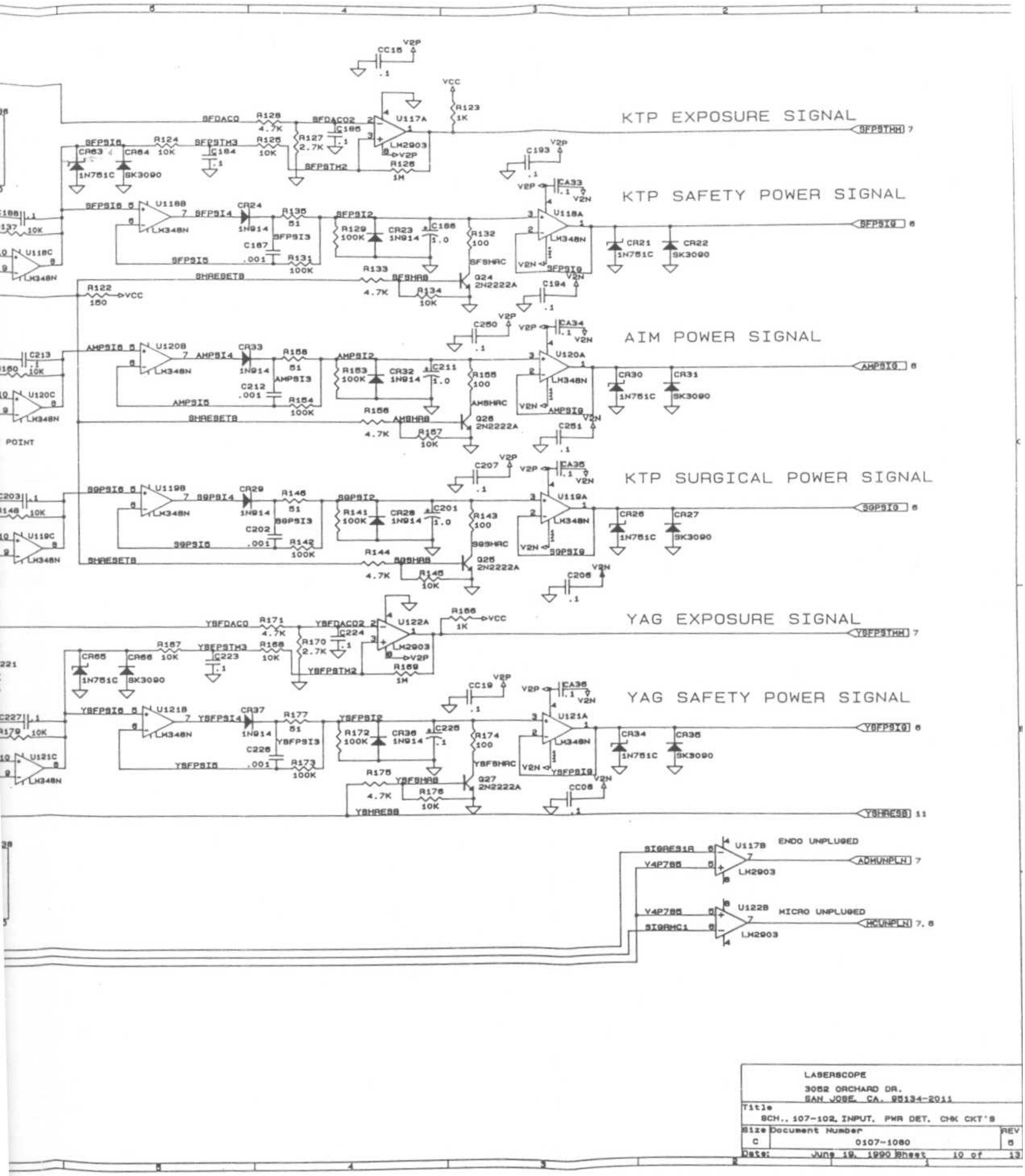

5 VOLT REFERENCE CKT.
LIGHT VALVE POWER CKT.
5V REF. ADJ.
LIGHT VALVE TEST POINTS
(AIM) EXPOSURE SHUTTER CABLE
(PRE_AIM) CALIBRATION SHUTTER CABLE
EYE SAFTEY FILTER CABLE
ENDO FUSE BLOW
LASERSCOPE
3052 ORCHARD DR.
SAN JOSE, CA. 95134-2011
Title
SCH., 107-102, SHUTTER'S, LIGHT V., DAC
Size C
Document Number 0107-1060
REV 5
Date: June 14, 1990
Sheet 9 of 13



KTP EXPOSURE SIGNAL
KTP SAFETY POWER SIGNAL
AIM POWER SIGNAL
KTP SURGICAL POWER SIGNAL
YAG EXPOSURE SIGNAL
YAG SAFETY POWER SIGNAL
SAFETY POWER DETECTOR CABLE
AIM POWER DETECTOR CABLE
SURGICAL POWER DETECTOR CABLE
YAG SAFETY POWER DETECTOR CABLE
KTP SURGICAL POWER TEST POINT
ENDO UNPLUGED
MICRO UNPLUGED
CC82 BYPASSES U123
74078
LH348N
LH2903
2N2222A
1N761C
SK3090
1N914

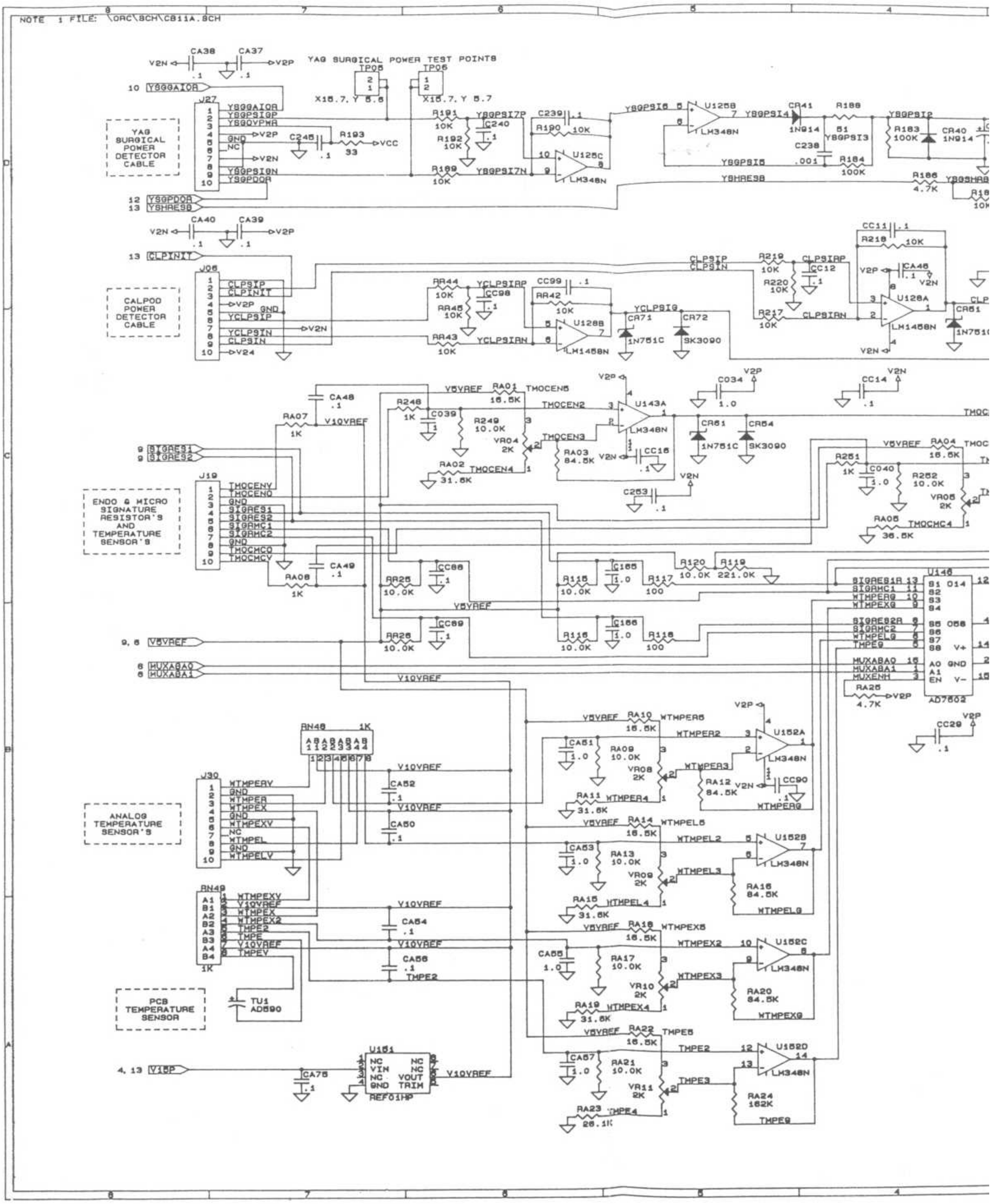


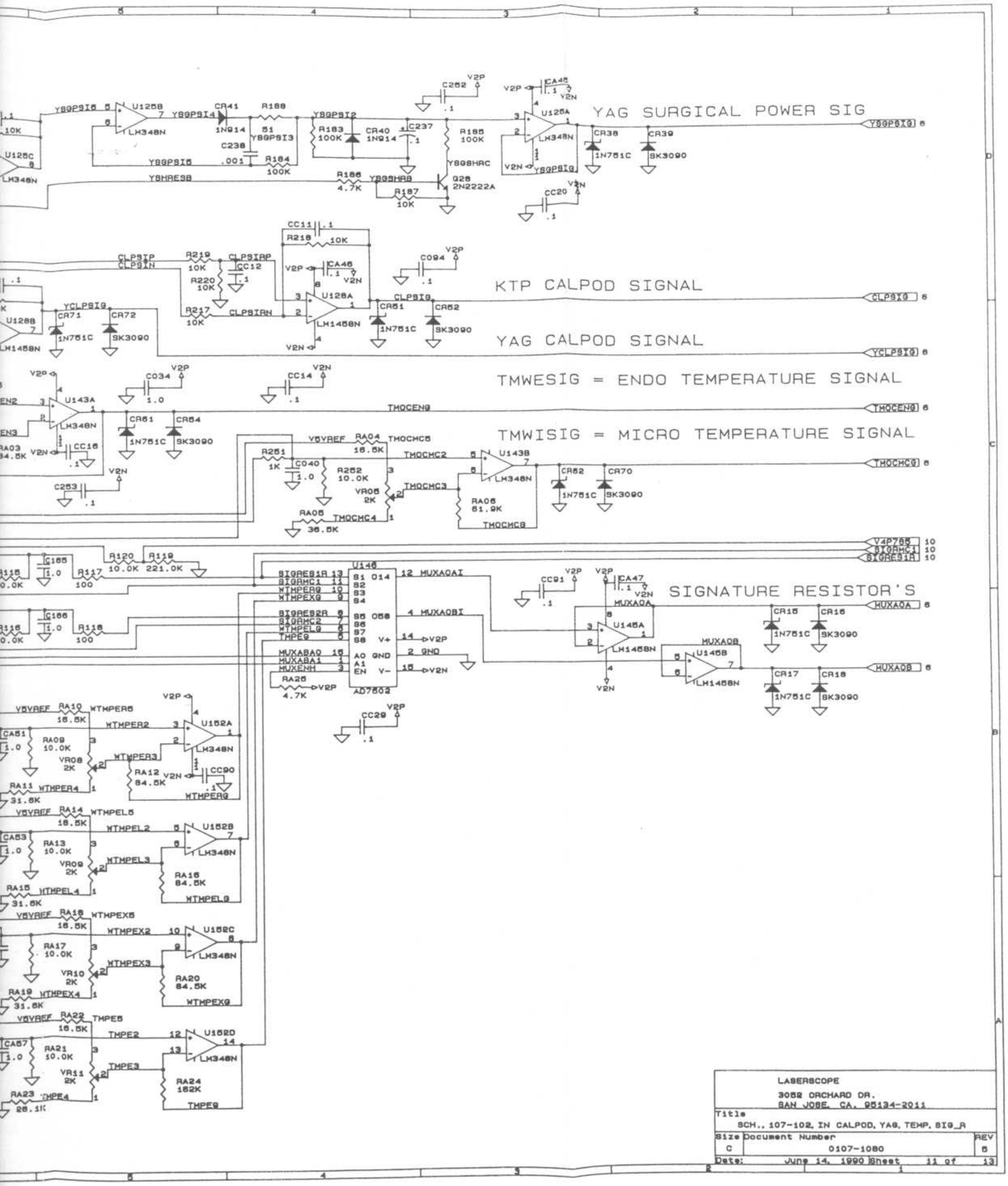
NOTE 1. FILE: ORC\SCH\KY10A.SCH
SAFETY POWER DETECTOR CABLE
AIM POWER DETECTOR CABLE
SURGICAL POWER DETECTOR CABLE
YAG SAFETY POWER DETECTOR CABLE
KTP SURGICAL POWER TEST POINT
X18.1, Y 8.6
X18.1, Y 8.8
SFDACO
SHRESET
SHRESETB
U116
U123
74078
RN38
150
J08
J10
J09
J26
U117A
LM2903
U122A
U118B
U118C
U120B
U120C
U119B
U119C
U121B
U121C
LM348N
1N914
1N751C
SK3090
YSFDACO
YSGAIOR
SGPDOR
SIGRES1A
SIGRMC1
V4P7SS
CC82 BYPASSES U123



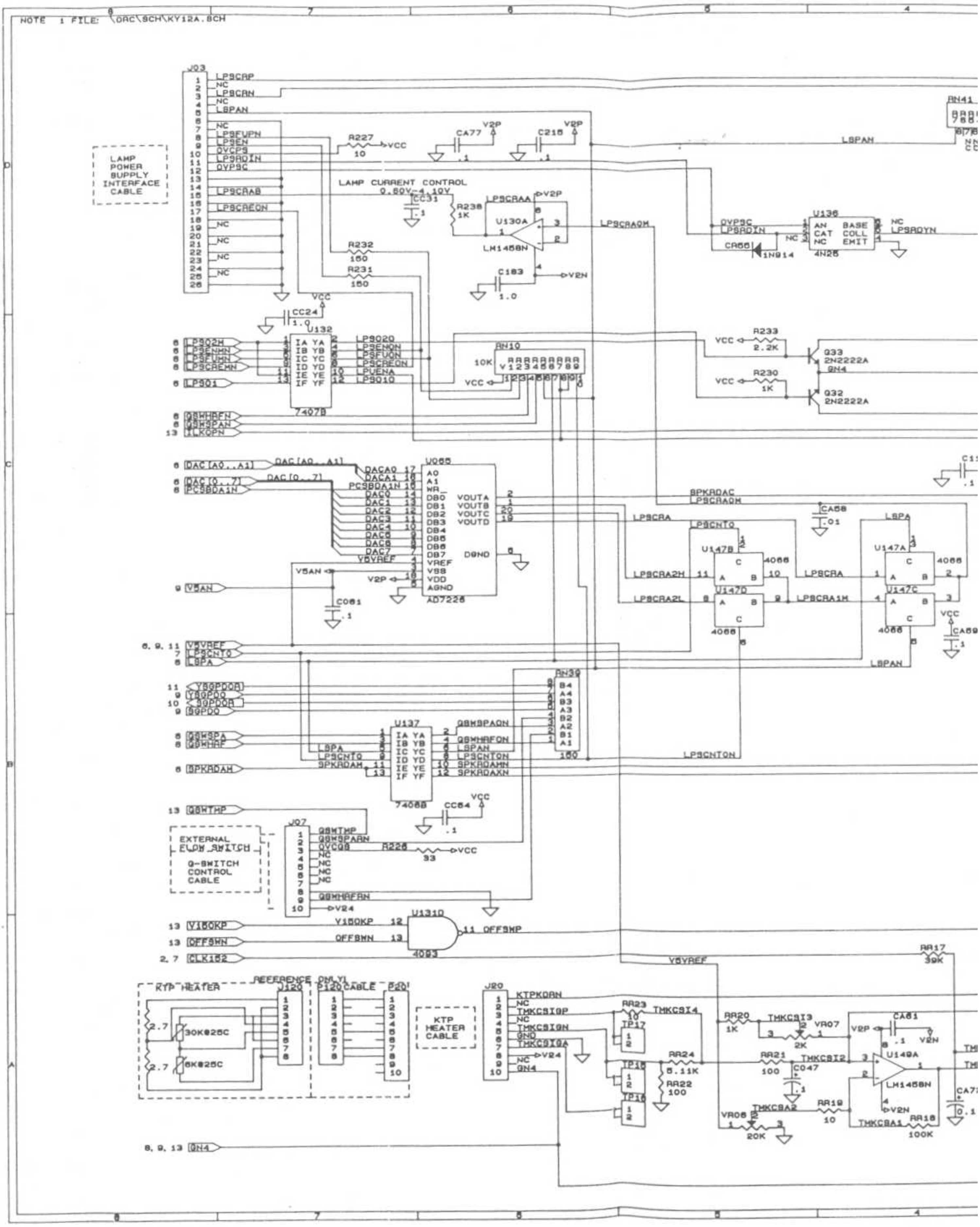
LASERSCOPE
3052 ORCHARD DR.
SAN JOSE, CA. 95134-2011

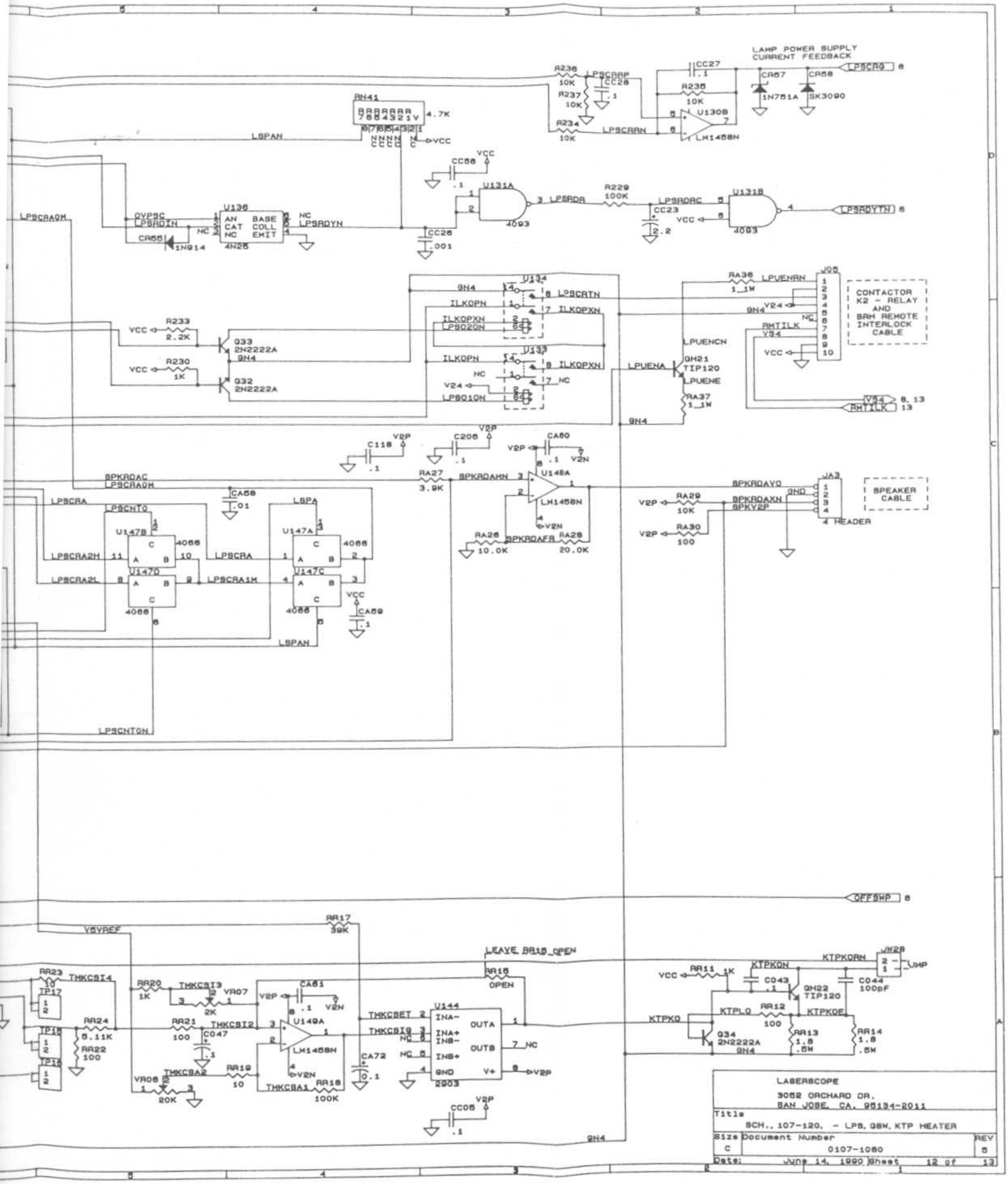
Title	SCH., 107-102, INPUT, PWR DET, CHK CKT'S	
Size C	Document Number 0107-1080	REV 5
Date:	June 19, 1990 Sheet 10 of 13	


NOTE 1 FILE: \ORC\SCH\C811A.SCH
YAG SURGICAL POWER TEST POINTS
YAG SURGICAL POWER DETECTOR CABLE
CALPOD POWER DETECTOR CABLE
ENDO & MICRO SIGNATURE RESISTOR'S AND TEMPERATURE SENSOR'S
ANALOG TEMPERATURE SENSOR'S
PCB TEMPERATURE SENSOR
J27
J06
J19
J30
RN48
RN49
U125B
U125C
U126A
U126B
U143A
U146
AD7502
U152A
U152B
U152C
U152D
LM348N
LM1458N
U161
REF01HP
TU1
AD590
V10VREF
V5VREF
V15P

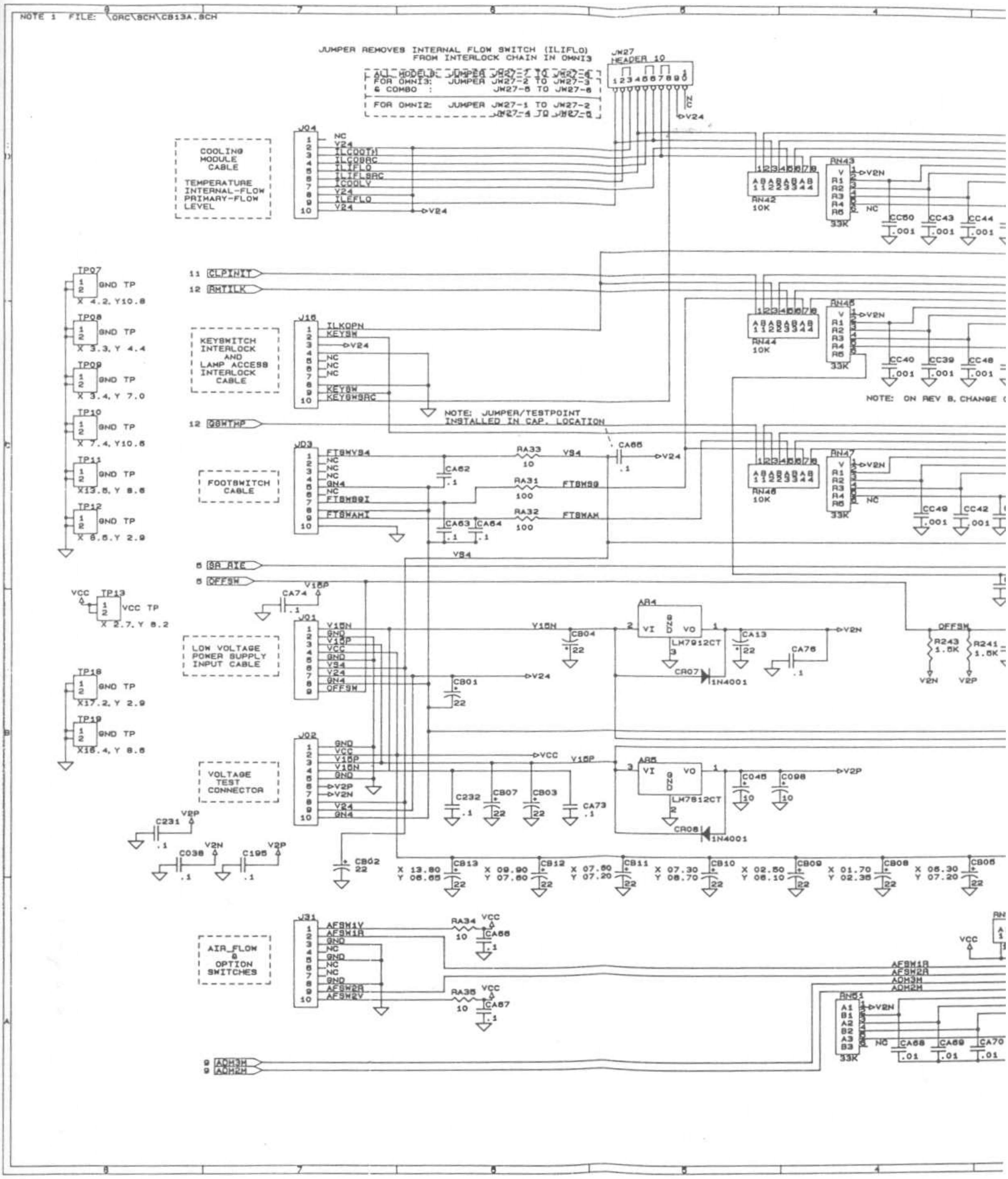


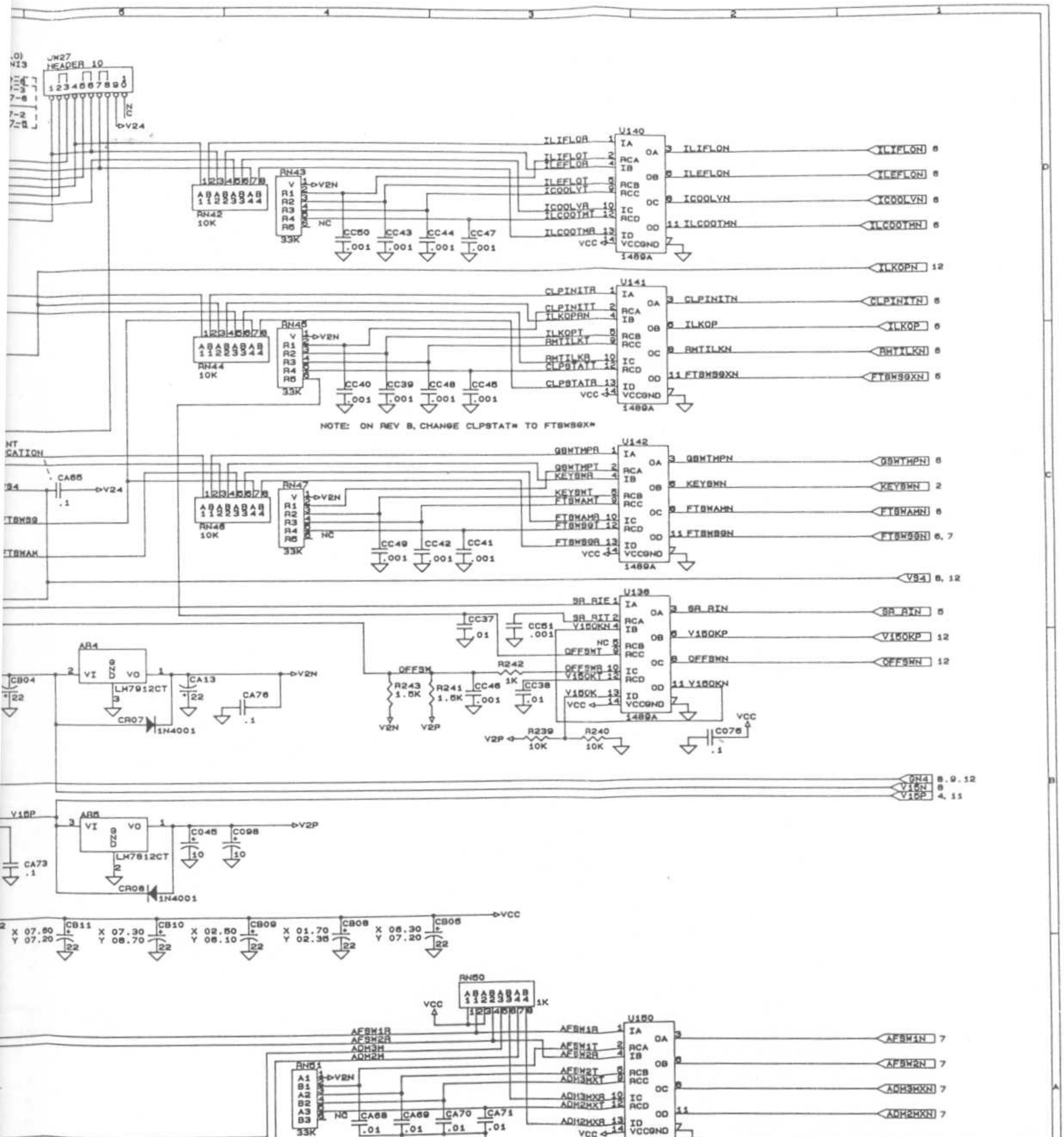
YAG SURGICAL POWER SIG
KTP CALPOD SIGNAL
YAG CALPOD SIGNAL
TMWESIG = ENDO TEMPERATURE SIGNAL
TMWISIG = MICRO TEMPERATURE SIGNAL
SIGNATURE RESISTOR'S
LASERSCOPE
3052 ORCHARD DR.
SAN JOSE, CA. 95134-2011
Title
SCH., 107-102, IN CALPOD, YAG, TEMP, SIG_R
Size C
Document Number 0107-1080
REV 5
Date: June 14, 1990 Sheet 11 of 13


NOTE 1 FILE: \ORC\SCH\KY12A.SCH
J03
LAMP POWER SUPPLY INTERFACE CABLE
LPSCRP
LPSCRN
LSPAN
LPSFUPN
LPSEN
OVCPS
LPSRDIN
OVPSC
LPSCRAB
LPSCREON
R227 10
CA77 .1
C218 .1
LAMP CURRENT CONTROL 0.60V-4.10V
CC31 .1
R238 1K
LPSCRAA
U130A
LH1458N
C183 1.0
R232 150
R231 150
LPSCRAOM
OVPSC
LPSRDIN
CR66 1N914
U136 4N26
AN CAT NC BASE COLL EMIT
LPSRDYN
LSPAN
RN41
CC24 1.0
U132 7407B
LPSO2H
LPSENMN
LPSFUMN
LPSCREMN
LPSO1
LPSO20
LPSENON
LPSFUON
LPSCREON
LPUENA
LPSO10
RN10 10K
R233 2.2K
Q33 2N2222A
GN4
R230 1K
Q32 2N2222A
QSWHBFN
QSWSPAN
ILKOPN
DAC[A0..A1]
DAC[0..7]
PCSBDA1N
U065 AD7226
DACA0 DACA1 DAC0 DAC1 DAC2 DAC3 DAC4 DAC5 DAC6 DAC7 V5VREF
A0 A1 WR DB0 DB1 DB2 DB3 DB4 DB5 DB6 DB7 VREF VSS VDD AGND
VOUTA VOUTB VOUTC VOUTD DGND
V5AN
C061 .1
SPKRDAC
LPSCRAOM
CA58 .01
LPSCRA
LPSCNTO
U147B 4066
LPSCRA2H
LPSCRA2L
U147D 4066
LPSCRA1M
LSPA
U147A 4066
U147C 4066
CA59 .1
LSPAN
V5VREF
LPSCNTO
LSPA
YSGPDOR
YSGPDO
SGPDOR
SGPDO
RN39 150
QSWSPA
QSWHRF
SPKRDAH
U137 7406B
QSWSPAON
QSWHRFON
LSPAN
LPSCNTON
SPKRDAMN
SPKRDAXN
CC64 .1
QSWTHP
J07
EXTERNAL FLOW SWITCH
Q-SWITCH CONTROL CABLE
QSWTHP
QSWSPARN
OVCQS
R228 33
QSWHRFRN
V24
V150KP
OFFSWN
U131D 4093
OFFSWP
CLK152
V5VREF
RR17 39K
KTP HEATER
REFERENCE ONLY
J120 P120 CABLE P20
30K@25C
6K@25C
KTP HEATER CABLE
J20
KTPKORN
TMKCSI9P
TMKCSI9N
GND
TMKCSI9A
GN4
RR23 10
TMKCSI4
TP17
TP18
TP19
RR24 5.11K
RR22 100
RR20 1K
TMKCSI3
VR07 2K
RR21 100
TMKCSI2
C047 .1
TMKCSA2
VR08 20K
RR19 10
CA61 .1
U149A LH1458N
TMKCSA1
RR18 100K
CA7 0.1
GN4



LAMP POWER SUPPLY
CURRENT FEEDBACK
CONTACTOR
K2 - RELAY
AND
BRM REMOTE
INTERLOCK
CABLE
SPEAKER
CABLE
HEADER
LEAVE RR15 OPEN
LASERSCOPE
3052 ORCHARD DR.
SAN JOSE, CA. 95134-2011
Title
SCH., 107-120, - LPS, QSW, KTP HEATER
Size
C
Document Number
0107-1080
REV
5
Date:
June 14, 1990
Sheet
12 of
13


NOTE 1 FILE: \ORC\SCH\CB13A.SCH
JUMPER REMOVES INTERNAL FLOW SWITCH (ILIFLO) FROM INTERLOCK CHAIN IN OMNI3
ALL MODELS: JUMPER JW27-7 TO JW27-8
FOR OMNI3: JUMPER JW27-2 TO JW27-3
& COMBO : JW27-5 TO JW27-6
FOR OMNI2: JUMPER JW27-1 TO JW27-2
JW27-4 TO JW27-5
JW27 HEADER 10
COOLING MODULE CABLE
TEMPERATURE INTERNAL-FLOW PRIMARY-FLOW LEVEL
KEYSWITCH INTERLOCK AND LAMP ACCESS INTERLOCK CABLE
NOTE: JUMPER/TESTPOINT INSTALLED IN CAP. LOCATION
FOOTSWITCH CABLE
LOW VOLTAGE POWER SUPPLY INPUT CABLE
VOLTAGE TEST CONNECTOR
AIR_FLOW & OPTION SWITCHES
NOTE: ON REV B, CHANGE
LM7912CT
LM7812CT
1N4001

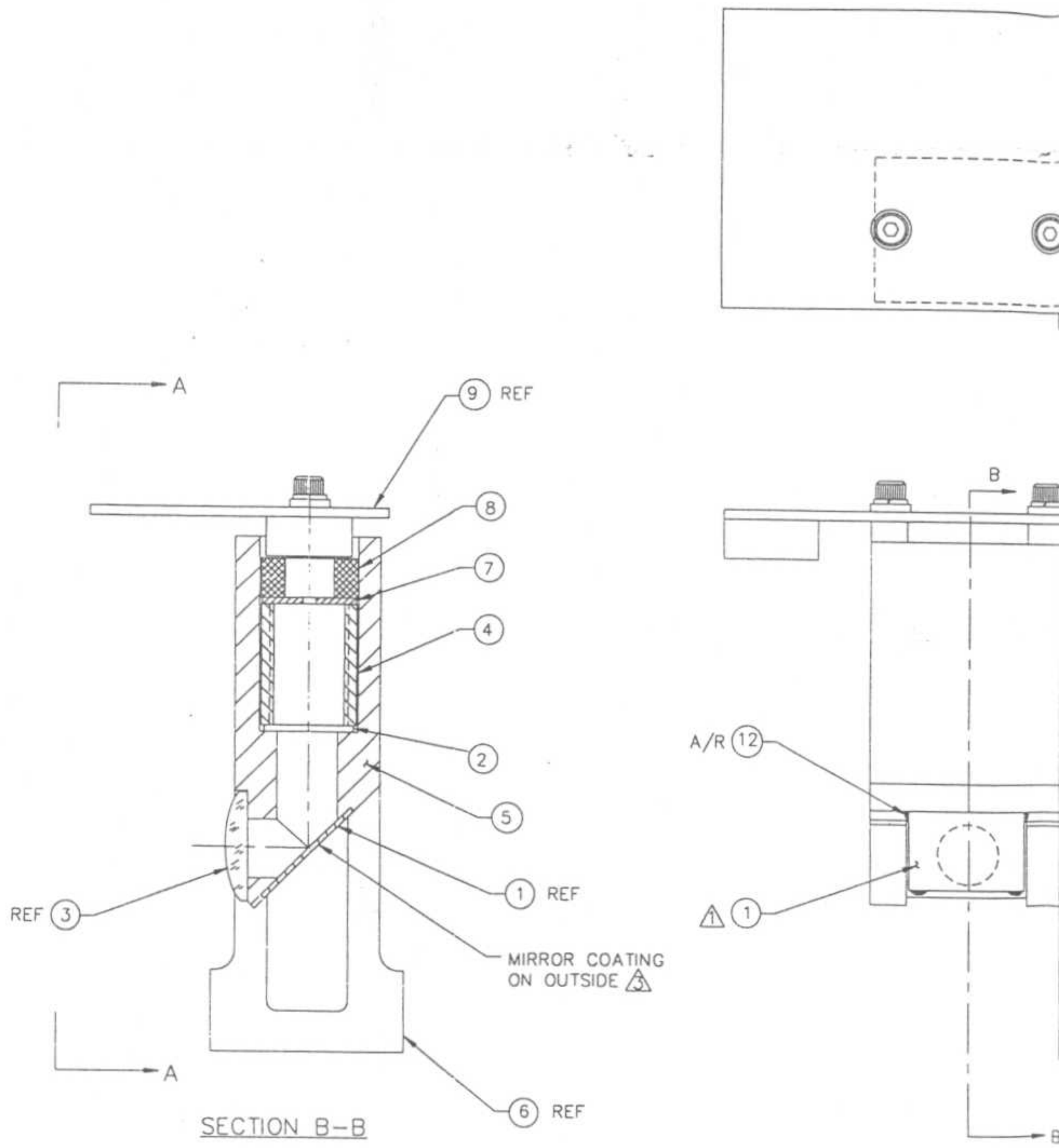


LASERSCOPE
3052 ORCHARD DR.
SAN JOSE, CA. 95134-2011

Title	SCH., 107-102 - INTPUT'S, INTERLOCK'S, PWR	
Size	Document Number	REV
C	0107-1080	5
Date: June 14, 1990	Sheet 13 of 13	

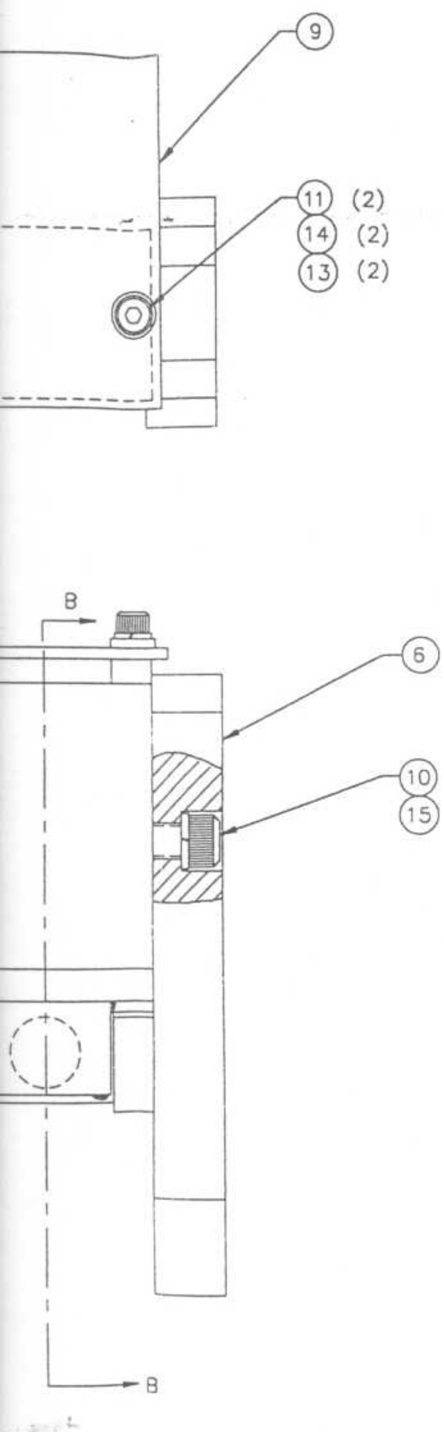
NOTES:

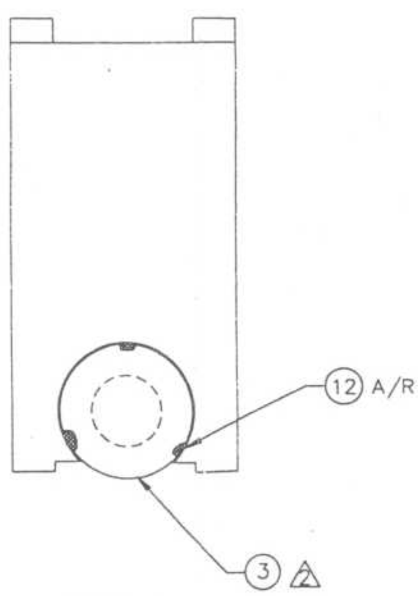
1. MIRROR, ITEM (1), IS ATTACHED WITH FOUR SMALL DABS OF ADHESIVE, ITEM (12). ADHESIVE IS CURED WITH UV LIGHT.
2. LENS, ITEM (3), IS ATTACHED WITH THREE SMALL DABS OF ADHESIVE, ITEM (12). ADHESIVE IS CURED WITH UV LIGHT.
3. MIRROR, ITEM (1), IS ORIENTED SUCH THAT MIRROR COATING IS ON OUTSIDE.



SECTION B-B

QTY	PART NUMBER	DESCRIPTION	ITEM
1	105-054	MIRROR, 1064 DETECTOR	1
1	100-4223	DIFFUSER	2
1	105-065	LENS, 36mm, 1064 DETECTORS	3
1	105-149	BAFFLE, POWER DETECTOR	4
1	105-154	HOUSING, POWER DETECTOR, 1064nm	5
1	105-156	BRACKET, POWER DETECTOR, 1064nm	6
1	105-1583	APERTURE, POWER DETECTOR, 1064nm	7
1	105-159	SEAL, POWER DETECTOR	8
1	105-4171	TESTED PCB ASSY, DETECTOR, MODEL 70X	9
1	7236-0806	SCREW, CAP, SKT, 8-32 X .38, BO	10
2	7236-0404	SCREW, CAP, SKT, 4-40 X .25, BO	11
A/R	1600-0035	ADHESIVE, MULTICURE	12
2	7276-0400	WASHER, FLAT, SM PTN, #4, BO	13
2	7280-0400	WASHER, SPLIT LOCK, #4, BO	14
1	7280-0800	WASHER, SPLIT LOCK, #8, BO	15





VIEW A-A
(ITEMS 6 & 9 NOT SHOWN)

REV LTR	ECO NO.	APPD	DATE
2	P0060	HW	6/5/89
A	1658	HW	9/21/88
B	1803	HY	

MODEL | NEXT ASSEMBLY

DO NOT SCALE DRAWING
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES:
.X ± ~ mm ~
.XX ± ~ ANG. ± ~°
.XXX ± ~ FINISH ~
BREAK ALL SHARP CORNERS

ASSY, DETECTOR, 1064nm

SCALE 2/1 | DRAWN BY J QUINLAN | DATE 5/31/89 | CHECKED BY R. Chu | APPROVED BY
MATERIAL NA
FINISH NA

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3052 ORCHARD DRIVE SAN JOSE, CA 95134

D | 105-246 | SHEET 1 OF 1 | REV B

FILE: 105-246 PLOT DATE: 3/8/90

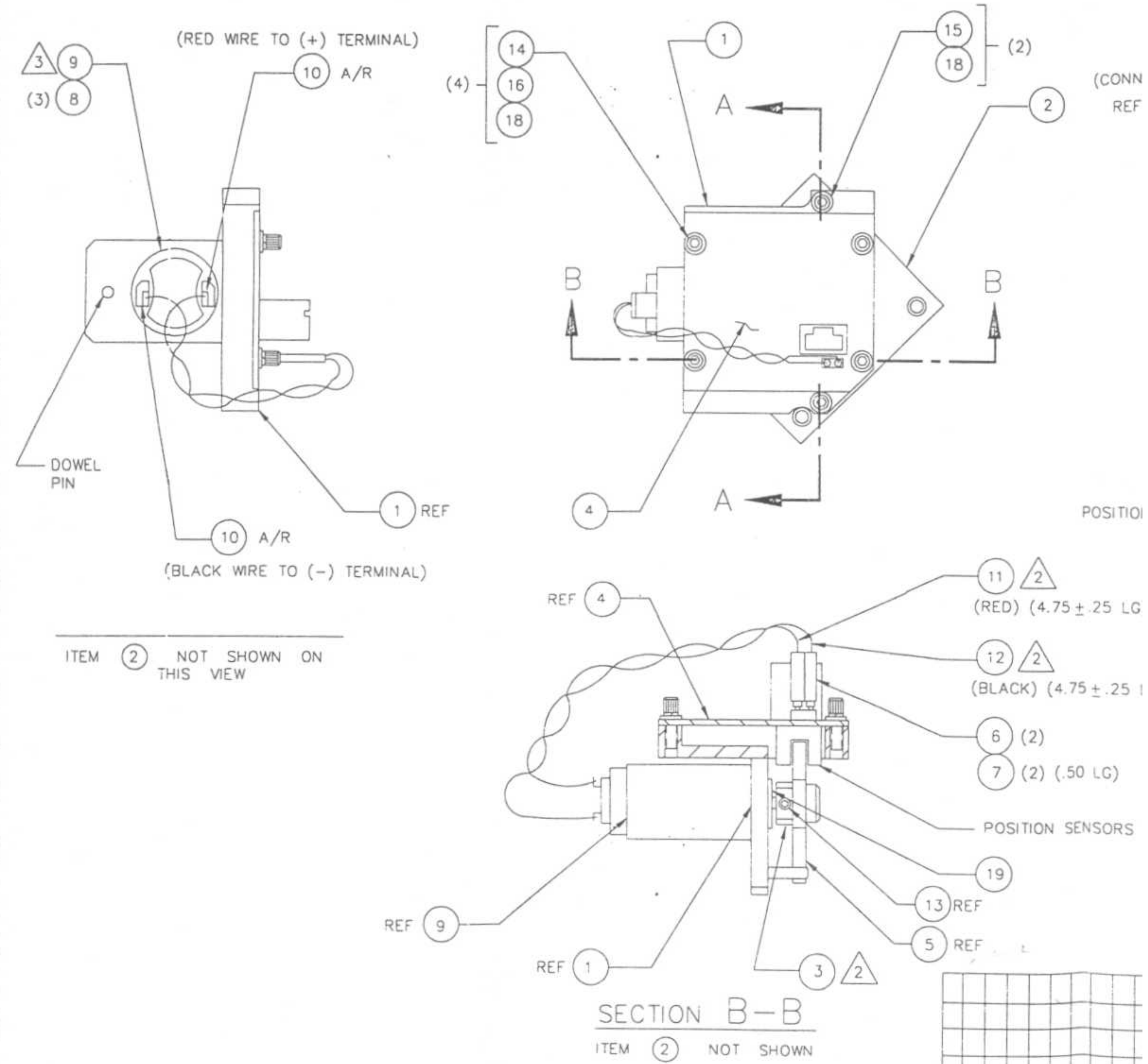
8 7 6 5

NOTES- (UNLESS OTHERWISE SPECIFIED).

1. INSTALL MOTOR, ITEM-9, WITH TERMINALS AS NEAR TO IN-LINE WITH DOWEL PIN IN BRACKET, ITEM-1, AS POSSIBLE.
2. TWIST RED & BLACK WIRES TOGETHER BEFORE TERMINATING.
3. ONCE ALL SOLDER OPERATIONS HAVE BEEN PERFORMED, REMOVE ANY RESIDUAL DUST, ETC. WITH COMPRESSED AIR. ALL SUBSEQUENT ASSEMBLY IS TO TAKE PLACE UNDER CLEAN AIR HOOD.
4. AFTER ATTACHING ARM, ITEM-5, TO HUB, ITEM-3, CENTER ARM IN GAP OF POSITION SENSORS, PART OF ITEM-4, & TIGHTEN SCREW ITEM-13, TO SECURE HUB/ARM TO SHAFT OF MOTOR, ITEM-9.
5. ELECTRICALLY CYCLE UNIT 100 CYCLES TO VERIFY OPERATION.

(B) 6. AFTER ASSEMBLY AND TESTING, THE T WITH LINT-FREE LENS TISSUE, AND TA MUST BE WRAPPED WITH LINT-FREE L

(B) 7. BAG AND LABEL TESTED ASSEMBLY WI



C B A

8 7 6 5

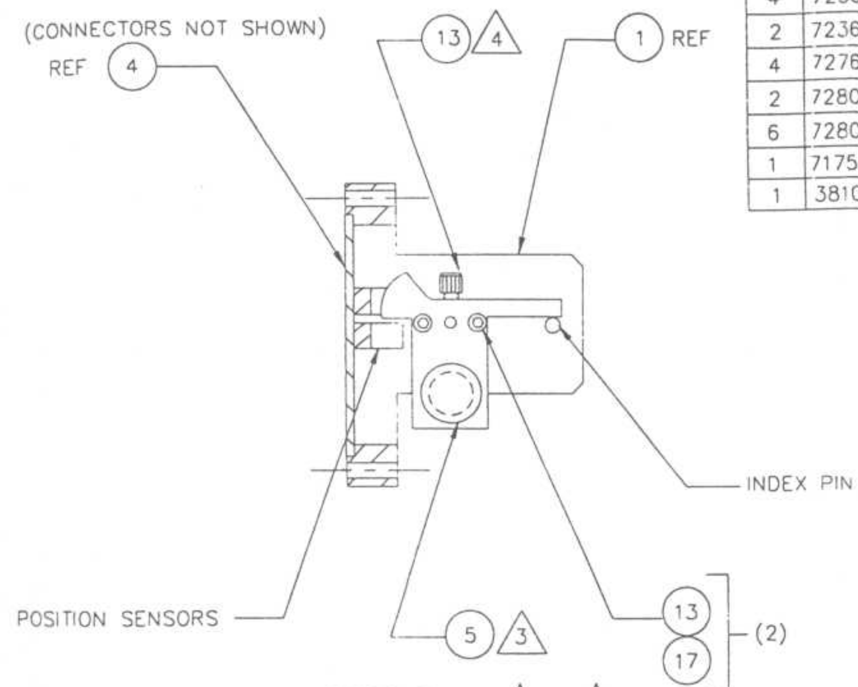
STING, THE THREE PORTS IN THE HOUSING MUST BE COVERED
SUE, AND TAPED IN PLACE, AND THE ENTIRE ASSEMBLY
LINT-FREE LENS TISSUE.

ASSEMBLY WITH PART NO. AND REV LEVEL.

QTY	PART NO.	DESCRIPTION	ITEM
1	105-179	BRACKET, MOTOR, SELECT MIRROR	1
1	105-199	HOUSING, SELECT MIRROR	2
1	105-208	HUB, PIVOT ARM, SELECT MIRROR	3
1	105-217	ASSY, PCB	4
1	105-278	ASSY, ARM, SELECT MIRROR	5
2	2100-0028	CONTACT, SOCKET	6
1.00"	2802-0005	HEAT SHRINK TUBING, 1/8" DIA	7
3	2825-0055	SCREW, FH, PD, M2x4MM	8
1	3500-0006	MOTOR, DC, 12V	9
A/R	4600-0000	SOLDER	10
4.75"	6070-0022	WIRE, HOOKUP, 22 AWG, RED	11
4.75"	6070-0029	WIRE, HOOKUP, 22 AWG, BLACK	12
3	7236-0204	SCREW, CAP, SKT, 2-56x.25, BO	13
4	7236-0404	SCREW, CAP, SKT, 4-40x.25, BO	14
2	7236-0412	SCREW, CAP, SKT, 4-40x.75, BO	15
4	7276-0400	WASHER, FLAT, SMALL PTN #4,BO	16
2	7280-0200	WASHER, SPLIT LOCK, #2, BO	17
6	7280-0400	WASHER, SPLIT LOCK, #4, BO	18
1	7175-0600	WASHER, FLAT, #6, SS	19
1	3810-0003	BAG, RESEALABLE POLY 4" x 6"	20

D

2



C

SECTION A—A

ITEM (2) NOT SHOWN

2

(4.75 ± .25 LG)

2

(4.75 ± .25 LG)

B

2)

2) (.50 LG)

ON SENSORS

A

REV LTR	ECO NO.	APPD	DATE
1	P0088	HW	6/30/89
A	1627	HW	8/24/89
B	1753?411		3/14/90

MODEL | NEXT ASSEMBLY

DO NOT SCALE DRAWING
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES:
.X ± | mm
.XX ± | ANG. : °
.XXX ± | FINISH
BREAK ALL SHARP CORNERS

ASSY, SELECT MIRROR
MODEL 70X

SCALE: NONE | DRAWN BY: R. A | DATE: 6/15/89 | CHECKED BY: D. Kuizenga | APPROVED BY: D. Kuizenga

MATERIAL: SEE B/M

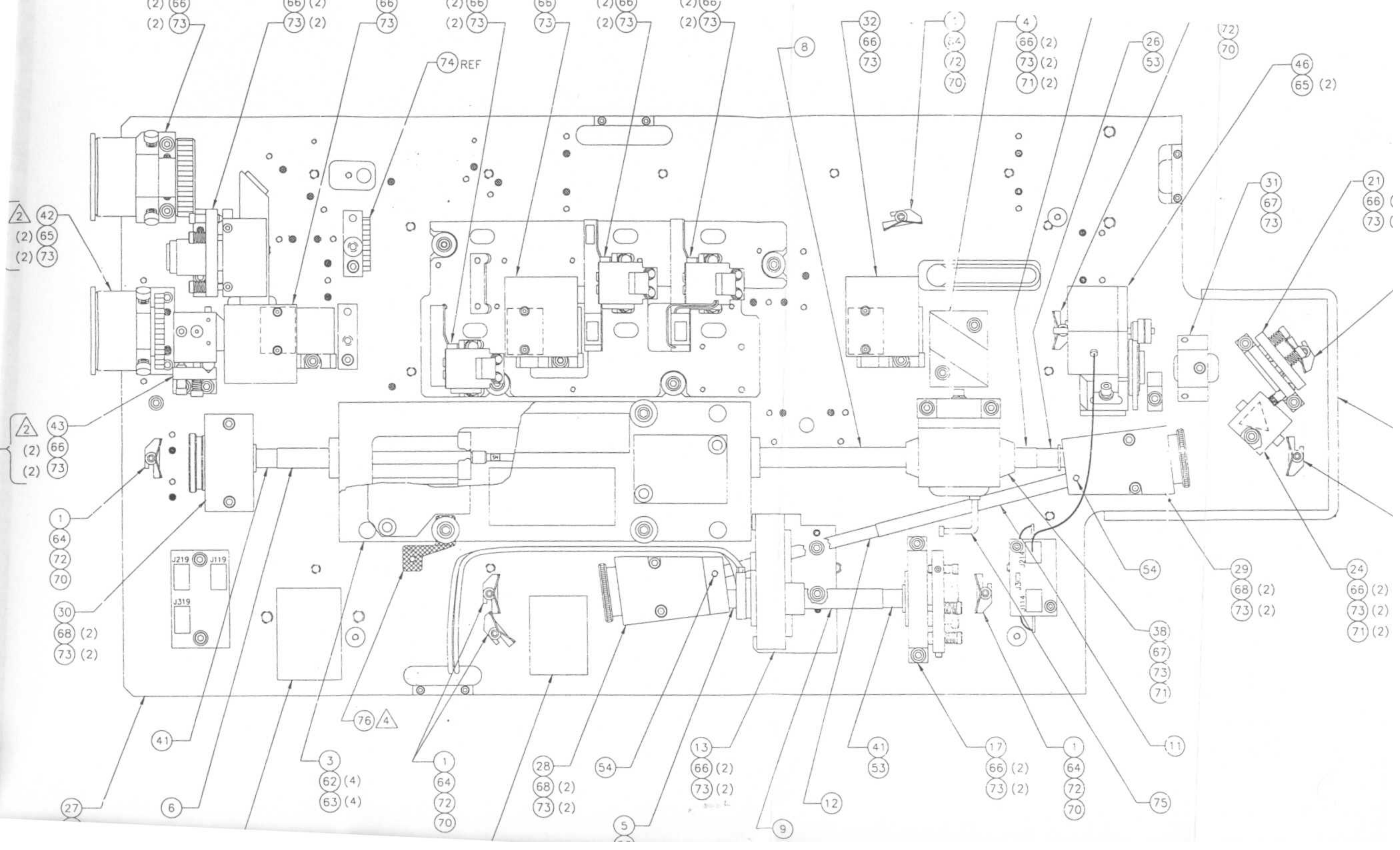
FINISH: ------

LASERSCOPE®
3052 ORCHARD DRIVE SAN JOSE, CA 95134

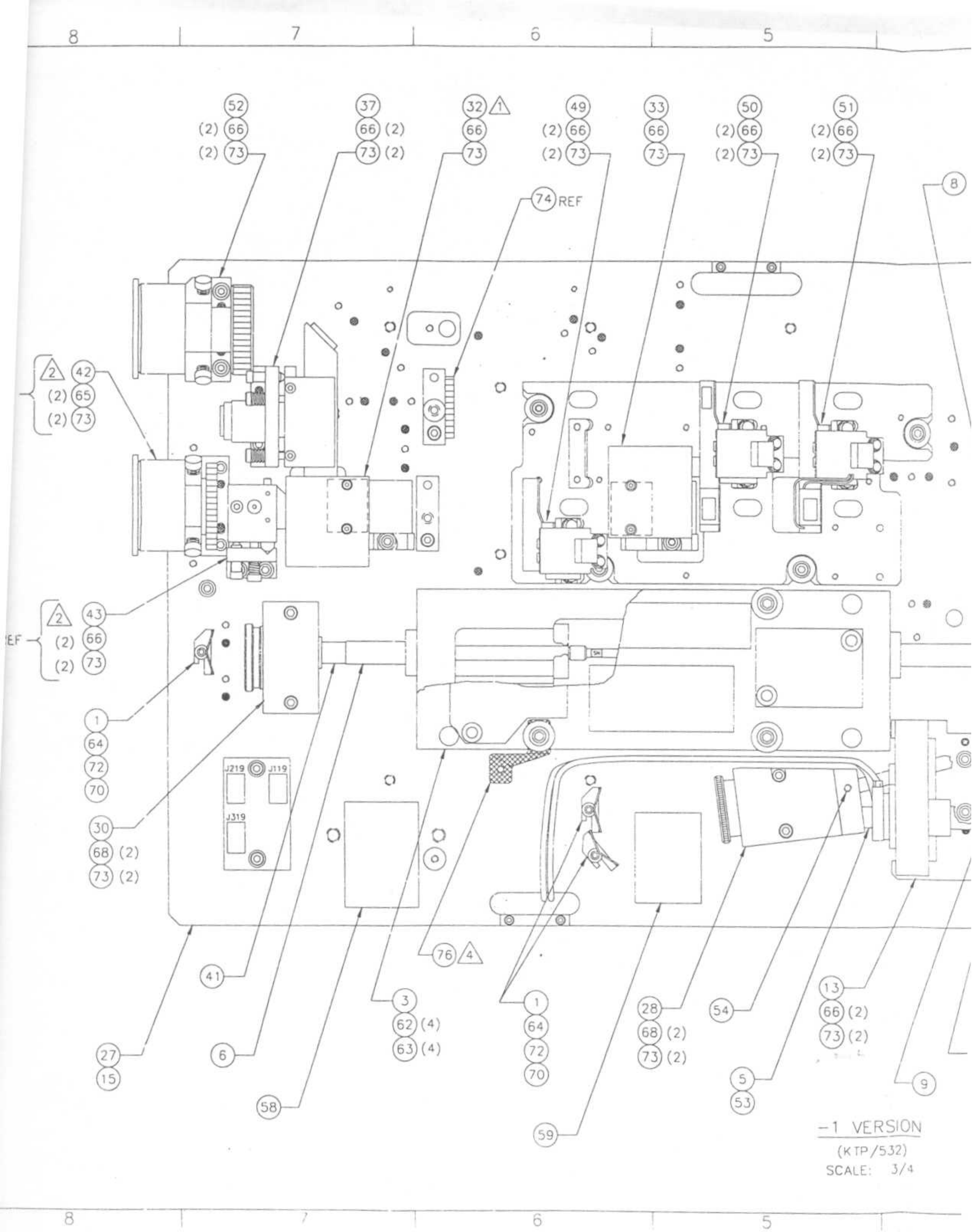
D | 105-247 | SHEET 1 OF 1 | REV B

FILE: 105-247 PLOT DATE: 3/9/90

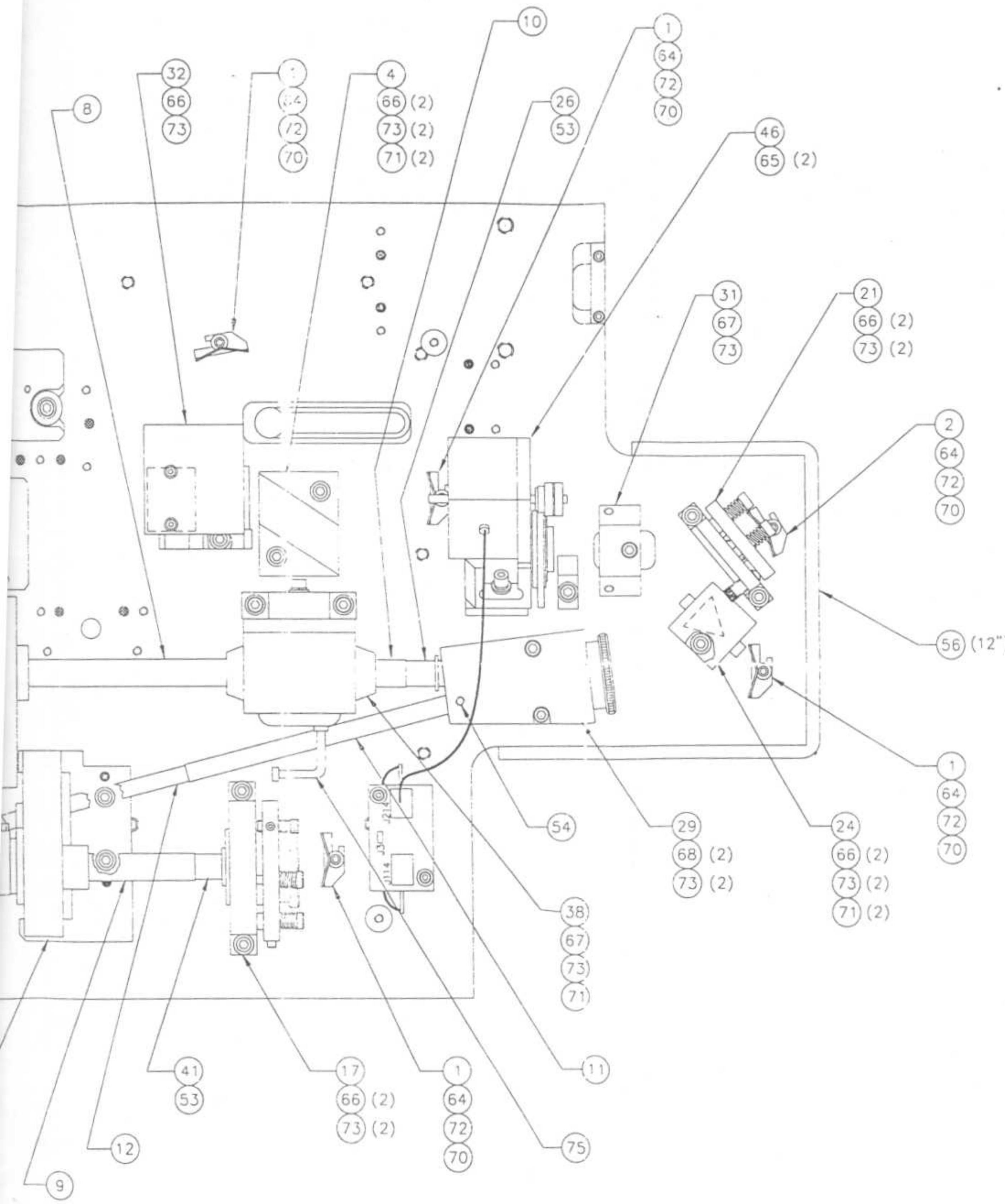
4 3 2



74 REF
J219
J119
J319
J214
J114



8
7
6
5
52
(2) 66
(2) 73
37
66 (2)
73 (2)
32
66
73
74 REF
49
(2) 66
(2) 73
33
66
73
50
(2) 66
(2) 73
51
(2) 66
(2) 73
8
42
(2) 65
(2) 73
43
(2) 66
(2) 73
EF
1
64
72
70
30
68 (2)
73 (2)
J219
J119
J319
41
6
27
15
58
76
3
62 (4)
63 (4)
1
64
72
70
59
28
68 (2)
73 (2)
54
5
53
13
66 (2)
73 (2)
9
-1 VERSION
(KTP/532)
SCALE: 3/4



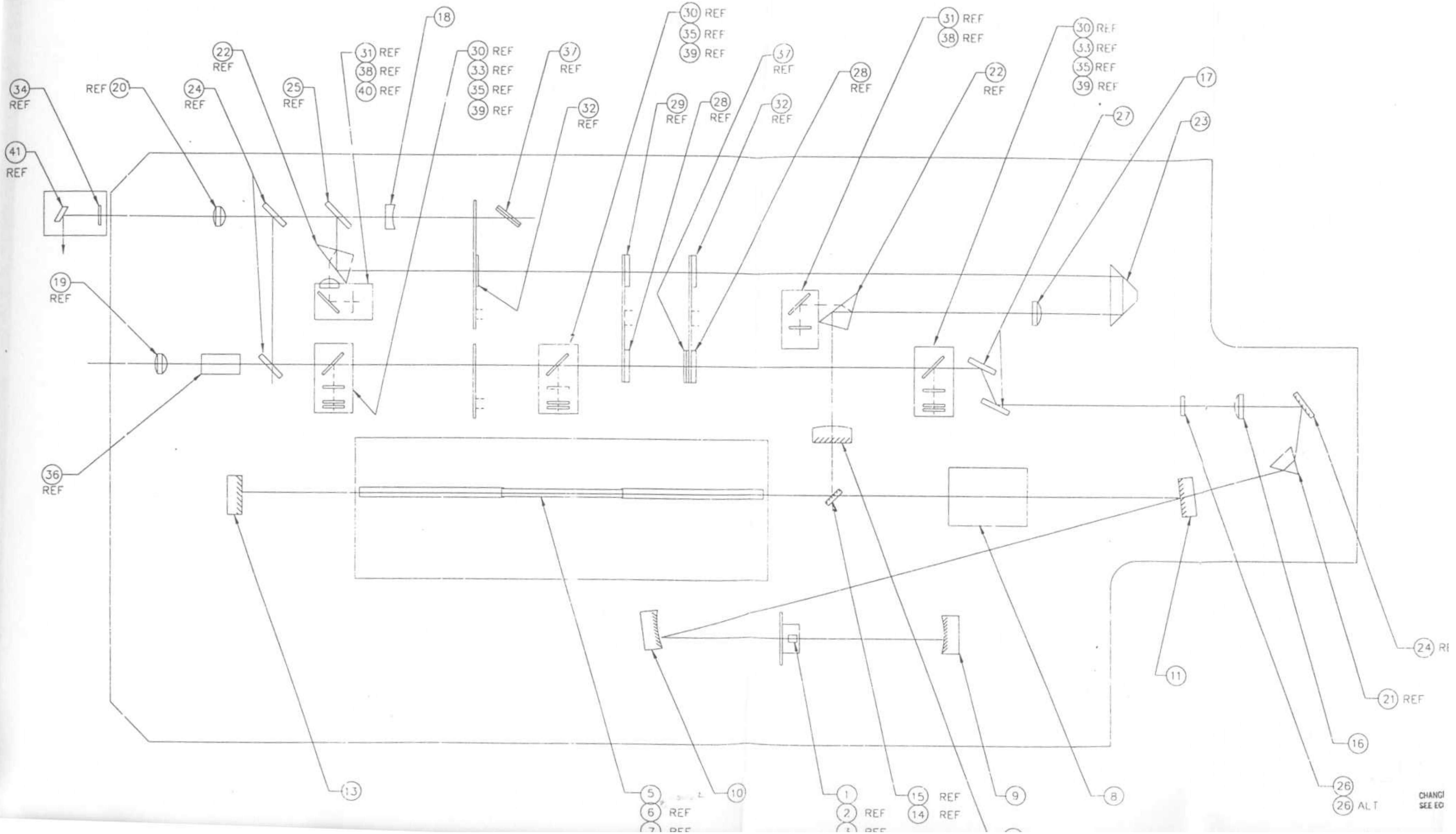
RSION
/532)
3/4

LASERSCOPE®
3052 ORCHARD DRIVE SAN JOSE, CA 95134

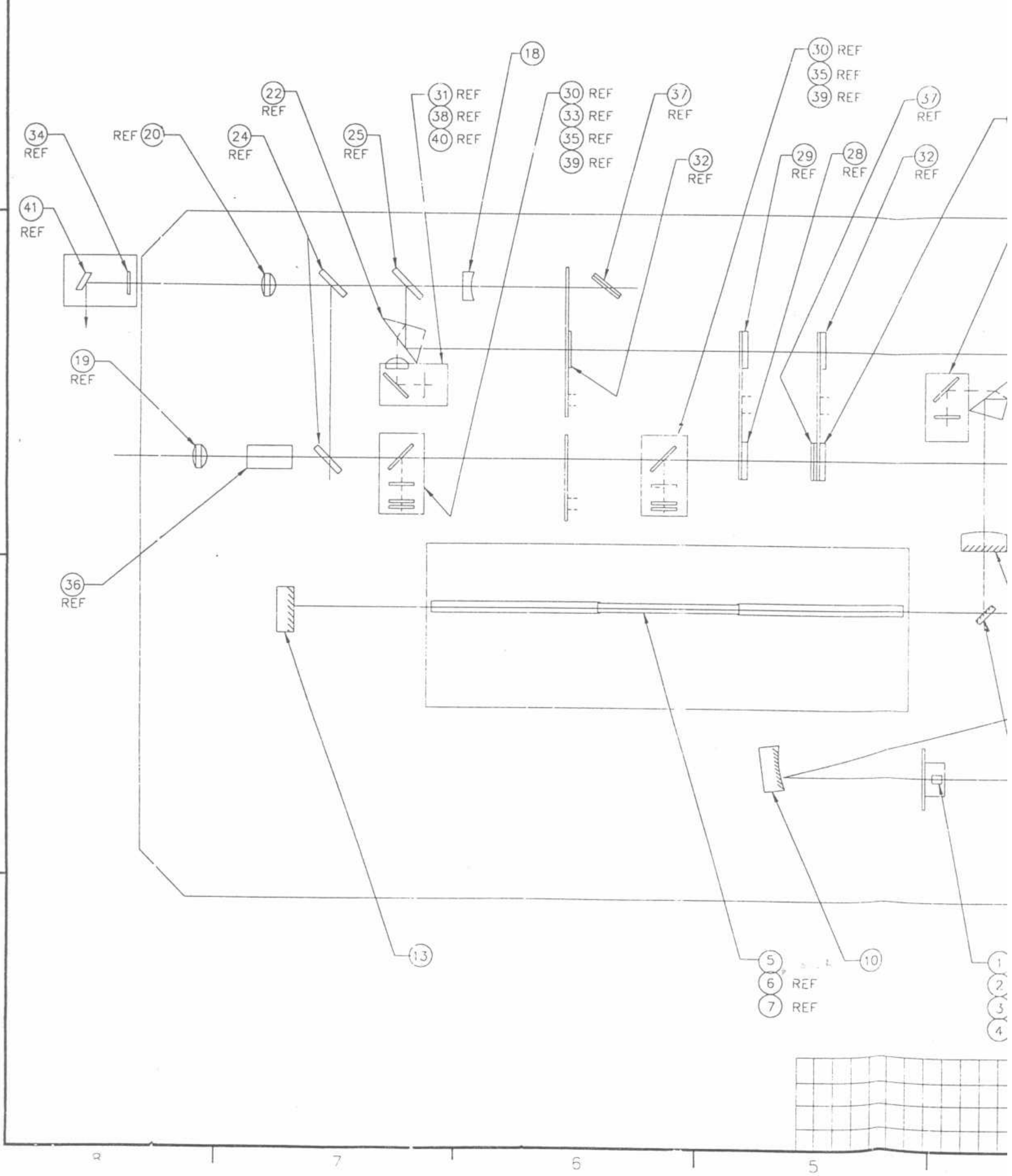
D	107-047X SHEET 2 OF 3	REV 3

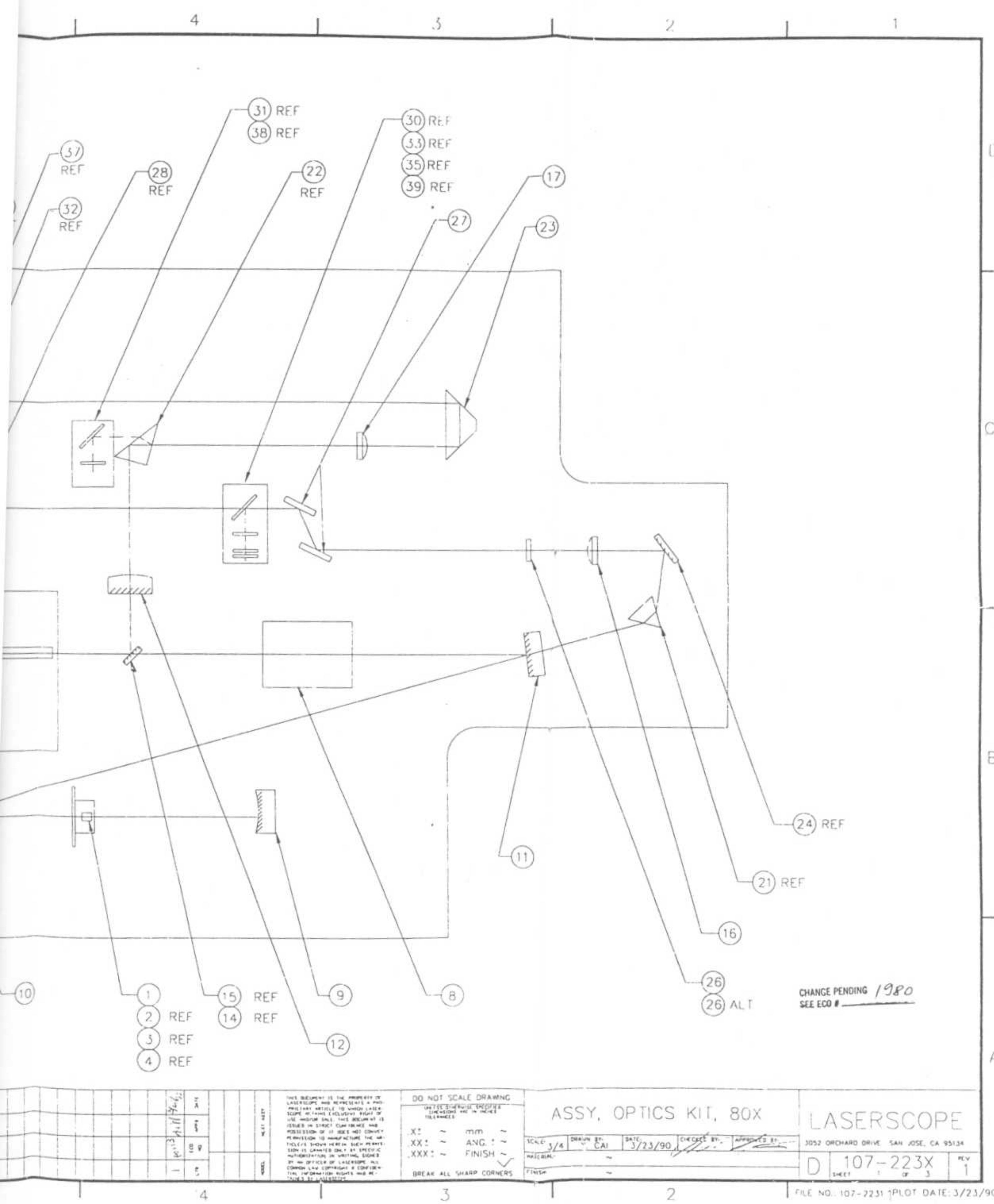
FILE NO.: 107-0472 PLOT DATE: 4/10/9

NOTES (UNLESS OTHERWISE SPECIFIED):



NOTES (UNLESS OTHERWISE SPECIFIED):




31 REF
38 REF
30 REF
33 REF
35 REF
39 REF
37 REF
32 REF
28 REF
22 REF
27
17
23
24 REF
21 REF
16
26
26 ALT
11
10
1
2 REF
3 REF
4 REF
15 REF
14 REF
9
12
8
CHANGE PENDING 1980
SEE ECO #
DO NOT SCALE DRAWING
ASSY, OPTICS KIT, 80X
LASERSCOPE
3052 ORCHARD DRIVE SAN JOSE, CA 95134
SCALE 3/4
DRAWN BY CAI
DATE 3/23/90
BREAK ALL SHARP CORNERS
D 107-223X
REV 1
FILE NO.: 107-2231 PLOT DATE: 3/23/90

QUANITY		PART NO.	DESCRIPTION	ITEM
-1 (KTP)	-2 (YAG)			
1	–	105-2042	ASSY, KTP CRYSTAL	1
REF	–	102-834	KTP CRYSTAL	2
REF	–	104-332	KTP CRYSTAL, REWORK	3
REF	–	104-086	KTP CRYSTAL, EVALUATION	4
1	–	100-659	ASSY, YAG ROD	5
REF	–	100-578	YAG ROD	6
REF	–	104-423	YAG ROD, REWORK	7
1	–	105-059	Q-SWITCH, COMBO	8
1	–	102-2511	MIRROR, 10cm, 1064/532	9
1	–	102-2512	MIRROR, 20cm, 1064/532	10
1	–	104-087	MIRROR, 532nm, OUTPUT COUPLER	11
–	1	105-036	MIRROR, 1064nm, COMBO, OUTPUT COUP.	12
1	–	105-C37	MIRROR, 1064nm, COMBO, LAM	13
–	REF (1)	105-038	MIRROR, 1064nm, COMBO, IN/OUT	14
–	REF (1)	105-278	ASSY, 1064nm IN/OUT MIRROR	15
1	–	105-039	LENS, 532nm, COMBO, COLLIMATING	16
–	1	105-040	LENS, 1064nm, COMBO, COLLIMATING	17
–	1	105-041	LENS, 633nm, COMBO, COLLIMATING	18
REF	–	105-042	LENS, 16mm, COMBO, MICROBEAM	19
REF	–	105-043	LENS, 40mm, COMBO, ENDOSTAT	20
REF (1)	–	105-045	PRISM, 60°, DISPERSING, COMBO	21
–	REF (2)	105-046	PRISM, BEAMSPLITTER, COMBO	22
–	1	105-047	PRISM, 180°, FOLDING, COMBO	23
REF (3)	–	105-048	MIRROR, 532nm, FOLDING, COMBO	24
–	REF (1)	105-049	MIRROR, 1064/633nm, COMBO	25
1	–	3040-0001	RETARDER	26
ALT (1)	–	105-061	HALFWAVE PLATE, MULTI-ORDER, COMBO	26
1	–	102-348	POLARIZERS, MATCHED PAIR	27
REF (2)	–	100-567	AIM AND PRE-AIM FILTER, 532nm, 80X	28
REF (2)	–	105-052	CALIBRATION FILTER, 1064nm, COMBO	29
REF (3)	–	105-053	BEAMSPLITTER, 532nm, COMBO	30
–	REF (2)	105-054	MIRROR, 1064nm DETECTORS, COMBO	31
REF (1)	REF (1)	105-070	BEAM REFLECTOR, SHUTTER, COMBO	32
REF (3)	–	105-056	DIFFUSER, GLASS FOR DETECTORS, COMBO	33
REF (1)	–	100-4221	DIFFUSER	34
REF (3)	–	105-066	POLARIZER, 532nm DETECTORS, COMBO	35
REF (1)	–	104-093	BEAM POINTING PLATE	36
REF (1)	REF (1)	105-062	LIGHT VALVE, COMBO	37
–	REF (2)	100-4223	DIFFUSER	38
REF (3)	–	105-064	FILTER, COLOR, KTP DETECTORS	39
–	REF (2)	105-065	LENS, 36mm, 1064nm DETECTORS	40
REF (1)	–	105-0692	LENS, CAL POD, COMBO	41

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3052 ORCHARD DRIVE SAN JOSE, CA 95134

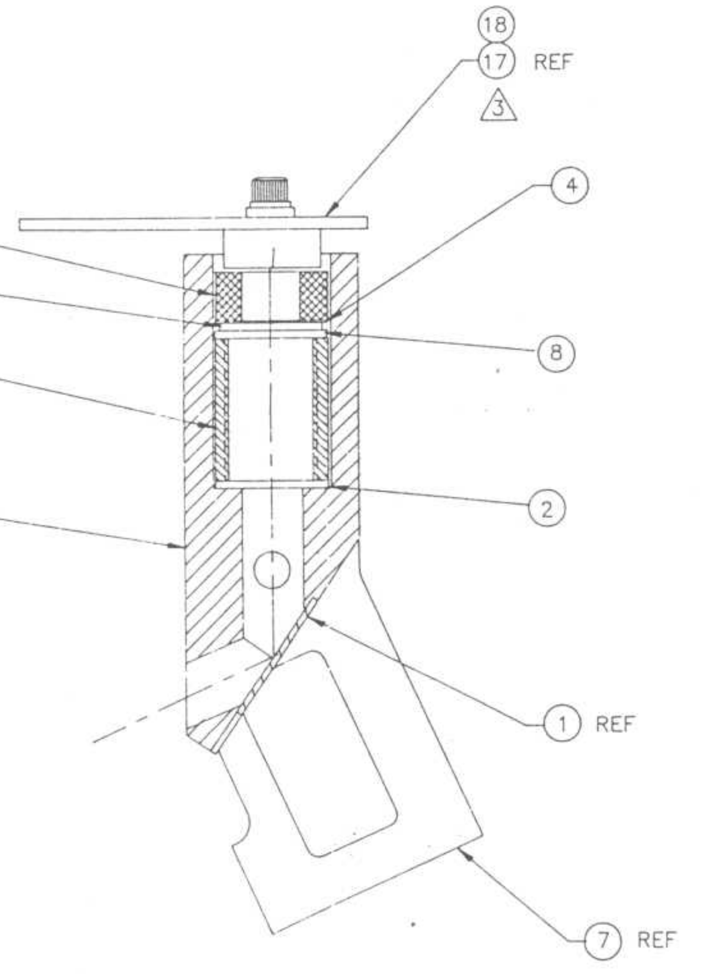
D 107-223X REV 1

SHEET 3 OF 3

FILE NO. 107-2233 PLOT DATE: 3/23/90

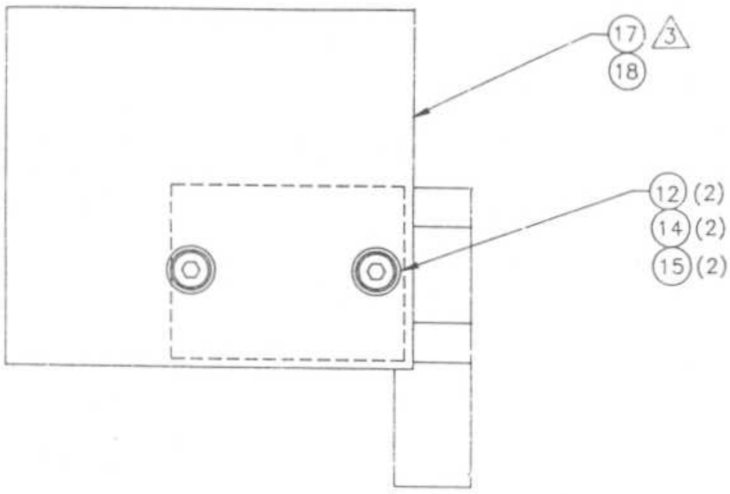
NOTES:

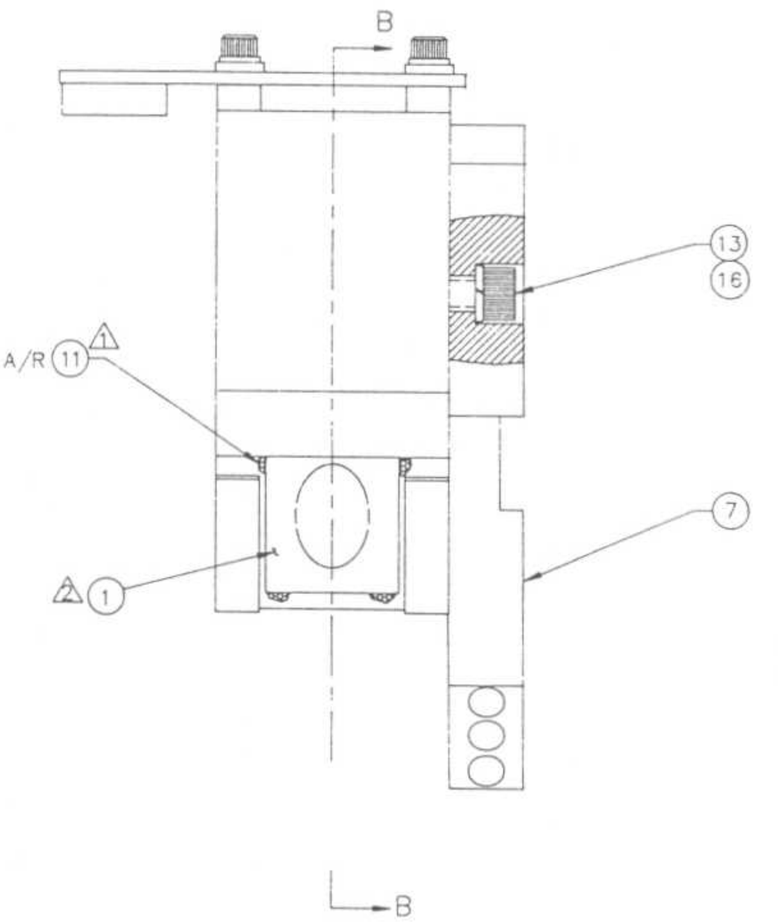
1. BEAMSPLITTER, ITEM (1), IS ATTACHED WITH FOUR SMALL DABS OF ADHESIVE, ITEM (11). ADHESIVE IS CURED WITH UV LIGHT.
2. ORIENTATION OF BEAMSPLITTER, ITEM (1), IS IMPORTANT. COATED SIDE MUST BE ON INSIDE. THE COATED SIDE OF THE BEAMSPLITTER CAN BE IDENTIFIED BY DRAGGING A COTTON SWAB ACROSS THE SURFACE. THE COATED SIDE WILL CREATE RESISTANCE WHILE THE GLASS SIDE WILL NOT. THIS MUST BE DONE VERY SOFTLY, AWAY FROM CENTER OF OPTIC, SO COATING IS NOT SCRATCHED. OPTIC MUST BE CLEANED WITH ACETONE OR METHANOL BEFORE ATTACHING TO ASSEMBLY.



SECTION B-B

-1 QTY	-2 QTY	PART NUMBER	DESCRIPTION	ITEM
1	1	105-053	BEAMSPLITTER, 532, COMBO	1
1	1	105-056	DIFFUSER, GLASS	2
1	1	105-064	FILTER, COLOR, KTP DETECTORS	3
1	1	105-066	POLARIZER, DETECTOR	4
1	1	105-149	BAFFLE, POWER, DETECTOR	5
1	1	105-152	HOUSING, POWER DETECTOR, 532nm	6
1	1	105-155	BRACKET, POWER DETECTOR, 532nm	7
1	1	107-283	FILTER, ND, KTP DETECTORS	8
1	1	105-159	SEAL, POWER DETECTOR	9
				10
A/R	A/R	1600-0035	ADHESIVE, MULTICURE	11
2	2	7236-0402	SCREW, CAP, SKT, 4-40 X .25, BO	12
1	1	7236-0806	SCREW, CAP, SKT, 8-32 X .38, BO	13
2	2	7276-0400	WASHER, FLAT, SM PTN, #4, BO	14
2	2	7280-0400	WASHER, SPLIT LOCK, #4, BO	15
1	1	7280-0800	WASHER, SPLIT LOCK, #8, BO	16
1		0105-4174	TESTED PCB POWER DETECTOR, K_DET, SURG	17
	1	0105-4175	TESTED PCB POWER DETECTOR, K_DET, SAF	18





3

DASH NUMBER	DESCRIPTION	TESTED PCB ASSY NUMBER
-1	KTP SURGICAL DETECTOR	105-4174
-2	KTP SAFETY DETECTOR	105-4175

REV LTR	ECO NO.	APPD	DATE
A	1532		
1	P0189		

MODEL | NEXT ASSEMBLY

DO NOT SCALE DRAWING
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES
.X± ~ mm ~
.XX± ~ ANG. ± ~ °
.XXX± ~ FINISH ~
BREAK ALL SHARP CORNERS

ASSY, DETECTOR
532nm, MODEL 80X

SCALE 2/1 | DRAWN BY Y CAI | DATE 3/23/90 | CHECKED BY | APPROVED BY
MATERIAL NA
FINISH NA

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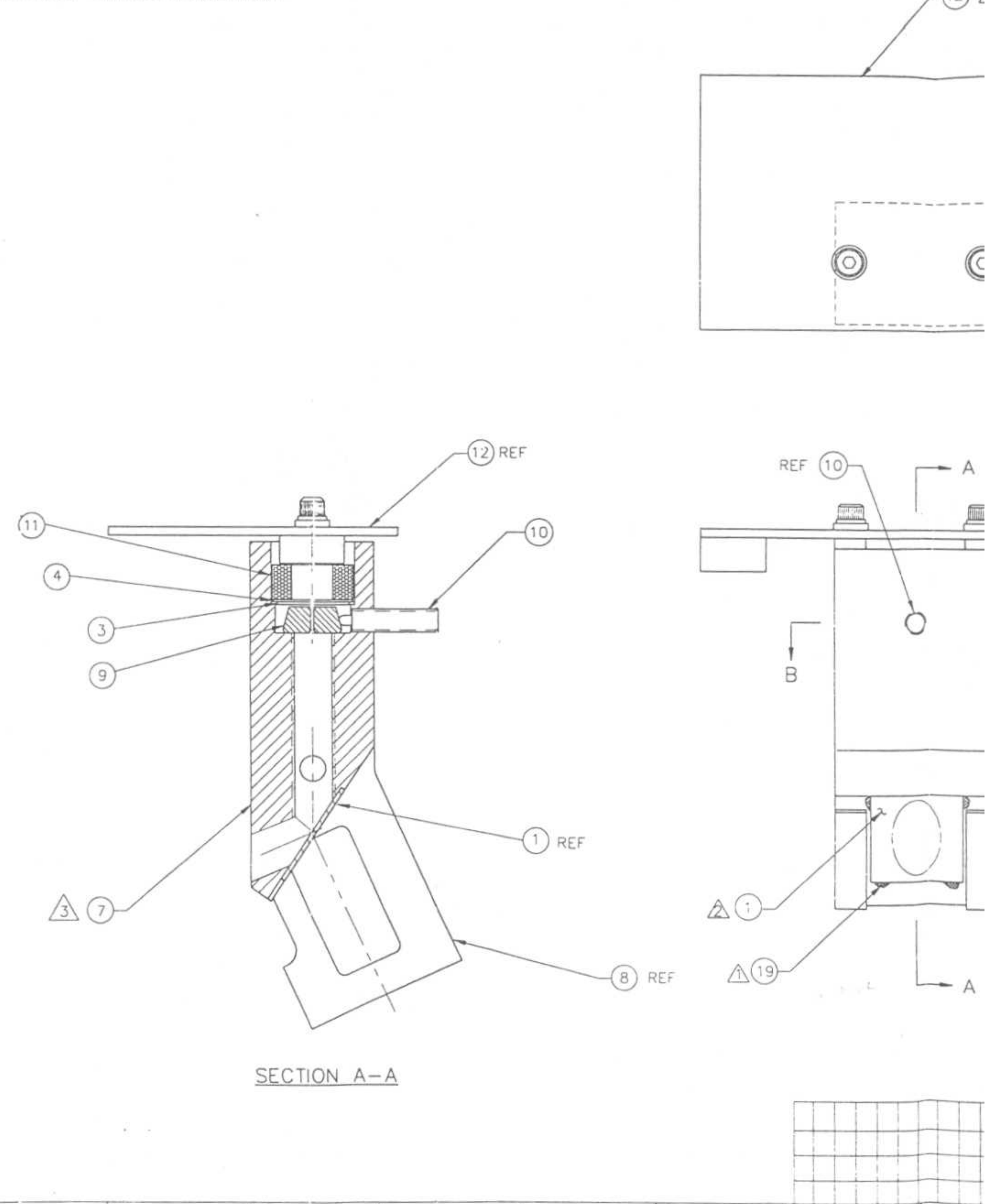
3052 ORCHARD DRIVE SAN JOSE, CA 95134

D | 107-086X | REV A
SHEET 1 OF 1

FILE 107-086X PLOT DATE 6/22/90

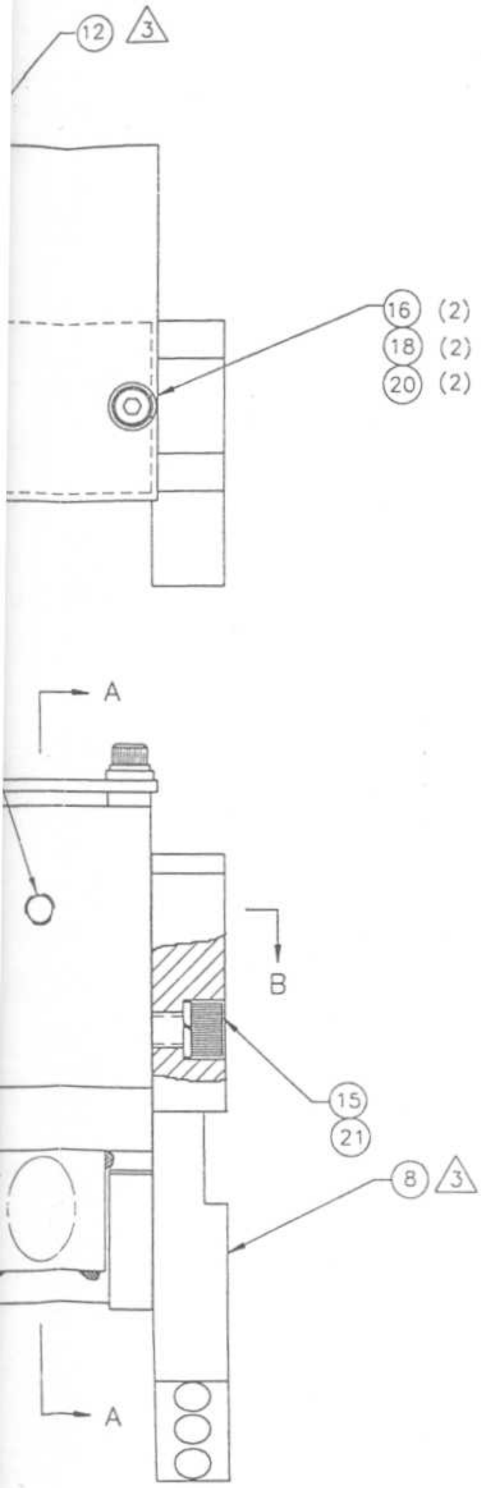
NOTES:

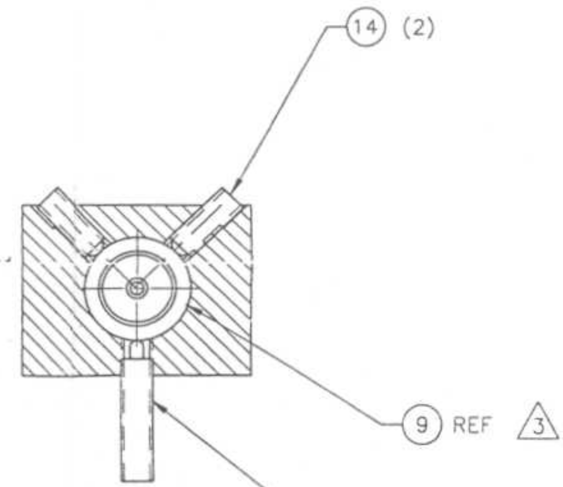
1. BEAMSPLITTER, ITEM (1) , IS ATTACHED WITH FOUR SMALL DABS OF ADHESIVE, ITEM (19) . ADHESIVE IS CURED WITH UV LIGHT.
2. BEAMSPLITTER, ITEM (1), ORIENTATION IS NOT IMPORTANT. COATED SIDE CAN BE ON INSIDE OR OUTSIDE.
3. DETECTOR HOUSING (7) IS ADJUSTED WITH RESPECT TO BRACKET (8) UPON INSTALLATION INTO RESONATOR PLATE. REFERENCE SERVICE MANUAL.



SECTION A-A

QTY	PART NUMBER	DESCRIPTION	ITEM
1	105-053	BEAMSPLITTER, 532, MODEL 70X	1
			2
1	105-064	FILTER, COLOR, KTP DETECTORS	3
1	105-066	POLARIZER, DETECTOR	4
			5
			6
1	107-082	HOUSING, POWER, DETECTOR, 532 AIM, 80X	7
1	105-155	BRACKET, POWER, DETECTOR, 532nm	8
1	105-427	APERTURE, 532 AIM DETECTOR, .025 ID	9
1	2504-0059	SPRING, PLUNGER, 8-32 H.P.	10
1	105-159	SEAL, POWER DETECTOR	11
1	105-4173	TESTED PCB ASSY, DETECTOR, AIM, MODEL 70X	12
			13
2	2825-0054	SCREW, SET, SILVER TIP, 8-32 x .75	14
1	7236-0806	SCREW, CAP, SKT, 8-32 X .38, BO	15
2	7236-0404	SCREW, CAP, SKT, 4-40 X .25, BO	16
2	7236-0402	SCREW, CAP, SKT, 4-40 X .13, BO	17
4	7280-0400	WASHER, SPLIT LOCK, #4, BO	18
A/R	1600-0035	ADHESIVE, MULTICURE	19
2	7276-0400	WASHER, FLAT, SM PTN, #4, BO	20
1	7280-0800	WASHER, SPLIT LOCK, #8, BO	21





SECTION B-B

REV LTR	1
ECO NO.	
APPD	
DATE	3/28/90

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MODEL | NEXT ASSEMBLY

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES

.X± ~ mm ~
.XX± ~ ANG. ± ~°
.XXX± ~ FINISH ~

BREAK ALL SHARP CORNERS

ASSY, DETECTOR, 532nm AIM, MODEL 80X

SCALE: 2/1 | DRAWN BY: J. L. | DATE: 3/28/90 | CHECKED BY: | APPROVED BY:

MATERIAL: NA

FINISH: NA

LASERSCOPE®

3052 ORCHARD DRIVE SAN JOSE, CA 95134

D 107-085 SHEET 1 OF 1 REV 1

FILE: 107-085 1 PLOT DATE: 3/28/90

8 | 7 | 5

NOTES: UNLESS OTHERWISE SPECIFIED

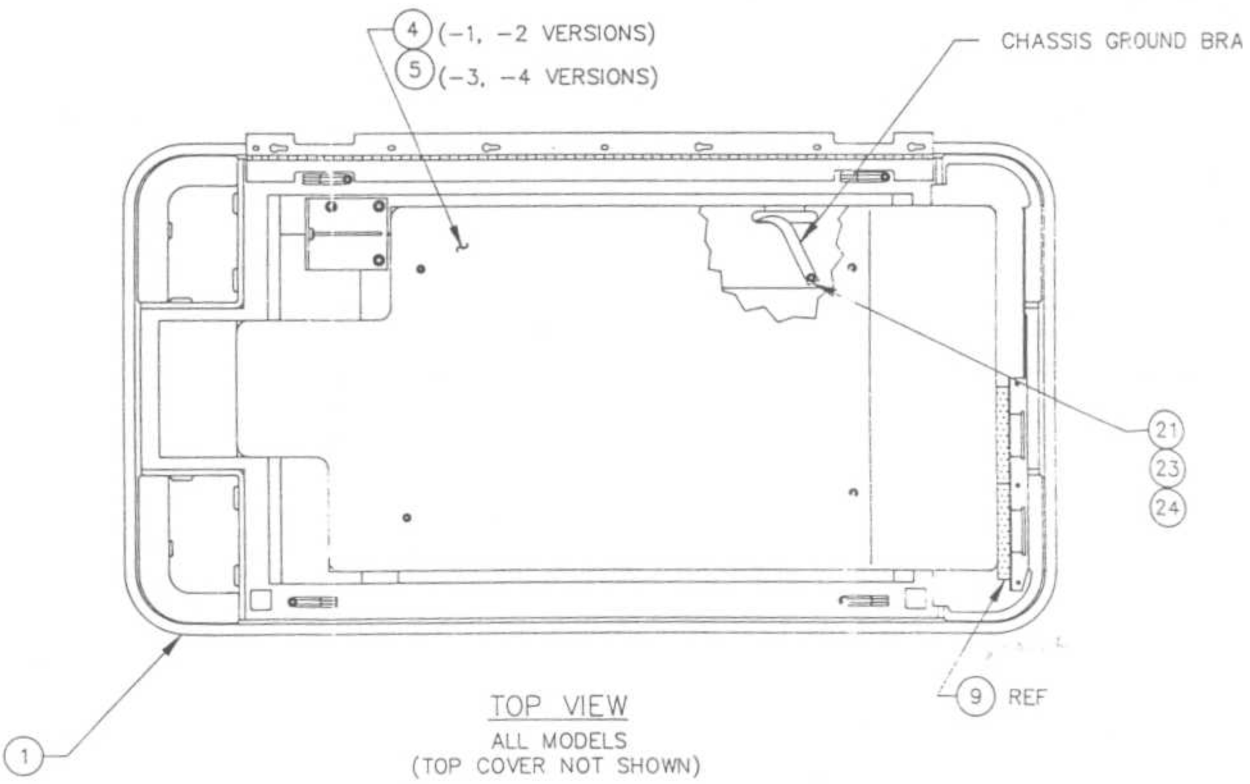
1. REPLACE FILTER CARTRIDGE, ITEM 45, WITH O-RING (INLET) SEAL UP AND DE-IONIZER/FILTER, ITEM 46, WITH INLET SEAL UP (AS INDICATED BY "THIS END UP" MOLDED ON FILTER) PRIOR TO SHIPMENT.

2. REMOVE KEYS FROM KEYSWITCH 16 PRIOR TO SHIPMENT. DO NOT SHIP KEYS WITH UNIT. COLLECT KEYS AND GIVE TO MARKETING (CLINICAL EDUCATION).

3. REFER TO DRAWING 107-047X, ITEM 15, FOR INSTALLATION OF INDICATED LASER COMPONENTS.

4. LABEL, ITEM 40 TO BE APPLIED AFTER UNIT HAS MET ETL REQUIREMENTS.

-4 QTY	-3 QTY	-2 QTY	-1 QTY	PART NUMBER	DESCRIPTION
1	1	1	1	0107-2630	LABEL, FOOTSWITC
1	1	1	1	0107-2640	LABEL, CAL-POD
1	1	1	1	0107-2650	LABEL, REMOTE IN
1	1			0105-1980	LABEL RADIATION
		1	1	0103-0880	LABEL DANGER R
1	1	1	1	0100-2730	LABEL, CERTIFICAT
1	1	1	1	0101-4560	LABEL EXPLOSION
1	1	1	1	2400-0006	LABEL ETL, BOX
1	1	1	1	0103-1670	TAG, QA, ACCEPTE
3	3			7236-0626	SCREW, CAP, SKT,
3	3			7275-0600	WASHER, FLAT, #6,
3	3			7280-0600	WASHER, SPLIT LO
1	1	1	1	2512-0139	FILTER, PARTICLE,
1	1	1	1	2512-0135	FILTER, DE-IONIZIN



TOP VIEW
ALL MODELS
(TOP COVER NOT SHOWN)

DESCRIPTION	ITEM
.. FOOTSWITCH CONN.	31
.. CAL-POD CONN.	32
.. REMOTE INTERLOCK	33
	34
.. RADIATION DANGER, COMBO	35
.. DANGER RADIATION	36
.. CERTIFICATION & I.D.	37
.. EXPLOSION HAZ GROUNDING	38
	39
L ETL, 80X	40
QA, ACCEPTED	41
..., CAP, SKT, 6-32 X 1.75, BO	42
..HER, FLAT, #6, BO	43
..HER, SPLIT LOCK, #6, BO	44
..ER, PARTICLE, .2 MICRON	45
..ER, DE-IONIZING/PARTICAL	46
	47
	48
	49
	50

-4 QTY	-3 QTY	-2 QTY	-1 QTY	PART NUMBER	DESCRIPTION	ITEM
[illegible]	1	1	1	0107-0631	ASSY, CONSOLE, SINGLE PHASE, DOMESTIC	1
						2
						3
		1	1	0107-0471	ASSY, RESONATOR, KTP, 80X	4
[illegible]	1			0107-0472	ASSY, RESONATOR, KTP/YAG, 80X	5
		1		0107-3110	PANEL, BLANK-OFF, TOP COVER, 80X	6
[illegible]		1		0105-3900	CLIP, BLANK-OFF	7
[illegible]		1		0105-3050	BLANK-OFF, DUST COVER	8
[illegible]	2	1	2	0105-2870	GASKET, OUTPUT COUPLER	9
[illegible]	1			0105-3690	ASSY, HE-NE POWER SUPPLY	10
	1		1	0105-2630	ASSY, COUPLER, MICROBEAM	11
	1		1	0105-2640	ASSY, BEAM POINTER	12
4	4	4	4	0104-1470	SPACER, LASER MOUNT, SHORT	13
[illegible]	1	1	1	0105-2850	PANEL, TRIM, OUTPUT COUPLERS	14
REF	REF	REF	REF	0107-047X	ASSY, RESONATOR, MODEL 80X	15
REF	REF	REF	REF	0107-0900	ASSY, KEYSWITCH, MODEL 80X	16
4	4	4	4	7857-1500	NUT, KEP, .31-18, ZN	17
2	2	2	2	2825-0007	SCREW, TAMPER RESISTANT, 8-32 X .50	18
4	4	4	4	7875-1500	WASHER, FLAT, .31, ZN	19
2		2		7236-0806	SCREW, CAP, SKT, 8-32 X .38, BO	20
[illegible]	3	1	3	7236-0808	SCREW, CAP, SKT, 8-32 X .50, BO	21
3	3	3	3	2825-0049	SCREW, FH, 100°, PD, 8-32 x .38, BO	22
5	5	5	5	7280-0800	WASHER, SPLIT LOCK, #8, BO	23
[illegible]	1	1	1	7275-0800	WASHER, FLAT, #8, BO	24
2	2	2	2	7236-0810	SCREW, CAP, SKT, 8-32 X .63, BO	25
						26
						27
2	2	2	2	0107-2600	LABEL, SERVICE WARNING	28
1	1	1	1	0107-2610	LABEL, COOLANT LEVEL	29
1	1	1	1	0107-2620	LABEL, E.S.F. CONN.	30

GROUND BRAID

21

23

24

DASH	DESCRIPTION
-1	801 SYSTEM, SINGLE PHASE
-2	802 SYSTEM, SINGLE PHASE
-3	803 SYSTEM, SINGLE PHASE
-4	804 SYSTEM, SINGLE PHASE

DO NOT SCALE DRAWING
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES
.X± ~ mm ~
.XX± ~ ANG. ± ~°
.XXX± ~ FINISH ~
BREAK ALL SHARP CORNERS

REV LTR 2 | ECO NO. | APPD | DATE

ASSY, FINAL, 80X SYSTEM, DOMESTIC

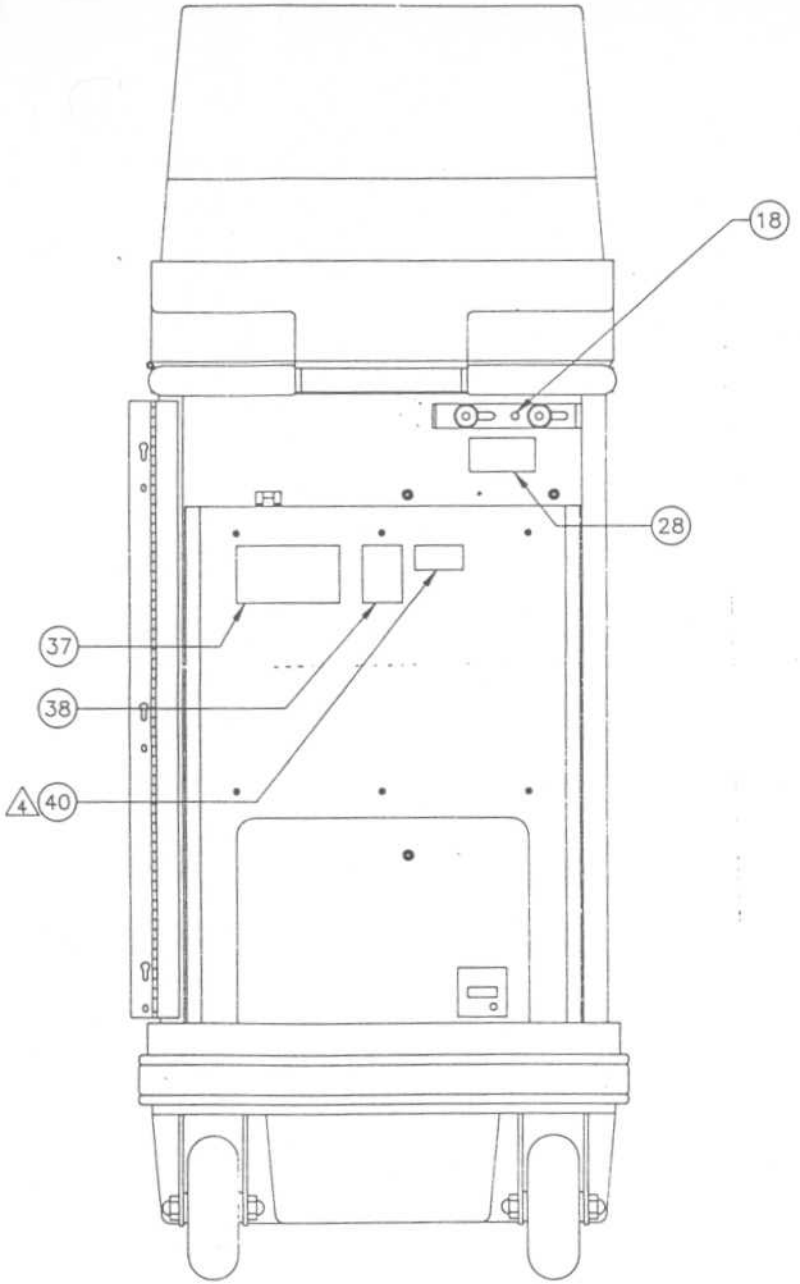
SCALE NTS | DRAWN BY J.Q. | DATE 6/18/90 | CHECKED BY | APPROVED BY
MATERIAL N/A
FINISH N/A

LASERSCOPE®
3052 ORCHARD DRIVE SAN JOSE, CA 95134

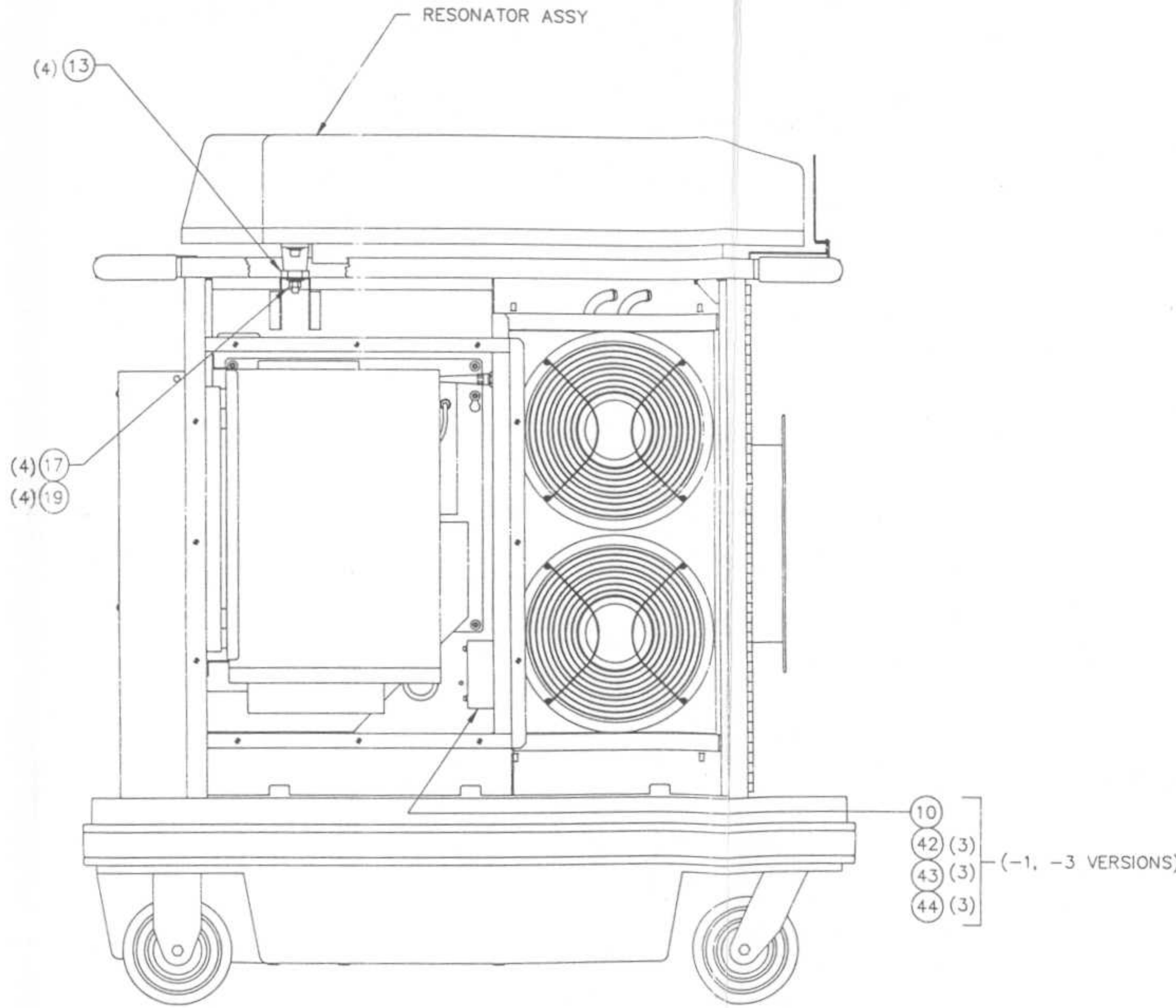
D 0107-062X SHEET 1 OF 3 REV 2

FILE: 107-0621 PLOT DATE: 6/22/90

4 3 2 1



REAR VIEW
REAR DOOR NOT SHOWN



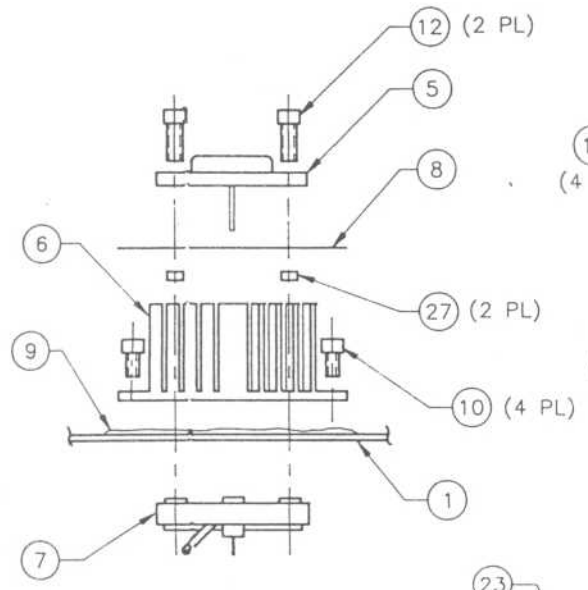
POWER SIDE VIEW
COVERS NOT SHOWN

LASERSCOPE®
3052 ORCHARD DRIVE SAN JOSE, CA 95134

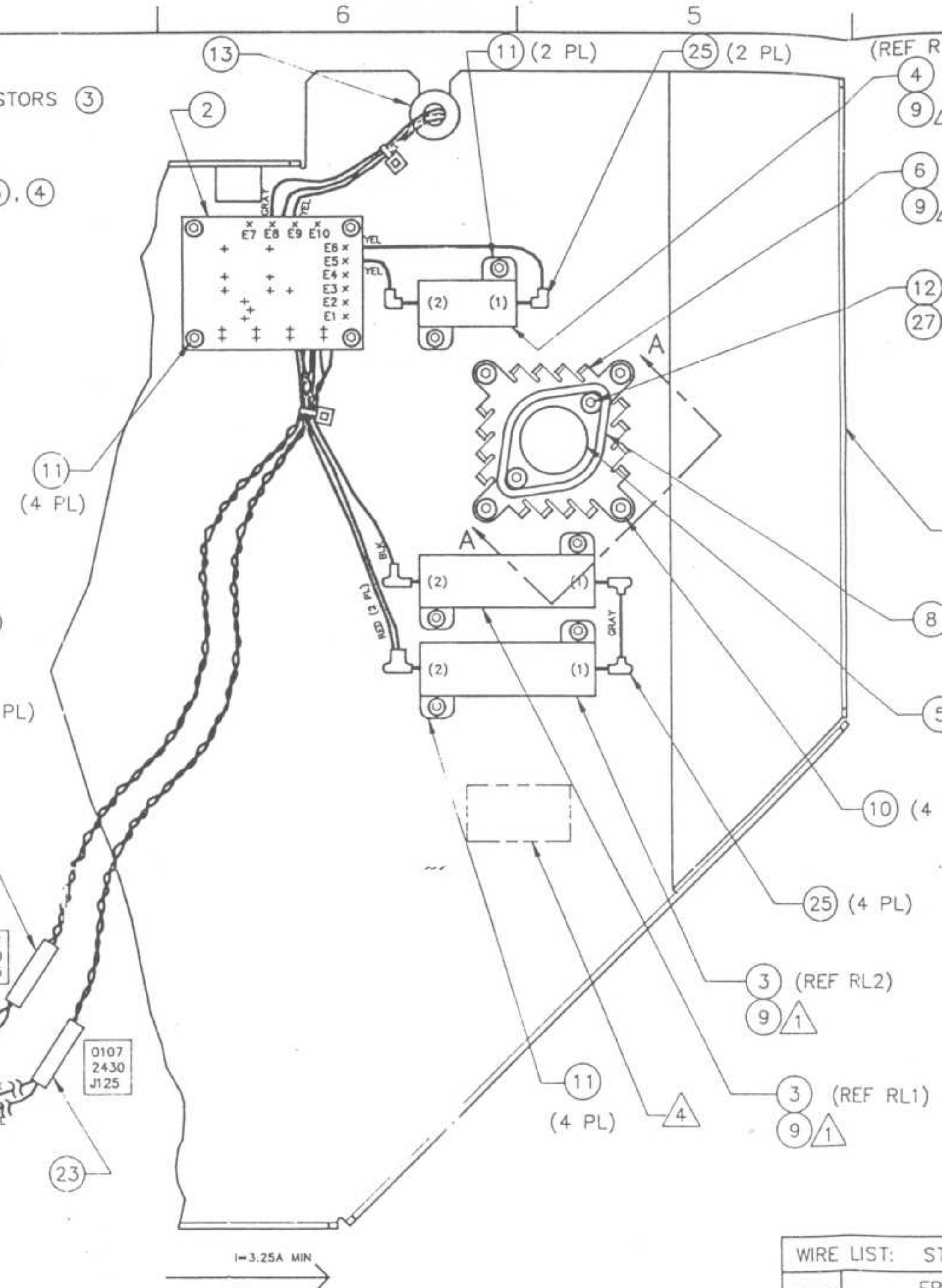
D	107−062X	REV 2

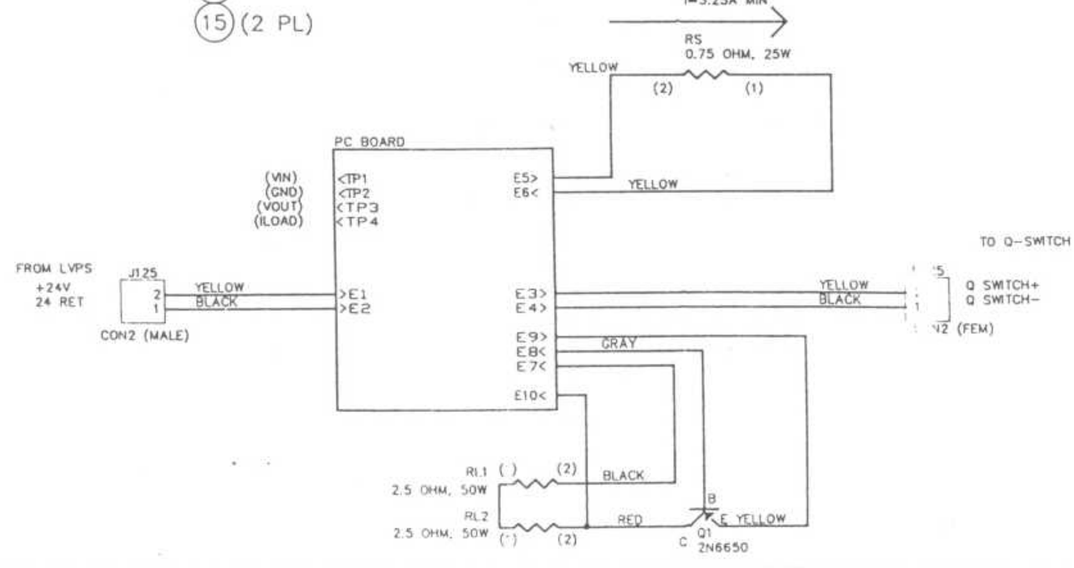
NOTES (UNLESS OTHERWISE SPECIFIED):

1. USE THERMAL GREASE (9) BETWEEN RESISTORS (3) AND (4), HEATSINK (6) AND DUCT (1).
2. WIRE ASSEMBLY AS SHOWN ON WIRE LIST.
3. INSULATE WIRE CONNECTIONS AT ITEMS (3), (4) AND (7) WITH SHRINK TUBE (25).
4. TEST ASSEMBLY PER 105-471. QA STAMP AS SHOWN.

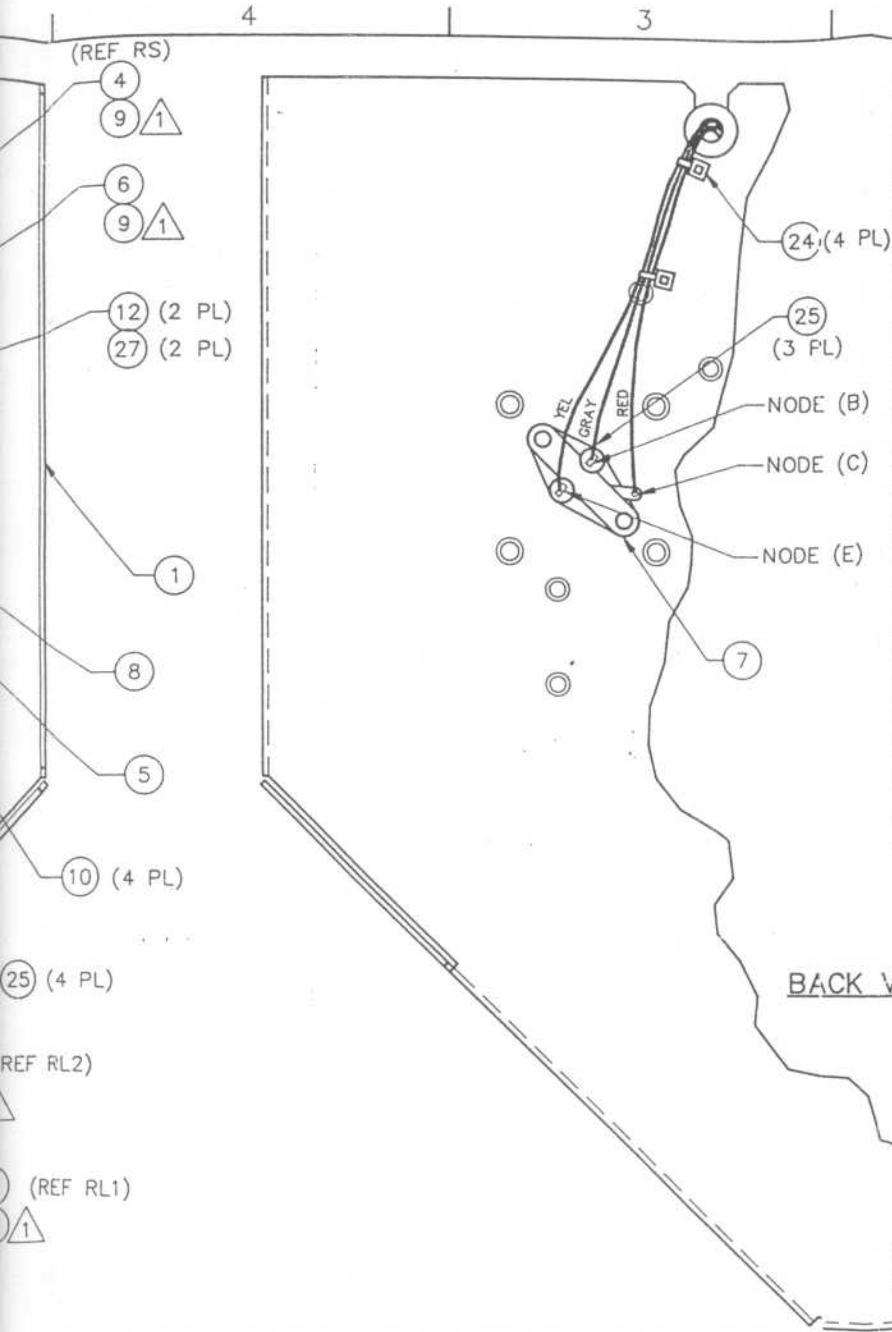


VIEW A-A
ROTATED 45° CW





WIRE LIST: ST	
WIRE NO.	FR
	ITEM
1	2
2	2
3	2
4	2
5	2
6	2
7	2
8	2
9	2
10	2
11	3 (RL2)
12	3 (RL1)



REF	QTY	PART NO.	DESCRIPTION	ITEM
	1	107-077	DUCT, W/SMART LOAD	1
	1	105-457	PCB ASSY, START-UP LOAD	2
RL1,2	2	4701-2513	2.5 OHM, 50W DALE RH-50	3
RS	1	4701-7522	0.75 OHM, 25W DALE RH-25	4
Q1	1	4850-0003	2N6650	5
	1	2620-0001	HEATSINK, TO3	6
	1	2506-0051	SOCKET, TO3	7
	1	2506-0050	THERMAL PAD, TO3	8
	A/R	1640-0003	THERMAL GREASE	9
	4	7236-0604	SCREW, 6-32 x .25, SOCKET HD.	10
	10	7236-0405	SCREW, 4-40 x .31, SOCKET HD.	11
	2	7236-0606	SCREW, 6-32 x .38, SOCKET HD.	12
	1	2806-0025	GROMMET, .1875 ID	13
J125	1	2100-0035	HOUSING, PIN	14
	2	2100-0039	CONTACT PIN	15
P125	1	2100-0036	HOUSING, SOCKET	16
	2	2100-0040	CONTACT SOCKET	17
	REF	5401-0000	CRIMPER, AMP #90325-1	18
	54.3"	6070-0049	WIRE, 18 GA, YELLOW	19
	47.0"	6070-0054	WIRE, 18 GA, BLACK	20
	19.0"	6070-0047	WIRE, 18 GA, RED	21
	8.8"	6070-0052	WIRE, 18 GA, GRAY	22
	2	6075-0000	WIRE MARKER	23
	4	2806-0009	CABLE TIE	24
	7"	2802-0002	SHRINK TUBE .375	25
	REF	105-4710	TEST PROCEDURE, START-UP LOAD	26
	2	2880-0037	WASHER, TEFLON, THINWALL	27

WIRE LIST: START-UP LOAD

WIRE NO.	FROM ITEM	FROM NODE	TO ITEM	TO NODE	WIRE COLOR	WIRE GAUGE	WIRE LENGTH	ITEM	COMMENTS
1	2	E1	14	2	YELLOW	18	21.0	19	WIRES 1 AND 2 TWISTED
2	2	E2	14	1	BLACK	18	21.0	20	WIRES 1 AND 2 TWISTED
3	2	E3	16	2	YELLOW	18	21.0	19	WIRES 3 AND 4 TWISTED
4	2	E4	16	1	BLACK	18	21.0	20	WIRES 3 AND 4 TWISTED
5	2	E5	4 (RS)	2	YELLOW	18	1.3	19	
6	2	E6	4 (RS)	1	YELLOW	18	3.5	19	
7	2	E7	3 (RL1)	2	BLACK	18	5.0	20	
8	2	E8	7	B	GRAY	18	7.5	22	
9	2	E9	7	E	YELLOW	18	7.5	19	
10	2	E10	3 (RL2)	2	RED	18	6.0	21	
11	3 (RL2)	2	7	C	RED	18	13.0	21	
12	3 (RL1)	1	3 (RL2)	1	GRAY	18	1.3	22	

REV LTR	ECO NO.	APPD	DATE
1	P0209	HW	5/1/90
2			

NEXT ASSEMBLY / MODEL

DO NOT SCALE DRAWING
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES
.X± ~ mm
.XX± ~ ANG. ± °
.XXX± ~ FINISH
BREAK ALL SHARP CORNERS

ASSY, DUCT WITH START-UP LOAD, 80X

SCALE 1/1 | DRAWN BY J. L. | DATE 4/18/90 | CHECKED BY | APPROVED BY
MATERIAL SEE BOM
FINISH ~

LASERSCOPE®
3052 ORCHARD DRIVE SAN JOSE, CA 95134

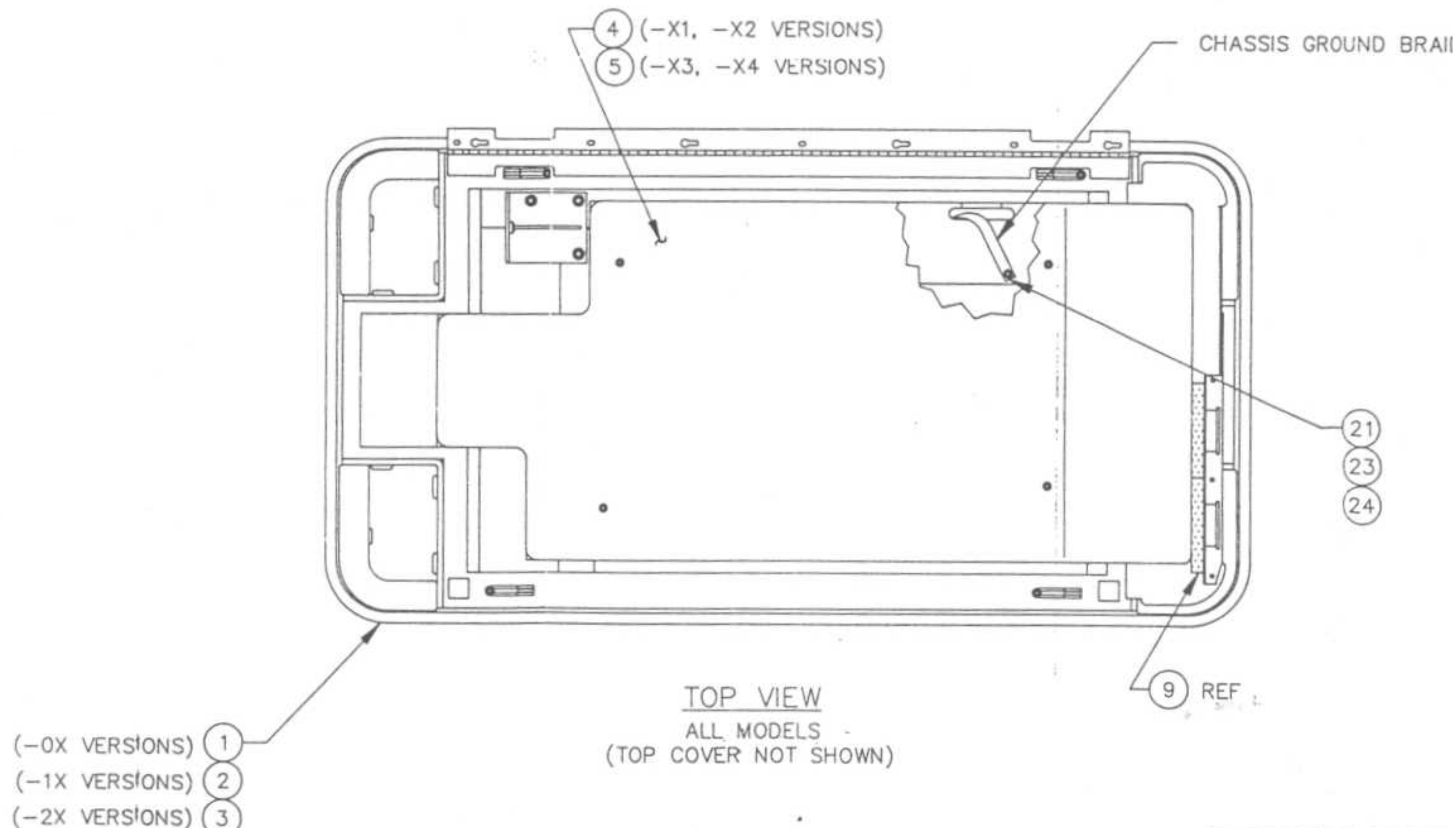
D 107-243 SHEET 1 OF 1 REV 2

FILE NO.: 105-243 PLOT DATE: 6/4/90

NOTES: UNLESS OTHERWISE SPECIFIED

1. REPLACE FILTER CARTRIDGE, ITEM (45) AND DE-IONIZER/FILTER, ITEM (46) PRIOR TO SHIPMENT.
2. REMOVE KEYS FROM KEYSWITCH (16) PRIOR TO SHIPMENT. DO NOT SHIP KEYS WITH UNIT. COLLECT KEYS AND GIVE TO MARKETING (CLINICAL EDUCATION).
3. REFER TO DRAWING 107-047X, ITEM (15), FOR INSTALLATION OF INDICATED LASER COMPONENTS.

-24	-23	-22	-21	-14	-13	-12	-11	-4	-3	-2	-1		
QTY	QTY	QTY	QTY	QTY	QTY	QTY	QTY	QTY	QTY	QTY	QTY	PART NUMBER	DESCRIPTION
								1	1	1	1	107-263	LABEL, FOOTSWITCH
								1	1	1	1	107-264	LABEL, CAL-POD C
								1	1	1	1	107-265	LABEL, REMOTE INT
								1	1			105-198	LABEL, RADIATION
										1	1	103-088	LABEL, DANGER RA
								1	1	1	1	100-273	LABEL, CERTIFICATIO
								1	1	1	1	101-456	LABEL, EXPLOSION
								1	1	1	1	103-167	TAG, QA, ACCEPTED
								3	3			7236-0626	SCREW, CAP, SKT,
								3	3			7275-0600	WASHER, FLAT, #6,
								3	3			7280-0600	WASHER, SPLIT LOC
								1	1	1	1	2512-0139	FILTER, PARTICLE, .
								1	1	1	1	2512-0135	FILTER, DE-IONIZING



TOP VIEW
ALL MODELS
(TOP COVER NOT SHOWN)

DESCRIPTION	ITEM
EL, FOOTSWITCH CONN.	31
EL, CAL-POD CONN.	32
EL, REMOTE INTERLOCK	33
	34
EL, RADIATION DANGER, COMBO	35
EL, DANGER RADIATION	36
EL, CERTIFICATION & I.D.	37
EL, EXPLOSION HAZ GROUNDING	38
	39
	40
, QA, ACCEPTED	41
EW, CAP, SKT, 6-32 X 1.75, BO	42
SHER, FLAT, #6, BO	43
SHER, SPLIT LOCK, #6, BO	44
ER, PARTICLE, .2 MICRON	45
ER, DE-IONIZING/PARTICAL	46
	47
	48
	49
	50

-24 QTY	-23 QTY	-22 QTY	-21 QTY	-14 QTY	-13 QTY	-12 QTY	-11 QTY	-4 QTY	-3 QTY	-2 QTY	-1 QTY	PART NUMBER	DESCRIPTION	ITEM
								1	1	1	1	107-0631	ASSY, CONSOLE, SINGLE PHASE, DOMESTIC	1
				1	1	1	1					107-0632	ASSY, CONSOLE, 3 PHASE, INTERNATIONAL	2
1	1	1	1									107-0633	ASSY, CONSOLE, SINGLE PHASE, INTERNATIONAL	3
										1	1	107-0471	ASSY, RESONATOR, KTP, 80X	4
								1	1			107-0472	ASSY, RESONATOR, KTP/YAG, 80X	5
								1		1		107-311	PANEL, BLANK-OFF, TOP COVER, 80X	6
								1		1		105-390	CLIP, BLANK-OFF	7
								1		1		105-305	BLANK-OFF, DUST COVER	8
								1	2	1	2	105-287	GASKET, OUTPUT COUPLER	9
								1	1			105-369	ASSY, HE-NE POWER SUPPLY	10
									1		1	105-263	ASSY, COUPLER, MICROBEAM	11
									1		1	105-264	ASSY, BEAM POINTER	12
								4	4	4	4	104-147	SPACER, LASER MOUNT, SHORT	13
								1	1	1	1	105-285	PANEL, TRIM, OUTPUT COUPLERS	14
								REF	REF	REF	REF	107-047X	ASSY, RESONATOR, MODEL 80X	15
								REF	REF	REF	REF	107-090	ASSY, KEYSWITCH, MODEL 80X	16
								4	4	4	4	7857-1500	NUT, KEP, .31-18, ZN	17
								2	2	2	2	2825-0007	SCREW, TAMPER RESISTANT, 8-32 X .50	18
								4	4	4	4	7875-1500	WASHER, FLAT, .31, ZN	19
								2		2		7236-0806	SCREW, CAP, SKT, 8-32 X .38, BO	20
								1	3	1	3	7236-0808	SCREW, CAP, SKT, 8-32 X .50, BO	21
								3	3	3	3	2825-0049	SCREW, FH, 100°, PD, 8-32 x .38, BO	22
								5	5	5	5	7280-0800	WASHER, SPLIT LOCK, #8, BO	23
								1	1	1	1	7275-0800	WASHER, FLAT, #8, BO	24
								2	2	2	2	7236-0810	SCREW, CAP, SKT, 8-32 X .63, BO	25
														26
														27
								2	2	2	2	107-260	LABEL, SERVICE WARNING	28
								1	1	1	1	107-261	LABEL, COOLANT LEVEL	29
								1	1	1	1	107-262	LABEL, E.S.F. CONN.	30

GROUND BRAID

21

23

24

DASH	DESCRIPTION
-01	801 SYSTEM, SINGLE PHASE, DOMESTIC
-02	802 SYSTEM, SINGLE PHASE, DOMESTIC
-03	803 SYSTEM, SINGLE PHASE, DOMESTIC
-04	804 SYSTEM, SINGLE PHASE, DOMESTIC
-11	801 SYSTEM, 3 PHASE, INTERNATIONAL
-12	802 SYSTEM, 3 PHASE, INTERNATIONAL
-13	803 SYSTEM, 3 PHASE, INTERNATIONAL
-14	804 SYSTEM, 3 PHASE, INTERNATIONAL
-21	801 SYSTEM, SINGLE PHASE, INTERNATIONAL
-22	802 SYSTEM, SINGLE PHASE, INTERNATIONAL
-23	803 SYSTEM, SINGLE PHASE, INTERNATIONAL
-24	804 SYSTEM, SINGLE PHASE, INTERNATIONAL

REV LTR	ECO NO.	APPD	DATE
1			5/24/90

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES

.X± ~ mm ~

.XX± ~ ANG. ± ~°

.XXX± ~ FINISH ~

BREAK ALL SHARP CORNERS

ASSY, FINAL, 80X SYSTEM

SCALE NTS | DRAWN BY J.Q. | DATE 5/17/90 | CHECKED BY | APPROVED BY

MATERIAL N/A

FINISH N/A

LASERSCOPE®

3052 ORCHARD DRIVE SAN JOSE, CA 95134

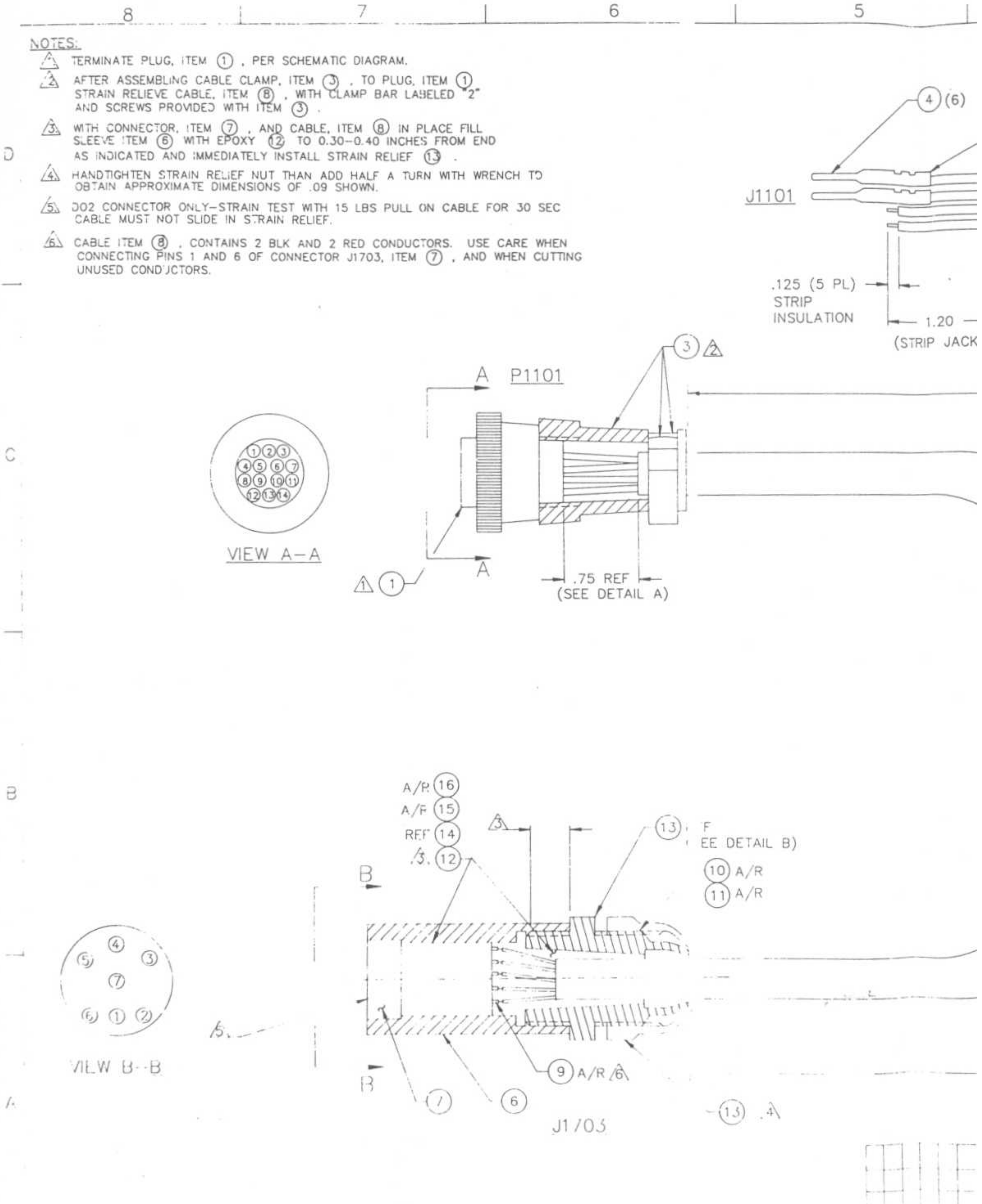
D | 107-30XX | SHEET 1 OF 3 | REV 1

FILE: 107-3001

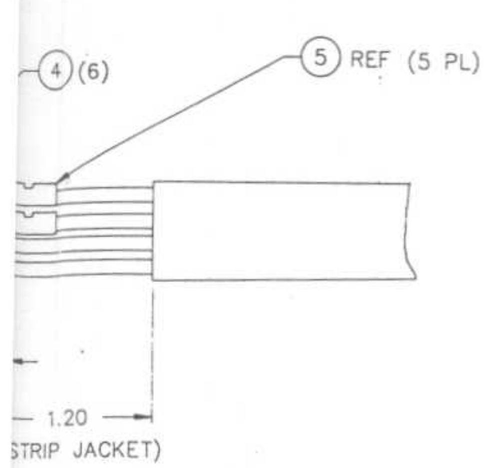
PLOT DATE: 5/18/90

NOTES:

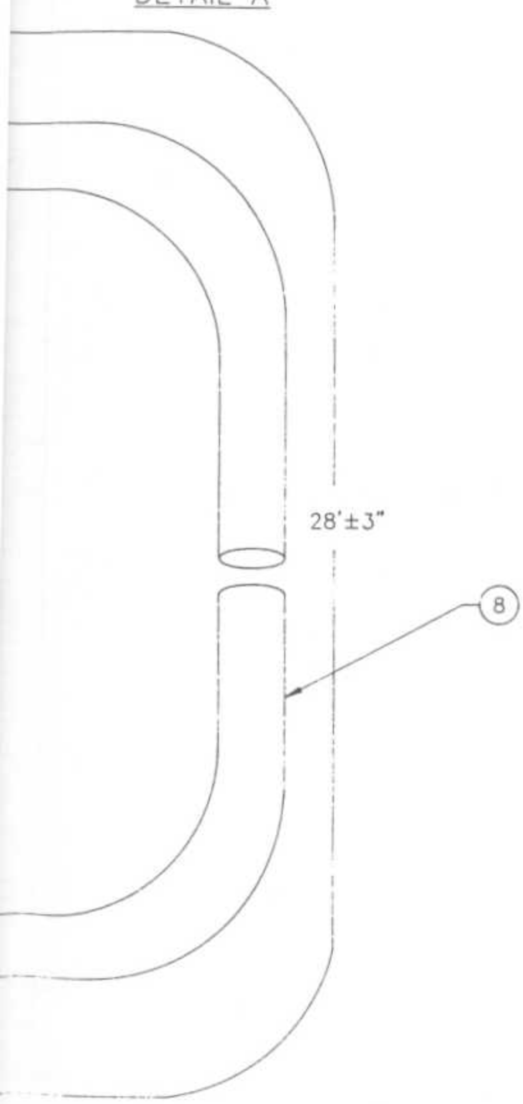
1. TERMINATE PLUG, ITEM (1), PER SCHEMATIC DIAGRAM.
2. AFTER ASSEMBLING CABLE CLAMP, ITEM (3), TO PLUG, ITEM (1), STRAIN RELIEVE CABLE, ITEM (8), WITH CLAMP BAR LABELED "2" AND SCREWS PROVIDED WITH ITEM (3).
3. WITH CONNECTOR, ITEM (7), AND CABLE, ITEM (8) IN PLACE FILL SLEEVE ITEM (6) WITH EPOXY (12) TO 0.30-0.40 INCHES FROM END AS INDICATED AND IMMEDIATELY INSTALL STRAIN RELIEF (13).
4. HANDTIGHTEN STRAIN RELIEF NUT THAN ADD HALF A TURN WITH WRENCH TO OBTAIN APPROXIMATE DIMENSIONS OF .09 SHOWN.
5. 002 CONNECTOR ONLY-STRAIN TEST WITH 15 LBS PULL ON CABLE FOR 30 SEC CABLE MUST NOT SLIDE IN STRAIN RELIEF.
6. CABLE ITEM (8), CONTAINS 2 BLK AND 2 RED CONDUCTORS. USE CARE WHEN CONNECTING PINS 1 AND 6 OF CONNECTOR J1703, ITEM (7), AND WHEN CUTTING UNUSED CONDUCTORS.



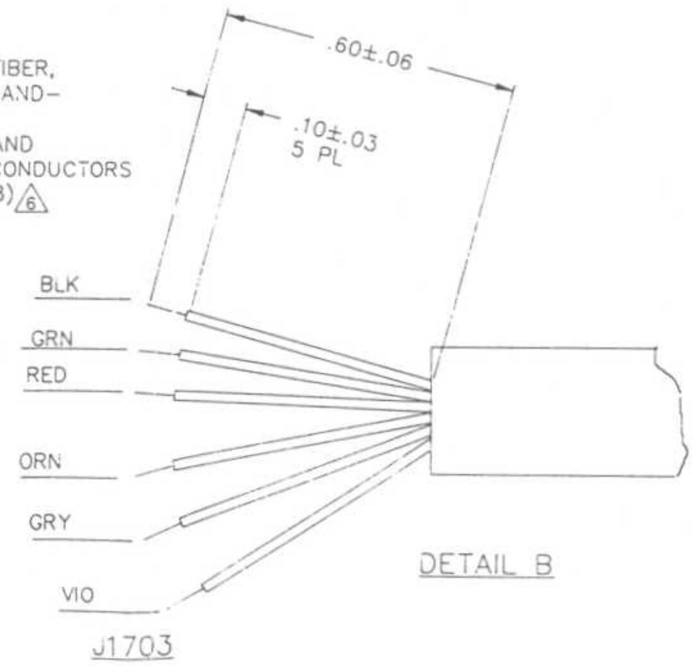
QTY	PART NUMBER	DESCRIPTION	ITEM
1	2100-0105	CONN, PLUG, CPC, SERIES 17	1
			2
1	2100-0106	CONN, CABLE CLAMP, SIZE 17 CPC	3
6	2100-0115	CONTACT, PIN, 30-26 AWG	4
REF	5401-0025	CRIMPER, AMP #90066	5
1	103-229	SLEEVE, DO2 CONNECTOR	6
1	2100-0095	CONNECTOR, PANEL MOUNT, FEMALE	7
29'	102-855	CABLE, FIBER	8
A/R	4600-0000	SOLDER 60/40	9
A/R	1600-0002	ADHESIVE, LOCTITE 609	10
A/R	1630-0000	PRIMER, LOCTITE N	11
A/R	1600-0049	EPOXY, 5 MIN CARTRIDGE	12
1	2806-0035	STRAIN RELIEF	13
REF	5400-0178	APPLICATOR GUN, DEVCON MK 5	14
A/R	5400-0179	MIX NOZZLE	15
A/R	5400-0101	BLUNT DISPOSABLE NEEDLE	16



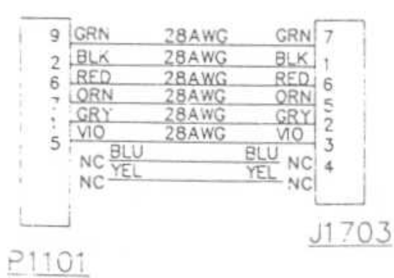
DETAIL A



(CUT DUMMY FIBER, BINDER TAPE, AND YEL, BLU AND UNUSED RED AND UNUSED BLK CONDUCTORS OUT OF ITEM 8) 6



DETAIL B



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DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES

X ± ~ mm ~
.XX ± ~ ANG ± ~
.XXX ± ~ FINISH ~

ASSY, CABLE, EYE SAFETY FILTER

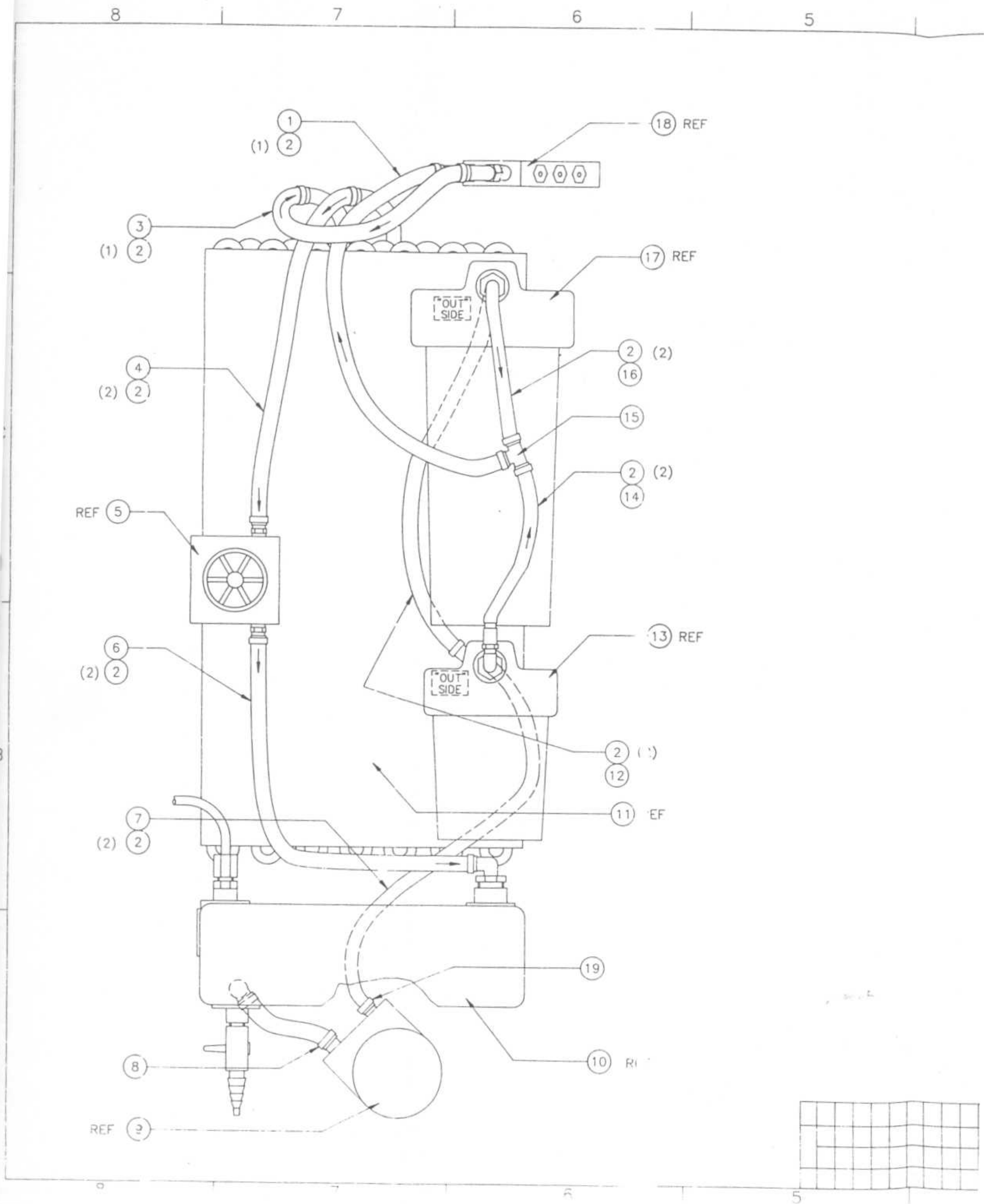
LASERSCOPE®

3052 ORCHARD DRIVE SAN JOSE, CA 95134

SCALE NTS | DRAWN BY J. Q. | DATE 3/13/90

MATERIAL NA

D 107-135

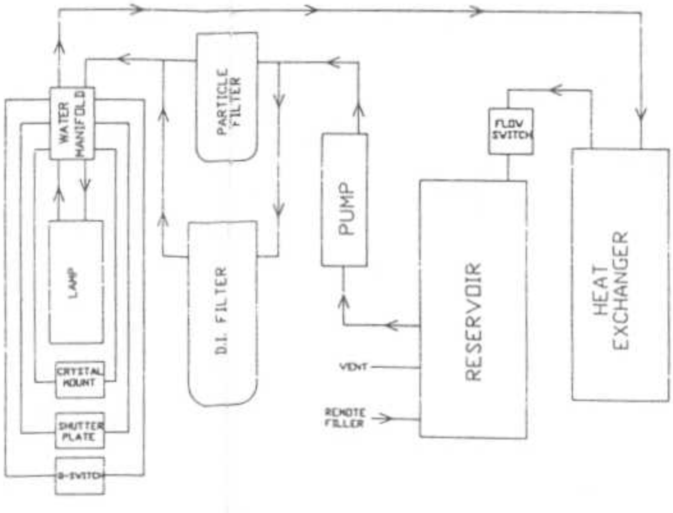


8
7
6
5
1
(1) 2
18 REF
3
(1) 2
17 REF
OUT SIDE
2 (2)
16
4
(2) 2
15
2 (2)
14
REF 5
13 REF
6
(2) 2
OUT SIDE
2
12
11
7
(2) 2
19
10
8
REF 9
5

4 3 2 1

QTY	PART NUMBER	DESCRIPTION	ITEM
12"	3200-0029	HOSE, PVC, .50 I.D.	1
13	2840-0017	CLAMP, HOSE, .825 I.D.	2
15"	3200-0029	HOSE, PVC, .50 I.D.	3
16"	3200-0029	HOSE, PVC, .50 I.D.	4
REF	107-219	ASSY, FLOW SWITCH	5
13"	3200-0029	HOSE, PVC, .50 I.D.	6
24"	3200-0029	HOSE, PVC, .50 I.D.	7
1	2512-0099	CLAMP, HOSE, WORM #8	8
REF	107-074	ASSY, PUMP 80X	9
REF	107-069	ASSY, RESERVOIR, 80X	10
REF	107-081	ASSY, HEAT EXCHANGER	11
13"	3200-0029	HOSE, PVC, .50 I.D.	12
REF	107-220	ASSY, PARTICLE FILTER	13
6"	3200-0029	HOSE, PVC, .50 I.D.	14
1	2512-0110	TEE, UNION	15
3.5"	3200-0029	HOSE, PVC, .50 I.D.	16
REF	107-221	ASSY, D.I. FILTER	17
REF	107-067	ASSY, WATER MANIFOLD	18
1	2512-0140	CLAMP, WORM #6	19
			20
			21
			22
			23
			24

SCHEMATIC,
COOLING SYSTEM



A	1942-HYY	11/2/90			
1	P0205	HW 4/24/90			
REV LTR	ECO NO.	APPD DATE			

MODEL | NEXT ASSEMBLY

DO NOT SCALE DRAWING
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES:
.X± mm
.XX± ANG. ± 1°
.XXX± FINISH
BREAK ALL SHARP CORNERS

ASSY, PLUMBING, 80X

SCALE 1/2 | DRAWN BY DAG | DATE 03-06-90 | CHECKED BY | APPROVED BY
MATERIAL
FINISH

LASERSCOPE®
3052 ORCHARD DRIVE SAN JOSE, CA 95134

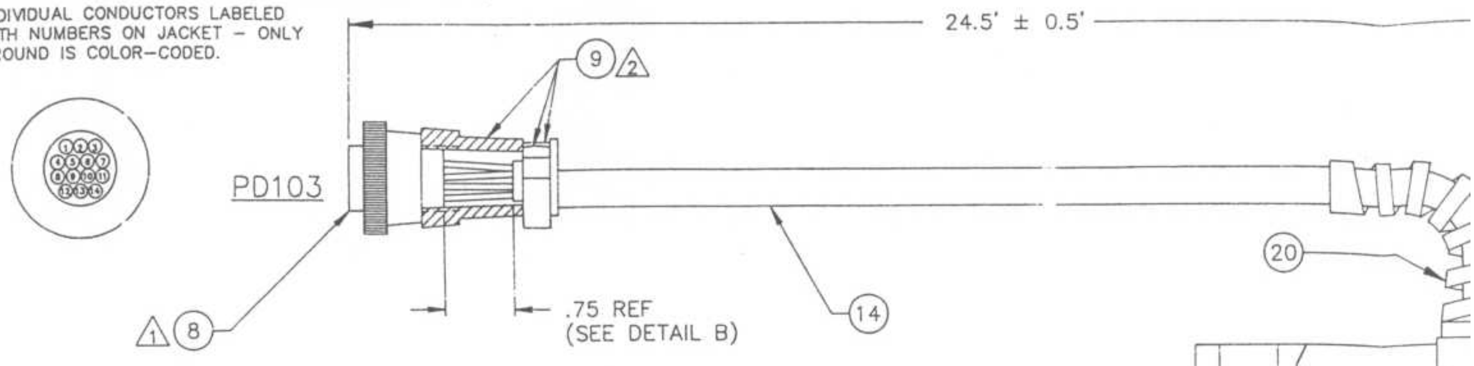
D 107-026
SHEET 1 OF 1

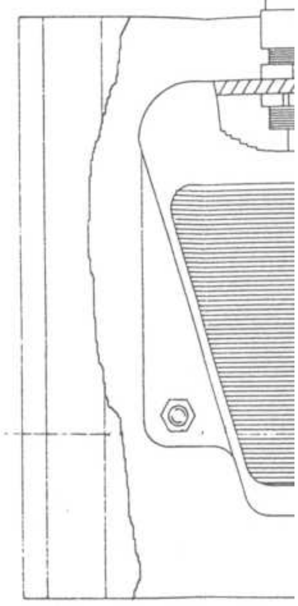
4 3 2

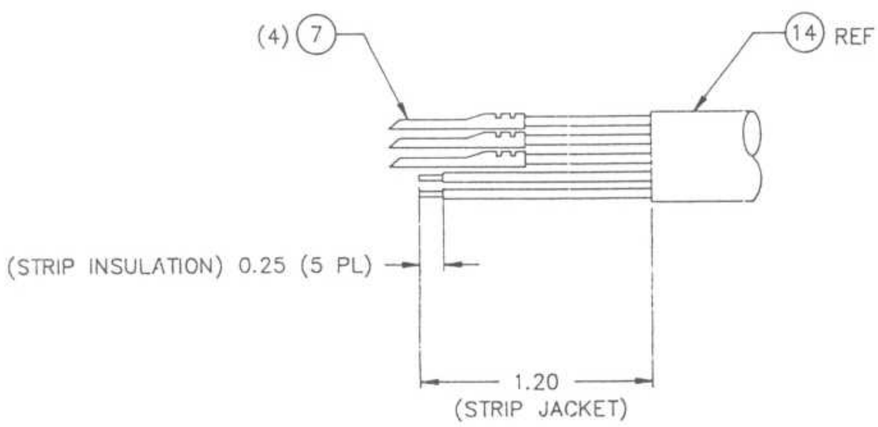
FILE NO: 107-026 PLOT DATE 7/6/

NOTES:

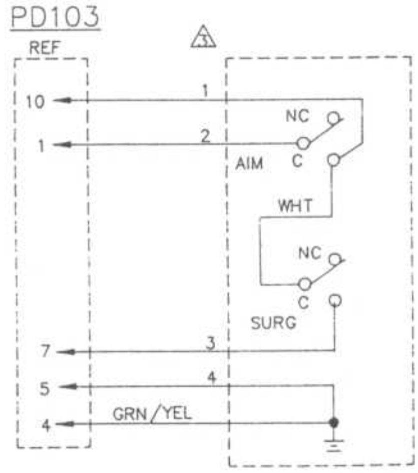
1. TERMINATE PLUG, ITEM (8), PER SCHEMATIC DIAGRAM
2. AFTER ASSEMBLING CABLE CLAMP, ITEM (9), TO PLUG, ITEM (8), STRAIN RELIEF CABLE, ITEM (14), WITH CLAMP BAR LABELED "2" AND SCREWS PROVIDED WITH ITEM (9).
3. INDIVIDUAL CONDUCTORS LABELED WITH NUMBERS ON JACKET – ONLY GROUND IS COLOR-CODED.



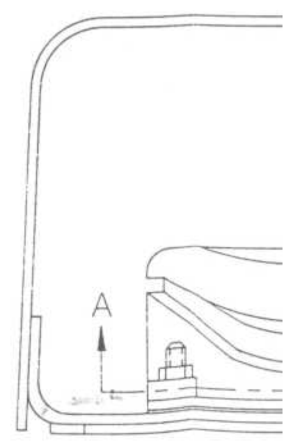


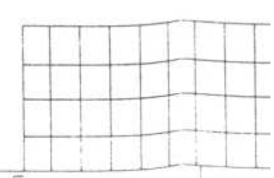


DETAIL B
SCALE: 2/1

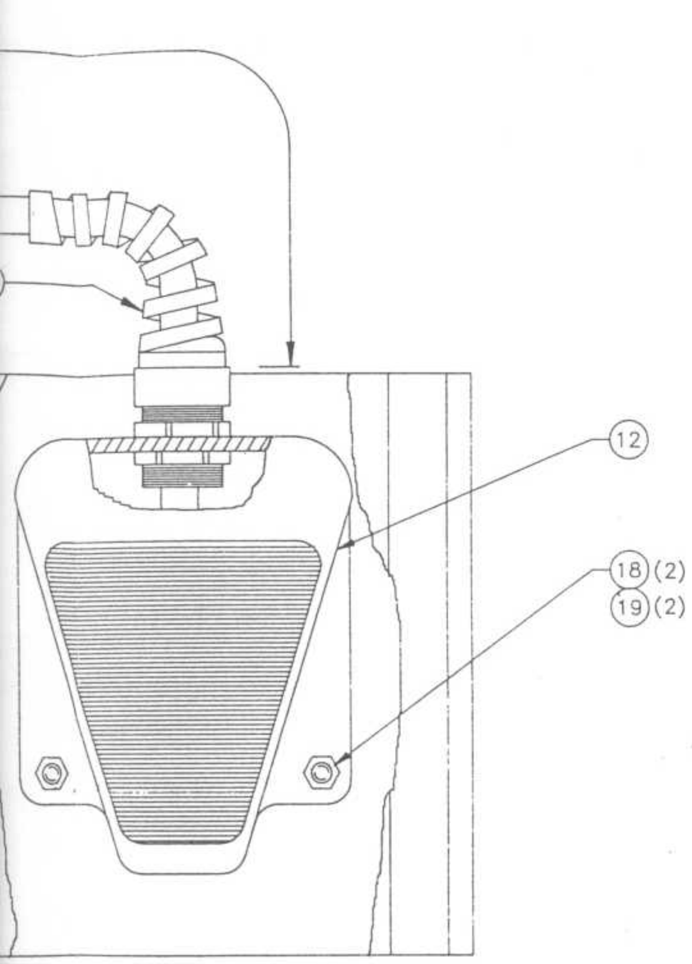


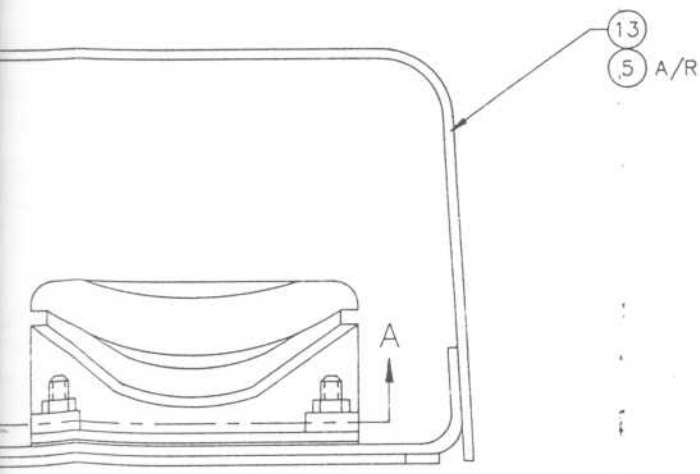
SCHEMATIC DIAGRAM

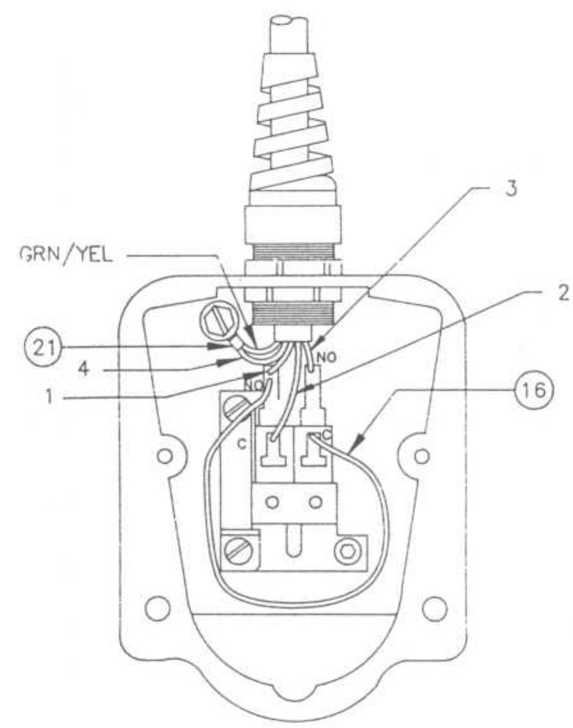




QTY	PART NUMBER	DESCRIPTION	ITEM
			1
1	101-308	SPRING, FOOTSWITCH	2
			3
			4
A/R	3210-0014	TAPE, PROTECTIVE	5
			6
5	2100-0114	CONTACT, PIN, 18-16 AWG	7
1	2100-0105	CONN, PLUG, CPC, SERIES 17-14	8
1	2100-0106	CONN, CABLE CLAMP, SIZE 17 CPC	9
			10
A/R	4600-0000	SOLDER	11
1	5110-0000	FOOTSWITCH	12
1	5110-0001	GUARD	13
25'	6025-0005	CABLE, 17 AWG, 5 COND	14
1	7204-0604	SCR, PAN HD, 6-32 X .25 TORX	15
5"	6070-0054	WIRE, HOOK-UP, 18 AWG	16
1	7882-0600	WASHER, INT TOOTH LOCK, NO 6	17
2	7228-0812	SHFH, 8-32 X .75, BO	18
2	7857-0800	NUT, KEP, 8-32, ZN	19
1	2806-0040	STRAIN RELIEF	20
1	2130-0007	TERMINAL, RING TONGUE	21







SECTION A-A
ROTATED 180° CW

REV LTR	ECO NO.	APPD	DATE
A	1934		
/			

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DO NOT SCALE DRAWING
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES:
.X± .3 mm ~
.XX± .10 ANG. ± ~°
.XXX± .020 FINISH ~
BREAK ALL SHARP CORNERS

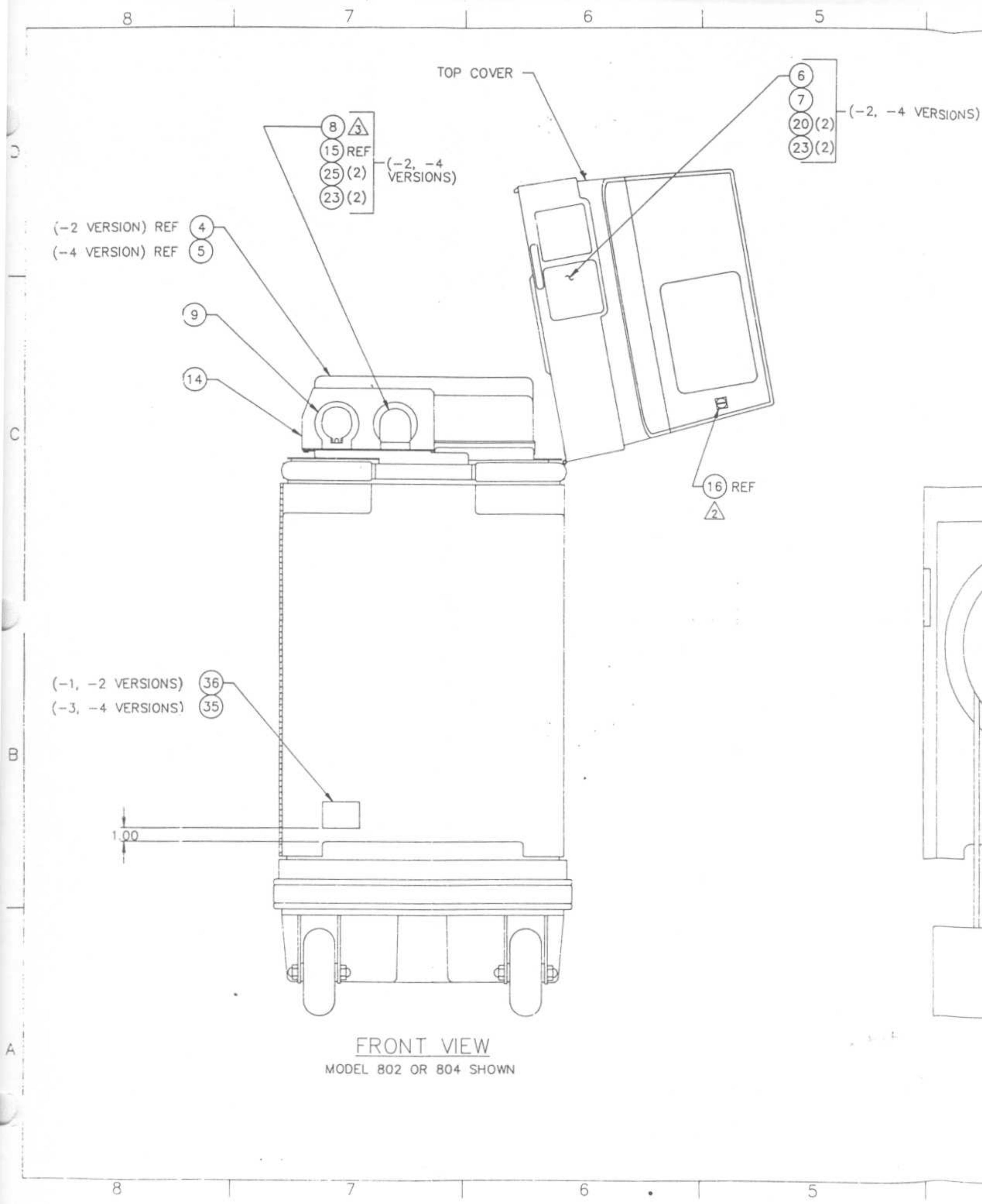
ASSEMBLY, FOOT SWITCH
MODEL 80X

SCALE 1/1 | DRAWN BY J. Q. | DATE 4/3/90 | CHECKED BY J. BOLL | APPROVED BY J BOLL
MATERIAL SEE B/M
FINISH NA

LASERSCOPE®
3052 ORCHARD DRIVE SAN JOSE, CA 95134

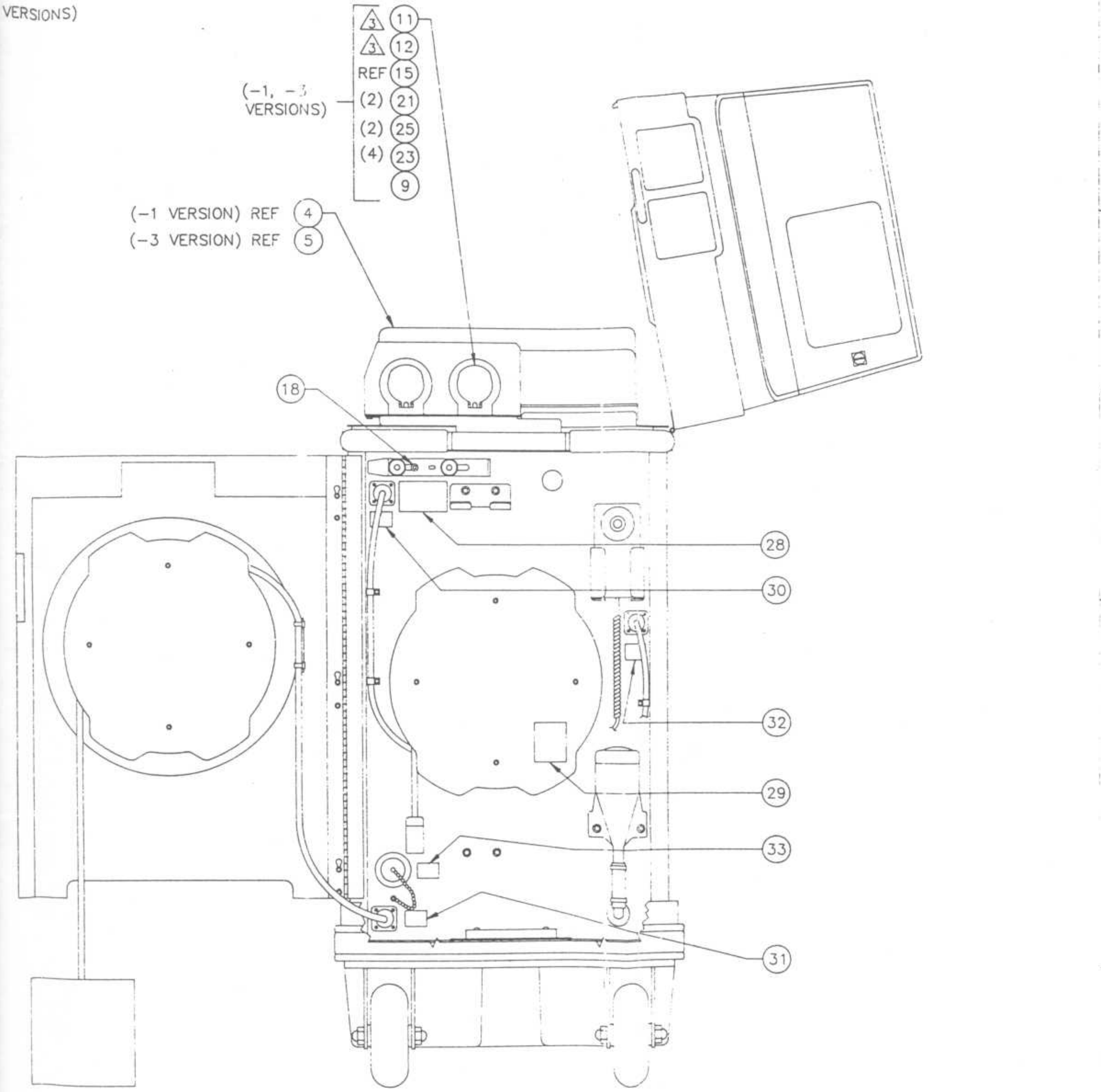
D 107-091 SHEET 1 OF 1 REV A

FILE: 107-091
PLOT DATE: 7/5/90



FRONT VIEW

MODEL 802 OR 804 SHOWN



FRONT VIEW

MODEL 801 OR 803 SHOWN

LASERSCOPE®

3052 ORCHARD DRIVE SAN JOSE, CA 95134

D 107-062X REV 2

SHEET 3 OF 3

FILE: 107-0623

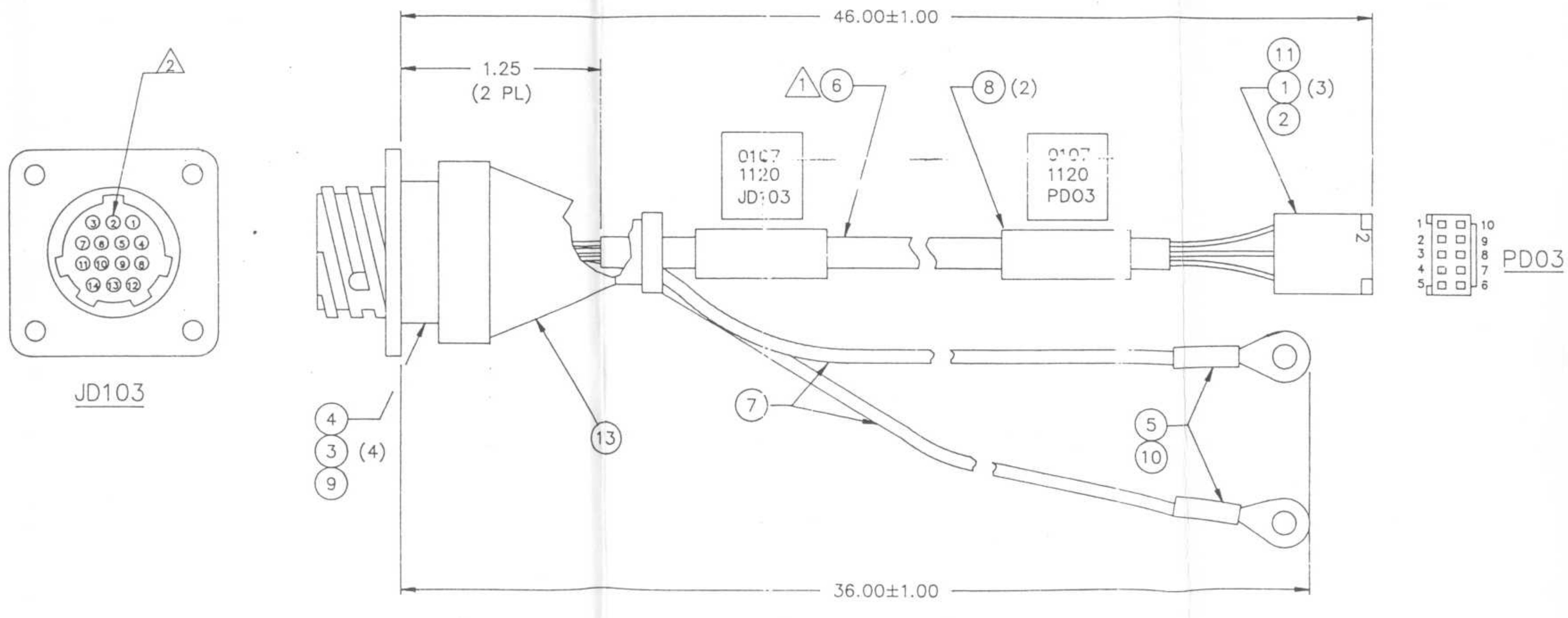
PLOT DATE: 6/18/90

NOTES (UNLESS OTHERWISE SPECIFIED):

1. TRIM UNUSED WIRES FLUSH TO CABLE JACKET.
2. INSTALL KEYING PLUG AT POSITION 2.

QTY	PART NO.	DESCRIPTION	ITEM
4	2100-0028	CONTACT, SOCKET	1
1	2100-0030	CONN, SOCKET HOUSING, 10 POS	2
4	2100-0116	CONTACT, SOCKET 24-20 AWG	3
1	2100-0104	CONN, RECEPTACLE, CPC, SERIES 17	4
2	2130-0014	TERMINAL, RING, 22-16 AWG, #10	5
46"	6020-0014	CABLE, MULTICOND, 22 AWG	6
72"	6070-0101	WIRE, HOOKUP, 20 AWG, GREEN/YELLOW	7
2	6075-0000	WIRE MARKER	8
REF	5401-0026	TOOL, CRIMPING, CPC	9
REF	5401-0014	TOOL, CRIMPING, 22-16 (P106)	10
REF	5401-0004	CRIMPER	11
1	2100-0103	KEYING PLUG, CPC CONN.	12
1	2100-0106	CONNECTOR, CLAMP, CABLE, SIZE 17, CPC	13

FROM	TO	COLOR
JD103 PIN-1	PD03 PIN-1	BLACK
JD103 PIN-7	PD03 PIN-7	RED
JD103 PIN-10	PD03 PIN-9	WHITE
JD103 PIN-4 & 5	ITEM 5	GRN/YEL
	PD03 PIN-10	SHIELD



P0195 HW 4/30/90	
P0179 HW 4/6/90	
P0168 HW 3/27/90	
ECO NO. APPD DATE	NEXT ASSY

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.X ± ~ MM ± ~
.XX ± .25 ANGLES ± ~°
.XXX ± ~ FINISH ~

CABLE ASSEMBLY, FOOTSWITCH, INTERNAL

SCALE 2/1 | DRAWN BY J.Q. | DATE 3/13/90 | CHECKED BY | APPROVED BY

MATERIAL SEE BOM

LASERSCOPE®
3052 ORCHARD DRIVE SAN JOSE, CA 95134

0107-1120 REV

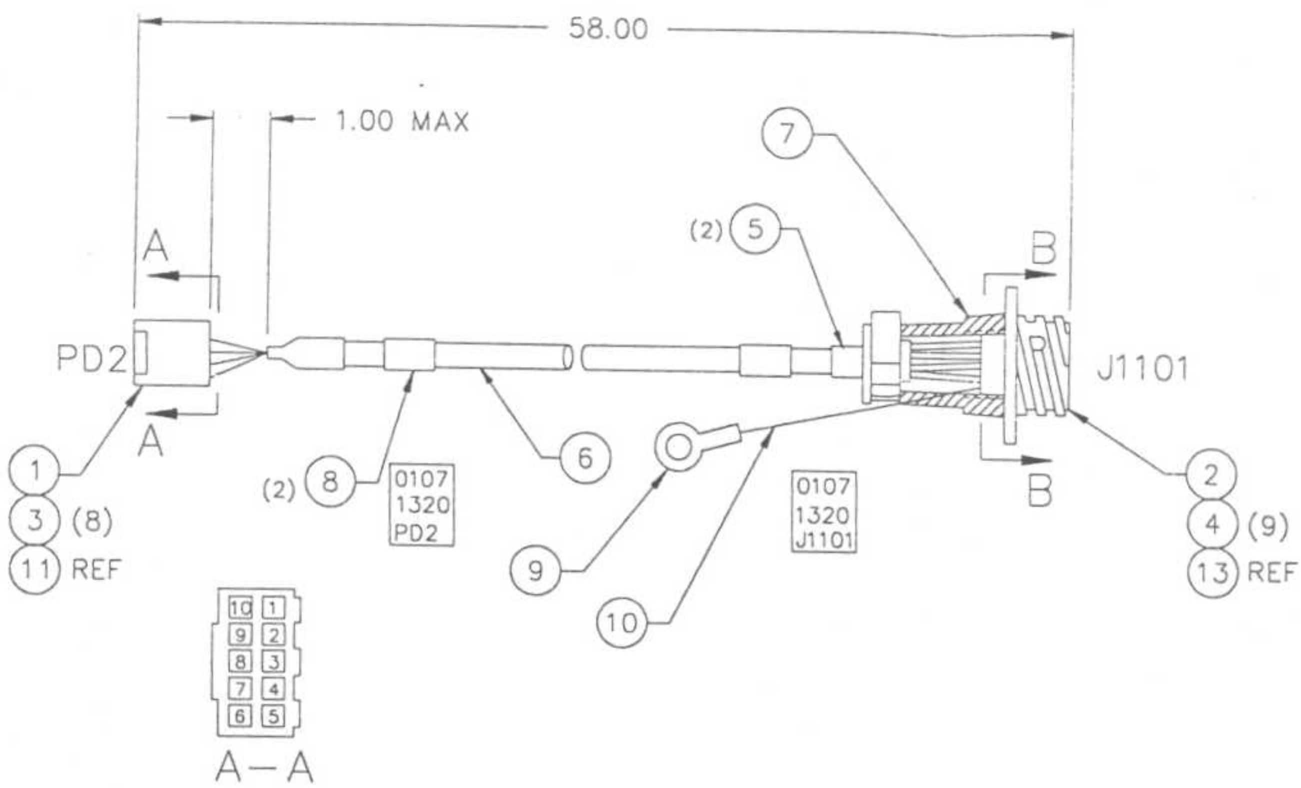
4 3

NOTES:

1. INSTALL KEYING PLUG AT POSITION 10.

D

C



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LTR	ECO NO.	APPD	DATE
1	R0168	HY	9/27/93

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DIMENSION
TOLERANCE

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BREAK ALL

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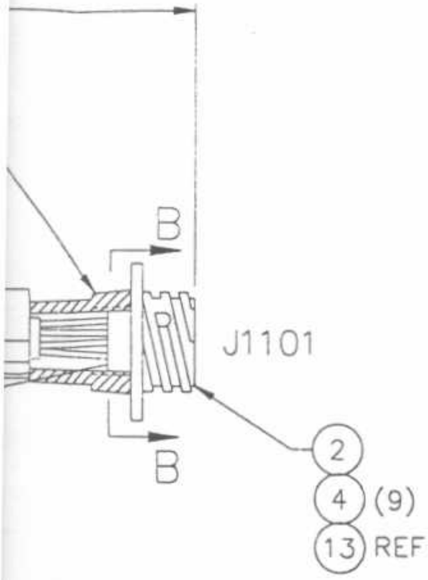
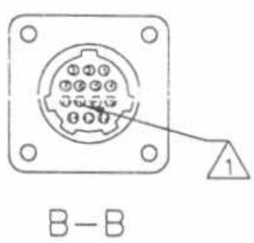
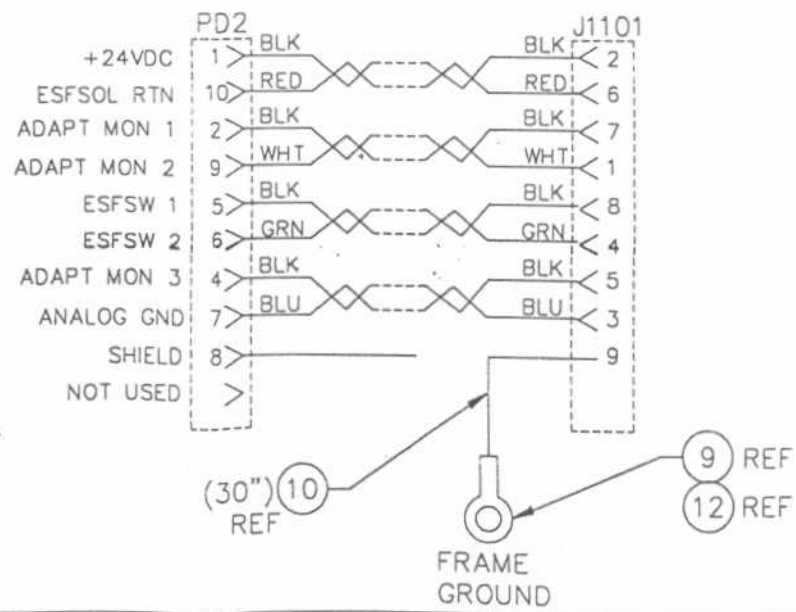
QTY	PART NUMBER	DESCRIPTION	ITEM
1	2100-0030	SOCKET HOUSING	1
1	2100-0104	CONNECTOR, RECEPTABLE, CPC	2
9	2100-0028	SOCKET	3
9	2100-0116	CONTACT, SKT, 24-20 AWG, GOLD	4
2"	2802-0003	SHRINK TUBE, .38 I.D.	5
60"	6020-0001	CABLE, 4 TW. PR., 24 AWG	6
1	2100-0106	CONNECTOR CLAMP, CPC	7
2	6075-0000	WIRE MARKER	8
1	2130-0014	TERM, RING, TONGUE	9
30"	6070-0101	WIRE, HOOK-UP, 20 AWG, GRN/YEL	10
REF	5401-0004	CRIMPER	11
REF	5401-0014	TOOL, CRIMPING, 22-16 (PIDG)	12
REF	5401-0026	TOOL, CRIMPING, CPC	13
1	2100-0103	KEYING PLUG, CPC CONN.	14

D

C







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LTR	ECO NO.	APPD	DATE
1	8016	HH	12/3/92

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.X ± ~ MM ± ~
.XX ± .50 ANGLES ± ~°
.XXX ± ~ FINISH

BREAK ALL SHARP CORNERS

ASSEMBLE, CABLE
ESF, INTERNAL

SCALE NTS | DRAWN BY J.Q. | DATE 3/14/90 | CHECKED BY J. Bisma | APPROVED BY J. Bisma

MATERIAL NA

FINISH NA

LASERSCOPE®

3052 ORCHARD DRIVE SAN JOSE, CA 95134

C 107-132 SHEET 1 OF 1 REV 1

2

FILE: 107-132

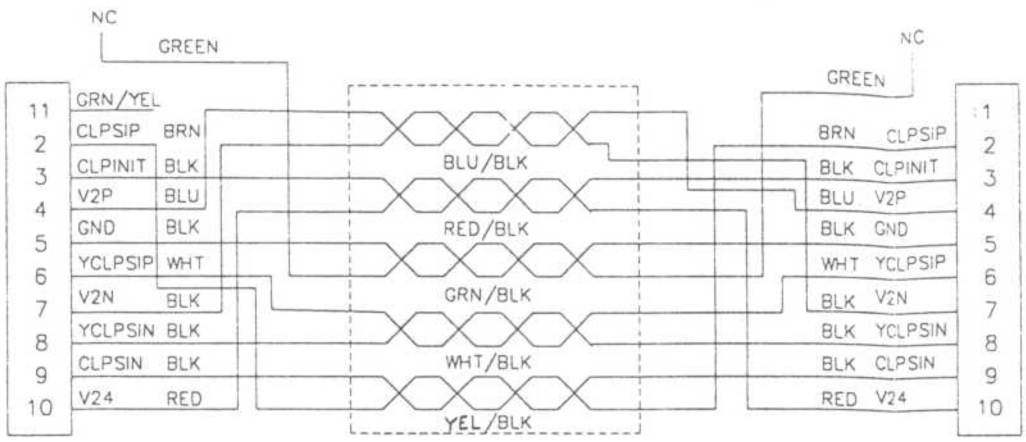
PLOT DATE: 3/15/90

4 3

NOTES (UNLESS OTHERWISE SPECIFIED):

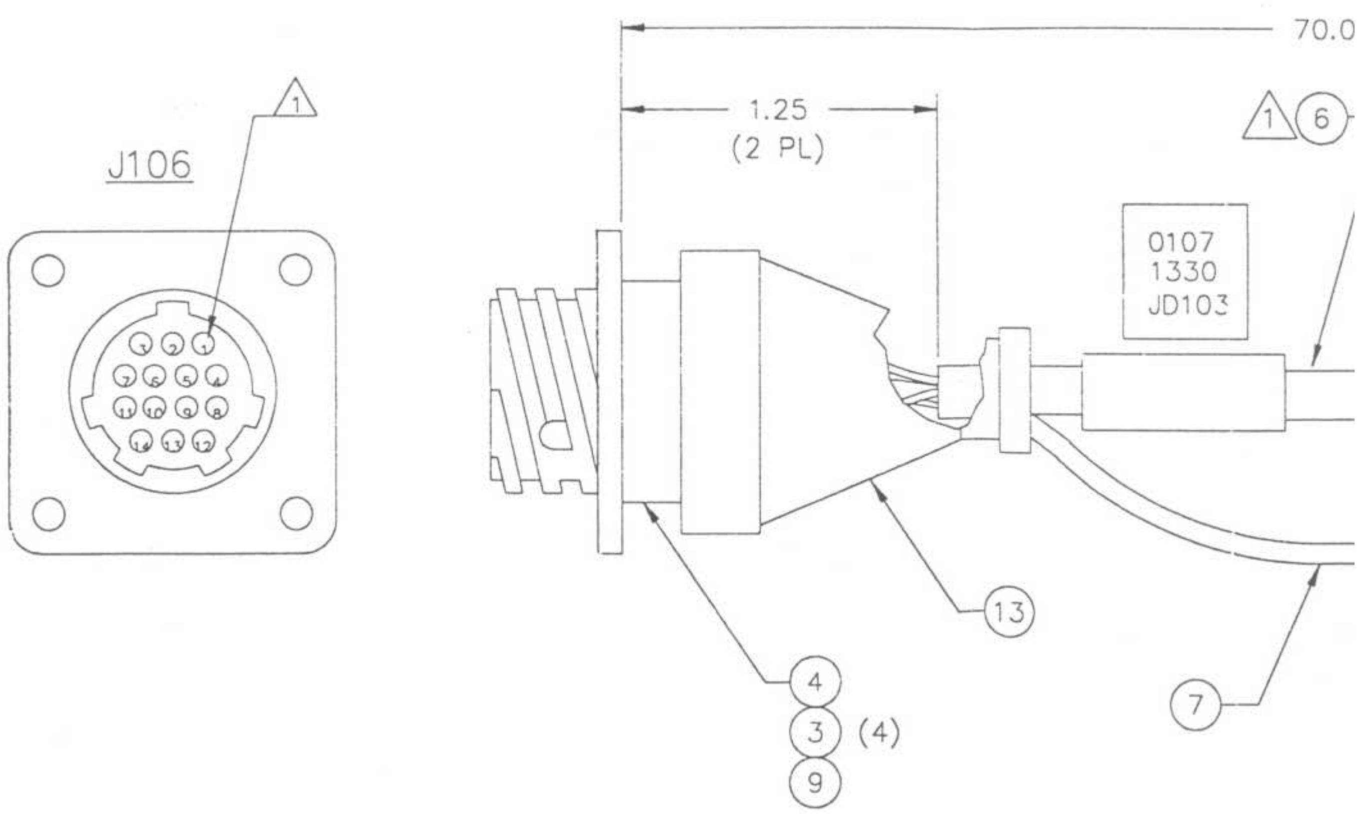
1. INSTALL KEYING PLUG AT POSITION 1.

D



CABLE SCHEMATIC

C



B

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LTR	ECO NO.	APPD	DATE
1	P0160	HY	5/27/93
2	P0724	HY	9/6/95
3	P0195	HY	4/4/95

MODEL | NEXT ASSY

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DO NOT

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TOLERAN

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.XXX ±

BREAK AL

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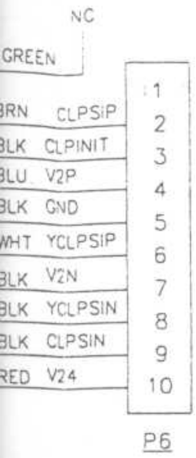
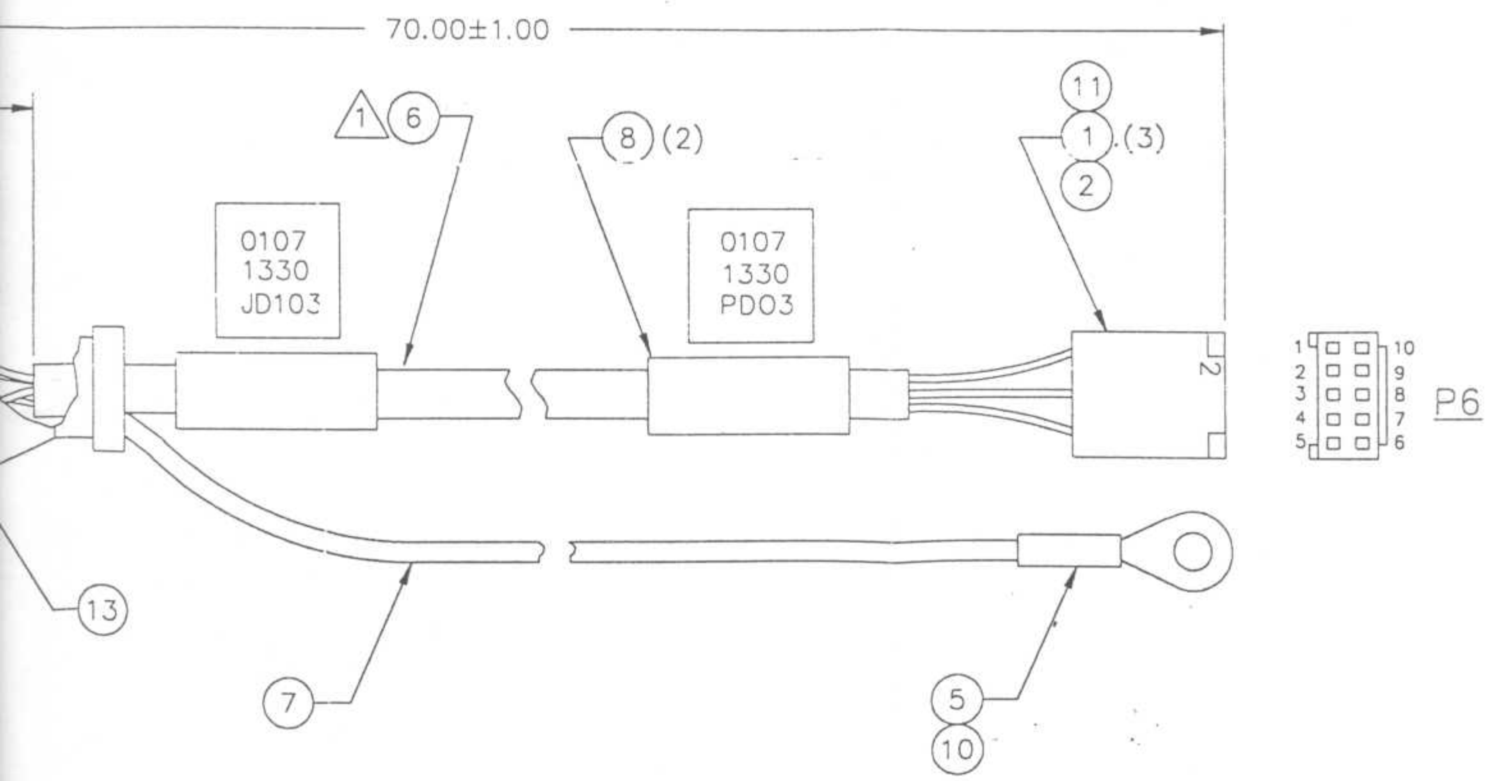
QTY	PART NO.	DESCRIPTION	ITEM
9	2100-0028	CONTACT, SOCKET	1
1	2100-0030	CONN, SOCKET HOUSING, 10 POS	2
9	2100-0116	CONTACT, SOCKET 24-20 AWG	3
1	2100-0104	CONN, RECEPTACLE, CPC, SERIES 17	4
1	2130-0014	TERMINAL, RING, 22-16 AWG, #10	5
70"	6020-0011	CABLE, 5 TW. PR., 24 AWG	6
48"	6070-0101	WIRE, HOOKUP, 20 AWG, GREEN/YELLOW	7
2	6075-0000	WIRE MARKER	8
REF	5401-0026	TOOL, CRIMPING, CPC	9
REF	5401-0014	TOOL, CRIMPING, 22-16 (J106)	10
REF	5401-0004	CRIMPER	11
1	2100-0103	KEYING PLUG, CPC CONN.	12
1	2100-0106	CONN, CLAMP, CABLE, SIZE 17, CPC	13





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NEXT ASSY | MODEL

DO NOT SCALE DRAWING

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.X ± ~ MM ± ~
.XX ± .25 ANGLES ± ~°
.XXX ± ~ FINISH ~

BREAK ALL SHARP CORNERS

CABLE ASSEMBLY,
CAL POD, INTERNAL

SCALE 2/1 | DRAWN BY J.Q. | DATE 3/13/90 | CHECKED BY R. Chy | APPROVED BY J. Zurawski

MATERIAL SEE BOM

FINISH ~

LASERSCOPE®

3052 ORCHARD DRIVE SAN JOSE, CA 95134

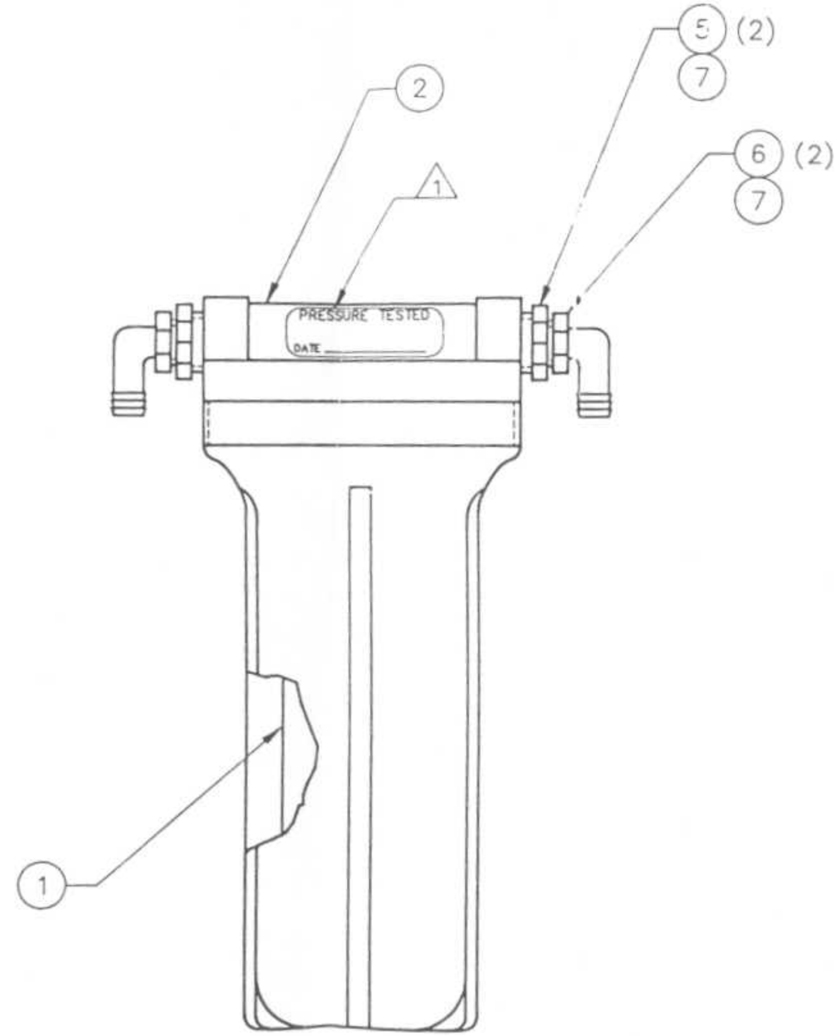
C | 107-133 | SHEET 1 OF 1 | REV 3

FILE NO.: 107-133 PLOT DATE: 4/23/90

NOTES:

1. PRESSURE TEST ASSEMBLY PER ITEM 8 AND APPLY LABEL AS SHOWN.

QTY	PART NO.	DESCRIPTION	ITEM
1	2512-0135	FILTER, DE-IONIZER	1
1	2512-0090	HOUSING, FILTER	2
2	2512-0137	BUSHING, 3/4 MP – 1/2 FP	5
2	2512-0023	CONN, 90, 1/2 MP – 1/2 BARB	6
A/R	3210-0002	TAPE, THREAD SEALANT, 1/2 IN	7
REF	107-253	PROCEDURE, PRESSURE TEST	8



CHANGE PENDING SEE ECO # 1944

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DO NOT SCALE DRAWING

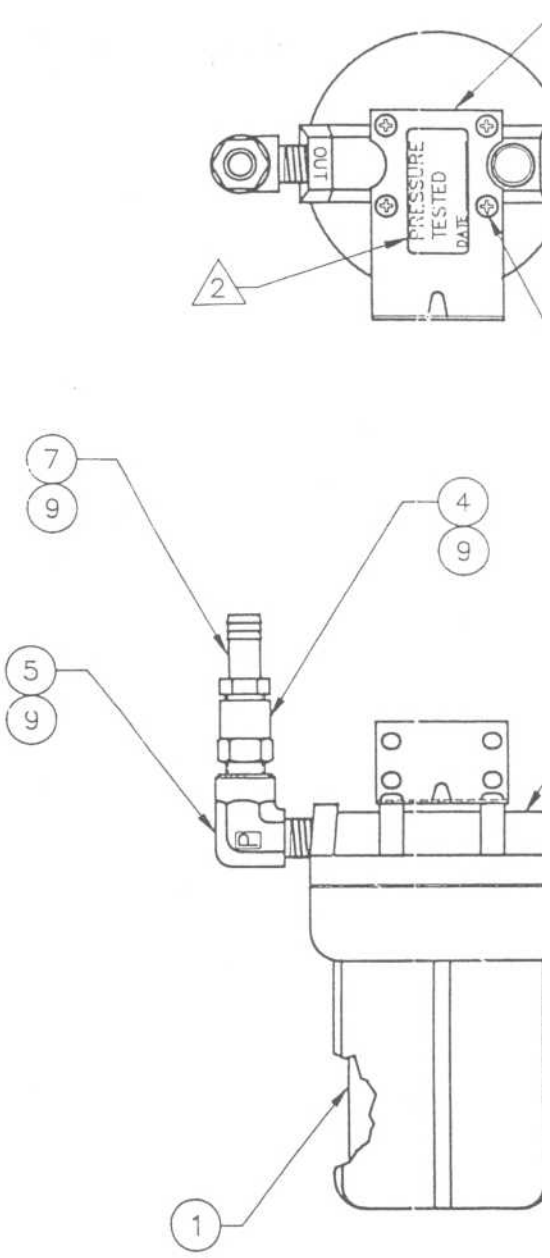
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES:

ASSEMBLY, D.I. FILTER, 80X

LASERSCOPE®

NOTES:

1. USE (4) SCREWS SUPPLIED WITH BRACKET KIT.
2. PRESSURE TEST ASSEMBLY PER ITEM (10) AND APPLY LABEL AS SHOWN.

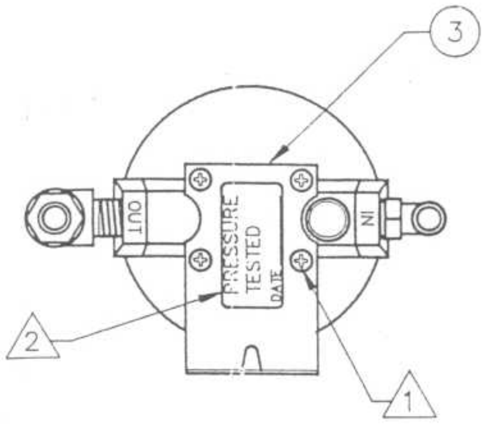


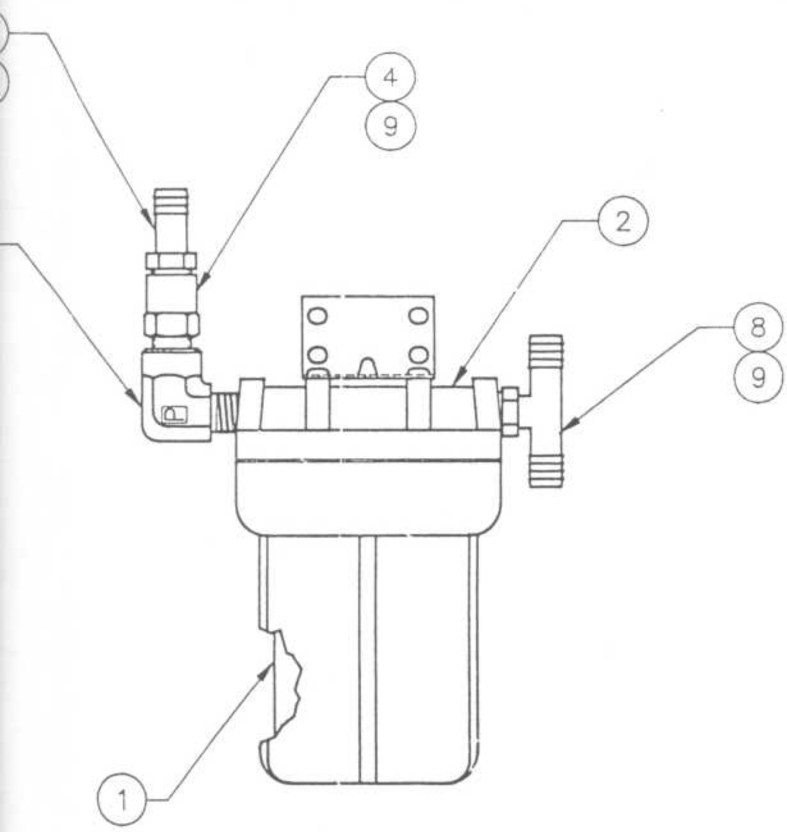
LTR	ECO NO.	APPD	DATE
3	P0242	AW	6/4/90
2	P0206	HW	5/10/90
1	P0190	HW	4/1/90

MODEL	NEXT ASSY

DO NO
UNLESS
DIMENS
TOLERA
.X ±
.XX ±
.XXX ±
BREAK

QTY	PART NO.	DESCRIPTION	ITEM
1	2512-0139	FILTER, PARTICLE, .2 MICRON	1
1	2512-0020	HOUSING, PARTICLE FILTER	2
1	2512-0021	BRACKET KIT, PARTICLE FILTER	3
1	2512-0052	FLOW REGULATOR, 3/8 NPT	4
1	2512-0153	CONN, 90, 3/8 MP – 3/8 FP, SS	5
1	2512-0119	CONN, ST, 3/8 MP – 1/2 BARB	7
1	2512-0144	TEE, BRANCH, 3/8 MP – 1/2 BARB	8
A/R	3210-0002	TAPE, THREAD SEALANT, 1/2 IN	9
REF	107-253	PROCEDURE, PRESSURE TEST	10





CHANGE PENDING
SEE ECO # 1946

MODEL | NEXT ASSY

DO NOT SCALE DRAWING
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES:
.X ± ~ MM ± ~
.XX ± ~ ANGLES ± ~°
.XXX ± ~ FINISH ~
BREAK ALL SHARP CORNERS

ASSEMBLY,
PARTICLE FILTER, 80X

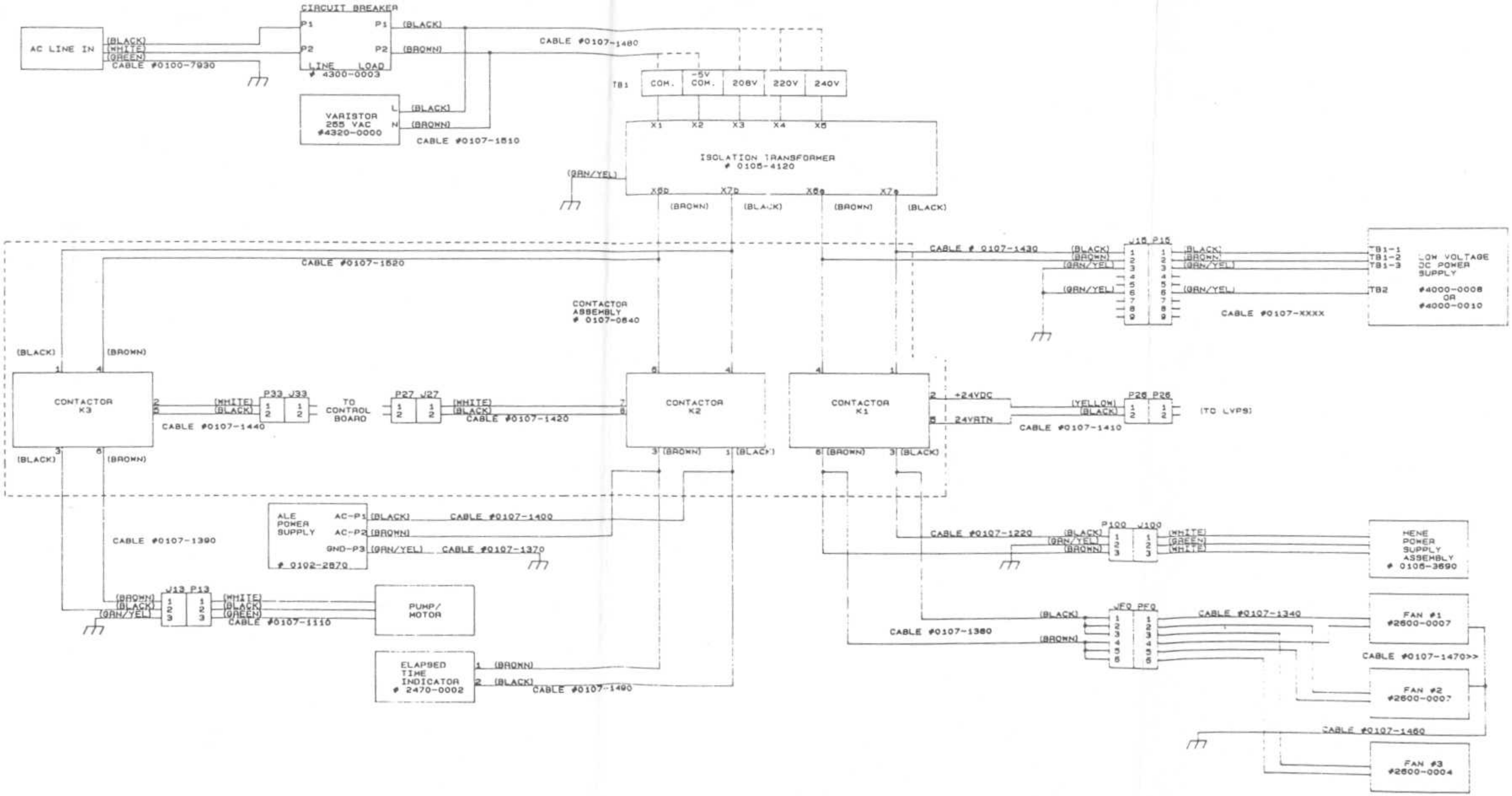
SCALE 1/2 | DRAWN BY J. L | DATE 3/27/90 | CHECKED BY | APPROVED BY

MATERIAL SEE BOM
FINISH ~

LASERSCOPE®
3052 ORCHARD DRIVE SAN JOSE, CA 95134

C | 107–220 | SHEET 1 OF 1 | REV 3

FILE NO.: 107–220 PLOT DATE: 6/1/90



LTR	ECO NO.	APPROVED BY:	AP. DATE
1	6012		4-5-90

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MODEL	NEXT ASSY.	APPROVED BY:	AP. DATE	CHECKED BY:	DRAWN BY:
					J. ZIEMSKI

LASERSCOPE
3052 ORCHARD DRIVE
SAN JOSE, CA. 95134-2011

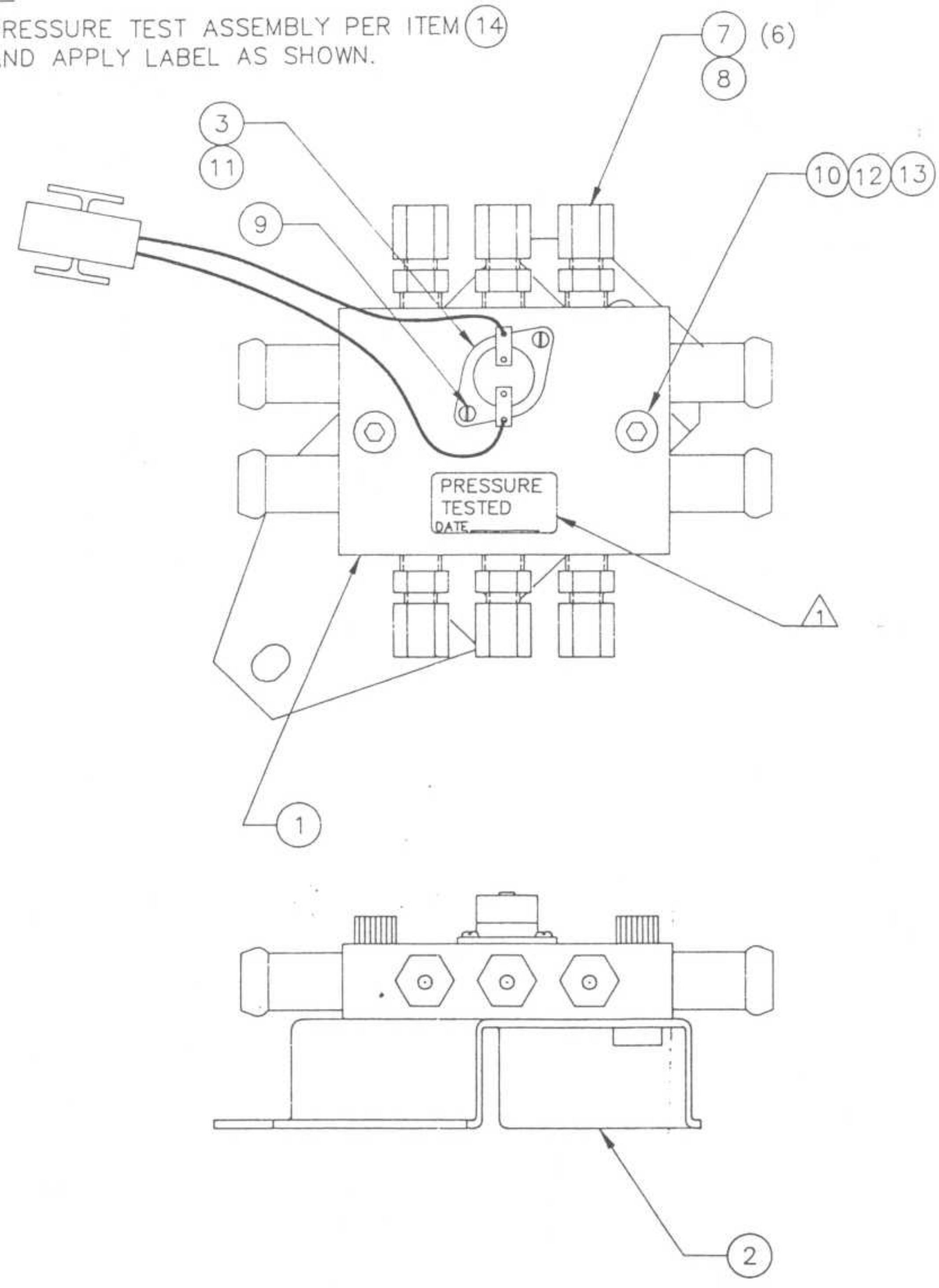
Title: MODEL 80X AC WIRING DIAG 60HZ/1 PHASE

Size	Document Number	REV
C	0107-2310	1

Date: March 30, 1990 Sheet 1 of 1

NOTES:

1. PRESSURE TEST ASSEMBLY PER ITEM 14 AND APPLY LABEL AS SHOWN.



LTR	ECO NO.	APPD	DATE
3	P0251	HYY	6/7/93
2	P0206	HYY	5/10/93
1	P0180	HYY	3/26/92

NEXT ASSY

MODEL

DO NOT SCAL

UNLESS OTHERWISE
DIMENSIONS ARE
TOLERANCES:

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QTY	PART NO.	DESCRIPTION	ITEM
1	107-315	BLOCK, WATER MANIFOLD, 80X	1
1	107-092	BRACKET, WATER MANIFOLD, 80X	2
1	107-075	ASSY, TEMPERATURE SWITCH, 80X	3
			4
			5
			6
6	2512-0142	CONN, NYLON, 1/8 NPT x 1/8 TUBE	7
A/R	3210-0002	TAPE, THREAD SEALANT, .25	8
2	7804-0404	SCREW, TORX, 4-40 x .25, ZINC	9
2	7836-1424	SCREW, SOCKET, .25-30 x 1.5	10
A/R	1640-0003	HEAT SINK COMPOUND	11
2	7875-1400	FLATWASHER, 1/4, ZINC	12
2	7880-1400	LOCKWASHER, 1/4. ZINC	13
A/R	107-253	PROCEDURE, PRESSURE TEST	14

D

C

B

CHANGE PENDING
SEE ECO # 1967

A

MODEL NEXT ASSY

DO NOT SCALE DRAWING
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES:
.X ± ~ MM ± ~
.XX ± ~ ANGLES ± ~ °
.XXX ± ~ FINISH ~
BREAK ALL SHARP CORNERS

ASSEMBLY,
WATER MANIFOLD, 80X

SCALE	DRAWN BY	DATE	CHECKED BY	APPROVED BY
1/1	J. L.	3/23/90		[signature]

MATERIAL SEE BOM
FINISH ~

LASERSCOPE®
3052 ORCHARD DRIVE SAN JOSE, CA 95134

C 107-067 SHEET 1 OF 1 REV 3

2 1

FILE NO.: 107-067 PLOT DATE: 6/7/90

2 1

QTY	PART NO.	DESCRIPTION	ITEM
1	107-315	BLOCK, WATER MANIFOLD, 80X	1
1	107-092	BRACKET, WATER MANIFOLD, 80X	2
1	107-075	ASSY, TEMPERATURE SWITCH, 80X	3
			4
			5
			6
6	2512-0142	CONN, NYLON, 1/8 NPT x 1/8 TUBE	7
A/R	3210-0002	TAPE, THREAD SEALANT, .25	8
2	7804-0404	SCREW, TORX, 4-40 x .25, ZINC	9
2	7836-1424	SCREW, SOCKET, .25-30 x 1.5	10
A/R	1640-0003	HEAT SINK COMPOUND	11
2	7875-1400	FLATWASHER, 1/4, ZINC	12
2	7880-1400	LOCKWASHER, 1/4. ZINC	13
A/R	107-253	PROCEDURE, PRESSURE TEST	14

10 12 13

1

D

C

B

CHANGE PENDING
SEE ECO # 1967

A

MODEL | NEXT ASSY

DO NOT SCALE DRAWING
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES:
.X ± ~ MM ± ~
.XX ± ~ ANGLES ± ~ °
.XXX ± ~ FINISH ~
BREAK ALL SHARP CORNERS

ASSEMBLY,
WATER MANIFOLD, 80X

SCALE 1/1 | DRAWN BY J. L. | DATE 3/23/90 | CHECKED BY | APPROVED BY

MATERIAL SEE BOM
FINISH ~

LASERSCOPE®
3052 ORCHARD DRIVE SAN JOSE, CA 95134

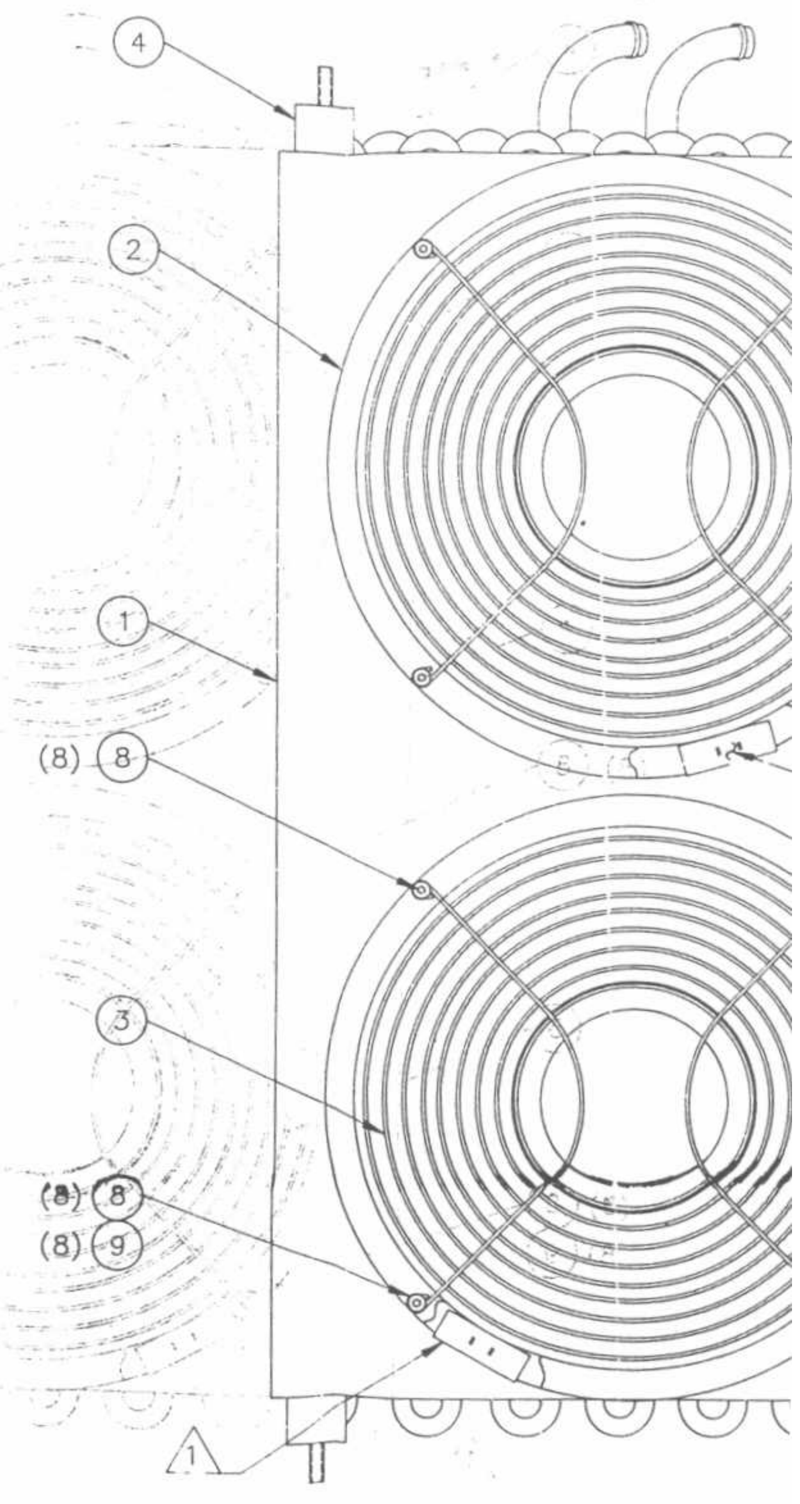
C | 107-067 | SHEET 1 OF 1 | REV 3

2 1

FILE NO.: 107-067 PLOT DATE: 6/7/90

NOTES:

1. ORIENT FANS ON HEAT EXCHANGER AS SHOWN.



LTR.	ECO NO.	APP'D	DATE
T	P0174	HW	3/28/90
A	6541	NW	7/9/92

MODEL | NEXT ASSY

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DO NOT SC

UNLESS OTHER
DIMENSIONS
TOLERANCES:
.X ± ~
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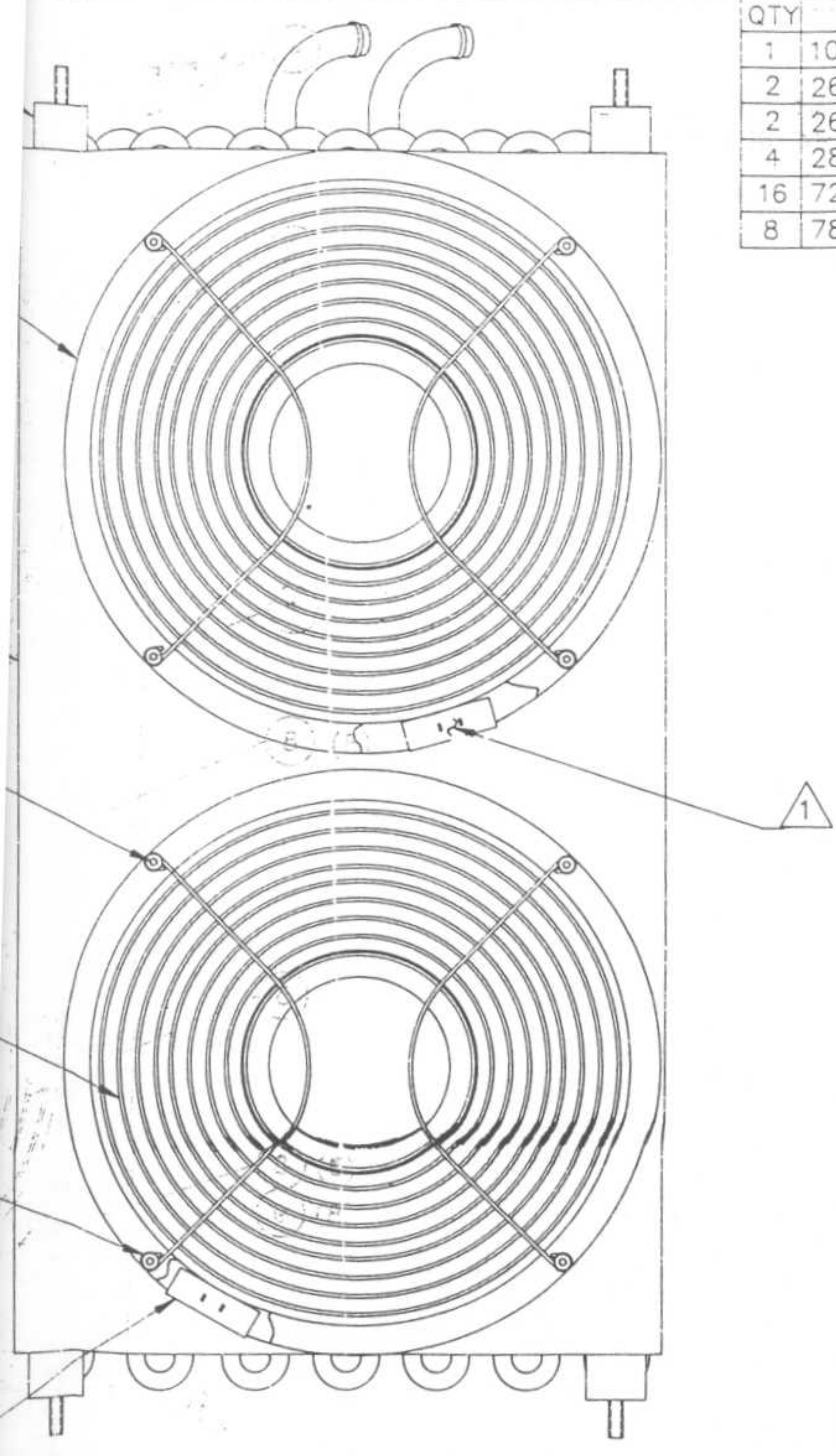
BREAK ALL S

QTY	PART NO.	DESCRIPTION	ITEM
1	107-017	HEAT EXCHANGER, 80X	1
2	2600-0007	FAN, 10" TUBEAXIAL	2
2	2600-0008	FINGER GUARD, 10" FAN	3
4	2835-0024	VIBRATION MOUNT, RUBBER	4
16	7237-0806	SCREW, BTN HEAD, 8-32 x .375	8
8	7857-0800	NUT, KEP, 8-32	9



LTR	NO.	APP'D/DATE	MODEL	NEXT ASSY

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES:
.X ± ~ MM ± ~
.XX ± ~ ANGLES ± ~°
.XXX ± ~ FINISH ~

BREAK ALL SHARP CORNERS

ASSEMBLY, HEAT EXCHANGER, 80X

SCALE	DRAWN BY	DATE	CHECKED BY	APPROVED BY
1/1	J. L.	3/15/90		

MATERIAL: SEE BOM

FINISH: ~

LASERSCOPE®

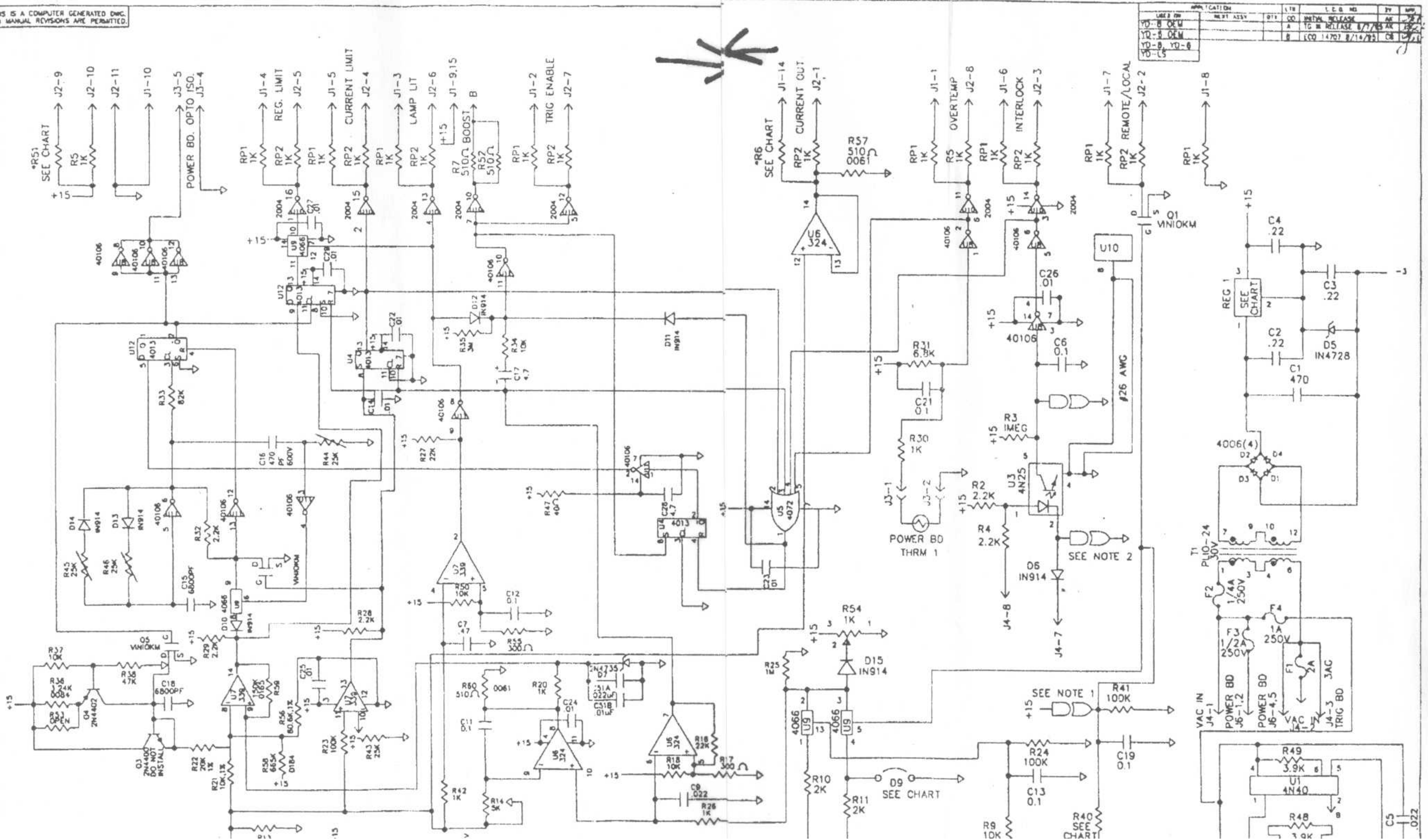
3052 ORCHARD DRIVE SAN JOSE, CA 95134

C 107-081 SHEET 1 OF 1 REV A

FILE NO.: 107-081 PLOT DATE: 7/5/90

FOR REFERENCE ONLY

NOV 16



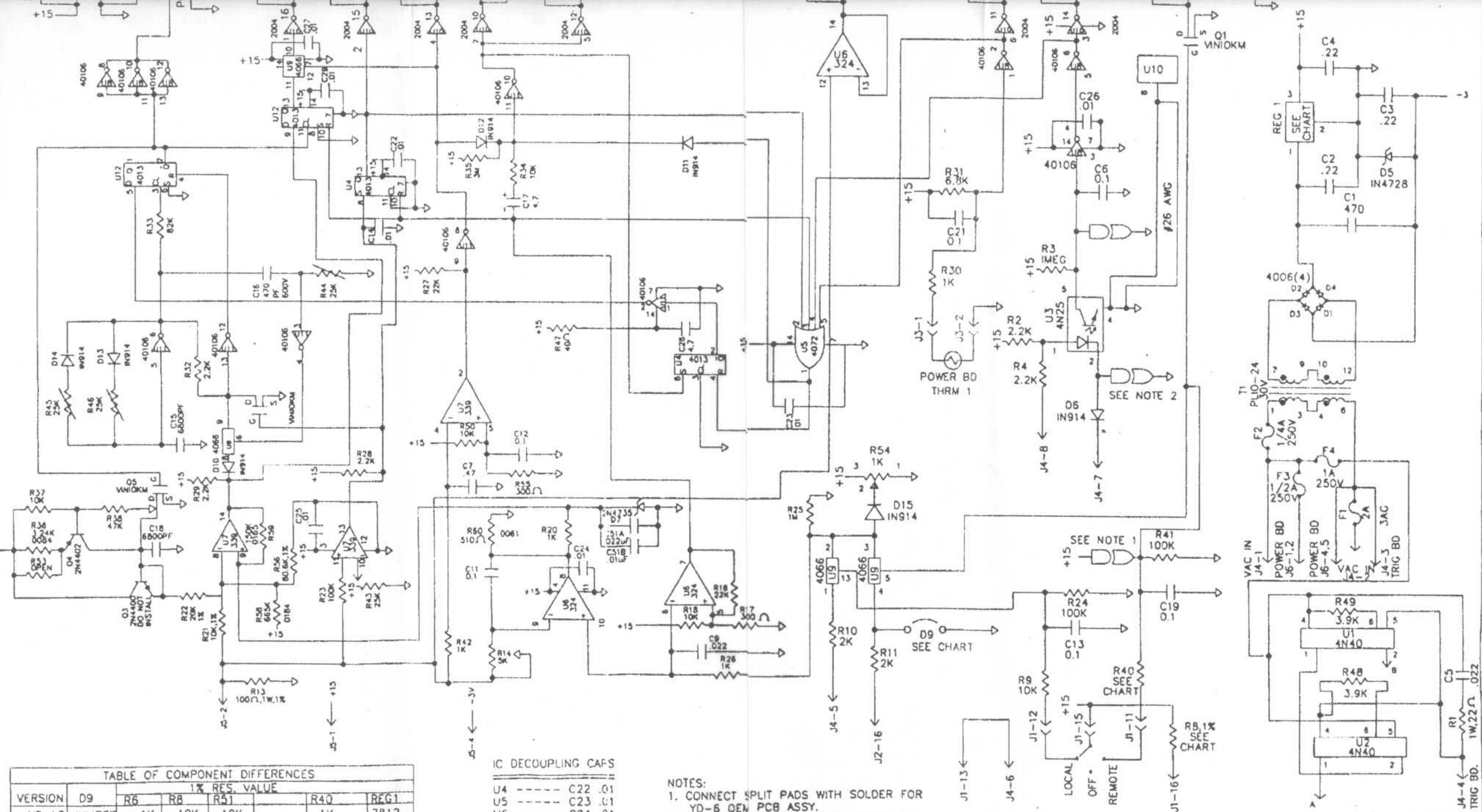


TABLE OF COMPONENT DIFFERENCES							
		1% RES. VALUE					
VERSION	D9	R6	R8	R51		R40	REG1
YD-LS	JUMPER	1K	10K	10K		1K	7812
YD-6	IN4742	4.99K	6.34K	6.34K		10K	7815
YD-8	IN4742	4.99K	6.34K	6.34K		10K	7815

IC DECOUPLING CAPS

U4	C22	.01
U5	C23	.01
U6	C24	.01
U7	C25	.01
U8	C26	.01
U9	C27	.01
U11	C28	4.7
U12	C29	.01

NOTES:
1. CONNECT SPLIT PADS WITH SOLDER FOR YD-6 OEM PCB ASSY.
2. CONNECT SPLIT PADS WITH SOLDER FOR YD-LS PCB ASSY.
3. R56 IS USED ONLY ON YD-8 ADD AT FINAL TEST, ONLY IF NECESSARY.

SHEET 1 OF 1

ELECTRONIC MEASUREMENTS, INC.

LOGIC BOARD SCHEMATIC

001-0201

B

NTE 3046

Section 13

E R R O R   M E S S A G E S   &   C O D E S

13.1 AUTOMATIC MONITORING

To insure safe operation and prevent damage to the system, the Model 800 Series includes circuitry that allows automatic computer monitoring of various internal system functions.

The detection of an internal fault is reported by printing a specific PROBLEM error message on the video display screen. If the fault is serious, the system is also automatically returned to System Status STANDBY (or in some cases to System Status OFF).

To resume normal system operation, the user (or a service engineer) must correct the cause of the fault.

13.1.1 Fault Categories

Priorities programmed into the computer software divide faults into the following categories:

- **Type 1 Faults** are the most serious; System Status is changed to OFF.
- **Type 2 Faults** can be detected when the System Status is STANDBY, READY, AIM, or SURGICAL BEAM ON. The laser safety shutter is closed and no laser light will be permitted to exit the system. If the fault is related to the Safety Shutter, the other shutters will be closed and the output of the RF Driver will go to Low RF.
- **Type 3 Faults** are the least serious; the System Status remains the same and usually the fault can be easily corrected by the operator.
- **Calibration Faults** only occur when the System Status is CALIBRATION.

13.2 FORMAT OF ERROR MESSAGES

For Type 1, Type 2 and CALILBRATION Faults the error message fills up the entire screen as shown in the example in Figure 13-1. The code number for the PROBLEM CODE is always included, but the one-line description of the fault is omitted for some types of faults. Listed under SOLUTION are suggested actions to take for correcting the fault.

For Type 3 Faults the error message is smaller and appears inside a box on the current screen. No problem code is included.

PROBLEM CODE: L020 Coolant Water Temperature Is Too High SOLUTION: Please check coolant level. Please refill coolant reservoir with de-ionized water if level is low. If the problem persists contact Laserscope Customer Service Department.

Figure 13-1. Example of Error Messa

13.3 INDEX OF FAULTS BY PROBLEM CODES

13.3.1 Type 1 Faults

L012	Internal Cooling Water Flow Interrupted, (page 13-5)
L013	Internal Water Flow Fault, (page 13-6)
L020	Coolant Water Temperature Is Too High, (page 13-7)
L021	Water Temperature Too High (Sensor-150F), (page 13-8)
L030	Coolant Water Level Is Too Low, (page 13-9)
L051	Laser Power Supply Failure, (page 13-10)
L052	Lamp Did Not Start, (page 13-11)
L060	ALE Runaway Problem, (page 13-12)

13.3.2 Type 2 Faults

D010	No Delivery Device Attached, (page 13-13)
D020	System Not Configured For The Delivery Device Attached, (page 13-14)
D021	Delivery Devices Attached To Both Fiber Interfaces, (page 13-15)
D040	The Delivery Device Attached Is Not Calibrated, (page 13-16)
D050	The Attached Delivery Device Is Not Connected To The Correct Fiber Interface, (page 13-17)
D060	Fiber Over-Temperature Warning, (page 13-18)
E011	Microbeam Or Eye Safety Filter Is Not Properly Attached, (page 13-19)
E012	Eye Safety Filter Is Connected, (page 13-20)
E013	Eye Safety Filter Is Not Attached, (page 13-21)
E014	Eye Safety Filter Is Not Attached, (page 13-22)
E015	Eye Safety Filter Is Connected, (page 13-23)
E020	Eye Safety Filter Malfunction, (page 13-24)
E021	Eye Safety Filter Redundancy Failure, (page 13-25)
P010	KTP Low Laser Power, (page 13-26)
P020	KTP Power Adjust Malfunction, (page 13-27)
P031	KTP Minimum Power Attainable Is Too High, (page 13-28)
P032	KTP Maximum Power Attainable Is Too Low, (page 13-29)
P110	YAG Low Laser Power, (page 13-30)
P120	YAG Power Adjust Malfunction, (page 13-31)
P131	YAG Minimum Power Attainable Is Too High, (page 13-32)
P132	YAG Maximum Power Attainable is Too Low, (page 13-33)
S010	Internal Clock Fault, (page 13-34)
S020	KTP Software Exposure Fault, (page 13-35)
S021	KTP Hardware Over Power Exposure Fault, (page 13-36)
S022	KTP Hardware Over Duration Exposure Fault, (page 13-37)
S023	KTP Hardware Under Interval Exposure Fault, (page 13-38)
S024	KTP Power Detector Fault, (page 13-39)
S025	Hardware Exposure Circuit Fault, (page 13-40)
S026	Q-Switch Driver Intermittent, (page 13-41)
S031	Internal Light Valve Fault, (page 13-42)
S032	KTP Gain Change Fault, (page 13-43)
S033	KTP Modulate Power Not Within 3 & 25 Watts, (page 13-44)
S034	KTP Light Valve Not Functional, (page 13-45)
S035	KTP Calibration Filter Off Shutter Blade, (page 13-46)
S036	KTP Aim Detector Not Functional, (page 13-47)

S041	KTP Stepper Motor Fault, (page 13-48)
S042	KTP Surgical Attenuator Malfunction, (page 13-49)
S043	Footswitch Wiring Fault, (page 13-50)
S044	Footswitch Redundancy Failure, (page 13-51)
S051	KTP Safety Shutter Cannot Open, (page 13-52)
S052	KTP Safety Shutter Cannot Close, (page 13-53)
S053	KTP Safety Shutter Is Not In The Correct Position, (page 13-54)
S054	KTP Safety Blade Off Shutter Assembly, (page 13-55)
S055	KTP Safety Cable Not Connected, (page 13-56)
S061	Exposure (Aim) Shutter Cannot Open, (page 13-57)
S062	Exposure (Aim) Shutter Cannot Close, (page 13-58)
S063	Aim Is Not In The Correct Position, (page 13-59)
S064	Aim Blade Off Shutter Assembly, (page 13-60)
S065	Aim Cable Not Connected, (page 13-61)
S071	Calibration (Pre-Aim) Shutter Cannot Open, (page 13-62)
S072	Calibration (Pre-Aim) Shutter Cannot Close, (page 13-63)
S073	Pre-Aim Is Not In The Correct Position, (page 13-64)
S074	Pre-aim Blade Off Shutter Assembly, (page 13-65)
S075	Calibration Cable Is Not Connected, (page 13-66)
S120	YAG Software Exposure Fault, (page 13-67)
S121	YAG Hardware Over Power Exposure Fault, (page 13-68)
S122	YAG Hardware Over Duration Exposure Fault, (page 13-69)
S123	YAG Hardware Under Interval Exposure Fault, (page 13-71)
S124	YAG Power Detector Fault, (page 13-71)
S132	YAG Gain Change Fault, (page 13-72)
S151	YAG Safety Shutter Cannot Open, (page 13-73)
S152	YAG Safety Shutter Cannot Close, (page 13-74)
S153	YAG Safety Shutter Is Not In The Correct Position, (page 13-75)
S154	YAG Safety Blade Off Shutter Assembly, (page 13-76)
S155	YAG Safety Cable Not Connected, (page 13-77)
S181	Laser Mirror Cannot Open (for KTP), (page 13-78)
S182	Laser Mirror Cannot Close (for YAG), (page 13-79)
S183	Laser Mirror Is Not In The Correct Position, (page 13-80)
S184	Laser Mirror Motor Assembly Fault, (page 13-81)
S185	Laser Mirror Cable Not Connected, (page 13-82)
S191	Beam Mirror Cannot Open (YAG & KTP w/ubeam), (page 13-83)
S192	Beam Mirror Cannot Close (KTP w/endostat), (page 13-84)
S193	Beam Mirror Is Not In The Correct Position, (page 13-85)
S194	Beam Mirror Motor Assembly Fault, (page 13-86)
S195	Beam Mirror Cable Not Connected, (page 13-87
S210	ALE Current Control Fault, (page 13-88)
S220	Software Over Temperature - 130F, (page 13-89)
W021	YAG Surgical Power Seen While in KTP, (page 13-90)
W022	KTP Surgical Power Seen While in YAG, (page 13-91)

13.3.3 Calibration Faults

C010	Delivery device transmission is too low, (page 13-93)
C020	Unable to calibrate - too much light, (page 13-93)
C030	Unable to calibrate - light unsteady, (page 13-94)
C040	Unable to calibrate - too little light, (page 13-94)
C050	KTP Calibration Pod Zero Level Error, (page 13-95)
C150	YAG Calibration Pod Zero Level Error, (page 13-95)

For LO error codes, refer to chart 13-1 for further clarification on pump and LPS02 status.

NOTE: Pump will stay on and LPS02 will remain closed.

ERROR CODE	PUMP	LPS02
LO12	OFF	OPEN
LO13	OFF	OPEN
LO20	ON	OPEN
LO21	ON	CLOSE
LO30	OFF	OPEN
LO51	ON	CLOSE
LO52	ON	CLOSE
LO60	ON	CLOSE

PROBLEM CODE: L012

Internal Cooling Water Flow Interrupted

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists contact
Laserscope Customer Service Department.

13.4 TYPE 1 FAULTS

L012

FAULT CONDITION

Computer looks at output of secondary flow switch (Proteus) and determines a fault whenever the conditions shown below are present.

HOW DID IT HAPPEN

1. If during LASER POWERING UP cycle: Internal water flow is still not on 10 seconds after relay K2 is energized.
2. If with LASER ON: Internal water flow turns off by itself.

TROUBLESHOOTING

1. Go to Service Screen 1A/1B, (KTP or YAG Laser ON/OFF & Interloc). Check status of INT FLW. It should be '0' with water flowing in secondary system and laser on, (lamp lit).
2. Check for operation of pump in secondary system.
3. Check for any obstructions or kinks in the hoses.
4. Check operation of Proteus flow switch.
5. Check level in tank of internal water supply.

NOTE: Pump will stop running and LPS02 relay will open.

PROBLEM CODE: L013

Internal Water Flow Fault

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists contact
Laserscope Customer Service Department.

L013

FAULT CONDITION

Computer looks at operation of secondary flow switch (Proteus); switch should be open when system is OFF.

HOW DID IT HAPPEN

1. Secondary flow switch is ON when relay K1 is opened/de-energized.
2. Pump stays on after laser is turned off.

TROUBLESHOOTING

1. Check operation of the pump in the secondary system. (Pump could be operating due to a contact that has stuck on relay K-2.)
2. Go to Service Screen 1A or 1B and note status of INT FLW; status should be '1' with laser off.

NOTE: Pump will stop running and LPS02 relay will open.

PROBLEM CODE: L020

System is overheating

SOLUTION:

The laser is shut down for cooling.
Please leave KEY ON to assist cooling.
Please also check that the air flow is blocked.
If there are any signs of a coolant leak below the system or if the problem persists, contact Laserscope Customer Service Department.

L020

FAULT CONDITION

Computer looks at operation of thermal switch on manifold.

HOW DID IT HAPPEN

Heat sensors register a temperature at or greater than 140 degrees Fahrenheit when laser is on.

TROUBLESHOOTING

1. Check for airflow interruptions.
2. Check that fans are running.

NOTE: Pump will stay on but LPS02 relay will be opened.

L021

PROBLEM CODE: L021

System is overheating

SOLUTION:

The laser is shut down for cooling.
Please leave KEY ON to assist cooling.
Please also check that the air flow is blocked.
If there are any signs of a coolant leak below the system or if the problem persists, contact Laserscope Customer Service Department.

FAULT CONDITION

Computer first will read 120 F and 130 F faults, (which are displayed as either Type 2 or Type 3 Faults but will not shut down the system). If computer then sees a 150 F fault, a Type 1 Fault will be declared.

HOW DID IT HAPPEN

1. Calibration of the water temperature sensor could be wrong.
2. Temperture sensing switch, (which switches at 140 F), is not working properly.

TROUBLESHOOTING

1. Check calibration on temperature sensing switch.
2. Check for broken fan and pump.

NOTE: Pump will stay on and LPS02 will remain closed.

L030

PROBLEM CODE: L030

Coolant Water Level Is Too Low

SOLUTION:

Please check coolant level.

Please refill coolant reservoir with de-ionized water if level is low.

If the problem persists contact Laserscope Customer Service Department.

FAULT CONDITION

Computer checks output of level switch inside water tank and looks for two levels. The first low level will generate a Type 3 warning. If water level falls lower, the computer will see the level switch as open and will then declare a Type 1 Fault that shuts down the system.

HOW DID IT HAPPEN

Coolant water level is too low when the laser is on.

TROUBLESHOOTING

1. Look inside tank and confirm that Level Switch is not stuck.
2. Check operation of Level Switch as follows:
   Go to service Screen 1A or 1B, (KTP or YAG Laser ON/OFF & Interloc), and note status of WTR LVL. Status should be '0' when tank is filled.

NOTE: Pump will stop running and LPS02 relay will be opened.

PROBLEM CODE: L051

Laser Power Supply Failure

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists contact
Laserscope Customer Service Department.

L051

FAULT CONDITION

Computer looks at lamp power supply READY signal after supply is enabled.

HOW DID IT HAPPEN

After laser has been on, the LPSRDY signal from lamp power supply (A.L.E.) changes from READY to DISABLED.

TROUBLESHOOTING

1. Check the lamp.
2. Check lamp power supply (A.L.E.).
3. Go to Service Screen 1A, (KTP Laser ON/OFF & Interloc), and note status of LPS RDY. Status should be '1' with supply on.
4. Perform following steps:
   a. Turn laser off with keyswitch, then turn it back on.
   b. Go to Service Screen 1A.
   c. Press AIM UP button, (close relay), then wait at least 5 sec.
   d. Press AIM DN button, (enable LSPS). Look for LPS EN* to change to '1.' If it doesn't, replace the Electronics Card. If LPS EN* changes to '1,' LPS RDY should change to '1' a few seconds later. If it doesn't, replace the lamp power supply.

NOTE: Pump will stay on and LPS02 will remain closed.

PROBLEM CODE: L052

Lamp Did Not Start

SOLUTION:

Please press ON to try again.

If the problem persists contact Laserscope Customer Service Department.

L052

FAULT CONDITION

Computer looks at lamp power supply READY signal after supply is enabled.

HOW DID IT HAPPEN

During the LASER POWERING UP cycle, the LPSRDY from lamp power supply (A.L.E.) does not change to READY after relay K2 is energized and lamp power supply has been enabled for 3 trials.

TROUBLESHOOTING

1. Check lamp.
2. Check resistivity of DI water for minimum of 0.4 megohms.
3. Check LEDs on lamp power supply (A.L.E.) for proper sequencing.
4. Check lamp power supply (A.L.E.).
5. Go to Service Screen 1A, (KTP Laser ON/OFF & Interloc), and note status of LPS RDY. Status should be '1' with supply on.
6. Perform following steps:
   a. Turn laser off with keyswitch, then turn it back on.
   b. Go to Service Screen 1A.
   c. Press AIM UP button, (close relay), then wait at least 5 sec.
   d. Press AIM DN button, (enable LSPS). Look for LPS EN* to change to '1.' If it doesn't, replace the Electronics Card. If LPS EN* changes to '1,' LPS RDY should change to '1' a few seconds later. If it doesn't, replace the lamp power supply.

NOTE: Pump will stay on and LPS02 will remain closed.

PROBLEM CODE: L060

ALE Runaway Problem

SOLUTION:

If the problem persists contact
Laserscope Customer Service Department.

L060

FAULT CONDITION

Computer looks at input current level from lamp power supply and compares it to the output of the lamp power supply Digital-to-Analog Converter.

HOW DID IT HAPPEN

1. Current from lamp power supply (A.L.E.) is more than 42 Amps.
2. Current from lamp power supply is 5% higher than output of the lamp power supply Digital-to-Analog Converter.
3. Happens only with laser on.

TROUBLESHOOTING

1. Go to Service Screen 1B and note readings for ALE and LCUR. If ALE reading exceeds LCUR reading by more than 5%, replace lamp power supply.
2. Insert probes from Fluke meter into test points on lamp power supply. Monitor current level during system turn on to make sure current is not higher than 42 Amps. If current exceeds 42 Amps, replace lamp power supply.

13.5 TYPE 2 FAULTS

Given next for each Type 2 Fault are the error message screen and information to aid you in correcting the fault.

PROBLEM CODE: D010

No Delivery Device Attached

SOLUTION:

Please attach a delivery device to the laser aperture.

Alternatively, the ON/STANDBY key may be pressed to clear this display.

D010

FAULT CONDITION

Computer looks at signature resistors 1 and 2, (SR1 and SR2)

HOW DID IT HAPPEN

1. During System Status STANDBY the operator attempted to change power or timer settings when no device was attached.
2. During System Status READY the operator attempted to disconnect a delivery device from the laser aperture.

TROUBLESHOOTING

If fault was not triggered by either of the above operator actions, go to Service Screen 4A/4B, (KTP or YAG Calibration). Attach the problem delivery device to the laser aperture, then note the appropriate SR1 and SR2 readings, (ENDO SR1 and ENDO SR2, or uBM SR1 and uBM SR2). Both readings should be less than 250 counts. If either or both are above 250, it means the shorting bars on the delivery device are faulty.

Check for proper insertion of the delivery device. If fault is still not cleared, change the delivery device.

PROBLEM CODE: D020

System Not Configured For The Delivery Device Attached

SOLUTION:

A device for which the system contains no control electronics has been attached to the laser aperture.

Please attach only devices for which the system has been configured.

For further information contact Laserscope Customer Service Department.

D020

FAULT CONDITION

Computer looks at signature resistors 1 and 2, (SR1 and SR2), and determines if the delivery device is valid for that system.

HOW DID IT HAPPEN

1. During System Status STANDBY or CALIBRATION, a consumable Endostat is attached to the laser aperture.
2. Incorrect shorting bars.

TROUBLESHOOTING

1. Remove consumable delivery device and replace with disposable.
2. If operation with consumable delivery device is desired, call Laserscope Service Department for authorization.
3. If delivery device is confirmed to be valid, (not consumable), then go to Service Screen 4A/4B, (KTP or YAG Calibration), and check readings for SR1 and SR2. Then compare readings against the proper values for this particlular delivery device, (refer to Section 5 in this manual).

PROBLEM CODE: D021

Delivery Devices Attached To Both Fiber Interfaces

SOLUTION:

Delivery devices are attached to both of the laser apertures.

Please attach only one device at a time.

For further information contact Laserscope Customer Service Department.

D021

FAULT CONDITION

Computer looks at signature resistors 1 and 2, (SR1 and SR2), at both laser apertures, to make sure that only one delivery device is attached at a time.

HOW DID IT HAPPEN

During system operation, valid signature resistor values are registered at both laser apertures, (indicating that two delivery devices are attached at the same time).

TROUBLESHOOTING

1. If two delivery devices are connected, remove one of them.
2. If only one delivery device is connected, go to Service Screen 4A/4B, (KTP or YAG Calibration), and check readings for SR1 and SR2 on both laser apertures.

   If a value is indicated for the aperture not having a delivery device, remove the cable between the aperture and the printed circuit board on the resonator assembly. If a value still remains on the screen, replace the pcb on the resonator. If the value disappears, replace that laser aperture.
3. If the above actions do not clear the fault, replace the Electronics Card.

PROBLEM CODE: D040

The Delivery Device Attached Is Not Calibrated

SOLUTION:

Please press the orange button on the calibration pod to proceed with calibration.

Alternatively, the ON/STANDBY key may be pressed to clear this display.

D040

FAULT CONDITION

Computer checks to see if the delivery device requires calibration.

HOW DID IT HAPPEN

Happens only during System Status STANDBY, if an operator attempts to change power or timing settings when the attached delivery device is not calibrated or does not have a default calibration constant.

TROUBLESHOOTING

Calibrate the delivery device.

PROBLEM CODE: D050

The Delivery Device Attached Is Not Connected To The Correct Fiber Interface

SOLUTION:

The delivery device is attached to the wrong fiber interface. Please unplug the delivery device and re-attach it to the other fiber interface.

For further information contact Laserscope Customer Service Department.

D050

FAULT CONDITION

Computer monitors signature resistors SR1 and SR2 of both couplers, to make sure cables from couplers to printed circuit board on resonator assembly are not interchanged.

HOW DID IT HAPPEN

In System Status STANDBY, the computer senses that the attached delivery device is connected to the wrong coupler.

TROUBLESHOOTING

1. Go to Service Screen 4A/4B, (KTP or YAG Calibration).
2. Attach an Endostat delivery device to the Endostat laser aperture, then note the signature resistor readings at the bottom of the screen.
3. If readings appear for uBM SR1 and uBM SR2 instead of for ENDO SR1 and ENDO SR2, it means that cables ______ and _____ are interchanged on the small printed circuit board on the resonator assembly.

NOTE It is physically impossible for an Endostat to be attached to the Microbeam port, and for a Microbeam to be attached to the Endostat port.

However, if the cables from couplers are interchanged onto the printed circuit board on the resonator assembly, then this error can result.

PROBLEM CODE: D060

Fiber Over-Temperature Warning

Please replace the delivery device with a new one.

Press ON/STANDBY to continue.

If problem recurs immediately, contact Laserscope Customer Service Department.

D060

FAULT CONDITION

Computer looks at the temperature sensor located in the coupler.

HOW DID IT HAPPEN

1. During exposure, when temperature rise is too quick:
   a. for endostats more than 12 counts/5 degrees in less than 1 second.
   b. for microbeam more than 9 counts/5 degrees in less than 1 second.

2. During exposure, when proximal end temperature of the fiber is too high:
   a. for endostats over 157 counts/120 degrees F.
   b. for microbeam over 235 counts/189 degrees F.

TROUBLESHOOTING

1. Check input end of fiber for burns and/or damage; replace delivery device if necessary.
2. Check output coupler alignment to make sure that no cladding light is visible through a 300 micron alignment fiber. If cladding light remains visible, check output coupler lens condition and orientation.
3. If the problem still remains after taking the above steps, go to Service Screen 8, (KTP Fiber Temperature Control). Verify that the ambient temperature is correct for the coupler; reset if necessary.
4. Check for correct room temperature setting.
5. From Service Screen 8, open shutters and put power into the fiber at a level comparable to the power that triggered the fault during operation in Applications Mode. While doing this, also observe the displayed temperature readout.
6. If temperature rises very rapidly (4 counts per second), it means there is still something wrong with the fiber, alignment or optic coupler.

   If temperature rises more slowly but keeps going up to approximately 128 degrees F (for Endostat) or 230 degrees F (for Microbeam), it also means there is something wrong with the fiber, alignment or optic coupler.

   If temperature rise is slow and stabilizes below the threshold, it means the fault is probably due to electronic noise.

COMMENTS

The fiber over-temperature feature is designed to protect the output coupler from damage if a defective fiber is used or if the coupler has gone out of alignment. This feature is not necessary for the operation of the laser; it may be disabled in the Fiber Temperature Control Screen.

PROBLEM CODE: E011

Microbeam Or Eye Safety Filter Is Not Properly Attached

SOLUTION:

Please check that the microbeam is firmly attached to the bottom of the microscope.

Please check that the eye safety filter is attached above the microscope body and the eye safety filter control cable is attached to the socket on the front left corner under the eye safety filter.

E011

FAULT CONDITION

Computer looks for Eye Safety Filter connected to ESF cable when Microbeam delivery device is used.

HOW DID IT HAPPEN

1. ESF cable is not connected to laser console when it is required or enabled.
2. This fault is reported only when an operator tries to go to System Status READY from STANDBY; this fault will never appear in STANDBY.

TROUBLESHOOTING

1. Check connection of Microbeam delivery device and connection of ESF cable.
2. Go to Service Screen 3, (Attachments and ESF), then attach ESF cable and Microbeam delivery device.
3. Check following entries on screen:
   ESF IN should be 10, and STATUS OUT should be 10.
4. If entries are not as specified above, try replacing the Eye Safety Filter, ESF cable, or Electronics Card.

PROBLEM CODE: E012

Eye Safety Filter Is Connected

SOLUTION:

The eye safety filter safety feature was previously overridden.

The REPEAT key should be pressed to re-engage the use of the eye safety filter. Please check that the eye safety filter is attached.

Alternatively, the eye safety filter cables can be disconnected. However, suitable eye protection must be worn if eye safety filter is disabled.

E012

FAULT CONDITION

Computer looks to make sure that Eye Safety Filter is not connected to ESF cable when this safety feature is disabled.

HOW DID IT HAPPEN

1. ESF cable is connected to laser console when it is not required or when this feature is disabled.
2. This fault is reported only when an operator tries to go to System Status READY from STANDBY; this fault will never appear in STANDBY.

TROUBLESHOOTING

1. Disconnect Eye Safety Filter from ESF cable, or else re-enable use of Eye Safety Filter.
2. Check for shorted pins in the connector end of the ESF cable.

PROBLEM CODE: E013

Eye Safety Filter Is Not Attached

SOLUTION:

Please attach the eye safety filter directly on top of the microscope body.

Insure the eye safety filter control cable is attached to the eye safety filter and to the eye safety filter cable from the system.

Alternatively, the REPEAT key may be pressed to override this safety feature. However, suitable eye protection must be worn if eye safety filter is disabled.

E013

FAULT CONDITION

Computer looks for Eye Safety Filter connected to ESF cable when either a Dermastat or Ophthostat is being used.

HOW DID IT HAPPEN

1. ESF cable is not connected to laser console when it is required or when this feature is enabled.
2. This fault is reported only when an operator tries to go to System Status READY from STANDBY; this fault will never appear in STANDBY.

TROUBLESHOOTING

1. Check connection of Microbeam delivery device and connection of ESF cable.
2. Go to Service Screen 3, (Attachments and ESF), then attach ESF cable and Microbeam delivery device.
3. Check following entries on screen:
   ESF IN should be 10, and STATUS OUT should be 10.
4. If entries are not as specified above, try replacing the Eye Safety Filter, ESF cable, or Electronics Card.

PROBLEM CODE: E014

Eye Safety Filter Is Not Attached

SOLUTION:

Please attach the eye safety filter directly on top of the endoscope eye piece.

Insure the eye safety filter is attached to the eye safety filter cable from the system.

Alternatively, the REPEAT key may be pressed to override this safety feature. However, suitable eye protection must be worn if eye safety filter is disabled.

E014

FAULT CONDITION

Computer looks for Eye Safety Filter connected to ESF cable when an Endostat is being used.

HOW DID IT HAPPEN

1. ESF cable is not connected to laser console when it is required or when this feature is enabled.
2. This fault is reported only when an operator tries to go to System Status READY from STANDBY; this fault will never appear in STANDBY.

TROUBLESHOOTING

1. Check connection of Endostat delivery device and connection of ESF cable.
2. Go to Service Screen 3, (Attachments and ESF), then attach ESF cable and Endostat delivery device.
3. Check following entries on screen:
   ESF IN should be 10, and STATUS OUT should be 10.
4. If entries are not as specified above, try replacing the Eye Safety Filter, ESF cable, or Electronics Card.

E015

PROBLEM CODE: E015

Eye Safety Filter Is Connected

SOLUTION:

The eye safety filter safety feature was previously overridden.

The REPEAT key should be pressed to re-engage the use of the eye safety filter. Please check that the eye safety filter is attached.

Alternatively, the eye safety filter cables can be disconnected. However, suitable eye protection must be worn if eye safety filter is disabled.

FAULT CONDITION

After an operator defeats the Eye Safety Filter feature, the computer makes sure that the Eye Safety Filter is not connected to the ESF cable, (even though the Eye Safety Filter is not attached to an instrument).

HOW DID IT HAPPEN

1. ESF cable is connected to the laser console, but the eye piece is not attached to the Eye Safety Filter when the eye safety filter feature is disabled.
2. This fault occurs right at the beginning of the exposure: the above condition is checked when the surgeon depresses the footswitch but before an actual exposure is allowed.

TROUBLESHOOTING

Check the Eye Safety Filter

PROBLEM CODE: E020

Eye Safety Filter Malfunction

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists contact
Laserscope Customer Service Department.

E020

FAULT CONDITION

Computer checks that Eye Safety Filter moves into correct position within a specified time window.

HOW DID IT HAPPEN

At beginning or end of EXPOSURE:

- Eye Safety Filter takes more than 80 msec to energize or more than 160 msec to de-energize
- 30 msec after Eye Safety Filter moves into place, the microswitch changes position

If during System Status STANDBY or READY:

- 30 msec after Eye Safety Filter moves into place, the microswitch changes position.

TROUBLESHOOTING

1. Replace the Eye Safety Filter.
2. Open the Eye Safety Filter and make sure the microswitch engages correctly.
3. Go to Service Screen 3, (Attachments and ESF), then toggle the Eye Safety Filter and note the responses on the screen.
   - When ESF is de-energized, you should see:
     OUT=00 IN=10
     STATUS OUT=10
   - When ESF is energized, you should see:
     OUT=11 IN=00
     STATUS OUT=00

PROBLEM CODE: E021

Eye Safety Filter Redundancy Failure

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact
Laserscope Customer Service Department.

E021

FAULT CONDITION

Computer checks to make sure that the input from the eye safety connector compares with certain signals on the Electronics Card. A fault is declared if the signals do not match.

HOW DID IT HAPPEN

1. Cable connections on eye safety filter could be loose.
2. Electronics Card could be defective.

TROUBLESHOOTING

1. Check connections on eye safety filter cables.
2. Replace Electronics Card.
3. Refer to Service screen 3 for ESF status:

INT UP	ESF	DRV=XX	SW=Y	Z
INT DN	ESF ARMED	SW SHOULD	BE=Y_1Y_2	Z_1Z_2

Where Y_1 and Y_2 must both be equal to Y and
Z_1 and Y_2 must both be equal to Z.

a) If Y_1 and Y_2 are different, replace Electronics Card.
b) If Z_1 and Z_2 are different, replace Electronics Card.
c) If Y_1 and Y_2 are the same but different from Y, check connections on eye safety filter cables and connectors.
d) If Z_1 and Z_2 are the same but different from Z, check connections on eye safety filter cables and connectors.

PROBLEM CODE: P010

KTP Low Laser Power

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact
Laserscope Customer Service Department.

P010

FAULT CONDITION

Computer looks at laser KTP output at Surgical Detector with surgical attenuator open; fault is declared if output is less than 0.2 watt.

NOTE: P010 usually means no KTP laser output.

HOW DID IT HAPPEN

1. During POWERING UP cycle in KTP, with attenuation set at minimum (Surg. Att. open) the maximum power measured was less than 0.2 watt, after computer tried three times.
2. During System Status STANDBY, the Surgical Detector reads zero count during power adjustment.

TROUBLESHOOTING

1. Power Laser up in Service Mode. If power is less than 5 watts, check Q switch operation. If power appears over 10 watts, proceed.
2. Look in Power Log. If recorded powers fluctuate over a wide range (5 to 15 watts), then Q-switch driver is suspect.
3. Look in internal error log, if S026 faults have occurred, Q/S driver is bad.
4. If either condition #2 or #3 occur, replace Q/S driver.
5. If power is low and Q/S driver is good, check resonator optics and equipment.
6. Use power meter to measure laser output.
7. Go to Service Screen 2A, (KTP Laser, Shutters, Detectors); check power output and detector gain.
8. Check detector for zero and correct gain set.
9. If no laser output, refer to the Laser & Optics troubleshooting guide in Section 10 of this manual.

PROBLEM CODE: P020

KTP Power Adjust Malfunction

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

P020

FAULT CONDITION

Computer makes sure that power adjustment is achieved within a 15-second window. Fault is declared if KTP is producing power but the power level cannot be adjusted within ±5% of the required level.

NOTE: P020 usually means the Surgical Detector is not working.

HOW DID IT HAPPEN

During System Status STANDBY, system takes more than 15 seconds to adjust power; message "ADJUSTING POWER" stays on screen for 15 sec., then fault is declared and error message appears.

TROUBLESHOOTING

1. Check Surgical Attenuator for loose waveplate or loose stop plate.
2. Check for possible oscillating detector output at Surgical Detector. To do this, go to Service Screen 2A, (KTP Laser, Shutters, Detectors), and note readings for Surgical Detector output. Readings should not change by more than 10 counts.

PROBLEM CODE: P031

KTP Minimum Power Attainable Is Too High

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact
Laserscope Customer Service Department.

P031

FAULT CONDITION

Computer checks for minimum power of 1 watt or less; program looks three times before declaring fault.

HOW DID IT HAPPEN

During POWERING UP cycle in KTP, with maximum attenuation the minimum power measured more than 1.0 watt, after computer tried three times.

TROUBLESHOOTING

1. Go to Service Screen 2A, (KTP Laser, Shutters, Detectors), and from this screen rotate the Surgical Detector all the way counter-clockwise.
2. Place a power meter after the 532 nm Safety Shutter and measure the power. If reading is greater than 1.0 watt, confirm that half waveplate is in a position to insure the maximum attenuation.
3. Remove the Surgical Attenuator. Then check for polarizers in correct position by checking minimum power again. (For correct positioning of the polarizer plates, you may need to refer to the KTP Laser Alignment Procedure in Section 10 of this manual.)
4. Replace Surgical Detector. From Service Screen 2A check Surgical Detector for zero and correct gain setting. Then compare output from Surgical Detector with output from Safety Detector. If both detectors track, don't perform any adjustments. If they don't track, reset to match your power meter.
5. After taking above actions, if minimum power is still more than 1.0 watt, rotate the KTP Output Coupler.

COMMENTS

Make sure that the Surgical Attenuator has been assembled correctly: the spring washer should be between the brass and teflon washers.

PROBLEM CODE: P032

KTP Maximum Power Attainable Is Too Low

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact
Laserscope Customer Service Department.

P032

FAULT CONDITION

Computer checks for maximum power of 5.0 watts or more with Surgical Attenuator open for maximum transmission; program looks three times before declaring fault.

HOW DID IT HAPPEN

During POWERING UP cycle in KTP, with minimum attenuation the maximum power measured is less than 5.0 watts, after computer tried three times. Q/S Driver intermittent is most common.

TROUBLESHOOTING

1. Power Laser up in Service Mode. If power is less than 5 watts, check Q switch operation. If power appears over 10 watts, proceed.
2. Look in Power Log. If recorded powers fluctuate over a wide range (5 to 15 watts), then Q-switch driver is suspect.
3. Look in internal error log, if S026 faults have occurred, Q/S driver is bad.
4. If either condition #2 or #3 occur, replace Q/S driver.
5. If power is low and Q/S driver is good, check resonator optics and equipment.
6. Measure laser output power; if low, refer to the Laser & Optics troubleshooting guide in Section 10 of this manual.
7. Go to Service Screen 2A, (KTP Laser, Shutters, Detectors), and check readings for zero and gain setting of Surgical Detector. Then compare output from Surgical Detector with output from Safety Detector. If both outputs match, don't adjust detectors. If they don't match, use your power meter and reset the detectors.
8. Check Surgical Attenuator for loose waveplate and/or loose stop plate.

COMMENTS

Make sure that the Surgical Attenuator has been assembled correctly: the spring washer should be between the brass and teflon washers.

PROBLEM CODE: P110

YAG Low Laser Power

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

P110

FAULT CONDITION

Computer measures laser YAG output at Surgical Detector; looks for more than 4 watts when current is 25 amps, and more than 8 watts when current is 35 amps.

NOTE: P110 usually means that there is no YAG laser output.

HOW DID IT HAPPEN

1. During POWERING UP cycle in YAG, the power measured at 25 amps is less than 4 watts or power measured at 35 amps is less than 8 watts.

2. During System Status STANDBY, when in YAG the YAG Surgical Detector reads zero count during power adjustment.

TROUBLESHOOTING

1. With power meter check YAG laser output at 25 amps and 35 amps.
2. Go to Service Screen 2B, (YAG Laser, Shutters, Detectors), then check readings for power output and detector gain.
3. Check detectors for zero and correct gain set.
4. If no YAG laser output, refer to the Laser & Optics troubleshooting guide in Section 10 of this manual.

PROBLEM CODE: P120

YAG Power Adjust Malfunction

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact
Laserscope Customer Service Department.

P120

FAULT CONDITION

Computer makes sure that power is adjusted within a 15-seconds time window. Fault is declared if YAG is producing power but the power level cannot be adjusted within ±5% of the required level.

NOTE: P120 usually means an unstable laser, unstable detector, or unstable lamp power supply (A.L.E.).

HOW DID IT HAPPEN

During System Status STANDBY, system takes more than 15 seconds to adjust power; message "ADJUSTING POWER" stays on screen for 15 sec., then fault is declared and error message appears.

TROUBLESHOOTING

1. Go to Service Screen 2B, (YAG Laser, Shutters, Detectors). and note readings for YAG Surgical Detector.
2. If counts vary by 10 or more, install power meter and measure power.
3. If power is stable, check or replace detector.
   If power is not stable, refer to the Laser & Optics troubleshooting guide in Section 10 of this manual.
4. Connect Fluke voltmeter to measure current output of lamp power supply, (A.L.E.). Meter readings should be stable, (that is, they should not change by more than ±200 mv).

PROBLEM CODE: P131

YAG Minimum Power Attainable Is Too High

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact
Laserscope Customer Service Department.

P131

FAULT CONDITION

Computer measures YAG output with current at 10 amps, and declares fault if YAG output power is more than 5 watts.

NOTE: P131 usually indicates that 1064 nm Surgical Detector is bad.

HOW DID IT HAPPEN

Happens <u>only</u> during POWERING UP, when YAG output at 10 amps is too high.

TROUBLESHOOTING

1. Go to Service Screen 2B, (YAG Laser, Shutters, Detectors). Note lamp current and output power.
2. Check power at 10 amps. Power cannot be greater than 5.0 watts.
3. Compare laser output measured on power meter with reading for Surgical Detector. Also check detector gain set.
4. Align YAG laser at high power, (with lamp currrent at about 35 amps).

PROBLEM CODE: P132

YAG Maximum Power Attainable Is Too Low

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact
Laserscope Customer Service Department.

P132

FAULT CONDITION

Computer measures YAG output with current at 40 amps, and declares fault if YAG output power is less than 20 watts.

NOTE: P132 usually indicates YAG laser low output or faulty 1064 nm Surgical Detector.

HOW DID IT HAPPEN

During POWERING UP cycle in YAG, when YAG output at 40 amps measures less than 20 watts.

TROUBLESHOOTING

1. Install power meter and measure YAG output at 40 amps. If power is less than 20 watts, refer to the Laser & Optics troubleshooting guide in Section 10 of this manual.
   If power is more than 20 watts, go to Service Screen 2B, (YAG Laser, Shutters, Detectors).
2. Check zero and gain setting for YAG Surgical Detector. Also make sure Surgical Detector and Safety Detector match. (For proper set-up procedure, see Section 10 of this manual.)
   If detectors don't match, install power meter and reset detectors to match power meter. (See alignment procedure in Section 10 of this manual.)

   NOTE: Use calibration factor when determining YAG output with your power meter. Also, don't run high power YAG into meter for extended period.

PROBLEM CODE: S010

Internal Clock Fault

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S010

FAULT CONDITION

Computer checks sequence of program execution every 50 msec and 150 msec; if an error is detected, a hard reset will be performed and a fault will be declared.

TROUBLESHOOTING

There is no practical method of troubleshooting this fault out in the field. However, by checking the Error Log, it will give us an idea what has cause the actual error:

1. Go to the Error Log and determine whether it is logged in the EXTERNAL error log or INTERNAL error log.
2. Check the system status whether it is a "5" or "F".

Refer to following diagram for the cause.

	External Error Log	Internal Error Log
Laser Off "F"	Failed Ram Check during power on	Program Lost
Type 5 "5"	WAFA with NMI	WAFA without NMI

If these errors are present, replace the Electronics Card.

PROBLEM CODE: S020
KTP Software Exposure Fault
SOLUTION:
Press ON/STANDBY to continue.
If the problem persists, contact Laserscope Customer Service Department.

S020

FAULT CONDITION

Computer looks at output of KTP Surgical Detector and declares fault if output is 33% higher than power level set by operator.
NOTE: This fault is declared in software.

HOW DID IT HAPPEN

During an exposure, after surgeon depressed the footswitch, power at Surgical Detector is found to be 33% higher than calculated power.

NOTE: This fault has absolutely nothing to do with the Safety Detector; it is most likely to happen during REPEAT mode when RF Driver (Q-switch Driver) switches between LOW RF and HIGH RF.

TROUBLESHOOTING

1. Power Laser up in Service Mode. If power is less than 5 watts, check Q switch operation. If power appears over 10 watts, proceed.
2. Look in Power Log. If recorded powers fluctuate over a wide range (5 to 15 watts), then Q-switch driver is suspect.
3. Look in internal error log, if S026 faults have occurred, Q/S driver is bad.
4. If either condition #2 or #3 occur, replace Q/S driver.
5. If power is low and Q/S driver is good, check resonator optics and alignment.
6. Go to Service Screen 1A, (KTP Laser ON/OFF & Interloc).
7. Install power meter behind LAM.
8. Go to full current and HIGH RF. Measure 1064 nm leakage through LAM.
9. Go to full current and LOW RF. Adjust RF Driver so that HIGH RF leakage at LAM is the same as LOW RF leakage at LAM. (Refer to RF Driver procedure in Section 8 of this manual.)

PROBLEM CODE: S021

KTP Hardware Over Power Exposure Fault

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S021

FAULT CONDITION

Safety Detector level is compared with power level set by operator (DAC); fault is triggered by hardware for conditions given below.

HOW DID IT HAPPEN

1. During EXPOSURE, if the KTP Safety Detector reads higher than the DAC comparator output; DAC is set to 33% higher than the power set (calibrated) by the operator.
2. During System Status STANDBY or READY, (no light at the Safety Detector yet), if the KTP Safety Detector registers more than 30 counts; DAC is set to 30 counts. (Or if in low power mode, KTP S.D. registers more than 15 counts, DAC is set to 15 counts.
3. During System Status CALIBRATION, if the KTP Saftey Detector registers more than 25 counts; DAC is set to 25 counts.

TROUBLESHOOTING

1. Power Laser up in Service Mode. If power is less than 5 watts, check Q switch operation. If power appears over 10 watts, proceed.
2. Look in Power Log. If recorded powers fluctuate over a wide range (5 to 15 watts), then Q-switch driver is suspect.
3. Look in internal error log, if S026 faults have occurred, Q/S driver is bad.
4. If either condition #2 or #3 occur, replace Q/S driver.
5. If power is low and Q/S driver is good, check resonator optics and alignment.
6. Go to Service Screen 2A, (KTP Laser, Shutters, Detectors). Check zero levels of the Surgical Detector and Safety Detector. Check gain.
7. During exposure, note whether readings for Safety Detector and Surgical Detector are the same. If they're not, set output from both detectors to a power level from a calibrated power meter. Make sure safety does not read higher than the surgical. (Refer to laser alignment procedure in Section 10 of this manual.)
8. During System Status STANDBY, READY and CALIBRATION, make sure no stray light reflections are going into the Safety Detector.

PROBLEM CODE: S022

KTP Hardware Over Duration Exposure Fault

SOLUTION:

Press ON/STANDBY to continue.

If problem recurs immediately, contact Laserscope Customer Service Department.

S022

FAULT CONDITION

Duration of signal from Safety Detector is compared in hardware to the pulse duration set by the operator; fault is triggered by hardware for the conditions given below.

HOW DID IT HAPPEN

1. During EXPOSURE, if ON period is longer than selected duration in KTP; the allowed window is DURATION + 10% + 5 msec.
2. During EXPOSURE, with duration set for CONTINUOUS, if shutters take more than 50 msec to block the light at the end of the exposure when the surgeon releases the footswitch.
3. Another likely cause of this fault can be spurious signals from the Safety Detector, due to shutter bounce of Exposure or Calibration Shutters.
4. Other than during EXPOSURE, (usually in READY), a spurious signal generated from the Safety Detector may trigger the duration fault circuit. (NOTE: Usually due to stray light.)

TROUBLESHOOTING

1. Power Laser up in Service Mode. If power is less than 5 watts, check Q switch operation. If power appears over 10 watts, proceed.
2. Look in Power Log. If recorded powers fluctuate over a wide range (5 to 15 watts), then Q-switch driver is suspect.
3. Look in internal error log, if S026 faults have occurred, Q/S driver is bad.
4. If either condition #2 or #3 occur, replace Q/S driver.
5. If power is low and Q/S driver is good, check resonator optics and alignment.
6. Go to Service Screen 2A, (KTP Laser, Shutters, Detectors), and check for zero level of Safety Detector.
7. Check output from KTP Safety Detector: with HIGH aim beam and Safety Shutter raised, output should be 10 counts for a GAIN of 1x and 10x and 5 counts for 60x gains. Also check aim level; it must be less than 4 mW.
8. Make sure that stray light reflection is not causing output of Safety Detector to go above 5 counts.
9. Check mechanical adjustment of shutter blades on Exposure (Aim) Shutter and Calibration (Pre-Aim) Shutter; the blades should be perfectly horizontal. If adjustment is required:
   a. Loosen two nuts that hold solenoid to shutter mount.
   b. Slightly rotate the solenoid as needed to bring the

    blade horizontal.
    c. Tighten the nuts.

10. If the above actions don't clear the fault, replace the Exposure and Calibration Shutters.
11. Replace Electronics Card.

PROBLEM CODE: S023

KTP Hardware Under Interval Exposure Fault

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S023

FAULT CONDITION

Interval between pulses from KTP Safety Detector is compared in hardware to duration set by computer. In REPEAT mode, this is interval set by the operator; in CONTINUOUS or single pulse, interval is set to 100 msec by computer.

HOW DID IT HAPPEN

1. During EXPOSURE, in REPEAT, the off period between pulses was shorter than the selected interval. (The off period can not be shorter than 90% of INTERVAL - 10 msec.)
2. In SINGLE PULSE, the default INTERVAL is 100 msec.; fault is triggered if any signal comes from the KTP Safety Detector within 100 msec. after the end of the pulse.
3. In CONTINUOUS mode, the default INTERVAL is 100 msec.; fault is triggered if any signal comes from the KTP Safety Detector within 100 msec. after surgeon releases the footswitch.
4. Fault may also be triggered by spurious signals from the KTP Safety Detector; most likely cause is due to shutter bounce of Exposure or Calibration Shutters.

TROUBLESHOOTING

1. Power Laser up in Service Mode. If power is less than 5 watts, check Q switch operation. If power appears over 10 watts, proceed.
2. Look in Power Log. If recorded powers fluctuate over a wide range (5 to 15 watts), then Q-switch driver is suspect.
3. Look in internal error log, if S026 faults have occurred, Q/S driver is bad.
4. If either condition #2 or #3 occur, replace Q/S driver.
5. If power is low and Q/S driver is good, check resonator optics and alignment.
6. Check mechanical adjustment of shutter blades on Exposure (Aim) Shutter and Calibration (Pre-Aim) Shutter; the blades should be perfectly horizontal. If adjustment is required:
   a. Loosen two nuts that hold solenoid to shutter mount.
   b. Slightly rotate the solenoid as needed to bring the blade horizontal.
   c. Tighten the nuts.
7. If the above actions don't clear the fault, replace either the Exposure or Calibration Shutter, (or replace both).
8. Replace Electronics Card.

PROBLEM CODE: S024

KTP Power Detector Fault

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S024

FAULT CONDITION

Computer checks difference between readings of KTP Surgical and Safety Detectors.

HOW DID IT HAPPEN

Only during EXPOSURE, if reading from KTP Safety Detector is 33% less than or 33% greater than reading from KTP Surgical Detector.

TROUBLESHOOTING

1. Go to Service Screen 2A, (KTP Laser, Shutters, Detectors). Put beam block in front of Endostat Coupler and open all shutters. While ramping power from minimum to maximum, note outputs from KTP Surgical and Safety Detectors. The outputs should not differ by more than 33% or 5 counts. (Make sure both detectors have same gain set and that there is no roll-off.) Safety reading should never be higher than surgical.
2. Install power meter and measure power. Reset zero and reset both detectors to track each other.
3. Look at detector outputs on the screen, and determine whether they track from minimum power to maximum power. If they don't track, make a comparison with each detector and the power meter, to determine which one is faulty. Then replace the faulty detector.
4. Make sure no stray light beams are going into either detector.

PROBLEM CODE: S025

Hardware Exposure Circuit Fault

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact
Laserscope Customer Service Department.

S025

FAULT CONDITION

Computer checks for various types of hardware exposure faults.

HOW DID IT HAPPEN

Computer detects hardware fault that is due to some cause other than over-power (S021), over-duration (S022), or under-interval (S023).

NOTE: This fault means there is a faulty circuit on the Electronics Card; it has nothing to do with shutters or detectors.

TROUBLESHOOTING

Replace the Electronics Card.

PROBLEM CODE: S026

Q-Switch Driver Intermittent

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact
Laserscope Customer Service Department.

S026

FAULT CONDITION

During warmup the operation of the Q-Switch driver is checked: computer goes to NO RF, LO RF and HI RF, and confirms that driver switches each time.

HOW DID IT HAPPEN

When switching from LO RF to HI RF the computer looks for a 2x increase in output power from the surgical detector. Fault is declared if power if too low, or if Q-Switch is not switching.

NOTE: Intermittent Q-Switch problems will be declared as an internal fault and so will not be visible to the customer. For logged switching information, refer to the Internal Error Log.

TROUBLESHOOTING

1. Go to Service Screen 7, (Special Tests), and look in the Error Log for S026, S021, S023 or any exposure faults! Look at Power Log for inconsistent powers.

   If the log contains any S026 Faults, replacle the Q-Switch driver.

   If the log contains any S021, S022 or S023 Faults, refer to the "TROUBLESHOOTING" guidelines given on those pages in this manual.

PROBLEM CODE: S031

KTP Aim Power > 4.5V

SOLUTION:

Press ON/STANDBY to continue.

If the problem repeats lower aim level and try again.

S031

FAULT CONDITION

In System Status STANDBY when operator adjusts aim level, computer looks at Aim Detector and adjusts light valve.

HOW DID IT HAPPEN

Computer declares fault if output of Aim Detector is still more than 4.5 volts (229 counts) two minutes after a power change (SURGICAL or AIM) or while in READY.

TROUBLESHOOTING

1. Go to Service Screen 2A, (KTP Laser, Shutters, Detectors). Check Aim Detector zero level.
2 Refer to Aim Alignment procedure (procedure for KTP Second Train Alignment in Section 10 of this manual).
3. If problem is still present after aligment of Aim Detector, replace the light valve.
4. If problem is still present after replacing the light valve, replace the Aim Detector.

PROBLEM CODE: S032

KTP Gain Change Fault

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S032

FAULT CONDITION

When system does a gain change, computer checks for a change by a factor of 10 ±33% for Surgical Detector and declares fault if outside this window.

HOW DID IT HAPPEN

1. During POWERING UP in KTP, the gain check at 2 watts failed; window allowed is ±33%.

2. During System Status STANDBY, the gain change does not meet the specified window of ±33%.

TROUBLESHOOTING

1. Go to Service Screen 2A, (KTP Laser, Shutters, Detectors). Check zero and gain setting of Surgical Detector. Compare Surgical Detector to a power meter to insure proper operation.
2. From Service Screen 2A set Surgical Detector for a gain of 10. Go to 5.0 watts and note detector counts. Reading should be at least 250 counts, (saturated). If less than 250, replace Surgical Detector PCB.

PROBLEM CODE: S033

KTP Modulate Power Not Within
3 & 25 Watts

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact
Laserscope Customer Service Department.

S033

FAULT CONDITION

During warmup the computer tries to set up the low and high power range for the aim beam. (Also see NOTE below.)

HOW DID IT HAPPEN

1. Fault is declared if system can't get the power within 3 and 25 watts, or if the modulation circuit is not working.

2. If no modulation but system has good regular power, problem could be on the Electronics Card, or be caused by dirty optics or a misaligned resonator.

NOTE: For Faults S033, S034, S035 and S036 the system will display a message telling about a the KTP aim beam not available. This message will give the user an option to continue operating the system without an aim beam. If the user chooses to continue, the error is bypassed and the system continues to operate.

TROUBLESHOOTING

1. Go to Service Screen 9, (Current Modulation Control), and press the AIM DN button to select "Modulation ON."
2. Connect the DVM to measure current at the output of the Lamp Power Supply (A.L.E.).
3. Press the INT UP button to increase the power, then compare the current reading on the DVM to the current modulation ALE reading displayed on the screen. The two readings should match approximately.
4. Check the optics.

PROBLEM CODE: S034

KTP Light Valve Not Functional

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S034

FAULT CONDITION

During warmup the computer searches for the minimum LV voltage that will start light scattering.

HOW DID IT HAPPEN

Due to a defective light valve, during warmup computer is unable to find the minimum voltage or the voltage found is more than 80 counts. (Approximately 13 Vrms)

NOTE: For Faults S033, S034, S035 and S036 the system will display a message telling about the KTP aim beam is not available (same as S033). This message will give the user an option to continue operating the system without an aim beam. If the user chooses to continue, the error is bypassed and the system continues to operate. Also, the low power mode (power levels less than 0.45 W) will not be available for use.

TROUBLESHOOTING

1. Go to Service Screen 2A, (KTP Laser, Shutters, Detectors). Press the DUR UP button to increase the light valve voltage and observe whether the light valve (on the Exposure Shutter) gets cloudy.
   If it doesn't get cloudy, check the light valve wires.
   If the wires are OK, replace the light valve and try again.
   If the light valve still doesn't get cloudy, replace the Electronics Card.
2. If the light valve gets cloudy in the above step, then check the Aim Detector setup (Aperture Alignment).
   If the setup is OK, replace the Aim Detector.
   If the problem persists, replace the Electronics Card.

PROBLEM CODE: S035

KTP Calibration Filter Off Shutter Blade

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S035

FAULT CONDITION

Computer reads the aim detector with the calibration shutter down (dropped); when shutter is raised, Aim Detector should be saturated. Also the computer makes sure that the calibration filter is in place during low power mode. (If filter is not in place, system won't be able to get low power because it will have too much light.)
Also see NOTE below.

HOW DID IT HAPPEN

Filter on Calibration Shutter is out of place or defective, (resulting in extremely high transmission to Aim Detector and causing detector to stay saturated).

NOTE: For Faults S033, S034, S035 and S036 the system will first display a message telling about the KTF aim beam is not available (same as S033). This message will give the user an option to continue operating the system without an aim beam. If the user chooses to continue, the error is bypassed and the system continues to operate. Also the low power mode (power levels less than 0.45 W) will not be available for use.

TROUBLESHOOTING

1. Go to Service Screen 2A, (KTP Laser, Shutters, Detectors). The value that appears immediately after AIM = will be 255 when the Aim Detector is saturated. If this level remains at 255 all the time, (meaning that the detector is saturated), check the filter on the Calibration Shutter. Replace it if necessary.

PROBLEM CODE: S036

KTP Aim Detector Not Functional

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S036

FAULT CONDITION

During check of Aim Detector operation, if the computer finds an error with the calibration filter, the computer makes sure it is not due to a defective Aim Detector.

HOW DID IT HAPPEN

Computer raises the calibration filter, which should cause Aim Detector to saturate. If it doesn't, the computer tries a second time by rotating the Attenuator Motor clockwise by 50 steps and then re-reading the Aim Detector for saturation. Fault is declared if second try fails.

NOTE: For Faults S033, S034, S035 and S036 the system will display a message telling about the KTP aim beam is not available (same as S033). This message will give the user an option to continue operating the system without an aim beam. If the user chooses to continue, the error is bypassed and the system continues to operate. Also, the low power mode (power levels less than 0.45 W) will not be available for use.

TROUBLESHOOTING

1. Go to Service Screen 2A, (KTP Laser, Shutters, Detectors). The value that appears immediately after AIM = will be 255 when the Aim Detector becomes saturated.
2. Press the DUR UP button to increase the light valve voltage, and note whether doing this can cause the Aim Detector to saturate.
3. If Aim Detector does not saturate, check for misaligned aim circuit.
4. If aim circuit is not misaligned, check operation of the light valve by pressing the DUR UP button and noting if light valve (on Exposure Shutter) gets cloudy.
   If it does not get cloudy, replace the light valve.
   If operation of light valve is OK, replace the Aim Detector.

NOTE: With an S036 Fault you won't be able to go into low power mode.

PROBLEM CODE: S041
KTP Stepper Motor Fault
SOLUTION:
Press ON/STANDBY to continue.
If the problem persists, contact Laserscope Customer Service Department.

S041

FAULT CONDITION

Computer looks at signal from binary counter on Electronics Card that drives stepper motor.

HOW DID IT HAPPEN

When driving motor, the computer declares a fault if no feedback signal is received from the binary counter within 5 seconds.

TROUBLESHOOTING

This problem is in the circuit on the Electronics Card and has nothing to do with the stepper motor. Replace the Electronics Card.

PROBLEM CODE: S042

KTP Surgical Attenuator Malfunction

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S042

FAULT CONDITION

System rotates attenuator by 100 steps and computer checks power; fault is declared if power does not decrease by at least 20%.

HOW DID IT HAPPEN

During POWERING UP, if power decreases by less than 20% when Surgical Attenuator is moved 100 steps counter-clockwise from maximum power.

TROUBLESHOOTING

1. Make sure that the Surgical Attenuator has been assembled correctly: the spring washer should be between the brass and teflon washers.
2. Check for the half waveplate slipping in the cell in the Surgical Attenuator.
3. Go to Service Screen 2A, (KTP Laser, Shutters, Detectors). Observe response of stepper motor when you press the INT UP and INT DN buttons. If stepper motor does not move, replace the motor.
4. If the above actions do not correct the problem, replace the Electronics Card.

PROBLEM CODE: S043

Footswitch Wiring Fault

SOLUTION:

Press ON/STANDBY to continue.

If problem recurs immediately, contact Laserscope Customer Service Department.

S043

FAULT CONDITION

Computer looks for closure of aim switch before closure of surgical switch (both are inside footswitch); fault is declared if this does not occur.

HOW DID IT HAPPEN

When footswitch is completely depressed, the surgical switch is closed while the aim switch is opened.

TROUBLESHOOTING

1. Go to Service Screen 3, (Attachments and ESF).
2. While observing levels reported for AIM FTSW and SUR FTSW, depress footswitch slowly. AIM FTSW should go to '1' first, followed by SUR FTSW going to '1.' (Fault is declared if sequence is reversed.)
3. Check positions of switches.
4. Check for cross wiring in footswitch.

PROBLEM CODE: S044

Footswitch Redundancy Failure

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S044

FAULT CONDITION

Computer double checks and compares the redundant incoming footswitch signals RAW1 and RAW2.

HOW DID IT HAPPEN

RAW1 and RAW2 and SUR FTSW don't compare; the cause is probably a component failure (1489 chip) on the Electronics Card.

TROUBLESHOOTING

1. Go to Service Screen 3, (Attachments and ESF).
2. The value that appears after AIM FTSW* should change from 0 to 1 when you press the footswitch down. The values after RAW1 and RAW2 also should change from 0 to 1 when you do this.

When depressed, **NOTE** following readings:

SUR FTSW	RAW 1	RAW 2	CODE	
0 1	0 1	0 1	OK OK	
0 1	1 0	1 0	S044 S044	Check footswitch Wiring
0 0 1 1	1 0 0 1	1 1 1 0	S044 S044 S044 S044	Change PCB

PROBLEM CODE: S051

KTP Safety Shutter Cannot Open

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact
Laserscope Customer Service Department.

S051

FAULT CONDITION

After commanding KTP Safety Shutter to open, computer looks at return signal from shutter and declares fault if status is incorrect.

HOW DID IT HAPPEN

After computer gives command to open shutter and waits 60 msec., the two switches (NC and NO) on the shutter do not give the correct positions.

TROUBLESHOOTING

1. Go to Service Screen 2A, (KTP Laser, Shutter, Detectors). Toggle the KTP Safety Shutter and note status. Readings should be as follows:

	NO	NC
Open	0	1
Closed	1	0

2. If readings are not as shown above, remove cable from KTP Safety Shutter. Then remove cable from Exposure Shutter (Aim Shutter) and connect it to the KTP Safety Shutter. Toggle the Exposure Shutter and note status readings for Exposure Shutter. If the problem goes away, perform further troubleshooting steps to determine if the trouble cause is on the Electronics Card or due to a faulty KTP Safety Shutter cable. (Don't forget to reconnect proper cables.)
3. Make sure that the blade on the KTP Safety Shutter moves freely between the optical sensors on the shutter circuit board.
4. Replace the KTP Safety Shutter.

PROBLEM CODE: S052

KTP Safety Shutter Cannot Close

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S052

FAULT CONDITION

After commanding KTP Safety Shutter to close, computer looks at return signal from shutter and declares fault if status is incorrect.

HOW DID IT HAPPEN

After computer gives command to close shutter and waits 60 msec., the two switches (NC and NO) on the shutter do not give the correct positions.

TROUBLESHOOTING

1. Go to Service Screen 2A, (KTP Laser, Shutter, Detectors). Toggle the KTP Safety Shutter and note status. Readings should be as follows:

	NO	NC
Open	0	1
Closed	1	0

2. If readings are not as shown above, remove cable from KTP Safety Shutter. Then remove cable from Exposure Shutter (Aim Shutter) and connect it to the KTP Safety Shutter. Toggle the Exposure Shutter and note status readings for Exposure Shutter. If the problem goes away, perform further troubleshooting steps to determine if the trouble cause is on the Electronics Card or due to a faulty KTP Safety Shutter cable. (Don't forget to reconnect proper cables.)
3. Make sure that the blade on the KTP Safety Shutter moves freely between the optical sensors on the shutter circuit board.
4. Replace the KTP Safety Shutter.

PROBLEM CODE: S053

KTP Safety Shutter Is Not In The Correct Position

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S053

FAULT CONDITION

Computer looks to ensure that KTP Safety Shutter is in previously-commanded position; if not in that position, a fault is declared.

HOW DID IT HAPPEN

Computer detects that positions of switches on KTP Safety Shutter have changed 50 msec. after the time when the computer had sensed the first correct switch positions (subsequent to issuing a command to open or close the shutter).

TROUBLESHOOTING

1. Go to Service Screen 2A, (KTP Laser, Shutter, Detectors). Toggle the KTP Safety Shutter and note status. Readings should be as follows:

	NO	NC
Open	0	1
Closed	1	0

2. If readings are not as shown above, remove cable from KTP Safety Shutter. Then remove cable from Exposure Shutter (Aim Shutter) and connect it to the KTP Safety Shutter. Toggle the Exposure Shutter and note status readings for Exposure Shutter. If the problem goes away, perform further troubleshooting steps to determine if the trouble cause is on the Electronics Card or due to a faulty KTP Safety Shutter cable. (Don't forget to reconnect proper cables.)
3. Make sure that the blade on the KTP Safety Shutter moves freely between the optical sensors on the shutter printed circuit board.
4. Replace the KTP Safety Shutter.

PROBLEM CODE: S054

KTP Safety Blade Off Shutter Assembly

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S054

FAULT CONDITION

Computer checks to make sure that KTP Safety Shutter blade is blocking one or the other of the two infrared photodetector beam paths on the shutter assembly.

HOW DID IT HAPPEN

Two optical switches are mounted on the shutter assembly. If both switches read open at the same time continuously for 1 second (two 0's), it means the shutter blade is either loose on the shutter assembly or else has actually fallen off.

TROUBLESHOOTING

1. Go to Service Screen 2A, (KTP Laser, Shutters, Detectors), and note the values that appear after SW= on the line for "KTP SFTY SHT".
   If SW=00, examine the blade on the KTP Safety Shutter. To check for looseness, look at the three screws that attach the blade to the assembly. If the blade has fallen off, replace it. (This condition happens very seldom.)

PROBLEM CODE: S055

KTP Safety Cable Not Connected

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact
Laserscope Customer Service Department.

S055

HOW DID IT HAPPEN

Computer checks the two optical switches on the KTP Safety Shutter; fault is declared if both switches read closed (two 1's) at the same time continuously for 1 second.

FAULT CONDITION

Cable on KTP Safety Detector is loose or disconnected.

TROUBLESHOOTING

1. Go to Service Screen 2A, (KTP Laser, Shutters, Detectors), and note the values that appear after SW= on the line for "KTP SFTY SHT".
   If SW=11, check connection of cable to KTP Safety Detector.
2. If cable checks OK, check the Electronics Card.

PROBLEM CODE: S061

Exposure (Aim) Shutter Cannot Open

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact
Laserscope Customer Service Department.

S061

FAULT CONDITION

After commanding Exposure (Aim) Shutter to open, computer looks at return signal from shutter and declares fault if status is incorrect.

HOW DID IT HAPPEN

After computer gives command to open shutter and waits 60 msec., the two switches (NC and NO) on the shutter do not give the correct positions.

TROUBLESHOOTING

1. Go to Service Screen 2A, (KTP Laser, Shutter, Detectors). Toggle the Exposure (Aim) Shutter and note status. Readings should be as follows:

	NO	**NC**
Open	0	1
Closed	1	0

2. If readings are not as shown above, remove cable from Shutter. Then remove cable from Calibration (Pre-Aim) Shutter and connect it to the Exposure Shutter. Toggle the Calibration Shutter and note status readings for Calibration Shutter. If the problem goes away, perform further troubleshooting steps to determine if the trouble cause is on the Electronics Card or due to a faulty Exposure Shutter cable. (Don't forget to reconnect the proper cables.)
3. Make sure that the blade on the Exposure Shutter moves freely between the optical sensors on the shutter printed circuit board.
4. Replace the Exposure Shutter.

PROBLEM CODE: S062

Exposure (Aim) Shutter Cannot Close

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S062

FAULT CONDITION

After commanding Exposure (Aim) Shutter to close, computer looks at return signal from shutter and declares fault if status is incorrect.

HOW DID IT HAPPEN

After computer gives command to close shutter and waits 60 msec., the two switches (NC and NO) on the shutter do not give the correct positions.

TROUBLESHOOTING

1. Go to Service Screen 2A, (KTP Laser, Shutter, Detectors). Toggle the Exposure (Aim) Shutter and note status. Readings should be as follows:

	NO	NC
Open	0	1
Closed	1	0

2. If readings are not as shown above, remove cable from Shutter. Then remove cable from Calibration (Pre-Aim) Shutter and connect it to the Exposure Shutter. Toggle the Calibration Shutter and note status readings for Calibration Shutter. If the problem goes away, perform further troubleshooting steps to determine if the trouble cause is on the Electronics Card or due to a faulty Exposure Shutter cable. (Don't forget to reconnect the proper cables.)
3. Make sure that the blade on the Exposure Shutter moves freely between the optical sensors on the shutter printed circuit board.
4. Replace the Exposure Shutter.

PROBLEM CODE: S063

Aim Is Not In The Correct Position

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S063

FAULT CONDITION

Computer looks to ensure that Exposure (Aim) Shutter is in previously-commanded position; if not in that position, a fault is declared.

HOW DID IT HAPPEN

Computer detects that positions of switches on Exposure Shutter have changed 50 msec. after the time when the computer had sensed the first correct switch positions (subsequent to issuing a command to open or close the shutter).

TROUBLESHOOTING

1. Go to Service Screen 2A, (KTP Laser, Shutter, Detectors). Toggle the Exposure (Aim) Shutter and note status. Readings should be as follows:

	NO	NC
Open	0	1
Closed	1	0

2. If readings are not as shown above, remove cable from Exposure (Aim) Shutter. Then remove cable from KTP Safety Shutter and connect it to the Exposure Shutter. Toggle the KTP Safety Shutter and note status readings for KTP Safety Shutter. If the problem goes away, perform further troubleshooting steps to determine if the trouble cause is on the Electronics Card or due to a faulty Exposure Shutter cable. (Don't forget to reconnect proper cables.)
3. Make sure that the blade on the Exposure Shutter moves freely between the optical sensors on the shutter printed circuit board.
4. Replace the Exposure Shutter.

PROBLEM CODE: S064

Aim Blade Off Shutter Assembly

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S064

FAULT CONDITION

Computer checks to make sure that Exposure (Aim) Shutter blade is blocking one or the other of the two infrared photodetector beam paths on the shutter assembly.

HOW DID IT HAPPEN

Two optical switches are mounted on the shutter assembly. If both switches read open at the same time (two 0's) continuously for 1 second, it means the shutter blade is either loose on the shutter assembly or else has actually fallen off.

TROUBLESHOOTING

1. Go to Service Screen 2A, (KTP Laser, Shutters, Detectors), and note the values that appear after SW= on the line for "EXP (AIM) SHT".
   If SW=00, examine the blade on the Exposure Shutter. To check for looseness, look at the three screws that attach the blade to the assembly. If the blade has fallen off, replace it. (This condition happens very seldom.)

PROBLEM CODE: S065

Aim Cable Not Connected

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S065

HOW DID IT HAPPEN

Computer checks the two optical switches on the Exposure (Aim) Shutter; fault is declared if both switches read closed (two 1's) at the same time continuously for 1 second.

FAULT CONDITION

Cable on Aim Detector is loose or disconnected.

TROUBLESHOOTING

1. Go to Service Screen 2A, (KTP Laser, Shutters, Detectors), and note the values that appear after SW= on the line for "EXP (AIM) SHT".
   If SW=11, check connection of cable to Aim Detector.
2. If cable checks OK, check the Electronics Card.

PROBLEM CODE: S071

Calibration (Pre-Aim) Shutter Cannot Open

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S071

FAULT CONDITION

After commanding Calibration (Pre-Aim) Shutter to open, computer looks at return signal from shutter and declares fault if status is incorrect.

HOW DID IT HAPPEN

After computer gives command to open shutter and waits 60 msec., the two switches (NC and NO) on the shutter do not give the correct positions.

TROUBLESHOOTING

1. Go to Service Screen 2A, (KTP Laser, Shutter, Detectors). Toggle the Calibration (Pre-Aim) Shutter and note status. Readings should be as follows:

	NO	NC
Open	0	1
Closed	1	0

2. If readings are not as shown above, remove cable from Shutter. Then remove cable from Exposure (Aim) Shutter and connect it to the Calibration Shutter. Toggle the Exposure Shutter and note status readings for Exposure Shutter. If the problem goes away, perform further troubleshooting steps to determine if the trouble cause is on the Electronics Card or due to a faulty Calibration Shutter cable. (Don't forget to reconnect the proper cables.)
3. Make sure that the blade on the Calibration Shutter moves freely between the optical sensors on the shutter printed circuit board.
4. Replace the Calibration Shutter.

PROBLEM CODE: S072

Calibration (Pre-Aim) Cannot Close

SOLUTION:

Press ON/STANDBY to continue.

If the problem perists, contact
Laserscope Customer Service Department.

S072

FAULT CONDITION

After commanding Calibration (Pre-Aim) Shutter to close, computer looks at return signal from shutter and declares fault if status is incorrect.

HOW DID IT HAPPEN

After computer gives command to close shutter, and waits 60 msec., the two switches (NC and NO) on the shutter do not give the correct positions.

TROUBLESHOOTING

1. Go to Service Screen 2A, (KTP Laser, Shutter, Detectors). Toggle the Calibration (Pre-Aim) Shutter and note status. Readings should be as follows:

	NO	NC
Open	0	1
Closed	1	0

2. If readings are not as shown above, remove cable from Shutter. Then remove cable from Exposure (Aim) Shutter and connect it to the Calibration Shutter. Toggle the Exposure Shutter and note status readings for Exposure Shutter. If the problem goes away, perform further troubleshooting steps to determine if the trouble cause is on the Electronics Card or due to a faulty Calibration Shutter cable. (Don't forget to reconnect the proper cables.)
3. Make sure that the blade on the Calibration Shutter moves freely between the optical sensors on the shutter printed circuit board.
4. Replace the Calibration Shutter.

PROBLEM CODE: S073

Pre-Aim Is Not In The Correct Position

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S073

FAULT CONDITION

Computer looks to ensure that Calibration (Pre-Aim) Shutter is in previously-commanded position; if not in that position, a fault is declared.

HOW DID IT HAPPEN

Computer detects that positions of switches on Calibration Shutter have changed 50 msec. after the time when the computer had sensed the first correct switch positions, (subsequent to issuing a command to open or close the shutter).

TROUBLESHOOTING

1. Go to Service Screen 2A, (KTP Laser, Shutter, Detectors). Toggle the Calibration (Pre-Aim) Shutter and note status. Readings should be as follows:

	NO	NC
Open	0	1
Closed	1	0

2. If readings are not as shown above, remove cable from Calibration Shutter. Then remove cable from Exposure Shutter and connect it to the Calibration Shutter. Toggle the Exposure Shutter and note status readings for Exposure Shutter. If the problem goes away, perform further troubleshooting steps to determine if the trouble cause is on the Electronics Card or due to a faulty Calibration Shutter cable. (Don't forget to reconnect proper cables.)
3. Make sure that the blade on the Calibration Shutter moves freely between the optical sensors on the shutter printed circuit board.
4. Replace the Calibration Shutter.

PROBLEM CODE: S074

Pre-aim Blade Off Shutter Assembly

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact
Laserscope Customer Service Department.

S074

FAULT CONDITION

Computer checks to make sure that Exposure (Pre-Aim) Shutter blade is blocking one or the other of the two infrared photodetector beam paths on the shutter assembly.

HOW DID IT HAPPEN

Two optical switches are mounted on the shutter assembly. If both switches read open at the same time (two 0's) continuously for 1 second, it means the shutter blade is either loose on the shutter assembly or else has actually fallen off.

TROUBLESHOOTING

1. Go to Service Screen 2A, (KTP Laser, Shutters, Detectors), and note the values that appear after SW= on the line for "CAL (PAIM) SHT".
   If SW=00, examine the blade on the Calibration Shutter. To check for looseness, look at the three screws that attach the blade to the assembly. If the blade has fallen off, replace it. (This condition happens very seldom.)

PROBLEM CODE: S075

Calibration cable Not Connected

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S075

HOW DID IT HAPPEN

Computer checks the two optical switches on the Exposure (Pre-Aim) Shutter; fault is declared if both switches read closed (two 1's) at the same time continuously for 1 second.

FAULT CONDITION

Cable on Calibration Shutter is loose or disconnected.

TROUBLESHOOTING

1. Go to Service Screen 2A, (KTP Laser, Shutters, Detectors), and note the values that appear after SW= on the line for "CAL (PAIM) SHT".
   If SW=11, check connections of cables to Calibration Shutter Assembly.
2. If cables check OK, check the Electronics Card.

PROBLEM CODE: S120

YAG Software Exposure Fault

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S120

FAULT CONDITION

Computer looks at output of YAG Surgical Detector and declares fault if output is 33% higher than power level set by operator. **NOTE:** This fault is declared in software.

HOW DID IT HAPPEN

1. During an exposure, if power at YAG Surgical Detector is found to be 33% higher than calculated power. (**NOTE:** This fault has absolutely nothing to do with the Safety Detector.)
2. YAG power only comes on when footswitch is depressed. This fault can occur if Lamp Power Supply (A.L.E.) current is not properly controlled by software and overshoots. (This is most likely to happen at low YAG power, between 5 to 10 watts.)

TROUBLESHOOTING

1. Go to Service Screen 2B, (YAG Laser, Shutter, Detectors). Check zero and gain set of YAG Surgical Detector.

PROBLEM CODE: S121

YAG Hardware Over Power Exposure Fault

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S121

FAULT CONDITION

Safety Detector level is compared with power level set by operator (DAC); fault is triggered by hardware for conditions given below.

HOW DID IT HAPPEN

1. During EXPOSURE, if the YAG Safety Detector reads higher than the DAC comparator output; DAC is set to 33% higher than the power set (calibrated) by the operator.
2. During System Status STANDBY or READY, if the YAG Saftey Detector registers more than 10 counts; DAC is set to 10 counts.
3. During System Status CALIBRATION, if the YAG Saftey Detector registers more than 25 counts; DAC is set to 25 counts.

TROUBLESHOOTING

1. Go to Service Screen 2B, (YAG Laser, Shutters, Detectors). Check zero and gain levels of the Surgical Detector and Safety Detector.
2. During exposure, note whether readings for Safety Detector and Surgical Detector are the same. If they're not, set output from both detectors to a power level from a calibrated power meter. (Refer to laser alignment procedure in Section 10 of this manual.)
3. During System Status STANDBY, READY and CALIBRATION, make sure no stray light reflections are going into the Safety Detector.

PROBLEM CODE: S122

YAG Hardware Over Duration Exposure Fault

SOLUTION:

Press ON/STANDBY to continue.

If problem recurs immediately, contact Laserscope Customer Service Department.

S122

FAULT CONDITION

Duration of signal from Safety Detector is compared in hardware to the pulse duration set by the operator; fault is triggered by hardware for the conditions given below.

HOW DID IT HAPPEN

1. During EXPOSURE, if ON period is longer than selected duration in YAG and allowed window is DURATION + 10% + 40 msec.
2. During EXPOSURE, with duration set for CONTINUOUS, if shutters take more than 50 msec to block the light at the end of the exposure when the surgeon releases the footswitch.
3. Other than during an exposure, (usually during System Status READY), a spurious time signal is generated from the YAG Safety Detector which triggers the duration fault circuit. (This is usually due to stray light.)
4. Another likely cause of this fault can be spurious signals from the Safety Detector, due to shutter bounce of Exposure or Calibration Shutters.

TROUBLESHOOTING

1. Go to Service Screen 2B, (YAG Laser, Shutters, Detectors), and check zero and gain level of Safety Detector.
2. Make sure that stray light reflection is not causing output of Safety Detector to go above 5 counts.
3. Check mechanical adjustment of shutter blades on Exposure (Aim) Shutter and Calibration (Pre-Aim) Shutter; the blades should be perfectly horizontal. If adjustment is required:
    a. Loosen two nuts that hold solenoid to shutter mount.
    b. Slightly rotate the solenoid as needed to bring the blade horizontal.
    c. Tighten the nuts.
4. If the above actions don't clear the fault, replace the Exposure and Calibration Shutters.
5. Replace Electronics Card.

PROBLEM CODE: S123

YAG Hardware Under Interval Exposure Fault

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S123

FAULT CONDITION

Interval between pulses from YAG Safety Detector is compared in hardware to duration set by computer. In REPEAT mode, this is interval set by the operator; in CONTINUOUS or single pulse, interval is set to 100 msec by computer.

HOW DID IT HAPPEN

1. During EXPOSURE, in REPEAT the off period between pulses was shorter than the selected interval. (The off period can not be shorter than 90% of INTERVAL - 40 msec.)
2. In SINGLE PULSE, the default INTERVAL is 100 msec.; fault is triggered if any signal comes from the YAG Safety Detector within 100 msec. after the end of the pulse.
3. In CONTINUOUS mode, the default INTERVAL is 100 msec.; fault is triggered if any signal comes from the KTP Safety Detector within 100 msec. after surgeon releases the footswitch.
4. Fault may also be triggered by spurious signals from the YAG Safety Detector; most likely cause is due to shutter bounce of Exposure or Calibration Shutters.

TROUBLESHOOTING

1. Check mechanical adjustment of shutter blades on Exposure (Aim) Shutter and Calibration (Pre-Aim) Shutter; the blades should be perfectly horizontal. If adjustment is required:
   a. Loosen two nuts that hold solenoid to shutter mount.
   b. Slightly rotate the solenoid as needed to bring the blade horizontal.
   c. Tighten the nuts.
2. If the above actions don't clear the fault, replace either the Exposure or Calibration Shutter, (or replace both).
3. Replace Electronics Card.

PROBLEM CODE: S124

YAG Power Detector Fault

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S124

FAULT CONDITION

Computer checks difference between readings of YAG Surgical and Safety Detectors.

HOW DID IT HAPPEN

Only during EXPOSURE, if reading from YAG Safety Detector is 33% less than or 33% greater than reading from YAG Surgical Detector.

TROUBLESHOOTING

1. Go to Service Screen 2B, (YAG Laser, Shutters, Detectors). Put beam block in front of Endostat Coupler and open all shutters. While ramping power from minimum to maximum, note outputs from YAG Surgical and Safety Detectors. The outputs should not differ by more than 33%. (Make sure both detectors have same gain set.)
2. Install power meter and measure power. Reset zero and reset gain of both detectors to track each other.
3. Look at detector outputs on the screen, and determine whether they track from minimum power to maximum power. If they don't track, make a comparison with each detector and the power meter, to determine which one is faulty. Replace the faulty detector.
4. Make sure no stray light beams are going into either detector.

PROBLEM CODE: S132

YAG Gain Change Fault

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S132

FAULT CONDITION

When system does a gain change, computer checks for a change by a factor of 10 ±33% for Surgical Detector and declares fault if outside this window.

HOW DID IT HAPPEN

1. During POWERING UP in YAG, the gain check at 8 watts failed; window allowed is ±33%.
2. During System Status STANDBY, the gain change does not meet the specified window of ±33%.

TROUBLESHOOTING

1. Go to Service Screen 2B, (YAG Laser, Shutters, Detectors). Check zero and gain setting of Surgical Detector.
2. From Service Screen 2B set Surgical Detector for a gain of 10. Go to 20 watts and note detector counts. Reading should be at least 250 counts, (saturated). If less than 250, replace Surgical Detector circuit board.

PROBLEM CODE: S151

YAG Safety Shutter Cannot Open

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S151

FAULT CONDITION

After commanding YAG Safety Shutter to open, computer looks at return signal from shutter and declares fault if status is incorrect.

HOW DID IT HAPPEN

After computer gives command to open shutter, and waits 60 msec., the two switches (NC and NO) on the shutter do not give the correct positions.

TROUBLESHOOTING

1. Go to Service Screen 2B, (YAG Laser, Shutter, Detectors). Toggle the YAG Safety Shutter and note status. Readings should be as follows:

	NO	NC
Open	0	1
Closed	1	0

2. If readings are not as shown above, remove cable from YAG Safety Shutter. Then remove cable from Exposure Shutter (Aim Shutter) and connect it to the YAG Safety Shutter. Toggle the Exposure Shutter and note status readings for Exposure Shutter. If the problem goes away, perform further troubleshooting steps to determine if the trouble cause is on the Electronics Card or due to a faulty YAG Safety Shutter cable. (Don't forget to reconnect proper cables.)
3. Make sure that the blade on the YAG Safety Shutter moves freely between the optical sensors on the shutter circuit board.
4. Replace the YAG Safety Shutter.

PROBLEM CODE: S152

YAG Safety Shutter Cannot Close

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact
Laserscope Customer Service Department.

S152

FAULT CONDITION

After commanding YAG Safety Shutter to close, computer looks at return signal from shutter and declares fault if status is incorrect.

HOW DID IT HAPPEN

After computer gives command to close shutter, and waits 60 msec., the two switches (NC and NO) on the shutter do not give the correct positions.

TROUBLESHOOTING

1. Go to Service Screen 2B, (YAG Laser, Shutter, Detectors). Toggle the YAG Safety Shutter and note status. Readings should be as follows:

	NO	NC
Open	0	1
Closed	1	0

2. If readings are not as shown above, remove cable from YAG Safety Shutter. Then remove cable from Exposure Shutter (Aim Shutter) and connect it to the YAG Safety Shutter. Toggle the Exposure Shutter and note status readings for Exposure Shutter. If the problem goes away, perform further troubleshooting steps to determine if the trouble cause is on the Electronics Card or due to a faulty YAG Safety Shutter cable. (Don't forget to reconnect proper cables.)
3. Make sure that the blade on the YAG Safety Shutter moves freely between the optical sensors on the shutter printed circuit board.
4. Replace the YAG Safety Shutter.

PROBLEM CODE: S153

YAG Safety Shutter Is Not In The Correct Position

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S153

FAULT CONDITION

Computer looks to ensure that YAG Safety Shutter is in previously-commanded position; if not in that position, a fault is declared.

HOW DID IT HAPPEN

Computer detects that positions of switches on YAG Safety Shutter have changed 50 msec. after the time when the computer had sensed the first correct switch positions (subsequent to issuing a command to open or close the shutter).

TROUBLESHOOTING

1. Go to Service Screen 2B, (YAG Laser, Shutter, Detectors). Toggle the YAG Safety Shutter and note status. Readings should be as follows:

	NO	NC
Open	0	1
Closed	1	0

2. If readings are not as shown above, remove cable from YAG Safety Shutter. Then remove cable from Exposure Shutter (Aim Shutter) and connect it to the YAG Safety Shutter. Toggle the Exposure Shutter and note status readings for Exposure Shutter. If the problem goes away, perform further troubleshooting steps to determine if the trouble cause is on the Electronics Card or due to a faulty YAG Safety Shutter cable. (Don't forget to reconnect proper cables.)
3. Make sure that the blade on the YAG Safety Shutter moves freely between the optical sensors on the shutter printed circuit board.
4. Replace the YAG Safety Shutter.

PROBLEM CODE: S154

YAG Safety Blade Off Shutter Assembly

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact
Laserscope Customer Service Department.

S154

FAULT CONDITION

Computer checks to make sure that YAG Safety Shutter blade is blocking one or the other of the two infrared photodetector beam paths on the shutter assembly.

HOW DID IT HAPPEN

Two optical switches are mounted on the shutter assembly. If both switches read open at the same time (two 0's) continuously for 1 second, it means the shutter blade is either loose on the shutter assembly or else has actually fallen off.

TROUBLESHOOTING

1. Go to Service Screen 2B, (KTP Laser, Shutters, Detectors), and note the values that appear after SW= on the line for "YAG SFTY SHT".
   If SW=00, examine the blade on the YAG Safety Shutter. To check for looseness, look at the three screws that attach the blade to the assembly. If the blade has fallen off, replace it. (This condition happens very seldom.)

PROBLEM CODE: S155

YAG Safety Cable Not Connected

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S155

HOW DID IT HAPPEN

Computer checks the two optical switches on the YAG Safety Shutter; fault is declared if both switches read closed (two 1's) at the same time continuously for 1 second.

FAULT CONDITION

Cable on YAG Safety Detector is loose or disconnected.

TROUBLESHOOTING

1. Go to Service Screen 2B, (YAG Laser, Shutters, Detectors), and note the values that appear after SW= on the line for "YAG SFTY SHT".
   If SW=11, check connection of cable to YAG Safety Detector.
2. If cable checks OK, check the Electronics Card.

PROBLEM CODE: S181

Laser Mirror Cannot Open (for KTP)

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S181

FAULT CONDITION

Computer looks at state of the two switches that sense the position of the Wavelength Select Mirror. Fault is declared if correct mirror position is not sensed.

HOW DID IT HAPPEN

After computer gives command to change mirror position and waits 500 msec., the two switches (NC and NO) on the mirror do not give the correct positions.

TROUBLESHOOTING

1. Turn laser off.
2. Go to Service Screen 3, (Attachments and ESF), and note status of the two switches for the Wavelength Select Mirror. Readings should be as follows:

	NO	NC
for KTP	0	1
for YAG	1	0

3. Place leads from DVM across motor for Wavelength Select Mirror. The driving voltage should measure -0.40 v ±0.07 v (during movement).
4. If voltage measures within this range but switch status is not correct, check cable from the Electronics Card to the Wavelength Select Mirror. If the cable is OK, replace the Wavelength Select Mirror assembly.
5. If voltage does not measure within this range, check connections of wires from motor to circuit board, and cable from the Electronics Card to the Wavelength Select Mirror. If no trouble causes found in the wiring, replace the Electronics Card.

PROBLEM CODE: S182

Laser Mirror Cannot Close (for YAG)

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S182

FAULT CONDITION

Computer looks at state of the two switches that sense the position of the Wavelength Select Mirror. Fault is declared if correct mirror position is not sensed.

HOW DID IT HAPPEN

After computer gives command to change mirror position and waits 500 msec., the two switches (NC and NO) on the mirror do not give the correct positions.

TROUBLESHOOTING

1. Turn laser off.
2. Go to Service Screen 3, (Attachments and ESF), and note status of the two switches for the Wavelength Select Mirror. Readings should be as follows:

	NO	NC
for KTP	0	1
for YAG	1	0

3. Place leads from DVM across motor for Wavelength Select Mirror. The driving voltage should measure -0.40 v ±0.07 v.
4. If voltage measures within this range but switch status is not correct, check cable from the Electronics Card to the Wavelength Select Mirror. If the cable OK, replace the Wavelength Select Mirror assembly. Flag may be rubbing switches.
5. If voltage does not measure within this range, check connections of wires from motor to circuit board, and cable from the Electronics Card to the Wavelength Select Mirror. If no trouble causes found in the wiring, replace the Electronics Card.

PROBLEM CODE: S183

Laser Mirror Is Not In The Correct Position

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S183

FAULT CONDITION

Computer looks to ensure that Wavelength Select Mirror is in previously-commanded position; if not in that position, a fault is declared.

HOW DID IT HAPPEN

Computer detects that positions of one or both switches on Wavelength Select Mirror have changed 100 msec. after the time when the computer had sensed the first correct switch positions (subsequent to issuing a command to change the mirror position).

TROUBLESHOOTING

1. Turn laser off.
2. Go to Service Screen 3, (Attachments and ESF), and note status of the two switches for the Wavelength Select Mirror. Readings should be as follows:

	NO	NC
for KTP	0	1
for YAG	1	0

3. Place leads from DVM across motor for Wavelength Select Mirror. The driving voltage should measure -0.40 v ±0.07 v.
4. If voltage measures within this range but switch status is not correct, check cable from the Electronics Card to the Wavelength Select Mirror. If the cable is OK, replace the Wavelength Select Mirror assembly. Flag may be rubbing switches.
5. If voltage does not measure within this range, check connections of wires from motor to circuit board, and cable from the Electronics Card to the Wavelength Select Mirror. If no trouble causes found in the wiring, replace the Electronics Card.

PROBLEM CODE: S184

Laser Mirror Motor Assembly Fault

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact
Laserscope Customer Service Department.

S184

FAULT CONDITION
Computer checks to make sure that Laser Mirror Motor Assembly is blocking one or the other of the two infrared photodetector beam paths on the assembly.

HOW DID IT HAPPEN
Two optical switches are mounted on the motor assembly. If both switches read open at the same time continously for 1 second (two 0's), it means the Laser Mirror Assembly is either loose on the motor assembly or the mirror assembly has fallen off.

TROUBLESHOOTING
1. Go to Service Screen 2A, (KTP Laser, Shutters Detectors), and note the values that appear after SW= on the line for the "LASER SWITCH".
   If SW=00, examine the mirror assembly, check for looseness, look at the connecting screws. Tighten loose screws, or replace unit if assembly has fallen off.

PROBLEM CODE: S185

Laser Mirror Cable Not Connected

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S185

FAULT CONDITION

Cable on Laser Mirror is loose or disconnected.

HOW DID IT HAPPEN

Computer checks the two optical switches on the Laser Mirror; fault is declared if both switches read closed (two 1's) at the same time continuously for 1 second.

TROUBLESHOOTING

1. Go to Service Screen 2A, (KTP Laser, Shutters, Detectors), and note the values that appear after SW= on the line for "LASER SWITCH".
   If Sw=11, check connection of cable to Laser Mirror.
2. If cable checks OK, check the Electronics Card.

PROBLEM CODE: S191

Beam Mirror Cannot Open (YAG & KTP w/ubeam)

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S191

FAULT CONDITION

After commanding the Coupler Select Mirror Pair (Beam Mirror) to open, computer looks at return signal from mirror pair and declares fault if status is incorrect.

HOW DID IT HAPPEN

After computer gives command to open and waits 1 second, the two switches on the mirror pair do not give the correct positions.

TROUBLESHOOTING

1. Go to Service Screen 3, (Attachments and ESF), and note status of the two switches for the Coupler Select Mirror Pair (Beam Mirror). Readings should be as follows:

	NO	NC
Mirror pair IN beam path	0	1
Mirror pair OUT of beam path	1	0

2. Place leads from DVM across motor for Coupler Select Mirror Pair. From Service Screen 3 toggle the mirror pair and note readings on the DVM. The driving voltage should measure +3.30 v ±0.10 v with mirror in one position, and -0.40 v ±0.07 v in the other position.
3. If voltages measure within the above range but switch status is not correct, check cable from Electronics Card to Coupler Select Mirror Pair. If cable is OK, replace Mirror Pair assembly.
4. If voltages do not measure within the above range, check connection of wires from motor to circuit board.
5. Check cable from Electronics Card to Coupler Select Mirror Pair. If cable is OK, replace printed circuit board on Coupler Select Mirror Assembly.
6. Replace Electronics Card.

PROBLEM CODE: S192

Beam Mirror Cannot Close (KTP w/endostat)

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S192

FAULT CONDITION

After commanding the Coupler Select Mirror Pair (Beam Mirror) to close, computer looks at return signal from mirror pair and declares fault if status is incorrect.

HOW DID IT HAPPEN

After computer gives command to close and waits 1 second, the two switches on the mirror pair do not give the correct positions.

TROUBLESHOOTING

1. Go to Service Screen 3, (Attachments and ESF), and note status of the two switches for the Coupler Select Mirror Pair (Beam Mirror). Readings should be as follows:

	NO	NC
Mirror pair IN beam path	0	1
Mirror pair OUT of beam path	1	0

2. Place leads from DVM across motor for Coupler Select Mirror Pair. From Service Screen 3 toggle the mirror pair and note readings on the DVM. The driving voltage should measure +3.30 v ±0.10 v with mirror in one position, and -0.40 v ±0.07 v in the other position.
3. If voltages measure within the above range but switch status is not correct, check cable from Electronics Card to Coupler Select Mirror Pair. If cable is OK, replace Mirror Pair assembly.
4. If voltages do not measure within the above range, check connection of wires from motor to circuit board.
5. Check cable from Electronics Card to Coupler Select Mirror Pair. If cable is OK, replace printed circuit board on Coupler Select Mirror Assembly.
6. Replace Electronics Card.

PROBLEM CODE: S193

Beam Mirror Is Not In The Correct Position

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S193

FAULT CONDITION

Computer looks to ensure that Coupler Select Mirror Pair (Beam Mirror) is in previously-commanded position; if not in that position, a fault is declared.

HOW DID IT HAPPEN

Computer detects that positions of switches on Coupler Select Mirror Pair have changed 100 msec. after time when the computer had sensed the first correct swtich positons (subsequent to issuing a command to open or close the mirror pair).

TROUBLESHOOTING

1. Go to Service Screen 3, (Attachments and ESF), and note status of the two switches for the Coupler Select Mirror Pair (Beam Mirror). Readings should be as follows:

	NO	NC
Mirror pair IN beam path	0	1
Mirror pair OUT of beam path	1	0

2. Place leads from DVM across motor for Coupler Select Mirror Pair. From Service Screen 3 toggle the mirror pair and note readings on the DVM. The driving voltage should measure +3.30 v ±0.10 v with mirror in one position, and -0.40 v ±0.07 v in the other position.
3. If voltages measure within the above range but switch status is not correct, check cable from Electronics Card to Coupler Select Mirror Pair. If cable is OK, replace Mirror Pair assembly.
4. If voltages do not measure within the above range, check connection of wires from motor to circuit board.
5. Check cable from Electronics Card to Coupler Select Mirror Pair. If cable is OK, replace printed circuit board on Coupler Select Mirror Assembly.
6. Replace Electronics Card.

PROBLEM CODE: S194

Beam Mirror Motor Assembly Fault

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S194

FAULT CONDITION

Computer checks to make sure that Beam Mirror Motor Assembly is blocking one or the other of the two infrared photodetector beam paths on the assembly.

HOW DID IT HAPPEN

Two optical switches are mounted on the motor assembly. If both switches read open at the same time continuously for 1 second (two 0's), it means the Beam Mirror is either loose on the assembly or has fallen off.

TROUBLESHOOTING

1. Go to Service Screen 2A, (KTP Laser, Shutters, Detectors), and note the values that appear after SW= on the line for "BEAM SWITCH".
   If SW=00, examine the Beam Mirror Assembly. Check for looseness, look for loose screws that attach the assembly. Tighten loose screws, or replace unit if assembly has fallen off.

PROBLEM CODE: S195

Beam Mirror Cable Not Connected

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact Laserscope Customer Service Department.

S195

FAULT CONDITION
Cable on Beam Mirror is loose or disconnected.

HOW DID IT HAPPEN
Computer checks the two optical switches on the Beam Mirror; fault is declared if both switches read closed (two 1's) at the same time continously for 1 second.

TROUBLESHOOTING
1. Go to Service Screen 2A, (KTP Laser, Shutters, Detectors), and note the values that appear after SW= on the line for "BEAM SWITCH".
   If SW=11, check connection of cable to Beam Mirror Assembly.
2. If cable checks OK, check the Electronics Card.

PROBLEM CODE: S210

ALE Current Control Fault

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact
Laserscope Customer Service Department.

S210

FAULT CONDITION

Computer compares Lamp Power Supply (A.L.E.) current input with Lamp Power Supply DAC output.

HOW DID IT HAPPEN

Happens in both KTP and YAG, when computer finds that Lamp Power Supply current input is more than 16% lower than Lamp Power Supply DAC output.

TROUBLESHOOTING

1. Go to Service Screen 1B, (YAG Laser ON/OFF & Interloc), and note counts of LCUR and ALE. Reading for ALE should not be more than 16% lower than LCUR reading.
2. Update Lamp Power Supply (A.L.E.) to Rev. 23.
3. If above actions do not eliminate the problem, replace the Lamp Power Supply.

PROBLEM CODE: S220

Software Over Temperature - 130F

SOLUTION:

Please check that the air flow is not blocked.

The system will return to the STANDBY mode after completion of the cooling period (appr. 3 minutes).

You may press ON/STANDBY to continue opertion before the cooling is completed. However, the laser will shut down if overheating continues.

S220

FAULT CONDITION

Computer monitors the water temperature and declares this fault as soon as temperature exceeds 130 F.

HOW DID IT HAPPEN

Water overheating has occurred. This fault is the first warning and is similar to L021, (a Type 1 fault that indicates further overheating).

TROUBLESHOOTING

1. Make sure there is enough space in front of the air intakes and enough ventilation around the console.
2. If the problem persists, check the cooling fans.

PROBLEM CODE: W021

YAG Surgical Power Seen While in KTP

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact
Laserscope Customer Service Department.

W021

FAULT CONDITION

Computer looks at output of YAG Surgical Detector when operating in KTP, and declares fault if light is detected.

HOW DID IT HAPPEN

When in KTP, more than 4 counts noted from YAG Surgical Detector.

TROUBLESHOOTING

1. Go to Service Screen 2B, (YAG Laser, Shutters, Detectors), and check that YAG Surgical Detector has been zeroed correctly. (For zeroing procedure, refer to YAG Detector Alignment in Section 10 of this manual.)
2. Check for stray KTP light going into YAG Surgical Detector.

PROBLEM CODE: W022

KTP Surgical Power Seen While in YAG

SOLUTION:

Press ON/STANDBY to continue.

If the problem persists, contact
Laserscope Customer Service Department.

W022

FAULT CONDITION

Computer looks at output of KTP Surgical Detector when operating in YAG, and declares fault if light is detected.

HOW DID IT HAPPEN

When in YAG more than 4 counts noted from KTP Surgical Detector.

TROUBLESHOOTING

1. Go to Service Screen 2A, (KTP Laser, Shutters, Detectors), and check that KTP Surgical Detector has been zeroed correctly. (For zeroing procedure, refer to KTP Detector Alignment in Section 10 of this manual.)
2. Make sure that IR filter is present in KTP Surgical Detector.

13.6 TYPE 3 FAULTS

Listed below are the Type 3 error message screens.

```
PROBLEM:  Auxiliary
  interlock open
SOLUTION: Close
  interlock
```

```
ATTENTION: Calibrate
  delivery device
  before use
```

```
ATTENTION: Aim
  'BLINK' is not
  available for KTP
```

```
PROBLEM:  Footswitch
  activated
SOLUTION: Remove
  foot from pedal
```

```
PROBLEM: System
  status not READY
SOLUTION: Press
  READY to correct
  system status
```

```
CAUTION: EYE SAFETY
  FILTER DISABLED.
  EYE PROTECTION FOR
  KTP/532 MUST BE
  WORN.
```

```
CAUTION: EYE SAFETY
  FILTER DISABLED.
  EYE PROTECTION FOR
  Nd:YAG/1064 MUST
  BE WORN.
```

```
WARNING: Overheating
SOLUTION: Check that
  the air flow is
  not blocked
```

```
WARNING: Overheating
  and may shut down
SOLUTION: Stop using
  laser till warning
  clears (~3 min.)
```

```
WARNING: Water low
SOLUTION: Refill
  reservoir with
  deionized or
  sterile water
```

13.7 CALIBRATION FAULTS

Given next for each Calibration Fault are the error message screen and information to aid you in correcting the fault.

```
PROBLEM: Delivery device transmission is
  too low.              Error Code: C010
  Transmission thruput :    %
SOLUTION: Clean optics of the delivery
  device as applicable or replace device
  with a different one.  Insure optical
  connectors are properly attached.
```

C010

FAULT CONDITION

Computer calculates transmission of delivery device being calibrated.

HOW DID IT HAPPEN

Computer finds device being calibrated has transmission below 30%.

TROUBLESHOOTING

1. Go to Service Screen 4A or 4B, (KTP or YAG Calibration), and note reading for THRUPUT.
2. Clean delivery device, (and recleave, where applicable). Then recalibrate the device.
3. Try a new delivery device.
4. Check fiber output coupler alignment. (For procedure refer to Endostat Coupler Alignment in Section 10 of this manual.)
5. Check electronic alignment of Cal-Pod. (For procedure refer to Section 9 of this manual.)

PROBLEM: Unable to calibrate - too much light. Error Code: C020
SOLUTION: Turn off microscope illumination and/or other ambient light sources when in calibration mode. Recalibrate delivery device.

C020

FAULT CONDITION

Computer compares power level detected by Cal-Pod against power level applied to delivery device.

HOW DID IT HAPPEN

Power level detected by Cal-Pod is greater than power level applied to delivery device.

TROUBLESHOOTING

1. Go to Service Screen 4A or 4B, (KTP or YAG Calibration). Check Cal-Pod zero and gain set. (For procedure refer to Section 9 of this manual.)
2. Check zero and gain set of KTP or YAG Surgical Detector, (whichever is appropriate). (For procedures, refer to Section 10 of this manual.)

PROBLEM: Unable to calibrate - light unsteady. Error Code: C030
SOLUTION: Support calibration pod on a table or chair while in calibration mode. Recalibrate delivery device.

C030

FAULT CONDITION

Computer checks variation over time of power level detected by Cal-Pod.

HOW DID IT HAPPEN

Computer finds that power level detected by Cal-Pod varies by more than 5% over 1 second.

TROUBLESHOOTING

During calibration, firmly support the delivery device and Cal-Pod to minimize the amount of movement.

PROBLEM: Unable to calibrate - too little light. Error Code: C040
SOLUTION: Be sure that the delivery device is directed into the calibration pod opening and that the proper sterile insert is being used. Recalibrate delivery device.

C040

FAULT CONDITION

After operator presses orange button on Cal-Pod, computer checks output from Cal-Pod detector.

HOW DID IT HAPPEN

Computer finds that output from Cal-Pod detector is less than 16 counts.

TROUBLESHOOTING

1. Make sure fiber of delivery device is properly directed into Cal-Pod.
2. Go to Service Screen 4A or 4B, (KTP or YAG Calibration), and note reading for THRUPUT.
3. Clean delivery device, (and recleave, where applicable). Then recalibrate the device.
4. Try a new delivery device.
5. Check fiber output coupler alignment. (For procedure refer to Endostat Coupler Alignment in Section 10 of this manual.)
6. Check electronic alignment of Cal-Pod. (For procedure refer to Section 9 of this manual.)

PROBLEM: KTP Calibration Pod Zero Level Error Error Code: C050
SOLUTION: Be sure that the delivery device is directed into the calibration pod opening and that the proper sterile insert is being used. Recalibrate delivery device.

C050

FAULT CONDITION

After operator presses orange button on Cal-Pod, computer checks output from Cal-Pod detector.

HOW DID IT HAPPEN

Computer finds output from Cal-Pod detector is present when it should not be. (Output should only be present when in Calibration Mode.)

TROUBLESHOOTING

1. Cal-Pod needs to be zeroed in KTP mode.

PROBLEM: YAG Calibration Pod Zero Level error. Error Code: C150
SOLUTION: Be sure that the delivery device is directed into the calibration pod opening and that the proper sterile insert is being used. Recalibrate delivery device.

C150

FAULT CONDITION

After operator presses orange button on Cal-Pod, computer checks output from Cal-Pod detector.

HOW DID IT HAPPEN

Computer finds output from Cal-Pod detector is present when it should not be. (Output should only be present when in Calibration Mode.)

TROUBLESHOOTING

1. Cal-Pod needs to be zeroed in YAG mode.