System 98

Service Manual

Datascope®

INTRODUCTION

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2. Theory of Operation
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FOREWORD

This Service Manual is intended as a guide for technically qualified personnel during repair and calibration procedures. The information has been divided into the eight chapters listed above. A detailed table of contents is provided on the first page of each chapter.

This publication may have been updated to reflect product design changes and/or manual improvements. Any such changes to this manual would be accomplished by supplying replacement pages and instructions for inserting or affixing them into the manual.

NOTE

Unauthorized servicing may void the remainder of the warranty. Check with the factory or with a local authorized Datascope representative to determine the warranty status of a particular instrument.

WARNING

The System 98 operates on line voltages. Therefore, an electric shock hazard may exist when the instrument covers are removed. Repair and calibration procedures should only be performed by qualified personnel who proceed with care and follow proper servicing techniques. Warnings are given in Chapters 4 and 7, as well as in other appropriate locations.

1. OPERATION

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NOTE: Complete Table of Contents for sections 1.2 and 1.3 are listed on the first page of each.

1.1 INTRODUCTION

This section of the Service Manual provides general information about the instrument.

Sections 1.2 and 1.3 are included as review of instrument functions and operation, although the reader is encouraged to refer to the Operating Instructions, P/N 0070-00-0402, for more complete details.

1.2 CONTROLS AND INDICATORS

This section of the Operating Instructions identifies and describes each feature and control of the System 98. For step-by-step operating instructions see Section 1.3 "Operation."

Refer to the section and page numbers listed below for the location and description of a specific feature, control, or display.

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Trigger Select Keys

1. ECG
2. Pressure
3. Internal
4. Pacer V/A -V
5. Pacer A

IABP Control Keys

6. IAB Frequency
7. IAB Augmentation
8. IAB Fill
9. Assist / Standby
10. IAB Inflation
11. IAB Deflation

Auxiliary Keys

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Patient Waveforms Keys

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18. Pressure Source
19. Inflation Interval
20. Freeze Display

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49. Battery Indicator
50. Helium Indicator
51. ECG Scale
52. BP Scale
53. Waveforms
54. Timing Markers
55. Trigger Indicator
56. Time in Standby
57. BP Waveform Tick Marks

Rear Panel

58. IAB Catheter Extender Input
59. Trainer Input
60. DC Output (CRM)
61. ECG Input
62. Pressure Input
63. Mains ON/OFF
64. External DC Input
65. Diagnostic Output
66. RS-232
67. Phone Line
68. System Timer
69. Equipotenial Lug
70. Pressure (Monitor Input)
71. ECG (Monitor Input)
72. ECG/ Pressure Output
73. Manual Fill Port
74. Drain Port
75. IAB Fill Port
76. Helium Pressure Gauge

Front Panel

77. IABP ON/OFF
78. Battery Charging LED

1.2.1 TRIGGER SELECT KEYS

The five individual Trigger Select keys illuminate when activated. They are used to select the one signal by which the balloon pump is triggered and sychronized to the cardiac cycle. Each of the five keys are described below.

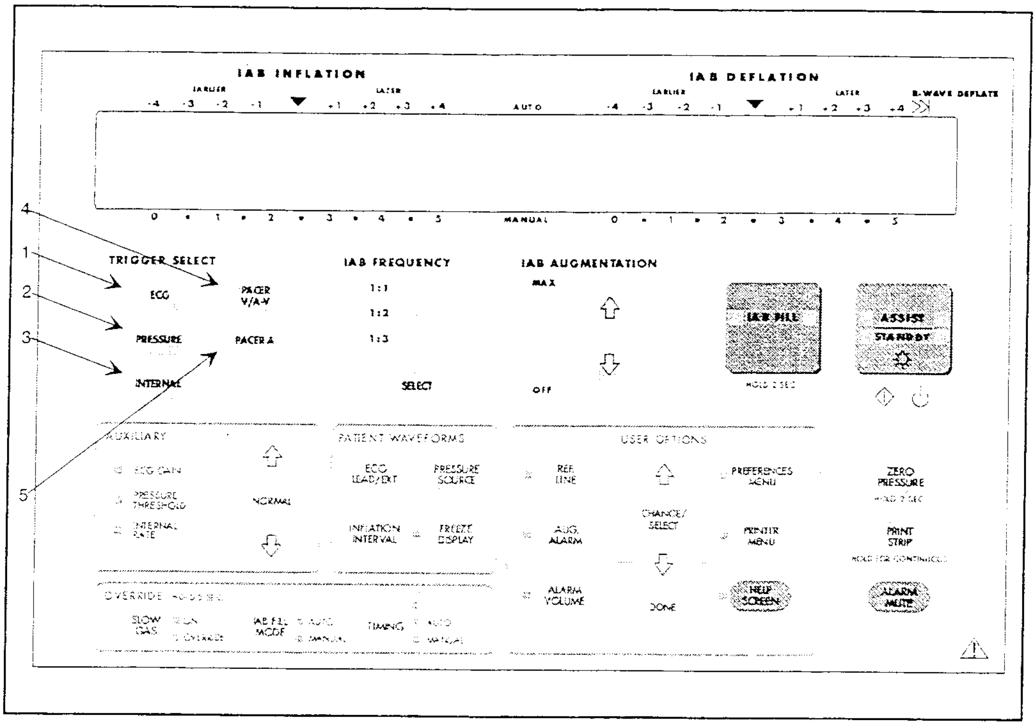


Figure 1-1

Trigger Select Keys

1. ECG

   The System will trigger on the patient's R-wave. The ECG signal source can be from either patient electrodes or an external ECG signal.

2. PRESSURE

   The System will trigger on the sytolic upstoke of the patient's arterial pressure waveform. The signal source can be either the pressure transducer or an external pressure signal. The pressure transducer must be zeroed to pump in the pressure trigger mode. When in the pressure trigger mode, this key can also be pressed to manually initiate an instantaneous resynchronization.

3. INTERNAL

   The System will trigger from a built in timer asynchronous with the cardiac cycle. Trigger rate is adjustable from 40 to 120 bpm using the UP and DOWN arrow keys located in the Auxiliary Keys group. In the presence of a valid QRS complex, the System automatically deflates the IAB on each R-wave detected. The "ECG detected" alert message and a tone are generated.

4. PACER V/A-V

The System will automatically identify and display which of the two pacer types, Ventricular or Atrio-Ventricular is present. The System triggers on the ventricular pulse in either case. The patient must be 100% paced and captured (i.e., no demand pacing). The ECG signal source can be either patient electrodes or an external ECG signal. Electro-surgical noise interference automatically suspends pumping and activates "*Trigger Interference*" alarm message and tone. The IAB remains deflated until ESU noise interference stops.

5. PACER A

The System will trigger on the patient's R-wave without interference from atrial pacer artifact. The ECG signal source can be either patient electrodes or an external ECG signal. This mode is recommended only if atrial pacer tails interfere with R-wave detection when using the ECG trigger mode. Fixed or demand atrial pacing can be used in this trigger mode.

1.2.2 IABP CONTROL KEYS

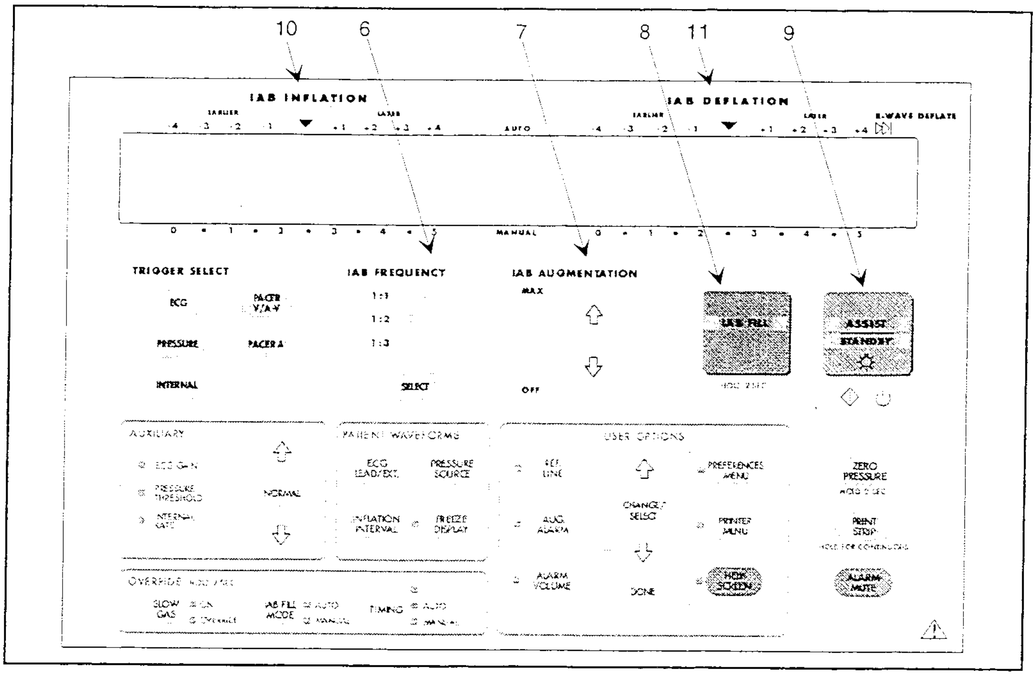


Figure 1-2

IAB CONTROL KEYS

6. IAB FREQUENCY

   Press this key to select the ratio of augmented cardiac cycles to actual cardiac cycles. Selections available are every beat assisted (1:1), every other beat assisted (1:2), or every third beat assisted (1:3). The selected IAB frequency is indicated by illuminated LED indicators. When either 1:2 or 1:3 is selected, both the assisted and unassisted systolic and diastolic pressures are displayed and may be printed. They are labeled accordingly.

7. IAB AUGMENTATION

   Pressing the UP and DOWN arrow keys will adjust the time interval, from OFF to MAX, during which drive pressure is applied to the safety disk. This interval determines the gas volume displaced from the safety disk into the patient balloon.

8. IAB FILL

   Press and hold for 2 seconds to initiate the IAB gas purge and fill cycle. Also used to perform the Safety Disk Leak Test by holding it pressed and turning the power on simultaneously.

9. ASSIST/STANDBY

   Press to initiate or suspend balloon pumping. The key is continuously illuminated in the Standby Mode and flashes during the inflation period in the Assist Mode. Whenever the ASSIST/STANDBY key is pressed for the first time following system power-up, a rapid start feature will expedite the start of IAB assist (see Section 1.3.2.12 for details).

10. IAB INFLATION

Slide control which adjusts the time duration between the trigger event and the beginning of the IAB inflation.

11. IAB DEFLATION

Slide control which adjusts the time at which the start of IAB deflation occurs. Deflation will occur at this time or upon trigger detection, whichever occurs first.

1.2.3 AUXILIARY KEYS

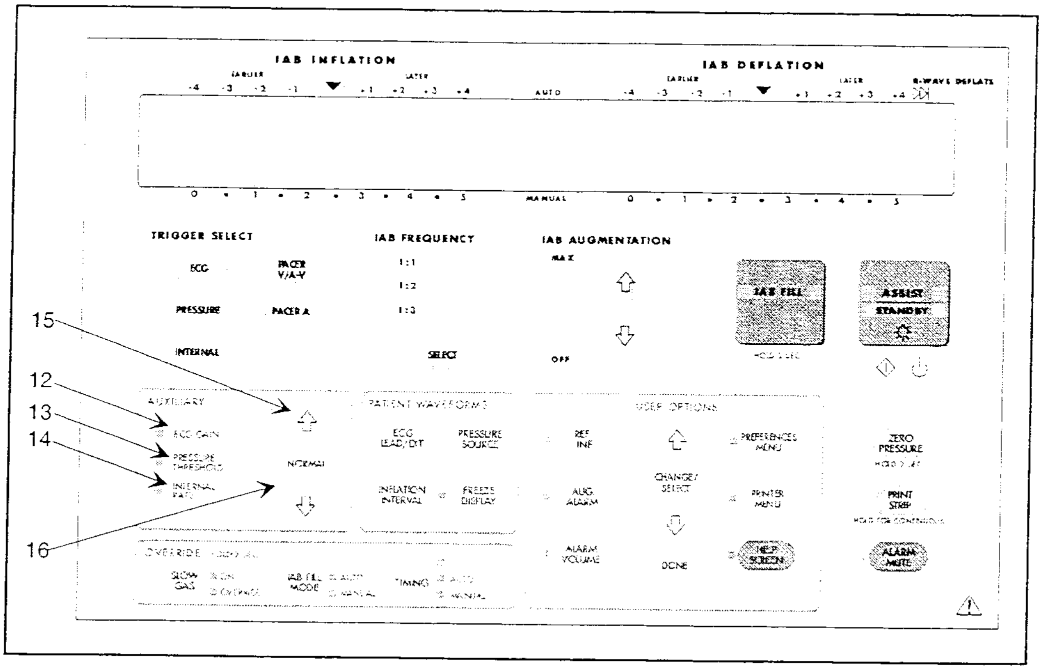


Figure 1-3

AUXILIARY KEYS

12. ECG GAIN

The ECG GAIN LED is illuminated when ECG, PACER V/A-V or PACER A is selected as the trigger source. When ECG GAIN is illuminated and the NORMAL key is pressed, a fixed gain (x1000) ECG signal is used for triggering the System 98. When either of the ARROW keys are pressed, the ECG signal gain can be varied over a range of 0.15 x Normal Gain to 3.0 x Normal Gain. The ECG Gain setting is posted in the "ECG GAIN" field on the display.

13. PRESSURE THRESHOLD

The PRESSURE THRESHOLD LED is illuminated when PRESSURE is selected as the trigger source. When PRESSURE THRESHOLD is illuminated and the NORMAL key is pressed, the System will automatically select the optimal threshold value and adapt to changes in systolic pulse height. When either ARROW key is pressed, the blood pressure trigger threshold can be manually adjusted in fixed steps of 1 mmHg within a 7 to 30 mmHg range. The current threshold is posted with the trigger source in the "Trigger" field on the display. The arterial waveform is also annotated to indicate when the system triggered and what point it triggered on.
NOTE: When manually adjusting Pressure Threshold, reassess the proper timing of balloon inflation and deflation and correct as required.

14. INTERNAL RATE

The INTERNAL RATE LED is illuminated when INTERNAL is selected as the trigger source. When INTERNAL RATE is illuminated and the NORMAL key is pressed the internal trigger rate is set to 80 bpm. When either ARROW key is pressed, the internal trigger rate is adjusted by 5 bpm over the range of 40 - 120 bpm. The current internal rate is posted in the "heart rate" field of the display.

15. UP & DOWN ARROW KEYS

The UP & DOWN ARROW keys allow adjustment of the ECG Gain, Pressure Threshold, or Internal Rate, depending on the selected trigger source.

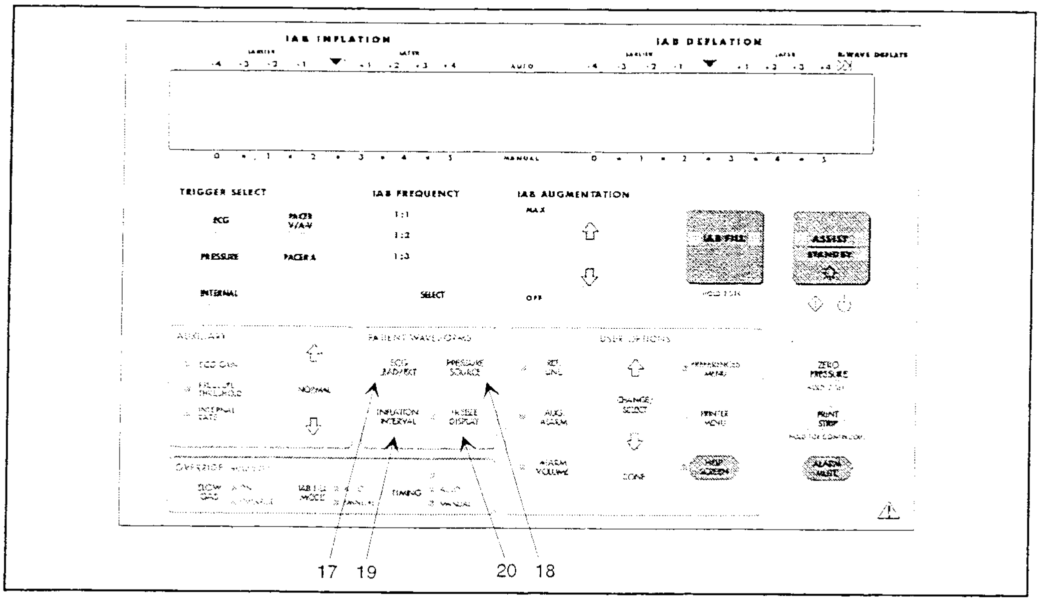
16. NORMAL

The NORMAL key selects the normal (default) setting for ECG Gain, Pressure Threshold, or Internal Rate. If any of these settings have been changed via the arrow keys, the normal setting can be instantly restored by pressing the NORMAL key once.

1.2.4 PATIENT WAVEFORMS KEYS

Figure 1-4

PATIENT WAVEFORMS KEYS



17. ECG LEAD/EXT.

Press to select the desired ECG signal source. The System 98 accepts a 5-leadwire patient cable and this key sequentially selects skin lead configuration I, II, III, aVR, aVL, aVF, and V. A 3-leadwire patient cable can be used, but will provide only leads I, II, and III. All other lead selections will provide a "*Lead Fault*" condition with no ECG waveform. In addition to the skin lead configuration an external monitor can be selected as an ECG source. When an external ECG signal is selected, "*EXTERNAL*" is posted in the "lead" field on the display. This key is disabled when the display is frozen.

18. PRESSURE SOURCE

Press to select the desired pressure signal source. When an external pressure signal is selected, "*EXTERNAL*" is posted in the "Pressure Source" field on the display. If a direct transducer source is selected, "*XDUCER*" is displayed. This key is disabled when the display is frozen.

19. INFLATION INTERVAL

While in the Assist Mode, press and hold to view the period of diastolic augmentation. The marked and highlighted portion identifies the balloon inflation period. When the key is quickly pressed and released, the physiological pressure delay to the pressure monitoring site is recalculated, with respect to balloon inflation. The recalculation occurs in synchrony with the pump cycle.

20. FREEZE DISPLAY

Press to freeze all traces on the display. Press again to unfreeze the traces. This key is disabled when the recorder is activated. When the traces are frozen and the recorder is activated, the freeze is overridden. The ECG gain, pressure source, and lead keys are disabled when in the freeze mode.

1.2.5 USER OPTIONS KEYS

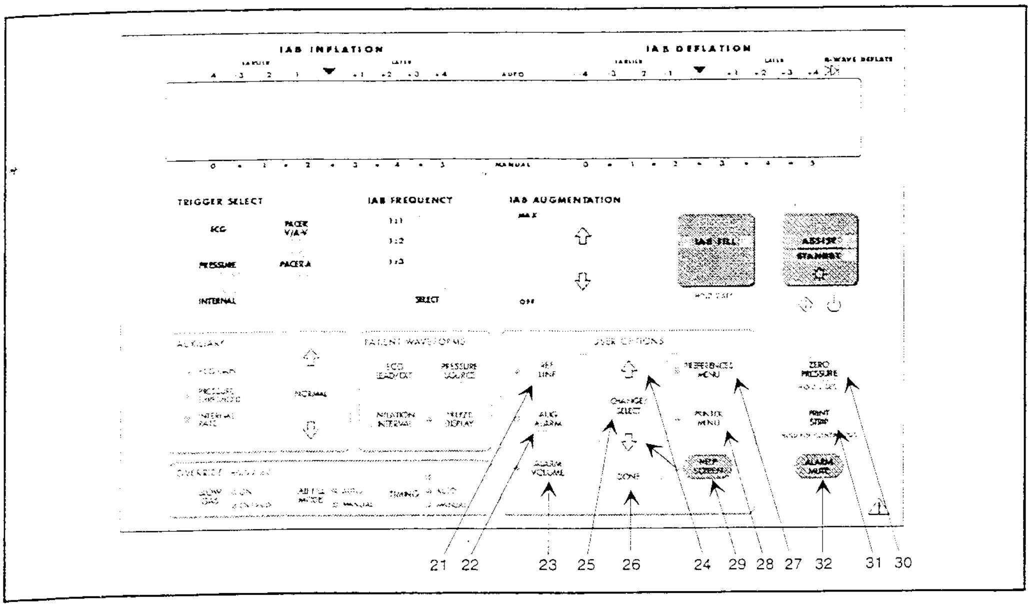


Figure 1-5

USER OPTIONS KEYS

21. REF. LINE

    Press to activate the REF LINE. The LED on the REF LINE key illuminates when activated. Once activated use the UP & DOWN ARROW keys (24) to adjust the reference line position.

22. AUG. ALARM

    The augmentation alarm limit is automatically determined during the first minute of pumping. This is done by an adaptive learning process whose goal is to set the alarm to 10 mmHg below the patient's augmented diastolic pressure. As part of this process, the alarm is armed after the first 15 seconds of pumping and the limit is fixed after one minute.

    This initial alarm setting can be changed, or set to "OFF", by the use of the UP and DOWN arrow keys. Pressing the arrow keys increments/decrements the aug. alarm limit by 2 mmHg. The alarm limit is displayed in the AUG ALARM field (48).

    The available range of alarm setting is 60 to 200 mmHg. When the alarm is in the off state, the word "OFF" appears as the alarm limit.

23. ALARM VOLUME

    Press to activate the volume control for the audible alarm. The LED on the ALARM VOLUME key illuminates when activated. Once activated use the Up & Down Arrow keys (24) to increase or decrease the alarm volume in 8 steps. The audible alarm volume cannot be turned off completely.

24. UP & DOWN ARROWS

    These keys are used in association with the AUG. ALARM, REF. LINE, HELP SCREEN, PRINTER MENU, PREFERENCE MENU, and ALARM VOLUME keys. The arrow keys are only active when one of the associated keys' LED is illuminated.

25. CHANGE / SELECT

Press to select or change an item in the PRINTER or PREFERENCES menus. This key is used in these menus to make selections or changes to the user configurable characteristics of the pump and/or printer.

26. DONE

Press to exit the current PRINTER, PREFERENCES or HELP menu.

27. PREFERENCES MENU

Press to activate the system preferences menu. The LED adjacent to the PREFERENCES MENU key will illuminate. Display options and audio tone options may be adjusted within these menus. The system time and date may also be set.

28. PRINTER MENU

Press to activate the printer configuration menu. The LED adjacent to the PRINTER MENU key will illuminate. Printer configuration items such as the number and type of waveforms to print, print duration, etc. may be set within this menu.

29. HELP SCREEN

Press to activate the Help Screen area on the display. The LED adjacent to the HELP SCREEN key will illuminate. Set-up procedures, abbreviated alarm descriptions, and corresponding corrective actions instructions are available in the Help Screens. Once the Help Screen is displayed, use the UP & DOWN ARROW keys (24) to page through the available screens. The UP ARROW displays the previous page and the DOWN ARROW displays the next page. Press the HELP SCREEN key again or the DONE key to return to the normal display.

30. ZERO PRESSURE

Press and hold for 2 seconds to zero the pressure transducer. The zeroing function will accommodate pressure transducers with offsets of up to ±120mmHg. The zeroing attempt may not be successful on transducers with a greater offset than ±120 mmHg and in those cases the message "*NO ZERO*" will be posted in the "Systolic" field of the display. This key is disabled when the System is in the Assist Mode and pressure trigger is selected, when a transducer is not connected, or when external pressure is selected.

31. PRINT STRIP

Press this key to initiate a recording. Press it briefly to print a strip of the duration specified in the printer menu. Press and hold the key for 2 seconds to print a continuous strip. Pressing the key while the printer is running will stop the current recording. The LED adjacent to the key will be lit continuously during a programmed duration recording and will blink during continuous recordings.

32. ALARM MUTE

Press to temporarily disable an active audible alarm for 30 seconds. This control does not override the alarm. If an alarm condition is not corrected within 30 seconds, the audible alarm is enabled again. Alarm messages will remain displayed while the associated audible tone is temporarily disabled. The LED illuminates when ALARM MUTE is activated, and extinguishes when ALARM MUTE is deactivated. In the event that a new alarm condition occurs when audible alarm's are muted, the alarm tone will be immediately reactivated.

1.2.6 OVERRIDE KEYS

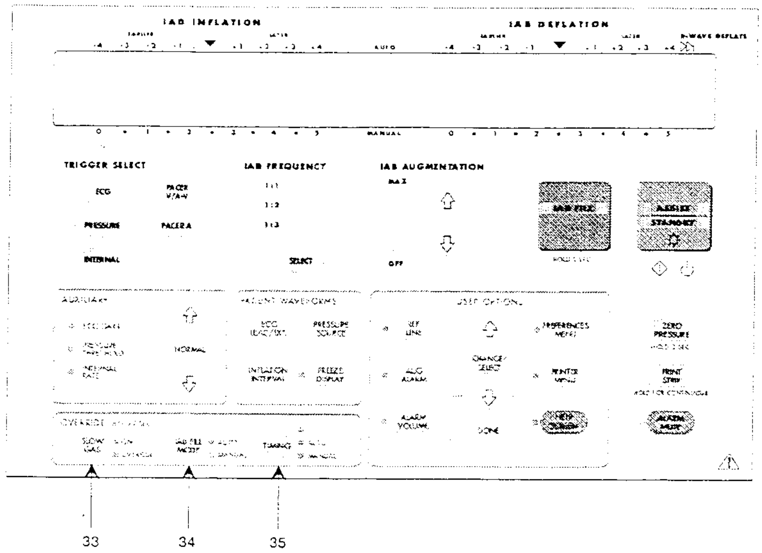


Figure 1-6
OVERRIDE KEYS

33. SLOW GAS

Press this key to enable or override the Slow Gas Loss Alarm. When the OVERRIDE LED is illuminated, the advisory message "*Slow Gas Loss Override On*" is displayed and the SYSTEM 98 continues to operate in the ASSIST mode even when a small gas loss is detected. A status message is displayed but no audible alarm is sounded. The gas loss alarm will flash as long as the slow gas loss condition exists.

NOTE: When in the Manual Fill Mode, the slow gas loss alarm message will be disabled. The OVERRIDE LED is illuminated.

When the ON LED is illuminated, and a slow gas loss is detected, pumping will be suspended, a continuous alarm tone will sound, and the message "*Leak in IAB Circuit*" is displayed.

WARNING: Continued pumping of an IAB which has a leak may result in formation of a large blood clot within the balloon causing an entrapped balloon condition which may require surgical removal of the IAB or in a gaseous embolic injury of organs.

34. IAB FILL MODE

This key is used to select between the IAB fill modes, Auto or Manual. The selected mode is identified by a LED. The Manual Fill Mode must be selected for Pediatric IAB's.

When the AUTO mode is selected, the System 98 will provide Rapid Start of IAB assist (see Section 1.3.2.12"Initiation of Assist") following a powerup. Thereafter, it will automatically purge and refill the IAB's shuttle gas at 2 hour intervals or upon activation of the FILL key.

When the MANUAL mode is selected, automation of the fill process inhibited. The IAB must be purged and filled manually (see Sections 1.3.2.14 "Manual Fill Mode" and 1.3.21.8 " Filling Pediatric Catheters"). Similarly, the automated sequence of steps affiliated with the Rapid Start feature are not supported. Consequently, this sequence of steps must be performed manually to initiate pumping.

35. TIMING

This key is used to change the IAB Inflation/Deflation Timing Mode.

When the AUTO LED is illuminated, the Cardio Sync™ software algorithms automatically track changes in patient heart rate or rhythm and adjusts the inflation and deflation points accordingly. Minimal timing adjustments are required by the operator in this mode.

When the MANUAL LED is illuminated, the IAB inflation/deflation points are fixed, determined by the position of the inflation/deflation controls. Operator adjustments are required in this mode when patient rates or rhythms change significally.

1.2.7 DISPLAY SCREEN

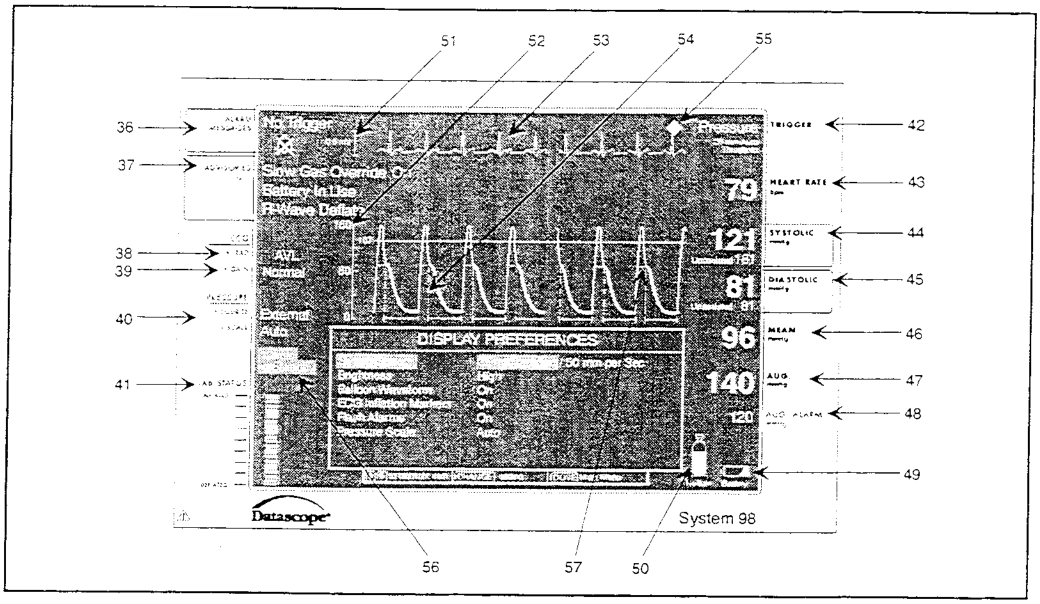


Figure 1-7
DISPLAY SCREEN

36. ALARM MESSAGES

This section of the screen is used to display alarm messages. One alarm message can be posted at a time. If more than one alarm condition occurs, the alarm message is displayed in priority order.

37. ADVISORIES

This section of the screen is used to display alert, status, and prompt messages. There are three available advisory lines in this section. If more than one message is displayed, the advisories are posted in priority order.

38. ECG LEAD

This field displays the selected ECG signal source and its status. Selections are skin leads (I, II, III, aVR,aVL,aVF,V) or EXTERNAL.

When skin leads are selected and a lead fault occurs, then the selected lead is alternately displayed with the text "Lead Fault".

When an "External" source is selected and a cable is not present, then the text "No Cable" is displayed.

39. ECG GAIN

Indicates the gain factor applied to the ECG signal. When normal gain is applied, "*Normal*" will be displayed in this field. When using variable ECG gain "N" is displayed with N varying over a range of 0.15 to 3.0.

40. PRESSURE SOURCE

Pressure Source displays the source of the blood pressure signal and its status. The text, "XDUCER" is displayed when a direct transducer input is selected. The text, " External" is displayed when an external signal source is selected. In cases wherein the selected source is not present, the text "No Cable" is displayed.

Pressure Scale displays the current state of the Pressure Scale setting either Manual or Auto. Refer to section 1.3.22.1 for more information on this setting.

41. IAB STATUS INDICATOR

A segmented bar graph that depicts movement of the diaphram within the saftey disk as sensed by the System's internal pressure transducers. No quantitive measurement is intended.

42. TRIGGER

Displays the selected trigger source for both IABP synchronization and Heart Rate determination. When pressure trigger is selected, the pressure trigger threshold and threshold adjustment mode (Auto or Manual) will be displayed along with the trigger source.

43. HEART RATE

This field is a numeric display of the current average heart rate in Beats Per Minute (BPM). The System 98 displays "0" when the heart rate drops below 15 BPM.

44. SYSTOLIC

Indicates peak systolic pressure in mmHg. Displays NO ZERO if transducer requires zeroing. Display is blank if a pressure transducer is not connected, or if external source is selected and the external cable plug is not inserted. When 1:2 or 1:3 is selected as the IAB Frequency, both the assisted and unassisted systolic pressures are displayed. They are labeled accordingly.

45. DIASTOLIC

Indicates end diastolic pressure in mmHg. Display is blank if the zero process has not been performed, if a pressure transducer is not connected, or if external source is selected and the external cable plug is not inserted. When 1:2 or 1:3 is selected as the IAB Frequency, both the assisted and unassisted diastolic pressures are displayed. They are labeled accordingly.

46. MEAN

Indicates mean pressure in mmHg. Display is blank if the zero process has not been performed, if a pressure transducer is not connected, or if external source is selected and external cable plug is not inserted.

47. AUG (Diastolic Augmentation)

Indicates peak augmented diastolic pressure in mmHg. The display is blank when IABP is in STANDBY, if the zero process for the transducer has not been performed, if a pressure transducer is not connected, or if external source is selected and external cable plug is not inserted.

48. AUG. ALARM

Indicates diastolic augmentation alarm limit in mmHg. If the alarm is not enabled, OFF is displayed.

49. BATTERY INDICATOR

Indicates the charge remaining in the internal batteries. This indicator is displayed only when the system is operating off of the internal batteries. Display of the "*Low Battery*" advisory message indicates less than 30 minutes of remaining battery life. When this message appears the battery symbol is displayed as empty and starts flashing. Connect the pump to AC power and turn the AC mains switch on as soon as possible.

50. HELIUM INDICATOR

Approximately indicates the amount of helium remaining in the tank. A "*Low Helium*" advisory message will be displayed when the tank is almost empty.

51. ECG Scale

The ECG scale is located immediately to the left of the displayed ECG waveform. It is provided to facilitate determination of ECG amplitude. The scale is one centimeter high. The annotation indicates the current scale factor for the displayed ECG waveform, e.g. 1 mv/cm.

NOTE: The displayed ECG signal is automatically scaled (amplified) for optimal screen presentation. Due to the automatic scaling, low ECG amplitudes may appear to be of normal amplitude when displayed. Judgements concerning ECG amplitude should be done with reference to the annotated scale or a printed ECG output.

52. Arterial Pressure (AP) Scale

The AP scale is located immediately to the left of the displayed AP waveform. The scale is a vertical line with annotated "tick" marks. The units of the annotation are mmHg. The scale is provided to facilitate determination of AP amplitude.

NOTE: The displayed AP signal can be automatically or manually scaled (amplified) and offset for optimal screen presentation (See section 1.3.22.1 for more information). When using automatic scaling, low AP amplitudes may appear to be of normal amplitude when displayed. Judgements concerning automatically scaled AP waveforms should be done with reference to the annotated scale, patient arterial pressure parameter display, or a printed AP output.

53. Waveforms (ECG, AP, shuttle gas)

Depending upon user preferences, the system displays either two waveforms (ECG and AP) or three waveforms (ECG,AP, Balloon Pressure). Order of display is fixed, ECG is displayed horizontally across the top of the screen. Next, Arterial Pressure is displayed across the middle of the screen and finally, across the bottom, the balloon pressure waveform (if enabled). If the balloon pressure waveform is not enabled, then the additional screen area is used by the arterial pressure waveform display.

Waveforms are plotted from left to right. The oldest data is erased and is replaced by new data. To facilitate identification of the newest data, an vertical "erase" bar is drawn. The newest data is to the left of the bar and the oldest is to the right. Visually, the traces appear fixed as a moving vertical bar move thru the traces and updates their appearance.

Waveforms are assigned a fixed window (invisible) in which they are drawn. For clarity of display, the ECG and AP waveforms have autoscaling algorithms (the AP waveform may be manually scaled in the Preferences Menu, see section 1.3.22.1 for more information). These algorithms continuously adjust the gain and offset of the displayed waveforms so that their dynamic aspect is fitted to the available display window. These measures simplify adjustment and assessment of IAB timing, since waveform's morphology is clearly displayed.

54. **Inflation Interval Markers**

While in Assist Mode, the Inflation Interval Markers can be displayed by pressing the INFLATION INTERVAL (19) key. The Inflation Interval Markers can be set in the Preference Menu (See Section 1.3.22.1) to permanently display on the ECG waveform. These markers indicate the approximate points at which the pump will initiate the inflation and deflation process. The marked segment is adjusted by moving the INFLATION (10) and DEFLATION (11) slide controls.

55. **Trigger Indicator**

A graphic trigger indicator is located at the top right of the screen. It has a diamond shape. It blinks on and off each time a trigger event is detected.

56. **Time In Standby**

Time in Standby is numerically displayed on the left side of the screen. This display is active only when the system is in Standby. The timer display starts when the system goes into the standby state for any reason. The timer display is cleared whenever pumping is re-initiated.

After an elapsed time of 20 minutes, an alert message is continuously displayed in the Advisory field of the screen. An audio tone is affiliated with the initial alert. It will sound a double beep for 30 seconds. Thereafter, it will sound every 5 minutes.

The alert is a reminder that a risk is incurred (thrombosis) if the IAB is not pumped for long periods of time.

57. **Tick Marks on AP waveform**

In the arterial pressure trigger mode, "Tick" marks (small horizonal lines) are added to the arterial pressure waveform. The tick marks provide a visual indication of the current arterial pressure trigger threshold. The marks do not indicate the exact moment of the trigger event, they are slightly delayed in time.

1.2.8 REAR PANEL

NOTE: All signal input and signal output ports are intended only for connection to specified equipment.

58. IAB CATHETER EXTENDER INPUT

    Used for connection of the IAB catheter and catheter extender combination.

59. TRAINER INPUT

    A mini-jack provides the appropriate timing signal required to synchronize the Series 90 Trainer.

60. DC OUTPUT (CONDENSATE REMOVAL MODULE CONNECTION)

    This is a six pin connector which provides power to the condensate removal module.

61. ECG INPUT

    A six-pin connector used for attaching patient cable connections. This connection is electrically isolated for patient safety.

62. PRESSURE INPUT

    A six-pin male connector used for attaching Datascope specified physiologic pressure transducers (see precautions listed on page xi of Operator Instructions). This connection is electrically isolated for patient safety.

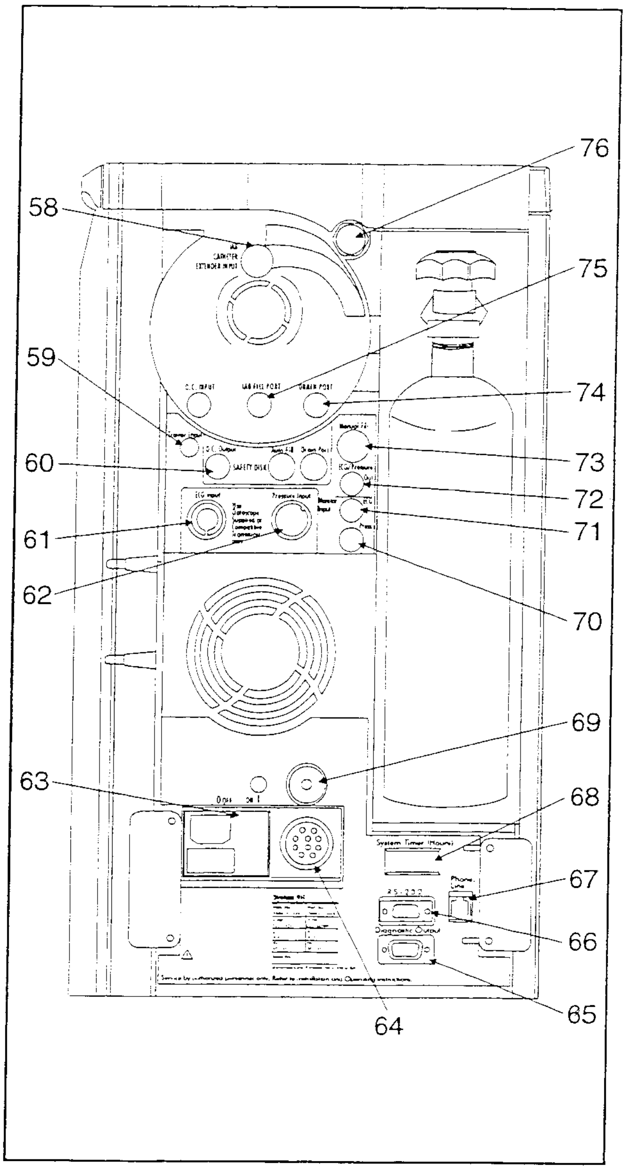


Figure 1-8

REAR PANEL

63. MAINS ON/OFF

A fuse holder, switch, and line cord receptacle used to apply and remove AC power to the System 98.

PRECAUTION: The batteries are charging only when the AC Mains switch is ON, the AC Mains cord is connected to an active AC power utility, and the battery charging status LED is illuminated.

64. EXTERNAL DC INPUT

An input connector for external DC voltage power to the system.

65. DIAGNOSTIC OUTPUT

Reserved for Datascope use only.

66. RS-232

A 9-pin D-type connector provided for RS-232 serial data communication lines.

67. PHONE LINE

A standard RJ11 modular telephone jack for connecting the internal modem to a standard analog phone line. NOTE: This phone line should be directly connected to an external phone system and not a company/ hospital switching system.

68. SYSTEM TIMER

Displays elapsed system operating time in hours (used to determine preventive maintenance intervals). The elapsed time cannot be reset. (See Section 8 for Preventive Maintenance Schedule.)

69. EQUIPOTENTIAL LUG

A connector used to equalize the voltage potential which may exist between the System 98 and earth ground or other hospital equipment.

70. PRESSURE (Monitor Input)

A 1/4" phone jack which permits the System 98 to display and/or trigger from a 1V/100mmHg Pressure signal acquired from an external monitor. When plugged in and external pressure source is selected, the monitor displays the arterial pressure and can be triggered from the externally supplied signal. See Section 1.3.20, "External Monitor Interfacing" for additional information.

71. ECG (Monitor Input)

A 1/4" phone jack which permits the System 98 to display and/or trigger from a 1V/mV ECG signal acquired from an external monitor. When plugged in and external ECG source is selected, the monitor displays and can be triggered from the externally supplied signal. See Section 1.3.20, "External Monitor Interfacing" for additional information.

72. ECG/PRESSURE OUTPUT

This 1/4" phone jack, (with ECG connected on the tip and blood pressure signal connected on the ring) provides patient signal information for external equipment. The output sensitivities are 1V/mV and 1V/100mmHg respectively. The phone jack sleeve provides common signal ground for both ECG and Pressure outputs.

73. MANUAL FILL PORT

This pnuematic fitting provides a means through which fill gas (helium) may be extracted when a syringe tip is attached and the helium cylinder is open. This pneumatic port can also be used to fill non-standard balloon volumes such as pediatric IAB sizes. This port is used ONLY for manual filling.

74. DRAIN PORT

This pneumatic port connects to the Safety Disk/Condensate Removal Module (CRM) assembly. This port is used to automatically drain excess water (condensate) from the System.

75. IAB FILL PORT

This pneumatic port connects to the Safety Disk/Condensate Removal Module (CRM) assembly. The IAB FILL PORT is normally used for automatic filling of balloons. This port is located on the safety disk, and can be used to manually fill or purge the IAB in the MANUAL FILL mode.

76. HELIUM PRESSURE GAUGE

Indicates the gas pressure in the cylinder, without requiring the System 98 to be "ON". The cylinder valve must be opened to check pressure.

1.2.9 FRONT PANEL

77. IABP ON/OFF

This recessed switch controls internal power to the pump console and monitor module. Operation of this switch does not affect the status of the internal battery charger.

78. BATTERY CHARGING LED

Illuminates continuously while the internal batteries are being charged at a low rate. The LED indicator flashes when the internal batteries are charging at a high rate.

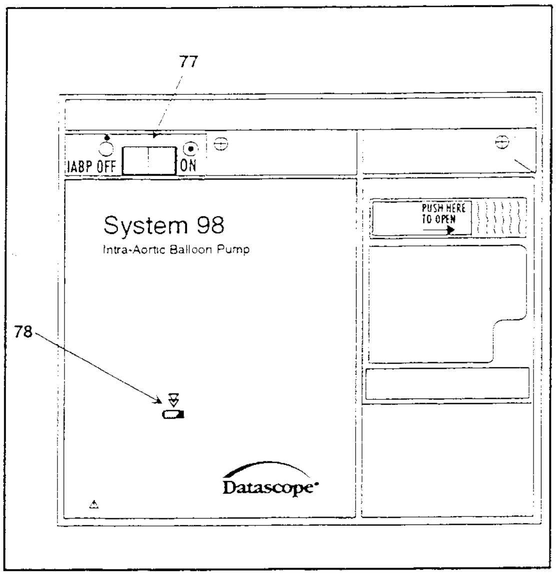


Figure 1-9

FRONT PANEL

PRECAUTION: The internal batteries are charging only when the AC Mains switch is ON and the AC Mains cord is plugged into an active AC power utility.

1.2.10 SPECIAL MODE ACTIVATION

During the power-up sequence of the System 98, certain functions or modes can be enabled by pressing assigned keys. The following table describes these functions and the key required to enable that function.

Press and hold the following key(s) while activating the power switch until the function or mode is enabled.

Power-up Special Function Keys		
Function	Key(s) to press and hold while powering up (call out number)	How to Exit
To Enter the Safety Disk Leak Test	IAB FILL (8)	When the test is completed the System will automatically enter the normal operating mode.
To Enter the Pediatric Safety Disk Leak Test	IAB FILL (8) and ASSIST/STANDY (9)	When the test is completed the System will automatically enter the normal operating mode.
To Enter the System Configuration Mode. (See section 1.3.23 for details on using this mode.)	PREFERENCES MENU (27)	From the Main Menu press the DONE key to exit this mode and enter the normal operating mode.
To restore System default settings (See section 1.3.2.12 for details.)	CHANGE / SELECT (25)	The System powers up in the normal operating mode with all default settings restored.
To Print Software Revisions	PRINT STRIP (31)	The System powers up in the normal operating mode with the software revisions printed from the recorder.
To enter Service Diagnostics (refer to section 4 for more details)	SLOW GAS (33) and IAB FILL MODE (34)	Power OFF

1.3 OPERATION

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1.3.1 INTRODUCTION

This section of the manual provides step-by-step instructions for properly operating the System 98. The Numbers in parentheses identify the controls and indicators described in Chapter 1.2.

GENERAL SAFETY *PRECAUTION*

Prior to operating the equipment, the user must be familiar with the controls and functions of the System (refer to Chapter 1.2) and have a thorough knowledge of intra-aortic balloon pumping.

1.3.2 Sequence for Establishing IABP

NOTE: See Section 1.3.12 for Helium cylinder installation. See Section 1.3.13 for safety disk installation.

1.3.2.1 Establish AC Operation

1. Remove catheter extender tubing or any plug from IAB catheter extender input connector (58). Visually inspect that the safety disk is properly seated and that all pneumatic fittings are sound.
2. Attach the line cord, appropriate for the country of use, securely into the MAINS power receptacle (63) on the pump console.
3. Plug the System line cord into a compatible grounded AC receptacle. In the U.S. use only receptacles marked "Hospital Grade." Do not use an adapter to eliminate the plug's connection to ground. If auxiliary equipment is used with the System 98, insure that the equipment is also properly grounded.
4. Set the MAINS ON/OFF switch (63) to the "ON" position.
5. Confirm AC operation by checking that the BATTERY CHARGING indicator (78) is illuminated or flashing.

If a Safety Disk Leak Test is desired continue with Step 1.3.2.2, otherwise proceed to Step 1.3.2.3.

1.3.2.2 Safety Disk Leak Test

1. Press and hold the IAB FILL key (8) while switching IABP ON/OFF (77) to ON. Release the IAB FILL key when the message "*LEAK TESTING SAFETY DISK*" appears in the ADVISORIES section (37) on the screen. NOTE: If the IAB Catheter Extender Input (51) is not vented to air at the start of the Safety Disk Leak Test, a double beep alarm tone will sound and the message "*UNPLUG DISK OUTLET*" will be displayed.

   After approximately 10 seconds a tone sounds and the message "*PLUG DISK OUTLET*" is displayed in the ADVISORIES section (37) on the screen.
2. Plug the IAB Catheter Extender Input (51) on the safety disk with a dead end Luer plug (supplied).

3. A double beep will sound at the end of the safety disk test. If the System passes the test, the message "*SYSTEM TEST OK*" is displayed in the ADVISORIES section (37) on the screen. Remove dead end luer plug.

NOTE: If the message on the display is "*SAFETY DISK TEST FAILS,*" inspect all pneumatic connections and Luer locks. Switch the IABP ON/OFF to the OFF position and repeat from Step "1".

If in doubt about the integrity of the safety disk, replace it. See Section 1.3.13, "Installation of the Safety Disk".

If the safety disk has been replaced and no leak is evident, but the screen still flashes "*SAFETY DISK TEST FAILS,*" the IAB AUTO FILL System may be malfunctioning and the manual fill procedure should be performed until a Service Representative can be contacted.

*WARNING: Use only the safety disk/CRM (P/N's 0997-00-0344/0997-00-0380) that is designed to be used with the System 98. **Do not** use a System 95 disk.*

WARNING: Do not perform this procedure when the System 98 is connected to the patient.

1.3.2.3 Normal Power Up Procedure (Without Safety Disk Leak Test)

1. If the System 98 is not already on, press the IABP ON/OFF switch (77) to ON.

   The System performs an electrical and pneumatic self test. When the self-check is successful the "*SYSTEM TEST O.K.*" message appears in the Advisories (37) field of the display. In the event that any electrical or pneumatic test fails, the message "*ELECTRICAL TEST FAILS CODE* #_____" is displayed on the screen. The code number indicates which test has failed in the System. Power cycle the System (power down for a minimum of 10 seconds) and if message repeats, record the code # and call Datascope Service Representative. See Section 4, Troubleshooting Procedure for probable cause and recommended action.

1.3.2.4 Establish Fill Gas Pressure

1. Slowly open the Helium cylinder valve fully counter-clockwise.

2. Make sure that the helium indicator (50) on the display indicates that an adequate volume of gas exists in the Helium tank. A mechanical helium pressure gauge (76) directly above the Helium tank provides an alternate check of the helium supply when the pump is off. Ensure the helium supply reading on the gauge is in the operating range (within the white area).

   NOTE: When the System is not in use, close the cylinder valve fully clockwise to prevent a potential leak and the depletion of the helium supply.

3. Check that the message "*LOW HELIUM*" advisory is **not** displayed. If the "*LOW HELIUM*" message is displayed, check helium cylinder icon or gauge for adequate gas capacity and check helium cylinder attachment for leaks. Replace the cylinder if necessary.

1.3.2.5 ECG Acquisition

An ECG signal can be aquired either directly from skin electrodes or indirectly as a high level output from an external monitor (refer to Section 1.3.20 "External Monitor Interfacing" for additional information on interfacing requirements when using external monitor sources).

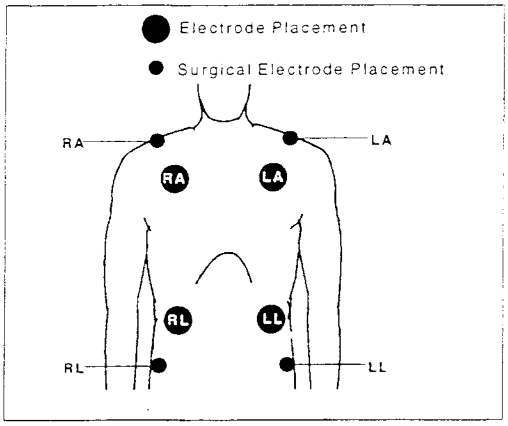


Figure 1-10
Electrode Placement

Direct ECG signal acquistion requires an ECG patient cable, lead wires and skin electrodes. Use only the Datascope supplied patient cable and leads to optimize motion and enviromental noise immunity.

The type of skin electrode and technique of applying the electrodes are also major factors in determining the quality of the signal obtained. Use high quality, silver-silver chloride electrodes. These are designed to acquire an ECG with excellent baseline stability, recovery from defibrillation, and minimum artifact from patient movement.

1. When acquiring an ECG directly from skin electrodes;

   a. Ensure that the patient lead wires are securely inserted into the yoke of the Datascope supplied ECG patient cable. Connect each patient lead wire to a skin electrode. The following table shows the number of ECG Electrodes vs. Leads available. The recommended minimum number of electrodes is 4 to provide optimal lead selection triggering options.

   b. Attach electrodes to the patient at the appropriate locations as shown.

   c. Plug ECG patient cable into the rear panel ECG INPUT (61) connector.

(#) ELECTRODES AVAILABLE	(#) ECG LEADS AVAILABLE
(3) RA, LA, LL	(3) I, II, III
(4) RA, LA, LL, RL	(6) I, II, III, aVR, aVL, aVF
(5) RA, LA, LL, RL, V	(7) I, II, III, aVR, aVL, aVF, V

2. When using a high level ECG output from an external monitor, plug the interface cable into the ECG MONITOR INPUT (71) jack.

3. Select desired lead setting for direct skin electrode acquisition, or the external monitor input by pressing the ECG LEAD/EXT key (17).

4. Check that an ECG waveform is now present on the System screen and that the heart rate read-out is now functional.

PRECAUTION Conductive parts of electrodes and associated connectors for applied parts, including the neutral electrode, should not contact other conductive parts including earth.

1.3.2.6 Arterial Pressure Acquisition

An arterial pressure signal can be acquired either directly from a physiologic pressure transducer or indirectly as a high level output from a compatible external monitor (refer to Section 1.3.20 "External Monitor Interfacing" for additional information on interfacing requirements when using external monitor sources).

1. When acquiring the arterial pressure directly from a transducer, plug the pressure transducer adapter cable into the rear panel PRESSURE INPUT connector (62). Verify that "XDUCER" is indicated in the PRESSURE SOURCE display field (40). If necessary, use the PRESSURE SOURCE key (20) to select and then proceed to step 3.

2. When using a high level pressure output from an external monitor, plug the interface cable into the PRESSURE MONITOR INPUT (70) jack and select external pressure input by pressing the PRESSURE SOURCE key (20). Verify pressure waveform display and proceed to step 7.

3. To establish a monitoring site, utilize the central lumen of the intra-aortic balloon or introduce an arterial pressure catheter into the patient's radial artery in accordance with standard hospital procedures. Aortic pressure monitoring is recommended for managing patients on IABP therapy.

4. Connect catheter line with a flushing device to the pressure transducer.

5. Zero pressure transducer as follows:

   Initially, the message "*NO ZERO*" is displayed in place of the systolic digital display value (44), indicating the need to zero the transducer.

   a. Open transducer vent to atmosphere.

   b. Press ZERO PRESSURE key (30) and hold for a minimum of two seconds.

   Two audible clicks will sound and the automatic zero process is performed.

   All of the numeric pressure values at the right side of the display will show 0 ±2mmHg when zeroing is successful.

   NOTE: If the transducer offset exceeds ±120mmHg, it will not be possible to automatically zero the transducer. A "*NO ZERO*" message indicates this is a fault condition. If this occurs, the transducer should be considered incompatible or defective and should not be used.

6. Close pressure transducer vent to atmosphere. Check that the pressure waveform is displayed and SYSTOLIC/DIASTOLIC and MEAN digital displays are functional at this time.

7. To measure any point on the pressure waveform, press REF. LINE (21) to activate the reference line. Once activated, use the UP & DOWN Arrow keys (24) to move the reference line.

   The numeric value of the pressure corresponding to the reference line position is shown at extreme left side of the line (when the monitor is initially turned on the reference line is automatically set to 0 mmHg. If this pressure level is below the current display window, the reference line will appear at the bottom of the window upon the first press of either arrow key.

1.3.2.7 Initial Set-Up of Controls for Balloon Pumping

1. Verify the pump controls are set as follows:

TRIGGER SELECT	(1)	ECG
IAB FREQUENCY	(6)	1:1
IAB AUGMENTATION	(7)	OFF
IAB INFLATION	(10)	Midpoint
IAB DEFLATION	(11)	Midpoint
SLOW GAS	(33)	ON
IAB FILL MODE	(34)	AUTO
TIMING	(35)	AUTO
ECG GAIN	(12)	NORMAL

1.3.2.8 Selection of Trigger

Both the patient's ECG and arterial pressure waveform should be visible on the monitor. ECG triggering is always recommended as the primary trigger mode. Triggering is evidenced by a flashing diamond at each trigger event.

- ECG

  Press the ECG TRIGGER SELECT key (1).
  The System recognizes a 120uV (minimum) QRS as a trigger event. This is indicated by a flashing diamond in the upper right corner of the screen. Pacemaker pulses are rejected in this mode.

  For the best pacer rejection performance, the use of the auto timing mode is recommended. In this mode the minimum QRS threshold of 120uV will be increased automatically if a pacer spike is present to avoid detection of pacer artifact. If artifact is not problematic but greater sensitivity is needed to detect very small R-waves while pacing, the manual timing mode can be used or the ECG GAIN control can be adjusted to increase ECG signal.

  When an extremely low or high level ECG signal is encountered, the signal strength can be altered by using the ECG GAIN (12) function. The UP & DOWN ARROW keys (15) will vary the ECG gain from 0.15 to 3.0 times the normal gain of 1,000. The 3.0 setting increases the trigger sensitivity from its normal value of 120µV to ≈40µV. Make sure QRS detection operates properly by observing the flashing diamond and the HEART RATE display.

  NOTE: "Normal" gain will handle most cases, gain alteration should be used ONLY if required.

- Pressure Trigger

Press the PRESSURE TRIGGER SELECT key (2).

In the PRESSURE trigger mode the System 98 will use the arterial blood pressure waveform as its trigger source.

The pump identifies and triggers on the upstroke of the systolic pressure pulse. This upstroke is identified as a positive upturn in arterial pressure; exceeding the current amplitude threshold level and rising at a rate consistent with systolic ejection. The trigger level is indicated by a horizontal "tick" mark beside the arterial pressure upstroke.

The System 98 continuously optimizes and adapts the threshold level to changes in the systolic pulse height. Manual threshold mode is provided for greater triggering flexibility. A threshold level from 7 to 30 mmHg can be manually selected in 1 mmHg steps (see Auxiliary keys, section 1.2.2). The threshold level and mode, manual or automatic, are posted just below the "PRESSURE" trigger mode indication in the "TRIGGER" source display field in the upper right corner of the screen.

WARNING: Readjust or re-evaluate inflation and deflation timing after each manual pressure trigger threshold change.

The System 98 is designed to trigger on the upstroke of systole and ignore rises in arterial pressure attributed to the augmenting action of the IAB. This protective refractory mechanism is very useful in blocking erroneous diastolic trigger events but consequently can mask very premature pulses associated with instantaneous rises in heart rate. The System 98 has the means of detecting and adapting to rises in rate, but extreme changes, such as rate doubling, can result in every other systole remaining "invisible" to detection. Alternate beat triggering is apparent when the displayed heart rate is half the patients actual rate. This condition is rare, but if observed can be immediately corrected by pressing or tapping the PRESSURE trigger key. This will suspend pumping for a single beat and restore proper trigger detection. If no user action is taken, proper triggering will be restored at the 60 second automatic synchronization check point. See details in the following paragraph.

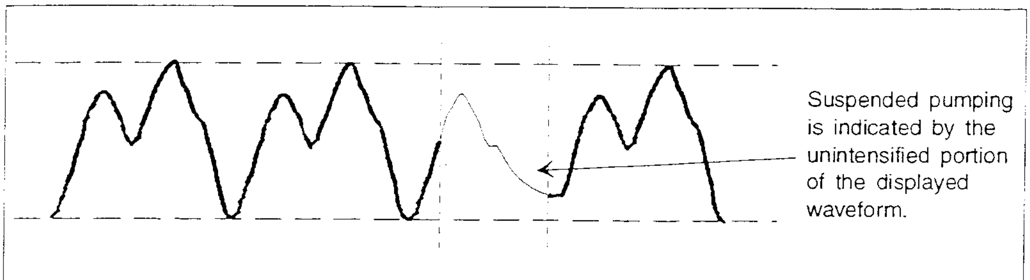


Figure 1-11

Suspended Pumping Waveform

An important fail-safe feature of the System 98 is the pressure trigger's 60 second periodic synchronization check. Every minute, when in 1:1 assist mode, pumping is suspended for a single beat. (See figure 1-11 above.) This permits the patient's natural systolic pulse and interval parameters, unaltered by the action of the IAB, to be checked. This check periodically ensures that the refractory and IAB timing intervals are being properly determined and if necessary, corrects these intervals. This automatic synchronization check can also be user initiated at any time by momentarily pressing the PRESSURE trigger key (LED illuminated). This provides the capability to immediately resynchronize triggering and timing in the rare event that a loss of synchronization is observed. When a synchronization check is initiated by pressing the PRESSURE trigger key, the timer for the next check is automatically reset to 60 seconds.

The System 98 will automatically adapt to sustained random dysrhythmias, such as atrial fibrillation. Such rhythms lack a predictable pattern and will produce early systolic ejections that can unavoidably overlap with balloon deflation, impairing stable and consistent systolic pulse detection. The System 98 automatically detects such rhythms and minimizes the probability of overlap by utilizing statistical heart rate data in its deflation timing determinations. Deflation is anticipated based on the fastest "global" rate recently observed rather than the current "local" instantaneous rate.

When this special timing mode is adopted, an "IRREGULAR TRIGGER" message is posted in the Advisory display field (upper left corner of the screen) and an alert tone is briefly activated. This message indicates to users that the System is compensating for an irregular rhythm by deflating somewhat earlier to avoid interfering with systolic ejection. Consequently, users should NOT attempt to adjust the deflation slider if the patient is dysrhythmic and the "Irregular Trigger" advisory message is posted. Adjustments to deflation timing could compromise trigger performance when the patient finally resumes a regular rhythm and the System automatically reverts back to standard timing mode.

NOTE: When pressure trigger is being used, balloon deflation should always be adjusted to occur and complete prior to the upstroke of systole. Late deflation timing causes a reduction in, and delay in detection of systolic pulse pressure. The System relies on a prominent and timely systolic upstroke for consistent, reliable pressure triggering. Any overlap of balloon deflation and systolic ejection, while in the pressure trigger mode, could cause triggers to be late or missed, potentially resulting in loss of synchronization.

PRECAUTION Pressure triggering is NOT recommended for use when sustained irregular cardiac rhythms or tachyarrhythmias are present. Remember to adjust deflation early enough so that deflation is completed prior to systole and be sure to provide continuous observation while triggering in this mode. If a "IRREGULAR TRIGGER" message appears, DO NOT attempt to adjust the deflation control as the system will automatically compensate by deflating earlier to avoid interfering with the systolic ejection.

- Ventricular Pacemaker (V/A-V mode) and related triggering (Pacer A)

Insure that the System 98 is reliably recognizing the pacemaker stimulus. Specifically, if a ventricular pacer is used, be sure an enhanced ventricular pacer pulse is observed on each cardiac cycle. Two enhanced pacer pulses must be observed when using an atrial-ventricular sequential pacer. If this is not the case, select a different ECG Lead or increase ECG GAIN until reliable detection is achieved.

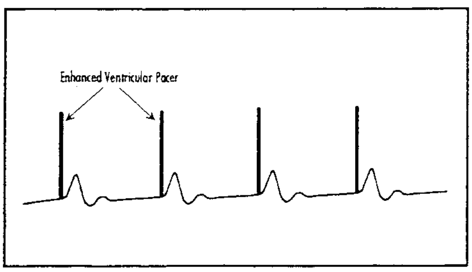


Figure 1-12 Pacer V

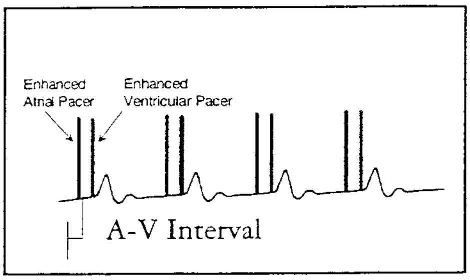


Figure 1-13 Pacer A-V

1. PACER A: Press the "PACER A" trigger select key (5) to trigger on the patient's QRS without interference from atrial pacer artifact. This mode is recommended only if atrial pacer tails interfere with R-wave detection when using the "ECG" trigger mode. Fixed or demand atrial pacing can be used in this trigger mode.

NOTE: The name "Pacer A" is a misnomer from the perspective that this trigger mode does not produce trigger's sychronous to the pacing stimulus. The merit that this naming convention provides is to associate the use of this trigger mode with the pressure of arterial pacing artifact.

2. PACER V/A-V: Press the "PACER V/A-V" trigger select key (4) when ECG trigger is unobtainable in the presence of a ventricular or atrial-ventricular sequential pacemaker. In this mode, the System automatically identifies and displays the appropriate pacer type. The System triggers on the ventricular pulse for either type of pacer, provided there is 100% paced rhythm (i.e.., no demand pacing). If the conditions for either pacer type are not met, a trigger alarm occurs and the message "*CHECK PACER TIMING*" is displayed.

   1. PACER V: The System recognizes the presence of a ventricular pacer provided the ventricular pacing interval is fixed and the rate is less than 185 bpm.

   2. PACER A-V: The System recognizes the presence of an atrial-ventricular sequential pacer provided the A-V interval is between 80 - 224 msec. and the rate is less than 125 bpm.

NOTE: Pacer V/A-V trigger will not function in the presence of ESU Interference. Pumping will be suspended temporarily and will resume automatically when interference disappears. The "*TRIGGER INTERFERENCE*" status message is displayed when ESU interference is detected in the Pacer V/A-V trigger mode.

- Internal Trigger

  Press the INTERNAL key (3).

  For asynchronous balloon pumping, the IABP may be triggered from an internal signal generator. The rate can be adjusted from 40 to 120 bpm, in increments of 5 bpm, by pressing NORMAL (16) or UP & DOWN ARROW (15) keys in the Auxiliary Keys Group. The System will display "INTERNAL" in the upper right corner of the screen.

  When Internal Trigger is selected, the System continues to monitor for R-wave activity via the ECG patient cable. If valid R-wave activity is detected, then the System sounds a double alarm beep for every R-wave detected and the trigger alarm indicator is illuminated with a message "*ECG DETECTED.*" The System deflates the IAB immediately after an R-wave detection to prevent competitively pumping with the patient. If reliable R-wave activity has resumed then the System should be switched back to the ECG Trigger mode for proper timing.

  WARNING: Never leave the System set in the Internal Trigger Mode if the patient is generating a cardiac output.

1.3.2.9 Selection of IAB Frequency

The selection of IAB Frequency determines the number of heart beats that are assisted by the IAB. The selections are: 1:1, every beat is assisted; 1:2, one out of two beats are assisted; or 1:3, one out of three beats are assisted. Press the IAB FREQUENCY key (6) to make selection.

The choice of IAB frequency determines the manner in which the arterial pressure indicies are computed and displayed. In 1:1 mode all beats are assisted and a single "assisted" value is displayed for each pressure index.

When either 1:2 or 1:3 is selected, the System 98 will seperately display the assisted and unassisted systolic and diastolic pressures. These pressure indicies are illustrated below in figure 3-5b. If the recorder is activated during 1:2 or 1:3 frequency, the assisted and unassisted systolic and diastolic pressure will also be printed as trailing information on the strip. Figure 1-14a below is a sample of the display illustrating the assisted and unassisted pressures. See section 1.3.10 for samples of the recorder printouts indicating the assisted and unassisted pressures.

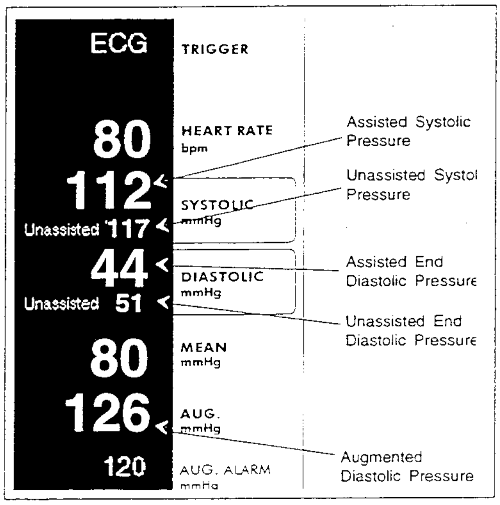


Figure 1-14a

Display Showing Assisted and Unassisted Pressure

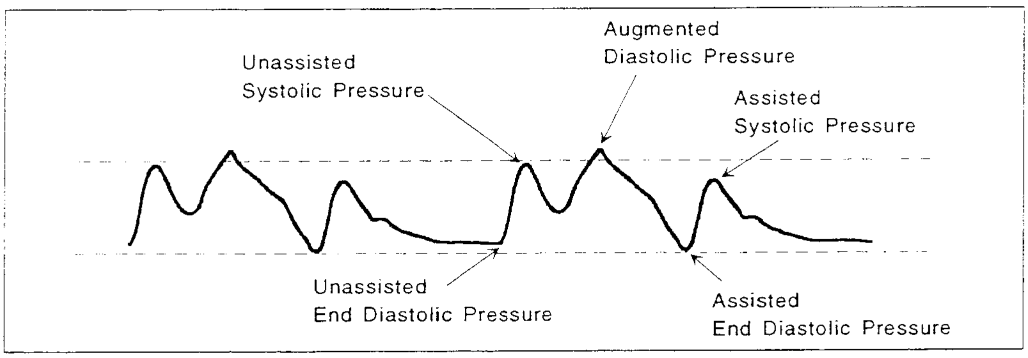


Figure 1-14b

Detail of Waveform Showing Assisted and Unassisted Pressure

1.3.2.10 Timing of Intra-Aortic Balloon

Automatic Timing Mode

In this mode the System 98 Cardio Sync™ software algorithms examine cardiac interval patterns, on a beat by beat basis to intelligently anticipate IAB timing. The System will automatically adjust the inflation and deflation timing of the IAB to track changes in rhythm and heart rate. The user must establish initial inflation and deflation timing points for each patient. Thereafter, the System will adjust timing automatically to accommodate changes in the patient's rate and rhythm. To use the Automatic Timing Mode:

1. Ensure that the system is in the auto timing mode, as indicated by the "AUTO" LED adjacent to the TIMING key (35). Establish initial timing as described in the "Initial Timing Adjustments" section below.

In auto timing mode, the System 98's unique ECG deflation timing logic provides consistent tracking under the demands of ectopics (isolated PVCs, couplets, bigeminy, trigeminy) and abrupt changes in heart rates. When either individual or paired ectopic beats are identified, the System 98 invokes pattern specific timing rules to precisely track the compensatory pause to follow. Pattern specific timing rules are also applied when the onset of a substantial change in rate is detected.

Sustained random dysrhythmias, such as atrial fibrillation, lack a well defined pattern. When managing such cases in the ECG trigger mode, consistency of IAB deflation can be maximized by moving the deflation slider to its extreme right side stop, labeled "*R-Wave Deflate*". The status message "*R-Wave Deflate*" will also be posted in the advisories field of the display. This setting will hold the IAB inflated during the entire diastolic period. Since the start of IAB deflation is delayed until the next R-wave trigger is detected, this setting may not be appropriate in all patient conditions. Increases in systolic pressure should be monitored and avoided.

Manual Timing Mode

A manual timing mode is provided to permit an expansion of the timing range available from the pump. In the manual mode, the user sets fixed inflation and deflation delays relative to the trigger point. Manual timing will NOT automatically adapt to changing heart rates or rhythms. To use manual timing mode:

1. Press the TIMING (Override) key (35) until the MANUAL LED is illuminated. Establish initial timing as described in the "Initial Timing Adjustments" section below.

The numbers under the INFLATE and DEFLATE controls are used as guides when setting the manual timing. On the inflate control, "0" represents inflation at the trigger event with each increment representing approximately a 125 msec delay. On the deflate control "0" represents deflation immediately after inflation with each increment representing approximately a 125 msec delay.

NOTE: In manual timing mode, IAB deflation delay begins at the point of IAB inflation. If the inflation point is adjusted, the deflation point will also move by an equal amount.

WARNING: If the heart rate varies by more than 10 bpm, readjustment of timing may be required when in the manual timing mode.

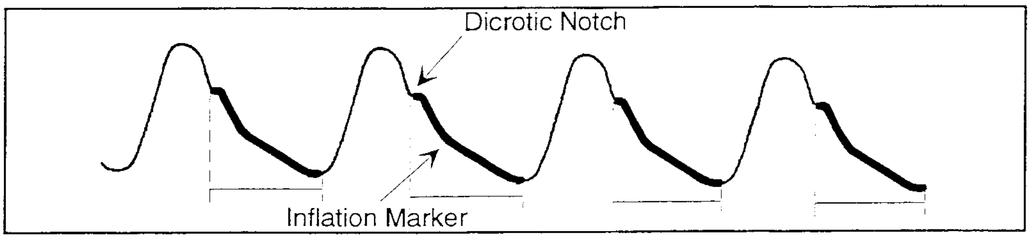
Initial Timing Adjustments - Use of the Inflation Marker

While in the Standby mode, an inflation marker is provided to aid in initial timing adjustment.

1. Use the INFLATION (10) slide control to move the marked segment of the arterial pressure trace so that it begins at the dicrotic notch.
2. Adjust the DEFLATION (11) slide control so that the marked segment ends slightly before the up slope of the arterial pressure waveform.

Figure 1-15

Intensified Inflation Marker



1.3.2.11 Arterial Pressure Delay (APD)

Arterial Pressure Delay (APD) is the time delay from when Arterial Pressure changes occur at the heart to when they are observed at the pump. APD will vary with the pressure monitoring site used (typically central lumen or radial) and with the physiology of the patient.

APD is a value used by the IABP to adjust the time position of the intensified segment of the Arterial Pressure Waveform. APD only effects the position of the intensified segment of the waveform, it does not effect timing. The initial APD default setting is set to 40 msec and is automatically computed on the first assisted beat, following power-up.

While pumping, press and hold the INFLATION INTERVAL key (19) to confirm that the marked and intensified segment of the arterial pressure trace begins approximately at the dicrotic notch.

If not, the Arterial Pressure transmission delay (APD) can be automatically recalculated by quickly pressing and releasing the INFLATION INTERVAL key (19). Confirm proper intensification position.

If still incorrect, APD can be manually adjusted in the Display Preferences section of the Preferences menu. Once APD is selected, the delay may be adjusted from 0 to 180 msec in 4 msec increments using the UP and DOWN ARROW keys (24). The marked and intensified segment of the Arterial Pressure waveform will consequently move later on the trace. This delay can be adjusted to approximate the start of intensification at the dicrotic notch.

NOTE: If the patient's pressure monitoring site is changed while pumping, the INFLATION INTERVAL key (19) can be quickly pressed and released to recalculate arterial pressure transmission delay. Reconfirm proper position. This will assure accurate digital pressure displays.

1.3.2.12 Initiation of Assist

The System 98 incorporates a single button rapid start feature when in the Auto Fill Mode, to expedite the start of IAB assist. The following sequence of operations occur automatically whenever the ASSIST/STANDBY key (9) is pressed for the first time following System 98 power-up:

IAB AutoFill - the IAB catheter circuit is double purged and filled with Helium shuttle gas (skipped if previously filled)

Start Assisting - inflation/deflation begins immediately following the AutoFill

Increase Augmentation - IAB displacement volume is gradually increased to max (skipped if Augmentation Keys (7) are pressed).

To Begin Initial Pumping Following a Power-Up:

1. Connect the IAB, with appropriate catheter extender, to the safety disk pneumatic connection labeled "IAB Catheter Extender Input" (58).

   NOTE: Incorrect IAB and extender combinations can result in incorrect filling volumes or AutoFill failures.

2. Press the ASSIST/STANDBY key (9) to initiate pumping. Confirm that an IAB AutoFill is in progress, indicated by the "Autofilling" message posted in the Advisories field of the display. The balloon catheter circuit will be purged and filled with a calibrated volume of Helium. This fill process will then be repeated.

3. Pumping will begin following the successful completion of AutoFill, indicated by the "Autofilling" message clearing and the ASSIST/STANDBY key indicators flashing with each inflation cycle. To facilitate arterial pressure transmission delay (APD) measurement following a power-up, an abbreviated IAB inflation will occur on the first pump cycle.

4. The System 98 will then progressively increase augmentation on each successive pump cycle until the MAX level is reached. This provides an opportunity, prior to full IAB volume displacement, to make the necessary fine adjustments of IAB INFLATION (10) and IAB DEFLATION (11) timing controls. Augmentation should begin at the dicrotic notch.

   The automatic augmentation feature may be disabled at any time by pressing either the UP or DOWN IAB AUGMENTATION key (7). Subsequent presses of the UP or DOWN keys (7) will incrementally increase or decrease augmentation respectively.

5. Confirm that maximum augmentation was reached, as indicated on the LED bar meter adjacent to the IAB AUGMENTATION keys (7). IAB assist should now be optimized.

6. Verify that after one minute of pumping, the Aug. Alarm limit (48) determination on the display panel is approximately 10mmHg below the patient's diastolic augmentation pressure.

   Fifteen seconds after a valid pressure source is detected, the augmentation alarm limit is automatically set 10mmHg below augmented diastolic pressure. During this one minute learning interval, the alarm limit can increase to a maximum of 200mmHg. However, the limit will never adapt more than 5mmHg below the initial beat's augmentation level. Subsequently, manual adjustments can be made at any time to this predetermined limit.

7. If adjustment to the alarm limit is desired, press the AUG. ALARM key (22). Then press the adjacent UP or DOWN ARROW keys (24) to increase or decrease the alarm limit respectively.

   NOTE: The augmentation alarm, when used properly, serves as an important backup to internal monitoring alarms. Due to the dynamic nature of the shuttle gas system, Gas Loss and IAB Catheter alarms do not operate under severe patient conditions (see Section 1.3.3 for more details). By setting the augmentation alarm, the system monitors the level of assist and will alert the user in the event of a decrease in augmentation pressure.

   Gas Loss and IAB Catheter alarms are inoperative when pumping in the MANUAL IAB FILL mode. Consequently, the use of the augmentation alarm is essential when caring for patients while operating in this mode.

   WARNING: Do not leave the patient unattended during IABP therapy.

To Refill IAB and Resume Pumping Subsequent to Rapid-Start:

The single button rapid-start feature is only available when pumping is initialized following power-up of the System 98. To manage pumping thereafter, the individual IAB Fill and Augmentation Control functions must be accessed directly. (Example: Direct control of these functions is necessary when responding to certain classes of pneumatic alarms, like "IAB Disconnect". This class of alarm requires that the IAB be refilled prior to resuming assist.) If this or any other event requires balloon refilling and pump initiation proceed as follows:

1. Verify that the AutoFill mode is selected by checking that the AUTO LED, adjacent to the IAB FILL MODE key (34), is illuminated.

2. Press and Hold the IAB FILL key (8) for 2 seconds and confirm that an IAB AutoFill is in progress, as indicated by the "Autofilling" message posted in the Advisories field of the display. The balloon catheter circuit will now be purged and refilled once with a calibrated volume of Helium.

3. Assist can be resumed by pressing the ASSIST/STANDBY key (9) when the "Autofilling" message has cleared.

   NOTE: While assisting in the AUTO fill mode the System 98 automatically purges and refills the balloon catheter circuit with Helium every two hours. This fill cycle will complete in approximately 6 seconds, after which assist will automatically resume. An AutoFill can be initiated, at any time, by pressing the IAB FILL key (8). This resets the 2 hour AutoFill timer. Should a 2 hour AutoFill time-out occur while in the STANDBY mode, an AutoFill will be performed immediately upon returning to the ASSIST mode.

   An AutoFill will also occur if local atmospheric pressure decreases or increases by 25 or 50 mmHg respectively, as may occur during air transport. These pressure changes will initiate AutoFills approximately every 1,000 feet of rise or 2,000 feet of drop in altitude to keep the balloon pressure acclimated to local conditions.

NOTE: If the AutoFill procedure fails to purge and fill the safety disk properly, the message "AUTOFILL FAILURE" will be displayed and an audible alarm activated. Corrective action can be obtained by pressing the HELP SCREEN key (29). MANUAL FILL help screens, as well as detailed fill illustrations (See Section 1.3.2.14) are provided should MANUAL FILL become necessary.

1.3.2.13 System Power-Up Defaults

The power-up settings depend upon the amount of time the System has been powered down.

The System recognizes when it has been powered down for less than 15 minutes. When the power is restored within the 15 minute period, the System retains the user settings (with exceptions as shaded in the table below) and trend. The shaded items always return to their default setting.

When the System is powered down for longer than 15 minutes the factory default setting are restored. At this point when the System is powered on, the user settings and the trend are cleared.

To adopt the factory default settings prior to a full 15 minutes power down, press the CHANGE/SELECT key (25) while powering on the System.

The following table lists all of the controls and their default settings. Default settings are programmed at Datascope and cannot be changed.

CONTROLS	DEFAULTS
Trigger Select	ECG
IAB Frequency	1:1
Assist/Standby Mode	Standby (not filled)
IAB Fill Status	Not Filled (a double auto fill is required)
IAB Augmentation	OFF
IAB Inflation	Manually Set - No Default
IAB Deflation	Manually Set - No Default
ECG Lead	II
Pressure Source	Internal
Pressure Zero	Not Zeroed
Arterial Pressure Delay	APD First Pump
Freeze Display	Not Frozen
Help Screen	OFF
Ref Line	@ 0 mmHg
Alarm Mute	Not Muted
Alarm Volume	Mid-Level
Aug Alarm	@ 10 mmHg below the patient's diastolic pressure
ECG Gain	Normal
Pressure Threshold	Normal
Internal Rate	Normal (Fixed 80 BPM)
Slow Gas	ON
Timing	AUTO
IAB Fill Mode	AUTO

The following table lists all of the default preferences, selected by pressing the PREFERENCES MENU key (27).

PREFERENCES	DEFAULTS
Sweep Speed	25 mm/sec.
Brightness	High
Balloon Waveform	As Last Set (Intially set to ON at Datascope)
ECG Inflation Markers	As Last Set (Intially set to OFF at Datascope)
Flash Alarm Messages	OFF
Beep Volume	OFF
Standby Advisory Tone	As Last Set (Intially set to OFF at Datascope)
Pressure Scale	As Last Set*

* The Pressure Scale setting will remain as set unless power is shut down for more than 15 minutes. In this case, if the Pressure Scale is set to manual the pump will return to 0-160 scale. If the Pressure Scale is set to Auto, the pump will always return to Auto until the user selects a manual setting.

The following table lists all the default printer menu settings, selected by pressing the PRINTER MENU key (28).

PRINTER MENU SETTINGS	DEFAULTS
First Waveform	ECG
Second Waveform	Arterial Pressure
Strip Length	15 seconds
Timed Print	OFF
Print on Alarm	OFF

1.3.2.14 Manual Fill Mode

If an Autofill failure remains unresolved after following the associated HELP SCREEN instructions, the IAB may be manually filled. Step-by-step HELP SCREEN instructions for manual fill are also provided for display at the bedside. These HELP SCREENS become available following a press and hold of the IAB FILL key (8) in the MANUAL FILL mode. The step-by-step manual fill instructions with graphical illustrations are included below for Adult IABs:

WARNING: *Gas loss and IAB catheter alarms are disabled while in the Manual Fill Mode. (The Slow Gas override LED is illuminated.)*

NOTE: When in the Manual Fill Mode, the condensate removal module system will not operate.

1. Select MANUAL using the IAB FILL MODE key (34).

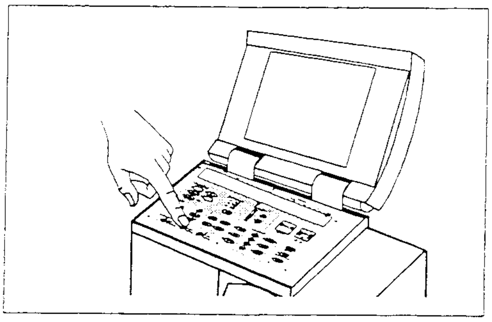


Figure 1-16

Press Manual Key

2. Remove the autofill tubing from the IAB Fill Port (75) on the safety disk.

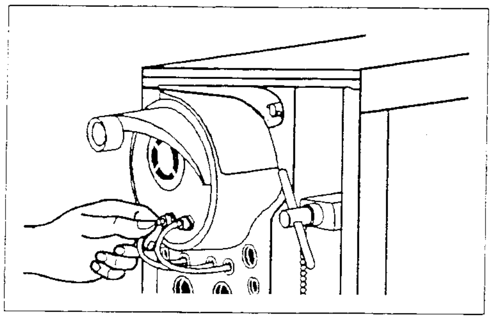


Figure 1-17

Remove Autofill Tubing

3. Attach a three way stopcock to the IAB Fill Port (75) on the safety disk.

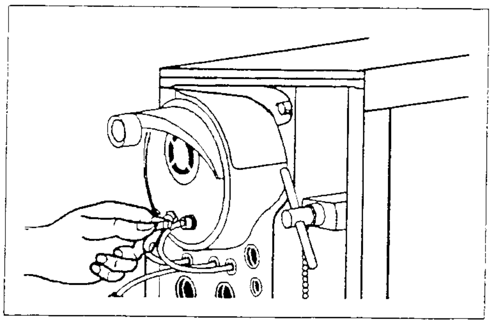


Figure 1-18

Attach 3-way Stopcock

4. Attach a plastic 60cc syringe to the stopcock.

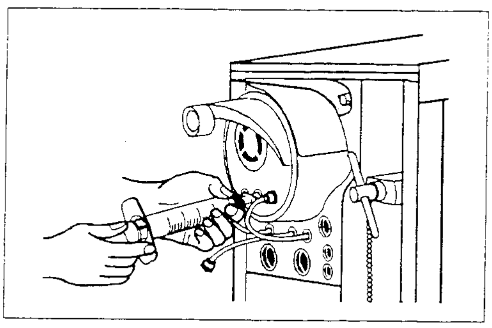


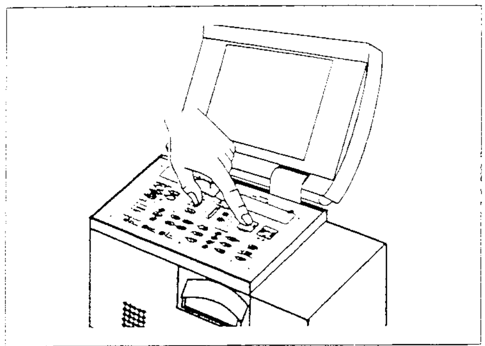
Figure 1-19

Attach Syringe

5. Press the IAB FILL key (8) for 2 seconds to relieve vacuum. Verify "MANUAL FILL" is displayed in the status area.

Figure 1-20

Press IAB Fill Key

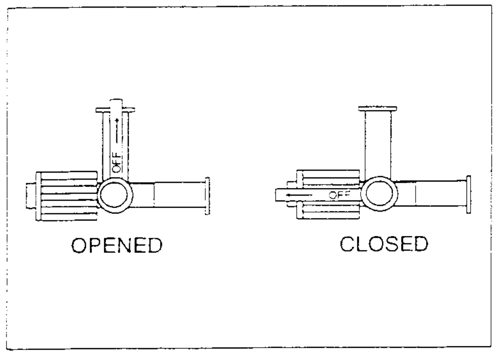


NOTE: All Datascope adult size IAB catheters plus extender have a manual fill volume of 80cc. When using catheters from another manufacturer consult that manufacturer for guidelines.

6. Open the stopcock between the disk and syringe. Evacuate the disk by pulling back on the syringe plunger.
7. Close the stopcock to the disk. Evacuate the syringe.
8. Repeat steps 6 and 7 until a strong resistance is noted. A strong resistance should be noted within three attempts. If a strong resistance is noted, proceed to step 10.

Figure 1-21

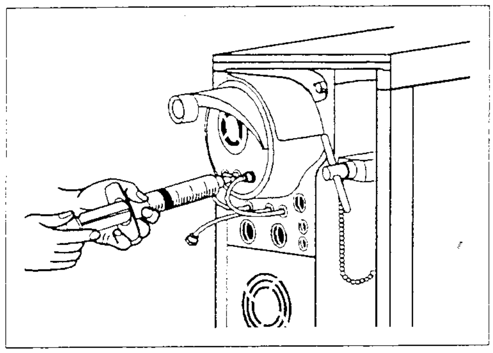
Open and Close Stopcock



9. If a strong resistance is not noted within three attempts, remove the Drain port tubing and attach the Drain port plug, located in the manual fill accessory kit, to the Drain port. Repeat steps 6 - 8.

Figure 1-22

Pull Back on the Plunger to Evacuate the Syringe



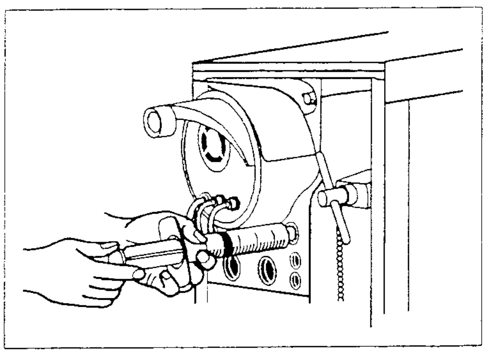
10. Attach the syringe to the Manual Fill Port (73) located on the rear panel. Hold hand over syringe plunger.

WARNING: Never use a glass syringe for the Manual Fill Procedure. Possible injury may occur if glass breaks.

11. Fill the syringe and discard the contents.
12. Re-fill the syringe with 40cc of helium.

Figure 1-23

Attach Syringe to Manual Fill Port



13. Quickly move and attach the syringe to the stopcock on the safety disk, and open the stopcock to the disk.

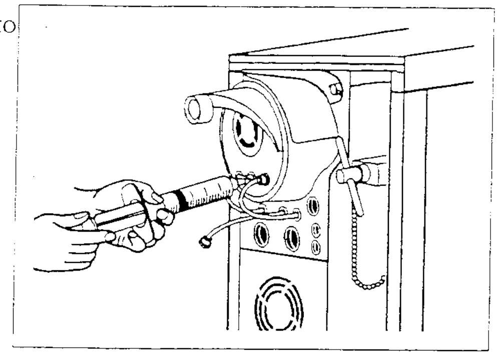


Figure 1-24

Attach Syringe to Stopcock

14. Press the IAB FILL key (8) for 2 seconds to allow the syringe contents to be drawn into the disk.

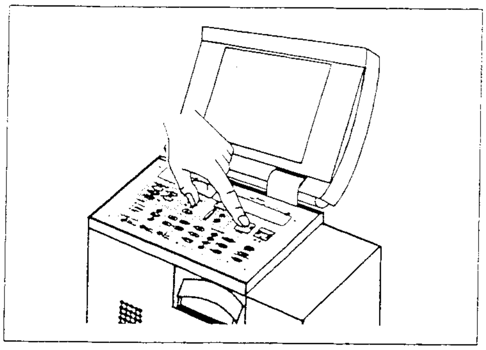


Figure 1-25

Press the IAB Fill Key

15. Close the stopcock to the disk.

16. Refill the syringe with the remaining 40cc fill volume of helium from the Manual Fill Port (73).

17. Quickly move and attach the syringe to the stopcock on the safety disk.

18. Open the stopcock to the safety disk. The remaining 40 cc of gas will be drawn into the disk.

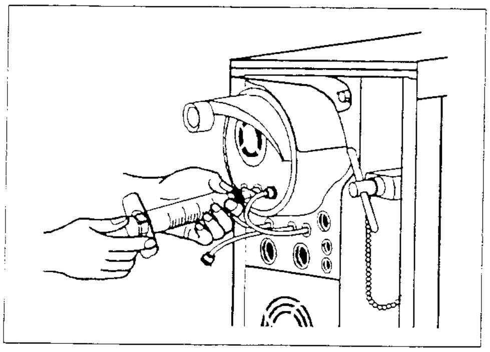


Figure 1-26

Syringe Contents Drawn into Disk

19. Close the stopcock and remove the syringe.

PRECAUTION If the contents of the syringe are not drawn into the safety disk DO NOT resume balloon pumping. Return to step 5 in the Manual Fill Procedure, paying careful attention to syringe fill volume. If second attempt fails, there most likely is a leak at one of the safety disk ports or stopcock and they should be checked.

20. Press the ASSIST/STANDBY key (9) to begin pumping.

NOTE: Due to diffusion of gas, the manual fill procedure should be repeated every 2 hours or as needed.

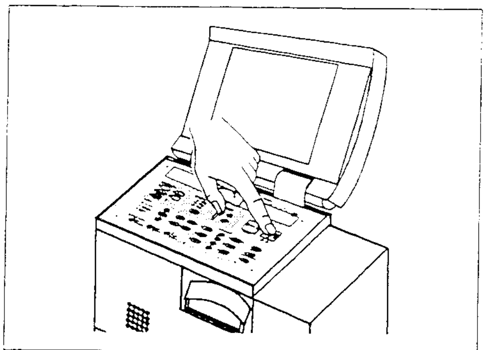


Figure 1-27

Press ASSIST/STANDBY Key

1.3.3 SYSTEM ALARMS, ALERTS, and STATUS/ PROMPTS

There are various types of condition-specific messages. They are: ALARMS, ALERTS, STATUS/PROMPTS and AUX (auxiliary). These messages are displayed based on the priority of the condition that prompted them.

When an ALARM message is displayed, IAB pumping is suspended and a steady tone is sounded.

When ALERT messages are displayed, IAB pumping is not suspended, but corrective action is required. ALERT conditions which require immediate action cause a continuous double beep tone to sound. All other ALERT conditions (except for *heart rate low*) sound a double beep tone that repeats for 30 seconds.

STATUS/PROMPT messages do not sound any tones (except for "Unplug Outlet and Plug Outlet") and are advisory in nature.

AUX messages are displayed when Setup or Help screens are available.

ALARM messages are displayed in the ALARM MESSAGES (36) section of the display. There is one alarm message line. If more than one alarm condition occurs simultaneously, the highest priority alarm is displayed. When the first alarm condition has been corrected, then the next highest priority alarm is displayed. See Message Summary Table for priority listing. The table is in priority order.

ALERT and STATUS/PROMPT messages are displayed in the ADVISORIES (37) section of the display. There are three lines in this display. If more than three messages need to be displayed simultaneously, the three highest priority messages are displayed. When one alert or status/prompt condition is corrected or eliminated, then the next highest priority message is displayed. See Message Summary Table for priority listing. The table is in priority order.

Gas Loss Alarms provide surveillance for leaks which can result in gas leaving or entering the IAB circuit. IAB Catheter Alarms detect an occlusion of the IAB catheter or extender. Gas can be trapped in the IAB and/or the safety disk depending on the timing of the occlusion with respect to the pump cycle.

Gas Loss including IAB Disconnect and IAB Catheter alarm operation is maintained at heart rates up to 140 BPM*. However one component of the catheter alarms, detection of gas trapped in the safety disk, is suspended at 112 BPM* to minimize nuisance alarms.

WARNING: The Augmentation Alarm, which is automatically set at power-up, provides back-up to these alarms at higher rates. Therefore, it is important that once set this alarm NOT be manually disabled.

WARNING: When the System is operated in the Manual Fill mode, IAB gas loss and catheter alarms are disabled.

**Timing sliders at nominal mid-position (Auto Timing).*

1.3.3.1 Alarm and Advisory Table

The following pages provide a table of all ALARM, ALERT, STATUS, and PROMPT messages. The table provides detailed information for each message, but does not contain corrective action. See the Help Screens for correction action.

Message Type	Message Displayed	Probable Cause	System Response	Audible Alarm	Alarm Reset
Alarm	"Electrical Test Fails, Code #___"	Failure of one or more electrical sub-system tests during system power-up diagnostic.	System is held in VENT mode / IAB deflated.	Steady, on immediately	Attempt to clear by cycling power OFF & ON.
	"System Failure"	Solenoid driver watchdog detected vacuum and/or pressure solenoid energized for approx. 2 seconds or IABP processor failure.	System disabled & default drive vacuum is restored to safety disk / IAB deflated.	Steady, on immediately	Attempt to clear by cycling power OFF & ON. Not user mutable.
	"Safety Disk Test Fails"	Leak detected in Safety Disk/Auto Fill Assembly during S.D. diagnostic test or test prompts not executed properly.	S.D. Diagnostic Mode/ IAB is NOT connected.	Steady, on immediately	Hold FILL key down for two seconds.
	"Autofill Failure - No Helium"	Balloon could not be AUTOMATICALLY filled because of inadequate Helium gas supply.	Vent / IAB deflated	Steady, on immediately	Manually, must hold FILL key for two seconds to either retry autofill or to manually fill.
	"Blood Detected"	Patient leak in IAB / catheter resulting in blood migration back to autofill tubing.	Vent / IAB deflated	Steady, on immediately	Manually, must hold FILL key for two seconds to retry manual fill.
	"Autofill Failure"	Balloon could not be AUTOMATICALLY filled as defined in performance section but, Helium supply is adequate.	Vent / IAB deflated	Steady, on immediately	Manually, must hold FILL key for two seconds to either retry autofill or to manually fill.
	"Rapid Gas Loss"	Large instantaneous (beat-to-beat) loss of approx. 2.5 cc of shuttle gas. Possible tear break in balloon or catheter.	Vent / IAB deflated	Steady, on immediately	Message and tone cleared when FILL key is pressed for two seconds. Standby condition cleared with manual depression of ASSIST/ STANDBY key AFTER successful fill.
	"IAB Disconnected"	Disconnection at IAB or extension catheter while in the ASSIST mode.	Vent / IAB deflated	Steady, on immediately	Message and tone cleared when FILL key is pressed for two seconds. Standby condition cleared with manual depression of ASSIST/ STANDBY key AFTER successful fill.

Message Type	Message Displayed	Probable Cause	System Response	Audible Alarm	Alarm Reset
Alarm	"High Drive Pressure"	Regulated pressure from compressor exceeds acceptable operating range.	Standby / IAB deflated	Steady, on immediately	Manually, by pressing ASSIST / STANDBY key.
	"Autofill Required"	Prompts the user to autofill the IAB. This prompt only occurs in the "Assist" mode when: 1) The current IAB fill was "Manual" and the user switched to the "Auto" mode. 2) The current IAB Fill is "Auto" and the automatic fill is over-due because the System was: a) switched to the "Manual" IAB fill mode, or b) in the "Standby" mode.	Standby / IAB deflated	Steady, on	Manually, when an autofill is initiated.
	"Check IAB Catheter"	Occlusion of IAB/ extension catheter or unwrapped balloon.	Standby / IAB deflated	Steady, on immediately	Manually, by pressing ASSIST / STANDBY key.
	"Leak in IAB Circuit"	Cumulative shuttle gas loss exceeds the 5 cc/hr. dynamic limit, or total loss exceeds 12.5 cc, relative to last autofill volume. Active ONLY in AUTO FILL mode with IAB inflation period > 150 msec and deflation period > 200 msec.	Standby / IAB deflated	Steady, on immediately	Message and tone cleared when fill key is pressed for two (2) seconds. Standby condition cleared with manual depression of ASSIST/ STANDBY key AFTER successful fill.
	"No Pressure Trigger Zero Transducer"	Displayed when internal source B.P. transducer is connected and pressure trigger is selected but the transducer has NOT been zeroed.	Standby / IAB deflated	Steady, on immediately	Message and tone cleared when transducer is manually zeroed. Standby condition cleared with manual depression of ASSIST / STANDBY key AFTER successful zeroing.
	"Low Vacuum"	Insufficient or no compressor vacuum.	Waiting to pump (Pseudo standby) / IAB deflated	Steady, on immediately	Automatically, when vacuum is restored.
	"Check Pacer Timing"	V/A-V pacer trigger interval varies >25% or an A-V pacer rate is >125 bpm.	Waiting to pump (Pseudo standby) / IAB deflated	On steady after 15 sec silence	Automatically, if pacer timing conditions are met. Manually, be de-selecting pacer trigger mode.
	"No Trigger"	Valid trigger, as defined in performance section, does NOT exist or is lost while in ECG or Pacer trigger mode.	Waiting to pump (Pseudo standby) / IAB deflated	On steady after 15 sec silence NOTE: The audible alarm will be suppressed, if a valid heart rate (R-R interval) was not detected since the pump was turned on.	Automatically, when trigger returns.

Message Type	Message Displayed	Probable Cause	System Response	Audible Alarm	Alarm Reset
Alarm	"No Pressure Trigger"	Valid trigger, as defined in performance section, does NOT exist or is lost while in Pressure trigger mode.	Waiting to pump (Pseudo standby) / IAB deflated	On steady after 15 sec silence	Automatically, when trigger returns.
	"Trigger Interference"	Electrosurgical noise detected while in the Pacer trigger mode.	Waiting to pump (Pseudo standby) / IAB deflated	Steady, on after 15 sec delay, time out after 15 sec	Automatically, when ESU interference stops.
Prompt	"Unplug Disk Outlet"	Prompts user at start of Safety Disk Leak Diagnostics to open the safety disk's catheter connector so that atmospheric pressure may be sampled. The diagnostic will remain paused until the prompt is cleared.	S.D. Diagnostic Mode / IAB is deflated	Steady, on immediately	Manual, press FILL key for two seconds to resume testing.
	"Plug Disk Outlet"	Prompts user at start of Safety Disk Leak Diagnostics, to cap the safety disk's catheter connector. The user is given 10 seconds to plug the connector before the prompt is cleared and the diagnostic resumes.	S.D. Diagnostic Mode / IAB is NOT connected	Steady, on immediately	Automatic, after ten second delay interval.
	"IAB Not Filled"	Notifies the operator that a request to assist has been made but the IAB circuit has NOT been filled with shuttle gas.	Vent Mode / IAB is deflated	None	Manual, press FILL key for two seconds to initiate a fill.
	"Manual Fill IAB"	Notifies the operator when to manually fill the IAB catheter with shuttle gas. Displayed in MANUAL FILL mode when the FILL key is activated, venting the safety disk.	Fill Mode (S.D. Drive Vented) / IAB deflated	None	Manual, press FILL key for two seconds.

Message Type	Message Displayed	Probable Cause	System Response	Audible Alarm	Alarm Reset
Alert	"ECG Detected"	ECG activity is detected persistently for 4-6 seconds while in the internal (non-synch.) mode.	Assisting / IAB is immediately deflated on each R-wave.	Continuous double beep	Automatically, when ECG activity ceases. Manually, de-selecting Internal trigger mode.
	"Irregular Trigger"	While in Pressure trigger mode, erratic trigger from: 1) arrhythmic patient rhythm 2) late deflation; inhibiting pressure pulse detection .	System automatically bases deflation on shorter cardiac intervals.	After 60 second delay, double beep - times out after 2-3 seconds and repeats every 5 min.	Automatically, when trigger interval is regular.
	"Augmentation Below Limit Set"	Diastolic augmentation has dropped below user selected limit.	Unaffected	Continuous double beep	Automatically, when augmentation rises above alarm limit.
	"Heart Rate Low"	H.R. < 40 BPM	Unaffected	None	Automatically, when H.R. increases
	"Low Battery (EXT)"	The external source falls below 30 minutes of operating time..	Unaffected	Double beep - times out after 30 seconds. Repeats every 10 minutes.	Automatically removes message, turns off tone, transfer to internal battery occurs.
	"Low Battery"	Battery reserve falls below 30 minutes of operating time.	Unaffected	Double beep - times out after 30 seconds. Repeats every 10 minutes.	Automatically removes message and turns off tone when AC is restored.
	"Maintenance Required Code # ___"	System maintenance may be required.	Unaffected	Double beep - times out after 30 seconds.	Attempt to clear by cycling power OFF and ON.
	"Low Helium"	Helium supply is below a 24-fill reserve as determined by tank pressure.	Unaffected	Double beep - times out after 30 seconds.	Automatically with new He tank.
	"Prolonged Time in Standby"	Pump has been in Standby for at least 20 minutes.	Unaffected	User Enabled /Disabled - Double beep times out after 30 seconds. Repeats every 5 minutes.	Resume pumping
	"No Patient Status Available"	Internal electronics failure.	Assisting / IAB inflating & deflating	Continuous double beep	Attempt to clear by cycling power OFF and ON.

Message Type	Message Displayed	Probable Cause	System Response	Audible Alarm	Alarm Reset
Status	"Leak Testing Safety Disk"	Displayed during the safety Disk Leak Diagnostic to indicate that testing is still in progress.	S.D. Diagnostic Mode / IAB is not connected	None	N/A
	"Autofilling"	Indicates that the System is in the process of automatically purging and refilling the IAB with Helium.	Fill Mode / IAB deflated	None	N/A
	"Gas Loss and Catheter Alarms Disabled"	All leak and catheter alarms are disabled when manual fill mode is selected (IAB catheter is manually filled).	Unaffected	None	N/A
	"Slow Gas Loss Override On"	Slow gas loss alarm disable is selected by user. (Note: Rapid loss function still active.)	Unaffected	None	N/A
	"R-Wave Deflate"	Operator enabled R-wave deflation by moving deflate slider to extreme right position.	Unaffected - Deflation begins on R-wave detection.	None	Move deflation slider away from extreme right position.
	"Battery in Use (EXT)"	Indicates System is operating from an external DC source.	Unaffected	None	Power System from an AC power source.
	"Battery in Use"	Indicates System is operating from an internal battery.	Unaffected	None	Power System from external battery source or AC power source.
	"System Test O.K."	Indicates that all sub-systems checked during power-up passed diagnostics.	Vent / IAB deflated	None	Automatic, message is displayed for approx. 10 seconds following the completion of tests.
	"System Trainer"	Displayed when the Series 90 Trainer is being used as ECG and Pressure source.	Unaffected	None	N/A
Aux	"Help Available for Initial Setup"	Displayed at power-up until the first pump cycle.	Unaffected	None	N/A
	"Help Available for Manual Fill IAB"	Displayed when the user selects MANUAL Fill. There is no advisory message displayed. Only a status message on the bottom of the screen.	Unaffected	None	N/A

1.3.4 Water Condensation

During the balloon pumping procedure, a fine mist or small droplets of water may occasionally be observed within the IAB extension catheter and/or fill and drain tubing. This mist is condensed water vapor. The System 98 has a condensate removal module which automatically collects and removes condensate without operator intervention.

If desired, the following procedure may be used to manually check and purge any condensate which may have collected in the IAB extension catheter.

1. Set IAB FILL MODE key (34) to "MANUAL" and the ASSIST/STANDBY key (9) to "STANDBY."
2. Disconnect patient balloon catheter extender from patient IAB and tip downward.
3. Set pump to "ASSIST."
4. Pump for approximately 20 to 30 seconds. Water will be expelled.
5. Set pump to "STANDBY" and reconnect extender to patient IAB.
6. Return the IAB fill switch to the original fill mode, purge and refill patient balloon/safety disk and resume balloon pumping.

NOTE: If large water droplets remain in 6 foot extender (P/N 0684-00-0182), it may be attached to suction to remove them. Be sure extension is disconnected from IAB and safety disk.

(See User Maintenance, Chapter 4 of Operating Instructions).

NOTE: When in the Manual Fill Mode or when the battery is low, the condensate removal module will not operate.

NOTE: When transferring a patient from another IABP System without a condensate removal feature, ensure that all droplets of condensate are removed from the extension catheter tubing before connecting to the System 98. To remove condensate the procedures above may be used or follow the IABP manufacturer's recommendations.

PRECAUTION Proper operation of the automatic condensate removal module requires proper connection of the safety disk assembly to the console. Excessive condensate may indicate the need to service the condensate removal module.

PRECAUTION The Condensate Removal Module (CRM) is designed to function most efficiently when the unit is in a normal upright (vertical) position. Transient operation of the CRM in a horizontal position should be limited if condensate removal functionality is required. Technical Service should be consulted for IABP's which are permanently configured for horizontal use.

1.3.5 CLINICAL CONSIDERATIONS DURING OPERATION

1. ECG: There are several methods to correct conditions which alter or hamper the acquisition of a reliable ECG. Repositioning or replacement of the ECG electrodes, choosing an alternate lead selection or ECG GAIN settings and checking that the patient cable is properly connected are the most common solutions.

2. Pressure: Flush arterial line at regular intervals per standard hospital procedure. Adequate flushing to maintain pressure line patency and alignment of stopcock in the proper position will prevent the majority of possible pressure trace problems.

3. Atrial Fibrillation: Use the AUTO timing mode. With the pump in "STANDBY", adjust the IAB INFLATION (10) and IAB DEFLATION (11) controls to position the highlighted inflation interval marker of the arterial waveform to correspond to diastole. In the ECG Trigger mode, the deflate slide control may be moved all the way to the right (to the R-wave deflate label) allowing the R-wave to deflate the IAB. "*R-Wave Deflate*" will also be posted in the advisories field of the display.

4. Triggering on Ectopics: In the Auto mode, the System 98 automatically deflates on and assists the ectopic beat, if the ectopic R-wave is sensed. If the ectopic is of small amplitude, reliable triggering can be maximized if an ECG Lead is selected which minimizes the amplitude difference between the normal QRS complex and that of the ectopic beat. No special adjustments are necessary.

5. Cardiac Arrest-Ventricular Fibrillation: When defibrillating the patient, the System 98 has protection and is completely isolated from the patient and the unit. However, the operator should stand clear of the System during defibrillation.

6. Ventricular Standstill or Prolonged Cardiac Arrest: If possible, use ECG or arterial pressure trigger during CPR. The System will synchronize trigger to the rate and rhythm of chest compressions. If ECG or arterial pressure trigger does not produce adequate trigger to allow for balloon movement, the IAB may be placed in the internal trigger mode. The normal internal rate is 80 BPM but can be varied between 40 and 120 BPM using the UP & DOWN ARROW keys (15). Adjust the augmentation key to produce a slight movement of the disk diaphragm by observing the IAB STATUS INDICATOR (41). Observe the IAB STATUS INDICATOR (41) and the patient's arterial pressure to make the proper adjustments. This allows minimal movement of the IAB which will reduce potential thrombus formation. Note that IAB FREQUENCY key (6) does not affect pump rate in INTERNAL trigger mode.

   WARNING: The patient balloon should not remain inactive (i.e. no inflating and deflating) for more than 30 minutes; due to the potential for thrombus formation.

7. Change in Pressure Monitoring Site: If patient's pressure monitoring site is changed while pumping, the INFLATION INTERVAL (19) key can be quickly pressed and released to recalculate arterial pressure transmission delay (APD). This will assure accurate digital pressure display values and arterial pressure trace inflation interval markers.

8. Simultaneous connection of several medical devices to the patient may cause summation of LEAKAGE CURRENTS which can exceed the values allowed by the Safety Agency Standards (see section 3 - Agency Compliance).

1.3.6 USE IN ELECTROSURGICAL ENVIRONMENT

The System 98 IABP has built in electrosurgical interference suppression which minimizes electrosurgical unit (ESU) noise from disturbing System performance. While the system will suppress ESU noise, it cannot eliminate it all together. Sparking to tissue occurs when an ESU is operated. This generates noise that extends into the ECG frequency range. Since the system must pass these frequencies, some ESU noise may interfere with the ECG signal, particularly with high ESU power settings.

Limiting the power of this noise energy is desirable. The magnitude of interference is directly related to the power setting of the ESU, which should be as low as possible for the intended effect. Successful ECG triggering in the presence of ESU noise depends, to a large extent, on proper patient preparation and ESU use.

Following the guidelines listed will minimize the amount of energy coupled from the ESU to the ECG input of the System 98, generally resulting in stable ECG triggering. However, if noise cannot be reduced to an acceptable level, the arterial pressure trigger mode can be selected. When ECG signal acquisition improves, always return to the original trigger mode selection.

When the System 98 is to be used in an electrosurgical environment, the following techniques are recommended to minimize interference from electrosurgical devices.

- Keep the ECG cables at right angles to the electrosurgical cables to the greatest extent possible.
- Locate the ECG electrodes as far away from the surgical site as possible.
- Locate the ECG electrodes approximately equidistant from the surgical site to minimize any difference in potential between electrodes.
- Place all ECG electrodes on the same plane (either anterior or posterior) to minimize any difference in potential between electrodes.
- Place the electrosurgical return plate directly under the surgical site.
- Use the minimum required electrosurgical setting.

WARNING: External bedside monitors used with the System 98 in the operating room, must be equipped with electro-surgical interference suppression.

1.3.7 USE DURING CARDIOPULMONARY BYPASS

During cardiopulmonary bypass the System 98 can be used to inflate and deflate an IAB already in position by selecting INTERNAL trigger mode. The internal rate can be adjusted by using the UP & DOWN ARROW keys (15) in the Auxiliary Keys group on the keypad.

While the patient is on full bypass, auto timing mode can be used and the INFLATION (10) and DEFLATION (11) controls set to mid position.

If ECG activity is detected while in the internal trigger mode, the IAB will be immediately deflated to avoid asynchronous pumping and resultant interference with systole.

WARNING: Do not remain in the internal trigger mode when the patient is generating a cardiac output.

When weaning a patient from cardiopulmonary bypass, the IABP can be used to assist cardiac function. If ECG is established it can be used to trigger the System. Check to see if a reliable ECG trigger is present by noting a flashing diamond in the upper right corner of the display. The diamond should flash one time for each R-wave.

If the patient's ECG amplitude is insufficient to cause triggering, the ECG GAIN may be adjusted to increase amplitude. If a pacer is present, the appropriate pacer trigger mode can also be used (see TRIGGER section 1.3.2.8). Pressure triggering is also available if a 7 mmHg minimum pulse pressure is present.

As bypass flow rate is decreased and the heart begins to generate a cardiac output, check that timing is correct. Frequent reassessment may be necessary as changes in patient condition may alter the relationship of electromechanical events.

1.3.8 WEANING A PATIENT FROM IABP SUPPORT

Weaning may be accomplished by a gradual and progressive reduction in IAB frequency, in IAB volume displacement (augmentation) or a combination of both.

When weaning, it is recommended that frequent assessment of hemodynamic parameters and patient condition be done.

WARNING: When weaning by reduced IAB augmentation, do not reduce augmentation to a point at which no movement of the IAB status indicator is observed.

1.3.9 PORTABLE OPERATION

Datascope recommends that certain conditions be met during portable operation. They are:

- Battery fully charged. If power is interrupted for less than 15 minutes, the system will restore most user settings upon start-up (refer to Section 1.3.2.13 "System Power-up Defaults" for more information).
- Back up battery available.
- Altitude changes are compensated for automatically in the Auto Fill mode or manually in the Manual Fill mode.
- The System is secure and stable when used on an ambulance, helicopter or fixed wing aircraft.

The System 98 is available in two versions. A console version with a hospital cart or the System 98 Universal Transport System (UTS). Both may be used in transport, however, for more intensive transport requirements, the UTS version mechanically attaches to a docking station for high load strength mounting. See section 5.5 in the Operating Instructions for details.

PRECAUTION The user should continually rely on visual alarm messages during high noise transport situations. The "Flash Alarms" option in the Preferences Menu should be turned on to improve the visibility of alarm messages.

PRECAUTION Prior to transport, ensure that the helium cylinder yoke handle is tight and the helium pressure gauge (76) is a least 25% full. Approximately every 30 minutes during transport. verify that the yoke handle has remained tight and that a noticeable pressure drop has not occurred.

PRECAUTION Prior to using the System in any other position except vertical, consult with Technical Service.

1.3.9.1 Battery Operation

During portable operation, the System 98 is powered by a rechargeable battery. Prior to portable operation the battery should be fully charged. A fully charged battery is indicated by a continuously illuminated BATTERY CHARGING LED (78). NOTE: It is important to perform preventive maintenance procedures on the battery. Refer to Chapter 4 for guidelines.

The "*BATTERY IN USE*" status message and BATTERY INDICATOR (49) display whenever the System 98 is operated from the internal rechargeable battery. When the battery has approximately 30 minutes of operating time remaining the following occurs:

- An audible double beep alarm is activated for 30 seconds.
- The "*LOW BATTERY*" or "*LOW BATTERY (EXT)*" alert message is displayed on the screen continuously.
- the BATTERY INDICATOR (49) is displayed as empty and it starts flashing.
- The condensate removal module will not operate.

The "BATTERY IN USE (EXT)" status message is displayed when the spare battery pack or external DC supply is connected and AC power is not present.

1.3.9.2 Battery Charging

To charge the internal battery:

1. Leave the System power cord plugged in and set the MAINS ON/OFF (63) to "ON."
2. Check that the BATTERY CHARGING LED (78) is illuminated.
3. Allow a minimum of 18 hours to fully charge a low battery
4. A fully-charged new internal battery will provide at least 120 minutes of portable operation. NOTE: A reduction in run time will occur over a battery's life for various reasons such as, age, storage temperature, and discharge depth. Batteries which are continually subjected to complete discharge cycles without the recommended immediate recharging, can incur permanent damage. For further information refer to the Preventive Maintenance Schedules A and B, in section 4.

1.3.9.3 Switching from AC to Battery Operation

1. The System automatically switches to battery power if AC power is removed (intentionally or due to power loss).
2. If necessary, charge the battery as described in accordance with previous instructions.
3. Verify that the "*BATTERY IN USE*" advisory message and BATTERY INDICATOR (49) is displayed.
   NOTE: Battery charging is not active in this state.
4. When AC power is restored the System automatically reverts from internal battery operation to AC Mains usage. The internal battery pack will resume its charging while the System operates from AC Mains power. Always verify that the BATTERY CHARGING LED (78) is continuously illuminated or flashing.

1.3.9.4 Operation from Vehicle Inverter

The System 98 can be powered from a portable AC source, such as an emergency vehicle inverter. (An inverter converts the low voltage, DC power from the vehicle's electrical system to AC power compatible with the System 98.) The inverter should be checked for proper operation by qualified maintenance personnel prior to emergency use. The message "Battery in Use" will not be displayed during proper AC inverter operation. The inverter must meet the following specifications:

SPECIFICATIONS OF VEHICLE INVERTER FOR USE WITH DATASCOPE SYSTEM 98

Voltage Output:	100-120 / 220-240 VAC ±10%
Frequency:	50 Hz ±2 Hz, 60 Hz ±2 Hz
Overshoots:	Shall not continuously generate overshoots greater than 375 volts peak with widths greater than 10 micro seconds when powering the System.
Waveform:	Sine wave, modified sine wave or square wave NOTE: Square wave level must be 110 VRMS or greater.
Output Capability:	Minimum of 1000 watts continuous power; 10A surge current
Safety Compliance:	Must meet or exceed safety standards per IEC 601-1.

The operating sequence is the same as described in Section 1.3.2.1, except that AC power is obtained from the inverter receptacle. Interruption of the vehicle inverter AC power will result in internal battery operation, as described in Section 1.3.9.1.

1.3.9.5 Operation From External DC Source

In this case, the System is to be powered from an external DC source such as may be available from an ambulance, helicopter, or external battery pack.

1. Connect a voltage-compatible* external source to the External DC Input Connector (64).
2. Internal battery will not be charged in this mode.
3. The IABP ON/OFF switch (77) will activate the System 98.
4. Interruption of the external DC source power will result in portable internal battery operation, as described in Section 1.3.9.1.
5. The internal BATTERY INDICATOR (49) will not be displayed during external DC operation

**See Section 3 in the Appendix for "Power" compatibility issues.*

1.3.9.6 Effects of Altitude Changes During Air Transportation

NOTE: Before using the System in air transportation, check for sufficient supply of helium since the balloon will be filled several times.

For proper operation during air transport, the System 98 balloon pressure must adapt to local atmospheric pressure. In the Auto Fill Mode the System will automatically purge and fill the IAB when local atmospheric pressure decreases or increases by 25 or 50 mmHg respectively. These pressure changes occur approximately every 1,000 feet of rise or 2,000 feet of drop in altitude.

NOTE: The Auto Fill Mode should be used during air transport. If the Auto Fill Mode cannot be used and the Manual Fill Mode is required, ensure that a manual fill is performed at the same intervals that an auto fill would occur.

NOTE: For information on outfitting an aircraft for IABP transport contact your local Datascope sales representative. Also, see Section 5 in the Operating Instructions for instructions for use for the Docking Station and Mobilizer.

1.3.9.7 Portable Operation Emergency Battery Back Up Recommendations

Datascope recommends that a back-up to the internal battery always be available.

In the event that the internal battery pack does not power the System, the operator should first attempt to restore power via AC Mains sources (including those listed in Section 1.3.9.4). The second attempt is to restore power via external DC sources as listed in Section 1.3.9.5.

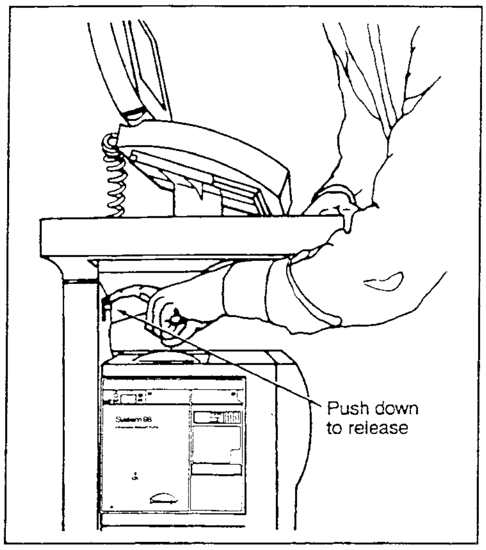
1.3.9.8 Removing Pump Console from the Cart

The console can be removed from the cart with or without the battery pack attached. Removing the console without the battery pack attached reduces the lift weight by approximately 35 lbs.

NOTE: When either removing the pump console from the cart or returning the pump console to the cart, ensure that the wheels of the cart are in the locked position.

Figure 1-28

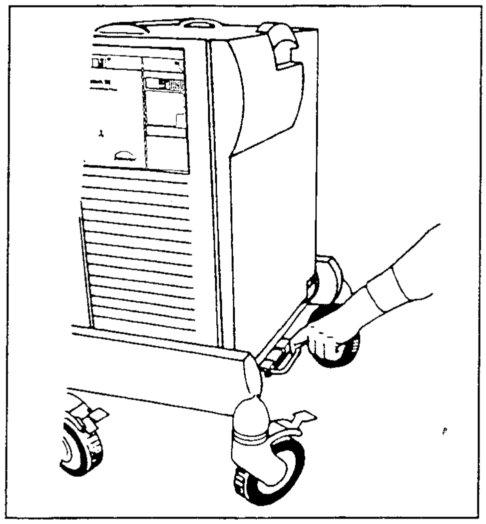
Push Down to Release Handle



1. Lock the wheels on the cart. Pivot the cart handle out of the way.The cart handle swivel release is located on the inside surface of the vertical support column near the top. To release, push knob down and pivot the handle counter-clockwise approximately 180°. Follow the same procedure when returning the handle to its normal "locked" position.
   To remove console with battery pack attached, continue with step 2. To remove console by detaching battery pack, skip to step 3.
2. To remove with the battery pack attached: Keep the release levers on the battery pack in the locked position. Pull the console release handle on the cart base by pressing the tab to the right of the handle and pulling straight out. Lift pump console (to lift, grab the pump console along the top edge of the front and rear panel) straight up, off the cart and place down near the cart. Skip to step 5.

Figure 1-29

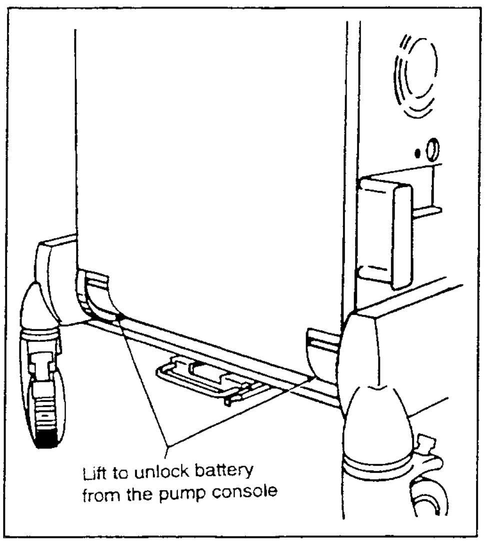
Pull Console Release Handle



3. To remove by detaching battery pack: While the console is attached to the cart, lift both battery release levers up to the unlocked position. Lift the console (to lift, grab the pump console along the top edge of the front and rear panel, as shown in the figure with step 4) straight up, off the cart and place down near the cart. The battery pack remains on the cart.
4. To release the battery pack from the cart, pull the console release handle located just below the battery pack (as shown figure 1-28). Use both hands to

Figure 1-30

Lift Levers to Unlock Battery



pick up the battery pack. Place the battery pack on a dry, flat surface. Lift the release levers up to the unlocked position. Lift the pump console (to lift, grab the pump console along the top edge of the front and rear panels) and carefully lower it straight down onto the battery pack. When firmly seated, push the release levers into the locked position. Test the electrical integrity by turning the IABP ON/OFF switch ON. If System does not turn on, lift the release levers, lift up pump console and lower again. Repeat until proper connection is made.

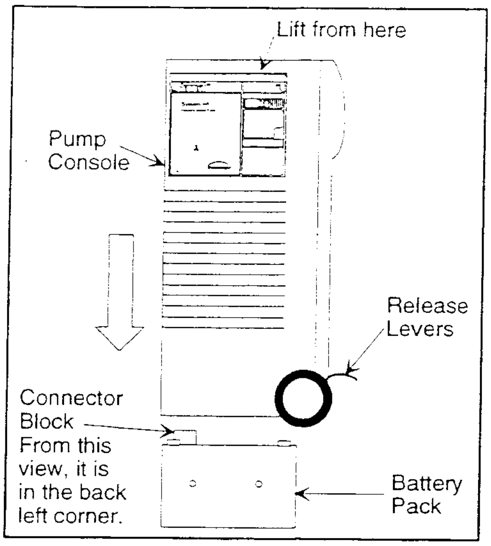


Figure 1-31

Placement of System Over the Battery

5. Push the button on the rear of the monitor to detach it from the cart handle.

6. Attach monitor on top of the pump console. Make sure that the monitor is securely attached before transporting the System.

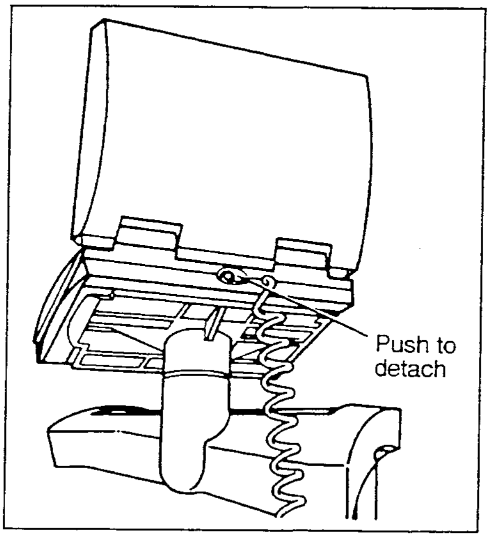


Figure 1-32

Push Button to Detach Monitor

7. Pull up the console handle and tilt the System to pull for transport.

   PRECAUTION Be sure to only pull the System by this handle, DO NOT PUSH.

NOTE: For information on outfitting an aircraft for IABP transport contact your local Datascope sales representative. Also, see Section 5 in the Operating Instructions for instructions for use for the Docking Station and Mobilizer.

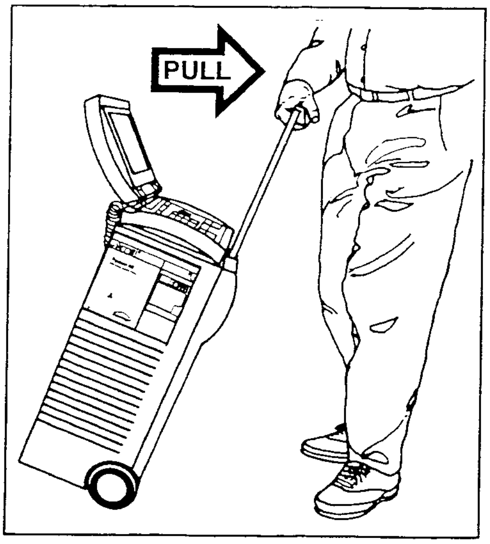


Figure 1-33

Pull Up Handle and Tilt System

1.3.10 PRINTER MENU (RECORDING WAVEFORMS AND TRENDS)

The dual trace chart recorder selectively provides a hard copy record of patient ECG, arterial pressure, and optional balloon pressure waveforms, as well as trend data.

Pressing the PRINTER MENU key (28) activates the printer configuration menu. The LED adjacent to the PRINTER MENU key (28) will be illuminated. The following printer configuration items may be set within this menu.

PRINTER MENU

Item	Function	Options
First Waveform	Select the first printed waveform	*ECG*/Arterial/Balloon
Second Waveform	Select the second printed waveform	Off/ECG/*Arterial*/Balloon
Strip Length	Set duration of manually printed strips	6 sec/*15 sec*/30 sec/60 sec
Timed Print	Set interval for automatically printed strips	*Off*/15 min/30 min/1 hr/2 hr/4 hr
Print on Alarm	Automatically print strip on an alarm	*Off*/On
Print Trends	Print Trend Data	SELECT to print now
Print Trigger/ Alarm Log	Print alarm and trigger history information	SELECT to print now

NOTE: Items in italiac are default values. If power is turned off for an extended period of time the system returns to these defaults.

The UP & DOWN ARROW keys (24) are used to highlight the desired item to be reviewed or changed. Pressing the CHANGE/SELECT key (25) displays all the preferences for the selected item. Once inside a desired item's menu the arrow keys are used to select the specific parameter to be changed. As the reverse video field moves through the list of configurable items, the selection field on the right expands to show the current selection in reverse video and other possible options to the right of it. Changes to the preference setting are accomplished by pressing the CHANGE/SELECT key (25). Once a change is made either move to another item or exit the menu to store this change. Exit by pressing the DONE key (26) to move up one menu or the PREFERENCES MENU key (27) to exit all menus.

Unless prematurely terminated, all but continuous recordings will last for the duration specified in this menu. Alarm recordings may therefore terminate prior to termination of the alarm condition.

An Alarm recording will terminate any previous recording, except continuous recordings. Also a higher priority alarm will replace a lower priority alarm recording.

Print requests which are either in progress or which are received when the printer runs out of paper are discarded.

When the display is in the FREEZE mode, activation of the recorder overrides the FREEZE mode. When the recorder is activated in the FREEZE mode the waveforms that are frozen on the display are printed followed by a rectangular gap (refer to figure 1-38).

Most routine printer operations are performed via the PRINT STRIP key (31). Momentarily pressing this key when the printer is idle will cause data configured via the printer configuration menu to be printed. The LED adjacent to the key will blink during printing. Pressing the PRINT STRIP key (31) for 2 seconds causes the printer to print continuously. The LED adjacent to the key will be illuminated continuously during a continuous recording. If the printer is running when the PRINT STRIP key (31) is momentarilly pressed, the current printout will stop immediately.

Trailer Anotation

- At the completion of the recording a status of patient and System information is printed. The IAB Frequency selection determines how the systolic and diastolic pressures are presented. When 1:2 or 1:3 is selected as the IAB Frequency, the recorder will print both assisted and unassisted systolic and diastolic pressure information. Below are samples of the various printouts. The date and time of the recording is automatically printed by the System 98. The Patient I.D. is left blank and can be filled in manually.

Patient I.D.__________
Date: 20/06/98
Time: 11:33
Alarm and Advisory Messages
Alarm and Advisory Messages
Alarm and Advisory Messages
TIMING: Auto
TRIGGER: ECG
HEART RATE: 80
ASSIST FREQ.: Standby
SYST/DIAS: 117/52
MEAN: 69

Figure 3-25 Print Out for Standby Mode

Patient I.D.__________
Date: 20/06/98
Time: 11:34
Alarm and Advisory Messages
Alarm and Advisory Messages
Alarm and Advisory Messages
TIMING: Auto
TRIGGER: ECG
HEART RATE: 80
ASSIST FREQ.: 1:1
SYST/DIAS: 113/46
AUG: 125
MEAN: 91

Figure 3-26 Print Out for IAB Frequency 1:1

Patient I.D.__________
Date: 20/06/98
Time: 11:33
Alarm and Advisory Messages
Alarm and Advisory Messages
Alarm and Advisory Messages
TIMING: Auto
TRIGGER: ECG
HEART RATE: 80
ASSIST FREQ.: 1:3
ASSISTED
Syst/Dias: 104/47
Aug: 126
UNASSISTED
Syst/Dias: 117/52
MEAN: 79

Figure 3-27 Print Out for IAB Frequency 1:3 (NOTE: 1:2 uses the same layout)

Sample Waveforms

- ECG: A delayed ECG waveform will be recorded for the length specified in the printer configuration menu. Numeric information for Lead selection and Size is printed at the beginning of the trace. If either are changed the numeric information is reprinted.

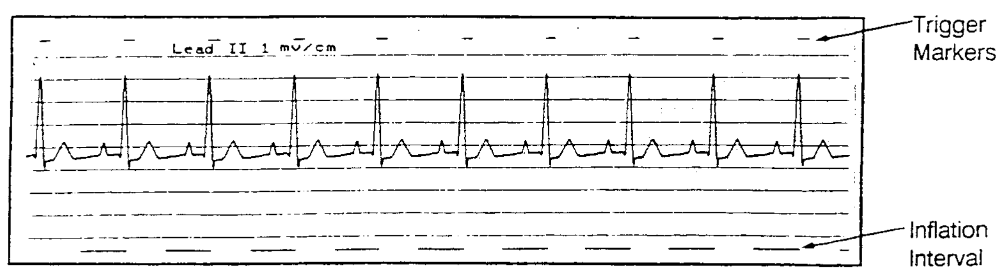


Figure 1-37 - ECG Sample

- Arterial Pressure: A delayed invasive arterial pressure waveform will be recorded for the length specified in the printer configuration menu or until another recorder function is selected. Scale information is annotated at the beginning of the trace. If the pressure scale changes the annotation is automatically repeated.

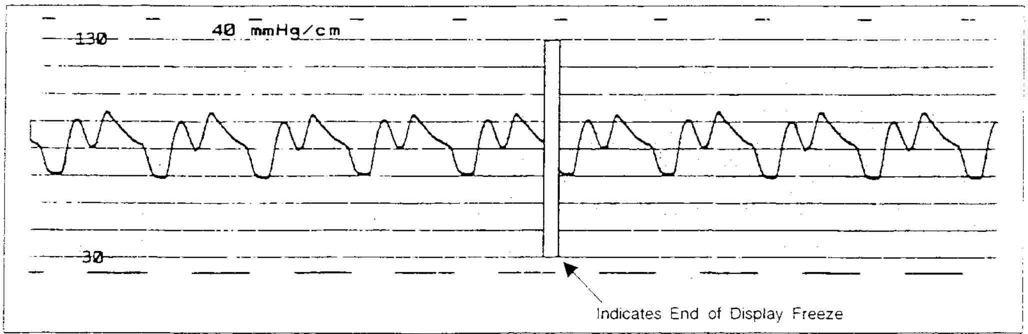


Figure 1-38 - Arterial Pressure Sample

- Balloon Waveform: A delayed balloon pressure waveform will be recorded for the length specified in the printer configuration menu or until another recorder function is selected.
  NOTE: There is no scale information printed for balloon pressure waveform.

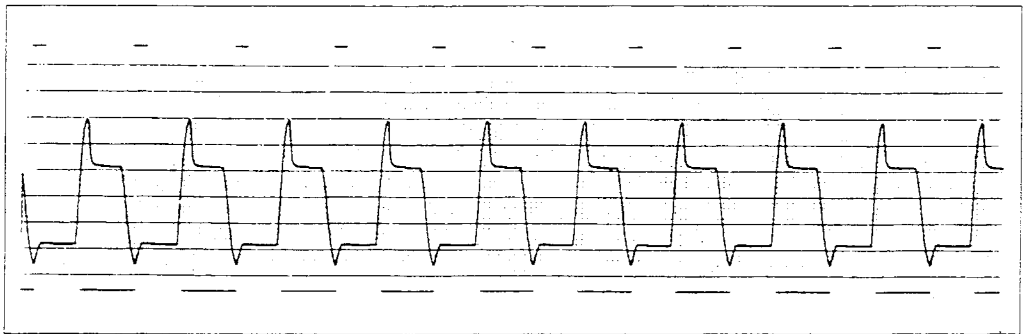


Figure 1-39 - Balloon Waveform Sample

- Trend: All of the accumulated trend pages are printed. Heart rate trend is printed first followed by the blood pressure trend (includes systolic, diastolic, mean, and augmented pressure). When both assisted and unassisted beats are present, systolic, diastolic and pressure indices consist of the pressures combined and averaged. **NOTE:** If no trend data is available the message "*NO TREND DATA AVAILABLE*" is printed.

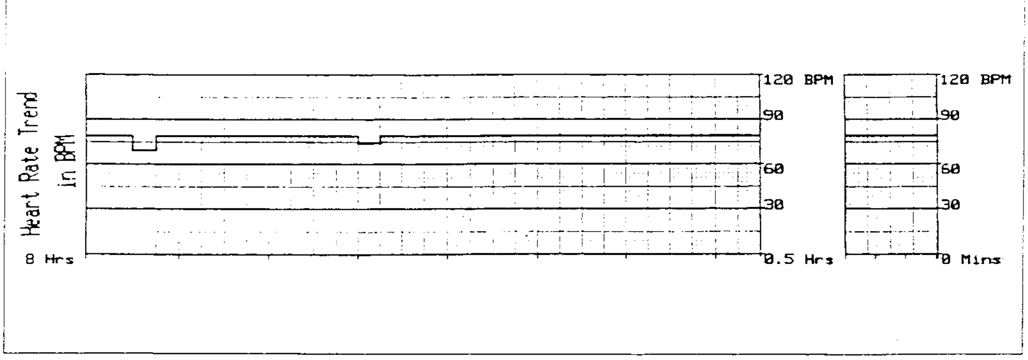


Figure 1-40 - Trend Sample

- Dual Waveforms: Two of the three possible waveforms, ECG, Arterial Pressure and Balloon Waveform may be recorded simultaneously for the length specified in the printer configuration menu or until another recorder function is selected. Waveforms will be printed as in the examples below, with the annotation, if any, for the first waveform printed before the annotation, if any, for the second waveform. Annotations will be as described previously for single waveform recordings.

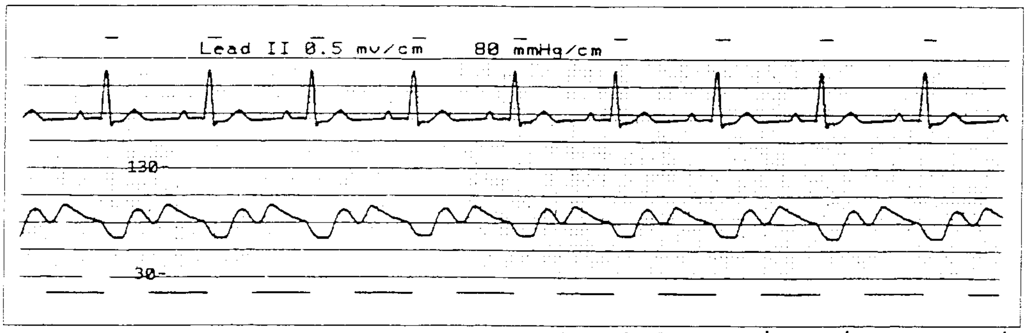


Figure 1-41 - ECG and Arterial Pressure Sample

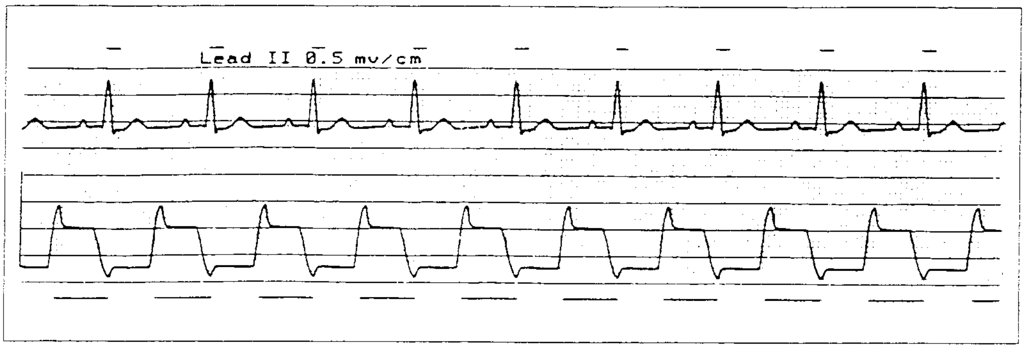


Figure 1-42 - ECG and Balloon Waveform Sample

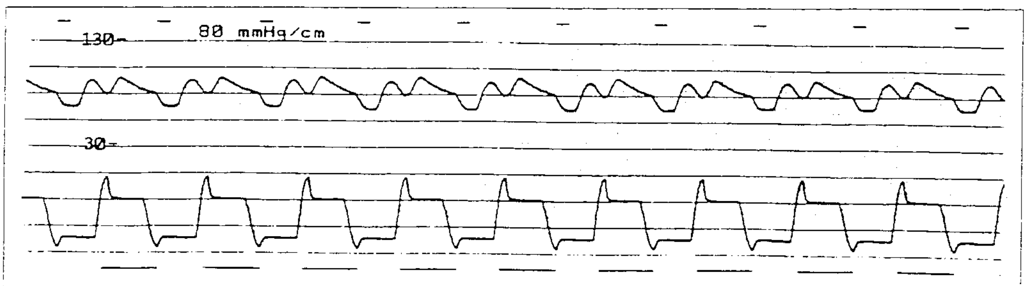


Figure 1-43 - Arterial Pressure and Balloon Waveform Sample

1.3.11 USING TREND

The IABP trend function and the chart recorder can be used as effective tools for patient data collection and record keeping. See Section 1.3.10 "Using the Recorder" for information on printing the trend data.

Eight hours of patient parameter data is collected. The plot graphically summarizes the parameter's behavior for the previous 8 hour interval. For intervals in excess of 8 hours, the oldest data is replaced by the newest data. Therefore, it is recommended to print the trend data every eight hours or earlier, and at the end of balloon pumping.

Trend is cleared when the IABP ON/OFF switch (77) is placed in the OFF position for more than 15 minutes or by pressing the CHANGE/SELECT key (25) while powering on the System.

For clairity and detail, the plots are partitioned into two subplots. The subplots have different time scales. The first plot presents the last half hour of data. This plot's time resolution is highest, at 3 minutes per minor division. The second plot presents the remaining seven and one half hours, at a time resolution of 6 minutes per minor division.

Refer to figure 1-40 in Section 1.3.10 for a trend printout sample.

Printing is sequential. First, trended heart rate is printed. Next, trended blood pressure parameters are printed.

In the case of blood pressure, multiple parameters are printed against the same time axis. These parameters are :

* systolic

* diastolic (end)

* augmented diastolic

* mean

When frequency weaning is used, heartbeats are assisted and unassisted. In this case, the plotted systolic pressure is the average of assisted and unassisted beats. Similarly, the plotted diastolic pressure is the average of assisted and unassisted beats.

In the event that trend data is not available, the phase "no trend data available" is printed in lieu of the trend data. This can occur if a trend printout is requested immediately after a system power up.

Similarly, if a trend plot is initiated prior to zeroing of the blood pressure transducer, then the blood pressure trend printout will report "no pressure available".

1.3.12 INSTALLATION AND REPLACEMENT OF HELIUM CYLINDER

PRECAUTION: Only personnel familiar with the handling of high pressure gas cylinders should install or replace the helium cylinder.

PRECAUTION: Use medical grade helium only.

The helium cylinder should be replaced whenever pressure drops below a preset level. This is indicated when the "LOW HELIUM" message is displayed during operation and/or when the helium pressure gauge (76) shows that the helium supply is in the red zone. There is no need to interrupt IABP. However, the cylinder should be replaced as soon as possible to avoid a potential "*AUTOFILL FAILURE*" which can delay pumping.

To replace cylinder:

1. Close helium cylinder valve fully clockwise.
2. Slowly loosen the cylinder yoke.
3. Remove the cylinder.
4. Check that the washer is present and in good condition on the cylinder yoke or the new tank.
5. Install a fresh helium cylinder.
6. Tighten the cylinder yoke.
7. Slowly open the helium cylinder valve.
8. Verify deflection of the helium gauge needle. (For helium cylinder specifications see section 3)

NOTE: Disposal of used helium cylinders should be in accordance with prevailing local statues and in conformance with recycling requirements.

NOTE: For instructions on installing the helium cylinder strap, see section 5.4 in the Operating Instructions

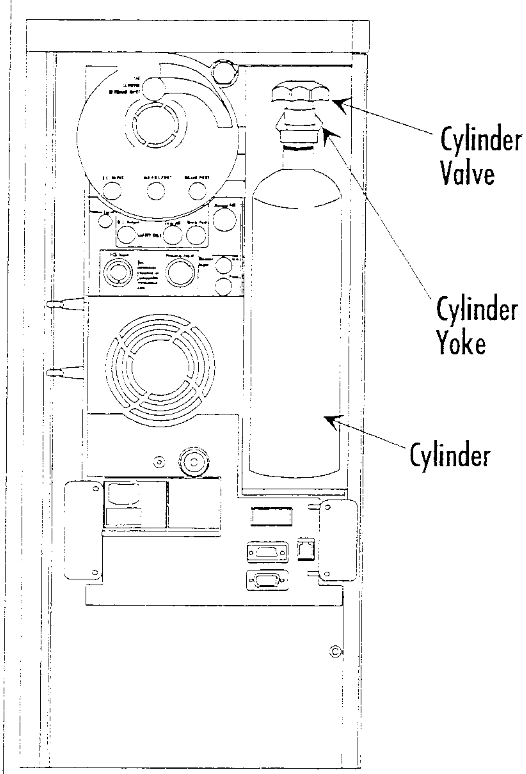


Figure 1-44

Helium Cylinder

1.3.13 INSTALLATION/ REMOVAL OF SAFETY DISK/CONDENSATE REMOVAL MODULE

PRECAUTION: The installation and removal of the safety disk requires a partial turning action to secure or remove. When securing, confirm that the rib on the top surface of the safety disk assembly is fully rotated to the 12 o'clock position.

WARNING: Datascope recommends the use of surgical gloves while doing these procedures to avoid contact with residual condensate or other body fluids. Disposal of used safety disk should be in accordance with prevailing hospital practices for medical refuse.

The safety disk and condensate removal module are combined into one assembly. The assembly is located on the rear of the System 98.

Installation/removal of the assembly:

1. Disconnect assembly's pneumatic connections: a. Luer fitting, labeled IAB FILL PORT (75)
   b. condensate drain line, located on the rear panel, labeled DRAIN PORT (74).
2. Disconnect assembly's electrical connector labeled DC INPUT (60).
3. Turn the safety disk approximately 30° counter-clock-wise.
4. Pull straight out.

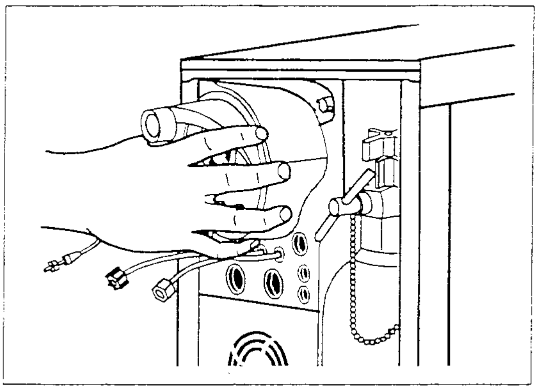


Figure 1-45

Turn the Safety Disk

Disassembly of Condensate Removal Module:

1. Remove the condensate removal module from the disk by removing the two screws and peeling back the label. Assemble the CRM to the new safety disk, replace and tighten screws and adhere label.
2. Fill in replacement hours and expiration date on label.
3. To install the assembly, reverse the above procedure aligning the curved narrow slot with the pin.

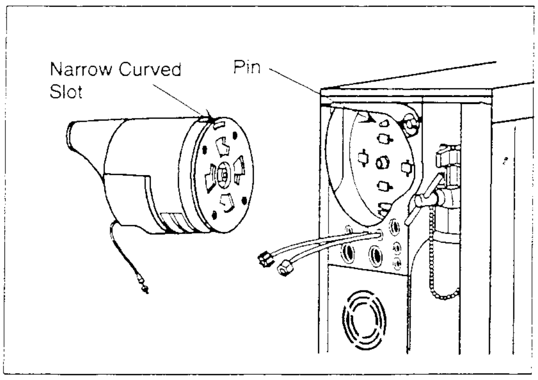


Figure 1-46

Line up the Safety Disk

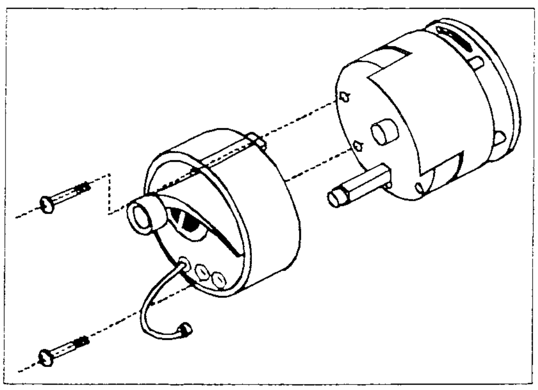


Figure 1-47

Safety Disk/CRM Assembly

1.3.14 DOPPLER INFORMATION

The doppler used with the System 98 is the Huntleigh Mini Dopplex®. This doppler uses ultrasound techniques to detect vascular blood flow

To use the doppler:

1. Open the top storage bin. The doppler is located inside the door panel.
2. Remove the doppler from the storage bin. Press the button on the tether reel to retract the doppler.
3. If battery replacement is necessary, remove the cover of the battery compartment, and lift out the old battery. Install a new 6LR61, 6LF22, or equivalent 9V alkaline battery. Replace cover.
4. Place a liberal amount of coupling gel on the transducer or the patient's skin.
5. Turn on the unit and position the probe over the artery to be considered.
6. Hold the probe at a 45° angle to the surface of the skin. Adjust the position and angle of the probe to obtain the optimum audio signal.

Refer to the Huntleigh Operators Manual for more detailed instructions.

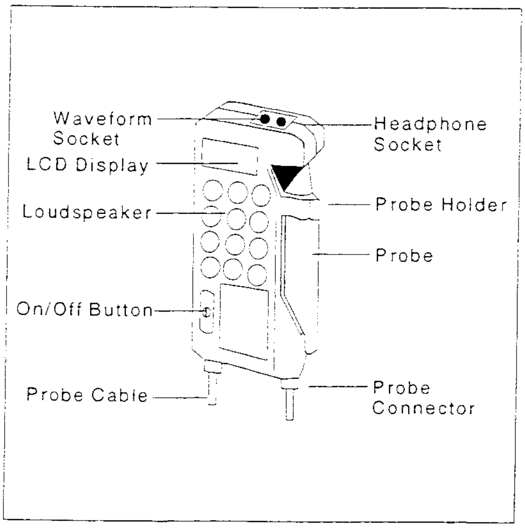


Figure 1-48

Doppler, Front View

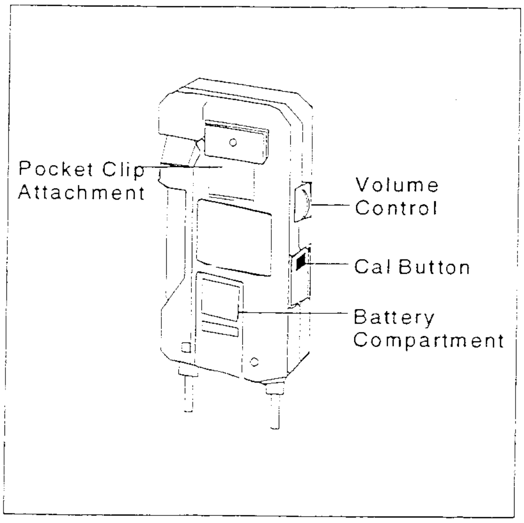


Figure 1-49

Doppler, Rear View

The System 98 transmits both Assisted and Unassisted Systolic and Diastolic Pressures.

1.3.15 Connecting the Modem

The System 98 has an internal modem. The modem is used for connection to phone lines which can link the System 98 to a remote PC, having PC•IABP remote clinical support software. The connection is made through a standard analog telephone line. NOTE: The telephone line should directly connect to the external phone system and not go through a company/hospital switching system.

1. Connect a standard analog phone line into the PHONE LINE connector (67).
2. Ensure that the telephone line is connected to the telephone jack.

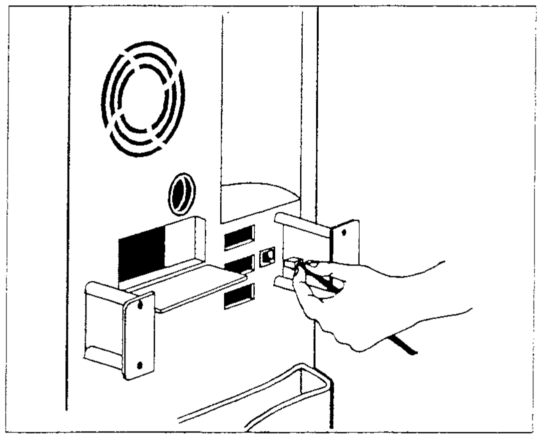


Figure 1-50

Connecting the Modem

1.3.16 Connecting PC•IABP

PC•IABP is a personal computer (PC) software application program that is designed for clinicians to assist in monitoring an Intra-Aortic Balloon Pump (IABP) supported patient from a remote location. PC•IABP will not affect operator settings on the IABP, or have the capability of altering patient parameters. PC•IABP displays all available information from the System 98 onto a remote PC screen.

1. Connect the modem as shown in section 1.3.15.
2. All other work is performed through the PC. See the PC•IABP Operating Instruction, P/N 0070-00-0291, for complete details.

1.3.17 Data Communication

The System 98 can transmit data that is requested by a host (i.e., PC•IABP), through the RS-232 port (66) and the Phone Line (67). The following is an overview of the scope of information available via the data communications port in the standard operating mode (for more information, refer to the Communication Protocol Manual P/N 0070-00-0319):

- Pump Control and Alarm Surveillance Settings
- ECG, Arterial Pressure, and Balloon Pressure Waveforms & Markings
- Physiologic Indices
- Alarms, Prompts, Alerts, and Status Messages
- Alarm, Fault, Trigger Mode and Trend Histories

1.3.18 Wheels and Casters

The System 98 features two dual function casters. They are located on the handle side of the cart. Pressing the appropriate pedals on the casters enables the user to have greater control when moving the System and can also lock the wheels and casters in place.

Press the caster pedals with the white arrow on a blue background to prevent the caster from swiveling (directional lock). This provides greater control when making turns and better tracking on long straight-a-ways. Return the pedal to the up position to have greater maneuverability when positioning the System into tight spaces.

Press the caster pedals with the white octagon on a red background to apply the wheel brake, which locks the wheel from rotating and the caster from swiveling. This should be used once the System has been positioned or when left unattended. NOTE: It is recommended that all four caster brakes be applied at this time.

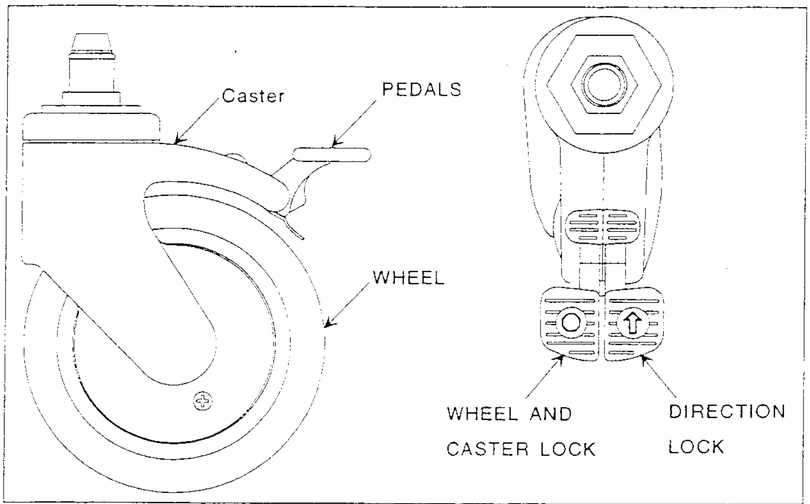


Figure 1-51

Dual Function Castors

1.3.19 HELP SCREENS

Help screens are provided to guide the user through set-up procedures and for consultation regarding alarm message descriptions and alarm resetting instructions. Help Screens are context sensitive and thus are only available when the situations arise. For example: The help screens for initial set-up are only available at power-on and a help screen for an alarm message is only available when that alarm occurs.

To display the Help Screens:

1. Press the front panel HELP SCREEN key (29). The key's LED illuminates. A help screen box displays at the bottom of the screen.

   NOTE: When a help screen is present on the screen, the ECG and Pressure waveforms are condensed in the upper portion of the screen. If the 3 trace mode is in operation, the third trace is replaced by the help screen. All alarms remain active and no data is lost when help screens are activated.

2. Use the UP & DOWN ARROW keys (24) to page through the screens available. Pressing the DOWN arrow displays the next available page of help screen information. Pressing the UP arrow displays the previous page of information. If there are no previous pages or next pages available and the UP or DOWN arrow is pressed, then the same page is displayed again.

3. Press the HELP SCREEN key (29) again or the DONE key (26) to return the screen to the normal waveform or trend graphics display.

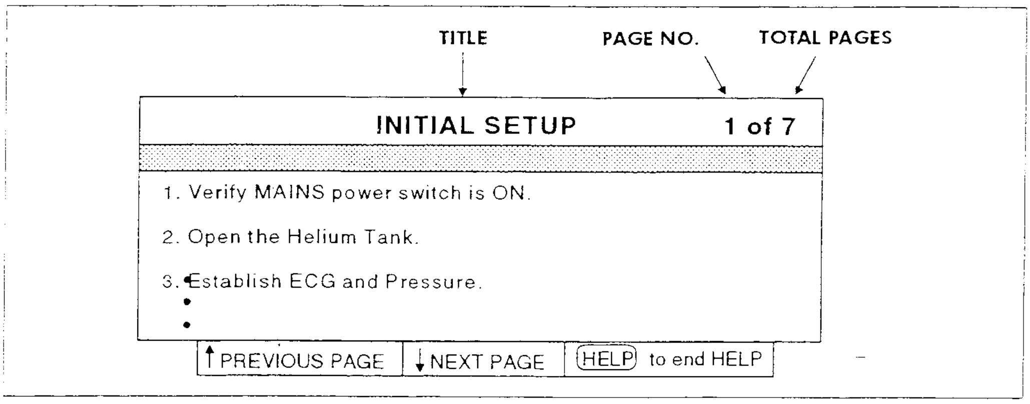


Figure 1-52

Example of Help Screen

The following pages show the available alarm and set-up help screens.

No Trigger

CONDITION	CORRECTIVE ACTION
• An electrode is detached or malpositioned.	1. Reattach or reposition the electrode.
• An incorrect trigger source has been selected.	1. Select a different trigger source using the TRIGGER SELECT keys. Resume pumping by pressing the ASSIST/STANDBY key.
• There is inadequate signal acquisition.	1. Try alternate/EXT lead selections. 2. Adjust the ECG gain setting by using the ECG GAIN Auxiliary keys.

No Pressure Trigger

CONDITION	CORRECTIVE ACTION
• The patient's pulse pressure is inadequate for pressure triggering.	1. If appropriate, select a different trigger source. Resume pumping by pressing the ASSIST/STANDBY key. 2. If pressure trigger is required and MANUAL THRESHOLD is selected, reduce the pressure trigger threshold. Press the down arrow key located in the Auxiliary keypad section until triggering resumes.
• There is no arterial pressure waveform present.	1. Verify that desired pressure waveform source, Ext/Internal, is selected. Press the Pressure Source key, in the Patient Waveform keypad section, to change the waveform source. 2. Verify that a properly wired transducer or monitor cable is connected. 1.3. Verify that transducer has not inadvertently been left vented to atmosphere following zeroing. 4. Re-zero transducer, while vented, and reapply arterial pressure to transducer.

No Pressure Trigger - Zero Transducer

CONDITION	CORRECTIVE ACTION
• Attempting to use pressure trigger without having the transducer zeroed.	1. Zero the transducer by opening the transducer to air and pressing the ZERO key for two seconds. 2. Resume pumping by pressing the ASSIST/STANDBY key.

Heart Rate Low

CONDITION	CORRECTIVE ACTION
• The patient heart rate is less than 40 bpm.	1. Assess the patient. 2. Verify proper timing.
• There is inadequate signal acquisition from the patient electrodes.	1. Check electrode contact and placement. Verify the integrity of the lead wires and the patient cable. 2. Adjust ECG GAIN by using the ECG GAIN Auxiliary keys.

Check Pacer Timing

CONDITION	CORRECTIVE ACTION
• The patient is not 100% Paced.	1. Select ECG trigger source, using the TRIGGER SELECT keys, when demand pacing a patient. Press the ASSIST/STANDBY key to resume pumping.
• The patient's AV paced rate is above 125 BPM. • The patient's V paced rate is above 185 BPM.	1. Reduce the pacer rate.
• The system is unable to identify the A-V interval.	1. Adjust the A-V time interval to between 80 to 224 msec.

ECG Detected

CONDITION	CORRECTIVE ACTION
• A valid ECG is now detected with the INTERNAL trigger selected as the trigger source.	1. Select ECG as the trigger source using the TRIGGER SELECT keys. 2. Verify proper timing. Resume pumping by pressing the ASSIST/STANDBY key.

Irregular Trigger

CONDITION	CORRECTIVE ACTION
• The patient's rhythm is too variable to accurately predict the next systolic pressure trigger event.	1. The System has automatically compensated by deflating earlier to avoid interfering with systolic ejection. Consequently, do NOT attempt to adjust the DEFLATION control. 2. Confirm that the patient's ECG also indicates irregularity. If rhythm disturbance persists, consider using ECG trigger mode for more reliable triggering.
• The patient's rhythm is regular, however IAB deflation timing is set too late, interfering with systolic detection.	1. Confirm that the patient's ECG rhythm is regular. If so, then adjust the DEFLATION control earlier to improve consistency of pressure trigger.

Trigger Interference

CONDITION	CORRECTIVE ACTION
• The system is detecting electro-surgical interference while in a pacer trigger mode.	1. Pumping automatically resumes when interference clears. 2. If condition persists however, and interferes with patient support, select PRESSURE trigger using the TRIGGER SELECT keys. 3. Verify timing and press the ASSIST/STANDBY key to resume pumping.

Rapid Gas Loss

CONDITION	CORRECTIVE ACTION
• A large leak has been detected in the IAB circuit.	1. Check for blood in the tubing. If found, stop pumping and notify physician. Refer to IAB manufacturer's instructions for IAB removal. 2. If blood is not found in the tubing, verify the connections are leak free. Refill the IAB and closely observe the tubing to verify no blood is present. Press the ASSIST/STANDBY key to resume pumping.

Leak in IAB Circuit (Loss)

CONDITION	CORRECTIVE ACTION
• There is a small leak in the IAB circuit, a loose connection, or a high rate of Helium diffusion, possibly due to the patient being febrile or tachycardiac.	1. Check for blood in the tubing. If found, stop pumping and notify physician. Refer to IAB manufacturer's instructions for IAB removal. 2. If blood is not found in the tubing, verify the connections are leak free. Refill the IAB and closely observe the tubing to verify no blood is present. Press the ASSIST/STANDBY key to resume pumping. 3. If the alarm persists and there is no evidence of a leak in the IAB catheter, consider setting the SLOW GAS LOSS ALARM key to the OVERRIDE position.

Leak in IAB Circuit (Gain)

CONDITION	CORRECTIVE ACTION
• A gas gain has been detected in the IAB circuit.	1. Verify all connections are leak free. 2. Refill the IAB. Press the ASSIST/STANDBY key to resume pumping. 3. If alarm persists, contact Datascope Service.

IAB Disconnected

CONDITION	CORRECTIVE ACTION
• The IAB catheter or extension tubing is disconnected.	1. Reattach the IAB catheter and extension tubing. 2. Refill the IAB catheter. Press the ASSIST/STANDBY key to resume pumping.

Gas Loss and Catheter Alarms Disabled

CONDITION	CORRECTIVE ACTION
• IAB FILL is set to MANUAL.	1. If appropriate, set IAB FILL to AUTO. The system must now be autofilled to activate the gas loss and catheter alarms. NOTE: The autofill system cannot be used with pediatric size catheters.

Blood Detected

CONDITION	CORRECTIVE ACTION
• Blood is detected in the IAB catheter.	1. Check for traces of blood in the IAB catheter and/or Drain Port tubing. 2. If blood is present, notify the Physician. Disconnect the IAB catheter from the console as soon as this can be done without endangering the patient. 3. Refer to the IAB catheter manufacturer's instructions for IAB removal. 4. Contact Datascope Service. 5. If no blood is present, then turn the IABP off by setting the SYSTEM POWER switch, located on the front panel, to the OFF position. 6. Wait 10 seconds. 7. Turn the IABP on by setting the SYSTEM POWER switch to the ON position. 8. Depress the IAB FILL key for 2 seconds to initiate an autofill. When the autofill completes, depress the ASSIST/ STANDBY key to resume pumping. 9. If "BLOOD DETECTED" message repeats, then the IAB must be manually filled before pumping can continue: Set IAB FILL MODE to MANUAL. 10. See the Help Screen, "MANUAL FILL IAB" for instructions on how to perform the manual fill procedure. 11. Contact Datascope Service.

Check IAB Catheter

CONDITION	CORRECTIVE ACTION
• The IAB remains in the sheath immediately after insertion.	1. Check the markings on the IAB catheter to assure the balloon has exited the sheath. If not pull sheath back to appropriate position. 2. Press the ASSIST/STANDBY key to resume pumping.
• The IAB membrane is not completely unfolded.	1. Aspirate to assure blood is not returned through the extracorporeal tubing. 2. If using a 34, 40 or 50cc IAB, manually inflate and deflate the IAB with 60 cc of gas through the male luer of the IAB. 3. If using a 25cc IAB, manually inflate and deflate the IAB with 50cc of gas through the male luer of the IAB. 4. Refill the IAB. Press the ASSIST/STANDBY key to resume pumping.
• There is a kink in the IAB catheter or tubing	1. Check the catheter tubing and relieve kink if possible. 2. Press the ASSIST/STANDBY key to resume pumping.

High Drive Pressure

CONDITION	CORRECTIVE ACTION
• There is a component failure in the pneumatic system.	1. Attempt to resume pumping by pressing the ASSIST/STANDBY key. 2. If the message persists, contact Datascope Service.

Low Vacuum

CONDITION	CORRECTIVE ACTION
• The patient is tachycardiac. • There is insufficient vacuum in the drive system.	1. Change the IAB frequency to 1:2 by using the IAB FREQUENCY key. 2. If the message persists, contact Datascope Service.

Augmentation Below Limit Set

CONDITION	CORRECTIVE ACTION
• There is a change in the patient's hemodynamic status.	1. Assess the patient.
• The augmentation alarm limit is set too high.	1. Reset the AUG ALARM limit to 8 - 10 mmHg below the patient's augmented diastolic pressure.
• The IAB AUGMENTATION is set too low.	1. If appropriate, increase augmentation by pressing the IAB AUGMENTATION key toward the maximum setting.
• The Helium concentration is low.	1. Refill the IAB catheter. Press ASSIST/STANDBY to resume pumping.

Low Helium

CONDITION	CORRECTIVE ACTION
• The Helium tank is closed.	1. Open the Helium tank
• There are fewer than 24 fills of Helium remaining in the tank.	1. Replace the Helium tank.

Low Battery (EXT)

CONDITION	CORRECTIVE ACTION
• There is less than 30 minutes of battery operating time remaining on the external battery.	1. The system will switch to internal batteries when the external batteries are depleted.

Low Battery

CONDITION	CORRECTIVE ACTION
• There is less than 30 minutes of battery operating time remaining.	1. Verify MAINS power switch, located above the AC power cord connector, is ON. 2. Connect system to an AC power outlet.

System Failure

CONDITION	CORRECTIVE ACTION
• There is a malfunction of the microprocessor.	1. Turn the IABP off by setting the SYSTEM POWER switch, located on the front panel to the OFF position. 2. Wait 10 seconds. 3. Turn the IABP on by setting the SYSTEM POWER switch, located on the front panel to the ON position. 4. If the condition repeats, contact Datascope Service.

Electrical Test Fails Code #____

CONDITION	CORRECTIVE ACTION
• There is a start-up failure in a major subsystem of the IABP.	1. Turn the IABP off by setting the SYSTEM POWER switch, located on the front panel to the OFF position. 2. Wait 10 seconds. 3. Turn the IABP on by setting the SYSTEM POWER switch, located on the front panel to the ON position. 4. If the condition persists, note the code number displayed and contact Datascope Service.

Slow Gas Loss Override On

CONDITION	CORRECTIVE ACTION
• The SLOW GAS LOSS ALARM is set to OVERRIDE.	1. Set the SLOW GAS LOSS ALARM to the ON position, if appropriate.

Maintenance Required Code # ____

CONDITION	CORRECTIVE ACTION
• The internal microprocessor has determined that system maintenance may be required.	1. Note the code number displayed and contact Datascope Service.

Autofill Failure

CONDITION	CORRECTIVE ACTION
• The IABP cannot fill the IAB catheter system automatically.	1. Verify that the correct size IAB catheter and extender are attached. 2. Verify that the autofill tubing is connected to the IAB Fill Port and the drain tubing is connected to the Drain Port, on the Safety Disk. 3. Refill the IAB catheter. Press ASSIST/STANDBY to resume pumping. If the autofill fails again, set IAB FILL MODE to MANUAL. 4. See the help screen for "Manual Fill IAB" for instructions on how to perform the Manual Fill procedure. 5. Contact Datascope Service.

Autofill Failure - No Helium

CONDITION	CORRECTIVE ACTION
• The Helium tank is closed.	1. Open the Helium tank.
• The Helium tank is empty.	1. Replace the Helium tank.

Safety Disk Test Fails

CONDITION	CORRECTIVE ACTION
• There is a leak in the drive system or its fittings.	1. Check that the fittings are leak tight and that the Safety Disk is properly installed. 2. Repeat the leak test. If the test fails again, replace the Safety Disk. 3. Repeat the leak test.

No Patient Status Available

CONDITION	CORRECTIVE ACTION
• There was an internal communications failure.	1. Monitor patient parameters closely on the external monitor. 2. Contact Datascope Service.

Autofill Required

CONDITION	CORRECTIVE ACTION
• The IAB FILL MODE has been changed from MANUAL to AUTO without an autofill.	1. If appropriate, return the IAB FILL key to MANUAL. Press the ASSIST/STANDBY key to resume pumping. 2. If the autofill mode is desired, refill the IAB catheter. Press the ASSIST/STANDBY key to resume pumping.

Battery in Use (EXT)

CONDITION	CORRECTIVE ACTION
• The IABP is being powered from an external (Battery or DC) power source.	1. Verify that it is necessary to operate from an external power source. If appropriate, switch to the AC power source. 2. Verify MAINS power switch, located above the AC power cord connector, is ON.

Battery in Use

CONDITION	CORRECTIVE ACTION
• The IABP is being powered from the internal batteries.	1. Verify that it is necessary to operate from the internal battery. If appropriate, switch to the AC power source. 2. Verify MAINS power switch, located above the AC power cord connector, is ON.

Prolonged Time in Standby

• The IABP has been in STANDBY mode for an extended period of time.	1. Verify whether it is appropiate to resume ASSIST. 2. Press the ASSIST/STANDBY key to resume pumping.

Manual Fill IAB (Follow these steps if IAB Fill Key has already been pressed)

Adult Size IAB Catheters

1. Remove the autofill tubing from the IAB Fill Port on the Safety Disk.

2. Attach a three way stopcock to the IAB Fill Port on the Safety Disk.

1.3. Attach a 60 cc syringe to the stopcock.

4. Open the stopcock between the disk and syringe. Evacuate the disk by pulling back on the syringe plunger.

5. Close the stopcock to the disk. Evacuate the syringe.

6. Repeat steps 4 and 5 until strong resistance is noted. A strong resistance should be noted within three attempts. If a strong resistance is noted, proceed to step 8.

7. If a strong resistance is not noted within three attempts, remove the Drain port tubing and attach the Drain port plug, located in the manual fill accessory kit, to the Drain port. Repeat steps 4 through 6.

NOTE: All Datascope adult size IAB Catheters have a manual fill pre-load of 80 cc. When using catheters from another manufacturer consult manufacturer for guidelines.

8. Attach the syringe to the manual fill port located below the Safety Disk.

9. Fill the syringe and discard the contents.

10. Fill the syringe with 40 cc of Helium.

11. Holding the syringe tip DOWN, attach the syringe to the stopcock on the Safety Disk, and open the stopcock to the disk.

12. Press the IAB FILL key for two seconds to allow the syringe contents to be drawn into the disk.

11.3. Close the stopcock to the disk.

14. Refill the syringe with the remaining 40 cc pre-load of Helium from the manual fill port.

15. Holding the syringe tip down, attach the syringe to the stopcock on the Safety Disk.

16. Open the stopcock to the Safety Disk. The remaining 40 cc of gas is drawn into the disk.

17. Close the stopcock and remove the syringe.

18. Press the ASSIST/STANDBY key to begin pumping.

Manual Fill IAB (Follow these steps if IAB Fill Key has already been pressed)

Pediatric IAB Catheters

1. The IABP Override keys, TIMING and IAB FILL, must be set to MANUAL.
2. Refer to the pediatric balloon catheter instructions for the correct Safety Chamber size, pre-load volume and extender.
3. On the Safety Disk, remove the autofill tubing from the IAB Fill Port and the drain tubing from the Drain Port.
4. Remove the Adult Safety Disk from the IABP. Install the pediatric adapter, drive hose and the appropriate size Safety Chamber as directed in the Operator manual.
5. Attach a three way stopcock to the IAB Fill Port on the Safety Chamber.
6. Attach the patient balloon and extender to the Safety Chamber.
7. Attach a 20 cc syringe to the stopcock.
8. Open the stopcock between the chamber and syringe. Evacuate the chamber by pulling back on the syringe plunger.
9. Close the stopcock to the chamber. Evacuate the syringe.
10. Repeat steps 8 and 9 until strong resistance is noted.
11. Attach a 20 cc syringe to the manual fill port below the Safety Disk.
12. Fill the syringe and discard the contents.
13. Fill the syringe with the correct pre-load volume of Helium as outlined in the catheter instructions. If the pre-load volume exceeds 20 cc, fill the syringe with half of the appropriate pre-load volume.
14. Holding the syringe tip DOWN, attach the syringe to the stopcock on the Safety Chamber, and open the stopcock to the chamber.
15. Press the IAB FILL key for two seconds to allow the syringe contents to be drawn into the chamber. Close the stopcock and remove the syringe.
16. If the pre-load volume exceeded 20 cc, add the remaining pre-load volume by repeating steps 13 thru 15.
17. Close the stopcock and remove the syringe.
18. Press the ASSIST/STANDBY key to begin pumping.

Manual Fill IAB (Follow these steps if IAB Fill Key has not been pressed)

Adult Size IAB Catheters

1. Remove the autofill tubing from the IAB Fill Port on the Safety Disk.

2. Attach a three way stopcock to the IAB Fill Port on the Safety Disk.

1.3. Attach a 60 cc syringe to the stopcock.

4. Press the IAB FILL key for two seconds to relieve vacuum.

5. Open the stopcock between the disk and syringe. Evacuate the disk by pulling back on the syringe plunger.

6. Close the stopcock to the disk. Evacuate the syringe.

7. Repeat steps 5 and 6 until strong resistance is noted. A strong resistance should be noted within three attempts. If a strong resistance is noted, proceed to step 9.

8. If a strong resistance is not noted within three attempts, remove the Drain port tubing and attach the Drain port plug, located in the manual fill accessory kit, to the Drain port. Repeat steps 5 through 7.

NOTE: All Datascope adult size IAB Catheters have a manual fill pre-load of 80 cc. When using catheters from another manufacturer consult manufacturer for guidelines.

9. Attach the syringe to the manual fill port located below the Safety Disk.

10. Fill the syringe and discard the contents.

11. Fill the syringe with 40 cc of Helium.

12. Holding the syringe tip DOWN, attach the syringe to the stopcock on the Safety Disk, and open the stopcock to the disk.

11.3. Press the IAB FILL key for two seconds to allow the syringe contents to be drawn into the disk.

14. Close the stopcock to the disk.

15. Refill the syringe with the remaining 40 cc pre-load of Helium from the manual fill port.

16. Holding the syringe tip down, attach the syringe to the stopcock on the Safety Disk.

17. Open the stopcock to the Safety Disk. The remaining 40 cc of gas is drawn into the disk.

18. Close the stopcock and remove the syringe.

19. Press the ASSIST/STANDBY key to begin pumping.

Manual Fill IAB (Follow these steps if IAB Fill Key has not been pressed)

Pediatric IAB Catheters

1. The IABP Override keys, TIMING and IAB FILL, must be set to MANUAL.
2. Refer to the pediatric balloon catheter instructions for the correct Safety Chamber size, pre-load volume and extender.
3. On the Safety Disk, remove the autofill tubing from the IAB Fill Port and the drain tubing from the Drain Port.
4. Remove the Adult Safety Disk from the IABP. Install the pediatric adapter, drive hose and the appropriate size Safety Chamber as directed in the Operator manual.
5. Attach a three way stopcock to the IAB Fill Port on the Safety Chamber.
6. Attach the patient balloon and extender to the Safety Chamber.
7. Attach a 20 cc syringe to the stopcock.
8. Press the IAB FILL key for two seconds to relieve vacuum.
9. Open the stopcock between the chamber and syringe. Evacuate the chamber by pulling back on the syringe plunger.
10. Close the stopcock to the chamber. Evacuate the syringe.
11. Repeat steps 9 and 10 until strong resistance is noted.
12. Attach a 20 cc syringe to the manual fill port located below the Safety Disk.
13. Fill the syringe and discard the contents.
14. Fill the syringe with the correct pre-load volume of Helium as outlined in the catheter instructions. If the pre-load volume exceeds 20 cc, fill the syringe with half of the appropriate pre-load volume.
15. Holding the syringe tip DOWN, attach the syringe to the stopcock on the Safety Chamber, and open the stopcock to the chamber.
16. Press the IAB FILL key for two seconds to allow the syringe contents to be drawn into the chamber. Close the stopcock and remove the syringe.
17. If the pre-load volume exceeded 20 cc, add the remaining pre-load volume by repeating steps 14 thru 16.
18. Close the stopcock and remove the syringe.
19. Press the ASSIST/STANDBY key to begin pumping.

Initial Set Up

1. Verify MAINS power switch is ON.

2. Open the Helium Tank.

1.3. Establish ECG and Pressure.

4. Zero the transducer:
   - Open the transducer to air.
   - Press the ZERO PRESSURE key for 2 seconds.
   - Close the transducer.

5. Confirm the initial pump settings:

Control Panel:	
TRIGGER SELECT:	ECG
IAB FREQUENCY:	1:1
IAB INFLATION:	Midpoint
IAB DEFLATION:	Midpoint
Overrides:	
TIMING:	AUTO
IAB FILL MODE:	AUTO
SLOW GAS:	ON
Auxiliarys:	
ECG GAIN:	NORMAL

6. Set the Initial Timing:
   - Adjust the IAB INFLATION and DEFLATION controls to position the inflation interval of the arterial waveform to begin at the dicrotic notch and end before the systolic upstroke.

7. Attach the IAB catheter and the appropriate extender to the Safety Disk.

8. Fill the IAB catheter and initiate pumping:
   - Press the ASSIST/STANDBY key and observe "Autofilling" message.
   - Once the "Autofilling" message clears, pumping begins.
   - Observe optimal augmentation during diastole.
   - Fine tune the timing by adjusting the IAB INFLATION and DEFLATION controls if needed.

9. Verify AUG. ALARM:
   - Verify that the AUG. ALARM setting is approximately 10 mmHg less than the patient's diastolic augmentation pressure.
   - Adjust, if needed, by pressing AUG. ALARM and using the arrow keys to change the value displayed on the screen.

10. Intial set-up is now complete.

1.3.20 EXTERNAL MONITOR INTERFACING

The System 98 can display and be triggered from patient ECG and Arterial Pressure signals provided by external monitors. External Monitor output signals must meet the following minimum requirements to prevent degradation of pump performance.

- External ECG Monitor Requirements

Bandwidth* (-3 dB referenced to 10 Hz):	0.5 Hz maximum to 100 Hz minimum (Set monitor to Diagnostic Quality bandwidth) NOTE: Direct patient leads are preferred for optimum Ventricular Pacer Triggering due to the system's intergral 100 Hz low pass filter
Propagation Delay* (Delay of QRS complex):	25 milliseconds maximum
Scale Factor* (referenced to 10 Hz):	1 V/mV ±10%
Pacer Enhancement (NOTE: Digital pacer pulse summed in.)	Enabled for Ventricular Pacer Triggering if feature is available on the monitor.

- External Arterial Blood Pressure Monitor Requirements

Bandwidth* (-3 dB referenced to DC):	DC to 15 Hz minimum
Propagation Delay*:	25 milliseconds maximum (Delay of AC coupled zero-crossings when a 1 Hz sine wave is applied to the external monitor input)
Scale Factor*:	1 V/ 100 mmHg ±2%

* *Required for proper IABP triggering and pressure accuracy.*

Datascope supplies as part of the System 98 accessories interface cables which can be custom wired for compatibility with any monitor which meets the minimum requirements above. Wiring instructions for both ECG and Arterial Pressure interface cables are provided on the next page.

ECG with Standard Accessory External Signal Cable (0012-00-0323)*

1. The cable is supplied with a stereo phone plug to be connected to the System 98 rear panel ECG Monitor Input jack (64). The other end should be terminated with the appropriate connector for the external monitor. Pacer trigger selections can be used with this cable.

2. The following connections should be made to the external monitor connector:

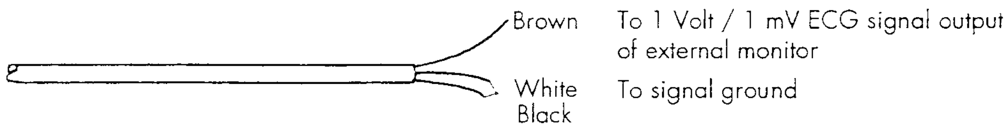


Figure 1-53 - External Signal Cable

Pressure with Standard Accessory External Interface Cable (0012-00-0323)*

1. The cable is supplied with a stereo phone plug to be connected to the System 98 rear panel Pressure Monitor Input jack (70). The other end should be terminated with the appropriate connector for the external monitor.

2. The following connection should be made to the external monitor connector.

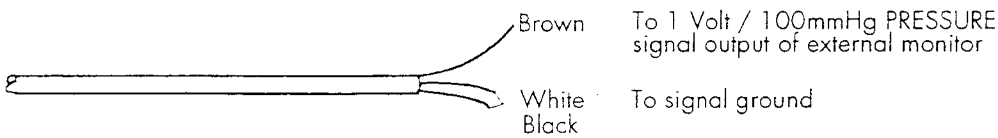


Figure 1-54 - External Interface Cable

WARNING: External bedside monitors used with the System 98 in the operating room must be equipped with electro-surgical interference suppression.

**Datascope does not recommend the use of the 0012-00-0467 cable with the System 98.*

For assistance in interfacing the System 98 with external monitors contact the Datascope Technical Support Department.

1.3.21 Pediatric Balloon Pumping

The following is an abbreviated version of the normal set up instructions. Please refer to Sections 1.3.1 through 1.3.16 for detailed procedures.

The drive system of the System 98 is modified for pediatric use by replacing the safety disk with the pediatric adapter assembly P/N 0998-00-0110-01. This adapter extends the drive pressure line allowing remote placement of the safety chamber isolator by the patient's side. This is required to keep pediatric IAB catheter length short. Note that the 4 and 6 ft. extension catheters are used only with adult balloons.

1.3.21.1 Pediatric Adapter Installation

1. Disconnect all pneumatic and electrical connections [IAB Fill Port (75), Drain Port (74), IAB Catheter Extender (58), and DC Input (60)}.

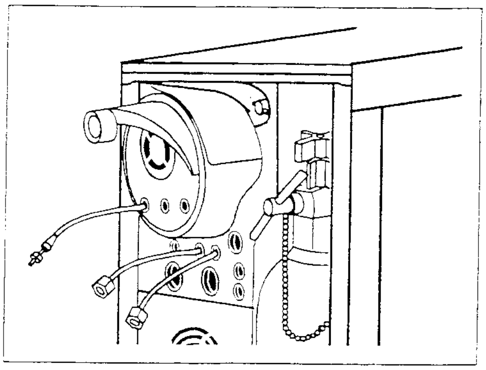


Figure 1-55

Disconnect Connections

2. Turn the adult safety disk approximately 30° counter-clock-wise and pull straight out.

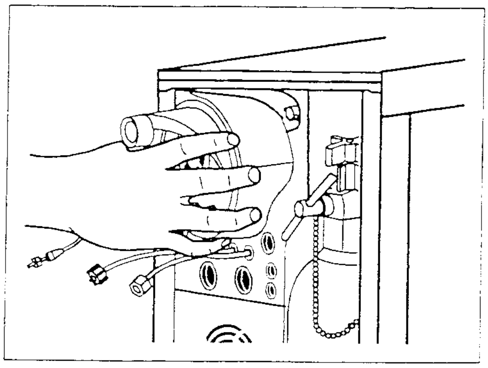


Figure 1-56

Remove Safety Disk

3. Install pediatric adapter assembly.

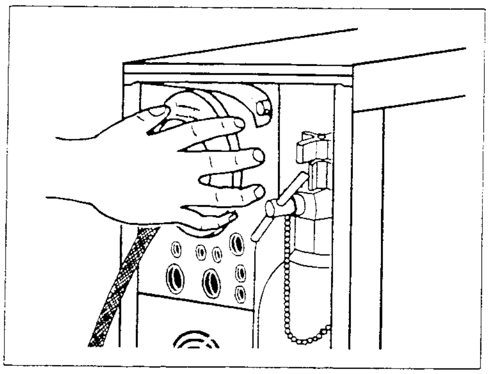


Figure 1-57

Install Pediatric Adapter Assembly

4. Hand-tighten the appropriate size pediatric safety chamber onto the other end of the adapter hose. Verify that the rubber o-ring is in place to ensure a proper seal. (See table below for the correct safety chamber selection.)

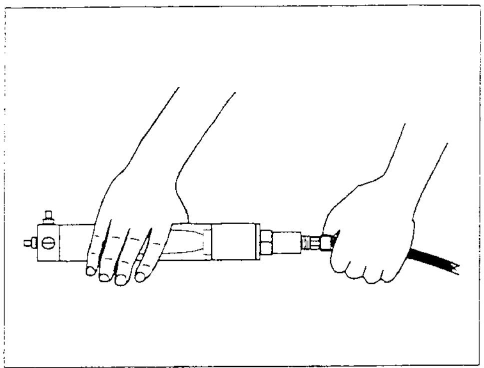


Figure 1-58

Attach Pediatric Safety Chamber

Datascope Pediatric IABs	Appropriate Safety Chamber
2.5, 5, 7 cc	Pediatric (15 cc) Safety Chamber
12, 20 cc	Adult (72 cc) Safety Chamber

1.3.21.2 Establish Power (AC Operation)

1. Remove any plug from the patient balloon connector on the safety chamber.
2. Attach the line cord, appropriate for the country of use, securely into the MAINS power receptacle (63) on the pump console.
3. Plug the System line cord into a compatible grounded AC receptacle. In the U.S. use only receptacles marked "Hospital Grade." Do not use an adapter to eliminate the plug's connection to ground. If auxiliary equipment is used with the System 98, insure that the equipment is also properly grounded.

If a Safety Chamber Leak Test is desired continue with Step 1.3.21.3 otherwise proceed to Step 1.3.21.4

1.3.21.3 Safety Chamber Leak Test (Pediatric)

Perform a safety chamber leak test using the following procedure:

1. Unplug the safety chamber fill port and install a plastic 3-way stopcock.
2. Move the safety chamber close to the System 98 and attach the autofill tube to the stopcock.
3. Open stopcock to the safety chamber.
4. Have available a dead end luer plug for later use in capping the patient balloon connector.
5. Press and hold the IAB FILL key (8) and the ASSIST/STANDBY key (9) while pressing the System Power On/Off switch to ON. Release both keys when the

message "*SAFETY* DISK LEAK TEST" appears adjacent to the ADVISORIES (37) on the display. See section 1.3.2.2 for a detailed description of the leak test.

At the completion of the leak test, remove the autofill tube. The 3-way stopcock can remain in order to facilitate manual filling of the IAB. Remove any plug from the patient balloon connector on the safety chamber.

1.3.21.4 Normal Power Up Procedure

If the System 98 is not already on, press the IABP ON/OFF switch (77) to ON.

1.3.21.5 Establish Fill Gas Pressure

1. Slowly open the Helium cylinder valve fully counter-clockwise.
2. Make sure that the helium pressure gauge (76) shows that the helium supply is in the operating range (within the white area).

   NOTE: When the System is not in use, close the cylinder valve fully clockwise to prevent a potential leak and the depletion of the helium supply.

3. Check that the message "*LOW HELIUM*" is not displayed. If the "*LOW HELIUM*" message is displayed, check helium display icon or helium cylinder gauge for adequate gas capacity and check helium cylinder attachment for leaks. Replace the cylinder if necessary.

1.3.21.6 Initial Set-up for Pediatric Balloon Pumping

1. Set the pump controls as follows:

TRIGGER SELECT	(1)	ECG
IAB FREQUENCY	(6)	1:1
IAB AUGMENTATION	(7)	OFF
IAB INFLATION	(10)	Midpoint
IAB DEFLATION	(11)	Midpoint
IAB FILL MODE	(34)	MANUAL
TIMING	(35)	MANUAL
SLOW GAS	(33)	OVERRIDE
ECG GAIN	(12)	NORMAL

2. Attach Pediatric IAB catheter to safety chamber now or after acquisition of ECG and pressure signals.

   See sections 1.3.2.5, 1.3.2.6, and 1.3.2.8 for ECG Acquisition, Arterial Pressure Acquisition, and Selection of Trigger.

1.3.21.7 Timing of Pediatric Balloon Pumping

MANUAL TIMING

Check that the MANUAL LED adjacent to the TIMING key (35) is illuminated. Use the INFLATION (10) slide control to move the higlighted segment of the arterial pressure trace so that it begins at the dicrotic notch. Adjust the DEFLATION (11) slide control so that the higlighted portion ends slightly before systole.

On the inflate control scale "0" represents inflation at the trigger event with each increment representing a 125 msec delay. On the deflate control scale "0" represents deflation immediately after inflation with each increment representing a 125 msec delay.

If inflation is adjusted, deflation is directly effected and will also require re-adjusting. If a trigger event is detected prior to the IAB deflation point, a safeguard will automatically deflate the IAB at the trigger event.

NOTE: The System 98 is designed to recognize heart rates up to 200 bpm. At rates in excess of 200 bpm ±4 bpm, the trigger refractory period causes the System 98 to automatically assist every other beat. In manual timing mode, IAB timing will NOT be adversely effected when this occurs. The System will automatically reresume assisting every beat when the heart rate falls below 200 ±4 bpm.

AUTO TIMING

WARNING: Use ONLY MANUAL TIMING when pumping with pediatric catheters. Efficacy of auto timing has not been clinically verified in the pediatric population and is not recommended.

IMPORTANT: At rates in excess of 200 ±4 bpm, it is possible that auto timing logic could cause patient harm, as inflation could extend into the next cardiac cycle. Under NO circumstances should auto timing be used when the patient's heart rate approaches this range.

1.3.21.8 Filling Pediatric Catheters

NOTE: Autofill is not calibrated to fill pediatric catheters. Follow this procedure and use the exact filling volume specified on the balloon package.

NOTE: The installation of the pediatric adapter assembly must be completed, as detailed in section 1.3.21.1, before proceeding.

1. Verify the IAB FILL MODE (34) is set to manual.
2. Attach a 3-way stopcock to the side port luer fitting on the chamber.
3. Press IAB FILL key (8) for 2 seconds. Screen will display "MANUAL FILL IAB" message.
4. Check that the helium gauge indicates sufficient gas pressure.

5. Attach an empty 20 cc syringe to the 3-way stopcock. Open the stopcock between the syringe and the safety chamber. Use only the plastic syringe supplied. Evacuate the safety chamber by pulling up on the plunger of the syringe. Close the stopcock to the safety chamber and press the plunger down to empty the syringe. Repeat this until a strong resistance is felt. Safety chamber balloon should be tightly collapsed after this procedure.

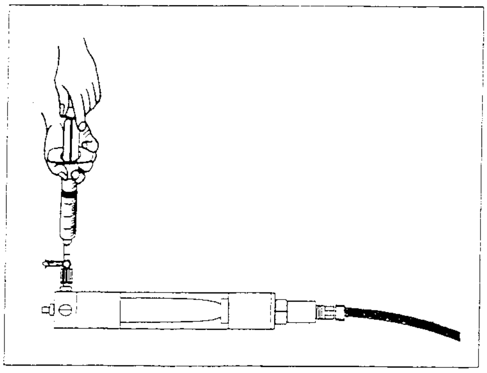


Figure 1-59

Attach Syringe to Stopcock

6. Close the stopcock to the safety chamber and remove the syringe.

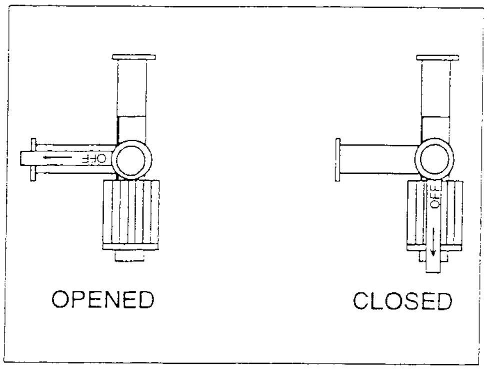


Figure 1-60

Open and Close

7. Attach a 20cc syringe to the Manual Fill Port (73). Fill the syringe and discard the contents. Fill the syringe a second time with the amount of fill (preload) volume specified on the balloon package.

WARNING: Extreme care should be taken during this process. Never use a glass syringe for this procedure. Hold your hand over the syringe plunger.

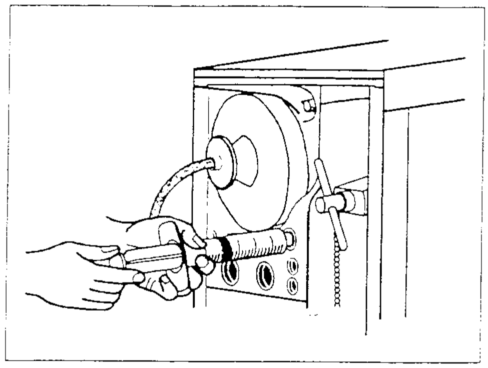


Figure 1-61

Attach Syringe to Manual Fill Port

8. Hold the syringe tip down and/or cover with your finger. Attach the filled syringe to the stopcock on the safety chamber and open the stopcock between the safety chamber and the syringe.

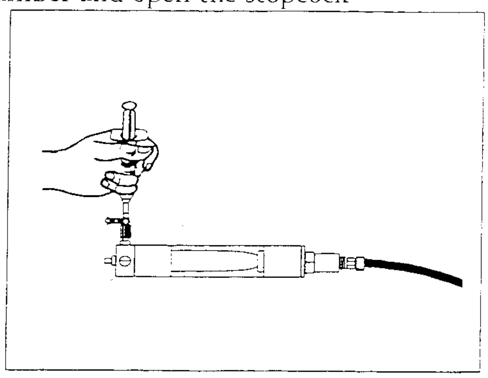


Figure 1-62

Attach filled Syringe to Stopcock

9. Press the IAB FILL key (8) for 2 seconds. Contents of the syringe will be pulled into the safety chamber.

   PRECAUTION If the contents of the syringe are not drawn into the safety chamber, DO NOT resume balloon pumping. Return to step 3 and repeat the procedure paying careful attention to the syringe fill volume. If the second attempt fails, there most likely is a leak at one of the safety chamber ports or stopcock and they should be checked.

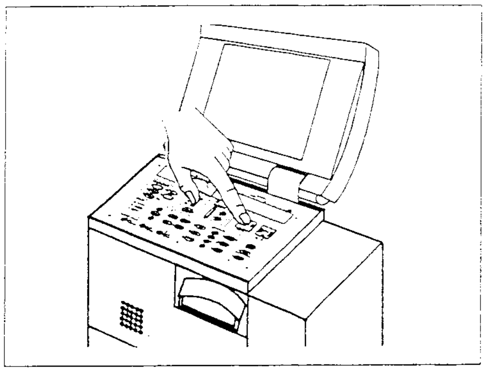


Figure 1-63
Press IAB Fill Key

10. Close the stopcock and remove the syringe. Manual fill is complete.

NOTE: Due to diffusion of gas, the manual fill procedure should be repeated every 45 minutes or as needed.

1.3.21.9 Initiation of Assist (Pediatric)

1. Check that IAB AUGMENTATION (7) is OFF.

2. To initiate assist, press the ASSIST/STANDBY (9) key. The indicator within the key begins to flash on each inflation.

   NOTE: A short full inflation cycle is initiated to facilitate Arterial pressure transmission delay (APD) measurements for the first initiation of assist only.

3. Use the IAB AUGMENTATION arrow key to slowly increase the level until IAB augmentation is maximum.

4. If necessary, adjust the IAB INFLATION (10) and IAB DEFLATION (11) controls to achieve proper timing. Augmentation should begin at the dicrotic notch.

5. While pumping, press and hold the INFLATION INTERVAL key (19) to confirm that the marked and intensified segment of the arterial pressure trace begins approximately at the dicrotic notch.

   If not, the Arterial Pressure transmission delay (APD) can be automatically recalculated by quickly pressing and releasing the INFLATION INTERVAL key (19). Confirm proper intensification position.

   If still incorrect, APD can be manually adjusted in the Display Preferences section of the Preferences menu. Once APD is selected, the delay may be adjusted from 0 to 180 msec in 4 msec increments using the UP and DOWN ARROW keys (24). The marked and intensified segment of the Arterial Pressure waveform will consequently move later on the trace. This delay can be adjusted to approximate the start of intensification at the dicrotic notch.

NOTE: If the patient's pressure monitoring site is changed while pumping, the INFLATION INTERVAL key (19) can be quickly pressed and released to recalculate arterial pressure transmission delay. Reconfirm proper position. This will assure accurate digital pressure displays.

6. Confirm that the AUG ALARM is ON and the limit is set approximately 10 mmHg below diastolic augmentation.

PRECAUTION When in the Manual Fill Mode, the IAB Catheter and Gas Loss Alarms are disabled. Therefore, use of the Low Augmentation Alarm is essential in pediatric IAB patient care. By setting the Low Augmentation Alarm, the System monitors the level of assist and alerts the user in the event that readjustment of controls and/or re-selection of modes of operation is required.

1.3.22 PREFERENCES MENU

The Preferences menu allows the operator to adjust display options, audio tone options and the system date and time. The Preferences menu can be accessed by pressing the PREFERENCES MENU key (27). While this menu is active the LED adjacent to the key will be illuminated. The initial preference selection menu appears:

PREFERENCE MENU

Display Preferences
Audio Preferences
Set Time and Date
Adjust APD

⬆⬇ to highlight item	SELECT item	DONE Exit

Figure 1-64

Preferences Menu

The UP & DOWN ARROW keys (24) are used to highlight the desired item to be reviewed or changed. Pressing the CHANGE/SELECT key (25) displays all the preferences for the selected item. Once inside a desired item's menu the arrow keys are used to select the specific parameter to be changed. As the reverse video field moves through the list of configurable items, the selection field on the right expands to show the current selection in reverse video and other possible options to the right of it. Changes to the preference setting are accomplished by pressing the CHANGE/SELECT key (25). Once a change is made either move to another item or exit the menu to store this change. Exit by pressing the DONE key (26) to move up one menu or the PREFERENCES MENU key (27) to exit all menus.

1.3.22.1 Display Preferences Menu

Perform the above key strokes to enter the Display Preferences menu:

DISPLAY PREFERENCES

Sweep Speed	25 mm per Sec	/50 mm per Sec
Brightness	High	
Balloon Waveform	On	
ECG Inflation Markers	On	
Flash Alarms	On	
Pressure Scale	Auto	

⬆⬇ to highlight item	CHANGE setting	DONE Main Menu

Figure 1-65

Display Preferences Menu

The following Display Preferences can be set by the user.

DISPLAY PREFERENCES		
Item	**Function**	**Options**
Sweep Speed	Change Waveform update speed	*25 mm per sec*/ 50mm per sec
Brightness	Change Display intensity	Low/Medium/*High*
Balloon Waveform*	Display balloon pressure waveform	Off/*On*
ECG Inflation Markers*	Display inflation markers on ECG waveform	*Off*/On
Flash Alarms	Flash alarm messages	*Off*/On
Pressure Scale	Auto or Manual Arterial Pressure scaling	Auto / 0-80 / 0-160 / 0-300

NOTE: Items in italiac are default values. Items with an * are retained until the user changes them. All other items (except Pressure Scale, see below) which are changed, will revert to the default value when power is turned off for more than 15 minutes.

Pressure Scale -

When Manual scale is selected and the system is powered off for less than 15 minutes, the pump will return to the selected scale.

When Manual scale is selected and the system is powered off for more than 15 minutes, the pump will return to the 0-160 scale.

If Auto scale is selected, the pump will return to Auto scale in all cases until a manual scale is selected.

1.3.22.2 Audio Preferences Menu

Enter the menu to Audio Preferences by following procedure outlined in section 1.3.22 "Preferences Menu".

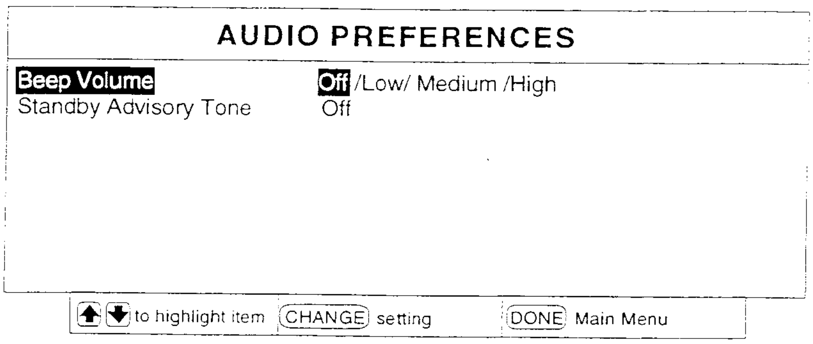


Figure 1-66

Audio Preferences Menu

The following Audio Preferences can be set by the user.

AUDIO PREFERENCES		
Item	**Function**	**Options**
Beep Volume	Set beep volume	*Off*/Low/Medium/High
Standby Advisory Tone*	Sound tone on Standby alert	*Off*/On

NOTE: Items in italiac are default values. Items with an * are retained until the user changes them. All other items which are changed, will revert to the default value when power is turned off for more than 15 minutes.

1.3.22.3 Set Time and Date

Enter the menu to Set Time and Date by following procedure outlined in section 1.3.22 "Preferences Menu".

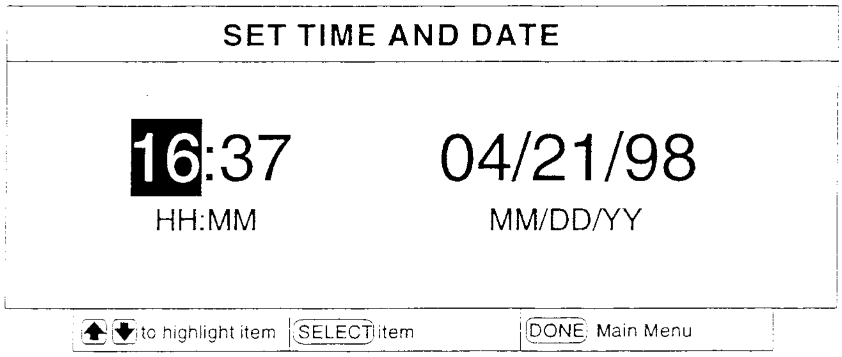


Figure 1-67
Set Time and Date

Time is displayed in a 24 hour format. The date format is specifed according to the system configuration setting (MM/DD/YY or DD/MM/YY). Press the CHANGE/SELECT key (25) to move the highlighted field to each of the five adjustable fields. Use the ARROW keys (24) to increment or decrement the highlighted field. Exit by pressing the DONE key (26) to move up one menu or the PREFERENCES MENU key (27) to exit all menus.

1.3.22.4 Adjust APD

Enter the menu to Adjust APD (Arterial Pressure Delay) by following procedure outlined in section 1.3.22 "Preferences Menu".

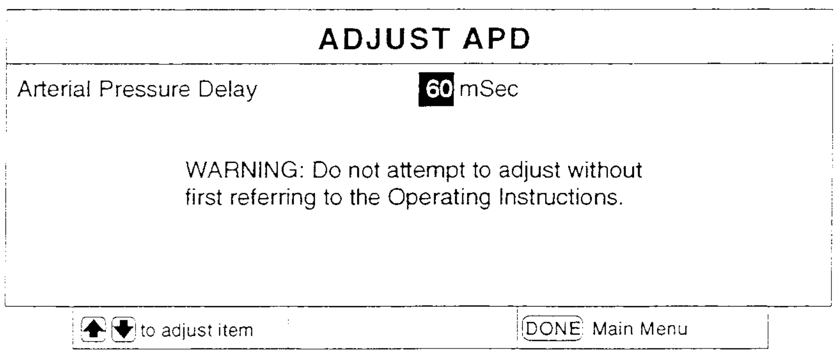


Figure 1-68
Adjust APD

This menu may be used to adjust a "calculated" Arterial Pressure Delay. Refer to section 1.3.2.11 for more information on APD. The delay may be adjusted from 0 to 180 msec in 4 msec increments using the UP and DOWN ARROW keys (24).

1.3.23 SYSTEM CONFIGURATION

1. To enter the System Configuration mode press and hold the PREFERENCE MENU key (27) while turning the IABP ON/OFF switch (77) to ON.

   NOTE: the key must be pressed until the System Configuration screen appears.

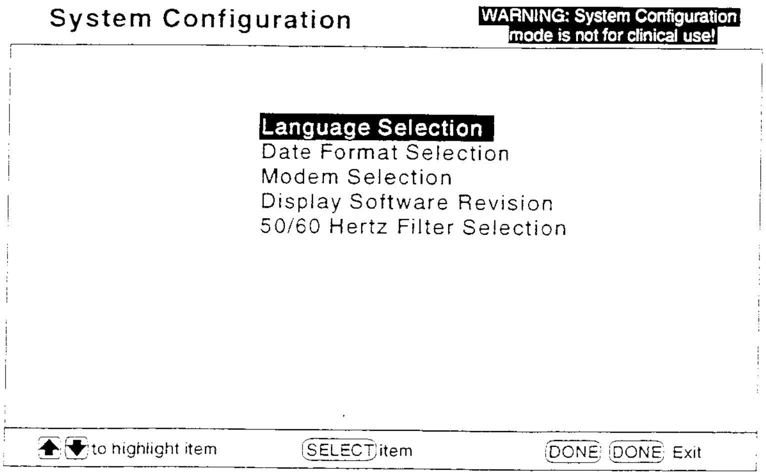


Figure 1-69

System Configuration

1.3.23.1 Language Selection

1. To enter the Language Selection menu item, press the UP & DOWN ARROW keys (24) to highlight Language Selection.
2. Press the CHANGE/SELECT key (25) to open the Language Selection menu item.

   NOTE: The list of languages will always be shown in the native language while all other text will be in the selected language.

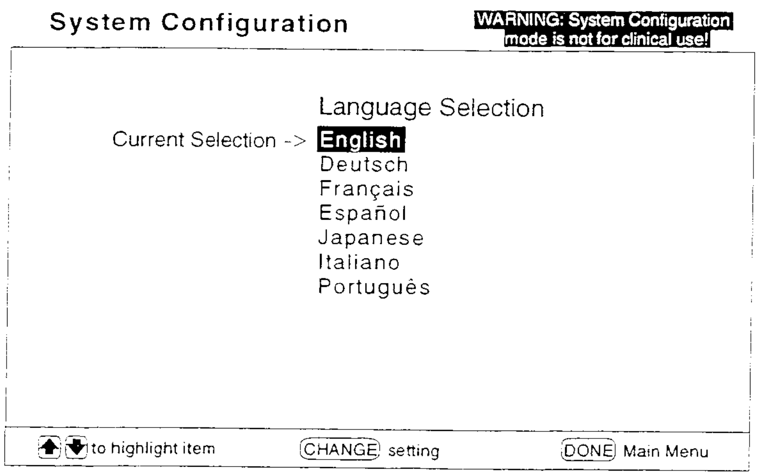


Figure 1-70

Language Selection

1.3.23.2 Date Format Selection

The System 98 allows the date to be set as DD/MM/YY or MM/DD/YY.

1. To enter the date format menu item, press the UP & DOWN ARROW keys (24) to select Date Format Selection and press the CHANGE/SELECT key (25).
2. Press the UP & DOWN ARROW keys (24) to select the desired format and press the CHANGE/SELECT key (25) to change it.
3. When the desired format is selected, press the DONE key (26) to move up one menu. The System restarts and returns to the normal monitoring mode.

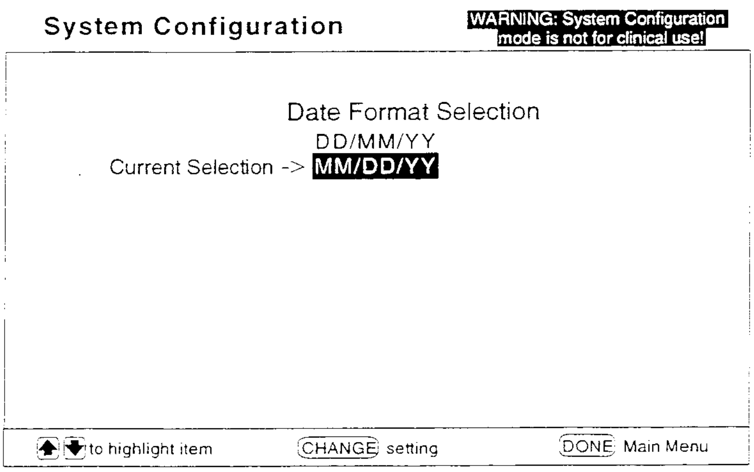


Figure 1-71

Date Format Selection Screen

1.3.23.3 Modem Selection

The System 98 is equipped with an internal modem which requires configuration before it can be used.

1. To enter the modem selection menu item, press the UP & DOWN ARROW keys (24) to highlight Modem Selection.
2. Press the CHANGE/SELECT key (25) to open the Modem Selection screen.
3. Press the UP & DOWN ARROW keys (24) to highlight the desired modem.
4. When the desired modem is highlighted, press the CHANGE/SELECT key (25).

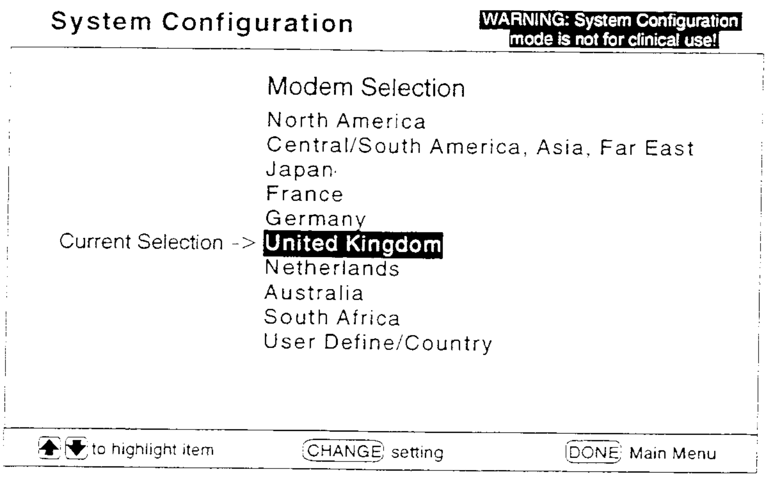


Figure 1-72

Modem Selection Screen

5. Press the DONE key (26) to move up one menu. The System restarts and returns to the normal monitoring mode.

- User Define/Country Selection

When User Define/Country is selected, the following screen is displayed.

NOTE: Contact Datascope Service Personnel for assistance in setting up a User defined modem.

Figure 1-73

User Define/Country Modem Selection

System Configuration WARNING: System Configuration mode is not for clinical use!

User Define/Country

Modem ID String	TDK-Germany
InitializationString	At&F-I17Z
Reset String	AT&F
Default DTE Baud Rate	9600
Override DTE Default	Off
Modem Location	Internal

↑↓ to highlight item   CHANGE setting   DONE Main Menu

1. To set or modify the Modem ID String, Initialization String, or Reset String, highlight one of them and press the CHANGE/SELECT key (25).

   A "Key Input" displays at the bottom of the screen along with the string to be modified in square brackets "[ ]".

Figure 1-74

User Define/Country Modem Selection with Key Input

System Configuration WARNING: System Configuration mode is not for clinical use!

User Define/Country

Modem ID String	TDK-Germany
InitializationString	At&F-I17Z
Reset String	AT&F
Default DTE Baud Rate	9600
Override DTE Default	Off
Modem Location	Internal

Key Input:

&/%\$-+=ABCDEFGHIJKLMNOPQRSTUVWXYZ

0123456789 SPACE   <- ->   SAVE

[TDK - Germany]

↑↓ to highlight item   CHANGE setting   DONE Main Menu

2. A highlighted cursor is placed on the first character within the square brackets. To change that character, use the UP & DOWN ARROW keys (24) to highlight the desired character in the "Key Input" section and press the CHANGE/SELECT key (25).

   The cursor now moves over to the next character within the square brackets. To skip a character or to go back to a character, highlight either the <- or -> in the "Key Input" and press the CHANGE/SELECT key (25). Each time this is done the cursor will move one space to the left or right accordingly.

3. The Initialization string must be set properly for the modem to function. The string is "AT&F-1 (country code) Z" where the country code is replaced with the appropriate number from the following table.

   For example, in the Austria the string will be: AT&F-I22Z and in Italy the string will be AT&F-I3Z

Country	Country Code
Austria	22
Belgium	23
Czech Republic	18
Denmark	10
Egypt	3
Finland	9
Ireland	24
Israel	15
Italy	3
New Zealand	11
Norway	8
Poland	3
Spain	6
Sweden	7
Switzerland	14
Turkey	3
UAE	2
All Other Countries	1

4. Press the DONE key (26) when all initialization information has been entered.

5. Verify the Reset String is set to AT&F.

6. To change the "Default DTE Baud Rate", highlight that line and press the CHANGE/SELECT key (25).

   The available choices display within that line. Choose 9600 and press the CHANGE/SELECT key (25).

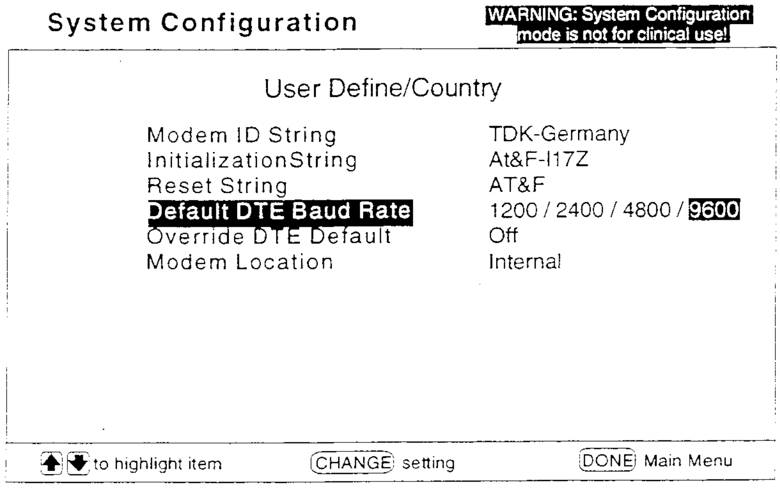


Figure 1-75

User Define/Country Modem Selection, Changing the Default DTE Baud Rate

7. To change the "Override DTE Default (Y/N)?", highlight that line and press the CHANGE/SELECT key (25).

   The choices of "Yes" and "No" display on that line. Choose NO and press the CHANGE/SELECT key (25).

8. To change the "Modem Location", highlight that line and press the CHANGE/SELECT key (25).

   A sub-menu displays the choices of "Internal" and "External". Choose "Internal" and press the CHANGE/SELECT key (25).

9. Press the DONE key (26) to exit.

10. At Modem Selection Screen, press DONE key (26).

11. At System Configuration Screen, press the DONE key (26). System should now return to regular operation, configured and ready for use.

1.3.23.4 Display Software Revision

1. To enter the Display Software Revision menu item, press the UP & DOWN ARROW keys (24) to highlight Display Software Revision.

2. Press the CHANGE/SELECT key (25) to open the Display Software Revision information.

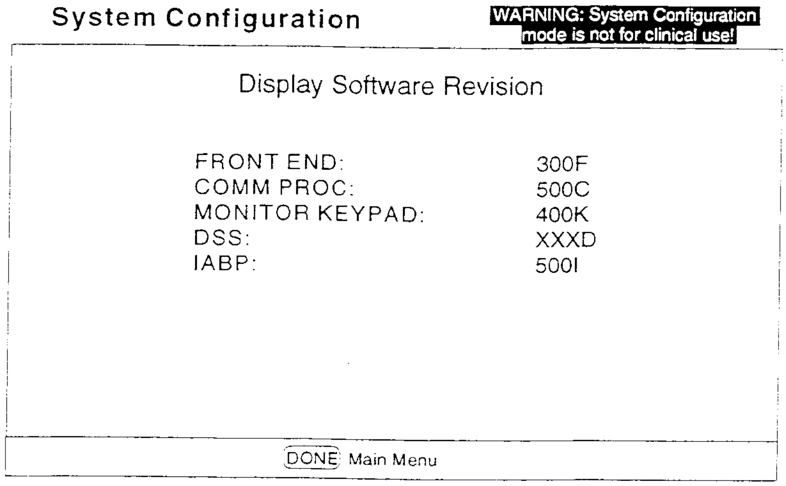


Figure 1-76

Software Revision

1.3.23.5 50/60 Hertz Filter Selection

The System 98 allows the selection either a 50 or 60 Hertz Filter.

1. To enter the 50/60 Hertz Filter Selection menu, press the UP & DOWN ARROW keys (24) to select 50/60 Hertz Filter Selection and press the CHANGE/SELECT key (25).

2. Press the UP & DOWN ARROW keys (24) to select the desired format and press the CHANGE/SELECT key (25) to change it.

3. When the desired format is selected, press the DONE key (26) to move up one menu. The System restarts and returns to the normal monitoring mode.

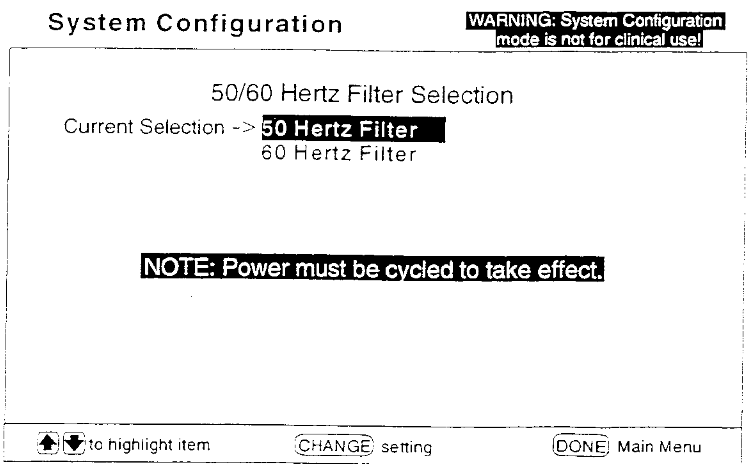


Figure 1-77

50/60 Hertz Filter Selection

2. THEORY OF OPERATION

CONTENTS OF THIS CHAPTER	Page
2.1 BLOCK DIAGRAMS	2-1
2.2 GENERAL THEORY OF OPERATION	2-2
2.3 DETAILED CIRCUIT DESCRIPTIONS	2-15
•2.4 FACTS ABOUT LEAD ACID BATTERIES	2-54

The Theory of Operation has been divided into two parts. The "General Theory of Operation", Section 2.2 describes the overall theory of operation of the instrument. This text is included to familiarize service personnel with the internal organization of the instrument. While reading this section refer to the System Block Diagram. The "Detailed Circuit Descriptions", Section 2.3, provides details regarding circuit operation. This text is included to assist service personnel while repairing the printed circuit boards on a component level. Refer to the individual block diagrams or the schematic drawings, in Chapter 5, when reading the Detailed Circuit Descriptions.

2.1 BLOCK DIAGRAMS

The Block Diagrams indicate the internal organization of the instrument. The block diagrams are used to gain both familiarity with the instrument and locate malfunctioning PC boards as readily as possible. To avoid clutter, the number of PC board interconnects is minimized. The interconnects shown represent major or essential signal flow and clock connections.

Block Diagrams

	Page
System Block Diagram	2-4
Front End Board (0670-00-0668)	2-5
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Monitor Module (0997-00-0464)	2-7
Keypad Controller Board (0670-00-0645)	2-8
Display Controller Board (0670-00-0640)	2-9
Solenoid Driver Board (0670-00-0639)	2-10
Video Receiver Board (0670-00-0641)	2-11
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Power Supply Assembly (0014-00-0033-02)	2-14

2.2 GENERAL THEORY OF OPERATION

Power Supplies

P/N	INPUT	OUTPUT
0014-00-0033-02	AC Mains Battery	0 - 35 volts (main or bulk supply) 24 V (solenoid supply) +/-12 volts, +5 volts - Battery charger, charge LED drive

Motor Controller Board: (0671-00-0004)
- DC motor speed control

Front End Board: (0670-00-0668)

ECG
- Patient isolation
- ESU filters
- Lead selection
- Reference lead drive
- External ECG signal selection
- Pacer detection
- ECG trigger signal conditioning
- ECG size
- ECG ESD protection
- ECG defibrillator protection

Pressure
- Patient isolation
- Pressure scaling
- Auto zero circuit
- Pressure gain adjustment
- External pressure signal selection
- Pressure ESD protection

Data Acquisition
- Pneumatic transducer Amplifiers
- A/D converter for display signals
- 12-Bit A/D converter
- Transducer excitation voltages

Microcontroller
- serial interface to Main board
- ECG circuit control latches
- Pressure circuit control latches
- controls A/D conversion
- pacer blanking
- ESU detect and timeout
- Auto zero control

Main Board: (0670-00-0666)

6809 Microprocessor (2MHz)
- 50K EPROM (Datasette)
- 12K RAM
- Solenoid control signals
- Watchdog timer
- Alarm processing
- Pneumatic switch status
- IABP control status
- Motor speed D/A converter

68020 Microprocessor (24MHz)
- 2M EPROM (Datasette)
- 2M RAM
- Real time clock and NVRAM
- Display interface
- Recorder control
- Recorder interface
- RS-232 interface
- Modem interface
- Configuration DIP switch

68HC711 Microprocessor
- Serial interface to the Front End, Solenoid Driver and Keypad Controller boards
- Shared RAM interface

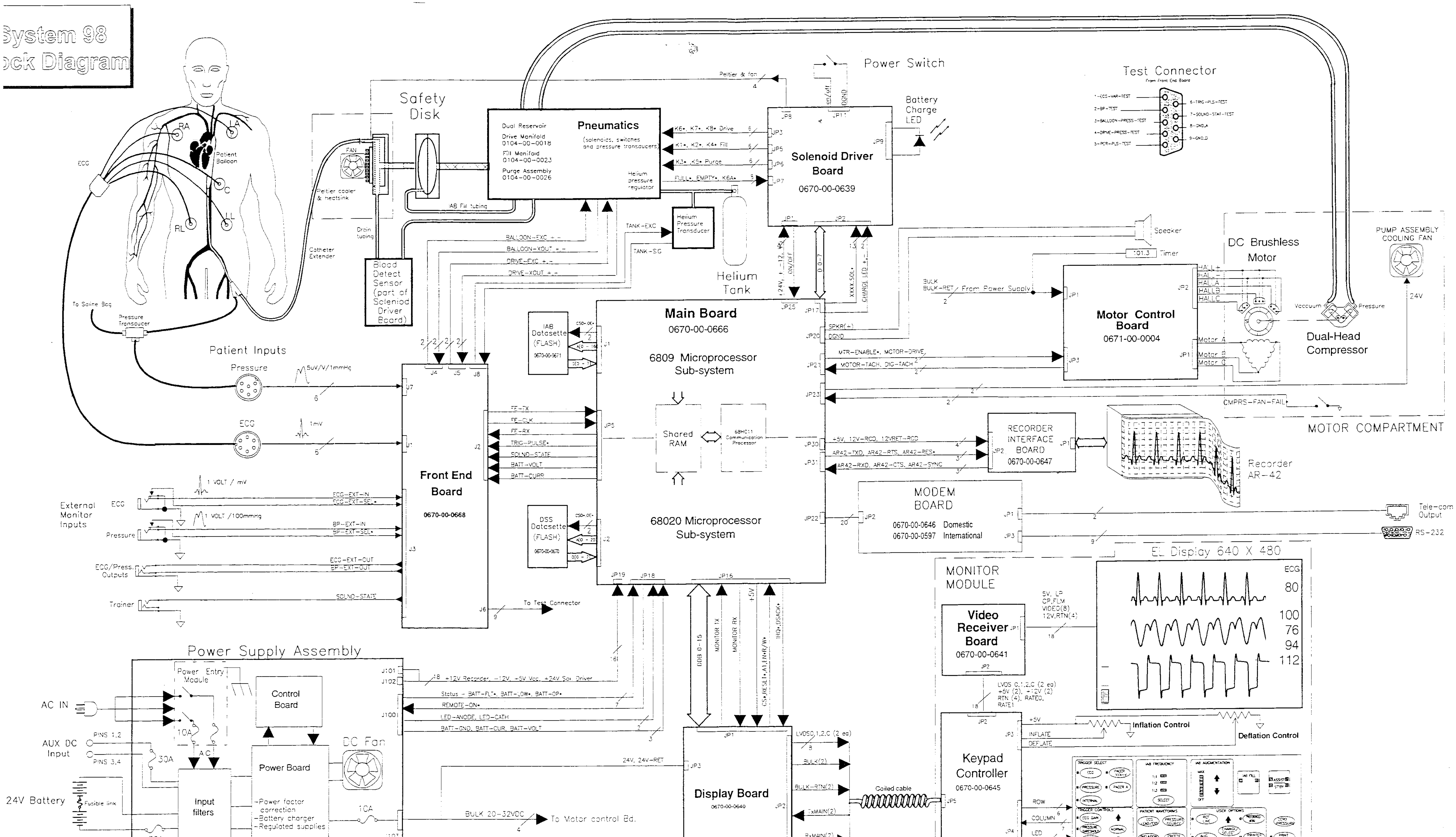
Shared RAM
- Port 1 interfaces with the 68020 sub-system
- Port 2 interfaces with the 6809 sub-system
- Port 3 interfaces with the 68HC711 (communications Processor)

Display Board: (0670-00-0640)
- Graphics Processor
- Low Voltage Differential Signaling (LVDS)
- Frame buffer memory
- EL display controller
- Clock generator

Solenoid Driver Board: (0670-00-0639)
- Solenoid activation circuits
- Prolonged inflation watchdog (System failure)
- Solenoid LED indicators
- Blood back sensor
- Condensate cooler control

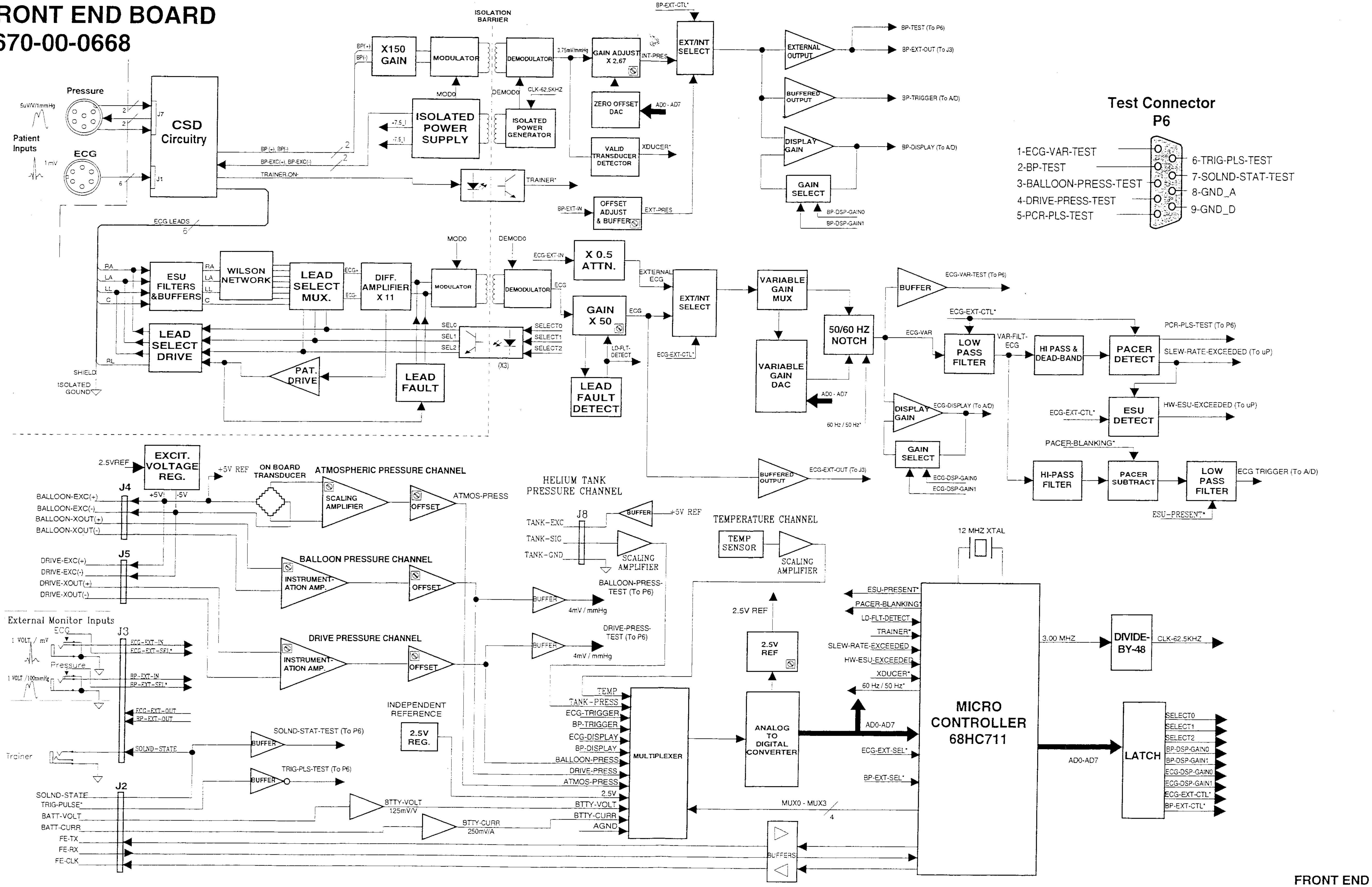
Keypad Controller: (0670-00-0645)
- Serial interface to Main board (68HC711 microcontroller)
- Keypad interface
- Keypad LED drivers
- Inflate, Deflate pot A/D converter

Video Receiver Board: (0670-00-0641)
- Differential video buffers
- Variable frame rate frame buffer



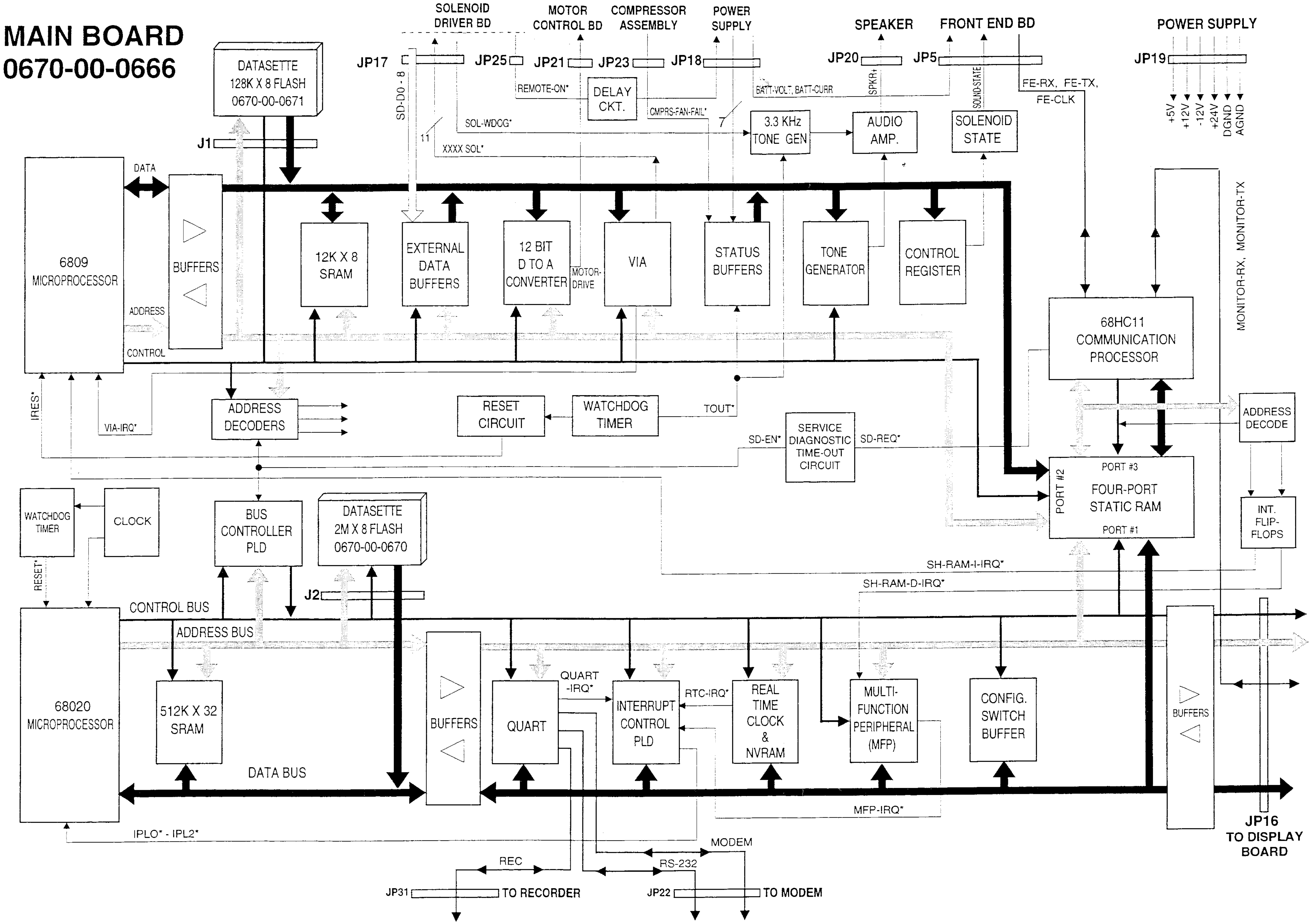
SYSTEM
Block Diagram

FRONT END BOARD
0670-00-0668

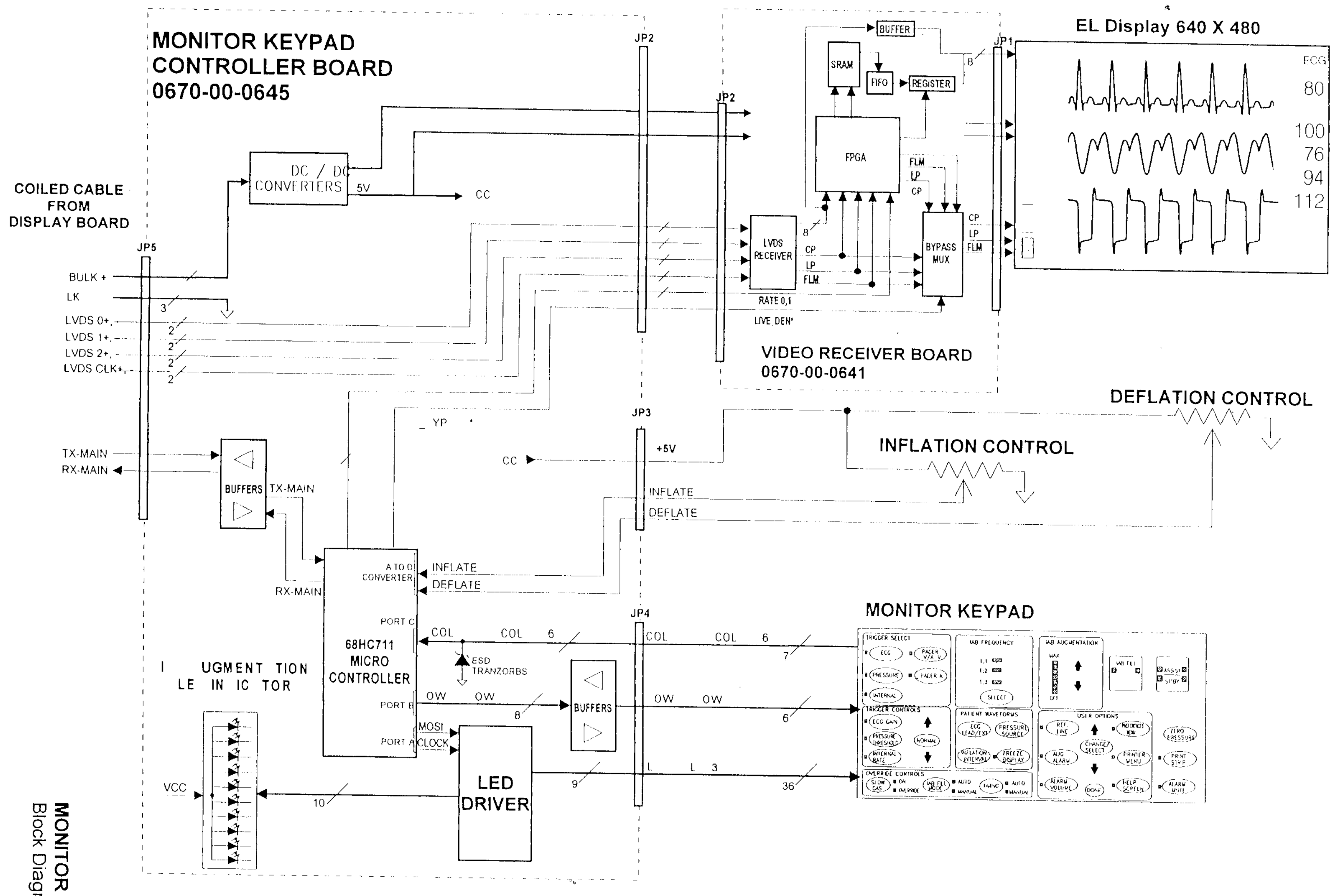


FRONT END BOARD
Block Diagram

MAIN BOARD
0670-00-0666

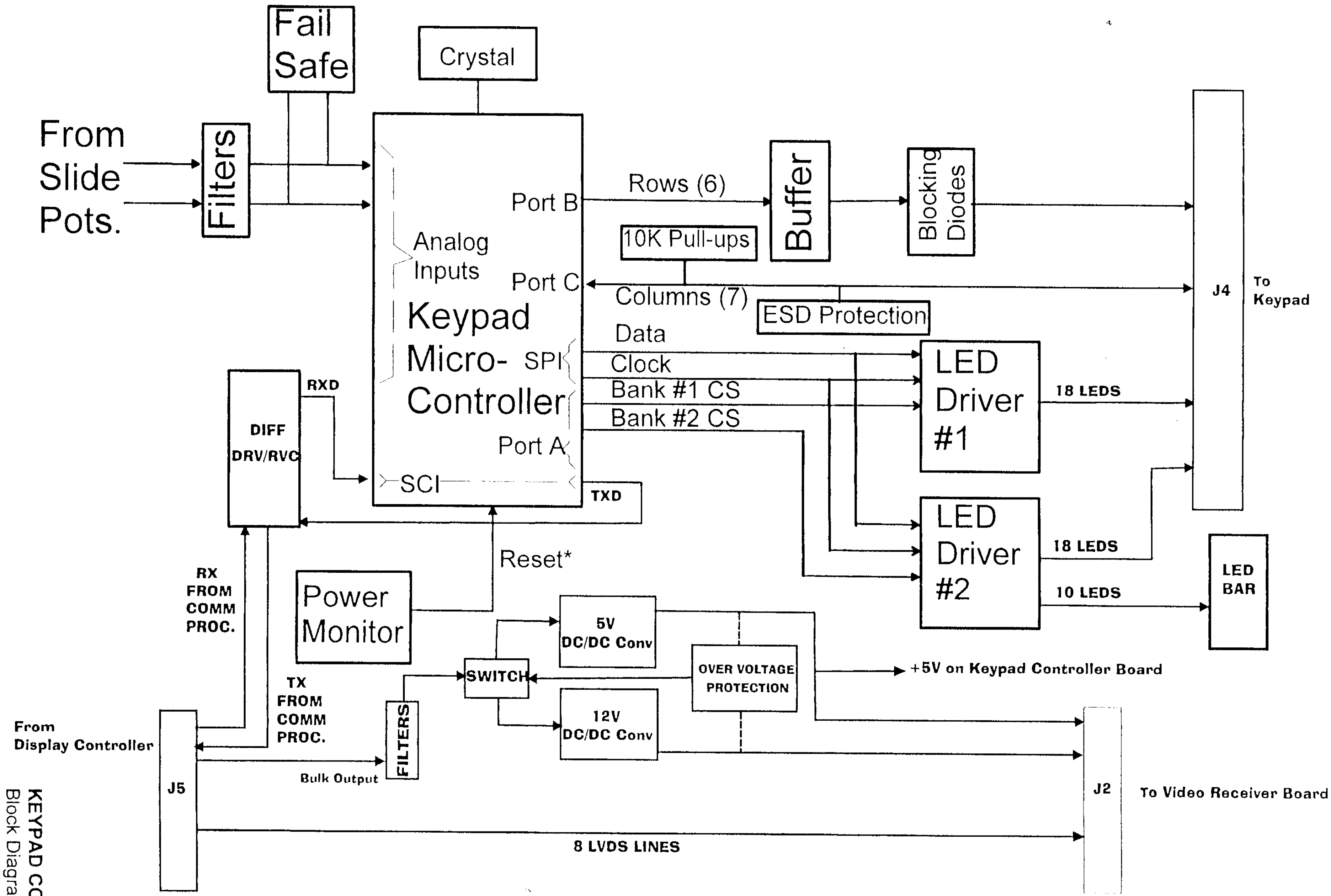


MONITOR MODULE
0670-00-0464



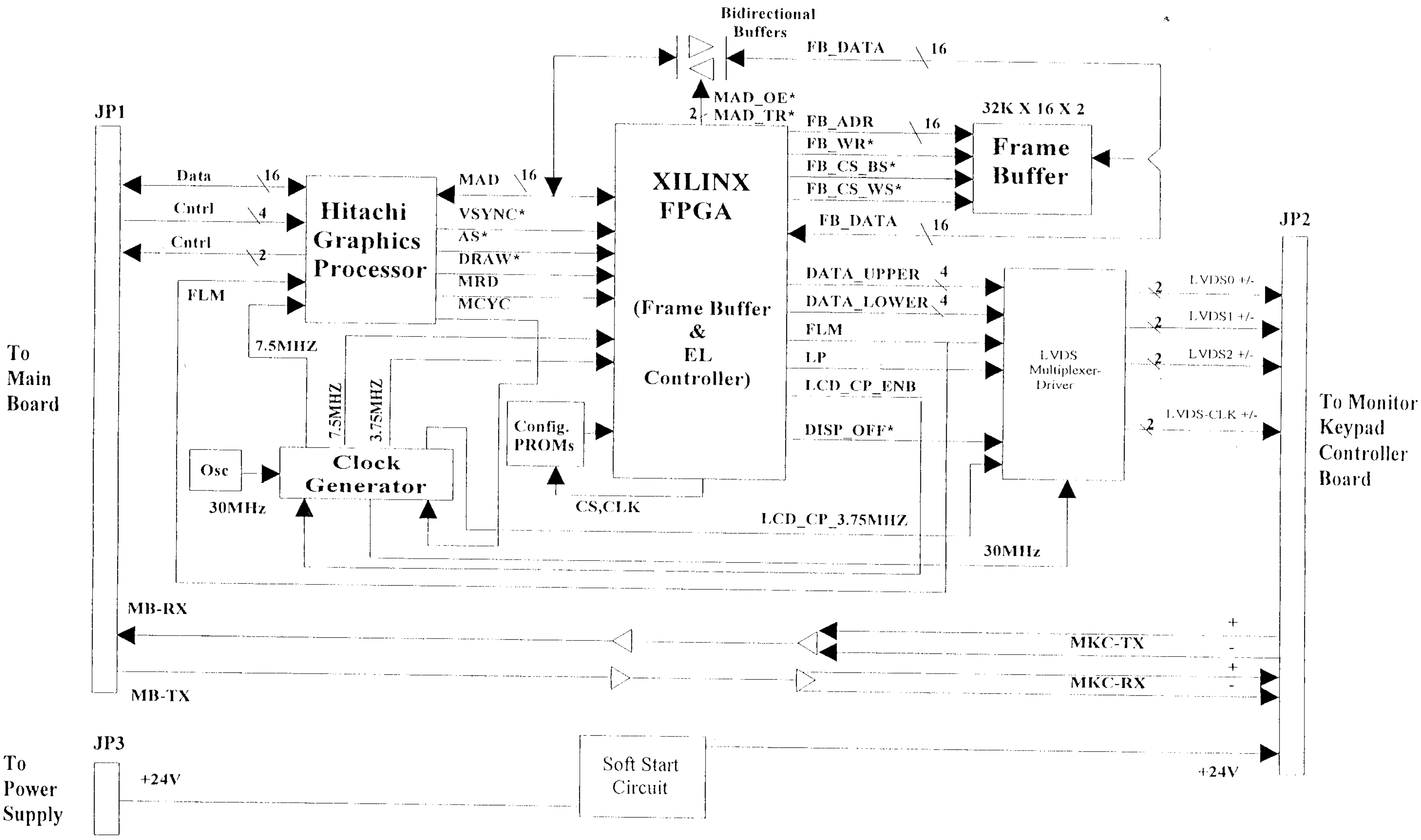
MONITOR MODULE
Block Diagram

KEYPAD CONTROLLER BOARD
0670-00-0645

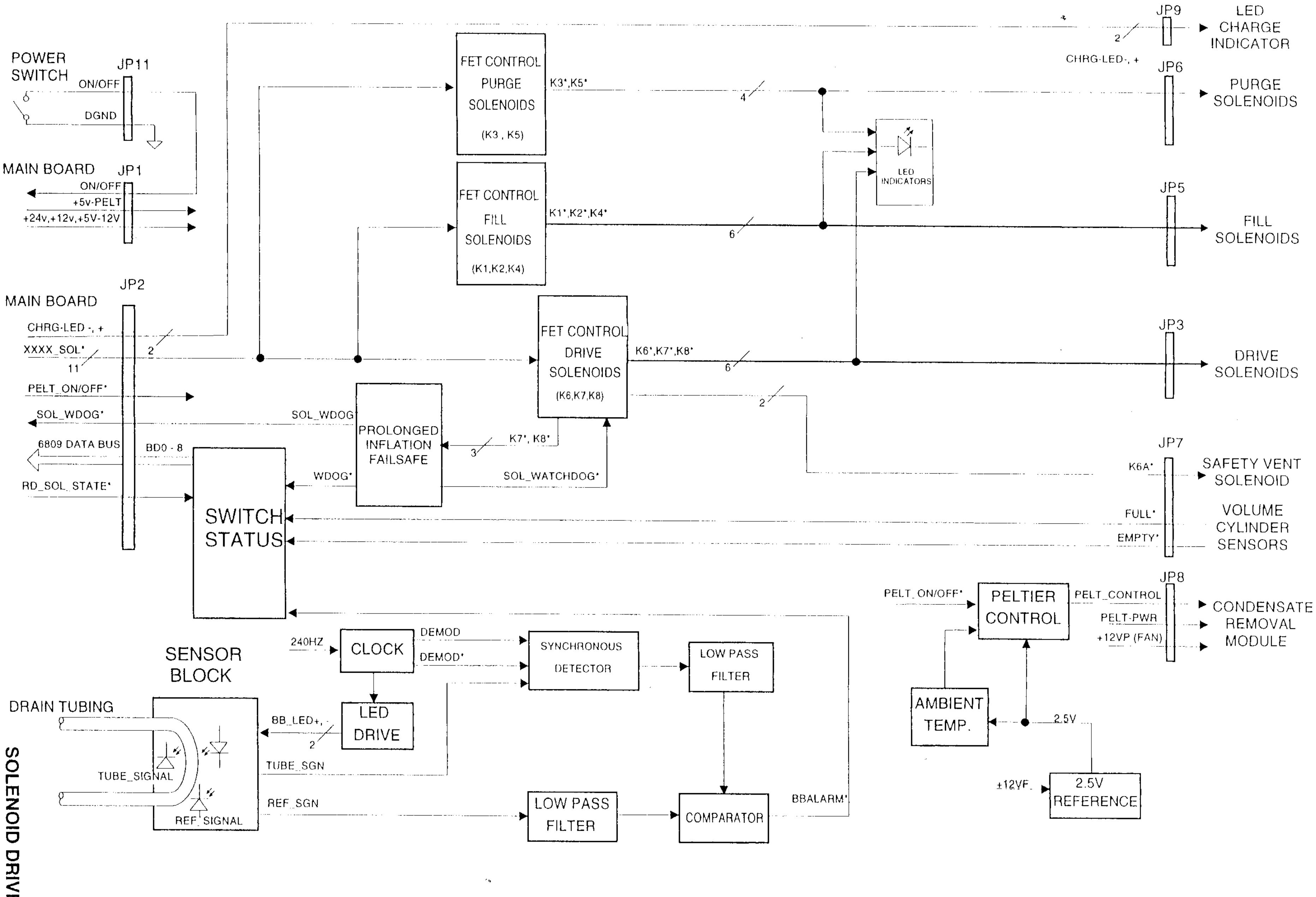


KEYPAD CONTROLLER
Block Diagram

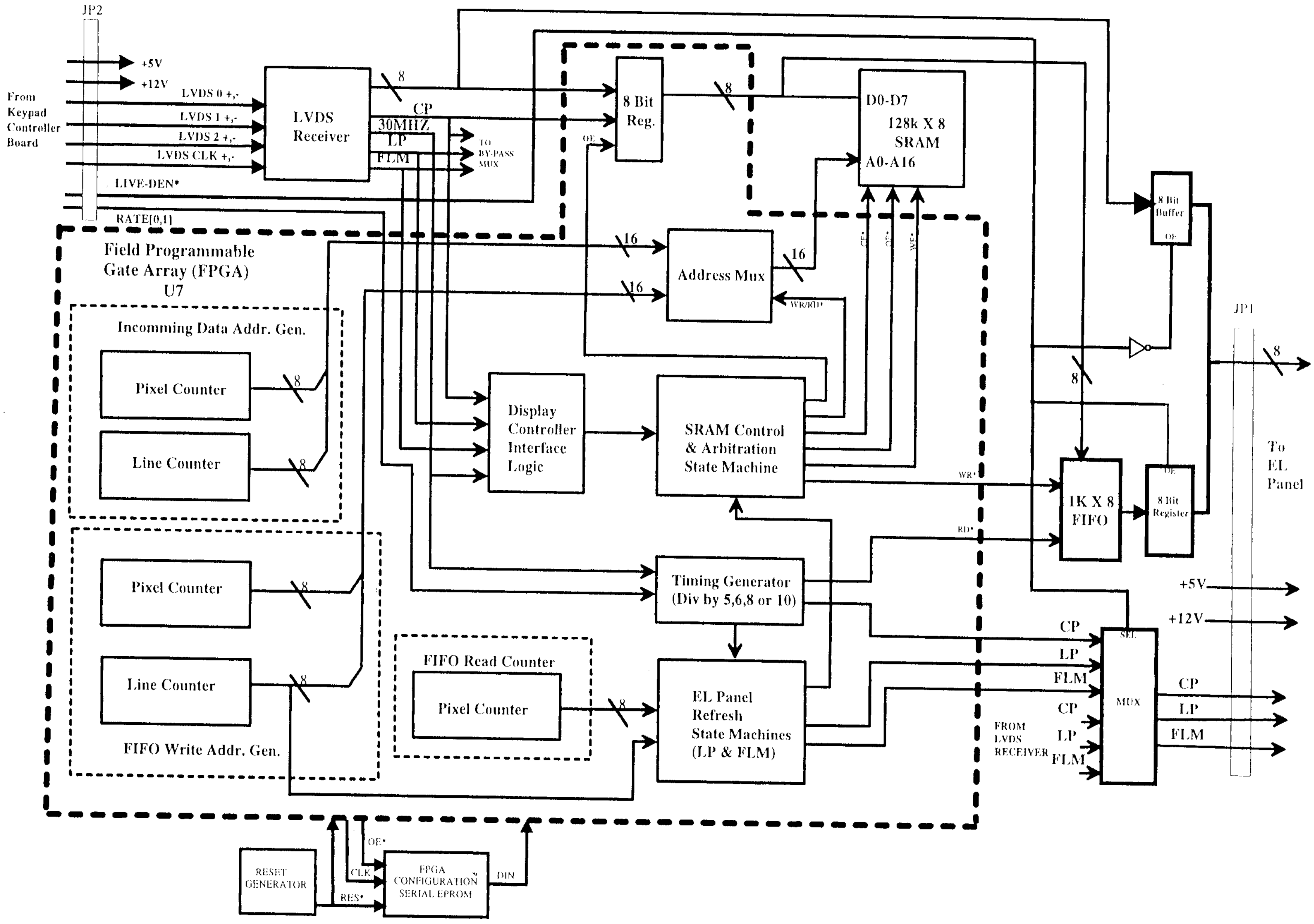
DISPLAY CONTROLLER BOARD
0670-00-0640



SOLENOID DRIVER BOARD
0670-00-0639

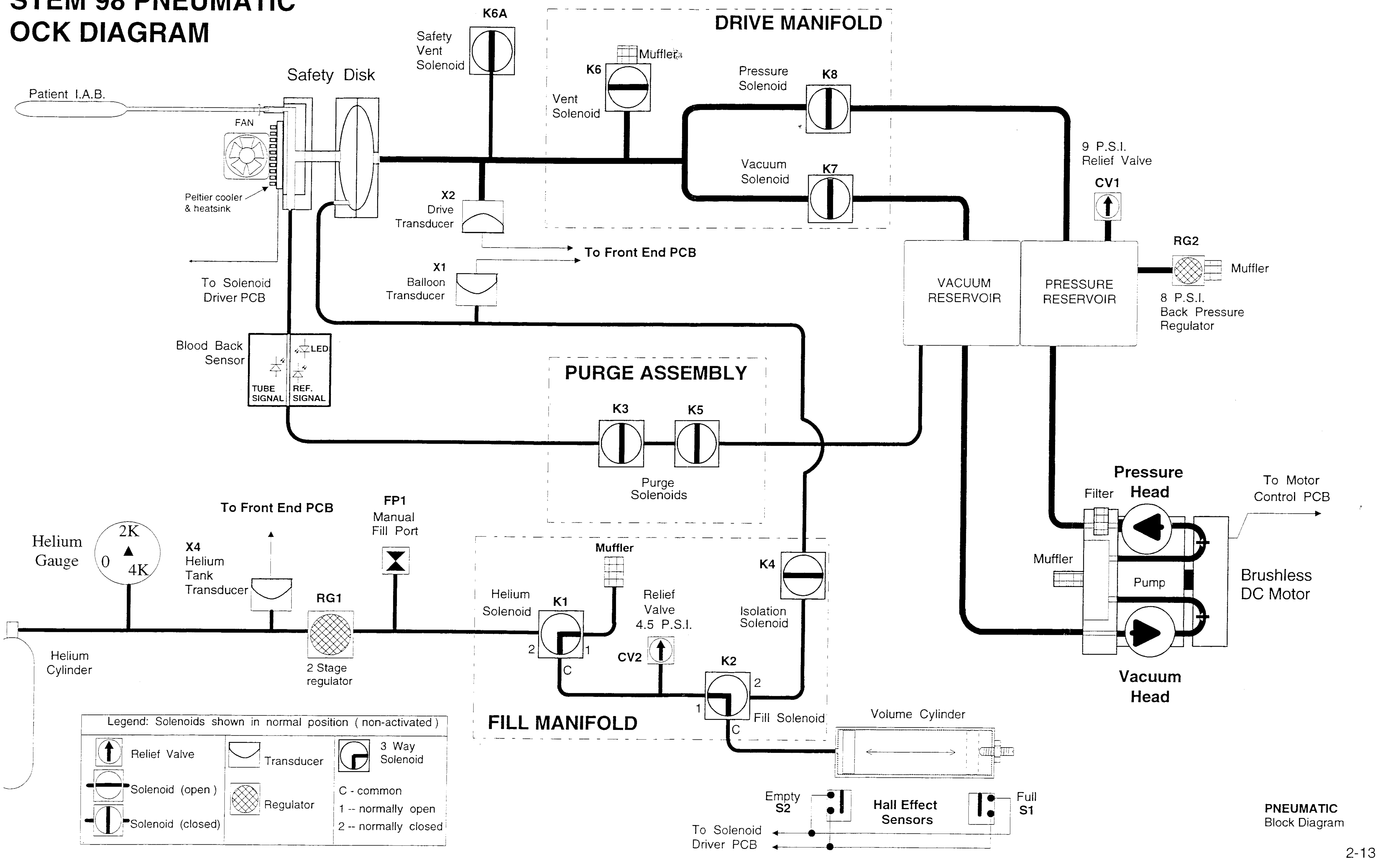


SOLENOID DRIVER
Block Diagram

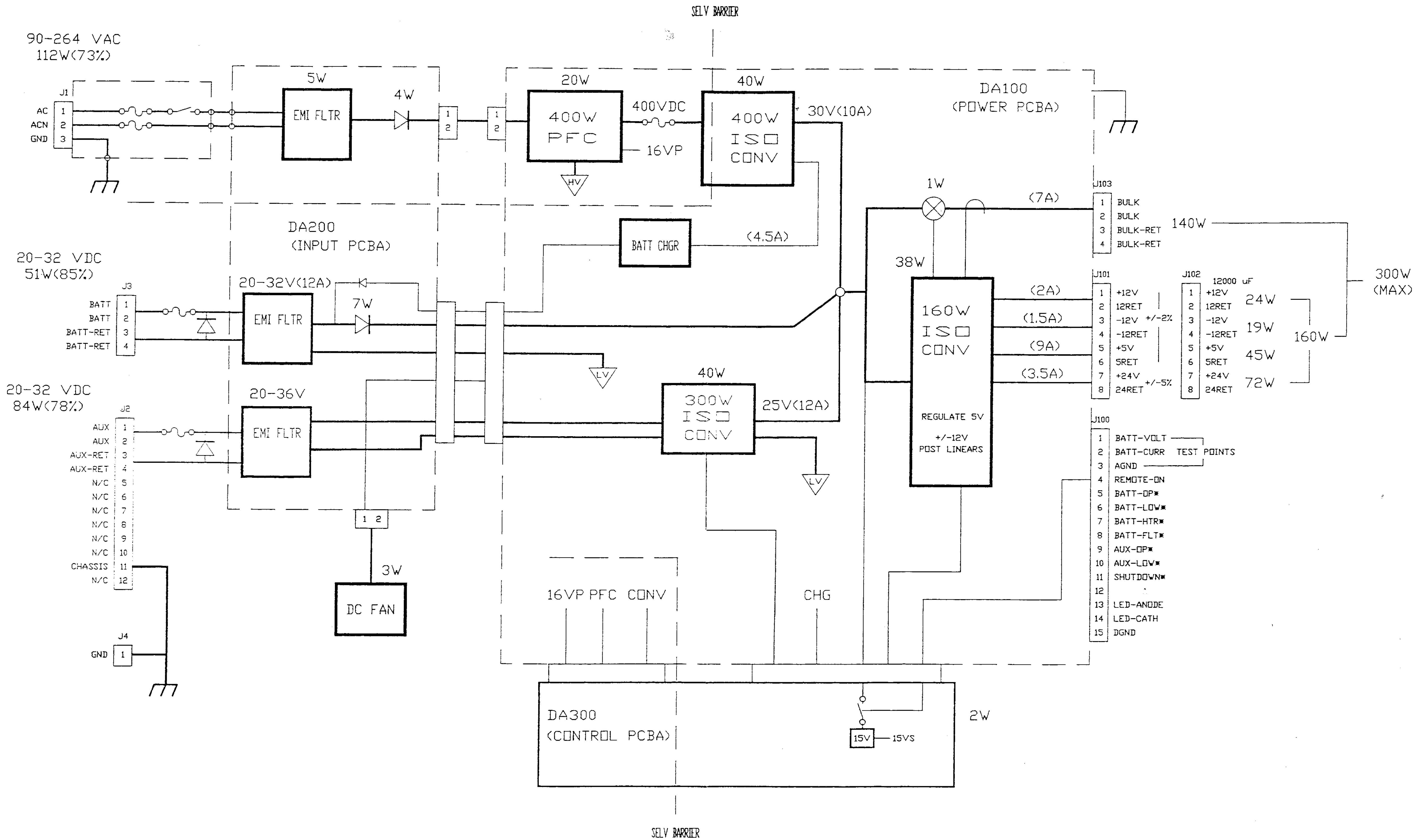


VIDEO RECEIVER
Block Diagram

STEM 98 PNEUMATIC OCK DIAGRAM



PNEUMATIC
Block Diagram



POWER SUPPLY ASSEMBLY
Block Diagram
0014-00-0033-02

2.3 DETAILED CIRCUIT DESCRIPTIONS

This section of the manual describes the operation of each circuit block. Refer to the schematic diagrams in Chapter 5.

Included are descriptions for the following Circuit Board Assemblies:

	Page
2.3.1 Front End Board (0670-00-0668)	2-16
2.3.2 Main Board (0670-00-0666)	2-27
2.3.3 Video Receiver Board (0670-00-0641)	2-38
2.3.4 Keypad Controller Board (0670-00-0645)	2-42
2.3.5 Display Controller Board (0670-00-0640)	2-44
2.3.6 Solenoid Driver Board (0670-00-0639)	2-47
2.3.7 Pneumatic Description	2-49

2.3.1 Front End Board (0670-00-0668)

The Front End Module may be subdivided into the following circuits:

- ECG Circuits
- Pressure Circuits
- Pneumatic Transducer Circuits
- Miscellaneous Signal Circuits
- A/D Converter and Microcontroller

ECG Circuits

- ECG CSD Circuitry

The ECG interface section of this board consists of an input connector J1, five 4.7K ohm series carbon composite resistors (R301-R305) and five 200V transzorbs (CR46-CR50) connected between each lead input and isolated ground.

- ECG Input Stage

Input signals are derived from the CSD (Connector Static Discharge) circuitry. The input ECG circuitry provides additional filtering of ESU noise by a three-pole lowpass passive filter for each lead. The leads are biased by high value pull-up resistors (R14 - R17). This allows detection of any lead-off condition and high electrode-skin resistance. All input signals are buffered by low-bias current operational amplifiers (U1 - U2) which drive the Wilson network. This arrangement of resistors provides the correct summation to obtain the augmented ECG leads.

- ECG Lead-Select Circuit

This circuit consists of three multiplexers/analog switches (U3 - U5) controlled by the Front End board's microcontroller via three opto-isolators (IOS1 - IOS3). Multiplexers U4 and U5 select the ECG electrodes to be sensed while U3 applies a patient drive to the proper lead.

- ECG Differential Amplifier

A differential amplifier with a gain of 11 V/V is formed by two low-bias current operational amplifiers (U22A &B). It drives a modulator and isolation transformer (T1). This configuration in combination with the patient drive circuitry assures a very high level of common mode signal rejection.

- Patient Leg Drive

Common mode signals picked-up from the differential amplifier by this integrator stage (U7A) drive the patient reference lead which reduces AC interference.

- Lead-Fault Circuit

Whenever a lead-fault condition or a high skin-electrode resistance is detected this window comparator circuit (U7B) forces the output of the differential amplifier to the supply rails, which essentially zeroes the ECG signal. The Lead-Fault signal discharges a capacitor in a lowpass filter within a later stage to promote a rapid recovery from this condition.

- Modulator / Demodulator

These circuits, consisting of analog switch U8 on the isolated side and analog switch U9 on the non-isolated side, allow the ECG signal to pass through a High-voltage barrier. Transformer T1 safely isolates the patient from chassis ground.

- ECG Gain and High-pass Filter

This stage consists of two op amps (U13A and U14A) in a configuration that amplifies AC signals above a 0.4 Hz high-pass break frequency by a factor of 50 V/V. The stage has a provision for a quick discharge of the integrating capacitor C40 when a Lead-Fault condition is detected by activating U15A. The variable gain pot R52 is provided for calibration to 500 mV/mV ±1%.

- ECG Lead Fault Window Comparator

U11 serves to detect lead-off condition and large ECG excursions. U15C is activated when a lead-off condition is detected and blocks the ECG signal from reaching the output.

- ECG Notch Filter

A second order notch filter (U19A & B), which is software configurable in the system configuration for either 50 or 60 Hz rejection, serves to reduce AC interference on the display and trigger channels. The notch is bypassed for 40 msec using analog switch (U18B) whenever a pacemaker pulse is detected to avoid the ringing response of the notch filter. The appropriate notch filter center frequency is selected as follows:

NOTCH FREQUENCY	60Hz/50Hz
60 HZ	1
50 HZ	0

Table 2-1

- ECG Variable Gain Control

A variable gain control stage consisting of two op amp buffers (U20A & B) and a 12-bit DAC (U21) serves to provide variable gain when selected. The DAC is loaded via two bytes from the board's microcontroller. The gain of this stage ranges from 0 V/V (for all zeroes) to 3 V/V (for all ones). A board power-up default value of 1365 decimal is loaded to set a stage gain of 1 V/V (Total Display Gain: 500 V/V).

- ECG Output Stages

There are four output stages with the following output signal names and electrical characteristics:

ECG-EXT-OUT	-gain of 2 V/V and a high frequency cutoff at 170 Hz (Total External ECG Output Gain: 1000 V/V)
ECG-DISPLAY	-selectable gains .5, 1.0, 2.0 and 3.0 V/V and a high frequency cutoff at 60 Hz (Total ECG Display Gain: 250, 500, 1000 and 1500 V/V)
ECG-VAR	-gain and a full bandwidth of 1000 Hz (Total ECG VAR Gain: 500 V/V)
ECG-VAR-TEST	-gain and a full bandwidth of 1000 Hz (Total ECG VAR Gain: 500 V/V)

Note that outputs ECG-EXT-OUT and ECG-DISPLAY have their high frequency response cut significantly to 30 Hz and 25 Hz, respectively, when ESU is detected.

- ECG External Input

The Front End board can accept an external 1 volt ECG input signal (ECG-EXT-IN). When the control signal ECG-EXT-CTL is high analog switches U17A & B switch the external signal to the notch filter and ECG conditioning circuits.

- ECG-VAR Signal Conditioning

The ECG signal ECG-VAR (either internal or external), is passed through a 1st order lowpass filter (U23B) to produce the signal VAR-FILT-ECG. The frequency response of VAR-FILT-ECG is automatically configured by U15D based on the ECG signal source. The break frequency, with internal ECG selected (direct from skin-electrodes), is 8.84 KHz (-3db). The break frequency, with external ECG selected (indirect from bedside monitor), is 105 Hz (-3db). The ECG signal is more aggressively filtered with external signal sources. In the external mode pacer pulse detection requires higher sensitivity of signal slew rates, therefore, greater noise suppression is provided.

The ECG signal, after being lowpass filtered, is routed in parallel through the following three circuit paths: Pacer and ESU Detection Path, QRS Trigger Path and Differentiator Path.

- Pacer and ESU Detection Path

Pacer and ESU Detection Path low frequency signals contained in VAR-FILT-ECG, such as the QRS complex, are attenuated via a 34 Hz (-3db), 3rd order Chebyshev high-pass filter U38A. The signal is then passed through a Dead-Band circuit U38B that attenuates signal levels within the 150 mV range. This reduces low-amplitude high-frequency noise from exceeding the pacer slew-rate thresholds. Signal levels exceeding the dead-band window are amplified by a gain of 2 V/V. After the dead-band circuit the conditioned signal is finally passed to the slew rate detector U39A. The detector threshold is switched by U44B and U44C to 40 or 1300 V/sec for external or internal ECG sources, respectively. The output of the slew-rate detector is applied to a window comparator circuit U40. This comparator triggers whenever the slew-rate detector output exceeds approximately 4.4 volts.

When a pacemaker pulse is detected, the window comparator generates a pulse or pulse pair (SLEW-RATE-EXCEEDED) which is trapped by a flip flop U65B and read by the microcontroller. The flip flop's PACER-DETECT* pulse is timed by the microcontroller to be 40 msec wide. It is used to control the blanking of pacer signals in the QRS trigger signal path and to flag the presence of a pacemaker signal to the Main Board and display subsystems. A refractory timing period is also developed by the microcontroller which inhibits the pacer blanking from retriggering within a 75 msec period. This refractory period allows adequate time for the 34 Hz (-3db) high pass filter to settle.

When ESU interference is present, the window comparator U40 output consists of multiple closely spaced pulses. These pulses are both examined both by software and hardware for ESU detection. In software, a counter within the microcontroller accumulates SLEW-RATE-EXCEEDED edges to establish the presence of ESU noise. An active low signal for ESU-PRESENT* shows that ESU noise has been detected.

In hardware, the comparator's output pulses are integrated by the ESU detector U41, this produces a DC voltage proportional to the frequency and duration of the interference. The integrator's output is then compared to a switchable voltage threshold. Thresholds are switched by U37C to 2.0 or 5.0 V for internal or external ECG sources, respectively. The higher threshold for externally derived signals prevents wide, band-limited pacer pulses from falsely triggering the ESU detector. When the threshold is exceeded, a re-triggerable one-shot U42A outputs an ESU detection signal (HW-ESU-PRESENT*). This signal remains high for approximately 2 seconds after the interference ceases.

The detection of ESU within the system results in the following actions:

1. Inhibit detection and flagging of pacers by the Front End board.

2. Indication to Main Board that pacer triggering should be suspended and display the Trigger Interference message if appropriate.

3. Selects more aggressive filtering of Display and External Output ECG signals on the Front End board.

- QRS Trigger Path

This path provides the necessary signal conditioning, required by the Main Board software algorithms, to insure reliable triggering on the QRS complex of the ECG signal. It consists of three stages that produce a signal (ECG-TRIG) exhibiting a frequency content predominantly associated with the QRS complex. The signal VAR-FILT-ECG is first passed through a 9Hz (-3dB), 1st order high pass filter U45A to reject DC offsets, motion artifact and attenuate lower frequency ECG components such as the P and T waves. The high pass filter output is passed to a pacer blanking circuit U45B that blanks or effectively short circuits the signal during the interval that the PACER-DETECT* signal is active. This blanking eliminates the pacemaker pulse from the trigger signal to prevent false triggering on this pulse. Pacer blanking can also be activated under software control (PACER-BLANKING*) to increase the blanking interval under specific trigger conditions. The blanking stage also subtracts any pacer overshoot or "tails." The final stage U47A in this path provides a 130 Hz (-3dB) low pass filter and a DC signal gain of 5.42 V/V. When ESU is detected the bandwidth automatically drops down to 14.3 Hz. This filter stage smooths the blanking process, suppresses ESU noise and provides anti-aliasing before digitization of the ECG-TRIGGER signal.

- ECG Differentiator Path

This path provides a signal representative of the 1st derivative of the ECG waveform. VAR-FILT-ECG is provided as input to the first stage U47A that differentiates signal components below 10 Hz. This stage also contains the real pole portion of a 62.5 Hz, (-3dB), 3rd order lowpass filter. The final op-amp stage U46B provides the remaining complex pole pair of the 62.5 Hz, 3rd order lowpass filter. It provides suppression of high frequency noise and anti-aliasing before signal digitization by the on board A/D converter.

Blood Pressure Circuits

- Blood Pressure CSD Circuitry

The Blood Pressure interface section of the board contains an input connector, J7, five 15V Zener Diodes arranged in parallel between the TRAINER signal and each of the transducer wires and isolated ground, series chokes, L5, L6, L7, L10 (47uH) and L8, L9, (2.7 uH). L8 and L9 have lower inductance in order to reduce their DC resistance and reduce the voltage drop when large currents flow within the transducer excitation loop.

- Blood Pressure Input Stage

Input signals are derived from the CSD (Connector Static Discharge) circuits. The input BP circuitry provides filtering of ESU noise by a single-pole lowpass differential filter. Both signal lines are biased by high-value, pull-up resistors (R111 & R114). This allows for detection of a Transducer-Off condition.

- Blood Pressure Input Amplifier

A differential amplifier with a gain of 150 V/V is formed by two low-bias current operational amplifiers U25A and U25B. It drives a modulator formed by U26 and a signal isolation transformer T3. This configuration assures a very high common mode rejection ratio.

- Modulator / Demodulator

The circuits consist of two full-wave analog switches, U26 on the isolated side and U27 on the non-isolated side. They allow the BP signal to pass through a high-voltage barrier via transformer T3 that safely isolates the patient from chassis ground.

- Isolated Power Supply

The isolated power supply voltages (approximately + 7.5 and -7.5 volts) are provided to the isolated sections of the ECG and BP Front Ends. The 5 V (130 mA maximum) supply is used to power either the System Trainer or a BP transducer. The isolation power transformer is driven by a pair of power transistors Q4 and Q5 in a Push-Pull configuration switched at the rate of the 62.5 KHz clock. The same clock is used for modulation and demodulation which assures accurate and noise-free recovery of the ECG and BP signals.

- +5V Regulator

The stage consists IC voltage regulator U24. It provides the 5V excitation voltage to the pressure transducer and to the Trainer. Current limiting is provided to prevent crashing of the +7.5 volt isolated supply during abnormal shorting of this output.

- Blood Pressure Transducer Detect Circuit

A simple voltage comparator U28 detects a significant DC voltage offset when the transducer is not connected to the input.

- Trainer Coupler

An opto-coupler (ISO4) with a low leakage current and a high withstand voltage produces a low TTL signal, specifically, TRAINER*, when the trainer is connected to the input.

• Blood Pressure Offset Zeroing Circuit

The zeroing circuit consists of a 12-bit DAC U31 and op amp buffer U32A used to develop a DC level that serves to cancel or zero the BP transducer's offset. The DAC is loaded via two bytes from the board's microcontroller. The zero value ranges from -1.75 V/-175 mmHg (for all ones) to +1.75 V/+175 mmHg (for all zeroes).

• Blood Pressure Level Shifter and Gain Stage

This stage consists of two op amps coupled through an attenuator. The first stage U32B amplifies the input signal and sums it with the offset zeroing signal. Since the DAC is unipolar a DC level shifter is used to provide a bipolar zeroing signal. The second stage U33B has a gain-setting pot R128 used to trim the gain of the overall channel for a standard pressure transducer to ±1%. The stage also provides a 15 Hz lowpass filter break.

• Blood Pressure External Input Buffer

Two-stage buffer (U34A and U34B) with a + 12 V adjustable offset and double real pole lowpass filter. The combined response yields an -3 DB bandwidth of 22 Hz.

• Blood Pressure Internal/External Selector

The Front End board can accept an external 1 volt Blood Pressure input signal (BP-EXT-IN). When the control signal BP-EXT-CTL is high, analog switches U37A & B switch the external signal to the conditioning circuits.

• Blood Pressure Display Stage

This stage consists of an amplifier (U35A) with four gain settings controlled by the board's microcontroller through analog switch U36.

• Blood Pressure Output Buffers

Two op amps (U35B and U33A) serve to buffer the BP-TRIGGER and BP-EXT-OUT outputs.

Pneumatic Transducer Circuits

- Pneumatic Transducer Excitation Voltage Generators

The +2.5 volt reference derived from the A/D converter's reference is trimmed by R253 and U59A and applied to op amps U49A and U49B. The op amps use matched resistor networks to obtain the +5 volt and -5 volt excitations required for the Balloon, Drive, and Atmospheric pressure transducers.

- Pneumatic Transducer Instrumentation Amplifier

Instrumentation amplifiers (U50 & U52) with integral thin film resistors are used to amplify the Balloon and Drive pressure transducer bridge output signals. Active atmosphere pressure transducer U54's output is buffered by U75. Multi-turn potentiometers are furnished to provide a gain adjust to ±1% during system calibration.

- Pneumatic Transducer Gain and Offset

Gain stages with a low pass corner at 130 Hz and 27 Hz serve to further condition the Balloon, Drive and Atmospheric pressure transducer signals. Multi-turn potentiometers are provided to zero the atmosphere output of each transducer.

- Pneumatic Transducer Output Buffer

Output buffers (U51B and UU53A) with the ability to drive moderate capacitive loads (e.g., cabling) provide the system with diagnostic test signals for the Balloon and Drive pressure channels.

- Helium Tank Pressure Channel

Op amp stage U76B accepts a 0.5 to 4.5 volt voltage level from an amplified high pressure transducer which measures the Helium Tank pressure over a 0 to 3500 PSIG range. The stage removes the input signal's offset and scales the signal to provide a 1.25 mV/PSIG scale factor for the overall channel. Op amp U76A serves to buffer the board's +5 volt reference voltage to furnish the pressure transducer's required +5 volt excitation voltage.

Miscellaneous Circuits

- Battery Channels

Precision unity-gain differential amplifiers U56A and U56B are used to buffer the voltages sourced by the Power Supply/Charger assembly that indicate battery voltage and current levels during system operation. A lowpass filter with a corner frequency of 16 Hz serves as an anti-aliasing filter.

• Temperature Channel

Op amp stage U77A serves to amplify (Note: gain of 5 V/V) the output of temperature sensor U78. The scale factor at the channel's output is 50 mV/deg-C.

• Solenoid State Test Buffer

A simple divider with a gain of 0.4 V/V followed by a buffer stage U47B capable of driving a capacitive cable is provided for test purposes to condition the SOLND-STAT-TEST signal.

A/D Converter and Microcontroller

• A/D Channel Multiplexer

The board's channel multiplexer consists of two high performance, low on-resistance and high speed CMOS 8-to-1 multiplexers U57 and U58 connected in parallel to provide a sixteen (16) channel capability. Four address lines, MUX0 through MUX3, are used to select the channels.

• A/D Converter

U61 is a 12-bit A/D converter complete with reference, clock and microprocessor interface. All sixteen (16) channels are converted at a uniform sample rate of 250 Hz (every 4 msec). The converter is operated in an 8-bit data mode whereby the 12-bit conversion is read by the microcontroller as eight (8) MSB's followed by four (4) left justified LSB's. The converter's 2.5 volt reference is trimmed for a tight level, specifically, +2.5 VDC ±10 mVDC, and buffered by an op amp to furnish the system with accurate sensor excitation levels and a precise reference. A high slew rate attenuator-buffer stage is used to scale the converter for 5.12 volt full scale operation rather than 5 volts for the device alone. This furnishes the converter with a convenient scale factor of 400 counts per volt (rather than 409.6 counts per volt).

The A/D converter's digitized value for analog ground (GND_A), is subtracted from the digitized values for all the other channels to reduce offset errors. Note that the last channel is a separate 2.5V reference used to furnish a check of the A/D converter and its internal reference.

- Microcontroller

The board uses a 68HC711 CMOS 8-bit microcontroller to format outgoing data and status records and to interpret incoming control commands from the system's Main Board.

The ECG/BP Control Latch serves to set ECG and BP display gains and to select the ECG lead configuration. The following bit-map is used:

SIGNAL NAME	FUNCTION	DATA BIT
ECG-DSP-GAIN0	ECG Display Gain Set	AD0
ECG-DSP-GAIN1	ECG Display Gain Set	AD1
BP-DSP-GAIN0	BP Display Gain Set	AD2
BP-DSP-GAIN1	BP Display Gain Set	AD3
SELECT0	Lead Select	AD4
SELECT1	Lead Select	AD5
SELECT2	Lead Select	AD6
ECG-ECT-CTL	External ECG Control	AD7

Table 2-2

The Misc Control Latch generates the address lines for the A/D converter's channel multiplexer. The latch also serves to generate the ECG variable gain set bit when this mode of operation is called for by the system's operator and to generate a lead select enable useful for momentarily blanking the ECG trace during a change in the lead configuration. Finally, the latch provides an active low bit which indicates that ESU noise has been detected within the system. The following bit-map is used:

SIGNAL NAME	FUNCTION	DATA BIT
MUX0	Multiplexer Channel Select	AD0
MUX1	Multiplexer Channel Select	AD1
MUX2	Multiplexer Channel Select	AD2
MUX3	Multiplexer Channel Select	AD3
ECG-VAR-SEL	Variable ECG Gain Select	AD4
LD-SEL-EN	Lead Select Enable	AD5
ESU-PRESENT*	ESU Detected (pulse)	AD6
BP-EXT-CTL	External Blood Pressure Control	AD7

Table 2-3

Port A bits, are used as follows:

SIGNAL NAME	TYPE	FUNCTION	PORT BIT
SPARE	Input	Spare	PA0
SPARE	Input	Spare	PA1
PACER-DETECT*	Input	Pacer Detected (Pulse)	PA2
SPARE	Input	Spare	PA3
60 Hz / 50 Hz*	Output	Notch Frequency Select (Level)	PA4
PACER-BLANKING*	Output	Extended Pacer Blanking (Pulse)	PA5
ENABLE-PACER-DETECT	Output	Pacer Detection Enable (Pulse)	PA6
SLEW-RATE-EXCEEDED	Input	Slew Rate Exceeded Indication	PA7

Table 2-4

The following input status lines are read by the microcontroller via Port E:

Table 2-5

SIGNAL NAME	FUNCTION	PORT BIT
HW-ESU-PRESENT*	Hardware ESU Detected (Pulse)	PE0
AD-STATUS	A/D Converter State (high during conv.)	PE1
TRAINER*	Connected Trainer Indication	PE2
ECG-EXT-SEL	External ECG Selected	PE3
ID	Identification Bit (default is high)	PE4
XDUCER*	BP Transducer Indication	PE5
LD-FLT-DETECT	Lead Fault Indication	PE6
BP-EXT-SEL	External BP Selected	PE7

A 12 MHz crystal is used to furnish the system with a 3 MHz E Clock. The E Clock frequency is divided by forty eight (48) using a ripple counter to obtain the 62.5 KHz clock required for ECG/BP modulator/demodulator operation and to provide an isolated power supply switching frequency.

A power monitor IC U63 is used to provide the processor an effective reset on power-up.

- Miscellaneous Buffers

Two logic inverters U71B and U71F followed by 0.4 V/V attenuators are used to scale signals TRIG-PULSE* and PACER-DETECT* to 2 volt-peak inverted replicas of these signals for test purposes. Two ESD protected inverters are provided to buffer the ECG-EXT-SEL* and BP-EXT-SEL* signals from the external monitor input jacks for internal use.

2.3.2 Main Board (0670-00-0666)

The Main Board incorporates all system control functions, including pump control, operator interface, display control, alarm and alert tone generation, recorder interface and Front End communications. It also provides two external interfaces via the RS-232 and Modem ports.

The Main Board is comprised of three major subsystems, which are:

-The 68020 (DSS) Subsystem
-The 6809 (IAB) Subsystem
-The 68HC11 (Comm) Subsystem

68020 (DSS) Subsystem

The 68020 (DSS) subsystem provides the system display, interfaces to the recorder and provides a portion of the operator interface function.

- Major Components

- The 68020, a 32 bit microprocessor

- Clock Generation Circuit

- Reset/Watchdog Timer

- Non-volatile program memory storage on removable Datasette (2M X 8)

- Executable/Data/Stack memory 512K X 32

- Read/write data storage of 2M byte

- Bus control PLDs provides address decoding, bus time-out, interrupt control and other functions

- The Real Time Clock/ NV-Ram function provides time-of-day data, real-time interrupt and 32K bytes of non-volatile data storage.

- The Quad-channel UART (QUART) provides four independent full-duplex serial I/O channels

- The Multifunction Peripheral (MFP) provides eight prioritized interrupt inputs, four timer channels and another serial I/O channel

- The Display Interface provides a 16 bit parallel interface to the Display Controller Board, which is a peripheral device to the 68020.

- Shared RAM 1K X 8

- Configuration Switch

• CPU (68020)

The CPU is a Motorola MC68020 32 bit CMOS microprocessor operating at 24MHz. It is equipped with 8 internal data registers, 8 address registers, 32 bit data and address busses and a 64 entry internal instruction-only cache. It can access memory or peripheral devices in as fast as 125 nano-seconds per bus cycle, or be caused to 'wait' for slower devices in increments of 42 nano-seconds. The 32 bit address bus gives the processor the ability to directly address up to 4 giga-bytes of physical memory, although only a small fraction of which is implemented in the Main Board. The CPU reads instructions from memory, either the Datasette or DRAM, executes them, and may modify the contents of memory or access peripheral devices accordingly.

The 68020 CPU's data and address bus (referred to as the local bus) interfaces only to the Datasette, SRAM, and Main PLD. Buffered versions of the data and address busses are generated to interface to all other 68020 peripheral devices.

• Clock Generation Circuitry

This function is comprised of a crystal controller 48 MHz oscillator and a frequency divider PLD. The crystal supplies a tightly regulated square-wave signal at 48 MHz whenever DC power is supplied to the board. The PLD divides this signal to 24 MHz, 16MHz and 2MHz and provides these signals, and the complement signal of the 8MHz clock signal, to synchronize the operation of all of the Main Board bus operations.

Reset/Watchdog Device

This device provides three functions: 1) It generates a power-on reset signal to the 68020 Sub-system, 2) It will reset the 68020 Sub-system whenever the voltage on the VCC supply (5.00V nominal) drops below 4.75V and 3) Has a strobe input which the 68020, under program control, must activate continuously no less often that 50 milli-seconds or the Watchdog will reset the 68020. This last function is to guard against a runaway or stalled processor. This function is assigned one byte address on the 68020's bus so that the processor can generate a strobe pulse to re-trigger the Watchdog timer by accessing the appropriate address.

• Datasette

All non-volatile program storage is provided by the removable Datasette. This small PC board contains one 2M X 8 FLASH memory device. The 68020 fetches instructions directly from the Datasette and executes them upon system power-up. All languages are also stored in the Datasette. The large size (2M bytes) of the Datasette also provides for program storage to support Integrated Service Diagnostic function. The Datasette is re-programmable, however no capability is provided for in-system programmability.

• Read/Write Memory

This function supplies 2M byte of writable memory to the 68020 processor in a 512K X 32 bit organization. It is comprised of four 256K X 16 SRAMs. The SRAM is used to store program instructions as well as data. The program is down-loaded to SRAM from the Datasette shortly after all power-on diagnostic tests have executed successfully. This is done due to the fact that the SRAM is 32 bits wide while the Datasette is only 8 bits wide and therefore program instruction fetches from SRAM execute 4 times faster than from the Datasette. All program instruction fetches from memory are 32 bits, therefore requiring 4 separate memory accesses from the Datasette, while only one from SRAM.

The SRAM may be accessed by the CPU in byte (8 bit), word (16 bit) or long-word (32 bits) for data reads/writes while instructions are read only in long-word format.

• Bus Control

The 68020's asynchronous bus is controlled by three PLDs: 1) The Main PLD (a MACH231 device) 2) The interrupt control PLD (a PAL20V8 device) and 3) The Write Enable PLD (a PAL16V8 device). Their functions are as follows.

The Main PLD provides the following major functions: 1) Address Decoding, 2) DSACK signal and WAIT-STATE generation, 3) Bus Time-Out & Bus-Error generation.

The 32 bit address space of the 68020 processor is decoded by this PLD to implement the address map of the 0670-00-0666 board DSS processor function. This provides all of the chip-select outputs from the PLD to memory and peripheral devices. Note that all valid address are defined as having the most significant 8 bits of the address as zeros.

The 68020 processor initiates bus cycles (either reads or writes) under program control that are encoded to move either 8, 16 or 32 bits of data to or from the CPU to memory or peripheral devices. However the CPU has no 'knowledge' of the size (data bus width) of the device being accessed. In addition, the 68020 can be slowed down on a cycle-by-cycle basis to accommodate slower devices. The MAIN PLD has been encoded with this knowledge according to the following table:

DSACK Encoding		
Function	DSACK0	DSACK1
8 Bit Device Ready	0	1
16 Bit Device Ready	1	0
32 Bit Device Ready	0	0
Insert Wait-States	1	1

Table 2-6

Within the 68020 subsystem all devices operate with a fixed number of wait states (from zero to 5) except the QUART, MFP and Display Controller. These three devices supply a DTACK signal to the MAIN PLD to indicate when their respective bus cycles may be terminated.

A 4 bit Bus-Time out counter is implemented within the MAIN PLD that counts at one eighth of the CPU clock during each bus cycle. If that counter ever reaches terminal count, which would take 7.5 micro-seconds, without either of the DSACK signal becoming active a Bus-Time Out condition is declared. The signal BERR* (Bus Error) is activated which terminates the bus cycle and causes the DSS processor to reset. In addition to a Bus Time-Out, any access to an invalid address or attempting to enter Service Diagnostic mode when not enabled will cause a Bus Error condition.

The Interrupt Control function encodes the Interrupt Request signals onto the Interrupt Priority Level signals which are presented to the CPU. The CPU, under program control, may defer responding to this request. This PLD also supplies the Interrupt Acknowledge (IACK) signals to the MFP and QUART when the CPU does respond to their respective interrupt requests in order that the MFP or QUART place their interrupt vector (an 8 bit number) on the most significant bits of the data bus. This function is incorporated into the Interrupt Control PLD.

The Write Enable PLD provides several versions of read and write strobes, each qualified by slightly different timing, to the memory and peripheral devices of the 68020 subsystem.

- Real-Time Clock / NVRAM

This device supplies a battery powered time-of-day function that occupies the first sixteen memory locations of the device. It can supply alarm and watch-dog interrupts. The resolution of the clock is 10 milli-seconds.

It also provides 32K bytes (minus 16 bytes for the time-of-day clock registers) of battery backed static RAM. This is used for fault journal and sleep mode data storage. The battery which supplies power to this device is internal to the device is a Lithium cell which will provide 10 years of data integrity.

- Quad UART

The QUART device provides four independent full-duplex serial interface ports. The Baud rates of the channels are independently programmable, which are derived from an external 3.68MHz crystal oscillator. Three of the four channels are defined in the DSS subsystem, while the fourth is reserved for R&D usage. This device occupies 64 byte addresses on the 68020's bus.

Channel B - RS232

This interface connects the 68020 subsystem with external devices. This channel is operated at a Baud rate of 9600

Channel C - Modem

This channel connects the 68020 to the internal Modem, which may be configured by the user to Baud rates between 1200 and 9600 Baud.

Channel D - Recorder

This channel allows the 68020 to control the optional AR-42 thermal array recorder. It allows control and data to be sent to the recorder and status of the recorder to be monitored. It is operated at a Baud rate of 38,400.

- Multifunction Peripheral

This device, as it's name implies, embodies several functions. It provides for eight input lines which may be used as prioritized interrupt inputs, two sixteen bit timers and a full-duplex serial channel. Two of the eight interrupt inputs are used, one for the Shared Ram interrupt request from the Comm. Processor (see below) and the other for the ACRTC interrupt request from the Display Controller board. The serial channel is not utilized. This device occupies 32 byte addresses on the 68020's bus.

- Display Controller Interface

This is a sixteen bit extension of the data bus that interfaces the 68020 to the Display Controller PCBA, which acts a slave peripheral to the 68020. An interrupt signal from the Display Controller synchronizes the 68020 to the Display Controller video frame rate. This interface occupies two word (16 bit) addresses on the 68020's bus.

- Shared RAM

The 68020 can access, to either read or write, the 1K byte static Shared RAM. The 6809 and 68HC11 subsections can also access this device to pass data between the subsections. This function is embodied in the Quad-port Static RAM.

- Configuration Switch

There is an eight position DIP switch on the Main Board that is used to set certain default conditions for the software, such as language and modem selection. The settings of this switch are readable by the 68020 CPU. This function occupies 1 byte address on the 68020's bus. This switch is accessible by removing the Display Controller shield.

6809 (IAB) Subsystem

The 6809 (IAB) subsystem provides for the control of the inflation and deflation of the balloon via control signals passed to the Solenoid Driver PCBA as well as the generation of the audible Alarm/Alert tones.

- Major Functions

- The 6809, a 8 bit microprocessor

- Clock Generation Circuit

- Reset/Watchdog Timer

- Program memory on removable Datasette (50K X 8) accessible any time

- Read/write data storage of 12K bytes

- Bus Control PLDs

- Versatile Interface Adaptor (VIA)

- Alert Tone Generator & Alarm

- Pump Motor Controls

- Control Register

- Status Buffers

- Shared RAM

- Central Processing Unit

The CPU is a Motorola MC68B09 8 bit processor with an external clock rate of 8MHz (running internally at 2mHz). It has a 16 bit address bus which allows it to directly address up to 64K bytes of physical memory and/or peripheral devices. The 6809 processor always fetches instructions and executes them directly out of the 8 bit Datasette, see below.

- Clock Generation Circuitry

The 8MHz processor clock is derived from the 16MHz 68020 CPU clock. The CPU generates the two-phase E and Q clocks which are utilized by the Bus Control function.

• Bus Control

There are three PLDs which decode the 6809 address bus and certain other signals in order to perform the address decoding and Service Diagnostic support. Address decoding is performed in order to provide chip select signals to the 6809's memory and peripheral devices so that they may be accessed by the CPU. This implements the IAB memory map. Service Diagnostic support provides a memory bank switch function, implemented by a seventeenth address bit, and certain other logic in the PLDs which allow the accessing of the Service Diagnostic firmware in the Datasette. Unlike the 68020 processor, above, there are no invalid addresses in the 6809 subsection.

A Non-Maskable Interrupt (NMI) signal will be generated to reset the 6809 in the event the processor attempts to write data to the Datasette.

• Reset/Watchdog Timer

This function is identical in description to the same for the 68020 processor, see above. In addition, there is a single flip-flop that latches the fact of the Watchdog Timer resetting the processor other than on system power-up. The output of this flip-flop is a signal called TOUT* (Time-Out) and is used in the Alarm Tone Generation circuitry, see below. This function occupies 1 byte address on the 6809's bus so that the processor can generate a strobe to re-trigger the Watchdog timer.

• Datasette

The Datasette provides the only program storage for the 6809 subsection. It is twice as large as the 6809 can address directly, as circuitry external to the 6809 will select either the bottom half (for normal system usage) or the top half (for Service Diagnostics) for the 6809 to access. The Bus Control function, above, will further limit the address range that is dedicated to the Datasette to 50K bytes at any given instant. The Datasette is re-programmable, however no provision is made to program this part in-system.

• Read/Write Memory

There is a 32K byte static RAM provided for the 6809 for data and stack space. The Bus Control function limits the addressing of this part to 12K bytes, in order to maximize the amount of memory space available to the Datasette for program storage.

• Versatile Interface Adaptor

The VIA is a peripheral device to the 6809 processor that provides two independent 8 bit parallel ports. These can be defined under firmware control as either inputs or outputs. In the present firmware, all 16 bits are defined as outputs. After a power-on reset all 16 bits are configured as inputs which are pulled up by internal resistors so that circuitry on the Solenoid Driver PCBA will drive the IAB control solenoids to a 'safe' state. The VIA also has a timer function and an interrupt out

- Alert/Alarm Tone Generation

This function produces all of the audible tones of the system. The Alert Tones, including key-click, trigger beep and the alarm tone are generated under firmware control by the 6809 via the Tone Generator peripheral IC, the Yamaha YM3812 8 bit sound-blaster device. It is capable of producing 9 independent, simultaneous tones. It's output is converted to an analog voltage by the YM3014 serial-input 16 bit D/A converter. The YM3812 occupies two addresses on the 6809's bus.

The SYS-FAIL ALARM TONE is generated by hardware circuitry, namely an 3.3 KHz oscillator that is held in reset as long as neither of two error conditions exist. These are a prolonged inflation watch-dog on the Solenoid Driver PCBA and the TOUT* signal from the 6809's own Watchdog Timer. If either, or both, of those signals become active (low) the SYS-FAIL ALARM will sound until power is removed from the system. The outputs from this circuit is summed with the output of the D/A converter (above), amplified and used to drive the system speaker. The output of the 3.3 KHz oscillator is normally heard upon system power-up for approximately 800 ms. This signal is applied to a circuit that attenuates the volume of this start-up beep by approximately 75%. All other tones are unaffected by this circuit.

- Pump Motor Controls

The 6809 controls the speed of the IAB pump motor via a 12 bit D/A converter. The output of this device is gain controlled so that full-scale generates 10.24VDC and zero-scale generates 0VDC. This signal is then sent to the Motor Controller PCBA. The 6809 accesses this device in two 8 bit writes, the first loads an internal 8 bit holding register which receives the 8 LS bits of the 12 bit value. The second write loads the MS 4 bits and transfers all 12 bits from the holding register into the DAC register for conversion to an analog voltage. The D/A converter occupies two addresses on the 6809's bus.

In addition, there is a flip-flop whose output enables the motor controller to drive the motor voltages. This flip-flop is cleared at system power-on, thereby disabling the motor. Once toggled by the 6809 under firmware control it will enable the motor and will remain in the enabled state until power is removed. This device occupies one address on the 6809's bus.

- Control Register

The Control Register is a 8 bit device that is used (under firmware control) to perform two functions: 1) Enable the accesses to the Motor Control D/A converter and 2) Control the Solenoid State Circuit. Only these three output bits of the device are defined, the remaining 5 are spare. This register occupies one address on the 6809's bus.

The MTR-D2A-EN* signal output from this register is used in the Bus Control PLDs to grant access to the Motor Control D/A converter. Thus, it is used as an interlock by the firmware to prevent inadvertent accesses to the D/A converter which would change the motor speed. A low on this output enables the firmware to load the D/A converter and thereby change the motor speed.

The Solenoid State circuit generates a signal that is used to indicate to the System Trainer the present 'state' of the solenoid control signals. It is drive to one of four voltages. Two output bits from the Control Register, along with an enable bit from the 68HC11 subsection (see below), control the Solenoid State circuit. If enabled by the 68HC11, the following table illustrates the output voltage as a function of the two control bits. If disabled by the 68HC11, the output voltage will be pulled low (0V) by R92.

Solenoid State Circuit Summary

SOLND-ST1	SOLND-ST0	VOLTAGE	FUNCTION
0	0	0V	DEFLATE
0	1	.5V	VENT
1	0	2V	HOLD
1	1	5V	INFLATE

Table 2-7

- Status Buffers

There are three status buffers available to the 6809 processor. These provide to the 6809 the ability to monitor various system functions; namely the power supply status signals, two over-temperature indicators and the status of the Solenoid Driver PCBA. These buffers occupy a total of three addresses on the 6809's bus.

- Shared RAM

The 6809 can access, to either read or write, the 1K byte static Shared RAM. The 68020 and 68HC11 subsections can also access this device to pass data between the subsections. This function is embodied in the Quad-port Static RAM.

68HC11 (Comm) Subsection

The 68HC11 (Comm) subsystem provides for synchronous and asynchronous communications with certain off-board system functions, namely the keypad controllers and the Front End processor, as well as the generation of interrupts to the 6809 and 68020 processors to control Shared RAM access.

- Major Functions

- Eight bit microcontroller operating at 8MHz clock rate

- Asynchronous serial link to Keypad Controller

- Synchronous serial channel to Front End Controller

- Shared RAM Access

- Interrupt Generation Flip-flops

- Motor Tachometer

- Power Supply Monitoring

- Processor

The Communications (Comm) Processor is based on the Motorola MC68HC711E9 micro-controller. This part has integrated program memory, data RAM, serial ports, and the ability to access external memory and peripheral devices.

The 68HC11 has 12K bytes of internal, one-time programmable, program PROM memory and 512 bytes of data RAM which is used for scratchpad and stack
usage. It also has 128 bytes of EEPROM, which is not used in the Main Board. There is also a register set that occupies 1K byte of address space that controls the on-chip peripheral functions.

The 68HC11 has five external ports of eight bits each. Two of these form the expanded bus. Port C is used as a multiplexed address/data port. This port is latched by the address latch during the initial portion of an external bus cycle and becomes the lower 8 bits of address. The upper eight bits of address are supplied by Port B. Port C then supplies the data during the latter portion of the external bus cycle. Thus, with a 16 bit external address bus, the 68HC11 can directly address up to 64K bytes of external memory minus the address space consumed by the internal memory (see above) and peripheral control register bank.

Port E bits may be used as analog inputs to the on-chip 8 bit A/D converter. These inputs are used to monitor system power supply voltages.

Port A is used to monitor and control various Comm. Processor functions, such as the 6809 and 68020 Shared RAM interrupts, the SD-REQ* which requests Service Diagnostic Mode, the SOL-ST-DIS* signal which is used to enable or disable the Solenoid State circuit within the 6809 sub-section and the DIG-TACH signal used to monitor the speed of the compressor pump motor. Another Port A function is to select which Keypad processor's serial channel (either Recorder Keypad or Main Keypad) will be used as input to the Comm. Processor's serial channel input.

The Port D pins are all used in their 'alternate' functions of serial channel pins and bus control lines.

The 68HC11 has an internal Watchdog Timer and supports two levels of interrupts. The interrupts are not used on the Main Board.

- Asynchronous Serial Communications

The 68HC11 supports an asynchronous serial channel, the SCI bus. The baud rate of this channel is programmable and is set to 9600 Baud in the Main Board. It is programmed to one start, eight data bits and one stop bit. The Baud rate is derived from the 8MHz clock. This interface allows communication with the keypad controller.

- Synchronous Serial Communications

The 68HC11 supports an synchronous communications channel, the SPI bus. The Comm. Processor is programmed to be the slave and the Front End processor is programmed to be the master. Thus the Front End will be generating the SCK (serial clock) signal and the Comm. Processor will be receiving this signal. This interface is to transmit digitized Front End data to the Comm. Processor. The rate of transmission is 3 MHz.

- Shared RAM

The 68HC11 can access, to either read or write, the 1K byte static Shared RAM. The 68020 and 6809 subsections can also access this device to pass data between the subsections. This function is embodied in the Quad-port Static RAM. The Comm. Processor places data received from the Front End processor into the Shared RAM for the 6809 and 68020 processors to use.

- Interrupt Generation Flip-Flops

This function is incorporated in a pair of flip-flops, one each for the 6809 and 68020 processors. These devices are cleared on system power-up. The Comm. Processor, by means of a external bus access to the appropriate addresses, can individually set each of these flip-flops. The low active output of each of these devices drives an interrupt input on the 6809 and 68020, respectively and is also monitored by the Comm. Processor. The 6809 and 68020 respond to their respective interrupt by reading data from the Shared RAM and finally clearing their respective interrupt flip-flop.

- Motor Tachometer

The DIG-TACH signal is a digital, 0V to +12V, signal from the Motor Controller PCBA with a frequency of 36 pulses per rotation of the motor. This signal is scaled down in voltage and input to a Schmitt trigger inverter and then used as the input to Port A bit 7 of the 68HC11, which may be used in a pulse accumulate mode. The Comm. Processor firmware utilizes the count accumulated from this input to determine the rotational rate of the pump motor.

2.3.3 Video Receiver Board (0670-00-0641)

The Video Reciever Board is functionally divided into two major circuit groups as follows:

- LVDS Receiver / De-multiplexer
- Frame Buffer

The detailed theory of operation of these two circuit funtional groups will be described below. The LVDS Receriver / De-mux is comprised of one IC while the Frame Buffer is comprised of several devices.

LVDS Signal Receiver

The LVDS (low voltage differential signalling) receiver function is implemented via a National Semiconductor DS90CR212 device, or equivalent. It works in conjunction with the DS90CR211 on the Display Controller which takes as inputs up to 21 parallel signal inputs and a high speed clock, time-division multiplexes the inputs at seven times the clock rate and then sends them out in serial fashion on three differential signal lines and one differential clock line.

Thus, the receiver must implement the exact opposite function. First it receives the differential signal and clock lines, de-serializes them into shift registers and makes them available at the device ouptuts.

The required signals to be transmitted from the Display Controller are as follows:

Four Upper Panel video bits	UD0..UD3
Four Lower Panel video bits	LD0..LD3
One Video Clock	CP
One Latch Pulse	LP
One First Line Marker	FLM
One Display Enable	DISPLAY ACTIVE

In addition, the LVDS clock is transmitted with the above named signals to synchronize their de-multiplexing. The LVDS clock is a free-running 30MHz clock. This is the timing source for all Frame Buffer functions.

The Video Clock (CP) is the signal that indicates a new 8 bit video sample is available at the output of the LVDS receiver on the falling edge of CP. This signal is sent/received as one of the LVDS signals. It has a rate of 3.75MHz, or one eighth of the 30MHz LVDS clock. There is a burst of 160 such pulses per horizontal scan line. Each falling edge latches in eight data pulses, four each for the upper and lower planes of the EL display. Therefore:

160 X 4 bits per clock = 640 bits (pixels) per scan line.

The Latch Pulse, analagous to Horizontal Sync, is a pulse that becomes active at the end of each horizontal scan line, after the CP pulse burst has been terminated for that line. It's function is to latch the data bits into a display panel. It is used in the Frame Buffer FPGA to clear the pixel counter and increment the line counter.

The First Line Marker (FLM) signal is activated during LP at the end of the topmost line of the display. It is analagous to Vertical Sync. It's function is to indicate the end of the first line of video to the display panel. It is used in the Frame Buffer FPGA to clear the line counter.

The Display Active signal indicates that the Display Controller is outputting valid display data. It is inactive on system power-up and goes active after the Display Controller has been initialized. This signal will be utilized to enable the Frame Buffer function to send video data to the EL display panel.

Since only 13 of the possible 21 output signals of the LVDS receiver are utilized, the remaining 8 output bits are unused and left open.

Frame Buffer

This circuit group has the task of inputting video data at the Display Controller's frame rate of 73Hz and outputting video to the EL panel at it's maximum rate of 120Hz. It consists of four major circuits:

- Frame Buffer Controller FPGA
- Frame Buffer Static RAM
- Line Storage FIFO
- Output Data Register and By-Pass Buffers

In addition, there is a power-on-reset generator IC, and a serial PROM that contains the configuration data for the FPGA, which is loaded into the FPGA on power-up. All Frame Buffer circuitry is synchronized to the 30MHz LVDS output clock.

- FPGA (Field Programmable Gate Array)

The Frame Buffer Controller FPGA design can be functionally sub-divided into eight circuit groups as follows:

SRAM State Machine: This functional portion of the FPGA design provides arbitration between Write Cycles for incoming data from the Display Controller to be written to the Static RAM and Read Cycles to provide data to fill the FIFO (below). The cycle timing is such that three bytes of data can be read out of the SRAM for each byte written in, that is a three-to-one interleave. Two periods of the 30MHz clock are defined for each SRAM access, one cycle for address generation and set-up time and the second cycle for the actual memory access.

Static RAM Address Counters: There are four eight-bit address counters within the FPGA, the Read and Write Pixel counters and the Read and Write Line counters. Both Read counters are concatenated to form the 16 bit Read Address, likewise for the two Write counters. These 16 bit address busses are multiplexed under control of the SRAM State Machine (above) and used to control the SRAM under all memory accesses. A 17th bit (always low) is provided to the SRAM for possible future expansion.

Clock Divisor Counter: A four bit binary counter is provided with a variable length count that will divide the incoming 30MHz clock by either 5,6,8 or 10. The rate so obtained, 6MHz, 5MHz, 3.75MHz or 3MHz, is used as the rate at which data is sent from the FIFO to the EL display panel. The FPGA inputs RATE0 and RATE1 control this function.

LP State Machine: The LP State Machine contains a 8 bit binary counter and sufficient decoding of the counter outputs to provide for the timing signals that repeat every outgoing horizontal scan line to the EL panel. The decoding is as follows:

Active portion of scan line	160 pixel clocks
Sync 'back porch'	16 pixel clocks
Sync width	16 pixel clocks
Sync 'front porch'	16 pixel clocks
	-------------------
	208 pixel clocks

FLM State machine: This state machine decodes the Read Line Counter in the SRAM Address Counter section (above). It detects two conditions, the first line (line count = 0) and last line (line count = 239). The detection of the first line is to enable the FLM (First Line Marker) signal to the EL and the last line detection is to reset the Read Line Counter.

LVDS Interface: This functional circuit group synchronizes the incoming timing signals from the LVDS receiver IC. The low-going edge of the CP pulse sets a flip-flop that indicates to the SRAM State Machine that incoming data has been latched into the Data Holding Latch (below) and is waiting to the written into the SRAM. The LP signal generates a synchronized internal signal that 1) clears the Write Pixel Counter and 2) clocks the Write Line Counter. The FLM signal generates a synchronized internal signal that clears the Write Line Counter.

The Data Holding Latch: captures the incoming data from the LVDS receiver on the falling edge of the CP signal. It has a tri-state buffer following it that is enabled by the SRAM State Machine during the subsequent Write cycle to provide the data to the inputs of the SRAM.

Configuration Serial PROM: The FPGA is a SRAM based device and, therefore, must be configured for use each time power is applied to the system. The FPGA contains a hard-wired state machine that loads the configuration data in serial fashion from this device each time power is applied. Therefore, the functinality of the FPGA could be changed, or upgraded, by a change of the Serial PROM without changing the FPGA.

- Static RAM

This memory device holds the entire video image being generated by the Display Controller PCBA. It is written to and read from by the signals being generated by the SRAM State Machine within the FPGA. The required size of the SRAM is

> 640 (pixels per line) X 480 (lines) X 1 (bit per pixel) / 8 (bits per byte)
> = 38,400 bytes

This obviously overflows a 32K X 8 SRAM, thereby requiring a 64K X 8 organization. Since this is not an industry standard part, a 128K X 8 organization was chosen. The speed requirement is that either a read or write access operate in one clock cycle of the 30MHz clock (33nS). Recall that each SRAM access consists of one cycle of the clock to allow address generation and set-up time and another clock cycle for the actual memory access.

- FIFO

The SRAM State Machine will read data out of the SRAM at 11.25MHz if interrupted by incoming data or 15MHz if not. The data stream to the EL panel must, however, be at a constant rate of 6MHz. Therefore, an 'elastic' storage element must be incorporated to buffer up to an entire horizontal scan line. The Read Pixel Counter, part of the LP State Machine, counts samples read out of the FIFO. A total of 160, eight bit samples are read out of the FIFO per horizontal scan line.

- Data Output Register and By-Pass Buffers

External to the FPGA is a 8 bit data register that receives the data output from the FIFO. The purpose of this register is to guarantee the input timing requirements of the EL Panel and to provide the CMOS drive levels required by the EL panel. It's outputs can be tri-stated and are wired in parallel with a 8 bit buffer that can be enabled to provide the incoming data from the LVDS Reciever. Another buffer similarily selects between the CP,LP and FLM signals either generated by the FPGA or incoming from the LVDS Receiver. Thus, this buffering arangement can supply the data and timing generated by the Frame Buffer or the 'live' incoming data and timing from the LVDS Receiver, referred to as 'by-pass' mode. This selection can be made is Service Diagnostic mode to assist the technician in troubleshooting suspected problems in the display area.

2.3.4 Keypad Controller (0670-00-0645)

The Keypad Controller board provides the System 98 with the following functions:

- Detecting, debouncing and reporting any keystroke activated by an operator at the keypad.
- Detecting and reporting the position of Inflate and Deflate potentiometers as activated by the operator.
- Activating LEDs residing on the keypad.
- Passing Video signals to the Video Receiver Board.
- DC/DC Converter to supply +5V and +12V to power the monitor module.

The Keypad Controller board is based upon the Motorola MC68HC711 microcontroller. Features include: 12 K bytes of EPROM, 512 bytes of electrically erasable programmable ROM (EEPROM), and 512 bytes of RAM.

The MC68HC711E9 (U1) is operating in a single-chip mode with no external address or data bus available. Port A is used as an input port. Port B serves as an output port to activate the Keypad row drivers. Port C is used as an input port to read back the Keypad column data. Port D serves as the serial communication interface (SCI) and serial peripheral interface (SPI). The SCI serves as a data link between the Keypad Controller and Main board. The SPI provides a communication link between the MC68HC711 and the LED display driver based upon National Semiconductor MM5451 (U6).

The MM5451 is specifically designed to operate LED displays with minimal interface with the display and data sources. Serial data transfer from the microcontroller is accomplished with 2 signals, serial data and clock. Using a format of leading "1" followed by 35 data bits allows data transfers without an additional write signal. The 35 data bits are latched after the 36th bit is complete, thus providing non-multiplexed, direct drive to the display. Outputs change only if the serial data bits differ from the previous data.

There are 36 LEDs mounted onto the keypad. In addition there are 10 more LEDs arranged into a bar graph assembly, representing the Augmentation LED indicator. The LED Bar Graph is mounted directly into the Monitor Keypad Controller board. Table 1 represents LED functional and numerical cross references with LED number corresponding to the serial data bit number. LEDs 0 through 17 are controlled by U5 and LEDs 18 through 35 are controlled by U4. The 10 LED Augmentation bar graph is controlled by U4.

KEYPAD LED ASSIGNMENTS			
LED 0	ECG	LED 18	SLOW GAS ON
LED 1	PRESSURE	LED 19	SLOW GAS OVER
LED 2	PACER V/AV	LED 20	FILL AUTO
LED 3	PACER A	LED 21	FILL MANUAL
LED 4	INTERNAL	LED 22	ECG GAIN
LED 5	1:1	LED 23	PRESSURE THRESHOLD
LED 6	1:2	LED 24	INTERNAL RATE
LED 7	1:3	LED 25	TIMING AUTO
LED 8	ASSIST 1	LED 26	TIMING MANUAL
LED 9	ASSIST 2	LED 27	DISPLAY FREEZE
LED 10	STDBY 1	LED 28	SPARE
LED 11	STDBY 2	LED 29	PREFERENCE MENU
LED 12	FILL 1	LED 30	PRINTER MENU
LED 13	FILL 2	LED 31	HELP SCREEN
LED 14	REFERENCE LINE	LED 32	PRINT STRIP
LED 15	ALARM VOLUME	LED 33	INFLATE INTERVAL
LED 16	AUG. ALARM	LED 34	SPARE
LED 17	ALARM MUTE	LED 35	SPARE

Table 2-8

The Keypad Controller board scans the keys by sequentially activating the scan Rows (ROW0- ROW5) and reading back the Column data (COLUMN0-COLUMN6).

The MC68HC711 is equipped with an analog-to digital (A/D) subsystem that is an 8-channel, 8 bit, multiplexed-input converter. The port E pins are fixed-direction analog inputs to the A/D multiplexer. Two pins are used as inputs for the Inflate and Deflate slide potentiometers.

The Keypad Controller board allows video signals from the Display Controller Board to pass through to the Video Receiver Board.

The Keypad Board receives the Bulk Voltage (18V-32V) from the Power Supply/Charger to power two DC/DC Converters (5V and 12V). These voltages are used to power the entire Head Assembly. The 5V supplies voltage for the Keypad Controller, Video Receiver and the EL Panel. The 12V is used only to power the EL Panel.

The 12V supply is powered by a DC/DC Converter (U7) switching at 200KHz. R29 and R31 are the programing resistors for the output voltage. R40 and R30 are the programming resistors for the overvoltage protection circuitry. When the supply reaches 16V it produces 6.2V on the cathode of CR12, which then causes the Zener to conduct thus turning on Q1 and Q3 (configured as a latching SCR) and then Q2 which then turns off the Mosfet (Q4) which interrupts the Bulk voltage shutting the DC/DC Converter down. To reset the Mosfet the Bulk power must be shut down. The Transient Voltage Suppressor D4 is used to limit the voltage beyond 17.5V until the Over Voltage Circuitry is enabled approx. 1.5ms.

The 5V supply is powered by a DC/DC Converter (U8) switching at 200KHz. R35 and R33 are the programing resistors for the output voltage. R28 and R34 are the programming resistors for the overvoltage protection circuitry. When the supply reaches 6.9V it produces 6.2V on the cathode of CR11, which then causes the Zener to conduct thus turning on Q1 and Q3 (configured as a latching SCR) and then Q2 which then turns off the Mosfet (Q4) which interrupts the Bulk voltage shutting the DC/DC Converter down. To reset the Mosfet the Bulk power must be shut down. The Transient Voltage Suppressor CR13 is used to limit the voltage beyond 7.5V until the Over Voltage Circuitry is enabled, approx. 1.5ms

2.3.5 Display Controller Board (0670-00-0640)

The Display Controller works with the System 98 Main Board MC68020 microprocessor subsystem to generate an image on the EL Display. The Display Controller stores the image in a frame buffer in which the EL Display Controller, resident on the Display Controller board, accesses to refresh the display.

The Display Controller PCBA consists of five subsections:

- The Hitachi HD63484 ACRTC graphics processor
- Frame Buffer Memory
- EL Display Controller
- Clock Generator
- Low Voltage Differential Signaling (LVDS)

Graphics Processor

The Hitachi HD63484 ACRTC Graphics Processor (U4) interfaces to the MC68020 microprocessor subsection of the Main Board. The ACRTC accepts primitive level graphics commands, from the MC68020 microprocessor, and processes them in order to generate an image in the frame buffer.

The ACRTC contains the following subsections:

- MPU interface-Accepts data and commands from the host 68020 processor and provides status registers and interrupts to signal the 68020 microprocessor when all received commands have been processed.
- Drawing Processor-performs the required read/modify/write operations to the Frame Buffer in order to generate the desired image.
- Display Processor-Performs the required read cycles from the Frame Buffer memory to update the display (this function not utilized on the 0640 PCBA).
- Timing Processor-generates the video timing signals, HS,VS and Blank. These are used on the 0640 but are further processed by the EL Display Controller.

Frame Buffer Memory

The frame buffer consists of four 32K X 8 bit devices (U9,U10,U11,U12) organized as two 32K X 16 bit memories. The ACRTC's most significant bit MAD [15] distinguishes the usage of the two memories.

MAD (15) BINARY	MEMORY SECTION
0	ACRTC Base Screen (Character Memory Plane)
1	ACRTC Window Screen (Graphic Memory Plane)

Table 2-9

Under control of the Main Board MC68020 microprocessor commands, the ACTRC writes text

to store Base Screen Memory Plane and Graphics (waveforms) to the Window Screen Memory Plane. The contents of the Frame Buffer Memory are represented, 1 bit per pixel, by the image of the EL Display Panel, that is, if a bit in the memory is a one the corresponding pixel will be illuminated, if the bit is a zero, the pixel will be extinguished.

EL Display Controller (U20)

The EL Display Controller is a Xilinx Field Programmable Gate Array (FPGA). This device is SRAM based, and therefore volatile which implies that it must be reprogrammed upon system power up. Each time power is supplied to the system a circuit within the FPGA loads it's data from serial PROM's U18 and U19 which contain the data to configure the FPGA to perform the EL Display Controller function. The EL Display Controller has two functions, interfacing to the ACRTC to the Frame Buffer and Display Refreshing.

ACRTC to the Frame Buffer Interfacing is accomplished by the EL Display Controller capturing the address output of the ACRTC during a memory access cycle and then allowing the data from the ACRTC to pass to/from the Frame Buffer by enabling the bidirectional data buffers, U5 and U6. ACRTC performs its normal read/ modify/write accesses to the frame buffer as if the EL Display Controller were not there, that is, the EL Display Controllers is invisible to the ACRTC. The EL Display Panel interfaces to the ACRTC through 16 bit address bus, MAD [15..0] and control signals AS, Draw and MRD. When control signals AS and Draw are active low the ACRTC is initiating a frame buffer read of write operation depending on the state of the MRD.

In conventional single scan display systems, the ACRTC also performs the Display Refresh task. However, the EL Display Panel is a dual-scan display which the ACRTC cannot support. Therefore the EL Display Controller must perform this task. A dual scan display is defined as one in which (for example using resolution 640 X 480) line #1 (upper) data is sent to the display device along with line #240 (lower) data; then line #2 (upper) and line #241 (lower) and so on until data from line #239 (upper) and line #480 (lower) is sent to the display. At the end of data for each pair of lines of signal LP (Latch Pulse) is activated and the end of lines 239/480 signal FLM (First Line Marker) is activated. Data is sent out in 8 bit parallel format, four bits for the upper portion of the display and four bits for the lower portion of the display and accompanied by CP (Clock Pulse) pulses. For each pair of lines, 160 CP are sent with data (160 X 4 = 640 pixels) per display line. FLM runs at 13.64 milliseconds, LP at 56 microseconds and CP in 160 clock bursts of 266.6 nanoseconds each.

During the memory cycles when the ACRTC is not accessing the Frame Buffer for image generation read/modify/write cycles the EL Display Controller is free to access the Frame Buffer. In this type of Frame Buffer memory cycle the EL Display Controller generates the address for the Frame Buffer memory from a pair of internal 16 bit address counters, one for the Base Screen and other for the Window Screen memory accesses.

Since the Frame Buffer data bus is 16 bits wide and the EL Display Panel requires 1 bit per pixel, each read of the Frame Buffer will provide 16 pixels of data for either the Base or Window screens. The 16 bit data bus is latched in the EL Display Controller into one of the four internal registers (Base Upper, Base Lower, Window Upper or Window Lower) and the contents are multiplexed down to 4 bits (4 pixels worth of data) onto either DU{3..0} (Upper Data) or the DL{3..0} (Lower Data) busses.

The Frame Buffer Memory uses 15 bit address bus FB_ADR{14..0}, 16 bit data bus FB_DATA{15..0} and control signals FB_WR, FB_CS_BS and FB_CS_WS. The Chip select signals FB_CS_BS and FB_CS_WS select the Base Screen and Window Screen memories. While FB_WR determines if the access is a read or write operation.

LCD_DISP_OFF enables the display and LCD_VEEOFF enables VEE power to the display. On system turn on LCD_DISP_OFF enables the display 40 milliseconds after the FLM, LP and CP are running. LCD_DISP_OFF enables VEE power to the display 40 milliseconds after LCD_DISP_OFF is enabled.

Clock Generator

A 30MHz Crystal supports a Clock Generator which divides down a 15 MHz oscillator signal to two 7.5 MHz and two 3.75 MHz clocks. The 7.5 MHz clocks individually drive the ACRTC processor and EL Display Controller. The 3.75 MHz clocks individually drive the EL Display Controller and LCD. In addition, the two 3.75 MHz clocks run in-phase with the ACRTC MCYC clock output. The 3.75 MHz clock driving the display is enabled by EL Display Controller signal LCD_CP_ENB.

The FPGA signals (4 Upper Data, 4 Lower Data, FLM, LP, Display Off, VeeOff) are connected to the LVDS. The signals are converted to Low Voltage Differential Signaling data streams. A 30 Mhz Clk is transmitted in parallel with the data streams over a 4th LVDS Link. On every cycle of the transmit clock, the 11 bits of input data are sampled and transmitted (differentially). The receiver which is located on the Video Receiver board converts the data stream back to the 11 bits of CMOS data. Through a transmit clock frequency of 30MHz the 11 bits of CMOS data are transmitted at a rate of 210Mbps.

The soft start circuitry (Q1, C54, R5, R6) delays the BULK_IN from powering the DC/DC Converters on the Keypad Controller PCBA by nominally 50ms.

2.3.6 Solenoid Driver Board (0670-00-0639)

The Solenoid Driver board provides control and drive circuits for the pneumatic solenoids and an interface to the pneumatic switches. The blood back detect circuit and the condensate removal drivers also reside here.

- Solenoid Drivers

The DRIVE SOLENOID CONTROL (K6A, K6, K7, K8) section of the board accept TTL level signals from the IABP Controller for the activation of the solenoids used to inflate and deflate the IAB. To speed up the solenoids activation time, conserve power and to keep the solenoids' average power dissipation low, solenoids (K6, K7, K8) are PWM driven with a bi-level current drive scheme. The initial Peak current last for approximately 15ms. When the Peak current interval expires, the current is reduced to a lower Holding current state.

The prolonged inflation failsafe circuit consists of a resettable counter and a latch, which monitors the Pressure and Vacuum solenoids activity. The Pressure and Vacuum solenoids must be de-energized every 2.1 second period for the counter to reset. If either solenoid is not de-energized during this cycle, or the Vacuum solenoid was not energized within 2.1 second following the activation of the Pressure solenoid, the Exhaust and the Safety Vent solenoids will open and vent all pressure. This condition is latched until power reset.

The FILL SOLENOID CONTROL section of the board accepts TTL level signals from the 6809 section of the Main board for activation of all the solenoids used to autofill the IAB with Helium. On board LED's are illuminated each time their corresponding solenoids are activated.

- Solenoid Status Buffer

The STATUS BUFFER allows the IABP Controller sub-system to read the fill system Hall Effect Sensors (EMPTY*, FULL*), the solenoid watchdog status (WDOG*) and the Blood detection alarm (BBALARM*) signals.

- Condensate Removal

During IABP therapy, water vapor may collect in the shuttle gas system (Safety Disk, catheter extender and patient balloon). This can be visualized by a mist in the catheter extender. As the concentration of water vapor increases and under the proper ambient temperature conditions, condensation forms. The condensation removal system isolates the location where this condensation forms, making it easier to collect and remove from the shuttle gas system. A Peltier cooler device (located in the Condensate Removal Module) is used to cool the shuttle gas, thus ensuring condensation will form within it.

As the ambient temperature drops, the probability of condensation forming throughout the shuttle gas system increases. Since it is no longer feasible to cause condensation to form at the desired location, the Peltier is disabled when the ambient temperature drops below 10C. Sensor (U22) is used to monitor ambient temperature and enable/disable the Peltier cooler.

A TTL compatible input signal PELT_ON/OFF* is provided at Q17 to allow external control of the Peltier cooler. A high level at this input disables the cooler.

- Blood Back Detect

In the event of an IAB perforation, blood may be drawn into the fill system during the purge cycle of an auto-fill. To prevent contamination of the auto-fill system, the purge line is monitored for the presence of blood. Blood detection is accomplished via optical means, the presence of blood interrupts a light beam transmitted through the drain tubing. The tubing is held captive in a sensor block that houses light emitting and detecting diodes. In the event that blood is detected, a bit (BBALARM*) is toggled on the solenoid status buffer (U20). The signal's status is polled by the 6809 microprocessor on the Main board. The microprocessor responds to the alarm condition by closing the purge valves (K3 & K5). The purge valves prevent further flow of blood into the IABP pneumatic system.

A single green LED (CR68) is used as the light source. Green light is used to assure maximum attenuation of the light by blood. The light source is chopped to allow the use of synchronous detection by the blood back detection electronics. Synchronous detection rejects the effects of offsets, leakage currents and ambient light.

The clock used by the LED chopper and the synchronous detector is generated by (U5). Synchronous detection is done with an inverting buffer, analog switches and a low pass active filter.

The sensor block has two photodetectors (photodiodes). One detector (the signal detector) is oriented so it exclusively receives light transmitted through the tubing (TUBE_SGN).

The other detector (the reference detector), is oriented such that it receives light directly from the LED (REF_SGN). The reference detector is used to measure the light output of the LED.

The signals from the photodetectors are conditioned by a pair of transconductance amplifiers (U23). Blood is detected by a comparator (U13A). The comparator detects when the light level from the signal detector is less than the preset reference level. The reference level is derived from the reference photodetector. This arrangement rejects any changes to the detection threshold that could be caused by the aging of the LED.

The comparator circuit incorporates hysteresis to prevent oscillatory behavior and to reject noise. The hysteresis is a percentage of the reference level, therefore, it tracks changes in the reference. Because of the design, the output signal level from the comparator is inappropriate for logic. A second comparator (U13B) is used to level shift the signal and makes it logic compatible.

2.3.7 Pneumatic Description

- Safety Disk

The Safety Disk is comprised of three main elements: two hollow, internally identical halves and a molded diaphragm. The diaphragm separates the two halves, and seals the internal volume of a Safety Disk itself. The diaphragm is driven by pressure or vacuum applied to one side of the Disk (drive side), the resultant pressure and vacuum on the other side (patient side) of the diaphragm is used to inflate and deflate the IAB.

The internal geometry of each of the disk halves is hemispherical to minimize diaphragm fatigue caused by the millions of cycles the diaphragm must endure. The edges of each part, where both halves butt together, are rounded to further relieve strain on the diaphragm.

The internal volume of the Safety Disk (volume displaced by the diaphragm while pumping) is sufficient to inflate a 40 cc IAB and pressurize the IAB, catheter extender and any fill system dead space to 100 mmHg.

Safety Disk

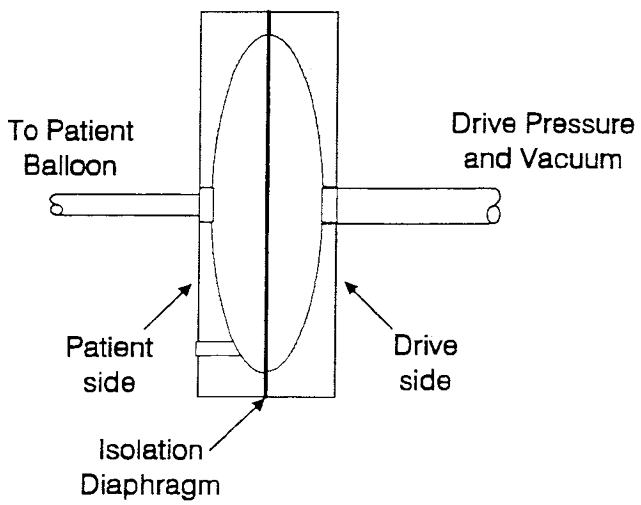


Figure 2-1

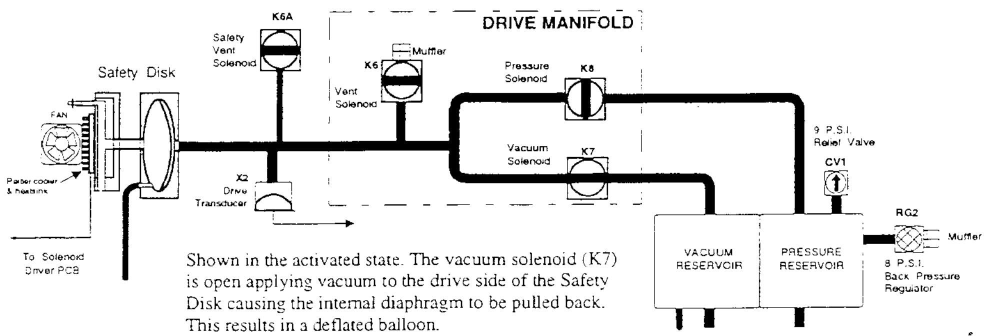
- Drive System

The System 98 pneumatic drive system consists of four solenoid valves (K6,K6A, K7,K8), the pump, an air filter, pressure and vacuum reservoirs, a pressure regulator, and a pressure relief valve.

The function of the drive system is to cycle pressure and vacuum to the Safety Disk which causes it's internal diaphragm to toggle from side to side. IAB inflation occurs when the diaphragm is pushed against the IAB (patient) side of the Safety Disk. IAB deflation occurs when the diaphragm is pulled against the drive side of the Safety Disk.

The pressure output from the pump is regulated to about 8 PSIG via a back pressure regulator (RG2). The back pressure regulator allows excess pressure to be vented to atmosphere. The vacuum output from the pump is not regulated since there is no hazard in having too high a vacuum level.

Figure 2-2



Shown in the activated state. The vacuum solenoid (K7) is open applying vacuum to the drive side of the Safety Disk causing the internal diaphragm to be pulled back. This results in a deflated balloon.

Variable augmentation is achieved by partially inflating the patient balloon. Via the front control, the user proportionally abbreviates the time during which the drive pressure valve, K8 is open. This reduces the effective pressure applied to the disk membrane. If the pressure is sufficiently low, the membrane does not fully "toggle" (conform to the disk walls). Hence only a portion of the disk's tidal volume is expelled, thus yielding a partial inflation of the patient balloon.

Large pulsations, inherent in diaphragm pumps, are filtered via reservoirs (RES1). The reservoirs also supply instantaneous demands for both pressure and vacuum which are present during inflation (pressure) and deflation (vacuum) of the IAB.

The default state (all solenoids de-activated) of the drive system has the safety disk vented to atmosphere via K6A, a normally open valve. Back pressure on the IAB, i.e. blood pressure, causes the balloon to remain deflated.

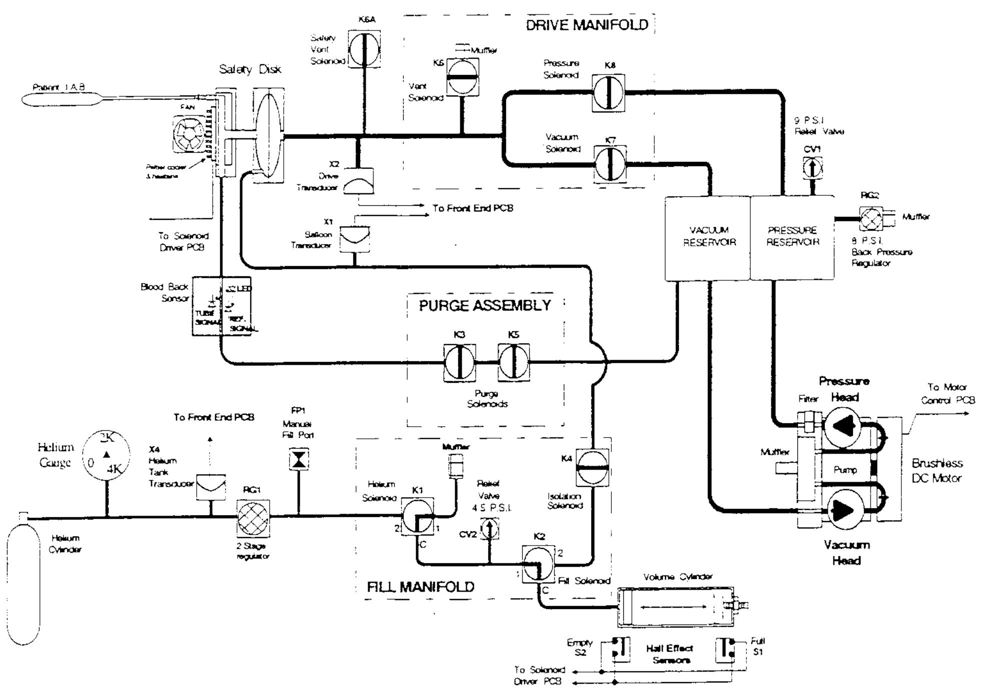


Figure 2-3

Inflation of the IAB occurs when the pressure solenoid (K8) is activated. There is usually a hold period in which all three of the main drive valves (K6, K7, and K8) are de-activated. This hold period is still part of the inflation cycle, since pressure is still being applied to the safety disk, but there is no pressure flow from the reservoir.

The deflation cycle of the IAB begins by activating the Vent solenoid (K6) which vents the Safety Disk drive to atmosphere. As venting adds to the deflation delay, the interval for which the vent valve is active should be minimized yet allow enough time to exhaust the pressure in the pneumatic drive. K6 is then deactivated, and K7 activated causing vacuum to be applied to the Safety Disk.

NOTE: The vent process is performed only when the vacuum level in the drive prior to inflation rises above a preset limit. If this limit is not exceeded the vent process is by-passed thereby reducing the deflation delay.

Once the Safety Disk membrane has fully "toggled", it is no longer necessary to continue to apply drive pressure or vacuum to the isolator. The pressure or vacuum stored within the isolator is sufficient to maintain the inflated/deflated state of the balloon.

When the system is in the standby state, i.e. not pumping, the patient balloon is kept deflated by opening the vacuum valve (K7), whenever the vacuum level rises above a preset limit. This maintains the vacuum level on the isolator's drive side.

To insure the IAB does not remain inflated when power is removed from the system, K6A is used to vent the drive side of the safety disk to atmosphere.

- Fill System

The IAB is inflated and deflated by shuttling a predetermined volume of fill gas into and out of the IAB. Preloading the shuttle gas system with a predefined volume of Helium is the function of the fill system.

A fill cycle begins by purging the shuttle gas system (IAB, catheter extender and Safety Disk. This is accomplished by activating the purge solenoids (K3 and K5), allowing the Safety Disk diaphragm to move to the patient side of the disk. The isolation valve (K4), and the Fill valve (K2) are activated to insure the volume cylinder is empty. After it has been determined that the volume cylinder is empty, K4 and K2 are deactivated. To allow the Safety Disk diaphragm to move to the patient side of the Disk, K6 is activated, venting the residual vacuum in the drive side to atmosphere. Purging continues until the shuttle gas pressure attains the first surveillance level. A leak in the shuttle gas system will cause the pressure to rise. Therefore the shuttle gas pressure is observed for a short period of time. If a rise in pressure is detected, surveillance continues, otherwise the purge is resumed until a second surveillance level is attained. Once again the shuttle gas is examined to flag any rise in pressure. Two surveillance levels are required to detect large and small leaks. By applying a greater differential pressure across the IAB membrane, smaller leaks can be detected. If no leaks were detected, the purge process continues.

While the shuttle gas system is being purged, the volume cylinder is filled with Helium. This is accomplished by activating the Helium solenoid (K1). K1 remains active for a timed interval after the (S1) is tripped. Deactivation of K1 vents the pressure in the volume cylinder to atmosphere. This action equalizes the helium in the volume cylinder to local atmospheric pressure. Once the purge and the volume cylinder filling are complete, vacuum is once again applied to the Safety Disk drive by activating K6A, and ,K7. Activation of the fill solenoid (K2) and isolation solenoid (K4) then connects the volume cylinder to the shuttle gas system. Vacuum in the shuttle gas system draws the charge of helium from the volume cylinder. Once the volume cylinder plunger returns to the empty position, as determined via activation of the Empty sensor (S2), the fill is complete, K2 & K4 are de-activated, completing the autofill process.

To maintain helium purity in the shuttle gas circuit the AUTOFILL process is repeated at 2 hour intervals when the FILL mode is in AUTO.

- Blood Back Detection

The presence of blood is detected by its absorption of green light. Once blood is detected, the valves K3 and K5 are closed, which blocks any further flow into the system.

- Condensate Removal

The condensate removal module is an integral part of a Safety Disk assembly. During IAB therapy, to prevent water from condensing in the catheter, the shuttle gas must be dehumidified. This is done with a cold trap attached to the Safety Disk. The cold trap uses a thermo-electric cooler (Peltier) to pump heat from the trap to a small fan cooled heat sink.

The temperature of the cold trap is below the dew point, consequently the water vapor condenses and collects in the trap. The collected water is removed during the purge portion of the fill cycle.

COMPONENT DESCRIPTION	
Designation	Description
K1	3 way solenoid valve that either supplies helium or vents to atmosphere the normally open port of K2.
K2	3 way solenoid valve that connects the volume cylinder to either the helium source (inactive) or to the Safety Disk via K4 (active).
K3	2 way normally closed solenoid valve. Allows the fill and IAB circuits to be purged.
K4	2 way normally closed solenoid valve that isolates the Safety Disk/IAB circuit from the rest of the fill system.
K5	2 way normally closed solenoid valve. Allows the fill and IAB circuits to be purged.
K6	2 way normally closed solenoid valve used to vent the Safety Disk (drive side) to atmosphere prior to deflation in order to conserve vacuum. Also vents the Safety Disk during purge.
K6A	2-way normally open solenoid, closed during normal operation.
K7	2 way normally closed solenoid valve. When active vacuum is applied to the Safety Disk (drive side).
K8	2 way normally closed solenoid valve. Activation of K8 allows pressurization of the Disk drive, causing the IAB to inflate.
RG1	two stage Helium pressure regulator.
RG2	7.75 PSIG Back Pressure regulator limits the drive pressure by venting excess pressure to atmosphere.
CV2	4.5 PSI relief valve to prevent overpressure in the helium supply.
CV1	9 PSI relief valve used as a failsafe to prevent the drive pressure from exceeding 9 PSI in the event of RG2 failure.
FP1	Manual Fill Port - Helium source for filling a syringe to manually fill the Disk/IAB.
X1	Balloon transducer - used to monitor IAB shuttle gas for purposes of leak detection and auto filling.
X2	Drive gas transducer - used to monitor Safety Disk drive pressure for the purposes of leak detection and drive pressure/vacuum alarms.
X4	Transducer that monitors helium tank pressure.
S1	Hall effect sensor. When active, the Volume chamber is filled (or in the FULL position) to the preset volume of gas.
S2	Hall effect sensor. When active, the Volume chamber is empty or in the Home position.
MUFFLER	Mufflers used to reduce noise generated by exhaust gases (via RG2, K6) and the pump.
VOLUME CYLINDER	Variable volume chamber, when filled contains the preset volume of Helium gas used to fill the shuttle gas system.
BBS1	Blood Back Optical Sensor. Part of solenoid driver board.
PRESSURE	Pressure Reservoir
VACUUM	Vacuum Reservoir
DC MOTOR /PUMP	DC motor combined with compressor/aspirator.
FILTER	40 micron filter for the pressure source.
SAFETY DISK	Safety Disk/Condensate Removal Assembly

Table 2-10

2.4 FACTS ABOUT LEAD ACID BATTERIES

This section is intended to provide facts about sealed lead acid batteries which may be useful during servicing procedures. Complete knowledge of lead acid batteries is not necessary to effectively service battery-operated DATASCOPE products. However, a basic understanding is essential for proper mainenance and failure diagnosis.

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2.4.1 Construction and Operation

The lead acid battery used in DATASCOPE products is maintenance free. During the service life of the battery there is no need to check specific gravity of electrolyte, or to add water. In fact, there is no provision for these maintenance functions. The construction and sealing technique used in making the battery is such that no leakage can occur from the terminals or case of the battery. The sealed construction and electrolyte suspension system permit operation of the battery in any position without loss of capacity, electrolyte, or service life.

The battery is equipped with a safe, low pressure venting system designed to release excess gas and reseal automatically in the event that gas pressure rises to a level above normal. The venting system operates at 7 psi to 10 psi, and is designed to release excess gas and keep the internal pressure within the optimum range of safe, efficient performance.

NOTE: It is important to check battery operating time. Operate the System on battery whenever calibration or preventive maintenance is performed. Insure that the batteries have been fully charged for a minimum of 18 hours. Make a note of the time at the start of the procedure and note the time when the System shuts down. This period should exceed the specifications listed in this manual. Battery replacement is suggested if operating time is marginal.

2.4.2 Characteristics During Charge

Proper charging is one of the most important factors considered when using maintenance free sealed lead-acid batteries. Battery performance and service life are directly related to the efficiency of the charging method selected.

The charging method used to charge the System 98 batteries is performed in three stages. The first stage is limited constant current followed by constant voltage at a high charge rate followed by constant voltage at a float (or trickle) rate.

In the initial charging stage the battery is charged by a limited constant current between 4 to 5 amps. During limited constant current charging battery voltage rises. Once terminal voltage reaches 30 volts the charging mode automatically switches to a high rate constant voltage charge.

The 30 volt charge rate is maintained until the charge current tapers to 0.9 amps. The charging mode is switched again, to a float rate constant voltage charge. The float rate is typically 27.5 volts.

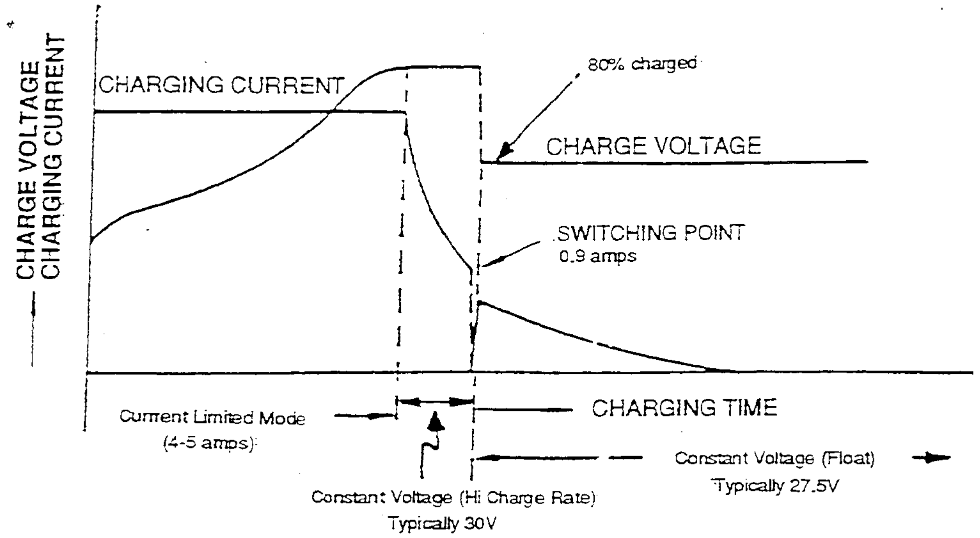

Figure 2-4

Charging Characteristics

Since any battery loses capacity through self-discharge, it is recommended that a "top charge" be applied to any battery which has been stored for a long period of time, prior to putting the battery into service. Excepting conditions in which storage temperatures have been abnormally high, top charging is recommended within the following parameters:

Battery Age	Top Charging Recommendations
Within 6 month of manufacture	4 to 6 hours at constant current of 0.1CA, or 15 to 20 hours at constant voltage of 2.40 volts per cell.
Within 12 months of manufacture	8 to 10 hours at constant current of 0.1CA, or 20 to 24 hours at constant voltage of 2.40 volts per cell.

When a battery has been subjected to deep discharge (commonly referred to as overdischarge), the amount of electricity which has been discharged is actually 1.5 to 2.0 times as great as the rated capacity of the battery. Consequently, a battery which has been overdischarged requires a longer charging period than normal. As a result of internal resistance, charging current accepted by an overdischarged battery during the initial stage of charging will be quite small, but will increase rapidly over the initial 30 minutes (approximately) until internal resistance has been overcome, and normal, full recovery charging characteristics resume.

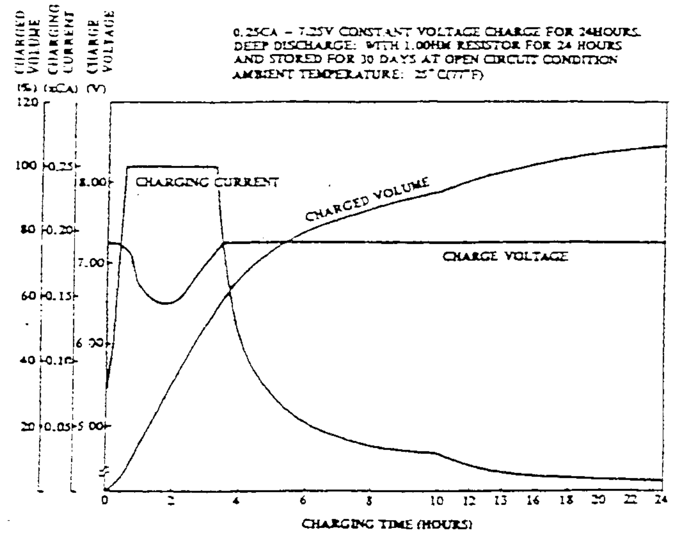

Figure 2-5

Charging Characteristics After Deep Discharge

Consideration should be given to the fact that if the charging method used is constant voltage in which the charger employs current sensing for either state of charge indication or for reducing voltage (a two step charger), during the initial stage of charging an overdischarged battery, the charger may give a false "full charge" indication, or may initiate charge at a float voltage.

As temperature rises, electrochemical activity in a battery increases. Similarly, as temperature falls, electrochemical activity decreases. Therefore, conversely, as temperature rises, charging voltage should be reduced to prevent overcharge, and increased as temperature falls to avoid undercharge.

In general, to assure optimum service life, use of a temperature compensated charger is recommended. The recommended compensation factor for the type of sealed lead-acid batteries used in DATASCOPE products is $\pm 4mV/^{\circ}C/cell$. The standard center point for temperature compensation is 20°C.

In actual use in indoor applications (5°C to 40°C or 41°F to 104°F), it is not necessary to provide the charger with a temperature compensation function, but it is desirable to set the voltage at the value shown in Figure 3 which corresponds most closely to the average ambient temperature of the battery during service.

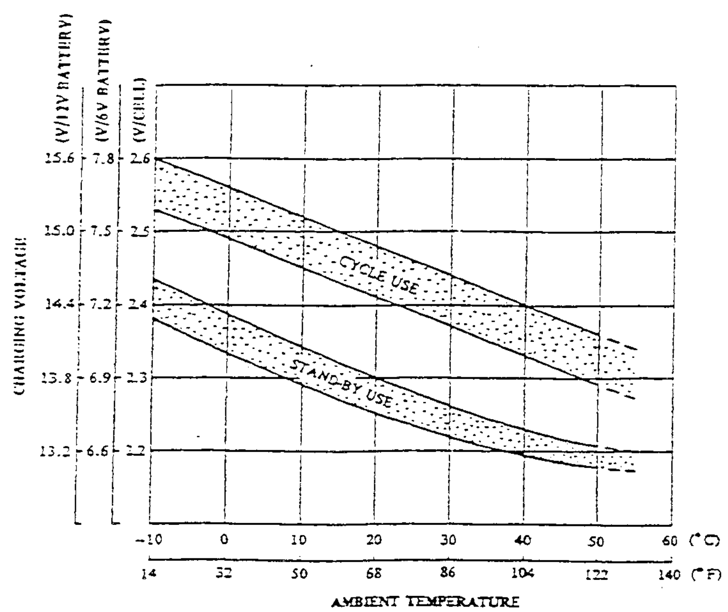

Figure 2-6

Relationship Between Charging Voltage and Temperature

2.4.3 Characteristics During Discharge

The standard industry practice to determine the nominal capacity of a maintenance free sealed lead-acid battery is to discharge a battery at a 20-hour rate to a final voltage of 1.75 volts per cell.

The curves shown in Figures 4 and 5, and the discharge rates shown in Tables 1 and 2 illustrate the typical discharge characteristics of the type of batteries used in some DATASCOPE systems. The symbol "C" expresses a percentage of ampere-hour rating of the battery measured at a 20-hour discharge rate.

Tables 1 and 2 clearly illustrate that the rated nominal capacity when a battery is discharged at a rate higher than the 20-hour rate. This should be taken into consideration when selecting a battery for an application.

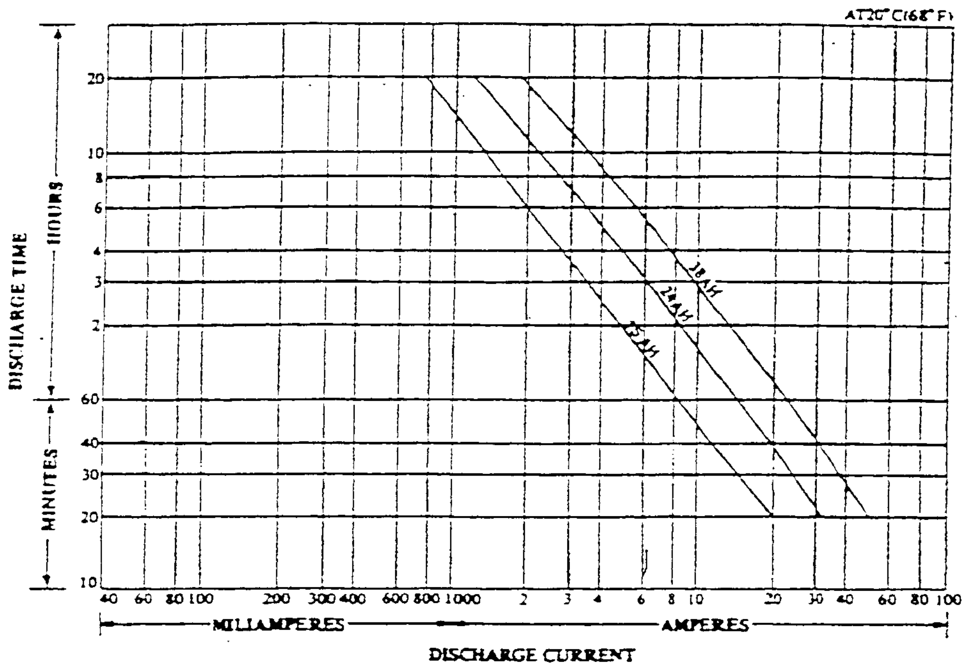

Figure 2-7

20- Hour Rate Capacity Selection Chart

Discharge Current								
20 H.R. Capacity	0.05C	0.1C	0.2C	0.4C	0.6C	1C	2C	3C
15.0	.75	1.50	3.00	6.00	9.00	15.0	30.0	45.0
24.0	1.20	2.40	4.80	9.60	14.40	24.0	30.0	45.0
38.0	1.90	3.80	7.60	15.20	22.80	38.0	76.0	114.0

Table 2-11

Discharge Current at Stipulated Discharge Rates

Figure 2-8

Discharge Characteristic Curves

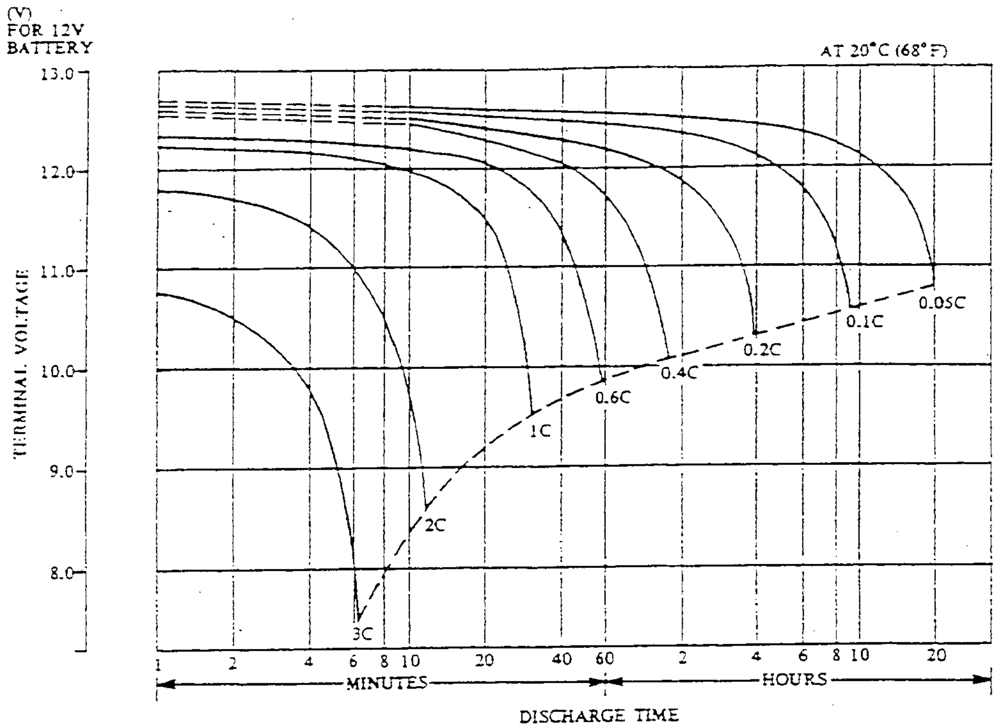

Table 2-12

Discharge Capacity at Various Discharge Rates

Discharge Capacity					
20 H.R. Capacity	20 H.R. 0.05CA to 1.75V/C	10 H.R. 0.093CA to 1.75V/C	5 H.R. 0.17CA to 1.70V/C	3 H.R. 0.25CA to 1.67V/C	1 H.R. 0.06CA to 1.55V/C
15.0 Ah	15.0 Ah	13.8 Ah	12.75 Ah	11.6 Ah	9.0 Ah
24.0 Ah	24.0 Ah	22.3 Ah	20.4 Ah	18.5 Ah	14.4 Ah
38.0 Ah	38.0 Ah	35.0 Ah	32.3 Ah	29.3 Ah	22.8 Ah

The self-discharge rate of most lead acid batteries is approximately 3% per month when batteries are stored at an ambient temperature of 20°C (68°F). The self-discharge rate will vary as a function of ambient storage temperature.

In general, when lead acid batteries of any type are stored in a discharged condition for extended periods of time, lead sulfate forms on the negative plates of the batteries. This phenomenon is referred to as "sulfation". Since the lead sulfate acts as an insulator, it has a direct detrimental effect on charge acceptance. The more advanced the sulfation, the lower the charge acceptance.

Table 3 below shows the maximum allowable storage time or shelf life at various ambient temperature.

Table 3 Shelf Life At Various Temperature

Temperature	Shelf Life
0°C (32°F) to 20°C (68°F)	12 months
21°C (70°F) to 30°C (86°F)	9 months
31°C (88°F) to 40°C (104°F)	5 months
41°C (106°F) to 50°C (122°F)	2.5 months

Brief excursions, i.e., a few days, into temperatures higher than the ranges recommended above will have no effect on storage time or service life. However, should the excursion persist for one month or more, the storage time must be determined according to the new ambient temperature.

In general, to optimize performance and service life, it is recommended that lead acid batteries which are to be stored for extended periods of time be given a supplementary charge, commonly referred to as a "top charge", periodically.

2.4.4 Failure Modes

The dotted line in Figure 2-8 indicates the lowest recommended voltage under load, or cut-off voltage, for sealed lead-acid batteries at various discharge rates. In general, lead-acid batteries are damaged in terms of capacity and service life if discharged below the recommended cut-off voltages.

NOTE: The System 98 has a cut off feature to prevent damage to the batteries.

It is generally recognized that all lead calcium alloy grid batteries are subject to overdischarge. For example, if a lead-acid battery was discharged to zero volts, and left standing in either open circuit or closed circuit for a long period of time, severe sulfation would occur, raising the internal resistance of the battery abnormally high. In such an extreme case, the battery may not accept a charge.

The following conditions may cause batteries to become permanently damaged:

- When stored in high temperatures (over 80°F).
- When stored for long periods of time (12 months or more) without recharging.
- When left standing in a discharged state.

2.4.5 Battery Life

There are a number of factors that will effect the length of cyclic service of a battery. The most significant are ambient temperature, discharge rate, depth of discharge, and the manner in which the battery is recharged. Generally speaking, the most important factor is depth of discharge.

The relationship between the number of cycles which can be expected, and the depth of discharge is readily apparent. In relation to a specified discharge rate, if the application requires a longer cyclic life than is obtainable by selecting the battery capacity according to the general rule of discharge rate vs. time, it is common practice to select a battery with larger capacity. Thus, at the specified discharge rate over the specified time, the depth of discharge will be shallower and cyclic service life will be longer.

Certain batteries are designed to operate in standby (float) service for approximately 5 years, based upon a normal service condition in which float charge voltage is maintained between 2.25 and 2.30 volts per cell in an ambient temperature of approximately 20°C (68°F).

In normal float service, where charging voltage is maintained at 2.25 to 2.3 volts per cell, the gases generated inside the battery are continually recombined into the negative plates, and returned to the water content of the electrolyte.

Through the gradual and slow corrosion of the electrodes, the battery will eventually lose capacity and come to the end of its service life. It should be noted that the corrosive process will be accelerated by high ambient operating temperatures and/or high charging voltage.

LENGTH OF SERVICE WILL BE DIRECTLY EFFECTED BY THE NUMBER OF DISCHARGE CYCLES, DEPTH OF DISCHARGE, AMBIENT TEMPERATURE, AND CHARGING VOLTAGE.

2.4.6 Safety Precautions

Batteries can generate explosive gases. Keep sparks, flames, burning cigarettes, or other ignition sources away at all times.

Do not connect or disconnect live circuits.

Turn off charger before attaching or removing a lead from the battery.

Ventilate the area when charging.

When charging a battery out of the System, never allow battery temperature to go above 125°F. If the battery feels hot, cut back or stop charging until battery cools.

Never attempt to charge a frozen battery. Allow the battery to warm to 60°F before placing on charge.

When removing the battery:

Always disconnect the ground cable first. When installing a battery always connect the ground cable last.

Information for this section was obtained from manuals from the following companies:

Prestolite

Prestolite Battery Division
Toledo, Ohio

Ratelco Inc.

Seattle, Washington

Yuasa Battery Company LTD.

Santa Fe Springs, California

NOTE: The information and charts contained herein are representative of most lead-acid batteries but not necessarily those contained in the System 98.

3. SPECIFICATIONS

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3.1 TRIGGER DETECTION

ECG:	Trigger threshold is dynamically adjusted by the system for improved sensitivity and selectivity of the R-wave detection. Minimum threshold in normal gain is 120 ±20µV In user-adjusted variable gain mode, the effective minimum threshold is 40µV at maximum gain. (40 ms pacer blanking)
Pacer A:	same R-wave detection as above except that pacer blanking is extended to 100 ms.
Pressure:	Normal mode: Automatically adjusted to 50% of the difference between peak systolic and end diastolic (averaged over multiple cycles). Variable mode: User adjustable between 7 and 30 mmHg, (±3 mmHg)
Pacer V/A-V:	V Pacer: fixed rate up to 185 bpm (no demand pacing) A-V Pacer: fixed rate up to 125 bpm (no demand pacing) with A-V intervals between 80 and 224 ms
Tall T-Wave Rejection: (ECG & Pacer A Trigger Mode)	Rejects all T-Waves where Q-T interval is <300 ms and the amplitude is <70% of QRS input amplitude.

Pacer Rejection: (ECG & Pacer A Trigger Mode)	Rejects all pulses of amplitude ±2.0 mV to ±700 mV and durations between 0.1 ms to 2.0 ms with: 1) no tail, 2) 100 ms time constant tail <1 mV, or 3) 25 ms time constant tail <1 mV, or 4) 4 ms time constant tail <2 mV **NOTE:** Pacer tail peak amplitudes shall not exceed 25% of the pacer pulse amplitude per AAMI EC13-1992 paragraph 3.1.4.2. (Pacer & tail rejection performance may be degraded in "Manual" timing and "Variable" ECG gain modes.)
Internal:	80 bpm, ±1bpm in Normal mode 40 -120 bpm in Variable mode
Electro-Surgical Interference Suppression (ESIS):	The operation of an Electro-Surgical Unit in the proximity of the IABP shall not cause any unrecoverable malfunction or require user intervention.

3.2 PNEUMATIC SYSTEM

Auto-Fill Time:	10 to 12 seconds maximum

3.3 ECG CHANNEL

- Input Characteristics

Leads:	I, II, III, AVR, AVL, AVF, V, or External
Input Linear DC Offset: Range:	±300mV minimum
Linear Input Range:	±5.0mV minimum (ECG Gain = NORMAL)
Input Impedance:	>5 MOhms differential, at 10 Hz for Leads I, II, III
Defibrillator Overload Protection:	Withstands up to 360 Joules for damped sinusoidal (per IEC 601-2-27:1994) and trapezoidal (per AAMI DF2:1996) waveforms applied to 100 Ohm load and 50 Ohm electrode impedance at 20 second intervals
Defibrillator Recovery Time:	2 seconds maximum for trace to return to screen from a defibrillator mono pulse (Note: exceeds 5 second maximum specified by AAMI EC13:1992 and IEC 601-2-27:1994 requirements)

Lead Fault Detection:	Guaranteed Lead fault detection when any active electrode wire becomes open. Guarantee no lead fault with electrode impedance ≤51K Ohms and with DC offsets ranging from -300 mV to +300 mV.
Noise:	<25 uV p-p referred to input (r.t.i) with 51K Ohm in parallel with 47 nF on each leg over ECG bandwidth.
Common Mode Rejection Ratio:	80 dB minimum, at 50/60 Hz with an imbalance of up to 51K Ohm in parallel with 47 nF and up to ±300mV DC offset.

- Display Characteristics

Autoscaling of waveform amplitude in "Normal" Gain:	Automatically scaled to occupy the majority of the ECG display window. 1 cm high bar to the left of waveform - annotated with X mV indicating the current scale factor. Accommodates amplitudes up to ± 5 mV (minimum) without clipping. Inhibited from adapting to transient artifacts such as caused by: Electro-Surgical Unit, lead fault/change of lead, pacemaker pulse heights; A/D over-ranging caused by changes in electrode offset potentials, large ectopic beats, or defibrillator discharges. Does not rescale when ECG peak amplitudes are less than 120 mv.
Display Sensitivity (Variable Gain ON):	0.15 to 3.0 cm/mV ±20% as detected by gain setting
Step Response on Screen:	15% max. overshoot (Pacer circuit disabled.)
Pacemaker Pulse Display:	Display pulse ≥2.0 mV (absolute magnitude r.t.i.) for a 0.1 to 2 ms duration input (in accordance with AAMI EC13 - 1992)
Usable Screen Area for ECG:	4 cm x 13.5 cm area on display.
Frequency Response to Screen Display at 25 mm/sec:	0.5 to 12 Hz (-3 dB max. attenuation)

- External Monitor via Output Connector

Frequency Response to ECG output connector:	0.5 to 135 Hz, -3 dB maximum (with ESU detection disabled).
Output Impedance:	<120 Ohms
ECG gain at External ECG Output:	1 V output per mV input ± 5 %

3.4 PRESSURE CHANNEL

- Transducer Requirements

Input Sensitivity:	5.0 µV/V/mmHg (nominal)
Transducer Excitation:	+5V DC ±5% (capable of supplying up to 130 mA)
Arterial Pressure Delay (APD):	Automatically calculated/set at system power on Manual adjust via Preferences Menu from 0 to 180 ms

- Arterial Pressure Display (Analog)

Autoscaling:	Dynamic (pulsatile) portion of waveform automatically scaled to occupy the majority of the display window. Static offset pressure (D.C. pedestal) removed. Scale factors (automatically selected) are 15,20,25, 30,40 and 50 mmHg/cm. The scale factor is noted on the printer strip. The scale factor may be inferred on the display from the Y-axis grid marks at 1 cm spacing and the pressure annotation (mmHg) beside the lowest, middle and highest grid marks. Accomodates dynamic pulse pressure differentials up to 200 mmHg (min.). Display is unclipped with pressure levels up to 300 mmHg above atmosphere. Autoscaling is inhibited during transducer zeroing and flushing. Display defaults to compressed scale including atmospheric pressure when transducer is not zeroed. Designed not to rescale unless peak systolic pressures are greater than 20 mmHg. This is to prevent "zooming in" and amplifying invalid / non-arterial waveforms.
Manual Scaling:	0-80, 0-160, 0-300 mmHg (selectable in Preferences)
Display Window:	4 cm x 13.4 cm (in autoscaling, or with Balloon Pressure waveform displayed, or with Help/ Preferences screen displayed) 8 cm x 13.4 cm (only in manual scaling without Balloon Pressure waveform and no Help/Preferences screen is displayed)
Trace Accuracy (two trace mode excluding Transducer):	3 mmHg or 3%, whichever is greater
Frequency Response to Display Trace:	D.C. to 11 Hz (+0 to -3 dB max.)
Reference Line:	0-300 mmHg

- Patient Parameters - Digital Arterial Pressure Display
  (Systolic, Diastolic, Mean and Augmented Diastolic Pressures)

Resolution:	1 mmHg, all settings
Accuracy:	2 mmHg or 2% whichever is greater
Range:	0 to 250 mmHg minimum
Update Rate:	2 seconds (nominal); 4 seconds worst case.

- Arterial Pressure External Output (Phone Jack)

Pressure Range:	0 to +300 mmHg
Accuracy:	2 mmHg or 2% whichever is greater (excluding transducer)
Scale:	10.0 mV/mmHg ± 2 %
Frequency Response:	DC to 15 Hz ± 15 % (+0 to -3 dB) for IAB direct pressure inputs DC to 22 Hz ± 15 % (+0 to -3 dB) for external (monitor) pressure inputs
Output Impedance:	< 5 Ohms up to 22 Hz
Noise:	5 mV p-p max. (0 to 1 Khz bandwidth), which equates to 1/2 mmHg p-p max r.t.i. (0 to 1 Khz bandwidth)

- Arterial Pressure Zero

Zero Accuracy:	±1 mmHg at pressure output, +1.0 mm deviation from zero line at maximum deflection range (0-200 mmHg) on the display.
Zero Drift:	0.15 mmHg/°C, (excluding transducer drift)
Zero Range:	±120 mmHg minimum
Auto-Zero Time:	<3 seconds.

3.5 HEART RATE METER

Usable Range:	15-200 bpm
Resolution (Display):	1 bpm
Accuracy (Display):	15-200 bpm, ±3 bpm or ±3%, whichever is greater.
Display Update Rate:	2 ± 0.1 second
Step Change Response Time:	7 seconds (including 2 second max. digital display update) to indicate new rate to within 15 bpm for a 40 bpm step change in a rate tested between 80 to 120 bpm. Tested to ANSI/AAMI Std. EC13-1983.

3.6 DISPLAY SYSTEM

Type:	Electro-luminescent
Total Viewing Area:	21.1 cm x 15.8 cm (8.3" x 6.2") 26.3 cm (10.4") diagonal
Viewing Angle:	160°
Display Brightness:	Low/Medium/High Brightness (user selectable)
Accuracy:	2 mmHg or 2%, whichever is greater
Waveforms:	1 ECG 1 Arterial Pressure 1 Balloon Pressure (user selectable)
Data Storage and Display:	5.4 seconds at 25mm/second erase bar speed 2.7 seconds at 50mm/second erase bar speed

3.7 RECORDER

Print Mechanism:	Thermal Array
Chart Width:	50mm
Chart Speeds:	25 mm/sec or 50 mm/sec (both ±5%)
Print Resolution:	Vertical: 8 dots/mm (200 dots/inch) Horizontal: 31.5 dots/mm (800 dots/inch) (at 25 mm/sec)

3.8 POWER

- Power Requirements

AC Mains Source:	100 - 120 VAC ± 10 %, 50/60 Hz ±3 Hz 220 - 240 VAC ± 10 %, 50/60 Hz ±3 Hz (automatic range switching) 300 watts nominal / 450 watts maximum (120 bpm pump rate with battery charging)
Power Factor Correction: (internal power supply)	0.95 Power Factor at nominal line (meets current Harmonic limits defined in EN61000-3-2: 1995)
Auxillary DC Source:	20.5 -35.0 VDC

- Internal Battery

Type:	24 VDC (nominal), 17.2 Amp-hours Sealed lead acid, maintenance free
Run Time:	2.25 hours minimum* (from full charge at room temperature, at 120 bpm)
Recharge Time:	18 hours maximum (from complete discharge to full charge)
"Battery Low" Threshold:	23 Volts, ±0.5 Volts
Battery Cutoff Threshold:	20.0 Volts, ±0.5 Volts

**NOTE: A reduction in run time can occur over a battery's life for various reasons such as age, storage temperature and discharge depth.*

- External Battery Pack

Type:	24 VDC (nominal), 17.2 Amp Hours Sealed lead acid, maintenance free
Run Time:	1.8 hours minimum* (from full charge at room temperature, at 120 bpm)
	Recharge Time: 18 hours maximum (from complete discharge to full charge)
"Battery Low" Threshold:	23 Volts, ±0.5 Volts
Battery Cutoff Threshold:	20.0 Volts, ±0.5 Volts

**NOTE: A reduction in run time can occur over a battery's life for various reasons such as age, storage temperature and discharge depth.*

3.9 HELIUM CYLINDER

- 90 Liter Refillable Helium Cylinder - P/N 0075-02-0001 (BSI, APPAVE approved)
  P/N 0075-02-0002 (TUV approved)

Capacity:	0.5 liters (30.5 in^3) @ 2900 psi (equivalent to approx. 90 std. liters @ 1 Bar (14.7 psi).
Weight (Full):	1.02Kg. (2.25Lbs) nominal.
Endurance (Nominal):	1.8 months (125 cc Standard Temperature and Pressure per fill @ fill every 2 hrs. pumping continuously 24 hrs. per day).
Approvals:	BSI, APPAVE, TUV, EEC per 84/526/EEC, BAM (Valve)
Container Specification:	7.06 cm x 23.19 cm (2.78" x 9.13") Overall Height 31.55 cm (12.42") aluminum cylinder pin-indexed yoke-type Medical Valve connection per ISO 407: 1991 (E) para. 7.2.7 / CGAV-1-1994 connection No. 930.

- 99 Liter Refillable Helium Cylinder - P/N 0075-00-0024-01

Capacity:	0.69 liters (46.2 in^3) @ 2200 psi (equivalent to approx. 99 std. liters @ 1 Bar (14.7 psi).
Weight (Full):	1.13Kg. (2.49lbs) nominal.
Endurance (Nominal):	2.0 months (125 cc standard Temperature & Pressure per fill @ fill every 2 hrs. pumping continuously 24 hrs. per day).
Compliance/Approvals:	U.S. DOT 3AL, Post Type Medical Valve U.S. CGA S-1.1-1994 U.S. CGA V-1-1994 U.S. CGA V-9-1991
Container Specification:	8.23 cm x 23.01 cm (3.24" x 9.06") Overall Height 30.71 cm (12.09") Service pressure of 153 Bar (2216 PSIG) aluminum cylinder pin-indexed yoke-type Medical Valve connection per ISO 407: 1991 (E) para. 7.2.7 / CGAV-1-1994 connection NO. 930.

- 140 Liter Disposable Helium Cylinder - P/N 0202-00-0104

Capacity:	0.95 liters (58 in^3) @ 2200 psi (equivalent to approx. 140 std. liters @ 1 Bar (14.7 psi).
Weight (Full):	1.82Kg. (4 lbs) nominal.
Endurance (Nominal):	2.9 months (125 cc standard Temperature & Pressure per fill @ fill every 2 hrs. pumping continuously 24 hrs. per day).
Compliance/Approvals:	U.S. DOT E8990, Post Type Medical Valve U.S. CGA S-1.1-1994.
Container Specification:	8.26 cm x 23.88 cm (3.25" x 9.40") Overall Height 31.37 cm (12.35"). Service pressure of 152 Bar (2200 psig) aluminum cylinder pin-indexed yoke-type Medical Valve connection per ISO 407: 1991 (E) para. 7.2.7 / CGAV-1-1994 connection NO. 930.

- Low Helium Indicator: <150 PSIG +25 / -15 PSIG

3.10 DOPPLER (Arterial Blood Flow Monitor)

Type:	8 Mhz, ultrasonic, non-directional, hand-held probe
Audible Output:	Integral speaker (with volume control) or removable headset
Display:	LCD display of on/off, battery status
Power:	9V battery

3.11 COMMUNICATIONS

- North American Modem

Operation:	Full or half duplex
Data Rate:	1200 bps, 2400 bps, 4800 bps, 7200bps, 9600 bps, 12000 bps, 14400 bps (V.32 bis) or 1200 bps, 2400 bps (V.22 bis).
Compatibility:	CCITT V.32 bis with automatic fall-back to CCITT V.22 bis and Bell 212A or CCITT V.22 bis
Registration:	FCC registered for direct connection to telephone system in North America.

- International Modem

Operation:	Full duplex
Data Rate:	28,800 to 2400 bps
Compatibility:	CCITT V.34 and lower speed protocols
Registration:	≥22 country certification

- Data Output Connector (RS-232)

Connector:	9 pin, D
Data Rate:	2400 bps
Compatibility:	EIA RS-232
Data Format:	Serial, binary, asynchronous; 8 data bits; 1 stop bit; no parity

3.12 PHYSICAL CHARACTERISTICS

- Weight

Standard Console (w/o monitor):	34.8 kg.	76.8 lbs.
Monitor:	4.28 kg.	9.45 lbs.
Internal Battery Pack 0146-00-0047:	15.4 kg.	34.0 lbs.
Safety Disk and CRM:	1.6 kg.	3.5 lbs.
Helium Tank (99 liter, full):	1.13 kg.	2.5 lbs.
Total - Console with Monitor, Battery, SD/CRM, and Helium Tank:	57.2 kg.	126.3 lbs.
Cart (including storage bin, doppler and doppler holder):	27.7 kg.	61.0 lbs.
UTS Console (w/o monitor, includes integral wheelbase):	39.8 kg.	87.8 lbs.
Internal Battery Pack 0146-00-0051:	13.6 kg.	30.0 lbs.
Monitor:	4.28 kg.	9.45 lbs.
Safety Disk and CRM:	1.6 kg.	3.5 lbs.
Helium Tank (99 liter, full):	1.13 kg.	2.5 lbs.
Total - UTS Console with all above:	60.4 kg.	133.2 lbs.

Optional Accessories:

Storage Bag 0997-00-0428:	1.6 kg.	3.4 lbs.
External Battery Pack: 0999-00-0336	16.8 kg.	37.0 lbs.
External Charger: 0999-00-0337	4.7 kg.	10.3 lbs.
Transport Docking Station (for UTS): 0436-00-0085-01	13.6 kg.	29.5 lbs.
Transport Docking Station - Lightweight (for UTS): 0436-00-0110	7.4 kg.	16.3 lbs.

- Mechanical Dimensions

Console & Display -

Display Closed:	26.9" H x 20.5" D x 10.8" W 68.3 cm H x 52.1 cm D x 27.4 cm W
Display Open 90°:	34.3" H 87.1 cm H

Console Mounted on Cart -

Display Closed:	43.1" H x 22.3" D x 16.8" W 109 cm H x 56.6 cm D x 42.7 cm W
Display Open 90°:	51.0" H 129.5 cm H

UTS (Univeral Transport System) Model -

Display Closed:	30.0" H x 22.5" D x 13.2" W 76.2 cm H x 57.2 cm D x 33.5 cm W
Display Open 90°:	37.4" H 95.0 cm H

3.13 ENVIRONMENTAL CHARACTERISTICS

- Operating Ambient

Operating Temperature:	10°C to 40°C
Operating Humidity:	5% to 95% R.H. non-condensing
	NOTE: The range of humidity specified is not found at all specified temperatures. Performance shall be verified at discrete temperature and humidity combinations per "ECRI - PB-296892" Section AIII.1.7c Class 2 guidelines.
Operating Altitude:	Sea Level to 12,000 feet (1,000 ft./minute maximum rate of change) WARNING: Under no circumstances should the System 98 ever be used in a hyperbaric chamber.

- Storage Ambient

Storage Temperature:	-40°C to 70°C
Storage Humidity:	5% to 95%, R.H. non-condensing
	NOTE: The range of humidity specified is not found at all specified temperatures. Performance shall be verified at discrete temperature and humidity combinations per "ECRI - PB-296892" Section AIII.1.7c Class 2 guidelines.

- Shock and Vibration

Shipping:	International Safe Transit Association (ISTA) "Preshipment Test Procedures:, Test Procedure 1, April 1996.
Operational:	
Random Vibration:	MIL-STD 810E (Vibration method 514.4, using Category 1 vibration amplitude for common carrier transport).
Sinusoidal Vibration:	RTCA/DO-160C, December 1989, (Vibrations Section 8, using Curve N vibration amplitude profile for helicoper mounted equipment).

Elevator Threshold Test:	ECRI* (AIII.3.1)
Barrier Impact Test:	ECRI* (AIII.3.2.2)
Drop Test:	
Steel Sphere Impact Test:	ECRI* (AIII.3.3)
Tip-over Test:	ECRI* (AIII.3.4)

*U.S. Department of Commerce, National Technical Information Service, PB-296 892 "Development of Environmental Test Methods for Non-Implantable Devices" by Emergency Care Research Institute (ECRI), Prepared for Food and Drug Administration, April, 1979.

- Electro Magnetic Compatibility

The System 98 shall meet the requirements of EN 60601-1-2:1993 with respect to electromagnetic compatibility (EMC):

Conducted Emissions:	EN 55011 Group 1, Class B AC power cord - 150 Khz to 30 Mhz
Radiated Emissions:	EN 55011 Group 1, Class A 30 Mhz to 1 Ghz
Conducted Susceptibility:	IEC 1000-4-6. level 2 10Khz to 100 Mhz, 3V/m, 80% AM @ 6 Hz
Radiated Susceptibility:	IEC 1000-4-3, level 2 80 Mhz to 1.0 Ghz, 3V/m, 80% AM @ 6 Hz (Additional Engineering testing to be conducted from 27 Mhz to 80 Mhz).
Electro-Static Discharge (ESD):	IEC 1000-4-2, level 3 (6KV contact discharge and/or 8 KV air discharge minimum, no reset; 8 KV contact. 15 KV air, no damage).
Electrical Fast Transient (EFT):	IEC 1000-4-4, level 3 (2KV supply leads and 1KV I/O cables minimum).
Surge Immunity:	IEC 1000-4-5, class 3 (1KV common mode and 2 KV differential applied to AC line
Magnetic Emissions:	MIL-STD-461/2D, RE101 30 Hz to 100 Khz @ 7cm
Magnetic Emissions:	MIL-STD-461/2D, RS101 30 Hz to 100 Khz
Steady State Voltage:	FDA 510K Reviewer's Guide, Section (m)(7)(ii)(c)(1) 95-132V operation and seamless AC/battery switching below 95

VRMS:

Dropout:	FDA 510K Reviewer's Guide, Section (m)(7)(ii)(c)(2) AC line dropout < 10 ms
Slow Sags and Surges:	FDA 510K Reviewer's Guide, Section (m)(7)(ii)(c)(3) AC line slow sags to 90 VRMS and surges to 150 VRMS for 500ms duration
Quasi-Static Field Suspectibility	FDA 510K Reviewer's Guide, Section (m)(7)(ii)(f) 2 KV/m electric field modulation at 0.5 Hz

- ESU Rejection

Performance During	The operation of an Electro-Surgical Unit in the proximity of the IABP shall not cause any unrecoverable malfunction or require user intervention.

3.14 SAFETY CHARACTERISTICS

- Risk (Leakage) Currents

When measured with the AAMI standard test load:

Enclosure Risk Current:	≤ 100μA Normal Condition ≤ 300μA Single Fault Condition
Patient Source Current:	≤ 10μA Normal Condition ≤ 50μA for Single Fault Condition
Patient Sink Current:	≤ 50μA

- Dielectric Withstand

System:	4000V RMS at 50/60Hz from any lead or combination of patient leads to AC Mains hot or neutral for one minute. 1500VAC at 50/60Hz from any lead or combination of patient leads to chassis for one minute.

- Ground Resistance

<0.1 Ohm from the MAINS power inlet module's ground contact pin to any exposed metal parts, which can become energized, as measured per IEC 601-1, 1988 (<0.2 Ohm when measured from the U-blade of the supplied line cord.)

3.15 AGENCY COMPLIANCES

The System 98 is designed to comply with the following agency standards:

- IEC 601-1: 1988/EN60601-1: 1990
- EC Medical Device Directive 93/42/EEC
- IEC 601-1-2: 1993/EN60601-1-2: 1995
- IEC 601-2-27: 1994
- IEC 601-2-34: 1994
- UL 2601: 1997
- CSA C22.2 - No. 601.1 - M90
- CSA C22.2 - No. 601.1S1 - 94

4. REPAIR INFORMATION

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4.1 INTRODUCTION

This chapter of the Service Manual provides the necessary technical information to perform repairs to the instrument. The most important prerequisites for effective troubleshooting are a thorough understanding of the instrument functions, as well as an understanding of the theory of operation. Therefore, if necessary, refer to the Operating Instructions (P/N 0070-00-0402) which describes the instrument functions and features, and refer to Chapter 2 of this manual which provides a theory of operation.

4.2 SAFETY PRECAUTIONS

In the event that the instrument covers are removed, observe the following warnings and general guidelines.

1. Do not short component leads together.
2. The troubleshooting charts are not intended as a rapid course on how to repair devices of this type. Rather, they are intended as a guide for qualified technical personnel only. The instrument covers must not be removed by other than technically qualified personnel who have received supplementary instructions regarding maintenance of medical electronic equipment or has had equivalent experience in this area.

4.3 TROUBLESHOOTING GUIDELINES

In an instrument as complex as this, it is virtually impossible to list each and every potential problem and appropriate action. Any given problem, however, can be effectively identified through an understanding of the instrument features and the theory of operation. These are prerequisites for repair. If necessary, read the Operating Instructions Manual and study the theory of operation presented in Chapter 2 of this manual. The time spent reading and absorbing this information is generally realized by a reduction in repair time and, ultimately, an increase in the overall experience of service personnel.

4.3.1 GENERAL TROUBLESHOOTING GUIDELINES

1. **Identify the Problem.** Due to the wide ranges of potential symptoms, certain problems may be more subtle than others. One approach to troubleshooting is to set-up the instrument for testing as described in Chapter 7 and attempt testing. If successful, there is a reasonable assurance that there is no problem. By contrast, the fact that a particular test is not successful is generally indicative of a failure in that specific area.

The cause of the symptom can now be further isolated by referring to Chapter 2. An examination to the Table of Contents (page 2-1) will reveal a listing of specific circuits or areas in the instrument, each of which is dedicated to provide a specific function.

Once the operation of that circuit is understood, troubleshooting can be completed by making measurements in that circuit to determine which component(s) is at fault.

2. **Avoid Shorting Component Leads.** During repair procedure it can become tempting to make a series of quick measurements. Always turn off the power before connecting and disconnecting test leads and probes. The accidental shorting of component leads can easily over stress components, resulting in a second unnecessary failure (aside from creating a possible safety risk).

3. **Use the Proper Equipment.** This equipment listed in Section 4.4 is suggested to fulfill a wide range of troubleshooting requirements. Use a soldering iron the appropriate wattage for a given job. For example, use a pencil-type iron (25 watts max.) for repairs to printed wiring boards and a pistol-grip (75 watts) for repairs requiring this much power. Do not use the high powered iron to repair the printed wiring boards as the conductors will lift from the board under the extreme heat, thus ruining it.

4. **Clean the Repair Area.** After soldering operations, clean off the repaired area with alcohol and a stiff hair brush. This will remove residual solder flux, making the repaired area more visible for inspection and returning the instrument to its original, neat appearance. Removal of the flux will also facilitate making electrical measurements in the affected area as the flux itself is not conductive.

4.3.2 EXCHANGE PROGRAM

Datascope offers an exchange program for certain assemblies in the instrument. In many cases, replacement of the complete assembly will result in the most expedient repairs. See section 6.4 for details concerning the exchange program.

4.4 SPECIAL TOOLS AND TEST EQUIPMENT REQUIRED

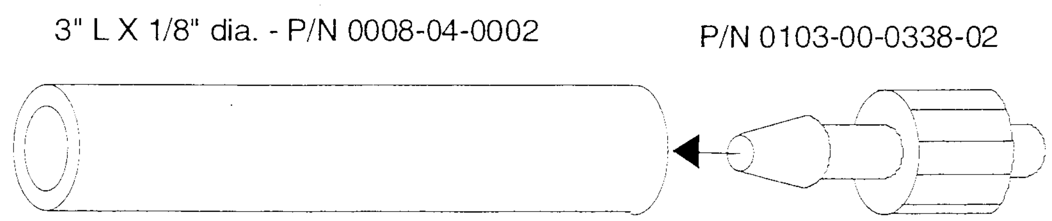
Test Equipment Required

- Dual trace oscilloscope
- Digital multimeter (3-1/2 Digits)
- ECG simulator and signal generator
- Mercury column or Electronic equivalent
- Safety analyzer
- Centimeter ruler
- Series 90 Trainer

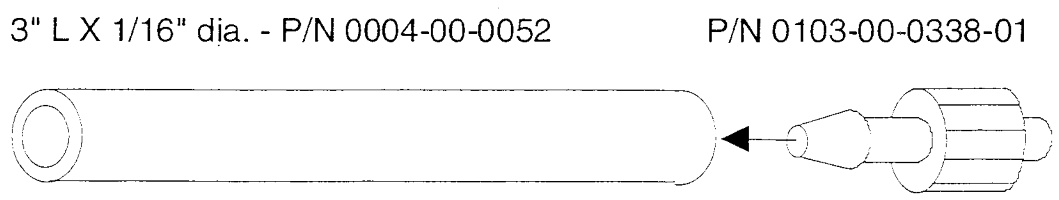
Special Items Required:

- Non-wired 1/4" stereo phone plug (P/N 0134-00-0016)
- 45.75 cc calibration chamber (P/N 0683-00-0314)
- 60 cc syringe (P/N 0103-00-0026)
- Luer plug (P/N 0103-00-0211)
- Helium cylinder
- Catheter extender (P/N 0684-00-0182)
- 40 cc Datascope balloon

• Atmospheric transducer tubing adapter (P/N 0008-04-0002, 0103-00-0338-02)



• Drive transducer tubing adapter (P/N 0004-00-0052, 0103-00-0338-01)



4.5 TROUBLESHOOTING CODE NUMBERS

The following table contains 68020 Monitor CPU (Main PCB) error codes. These codes are output to the recorder for display.

Code #	Description
1	Power up Watchdog test failed.
2	68020 CPU not functioning correctly.
3	Boot checksum incorrect.
4	Power up RAM test failed.
5	68020 code transfer to DRAM did not verify correctly.
6	Interrupt fault. 68020 exception condition during boot up.

The following table contains the 6809 IABP CPU (Main PCB) error codes. These codes are displayed on the monitor in the alarm section.

Code #	Description	Code #	Description
21	ROM checksum test	38	Prolonged inflation test failure
22	System RAM address	39	Comm. HC11 failed to interrupt 6809 and / or 68020 CPUs.
23	RAM walking ones	40	IABP (6809) Datasette not compatible with 68020 Datasette
24	RAM pattern test	41	Monitor (68020) Datasette not compatible with 6809 Datasette
25	UART comm. loop back test	42	IABP (6809) Datasette not compatible with Front End HC11
26	NMI test	43	IABP (6809) Datasette not compatible with Comm. HC11
27	Watch-dog test	44	IABP (6809) Datasette not compatible with Monitor/Keypad HC11
28	Start up test failure	46	Monitor (68020) Datasette not compatible with Front End HC11
29	IABP/Comm HC11 software flip-flop error at power up	47	Monitor (68020) Datasette not compatible with Comm. HC11
30	Service Diagnostics ROM Failure	48	Monitor (68020) Datasette not compatible with Monitor/Keypad HC11
31	Not used	50	Motor speed out of specification.
32	Power-up RAM Test Failure	51	Adjusted motor speed out of specification
33	NMI detected during power up	52	Drive transducer offset failure
34	No comm. with 68020.	53	Shuttle transducer offset failure
35	No comm. with 6809.	54	ATM transducer calibration failure
36	Software trap detected during power up	55	68020 / 6809 Sync failure entering system configuration mode
37	Soft interrupt during power up	56	Excessive Drive Pressure

The following table contains the Communications CPU (68HC11 Main PCB) and the Front End board CPU error codes. These codes are displayed on the monitor.

Code #	Description	Code #	Description
61	Comm HC11 ROM test	92	Front End HC11 RAM address
62	Comm HC11 RAM address	93	Front End HC11 RAM walking ones test
63	Comm HC11 RAM walking ones test	94	Front End HC11 RAM pattern test
64	Comm HC11 RAM pattern test	98	Front End HC11 watch-dog test
65	Comm HC11 shared RAM address	117	Front End A/D reference failure at power up
66	Comm HC11 shared RAM walking ones test	118	Front End HC11 can not communicate with Main HC11
67	Comm HC11 shared RAM pattern test	119	Front End CPU failure
68	Comm HC11 watch-dog test	120	Monitor/Keypad CPU failure
69	Comm HC11 power up RAM test	122	Keypad did not respond to poll
70	Comm HC11 Main failure	>124	Invalid error condition
91	Front End HC11 ROM test		

The following table contains the Monitor/Keypad board CPU (68HC11 Monitor keypad) error codes. These codes are displayed on the Monitor keypad by illuminating an LED pattern.

LED Pattern	Description
Ref. Line / Alarm Mute	Power-up RAM test failure
Alarm Mute	ROM test failure
Aug. Alarm	System RAM address test failure
Aug. Alarm / Alarm Mute	System RAM walking ones test failure
Alarm Volume	System RAM pattern test failure
Ref. Line	Watch-dog test failure

During normal operation an alert message "*Maintenance Required Code #____*" may be displayed. These codes alert the operator that an internal failure may limit system performance and that the system should be serviced as soon as possible. The following table contains the failure codes and the suggested action required to remedy the fault.

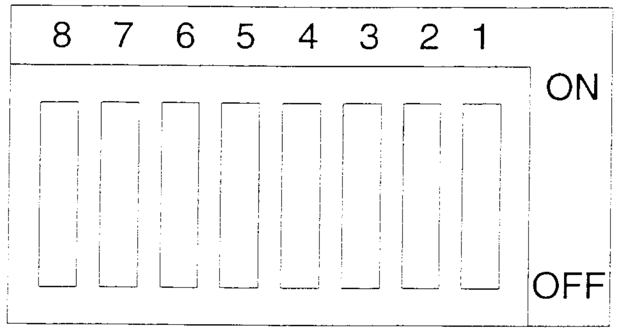
Code #	Description	Remedy
1	Atmospheric transducer offset failure	Calibrate the transducer as per section 7.4.10. If the Transducer can not be calibrated replace the Front End board.
2	Drive transducer offset failure	Calibrate the transducer as per section 7.4.8. If the Transducer can not be calibrated replace the pneumatic drive transducer
3	Balloon transducer offset failure	Calibrate the transducer as per section 7.4.9. If the Transducer can not be calibrated replace the balloon transducer.
4	Compressor over-temperature condition	Check the operation of the Compressor cooling fan (located inside the compressor assembly). Check that air flow is not obstructed and vacuum excessive dust from the compressor.
5	Helium Pressure transducer out of calibration	Calibrate the transducer per section 7.5.6.

4.6 CONFIGURATION DIP SWITCH (S2) Set-up on the Main Board

This DIP switch is used to provide default configuration information for the 68020 processor. The definitions of the bits within this buffer are summarized in the table below:

Bit #	Function
0	Modem type Bit 0
1	Modem type Bit 1
2	Modem type Bit 2
3	Modem type Bit 3
4	Language Bit 0
5	Language Bit 1
6	Language Bit 2
7	Language Bit 3

S2 DIP Switch on the Main Board



Language Option Selections:	S2-8	S2-7	S2-6	S2-5
ENGLISH	OFF	OFF	OFF	OFF
GERMAN	OFF	OFF	OFF	ON
FRENCH	OFF	OFF	ON	OFF
SPANISH	OFF	OFF	ON	ON
JAPANESE	OFF	ON	OFF	OFF
ITALIAN	OFF	ON	OFF	ON
PORTUGUESE	OFF	ON	ON	OFF

4.7 System Configuration

Refer to section 1.3.23 in this manual, for information on the configuration of the following items:

- Language Selection
- Date Format Selection
- Modem Selection
- Display Software Revision
- 50/60 Hertz Filter Selection

4.8 Service Diagnostics

4.8.1 Introduction

Service Diagnostic software is resident within the System 98. It can be accessed at power up by holding the SLOW GAS and the IAB MODE FILL keys on the Monitor keypad. Service Diagnostic software assists in the troubleshooting and performance verification of the System 98, thereby reducing downtime and simplifying maintenance procedures.

The Service Diagnostics allow for the verification and troubleshooting of the following sub-systems:

- Pneumatics
- EL Display
- Keypad / Control Switches
- Recorder
- RS-232 Port & Modem
- Autofill

Additionally, Service Diagnostics provide automated leak and performance tests, an error log, and remote control capability.

4.8.2 User Interface

IABP controls are nonfunctional. All user input is provided through the following keys.

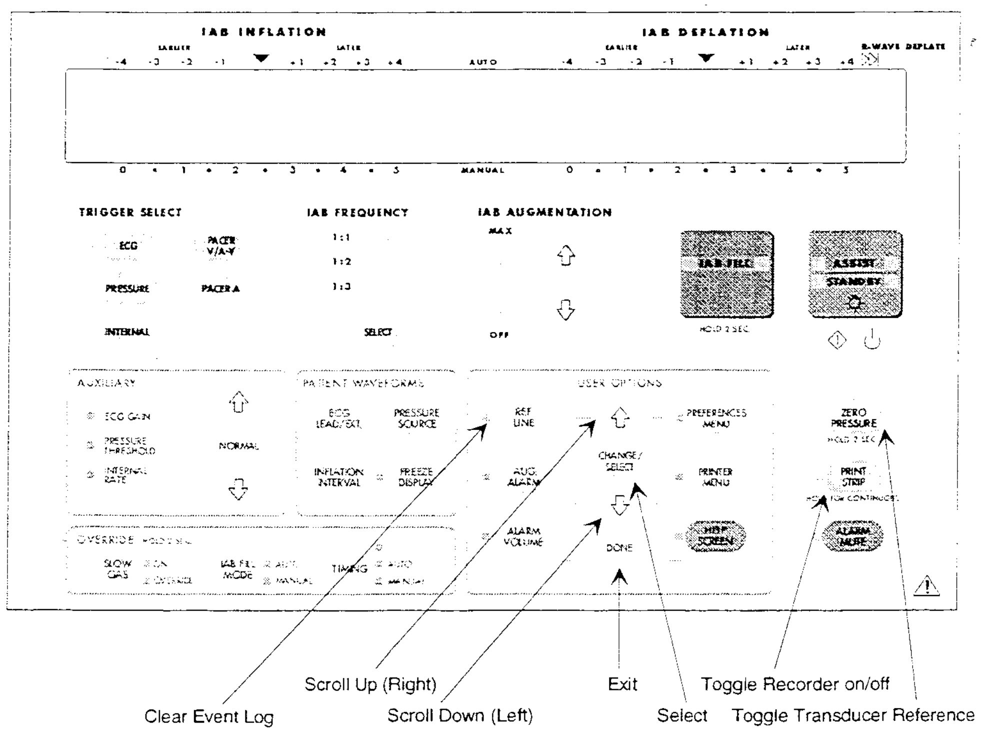


Figure 4-1
User Interface

To enter the Diagnostics press and hold the SLOW GAS and the IAB MODE FILL keys on the Monitor keypad as you power on the System 98. Continue to hold the keys until the following warning screen is displayed.

System 98 - Service Diagnostics

WARNING - Do Not use Service Diagnostics while the system is connected to a patient.
Use of Service Diagnostics while the system is connected to a patient, may subject the patient to injury.
Verify patient is NOT connected to the system and press the 'Preferences Menu' key to proceed.

Figure 4-2

Service Diagnostic Warning

4.8.3 Menu

Pressing the USER OPTIONS UP or DOWN keys highlight each individual test. Pressing the CHANGE/SELECT key will activate the highlighted test.

- Pneumatic System Test
- Display Test
- Keypad/Control Test
- External RS-232 Port Test
- Modem Test
- Recorder Test
- Functional Tests
  - Autofill Test
  - Safety Disk Leak Test
  - K6, K6A, K7, K8 Leak Test
  - Pneumatic Performance Test
  - Autofill Calibration
  - Motor Calibration/Test
  - Helium Tank Calibration
- Diagnostic Support
  - Display Event Logs
    - Fault Journal
    - Last Faults
    - Last Alarms
    - Last Electrical Failures
    - Last Triggers
  - Display Internal Stats
  - Display Software Revision
- Remote Diagnostic Control

Figure 4-3

Service Diagnostic Menu Tree

4.8.4 Main Menu

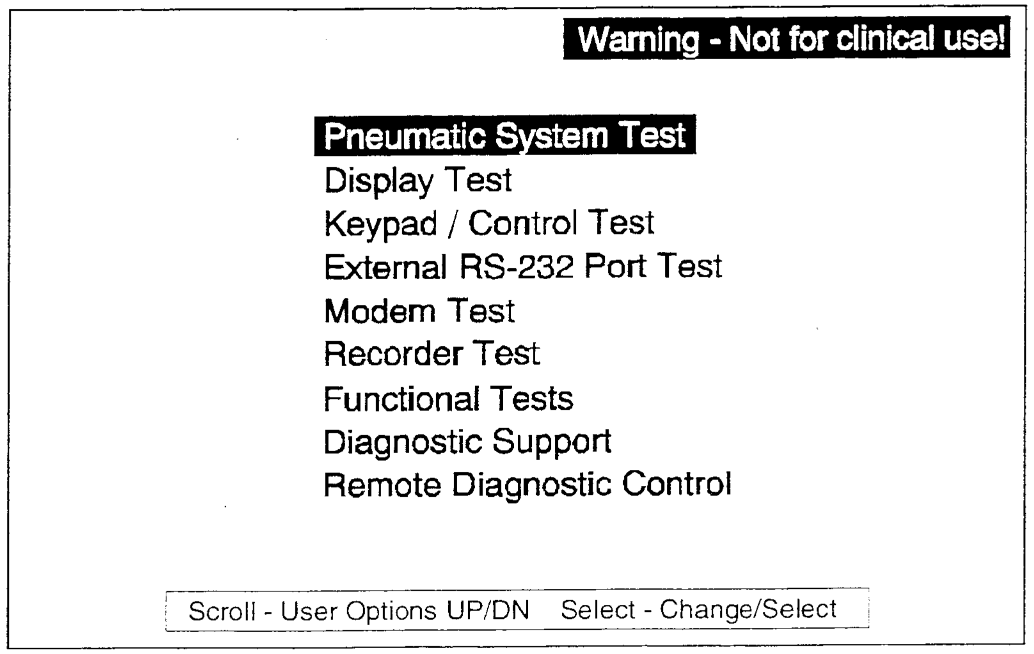


Figure 4-4
Main Menu

After the start-up tests, the main menu (title screen) is displayed. Pressing the USER OPTIONS UP or DOWN keys will highlight each individual selection. Pressing the CHANGE/SELECT key will activate the highlighted selection.

The Main Menu screen will be displayed after exiting any of the individual test selections.

4.8.5 Pnuematic System Test

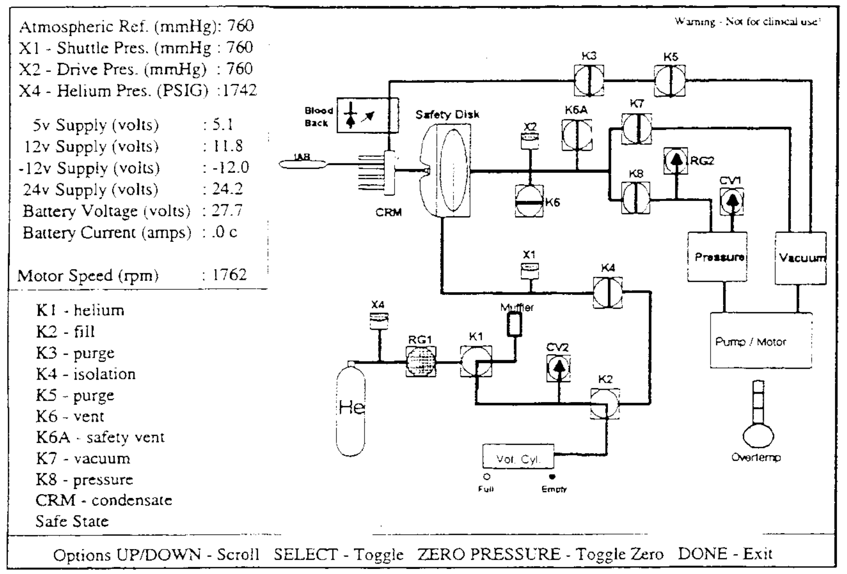


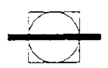
Figure 4-5

Pneumatic System Test Screen

The Pneumatic System Test screen is a schematic representation of the System 98 pneumatics. This test screen can be used to leak test solenoids, verify transducer calibration, regulator outputs, solenoid control lines, and pneumatic switch operation.

Solenoid references (K1 - K8) are displayed on the left hand side of the screen. The USER OPTIONS UP/ DOWN keys on the monitor keypad are used to highlight a particular solenoid. Pressing the CHANGE/SELECT key will then toggle (activate/deactivate) the highlighted solenoid. Any combination of solenoids can be activated. Once a solenoid is activated it's associated reference is displayed in reverse graphics (K1 is shown activated). A continuous line drawn through a solenoid indicates gas can flow through it.

No flow



Flow

NOTE: The software prohibits the user from simultaneously activating more than one of the K6, K7 or K8 solenoids. It also automatically deactivates any of those three if they are left active for more than 5 minutes.

Transducer outputs, power supply voltages, battery voltage, battery current, and motor speed are displayed in the measurement box in the upper left corner of the display. Pressures are displayed in units of millimeters of mercury (mmHg), except for the helium tank pressure (X4) which is displayed in pounds per square inch (PSIG).

When the pneumatic test screen is first entered the atmosphere, shuttle and drive transducer outputs are displayed as absolute values. The transducers can be zeroed (referenced to atmospheric pressure) by pressing the ZERO PRESSURE key.

After start-up and autofilling, the balloon and atmospheric transducers are compared to the drive transducer. The values are then compensated so that the shuttle (balloon) and atmospheric transducers values equal the drive transducer at atmospheric pressure. The offset difference from the drive transducer is displayed in brackets ( ) next to the shuttle and atmospheric pressure readings.

The numbers in brackets ( ) next to the helium pressure indicates the helium pressure offset. If the calibration is out of specification (xx) will be displayed. This would also cause a "Maintenance Required Code 5" to be displayed during the normal operating mode of the IABP.

The transducer outputs can be converted to other pressure units using the following conversions:

____ mmHg (0.0394) = inHg	____ inHg (25.4) = mmHg
____ mmHg (0.0193) = PSI	____ PSI (51.7) = mmHg
____ mmHg (0.00132) = Atm	____ Atm (760) = mmHg

The battery current reading is followed by "c" for charging or "d" for discharging. It is normal for the current to read ".0c" when the battery is in trickle charge mode.

Refer to next page for Component Descriptions.

COMPONENT DESCRIPTION / SERVICE DIAG PNEUMATIC SCREEN	
Designation	Description
K1	3 way solenoid valve that either supplies helium or vents to atmosphere the normally open port of K2.
K2	3 way solenoid valve that connects the volume cylinder to either the helium source (inactive) or to the Safety Disk via K4 (active).
K3	2 way normally closed solenoid valve when open allows the fill and IAB circuits to be purged.
K4	2 way normally closed solenoid valve that isolates the Safety Disk/IAB circuit from the rest of the fill system.
K5	2 way normally closed solenoid valve when open allows the fill and IAB circuits to be purged.
K6	2 way normally closed solenoid valve used to vent the Safety Disk (drive side) to atmosphere prior to deflation in order to conserve vacuum. Also vents the Safety Disk during purge.
K6A	2-way normally open solenoid, closed during normal operation.
K7	2 way normally open solenoid valve. When active vacuum is applied to the Safety Disk (drive side).
K8	2 way normally closed solenoid valve. Activation of K8 allows pressurization of the Disk drive, causing the IAB to inflate.
RG1	two stage Helium pressure regulator.
RG2	7.75 PSIG Back Pressure regulator limits the drive pressure by venting excess pressure to atmosphere.
CV2	4.5 PSI relief valve to prevent overpressure in the helium supply.
CV1	9 PSI relief valve used as a failsafe to prevent the drive pressure from exceeding 9 PSI in the event of RG2 failure.
X1	Balloon transducer - used to monitor IAB shuttle gas for purposes of leak detection and auto filling.
X2	Drive gas transducer - used to monitor Safety Disk drive pressure for the purposes of leak detection and drive pressure/vacuum alarms.
X4	Transducer that monitors helium tank pressure.
FULL	Hall effect sensor. When active, the Volume chamber is filled (or in the FULL position) to the preset volume of gas.
EMPTY	Hall effect sensor. When active, the Volume chamber is empty or in the Home position.
MUFFLER	Mufflers used to reduce noise generated by exhaust gases (via RG2, K6) and the pump.
VOLUME CYLINDER	Variable volume chamber, when filled contains the preset volume of Helium gas used to fill the shuttle gas system.
BLOOD BACK	Blood Back Optical Sensor. Part of solenoid driver board.
PRESSURE	Pressure Reservoir
VACUUM	Vacuum Reservoir
DC MOTOR /PUMP	DC motor combined with compressor/aspirator.
FILTER	40 micron filter for the pressure source.
SAFETY DISK	Safety Disk/Condensate Removal Assembly

4.8.6 Display Test

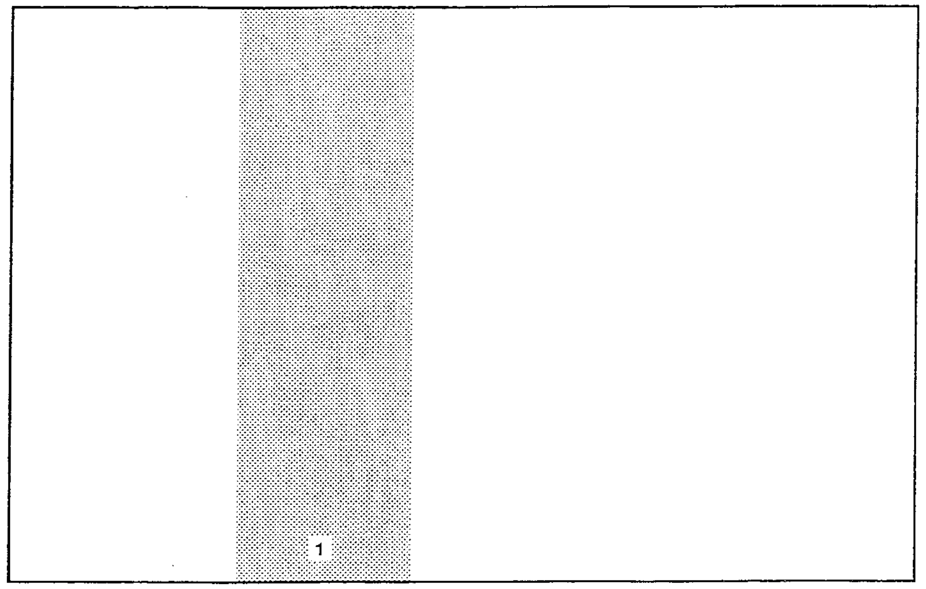


Figure 4-5

Plasma Display Test Screen 1

The display test is used to verify the proper operation of the electroluminescent screen, the Display board and the associated interconnecting cables. The test is made up of three individual checks.

When the display test is first selected, a movable variable intensity vertical bar is displayed. The bar is 130 pixels wide by 400 pixels high and can be swept across the screen from left to right by pressing the USER OPTIONS UP/DOWN keys. The bar is annotated with it's intensity level (annotation is in reverse video) near the bottom of the bar. The intensity level can be changed by pressing the CHANGE/SELECT key. The range of intensity is from 0 (dimest) to 3 (brightest). The bar defaults to intensity level 1. This check is helpful for identifying open pixels or dim areas on the screen.

Press the REF LINE key to test the Base Screen Memory. In this test the screen is painted from the top to the bottom of the display. At the conclusion of the test the message "Base Screen Memory OK" is displayed. Pressing the DONE key during the memory test causes an abort message to appear followed by a return to the single bar display. If an error occurs during the test, a message is displayed identifying the location of the error.

Press the REF LINE key again to test the Window Screen Memory. In this test the screen is painted from the top to the bottom of the display. At the conclusion of the test the message "Window Screen Memory OK" is displayed. Pressing the DONE key during the memory test causes an abort message to appear followed by a return to the single bar display. If an error occurs during the test, a message is displayed identifying the location of the error.

Press the DONE key to return to the main screen.

4.8.7 Keypad / Control Test

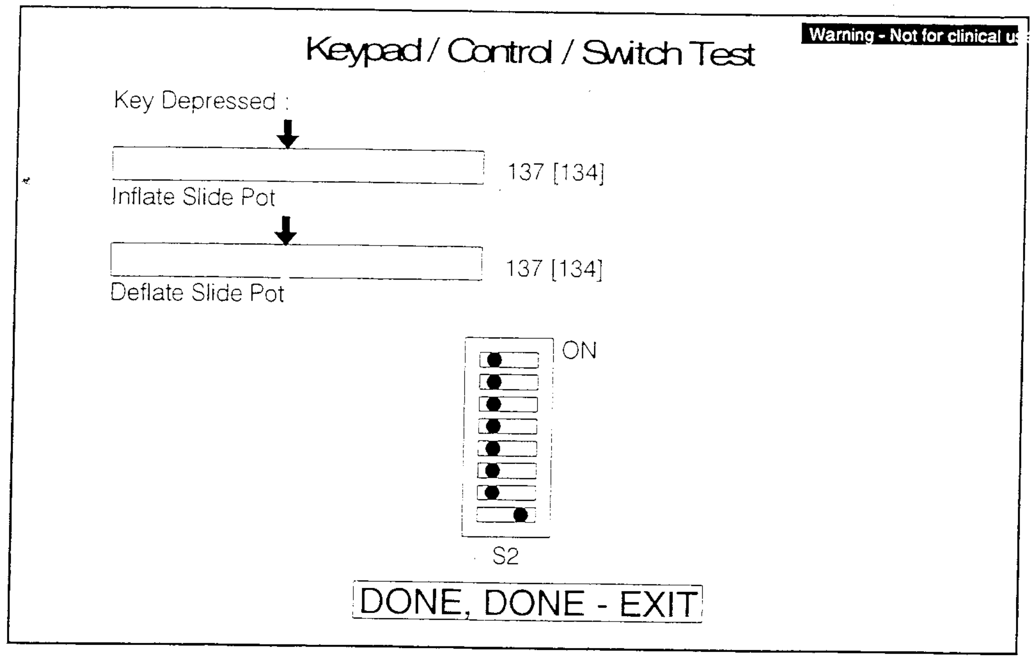


Figure 4-6

Keypad/Control Test Screen

The Keypad / Control Test is provided to verify the operation of all front panel switches and potentiometers.

All keys are identified and displayed in the area labeled key depressed.

Keypad LEDs are lit when their corresponding keys are pressed. If multiple LEDs are associated with a key, such as the augmentation bar, all its LEDs will light simultaneously.

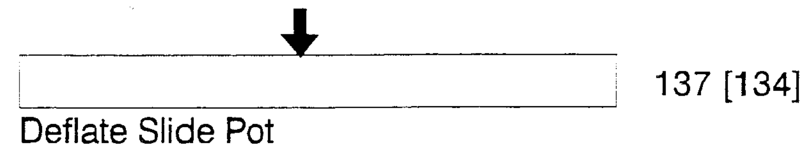
Potentiometer data is displayed as a linear bar (array) of 255 elements for each of the pots. Each element represents a distinct voltage value as read by the analog to digital converter on the Monitor Keypad Controller board.

S2 is the eight position dip switch located on the Main board. This switch is used to configure System 98 default options.

To test the potentiometers, slide the controls to minimum. Very slowly slide the control from minimum to maximum. To obtain valid test results, it will be necessary to move the control back and forth until the entire bar is illuminated. Moving the control too quickly could result in a false failure indication. Each element of the array is displayed as a line which is two pixels wide and 18 pixels high. A properly functioning potentiometer will display a solid bar i.e., all the elements are lighted.

Figure 4-7

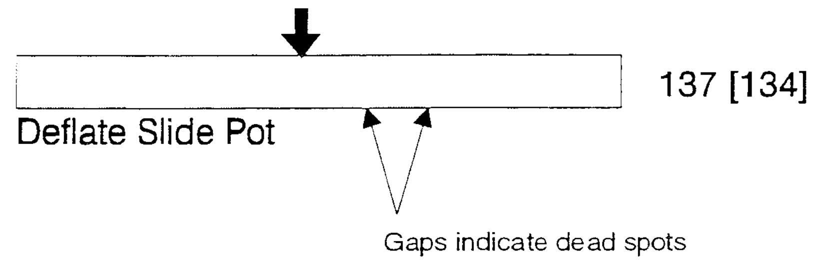
Properly Functioning Potentiometer



If a pot is traversed from minimum to maximum and a solid bar is not displayed (elements of the bar are missing), a dead spot in the control is indicated.

Figure 4-8

Potentiometer with Dead Spots



Press DONE twice to return to main menu.

4.8.8 External RS-232 Port Test

Warning - Not for clinical use!

External RS-232 Port Test

Instructions : Connect pin 2 to 3 on external RS-232 connector. Press SELECT key.

Transmitted Characters :
THE QUICK BROWN FOX JUMPED OVER THE LAZY DOGS BACK

Received Characters :
THE QUICK BROWN FOX JUMPED OVER THE LAZY DOGS BACK

Status : TEST PASSED

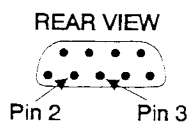
CHANGE/SELECT - START TEST DONE - EXIT

Figure 4-9

RS-232 Test Screen

The purpose of this test is to verify the integrity of the RS-232 channel. The user will be instructed to jumper the transmit and receive pins together on the rear panel RS-232 connector. This action will allow the serial communication channels to transmit data and receive back the data that is sent.

1. Use bus wire to jump pins 2 and 3 (transmit and receive lines) of the rear panel RS-232 connector together.



2. Press the CHANGE/SELECT key to run the test. Transmitted characters are compared to received characters until the entire test string "THE QUICK BROWN FOX JUMPED OVER THE LAZY DOGS BACK" has been sent.
3. The status line will indicate if the test passes. If the data is received incorrectly or data is missing the test will fail and display "Incorrect or no characters received". The test will also fail if the transmit and receive are not jumped together.
4. Press the DONE key to exit the test.

4.8.9 Modem Setup / Test

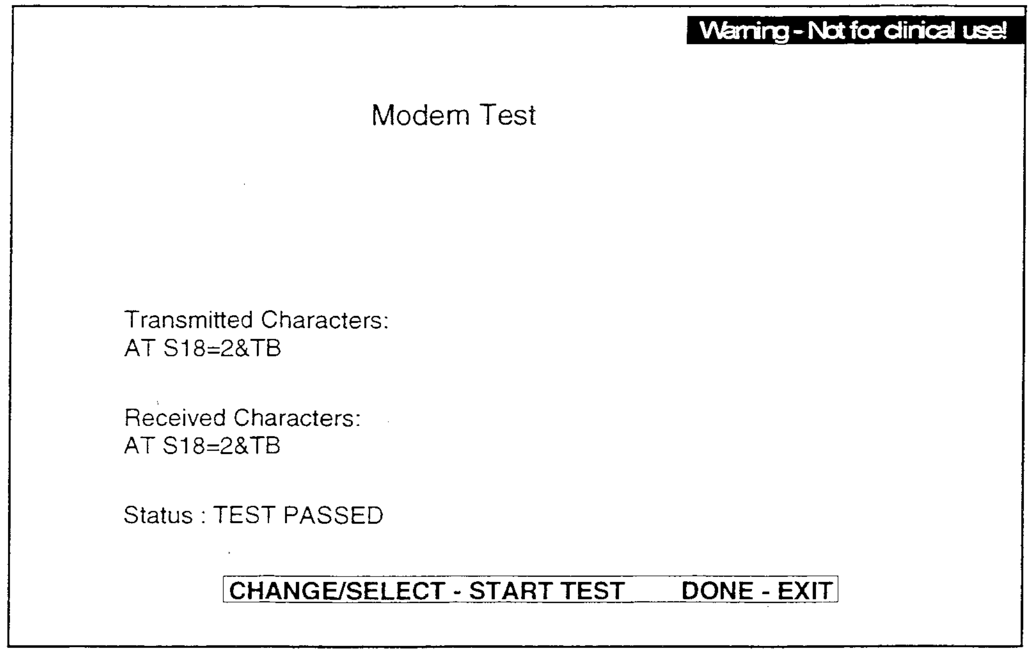


Figure 4-10
Modem Test Screen

The service diagnostic Modem Test is designed to:

Check the integrity of the internal modem by using the modem's built-in diagnostic test. The test will report the number of errors detected (3 digit number above status) and pass/fail status.

The modem setup is done via the system configuration mode. See Section 1.3.23 for more details.

Press DONE to exit the test.

4.8.10 Recorder Test

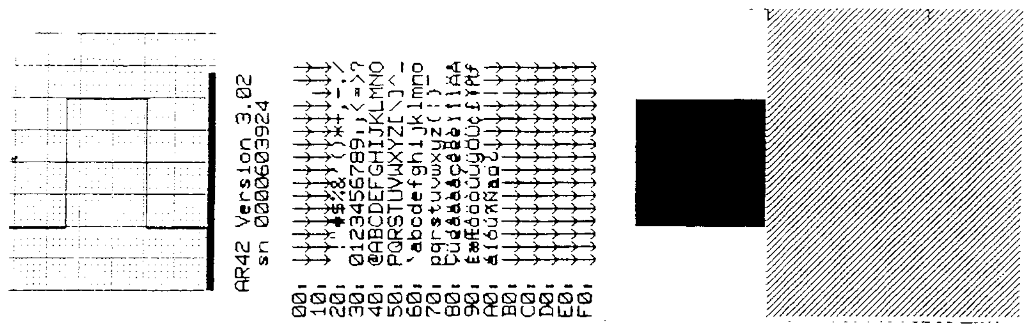


Figure 4-11
Recorder Test Strip

The recorder test is designed to verify the functionality of the System recorder. The service diagnostic software is designed to send data to the recorder that will verify its ability to print waveforms, grids, and ASCII characters. A chart speed of 25 mm/sec is used. A centimeter ruler is required for this test. Select the Recorder Test from the Main Menu by pressing the CHANGE/SELECT key. The recorder will automatically run and the following tests will be performed:

1. 5 mm grid is printed with 1 mm subdivisions. Measure the span of 10 grids and verify it is equal to 5 cm.
2. Verify the 60 BPM square wave is 2 cm peak to peak.
3. A solid bar is printed, examine the bar and insure that all the pixels are operating.
4. Verify the character set is printed as shown above.

4.8.11 Functional Tests

The functional test screen is a sub-menu made up of 7 individual automated tests:

1 - Autofill Test
2 - Safety Disk Leak Test
3 - K6,K6A,K7,K8 Leak Test
4 - Pneumatic Performance Test
5 - Autofill Calibration
6 - Motor Calibration / Test
7 - Helium Tank Calibration

Press the USER OPTIONS UP/DOWN keys to highlight each individual test.

Press the CHANGE/SELECT key to activate the highlighted selection.

Press the DONE key to exit the functional tests and return to the title screen.

Press the PRINT STRIP key to toggle the recorder on and off.

4.8.11.1 Autofill Test

The Autofill Test is designed to perform a standard autofill while providing status information to the user. This test requires that a Datascope catheter extender P/N 0684-00-0182 and a 40 cc IAB are attached to the Safety Disk.

1. Insure there is adequate helium pressure by verifying that X4 (Helium Pressure) displays a value greater than 150 (PSIG).
2. Attach the six foot catheter extender and 40 cc balloon to the Safety Disk.
3. Press the CHANGE/SELECT key to initiate an autofill. The Autofill Data box will display a test status message which indicates the stage of the autofill process. If an autofill failure occurs, a status message is posted describing the failure.

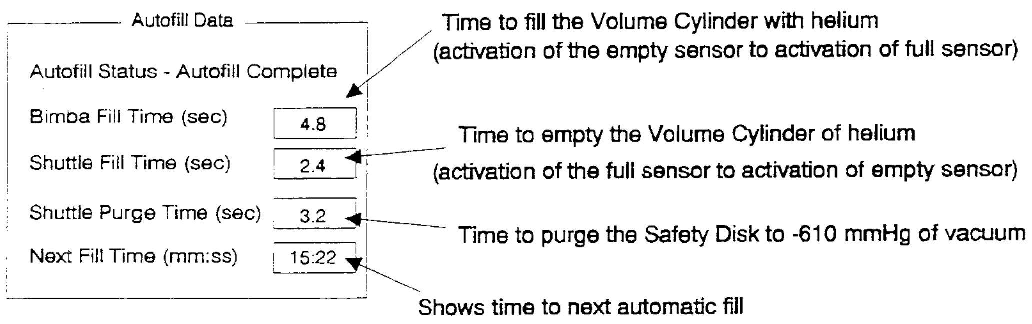


Figure 4-12
Autofill Status Box

4. The Autofill status box displays the Bimba fill time. Verify that this time is between 3 and 6 seconds. A faster fill time could indicate an over-pressure condition of the 2 PSI regulator. Slower fill times could indicate possible leaks or flow restrictions in the fill gas path. Verify that the Shuttle Fill time is 3 seconds maximum. A greater period indicates leaks or a flow restriction in the shuttle gas path. Shuttle purge time should be less than 9 seconds.
5. After filling, the Safety Disk and IAB are cycled at 150 BPM. The test will automatically repeat itself every 30 minutes if left idle. The "Next Fill Time" area displays the time remaining until the next autofill. This feature is useful in trying to isolate intermittent autofill problems. If a failure occurs, the timer is suspended and the failure status message is posted. Pressing the CHANGE/SELECT key at any time during the waiting period will cause a new Autofill and reset the "Next Fill Time" to 30 minutes.
6. Press the ZERO PRESSURE key to display pressure readings referenced to atmosphere pressure.
7. Press the DONE key to exit the Autofill Test and return to the Functional tests screen.

4.8.11.2 Safety Disk Leak Test

This test is functionally equivalent to the leak test that is included in the System 98 operating software. The primary differences are, the ability to halt a test in progress by pressing the DONE key, and the display of test status messages and elapsed time. Three separate leak tests are performed. First K3 is activated thereby pnuematically removing it from the circuit. The system checks for a vacuum leak, which could be caused by a hole in the safety disk membrane or a leak through the K5 solenoid. After two minutes K3 is de-activated (closing the valve) and K5 is activated (pnuematically removing it from the circuit). The system again checks for vacuum leaks which could be caused by a hole in the safety disk membrane or a leak through the K3 solenoid. After two minutes K5 is de-activated (closing the valve) and K8 is activated causing the safety disk to pressurize. The third test will now begin.

During the test, status messages will inform the user when tests are completed. At the conclusion of each test the pressure change is posted. A change greater than ±4 mmHg for any of the tests indicates there is a leak in the system. A luer plug P/N 0103-00-0211 is required for this test.

1. Select "Functional Tests" from Main Menu and select Safety Disk Leak Test.
2. Start with the IAB catheter port of the Safety Disk unplugged. Press the CHANGE/SELECT key to start the test. Wait for a tone to sound and the instruction "Plug Safety Disk". Immediately seal the IAB catheter port using the luer plug. If the test is started with the IAB port already plugged, the instruction "Unplug Safety Disk" is displayed. Unplug the port and wait for the "Plug Safety Disk" instruction. The test will take approximately 6.5 minutes to complete.
3. Press the DONE key to return to the Functional Tests screen.

4.8.11.3 K6, K6A, K7, K8 Leak Test

This test checks for leaks in the drive section of the System 98 pneumatics. The drive section is first vented to atmosphere and held for 60 seconds, then pressurized to approximately 8 PSI and held for 60 seconds and then evacuated and held for 60 seconds. X2, the drive transducer is read to determine the pressure during these periods. The pneumatic schematic is displayed on screen along with the measurement box and a test status box. The test status box contains the current status of the test, pressure difference from start to end of test and the elapsed time (in seconds).

1. From the Functional Test Menu SELECT K6, K6A, K7, K8 Leak Test.

2. Start with the IAB catheter port of the Safety Disk unplugged. Press the CHANGE/SELECT key to start the test. Wait for a tone to sound and the instruction "Plug Safety Disk". Seal the IAB catheter port using the luer plug. If the test is started with the IAB port already plugged, the instruction "Plug Safety Disk" will not appear and testing will proceed.

3. At the start of the test, K3 & K5 are activated to purge the shuttle side of the Safety Disk below 200 mmHg, and K6 is activated until the drive pneumatics are vented to atmosphere. At which time these solenoids become deactivated and K6A is activated. This portion of the test is 60 seconds and checks for leaks at K7 and K8. After 60 seconds, the Elapsed Time stops and the differential pressure is posted in the Test #1 section.

The second portion of the test activates K8 to pressurize the drive side of the Safety Disk to approximately 8 PSI. This portion of the test is 60 seconds and checks for leaks to atmosphere through K6 or K6A, or a vacuum leak through K7. At 120 seconds on the Elapsed Time, the time stops and the differential pressure is posted in the Test #2 section.

The third portion of the test rapidly toggles K6A and K7 until a partial vacuum is achieved. This portion of the test is 60 seconds and checks for leaks to atmosphere through K6 or K6A, or a pressure leak through K8. At 180 seconds on the Elapsed Time, the time stops and the differential pressure is posted in the Test #3 section.

TEST	ACCEPTABLE LEVEL
TEST # 1	±45 mmHg
TEST # 2	±65 mmHg
TEST # 3	±20 mmHg

4. Press the DONE key to return to the functional test screen.

4.8.11.4 Pneumatic Performance Test

1. Select Pneumatic Performance Test from the Functional Test menu.

2. Press ZERO PRESSURE key to display pressure readings referenced to atmosphere pressure. Verify the catheter input port of the Safety Disk is open to atmosphere.

3. Press the CHANGE/SELECT key to start the test. The system begins to pump at 150 BPM for 30 seconds.

4. Once the system stops pumping, observe the vacuum recovery time display window. This period should be less than 10 seconds.

5. Verify the average pressure reads between 300 and 413 mmHg. A lower reading may indicate a leak in the pneumatic system, a need to adjust the 8 PSI regulator, a flow restriction in the pressure line (clogged muffler), or the need to rebuild the pump motor. A higher reading indicates a problem with the 8 PSI regulator or the need to adjust it.

6. Verify the average vacuum reads a minimum of 176 mmHg (a lower number indicates more vacuum). A higher reading may indicate a leak in the pneumatic system or the need to rebuild the compressor.

7. Verify the minimum acceptable levels as shown in the following table:

Parameter	Acceptable Level	Remarks
First Inflate Delay (ms)	< 24 msec	Time from inflate command until the diaphragm begins to move.
First Deflate Delay (ms)	< 24 msec	Time from deflate command until the diaphragm begins to move.
Max. Vacuum (mmHg)	≤ -200 mmHg	Max. peak vacuum
Avg. Vacuum (mmHg)	≤ -176 mmHg	Average vacuum
Max. Pressure (mmHg)	≤ 436 mmHg	Max. peak pressure
Avg. Pressure (mmHg)	300 to 413 mmHg	Average Pressure
Inflate Transition (ms)	< 36 msec *	Time to exceed 75% of peak pressure
Deflate Transition (ms)	< 36 msec *	Time to exceed 75% of peak vacuum
Recovery Time (secs)	< 10 sec	Time to reach 150 mmHg

* For adult safety disks with serial numbers below 15000 this time is less than 44 msec.

8. Press the DONE key twice to return to the Main Menu.

9. Exit Service Diagnostics by switching the ON/OFF switch to OFF.

4.8.11.5 Autofill Calibration

This test simplifies the autofill calibration process. The routine is identical to the Autofill Test (section 4.8.11.1) except that after filling the Safety Disk with helium it is left in a pressurized state by activating the K8 (pressure) solenoid. See section 7 for the complete calibration procedure using this test.

4.8.11.6 Motor Calibration / Test

This test verifies the integrity of the motor speed circuitry on the Main board, the Motor Controller board, the DC motor and the associated cables and connectors. The test is separated into four parts.

Attempt to set the motor speed to 1600 RPM by applying 8 volts to the Motor Controller board.

Verify the actual speed is within 20 percent of 1600 RPM.

Re-adjust the motor speed by calculating the necessary scale factor based on the actual speed.

Verify that the adjusted speed is within 3 percent of 1760 RPM.

Results can be printed to the recorder by pressing the PRINT STRIP key.

4.8.11.7 Helium Tank Calibration

This test calibrates the helium pressure circuit.

Close the helium tank valve and remove the helium tank from the pump.

Press CHANGE/SELECT to start the text. The helium offset is displayed. If the offset is too large an "Out of Specification" is displayed. If the offset is within the limits a "Within Specification" is displayed.

4.9 DIAGNOSTIC SUPPORT

The Diagnostic Support menu contains the following sub menus:

Display Event Logs
Display Internal Statistics
Display Software Revision

4.9.1 Display Event Logs

From the main menu select DIAGNOSTIC SUPPORT. From the sub menu select DISPLAY EVENT LOGS.

The System 98 maintains an event log in non-volatile RAM located on the Main board. The display shows the fault number and the number of times the fault has occurred. Pressing the PRINT STRIP key will print the fault log on the recorder.

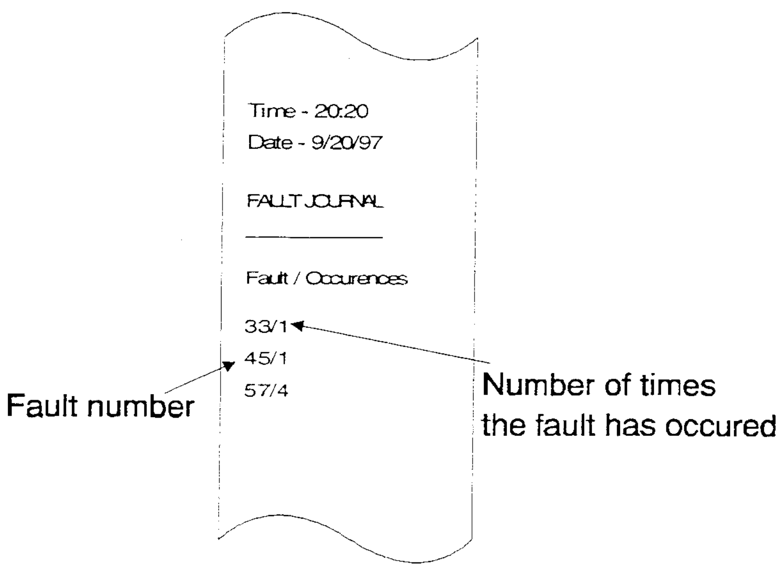


Figure 4-13

Fault Log Recorder Strip

Press the CHANGE/SELECT key to display the time and date of the last 20 faults, as well as more detailed information on Autofill failures. Press the PRINT STRIP key to print the last 20 failures to the recorder.

This screen allows the internal statistics to be cleared by pressing the REF. LINE key twice. This should only be done if the non-volatile Ram has been corrupted or the Main board has been replaced.

The following is a list of Main Board fault codes.

Fault Index	Description	System Response
01	RTOS and virtual device manager faults	fault is logged
02	Main board faults	fault is logged
03	VRTX error return faults	fault is logged
04	Display interface fault	fault is logged

Fault Index	Description	System Response
05	ACRTC driver fault	fault is logged
06	ACRTC controller fault	fault is logged
07	Communications faults	fault is logged
08	In-process BIT checksum fault	68020 resets
09	In-process BIT half way stack probe fault	fault is logged
10	In-process BIT 80% stack probe fault	68020 resets
11	In-process BIT A/D reference voltage fault	fault is logged
12	In-process BIT A/D interrupt frequency fault	fault is logged
13	In-process BIT timer manager interrupt freq. fault	fault is logged
14	In-process BIT VRTX timer interrupt freq. fault	fault is logged
15	Real-time clock ISR fault	68020 resets
16	68020 CPU test fault	68020 resets
17	Display controller test fault	fault is logged
18	A/D reference test fault	fault is logged
19	Recorder test fault	fault is logged
20	Comm fault	fault is logged
21	Comm fault	fault is logged
22	Deadman timer real-time clock service routine fault	68020 resets
23	Deadman task not running fault	68020 resets
24	Undefined or invalid 68020 interrupt fault	68020 resets
25	68020 bus error	68020 resets
26	68020 address error	68020 resets
27	68020 illegal instruction	68020 resets
28	68020 privilege violation	68020 resets
29	68020 format error	68020 resets
30	68020 uninitialized device interrupt fault	68020 resets
31	68020 spurious interrupt	68020 resets
32	68020 divide by zero	68020 resets
33	Bad system NVRAM info record fault	fault is logged
35	Trend unit faults	fault is logged
36	68020 keypad unit faults	fault is logged
37	68020 recorder unit faults	fault is logged
38	Modem driver fault	fault is logged
40	68020 memory manager error	68020 resets
41	68020 memory free fault	68020 resets
42	68020 memory allocation fault	68020 resets
45	System failure	System shutdown

The following is a list of IABP (Main board 6809 CPU) fault codes.

Fault Index	Description	System Response
47	IAB stack probe fault	fault is logged
48	Task fault	fault is logged
49	ROM write fault	IAB shutdown - System failure
50	Software interrupt fault	IAB shutdown - System failure
51	Software interrupt fault	IAB shutdown - System failure
52	IAB/COMM flip flop fault	IAB shutdown - System failure
53	Front End fault	IAB shutdown - System failure
54	Prolonged inflation failsafe	IAB shutdown - System failure
55	Monitor keypad fault	IAB shutdown - System failure
56	IAB dead man fault	IAB shutdown - System failure
57	Autofill failure	See Autofill failure codes
58	Bimba fill fault	Vol. Cyl. fill time > than 6 sec. (no failure)
59	Bimba empty fault	Vol. Cyl. empty time > than 6 sec. (no failure)
60	Trigger Data fault	68020 to 6809 trigger data timeout
61	Excess Drive Pressure fault	Drive Pressure > 25 mmHg over ATM in standby

The following is a list of the autofill failure faults. These faults are logged as part of the last 20 faults. When fault 57 (Autofill failure) is displayed, then the second from the last digit, indicates the specific failure mode. If the fault is preceded by the number 8, then the Autofill failure was the result of a blood back detection (ie., 81 O and 8B O).

Fault Index	Failure Description	Remarks
10	Volume cylinder did not home within 10 seconds at the beginning of Autofill.	Atmospheric calibration was necessary at the beginning of the autofill. Calibration was OK.
20	Volume cylinder did not home within 10 seconds at the beginning of Autofill.	Vacuum level checked OK.
30	Low vacuum failure.	Atmospheric calibration was necessary at the beginning of the autofill. Calibration was OK.
40	Software failure. Start of IAB purge failure.	Software did not advance to the next state.
50	Volume cylinder did not move off home within 5 seconds.	No helium pressure, sensor position, volume cylinder stuck.
60	Software failure. Purge IAB delay before opening vent valve failed.	Software did not advance to the next state.
70	Volume cylinder did not fill with helium within 10 seconds.	Low helium pressure, sensor position, volume cylinder stuck.
80	IAB purge failure - Did not reach 24 inHg vacuum within 10 seconds.	Vacuum leak, low compressor output, leak in IAB circuit.
90	Safety Disk fill failure - volume cylinder did not home within 10 seconds.	Wrong size IAB or IAB extender, sensor position, volume cylinder stuck.
A0	Software failure. Atmospheric vent not complete.	Software did not advance to the next state.
B0	Atmospheric calibration failure.	Transducer could not be zeroed at conclusion of Autofill.
C0	Software failure. Atmospheric vent not complete.	Software did not advance to the next state.

Last Alarms

Press the CHANGE/SELECT key again to display the last 20 alarms. This fault log can be cleared by pressing the REF LINE key twice.

Last Alarms	
22/04/98 10:01:58	Autofill Failure-No Helium
21/04/98 10:01:58	Autofill Failure-No Helium
20/04/98 10:01:30	Autofill Failure-No Helium
17/03/98 14:15:20	No Trigger
00/00/00 00:00:00	
00/00/00 00:00:00	
00/00/00 00:00:00	
00/00/00 00:00:00	
00/00/00 00:00:00	
00/00/00 00:00:00	
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00/00/00 00:00:00	
00/00/00 00:00:00	
00/00/00 00:00:00	

REF LINE, REF LINE - Clear Journal   SELECT- Next Log   DONE-Exit

Press PRINT STRIP to Start Recorder

Figure 4-14
Last Alarms Log

Last Electrical Failures

Press the CHANGE/SELECT key again to display the last 20 power up selftest failures. This fault log can be cleared by pressing the REF LINE key twice.

Last Electrical Failures	
22/02/98 10:01:58	Electrical Test Fails Code #119
00/00/00 00:00:00	
00/00/00 00:00:00	
00/00/00 00:00:00	
00/00/00 00:00:00	
00/00/00 00:00:00	
00/00/00 00:00:00	
00/00/00 00:00:00	
00/00/00 00:00:00	
00/00/00 00:00:00	
00/00/00 00:00:00	
00/00/00 00:00:00	
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00/00/00 00:00:00	
00/00/00 00:00:00	
00/00/00 00:00:00	
00/00/00 00:00:00	0 0 0

REF LINE, REF LINE - Clear Journal   SELECT- Next Log   DONE-Exit

Press PRINT STRIP to Start Recorder

Figure 4-15
Last Electrical Failures Log

Last Triggers

Press the CHANGE/SELECT key again to display the last 20 trigger modes. This fault log can be cleared by pressing the REF LINE key twice.

Last Triggers

22/02/97 10:01:58	ECG
21/04/97 12:00:10	PRESSURE
20/04/97 13:00:20	ECG
19/04/97 14:00:30	INTERNAL
00/00/00 00:00:00	
00/00/00 00:00:00	
00/00/00 00:00:00	
00/00/00 00:00:00	
00/00/00 00:00:00	
00/00/00 00:00:00	
00/00/00 00:00:00	
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00/00/00 00:00:00	
00/00/00 00:00:00	
00/00/00 00:00:00	
00/00/00 00:00:00	
00/00/00 00:00:00	

REF LINE, REF LINE - Clear Journal   SELECT- Next Log   DONE-Exit

Press PRINT STRIP to Start Recorder

Figure 4-14

Last Triggers Log

4.9.2 Display Internal Statistics

This screen shows the following system information:

- Pump cycle count (number of times the IAB has been inflated)
- Accumulated assist time (time in hours:minutes that the system has been in ASSIST Mode)
- Battery statistics:
  - Last 3 start of discharge times
  - Last 3 end of discharge times
  - Last 3 full charge or top off times

This screen allows the internal statistics to be cleared by pressing the REF. LINE key twice. This should only be done if the non-volatile Ram has been corrupted or the Main board has been replaced.

4.9.3 Display Software Revision

Display Software Revisions of System 98.

4.10 REMOTE DIAGNOSTIC CONTROL

For Future Use.

5. ASSEMBLY AND SCHEMATIC DIAGRAMS

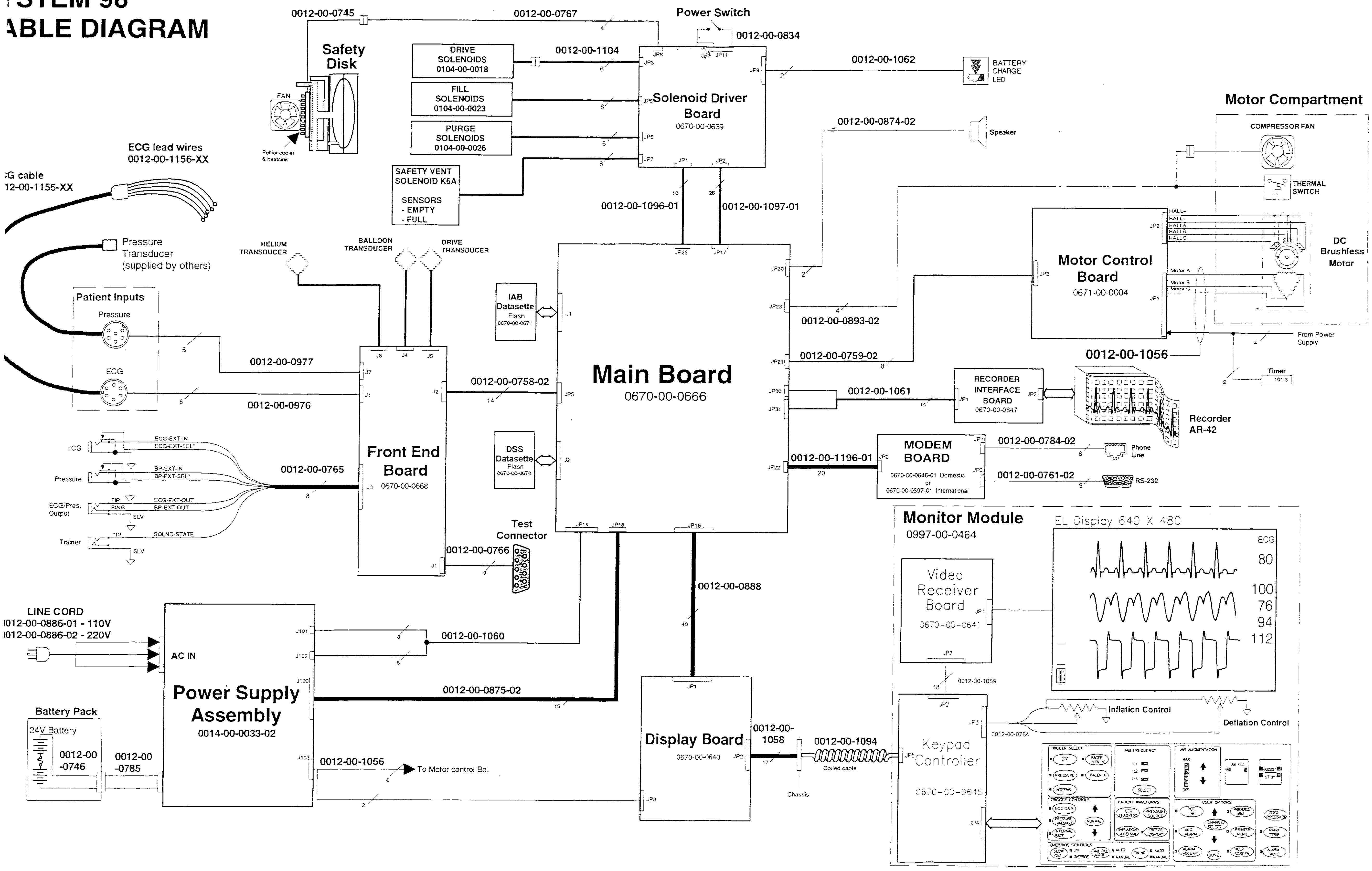
Schematic diagrams and accompanying assembly diagrams of printed circuit boards are provided in this chapter.

The following is a list of the diagrams and the corresponding diagram number (if available) and the page where it can be found.

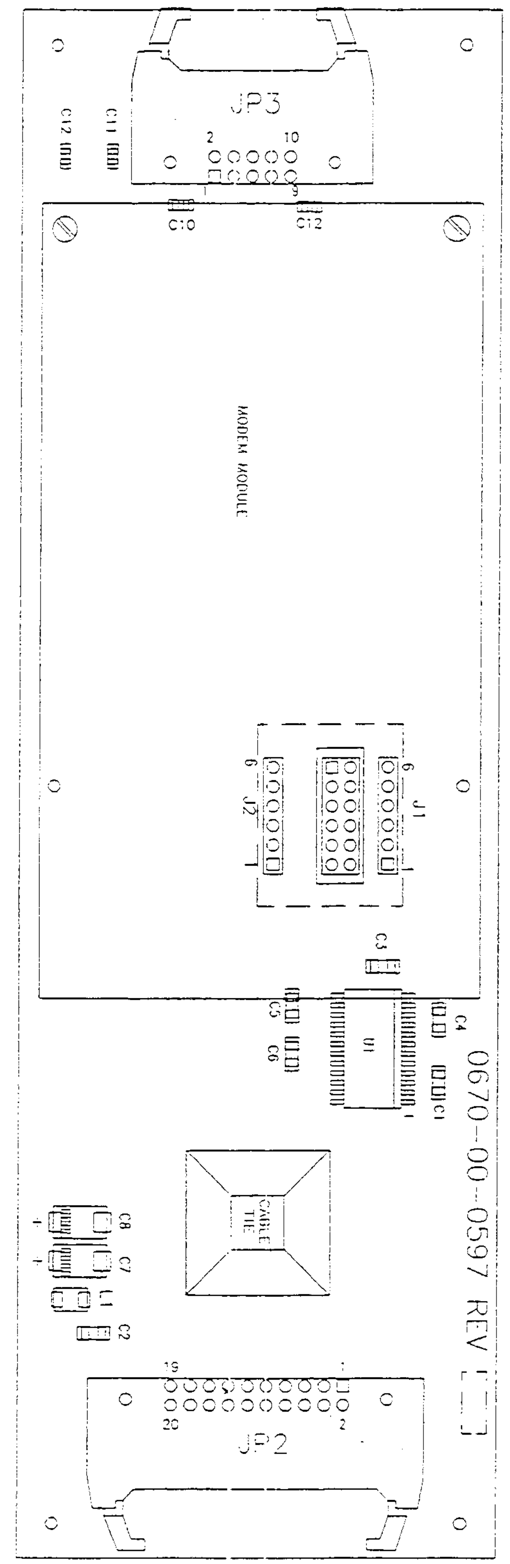
Diagram Name	Diagram Part Number	Page
Cable Interconnect Diagram		5-3
Modem Board Assembly (International)	0670-00-0597	5-4
Modem Board Schematic (International)	0387-00-0597	5-5
Solenoid Driver Board Assembly	0670-00-0639	5-6
Solenoid Driver Board Schematic	0387-00-0639	5-7
Display Controller Board Assembly	0670-00-0640	5-14
Display Controller Board Schematic	0387-00-0640	5-15
Video Receiver Board Assembly	0670-00-0641	5-20
Video Receiver Board Schematic	0387-00-0641	5-21
Keypad Cntrl, Board Assembly	0670-00-0645	5-22
Keypad Cntrl, Board Schematic	0670-00-0645	5-23
Modem Board Assembly (Domestic)	0670-00-0646	5-26
Modem Board Schematic (Domestic)	0387-00-0646	5-27
Recorder Interconnect Board Assembly	0670-00-0647	5-28
Recorder Interconnect Board Schematic	0387-00-0647	5-29
Main Board Assembly	0670-00-0666	5-30
Main Board Schematic	0387-00-0666	5-31
Front End Board Assembly	0670-00-0668	5-40
Front End Board Schematic	0387-00-0668	5-41
Datasette Board, DSS Assembly	0670-00-0670	5-52
Datasette Board, DSS Schematic	0387-00-0670	5-53

Diagram Name	Diagram Part Number	Page
Datasette Board, IABP Assembly	0670-00-0671	5-54
Datasette Board, IABP Schematic	0387-00-0671	5-55
External Monitor Cable Assembly	0012-00-0765	5-56

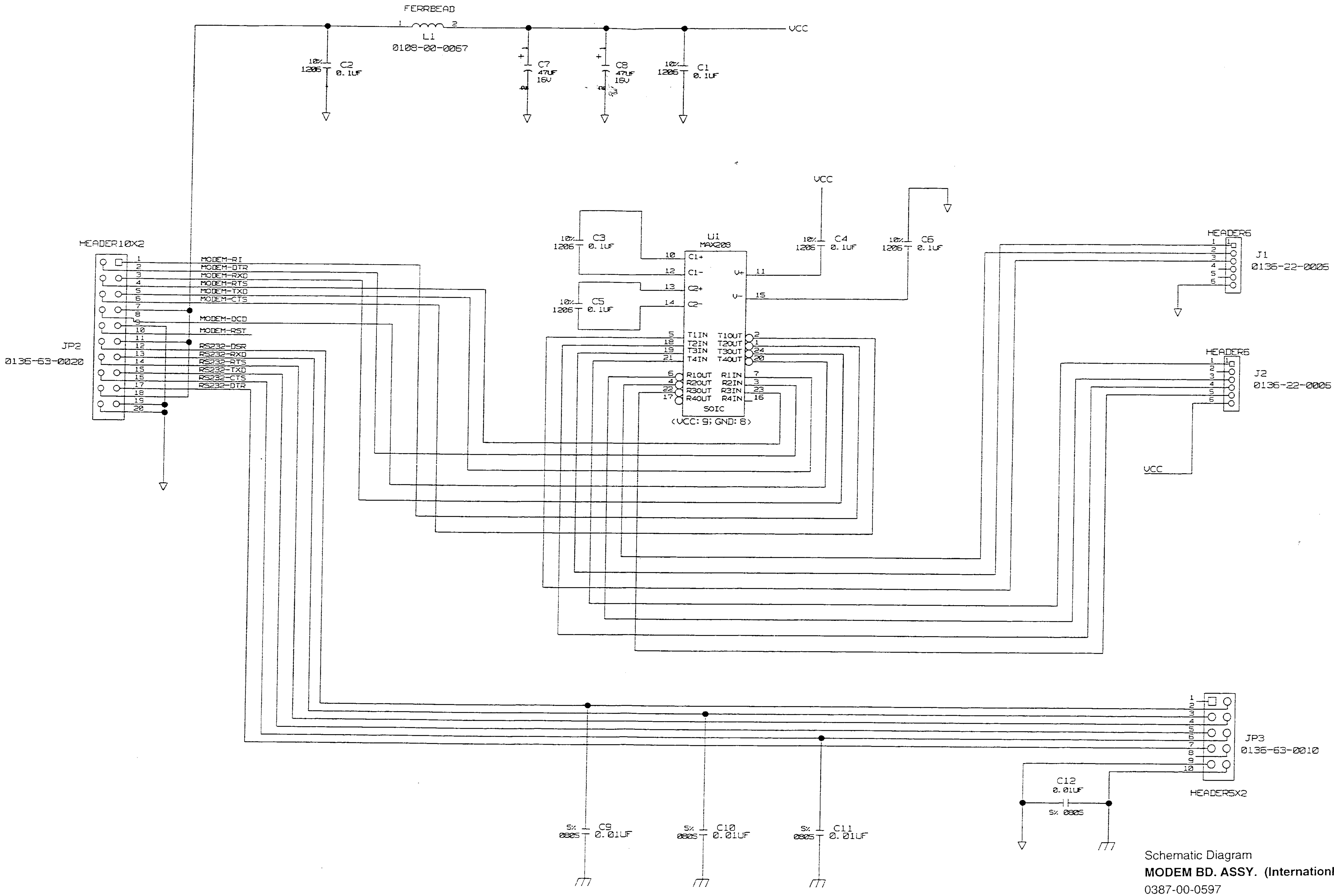
⁄STEM 98
⁄ABLE DIAGRAM



CABLE INTERCONNECT DIAGRAM



MODEM BD. ASSY.
(Internationl)
0670-00-0597



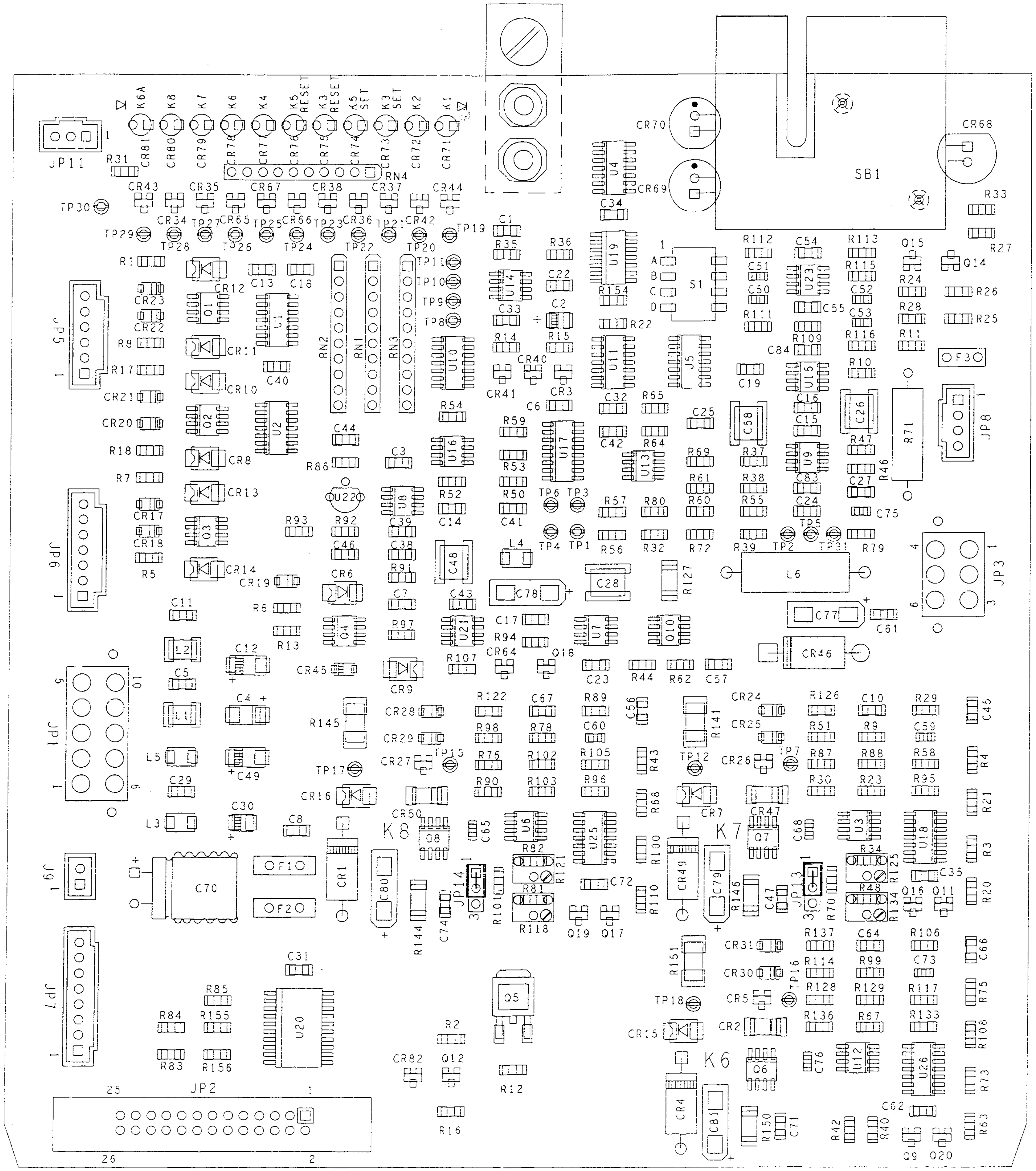
THIS PAD IS AT THE UPPER LEFT MOUNTING HOLE FOR THE PCB.

Schematic Diagram

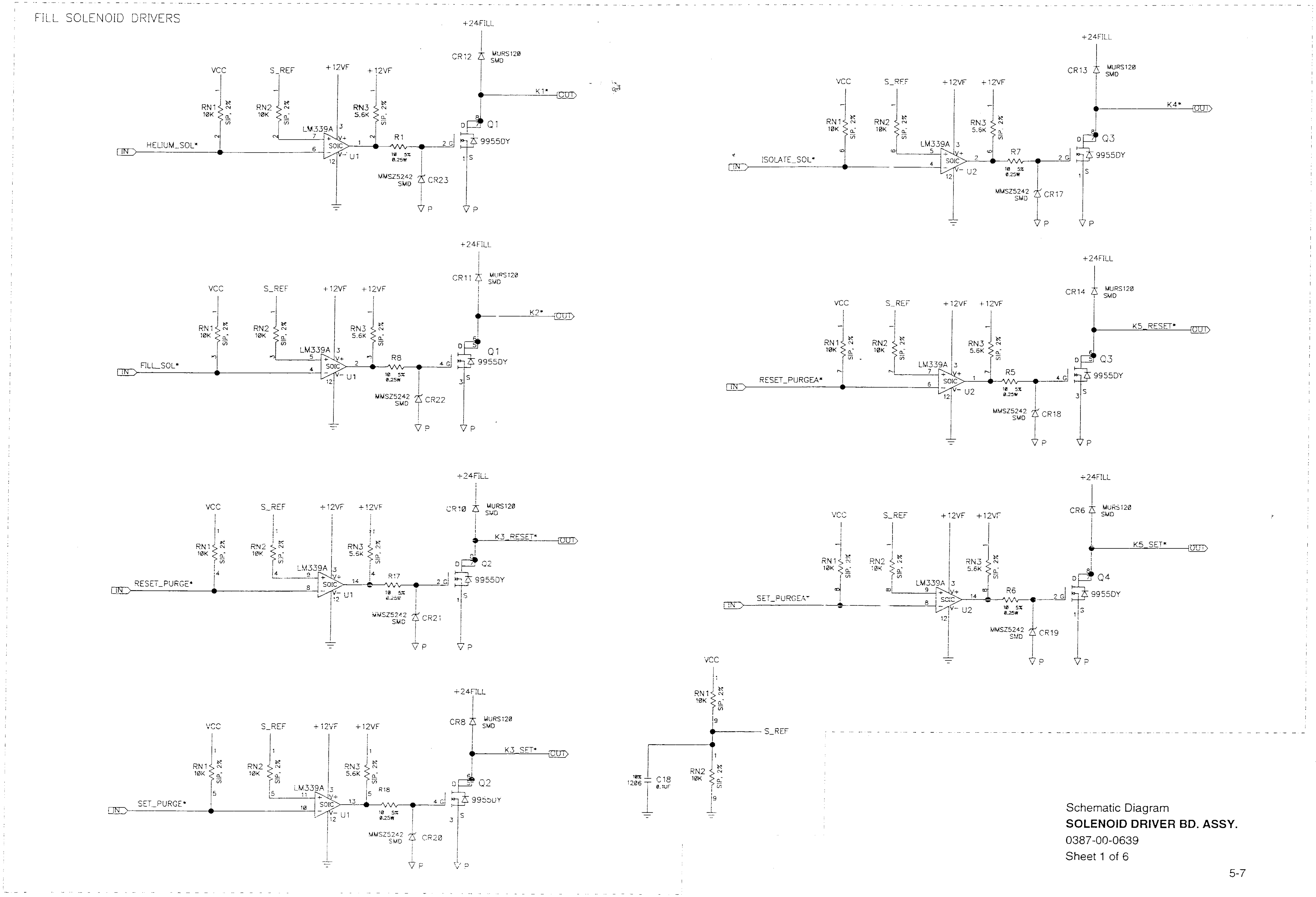
MODEM BD. ASSY. (Internationl)

0387-00-0597

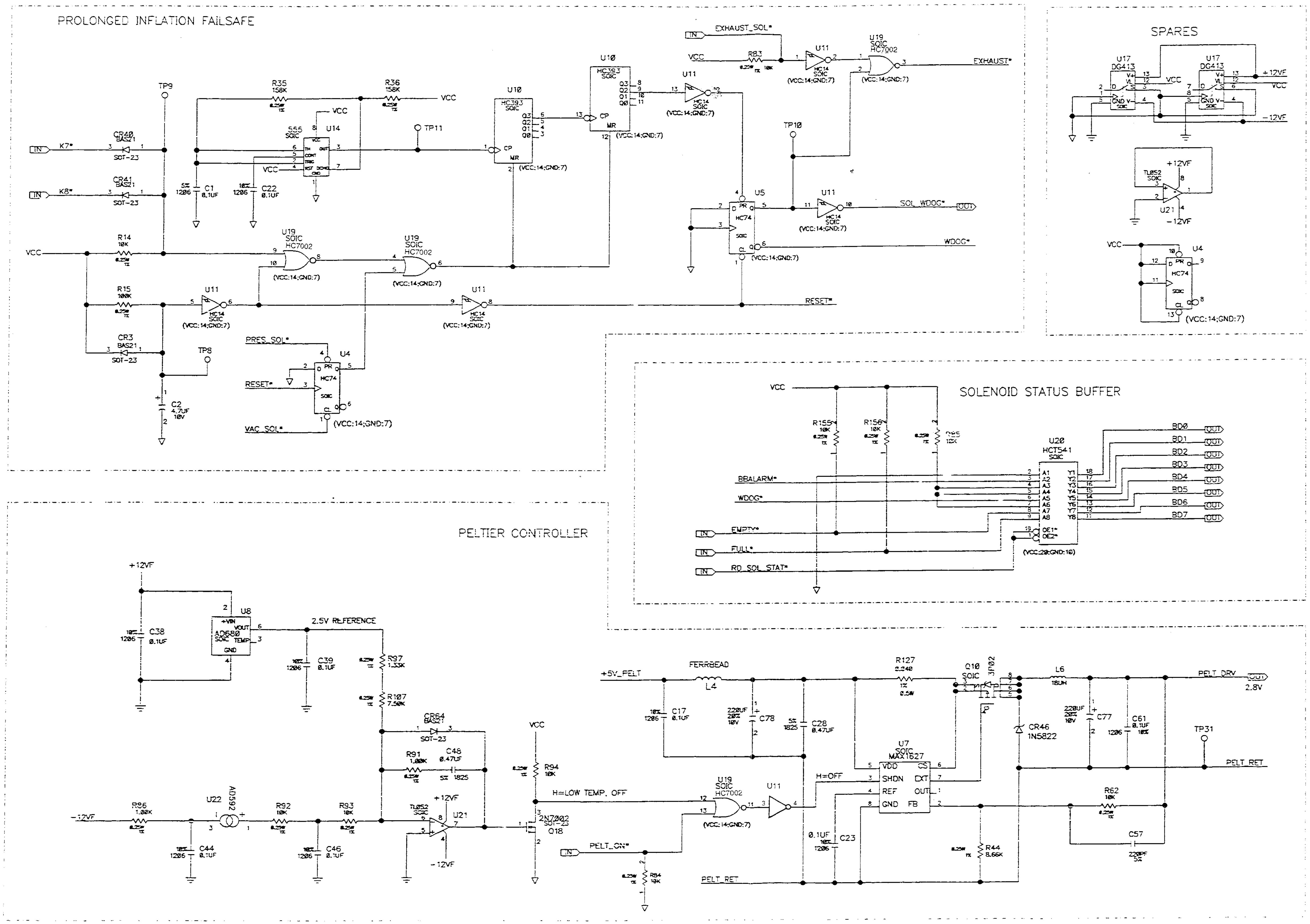
Sheet 1 of 1



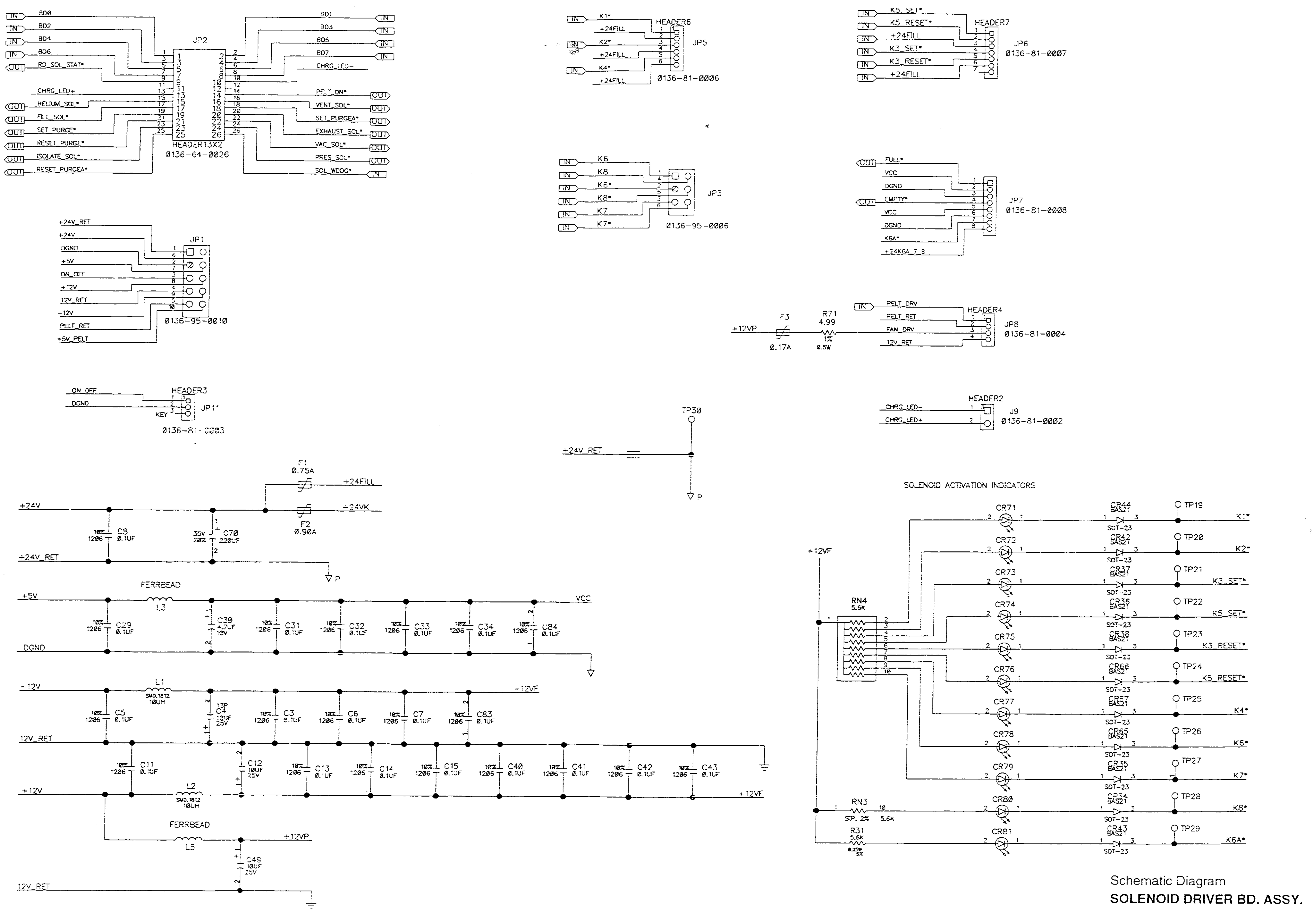
SOLENOID DRIVER BD. ASSY.
0670-00-0639



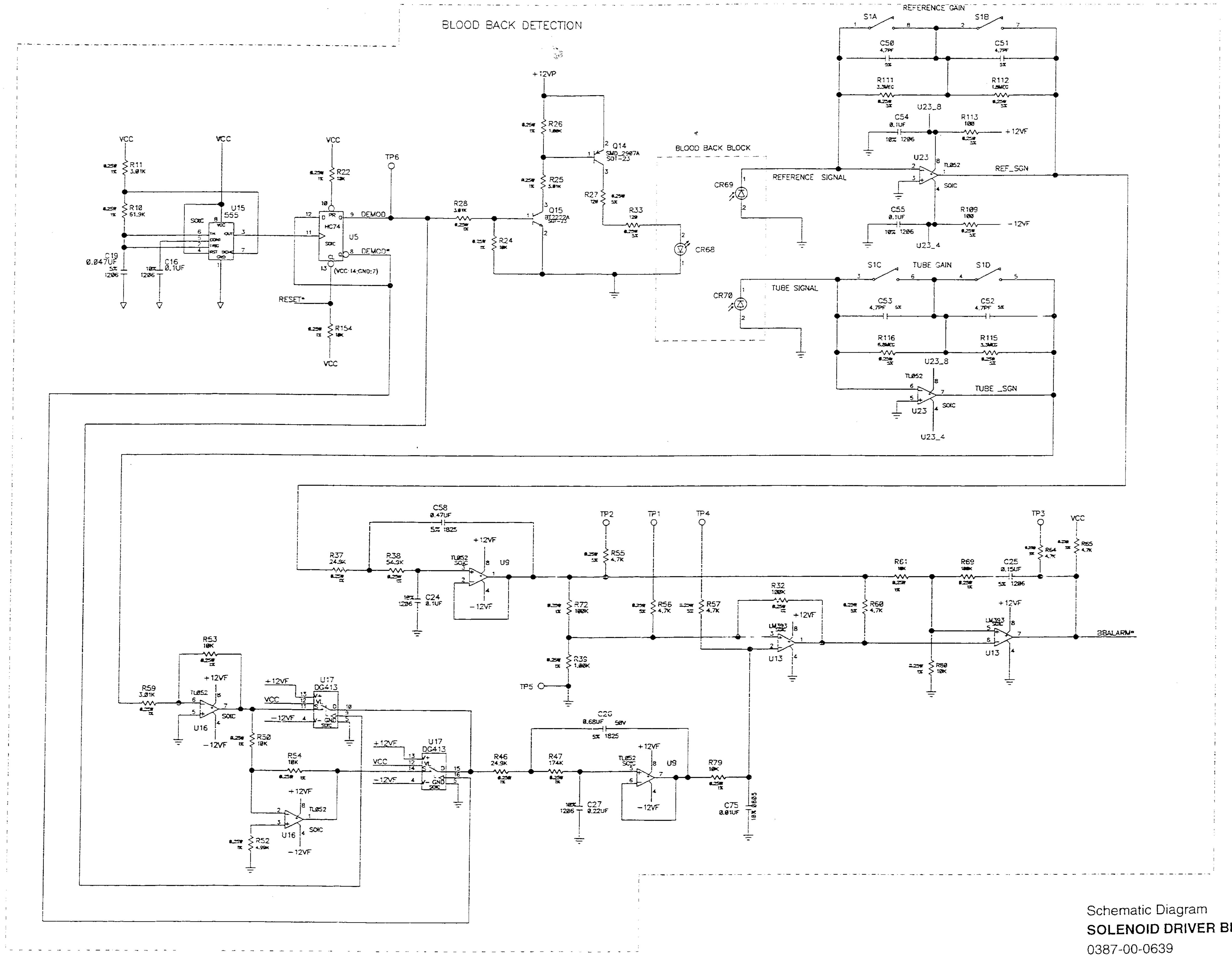
Schematic Diagram
SOLENOID DRIVER BD. ASSY.
0387-00-0639
Sheet 1 of 6



Schematic Diagram
SOLENOID DRIVER BD. ASSY.
0387-00-0639
Sheet 2 of 6



Schematic Diagram
SOLENOID DRIVER BD. ASSY.
0387-00-0639
Sheet 3 of 6



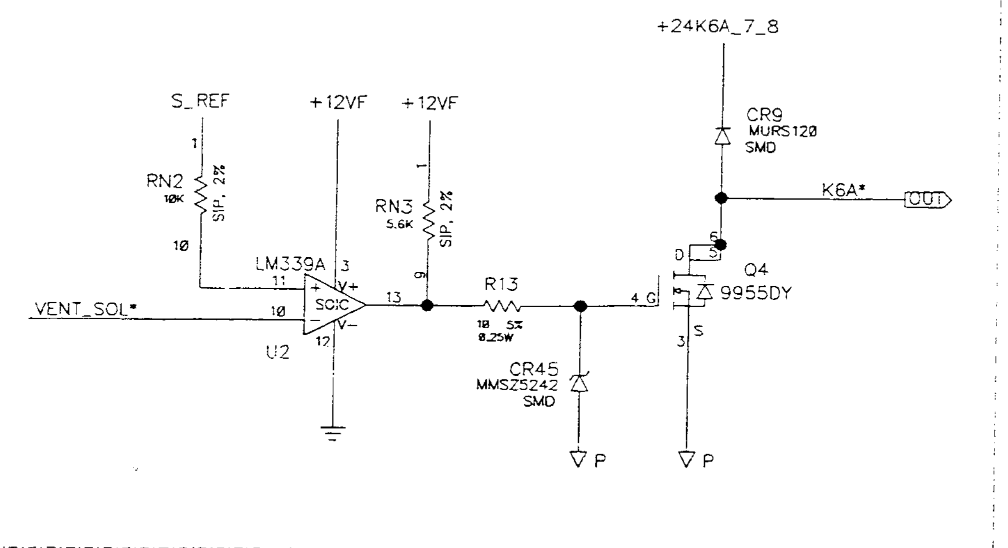
Schematic Diagram

SOLENOID DRIVER BD. ASSY.

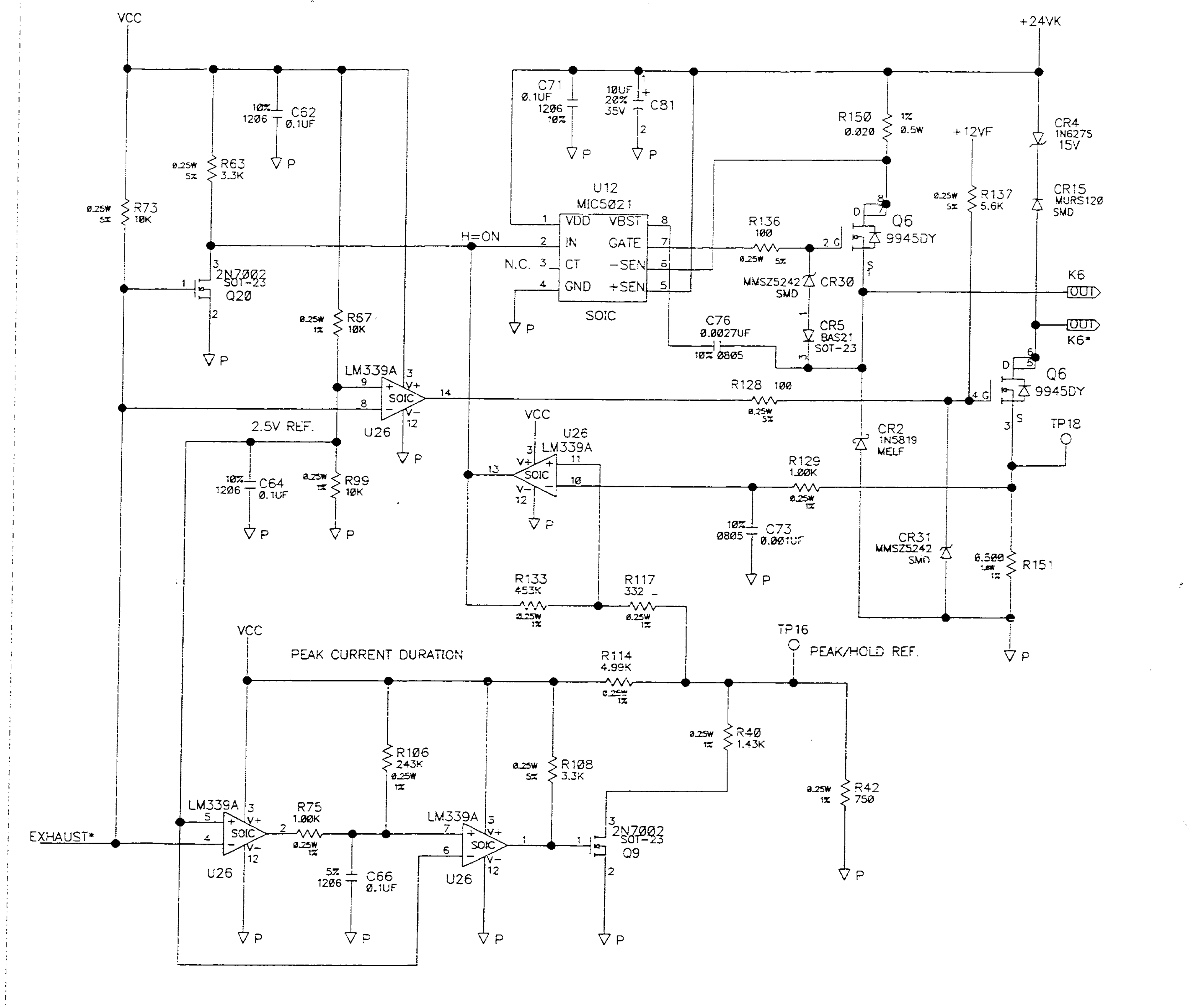
0387-00-0639

Sheet 4 of 6

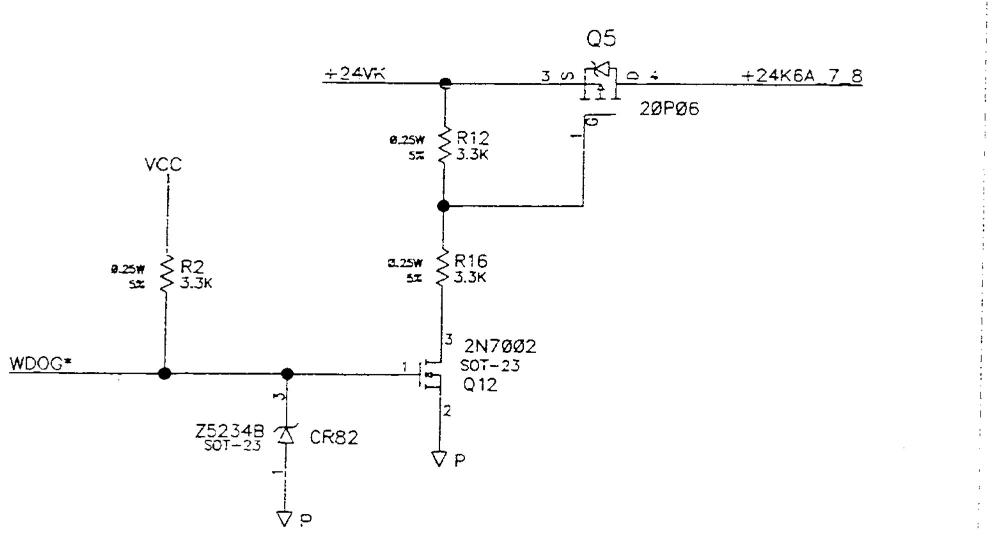
K6A N.O. SAFETY VENT SOLENOID DRIVE



K6 N.C. EXHAUST SOLENOID DRIVE



WATCHDOG SOLENOID POWER

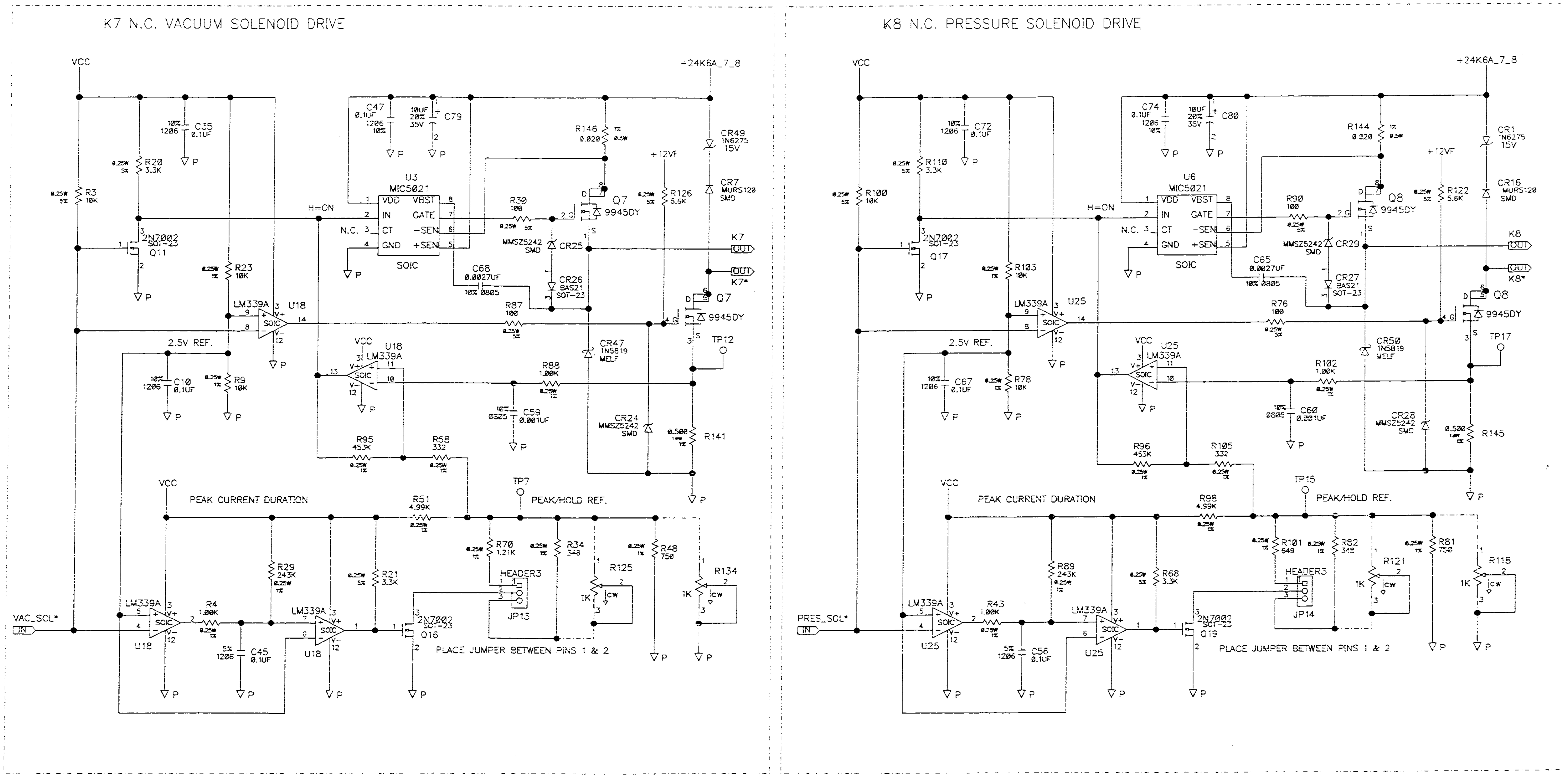


Schematic Diagram

SOLENOID DRIVER BD. ASSY.

0387-00-0639

Sheet 5 of 6

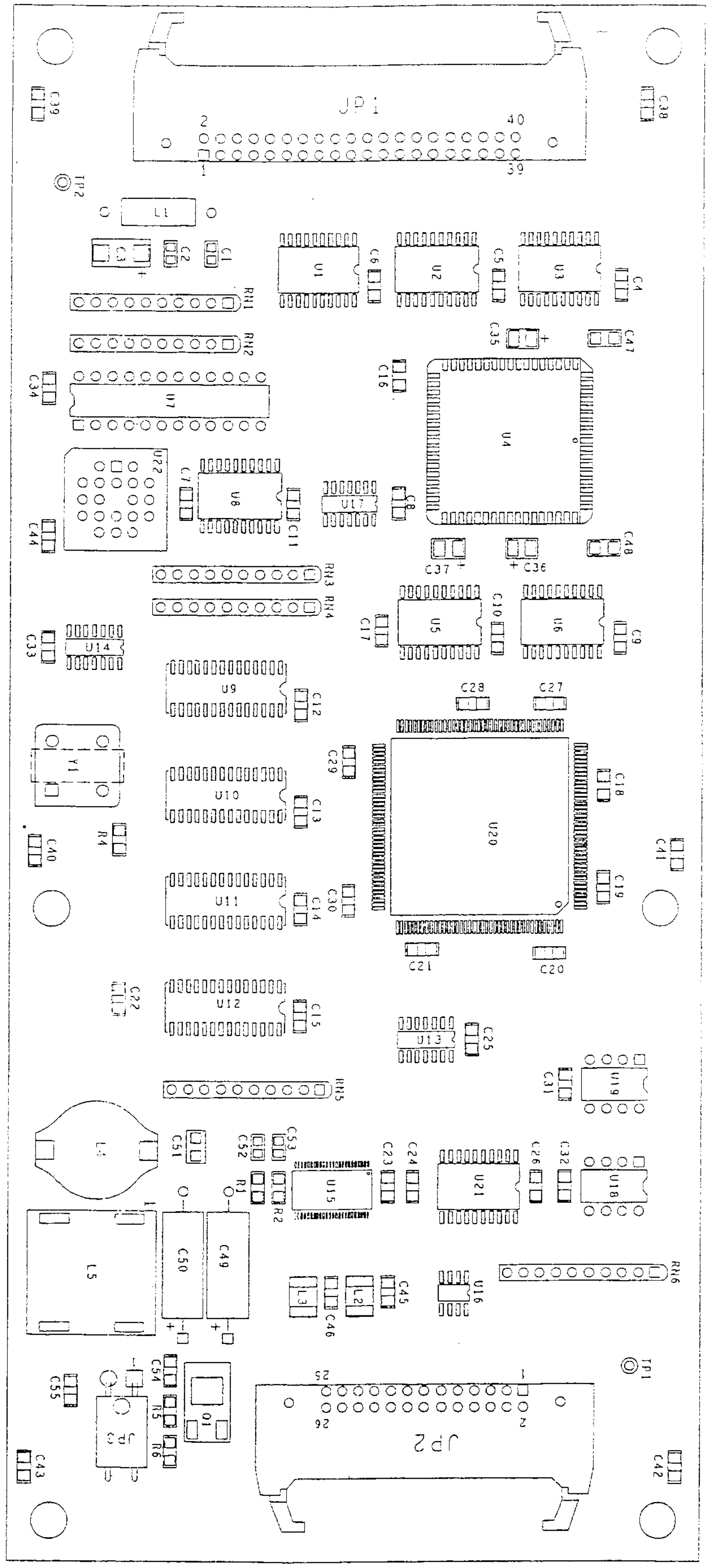


Schematic Diagram

SOLENOID DRIVER BD.

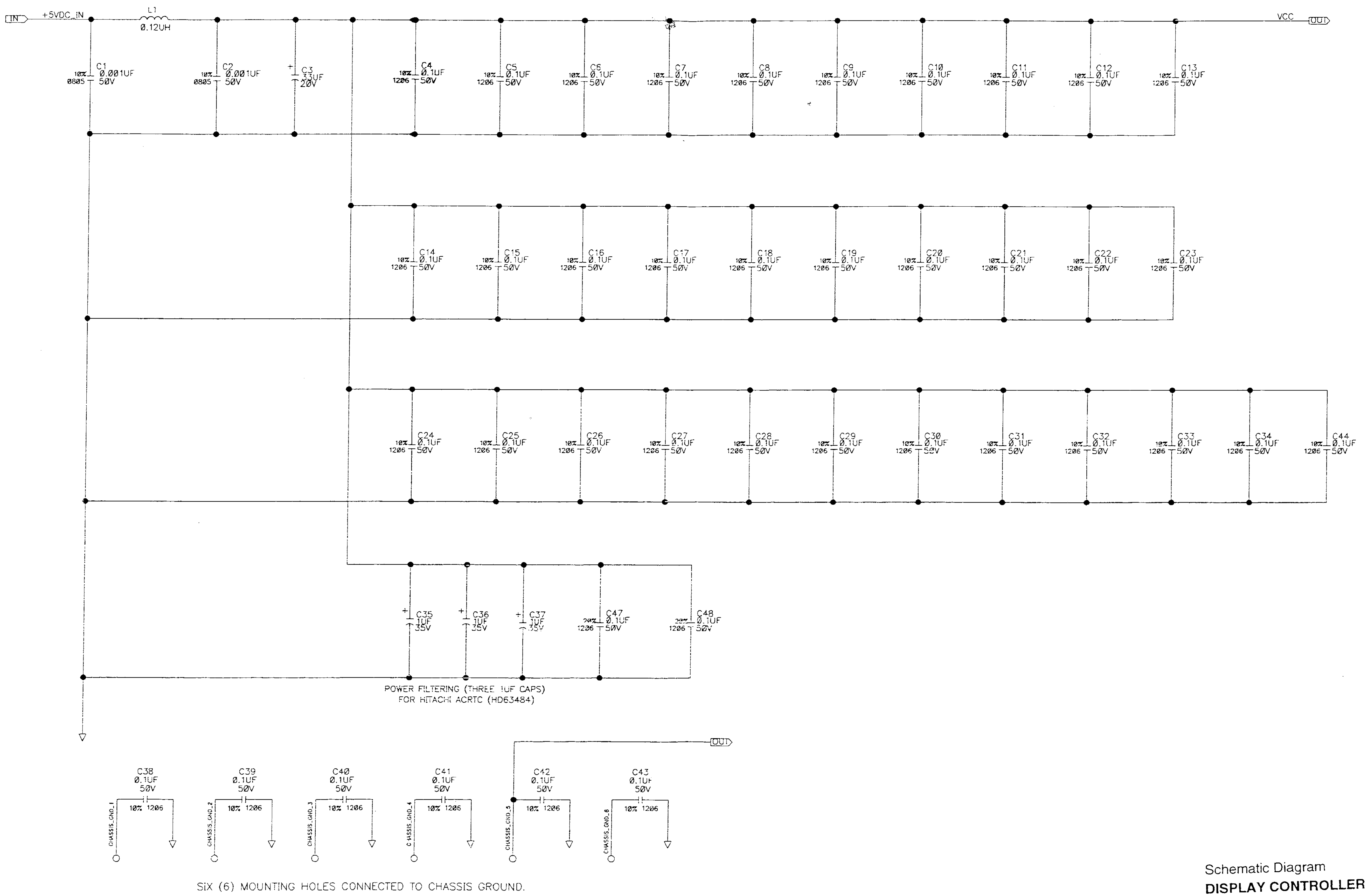
0387-00-0639

Sheet 6 of 6

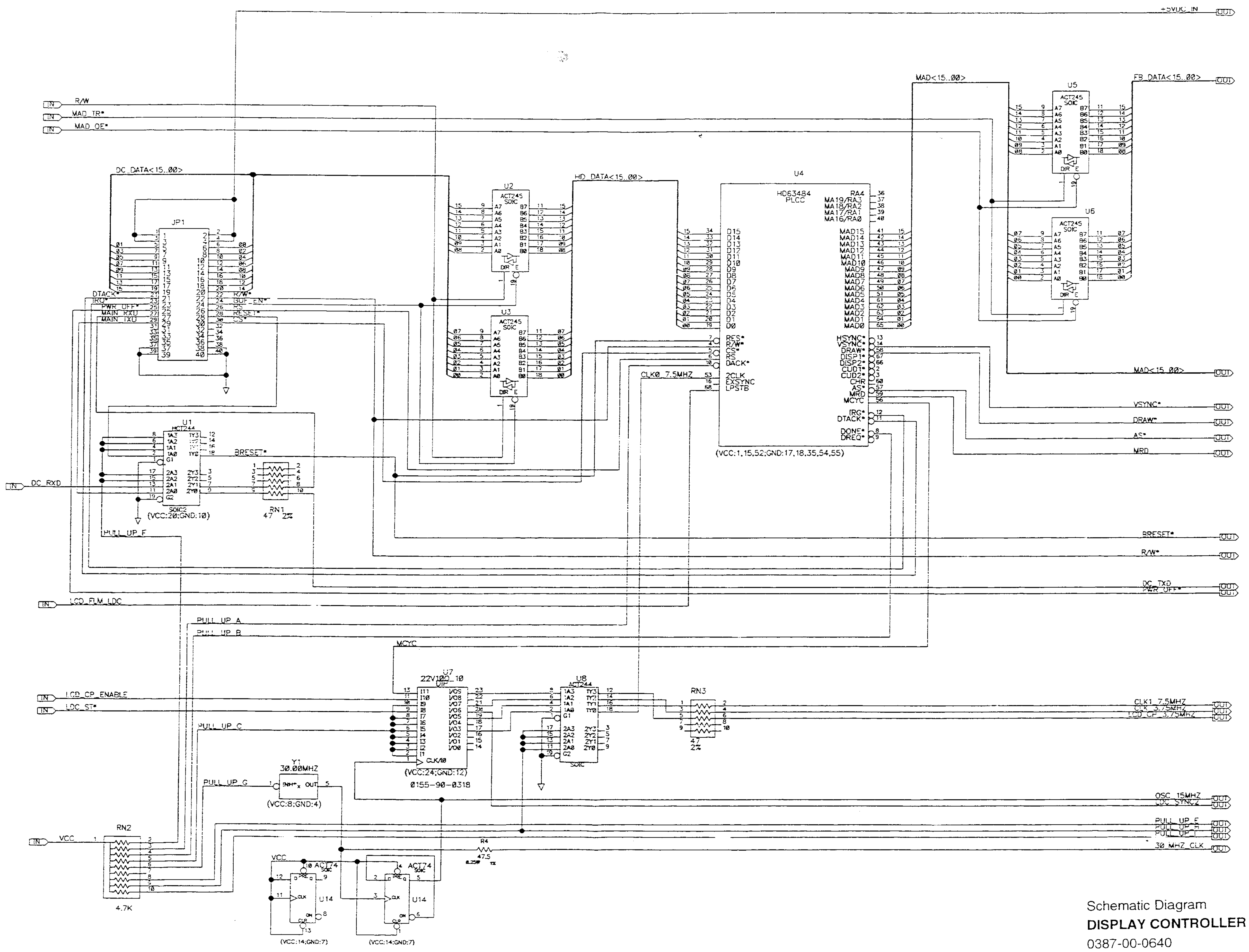


DISPLAY CONTROLLER BD. ASSY.

0670-00-0640



Schematic Diagram
DISPLAY CONTROLLER BD.
0387-00-0640
Sheet 1 of 5

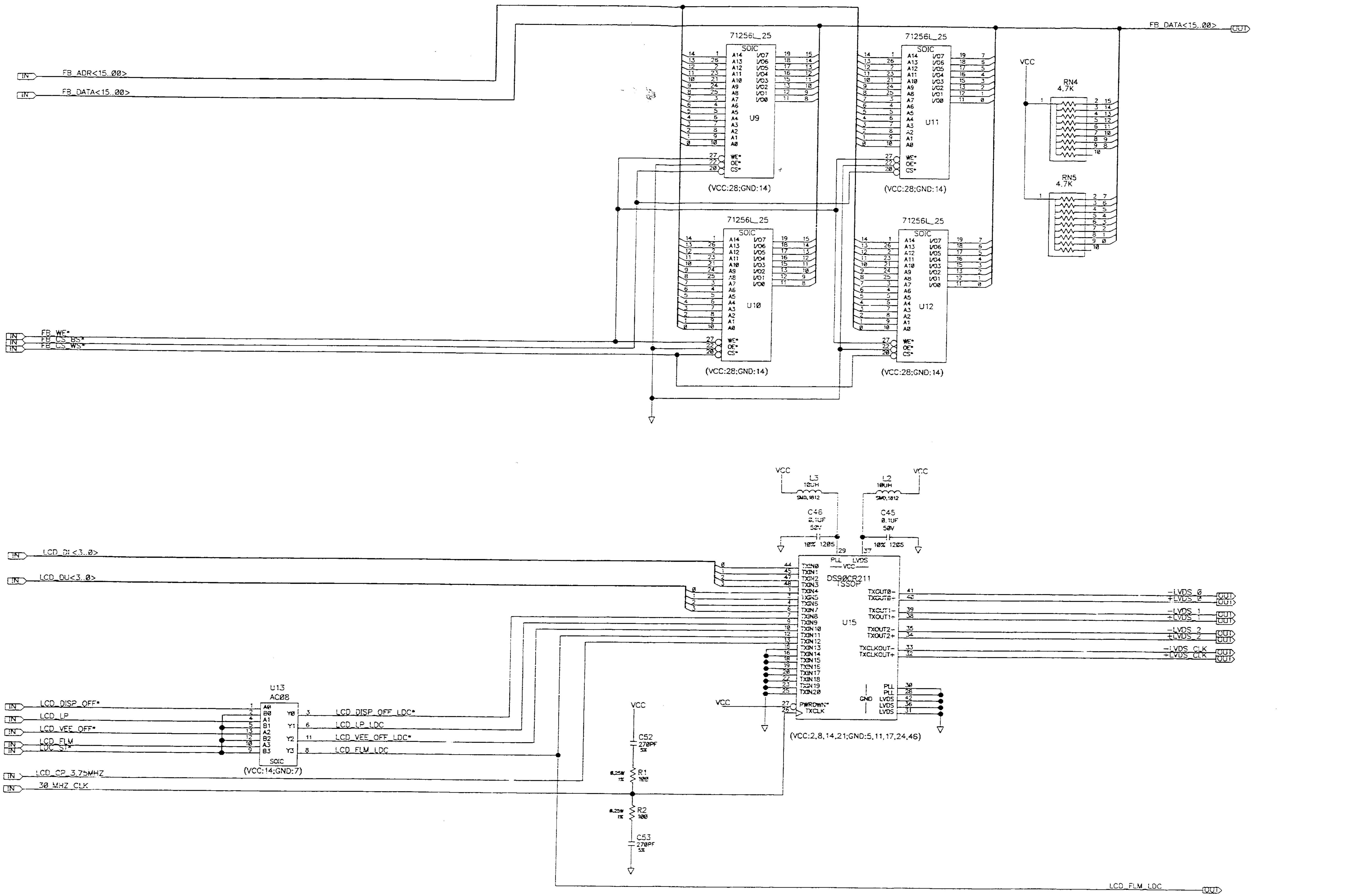


Schematic Diagram

DISPLAY CONTROLLER BD.

0387-00-0640

Sheet 2 of 5



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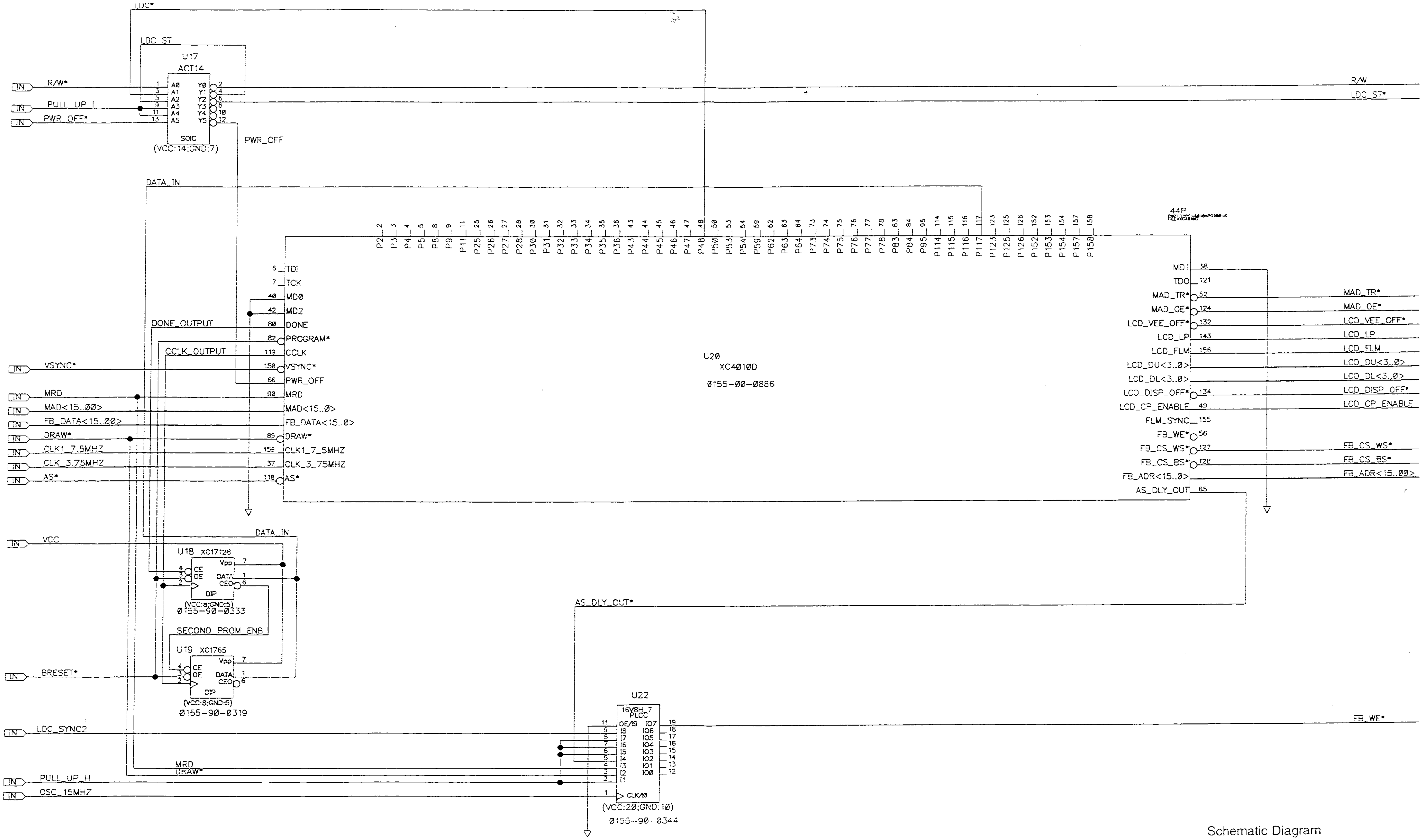
DISPLAY CONTROLLER BD.
0387-00-0640
Sheet 3 of 5

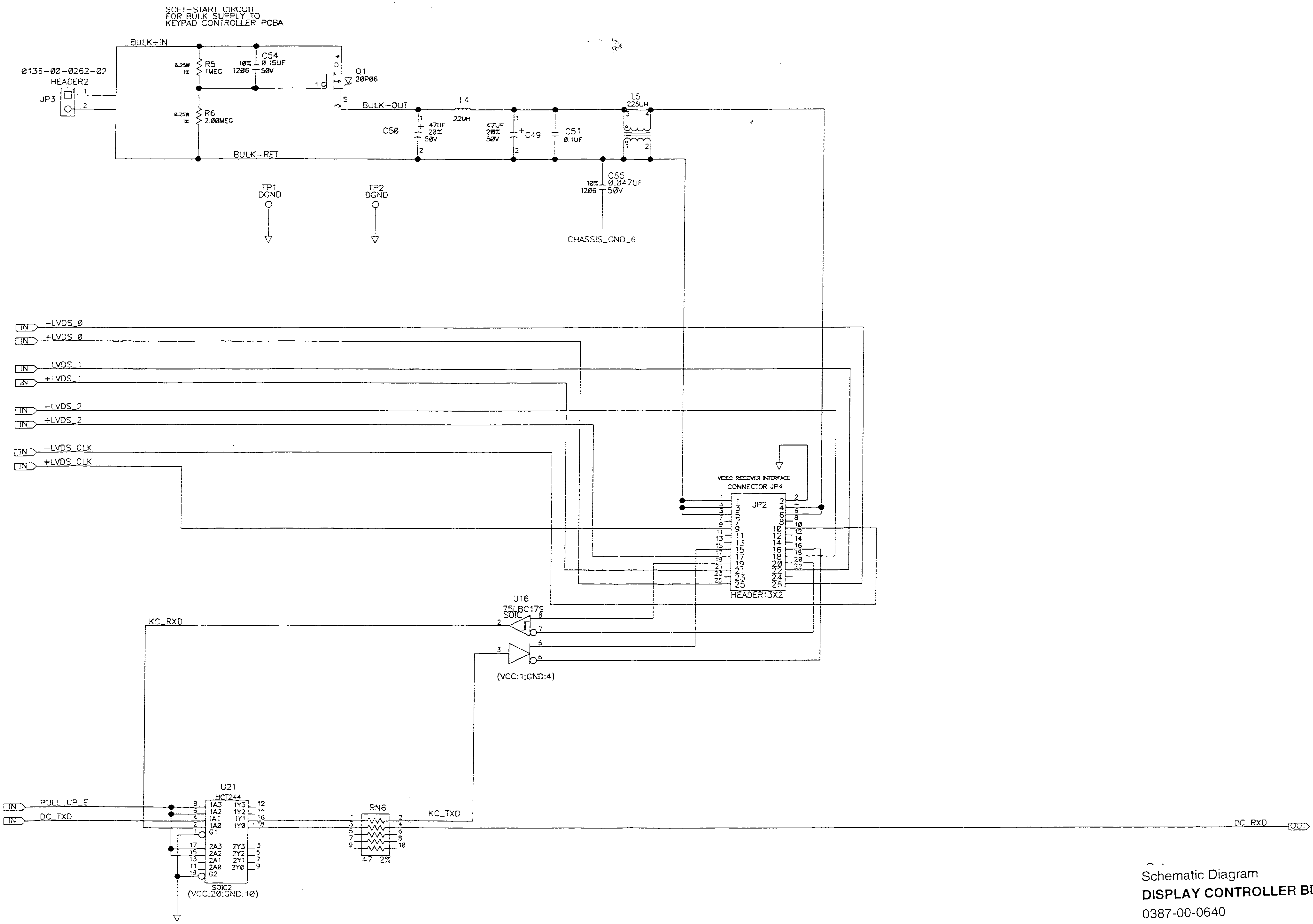


Schematic Diagram

DISPLAY CONTROLLER BD.

0387-00-0640

Sheet 4 of 5

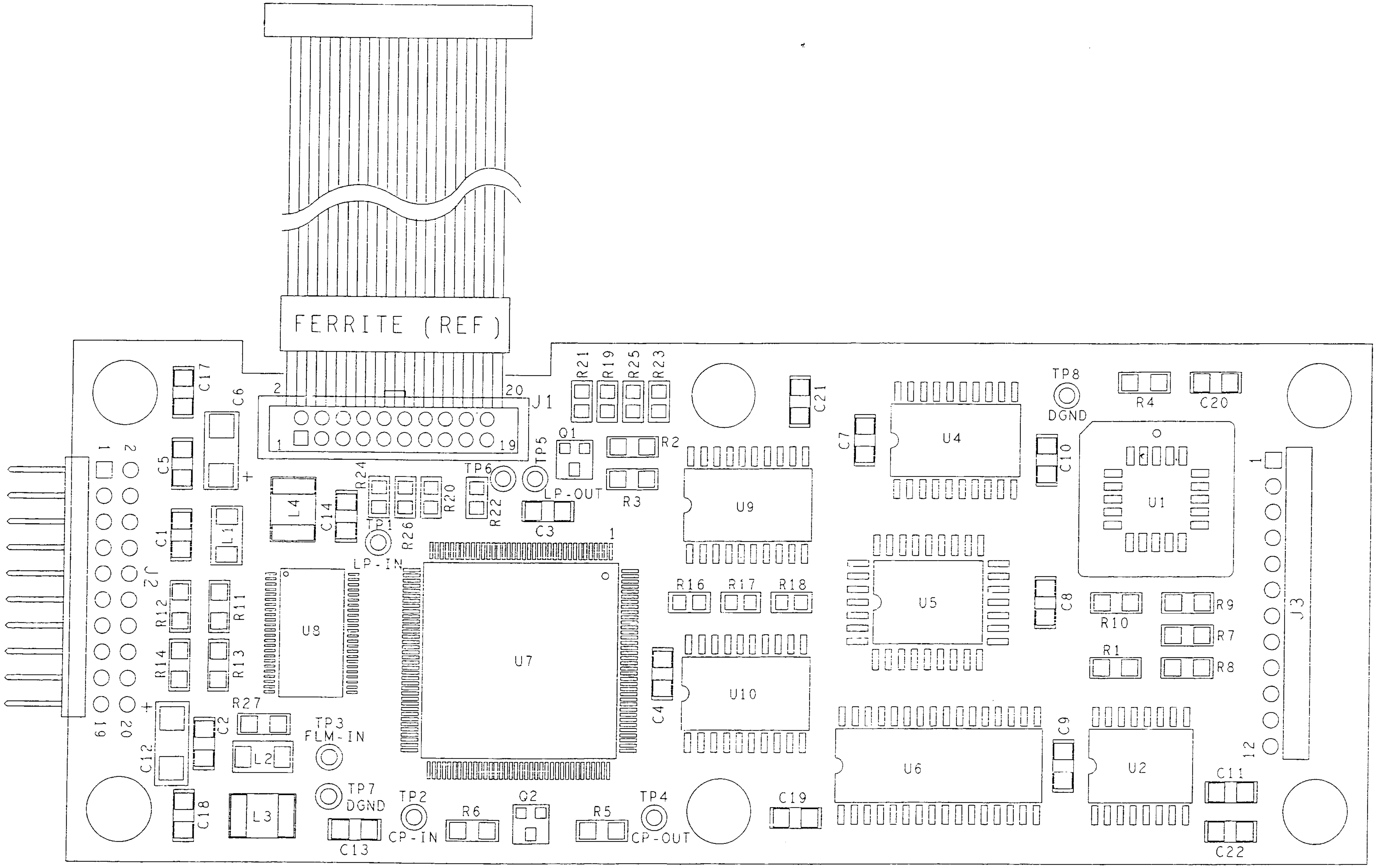


Schematic Diagram

DISPLAY CONTROLLER BD.

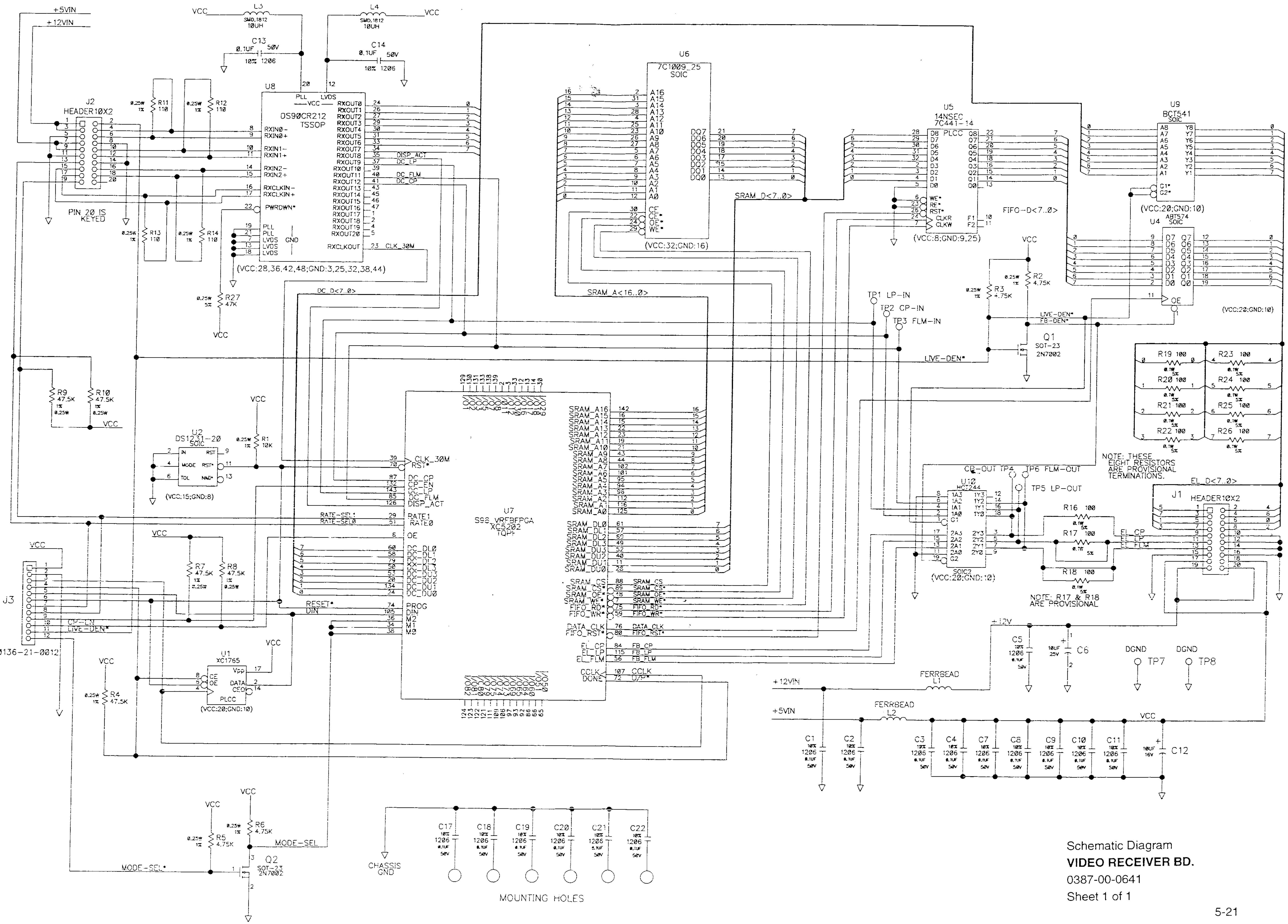
0387-00-0640

Sheet 5 of 5



VIDEO RECEIVER BD. ASSY.

0670-00-0641

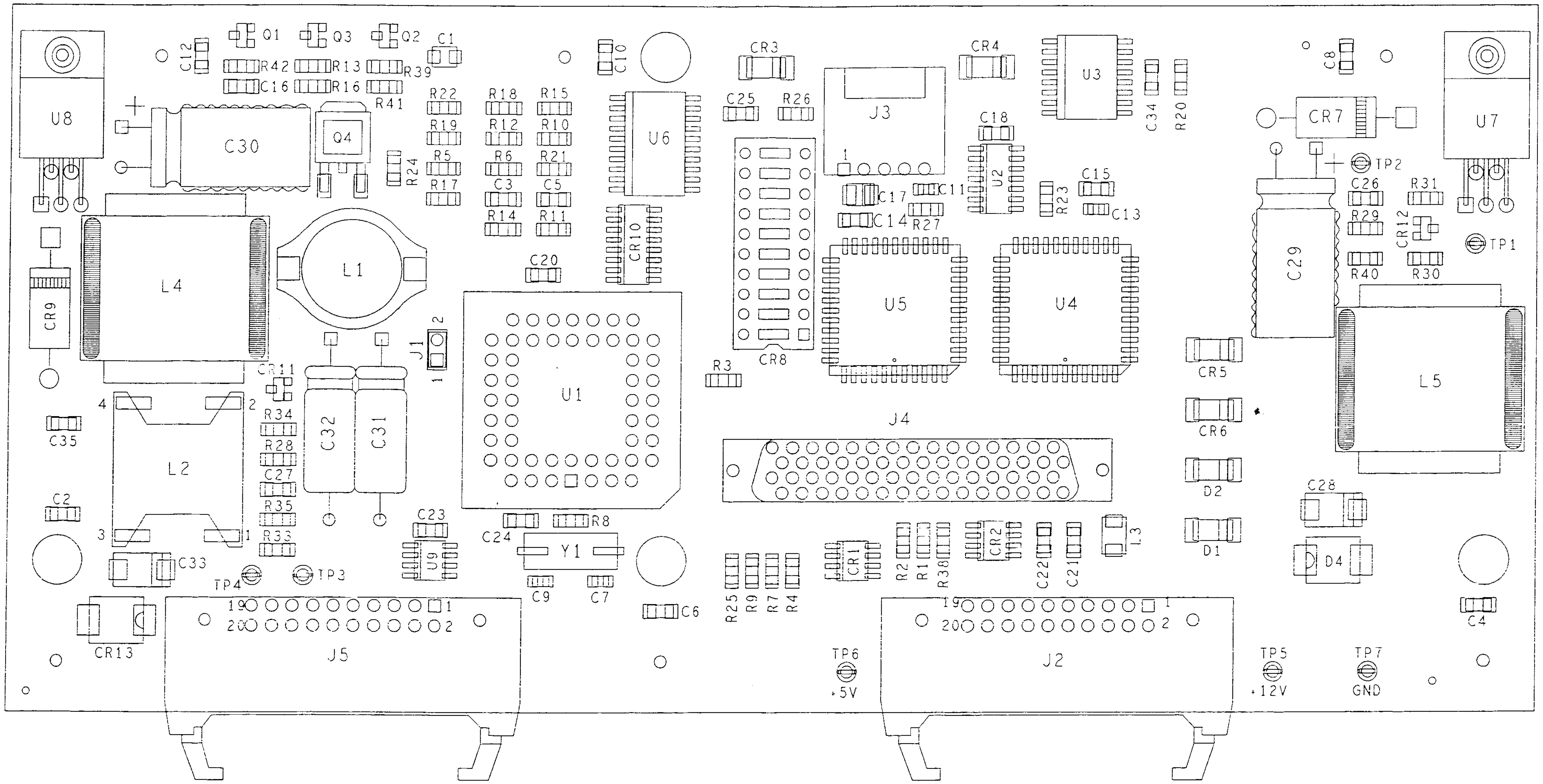


Schematic Diagram

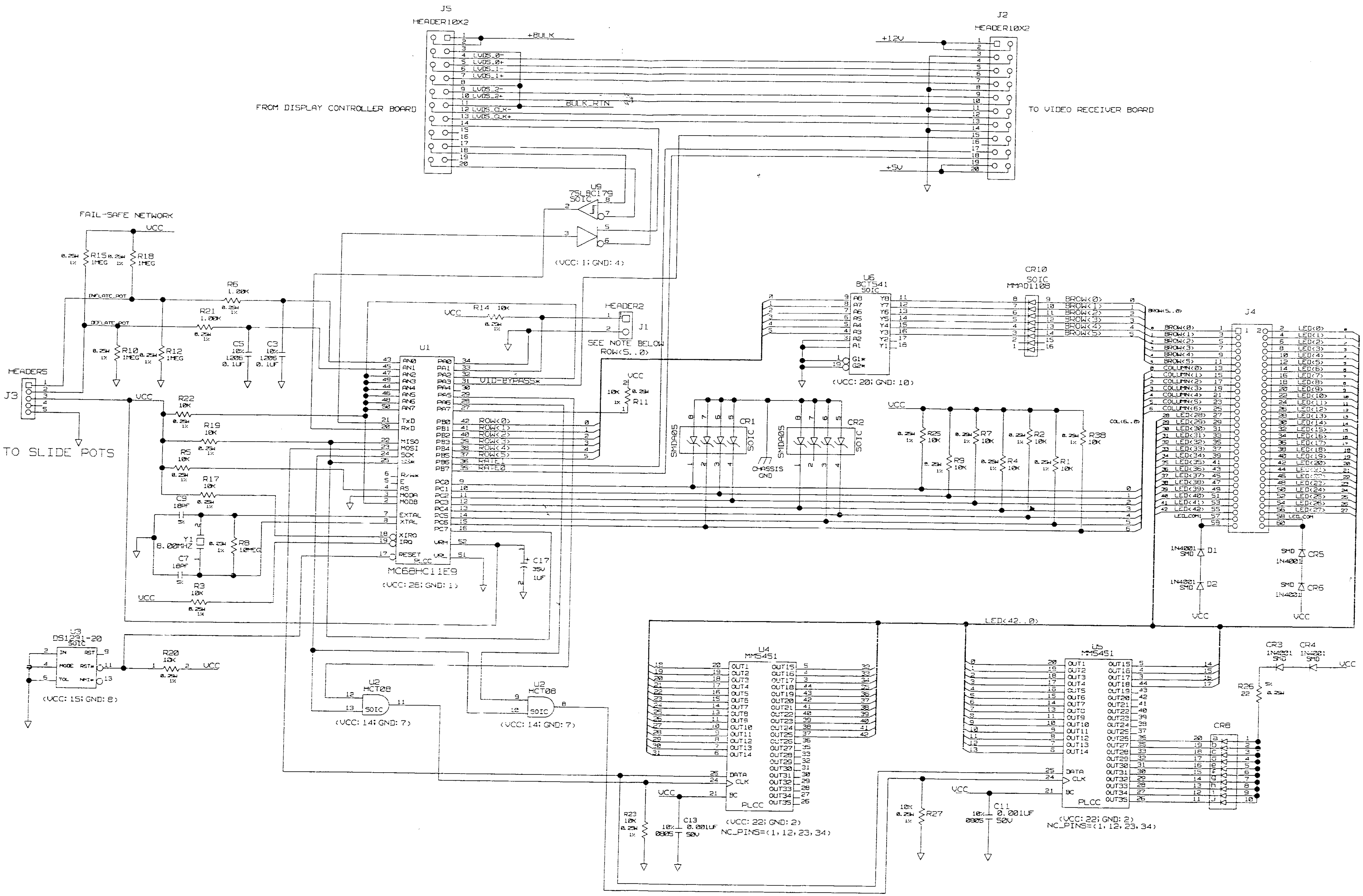
VIDEO RECEIVER BD.

0387-00-0641

Sheet 1 of 1



KEYPAD CONTROLLER BD. ASSY.
0670-00-0645



Schematic Diagram

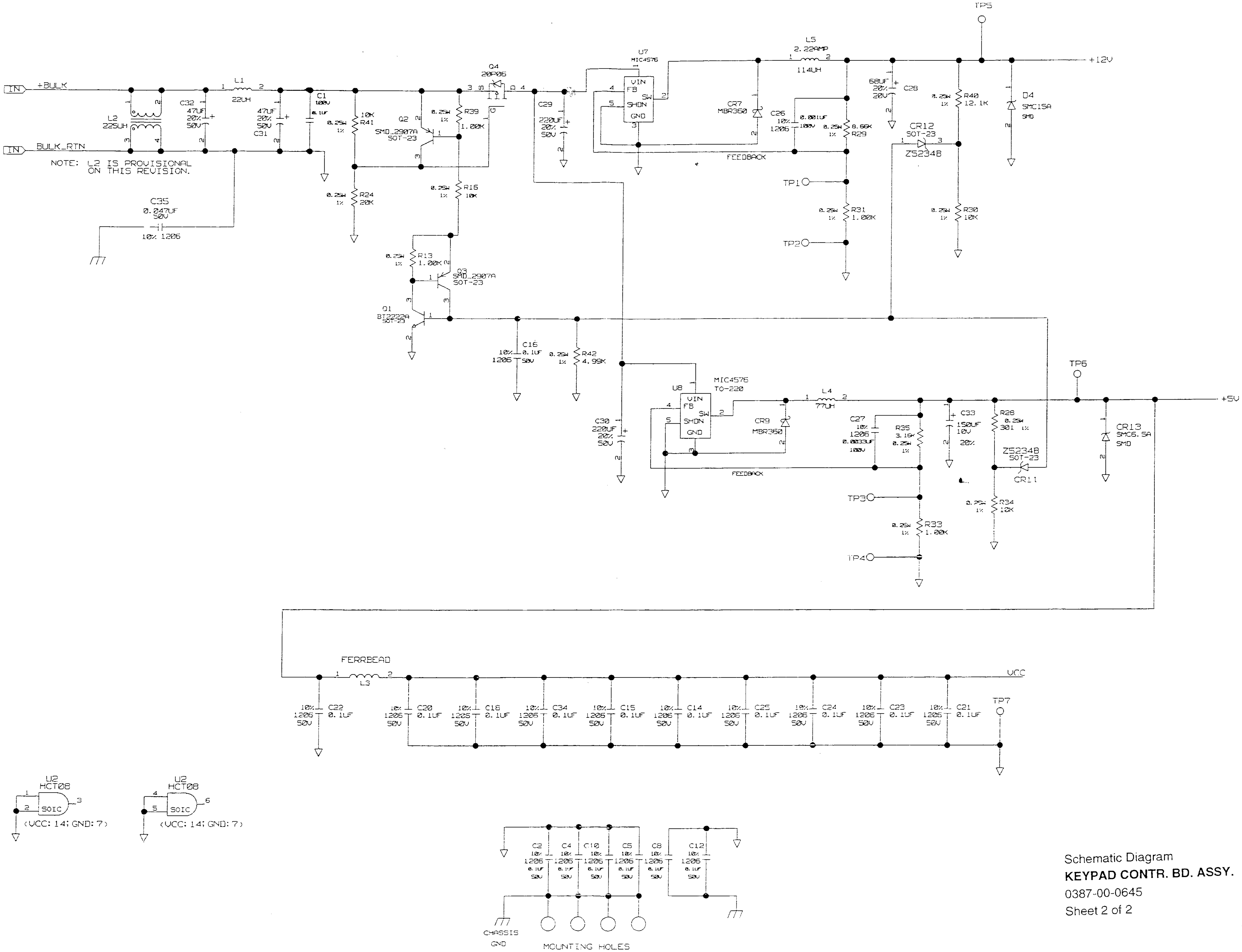
KEYPAD CONTR. BD. ASSY.

0387-00-0645

Sheet 1 of 2

NOTES:

CONFIGURATION JUMPER SETTINGS
J1 OFF FOR 100MM SLIDE POTS
J1 ON FOR 90MM SLIDE POTS

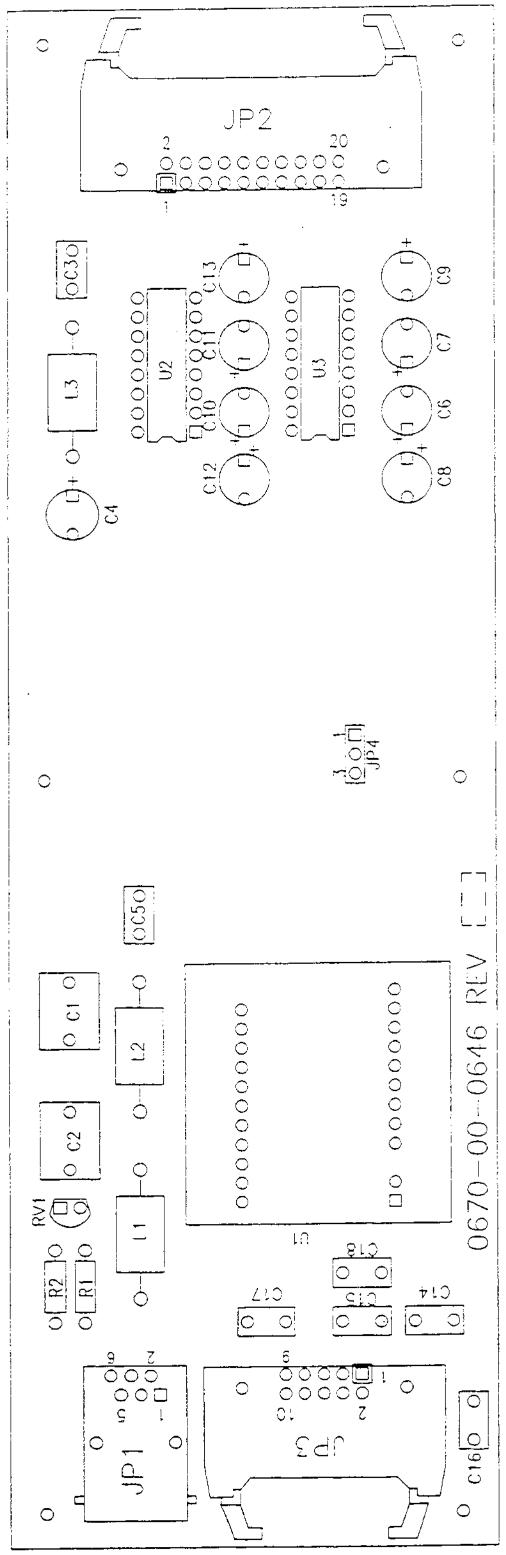


Schematic Diagram

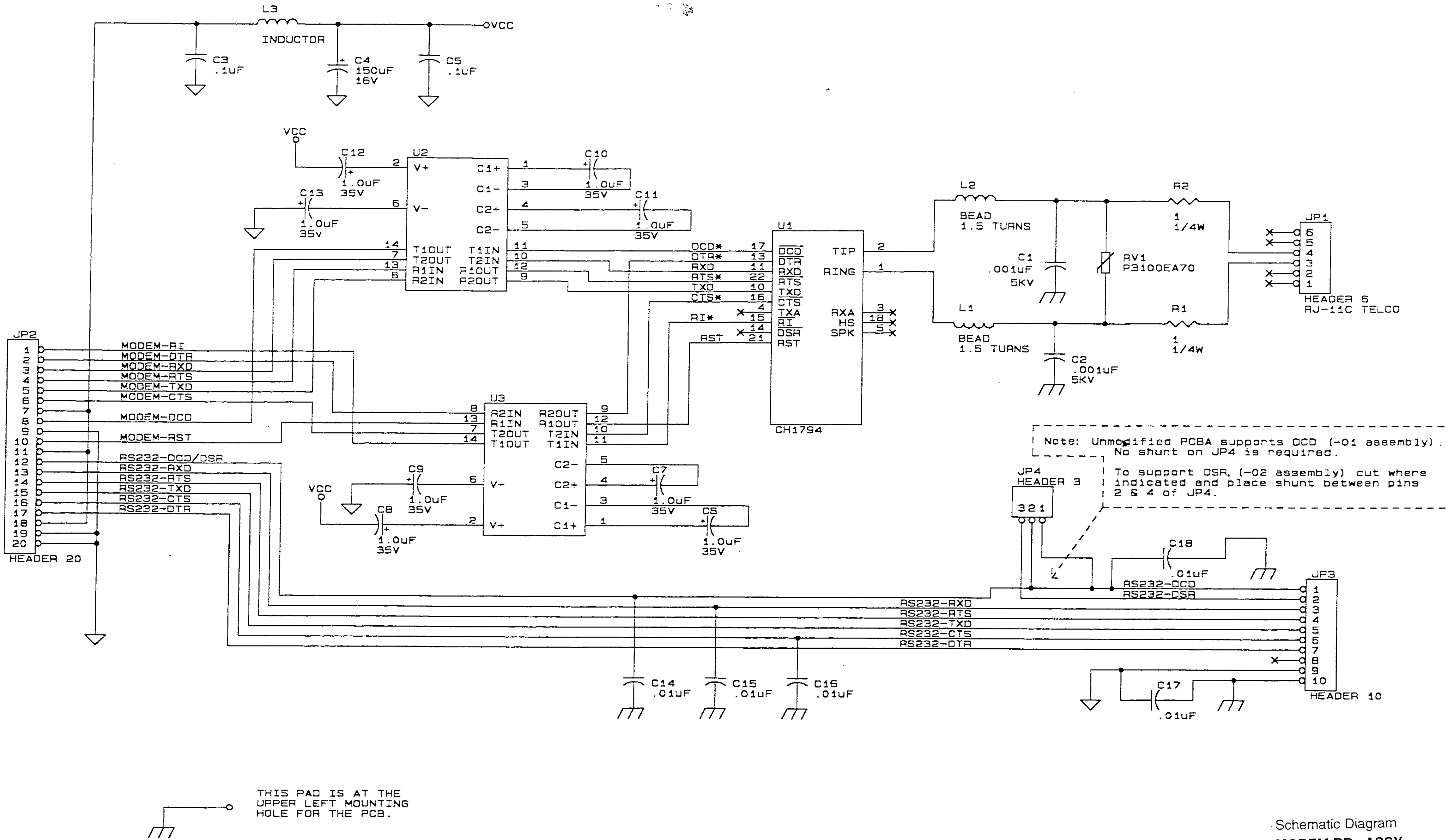
KEYPAD CONTR. BD. ASSY.

0387-00-0645

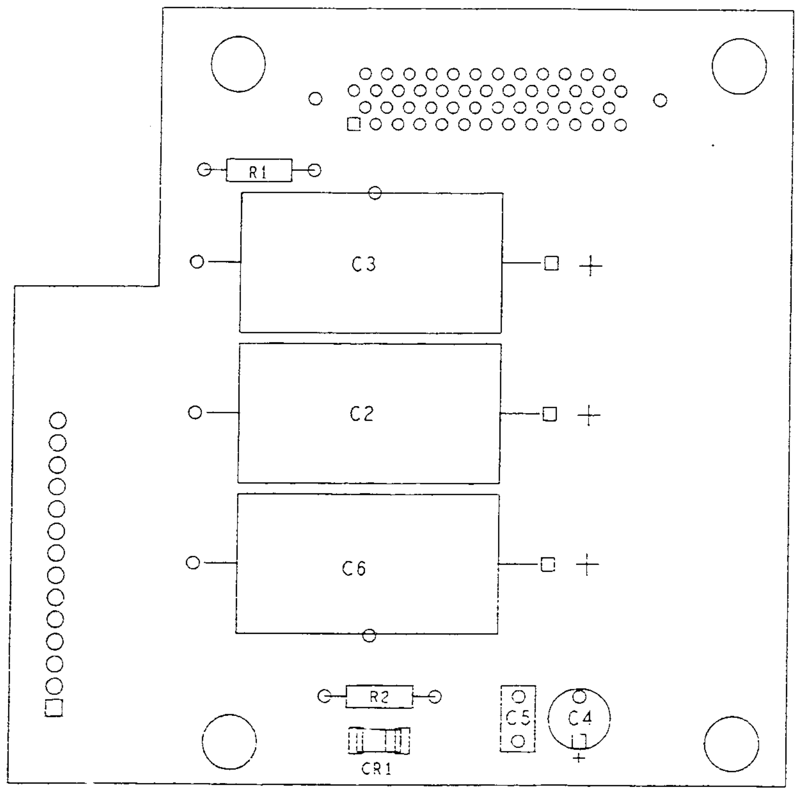
Sheet 2 of 2



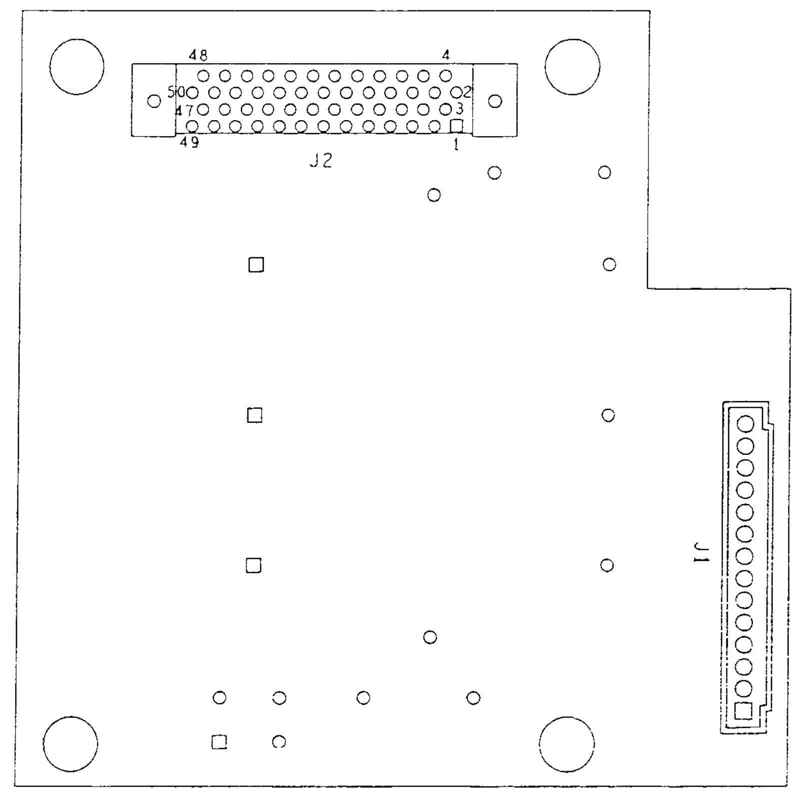
MODEM BD. ASSY.
(Domestic)
0670-00-0646



Schematic Diagram
MODEM BD. ASSY.
(Domestic)
0387-00-0646
Sheet 1 of 1

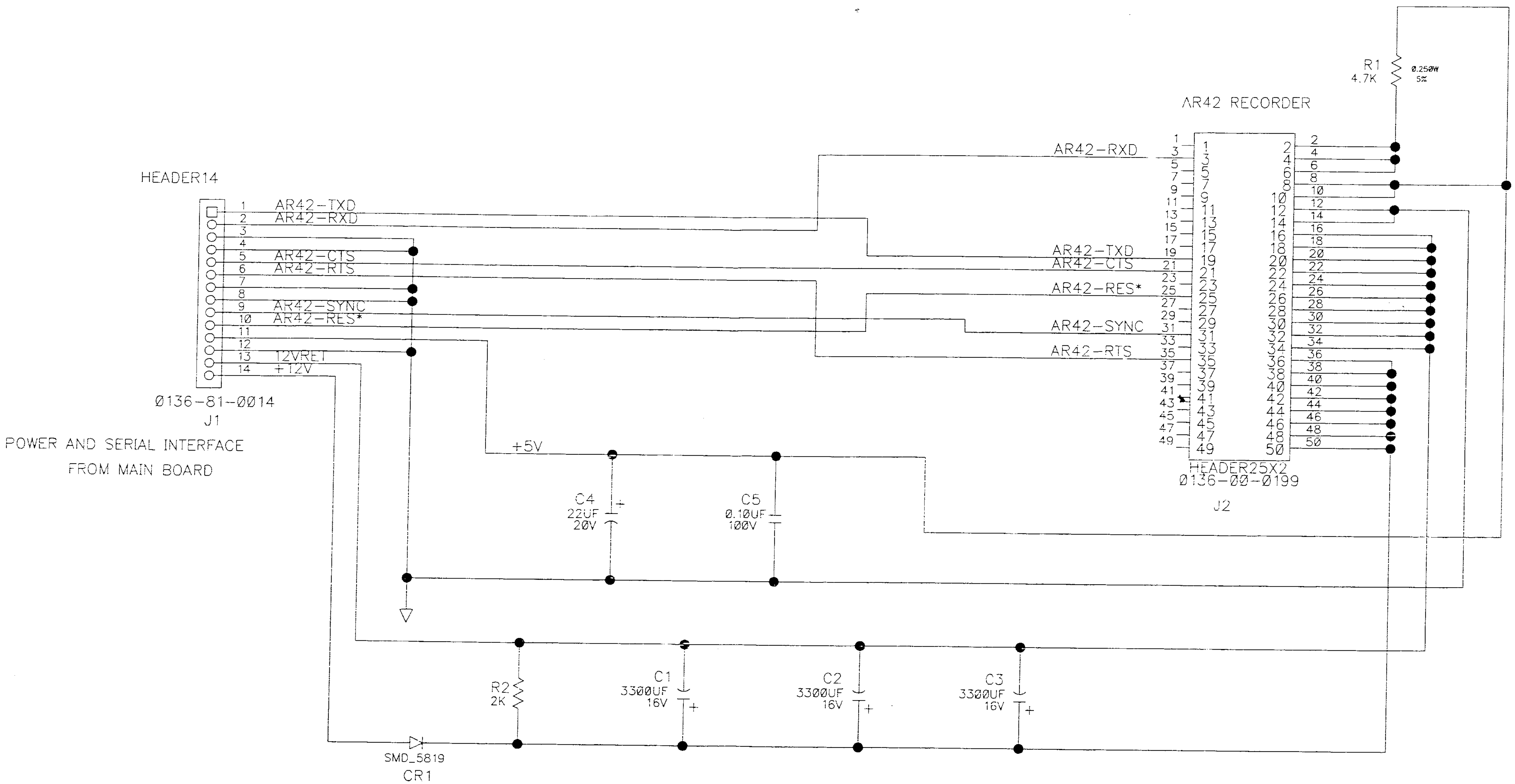


TOP ASSEMBLY



BOTTOM ASSEMBLY

RECORDER INTERCONNECT
BD. ASSY.
0670-00-0647

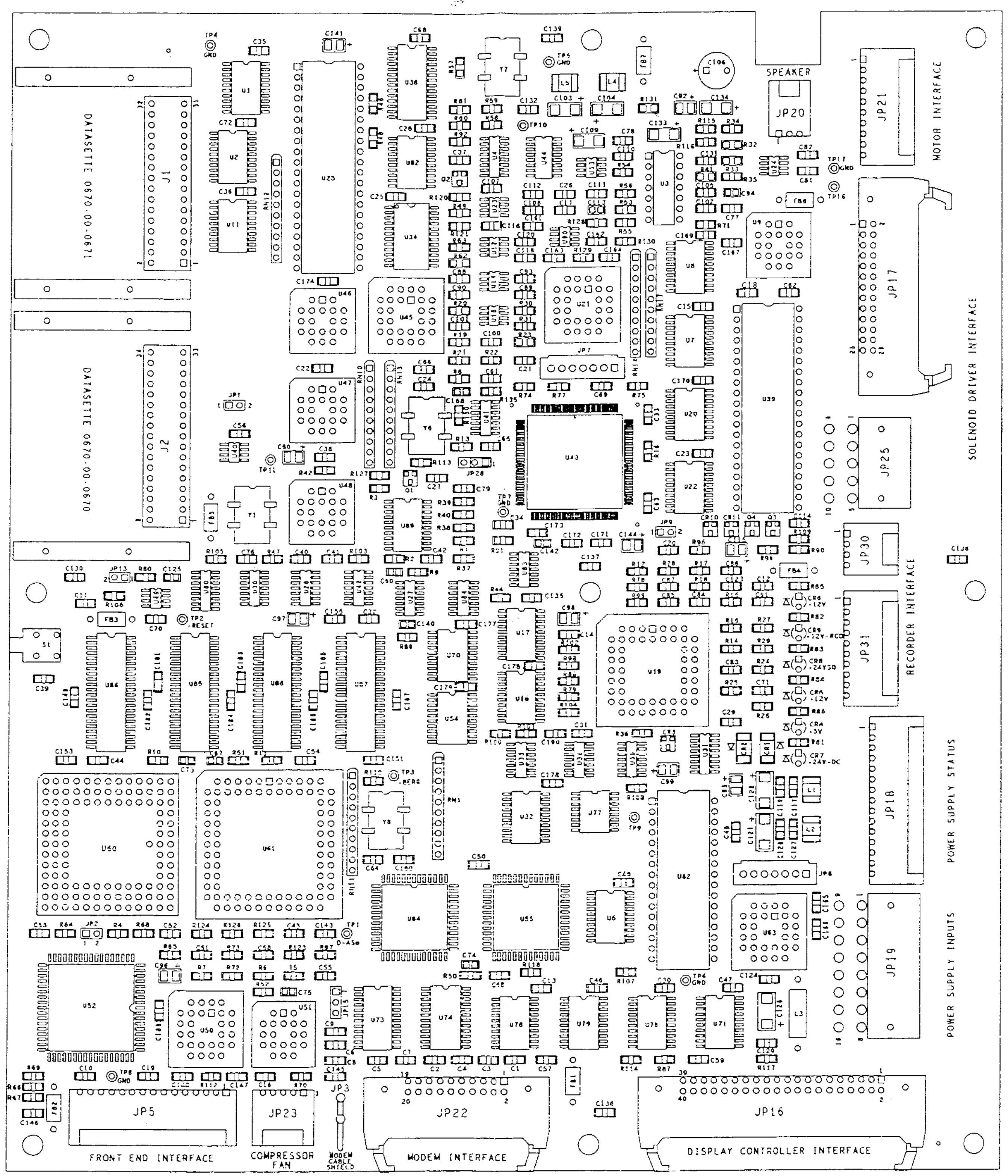


Schematic Diagram

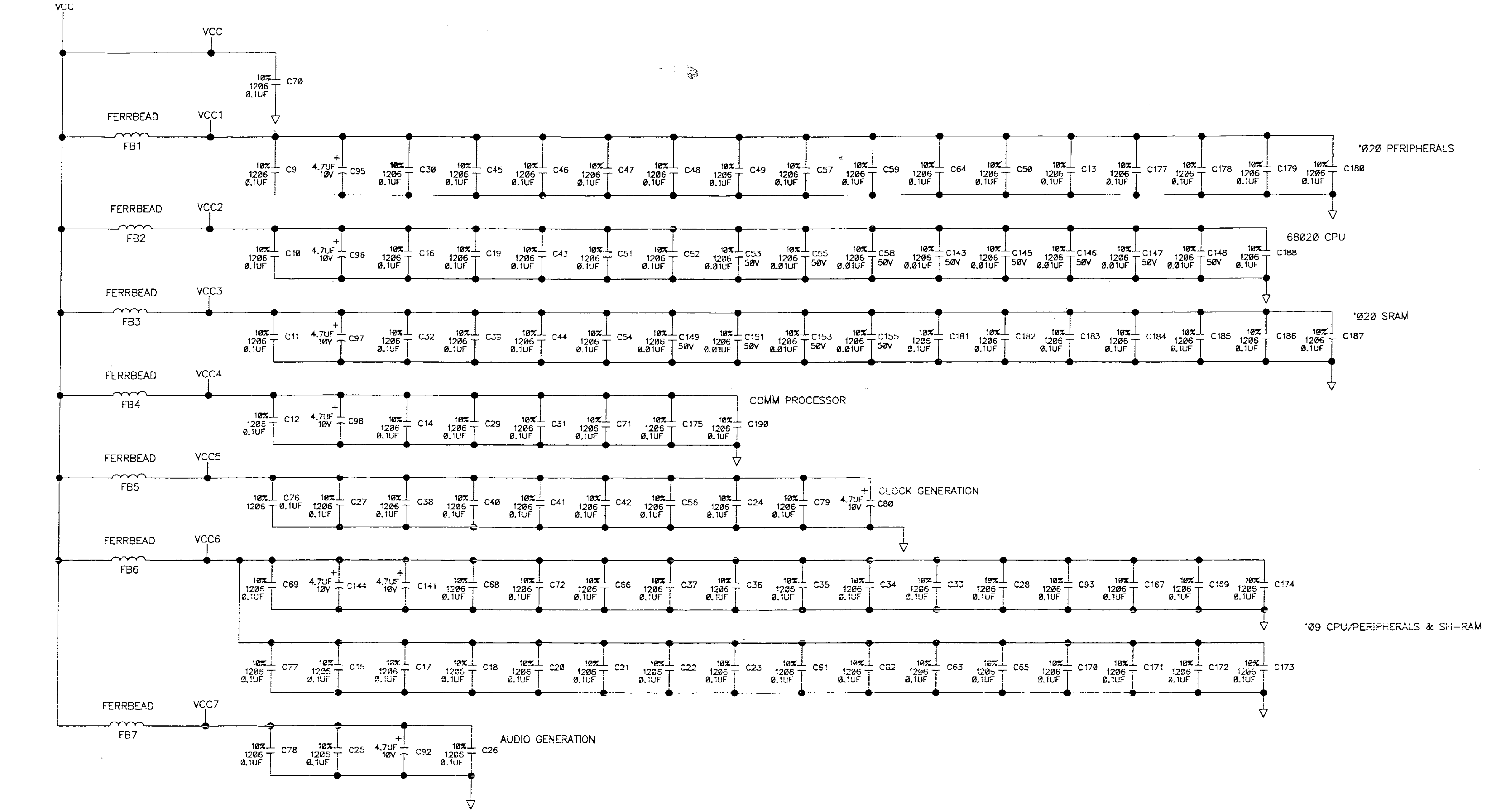
RECORDER INTERCONNECT BD.

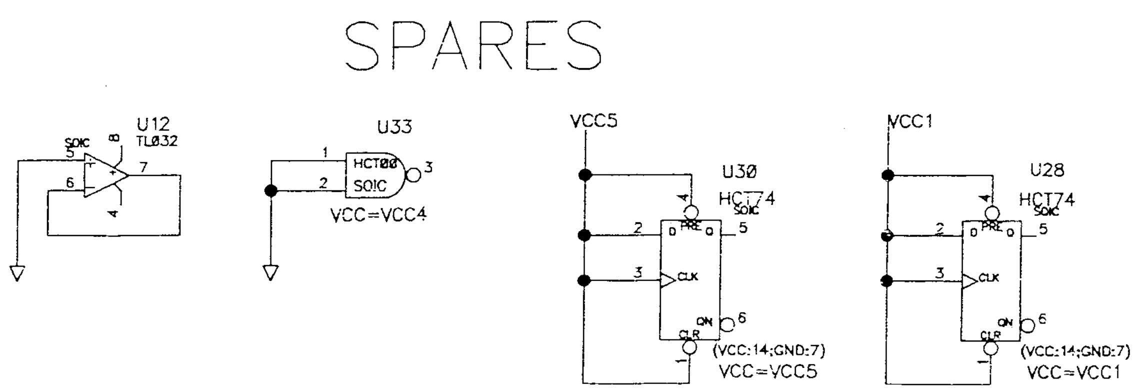
0387-00-0647

Sheet 1 of 1

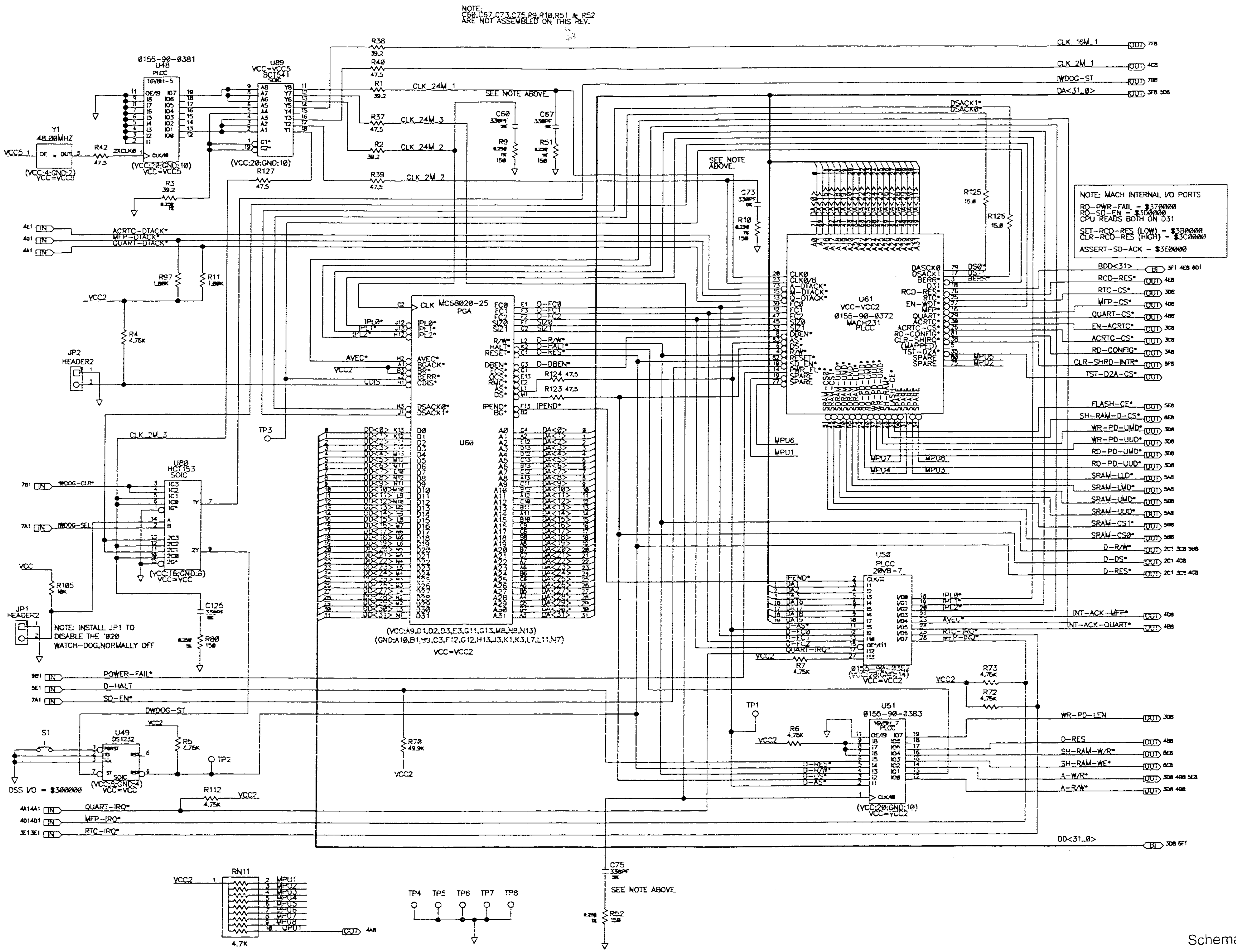


MAIN BOARD ASSY.
0670-00-0666





Schematic Diagram
MAIN BOARD
0387-00-0666
Sheet 1 of 9



Schematic Diagram

MAIN BOARD

0387-00-0666

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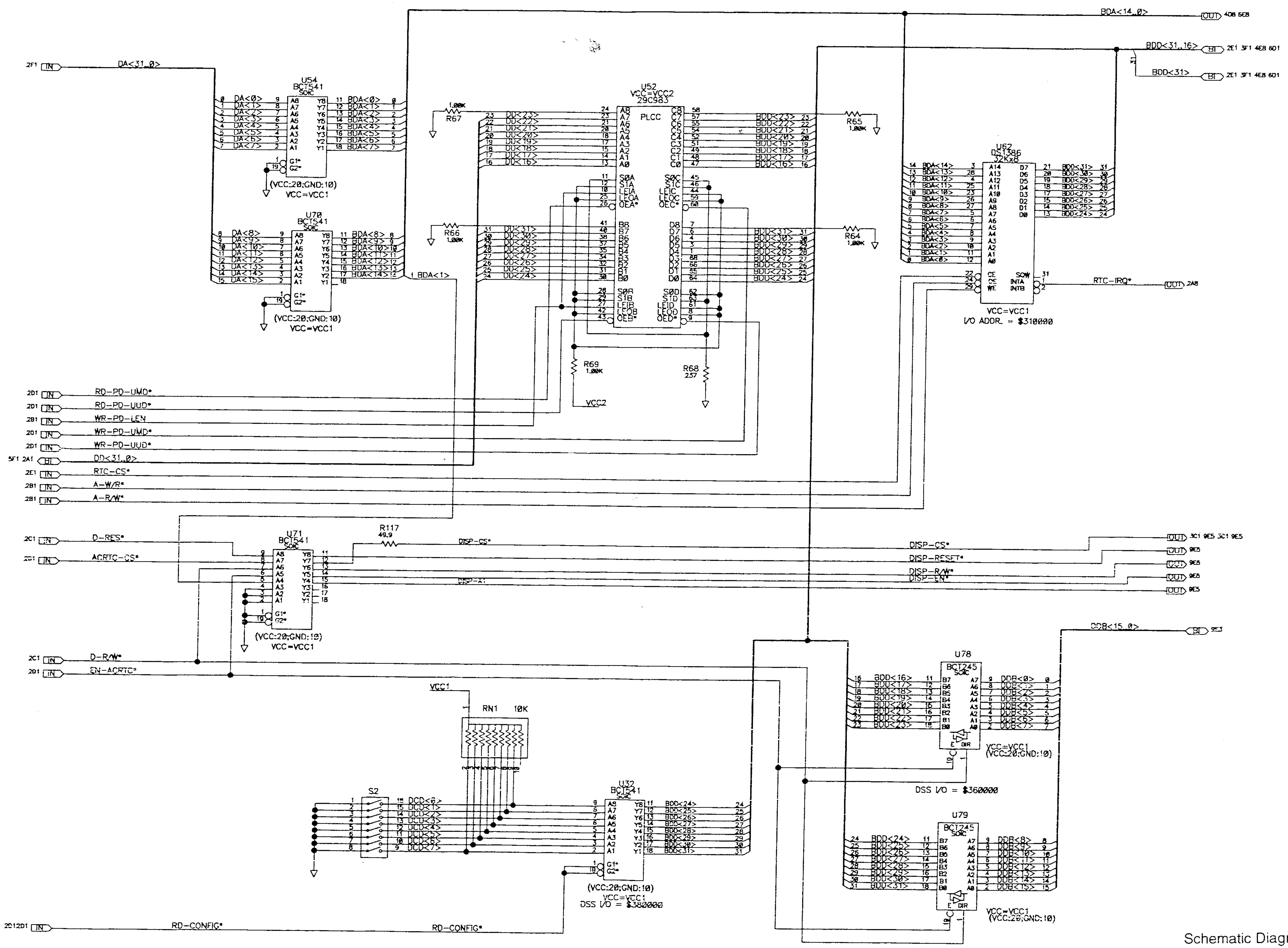

Schematic Diagram
MAIN BOARD
0387-00-0666
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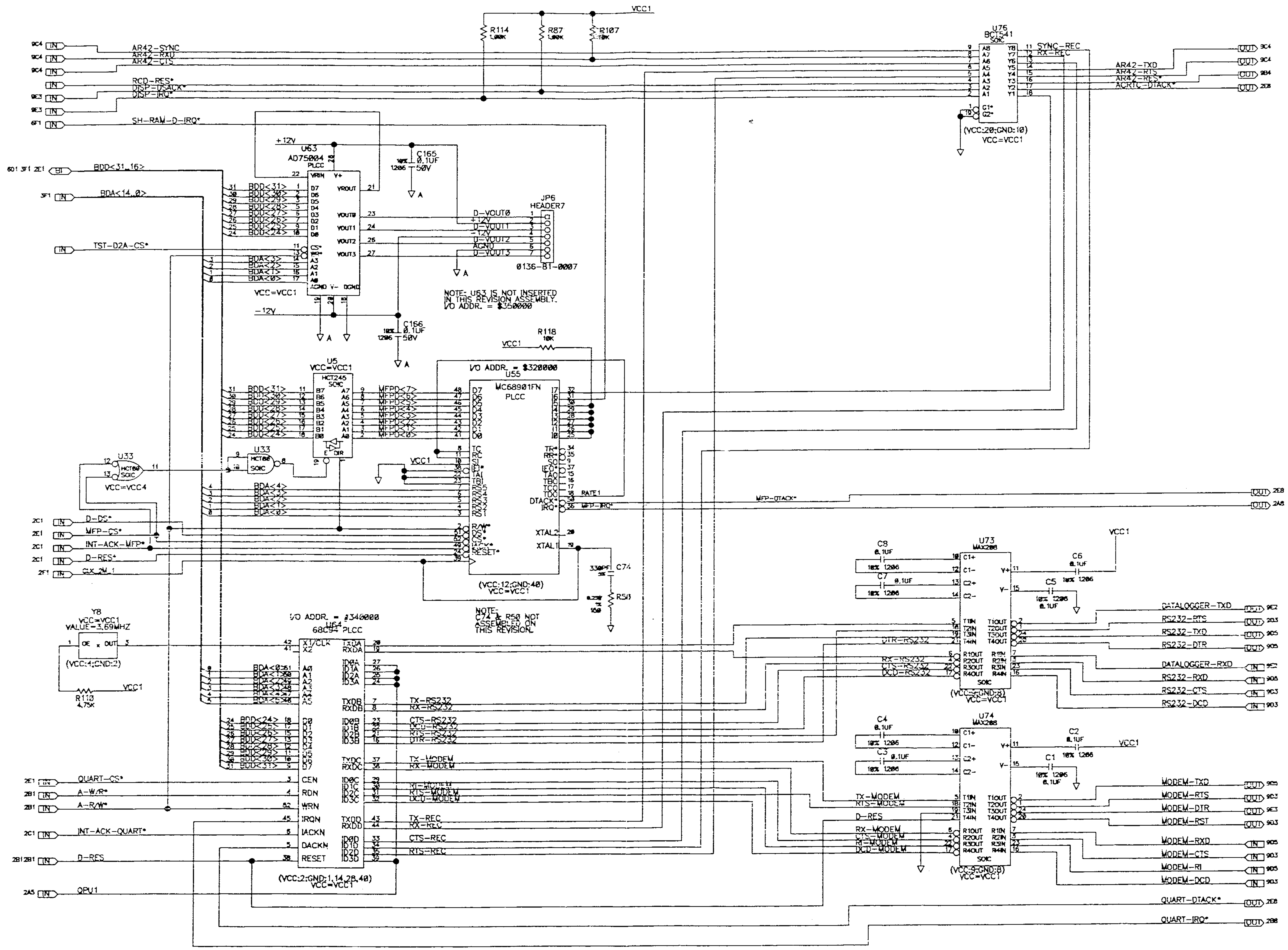

Schematic Diagram

MAIN BOARD

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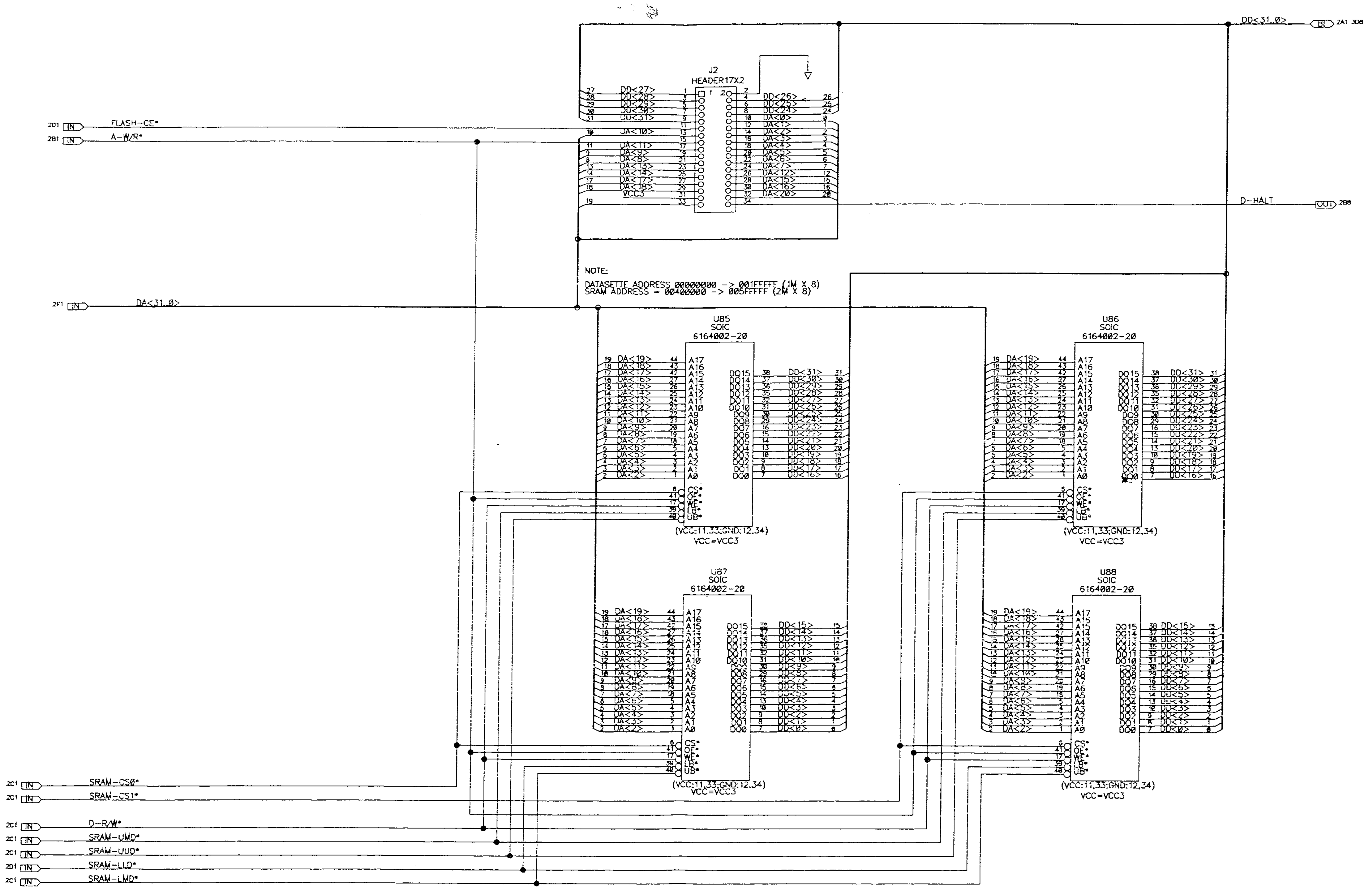
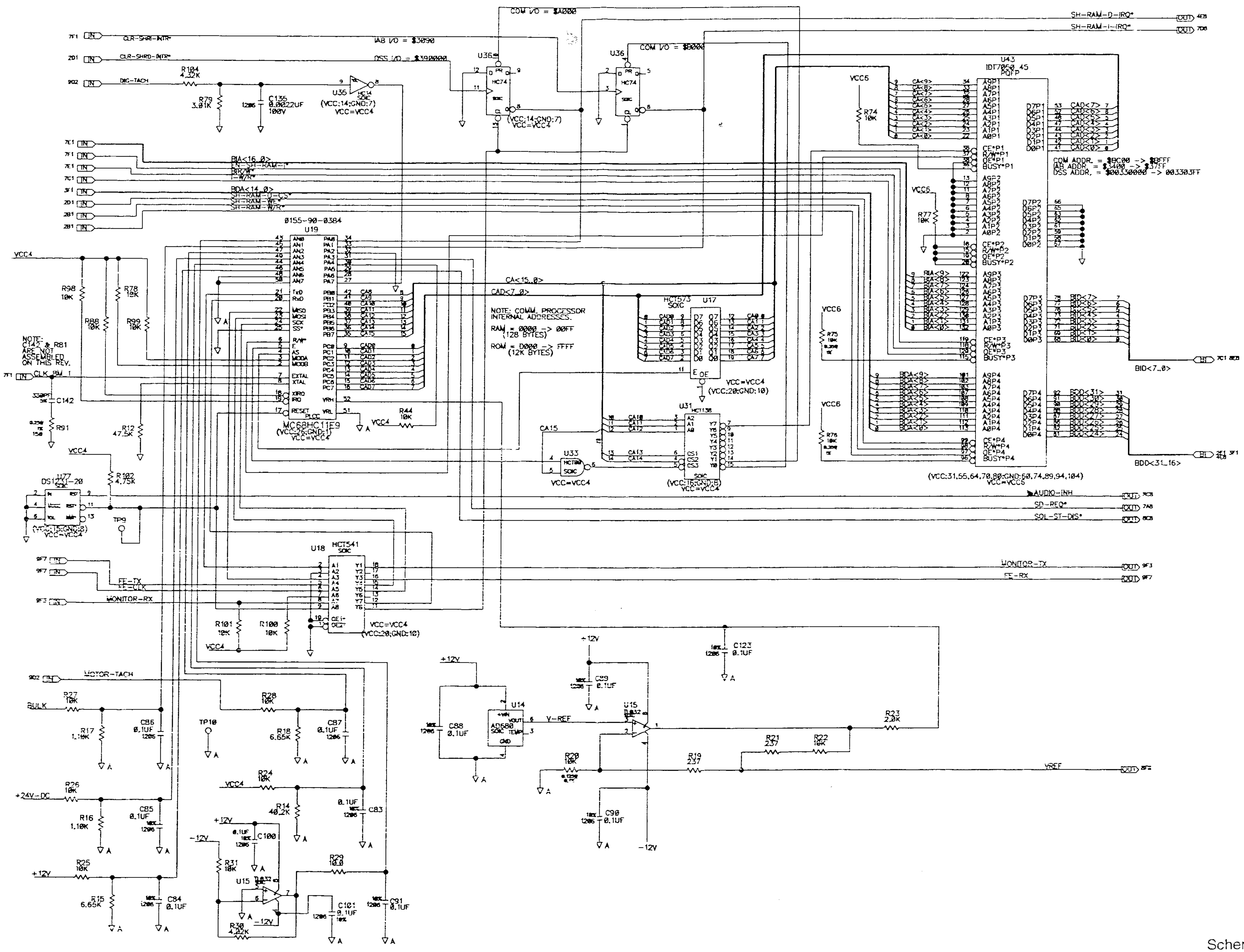


Schematic Diagram

MAIN BOARD

0387-00-0666

Sheet 5 of 9



Schematic Diagram

MAIN BOARD

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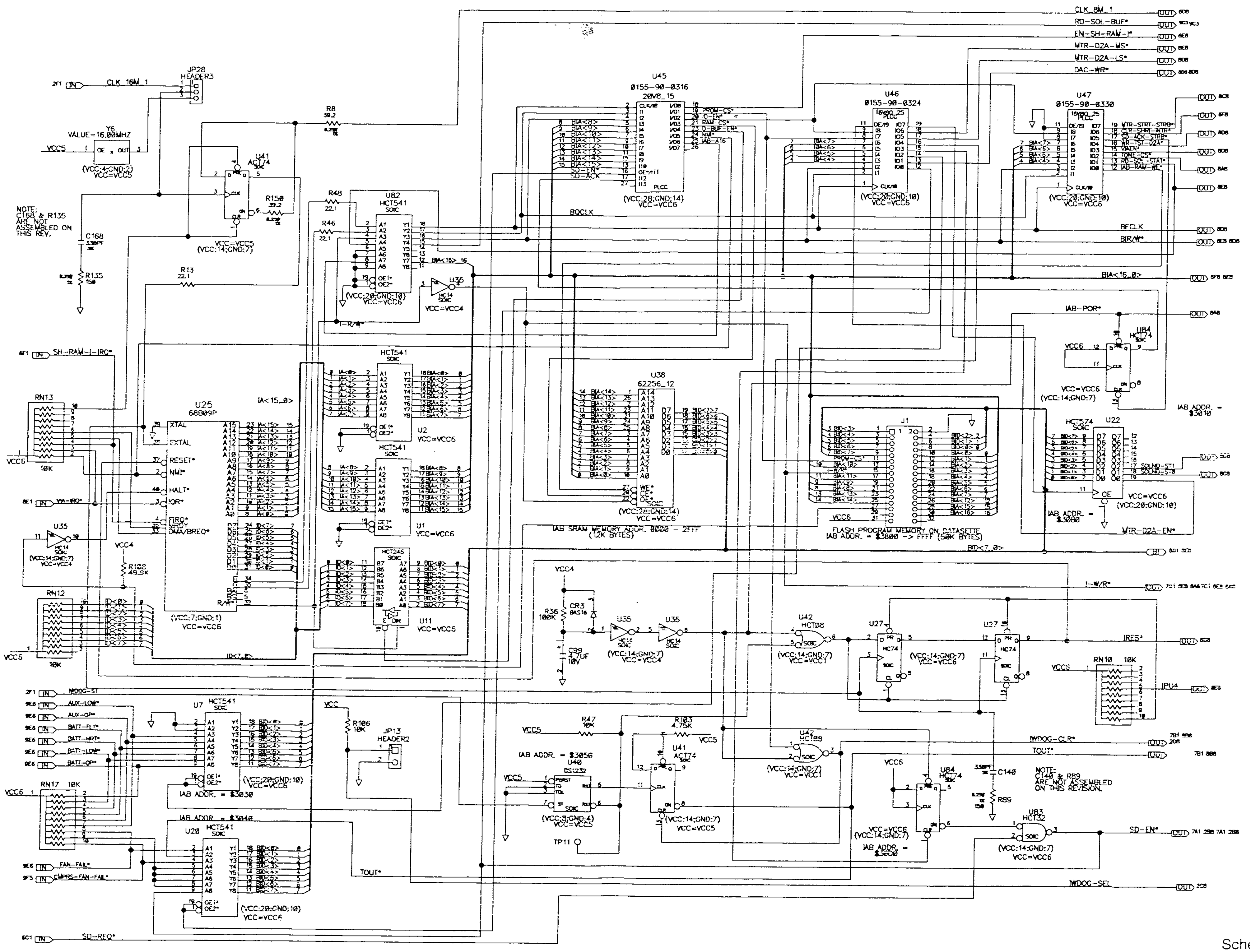

Schematic Diagram

MAIN BOARD

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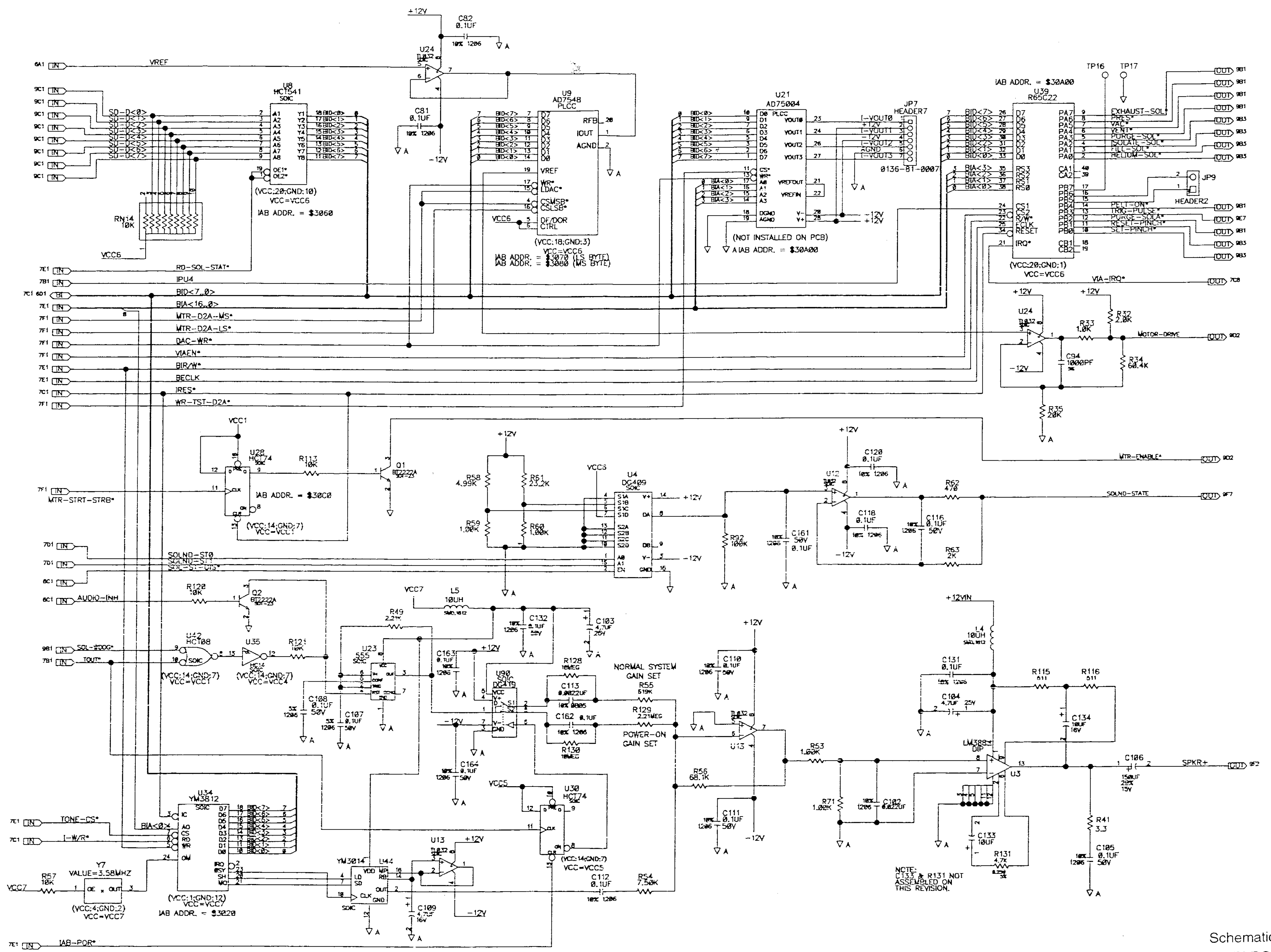

Schematic Diagram

MAIN BOARD

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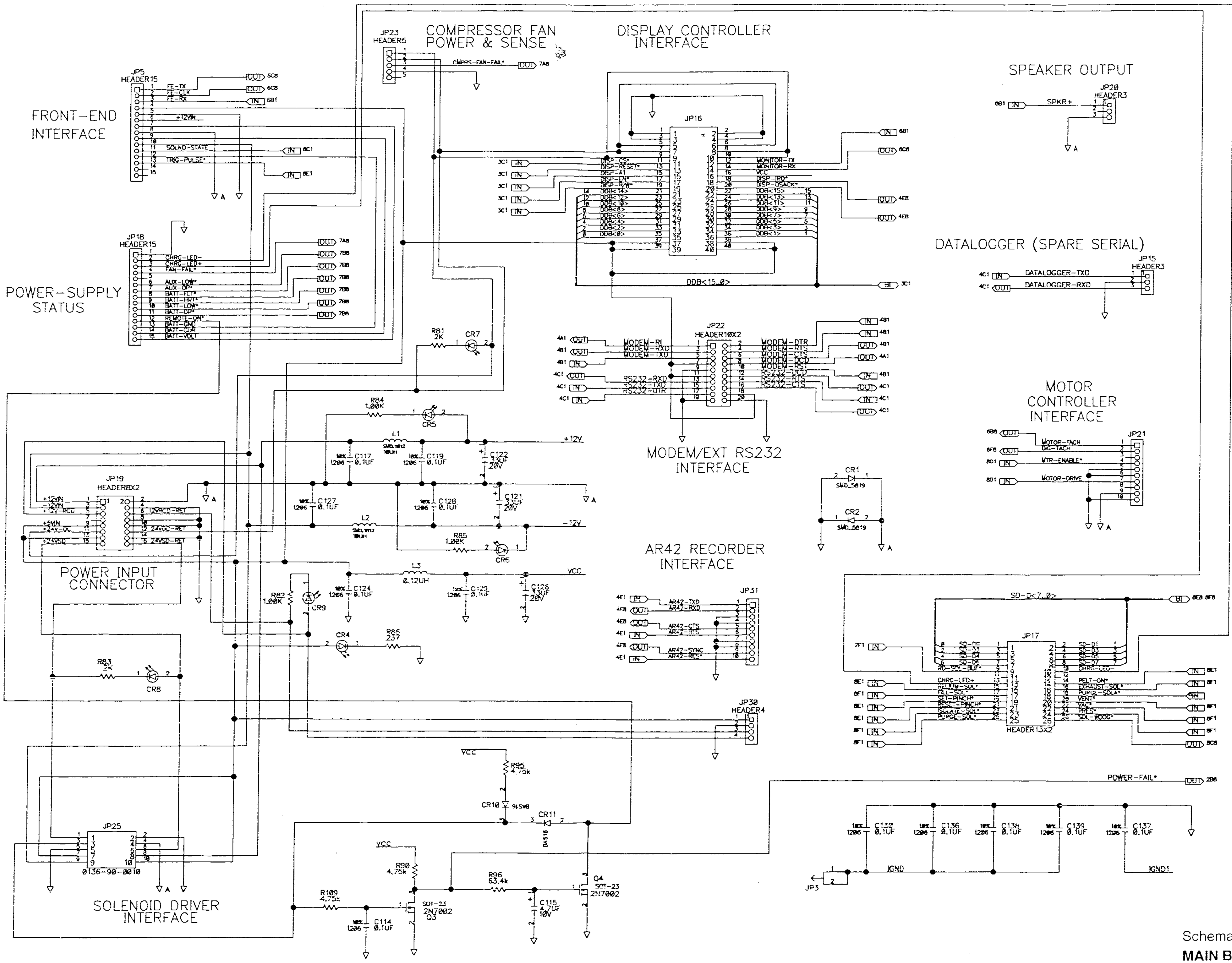

Schematic Diagram
MAIN BOARD
0387-00-0666
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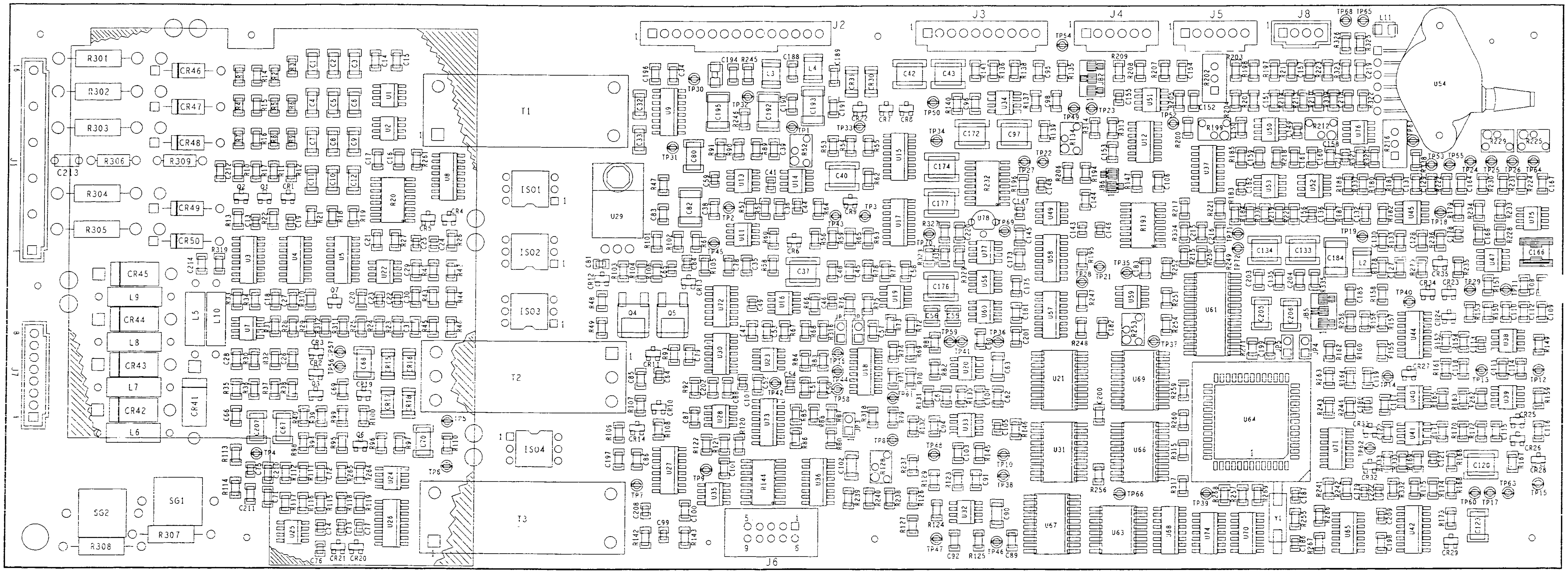
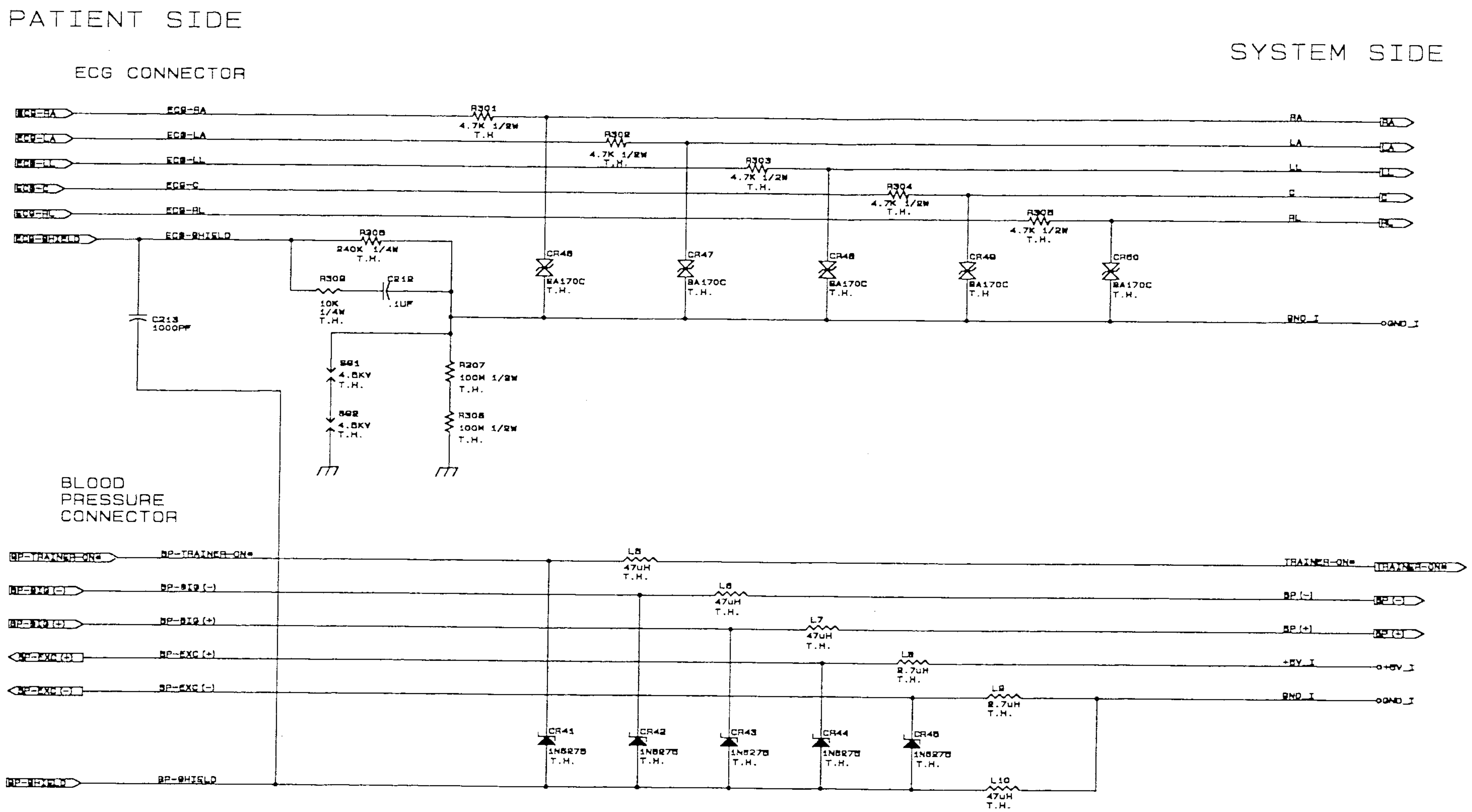


FRONT END BOARD ASSY.

0670-00-0668

CSD CIRCUITRY



Schematic Diagram
FRONT END BOARD
0387-00-0668
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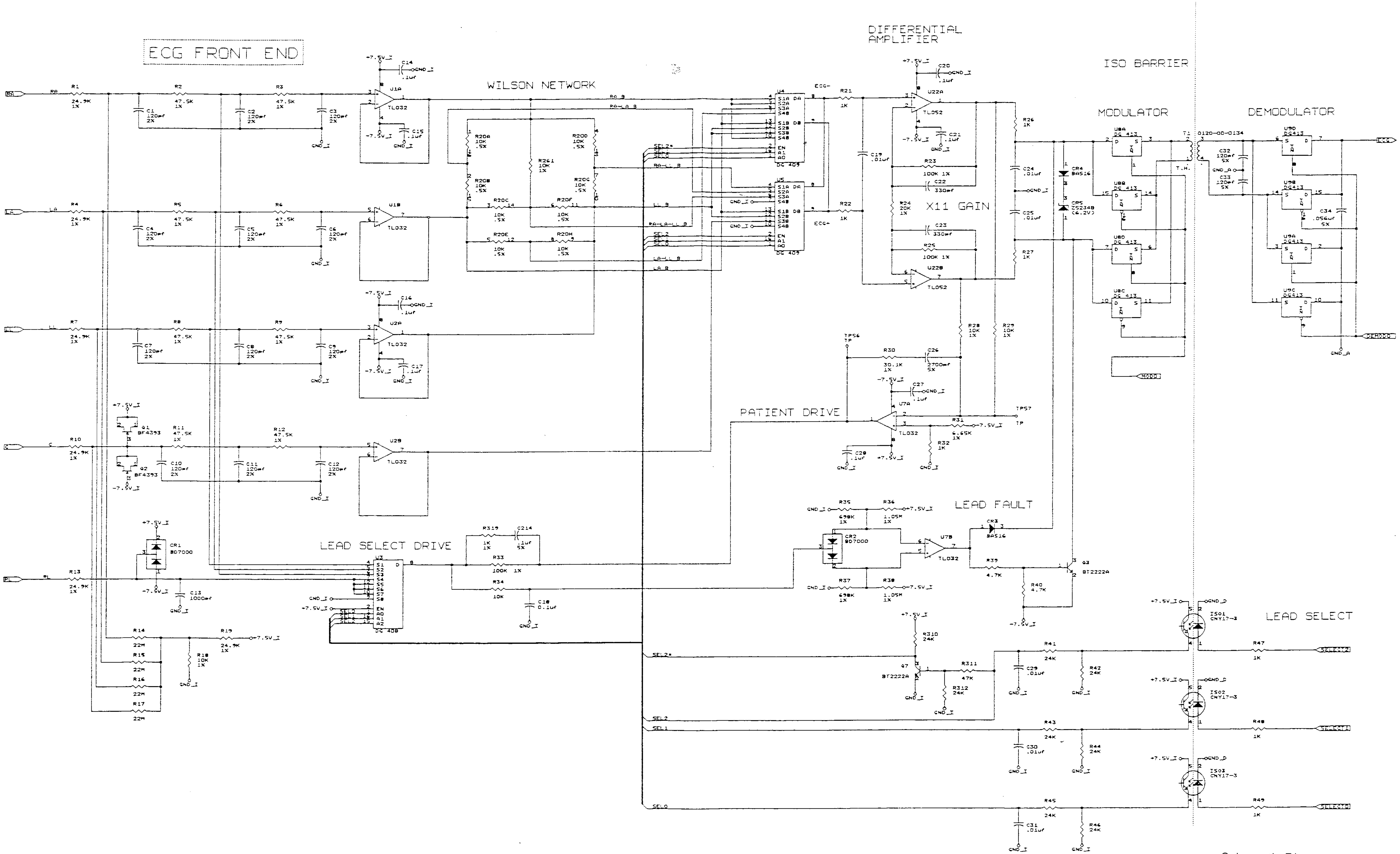

Schematic Diagram
FRONT END BOARD
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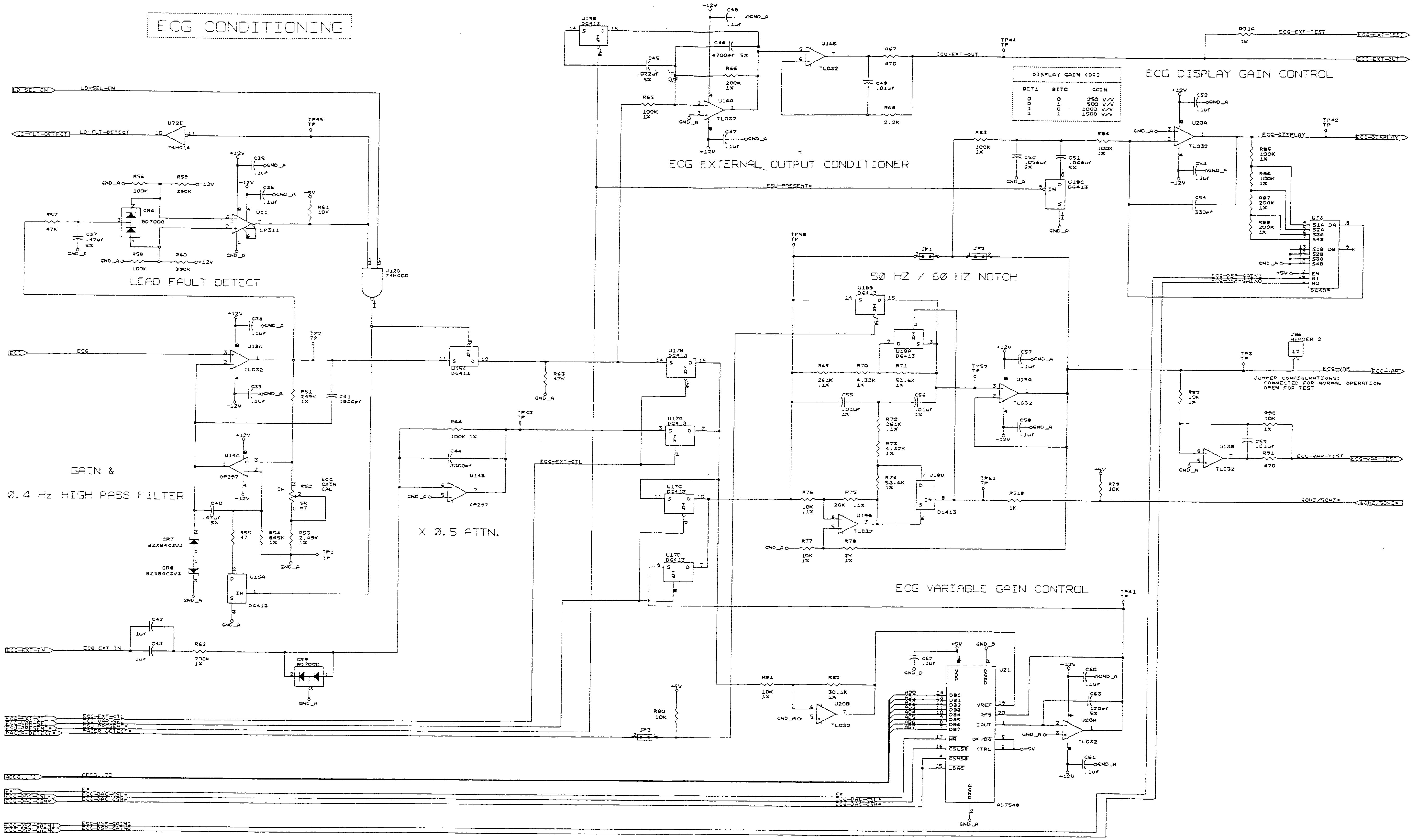

Schematic Diagram
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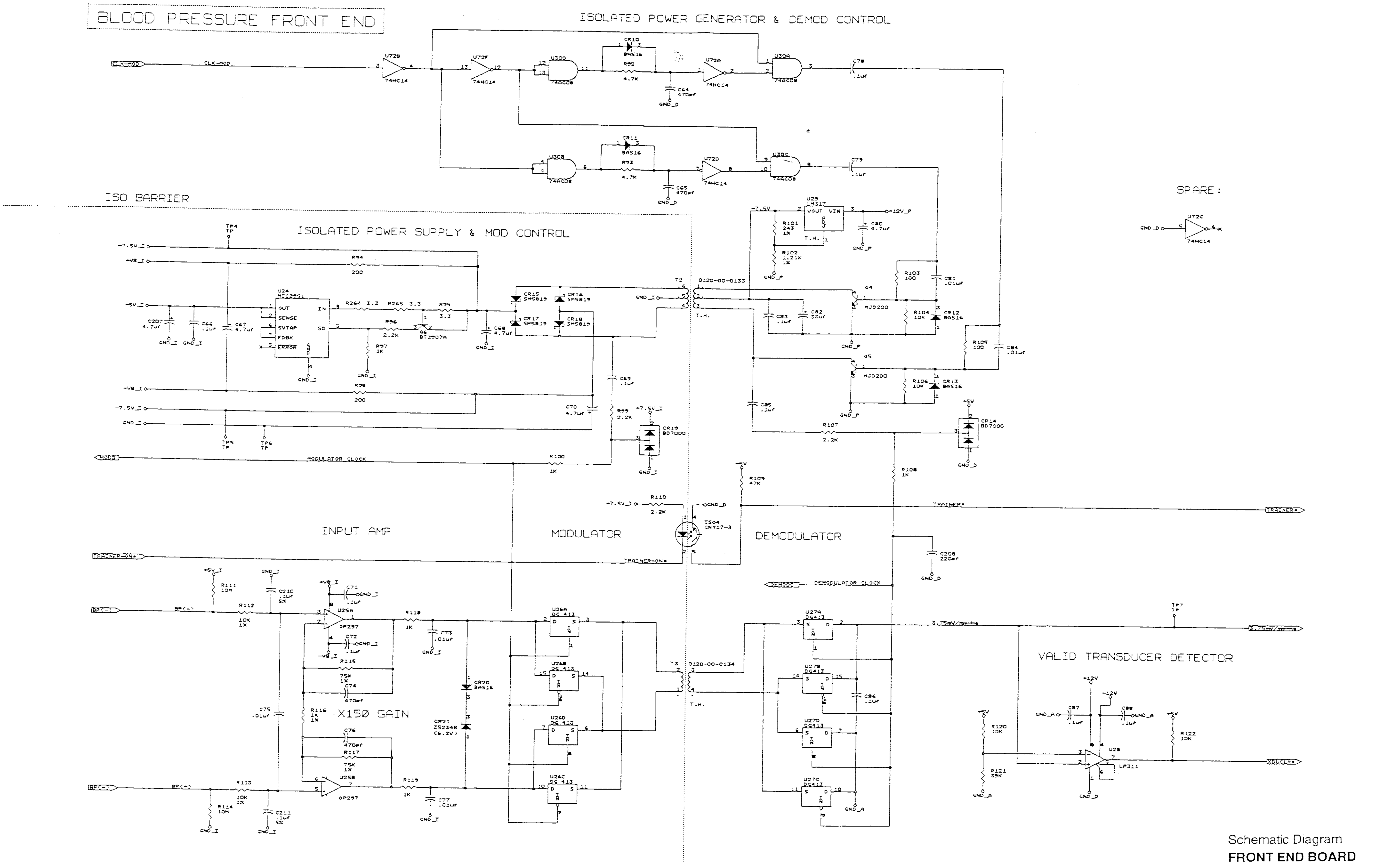

Schematic Diagram
FRONT END BOARD
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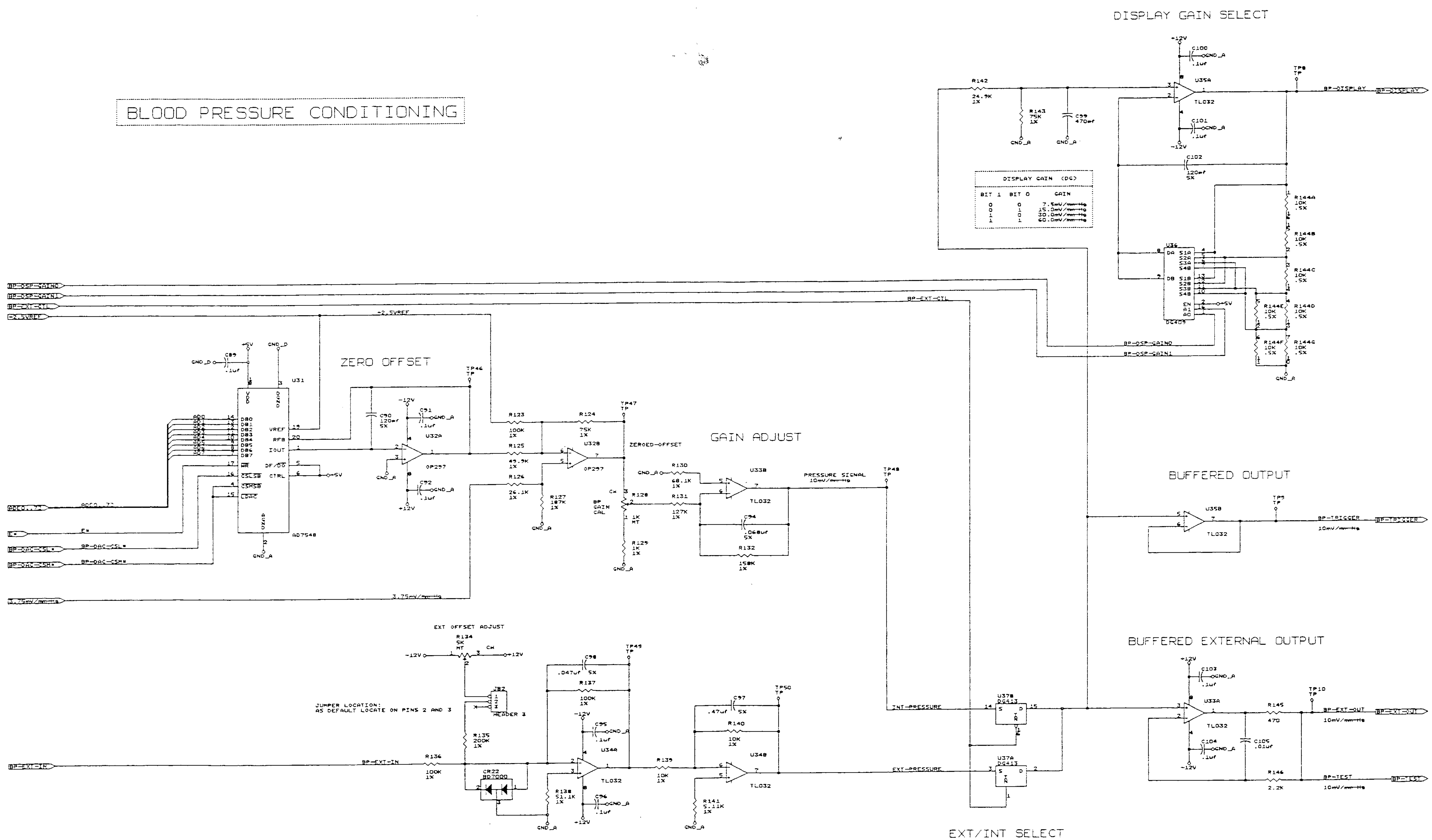

Schematic Diagram
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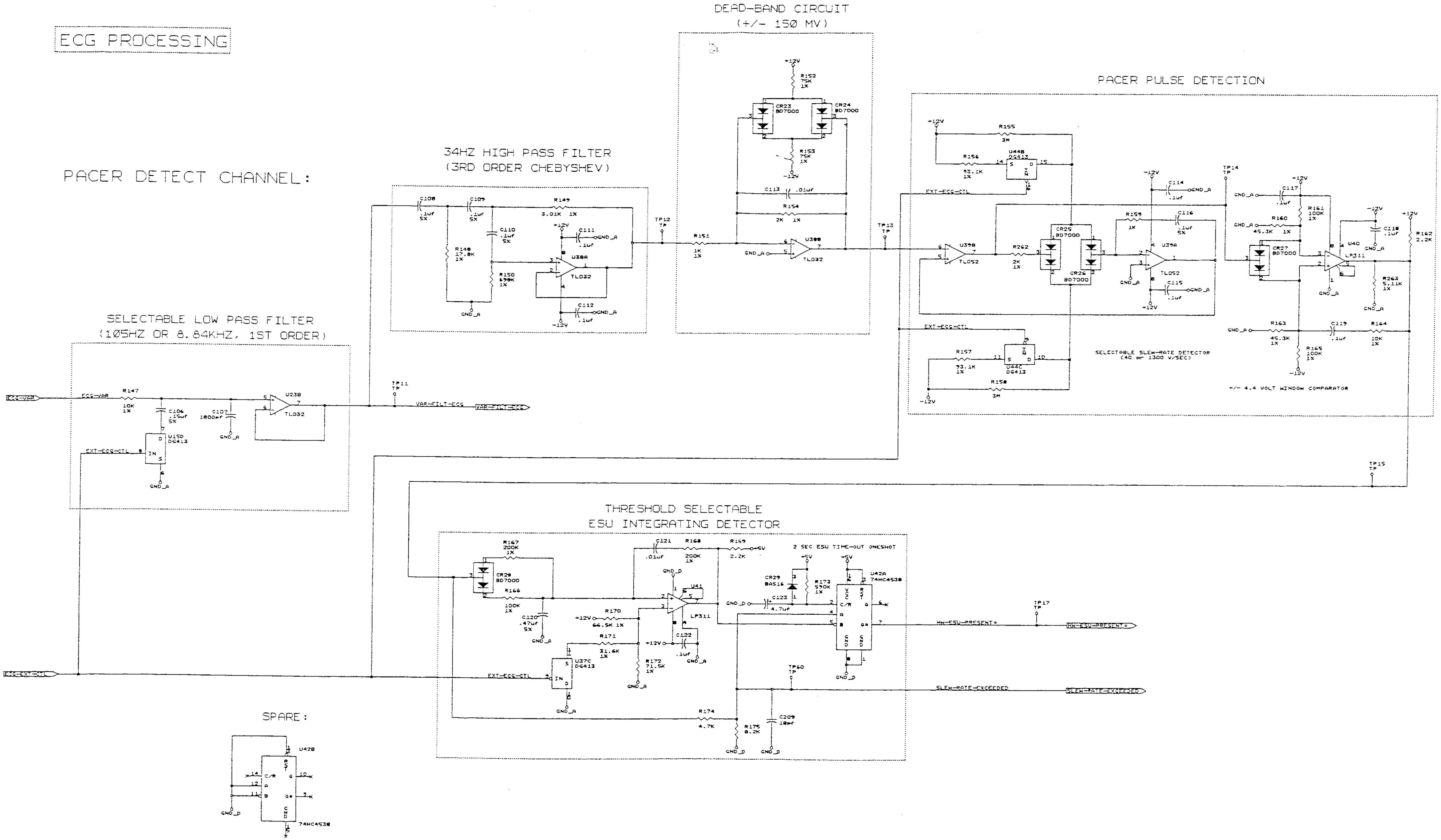

Schematic Diagram
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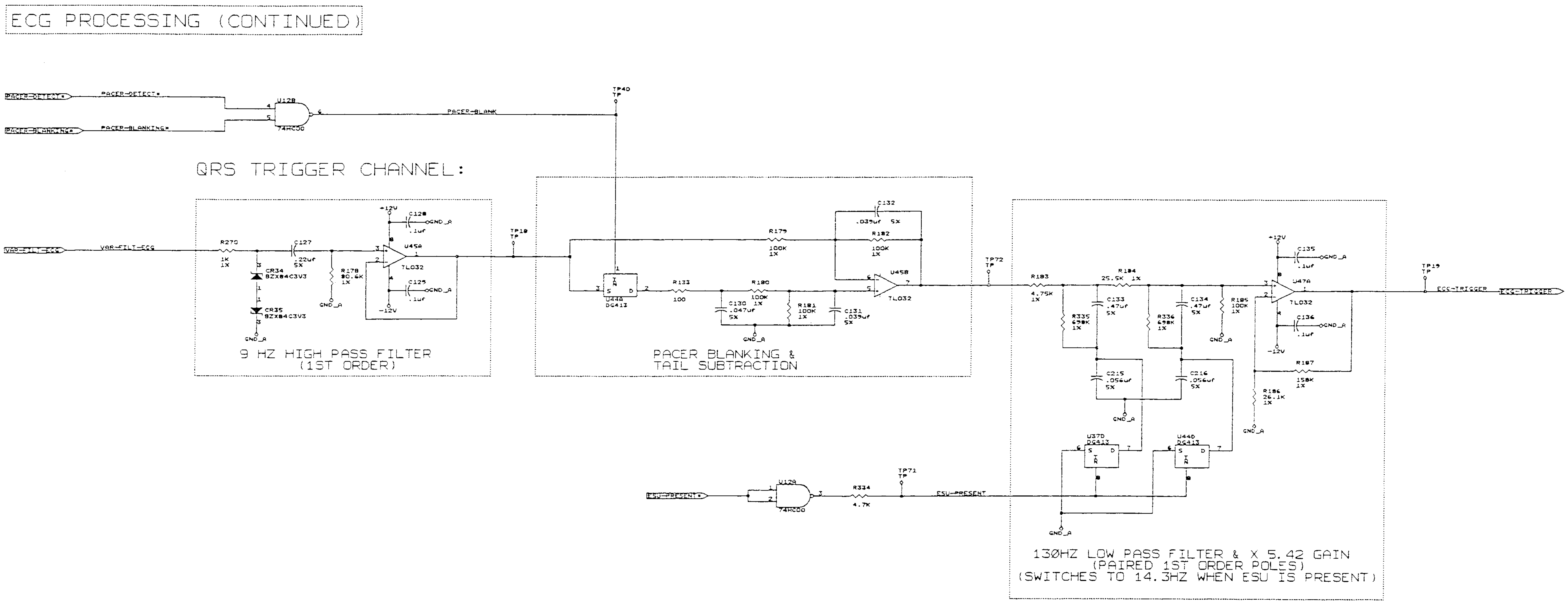

Schematic Diagram

FRONT END BOARD

0387-00-0668

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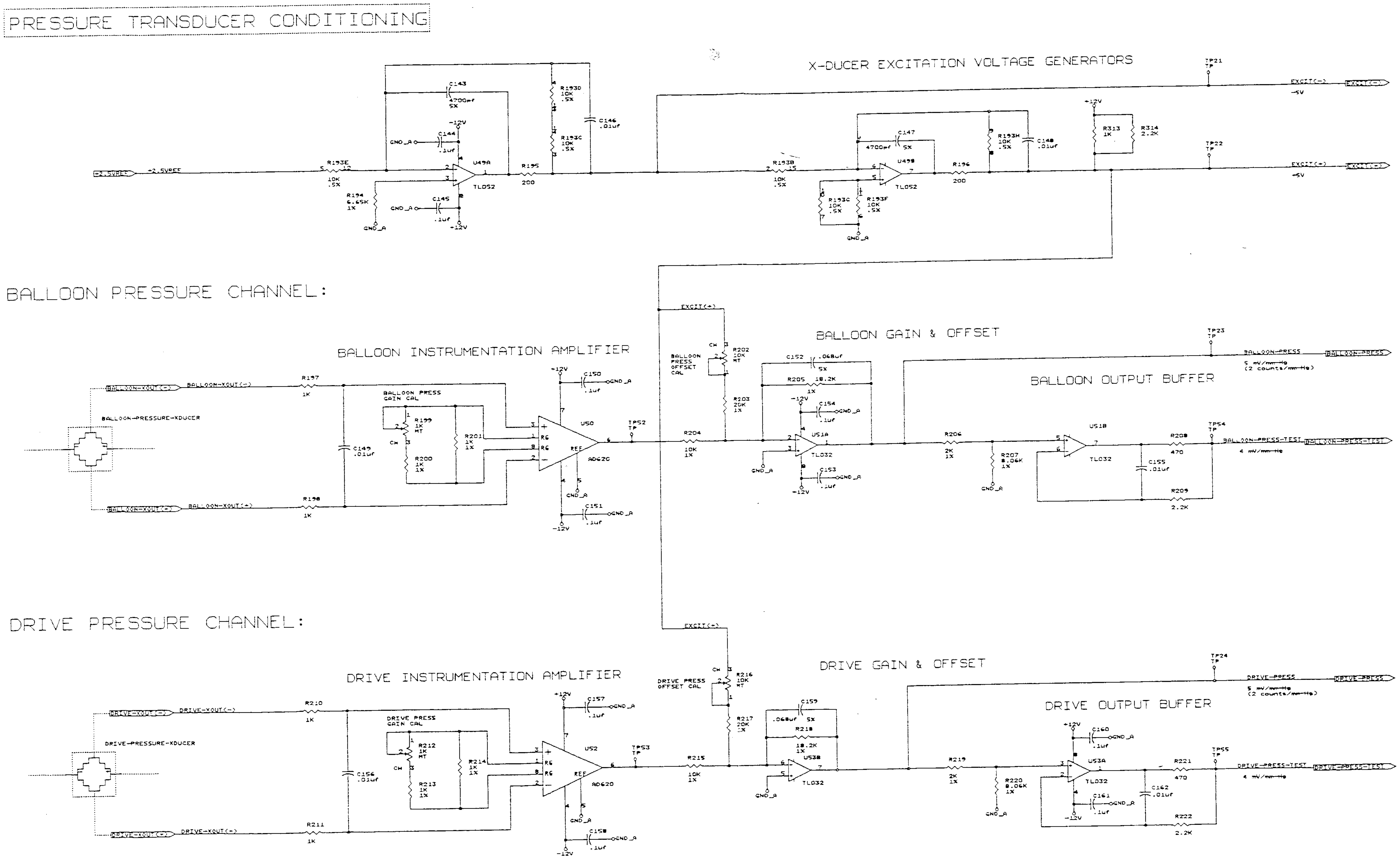

Schematic Diagram
FRONT END BOARD
0387-00-0668
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MISCELLANEOUS SIGNAL CONDITIONING

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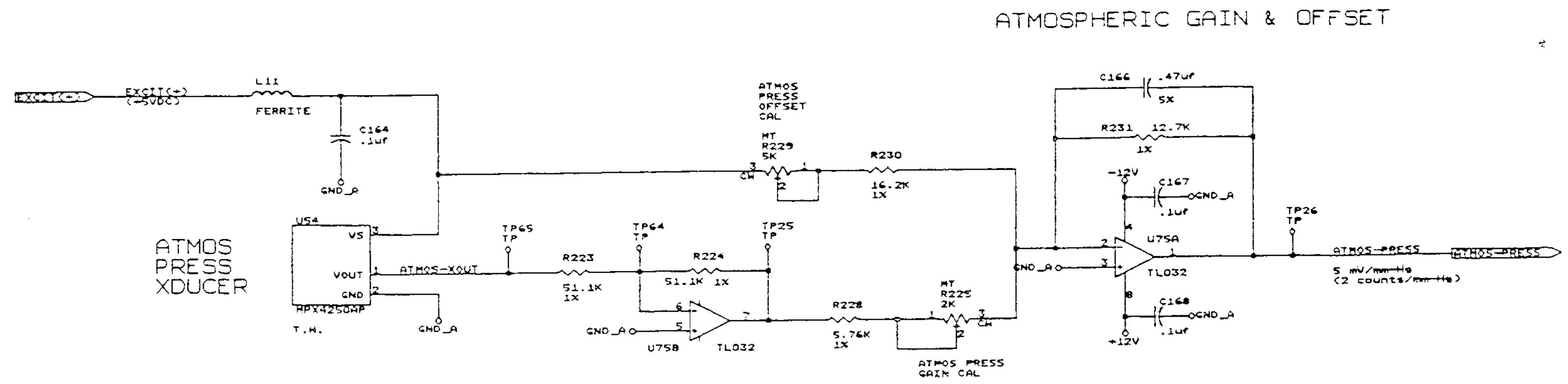
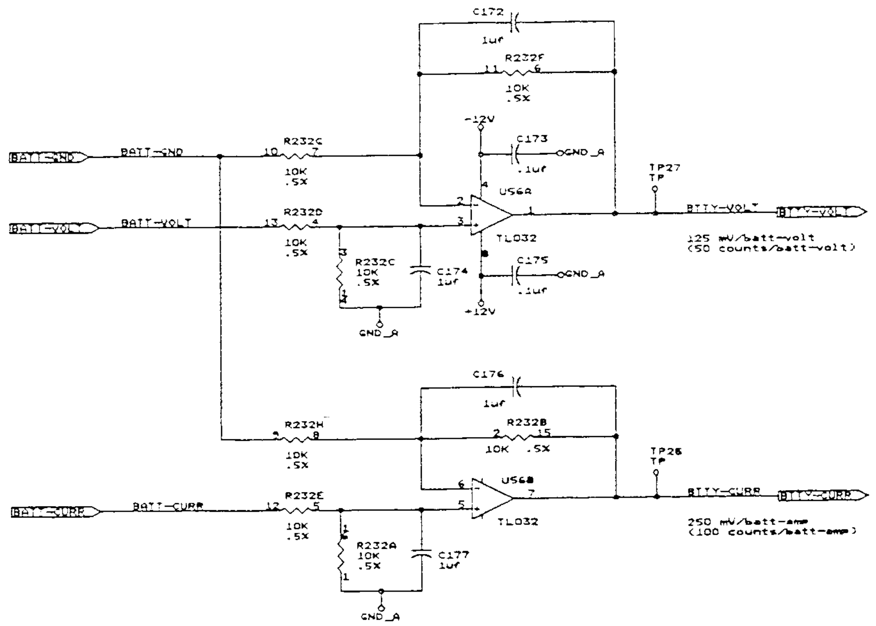


BATTERY CHANNELS:



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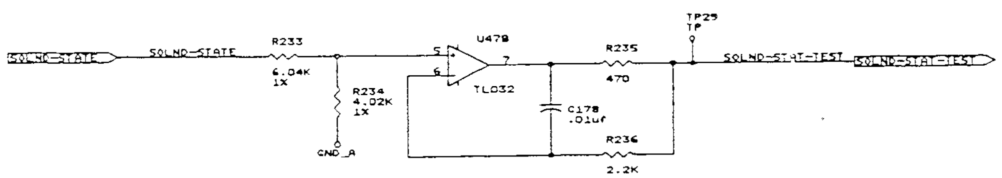
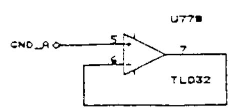
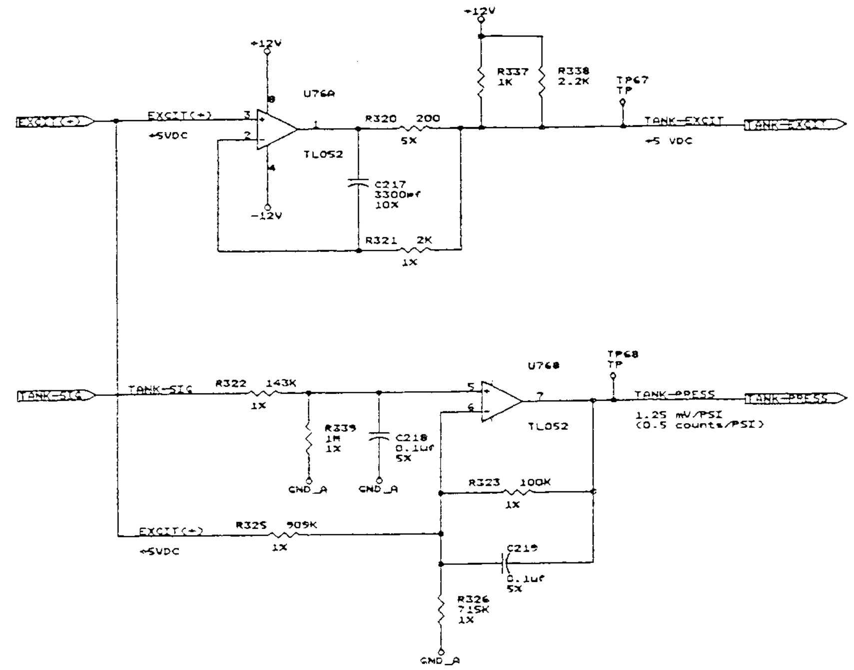


SPARE:



HELIUM TANK PRESSURE CHANNEL:



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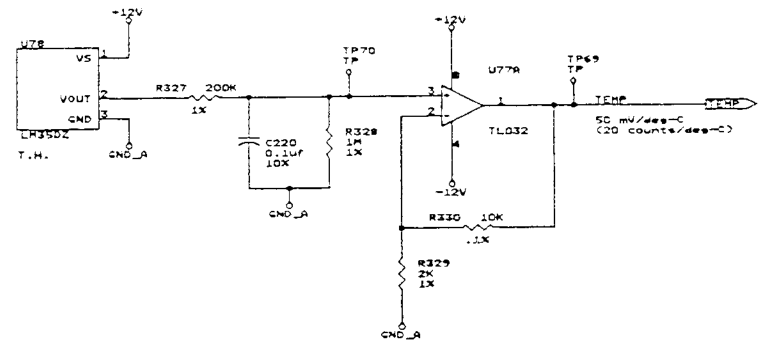

Schematic Diagram
FRONT END BOARD
0387-00-0668
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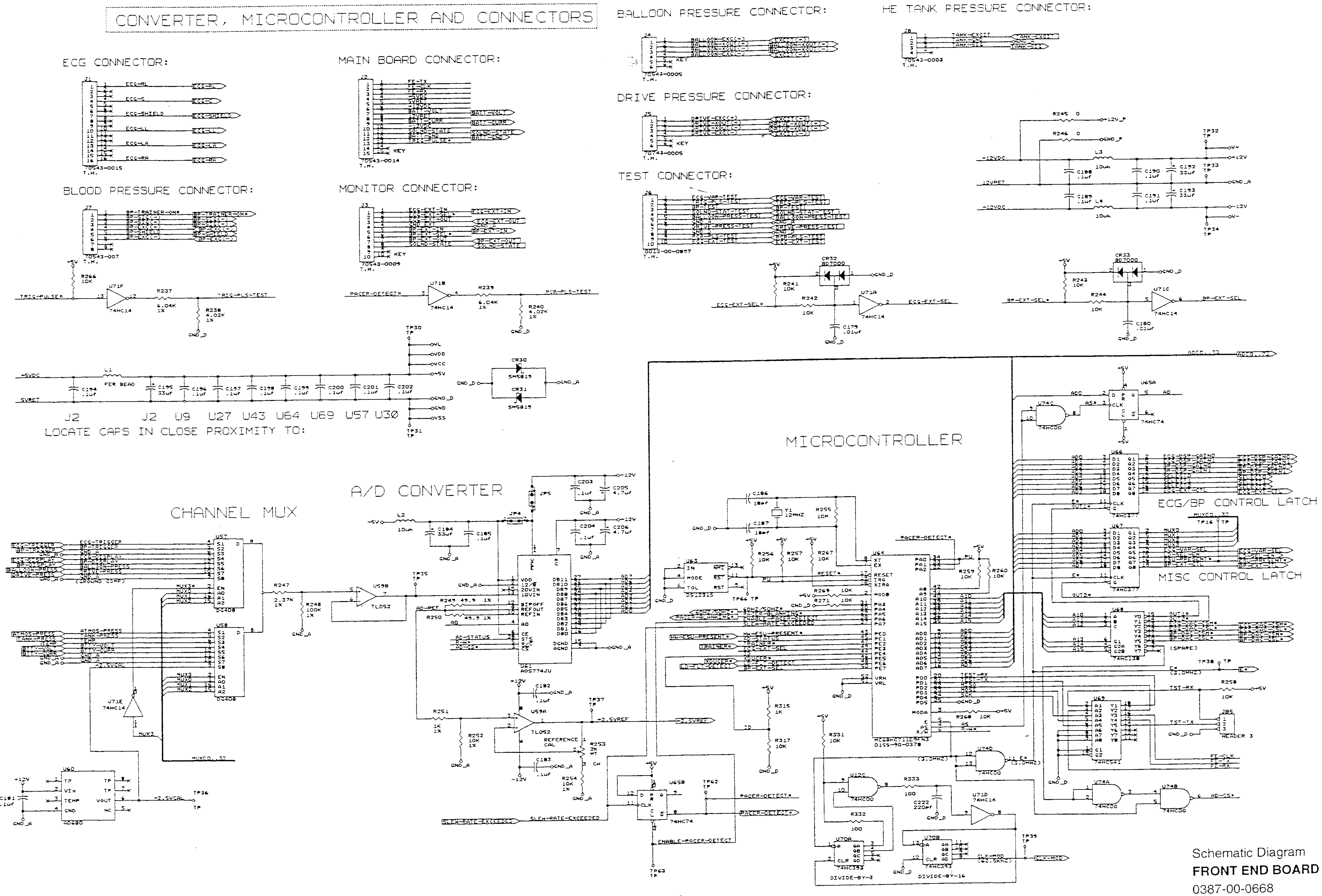

Schematic Diagram
FRONT END BOARD
0387-00-0668
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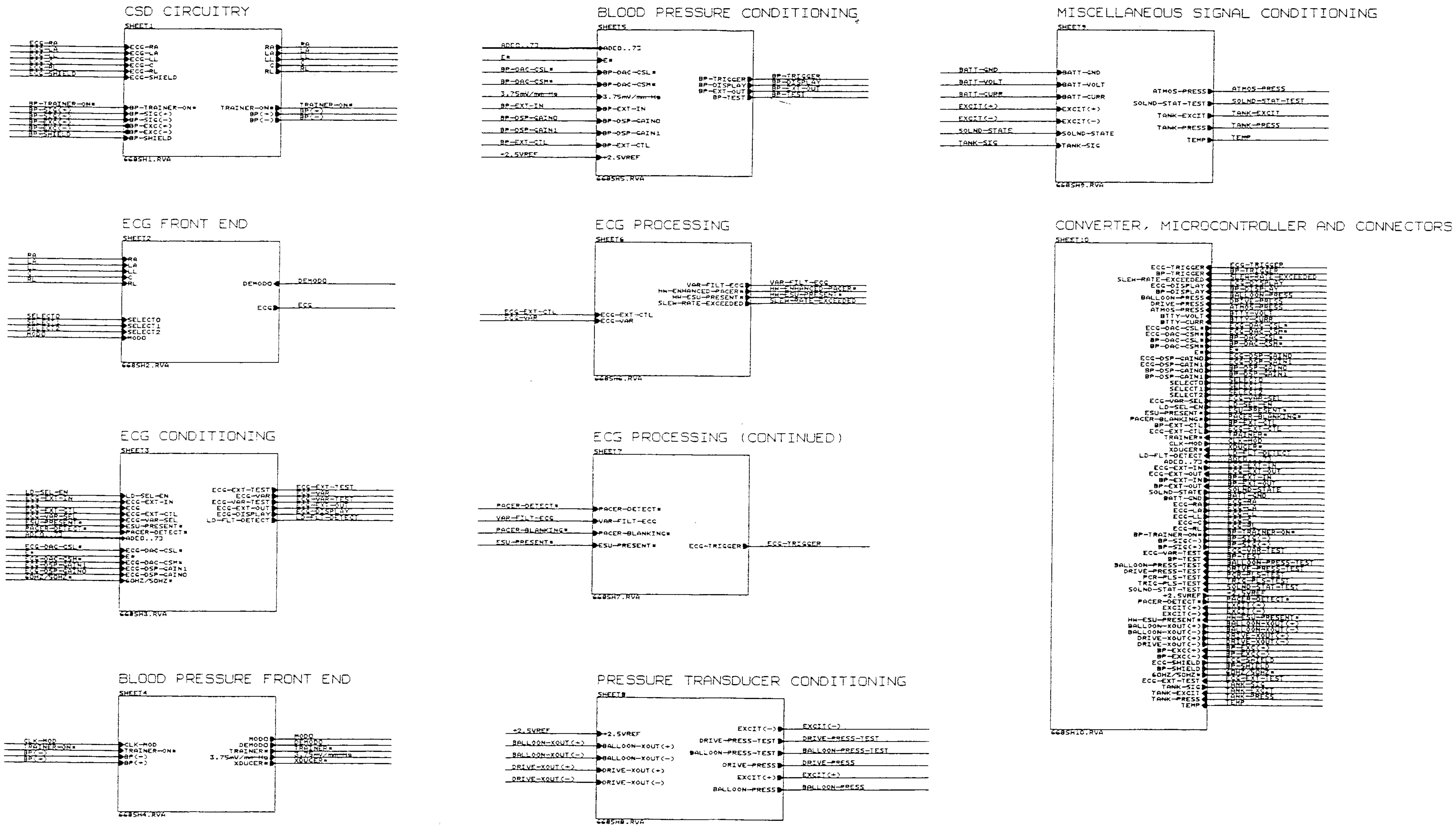
ROOT LEVEL SCHEMATIC



Schematic Diagram
FRONT END BOARD
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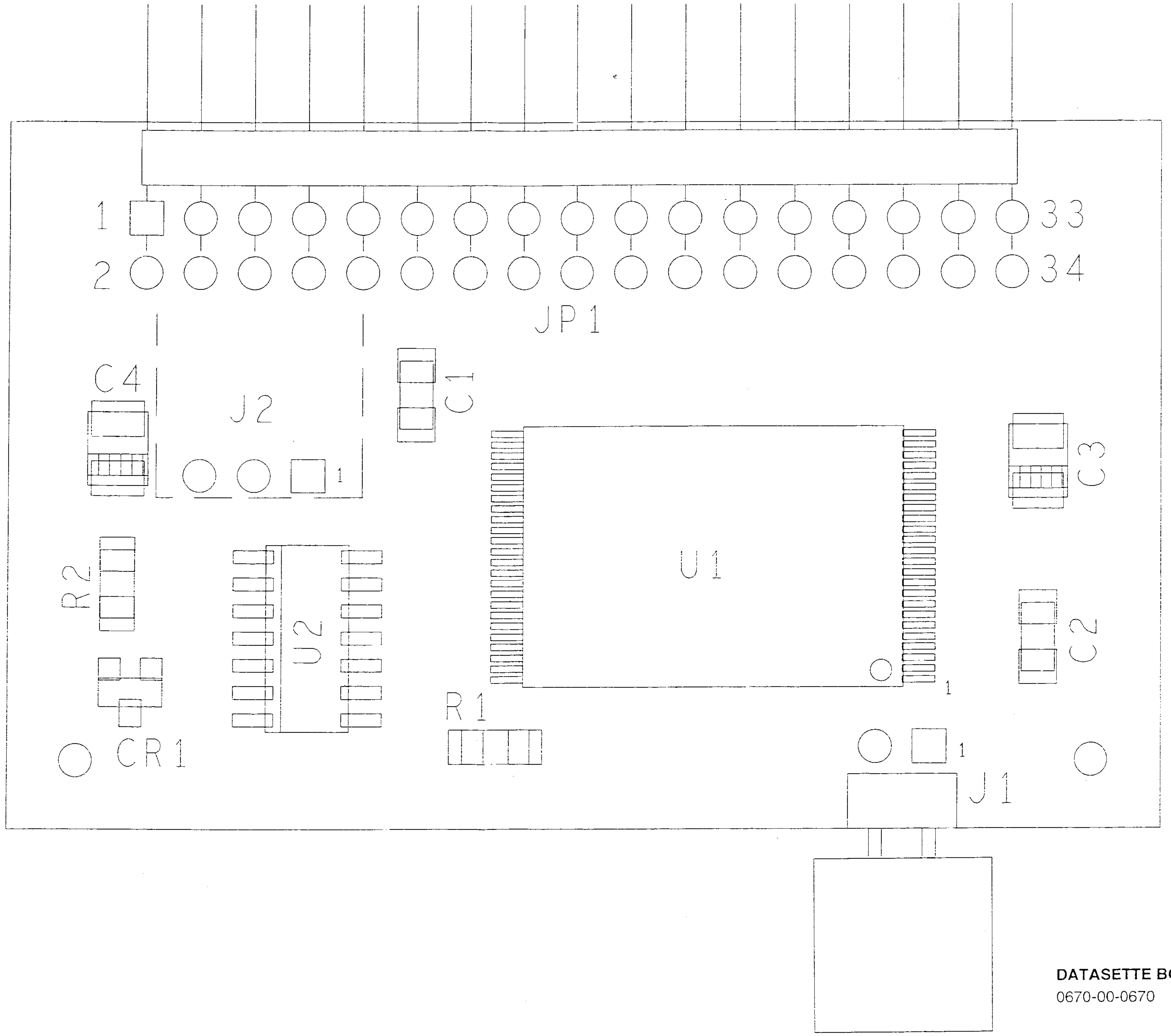
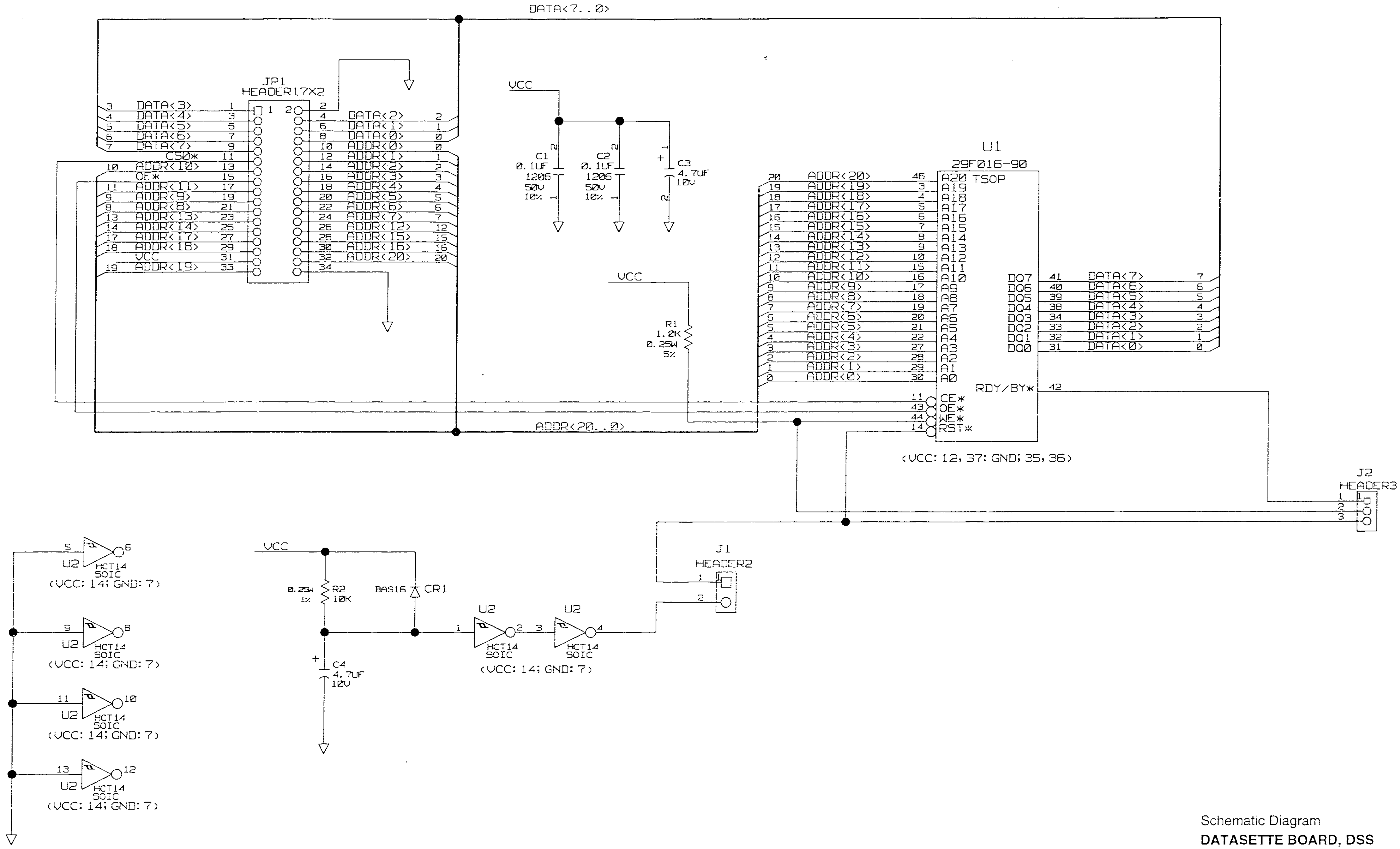


DATASETTE BOARD, DSS ASSY.
0670-00-0670

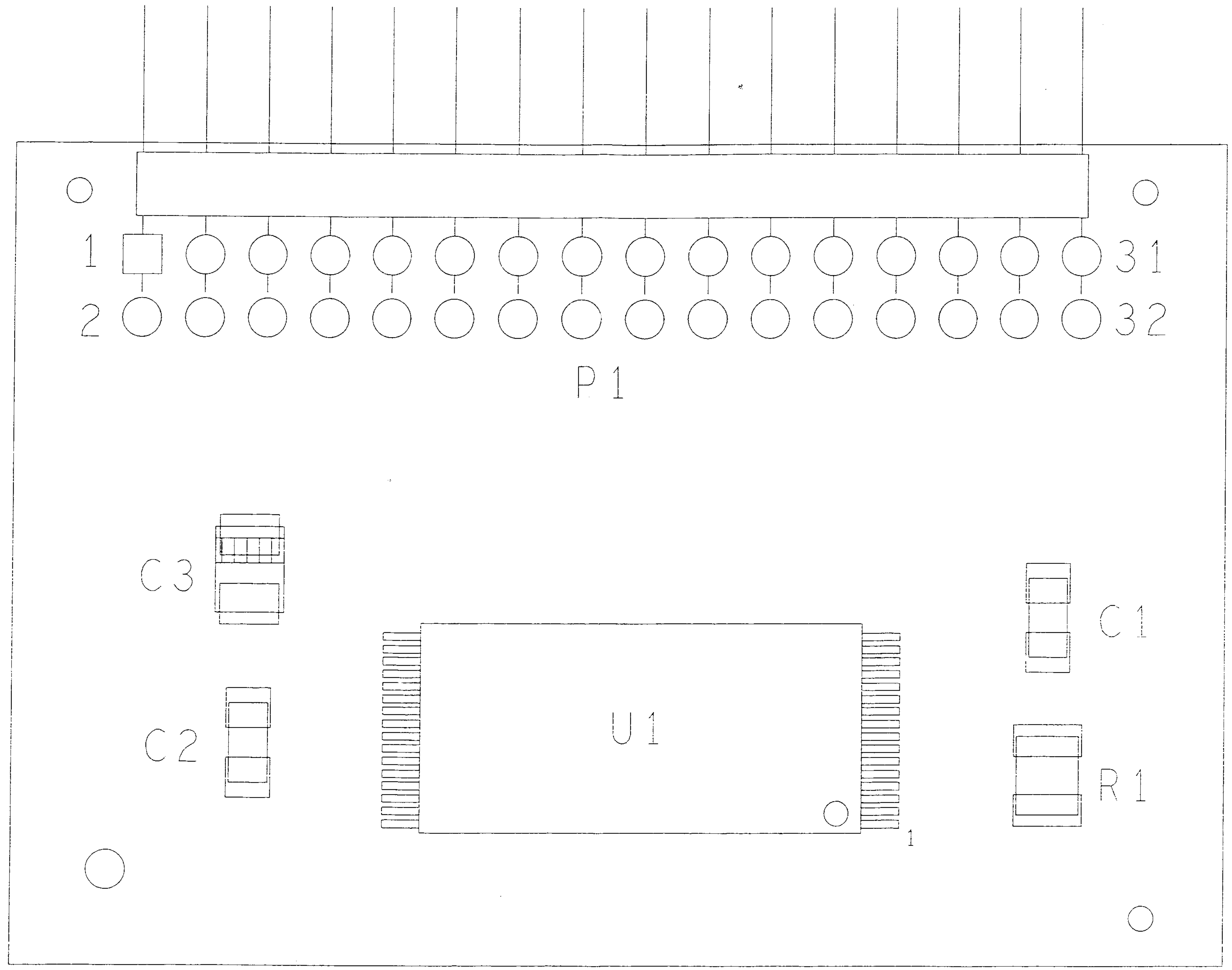


Schematic Diagram

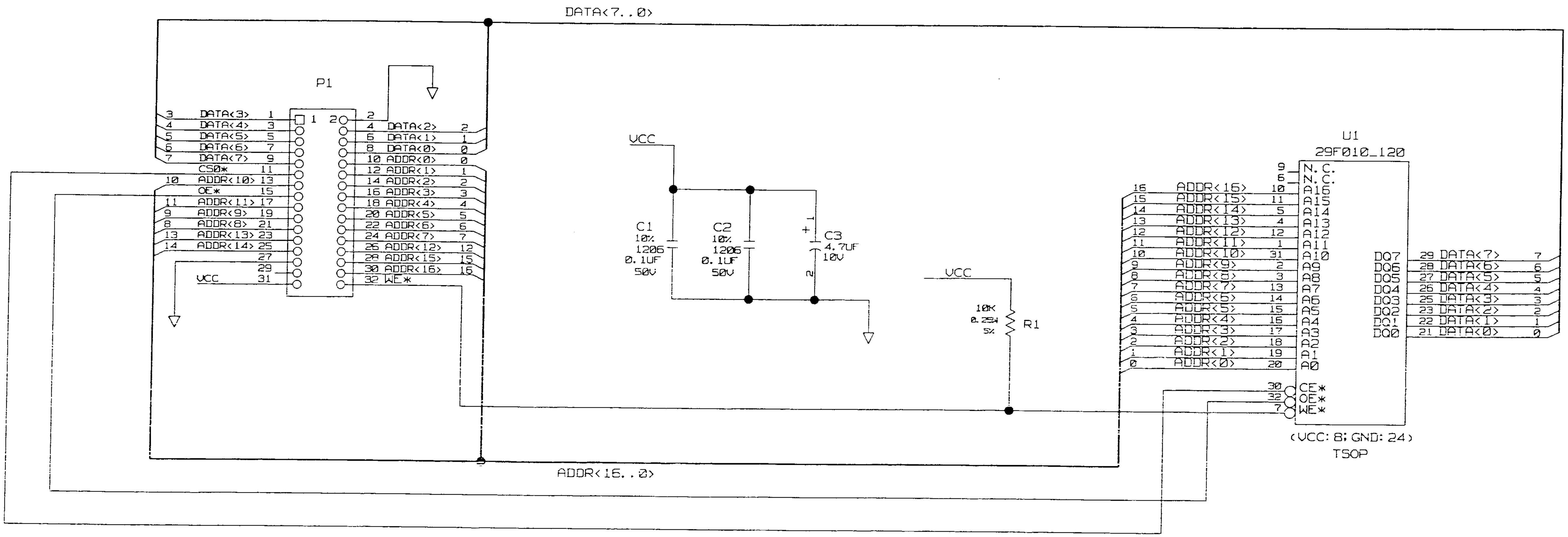
DATASETTE BOARD, DSS

0387-00-0670

Sheet 1 of 1



DATASETTE BOARD, IABP ASSY.
0670-00-0671



Schematic Diagram

DATASETTE BOARD, IABP

0387-00-0671

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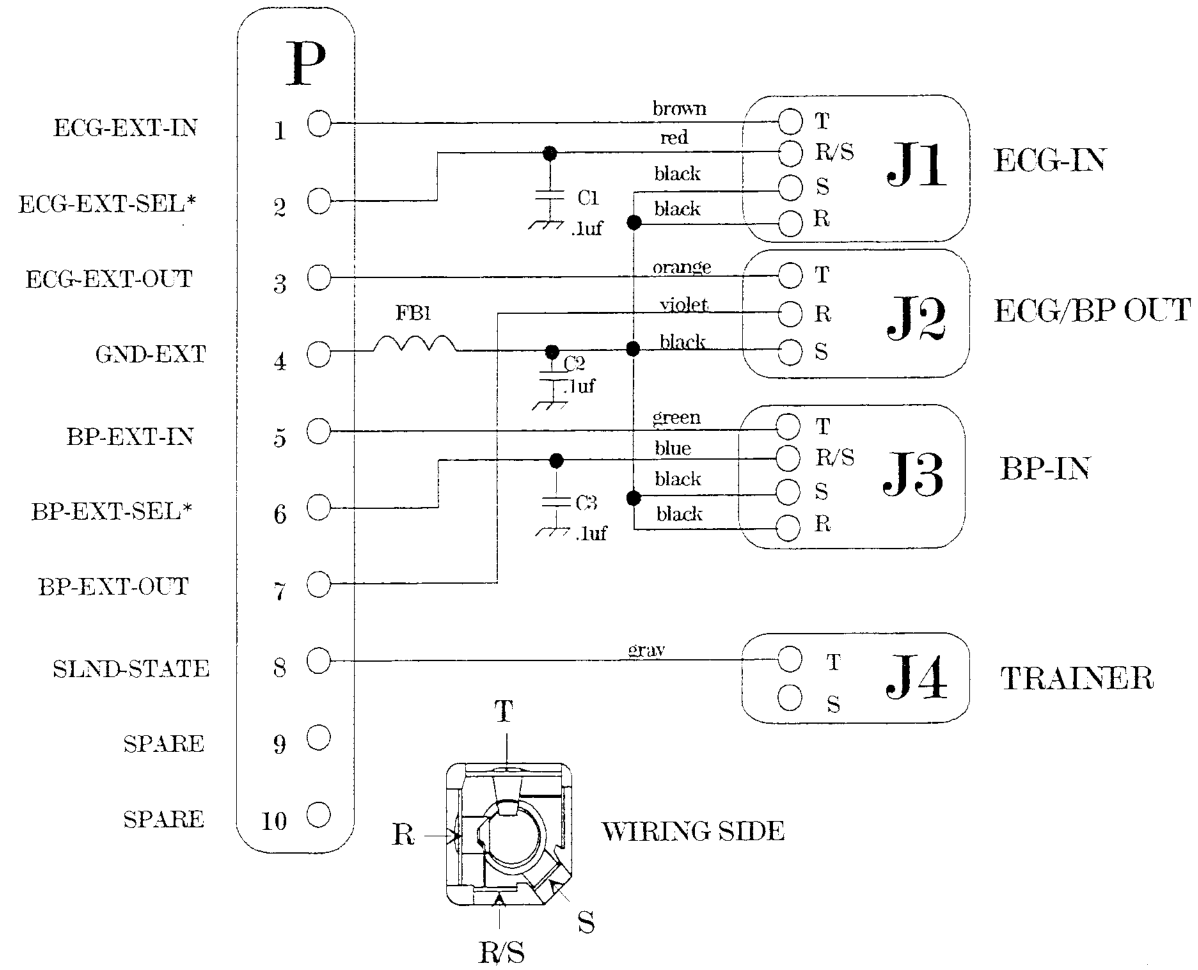

EXTERNAL MONITOR CABLE ASSY.
0012-00-0765

6. REPLACEMENT PARTS

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6.1 INTRODUCTION

This chapter of the Service Manual provides information necessary to identify the replacement parts and assemblies of the instrument.

6.2 AVAILABLE REPLACEMENT PARTS AND SUB-ASSEMBLIES

The parts listings which follow are divided into two sections. The Isometric Drawings and the accompanying partslists identify the available chassis mounted components. A partslist for the components on each circuit board then follows. Many components such as resistors, capacitors, intergrated circuits, transistors, etc..., are not stocked by Datascope but are described with sufficient detail to allow for procurement through local channels. However, in some cases, components are selected by Datascope to meet special performance criteria above and beyond the component manufactures specifications. This may apply to solid state components, relays and batteries. The use of other than Datascope components in these applications may result in degradation of reliability or instrument performance characteristics.

6.3 PRODUCT VARIATIONS AND OPTIONS

Product variations, due to differences for various line voltages, may require different components. These variations are reflected, where necessary, on the parts lists.

6.4 EXCHANGE PROGRAM

Datascope offers an exchange policy for many of the printed circuit board assemblies. This program may provide the most expedient method of servicing the equipment. A standard charge for this service is made. Contact the Datascope Service Department for details concerning this exchange program.

Many circuit boards make extensive use of multilayer and surface mount technology. Individual component replacement is not recommended on these boards. Board exchange or replacement is the most efficient method of repair for these type of assemblies. Component level repair is not recommended.

Circuit boards, returned as parts of the exchange program, that show evidence of improper repair techniques and are damaged in the process are not considered for exchange. Damaged boards will be invoiced at full value and no exchange credit will be applied.

6.5 REPLACEMENT PARTS PRICING INFORMATION

Current parts prices and exchange charges can be determined by contacting Datascope, Order Entry Department.

6.6 ORDERING INFORMATION

Replacement parts and assemblies are available from Datascope Corp., and in Europe from Datascope B.V. Please follow these guidelines when ordering replacement items for the instrument.

1. Include the Model and Serial Number of the instrument.
2. Include the Datascope Part Number exactly as it appears in the Parts List under the column, "Datascope Part Number."
3. Include a description of the item.

EXAMPLE ORDERS: (1) ea. P/N 0334-00-1120
Label, Fuse Replacement, Serial No. XXXX

(2) ea. P/N 0213-07-0404
Screw, Self Tap, #4 x 0.25", Serial No. XXXX

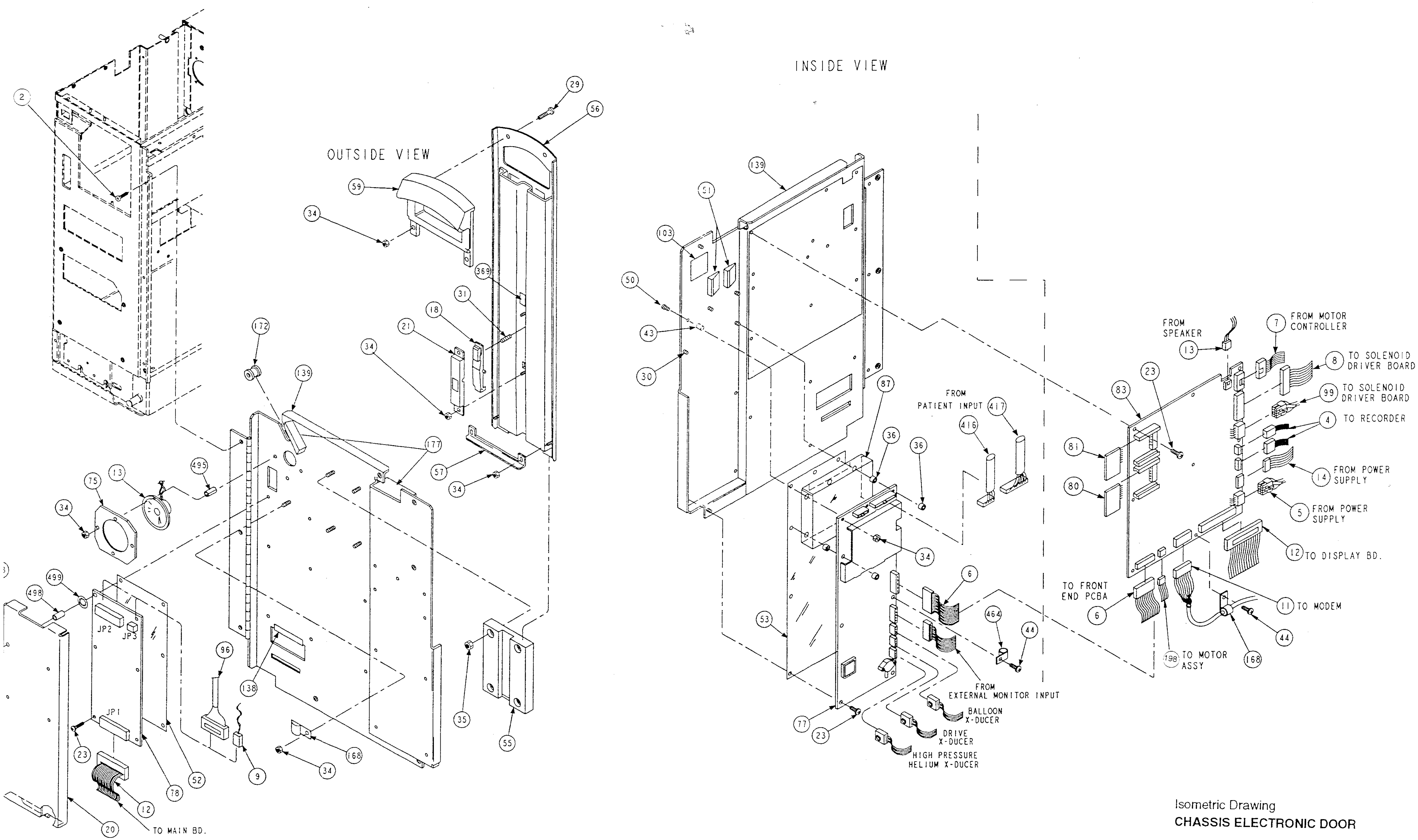
NOTES:

Datascope Corp. maintains a policy of continuous development for product improvement and reserves the right to change materials, specifications, and prices without notice.

6.7 ABBREVIATIONS

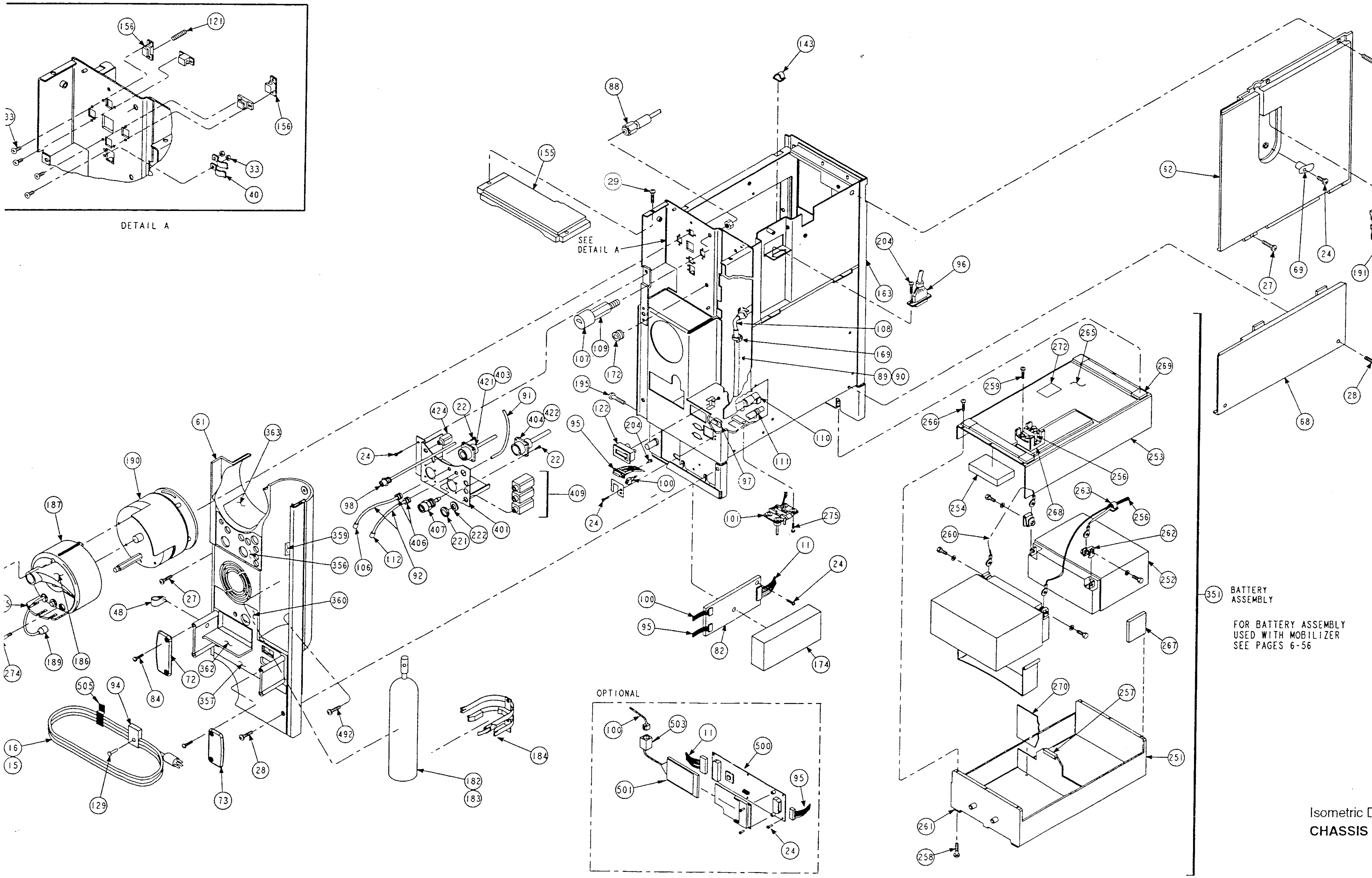
The following abbreviations may appear in the parts listings which follow and throughout the manual.

Abbreviation	Term	Abbreviation	Term
A/D	Analog to Digital	NTWK	Network
AMP	Amplifier		
		OP	Operational
BUF	Buffer		
		PB	Push Button
CAP	Capacitor	PIA	Peripheral Interface Adaptor
CC	Carbon Composition	POT	Potentiometer
CER	Ceramic	PRESS	Pressure
CERM	Ceramic	PWR	Power
CNTR	Counter		
CONN	Connector	RAM	Random Access Memory
CONT	Controller	REC	Receiver
CONV	Converter	RECT	Rectangular
CPU	Central Processing Unit	REG	Regulated RES Resistor
DCDR	Decoder	STG	Stage
DIFF	Differential	STK	Stacked
DIA	Diastolic	SUP	Supply
DIO	Diode	SW	Switch
D/A	Digital to Analog	SYST	Systolic
ELEC	Electrolytic	TANT	Tantalum
EPROM	Erasable Programmable Read Only Memory	TRANS	Transistor
		TRANSIS	Transistor
FXD	Fixed	VAR	Variable
I.C.	Integrated Circuit	VIA	Versatile Interface Adapter
INT. CKT.	Integrated Circuit		
		XDCR	Transducer
KYBD	Keyboard	XFMR	Transformer
		XSTL	Crystal
LED	Light Emitting Diode	XSTR	Transistor
MF	Metal Film		
MONO	Monostable		
MYLR	Mylar		

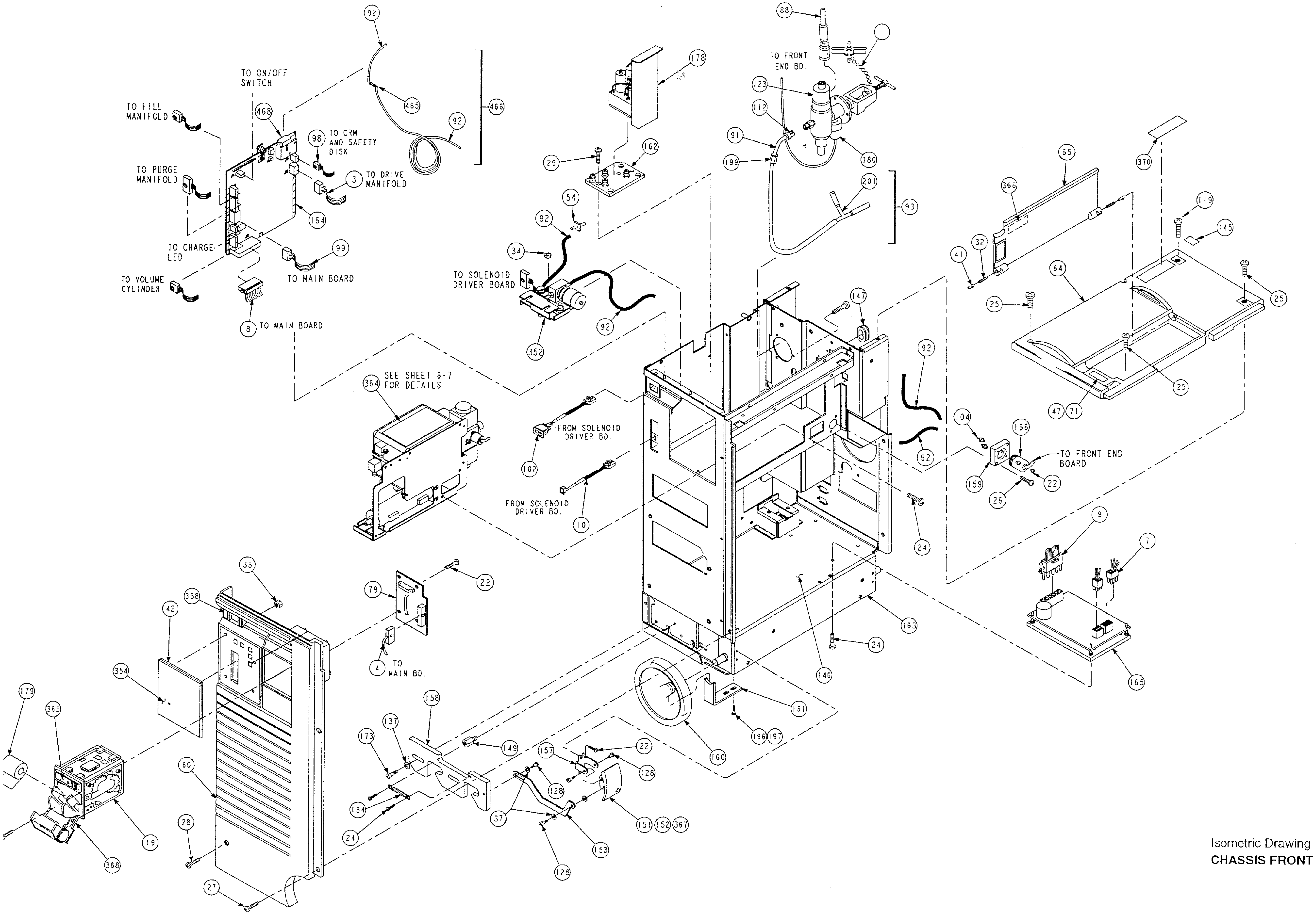


Isometric Drawing

CHASSIS ELECTRONIC DOOR

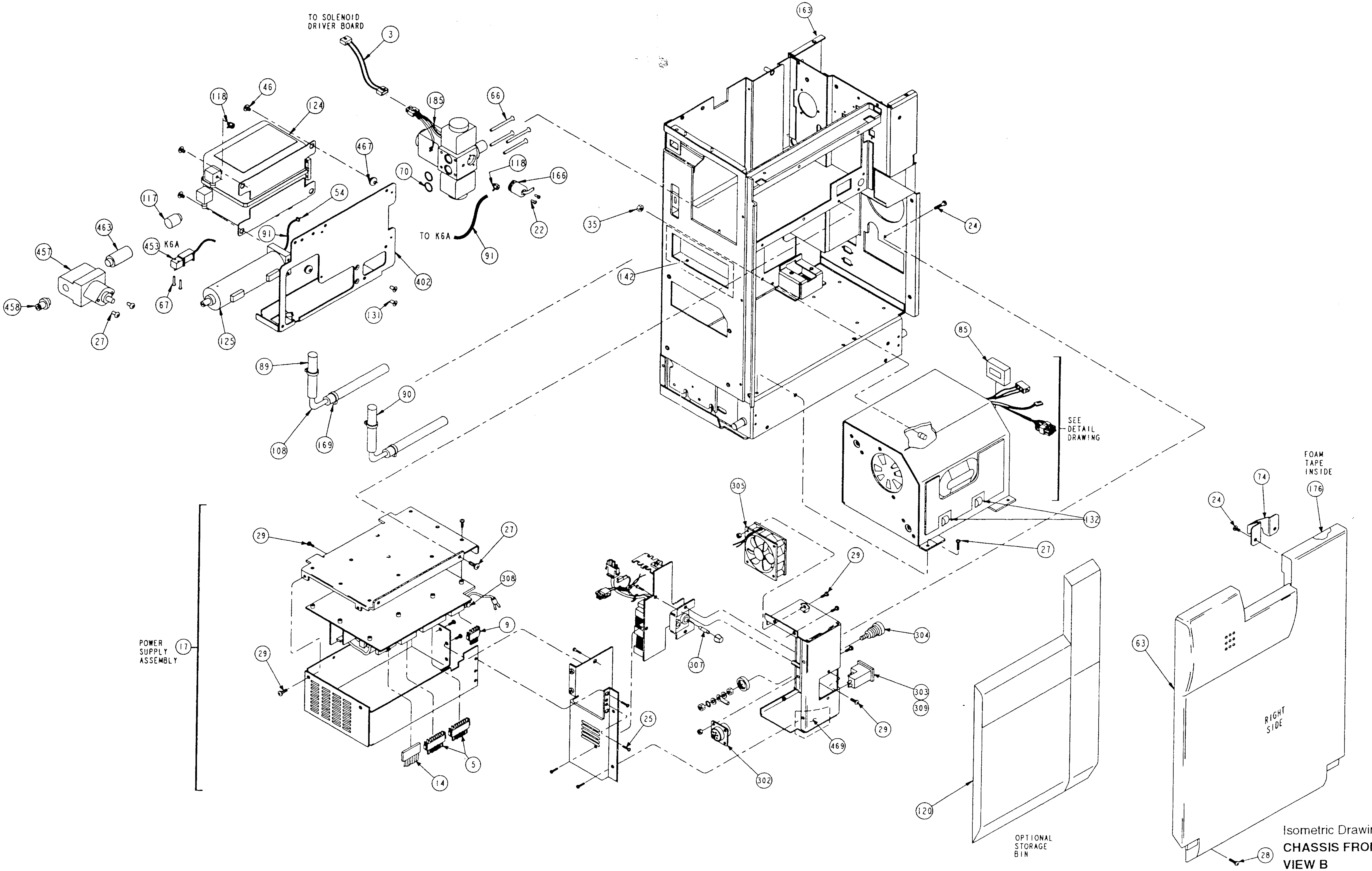


Isometric Drawing
CHASSIS REAR VIEW



Isometric Drawing

CHASSIS FRONT VIEW A



Isometric Drawing
CHASSIS FRONT VIEW B

6.8 ISOMETRIC DRAWINGS AND PARTS LISTS

6.8.1 CHASSIS

Figure No.	Description	Datascope Part Number
1	Helium Cylinder Valve Knob	0366-00-0092
1	Helium Cylinder Valve Knob (German Units Only)	0366-00-0098
2	Pan Head Screw, #6-32 X 0.312"	0212-00-0605
3	Cable, Drive Assembly to Solenoid Driver Board	0012-00-1104
4	Cable, Main PCB to Recorder PCB	0012-00-1061
5	Cable, Power Supply to Main PCB	0012-00-1060
6	Cable, Front End PCB to Main PCB	0012-00-0758-02
7	Cable, Main PCB to Motor Cntrl PCB	0012-00-0759-02
8	Cable, Solenoid Driver PCB to Main PCB	0012-00-1097-01
9	Cable, Power Supply to Motor/Display PCB	0012-00-1056
10	Cable, LED Charge	0012-00-1062
11	Cable, Main PCB to Modem PCB	0012-00-1196-01
12	Cable, Main PCB to Display PCB	0012-00-0888
13	Speaker & Cable	0012-00-0874-02
14	Cable, Power Supply to Main PCB	0012-00-0875-02
15	Line Cord, 110V AC	0012-00-0886-01
16	Line Cord, 220V AC	0012-00-0886-02
17	Power Supply Assembly	0014-00-0033-02
18	Slide Latch	0105-00-0087
19	Recorder, AR-42	0161-00-0014
20	Cover, Display PCB	0198-00-0004
21	Cap Latch	0200-00-0292
22	Pan Head Screw, #4-40 X 0.25"	0212-12-0404
23	Pan Head Screw, #6-32 X 0.187"	0212-12-0603
24	Pan Head Screw, #6-32 X 0.25"	0212-12-0604
25	Screw, Self Sealing, Pan HD #6-32 X .625"	0212-27-0610
26	Pan Head Screw, #6-32 X 0.625"	0212-12-0610
27	Pan Head Screw, #8-32 X 0.25"	0212-12-0804
28	Pan Head Screw, #8-32 X 0.375"	0212-12-0806
29	Flat Head Screw, #6-32 X 0.25"	0212-17-0604

Figure No.	Description	Datascope Part Number
30	Nylon Flat Head Screw, #6-32 X 0.5"	0212-25-0001
31	Compression Spring	0214-00-0214
32	Compression Spring	0214-00-0217
33	Shakeproof Nut # 4-40	0220-06-0004
34	Shakeproof Nut # 6-32	0220-06-0006
35	Shakeproof Nut # 8-32	0220-06-0008
36	Nylon Locking Nut # 6-32	0361-04-0068
37	Nylon Washer	0210-07-0002
40	Spring Finger Clip	0344-00-0221
41	Hinge Pivot Pin	0226-00-0005
42	Plate, Spacer	0380-00-0233
43	Spacer	0361-06-0014
44	Screw, # 4-40 X .312"	0212-12-0405
46	Screw, Shock Mount	0217-00-0013
47	Self Tapping Screw, #4 X 0.25"	0213-07-0404
48	Clamp	0343-00-0073
51	Cable Clamp	0343-00-0005
52	Insulator, Display PCB	0349-00-0231
53	Insulator, Front End PCB	0349-00-0254
54	Fitting, Volume Cylinder	0103-00-0341
55	Slide Guide	0351-00-0069
56	Slide Panel	0351-00-0070
57	Handle Guide Stop	0351-00-0076
59	Pullout Handle	0367-00-0034
60	Front Panel	0380-00-0197
61	Rear Panel	0380-00-0198
62	Left Side Panel	0380-00-0199
63	Right Side Panel	0380-00-0200
64	Top Panel	0380-00-0330
65	Top Cover Door	0380-00-0229
66	Screw, #8-32 x 2.00"	0212-12-0832
67	Screw, #4-40 x .625"	0212-12-0410
68	Access Panel	0380-00-0240
69	Cord Retainer	0380-00-0242
70	O-Ring	0354-00-0066

Figure No.	Description	Datascope Part Number
71	Top Cover Door Striker Plate	0386-00-0180
72	Left Cord Wrap Plate	0380-00-0327-01
73	Right Cord Wrap Plate	0380-00-0327-02
74	Hook Bracket	0406-00-0592
75	Plate, Speaker Mtg.	0386-00-0219
77	Front End PCB	0670-00-0668
78	Display PCB	0670-00-0640
79	Recorder Interconnect PCB	0670-00-0647
80	Datasette, DSS	0670-00-0670
81	Datasette, IABP	0670-00-0671
82	Modem PCB (Domestic)	0670-00-0646
83	Main PCB	0670-00-0666
84	Shoulder Screw, 6-32	0217-00-0012
85	Foam Gasket	0354-00-0045
87	Insulator, Front End PCB	0349-00-0255
88	High Pressure Helium Hose	0009-00-0002
89	Vacuum Hose	0004-00-0050
90	Pressure Hose	0004-00-0051
91	Tubing, 1/16" ID Santoprene	0004-00-0052
92	Tubing, 1/16" ID Polyurethane	0008-08-0001
93	Assembly, Helium Tube	0008-00-0311
94	Line Cord Retainer (Use w/ 110V Line Cord)(Order 2)	0226-00-0010-01
94	Line Cord Retainer (Use w/ 220V Line Cord)(Order 2)	0226-00-0010-02
95	Cable, Modem PCB to Rear Panel (RS-232)	0012-00-0761-02
96	Cable, Display PCB to Monitor Module	0012-00-1058
97	Cable, Front End PCB to Rear Panel Test Conn	0012-00-0766
98	Cable, Solenoid Driver PCB to CRM	0012-00-0767
99	Cable, Main PCB to Solenoid Driver PCB	0012-00-1096-01
100	Cable, Modem PCB to Rear Panel (Modem)	0012-00-0784-02
101	Cable, Battery Assembly to Power Supply	0012-00-0785
102	Cable, On/Off Switch	0012-00-0834
103	Label, Cable Routing	0334-00-1352
104	Hose Fitting	0103-00-0158
106	Male Luer Fitting	0103-00-0338-01
107	Pressure Gauge	0103-00-0418

Figure No.	Description	Datascope Part Number
108	Elbow Fitting	0103-00-0363
109	Pneumatic Fitting	0103-00-0455
110	Vacuum Fitting	0103-00-0374
111	Pressure Fitting	0103-00-0376
112	Pneumatic Coupling	0103-00-0382-02
117	9 PSI Relief Valve	0103-01-0001
118	Fitting, Swivel	0104-00-0046
119	Screw, Self Sealing, Pan HD #6-32 X 1.0"	0212-27-0616-01
120	Storage Bin (Optional)	0997-00-0428
121	Ball Plunger	0105-07-0003
122	Timer	0118-00-0018
123	Helium Regulator Assembly	0119-00-0168
124	Pneumatic Reservoir	0202-00-0127
125	Volume Cylinder	0202-00-0133
128	Shoulder Screw, #4-40 X 0.125"	0212-00-0097
129	Self Tapping Screw, #4 X 0.375"	0213-07-0406
131	Flat Head Screw, #10-32 X 0.375"	0212-22-1006
132	Cable Clamp	0343-05-0002
133	Flat Head Screw, #4-40 X 0.3125"	0213-07-0405
134	Spring	0214-00-0218
137	Flat Washer	0221-00-0122
138	Grommet	0252-02-0004
139	Electronic Panel	0333-00-0219
142	Foam Gasket	0349-00-0208
143	Cable Clamp	0343-05-0001
145	Label, Screw Cover	0334-00-1159
146	Sound Insulator	0349-00-0224
147	Grommet	0358-00-0041

Figure No.	Description	Datascope Part Number
149	Standoff	0361-27-0250
151	Left Battery Release Lever	0367-00-0039-01
152	Right Battery Release Lever	0367-00-0039-02
153	Link	0376-00-0008
155	Plate	0386-00-0197
156	Guide Block	0391-00-0062
157	Lever Mounting Block	0391-00-0067
158	Latch Block	0391-00-0068
159	Transducer Mounting Block	0391-00-0079
160	Wheel	0401-00-0018
161	Wheel Bracket	0406-00-0600
162	Fill Manifold Bracket	0406-00-0613
163	Chassis	0441-00-0100
164	Solenoid Driver PCB	0670-00-0639
165	Motor Control PCB	0671-00-0004
166	Pressure Transducer	0682-00-0076
168	"P" Clamp	0343-10-0002
169	Tie Wrap	0125-01-0001
172	Grommet	0348-01-0012
173	Shoulder screw, #8-32 X 0.3125"	0212-00-0098
174	Modem Cover	0441-00-0094
175	Safety Disk Guard	0380-00-0284
176	Gasket	0354-00-0046
177	Gasket	0354-00-0047
178	Fill Assembly	0104-00-0023
179	Recorder Paper (10 rolls)	0683-00-0422-02
180	High Pressure Transducer	0682-00-0079-01
182	Refillable Helium Tank (Qty. 1)	0075-00-0024-01
182	Refillable Helium Tank (Qty. 3) (German Units Only)	0075-02-0002-03
182	Refillable Helium Tank (Qty. 3) (U.K. & French Units Only)	0075-02-0001-03
183	Disposable Helium Tank	0202-00-0104

Figure No.	Description	Datascope Part Number
184	Helium Strap	0406-00-0656
184	Helium Strap (German, Int'l., UK & French Units Only)	0406-00-0701
185	Drive Assembly	0104-00-0018
186	Catheter Strain Relief	0358-00-0042
187	Condensate Removal Module (English)	0997-00-0380-01
187	Condensate Removal Module (German)	0997-00-0380-02
187	Condensate Removal Module (French)	0997-00-0380-03
187	Condensate Removal Module (Spanish)	0997-00-0380-04
187	Condensate Removal Module (Japanese)	0997-00-0380-05
187	Condensate Removal Module (Italian)	0997-00-0380-06
187	Condensate Removal Module (Portuguese)	0997-00-0380-07
188	Pan Head Screw, #10-32 x 1.625"	0216-06-1026
189	Cable, CRM to Rear Panel	0012-00-0745
190	Safety Disk (English)	0997-00-0344-01
190	Safety Disk (German)	0997-00-0344-02
190	Safety Disk (French)	0997-00-0344-03
190	Safety Disk (Spanish)	0997-00-0344-04
190	Safety Disk (Japanese)	0997-00-0344-05
190	Safety Disk (Italian)	0997-00-0344-06
190	Safety Disk (Portuguese)	0997-00-0344-07
191	Coiled Cable	0012-00-1094
192	Silicone Tubing	0004-00-0047
193	Barb Fitting	0103-00-0394
195	Pan Head Screw, #4-40 X 1.125"	0212-12-0418
196	Pan Head Screw, #6-32 X 0.5"	0212-12-0608
197	Flat Washer	0221-01-0001
198	Cable, Thermal Switch	0012-00-0893-02
199	Filter Ofrice Restrictor	0103-16-0001
200	Flow Restrictor	0103-11-0022
201	"Y" Fitting	0103-00-0337-01
202	Mylar Insulator	0349-00-0244
203	Tubing, Pinch Valve	0008-00-0310
204	Pan Head Screw, #4-40 X .187"	0212-12-0403
221	Nut, Custom	0217-00-0011
222	Washer	0221-06-0002
251	Battery Pack Chassis	0441-00-0073
252	Battery	0146-00-0039
253	Battery Pack Cover	0441-00-0074

Figure No.	Description	Datascope Part Number
254	Cushion	0349-00-0196
256	Cable, Battery to Connector	0012-00-0746
257	Channel Extrusion	0252-01-4181
258	Flat Head Screw, #4-40 X 0.25"	0212-17-0404
259	Pan Head Screw, #6-32 X 1"	0212-12-0616
260	Fusible Link	0011-00-0015
261	Foot	0348-00-0163
262	Terminal Nut # 10-32	0220-00-0082
263	Cable Clamp	0343-05-0001
265*	Label, Battery Docking (English)	0334-00-1421-01
266	Pan Head Screw, #4-40 X 0.25"	0212-12-0404
267	Foam Pad	0685-00-0063
268	Connector Mounting Block	0380-00-0243
269	Handle	0367-00-0009
270	Insulator	0349-00-0225
272	3x3" Mylar Insulator	0349-00-0198
274	Screw #10-32 x 2.875 Pan Hd.	0216-02-1046
275	Screw, #6-32 x 0.5 Pan Hd.	0212-00-0608
302	DC Input Connector	0131-00-0234
303	AC Input Module	0131-00-0235
304	Ground Lug	0124-00-0124
305	Fan	0119-00-0152
307	DC Input Fuse, 30A	0159-00-0035
308	Bulk Fuse, 10A	0159-00-0036
309	AC Fuse, 10A	0159-00-0036
351*	Battery Assembly (English)	0146-00-0047-01
352	Purge Manifold	0104-00-0026
354	Overlay, Charge Indicator	0330-00-0018-01
356*	Rear Panel I/O Label	0334-00-1327
357*	Lower AC Label	0334-00-1416-01
358*	On/Off Label	0334-00-1061
359	Helium Label	0334-00-1062
360*	Upper AC Label	0334-00-1422
362*	Fuse Replacement Label	0334-00-1120
363*	Warning Label	0334-00-1121
364	Assembly, Pneumatic	0997-00-0926
365*	Push Here Label	0334-00-1175

**See page 6-17 for International Part Numbers.*

Figure No.	Description	Datascope Part Number
366	Blank Label	0334-00-1181
367*	Battery Pack Release Label	0334-00-1126
368*	Recorder Label	0334-00-1174
369*	Handle Release Label	0334-00-1158
370	Helpline Label	0334-00-1425-01
370	Helpline Label (Blank)	0334-00-1425-02
401	CSD Bracket Assembly	0997-00-0434
402	Bracket, Pneumatic	0441-00-0102
403	ECG Cable Assembly	0012-00-0975
404	Pressure Cable Assembly	0012-00-0977
406	Grommet	0348-01-0007
407	Manual Fill Valve	0103-00-0365
409	Cable Assembly, External I/O	0012-00-0765
416	Cable, Pressure to Front End PCB	0012-00-0977
417	Cable, ECG to Front End PCB	0012-00-0976
421	ECG Connector	0131-00-0079
422	Pressure Connector	0131-00-0094
424	Phone Jack, TT-253	0131-00-0113
453	K6A, Vent Valve	0119-00-0170
457	8 PSI Regulator	0103-00-0351
458	Quick Connect Coupling	0103-00-0382-01
463	Muffler	0103-00-0065
464	Cable Clamp	0125-00-0018
465	Glass Tubing	0008-00-0309
466	Fill Tubing Assembly (Glass Tubing & Tubing 1/16" ID Polyurethane)	0008-00-0312
467	Shock Mount	0348-09-0001
468	Plug, Blood Back Sensor	0380-00-0174
469	Mylar Insulator	0349-00-0198

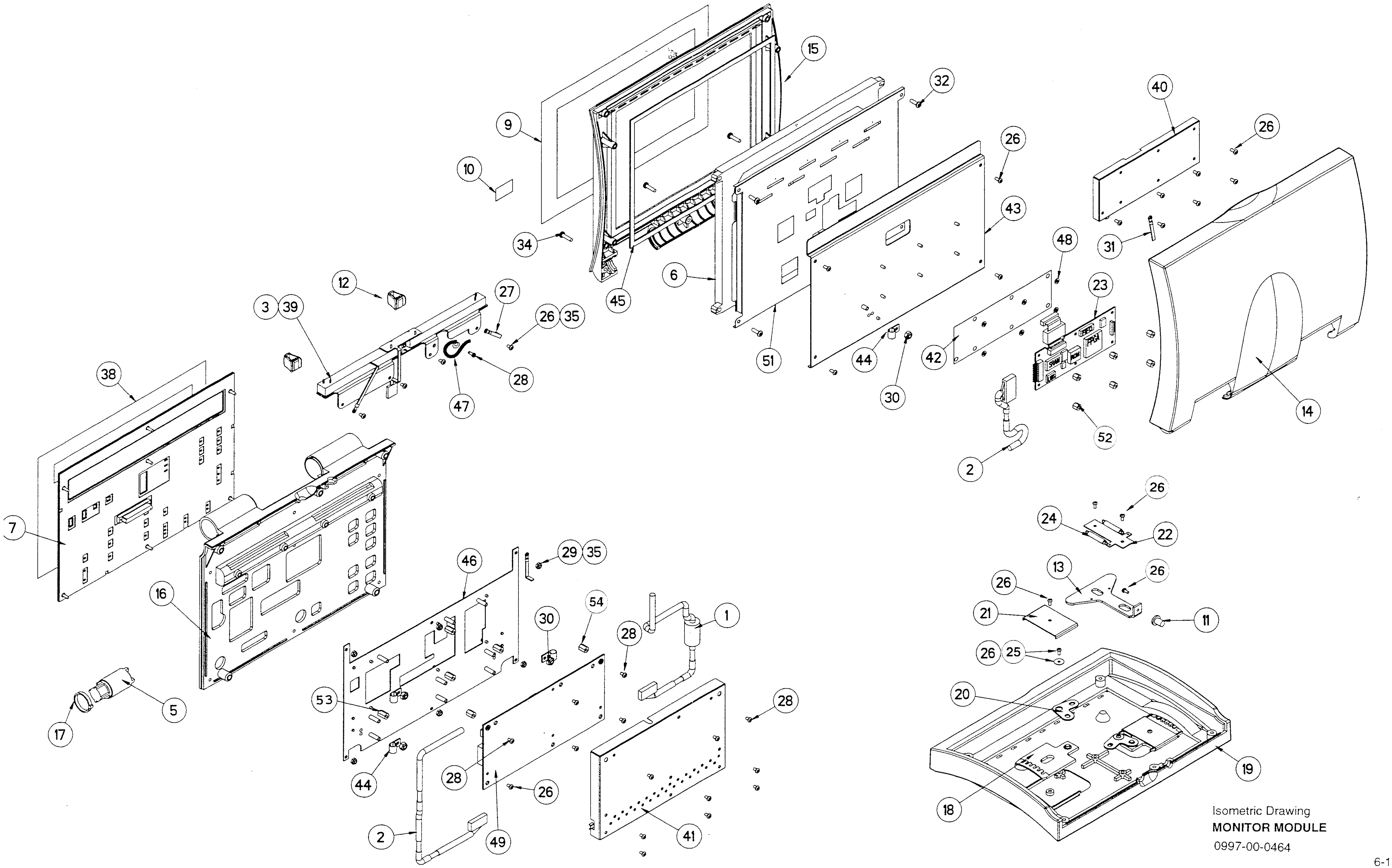
**See page 6-17 for International Part Numbers.*

Figure No.	Description	Datascope Part Number
492	Pan Head Screw	0212-12-0808
495	Standoff	0361-27-1000
498	Standoff	0361-27-0375
499	Star Washer	0210-09-0006
500	Modem Board (International)	0670-00-0597
501	Modem, PCMCIA	0671-00-0034-02
503	M/M Adapter, RJ-11	0671-00-0034-05
504	Mylar Tape	0349-00-0274
505	Line Cord Wrap	0125-00-0020

6.8.2 CHASSIS INTERNATIONAL PARTS LIST

Fig No.	Description	Spanish Part Number	German Part Number	Japanese Part Number
265	Label, Battery Docking	0334-00-1421-04	0334-00-1421-02	
351	Battery Assembly	0146-00-0047-04	0146-00-0047-02	
356*	Rear Panel I/O Label	0334-00-1234-03	0334-00-1234-01	0334-00-1234-04
357	Lower AC Label	0334-00-1422-04	0334-00-1422-02	0334-00-1422-05
358	On/Off Label	0334-00-1236-03	0334-00-1236-01	
360	Upper AC Label	0334-00-1254-03	0334-00-1254-01	0334-00-1254-04
362	Fuse Replacement Label	0334-00-1241-03	0334-00-1241-01	
363	Warning Label	0334-00-1242-03	0334-00-1242-01	0334-00-1242-04
365	Push Here Label	0334-00-1253-03	0334-00-1253-01	0334-00-1253-04
367	Battery Pack Label	0334-00-1247-03	0334-00-1247-01	
368	Recorder Label	0334-00-1252-03	0334-00-1252-01	
369	Handle Release Label	0334-00-1251-03	0334-00-1251-01	0334-00-1251-04

Fig No.	Description	French Part Number	Italian Part Number	Portuguese Part Number
265	Label, Battery Docking	0334-00-1421-03	0334-00-1421-05	0334-00-1421-06
351	Battery Assembly	0146-00-0047-03	0146-00-0047-05	0146-00-0047-06
356*	Rear Panel I/O Label	0334-00-1234-02	0334-00-1234-05	0334-00-1234-06
357	Lower AC Label	0334-00-1422-03	0334-00-1422-06	0334-00-1422-07
358	On/Off Label	0334-00-1236-02		
360	Upper AC Label	0334-00-1254-02	0334-00-1254-05	0334-00-1254-06
362	Fuse Replacement Label	0334-00-1241-02	0334-00-1241-04	0334-00-1241-05
363	Warning Label	0334-00-1242-02	0334-00-1242-05	0334-00-1242-06
365	Push Here Label	0334-00-1253-02	0334-00-1253-05	0334-00-1253-06
367	Battery Pack Label	0334-00-1247-02	0334-00-1247-05	0334-00-1247-06
368	Recorder Label	0334-00-1252-02	0334-00-1252-04	0334-00-1252-05
369	Handle Release Label	0334-00-1251-02	0334-00-1251-05	0334-00-1251-06



Isometric Drawing
MONITOR MODULE
0997-00-0464

6.8.3 MONITOR MODULE (0997-00-0464)

Figure No.	Description	Datascope Part Number
1	Coiled Cable	0012-00-1094
2	Cable, Display	0012-00-1059
3	Slide Pot Assembly	0012-00-0764
5	Clutch	0105-00-0071
6	EL Display	0160-00-0026
7	Monitor Keypad	0331-00-0101
9*	Display Bezel Label	0334-00-1417-01
10	Screw Concealment Label	0334-00-1159
11	Monitor Release Knob	0366-00-0096
12	Slide Pot Knob	0366-00-0086
13	Monitor Release Lever	0367-00-0057
14	Rear Display Housing	0380-00-0326
15	Front Panel Bezel	0380-00-0325
16	Keypad Bezel	0380-00-0206
17	Clutch Spacer	0380-00-0210
18	Docking Slide	0380-00-0211
19	Keypad Bottom Housing	0380-00-0333
20	Docking Linkage	0384-00-0019
21	Retainer Slide Bracket	0406-00-0571
22	Retainer Lever Bracket	0406-00-0572
23	Video Receiver PCB	0670-00-0641
24	Spring	0214-00-0233
25	Flat Washer	0221-00-0129
26	Pan Head Screw, #4-40 X 0.181"	0212-12-0403
27	Ground Strap	0012-00-0623
28	Pan Head Screw, #4-40 X 0.375"	0212-12-0406
29	Nut, Stop #4-40	0220-07-0004
30	Nut, Stop #6-32	0220-07-0006
31	Ground Strap	0346-00-0034-01

**See page 6-20 for International Part Numbers.*

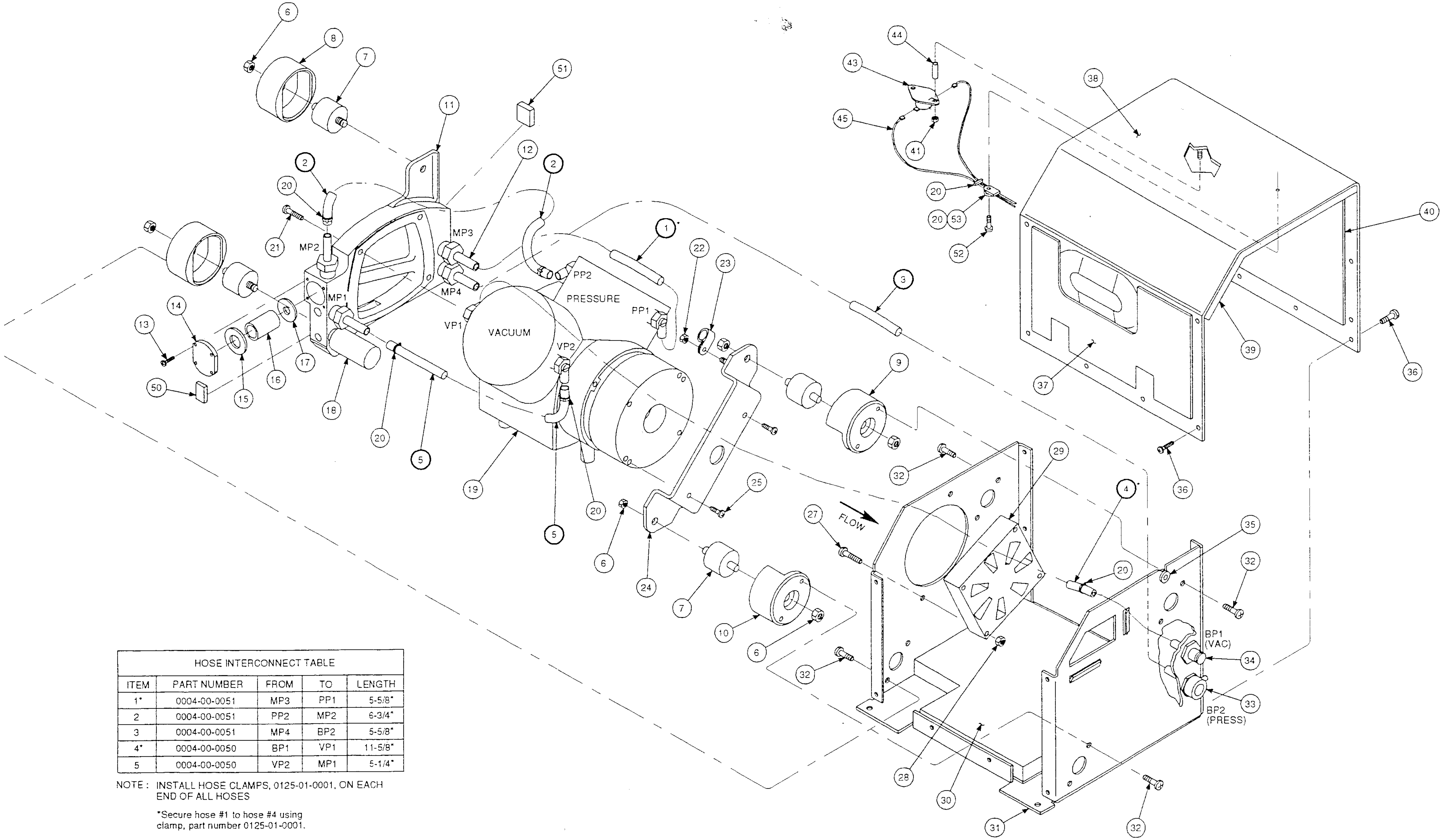
Figure No.	Description	Datascope Part Number
32	Pan Head Screw, #6-32 X 7/16"	0212-12-0607
34	Pan Head Screw, #6-32 X 9/16"	0212-12-0609
35	Tooth Washer,#4	0210-09-0004
38*	Keypad Label Overlay	0330-00-0019-01
39	Pan Head Screws, #4-40 X 0.25"	0212-12-0404
40	Shield, Video Receiver	0337-00-0112
41	Shield, Keypad Controller	0337-00-0113
42	Insulator	0349-00-0293
43	Plate, Upper Keypad	0406-00-0732
44	Cable Clamp, Grounding	0343-12-0002
45	Gasket, Screen	0354-00-0056
46	Plate, Lower Keypad	0406-00-0731
47	Cable Tie	0125-00-0018
48	Washer, Nylon	0210-07-0002
49	Keypad Controller PCB	0670-00-0645
51	Shield Display	0337-00-0116
52	Standoff #4-40 x 1/4"	0361-04-0033
53	Standoff #4-40 x 13/32"	0361-04-0069
54	Standoff #4-40 x 23/64"	0361-04-0070
NS	Cable Tie	0125-01-0001

NS - Not Shown

* See table below

6.8.4 MONITOR MODULE INTERNATIONAL PARTS LIST

Language	Fig No. 9 - Display Bezel Label	Fig No. 38 - Keypad Label Overlay
German	0334-001417-02	0330-00-0019-02
French	0334-001417-03	0330-00-0019-03
Spanish	0334-001417-04	0330-00-0019-04
Japanese	0334-001417-05	0330-00-0019-05
Italian	0334-001417-06	0330-00-0019-06
Portuguese	0334-001417-07	0330-00-0019-07



HOSE INTERCONNECT TABLE

ITEM	PART NUMBER	FROM	TO	LENGTH
1*	0004-00-0051	MP3	PP1	5-5/8"
2	0004-00-0051	PP2	MP2	6-3/4"
3	0004-00-0051	MP4	BP2	5-5/8"
4*	0004-00-0050	BP1	VP1	11-5/8"
5	0004-00-0050	VP2	MP1	5-1/4"

NOTE : INSTALL HOSE CLAMPS, 0125-01-0001, ON EACH END OF ALL HOSES

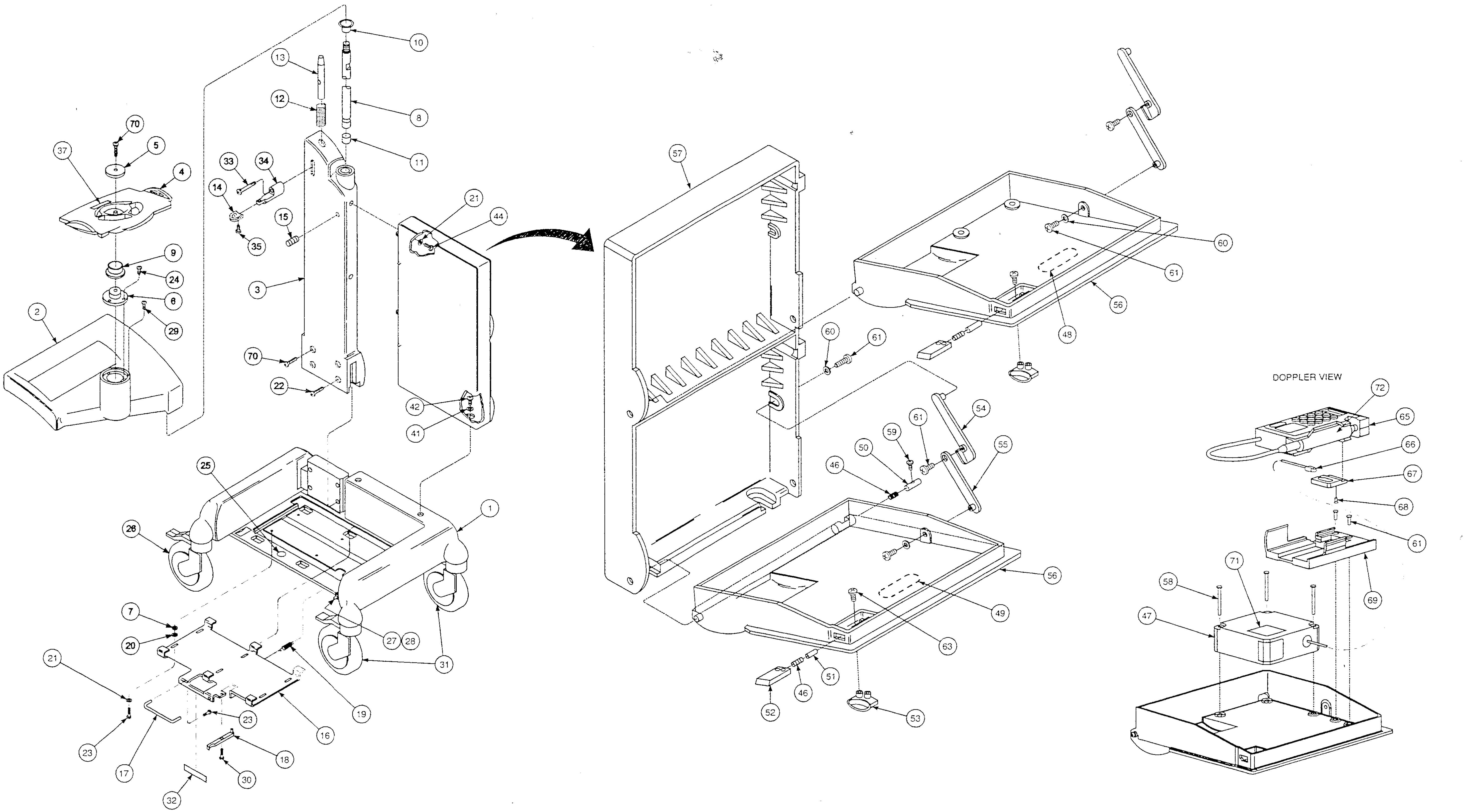
*Secure hose #1 to hose #4 using clamp, part number 0125-01-0001.

Isometric Drawing
COMPRESSOR ASSEMBLY

6.8.5 COMPRESSOR ASSEMBLY

Figure No.	Description	Datascope Part Number
1	Pressure Hose	0004-00-0051
2	Pressure Hose	0004-00-0051
3	Pressure Hose	0004-00-0051
4	Vacuum Hose	0004-00-0050
5	Vacuum Hose	0004-00-0050
6	Shake-proof Nut, 0.25-20	0220-06-0025
7	Shock Mount	0348-00-0169-01
8	Shock Mount Limit	0348-00-0173
9	Shock Mount Limit, Top	0348-00-0172-01
10	Shock Mount Limit, Bottom	0348-00-0172-02
11	Compressor Manifold	0391-00-0072
12	Barb Hose Fitting	0103-00-0386
13	Pan Head Screw, #2-56 X 0.375"	0212-12-0206
14	Filter Access Cover	0200-00-0293
15	Filter Gasket	0354-00-0042-02
16	Filter Element	0103-00-0370
17	Filter Gasket	0354-00-0042-01
18	Muffler	0103-00-0065
19	Pump Assembly	0102-00-0001
20	Clamp	0125-01-0001
21	Pan Head Screw, M5 X 25mm	0211-00-0135
22	Shake-proof Nut, #8-32"	0220-06-0008
23	Cable Clamp	0343-03-6206
24	Motor Bracket	0406-00-0568
25	Pan Head Screw, #8-32 X 0.375"	0212-12-0806
27	Pan Head Screw, # 6-32 X 1"	0212-12-0616
28	Hex Nut,# 6-32	0223-00-0006
29	Fan	0119-00-0149
30	Foam Insulation, Bottom	0349-00-0204
31	Pump Housing	0406-00-0569

Figure No.	Description	Datascope Part Number
32	Flat Head Screw, #8-32 X 0.375"	0212-17-0806
33	Pressure Fitting	0103-00-0373
34	Vacuum Fitting	0103-00-0375
35	Grommet	0348-01-0012
36	Pan Head Screw, #4-40 X 0.25"	0212-12-0405
37	Sound Damper, Front	0349-00-0206
38	Pump Cover	0337-00-0081
39	Foam Insulation, Pump Cover	0349-00-0240
40	Sound Damper, Rear	0349-00-0205
41	Shake-proof Nut, #4-40	0220-06-0004
43	Thermal Switch	0263-00-0003
44	Spacer	0361-32-0500
45	Cable	0012-00-0893-02
50	Bumper	0348-00-0179
51	Bumper	0348-00-0180
52	Pan Head Screw, #6-32 x 0.18"	0212-12-0603
53	Tie Anchor Mount	0125-00-0019



Isometric Drawing
CART ASSEMBLY

6.8.6 CART ASSEMBLY

Figure No.	Description	Datascope Part Number
1	Cart Base	0426-00-0067
2	Cart Handle	0367-00-0037-02
3	Vertical Support Bar	0426-00-0051-02
4	Monitor Platform	0345-00-0012
5	Swivel Retainer	0221-00-0115
6	Shaft Platform	0384-00-0026
7	Flat Washer (Metal)	0210-10-0416
8	Handle Shaft	0367-00-0036
9	Bearing	0402-00-0004
10	Bearing	0402-00-0001-01
11	Bearing	0402-00-0001-02
12	Spring	0214-00-0215
13	Pin Latch	0226-00-0002
14	Release Knob	0367-00-0038
15	Hex Screw	0212-06-1012-20
16	Locking Bracket	0406-00-0570
17	Handle	0367-00-0044
18	Release Lever	0367-00-0041
19	Spring	0214-00-0216
20	Shoulder Washer	0221-00-0120
21	Flat Washer	0221-00-0122
22	Pan Head Screw, #1/4-20 X 1.75"	0212-12-2528
23	Screw, #10-32 X 0.5"	0216-02-1008
24	Flat Head Screw, #6-32 X 0.3125"	0212-14-0605
25	Rubber Bumper	0348-03-0004
26	Casters, Track Lock	0401-00-0024
27	Ground Lug	0124-00-0104-01
28	Ground Lug Washer	0124-00-0104-02
29	Screw, Monitor Stop	0212-07-0612-02
30	Shoulder Screw	0212-00-0096

Figure No.	Description	Datascope Part Number
31	Casters	0401-00-0017
32*	Label, Release (English)	0334-00-1055
33	Screw, #6-32 X 0.75"	0212-15-0624-01
34	Knob Retainer	0226-00-0007
35	Set Screw	0212-06-0404-23
37*	Monitor Mounting Label (English)	0334-00-1123
41	Flat Washer	0210-10-0416
42	Screw, #1/4-20	0212-12-2506
44	Screw, #10-32	0212-07-1028-12
46	Spring	0214-00-0225
47	Tether Assembly	0997-00-0406
48*	Label, "Doppler" (English)	0334-00-1125
49*	Label, "Storage" (English)	0334-00-1157
50	Hinge Pin	0226-00-0008
51	Latch Shaft	0384-00-0022
52	Door Latch	0105-00-0091
53	Door Knob	0366-00-0090
54	Frame Bracket	0406-00-0626
55	Door Bracket	0406-00-0621
56	Storage Bin Door	0370-00-0019
57	Storage Bin Frame	0426-00-0060
58	Screw, #6-32 X 1.375"	0212-12-0622
59	Screw, #4-40 X 0.125"	0212-12-0402
60	Flat Washer, #6	0221-00-0006
61	Screw, #6-32 X 0.25"	0212-12-0604
63	Self Tapping Screw	0213-05-0612
65	Doppler (Complete)	0154-01-0001
66	Fastener, Crimp	0105-00-0093
67	Clamp, Block, Tether	0343-00-0084
68	Screw, #4-40 X .25Lg, Flt Hd.	0212-14-0404
69	Holder, Doppler	0352-00-0049
70	Pan Head Screw, 1/4 - 20 x .50 Lg	0212-12-2508
71*	Label, Tether Release (English)	0334-00-1155
72	Probe, VP8 (Probe Only)	0154-01-0005

**See page 6-29 for International Part Numbers.*

6.8.7 CART ASSEMBLY INTERNATIONAL PARTS LIST

Fig No	Description	German Part Number	French Part Number	Spanish Part Number
52	Label, Release	0334-00-1251-01	0334-00-1251-02	0334-00-1251-03
37	Monitor Mounting Label	0334-00-1244-01	0334-00-1244-02	0334-00-1244-03
48	Label, Doppler			
49	Label, Storage	0334-00-1250-01	0334-00-1250-02	
71	Label, Tether Release	0334-00-1248-01	0334-00-1248-02	0334-00-1248-03

Fig No	Description	Japanese Part Number	Italian Part Number	Portuguese Part Number
52	Label, Release		0334-00-1251-04	0334-00-1251-05
37	Monitor Mounting Label	0334-00-1244-04	0334-00-1244-05	0334-00-1244-06
48	Label, Doppler	0334-00-1246-04		
49	Label, Storage	0334-00-1250-04	0334-00-1250-05	0334-00-1250-06
71	Label, Tether Release	0334-00-1248-04	0334-00-1248-05	0334-00-1248-06

MODEM BD INTL P/N 0670-00-0597

Item No	Part Number	Description	Reference
1	0287-01-1104	CAP, SMD, 0.1uF	C1-C6
2	0136-63-0010	HEADER,2X5,.100"CNTR	JP3
3	0108-00-0067	INDUCTOR,BEAD	L1
4	0155-00-0709	IC, SMD,RS232 TRANSCEIVER, 5V POWERED	U1
5	0136-63-0020	HEADER, .100"CNTR, 2X10	JP2
6	0289-00-3476	CAP,TANT,SMD,47uF,16V	C7-C8
7	0388-00-0597	PCB, MODEM BOARD, Rev 2	
8	0287-00-1103	CAP, SMD, .01uF	C9-C12
9	0670-00-0630	INTERCONNECT BOARD, Rev 2	
10	0212-12-0206	SCREW, #2-56	
11	0223-00-0002	NUT, HEX, #2-56	
12	0361-32-0250	STANDOFF, NYLON, #4-40	
13	0223-00-0004	NUT, HEX, #4-40	
14	0212-12-0403	SCREW, #4-40, 3/16"	
15	0343-00-0092	CLAMP	
16	0348-00-0182	FOOT	
17	0671-00-0038	OEM PCB, INTERFACE PCMCIA	

SOLENOID DRIVER BD. P/N 0670-00-0639

Item No	Part Number	Description	Reference
1	0108-00-0067	FERRITE BEAD SMD	L3-L5
2	0108-11-0100	INDUCTOR MOLDED SURFACE MOUNT 1812, 10UH	L1,L2
3	0108-12-0180	INDUCTOR FIXED SWITCHING REGULATOR CHOKE, 18UH	L6
4	0136-00-0201	CONNECTOR PC TEST POINT	TP1-TP12,TP15-TP31
5	0136-22-0003	CONNECTOR PC HEADER STRAIGHT SINGLE ROW .100 PITCH	JP13,JP14
6	0136-64-0026	CONNECTOR PC HEADER STRAIGHT	JP2
7	0136-81-0002	CONNECTOR PC .120 POCKET LOW PROFILE STRAIGHT PC MOUNT	J9
8	0136-81-0003	CONNECTOR PC .120 POCKET LOW PROFILE STRAIGHT PC MOUNT	JP11
9	0136-81-0004	CONNECTOR PC .120 POCKET LOW PROFILE STRAIGHT PC MOUNT	JP8
10	0136-81-0006	CONNECTOR PC .120 POCKET LOW PROFILE STRAIGHT PC MOUNT	JP5
11	0136-81-0007	CONNECTOR PC .120 POCKET LOW PROFILE STRAIGHT PC MOUNT	JP6
12	0136-81-0008	CONNECTOR PC .120 POCKET LOW PROFILE STRAIGHT PC MOUNT	JP7
13	0136-95-0006	CONNECTOR PC MINI-FIT POWER DUAL ROW	JP3
14	0136-95-0010	CONNECTOR PC MINI-FIT POWER DUAL ROW	JP1
15	0151-00-0184	TRANSISTOR SMD NPN GENERAL PURPOSE 2222A	Q15
16	0151-00-0185	TRANSISTOR PNP 2907A SMD	Q14
17	0151-00-0189	TRANSISTOR SMD DUAL N CHANNEL FET 9955DY	Q1-Q4
18	0151-00-0190	TRANSISTOR SMD N CHANNEL TMOS FET 2N7002	Q9,Q11,Q12,Q16-Q20
19	0151-00-0197	TRANSISTOR SMD 20P06 P-CHANNEL MOSFET	Q5
20	0151-00-0200	TRANSISTOR 9945DY MOSFET DUAL N-CHANNEL SMD	Q6-Q8
21	0151-00-0202	TRANSISTOR 3P02 P-CHANNEL MOSFET SMD	Q10
22	0153-00-0056	LED RED	CR71-CR81
23	0153-00-0091	DIODE 1N6275 15V ZENER	CR1,CR4,CR49
24	0153-00-0155	DIODE VTB1112 PHOTO-DIODE	CR69,CR70
25	0153-00-0179	DIODE BAS21 SWITCHING 250V SURFACE MOUNT	CR3,CR5,CR26,CR27,CR34-CR38,CR40-CR44,CR64-CR67
26	0153-00-0186	DIODE 1N5819 SCHOTTKY RECTIFIER SMD	CR2,CR47,CR50
27	0153-00-0190	DIODE Z5234B SMD ZENER 6.2V	CR82
28	0153-00-0192	DIODE 1N5822 SCHOTTKY RECTIFIER	CR46
29	0153-00-0200	DIODE MURS120T3 ULTRA FAST POWER RECTIFIER	CR6-CR16
30	0153-00-0201	DIODE MMSZ5242 ZENER 12V SMD	CR17-CR25,CR28-CR31,CR45
31	0153-11-0001	DIODE LIGHT EMITTING (LED)	CR68
32	0155-00-0649-02	IC DG413 CMOS QUAD ANALOG SWITCHES SPST	U17
33	0155-00-0651	IC 2.5V REFERENCE LOW POWER	U8
34	0155-00-0657	IC 74HC14 HEX SCHMITT TRIGGER INVERTER CMOS	U11
35	0155-00-0686	IC 74HC393 COUNTER RIPPLE DUAL 4-STAGE BINARY CMOS	U10
36	0155-00-0689	IC 74HC74 FLIP-FLOP DUAL D-TYPE POSITIVE- EDGE TRIGGERED	U4,U5
37	0155-00-0690	IC TL052 OP AMP DUAL JFET	U9,U16,U21,U23
38	0155-00-0699	IC 74HCT541 OCTAL BUFFER WITH 3-STATE OUTPUTS	U20
39	0155-00-0741	IC TLC555C TIMER LOW POWER	U14,U15
40	0155-00-0756	IC AD592 TEMPERATURE TRANSDUCER PRECISION	U22
41	0155-00-0757	IC LM339 QUAD COMPARATOR LOW-POWER LOW OFFSET	U1,U2,U18,U25,U26
42	0155-00-0758	IC LM393 DUAL COMPARATOR LOW-POWER LOW OFFSET	U13
43	0155-00-1050-01	IC 74HC7002 QUAD 2-INPUT NOR GATE	U19
44	0155-00-0929-01	IC MIC5021 HIGH SIDE MOSFET DRIVER	U3,U6,U12
45	0155-00-0935-01	IC MAX1627 DC-DC CONTROLLER ADJUSTABLE	U7

SOLENOID DRIVER BD. P/N 0670-00-0639

Item No	Part Number	Description	Reference
46	0159-28-0017	FUSE RESETTABLE SOLID STATE, 0.17A	F3
47	0159-28-0075	FUSE RESETTABLE SOLID STATE, 0.75A	F1
48	0261-28-0004	SWITCH LOW PROFILE DIP SMD	S1
49	0286-00-24R7	CAPACITOR SMD 0805 CERAMIC 100V 5%, 4.7PF	C50-C53
50	0286-03-2221	CAPACITOR SMD 1206 CERAMIC 100V 5%, 220PF	C57
51	0287-00-1102	CAPACITOR SMD 0805 CERAMIC X7R 10%, 0.001UF	C59,C60,C73
52	0287-00-1103	CAPACITOR SMD 0805 CERAMIC X7R 10%, 0.01UF	C75
53	0287-00-1272	CAPACITOR SMD 0805 CERAMIC X7R 10%, 0.0027UF	C65,C68,C76
54	0287-01-1104	CAPACITOR SMD 1206 CERAMIC X7R 10%, 0.1UF	C3,C5-C8,C10,C11,C13-C18,C22-C24,C29,C31-C35,C38-C44,C46, C47, C54,C55,C61,C62,C64,C67, C71,C72,C74,C83,C84
55	0287-01-1224	CAPACITOR SMD 1206 CERAMIC X7R 10%, 0.22UF	C27
56	0287-01-2154	CAPACITOR SMD 1206 CERAMIC X7R 5%, 0.15UF	C25
57	0287-01-2473	CAPACITOR SMD 1206 CERAMIC X7R 5%, 0.047UF	C19
58	0287-02-2474	CAPACITOR SMD 1825 CERAMIC X7R 5%, 0.47UF	C28,C48,C58
59	0287-02-2684	CAPACITOR SMD 1825 CERAMIC X7R 5%, 0.68UF	C26
60	0289-00-2475	CAPACITOR SMD TANTALUM 20%, 4.7UF, 10V	C2,C30
61	0289-00-5106	CAPACITOR SMD TANTALUM 20%, 10UF, 25V	C4,C12,C49
62	0289-02-2227	CAPACITOR SMD TANTALUM SWITCH MODE, 220UF, 10V	C77,C78
63	0289-02-6106	CAPACITOR SMD TANTALUM SWITCH MODE, 10UF, 35V	C79-C81
64	0290-17-3221	CAPACITOR ALUMINUM ELECTROLYIC LOW ESR, 220UF, 35V	C70
65	0307-06-2103	RESISTOR NETWORK SIP 9 ELEMENT, 10K	RN1,RN2
66	0307-06-2562	RESISTOR NETWORK SIP 9 ELEMENT, 5.6K	RN3,RN4
67	0319-00-4R99	RESISTOR FIXED METAL FILM 1/2W 1%, 4.99	R71
68	0324-00-0100	RESISTOR SMD THICK FILM 1/4W 5%, 10	R1,R5-R8,R13,R17,R18
69	0324-00-0101	RESISTOR SMD THICK FILM 1/4W 5%, 100	R30,R76,R87,R90,R109,R113,R128, R136
70	0324-00-0103	RESISTOR SMD THICK FILM 1/4W 5%, 10K	R3,R73,R100
71	0324-00-0121	RESISTOR SMD THICK FILM 1/4W 5%, 120	R27,R33
72	0324-00-0185	RESISTOR SMD THICK FILM 1/4W 5%, 1.8MEG	R112
73	0324-00-0332	RESISTOR SMD THICK FILM 1/4W 5%, 3.3K	R2,R12,R16,R20,R21,R63,R68,R108, R110
74	0324-00-0335	RESISTOR SMD THICK FILM 1/4W 5%, 3.3MEG	R111,R115
75	0324-00-0472	RESISTOR SMD THICK FILM 1/4W 5%, 4.7K	R55-R57,R60,R64,R65
76	0324-00-0562	RESISTOR SMD THICK FILM 1/4W 5%, 5.6K	R31,R122,R126,R137
77	0324-00-0685	RESISTOR SMD THICK FILM 1/4W 5%, 6.8MEG	R116
78	0324-01-1001	RESISTOR SMD THICK FILM 1/4W 1%, 1.00K	R4,R26,R39,R43,R75,R86,R88,R91, R102,R129
79	0324-01-1002	RESISTOR SMD THICK FILM 1/4W 1%, 10K	R9,R14,R22-R24,R50,R53,R54,R61, R62,R67,R78-R80,R83-R85,R92-R94,R99,R103,R154-R156
80	0324-01-1003	RESISTOR SMD THICK FILM 1/4W 1%, 100K	R15,R32,R69,R72
81	0324-01-1211	RESISTOR SMD THICK FILM 1/4W 1%, 1.21K	R70
82	0324-01-1331	RESISTOR SMD THICK FILM 1/4W 1%, 1.33K	R97
83	0324-01-1431	RESISTOR SMD THICK FILM 1/4W 1%, 1.43K	R40
84	0324-01-1583	RESISTOR SMD THICK FILM 1/4W 1%, 158K	R35,R36

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Item No	Part Number	Description	Reference
85	0324-01-1743	RESISTOR SMD THICK FILM 1/4W 1%, 174K	R47
86	0324-01-2433	RESISTOR SMD THICK FILM 1/4W 1%, 243K	R29,R89,R106
87	0324-01-2492	RESISTOR SMD THICK FILM 1/4W 1%, 24.9K	R37,R46
88	0324-01-3011	RESISTOR SMD THICK FILM 1/4W 1%, 3.01K	R11,R25,R28,R59
89	0324-01-3320	RESISTOR SMD THICK FILM 1/4W 1%, 332	R58,R105,R117
90	0324-01-3480	RESISTOR SMD THICK FILM 1/4W 1%, 348	R34,R82
91	0324-01-4533	RESISTOR SMD THICK FILM 1/4W 1%, 453K	R95,R96,R133
92	0324-01-4991	RESISTOR SMD THICK FILM 1/4W 1%, 4.99K	R51,R52,R98,R114
93	0324-01-5492	RESISTOR SMD THICK FILM 1/4W 1%, 54.9K	R36
94	0324-01-6192	RESISTOR SMD THICK FILM 1/4W 1%, 61.9K	R10
95	0324-01-6490	RESISTOR SMD THICK FILM 1/4W 1%, 649	R101
96	0324-01-7500	RESISTOR SMD THICK FILM 1/4W 1%, 750	R42,R48,R81
97	0324-01-7501	RESISTOR SMD THICK FILM 1/4W 1%, 7.50K	R107
98	0324-01-8661	RESISTOR SMD THICK FILM 1/4W 1%, 8.66K	R44
99	0327-01-R020	RESISTOR THICK FILM 1/2W 1%, 0.02	R144,R146,R150
100	0327-01-R040	RESISTOR THICK FILM 1/2W 1%, 0.04	R127
101	0327-02-R500	RESISTOR THICK FILM 1W 1%, 0.5	R141,R145,R151
102	0388-00-0639	PCB	
103	0105-07-0001	Ball Plunger	
104	0212-17-0406	SCREW, FLAT HEAD, #4	
105	0213-01-0404	SCREW, SELF TAP, #4 X 3/8"	For SB1
106	0220-07-0004	NUT, #4, Self Lock	
107	0380-00-0173	Blood Back Sensor Block	SB1
108	0380-00-0174	Blood Back Sensor Keeper	
109	0406-00-0724	Bracket, PCB Mounting	
110	0530-00-0011-01	Adhesive Sealant Silicon Rubber	To secure C70,CR68,CR69,CR70
111	0287-01-2104	CAPACITOR SMD 1206 CERAMIC X7R 5%, 0.1UF	C1,C45,C56,C66
112	0131-00-0228	Shunt	For JP13, JP14
113	0159-28-0090	FUSE RESETTABLE SOLID STATE, 0.9A	F2

DISPLAY CONTR. BD P/N 0670-00-0640

Item No	Part Number	Description	Reference
1	0289-00-4336	CAP, SMD, TANTANLUM, 33 UF, 20V	C3
2	0289-00-6105	CAP, SMD, TANTANLUM, 1UF, 35V	C35-C37
3	0287-01-1104	CAP, SMD, CERAMIC, 0.1 UF, 10%	C4-C34; C38-C46
4	0287-00-1102	CAP, SMD, CERAMIC, 0.001 UF, 10%	C1-C2
5	0108-05-0002	Inductor, 0.12UH, 3 AMP	L1
6	0136-63-0040	HEADER, 0.100 INCH CENTERS, 2X20	JP1
7	0136-00-0262-02	HEADER, RA,0.156 INCH CENTERS w/PEGS, 1X2	JP3
9	0136-96-0026	HEADER, 0.100 INCH CENTERS, 2X13	JP2
10	0155-00-0592	IC, SMD, HITACHI ACRTC, HD63484CP98, 9.8 MHz, 68-PIN PLCC	U4
11	0155-00-0886-02	IC, SMD, XILINX FPGA, XC4010D-6PQ160C, 160-PIN PQFP	U20
12	0155-90-0333	ASSY, IC, PROGRAMMED, DIP, XILINX PROM, XC17128-PD8C, 8-PIN PLASTIC DIP	U18
13	0155-90-0319	ASSY, IC, PROGRAMMED, DIP, XILINX PROM, XC1765D-PD8C, 8-PIN PLASTIC DIP	U19
14	0155-90-0318	ASSY, IC, PROGRAMMED, DIP, AMD PLD, PALCE22V10Q-10PC/5, 24-PIN 300 mil DIP	U7
15	0155-90-0344	ASSY, IC, PROGRAMMED, PLCC, AMD PLD, PALCE16V8H-7JC/5, 20-PIN PLCC	U22
16	0155-00-0884-03	IC, SMD, IDT 32K X 8 SRAMS, IDT71256L25Y, 28-PIN SOJ	U9-U12
18	0155-00-0700	IC, SMD, OCTAL BUFFER, 74ACT244, 20-PIN SOIC	U8
19	0155-00-0711-01	IC, SMD, OCTAL BUFFER, 74HCT244, 20-PIN SOIC	U1, U21
20	0155-00-0733	IC, SMD, OCTAL TRANSCEIVER, 74ACT245, 20-PIN SOIC	U2-U3, U5-U6
21	0155-00-0835-02	IC, SMD, SCHMITT TRIGGER INVERTER, 74ACT14, 14-PIN SOIC	U17
22	0155-00-0655	IC, SMD, QUAD AND GATES, 74AC08, 14-PIN SOIC	U13
24	0307-06-2472	RES NTWK, SIP, 10 PIN, COM TERM, 4.7K, 2%	RN2, RN4-RN5
25	0307-01-0470	RES NTWK, SIP, 10 PIN, 5 ISOLATED ELEMENTS, 47 OHM, 2%	RN1, RN3, RN6
26	0136-01-1008	SOCKET, DIP, 8 PINS	XU18 and XU19 (For Xilinx PROM, Ref Numbers U18 and U19)
27	0136-56-1324	SOCKET, 300 mil 24-pin DIP	XU7. (For AMD PLD, Reference Number U7)
28	0136-57-0020	SOCKET, PLCC, 20 PIN	XU22 (For AMD PLD, Reference Number U22)
30	0212-12-0206	Screw, 2-56	
31	0223-00-0002	Nut, Hex, 2-56	
32	0155-00-0695	IC.SMD,Dual FF,74ACT74	U14
33	0155-00-0924-01	IC,SMD,LVDS Mux/xmtr,DS90CR211	U15
34			
35	0108-00-0091	Inductor,SMD,Power	L4
36	0108-11-0100	Inductor,SMD,Molded,10uH	L2,L3
37	0158-05-0008	Osc,SMD,Crysal,30.000MHz	Y1
38	0283-00-0058	Cap,SMD,Cer,.1uF,10%	C51

DISPLAY CONTR. BD P/N 0670-00-0640

Item No	Part Number	Description	Reference
39	0287-01-0104	Cap,SMD,Cer,.1uF,20%	C47,C48
40	0290-18-4706	Cap,Elect,47uF	C49,C50
41	0324-01-47R5	Res,SMD,47.5 Ohm,1%	R4
44	0155-00-0959-02	IC,SMD,Diff dirv/recv.75LBC179	U16
45	0388-00-0640	PCB,Disp Contr.	
46	0324-01-1004	Res,SMD,Thk Flm, 1M Ohm,1%,1/4W	R5
47	0324-01-2004	Res,SMD,Thk Flm, 2M Ohm,1%,1/4W	R6
48	0287-01-1154	Cap,SMD,.15uF,10%	C54
49	0287-01-1473	CAP, SMD, CERAMIC, 0.047UF, 10%	C55
50	0151-00-0197	FET,SMD,P-Channel, 20P06	Q1
51	0136-00-0201	Test Point	TP1,TP2

VIDEO RECEIVER. BD P/N 0670-00-0641

Item No	PART NUMBER	DESCRIPTION	REFERENCE
1			
2	0108-11-0100	INDUCTOR MOLDED SURFACE MOUNT 1812, 10UH	L3,L4
5	0136-21-0012	CONNECTOR PC HEADER RIGHT ANGLE SINGLE ROW .100 PITCH	J3
6	0136-62-1020	CONNECTOR PC HEADER RIGHT ANGLE DUAL ROW .100 PITCH	J2
7	0151-00-0190	TRANSISTOR SMD N CHANNEL TMOS FET 2N7002	Q1,Q2
8	0155-00-0640-04	IC DS1231 POWER SUPPLY MONITOR	U2
9	0155-00-0711-01	IC OCTAL BUFFER/LINE DRIVER 74HCT244	U10
10	0155-00-0840-01	IC 74BCT541 OCTAL BUFFERS AND LINE DRIVERS	U9
11	0155-90-0385	IC XC1765 SERIAL CONFIGURATION PROM	U1
12	0155-00-0923-01	IC DS90CR212 LVDS RECEIVER 12 BIT DE-MULTIPLEXER	U8
13	0155-00-0939-02	IC 7C1009 CMOS STATIC RAM 128K X 8 HIGH SPEED	U6
14	0155-00-0940-02	IC 74ABT574 OCTAL D-TYPE FLIP-FLOP WITH TRI-STATE OUTPUTS	U4
15	0155-00-0941-03	IC 7C441 FIFO 512 X 9 14NSEC	U5
16	0155-00-0946-02	IC XC5202 FIELD PROGRAMMABLE GATE ARRAY 64 LOGIC CELL	U7
17	0287-01-1104	CAPACITOR SMD 1206 CERAMIC X7R 10%, 0.1UF	C1-C5,C7-C11,C13,C14, C17-C22
18	0289-00-3106	CAPACITOR SMD TANTALUM 20%, 10UF	C12
19	0289-00-5106	CAPACITOR SMD TANTALUM 20%, 10UF	C6
20	0324-01-1002	RESISTOR SMD THICK FILM 1/4W 1%, 10K	R1
21	0324-01-1100	RESISTOR SMD THICK FILM 1/4W 1%, 110	R11-R14
22	0324-01-4751	RESISTOR SMD THICK FILM 1/4W 1%, 4.75K	R2,R3,R5,R6
23	0324-01-4752	RESISTOR SMD THICK FILM 1/4W 1%, 47.5K	R4,R7-R10
24	0388-00-0641	PCB, Video Receiver	
25	0012-00-1101	Cable, 20-pin ribbon, to EL panel	J1
26	0136-78-0020	Socket, SMD,20 PLCC IC	XU1
27	0108-00-0067	Ferrite Bead, SMD	L1,L2
28	0326-00-0101	RESISTOR SMD THICK FILM 1/10W 5%, 100 Ohm	R16
29	0324-00-0473	RESISTOR SMD THICK FILM 1/10W 5%, 47KOhm	R27
30	0136-00-0201	Test Point	TP1-TP8

KEYPAD CONTRL. BD P/N 0670-00-0645

Item No	PART NUMBER	DESCRIPTION	REFERENCE
1	0108-00-0067	FERRITE BEAD SMD	L3
2			
3	0108-00-0091	INDUCTOR POWER SMT, 22UH	L1
4	0108-14-0001	INDUCTOR SWITCHING SURFACE MOUNT, 114UH	L5
5	0108-14-0002	INDUCTOR SWITCHING SURFACE MOUNT, 77UH	L4
6	0136-00-0269	CONNECTOR PC HEADER 60 POSITION DUAL ROW STRAIGHT .050 PITCH	J4
7	0136-96-0020	CONNECTOR PC HEADER RIGHT ANGLE	J2,J5
8	0136-74-0005	CONNECTOR PC .120 POCKET LOW PROFILE RIGHT ANGLE PC MOUNT	J3
9	0136-22-0002	HEADER, .100"CNTR, 1X2	J1
10	0150-13-0004	LED DISPLAY BAR GRAPH ARRAY 10 ELEMENT,GREEN	CR8
11	0151-00-0184	TRANSISTOR SMD NPN GENERAL PURPOSE 2222A	Q1
12	0151-00-0185	TRANSISTOR PNP 2907A SMD	Q2,Q3
13	0151-00-0197	TRANSISTOR SMD 20P06 P-CHANNEL MOSFET	Q4
14	0153-00-0213-01	DIODE SMD VOLTAGE SUPPRESSOR SMC15AT3	D4
15	0153-00-0173	DIODE 1N4001 1.0A SMD	CR3-CR6,D1,D2
16	0153-00-0191	DIODE SMDA05 QUAD TRANSIENT VOLTAGE SUPPRESSOR	CR1,CR2
17	0153-00-0202	DIODE MMAD1108 8 ELEMENT ARRAY SMD	CR10
18	0153-00-0205	DIODE MBR360 SCHOTTKY RECTIFIER 60V 3A	CR7,CR9
19	0153-00-0190	DIODE BZ5234B ZENER 6.2V 5% SOT 23	CR11,CR12
20	0153-00-0212-01	DIODE SMC6.5A SMD VOLTAGE TRANSIENT SUPPRESSOR 6.5V	CR13
21	0155-00-0640	IC DS1231 POWER SUPPLY MONITOR	U3
22	0155-90-0377	IC 68HC711E9 MICROCONTROLLER CMOS	U1
23	0155-00-0692	IC 74HCT08 QUAD 2 INPUT AND GATE	U2
24	0155-00-0840-01	IC 74BCT541 OCTAL BUFFERS AND LINE DRIVERS	U6
25	0155-00-0894-02	IC MM5451 5 DIGIT LED DRIVER	U4,U5
26	0155-00-0959-02	IC 75LBC179 DIFFERENTIAL DRIVER/RECEIVER	U9
27	0155-00-0966-01	IC MIC4576 VOLTAGER REGULATOR 3A BUCK	U7,U8
28	0158-06-0002	CRYSTAL QUARTZ, 8.00MHZ	Y1
29	0283-00-0058	CAPACITOR CERAMIC 0.1UF 10% 100V SMD 1210, 0.1UF	C1
30	0286-00-2180	CAPACITOR SMD 0805 CERAMIC 100V 5%, 18PF	C7,C9

KEYPAD CONTRL. BD P/N 0670-00-0645

Item No	PART NUMBER	DESCRIPTION	REFERENCE
31	0287-00-1102	CAPACITOR SMD 0805 CERAMIC X7R 10%, 0.001UF	C11,C13
32	0287-01-1102	CAPACITOR SMD 1206 CERAMIC X7R 10%, 0.001UF	C26
33	0287-01-1104	CAPACITOR SMD 1206 CERAMIC X7R 10%, 0.1UF	C3,C5,C14-C16,C18,C20-C25,C34
34	0287-01-1332	CAPACITOR SMD 1206 CERAMIC X7R 10%, 0.0033UF	C27
35	0289-00-6105	CAPACITOR SMD TANTALUM 20%, 1UF	C17
36	0289-02-2157	CAPACITOR SMD TANTALUM SWITCH MODE, 150UF	C33
37	0289-02-4686	CAPACITOR SMD TANTALUM SWITCH MODE, 68UF	C28
38	0287-01-1473	CAPACITOR SMD 1206 CERAMIC X7R 10%, 0.047UF	C35
39	0290-12-0007	CAPACITOR ALUMINUM ELECTROLYIC RADIAL PC MOUNT, 220UF	C29,C30
40	0290-18-4706	CAPACITOR ELECTROLYTIC ALUMINUM MINIATURE AXIAL LEADS, 47UF	C31,C32
41	0324-00-0220	RESISTOR SMD THICK FILM 1/4W 5%, 22	R26
42	0324-01-1001	RESISTOR SMD THICK FILM 1/4W 1%, 1K	R6,R13,R21,R31,R33,R39
43	0324-01-1002	RESISTOR SMD THICK FILM 1/4W 1%, 10K	R1-R5,R7,R9,R11,R14,R16, R17,R19,R20,R22,R23,R25, R27,R30,R34,R38,R41
44	0324-01-1004	RESISTOR SMD THICK FILM 1/4W 1%, 1MEG	R10,R12,R15,R18
45	0324-01-4991	RESISTOR SMD THICK FILM 1/4W 1%, 4.99K	R42
46	0324-01-1005	RESISTOR SMD THICK FILM 1/4W 1%, 10MEG	R8
47	0324-01-1212	RESISTOR SMD THICK FILM 1/4W 1%, 12.1K	R40
48	0324-01-2002	RESISTOR SMD THICK FILM 1/4W 1%, 20K	R24
49	0324-01-3161	RESISTOR SMD THICK FILM 1/4W 1%, 3.16K	R35
50	0324-01-3010	RESISTOR SMD THICK FILM 1/4W 1%, 301	R28
51	0324-01-8661	RESISTOR SMD THICK FILM 1/4W 1%, 8.66K	R29
52	0136-00-0201	TEST POINT	TP1-TP7
53	0388-00-0645	PCB, KEYPAD	
54	0349-00-0298	INSULATOR, TRANSISTOR TO-220	
55	0349-00-0299	INSULATOR, MOLDED SCREW	
56	0530-00-0072	ADHESIVE	
57	0530-00-0011-02	ADHESIVE (Silicone Sealant)	
58	0361-00-0441	CONNECTOR, SPACER	
59	0131-00-0095	CONNECTOR, JUMPER	
60	0136-00-0270	CONNECTOR PC, SOCKET STRIP	

MODEM BOARD		P/N 0670-00-0646	
Item No	Part Number	Description	Reference
1	0283-00-0057	CAP, .001uF, 5KV	C1,C2
2	0283-04-0104	CAP, .1uF, 100V	C3,C5
3	0290-02-3105	CAP, TANT, 1uF,35V	C6,C7,C8,C9,C10,C11,C12,C13
4	0131-00-0095	SHUNT	
5	0136-00-0141	HEADER,TELEPHONE,4CKT	JP1
6	0136-63-0010	HEADER,2X5,.100"CNTR	JP3
7	0108-00-0073	INDUCTOR,BEAD	L1,L2,L3
8	0307-00-0076	VARISTOR	RV1
9	0315-00-0010	RES,1 OHM, 1/4W	R1,R2
10	0155-00-0936	MODEM MODULE, CH1794	U1
11	0155-00-0400	IC, DUAL RS232	U2,U3
12	0136-63-0020	HEADER, .100"CNTR, 2X10	JP2
13	0290-02-4157	CAP,TANT,150uF,16V	C4
14	0388-00-0646	PCB, MODEM BOARD	
15	0212-12-0206	SCREW, #2-56	
16	0223-00-0002	NUT, HEX, #2-56	
17	0136-22-0003	HEADER, .100" CNTR, 1X3	JP4
18	0283-03-0103	CAP, .01uF, 100V	C14,C15,C16, C17, C18

RECORDER INT. BD P/N 0670-00-0647

Item No	Part Number	Description	Reference
1	0290-18-3323	CAP, ELECTROLYTIC, 3300uF/16V	C1,C2,C3
2	0290-02-1226	CAP, ELECTROLYTIC, 22uF/20V	C4
3	0283-04-0104	CAP, CERAMIC, 0.1uF/100V	C5
4	0136-00-0199	CONN HEADER, 50-PIN, SOCKET, STRAIGHT	J2
6	0315-00-0472	RES, CARB, 4.7K, 5%, 1/4W	R1
7	0388-00-0647	PCB, RECORDER INTERFACE	
8	0125-01-0004	TIE WRAP (FASTRAP)	
10	0153-00-0186	DIODE, SMD, SCHOTKY, SM5819	CR1
11	0315-00-0202	RES,CARB,2K,1/4W,5%	R2
12	0136-81-0014	CONN HEADER, 14-PIN, STRAIGHT, LATCH	J1

MAIN BOARD P/N 0670-00-0666

Item No	Part Number	Description	Reference
1	0289-00-3106	CAP, SMD,TANTALUM, 10uF, 16V	C109,C134
2	0289-00-2475	CAP,SMD,TANTALUM, 4.7uF, 10V	C80,C92,C95-C99,C115,C141,C144
3	0287-01-1104	CAP, SMD,CERAMIC, .1uF,10%	C1-C52,C54,C56,C57,C59,C61-C66,C68-C72,C76-79,C81-C91,C93,C100-C101,C105,C107,C110-C112,C114,C116-C120,C123,C124,C127-C132,C136-C138,C139,C161-C167,C169-175,C177-188,C190
5	0290-02-4157	CAP, DIP TANT,150uF, 15V	C106
6	0286-00-1102	CAP, SMD,CERAMIC, 1000pF, 10%	C94
9	0289-00-4336	CAP,SMD.TANTALUM,33uF,20V	C121, C122,C126
11	0287-01-1222	CAP,SMD,CER,.0022uF	C135
12	0153-00-0056	DIODE,LED,RED	CR4-CR9
13	0153-00-0186	DIODE,SMD,SCHOTTKY, {5819}	CR1,CR2
14	0153-00-0170	DIODE, SMD, {BAS16}	CR3,CR10,CR11
15	0124-00-0130	DISCONNECT, MALE	JP3
16	0136-22-0002	HEADER, .100"CNTR, 1X2	JP1, JP2, JP9, JP13
17	0136-22-0003	HEADER, .100"CNTR, 1X3	JP15, JP28
18	0136-74-0004	HEADER ,.100"CNTR,1X4,R/A	JP30
19	0136-74-0015	HEADER, .100" CNTR, 1X15, R/A	JP5,JP18
20	0136-90-0010	HEADER ,.165"CNTR,R/A,2X5	JP25
21	0136-63-0040	HEADER ,.100" CNTR , 2X20,R/A	JP16
22	0136-90-0016	HEADER ,.165" CNTR, R/A,2X8	JP19
23	0136-26-0032	HEADER,.100" CNTR,2X16	J1
24	0136-74-0003	HEADER,.100" CNTR, 1X3,R/A	JP20
25	0136-63-0026	HEADER,.100" CNTR,2X13,R/A	JP17
26	0136-74-0010	HEADER,.100" CNTR, 1X10	JP21,JP31
27	0136-26-0034	HEADER,.100" CNTR,2X17	J2
28	0136-63-0020	HEADER, .100" CNTR, R/A,2X10	JP22
29	0136-74-0005	HEADER, .100"CNTR, R/A, 1X5	JP23
30	0136-00-0155	SOCKET,PGA,114 PINS	XU60
32	0136-57-0028	SOCKET,PLCC,THRU-HOLE,28 PINS	XU63,XU21,XU50,XU45
33	0136-57-0052	SOCKET,PLCC,THRU-HOLE,52 PINS	XU19
34	0136-57-0084	SOCKET PLCC,THRU-HOLE,84 PINS	XU61
35	0136-57-0020	SOCKET PLCC,THRU-HOLE,20 PINS	XU9,XU46 - XU48, XU51
36	0136-00-0040	SOCKET,IC,40 PINS, .6"	XU25
37	0108-11-0100	INDUCTOR, SMD, 10 uH, (1812)	L1, L2, L4, L5
38	0108-05-0002	INDUCTOR,.12uH, 3 AMP	L3
39	0307-06-2103	RES NTWK, 10 PIN, COMMON TERM, 10K OHM, 5%	RN1,RN10-RN14 ,RN17
41	0324-01-51R1	RES,SMD,THK FLM, 51.1,1%,1/4W	R117
42	0324-01-1001	RES, SMD, THK FLM 1K, 1%, 1/4W	R11,R53,R59,R60,R64-R67,R69,R71,R82,R84,R85,R87,R97,R114
43	0324-00-0472	RES,SMD,THK FLM,4.7K, 5%, 1/4W	R4-R7,R72,R73,R90,R95,R102,R103,R109,R110,R112
44	0324-01-6812	RES,SMD,THK FLM,68.1K,1%,1/4W	R56
45	0324-01-1002	RES,SMD,THK FLM,10K, 1%, 1/4W	R24-R29,R31,R44,R47,R57,R74-R78,R88,R98-R101,R105-R107,R113,R118,R120
46	0324-01-4022	RES,SMD,THK FLM,40.2K,1%,1/4W	R14
47	0324-01-6651	RES,SMD,THK FLM,6.65K,1%,1/4W	R15,R18
48	0324-01-1101	RES,SMD,THK FLM,1.10K,1%,1/4W	R16,R17
49	0324-01-2370	RES,SMD,THK FLM,237,1%,1/4W	R19,R21,R68,R86,R121
50	0325-02-1002	RES,SMD,THK FLM,10.0K,.1%,1/8W	R20,R22
51	0324-00-0202	RES,SMD,THK FLM,2K,5%,1/4W	R23,R32

MAIN BOARD P/N 0670-00-0666

Item No	Part Number	Description	Reference
52	0324-01-4021	RES,SMD,THK FLM,4.02K,1%,1/4W	R30
53	0324-00-0102	RES,SMD,THK FLM,1K,5%,1/4W	R33
54	0324-01-6042	RES,SMD,THK FLM,60.4K,1%,1/4W	R34
55	0324-01-2002	RES,SMD,THK FLM,20K,1%,1/4W	R35
56	0324-01-1003	RES,SMD,THK FLM,100K,1%,1/4W	R36,R92
57	0324-00-0471	RES,SMD,THK FLM,470,5%,1/4W	R62
58	0324-00-0470	RES,SMD,THK FLM,47,5%,1/4W	R37,R39,R40,R42,R123,R124,R127
59	0324-01-2322	RES,SMD,THK FLM,23.2K,1%,1/4W	R61
60	0324-01-2001	RES,SMD,THK FLM,2.00K,1%,1/4W	R63,R81,R83
61	0324-01-3011	RES,SMD,THK FLM,3.01K,1%	R79
62	0324-01-5100	RES,SMD,THK FLM,510,1%	R115,R116
63	0324-01-4752	RES,SMD,THK FLM, 47.5K,1%,1/4W	R12
64	0324-01-4321	RES,SMD,THK FLM,4.32K,1%,1/4W	R104
65	0324-01-4991	RES,SMD,THK FLM,4.99K,1%,1/4W	R58
66	0324-01-4992	RES,SMD,THK FLM,49.9K,1%,1/4W	R70,R108
67	0324-00-03R3	RES, SMD, THK FLM 3.3	R41
68	0261-00-0182	SW, PB, R/A PC MTG.	S1
69	0261-28-0008	SWITCH, SMD, DIP-8	S2
71	0155-00-0635-01	IC, SMD, MICRO-MONITOR, {DS1232}	U40, U49
72	0155-00-0648-01	IC, SMD, QUAD 4-TO-1 ANALOG MUX, {DG409}	U4
73	0155-00-0841-01	IC,SMD,OCTAL TRANSCEIVER, {BCT245}	U78,U79
74	0155-00-0693	IC,SMD,HEX INVERTER, SCHMITT TRIGGER ,{HCT14}	U35
79	0155-00-0582	IC,TIMEKEEPER WITH RAM,{1386-32K}	U62
80	0155-00-0751	IC,PLCC,BUS EXCHANGE, {29C983}	U52
81	0155-00-0481	IC,PLCC,uP PERIPHERAL, {68901}	U55
82	0155-00-0827	IC,PLCC, QUAD UART {68C94}	U64
83	0155-00-0709	IC,SMD,RS232 TRANSCIEVER, 5V POWERED,{208}	U73,U74
86	0155-00-0660	IC,SMD,POWER MONITOR {1231}	U77
87	0155-00-0829	IC,SMD,DUAL 4-TO-1 MUX, {HCT153}	U80
88	0155-00-0707	IC,SMD,QUAD PORT STATIC RAM, 1K X 8,{7050S35}	U43
89	0155-00-0697	IC,SMD,3-TO-8 DECODER W/ENABLES, {HCT138}	U31
90	0155-90-0384	ASSY,IC,PROGRAMMED, {68HC711E9-CFN2}	U19
91	0155-00-0696	IC,SMD,DUAL FIIP-FLOP,{HCT74}	U27,U28,U30,U36,U84
92	0155-00-0652-02	IC,PLCC,D/A CONV, 12 BIT, {7548}	U9
93	0155-00-0651	IC,VOLT REF, 2.5V,{AD680}	U14
94	0155-00-0699	IC,SMD, OCTAL BUFFER, {HCT541}	U1,U2,U7,U8,U18,U20,U82
95	0155-00-0692	IC,SMD, QUAD POSITIVE AND GATE, {HCT08}	U42
96	0155-00-0606	IC,uP PERIPHERAL, {R65C22}	U39
97	0155-00-0607	IC, MICROPROCESSOR, 8 BIT, {68B09}	U25
98	0155-00-0695	IC,SMD,DUAL FLIP-FLOP, {ACT74}	U41
99	0155-00-0833	IC,SMD,OCTAL TRANSCIEVER, {HCT245}I	U11,U5
100	0155-00-0820	IC,SMD,SRAM,32K X 8, {62256FP-12}	U38

MAIN BOARD P/N 0670-00-0666

Item No	Part Number	Description	Reference
101	0155-00-0830	IC,SMD,POWER AMP, {LM388}	U3
102	0155-00-0730	IC,SMD, OCATL REGISTER, TRI-STATE, {HCT574}	U22
104	0155-00-0840-01	IC,SMD,OCTAL BUFFER, {BCT541}	U32,U54,U70,U71,U76,U89
105	0155-00-0656	IC,SMD,QUAD NAND GATE, {HC00}	U33
106	0155-00-0741	IC,SMD,TIMER, {555}	U23
107	0155-00-0682-01	IC,SMD,TONE GENERATOR, {YM3812}	U34
108	0155-00-0683-01	IC,SMD,SERIAL INPUT D/A CONVERTER, {YM3014}	U44
109	0155-00-0645	IC,SMD,QUAD OP-AMP, {TL032}	U12,U13,U15,U24
110	0155-00-0750	IC,SMD,OCTAL LATCH, {HCT573}	U17
111	0155-90-0316	ASSY,PLD,PROGRAMMED, {20V8Q-15}	U45
112	0155-90-0324	ASSY,PLD,PROGRAMMED, {16V8H-25}	U46
113	0155-90-0330	ASSY,PLD,PROGRAMMED, {16V8H-25}	U47
114	0158-07-0004	OSC,CRYSTAL,SMD, {3.68MHz}	Y8
116	0158-07-0007	OSC.,CRYSTAL,SMD, {3.58MHz}	Y7
117	0351-00-0066	SLIDE,DATASETTE	
119	0213-01-0204	SCREW,2-56,SELF TAPPING	
120	0136-00-0201	TEST POINT	TP 1 - TP11,TP16,TP17
121	0388-00-0666	PCB, S98 MAIN BOARD	
124	0151-00-0184	TRANS,SMD, {2222}	Q1,Q2
125	0131-00-0095	Shunt	For JP6 and JP28
126	0108-00-0058	FERRITE BEAD	FB1-FB7
127	0151-00-0190	FET, SMD, {2N7002}	Q3,Q4
129	0155-00-0742	IC,SMD,QUAD 2 INPUT OR GATE, {HCT32}	U83
130	0289-00-5475	CAP,SMD, Tantalum, 4.7uF,25V	C103, C104
131	0324-01-22R1	Res, SMD, Thk Flm, 22.1, 1%	R13, R46, R48
132	0324-01-6342	Res, SMD, Thk Flm, 63.4K, 1%	R96
133	0155-00-0967-01	IC,SMD,SRAM,256k X 15,20nS	U85-U88
135	0155-90-0372	IC,SMD.PLD.MACH231-7JC	U61
136	0155-90-0383	IC,PLCC,PLD,16V8-7JC	U51
137	0155-90-0381	IC,PLCC,PLD,16V8-5JC	U48
138	0155-90-0382	IC,PLCC,PLD,20V8-7JC	U50
139	0287-01-1103	CAP,SMD,CERAMIC,.01uF	C53,C55,C58,C143,C145-C149,C151,C153,C155
140	0155-00-0969-01	IC,PGA,Micro-processor,32Bit,25MHz MC68020RC25	U60
143	0158-07-0013	OSC,SMD,CRYSTAL,48.000MHz	Y1
144	0287-01-1223	Cap, SMD,Ceramic,.022uF,10%	C102
145	0287-01-2104	Cap,SMD,Ceramic,.1uF,5%	C108
146	0324-01-2211	Res,SMD,Thk Flm,2.21K,1/4W,1%	R49
147	0324-01-7501	RESISTOR SMD THICK FILM 1/4W 1%, 7.50K	R54
149	0324-01-1005	Res,SMD,Thk Flm,10M,1/4W,1%	R128,R130
150	0155-00-0975-02	IC, SMD,Analog switch, DG419	U90
151	0324-01-6193	Res,SMD,Thk Flm,619K,1/4W,1%	R55
152	0287-00-1222	CAPACITOR SMD 0805 CERAMIC X7R 10%, 0.0022UF	C113
153	0324-01-39R2	RES,SMD,THK FLM,39 Ohm,1%, 1/4W	R1-R3,R38,R8,R150

MAIN BOARD P/N 0670-00-0666

Item No	Part Number	Description	Reference
154	0324-01-2214	RES,SMD,THK FLM,2.21MOhm,1%,1/4W	R129
155	0324-01-15R0	RES,SMD,THK FLM,15 Ohm,1%, 1/4W	R125,R126
157	0136-81-0007	Header, SIP, .100" cntr, shrouded, 7 pin	JP6,JP7

FRONT END BOARD P/N 0670-00-0668

Item No	Part Number	Description	Reference
1	0286-01-3121	Capacitor, Ceramic, 120pF,2%	C1,C2,C3,C4,C5,C6,C7,C8,C9,C10,C11,C12
2	0286-01-2121	Capacitor, Ceramic, 120pf, 5%	C32,C33,C63,C90,C102
3	0287-00-1102	Capacitor, Ceramic, 1000pf, 10%	C13
4	0287-01-1104	Capacitor, Ceramic, .1uf, 10%	C14,C15,C16,C17,C18,C20,C21, C27,C28,C35,C36,C38,C39, C47,C48,C52,C53,C57,C58, C60,C61,C62,C66,C69,C71, C72,C78,C79,C83,C85,C86, C87,C88,C89,C91,C92,C95, C96,C100,C101,C103,C104, C111,C112,C114,C115,C117, C118,C119,C122,C128,C129, C135,C136,C144,C145,C150, C151,C153,C154,C157,C158, C160,C161,C164,C167,C168, C173,C175,C181,C182,C183, C185,C188,C189,C190,C191, C194,C196,C197,C198,C199, C200,C201,C202,C203,C204,C212,C220
5	0287-00-1103	Capacitor, Ceramic, .01uf, 10%	C19,C24,C25,C29,C30,C31, C49,C59,C73,C75,C77,C81, C84,C105,C113,C121,C146, C148,C149,C155,C156,C162, C178,C179,C180
6	0286-00-1331	Capacitor, Ceramic, 330pf, 10%	C22,C23,C54
7	0287-01-2563	Capacitor, Ceramic, .056uf, 5%	C34,C50,C215,C216
8	0287-02-2474	Capacitor, Ceramic, .47uf, 5%	C37,C40,C97,C120, C133,C134,C166
9	0287-00-1182	Capacitor, Ceramic, 1800pf, 10%	C41,C107
10	0287-02-1105	Capacitor, Ceramic, 1uf, 10%	C42,C43,C172,C174,C176, C177
11	0287-00-1332	Capacitor, Ceramic, 3300pf, 10%	C44,C217
12	0287-01-2223	Capacitor, Ceramic, .022uf, 5%	C45
13	0287-00-2472	Capacitor, Ceramic, 4700pf, 5%	C46,C143,C147
14	0287-01-2683	Capacitor, Ceramic, .068uf, 5%	C51,C94,C152,C159
15	0286-02-4103	Capacitor, NPO, .01uf, 1%	C55,C56
16	0286-00-1471	Capacitor, Ceramic, 470pf, 10%	C64,C65,C74,C76,C99
17	0289-00-5475	Capacitor, Tantalum, 4.7uf, 20%	C67,C68,C70,C80,C123,C205,C206,C207
18	0289-00-4336	Capacitor, Tantalum, 33uf, 20%	C82,C184,C192,C193,C195
19	0287-01-2473	Capacitor, Ceramic, .047uf, 5%	C98,C130
20	0287-01-2154	Capacitor, Ceramic, .15uf, 5%	C106
21	0287-01-2104	Capacitor, Ceramic, .1uf, 5%	C108,C109,C110,C116,C210,C211,C214,C218,C219
22	0287-01-2393	Capacitor, Ceramic, .039uf, 5%	C131,C132
23	0287-01-2224	Capacitor, Ceramic, .22uf, 5%	C127
24	0286-00-1180	Capacitor, Ceramic, 18pf, 10%	C186,C187,C209
25	0286-00-1221	Capacitor, Ceramic, 220pf, 10%	C208,C222
26	0287-01-2272	Capacitor, Ceramic, 2700pf, 5%	C26
28	0283-05-0102	Capacitor, Ceramic, 1000pF,10%	C213
29	0153-00-0171	Diode, Dual, BD7000	CR1,CR2,CR6,CR9,CR14,CR19,CR22, CR23,CR24,CR25,CR26,CR27,CR28, CR32,CR33
30	0153-00-0170	Diode, Gen. Pur., BAS16	CR3,CR4,CR10,CR11,CR12, CR13,CR20,CR29
31	0153-00-0190	Diode, Zener, Z5234B	CR5,CR21
32	0153-00-0184	Diode, Zener, BZX84C3V3	CR7,CR8,CR34,CR35

FRONT END BOARD P/N 0670-00-0668

Item No	Part Number	Description	Reference
33	0153-00-0186	Rectifier, Schottky, SM5819	CR15,CR16,CR17,CR18,CR30,CR31
34	0153-00-0091	Diode, Zener, 1N6275	CR41,CR42,CR43,CR44,CR45
35	0153-00-0160	Transzorb, SA170C	CR46,CR47,CR48,CR49,CR50
36	0155-00-0576	Opto-Isolator, CNY17-3	ISO1,ISO2,ISO3,ISO4
37	0136-81-0016	Header, 70543-0015	J1
38	0136-81-0015	Header, 70543-0014	J2
39	0136-81-0010	Header, 70543-0009	J3
40	0136-81-0006	Header, 70543-0005	J4,J5
41	0136-81-0008	Header, 70543-0007	J7
42	0136-81-0004	Header, 70543-0003	J8
43	0136-71-0002	Header, 22-29-2031	JB2,JB5
44	0136-71-0003	Header, 22-29-2021	JB6
45	0108-00-0067	Ferrite Bead, SMT, 2743019447	L1,L11
46	0108-11-0100	Inductor, 10uh, 1812	L2,L3,L4
47	0108-05-0033	Inductor, 47uh	L5,L6,L7,L10
48	0108-05-0018	Inductor, 2.7uh	L8,L9
49	0012-00-0897	Cable Assembly, Front End Flying	J6
50	0151-00-0183	Trans., JFET, BF4393	Q1,Q2
51	0151-00-0184	Trans., NPN, BT2222A	Q3,Q7
52	0151-00-0186	Trans, Power, NPN, MJD200	Q4,Q5
53	0151-00-0185	Trans., PNP, BT2907A	Q6
54	0324-01-2492	Resistor, Thick Film, 24.9K, 1%, 1/4W	R1,R4,R7,R10,R13,R19,R142
55	0324-01-4752	Resistor, Thick Film, 47.5K, 1%, 1/4W	R2,R3,R5,R6,R8,R9,R11,R12
56	0324-00-0226	Resistor, Thick Film, 22M, 5%, 1/4W	R14,R15,R16,R17
57	0307-14-1002	Resistor, Network, 10K, .5%	R20,R144,R193,R232
58	0324-00-0102	Resistor, Thick Film, 1K, 5%, 1/4W	R21,R22,R26,R27,R32,R47, R48,R49,R97,R100,R108,R118, R119,R159,R197,R198,R210, R211,R313,R315,R316,R318,R337
59	0324-01-1003	Resistor, Thick Film, 100K, 1%, 1/4W	R23,R25,R64,R65,R83,R84, R85,R86,R123,R136,R137, R161,R165,R166,R179,R180, R181,R182,R185,R248, R323
60	0324-01-2002	Resistor, Thick Film, 20K, 1%, 1/4W	R24,R203,R217
61	0324-01-1002	Resistor, Thick Film, 10K, 1%, 1/4W	R18,R28,R29,R77,R81,R89,R90, R112,R113,R139,R140,R147,R164, R204,R215,R252,R254,R261
62	0324-01-6651	Resistor, Thick Film, 6.65K, 1%, 1/4W	R31,R194
63	0324-00-0104	Resistor, Thick Film, 100K, 5%, 1/4W	R33,R56,R58
64	0324-01-6983	Resistor, Thick Film, 698K, 1%, 1/4W	R35,R37,R150,R335,R336
65	0324-01-1054	Resistor, Thick Film, 1.05M, 1%, 1/4W	R36,R38
66	0324-00-0472	Resistor, Thick Film, 4.7K, 5%, 1/4W	R39,R40,R92,R93,R174,R334
67	0324-00-0473	Resistor, Thick Film, 47K, 5%, 1/4W	R57,R63,R109,R311
68	0324-01-2493	Resistor, Thick Film, 249K, 1%, 1/4W	R51
69	0312-03-0502	Resistor, Trimmer, Multi-Turn, 5K	R52,R134,R229
70	0324-01-2491	Resistor, Thick Film, 2.49K, 1%, 1/4W	R53
71	0324-01-8453	Resistor, Thick Film, 845K, 1%, 1/4W	R54
72	0324-00-0470	Resistor, Thick Film, 47, 5%, 1/4W	R55
73	0324-00-0394	Resistor, Thick Film, 390K, 5%, 1/4W	R59,R60

FRONT END BOARD P/N 0670-00-0668

Item No	Part Number	Description	Reference
74	0324-00-0103	Resistor, Thick Film, 10K, 5%, 1/4W	R34,R61,R79,R80,R104,R106, R120,R122,R241,R242, R243,R244,R256,R257,R258, R259,R260,R266,R267,R268, R269,R271,R317,R331
75	0324-01-2003	Resistor, Thick Film, 200K, 1%, 1/4W	R62,R66,R87,R88,R135,R167,R168,R327
76	0324-00-0471	Resistor, Thick Film, 470, 5%, 1/4W	R67,R91,R145,R208,R221, R235
77	0324-00-0243	Resistor, Thick Film, 24K, 5%, 1/4W	R41,R42,R43,R44,R45,R46,R310,R312
78	0324-01-8062	Resistor, Thick Film, 80.6K, 1%, 1/4W	R178
79	0324-01-9093	Resistor, Thick Film, 909K, 1%, 1/4W	R325
80	0324-01-1433	Resistor, Thick Film, 143K, 1%, 1/4W	R322
81	0324-01-1004	Resistor, Thick Film, 1.0M, 1%, 1/4W	R328,R339
82	0324-00-0222	Resistor, Thick Film, 2.2K, 5%, 1/4W	R68,R96,R99,R107,R110,R146, R162,R169,R209,R222,R236,R314,R338
83	0325-02-2613	Resistor, Thin Film, 261K, .1%, 1/8W	R69,R72
84	0324-01-4321	Resistor, Thick Film, 4.32K, 1%, 1/4W	R70,R73
85	0324-01-5362	Resistor, Thick Film, 53.6K 1%, 1/4W	R71,R74
86	0325-02-2002	Resistor, Thin Film, 20K, .1%, 1/8W	R75
87	0325-02-1002	Resistor, Thin Film, 10K, .1%, 1/8W	R76,R330
88	0324-01-2001	Resistor, Thick Film, 2K, 1%, 1/4W	R78,R154,R206,R219,R262,R321,R329
89	0324-01-3012	Resistor, Thick Film, 30.1K, 1%, 1/4W	R30,R82
90	0324-00-0201	Resistor, Thick Film, 200, 5%, 1/4W	R94,R98,R195,R196,R320
91	0324-00-03R3	Resistor, Thick Film, 3.3, 5%, 1/4W	R95,R264,R265
92	0324-01-2430	Resistor, Thick Film, 243, 1%, 1/4W	R101
93	0324-01-1211	Resistor, Thick Film, 1.21K, 1%, 1/4W	R102
94	0324-00-0101	Resistor, Thick Film, 100, 5%, 1/4W	R103,R105,R133,R332,R333
95	0324-00-0106	Resistor, Thick Film, 10M, 5%, 1/4W	R111,R114,R255
96	0324-01-7502	Resistor, Thick Film, 75K, 1%, 1/4W	R115,R117,R124,R143, R152,R153
97	0324-01-1001	Resistor, Thick Film, 1K, 1%, 1/4W	R116,R129,R151,R200,R201, R213,R214,R251,R270,R319
98	0324-00-0393	Resistor, Thick Film, 39K, 5%, 1/4W	R121
99	0324-01-4992	Resistor, Thick Film, 49.9K, 1%, 1/4W	R125
100	0324-01-2612	Resistor, Thick Film, 26.1K, 1%, 1/4W	R126,R186
101	0324-01-1873	Resistor, Thick Film, 187K, 1%, 1/4W	R127
102	0312-03-0102	Resistor, Trimmer, Multi-Turn, 1K	R128,R199,R212
103	0324-01-6812	Resistor, Thick Film, 68.1K, 1%, 1/4W	R130
104	0324-01-1273	Resistor, Thick Film, 127K, 1%, 1/4W	R131
105	0324-01-1583	Resistor, Thick Film, 158K, 1%, 1/4W	R132,R187
106	0324-01-5761	Resistor, Thick Film, 5.76K, 1%, 1/4W	R228
107	0311-05-0103	Resistor, Trimmer, Multi-Turn, 10K	R202,R216
108	0324-01-5112	Resistor, Thick Film, 51.1K, 1%, 1/4W	R138,R223,R224
109	0324-01-5111	Resistor, Thick Film, 5.11K, 1%, 1/4W	R141,R263
110	0324-01-1782	Resistor, Thick Film, 17.8K, 1%, 1/4W	R148
111	0324-01-3011	Resistor, Thick Film, 3.01K, 1%, 1/4W	R149
112	0324-00-0305	Resistor, Thick Film, 3M, 5%, 1/4W	R155,R158
113	0324-01-9312	Resistor, Thick Film, 93.1K, 1%, 1/4W	R156,R157
114	0324-01-4532	Resistor, Thick Film, 45.3K, 1%, 1/4W	R160,R163
115	0324-01-6652	Resistor, Thick Film, 66.5K, 1%, 1/4W	R170
116	0324-01-3162	Resistor, Thick Film, 31.6K, 1%, 1/4W	R171

FRONT END BOARD P/N 0670-00-0668

Item No	Part Number	Description	Reference
117	0324-01-7152	Resistor, Thick Film, 71.5K, 1%, 1/4W	R172
118	0324-01-5903	Resistor, Thick Film, 590K, 1%, 1/4W	R173
119	0324-00-0822	Resistor, Thick Film, 8.2K, 5%, 1/4W	R175
120	0324-01-4751	Resistor, Thick Film, 4.75K, 1%, 1/4W	R183
121	0324-01-2552	Resistor, Thick Film, 25.5K, 1%, 1/4W	R184
122	0324-01-1622	Resistor, Thick Film, 16.2K, 1%, 1/4W	R230
123	0324-01-1822	Resistor, Thick Film, 18.2K, 1%, 1/4W	R205,R218
124	0324-01-8061	Resistor, Thick Film, 8.06K, 1%, 1/4W	R207,R220
125	0324-01-6041	Resistor, Thick Film, 6.04K, 1%, 1/4W	R233,R237,R239
126	0324-01-4021	Resistor, Thick Film, 4.02K, 1%, 1/4W	R234,R238,R240
127	0324-01-2371	Resistor, Thick Film, 2.37K, 1%, 1/4W	R247
128	0324-01-49R9	Resistor, Thick Film, 49.9, 1%, 1/4W	R249,R250
129	0312-03-0202	Resistor, Trimmer, Multi-Turn, 2K	R225,R253
130	0324-01-1272	Resistor, Thick Film, 12.7K, 1%, 1/4W	R231
131	0301-00-0472	Resistor, Carbon, 4.7K, 5%, 1/2W	R301,R302,R303,R304,R305
132	0315-00-0244	Resistor, Carbon, 240K, 5%, 1/4W	R306
133	0315-00-0103	Resistor, Carbon, 10K, 5%, 1/4W	R309
134	0301-00-0107	Resistor, Carbon, 100M, 5%, 1/2W	R307,R308
176	0324-01-7153	Resistor, Thick Film, 715K, 1%, 1/4W	R326
135	0167-00-0008	Spark Gap, CG3-4.5L, 4.5KV	SG1, SG2
136	0120-00-0134	Transformer, Signal Isolation	T1,T3
137	0120-00-0133	Transformer, Power Isolation	T2
138	0136-00-0201	Test Point	TP1,TP2,TP3,TP4,TP5,TP6, TP7,TP8,TP9,TP10,TP11,TP12, TP13,TP14,TP15,TP16,TP17,TP18, TP19,TP21,TP22,TP23,TP24, TP25,TP26,TP27,TP28,TP29,TP30, TP31,TP32,TP33,TP34,TP35,TP36, TP37,TP38,TP39,TP40,TP41,TP42, TP43,TP44,TP45,TP46,TP47,TP48, TP49,TP50,TP52,TP53,TP54,TP55, TP56,TP57,TP58,TP59,TP60,TP61, TP62,TP63,TP64,TP65,TP66,TP67, TP68,TP69,TP70,TP71,TP72
139	0155-00-0645	Op Amp, Dual, TL032	U1,U2,U7,U13,U16,U19,U20, U23,U33,U34,U35,U38,U45,U47,U51, U53,U56,U75,U77
140	0155-00-0647	Mux, 8-Chan, DG408	U3,U57,U58
141	0155-00-0649-02	Switch, Quad, DG413	U8,U9,U15,U17,U18,U26, U27,U37,U44
142	0155-00-0650	Comparator, LP311	U11,U28,U40,U41
143	0155-00-0656	NAND, Quad, 74HC00	U12,U74
144	0155-00-0646-03	Op Amp, Dual, Prec., OP297	U14,U25,U32
145	0155-00-0652-01	DAC, 12-Bit, MX7548	U21,U31
146	0155-00-0690	Op Amp, Dual, TL052	U22,U39,U49,U59,U76
147	0155-00-0644	Regulator, Voltage, MIC2951	U24
148	0155-00-0194	Regulator, Voltage, LM317	U29
149	0155-00-0655	AND, Quad, 74AC08	U30
150	0155-00-0648-01	Switch, 4-Chan, Dual, DG409	U4,U5,U36,U73
151	0682-00-0078	Transducer, Pressure, MPX4250	U54
152	0155-00-0658	Oneshot, Dual, 74HC4538	U42
153	0155-00-0653	Instrumentation Amp, AD620	U50,U52
154	0155-00-0651	Reference Voltage, AD680	U60
155	0155-00-0897	A/D Conv., 12-Bit, ADS774JU	U61

FRONT END BOARD P/N 0670-00-0668

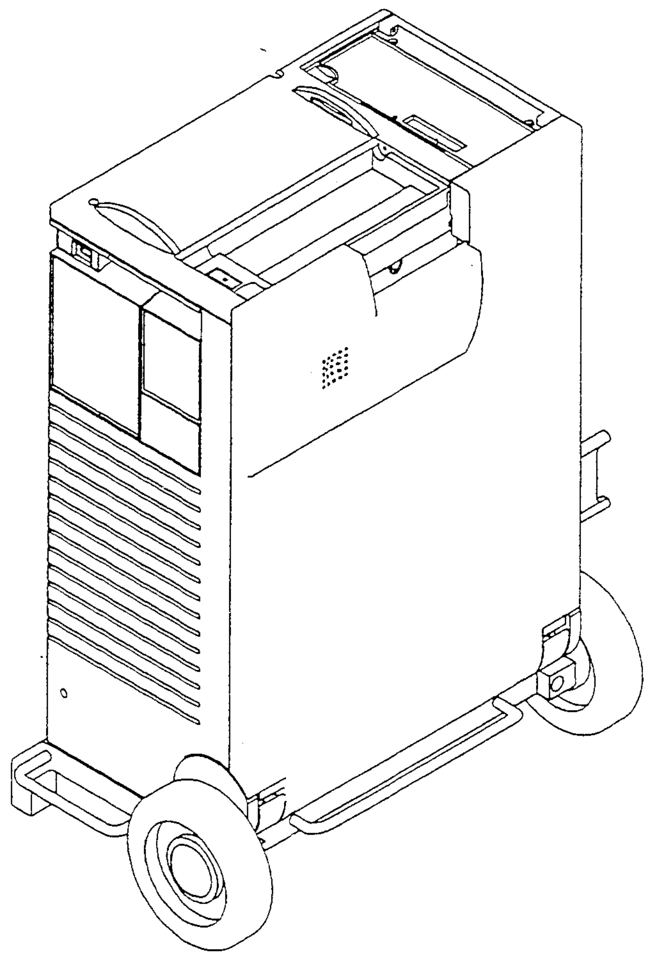
Item No	Part Number	Description	Reference
156	0155-00-0640-05	Power Monitor, DS1231	U63
157	0155-90-0378	Microcontrlr, Prog, Fr End, 68HC711E9	U64
158	0155-00-0689	Flip Flop, Dual, 74HC74	U65
159	0155-00-0687	Flip Flop, Octal, 74HC377	U66,U67
160	0155-00-0688	Decoder, 1-of-8, 74HC138	U68
161	0155-00-0685	Buffer, Octal, 74HC541	U69
162	0155-00-0686	Counter, 4-Bit, Dual, 74HC393	U70
163	0155-00-0657	Schmitt Trigger, Hex, 74HC14	U71,U72
164	0155-00-0968-01	Temperature Sensor, LM35DZ	U78
165	0158-06-0003	Crystal, 12 MHZ	Y1
166	0337-00-0087	Shield, Top	
167	0337-00-0088	Shield, Bottom	
168	0131-00-0237	Shunt, Programmable	Locate on JB2 and JB6
169	0136-78-0052	Socket, Chip Carrier, 52-Pin	XU64
170	0212-12-0404	Screw, Pan Head, #4-40 x 1/4"	For U29
171	0220-06-0004	Nut, Keps, #4	For U29 and U54
172	0212-12-0408	Screw, Pan Head, #4-40 x 1/2"	For U54
173	0349-00-0256	Insulator, Electrical	For Bottom Shield
174	0388-00-0668	PCB, Front End Module	
175	0387-00-0668	Schematic, Front End Module	

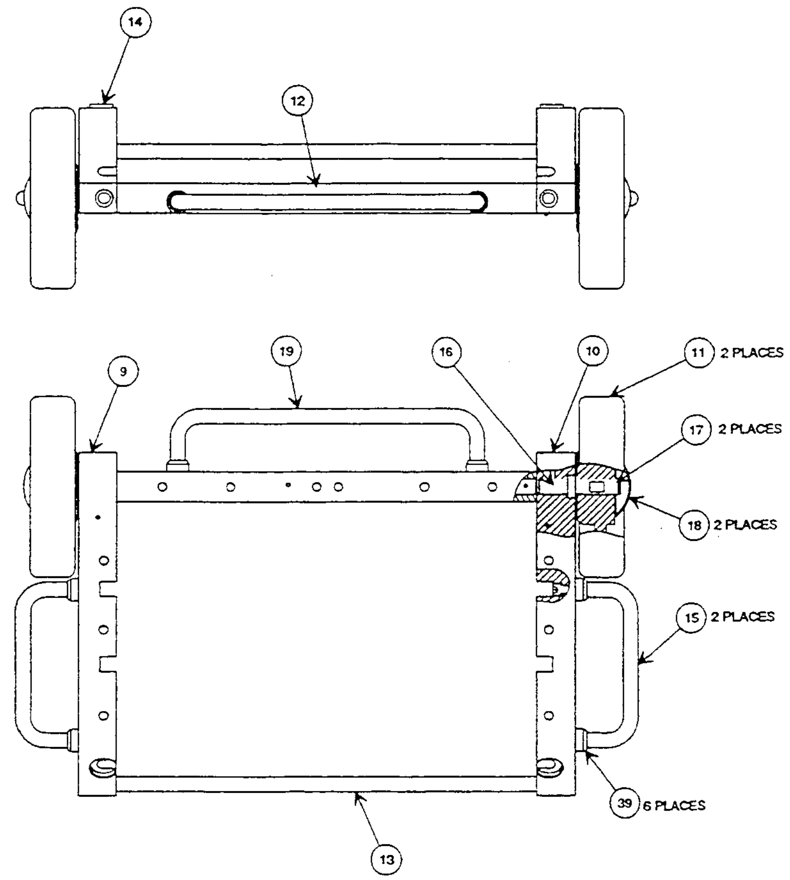
DATASETTE BD, DSS P/N 0670-00-0670

Item No	Part Number	Description	Reference
1	0287-01-1104	CAP,SMD,CER,.1uF	C1,C2
2	0289-00-1475	CAP,SMD,TANT,4.7uF,10V	C3,C4
4	0155-90-0388	ASSY,IC,PROGRAMMED, (29F016-90)	U1
6	0388-00-0670	PCB, S98 DSS DATASETTE	PCB
7	0324-00-0103	RES,SMD,THK FLM,10K,5%,1/4W	R1,r2
10	0334-00-0958	LABEL, EPROM	FOR U1
11	0334-00-0843	LABEL,READY SYS COPYRIGHT	
12	0361-00-0150	SPACER,HDR, .1"X.1" CNTR, 2X1	
13	0136-62-1034	HDR,2X17,.1"CNTR,R/A	JP1
14	0136-21-0002	HDR, 1X2, .100"CNTR,R/A	J1
~~15~~	~~0131-00-0228~~	~~SHUNT, PROGRAMMABLE~~	~~FOR J1~~
16	0136-74-0003	HDR, 1X3, .100"CNTR,R/A	J2
17	0155-00-0693	IC,SMD,HEX INVERTER, SCHMITT TRIGGER ,(HCT14)	U2
18	0153-00-0170	Diode, SMD, BAS16LT1	CR1

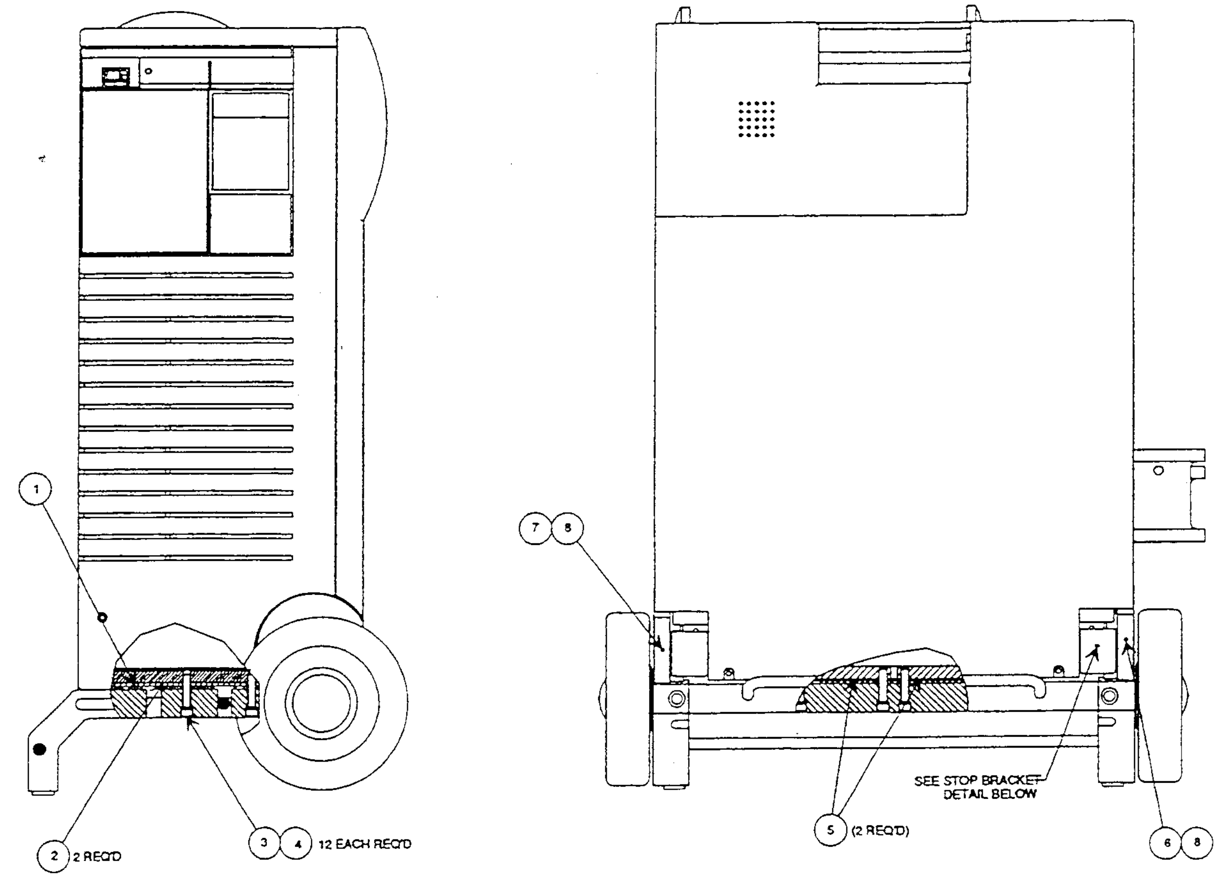
DATASETTE BD, IABP P/N 0670-00-0671

Item No	Part Number	Description	Reference
1	0287-01-1104	CAP,SMD,.CER,.1uF	C1,C2
2	0289-00-1475	CAP,SMD,TANT,4.7uF,6.3V	C3
4	0155-90-0387	ASSY,IC, PROGRAMMED, (29F010-120)	U1
7	0388-00-0671	PCB,S98 IAB DATASETTE	PCB Rev. 1
8	0324-00-0103	RES,SMD,THK FLM, 10K,5%,1/4W	R1
10	0334-00-0636	LABEL EPLD	FOR U1
11	0136-62-1032	HEADER,2X16,.1" CNTR. R/A	P1
12	0361-00-0150	SPACER, HDR,.1"X.1" CNTR, 2X18	For use under P1

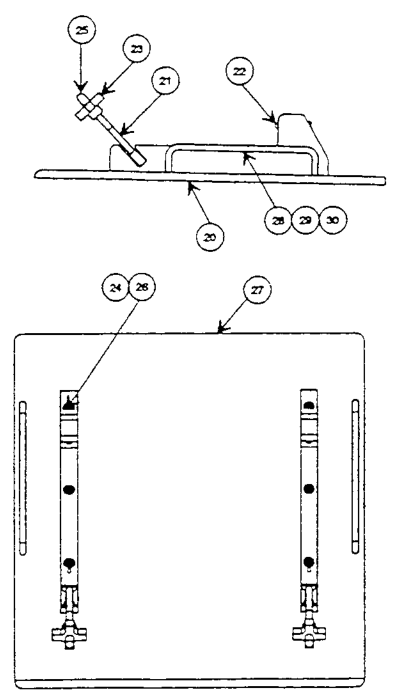




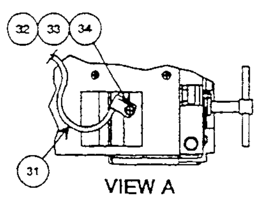
MOBILIZER



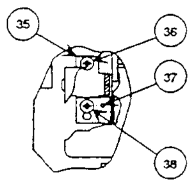
MOBILIZER

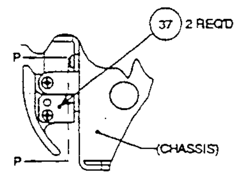


DOCKING STATION

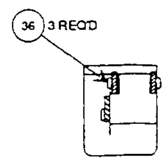


VIEW A





VIEW B



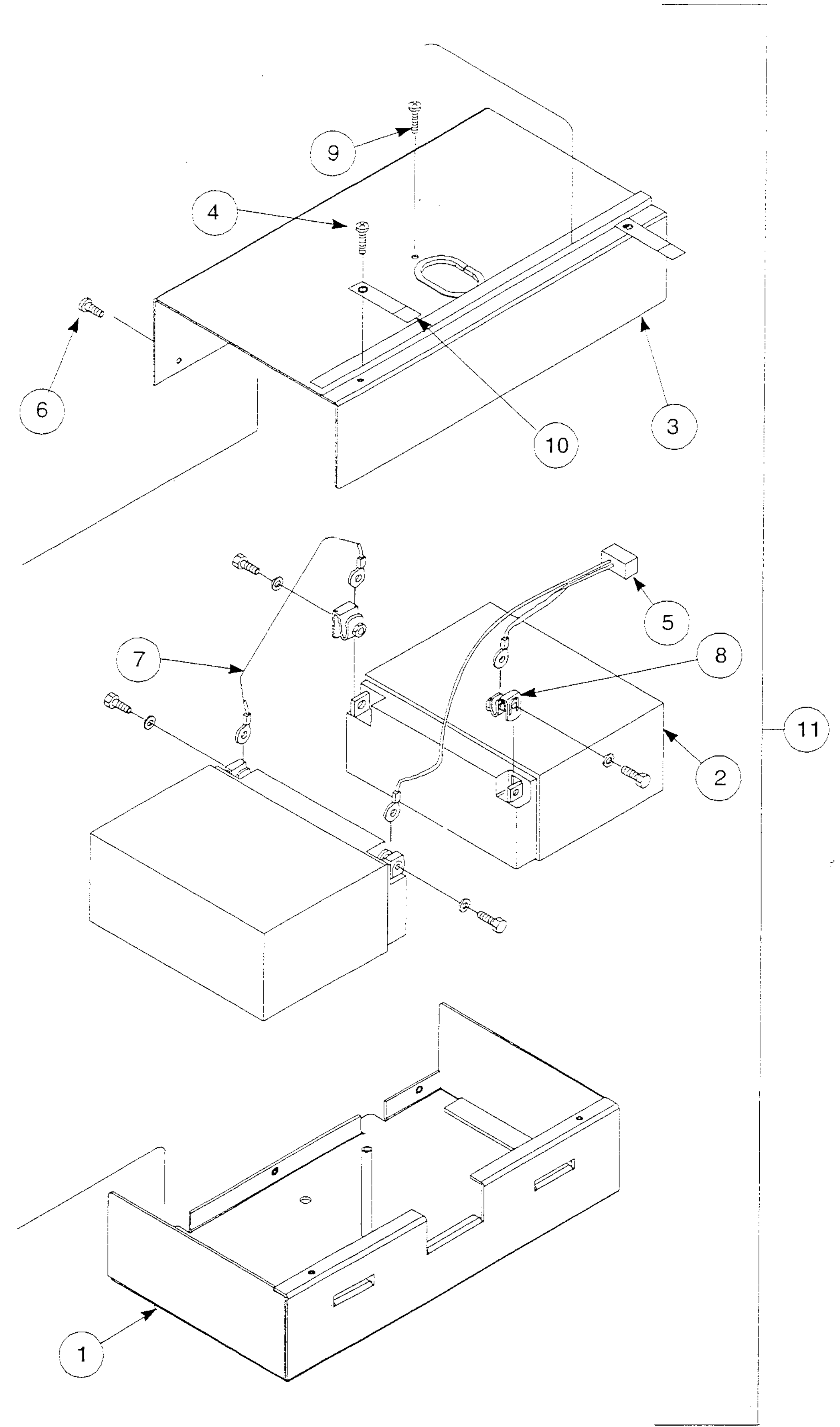
STOP BRACKET
2 PLACES

BASIC DOCKING STATION
AND MOBILIZER

6.10 BASIC DOCKING STATION AND MOBILIZER

Figure No.	Description	Datascope Part Number
1	Plate, Battery	0386-00-0228
2	Nut Plate, Front	0436-00-0092-11
3	Screw	0212-26-0620
4	Spring Lock Washer, Black	0221-10-0006
6	Blanking Plug, Right	0436-00-0092-10
7	Blanking Plug, Left	0436-00-0092-09
8	Set Screw	0215-05-1016-00
9	Rail, Left	0436-00-0092-02
10	Rail, Right	0436-00-0092-03
11	Wheel Assembly	0436-00-0092-04
12	Rail, Front	0436-00-0092-05
13	Rod	0436-00-0092-06
14	Urethane Spring	0214-00-0232
15	Handle, S.S. Unicorp #A9577	0436-00-0092-15
16	Axle	0436-00-0092-07
17	Snap Ring	0226-01-0500
18	Hub Cap	0436-00-0092-08
19	Handle, S.S. Unicorp #A9617	0436-00-0092-14
20	Mounting Rail	0436-00-0085-02
21	Swing Eye Bolt	0436-00-0085-03
22	Pin, Conical	0436-00-0085-04
23	Wing Nut	0436-00-0085-05
24	Spring Lock Washer, Black	0221-10-0008
25	Rubber Cap	0436-00-0085-06
26	Screw, SCS-298	0212-26-0820
27	Adapter Plate	0436-00-0085-07
28	Handle	0367-00-0053-02
29	Screw, SCS-190	0212-26-0612
30	Spring Lock Washer	0221-10-0006
31	Cable, Battery	0012-00-0964
NS	Screw, SCS-196	0212-26-0616
NS	Screw, SCS-202	0212-26-0624
NS	Adhesive, Loctite, 242	0530-00-0001
32	Screw, #6-32 x .31 Lg.	0212-12-0605
33	Washer, Flat	0221-00-0001
34	Clamp, Cable	0343-03-6206

Figure No.	Description	Datascope Part Number
35	Block, Lever Mounting	0391-00-0067
36	Screw, #4-40 x .25 Lg Pan. Hd.	0212-12-0404
37	Bracket, Stop	0406-00-0727
38	Screw, #4-40 x .38 Lg Pan. Hd.	0212-12-0406
39	Ferrule, S.S. Unicorp #13-207	0436-00-0092-16



9
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1

Figure No.	Description	Datascope Part Number
1	Battery Pack Housing	0441-00-0086
2	Battery	0146-00-0039
3	Battery Pack Cover	0198-00-0006
4	Screw, pan hd, #6-32 X 0.31"	0212-12-0603
5	Cable, Battery to Connector	0012-00-0963
6	Screw, flat hd, #6-32 X 0.18"	0212-07-0603
7	Fusible Link-0603	0011-00-0015
8	Terminal Nut #10-32	0220-00-0082
9	Screw, pan hd, #10-32 X 0375"	0216-02-1006
10	Strap	0346-00-0040
11	Battery Assembly	0146-00-0051

6.10.1 Use of the Basic Docking Station (P/N 0436-00-0085-01) and Mobilizer

1. Ensure that the docking station has been properly secured to the transport vehicle deck. (see instruction sheet enclosed with the docking station).

2. Position swing bolts as shown in figure 6-1 and red knobs are fully backed out (turn the red knobs counter-clockwise).

3. Place the System in front of the docking station and center it. Roll the System into place using the docking station handles as guides.

4. Without tilting the System, ensure the conical pins have been fully engaged by the conical holes on the mobilizer.

5. Move the swing bolts into position as shown in figure 6-4. Turn the red knobs clockwise until gaps are fully closed and a sudden increase in resistance is felt.

6. Check the function of the docking station by rocking the top of the System in all directions. No motion between the mobilizer and the docking station should be apparent.

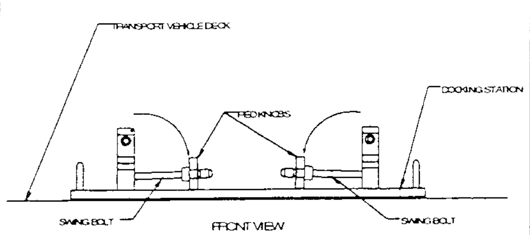
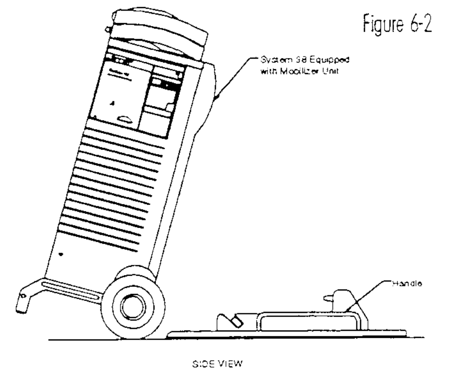


Figure 6-1



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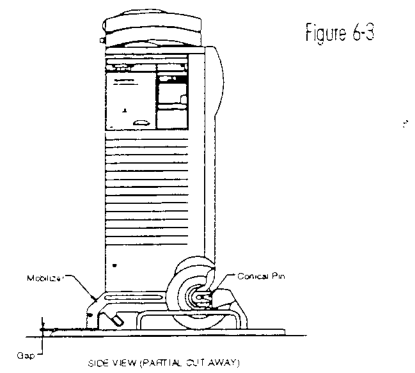


Figure 6-3

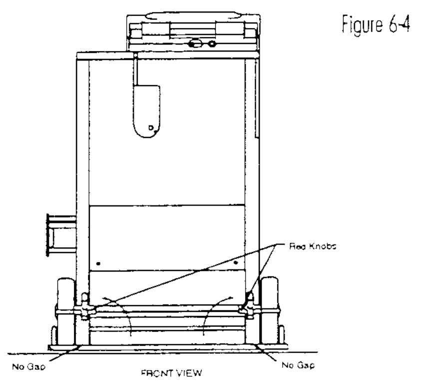
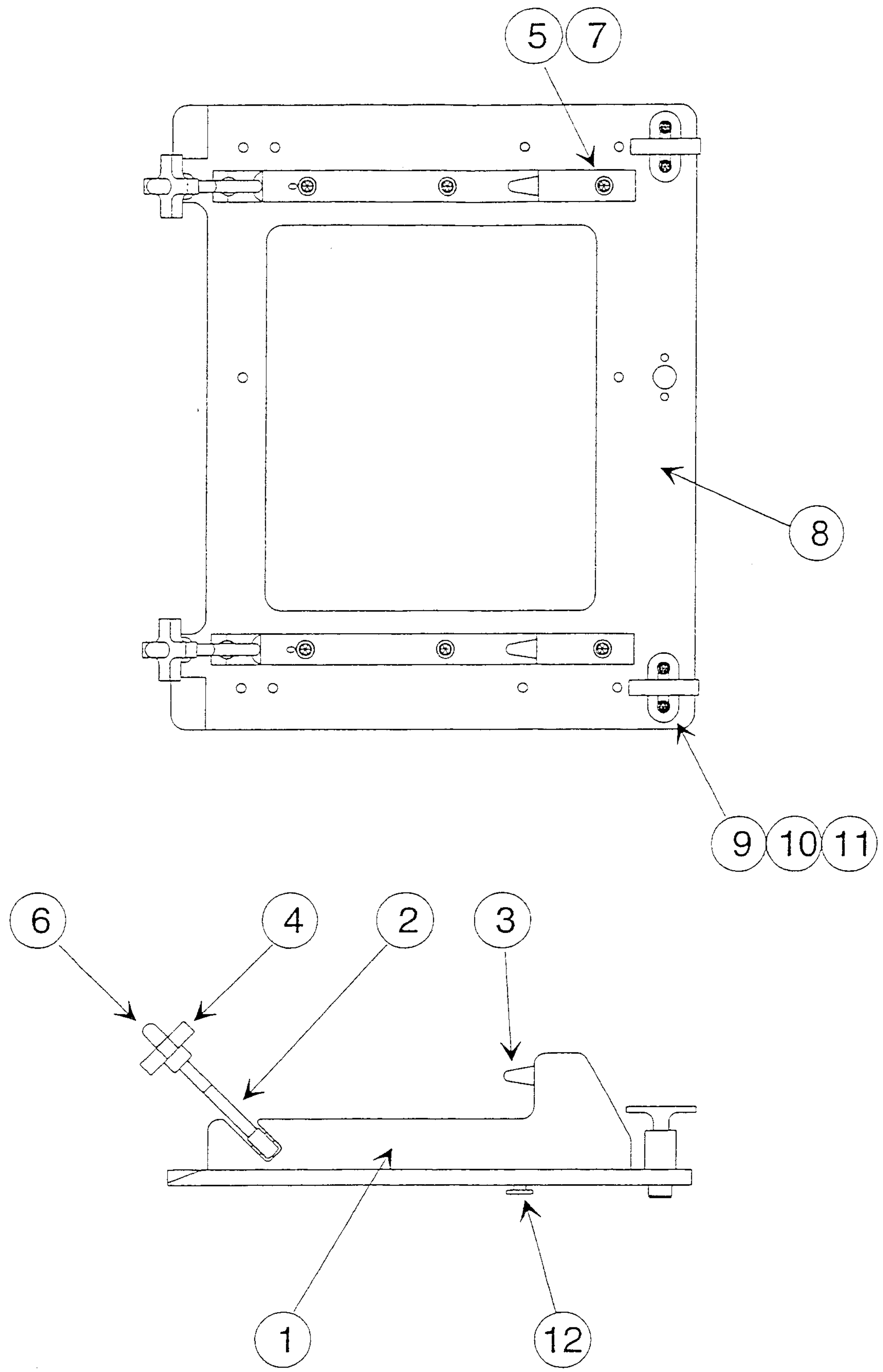


Figure 6-4

6.11 LIGHT WEIGHT DOCKING STATION AND MOBILIZER

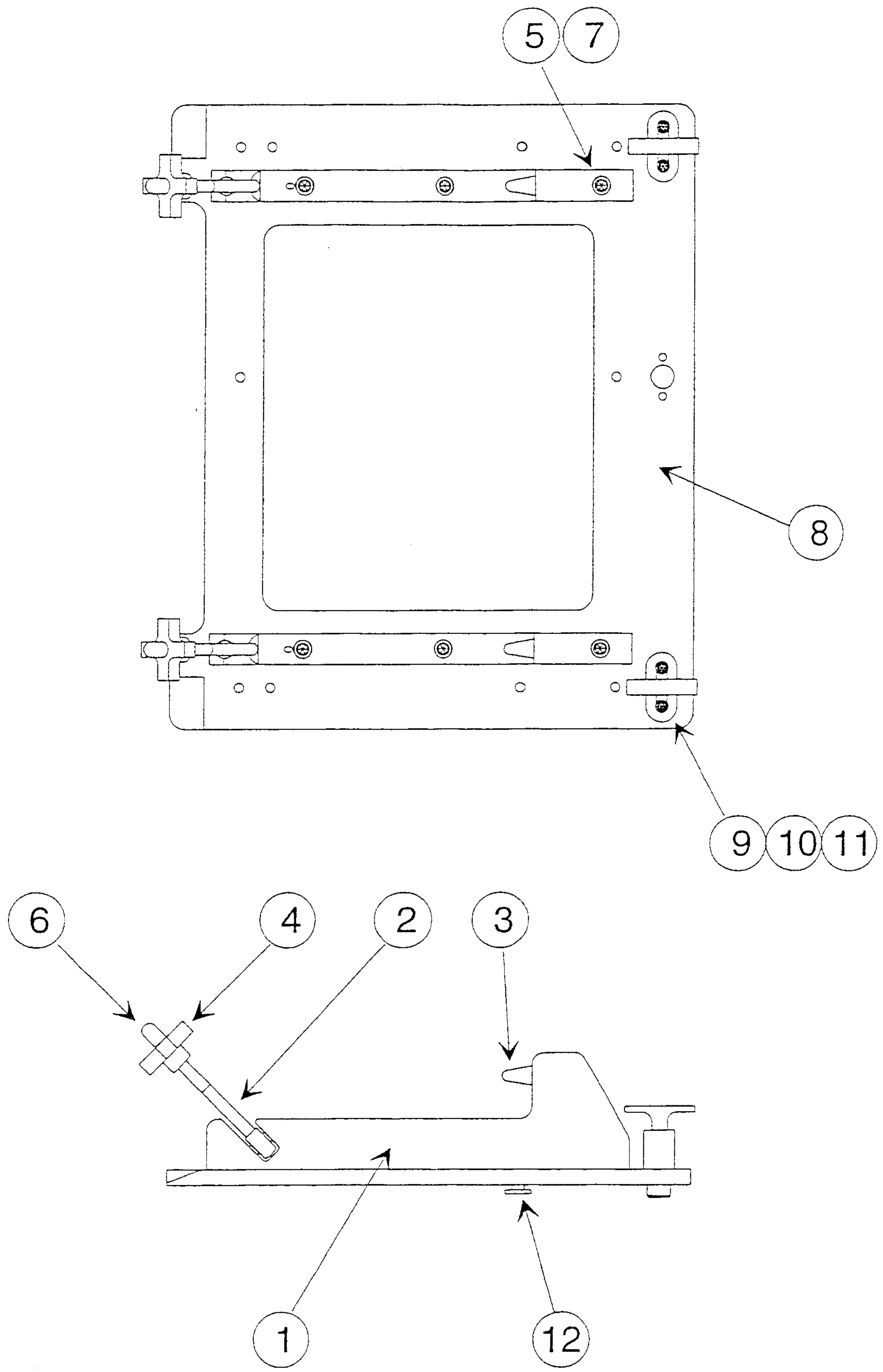
Figure No.	Description	Datascope Part Number
1	Mounting Rail	0436-00-0085-02
2	Swing Eye Bolt	0436-00-0085-03
3	Pin, Conical	0436-00-0093-06
4	Wing Nut	0436-00-0085-05
5	Spring Lock Washer, Black	0221-10-0008
6	Rubber Cap	0436-00-0085-06
7	Screw, SCS-298	0212-26-0820
8	Adapter Plate	0436-00-0110-01
9	Shear Pin Assembly	0436-00-0110-02
10	Screw, SCS-202	0212-00-0624
11	Spring Lock Washer	0221-10-0006
12	Seat Fitting	0436-00-0110-03



LIGHT WEIGHT
DOCKING STATION

6.11 LIGHT WEIGHT DOCKING STATION AND MOBILIZER

Figure No.	Description	Datascope Part Number
1	Mounting Rail	0436-00-0085-02
2	Swing Eye Bolt	0436-00-0085-03
3	Pin, Conical	0436-00-0093-06
4	Wing Nut	0436-00-0085-05
5	Spring Lock Washer, Black	0221-10-0008
6	Rubber Cap	0436-00-0085-06
7	Screw, SCS-298	0212-26-0820
8	Adapter Plate	0436-00-0110-01
9	Shear Pin Assembly	0436-00-0110-02
10	Screw, SCS-202	0212-00-0624
11	Spring Lock Washer	0221-10-0006
12	Seat Fitting	0436-00-0110-03



LIGHT WEIGHT
DOCKING STATION

6.12 SYSTEM 98 CONFIGURATIONS

The System 98 is available in the following configurations:

Language	Part Number 0998-00-0446-XX	Universal Transport System	Modem[1]	AC Line Cord[2]	Accessory Kit 0020-00-0122-XX
English (North America)	-53	No	0670-00-0646-01	-01	-01
	-83	Yes			
English (International)	-55	No	0670-00-0597	-02	-02
	-85	Yes			
Spanish	-57	No	0670-00-0597	-01	-05
	-87	Yes			
	-58	No	0670-00-0597	-02	-05
	-88	Yes			
German	-61	No	0670-00-0597	-02	-03
	-91	Yes			
French (Canada)	-62	No	0670-00-0646-01	-01	-04
	-92	Yes			
French (International)	-64	No	0670-00-0597	-02	-04
	-94	Yes			
Japanese	-65	No	0670-00-0597	-01	-06
	-95	Yes			
Italian	-67	No	0670-00-0597	-02	-07
	-97	Yes			
Portuguese	-68	No	0670-00-0597	-02	-08
	-98	Yes			
	-69	No	0670-00-0597	-01	-08
	-99	Yes			

*Refer to detailed technical specifications on the use of these power sources. Also see Section 1.3.9.4.

1 0670-00-0646-01 = built-in U.S. Modem; 0670-00-0597 = built-in International Modem.

2AC power cord, (0012-00-0886-XX): -01 has NEMA 5-15 plug (U.S.);
-02 has CEE-7 plug (Europe).

6.11.1 Use of the Light Weight Docking Station (P/N 0436-00-0110) and Mobilizer

1. Ensure that the docking station has been properly secured to the transport vehicle deck. (see instruction sheet enclosed with the docking station).
2. Position swing bolts as shown in figure 6-5 and red knobs are fully backed out (turn the red knobs counter-clockwise).
3. Place the System in front of the docking station and center it. Roll the System into place using the sides of the docking station as guides.
4. Without tilting the System, ensure the conical pins have been fully engaged by the conical holes on the mobilizer.
5. Move the swing bolts into position as shown in figure 6-8. Turn the red knobs clockwise until gaps are fully closed and a sudden increase in resistance is felt.
6. Check the function of the docking station by rocking the top of the System in all directions. No motion between the mobilizer and the docking station should be apparent.

Figure 6-5

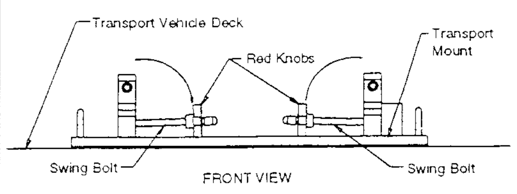


Figure 6-6

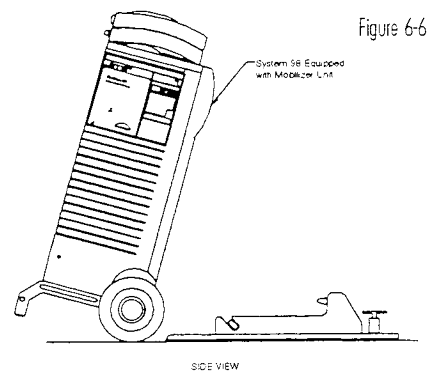


Figure 6-7

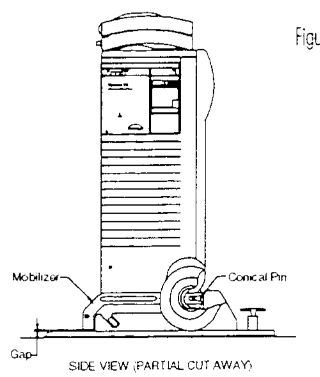
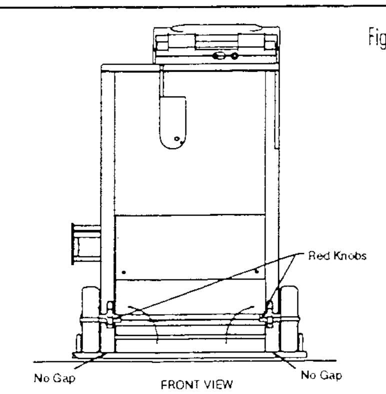


Figure 6-8



6.12 SYSTEM 98 CONFIGURATIONS

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Language	Part Number 0998-00-0446-XX	Universal Transport System	Modem[1]	AC Line Cord[2]	Accessory Kit 0020-00-0122-XX
English (North America)	-53	No	0670-00-0646-01	-01	-01
	-83	Yes			
English (International)	-55	No	0670-00-0597	-02	-02
	-85	Yes			
Spanish	-57	No	0670-00-0597	-01	-05
	-87	Yes			
	-58	No	0670-00-0597	-02	-05
	-88	Yes			
German	-61	No	0670-00-0597	-02	-03
	-91	Yes			
French (Canada)	-62	No	0670-00-0646-01	-01	-04
	-92	Yes			
French (International)	-64	No	0670-00-0597	-02	-04
	-94	Yes			
Japanese	-65	No	0670-00-0597	-01	-06
	-95	Yes			
Italian	-67	No	0670-00-0597	-02	-07
	-97	Yes			
Portuguese	-68	No	0670-00-0597	-02	-08
	-98	Yes			
	-69	No	0670-00-0597	-01	-08
	-99	Yes			

*Refer to detailed technical specifications on the use of these power sources. Also see Section 1.3.9.4.

1 0670-00-0646-01 = built-in U.S. Modem; 0670-00-0597 = built-in International Modem.

2AC power cord, (0012-00-0886-XX): -01 has NEMA 5-15 plug (U.S.);
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7. CALIBRATION PROCEDURE

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7.1 INTRODUCTION

This chapter of the Service Manual provides detailed information required to properly test and calibrate the System 98. Calibration consists of making mechanical and electrical adjustments with the proper test equipment. The instrument should be tested and calibrated after repairs have been completed or at regular intervals as part of a preventive maintenance procedure.

NOTE: Both calibration and a functional test must be performed to verify complete and proper operation.

NOTE: Calibration is conducted in normal operating mode and in Service Diagnostic mode.

7.2 WARNINGS AND GENERAL GUIDELINES

1. Before disconnecting any pneumatic hoses, the hoses and mating fittings should be tagged to show the proper connections. When reconnecting, all hoses must be checked for proper connection. To further assure proper connection, all pneumatic calibrations and tests defined in this manual should be accomplished before use on a patient.
2. Once the instrument covers have been removed, an electric shock hazard may exist. Therefore, calibration should only be performed by qualified service personnel who proceed with care and follow proper servicing techniques.
3. Do not attempt to calibrate the instrument without the test equipment and special tools listed in section 7.3.
4. Exercise care when reaching into the opened instrument which contains line (mains) voltage.
5. When making adjustments and measurements, avoid accidental shorting of component leads that can lead to component failure.
6. Perform all steps in the order given. Do not skip any steps unless otherwise noted.
7. Understand each step of the procedure thoroughly before performing the procedure.
8. Before removing or replacing any circuit boards, disconnect the System 98 from line power and switch the IABP ON/OFF to the OFF position.

7.3 SPECIAL TOOLS AND TEST EQUIPMENT REQUIRED

Test Equipment Required

- Dual trace oscilloscope
- Digital multimeter (3-1/2 Digits)
- ECG simulator and signal generator
- Mercury column or Electronic equivalent
- Safety analyzer
- Centimeter ruler
- Series 90 Trainer

Special Items Required:

- Non-wired 1/4" stereo phone plug (P/N 0134-00-0016)
- 45.75 cc calibration chamber (P/N 0683-00-0314)
- 60 cc syringe (P/N 0103-00-0026)
- Luer plug (P/N 0103-00-0211)
- Atmospheric transducer tubing adapter

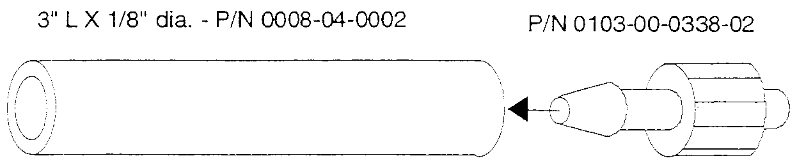


Figure 7-1

Atmospheric Transducer Tubing Adapter

- Drive transducer tubing adapter

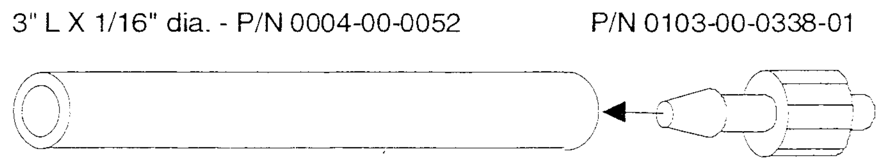


Figure 7-2

Drive Transducer Tubing Adapter

- Helium cylinder
- Catheter extender (P/N 0684-00-0182)
- 40 cc Datascope balloon

7.4 CALIBRATION

7.4.1 Preliminary Steps

A thorough understanding of the operation of the System 98 is recommended before attempting calibration. Refer to section 1 of this manual for a description of operation or refer to the Operating Instructions (P/N 0070-00-0402).

7.4.2 Initial Set-up for Calibration

1. Fold out the last page of this procedure for test point, calibration pot and connector locations.
2. Loosen and remove the two screws at the bottom of the right side cover (speaker side) and loosen the four screws on the top cover. Slide the right side cover up and toward you to remove it.
3. Loosen the flat-blade captive screws on the electronics panel. Carefully open the panel only far enough to reach the connectors at J1 and J7 (large connectors at the top edge of the Front End board) and J6 (captive ribbon cable on the Front End board). Unplug the cables and open the panel.

7.4.3 Power-up Test Routine

1. Switch the IABP ON/OFF switch to ON. The System 98 has its own internal power-up diagnostics. The System will automatically sequence through the tests every time it is powered on. If all tests are successful, the advisory message "*System Test O.K.*" is displayed.
2. If a power-up self-test subsystem fails, the screen will display the advisory message "Electrical Test Fails Code #__." If a power-up self test of the monitor subsystem fails, the recorder will attempt to print an error code. Section 4 of this manual contains a complete listing of failure codes.
3. If the System 98 has been powered off for more than 15 minutes, then all controls will power up in their default settings. If it has been less than 15 minutes, switch the IABP ON/OFF switch to ON while holding the CHANGE/SELECT key pressed. The default settings will be reinstated.

The next 10 checks and calibration procedures are conducted in Service Diagnostics.

7.4.3.1 Entering Service Diagnostics

To enter the Service Diagnostics, press and hold the SLOW GAS and IAB FILL MODE keys while switching the IABP ON/OFF switch to ON. Hold these keys down until the "Warning" page is displayed.

System 98 - Service Diagnostics

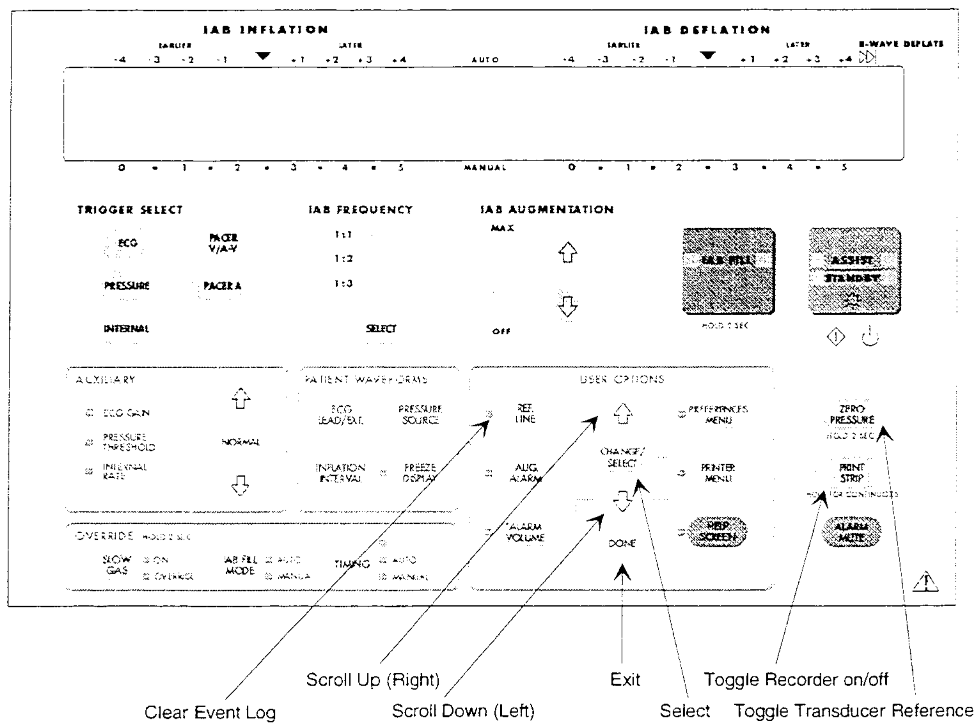
WARNING - Do Not use Service Diagnostics while the system is connected to a patient.
Use of Service Diagnostics while the system is connected to a patient, may subject the patient to injury.
Verify patient is NOT connected to the system and press the 'Preferences Menu' key to proceed.

Figure 7-3
Warning

Press the PREFERENCES MENU key to enter the main menu.

7.4.4 User Interface

IABP controls are non-functional. All user input is provided through the following keys:



7.4.5 Power Supply Checks

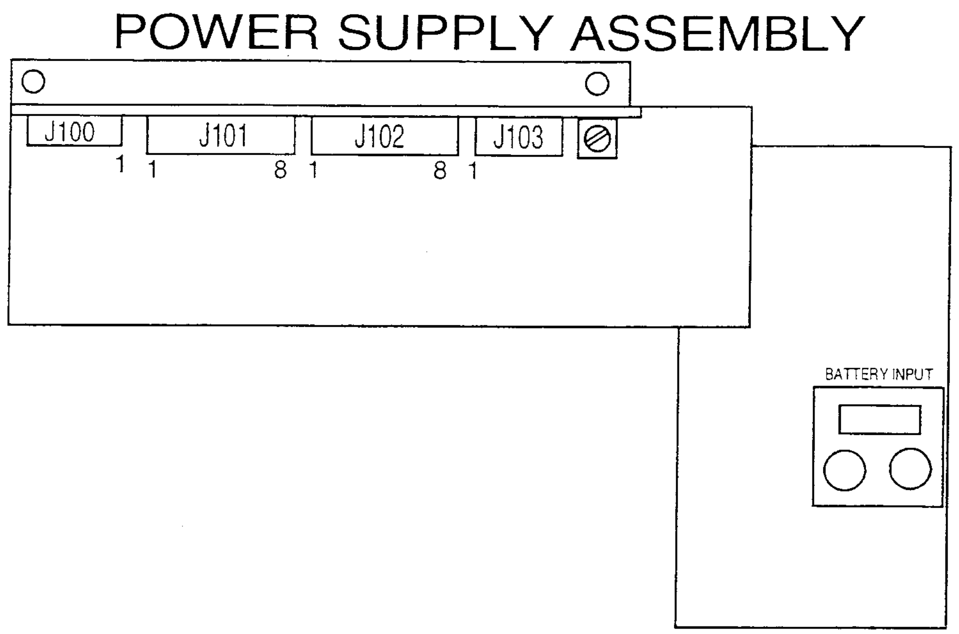


Figure 7-4

1. Operating from AC power, verify the red LEDs CR4 through CR9 on the Main board are illuminated. Check that the voltages at J101 and J102 of the power supply assembly are within the following tolerances:

Table 7-1

Pin Number		Voltage	Range
+ Lead	- Lead		
5	4	+5V	5.1V to 5.2V
1	2	+12V	11.75V to 12.25V
3	2	-12V	-11.75V to -12.6V
7	8	24V	22.8V to 25.2V

2. Select Pnuematic System Test and verify the voltages displayed in the status box match the measured voltages ± 5%.

3. With the BATTERY CHARGING indicator illuminated in a steady state, verify the battery voltage reads between 27 and 28 volts.

4. To insure a high current charging state, switch AC MAINS to OFF and operate the System on battery for a maximum of 30 seconds. Switch AC MAINS back ON and verify the battery current display reads between 4c and 5c.

   SUGGESTION: To test the battery run time it is suggested that the remainder of the calibration and preventive maintenance procedures be performed while operating from the battery. Insure that the batteries have been fully charged for a minimum of 18 hours. Make a note of the time at the start of the procedure and note the time when the System shuts down. This period should exceed the specifications listed in section 3 of this manual. Battery replacement is suggested if operating time is marginal.

7.4.6 Reference Voltage Check

1. Refer to calibration test point locations on page 7-29. Connect a DVM between TP22 and TP33 (GND_A) on the Front End board.

2. Adjust R253 on the Front End board for 5V ±0.1V.

7.4.7 Internal Transducer Check

1. From the Main Menu , press the CHANGE/SELECT key to enter the Pneumatic System Test screen. Note the transducer offset values displayed in brackets () next to the atmospheric and shuttle transducers.

2. If these readings are between -4 mmHg and 4 mmHg calibration of the transducers is not required. Skip to section 7.4.11 if within range. If not, calibrate the drive, balloon (shuttle) and atmospheric transducers as per the following 3 sections.

3. Press the DONE key to exit the Pneumatic SystemTest screen.

7.4.8 Drive Transducer Calibration

1. Disconnect the 1/16" tubing from the drive assembly barbed fitting (see diagram) and using the tubing adapter, shown in section 7.3, attach a mercury manometer to the barbed fitting.

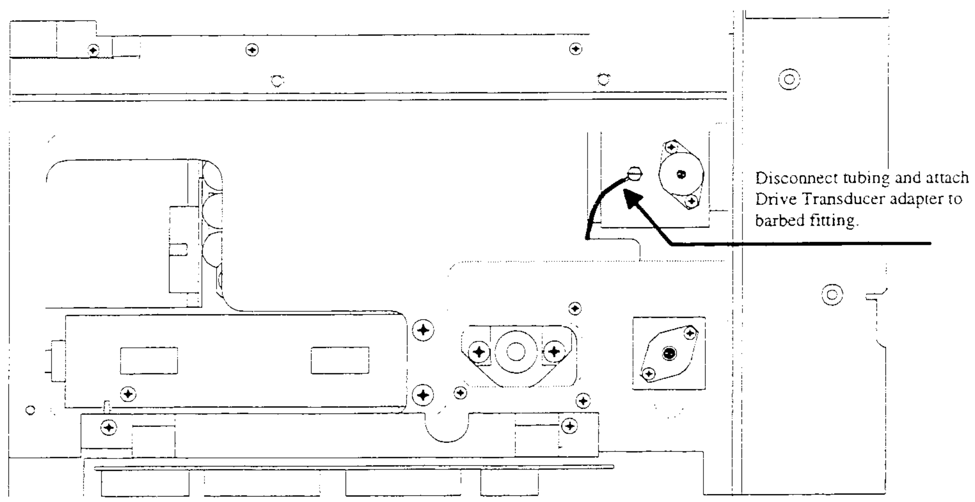


Figure 7-5
Drive Assembly

2. Connect a DVM to the DRIVE-PRESS signal at TP24 and ground at TP33 (GND_A) of the Front End board.

3. Note the offset voltage with 0mmHg of pressure applied. Apply 200mmHg from the manometer and note this voltage.

4. Refer to the last page of this section for test points and calibration pot locations. Adjust R212 (GAIN) on the Front End board for a difference

between the two voltage readings of 1 VDC±0.01V. Repeat until this difference is achieved.

5. The transducer offset is calibrated using the current absolute barometric pressure expressed in mmHg. Use the formula:

$$\frac{Barometric\ pressure}{200mmHg} - 3.8V = V\ offset$$

For example 760 mmHg (standard atmospheric pressure at sea level) will equal an offset voltage of 0 volts.

$$\frac{760mmHg}{200mmHg} - 3.8 = 0\ V\ offset$$

NOTE: If the absolute barometric pressure is unavailable, use the following table:

Table 7-2

ALTITUDE (feet)	PRESSURE (mmHg)	VOLTAGE OFFSET
sea level	760	0
1000	733	-0.14
2000	707	-0.27
3000	681	-0.40
4000	656	-0.52
5000	632	-0.64
6000	609	-0.76
7000	586	-0.87
8000	564	-0.98
9000	543	-1.09
10000	523	-1.19

6. Apply 0mmHg and adjust R216 (OFFSET) to the calculated value. Apply 200mmHg and verify the difference is 1V ± 0.01V.

7. Reconnect the 1/16" tubing to the pnuematic drive assembly. Enter the Pnuematic System Test screen. Verify the Drive Transducer reads the barometric pressure.

NOTE: Absolute barometric pressure is the barometric pressure NOT compensated for elevation. DO NOT USE a "weather barometer" for a reading.

7.4.9 Balloon (Shuttle) Transducer Calibration

1. Remove the tubing from the IAB FILL PORT on the Safety Disk and connect the tubing to a mercury manometer.
2. Refer to the last page of this section for test points and calibration pot locations. Connect a DVM to the BALLOON-PRESS signal at TP23 and ground at TP33 (GND_A) of the Front End board.
3. Note the offset voltage with 0mmHg of pressure applied. Apply 200mmHg from the manometer and note this voltage.
4. Adjust R199 (GAIN) on the Front End board for a difference between the two voltage readings of 1 VDC ± 0.01V. Repeat until this difference is achieved.
5. The transducer offset is calibrated using the barometric pressure expressed in mmHg. Use the value calculated for the Drive Transducer calibration.
6. Apply 0mmHg adjust R202 (offset) to the calculated value.
   Apply 200mmHg and verify the difference is 1V±0.01V.
7. Power down the system and reenter the service diagnostic mode. Select the pnuematic test screen. Verify that the shuttle and drive transducer readings are the same and that the offset value in brackets () is between -4 mmHg and 4 mmHg.

7.4.10 Atmospheric Transducer Calibration

1. Refer to the last page of this section for test points and calibration pot locations.Use the tubing adapter, shown in section 7.3, to attach the mercury manometer to the atmospheric transducer (U54) on the Front End board. Slide the tubing over the port on the transducer.
2. Connect a DVM to the ATMOS-PRESS signal at TP26 and ground at TP33 (GND_A) of the Front End board.
3. Note the offset voltage with 0mmHg of pressure applied. Apply 200mmHg from the manometer and note this voltage.
4. Adjust R225 (GAIN) on the Front End board for a difference between the two voltage readings of 1 VDC ±0.01V. Repeat until this difference is achieved.
5. The transducer offset is calibrated using the current barometric pressure expressed in mmHg. Use the value calculated for the Drive Transducer calibration.
6. Apply 0mmHg and adjust R229 (OFFSET) to the calculated value. Apply 200mmHg and verify the difference is 1V ± 0.01V.
7. Power down the system and reenter the Service Diagnostic mode. Select the Pnuematic Test screen. Verify that the Atmospheric and Drive Transducer readings are the same and that the offset value in brackets () is between -4 mmHg and 4 mmHg.

7.4.11 Safety Disk Leak Test

This test is functionally equivalent to the leak test that is included in the System 98 operating software. The primary differences are, the ability to halt a test in progress by pressing the DONE key, and the display of test status messages and elapsed time. Three separate leak tests are performed. First K3 is activated thereby pnuematically removing it from the circuit. The system checks for a vacuum leak, which could be caused by a hole in the safety disk membrane or a leak through the K5 solenoid. After two minutes K3 is de-activated (closing the valve) and K5 is activated (pnuematically removing it from the circuit). The system again checks for vacuum leaks which could be caused by a hole in the safety disk membrane or a leak through the K3 solenoid. After two minutes K5 is de-activated (closing the valve) and K8 is activated causing the safety disk to pressurize. The third test will now begin.

During the test, status messages will inform the user when tests are completed. At the conclusion of each test the pressure change is posted. A change greater than ±4 mmHg for any of the tests indicates there is a leak in the system.
A luer plug P/N 0103-00-0211 is required for this test.

1. Select "Functional Tests" from the Main Menu and select Safety Disk Test.

2. Start with the IAB catheter port of the Safety Disk unplugged. Press the CHANGE/SELECT key to start the test. Wait for a tone to sound and the instruction "Plug Safety Disk". Immediately seal the IAB catheter port using the luer plug. If the test is started with the IAB port already plugged, the instruction "Unplug Safety Disk" is displayed. Unplug the port and wait for the "Plug Safety Disk" instruction. The test will take approximately 6.5 minutes to complete.

3. Press the DONE key to return to the Functional Tests screen.

7.4.12 K6, K6A, K7, K8 Leak Test

This test checks for leaks in the drive section of the System 98 pneumatics. The drive section is first vented to atmosphere and held for 60 seconds, then pressurized to approximately 8 PSI and held for 60 seconds and then evacuated and held for 60 seconds. X2, the drive transducer is read to determine the pressure during these periods. The pneumatic schematic is displayed on screen along with the measurement box and a test status box. The test status box contains the current status of the test, pressure difference from start to end of test and the elapsed time (in seconds).

1. From the Functional Test Menu SELECT K6, K6A, K7, K8 Leak Test.

2. Start with the IAB catheter port of the Safety Disk unplugged. Press the CHANGE/SELECT key to start the test. Wait for a tone to sound and the instruction "Plug Safety Disk". Seal the IAB catheter port using the luer plug. If the test is started with the IAB port already plugged, the instruction "Plug Safety Disk" will not appear and testing will proceed.

3. At the start of the test, K3 & K5 are activated to purge the shuttle side of the Safety Disk below 200 mmHg, and K6 is activated until the drive pneumatics are vented to atmosphere. At which time these solenoids become deactivated and K6A is activated. This portion of the test is 60 seconds and checks for leaks at K7 and K8. After 60 seconds, the Elapsed Time stops and the differential pressure is posted in the Test #1 section.

The second portion of the test activates K8 to pressurize the drive side of the Safety Disk to approximately 8 PSI. This portion of the test is 60 seconds and checks for leaks to atmosphere through K6 or K6A, or a vacuum leak through K7. At 120 seconds on the Elapsed Time, the time stops and the differential pressure is posted in the Test #2 section.

The third portion of the test rapidly toggles K6A and K7 until a partial vacuum is achieved. This portion of the test is 60 seconds and checks for leaks to atmosphere through K6 or K6A, or a pressure leak through K8. At 180 seconds on the Elapsed Time, the time stops and the differential pressure is posted in the Test #3 section.

TEST	ACCEPTABLE LEVEL
TEST # 1	±45 mmHg
TEST # 2	±65 mmHg
TEST # 3	±20 mmHg

4. Press the DONE key to return to the functional test screen.

7.4.13 Pressure Regulator and Vacuum Check

1. From the Main menu select the Pneumatic System Test. Use the USER OPTIONS UP/DOWN keys and the CHANGE/SELECT key to activate K6A (to close the solenoid) and K7 (to open the solenoid). Verify that X2-Drive-Pres reads a minimum of 125 mmHg. A lower number indicates more vacuum. A higher reading may indicate a leak in the pneumatic system or the need to rebuild the pump motor. Select Safe State to deactivate K6A and K7.

2. Press ZERO PRESSURE to change the pressure reference to atmosphere. Use the USER OPTIONS UP/DOWN keys and the CHANGE/SELECT key to activate K6A and K8. Verify that the X2-Drive-Pres. reads between 375 and 413mmHg.

3. If necessary adjust the 8 PSI regulator so that the pressure is within this range.

4. Press the DONE key to return to the Main Menu.

7.4.14 Autofill Calibration

NOTE: The System must pass the previous leak tests prior to this calibration.

1. Select the Autofill Calibration from the Functional Tests menu. Insure there is adequate helium pressure by verifying that X4 (as shown on the pneumatic drawing) shows a pressure greater than 150 PSIG.

2. Disconnect the autofill tubing from the Safety Disk and connect it to the female luer fitting on the calibration chamber P/N 0683-00-0314. Connect the other port of the calibration chamber to the catheter fitting on the Disk. With the IAB FILL port open to atmosphere, press the ZERO PRESSURE key.

3. Connect a 60cc syringe P/N 0103-00-0026 to the IAB FILL PORT. Press the CHANGE/SELECT key to initiate an autofill. After filling, the plunger of the syringe will move out. Apply some resistance to the plunger as it moves out. Hold the plunger steady to maintain a X1-Shuttle Pres. reading of 100 mmHg. The syringe should be between 37cc and 40cc. If this volume is out of range, loosen the volume cylinder lock nut and adjust for the proper volume. Rotating the screw clockwise decreases the volume. Repeat these steps as necessary until adjustment is achieved.

4. If the autofill volume is adjusted, then adjustment of the full sensor may be necessary. Verify the position of the sensor by observing the sensor LED. Initiate an autofill and verify that the FULL LED flashes twice during each autofill cycle. If the LED flashes twice, then adjustment is not needed and you should skip step 6.

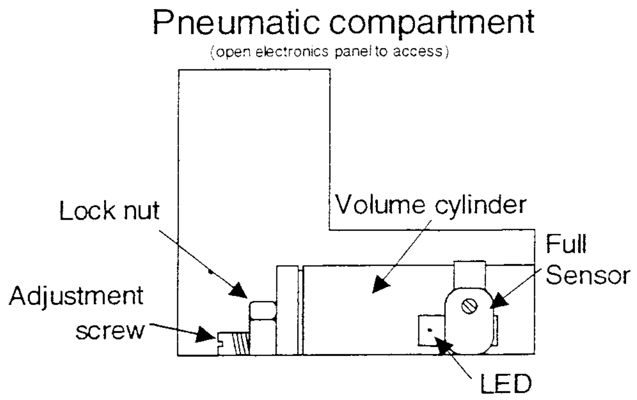


Figure 7-6

Pneumatic Compartment

5. Adjustment of Full Sensor. Remove the syringe from the IAB FILL PORT and initiate an autofill. The autofill will fail. This insures the piston in the volume cylinder is at the full position. Loosen the sensor mounting screw and move the sensor all the way to the left (toward the adjustment screw). Slowly move the sensor back to the right until the LED turns on. Continue to move the sensor **slowly** until the LED just turns off. Tighten the sensor screw at this point. Attach the syringe and verify the sensor position as per step 4.

6. The Autofill status box displays the Bimba fill time. Verify that this time is between 3 and 6 seconds. A faster fill time could indicate an over-pressure condition of the helium regulator. Slower fill times could indicate possible leaks or flow restrictions in the fill gas path. Verify that the Shuttle Fill time is 3 seconds maximum. A greater period indicates leaks or a flow restriction in the shuttle gas path. Shuttle purge time should be less than 9 seconds.

7. Select DONE to exit out of Autofill Calibration selection. Select DONE to exit the Functional Test selection. Power the unit off by switching the ON/OFF switch to OFF.

7.4.15 Solenoid Driver Board Checks

Re-power the System 98 into the normal operating mode.

1. If not previously removed, remove the top cover from the system. Refer to calibration test point locations on page 7-29.

2. Connect a DVM to TP2 (+) and TP5 (-) on the Solenoid Driver board (0670-00-0639) to verify the Blood Detect circuitry.

3. Verify that the voltage reading is between 2.5 and 5 volts. If the voltage is out-of-range, configure S1 (A & B) as follows to obtain a voltage in the correct range.

	S1A	S1B
1st Choice	Open	Open
2nd Choice	Closed	Open
3rd Choice	Open	Closed
Not Used	Closed	Closed

If the voltage is still out-of-range, it may be an indication that the Blood Back sensor has degraded or the circuitry is not functioning properly.

4. Connect a DVM to TP4 (+) and TP5 (-) on the Solenoid Driver board (0670-00-0639).

5. Verify that the voltage reading is between 1 volt and 2.3 volts. If the voltage is out-of-range, configure S1 (C & D) as follows to obtain a voltage in the correct range.

	S1C	S1D
1st Choice	Open	Open
2nd Choice	Closed	Open
3rd Choice	Open	Closed
Not Used	Closed	Closed

If the voltage is still out-of-range, it may be an indication that the Blood Back sensor has degraded or the circuitry is not functioning properly.

6. Remove the fill tubing from the Blood Back sensor and block the light path by sliding a piece of wire or a dark strip of paper in the tubing's place.

7. Set the IAB FILL mode to AUTO. While observing the K6A LED on the Solenoid Driver board, initiate an autofill. Verify the System displays a "*Blood Detected*" message and that K6A LED goes off. Power down and remove the obstruction from the sensor.

8. Place the drain tubing back in the blood sensor. Attach the catheter extender (P/N 0684-00-0182) and a 40cc balloon to the IAB Catheter Port of the Safety Disk. Power up the System and initiate an AUTOFILL. Verify the system can complete an autofill.

9. Press the ASSIST/STANDBY key to initiate pumping. Verify the voltage between L6 (side closest to JP3) and TP31 (supply to Condensate Removal Module chiller block) is 2.8V ± 0.1V.

10. Reattach the top cover to the System.

7.4.16 ECG Gain

NOTE: This procedure assumes that LEAD I is selected and that signals are applied to the rear panel ECG patient connector between pin A (RA) and pin B (LA) with pin C (LL) shorted to pin B. (Typical of most ECG simulators.)

1. Reconnect the cables to J1 and J7 on the Front End board if removed to open door. Leave the door open enough to reach to the calibration potentiometers and test points on the board.
2. Attach ECG signal from the simulator/signal generator. Verify ECG display.
3. Select ECG trigger. Apply a 1mV p-p 5Hz sine wave* from the simulator/signal generator to the patient ECG connector on the rear panel. Set the ECG display to LEAD I.
4. Connect the oscilloscope to TP2 (ECG) and TP33 (GND_A) on the Front End PCB.
5. Adjust R52 (GAIN) for a 0.5V p-p (±50mV) signal. Remove the scope connection.

* *Use 1 mv ECG signal if this waveform is not available.*

7.4.17 Blood Pressure Gain Calibration

1. Attach a pressure simulator or mercury column and transducer to the pressure input connector.
2. Apply 0mmHg and zero the pressure channel by pressing the ZERO PRESSURE key until two clicks are heard. Verify that the pressure trace merges with the baseline and the digital display reads zero.
3. Connect a DVM to TP48 (INT-PRESSURE) and TP33 (GND_A).
4. Apply 150mmHg from the simulator and adjust R128 (BP Gain) on the Front End board for a 1.50V (±10mV) output. Verify the MEAN display shows 150mmHg (±3mmHg).

   NOTE: If interfacing with an external monitor with other than 0mmHg = 0 volt offset, adjust R134 to compensate for the external monitor offset. Install the jumper at JB2 between pins 1 and 2 on the Front End board (move from pins 2 and 3 which is the normal position used where the monitor is 0mmHg = 0 volt). Connect the "zeroed" external monitor to the System 98 Monitor Input Pressure phone jack and adjust R134 for 0 mmHg on the display.

7.5 FUNCTIONAL TESTS - Test with System 98 completely assembled

7.5.1 Keypad / Control Test

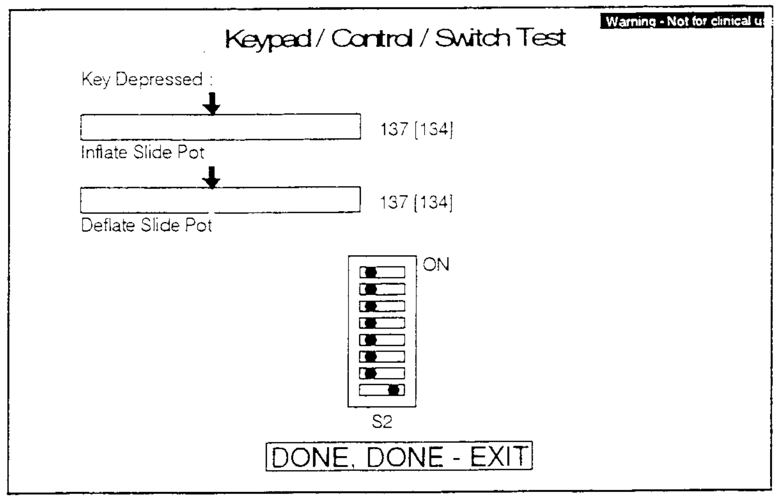


Figure 7-7
KeyPad Control Test Screen

1. Enter the Service Diagnostic mode and Select Keypad / Control Test from the main menu.
2. Press all keys on the Monitor keypad. Verify that the corresponding key is identified in the Key Depressed Field of the display. Verify that LEDs associated with keys are lit when the keys are pressed.
3. Slide the inflation and deflation controls to minimum (earlier). Very slowly slide the control from minimum to maximum (earlier to later). To obtain valid test results, it will be necessary to move the control back and forth until the entire bar is illuminated. Moving the control too quickly could result in a false failure indication. Each element of the array is displayed as a line which is two pixels wide. A properly functioning potentiometer will display a solid bar i.e., all the elements are lighted.

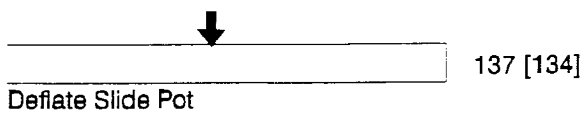


Figure 7-8
Properly Functioning Potentiometer

If a pot is traversed from minimum to maximum and a solid bar is not displayed (elements of the bar are missing), a dead spot in the control is indicated.

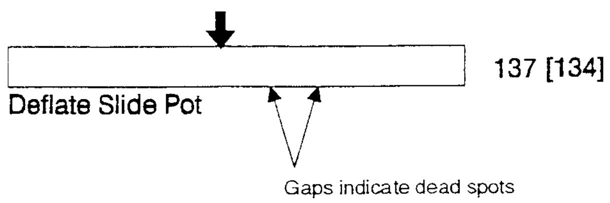


Figure 7-9
Potentiometer with Dead Spots

4. Press DONE key twice to return to main menu.

7.5.2 External RS-232 Port Test

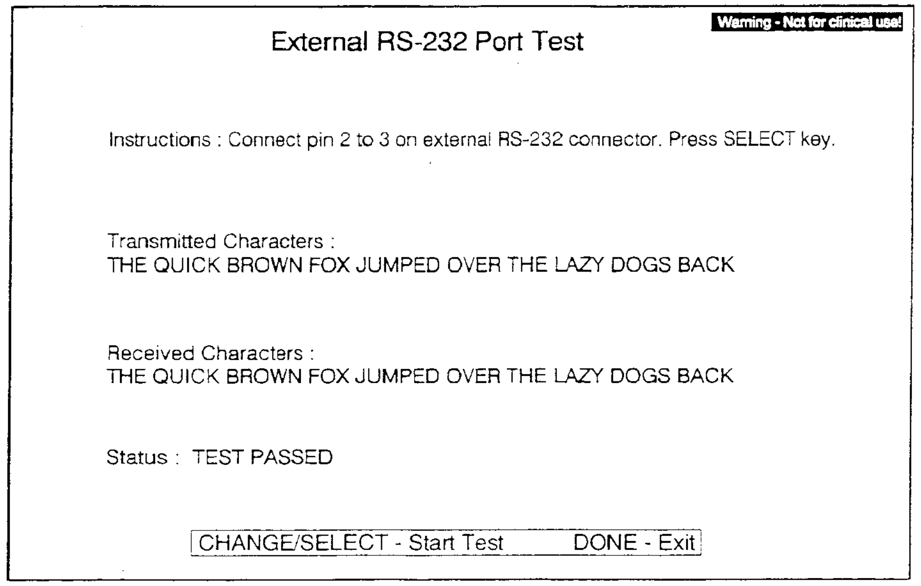
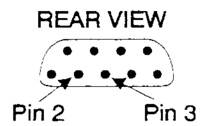


Figure 7-10

RS-232 Test Screen

The purpose of this test is to verify the integrity of the RS-232 channel. The transmit and receive pins need to be connected together on the rear panel RS-232 connector. This action will allow the serial communication channels to transmit data and receive back the data that is sent.

1. Select External RS-232 Port Test from the main menu.
2. Use bus wire to jump pins 2 and 3 (transmit and receive lines) of the rear panel RS-232 connector together.



3. Press the SELECT key to run the test. Transmitted characters are compared to received characters until the entire test string "THE QUICK BROWN FOX JUMPED OVER THE LAZY DOGS BACK" has been sent.
4. The status line will indicate if the test passes. If the data is received incorrectly or data is missing the test will fail and display "Incorrect or no character received". The test will also fail if the transmit and receive are not jumped together.
5. Remove jumper.
6. Press the DONE key to exit the test.

7.5.3 Modem Test

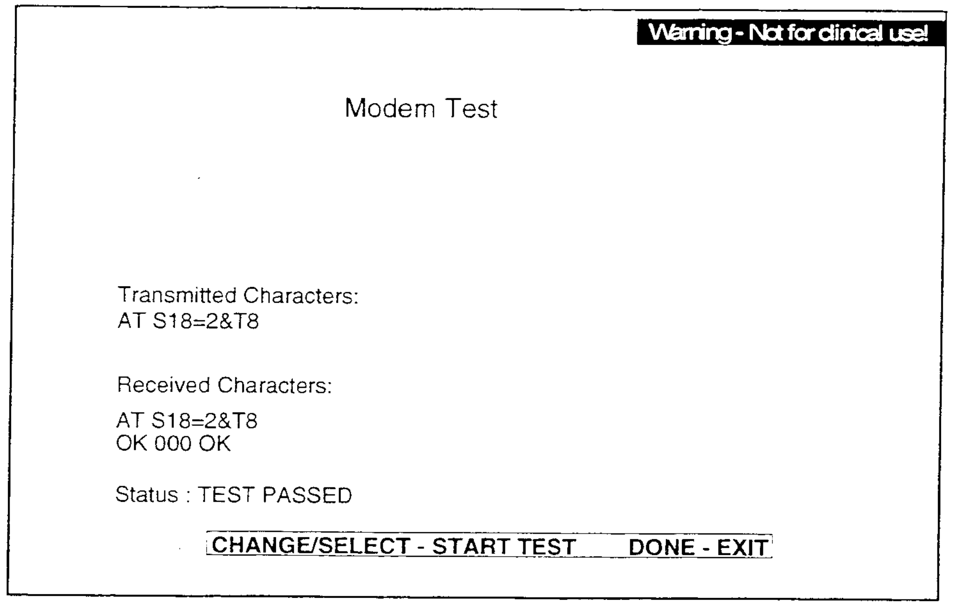


Figure 7-11
Modem Test Screen

1. Select Modem Test from the main menu.
2. Press the select key and verify that "test passed" is displayed in status area.
3. Press the DONE key to exit the test.

7.5.4 Recorder Test

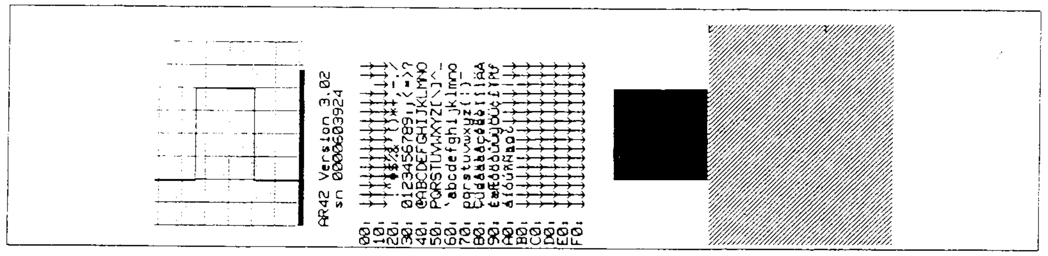


Figure 7-12
Recorder Test Strip

1. Select Recorder Test from the main menu.
2. Verify the following:
   a. 5 mm grid is printed with 1 mm subdivisions. Measure the span of 10 grids and verify it is equal to 5 cm.
   b. Verify the 60 BPM square wave is 2 cm peak to peak.
   c. A solid bar is printed, examine the bar and insure that all the pixels are operating.
   d. Verify the character set is printed as shown above.
3. Press the DONE key to exit the test.

7.5.5 Motor Calibration Test

1. Select Functional Tests from the main menu and select Motor Calibration / Test from the sub-menu.
2. Press the SELECT key to start the test.
3. The following checks are performed:
   - Attempt to set the motor speed to 1600 RPM by applying 8 volts to the Motor Controller board.
   - Verify the actual speed is within 20 percent of 1600 RPM.
   - Re-adjust the motor speed by calculating the necessary scale factor based on the actual speed.
   - Verify that the adjusted speed is within 3 percent of 1760 RPM.
4. Verify that "Pass" is displayed in the status area of the display.
5. Press the DONE key to exit the test and return to the Functional Test menu.

7.5.6 Helium Tank Calibration

This test calibrates the helium pressure circuit.

Close the helium tank valve and remove the helium tank from the pump.

Press CHANGE/SELECT to start the text. The helium offset is displayed. If the offset is too large an "Out of Specification" is displayed. If the offset is within the limits a "Within Specification" is displayed.

7.5.7 Pneumatic Performance Tests

1. Select Pneumatic Performance Test from the Functional Test menu.

2. Press ZERO PRESSURE key to display pressure readings referenced to atmosphere pressure. Verify the catheter input port of the Safety Disk is open to atmosphere.

3. Press the CHANGE/SELECT key to start the test. The system begins to pump at 150 BPM for 30 seconds.

4. Once the system stops pumping, observe the vacuum recovery time display window. This period should be less than 10 seconds.

5. Verify the average pressure reads between 300 and 413 mmHg. A lower reading may indicate a leak in the pneumatic system, a need to adjust the 8 PSI regulator, a flow restriction in the pressure line (clogged muffler), or the need to rebuild the pump motor. A higher reading indicates a problem with the 8 PSI regulator or the need to adjust it.

6. Verify the average vacuum reads a minimum of -176 mmHg (a lower number indicates more vacuum). A higher reading may indicate a leak in the pneumatic system or the need to rebuild the compressor.

7. Verify the minimum acceptable levels as shown in the following table:

Parameter	Acceptable Level	Remarks
First Inflate Delay (ms)	< 24 msec	Time from inflate command until the diaphragm begins to move.
First Deflate Delay (ms)	< 24 msec	Time from deflate command until the diaphragm begins to move.
Max. Vacuum (mmHg)	< -200 mmHg	Max. peak vacuum
Avg. Vacuum (mmHg)	< -176 mmHg	Average vacuum
Max. Pressure (mmHg)	< 436 mmHg	Max. peak pressure
Avg. Pressure (mmHg)	300 to 413 mmHg	Average pressure
Inflate Transition (ms)	< 36 msec *	Time to exceed 75% of peak pressure
Deflate Transition (ms)	< 36 msec *	Time to exceed 75% of peak vacuum
Recovery Time (secs)	< 10 sec	Time to reach 150 mmHg (absolute)

* For adult safety disks with serial numbers below 15000 this time is less than 44 msec.

8. Press the DONE key twice to return to the Main Menu.

9. Exit Service Diagnostics by switching the ON/OFF switch to OFF.

7.5.8 Blood Pressure Channel Checks

1. Power ON the unit into normal operating mode by switching the ON/OFF switch to ON.

2. Attach a blood pressure simulator or the Series 90 Trainer to the pressure input connector. Do not zero the pressure channel at this time. Select PRESSURE trigger and the MANUAL FILL mode.

3. Simulate a manual fill by pressing the IAB FILL key twice (hold for two seconds each time) and initiate pumping. Verify that the System alarms and that the screen displays "*No Pressure Trigger-Zero Transducer.*" Activate the HELP screen by pressing the HELP key and verifying the LED is illuminated and the help screen is displayed. Deactivate the HELP screen.

4. Set the Trainer to vent (or simulator to "0" mmHg). Zero the pressure channel. Apply an 80 BPM pressure signal and verify the IABP triggers. Observe the flashing diamond, a Heart Rate reading, and "Pressure XX (e.g. 22) mm Auto Threshold" is indicated in the trigger source displayed in the upper right hand corner of the display. Initiate pumping by pressing the ASSIST/STANDBY key. The augmentation should increase automatically or increase the augmentation by pressing the IAB AUGMENTATION key. Verify that the LED bar graph illuminates in relation to the UP and DOWN IAB AUGMENTATION keys.

5. Verify that the PRESSURE THRESHOLD indicator is illuminated. Press the UP key and verify the trigger threshold increments and that the marker on the pressure display moves up. Press the DOWN key and verify the trigger threshold decrements and that the marker on the pressure display moves down. Press the NORMAL key and verify that the pressure threshold returns to Auto.

6. Press the Pressure Trigger key and verify pumping stops for one beat. Tap the INFLATION INTERVAL key and note that there is a momentary interruption in pumping. Hold the INFLATION INTERVAL key pressed and observe that part of the pressure trace is highlighted and inflation interval markers are displayed. Observe that all pressure digits are displayed.

7. Set the AUG. ALARM limit to 10mmHg below the current augmentation pressure. (At power up, the System automatically sets it after one minute of assist.) With the AUG. ALARM key LED illuminated, verify that the UP/DOWN arrow keys increase/decrease the augmentation alarm setting. Adjust the alarm value so it is 10mmHg below the current augmentation pressure.

8. If using a System 90 Series Trainer, decrease the augmentation level by pressing the IAB AUGMENTATION down key. When the augmentation is below the alarm set point, verify the double beep alarm and the "*Augmentation Below Limit Set*" message is activated. If a Trainer is not available, increase the AUG. alarm limit to a value higher than the displayed AUG. value and verify the double beep alarm and the "*Augmentation Below Limit Set*" message is activated. Return the limit to 10mmHg below the AUG. value.

9. Activate the REFERENCE LINE. Insure that the keypad LED is illuminated and measure the pressure waveform using the reference line arrow keys. Digital display and reference line measurements should agree, ±3mmHg.

Press the PREFERENCES MENU key and verify the Preferences Menu appears. Select Display Preferences and Pressure Scale. Select auto and verify "auto" appears next to Pressure Source located on the left side of display. Select the other scales and verify "manual" appears next to Pressure Source. Set Pressure Scale to 0-160. Turn off Balloon Waveform and exit the Preferences Menu. Verify the Pressure Scale uses the bottom 2/3 of the display. Turn on Balloon Waveform, verify the Pressure Scale (0-160) now occupies the center 1/3 of the screen and the Balloon Waveform is on the bottom 1/3.

7.5.9 ECG Channel Checks

1. Connect all 5 lead wires to the simulator (or connect the System 90 Series IABP Trainer) and apply an ECG signal. Verify the operation of the ECG LEAD/EXT key by observing the display while pressing the key and checking for the following lead changes: I, II, III, AVR, AVL, AVF, V and EXTERNAL. Verify when EXTERNAL is displayed the message "*NO CABLE*" appears.

2. Verify that there is a "*LEAD FAULT*" message displayed next to LEAD whenever the LA, RA, or LL leads are disconnected from the simulator/signal generator or the Trainer is unplugged.

3. Apply an ECG signal with R-wave less than 100 uV from the simulator/signal generator or select the AVL lead from the 90 Series Trainer. Verify that the System displays a "*NO TRIGGER*" message.

4. Verify that the ECG GAIN indicator is illuminated on the keypad and reflects NORMAL on the display.

5. Gradually increase the ECG GAIN by pressing the ECG GAIN UP arrow key until the "*NO TRIGGER*" message disappears and a flashing diamond is visible on the display and check for a trigger rate. Return the ECG GAIN to the NORMAL position.

6. Apply a 1mV ECG from the simulator/signal generator or select Normal Sinus Rhythm from the Series 90 Trainer and select Lead II by pressing the ECG LEAD/EXT key. Select INTERNAL trigger. Verify the System alarms and displays the "*ECG DETECTED*" message. Remove the ECG signal.

7. With INTERNAL trigger selected, verify the System triggers at 80 BPM . Vary the INTERNAL rate by pressing the UP and DOWN arrow keys and verify the internal rate varies from 40 BPM to 120 BPM. Return to the NORMAL position.

8. Apply an ECG with A-V PACER. Verify that the System triggers in ECG TRIGGER mode. Switch trigger mode to PACER V/A-V and verify that the System triggers and that the "*Pacer A/V*" trigger message is displayed.

9. Apply an ECG with V pacer. Verify that the System triggers in ECG trigger mode. Switch trigger mode to PACER V/A-V and verify that the System triggers and that the "*Pacer V*" trigger message is displayed.

10. Apply an ECG with an Atrial pacer. Verify that the System triggers in ECG trigger mode. Switch trigger mode to PACER A and verify that the System triggers and that the "*Pacer A*" trigger message is displayed.

11. Apply an ECG with A-V DEMAND pacer. Verify that the System triggers in ECG trigger mode. Switch trigger mode to PACER V/A-V and verify that the System **does not** trigger and that the "*CHECK PACER TIMING*" and/or "*NO TRIGGER'* messagaes are displayed.

12. Apply a 1 Volt 60 BPM ECG signal to the rear panel ECG monitor input jack (+) to the tip and (-) to the ring and sleeve. Verify that the ECG signal is displayed and that "*External*" is displayed next to LEAD. Verify that the System triggers in the ECG and PACER A trigger modes.

7.5.10 Preference and Printer Menu Checks

PREFERENCES MENU

Press the PREFERENCES MENU key to display the Preferences Menu window. Select display preferences. Verify that the sweep speed and brightness level can be changed. Verify that Flash Alarms is on and there is no external ECG signal. Use the ECG LEAD/EXT key to select external ECG input. Verify the no trigger alarm flashes. Change flash alarm to off and verify the alarm no longer flashes.

Select Lead II and turn on the ECG inflation markers. Verify ECG inflation markers appear below the ECG waveform. Press DONE to return to the Preferences Menu.

Press Audio Preferences. Verify the beep volume can be changed. Press DONE twice to return to the main screen.

PRINTER MENU

Press PRINTER MENU to display the Printer Preferences Menu. Verify that ECG, Arterial Pressure and Balloon Pressure waveforms can all be printed. Verify the recorder can print either single or dual waveforms and anotated information. Verify both trends and the trigger/alarm logs can be printed. Press DONE twice to return to main menu.

7.5.11 Pumping Checks

1. Attach a 6-foot catheter extender and 40cc patient balloon to the Safety Disk.
2. Apply 130 BPM ECG signal and select ECG trigger.
3. Set the INFLATION and DEFLATION controls to mid-position. Set the FILL and TIMING controls to AUTO and initiate an autofill.
4. Initiate pumping and let the System pump for a minimum of five minutes.
5. Initiate an autofill and verify that the autofill process is complete within 10 seconds and no autofill failure occurs. An autofill failure may suggest a vacuum performance problem.
6. Apply 100 BPM ECG signal and select ECG trigger.
7. Initiate pumping and select the IAB FREQUENCY of 1:2. Verify that the LED is illuminated and that every other beat is assisted. Verify unassisted pressure values are displayed under the SYSTOLIC and DIASTOLIC screen measurements. Select 1:3 and verify that the LED is illuminated and that every third beat is assisted. Return the control to 1:1.
8. Vary the IAB AUGMENTATION keys from OFF to MAX and verify that when at OFF the balloon is totally deflated and the IAB STATUS indicator is at minimum. Verify that when set at MAX, the balloon completely inflates and that the IAB STATUS indicator deflects to the top. Verify that the LED bar graph illuminates in relation to the IAB AUGMENTATION keys.

9. While pumping, kink the catheter extender at the patient balloon end. Verify that the System stops pumping and that the "*Check IAB Catheter*" message is displayed. Resume pumping by pressing the ASSIST/STANDBY switch, let the System pump for a minimum of 10 beats and then disconnect the balloon from the catheter extender. Verify that the System stops pumping and the "*IAB Disconnected*" message is displayed. Reconnect the extender and autofill the balloon to reset the alarm.

7.5.12 Portable Operation Check

1. If the calibration procedure has not been performed on battery power, check battery operation at this time.
2. While pumping, unplug the System from line power and verify pumping continues uninterrupted, the "*BATTERY IN USE*" message is displayed and the battery icon appears on the screen.
3. Reestablish AC power. Verify uninterrupted pumping and that the BATTERY CHARGING indicator is illuminated.
4. Switch the AC MAINS switch on the rear panel to the off position and operate the System on battery for a maximum of 30 seconds. Switch the AC MAINS switch back to the ON position and observe the BATTERY CHARGING indicator. Verify the proper sequence of the indicator as follows. After first turning the switch on, the LED should be flashing on-off, followed by a constant illuminated state. This LED sequence indicates that the charger is functioning properly.

7.5.13 Manual Fill Valve

Attach a 60cc syringe to the rear panel MANUAL FILL valve. Push the syringe into the valve and verify it fills with helium. Insure that the valve seals after the syringe is removed.

7.5.14 Timer Check

Verify that time has elapsed on the hour meter since the beginning of the procedure. If necessary, record these hours on preventive maintenance records.

7.5.15 Helium Checks

1. Insure helium gauge reads above 150 PSI when the tank is open and the "*Low Helium*" message is not activated.
2. Close the helium tank valve and note the gauge reading. Leave the valve closed for 5 minutes and then read the gauge again. The gauge reading should not drop. A drop in gauge pressure indicates a leak in the helium supply circuit.

3. Leave the tank valve closed and bleed off the helium supply by activating the MANUAL FILL valve, or by repeatedly autofilling. Verify that the "*Low Helium*" alarm message is displayed before the helium gauge reaches 0 PSI.

7.5.16 Fan Check

1. Check that the rear panel cooling fan is exhausting and that the fan grill is unobstructed and clean. Vacuum if necessary.

2. Check that the Condensate Removal Module cooling fan is functional and that the fan opening is unobstructed and clean, vacuum if necessary.

3. Leave the tank valve closed and bleed off the helium supply by activating the MANUAL FILL valve, or by repeatedly autofilling. Verify that the "*Low Helium*" alarm message is displayed before the helium gauge reaches 0 PSI.

7.5.16 Fan Check

1. Check that the rear panel cooling fan is exhausting and that the fan grill is unobstructed and clean. Vacuum if necessary.

2. Check that the Condensate Removal Module cooling fan is functional and that the fan opening is unobstructed and clean, vacuum if necessary.

7.6 LEAKAGE CURRENT TEST - SAFETY CHECKS

7.6.1 Source Current, Chassis Case to Ground Leakage

1. Plug the System into the safety analyzer, as shown in figure 7-13. Connect the CASE ground lead of the analyzer to the GND lug.

2. With the unit fully "ON", perform the test under the following conditions.

a) Case Grounded:
1) Polarity Normal
2) Polarity Normal with Open Neutral

b) Case Ungrounded:
1) Polarity Normal
2) Polarity Normal with Open Neutral
3) Reverse Polarity

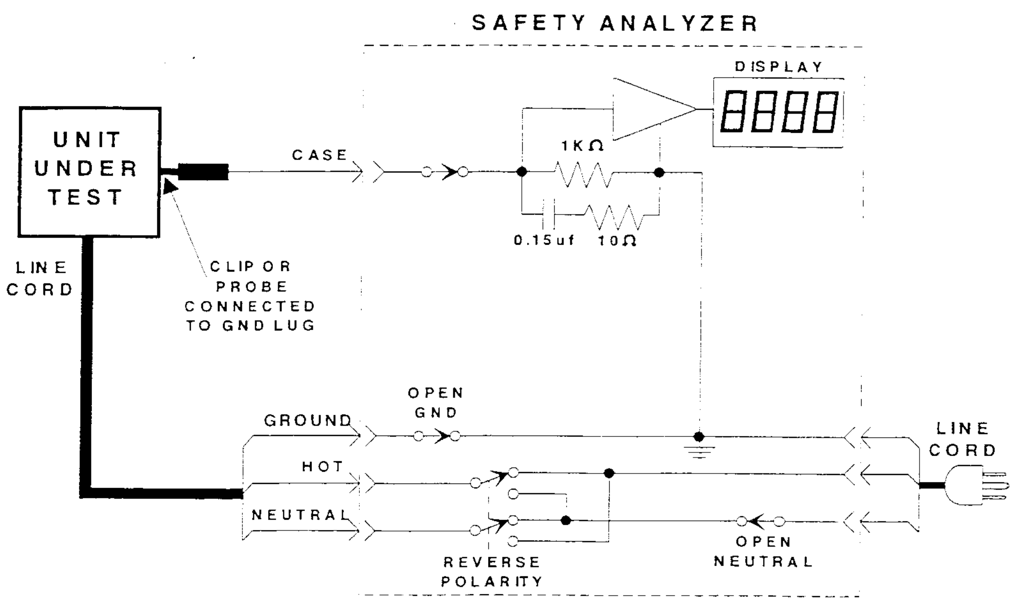


Figure 7-13

c) Using the table below, verify that the current reading for the input voltage is less than what is indicated for the specified test.

Maximum Leakage Current		
Input Voltage	Case Grounded	Case Ungrounded
100 - 120V	100 uA	100 uA
220 - 240V	100 uA	500 uA

Table 7-6

7.6.2 Lead to Ground

Sink Current Patient Circuit

1. Connect the PATIENT CABLE from the safety analyzer to the System 98, as shown in figure 7-14.

2. Depress the "APPLY 115VAC" button and note the reading.

3. Repeat the test for normal, open ground, and reverse polarity combinations. Verify that the current reading for any test is less than 20uA for 100 - 120V input voltage and less than 50uA for 220 - 240V input voltage.

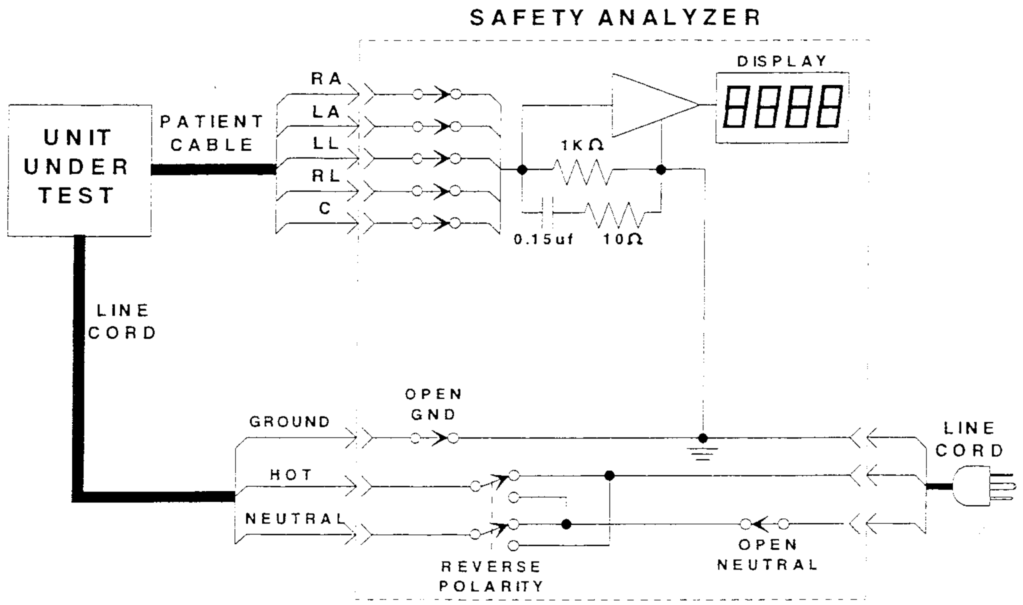


Figure 7-14

7.6.3 Ground Resistance

This test measures the resistance from the case (ground lug) to the U-blade on the AC line cord. (Consult your model safety analyzer for specific test instructions)

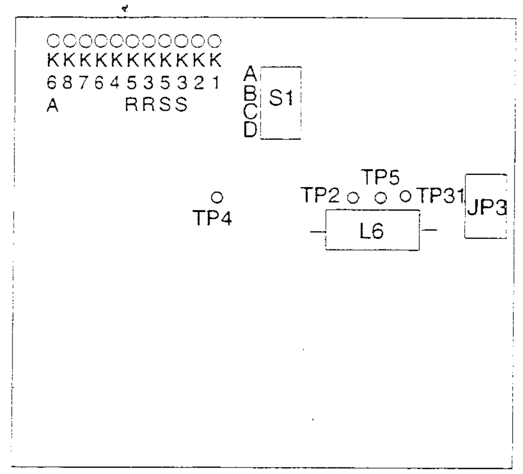
1. Plug the System 98 into the safety analyzer. Attach the resistance measuring probe on the analyzer to the System 98 ground lug on the rear panel.

2. Invoke the resistance function on the safety analyzer. Follow the instructions for the safety analyzer.

3. Verify the resistance to ground is less than 0.1 ohms.

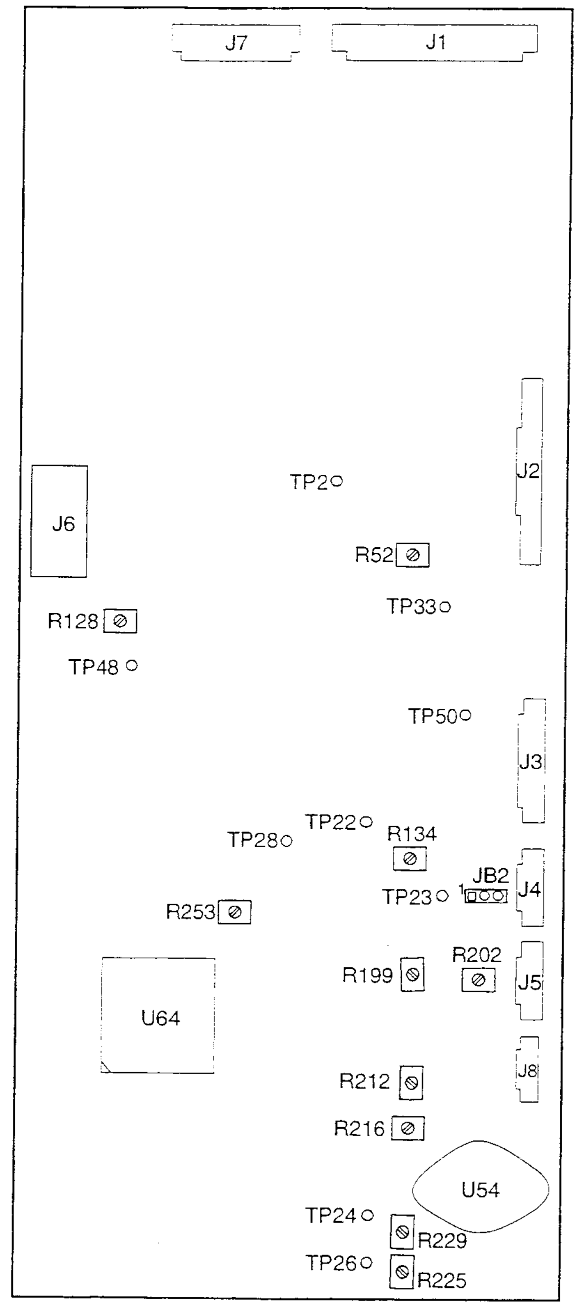
Solenoid Driver Board

(Located under the top cover)



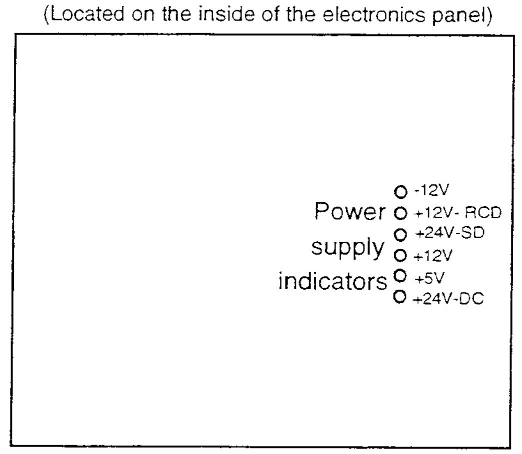
Front End Board

(Located on the inside of the electronics panel)



Main Board

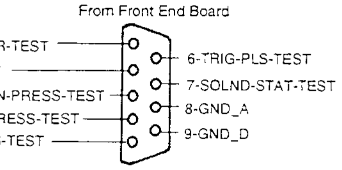
(Located on the inside of the electronics panel)



Rear Panel Diagnostics

Test Connector

From Front End Board



NOTE: Only the test points needed for calibration are shown, complete board layouts are shown in section 5
Individual board drawings are for reference only and are not drawn to scale.

8. PREVENTIVE MAINTENANCE

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8.1 INTRODUCTION

This section provides guidelines and instructions for performing preventive maintenance on the Datascope System 98. The clinical user and the biomedical equipment technician (BMET) are provided with the necessary information to enhance the reliability of the equipment.

8.2 REQUIRED PARTS

2500 hour preventive maintenance kit, P/N 0040-00-0146. This kit is installed at 2,500, 7,500, 12,500 etc. hours and includes the following items:

2500 Hour Maintenance Kit		
Qty	Description	Part number
2	Pump Diaphragms	0348-00-0129
1	Muffler	0103-00-0065
1	Filter Element	0103-00-0370
4	Hose Clamps	0125-01-0001
1	Filter Gasket	0354-00-0042-01
1	Filter Gasket	0354-00-0042-02

5000 hour preventive maintenance kit, P/N 0040-00-0147. This kit is installed at 5,000, 10,000, 15,000 etc. hours and includes the following items:

5000 Hour Maintenance Kit		
Qty	Description	Part number
1	Pressure Head	0997-00-0402
1	Vacuum Head	0997-00-0401
2	Pump Diaphragms	0348-00-0129
1	Filter Element	0103-00-0370
1	Muffler	0103-00-0065
4	Hose Clamps	0125-01-0001
1	Filter Gasket	0354-00-0042-01
1	Filter Gasket	0354-00-0042-02

Special Items:

- 0 - 30 inch pound torque screwdriver
- # 242 Loctite

8.3 SYSTEM LOG BOOK

A valuable tool for implementing a preventive maintenance program is the establishment of a log book in which relevant information is recorded on a regular basis. This allows for verification of necessary maintenance and for evaluating equipment reliability.

The following is recommended as the contents of the log book:

1. A listing of the Safety Disk and System serial numbers.
2. Dates on which preventive maintenance is performed and by whom.
3. Intervals of consumable and maintenance parts replacements; a reading from the System timer should also be recorded.
4. Phone numbers for local Service Representatives and for the Datascope Service Department.
5. Results from safety testing, including chassis and patient leakage currents.
6. Performance related measurements, including pressure and vacuum levels and any discrepancies found during calibration and functional tests.

8.4 PREVENTIVE MAINTENANCE SCHEDULES

Two preventive maintenance schedules have been provided.

Schedule A indicates which actions should be taken by either the Clinical User or by a Biomedical Technician (BMET). These steps do not require the use of tools and may be performed in a clinical setting.

Schedule B indicates the actions which should be performed only by a BMET or other qualified service personnel. Tools are required and, in some cases, the instrument covers must be removed.

Schedule A

To be performed by the clinical user or the BMET

WARNING: Preventive Maintenance should not be performed when the IABP is attached to a patient.

Required Action	Interval			
	Before or After Each Use	Every Month	Every 6 Months	Every 1000 hrs. of use or 2 Yrs.*
1. Clean system if necessary. Check cables, autofill tubing, safety disk luer fittings, and line cord.	●			
2. Perform Safety Disk Leak Test (refer to section 1.3.2.2).	●			
3. Check autofill operation and helium supply.		●		
4. Check lead fault, transducer operation, low helium, BATTERY CHARGING indicator (refer to section 7).		●		
5. Check battery backup (refer to section 1.3.9.5).	●			
6. Replace safety disk (refer to section 1.3.13).				●
7. Check battery run time. Replace batteries when operating time is marginal (refer to section 7.4.5).			●	

**Whichever comes sooner.*

Schedule B

To be performed by the BMET.

Required Action	Interval: Every 6 Months	Every 2500 Hours	Every 5000 Hours
1. Perform visual inspection check list.	●		
2. Calibrate System and perform functional test.	●		
3. Check battery for rated voltage and check battery run time. Replace batteries when operating time is marginal or after 3 years.*	●		
4. Replace the muffler, the pneumatic filter and diaphragms located on the pump assembly. Confirm operation of the power supply and compressor housing fans.		●	
5. Clean the pump compartment. Inspect hoses and pump shock mounts.		●	
6. Replace the vacuum and pressure heads on the pump.			●

**This does not imply a three year warranty.*

8.5 VISUAL INSPECTION CHECKLISTS

8.5.1 Visual Inspection Checklist - every week or before each use. To be performed by the clinical user or the BMET.

1. Unit Appearance: Inspect unit for physical damage. Check the operation of the docking mechanism on the monitor module. Check the battery latch and the locking function of the casters on the hospital cart.

2. Cords and Cables: Inspect line cord, patient cable, external interface cables, and transducer cables for frayed wires, loose connections, or any physical damage.

3. Controls and Switches: Check all controls, switches, and ensure they are tight and mechanically sound.

4. Safety Disk: Check fill tubing and Safety Disk for damage. Check fittings for tightness. Check the operation of the fan on the condensate removal module.

5. Cooling Fan: Check rear panel fan for operation and clean the rear panel grill if necessary.

6. Doppler: Check the operation of the Doppler and the operation of Doppler retractor mechanism.

8.5.2 Visual Inspection Checklist - every 6 months or 2500 hours of use. To be performed by BMET or other qualified service personnel.

1. Pneumatic compartment: Check all pneumatic fittings and tubing for cracks and for tightness in the entire pneumatic compartment. Inspect cables and connectors for frayed wires, loose connections, or any physical damage.

2. Fill Purge assemblies: Check the associated tubing for kinking or cracks. Inspect cables and connectors for frayed wires, loose connections, or any physical damage. Insure the purge tubing is clear and that it is routed through the blood sensor.

3. Motor Compartment: Check the motor compartment for dust and debris and vacuum as necessary. Replace the muffler if excessive dust is observed. Inspect pump tubing, and fittings for tightness and cracks. Inspect the shock mounts for cracking or excessive wear, replace if necessary. Check fan operation.

4. Electronics panel: Check the connectors and cables on the electronics panel (Main and Front End PCBs). Inspect cables and connectors for frayed wires, loose connections, or any physical damage.

8.6 ACCESS AND REPLACEMENT INSTRUCTIONS

8.6.1 Pump Maintenance Instructions

Replacement Diaphragms	P/N - 0348-00-0129
Replacement Pressure Head	P/N - 0997-00-0402
Replacement Vacuum Head	P/N - 0997-00-0401

The pressure/vacuum pump is fitted with neoprene diaphragms which should be replaced at 2500 hour intervals to enhance System reliability.

1. Refer to figure 8-1. Remove the System from the hospital cart. Remove the right side cover and the left lower cover from the System. Remove the two nuts at the rear of the pump compartment and remove the pressure and vacuum lines through the access hole provided. Remove the two screws at the base of the pump assembly and slide the pump housing out. Remove the 14 screws which retain the cover and remove the cover.

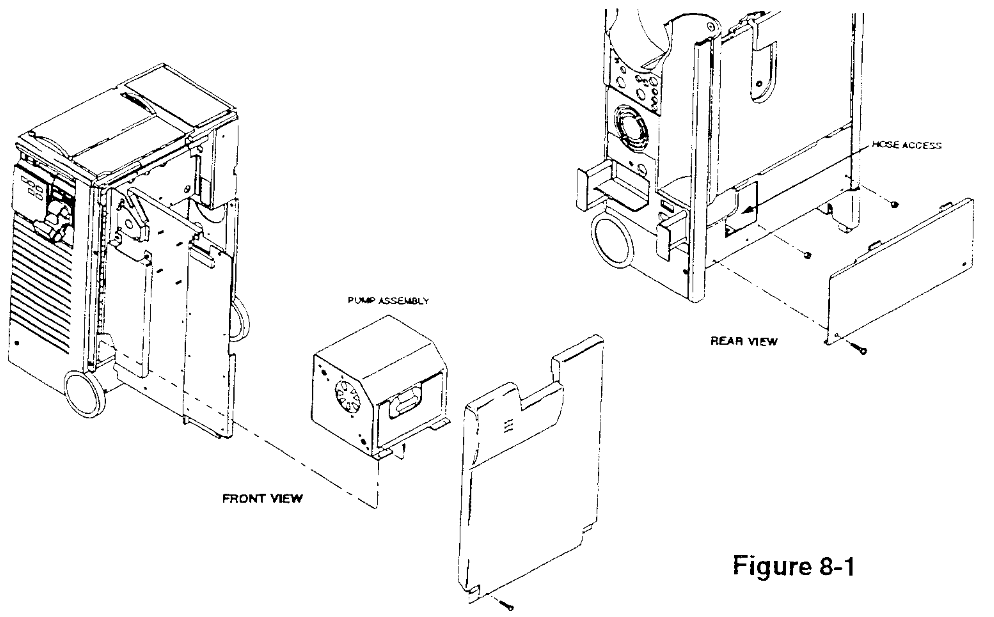

Figure 8-1

2. Refer to figure 8-2. Cut off the hose clamps from the vacuum and pressure heads on the pump assembly. Remove the hoses from the heads.

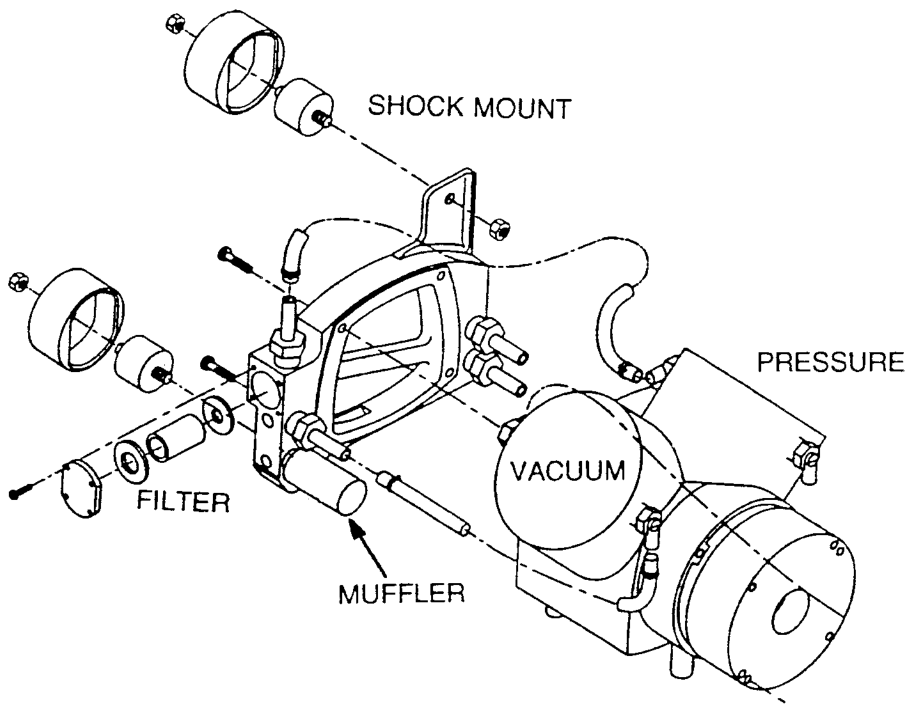

Figure 8-2

3. Using a 4mm hex wrench, loosen and remove the four pump head bolts on both heads. Remove both pump heads.

NOTE: If maintenance is being performed at the 5000 hour interval the pump heads are discarded and replaced with new ones.

4. Refer to figure 8-3. Loosen and remove the diaphragm retaining screw.

5. Remove and discard the diaphragm.

6. Install the replacement diaphragms in the following manner: Pressure side = smooth surface facing out, Vacuum side = rough surface facing out. Apply 1 or 2 drops of #242 Loctite to the diaphragm retaining screw and tighten securely. Insure that the diaphragm lies flat across the compressor housing.

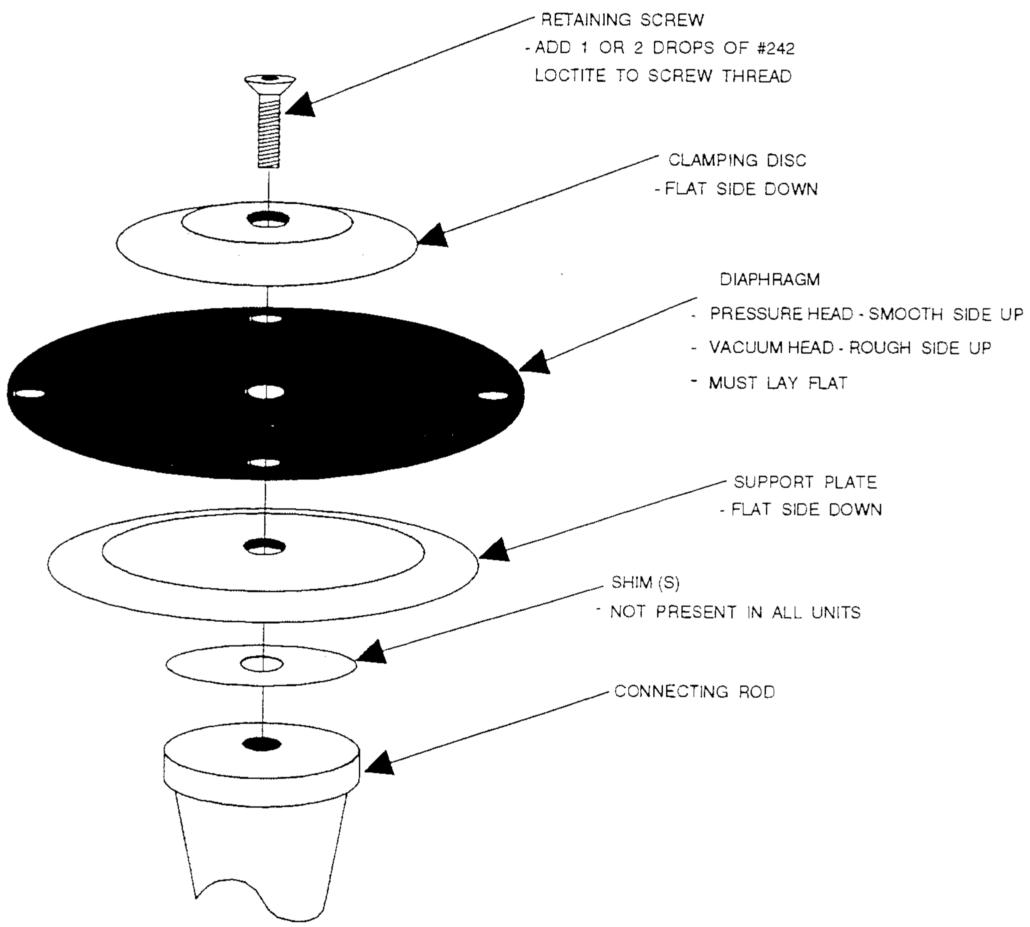

Figure 8-3

7. Reinstall the pump heads (install new heads if at the 5000 hour interval) and tighten the four head screws to 25 inch pounds using the cross pattern as shown in figure 8-4.

8. Reinstall the tubing to the pump heads using new hose clamps.

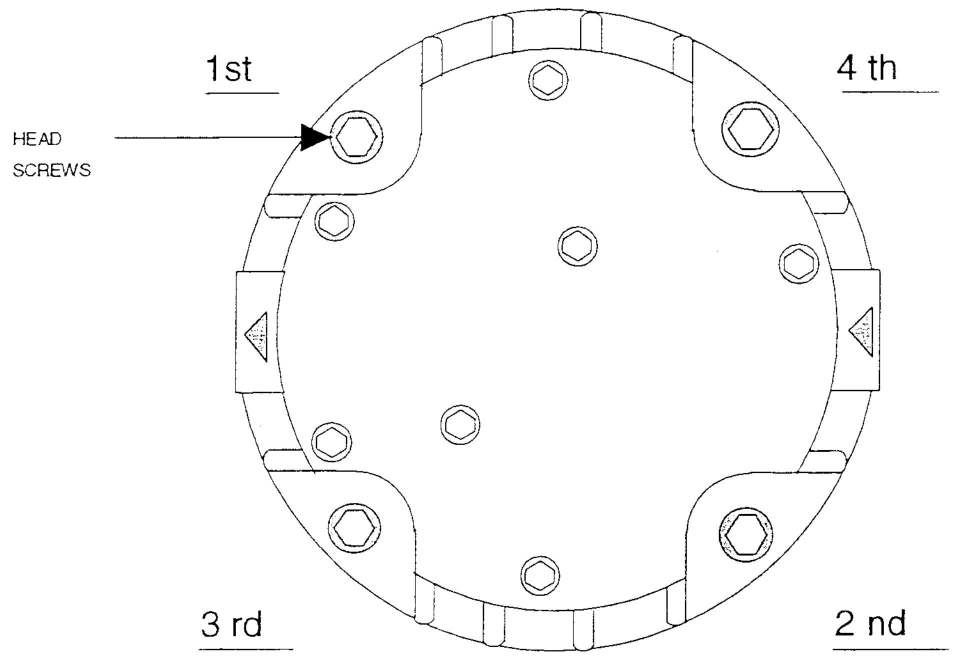

Figure 8-4

8.6.2 Pump Muffler Replacement

Replacement Muffler P/N - 0103-00-0065

1. Refer to figure 8-1. Remove the System from the hospital cart. Remove the right side cover and the left lower cover from the System. Remove the two nuts at the rear of the pump compartment and remove the pressure and vacuum lines through the access hole provided. Remove the two screws at the base of the pump assembly and slide the pump housing out. Remove the 14 screws which retain the cover and remove the cover.

2. Refer to figure 8-2. Remove the muffler by rotating it counterclockwise.

3. Replace the muffler, do not over-tighten. There is no need to apply sealant to the pipe fittings.

8.6.3 Pneumatic Filter Replacement Instructions

The pneumatic filter is a porous element which will capture particles larger than 40 microns if they should enter the pressure drive system. Regular replacement of the filter element will prevent eventual restriction in airflow.

Replacement Filter	P/N - 0103-00-0370
Washer	0354-00-0042-01
Washer	0354-00-0042-02

1. Refer to figure 8-1. Remove the System from the hospital cart. Remove the right side cover and the left lower cover from the System. Remove the two nuts at the rear of the pump compartment and remove the pressure and vacuum lines through the access hole provided. Remove the two screws at the base of the pump assembly and slide the pump housing out. Remove the 14 screws which retain the cover and remove the cover.
2. Refer to figure 8-2. Remove the four screws which retain the filter access cover.
3. Remove the filter element and discard.
4. Clean all parts with a damp soft cloth as necessary.
5. Replace the filter element and washers, reinstall the cover.

8.6.4 Shock Mounts and Hoses

Replacement Shock	P/N - 0348-00-0169-01
Pressure Tubing	0004-00-0051
Vacuum Tubing	0004-00-0050
Replacement Clamps	0125-01-0001

1. Refer to figure 8-1. Remove the System from the hospital cart. Remove the right side cover and the left lower cover from the System. Remove the two nuts at the rear of the pump compartment and remove the pressure and vacuum lines through the access hole provided. Remove the two screws at the base of the pump assembly and slide the pump housing out. Remove the 14 screws which retain the cover and remove the cover.
2. Vacuum accumulated dust from inside the pump compartment.
3. Refer to figure 8-2. Inspect the four shock mounts for signs of cracking or excessive wear. Replace as necessary.
4. Inspect the vacuum and pressure tubing for tightness. Check for cracking or excessive wear.

8.6.5 Battery Replacement

Although the rechargeable batteries used in the System 98 can be charged and discharged many times, they are gradually consumed during the normal course of operation. The battery should be replaced every 3 years or sooner if the battery operating time is marginal. Battery replacement should be performed by a BMET or other qualified service personnel. Batteries must be replaced in sets.

Replacement Battery Pack Assembly
P/N -0146-00-0047 or
0146-00-0051*
Replacement batteries**
P/N -0146-00-0039

1. Place the System 98 to IABP OFF. Unplug the line cord from the AC outlet and insure the BATTERY CHARGING indicator is not lit.
2. ·Lift the battery release latches. Lift the System 98 off of the battery assembly and place aside.
3. Refer to figure 8-5. Remove the top cover. Remove the jumper and the cable assembly from the battery terminals being careful not to contact adjacent terminals.
4. Remove the batteries from the tray. Remove and reuse the terminal clips to reconnect the jumper and cable assembly to the new batteries. **Be sure to connect the red wire to the + terminal and the black wire to the - terminal.**
5. Reinstall the top cover being careful to route the cables in the raised area of the top cover.
6. Install the battery assembly into the System 98.

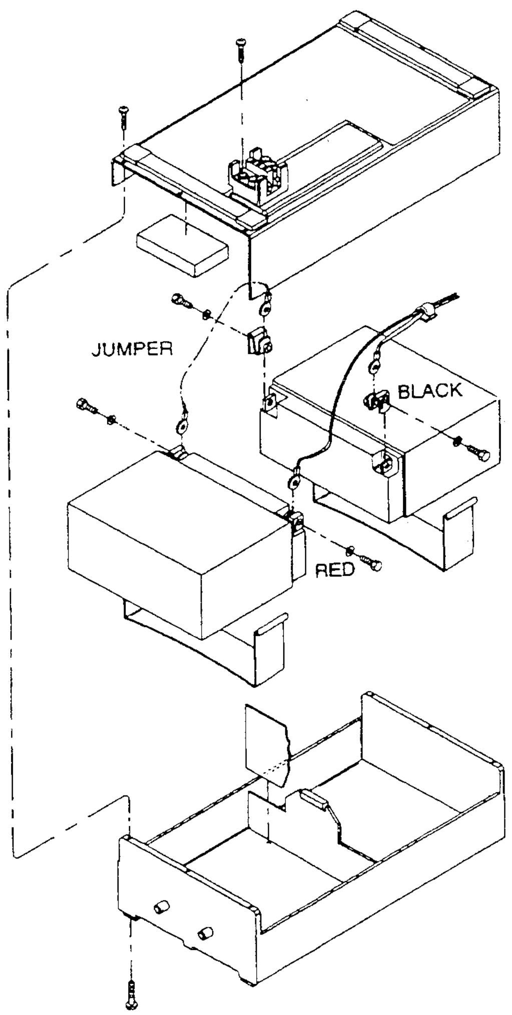

Figure 8-5

7. Plug in the line cord, insure the AC MAINS switch is ON and verify the BATTERY CHARGING indicator is lit.

**This battery assembly is used when the System 98 is ordered with a docking station, refer to page 6-56 for an illustration of this battery assembly.*
***Both batteries must be replaced together.*

8. Switch the System 98 on and select INTERNAL trigger. Wait a minimum of 1 minute and then unplug the System. Verify the System operates from battery and that the BATTERY IN USE message is displayed. Reestablish AC power and verify the BATTERY CHARGING indicator is illuminated.

9. In order to establish a full battery charge prior to returning the System to service leave it plugged in and charging overnight (18 hours).

Datascope Corp. | 580 Winters Avenue, P.O. Box 5 | Paramus, N.J. 07653-0005, U.S.A. | Telephone: (201) 265-8800 | (800) 288-2121 | Fax:(201) 265-8562

Datascope B.V. | DRS. V. van Royenstraat 8 | P.O. Box 26 | 3870 CA Hoevelaken | Holland | Telephone: 31-3325-44911 | Fax: 31-3325-72974

Datascope GmbH | Zeppelinstraße 2-4 | D-64625 Bensheim | Germany | Telephone: 49-6251-1705-0 | Fax: 49-6251-67877

Datascope Medical Co., Ltd. | Lakeview Court | Spitfire Close | Ermine Business Park | Huntingdon | Cambs PE18 6XR | England | Telephone: 44-1-480-433477 | Fax: 44-1-480-423638

Datascope S.A.R.L. | Europarc Créteil | 123 Chemin de Bassins | 94035 Créteil Cedex | Telephone: 33-1-45-139150 | Fax: 33-1-45-139151

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