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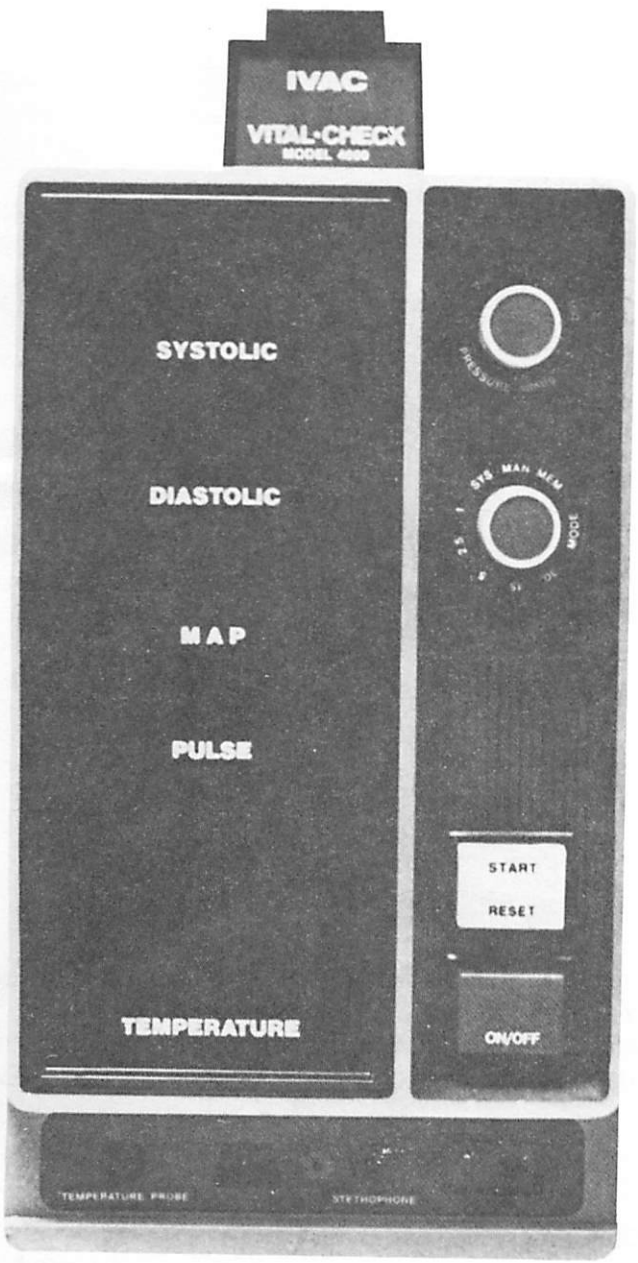
CALIBRATION VERIFICATION page 5-21



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ORAL TEMP PROBE
1880L 33.00

VITAL·CHECK®
SERVICE MANUAL

VITAL SIGNS MEASUREMENT SYSTEM
MODEL 4000

Manufactured under one or more of the following patents:

UNITED STATES, D-227,123; D-227,500; D-233,667; D-248,490; D-257,429; 3,702,076; 3,877,307; 3,942,123; 4,313,445. CANADA, Patented/Brevete 1973; 1976; 1977; 1981. GREAT BRITAIN Regd. No. 958,664; 958,665. JAPAN, Patent No. ("Patent No." must be in Japanese characters) 871,877. WEST GERMANY, Gesch. Muster No. MR8226; 8270. Other U.S. and foreign patents pending.

IVAC CORPORATION 10300 CAMPUS POINT DRIVE SAN DIEGO, CALIFORNIA 92121-1579
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CHAPTER 1
INTRODUCTION

1-1 GENERAL

This service manual contains information for use in maintaining and servicing the IVAC VITAL•CHECK Monitor - Model 4000/4001 Vital Signs Measurement System (shown in figure 1-1). This manual is written for personnel experienced in analyzing, troubleshooting, and repairing analog/digital electronic equipment.

NOTE

Throughout this manual, all information applies to both Model 4000 and Model 4001, unless otherwise specified.

The terms monitor, instrument, and unit are used interchangeably and refer to the IVAC VITALoCHECK Monitor - Model 4000/4001.

1-2 DEFINITION OF TERMS

The definitions of certain terms and concepts used throughout this manual are listed below.

a. **NOTE** - Notes found in the text indicate parenthetical information which is of particular importance to the reader.

b. **WARNINGS** - Warnings are precautionary measures which, if not followed, could cause injury to persons operating or repairing the VITAL•CHECK monitor.

c. **CAUTIONS** - Cautions are precautionary measures which, if not followed, could cause damage to the VITAL•CHECK monitor.

d. Defective - The term "defective" is used in the text to describe any component that is not functioning for any reason.

1-3 ABBREVIATIONS

The reference designations and abbreviations used throughout this manual are defined in table 1-1.

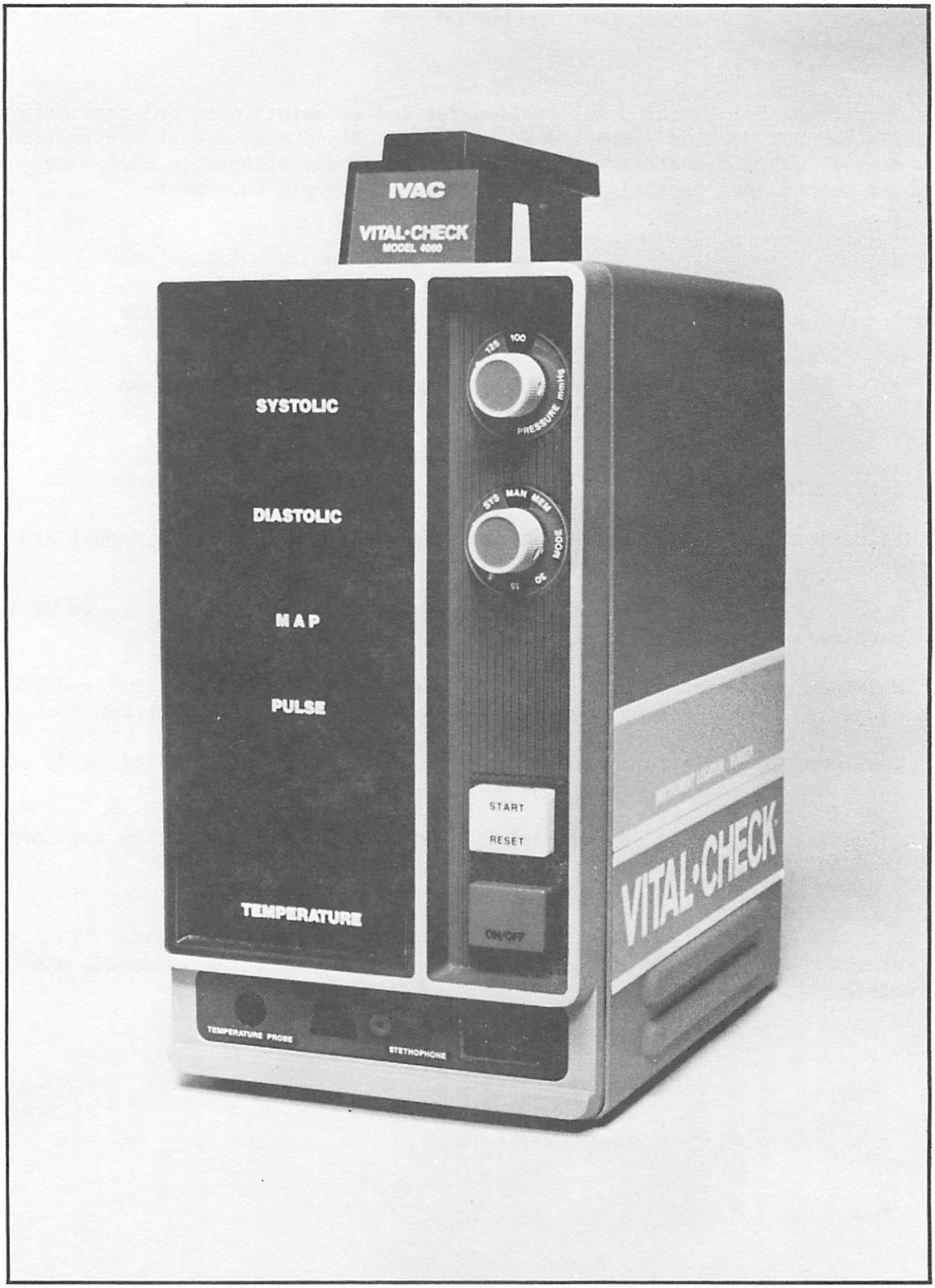


Figure 1-1. VITAL•CHECK Monitor -- Model 4000/4001

Table 1-1. Reference Designations and Abbreviations

Reference Designation	Definition
A	assembly
C	capacitor
CR	diode
DS	display
E	eyelet or solder landing
F	fuse
J	jack or connector on pw board, terminal header
L	inductor
P	plug or programmable shunt
Q	transistor or IC output
R	resistor
RN	resistor network
S	switch
SPKR	speaker
T	transformer
TP	test point
U	integrated circuit
X ___	socket for electronic component (the designation for the component appears in the blank space)
Y	crystal
Abbreviation	**Definition**
A	ampere
AC	alternating current
A/D	analog to digital
Ah	ampere-hour
Al	aluminum
APS	absolute pressure signal
A/R	as required
BATT	battery
cm	centimeter
COML	commercial
°C	degrees Celsius
D/A	digital to analog
DAC	digital analog converter
DC	direct current
dia	diameter
DMM	digital multimeter
DPL	display board
DPL DVR	display driver board
EPROM	erasable programmable read only memory
ft	foot
F	farad

Table 1-1. Reference Designations and Abbreviations (Continued)

Abbreviation	Definition
F	false (logic)
FF	flip-flop
°F	degrees Fahrenheit
FET	field-effect transistor
gm	gram
Hex	hexagonal
Hi	high logic level
hr	hour
Hz	hertz
IC	integrated circuit
ID	inside diameter
in.	inch
I/O	input/output
IV	intravenous
kΩ	kilohm
kg	kilogram
kHz	kilohertz
kV	kilovolt
KVO	keep vein open
kW	kilowatt
lb	pound
LED	light emitting diode
lg	long
LG	logic board
LG EXT	logic extension board
Lo	low logic level
LSI	large scale integration
MΩ	megohm
MCS	microphone signal
MHz	megahertz
MIC	microphone
µamp	microamp
µF	microfarad
µsec	microsecond
m	milli
mA	milliampere
mmHg	millimeters of mercury
ml	milliliter
mm	millimeter
ml/hr; ml per hr	milliliters per hour
msec	millisecond
MUX	digital multiplex
min	minute
MOS	metal-oxide semiconductor
no; nos.	number or numbers

Table 1-1. Reference Designations and Abbreviations (Continued)

Abbreviation	Definition
n	nano
nsec	nanosecond
N/A	not applicable
NPN	negative-positive-negative (transistors)
oz	ounce
OD	outside diameter
	ohm
P/N	part number
p/o	part of
p	pico
pF	picofarad
PCB	printed circuit board
PL	places
PNP	positive-negative-positive (transistors)
PNEU	pneumatic board
PR	power regulator
psi	pounds per square inch
psig	pounds per square inch-gauge
pw	printed wiring
RAM	random-access memory
rms	root mean square
ROM	read-only memory
RPS	relative pressure signal
SCR	silicon controlled rectifier
sec	second
SIP	single in-line package
S/N	serial number
SW	rotary switch board assembly
T	true (logic)
THERM	thermometer board
thk	thick
TTL	transistor-transistor logic
V	volt(s)
VAC	volts alternating current
VDC	volts direct current
VTBI	volume to be infused
W	watt
x	times or by (mathematical)

1-4 DESCRIPTION OF VITALoCHECK MONITOR

1-4-1 Specifications

The monitor specifications are listed in table 1-2.

Table 1-2. Specifications and Features

Features	Specifications
Power requirements:	
AC	(Model 4000) 95-135 VAC, 50/60 Hz 0.7A 3-wire grounded (Model 4001) 190-270 VAC, 50/60 Hz 0.375A 3-wire grounded
DC	Internal rechargeable sealed lead-acid battery pack: Output voltage 12.0 VDC; capacity 2.5 Ah. A discharged pack is automatically charged whenever AC power is present: to 70% full charge in 3 hours when unit is not operating; and 70% full charge in 5 hours when unit is operating. A full charge will occur in 12-16 hours.
Measurement range:	
BP	20-275 mmHg with 1 mmHg resolution. (Transducer accuracy is $\pm$3 mmHg or $\pm$2% of reading, whichever is greater.)
Pulse rate	20-200 beats/minute
Temperature	Predictive mode: 32.2 to 42.1 ^{o}C $\pm$0.1^{o}C (90.0 to 107.9^{o}F $\pm$0.2^{o}F)
	Monitor mode: 31.1 to 42.1 ^{o}C $\pm$0.1^{o}C (88.0 to 107.9 ^{o}F $\pm$0.2^{o}F)
Maximum cuff pressure (normal operation)	300 mmHg
Maximum cuff inflation time (normal operation)	4 minutes
Cuff inflation rate	20-40 mmHg/sec
Cuff deflation rate	4-6 mmHg/sec normal 2-3 mmHg/sec for retries

Table 1-2. Specifications and Features (Continued)

Features	Specifications
Failsafe cuff pressure	330-335 mmHg
Failsafe cuff inflation time	4.5 minutes
Failsafe deflation rate	300 to 10 mmHg in 3 seconds
Dimensions: Length Width Height Weight	 21.27 cm (8.38 in.) 14.29 cm (5.63 in.) 29.53 cm (11.63 in.) 7.2 kg (15.8 lbs)
Environment:	
Temperature	Storage: -30 to 149°F Operating: 60 to 110°F (blood pressure system) 60 to 110°F (thermometer system; room ambient-monitor mode) 60 to 94°F (thermometer tip temperature - predictive mode) 60 to 86°F (thermometer system, room ambient - predictive mode, battery operation) 60 to 84°F (thermometer room ambient - predictive mode, AC operation)
Humidity	Storage and operating: 15-95%; relative humidity, noncondensing
Shock	30G for 11 msec on any axis
Vibration	(in shipping carton) 2 hours in each of 3 axes. 10-50 Hz over a ten-minute period at 5G maximum.
Regulatory standard	UL544; FDA (MDS-201-004); IEC 601.1; CSA

1-5 ACCESSORIES

a. Stethoscope - Model 1107 (figure 1-2). A stethoscope equipped with a standard luer connector can be connected to the VITAL•CHECK monitor to monitor Korotkoff sounds detected by the instrument as it takes a BP measurement.

b. Accessory Holder - Model 4010 (figure 1-3). The accessory holder, which attaches to the IVAC Vital Sign Instrument Stand - Model 1020VS, is a convenient storage place for the cuff, probes, and probe covers when they are not in use.

c. IVAC Standard Probes - Models P880L/P882L (long cord) (figure 1-4). The P880L/P882L probe contains a heat-sensing thermistor located inside a stainless steel shaft. The thermistor provides a temperature-proportional resistance to the thermometer through the probe connection and flexible 15-inch coil cord attached to the base of the probe shaft. Also located at the base of the probe is an ejection button for easy disposal of used probe covers. Oral probes are blue, rectal probes are red; the oral and rectal probes are electronically identical. These probes are designed to be used in either the predictive or the monitor mode of operation.

d. IVAC Standard Probes - Models P880/P882 (oral/rectal) (figure 1-4). These probes are identical to the P880L/P882L probes except that they are equipped with a 6-inch coil cord. These probes are designed to be used in either the predictive or the monitor mode of operation.

e. IVAC Probe Cover - Model 850 (figure 1-4). The probe cover is a thin plastic sheath with thermal characteristics carefully selected to match the requirements of the VITAL•CHECK monitor. The probe cover is used to cover the shaft of the probe to prevent cross-contamination or infection during temperature measurement.

NOTE

IVAC Corporation does not guarantee the accuracy of the temperature readings obtained unless genuine IVAC probes and probe covers are used with the VITAL•CHECK monitor. Inaccurate readings may occur unless IVAC probe covers or probe covers having thermal characteristics equivalent to those of IVAC probe covers are used.

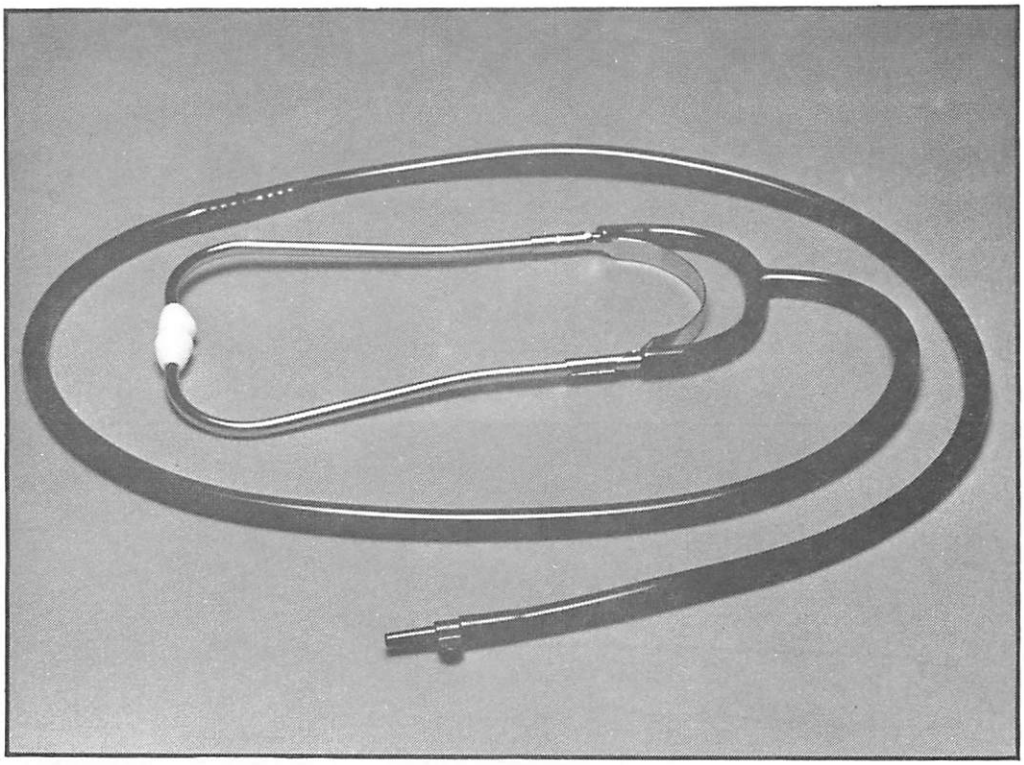


Figure 1-2. Stethoscope -- Model 1107

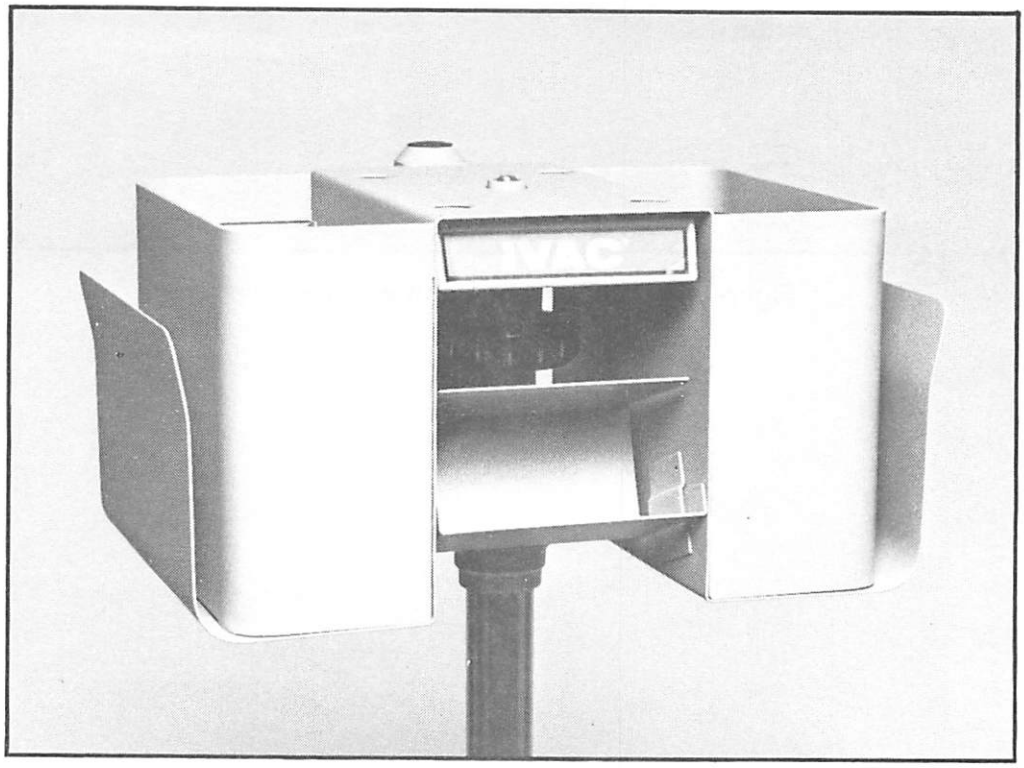


Figure 1-3. Accessory Holder -- Model 4010

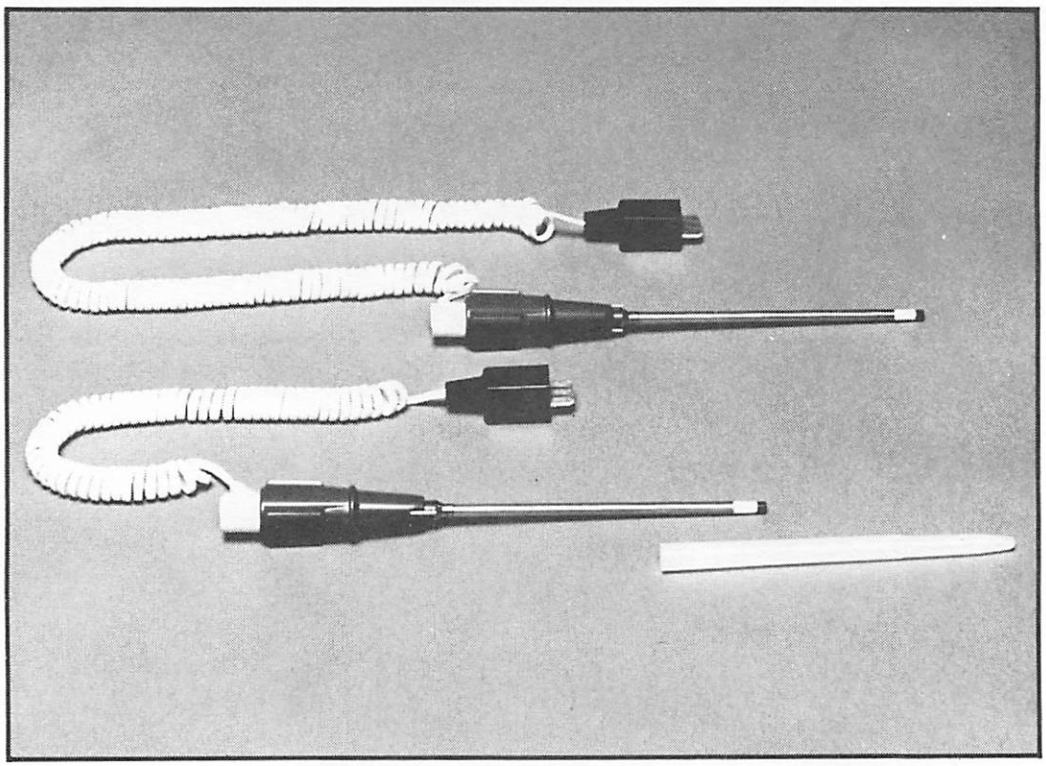


Figure 1-4. IVAC Probes and Probe Covers

Figure 1-5a. Disposable Esophageal/Rectal Probe

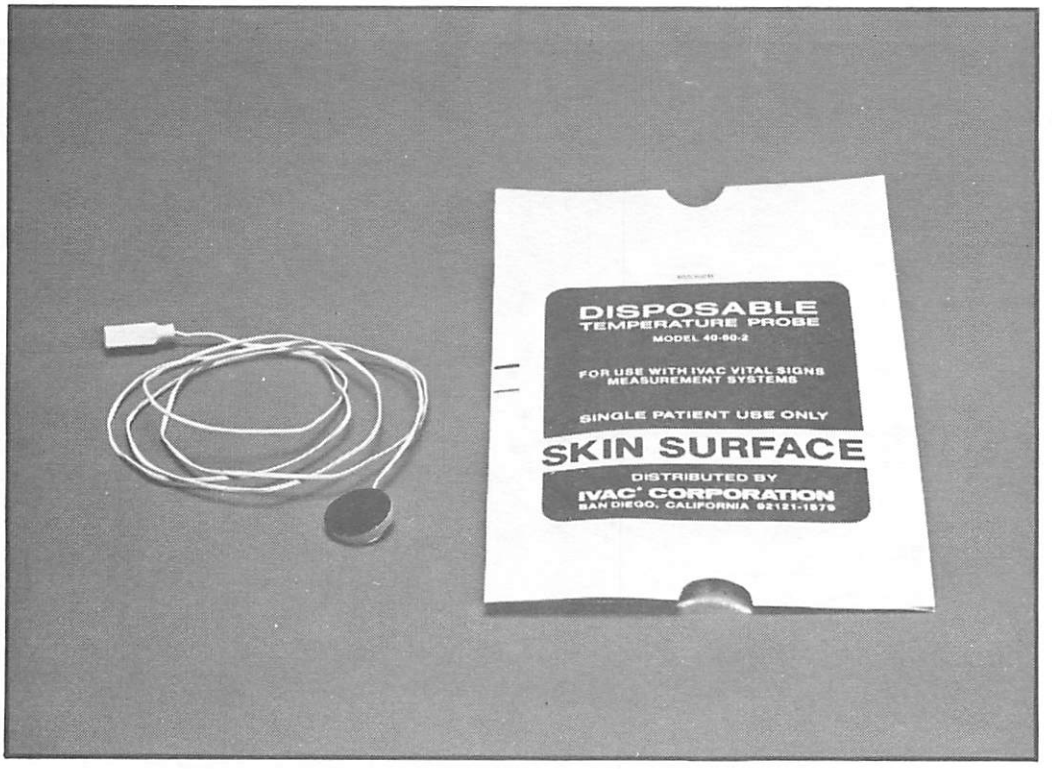


Figure 1-5b. Skin Surface Probe and IVAC TEMP•PADS

Figure 1-6. IVAC Temperature Probe Esophageal Stethoscope -- Model 4082

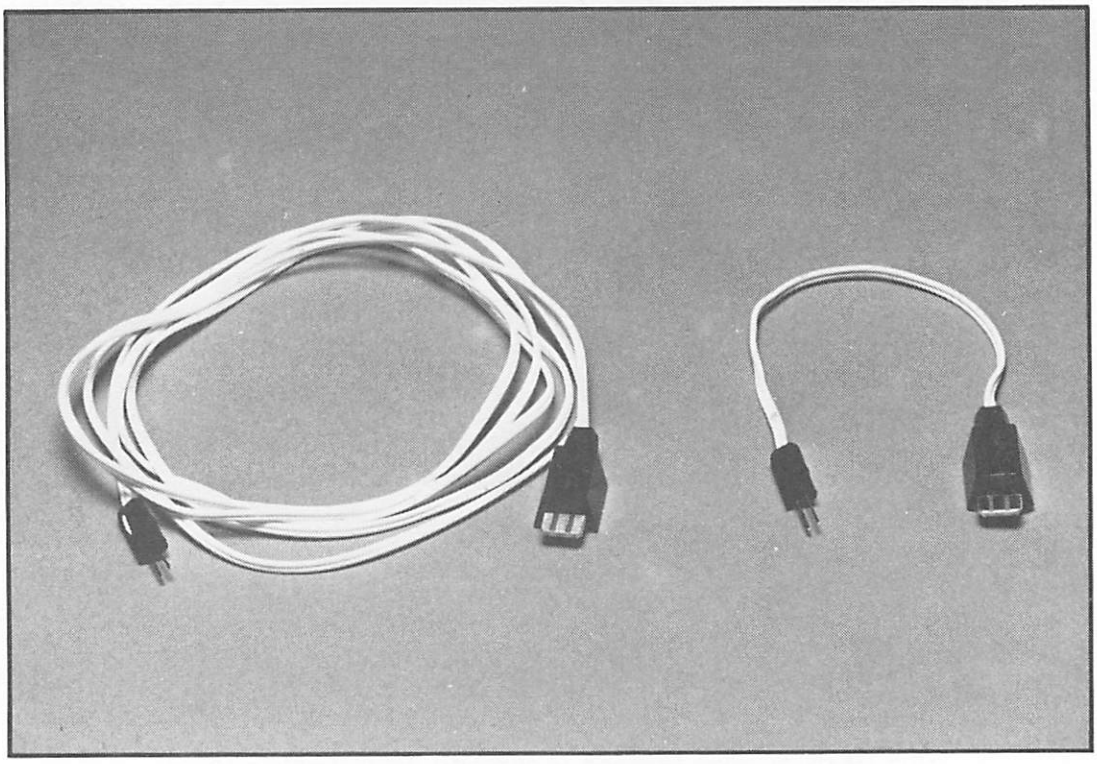


Figure 1-7. Probe Extension Cable and Probe Adapter

f. IVAC Disposable Esophageal/Rectal (Model 4052) and Skin Surface Probes (Model 4062) (figure 1-5). The disposable probes are 0.10 inch in diameter and 36 inches long. An eighteen-inch section of the esophageal/rectal probe is encapsulated in PVC. The skin surface probe comes with a 5/8-inch diameter foam adhesive pad for initial surface attachment. Disposable probes require the use of either the probe adapter or the probe extension cable. Probe covers are not required. These probes function in a manner similar to the P880L/P882L probes, but are to be used once and then disposed of. The disposable skin surface probe may be used more than once on the same patient (reaffix with the IVAC TEMP•PAD™), but must be disposed of following the completion of a measurement cycle. These probes can only be used in the monitor mode of operation.

g. IVAC TEMP•PAD - Model 4072 (figure 1-5). The TEMP•PAD is a self-adhesive pad (with peel-off backing) used for reaffixing the disposable probe when used again on the same patient.

h. IVAC Temperature Probe Esophageal Stethoscope - Model 4082, 18 French (figure 1-6). This device is used with the VITAL•CHECK monitor in the monitor mode. A patient's temperature may be determined in three to five minutes. If disconnected for intermittent monitoring (once the probe reaches the patient's stable temperature), temperature can be immediately monitored, by reinserting the probe extension connector into the probe extension cable.

i. IVAC Probe Extension Cable - Model P869 (figure 1-7). The probe extension cable is a 6-foot long connecting cable which attaches to both the VITAL•CHECK monitor and the disposable probe, providing a reusable interface for the disposable probe.

j. IVAC Probe Adapter - Model P868 (figure 1-7). The probe adapter, a 1-1/2 inch long connector, can be used instead of the probe extension cable to connect the disposable probe to the VITAL•CHECK monitor.

k. IVAC Adult Size BP Cuff - Model 1138 (figure 1-8). The cuff wraps as a standard BP cuff. The adult cuff fits arms in the size range 27.9 to 41.7 cm.

l. IVAC Large Adult Size BP Cuff - Model 1139 (figure 1-8). Identical in form and function to the Model 1138 cuff, but designed to fit large adults. The large adult cuff fits arms in the range of 33.0 to 50.8 cm.

m. IVAC Child Size BP Cuff - Model 1137 (figure 1-8). Identical in form and function to the Model 1138, but designed to fit children. The child size cuff fits arms in the range of 19.6 to 28.7 cm.

n. IVAC Thermometer Tester - Model 828A (figure 1-9). The thermometer tester confirms in a few seconds that the VITAL•CHECK monitor thermometer function is calibrated by displaying either 98.6°F or 37°C, depending on the setting of the °F-°C switch.

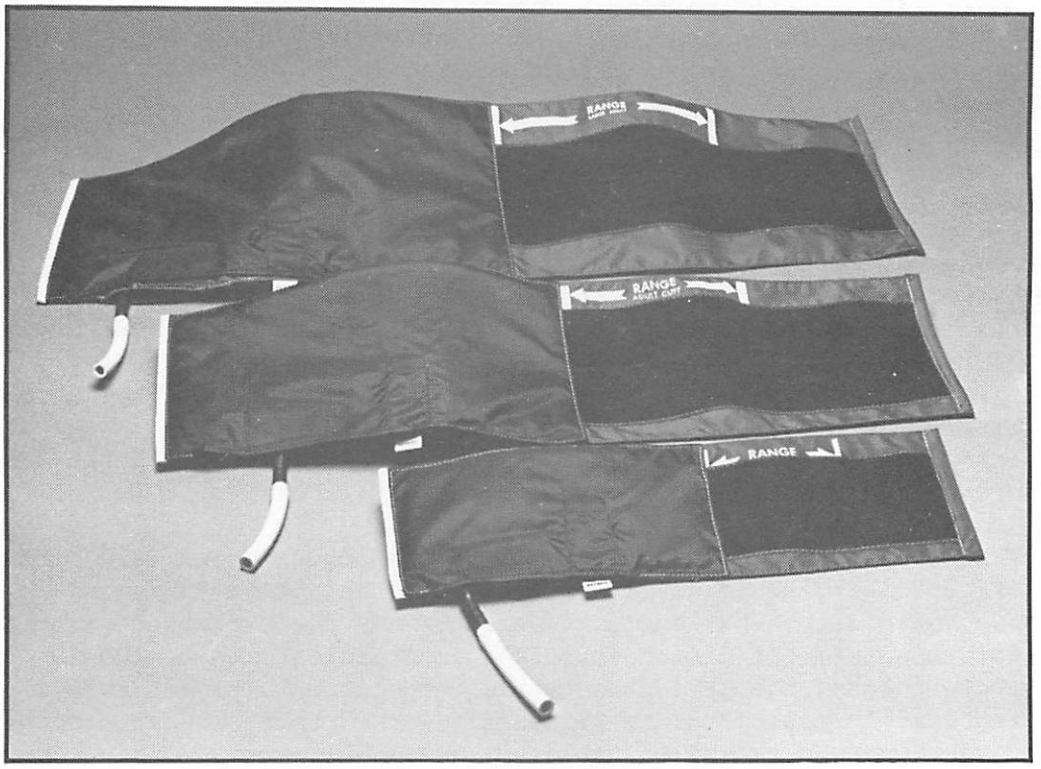


Figure 1-8. IVAC Blood Pressure Cuffs

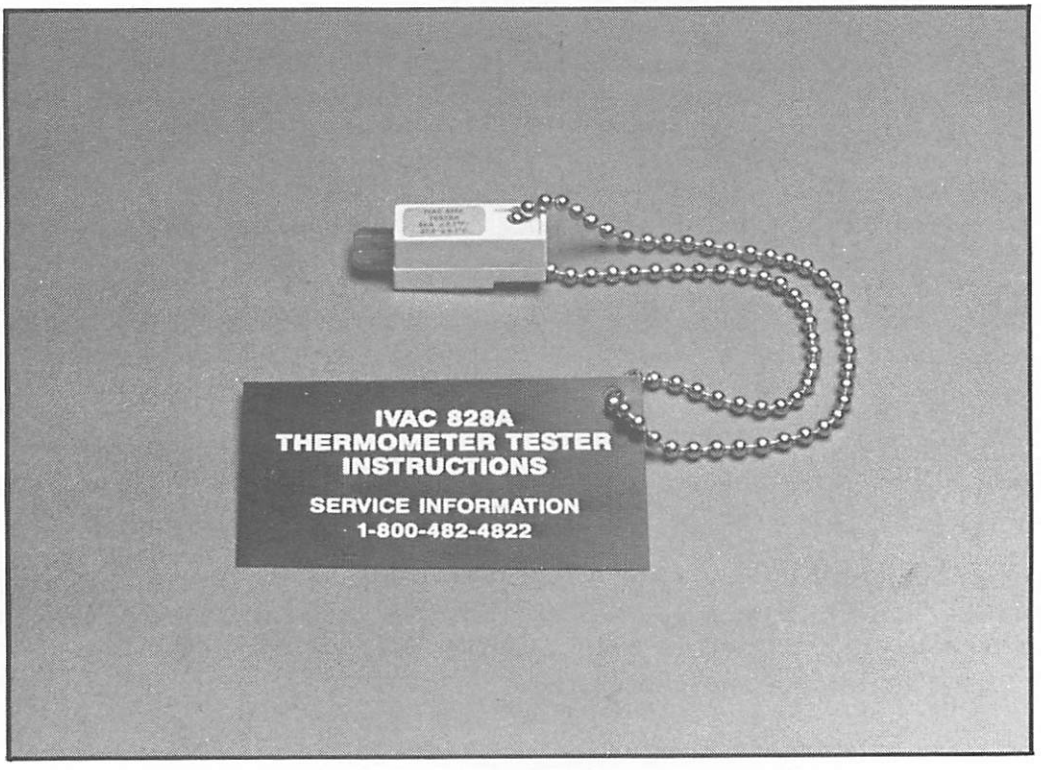


Figure 1-9. IVAC Thermometer Tester

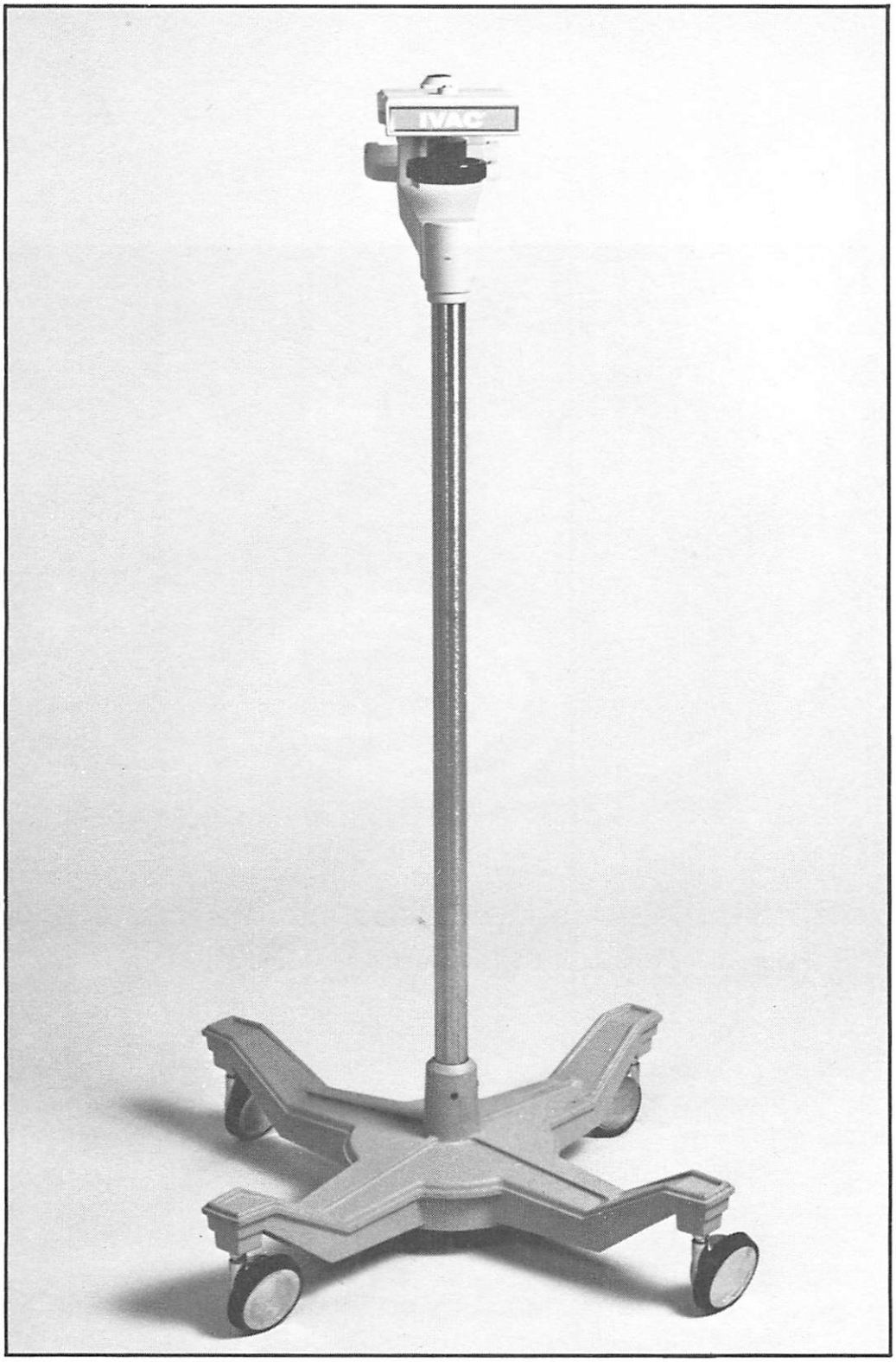


Figure 1-10. Vital Sign Instrument Stand -- Model 1020VS

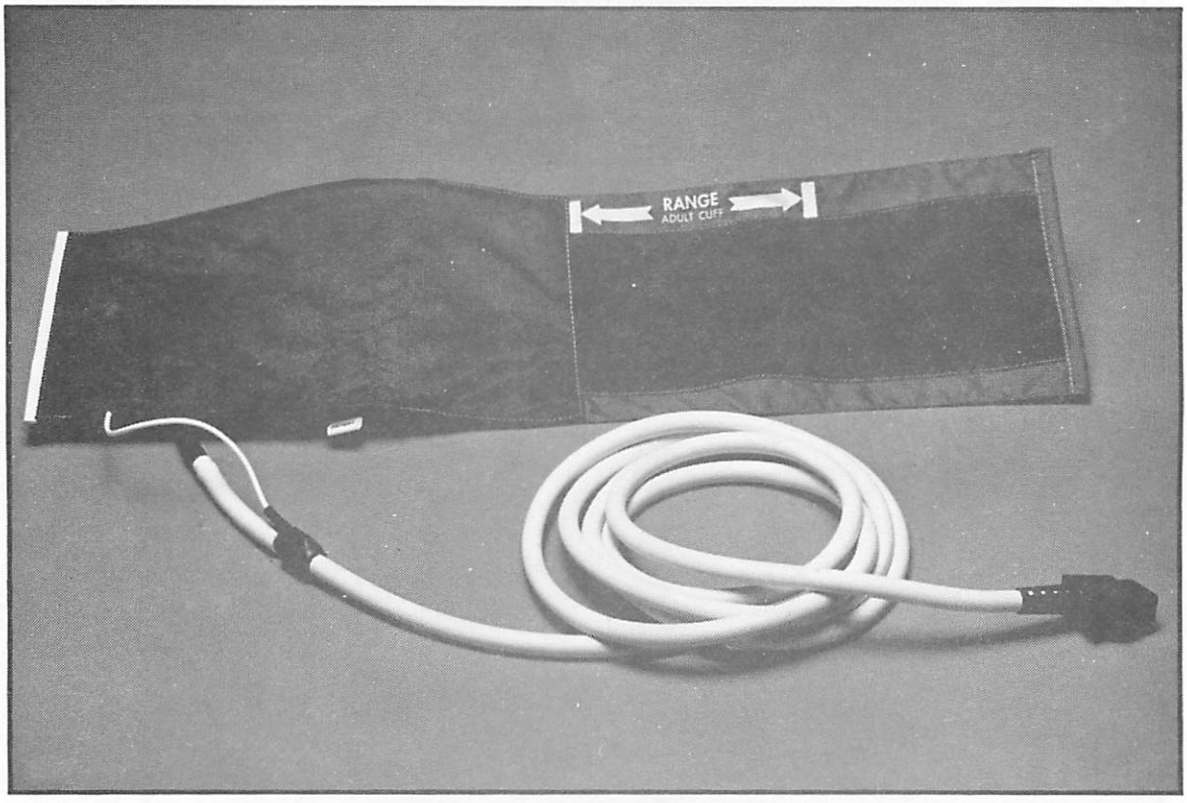


Figure 1-11. Umbilical Cables, Models 1131 and 1132

o. IVAC Vital Sign Instrument Stand - Model 1020VS (figure 1-10). Designed to accommodate the VITAL•CHECK monitor, this stand has a low center of gravity and rolling casters for easy maneuverability from one area to another.

p. Umbilical Cable, 6 ft. - Model 1131 (figure 1-11). The umbilical cable consists of a flexible air hose, a coaxial cable and microphone for connection between the cuff and the instrument. The air hose is used to deliver air to inflate the cuff; the coaxial cable and the microphone deliver korotkoff signals to the instrument.

q. Umbilical Cable, 12 ft. - Model 1132 (figure 1-11). Same in form and function as the Model 1131 but is 12 feet long.

r. Writing Table - Model 4015 (figure 1-12). A metal table which attaches to the monitor's handle.

s. Writing Table Note Pads, P/N 127335 (figure 1-12), for use with the writing table.

NOTE

Items b, o, r, and s are combined to form the IVAC Vital Sign Instrument Stand - Model 1030VS.

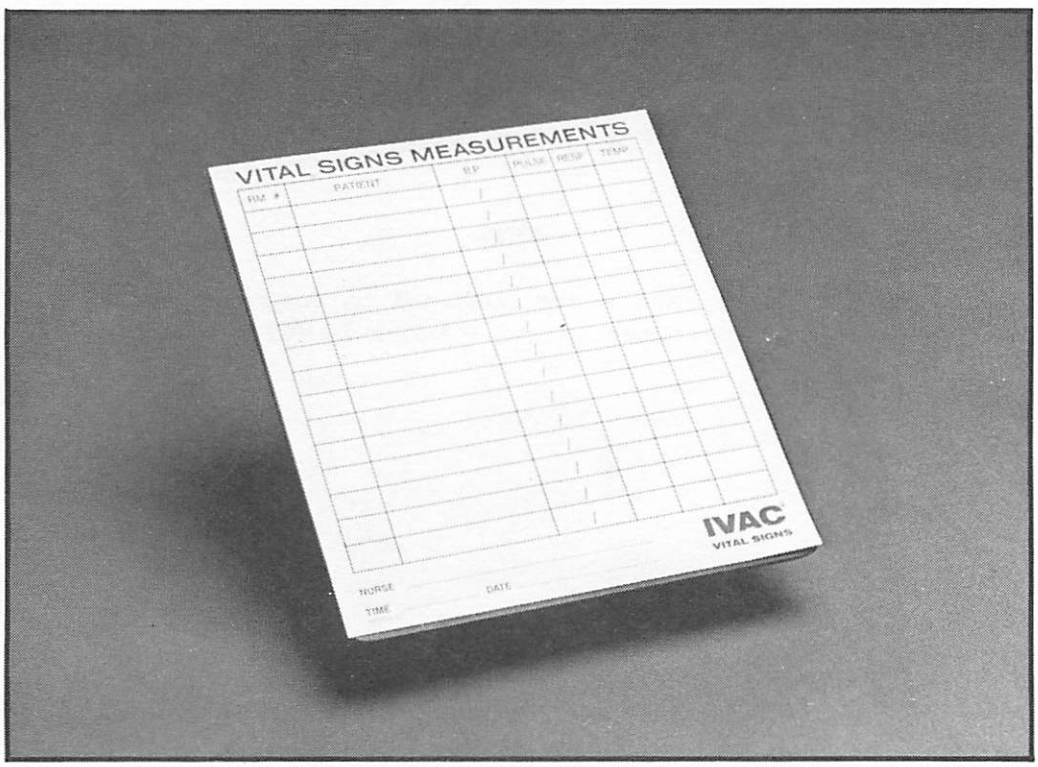


Figure 1-12. Writing Table with Note Pads

CHAPTER 2
OPERATION AND FUNCTIONAL CHECKOUT

2-1 INTRODUCTION

The IVAC VITAL•CHECK™ Vital Signs Measurement System - Model 4000 is a microprocessor-based electronic instrument specifically designed to measure and display a patient's systolic and diastolic blood pressure (BP), mean arterial pressure (MAP), pulse rate, and temperature. This chapter describes the operation of the VITAL•CHECK monitor, as well as brief functional tests designed to verify proper operation.

2-2 OPERATION

2-2-1 BP/Pulse Operation

There are three modes of operation employed by the VITAL•CHECK monitor involving blood pressure (BP) and pulse. The following sections (2-2-2-1 through 2-2-2-3) describe the manual mode, the systolic mode, and the automatic mode.

2-2-2-1 Manual Mode. In manual mode (the MODE selector set to MAN), the VITAL•CHECK monitor initiates a measurement cycle each time the START/RESET switch is pressed and while the instrument is not in standby.

a. Plug the VITAL•CHECK monitor into an appropriate AC outlet.

b. Connect the BP cuff to the cuff umbilical cord by fully inserting the end of the umbilical connector (with the microphone wire breakout) into the short length of tubing attached to the cuff. The male connector is fully inserted into the tube when the end of the tube bottoms against the connector body at the base of the strain relief.

CAUTION

To disconnect the cuff from the cuff cord, be sure to hold the connectors--not the wiring--firmly when pulling the connectors apart.

c. To install the microphone, peel the black nylon cover away from the cuff body. This cover is sewn on three sides and is held against the cuff body with Velcro*. Fully insert the microphone into the small pocket on the inside of the cover. The Velcro on the microphone bag should be attached to the Velcro provided at the pocket. This secures the microphone to the cuff and ensures correct orientation of the microphone in the pocket (see figure 2-2).

*Velcro is a registered trademark of VELCRO USA, Inc.

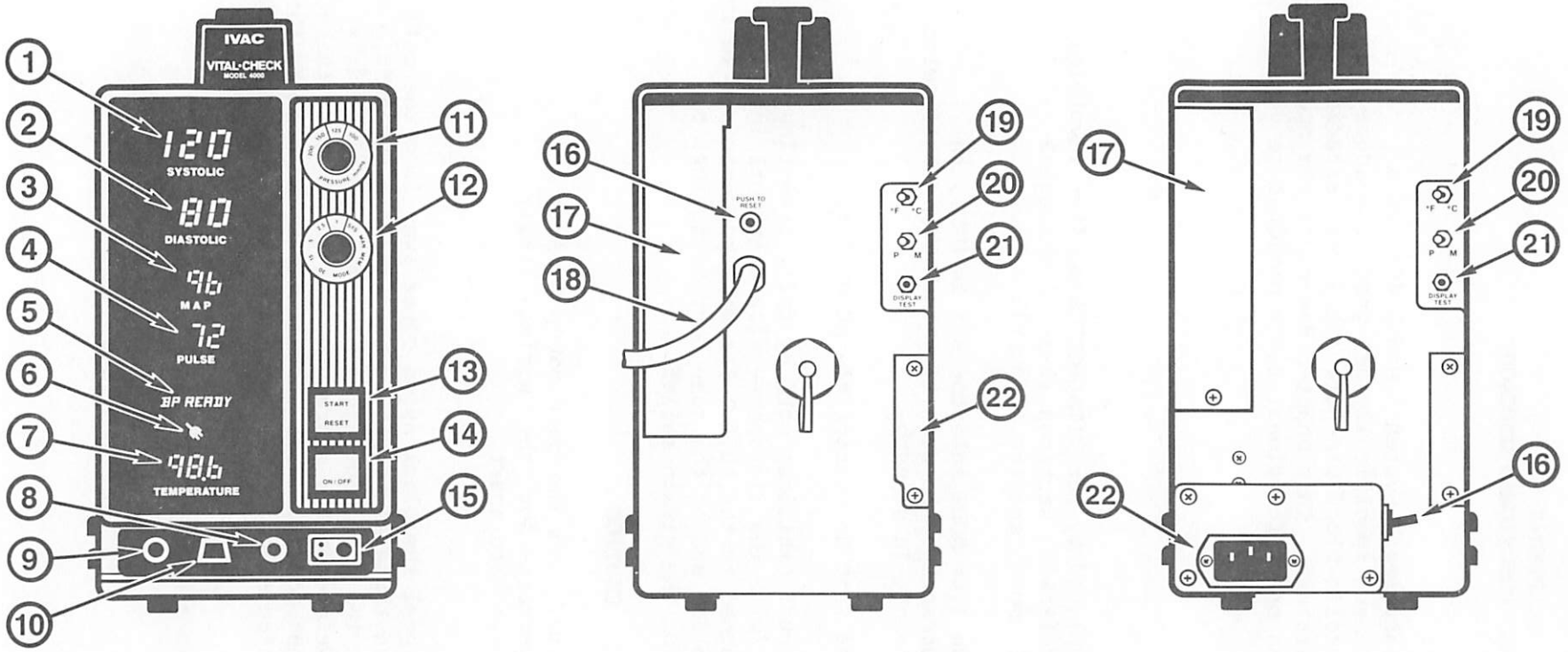


Figure 2-1
Features, Controls, and Indicators

1. SYSTOLIC blood pressure display
2. DIASTOLIC blood pressure display
3. Mean arterial pressure (MAP) display
4. PULSE display
5. Information display
6. Charge indicator
7. TEMPERATURE display
8. Stethoscope connector
9. Probe storage well
10. Probe connector socket
11. PRESSURE selector
12. MODE selector
13. START/RESET switch
14. ON/OFF switch
15. Cuff/microphone connector socket
16. Circuit breaker
17. Battery access panel
18. Power cord
19. ^{O}F-^{O}C select switch
20. P-M (predictive, monitor) switch
21. DISPLAY TEST switch
22. Power cord receptacle

Table 2-1. Features, Controls, and Indicators

Control/Indicator	Function
SYSTOLIC display	Displays the systolic BP measurement.
DIASTOLIC display	Displays the diastolic BP measurement.
MAP display	Displays the mean arterial pressure.
PULSE display	Displays the pulse measurement.
Information display	Displays informational messages to aid in operating the instrument.
Charge indicator	Illuminates when the instrument is plugged into AC and the battery is charging.
TEMPERATURE display	Displays temperature measurement; display will be in Fahrenheit or Celsius depending upon the position of the ^{O}F-^{O}C switch.
Stethoscope connector	An audio fitting (luer); allows the monitoring of the Korotkoff sounds by use of a stethoscope equipped with a standard luer connector.
PRESSURE selector	Used to select the desired initial cuff inflation pressure setting; 100, 125, 150, or 200 mmHg.
MODE selector	Used to select the desired BP mode: manual, systolic, or automatic.
START/RESET switch	Used to initiate a BP measurement or to abort a measurement cycle which has already been initiated; may also be used to deflate the cuff in the event of patient distress.
ON/OFF switch	Applies power to or removes power from the VITAL•CHECK monitor.
Circuit breaker	Protects the internal circuitry from overload.
^{O}F-^{O}C select switch	Used to select which temperature scale will be displayed: Fahrenheit (^{O}F) or Celsius (^{O}C).
P-M mode select switch	Used to select the desired temperature measurement mode: predictive (P) or monitor (M).
DISPLAY TEST switch	Allows entrance to the thermometer calibration mode, and is used to initiate a display test. In conjunction with the START/RESET switch and the PRESSURE selector, the DISPLAY TEST switch is used to enter the offline display test mode and advance to each of the tests within this mode.

d. The excess microphone cord can be loosely placed inside the pocket formed between the cover and the cuff body (see figure 2-2). Reseal the Velcro to close the cover over the excess cord.

e. Plug the BP cuff umbilical cord into the cuff/microphone connector socket on the front of the VITAL•CHECK monitor.

f. Place the cuff microphone directly over the brachial artery. Hold the microphone in place while wrapping the cuff.

NOTE

Wrap the cuff at a slight angle if the patient's arm is excessively tapered (see figure 2-3). While wrapping the cuff on the arm, note the index and range marks. If the index mark on the cuff does not fall between the range marks, then the wrong size cuff is being used. To ensure accuracy, select a larger or smaller cuff, as required, and follow steps a through f above.

g. Press the ON/OFF switch to turn on the VITAL•CHECK monitor. Instruct the patient to relax, remain still, and not to talk during the measurement cycle.

NOTE

The monitor will momentarily display all 8's as a display check and then emit two audible beeps.

h. Set the PRESSURE selector for the desired cuff inflation pressure.

i. Set the MODE selector to MAN. The MANUAL message will be displayed, indicating operation in the manual mode.

j. Initiate a measurement cycle by pressing the START/RESET switch. The VITAL•CHECK monitor will automatically begin a measurement cycle by inflating the cuff to the preselected pressure. The information display will indicate cuff pressure until the BP is determined. When the BP measurement has been completed, the systolic, diastolic, pulse, and MAP measurements will be displayed. In addition, the BP READY message will display alternately with the mode, and the instrument will sound an audible tone. While each subsequent BP is being determined, the results from the previous measurement will flash on the display.

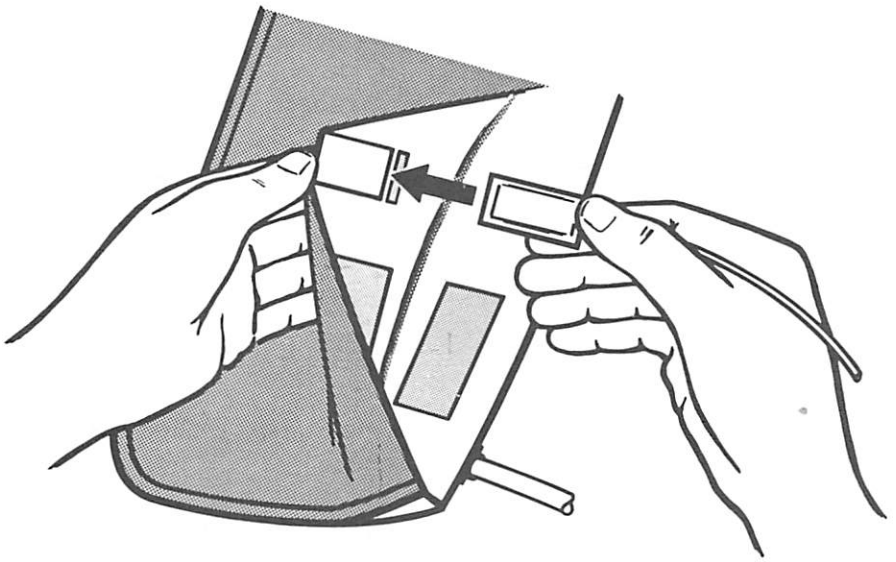


Figure 2-2. Inserting Microphone Into Cuff

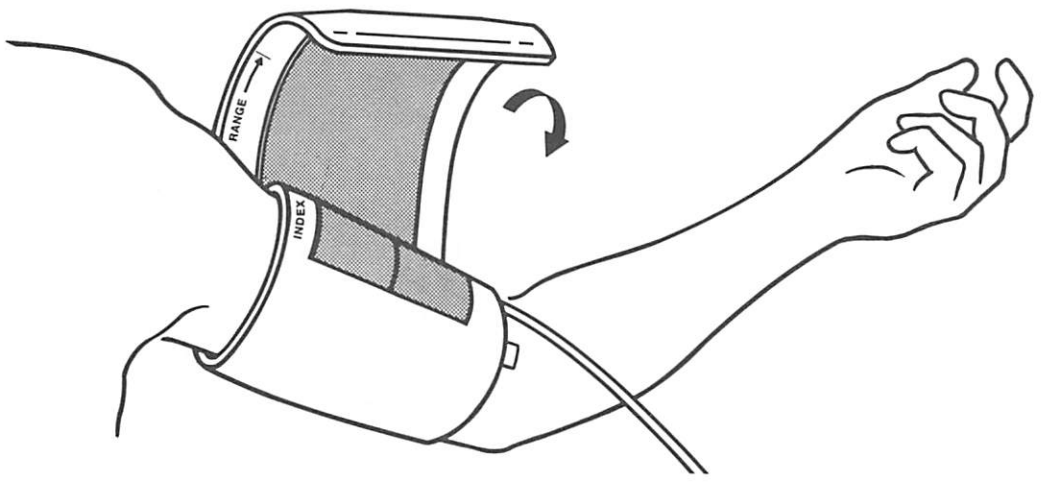


Figure 2-3. Cuff Wrapping Procedure

NOTE

If the microphone is not properly positioned or the Korotkoff sounds are too weak, the BP READY message will be replaced by BP*READY, indicating that the BP was determined by the oscillometric rather than the auscultatory method.

k. Turn off the VITAL•CHECK monitor by pressing the ON/OFF switch.

2-2-2-2 Systolic Mode. The systolic mode (the MODE selector set to SYS) initiates an automatic cycle of continuous systolic measurements for approximately five minutes.

a. Perform steps a through g of the preceding paragraph (2-2-2-1).

b. Set the MODE selector to SYS.

c. Press the ON/OFF switch. After the two beeps, the SYSTOLIC message will be displayed, indicating systolic mode.

d. Press the START/RESET switch. During deflation, the cuff pressure will appear on the information display. The systolic measurement will appear on the systolic display, then the cuff will quickly deflate to zero. BP READY will alternate with SYSTOLIC in the information display. After approximately five seconds, the display will begin flashing and the cuff will begin to inflate again to just above the last systolic pressure reading. This sequence is repeated for approximately five minutes, then the information display will read SYSTOLIC COMPLETE, indicating the last systolic measurement.

NOTE

To abort at any time during the procedure, press the START/RESET switch once. To restart the procedure, press the START/RESET switch after the cycle has ended.

NOTE

The systolic mode will only operate via the auscultatory method. If the VITAL•CHECK monitor is unable to detect Korotkoff sounds during a systolic measurement cycle, the monitor will take one oscillometric BP measurement, including systolic and diastolic BP, MAP, and pulse, and then will discontinue further systolic measurements. If this occurs, reposition the cuff over the brachial artery and press the START/RESET switch to initiate another set of systolic measurements.

e. Turn off the VITAL•CHECK monitor by pressing the ON/OFF switch.

2-2-2-3 Automatic Mode (Repetitive Measurements at Selected Intervals).

The automatic mode (MODE selector set at the desired time interval in minutes) allows automatic repetitive BP measurements. While in the automatic mode, the VITAL•CHECK Monitor will initiate measurement cycles at the interval (in minutes) selected on the MODE selector.

a. Perform steps a through g of paragraph 2-2-2-1.

b. Set the MODE selector to the desired time (minutes) interval (1, 2.5, 5, 15, or 30).

c. Press the ON/OFF switch. The first measurement will start at the selected time interval. The information display will show the time remaining until a measurement will automatically be initiated. The selected time interval will alternate with the BP READY message five times when the measurement is complete.

NOTE

If an extra measurement is desired during automatic operation, press the START/RESET switch. This will initiate an extra measurement without disturbing the previously selected measurement cycle.

NOTE

If at any time you wish to discontinue a BP measurement and deflate the cuff, press the START/RESET switch and cuff pressure will be deflated immediately (all modes).

d. Turn off the VITAL•CHECK monitor by pressing the ON/OFF switch.

2-2-2-4 Irregularity Indicator. Three decimal points flashing in the pulse display at the completion of a BP measurement indicate a possible irregularity in the pulse. Palpate the pulse to evaluate the irregularity.

2-2-2-5 Blood Pressure Function Information Diaplay Messages. Operator prompts/messages may appear when operating the VITAL•CHECK monitor BP function. Table 2-2 lists the messages and their corresponding explanations.

2-2-2-6 Memory Mode. The memory mode gives the user the capability to recall (redisplay) the results of the previous 20 BP measurements. The last 20 (or up to 20) BP measurements--prior to the one being displayed--are stored, and can be recalled in a last-in, first-out sequence (the last measurement stored will be the

first one recalled). To enter the memory mode, set the MODE selector to MEM and press the START/RESET switch. To advance to each succeeding measurement, press the START/RESET switch once.

NOTE

The contents of the memory will be cleared by turning the power off.

During memory mode operation, the information display tells:

a. In which operating mode each measurement was taken (MAN, SYS, 1, 2.5, 5, 15, or 30).

b. Whether the reading was obtained by oscillometry (indicated by an asterisk) or auscultatation (no asterisk).

c. Whether the SIGNAL QUALITY message was displayed (indicated by a Q).

d. The number of the reading (1 through 19).

NOTE

The word END will appear instead of a number with the last stored measurement whether 20 measurements or less were stored.

If the VITAL•CHECK monitor was unable to complete a measurement, an abbreviated version of the alarm that occurred will be stored in place of the mode. The abbreviations and the corresponding alarms are:

ART -- ARTIFACT
LS -- LOW SIGNAL
PM -- PATIENT MOVEMENT
AIR -- CUFF TOO LOOSE OR AIR LEAK
IP -- INCREASE PRESSURE
INF -- INFLATION TIME TOO LONG

Two measurements must have been taken for the memory mode to operate. If either one or no measurement was taken, the VITAL•CHECK monitor will display NO DATA when memory mode is initiated.

Alarm (error) messages will be stored during automatic mode operation unless an extra (manually initiated) measurement is taken before the next automatic measurement is initiated. If an extra measurement is taken after an error message and before the next automatically initiated measurement, the manually initiated

measurement will replace the previous error message. The information display will read 1, 2.5, 5, 15 or 30 for a manually initiated measurement that replaces an error message in a series of automatic measurements; otherwise it will read MAN. Alarm messages will not be stored in the systolic or manual modes of operation.

To exit the memory mode and return to a normal operating mode, set the mode selector to the desired mode.

Table 2-2. BP Display Messages

Message	Meaning
MANUAL	The manual mode is selected.
SYSTOLIC	The systolic mode is selected.
MEMORY	The memory mode is selected.
1 MIN./2.5 MIN./5 MIN./ 15 MIN./30 MIN.	The interval (in minutes) selected for automatic mode measurement.
BP READY	A blood pressure measurement was completed using the auscultatory method; display alternates with the appropriate operating mode message.
BP*READY	A blood pressure measurement was completed using the oscillometric method; display alternates with the appropriate operating mode message.
cuff pressure/*	The cuff pressure value during the deflation cycle is displayed along with a blinking *. The * indicates a detected Korotkoff sound.
100/125/150/200	The cuff inflation pressure setting during the inflation cycle.
ARTIFACT	Excessive artifacts have been detected; the display is accompanied by five audible tones. The unit will automatically reinflate and retry the BP measurement.
LOW BATTERY	Approximately 15 minutes of battery life remain before the monitor shuts off.
CHARGE BATTERY	There is not enough charge in the battery to take a BP measurement. The monitor will sound five audible tones and then shut off.

Table 2-2. BP Display Messages (Continued)

Message	Meaning
LOW SIGNAL	The signal sensed by the VITAL•CHECK monitor is too low for a BP measurement; display is accompanied by five audible tones. In both the manual and automatic modes, the unit will automatically reinflate and retry the BP measurement at one-half the normal deflation rate.
(xxM xxS)	Time remaining in minutes and seconds until a measurement will automatically be initiated.
SYSTOLIC COMPLETE	A systolic cycle (approximately 5 minutes) has been completed; the display is accompanied by a single low frequency tone.
PATIENT MOVEMENT	Excessive patient movement during the measurement process has disturbed the instrument's ability to determine the BP; display is accompanied by five audible tones.
CUFF TOO LOOSE or AIR LEAK	Cuff pressure cannot be controlled accurately because of air leaks; display is accompanied by five audible tones.
LOW CUFF PRESSURE	Inflation pressure was insufficient to occlude artery; monitor will repump (up to a maximum of two times) to a higher pressure and initiate another measurement. NOTE: The pressure will increase by 25 mmHg for the 100, 125, and 150 settings, and by 75 mmHg when set to 200. This message occurs only when too low a deflation pressure is detected at the end of a BP determination. The measurement will be re-tried with an increased goal pressure.
INCREASE PRESSURE	The cuff pressure is not high enough to take an accurate measurement after two automatic inflation pressure increases. The display is accompanied by five audible tones.
SIGNAL QUALITY	The signal detected by the monitor may be distorted by patient movement or other disturbance. The BP displayed is a best estimate under these conditions.
INFLATION TIME TOO LONG	The system determines that the cuff has been inflated too long without sufficient deflation (vein recovery) time; the display is accompanied by five audible tones. NOTE: The VITAL•CHECK monitor will not initiate a blood pressure measurement while this message is scrolling.

Table 2-2. BP Display Messages (Continued)

Message	Meaning
FIX ME x	The VITAL•CHECK monitor detects a malfunction, flashes FIX ME x (x is a character defining the type of malfunction detected), sounds five audible tones, and ceases operation. The monitor can only be restarted by pressing the ON/OFF switch. If after cycling the ON/OFF switch the malfunction persists, refer the problem to qualified service personnel.
STANDBY	When operating on battery, all displays are blanked approximately 19 seconds after they are updated.

2-2-3 Temperature Measurement Operation

The VITAL•CHECK monitor temperature measurement function may be employed in either of two modes, the predictive mode or the monitor mode. These modes are described in the following paragraphs (2-2-3-1 and 2-2-3-2).

2-2-3-1 Thermometer Operation in the Predictive Mode. Use the predictive mode (P) under ordinary clinical conditions since it provides the fastest way of taking a temperature with the VITAL•CHECK monitor.

NOTE

Only the P880L/882L (long cord) and P880/P882 probes are to be used for temperature measurement in the predictive mode.

a. Set the P-M switch, located on the rear panel of the VITAL•CHECK monitor to the P (predictive mode) position.

b. Set the ^{O}F-^{O}C switch, located on the rear panel of the monitor, to the desired setting.

c. Press the ON/OFF switch to turn on the instrument.

d. Plug the P880L or P880 (oral) probe connector plug into the probe connector socket.

e. With your thumb and forefinger, grasp the base of the probe and withdraw the probe from its storage well. This action automatically turns on the thermometer function. Support the bottom of the box of probe covers, then insert the thermometer probe completely and firmly into a probe cover to ensure a secure fit (see figure 2-4). Be careful not to press the button at the base of the probe as this might loosen or eject the probe cover.

NOTE

Performance of the IVAC VITAL•CHECK thermometer function in predictive mode is affected by thermal characteristics of the probe covers used. Therefore, inaccurate readings may occur unless IVAC probes and probe covers, or probe covers having thermal characteristics equivalent to those of IVAC probe covers, are used.

f. Have patient open mouth slightly. Holding the probe loosely, gently insert the probe tip and carefully slide it back under the front of the tongue, along the gumline, to the sublingual pocket where the richest blood supply is located (see figure 2-5). Using this technique will minimize the time required for taking a temperature, and provides the proper temperature for predictive readings.

g. Hold the probe during the entire temperature measurement process and keep the probe tip in contact with tissue at all times. Do not allow the patient to reposition the probe.

h. A tissue contact indicator will appear in the rightmost position of the TEMPERATURE display while the patient's temperature is being determined. After approximately 25 seconds, an audible tone will sound and the patient's temperature (in degrees and tenths of a degree) will blink on the TEMPERATURE display for a duration of approximately 20 seconds. Then the display will clear as the thermometer automatically shuts off.

NOTE

If the room temperature is higher than 60 to 84°F and probe tip temperature is higher than 94.0°F, the thermometer may not be able to quickly "predict" the patient's temperature. Instead, the temperature indicated on the display will slowly rise until, after three to five minutes, the patient's temperature has been reached. (No audible tone will sound, and a flashing F or C will appear in place of the tissue contact indicator.)

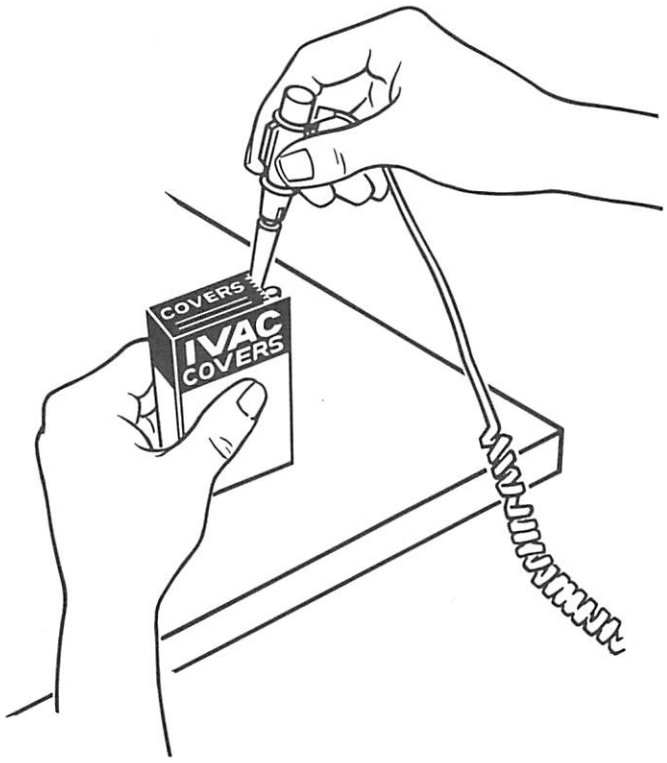


Figure 2-4. Inserting Probe Into Probe Covers

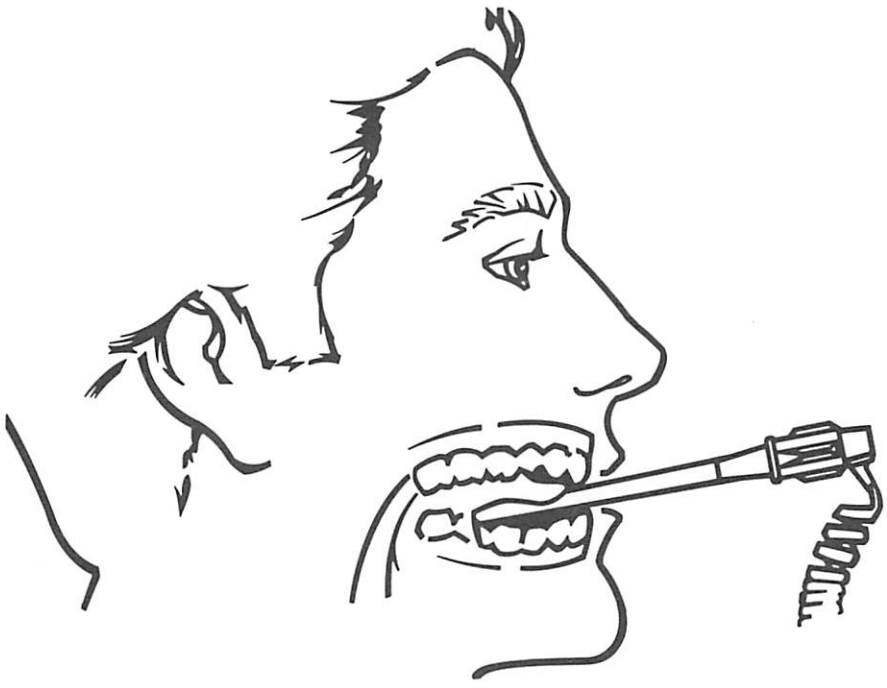


Figure 2-5. Positioning the Oral Probe

i. Note the displayed temperature and remove the probe from the patient's mouth. Hold the probe as you would a syringe and press the ejection button at the base of the probe to eject the used probe cover (see figure 2-6).

j. Return the probe to its storage well (see figure 2-7). This will automatically turn off and reset the thermometer function for the next temperature measurement.

k. For rectal temperature measurement, use the red P882L or P882 (rectal) probe. Connect the probe to the VITAL•CHECK monitor and a probe cover to the probe as described in steps d and e above.

l. Touch the tissue about one-half of an inch above the sphincter muscle and carefully insert the probe, using current hospital technique for penetration. The probe should not be inserted more than 1 to 1 1/2 inches. (The use of a lubricant is optional.) In approximately 25 seconds, the audible tone will sound, signifying that the patient's temperature has been determined. Note the temperature, withdraw the probe, and eject the used probe cover as described in step i above. Reset the thermometer function as described in step j.

WARNING

Do not push the eject button while the probe is in the patient.

2-2-3-2 Thermometer Operation in Monitor Mode. In monitor mode (M), the thermometer continuously measures the patient's temperature as it rises or falls.

NOTE

The esophageal/rectal and skin surface disposable probes are to be used for temperature measurement in monitor mode.

a. Press the ON/OFF switch to turn on the VITAL•CHECK monitor.

b. Set the P-M switch, located on the rear panel of the monitor, to M (monitor mode).

c. Set the ^{O}F-^{O}C switch, located on the rear panel of the monitor, to the desired setting.

d. Determine the type of probe you wish to use (esophageal/rectal or skin surface). Position the selected probe according to standard hospital procedure.

e. Connect either the Probe Adapter - Model P868 or the Probe Extension Cable - Model P869 to the VITAL•CHECK monitor probe connector socket.

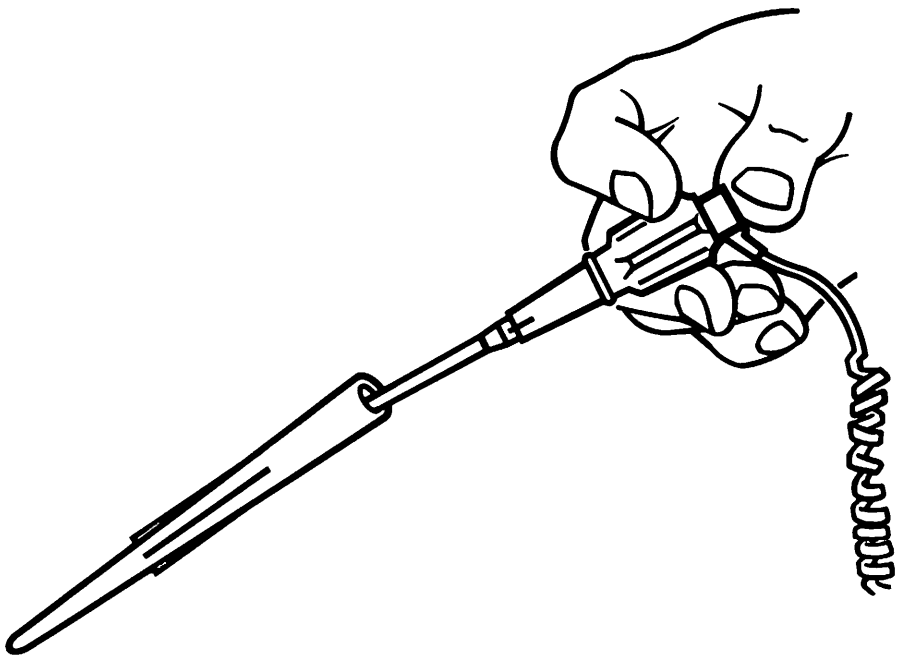


Figure 2-6. Ejecting Probe Cover

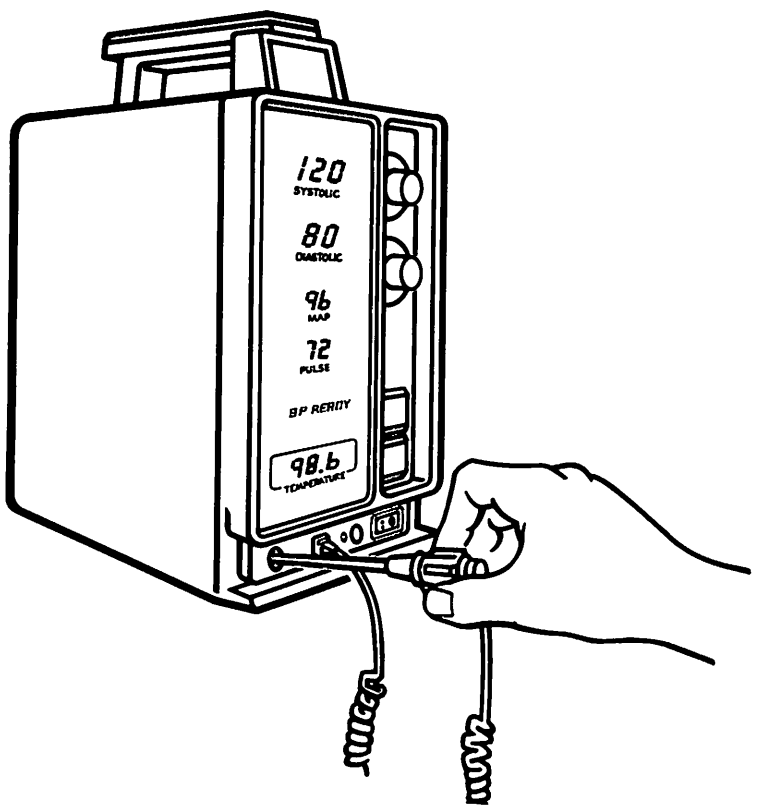


Figure 2-7. Returning Probe to Storage Well

f. Insert the probe connector into the probe adapter or probe extension cable.

g. Within three to five minutes, the display should stop changing, indicating the patient's current temperature; as the patient's temperature rises or falls, the display will change accordingly. The reading on the display continuously flashes on and off to indicate operation in the monitor mode.

h. For intermittent monitoring, the probe may be left in position. Disconnect the probe adapter or extension cable connector from the disposable probe connector. To monitor the patient's temperature, reconnect the disposable probe connector to the probe adapter or extension cable connector.

i. Remove the probe from the patient and discard the probe into a waste container.

NOTE

The disposable skin surface probe may be used again on the same patient; to reaffix the probe, use an IVAC TEMP•PAD™ replacement pad. The probe may not be reused on another patient; discard probe after single-patient use.

j. Press the ON/OFF switch to turn off the VITAL•CHECK monitor.

2-2-3-3 Axillary Temperature Measurement. The disposable skin surface probe may be used for axillary temperature measurement. Secure the probe tip as close as possible to the axillary artery, then follow the instructions for temperature measurement in the monitor mode.

2-2-3-4 Temperature Error Messages. The error messages listed in table 2-3 may appear on the TEMPERATURE display during operation of the temperature function. If an error message occurs while in the predictive mode, eject the probe cover, reset the thermometer by returning the probe to its storage well, and retake the patient's temperature.

2-2-4 Battery Operation

The VITAL•CHECK monitor is equipped with a self-contained battery for portable operation. To operate the monitor on battery power, unplug the power cord from the AC outlet and continue as you would for AC operation.

Table 2-3. Temperature Error Messages

Message	Meaning
ERR t	The thermometer unit fails to obtain a temperature within 1 minute after insertion (in predictive mode only).
ERR L	The thermometer senses a loss of proper tissue contact within the mouth for more than 30 seconds (in predictive mode only).
ERR H	The probe temperature exceeds 42.1°C (107.9°F).
ERR 0	There is an analog/digital (A/D) electronics error. If the error persists after resetting the thermometer, return the VITAL•CHECK monitor for service.

NOTE

To retain full battery charge, keep the monitor plugged into an appropriate AC outlet whenever possible.

2-2-4-1 Low Battery. When the battery charge begins to run low while operating on battery power, the monitor will display LOW BATTERY on the information display. This message indicates enough charge for approximately 15 minutes of operation. As the charge in the battery is further depleted, CHARGE BATTERY will flash, accompanied by five audible tones; the monitor will then turn itself off.

NOTE

When the monitor shuts off, the memory will be erased. Continued attempts to restart the monitor by turning it on again may result in draining the battery completely. If this occurs, the monitor will not respond to any attempt to turn it on until it is plugged into an AC outlet.

Charge the battery for three to four hours prior to operating on battery power. Recharging the battery from a completely discharged state requires 12 to 16 hours.

NOTE

Battery information messages are overridden by error messages and operation in memory mode.

2-2-4-2 Standby Mode. A standby mode exists to conserve battery power. The monitor automatically enters the standby mode approximately 19 seconds after the last display update; STANDBY will flash on the display. To redisplay a measurement result, press START/RESET once. To initiate a BP measurement while the monitor is in standby mode, press START/RESET twice.

2-3 CLEANING AND STERILIZING

2-3-1 Cleaning and Sterilizing the VITAL•CHECK Monitor

a. Do not steam autoclave or immerse the VITAL•CHECK monitor as damage to the instrument may occur.

b. It is a good practice to clean the exterior surfaces of the monitor periodically by wiping it with a soft cloth dampened with isopropyl alcohol (greater than 70% by weight), prepackaged alcohol wipes, warm water, or a general nonstaining chemical disinfectant. Refer to the Housekeeping, Central Service, or Infection Control departments in your facility for further information.

d. Do not use solvents or cleaning agents as they could damage the plastic surfaces of the VITAL•CHECK monitor.

e. The VITAL•CHECK Monitor may be ETO gas sterilized, provided that the maximum temperature does not exceed 58°C (136.4°F) and that the relative humidity does not exceed 60% noncondensing. Aerate the VITAL•CHECK monitor for 24 hours in free air or 8 hours in an aerator after sterilizing. Verify that the instrument operates properly following aeration. This procedure is intended as a guideline only. It is the user's responsibility to verify that the sterilization is successful by using proper controls and biological indicators designed for that purpose.

2-3-2 Cleaning the Blood Pressure Cuff

To clean the blood pressure cuff, unplug the monitor from AC power. Disconnect the umbilical cable from the cuff. Then hold your finger over the air fitting on the cuff while laundering it in warm water with a mild detergent. Clean the umbilical cable as you would the exterior of the monitor.

2-4 FUNCTIONAL CHECKOUT

The tests described in this section are designed to verify correct operation of the VITAL•CHECK Monitor before it is used with a patient. These tests may also be used to perform periodical functional checks on the instrument. Failure of the monitor to pass any of the tests may necessitate return of the instrument to IVAC or an IVAC dealer. Retain all shipping cartons, packing inserts and slips. Table 2-4 lists the test equipment/tools required to perform these checkout tests.

Table 2-4. Test Equipment Required for Functional Checkout

Item	Manufacturer Model No., Specifications	Application
Thermometer tester	IVAC Model 828A	Tests the operation of the thermometer function.
Substitute arm	Heavy cardboard or glass (or other material) of suitable size (4 ±1 inches in diameter) for adult size cuff	Provides a substitute arm on which to place the cuff during functional checkout and testing.

2-4-1 BP/Pulse Mode Checkout

The following paragraphs (2-4-1-1 and 2-4-1-2) describe functional checks to verify the operation of the BP/pulse function of the VITAL•CHECK monitor, as well as the correct functioning of the switches.

2-4-1-1 Basic Operation

a. Place the cuff on a substitute arm.

b. Connect the cuff to the VITAL•CHECK monitor.

c. Set the MODE selector to MAN.

d. Set the PRESSURE selector to 150.

e. Press the ON/OFF switch to turn on the VITAL•CHECK monitor. The TESTING message should appear for 2 ±1 seconds, then the MANUAL message should appear.

f. Press the START/RESET switch. The motor should start and 150 should flash on the information display.

g. The motor should then stop and in 5 ±1 seconds, deflation should begin. The actual cuff pressure is displayed (it should start at 150 -0, +30 mmHg).

h. The cuff should then deflate to 15 ±5 mmHg at 5 ±0.5 mmHg/second.

i. The cuff should then deflate rapidly to zero, and the LOW SIGNAL message should be displayed while the instrument emits five audible tones. (The instrument will re-inflate automatically to 125 0, +30 mmHg and deflate to 15 ±5 mmHg at 2.5 ±0.5 mmHg/second.)

j. Plug a stethoscope into the VITAL•CHECK monitor front panel.

k. Remove the cuff from the substitute arm and place it on a person's arm, following the instructions listed in paragraph 2-2-2-1, step f.

l. Press the START/RESET switch. The initial goal pressure (150) should flash.

m. After the pump-up stops, the monitor should pause while it checks for air leaks. The cuff pressure should then be displayed on the information display and the cuff should begin to deflate.

n. Asterisks (*) (indicating detected Korotkoff sounds) should appear in the information display as the cuff deflates. The Korotkoff sounds should be audible in the stethoscope as the cuff deflates.

NOTE

If two Korotkoff sounds are detected during the first 3.5 seconds of deflation, the monitor will repump by 25 mmHg more than the previous inflation pressure and restart deflation.

o. Controlled deflation should continue until the diastolic pressure is detected, at which point the cuff pressure is immediately deflated to zero and the measurement is completed. The instrument should then emit one audible tone and display the systolic BP, diastolic BP, mean arterial pressure (MAP) and pulse. The information display should alternate between BP READY and MANUAL five times and then display MANUAL.

NOTE

If the patient's Korotkoff sounds are too weak (due to cuff misalignment or greater than normal adipose tissue) the monitor may not be able to compute the BP utilizing the auscultatory method. Thus it will fall back on the oscillometric method. If this is the case, the BP READY message will be replaced by BP*READY.

2-4-1-2 Switch Function Checkout

a. MODE selector switch

1. While the instrument is still displaying the vital signs, turn the MODE selector from manual to systolic. SYSTOLIC should be displayed.

2. Turn the MODE selector to 1; after four seconds, the display should count down from 1 minute.

3. Turn the MODE selector back to SYS for four seconds, and then set it to 2.5. The display should show 2.5 MIN. for a short period, and then count down from 2.5 minutes.

4. Turn the MODE selector back to SYS for four seconds, and then set it to 5. The display should show 5.0 MIN. for a short period, and then count down from 5 minutes.

5. Turn the MODE selector back to SYS for four seconds, and then set it to 15. The display should show 15 MIN. for a short period, and then count down from 15 minutes.

6. Turn the MODE selector back to SYS for four seconds, and then set it at 30. The display should show 30 MIN. for a short period, and then count down from 30 minutes.

b. Pressure selector switch

1. With the MODE Selector set to MAN, turn the PRESSURE selector to 100. Start a blood pressure check by pressing the START/RESET switch. A 100 should appear on the information display.

2. Immediately press the START/RESET switch again. Turn the PRESSURE selector to 125. Press the START/RESET switch. A 125 should appear on the display.

3. Immediately press the START/RESET switch again. Turn the PRESSURE selector to 150. Press the START/RESET switch. A 150 should appear on the display.

4. Immediately press the START/RESET switch again. Turn the PRESSURE selector to 200. Press the START/RESET switch. A 200 should appear on the display. Immediately press the START/RESET switch again.

2-4-2 Thermometer Mode Checkout

The operation of the VITAL•CHECK monitor thermometer function may be checked using either the Model 828A thermometer tester or a circulating water bath.

NOTE

Remove the probe and probe connector from the monitor.

2-4-2-1 If Using the Thermometer Tester:

a. Turn on the VITAL•CHECK monitor by pressing the ON/OFF switch.

b. Set the P-M switch to the M position (monitor mode).

c. Set the ^{o}F-^{o}C switch to the desired setting.

d. Insert the thermometer tester into the VITAL•CHECK monitor probe connector socket. Verify that the display flashes 37.0^{o}C (±0.1^{o}C) or 98.6^{o}F (±0.2^{o}F).

e. With the thermometer tester still connected, set the P-M switch to P (predictive mode). The displayed temperature should remain the same; only the C or F indicating the temperature scale should flash.

f. Change the setting of the ^{o}F-^{o}C switch and verify that the display changes accordingly.

g. Remove the thermometer tester. Plug a P880L/P882L (or P880/P882) probe connector into the VITAL•CHECK monitor probe connector socket, then place the probe in the storage well. Verify that the temperature display goes blank.

h. Turn off the VITAL•CHECK monitor by pressing the ON/OFF switch.

2-4-2-2 If Using a Water Bath:

a. Turn the VITAL•CHECK monitor on by pressing the ON/OFF switch.

b. Adjust the temperature of the bath to between 31.1^{o}C and 42.1^{o}C (88.9^{o}F to 107.9^{o}F); the water bath should be accurate to within ±0.02^{o}C (±0.03^{o}F).

Use the reference thermometer to check the temperature of the water bath, and ensure that the water is in rapid circulation.

c. Set the P-M switch to M (monitor mode).

d. Set the ^{o}F-^{o}C switch to the desired setting.

e. Plug the P880L/P882L (or P880/P882) probe connector into the VITAL•CHECK monitor probe connector socket.

f. Insert the probe into the water bath to a depth of 3 inches (it is not necessary to use a probe cover). Verify that the reading does not differ by more than 0.1^{o}C (0.2^{o}F) from the actual temperature of the water, and that the display flashes on and off.

g. Set the P-M switch to P (predictive mode). The displayed temperature should remain the same; only the C or F indicating the temperature scale should flash. The temperature of the probe must be above 94^{o}F (34.4^{o}C) to perform this step.

h. Change the setting of the F-^{o}C switch and verify that the display changes accordingly.

i. Remove the probe from the water bath, dry it off, and replace the probe in the storage well. Verify that the temperature display goes blank.

j. Turn the VITAL•CHECK monitor off by pressing the ON/OFF switch.

2-4-3 Display Check

There are two methods for checking the operation of the monitor's displays. The first provides a quick check of the displays. The second, the offline display test mode, provides not only a more complete check of the display characters, but also a means for reading the instrument's software revision level. These two methods are described below.

2-4-3-1 Display Test. To check the monitor's displays, press and hold the DISPLAY TEST switch on the rear panel of the instrument. Eights (8's) with righthand decimal points will appear in the SYSTOLIC, DIASTOLIC, MAP, PULSE, and TEMPERATURE displays, and the information display will alternate between asterisks and "boxes" (capital O's). The TEMPERATURE display will have only one decimal point.

2-4-3-2 Offline Display Test Mode. To enter this mode, press and hold the DISPLAY TEST switch on the rear panel, then press the START/RESET switch on the front panel, and release both switches. There are three separate tests within this mode. Entering the offline display test mode as described initiates the first test; pressing the DISPLAY TEST switch advances the sequence of the tests. To exit this mode immediately after entering it, press the DISPLAY TEST switch three times, or press the ON/OFF switch twice. This places the monitor in a normal operating mode. The individual tests within the offline display test mode are:

a. Segment Address Test. Each numeric display (except TEMPERATURE) lights sequentially with a number or character corresponding to its position in the sequence. The specific numbers or characters and the positions in which each is displayed follow.

1. SYSTOLIC display

1's digit	0
10's digit	1
100's digit	2

2. DIASTOLIC display

1's digit	3
10s digit	4
100's digit	5

3. MAP display

1's digit	6
10's digit	7
100's digit	8

4. PULSE display

1's digit	9
10's digit	lower four segments of an 8
100's digit	upper four segments of an 8

5. Information display: segments will light one at a time right to left with the numerical sequence of 0 to 7.

NOTE

The TEMPERATURE display will remain illuminated with all 8's while in any of the tests of the offline display test mode.

NOTE

Press the DISPLAY TEST switch to advance to the second test.

b. Character Test. All numeric displays (except TEMPERATURE) cycle simultaneously through the digits 0 through 9. The information display cycles through its complete available character set, with each display position simultaneously displaying the same character.

NOTE

Press the DISPLAY TEST switch to advance to the next test.

c. Software Revision Level. The information display shows the instrument's software revision level as REV 0.XX, where XX is the number of the revision level from 00 to 99.

2-4-3-3 Battery Charge Checkout. When the instrument is plugged into AC power, the green light above the TEMPERATURE display should illuminate, indicating that the battery is being charged.

CHAPTER 3
FUNCTIONAL DESCRIPTION

3-1 INTRODUCTION

This chapter contains a functional description of the VITAL•CHECK Monitor - Model 4000. It includes a detailed description of the pneumatic system, electronics, and software. The descriptions are supported by block diagrams (figures 3-1 and 3-2) and schematics (figures 3-3 through 3-37).

NOTE

> Logic levels are defined per Positive Truth logic. That is, "1" or "high" (Hi) voltage is interpreted as True (T) and "0" or "low" (Lo) voltage is interpreted as False (F). The VITAL•CHECK monitor contains a mix of logic types (CMOS, HCMOS, and H/NMOS, so the actual voltages for a given logic level will vary according to the type of device being monitored.

The VITALoCHECK monitor consists of the following major assemblies:

a. Chassis
b. Power transformer and circuit breaker
c. Sealed lead-acid battery pack
d. Nine printed wiring (PW) boards
    1. Power regulator (PR)
    2. Logic (LG)
    3. Logic extension (LG EXT)
    4. Pneumatic (PNEU)
    5. Thermometer (THERM)
    6. Display driver (DPL DVR)
    7. Display (DPL)
    8. Rotary switch (SW) (two boards)
e. Pneumatic system
f. Switches
g. Accessories interconnect

3-2 FUNCTIONAL DESCRIPTION

The VITAL•CHECK Monitor - Model 4000 is a combination of two measurement systems, a thermometer and a BP monitor. Each system has its own microprocessor to perform measurement tasks independently of the other system. The two systems share a single power supply and the displays and display drivers are located on common circuit boards.

3-2-1 Thermometer System

The thermometer system consists of the elements shown in figure 3-1. The probe provides an analog temperature signal to the system. The signal is processed by signal conditioning circuitry and is digitized into three four-bit words by the A/D converter. This data is used by the microcontroller (COP 444) to compute the temperature.

The microcontroller contains programs which use the information provided from the A/D converter, as well as the state of the ^{O}F-^{O}C, P-M, and DISPLAY TEST switches to run the display drivers, the speaker, and the watchdog circuit. For example, a different program is used when the predictive mode is selected than when the monitor mode is selected, resulting in the different displays and signals from the speaker.

The thermometer function (temperature, calibrate, or display test) is controlled by signals received from the 80C85 microprocessor located on the logic board. The 80C85 interprets the state of the DISPLAY TEST switch and internal probe on/off switch (which is activated by removing the probe from or replacing it into the storage well on the front of the monitor) to determine which signals to send. With the exception of this mode control, the thermometer operates independently of the blood pressure system.

3-2-2 Mechanical Description

The following paragraphs describe the mechanics involved in the pneumatic system, the cuff assembly and the microphone/umbilical cable assembly.

3-2-2-1 Pneumatic System

NOTE

The entire pneumatic system is contained in the pneumatic module. A brief description of the function of each major component follows.

a. Pump: A diaphragm type pump which furnishes air pressure to inflate occluding cuff.

b. Overpressure switch: The switch is adjusted to trip when system (cuff) pressure reaches 350 to 430 mmHg due to a malfunction of the control circuits. When tripped, the leaker and dump valves are forced open, and the pump motor is disabled.

c. Accumulator: The accumulator, or reservoir, determines the minimum air capacity of the pneumatic system. Too small a volume of air can cause the cuff to deflate in an erratic manner. There is also a fitting in the accumulator that is accessible on the rear of the instrument case, which is used with an external pressure gauge to check instrument accuracy.

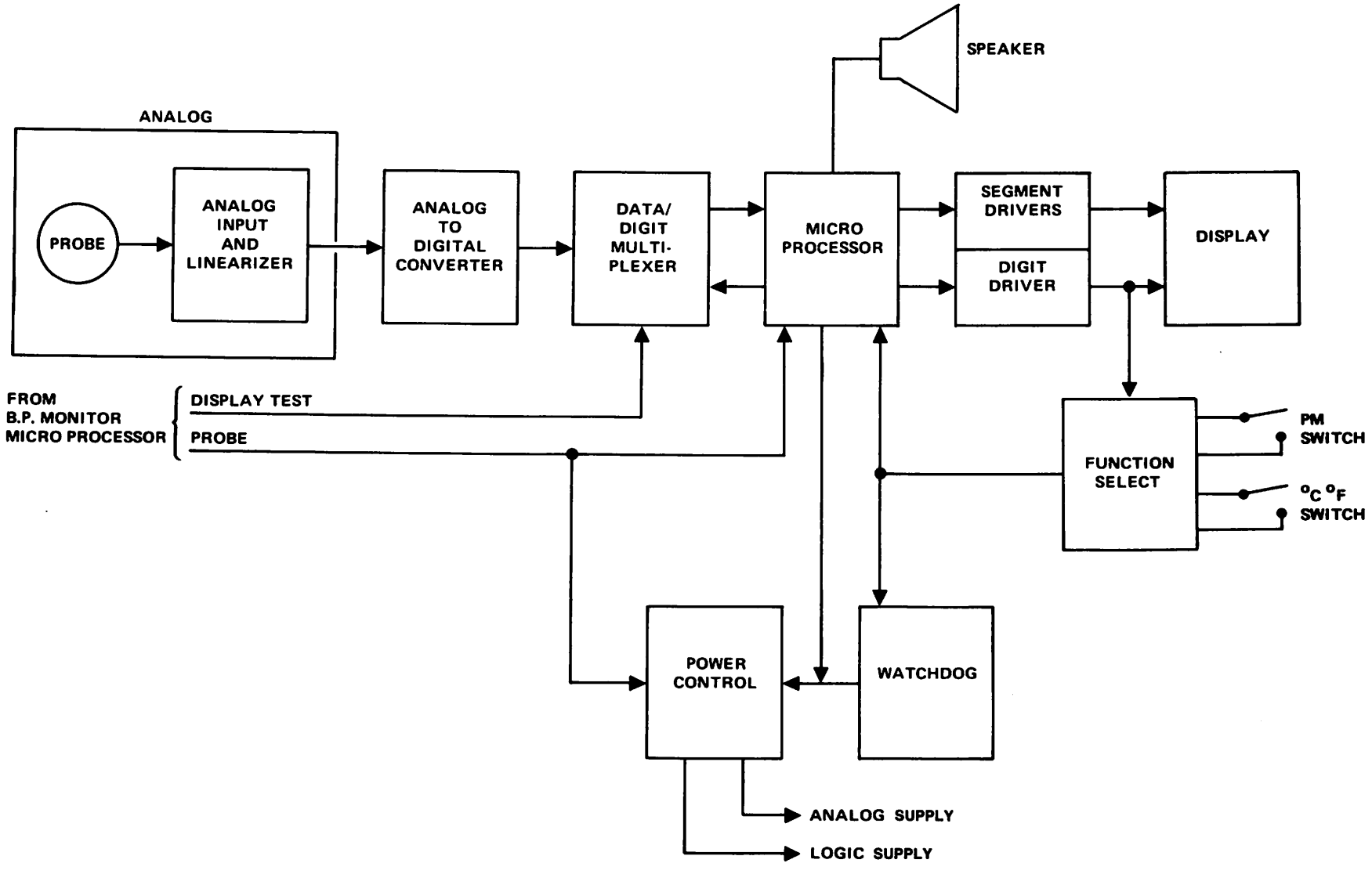


Figure 3-1. Thermometer System Functional Diagram

d. Leaker valve: This is an electrically controlled air valve. The valve, under microprocessor control, allows the cuff to deflate at a linear rate of 5 mmHg or 2.5 mmHg per second.

e. Pressure transducer: The transducer converts air pressure to an electrical signal that is proportional to cuff pressure. This signal is used in two ways. First, it is used to enable the microprocessor to linearly deflate the cuff. Second, this signal, modulated by the varying blood pressure in the artery, is used in making a blood pressure determination.

f. Dump valve: This valve is normally an open valve and has several functions. Between determinations, this open valve allows the cuff pressure to bleed to zero. When the monitor pumps up, this valve closes and remains closed during controlled cuff deflation, then opens at the end of the data taking routine. The exception to this mode of operation is that the valve is forced open when the overpressure switch is operated.

g. Stethoscope driver: Microphone signals (Korotkoff sounds) are acoustically coupled to a stethoscope port on the front panel. This enables the user to monitor the blood pressure determination with the use of a conventional stethoscope.

3-2-2-2 Cuff Assembly. Input signals for the VITAL•CHECK monitor are picked up by means of a blood pressure cuff assembly. The cuff assembly consists of a cuff and an internal air bladder. Also included is a removable microphone/umbilical cable assembly, which connects the cuff to the monitor.

a. The cuff is a nylon, wrap-around blood pressure cuff which is held securely around the patient's limb by means of "hook and loop" type fasteners.

b. The air bladder is a latex bag that fits inside the cuff. The bladder is positioned to accurately hold the microphone in place over the artery, constricting the patient's limb when inflated.

c. The removable microphone fits inside a black, ripstop, nylon flap on the cuff. The microphone contains a piezoelectric element that responds to arterial sounds. The microphone case design supports and protects the element from damage while enhancing its sensitivity to arterial-generated sounds.

3-2-2-3 Microphone/Umbilical Cable Assembly. When inserted into the cuff flap and fastened, the microphone and attached umbilical cable provide a connection from the cuff to the VITAL•CHECK monitor. The microphone is sealed in a white, acoustically sensitive bag. An outer "hook and loop" type fastener fastens the microphone to the inside of the cuff flap and is attached to the sealed microphone

cover bag. This design permits easy installation and removal of the microphone from the cuff. The attached umbilical cable consists of a microphone cable and an air tube for cuff inflation. The microphone/umbilical cable assembly is available in two lengths: 6-foot, Model 1131; and 12-foot, Model 1132.

3-2-3 Electrical Description

Figure 3-2 illustrates the functioning of the VITAL•CHECK monitor's electrical system. The BP system is controlled by a microprocessor (80C85) with a program stored in two EPROMS (total program space is 16K x 8). Also present are one random access memory (RAM) with storage space of 2K x 8, one eight-bit analog/digital (A/D) converter, one twelve-bit D/A converter, and several I/O ports. These components control various functions and display information to the user. A failsafe circuit, operates independently after being initially tested by the 80C85, which provides a power-up self-test and background test. The failsafe circuit automatically disables the instrument in case of a malfunction. The following paragraphs describe the individual circuits of the VITAL•CHECK monitor system.

3-2-3-1 Power Supply (figures 3-3 and 3-4). Incoming AC power is stepped down by a transformer; it is then rectified, filtered and regulated to provide a +12 VDC voltage source. This voltage source charges the battery pack and is further regulated to provide +5 VDC and -10 VDC. An on/off flip-flop is used to turn the +12 VDC, +5 VDC, and -10 VDC on and off to the rest of the instrument. A battery voltage sensing circuit is used to signal the 80C85 when a low/discharged battery voltage condition exists.

3-2-3-2 Failsafe circuit: The failsafe circuit is reset at power-up. The 80C85 initiates a self-test routine to verify proper operation of the following:

a. Simulated pressure input to verify pressure signal channel comparators

b. Watchdog and 4.5 minute timer circuit to verify the timer driving frequency and timer reset circuits.

c. Motor/pump control: To verify motor/pump is on line and can be disabled.

d. Disable flip-flop: Verifies that the flip-flop can be set to disable the instrument should a malfunction occur. If a malfunction is detected, the type of malfunction will be displayed on the information display. An audio alarm will be sounded and an error code will be

written to the PULSE display. The leaker and dump valve will be forced to open and the motor/pump will be disconnected from power source, rendering the instrument inoperative.

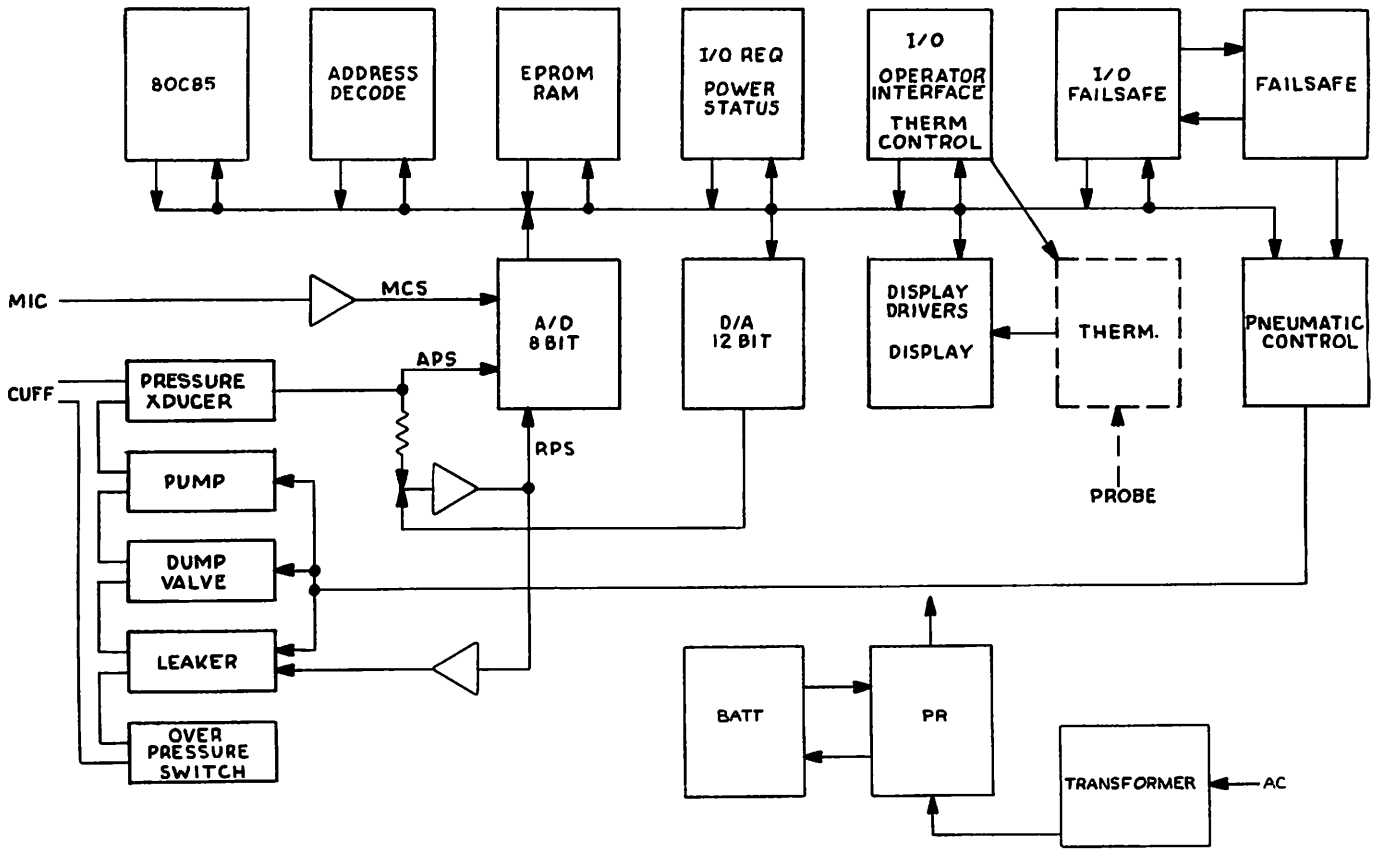


Figure 3-2. Blood Pressure System Functional Diagram

After initialization, the following failsafe circuits operate independently from the 80C85:

aa. Watchdog circuit: A loss or change of the 90 Hz frequency will set the disable flip-flop.

bb. 4.5 minute timer: When pressure reaches 20 mmHg and beyond, the timer is enabled to count using the 90 Hz frequency. The timer will set the disable flip-flop in 4.5 minutes. When pressure drops back below 20 mmHg, the timer is reset and ready for another cycle.

cc. Overpressure switch: A mechanical overpressure switch triggered at 390 mmHg sets the disable flip-flop.

dd. Overpressure comparator: A comparator with a threshold of 335 mmHg will set the disable flip-flop if the pressure reaches that value. The mechanical overpressure switch is a backup to the overpressure comparator, in case of pressure transducer failure.

ee. Disable flip-flop: This circuit directly disables the motor/pump, dump valve, leaker and START/RESET switch if a fault occurs.

3-2-3-3 Pneumatic Control and Analog (A/D and D/A) I/O. When a BP measurement is initiated, the 80C85 issues commands to close the leaker, dump valve, and to enable the motor drive circuit. The stethophone is muted while the motor is running to prevent undesirable noise from being amplified. Air flows from the pump to a cuff via the umbilical cord connected to the front panel receptacle. The 80C85 reads the pressure setting from the front panel switch and the absolute pressure signal (APS) from the pressure transducer. When the desired pressure is reached, the motor drive circuit is disconnected. The system is put on hold for five seconds to allow the air pressure to reach equilibrium. Then, a deflation cycle begins.

The deflation rate is maintained at 5 mmHg/second through a combination of software and hardware. Each 16 milliseconds, the 80C85 outputs a value to the D/A converter. The output of the converter is summed with the APS to create a relative pressure signal (RPS). This signal is sampled via an A/D converter and also controls the leaker. The leaker bleeds air from the system to maintain a constant deflation rate. During deflation, the 80C85 samples three signals: MCS, APS, and RPS. When sufficient data has been obtained to determine a blood pressure, the deflation cycle is terminated. The leaker and dump valve are opened to rapidly deflate the cuff. The data is then processed and displayed on the front panel.

3-2-3-4 Microprocessor, Memory, and I/O. A CMOS version of the 8085, the 80C85 is used as the processor. Software is stored in two EPROMs having total memory space of 16K x 8. A RAM having 2K x 8 space is used for data storage. An address decoder circuit consisting of two three-to-eight decoders and several logic gates are used to select memory (both EPROM and RAM) and I/O ports. The serial output port on the 80C85 (SOD, pin 4) is used to issue the pump on/off control. The serial input port (SID, pin 5) on the 80C85 is not used.

The microprocessor interrupt system is configured as follows:

a. $\overline{\text{RESETIN}}$ (pin 36): power up reset
b. RST 7.5 (pin 7): every 0.68 milliseconds, updates the internal time base
c. RST 5.5 (pin 9): to initiate BP measurement cycle

No other interrupts are used.

3-2-3-5 Display and Operator Interface I/O. The thermometer display (5-digit LEDs) is driven from drivers located on the display driver board.

Four three-digit LED groups are formed from two self-scanning, decoding MM74C912s and are memory mapped to the 80C85.

The information display consists of two DL2416s, giving eight-character capacity, and are memory mapped to the 80C85.

The pressure and mode rotary switches are encoded into a two-bit and four-bit BCD format. The display test switch and thermometer probe switch form two bits. These eight bits are grouped as an input port to the 80C85.

3-3 DETAILED CIRCUIT DESCRIPTION

The following paragraphs provide a detailed description of each circuit in the VITALoCHECK monitor.

3-3-1 Power Input and Power Regulator Board (figure 3-3)

Figure 3-3 represents the AC power input circuits. The ground terminal is connected to the instrument chassis. The AC lines are protected by a circuit breaker, 1A for Model 4000 and 0.45A for Model 4001. The line voltage is stepped down to 20 VAC by a transformer T1, rectified by the diode bridge CR1-CR4, and then filtered by C1 (figure 3-4). The unregulated DC voltage reaches 28V nominally at this point.

3-3-2 Battery Charger Regulator (figure 3-4)

The battery charger regulator is a switching regulator based on the TL-494 regulator chip. The switching frequency is set by R12 and C3 at 20 kHz and is synchronized to 23 kHz when the instrument is turned on, reducing harmonic interference. The synchronizing frequency is derived from LG-U1-4. C43, U7-3, CR9, R22, R23, and Q5 form a trigger circuit which discharges C3 at the synchronizing rate. When AC power is initially supplied, the unregulated DC at CR6-K rises from 0V. Q6 conducts when this voltage exceeds approximately 12V, providing a ground path to U1. U1 is enabled when a ground path is established. The regulated output is 14.2 VDC. This output is used to charge the battery pack.

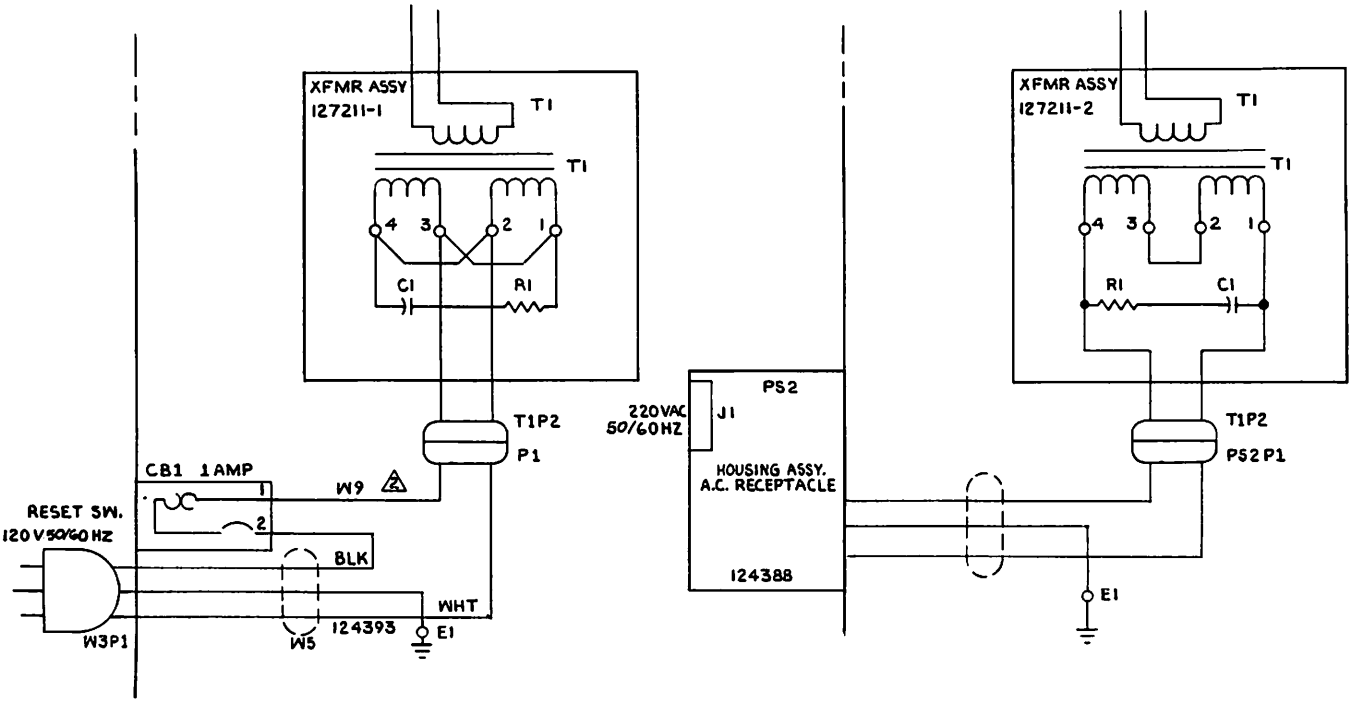


Figure 3-3. AC Power Input Circuit

Feedback paths for the two error amplifiers in U1 are formed by C4, R9, C5, and R10. The voltage error amplifier takes in the internal 5.0V reference via R11 and the output voltage in at U1-16 via R16, R14, and R15. R13 limits output current to a safe level and is combined with R6 and R7 to form a current sensing path for U1-1 and U1-2. These error signals combine with the switching waveform to yield a pulse width modulated (PWM) signal at U1-8, 11.

A current drive switched by the PWM signal is formed by Q1, Q2, and R3-5. A low, wide PWM state, produced by a lower-than-desired output voltage, turns Q2 and Q1 on at a longer time interval. This passes more current to L1 to charge C6 to the desired output level. The output voltage can be adjusted by trimpot R15.

CR7, C42, and R80 rectify and filter the switching current at Q1-C (and Q2-C) and turn Q3 on to light up DPL-CR1 as a charge indicator. Q4 switches Lo to signal the 80C85 that AC power is present.

Battery voltage at CR6 and R1 (which turn on Q6) is blocked by CR5 when AC power is not present.

The battery pack is protected by a clad-fuse at the negative terminal. Currently, the overvoltage circuit CR13, U4-13, is not used (JB open).

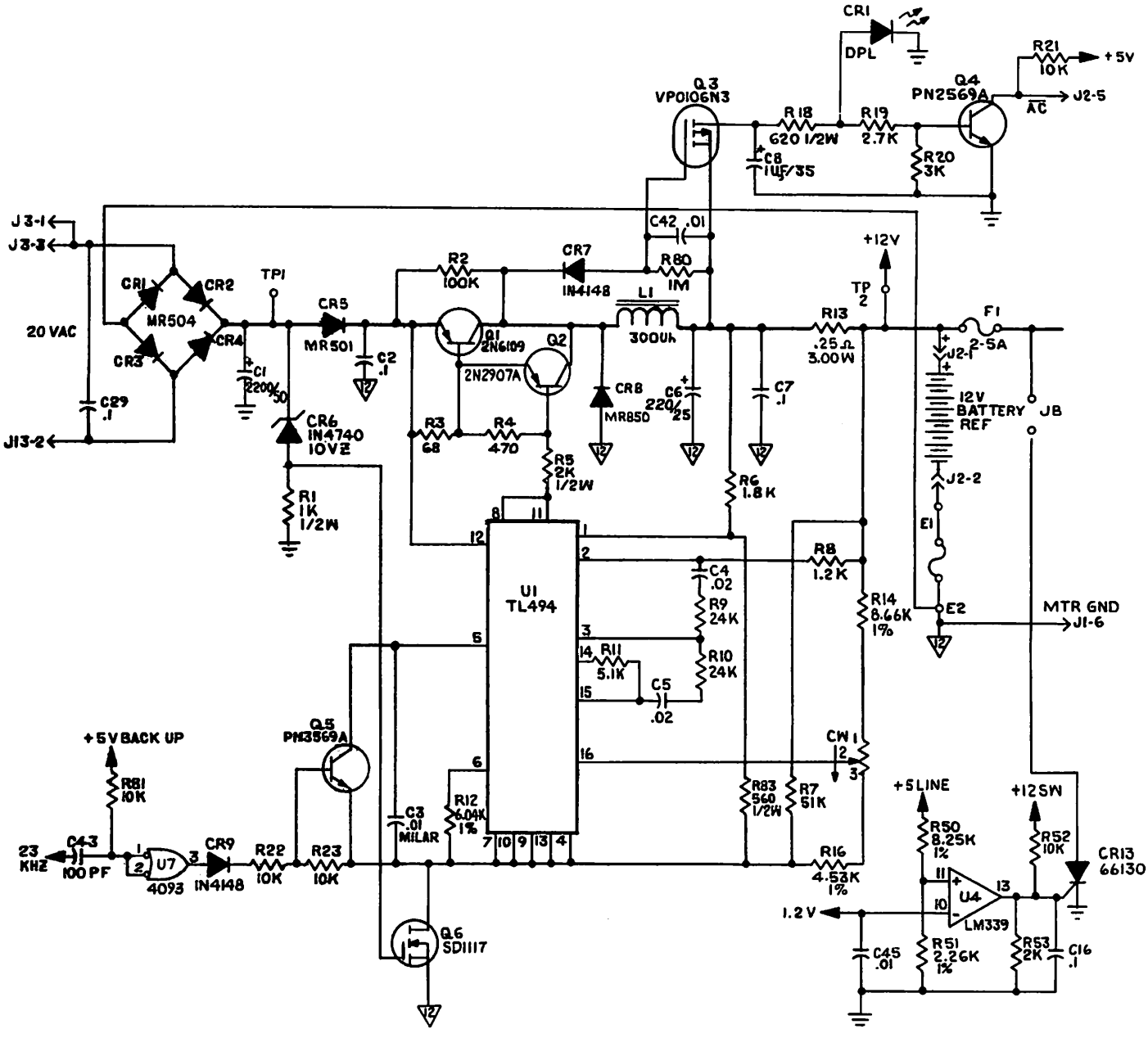


Figure 3-4. Battery Charger Regulator Circuit

3-3-3 Negative Supply (Motor) Regulator (figure 3-5)

Output for this regulator is -10 VDC. It is used to supply negative bias for the analog circuitry. The switching frequency is set at 22 kHz; it is not synchronized with any frequency. Circuit operation is similar to that of the battery charger regulator except that on/off control is provided by Q15. Q15-B is connected to Q12-E. When the on/off flip-flop U5-15 is Hi, Q12 and Q11 turn on, pulling Q15-B Hi. This allows the PWM signal to switch the current drivers formed by Q13 and Q14.

3-3-4 +5 Line Regulator (figure 3-5)

Output for this regulator is set at +5 VDC. The switching frequency is 20 kHz, synchronized at 23 kHz when the instrument is turned on. Circuit operation is similar to that of the battery charger regulator except that on/off control is provided by Q18. (See section 3-3-3 above.) CR15, a 5.6V zener diode, is used to guard against overvoltage.

3-3-5 +5V Backup (figure 3-6)

+5V backup is a low power regulator designed to run directly from the battery output for power control/status operation. This regulator remains on, supplying +5 VDC as long as battery voltage is above +5 VDC.

A transistor array, U8, is configured as a differential amplifier. U8-1, the noninverting input, is referenced at 1.2V by R46 and VR1. The inverting input, U8-5, senses the output voltage at U8-7 via R47 and R48.

The output of the differential amplifier drives the base of the NPN transistor U8-9, 7 to provide +5 VDC regulated output at U8-7.

3-3-6 Power On/Off Control and Battery Status (figure 3-7)

When the unit is not plugged into AC power and the battery is connected, the +5V backup rises initially from 0V. R29 and C13 force U6-3 Hi, resetting U5 (Q=0, $\bar{Q}$=1). R24 and C11, a debouncing network for the ON/OFF switch, forces U6-4 momentarily Hi, generating a clock signal to U5-13. This clock is ignored due to U5-12 being held Hi at this point (R29 and C13 time constant is longer than that of R24 and C11). R41, R26, and C12 also force U6-10 Lo. U6-10 stays Lo unless U6-8 changes to Lo. U6-10 and U6-11 are configured as an RS latch. When AC power is applied, U6-8 is pulled Lo through CR10 and Q6, allowing U5 to be enabled.

Following stabilization of the above actions, U5 has the following setups:

(U5-10) J : Hi
(U5-11) K : +5 backup
(U5-12) R : Lo
(U5-13) CLK : Lo
(U5-9) S : grounded
(U5-15 Q : Lo, keeping U2 and U3 (+5LINE and negative supply) off
(U-14) $\bar{Q}$: Hi, keeping battery status circuit off

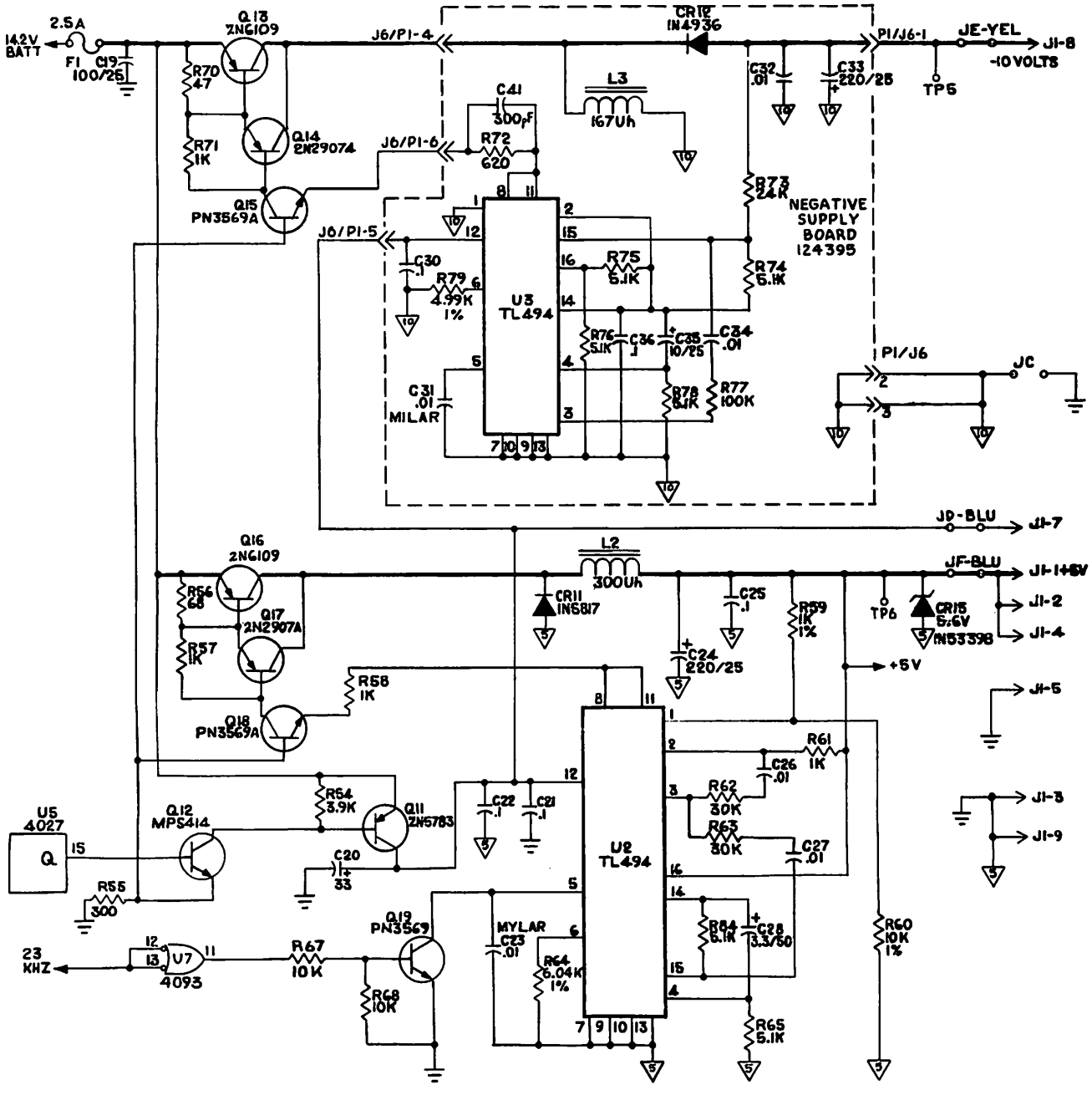


Figure 3-5. Negative Supply and +5 Line Regulator

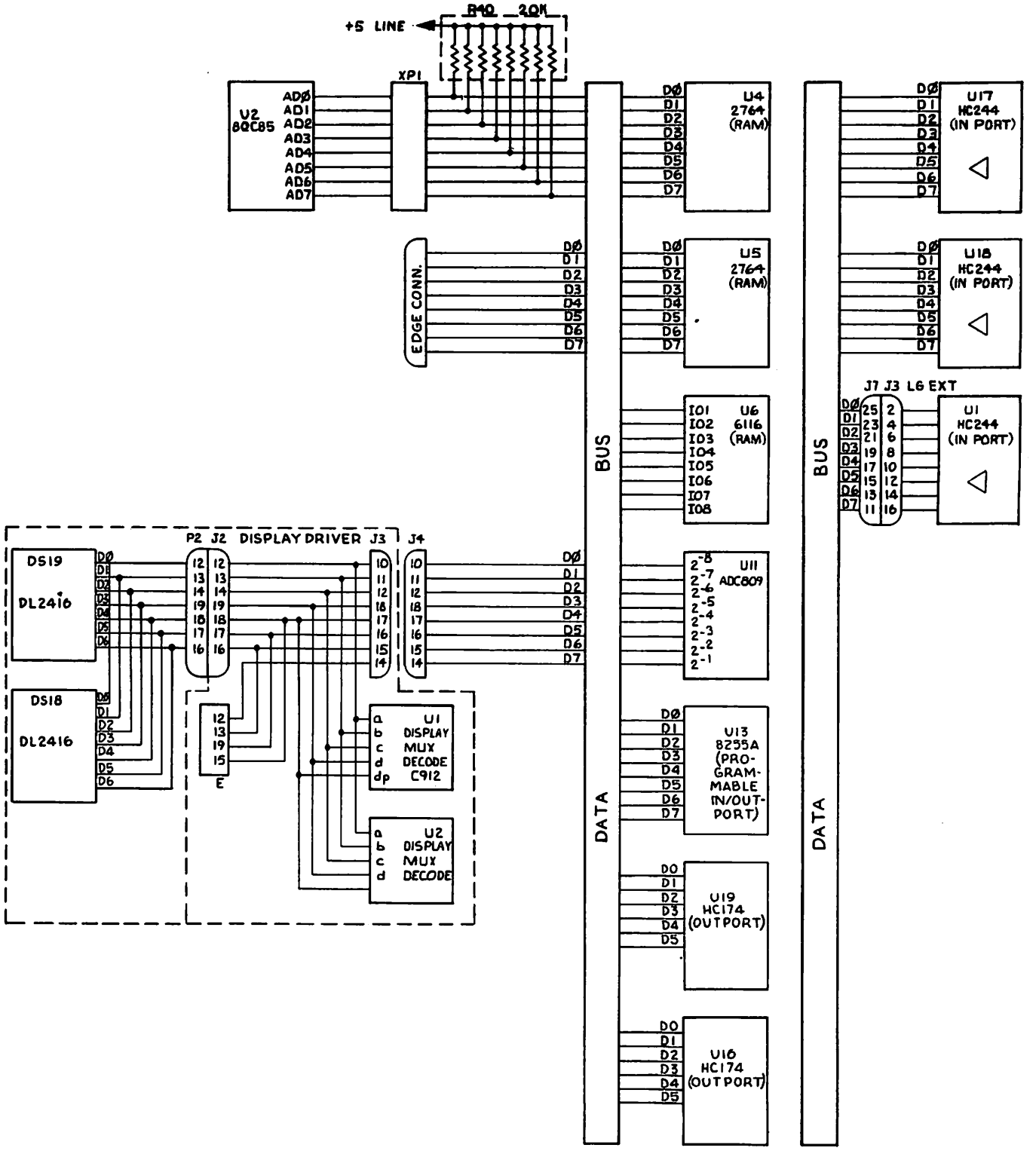


Figure 3-13. Data Bus System

3-3-10 BP System

3-3-10-1 Data Bus System (figure 3-13). The data bus system is a standard, non-buffered bus system. All data lines are pulled up to +5LINE through a 20K resistor network. The bus system passes through a jumper plug (XP1) before entering the 80C85. The bus can be accessed externally through an edge connector on the logic board.

3-3-10-2 Address Bus System (figure 3-14). The address bus is a non-buffered system. The lower eight bits are latched by U3 when ALE = Hi. The higher eight bits originate directly from the 80C85 CPU.

3-3-10-3 Address Decoder and Bus Control Lines (figure 3-15 and 3-16). The decoded signals, when combined with the bus control signals ALE, IO/$\overline{M}$, $\overline{WR}$ and $\overline{RD}$, enable the 80C85 to select memory devices and I/O ports. The IO/$\overline{M}$ pin (80C85-34) is connected to U7-A2 and U8-A2 such that a memory instruction will only activate the four lower output bits of U7 and U8 (i.e., 00-03, to select EPROMS, RAM and displays). An I/O instruction will only activate the four higher output bits of U7 and U8 (i.e., 04-07, to select I/O ports consisting of latches, buffers and programmable I/O device). The 80C85 can address 64K of memory spaces (0000-FFFF) and 256 I/O ports (00-FF).

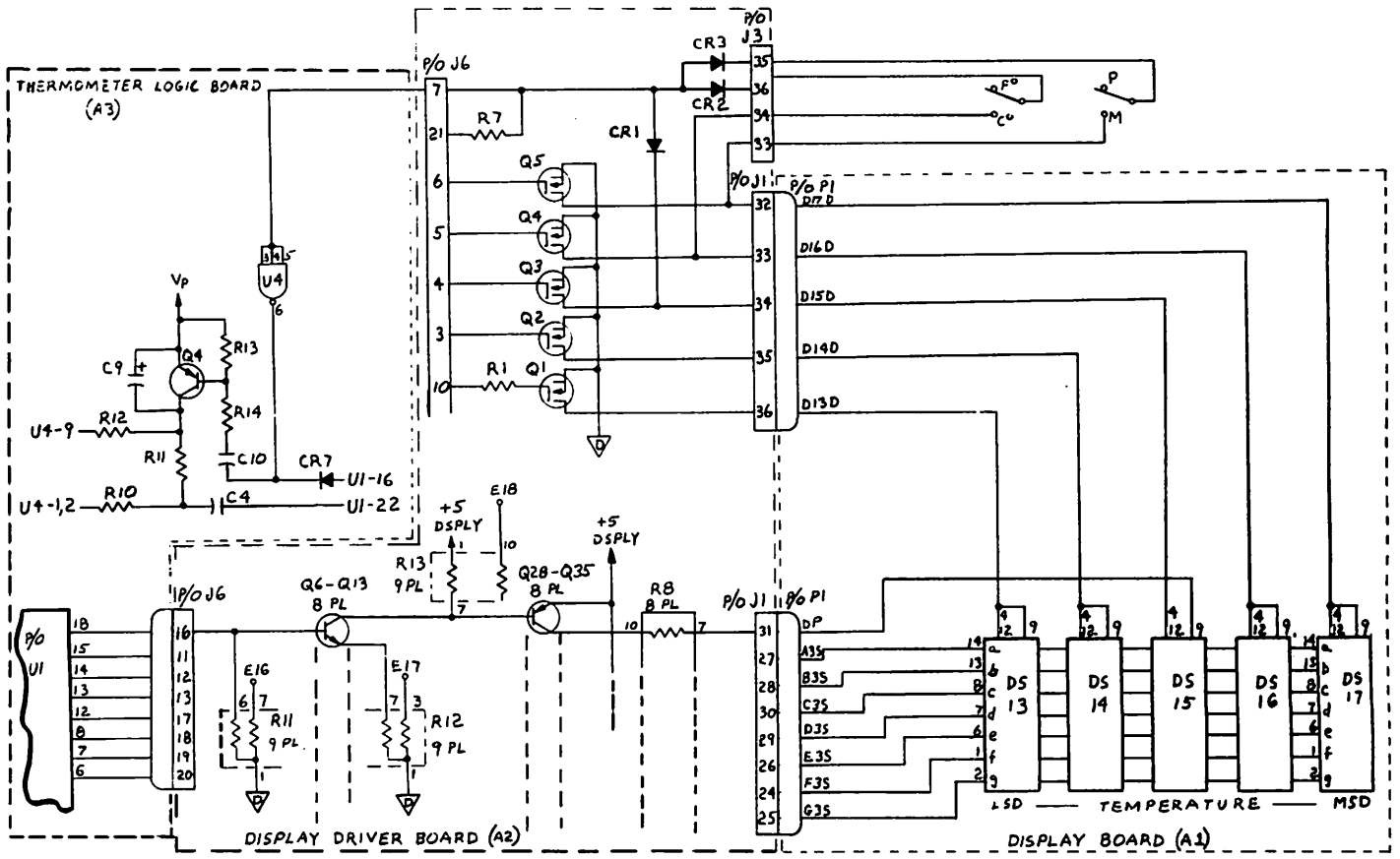


Figure 3-12. Watchdog Temperature Mode Switch and Display

3-3-9-8 Error Messages. There are four error messages or alarms which are displayed on the temperature display as a result of a certain operational or functional errors.

a. Err t. Err t occurs in the predictive mode and usually indicates an operator error. The display will flash Err t seven times alternating with the audible tone before the thermometer turns off. Three conditions cause an Err t alarm:

   1. An Err t alarm will occur when the probe tip temperature remains less than 32.2°C (90.0°F) throughout the temperature-taking cycle. For example, Err t would be displayed if the probe was removed from the storage well and laid on a table. Normally, the display reads 32.2L (90.0L) when the probe is removed from the storage well, with the display advancing as the thermistor temperature rises above 32.2°C (90.0°F).

   2. An Err t alarm will also occur when the final temperature is not computed within one minute after the display starts advancing. This can be caused by repositioning the probe so that it is in intermittent contact with tissue long enough to discontinue advancing the display.

   3. If the room temperature is greater than 34.4°C (94.0°F) when the probe is removed from the storage well at the start of the temperature-taking cycle, the thermometer will enter a peak reading mode. In this mode, the display advances as the thermistor temperature increases, but it never declines if the temperature drops. The display will advance to the peak or highest temperature sensed and then stop advancing. When the thermometer remains in the peak reading mode for approximately six minutes, Err t will appear on the display.

b. Err L. This is an alarm of the predictive mode and occurs when tissue contact is lost and is not regained with 30 seconds. The alarm display will flash seven times, alternating with the audible tone before the thermometer turns off.

c. Err H. If the probe temperature exceeds 42.1°C (107.9°F) in either the predictive or the monitor mode, Err H will occur. This may indicate that either the probe or the A/D converter is malfunctioning. The display will flash Err H seven times, alternating with the audible tone before the thermometer turns off.

d. Err 0. An err 0 indication can occur if the A/D converter malfunctions such that the processor cannot properly read the data within a certain time window. This indicates that the instrument needs service.

temperature measurement is completed or the probe is inserted into the storage well. G2 is an input which senses the state of the probe switch signal; G3 is an input used for testing purposes.

Microprocessor outputs L7 and D0 through D3 are the display enable strobes. They send signals to the display board indicating which display (DS13 through DS17) is to be illuminated. This output works in conjunction with the SK (decimal point) and L0 through L6 output which indicates to the display board which segments (a through g) are illuminated for any one display. Only one digit is illuminated at any given time, but the digits are turned on and off in succession 250 times per second. This gives the display the appearance of containing five digits which are illuminated constantly.

When L7 and D0 through D3 are driven Hi one at a time, they cause Q1 through Q5 on the display driver board, respectively, to conduct. These transistors provide current to drive the display cathodes. L0 through L6 and SK drive segments g through a and the decimal point, respectively, through buffers Q6 through Q13 and Q28 through Q35 on the display driver board. The signals from L0 through L6 are sent to all five displays simultaneously. The display for which the data is valid is enabled (strobed) by the appropriate display enable strobes, L7 and D0 through D3.

S0 is an output that turns on Q5, causing the speaker to be activated when it conducts. CK0 and CK1 are external connections to the clock oscillator, which utilizes a 2.00 MHz crystal. This frequency is internally divided by 32 to achieve the 16 microsecond cycle time of the microprocessor. Capacitors C13 and C14 establish the load for the crystal. The timing established by the crystal oscillator ensures that all the circuits and routines of the programs within the microprocessor sequence at the proper rate.

The reset (RES), ground (GND), and power (Vcc) terminals of the microprocessor are part of a circuit which applies power to the microprocessor and initializes it. When power is first applied to Vcc, C11 charges through R33. A logical 0 at the RES terminal initializes the microprocessor when power is applied. Charging C11 through R33 delays the rise to logical 1, allowing the initialization to occur.

3-3-9-6 Watchdog Circuit (figure 3-12). The watchdog circuit turns the thermometer board off if there is a microprocessor malfunction causing a loss of the digit strobes. The watchdog circuit constantly receives signals from the displays through Q3 (display driver board), and Q4 and Q5 (also display driver board) if the ^{O}F-^{O}C or P-M switches are closed. Under normal conditions, C9 (Thermal Logic Board) remains discharged by Q4 and yields a high input at U4-1 and 2. However, if a malfunction occurs and no signal is received at U4-3, 4, and 5, C9 charges through R12. The resulting low signal is received at U4-1 and 2, resetting the latch and turning off the thermometer board.

3-3-9-7 Monitor Mode. Setting the P-M switch to M for monitor mode causes the microprocessor to use a different program than that used in the predictive mode. The microprocessor detects the state of the P-M switch through input SI.

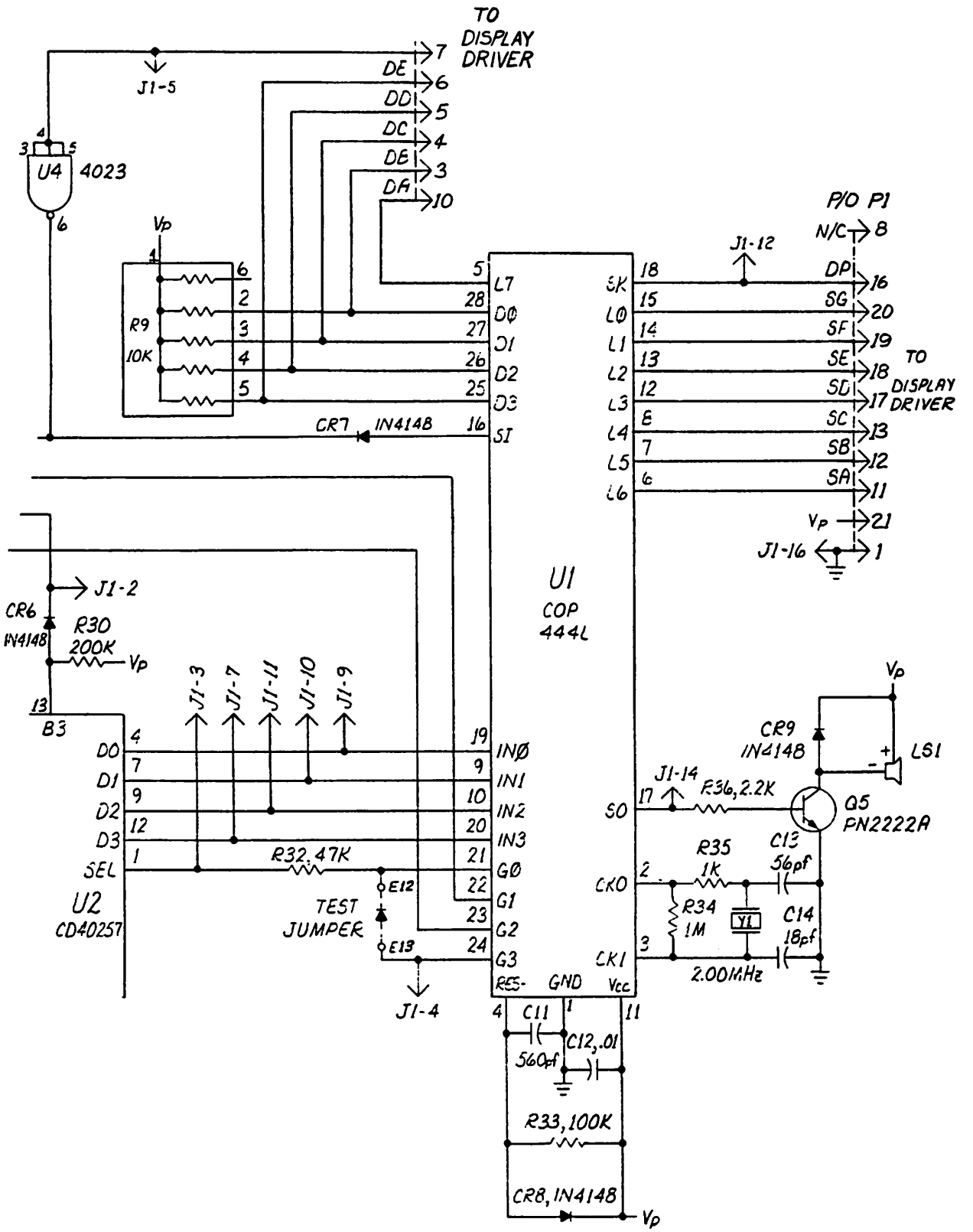


Figure 3-11. Microprocessor Thermometer Logic Board

The digits do not indicate the exact temperature, but represent the temperature data. For example, 000 represents 88.0°F and 999 represents 108.0°F, the top and bottom of the temperature range. Every value from 000 to 999 represents a temperature from 88.0°F to 108.0°F. The microprocessor converts this raw value to the actual temperature reading. The digits are output sequentially with the MSD, NSD, and LSD digit strobes, indicating which digit is present. U3 operates continuously at a rate of approximately 9.5 milliseconds per conversion.

3-3-9-4 Multiplexer (figure 3-10). The multiplexer accepts digital information from the A/D converter and the pulse signal and sends it to the microprocessor in the form of four-bit data words. Inputs A0 thorugh A3 (U2-2, 5, 11, and 14) are temperature data and B0 through B3 (U2-3, 6, 10, and 13) are digit strobes and the pulse state. A0 through A3 and B0 through B3 are two distinct four-bit words. A0 receives data from the "1" output of U3; A1 from the "2" output; A2 from the "4" output; and A3 from the "8" output. B0 receives data from the MSD output of U3; B1 from the LSD output; B2 from the NSD output. B3 receives the pulse state.

The multiplexer select (SEL), U2-1, acts as a switch to determine which four-bit word is sent to the microprocessor through outputs D0 through D3 (U2-4, 7, 9, and 12). SEL connects A0 through A3 or B0 through B3 to D0 through D3 and the microprocessor. The "A" word is selected when SEL is 0; the "B" word is selected when SEL is 1. SEL is controlled by the G0 output of the microprocessor (U1-21).

The Z input of the multiplexer (U2-15) is normally pulled down by R31. It can be driven Hi by test equipment to put the multiplexer's outputs in a high-impedance state. This allows simulation of data to facilitate testing.

3-3-9-5 Microprocessor, Display Driver, and Display (figure 3-11). The COP444 microprocessor sends and receives signals to and from all parts of the thermometer, display driver, and display boards. The COP444 coordinates the processing of data through self-contained programs which operate on four-bit data words. It has a ROM which contains the program instructions for all the functions and decisions the microprocessor makes, and a RAM which temporarily stores data.

Within the programs of the microprocessor are instructions for operating in the monitor and predictive modes, and for recognizing and entering alarm conditions. The microprocessor receives digital temperature data from the multiplexer and uses it to run the display panel. The microprocessor also operates the speaker, and receives and processes information from the settings of the P-M, °F-°C, DISPLAY TEST, and probe switch signals from the 80C85.

Various input and output ports are shown in the schematic for the microprocessor, U1. Inputs IN0 through IN3 receive data from D0 through D3 outputs of multiplexer U2 regarding temperature, digit strobe (LSD, NSD, and MSD), and DISPLAY TEST switch state (on or off) via U2-13 (PULSE). The G port (G0 through G3) has both inputs and outputs. G0 is an output which signals to the multiplexer select which set of data--temperature (A0 through A3), or digit strobe and pulse switch (display test) state (B0 thorugh B3)--to send to the U1 IN port. G1 is an output which resets the power control flip-flop for automatic turn-off of the thermometer system when a

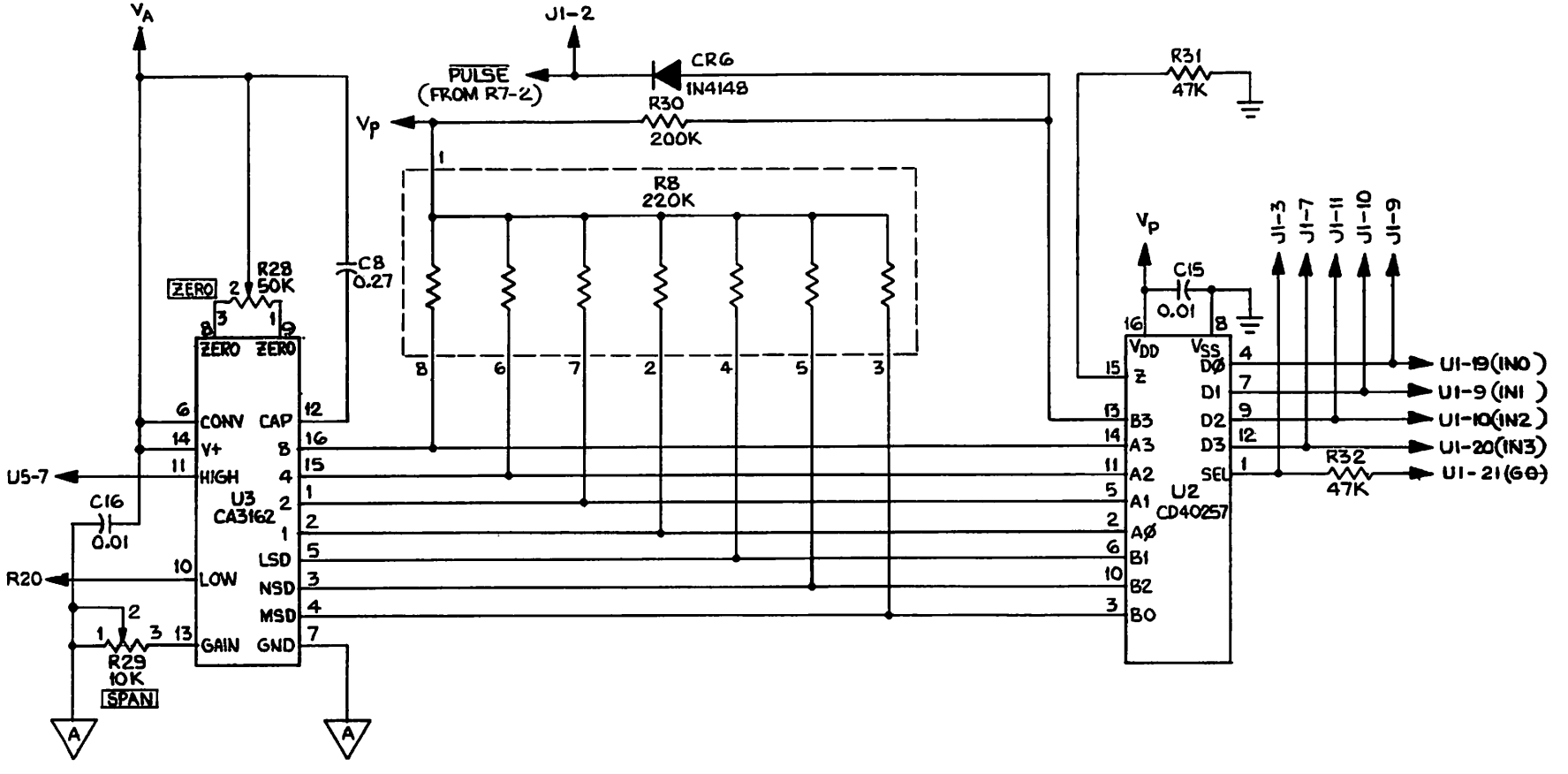


Figure 3-10. Analog-to-Digital Converter and Multiplexer Schematic

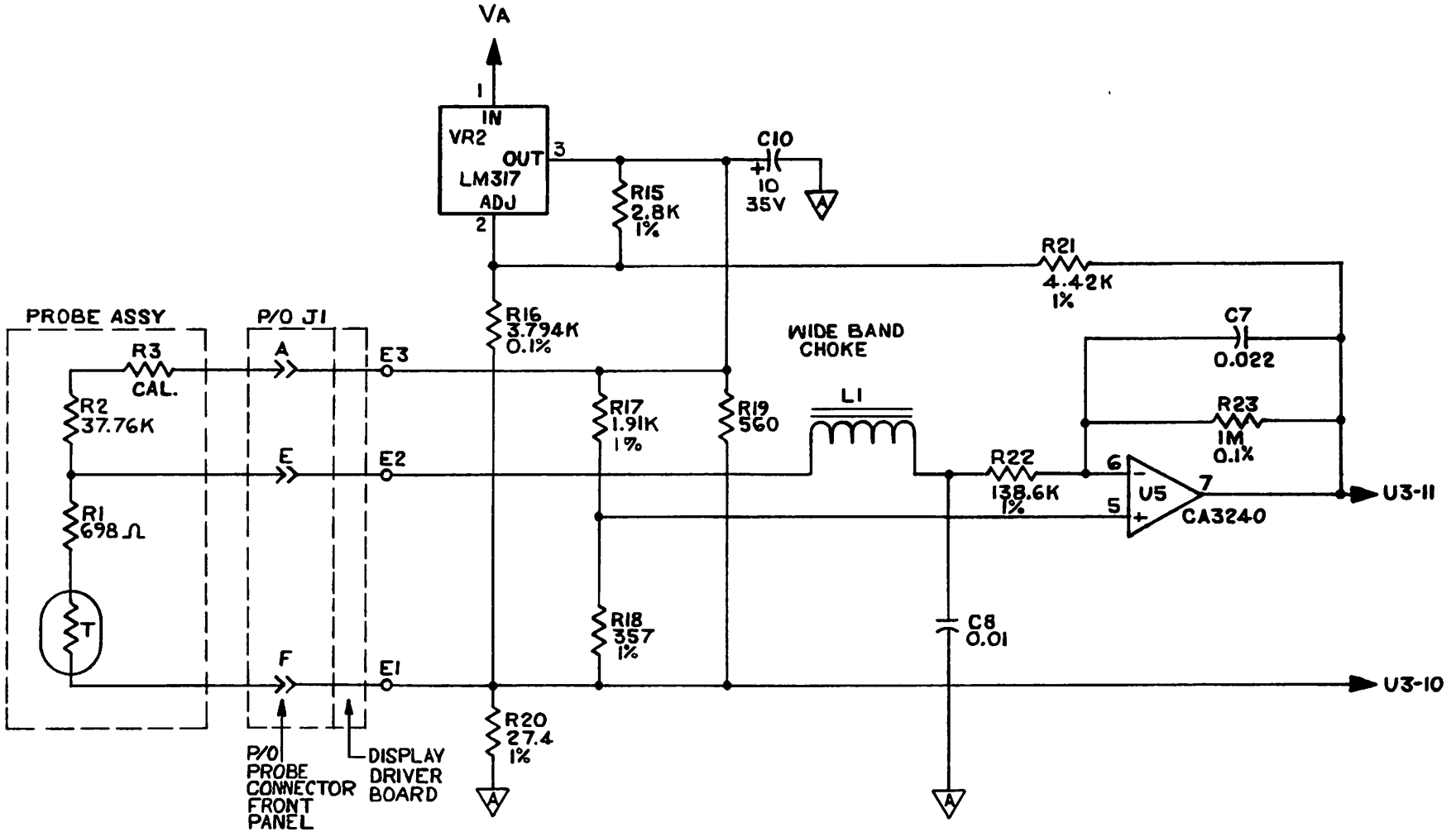


Figure 3-9. Analog Input and Linearizer Schematic

3-3-9-2 Analog Input and Linearizer (figure 3-9). The analog input and linearizer consists of probe circuitry U5-5, 6, and 7; voltage regulator VR2; resistors R15 thorugh R23; wide band choke L1; and capacitors C5 through C7 (see figure 3-9). The voltage U5-7 is linearly proportional to the temperature of the probe tip. Filtering of noise and stray interference is provided by L1, C5, C6, and C7.

As the temperature of the probe tip rises, the resistance of the thermistor, R_t, decreases nonlinearly. This varying resistance leads to a changing voltage which is applied to the ADJ (adjust) terminal of VR2 from U5-7. From the OUT terminal, the voltage goes through R17, R18, and the probe circuit. These resistors are configured as a bridge whose output is applied to the differential inputs of operational amplifier (op amp) U5 at pins 5 and 6. This amplifier's gain is set by R22 and R23. This circuit scales the voltage to a range of 0 to 1 VDC, which is the voltage level accepted by the A/D converter at U3-11.

The output voltage from U5-7 is applied to the ADJ terminal of VR2 via R21, as well as to U3-11. The loop through R21, ADJ, and OUT of VR2 compensates for the nonlinear resistance versus temperature of the thermistor. The voltage regulator VR2 always maintains the OUT voltage 1.2V higher than the ADJ voltage, which drives the top of the bridge at R17, R2, and R3 of the probe. The effect of the loop through R21, ADJ, and OUT is to increase the voltage applied to the top of the bridge as the temperature of the probe tip rises. The output voltage at U5-7 is 0 to 1V with respect to U3-10, with 0V corresponding to 32.2°C (90.0°F) and 1V corresponding to 42.2°C (108°F).

3-3-9-3 A/D Converter (figure 3-10). U3 is a self-contained dual slope A/D converter which converts voltage from the analog circuit to binary coded decimal (BCD) form which the microprocessor can use. The signal input range is 0 to 1 VDC. The A/D converter contains a three-decade BCD counter which is used to determine a digital output indicating between 0.000V and 0.999V in. At the beginning of a conversion cycle C8 charges at a rate proportional to an internal reference voltage. C8 then discharges at a rate proportional to the input voltage. The counter counts until C8 discharges. The total count is then sent to the microprocessor via multiplexer U2.

U3-10 and 11 are a differential input for voltage signals from the analog circuitry. The span or range of data conversion is trimmed by variable resistor R29 which adjusts the reference current utilized by the converter.

The zero adjust circuit of U3 ensures that when the input from the analog circuit is zero volts, the digital output of U3 is also zero. R28 is a variable resistor which can be manually adjusted.

The voltage level is coded in three four-bit data words at the 8, 4, 2, and 1 outputs of U3 (U3-16, 15, 1, and 2). Each four-bit word is equivalent to one raw digit of the temperature reading. Whether it is the ones (least significant digit (LSD)), the tens (next significant digit (NSD)), or the hundreds (most significant digit (MSD)), is indicated by the LSD, NSD, and MSD outputs of U3 (U3-5, 3, and 4).

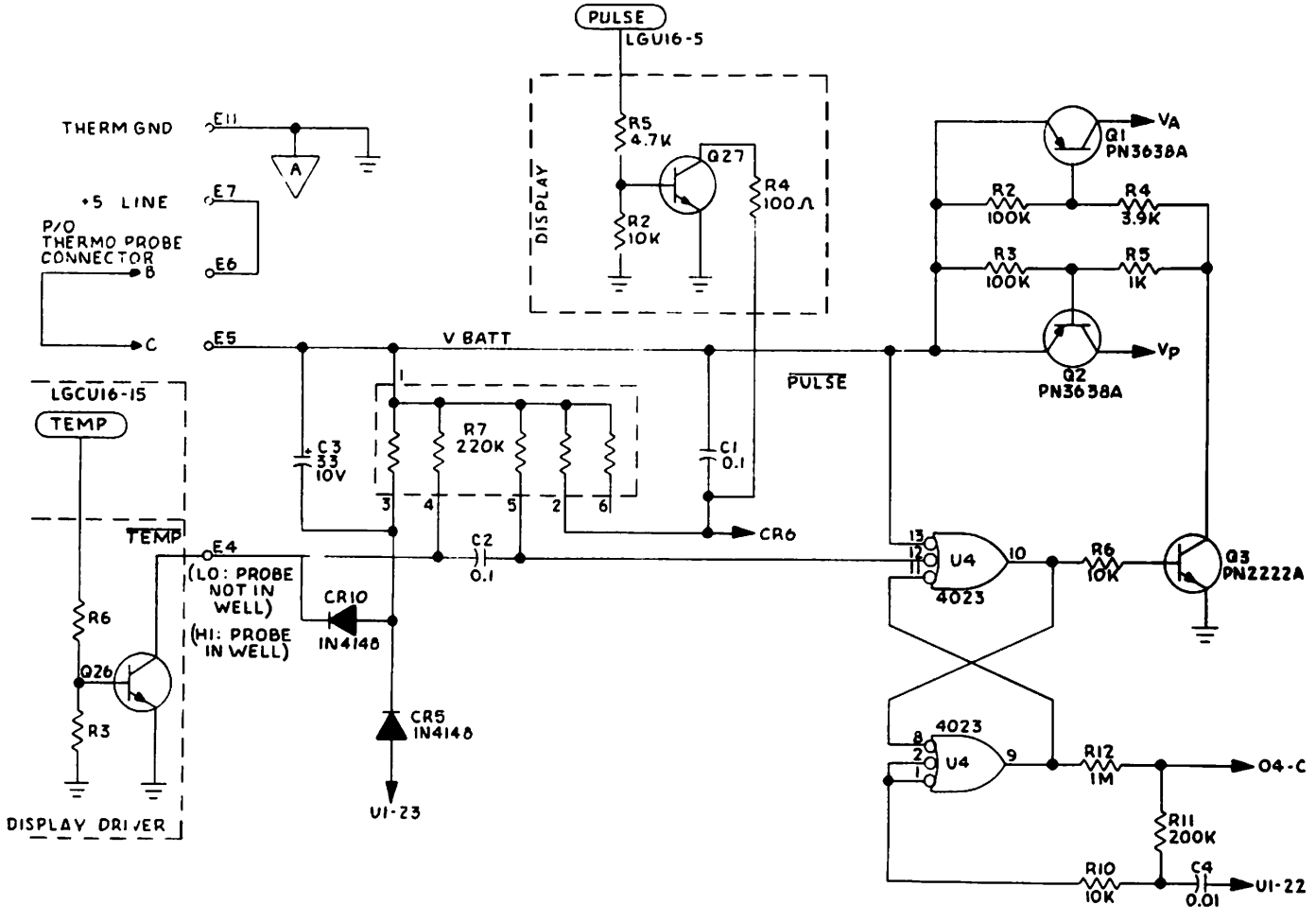


Figure 3-8. Power Supply and Power Control Schematic

3-3-8 Battery Status Circuit (figure 3-7)

When the battery status circuit is turned on, the battery voltage is divided into three levels through Q10-E, Q10-C, CR14, and R35-R39. Three comparators referenced at 1.2V sense these three levels separately. The battery voltage thresholds, detected by the comparators are:

Battery < 11.4V, U4-14 ($\overline{\text{RESET}}$) = Lo
Battery < 11.5V, U4-2 = Hi (i.e., $\overline{\text{DEAD BAT}}$ = Lo)
Battery < 11.6V, U4-1 = Hi (i.e., $\overline{\text{LOW BAT}}$ = Lo)

If battery voltage drops, the three levels drop accordingly. The comparator will switch state if its sensing input drops below the 1.2V reference level. The 80C85 polls these states to determine battery condition.

3-3-9 Thermometer System

3-3-9-1 Power Control (figure 3-8)

The +5V line enters the thermometer board at E7 via the display driver board. (The CR1-CR4 bridge, R1 and low battery voltage detection circuit U5-1, 2, 3, are not used.) A thermometer probe or tester, when plugged in, connects E6 and E5, powering up the control circuit. An RS flip-flop, configured by U4-9, 10 latches the state of the control circuit. The 80C85 samples the probe switch periodically at LG-U17-13 and outputs a signal, TEMP, at LG-U16-15 to DPL-Q26-B through R6 and R3 according to the following conditions:

Probe not in well: TEMP = Hi (i.e., E4 = Lo)
Probe in well: TEMP = Lo (i.e., E4 = Hi)

There are two methods for activating the thermometer. They are:

a. By inserting the probe connector only (probe storage well is empty, i.e., E4 = Lo). +5V charges C2 through R7-5, holding U4-12 Lo until C2 charges to a Hi level. This delay causes U4-10 to become Hi, turning on Q3. Q1 and Q2 turn on to provide Va and Vp for the rest of the circuit. The thermometer can be deactivated by removing the connector or by outputting a low level pulse to U4-1, 2 (by the COP444). Inserting a probe into the well also causes the COP444 to output a low level pulse to U4-1, 2. The COP444 senses the inserted probe condition through CR10 and CR5 via its G2 port.

b. By removing the probe from the storage well (initially, connector and probe are in place; i.e., E4=Hi and thermometer is off). The 80C85 pulls E4 to ground when the probe switch is closed by removal of the probe. This Hi to Lo transition is coupled through C2, setting flip-flop U4-10 Hi, activating the thermometer. The thermometer is deactivated as described in paragraph a, above.

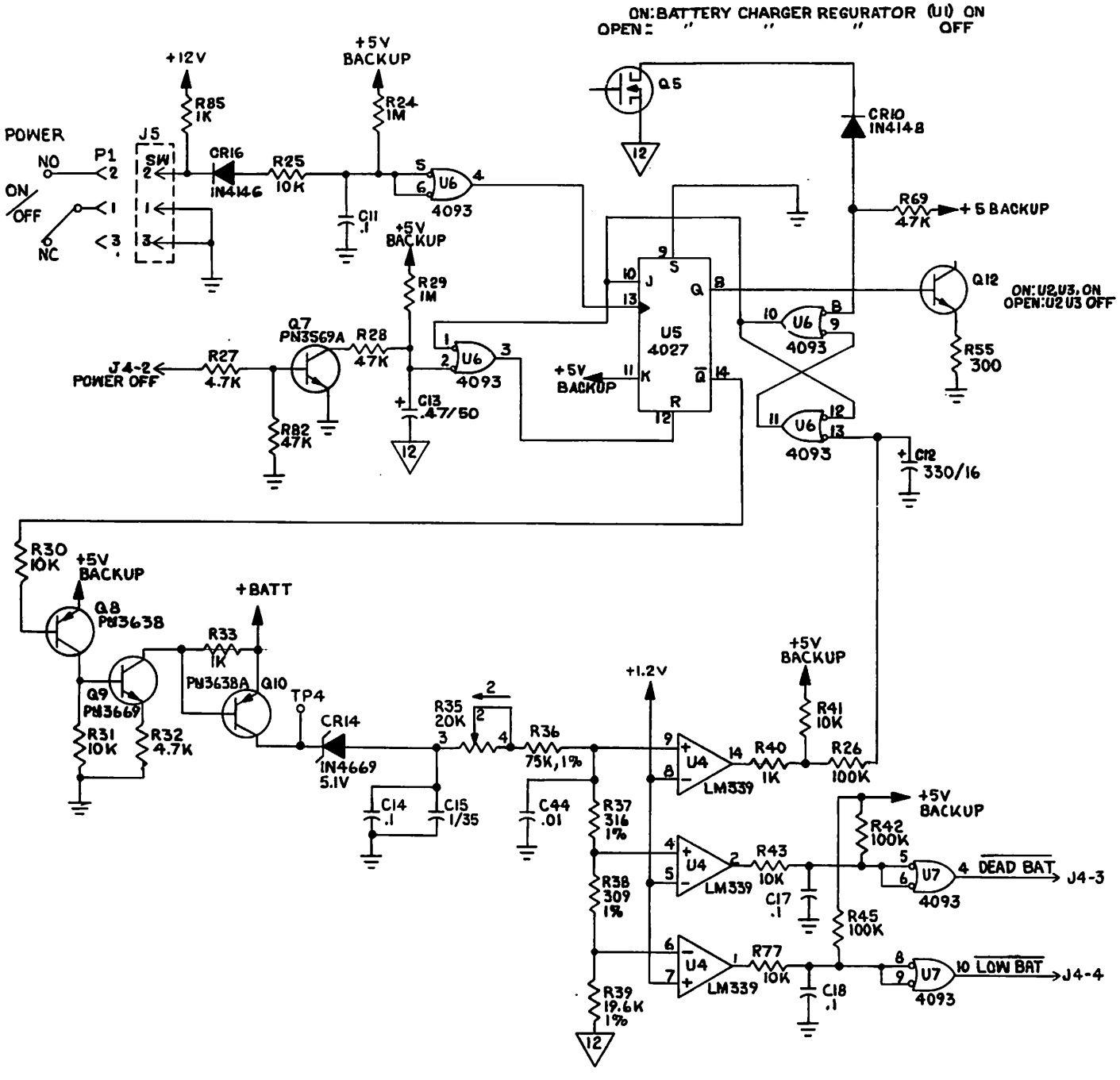


Figure 3-7. Power ON/OFF Control and Battery Status

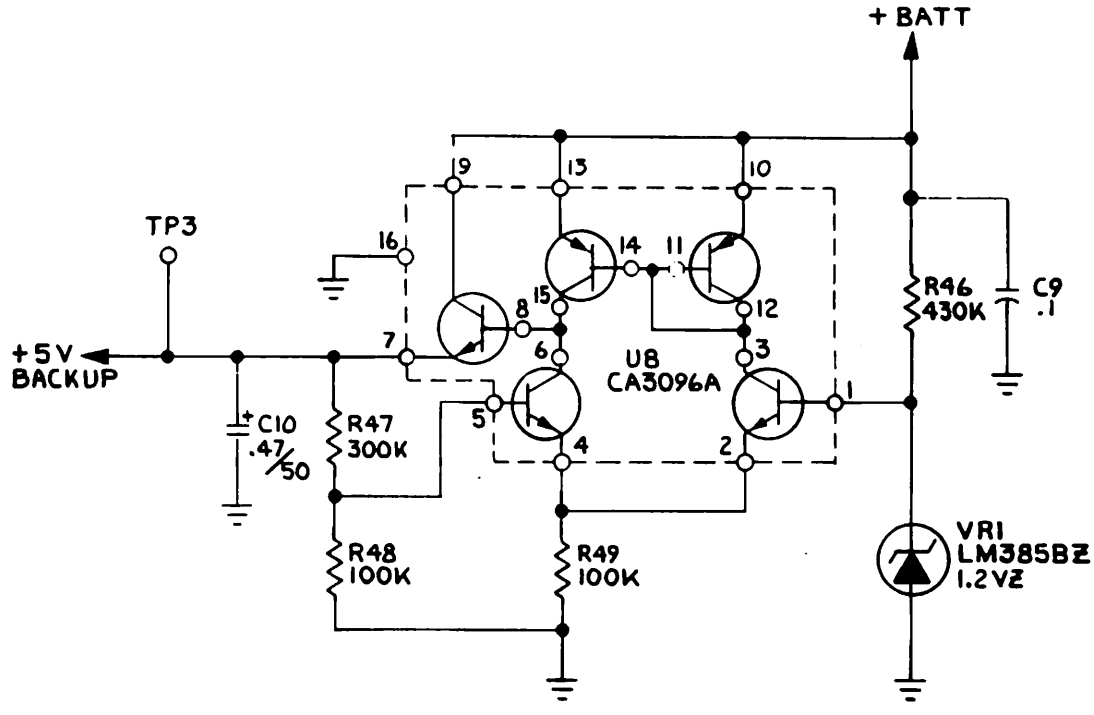


Figure 3-6. +5V Backup

When the power ON/OFF switch is activated once, a Lo to Hi (then returning to Lo) clock pulse is generated at U5-13. Q and $\bar{Q}$ of U5 exchange states, turning the +5 VDC, 12 VDC, -10 VDC supplies, and the battery status circuit on. The next time the power ON/OFF switch is activated, Q and $\bar{Q}$ again exchange states, turning the supplies and the battery status circuit off.

The power on/off operation can be overridden by a Hi signal being output at Q7-B through R27 and R82 (an 80C85 command to shut down instrument operation). Turning on Q7 will force U6-3 Hi, hence resetting U5. This condition occurs according to the status of U7-4 (DEAD BAT). The 80C85 samples this signal periodically.

3-3-7 Reset Circuit (figure 3-7)

A reset circuit is built in with a reset signal from U4-14. When battery voltage falls below 11.4V and is not detected by the 80C85, U4-14 switches from Hi to Lo, discharging C12 and forcing U6-10 to go Lo. The Lo at U6-10 forces U6-3 and U5-12 Hi, holding U5 reset and disabling the instrument.

When AC power is applied, the reset circuit is disabled as Q6-D is pulled to ground level pulling U6-8 to ground level through CR10 and forcing U6-10 Hi. U5 then becomes a toggle flip-flop and will respond to a power on/off signal from U6-4 or the 80C85 power off command from U6-3.

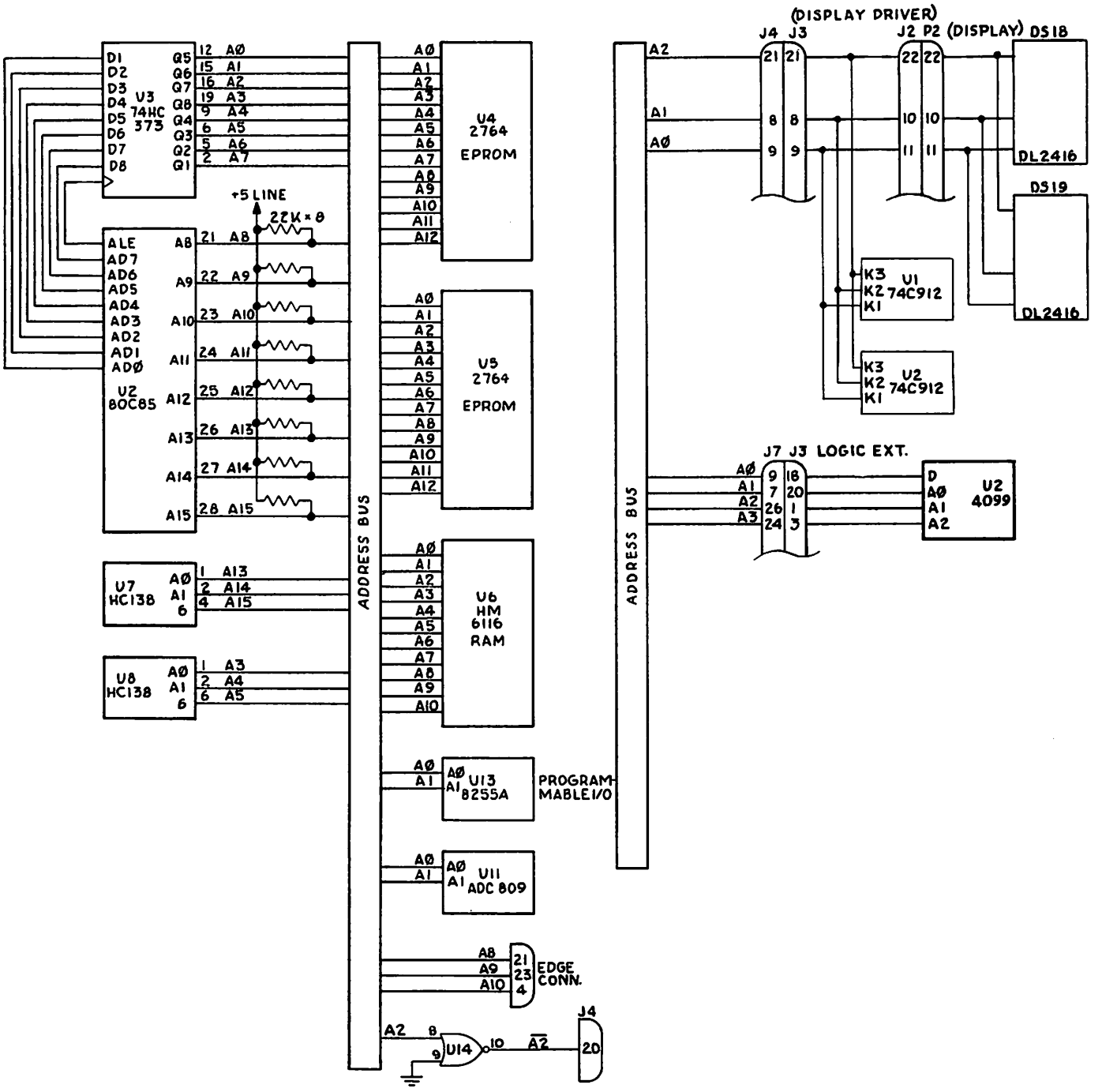


Figure 3-14. Address Bus System

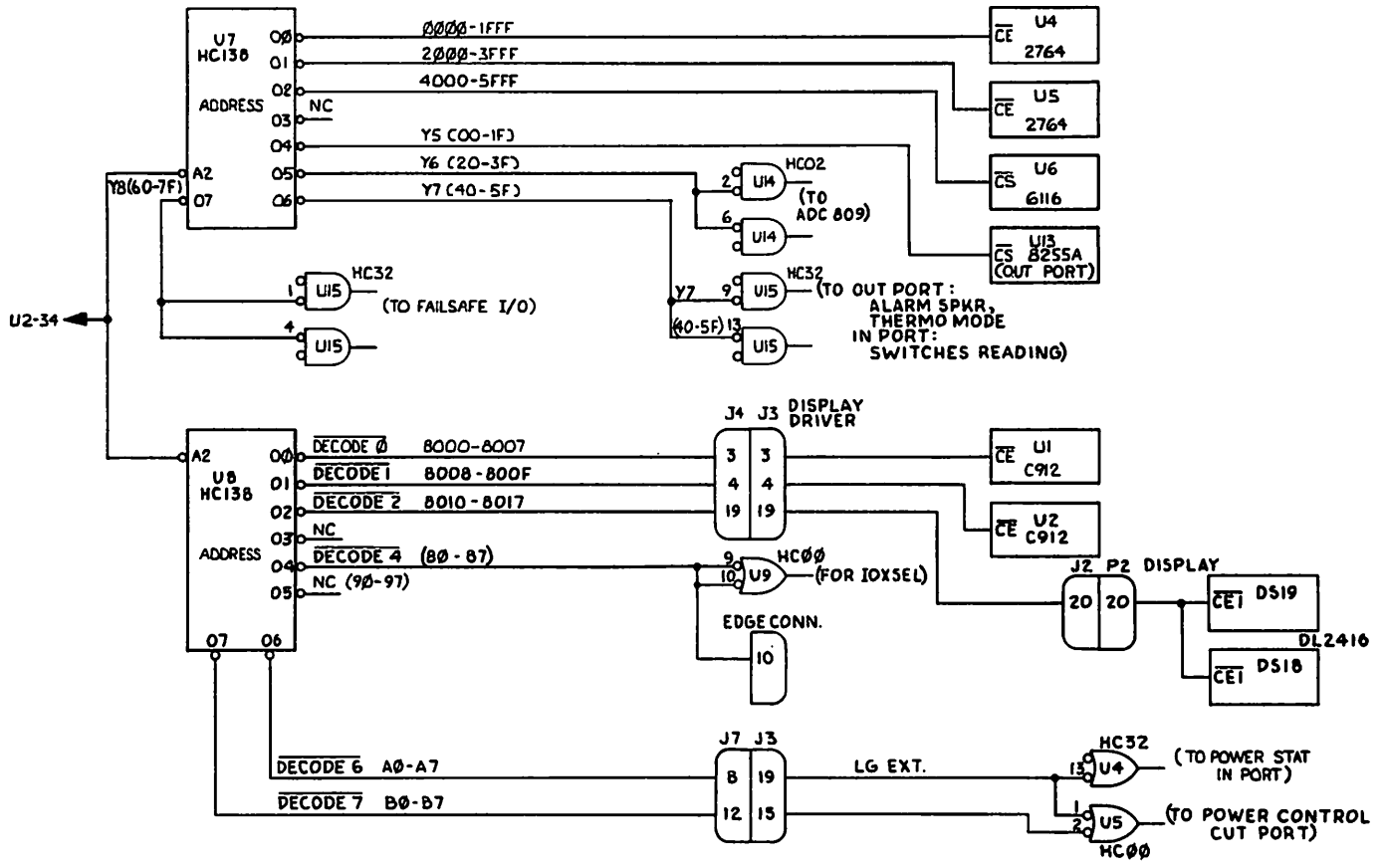


Figure 3-15. Address Decoder

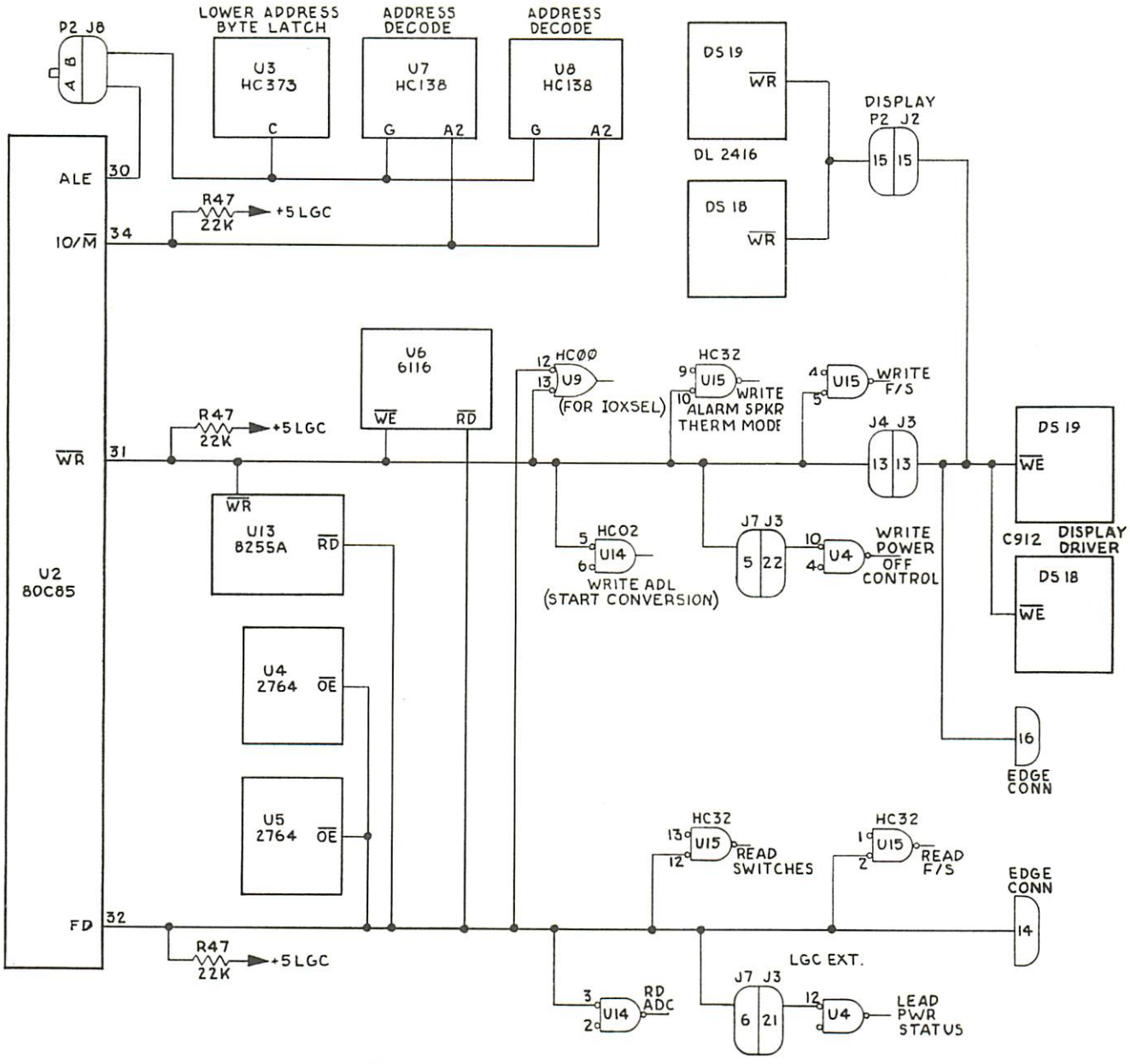


Figure 3-16. Bus Control Lines

Table 3-1 Memory Map, BP System

IO/$\overline{M}$	Address (Hex)	Selected	Device Read/Write	Remarks
Lo	0000-1FFF	LG-U4	Read only	EPROM, 8K x 8
Lo	2000-3FFF	LG-U5	Read only	EPROM, 8K x 8
Lo	4000-5FFF	LG-U6	Read/write	RAM, 2K x 8, not fully decoded
Lo	8000-8007	DPL-DVR-U1	Write only	8000 = SYSTOLIC LSD 8001 = SYSTOLIC NSD 8002 = SYSTOLIC MSD 8003 = DIASTOLIC LSD 8004 = DIASTOLIC NSD 8005 = DIASTOLIC MSD 8006 = NULL 8007 = NULL
Lo	8008-800F	DPL DVR-U2	Write only	8008 = MAP LSD 8009 = MAP NSD 800A = MAP MSD 800B = PULSE LSD 800C = PULSE NSD 800D = PULSE MSD 800E = NULL 800F = NULL
Lo	8010-8017	DPL-DS18 DPL-DS19	Write only	Information display, 8 characters 8017 = DS18 leftmost character 8010 = DS19 rightmost character
Hi	00-1F	LG-U13	Read/write	Programmable I/O port Output: 12 bits to D/A converter 1 bit to open dumper 1 bit to open leaker 1 bit to close leaker 5 bits = not used Input: 4 bits for LG-S1 setting
Hi	20-3F	LG-U11	Read/write	Write (D0-D7 = don't care) to initiate A/D conversion and load channel select 20 = MCS 21 = RPS

Table 3-1 Memory Map, BP System (Continued)

IO/$\overline{M}$	Address (Hex)	Selected	Device Read/Write	Remarks
				22 = APS 23 = SPARE (TEST) Read to access digitized value
Hi	40-5F	LG-U16	Write only	D0 = high pitch audio alarm D1 = low pitch audio alarm D2 = not used D3 = not used D4 = (pulse) thermometer display test D5 = (temp) thermometer enable D6 = not available D7 = not available
Hi	40-5F	LG-U17	Read only	Operator interface: D0-D1 = Pressure selector setting D2-D5 = Mode selector setting D6 = Probe switch D7 = Display test switch
Hi	60-7F	LG-U19	Write only	Failsafe circuit testing command: D0 = FS0 D1 = FS1 D2 = FS2 D3 = $\overline{FS3}$ D4 = FS4 D5 = FS5 D6-D7 = not available
Hi	60-7F	LG-U18	Read only	Failsafe circuit monitor: D0 = FS0 D1 = FS1 D2 = FS2 D3 = FSCOMP D4 = FSMOT D5 = FSDUMP D6 = FSDIS D7 = not used
Hi	80-87			Available at the edge connector External I/O

Table 3-1 Memory Map, BP System (Continued)

IO/$\overline{M}$	Address (Hex)	Selected	Device Read/Write	Remarks
Hi	90-97	LGEXT-U1	Read only	D0 = $\overline{AC}$ D1 = $\overline{LO\ BAT}$ D2 = $\overline{DEAD\ BAT}$ D3-D6 = LO, not used D7 = LG EXT U3-13 (event rate calculator) status, not used
Hi	90-9F	LG EXT-U2	Write only	Dummy write (D0-07 = Don't care) to turn off instrument = 91
				*Note I/O ports are not fully decoded.

3-3-10-4 System Clock (figure 3-17). A 6 MHz crystal is used to generate the necessary clock signal for the 80C85. The 3 MHz CLK output is pulled to +5LINE through R36. This is the digital system clock reference frequency. This clock is fed to a 12-bit ripple counter, U1, and divided into harmonically related lower frequencies for the other parts of the system. Those frequencies are:

a. 375 kHz - to drive the A/D converter, U11, and the watchdog circuit on the pneumatic board.

b. 23 kHz - to synchronize the switching circuit frequency on the power regulator board.

c. 1.46 kHz - as the high pitch speaker driver and 80C85 timer interrupt (RST 7.5).

d. 732 Hz - the low pitch speaker drive.

The 80C85 writes a control word to U16, an output port, to turn on Q8 for a high-pitched audio alarm, or to turn on Q9 for a low-pitched audio alarm. Writing another control word will turn the audio alarm off.

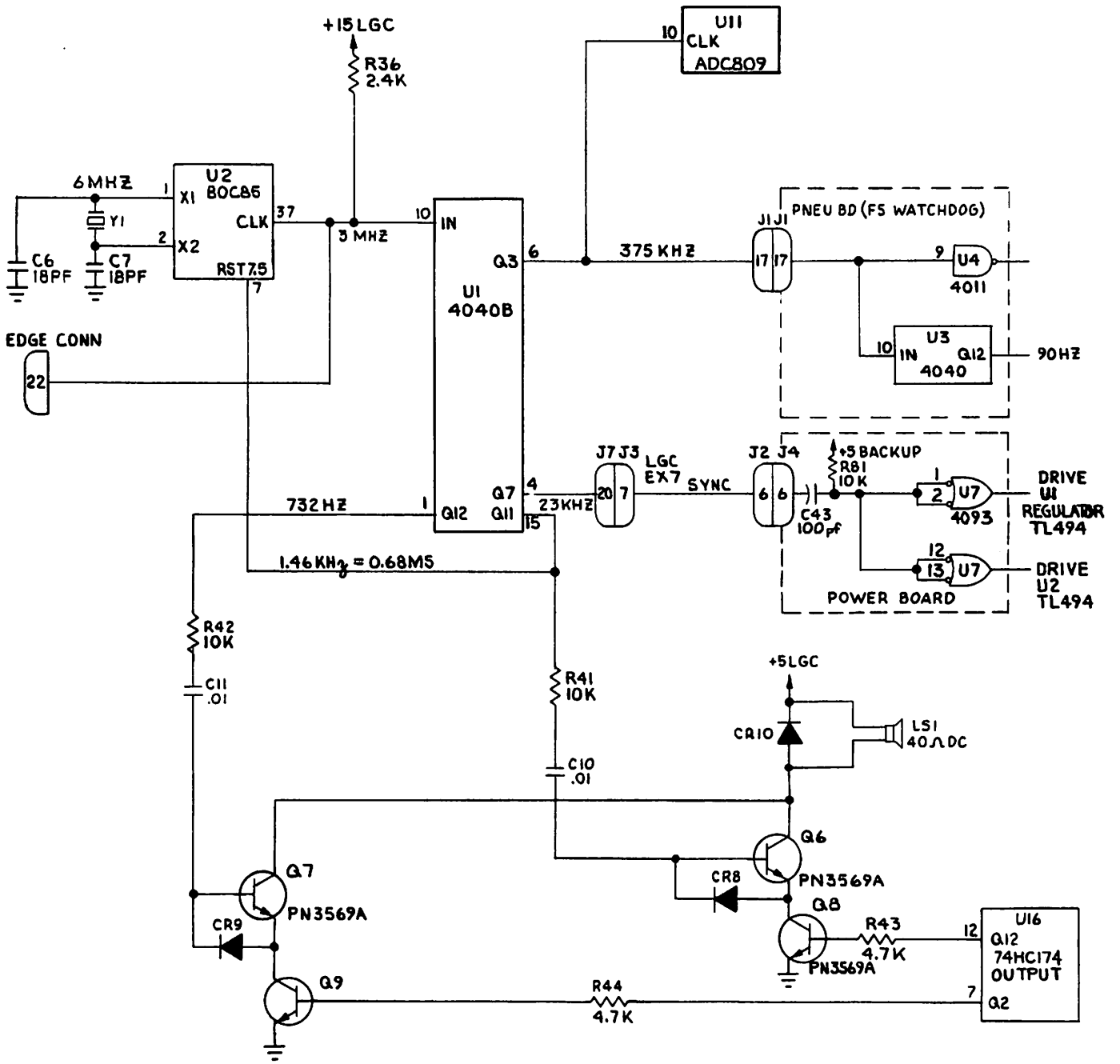


Figure 3-17. System Clock and Audio Alarm Circuit

3-3-10-5 Interrupt System and CPU Serial I/O.

Reset in	:	power-up reset is provided by the R38, C8, and CR7 network.
Trap	:	not used.
RST 7.5	:	driven by a 1.46 kHz clock for internal timer routine update.
RST 6.5	:	not used.
RST 5.5	:	driven by Pneu-U13-4, to signal a new BP measurement cycle.
INTR	:	not used.
Hold	:	not used.
Ready	:	not used.
Reset out	:	used to reset the LG U13 and LGEXT-U2.
Serial input	:	not used
Serial output	:	buffered by Q5. Used to turn the motor/pump on/off.

(See figure 3-18.)

3-3-10-6 User Interface Input (figure 3-19). A CD4532 (U1 on the rotary switch board) encoder is used to encode the ten-position switch S1 for function selections. Eight positions are used. The encoded outputs are passed to LG-U17 and read by the 80C85 as:

Function	P1-7, 5, 4, 10 (Corresponds to D5, D4, D3, D2 on data bus)
MEM	0 0 0 0
MAN	0 0 0 1
SYS	0 0 1 0
1 minute	0 0 1 1
2.5	0 1 0 0
5	0 1 0 1
15	0 1 1 0
30	0 1 1 1
Reserved	1 0 0 0
Reserved	1 0 0 1

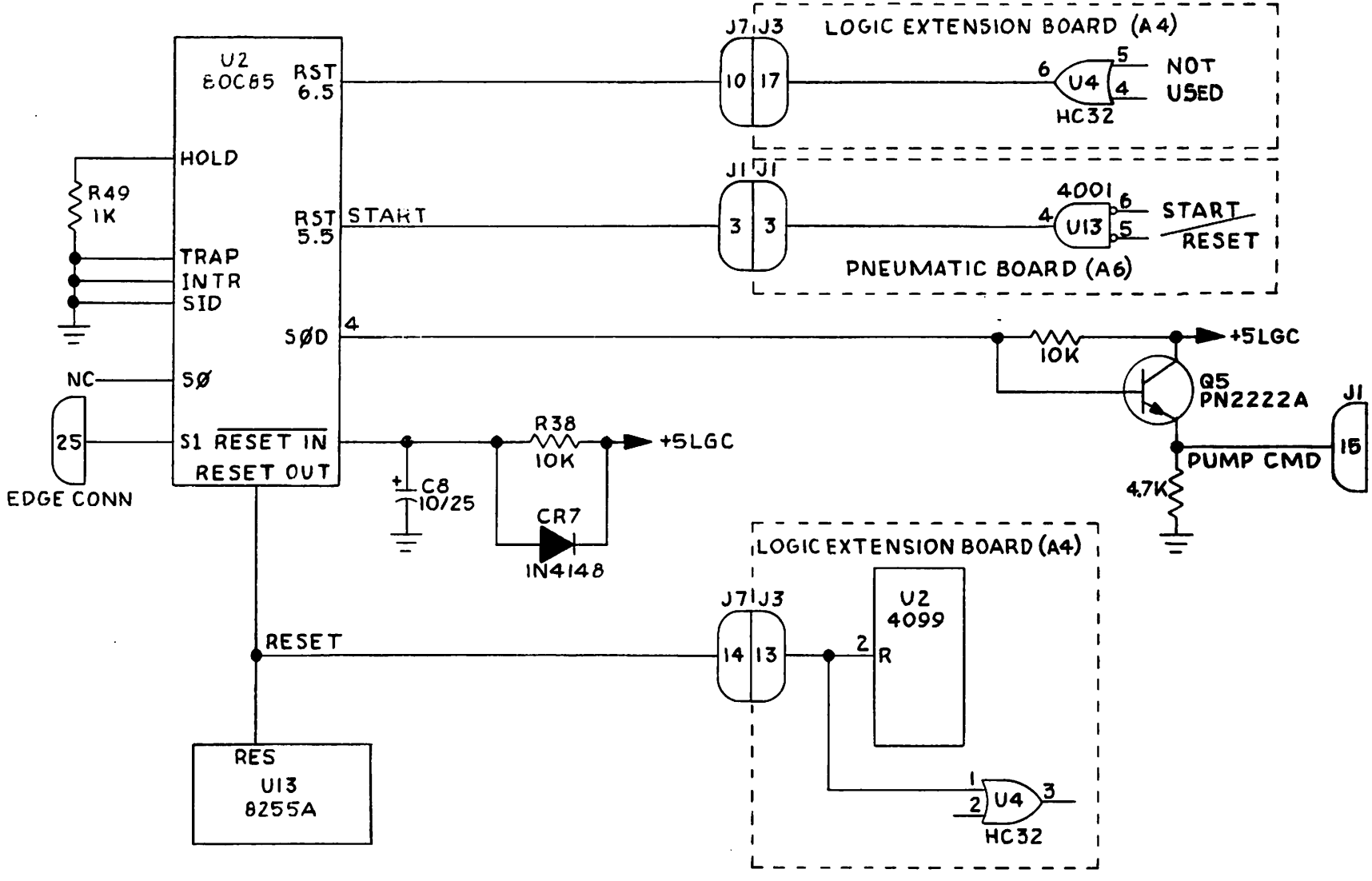


Figure 3-18. 80C85 Interrupt System and Serial I/O

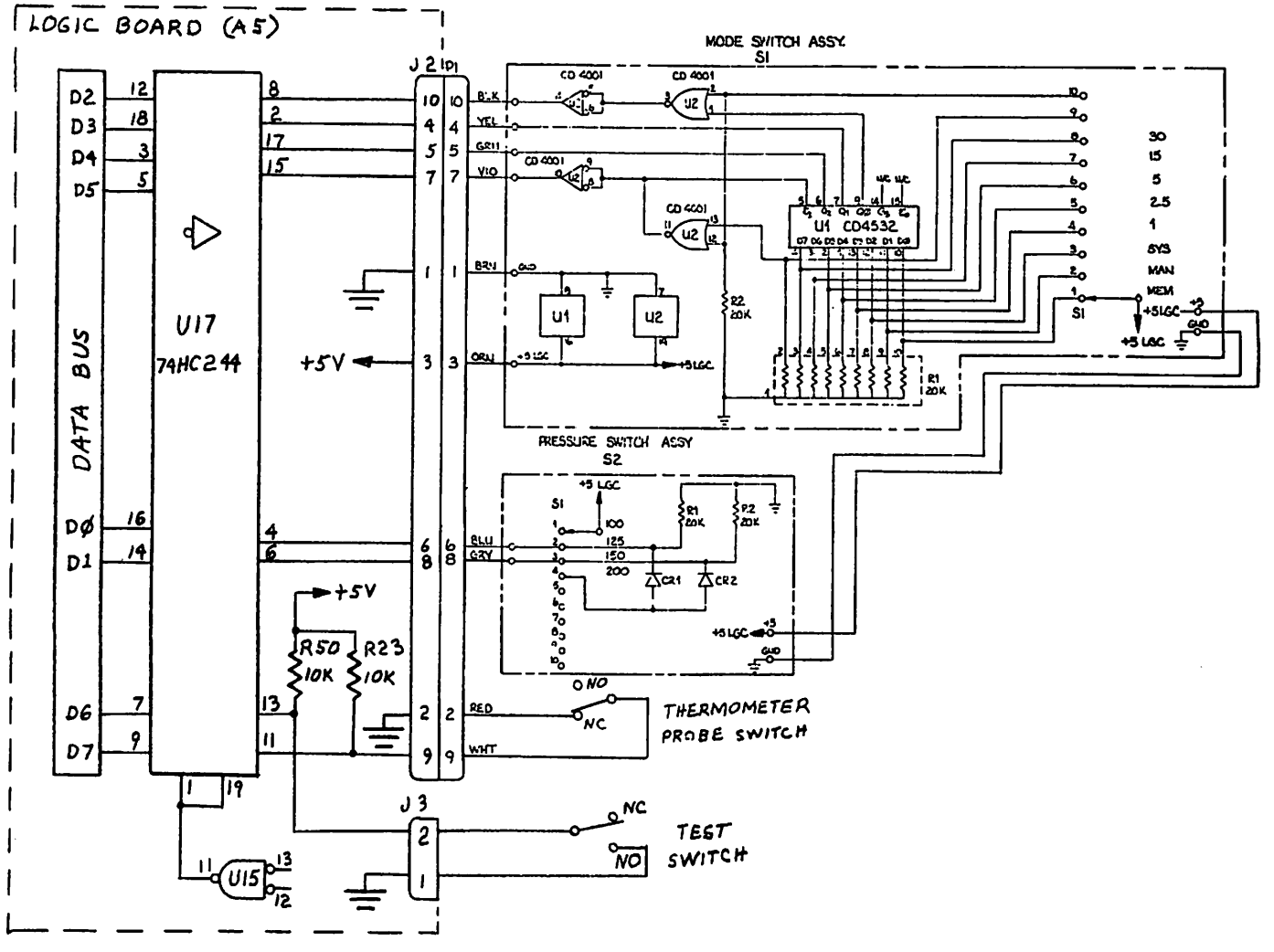


Figure 3-19. Rotary Switch Encoder

The four-position switch S2 selects pressure setting and is encoded by CR1-CR2, R1-R2 as:

Pressure	P1-8, 6 (Corresponds to D1, D0 on data bus)
100	0 0
125	0 1
150	1 0
200	1 1

The thermometer probe switch is encoded as:

Probe Status	P1-9 (Corresponds to D6 on data bus)
Activated	0
Not activated	1

The display test switch is encoded as:

PJ3-2	(corresponds to D7 on data bus)
Activated	0
Not activated	1

3-3-10-7 Failsafe I/O Port (figure 3-20). The 80C85 writes/reads failsafe commands and results via U18/U19. Only six lower bits of the data bus are utilized on the failsafe output port.

3-3-10-8 Failsafe Circuit Power-Up/Commanded Reset (figure 3-21). The failsafe output port is cleared at power-up by RC network C17, R17. The charging actions of R17 and C17 at power-up forces U9-3 and U9-11 Hi. Flip-flop U12-6, 9 latches a Lo at U12-9.

U12-10 generates a Lo level to reset the failsafe output port during U9-11 Hi. This port can also be reset by the 80C85. Writing a Hi on FS5 (to U12-5) sets flip-flop U9-6, 9, forcing U12-10 to go Lo. (See figure 3-21). The time constant of C16-R20 sets flip-flop U9-6, 9 in nominally six seconds after power on in the absence of FS5 being set Hi by the 80C85.

The C17, R17 network forces U10-10 Hi momentarily to reset the failsafe disconnect flip-flop (U10-13 = Lo) for normal operation. Writing a Hi pulse on FS2 (to U11-14) also causes U10-10 go Hi momentarily, resetting the failsafe disconnect flip-flop.

Flip-flop U4-3, 4 is activated by the START/RESET (momentary) pushbutton switch. At power-up, U4-3 is latched at Hi. When the START/RESET switch is activated, U4-3 changes state setting U13-4 Hi. This signal is used to interrupt the 80C85 at the RST 5.5 (Hi level active) pin.

Any time the failsafe flip-flop is activated (U10-13 = Hi), the U4-3 flip-flop output is prevented from interrupting the 80C85 by the gate U13-5 and 6.

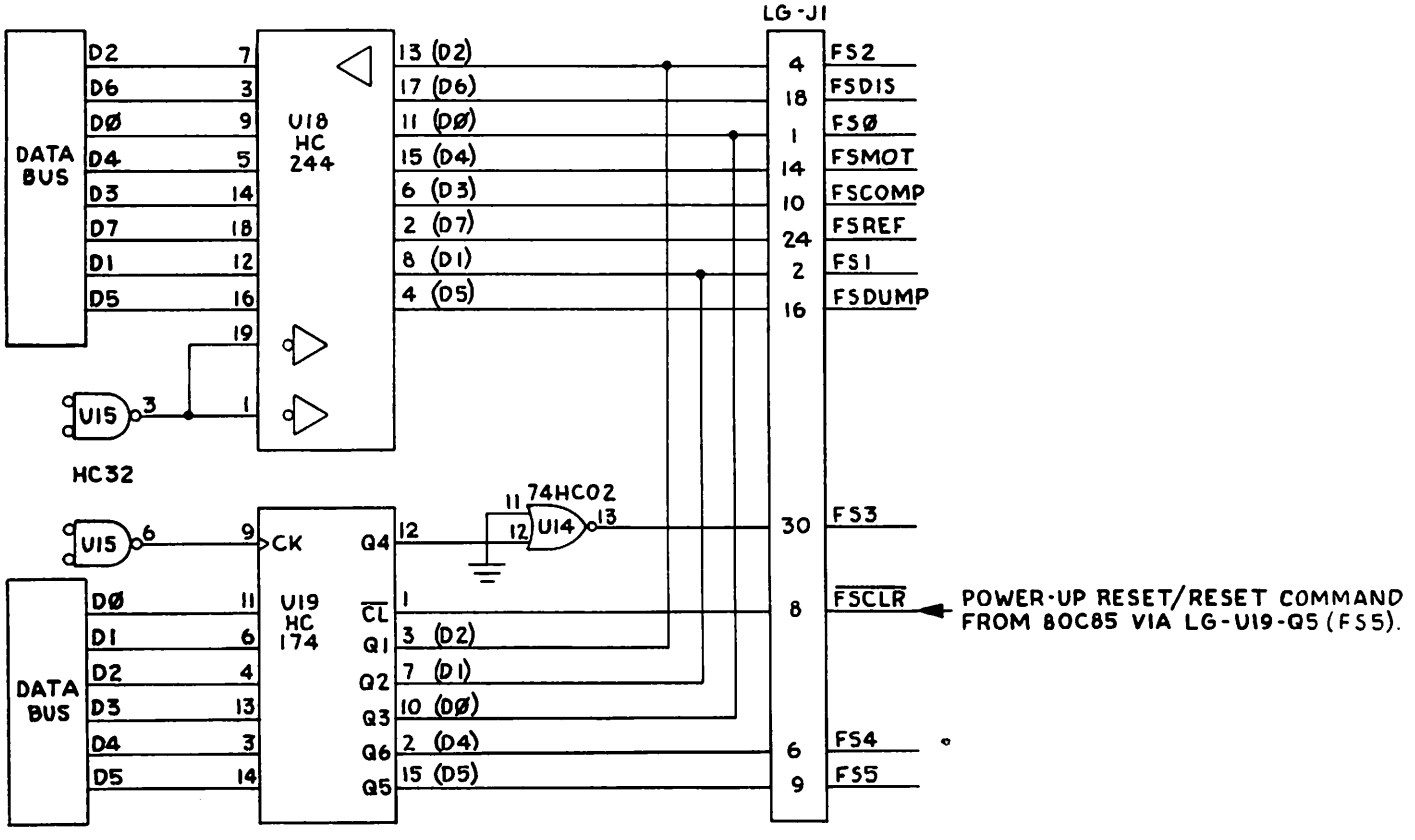


Figure 3-20. Failsafe I/O Port

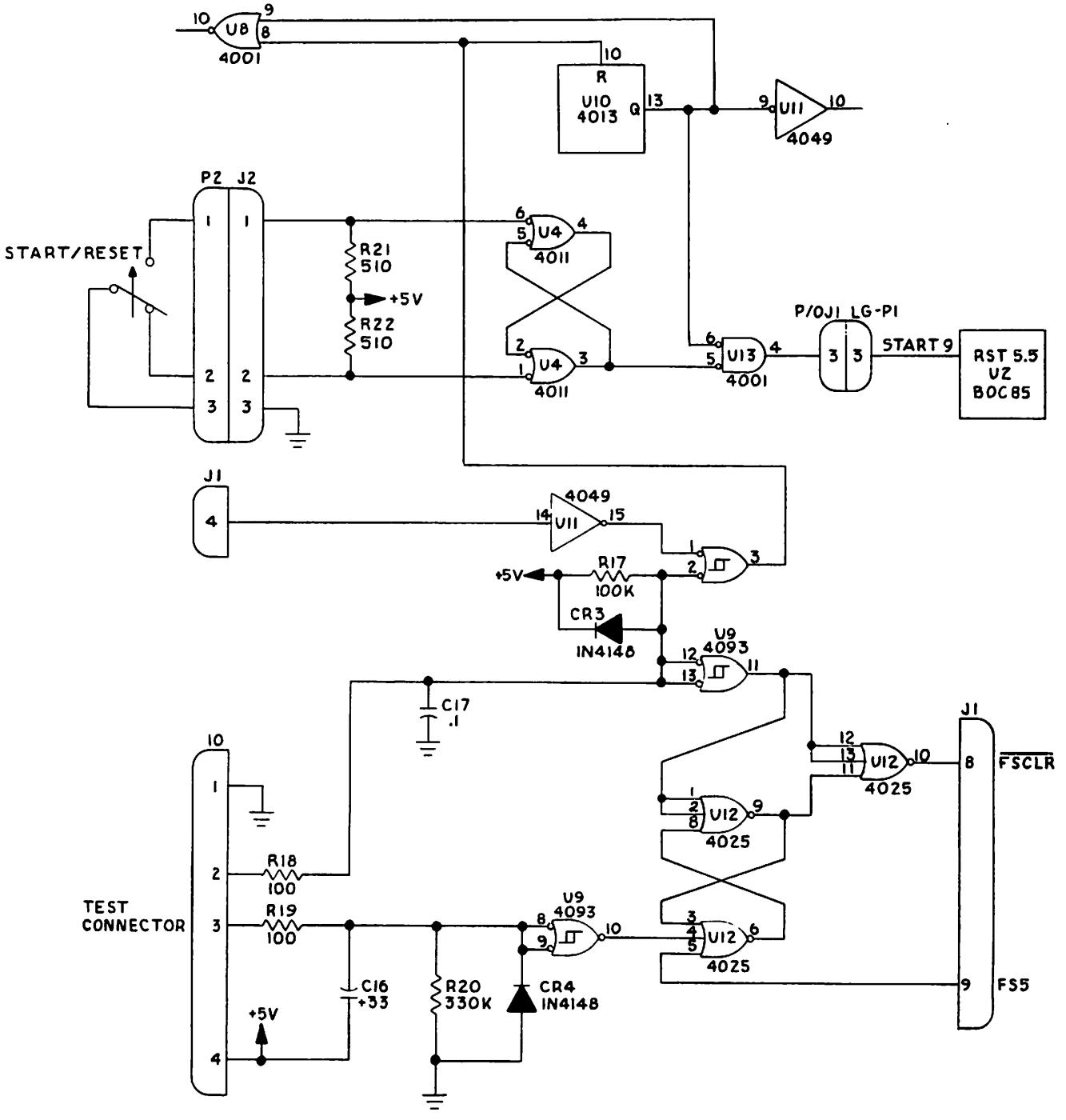


Figure 3-21. Failsafe Circuit Power-Up/Command Reset

3-3-10-8 Watchdog, 4.5 Minute Timer, and Pressure Test Circuits (figure 3-22). R7, R8, R10, and +5REF form a precision reference network for input to a pair of comparators at U2-5, U2-10. The other inputs are tied directly to the output of the analog multiplexer U1. There are four channels in U1, 0A-3A to be selected by the 80C85 by writing FS0, FS1 to U1-10, 9. The four inputs are:

FS1	FS0	Output at A0	Signal
0	0	0A	Scaled down APS (in volts)
0	1	1A	Voltage representing APS < 20 mmHg
1	0	2A	Voltage representing 20 mmHg < APS < 300 mmHg
1	1	3A	Voltage representing APS > 300 mmHg

The 80C85 switches the three higher channels for self-test purposes and the other channel for normal instrument operation. The states at U2-2, 13 are set according to:

Channel Selected	U2-2	U2-13
0A	(according to the sensed pressure signal during normal operation and the truth table set by 1A, 2A, and 3A)	
1A	1	0
2A	1	1
3A	0	1

With U2-13 Hi (representing APS >20 mmHg, test or operation), U13-10 becomes Lo, enabling U7 to count up (4.5 minute timer) from the reset state.

U3 divides the 375 kHz clock down to 91 Hz. By writing to FS3 and FS4 the 80C85 switches 375 kHz (for self-test) or 91 Hz (for watchdog, normal operation) in at U6-1.

U10-4 is held at Hi during normal operation. This keeps U10-1 Lo all the time. U6-4 outputs a 1.43 Hz clock to clock U10 (out at U10-13), enabling the leaker, motor drive, and dump valve circuits.

When the pressure signal goes beyond 20 mmHg, U7 starts counting. U7-2, 3 become Hi together in four minutes, 33 seconds, switching U8-3 from Hi to Lo. The 1.43 Hz clock will clock U10-5 (tied to +5V) out at U10-1 and then at U10-13. This disables the instrument by opening the leaker and dump valve and disabling the pump. If APS drops below 20 mmHg before time-out, U7 will be reset. The cycle will start again when the pressure signal goes beyond 20 mmHg. This feature provides safety by preventing the cuff from being inflated too long.

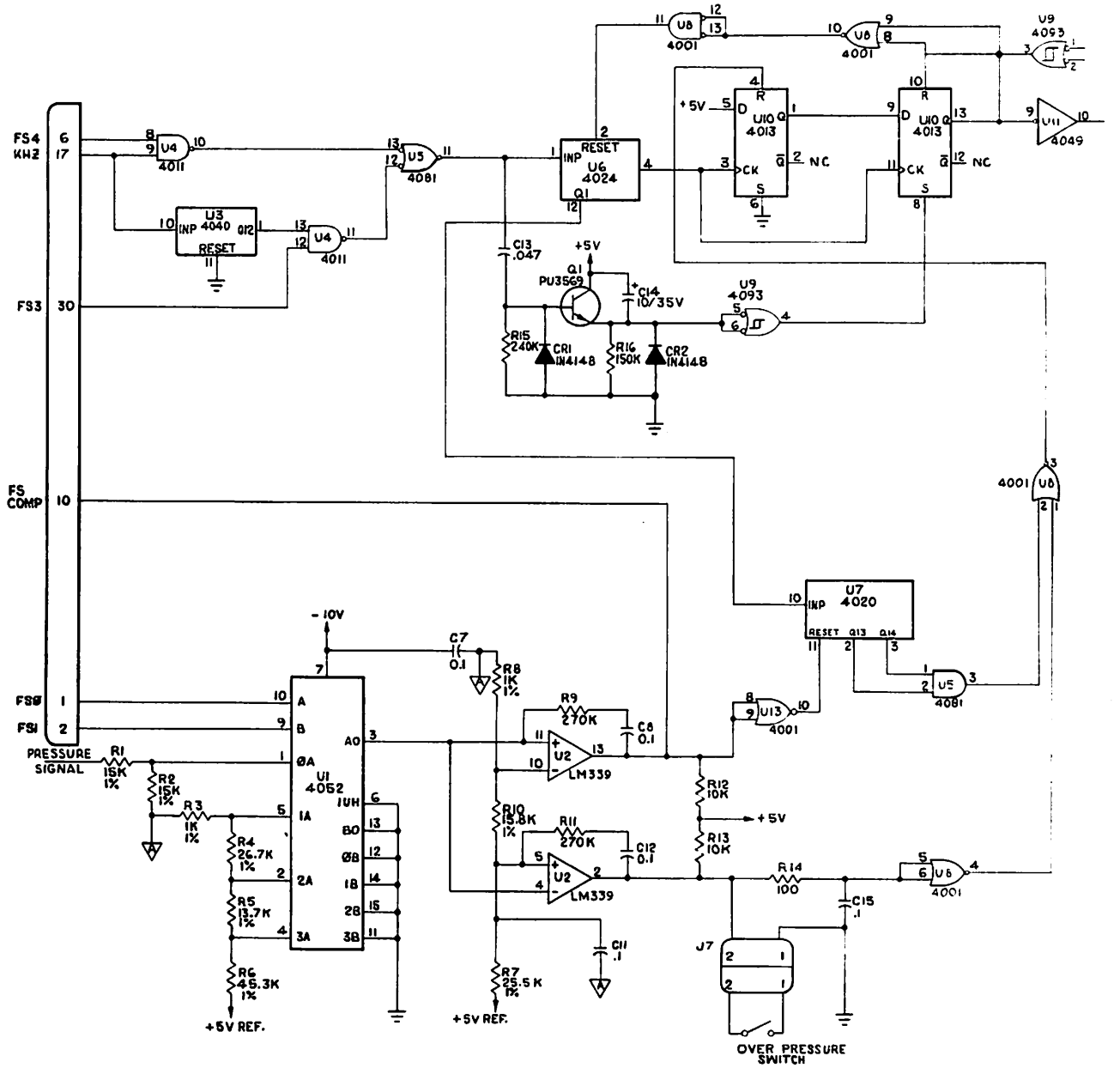


Figure 3-22. Watchdog, 4.5 Minute Timer and Pressure Test Circuits

During self-test, the 80C85 switches in the 375 kHz for clocking the timer. It takes 65.5 milliseconds for time-out, thus allowing the 80C85 to rapidly test the timer circuit.

If the pressure reaches 335 mmHg, the overpressure comparator U2-2 goes Lo, causing U8-3 to switch to Lo. This also disables the instrument, providing overpressure safeguard. A secondary overpressure safeguard is provided by the overpressure switch. If the pressure reaches 350 to 430 mmHg, the switch closes and sets U8-3 Lo to disable the instrument.

3-3-10-9 Stethoscope Amplifier, Leaker, Motor Drive and Dump Valve Enabling Circuits (figure 3-23). When U10-13 is Lo (instrument enabled), Q2 turns on via U11-10 and provides a current path to the leaker through Q3. This current also turns on Q6, via Q4, providing a 12 VDC source for the motor/pump. Q10 also turns on to provide a source for the dump valve. The following table shows the commands needed from the 80C85 to actuate the individual circuits:

Command Mnemonic	Command State	Effect
Pump (J1-15)	1	Q5-7 on, motor runs, microphone muted, FSMOT = 0
	0	Opposite above
$\overline{\text{DFO}}$ (J1-7)	1	Q8, 9 on, dumper closed, microphone un-muted, FSDUMP = 0
	0	Opposite above

Leaker (-) (J1-33) controls the closure of the leaker and is described in section 3-3-10-10. When U10-13 is Hi (instrument disabled), all of the above circuits are disabled regardless of any command from the 80C85. The 80C85 reads the failsafe input port for status and displays the error messages accordingly.

R50, CR8, and R51, CR9 form a diode OR-gate and drive Q12 to mute the stethoscope amplifier while the motor is running or the instrument is disabled or idle. U15 is an audio-preamp driving a push-pull amplifier formed by Q13, 14 and the associated components. The feedback path, C28, R54, and R60, provides a gain of 20 for the amplifier.

3-3-10-10 MCS, RPS, APS, DAC, and Leaker Control Circuits (figure 3-24). On the logic board, the cuff microphone signal is coupled via C13 to the preamp U20-14 having a gain of 4.3. The second stage, with a gain of 5.6, is level shifted by R29, R30, R35 to a 2.5V quiescent level. The output is bounded by a clamp circuit formed by U20-7, 8, CR11, 12, and R34. The output level is confined between -0.5V and +5.05V, and input to the ADC (U11-26, channel 0).

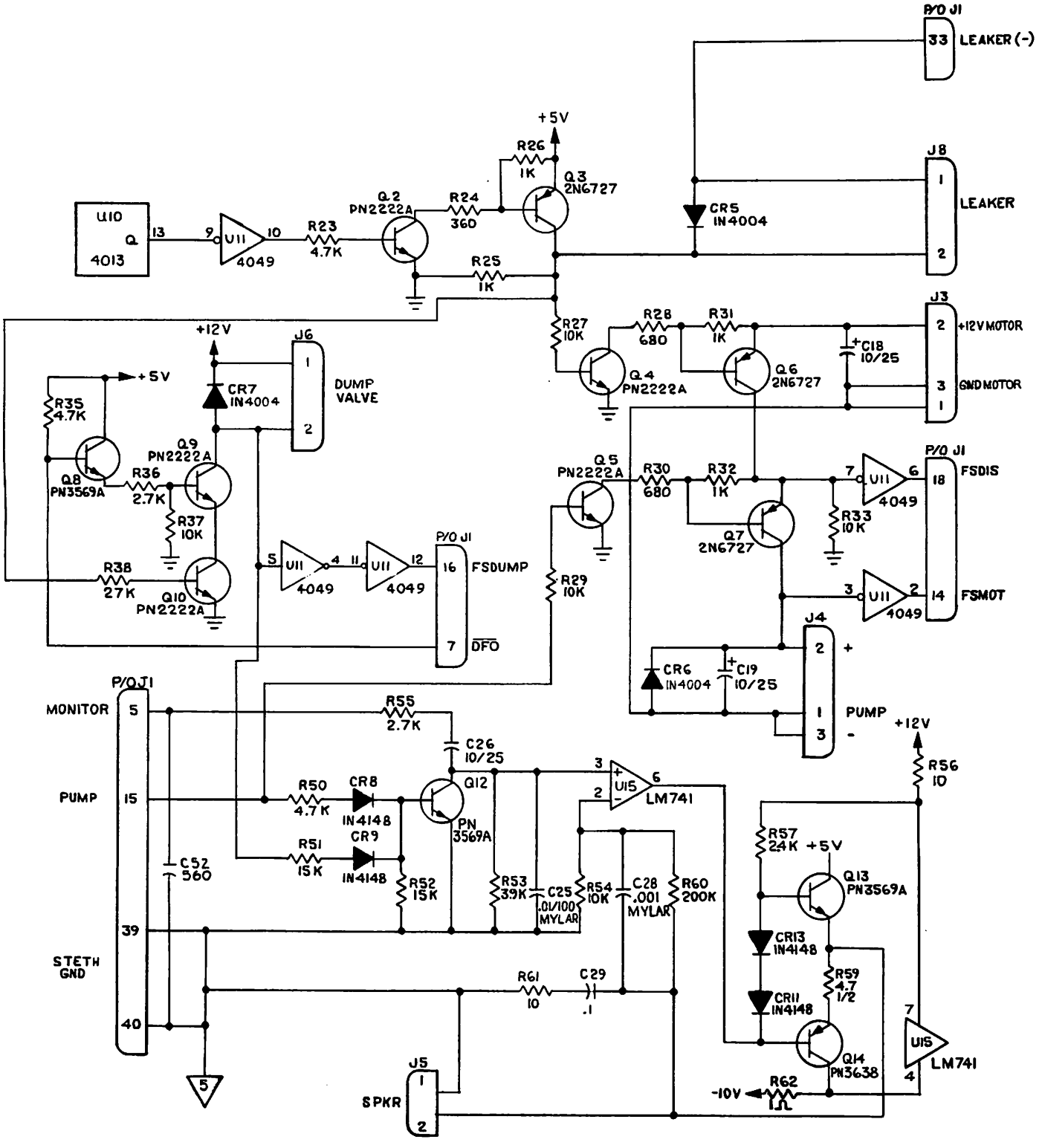


Figure 3-23. Stethoscope Amplifier, Leaker, Motor Drive, and Dump Valve Enabling Circuits

On the pneumatic board, U14-1 and Q11 set the pressure transducer excitation voltage at 8V to yield an output of 12 mV/mmHg. The output is calibrated by R41 (span) and R45 (zero). The output signal is buffered by U14-7. On the logic board, this signal pressure combines with the DAC output (U12-18) at U10-6 (a differential amplifier) to yield the RPS for input to U11-27 (ADC channel 1). APS is the pressure signal scaled by R9 and R10, and output to U11-28 (ADC channel 2). The RPS signal is clamped by U10-14, 1 and CR1, CR2 to be within -0.05V and +5.05V.

A center adjustment (R43 on the pneumatic board) is provided to bias the leaker to compensate for variations. On the logic board, Q3, C3, CR4 and R16 act as a slew rate limiter, preventing the leaker from reacting to arterial pressure pulses in the pressure signal.

Signal $\overline{\text{LFO}}$, when Lo, forces the leaker open via U10-8 and Q1, the leaker driver. Signal LSO when Hi, overrides all other leaker controls and forces the leaker tightly closed.

When the 80C85 wants to deflate the cuff, it issues twelve-bit values to U12 (DAC). The analog output of the DAC combines differentially with the sensed pressure voltage, resulting in a difference (or error) voltage at U10-7. U10-8 inverts this voltage to drive Q1-B, which controls the opening of the leaker, maintaining RPS at a value of approximately 2.5 volts. R6 and R5 serve to scale and offset the difference in voltage at U10-7, yielding RPS.

Q1 is a power amplifier configured as an emitter follower which carries the rather heavy leaker coil current. R14-R12 set the leaker driver loop gain.

Q2 clamps the input at U10-9 to prevent U10-8 from going negative.

R7 feeds a sample of the actual pressure signal to the leaker driver to compensate for different flow rates in the leaker orifice at different pressures.

The 80C85 reads the setting of S1 for various types of functions. See software description, section 3-4 for details.

3-3-10-11 BP System Information Displays (figures 3-25, 3-26, and 3-27). The systolic, diastolic, MAP, and pulse each have a three-digit display. They are segmented into two groups using common cathode seven-segment LED displays. Two MM74C912 (U1 and U2) are used to latch the data written in by the 80C85. The MM74C912 is a BCD to seven-segment latch, decoder, driver, and self-scan multiplexer. Each MM74C912 is able to multiplex up to six digits plus decimal points. The 80C85 uses four lower data bus bits to write the BCD-formatted numerical data into U1 and U2. Data bus line 4 (D4) is used to convey the decimal point information. See table 3-1 (memory map) for address allocation.

Each segment is current-limited by R9 and R10. Each digit is strobed by a MOSFET (SPI 1117), Q14-Q18, Q20-Q25.

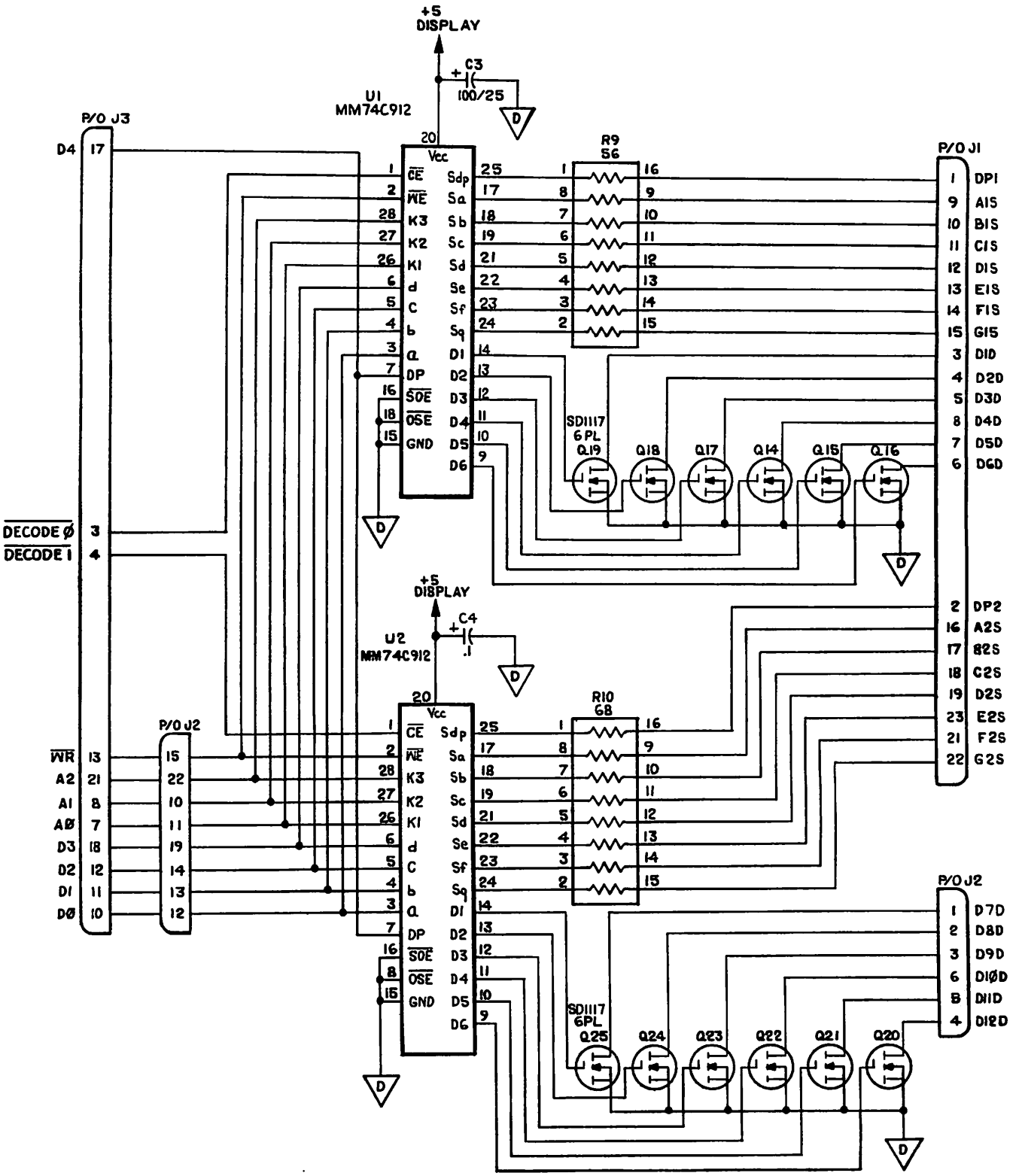


Figure 3-25. BP System Display Latch, Decoder and Driver

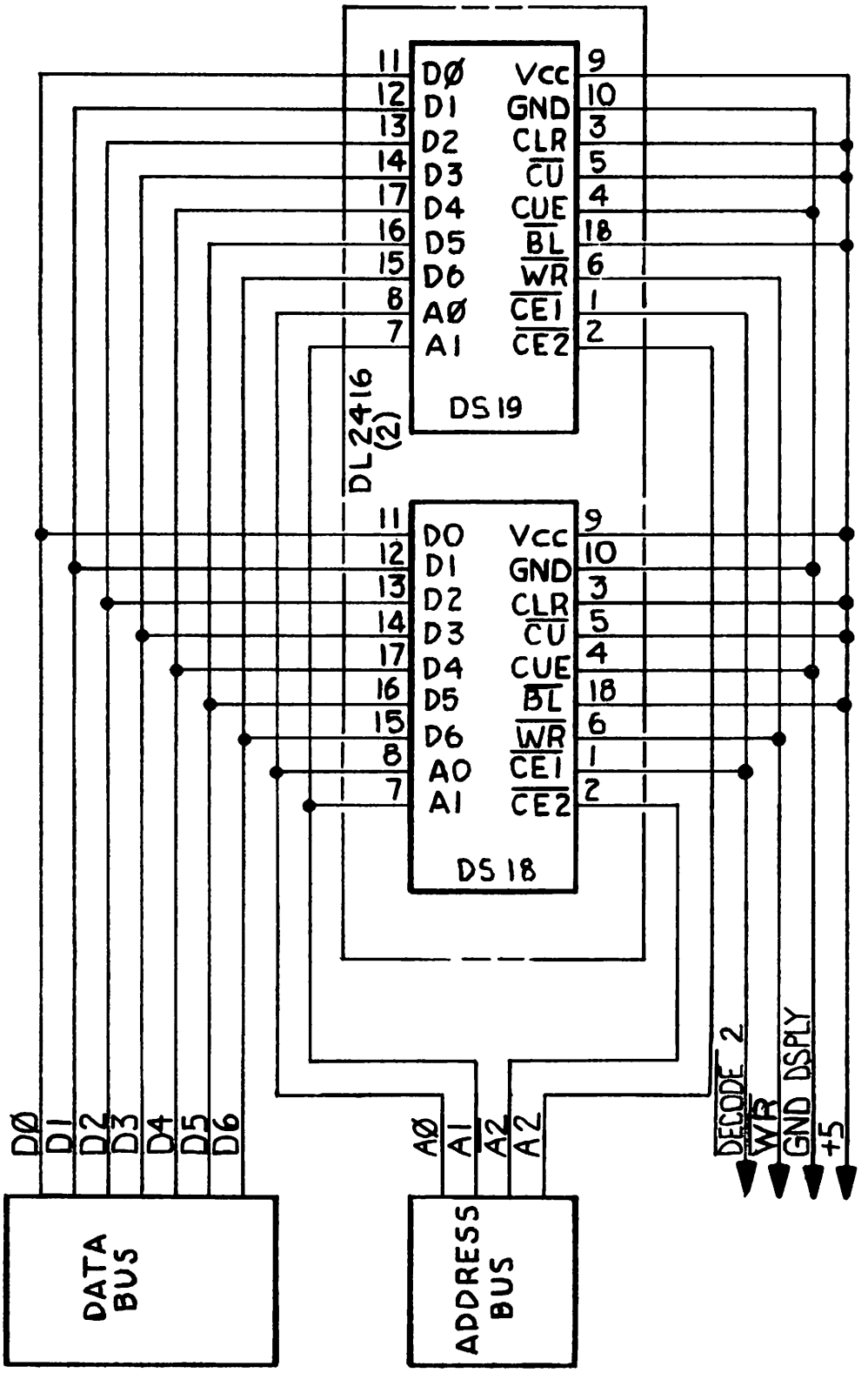


Figure 3-26. Information Display

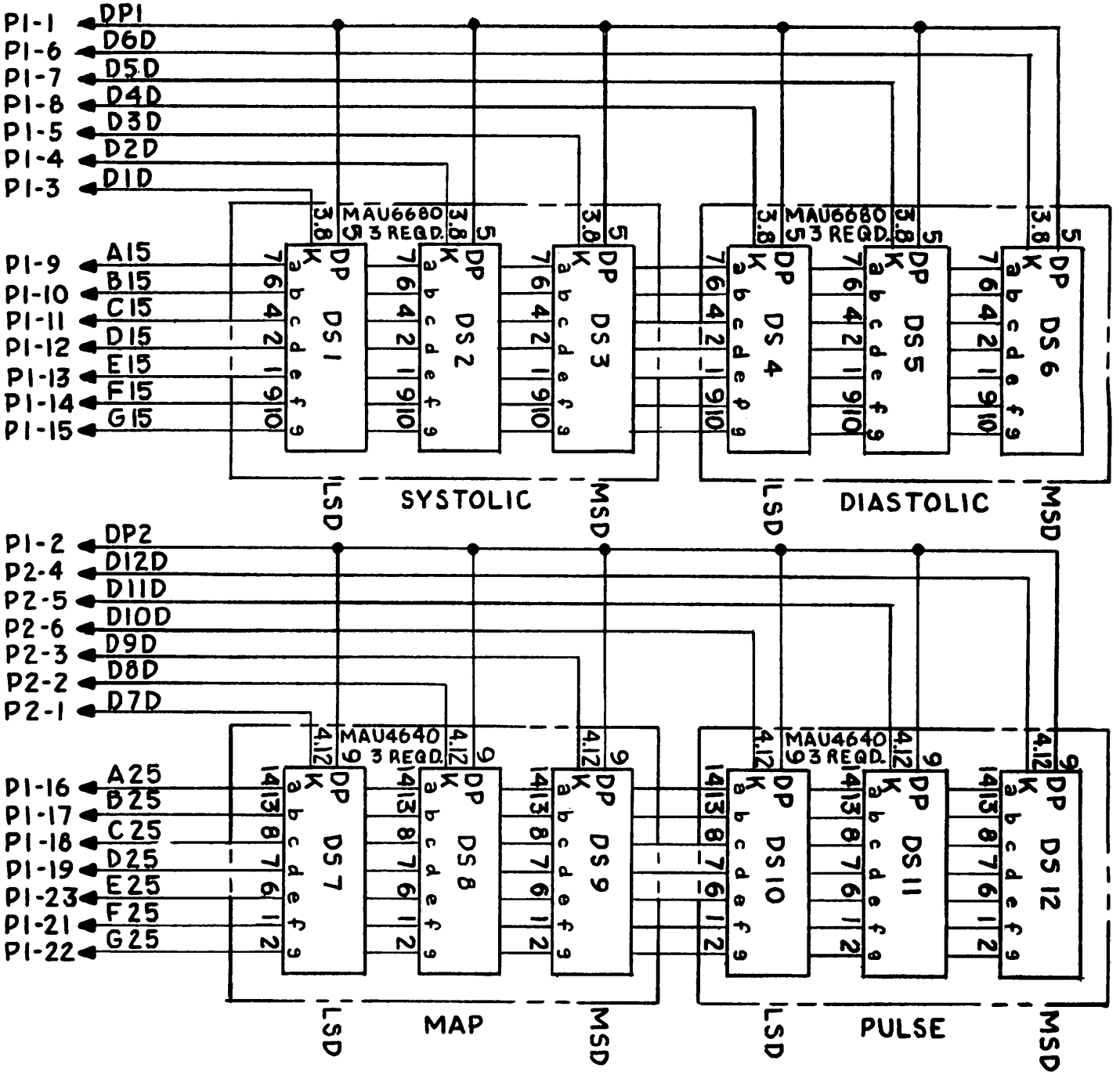


Figure 3-27. BP System Display

The information display consists of two DL2416 intelligent LED displays. The DL2416 (four digits) contains RAM, ROM decoder, multiplexer, and driver. It accepts seven-bit ASCII code directly from the 80C85 (D0-D6). The information display is configured as a write-only memory from the 80C85. See table 3-1 (memory map) for address allocation.

3-4 SOFTWARE

The VITAL•CHECK monitor contains two entirely separate programs, one for the thermometer and one for the blood pressure monitor. The thermometer program resides in 2k x 8 of ROM which is located inside the COP444L microprocessor. The blood pressure monitor program resides in two 8K x 8 EPROMs and is executed by an 80C85 microprocessor.

3-4-1 Thermometer Program

The thermometer program is a noninterrupt-driven program that performs tasks based on the settings of the DISPLAY TEST, ^{O}F-^{O}C, and P-M switches, and on the internal probe on/off switch (activated by removing the probe from or replacing it into the storage well on the front of the monitor). A description of the program operation and features is integrated with the electronics description of the thermometer (see paragraph 3-2-1 and section 3-3.

3-4-2 Blood Pressure Program

The blood pressure monitor program is organized into twelve modules that are linked together at load time. Three modules and a segment of another module perform interrupt processing tasks. The remainder perform the following tasks:

a. Cuff inflation or pump-up
b. Deflate
c. Compute blood pressure
d. Calibrate
e. Offline display test
f. Diagnostic tests
g. Redisplay values (memory mode)

Figures 3-28 through 3-30 depict program operation in flowchart form. The main program flow is shown in figure 3-28. Processing for the two interrupts is flowcharted in figures 3-29 and 3-30. The two interrupts are the START/RESET switch and the time base interrupt, occurring approximately every 683 microseconds.

When power is first applied, software diagnostics of memory and the failsafe hardware are executed. If a malfunction is detected at this time, the program will display a FIX ME message and halt. Upon completing the diagnostics, the program initializes various timers and other data values and finally enters a wait loop. The program exits the wait loop to start a blood pressure measurement when the auto start condition is detected or when the START/RESET interrupt occurs. While in the wait loop, the program checks that the pump motor is off and that the cuff pressure does not exceed 20 mmHg for longer than 20 seconds. If either test fails, the VITAL•CHECK monitor will display a FIX ME message. Also during wait, it tests the internal switches to see if the calibrate mode has been selected.

When a blood pressure measurement has been requested, the program enters the inflate cycle. When inflation is complete, the deflate and data-taking cycle is entered. Finally, the program computes the blood pressure and returns to the wait loop.

The START/RESET interrupt program (figure 3-29) determines what function the operator has requested and responds accordingly. The program does not return control to the interrupted location. Instead, it passes control to the main program at the location shown. The START/RESET interrupt can be disabled; it is disabled, for example, during memory mode. In memory mode, the program polls (or monitors) the state of the START/RESET switch instead of using the interrupt.

The time base interrupt program executes one of several branches each time the interrupt occurs (see figure 3-30). The program is organized so that each branch is executed periodically. For example, the microphone signal is sampled and processed every two milliseconds. When execution of a branch is completed, control returns to the interrupted program unless a failsafe error condition is detected. The time base interrupt is disabled when the VITAL•CHECK monitor offline display test is being executed, and at power on when the diagnostics are performed.

3-4-3 Hardware Checks

The computer program tests the VITAL•CHECK monitor's hardware for unsafe conditions, initially at power-on and periodically. If such a condition is detected, the VITAL•CHECK monitor beeps audibly five times and displays a FIX ME x message (where x is a number or letter identifying the type of problem encountered). The values for x and a summary of their meanings appear in tables 3-2 and 3-3. The computer program halts after displaying the message and can only be restarted by cycling the power switch on and off. Tests for FIX ME conditions 0, 2, and A through K are run only once each time power is applied; tests for conditions 4, 5, L, and N are performed periodically.

Tests corresponding to messages A through N are executed by comparing the value of the failsafe input port, FAIL1 (60 HEX), with an expected value. The failsafe output port, FAIL0 (60 HEX), is used to simulate conditions for tests corresponding

to messages D through K. Both the expected input code and the output code (where appropriate) are listed in table 3-3. Table 3-4 summarizes the meanings of the bits on the failsafe input and output ports.

When the comparison test is made, failsafe input bits 0 through 6 must match the expected input code (failsafe bit 7 is not used and is masked by the software). If they do not match, the program displays the FIX ME message for the particular test being run and outputs to the PULSE display, in octal representation, the actual value of the failsafe input port.

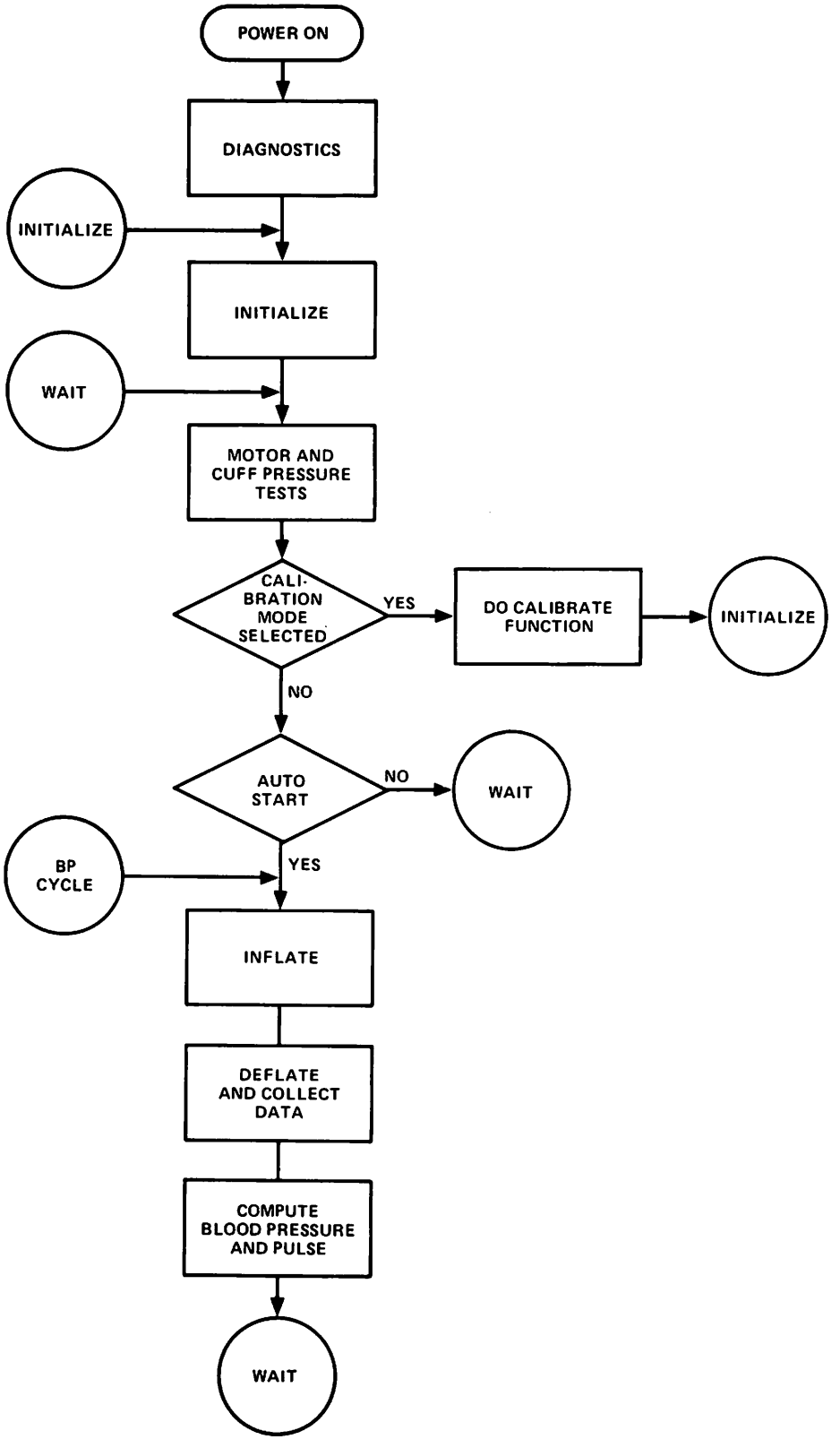


Figure 3-28. Main Program Flowchart

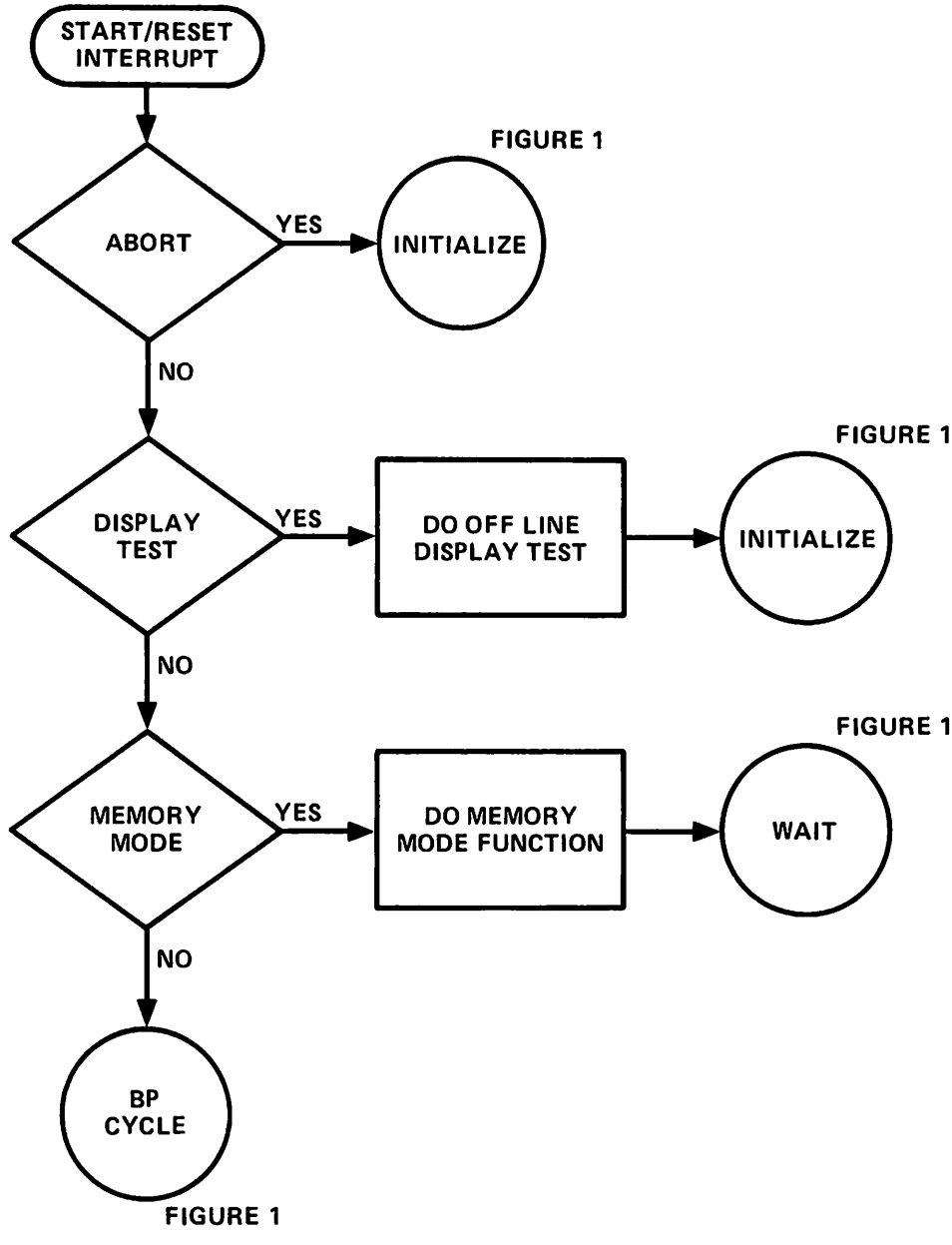


Figure 3-29. Start/Reset Interrupt

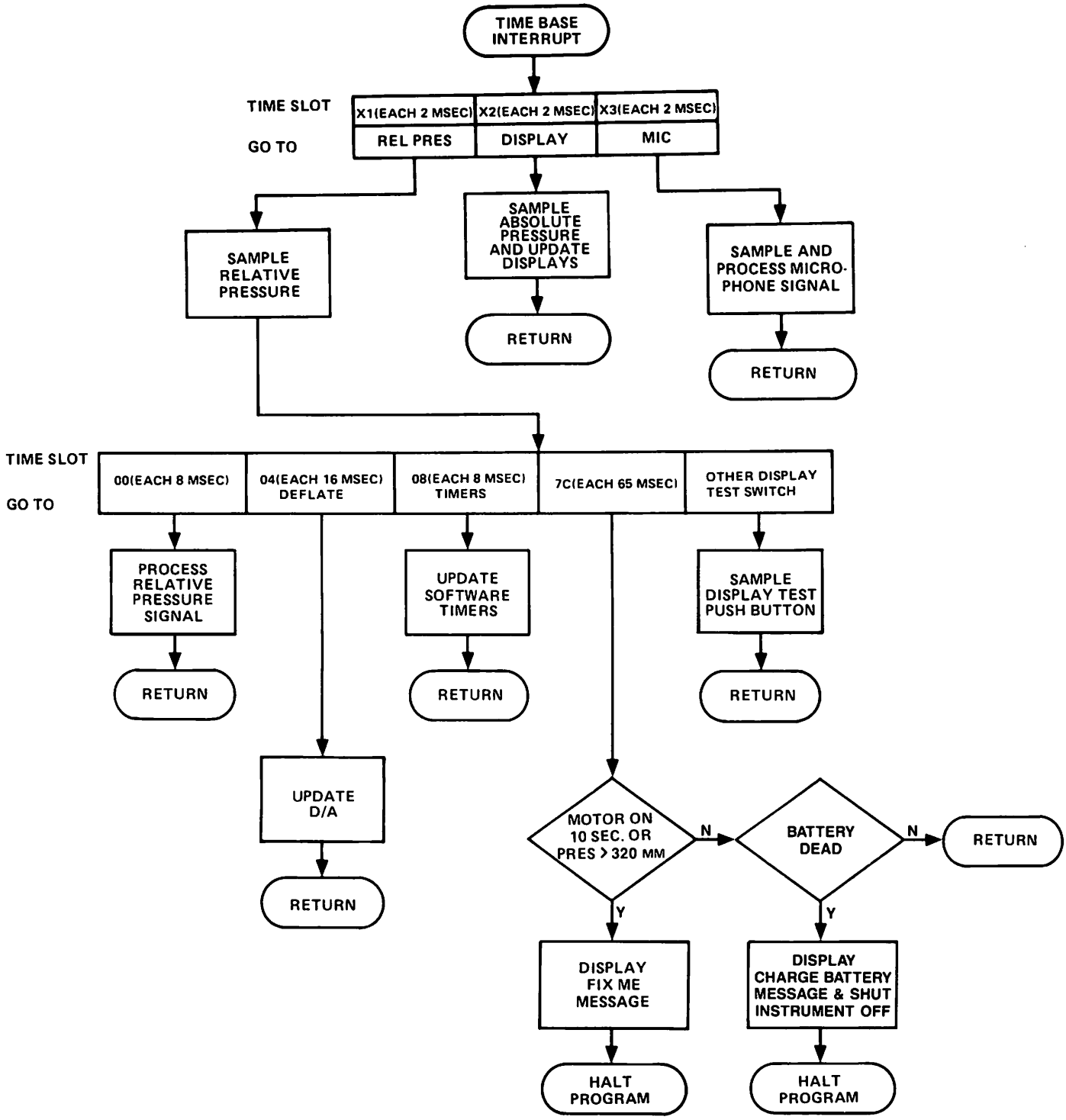


Figure 3-30. Time Base Interrupts

Table 3-2. FIX ME Alarms

FIX ME	Description
0	RAM fails read/write test
1	Not used
2	CRC check of EPROM program memory fails
3	Program attempted to execute nonexistent program memory
4	Pump motor on for 100 seconds
5	Cuff pressure equal to or greater than 320 mmHg
A-N	Refer to table 3-3

Table 3-3. Summary of A to N Alarm Conditions

Message Code	Type of Test	Expected Result Input 60 HEX (FAIL1)	
		Binary	Octal
A	Initial power-on state	0110000	060
B	Check dump valve closed bit	00010000	020
C	Check pump motor on bit	00100000	040
D	Simulated pressure less than 20 mm; OUT60 = 00000001	00110001	061
E	Simulated pressure is between 20 mmHg and 400 mmHg; OUT60 = 00000010	00111010	072
F	60 Hz watchdog; OUT60 = 00001000	01110000	160
G	Disable on over pressure; OUT60 = 00011011	01111011	173
H	4.5 minute timeout at less than 4.5 minute; OUT60 = 00011010	00111010	072
I	4.5 minute timeout, time greater than 4.5 minute; OUT60 = 00011010	01111010	172
J	Test disconnect from failsafe; OUT60 = 00100101	00110000	60
K	Test can reset disconnect F/F U6; OUT60 = 00000100	00110100	64
L	Pump off, dumper open while at idle state	00110000	60
M	Pressure greater than 20 mm for 20 seconds while at idle state	00110000	60
N	20 mm Sense Signal, FSCOMP, inoperative	0XXX1XXX	N/A

Table 3-4. Failsafe I/O Ports

Input Port 60 HEX (FAIL1)

Bit	7	6	*	5	4	3	*	2	1	0
Mnemonic	0	FSDIS		FSDUMP	FSMOT	FSCOMP		FS2	FS1	FS0

FSDIS 0 = Failsafe OK
1 = Alarm condition, system disconnected by failsafe hardware

FSDUMP 0 = Dumper closed
1 = Dumper open

FSMOT 0 = Pump on
1 = Pump off

FSCOMP 0 = Pressure less than 20 mmHg
1 = Pressure greater than 20 mmHg

FS2-FS0 See output

Output Port 60 HEX (FAIL0)

Bit	7	6	*	5	4	3	*	2	1	0
Mnemonic	0	0		FS5	FS4	$\overline{FS3}$		FS2	FS1	FS0

FS5 1 = Disconnect failsafe from S/W control

FS4	$\overline{FS3}$	Clock Select
0	0	60 Hz clock
0	1	Neither clock
1	0	Both, not allowed
1	1	375 kHz clock

FS2 1 = Reset alarm, FSDIS (when under S/W control)

FS1, FS0 select inputs to pressure comparators

FS1	FS0	Selected Cuff Pressure
0	0	Actual cuff pressure
0	1	Simulated less than 20 mmHg
1	0	Simulated equal or more than 20 mmHg
1	1	Simulated pressure of more than 400 mmHg

CHAPTER 4
TROUBLESHOOTING

4-1 INTRODUCTION

This chapter provides help in troubleshooting the VITAL•CHECK Monitor should repair be necessary. The troubleshooting tables are divided into two sections to cover the blood pressure and thermometer functions; each section contains descriptions of possible alarms or malfunctions which could be encountered in operating the instrument. Referring to this chapter before attempting to service, repair, or replace any component will save time and may avoid unnecessary repair. In addition, chapter 3, Functional Description, may aid in detecting failures. Should a problem occur, first ensure:

a. That the instrument is being operated properly.
b. The integrity of the cuff.
c. The correct installation of the connectors inside the instrument.

WARNING

Disconnect AC power and battery pack connector whenever unplugging or replacing connectors or components.

CAUTION

Follow procedures for preventing static electricity any time you are working on the instrument. Failure to do so could cause damage to the static-sensitive components used in the instrument.

4-2 TABLES

The tables contained in this chapter are:

a. Table 4-1. BP System Troubleshooting Guide
b. Table 4-2. Thermometer System Troubleshooting Guide
c. Table 4-3. Voltage Specifications
d. Table 4-4. Connector/Signal List

Table 4-1. BP System Troubleshooting Guide

Instrument Malfunction		
Trouble	Probable Cause	Solution
Instrument completely inoperative	Dead electrical outlet and dead battery	Plug into live outlet.
	Loss of continuity in AC input circuits	Check continuity of line cord, circuit breaker and transformer windings.
	Defect on power regulator board	Check power supply voltages and power supply harness integrity.
	Defective 6 MHz crystal or microprocessor inoperative	Check for 3 MHz square wave at U2-37 on logic board.
		If voltages are correct, but no 3 MHz square wave is present, replace U2, then Y1 on logic board.
	Circuit breaker tripped	Reset circuit breaker.
	Circuit breaker trips repeatedly	Check for shorted windings or shorts between windings on power transformer, or shorted CR1-CR4 on power regulator board.
Instrument completely inoperative, but charge light is on while operating on AC	Blown fuse F1	Replace F1 on power regulator board.
	Clad fuse open	Repair blown clad with #26 bus wire.
Instrument completely inoperative while operating on battery	Dead or defective battery pack	Replace battery pack with full charge.
	Clad fuse open	Repair blown clad with #26 bus wire.
	Battery pack connectors loose	Check integrity of battery pack connectors.

Table 4-1. BP System Troubleshooting Guide (Continued)

Instrument Malfunction		
Trouble	Probable Cause	Solution
Instrument inflates to other than selected pressure; instrument enters operating mode other than mode selected	Knob slipped on switch	Reposition knob and tighten.
	Open connection in switch harness	Inspect harness and repair broken connections.
	Defective switch	Replace switch.
	Defective U17 on logic board	Replace U17.
	Defective U1 on rotary switch board	Replace U1.
DISPLAY TEST button inoperative	Open connection in harness	Inspect harness and repair.
	Defective switch	Replace switch.
	Defective U17 on logic board	Replace U17.
High and low beep tones absent	Defective speaker (LS1) on logic board	Replace speaker if resistance does not measure 45 ±5Ω.
	Defective U1 on logic board	Replace U1 if no signal is present at pins 1 and 15 (if the 3 MHz CLK signal is present at U1-10).
	Defective U7, U15 on logic board	Replace U15, then U7.
High beep tone absent	Defective Q6, Q8 or associated components on logic board	Check Q6, Q8 and associated components, and replace defective component.
	Defective U1 or U16 on logic board	Replace U1 if no signal at pin 15, otherwise replace U16.

Table 4-1. BP System Troubleshooting Guide (Continued)

Instrument Malfunction		
Trouble	**Probable Cause**	**Solution**
Low beep tone absent	Defective Q7, Q9, or associated components on logic board	Check Q7, Q9 and associated components, and replace defective component.
	Defective U1 or U16 on logic board	Replace U1 if no signal at pin 1, otherwise replace U16.
START/RESET switch has no effect	Failsafe 4 1/2 minute time-out or overpressure or other failsafe fault	Cycle the instrument's power off and on to reset the instrument.
	Defective switch or broken connection in switch harness	Inspect switch harness and repair or replace switch if no continuity present.
	Defective 40-conductor cable	Replace cable.
	Defective U4, U13 on pneumatic board	Replace U4 if U4-3 does not go to a logic 0 when switch is actuated, otherwise replace U13.
	Defective U2 on logic board	Replace U2.
No sound in stethoscope, no flashing asterisk during blood pressure measurement, instrument always indicates BP*READY (oscillometric measurement)	Defective cuff	Replace cuff.
	Defective U20 or associated components on logic board	Apply 100 mV, 10 Hz signal to the MIC HI point on the logic board and trace the signal through U20 to U11-26. Voltage gain should be approximately 24.
No sound in stethoscope, but instrument displays flashing asterisk during blood pressure measurement and takes auscultatory measurements	Defective 40-conductor cable	Replace cable.
	Defective Q12 or associated component on pneumatic board	Check operation of Q12 during BP cycle to ensure it is turned off during deflation.
	Defective U15, Q13, Q14, speaker, or associated components on pneumatic board	Apply a 100 mV, 50 Hz signal to MIC HI on the logic board, place the instrument in the CAL mode with the MODE switch set to MAN. Trace the signal from U20 on the logic board to U15-6 on the pneumatic board.

Table 4-1. BP System Troubleshooting Guide (Continued)

Instrument Malfunction		
Trouble	Probable Cause	Solution
	Defective speaker (positioned behind the stethoscope connector)	Speaker should measure between 200-500 Ω. Replace of open or shorted.
Excess noise in stethoscope	No stethoscope muting; defective Q12 or associated components on pneumatic board	Check Q12 for approximately 0.7V at base except during deflation cycle.
Alarms		
CUFF TOO LOOSE OR AIR LEAK (pump runs)	Cuff loosely applied	Properly apply cuff.
	Cuff improperly connected to instrument	Properly mate cuff connector with receptacle on instrument.
	Leaky cuff	Replace cuff.
	Pressure port cover on rear of instrument loose or not sealed	Check and firmly tighten cover hand-tight, being careful to avoid cross-threading cap. Check that the O-ring is present and not damaged inside the cover.
	Internal pneumatic system leakage	With the instrument in the CAL mode, manually inflate the pneumatic system with the calibration fixture. The MODE switch must be in the MAN position.
		One at a time, using a pair of small pliers, pinch the tubes connecting to the leaker, overpressure switch, dump valve, pressure transducer, and pump to isolate leak.
	Leaker not sealing	Replace leaker if approximately 4V is present across coil.
		If approximately +5V is absent at J8-2 on pneumatic board, check Q3 and associated circuitry.

Table 4-1. BP System Troubleshooting Guide (Continued)

Alarms		
Alarm	Probable Cause	Solution
CUFF TOO LOOSE OR AIR LEAK (pump runs) (continued)		If +5V is present, but J8-1 is not less than +1V, check Q1, Q4, U13, and associated components on logic board.
		Check for open conductor in 40-conductor flat cable.
	Overpressure switch leaking	Replace overpressure switch.
	Dump valve leaking or not closed	Replace dump valve if approximately 12V present between J6-1 and 2 on the pneumatic board.
		If 12V is absent, check the 40-conductor cable for an open conductor, then check Q9 and Q10 and associated circuitry on pneumatic board.
	Pressure transducer leaking	Replace pressure transducer and calibrate the pressure channel.
	Pump leaking	Replace check valve in line between pump and reservoir.
	Other leaks	Check integrity of cuff connector and O-ring in pressure port cover. Use detergent to find leaks in reservoir fittings.
CUFF TOO LOOSE OR AIR LEAK (pump does not run)	Pump jammed	Motor shifted in mount on pump assembly, bottoming out on pump stroke. Readjust on mount.
		Obstruction caught in connecting rod area on pump assembly.
		Tubing between pump and reservoir pinched closed, or defective check valve.

Table 4-1. BP System Troubleshooting Guide (Continued)

Alarms		
Alarm	Probable Cause	Solution
CUFF TOO LOOSE OR AIR LEAK (pump does not run) (continued)	Defective pump	Replace pump.
	No pump drive voltage	If approximately 12V is not present across pump motor when attempt is made to pump, check for open conductor in 40-conductor cable, 12 to 14V across J3-1 and 2 on pneumatic board, Q5-Q7 and associated components on pneumatic board, then U2 and Q5 on the logic board.
LOW SIGNAL	Cuff improperly installed or very weak pulse	Verify proper cuff placement.
		Replace cuff.
		Check U10, U11, U20 and associated components on logic board.
LOW SIGNAL (Instrument holds, beeps continuously, and repumps to higher pressures)	Defective microphone or audio cable in cuff assembly	Replace cuff.
	Open shield in cable from cuff connector to logic board	Replace or repair cable.
	Leaker malfunction	Replace leaker. Check Q1-Q4, U10 and associated circuitry on logic board. Check U12, U13.
PATIENT MOVEMENT or ARTIFACT	Excessive patient motion	Instruct patient to remain still.
	Poor cuff placement	Verify correct cuff placement.
	Defective cuff	Replace cuff.

Table 4-1. BP System Troubleshooting Guide (Continued)

Alarms		
Alarm	**Probable Cause**	**Solution**
FIX ME 0	RAM read/write error	Replace U6, then U2, U3, and U7 on logic board.
FIX ME 2	ROM CRC (cyclic redundancy check) error	Replace U4 and U5, then U2, U3, and U7 on logic board.
FIX ME 3	Program jump to nonexistent memory	Replace U2, then U4 and U5, then U3 and U7 on logic board.
FIX ME 4	Pump on too long or cannot be turned off.	Check for shorted conductor in 40-conductor cable.
		Check for shorted Q5, Q6, or Q7 on pneumatic board.
		Check for shorted Q5 on logic board, then replace U2 on logic board.
		Check for defective Q2 and associated components on pneumatic board.
		Replace U18 on logic board.
FIX ME 5	Pressure exceeded 334 mmHg	Cycle power ON/OFF switch and retry measurement.
		Refer to FIX ME 4, above.
FIX ME A (all references are to pneumatic board unless otherwise specified)	Improper initial conditions/ pulse display contains octal 1xx.	Check U10-8 for logic 0. If logic 1, look for a 90 Hz square wave at U3-1, U4-11, and Q1 base. Q1 emitter should be logic 1.
		If U10-8 is logic 0, look for logic 0 at U8-1. If it is logic 1 instead of 0, check for shorted over-pressure switch, defective U2, R7, R8, R10, or C11.

Table 4-1. BP System Troubleshooting Guide (Continued)

Alarms		
Alarm	**Probable Cause**	**Solution**
FIX ME A (continued)		Check that U9-3 has a momentary logic 1, then goes to logic 0 when power is turned on.
		Check U5-11 for a 90 Hz square wave that contains no 375 kHz component.
		U2-4 should be less than 0.01V. If not, either U1, the pressure transducer, or associated components is defective, or calibration is required.
	Pulse display contains octal number 040	Check Q4-Q7 and associated components.
		Check 40-conductor cable.
	Pulse display contains octal number 020	Check Q8-Q10 and associated components, and 40-conductor cable. Check U13 on logic board. Check dump valve coil for a resistance of 220 ±20Ω.
FIX ME B (pulse display reads octal 060)	Unable to close dump valve	Defective 40-conductor cable.
		Check Q8-Q10 and associated components.
		Check dump valve coil for a resistance of 220 ±20Ω.
FIX ME C (pulse display reads octal 060)	Unable to start pump	Defective 40-conductor cable.
		Check Q5-Q7 and associated components.
		Check Q5 and U2 on logic board.
		Check pump motor for a resistance of 30 to 45Ω.

Table 4-1. BP System Troubleshooting Guide (Continued)

Alarms		
Alarm	Probable Cause	Solution
FIX ME D	<20 mm comparator test failures; U2-9 measures 0.05 to 0.07V	Check U2, C11, R7, R8, R10.
	U2-9 does not measure 0.05 to 0.06V	Check U1, R3-R6, 40-conductor cable, and +5 REF.
FIX ME E	>20 mm comparator test failure; U2-9 measures 1.50 to 1.70V	Check U2, C11, R7, R8, R10.
	U2-9 does not measure 1.50 to 1.70V	Check U1, R3-R6, 40-conductor cable, and +5 REF.
FIX ME F (pulse display contains octal 060)	90 Hz watchdog test failure	Check 40-conductor cable; check U9, Q1, U10 and associated components, and check U19 on logic board.
FIX ME G	Overpressure comparator test failure; U2-9 measures 2.40 to 2.55V	Check U2, C11, R7, R8, R10.
	U2-9 does not measure 2.40 to 2.55V	Check R3-R6, U1, 40-conductor cable, and +5 REF.
FIX ME H	Premature time-out during 4 1/2 minute timer test at 375 kHz	Check U6 and U7 outputs for correct binary division of input signal.
FIX ME I	Failure to time-out during 4 1/2 minute timer test at 375 kHz	Check 40-conductor cable and U4, U5, U6, U7, U8, U9, U10.
		Check U19 on logic board.
FIX ME J	Cannot disable output port to failsafe logic	Check 40-conductor cable and U9, U12.
		Check U19 on logic board.

Table 4-1. BP System Troubleshooting Guide (Continued)

Alarms		
Alarm	**Probable Cause**	**Solution**
FIX ME K	Cannot reset U10 during failsafe logic test	Check 40-conductor cable and U6, U9, U11.
		Check U19 on logic board.
		NOTE: This test is interspersed among other failsafe logic tests, with the result that other conditions such as excessive offset in the pressure channel or a defective pressure transducer can cause this alarm.
FIX ME L	Initial conditions (i.e., pump off, dump valve open) not attained in idle state	Check the pulse display for incorrect bits.
		Check 40-conductor cable and Q4-Q10 and associated components.
		Check U13, U18 and U19 on logic board.
FIX ME M	Pressure >20 mmHg for 20 seconds in idle state	Check pressure transducer and offset adjustment in pressure channel.
	Dump valve or leaker not opening	Check valve or leaker.
	Plugged airways or kinked tubing	Check integrity of pneumatics.
	Excess air being squeezed from cuff during operation	Follow operating instructions.
FIX ME N	20 mmHg comparator (U2-13) does not detect pressure when system is inflated beyond 33 mmHg	Check U1, R1, R2, 40-conductor cable.

Table 4-1. BP System Troubleshooting Guide (Continued)

Display Malfunctions		
Sympton	Problem	Solution
Entire SYSTOLIC, DIASTOLIC, MAP, and PULSE display blank	Poor connections between logic and display driver boards or defective 40-conductor cable to pneumatic module	Check mating and integrity of 36-pin connector between logic and display driver boards.
Missing SYSTOLIC/DIASTOLIC or MAP/PULSE group, or wrong information in one or more digits	Poor contacts in 36-pin connector between logic and display driver boards	Check mating and integrity of 36-pin connector between logic and display driver boards.
	Defective U1 or U2 on display driver board	Replace U1 if SYSTOLIC/DIASTOLIC problem, or U2 if MAP/PULSE problem.
	Defective U8 on logic board	Replace U8.
Missing segment in one digit	Defective digit	Replace digit.
Same missing or dim segment in SYSTOLIC/DIASTOLIC or MAP/PULSE group	Poor contact in connector between display and display driver boards	Check mating and integrity of contacts.
	Defective R9 or R10 on display driver board	Replace R9 if SYSTOLIC/DIASTOLIC problem, R10 if MAP/PULSE problem.
	Defective U1 or U2 on display driver board	Replace U1 if SYSTOLIC/DIASTOLIC problem, or U2 if MAP/PULSE problem.
One digit completely missing or dim	Poor contact in connector between display and display driver boards	Check mating and integrity of contacts.

Table 4-1. BP System Troubleshooting Guide (Continued)

Display Malfunctions		
Symptom	Problem	Solution
One digit completely missing or dim (continued)	Defective Q14-Q25 on display driver board	Replace Q14-Q25 corresponding to missing digits: SYSTOLIC LSD: Q19 SYSTOLIC NSD: Q18 SYSTOLIC MSD: Q17 DIASTOLIC LSD: Q14 DIASTOLIC NSD: Q15 DIASTOLIC MSD: Q16 MAP LSD: Q25 MAP NSD: Q24 MAP MSD: Q23 PULSE LSD: Q22 PULSE NSD: Q21 PULSE MSD: Q20
	Defective U1 or U2 on display driver board	Replace U1 if SYSTOLIC/DIASTOLIC digit missing or U2 if MAP/PULSE digit missing.
Wrong or missing information in information display	Poor contacts in connectors between logic and display driver boards or between display driver and display boards	Check mating and integrity of contacts.
	Defective display module	Replace display module.
	Defective U8 on logic board	Replace U8 on logic board.
Missing characters or segments in information display	Defective display module	Replace display module.

Table 4-2. Thermometer System Troubleshooting Guide

Instrument Malfunction/Alarm		
Problem	Probable Cause	Solution
Thermometer completely inoperative	Broken wires in probe harness or probe switch harness	Inspect harness and repair.
NOTE: The entire VITALoCHECK monitor must be operational for the thermometer to operate	Probe connector pushed out of position in panel	Return the probe connector to its position. Use a tie-wrap to anchor connector.
	Thermometer board loose from display driver board	Ensure proper mating of the connectors between the display driver and thermometer boards. Be sure the thermometer board is anchored with a tie-wrap.
	Defective or misadjusted probe switch	Replace probe switch if there is no continuity. Adjust to close with probe withdrawn and open with probe inserted.
	No power (+5V)	Look for +5 ±0.25V at E7 on the thermometer board. Source is J1-1 on the power regulator board.
	Defective crystal (U1)	Check for 2.00 MHz waveform at U1-2 with a high impedance scope. If not present, replace Y1.
	Defective U1	If a 2.00 MHz waveform does not appear after replacing Y1, replace U1.
	Defective U4, Q1, Q2, Q3, C2, R7, CR5, CR10 or associated components.	Refer to voltage table to isolate problem. Replace suspected component.
	Defective Q26, Q27 and associated components on display driver board or U16 on logic board	Check that Q26 and Q27 have base drive when DISPLAY/TEST switch is actuated.

Table 4-2. Thermometer System Troubleshooting Guide (Continued)

Instrument Malfunction/Alarm		
Problem	Probable Cause	Solution
Thermometer active but does not read temperature, or give immediate ERR H alarm	Defective probe	Replace probe or substitute Model 828A thermometer tester to test thermometer.
	Broken or shorted wires in probe connector harness	Inspect and repair wiring.
	Defective U3, U5, VR2 or associated components	Replace U3, ensure that R28 or R29 are intact. Measure voltages at U3, U5, and VR2 and compare to values on voltage table.
	Poorly mated connectors between thermometer and display driver boards.	Check mating and integrity of connectors.
Turns off in 2 to 3 seconds	Poorly mated connectors between thermometer and display driver boards	Check mating and integrity of connectors.
	Defective U4	With an oscilloscope check that the waveform at U4-6 is an inverted likeness of U4-3, 4, 5.
	Defective Q4 and associated circuitry	Check to see that Q4 is keeping C9 discharged if a waveform is present at U4-6.
	Defective CR1 on display driver board	Replace CR1 if no waveform is present at U4-3, 4, 5 when in the predictive and ^{o}F mode.
One blank digit in display; thermometer may turn off in 2 to 3 seconds if center digit is affected	Poorly mated or open connections at connectors between thermometer and display driver boards or between display driver and display boards	Check integrity and mating of connectors.

Table 4-2. Thermometer System Troubleshooting Guide (Continued)

Instrument Malfunction/Alarm		
Problem	Probable Cause	Solution
One blank digit in display; thermometer may turn off in 2 to 3 seconds if center digit is affected (continued)	Defective transistors Q1-Q5 on display driver board	Replace Q1-Q5 according to digit: Hundreds: Q5 Tens: Q4 Units: Q3 Tenths: Q2 Indicator: Q1
	Defective U1	Replace U1.
Missing segment on one digit	Defective digit	Replace digit.
Same segment missing or always lit on all five digits	Poorly mated or open connection between thermometer and display driver boards or between display driver and display boards	Check integrity and mating of connectors.
	Defective Q6-13, Q28-Q35 on display driver board	Replace Q6-Q13, Q28-Q35 according to affected segment. a: Q13, Q30 b: Q12, Q29 c: Q11, Q33 d: Q9, Q31 e: Q8, Q32 f: Q7, Q28 g: Q6, Q35
	Defective R8, R11, R12, R13 on display driver board	Replace R11, R12, R13, R8.
	Defective U1	Replace U1.

Table 4-2. Thermometer System Troubleshooting Guide (Continued)

Instrument Malfunction/Alarm		
Problem	Probable Cause	Solution
Decimal point missing or always lit	Poorly mated or open connection between thermometer and display driver boards or between display driver and display boards	Check integrity and mating of connectors.
	Defective digit	Replace digit.
	Defective Q10, Q34 on display driver board	Replace Q10, Q34.
	Defective R8, R11, R12, R13 on display driver board	Replace R8, R11, R12, R13.
	Defective U1	Replace U1.
One digit very bright and jumbled	Short between traces on thermometer, display driver, or display boards	Check for shorts.
	Defective Q1-Q5 on display driver board	Replace Q1-Q5 according to affected digit. Hundreds: Q5 Tens: Q4 Units: Q3 Tenths: Q2 Indicator: Q1
	Defective U1	Replace U1.
Thermometer will not turn itself off	Defective U4	Remove the probe connector and place the probe into the storage well, then replace the probe connector. Withdraw the probe from the well to turn on the thermometer and then replace the probe in the well. A negative spike should appear at U4-1, 2. If this negative spike appears, replace U4.

Table 4-2. Thermometer System Troubleshooting Guide (Continued)

Instrument Malfunction/Alarm		
Problem	Probable Cause	Solution
Thermometer will not turn itself off (continued)	Defective C4, R10	If no negative spike appears at U4-1, 2 but U1-22 goes from logic 1 to 0, C4 or R10 need to be replaced.
	Defective U1	If U1-22 stays logical 1, replace U1.
Temperature takes 3 to 5 minutes to obtain, there is no audible tone, and F or C appears instead of the rotating indicator	Instrument is in monitor mode, or initial temperature was 94°F or above	If entire display is flashing, the thermometer is in the monitor mode. Eject probe cover, set P-M switch to P. Reset instrument by inserting probe into storage well. Retake temperature.
		If only the C or F is flashing, the thermometer is in the peak holding mode. This mode is activated when the room and probe temperatures are higher than 34.4°C (94°F) when temperature-taking begins in the predictive mode. Retake temperature when temperatures are lower than 34.4°C (94°F).
Thermometer does not respond to one or both function switches	Broken wires in switch harness	Inspect and repair.
	Poor or open contacts in connector between logic and display driver boards or between display driver and thermometer boards	Check integrity and mating of connectors.
	Defective switch	Replace switch.
	Defective CR2 or CR3 on display driver board	Replace defective CR2 or CR3.

Table 4-2. Thermometer System Troubleshooting Guide (Continued)

Instrument Malfunction/Alarm		
Problem	Probable Cause	Solution
Thermometer turns on with unusual characters in display with only decimal point lit, or does not turn off unless probe connector is unplugged	Defective C11, CR8, R33	Using ohmmeter, check for short circuits at C11 and CR8, and the approximate resistance at R33 with U1 removed from socket. If short circuits are found or resistance is inappropriate, replace faulty components as needed.
	Defective U1	Replace U1.
No audible tone	Defective speaker or CR9	Check the continuity of speaker with an ohmmeter. Replace if 30 to 40Ω are not obtained.
		If the resistance is very low, CR9 may be shorted and should be replaced.
	Defective Q5	Check for square wave at U1-17. If present, check for square wave at collector of Q5. If square wave is not present at Q5, replace Q5.
	Defective U1	Check for square wave at U1-17. If there is no waveform at U1-17, replace U1.
ERR O	Defective U3	Replace U3.
	Defective U2	Replace U2.
ERR t	The thermometer fails to obtain a temperature within 1 minute after insertion	Eject probe cover. Reset the thermometer by returning the probe to its storage well. Retake temperature.
ERR L	The thermometer senses a loss of proper tissue contact within the mouth for more than 30 seconds	Eject probe cover. Reset instrument by returning probe to storage well. Properly position probe in patient's mouth and retake the temperature, holding the probe base constantly. Do not allow patient to reposition probe.

Table 4-3. Voltage Specifications

NOTE

Unless otherwise specified, these values are with the AC line at 120 volts, the thermometer probe removed from the instrument, the MODE switch in the MAN position, and all but the information display blank. Logic 0 is a voltage between 0 and +0.2V, logic 1 is a voltage between 4 and 5V.

Power Regulator Board	
Across transformer secondary leads:	22 VAC nominal
Across C1:	18-35 VDC
Across battery pack:	14.4 ±0.1 VDC
Across C10 (+5 BACKUP)	5 ±0.2 VDC
Across C25 (+5 LOGIC)	5 ±0.25 VDC
Across C33 (-10 VOLTS)	-10 ±1 VDC

J1 (Referred to Pin 3)

1:	+5 ±0.25	2:	+5 ±0.25
3:	0	4:	_5 ±0.25
5:	0	6:	0
7:	+14 ±1	8:	-10 ±1.5
9:	0	10:	+14.4 ±0.1
11:	Do not measure		

Table 4-3. Voltage Specifications (Continued)

Logic Board (Referred to J1-3, Power Supply)	
U1-1:	Square wave, 732 Hz
U2-3:	logic 0
U2-9:	logic 0
U2-36:	logic 1
U2-40:	+5 ±0.25
U10-1:	+10.5 ±1.5
U10-3:	5.05 ±0.25
U10-7:	0 ±0.6
U10-8:	+5.7 ±0.5
U10-10:	1 to 2V nominal
U10-12:	-0.05 ±0.02
U10-14:	-10 ±1.5
U10-4:	+14 ±1
U10-11:	-10 ±1.5
U11-12	+5 ±0.25
U11-27:	+2.5 ±0.3
U20-1:	+2.5 ±0.2
U20-3:	+0.38 ±0.03
U20-4:	+13.4 +0.6, -1
U20-7:	-8 ±1.5
U20-8:	+12 ±1.5
U20-11	-9.4 ±1
U20-14:	0
Pneumatic Board (Referred to J1-3, Power Supply)	
U1-1:	0 to 0.002
U1-2:	1.6 ±0.1
U1-3:	0 to 0.002
U1-4:	2.39 ±0.15
U1-5:	0.058 ±0.01
U9-5, 6	logic 1
U9-12, 13	logic 1
U9-1	logic 1
U9-2	logic 1
U9-11	logic 0
U15-6	-0.7 ±0.2
Q13-E	0 to 0.01

Table 4-3. Voltage Specifications (Continued)

Pneumatic Board (Referred to J1-10, Power Supply)	
U14-1	+8.7 ±1
U14-3:	+5 ±0.25
U14-4:	-10 ±1.5
U14-5:	0 to 0.2
U14-7:	0 to 0.004
U14-8:	+14 ±1
IN+	+8 ±1
OUT+	0 to ±0.075
Q3-C:	+4.9 ±0.25
Q4-C:	0 to +0.1
Q6-C:	+14 ±1
Display Driver Board	
U1-20:	+5 ±0.25
Display Board	
DS18-9:	+5 ±0.25

Thermometer Completely Inoperative		
Point	Expected Voltage	Probable Defective Item
U4-14	4.75 to 5.25	Thermometer harness
U4-10	4.75 to 5.25	U4
Q3-C	0 to 0.1	Q3
U1-11	4.75 to 5.25	Q2
U5-8	4.75 to 5.25	Q1
U1-4	4.75 to 5.25	C11, U1, R33
E4	0	Q26 on display driver board
Thermometer Does Not Read Temperature		
U1-23	1.2 to 1.4	CR5, CR10, C3
U4-10	4.75 to 5.25	U4, C2, R7
U5-8	4.75 to 5.25	Q1
U5-7	1 or less	U5
VR2	OUT 1.23V > ADJ	VR2
U3-10	0.1 or less	R20
U3-3, 4, 5	0 to 5V pulses	U3, R8

Table 4-4. Connector/Signal List

Logic Board

J1

1 -	FS0	2 -	FS1
3 -	START	4 -	FS2
5 -	MON	6 -	FS4
7 -	DF0	8 -	FSCLR
9 -	FS5	10 -	FSCOMP
11 -	+12	12 -	+12
13 -	BLANK	14 -	FSMOT
15 -	PMP	16 -	FSDUMP
17 -	375 kHz	18 -	FSDIS
19 -	+5 LGC	20 -	+5 LGC
21 -	LOGIC GND	22 -	LOGIC GND
23 -	-10	24 -	FSREF
25 -	+5 REF	26 -	+5 REF
27 -	-10	28 -	PRESSURE
29 -	CENTERING	30 -	FS3
31 -	ANALOG GND	32 -	ANALOG GND
33 -	LEAKER (-)	34 -	N/C
35 -	N/C	36 -	N/C
37 -	N/C	38 -	N/C
39 -	STETH GND	40 -	STETH GND

N/C = Not Connected

J2

1 -	LOGIC GND	2 -	LOGIC GND
3 -	+5 LGC	4 -	MODE SW
5 -	MODE SW	6 -	PRESSURE SW
7 -	MODE SW	8 -	PRESSURE SW
9 -	PROBE SW	10 -	MODE SW

J3

1 -	PULSE	2 -	TEMP
3 -	DECODE 0	4 -	DECODE 1
5 -	BLANK	6 -	LOGIC GND
7 -	LOGIC GND	8 -	A1
9 -	A0	10 -	D0
11 -	D1	12 -	D2
13 -	WR	14 -	D7
17 -	D4	18 -	D3
19 -	DECODE 2	20 -	A2
21 -	A2	22 -	+5 LGC
23 -	+5 LGC	24 -	LOGIC GND
25 -	ANALOG GND	26 -	ANALOG GND
27 -	+12	28 -	-10

Table 4-4. Connector/Signal List (Continued)

J3 Continued			
29 -	-10	30 -	STETH GND
31 -	STETH GND	32 -	N/C
33 -	P-M SWITCH	34 -	F-C SWITCH
35 -	P-M SWITCH	36 -	F-C SWITCH
Logic Board			
MIC			
1 -	MIC HI	2 -	N/C
3 -	MIC LO		
J5			
1	+5 LGC	2 -	GND LGC
3 -	+5 LGC	4 -	IOX SEL
5 -	WR	6 -	RD
7 -	A1	8 -	DECODE 6
9 -	A0	10 -	RST 6.5
11 -	D7	12 -	DECODE 7
13 -	D6	14 -	RESET
15 -	D5	16 -	ADC START
17 -	D4	18 -	START
19 -	D3	20 -	SYNC
21 -	D2	22 -	GND LGC
23 -	D1	24 -	A3
25 -	D0	26 -	A2
Pneumatic Board			
J1			
1 -	FS0	2 -	FS1
3 -	START	4 -	FS2
5 -	MON	6 -	FS4
7 -	DF0	8 -	FSCLR
9 -	FS5	10 -	FSCOMP
11 -	+12	12 -	+12
13 -	BLANK	14 -	FSMOT
15 -	PMP	16 -	FSDUMP
17 -	375 kHz	18 -	FSDIS
19 -	+5 LGC	20 -	+5 LGC
21 -	LOGIC GND	22 -	LOGIC GND
23 -	-10	24 -	FSREF
25 -	+5 REF	26 -	+5 REF
27 -	-10	28 -	PRESSURE

Table 4-4. Connector/Signal List (Continued)

Pneumatic Board Continued			
J1			
29 -	CENTERING	30 -	FS3
31 -	ANALOG GND	32 -	ANALOG GND
33 -	LEAKER (-)	34 -	N/C
35 -	N/C	36 -	N/C
37 -	N/C	38 -	N/C
39 -	STETH GND	40 -	STETH GND
J2			
1 -	ST/RST SW (N.O.)	2 -	ST/RST SW (N.C.)
3 -	LGC GND		
Pneumatic Board			
J3			
1 -	GND MOTOR	2 -	+12V MOTOR
3 -	GND MOTOR		
J4			
1 -	PUMP (-)	2 -	PUMP (+)
3 -	PUMP (-)		
J5			
1 -	SPKR	2 -	SPKR
J6			
1 -	+12V	2 -	DUMP VALVE
J7			
1 -	LOGIC GND	2 -	OVERPRESSURE SWITCH
J8			
1 -	LEAKER (-)	2 -	LEAKER (+)
J9			
1 -	LGC GND	2 -	N/C
3 -	N/C	4 -	N/C
J10			
1 -	LGC GND	2 -	R18
3 -	R19	4 -	+5 LGC

Table 4-4. Connector/Signal List (Continued)

Display Driver Board			
J1			
1 -	DP1	2 -	DP2
3 -	D1D	4 -	D2D
5 -	D3D	6 -	D6D
7 -	D5D	8 -	D4D
9 -	A1S	10 -	B1S
11 -	C1S	12 -	D1S
13 -	E1S	14 -	F1S
15 -	G1S	16 -	A2S
17 -	B2S	18 -	C2S
19 -	D2S	20 -	CHG
21 -	F2S	22 -	G2S
23 -	E2S	24 -	F3S
25 -	G3S	26 -	E3S
27 -	A3S	28 -	B3S
29 -	D3S	30 -	C3S
31 -	DP	32 -	D17D
33 -	D16D	34 -	D15D
35 -	D14D	36 -	D13D
J2			
1 -	D7D	2 -	D8D
3 -	D9D	4 -	D12D
5 -	D11D	6 -	D10D
7 -	D5	8 -	LOGIC GND
9 -	LOGIC GND	10 -	A1
11 -	A0	12 -	D0
13 -	D1	14 -	D2
15 -	WR	16 -	D6
17 -	D5	18 -	D4
19 -	D3	20 -	DECODE 2
21 -	A2	22 -	A2
23 -	LOGIC GND	24 -	+5 DSPLY
J3			
1 -	PULSE	2 -	TEMP
3 -	DECODE 0	4 -	DECODE 1
5 -	BLANK	6 -	LOGIC GND
7 -	LOGIC GND	8 -	A1
9 -	A0	10 -	D0
11 -	D1	12 -	D2
13 -	WR	14 -	D7
15 -	D6	16 -	D5

Table 4-4. Connector/Signal List (Continued)

J3 Continued			
17 -	D4	18 -	D3
19 -	DECODE 2	20 -	A2
21 -	A2	22 -	+5 LGC
23 -	+5 LGC	24 -	LOGIC GND
25 -	ANALOG GND	26 -	ANALOG GND
27 -	+12	28 -	-10
29 -	-10	30 -	STETH GND
31 -	STETH GND	32 -	N/C
33 -	P-M SWITCH	34 -	F-C SWITCH
35 -	P-M SWITCH	36 -	F-C SWITCH
J4			
1 -	+5	2 -	+5 DSPLY
3 -	DISPLAY GND	4 -	+5 LGC
5 -	ANALOG GND	6 -	STETH GND
7 -	+12	8 -	-10
9 -	LOGIC GND	10 -	LOGIC GND
11 -	CHG		
J5			
1 -	THERM GND	2 -	+5 THERM
3 -	THERM "VBAT"	4 -	PROBE HI
5 -	N/C	6 -	PROBE TAP
7 -	PROBE LO	8 -	N/C
J6			
1 -	THERM GND	2 -	N/C
3 -	DB	4 -	DC
5 -	DD	6 -	DE
7 -	FUNCT	8 -	N/C
9 -	PULSE	10 -	DA
11 -	SA	12 -	SB
13 -	SC	14 -	N/C
15 -	N/C	16 -	DP
17 -	SD	18 -	SE
19 -	SF	20 -	SG
21 -	VP		

Table 4-4. Connector/Signal List (Continued)

E			
E1 -	PROBE LO	E2 -	PROBE TAP
E3 -	PROBE HI	E4 -	PROBE SWITCH
E5 -	THERM "VBAT"	E6 -	+5 THERM
E7 -	+5 THERM	E8 -	N/C
E9 -	THERM GND	E10 -	N/C
E11 -	THERM GND		
Power Supply board			
J1			
1 -	+5	2 -	+5
3 -	+5 GND	4 -	+5
5 -	COMMON	6 -	GND
7 -	U2-12, U3-12	8 -	-10
9 -	+5 GND	10 -	MTR
11 -	CHG		
J2			
1 -	BATTERY (+)	2 -	BATTERY (-)
J3			
1 -	AC IN LO	1 -	AC IN HI
3 -	AC IN HI		
J4			
1 -	LGC GND	2 -	POWER OFF
3 -	DEAD BAT	4 -	LOW BAT
5 -	AC	6 -	SYNC
J5			
1 -	COMMON	2 -	POWER SW. NO.
3 -	COMMON		
Logic Extension Board			
J1			
1 -	LGC GND	2 -	ERC RESET IN
3 -	LGC GND	4 -	ERC START/STOP

Table 4-4. Connector/Signal List (Continued)

J2

1 -	GND	2 -	TURN OFF
3 -	DEAD BAT	4 -	LO BAT
5 -	AC	6 -	SYNC

J3

1 -	A2	2 -	D0
3 -	A3	4 -	D1
5 -	LGC GND	6 -	D2
7 -	SYNC	8 -	D3
9 -	START	10 -	D4
11 -	ADC START	12 -	D5
13 -	RESET	14 -	D6
15 -	DECODE 7	16 -	D7
17 -	RST 6.5	18 -	A0
19 -	DECODE 6	20 -	A1
21 -	RD	22 -	WR
23 -	IOX SEL	24 -	+5V
25 -	LGC GND	26 -	+5V

The following connectors have the same pin assignments as listed:

Connector	Same Pin Assignment as in
DISPLAY DRIVER J1	DISPLAY BD P1
DISPLAY DRIVER J2	DISPLAY BD P2
THERM BD E	DISPLAY DRIVER E
THERM BD P1	DISPLAY DRIVER J6

CHAPTER 5
CORRECTIVE MAINTENANCE

5-1 INTRODUCTION

This section contains the procedures required to properly disassemble, repair and replace, assemble, test, and calibrate the VITAL•CHECK Monitor - Model 4000/4001 Vital Signs Measurement System if a malfunction or problem is detected. Functional tests, alarm tests, and self-tests are also provided. Included in this section is a list of the tools and test equipment required to perform the procedures described.

NOTE

A thorough familiarity with the function and operation of the various circuits in the VITAL•CHECK monitor will enable repair, replacement, or calibration analysis to be accomplished more quickly (refer to chapter 3, Functional Description).

5-2 TOOLS, TEST EQUIPMENT, AND MATERIALS

Table 5-1 lists the test equipment required for performing checkout or maintenance procedures on the VITAL•CHECK monitor. The additional tools and materials used are listed below.

a. Pressure calibration test fixture, constructed as per figure 5-1

b. Hunter 11344 (or equivalent) T-handle allen wrench, 6 inches long by 7/64

c. Allen wrench, 1/16 inch

d. DIP clip, 28 pin

e. Test leads compatible with the DIP clip and the digital multimeter (DMM)

f. Spanner wrench, constructed as per figure 5-2

g. BP cuff and substitute arm, 4 ±1 inches in diameter

h. IVAC P880L, P882L, P880, or P882 standard probe

i. Screwdrivers:
No. 2 phillips
1/8 inch by 6 inch flat

j. Accessory stethoscope

l. Long-nose pliers

n. Trimpot adjustment tool

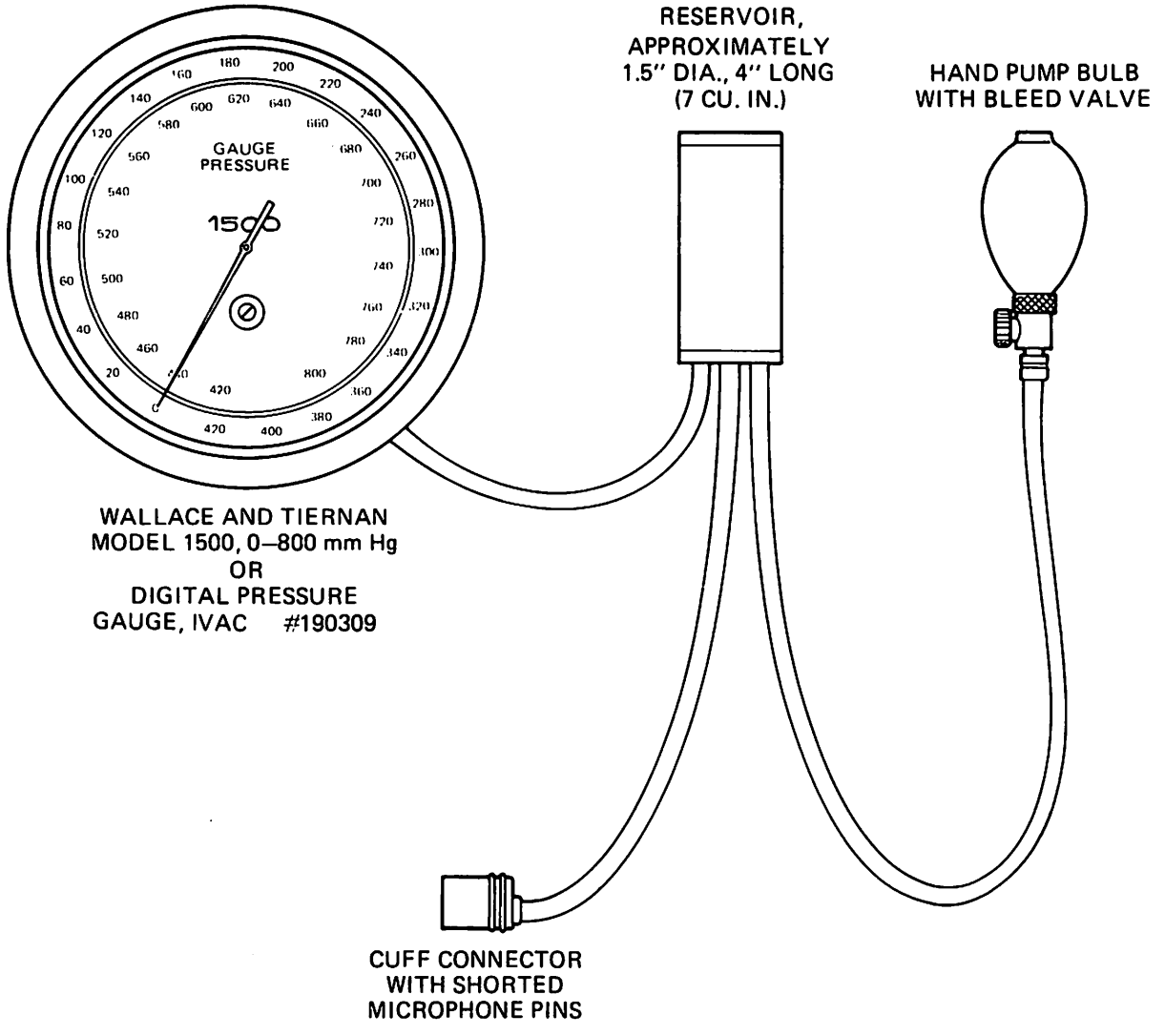
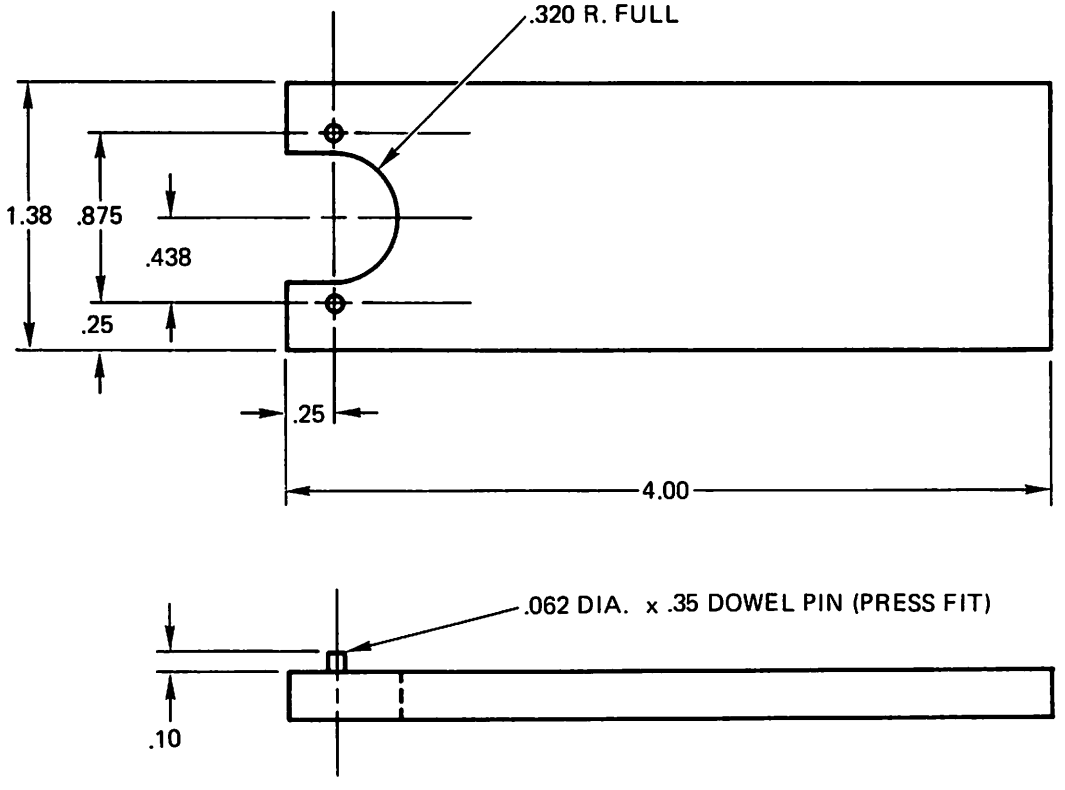


Figure 5-1. Pressure Calibration Test Fixture



TOLERANCE: .xx ± .01
.xxx ± .005

125

MATERIAL: AL.ALY. 6061-T6 .25 PLATE
DOWEL PIN S.S.

BREAK AND DEBURR ALL SHARP EDGES.

Figure 5-2. Spanner Wrench

Table 5-1. Test Equipment

Name	Manufacturer/Model No.
Pressure gauge	Wallace and Tiernan Model 1500, 0-800 mmHg or equivalent
Digital multimeter (DMM)	Fluke 8040 or equivalent
Controlled solder station	Weller TC 202 or equivalent
Circulating water bath	Bronwil 1420M or equivalent
Thermometer tester	IVAC 828A
Safety tester	BIO-TEK Model 11 or equivalent BIO-TEK Model 150M or equivalent Hipotronics Model H or equivalent
Variable DC Power Supply	Power Design Model 6050A or equivalent
Resistor 50Ω, 25W	Dale, RH25, 50Ω, ±3%
Resistor 10Ω, 50W	Dale, RH50, 10Ω, ±3%

5-3 CLEANING AND VISUAL INSPECTION

WARNING

Use extreme caution in servicing the instrument when connected to AC power. Hazardous voltages are present when AC power is connected regardless of the position of the ON/OFF switch.

CAUTION

The use of static protection devices is mandatory when handling PC boards.

Examining the instrument's condition, prior to rework, is necessary to determine the course of action to take. Perform the procedure listed below to inspect and clean the entire unit.

a. Examine the unit carefully for cleanliness. Any cosmetically defective part(s) should be replaced or cleaned. Determine and correct the source of any residue or frayed particles. Any worn, broken, or bent part(s) must be cleaned or replaced as necessary.

b. Foreign solutions of any kind on internal parts or components indicate that disassembly and cleaning are required to remove the solution.

c. Visually inspect the chassis and its subassemblies for:

1. Worn, damaged, or missing components
2. Burned clad or components
3. Improper component substitutions
4. Contamination, paying particular attention to the connectors and their contacts
5. Integrated circuits that are loose in their sockets; sockets with poor retention should be replaced

5-4 DISASSEMBLY

NOTE

Do not disassemble the monitor any further than necessary to perform the required maintenance.

CAUTION

Exercise care and use proper static grounding techniques when handling the board assemblies.

5-4-1 Removing the Case (Refer to figure 6-1)

a. Place the monitor face down on a soft surface so as not to scratch the front panel.

b. Using a phillips screwdriver, remove the four screws (41) holding the rubber feet (31).

c. Using the T-handle allen wrench, remove the two screws (42) which hold the case top to the front panel, ensuring that the O-rings (34) are not lost when the screws are removed.

d. Gently spread the bottom of the case (9) open and remove it by sliding it off the rear of the instrument.

5-4-2 Removing Battery Pack (with instrument still in case) (refer to figure 6-1)

a. Remove the screw (38) from the battery access cover (13) located on the rear of instrument; remove the battery access cover (13) from the body assembly.

b. Slide the battery pack assembly (7) out of the chassis assembly and unplug the battery connector. (Do not handle the battery by its wires.)

5-4-3 Exposing the PC Boards (Refer to figure 6-1)

a. Return the monitor to an upright position.

b. Remove the phillips screw (43) on the rear edge of the logic board (3) and swing the logic board/front panel open.

5-4-4 Removing and Disassembling the Logic Board (Refer to figure 6-5)

a. Disconnect connectors J7, J1, J2 and the microphnone connector located above J1, from the logic board.

b. Remove the two nuts and screws (10, 11) holding the logic board (1) to the hinge bar assembly (5).

c. Carefully disengage J4 by pulling the logic board away from the display driver board (2).

CAUTION

Maintain a 90° angle between the two boards as you pull them apart so as not to damage the connector.

5-4-5 Removing and Disassembling Display Boards and Thermometer (Refer to figure 6-5)

a. Disconnect J5 and J4 on the display driver board (2).

b. Remove the phillips screw (40, illustrated on figure 6-1) on the left side of the display driver board (2).

c. Locate the small hole in the front panel at the top of the hinge bar assembly (5). Using a small punch or paper clip, depress the spring pin within this hole and work the top of the hinge block out of the front panel.

d. Remove the module by lifting it from the front panel.

e. Remove the display board (3) and thermometer board (4) by carefully unplugging them from the display driver board, taking care not to damage the connectors.

5-4-6 Removing Front Panel Switches (Refer to figure 6-3)

5-4-6-1 Rotary Switches

a. Remove the rotary switch knobs (17, 18) by loosening the two set screws in each knob with an allen wrench, and then pulling the knobs off.

b. Remove the lock nut holding each switch (8) into the front panel, then lift the switches out from the rear.

5-4-6-2 Pushbutton Switches

a. Remove the plastic insert from each switch (14, 15) by pressing the side of the insert while pulling it away from the switch.

b. Remove the switch by pushing against its backside and lifting the switch out of the front panel (12).

5-4-7 Removing the Interface Panel (Refer to figure 6-3)

a. Remove the hex head screw (58) in the center of the interface panel (54).

NOTE

Do not lose the T-nut on the rear of the interface panel after removing the screw (58).

b. Disconnect the stethoscope speaker assembly (55) and the silicone tube which goes to the umbilical connector (54) on the interconnect panel.

c. Slide the tinnerman clip off the post on the rear of the interface panel and remove the panel from the front.

5-4-8 Removing and Disassembling the Power Regulator Board (Refer to figure 6-1)

a. Disconnect J1, J2, J3, J4, and J5 from power regulator board.

b. Loosen the screw (43) on the upper-card guide (16) enough to swing the stop plate (18) out of the way.

c. Carefully pull the power regulator board (6) out, assuring that no damage is done to the wire harnesses.

5-4-9 Removing and Disassembling the Pneumatic Module (Refer to figure 6-6)

a. Remove the calibration port cap (22, figure 6-1) from the rear of the instrument.

b. Using a spanner wrench (refer to figure 5-2), remove the retaining nut (21, figure 6-1).

c. Remove the two screws (39) holding the pneumatic module (4) to the bottom of the power chassis (1, figure 6-1).

d. Loosen the screw (43) on the upper-card guide (16, figure 6-1) enough to swing the stop plate out of the way.

e. Disconnect connectors J3 on the logic extension board and J1 on the pneumatic board.

f. Remove the two screws (23) which hold the pneumatic board (2) to the module and swing the board open.

g. Disconnect J5, J2, J3, from the pneumatic board.

h. Remove the pneumatic module.

i. Remove the tygon hose connected to the transducer (see ref, figure 6-6) on the the pneumatic board.

j. Disconnect J4, J6, J7, and J8 from the pneumatic board.

k. Lift and remove the pneumatic board (2).

l. Remove the two screws (25) connecting the over pressure switch (8) to the back of the pneumatic module.

m. Remove the two screws (24) connecting the dump valve (7) to the top of the pneumatic module.

n. Remove the two screws (27) connecting the leaker valve (6) to the top of the pneumatic module.

CAUTION

The leaker is a very sensitive mechanism. Handle with care. Do not disassemble the leaker. Because part positions are critical to proper operation, this assembly is not field repairable.

o. Remove the two screws on the bottom left-hand side of the pneumatic chassis (1) and spread the chassis apart to remove the reservoir (4).

5-4-10 Removing the Logic Extension Board (Refer to figure 6-3)

Remove the three screws (38) from the top of the power chassis assembly (1). Remove the logic extension board assembly (29), with the harness connected to J2.

5-5 ASSEMBLY

5-5-1 Replacing the Logic Extension Board (Refer to figure 6-3)

Using the three screws (38), reconnect the logic extension board (29) to the power chassis (1).

5-5-2 Assembling and Replacing the Pneumatic Module (Refer to figure 6-6)

5-5-2-1 Assembly

a. Spread the pneumatic chassis (1) apart, replace the reservoir (4) assuring a flush fit within the inner walls of the pneumatic chassis.

b. Replace the two screws on the bottom left-hand side of pneumatic chassis.

c. Reconnect the leaker (6) to the top of the pneumatic module using the two screws (27).

d. Reconnect the dump valve (7) to the top of the pneumatic module using the two screws (24).

e. Reconnect the pressure switch (8) to the back of the pneumatic module using the two screws (25).

f. Install the pneumatic board.

g. Reconnect the hoses (12, 13) to the pressure transducer (see ref, figure 6-6), over pressure switch (8), leaker assembly (6), and the dump valve (7).

h. Reinstall connectors J2, J4, J5, J6, J7, and J8 on the pneumatic board (2).

5-5-2-2 Replacement (Refer to figure 6-1)

a. Reconnect the pneumatic module to the bottom of the power chassis (1) using the two screws (39).

b. Replace the connector on J3 of the pneumatic board.

c. Using a spanner wrench (figure 5-2) replace and tighten the retaining nut (21), assuring that the seal cap strap (20) is placed before the retaining nut.

d. Reconnect the flat cables to J3 on the logic extension board and J1 on the pneumatic board.

5-5-3 Assembling and Replacing the Power Regulator Board (Refer to figure 6-1)

a. Reinstall power regulator board (6) in the guide slots of the upper and lower card guides (16, 17).

NOTE

To avoid hanging up of the power regulator board, place the wiring harness in front of the lower card guide (17) and under the power regulator board, so that the connectors are visible.

b. Adjust the stop plate (18) on both sides of upper card guide (16) so as to hold power regulator board (6) in place; tighten screws (43).

c. Reconnect J1, J2, J3, and J4, J5 to the power regulator board.

5-5-4 Replacing the Interface Panel (Refer to figure 6-3)

a. Replace the interface panel (54) by sliding it into the front of the instrument and hooking the tinnerman clip over the post on the rear of the interface panel.

b. Replace the hex head screw (58) in the center of the interface panel. Assure that the T-nut is vertical and engages the front panel (12).

5-5-5 Replacing the Front Panel Switches

5-5-5-1 Pushbutton Switches

a. Install the pushbutton switches (14, 15) by inserting them through the front of the panel (12) until they lock into place.

b. Replace the plastic silkscreened insert on each switch, holding the sides of each insert and pushing it into the switch.

5-5-5-2 Rotary Switches

a. From the rear of the front panel (12), insert the rotary switch assembly (16), then replace the lock nut to hold each switch in place.

b. Replace the rotary switch knobs (17 and 18), then tighten the two set screws in each knob with an allen wrench. Assure that the actual switch positioning corresponds with the actual setting with the silkscreen on the knobs.

5-5-6 Assembling and Replacing the Logic Module (Refer to figure 6-5)

5-5-6-1 Assembly

a. Reconnect the thermometer board (4) and display board (3) to the display driver board (2), taking care not to damage the connectors. Ensure that the thermometer board is retained with a tie wrap.

b. Maintain a 90° angle between the logic board (1) and the display driver board (2); carefully engage J4, reconnecting the logic and display driver boards.

CAUTION

To avoid damage to the connector, maintain a 90° angle between the two boards as you connect them.

c. Replace the two nuts and screws (10, 11) to connect the logic board to the hinge bar assembly (5).

5-5-6-2 Replacement (Refer to figure 6-1)

a. Set the logic module back into the front panel (12, figure 6-3).

b. Depress the spring pin in the top of the hinge bar assembly (5, figure 6-5) and work the top of the hinge block back into the front panel. Release the pin so that it slips into the hole at the top of the front panel.

c. Reconnect J1, J2, J6, and the microphone connector to the logic board (1, figure 6-5).

5-5-7 Enclosing the Boards (Refer to figure 6-1)

a. Rotate the logic module back into the instrument. Using the phillips screw (40), reconnect the display driver board (2, figure 6-5) to the front panel. Do not over tighten the screw.

b. Fold the cable as shown in figure 5-3, view A; then hold the cable as shown in view B. Swing the logic board (3)/front panel closed, and replace the phillips screw (45) on the rear of the logic board.

5-5-8 Replacing the Battery (Refer to figure 6-1)

a. Plug in battery connector and slide the battery pack (7) into the chassis assembly (1).

b. Install the battery access cover (13) and replace the screw (38) on the bottom of the battery access cover.

5-5-9 Replacing the Case (Refer to figure 6-1)

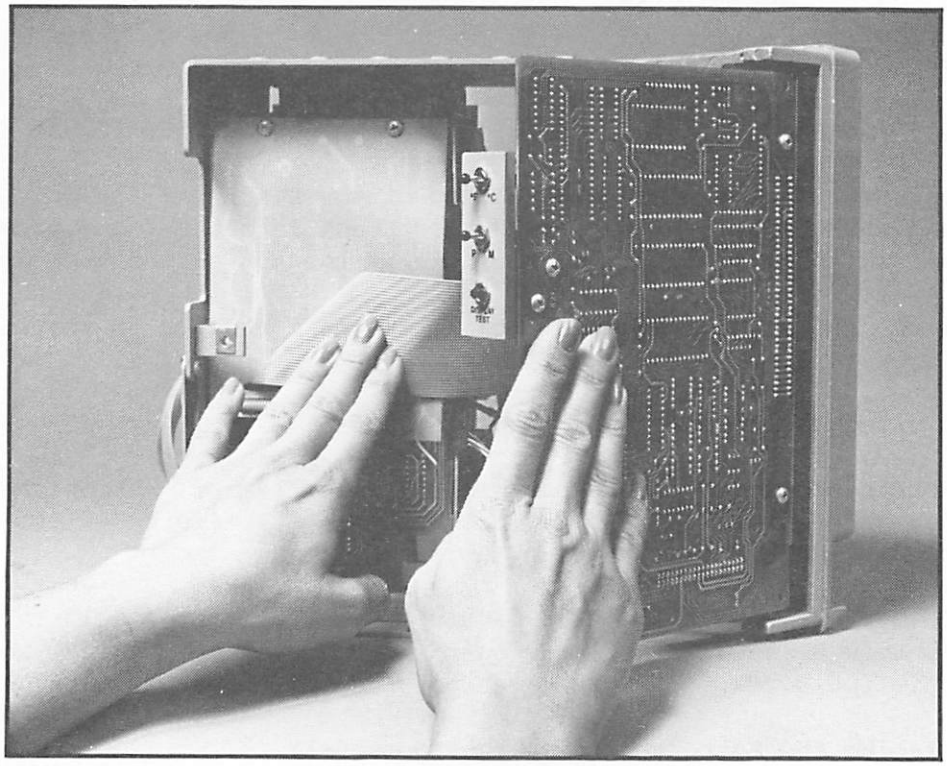
a. Place the monitor face down on a soft surface so as not to scratch the front panel.

b. Gently spread the bottom of the case (9) open and slide it onto the monitor from the rear.

c. Replace the screws (42) which hold the case top to the front panel, ensuring that the O-rings (34) and flat washers (37) are in place.

d. Replace the rubber feet (31) using the screws (41), and stand the monitor right-side up.

VIEW A



VIEW B

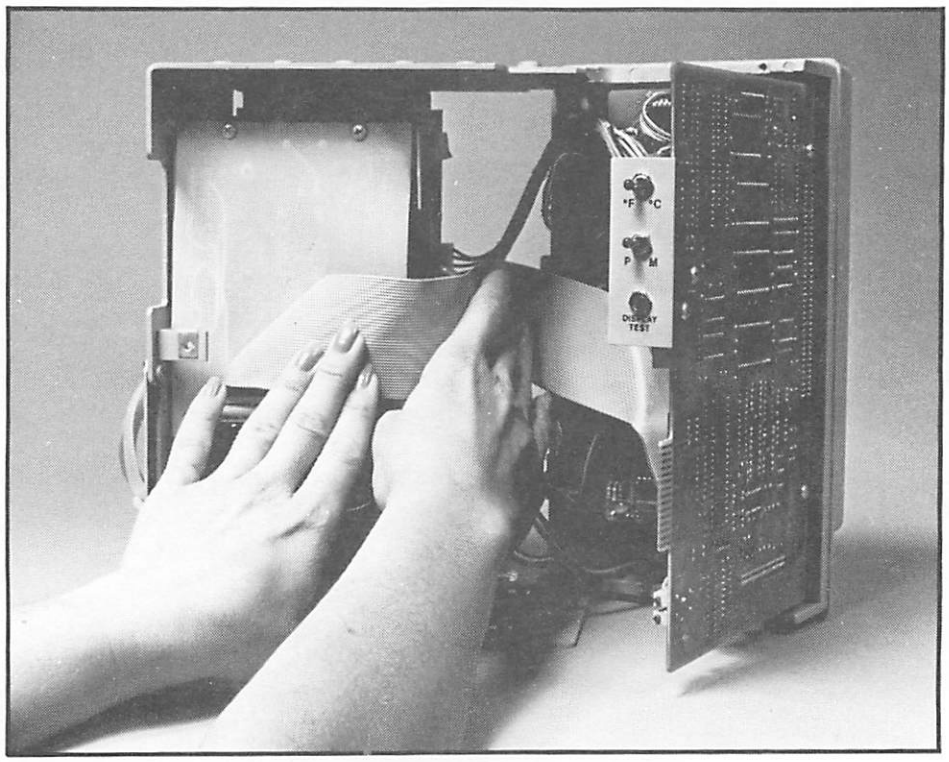


Figure 5-3. Closing the Monitor During Assembly

5-6 CALIBRATION

NOTE

Whenever the cover is removed for inspection, cleaning, updating, testing, troubleshooting, or repairing the VITAL•CHECK monitor, the instrument must be recalibrated.

a. Remove the outer case as per paragraph 5-4-1.

b. Remove the screw at the rear of the logic board and open the instrument.

WARNING

Use extreme caution in servicing the instrument when connected to AC power. Hazardous voltages are present when AC power is connected, regardless of the position of the ON/OFF switch.

c. Connect the AC cord to an active AC power source appropriate to the power rating of the instrument. Verify that the green charge indicator under the information display illuminates.

d. Rotate the MODE selector to MAN.

NOTE

Any time the system is pressurized above 20 mmHg, a hardware timer will be operating and will disable the instrument when it times out after a period of 4 1/2 minutes. If this occurs during calibration, cycle the ON/OFF switch off and then on to reset the instrument.

5-6-1 BP Calibration

5-6-1-1 Power Regulator Adjustment

CAUTION

Take care to avoid any short circuits at or around J1, as blown fuses or other damages can occur. The battery can supply enough current to damage wiring and cause injury.

a. Disconnect the instrument from the AC power source.

b. Disconnect the battery from J2.

c. Disconnect the harness from J1 (to the display driver).

d. Disconnect the harness from J4 (to the logic extension board).

e. Connect a 50Ω, 25W dummy load between TP2 and C1- using test leads. Be sure adjacent points are not shorted.

f. Set the DVM to the 20V range and connect the (+) lead to TP2 and the (-) lead to C1- (GND).

g. Connect the instrument to the AC power source and verify that the DVM indicates the presence of voltage in the range of approximately 13 to 15 volts.

h. Adjust R15 so that the voltage at TP2-C1- is 14.4 ±0.05 volts as indicated by the DVM.

i. Disconnect the instrument from the AC power source.

j. Adjust a variable DC power supply (0-15V, 1 1/2A) to 14.0 volts. do not exceed this voltage.

k. Connect the power supply (+) to TP2 and the (-) to C1- (GND).

NOTE

Observe polarity to prevent damage to the power regulator.

l. Monitor J4-4 with an oscilloscope or DVM to observe the logic level at this pin ($\overline{\text{LOWBAT}}$) (J4-1 is GND).

m. Momentarily connect the instrument to the AC power source to clear the power failsafe flip-flop.

n. Actuate the ON/OFF switch to energize the entire power regulator (now operating from external DC power supply).

o. Test TP6 for a level of approximately 5 volts to ensure power regulator is energized.

p. Verify that a logic 1 is at J4-4.

q. Slowly lower the DC power supply voltage and note at what voltage J4-4 goes to logic 0. Reset the supply to 14 volts.

r. Repeat the above step and adjust R35 until J4-4 goes to logic 0 with the power supply at 11.6 ±0.05V. Verify that this can be repeated.

s. Turn the power supply off and remove it from the power regulator.

t. Remove the 25Ω, 25W resistor and the test equipment from the power regulator.

u. Reconnect J1 and J4.

v. Reconnect the battery to J2, being certain that the plug is not connected backward. Improper polarity will damage the power regulator. (+ is J2-1.)

w. Perform a functional check on the instrument.

Table 5-2. Power Regulator Board Voltages and Waveforms

Signal	Test Point	Conditions	Limits
Unregulated DC voltage	Tp1 to gnd*	Input AC voltages: 95-135 VAC; 190-270 VAC. Battery disconnected. ON/OFF switch off. 25Ω, 25W resistor connected from Tp2 to gnd.	18-35 VDC; ripple voltage should be <1.5V.
Regulated DC voltage	Tp2 to gnd	Same conditions as above	14.4 ±.1 VDC; ripple <350 mV.
Regulated DC voltage with load	Tp2 to gnd	Nominal AC input. Battery disconnected. ON/OFF switch off. 10Ω, 50W load resistor connected to regulated DC voltage	14.4 ±.1 VDC; ripple <350 mV.
+5V Backup	Tp3 to gnd	Nominal AC input; battery connected; ON/OFF switch on.	5 ±.2 VDC; ripple <100 mV.
+5V Logic	Tp6 to gnd	Same conditions as above	5 ±.2 VDC; ripple <300 mV.
-10 Volts	Tp5 to gnd	Same conditions as above	10 ±1 VDC; ripple <500 mV.
23 kHz	U1 pins to gnd	Same conditions as above	23 kHz ±1 kHz sawtooth waveform approximately 0-3.5 VDC.
23 kHz	U2 pin 5 to gnd	Same conditions as above	23 kHz ±1 kHz sawtooth waveform approximately 0-3.5 VDC.
25 kHz	U3 pin 5 to gnd	Same conditions as above	25 kHz ±3 kHz; approxmately 0-3.5 VDC sawtooth waveform.
$\overline{\text{LOW BATT}}$	U7 pin to gnd	AC removed and battery disconnected. Low voltage DC power supply with vernier set to 14.4V connected to J2-1 and J2-2 (CAUTION: observe polarity); momentarily short U6 pin 8 to gnd. (Resets latch U6) ON/OFF switch on. Slowly lower DC supply voltage.	$\overline{\text{LOW BATT}}$ signal goes from 5V to 0V at 11.6 ±.05 VDC (Tp2 to gnd).

*C1-

5-6-1-2 Pressure Adjustment

a. Attach the dip clip to U11 on the logic board.

b. Connect the COM (-) lead from the DMM to pin 16 on the dip clip.

c. Set the DMM to the 20 volt range.

NOTE

The use of static protection devices is mandatory when handling PC boards. When changing connections on the dip clip, be sure that the instrument is turned off.

d. Push the VITALoCHECK monitor's ON/OFF switch to apply power to the instrument.

NOTE

If the instrument displays a FIX ME K alarm, perform steps 1 through 8 below.

1. Remove power from the instrument.
2. Set the DMM to the 2-volt range.
3. Connect the positive (+) DMM lead to pin 28 on the dip clip.
4. Apply power to the instrument.
5. Adjust R45 (zero) on the pneumatic module for a reading of 0.000 ±0.003 on the DMM.
6. Remove power from the instrument.
7. Set the DMM to the 20 volt range.
8. Apply power to the instrument. Verify that the instrument does not display FIX ME K.

e. Connect the DMM positive (+) lead to U11 pin 28 and the COM (-) lead to pin 16.

f. Apply power to the instrument.

g. Instrument should display all eights on the systolic, diastolic, map and pulse display. The information display should read TESTING. After three seconds, the display will disappear and only the information display will read MANUAL.

h. Place section 4 of SW1 on the logic board in the upper position. Verify that numbers appear in the SYSTOLIC, DIASTOLIC, and PULSE displays, and that CAL appears in the information display.

i. Connect the pressure calibration test fixture (figure 5-1) to the cuff connector receptacle on the front of the instrument.

j. Adjust R35 on the logic board for a reading of 128 ±1 in the PULSE display. Verify that the reading is stable and does not show more than one count of noise variation.

k. Set the MODE selector to SYS.

l. Set the DMM to the 2-volt scale.

m. Adjust R45 (zero) on the pneumatic module for a reading of 0.000 ±0.001 volt on the DMM.

n. Set the MODE selector to MAN and set the PRESSURE selector to 125.

o. Manually inflate the system to approximately 220 mm on the calibration gauge. Verify that after inflation, the pressure falls 5 to 10 mm in a period of approximately 10 seconds, and then remains stable or displays a very slow drop of up to 10 mm per minute. If the pressure falls faster, the instrument is in need of repair.

p. Adjust the pressure to 201 mm on the calibration gauge.

NOTE

The pressure selections are decoded as follows in the CAL mode.

(Unit) Pressure (mmHg)	(Gauge) CAL (mmHg)
100	150
125	200
150	250
200	300

q. Adjust R41 (SPAN) on the pneumatic board for a reading that fluctuates between 200 and 202 on the SYSTOLIC display. Be sure that the calibration gauge reading stays at 201 mm during adjustment.

r. Adjust the pressure to 200 mm on the calibration gauge.

s. Adjust R18 on the logic board for a reading of 128 ±4 on the DIASTOLIC display.

t. Set the MODE selector to SYS to deflate the system. Verify that 15 seconds after deflating, the DMM indicates 0.000 ±0.003 volts. If out of range, repeat steps m through s above.

u. Set the PRESSURE selector to 200.

v. Set the MODE selector to MAN.

w. Manually inflate the system to approximately 320 mm on the calibration gauge and wait for the pressure to stabilize.

x. Adjust the pressure to 300 mm on the calibration gauge. Verify that the reading in the SYSTOLIC display is 300 ±4, and the reading in the DIASTOLIC display is 128 ±64. If the readings are out of range marginally, recheck the calibration gauge reading and perform steps n through t above.

y. Set the PRESSURE selector to 150.

z. Adjust the pressure to 250 mm on the calibration gauge. Verify that the reading in the SYSTOLIC display is 250 ±2 and the reading in the DIASTOLIC display is 128 ±32. If the readings are out of range marginally, recheck the calibration gauge reading and perform steps n through x above.

aa. Set the PRESSURE selector to 100.

ab Adjust the pressure to 150 mm on the calibration gauge. Verify that the reading in the SYSTOLIC display is 150 ±2 and the reading in the DIASTOLIC display is 128 ±16. If the readings are out of range marginally, recheck the calibration gauge reading and perform steps n through z above.

ac. Remove power from the instrument.

ad. Return section 4 of SW1 on the logic board to the lower position. If the instrument cannot be adjusted to meet the specified limits, or has a leakdown rate greater than 10 mm per minute, the instrument is in need of repair.

5-6-1-3 Deflation Loop Balance

a. Connect the DMM positive (+) lead to U11 pin 27 and the COM (-) lead to pin 16.

b. Set the DMM to the 20-volt range.

c. Apply power to the instrument.

d. Ensure that the MODE selector is set to MAN.

e. Set the PRESSURE selector to 200.

f. Initiate an inflation cycle by pressing the START/RESET switch. Observe the reading on the DMM as the instrument deflates from 200 mm to approximately 50 mm on the calibration gauge, just before "dumping".

g. Repeat the inflation/deflation sequence and adjust R43 (centering) on the pneumatic module until the average between the maximum and minimum readings on the DMM between 200 mm and 50 mm is 2.5 ±0.15 volts. If the instrument cannot be adjusted to conform to this specification, the instrument is in need of repair.

h. Remove power from the instrument.

i. Remove the dip clip from the instrument.

5-6-2 Thermometer Calibration

NOTE

Calibration of the thermometer board is necessary whenever the analog portion (U3, U5, R15 through R29, VR2 and C8) is worked on.

NOTE

Two circulating hot water baths should be used for calibration. One water bath may be used for calibration, but more time must be allowed for temperature adjustment and stabilization between adjustments.

a. If two circulating hot water baths are used, one must have a temperature of 31.1 ±0.02°C (88 ±0.03°F) and the other 41.1 ±0.01°C (106 ±0.03°F).

NOTE

U3 will malfunction if R28 is grossly maladjusted. In this case the display would be zeros, there would be no scanning at the output of U3, and there would be no response to any analog input.

b. When the hot water baths have been adjusted to the correct temperature, remove the probe from the probe storage well and the probe connector from the probe connector socket.

c. Place the probe into the 31.1°C (*88°F) water bath.

d. Press the DISPLAY TEST switch while inserting the probe connector into the connector socket. Three digits and a "d" should appear on the display. Be sure that the reading is stabilized. (The digit may be a minus (-) sign.)

e. Adjust R28 until the display reads 000d (±1).

f. Place the probe into the 41.1°C (106°F) water bath and allow the display to stabilize.

g. Adjust R29 until the display reads 900d (±1).

h. Verify the accuracy of the adjustments made to R18 and R29 by repeating steps c through g, omitting step d.

i. Press the ON/OFF switch to remove power from the instrument.

j. Remove the AC cord from the outlet.

k. Close the instrument, taking care that the cables are routed properly in the spaces allotted. Replace the screw going through the rear center of the logic board to hold the instrument closed.

l. Replace and secure the outer case in accordance with paragraph 5-5-7.

5-7 CALIBRATION VERIFICATION

Calibration verification identifies the test methods and acceptable results required to ensure that the VITAL•CHECK monitor has been calibrated and operates properly.

5-7-1 Setup

a. Remove the test connector cover from the lower right portion of the rear panel by removing the two phillips-head screws.

b. Ensure that section 4 of SW1 on the logic board (this switch is accessible via step a above) is in the lower position.

c. Remove the thermometer probe and probe connector from the instrument.

d. Insert the pressure calibration test fixture into the cuff receptacle.

e. Plug the instrument into an AC outlet appropriate to the power requirements on the name rating label.

f. Verify that the green charge indicator under the information display illuminates.

5-7-2 Procedure

a. Set the PRESSURE selector to 200.

b. Set the MODE selector to MAN.

c. Press the ON/OFF switch to energize the instrument. Verify that:

1. The information display reads TESTING, the SYSTOLIC, DIASTOLIC, MAP and PULSE displays contain eights (8s), and the temperature display is blank.

2. After approximately three seconds, all displays will blank except the information display which reads MANUAL, accompanied by a low pitched beep of approximately 700 Hz.

d. Rotate the mode selector to MEM. Verify that the information display reads MEMORY.

e. Rotate the MODE selector to SYS. Verify that the information reads a steady SYSTOLIC.

f. Rotate the MODE selector to 1. Verify that the information display reads a steady 1 MIN., and then begins a countdown sequence of one count per second.

g. Rotate the MODE selector to SYS for four seconds.

h. Rotate the MODE selector to 2.5. Verify that the information display reads a steady 2.5 MIN., and then begins a countdown sequence of one count per second.

i. Rotate the MODE selector to SYS for four seconds.

j. Rotate the MODE selector to 5. Verify that the information display reads a steady 5 MIN., and then begins a countdown sequence of one count per second.

k. Rotate the MODE selector to SYS for four seconds.

l. Rotate the MODE selector to 15. Verify that the information display reads a steady 15 MIN., and then begins a countdown sequence of one count per second.

m. Rotate the MODE selector to SYS for four seconds.

n. Rotate the MODE selector to 30. Verify that the information display reads a steady 30 MIN., and then begins a countdown sequence of one count per second.

o. Rotate the MODE selector to SYS.

p. Place section 4 of SW1 to the upper position. Verify that:

1. The MAP and TEMPERATURE displays are blank.
2. The information display reads CAL.
3. The SYSTOLIC display reads 000 (±1).
4. The DIASTOLIC display reads 128 (±16).

5. The PULSE display reads 128 (±4). This reading should not display more than ±1 count of noise.

q. Rotate the MODE selector to MAN.

r. Ensure that the PRESSURE selector is at 200. Verify that the DIASTOLIC display reads 255.

s. Manually inflate the system to 330 mm (±5) on the test gauge. Verify that the pressure falls approximately 10 to 15 mm in the first 5 to 10 seconds after inflation, and stabilizes thereafter. If the pressure on the test gauge continues to fall faster than 10 mm per minute, there is excessive leakage in the pneumatic system.

t. Adjust the pressure until the SYSTOLIC display fluctuates between 300 and 302. Verify that:

   1. The test gauge reads 301 (±6)
   2. The DIASTOLIC display reads 112 (±54).

u. Rotate the PRESSURE selector to 150.

v. Adjust the pressure until the SYSTOLIC display fluctuates between 250 and 252. Verify that:

   1. The test gauge reads 251 (±4).
   2. The DIASTOLIC display reads 112 (±48)

w. Rotate the PRESSURE selector to 125.

x. Adjust the pressure until the SYSTOLIC display fluctuates between 200 and 202. Verify that:

   1. The test gauge reads 201 (±4)
   2. The DIASTOLIC display reads 112 (±16)

y. Rotate the PRESSURE selector to 100.

z. Adjust the pressure until the SYSTOLIC display fluctuates between 150 and 152. Verify that:

   1. The test gauge reads 151 (±2)
   2. The DIASTOLIC display reads 112 (±16).

aa. Deflate the system.

ab. Manually inflate the system to 320 mm on the test gauge without exceeding 320 mm. Verify that the system remains inflated.

ac. Manually inflate the system slowly from 320 mm toward 345 mm on the test gauge. Verify that:

1. Before 345 mm is reached, the system reaches a point where it rapidly deflates.

2. It is not possible to inflate the system.

ad. Cycle the ON/OFF switch off and on to reset the instrument. Verify that it is possible to manually inflate the system.

ae. Deflate the system.

NOTE

Perform steps af through al only if the instrument cover has already been removed and the instrument is opened.

af. With the power off, short across R2, using a jumper cable, (a 15kΩ, 1% resistor) on the pneumatic board to disable the overpressure comparator.

ag. Apply power to the instrument.

ah. Manually inflate the system to 340 mm on the test gauge without exceeding 340 mm.

ai. Verify that the instrument remains inflated.

aj. Slowly inflate the instrument without exceeding 40 mm.

ak. Verify that the instrument rapidly deflates at a pressure between 350 and 430 mm.

al. Remove the jumper cable from R2 on the pneumatic board.

am. Remove the pressure calibration test fixture from the instrument and return section 4 of SW1 to the lower position.

an. Insert the Thermometer Tester - Model 828A into the probe connector socket.

ao. Set the P-M switch to M and the ^{o}F-^{o}C switch to ^{o}F. Verify that the temperature display flashes 98.6^{o}F (±0.2^{o}F).

ap. Set the ^{o}F-^{o}C switch to ^{o}C. Verify that the display flashes 37.0^{o}C (±0.1^{o}C).

aq. Set the P-M switch to P. Verify that the display reads 37.0^{o}C (±0.1^{o}C) and that only the C flashes on and off.

ar. Set the ^{o}F-^{o}C switch back to ^{o}F. Verify that the display reads 98.6^{o}F (±0.2^{o}F) and that only the F flashes on and off.

as. Remove the thermometer tester from the instrument.

at. Remove power from the instrument.

au. Reconnect the test connector cover to the lower right portion of the rear panel. If the unit did not meet the requirements of this section, it must be recalibrated in accordance with the procedure in section 5-6.

5-8 FUNCTIONAL TESTS

a. Plug the instrument into an AC outlet appropriate to the power requirements on the name rating label.

b. Press the ON/OFF switch to energize the instrument. Verify that the SYSTOLIC, DIASTOLIC, MAP, and PULSE displays show all 8's and the TESTING message appears for 2 ±1 seconds. The SYSTOLIC, DIASTOLIC, MAP and PULSE displays should go blank. A mode message accompanied by 2 beeps replaces the TESTING message.

5-8-1 Mode Switch Function Test

a. Set the MODE selector to MAN.

b. Turn the instrument off and on. Verify that after the TESTING message, MANUAL appears in the information display.

c. Turn the MODE selector to MEM. Verify that MEMORY appears in the information display.

d. Turn the MODE selector to SYS. Verify that SYSTOLIC appears in the information display.

e. Turn the MODE selector to 1. Verify that the display shows 1 MIN., then counts down from 1 minute.

f. Turn the MODE selector back to SYS for four seconds, and then set it at 2.5. Verify that the display shows 2.5 MIN., then counts down from 2.5 minutes.

g. Turn the MODE selector back to SYS for four seconds and then set it at 5. Verify that the display shows 5 MIN., then counts down from 5 minutes.

h. Turn the MODE selector back to SYS for four seconds and then set it at 15. Verify that the display shows 15 MIN, then counts down from 15 minutes.

i. Turn the MODE selector to SYSTOLIC for four seconds, and then set it at 30. Verify that the display shows 30 MIN., then counts down from 30 minutes.

5-8-2 Pressure Switch Function and Abort (RESET) Test

a. Set the MODE selector to MAN.

b. Set the PRESSURE selector to 100.

NOTE

A BP cuff is necessary for this test. It must be installed on an arm as per chapter 2, Operation and Functional Checkout, or mounted on a 4 to 5 inch diameter tube.

c. Press the START/RESET switch to initiate an inflation cycle. Verify that 100 flashes in the information display.

d. Immediately press the START/RESET switch again. Verify that the pump stops, and that MANUAL appears in the information display accompanied by two audible tones.

e. Set the PRESSURE selector to 125.

f. Press the START/RESET switch to initiate an inflation cycle. Verify that 125 flashes in the information display.

g. Immediately press the START/RESET switch again to stop the instrument as in step d above.

h. Set the PRESSURE selector to 150.

i. Press the START/RESET switch to initiate an inflation cycle. Verify that 150 flashes in the information display.

j. Immediately press the START/RESET switch again to stop the instrument as in step d above.

k. Set the PRESSURE selector to 200.

l. Press the START/RESET switch to initiate an inflation cycle. Verify that 200 flashes in the information display.

m. Immediately press the START/RESET switch again to stop the instrument as in step d above.

5-8-3 Display and Battery Tests

a. Set the MODE selector to MAN. Remove the power cord from the outlet and observe that the green charge indicator extinguishes. Verify that after approximately 20 seconds the information display changes from a steady MANUAL to a flashing STANDBY.

b. Intall a temperature probe on the instrument.

c. Press the DISPLAY TEST switch on the rear panel of the instrument. Verify that all segments of the SYSTOLIC, DIASTOLIC, MAP, PULSE, and TEMPERATURE displays illuminate and that the information display alternates between capital Os and asterisks.

d. Press and hold the DISPLAY TEST switch, press the START/RESET switch twice, then release both switches. Verify that each numeric digit (except the TEMPERATURE display) lights sequentially one at a time with a number or character that corresponds to its position in the sequence. The number or character must be as follows:

1. SYSTOLIC
   - ls digit - 0
   - 10s digit - 1
   - 100s digit - 2

2. DIASTOLIC
   - ls digit - 3
   - 10s digit - 4
   - 100s digit - 5

3. MAP
   - ls digit - 6
   - 10s digit - 7
   - 100s digit - 8

4. PULSE
   - ls digit - 9
   - 10s digit - lower 4 segments of an 8
   - 100s digit - upper 4 segments of an 8

5. Similarly, the segments of the information display will light one at a time right to left with the numerical sequence 0 to 7. Each character or number must remain displayed for approximately 0.6 seconds.

6. The TEMPERATURE display will continuously display all 8s.

NOTE

A probe must be installed in the probe connector and probe storage well.

e. Press the DISPLAY TEST switch again. Verify that:

1. All numeric displays (except TEMPERATURE) cycle simultaneously through the digits 0 to 9.

2. The information display cycles through the characters that correspond to the hexadecimal codes 20 to 5F. (See figure 5-4.)

3. The TEMPERATURE display continuously displays all 8s.

NOTE

A probe must be installed in the probe connector and probe storage well.

CHARACTER SET

				D0	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H
				D1	L	L	H	H	L	L	H	H	L	L	H	H	L	L	H	H
				D2	L	L	L	L	H	H	H	H	L	L	L	L	H	H	H	H
				D3	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H
	D6	D5	D4	HEX	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
	L	H	L	2		!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
	L	H	H	3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
	H	L	L	4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
	H	L	H	5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_

All other input codes display "blank"

Figure 5-4. Hexadecimal Code Characters

f. Press the DISPLAY TEST switch again. Verify that:

1. The TEMPERATURE display remains illuminated with all 8s and the other numeric displays are blank.

2. The current software revision level message REV x.xx (where x.xx represents the level) appears in the information display.

g. Press the DISPLAY TEST switch again. Verify that the instrument sounds two audible tones and displays MANUAL in the information display.

5-8-4 BP Measurement Test

a. Plug the instrument into an appropriate AC outlet. Verify that the green charge indicator illuminates.

b. Set the PRESSURE selector to 150.

c. Set the MODE selector to MAN.

d. Apply power by pressing the ON/OFF switch. Verify that the instrument briefly displays the message TESTING and then sounds two audible tones and displays MANUAL.

NOTE

The TESTING message will be displayed each time power is applied.

e. Plug the cuff connector into the cuff connector receptacle. Plug a stethoscope into the stethoscope receptacle.

f. Place the cuff on a person's arm following the cuff placement instructions provided in the VITAL•CHECK Monitor - Model 4000 Directions For Use.

g. Press START/RESET. Verify that:

1. The initial goal pressure (150) flashes.

2. After the pumping stops, the instrument pauses while it checks for complete occlusion (no Korotkoff sounds) and air leaks. The cuff pressure is then displayed on the information display and the cuff begins to deflate.

NOTE

If two Korotkoff sounds are detected during the first 3.5 seconds of deflation, the monitor will repump by 25 mmHg more than the previous inflation pressure and restart deflation.

NOTE

If the patient's Korotkoff sounds are too weak (due to cuff misalignment or greater-than-normal adipose tissue) the monitor may not be able to compute the BP utilizing the auscultatory algorithm, thus it will fall back on the oscillometric algorithm. If this is the case, the BP READY message will be replaced by BP*READY. The unit should be retested using another person's arm (ensure that the cuff is correctly positioned) to verify the auscultatory algorithm.

3. An asterisk (*) flashes on the information display as the instrument detects Korotkoff sounds during deflation.

4. The Korotkoff sounds are audible in the stethoscope as the cuff deflates, and the sound in the stethoscope is muted during inflation and after deflation. Muting can be verified by tapping the cuff microphone (positioned under the ARTERY label) and comparing the difference in sound level in the stethoscope earpiece.

5. Controlled deflation continues until the diastolic pressure is detected, at which point the cuff pressure is immediately dumped to zero and the measurement is completed. The instrument then sounds an audible tone and displays the systolic BP, diastolic BP, MAP, and PULSE. The information display alternates between BP READY and MANUAL five times, and then displays MANUAL.

NOTE

The results of this test are dependent upon the characteristics of the individual whose blood pressure is being monitored. If the instrument does not perform as specified, repeat the test on another person.

h. If the instrument fails to operate as indicated, it is in need of repair.

5-8-5 Thermometer Predictive Mode Test

a. Insert the probe connector into the probe connector socket, and the probe into the probe storage well.

b. Set the P-M switch to P.

c. Remove the probe from the storage well and immerse the probe to a depth of 2 inches into a circulating water bath with a temperature of approximately 37°C (98.6°F). (Exact temperature is not critical.)

d. Verify that the thermometer display rapidly advances and that the tissue contact indicator rotates in response to the heat.

e. After 15 to 20 seconds, verify that the display stops advancing and that an F or C appears in the far right-hand digit. Note that the temperature reading will not be accurate with this fast testing method.

f. Verify that when the F or C appears, the entire display flashes on and off, with the audible tone sounding when the display flashes off. The display and audible tone should cease after 12 cycles.

g. If the unit does not perform as required, it is in need of repair.

5-8-6 Thermometer Err t Alarm Test

a. The ^{o}F-^{o}C switch may be set to either ^{o}F or ^{o}C. Set the P-M switch to P.

b. Simultaneously remove the probe from the storage well and start the stopwatch. Err t should appear in the thermometer display within 101 ±2 seconds. The display should flash on and off seven times.

5-8-7 Thermometer Err L Alarm Test

a. Remove the probe from the probe storage well. Install a probe cover and take an oral temperature measurement in the normal manner. Note the reading.

b. Using another probe cover, take another temperature. When the displayed temperature is 0.3^{o}C (0.5^{o}F) less than the previous reading, simultaneously remove the probe and start the stopwatch. Quickly place the probe in an area with a temperature less than the displayed temperature, but greater than 32.2^{o}C (90.9^{o}F).

c. Verify that the tissue contact indicator does not move throughout this test.

d. When the unit displays Err L, stop the stopwatch. The stopwatch should read 35 ±1 seconds, and the display should flash seven times. This procedure may have to be performed a few times to achieve satisfactory results.

5-8-8 Thermometer Err H Alarm Test

a. Remove the probe from the probe storage well. Place the probe without a cover into a water bath with a temperature greater than 42.2^{o}C (108.0^{o}F) but less than 57.2^{o}C (135^{o}F).

b. The display should advance to 42.2^{o}C (108.0^{o}F), at which time Err H should flash seven times.

5-9 SAFETY TESTS

5-9-1 Ground Current Leakage Test

Use a BIO-TEK Model 150M or equivalent tester to measure the ground current leakage. Refer to the electrical safety tester's operation manual for the proper measurement technique. Leakage must be less than or equal to 15 microamps for normal and reversed line polarity for 120 VAC input.

5-9-2 Dielectric Withstand Test

Use a Hipotronics Model H or equivalent instrument to perform the dielectric withstand test. Refer to the electical safety tester's operation manual for the proper measurement technique. The monitor must withstand 1500 VAC without leakage or breakdown.

5-9-3 Ground Resistance Testing

Use a BIO-TEK Model 11 with a BIO-TEK Model 150M or equivalent equipment to measure resistance from the ground pin on the AC power plug to the chassis (screw head on back panel). Refer to the electrical safety tester's operation manuals for the proper measurement technique. Resistance should be less than or equal to 0.2Ω at 25A, 50 to 60 Hz AC rms.

CHAPTER 6
ILLUSTRATED PARTS BREAKDOWN

6-1 INTRODUCTION

The illustrated parts breakdown for the IVAC VITAL•CHECK Monitor - Model 4000 consists of the complete system divided into assemblies, subassemblies, and individual component parts. Figures 6-1 through 6-9 are the exploded view illustrations for the instrument. Figures 6-10 thorugh 6-12, 6-14 through 6-19, and 6-21 through 6-23 are the PW board assembly drawings. Figure 6-13 illustrates the thermometer/display switch assembly; 6-20 shows the rotary switch boards harness assembly; and figure 6-24 identifies the major assemblies of the IVAC Instrument Stand - Model 1020VS. Each figure is accompanied by a parts list.

6-2 ILLUSTRATIONS

The following paragraphs describe exploded view and board assembly illustrations.

6-2-1 Exploded View Illustrations. Exploded view illustrations serve as visual aids for identifying the component parts of each assembly. Index numbers used on the illustrations, when used in conjunction with the appropriate parts list, identify each part shown.

6-2-2 Board Assembly Illustrations. Board assembly drawings illustrate the board layout, identifying the location of each component. The accompanying parts list describes each component in detail.

6-3 PARTS LISTS

The parts lists provide part numbers and descriptions of every part/subassembly which is identified on the drawings, and which may require replacement when the instrument is serviced or repaired. In the case of electronic components on PW board, reference designations are supplied (rather than index numbers) as an aid to locating the component in the circuit (PW boards are not depicted as exploded views). Paragraphs 6-3-1 through 6-3-5 explain the contents of the parts lists in further detail.

6-3-1 FIG./INDEX NO. This column lists the number of the figure referenced by the parts list, and provides index numbers of assemblies/components identified on the drawing. The index numbers on an illustration correspond to the same number appearing in the parts list.

6-3-2 REF DES. Each electronic component assigned a circuit symbol has that designation listed in this column. Where the sequence is broken due to the removal, revision, or change of a component, the notation "not used" appears in the DESCRIPTION column opposite the designation that has been removed. Used in conjunction with the schematic diagrams and the descriptions in the parts lists, the reference designation numbers (which also appear on the board assembly drawings to identify each component's location), provide data required to troubleshoot or repair/replace any component.

6-3-3 PART NO. The number appearing in this column is an IVAC-assigned part number in one of two categories:

a. IVAC designed and built: 100000 series numbers
b. IVAC procured but built by (and available from) an outside vendor: 300000 series numbers

All 300000 series numbers may be purchased either from IVAC or from the original manufacturer/distributor. Upon request, IVAC will supply the manufacturer's name and part number.

6-3-4 DESCRIPTION. This column of the parts list provides descriptive data--type, size, color, etc.--required to identify the part when ordering or replacing it. Abbreviations used are defined in table 1-1. Commercially procurable parts (except for electronic components) are listed as COML. These parts, in addition to all electronic components with a 300000 series part number, are available commercially.

6-3-5 QTY. This column indicates the total number of each part used within the assembly.

6-3-6 USABLE ON CODE. This column indicates which model the part is used on, either 110V or 220V. When nothing appears in this column, the part is used on either model.

6-4 ORDERING PARTS

Parts can be ordered by writing or calling the IVAC Service Department at the address/phone number given below. When requesting a part, please provide the following information:

a. Instrument name
b. Instrument model number
c. The six-digit part number
d. Description of the part as it appears in the parts list

Contact: IVAC Corporation
10300 Campus Point Drive
San Diego, CA 92121-1579
ATTN: Service Stockroom
(800) 482-4822

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-1		127350	IVAC VITALoCHECK MONITOR - MODEL 4000 FINAL ASSEMBLY		
-1		127351-1	Power Chassis Assembly, 110V	1	110
-2		127351-2	Power Chassis Assembly, 220V	1	220
-3		127352	Logic Module Assembly	1	
-4		124364	Pneumatic Module Assembly	1	
-5			Not Used		
-6		124397	Power Regulator ASsembly	1	
-7		124373	Battery Pack Assembly	1	
-8			Not Used		
-9		127248	Cover	1	
-10		126035	Carrying Handle	1	
-11			Not Used		
-12			Not Used		
-13		127253	Battery Access Cover	1	
-14		127255	CIM Connector Cover	1	
-15			Not Used		
-16		127213	Card Guide, upper	1	
-17		124864	Card Guide, lower	1	
-18		124869	Stop Plate	2	
-19			Not Used		
-20		124156	Seal Cap Strap	1	
-21		124168	Spanner Nut	1	
-22		124164	Seal Cap	1	
-23		302590	O-Ring, .489 ID (COML)	1	
-24			Not Used		
-25		124827-1	Cable Assembly, logic, pneumatic and logic extension	1	
-26			Not Used		

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-1					
-27		126033	Extension Cable, batt/power supply	1	
-28		124398	Harness Assembly I/O power supply	1	
-29		126061-6	Chassis Pad	3	
-30		126062-3	Insulator, miscellaneous	1	
-31		302709	Rubber Bumper (COML)	4	
-32		124248	Cover Shield	2	
-33		124374-5	Battery Pad	1	
-34		302675	O-Ring, .114 ID (COML)	2	
-35		300027	Cord Tie (COML)	A/R	
-36		302843	Rubber Adhesive (COML)	A/R	
-37		302153	Washer, #6, flat (COML)	2	
-38		300330	Screw, 6-32 x 1/4, pan head, phillips (COML)	3	
-39		303122	Screw, sheet metal, #6 x 3/8, flat head, phillips, steel plated (COML)	2	
-40		301648	Screw, 6-32 x 3/8, truss head, phillips (COML)	1	
-41		303152	Screw, sheet metal, #6 x 1/2, flat head, phillips, steel plated (COML)	4	
-42		302875	Screw, 6-32 x 1, hex socket head (COML)	2	
-43		303123	Screw, sheet metal, #6 x 3/8, pan head, phillips, steel plated (COML)	6	
-44		302099	Screw, 6-19 x 7/8 HI-LO, flat head, phillips (COML)	1	
-45		302872	Screw, #6 x 1/4, drive (COML)	1	
-46		300370	Screw, 8-32 x 1/2, pan head, phillips (COML)	2	
-47			Not Used		

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-2		124884-08	LABEL/LITERATURE ASSEMBLY - MODEL 4000		
-1		124094	Battery Charge Notice Card	1	
-2			Not Used		
-3		100133	Claim Notice Card	1	
-4		125999	Limited Warranty Card	1	
-5		124499	Directions For Use	1	
-6			Not Used		
-7		127355	Label, Knob Insert	2	
-8		126058	Label, Handle	1	
-9		127356	Label, VITAL•CHECK	1	
-10		124432-10	Label, Serial Number	1	
-11		125569	Label, Serial Number Replacement	A/R	
-12		124433	Label, Configuration Control	1	
-13		124098	Label, Name Rating	1	
-14		125181-01	Label, Model Code	1	
-15		126037	Label, Danger	1	
-16		126036	Label, Service Assistance	1	
-17			Not Used		
-18		126038	Label, UL Approval	1	
-19		126020	Label, Trademarks	1	
-20			Not Used		
-21		127358	Label, Distribution	1	
-22		127357	Label, Operating Instructions	1	
-23		127350	Final Assembly, 110V	1	
-24		122381	Label, Caution	1	

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-3		127351	POWER CHASSIS ASSEMBLY		
-1		127256	Chassis, 110V	1	
-2		127257	Chassis, 220V	1	
-3		127211-1	Transformer Assembly, 110V	1	
-4		127211-2	Transformer Assembly, 220V	1	
-5			Not Used		
-6		123144	Cord Tie	1	110
-7			Not Used		
-8			Not Used		
-9			Not Used		
-10		126043	Battery/Transformer Bracket	1	
-11		127353	AC Receptacle Housing	1	220
-12		127249	Front Panel, machined	1	
-13			Not Used		
-14		124344	START/RESET Switch Assembly	1	
-15		124345	Power Switch Assembly	1	
-16		126048	Harness Assembly, rotary switch boards	1	
-17		124347	MODE Knob	1	
-18		124348	PRESSURE Knob	1	
-19			Not Used		
-20		124419	Highlight Insert	2	
-21		303102	Spacer, hex, 8-32 x 1 5/8 (COML)	4	220
-22		124391	Power Supply Harness	1	
-23		124203	Silkscreened Lens	1	
-24		126059	Lens Filter	1	
-25		300949	Wire, 22 AWG, stranded, black (COML)	7"	110

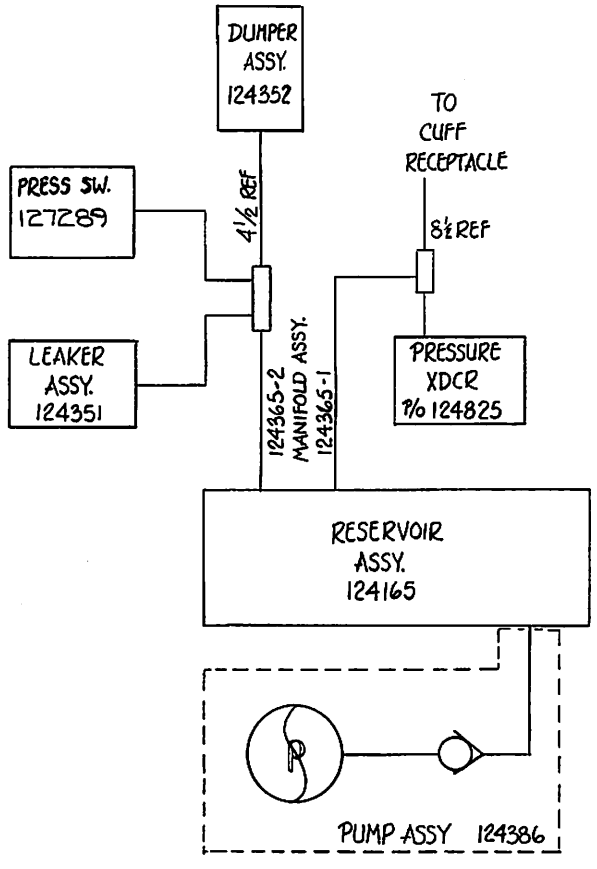
FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-3					
-26		300610	Shrink Tubing, 1/4" ID (COML)	A/R	
-27		302597	Clip (COML)	6	
-28		124393	Power Cable Assembly	1	110
-29		124865	Logic Extension Board Assembly (see figure 6-19 for breakdown)	1	
-30		124843	ERC Harness Assembly	1	
-31		300646	Strain Relief (COML)	1	110
-32		302587	Circuit Breaker (COML)	1	110
-33		303125	Speed Nut Fastener, #6, "U" type (COML)	5	
-34		302073	Connector Housing (COML)	1	110
-35		302747	Female Crimp Terminal (COML)	2	110
-36		302671	Connector Housing (COML)	1	
-37		301648	Screw, 6-32 x 3/8, truss head, phillips (COML)	3	
-38		300832	Screw, 6-32 x 1/4 pan head, phillips (COML)	6	
-39		301850	Spacer, hex, 6-32 x 3/8	3	
-40		302871	Screw, 8-32 x 1 1/8, par. head, phillips (COML)	4	
-41		300036	Kep Nut, #6-32 (COML)	1	
-42		300929	Hex Nut, 8-32 (COML)	2	
-43		300370	Screw, 8-32 x 1/2, pan head, phillips (COML)	4	220
-44		300568	Screw, 6-32 x 3/8, flat head, phillips (COML)	3	
-45			Not Used		
-46			Not Used		
-47			Not Used		
-48			Not Used		
-49			Not Used		
-50			Not Used		

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-3					
-51			Not Used		
-52			Not Used		
-53			Not Used		
-54		124649	Front Panel Interconnect Assembly	1	
-55			Not Used		
-56		302596	Drive Rivet (hinge pin) (COML)	2	
-57		124405	T-Bar	1	
-58		302869	Screw, 6-32 x 1/2, flat head socket (COML)	1	
-59		302873	Clip (COML)	1	
-60		303099	Screw, 8-32 x 1, truss head, phillips (COML)	4	220
-61		124374-1	Front Pad	1	
-62		124374-2	Bottom Pad	1	
-63		124374-3	Side Pad	1	
-64		124374-4	Top Pad	1	
-65		126056	Battery Compartment Liner	1	
-66		300695	Solder (COML)	A/R	110
-67		300399	Thread Adhesive (COML)	A/R	220
-68		126062	Insulator	1	
-69		303085	Flexible Grommet (COML)	4	3/4"
-70		126056-2	Side Liner	1	
-71		124406-3	Insulator	1	
-72		303106	Cable Clamp	1	110

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	USABLE QTY	ON CODE
6-4		124849	FRONT PANEL INSERT INTERCONNECT ASSEMBLY		
-1		127292	Front Panel Insert Silkscreen	1	
-2		124466	Cuff Receptacle Cable Assembly	1	
-3		124112	Probe Assembly Harness	1	
-4		124113	Switch-Mod Carrier	1	
-5			Not Used		
-6		302613	Rubber Grommet (COML)	1	
-7		127229	Retaining Clip	1	
-8		124182	Switch Carrier Connector	1	
-9		301044	Strap Tie (COML)	1	
-10			Not Used		
-11		302843	Adhesive (COML)	A/R	
-12			Not Used		
-13		303154	Neoprene Tubing, 3/8 ID x 1/8 wall	7/16"	

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-5		127352	LOGIC MODULE ASSEMBLY		
-1		124389	Logic Board Assembly (see figure 6-12 for breakdown)	1	
-2		124855	Display Driver Board Assembly (see figure 6-14 for breakdown)	1	
-3		124835	Display Board Assembly (see figure 6-15 and 6-16 for breakdown)	1	
-4		124192	Thermometer Board Assembly (see figure 6-23 for breakdown)	1	
-5		124185	Binge Bar Assembly	1	
-6		127354	Thermometer/Display Switch Assembly	1	
-7			Not Used		
-8		124346	Switch Bracket Insulator	1	
-9			Not Used		
-10		300802	Screw, machine, 6-32 x 3/4, pan head, phillips (COML)	4	
-11		300036	Kep Nut, 6-32 (COML)	4	
-12		300034	Screw, machine, 6-32 x 3/8, pan head, phillips (COML)	2	
-13			Not Used		
-14		300516	Washer, fiber, #6	1	
-15			Not Used		
-16		124442	Nut Plate	1	
-17			Not Used		
-18		301044	Strap Tie (COML)	2	
-19			Not Used		
-20			Not Used		
-21		127233	Charging Indicator Label	1	
-22			Not Used		
-23		302273	LED Mounting Grommet (COML)	1	

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	USABLE QTY ON CODE
-24		302893	Shrink Tubing, black, .250 ID (COML)	3/16"
-25			Not Used	
-26		302700	Fast-setting Adhesive	A/R

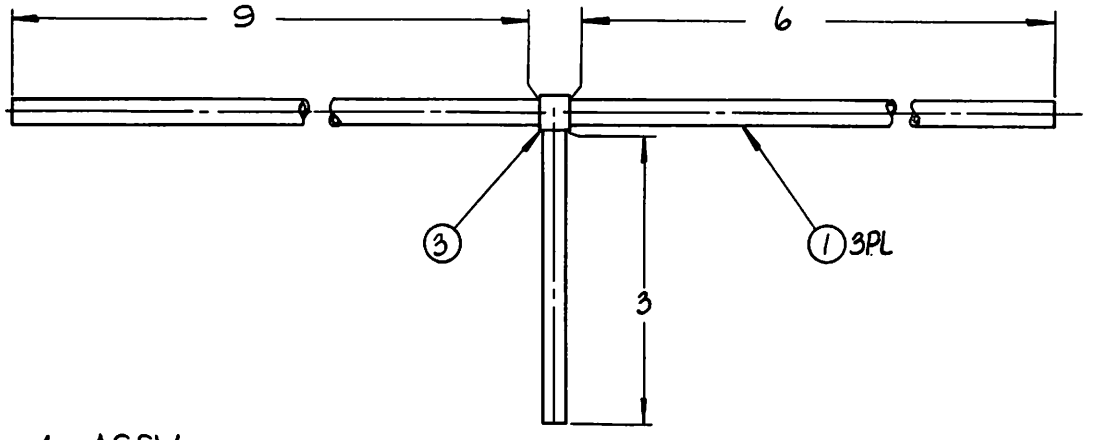


TUBING SCHEMATIC

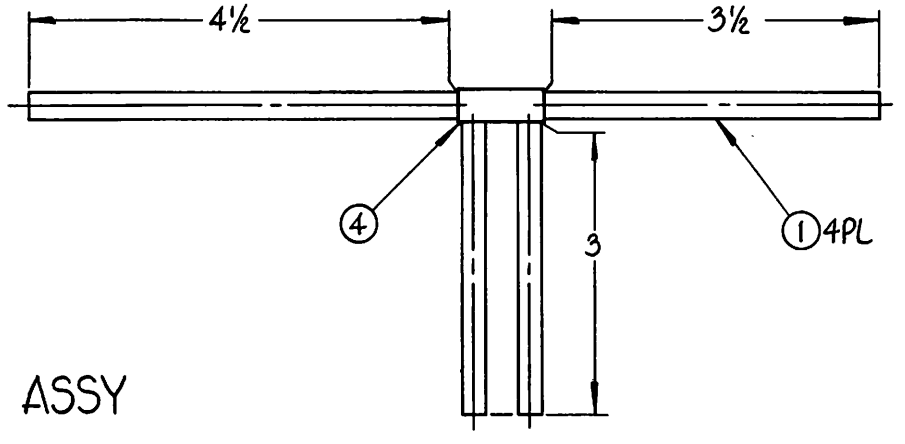
Figure 6-6. Pneumatic Module Assembly
(Sheet 2 of 2)

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-6		124364	PNEUMATIC MODULE ASSEMBLY		
-1		124367	Pneumatic Chassis	1	
-2		124825-2	Pneumatic Board Assembly (see figures 6-17 and 6-18 for breakdown)	1	220
		124825-1	Pneumatic Board Assembly (see figures 6-17 and 6-18 for breakdown)	1	110
-3		124119	Motor Cover	1	
-4		124165	Reservoir Assembly	1	
-5			Not Used		
-6		124351	Leaker Assembly	1	
-7		124352	Dumper Assembly	1	
-8		126030	Pressure Switch Assembly	1	
-9		124386	Pump Assembly (see figure 6-8 for breakdown)	1	
-10		126061-4	Pneumatic Chassis Pad	1	
-11		126061-3	Motor Cover Pad	1	
-12		124365-1	Manifold Assembly (see figure 6-7 for breakdown)	1	110
-13		124365-2	Manifold Assembly (see figure 6-7 for breakdown)	1	220
-14		124859	Motor Strap	1	
-15		126061-2	Motor Strap Pad	1	
-16		303085	Flexible Grommet (COML)	A/R	
-17		126061-1	Pneumatic Chassis Pad (tab)	1	
-18		301606	Cable Tie (COML)	1	
-19		126062-2	Pneumatic Assembly Insulator	1	
-20			Not Used		
-21		303126	Fastener, speed nut #6, U-type (COML)	8	
-22		300045	Kep Nut, 4-40 (COML)	2	
-23		303123	Screw, sheet metal, 6-32 x 3/8 pan head, phillips (COML)	2	

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
-24		300330	Screw, machined, 6-32 x 1/4 pan head, phillips (COML)	3	
-25		303105	Screw, machined, 4-40 x 3/4, flat head, phillips (COML)	2	
-26		303122	Screw, sheet metal, 6 x 3/8, flat head, phillips (COML)	4	
-27		300345	Screw, machined, 4-40 x 1/4 pan head, phillips (COML)	2	
-28			Not Used		
-29		303153	Washer, external tooth lock, steel plated (COML)	1	



-1 ASSY



-2 ASSY

NOTES (UNLESS OTHERWISE SPECIFIED):

1 ENDS OF TUBES TO BUTT AGAINST SHOULDERS OF FITTINGS.

Figure 6-7. Manifold Assembly

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-7		124365	MANIFOLD ASSEMBLY		
-1			Assembly, 110V	1	110
-2			Assembly, 220V	1	220
-3			Not Used		
-4			Not Used		
-5		302592	Double Tee (COML)	1	220
-6		302593	Tee (COML)	1	110
-7		303109	Silicone Tubing, 6" long (COML)		110
-8		303109	Silicone Tubing, 10 1/2" long (COML)		110
-9		303109	Silicone Tubing, 3" long (COML)		
-10		303109	Silicone Tubing, 4 1/2" long (COML)		220
-11			Not Used		
-12		303109	Silicone Tubing, 1/2" long (COML)		220

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-8		124386	PUMP ASSEMBLY		
-1		302605	Pump (COML)	1	
-2	C1	300519	Capacitor, Tantalum, 10 µf, 25V (COML)	1	
-3	C2	301979	Capacitor, Ceramic, 0.1 µf, 50V (COML)	1	
-4		302670	Rectangular Connector (COML)	1	
-5		302666	Crimp Terminal (COML)	2	
-6		300469	Solder Lug (COML)	2	
-7		124406-1	Motor Capacitor Insulator	2	
-8		300614	Wire, 22 AWG, red (COML)	A/R	
-9		300622	Wire, 22 AWG, black (COML)	A/R	
-10		300622	Wire, 22 AWG, black, 4" long (COML)	1	
-11		300017	Wire, 22 AWG, bus, 2" long	1	
-12		300785	Shrink Sleeving, 1/8" ID (COML)	A/R	
-13		300027	Cord Tie (COML)	A/R	
-14		301137	Sleeving (COML)	A/R	
-15		303109	Silicone Tubing, 1 1/2" long (COML)	1	
-16		303109	Silicone Tubing, 5 1/8" long (COML)	1	
-17		124247	Check Valve	1	
-18		302703	Copper Foil, adhesive back, 4 1/4" long	1	
-19		300695	Solder (COML)	A/R	
-20		124406-2	Motor Brush Insulator	2	
-21		127238	PVC Tube, 1/2" long	2	
-22		301925	Cyclohexanone (COML)	A/R	

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-9		124397	INITIAL POWER REGULATOR ASSEMBLY		
-1		124445	Power Regulator Board Assembly (See figure 6-10 for breakdown)	1	
-2		124395	Negative Supply Board Assembly (see figure 6-11 for breakdown)	1	
-3	L1,L2	124838	Inductor, 300 µh	2	
-4	L3	124839	Inductor, 167 µh	1	
-5		303050	Washer, #6, fiber (COML)	6	
-6		303025	Spacer, #6, 7/8" long (COML)	3	
-7		300516	Washer, #6, fiber (COML)	3	
-8		301144	Screw, 6-32, 1" long, flat head, phillips (COML)	3	
-9		300034	Screw, 6-32 x 3/8" long, pan head, phillips (COML)	3	
-10		300695	Solder (COML)	A/R	
-11		126068	Power Regulator Header	1	
-12		303051	Spacer, #2, .12" long (COML)	2	
-13		300875	Shrink Tubing, 1/8", clear (COML)	A/R	

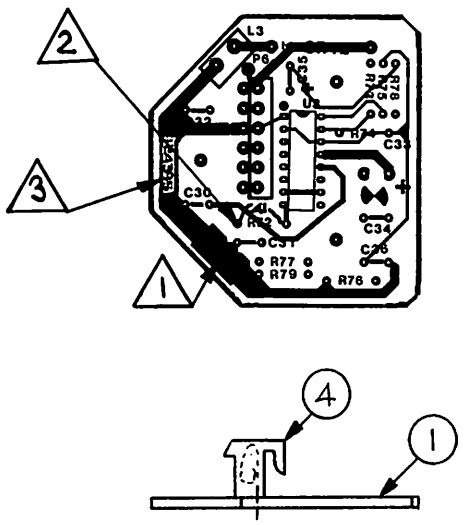
FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-10		124445	POWER REGULATOR PW BOARD ASSEMBLY		
-1		124446	Power Regulator PW board	1	
-2			Not Used		
-3			Not Used		
-4	R1	300591	Resistor, Fixed Carbon, 1kΩ, 1/2W ±5% (COML)	1	
-5	R5	302211	Resistor, Fixed Carbon, 2kΩ, 1/2W ±5% (COML)	1	
-6	R18	302172	Resistor, Fixed Carbon, 620Ω, 1/2W ±5% (COML)	1	
-7	R83	301121	Resistor, Fixed Carbon, 560Ω, 1/2W ±5% (COML)	1	
-8	R2,26, 42,45, 48,49	300185	Resistor, Fixed Carbon, 100kΩ, 1/4W ±5% (COML)	6	
-9	R3,56	300109	Resistor, Fixed Carbon, 68Ω, 1/4W ±5% (COML)	2	
-10	R4	300129	Resistor, Fixed Carbon, 470Ω, 1/4W ±5% (COML)	1	
-11	R6	300143	Resistor, Fixed Carbon, 1.8kΩ, 1/4W ±5% (COML)	1	
-12	R7	300178	Resistor, Fixed Carbon, 51kΩ, 1/4W ±5% (COML)	1	
-13	R8	300139	Resistor, Fixed Carbon, 1.2kΩ, 1/4W ±5% (COML)	1	
-14	R9,10	300170	Resistor, Fixed Carbon, 24kΩ, 1/4W ±5% (COML)	2	
-15	R11,65, 84	300154	Resistor, Fixed Carbon, 5.1kΩ, 1/4W ±5% (COML)	3	
-16	R21-23, 25,30, 31,41, 43,44, 52,61, 68,81	300161	Resistor, Fixed Carbon, 10kΩ, 1/4W ±5% (COML)	13	
-17			Not Used		
-18	R19	300147	Resistor, Fixed Carbon, 2.7kΩ, 1/4W ±5% (COML)	1	
-19	R20	300148	Resistor, Fixed Carbon, 3kΩ 1/4W ±5% (COML)	1	
-20	R24,29 80	300209	Resistor, Fixed Carbon, 1MΩ, 1/4W ±5% (COML)	3	
-21	R27,32	300153	Resistor, Fixed Carbon, 4.7kΩ, 1/4W ±5% (COML)	2	

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-10					
-22	R28,69, 82	300177	Resistor, Fixed Carbon, 47kΩ, 1/4W ±5% (COML)	3	
-23	R33,40, 57,58 61,71, 85	300137	Resistor, Fixed Carbon, 1kΩ, 1/4W ±5% (COML)	6	
-24			Not Used		
-25	R46	300200	Resistor, Fixed Carbon, 430kΩ, 1/4W ±5% (COML)	1	
-26	R47	300196	Resistor, Fixed Carbon, 300kΩ, 1/4W ±5% (COML)	1	
-27	R53	300144	Resistor, Fixed Carbon, 2kΩ, 1/4W ±5% (COML)	1	
-28	R54	300151	Resistor, Fixed Carbon, 3.9kΩ, 1/4W ±5% (COML)	1	
-29			Not Used		
-30	R62,63	300172	Resistor, Fixed Carbon, 30kΩ, 1/4W ±5% (COML)	2	
-31	R70	300105	Resistor, Fixed Carbon, 47Ω, 1/4W ±5% (COML)	1	
-32			Not Used		
-33	R55	300124	Resistor, Fixed Carbon, 300Ω, 1/4W ±5% (COML)	1	
-34			Not Used		
-35	R13	303049	Resistor, wire wound, precision power, .25Ω, 3.00W ±5% (COML)	1	
-36			Not Used		
-37			Not Used		
-38			Not Used		
-39	R12,64	301547	Resistor, Fixed Metal, 6.04kΩ, 1/4W ±1% (COML)	2	
-40	R14	302394	Resistor, Fixed Metal, 8.66kΩ, 1/4W ±1% (COML)	1	
-41	R16	302395	Resistor, Fixed Metal, 4.53kΩ, 1/4W ±1% (COML)	1	
-42	R36	303048	Resistor, Fixed Metal, 75kΩ, 1/4W ±1% (COML)	1	
-43	R37	301350	Resistor, Fixed Metal, 316Ω, 1/4W ±1% (COML)	1	
-44	R38	301349	Resistor, Fixed Metal, 309Ω, 1/4W ±1% (COML)	1	

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-10					
-45	R39	300434	Resistor, Fixed Metal, 19.6kΩ, 1/4W ±1% (COML)	1	
-46	R50	301450	Resistor, Fixed Metal, 8.25kΩ, 1/4W ±1% (COML)	1	
-47	R51	302973	Resistor, Fixed Metal, 2.26kΩ, 1/4W ±1% (COML)	1	
-48	R59	300401	Resistor, Fixed Metal, 1kΩ, 1/4W ±1% (COML)	1	
-49	R60	300404	Resistor, Fixed Metal, 10kΩ, 1/4W ±1% (COML)	1	
-50			Not Used		
-51			Not Used		
-52	R15	302623	Potentiometer, Trimmer, 1kΩ, 0.75W ±10% (COML)	1	
-53	R35	300518	Potentiometer, Trimmer, 20kΩ, 0.75W ±10% (COML)	1	
-54	CR15	302708	Diode, Zener, 5.6V ±5%, 5W, IN5339B (COML)	1	
-55	CR14	302163	Diode, Zener, 5.1V ±5%, 0.25W, IN4689 (COML)	4	
-56	CR1-4	302941	Diode, Rectifier, 3A, MR504 (COML)	4	
-57	CR5	302940	Diode, Recifier, 3A, MR501 (COML)	1	
-58	CR6	300585	Diode, Zener, 10V ±5%, 1.0W, 25 mA, IN4740 (COML)	1	
-59	CR7,9 10,16	301453	Diode, Switching, 75V, 10 mA, IN4148 (COML)	4	
-60	CR8	302942	Diode, SCR, 3A, MR850 (COML)	1	
-61	CR11	302197	Diode, Schottky Rectifier, 20V, 1.0A, IN5817 (COML)	1	
-62	CR13	300411	Diode, Rectifier, 200V, 2.4A, 66130 (COML)	1	
-63	VR1	302424	Diode, Voltage Reference, 1.235V ±1%, LM385 BZ (COML)	1	
-64	C1	303012	Capacitor, Aluminum Electrolytic, 2200 µf ±20%, 50V (COML)	1	
-65	C2,7,9 11,14, 16-18, 21,22, 25,29 37-40, 46	301979	Capacitor, Rectangular Ceramic, 0.1 µf ±20%, 50V (COML)	17	
-66	C3,23	302805	Capacitor, Metalized Polyester, .01 µf ±5%, 50V (COML)	2	

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-10					
-67	C4,5	301978	Capacitor, Rectangular Ceramic, .022 µf ±20%, 50V (COML)	2	
-68	C6,24	303013	Capacitor, Aluminum, Electrolyte, 220 µf ±20%, 25V (COML)	2	
-69	C8,15	301057	Capacitor, Tantalum, solid electrolyte, 1 µf ±10%, 35V (COML)	2	
-70	C10,13	301561	Capacitor, Tantalum, solid electrolyte, 0.47 µf ±10% 50V (COML)	2	
-71	C12	300519	Capacitor, Tantalum, solid electrolyte, 10 µf ±10%, 25V (COML)	1	
-72	C19	301976	Capacitor, Aluminum, electrolyte, 100 µf -10 +50%, 25V (COML)	1	
-73	C20	301704	Capacitor, Tantalum, solid electrolyte 33 µf ±10% 25V (COML)	1	
-74	C26,27	302569	Capacitor, Ceramic Rectangular, .01 µf ±20%, 50V (COML)	2	
-75	C28	302421	Capacitor, Tantalum, solid electrolyte, 3.3 µf ±10%, 50V (COML)	1	
-76	C42,44 45	301977	Capacitor, Ceramic Disc, .01 µf ±20%, 50, 75, 100, or 500V (COML)	3	
-77	C43	300413	Capacitor, Ceramic Disc, 100 pf ±10%, 1kV (COML)	1	
-78	Q1,13, 16	301553	Transistor, PNP power, 1.8W, 7.0A, 2N6109 (COML)	3	
-79	Q2,14, 17	302455	Transistor, PNP, PN2907A (COML)	3	
-80	Q8,10	300702	Transistor, PNP, 300 mW, 500 mA (COML)	2	
-81	Q4,5,7 9,15, 18,19	301551	Transistor, NPN, 600 mW, 500 mA (COML)	7	
-82	Q6	302422	Transistor, Field Effect, SP1117BD (COML)	1	
-83	Q11	303131	Transistor, PNP, 1.2A, 2N5783 (COML)	1	
-84	Q3	303091	Transistor, P-Channel, VP0106N3 (COML)	1	
-85	Q12	302566	Transistor, NPN, Monolithic Darlington, MPSA14 (COML)	1	
-86	U1,2	302196	Integrated Circuit, switching voltage regulator, TL494 (COML)	2	

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-10					
-87	U4	301753	Integrated Circuit, quad voltage comparators, LM339 (COML)	1	
-88	U5	302524	Integrated Circuit, CMOS, dual J-K flip-flop, 4027 (COML)	1	
-89	U6,7	302123	Integrated Circuit, CMOS, quad 2-input NAND Schmitt trigger, 4093 (COML)	2	
-90	U8	302939	Transistor Array, 2 PNP, 3NPN, CA3096A (COML)	1	
-91			Not Used		
-92			Not Used		
-93			Not Used		
-94	F1	301613	Fuse, 2.5A, 250V (COML)	1	
-95			Not Used		
-96	J1	302647	Terminal Header, single row, 11 pins (COML)	1	
-97	J2	303017	Terminal Header, single row, 2 pins (COML)	1	
-98	J3	303016	Terminal Header, single row, 3 pins (COML)	1	
-99	J4	302663	Terminal Header, single row, 6 pins (COML)	1	
-100	J5	302646	Terminal Header, single row, 3 pins (COML)	1	
-101	J6	303018	Terminal Header, chassis mount wafer, 6 pins (COML)	1	
-102		301578	Terminal Header, single row, 36 pins (COML)	1	
-103			Not Used		
-104	JA,E	302988	Jumper, Lo-Profile, PC board type (COML)	2	
-105	JD,F	302989	Jumper, Lo-Profile, PC board type, 2A (COML)	2	
-106		300813	Wire, Bus, solid copper, 20 AWG (COML)	A/R	
-107		302233	Wire, Electrical, solid, kynar insulation, 30 AWG	A/R	



NOTES (UNLESS OTHERWISE SPECIFIED):

1. STAMP OR MARK REV LETTER OF THIS DRAWING WITH PERMANENT NON-CONDUCTIVE CONTRASTING COLORED INK APPROX. WHERE SHOWN. CHARACTERS TO BE .06 INCH HIGH NOMINAL.
2. CAPACITOR C41, (ITEM 11), TO BE SOLDERED ACROSS RESISTOR R72, (ITEM 13).
3. REMOVE NUMBER "124873" AND MARK NUMBER OF THIS DRAWING IN SAME PLACE USING PERMANENT NON-CONDUCTIVE CONTRASTING COLORED INK. CHARACTERS TO BE .06 INCH HIGH NOMINAL.

Figure 6-11. Negative Supply PW Board Assembly

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-11		124395	NEGATIVE SUPPLY PW BOARD ASSEMBLY		
-1		124874	Negative Supply PW Board	1	
-2			Not Used		
-3	U3	302196	Integrated Circuit, switching voltage regulator, 16 pin TL494C (COML)	1	
-4	P6	303026	PW Board Connector, 6 circuits, single row (COML)	1	
-5	CR12	301550	Rectifier Diode, fast recovery, 400V, 1.0A, IN4936 (COML)	1	
-6	C35	300519	Capacitor, Tantalum, solid electrolyte, 10 µf ±10%, 25V (COML)	1	
-7	C30,36	301979	Capacitor, Rectangular Ceramic, .1 ±f ±20%, 50V (COML)	2	
-8	C32,34	302569	Capacitor, Ceramic Disc, .01 µf ±20%, 50V (COML)	2	
-9	C31	300855	Capacitor, Mylar, .01 µf ±10%, 200V (COML)	1	
-10	C33	303013	Capacitor, Aluminum, electrolyte, 220 µf ±20%, 25V (COML)	1	
-11	C41	300400	Capacitor, Ceramic Disc, 100 pF ±10%, 1kΩV (COML)	1	
-12			Not Used		
-13	R72	300132	Resistor, Fixed Carbon, 620Ω, 1/4W, ±5% (COML)	1	
-14			Not Used		
-15	R74,76 78	300154	Resistor, Fixed Carbon, 5.1kΩ, 1/4W ±5% (COML)	4	
-16			Not Used		
-17	R73	300170	Resistor, Fixed Carbon, 24kΩ, 1/4W ±5% (COML)	1	
-18			Not Used		
-19	R79	303046	Resistor, Fixed Carbon, 4.99kΩ, 1/4W ±1% (COML)	1	
-20			Not Used		
-21	R77	300185	Resistor, Fixed Carbon, 100kΩ, 1/4W, ±5% (COML)	1	

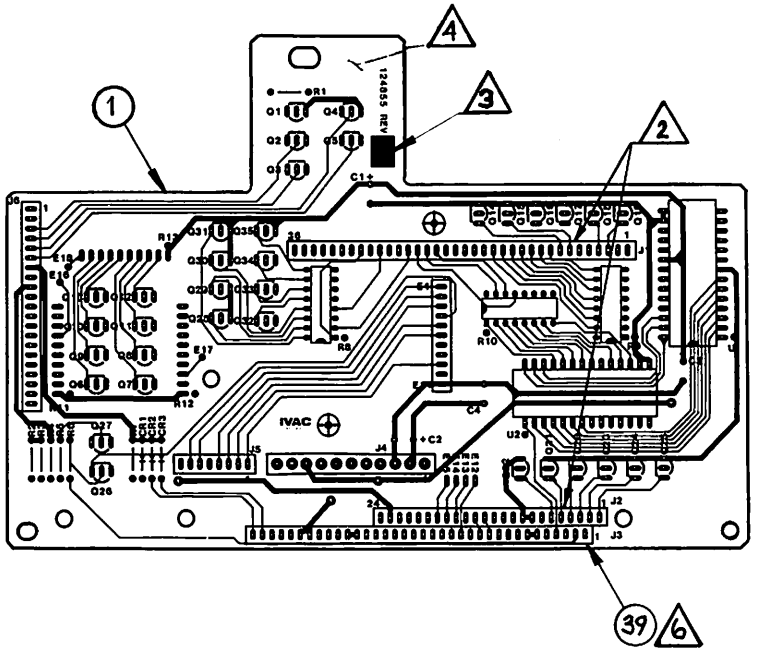
FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-12		124845	LOGIC PW BOARD - INITIAL ASSEMBLY		
-1		124846	Logic PW Board	1	
-2			Not Used		
-3		124406-3	Insulator	1	
-4	C1,9, 12,13, 23-26, 30-33, 36-42	301979	Capacitor, Rectangular Ceramic, .1µf ±20%, 50V (COML)	19	
-5	C2,5 10,11	302490	Capacitor, Rectangular Ceramic, .01 µf ±20%, 50V (COML)	4	
-6	C3,8, 14, 16-22, 27-29, 34,35	300519	Capacitor, Tantalum, solid electrolyte, 10 µf ±10%, 25V (COML)	15	
-7	C4	300294	Capacitor, Metalized Polyester, .47 µf ±10%, 50 or 100V (COML)	1	
-8	C6,7	302435	Capacitor, Ceramic Disc, 18 pF ±10%, 500 or 1000V (COML)	2	
-9	C15	301092	Capacitor, Metalized Polyester, .047 µf ±5%, 200V (COML)	1	
-10	C43	300295	Capacitor, Metalized Polyester, .1 µf ±10%, 200V (COML)	1	
-11			Not Used		
-12	CR1,2, 4-12	301453	Switching Diode, 75V, 10 mA (COML)	11	
-13			Not Used		
-14			Not Used		
-15			Not Used		
-16	LS1	302529	Transducer, Audio, miniature, 6V at 70 dB (COML)	1	
-17			Not Used		
-18			Not Used		
-19	Q1	302639	Transistor, PNP power, 1.2W, 2A, 2N6727 (COML)	1	
-20	Q2-4 6-9	301551	Transistor, NPN, 600 mW, 500 mA, PN3569A (COML)	7	

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-12					
-21	Q5	301928	Transistor, NPN amplifier and switch, 600 mW, 800 mA, PN2222A (COML)	1	
-22			Not Used		
-23	R3	302620	Resistor, Fixed Metal, 34.8kΩ, 1/4W ±1% (COML)	1	
-24	R16	300177	Resistor, Fixed Carbon, 47kΩ, 1/4W ±5% (COML)	1	
-25	R32,33 48,49	300137	Resistor, Fixed Carbon, 1.0kΩ, 1/4W ±5% (COML)	4	
-26			Not Used		
-27	R5,6,8	300401	Resistor, Fixed Metal, 1.00kΩ, 1/4W ±5% (COML)	3	
-28	R7	300195	Resistor, Fixed Carbon, 270kΩ, 1/4 ±5% (COML)	1	
-29	R9	301326	Resistor, Fixed Metal, 174Ω, 1/4W ±5% (COML)	1	
-30	R10	301389	Resistor, Fixed Metal, 825Ω, 1/4W ±1% (COML)	1	
-31	R11,1	300405	Resistor, Fixed Metal, 51.1kΩ, 1/4W ±1% (COML)	2	
-32	R12	300192	Resistor, Fixed Carbon, 200kΩ, 1/4W ±5% (COML)	1	
-33	R13	300169	Resistor, Fixed Carbon, 22kΩ, 1/4W ±5% (COML)	1	
-34	R14,45	300185	Resistor, Fixed Carbon Film, 100kΩ, 1/4W ±5% (COML)	2	
-35	R15,39 43,44	300153	Resistor, Fixed Carbon, 4.7kΩ, 1/4W ±5% (COML)	4	
-36	R17	302395	Resistor, Fixed Metal, 4.53kΩ, 1/4W ±1% (COML)	1	
-37	R18,35	302623	Potentiometer, Trimmer, 1kΩ ±10%, 0.75W (COML)	2	
-38	R19	302460	Resistor Network, 10kΩ ±2%, 6 pin (COML)	1	
-39	R20,21, 23,26, 28,37 38,41 42,50	300161	Resistor, Fixed Carbon, 10kΩ, 1/4W ±5% (COML)	10	
-40	R25	300209	Resistor, Fixed Carbon, 1M, 1/4W ±5% (COML)	1	
-41	R27	300173	Resistor, Fixed Carbon, 33kΩ, 1/4W ±5% (COML)	1	
-42	R29	300517	Resistor, Fixed Metal, 30.1kΩ, 1/4W ±1% (COML)	1	
-43	R30	302622	Resistor, Fixed Metal, 2kΩ, 1/4W ±1% (COML)	1	

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
-44	R31	300179	Resistor, Fixed Carbon, 56kΩ, 1/4W ±1% (COML)	1	
-45	R36	300146	Resistor, Fixed Carbon, 2.4kΩ, 1/4W ±5% (COML)	1	
-46	R40	302682	Resistor Network, 20kΩ ±2%, 10 pin (COML)	1	
-47	R46	303045	Resistor Network, 22kΩ ±2%, 8 pin (COML)	1	
-48	R47	303044	Resistor Network, 22kΩ ±2%, 6 pin (COML)	1	
-49	R2,4	301340	Resistor, Fixed Metal, 249Ω, 1/4W, ±1% (COML)	2	
-50	R34	300152	Resistor, Fixed Carbon, 4.3kΩ, 1/4W ±5% (COML)	1	
-51	S1	302426	Switch, 8 pin SPST, 4-position (COML)	1	
-52			Not Used		
-53			Not Used		
-54	U1	302252	Integrated Circuit, CMOS, CD4040B (COML)	1	
-55	U2	302756	Integrated Circuit, CMOS, 80C85A	1	
-56	U3	302695	Integrated Circuit, CMOS, 74 HC373 (COML)	1	
-57	U4,5	150515-1	Memory Assembly	2	
-58	U6	302627	Integrated Circuit, HM6116P3 (COML)	1	
-59			Not Used		
-60	U9	302694	Integrated Circuit, CMOS, 74HC00	1	
-61	U10	301554	Integrated Circuit, quad op amp, LM324M (COML)	1	
-62	U11	302385	Integrated Circuit, A/D converter, ADC0809 (COML)	1	
-63	U12	302628	Integrated Circuit, D/A converter, AM6012 (COML)	1	
-64			Not Used		
-65	U14	302960	Integrated Circuit, high speed CMOS, 74HC02 (COML)	1	
-66	U15	302961	Integrated Circuit, high speed CMOS, 74HC32 (COML)	1	
-67	U16,19	302963	Integrated Circuit, high speed CMOS, 74HC174 (COML)	2	
-68	U17,18	302964	Integrated Circuit, high speed CMOS, 74HC244 (COML)	2	
-69	U20	302631	Integrated Circuit, quad low power op amp, LF444CN (COML)	1	

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
-70	U13	303143	Integrated Circuit, programmable peripheral interface 82C55A (COML)	1	
-71	U13	302629	Integrated Circuit, programmable peripheral interface 82C55A (COML)	1	
-72	P1	302218	Shunt Package, 16 pin (COML)	1	
-73	P2	302547	Jumper, lo-profile, PC board type (COML)	1	
-74			Not Used		
-75	Y1	302530	Crystal, Quartz, 6 MHz (COML)	1	
-76			Not Used		
-77			Not Used		
-78	XU2,13	302158	Socket, Integrated Circuit, 40 position (COML)	2	
-79	XU6	302236	Socket, Integrated Circuit, 24 position	1	
-80	XU4,5 11	302157	Socket, Integrated Circuit, 20 position (COML)	3	
-81	XU12	302680	Socket, Integrated Circuit, 20 position (COML)	1	
-82	XP1	301601	Socket, Integrated Circuit, 16 position (COML)	1	
-83			Not Used		
-84			Not Used		
-85	J1	302649	Terminal Header, dual row, 40 pin (COML)	1	
-86	J2	302661	Terminal Header, single row, 10 pin (COML)	1	
-87	J3	302663	Terminal Header, single row, 6 pin (COML)	1	
-88	J4	302672	Socket, Terminal Header, horizontal, single row, 36 pin (COML)	1	
-89	J5	302646	Terminal Header, single row, 3 pin (COML)	1	
-90	J7	302987	Terminal Header, right angle, polarized, 26 pin (COML)	1	
-91	J8	301578	Terminal Header, single row, 36 pin (COML)	A/R	
-92		302353	Wire, 30 AWG, kynar insulated (COML)	A/R	
-93		302021	Wire, 30 AWG, bus (COML)	A/R	
-94	U7,8	302962	Integrated Circuit, high speed CMOS, 74HC138 (COML)	2	

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-13		127354	THERMOMETER/DISPLAY SWITCH ASSEMBLY		
-1		302660	Crimp Terminal Housing, single row, 6 pin (COML)	1	
-2		302726	Crimp Terminal Insert for 22-30 AWG wire (COML)	6	
-3		302641	Toggle Switch, miniature, silver contacts (COML)	2	
-4		302642	Pushbutton Switch, miniature, gold plated contacts (COML)	1	
-5		302481	Wire, 26 AWG, blue (COML)	4"	
-6		302483	Wire, 26 AWG, green (COML)	3"	
-7		302482	Wire, 26 AWG, yellow (COML)	4"	
-8		302485	Wire, 26 AWG, brown (COML)	2"	
-9		302480	Wire, 26 AWG, red (COML)	2"	
-10		302486	Wire, 26 AWG, orange (COML)	3"	
-11		127427	Switch Bracket	1	
-12			Not Used		
-13		300695	Solder (COML)	A/R	
-14		300027	Tie Cord	A/R	



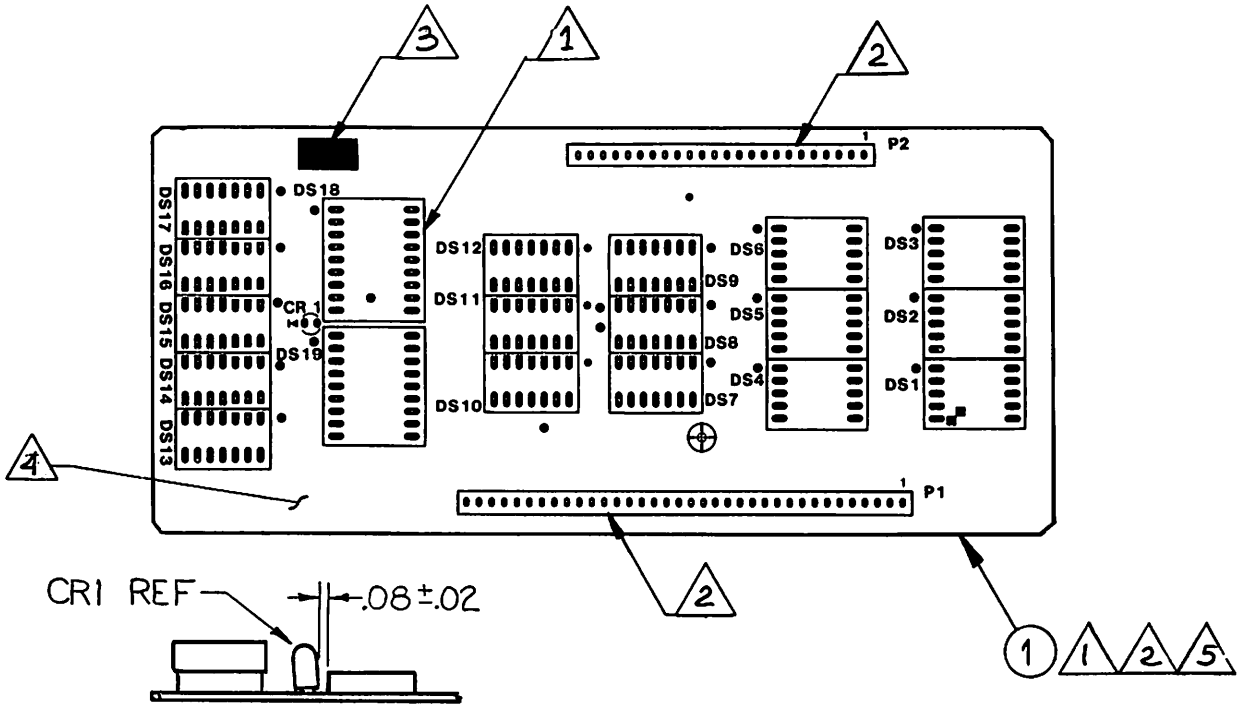
NOTES (UNLESS OTHERWISE SPECIFIED):

1. RECEPTACLE J1 (ITEM 37) AND RECEPTACLE J2 (ITEM 38) ARE ASSEMBLED ON THE FARSIDE OF BOARD (ITEM 1).
2. STAMP OR MARK REV. LETTER OF THIS DRAWING APPROX. WHERE SHOWN USING PERMANENT, NON-CONDUCTIVE WHITE INK. CHARACTERS TO BE .06 INCH HIGH NOMINAL.
3. Q.C. STAMP AND DATE APPROX. WHERE SHOWN USING PERMANENT, NON-CONDUCTIVE WHITE INK. CHARACTERS TO BE .06 INCH HIGH NOMINAL.
4. LEAD PROJECTION TO BE .030″ MAX. FROM FARSIDE OF BOARD (ITEM 1).
5. THE LONG PINS (.400) OF HEADER J3 (ITEM 39) MUST PROJECT OUT FROM THE COMPONENT SIDE OF THE P.C. BOARD WITH THE SHORT PINS SOLDERED INTO THE BOARD AND CLIPPED (SEE NOTE 5).

Figure 6-14. Display Driver PW Board Assembly

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-14		124855	DISPLAY DRIVER PW BOARD ASSEMBLY		
-1		124856	Display Driver PW Board	1	
-2			Not Used		
-3			Not Used		
-4			Not Used		
-5	C1,2	300519	Capacitor, Tantalum, solid electrolyte, 4.7 µF ±10%, 50V (COML)	2	
-6	C4	301979	Capacitor, Rectangular Ceramic, .10 µF ±20%, 50V (COML)	1	
-7	C3	301976	Capacitor, Aluminum, electrolyte, 100 µF -10 +50, 25V (COML)	1	
-8			Not Used		
-9			Not Used		
-10	CR1-3	301453	Diode, Switching, 75V, 10 mA, IN4148 (COML)	3	
-11			Not Used		
-12			Not Used		
-13			Not Used		
-14	Q6-13, 26,27	301928	Transistor, NPN amplifier and switch, 600 mW, 800 mA, PN2222A	10	
-15	Q1-5 11-25	302422	Transistor, Field Effect, n-channel, SP1117 (COML)	17	
-16	Q28-35	300702	Transistor, PNP amplifier and switch, 300 mW, 50 mA, PN3638A	8	
-17			Not Used		
-18			Not Used		
-19			Not Used		
-20	R1	302699	Resistor, 0Ω, 1/4W, ±5% (COML)	1	
-21	R2,3,7	300161	Resistor, Fixed Carbon, 10kΩ, 1/4W ±5% (COML)	3	
-22	R4	300113	Resistor, Fixed Carbon, 100Ω, 1/4W ±5% (COML)	1	
-23	R5,6	300153	Resistor, Fixed Carbon, 4.7kΩ, 1/4W ±5% (COML)	2	

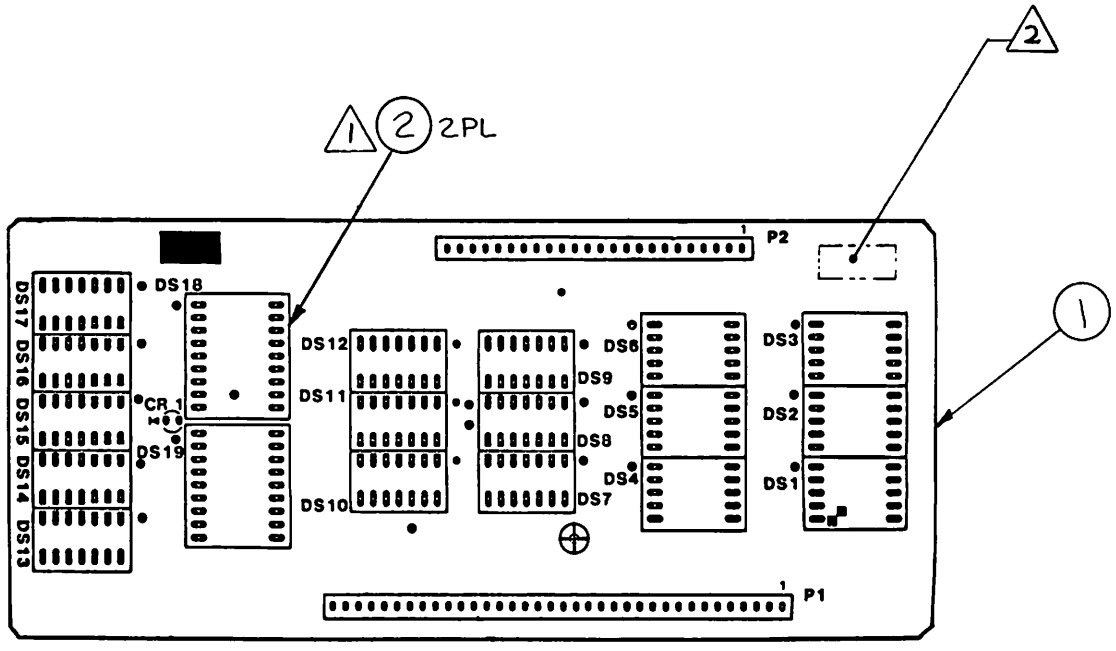
FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-14					
-24			Not Used		
-25	R9	303001	Resistor Network, 56Ω ±2%, 16 pin (COML)	1	
-26	R10	302999	Resistor Network, 68Ω ±2%, 16 pin (COML)	1	
-27	R11,13	302297	Resistor Network, 10kΩ ±2%, 10 pin (COML)	2	
-28	R12	302327	Resistor Network, 4.7kΩ ±2%, 10 pin (COML)	1	
-29	R6	303000	Resistor Network, 82Ω ±2%, 16 pin (COML)	1	
-30			Not Used		
-31			Not Used		
-32	U1,2	302632	Integrated Circuit, 6 digit BCD display controller/ driver, MM74C912 (COML)	2	
-33			Not Used		
-34			Not Used		
-35			Not Used		
-36			Not Used		
-37	J1	302674	Socket, Terminal Header, single row, 36 pin (COML)	1	
-38	J2	302291	Socket, Terminal Header, single row, 24 pin (COML)	1	
-39	J3	302935	Terminal Header, single row, 36 pin (COML)	1	
-40	J4	302647	Terminal Header, single row, 11 pin (COML)	1	
-41	J5	302667	Terminal Header, single row, 8 pin (COML)	1	
-42	J6	302677	Socket, Terminal Header, single row, 21 pin (COML)	1	
-43	E1-11	302676	Socket, Terminal Header, single row, 11 pin (COML)	1	



1. BREAK OFF PINS 10, 20, 21, AND 31 FROM SOCKET (ITEM 13) AND INSERT INTO BOARD (ITEM 1).
2. HEADER (ITEM 18) AND HEADER (ITEM 17) ARE ASSEMBLED ON THE FAR SIDE OF BOARD (ITEM 1).
3. STAMP OR MARK REVISION LETTER OF THIS DRAWING WITH PERMANENT NON-CONDUCTIVE CONTRASTING COLORED INK APPROX. WHERE SHOWN. CHARACTERS TO BE .06 INCH HIGH NOMINAL.
4. Q.C. STAMP AND DATE APPROX. WHERE SHOWN WITH PERMANENT NON-CONDUCTIVE WHITE INK. CHARACTERS TO BE .06 INCH HIGH NOMINAL
5. LEAD PROJECTIONS TO BE .030 INCH MAX. FROM FARSIDE OF BOARD (ITEM 1).

Figure 6-15. Display PW Board — Initial Assembly

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-15		124835	DISPLAY PW BOARD - INITIAL ASSEMBLY		
-1		124836	Display PW Board	1	
-2			Not Used		
-3			Not Used		
-4			Not Used		
-5	DS1-6	302588	LED Display, orange, 7 segment with right hand decimal, MAN6680F (COML)	6	
-6	DS7-17	302274	Display, 7 segment, orange, right hand decimal, MAN4640F (COML)	11	
-7			Not Used		
-8			Not Used		
-9			Not Used		
-10			Not Used		
-11			Not Used		
-12	XDS 7-17	302029	Socket, Integrated Circuit, 14 pin (COML)	11	
-13	XDS 18,19	302158	Socket, Integrated Circuit, 40 pin (COML)	1	
-14			Not Used		
-15			Not Used		
-16			Not Used		
-17	P1	301578	Terminal Header, single row, 36 pin (COML)	1	
-18	P2	302610	Terminal Header, single row, 24 pin (COML)	1	
-19			Not Used		
-20			Not Used		
-21	CR1	303128	Diode, Light Emitting, green (COML)	1	



NOTES (UNLESS OTHERWISE SPECIFIED):

1. DISPLAY (ITEM 2) 2 PL TO BE PLUGGED IN STARTING AT PIN 1 OF SOCKET LEAVING SOCKET PINS 20 & 21 UNUSED.
2. STAMP OR MARK NO. OF BOARD ASSY AND REVISION LETTER OF THIS DRAWING APPROX. WHERE SHOWN USING PERMANENT NON-CONDUCTIVE CONTRASTING COLORED INK. CHARACTERS TO BE .O6 INCH HIGH NOMINAL.

Figure 6-16. Display PW Board Assembly

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-16			DISPLAY PW BOARD ASSEMBLY		
-1		124835	Display PW Board, Initial Assembly		
-2	DS,18, 19	302134	LED, Display, 16 segment alphanumeric DL 2416T (COML)	2	

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-17		124455	PNEUMATIC PW BOARD - INITIAL ASSEMBLY		
-1		124456	Pneumatic PW Board	1	
-2			Not Used		
-3	R1,2	302618	Resistor, Fixed Metal, 15 kΩ, 1/4W ±1% (COML)	2	
-4	R3,8	300401	Resistor, Fixed Metal, 1 kΩ, 1/4W ±1% (COML)	2	
-5	R4	302976	Resistor, Fixed Metal, 26.7 kΩ, 1/4W ±1% (COML)	1	
-6	R5	302972	Resistor, Fixed Metal, 13.7 kΩ, 1/4W ±1% (COML)	1	
-7	R6	302977	Resistor, Fixed Metal, 45.3 kΩ, 1/4W ±1% (COML)	1	
-8	R7	300432	Resistor, Fixed Metal, 25.5 kΩ, 1/4W ±1% (COML)	1	
-9	R10	301548	Resistor, Fixed Metal, 15.8 kΩ, 1/4W ±1% (COML)	1	
-10	R39	302622	Resistor, Fixed Metal, 2 kΩ, 1/4W ±1% (COML)	1	
-11	R40	302442	Resistor, Fixed Metal, 2.8 kΩ, 1/4W ±1% (COML)	1	
-12	R42	300405	Resistor, Fixed Metal, 51.1 kΩ, 1/4W, ±1% (COML)	1	
-13	R44	300458	Resistor, Fixed Metal, 150 kΩ, 1/4W ±1% (COML)	1	
-14	R46	300482	Resistor, Fixed Metal, 100 kΩ, 1/4W ±1% (COML)	1	110
-15	R47	302395	Resistor, Fixed Metal, 4.53 kΩ, 1/4W ±1% (COML)	1	
-16	R48	302617	Resistor, Fixed Metal, 2.49 kΩ, 1/4W ±1% (COML)	1	
-17	R49	300436	Resistor, Fixed Metal, 5.11 kΩ, 1/4W ±1% (COML)	1	
-18	R64	302517	Resistor, Fixed Metal, 8.45 kΩ, 1/4W ±1% (COML)	1	
-19	R63	302392	Resistor, Fixed Metal, 3.01 kΩ, 1/4W ±1% (COML)	1	220
-20	R67	303046	Resistor, Fixed Metal, 4.99 kΩ, 1/4W ±1% (COML)	1	220
-21	R68,70	302975	Resistor, Fixed Metal, 17.8 kΩ, 1/4W ±1% (COML)	2	220
-22	R71,72 73,74	300404	Resistor, Fixed Metal, 10 kΩ, 1/4W ±1% (COML)	4	220
-23			Not Used		
-24	R45	300518	Potentiometer, Trimmer, multiturn, .75W, 20 kΩ ±10% (COML)	1	220
-25	R9,11	300195	Resistor, Fixed Carbon, 270 kΩ, 1/4W ±5% (COML)	2	

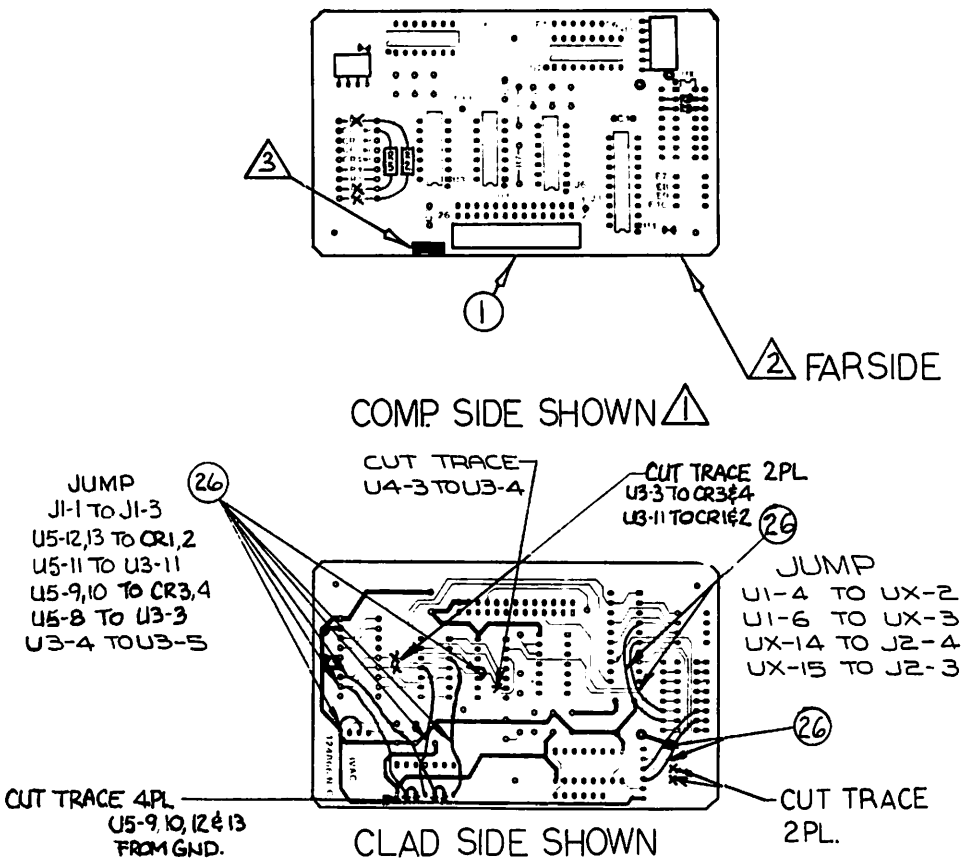
FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-17					
-26	R12,13 27,29, 33,37, 54	300161	Resistor, Fixed Carbon, 10 kΩ, 1/4W ±5% (COML)	7	
-27	R16	300189	Resistor, Fixed Carbon, 150 kΩ, 1/4W ±5% (COML)	1	
-28	R14,18 19	300113	Resistor, Fixed Carbon, 100Ω, 1/4W ±5% (COML)	3	
-29	R15	300194	Resistor, Fixed Carbon, 240 kΩ, 1/4W ±5% (COML)	1	
-30	R17	300185	Resistor, Fixed Carbon, 100 kΩ, 1/4W ±5% (COML)	1	
-31	R20	300197	Resistor, Fixed Carbon, 330 kΩ, 1/4W ±5% (COML)	1	
-32	R23,35 50	300153	Resistor, Fixed Carbon, 4.7 kΩ, 1/4W ±5% (COML)	3	
-33	R24	300126	Resistor, Fixed Carbon, 360Ω, 1/4W ±5% (COML)	1	
-34	R25,26, 31,32, 34	300137	Resistor, Fixed Carbon, 1 kΩ, 1/4W ±5% (COML)	5	
-35	R28,30	300133	Resistor, Fixed Carbon, 680Ω, 1/4W ±5% (COML)	2	
-36	R36,38 55	300147	Resistor, Fixed Carbon, 2.7 kΩ, 1/4W ±5% (COML)	3	
-37	R51,52	300165	Resistor, Fixed Carbon, 15 kΩ, 1/4W ±5% (COML)	2	
-38	R53	300151	Resistor, Fixed Carbon, 3.9 kΩ, 1/4W ±5% (COML)	1	
-39			Not Used		
-40	R66,77	300089	Resistor, Fixed Carbon, 10Ω, 1/4W ±5% (COML)	2	220
-41	R56,61	300089	Resistor, Fixed Carbon, 10Ω, 1/4W ±5% (COML)	2	
-42	R57	300146	Resistor, Fixed Carbon, 2.4 kΩ, 1/4W ±5% (COML)	1	
-43	R60	300192	Resistor, Fixed Carbon, 200 kΩ, 1/4W ±5% (COML)	1	
-44	R62	302606	Resistor, Fixed Carbon, 1Ω, 1/4W ±4% (COML)	1	
-45	R65	302255	Resistor, Fixed Carbon, 1.78 kΩ, 1/4W ±1% (COML)	1	220
-46	R69	301322	Resistor, Fixed Metal, 158Ω, 1/4W ±1% (COML)	1	220
-47	R59	302978	Resistor, Fixed Carbon, 4.7Ω, 1/2W ±5% (COML)	1	

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-17					
-48			Not Used		
-49	R21,22	300130	Resistor, Fixed Carbon, 510Ω, 1/4W ±5% (COML)	2	
-50	R41	302623	Potentiometer, Trimmer, 1 kΩ ±10%, .75W (COML)	1	
-51	R43		Potentiometer, Trimmer, 50 kΩ ±10%, .75W (COML)	1	
-52	R45	300982	Potentiometer, Trimmer, 10 kΩ ±10%, .75W (COML)	1	110
-53			Not Used		
-54	Q2,4,5, 9,10	301928	Transistor, NPN amplifier and switch, 600 mW, 800 mA, PN2222A (COML)	5	
-55	Q3,6,7	302639	Transistor, PNP power, 1.2W, 2A, 2N6727 (COML)	3	
-56	Q14	300702	Transistor, PNP amplifier and switch, 300 mW, 500 mA, PN3638A (COML)	1	
-57	Q1,8, 11,12, 13	301551	Transistor, NPN, 600 mW, 500 mA, PN3569A (COML)	5	
-58	Q15	301551	Transistor, NPN, 600 mW, 500 mA, PN3569A (COML)	1	220
-59	C1,2,4, 6,13, 19,21, 23,26, 42	300519	Capacitor, Tantalum, solid electrolyte, 10 µF ±10%, 25V (COML)	10	
-60	C46,49	300519	Capacitor, Tantalum, solid electrolyte, 10 µF ±10%, 25V (COML)	2	220
-61	C3,5, 7-9,11, 12,15, 17,29, 31-41,43	301979	Capacitor, Rectangular Ceramic, .10 µF ±20%, 50V (COML)	22	
-62	C45,47 48,50, 51	301979	Capacitor, Rectangular Ceramic, .10 µF ±20%, 50V (COML)	5	220
-63	C13	301092	Capacitor, Metalized Polyester, .047 µF ±5%, 200V (COML)	1	
-64	C14	301057	Capacitor, Tantalum, solid electrolyte, 1 µF ±10%, 35V (COML)	1	
-65	C16	301413	Capacitor, Tantalum, solid electrolyte, 33 µF ±10%, 10V (COML)	1	

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-17					
-66	C20,22 24	302490	Capacitor, Rectangular Ceramic, .01 µF ±20%, 50V (COML)	3	220
-67	C44	302490	Capacitor, Rectangular Ceramic, .01 µF ±20%, 50V (COML)	1	
-68	C25	302805	Capacitor, Metalized Polyester, .01 µF ±5%, 50V (COML)	1	
-69			Not Used		
-70	C28	302824	Capacitor, Metalized Polyester, .001 µF ±10%, 100 VDC (COML)	1	
-71	C52	301513	Capacitor, Ceramic Disc, 560 pf ±10%, 1 kV (COML)	1	
-72			Not Used		
-73	CR1-4, 8-11	301453	Diode, Switching, 75V, 10 mA, IN4148 (COML)	8	
-74	CR5,6, 7	302046	Diode, Rectifier, 400V, 1.0A, IN4004 (COML)	3	
-75			Not Used		
-76	U1	302635	Integrated Circuit, CMOS, analog multiplexer/ demultiplexer, 16 pin, 4052 (COML)	1	
-77	U2	301753	Integrated Circuit, quad voltage comparators, 14 pin LM339 (COML)	1	
-78	U3	302252	Integrated Circuit, CMOS, binary counter with buffered outputs, 16 pin, 4040 (COML)	1	
-79	U4	301558	Integrated Circuit, CMOS, quad 2 input NAND, 14 pin, 4011 (COML)	1	
-80	U5	302215	Integrated Circuit, CMOS, quad 2 input AND, 14 pin, 4081 (COML)	1	
-81	U6	301559	Integrated Circuit, CMOS, 7-stage binary counter, 14 pin, 4024 (COML)	1	
-82	U7	301968	Integrated Circuit, CMOS, 14 stage binary counter/ divider, 16 pin, 4020 (COML)	1	
-83	U8,13	301557	Integrated Circuit, CMOS, quad 2 input NOR, 14 pin, 4001 (COML)	2	
-84	U9	302123	Integrated Circuit CMOS, quad 2 input NAND, 14 pin, 4093 (COML)	1	

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-17					
-85	U10	301632	Integrated Circuit, CMOS, dual "D" type flip-flop 14 pin, 4013 (COML)	1	
-86	U11	302060	Integrated Circuit, CMOS, hex inverting buffer, 16 pin, 4049 (COML)	1	
-87	U12	301631	Integrated Circuit, CMOS, 3 input NOR, 14 pin, 4025 (COML)	1	
-88	U14	302607	Integrated Circuit, op amp, 8 pin, LP353N (COML)	1	
-89	U15	301094	Integrated Circuit, op amp, 8 pin, LM741 (COML)	1	
-90	U16	301554	Integrated Circuit, quad op amp, 14 pin, LM324 (COML)	1	
-91	U17,18	302995	Integrated Circuit, op amp, 8 pin, CA3193 (COML)	2	220
-92		302353	Jumper Wire, #30, kynar (COML)	A/R	
-93	VR1	302149	Integrated Circuit, positive voltage regulator, LM78L05 (COML)	1	
-94			Not Used		
-95	J1	303103	Terminal Header, right angle, 40 pin (COML)	1	
-96	J2,3,4	302646	Terminal Header, 3 pin (COML)	3	
-97	J5-8	302645	Terminal Header, 2 pin (COML)	4	
-98	J10	302724	Terminal Header, 4 pin (COML)	1	
-99	TP1 TP2	301578	Terminal Header, 36 pin (COML)	1	
-100	J11	301578	Terminal Header, 36 pin (COML)	1	110
-101	P1	302547	Jumper (COML)	1	110

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-18		124825	PNEUMATIC PW BOARD ASSEMBLY		
-1		124455-1	Pneumatic PW Board - Initial Assembly	1	110
-2		124455-2	Pneumatic PW Board - Initial Assembly	1	220
-3	R80	302263	Resistor, Fixed Metal, 20kΩ, 1/4 ±1% (COML)	1	220
-4	R79	300404	Resistor, Fixed Metal, 10kΩ, 1/4W ±1% (COML)	1	220
-5		302996	Transducer, Pressure, 4 pin (COML)	1	220
-6		302024	Transducer, Pressure, (COML)	1	110
-7	R78	302622	Resistor, Fixed Metal, 2kΩ, 1/4W, ±1% (COML)	1	220
-8		300340	Screw, Machine, 4-40 x 1/2", pan head, slotted, steel plated (COML)	2	220
-9		301624	Washer, #4, fiber (COML)	4	110
-10		301712	Washer, #4, fiber (COML)	2	220
-11			Not Used		
-12		300072	Washer, internal tooth lock, #4 (COML)	2	220
-13		302812	Adhesive, thread locking (COML)	A/R	220
-14		300928	Nut, 4-40 hex, steel plated (COML)	2	220
-15		300695	Solder, 63/47 (COML)	A/R	



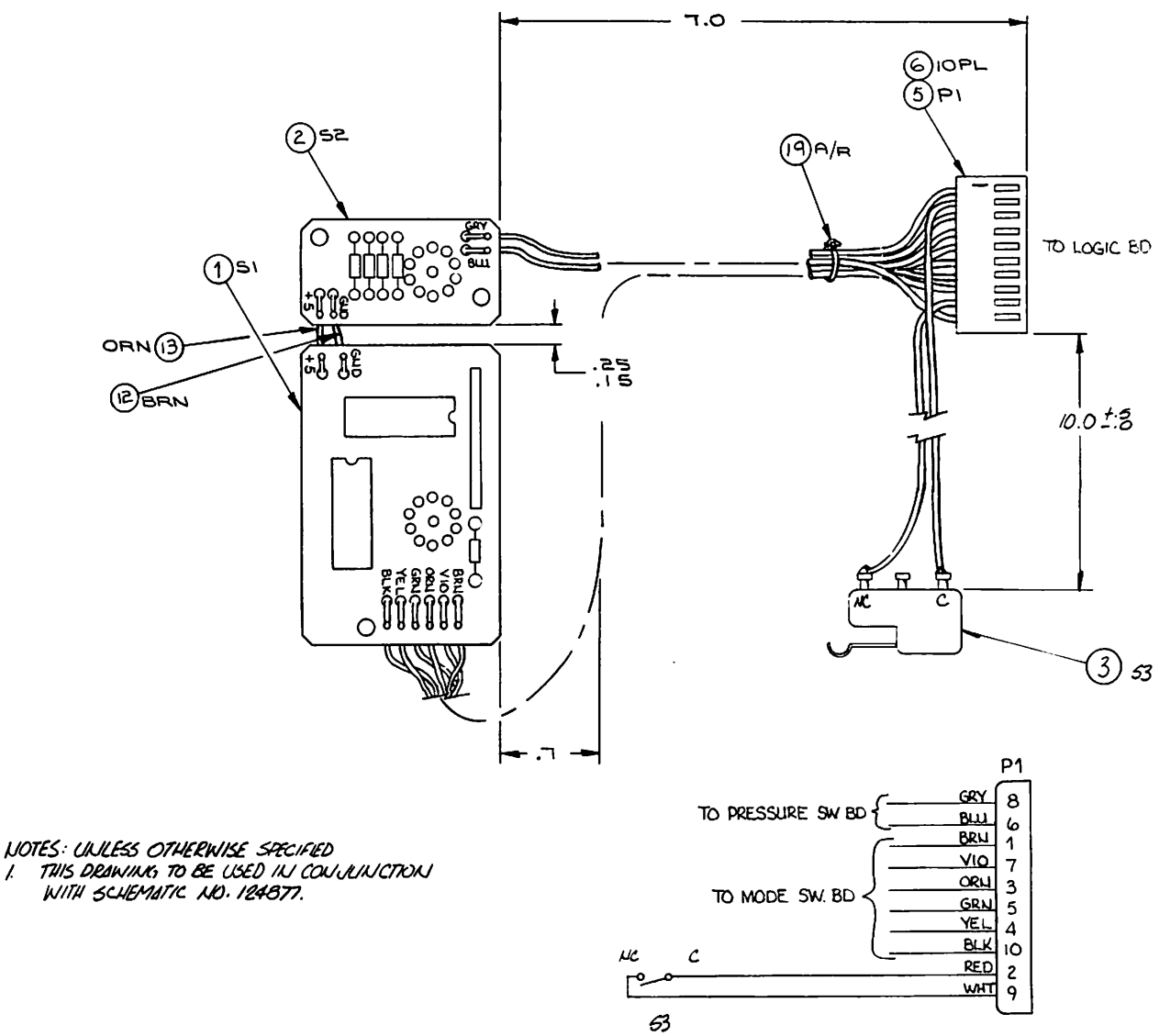
NOTES (UNLESS OTHERWISE SPECIFIED):

1. ALL COMPONENTS EXCEPT CONNECTOR J3 (ITEM6), SHALL NOT EXTEND BEYOND .250 INCHES FROM COMPONENT SIDE OF BOARD.
2. LEADS SHALL NOT PROJECT BEYOND .030 INCHES FROM CLAD SIDE OF BOARD.
3. STAMP OR MARK REVISION LETTER OF THIS DRAWING WITH PERMANENT NON-CONDUCTIVE CONTRASTING COLORED INK APPROX. WHERE SHOWN. CHARACTERS TO BE .06 INCH HIGH NOMINAL.

Figure 6-19. Logic Extension PW Board Assembly

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-19			LOGIC EXTENSION PW BOARD ASSEMBLY		
-1		124866	Logic Extension PW Board	1	
-2			Not Used		
-3			Not Used		
-4	J1	302797	Terminal Header, single row, 4 pin (COML)	1	
-5	J2	302986	Terminal Header, single row, 6 pin (COML)	1	
-6	J3	302987	Connector, dual row, right angle, 26 pin (COML)	1	
-7			Not Used		
-8			Not Used		
-9	U3	301632	Integrated Circuit, CMOS, dual "D" type flip-flop, 14 pin, CD4013 (COML)	1	
-10	U4	302961	Integrated Circuit, high speed CMOS, quad 2 input OR, 14 pin, 74HC32 (COML)	1	
-11	U6	301557	Integrated Circuit, CMOS, quad 2 input NOR, 14 pin, CD 4001 (COML)	1	
-12	U5	302694	Integrated Circuit, high speed CMOS, quad 2 input NAND, 14 pin, 74HC00 (COML)	1	
-13	U1	302343	Integrated Circuit, tri-state, 20 pin, 74C244 (COML)	1	
-14	U2	302958	Integrated Circuit, CMOS, 16 pin, CD4099 (COML)	1	
-15			Not Used		
-16			Not Used		
-17	R2,5	300195	Resistor, Fixed Carbon, 270kΩ, 1/4W ±5% (COML)	2	
-18	R1,4, 7-9	300161	Resistor, Fixed Carbon, 10kΩ, 1/4W ±5% (COML)	5	
-19	R6	300183	Resistor, Fixed Carbon, 82kΩ, 1/4W ±5% (COML)	1	
-20			Not Used		
-21	CR1-CR4	301453	Diode, Switching, IN4148 (COML)	4	
-22			Not Used		

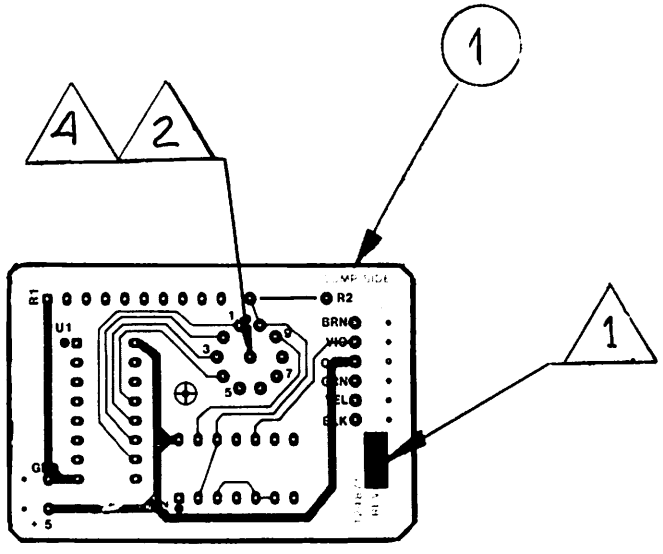
FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-19					
-23	C7	302824	Capacitor, Metalized Polyester, .001 µF ±10%, 100 VDC (COML)	1	
-24	C8,9	301778	Capacitor, Ceramic Disc, .001 µF ±10%, 50V (COML)	2	
-25	C1-6	301979	Capacitor, Ceramic Rectangular, .1 µF ±20%, 50V (COML)	6	
-26		302353	Jumper Wire, #30, kynar (COML)	A/R	



NOTES: UNLESS OTHERWISE SPECIFIED
1. THIS DRAWING TO BE USED IN CONJUNCTION WITH SCHEMATIC NO. 124877.

Figure 6-20. Rotary Switch Boards Harness Assembly

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-20		126048	ROTARY SWITCH BOARDS HARNESS ASSEMBLY		
-1		124875	Mode Rotary Switch Board Assembly (see figure 6-21 for breakdown)	1	
-2		126975	Pressure Rotary Switch Board Assembly (see figure 6-22 for breakdown)	1	
-3		301665	Probe Switch (COML)	1	
-4			Not Used		
-5		302662	Connector, single row, 10 pin (COML)	1	
-6		302666	Crimp Terminal (COML)	10	
-7		302480	Wire, 26 AWG, stranded, red (COML)	A/R	
-8		302481	Wire, 26 AWG, stranded, blue (COML)	A/R	
-9		302482	Wire, 26 AWG, stranded, yellow (COML)	A/R	
-10		302483	Wire, 26 AWG, stranded, green (COML)	A/R	
-11		302484	Wire, 26 AWG, stranded, black (COML)	A/R	
-12		302485	Wire, 26 AWG, stranded, brown (COML)	A/R	
-13		302486	Wire, 26 AWG, stranded, orange (COML)	A/R	
-14		302487	Wire, 26 AWG, stranded, violet (COML)	A/R	
-15		302488	Wire, 26 AWG, stranded, white (COML)	A/R	
-16		302706	Wire, 26 AWG, stranded, grey (COML)	A/R	
-17			Not Used		
-18		300695	Solder (COML)	A/R	
-19		300027	Tie Cord (COML)	A/R	

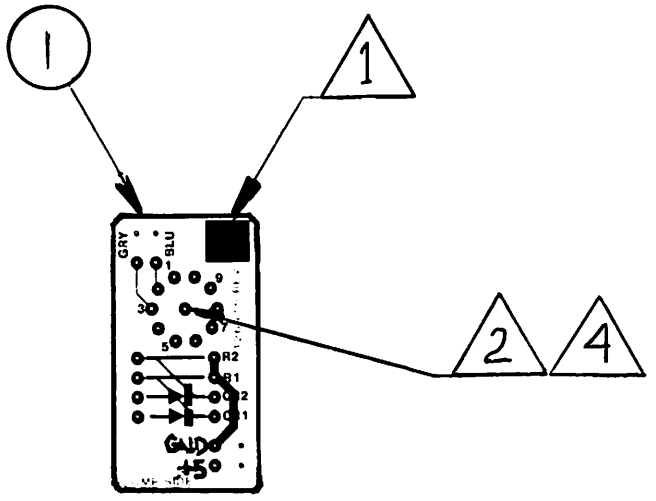


NOTES (UNLESS OTHERWISE SPECIFIED):

1. STAMP OR MARK REVISION LETTER OF THIS DRAWING WITH PERMANENT NON-CONDUCTIVE CONTRASTING COLORED INK APPROX. WHERE SHOWN. CHARACTERS TO BE .06 INCH HIGH NOMINAL.
2. SWITCH (ITEM 5) TO BE MOUNTED ON FARSIDE OF BOARD (ITEM 1). NOTE PIN LOCATIONS ON COMPONENT SIDE OF BOARD.
3. LEAD PROJECTION TO BE .055 INCH MAX. ON BOTH SIDES OF BOARD (ITEM 1).
4. INSERT STOPS AT 8-9 AND 1-10 AND APPLY SEALING DISC (P/O ITEM 5) TO RETAIN STOPS. ENSURE SWITCH HAS ONLY 8 POSITIONS.

Figure 6-21. Rotary Switch PW Board Assembly — Mode

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-21		124875	ROTARY SWITCH PW BOARD ASSEMBLY - MODE		
-1		124876	Rotary Switch PW Board - Mode		
-2			Not Used		
-3			Not Used		
-4			Not Used		
-5	S1	302967	Rotary Switch, miniature, 10 position (COML)	1	
-6			Not Used		
-7			Not Used		
-8			Not Used		
-9	U1	302959	Integrated Circuit, CMOS, 16 pin (COML)	1	
-10	U2	301557	Integrated Circuit, CMOS quad 2 input NOR, 14 pin (COML)	1	
-11			Not Used		
-12			Not Used		
-13			Not Used		
-14	R1	302682	Resistor Network, 10 pin, 20kΩ ±2% (COML)	1	
-15			Not Used		
-16			Not Used		
-17	R2	300168	Resistor, Fixed Carbon, 20kΩ, 1/4W ±5% (COML)	1	



NOTES (UNLESS OTHERWISE SPECIFIED):

1. STAMP OR MARK REVISION LETTER OF THIS DRAWING WITH PERMANENT NON-CONDUCTIVE CONTRASTING COLORED INK APPROX. WHERE SHOWN. CHARACTERS TO BE .06 INCH HIGH NOMINAL.
2. SWITCH (ITEM 5) TO BE MOUNTED ON FARSIDE OF BOARD (ITEM 1). NOTE PIN LOCATIONS ON COMPONENT SIDE OF BOARD.
3. LEAD PROJECTION TO BE .055 INCH MAX. ON BOTH SIDES OF BOARD.
4. INSERT STOPS AT 4-5 AND 1-10 AND APPLY SEALING DISC (P/O ITEM 4) TO RETAIN STOPS. ENSURE SWITCH HAS ONLY 4 POSITIONS.

Figure 6-22. Rotary Switch PW Board Assembly — Pressure

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-22		126975	ROTARY SWITCH PW BOARD ASSEMBLY - PRESSURE		
-1		126976	Rotary Switch PW Board - Pressure	1	
-2			Not Used		
-3			Not Used		
-4			Not Used		
-5			Rotary Switch, miniature, 10 position (COML)	1	
-6			Not Used		
-7			Not Used		
-8			Not Used		
-9	CR1,2	301453	Diode, Switching, 75V, 10 mA (COML)	2	
-10			Not Used		
-11			Not Used		
-12			Not Used		
-13			Not Used		
-14	R1,2	300168	Resistor, Fixed Carbon, 20kΩ, 1/4W ±5% (COML)	2	

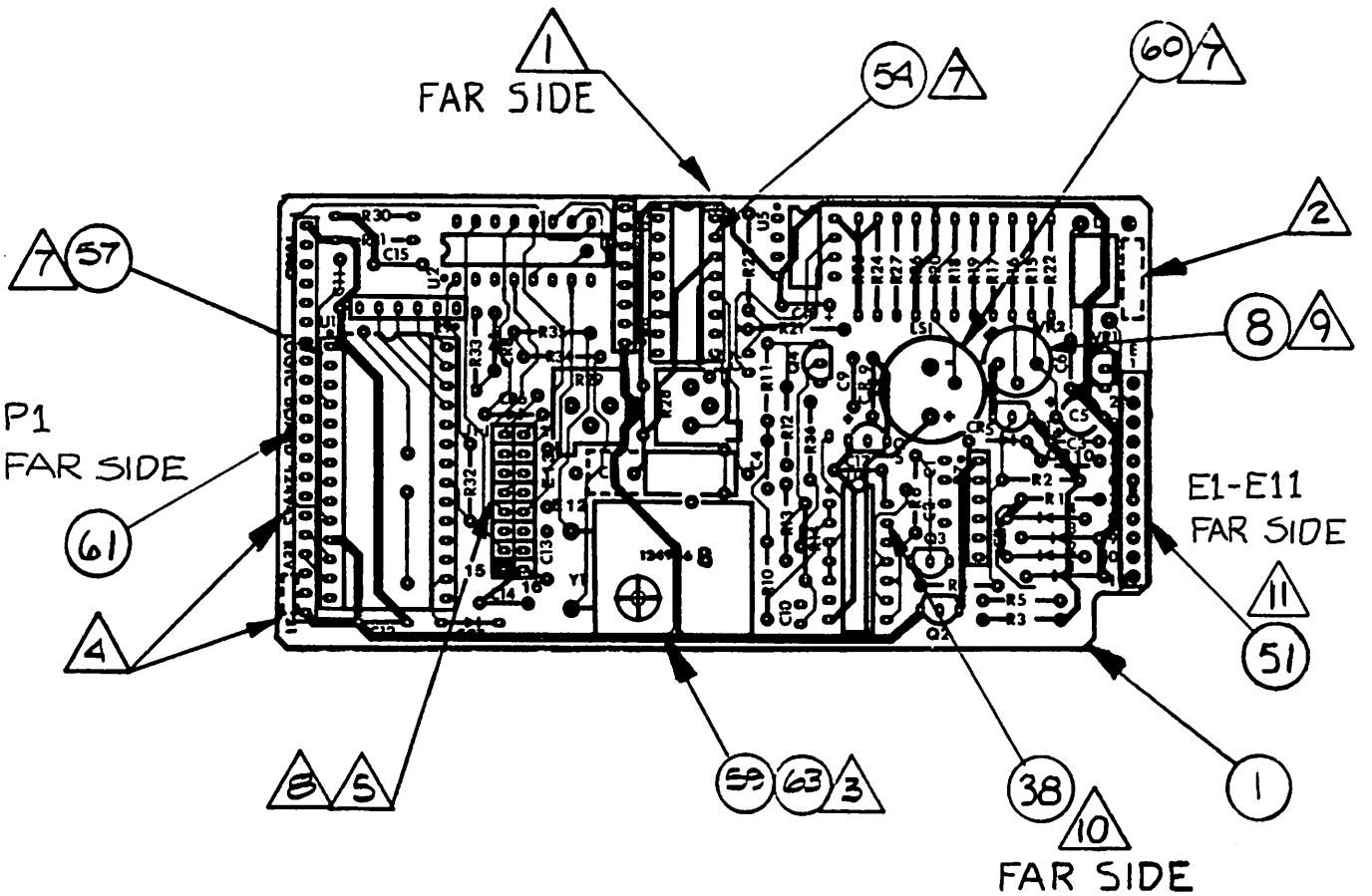


Figure 6-23. Thermometer PW Board Assembly

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-23		124192	THERMOMETER PW BOARD ASSEMBLY		
-1		124946	Logic PW board	1	
-2			Not Used		
-3	U1	150010	Integrated Circuit, COP 444L	1	
-4	U2	302438	Integrated Circuit, CMOS, 16 pin CD 40257BE (COML)	1	
-5	U3	302448	Integrated Circuit, A/D converter/BCD MUX, 16 pin, CA3162E (COML)	1	
-6	U4	302160	Integrated Circuit, CMOS, triple 3 input NAND, 14 pin, 4023BE (COML)	1	
-7	U5	302206	Integrated Circuit, BiMos dual op amp, 8 pin, CA3240E (COML)	1	
-8	VR2	302451	Integrated Circuit, adjustable voltage regulator, LM317 (COML)	1	
-9			Not Used		
-10	R1	300089	Resistor, Fixed Carbon, 10Ω, 1/4W ±5% (COML)	1	
-11	R2,3, 33	300185	Resistor, Fixed Carbon, 100kΩ, 1/4W ±5% (COML)	3	
-12	R4	300151	Resistor, Fixed Carbon, 3.9kΩ, 1/4W ±5% (COML)	1	
-13	R5,35	300137	Resistor, Fixed Carbon, 1kΩ, 1/4W ±5% (COML)	2	
-14	R6,10, 14	300161	Resistor, Fixed Carbon, 10kΩ, 1/4W ±5% (COML)	3	
-15	R7	302461	Resistor Network, 220kΩ ±2%, 6 pin (COML)	1	
-16	R8	302433	Resistor Network, 220kΩ ±2%, 8 pin (COML)	1	
-17	R9	302460	Resistor Network, 10kΩ ±2%, 6 pin (COML)	1	
-18	R11,30	300192	Resistor, Fixed Carbon, 200kΩ, 1/4W ±5% (COML)	2	
-19	R12,34	300209	Resistor, Fixed Carbon, 1.0MΩ, 1/4W ±5%	2	
-20	R13	300178	Resistor, Fixed Carbon, 51kΩ, 1/4W ±5% (COML)	1	
-21	R15	302442	Resistor, Fixed Metal, 2.80kΩ, 1/4W ±1% (COML)	1	
-22	R16	302443	Resistor, Fixed Metal, 3.794kΩ, 1/4W ±0.1% (COML)	1	
-23	R17	302441	Resistor, Fixed Metal, 1.91kΩ, 1/4W ±1% (COML)	1	

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-23					
-24	R18	301355	Resistor, Fixed Metal, .357Ω, 1/4W ±1% (COML)	1	
-25	R19	300131	Resistor, Fixed Carbon, .560Ω, 1/4W ±5% (COML)	1	
-26	R20	301249	Resistor, Fixed Metal, 27.4Ω, 1/4W ±1% (COML)	1	
-27	R21	302429	Resistor, Fixed Metal, 4.42kΩ, 1/4W ±1% (COML)	1	
-28	R22	302445	Resistor, Fixed Metal, 138.6kΩ, 1/4W ±.1% (COML)	1	
-29	R23	300490	Resistor, Fixed Metal, 1MΩ, 1/4W ±.1% (COML)	1	
-30	R24	302444	Resistor, Fixed Metal, 40.20kΩ, 1/4W ±1% (COML)	1	
-31	R25	301083	Resistor, Fixed Metal, 37.76kΩ, 1/4W ±.1% (COML)	1	
-32	R26	302453	Resistor, Fixed Metal, 14.3kΩ, 1/4W ±1% (COML)	1	
-33	R27	302446	Resistor, Fixed Metal, 475kΩ, 1/4W ±1% (COML)	1	
-34	R28	302430	Potentiometer, Cermet, multi-turn, 50kΩ ±10%, 1/2W (COML)	1	
-35	R29	302431	Potentiometer, Cermet, multi-turn, 10kΩ ±10% (COML)	1	
-36	R31,32	300177	Resistor, Fixed Carbon, 47kΩ, 1/4W ±5% (COML)	2	
-37	R36	300145	Resistor, Fixed Carbon, 2.2kΩ, 1/4W ±5% (COML)	1	
-38		302356	Wire, electrical hookup, 30 AWG, orange (COML)	A/R	
-39	C1,2, 10	301979	Capacitor, Rectangular Ceramic, .10 µF ±20%, 50V (COML)	3	
-40	C9	302421	Capacitor, Tantalum, solid electrolyte, 3.3 µF ±10%, 50V (COML)	1	
-41	C4,6, 12, 15-17	302490	Capacitor, Rectangular Ceramic, .01 µF ±20%, 50V (COML)	6	
-42	C5	300519	Capacitor, Tantalum, solid electrolyte, 10 µF ±10%, 25V (COML)	1	
-43	C7	301978	Capacitor, Rectangular Ceramic, .022 µF ±20%, 50V (COML)	1	
-44	C8	302436	Capacitor, Metalized mylar, 0.27 µF ±10%, 100V (COML)	1	
-45	C11	301513	Capacitor, Ceramic Disc, 560 pF ±10%, 1 kV (COML)	1	
-46	C13	300555	Capacitor, Ceramic Disc, 56 pF ±10%, 1 kV (COML)	1	

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-23					
-47	C14	302435	Capacitor, Ceramic Disc, 18 pF ±10%, 500 or 1000V (COML)	1	
-48	C18	302489	Capacitor, Tantalum, solid electrolyte, 4.7 µF ±10%, 10V (COML)	1	
-49	C3	301413	Capacitor, Tantalum, solid electrolyte, 33 µF ±10%, 10V (COML)	1	
-50	L1	301779	Choke, Wideband, 680Ω ±20%, 180 MHz (COML)	1	
-51	E1-11	301578	Terminal Header, single row, 36 pin (COML)	1	
-52	Q1,2,4	300702	Transistor, PNP amplifier and switch, 300 mW, 500 mA, PN3638A (COML)	3	
-53	Q3,5	301928	Transistor NPN amplifier and switch, 600 mW, 800 mA, PN222A (COML)	2	
-54	XU3	301601	Socket, Integrated Circuit, 16 pin (COML)	1	
-55	CR1-CR4	302046	Diode, Rectifier, 400V, 1.0A, IN4004 (COML)	4	
-56	CR5-CR10	301453	Diode, Switching, 75V, 10 mA, IN4148 (COML)	6	
-57	XU1	302157	Socket, Integrated Circuit, 28 pin (COML)	1	
-58	VR1	302457	Diode, Voltage Reference, 15 µA, 1.235V ±2% (COML)	1	
-59	Y1	302450	Crystal, Quartz, 2 MHz ±50 ppm (COML)	1	
-60	LS1	302452	Transducer, Audio, miniature, 1.5V, 1.9-4.3 kHz (COML)	1	
-61	P1	302555	Terminal Header, single row, 21 pin (COML)	1	
-62	J1	302185	Terminal Header, 72 pin (COML)	1	
-63		302097	Silastic Adhesive/Sealant, white (COML)	A/R	

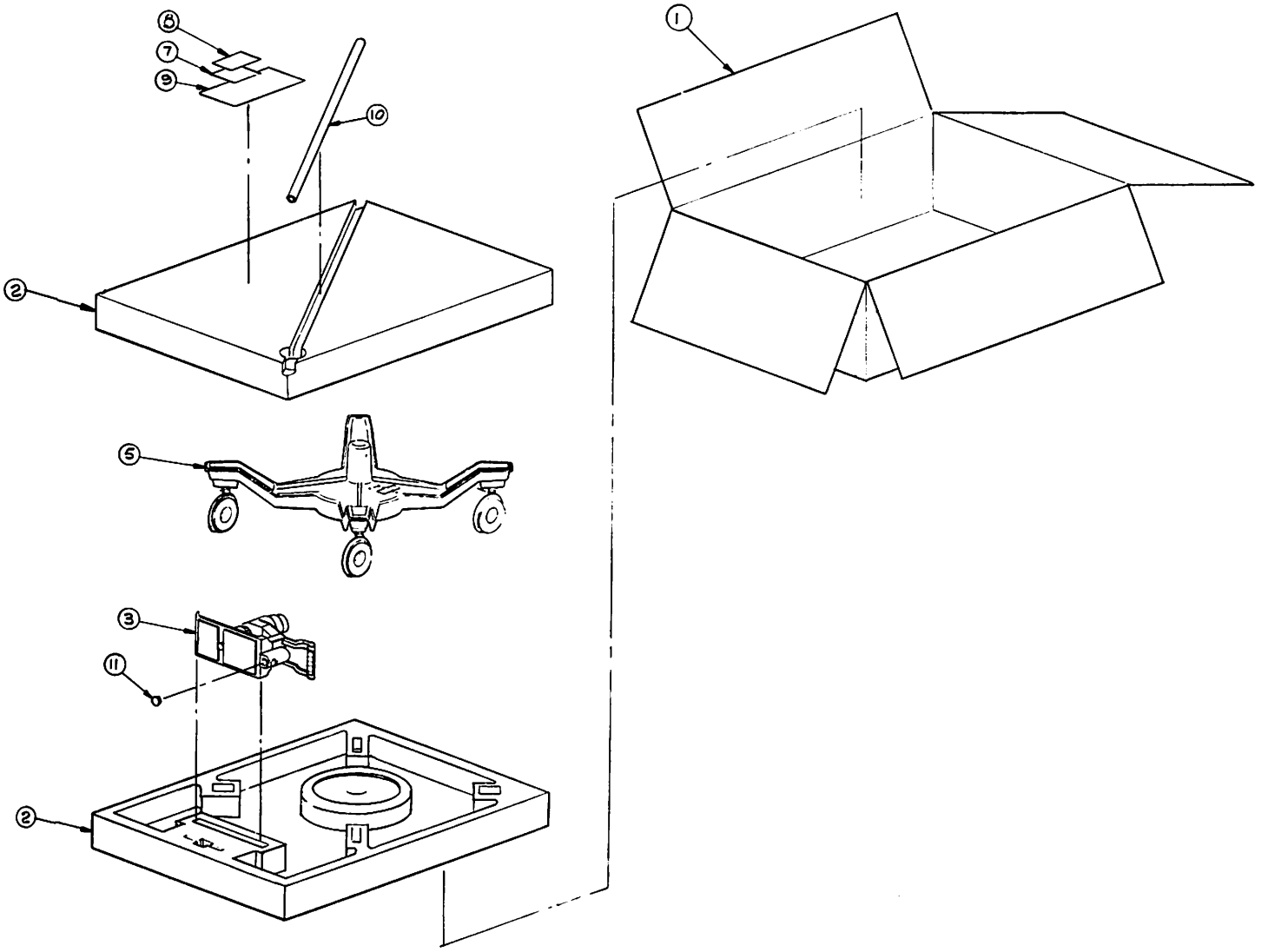


Figure 6-24. 1020VS Instrument Stand Top Assembly

FIGURE INDEX	REF DES	PART NUMBER	DESCRIPTION	QTY	USABLE ON CODE
6-24		124090	1020 VS INSTRUMENT STAND TOP ASSEMBLY		
-1		124337	Shipping Box	1	
-2		124316	Packing Insert	2	
-3		124315	Pedestal Assembly	1	
-4			Not Used		
-5		127401	Base - Final Assembly	1	
-6			Not Used		
-7		100179	Warranty Card	1	
-8		100133	Claim Notice Card	1	
-9		124421	Setup Instructions - 1020 VS	1	
-10		123106	Base Pole - 1020 VS	1	