IVAC CORPORATION

SERVICE BULLETIN

MODEL (S) AFFECTED	DATE	BULLETIN NUMBER
Model 4200 Instruments	10/30/89	#265

SUBJECT

This bulletin contains user information for the IVAC VITAL§CHECK[R] Model 4200 Calibration Verification Procedures.

REASON

IVAC Corporation has recently introduced the Model 4200 instrument into the marketplace. Because various nontechnical personnel will be using calibration verification to document the accuracy of the instrument and/or thermometer before use, IVAC Corporation has created this user service bulletin as a means to convey such information. This bulletin is not intended to replace, nor be the equivalent of the instrument's technical service manual or directions for use.

SOLUTION

The following information will provide the user with step-by-step instructions on how to perform calibration verifications. For detailed information, refer to the instrument's technical service manual or directions for use.

REFERENCES

IVAC VITAL§CHECK[R] - Model 4200 Technical Service Manual, current revision

IVAC VITAL§CHECK[R] - Model 4200 Directions For Use, current revision

ACTION

To verify the instrument and/or thermometer calibration verification accuracy, perform the following procedures, as applicable, and document the results per standard hospital procedures.

EQUIPMENT REQUIRED

Pressure Meter	Heise Model 901A or Wallace and Tiernan Model 1500, or equivalent
Calibration Tester	Model 828A

Reservoir or substitute arm

Tubing (3 feet) P/N 303109

Two Tee fittings P/N 303815

Hand pump

Air hose with microphone disabled

TEST DESCRIPTIONS

Calibration verification ensures that the instrmment blood pressure and thermometer measurement systems have been correctly calibrated and operate accurately before return to patient use.

Blood Pressure Calibration Verification

NOTE

The Model 4200 must be in calibration (CAL) mode to perform the Blood Pressure Calibration Verification. Follow instructions in step a to place instrument in the CAL mode.

a. Note positions of the internal DIP switch S2 (see figure 1 and table 1), then set S2 DIP switch in the CAL mode, as follows: switch no. 1, 2, and 3 to the down position, and switch no. 4 to the up position. Note: The S2 switch is accessed at the right-hand louvers located at the front panel overhang. Lay the instrument down on its back panel and use a non-metallic tool (i.e., wooden end of Q-tip) to place internal switches in the desired positions.

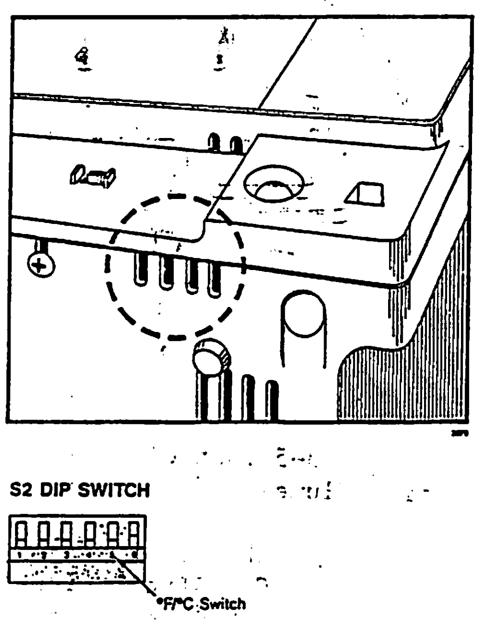


Figure 1. S2 Internal DIP Switch

Table 1. Calibration Mode

Switch Number	Position
1	Down
2	Down
3	Down
4	Up (Cal mode)
5	Up °F or Down °C

b. Install pressure gauge and pressure source at the cuff nipple using a tee fitting and other fittings (see figure 2), as required. Note: Leaky fittings will reduce the reliability of the test.

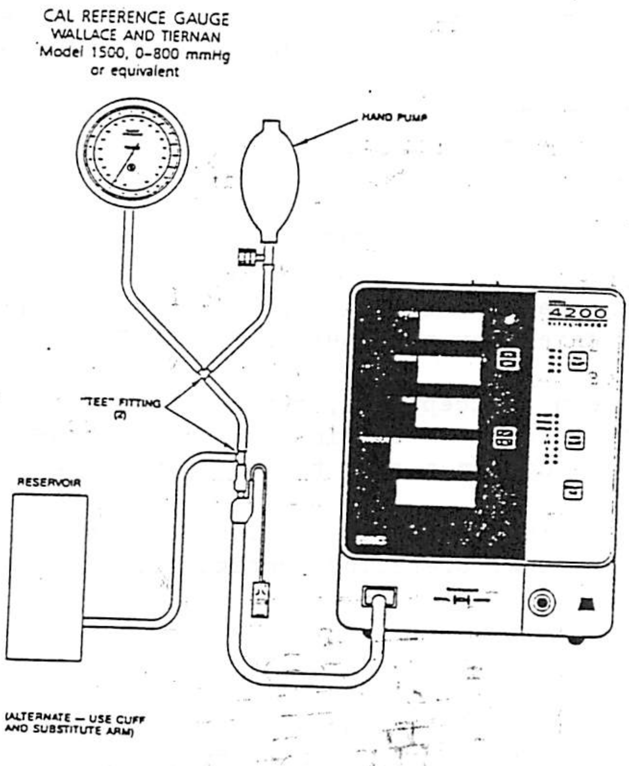


Figure 2. Pressure Calibration Test Fixture

c. Wrap cuff around a cylinder (3-5 inch diameter) or use a reservoir to provide sufficient air volume.

d. Press the ON/OFF switch to turn the instrument on. The information display will read TESTING, then CAL, indicating that it is in the CAL mode, and the SYSTOLIC display will read 000, indicating that zero pressure is applied.

e. Set the MODE SELECT to MANUAL and PRES. SELECT, as required. (See step f.)

f. Apply test pressures in the ranges as required below and verify that the SYSTOLIC display matches the reading on the external gauge. Make allowance for error tolerances of the external gauge. (See table 2.)

Table 2. Test Pressures

PRES. SELECT	Pressure* Applied	SYSTOLIC Reading	DIASTOLIC Reading
200	301 +/-6	300-302	108 +/-60
150	251 +/-3	250-252	108 +/-40
100	151 +/-2	150-152	108 +/-20

*Adjust pressure until SYSTOLIC fluctuates between desired readings, then check applied pressure for correct value.

NOTE

The instrument has a resolution of 2 mmHg, and will read out only to the nearest even number in the SYSTOLIC display.

g. If the readings are not acceptable, refer to the recalibration procedure, as described in the technical service manual (section 6.9.4).
Note: This procedure does not test the cuff or cable, which may leak air.

h. Before returning the instrument to clinical use, reset the internal DIP switch S2 to the original operating configuration, as noted in step a.

Thermometer Calibration Verification

a. Insert calibration tester (Model 828A) into the probe connector socket. Turn on the instrument if it is not already on.

b. Set the NORMAL/MONITOR mode switch to MONITOR, the S2 internal DIP switch no. 5 (see figure 1) to the up (°F) position, and verify that the temperature display flashes 98.6°F (+/-0.2°F).

NOTES

1) If the thermometer does not turn on, install and then remove a probe from the probe storage well.

2) For °C, set the internal DIP switch S2 no. 5 to the down position.

c. Set the NORMAL/MONITOR mode switch to NORMAL, verify that the display reads 98.6°F (+/-0.2°F), and that only the F flashes on and off.

d. Remove the thermometer tester from the instrument and return the internal DIP switch S2 to the °C setting, if necessary.

USER INQUIRIES

If the instrument fails calibration verifications, and the cause cannot be determined, do not use the instrument. Refer to qualified service personnel.

Application and service information may be obtained by writing to the IVAC Service Department at:

IVAC Corporation
10300 Campus Point Drive
San Diego, CA 92121-1579
ATTN: Instrument Service

Within the United States, IVAC Corporation Corporate Customer Service provides a toll-free telephone line for customer convenience. For information or assistance call (800) 482-4822.

Please include with the request for service information a description of the difficulty experienced, including the message displayed at the time of difficulty, if any.

Should it be necessary to return the instrument for service, carefully package the instrument and accessories (preferably in the original packing), and return it to the appropriate service center or distribution center. IVAC Corporation cannot assume any responsibility for loss of or damage to returned equipment while in transit.

IVAC CORPORATION SERVICE BULLETIN

MODEL (S) AFFECTED	DATE	BULLETIN NUMBER
Model 4200 VITAL•CHECK® Vital Signs Measurement System	July 1992	#274A

SHEET 1 OF

SUBJECT:

Updates to Power Regulator and Logic/Analog boards to reduce electrostatic discharge and motor current startup-induced failures.

EXPLANATIONS:

(1) Electrostatic discharge may cause component failures on the Power Regulator and Logic/Analog boards. Exhibited symptoms are:

- Instrument will not turn on; no +5VAO.
- Defective audio; U40 defective.
- FIX ME B, leaker control problem, or instrument does not deflate during measurement cycle; U42 defective.
- Memory mode lockup (instrument stays in memory mode).
- Operational mode changes (instrument continuously fluctuates between modes).

(2) Motor startup current may cause component failures on the Power Regulator board. Exhibited symptoms are:

- FIX ME A, C, D, or F.

(3) Zener diode CR8 (if present in the C104 location on the Logic/Analog board) causes battery standby current to double. This could reduce battery life when the instrument is off and not plugged into AC power.

REFERENCES:

Model 4200 Technical Service Manual

Figure 1. Power Regulator Board - Location of Updates

Figure 2. Schematic - Power Regulator U105 Removed, VR102 Added

Figure 3. Schematic - Power Regulator Q115 and Q116.

Figure 4. Logic/Analog Board - Jumper on Clad Side

Figure 5. Logic/Analog Board - Location of Updates

Figure 6. Schematic - CR9 Installed in C98 Location on Logic/Analog Board

Figure 7. Schematic - Zener Diodes Installed in Unused Capacitor Locations on Logic/Analog Board.

Figure 8. Schematic - Logic/Analog Q9 Changed to MOSFET

Figure 9. Ground Harness Assembly Modification

UPDATES

Power Regulator Board Updates

A. To correct for electrostatic discharge-induced failures, the following changes have been incorporated onto the Power Regulator board. See Figures 1 and 2.

1. Q111 (FET transistor) was replaced with a +5V micropower voltage regulator (VR102). The voltage regulator was installed with its flat side facing the line marked on the board for Q111.
2. C116 was changed to a 10µF capacitor.
3. U105 was removed from the board. In its place, a 28 AWG insulated jumper was soldered between the pin 15 and pin 16 locations for U105.
4. R138 (301 kΩ), R139 (100 kΩ), and R 140 (100 kΩ) were removed from the board.

B. To correct for motor startup current-induced failures, the following changes have been incorporated onto the Power Regulator board. See Figures 1 and 3.

1. R158 and R161 were changed to 300 Ω, 1W resistors. Protective sleeves of clear shrink tubing were added to the upper resisitor leads.
2. Q115 and Q116 were changed from 2N6727 transistors to MPS 750 or ZTX 750 transistors.
3. R155 and R156 were changed to 3.9 kΩ resistors.

Logic/Analog Board Updates

A. To correct for electrostatic discharge-induced failures, the following changes have been incorporated onto the Logic/Analog board. See Figures 4 through 9.

1. J10 pin 2 and J8 pin 1 were jumpered on the clad side of the logic board with two inches of 24 AWG insulated wire.
2. U40 and U42 were changed from 8255A ICs to 82C55A ICs.
3. Zener diodes were installed in the unused locations marked for capacitors C98, C100, C101, C102, and C103. The diodes were installed with: (a) the marked (cathode) end toward, and in the square closest to, J6, and (b) the other (anode) lead into the outer set of holes marked for the capacitors, on the same pad.
4. Q9 was changed from a 2N2222A transistor to a MOSFET transistor (VN0610LL) with its flat side facing as marked on the board.
5. The green wire that connects the logic board to the AC ground lug on the mounting plate (via J10) was cut off. The green wire was part of the ground harness assembly.

B. The zener diode located at C104 on the Logic/Analog board was removed to reduce battery standby current. See Figure 5.

NEW PART NUMBERS

Use the following to update the parts lists in chapter 8 of the Model 4200 Technical Service Manual.

Power Regulator Board

Part Number	Description	Reference Designator
133875	Power Regulator Board Assembly	
300151	3.9 kΩ 5%, 1/4 watt, carbon film resistor	R155, R156
302059	300 Ω 5%, 1 watt, carbon film resistor	R158, R161
301116	Clear shrink tubing (for use with R158, R161)	
300519	10 µF, 20%, 25V, solid tantalum electrolyte capacitor	C116
303631	PNP Transistor (Motorola MPS 750 or Ferranti ZTX 750)	Q115 Q116
304083	+5V Micropower Voltage Regulator (National LP2950CZ-5.0)	VR102
	Not Used (VR102 now located where Q111 was)	Q111 U105
	Not Used	R138 R139 R140

Logic/Analog Board

134071	Logic/Analog Board Kit	
303143	IC 82C55A, Mitsubishi M5M82C55AP-2 or OKI MSM82C55A-2RS	U40 U42
302422	N-channel MOSFET transistor (Siliconix VN0610LL)	Q9
302181	Zener diode 5.6 V, Motorola IN4690 or TRW LVA356A (CR9 is located at C98, CR10 is at C100, CR11 is at C101, CR 14 is at C102, and CR15 is at C103.)	CR9 CR10 CR11 CR14 CR15

Miscellaneous

133570	Ground Harness Assembly (This does not have ground wire to connect to Logic/Analog board.)	

UPDATE SCHEMATICS

Use the attached partial schematics to update the Logic/Analog board and Power Regulator board schematics in chapter 4 of the Model 4200 Technical Service Manual.

Use this item in this Service Bulletin:	To update this item in the Service Manual:
Figure 2	Figure 4-4, Page 4-24/4-25
Figure 3	Figure 4-4, Page 4-26/4-27
Figures 6 and 7	Figure 4-1, Page 4-8/4-9
Figure 8	Figure 4-1, Page 4-4/4-5
Figure 9	Figure 8-5c, Page 8-13/8-14 (item 219)

TECHNICAL TIPS

Tip #1

The instrument may display the message NOT USED the first time it is powered up after the Logic/Analog board is replaced. This message is not normally displayed by the Model 4200; it is associated with another version of the instrument, the Model 4200C, and its real time clock circuit.

Press the Mode Select or Pressure Select switch to clear the message from the instrument.

Tip #2

Calibration is required whenever major repairs are done. This includes replacement of the Power Regulator board or the Logic/Analog board. See section 6.9 in the Model 4200 Technical Service Manual for the calibration procedures.

One adjustment that is sometimes forgotten is section 6.9.8, the Deflation Loop Balance Adjustment. It is important that this adjustment be done whenever the Logic/Analog or Leaker Assembly is repaired or replaced.

TECHNICAL INQUIRIES

For additional assistance, contact Technical Support in IVAC Field Service Operations (domestic or international).

Address: IVAC Corporation
10300 Campus Point Drive
San Diego, CA 92121-1579 U.S.A.

Attn: Service Operations

Telephone: (619) 458-6003 for Technical Support
(800) 854-7128 for toll-free assistance (U.S.A. only)

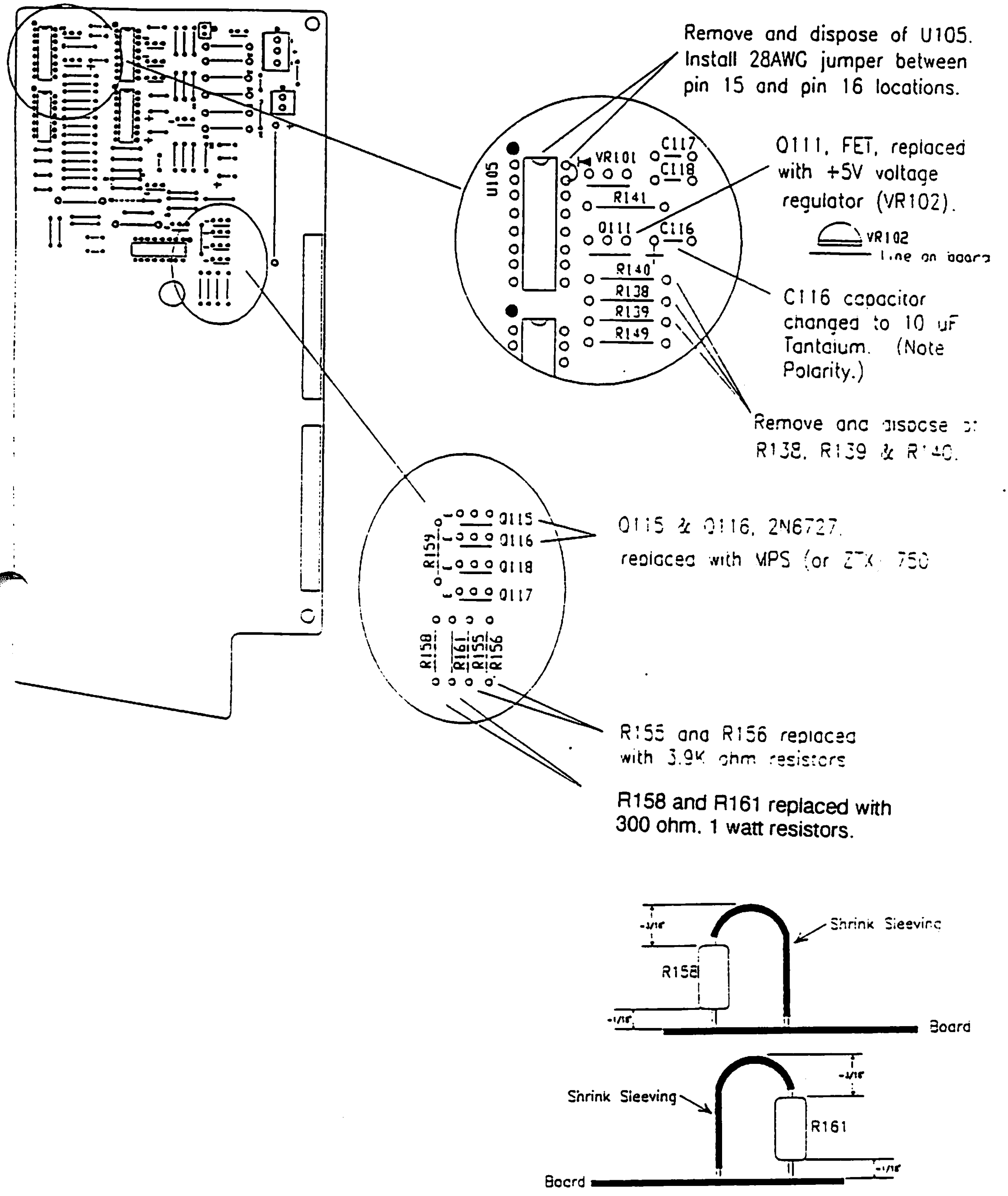
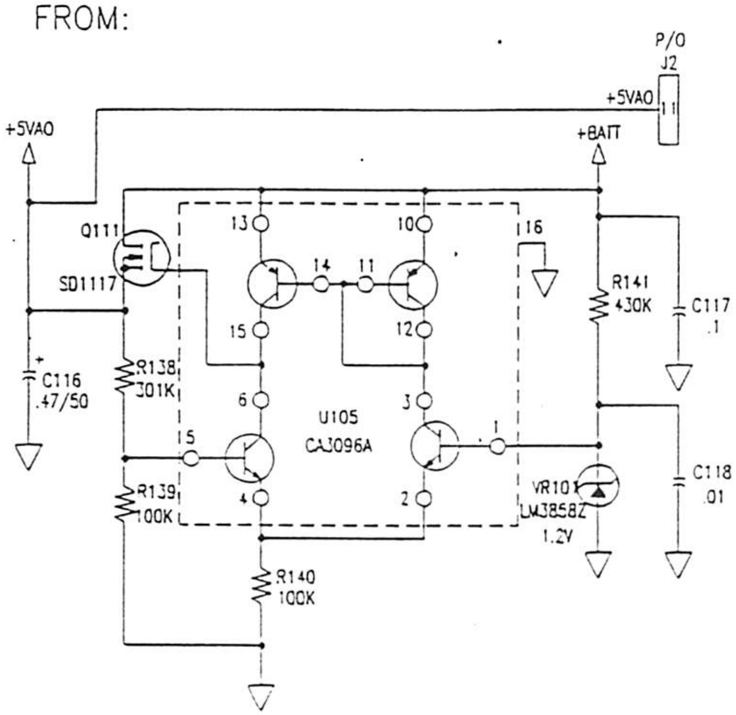


Figure 1
Power Regulator Board - Location of Updates

FROM:



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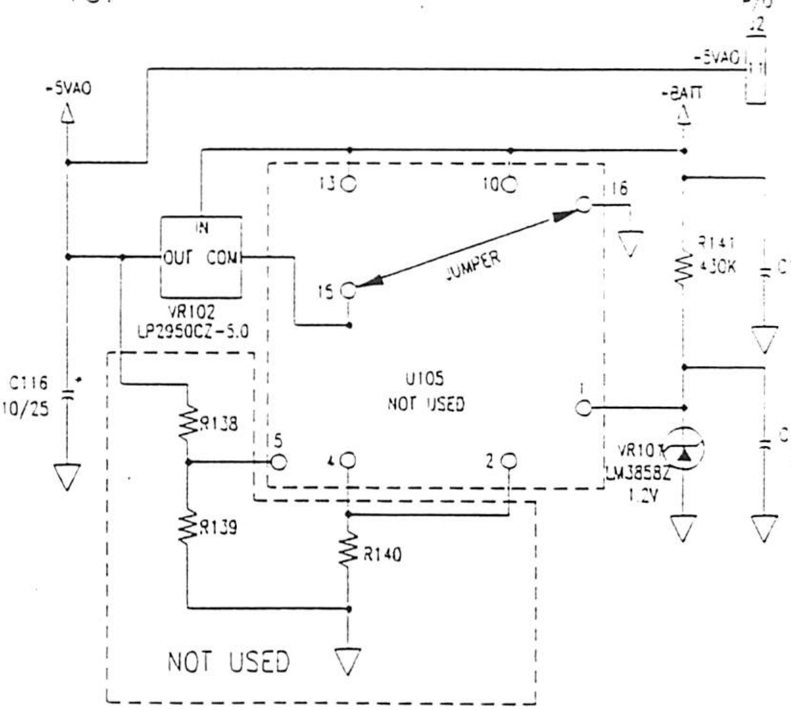


Q111 replaced with VR102.
U105 removed.
Pins 15 and 16 of U105 are jumpered.
R138, R139 and R140 removed.
C116 changed to 10 uF.

Figure 2
Schematic - Power Regulator U105 Removed, VR102 Added

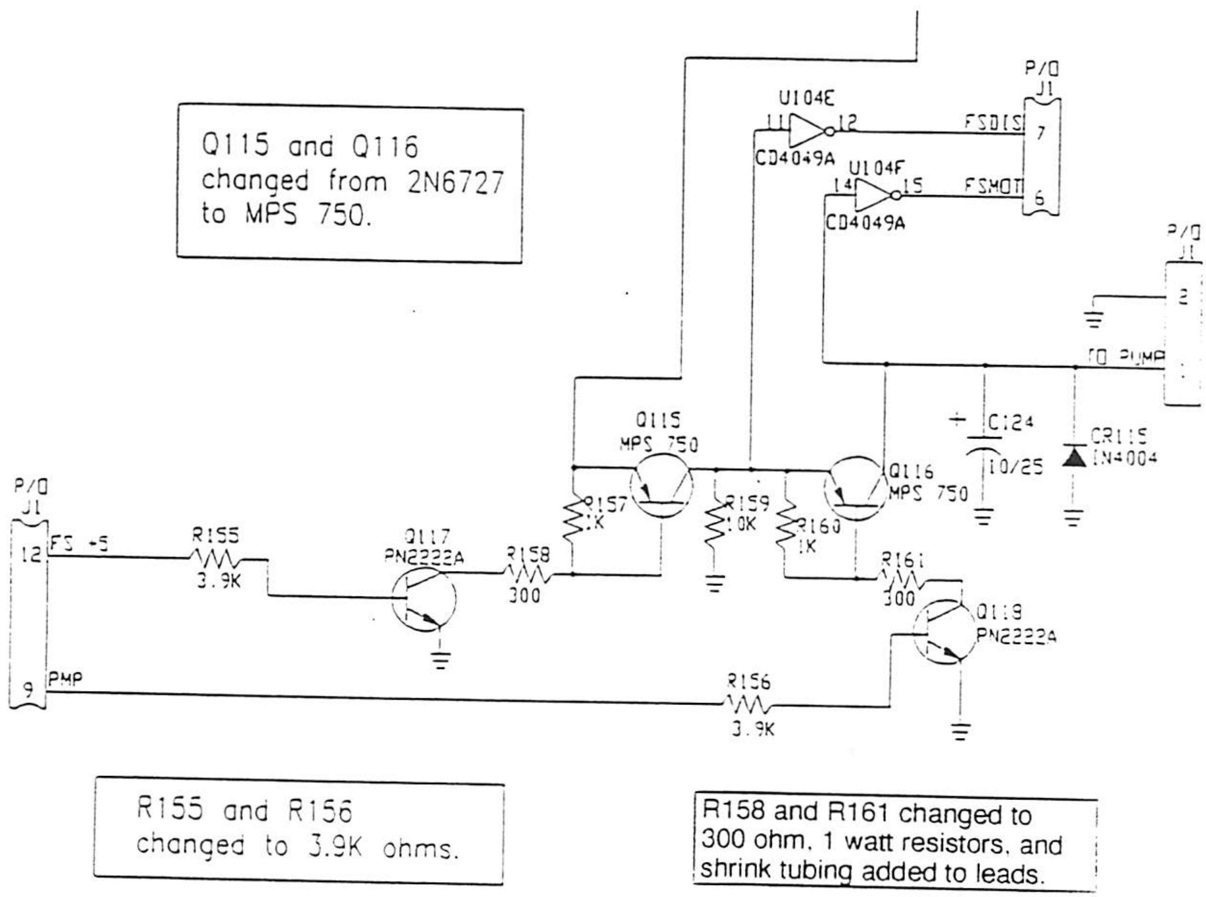


Figure 3
Schematic - Power Regulator Q115 and Q116

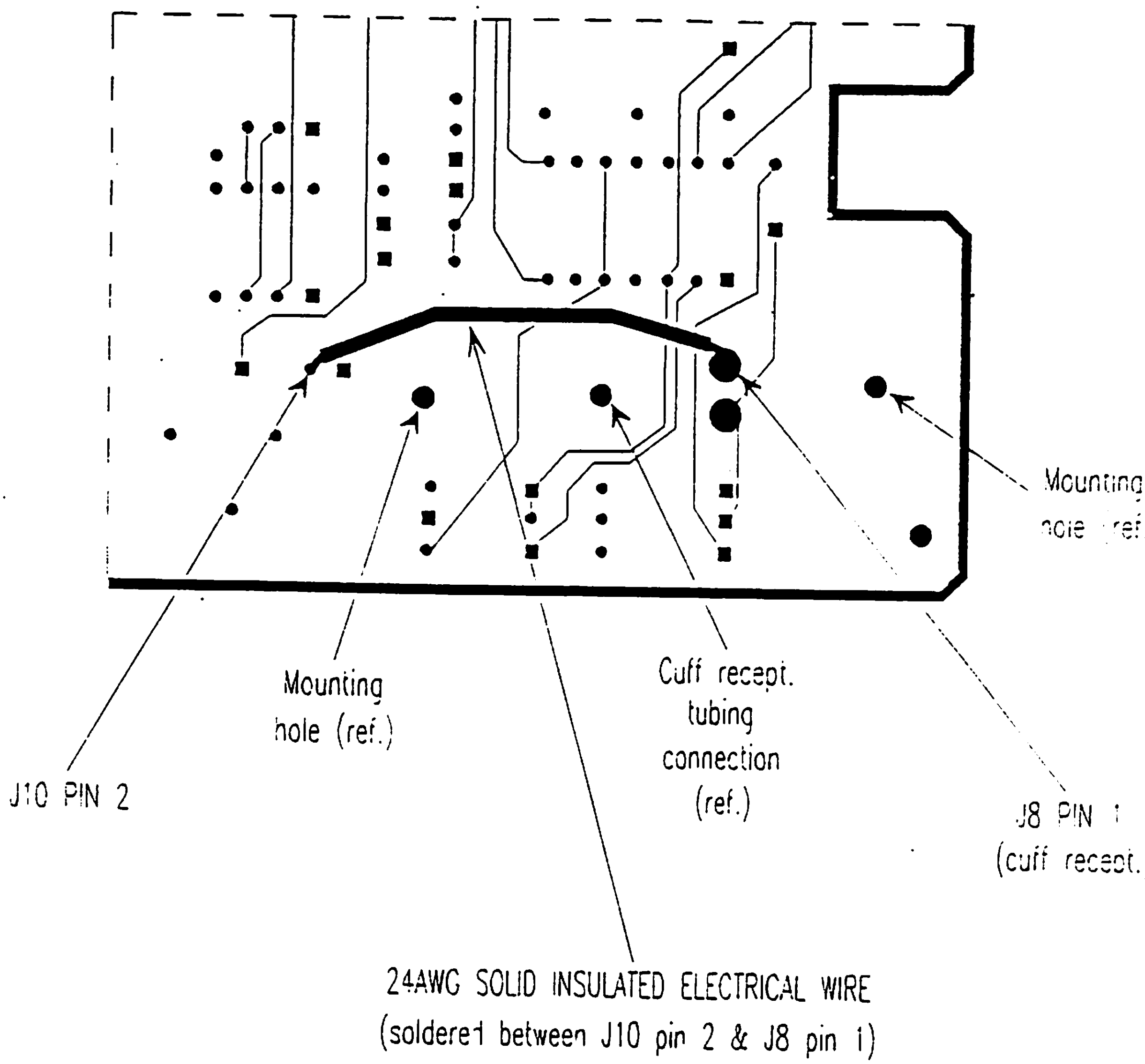


Figure 4
Logic/Analog Board - Jumper on Clad Side

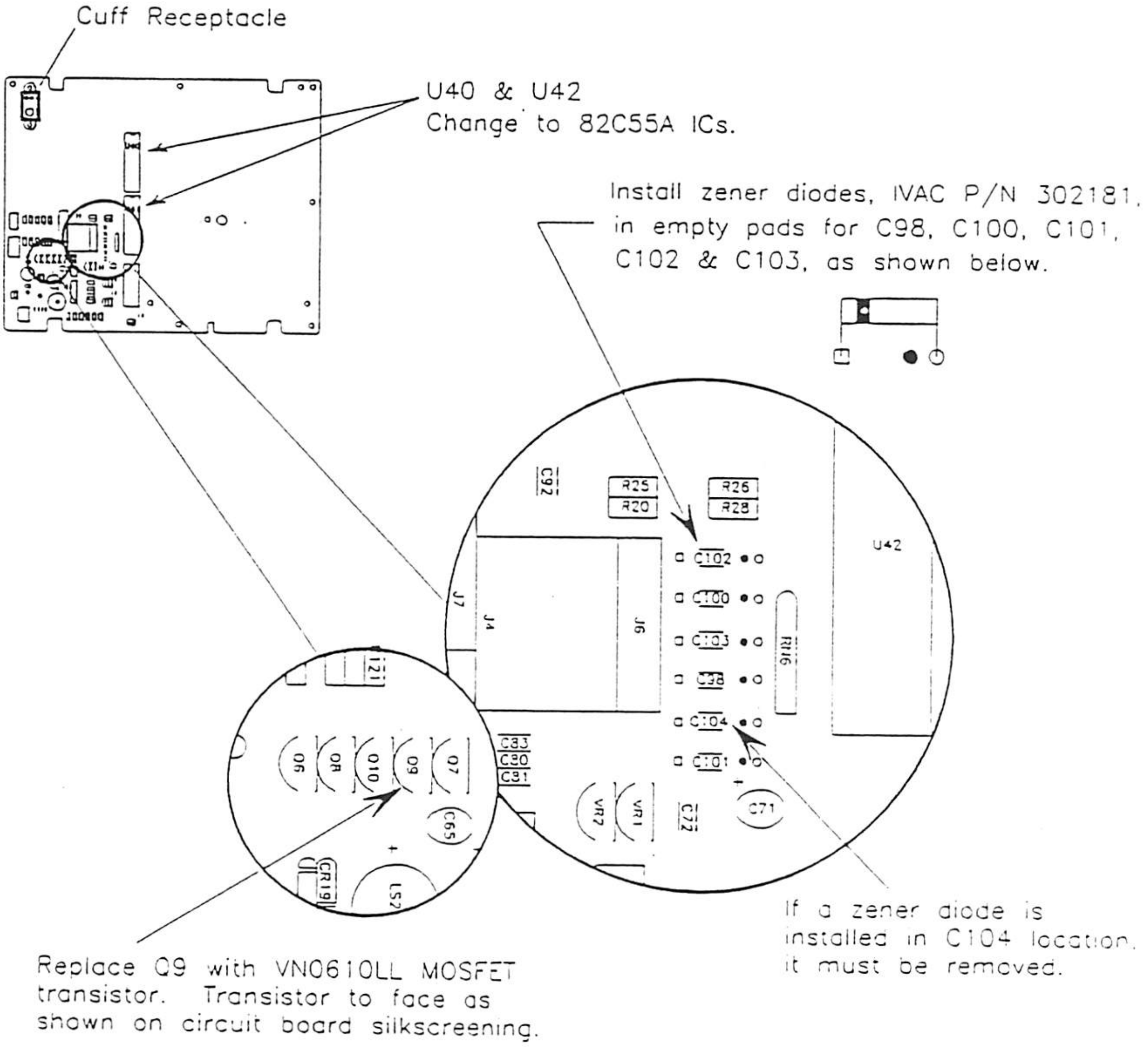
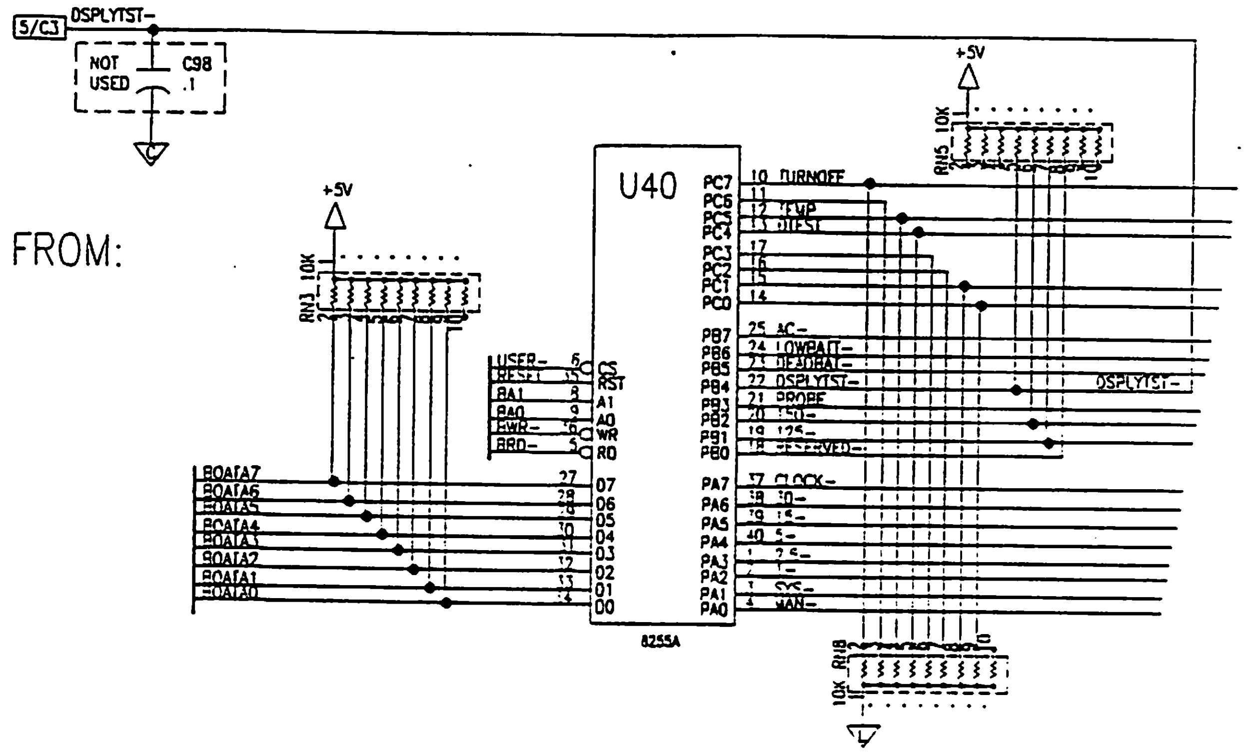


Figure 5
Logic/Analog Board - Location of Updates

FROM:



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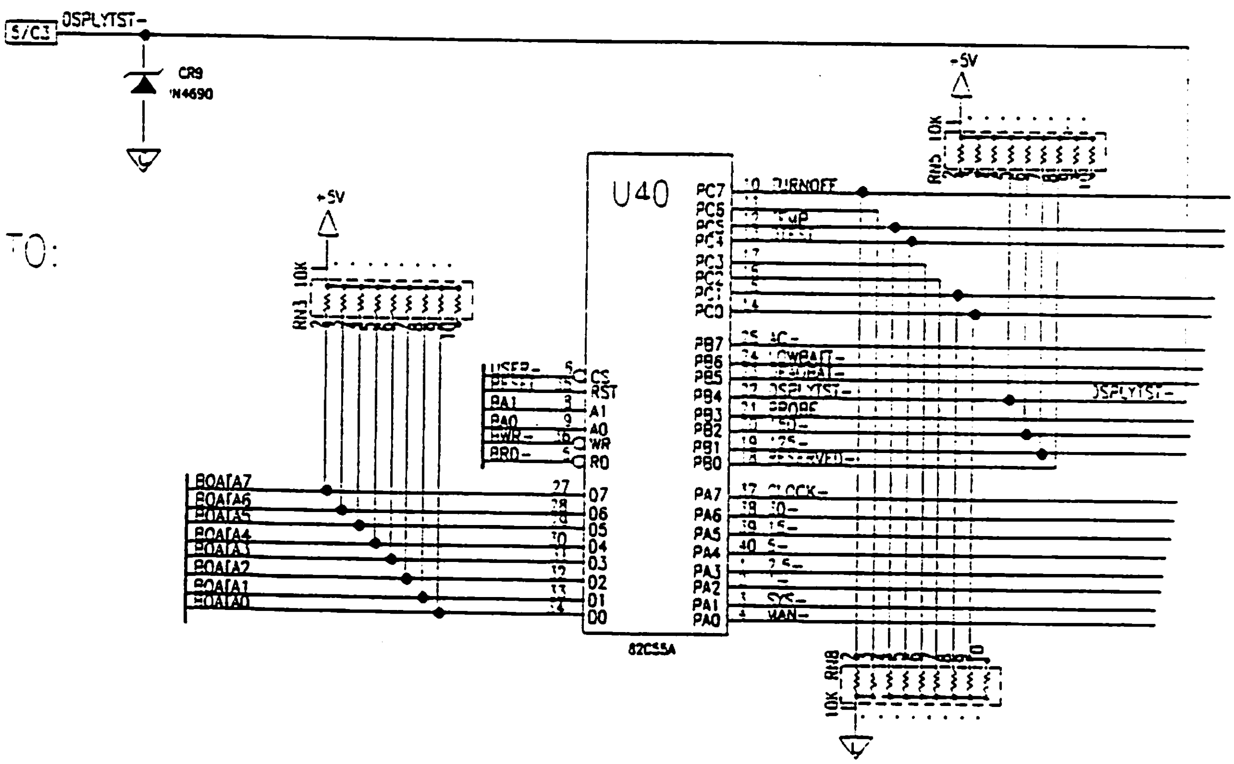

Figure 6

Schematic - CR9 Installed in C98 Location on Logic/Analog Board

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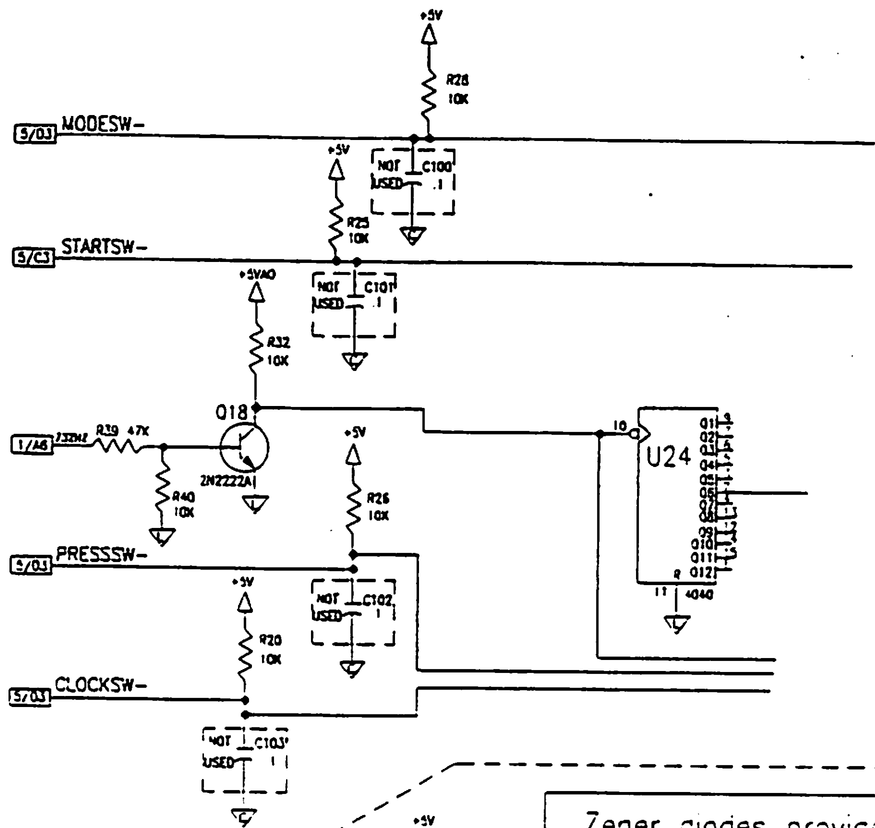


TO:

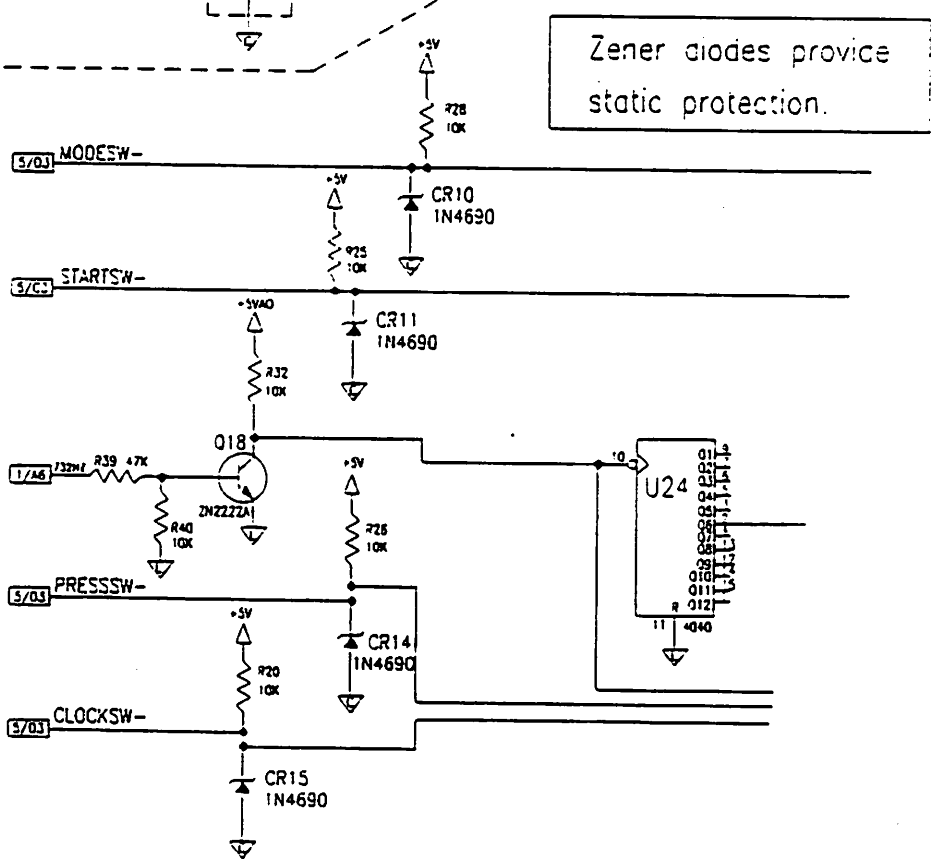


Figure 7
Schematic - Zener Diodes Installed in Unused Capacitor Locations on Logic/Analog Board

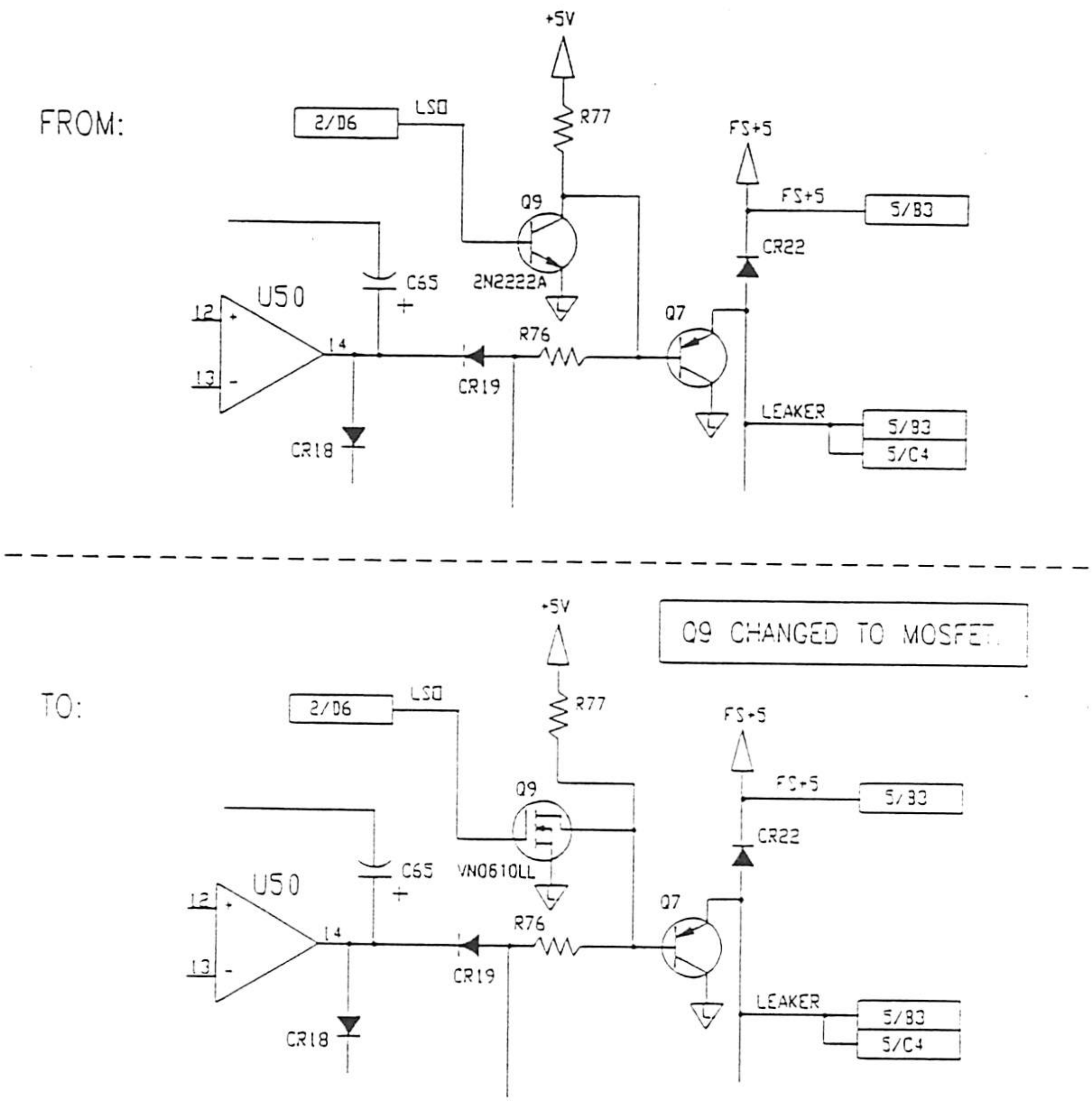


Figure 8
Schematic - Logic/Analog Q9 Changed to MOSFET

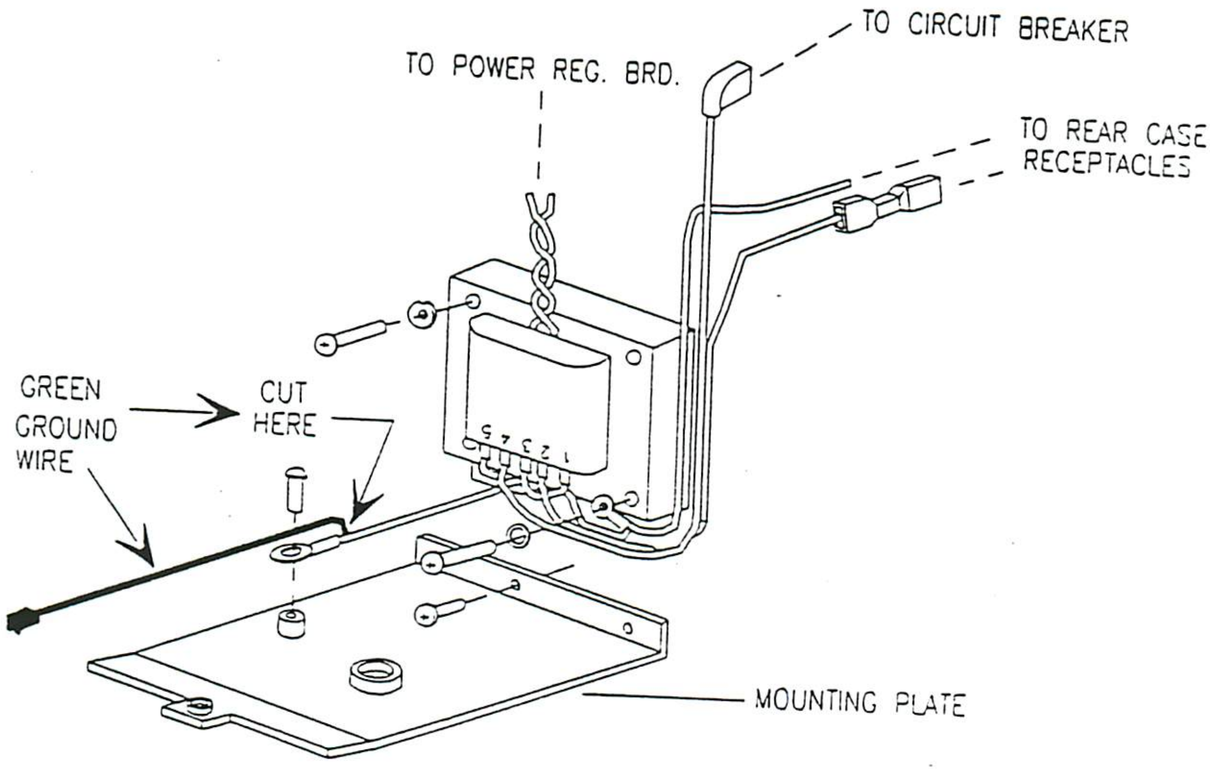


Figure 9
Ground Harness Assembly Modification

IVAC CORPORATION

SERVICE BULLETIN

MODEL(S) AFFECTED	DATE	BULLETIN NUMBER
4200	Jan 1992	289

SUBJECT: Troubleshooting Tip for Temperature Display brightness and for replacement of Q64 on Display Thermometer Board.

PROBLEM: If transistor, Q64, on the display/thermometer board is being or has been replaced, the right-most 7-segment LED, DS14, in the front panel temperature display will be dimmer in comparison to the other LED's. This is because a siliconix VN0610LL FET (PN 302422) is now used at Q64 location on the circuit board where a SD1117 FET was previously used. Q64 drives DS14, the right-most 7-segment LED. To turn on the VN0610LL FET a higher gate voltage is required than for the SD1117 FET. By removing R62 the gate voltage is increased to Q64 which in turn lights the LED appropriately. See Figure 1.

SOLUTION: 1) If troubleshooting a dim temperature display at DS14, ensure that R62 has been removed when Q64 is a VN0610LL FET.

2) If replacing a defective Q64 on the display/thermometer board with a a VN0610LL FET, clip R62's axial leads and remove. See Figure 2.

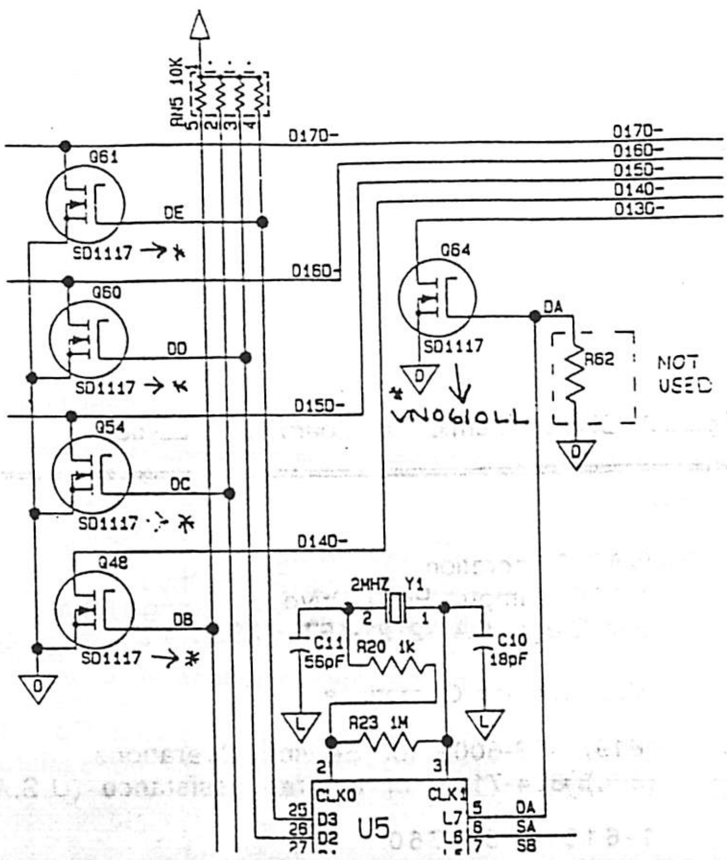


Figure 1. Display/Thermometer Partial Schematic

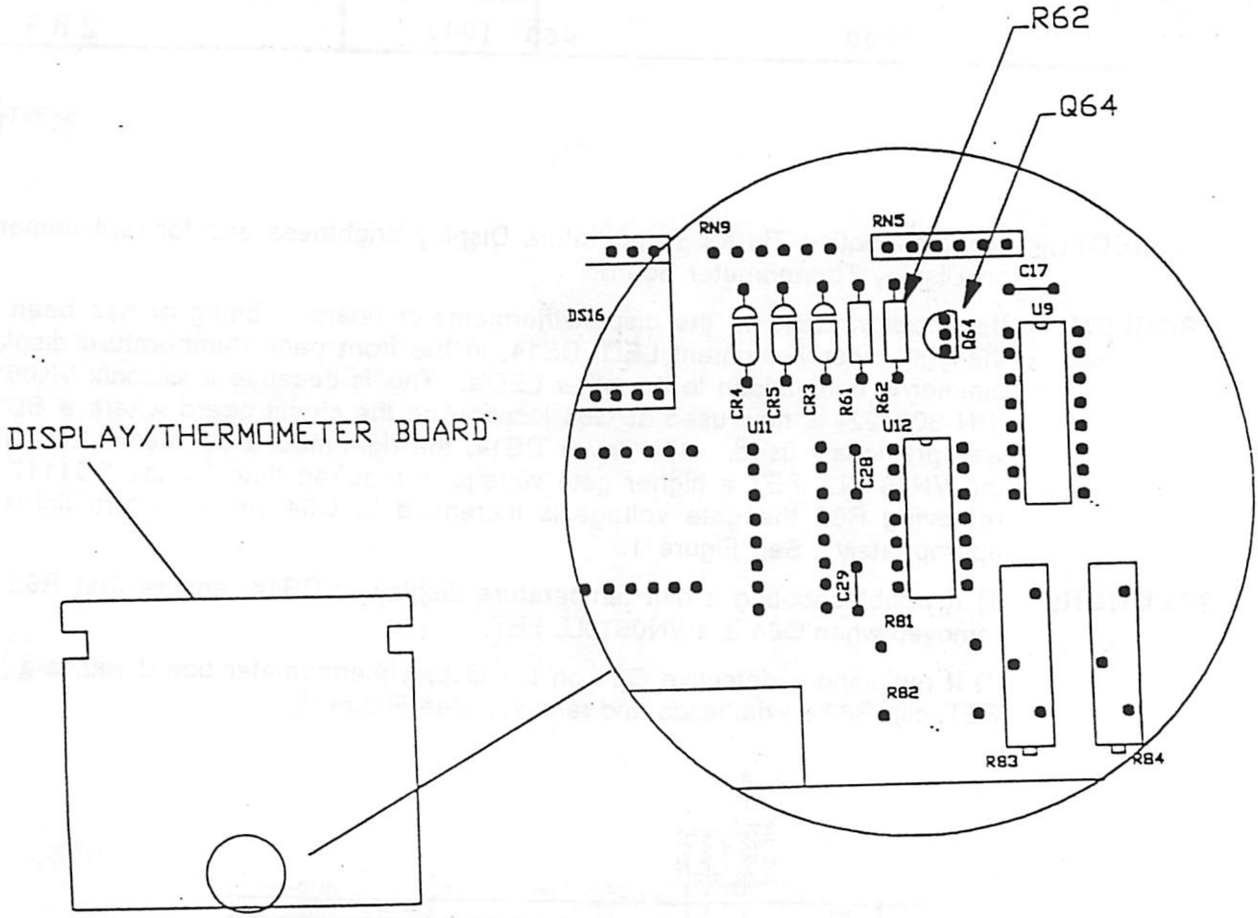


Figure 2. Display/Thermometer Board Partial Layout

TECHNICAL INQUIRIES:

Address: IVAC Corporation,
10300 Campus Point Drive
San Diego, CA 92121-1579 U.S.A.

Attn: Service Operations

Telephone: (619) 458-6003 for Service Operations
(800) 854-7128 for toll-free assistance (U.S.A. only)

FAX: 1-619-458-7760

Telex: 276061 ELI LILLY IND A (Identify IVAC San Di ... nination.)

Product Support: 1-800-854-7128
1-619-458-6003

Service Bulletin 342A *IVAC P/N 137757B*

Service Bulletins are supplements to IVAC technical service manuals.

Model(s) Affected: 4200
Date: September 7, 1993
Subject: Power Regulator Board Assembly Update

Reason or Purpose

The purpose of this bulletin is to inform customers and field service personnel of an update that has taken place on the power regulator board assembly.

Explanation

In order to ensure that the -12V supply specification (-12 ± 1 volt) is met, the tolerance value of certain resistors (R165, R166, R167, and R168) on the power regulator board has been changed from 5% to 1%. If the -12V specification is not met after performing the calibration check per Section 6.9.1 of the Model 4200 Technical Service Manual, then the board needs to be updated.

References

Refer to the Power Regulator Board Breakdown drawing in Chapter 8, Page 8-24/25 of the Model 4200 Technical Service Manual.

Parts and Equipment Required

Soldering station (static safe)

Phillips (#1) screwdriver

If the board needs to be updated, the following parts may be ordered:

> Resistor, fixed metal film, 1/4 W, 5.11K ohms, 1%, quantity (3), reference designators R165, R167, R168, P/N 300436
>
> Resistor, fixed metal film, 1/4 W, 30.1K ohms, 1%, quantity (1), reference designator R166, P/N 300517

Action

Use this bulletin to update the following sections in the Model 4200 Technical Service Manual:

> Chapter 3, Page 3-75, Figure 3-30, -12V Supply Schematic
> Chapter 4, Page 4-26/27, Figure 4-4, Power Regulator Board Schematic (Sheet 2)
> Chapter 8, Page 8-29, Item 115, 122, Illustrated Parts Breakdown

Refer to the attached partial drawings which show the changes to the -12V supply (Figure 1), the power regulator board schematic (Figure 2), and the power regulator board breakdown (Figure 3).

Technical Inquiries

For additional technical assistance, contact IVAC Service Operations.

Address:	IVAC Corporation 10300 Campus Point Drive San Diego, CA 92121-1579 U.S.A.
Attention:	Product Support
Telephone:	(619) 458-6003 (800) 854-7128 for toll-free assistance (U.S.A. only)
FAX:	1-619-458-7507

Figure 1. -12V Supply

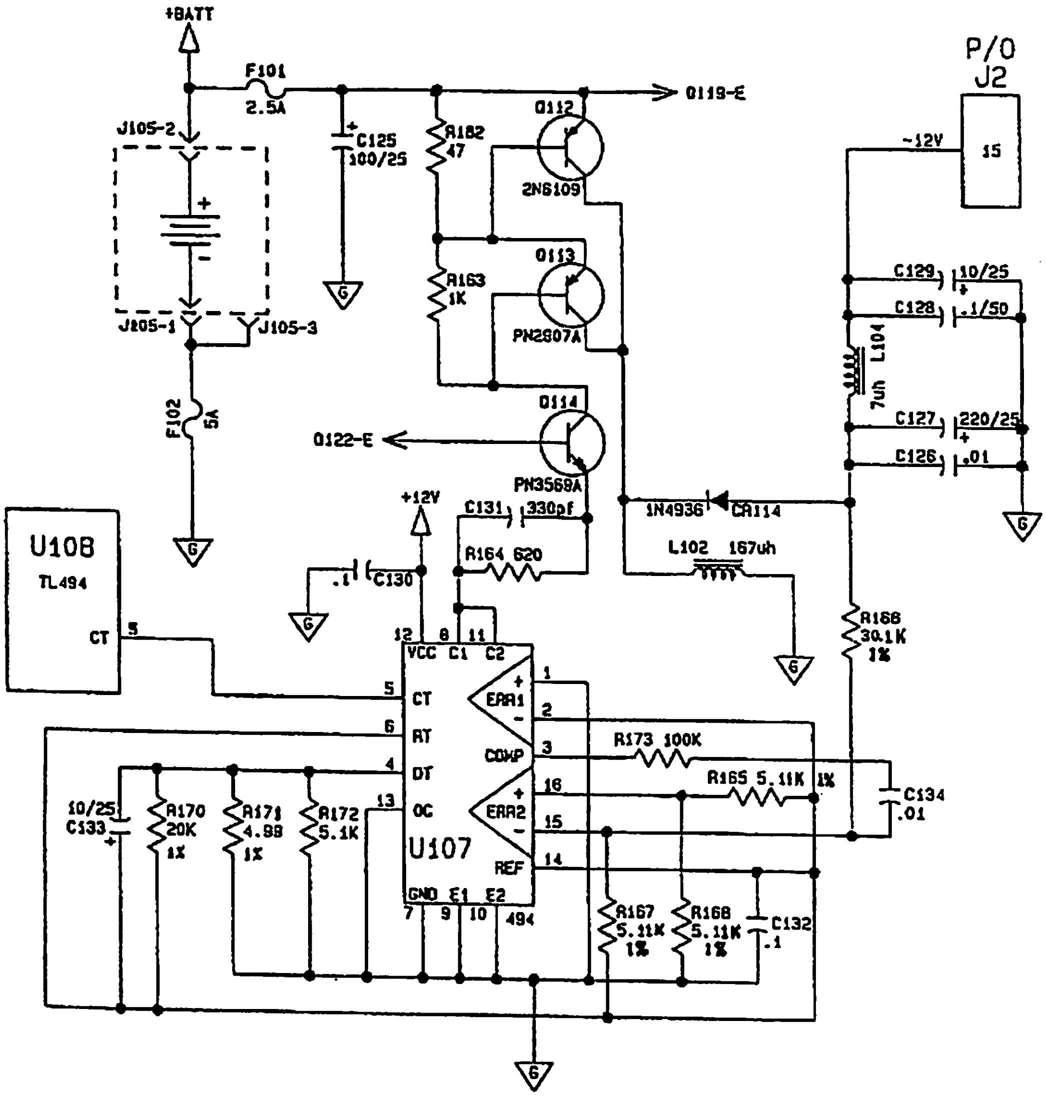


Figure 2. Power Regulator Board Schematic

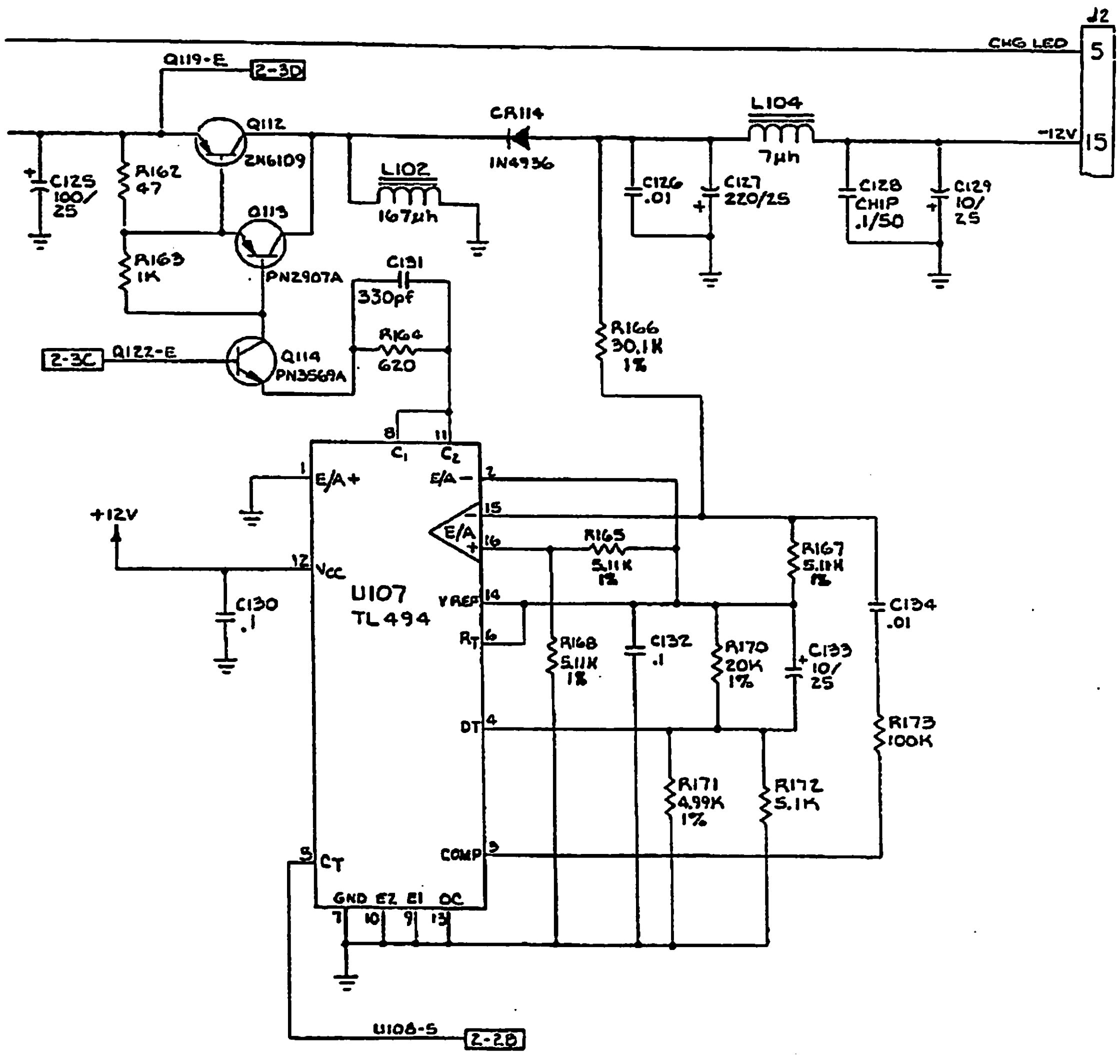
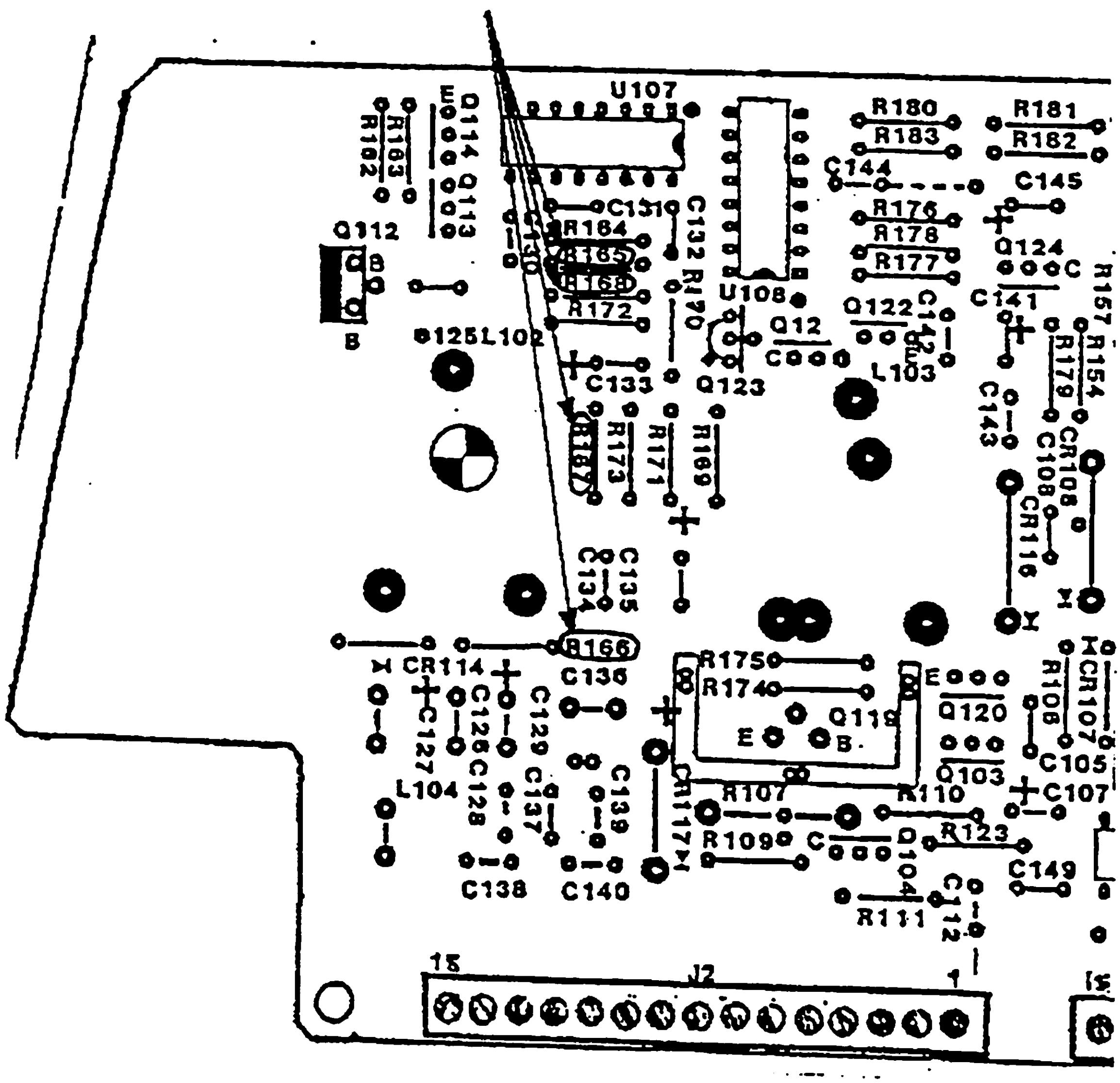


Figure 3. Power Regulator Board Breakdown



IVAC®
CORPORATION

P/N 139436A

Service Bulletin

Number 352

Service Bulletins are supplements to IVAC technical service manuals.

Model(s) Affected: 4000, 4000A, 4200
Date: March, 1994
Subject: Battery Charge Voltage Setting

Purpose

The purpose of this bulletin is to provide a procedure for updating the battery charge voltage setting from 14.1V to 14.4V for the 4000, 4000A, and 4200 Series instruments.

Explanation

IVAC Engineering, along with the battery supplier, have concluded that instruments having a battery charge setting of 14.1V may not provide a high enough charging level to prevent passivation from occurring in batteries used under low duty cycle applications. This passivation is a chemical process where a lead sulfate layer can be developed between the positive grid and active material internal to the battery. This condition can inhibit effective discharge of the active material resulting in a progressively shorter battery life. This passivation process can be reduced by increasing the battery charge level to 14.4 ±0.05V.

References

4000, 4000A, and 4200 Series Technical Service Manuals

Parts and Equipment Required

- Digital volt meter, Beckman Model 3030 or equivalent
- Trimpot adjustment tool or small, straight edge screw driver
- Harness assembly from an old battery, that would normally be disposed of, to use as a test harness
- #2 Phillips screw driver
- Torque Seal - GE Glyptl #7526F or Metron Optics P Series Marker (P1-P12), or equivalent

Recommended Action

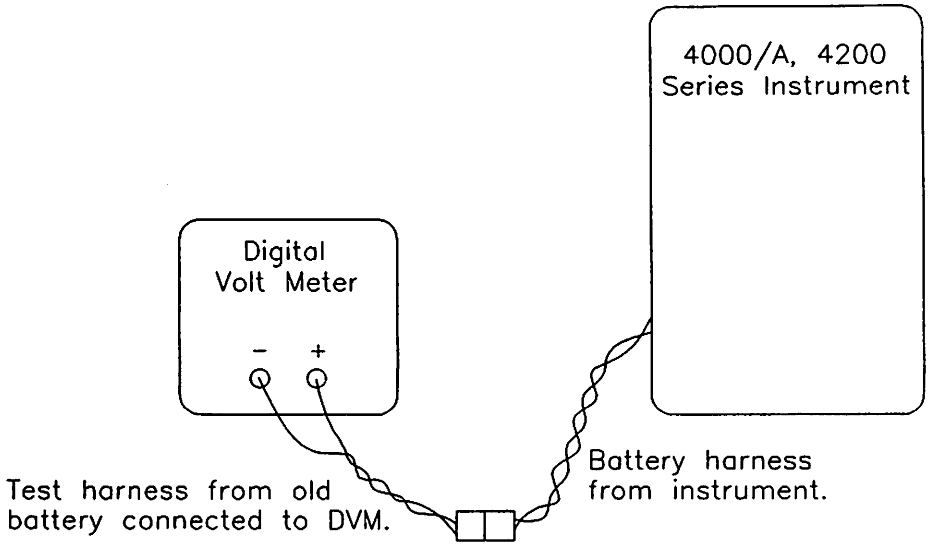
NOTE: The battery charge voltage setting noted in the most current 4000 Series and 4000A Series Technical Service Manuals is 14.4V; however, since the initial publishing of the manuals instruments have been manufactured to the 14.1V standard. These instruments can now be set to 14.4V in accordance with the following instructions.

WARNING

Disconnect the instrument from AC power before disassembling. Use extreme care when servicing an instrument that is connected to AC power. Hazardous voltages are present when AC power is connected regardless of the setting of the ON/OFF switch.

1. Disconnect the instrument from AC power.
2. Remove the battery cover. (*Refer to the Corrective Maintenance chapter of the service manual for disassembly instructions.*)
3. Disconnect the battery harness.
4. Connect the digital volt meter (DVM) to the test harness. Connect the test harness to the battery harness coming from the power regulator board. (*See Figure 1.*)
5. Set the DVM to the 20V range and connect the instrument to AC power.
6. Adjust the potentiometer, R15 (4000) or R121 (4000A and 4200), on the power regulator board until the DVM reads 14.4 ±0.05V.
7. Apply torque seal to the adjustment screw on R15 (4000) or R121 (4000A and 4200). This is done to lock the adjustment and indicate that this instrument has been adjusted to the updated charge voltage.
8. Disconnect the instrument from AC power, and disconnect the test harness.
9. Reconnect the instrument's battery harness, and reinstall the battery cover. (*Refer to the Corrective Maintenance chapter of the service manual for reassembly instructions.*)
10. All technical service manual references to a battery voltage of 14.1 can now be changed to 14.4 ±0.05V.

Figure 1 - DVM Connection



Product Support: 1-800-854-7128
1-619-458-6003

IVAC P/N 139547 A

Service Bulletin

Number 356

Service Bulletins are supplements to IVAC technical service manuals.

Model(s) Affected: 4200
Release Date: June, 1994
Subject: Power Regulator Board Assembly

Purpose

The purpose of this bulletin is to inform you of the changes to the Model 4200 power regulator board assembly (P/N 136070) and schematic.

References

Model 4200 Technical Service Manual

Action

Refer to the following information on the changes to the power regulator board and schematic when servicing the instrument.

The power regulator board and schematic has changed as follows:

1. The following "not used" locations — U105, R138, R139, R140 — were removed on the new board (refer to Figure 1 and 2).
2. The J107 jumper was removed on the new board (refer to Figure 3).
3. Pin 1 of the J105 jumper (battery extension harness) was made a "no connect" pin to prevent nuisance fuse blows of F102 caused by connecting J105 one pin off (refer to Figure 3).
4. Resistors R161 and R158 were laid down on the new board (refer to Figure 1).
5. A plastic rivet (Item 159, P/N 302707) was added to secure Q112 to the circuit board and to prevent lead breakage of Q112 (refer to Figure 1).

The following notes apply to the board assembly. Refer to Figure 1.

1. Component leads should not exceed more than 0.175 of an inch from the bottom side of the board.
2. The static-sensitive assembly or part must be handled at a grounded work station by grounded personnel.

3. Install the cable tie (Item 148) through the board and around the cap (Item 44). Position the cable tie so that the connection of the cable ends are on the inboard side of the cap and on the component side of the board.
4. Apply silicone between the transistors and the heatsinks (Item 147), prior to the installation of the fasteners (Items 152, 153).

Technical Inquiries

For additional technical assistance, contact IVAC Service Operations.

Attention: Technical Support

Telephone: (619) 458-6003
(800) 854-7128 for toll-free assistance (U.S.A. only)

FAX: 1-619-458-7507

Mail: P.O. Box 85335
San Diego, CA 92186-5335 U.S.A.

Figure 1. Top side of Power Regulator Board Assembly

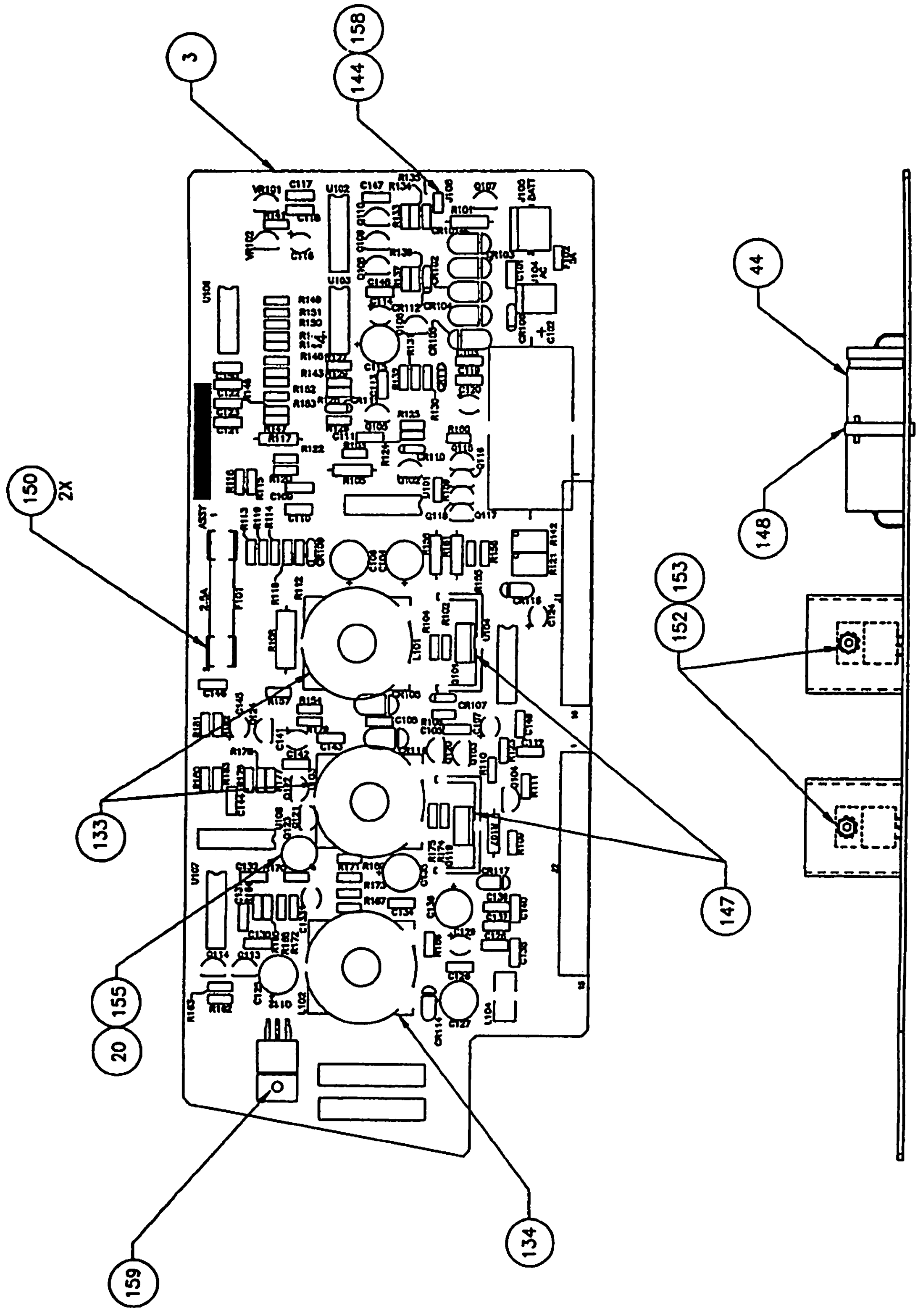
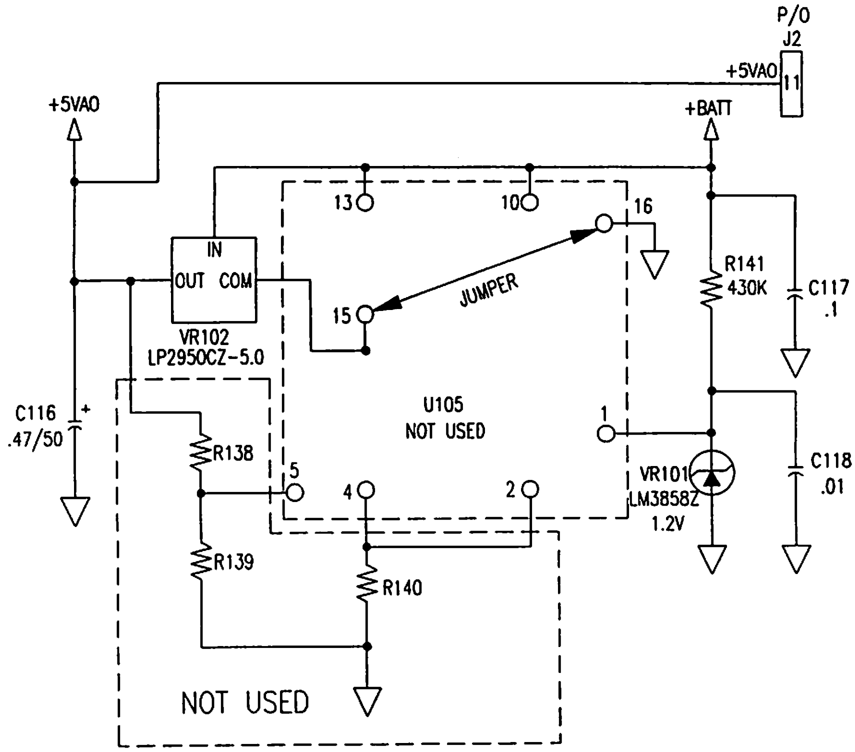


Figure 2. References Removed

FROM:



TO:

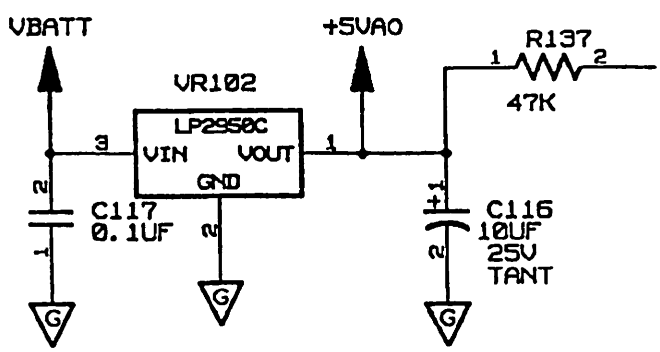
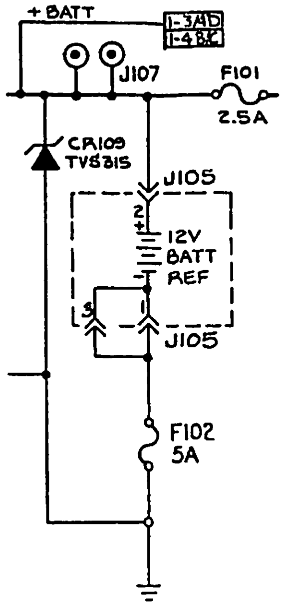


Figure 3. "No Connect" Circuitry

FROM:



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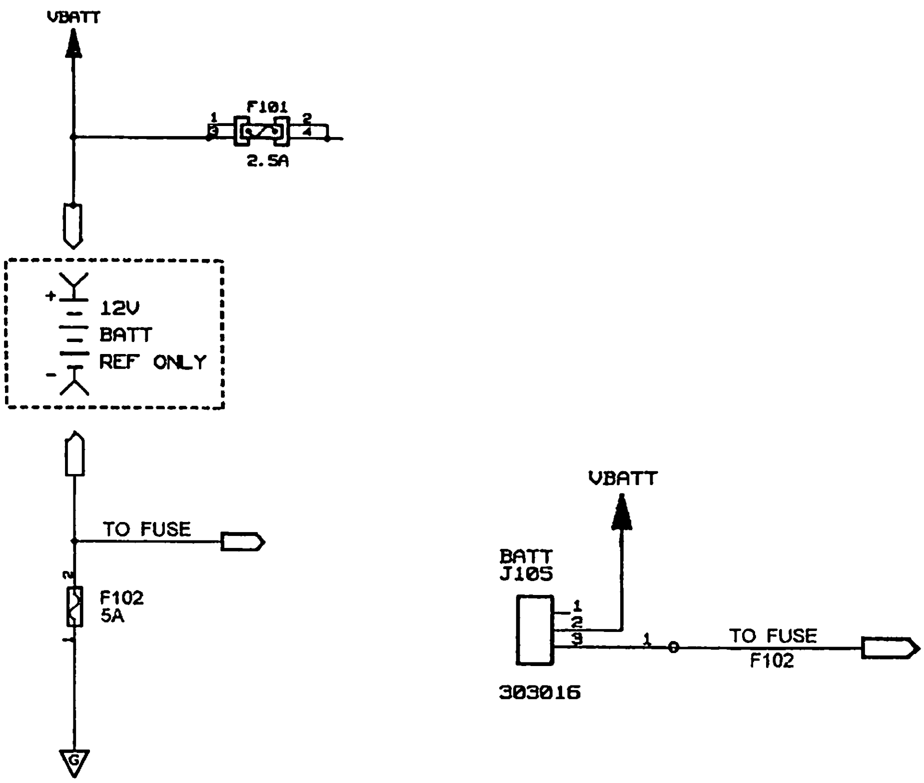


IVAC®
CORPORATION

P/N 139963 A

Service Bulletin

Number 367

Service Bulletins are supplements to IVAC technical service manuals.

Model(s) Affected: 1042
Date: August, 1994
Subject: Instrument Stand Assembly Update

Purpose

The purpose of this bulletin is to provide information on a change to the Model 1042 instrument stand assembly.

Explanation

The lock nut (Item 016) on the bottom of the threaded rod (Item 004) of the instrument stand can vibrate loose and fall off, thus causing the stand to become unstable and possibly tip over. The addition of a jam nut to the bottom of the threaded rod on the stand assembly, below the lock nut, can ensure a secure hold and increase the stability of the stand.

References

Model 4200 Technical Service Manual, P/N 132376

Model 1042 Instrument Stand Setup Procedure, P/N 132174

Parts/Materials/Equipment Required

- Jam nut, 1/4 X 20 Hex, P/N 303725
- Wrench, 6" crescent, or equivalent

Recommended Action

1. Update pages 8-50 and 8-53 in the technical service manual with the attached sheets.
2. Install the jam nut (Item 010) as necessary onto the threaded rod of any unstable stands and tighten it securely against the lock nut. Refer to the Model 1042 Instrument Stand Setup Procedure (Item 013).

IVAC Corporation, 10300 Campus Point Drive, San Diego, CA 92121-1579 U.S.A.
Parts Ordering: Refer to Illustrated Parts Breakdown chapter of the Technical Service Manual
Parts Inquiries: 1-800-854-7128, 1-619-458-6005
Technical Inquiries: 1-800-854-7128, 1-619-458-6003, FAX 1-619-458-7507

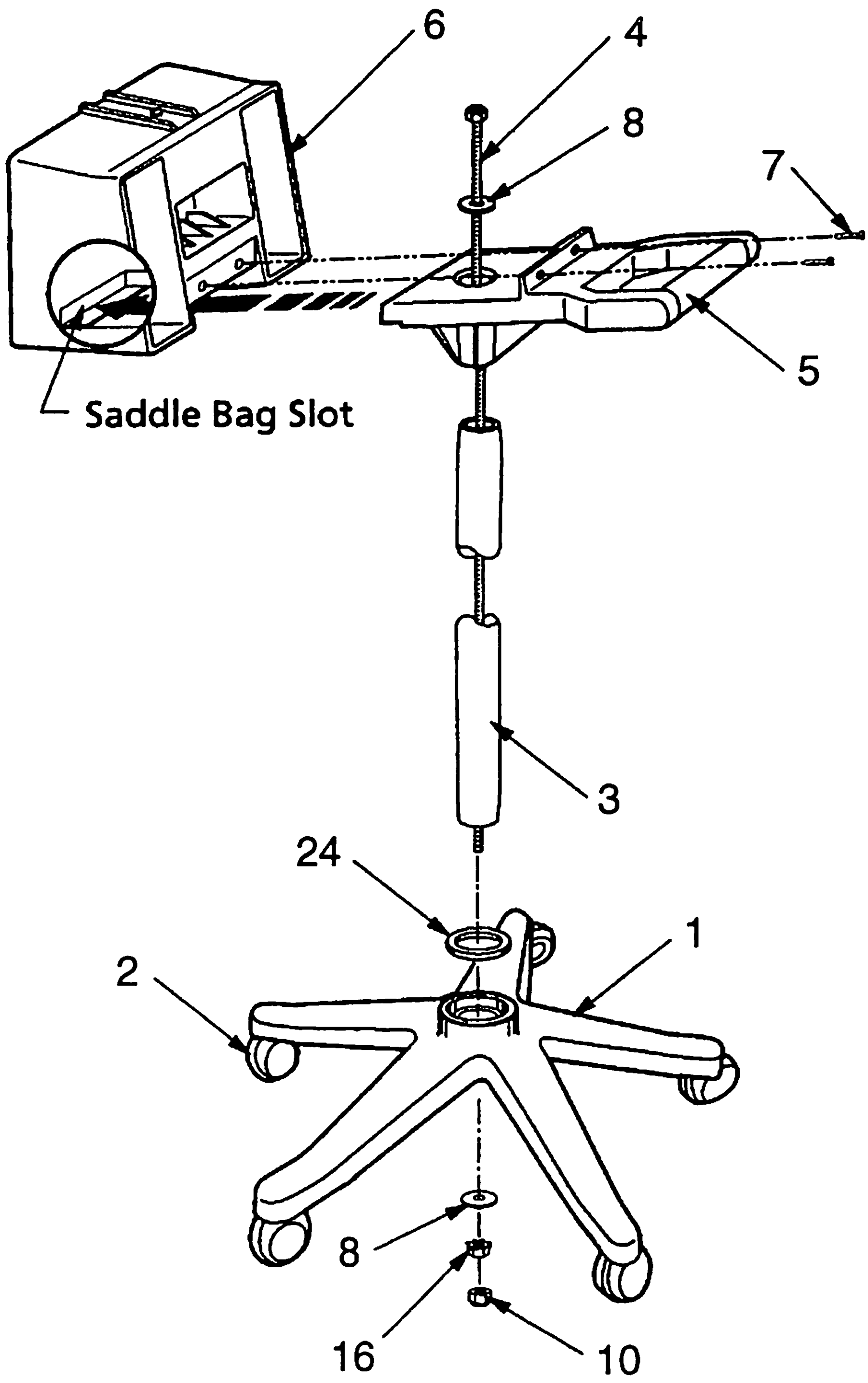


Figure 8-18A. Model 1042 Instrument Stand Final Assembly

1042 INSTRUMENT STAND

ITEM	PART NUMBER	DESCRIPTION	QTY	ISS UOM	REF DES
001	303854	BASE, CHAIR, 22", W/O CASTERS	1	EA	
002	303853	CASTER, 3" WHEEL, RUBBER TREAD	5	EA	
003	303858	POLE, STL, 16 GA, 1.75" DIA	1	EA	
004	130852	ROD, PED POLE, 1042	1	EA	
005	130847	HANDLE, 1042	1	EA	
006	131039	ASSY, SADDLEBAGS, 1042	1	EA	
007	303925	SCREW, 1/4-20 X 5/8, BTHD CAP	2	EA	
008	303883	WSHR, 1/4 X 1.5 X 0.63	2	EA	
010	303725	JAM NUT, 1/4" X 20 HEX	1	EA	
011	130850	PL, COVER, REAR (Part of Item 006)	2	EA	
012	303823	SCREW, 4-20 X 5/8 (Part of Item 006)	8	EA	
013	132174	INSTC, SETUP, 1042	1	EA	
014	303253	WRENCH, HEX 5/32 ACR FL	1	EA	
016	300824	NUT, KEP, 1/4-20 S PL	2	EA	
017	303894	WRENCH, COMBO, 7/16", 3-5" LONG	1	EA	
021	126527	STUD, POLE ADAPTER	1	EA	
022	303839	KNOB, FLUTED, BLK, 1-3/4 DIA	1	EA	
023	*	ADHESIVE, THREAD, LOCTITE 271 (Part of Item 006)		AR	
024	303852	TETRASEAL	1	EA	
025	303923	WASHER	2	EA	
701	132543	BOX, SHPG, 1042	1	EA	
702	132544	INS, PKG, BASE, 1042 (Replaces Items 703, 707, 708)	1	EA	
709	132545	SHPG BOX LINER	1	EA	
710	132546	BOX, CASTERS AND TOOLS	1	EA	

* Part not available for sale

Service Bulletin

Number 368

Service Bulletins are supplements to IVAC technical service manuals.

Model(s) Affected: 4000, 4000A, 4200
Date: September, 1994
Subject: Leakage Current Specification Change

Purpose

The purpose of this bulletin is to provide information on a change to the leakage current specification referenced in the service manuals. This will help eliminate unnecessary instrument returns or calls for service.

Explanation

The leakage current specification stated in the electrical safety tests (15 microamps maximum) does not conform to the current U.L. 544 specification. As a result, some functional Vital•Check units are being returned to IVAC because they do not meet the 15 microamp specification.

References

Model 4000 Technical Service Manual, Section 5-9-1

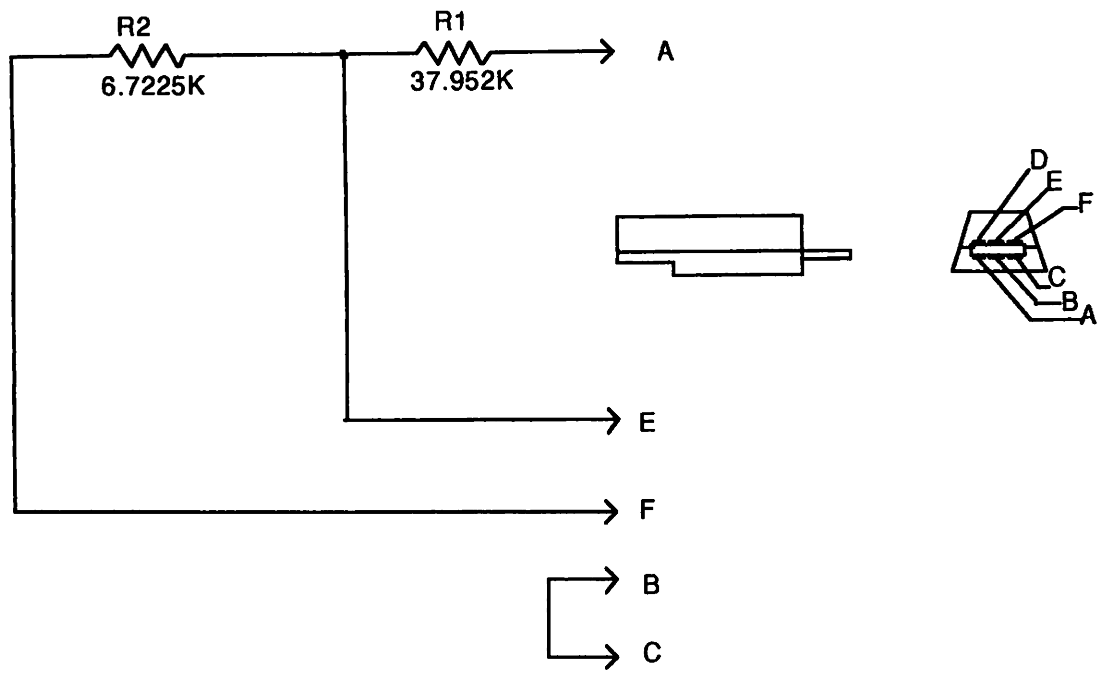
Model 4000A Technical Service Manual, Section 5.11.1

Model 4200 Technical Service Manual, Section 6.11.1

Recommended Action

Change the leakage current specification to **less than 100** microamps, so that it will conform to the current U.L.544 and IVAC in-house specification for the ground current leakage test on the Model 4000, 4000A, and 4200 instruments.

Figure 4. Wiring Diagram for Model 828A Tester



Model 828A Tester Parts List

Here is a list providing descriptions of replaceable parts used on the probe simulator. Use this list in conjunction with Figure 4.

ITEM	PART NO. REF	DESCRIPTION	QTY	
001	303951	RESISTOR 37.952K, 0.01%, 0.1W	1	R1
002	301776	RESISTOR, 6.7225K, 0.01%. 0.1W	1	R2

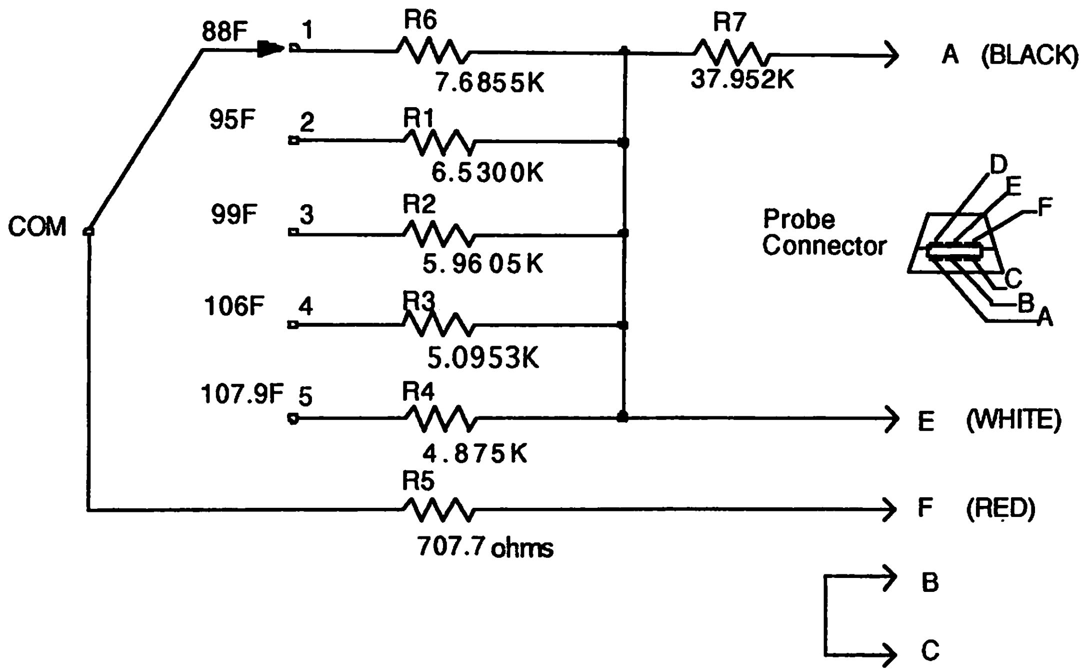
2.0 Technical Assistance

Address: IVAC Corporation
10300 Campus Point Drive
San Diego, California 92121-1579 U.S.A.
Attn.: Technical Support

Telephone:(619) 458-6003 for Service Operations
(800) 854-7128 for toll-free assistance (U.S.A.only)

FAX: 1-619-458-7507

Figure 3. Wiring diagram for Probe Simulator.



1.4 Calibration Verification of Model 828A Tester

The 828A Tester can be used as an alternate method to check calibration on the Model 2000, 4000, 4000A and 4200 instruments. The specifications are 98.6° ± 0.2°F or 37.0° ± 0.1°C.

IVAC does *not* provide calibration service or repairs for the Model 828A Tester. Calibration of the tester needs to be verified at least once a year. The following is the procedure to verify calibration of the Model 828A Tester.

1. Set multimeter to K ohms, Range 200.
2. Measuring from pin A to pin E of the tester probe connector (see Figure 4), verify the reading is 37.944K to 37.960K ohms.
3. Set multimeter to K ohms, Range 20.
4. Measuring from pin E to pin F of the tester probe connector (see Figure 4), verify the reading is 6.721K to 6.724K ohms.
5. If the measured values do not fall within the specified ranges, then the tester does not pass the calibration verification. Replace the related resistor and verify calibration again. See Figure 4 for wiring diagram of the Model 828A Tester.

1.3 Calibration Verification Of Probe Simulator

IVAC does *not* provide calibration service or repairs for the probe simulator fixture. Calibration of the probe simulator needs to be verified at least once a year. The following is the procedure to verify calibration of the probe simulator.

1. Set multimeter to K ohms, Range 200.
2. Measuring from pin A to pin E of the probe simulator's probe connector (see Figure 3), verify the reading is 37.944K to 37.960K ohms.
3. Set multimeter to K ohms, Range 20.
4. Measuring from pin E to pin F of the probe simulator's probe connector (see Figure 3), verify the following readings:

Simulator Setting	Multimeter Reading
88	8.391K to 8.395K
95	7.236K to 7.240K
99	6.666K to 6.670K
106	5.801K to 5.805K
107.9	5.581K to 5.584K

3. If the measured values do not fall within the specified ranges, then the probe simulator does not pass the calibration verification. Replace the related resistor and verify calibration again. See Figure 3 for wiring diagram of probe simulator.

Probe Simulator Parts List

Here is a list providing descriptions of replaceable parts used on the probe simulator. Use this list in conjunction with Figure 3.

ITEM	PART NO. REF	DESCRIPTION	QTY	
001	*	SWITCH, ROTARY, 1 POLE-12 POSITION C&K A112-03-R-S-Z-G	1	
002	303953	RESISTOR, 6.530K, 0.01%. 0.05W	1	R1
003	303956	RESISTOR, 5.9605K, 0.01% 0.05W	1	R2
004	303950	RESISTOR, 5.0953K, 0.01%, 0.05W	1	R3
005	303954	RESISTOR, 4.875K, 0.01%, 0.05W	1	R4
006	303955	RESISTOR, 707.7Ω, 0.01%, 0.05W	1	R5
007	303952	RESISTOR, 7.6855K, 0.01%, 0.05W	1	R6
008	303951	RESISTOR, 37.952K, 0.01%, 0.05W	1	R7

* Parts not available separately

NOTE: Other readings can be checked at operator's discretion by setting the probe simulator to the desired setting. Verify thermometer readings using the table below:

Simulator Setting	Thermometer Reading
88	000d ±1
95	349d ±2
99	549d ±2
106	900d ±1
107.9	999d ±2 (see following note)

NOTE: The thermometer can only display a maximum of 999d in its calibration mode. The thermometer will display an overrange condition if the calibration number is above 999d (see Figure 2). An overrange condition at a probe simulator setting of 107.9 should not be considered a failure if the thermometer is within specifications at the other settings.

9. Calibration is complete. Remove probe simulator connector from the instrument and reassemble the instrument as needed.

   Model 2000: Refer to assembly steps l through p in Section 6-5-1 of its service manual.

   Model 4000, 4000A or 4200: Refer to the corrective maintenance chapter in the service manual of the instrument under test.

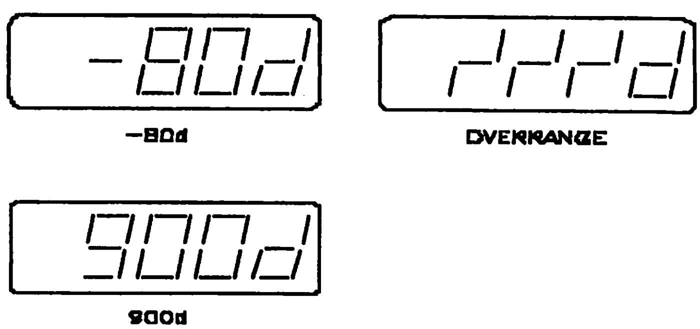
10. Set the predictive (normal) mode of operation, if desired.

    Models 2000, 4000 and 4000A: Set the P/M switch to P. Install the probe onto the instrument.

    Model 4200: Set the Normal/Monitor switch to Normal . Install the probe onto the instrument.

11. Return the thermometer to standard operation: turn the thermometer off and then on. It will come on in the chosen mode.

Figure 2. *Examples of Thermometer Display in Calibration Mode.*



3. Instrument preparation after disassembly:

   Model 4000, 4000A or 4200: Reconnect the instrument to AC power. Verify that the charge indicator illuminates. Press the ON/OFF switch to turn the instrument on. Set the MODE switch to MAN (manual).

   Models 2000, 4000 and 4000A: Set the P/M switch to M (monitor mode).

   Model 4200: Set the Normal/Monitor switch to Monitor.

4. Set the probe simulator to 88.

5. Place thermometer (section of the instrument) into the calibration mode.

   Model 2000: Press and hold the PULSE button while connecting the probe simulator to the thermometer. The thermometer will show all 8's. After releasing the PULSE button, the thermometer will display a readout of two or three digits followed by a "d". (See Figure 2, for examples.) This indicates the thermometer is in the calibration mode.

   NOTE: If the thermometer does not turn on, insert the probe into the thermometer's probe well and then remove the probe. Unplug the probe simulator and repeat the above procedure to put the instrument into calibration mode.

   Model 4000, 4000A, 4200: Press and hold the DISPLAY TEST switch while connecting the probe simulator to the instrument. The instrument will show all 8's in the thermometer display. After releasing the DISPLAY TEST switch, the thermometer will display a read out of two or three digits followed by a "d". (See Figure 2 for examples.) This indicates the instrument is in the calibration mode.

   NOTE: If the thermometer does not turn on, insert the probe into the thermometer's probe well and then remove the probe. Unplug the probe simulator and repeat the above procedure beginning at: Press and hold the DISPLAY TEST.

6. Zero potentiometer adjust.

   Models 2000, 4000 and 4000A: R28 on thermometer board

   Model 4200: R84 on display/thermometer bd.

   Verify that the display reads 000d (±1) with the probe simulator set at 88. If not, adjust the zero potentiometer until the display reads 000d (±1). Ensure that the reading has stabilized before going to the next step.

7. Span potentiometer adjust.

   Models 2000, 4000 and 4000A: R29 on thermometer board

   Model 4200: R83 on display/thermometer board.

   Set the probe simulator to 106, and verify the thermometer display reads 900d (±1). If not, adjust the span potentiometer until the display reads 900d (±1). Ensure the reading is stable before going to the next step.

8. Verify the accuracy of adjustments made to the zero and span potentiometers by repeating steps 6 and 7.

1.2 Thermometer Calibration Using Probe Simulator

Calibration is necessary whenever the analog portion of the thermometer board in the instrument (see note below) is modified or repaired, or if the thermometer fails calibration verification.

NOTE: The VITAL•CHECK® monitor Models 4000 and 4000A contain a thermometer board similar to the Model 2000 thermometer board. The analog portion of this board is U3, U5, R15-R29, VR2, and C8.

NOTE: The VITAL•CHECK® monitor Model 4200 has equivalent circuitry on its display/thermometer board. The analog portion of this board is U6, U7, R54, R55, R68-R72, R83, R84, U13, and C22.

1. Disconnect and remove the thermometer's probe from the instrument under test.
2. Gain access to the thermometer's zero and span potentiometers.

   Model 2000: To access the thermometer board and potentiometers, it is necessary to disassemble the instrument. Refer to disassembly instructions in the Model 2000 Service Manual, Chapter 6, steps 6-3-1a to d.

   Models 4000 and 4000A: To access the thermometer board potentiometers, it is necessary to disassemble the instrument. Refer to the corrective maintenance chapter in the service manual of the instrument under test for complete instructions. Basic instructions are:

   a. Disconnect the instrument from AC power.

   b. Remove the outer cover.

   c. Remove the screws on the back of the logic board.

   d. Pivot the logic board away from the rear panel.

   Model 4200: To access the display/thermometer board potentiometers, place adjustment tool through the slots in the bottom of the instrument.

   Refer to the table below for figures showing the locations of the zero and span potentiometers.

Service Manual	Circuit	Potentiometers: Zero/Span	See Figure
2000	Thermometer Bd.	R28, R29	Figure 7-2
4000	Thermometer Bd.	R28, R29	Figure 6-23
4000A	Thermometer Bd.	R28, R29	Figure 6-13
4200	Display/ Thermometer Bd.	R84, R83	Figure 6-6

Simulator Setting	Thermometer Reading	
88	88.0 ± 0.2 F (31.1 ± 0.1 C)	See note 1.
95	95.0 ± 0.2 F (35.0 ± 0.1 C)	
99	99.0 ± 0.2 F (37.2 ± 0.1 C)	
106	106.0 ± 0.2 F (41.1 ± 0.1 C)	
107.9	107.9 ± 0.2 F (42.1 ± 0.1 C)	See note 2.

NOTE 1: At a probe simulator setting of 88, the thermometer may display an "L" rather than an "F" or a "C", since this is the low end of the temperature scale.

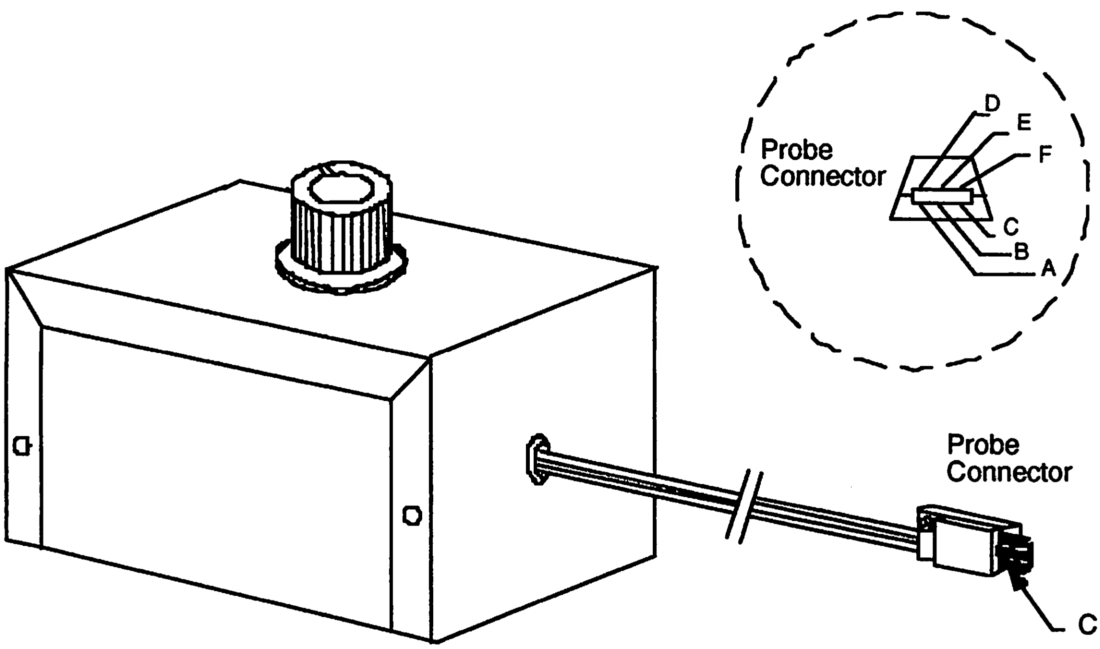
NOTE 2: The thermometer can display an Err H alarm at a probe simulator setting of 107.9. An Err H alarm at a setting of 107.9 should not be considered a failure if the thermometer is within specifications at the other settings (overrange indicator in Figure 2).

6. Calibration verification is complete. Disconnect the probe simulator and install the probe into the instrument. If the instrument does not pass the calibration verification, then the instrument needs to be calibrated or repaired.
7. Return to predictive mode, if desired.

   Models 2000, 4000 and 4000A: Return the P/M switch to P.

   Model 4200: Return the Normal/Monitor switch to Normal.

Figure 1. Probe Simulator



1.1 Calibration Verification of Thermometer Using Probe Simulator

Calibration of the Model 2000 thermometer or the thermometer section of the Models 4000, 4000A and 4200 needs to be verified whenever the instrument is repaired or once every six months as part of the Preventive Maintenance procedure.

1. Disconnect and remove the thermometer's probe from the instrument under test.
2. Instrument preparation:

   Models 4000, 4000A and 4200: Connect the instrument to AC power. Verify that the charge indicator illuminates. Press the ON/OFF switch to turn the instrument on. Set the MODE switch to MAN.

   Models 2000, 4000 and 4000A: Set the P/M switch to M (monitor mode).

   Model 4200: Set the Normal/Monitor switch to Monitor.
3. Set the probe simulator to 88.
4. Connect the probe simulator to the instrument.

   NOTE: If the thermometer does not turn on, insert the probe into the thermometer's probe well and then remove probe.
5. Verify thermometer readings using the following table.

1.0 Procedures

Supplement the above referenced technical service manuals with the following information. Specifically:

- Model 2000; Chapter 6, Section 6-6-1 for thermometer calibration and Section 6-6-2-4 for calibration verification alternate procedure.
- Model 4000; Chapter 5, Section 5-6-2 for thermometer calibration and Section 5-7-2 for calibration verification alternate procedure.
- Model 4000A; Chapter 5, Section 5.9.9.2 for thermometer calibration and Section 5.10.2 for calibration verification alternate procedure.
- Model 4200; Chapter 6, Section 6.9.9.2 for thermometer calibration and Section 6.10.2 for calibration verification alternate procedure.

NOTES

- Calibration verification of the Model 2000 thermometer or the thermometer portion of the Models 4000, 4000A and 4200 is necessary:
  - Whenever the instrument is repaired.
  - Once every six months as part of the Preventive Maintenance procedure.
- Calibration of the thermometers is necessary:
  - Whenever the analog portion of the thermometer board in the instrument is repaired or modified.
  - When the thermometer fails calibration verification.
- Calibration verification of the probe simulator fixture is necessary once a year as part of the Preventive Maintenance procedure. This test must be performed by your facility. Do not return probe simulator to IVAC for calibration verification or repair. (Warranty on probe simulator is 90 days.)
- For the Model 2000 thermometer, add the following information under Section 6.6 of the technical service manual.

  Preventive Maintenance should be performed every six months. This includes a visual inspection and functional check (section 3.2) as well as calibration verification using either the probe simulator (P/N 191815), calibration tester (828A) or a water bath.

Service Bulletin

Number 269C

Service Bulletins are supplements to IVAC technical service manuals.

Model(s) Affected: 2000, 4000, 4000A, 4200 (Thermometer and Blood Pressure Monitors)
Release Date: March, 1995
Subjects: Probe Simulator Fixture (P/N 191815)
Calibration Verification of Probe Simulator
Calibration Verification of Model 828A Tester.

Purpose

This service bulletin supersedes Service Bulletin 269B. The purpose of this bulletin is to update the calibration verification procedure for the Model 828A Tester to correct an error in the specification. This bulletin also clarifies the Model 2000 Preventive Maintenance procedure.

Explanation

A probe simulator fixture is available for field use to calibrate and verify calibration of the TEMP•PLUS® Model 2000 thermometer, and (thermometer portions of) the VITAL•CHECK® monitor Models 4000, 4000A and 4200. (The probe simulator is an alternate method of verifying calibration in place of the Model 828A tester.)

Calibration verification of the probe simulator in Service Bulletin 269A has been changed to provide the correct resistors' multimeter reading tolerances. This will alow you to check the probe simulator once a year as part of the Preventive Maintenance procedure.

A procedure to verify calibration of the Model 828A Tester has not previously been provided, but is now provided in this bulletin.

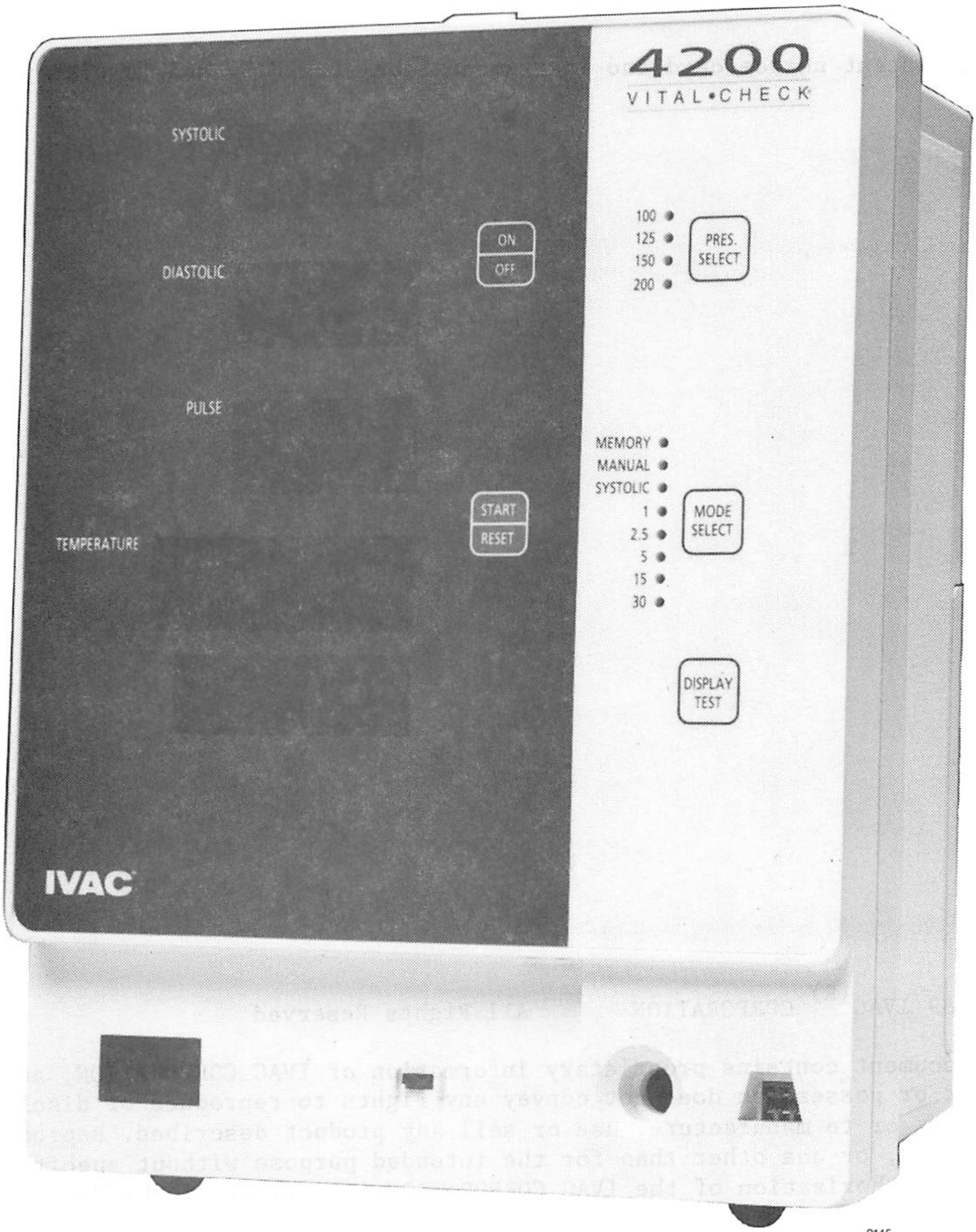
References

- Model 2000 Technical Service Manual
- Model 4000 Technical Service Manual
- Model 4000A Technical Service Manual
- Model 4200 Technical Service Manual

Parts and Equipment Required

- IVAC Probe Simulator (P/N 191815)
- FLUKE Multimeter Model 8800A or equivalent 5 1/2 digit meter.

Date of Issue: July: 1989



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Service Manual

IVAC(R) VITAL•CHECK(R) Vital Signs
Measurement System - Model 4200

PATENT INFORMATION

See patent notice card and instrument label for U.S. and foreign patents.

This service manual is subject to change without notification. For current technical information please call (800) 854-7128 ext. 10, or write IVAC Corporation, 10300 Campus Point Drive, San Diego, CA 92121-1579.

131523A

Printed in U.S.A.

REVISION/CHANGE RECORD PAGE

Date	Revision	By	Description
7/89	A	Pm	Original Issue

VITAL SIGNS MEASUREMENT SYSTEMS LIMITED WARRANTY

IVAC Corporation ("IVAC") warrants that:

a. Each new IVAC(R) instrument (e.g., thermometer including charger base, VITAL•CHECK(R)), including non-disposable probes which accompany the new instrument at the time of purchase, is free from defects in material and workmanship under normal use and service for a period of one year from the date of delivery by IVAC to the first purchaser.

b. Each new accessory purchased separately (e.g., non-disposable probes) and those accompanying a new instrument (e.g., cuffs) are free from defects in material and workmanship under normal use and service for a period of ninety (90) days from the date of delivery by IVAC to the first purchaser.

If any product requires service during the applicable warranty period, the purchaser should communicate directly with the IVAC home office (San Diego, California) to determine appropriate repair facility. Repair or replacement will be carried out at IVAC's expense, subject to the terms of this warranty. The product requiring service should be returned promptly, properly packaged and postage prepaid. Loss or damage in return shipment to IVAC shall be at purchaser's risk.

In no event shall IVAC be liable for any incidental, indirect or consequential damages in connection with the purchase or use of any IVAC product. This warranty shall not apply to, and IVAC shall not be responsible for, any loss arising in connection with the purchase or use of any IVAC product which has been repaired by anyone other than an authorized IVAC service representative or altered in any way so as, in IVAC's judgement, to affect its stability or reliability, or which has been subject to misuse or negligence or accident, or which has had the serial or lot number altered, effaced or removed, or which has been used otherwise than in accordance with the instructions furnished by IVAC. This warranty is in lieu of all other warranties, express or implied, and of all other obligations of liabilities on IVAC's part, and IVAC neither assumes nor authorizes any representative or other person to assume for it any other liability in connection with the sale of IVAC products.

IVAC DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE OR APPLICATION.

See packing inserts for international warranty, if applicable.

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CHAPTER SEVEN - PERIODIC INSPECTIONS

CHAPTER EIGHT - ILLUSTRATED PARTS BREAKDOWN

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LIST OF TABLES

CHAPTER ONE - GENERAL INFORMATION

1.0 INTRODUCTION

This publication represents the original issue of the service manual for the IVAC VITAL•CHECK[R] Vital Signs Measurement System - Model 4200. (See figure 1-1.) This section contains information for use in maintaining and servicing the instrument and is written for personnel experienced in analyzing, troubleshooting, and repairing analog and digital microprocessor-based electronic equipment.

NOTE: Model 4200C instruments are compatible with the IVAC Computer Interface Module (CIM). For instructions on using the Model 4200C instrument equipped with CIM, refer to the CIM II Directions For Use.

1.1 FEATURES

This is a microprocessor-based electronic instrument specifically designed to measure and display a patient's systolic and diastolic blood pressures (BP), pulse rate, and temperature.

Among the many features of the instrument are:

- LED readouts for digitally displaying the systolic and diastolic BP, pulse rate, and temperature.
- BP determined by: auscultation (primary method) or oscillometry (secondary method).
- Selection of four different initial cuff inflation pressures (100, 125, 150, and 200 mmHg).
- Automatically initiated repetitive BP measurements at preset intervals of 1, 2.5, 5, 15, and 30 minutes.
- Automatic reinflation and measurement of BP in cases of artifact, unusually high pressures, or low signal.
- Reads BP up to 275 mmHg systolic, and down to 20 mmHg diastolic.
- Choice of cuff sizes: small child, child, adult, and large adult cuffs.
- A systolic mode allowing continuous, systolic-only, measurements for a 5 minute period.
- Audible tones to indicate when new BP measurements have been determined and are being displayed, and also when temperature computation is completed (in normal mode).

- Eight character information display; messages indicate operational prompts and error diagnostics.
- Choice of Celsius or Fahrenheit temperature displays via °F/°C internal DIP switch at front panel overhang.
- Two modes of temperature measurement: normal and monitor (continuous monitoring).
- Oral and rectal thermometer probes.
- The stand provides a storage space for the cuff and probe covers.
- Pulse irregularity indication (three dots in PULSE display).
- Operates on AC or self-contained battery power.

1.2 PHYSICAL DESCRIPTION

This instrument is designed to measure and display blood pressures (BP), pulse rate, and patient's temperatures and may be operated on either AC or battery power. It provides alphanumeric displays showing information such as patient's systolic or diastolic BP, pulse, and temperature, as well as BP function information display and error messages regarding the state of the instrument.

The instrument weighs 5.897 kg (13 lb) and is housed in a white case with a dark grey front panel. The built-in handle allows the instrument to be easily carried from one area to another (when writing table is not installed). For more portability, the instrument is specifically designed to be used with the IVAC Vital Signs Instrument Stand - Model 1042, which has storage space for cuffs and probe covers, as well as cord wrap storage.

The instrument display panel contains several touch switches: the PRES. SELECT switch, to select mmHg initial cuff inflation pressure; the MODE SELECT switch, to select desired operating mode; the DISPLAY TEST switch, allowing the thermometer to enter the calibration mode and also to initiate a display test; the ON/OFF switch, to apply power to and from the instrument; the START/STOP switch, to initiate a measurement cycle or to terminate a cycle in progress; the NORMAL/MONITOR Mode switch, to select mode for temperature measurement; and the CHARGE indicator, indicating AC or battery power.

For more detailed descriptions of instrument display controls and indicators, BP function information display and error messages see Chapter Two (tables 2-1, 2-2, and 2-3, respectively).

For instrument specifications and features refer to table 1-1 of this chapter.

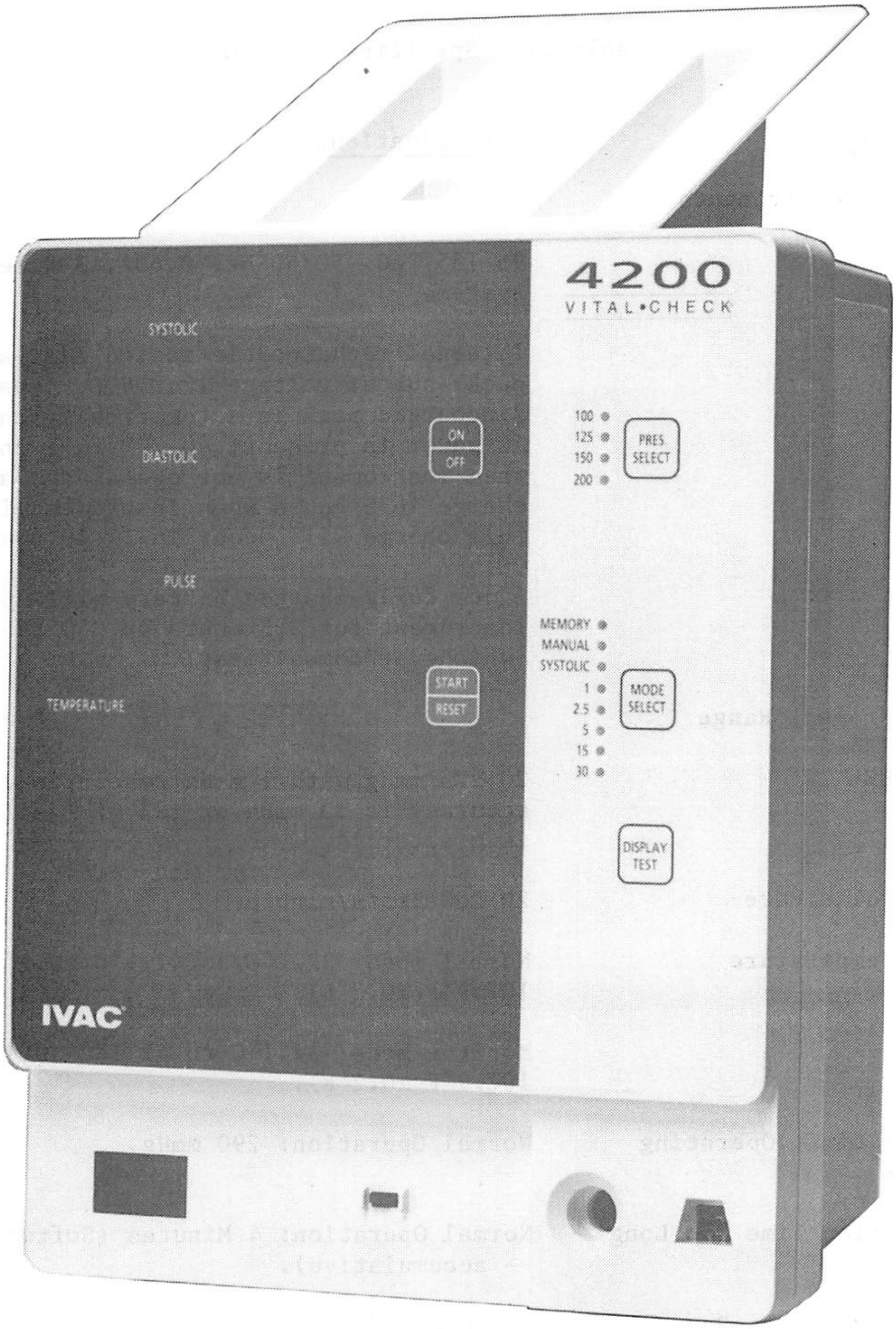

Figure 1-1. VITAL●CHECK Instrument - Model 4200

Table 1-1. Specifications and Features

Features	Specifications
Power requirements	
• AC	95-135 VAC, 50/60 Hz, 0.65A, 3-wire grounded system.
• 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 instrument is not operating; and 70% full charge in 5 hours when instrument is operating. A full charge will occur in 12-16 hours. A new fully-charged battery will operate the instrument for 2.5 hours or 150 BP measurements (whichever comes first).
Measurement Range	
• BP	20-275 mmHg with 1 mmHg resolution. (Transducer accuracy is ±3 mmHg or ±2% of reading, whichever is greater.)
• Pulse Rate	20-200 Beats/minute.
• Temperature	Normal mode: 32.2°C to 42.1°C ±0.1°C (90.0°F to 107.9°F ±0.2°F). Monitor mode: 31.1°C to 42.1°C ±0.1°C (88.0°F to 107.9°F ±0.2°F).
Upper Limit Operating Range	Normal Operation: 290 mmHg.
Inflation Time Too Long	Normal Operation: 4 Minutes (Software controlled -- accumulative).
Cuff Inflation Rate	20-40 mmHg/sec.

Cuff Deflation Rate	
• Normal	4-6 mmHg/sec.
• For Retries	2-3 mmHg/sec.
Accuracy	
• BP	Meets ANSI/AAMI SP-10-1987, American National Standard for Electronic or Automatic Sphygmomanometer (when tested with adult cuff).
• Temperature	+/-0.1°C, +/-0.2°F (when tested in a calibrated water bath).
Failsafe Cuff Pressures	
• Software	$\leq$ 320 mmHg (Normal operating mode - FIX ME "5").
• Electrical	330-335 mmHg (Normal/calibration mode).
• Mechanical	375-405 mmHg (Normal/calibration mode).
Failsafe Cuff Inflation Time	4.5 Minutes.
Failsafe Cuff Deflation Rate	300 to 20 mmHg in 3 seconds or less.
Dimensions	
• Length	20.32 cm (8 in.).
• Width	22.10 cm (8.7 in.).
• Height	33.02 cm (13 in.).
Weight	5.897 kg (13 lb).

Environment

• Temperature	Storage: -30°F to 149°F.
	Operating:
	60°F to 110°F (blood pressure system).
	60°F to 110°F (thermometer system; room ambient - monitor mode).
	60°F to 94°F (thermometer tip temperature - normal mode).
	60°F to 86°F (thermometer system, room ambient - normal mode, battery operation).
	60°F to 84°F (thermometer room ambient - normal 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; 5-50 Hz over a 2 minute period at 5G maximum.

1.3 DEFINITION OF TERMS

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

a. NOTE: Indicates important explanatory or parenthetical material as a reference to assist the user.

b. CAUTION: Indicates important explanatory information which, if not followed, can result in extensive damage to equipment.

c. WARNING: Indicates important explanatory information which, if not followed, can result in personal injury.

Reference designations and abbreviations are listed in table 1-2 as a reference for common technical terms used within service manuals.

1.4 ACCESSORIES

a. Accessory Holder - (figure 1-2). The accessory holder, which is an integral part of the IVAC Vital Signs Instrument Stand - Model 1042, is designed to provide convenient storage space for cuff and probe covers when they are not in use, as well as cord wrap storage.

b. IVAC Standard Probes - Models 1880L Oral (blue, long cord) and 1882L Rectal (red, long cord) (figure 1-3). The Model 1880L/1882L probe contains a heat-sensing thermistor located inside a plastic shaft. Both models are electronically identical. The thermistor provides a temperature-proportional resistance to the thermometer through the probe connection and flexible 14-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. These probes are designed to be used in either the normal or monitor mode of operation. All utilize IVAC Probe Covers - Model 850.

c. IVAC Probe Covers - Model 850 (figure 1-3). The probe cover is a thin plastic sheath with thermal characteristics carefully selected to match the requirements of the VITAL•CHECK instrument. The probe cover is used to cover the shaft of the probe to prevent cross-contamination or infection during temperature measurement.

NOTE: IVAC cannot guarantee proper fitting of covers, accuracy of temperature readings, or the overall functions of its thermometer when using probe covers that are not IVAC products.

d. IVAC Adult Size BP Cuff - Model 1148 (figure 1-5). The cuff wraps as a standard BP cuff and fits arms in the size range 27.9 to 41.7 cm.

e. IVAC Large Adult Size BP Cuff - Model 1149 (figure 1-5). Identical in form and function to the Model 1148 cuff, but designed to fit arms in the size range of 33.0 to 50.8 cm.

f. IVAC Child Size BP Cuff - Model 1147 (figure 1-5). Identical in form and function to the Model 1148 cuff, but designed to fit child size arms in the size range of 19.6 to 28.7 cm.

g. IVAC Vital Signs (VS) Instrument Stand - Model 1042 (figure 1-4). This stand is specifically designed to accommodate the VITAL•CHECK instrument - Model 4200. It has a low center of gravity and rolling casters for easy maneuverability from one area to another. The saddle-bag design provides a convenient storage place for cuff and probe covers when not in use, as well as cord wrap storage. (When ordering parts for the instrument stand assembly, refer to Chapter Eight (ILLUSTRATED PARTS BREAKDOWN) of this manual.)

h. IVAC Thermometer Tester - Model 828A (figure 1-6). The thermometer tester confirms in a few seconds that the VITAL•CHECK instrument thermometer function is calibrated by displaying either 98.6°F or 37°C, depending on the setting of the S2 internal DIP switch no. 5 (°F/°C), located at the bottom, right-hand side of the instrument at front panel overhang (figure 2-2).

i. Umbilical Cable (6 ft) - Model 1131 (figure 1-7). The umbilical cable consists of a flexible air hose and a coaxial cable and microphone for connection between the cuff and the VITAL•CHECK instrument. The air hose is used to deliver air to inflate the cuff, and the coaxial cable and microphone deliver Korotkoff signals to the instrument.

j. Umbilical Cable (12 ft) - Model 1132 (figure 1-7). Same in form and function as the Model 1131 but is 12 feet long.

k. Writing Table - PN 131298 (figure 1-8). A plastic table which attaches to the top of the VITAL•CHECK instrument to assist users in note taking.

l. Writing Table Note Pads (5 Tablets) - PN 127335 (figure 1-8). Note pads for use with the Writing Table - PN 131298, which provide the user with a quick chart to record patient information such as: room number, patient name, blood pressure, pulse, respiration, and temperature.

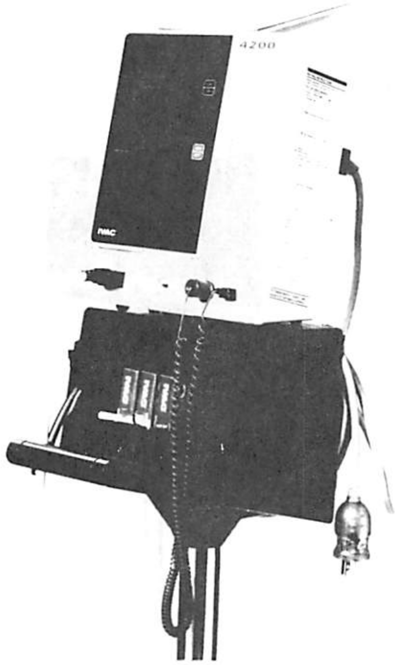

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Figure 1-2. Accessory Holder

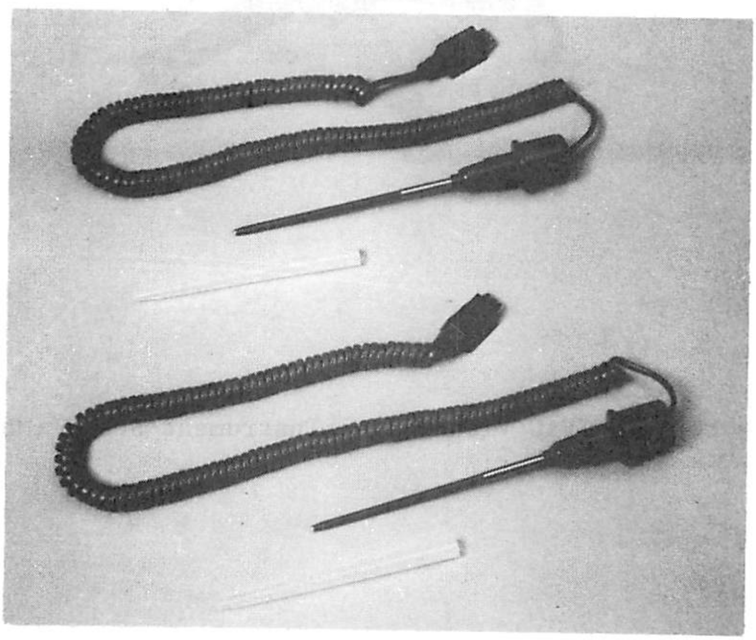

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Figure 1-3. IVAC Standard (Long) Probes
(1880L, 1882L) and Probe Covers (850)

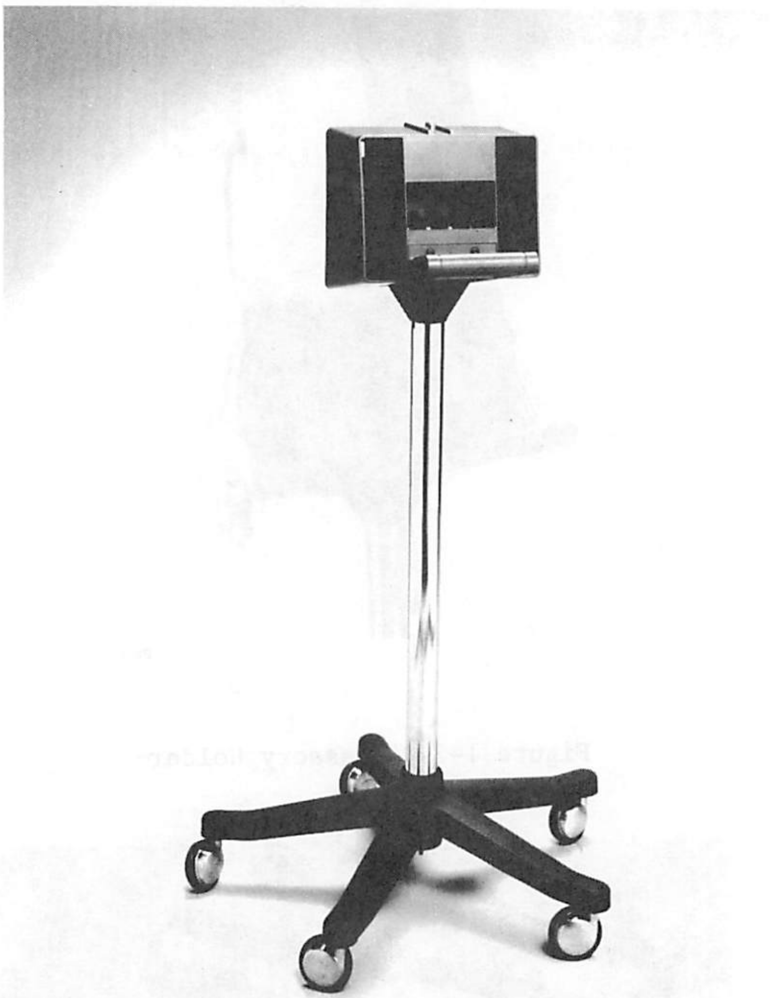

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Figure 1-4. IVAC Vital Signs Instrument Stand (Model 1042)

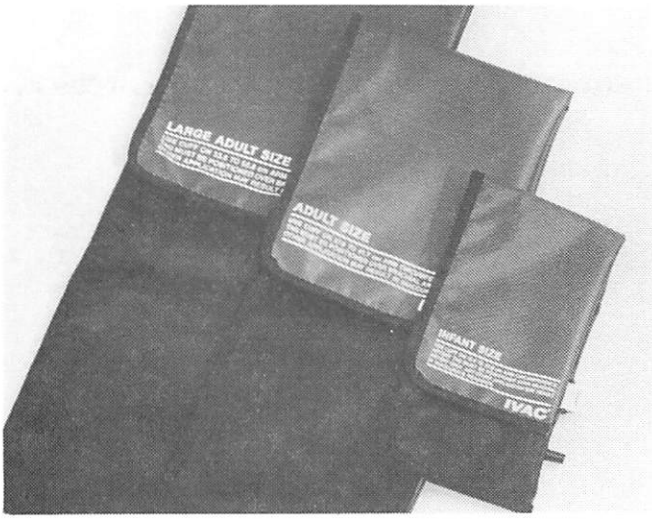

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Figure 1-5. IVAC Blood Pressure Cuffs (1147, 1148, 1149)

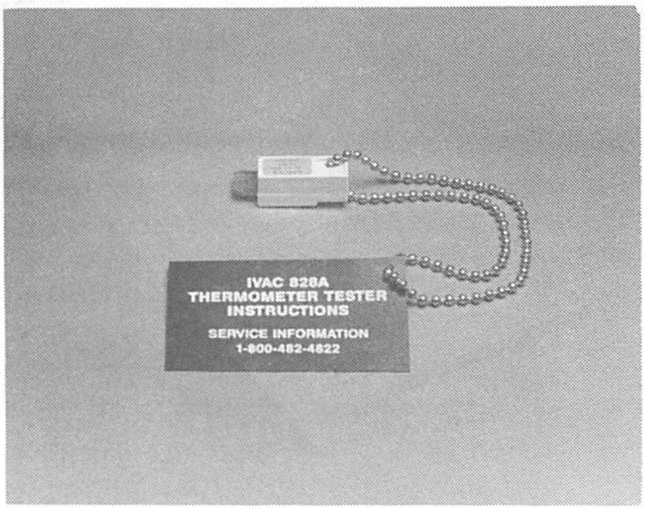

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Figure 1-6. IVAC Thermometer Tester (828A)

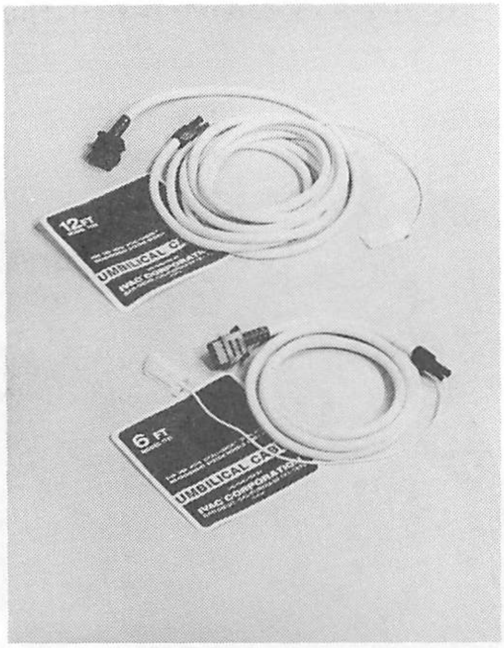

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Figure 1-7. Umbilical Cables (1131 or 1132)
(6 and 12 ft lengths)

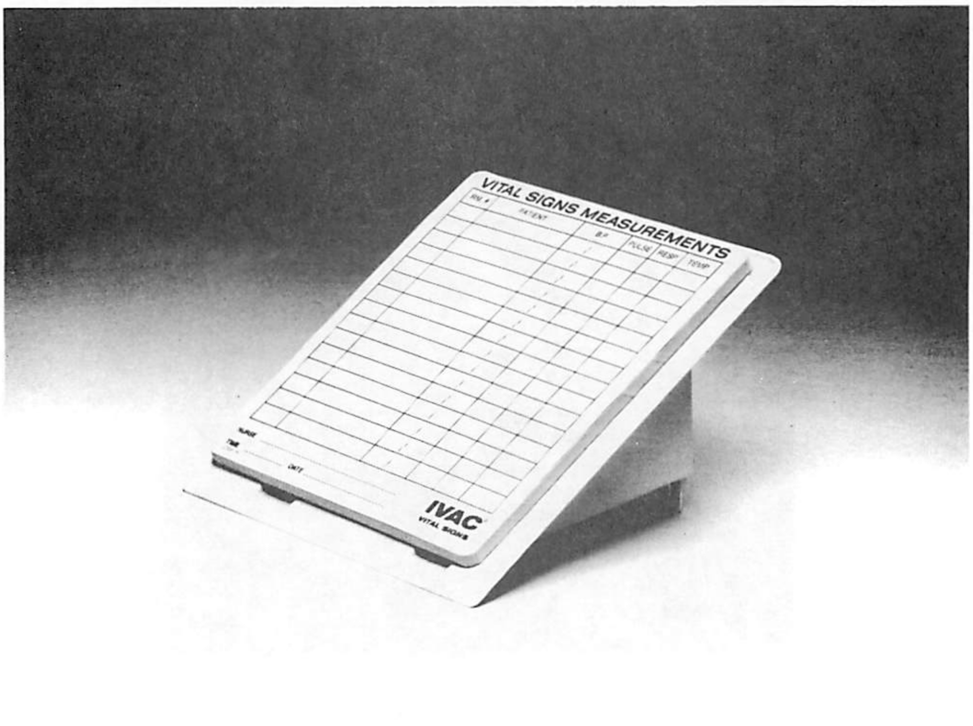

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Figure 1-8. Writing Table with Note Pads

Table 1-2. Reference Designations and Abbreviations

Reference Designation	Definition
C	capacitor
CR	diode
DS	display
F	fuse
J	connector on printed wiring board, terminal header
L	inductor
LS	speaker
P	pressure transducer
Q	transistor
R	resistor
RN	resistor network
S	switch
TP	test point
U	integrated circuit
VR	zener diode, voltage reference diode, or voltage regulating integrated circuit
X ___	socket for electronic component (the designation for the component appears in the blank space)
XP, XU	socket for integrated circuit
Y	crystal

Abbreviation	Definition
A	ampere
AC	alternating current
A/D	analog to digital
Ah	ampere-hour
A/R	as required
cm	centimeter
COML	commercial
CMOS	complementary metal-oxide semiconductor
CPU	central processing unit
°C	degrees Celsius
D/A	digital to analog
DC	direct current
dia	diameter
DIP	dual in-line package
EPROM	erasable programmable read-only memory
ft	foot; feet
F	farad
°F	degrees Fahrenheit
FET	field-effect transistor
gm	gram

>	greater than
<	less than
hex	hexadecimal, hexagonal
Hg	mercury
hr	hour
Hz	hertz
IC	integrated circuit
ID	inside diameter
in.	inch
I/O	input/output
IV	intravenous
kg	kilogram
kHz	kilohertz
kΩ	kilohm
kV	kilovolt
KVO	keep vein open
kW	kilowatt
lb	pound(s)
LED	light emitting diode
M	mega
MAP	mean arterial pressure
mcg	microgram
MHz	megahertz
MΩ	megohm
μamp	microamp
μF	microfarad
μP	microprocessor
μsec	microsecond
m	milli
mA	milliampere
ml	milliliter
mm	millimeter
mmHg	millimeters of mercury
ml/hr; ml per hr	milliliters per hour
msec	millisecond
min	minute
MOS	metal-oxide semiconductor
MUX	digital multiplex
n	nano
N/A	not applicable
no; nos.	number; numbers
NPN	negative-positive-negative
nsec	nanosecond
Ω	ohm
OD	outside diameter
p	pico
PCB	printed circuit board
pF	picofarad
P/N	part number
PNP	positive-negative-positive
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
TTL	transistor-transistor logic
V	volt(s)
VAC	volts alternating current
VDC	volts direct current
Vrms	volts root mean square
VTBI	volume to be infused
W	watt
x	by; times (mathematical)

CHAPTER TWO - OPERATION

2.0 INTRODUCTION

The IVAC VITAL•CHECK Vital Signs Measurement System - Model 4200 is a microprocessor-based electronic instrument specifically designed to measure and display a patient's systolic and diastolic blood pressure (BP), pulse rate, and temperature. This chapter describes the operation and functional checkout and inspection procedures required for the instrument, as well as correct storing and cleaning methods. Operating instructions are included for testing purposes only.

2.1 INITIAL SETUP

a. Carefully unpack the instrument and its accessories, and ensure that each item is undamaged.

b. Set the S2 internal DIP switch (no. 5) for °F/°C:

   1. Lay the instrument down on its back panel to access the right-hand louvers located at front panel overhang (figure 2-2).

   2. Using a non-metallic tool (i.e., wooden end of Q-tip), place the internal DIP switch (no.5) to the "up" position for degrees Fahrenheit or "down" for degrees Celsius, as desired. (See figure 2-2.)

   3. Return instrument back to upright position.

c. Attach the instrument to an IVAC Model 1042 instrument stand by placing the threaded opening at bottom center of the instrument over the threaded stud in top center of the stand (recessed section of instrument front to align with top front of stand), or place on a table or other support, as desired.

d. Plug power cord into socket located at the back of the instrument.

e. Plug the instrument into an appropriate AC outlet.

   NOTES:

   1) Always use the AC power connector, as supplied, to ensure proper grounding.

   2) Charge the batteries for at least 3 to 4 hours before operation on battery power.

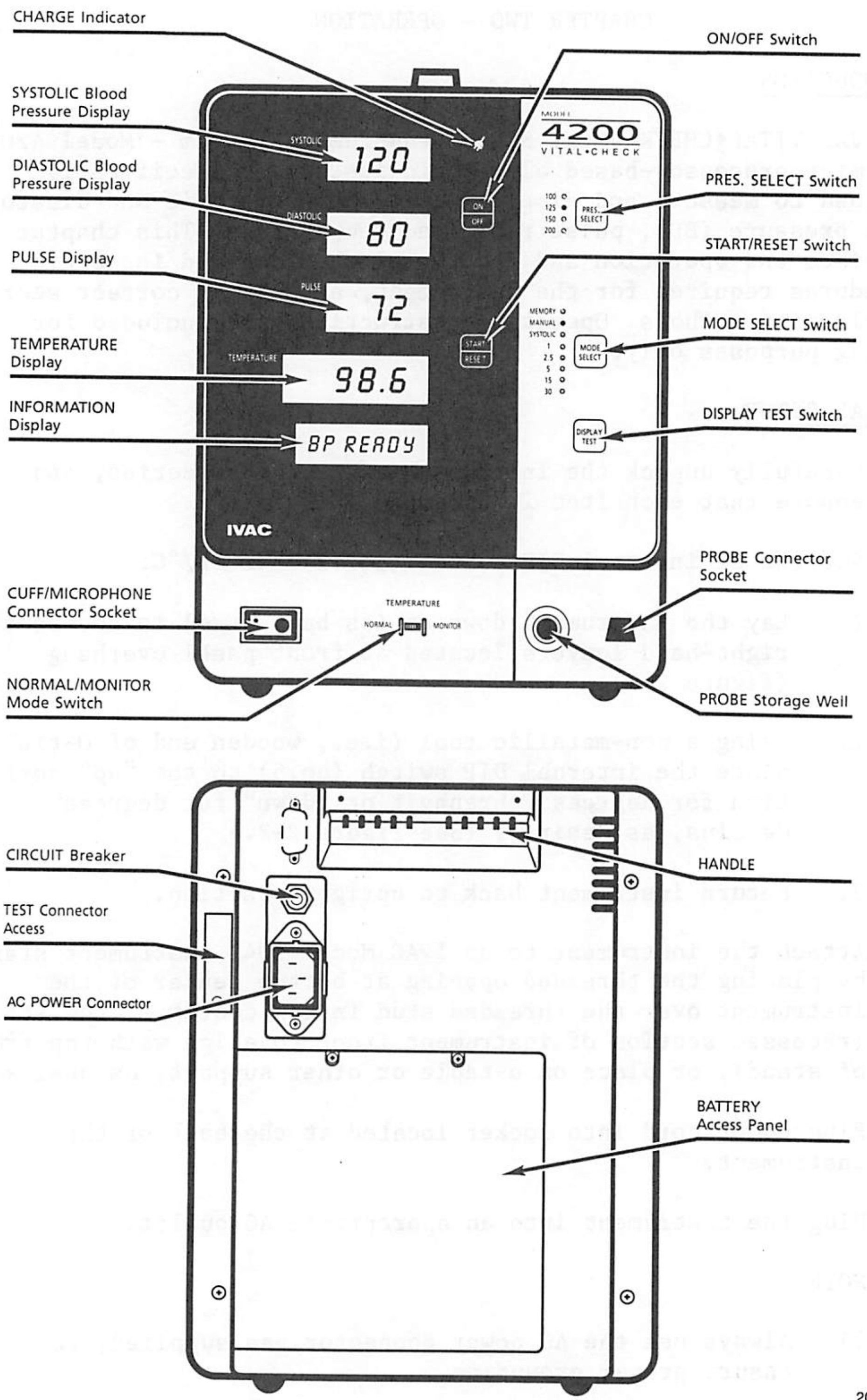
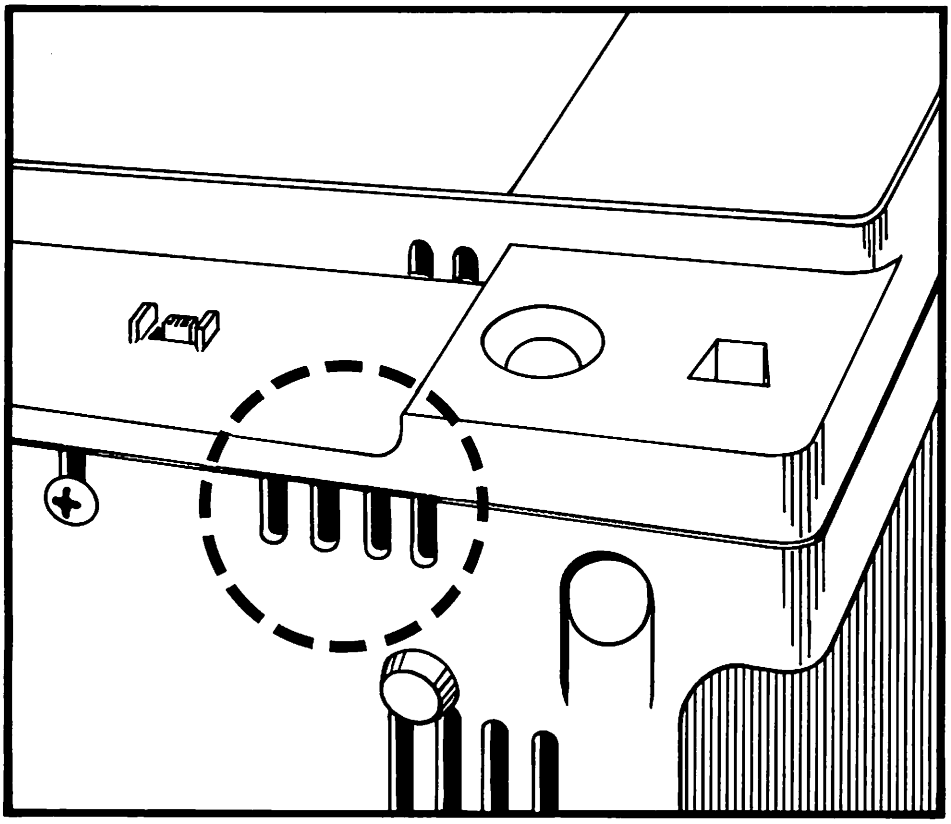


Figure 2-1. Controls and Indicators



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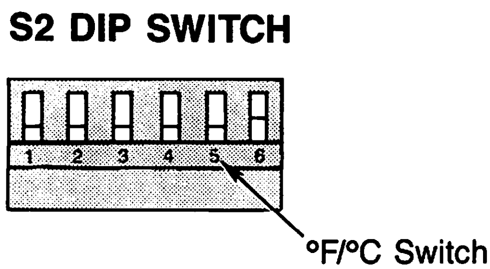
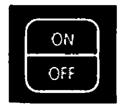
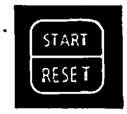
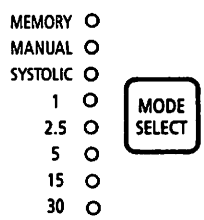
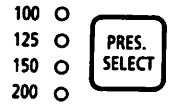


Figure 2-2. Internal DIP Switch (No. 5) Location
(Bottom View of Model 4200)

Table 2-1. Controls/Indicators

Function	Controls/Indicators
ON/OFF switch Applies power to or removes power from the instrument.	
START/RESET switch Initiates measurement cycle or terminates a cycle in progress and returns to the display from stand-by. (Switch can be used to deflate the cuff in the event of patient distress.) Used to step through BP measurements (up to last 20) in MEMORY mode, if power has not been turned off.	
MODE SELECT switch Determines the manual, systolic, automatic, or memory modes. In MANUAL mode, BP measurements are initiated using the START/RESET switch. In SYSTOLIC mode, continuous systolic measurements are performed for about 5 minutes. The automatic mode initiates repetitive measurement cycles at selected intervals of 1, 2.5, 5, 15, or 30 minutes. MEMORY mode allows the user to recall results of previous BP measurements. To access specific mode, press and release switch until desired mode indicator is lit.	

PRES. SELECT switch



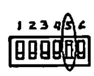
Allows for selection of 100, 125, 150, or 200 mmHg initial cuff inflation pressure.

To access specific inflation pressure, press and release switch until desired mode indicator is lit.

Charge indicator

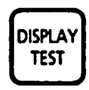
Illuminates when the instrument is plugged into an AC line and the battery is charging.

S2 Internal DIP switch (no. 5) °F/°C



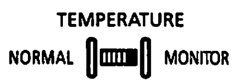
Selects whether the temperature will be displayed in degrees Fahrenheit (°F) or Celsius (°C). Located at the front overhang of the instrument, this unlabeled switch is no. 5 in the row of louver switches (up position = °F, down position = °C). Do not change any other louver switches.

DISPLAY TEST switch



Allows the thermometer to enter the calibration mode and is also used to initiate a display test. In conjunction with the START/RESET switch, this switch is used to enter the off-line display test mode and advance to each test within this mode.

NORMAL/MONITOR Mode switch



Selects normal or monitor mode for temperature measurement.

2.2 OPERATING INSTRUCTIONS

The following section describes instrument operation for testing purposes only. Operating precautions and instructions are included for informational purposes only. For use with patients, refer to the Model 4200 Directions For Use, packed with each instrument.

NOTE: Model 4200C instruments are compatible with the IVAC Computer Interface Module (CIM). For instructions on using the Model 4200C CIM equipped, refer to the CIM II Directions For Use.

All controls and indicators used to operate the instrument are described and illustrated in figure 2-1 and table 2-1. Blood Pressure (BP) display and temperature error messages are described in tables 2-2 and 2-3.

WARNING: Should an instrument be dropped or severely jarred, the instrument should be inspected by a qualified service technician to ensure its proper function.

2.2.1 Blood Pressure/Pulse Operation - MANUAL Mode

In manual mode (MODE SELECT switch set to MANUAL), the instrument initiates a measurement cycle each time the START/RESET switch is pressed and while the instrument is not in standby mode or taking a BP measurement. (Refer to figure 2-1 as necessary.)

a. Ensure that instrument is plugged into an appropriate AC line.

b. Connect the cuff to the umbilical cable by fully inserting the end of the connector 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 the microphone is not in its pocket, and hold the connectors--not the wiring--firmly when pulling the connectors apart.

c. Install the microphone by peeling the nylon cover away from the cuff body, which is held against the cuff body with Velcro.*

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

d. Insert the microphone into the small pocket on the inside of the cover.

The Velcro at microphone bag should be attached to the Velcro at pocket, to secure the microphone to the cuff and ensure proper placement of the microphone in the pocket. (See figure 2-3.)

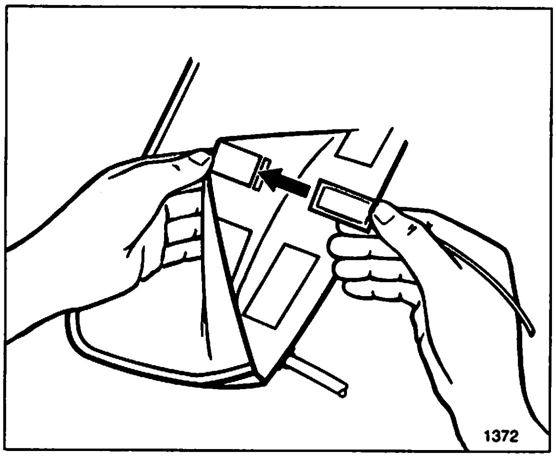


Figure 2-3. Microphone Placement

e. Place excess microphone cord loosely inside the pocket formed between the cover and the cuff body. (See figure 2-3.)

f. Reseal the Velcro to close the cover over excess cord.

g. Plug the BP cuff umbilical cable into the cuff/microphone connector socket on the front of the instrument.

h. Place the cuff microphone directly over the brachial artery (inner arm, above elbow), holding 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 2-4.) 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, the wrong size cuff is being used. To ensure accuracy, select a larger or smaller cuff, as required, and repeat steps b through f of this section.

CAUTION: Artery tag must be positioned over brachial artery only. Any other application may result in inaccurate readings.

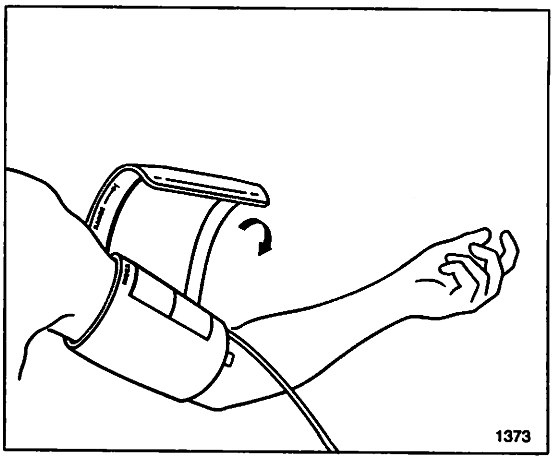


Figure 2-4. Wrapping Cuff

i. Press the ON/OFF switch to turn the instrument on, instruct the patient to relax, remain still, and not to talk during the measurement cycle.

NOTE: The instrument will momentarily read all 8's in the SYSTOLIC, DIASTOLIC and PULSE displays and "TESTING" in the bottommost information display as a display check, then emit two audible beeps.

j. Press and release the PRES. SELECT switch until desired cuff inflation pressure indicator is lit.

k. Press and release the MODE SELECT switch until the MANUAL mode indicator is lit; the MANUAL message will be displayed, indicating manual mode.

l. Initiate a measurement cycle by pressing the START/RESET switch; the instrument will automatically begin a measurement cycle by inflating the cuff to the pre-selected pressure. (The actual pressure will normally be about 15 mmHg over selected pressure.)

The information display will indicate cuff pressure until the BP is determined. When the BP measurement has been completed, the systolic, diastolic, and pulse, 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.

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.

m. Press the ON/OFF switch to turn the instrument off.

2.2.2 Blood Pressure/Pulse Operation - SYSTOLIC Mode

The systolic mode initiates an automatic cycle of continuous systolic measurements for about 5 minutes.

a. For operating in the systolic mode, follow steps a through j of section 2.2.1, press and release the MODE SELECT switch until the SYSTOLIC indicator is lit, then press the START/RESET switch.

During deflation, the cuff pressure will appear on the information display and the systolic measurement will appear on the SYSTOLIC display, then the cuff will quickly deflate to zero. After about 5 seconds, the display will begin flashing and the cuff will begin to reinflate to just above the estimated pressure reading. This sequence is repeated for about 5 minutes, then the information display will read SYSTOLIC COMPLETE, indicating the last systolic measurement.

NOTE: Operation in this mode may result in INFLATION TIME TOO LONG message. If this occurs, turn the instrument off and squeeze cuff to remove remaining air. Turn instrument back on and initiate another set of systolic measurements.

b. To abort at any time during the procedure, press the START/RESET switch once.

c. 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 instrument is unable to detect Korotkoff sounds during a systolic measurement cycle, the instrument will take one oscillometric BP measurement, including systolic and diastolic BP and pulse, and then discontinue further systolic measurements. The message BP*READY will appear in the information display to indicate that the measurement is oscillometric. If this occurs, reposition the cuff over the brachial artery and press the START/RESET switch to initiate another set of systolic measurements.

2.2.3 Blood Pressure/Pulse Operation - Automatic Mode

(Repetitive Measurements at Selected Intervals)

The automatic mode allows automatic repetitive BP measurements. While using the automatic feature, the instrument will initiate measurement cycles at the interval selected on the MODE SELECT switch.

a. For operating in the automatic mode, follow steps a through j of section 2.2.1, press and release the MODE SELECT switch to the desired time interval (1, 2.5, 5, 15, or 30 minutes).

The selected time will alternate with the BP READY message 5 times when the measurement is complete. After the MODE SELECT switch has been set, 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.

b. If an extra measurement is desired during automatic operation, press the START/RESET switch; this will initiate an extra measurement without changing the time remaining on the previously selected measurement cycle.

c. 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).

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.

2.2.5 Blood Pressure Function Information Display Messages

Operator prompts/messages may appear during operation of the instrument BP function. (See table 2-2 for messages and corresponding explanations.)

Table 2-2. BP Display Messages

Message Explanation — **Display**

MANUAL

The manual mode is selected.

SYSTOLIC

The systolic mode is selected.

MEMORY

The memory mode is selected.

1.0 MIN./2.5 MIN./5.0 MIN./30 MIN.

The interval (1.0, 2.5, 5.0, 15, or 30), in minutes, selected for automatic mode measurement.

xxM xxS

Time remaining in minutes and seconds until a measurement will automatically be initiated.

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.

100/125/150/200

The initial cuff inflation pressure setting (100, 125, 150, or 200 mmHg) during the inflation cycle.

CUFF PRESSURE*

The cuff pressure value during the deflation cycle is displayed along with a blinking asterisk (*), indicating a detected Korotkoff sound.

ARTIFACT

Excessive artifacts have been detected; the display is accompanied by 5 audible tones. The instrument will automatically reinflate and retry the BP measurement.

LOW BATTERY

About 15 minutes of battery life remain before the instrument shuts off.

CHARGE BATTERY

CHARGE BATTERY

There is not enough charge in the battery to take a BP measurement. The instrument will sound 5 audible tones and then shut off.

LOW SIGNAL

LOW SIGNAL

Signal sensed by the instrument is too low for a BP measurement; display is accompanied by 5 audible tones. In both the manual and automatic modes, the instrument will automatically reinflate and retry the BP measurement at half the normal deflation rate.

SYSTOLIC COMPLETE

SYSTOLIC COMPLETE

A systolic cycle (about 5 minutes) has been completed; the display is accompanied by a single, low-frequency tone.

PATIENT MOVEMENT

PATIENT MOVEMENT

Excessive patient movement during the measurement process has disturbed the instrument's ability to determine the BP; display is accompanied by 5 audible tones.

CHECK FOR AIR LEAKS

CHECK FOR AIR LEAKS

Cuff pressure cannot be controlled accurately because of air leaks; display will be accompanied by 5 audible tones.

LOW CUFF PRESSURE

LOW CUFF PRESSURE

Inflation pressure was insufficient to occlude artery; instrument will repump (up to a maximum of 2 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.

INCREASE PRESSURE

INCREASE PRESSURE

The cuff pressure is not high enough to take an accurate measurement after 2 automatic inflation pressure increases; the display is accompanied by 5 audible tones.

CHECK FOR REVERSED MICROPHONE

CHECK FOR REVERSED MICROPHONE

The microphone installed in the cuff pocket may be reversed. Refer to the Operating Instructions of this manual (section 2.2.1) for proper microphone installation and reinitiate the BP measurement.

CHECK CUFF PLACEMENT

CHECK CUFF PLACEMENT

The cuff microphone may not have been placed directly above the brachial artery. Refer to the Operating Instructions of this manual (section 2.2.1) for proper cuff placement.

NOTE: If this message is displayed with all blood pressure readings, a dead microphone channel is the most likely cause, requiring repair of the instrument and/or replacement of the umbilical assembly.

SIGNAL QUALITY

SIGNAL QUALITY

The signal detected by the instrument may be distorted by patient movement or other disturbance. The BP displayed is a best estimate under these conditions.

INFLATION TIME TOO LONG

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 5 audible tones.

NOTE: The instrument will not initiate a BP measurement while this message is scrolling.

FIX ME x

FIX ME 5

The instrument detects a malfunction, flashes FIX ME x (x is a letter or number defining the type of malfunction detected), sounds 5 audible tones, and ceases operation. The instrument can only be restarted by pressing the ON/OFF switch. If the malfunction persists after cycling the ON/OFF switch, refer the problem to qualified service personnel.

STANDBY

STANDBY

When operating on battery, all displays are blanked about 19 seconds after they are updated.

2.2.6 MEMORY Mode

The memory mode gives the user the capability to recall (redisplay) the results of the previous 19 BP measurements. Including the one being displayed, the last 20 (or up to 20) BP measurements are stored and can be recalled in a last in first out sequence (the last measurement stored will be the first one recalled).

Two measurements must be taken for the memory mode to operate; if either one or no measurement was taken, the instrument will display NO DATA when memory mode is initiated.

a. To enter the memory mode, press and release the MODE SELECT switch until the MEMORY indicator is lit, then press the START/RESET switch.

b. To redisplay to each preceding measurement, press and release the START/RESET switch once.

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

During memory mode operation, the information display tells:

- Which operating mode each measurement was taken in: MANUAL (MAN), SYSTOLIC (SYS), or automatic (1.0, 2.5, 5.0, 15, or 30).
- Whether the reading was obtained by auscultation (no asterisk) or oscillometry (indicated by an asterisk). Example: MAN*4/SYS 8 (auscultation).
- Whether the SIGNAL QUALITY message was displayed (indicated by a "Q").
- Whether the CHECK FOR REVERSED MICROPHONE message was displayed (indicated by an "M").
- Whether the CHECK CUFF PLACEMENT message was displayed (indicated by a "C").

The number of the reading (1 through 19).

NOTE: The word END will appear instead of a number with the last stored measurement. If the instrument was unable to complete a measurement due to an interruption, 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 - CHECK FOR AIR LEAKS
IP - INCREASE PRESSURE
INF - INFLATION TIME TOO LONG

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 1.0, 2.5, 5.0, 15 or 30 for a manually initiated measurement that replaces an error message in a series of automatic measurements; otherwise, it will read MANUAL. Alarm messages will not be stored in the systolic or manual modes of operation.

2.2.7 Temperature Measurement - NORMAL Mode

For use with Model 1880L (blue) Oral/1882L (red) Rectal probes only.

Use the NORMAL mode for operation under ordinary clinical conditions since it provides the fastest way of taking a temperature with the instrument.

a. Set the NORMAL/MONITOR Mode switch to the NORMAL mode position.

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

c. Install the desired probe.

   NOTE: Place probe covers in their storage well on the instrument stand.

d. 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.)

e. Hold the instrument stand handle with one hand, and with the other hand insert the thermometer probe completely and firmly into a probe cover to ensure a secure fit. (See figure 2-5.)

NOTES:

1) Do not press the button at the base of the probe, as this might loosen or eject the probe cover.

2) IVAC cannot guarantee proper fitting of covers, accuracy of temperature reading, or the overall functions of its thermometer when using probe covers that are not IVAC products.

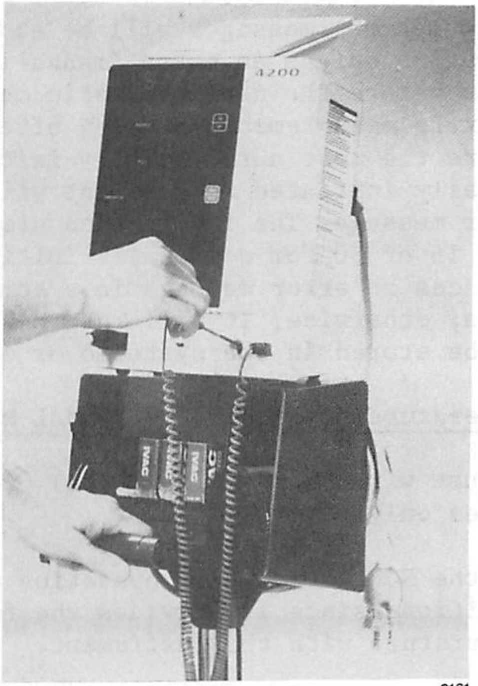


Figure 2-5. Probe Cover Attachment

f. For oral temperatures using the blue 1880L (oral) probe, have patient open mouth slightly, then gently insert the probe tip and slide it back under the front of the tongue, along the gumline, to the sublingual (heat) pocket where the richest blood supply is located. (See figure 2-6.)

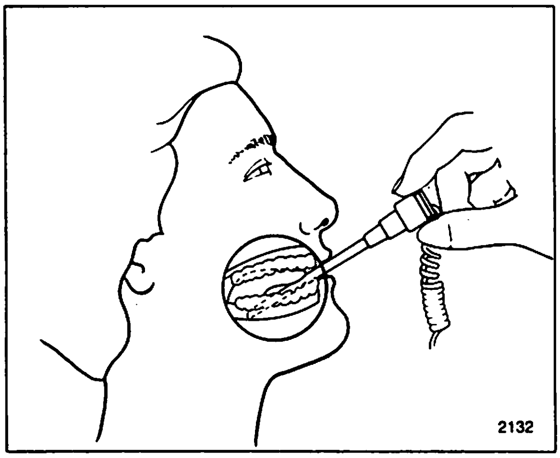


Figure 2-6. Probe Placement

g. Hold the probe during the entire temperature measurement process, keeping the probe tip in contact with tissue at all times; do not allow the patient to reposition the probe.

A tissue contact indicator (pinwheel) will appear in the rightmost position of the TEMPERATURE display during temperature measurement process. When the final temperature is achieved, an audible tone will sound and the patient's temperature (in degrees and tenths of a degree) will blink on the TEMPERATURE display for about 20 seconds. The display will then clear, as the thermometer automatically shuts off.

NOTE: If the probe tip temperature is higher than 94.0°F (34.4°C) as indicated by flashing F or C, the instrument will not quickly determine the patient's temperature. Instead, the temperature indicated on the display will slowly rise until, after 3 to 5 minutes, it stabilizes. No audible tone will sound. This is the same as the MONITOR mode.

h. Note the displayed temperature and remove the probe from the patient's mouth.

i. 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 into a waste container. (See figure 2-7.)

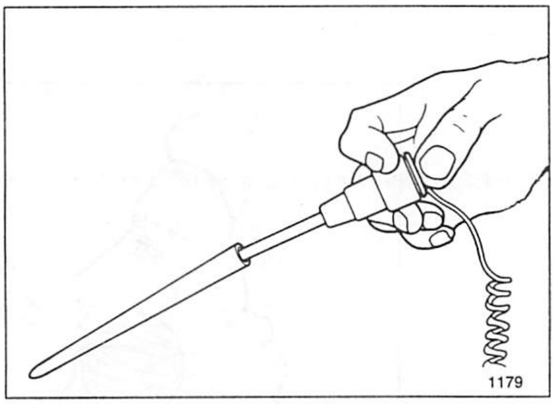


Figure 2-7. Ejecting Probe Cover

j. Return the probe to its storage well, automatically turning off and resetting the thermometer function for the next temperature measurement. (See figure 2-8.)

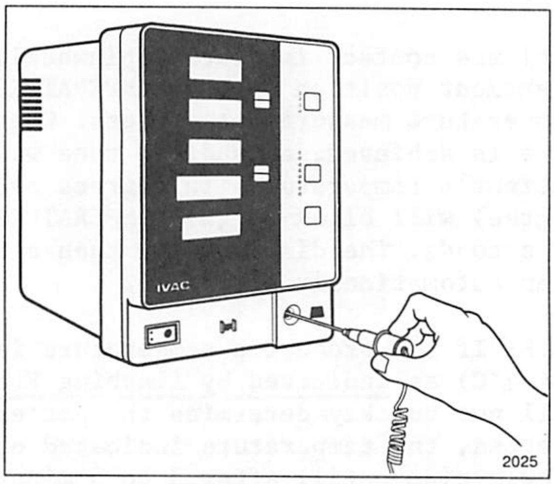


Figure 2-8. Probe Storage Well

k. For rectal temperature measurement, use the red 1882L (rectal) probe; connect the probe to the instrument and attach a probe cover to the probe as described in steps c through e of this section.

l. Touch the tissue about one-half inch above the sphincter muscle and carefully insert the probe, using current hospital technique for penetration. (The use of a lubricant is optional.)

When the final temperature is achieved, an audible tone will sound.

m. Note the temperature, withdraw the probe, and eject the used probe cover as described in steps h and i of this section.

n. Reset the thermometer function as described in step j of this section.

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

2.2.8 Temperature Measurement - MONITOR Mode

NOTE: In MONITOR mode, the thermometer continuously measures the patient's temperature as it rises or falls.

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

b. Set the NORMAL/MONITOR Mode switch to MONITOR mode position.

c. Select desired probe (1880L or 1882L) and position it according to standard hospital procedure.

Within 3 to 5 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.

d. When monitoring is no longer desired, remove the probe from the patient, then discard the probe cover into a waste container.

e. Press the ON/OFF switch to turn the instrument off.

2.2.9 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 normal mode, eject the probe cover, reset the thermometer by returning the probe to its storage well, then retake the patient's temperature.

Table 2-3. Temperature Error Messages

Message Explanation	Display
Err t The instrument fails to obtain a temperature within 1 minute after insertion (in NORMAL mode only).	Err t
Err L The thermometer senses a loss of proper tissue contact within the mouth for more than 30 seconds (in NORMAL mode only).	Err L
Err H The probe temperature exceeds 107.9°F (42.1°C).	Err H
Err O There is an analog/digital (A/D) electronics error. If the error persists after resetting the thermometer, return the instrument for service.	Err O

If an error message occurs while in the NORMAL mode, eject the probe cover, reset the thermometer by returning the probe to its storage well, and retake the patient's temperature.

2.3 BATTERY OPERATION

This equipment is equipped with a self-contained battery for portable operation.

a. To operate on battery power, unplug the power cord from the AC outlet and continue as you would for AC operation.

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

   When the battery charge begins to run low while operating on battery power, the instrument will display LOW BATTERY on the information display. This message indicates enough charge for about 15 minutes of operation. As the charge in the battery is further depleted, CHARGE BATTERY will flash, accompanied by 5 audible tones. The instrument will then turn itself off.

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

b. Charge the battery for 3 to 4 hours prior to operating on battery power. (To fully charge the battery from a completely discharged state will require 12 to 16 hours.)

   NOTE: Battery information messages are overridden by error messages and operation in MEMORY mode.

   A standby mode exists to conserve battery power. The instrument automatically enters standby mode about 19 seconds after the last display update; STANDBY will flash on the display.

c. To redisplay a measurement result, press the START/RESET switch once.

d. To initiate a BP measurement while the instrument is in standby mode, press the START/RESET switch twice.

2.4 DISPLAY CHECK

a. Press the ON/OFF switch to turn the instrument on, and verify that information display reads TESTING for about 3 seconds and then displays mode setting (i.e., MANUAL, SYSTOLIC, MEMORY).

b. To check the instrument's displays, press and hold the DISPLAY TEST switch.

Eights (8's) will appear in every numeric display position indicating that the displays are operating properly; the information display will alternate between asterisks and "boxes" (capital O's). A probe must be installed on the instrument in order for the temperature display to be tested.

c. The off-line display test mode is used to provide a more complete check of the display characters and to read the instrument's software revision level; to enter this mode, press and hold the DISPLAY TEST switch, then press the START/RESET switch.

d. To exit this mode, either press the DISPLAY TEST switch 3 more times or cycle the ON/OFF switch off, then on again.

2.5 REAL-TIME CLOCK (Model 4200C only)

The Model 4200C has a real-time clock and an interface between the thermometer and main processor to transmit temperature and time of measurement. Operate the instrument in the manual mode as described in the Model 4200 Directions For Use, accompanying each instrument.

2.5.1 To Display Time

a. Press the instrument front panel between the 125 and 150 labels and between the 5 and 15 labels simultaneously for up to 5 seconds, until mode and pressure indicator lights go off.

b. Verify that the current time is displayed in the information display as follows:

in 12-hour format: HH:MM AM (or PM)
in 24-hour format: HH:MM:SS

(where HH = hours, MM = minutes, and SS = seconds).

NOTE: On first power up after disconnecting battery, SET TIME will continue to be displayed until the START/RESET switch is pressed again.

2.5.2 To Set Time and Date

The following instructions are provided to set the instrument calendar and clock to current time.

NOTE: On first power-up after disconnecting battery, SET TIME will be displayed and will override other messages.

a. Perform steps as in section 2.5.1.

b. To change between the 12-hour and 24-hour format, press the START/RESET switch; each press will select the alternate format.

c. To Set Time:

1. Press the DISPLAY TEST switch once:

   In the 12-hour format, AM (or PM) will flash. AM or PM can be selected by pressing the START/RESET switch. Each press will alternate the AM/PM display.

   In the 24-hour format, the seconds display will flash. The seconds may now be set to 01 by pressing the START/RESET switch once.

2. Press the DISPLAY TEST switch once:

   The hours display will now flash. Advance through the hours display by pressing the START/RESET switch once to advance each hour.

3. Press the DISPLAY TEST switch once:

   The minutes 10's display will now flash. Advance through the minutes by tens by pressing the START/RESET switch once to advance each 10 minutes.

4. Press the DISPLAY TEST switch once:

   The minutes 1's display will now flash. Advance through the minutes from 1 to 9 by pressing the START/RESET switch once to advance each minute.

5. Press the DISPLAY TEST switch once:

   The information display will now indicate the date as follows:

   MM - DD - YY

   (where MM = Month, DD = Day, YY = Year).

   The months display will be flashing. Advance through the months by pressing the START/RESET switch once to advance each month.

6. Press the DISPLAY TEST switch once:

   The days display will now flash. Advance through the days of the month by pressing the START/RESET switch once to advance each day.

7. Press the DISPLAY TEST switch once:

   The years tens display will now flash. Advance through the years by ones by pressing the START/RESET switch once to advance each year.

8. Press the DISPLAY TEST switch once:

   The years ones display will now flash. Advance through the years by ones by pressing the START/RESET switch once to advance each year.

9. When the time, date, and year are properly set, press the DISPLAY TEST switch again; the time display will return to the information display.

   NOTE: It is not necessary to go through the complete sequence once this sequence is started. At any point, either the MODE or PRES. SELECT switches can be pressed to exit the setting sequence. Once set, the clock will remain set when the instrument is detached from its power source.

d. Upon exit, be sure to check for correct mode and pressure settings.

2.6 STORING, STERILIZING, AND CLEANING

2.6.1 Storing the IVAC Instrument

When storing the IVAC instrument, connect it to AC power to ensure full battery charge the next time it is used. Do not store the instrument with battery in a discharged state, as this may result in permanent damage.

2.6.2 Sterilizing Instrument

a. The instrument may be EtO gas sterilized, provided that the maximum temperature does not exceed 58°C (136.4°F) and that relative humidity does not exceed 60% noncondensing.

b. After sterilization, aerate the instrument for 24 hours in free air or 8 hours in an aerator.

c. Following aeration, verify proper instrument operation.

2.6.3 Cleaning Instrument

a. Do not steam autoclave or immerse this instrument as damage to the instrument may occur.

b. Periodically clean the exterior surfaces of the instrument and blood pressure cuff, using a cloth dampened with warm water or a mild nonabrasive detergent mixed with water; care should be taken in the choice of cleaning agents and disinfectants (Cidex, Glutarex, and Vestaleen are acceptable) used on this instrument.

c. DO NOT USE ALCOHOL, AMMONIA, OR AMMONIUM CHLORIDE-BASED AGENTS because they may damage the plastic parts and could cause failure of certain critical parts on the instrument.

For general cleaning, use of a mild, nonabrasive detergent mixed in water is recommended. Commercially available liquid dish cleaning detergents work well.

2.6.4 Cleaning Blood Pressure Cuff

a. Disconnect the microphone and umbilical cable.

b. Cover or plug the air inlet fitting on the cuff (umbilical attachment) while cleaning the cuff to prevent water from entering.

c. Clean the cuff by hand using the instrument cleaning method described in section 2.6.3; DO NOT MACHINE LAUNDER THE CUFF AS DAMAGE MAY OCCUR.

2.7 FUNCTIONAL CHECKOUT - REGULAR INSPECTIONS

To ensure the instrument remains in good operating condition, regular inspections are required.

Procedures for inspection may also be provided in future service bulletins. Failure of the instrument to pass any of the tests may necessitate its return to IVAC or an IVAC dealer. Retain all original shipping cartons, packing inserts, and slips.

WARNING: Failure to perform the regular inspections required may result in a failure of the instrument to perform or alarm as specified.

Regular Inspections

Regular inspections consist of performing the procedures described in the Blood Pressure/Pulse Operation (section 2.2.1), Temperature Measurement Operation (section 2.2.2) and Storing, Cleaning, and Sterilizing (section 2.6) sections of this manual before each usage of the instrument.

These inspections are not covered under any contract or agreement offered by IVAC Corporation and must be performed by the user.

CHAPTER THREE - FUNCTIONAL DESCRIPTION

3.0 INTRODUCTION

This chapter contains a functional description of the VITAL•CHECK instrument - Model 4200.

The electrical components are contained on four printed circuit boards and on the front panel and chassis switch panel. (See table 3-1 for monitor boards and abbreviations.)

This instrument has two microprocessors. The main processor is located on the logic/analog board and carries out instructions for blood pressure measurement and global control. A second processor is located on the display/thermometer board, and controls temperature measurement only.

Full schematics for each of the boards are found in Chapter Four, SCHEMATICS, of this manual. (Refer to Chapter Four as applicable.)

Table 3-1. Monitor Boards

Logic/Analog	(LA)
Display/Thermometer	(DT)
Power Regulator	(PR)
Transition	

The main processor is designated U9 and is located on the logic/analog board. The processor on the display/thermometer board is designated U5. In the text, U9 is referred to as the "CPU." U5 is called the "μcontroller."

3.1 OVERVIEW

The VITAL•CHECK instrument is two instruments in one: one measuring system takes temperature, the other measures blood pressure and pulse. They share a common power supply.

The thermometer is an independent system, and contains its own controller and logic. The thermometer cycle is activated by removing the temperature probe from the probe well. When a measurement is completed, the results are reported directly to the temperature display.

The blood pressure and pulse measurement system processes signals from the blood pressure cuff. The measurement cycle begins with cuff inflation. During deflation, the CPU collects and stores data. Three data channels are strobed: microphone audio, pressure oscillations associated with pulse, and cuff pressure readings. At the completion of the cycle the data is processed to detect the pulse (i.e., heart beats). The sound and motion of the pulse is analyzed to identify the characteristic pattern associated with systole and diastole. The absolute pressures in the cuff at systole and diastole are recalled and reported as systolic and diastolic blood pressure.

During operation, the instrument also monitors itself, and will alarm and cease BP and temperature operation if a problem is detected.

The VITAL•CHECK instrument is powered by a rechargeable battery.

There are significant hardware differences between the Model 4200 and CIM equipped Model 4200 instruments. The CIM equipped 4200 contains an external dataport. Supporting circuitry includes a real time clock and I/O port to couple the thermometer display to the CPU bus. These enhancements make the CIM equipped 4200 computer-compatible and permit use of it as part of an automated record keeping system. Circuitry unique to the CIM equipped 4200 is discussed in more detail in section 3.11.

3.2 THE CPU

This section details the CPU, bus structure, clock, clock divider, interrupts and wait state generator.

Block diagrams, figures 3-1 and 3-2, show the control, data and address bus connections between the CPU and peripheral devices. Each peripheral is discussed further in sections 3.3 through 3.10.

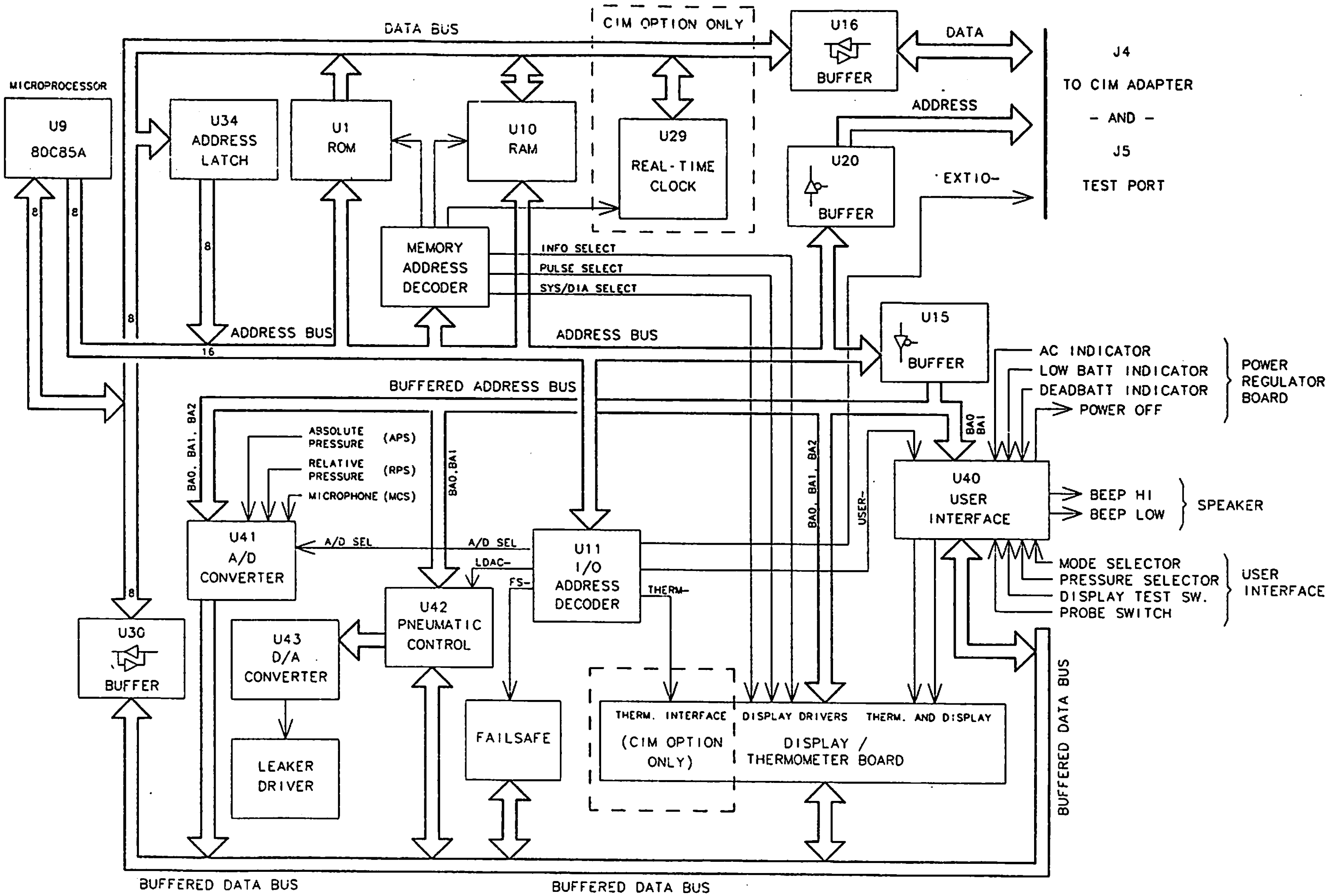


Figure 3-1. Block Diagram of Logic/Analog Board

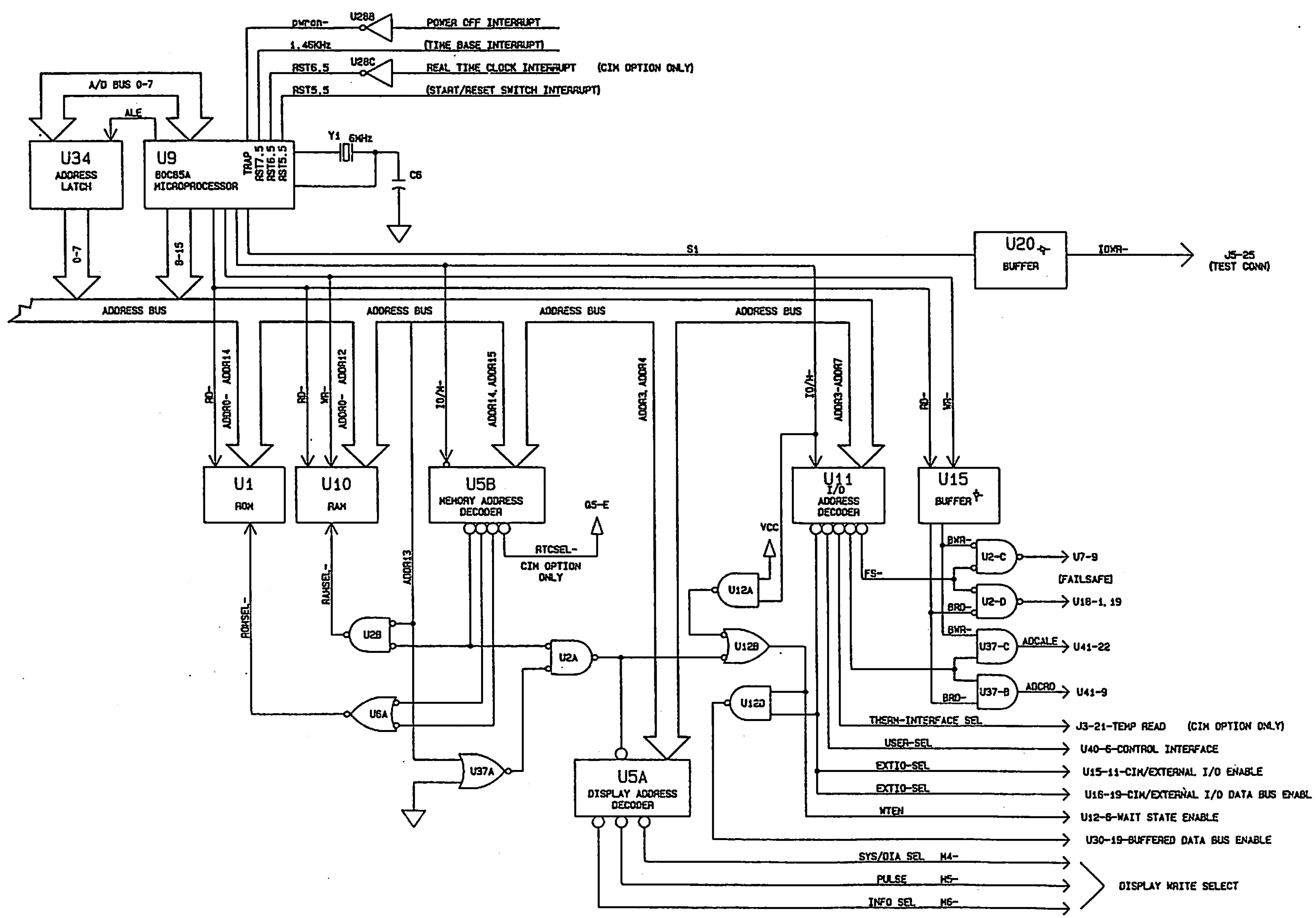


Figure 3-2. Block Diagram of Control and Address Bus Decoding

3.2.1 CPU and Address Latch (figure 3-3)

The CPU, an 80C85 (the CMOS version of the 8085), is an 8-bit microprocessor that features: an integral clock generator; four vectored interrupts; data transfer on a multiplexed, 8-bit, bi-directional, three-state bus (D0-7); 64 kilobyte addressing capability, and addressing of up to 256 I/O locations.

The 80C85 is configured as follows:

a. RSTIN-

   Power-up reset is provided by the C13, CR1, and R1 network.

b. RSTOUT

   Used to reset U33, U42, and U40.

c. HOLD

   Not used.

d. READY

   Used as a CPU timing control for wait-state generator.

e. SID (SERIAL INPUT)

   Used for developmental purposes only. Monitors one-half of the interrupt clock frequency.

f. SOD (SERIAL OUTPUT)

   Buffered by Q1. Used to turn the motor/pump on and off during a blood pressure cuff inflation cycle.

The CPU uses address latch U34 to form the lower 8 bits of the 16-bit address bus. The 16 address bits are used to select a device (RAM, ROM, I/O ports) with which to exchange data.

3.2.2 Data Bus (figure 3-1)

The 8-bit data bus is a conventional three-state bus. Resistor pack RN4 is connected to +5V logic and pulls the data bus lines high during times that the bus may be undriven (3-stated). The buffered bus can be accessed externally through test connector J5 on the logic/analog board.

The data bus connects directly to the address latch (U34), program ROM (U1), RAM (U10), Real-time clock (CIM option only, U29), and two bidirectional buffers (U16 and U30).

One buffer (U16) is for the "CIM/test/external I/O data bus," and is part of the external communications port. It is selected when the CIM/test/external I/O port is selected. It is bidirectional and its normal output to the connector is reversed to drive the CPU data bus during a read cycle.

The second buffer (U30) connects to what will be termed the "buffered data bus." U30 is enabled via gate U12-11. It is bi-directional, and during a read cycle its normal output to the buffered data bus is reversed to drive the CPU data bus.

The schematics refer to the data bus as bits A/D0 through A/D7. On the drawings, the buffered data bus is called bits BDATA0 through BDATA7. The CIM/test/external I/O bus is called out as IOD0 through IOD7.

3.2.3 Buffered Data Bus (figure 3-1)

The buffered data bus is an 8-bit bus, BDATA0 to BDATA7, and is buffered by U30. The buffered data bus connects to all I/O ports and to the display drivers and displays. The block diagram, figure 3-1, shows the relationship between the data bus and the buffered data bus.

Resistor pack RN3 pulls the buffered data bus high when not driven.

3.2.4 CIM/Test/External I/O Buffered Data Bus (figure 3-1)

The external bus is an 8-bit bus, IOD0 to IOD7, for CIM interfacing and testing. Buffer U16 connects to an external I/O port, J4 and J5. Resistor pack RN2 pulls these data bus lines high when not driven.

3.2.5 Address Bus (figure 3-2)

The address bus is a conventional 16-bit system, with the lower 8 bits latched in U34 during the address latch portion of the CPU cycle (ALE goes LO), and the upper 8 bits derived directly from the CPU. Included on the upper 8 bits of the bus are 10kΩ pull-ups to eliminate ambiguous logic levels during times that the bus may be undriven (3-stated).

During an I/O operation the low-order and high-order address bits copy each other.

The address bus is connected directly to the address decoders (U5 and U11), program ROM (U1), RAM (U10), and buffers (U15 and U20). Part of buffer U15 is used to buffer the three lowest-order bits (ADDR0, ADDR1, ADDR2) for all I/O ports and the display drivers and displays. Part of buffer U20 is used to buffer the three lowest-order of the high-order bits (ADDR8, ADDR9, ADDR10) to the test and CIM connectors.

The address bus is not connected to the real-time clock, U29, (CIM option only) as U29 has its own internal address latch, utilizing the ALE signal from the CPU.

The schematics refer to the address bus as ADDRESS BUS, bits ADDR0 through ADDR15. The buffered address bits are BA0, BA1, and BA2. The CIM/test/external I/O connector buffered address bits are IOA0, IOA1, and IOA2.

3.2.6 Control Bus (figure 3-2)

Five signals issued by the CPU are used to control the various devices connected to the CPU. They are:

a. IO/M- (Input/Output or Memory)

HI for an input/output (I/O) operation or LO for a memory read or write operation. IO/M- is used to select the memory address decoder (U5) or the I/O address decoder (U11). A 10kΩ pull-up is included to eliminate ambiguous logic levels during times this line may be undriven (3-stated).

b. RD- (Read)

LO to read a memory location or I/O device. This signal also controls the direction of the bidirectional data bus buffers. RD- is buffered via part of U15 to all I/O ports, and via part of U20 as ERD- to the CIM and test connectors. A 10kΩ pull-up is included to eliminate ambiguous logic levels during times this line may be undriven (3-stated).

c. WR- (Write)

LO to write to a memory location or I/O device. This signal is buffered via part of U15 as BRD- to all I/O ports and displays and display drivers, and via part of U20 as EWR- to the CIM and test connectors. A 10kΩ pull-up is included to eliminate ambiguous logic levels during times this line may be undriven (3-stated).

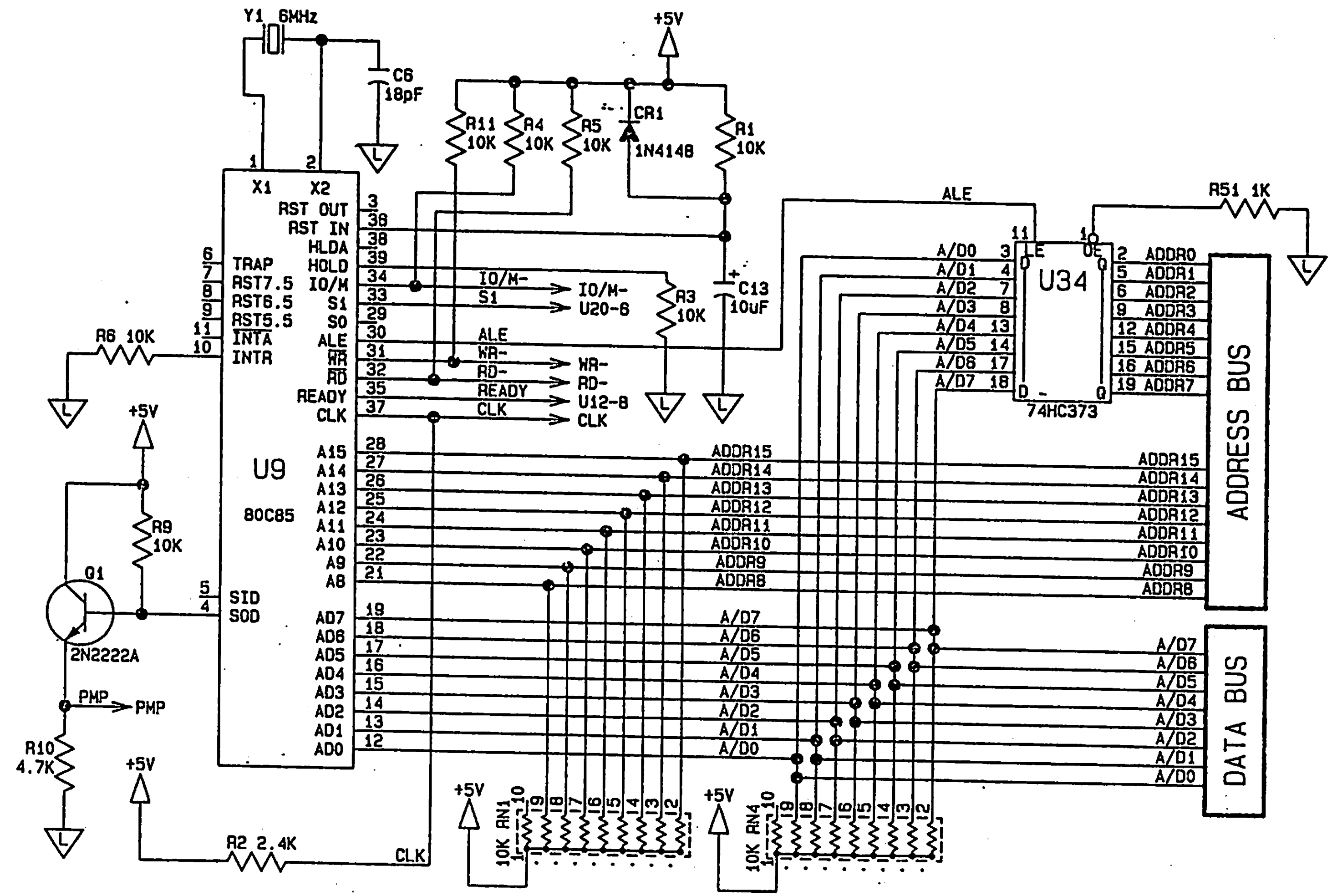


Figure 3-3. CPU and Address Latch

d. S1 (Status 1)

LO during a write operation. This signal is buffered via part of U20 as IOWR- to the CIM and test connectors. This is a special signal used only by the optional CIM module as a read or write signal (RD/WR-).

e. ALE (Address Latch Enable)

HI during first part of processor cycle when the low order address is present on the data bus. The low order address is latched in U34 when ALE goes LO. ALE also connects to the wait-state enable circuit (section 3.2.10) and to the real-time clock (CIM option only).

3.2.7 Clock (figure 3-4)

The entire system timing is derived from the CPU clock, except for the thermometer µcontroller and display scanning. A 6 MHz crystal is used to generate the necessary clock signal for the CPU.

The 6 MHz quartz crystal controls the frequency of an internal oscillator in the CPU. The internal frequency is divided by two to become the CPU clock, with a period of 333 nanoseconds (3 MHz).

The 3 MHz clock signal (CLK) from the CPU is the logic reference frequency.

CLK is buffered via part of U15 as BCLK for the thermometer interface (CIM option only) on the display/thermometer board, and buffered via part of U20 as ECLK for the CIM and test connectors. CLK output is pulled to +5V through R2.

3.2.8 Clock Divider (figure 3-4)

CLK is fed to a 12-bit ripple counter, U26, and divided into harmonically related lower frequencies for other parts of the system. Those frequencies are 375 kHz, 23.4 kHz, 1.46 kHz, and 732 Hz.

a. 375 kHz Signal

This timing signal is used to drive the A/D converter clock (U41) and the failsafe circuit.

b. 23.4 kHz Signal

A 23.4 kHz signal is used to synchronize the switching circuit frequency on the power regulator board.

c. 1.46 kHz Signal

A 1.46 kHz signal from U26 pin 15 is delivered to the RST7.5 interrupt input on the CPU to serve as a time base, and delivered to U36 pin 5 to serve as the high-pitched alarm.

d. 732 Hz Signal

A 732 Hz signal from U26 pin 1 is applied to the SID input on the CPU (for developmental purposes) and to U36 pin 1 as the low-pitched audio alarm. The 732 Hz signal is buffered by Q18, serving as a clock source for the operator control state machines U31 and U32 via U24 clock divider.

3.2.9 Interrupts (figure 3-2)

The 80C85 CPU interrupt system is configured as follows:

a. RST7.5 (pin 7)

The time base interrupt RST7.5 is the basis of all the software timing in the instrument. Some functions of the time base interrupt are controlling the deflation rate, determining pulse rate and operating the auto mode timers. U26, a binary divider chain, is driven from the 3 MHz CPU clock. The eleventh stage provides a 1.46 kHz (683 microsecond) signal to RST7.5 so that every 683 microseconds the CPU is interrupted to update timers and perform other periodic tasks. This interrupt is always in effect when the instrument is turned on, except for the initial start-up sequence.

b. RST6.5 (pin 8)

Interrupt RST6.5 is generated by the real-time clock (U29, CIM option only). Once per second, upon completion of updating its registers, the real-time clock issues an interrupt via U28-6 to the CPU. When the real-time clock is ready to be read, it pulls its pin 19 LO, driving U28 pin 6 HI, to interrupt the CPU.

In Model 4200A instruments, U29 is not installed and U28 pin 6 is always HI via R16, so RST6.5 is always LO, resulting in no interrupt.

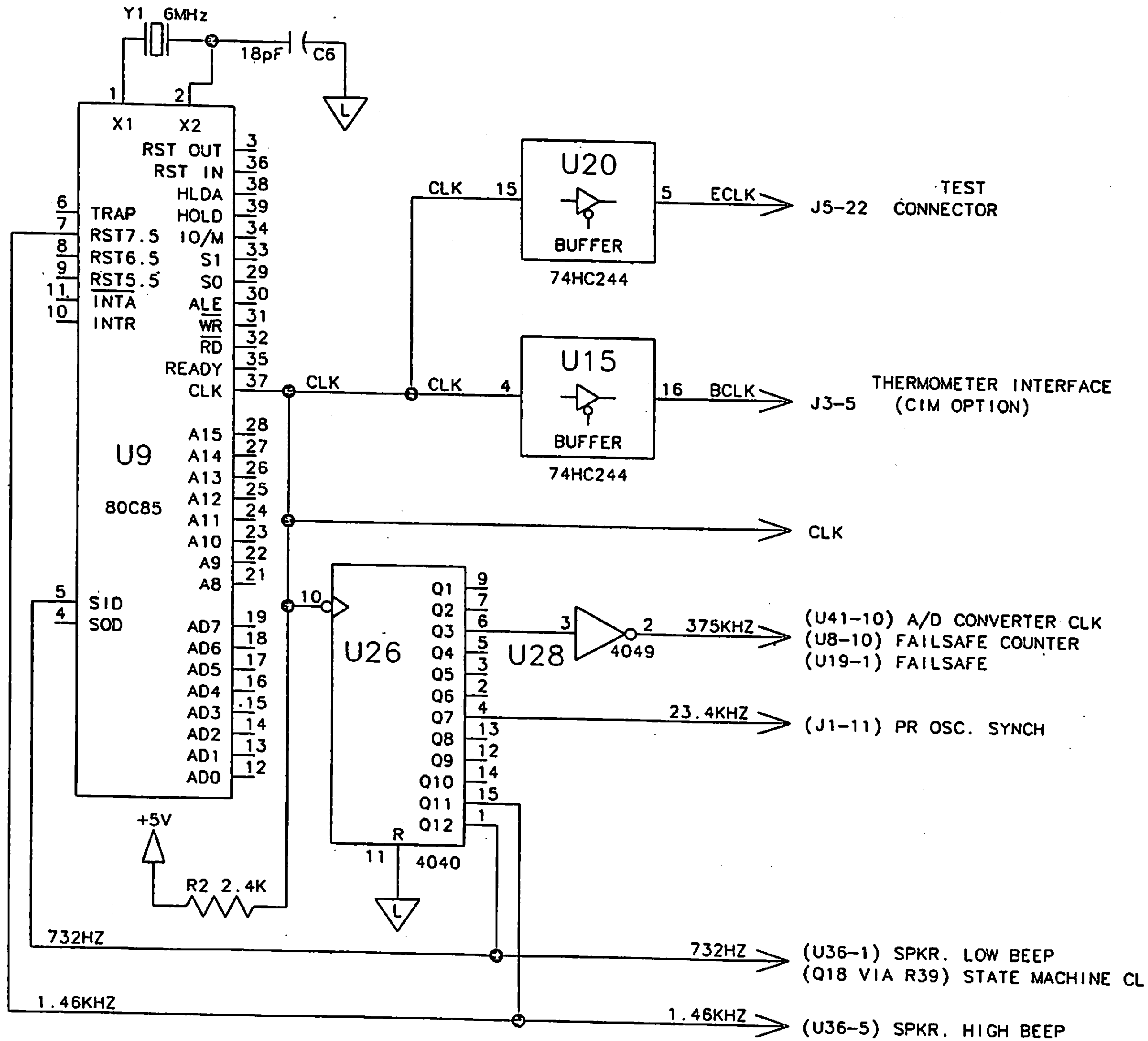


Figure 3-4. Clock and Clock Divider

c. RST5.5 (pin 9)

The instrument's START/RESET function is through the low priority interrupt, RST5.5 (figure 3-5). This interrupt is provided by U32, which is used to debounce the START/RESET switch. Pressing the START/RESET switch brings U32 pin 3 LO (STARTSW-) which results in a synchronized and debounced HI signal at U32 pin 16 (START). This generates an RST5.5 interrupt at the CPU. Releasing the START/RESET switch allows U32 pin 3 to go HI, bringing U32 pin 16 LO.

d. TRAP (pin 6)

The power-down interrupt TRAP is used to allow the CPU to shut down before power is actually removed. When the instrument is turned off, U28 pin 5 goes LO, causing pin 4 to go HI. This causes the CPU to execute a TRAP interrupt (highest priority) and stop before the +5V logic supply is removed. This feature is principally incorporated for the CIM equipped instruments to avoid disrupting the real-time clock, but is functional in all the instruments.

3.2.10 Wait-State Generator (figure 3-6)

U21 and U12-8 comprise a circuit which adds one extra clock period (i.e., a "wait state" of 333 nanoseconds), to the access cycles of the displays and I/O ports to accommodate the extra propagation delay of the bus buffers and slower access devices such as the A/D converter. The wait state is activated each time either of the bidirectional buffers U16 and U30 are enabled.

A wait state request is presented to the CPU READY input for I/O or display address. WTEN enables gate U12-8 during IO/M- or display select, applying the timing signal from U21 pin 9 to the CPU READY.

At each processor cycle, the arrival of the high leading edge of ALE at U21 pin 3 causes a HI signal to be clocked through to U21-9 and out to U12 pin 10, where it is ANDed with WTEN to hold the CPU in a wait state.

When the high is clocked into U21-9, U21-5 is cleared until the next CPU ALE cycle, which also causes U21-9 to be clocked LO, allowing the CPU to exit the wait state.

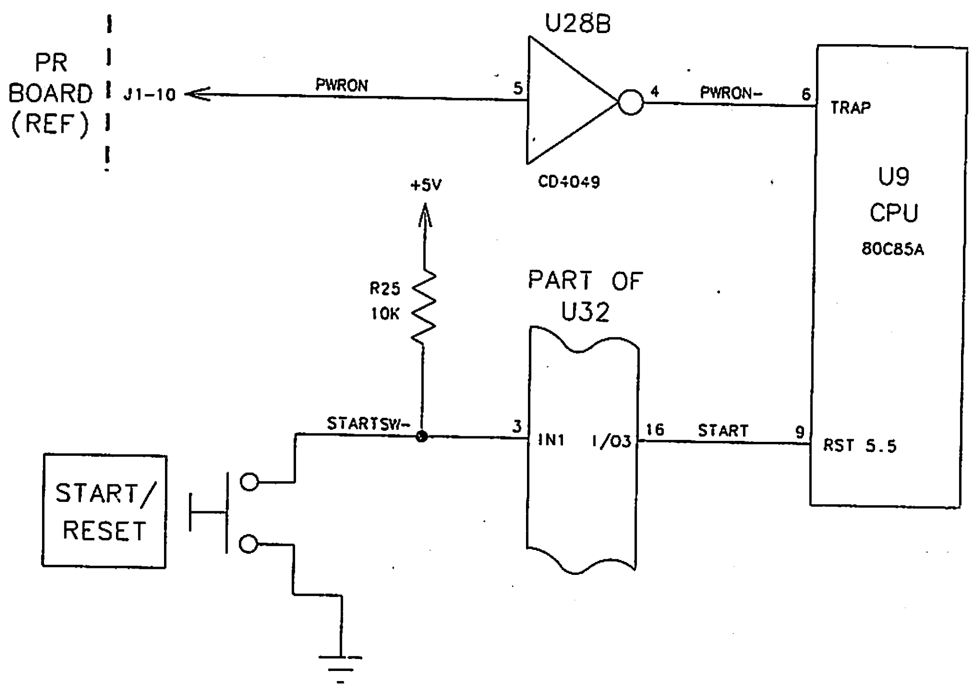


Figure 3-5. START/RESET Interrupt

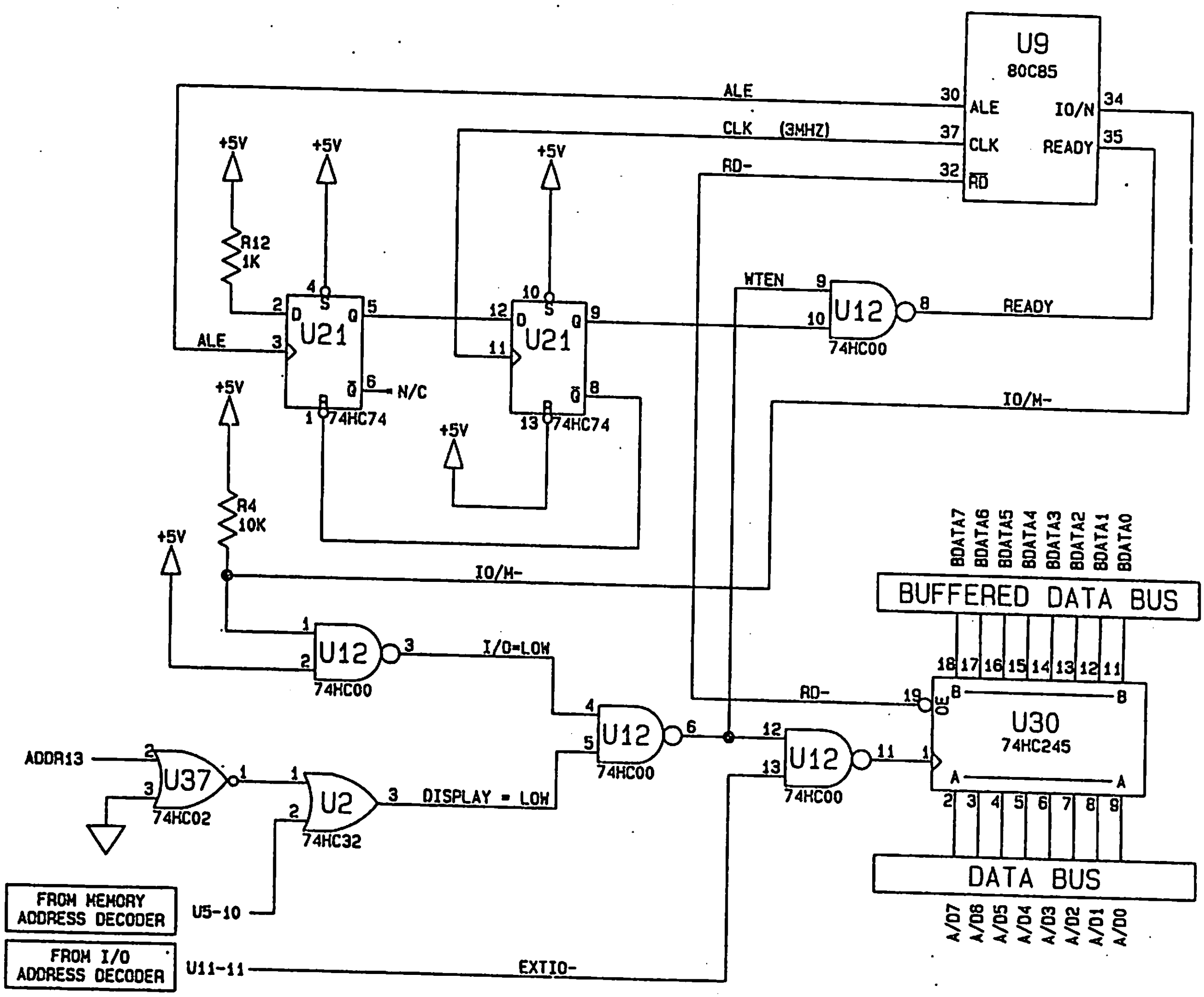


Figure 3-6. WTEN and READY Signals (U410)

3.3 MEMORY ADDRESS AND DISPLAY DECODING (figure 3-7)

The memory address decoder comprises two sections of U5. These are a dual two-to-four decoder with accompanying logic gates.

Decoder U5 is used in conjunction with gates U6-3, U2-6, U2-3, and U37-1 to enable memory-mapped parts of the system. This includes the displays, RAM, ROM, and in the CIM equipped instrument, the real-time clock. Table 3-2 shows the decoder configuration.

Displays are memory-mapped (figure 3-7). The displays consist of two alphanumeric DL2416s (giving eight-character message capacity) and separate 3-digit LED displays for systolic blood pressure, diastolic blood pressure, and pulse.

Address decoder U5-15 is enabled when IO/M- is LO. At that time, ADDR14 and ADDR15 will cause one of the four outputs Y0, Y1, Y2, or Y3 to go LO. Y0 or Y1 select ROM. Y2 selects RAM via U2-6, if ADDR13 is LO; or selects the displays if ADDR13 is HI, via U37-1 and U2-3. Pin 3 of U2 is LO when the displays are selected. This enables U5-1 where further decoding for the displays is done. This signal also enables the CPU wait state and enables the buffered data bus buffer via U12-6 (WTEN).

It should be noted that temperature is displayed in a fourth LED cluster under the control of a separate microprocessor on the temperature board. Refer to section 3.10.

3.3.1 Read Only Memory (ROM, U1, figure 3-8)

The blood pressure measurement program is stored in one EPROM (total program space is 32K x 8).

The software program is outlined in section 3.12.2.

3.3.2 Random Access Memory (RAM, U10, figure 3-9)

The RAM is an 8KB x 8 or 32KB x 8 static device used as data storage and CPU stack. It is selected via U5B and U2B (RAMSEL-) and controlled by RD- for read and WR- for write operations.

The instrument is designed to accomodate either an 8 KB x 8 or a 32 KB x 8 device without changing switches or jumpers. This is accomplished by pin 26 being tied HI (CS2 on 8 KB x 8, A13 on 32 KB x 8) and by pin 1 being tied LO (no connection on 8 KB x 8, A14 on 32 KB x 8). The 32 KB x 8 device functions as an 8 KB x 8 device in this application.

3.3.3 Display Drivers

The blood pressure, pulse, and information displays are memory-mapped.

Display drivers U1 and U4 on the display/thermometer board are connected to the buffered data bus BDATA0 through BDATA4, and are enabled by M4- and M5- from the memory address decoder (U5). U1 is the systolic and diastolic display driver. U4 is the pulse display driver.

The information displays DS15 and DS16 are selected by M6-. These 64 character displays perform additional decoding of BA0-2 and are also connected to the buffered data bus.

Memory display decoding is tabulated in table 3-2. Functional descriptions of the 7-segment and information displays are provided in section 3.7.

3.3.4 Real-Time Clock (U29, CIM option only)

The real-time clock is initialized by write commands from the CPU and is read when date and time is required for the 4200 measurment system.

After updating its registers once a second, the real-time clock issues an interrupt (RST6.5) to the CPU to indicate that it is safe to read the registers.

U29 is enabled by Q5, driven by RTCSEL- from the memory address decoder. To prevent disruption to U29 registers during power down, the chip enable (CS) is held high by circuitry explained in section 3.11.3.

Table 3-2. Memory/Display Address Decoding

MEMORY	IO/M-	RD-	WR-	S1	ADDR 0	ADDR 1	ADDR 2	ADDR 3	ADDR 4	ADDR 5	ADDR 6	ADDR 7	ADDR 8	ADDR 9	ADDR 10	ADDR 11	ADDR 12	ADDR 13	ADDR 14	ADDR 15
MEMORY ADDRESS DECODER: U5B																				
READ ONLY MEMORY (Y0, Y1) U1																				
READ (ROMSEL- = LO)	0	0	1	X	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	0
RANDOM ACCESS MEMORY (Y2) U10																				
READ (RAMSEL- = LO)	0	0	1	X	A	A	A	A	A	A	A	A	A	A	A	A	A	0	0	1
WRITE (RAMSEL- = LO)	0	1	0	X	A	A	A	A	A	A	A	A	A	A	A	A	A	0	0	1
REAL-TIME CLOCK (Y3) U29																				
READ (RTCSEL- = LO)	0	0	1	X	A	A	A	A	A	A	X	X	X	X	X	X	X	X	1	1
WRITE (RTCSEL- = LO)	0	1	0	X	A	A	A	A	A	A	X	X	X	X	X	X	X	X	1	1

NOTE: Symbols (X) not used; (A) indicates an address selection within the address range of the device.

Table 3-2. Memory/Display Address Decoding (cont.)

MEMORY	IO/M-	RD-	WR-	S1	ADDR 0	ADDR 1	ADDR 2	ADDR 3	ADDR 4	ADDR 5	ADDR 6	ADDR 7	ADDR 8	ADDR 9	ADDR 10	ADDR 11	ADDR 12	ADDR 13	ADDR 14	ADDR 15
DISPLAY ADDRESS DECODER: U403B																				
Systolic LSD (1s unit)	0	1	0	X	0	0	0	0	0	X	X	X	X	X	X	X	X	1	0	1
Systolic NSD (10s unit)	0	1	0	X	1	0	0	0	0	X	X	X	X	X	X	X	X	1	0	1
Systolic MSD (100s unit)	0	1	0	X	0	1	0	0	0	X	X	X	X	X	X	X	X	1	0	1
Diastolic LSD (1s unit)	0	1	0	X	0	0	1	0	0	X	X	X	X	X	X	X	X	1	0	1
Diastolic NSD (10s unit)	0	1	0	X	0	0	0	1	0	X	X	X	X	X	X	X	X	1	0	1
Diastolic MSD (100s unit)	0	1	0	X	0	0	0	0	1	X	X	X	X	X	X	X	X	1	0	1
Pulse LSD (1s unit)	0	1	0	X	1	1	0	1	0	X	X	X	X	X	X	X	X	1	0	1
Pulse NSD (10s unit)	0	1	0	X	0	0	1	1	0	X	X	X	X	X	X	X	X	1	0	1
Pulse MSD (100s unit)	0	1	0	X	1	0	1	1	0	X	X	X	X	X	X	X	X	1	0	1
Information left	0	1	0	X	1	1	1	0	1	X	X	X	X	X	X	X	X	1	0	1
Information 2	0	1	0	X	0	1	1	0	1	X	X	X	X	X	X	X	X	1	0	1
Information 3	0	1	0	X	1	0	1	0	1	X	X	X	X	X	X	X	X	1	0	1
Information 4	0	1	0	X	0	0	1	0	1	X	X	X	X	X	X	X	X	1	0	1
Information 5	0	1	0	X	1	1	0	0	1	X	X	X	X	X	X	X	X	1	0	1
Information 6	0	1	0	X	0	1	0	0	1	X	X	X	X	X	X	X	X	1	0	1
Information 7	0	1	0	X	1	0	0	0	1	X	X	X	X	X	X	X	X	1	0	1
Information right	0	1	0	X	0	0	0	0	1	X	X	X	X	X	X	X	X	1	0	1

NOTE: Symbols (X) not used; (A) indicates an address selection within the address range of the device.

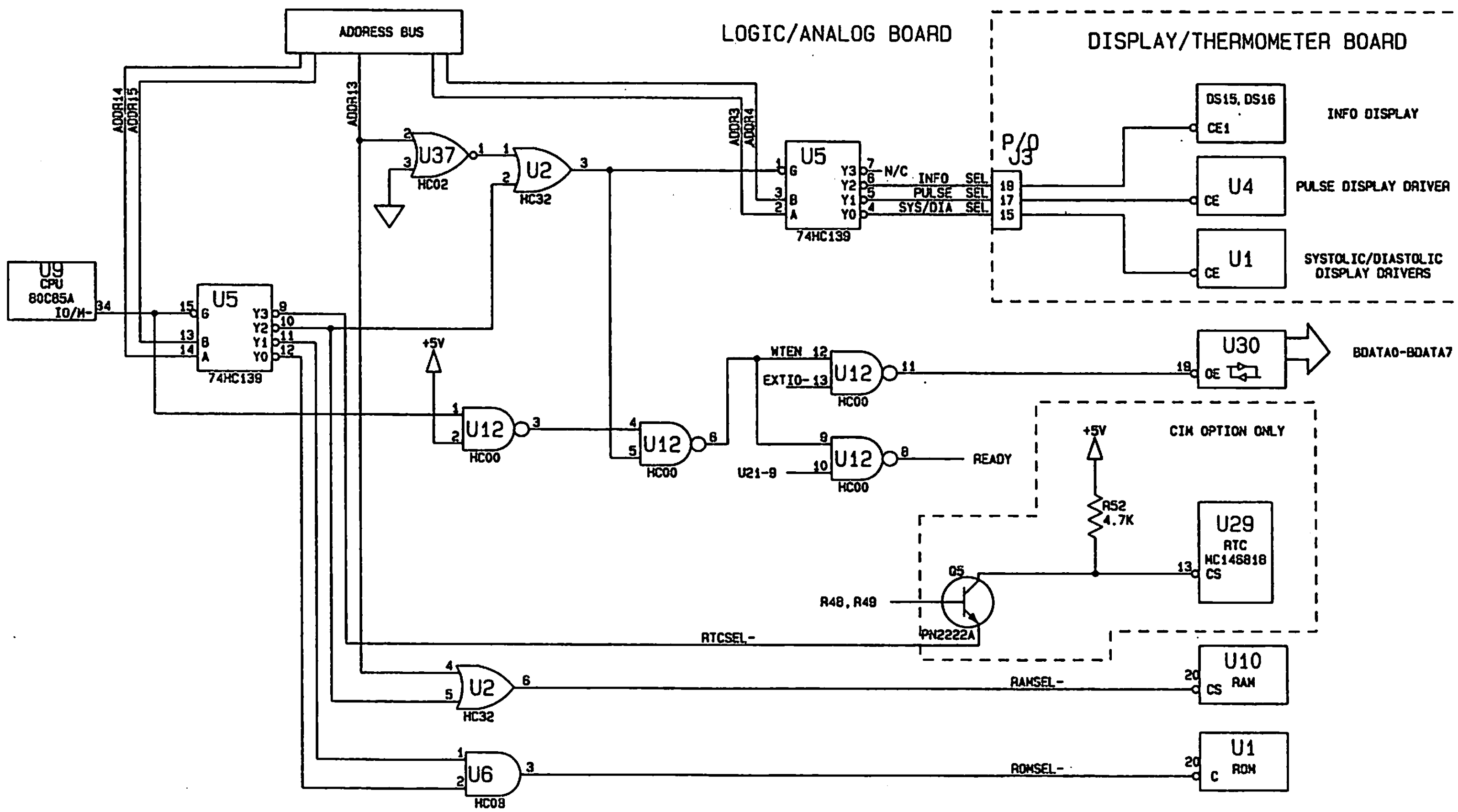


Figure 3-7. Memory Address Decoder and Display Drivers

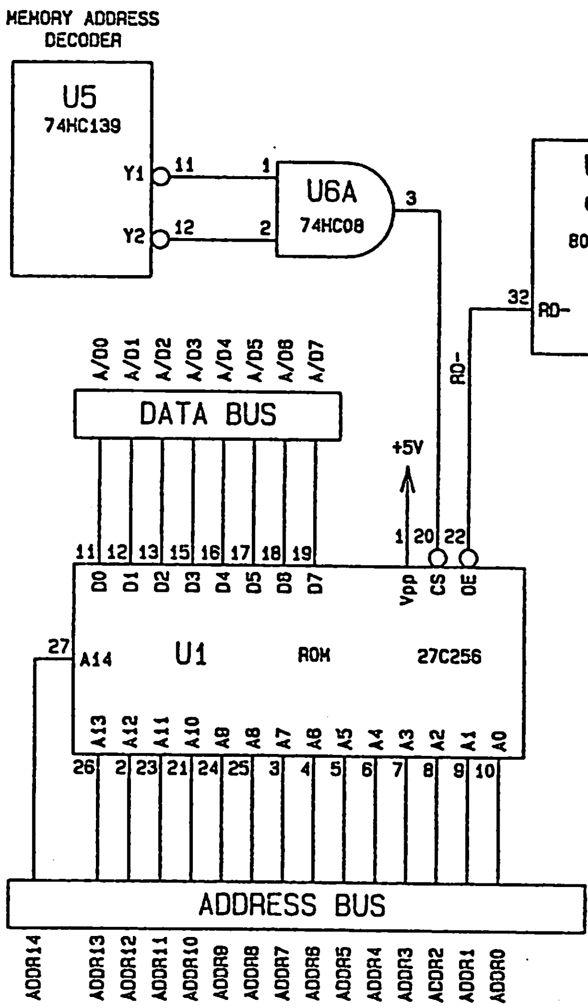


Figure 3-8. Read Only Memory

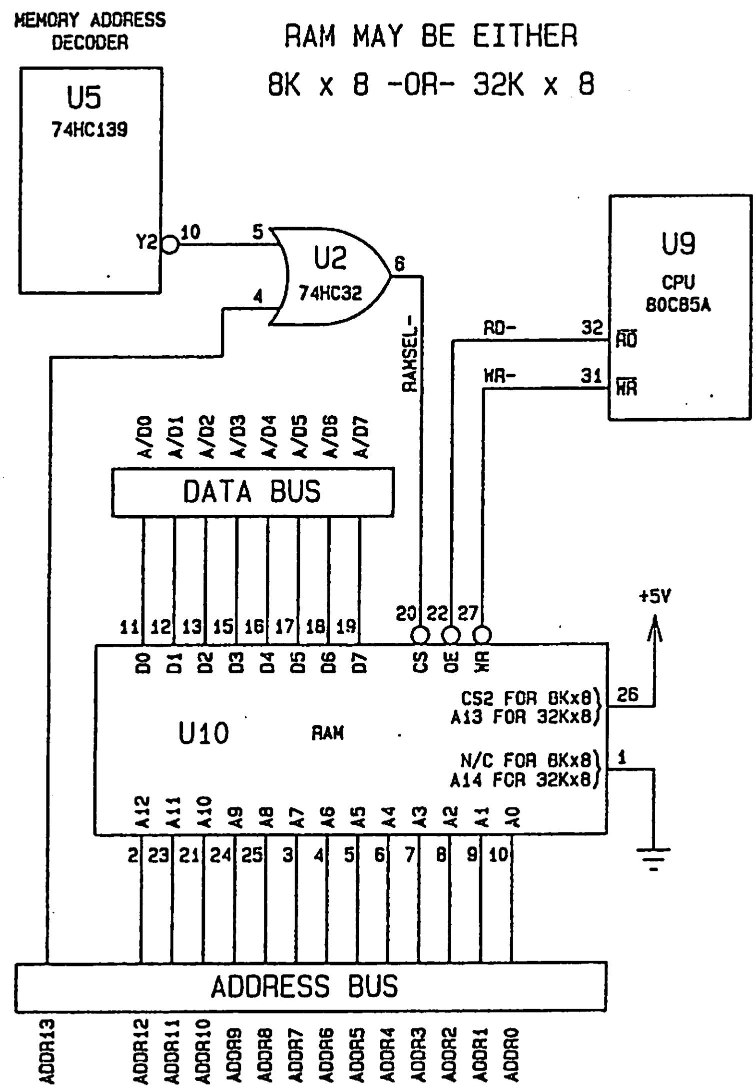


Figure 3-9. Random Access Memory

3.4 I/O ADDRESS DECODING (U11, figure 3-10)

Address decoder U11 is used to enable all the I/O ports. I/O devices include:

- A/D converter port
- Pneumatic control port and D/A latch
- User interface port
- TEMPERATURE display interface port (CIM option only)
- Failsafe I/O port
- CIM interface and test connector

Address decoder U11 is enabled when IO/M- is HI and bits ADDR6 and ADDR7 are LO. At that time, ADDR3, ADDR4, and ADDR5 will cause one of the six outputs, Y0 through Y5, to go LO. Y0 is gated with BWR- in U37-10 to form an A/D address load strobe and with BRD-in U37-4 to form an A/D buffer read strobe. Y1 selects the D/A latch and analog control I/O port. Y2 selects the operator controls I/O port. Y3 selects the failsafe I/O port and Y4 selects the test connector and CIM. Y4 also enables U16, the bidirectional data bus buffer and disables U30, the internal buffered data bus buffer via U12-11. On the CIM equipped instruments, Y5 selects the thermometer interface I/O port. Table 3-3 summarizes the I/O decoder configuration.

3.4.1 A/D Converter Port (U41, figure 3-10)

The A/D converter, U41 on the logic/analog board, is an 8-bit successive approximation type with a built-in, 8-channel multiplexer.

U41 is controlled by ADCRD, ADCALE and a HI at ST. Two pressure and one audio data conversion channels are selected by further internal decoding of BA0 - BA2.

The functional description of the A/D converter is part of blood pressure data acquisition and is supplied in section 3.5.4.

3.4.2 Pneumatic Control Port (U42, figure 3-10)

The pneumatic control is U42 on the logic/analog board. This is a 3-port device. The first two ports (PA4-7 and PB0-7) are used as the 12-bit data latch for the D/A converter. PA0-3 are unused. The third port is divided into two 4-bit sections. PC4-7 is used to read the first 4 positions of the S2 switch on logic/analog board

(S2 switches 5 and 6 are read/used differently). PC0-3 are outputs. PC0 controls the dump valve (DFO-). PC1 is used to hold the leaker closed (LSO). PC2 is used to hold the leaker open (LFO-). PC3 is the A/D converter conversion control.

3.4.3 User Interface Port (U40, figure 3-10)

The user interface I/O port, U40 on the logic/analog board, is one of two 8255A IC's in the instrument. Ports PA, PB and PC are used.

The first port (PA0-7) and part of the second port (PB0) are used to read the MODE selector setting. The rest of the second port is used to read the pressure selector setting (PB1, PB2), the thermometer probe switch (PB3), the display test switch (PB4), the battery status from the power regulator (PB5, PB6), and the AC power status from the power regulator (PB7).

The third port is used as an output port as follows: select high pitch beep (PC0), select low pitch beep (PC1), thermometer display test (PC4), turn on thermometer (PC5), and turn instrument off (PC7). The remaining three bits are not used.

Further description is found in section 3.6.

3.4.4 Temperature Display Interface Port (U10 - Display/Thermometer Board, CIM Option Only, figure 3-10)

The temperature display interface, U10 on the display/thermometer board, is a programmed peripheral with 1 kilobyte of program ROM and 64 bytes of RAM. It is enabled by THERM- from the I/O address decoder.

To the CPU, U10 is an I/O port. However, it is a satellite processor that reads and converts the COP444L temperature display driver output to 80C85 compatible data that is read by the CPU.

Further description is found in section 3.12.

Table 3-3. I/O Decoding

I/O PORT	IO/M-	RD-	WR-	S1	ADDR 0	ADDR 1	ADDR 2	ADDR 3	ADDR 4	ADDR 5	ADDR 6	ADDR 7	ADDR 8	ADDR 9	ADDR 10	ADDR 11	ADDR 12	ADDR 13	ADDR 14	ADDR 15
I/O ADDRESS DECODER: U11																				
A/D CONVERTER (Y0) U41																				
A/D address load (ARCALE = HI, BWR- = LO)																				
Select microphone (MSC)	1	1	0	X	0	0	0	0	0	0	0	0	X	X	X	X	X	X	X	X
Select relative pressure (RPS)	1	1	0	X	1	0	0	0	0	0	0	0	X	X	X	X	X	X	X	X
Select absolute pressure (APS)	1	1	0	X	0	1	0	0	0	0	0	0	X	X	X	X	X	X	X	X
A/D buffer read (ADCRD = HI, BRD- = LO)	1	0	1	X	X	X	X	0	0	0	0	0	X	X	X	X	X	X	X	X
A/D start conversion	1	1	0	X	0	1	X	1	0	0	0	0	X	X	X	X	X	X	X	X
PNEUMATIC CONTROL (Y1) U42																				
PC0, dump valve open command (DFO-)	1	1	0	X	0	1	X	1	0	0	0	0	X	X	X	X	X	X	X	X
PC1, hold leaker closed command (LSO)	1	1	0	X	0	1	X	1	0	0	0	0	X	X	X	X	X	X	X	X
PC2, hold leaker open command (LFO-)	1	1	0	X	0	1	X	1	0	0	0	0	X	X	X	X	X	X	X	X
PC3, A/D start conversion	1	1	0	X	0	1	X	1	0	0	0	0	X	X	X	X	X	X	X	X
PC4-7, Test/Cal Config., S2 DIP switch	1	0	1	X	0	1	X	1	0	0	0	0	X	X	X	X	X	X	X	X
D/A LATCH (Y1) U42																				
PA4-7	1	1	0	X	0	0	X	1	0	0	0	0	X	X	X	X	X	X	X	X
PB0-7	1	1	0	X	1	0	X	1	0	0	0	0	X	X	X	X	X	X	X	X

NOTES: (1) During I/O operation, A8-A15 copy A0-A7.
(2) Symbols (X) not used; (A) indicates an address selection within the address range of the device.

Table 3-3. I/O Decoding (cont.)

I/O PORT	IO/M-	RD-	WR-	S1	ADDR 0	ADDR 1	ADDR 2	ADDR 3	ADDR 4	ADDR 5	ADDR 6	ADDR 7	ADDR 8	ADDR 9	ADDR 10	ADDR 11	ADDR 12	ADDR 13	ADDR 14	ADDR 15
USER INTERFACE PORT (Y2) U40																				
PA0-7, PB0, read MODE switch setting	1	0	1	X	0	0	X	0	1	0	0	0	X	X	X	X	X	X	X	X
PB1-2, read pressure switch setting	1	0	1	X	1	0	X	0	1	0	0	0	X	X	X	X	X	X	X	X
PB3, read thermometer probe sensor	1	0	1	X	1	0	X	0	1	0	0	0	X	X	X	X	X	X	X	X
PB4, read display/test switch	1	0	1	X	1	0	X	0	1	0	0	0	X	X	X	X	X	X	X	X
PB5-6, read battery status from PR board	1	0	1	X	1	0	X	0	1	0	0	0	X	X	X	X	X	X	X	X
PB7, read AC power status	1	0	1	X	1	0	X	0	1	0	0	0	X	X	X	X	X	X	X	X
PC0, select LO BEEP speaker drive	1	1	0	X	0	1	X	0	1	0	0	0	X	X	X	X	X	X	X	X
PC1, select HI BEEP speaker drive	1	1	0	X	0	1	X	0	1	0	0	0	X	X	X	X	X	X	X	X
PC2, not used																				
PC3, not used																				
PC4, run display test	1	1	0	X	0	1	X	0	1	0	0	0	X	X	X	X	X	X	X	X
PC5, activate themometer function	1	1	0	X	0	1	X	0	1	0	0	0	X	X	X	X	X	X	X	X
PC6, not used																				
PC7, turn instrument off	1	1	0	X	0	1	X	0	1	0	0	0	X	X	X	X	X	X	X	X
FAILSAFE INPUT PORT (Y3)																				
U18, FS- = LO, BRD- = LO	1	0	1	X	X	X	X	1	1	0	0	0	X	X	X	X	X	X	X	X
FAILSAFE OUTPUT PORT (Y3)																				
U7, FS- = LO, BWR- = LO	1	1	0	X	X	X	X	1	1	0	0	0	X	X	X	X	X	X	X	X

NOTES: (1) During I/O operation, A8-A15 copy A0-A7.
(2) Symbols (X) not used; (A) indicates an address selection within the address range of the device.

Table 3-3. I/O Decoding (cont.)

I/O PORT	IO/M-	RD-	WR-	S1	ADDR 0	ADDR 1	ADDR 2	ADDR 3	ADDR 4	ADDR 5	ADDR 6	ADDR 7	ADDR 8	ADDR 9	ADDR 10	ADDR 11	ADDR 12	ADDR 13	ADDR 14	ADDR 15
CIM/TEST CONNECTORS (Y4) U16																				
READ	1	0	1	1	X	X	X	0	0	1	0	0	A	A	A	X	X	X	X	X
WRITE	1	1	0	0	X	X	X	0	0	1	0	0	A	A	A	X	X	X	X	X
THERMOMETER DISPLAY INTERFACE (Y5) U10																				
Read status	1	0	1	X	1	X	X	1	1	0	1	0	0	X	X	X	X	X	X	X
Read data	1	0	1	X	0	X	X	1	1	0	1	0	0	X	X	X	X	X	X	X
Write test command	1	1	0	X	0	X	X	1	1	0	1	0	0	X	X	X	X	X	X	X

NOTES: (1) During I/O operation, bits A8-15 copy A0-A7.
(2) A8, A9, an A10 determine the address level within the CIM/test/external I/O port.
(3) For CIM, A8 is IOA0 and A9 is IOA1.
(4) A10 does not affect CIM addressing, but is IOA2.
(5) Symbols (X) not used; (A) indicates an address selection within the address range of the device.

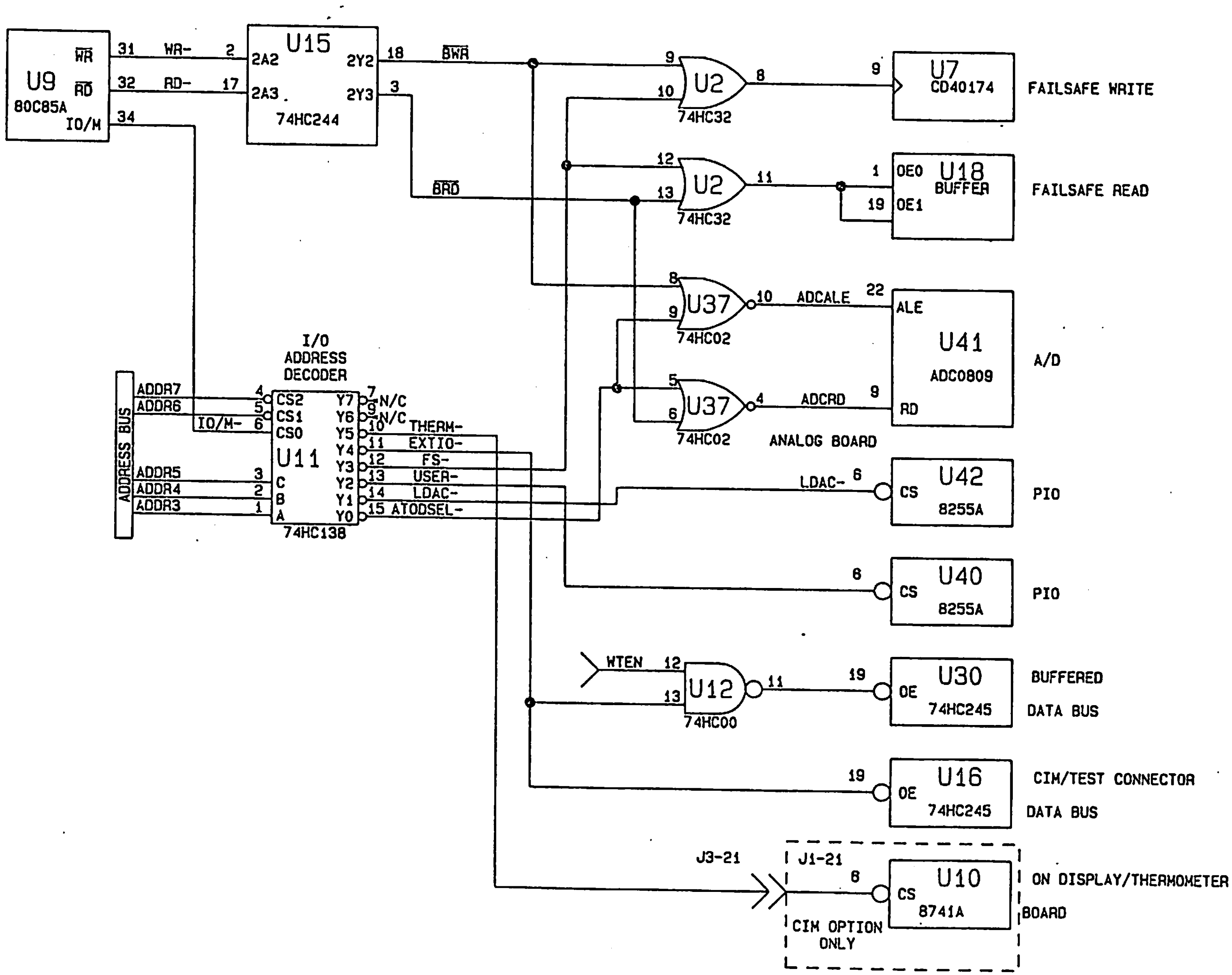


Figure 3-10. I/O Address Decoding

3.4.5 Failsafe Ports (U18, U7 figure 3-10)

The failsafe input port is a 3-state buffer, U18, which is enabled by ANDing the failsafe select (FS-) from the I/O address decoder and buffered read (BRD-) in U2D. Performing a read operation places the current failsafe status on the buffered data bus. The failsafe output port is a six-bit latch, U7, which latches the lower six bits of the buffered data bus (BDATA0 through BDATA5). It is clocked by the trailing edge of buffered write (BWR-) ANDed with failsafe select (FS-) during a write operation in U2-8. The contents of U7 remain latched until another write operation, or cleared via pin 1.

3.4.6 CIM/Test Connectors (figure 3-10)

The signals at this connector are buffered with their own buffers, U16 and U20. U16 is a bidirectional buffer for the data bus and U20 buffers the rest of the related I/O signals, ERD- (read), EWR- (write), IOWR- (CIM read or write) and ERESET (CPU power-on reset). Eight address levels are available via IOA0, IOA1 and IOA2. Part of U15 is used to buffer the external I/O enable signal, EXTSEL-. When the external I/O is selected and U16 enabled, internal bus buffer U30 is disabled via U12-11.

3.5 BLOOD PRESSURE MEASUREMENT

The mechanical assemblies are discussed first, followed by a general description of the measurement cycle. The four parts of the cycle (inflation, deflation, data acquisition, and data processing) are then discussed in more detail.

3.5.1 The Pneumatic Assembly

The pneumatic assembly consists of a compressor pump, accumulator (or pressure reservoir), pressure sensor (located on the logic/analog board), leaker valve, dump valve, overpressure switch, and transition board. The mechanical assemblies are described in the following paragraphs.

a. Compressor Pump

The pump inflates the pressure cuff. It is a diaphragm type compressor powered by a stroke from a small crankshaft and connecting rod driven by a 12 VDC motor.

b. Accumulator

The accumulator (or reservoir), provides a minimum air capacity of the pneumatic system. Without the reservoir, too small a volume of air could cause the cuff to deflate in an erratic manner.

c. Pressure Sensor (Transducer)

The sensor 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 CPU 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.

d. Leaker Valve

This is a reed-type air valve. Under CPU control, the leaker deflates the cuff at a linear rate of 5 mmHg/sec or 2.5 mmHg/sec, depending on the operating mode and pressure signal characteristics.

e. 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 instrument 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 tripped or other sections of the failsafe circuit is activated.

f. Overpressure Switch

This safety switch is adjusted to trip if the 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.

g. Transition Board

The transition board serves as a "junction box" for the electrical components on the pneumatic assembly.

3.5.2 The Measurement Cycle

A blood pressure measurement is taken as described in the following paragraphs.

a. Inflation

On signal from the START/RESET switch, or automatic timer, the CPU starts the pump via serial output data (SOD) signal to inflate the cuff. Pressure in the cuff is monitored by the pressure sensor and reported back to the CPU via the A/D converter. The CPU stops the pump when the user-selected cuff pressure is reached.

b. Deflation

After a moment for the heat of compression to equilibrate, and to check for leaks, the cuff is deflated at a constant rate, and data is collected from the microphone mounted in the cuff and from the pressure sensor.

c. To deflate the cuff, the CPU uses a deflation algorithm which controls the rate of deflation. Under control of the algorithm, the D/A converter becomes a variable negative current source, subtracting current from the pressure sensor output.

d. As each new value from the deflation algorithm is downloaded into the D/A converter, the current subtracted by the D/A converter steps down (i.e., less and less current is subtracted from the pressure sensor output). The current is subtracted at the input node to an error amplifier.

e. An error amp senses the remaining (or "difference") current. At each step in the deflation algorithm, the error amp senses the residual difference between the current subtracted by the D/A converter and the current supplied by the pressure sensor. The difference is amplified (with a gain of about 1:60), inverted, and fed into the leaker control circuit as a voltage.

f. Each step decrease in negative current at the D/A converter leads the pressure in the cuff lower by creating a positive difference current that is inverted and drives open the leaker valve to maintain the 5 mm/sec deflation rate. The pressure in the cuff is lead downward in a smooth, linear deflation curve by rapid step changes in the D/A current drain.

g. Data Acquisition

During deflation, data is collected. Three signals are digitized and stored for processing. The absolute pressure signal (APS) from the pressure sensor, the relative pressure signal (RPS) output from the pressure error amp, and the output from the microphone amplifier signal (MCS) are read by the A/D converter to the CPU. The CPU strobes these three signals every 2 milliseconds during a measurement cycle. The data is partially processed and stored in RAM for final processing at the end of the measurement cycle.

As shown in figure 3-11, the APS has a constant negative slope during deflation, and is digitized in coarse, 2 mmHg steps. The RPS and MCS respond to the very small voltage changes associated with pulse in the artery.

h. Data Processing

At the completion of the measurement cycle, the digital signals stored in RAM are processed. The software flags certain patterns associated with pulse, systole and diastole. Absolute pressure readings at systole and diastole are recalled and reported as systolic and diastolic blood pressure. Pulse in heart beats per minute is calculated by a simple algorithm.

3.5.3 Inflation Control (figure 3-12)

The pump driver circuit controls inflation of the blood pressure cuff. Cuff inflation is initiated by the CPU through serial I/O port SOD.

To inflate the cuff, the CPU drives the SOD port HI, causing Q118 on the power regulator board to be turned on via emitter follower Q1; thus turning on Q116 on the power regulator board to drive the pump motor. Air flows into the cuff through the umbilical cord connected to the front panel receptacle.

Both Q115 and Q116 must be on for battery voltage to be switched to the pump. Q115 is normally turned on constantly. It is part of the failsafe system and is a redundant switch to back-up Q116. The state of Q115 is monitored via U104-12 by the failsafe I/O port on the logic board. The pump drive is monitored via U104-15 by the failsafe I/O port on the logic board. U104 is on the power regulator board.

When the pump motor is started, the CPU issues commands to close the leaker and dump valve. Q9 is driven by signal LSO from U42 pin 15 to completely close the leaker during inflation and to hold until start of deflation.

The CPU reads the pressure setting from the front panel selector and the cuff pressure signal from the pressure sensor. When the desired cuff 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 and to check for leaks. Then a deflation cycle begins.

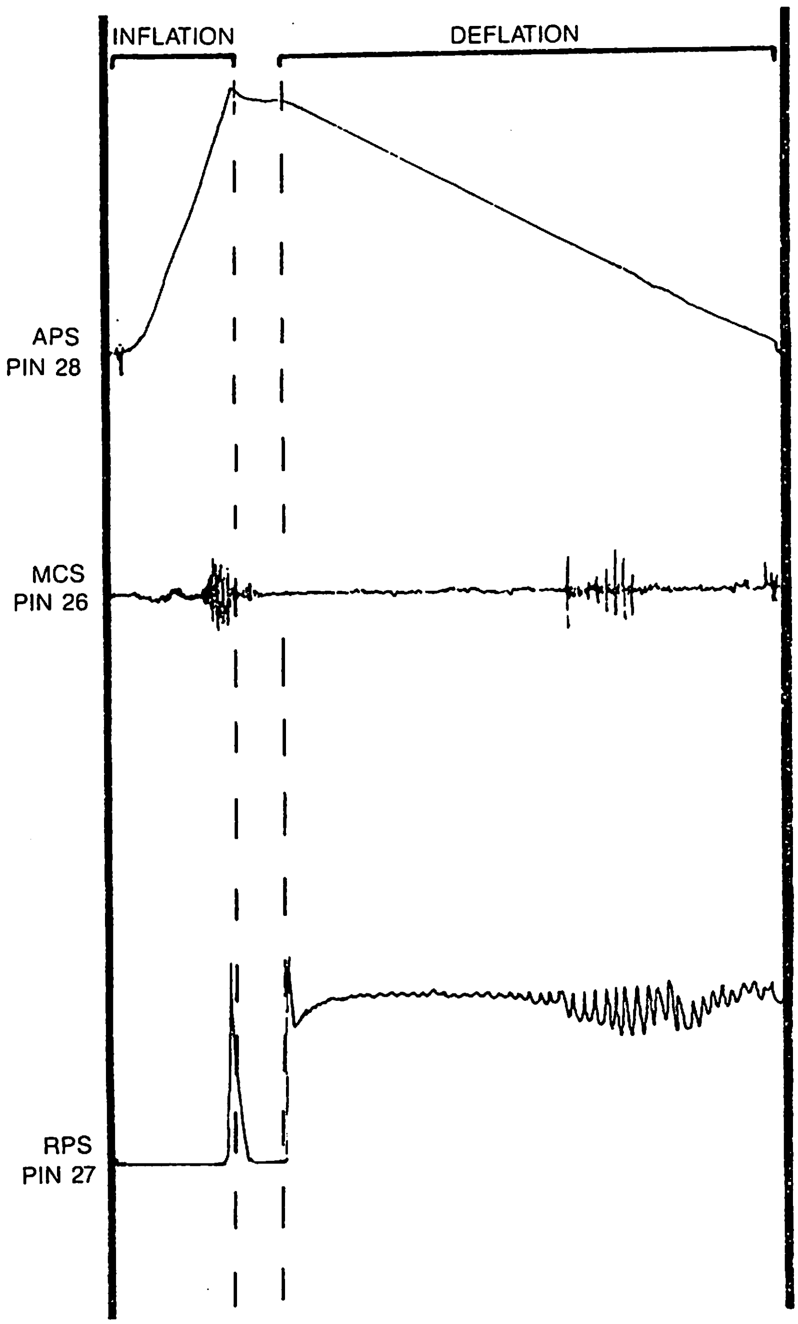


Figure 3-11. Sample Data From APS and RPS Inputs to A/D Converter

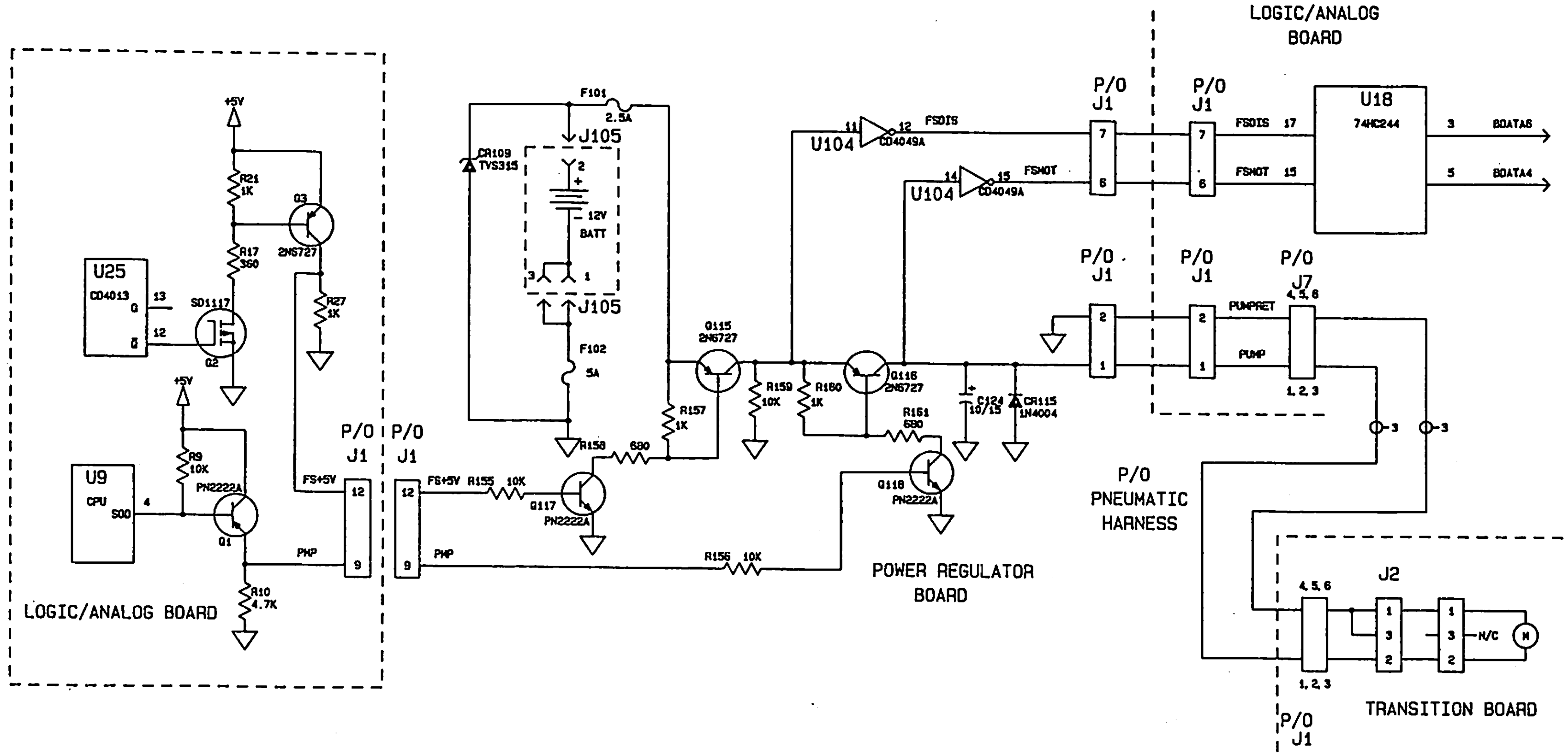


Figure 3-12. Pump Driver

3.5.4 Deflation Control (figure 3-13)

The deflation control circuit consists of several parts: the pressure sensor and error amplifier U50, the leaker driver and leaker valve, and the pneumatic control port and D/A converter U43. Taken together, these components form a closed loop with negative feedback.

During deflation, the CPU continually updates the required cuff pressure to U43. The D/A analog output is compared with the actual cuff pressure at U50. The difference between the required and actual pressure controls the leaker's orifice, maintaining the proper deflation rate.

D/A analog output is a variable negative current. The source for the negative current is a -12V power supply on the power regulator board (J2-15).

a. Pneumatic Control Port (U42) and D/A Converter (U43)

The pneumatic control port latches cuff deflation data loaded into it by the CPU.

The pneumatic control port also issues a HI at PC3 to start each A/D converter conversion cycle. Pressure and microphone data are collected at 2 ms intervals, as described in section 3.5.5.

The D/A converter is a 12-bit device. Data to U43 is latched by the pneumatic control port and provided as a 12-bit parallel word.

The D/A converter outputs a negative current (PREF). The analog reference current output at any time in the cuff deflation cycle is a function of the cuff deflation data provided by the CPU. R117 (BALANCE) is a potentiometer used to trim the D/A output.

b. Pressure Sensor and Error Amplifier

The pressure sensor and amplifier circuit U47, U48, U49, and U45 outputs a voltage corresponding to the pressure in the cuff, which is transformed by R101 into a current that drives error amplifier U50-1 (figure 3-16).

The negative reference current (PREF) from the D/A converter is added to the pressure sensor output at R101, and the error current is amplified by error amp U50-1. The error current corresponds to the difference between the expected analog value from the cuff deflation algorithm and the actual current value from the pressure sensor. This error signal is used to modulate the leaker valve via the leaker driver circuit.

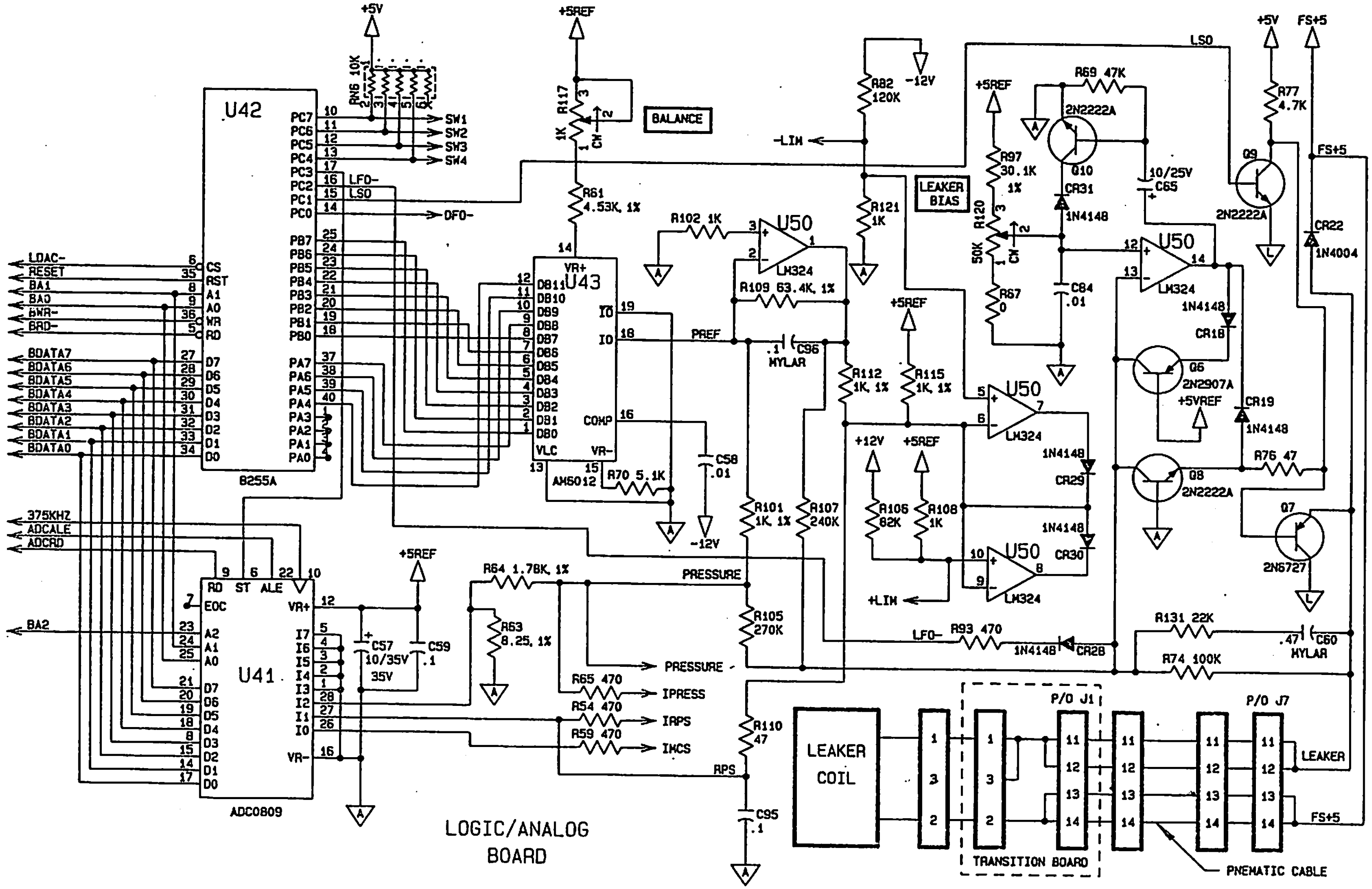


Figure 3-13. Data Acquisition and Deflation Control Loop

c. Leaker Valve

The leaker valve contains a magnetic core and coil. When current is applied to the leaker coil, the valve is drawn closed in proportion to the amount of current applied. When the current is removed, a spring opens the valve.

d. Leaker Driver (Figure 3-13)

The leaker driver consists of U50 (pins 12, 13, and 14), Q6, Q7, Q8, Q9, Q10, and associated components. The error signal from U50 pin 1, is applied through R107 to error amp U50 pin 13 inverting input. U50 pin 14 output then drives Q7, an emitter-follower current booster, via CR19 and R76. This voltage is applied to the leaker coil, opening or closing the leaker valve as required to zero the error current via the pneumatic pressure path to the pressure sensor. CR22 clips inductive spikes from the leaker coil.

R74, R131, and C60 form a negative feedback network around U50-14 and Q7. Q10 and associated components form a unidirectional slow-rate limiter to control the response of the leaker to arterial pressure pulses. Q6, Q8, CR18, and CR19 serve as bounds to prevent saturating the leaker driver stage.

An adjustable bias from R120 is injected into the loop at U50 pin 12 to compensate for variations among different leakers. This bias conditions the error signal to suit the leaker characteristics.

A sample of the pressure signal is also applied to the leaker driver through R105 to compensate the leaker at low pressure.

The pneumatic control port issues LFO- to force the leaker completely open (Q7 is off) at the end of a blood pressure measurement cycle.

e. Dump Valve (figure 3-14)

The pneumatic control port issues DFO- to open the dump valve and rapidly deflate the cuff at the end of each measurement cycle (DFO- = LO). U39 pins 2, 6, and 10, buffer DFO- to drive Q14. Q14 is the main switch, with Q12 being the backup switch which opens the valve in the event of a failsafe failure. U28 pins 12 and 15 is a level shifter which furnishes the failsafe I/O port with the dump valve control status.

3.5.5 Data Acquisition and Processing (figures 3-15 and 3-16)

a. A/D Converter

Every 2 ms during the measurement cycle, the CPU strobes all three of the A/D converter's data channels. The microphone channel (MCS) and the two pressure channels (APS and RPS) are converted to 8-bit binary and loaded onto the buffered data bus by the CPU.

The CPU accesses the A/D converter at every time base interrupt with this sequence of operations:

- read previously converted value (ADCRD = HI),
- load next multiplexer channel to convert (ADCALE = HI),
- and start conversion (PC3 = HI).

Conversion control (start conversion) is accomplished through pneumatic control port U42 pin 17 (PC3). This line is held high about 25 μs to start a conversion. A new conversion occurs every 683 μs.

b. +5V Reference

A +5V reference voltage is derived from a 1.24V reference diode VR1. An amplifier with a gain of four, consisting of U45B, VR2, R73, and R66 raises the reference diode voltage to about 5 volts. VR2 is a current booster.

+5V reference is used as a reference for the pressure sensor, D/A and A/D converter, and failsafe on the logic/analog board.

c. Microphone Channel (figure 3-15)

The microphone channel is used to amplify and condition the microphone signal prior to applying it to the A/D converter.

U46-14 is a high input impedance preamplifier with the microphone signal applied to the noninverting input. R94 and R95 set the stage gain to about 4.3. U46-1 is a low-pass filter with a roll-off at about 60 Hz. This stage has a gain of 5.6, set by R90 and R71. The output of this stage, labeled MCS (U46 pin 1), drives input channel zero of the A/D converter (U41 pin 26). Voltage divider R57 and R56 set the quiescent point of MCS to about one-half scale at the A/D to accommodate the bipolar microphone signal. U46-7 and U46-8 form an active clamp to prevent microphone signal excursions from exceeding the input voltage limits of the A/D converter. If MCS begins to go more negative than -LIM, U46-7 will swing negative, forward biasing CR12, clamping the signal at U46-2. If MCS begins to go more positive than +LIM, U46-8 will swing positive, forward biasing CR13, clamping signal at U46 pin 2.

d. Pressure Channel (figure 3-16)

U44, Q13, R75, and reference diode VR1 form a current source of 1.5 milliamperes to provide excitation to the pressure sensor P1. Q13 collector provides the 1.5 mA current to pin 5. This current flows through the sensor to pin 6 causing a voltage drop across R75 which is equal to the voltage at VR1, about 1.24 volts. If the voltage across R75 should differ from that at VR1, U44 will amplify the difference, changing the bias at Q13 base in such a direction as to adjust the current from Q13 collector, through the sensor, to cause the voltage drop across R75 to match the reference voltage from VR1.

U47, U48, U49, and associated components are a differential instrumentation type amplifier which amplifies output from pins 4 and 10 of the sensor to a level of 12 millivolts per mmHg. R119 (SPAN) is a gain adjustment which compensates for variations in output between different pressure sensors.

Two pressure signals are digitized. APS is the conditioned full scale pressure output of the pressure sensor. RPS is a relative pressure output from error amp U50-1.

- APS. U45-1 buffers the output of the instrumentation amplifier. The networks consisting of R78 and R80 and R118 and R116 and R87 are used to cancel the zero pressure offset voltage of the pressure sensor.

  The pressure signal is fed to R101 and R105 of the deflation control system, to the failsafe test connector J5 pin 27 via R65, and to the A/D converter (U41 pin 28) through resistor network R64 and R63.

  R64 and R63 are a voltage divider to scale the pressure signal to about 9.9 millivolts per mmHg to allow the A/D converter to digitize 1 count per 2 mmHg of pressure.

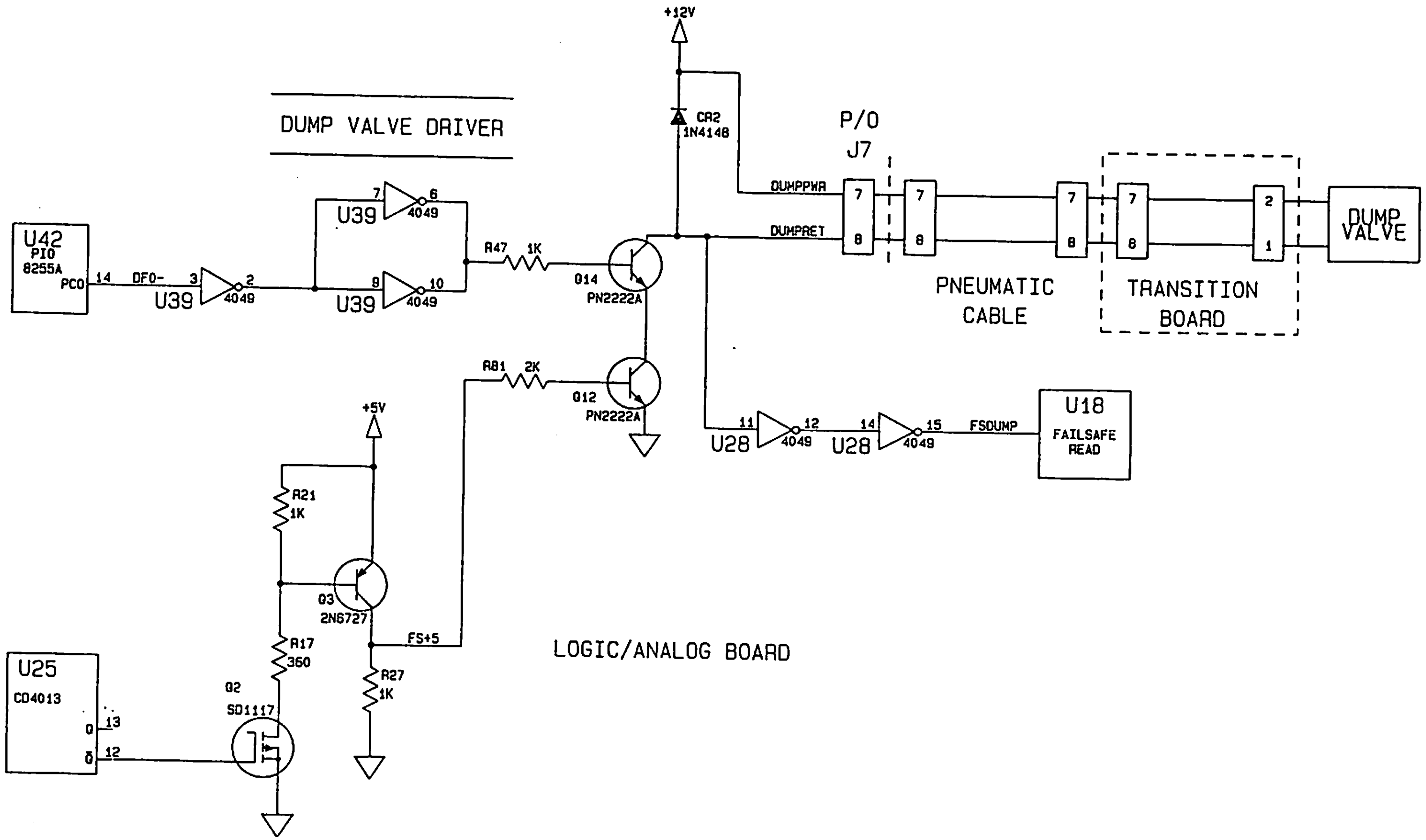


Figure 3-14. Dump Valve Driver Circuit

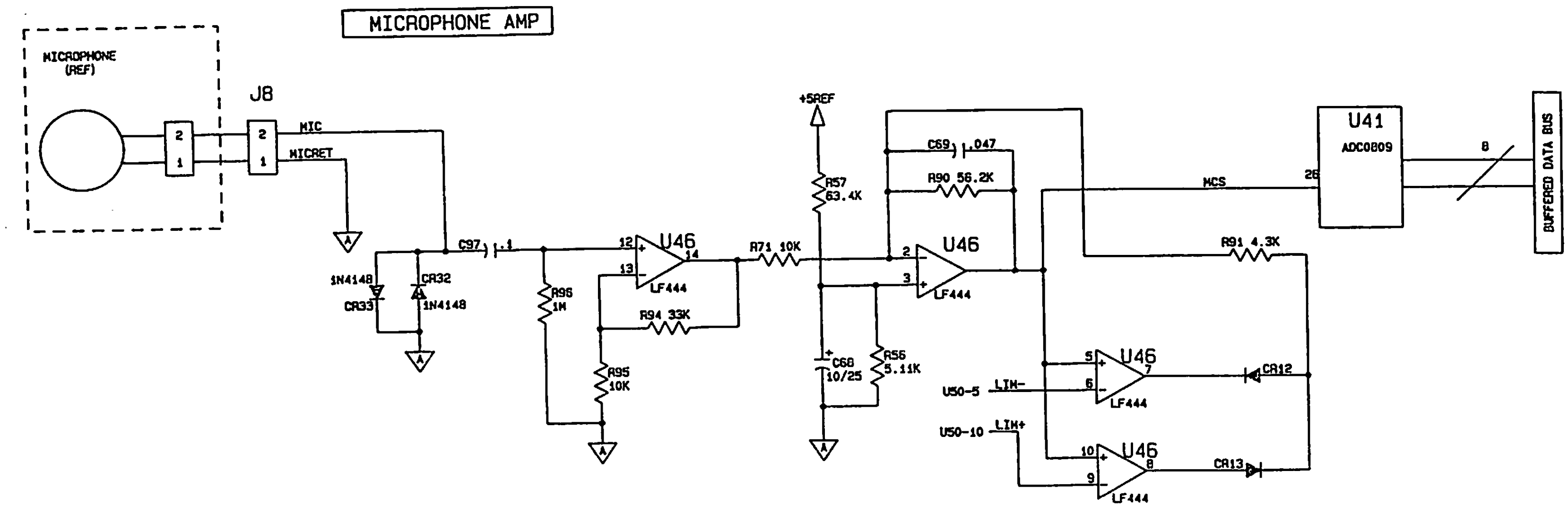


Figure 3-15. Microphone Channel

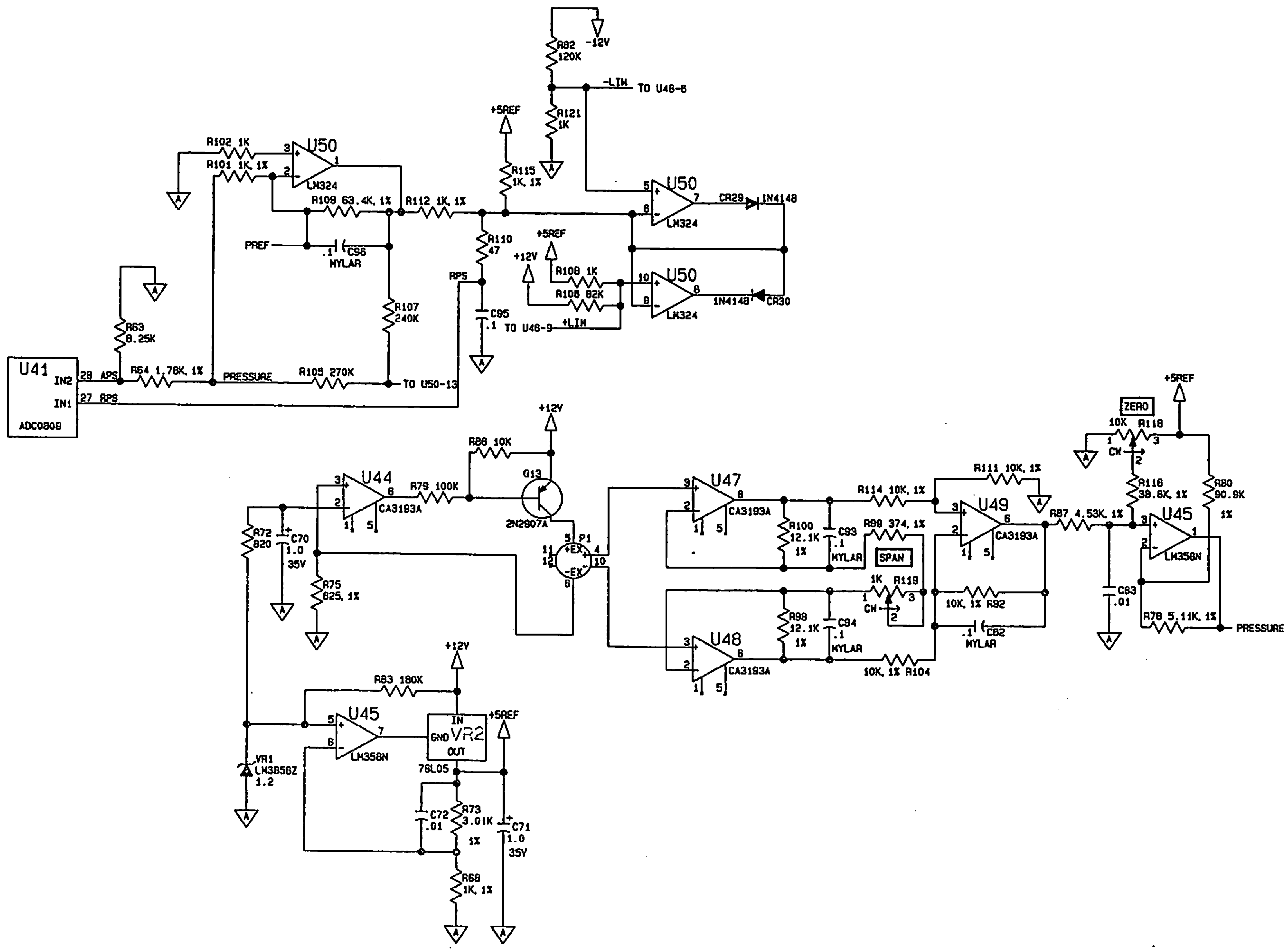


Figure 3-16. Pressure Channel

- RPS. The relative pressure signal (RPS), used by the CPU to detect pulse, originates at error amplifier U50 pin 1. This error amplifier output at pin 1 drives input channel 1 of the A/D converter (U41 pin 27) via a voltage divider/level shifting network R112 and R115 and isolating resistor R110. U50 (pins 5, 6, and 7) and U50 (pins 8, 9, and 10) are an active clamp to prevent the relative pressure signal from exceeding the input voltage limits of the A/D. Voltage divider R121 and R82 provide a negative reference voltage at U50 pin 5 (and also U46 pin 6) and voltage divider R106 and R108 provide a positive reference voltage at U50 pin 10 (and also U46 pin 9). If the relative pressure signal exceeds the negative reference (more negative), U50 pin 7 will go positive, forward biasing CR29, clamping the relative pressure signal. If the relative pressure signal exceeds the positive reference, U50 pin 8 will go negative, forward biasing CR30 and clamping the signal.

3.6 USER INTERFACE (figures 3-17A and 3-17B)

The user interface comprises U40, speaker LS1, and the user mode selector, pressure selector logic, and DISPLAY TEST switch.

U40 is a three port device. It is selected by USER- from the I/O address decoder. Further decoding of the registers is done with BA0 and BA1.

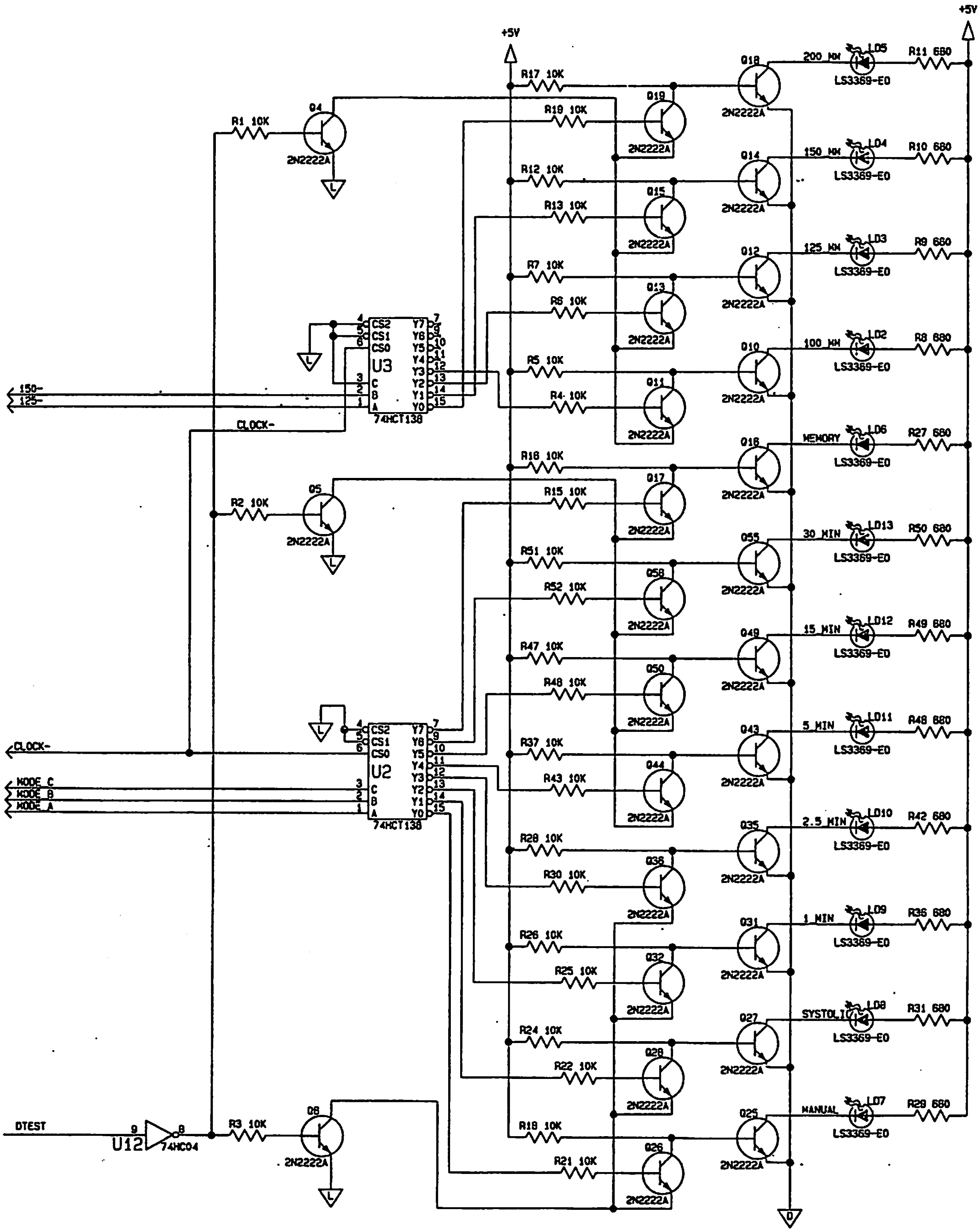


Figure 3-17B. User Interface Display/Thermometer Board

3.6.1 Switches

The mode and pressure select functions and the display test switch are ported through U40. PA0-PA7 and PB0 read the mode function. PB1-PB2 read the pressure function.

A membrane keyboard is used to allow selection of the instrument's operating mode and initial inflation pressure. LED indicators display the selected mode and pressure settings. Two CMOS PLDs (programmable logic device) configured as state machines, and some combinational logic translate the momentary action of the membrane switches to logic levels that emulate multiposition switches. Each mode or pressure keyboard switch actuation advances its respective state machine to the next "switch position." One of four LEDs is illuminated to indicate one of four pressure select options selected, and one of eight LEDs is illuminated to indicate one of eight mode select options selected. Debouncing of the membrane switches is accomplished by the PLD state machines.

To gain access to the real-time clock in CIM equipped instruments, two series connected hidden switches must be actuated simultaneously for a minimum of one second (five seconds maximum) to select the real-time clock mode function.

a. Mode Select

Actuating the MODE SELECT switch increments the PLD mode state machine to the next one of eight mode states. The mode state appears externally at U32 pins 19, 18, and 17 (I/O0, I/O1, and I/O2). (See table 3-4.)

Table 3-4. PLD Mode States

Mode	I/O0	I/O1	I/O2
MEMORY	HI	HI	HI
MANUAL	LO	LO	LO
SYSTOLIC	HI	LO	LO
1 min	LO	HI	LO
2.5 min	HI	HI	LO
5 min	LO	LO	HI
15 min	HI	LO	HI
30 min	LO	HI	HI

There are actually two internal states in the mode select state machine for each external mode state. Each internal state corresponds to a make and then break of the MODE SELECT switch. The real-time clock mode state is an independent state, described below, that externally overrides the mode state.

The MEMORY mode is selected by the software when none of the other seven active-LO modes and the active LO CLK mode are asserted at the input port U40. (Although decoder U35 pin 7 is not connected, it is functionally equivalent to MEMORY-.)

The MANUAL mode has been assigned the state LO LO LO so that it will be selected by default when power is first applied to the PLD, as the output registers are cleared upon initial application of power (i.e., battery installation).

Decoding of the three line mode state to the active-LO linear select method to drive the CPU input port (U40) is accomplished by U35. U2 on the display/thermometer board decodes the mode state to drive the mode indicator LEDs.

Selecting the real-time clock mode does not affect the current state of the mode and pressure select state machines. Selecting the real-time clock mode asserts the signal CLOCK-, which overrides the mode select state at the decoder U35, and blanks the mode and pressure select LEDs by disabling the decoders U2 and U3 on the display/thermometer board. (The signal CLOCK- itself is not actually a clock signal.)

A time delay is provided to avoid inadvertent selection of this function. Actuating the hidden switches turns off Q19, allowing C99 to charge, eventually driving IN8 of PAL U31 LO, selecting the real-time clock function.

Actuation of either the MODE SELECT or PRES. SELECT switch deselects the CLK mode.

b. Pressure Select

Actuating the PRES. SELECT switch increments the PLD pressure state machine to the next one of four pressure states. The pressure state appears externally at U31 pins 17 and 16 (I/02 and I/03) and is inverted by two sections of U14. (See table 3-5.)

Table 3-5. Inverted Pressure States

Pressure	I/02-	I/03-
100 mmHg	HI	HI
125 mmHg	HI	LO
150 mmHg	LO	HI
200 mmHg	LO	LO

There are actually two internal states in the pressure select state machine for each external pressure state. Each internal state corresponds to a make and then break of the PRES. SELECT switch.

The 100 mmHg setting has been assigned the inverted state HI HI so that it will be selected by default when power is first applied to the PLD.

The pressure state is not further decoded, but directly drives the CPU input port U40. U3 on the display/thermometer board decodes the pressure state to drive the pressure indicator LEDs.

c. Audible Feedback

LS2 provides audible feedback for switch actuation. PLD U31 gates a short burst of 732 Hz to LS2 via Q11 upon closure of a MODE SELECT or PRES. SELECT switch, or the hidden switches.

d. Clocks

The PLDs are supplied a 11.44 Hz (87 mSec period) clock divided down by U24 from the 732 Hz clock provided by the processor clock divider U26. This clock is used by the switch debouncing and synchronizing logic in the PLDs. Q18 serves to provide a known logic state for the divider U24 and PLD U31 when the instrument is turned off.

e. Power-Off Mode

The PLDs U31 and U32, and the clock divider U24 remain powered by the +5VAO supply when the instrument is turned off, allowing the pressure and mode settings to be retained.

The PLD inputs are disabled and their outputs are driven to the high impedance state by the $\overline{\text{PWR\_GOOD}}$ signal going LO when the instrument is turned off. This disallows mode or pressure selection changes while the instrument is turned off. The $\overline{\text{PWR\_GOOD}}$ signal is timed so that it goes LO before the instrument's power supply voltages decay upon instrument "turn off", and goes HI after the power supply voltages have stabilized upon instrument "turn on."

f. Display Test Mode

The pressure indicator and mode indicator LEDs are illuminated via the signal DTEST, along with the rest of the displays during a display test sequence.

g. LED Drivers

The LED drivers are divided into three groups, with the four predrivers in each group controlled by display test control switch Q4, Q5, or Q6, respectively. During normal instrument operation, Q4, Q5, and Q6 are turned on (saturated). This results in all but one of the four predrivers being turned on in the upper group of four (pressure readout) and all but one of the eight predrivers being turned on in the two lower groups of four (mode readout), thus holding off all but one LED driver transistor in each readout.

During the display test function, Q4, Q5, and Q6 are turned off, disabling all twelve predrivers, thus enabling all twelve LED drivers.

U3 decodes the pressure state to one of four active LO levels; turning off one of the four predriver transistors Q11, Q13, Q15, or Q19; enabling one of the four LED drivers Q10, Q12, Q14, or Q18.

U2 decodes the mode state to one of eight active LO levels; turning off one of the eight predriver transistors: Q26, Q28, Q32, Q36, Q44, Q50, Q56, or Q17; enabling one of the eight LED drivers Q25, Q27, Q31, Q35, Q43, Q49, Q55, or Q16.

The thermometer probe detect circuitry (located in the probe storage well) is read at PB3 and is used to detect whether the thermometer probe is in or out of its storage well. A LO signals the CPU to turn on the thermometer and initiate a temperature measurement. This function is described in section 3.10.

The probe detector optics consists of DS1, an IRLED (infrared LED) type IRL-80A, and Q17, a phototransistor type LPT-80A-4. The IRLED is operated in a continuous mode. When a temperature probe is present in the instrument's probe well, the probe body blocks the IR emission traveling from the IRLED to the phototransistor, turning it off (collector is logic HI), thereby causing the thermometer to be turned off by the instrument's CPU. With the probe removed from the well, IR emission from the IRLED (as well as ambient light) reaches the phototransistor, saturating it (collector is logic LO), causing the CPU to turn the thermometer on.

The optics system is enclosed in a light-tight housing, such that ambient light cannot reach the phototransistor when a temperature probe is in place.

Other thermometer function switches are not read by the CPU. The thermometer contains a μcontroller which reads the NORMAL/MONITOR mode switch and the S2 internal DIP switch no. 5 (°F°C) directly.

Other user switches that are not read at U40 include: the START/RESET switch, which is part of CPU RST5.5 (section 3.2.9), and the ON/OFF switch, which is part of an electronic switching circuit on the power regulator board (section 3.9.10).

3.6.2 Speaker Alarm Circuit (figure 3-18)

The port controls the speaker alarm circuit, and is selected by BWR-, BA0 and BA1. BEEP HI (PC0) or BEEP LO (PC1) is issued via U40 to the speaker circuit to generate an audible alarm.

The CPU writes a control word to U40 to issue HI BEEP for a high-pitched (1.46 kHz) audio alarm, or to issue LO BEEP for a low-pitched (732 Hz) audio alarm. Writing another control word will turn the audio alarm off.

The exciter clock frequencies are generated at the clock divider and are gated through U36 by the control signals from U40. FET Q16 pulses the speaker in response to the clock frequencies.

3.6.3 Battery Status Monitor

Battery and A/C status are ported to PB5, 6 and 7.

When operating on battery power, U40 receives signals from the battery status comparator U106 via U104 on the power regulator board. When battery voltage drops below threshold, first LOWBATT- and then DEADBAT- go LO, and these signals are read by the CPU through the user interface port so that the appropriate alarm can be issued.

3.7 DISPLAY FUNCTIONS (figure 3-19)

The display circuit is on the display/thermometer board. The displays are memory mapped to the CPU.

3.7.1 7-Segment Displays (figure 3-20)

a. Systolic and Diastolic

U1 on the display/thermometer board is a self-contained, self-scanning display driver, decoder and display RAM. The display RAM appears as six write-only addresses to the CPU, which correspond to six digits driven by U1. Q3, Q2, Q1, Q9, Q8, and Q7 are the digit drivers, while U1 itself directly provides the segment and decimal point drive.

In operation, one digit at a time is driven. The appropriate lines, SA through SG and SDP, for a given digit are enabled and one of the transistors (Q3, Q2, Q1, Q9, Q8, and Q7), is turned on via a corresponding output, DS1 through DS6, to complete the circuit through the digit being driven. This process is then repeated for the next digit, and this continues at a rate fast enough to make it appear that the six digits are constantly illuminated.

The systolic and diastolic displays are DS1 through DS6 on the display/thermometer board. RN1 determines the current that flows through the display segments. On U1, the D0-D4 inputs are data inputs from the buffered data bus. A1, A2, and A3 are the digit address inputs on the buffered address bus.

b. Pulse

This display operates identically to the systolic and diastolic displays. U4 is the display driver; Q20, Q21, and Q22 being the digit drivers, and RN2 the segment current-limiting resistor. The pulse display is DS7 through DS9 on the display/thermometer board.

3.7.2 Information Display (figure 3-21)

The information display consists of two 4-digit alphanumeric displays, DS15 and DS16 on the display/thermometer board. Each display is a completely self-contained display RAM, decoder, driver and LED display. Each unit appears as 4 write-only addresses to the CPU, and both are enabled (M6-) by address decoder U5-6 on the logic/analog board, along with buffered address bit 2 (BA2). Buffered address bits 0 and 1 (BA0, BA1) select the individual character position, and buffered data bits 0 through 6 (BDATA0 through BDATA6) contain the character data.

3.7.3 Temperature Display

The temperature display (5-digit LEDs) is driven from drivers located on the display/thermometer board, and is covered in more detail in section 3.10.

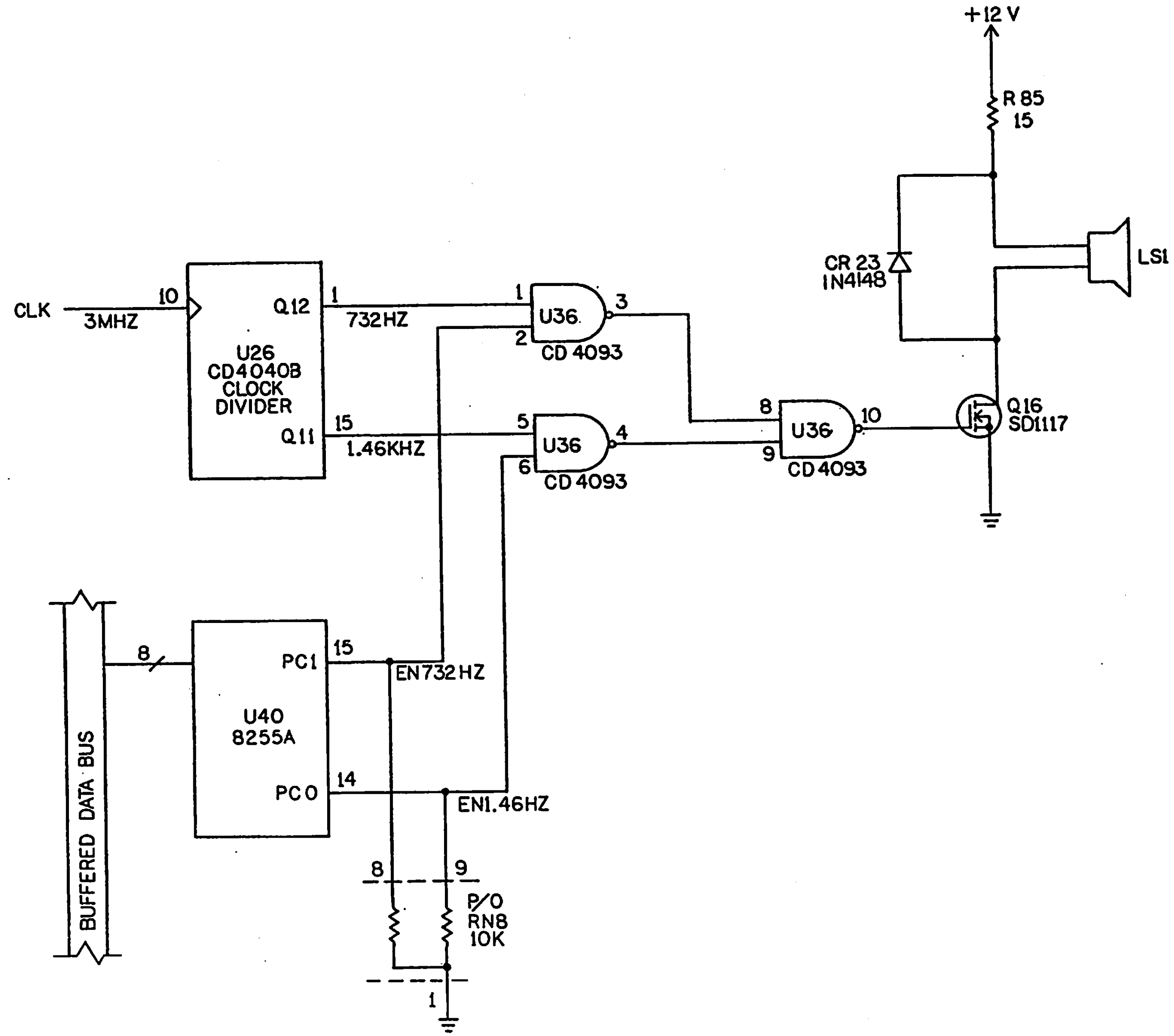


Figure 3-18. Speaker Alarm Circuit

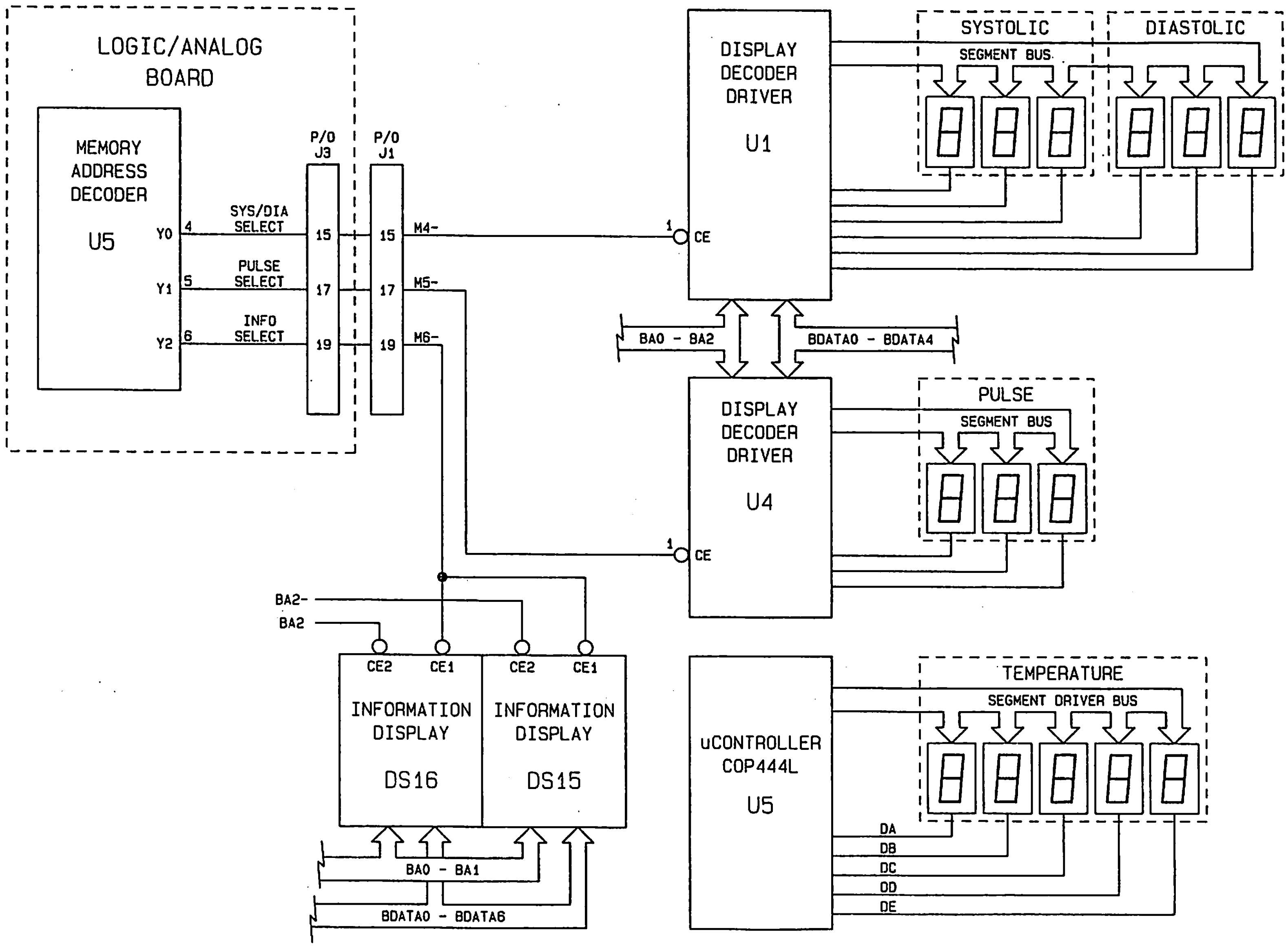


Figure 3-19. Display and Display Driver Boards Block Diagram

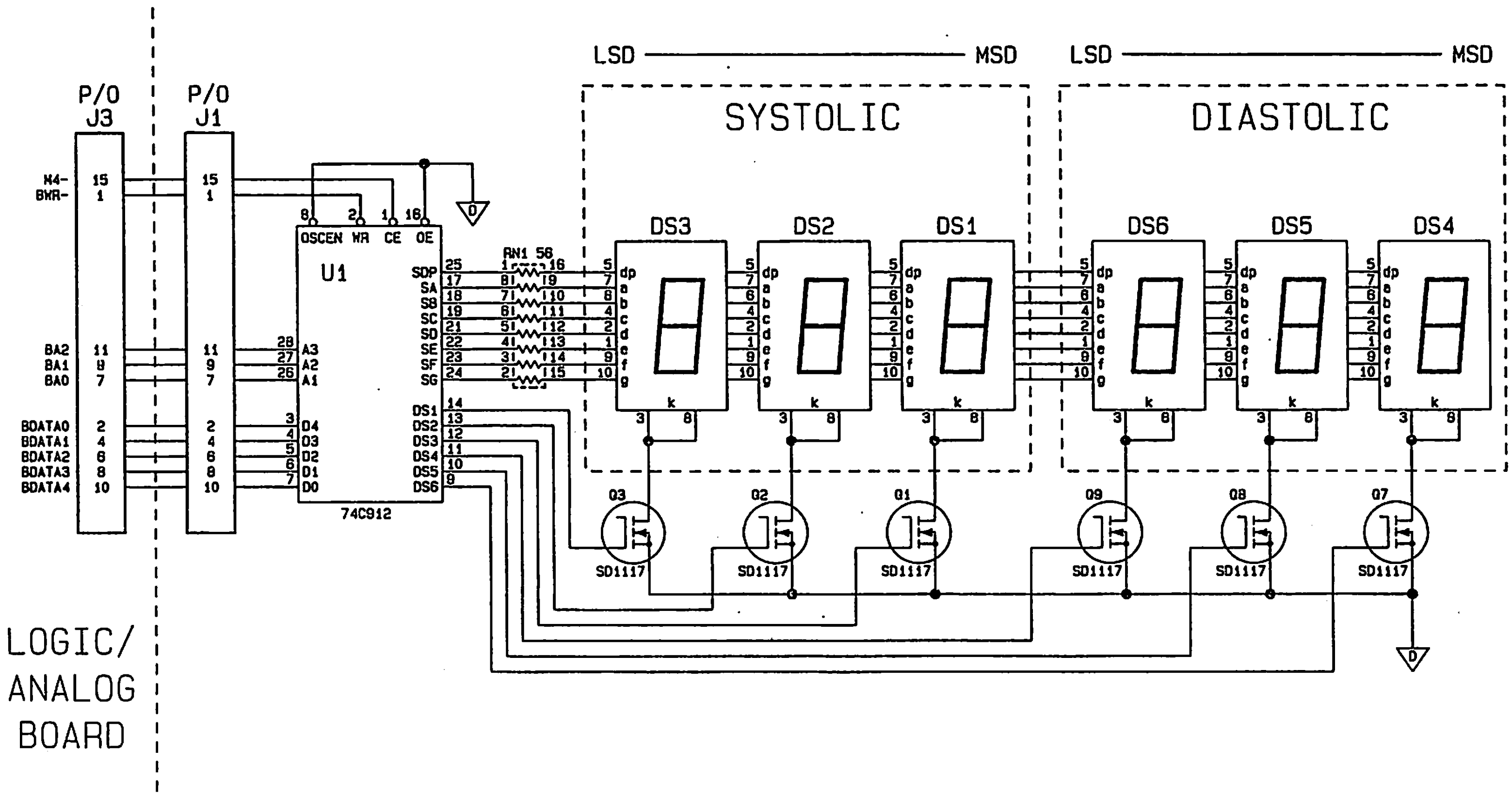


Figure 3-20. 7-Segment Display Driver Circuit

3.8 HARDWARE FAILSAFE CIRCUIT (figure 3-22A, 3-22B)

The purpose of the hardware failsafe circuitry is to protect the individual whose blood pressure is being taken from an overpressure or excessive inflation time condition if the CPU has lost control of the pneumatic system. The failsafe is tested by the CPU at instrument start-up, and then write-locked from the CPU so that it is independent and can only be monitored.

a. Disable Flip-Flop

U25-13 is the disable flip-flop. At instrument start-up, it is cleared via U23-3 and the time constant of R8 and C67 delaying the application of logic HI to U23 pin 1. This causes pin 3 to be momentarily HI, clearing U25-13. U25 pin 13 (Q) will be LO and pin 12 ($\overline{Q}$) will be HI, turning on Q2, which turns on Q3 via R17. Q3 collector provides power (FS+5) to the leaker, enables part of the dump valve driver and enables part of the pump driver (power regulator board). If U25-1 becomes set for any reason, power is removed from the leaker driver, opening the leaker valve; the dump valve driver is disabled, opening the dump valve; and the pump driver is disabled so that the pump will not operate.

Q12 on the logic/analog board is the dump valve disable. Q115 on the power regulator board is the pump disable. It is normally always turned on via Q117. Normally, Q117 is turned on via R155 by FS+5. The state of the failsafe flip-flop is monitored via Q2, Q3, Q117, Q115 and U104-12 (FSDIS).

b. Clock Chain

The clock chain is a series of binary ripple counters used to derive the various timing signals in the failsafe. A 375 kHz clock from the system clock divider drives U8 and gate U19-3. U8 is a 12-stage ripple counter which divides the 375 kHz clock down to 91.6 Hz at pin 1 (Q12), which then drives gate U19-10. U19-3 can be enabled to provide the 375 kHz clock to U6-6 by the CPU setting line FS4 high to quickly test the 4.5 minute timer, or the 91.6 Hz clock can be provided to U6-6 by the CPU setting line FS3 low, enabling U19-10 via inverter U19-4. The 91.6 Hz clock is selected by default as U7 is reset at power-on or as the failsafe is write-locked after the power-on test.

U6-6 provides the 91.6 Hz (or 375 kHz) clock to another ripple counter, U17. Assuming normal operation using the 91.6 Hz clock, U17 pin 12 (Q1) provides a 45.8 hz clock to the 4.5 minute timer and a 1.43 hz clock (700 milliseconds) to U25-3 and U25-11. If the failsafe flip-flop (U25-13) is set, U17 is held reset via U3-10 and U3-4 to prevent the failsafe from clocking itself back out of a fault condition.

c. Clock Loss Watchdog

The clock loss watchdog detects the loss of the operating clock from the failsafe circuitry. In normal operation, the clock signal, which appears at U6 pin 6, is coupled through C42 to Q4. This keeps Q4 turning on and off, which in turn, keeps C41 discharged. Thus, U23 pins 8 and 9 are high and pin 10 is LO. If the clock fails, Q4 will no longer conduct, allowing C41 to charge through R22 toward logic LO. When U23 pins 8 and 9 reach LO, pin 10 is driven HI, directly setting U25-13.

d. 4.5 Minute Timer

The 4.5 minute timer is a backup to the software inflation timer. It is enabled when the cuff pressure exceeds 20 mmHg and held reset when the cuff pressure is less than 20 mmHg. The pressure signal appears at comparator U38-3 input via multiplexer U27 and divider R43 and R34. R24, R31, and R35 form a divider which furnishes the references level for comparator U38-1 (and U38-7, the overpressure sense comparator). When the cuff pressure exceeds 20 mmHg, U38 pin 1 goes HI, pulling the inverter U19 pins 12 and 13 high via R45. U19 pin 11 then goes LO, removing the reset from the 14 stage ripple counter U22. U22 will then count the 45.8 Hz clock from U17. If the cuff pressure drops below 20 mmHg within 4.5 minutes of exceeding 20 mmHg, U38 pin 1 will go LO, causing U19 pin 11 to go HI, and hold U22 reset. If the cuff pressure does not drop below 20 mmHg, U22 will continue to count; 4.5 minutes after counting has started, pins 2 (Q13) and 3 (Q14) will both be HI, allowing the AND gate U6 pin 8 to go HI. U13 pin 10 will then go LO. The action that U25-1 and U25-13 then take will be described in step e of this section. U38 pin 1 is monitored by the CPU via the input port U18 (FSCOMP) pin 6.

e. Overpressure Detection

The failsafe overpressure detection is a backup to the software overpressure protection. It is implemented with a comparator monitoring the pressure channel that has a threshold of 335 mmHg. The pressure signal appears at comparator U38 pins 3 and 6 input via multiplexer U27 and divider R43 and R34. R24, R31, and R35 form a divider which furnishes the reference levels of 1.99V at U38-5 and 0.118V at U38-2. If the pressure rises above about 335 mmHg, U38 pin 7 will go LO, causing inverter U3 pin 11 to go HI, and U13 pin 10 to go LO. This removes the reset from U25-4 and allows the next clock from U17 pin 4 to clock U25 pin 1 (Q) HI. The following clock, 700 milliseconds later, will clock U25 pin 13 (Q) HI, disabling the instrument. U17 will be held reset via U3-10 and U3-4, removing the clock from U25, so that the state of U25 cannot be changed. If the overpressure is a transient and falls back below 335 mmHg before the next 700 millisecond clock clocks U25-11, U25-4 will be reset (pin 1 LO) and no fault will be detected. The mechanical overpressure sensing switch (on the pneumatic module) is connected to U38 pin 7 via J7 on the logic/analog board, and J1 and J4 on the transition board. It is normally open. If the cuff pressure exceeds the switch's threshold, it closes, connecting U38 pin 7 to ground with the same effect as if comparator U38-7 detected a pressure greater than 335 mmHg. The mechanical overpressure switch is a backup to the overpressure comparator in the event the pressure voltage fails to appear at the overpressure comparator.

f. Power-On Testing

When the instrument is first turned on, the failsafe is exercised to simulate faults and test the comparators (U38-1 and U38-7). Extra circuitry is included for power-on testing.

When the instrument is turned on, a power-on reset is obtained from the time constant of R8 and C67 which is shaped by Schmidt triggers U23-3 and U23-4. The reset pulse from U23-3 clears flip-flop U25-13 and initializes counter U17 to zero via U3-10 and U3-4. The reset pulse from U23-4 clears RS flip-flop U13-6 and U13-9 so that U13 pin 9 is LO and clears output port U7 via U3-3 so that all six outputs Q1 through Q6 are LO. The 91.6 Hz clock is now selected via FS3 (U7 pin 10) and the multiplexer U27 is set to the pressure signal via FS0 and FS1 (both low), U27 pins 10 and 9, respectively. This is the normal operating mode of the failsafe except that now the CPU can write to U7 and change the state of any of the signals FS0 through FS5. The CPU can now exercise the failsafe. Signals FS0 and FS1 select simulated pressures of less than 20 mmHg (U27 pin 5), greater than 20 mmHg but less than 335 mmHg (U27 pin 2) or greater than 335 mmHg (U27 pin 4) to test the comparators U38-1 and U38-7. The simulated pressures are obtained from a divider consisting of R37, R19, R23, and R30.

Signal FS2 (U7 pin 7) is used to clear U25-13 via U39-12 and U23-3 after a simulated fault. Signal FS4 (U7 pin 12), when HI, selects the 375 kHz clock to rapidly test the failsafe system. Signal FS3 (U7 pin 10), when LO, selects the 91.6 Hz clock for normal operation. By setting FS3 low and FS4 high, the clock can be removed entirely to test the clock loss detector Q4 and U23-10 and associated components.

Signal FS5 (U7 pin 15) is used to write-lock the failsafe system output port U7. When the CPU has completed the power-on failsafe testing, it writes a high to FS5. This sets R/S flip-flop U13-6 and U13-9, making U13 pin 9 high. U3 pin 3 is then low, holding U7 in a reset condition so that the CPU cannot write to it. This isolates the failsafe from the CPU so that a CPU failure cannot render the failsafe ineffective. In the event that the CPU cannot complete the failsafe testing and write-lock the output port, there is a circuit to automatically write-lock in about six seconds. This circuit is implemented with RC network R7 and C77. When C77 charges through R7 to the low threshold of U23-11, U23 pin 11 goes high, setting R/S flip-flop U13-6 and U13-9 in the same manner as FS5 would have.

3.9 POWER REGULATOR BOARD FUNCTIONS (figure 3-23)

Incoming AC power is stepped down by a transformer. It is then rectified, filtered and regulated to provide a +14 VDC voltage source. This voltage source charges the battery pack and is further regulated to provide +5 VDC and -12 VDC. An on/off flip-flop is used to turn the +12 VDC, +5 VDC, and -12 VDC on and off for the rest of the instrument. A battery voltage sensing circuit is used to signal the CPU when a low or discharged battery voltage condition exists.

3.9.1 Transformer, Rectifier, and Filter (figure 3-24 and 3-25)

Figure 3-24 represents the AC power input circuits. The ground terminal is connected to the instrument ground. The instrument is protected by a 1 amp circuit breaker. The line voltage is stepped down to 20 VAC nominal by transformer T1. A snubber network consisting of C1 and R1 on the primary of T1 absorbs transients on the AC line.

Referring to figure 3-25, diodes CR101 through CR104 and filter capacitor C102 rectify and filter the voltage from the secondary of T1 to an unregulated voltage of nominally 28 VDC.

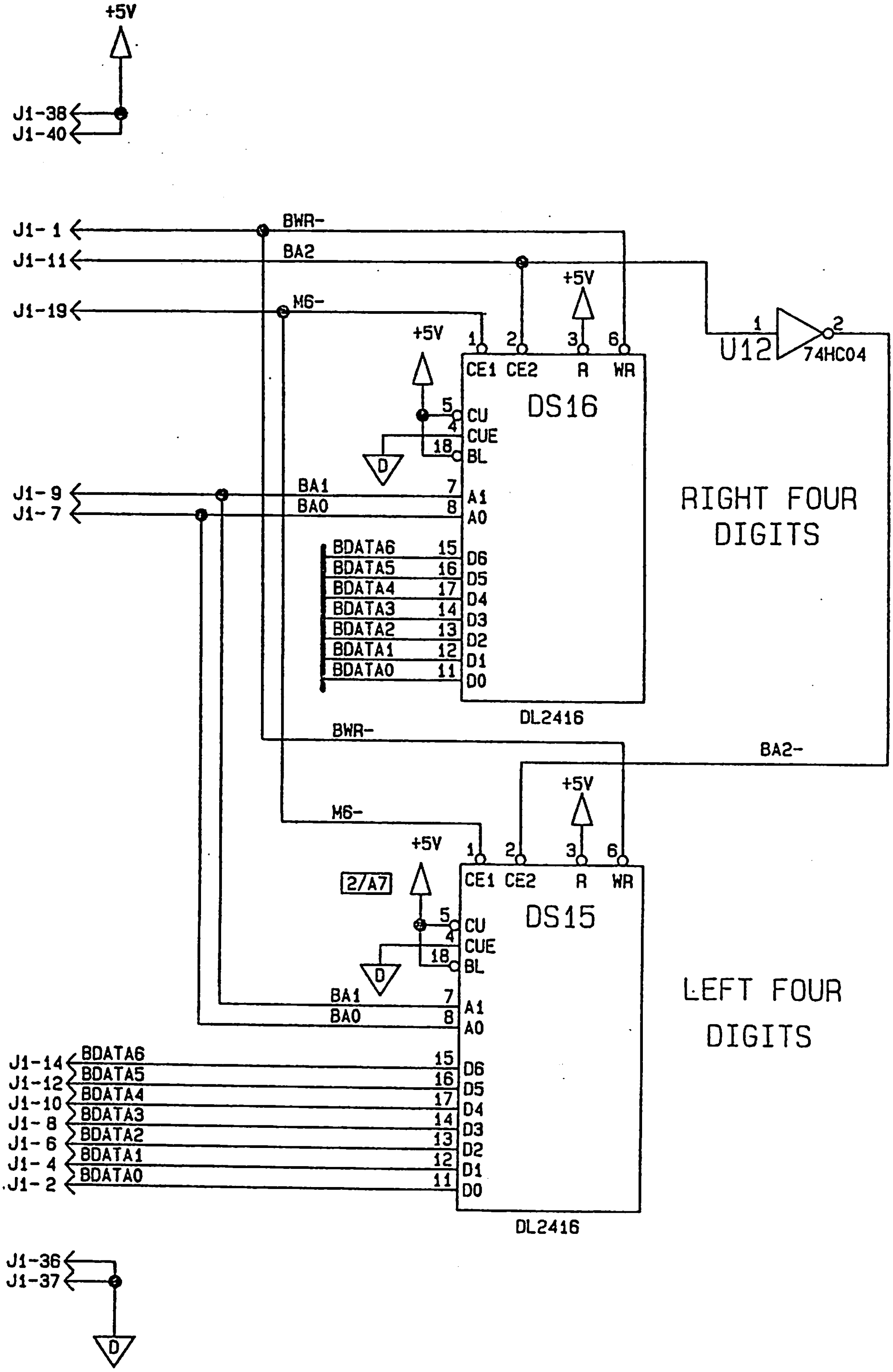


Figure 3-21. Information Display Driver Circuit

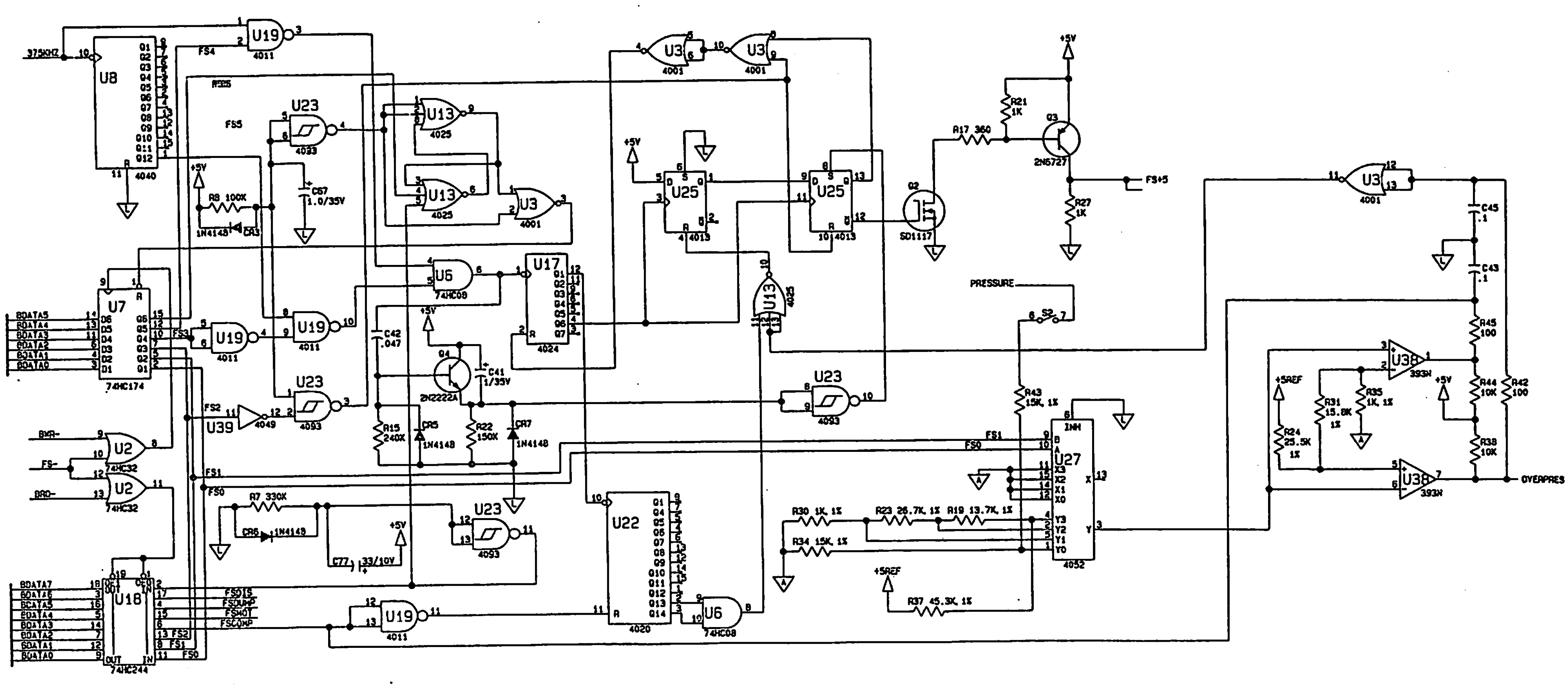


Figure 3-22A. Failsafe Circuit

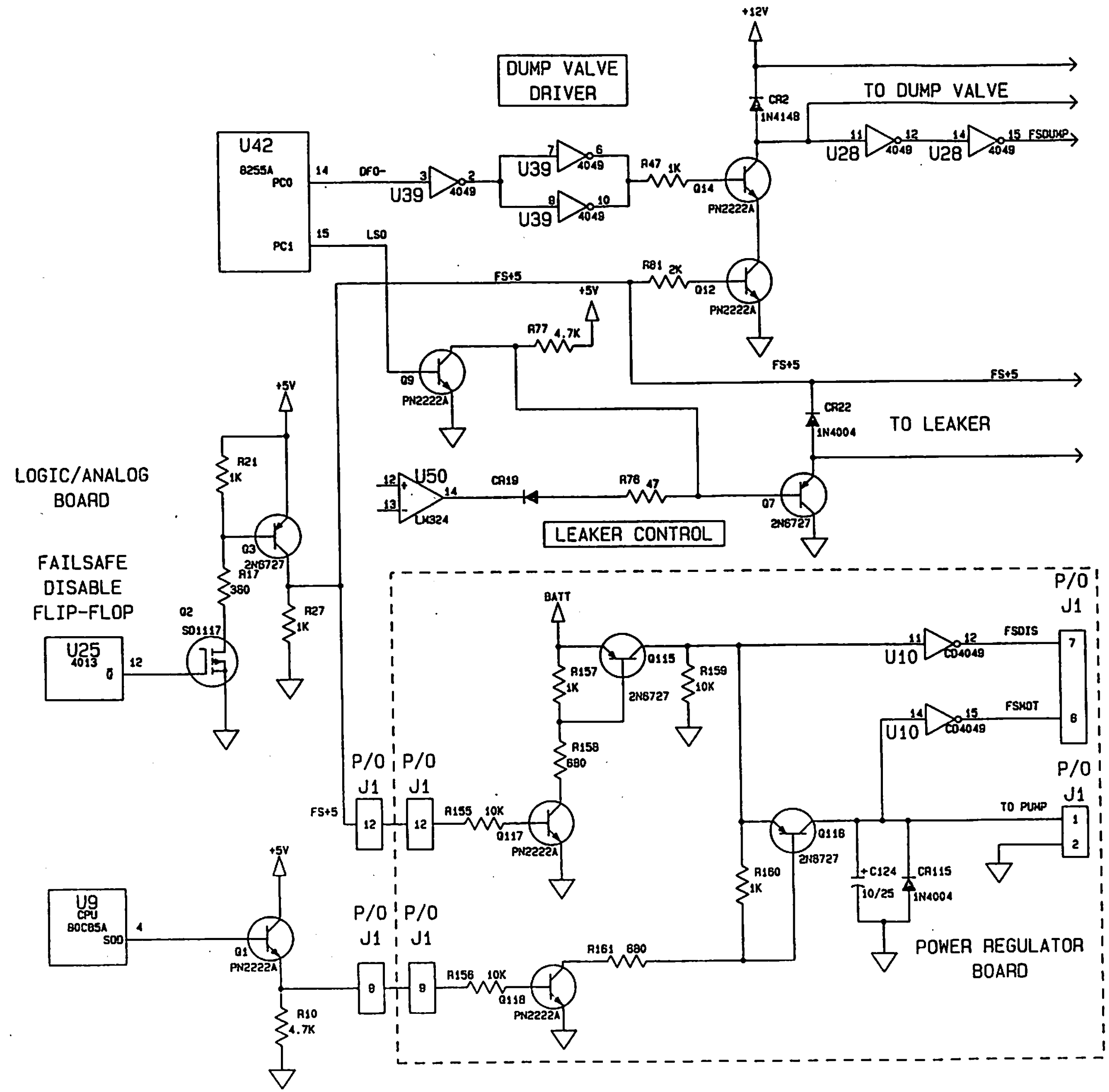


Figure 3-22B. Failsafe Circuit

3.9.2 Battery Charger Regulator (figure 3-25)

When the instrument is plugged in to an AC power source, the battery charger regulator serves to charge the battery at all times and provides operating power to the instrument when it is turned on.

This circuit is a switching regulator based on a TL-494 regulator (U101), driving pass transistors Q101 and Q102 with a pulse width modulated signal. L101 stores energy when Q101 is turned on and releases energy through commutating diode CR108 when Q101 is turned off. C106 smooths the voltage at the output side of L101. Output current limiting to nominally 2 amps maximum is accomplished by measuring the voltage drop across R108 at pins 1 and 2 of U101 via the network consisting of R112 and R119.

Voltage feedback is through R120, R121 and R122 which form an adjustable divider, allowing the output voltage to be precisely set. The reference voltage is derived from pin 14 of U101 and supplied via R114 to pin 15.

This current and voltage feedback internally adjusts the pulse width driving Q101 such that an appropriate amount of energy is deposited in L101 to maintain the voltage across C106 at a constant value. For example, if the load were to increase on the regulator, this would cause the voltage at C106 to decrease, decreasing also the voltage at U101 pin 16 with regard to the reference voltage at pin 15. U101 would then increase the pulse width driving Q101, increasing the energy stored in L101, thus restoring the voltage level at C106. The switching frequency driving Q101 is determined by C111 and R113. When the instrument is turned off, the switching frequency-free runs at about 20 kHz. Q105 will be turned off at this time. When the instrument is turned on, a differentiated pulse of 23.4 kHz is applied to Q105, causing the switching frequency to lock at 23.4 kHz. The 23.4 khz frequency is a submultiple of the CPU clock frequency, thus the switching regulator is synchronized to the CPU clock, alleviating problems caused by asychronous noise injected into the instrument by the switching regulator.

Q107 is included to prevent the battery from draining back through the charger regulator to ground when the instrument is disconnected from AC power. When AC power is disconnected, the voltage across C102 is drained by the regulator and CR106 and R101, effectively turning off Q107. When Q107 is off, the regulator is disconnected from the system ground and current drain cannot occur.

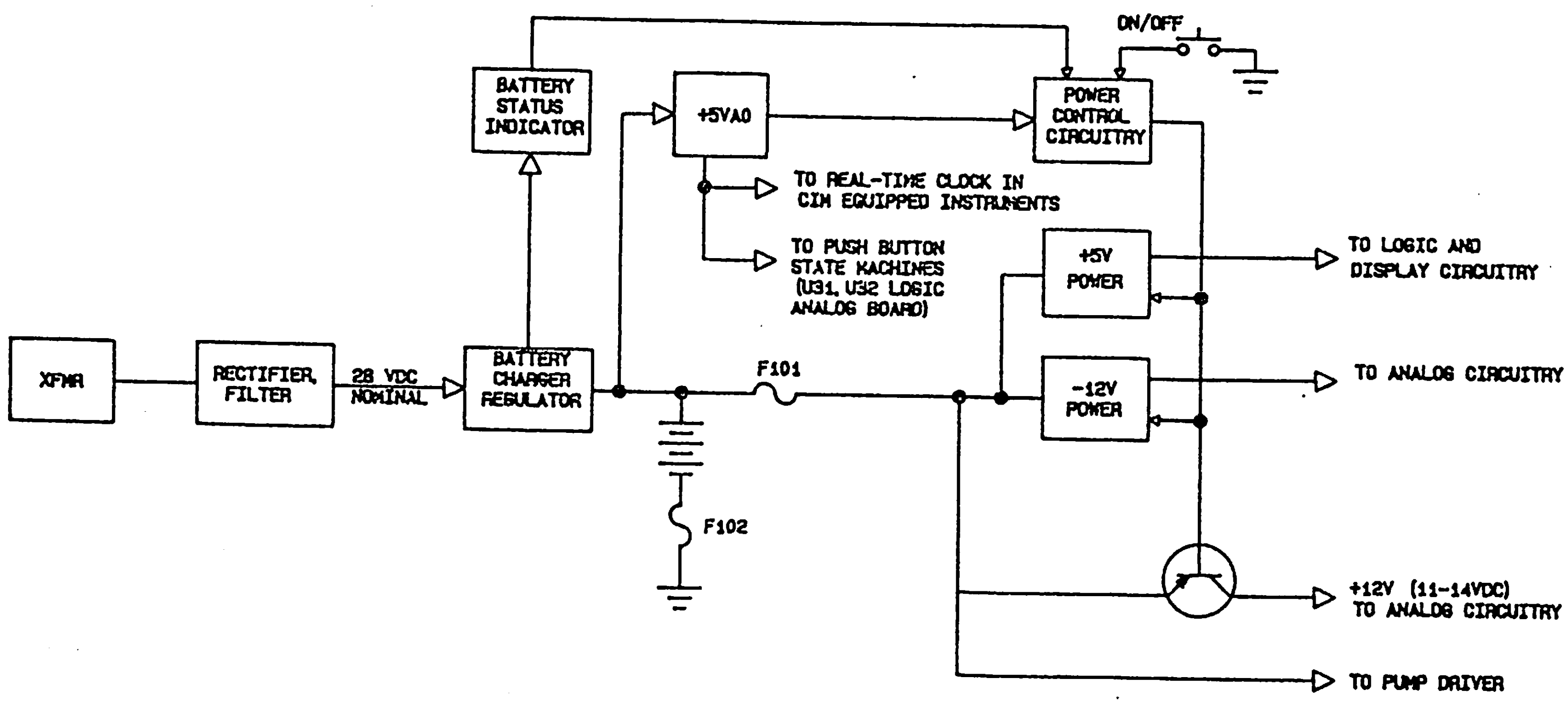


Figure 3-23. Block Diagram of Power Supplies

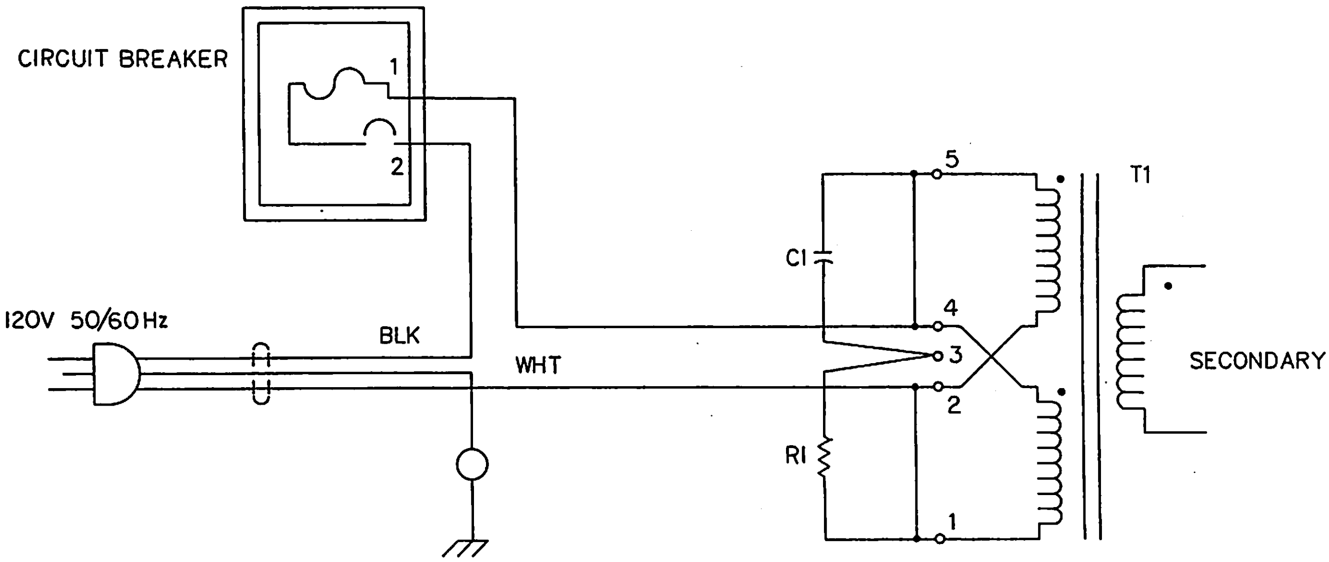


Figure 3-24. AC Power Connection

CR105 blocks the battery voltage from reaching C102. With the instrument connected to AC power, the voltage at C102 reaches about 28 VDC, causing CR106 to conduct, biasing Q107 on to complete the ground circuits for U101 and associated circuitry; enabling the battery charger regulator.

CR109 protects the battery and the rest of the instrument from overvoltage in case of failure of the regulator, such as might occur if Q101 were shorted.

3.9.3 Fuses (figure 3-25)

Two fuses are in the battery circuit. F101, a 2.5 amp fuse, protects against a fault in the power regulator or somewhere else in the power distribution system in the instrument. F102, a 5 amp fuse, protects the battery and associated circuitry in case of a direct short to ground from the battery.

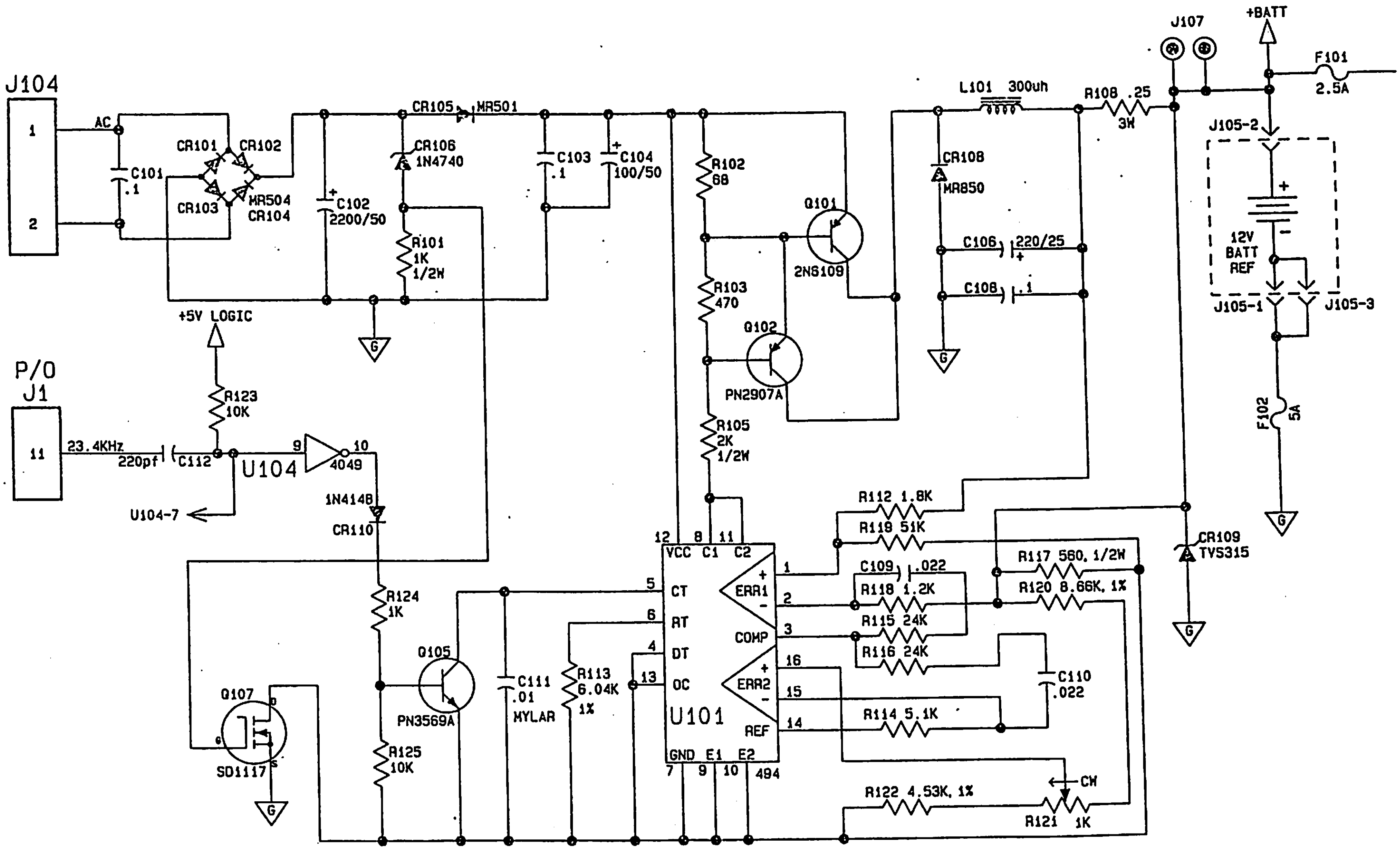


Figure 3-25. Rectifier, Line Regulator, and Battery Charger

3.9.4 Battery Charge Indicator (figure 3-26)

CR107, Q103, C105, R106, and C107 detect the switching waveform at Q101 collector, indicating that the instrument is plugged in and the switching regulator is functioning, thus charging the battery. Q103 will be turned on in this case, supplying current through R107, illuminating the charge indicator LED on the display/ thermometer board. This also turns on Q104 through R109 to send a logic LO to port U40 on the logic/analog board, signaling the CPU that the instrument is operating on AC power.

3.9.5 Battery Status Monitor (figure 3-27)

The battery condition is monitored by three comparators, U106 pins 1, 2, and 14. VR101 provides a reference voltage to the comparators. If the battery voltage drops below 11.6 volts, the voltage at the junction of R145 and R146 will drop below the reference voltage resulting in U106 pin 1 going HI, and U104 pin 4 going LO. Similarly, if the battery drops below 11.5 volts, the voltage at the junction of R144 and R145 will drop below the reference voltage causing U106 pin 2 to go HI and U104 pin 2 to go LO. The signals from U104 pins 2 and 4 are monitored by the CPU through port U40 on the logic/analog board. If the voltage drops below 11.4 volts, the voltage at the junction of R143 and R144 will drop below the reference voltage. This causes U106 pin 14 to go LO, discharging C115, setting flip-flop U103 pins 4 and 10, disabling the instrument (figure 3-28).

C115 and R147 prevent short-term voltage drops from, for example, the pump motor load, from turning off the instrument. Table 3-6 summarizes the comparator reference thresholds.

Table 3-6. Battery Status Monitor Reference Thresholds

Battery < 11.6V, U106-1	= HI (i.e., LOWBATT- = LO)
Battery < 11.5V, U106-2	= HI (i.e., DEADBAT- = LO)
Battery < 11.4V, U106-14	= LO (i.e., RESET- = LO)

The voltage source to the battery status monitor comes from part of the power-on circuit.

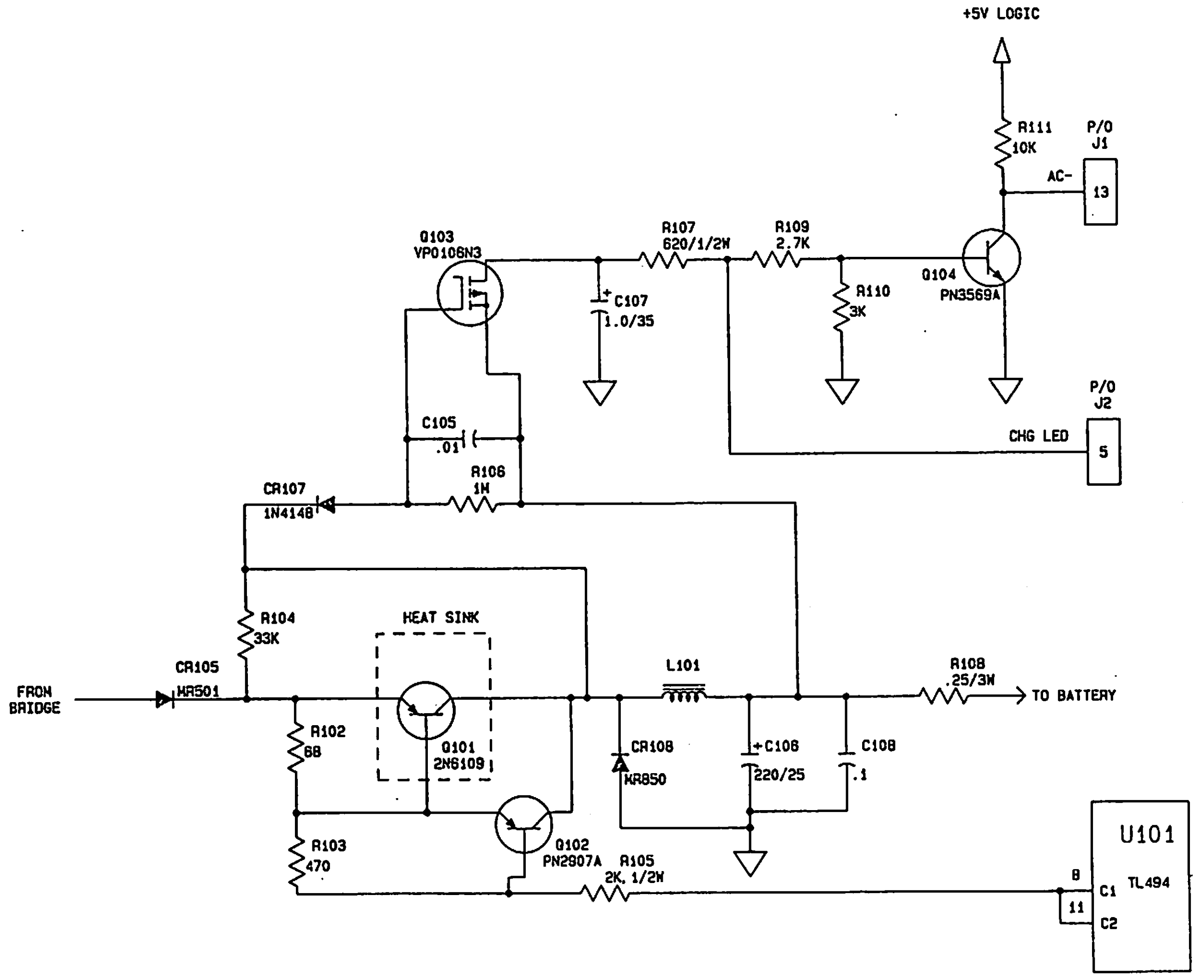


Figure 3-26. Battery Charge Indicator

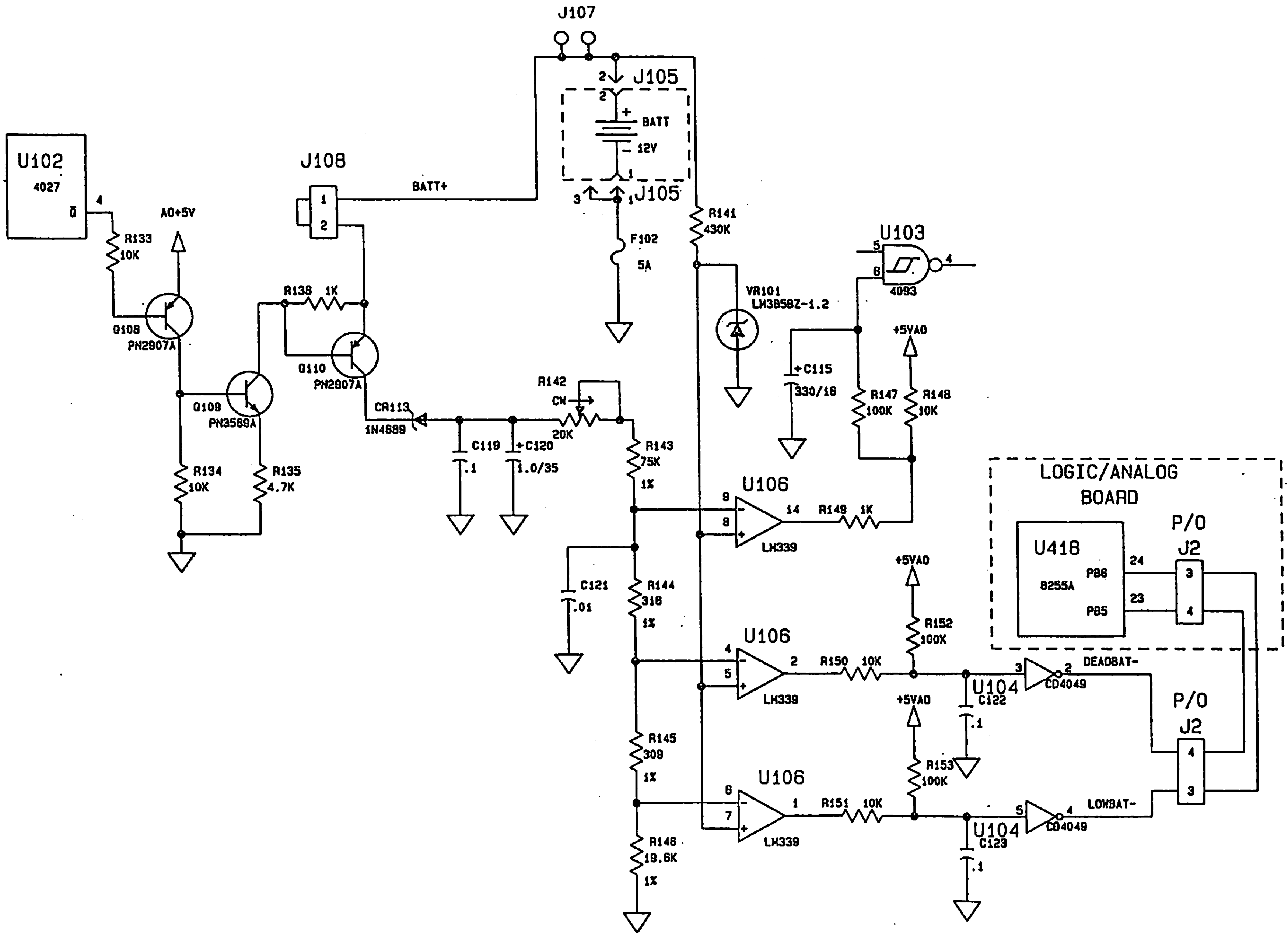


Figure 3-27. Battery Status Monitor

3.9.6 Power On/Off Control (figure 3-28)

The instrument is turned on or off electronically rather than with an electro-mechanical switch. However, a pushbutton is used to actuate the electronic switching.

U102, a JK flip-flop, is the main control element. In normal operation, U102 is toggled (changes state) every time the ON/OFF switch is activated. R128, R127, C113 and U103-11, a Schmitt trigger, debounce the ON/OFF switch and apply a clock pulse to U102-13 upon ON/OFF switch activation. If the instrument was previously turned off, U102 will toggle so that the Q output, pin 15, will go HI and the $\overline{Q}$ output, pin 14, will go LO. The high Q output is applied to the logic board through J1-10 (PWRON) and to the base of Q122, turning on the +12V power supply, which in turn enables the +5 logic and -12V power supplies and powers up the instrument. Actuating the power switch again will reverse the above process.

The +12V and +5V power supplies are discussed further in sections 3.9.7 and 3.9.8.

The LO $\overline{Q}$ output of U102 is applied through R133 to Q108, turning it on, which then turns on Q109 and Q110 to apply battery voltage to the battery status comparators, U106 pins 1, 2, and 14, through the divider chain CR113, R142, R143, R144, R145, and R146. The battery status circuitry is described in section 3.9.5 (figure 3-27).

The battery status circuit can hold U102 reset. U103-4 and U103-10 are configured as an R/S flip-flop which can be set to prevent U102 from being toggled to turn the instrument on. If the battery voltage drops below 11.4 volts, the battery status output (U106-14) will go LO. This LO is coupled through R147, discharging C115 and causing U103-4 and U103-10 to be set with pin 10 LO and pin 4 HI. The LO level from U103 pin 10 is coupled to U103 pin 1, causing U103 pin 3 to go HI, holding U102 reset and the instrument off. To reset U103-4 and U103-10, the instrument must be connected to an AC power source. This action turns on Q107, pulling CR112 LO, which pulls U103 pin 8 LO, resetting U103-4 and U103-10 so U103 pin 10 is HI and U103 pin 4 is LO.

The CPU can turn the instrument off by resetting U102. This is done via output U40 port on the logic/analog board turning on Q106, driving U103 pin 2 LO, causing U103 pin 3 to go HI, resetting U102.

The on/off control circuit is always active, and is powered by the +5VAO supply discussed in section 3.9.10.

3.9.7 +12 Volt Supply (figure 3-29)

The +12V supply is derived directly from the battery via Q123. Although labeled +12V, the actual voltage can be between about +11 to +14 volts, depending on the state of battery charge and whether the instrument is plugged in.

The pump motor is not powered by the +12V supply, but through its own switch, Q115 and Q116, directly from the battery via F101.

The power ON/OFF switch controls the +12V supply, which in turn controls the +5V Logic and -12V supply. To turn the instrument on, J/K flip-flop U102 is toggled by the ON/OFF switch. U102-15, the Q output, goes HI, and current flows to the base of Q122, which is configured as an emitter follower. Current then flows into Q122 collector from Q123 base, also turning on Q123, the +12 volt supply switch.

The current flowing through Q122 flows through R178 and also through Q121 base and Q114 base, turning them on. The +12V from Q123 collector is applied to U107 (+5V supply) and U108 (-12V supply) causing them to be enabled, supplying power to the rest of the instrument.

3.9.8 +5V Logic Supply (figure 3-29)

The +5V supply furnishes most of the logic Vcc potentials in the instrument, power to the displays, and power to the thermometer.

This supply is very similar to that of the battery charger regulator. It is powered from the battery voltage or battery charger regulator via F101. U108 drives the pass transistor, Q119, via Q120 and Q121 with a pulse width modulated signal at a 23.4 kHz rate. L103 is the energy storage inductor, CR116 is the commutating diode, and C136 serves as a filter capacitor.

CR117 is an overvoltage protection diode to protect the items on the 5 volt line in case of a regulator failure, such as a shorted Q119. C144 and R180 result in a free-running switching frequency of about 20 kHz, which is synchronized to 23.4 kHz, a submultiple of the 80C85 clock frequency, by a differentiated 23.4 kHz pulse via Q124.

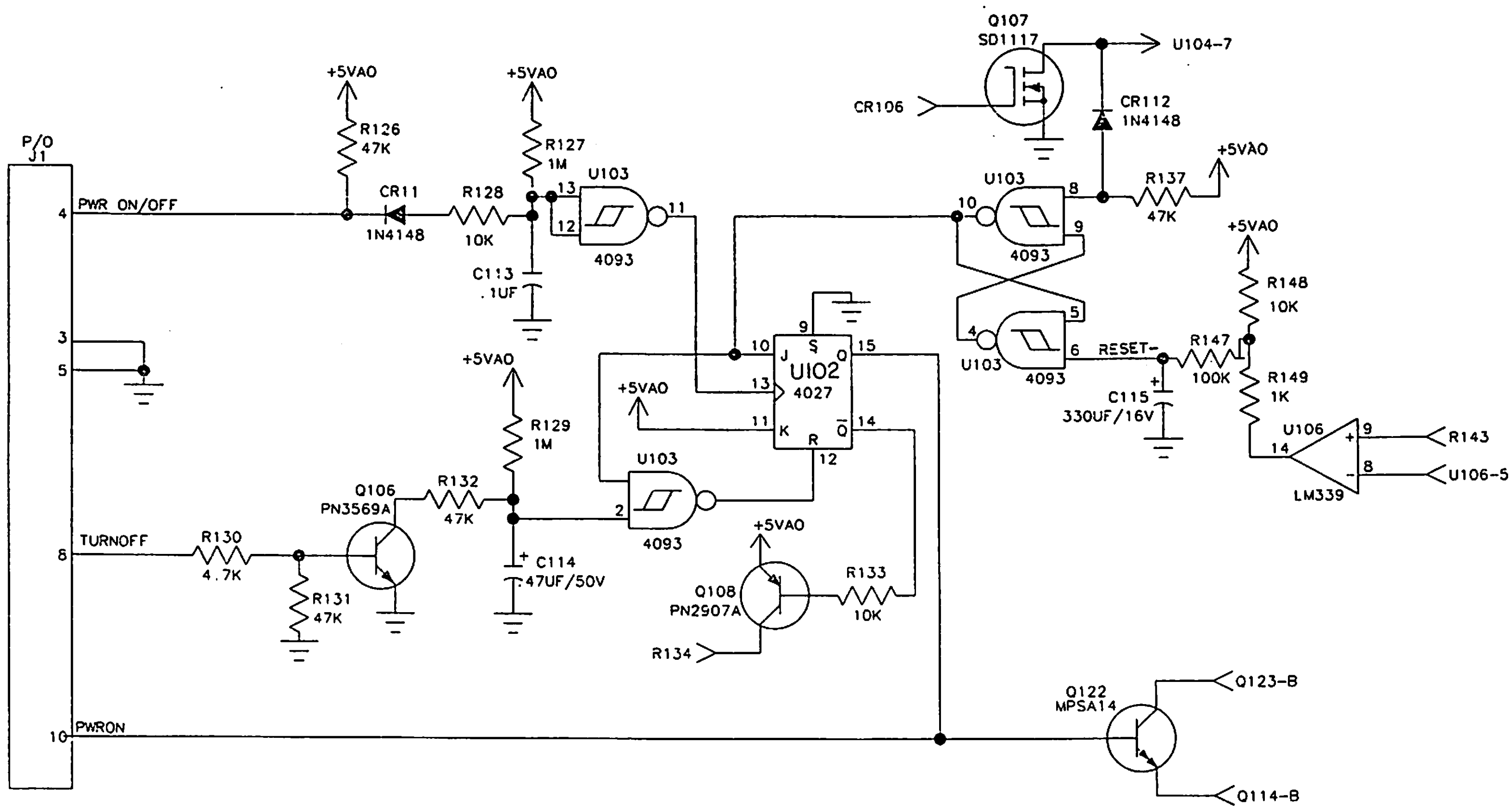


Figure 3-28. Power ON/OFF Control

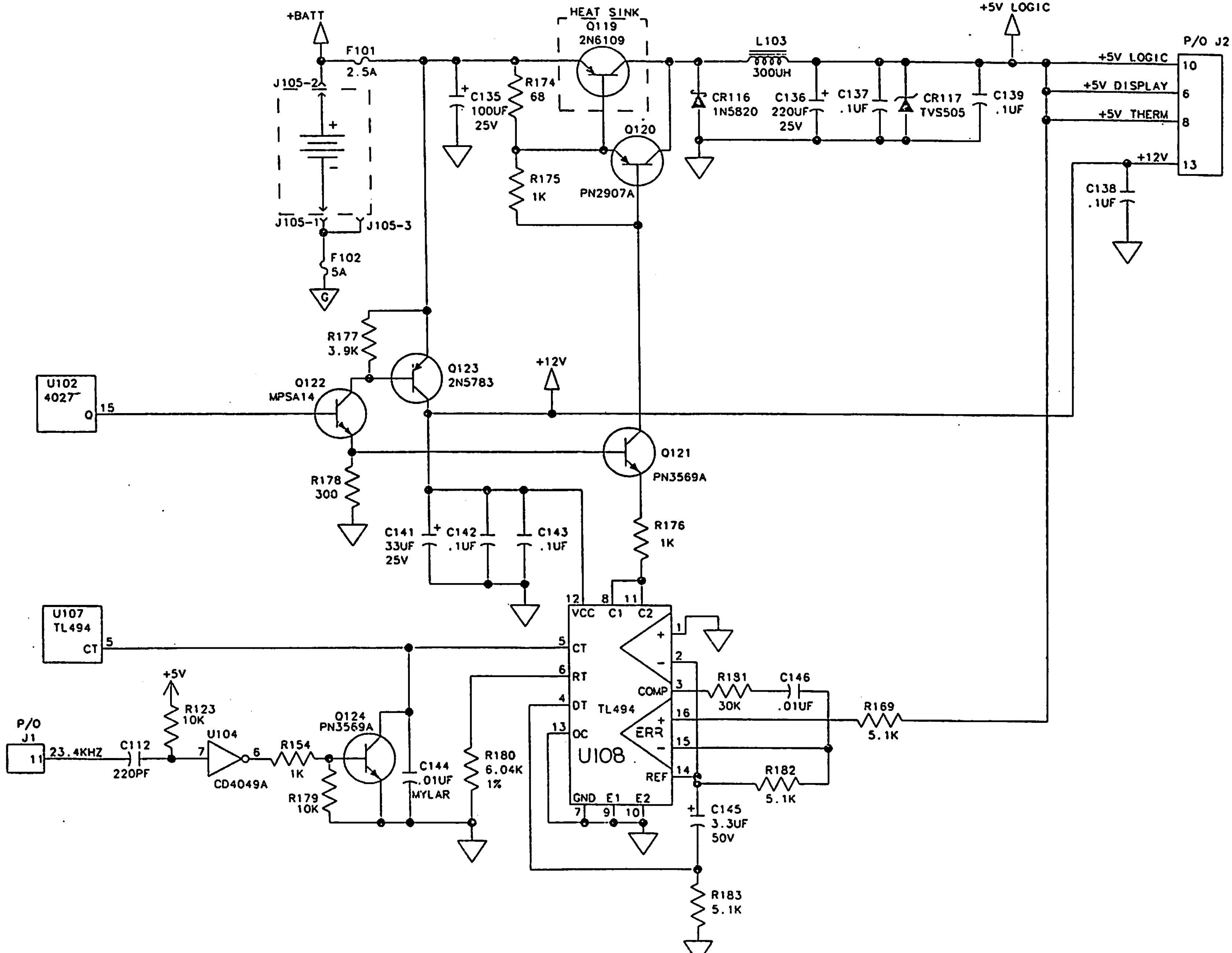


Figure 3-29. +12 and +5V Power Supplies

3.9.9 -12 Volt Supply (figure 3-30)

The -12V supply is used to supply negative bias voltages for the analog circuitry in the instrument. It is powered from the battery or battery charger regulator via F101.

This supply is a pulse width modulated type of flyback switching supply, capable of converting the positive battery voltage directly to a negative voltage. Q112 is the pass element, driven by U107 via Q113 and Q114 in the same manner as in the battery charger regulator. When Q112 conducts, energy is stored in L102. When Q112 is switched off, the energy stored in L102 causes the voltage at the L102 and CR114 junction to swing negative, forward biasing CR114 and charging C127. C127 serves as a filter capacitor. The negative voltage at C127 is compared with the reference voltage in U107 via R166, R167, R170 and R172. In the same manner as in the battery charger regulator, the switching pulse width is adjusted to maintain the output voltage at the correct level. There is no current-limiting feature in this supply. L104 and C128 and 129 form a noise filtering network. A synchronized 23.4 kHz ramp is supplied to U107 pin 5 from U108 pin 5.

3.9.10 +5 Volt Always-On Supply (+5VAO, figure 3-31)

This supply is a small linear regulated supply designed to run directly from the battery/battery charger voltage. It is used to maintain power at all times on the always-active components used for the power ON/OFF control, and also used to power the real-time clock and oscillator on the CIM equipped instruments and the pushbutton state machines (U31 and U32).

VR101, a reference diode, is used as a 1.24V reference. Q111 is the pass element, with the +5VAO potential available at its source connection. U105, a transistor array, is configured as a differential amplifier, comparing the +5VAO potential via R138 and R139 with the 1.24V reference. The resultant error signal drives the gate of Q111 to maintain the +5VAO value.

This circuit is designed to draw very little overhead current so as not to load the battery.

3.10 THERMOMETER FUNCTIONS (figure 3-32)

3.10.1 Temperature Measurement

The display/thermometer board is an essentially independent measuring system, containing its own hardware and software. Once activated by removal of the thermometer probe from its socket, a measurement cycle is initiated. The thermometer probe sends an analog temperature signal to the module. The signal is processed by signal conditioning circuitry and is digitized into groups of three BCD words by the A/D converter. This data is used by the µcontroller to compute and display the temperature.

As shown in the block diagram (figure 3-32) the analog temperature signal is linearized and converted to BCD. The µcontroller reads the data through the multiplexer, and writes the temperature to the display. The thermometer module also contains a power control circuit so that internal power on the board is off when not in use.

3.10.2 µController (U1, figure 3-33)

The µcontroller (U1) is an NSC COP444L customized IC. It contains 2K bytes of ROM, 128 bytes of RAM, an internal clock generator, timing registers, and I/O porting for data acquisition and display writing.

The µcontroller reads and processes digital temperature data from the A/D converter and writes temperature display data to the display driver board. Self-contained software uses four bit-words to process data.

In addition, the µcontroller operates the display/thermometer board speaker (LS1), and reads and processes settings of the NORMAL/MONITOR mode switch, the S2 internal DIP switch no. 5 (°F/°C), and the DISPLAY TEST switch.

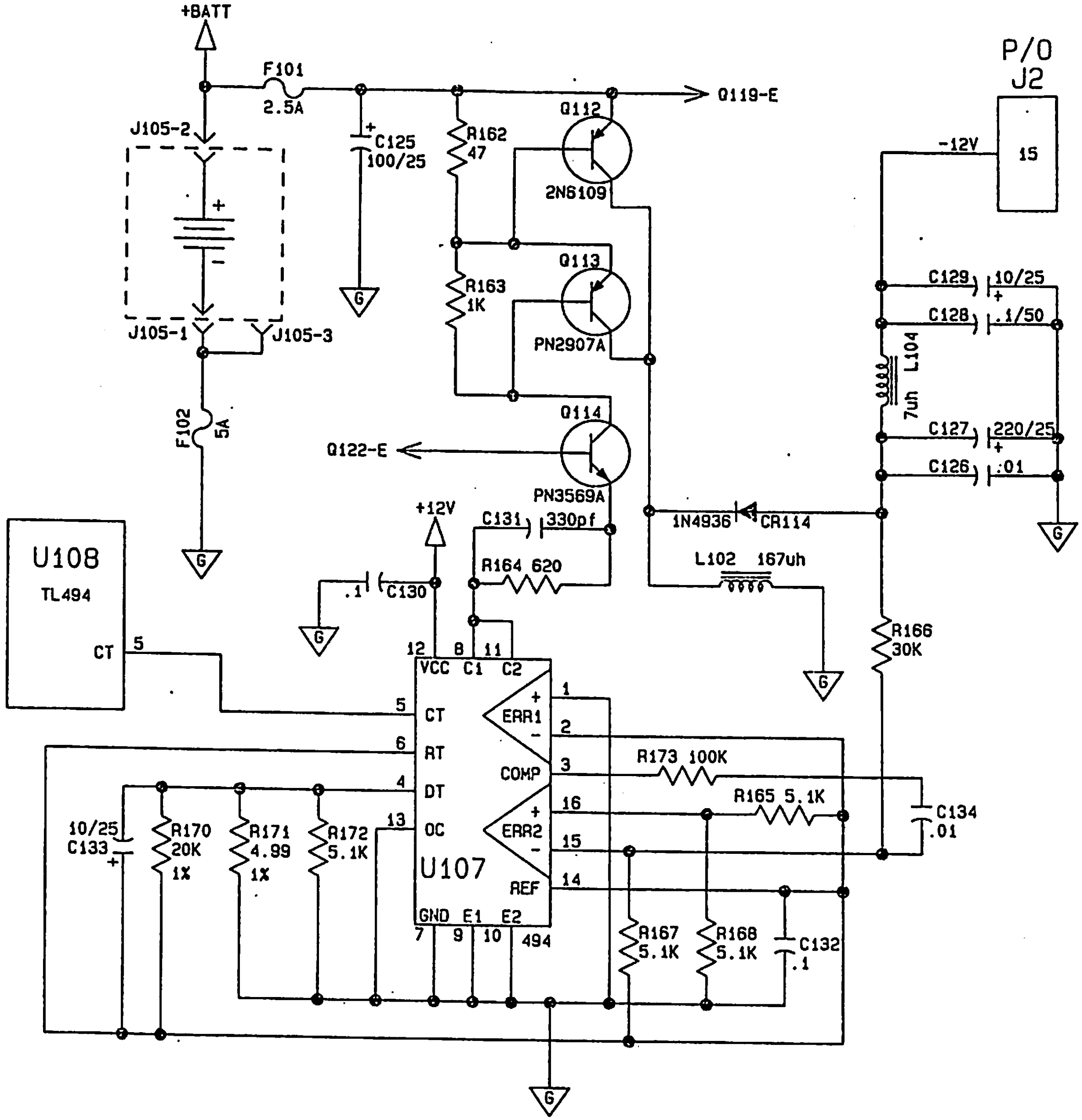


Figure 3-30. -12V Supply

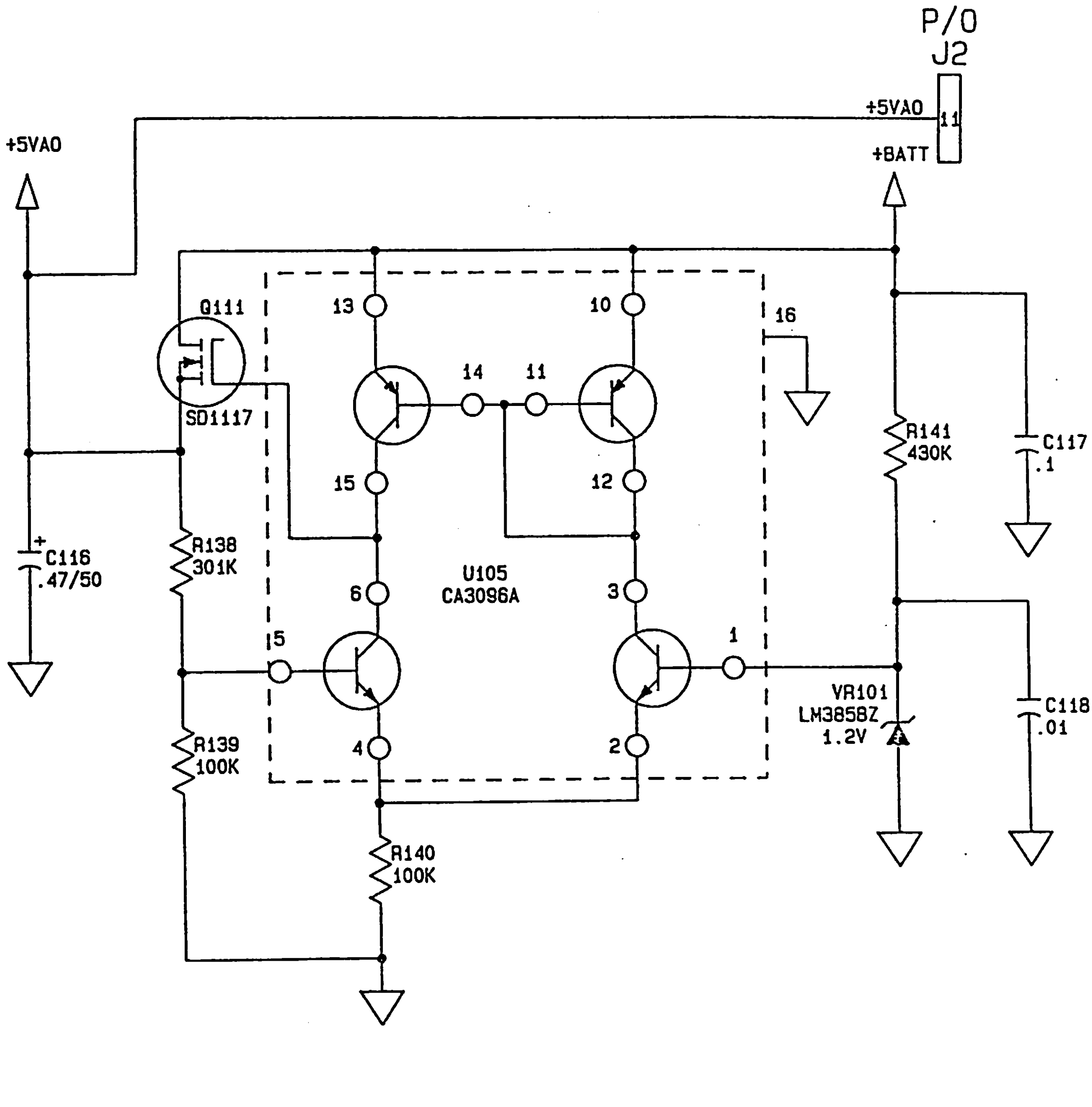


Figure 3-31. +5V Always-On Supply

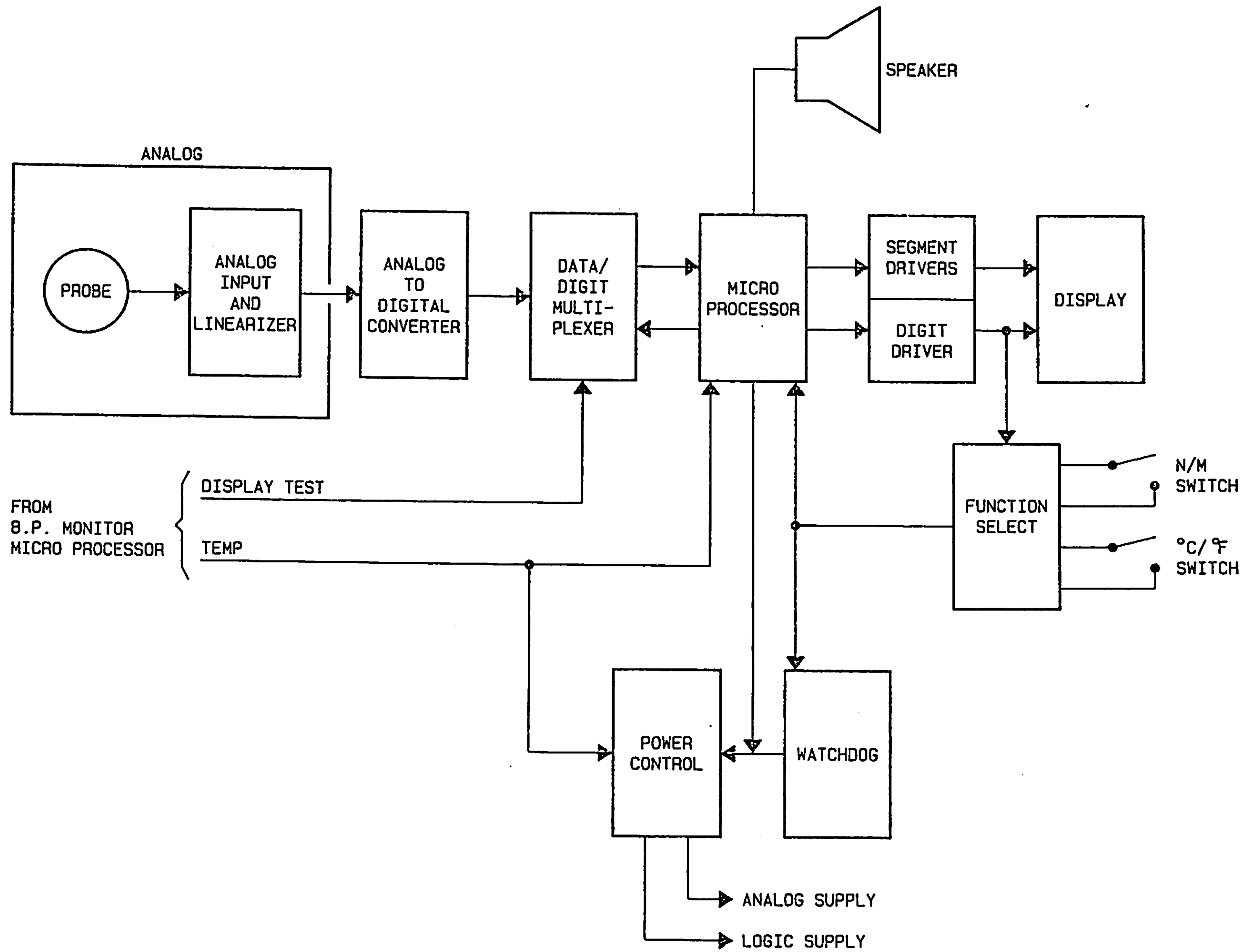


Figure 3-32. Block Diagram of the Thermometer

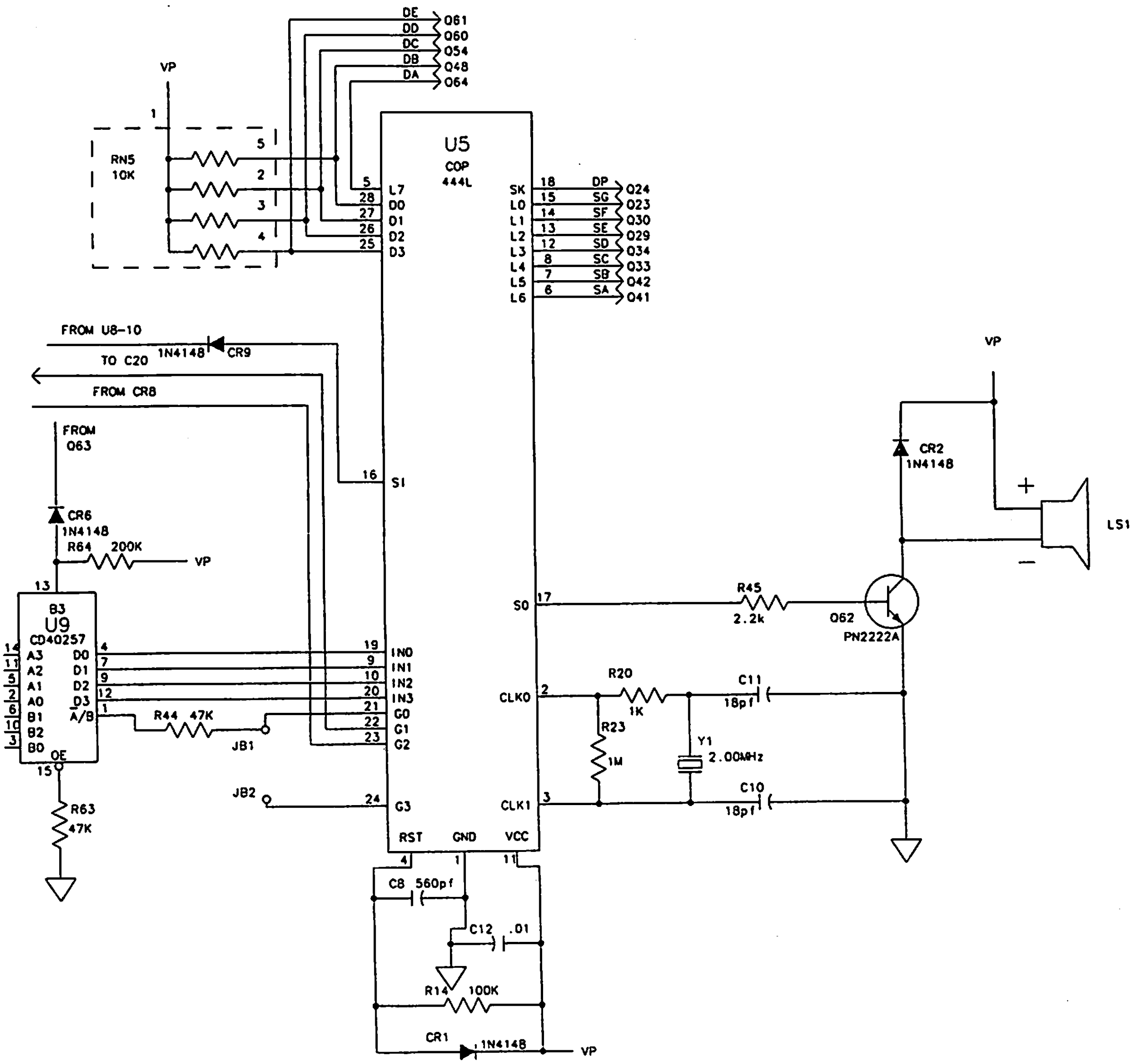


Figure 3-33. Thermometer μController

The thermometer µcontroller, U5, is an independent system, measuring temperature and controlling the temperature display without processing by the CPU. Only the thermometer probe sense signal, which is used to turn the thermometer board on at the beginning of a measurement cycle, and display test command is received from the CPU.

The µcontroller is configured as follows:

- Inputs IN0 through IN3 receive data from D0 through D3 outputs of multiplexer U9 regarding temperature, digit strobe (LSD, NSD, and MSD), and display test state (on or off) via U9-13.

- The G port (G0 through G3) has both inputs and outputs. G0 is an output which selects the multiplexer channel, data (A0 through A3), or digit strobe and display test state (B0 through B3), to be read at the U5 IN port. G1 is an output which resets the power control flip-flop for automatic turn-off of the thermometer when a temperature measurement is completed or the probe is inserted into the storage well. G2 is an input which senses the state of the probe sense signal via the CPU; G3 is an input used for testing purposes.

- Serial I/O register S0 is an output that turns on Q62, causing the speaker to be activated when it conducts.

- CLK0 and CLK1 are the external inputs for the clock generator, which utilizes a 2.00 MHz crystal. Capacitors C10 and C11 establish the load for the crystal. The crystal frequency is internally divided by 32 to achieve the 16 microsecond cycle time of the µcontroller. This cycle time ensures that the routines of the programs within the µcontroller execute at the proper rate.

- RST input, with C8 and R14 performs the power-on initialization.

  Outputs L0 through L6 are the display segment drivers. Outputs D0 through D3 and L7 are the display digit drivers. The display decimal point is driven from output SK.

3.10.3 Analog Input and Linearizer (figure 3-34)

The analog input and linearizer consists of U7-5, 6, and 7; voltage regulator U13; resistors R53, R54, R55, R67, R68, R69, R70, R71, and R72; wide-band choke L1; and capacitors C18, C23, and C24. The voltage at U7-7 is linearly proportional to the temperature of the probe tip. Filtering of noise and stray interference is provided by L1, C24, C18, and C23.

As the temperature of the probe tip rises, the resistance of the thermistor, Rt, decreases nonlinearly. This varying resistance leads to a changing voltage which is applied to the REF terminal of U13 from U7-7. From the OUT terminal, the voltage goes through R71, R72, and the probe circuit. The output of U13-3 is also applied to U7-5 via R71. These resistors are configured as a bridge whose output is applied to the differential inputs of operational amplifier (op amp) U7 at pins 5 and 6. This amplifier's gain is set by R55 and R54. 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 U6-11.

The output voltage from U7-7 is applied to the REF terminal of U13 via R53, as well as to U6-11. The loop through R53, REF, and OUT of U13 compensates for the nonlinear resistance versus temperature of the thermistor. The voltage regulator U13 always maintains the OUT voltage 1.2V higher than the REF voltage, which drives the top of the bridge at R71 and R3 of the probe. The effect of the loop through R53, REF, 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 U7-7 is 0.000 to 1.000V with respect to U6-10, with 0.000V corresponding to 31.1°C (88.0°F) and 1.000V corresponding to 42.2°C (108°F).

3.10.4 A/D Converter (U6, figure 3-35)

U6 is a self-contained, dual-slope A/D converter which converts voltage from the analog circuit to binary coded decimal (BCD) form which the μcontroller can use. The signal input range is 0.000 to 1.000 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 input. At the beginning of a conversion cycle C22 charges at a rate proportional to an internal reference voltage. C22 then discharges at a rate proportional to the input voltage. The counter counts until C22 discharges. The total count is then sent to the μcontroller via multiplexer U9.

U6-10 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 R83 (SPAN) which adjusts a reference current utilized internally by the converter.

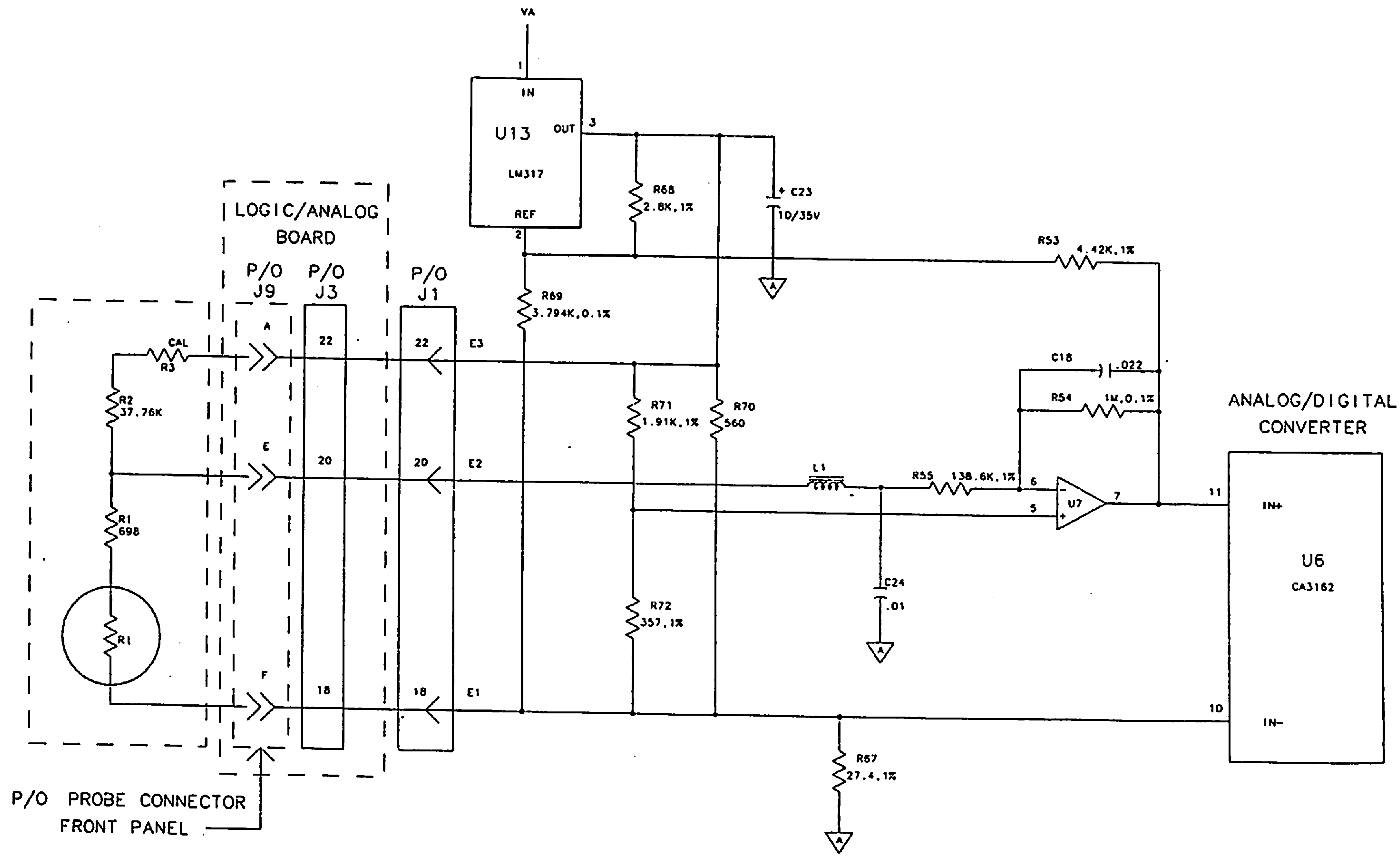


Figure 3-34. Analog Input and Linearizer

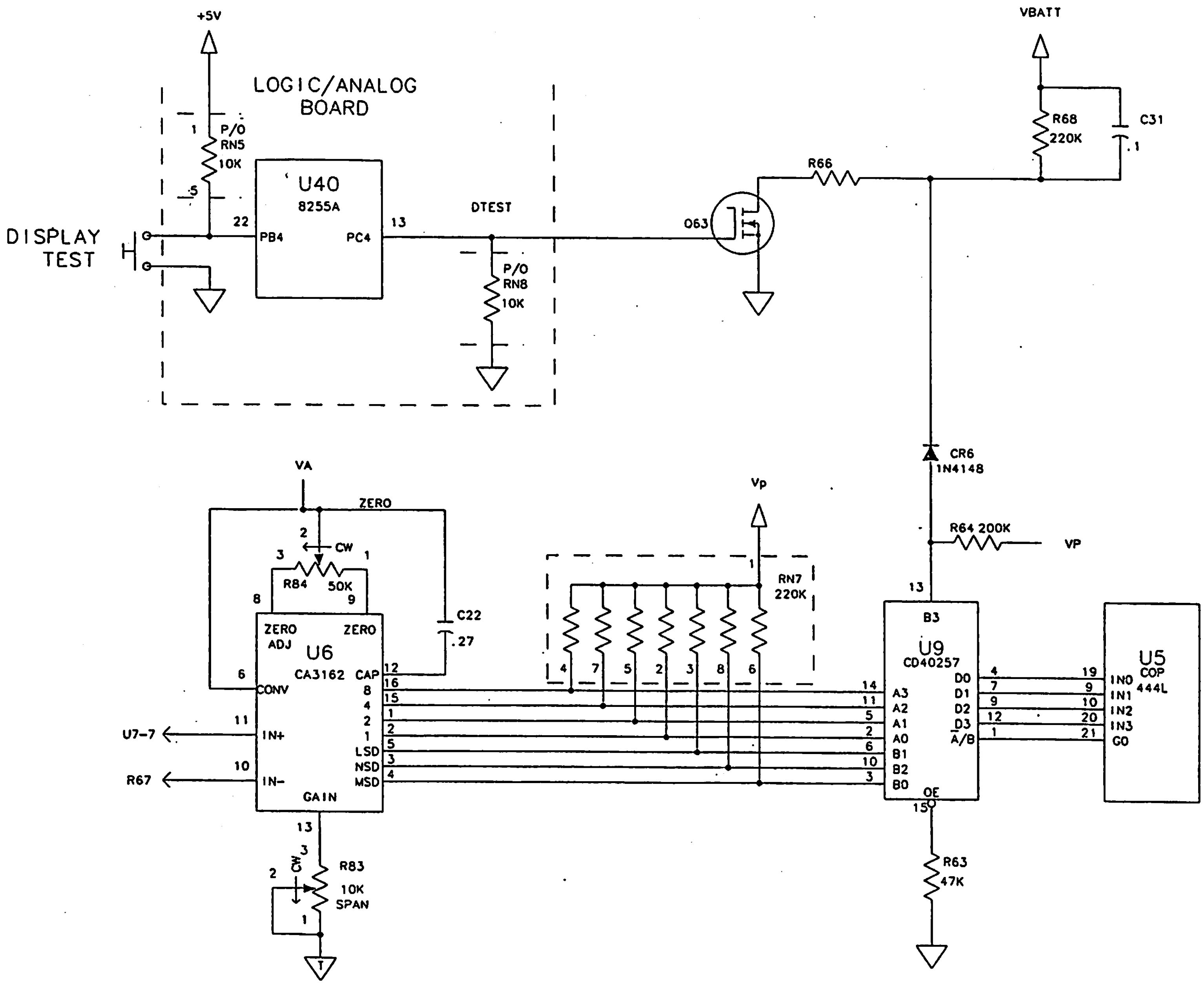


Figure 3-35. A/D Converter and Multiplexer

The zero adjust circuit of U6 ensures that when the input from the analog circuit is zero volts, the digital output of U6 is also zero. R84 (ZERO) 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 U6 (U6-16, 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 U6 (U6-5, 3, and 4).

The digits do not indicate the actual temperature, but represent the temperature data. For example, 000 represents 88.0°F and 999 represents 107.9°F, the top and bottom of the temperature range. Every value from 000 to 999 represents a temperature from 88.0°F to 107.9°F. The μcontroller 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. U6 operates continuously at a rate of about 9.5 milliseconds per conversion.

3.10.5 Multiplexer (U9, figure 3-35)

The multiplexer accepts digital information from the A/D converter and display test signal. Output is to the μcontroller in the form of four-bit data words at D0-D3.

Inputs A0-A3 (U9-2, 5, 11, and 14) are temperature data. Inputs B0-B3 (U9-3, 6, 10, and 13) are digit strobes and the display test state. A0 receives data from the "1" output of U6; A1 from the "2" output; A2 from the "4" output; and A3 from the "8" output. B0 receives data from the MSD output of U6; B1 from the LSD output; B2 from the NSD output. B3 receives the display test state. A0-A3 and B0-B3 are two distinct four-bit words.

The multiplexer select (SEL), at U9-1, acts as a switch to pick which four-bit word, A or B, is sent to the μcontroller through outputs D0 through D3 (U9-4, 7, 9, and 12). The A word is selected when SEL is LO; the B word is selected when SEL is HI. SEL is controlled by the G0 output of the μcontroller (U5-21).

The OE input of the multiplexer (U9-15) is normally pulled down by R63. 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.

3.10.6 Display and Display Driver (figure 3-36)

µController outputs L7 and D0 through D3 are the display enable strobes. They send signals to the display indicating which display (DS10 through DS14) is to be illuminated. This output works in conjunction with the SK (decimal point) and L0 through L6 output which indicates to the display which segments (a through g) are illuminated for any one digit. 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 Q64, Q48, Q54, Q60, or Q61, respectively, to conduct. These transistors sink current from the display cathodes. L0 through L6 and SK drive segments g through a and the decimal point, respectively, through buffers Q41 and Q40, Q42 and Q39, Q33 and Q47, Q34 and Q46, Q29 and Q53, Q30 and Q52, Q23 and Q59, and Q24 and Q58. 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. (The decimal point is only connected at DS12.)

3.10.7 Watchdog Circuit (figure 3-37)

The watchdog circuit turns the thermometer off if there is a µcontroller malfunction causing a loss of the digit strobes. The watchdog circuit constantly receives signals from the displays through Q54 and Q60 and Q61 if the S2 internal DIP switch no. 5 (°F/°C) or the NORMAL/MONITOR mode switch are closed (MONITOR or °C selected). Under normal conditions, C21 remains discharged by Q51 and yields a high input at U8 pins 4 and 5. However, if a malfunction occurs and no signal is received at U8 pins 11, 12, and 13, C21 charges through R57. The resulting LO signal is received at U8 pins 4 and 5, resetting the latch and turning off the display/thermometer board.

3.10.8 Normal/Monitor Modes (figure 3-37)

a. Normal Mode

Setting the NORMAL/MONITOR mode switch to normal mode causes the µcontroller to use a different program than that used in the monitor mode. Temperature is estimated in about 30 seconds based on the rate of change of the resistivity in the probe. The predicted value is reported to the display.

b. Monitor Mode

Setting the NORMAL/MONITOR mode switch to monitor mode causes the µcontroller to use a different program than that used in the normal mode. Temperature in the probe is allowed to equilibriate and is continuously monitored and updated to the display. The µcontroller detects the state of the NORMAL/MONITOR mode switch through input SI via U8-10.

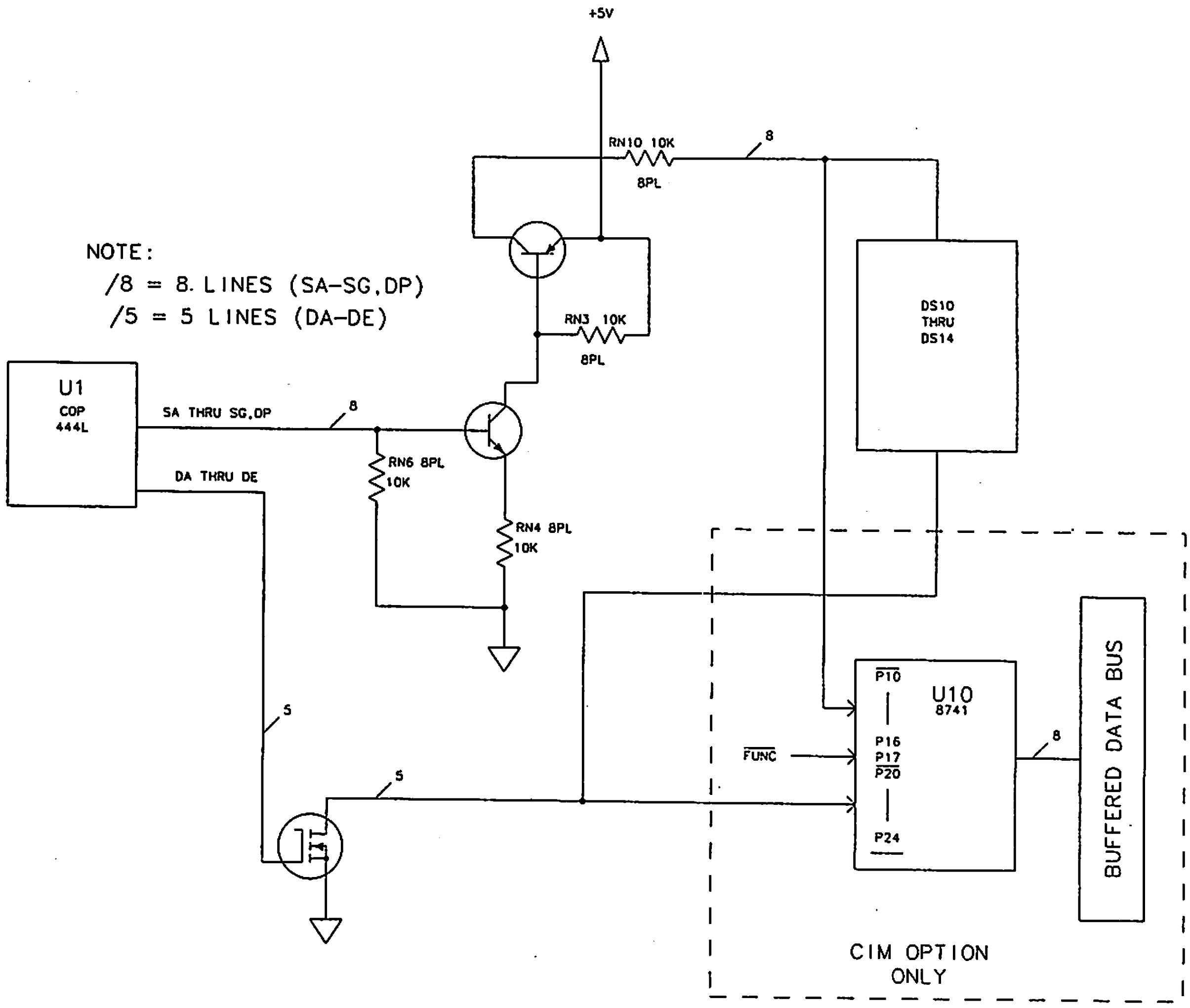


Figure 3-36. Temperature Display and Display Driver

3.10.9 S2 Internal DIP Switch No. 5 (°F/°C) (figure 3-37)

Setting the °F/°C DIP switch to °C (Centigrade) or °F (Fahrenheit) causes the µcontroller to use different constants to calculate the temperature. The µcontroller detects the state of the switch through input SI via functional signal from U8-10.

The S2 internal DIP switch (no.5) is accessible through louver holes in the bottom, right-hand side of the instrument (°F = up position; °C = down position).

3.10.10 Power Control Circuit (figure 3-38)

The power control circuit consists of Q37, Q38, Q45, and U8.

Power enters the thermometer at J1-24. J1-24 is connected to +5V supply by plugging in a thermometer probe or tester.

The CPU turns the thermometer module on and off by controlling the power control circuit. The CPU monitors the thermometer probe well to determine when to power-up the thermometer board. When the temperature probe is plugged in but out of its well (i.e., the probe sense optics are turned on) the TEMP signal (U40 pin 12) from the CPU goes HI. (See table 3-7.)

Table 3-7. CPU Monitoring of Thermometer Probe Well

Condition	CPU signal	Q57 Drain
Probe not in well:	TEMP = HI	LO
Probe in well:	TEMP = LO	HI

R/S flip-flop U8, pin 9, applies power through Q38 and Q45. When U4 pin 9 goes HI, power flows to ground through Q37, saturating Q38 and Q45. Q38 supplies power (VA) to the analog input and linearizer (U7) and A/D converter (U6). Q45 supplies power (VP) to the multiplexer (U9) and µcontroller. +5THERM is always present when the probe connector is plugged in, and supplies power to U8.

Depending on the position of the thermometer probe, there are two methods for activating the thermometer:

a. By removing the probe from the storage well when initially both the connector and probe are in place (i.e., Q57 drain HI and the thermometer is off). In this case, removal of the probe causes the CPU to pull Q57 drain to ground. This HI to LO transition is coupled through C27, setting flip-flop U8-9 HI and activating the thermometer.

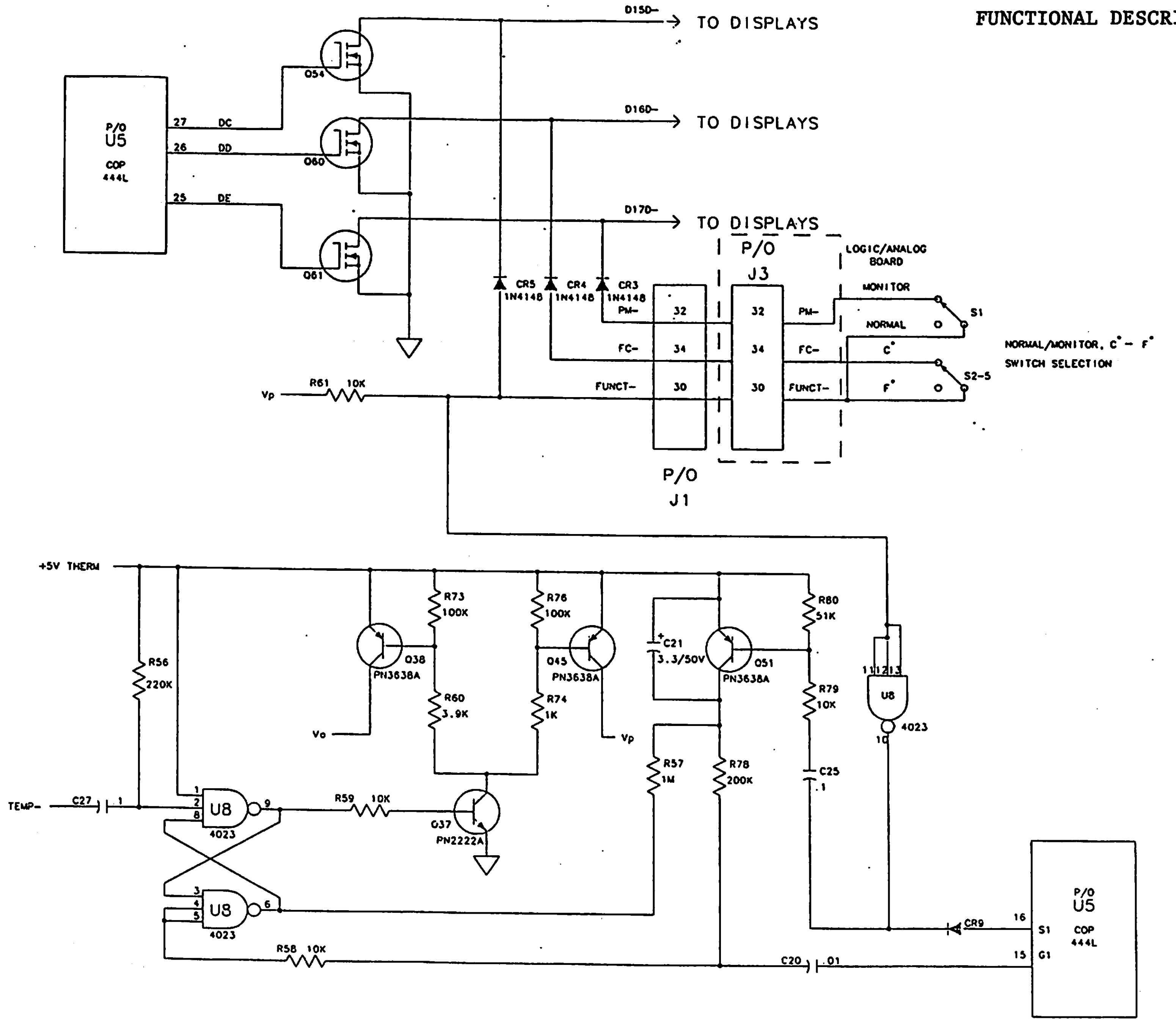


Figure 3-37. Watchdog, Normal/Monitor, and °F/°C Selector Circuits

b. By inserting the probe connector when the probe storage well is empty (i.e., Q57 drain LO). In this case, +5V charges C27 through R56, and U8 pin 2 is held LO until C27 charges to a HI level. This delay causes U8 pin 9 to become HI, activating the thermometer.

Application of power from Q45 initializes the µcontroller. When power is first applied, VP goes HI and RST is LO. Charging C8 through R14 delays the rise of RST to logical 1, allowing initialization to occur.

The thermometer can be deactivated by removing the probe connector. Alternatively, inserting the probe into the probe storage well causes the µcontroller to output a LO to U8 pins 4 and 5, causing U8-9 to flip to LO. The µcontroller senses the inserted probe condition through CR7 and CR8 via its G2 port.

3.11 CIM EQUIPPED MODEL 4200C

The CIM equipped Model 4200C contains three additional functional blocks. These blocks are designed to permit ASCII monitoring of the instrument through an RS-232 port.

The blocks are an IVAC CIM II board, a real-time clock, and a thermometer display interface port.

3.11.1 CIM Interface (figure 3-39)

The CIM equipped Model 4200C incorporates an IVAC CIM II board which contains a UART, baud rate generator, and RS232 level converters to interface to an external data gathering system. The CIM II board is interfaced to the 4200C through J4. This 16-pin dedicated connector is in parallel with the test connector J5, but carries only the signals and power required by the CIM II board.

U16 is a bi-directional buffer used to isolate the CIM board loading from the data bus. It is enabled by EXTIO- (external I/O access), and the data direction is determined by RD-. RN2 maintains a HI to avoid ambiguous logic levels on the external bus IOD0-IOD7 when U16 is not enabled.

The address lines IOA0 and IOA1 are buffered ADDR8 and ADDR9. (The upper eight address lines copy the lower eight address lines during an IO transfer.)

The read or write command to the CIM board is derived and buffered from the S1 status line from the CPU as IOWR-. LO is a write operation and HI is a read operation.

The CIM board is selected for an I/O operation when IOXSEL- is LO. It's timing is derived from the address decoder output EXTIO- and WR- or RD-.

+5 Volts and +12 volts are provided at J4 to operate the CIM board.

3.11.2 Thermometer Display Interface Circuit (figure 3-40)

The thermometer interface (U10) is an 8741A satellite processor on the display/thermometer board. It contains 1K byte of program ROM and 64 bytes of RAM. It decodes temperature display segment and digit driver signals and thermometer control signals. These signals are processed to convert the display information to an 8-bit status code and four-digit BCD code for transmittal to the CPU. The interface is required because the multiplexed temperature display is not compatible with the CPU data bus and CPU's timing.

The thermometer interface interprets all possible conditions that can occur with the thermometer, as well as the contents of the temperature display.

The thermometer display interface is clocked by the buffered 3 MHz clock signal (BCLK) from the CPU via U12, pin 6 and 4. Power-on reset (BRESET) from the CPU is inverted to initialize the thermometer display interface.

U10 ports P10-16 and P20-24 serve as input ports for the temperature display segment and digit strobe signals, respectively. T0, P25 and P26 monitor thermometer power status and P17 monitors the NORMAL/MONITOR switch and the S2 internal DIP switch settings (nos. 1-6).

U11 functions as a pulse stretcher monitoring the temperature display decimal point (BDP), because the decimal point is intermittently clocked at the thermometer µcontroller's clock rate (62.5 kHz).

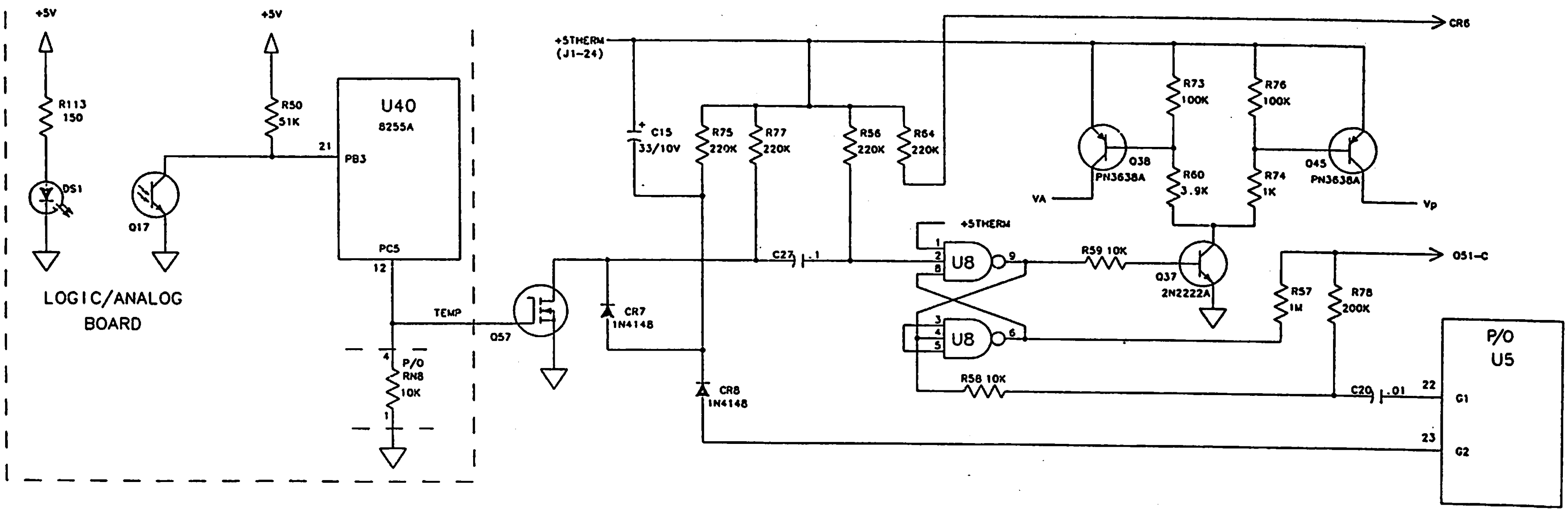


Figure 3-38. Thermometer Power Supply and Control Circuit

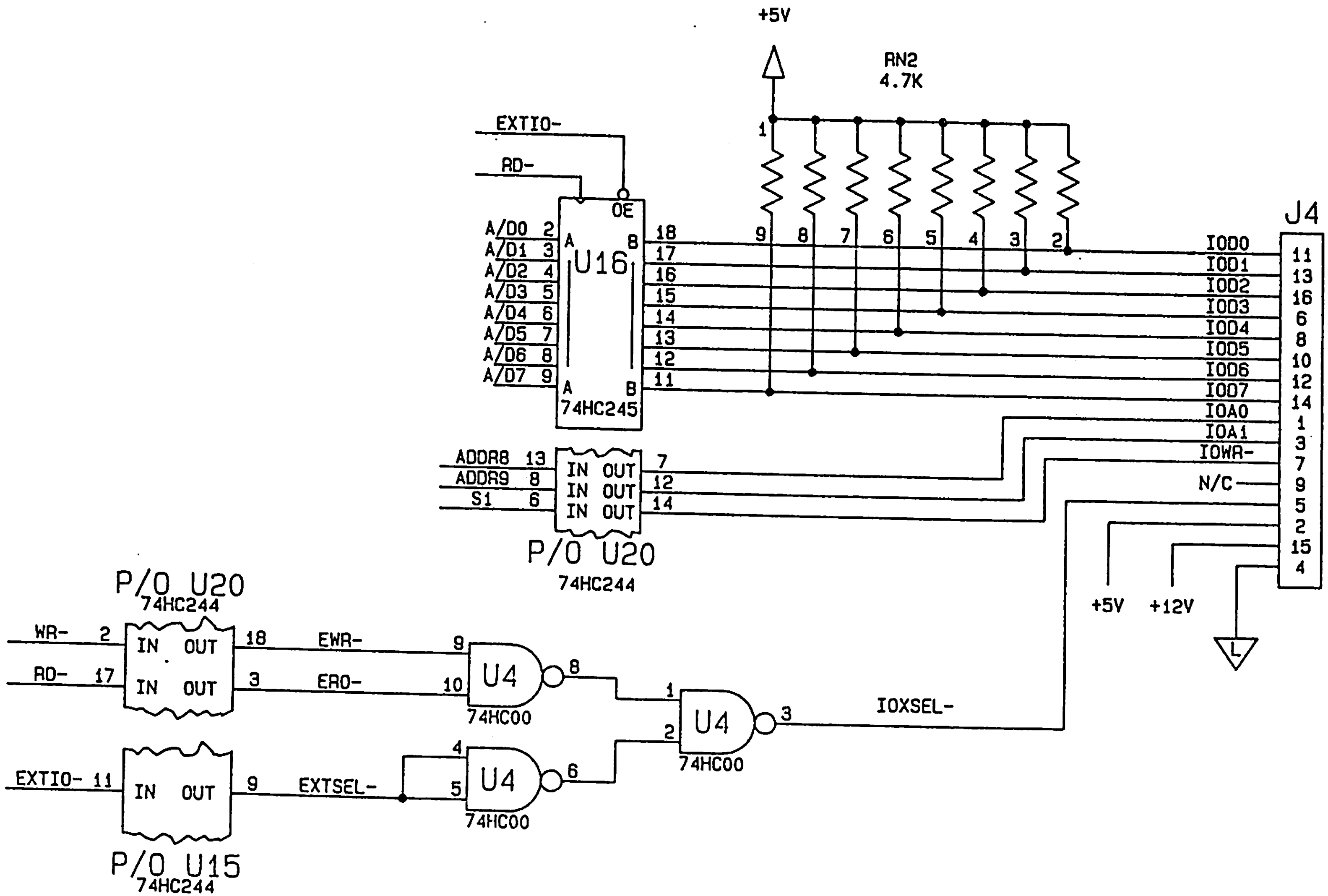


Figure 3-39. CIM Interface

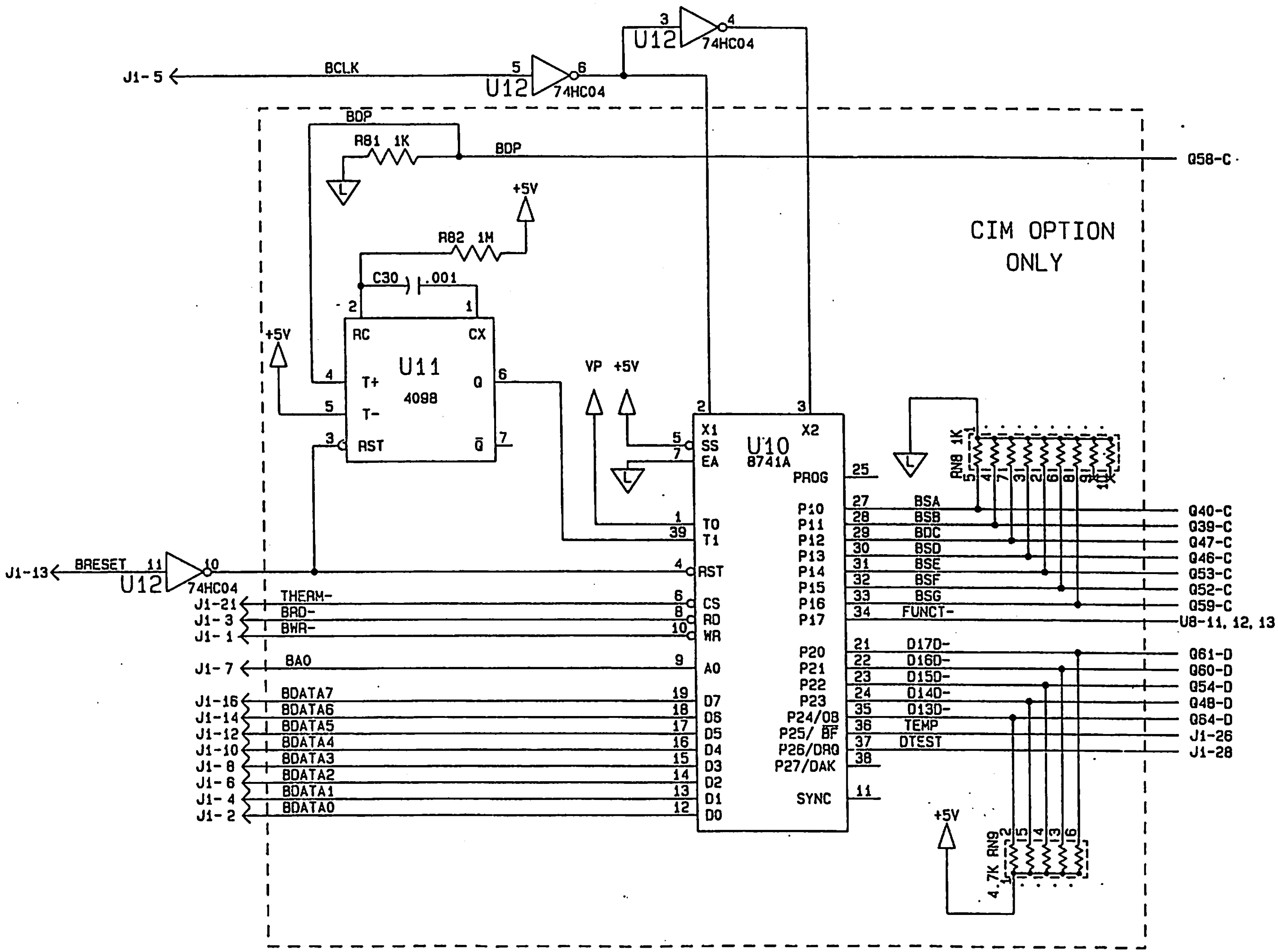


Figure 3-40. Thermometer Display Interface

3.11.3 Real-Time Clock (CIM Option only, figure 3-41)

The real-time clock, U29 on the logic/analog board, is included in the CIM equipped instrument for providing time and date of measurements to external devices, such as printers. A 32.768 kHz oscillator is the time base (Y2). U29, Y2, and also U33 are powered by the +5VAO (+5 volts always-on) from the power regulator board so that the clock continues to function with the instrument turned off. U33 is a power-off detection circuit which disconnects the chip-enable (CS) of U29 from the address decoder to prevent disruption of the time-keeping and RAM data during instrument power down. A signal PWRON from the power regulator board goes LO at power-down time before the +5 volt logic supply is removed. This is inverted by U28D. The inverted PWRON sets R/S flip-flop U33-4 and U33-10 with pin 4 LO, turning off Q5 which disconnects the active low CS of U29 from the address decoder U5-9. CS is then pulled HI through R52, keeping U29 disconnected from the bus. U33-11 prevents the R/S flip-flop from setting during a time when CS is LO, delaying the disconnect process until U29 is not being accessed. When the instrument is turned on, the CPU reset (RESET) goes high for a predetermined period at U33 pin 1. While RESET is HI, C56 charges through R53 until U33 pin 2 is HI, delaying reset and causing pin 3 to go LO, resetting RS flip-flop U33-4 and U33-10. Pin 4 then goes HI, turning on Q5, connecting U29 to the address decoder U5-9. U29 uses the multiplexed feature of the data bus to derive both address and data from the processor, using the ALE control line. Network R14 and C33 delays the initial application of +5VAO to U29 pin 22 to set an internal power fail software flag in U29 when power is applied to the instrument for the first time.

U33-4 also provides the power status signal PWR_GOOD to U31 and U32.

3.12 SOFTWARE

This instrument contains two entirely separate programs, one for the thermometer and one for the blood pressure monitor. The thermometer program resides in 2 KB x 8 of ROM which is located inside the COP444L µcontroller. The blood pressure monitor program resides in one 32 KB x 8 EPROM and is executed by an 80C85 CPU.

3.12.1 Thermometer Program

The thermometer program is a noninterrupt-driven program that performs tasks based on the settings of the DISPLAY TEST switch, the S2 internal DIP switch no. 5 (°F/°C), and the NORMAL/MONITOR mode switch, and on the internal probe detect optics (activated by removing the probe from or replacing it into the storage well on the front of the instrument). A description of the program operation and features is integrated with the electronics description of the thermometer (see section 3.10).

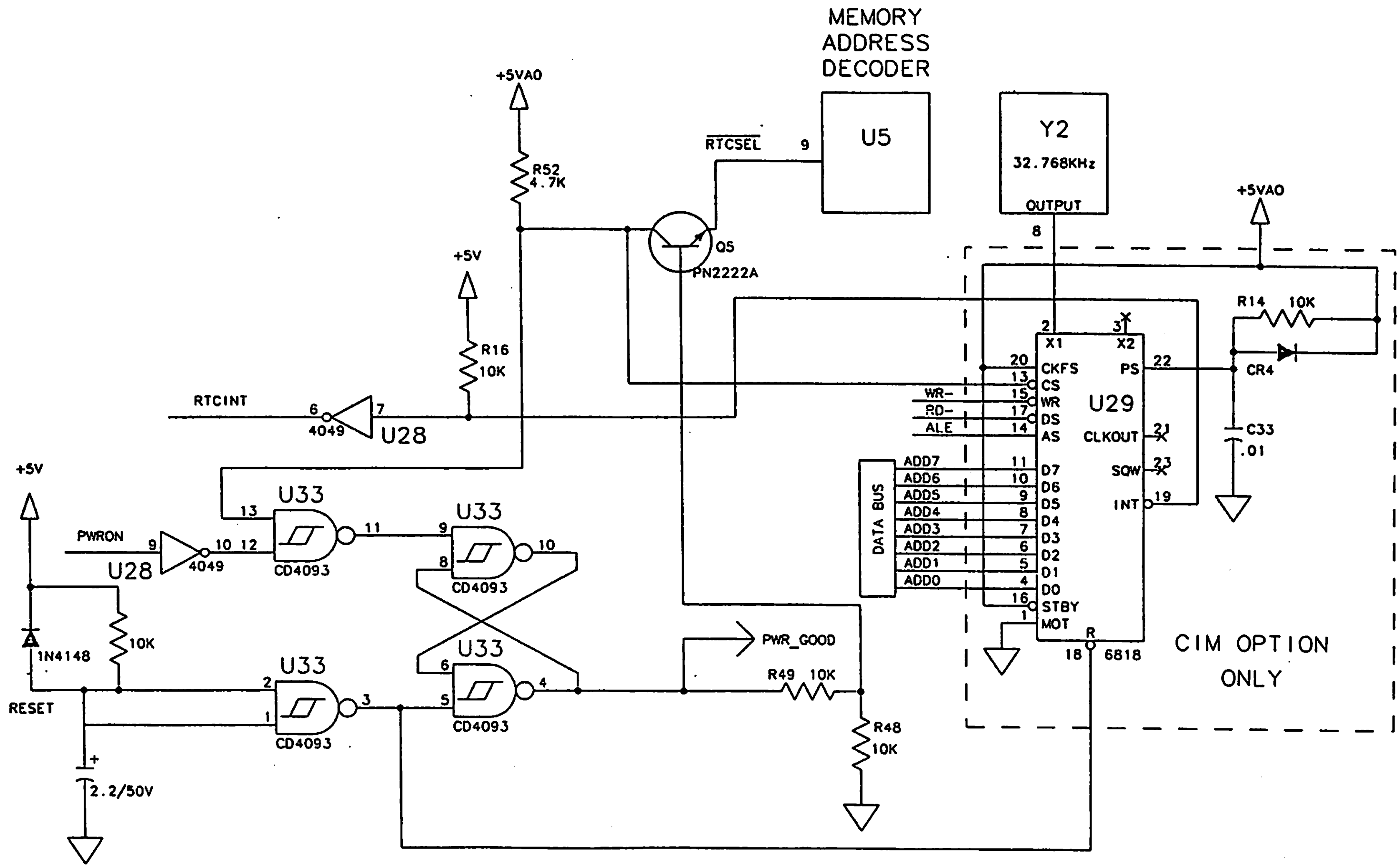


Figure 3-41. Real-Time Clock

3.12.2 Blood Pressure Program

The blood pressure monitor program is organized into 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 3-42 through 3-44 depict program operation. The main program flow is shown in figure 3-42. Flowcharts (figures 3-43 and 3-44) show how the two interrupts are processed. The two interrupts are the START/RESET switch and the time base interrupt, occurring about every 683 microseconds. The real-time clock is a third interrupt.

When power is first applied, software diagnostics of memory and 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 instrument 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 3-43) 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 3-44). 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 instrument offline display test is being executed, and at power-on when the diagnostics are performed.

3.12.3 Hardware Checks

The computer program tests the instrument's hardware for unsafe conditions, initially at power-on and periodically. If such a condition is detected, the instrument beeps audibly five times and displays a FIX ME x message (where x is a number or letter identifying the type of problem found). The values for x and their meanings appear in chapter 5.0. 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 (also W, X, Y and Z for CIM equipped instruments) are run only once each time power is applied; tests for conditions 4, 5, and L to N are performed periodically.

Tests corresponding to messages A through N are executed by comparing the value of the failsafe input port, FAIL1, with an expected value. The failsafe output port, FAIL0, 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 5-1. Table 5-2 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.

Example: Pulse display 041 with FIX ME D.

	FSDIS /	FSDUMP	FSMOT	FSCOMP /	FS2	FS1	FS0
Binary	0	1	0	0	0	0	1
Octal	0		4			1	

Then compare with tables 5-1 and 5-2 to determine the faulty signal. The good signal corresponds to a 061 code. Therefore, there is a problem with the motor or motor detect circuitry in this case. The motor was detectd as being on when the motor should be off (a "1").

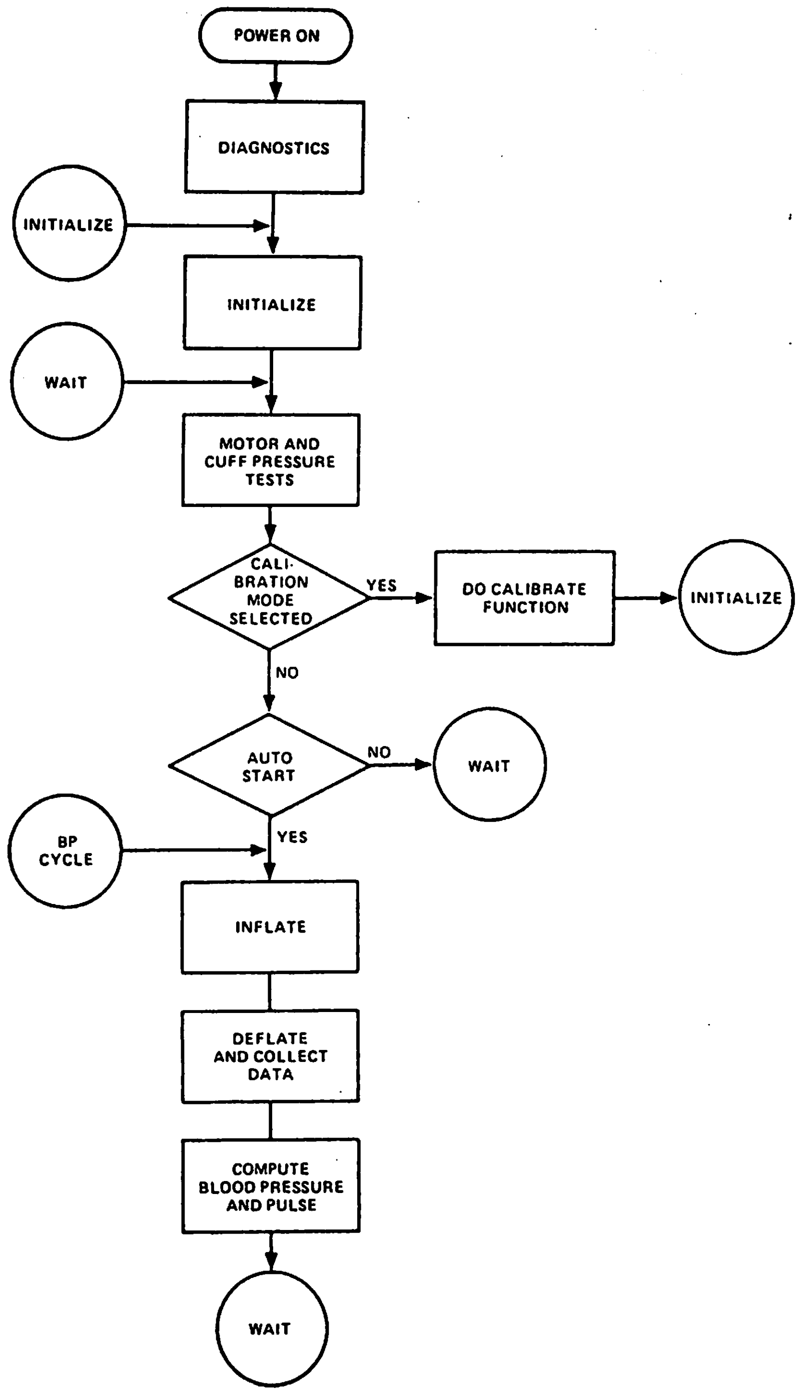


Figure 3-42. Main Program Flowchart

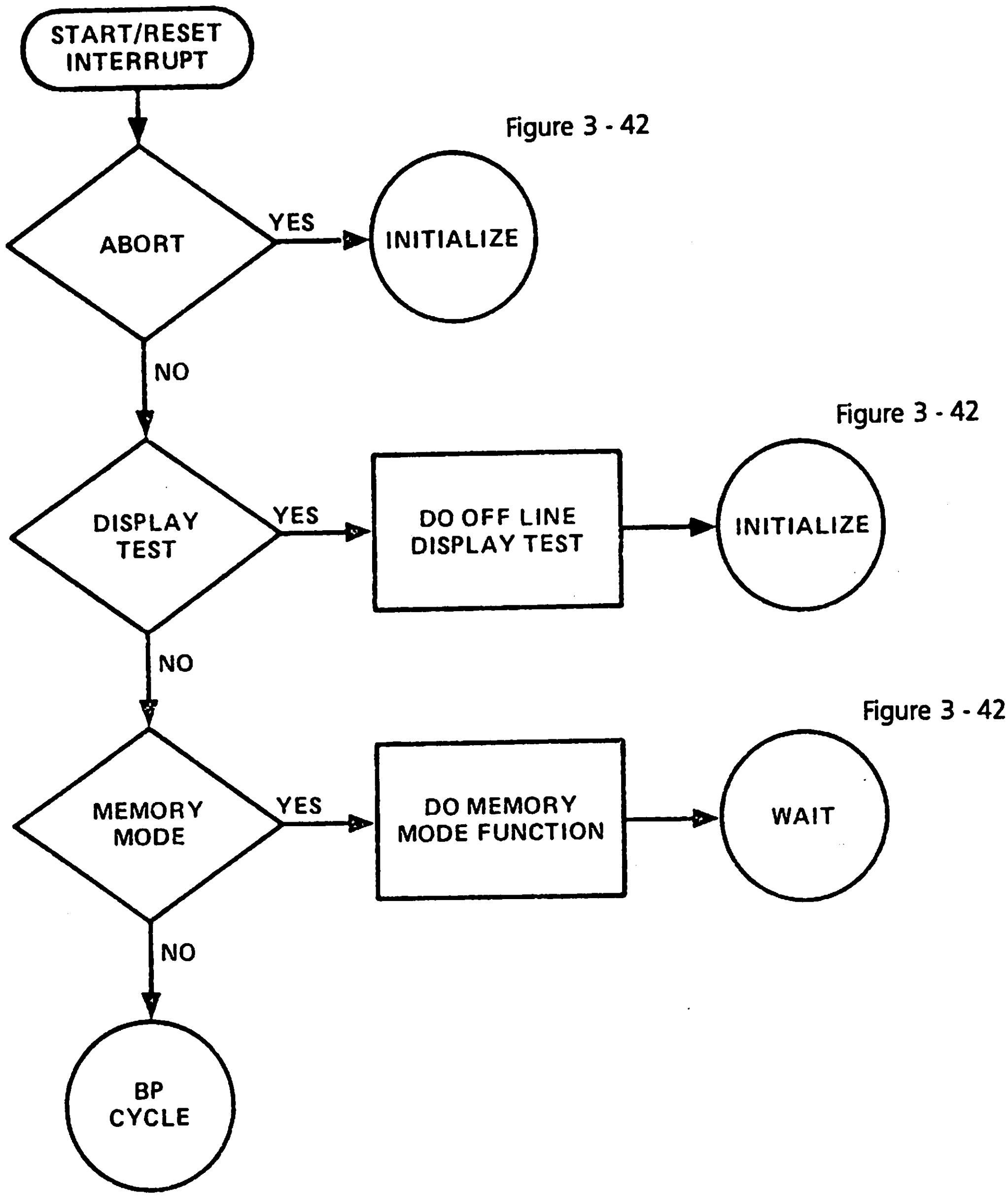


Figure 3-43. START/RESET Interrupts

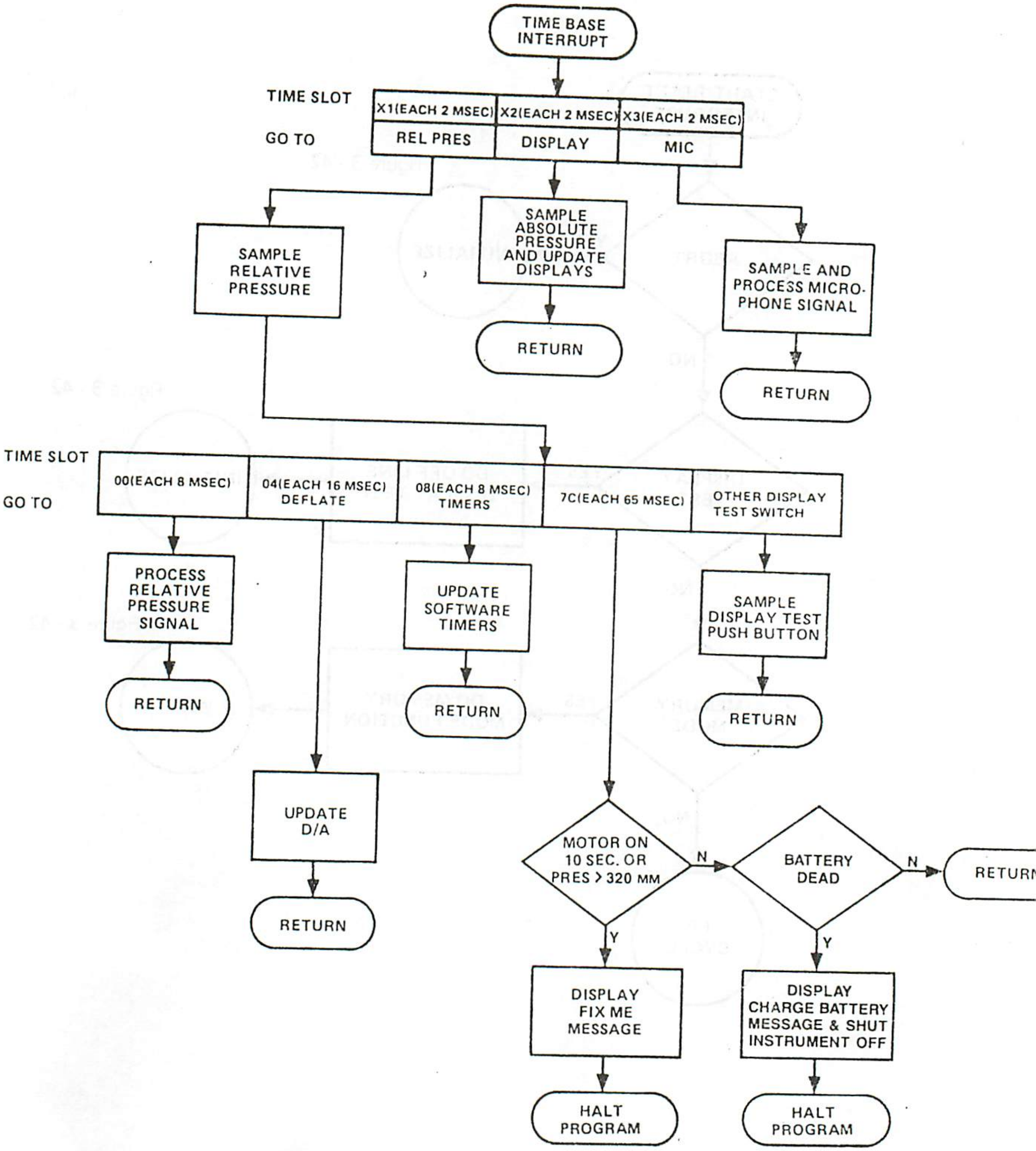


Figure 3-44. Time Base Interrupts

CHAPTER FOUR - SCHEMATICS

1.0 INTRODUCTION

This chapter contains the schematic diagrams that depict the detailed system operation of the VITAL•CHECK instrument - Model 4200. For specific schematic partial/block diagrams, refer to Chapter Three, FUNCTIONAL DESCRIPTION, of this manual.

NOTE: Schematics included in this manual represent the original issue of the printed circuit boards, and may not reflect future board revisions.

CHAPTER FIVE - TROUBLESHOOTING

5.0 INTRODUCTION

This chapter provides help in troubleshooting the VITAL•CHECK instrument should repair be necessary. Referring to this chapter before attempting to service, repair, or replace any component will save time and may avoid unnecessary repair.

Should a problem occur, first ensure:

a. That the instrument is being operated properly.

b. The integrity of the cuff and cable.

CAUTION: Always follow static grounding procedures when troubleshooting this instrument.

Logic levels are defined as a nominal potential of +5V for a "1" or "HI" state, and zero volts for a "0," "LO," or logic ground.

The following is an outline to the tables in this chapter:

a. Table 5-1. FIX ME Alarms

b. Table 5-2. Failsafe I/O Ports

c. Table 5-3. BP System Troubleshooting Guide

d. Table 5-4. Thermometer System Troubleshooting Guide

e. Table 5-5. Power Regulator Board Voltage Specifications

f. Table 5-6. Logic/Analog Board Voltage Specifications

g. Table 5-7. Display/Thermometer Board Voltage Specifications

5.1 HARDWARE CHECKS

This instrument performs self-diagnostic hardware checks. If any of these checks fail, the CPU issues a FIX ME x message, where x is the check that failed.

The use of the FIX ME x messages for troubleshooting is explained in this section. If a FIX ME x message does not appear, continue to section 5.2.

Tests for FIX ME x conditions 0, 2, and A to K (also W to Z for the CIM equipped instruments) are run once when the instrument is turned on. Tests for 3, 4, 5, and L to N are run periodically during operation.

FIX ME conditions A to K are tests of the failsafe circuit. The CPU writes an 8-bit word to failsafe output port FAILO (U7, FSO-5). The circuit response is read back to the CPU through failsafe input port FAILI (U-18, BDO-7) and is compared with an expected value. If the expected value is not obtained, the CPU issues an alarm message to the information display, and displays an octal value in the PULSE display. This octal value corresponds to the 8-bit input from FAILI.

Table 5-1 summarizes the alarm messages. For the failsafe tests, the expected, correct binary output is shown in octal for reference. Table 5-2 shows the significance of each bit BDO-7 in the message.

Table 5-1. FIX ME Alarms

FIX ME Code	Type of Test	Expected Result Binary	Expected Result Octal
0	RAM write/read check failed.		
2	EPROM CRC check failed.		
3	Attempt to execute from nonexistent memory.		
4	Pump motor on more than 100 seconds.		
5	Cuff pressure exceeded 320 mmHg.		
A	Initial power-on state not correct (pressure greater than 20 mmHg, or dump valve closed, or pump motor activated, or failsafe disconnect flipflop set, or failsafe disconnect flipflop being held clear, or incorrect pressure comparator test multiplexer channel selected).	00 110 000	060
B	Failure to detect dump valve closure or dump valve not able to be closed.	00 010 000	020
C	Failure to detect pump motor on or pump motor not able to be turned on.	00 100 000	040
D	Simulated 20 mmHg pressure sense comparator failed less than 20 mmHg simulation (FAILO Port = 00 000 001).	00 110 001	061
E	Failsafe 20 mmHg and 335 mmHg pressure sense comparators failed greater than 20 mmHg, less than 335 mmHg simulation (FAILO Port = 00 000 010).	00 111 010	072
F	Failsafe clock loss; watchdog failed clock loss simulation (FAILO Port = 00 001 000).	01 110 000	160
G	Failsafe 335 mmHg pressure sense comparator failed greater than 335 mmHg simulation (FAILO Port = 00 011 011).	01 111 011	173
H	Failsafe 4.5 minute timer high speed simulation timed out prematurely (FAILO Port = 00 011 010).	00 111 010	072

I	Failsafe 4.5 minute timer high speed simulation failed to time out within the required time (FAILO Port = 00 011 010).	01 111 010	172
J	Failsafe I/O port failed to write-lock on command from the CPU at the conclusion of power-on failsafe testing (FAILO Port = 00 100 101).	00 110 000	060
K	Failsafe disconnect flipflop failed to be reset by the CPU during power-on testing (FAILO Port = 00 000 100).	00 110 100	064
L	Pump not off or dump valve not open at idle state.	00 110 000	060
M	Pressure exceeded 20 mmHg more than 20 seconds at idle state.	00 110 000	060
N	Failsafe pressure sense 20 mmHg comparator failed to detect pressure upon cuff inflation. S2-6 probably open.		
W	I/O failure between the thermometer interface (U10) and the CPU.		
X	RAM or ROM failure in the thermometer interface (U10).		
Y	Failure of the thermometer interface (U10) to properly read the temperature display segments or digits strobes.		
Z	Failure of the thermometer interface (U10) to properly read the temperature display segments or digit strobes.		

Table 5-2. Failsafe I/O Ports

Failsafe Input Port (FAILI): U18

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 (changes during testing)

Failsafe Output Port (FAILO): U7

Bit	7	6	/	5	4	3	/	2	1	0
Mnemonic	0	0		FS5	FS4	FS3-		FS2	FS1	FS0

FS5 1 = Disconnect failsafe from software control

FS4	FS3-		Clock Select
0	0	=	No clock
0	1	=	90 Hz clock
1	0	=	375 Hz clock
1	1	=	Both clocks

FS2 1 = Reset flipflop, FSDIS (when under software control)

FS1, FS0 select inputs to pressure comparators

FS1	FS0		Selected Cuff Pressure
0	0	=	Actual cuff pressure (APS)
0	1	=	Simulated less than 20 mmHg
1	0	=	Simulated between 20 and 335 mmHg
1	1	=	Simulated pressure of more than 335 mmHg

The following example illustrates use of the failsafe tables, 5-1 and 5-2.

The CPU exercises the failsafe circuits on start-up as discussed in Chapter Three, section 3.8 and 3.12.3. The output port used to simulate conditions for testing is FAILO (U7, FS0-5). The CPU compares the value of the failsafe input port FAILI (U18, BDATA0-7) with an expected value. If the expected value is not read from the system, the CPU issues an alarm message to the information display, and displays an octal value in the PULSE display.

During start-up test G, the microprocessor makes FS0 and FS1 HI to simulate a pressure of greater than 335 mmHg, using resistor ladder R19, R23, R30, and R37. Simultaneously, it uses FS3 and FS4 to pass through the 375 kHz clock to counter U17. FS2 is LO, removing the reset from flip/flop U25. This simulates a situation in which the software overpressure detect flag is disabled and the hardware failsafe backup is tested as described in Chapter Three, section 3.8 (step e). If the microprocessor fails to obtain the required 01111011 (173) input from U18, it alarms FIX ME G, indicating a problem with the failsafe overpressure circuit. Suspect components might include U27, U38, or one of the surrounding resistors.

5.2 TROUBLESHOOTING GUIDES

If a FIX ME message is not displayed, observe the operation of the instrument. Use table 5-3 if the instrument is inoperative and/or if a functional problem can be localized to the blood pressure measurement system. Use table 5-4 if a functional problem resides in the thermometer function.

The remainder of the tables in this chapter serve as reference guides for circuit and component level troubleshooting. Test points, test conditions, and reference voltages are provided for each of the circuit boards.

Table 5-3. BP System Troubleshooting Guide

Instrument Malfunction

Problem	Probable Cause	Solution
Instrument completely inoperative, but charge light is on when connected to AC.	Blown fuse F101.	Replace F101 and check that CR109 is not shorted on power regulator board.
	Defective 6 MHz crystal or microprocessor inoperative.	Check for 3 MHz square wave at U9-37 on logic/analog board. If voltages are correct, but no 3 MHz square wave is present, replace U9, then Y1 on board.
Instrument completely inoperative when disconnected from AC (battery only).	Dead or defective battery pack.	Replace battery pack with full charge.
	Blown fuse F102.	Replace F102 and check that CR109 is not shorted on power regulator board.
	Battery pack connectors loose.	Check integrity of battery pack connectors and harness.
	Battery trip adjustment.	Adjust R142 for 11.6V low battery alarm.
Instrument completely inoperative.	Dead electrical outlet and dead battery.	Plug into live outlet for a minimum of 3 hours before use.
	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 (+12V switching regulator, U101), and power supply harness integrity. Check C116 for +5V; if not, replace or check U105 and Q111.
	No +5VAO (Reg. Bd.)	If U105-15 is 0V, replace U105. If U105-15 is 12V or more, replace Q111.

(cont.)	Circuit breaker tripped.	Reset circuit breaker.
	Circuit breaker trips repeatedly.	Check for shorted windings or shorts between windings on power transformer, or shorted CR101-CR104 on power regulator board.
Instrument inflates to other than selected pressure; instrument enters operating mode other than mode selected.	Defective U35 or U31 on logic/analog board.	Replace U35, U31.
	Defective U2 or U3 on display/thermometer board.	Replace U2 or U3.
	Defective U40 on logic/analog board.	Replace U40.
DISPLAY TEST switch inoperative.	Open connection in switch tail, or, defective switch.	Replace switch panel.
	Defective U40 on logic/analog board.	Replace U40.
High and low beep tones absent.	Defective speaker LS1 on logic/analog board.	Replace speaker if resistance does not measure 45 ±5Ω.
	Defective U26 on logic/analog board.	Replace U26 if no signal is present at pins 1 and 15 (if the 3 MHz CLK signal is present at U26-10).
	Defective Q16 and U36 on logic/analog board.	Replace Q16, then U36.
High beep tone absent.	Defective U36 and U40 on logic/analog board.	Replace U36, then U40.
	Defective U26 on logic/analog board.	Replace U26 if no signal at pin 15.

Low beep tone absent.	Defective U36 and U40 on logic/analog board.	Replace U36, then U40.
	Defective U26 on logic/analog board.	Replace U26 if no signal at pin 1.
START/RESET switch has no effect.	Failsafe 4.5 minute time-out or overpressure or other fail-safe fault.	Cycle instrument's power off and on to reset instrument.
	Defective switch or broken connection in switch tail.	Replace switch panel if no continuity present.
	Defective U32 on logic/analog board.	Replace U32.
	Defective U9 on logic/analog board.	Replace U9.

Alarms

Message	Probable Cause	Solution
No flashing asterisk during blood pressure measurement, instrument always indicates BP*READY (oscillometric measurement).	Defective microphone in cuff.	Replace microphone/umbilical assembly.
	Defective U46 or associated components on logic/analog board.	Apply 100 mV, 10 Hz signal to J8 pin 2 on board and trace signal through U46 to U41. Voltage gain should be about 24.
CHECK FOR AIR LEAKS (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.
	Internal pneumatic system leakage.	With instrument in CAL mode, manually inflate the pneumatic system with calibration fixture. The MODE SELECT switch must have the MANUAL indicator lit. One at a time, using small pliers, pinch tubes connecting to leaker, overpressure switch, and pressure transducer to isolate leak. Check reservoir assembly for air leak.
	Leaker not sealing.	Replace leaker if about 4V is present across coil (J5 on transition board).
		If about +5V to GND is absent at J7-11 on logic/analog board, check Q3 and associated circuitry on board.
		If +5V is present, but J5-2 on transition board is not less than +1V to GND, check Q7, U50, and associated components on logic/analog board.
		Check for open conductor in 14-conductor flat cable.

(cont.)	Overpressure switch leaking.	Replace switch.
	Dump valve leaking or not closed.	Replace manifold assembly if about 12V is present between J3-1 and 2 on transition board. If 12V is absent, check 14-conductor flat cable for an open conductor, then check Q12, Q14, and associated circuitry on logic/analog board.
	Pressure sensor leaking.	Replace pressure sensor and calibrate the pressure channel.
	Tube connecting to pressure sensor kinked.	Replace or straighten tube.
CHECK FOR AIR LEAKS (Pump does not run.)	Pump jammed.	Obstruction caught in connecting rod area on pump assembly.
	Defective pump.	Replace pump.
	No pump drive voltage.	If about 12V is not present across pump motor when attempt is made to pump, check for open conductor between J2 on transition board, and Q115, Q116, and associated components on power regulator board, then U9 and Q1 on logic/analog board.
LOW SIGNAL	Cuff improperly installed or very weak pulse.	Verify proper cuff placement. Replace microphone/umbilical assembly. Check U46, U41, and associated components on logic/analog board.

LOW SIGNAL (Instrument holds, beeps continuously, and re-pumps to higher pressures.)	Defective microphone or audio cable in cuff assembly.	Replace microphone/umbilical assembly.
	Leaker malfunction.	Perform leaker bias adjustment.
		Replace leaker. Check Q6, Q7, Q8, Q9, Q10, U50, and associated circuitry on logic/analog board. Check U43 and U42.
PATIENT MOVEMENT or ARTIFACT	Excessive patient motion.	Instruct patient to remain still.
	Poor cuff placement.	Verify correct cuff placement.
	Defective cuff.	Replace cuff.
FIX ME 0	RAM read/write error.	Replace U10, then U5, U2, U1, and U9 on logic/analog board.
FIX ME 2	ROM CRC (cyclic redundancy check) error.	Replace U1, then U5, U6, and U9 on logic/analog board.
FIX ME 3	Program jump to nonexistent memory.	Replace U9, then U1, U5, and U6 on logic/analog board.
FIX ME 4	Pump on too long or cannot be turned off.	Check for shorted Q115-Q118 on power regulator board.
		Check for shorted Q1 on logic/analog board, then replace U9 on logic/analog board.
		Check for defective U104 (FSMOT) on power regulator board.
		Replace U18 on logic/analog board.
FIX ME 5	Pressure exceeded 320 mmHg.	Cycle power ON/OFF switch and retry measurement.
		Refer to FIX ME 4, above.

FIX ME A (All references are to logic/analog board unless otherwise specified.)	Improper initial conditions/ pulse display contains octal 1XX.	Check U23-10 for logic 0. If logic 1, look for a 90 Hz square wave at U17-1, U6-6, and Q4 base. Q4 emitter should be logic 1.
		Check U108 or C136 for proper 5V level (±0.25V).
(PULSE display reads: octal 160 or 170.)		If U23-10 is logic 0, look for logic 0 at U25-1. If it is logic 1 instead of 0, check for shorted overpressure switch, defective U38, R31, R35, R38, or C45.
		Adjust overpressure switch to try to clear alarm before replacing switch.
		Check U25-12, if high, check Q2 and Q3 and replace as necessary.
		Check FS0 and FS1, if high, check Q117, Q118, and U104 pin 12 on power regulator board and replace as necessary.
		Check 14-pin ribbon cable.
		Check Q115 for open, on power regulator board.
		Check that U23-3 has a momentary logic 1, then goes to logic 0 when power is turned on.
		Check U6-6 for a 90 Hz square wave that contains no 375 kHz component.
		U38-3 should be less than 0.01V. If not, either U27, the pressure sensor, or associated components is defective, or calibration is required.

(cont.)	PULSE display contains octal number 040.	Check Q117, Q118, U104, and associated components on power regulator board.
	PULSE display contains octal number 020.	Check Q12, Q14, Q42, U28, U39, and associated components, and 14-conductor flat cable. Check dump valve coil for a resistance of 240 ±20Ω.
FIX ME B (PULSE display reads octal 060.)	Unable to close dump valve.	Defective 14-pin cable.
		Check Q12, Q14, U42, U28, U39, and associated components.
		Check dump valve coil for a resistance of 240 ±20Ω.
FIX ME C (PULSE display reads octal 060.)	Unable to start pump.	Check Q115-Q118, U104, and associated components on power regulator board.
		Check Q1 and U9.
		Replace pump assembly.
PULSE display reads octal 000.		Check dump valve (see FIX ME B also).
FIX ME D	<20 mm comparator test fail; U27-5 measures 0.05 to 0.07V.	Check U27, U38, R24, R31, and R35.
	U27-5 does not measure 0.05 to 0.07V.	Check U27, R19, R23, R30, R37, and +5V REF.
PULSE display reads octal 041.	Defective motor.	Replace pump assembly.
FIX ME E	>20 mm comparator test fail; U27-2 measures 1.50 to 1.70V.	Check U27, U38, R24, R31, and R35.
	U27-2 does not measure 1.50 to 1.70V.	Check U27, R19, R23, R30, R37, and +5V REF.

FIX ME F (PULSE display reads octal 060.)	90 Hz watchdog test failure.	Check U23, Q4, U25, and U18. Check Q115 and Q116 on power regulator board.
FIX ME G	Overpressure comparator test failure; U27-4 measures 2.40 to 2.55V.	Check U27, U38, R24, R31, and R35.
	U27-4 does not measure 2.40 to 2.55V.	Check U27, R19, R23, R30, R37, and +5V REF.
FIX ME H	Premature time-out during 4.5 minute timer test at 375 kHz.	Check U17 and U22 outputs for correct binary division of input signal.
FIX ME I	Failure to time-out during 4.5 minute timer test at 375 kHz.	Check U7, U19, U6, U17, U13, U22, and U18.
FIX ME J	Cannot write-lock output port to failsafe logic.	Check U18, U7, U13, and U3.
FIX ME K	Cannot reset U25 during failsafe logic test.	Check U7, U23, U39, and U25. NOTE: This test is interspersed among previous failsafe logic tests, with result that other conditions such as excessive offset in pressure channel or a defective pressure sensor can cause this alarm.
FIX ME L	Initial conditions (i.e., pump off, dump valve open) not attained in idle state.	Check PULSE display for incorrect bits per table 5-1. Check Q115-Q118 on power regulator board and Q12-Q14 and U25 on the logic/analog board, and associated components. Check that S2-6 is in down position or not defective.

FIX ME M	Pressure >20 mmHg for 20 seconds in idle state.	Check pressure sensor 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 (U38-1) does not detect pressure when system is inflated beyond 33 mmHg.	Check U38, R43, R34, and S2-6. Check ADC (U41).

Malfunctions

Symptom	Probable Cause	Solution
All displays show dots.	No clock.	Check Y-1 for 6 MHz out.
All displays are blank.	Poor connections between logic/ analog and display/thermometer boards.	Check mating and integrity between boards.
Missing systolic, diastolic or pulse group, or wrong information in one or more digits.	Poor contacts in cable between logic/analog and display/ thermometer boards.	Check mating and integrity between boards.
	Defective U1 or U4 on display/ thermometer board.	Replace U1 if systolic/diastolic problem, or U4 if pulse problem.
	Defective U5 on logic/analog board.	Replace U5.
Missing segment in one digit.	Defective digit.	Replace digit.
Same missing or dim segment in systolic, diastolic, or pulse group.	Defective RN1 or RN2 on display/ thermometer board.	Replace RN1 if systolic/diastolic problem, or RN2 if pulse problem.
	Defective U1 or U4 on display/ thermometer board.	Replace U1 if systolic/diastolic problem, or U4 if pulse problem.
One digit completely missing or dim.	Defective transistor on display/ thermometer board.	Replace transistor corresponding to missing digits: Systolic LSD: Q3. Systolic NSD: Q2. Systolic MSD: Q1. Diastolic LSD: Q9. Diastolic NSD: Q8. Diastolic MSD: Q7. Pulse LSD: Q22. Pulse NSD: Q21. Pulse MSD: Q20.

(cont.)	Defective U1 or U4 on display/ thermometer board.	Replace U1 if systolic/diastolic digit missing or U4 if pulse digit missing.
Wrong or missing information in information display.	Poor contacts in cable between logic/analog and display/thermometer boards.	Check mating and integrity of contacts.
Missing characters or segments in information display.	Defective U5 on logic/analog board.	Replace U5.
	Defective display module (DS15 or DS16).	Replace display module.
Won't deflate.	Bias adjustment.	Perform deflation loop balance adjustment.
		Replace leaker assembly and check ADC (U41).
Cuff too loose/cuff placement.	Defective microphone or amplifier circuit.	Replace umbilical cable.
		Check U46 pins 1 and 14.

Table 5-4. Thermometer System Troubleshooting Guide

Instrument Malfunction/Alarm

Problem	Probable Cause	Solution
Thermometer completely inoperative.	Defective or contaminated DS1 or Q17 on logic/analog board.	Replace or clean DS1 or Q17.
NOTE: The entire instrument must be operational for thermometer to operate. The description refers to the display/thermometer board.	No power (+5V).	Look for +5 ±0.25V at U8-14 on display/thermometer board. Probe or tester must be plugged in.
	Defective crystal (Y1.)	Check for 2.00 MHz waveform at U5-2 with a high impedance scope. If not present, replace Y1.
	Defective U5.	If a 2.00 MHz waveform does not appear after replacing Y1, replace U5.
	Defective U8, Q37, Q38, Q45, C27, R56, CR7, CR8, or associated components.	Refer to voltage table to isolate problem. Replace suspected component.
	Defective Q57, Q63, and associated components or U40 on logic/analog board.	Check that Q57 and Q63 have gate drive when DISPLAY TEST switch is actuated.
Thermometer active but does not read temperature, or gives immediate ERR H alarm.	Defective probe.	Replace probe or substitute Model 828A thermometer tester to test thermometer.
	Defective U6, U7, U13 or associated components.	Replace U6, ensure that R84 or R83 are intact. Measure voltages at U6, U7, and U13 and compare to values on voltage table.

Turns off in 2 to 3 seconds.	Defective U8.	With an oscilloscope check that the waveform at U8-10 is an inverted likeness of U8-11, 12, and 13.
	Defective Q51 and associated circuitry.	Check to see that Q51 is keeping C21 discharged if a waveform is present at U8-10.
	Defective CR5.	Replace CR5 if no waveform is present at U8-11, 12, and 13, when in the normal and °F mode.
One blank digit in display; thermometer may turn off in 2 to 3 seconds if center digit is affected.	Defective transistors Q48, Q54, Q60, Q61, and Q64.	Replace transistor according to digit: Hundreds: Q61. Tens: Q60. Units: Q54. Tenths: Q48. Indicator: Q64.
	Defective U5.	Replace U5.
Missing segment on one digit.	Defective digit.	Replace digit.
Same segment missing or always lit on all five digits, or decimal point missing or always lit.	Defective transistor.	Replace according to affected segmented: dp: Q24, Q58. a: Q41, Q40. b: Q42, Q39. c: Q33, Q47. d: Q34, Q46. e: Q29, Q53. f: Q30, Q52. g: Q23, Q59.
	Defective RN10, RN3, RN4, or RN6.	Replace RN10, RN3, RN4, or RN6.
	Defective U5.	Replace U5.

One digit very bright and jumbled.	Short between traces.	Check for shorts.
	Defective transistors on display/ thermometer board.	Replace transistors according to affected digit: Hundreds: Q61. Tens: Q60. Units: Q54. Tenths: Q48. Indicator: Q64.
	Defective U5.	Replace U5.
Thermometer will not turn itself off.	Defective U8.	Remove probe connector, place probe into storage well, then replace probe connector. Withdraw probe from well to turn on thermometer, then replace probe in well. A negative spike should appear at U8-4, 5. If this negative spike appears, replace U8.
	Defective C20, R58.	If no negative spike appears at U8-4, 5 but U5-22 goes from logic 1 to 0, then C20 or R58 needs to be replaced.
	Defective U5.	If U5-22 stays logical 1, replace U5.
	Defective probe sense circuit.	Check DS1 or Q17.

Temperature takes 3 to 5 minutes to obtain, there is no audible tone, and F or C appears instead of rotating indicator.	Instrument is in monitor mode, or initial temperature was 94°F or above.	If entire display is flashing, thermometer is in monitor mode. Eject probe cover, set the NORMAL/MONITOR mode switch to NORMAL. Reset instrument by inserting probe into storage well. Retake temperature.
		If only the C or F is flashing, thermometer is in peak holding mode. This mode is activated when room and probe temperatures are higher than 34.4°C (94°F) when temperature-taking begins in normal mode. Retake temperature when temperatures are lower than 34.4°C (94°F).
Thermometer does not respond to one or both function switches.	Defective switch.	Replace switch.
	Defective CR3 or CR4 on display/thermometer board.	Replace defective CR3 or CR4.
Thermometer turns on with unusual characters in display with only decimal point lit, or does not turn off unless probe connector is unplugged.	Defective C8, CR1, or R14.	Using ohmmeter, check for short circuits at C8 and CR1, and approximate resistance at R14 with U5 removed from socket. If short circuits are found or resistance is inappropriate, replace faulty components as needed.
	Defective U5.	Replace U5.
No audible tone.	Defective speaker or CR2.	Check the continuity of speaker with an ohmmeter. Replace if 30 to 40Ω are not obtained.
		If the resistance is very low, CR2 may be shorted and should be replaced.
	Defective Q62.	Check for square wave at U5-17. If present, check for square wave at collector of Q62. If square wave is not present at Q62, replace Q62.
	Defective U5.	Check for square wave at U5-17. If there is no waveform at U5-17, replace U5.

ERR O	Defective U6.	Replace U6.
	Defective U9.	Replace U9.
ERR t	The thermometer fails to obtain a temperature within 1 minute after insertion.	Eject probe cover. Reset thermometer by returning probe to 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 temperature, holding probe base constantly. Do not allow patient to reposition probe.

Table 5-5. Power Regulator Board Voltages and Waveforms

Signal	Test Point*	Conditions	Limits
Unregulated DC voltage	C102+ U101-12	Input AC voltages: 95-135 VAC. Battery disconnected. ON/OFF switch off. 25Ω, 25W resistor connected from J107 to gnd.	18-35 VDC; ripple voltage should be <1.5V.
Regulated DC voltage	F101	Same conditions as above.	14.1 ±.1 VDC; ripple <350 mV.
Regulated DC voltage with load	F101	Nominal AC input. Battery disconnected. ON/OFF switch off. 10Ω, 50W load resistor connected to regulated DC voltage.	14.1 ±.1 VDC; ripple <350 mV.
+5VAO	J2-11 C116+	Nominal AC input; battery connected; ON/OFF switch on.	5 ±.25 VDC; ripple <100 mV.
+5V Logic	J2-10 C136	Same conditions as above.	5 ±.25 VDC; ripple <300 mV.
+14.1 Volts (+12V)	J2-13 C141	Same conditions as above.	14.1 ±.15 volts.
-12 Volts	J2-15 C-129	Same conditions as above.	-12 ±1 VDC; ripple <500 mV.
23.4 kHz	U101 pin 5	Same conditions as above.	23.4 kHz ±1 kHz sawtooth waveform about 0-3.5 VDC.
23.4 kHz	U108 pin 5	Same conditions as above.	23.4 kHz ±1 kHz sawtooth waveform about 0-3.5 VDC.
23.4 kHz	U107 pin 5	Same conditions as above.	23.4 kHz ±1 kHz sawtooth waveform about 0-3.5 VDC.

LOW BATT-	J108 (to gnd)	AC removed and battery disconnected. Low voltage DC power supply with vernier set to 14.0V connected to J105-2 and gnd. CAUTION: Observe polarity; momentarily short U103 pin 8 to gnd. (Resets latch U103.) ON/OFF switch on. Slowly lower DC supply voltage.	LOW BATT- signal goes from 5V to 0V at 11.6 ±.05 VDC.

* NOTES:

1) Unless otherwise specified, these tests are with the AC line at 120 volts, the thermometer probe removed from the instrument, MODE set in MANUAL, and all but the information display blank.

2) Logic 0 is a voltage between 0.0 and +0.2V; Logic 1 is a voltage between 4 and 5.0V.

Table 5-6. Logic/Analog Board Voltage Specifications

Unless specified, all points referred to ground:

Point	Voltage Spec.
U9-37 (CLK)	3 MHz square wave, logic 0 to logic 1
U9-36 (RST IN)	logic 1
U9-3 (RST OUT)	logic 0
U9-7 (RST7.5)	1.46 kHz square wave, logic 0 to logic 1
U9-9 (RST5.5)	logic 0 (logic 1 START/RESET actuated)
U9-8 (RST6.5)	logic 0 (with CIM Option: 1 Hz pulse, logic 0 to logic 1)
U9-4 (SOD)	logic 0 (except when pump on)
U9-6 (TRAP)	logic 0
U29-20 (CIM Option only)	+5 ±0.2 VDC
U29-2 (CIM Option only)	32.768 kHz square wave, logic 0 to logic 1
U29-18 (CIM Option only)	logic 1
U33-4 (PWR_GOOD)	logic 1
U26-1 (LOW TONE)	732 Hz square wave, logic 0 to logic 1
U26-15 (HIGH TONE)	1.46 kHz square wave, logic 0 to logic 1
U26-4 (POWER SUPPLY CLOCK)	23.4 kHz square wave, logic 0 to logic 1
U26-6 (A/O CLOCK, FAILSAFE CLOCK)	375 kHz square wave, logic 0 to logic 1
U40-10 (TURN OFF)	logic 0
U40-12 (TEMP)	logic 1 (probe removed from well)
U40-13 (DTEST)	logic 0
U40-23 (DEADBAT-)	logic 1 (battery charged)

U40-24 (LOWBATT-)	logic 1 (battery charged)
U40-25 (AC-)	logic 0 (when plugged into AC)
U36-10 (AUDIO)	logic 0 (no audio present)
U17-1	91.6 Hz square wave, logic 0 to logic 1
U17-12 (4.5 MIN TIMER CLOCK)	45.8 Hz square wave, logic 0 to logic 1
U17-4	1.43 Hz square wave, logic 0 to logic 1
U17-2	logic 0
U25-4	logic 1 (not allowed to clock a 1 to second stage)
U25-8	logic 0
U25-12	logic 1 (FS+5 activated to enable dumper, leaker, and pump control circuits)
U25-10	logic 0
U23-2 (FS2-)	logic 1
U23-1	logic 1
U23-11	logic 1
U23-4	logic 0
U22-11	logic 1
U22-2 and U22-3 (4.5 MIN TIMER)	logic 0 (both HI at the end of 4.5 MIN)
U3-3	logic 0
U13-9	logic 1
U27-1 (To ANALOG GROUND)	0.0 ±0.024 VDC (system deflated)

Unless specified, all points referred to analog ground (U41-16):

Point	Voltage Spec.
U27-5	0.058 ±0.004 VDC
U27-2	1.60 ±0.010 VDC
U27-4	2.39 ±0.180 VDC
U38-1	logic 0 (system deflated <20 mmHg)
U38-7	logic 1 (system <335 mmHg)
U38-3	0.0 ±0.024 VDC (system deflated)
U38-2	0.118 ±0.010 VDC (reference)
U38-5	1.99 ±0.15 VDC (reference)

Pin or Lead Position	Voltage Spec.
From U42-14 to U42-7	logic 0
From U42-15 to U42-7	logic 0
From U42-16 to U42-7	logic 0
Q14 collector	12.7 ±1.7 VDC (dumper open)
U41-28 (APS)	0.0 ±0.02 VDC (idle state)
U41-27 (RPS)	2.5 ±0.25 VDC (idle state)
U41-26 (MICS)	2.5 ±0.25 VDC (idle state)
From U41-10 to U42-7	375 kHz square wave, logic 0 to logic 1
U46-14	0.0 ±0.04 VDC

Unless specified, all points referred to ground:

Point	Voltage Spec.
From U46-9 to VR2 "OUT"	0.050 to 0.125 VDC
U46-6	-0.1 ±0.025 VDC
VR2 "OUT" (+5VDC REF)	4.75 to 5.15 VDC
U44-2	1.22 to 1.25 VDC
U45-1 (APS)	0.0 ±0.024 VDC (system deflated)
U45-5	1.22 to 1.25 VDC
U50-1	0.0 ±0.5 VDC
U50-5 (-LIM)	-0.1 ±0.025 VDC
From U50-10 (+LIM) to VR2 "OUT"	0.050 to 0.125 VDC
U50-12	1.5 ± 0.5 VDC
U50-14	5.5 to 7.0 VDC

Table 5-7. Display/Thermometer Board Voltage Specifications

Unless specified, all points referred to ground:

Point	Voltage Spec.
U1-20	+5 ±0.25 VDC
U10-2 (CIM Option only)	3 MHz square wave, logic 0 to logic 1
U10-3 (CIM Option only)	3 MHz square wave, logic 0 to logic 1
U10-4 (CIM Option only)	logic 1
U10-39 (CIM Option only)	logic 0

Thermometer completely inoperative; unless specified, all points referred to ground:

Point	Expected Voltage	Probable Defective Item
U8-14	4.75 to 5.25 VDC	Probe Connector
U8-10	Waveform, logic 0 to logic 1	U8
Q37-C	0 to 0.1 VDC	Q37
U5-11 (VP)	4.75 to 5.25 VDC	Q45
U7-8 (VA)	4.75 to 5.25 VDC	Q38
U5-4 (RST)	4.75 to 5.25 VDC	C8, U5, or R14
Q57-D	0 VDC	Q57 on display/thermometer board, DS1 or Q17 on logic/analog board

Thermometer does not read temperature; unless specified, all points referred to ground.

Point	Expected Voltage	Probable Defective Item
U5-23 (PROBE SENSOR IN)	1.2 to 1.4 VDC	CR7, CR8, or C15
U8-9	4.75 to 5.25 VDC	U8, C27, or R56
U7-8	4.75 to 5.25 VDC	Q38
U7-7 (TEMP SIGNAL)	1 VDC or less	U7
U13	OUT 1.23 VDC > REF	U13
U6-10	0.1 VDC or less	R67
U8-11, 12, and 13	0 to 5 VDC pulses	U8 or R61

CHAPTER SIX - CORRECTIVE MAINTENANCE

6.0 INTRODUCTION

This chapter describes disassembly, inspection, repair and reassembly procedures for the VITAL•CHECK instrument. Calibration and testing is required after reassembly, as is explained in section 6.9 through 6.12.

Familiarity with the function and operation of the mechanical assemblies and electrical circuits will facilitate repair and replacement. Refer to Chapter Three, FUNCTIONAL DESCRIPTION and Chapter Five, TROUBLESHOOTING, as necessary.

WARNING: Disconnect the instrument from AC power before disassembly. Use extreme care when servicing an instrument that is connected to AC power. Hazardous voltages are present when AC power is connected, regardless of the setting of the ON/OFF switch.

CAUTIONS:

1) Do not use LOCTITE thread adhesive on case screws. The outgassing may cause the case to crack.

2) Exercise care and use proper grounding techniques when handling board assemblies. All PW boards contain static sensitive components. All IC's, small transistors, small diodes, and precision metal film resistors (1% type) are considered sensitive. Power diodes (rectifiers) and power transistors are not sensitive. CMOS and MOS IC's and transistors are most sensitive.

NOTE: Do not remove dump valve from manifold assembly. Air leaks could occur due to improper seating of rubber gasket. Replace manifold assembly if dump valve is defective.

IVAC recommends that the instrument be disassembled no more than is required to effect inspection or repair. Repairs will generally be localized to a particular subassembly of the instrument. Disassembly and repair procedures for each major subassembly are organized in a self-contained section of this chapter. The disassemblies are outlined in table 6-1.

Table 6-1. Disassembly and Repair Index

Heading	Section
DISASSEMBLY	6.2
Battery Writing Table Cases (Front/Rear)	
POWER SUPPLIES	6.3
Transformer Circuit Breaker Power Cord Socket Power Regulator Board	
PNEUMATIC ASSEMBLY	6.4
Preliminary Steps Leaker Assembly Overpressure Switch Pump Assembly Manifold Assembly Reservoir	
Logic/Analog and Display/ Thermometer Boards	6-5
Front Case Assembly	6-6
Rear Case Assembly	6-7
User Interface Switches	6-8

6.1 TOOLS, TEST EQUIPMENT, AND SUPPLIES

Refer to table 6-2 for the tools and test equipment required for corrective maintenance and calibration.

Table 6-2. Tools, Test Equipment, and Supplies

Item Name	Manufacturer/Model No.
Pressure gauge	WALLACE AND TIERNAN (201-759-8000), Model 1500 (0-800 mmHg), Heise Model 901A (0-500 mmHg), or equivalent
Digital multimeter (DMM)	FLUKE, 8040 (203-426-3115) or equivalent
DIP clip, 28 pin	
Test leads	(Compatible with DIP clip and DMM)
Controlled solder station	WELLER, TC 202 or equivalent
Pressure calibration test fixture	(Constructed as per figure 6-1)
Long-nose pliers	
Trimpot adjustment tool	
Screwdrivers	Phillips, no. 1, magnetic tipped Phillips, no. 2, flat bladed, 1/8 by 6 in.
Blood pressure cuff	IVAC Corp. (Model 1148)
Air hose	IVAC Corp. (Model 1131)
Substitute arm	Cylinder (3 ±1 in. diameter; cardboard, acrylic, or other material)
Temperature probe	IVAC, P1880L or P1882L

Circulating water bath or temperature tester (for calibration)	BRONWIL, 1420M or equivalent, or IVAC, P/N 191815
Calibration tester	IVAC, Model 828A
Lubricant (for instrument)	Dupont, Kyrtox GPL-205 (phone: 1-800-441-9942)
Lubricant (for O-ring)	GE, G321 Vesilube (phone: 518-237-3330)
Safety tester	DYNATECH, Model 232B 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%
Tee fitting (2)	IVAC, P/N 303815
or	
4-End double tee fitting	IVAC, P/N 302592
Reservoir	IVAC, P/N 120078
Tubing	IVAC, P/N 303154
CAL extender	IVAC P/N 191097

NOTE: The use of the reservoir replaces the need for a substitute arm and blood pressure cuff.

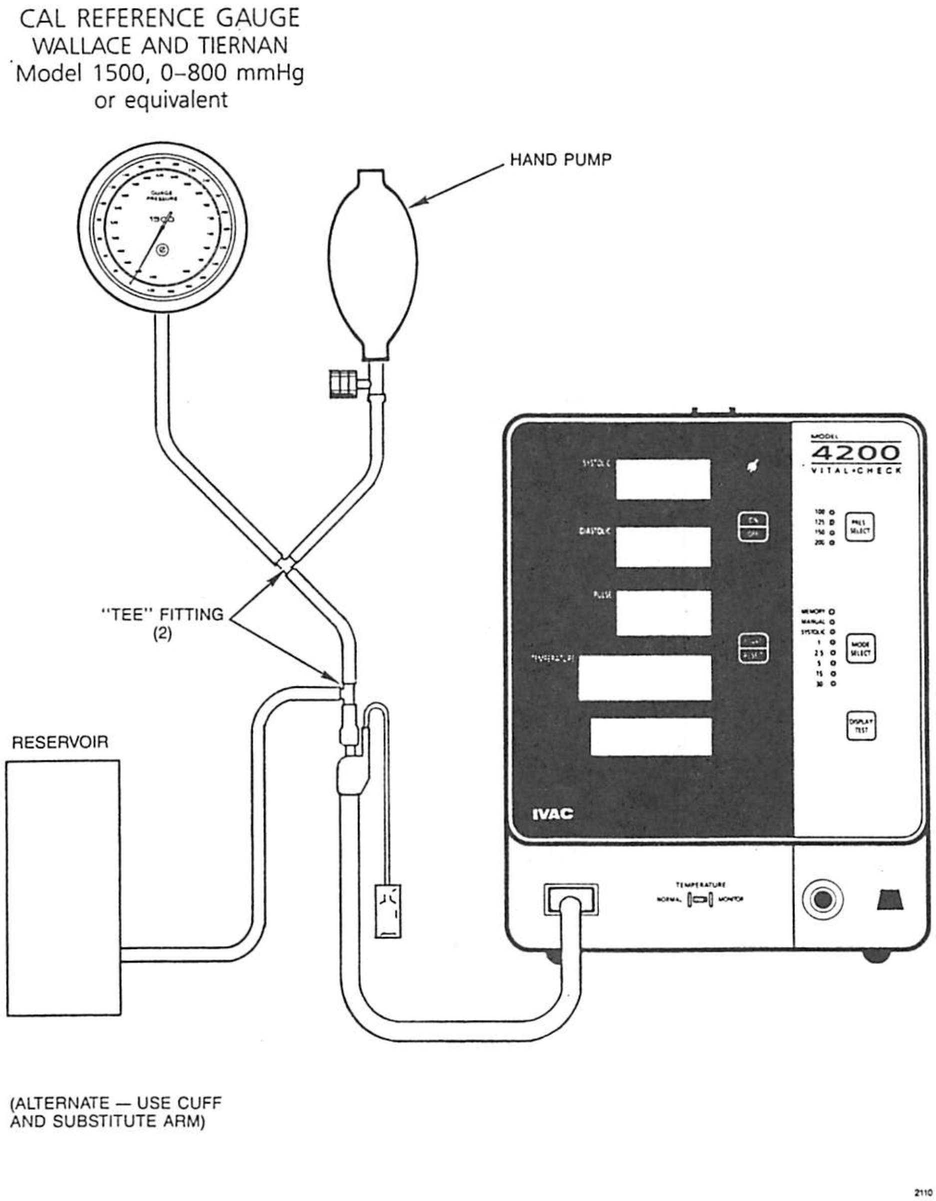


Figure 6-1. Pressure Calibration Test Fixture

6.2 DISASSEMBLY

Some preliminary disassembly is required to gain access to the functional components of the instrument. Figures 6-2 and 6-3 show the internal location of the major subassemblies and their screws.

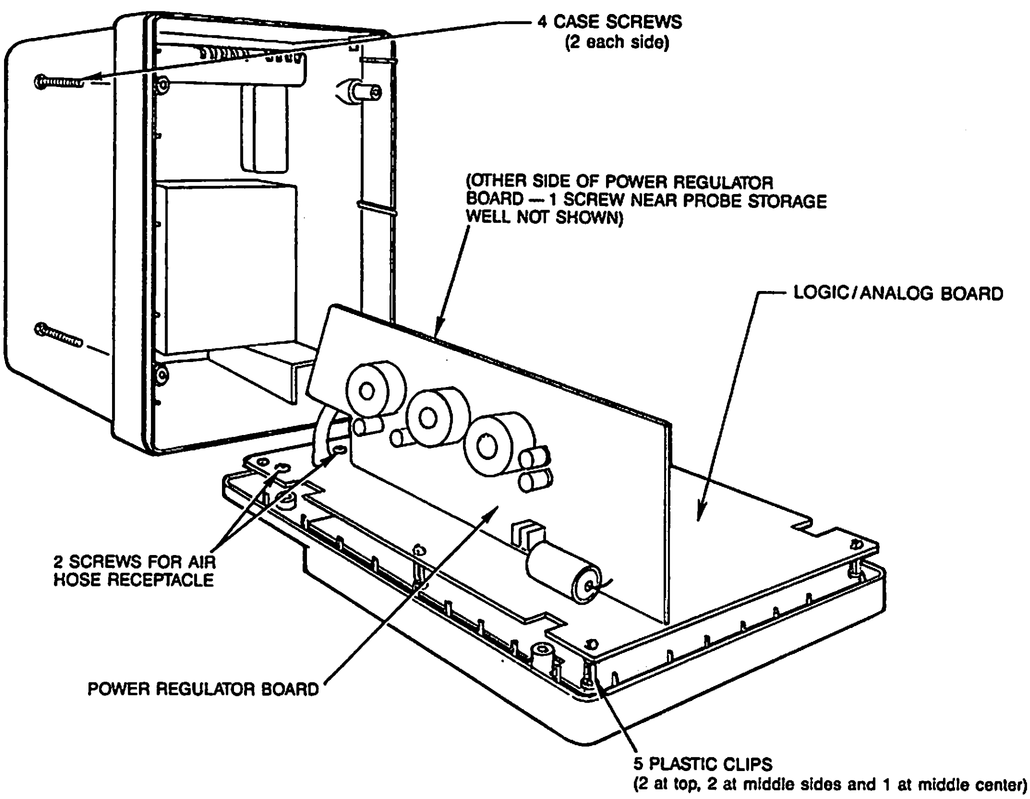


Figure 6-2. Accessing Logic/Analog Board

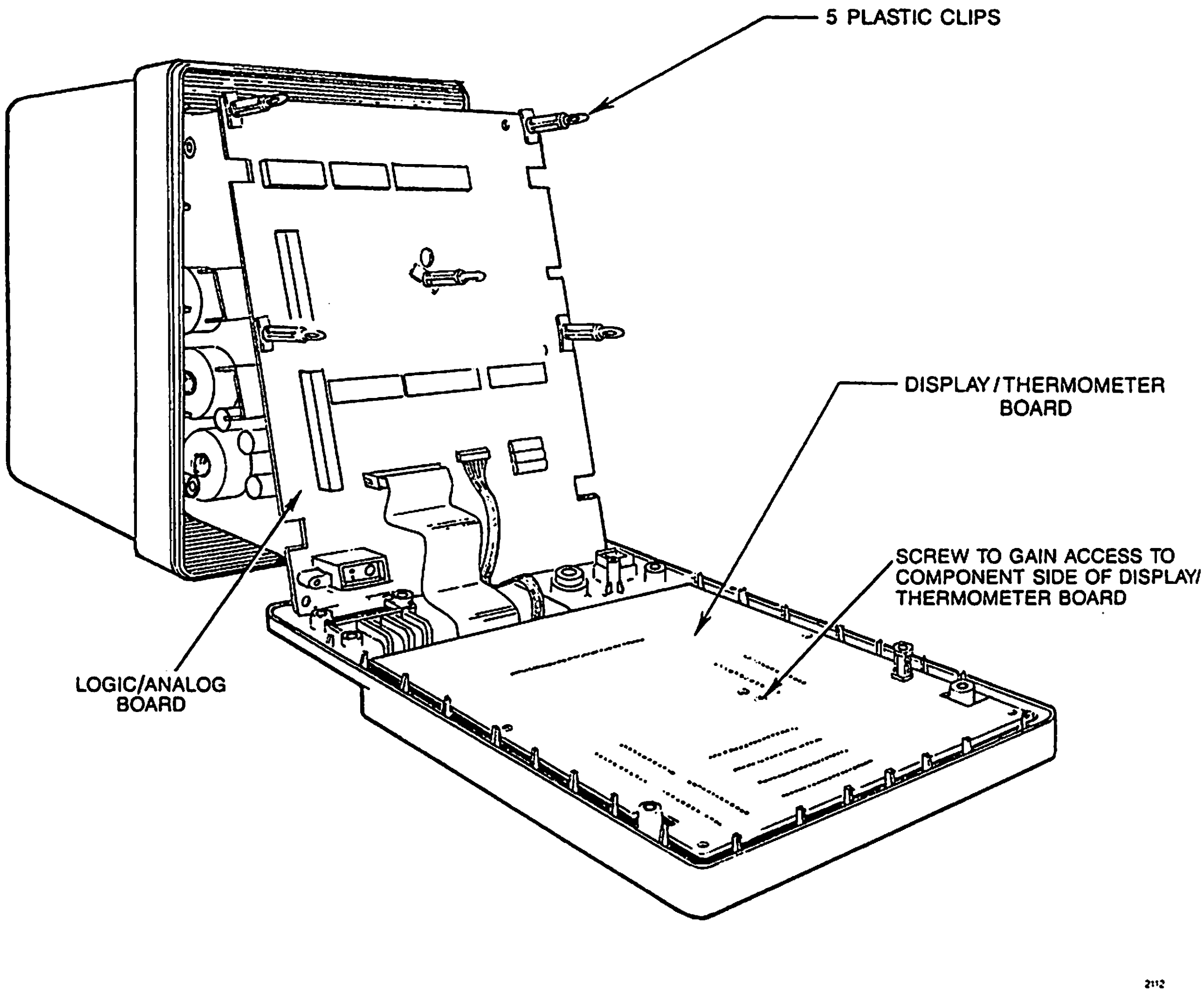


Figure 6-3. Accessing Display/Thermometer Board

6.2.1 Battery (figure 8-5A, item 202)

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

b. Using a Phillips head (no. 1) screwdriver, remove the two thread-forming screws (items 113) securing the battery cover (item 203), then remove cover.

c. Locate and disconnect the battery harness connector (item 221).

d. Gently lift the battery pack (item 202) out of the instrument, being careful not to let the harness (item 221) slide inside the instrument.

e. Service/replace, as necessary.

f. To reassemble:

1. Reconnect battery harness and return battery pack back into pocket, placing against foam side first.

2. Reinstall battery cover.

g. Verify operation per section 6.12.

h. Note that when all power has been removed from the instrument, line power must be applied momentarily before the instrument will function on battery power.

6.2.2 Writing Table (figure 8-5A)

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

b. Using a Phillips head (no. 1) screwdriver, remove the two thread-forming screws (items 113) securing the writing table.

c. Slide the table out of its catch and remove it.

d. Service/replace, as necessary.

e. To reassemble, slide the table back into front catch and reinstall screws.

6.2.3 Cases (figure 8-5A)

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

b. Using a Phillips head (no.1) screwdriver, remove the 4 screws (items 110) securing the front and back cases.

c. Place the instrument upright on a static-protected surface, then slide the front case forward. Disconnect battery harness from regulator board. Rotate front case so that it can be laid on its face.

d. Remove ground harness from logic/analog board (J10).

e. To reassemble, slide the front case backward and rotate it backward onto its face, then reinstall screws. Ensure that the regulator board is placed in the slot to guide it back in place.

6.3 POWER SUPPLIES (figures 8-5A, 8-5B, and 8-5C)

The power supply consists of the battery (item 202), transformer (item 205), circuit breaker (item 206), power cord socket (item 210), and power regulator board (item 16). The instrument clip fuse F101 (2.5A) and fuse F102 (5A) are located on the power regulator board and are accessible after case disassembly per section 6.2.3.

WARNING: Disconnect the instrument from AC power before disassembly. Use extreme care when servicing an instrument that is connected to AC power. Hazardous voltages are present when AC power is connected, regardless of the setting of the ON/OFF switch.

6.3.1 Transformer (figure 8-5C, item 205)

a. Perform case disassembly per section 6.2.3.

b. Disconnect the transformer wiring harness from J104 on the power regulator board (item 16). (See figure 6-4.)

c. Disconnect the transformer wiring harness from the circuit breaker, black wire and line cord socket, white wire.

d. Remove the two machine screws (items 212) and washers (items 116) from the transformer and move grounding harness (item 219) out of the way. Remove transformer shield (item 117).

e. Service/replace, as necessary.

f. To reassemble:

   1. Reconnect transformer onto locating posts and secure with machine screws and washers, being sure to reconnect ground harness.

   2. Torque screws to 12-15 inchpounds, minimum.

   3. Reconnect wiring harnesses.

g. Verify operation per section 6.11.

6.3.2 Circuit Breaker (figure 8-5C, item 206)

a. Perform case disassembly per section 6.2.3.

b. Remove hex nut from circuit breaker on rear case.

c. Pull circuit breaker (item 206) out of mounting hole from inside and remove power harness (item 220) and disconnect black wire from transformer assembly.

d. Service/replace, as necessary.

e. To reassemble:

   1. Reconnect harnessing and reinsert through D-hole in back case.

   2. Retighten hex nut onto circuit breaker.

f. Verify operation per section 6.11.

6.3.3 Power Cord Socket (figure 8-5C, item 209 or 219)

a. Perform case disassembly per section 6.2.3.

b. Remove ground harness (item 219) from logic/analog board (item 15), mounting bracket (item 208), and transformer (item 205).

c. Remove black and white wires from power cord socket.

WIRING DIAGRAM (Source 124468)

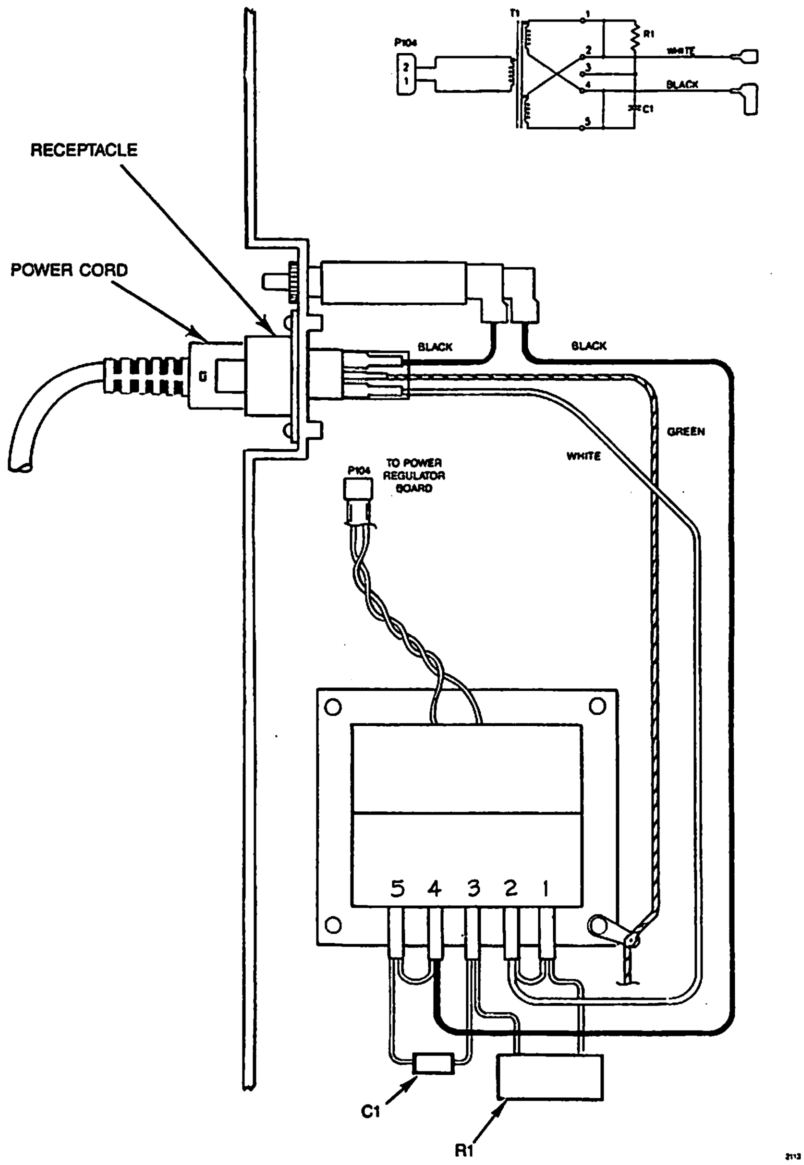


Figure 6-4. Transformer/CB/Cord Wiring Diagram

d. Remove the two thread-forming screws (item 215) retaining the socket (item 209) and cord retainer (item 210), then pull ground strap through the hole.

e. Service/replace, as necessary.

f. To reassemble:

   1. Push grounding strap through hole and reinstall socket and cord retainer, being sure that ground pin on the socket is towards the center of the instrument.

   2. Reconnect the grounding strap to the transformer, mounting bracket, and logic/analog board, being sure to torque transformer mount screw to 12-15 inchpounds.

6.3.4 Power Regulator Board (figure 8-5C, item 16)

a. Perform case disassembly per section 6.2.3.

b. Disconnect the battery harness (item 221) from J105 on the power regulator board (item 16).

c. Disconnect the transformer harness (item 205) from J104 on the power regulator board.

d. Holding the back of the logic/analog board (item 15), pull up on notched (bottom) corner of the power regulator board to remove, being careful not to bend the pins on power regulator board.

e. The power regulator board is serviceable; refer to Chapter Three, FUNCTIONAL DESCRIPTION, and Chapter Eight, ILLUSTRATED PARTS BREAKDOWN (figure 8-14) to identify any defective component.

f. To reassemble:

   1. Align the pin on the power regulator board closest to the notch with its hole in the logic/analog board.

   2. Using a scissor action, press the power regulator board pins through holes in the logic/analog board, and into their connector, being sure edge of power regulator board is against the back of the logic/analog board, to ensure pins are fully seated.

   3. Reconnect the battery and transformer harnesses.

6.4 PNEUMATIC ASSEMBLY (figures 8-5C and 8-7)

Removal of the pneumatic assembly is not necessary for most pneumatic component repairs. However, removal is outlined here for those sections where it is required.

6.4.1 Preliminary Steps

a. Perform case disassembly per section 6.2.3.

b. Remove the silicone tubing (item 261) leading to the assembly from the tee fitting (item 264) at the logic/analog board (item 15).

c. Remove the pneumatic ribbon cable from the pneumatic assemblies transition board (item 267). Press both tabs away from connector to loosen pneumatic ribbon cable.

d. Remove the three thread-forming screws (item 215) and upper washers (item 217) holding the pneumatic assembly (item 20).

e. Lift the module off its mounting bosses and out of the back case.

6.4.2 Leaker Assembly (figure 8-7, item 254)

a. Perform preliminary disassembly per section 6.2.3.

b. Disconnect the leaker harness from the transition board (item 267).

c. Remove the two thread-forming screws (items 266) securing the leaker and remove leaker.

d. Remove silicon tubing from leaker.

e. Service/replace, as necessary.

f. To reassemble:

   1. Align leaker with mounting holes and install thread-forming screws, being careful not to overtighten.

   2. Reconnect leaker harness to transition board.

g. Verify proper function per section 6.12.

6.4.3 Overpressure Switch (figure 8-7, item 257)

a. Perform case disassembly per section 6.2.3.

b. Disconnect pressure switch harness (item 268) from transition board (item 267).

c. Slide pressure switch out from under the plastic catch, then remove it and the silicon tubing (item 261) from manifold (item 252).

d. Remove silicon tubing from pressure switch.

e. Service/replace, as necessary.

f. To reassemble:

1. Push the silicon tubing all the way onto pressure switch fitting marked "P" and then onto nipple on manifold.

2. Slide the other switch fitting under the manifolds plastic catch, install harness onto transition board.

g. Verify proper function per section 6.12.

6.4.4 Pump Assembly (figures 8-7 and 8-13, item 253)

a. Perform case disassembly per section 6.2.3.

b. Disconnect pump assembly harness from the transition board (item 267).

c. Remove the three thread-forming screws (item 263) holding the motor bracket to the manifold (item 252) using a Phillips (no. 1) screwdriver, then remove pump assembly.

d. To service with lubricant:

1. Slide piston (item 278) off eccentric drive (item 277) and clean piston hole and eccentric shaft with a clean cotton swab or lint-free cloth.

2. Apply pump lubricant (KYRTOX - GPL 205) to eccentric shaft and piston hole, then slide the piston onto eccentric shaft, being sure piston face with four small depressions is towards the motor.

e. Replace, as necessary.

f. To reassemble:

1. Rotate eccentric and piston to full up position, so that diaphragm is against motor bracket.

2. Align pump assembly with manifold mounting holes and seat into pocket.

3. Reinstall the thread-forming screws, being careful not to overtighten.

4. Attach pump harness to transition board.

g. Verify proper function per section 6.12.

6.4.5 Manifold Assembly (figures 8-6 and 8-7, item 252)

a. Perform case disassembly per section 6.2.3.

b. Remove pneumatic assembly (item 20) per section 6.4.1.

c. Perform disassembly portions of sections 6.4.2, 6.4.3, and 6.4.4.

d. Remove the self-sealing machine screw and its o-ring (item 262).

e. Remove the thread-forming screws (item 266, 2 places) to separate reservoir assembly and remove transition board (item 267). Remove silicon tubing section from manifold assembly.

f. Pull reservoir from manifold assembly (item 252), noting o-ring (item 258) placement.

g. Roll vibration grommets (item 259) out of mounting slots on manifold.

h. Service/replace, as necessary.

i. To reassemble:

1. Squeeze and roll vibration grommets into manifold slots.

2. Apply lubricant (G321) to o-ring. Seat large o-ring against the ridge on the reservoir (item 251).

3. Seat the reservoir and o-ring into the manifold and reinstall self-sealing machine screw and thread-forming screw.

4. Reattach silicon tubings and reassemble individual components per above sections.

5. Install pnuematic assembly onto three mounting bosses, being sure the proper washer sandwiches the vibration grommet on both sides, then reinstall screws. Do not overtighten screws because the case may crack as a result.

6. Attach ribbon cable. Ensure tabs click back in place to lock connector in place.

j. Verify proper function per section 6.12.

6.4.6 Reservoir (figure 8-7, item 251)

a. Perform case disassembly per section 6.2.3.

b. Remove pneumatic assembly (item 20) per section 6.4.5.

c. Ensure self-sealing machine screw and its o-ring (item 262) and thread-forming screw (item 266) are removed.

d. Pull reservoir (item 251) from manifold (item 252) and remove o-ring (item 258).

e. Service/replace, as necessary.

f. To reassemble:

1. Apply lubricant (G321) to o-ring. Seat o-ring against flange on reservoir.

2. Seat reservoir and o-ring into manifold and reinstall screws.

3. Install pneumatic assembly onto the three mounting bossess, being sure a washer sandwiches the mounting grommet on both sides, then reinstall screws.

4. Attach ribbon cable. Ensure tabs click back in place to lock connector in place.

g. Verify proper function per section 6.12.

6.5 LOGIC/ANALOG AND DISPLAY/THERMOMETER BOARDS (figure 8-5B)

a. Perform case disassembly per section 6.2.3.

b. Remove pneumatic ribbon cable from the pneumatic assembly (item 20).

c. Perform power regulator disassembly per section 6.3.4.

d. Remove ground wire from logic/analog board (part of item 219).

e. Remove the two machine screws by the cuff receptacle (items 112) and the thread-forming screw by probe well (item 113) from the accessory attachment end of the board.

f. Using a Phillips magnetic-tip screwdriver, remove the thread-forming screw (item 113) through the center of the logic/analog board (item 15), holding the temperature/display board (item 17) in place.

g. Lift the board set (both boards) off the front case (item 11) and rotate it back up against the rear case (item 10); note the cable placement.

h. Pull the display/thermometer board off the logic/analog board at each of the five snap-in standoffs (items 114) and lay it back into the front case.

i. Unplug the fan-folded ribbon cable and the touch-switch tail flex cable.

j. To service, refer to Chapters Three, FUNCTIONAL DESCRIPTION, Five, TROUBLESHOOTING, and Eight, ILLUSTRATED PARTS BREAKDOWN (figures 8-15 and 8-16) for further information.

k. To reassemble:

   1. Assemble display/thermometer board and thread-forming screw, holding front case. Ensure that board lays flat on supports on the front case.

   2. Attach the touch-switch tail flex cable and fan-folded ribbon cable to the logic/analog board, aligning front case and display/thermometer board mount holes.

3. Snap standoff attached to logic/analog board through the holes on the display/thermometer board, being sure all accessory connectors and the normal monitor switch are properly seated into or through their mounting holes, then reinstall screws.

4. Reinstall power regulator board per section 6.3.4.

1. Verify proper function per section 6.12.

6.6 FRONT CASE ASSEMBLY (figure 8-3, item 11)

a. Perform case disassembly per section 6.2.3.

b. Perform logic/analog disassembly (except for removal of the power regulator board), per section 6.5.

c. Service/replace, as necessary.

d. To reassemble, perform the logic/analog reassembly per section 6.5.

e. Ensure ribbon cable to pneumatic module clears case and allows access to DIP switch (S2).

f. Verify proper function per section 6.12.

6.7 REAR CASE ASSEMBLY (figures 8-4, 8-5A and 8-5C, item 10)

a. Perform case disassembly per section 6.2.3.

b. Remove the two thread-forming screws (items 113) and one machine screw (item 213), to remove the mounting bracket (item 208).

c. Once removed from instrument, remove grounding harness (item 219) from bracket, if not already removed.

d. Perform the battery, transformer, circuit breaker, power cord socket, and pneumatic assembly disassemblies per sections 6.2.1, 6.3.1, 6.3.2, 6.3.3, and 6.4.1.

e. Remove the test cover retaining screw (item 113) and cover (item 13).

f. Service/replace, as necessary.

g. To reassemble:

1. Reinstall test cover retaining screw and cover.

2. Perform sections 6.4.1, 6.3.3, 6.3.2, 6.3.1, and 6.2.1, respectively.

3. Reinstall grounding harness to bracket and the two thread-forming screws and one machine screw to the mounting bracket.

4. Perform case reassembly per section 6.2.3.

h. Verify proper function per section 6.12.

6.8 USER INTERFACE SWITCHES

NOTE: To service, replacement of the front case assembly is required (figure 8-3, item 11).

6.9 CALIBRATION

If at any stage of this procedure the instrument cannot be calibrated, corrective maintenance may be required. Refer to Chapter Five, TROUBLESHOOTING.

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.

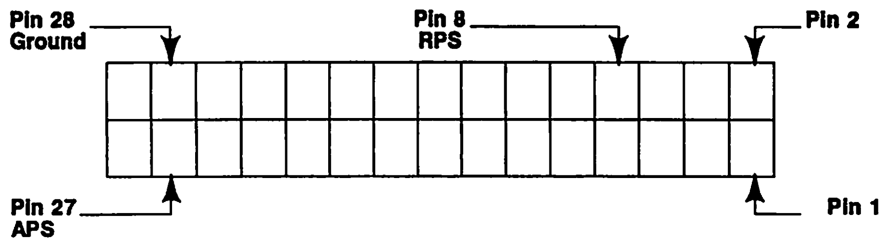
NOTE: Any time the system is pressurized above 20 mmHg, a hardware timer will be operating and will disable the instrument when it times out after a period of 4.5 minutes. If this occurs during calibration, cycle the ON/OFF switch off, then on to reset the instrument.

Although the illustrations show the instrument closed, the calibration procedure is performed with the instrument opened. Sections 6.9.5, 6.9.6, and 6.9.8 may be performed on a closed instrument through the test connector. Periodic preventative maintenance can be done with the instrument closed, except for lubrication of the pump assembly. (Reference table 6-3.)

Table 6-3. Calibration Points

Test Fixture Connector

APS Signal - pin 27 of P5 (test connector)
RPS Signal - pin 8 of P5 (test connector)
Ground - pin 28 of P5 (test connector)



ADC Pins *

APS Signal - U41 pin 28
RPS Signal - U41 pin 27
Ground - U41 pin 16

*Calibration points referenced in manual (instrument opened for repair). Refer to test fixture connector pin numbers to calibrate the instrument when closed.

6.9.1 +5, +12 and -12V Checks on Power Regulator Board

CAUTION: Take care to avoid any short circuits at or around J2 and J105, as blown fuses or other damage can occur. The battery can supply enough current to damage wiring and cause injury.

a. Disconnect the battery connection, J105, on the power regulator board.

b. Connect the ground lead from the DMM (digital multimeter) to C102(-) (GND) and set the DMM on the 20 VDC range.

c. Connect the instrument to AC power.

d. Check the voltage at J2 pin 11 (+5 VAO) with the DMM; pin 11 voltage should be +5 ±0.25 volts.

e. Press the ON/OFF switch to apply power to the instrument.

f. Table 6-4 shows the four major voltage levels for driving various circuits in the instrument; check the voltage at the pins listed. If any voltages are out of range, the corresponding power regulator circuit is in need of calibration or repair.

Table 6-4. Power Supply Voltages

1. J2 Pin 10	+5.0 ±0.25 Volt (+5V Logic)
2. J2 Pin 11	+5.0 ±0.25 Volt (+5 VAO)
3. J2 Pin 13	+14.1 ±0.15 Volt (+12V)
4. J2 Pin 15	-12.0 ±1.00 Volt (-12V)

g. Disconnect instrument from AC power.

6.9.2 Check Battery Charge Voltage (Regulated DC)

a. Disconnect the battery connection, J105, on the power regulator board, if not already disconnected.

b. Set the DVM to the 20 VDC range and connect the (+) lead to J105 pin 2 and the (-) lead to C102(-) (GND).

c. Connect the instrument to the AC power source and verify that the DVM indicates 14.1 ±0.1 VDC; if it does not, adjust R121 until it is within specifications.

d. Disconnect the instrument from AC power.

6.9.3 Check Low Battery Circuit

a. Disconnect the battery connection, J105, on the power regulator board, and disconnect instrument from AC power, if not already disconnected.

b. Adjust a variable DC power supply (0-15V, 1.5A) to 14.0 volts; do not exceed this voltage.

c. Connect the power supply (+) to J105 pin 2 and the (-) to C102(-) (GND).

NOTE: Observe polarity to prevent damage to the power regulator.

d. Monitor J2 pin 3 with an oscilloscope or DVM to observe the logic level at this pin (LOWBATT-), using C102(-) as GND.

e. Momentarily connect the instrument to AC power to clear the power failsafe flip-flop, then disconnect AC power.

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

g. Test J2 pin 10 for a level of about 5 volts to ensure power regulator is energized.

h. Verify that a logic 1 is at J2 pin 3.

i. Slowly lower the DC power supply voltage and verify that voltage at J2 pin 3 goes to logic 0 when the power supply is decreased to 11.6 ±0.1V, then reset the supply to 14 volts.

j. Verify that step i can be repeated; if it cannot, adjust external power supply to 11.6 ±.05 VDC, then adjust R142 until J2 pin 3 just changes state.

k. Lower the voltage 0.1 VDC, reducing voltage very slowly, then verify that the instrument displays CHARGE BATTERY, beeps, and shuts off.

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

m. Remove the test equipment from the power regulator board.

n. Reconnect the battery to J105, being certain that the plug is not connected backward. (Improper polarity will damage the power regulator.)

6.9.4 5V Reference Voltage on Logic/Analog Board (ADC-U41)

a. Using a 28-pin DIP clip, connect a DMM to U41 pin 12(+) and U41 pin 16(-) on the logic/analog board.

b. Connect the instrument to AC power, then press the ON/OFF switch to apply power.

c. With the DMM on the 20 VDC scale, the reading should be 4.9 ±0.2 volts.

6.9.5 Pressure Channel Zero Adjustment

a. Using the 28-pin DIP clip, connect the DMM positive lead to U41 pin 28 (APS) and ground lead to U41 pin 16.

b. Set the DMM to the 2 VDC range.

c. Adjust R118 (ZERO) on the logic/analog board to a reading of 0.000 ±0.001V on the DMM. (See figure 6-6.)

6.9.6 Pressure Calibration

a. Prior to performing this adjustment, make sure that the pressure channel zero adjustment section 6.9.5 has been performed.

b. The internal DIP switch S2 is accessible through louver holes in the bottom, right-hand side of the instrument with the instrument closed (see figure 6-5); note the hospital setting of the DIP switches, nos. 1-4. (See table 6-5.)

Table 6-5. Internal DIP Switch S2 Configurations

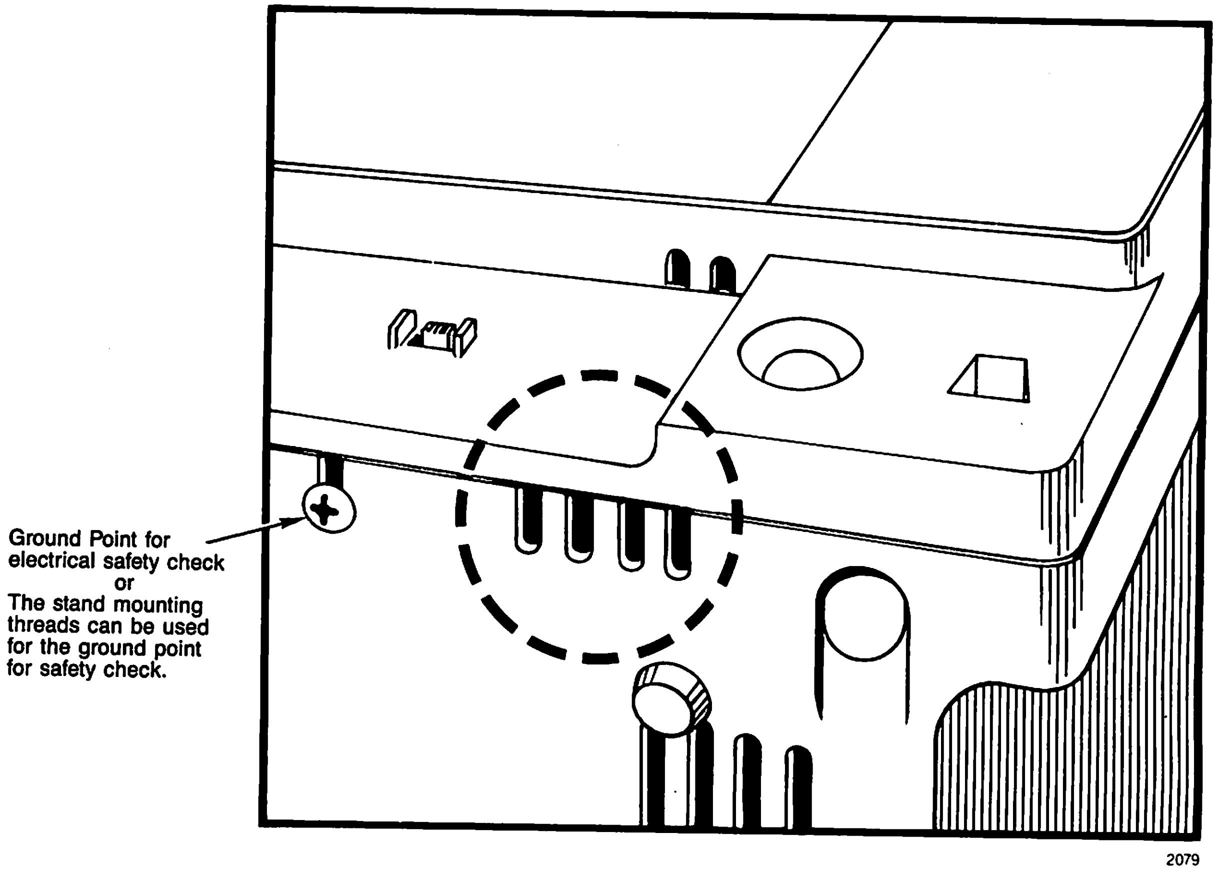
	S2 Switch Numbers					
	1	2	3	4	5	6
4200 Operating Mode:	C	C	C	C	-	
Calibration Mode:	C	C	C	O	-	
Send-Only Mode (CIM option only):	C	O	C	C	-	
Printer Mode (CIM option only):	C	O	C	O	-	
Thermometer °F	-	-	-	-	O	
Thermometer °C	-	-	-	-	C	

Symbols: (C) closed/down; (O) open/up.

c. Set internal DIP switch S2 in the calibration mode (no. 4 to up position):

No. 1 - Down
No. 2 - Down
No. 3 - Down
No. 4 - Up

d. Ensure information display reads CAL if instrument is already turned on.



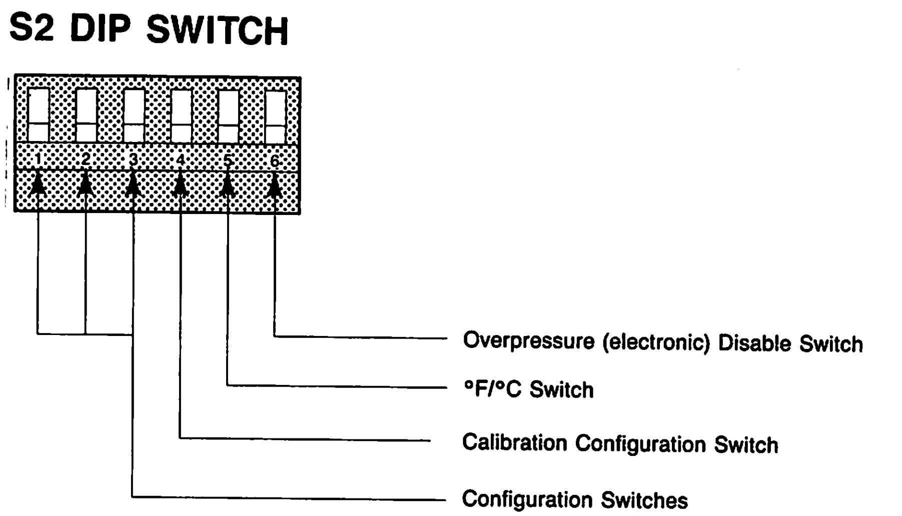


Figure 6-5. S2 Internal DIP Switch

e. As shown in figure 6-1, install pressure gauge and pressure source at the cuff nipple using a tee fitting and other fittings as required.

NOTE: Leaky fittings will reduce the reliability of the test and make calibration difficult.

f. Wrap the cuff around a cylinder (3-5 in. diameter) or use a reservoir. This will provide sufficient air volume to make calibration easier.

g. Place a 28-pin DIP clip on U41 on the logic/analog board and connect the DMM ground lead to pin 16 and the positive lead to pin 28 (APS).

h. Set the DMM to the 2 VDC range.

i. Press the ON/OFF switch to turn the instrument on and verify that the information display reads TESTING, followed by CAL, indicating that the instrument is in calibration mode, and the SYSTOLIC display reads 000, indicating that zero pressure is applied.

NOTE: In the following procedure, the setting of the PRES. SELECT switch is not an indication of the nominal applied pressure, but is used internally by the calibration software. (See table 6-6 to translate the setting of the switch to the nominal applied pressure for calibration and decoding pressure selections.)

Table 6-6. CAL Mode Pressure Selections

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

j. Set the PRES. SELECT to 125.

k. Set the MODE SELECT to MANUAL.

l. Inflate the system to about 220 mmHg on the calibration gauge and verify that the pressure stabilizes within 10 seconds after inflation and does not fall faster than 10 mmHg/min. If the pressure falls, there is a leak in the pneumatic system that must be corrected before calibration can proceed; adjust the pressure to 201.0 mmHg on the test gauge.

m. Adjust R119 (SPAN) on the logic/analog board for a reading that fluctuates between 200 and 202 on the SYSTOLIC display, being sure that the test gauge stays at 201.0 mmHg during this adjustment. (See figure 6-6.)

NOTE: The instrument has a resolution of 2 mmHg, and will read out only to the nearest even number on the SYSTOLIC display.

n. Adjust the pressure to 200.0 mmHg on the test gauge.

o. Adjust R117 (BALANCE) on the logic/analog board until a reading of 128 ±4 appears on the DIASTOLIC display, being sure that the test gauge stays at 200.0 mmHg during this adjustment. (See figure 6-6.)

p. Set the MODE SELECT to SYSTOLIC to depressurize the system and verify that the DMM indicates 0.000 ±0.003 VDC within about 10 seconds of deflation; if it does not, perform the pressure channel zero adjustment and repeat steps j through p. If step o fails a second time, the pressure sensor should be replaced.

q. Set the PRES. SELECT to 200 and the MODE SELECT to MANUAL.

r. Inflate the system to about 320 mmHg on the test gauge and wait for the pressure to stabilize.

s. Adjust the pressure until the SYSTOLIC display fluctuates between 300 and 302, then verify that test gauge reads 301.0 ±6 mmHg and the DIASTOLIC display reads 108 ±60; if either reading is out of tolerance, repeat steps j through s.

t. Set the PRES. SELECT to 150.

u. Adjust the pressure until the SYSTOLIC display fluctuates between 250 and 252, then verify that test gauge reads 251.0 ±3 mmHg and the DIASTOLIC display reads 108 ±40; if either reading is out of tolerance, repeat steps j through u.

v. Set the PRES. SELECT to 100.

w. Adjust the pressure until the SYSTOLIC display fluctuates between 150 and 152, then verify that test gauge reads 151.0 ±2 and the DIASTOLIC display reads 108 ±20; if either reading is out of tolerance, repeat steps j through w.

x. If the instrument cannot be adjusted to conform to the above specifications, refer to Chapter Five, TROUBLESHOOTING.

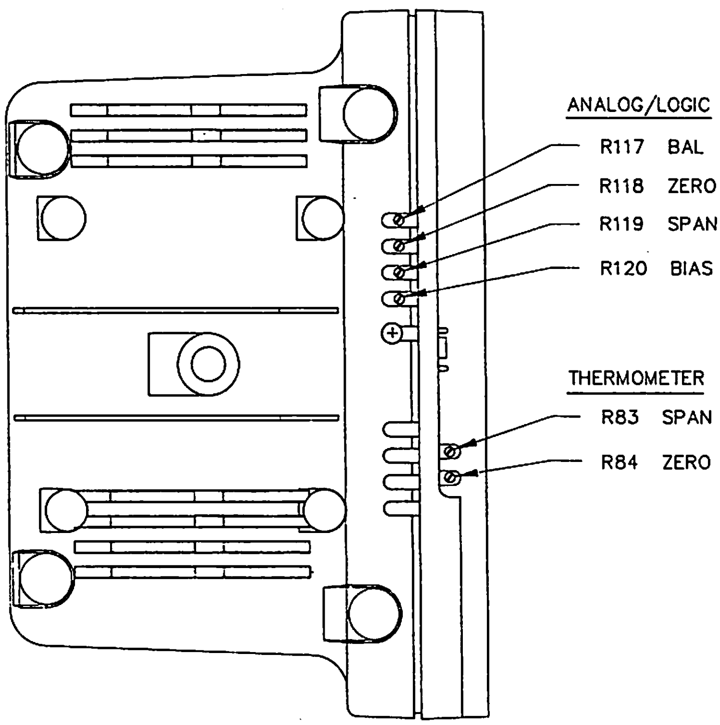


Figure 6-6. Logic/Analog and Display/Thermometer

6.9.7 Overpressure Switch Adjustment (Mechanical)

a. Set the S2 internal DIP switch, no. 6, to the up position. (See figure 6-5.)

b. Note positions of S2 switches, nos. 1 to 4 (referencing table 6-4), then set DIP switch no. 4 in the calibration mode:

1 - Down
2 - Down
3 - Down
4 - Up

c. As shown in figure 6-1, install pressure gauge and pressure source at the cuff nipple using a tee fitting and other fittings as required.

NOTE: Leaky fittings will reduce the reliability of the test.

d. Wrap cuff around a cardboard cylinder (3-5 in. diameter) or use reservoir for providing sufficient air volume.

e. Set the MODE SELECT to MANUAL and the PRES. SELECT to 200.

f. Press the ON/OFF switch to turn the instrument on; the information display will read TESTING, then CAL, indicating that the instrument is in calibration mode.

g. Inflate the instrument and stabilize the pressure at 340 ±5 mmHg on reference gauge and verify that the pressure does not drop at a rate greater than 10 mmHg/min; if it does, there may be excessive air leakage from the cuff or fittings.

h. Slowly increase the pressure and verify that the instrument suddenly and rapidly depressurizes at 390 ±15 mmHg on the reference gauge. If so, the overpressure switch adjustment is correct; go to step k; if not, continue to step i.

i. To adjust the switch:

1. Cycle the ON/OFF switch off, then back on, then re-inflate the system.

2. Turn the adjustment screw until the switch trips at the correct pressure by turning the adjustment screw clockwise to lower the overpressure trip point; turn counter-clockwise to raise the overpressure trip point.

NOTE: Each time the overpressure switch is tripped, the instrument is disabled and cannot be inflated; cycle power to clear the failsafe flip-flop.

j. Repeat steps g and h.

k. Press the ON/OFF switch to turn the instrument off, then return S2 DIP switches (nos. 1-4 and 6) back to original configuration.

6.9.8 Deflation Loop Balance Adjustment

a. Connect the DMM ground lead to U41 pin 16 and the positive lead to U503 pin 27 (RPS) on the logic/analog board, then set the DMM to the 20 volt range.

b. Set the internal DIP switch S2 (see figure 6-5), as follows:

1 - Down
2 - Down
3 - Down
4 - Down
6 - Down

NOTE: The instrument must be upright during this adjustment.

c. Install pressure gauge as in section 6.9.6, step d, using a tee fitting and other fittings, as required. (See figure 6-1.)

NOTE: Leaky fittings will reduce the reliability of the test.

d. Wrap cuff around a cardboard cylinder (3-5 in. diameter) or use a reservoir to provide sufficient air volume.

e. Ensure that the MODE SELECT is set to SYSTOLIC.

f. Set the PRES. SELECT to 200.

g. Initiate an inflation cycle by pressing the START/RESET switch; observe the readings on the DMM as the instrument deflates and passes through 200 mmHg and 50 mmHg on the calibration gauge.

h. Repeat the inflation/deflation sequence and adjust R120 (LEAKER BIAS) on the logic/analog board (see figure 6-6) until the average between the minimum and maximum readings on the DMM at 200 and 50 mmHg is 2.5 ±.15 volts.

i. Press the ON/OFF switch to remove power from the instrument, then remove test equipment.

6.9.9 Thermometer Calibration

All references are made to the display/thermometer board unless otherwise noted. This calibration is easily performed with the instrument closed.

NOTE: Calibration of the thermometer is necessary whenever the analog portion (U6, U7, R53 to R72, U13, and C22) on the display/thermometer board is worked on.

6.9.9.1 Water Bath Method (optional)

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: U6 will malfunction if R84 is grossly maladjusted. In this case the display would be zeros, there would be no scanning at the output of U6, and there would be no response to any analog input.

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

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

d. Press the DISPLAY TEST switch while inserting probe connector into the connector socket; three digits and a "d" should appear in the TEMPERATURE display. Be sure that the reading is stabilized (digits may have minus (-) signs included.)

e. Verify that the display reads 000d (±1); if it does not, adjust R84 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. Verify that the display reads 900d (±1); if it does not, adjust R83 until the display reads 900d (±1).

h. Verify the accuracy of the adjustments made to R84 and R83 by repeating steps c through g, omitting step d.

i. Press the ON/OFF switch to turn off the instrument.

j. Disconnect the instrument from AC power.

6.9.9.2 Test Fixture Method

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

b. Set the temperature calibration test fixture (IVAC P/N 191815) to 88.

c. Press the DISPLAY TEST switch while inserting the connector from the fixture into the instrument's connector; three digits and a "d" should appear in the temperature display. Be sure that the reading is stabilized. (The digits may have minus (-) sign included.)

d. Verify that the display reads 000d (±1); if it does not, adjust R84 until the display reads 000d (±1). (See figure 6-6.)

NOTE: If the thermometer does not turn on, install and then remove a probe from the probe well.

e. Set the test fixture to 106 and verify that the display reads 900d (±1); if it does not, adjust R83 until the display reads 900d (±1).

f. Verify the accuracy of adjustments made to R84 and R83 by repeating steps b, d, and e.

g. Press the ON/OFF switch to turn the instrument off.

6.9.10 Real-Time Clock (CIM option only)

The real-time clock must be reset any time battery power is lost. SET TIME will override all other messages in the information display if the clock requires setting.

a. Select the clock mode by simultaneously pressing and holding contact between two locations: just to the left of the 125 and 150 PRES. SELECT switch and just to the left of the 5 and 15 MODE SELECT switch. (Contact will be verified by a short beep.)

b. Continue to hold contact at both locations until both the PRES. SELECT and MODE SELECT indicators go out, then release the contact pressure.

c. If the information display reads SET TIME, press the START/RESET switch; the information display will now read the time of day as follows:

in 12 hour format: HH:MM AM (or PM)
in 24 hour format: HH:MM:SS

(HH = hours, MM = minutes and SS = seconds)

d. To change between 12 and 24 hour format, press the START/RESET switch.

e. To set time:

1. Press the DISPLAY TEST switch once:

2. In the 12-hour format, AM (or PM) will flash. AM or PM can be selected by pressing the START/RESET switch; each press will alternate the AM/PM indication.

3. In the 24-hour format the seconds display will flash; the seconds may now be set by pressing the START/RESET switch.

f. Press the DISPLAY TEST switch, the hours display will now flash; press the START/RESET switch once for each hour to be changed.

g. Press the DISPLAY TEST switch, the minutes 10's display will now flash; press the START/RESET switch once for each ten minutes to be changed.

h. Press the DISPLAY TEST switch, the minutes 1's display will now flash; press the START/RESET switch once for each minute to be changed.

i. Press the DISPLAY TEST switch, the information display will now display the date as follows:

MM-DD-YY

(MM = Month, DD = Day, YY = Year)

The months display will be flashing; press the START/RESET switch once for each month to be changed.

j. Press the DISPLAY TEST switch, the days display will now flash; press the START/RESET switch once for each day to be changed.

k. Press the DISPLAY TEST switch, the year 10's display will now flash; press the START/RESET switch once for each ten years to be changed.

l. Press the DISPLAY TEST switch, the year 1's display will now flash; press the START/STOP switch once for each year to be changed.

m. Press the DISPLAY TEST switch, the time display will return to the information display; the clock IC (U29) will remain set unless power is lost to the logic/analog board. (If the battery is disconnected for any reason, the time and date must be reset.)

n. To exit the clock mode, actuate either the MODE SELECT or PRES. SELECT switch. (The clock setting mode can be exited at any state in this manner.

o. After exiting the clock mode, ensure that the mode and pressure settings are correct.

6.10 CALIBRATION VERIFICATION

Calibration verification ensures that the instrument blood pressure and thermometer measurement systems have been correctly calibrated and operate accurately before return to patient use.

6.10.1 Blood Pressure Calibration Verification

a. Note positions of internal DIP switch S2 (refer to figure 6-5 and table 6-4), then set S2 DIP switch in the calibration configuration mode:

1 - Down
2 - Down
3 - Down
4 - Up

b. As shown in figure 6-1, install pressure gauge and pressure source at the cuff nipple using a tee fitting and other fittings as required.

NOTE: Leaky fittings will reduce the reliability of the test.

c. Wrap cuff around a cylinder (3-5 in. diameter) or use a reservoir to provide sufficient air volume.

d. Press the ON/OFF switch to turn the instrument on; the information display will read TESTING, then CAL, indicating that the instrument is in calibration mode, and the SYSTOLIC display will read 000, indicating that zero pressure is applied.

e. Set the MODE SELECT to MANUAL and PRES. SELECT as required. (See step f.)

f. Apply test pressures in the range as required below and verify that the SYSTOLIC display matches the reading on the external gauge, making allowance for error tolerances of the external gauge. (See table 6-7.)

Table 6-7. Test Pressures

PRES. SELECT	Pressure* Applied	SYSTOLIC Reading	DIASTOLIC Reading
200	301 ±6	300-302	108 ±60
150	251 ±3	250-252	108 ±40
100	151 ±2	150-152	108 ±20

*Adjust pressure until SYSTOLIC fluctuates between desired readings, then check applied pressure for correct value.

NOTE: The instrument has a resolution of 2 mmHg, and will read out only to the nearest even number in the SYSTOLIC display.

g. If the readings are not acceptable, refer to the recalibration as described in section 6.9.4.

NOTE: This procedure does not test the cuff, which may be leaky.

h. Before returning the instrument to clinical use, reset internal DIP switch S2 to the original operating configuration.

i. Reinstall the test connector cover and rear pneumatic port seal.

6.10.2 Thermometer Calibration Verification

a. Insert thermometer tester (model 828A) into the probe connector socket. Turn on the instrument if not already turned on.

b. Set the NORMAL/MONITOR mode switch to MONITOR, the S2 internal DIP switch no. 5 (see figure 6-5) to the up (°F) position, and verify that the temperature display flashes 98.6°F (±0.2°F).

NOTES:

1) If the thermometer does not turn on, install and then remove a probe from the probe storage well.

2) For °C, set the internal DIP switch S2 no. 5 to the down position.

c. Set the NORMAL/MONITOR mode switch to NORMAL, verify that the display reads 98.6°F (±0.2°F), and that only the F flashes on and off.

d. Remove the thermometer tester from the instrument and return the DIP switch to the °C setting, if necessary.

6.11 ELECTRICAL SAFETY TESTS

6.11.1 Ground Current Leakage Test

Use a DYNATECH 232B 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 μamps for normal and reversed line polarity for 120 VAC input.

6.11.2 Ground Resistance Testing

Use a DYNATECH 232B or equivalent equipment to measure resistance from the ground pin on the AC power plug to the chassis (stand mounting threads on bottom of the instrument). Refer to the electrical safety tester's operation manuals for the proper measurement technique. Resistance should be less than or equal to 0.1Ω at 25A, 50 to 60 Hz AC rms.

6.12 FINAL TESTS

Set up the instrument as follows:

a. Connect the instrument to AC power.

b. Press the ON/OFF switch and verify that the SYSTOLIC, DIASTOLIC, and PULSE displays show all 8's and TESTING appears in information display for 3 ±1 seconds. The SYSTOLIC, DIASTOLIC, and PULSE displays should go blank. A mode message accompanied by 2 beeps replaces TESTING.

6.12.1 Battery Operation Test

a. Set the MODE SELECT to MANUAL, then disconnect the instrument from AC power.

b. Verify that the green charge indicator goes off and that after about 20 seconds the information display changes from a steady MANUAL to a flashing STANDBY message.

6.12.2 Display Test

a. Install a temperature probe on the instrument, then reconnect instrument to AC power.

b. Press the DISPLAY TEST switch and verify that all segments of the SYSTOLIC, DIASTOLIC, PULSE, and TEMPERATURE displays light, and that the information display alternates between capital O's and asterisks, and that all four of the pressure indicators and all eight of the mode indicators light.

c. Press and hold the DISPLAY TEST switch as you press and hold the START/RESET switch, then release both switches; verify that each numeric digit (except the TEMPERATURE display) lights sequentially, with a number or character that corresponds to its position in the sequence. The number or character must be as stated in table 6-8.

Table 6-8. Display Test Sequences

1. SYSTOLIC

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

2. DIASTOLIC

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

3. PULSE

1's digit	-	9
10's digit	-	lower 4 segments of an 8
100's 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 about 0.6 seconds.

6. The TEMPERATURE display will continuously display 88888.

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

7. The pressure and mode indicators are all lit.

d. Press the DISPLAY TEST switch again and verify that:

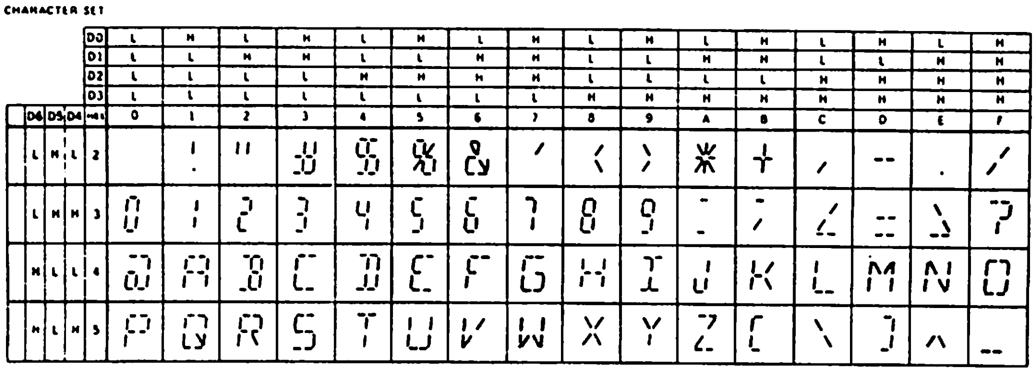
   1. All numeric displays (except TEMPERATURE) cycle simultaneously through the digits 0 to 9.

   2. The information display cycles through the characters that correspond to the hexadecimal codes 20 to 5F. (See figure 6-7.)

   3. The TEMPERATURE display continuously displays 88888.

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

   4. The pressure and mode indicators are all lit.



All other input codes display "blank"

Figure 6-7. Hexadecimal Code Characters

e. Press the DISPLAY TEST switch again and verify that:

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

   2. The pressure and mode indicators are all lit.

   3. The current software revision level message REV X.XX (where X.XX represents the level) appears in the information display.

f. Press the DISPLAY TEST switch again and verify that the instrument sounds two audible tones and displays the mode setting in the information display.

6.12.3 Blood Pressure Measurement Test

a. Connect the instrument to AC power and verify that the green charge indicator lights.

b. Press the ON/OFF switch and verify that TESTING appears in the information display briefly, accompanied by two audible tones, then the mode setting.

   NOTE: TESTING will appear in the information display each time power is applied to the instrument.

c. Set the PRES. SELECT to 150 and the MODE SELECT to MANUAL.

d. Plug the cuff connector into the cuff connector receptacle.

e. Place the cuff on a person's arm, following the cuff placement instructions provided in the VITAL•CHECK instrument - Model 4200 Directions For Use.

f. Press the START/RESET switch and verify that:

1. The initial goal pressure (150 mmHg) 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.

NOTES:

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

2) If the person's Korotkoff sounds are too weak (due to cuff misalignment or greater-than-normal adipose tissue) the instrument may not be able to compute the blood pressure (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 instrument 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. 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, and PULSE. The information display alternates between BP READY and MANUAL five times, 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.

g. The instrument is in need of repair if it alarms FIX ME or fails to operate as indicated.

6.12.4 MODE Function Test

a. With the instrument turned on, set the MODE SELECT to MANUAL.

b. Cycle the ON/OFF switch off and then on, and verify that TESTING appears in the information display, then MANUAL.

c. Set the MODE SELECT to MEMORY and verify that MEMORY appears in the information display.

d. Set the MODE SELECT to SYSTOLIC and verify that SYSTOLIC appears in the information display.

e. Set the MODE SELECT to 1 and verify that the display shows 1 MIN., then counts down from 1 minute.

f. Set the MODE SELECT back to SYSTOLIC for 4 seconds, then set it at 2.5 and verify that the display shows 2.5 MIN., then counts down from 2.5 minutes.

g. Set the MODE SELECT back to SYSTOLIC for 4 seconds, then set it at 5 and verify that the display shows 5 MIN., then counts down from 5 minutes.

h. Set the MODE SELECT back to SYSTOLIC for 4 seconds, then set it at 15 and verify that the display shows 15 MIN., then counts down from 15 minutes.

i. Set the MODE SELECT back to SYSTOLIC for 4 seconds, then set it at 30 and verify that the display shows 30 MIN., then counts down from 30 minutes.

6.12.5 Pressure Function and Abort (RESET) Test

a. Set the MODE SELECT to MANUAL.

b. Set the PRES. SELECT to 100.

NOTE: A BP cuff is necessary for this test. It must be installed on an arm as per Chapter Three, FUNCTIONAL DESCRIPTION, or mounted on a cylinder (3-5 in. diameter).

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

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

e. Set the PRES. SELECT to 125.

f. Press the START/RESET switch to initiate an inflation cycle and 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 PRES. SELECT to 150.

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

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

k. Set the PRES. SELECT to 200.

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

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

6.13 CIM II INTERFACE FUNCTIONAL TEST (Model 4200C Only)

There is no preventative maintenance on the solid-state components contained in the CIM.

For information on the proper use and care of the CIM in connection with this instrument, refer to the IVAC CIM Service Manual (part number 128696), and accompanying service bulletins.

To check the CIM, the interface wiring, and the computer system, use the following procedure.

a. Ensure that the computer connector on the Model 4200 instrument back panel is connected to the appropriate cable.

b. Turn on the computer and ensure that it is set up to receive data.

c. Take a blood pressure and compare the readout from the instrument display to the data received by the computer, and ensure that the computer correctly received the data.

CHAPTER SEVEN - PERIODIC INSPECTIONS

7.0 INTRODUCTION

This chapter describes the periodic inspections necessary to ensure the VITAL•CHECK instrument - Model 4200 continues to operate properly.

Periodic inspections are available through IVAC to those customers located within the on-site service territory of an IVAC authorized service repair organization. Customers within the United States may call IVAC's toll-free Corporate Customer Service Line (800) 482-4822 for information.

7.1 PERIODIC/PREVENTATIVE MAINTENANCE INSPECTIONS

Periodic/preventative maintenance inspections consist of the following inspection procedures and in service bulletins which may supplement the service manual. These inspections must be performed upon receipt of the instrument and at least as often as the intervals indicated. (See table 7-1.) Under heavy usage, more frequent inspections may be indicated.

The periodic/preventative maintenance inspections must be performed in accordance with IVAC requirements and guidelines, and are also intended to complement the intent of JCAHO requirements.

WARNING: Do not perform this checkout while using the instrument on a patient.

If the instrument does not pass a test/inspection, then servicing is required. Do not place the instrument back in use until all tests/inspections pass.

Table 7-1. Periodic/Preventative Maintenance Inspections

Procedure	Frequency
Perform Case and Power Cord Inspection	6 Months
Perform Umbilical Tubing and Cuff Connectors Inspection	6 Months
Perform Electrical Safety Tests	6 Months
Perform Display Test	6 Months
Perform Battery Operation Test	6 Months
Check Blood Pressure Calibration Verification	6 Months
Check Instrument Stand Assembly (Model 1042)	6 Months
Perform Pump Assembly Lubrication	12 Months
Perform Functional Checkout - Regular Inspections	6 Months
Check CIM II Interface - Functional Test (Model 4200C only)	6 Months

7.2 CASE AND POWER CORD INSPECTION

Verify the following:

a. Instrument case and hardware are intact.

b. Silk screening, decals and labels are intact.

c. There are no cuts or gross deformities in the cord.

d. Integrity of hospital grade power plug.

e. Undamaged circuit breaker.

7.3 UMBILICAL TUBING AND CUFF CONNECTORS INSPECTION

Verify the following:

a. There are no cuts or gross deformities in tubing.

b. There are no cracks or cuts in cuffs.

7.4 ELECTRICAL SAFETY TESTS

Refer to Chapter Six, CORRECTIVE MAINTENANCE (section 6.11).

7.5 DISPLAY TEST

Refer to Chapter Six, CORRECTIVE MAINTENANCE (section 6.12.2).

7.6 BATTERY OPERATION TEST

Refer to Chapter Six, CORRECTIVE MAINTENANCE (section 6.12.1).

7.7 CHECK BLOOD PRESSURE CALIBRATION VERIFICATION

Refer to Chapter Six, CORRECTIVE MAINTENANCE (section 6.10.1).

7.8 CHECK INSTRUMENT STAND ASSEMBLY (Model 1042)

Verify the following:

a. Screws are tight and intact.

b. Casters move with ease.

c. Assembly parts are intact.

7.9 PUMP ASSEMBLY LUBRICATION (Figure 8-13)

Case Disassembly

a. Place the instrument facedown on a soft surface so as not to scratch the front panel.

b. Using a Phillips (no. 1) screwdriver, remove the 4 screws securing the front and rear cases.

c. Place the instrument upright on a static-protected surface and slide the front case forward and rotate it forward onto its face.

d. Disconnect pump assembly harness from the transition board.

e. Remove the 3 thread-forming screws holding the motor bracket to the manifold using a Phillips (no. 1) screwdriver, then remove pump assembly.

f. Slide the piston off eccentric drive and clean piston hole and eccentric shaft with a clean cotton swab or lint-free cloth.

Lubrication

a. Coat the eccentric shaft and piston hole with a small dab of pump lubricant (Dupont - Kyrtox GPL-205), then slide the piston onto eccentric shaft.

b. Ensure that piston face with 4 small depressions is towards the motor.

Case Reassembly

a. Rotate eccentric and piston to the full up position so that diaphragm is against motor bracket.

b. Align pump assembly with manifold mounting holes, then seat into pocket.

c. Install 3 thread-forming screws, being careful not to overtighten.

d. Attach pump harness to transition board.

e. With the instrument in an upright position, slide the front case backward and rotate it backward.

f. Using a Phillips (no. 1) screwdriver, install the 4 screws which secure the front and rear cases.

7.10 FUNCTIONAL CHECKOUT - REGULAR INSPECTIONS

Refer to Chapter Two, OPERATION (section 2.7).

7.11 CHECK CIM II INTERFACE - FUNCTIONAL TEST (Model 4200C only)

Refer to Chapter Six, CORRECTIVE MAINTENANCE (section 6.13).

CHAPTER EIGHT - ILLUSTRATED PARTS BREAKDOWN

8.0 INTRODUCTION

The illustrated parts breakdown for the IVAC VITAL•CHECK instrument - Model 4200 consists of the complete system divided into assemblies, subassemblies, and individual component parts.

8.1 ILLUSTRATIONS

The following paragraphs describe exploded view and board assembly illustrations.

8.1.1 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.

8.1.2 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.

8.2 PARTS LISTS

The parts lists provide part numbers and descriptions for parts or subassemblies which are identified on the drawings, and which may require replacement when the instrument is serviced or repaired. Some parts can only be ordered as part of a subassembly (i.e., dump valve). 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 8.2.1 through 8.2.5 explain the contents of the parts lists in further detail.

8.2.1 Item and Index Number

This column lists the number of the item 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.

8.2.2 Part Number

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.

8.2.3 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.

8.2.4 Quantity

This column indicates the total number (quantity) of each part used within the assembly.

8.2.5 Issue Unit of Measure

This column indicates the unit of measure for each given part number.

8.2.6 Reference Designation

Each electronic component assigned a circuit symbol has that reference designation listed in this column. 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.

8.3 ORDERING PARTS

Parts can be ordered by writing or calling the IVAC Service Department at the following address/phone number. 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: Customer Service
(800) 482-4822

NOTES:

1. LABELS SHALL BE POSITIONED AS SHOWN USING APPLICABLE DIMENSIONS. LABELS SHALL BE STRAIGHT, CENTERED, AND SHALL NOT OVERHANG EDGES OR OVERLAP OTHER LABELS.

2. IF THE BAR CODE SERIAL NUMBER LABEL(ITEM 603) IS DAMAGED OR UNAVAILABLE, TYPE THE MODEL AND SERIAL NUMBER ON THE SERIAL NUMBER REPLACEMENT LABEL(ITEM 613).

3. LABEL(S) TO ALIGN WITH THIS EDGE.

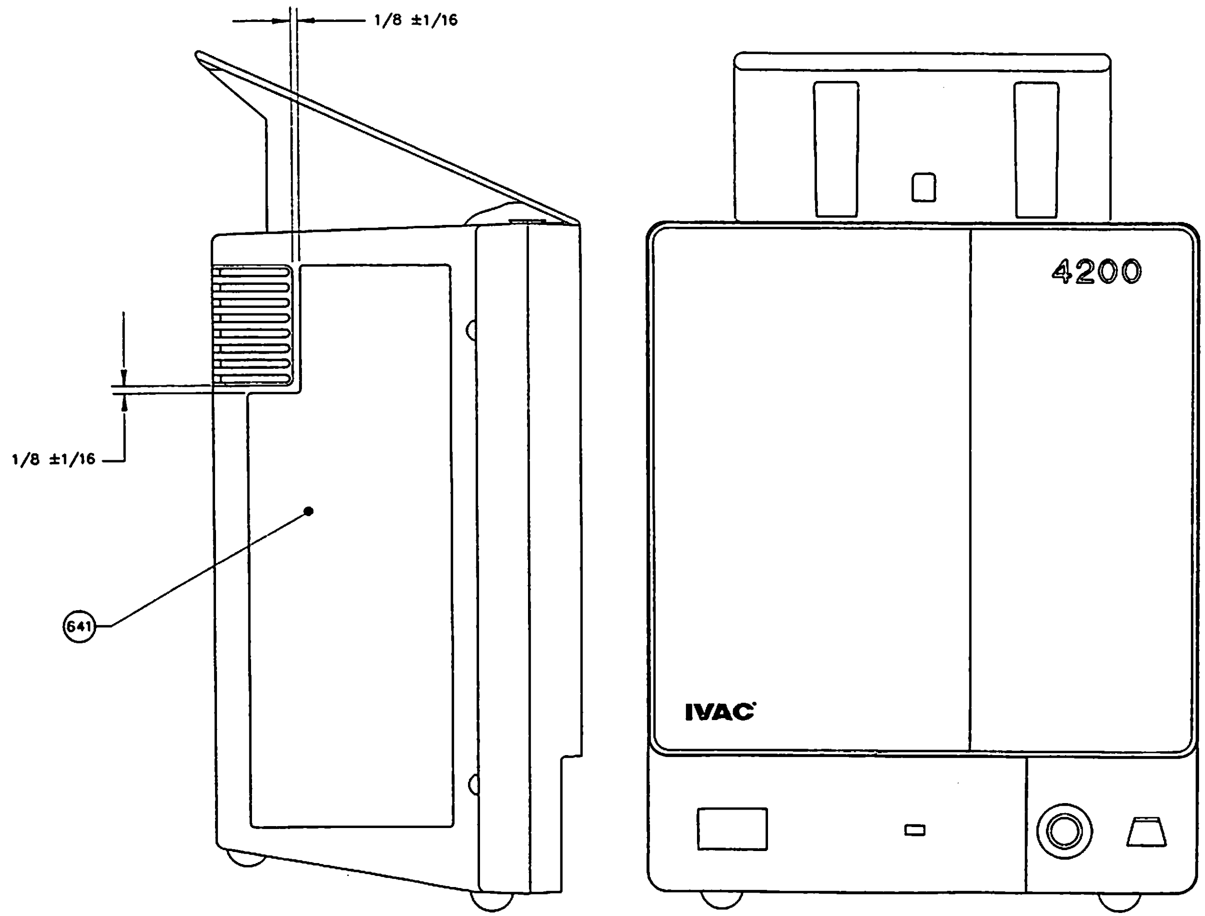


Figure 8-1A. Label/Literature

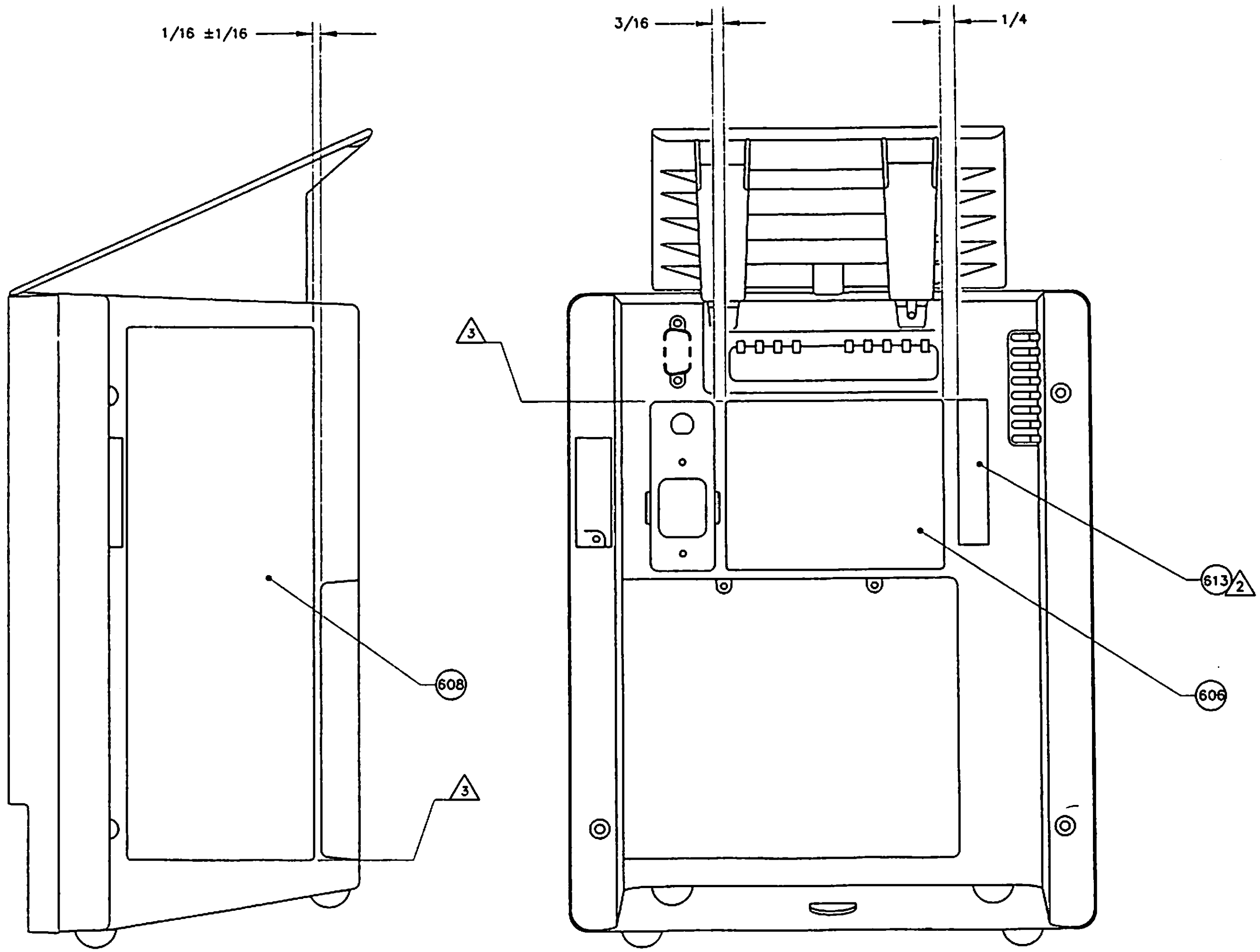


Figure 8-1B. Label/Literature

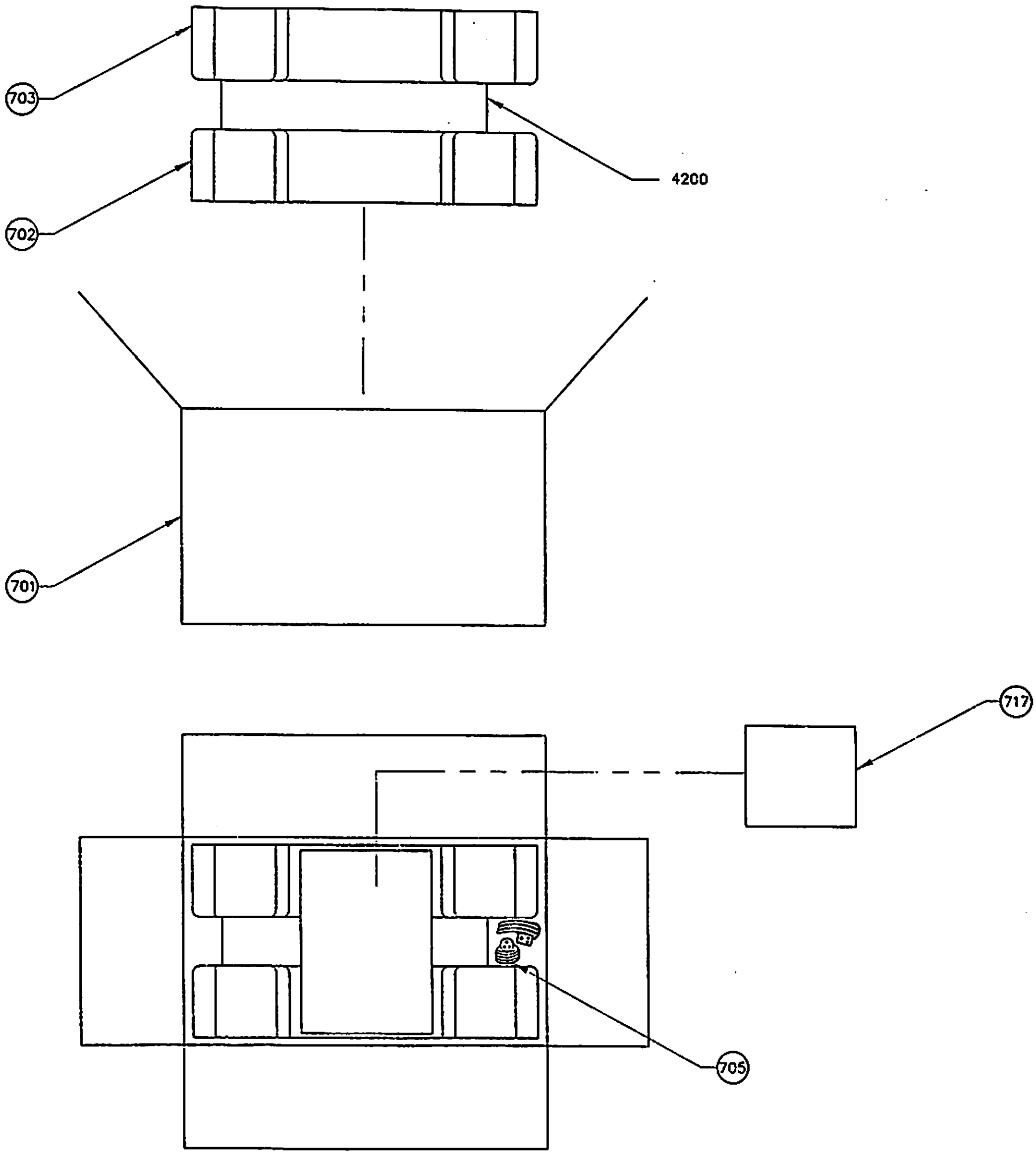


Figure 8-2. Packaging Assembly

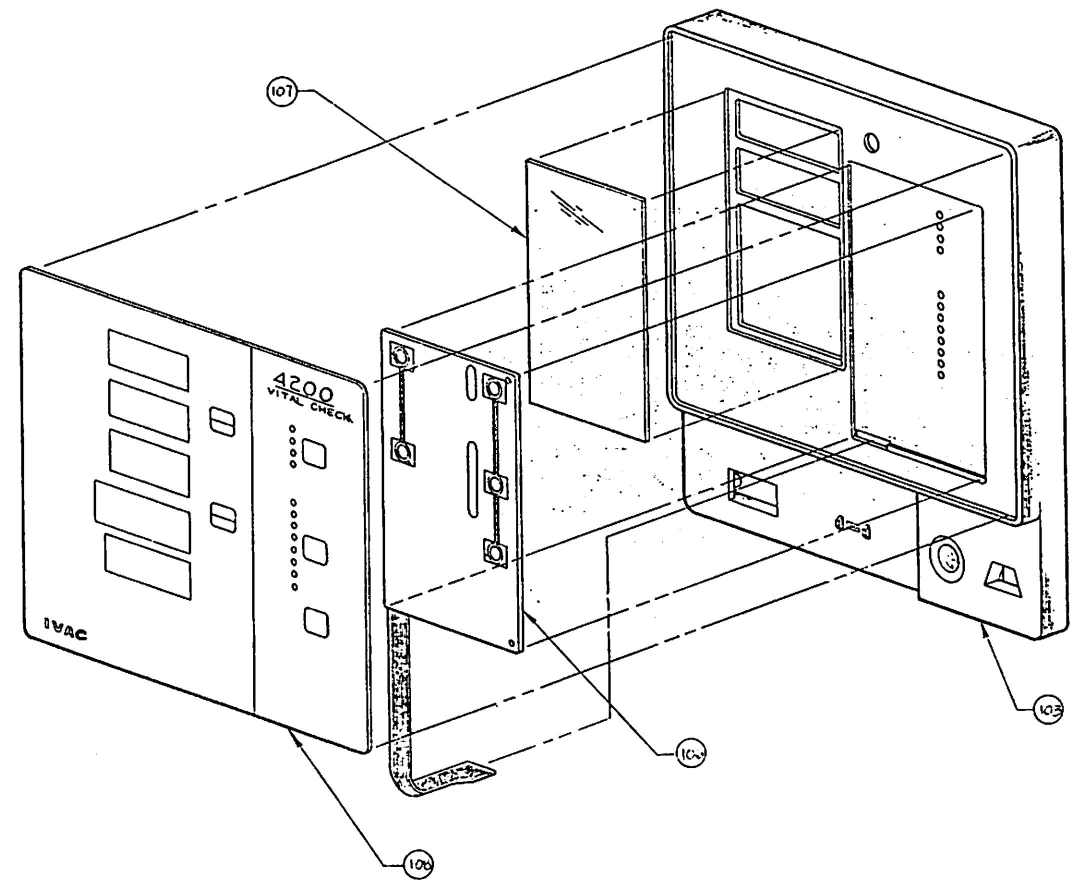


Figure 8-3. Front Case Kit (Item 11)

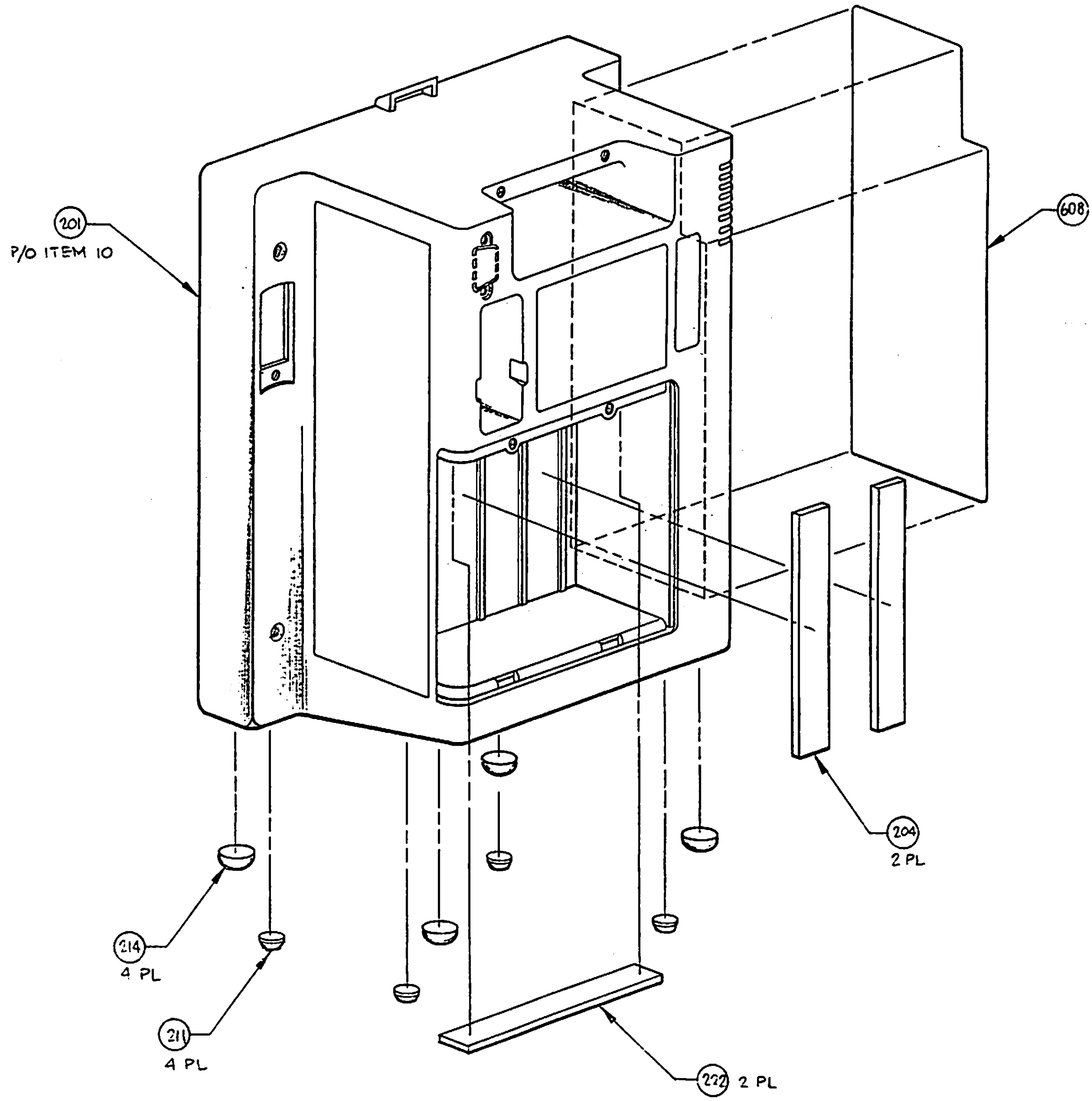


Figure 8-4. Rear Case Kit (Item 10)

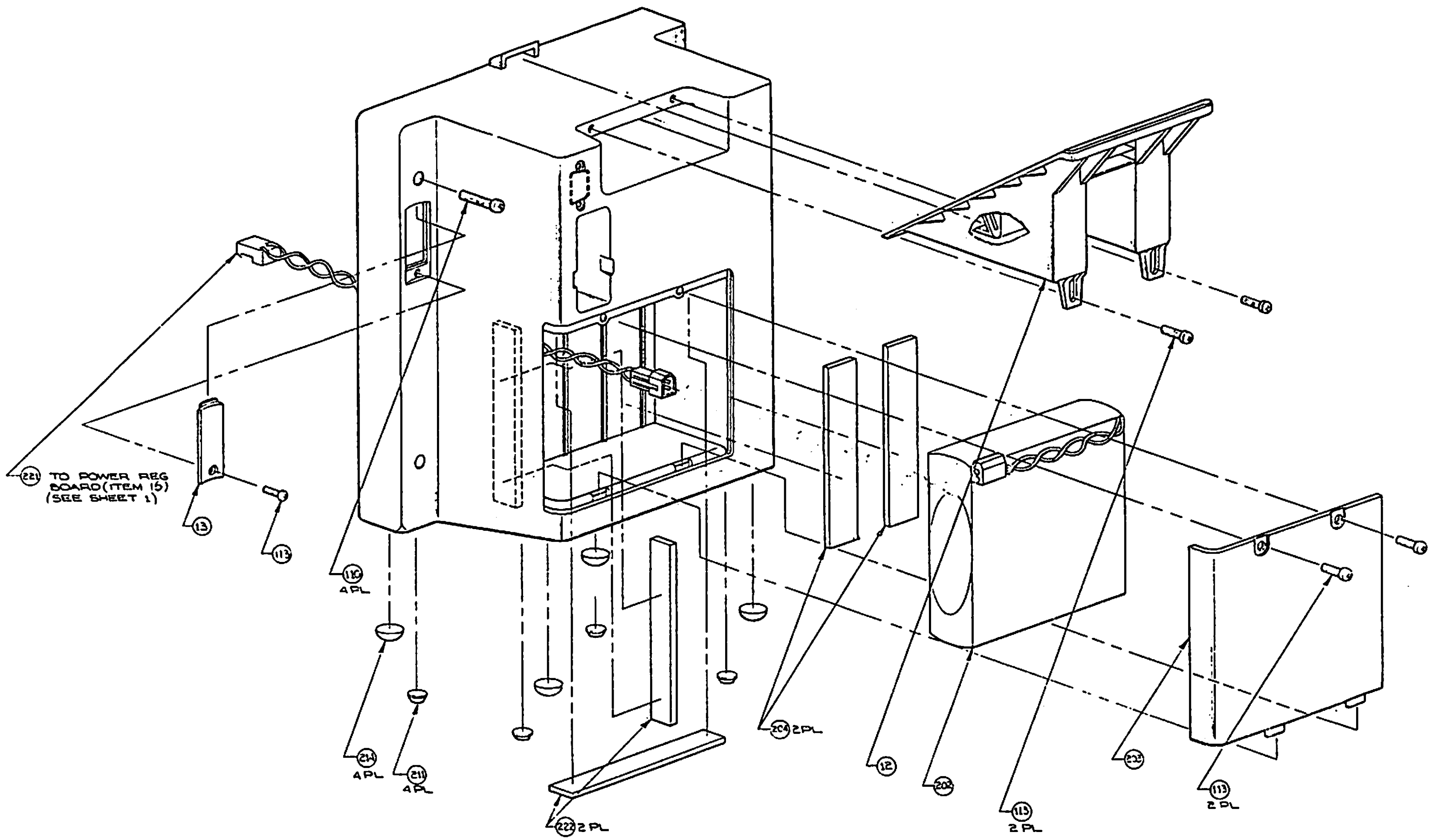


Figure 8-5A. Final Instrument Assembly (Item 220)

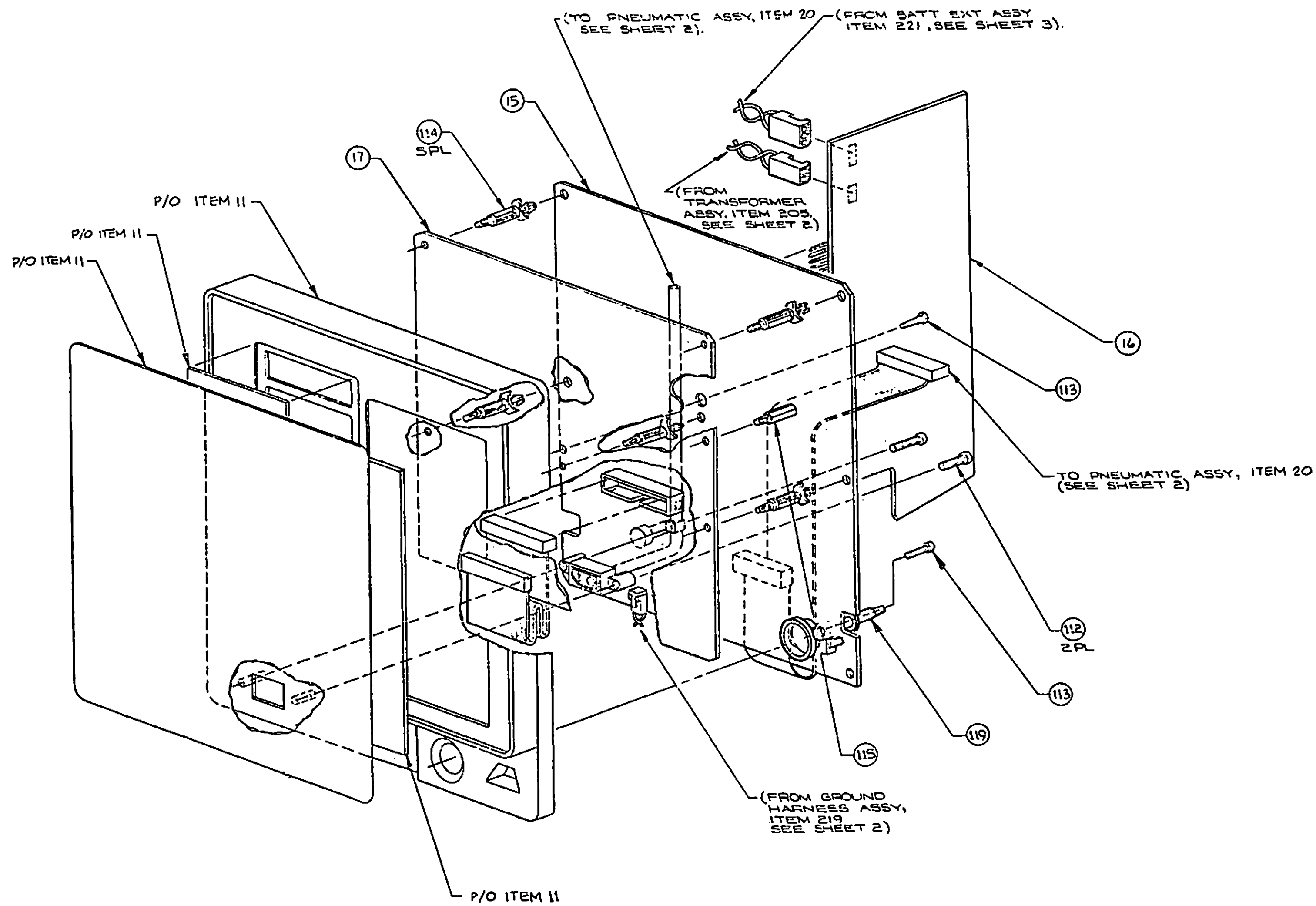


Figure 8-5B. Final Instrument Assembly

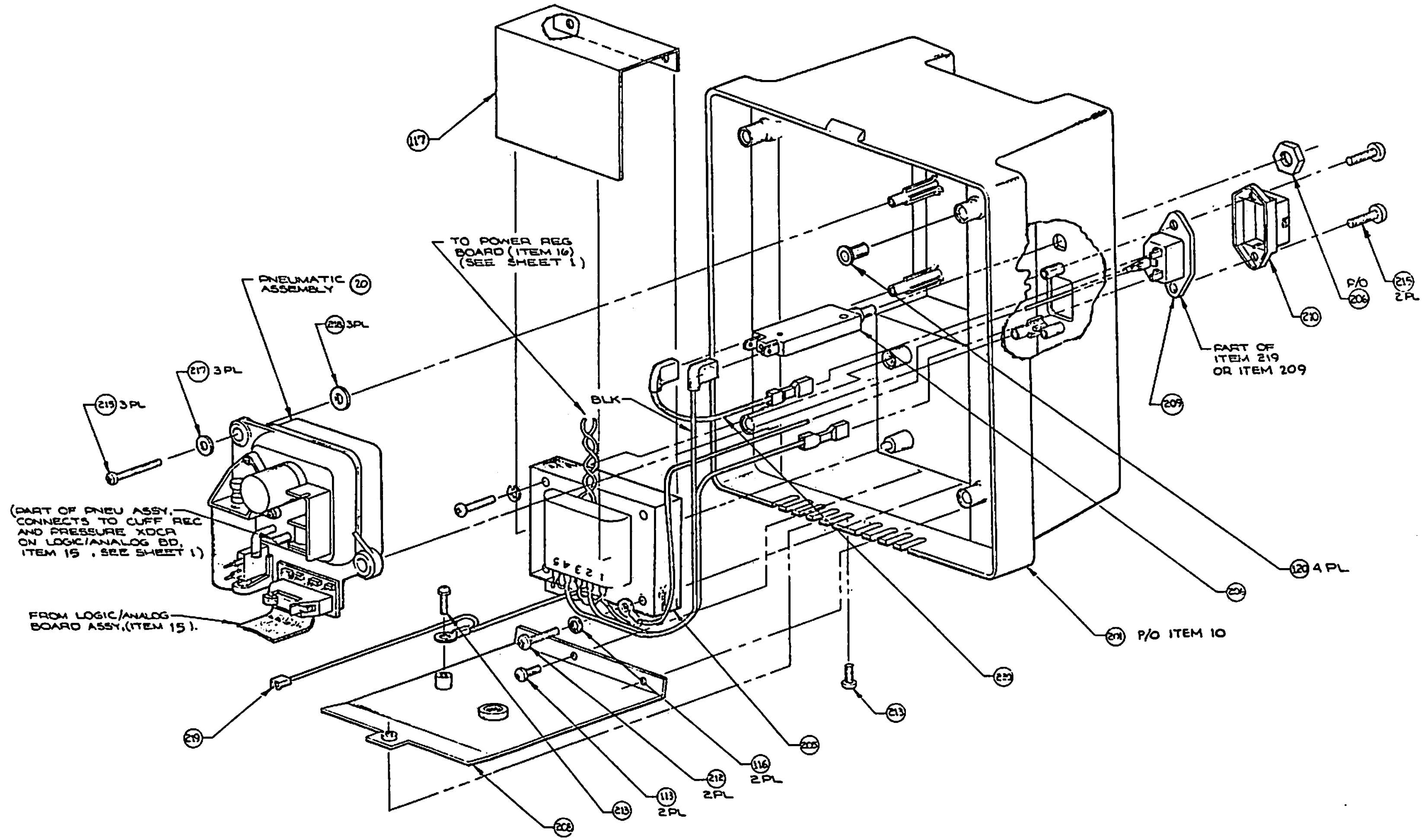


Figure 8-5C. Final Instrument Assembly

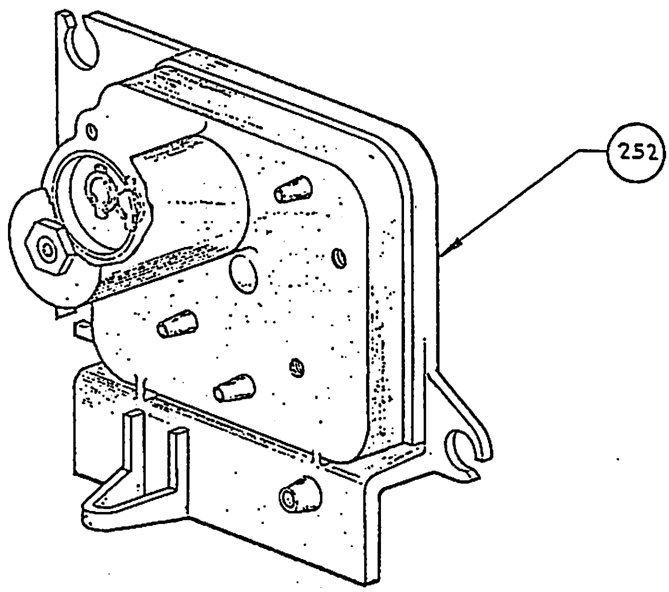


Figure 8-6. Manifold Assembly

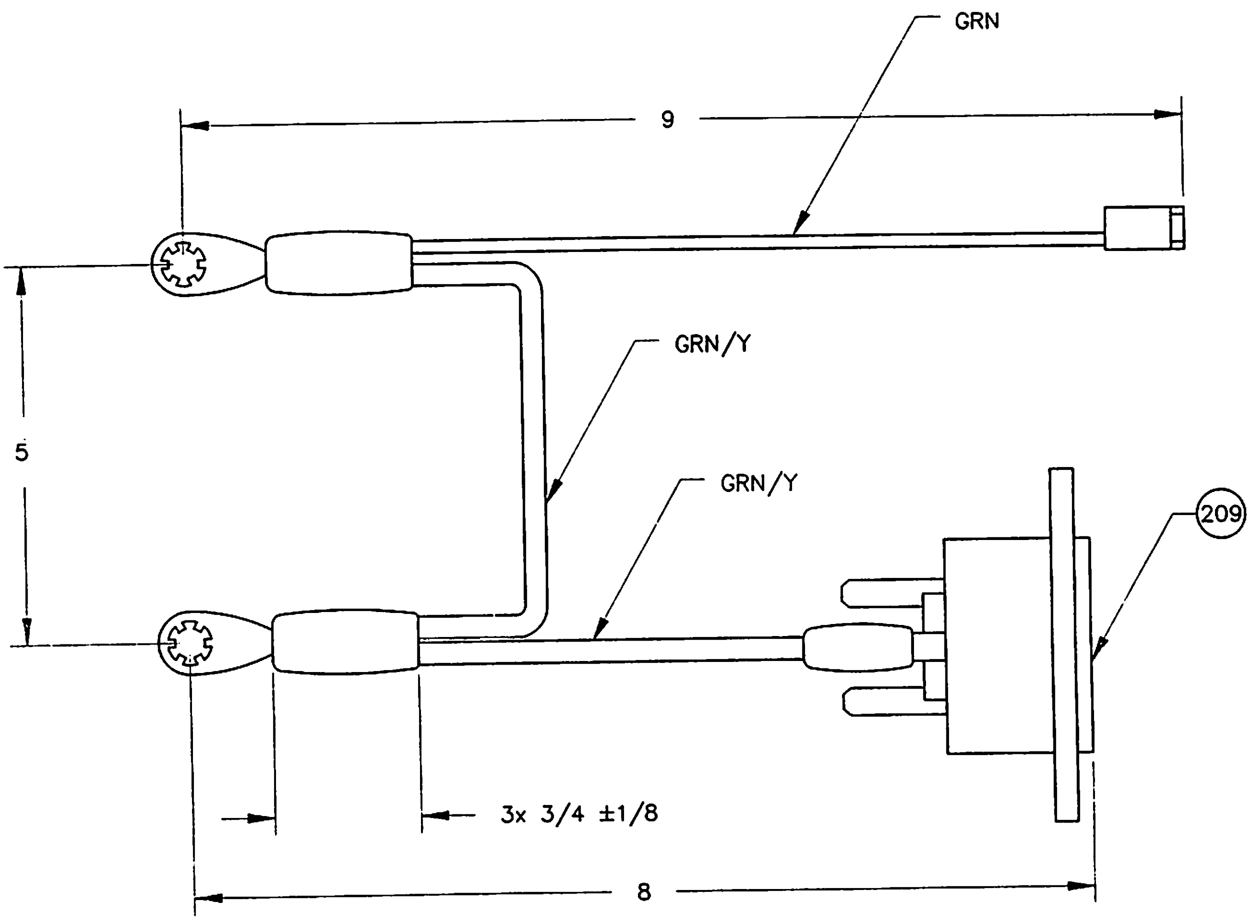


Figure 8-8. Ground Harness Assembly (Item 219)

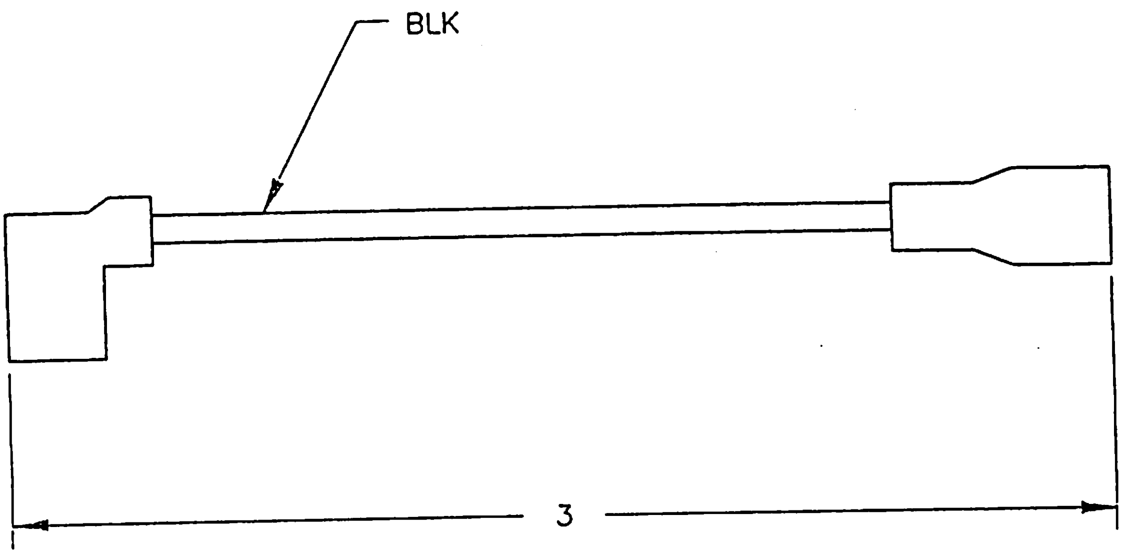


Figure 8-9. Power Harness Assembly (Item 220)

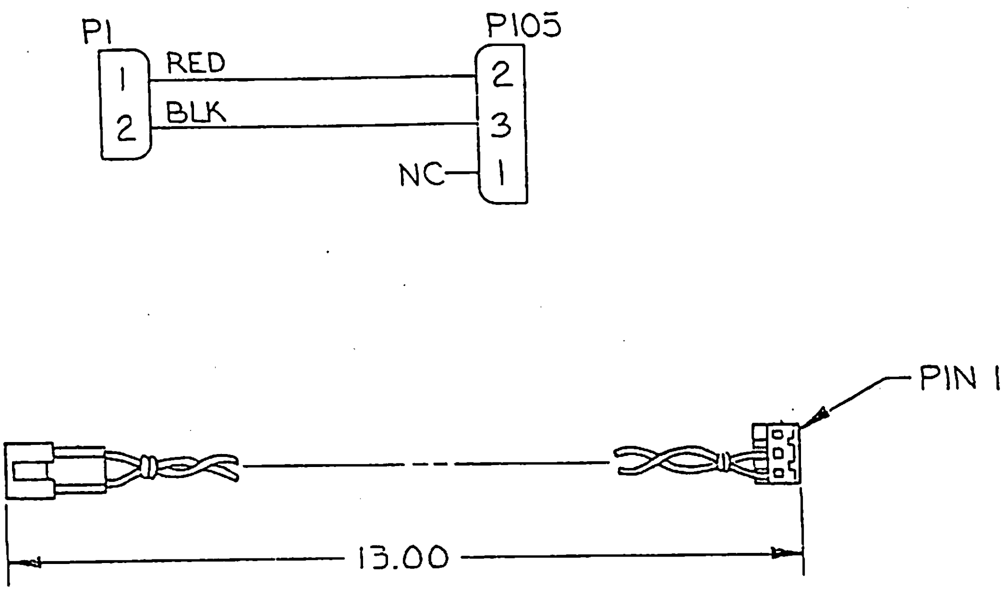


Figure 8-10. Battery Extension Harness Assembly (Item 221)

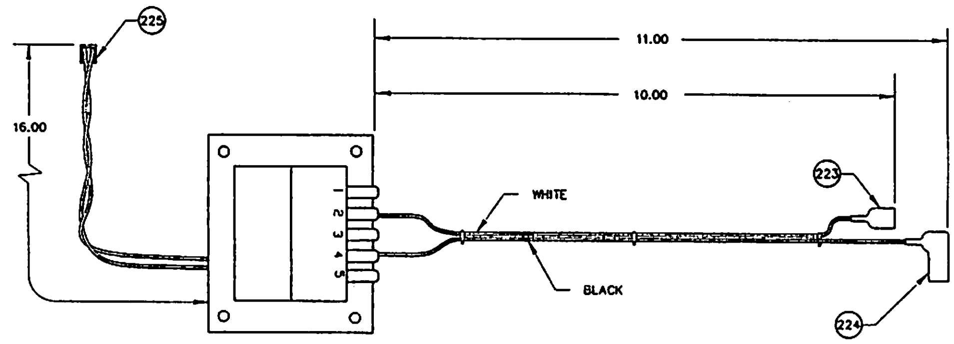


Figure 8-11. Transformer Assembly (Item 205)

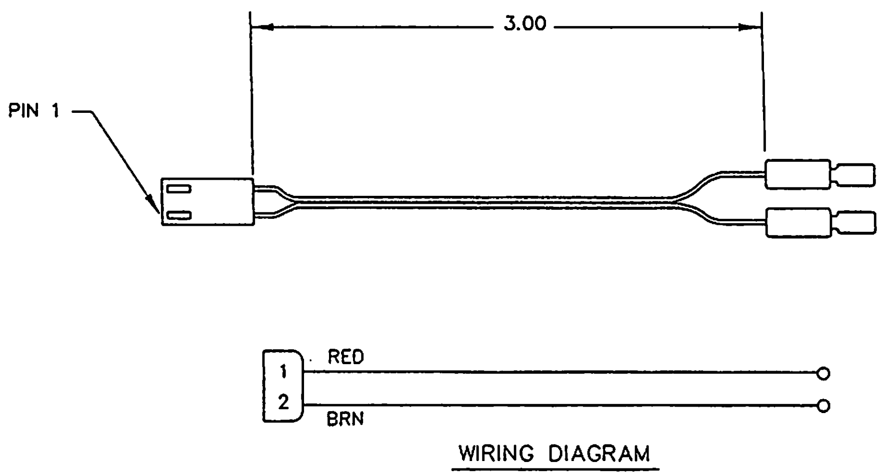


Figure 8-12. Pressure Harness Assembly (Item 268)

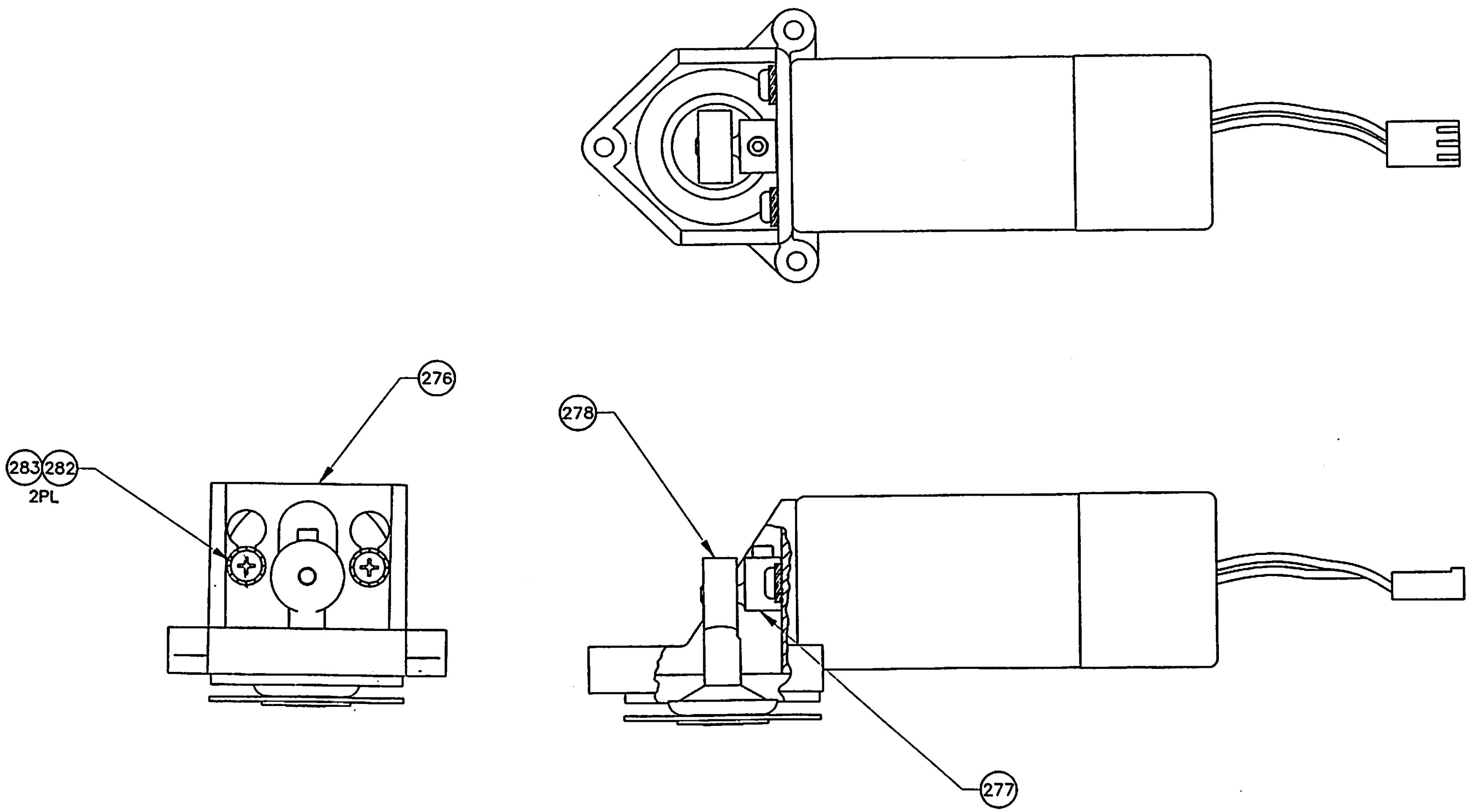


Figure 8-13. Pump Assembly

ITEM	PART NUMBER	DESCRIPTION	QTY	ISS UOM	REF DES
	*	ASSY,FINAL,4200			
003	132400	MEMORY ASSY	1	EA	
010	132401	REAR CASE ASSY	1	EA	
011	132402	FRONT CASE ASSY	1	EA	
012	131298	TBL,WRIT	1	EA	
013	132381	COVER,TE	1	EA	
015	132403	KIT,ASSY,LGC/ANALOG BD	1	EA	
016	131090	ASSY,PWR,REG BD	1	EA	
017	131070	ASSY,DSP/THERM BD	1	EA	
020	*	PNEUMATIC ASSY	0	EA	
021	132405	RESERVOIR ASSY (ITEMS 251,252, 258,260)	1	EA	
103	*	CASE,FRT	1	EA	
106	*	SW,MEMB	1	EA	
107	*	WINDOW,D	1	EA	
108	*	OVLY,SW	1	EA	
110	300361	SCREW,MA	4	EA	
112	303821	SCREW,MA	2	EA	
113	303822	SCREW,TR	11	EA	
114	303810	SP,PCB,S	5	EA	
115	303811	SP,PCB,S	1	EA	
116	300037	WASHER	1	EA	
117	132367	TRANSFORMER SHIELD	1	EA	
119	303926	DUCKBILL CHECK VALVE	1	EA	
120	303884	BRASS INSERT	4	EA	
201	*	CASE,REAR	1	EA	
202	124373	BATT PAC CHARGED	1	EA	
203	131309	COVER,BA	1	EA	
204	127149	PAD,TOP	2	EA	
205	131119	ASSY,HAR,TRANSFORMER	1	EA	
206	302587	CKT BKR,	1	EA	
208	131438	BKT,MTG	1	EA	
209	303250	PWR CORD CONNECTOR	1	EA	
210	303249	ADPT,IEC	1	EA	
211	303724	BUMPER,R	4	EA	
212	300374	SCREW,MA	2	EA	
213	301696	SCREW,MA	2	EA	
214	303848	BUMPER,R	4	EA	
215	303823	SCREW,TR	3	EA	
217	303806	WSHR,FL	3	EA	
218	303807	WSHR,FL	3	EA	
219	131117	ASSY,HAR GROUND	1	EA	

*Parts listed without an assigned part number are not sold as individual parts.

ITEM	PART NUMBER	DESCRIPTION	QTY	ISS UOM	REF DES
220	131343	ASSY,HAR PWR	1	EA	
221	130978	ASSY,HAR BATTERY	1	EA	
222	127373	PAD,TOP	2	EA	
223	303449	TERM,XFRM	1	EA	
224	303267	TERM,XFRM	1	EA	
225	303015	CONNECTOR,XFRM	1	EA	
251	131311	BASE,RES	1	EA	
252	132406	MANIFOLD ASSY	1	EA	
253	132407	KIT,ASSY,PUMP	1	EA	
254	132408	KIT,ASSY,LEA	1	EA	
255	*	CHECK VA	1	EA	
256	*	RING,RET	1	EA	
257	303350	PRES SNS	1	EA	
258	303813	O-RING,2	1	EA	
259	303812	GROMMET	3	EA	
260	131495	GASKET,P	1	EA	
261	303109	TBG,SIL	1.5	FT	
262	303841	SCREW,MA	1	EA	
263	303823	SCREW,TR	3	EA	
264	302593	FITTING	1	EA	
265	*	VALVE,SO	1	EA	
266	303655	SCREW,TR	4	EA	
267	131085	ASSY,PNE TRAN BD	1	EA	
268	131344	ASSY,HAR OVP SENSOR	1	EA	
276	*	BKT,MOTO	1	EA	
277	*	ECCENTRIC	1	EA	
278	*	PISTON,4	1	EA	
282	303819	SCREW,MA	2	EA	
283	303824	WSHR,EXT	2	EA	
603	125569	LBL,S/N,REPLACEMENT	1	EA	
606	132319	LBL,NAME	1	EA	
608	131875	LBL,OPER	1	EA	
613	125569	LBL,S/N	0	EA	
641	131876	LBL,TRBS	1	EA	
701	132425	BOX,SHPG	1	EA	
702	132426	FOAM,SHP	1	EA	
703	132427	FOAM,SHP	1	EA	
705	303286	CORD,PWR	1	EA	
717	127335	TABLET	5	EA	

*Parts listed without an assigned part number are not sold as individual parts.

NOTES (UNLESS OTHERWISE SPECIFIED):

3. INSTALL CABLE TIE (ITEM 148) THRU BOARD AT LOCATIONS SHOWN, AND AROUND CAP (ITEM 44). POSITION CABLE TIE (ITEM 148) SUCH THAT CONNECTION OF CABLE ENDS ARE ON THE INBOARD SIDE OF THE CAP (ITEM 44), AND ON THE COMPONENT SIDE OF THE BOARD.

4. APPLY SILICONE BETWEEN TRANSISTORS (ITEM 21) AND HEATSINKS (ITEM 147), PRIOR TO INSTALLATION OF FASTENERS (ITEMS 152, 153).

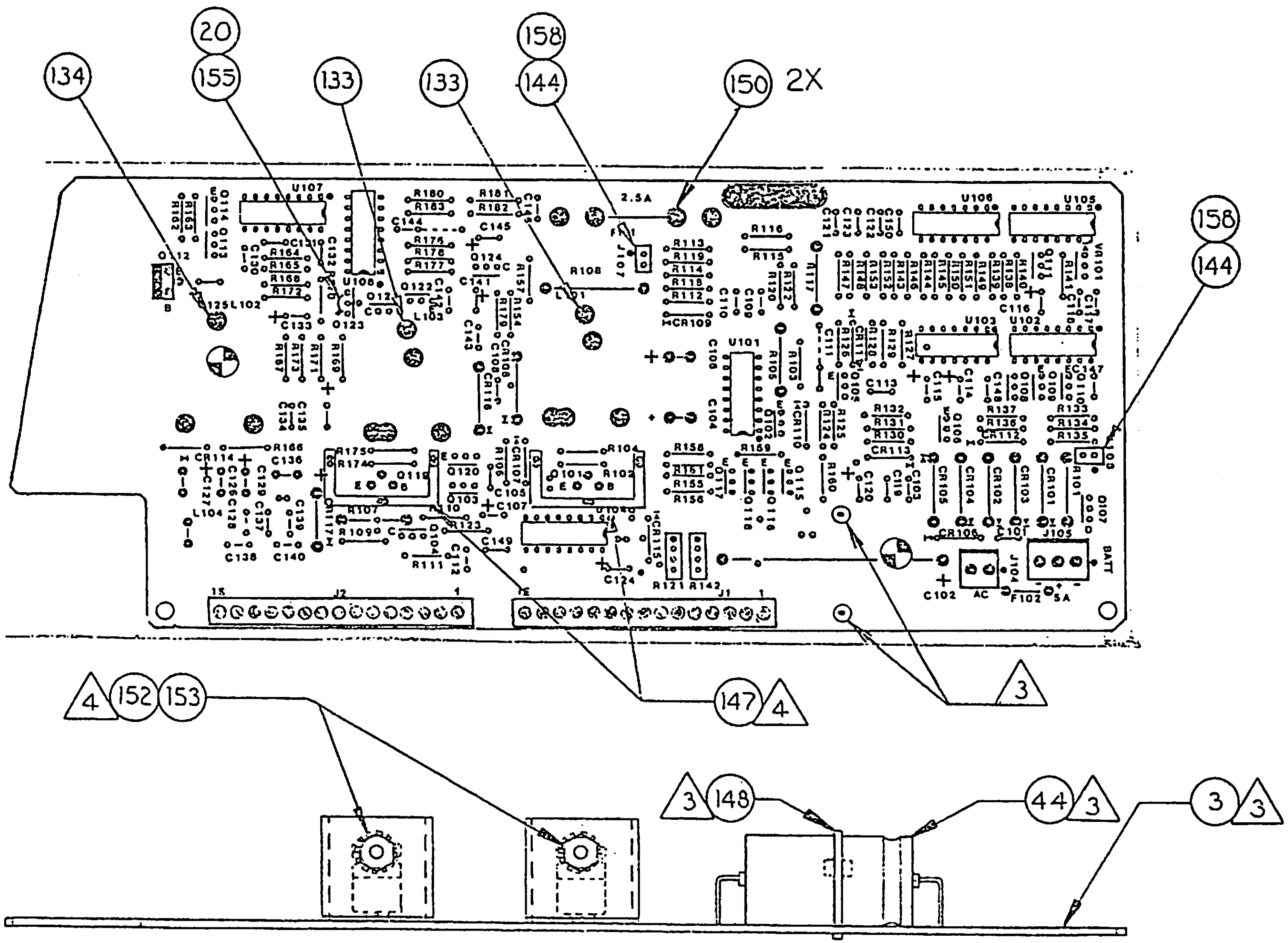


Figure 8-14. Power Regulator Board (Item 16)

ITEM	PART NUMBER	DESCRIPTION	QTY	ISS UOM	REF DES
016	131090	ASSY,PWR REG BD,4200(SEE FIG 8-5B)	1	EA	DWG010
010	302196	IC,TL494 VOLT REG 16 DIP	3	EA	U101
					U107
					U108
011	302524	IC,CD4027BE J-K FL-FL 16 DIP	1	EA	U102
012	302123	IC,4093B CMOS 2-IN NAND 14 DIP	1	EA	U103
013	302060	IC,4049 CMOS INV BFR 16 DIP	1	EA	U104
014	301753	IC,LM339N VOLT COMP 14 DIP	1	EA	U106
017	302939	XSTR,CA3096AE	1	EA	U105
018	302422	XSTR,SD1117	2	EA	Q107
					Q111
019	302566	XSTR,MPSA14	1	EA	Q122
020	303131	XSTR,2N5783	1	EA	Q123
021	301553	XSTR,6109	3	EA	Q101
					Q112
					Q119
022	302455	XSTR,PN2907A	5	EA	Q102
					Q108
					Q110
					Q113
					Q120
023	301551	XSTR,3569	7	EA	Q104
					Q105
					Q106
					Q109
					Q114
					Q121
					Q124
024	303091	XSTR,VP0106N3	1	EA	Q103
025	301928	XSTR,MPS/NP/PN/2222A(+)	2	EA	Q117
					Q118
026	302639	XSTR,2N6727	2	EA	Q115
					Q116
030	302424	DIODE,VOLT REF LM385BZ	1	EA	VR101
031	301453	DIODE,SW IN4148	4	EA	CR107
					CR110
					CR111
					CR112
032	302046	DIODE,RECT IN4004	1	EA	CR115
033	302163	DIODE,ZENER IN4689/LVA351A	1	EA	CR113
034	300585	DIODE,ZENER IN474D	1	EA	CR106
035	302941	DIODE,RECT MR504	4	EA	CR101
					CR102
					CR103
					CR104
036	302940	DIODE,RECT MR501	1	EA	CR105
037	302942	DIODE,RECT MR850	1	EA	CR108
038	301550	DIODE,RECT IN4936	1	EA	CR114

ITEM	PART NUMBER	DESCRIPTION	QTY	ISS UOM	REF DES
039	303173	DIODE,SCHOTTKY IN5820	1	EA	CR116
040	303281	DIODE,ZENER TVS 315	1	EA	CR109
041	303171	DIODE,ZENER TVS 505	1	EA	CR117
044	303012	CAP,ELCT AX 2200UF 20% 50V	1	EA	C102
045	303013	CAP,ELCT AX 220UF 20% 25V	3	EA	C106
					C127
					C136
046	303211	CAP,ELCT 330UF 20% 16V	1	EA	C115
047	303384	CAP,ELCT 100UF 20% 50V	1	EA	C104
050	303404	CAP,ELCT 100UF 20% 25V	2	EA	C125
					C135
051	303478	CAP,CER .1UF 100VDC	1	EA	C101
052	302421	CAP,TANT 3.3UF 10% 50V	1	EA	C145
053	301057	CAP,TANT 1UF 10% 35V	2	EA	C107
					C120
054	301561	CAP,TANT .47UF 10% 50V	2	EA	C114
					C116
055	300519	CAP,TANT 10UF 20% 25V	3	EA	C124
					C129
					C133
056	301704	CAP,TANT 33UF 10% 25V	1	EA	C141
060	301979	CAP,CER .10UF 20% 50V	20	EA	C103
					C108
					C113
					C117
					C119
					C122
					C123
					C128
					C130
					C132
					C137
					C138
					C139
					C140
					C142
					C143
					C147
					C148
					C149
					C150
061	301978	CAP,CER .022UF 20% 50V	2	EA	C109
					C110
062	301977	CAP,CER .01UF 20% 50-500V	6	EA	C105
					C118
					C121
					C126
					C134
					C146

ITEM	PART NUMBER	DESCRIPTION	QTY	ISS UOM	REF DES
063	300305	CAP,CER DISC 220PF 20% 1KV	1	EA	C112
064	300400	CAP,CER DISC 330PF 10% 50V	1	EA	C131
069	302805	CAP,M POLY .01UF 5% 50V	2	EA	C111
					C144
074	300591	RES,CF 1/2W 1K 5%	1	EA	R101
075	301121	RES,CF 1/2W 560 OHMS 5%	1	EA	R117
076	302172	RES,CF 1/2W 620 OHMS 5%	1	EA	R107
077	302211	RES,CF 1/2W 2K 5%	1	EA	R105
080	303049	RES,WW PRCN 3W 0.25 OHMS 1%	1	EA	R108
087	300434	RES,MET F 1/4W 19.6K 1%	1	EA	R146
088	301349	RES,MET F 1/4W 309 OHMS 1%	1	EA	R145
089	301350	RES,MET F 1/4W 316 OHMS 1%	1	EA	R144
090	300486	RES,MET F 1/4W 100.0K 1%	1	EA	R139
091	303282	RES,MET F 1/4W 301.0K 1%	1	EA	R138
092	302263	RES,MET F 1/4W 20.0K 1%	1	EA	R170
093	303048	RES,MET F 1/4W 75.0K 1%	1	EA	R143
094	303046	RES,MET F 1/4W 4.99K 1%	1	EA	R171
096	302394	RES,MET F 1/4W 8.66K 1%	1	EA	R120
097	301547	RES,MET F 1/4W 6.04K 1%	2	EA	R113
					R180
098	302395	RES,MET F 1/4W 4.53K 1%	1	EA	R122
103	300105	RES,CF 1/4W 47 OHMS 5%	1	EA	R162
104	300109	RES,CF 1/4W 68 OHMS 5%	2	EA	R102
					R174
105	300124	RES,CF 1/4W 300 OHMS 5%	1	EA	R178
106	300129	RES,CF 1/4W 470 OHMS 5%	1	EA	R103
107	300132	RES,CF 1/4W 620 OHMS 5%	1	EA	R164
108	300137	RES,CF 1/4W 1.0K 5%	9	EA	R124
					R136
					R149
					R154
					R157
					R160
					R163
					R175
					R176
109	300147	RES,CF 1/4W 2.7K 5%	1	EA	R109
110	300148	RES,CF 1/4W 3.0K 5%	1	EA	R110
111	300153	RES,CF 1/4W 4.7K 5%	2	EA	R130
					R135
112	300133	RES,CF 1/4W 680 OHMS 5%	2	EA	R158
					R161
113	300139	RES,CF 1/4W 1.2K 5%	1	EA	R118
114	300143	RES,CF 1/4W 1.8K 5%	1	EA	R112

ITEM	PART NUMBER	DESCRIPTION	QTY	ISS UOM	REF DES
115	300154	RES,CF 1/4W 5.1K 5%	8	EA	R114
					R165
					R167
					R168
					R169
					R172
					R182
					R183
116	300161	RES,CF 1/4W 10K 5%	13	EA	R111
					R123
					R125
					R128
					R133
					R134
					R148
					R150
					R151
					R155
					R156
					R159
					R179
117	300177	RES,CF 1/4W 47K 5%	4	EA	R126
					R131
					R132
					R137
118	300170	RES,CF 1/4W 24K 5%	2	EA	R115
					R116
119	300151	RES,CF 1/4W 3.9K 5%	1	EA	R177
120	300185	RES,CF 1/4W 100K 5%	5	EA	R140
					R147
					R152
					R153
					R173
121	300178	RES,CF 1/4W 51K 5%	1	EA	R119
122	300172	RES,CF 1/4W 30K 5%	2	EA	R166
					R181
123	300200	RES,CF 1/4W 430K 5%	1	EA	R141
124	300209	RES,CF 1/4W 1M 5%	3	EA	R106
					R127
					R129
125	300173	RES,CF 1/4W 33K 5%	1	EA	R104
127	303800	POT, CERMET, 1K 10%, 0.5W	1	EA	R121
128	303799	POT, CERMET,TRIM, 20K 10% 0.5W	1	EA	R142
130	301680	FUSE,2.5A 250V NORM-BLO	1	EA	F101
131	303425	FUSE,SUB-MINI 5A 125V	1	EA	F102
133	127555	INDUCTOR, 300UH	2	EA	L101
					L103

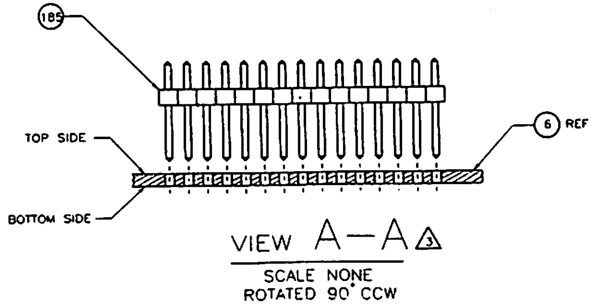
ITEM	PART NUMBER	DESCRIPTION	QTY	ISS UOM	REF DES
134	127556	INDUCTOR, 167UH	1	EA	L102
135	127557	INDUCTOR, 7UH	1	EA	L104
139	303856	TERM HDR,RTANG, 15P, .156 CTR	2	EA	J001 J002
141	302646	TERM HDR,3P FRICT LK 0.100C	2	EA	J103 J106
142	303016	TERM HDR,3P 0.156 CTR	1	EA	J105
143	303017	TERM HDR,2P 0.156 CTR	1	EA	J104
144	301578	TERM HDR,36/P 0.100 SP	1	EA	J107 J108
147	303361	HEAT SINK,H:0.95 FOR PLSTC	2	EA	
149	301044	TIE STRAP,CBL 0.62-1.25 MAX	1	EA	
150	303164	CLIP,FUSE PC/TABS 0.250 DIA	2	EA	
152	300330	SCREW,MACH 6-32X1/4 PNH PHH	2	EA	
153	300036	NUT,KEP 6-32 S PL	2	EA	
155	303394	INSUL,TRANS,FOR3/4 LEAD TO-5	1	EA	
158	302547	JMPR,L:0.200 W:0.100 H:0.270	2	EA	P107 P108

NOTES (UNLESS OTHERWISE SPECIFIED):

1. Item numbers refer to logic board components.
2. Install J5 (item 185) with longer pins soldered to logic/analog board.

HIGHEST REFERENCE DESIGNATOR USED								
U50	R131	C106	RN8	CR35	P1	LS2	Q19	VR2
J82	DS1	Y2	S2	J10				

REFERENCE DESIGNATOR NOT USED								
R58	R62	R68	R88	R89	R103	CR20	CR21	
R122-R130	CR8-CR11	CR14-CR16	CR25-CR27					



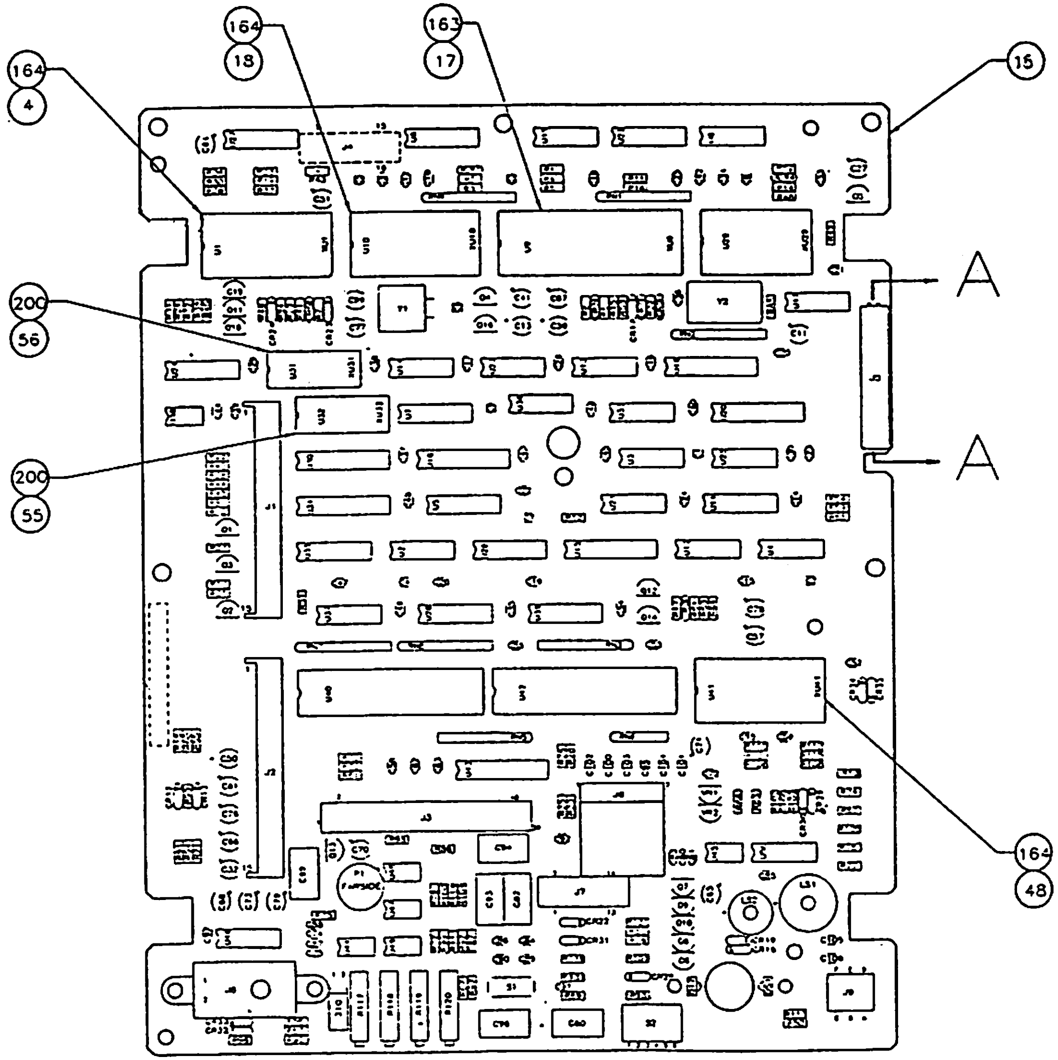


Figure 8-15. Logic/Analog Board (Item 015)

ITEM	PART NUMBER	DESCRIPTION	QTY	ISS UOM	REF DES
015	132403	KIT ASSY LOGIC BD (SEE FIG 8-5B)	1	EA	DWG010
004	132400	W/REV4 150006 KIT	1	EA	U001
005	131524	PARTS,CIMII,LGC/ANLG,4200 (SEE APPENDIX A)	AR	EA	
011	302961	IC,2-IN OR 14 DIP 74HC32	1	EA	U002
012	301557	IC,4001 CMOS 2-INP NR 14 DIP	1	EA	U003
013	302694	IC,2-IN NAND 14 DIP 74CH00	2	EA	U004 U012
104	302759	IC,74CH139 CMOS 16 DIP	1	EA	U005
015	302760	IC,74HC08 CMOS 2/AND 14 DIP	1	EA	U006
016	302130	IC,40174B CMOS FL/FL 16 DIP	1	EA	U007
017	302756	IC,MSC80C85A MICROPROC. 40 DIP	1	EA	U009
018	303639	IC,CMOS RAM 8KX8 28 DIP	1	EA	U010
019	302962	IC,DCDR/DEMUX 16 DIP 74HC138	1	EA	U011
020	301631	IC,4025 CMOS 3-INP NOR 14 DIP	1	EA	U013
021	303257	IC,74HC245 XCVR 20 DIP	2	EA	U016 U030
022	125007	IC,CMOS,7 STAGE BINARY COUNTER	1	EA	U017
033	302964	IC,BUFFER H 20 DIP 74HC244N	3	EA	U015 U018 U020
034	301558	IC,4011 CMOS 2-INP NAND 14 DIP	1	EA	U019
035	303258	IC,74HC74 D FL/FL 14 DIP	1	EA	U021
036	301968	IC,4020B CMOS CNTR/DIV 16 DIP	1	EA	U022
037	302123	IC,4093B CMOS 2-IN NAND 14 DIP	3	EA	U023 U033 U036
038	302252	IC,4040B CMOS CNTR/DIV 16 DIP	3	EA	U008 U024 U026
039	301632	IC,4013B CMOS FL/FL 14 DIP	1	EA	U025
040	302635	IC,4052B CMOS 16 DIP	1	EA	U027
041	302060	IC,4049 CMOS INV BFR 16 DIP	2	EA	U028 U039
042	303849	IC,74HCT04A,HEX INVERT,14 PIN	1	EA	U014
043	303850	IC,74HCT138,3-8 DECODE,16 PIN	1	EA	U035
044	302695	IC,H SP LTCH 20 DIP 74HC373	1	EA	U034
045	302960	IC,2-IN NOR 14 DIP 74HC02	1	EA	U037
046	302369	IC,LM393N VOLT COMP 8 DIP	1	EA	U038
047	302629	IC,8255A PRPHL INTFC 40 DIP	2	EA	U040 U042
048	302385	IC,ADC0809N A/D CONV 28 DIP	1	EA	U041
049	302628	IC,AM6012PC/DC D/A CONV 20 DIP	1	EA	U043

ITEM	PART NUMBER	DESCRIPTION	QTY	ISS UOM	REF DES
050	302995	IC,CA3193AE OPAMP 8 DIP	4	EA	U044
					U047
					U048
					U049
051	302016	IC,LM358N OPAMP 8 DIP	1	EA	U045
052	302631	IC,LF444CN JFET OPAMP 14 DIP	1	EA	U046
053	301554	IC,LM324NA OPAMP 14 DIP	1	EA	U050
055	132212	PLD,MODE STATE MACHINE,4200	1	EA	U032
056	132210	PLD,PRESS STATE MACHINE,4200	1	EA	U031
066	300161	RES,CF 1/4W 10K 5%	22	EA	R001
					R003
					R004
					R005
					R006
					R009
					R011
					R012
					R016
					R020
					R025
					R026
					R028
					R032
					R038
					R040
					R044
					R048
					R049
					R053
					R086
					R095
067	300146	RES,CF 1/4W 2.4K 5%	1	EA	R002
068	300153	RES,CF 1/4W 4.7K 5%	5	EA	R010
					R033
					R036
					R052
					R077
069	300135	RES,CF 1/4W 820 OHMS 5%	1	EA	R072
070	300194	RES,CF 1/4W 240K 5%	2	EA	R015
					R107
071	300209	RES,CF 1/4W 1M 5%	1	EA	R096
072	300193	RES,CF 1/4W 220K 5%	1	EA	R029

ITEM	PART NUMBER	DESCRIPTION	QTY	ISS UOM	REF DES
073	300401	RES,MET F 1/4W 1.0K 1%	6	EA	R030
					R035
					R066
					R101
					R112
					R115
074	302976	RES,MET F 1/4W 26.7K 1%	1	EA	R023
075	302972	RES,MET F 1/4W 13.7K 1%	1	EA	R019
076	300432	RES,MET F 1/4W 25.5K 1%	1	EA	R024
077	301548	RES,MET F 1/4W 15.8K 1%	1	EA	R031
078	300113	RES,CF 1/4W 100 OHMS 5%	2	EA	R042
					R045
079	300137	RES,CF 1/4W 1.0K 5%	8	EA	R021
					R027
					R047
					R051
					R102
					R108
					R113
					R121
080	302618	RES,MET F 1/4W 15.0K 1%	2	EA	R034
					R043
081	300126	RES,CF 1/4W 360 OHMS 5%	1	EA	R017
082	302977	RES,MET F 1/4W 45.3K 1%	1	EA	R037
083	300189	RES,CF 1/4W 150K 5%	1	EA	R022
084	302395	RES,MET F 1/4W 4.53K 1%	2	EA	R061
					R087
085	301450	RES,MET F 1/4W 8.25K 1%	1	EA	R063
086	302255	RES,MET F 1/4W 1.78K 1%	1	EA	R064
087	300129	RES,CF 1/4W 470 OHMS 5%	6	EA	R054
					R055
					R059
					R060
					R065
					R093
088	300154	RES,CF 1/4W 5.1K 5%	1	EA	R070
089	300144	RES,CF 1/4W 2.0K 5%	1	EA	R081
090	303047	RES,MET F 1/4W 63.4K 1%	2	EA	R057
					R109
091	301993	RES,MET F 1/4W 56.2K 1%	1	EA	R090
092	300436	RES,MET F 1/4W 5.11K 1%	2	EA	R056
					R078
093	300152	RES,CF 1/4W 4.3K 5%	1	EA	R091
094	300191	RES,CF 1/4W 180K 5%	1	EA	R083
095	302392	RES,MET F 1/4W 3.01K 1%	1	EA	R073
096	301389	RES,MET F 1/4W 825 OHMS 1%	1	EA	R075

ITEM	PART NUMBER	DESCRIPTION	QTY	ISS UOM	REF DES
097	300185	RES,CF 1/4W 100K 5%	4	EA	R008
					R046
					R074
					R079
098	301989	RES,MET F 1/4W 12.1K 1%	2	EA	R098
					R100
099	300404	RES,MET F 1/4W 10.0K 1%	5	EA	R071
					R092
					R104
					R111
					R114
100	302817	RES,MET F 1/4W 38.8K 1%	1	EA	R116
101	302372	RES,MET F 1/4W 90.9K 1%	1	EA	R080
102	300195	RES,CF 1/4W 270K 5%	1	EA	R105
103	300105	RES,CF 1/4W 47 OHMS 5%	3	EA	R041
					R076
					R110
104	300183	RES,CF 1/4W 82K 5%	1	EA	R106
105	300169	RES,CF 1/4W 22K 5%	1	EA	R131
106	302699	RES,JMPR 0 OHM 2.5A MAX	1	EA	R067
107	300187	RES,CF 1/4W 120K 5%	1	EA	R082
108	300177	RES,CF 1/4W 47K 5%	2	EA	R039
					R069
109	300093	RES,CF 1/4W 15 OHMS 5%	2	EA	R084
					R085
110	300178	RES,CF 1/4W 51K 5%	1	EA	R050
111	300089	RES,CF 1/4W 10 OHMS 5%	2	EA	R013
					R018
112	300173	RES,CF 1/4W 33K 5%	1	EA	R094
113	300197	RES,CF 1/4W 330K 5%	1	EA	R007
114	302460	RES NTWK,6 SIP 5R 10K 2%	1	EA	RN006
115	302327	RES NTWK,10 SIP 9R 4.7K 2%	1	EA	RN002
116	302297	RES NTWK,10 SIP 9R 10K 2%	6	EA	RN001
					RN003
					RN004
					RN005
					RN007
					RN008
117	300517	RES,MET F 1/4W 30.1K 1%	1	EA	R097
118	301357	RES,MET F 1/4W 374 OHMS 1%	1	EA	R099
127	302623	POT, CERMET 1K 10% 0.75W	2	EA	R117
					R119
128	300982	POT,TRIM 10K 10% 0.75W	1	EA	R118
129	302624	POT,CERMET 50K 10% 0.75W	1	EA	R120

ITEM	PART NUMBER	DESCRIPTION	QTY	ISS UOM	REF DES
130	301453	DIODE,SW IN4148	19	EA	CR001
					CR002
					CR003
					CR005
					CR006
					CR007
					CR012
					CR013
					CR017
					CR018
					CR019
					CR023
					CR024
					CR028
					CR029
					CR030
					CR031
					CR032
					CR033
131	302424	DIODE,VOLT REF LM385BZ	1	EA	VR001
132	301928	XSTR,MPS/NP/PN/2222A(+)	9	EA	Q001
					Q004
					Q005
					Q008
					Q009
					Q010
					Q012
					Q014
					Q018
133	302455	XSTR,PN2907A	2	EA	Q006
					Q013
134	302639	XSTR,2N6727	2	EA	Q003
					Q007
135	302422	XSTR,SD1117	4	EA	Q002
					Q011
					Q016
					Q019
136	303865	XSTR,LTP-80A-4,PHOTO,NPN	1	EA	Q017
137	302046	DIODE,RECT IN4004	1	EA	CR022
138	302197	DIODE,IN5817	2	EA	CR034
					CR035
139	302149	IC,78L05	1	EA	VR002
147	301823	CAP,TANT 2.2UF 10% 50V	1	EA	C056

ITEM	PART NUMBER	DESCRIPTION	QTY	ISS UOM	REF DES
148	301979	CAP,CER .10UF 20% 50V	60	EA	C001
					C002
					C004
					C005
					C007
					C008
					C009
					C010
					C012
					C014
					C015
					C016
					C017
					C018
					C019
					C020
					C021
					C022
					C023
					C024
					C025
					C026
					C028
					C029
					C030
					C031
					C034
					C035
					C036
					C037
					C038
					C039
					C040
					C043
					C044
					C045
					C046
					C047
					C048
					C049
					C053
					C054
					C055
					C059
					C062
					C063
					C074
					C075

ITEM	PART NUMBER	DESCRIPTION	QTY	ISS UOM	REF DES
					C080
					C081
					C085
					C086
					C087
					C088
					C089
					C090
					C091
					C092
					C095
					C097
149	301979	CAP,CER .10UF 20% 50V	2	EA	C003
					C052
150	302435	CAP,CER DISC 180F 10% 500/1KV	1	EA	C006
151	300519	CAP,TANT 10UF 20% 25V	16	EA	C011
					C013
					C027
					C032
					C050
					C051
					C057
					C061
					C065
					C066
					C068
					C073
					C076
					C078
					C079
					C099
152	302490	CAP,CER .01UF 20% 50V	4	EA	C058
					C072
					C083
					C084
154	301092	CAP,M POLY AX .047UF 5% 200V	1	EA	C069
155	301057	CAP,TANT 1UF 10% 35V	5	EA	C041
					C064
					C067
					C070
					C071
156	301413	CAP,TANT 33UF 10% 10V	1	EA	C077
157	300295	CAP,M POLY AX .10UF 10% 200V	4	EA	C082
					C093
					C094
					C096
158	300294	CAP,M PLY AX .47UF 10% 50/100V	1	EA	C060
159	302530	CRYSTAL,QTZ 6.0MHZ 76F838/MP-1	1	EA	Y001

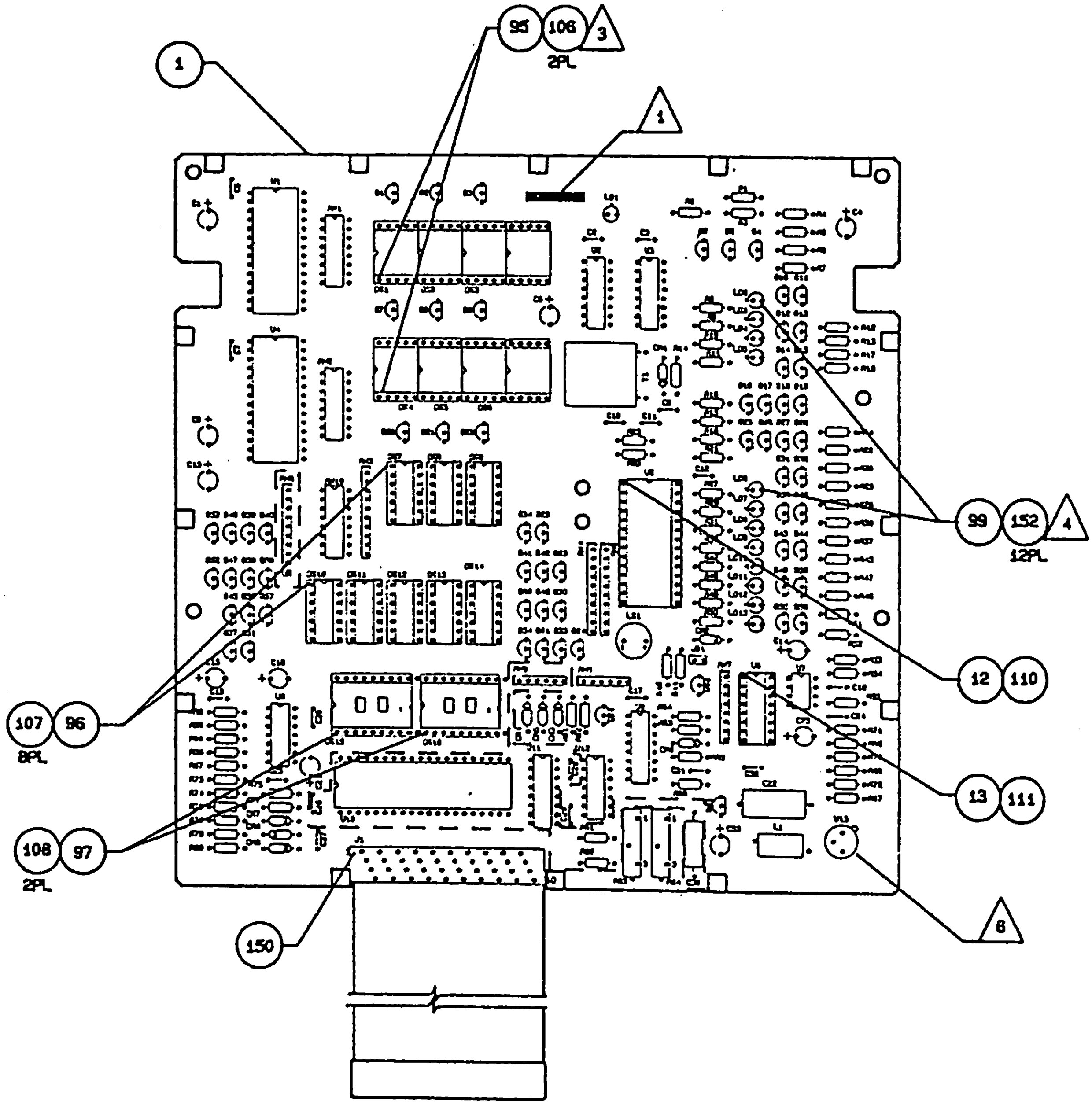
ITEM	PART NUMBER	DESCRIPTION	QTY	ISS UOM	REF DES
160	302452	XDCR,AUD PC MNT	1	EA	LS002
161	302529	XDCR,AUD QMB-06	1	EA	LS001
162	303393	INSUL,CAP CK06	2	EA	
163	302158	SKT,IC 40/DIP L PF TIN	1	EA	XU009
164	302157	SKT,IC 28/DIP L PF TIN	2	EA	XU001 XU010
165	303158	TERM HDR,M 40P .100 T SP	1	EA	J003
166	302965	CAP,MONO CER .047YF 10% 50V	1	EA	C042
176	131254	XDCR,PRES,LOW SPAN,4KA	1	EA	P001
177	303833	SW,MINI SLIDE,DPDT	1	EA	S001
178	303835	SW,PIANO DIP,6P,SIDE ACTUATED	1	EA	S002
179	302547	JMPR,L:0.200 W:0.100 H:0.270	2	EA	
182	303864	DIODE,IR EMIT,IRL-80A	1	EA	DS001
183	303857	TERM HDR SKT,REAR,15P, .156 CTR	2	EA	J001 J002
185	303832	TERM HDR SKT,30P,.100 CTR	1	EA	J005
186	303834	CONN,FLAT FLX CBL,7P,.1 CTR	1	EA	J006
198	301010	CONN,PC 3/C 0.150 CTR	1	EA	J009
199	131455	REC,CUFF,4200	1	EA	J008
200	302680	SKT,IC 20/DIP L PF TIN	2	EA	XU031 XU032
202	131359	HSG,SNSR,PROBE,4200	1	EA	
203	303527	TERM HDR,RTANG 2.P .100 CTR	1	EA	J010
204	131345	HARN,PNEU CTRL,4200	1	EA	J007

NOTES (UNLESS OTHERWISE SPECIFIED):

3. DS1-DS6 (ITEM 95) SHALL BE INSTALLED IN SOCKETS XDS1, XDS4 (ITEM 106).

4. LD2-LD13 (ITEM 99) SHALL BE INSTALLED IN SPACERS (ITEM 152).

6. RAISE U13 (ITEM 20) 1/8 INCH +/- 1/16 OFF BOARD.



COMPONENT SIDE

Figure 8-16. Display/Thermometer Board

ITEM	PART NUMBER	DESCRIPTION	QTY	ISS UOM	REF DES
017	131070	ASSY,DSPL/THERM BD,4200 (SEE FIG 8-5B)	1	EA	DWG010
010	302632	IC,MM74C912 CNTR/DRVR 28 DIP	2	EA	U001 U004
011	303850	IC,74HCT138,3-8 DECODE,16 PIN	2	EA	U002 U003
012	150010	IC,CPU,MASK PRGM,2K/4KA/1160	1	EA	U005
013	302448	IC,3162EX A/D CONV 16 DIP	1	EA	U006
014	302206	IC,CA3240 BIMOS OP AMP 8 DIP	1	EA	U007
015	302160	IC,4023B CMOS 3-IN NAND 14 DIP	1	EA	U008
016	302438	IC,CD40257BE CMOS 16 DIP	1	EA	U009
019	302761	IC,74HC04 14 DIP INVERTER	1	EA	U012
020	302451	IC,LM317H VOLT REG TO-5 OR 39	1	EA	U013
021	300161	RES,CF 1/4W 10K 5%	31	EA	R001 R002 R003 R004 R005 R006 R007 R012 R013 R015 R016 R017 R018 R019 R021 R022 R024 R025 R026 R028 R030 R037 R043 R047 R048 R051 R052 R058 R059 R061 R079

ITEM	PART NUMBER	DESCRIPTION	QTY	ISS UOM	REF DES
022	300133	RES,CF 1/4W 680 OHMS 5%	12	EA	R008
					R009
					R010
					R011
					R027
					R029
					R031
					R036
					R042
					R046
					R049
					R050
023	300185	RES,CF 1/4W 100K 5%	4	EA	R014
					R062
					R073
					R076
024	300137	RES,CF 1/4W 1.0K 5%	2	EA	R020
					R074
025	300209	RES,CF 1/4W 1M 5%	2	EA	R023
					R057
026	303000	RES NTWK,16 DIP 8R 82 OHMS 2%	1	EA	RN010
027	300177	RES,CF 1/4W 47K 5%	2	EA	R044
					R063
028	300145	RES,CF 1/4W 2.2K 5%	1	EA	R045
029	302429	RES,MET F 1/4W 4.42K 1%	1	EA	R053
030	300490	RES,MET F 1/4W 1.0M 0.1%	1	EA	R054
031	302445	RES,MET F 1/4W 138.600K 0.1%	1	EA	R055
032	300193	RES,CF 1/4W 220K 5%	4	EA	R056
					R065
					R075
					R077
033	300151	RES,CF 1/4W 3.9K 5%	1	EA	R060
034	300192	RES,CF 1/4W 200K 5%	2	EA	R064
					R078
035	300113	RES,CF 1/4W 100 OHMS 5%	1	EA	R066
036	301249	RES,MET F 1/4W 27.4 OHMS 1%	1	EA	R067
037	302442	RES,MET F 1/4W 2.80K 1%	1	EA	R068
038	302443	RES,MET F 1/4W 3.794K 0.1%	1	EA	R069
039	300131	RES,CF 1/4W 560 OHMS 5%	1	EA	R070
040	302441	RES,MET F 1/4W 1.91K 1%	1	EA	R071
041	301355	RES,MET F 1/4W 357 OHMS 1%	1	EA	R072
042	300178	RES,CF 1/4W 51K 5%	1	EA	R080
045	300982	POT,TRIM 10K 10% 0.75W	1	EA	R083
046	302624	POT,CERMET 50K 10% 0.75W	1	EA	R084
050	303001	RES NTWK,16 DIP 8R 56 OHMS 2%	1	EA	RN001
051	302999	RES NTWK,16 DIP 8R 68 OHMS 2%	1	EA	RN002
052	302297	RES NTWK,10 SIP 9R 10K 2%	2	EA	RN003
					RN006

ITEM	PART NUMBER	DESCRIPTION	QTY	ISS UOM	REF DES
053	302327	RES NTWK,10 SIP 9R 4.7K 2%	1	EA	RN004
054	302460	RES NTWK,6 SIP 5R 10K 2%	1	EA	RN005
055	302433	RES NTWK,8 SIP 7R 220K 2%	1	EA	RN007
060	302422	XSTR,SD1117	16	EA	Q001
					Q002
					Q003
					Q007
					Q008
					Q009
					Q020
					Q021
					Q022
					Q048
					Q054
					Q057
					Q060
					Q061
					Q063
					Q064

ITEM	PART NUMBER	DESCRIPTION	QTY	ISS UOM	REF DES
061	301928	XSTR,MPS/NP/PN/2222A(+)	37	EA	Q004
					Q005
					Q006
					Q010
					Q011
					Q012
					Q013
					Q014
					Q015
					Q016
					Q017
					Q018
					Q019
					Q023
					Q024
					Q025
					Q026
					Q027
					Q028
					Q029
					Q030
					Q031
					Q032
					Q033
					Q034
					Q035
					Q036
					Q037
					Q041
					Q042
					Q043
					Q044
					Q049
					Q050
					Q055
					Q056
					Q062
062	300702	XSTR,3638A	3	EA	Q038
					Q045
					Q051
063	302455	XSTR,PN2907A	8	EA	Q039
					Q040
					Q046
					Q047
					Q052
					Q053
					Q058
					Q059

ITEM	PART NUMBER	DESCRIPTION	QTY	ISS UOM	REF DES
065	301453	DIODE,SW IN4148	9	EA	CR001
					CR002
					CR003
					CR004
					CR005
					CR006
					CR007
					CR008
					CR009
070	300519	CAP,TANT 10UF 20% 25V	7	EA	C001
					C004
					C006
					C009
					C013
					C023
					C033
071	301979	CAP,CER .10UF 20% 50V	14	EA	C002
					C003
					C005
					C007
					C012
					C017
					C019
					C025
					C027
					C028
					C029
					C031
					C032
072	301513	CAP,CER DISC 560PF 10% 1KV	1	EA	C008
073	302435	CAP,CER DISC 18PF 10% 500/1KV	1	EA	C010
074	300555	CAP,CER DISC 56PF 10% 1KV	1	EA	C011
075	302489	CAP,TANT 4.7UF 10% 10V	1	EA	C014
076	301413	CAP,TANT 33UF 10% 10V	2	EA	C015
					C016
077	301978	CAP,CER .022UF 20% 50V	1	EA	C018
078	302490	CAP,CER .01UF 20% 50V	2	EA	C020
					C024
079	302421	CAP,TANT 3.3UF 10% 50V	1	EA	C021
080	302436	CAP,M MYLAR AX .27UF 10% 100V	1	EA	C022
090	302450	CRYSTAL,QTZ 2.000 MHZ	1	EA	Y001
091	301779	CHOKE,W BND VK 200 20/48	1	EA	L001
092	302452	XDCR,AUD PC MNT	1	EA	LS001
095	303843	DSPL,LED,HI-EFF R,7 SEG	6	EA	DS001
					DS002
					DS003
					DS004
					DS005
					DS006

ITEM	PART NUMBER	DESCRIPTION	QTY	ISS UOM	REF DES
096	302274	DSPL,7/SEG MAN4640AF	8	EA	DS007
					DS008
					DS009
					DS010
					DS011
					DS012
					DS013
					DS014
097	302134	DSPL,LED AN DL2416	2	EA	DS015
					DS016
098	303128	DIODE,LE GRN HLMP-3950	1	EA	LD001
099	303802	DIODE,LE,LO CURRENT,HI EFF RED	12	EA	LD002
					LD003
					LD004
					LD005
					LD006
					LD007
					LD008
					LD009
					LD010
					LD011
					LD012
					LD013
106	302158	SKT,IC 40/DIP L PF TIN	6	EA	XDS001
					XDS002
					XDS003
					XDS004
					XDS005
					XDS006
107	302029	SKT,IC 14/DIP L PF TIN	8	EA	XDS007
					XDS008
					XDS009
					XDS010
					XDS011
					XDS012
					XDS013
					XDS014
108	302778	SKT,IC 18/DIP TIN	2	EA	XDS015
					XDS016
110	302157	SKT,IC 28/DIP L PF TIN	1	EA	XU005
111	301601	SKT,IC 16/DIP L PF TIN	1	EA	XU006
150	131526	HARN,DSPL/THERM,4200(BOM)	1	EA	J001
151	B	PARTS,CIMII,DIP/THERM 4200 (SEE APPENDIX A)	1	AR	
152	303801	SP,LED,.250",NYL	12	EA	

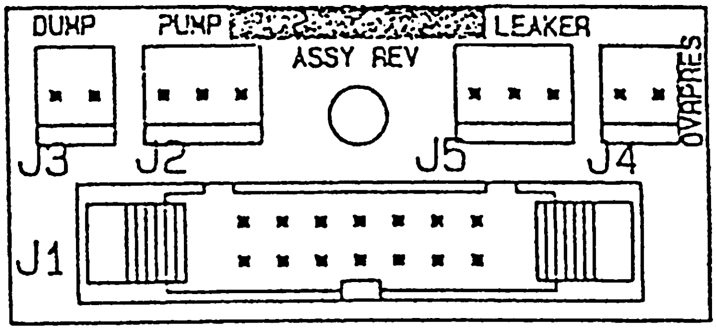


Figure 8-17. Pneumatic Transition Board (Item 267)

ITEM	PART NUMBER	DESCRIPTION	QTY	ISS UOM	REF DES
267	131085	ASSY,PNEU TRAN BD,4200(SEE FIG 8-7)	1	EA	DWG250
004	302645	TERM HDR,2P FRICT LK 0.100C	2	EA	J003 J004
005	302646	TERM HDR,3P FRICT LK 0.100C	2	EA	J002 J005
006	303847	TERM HDR,M,BOX,14P, 0.100CTR	1	EA	J001

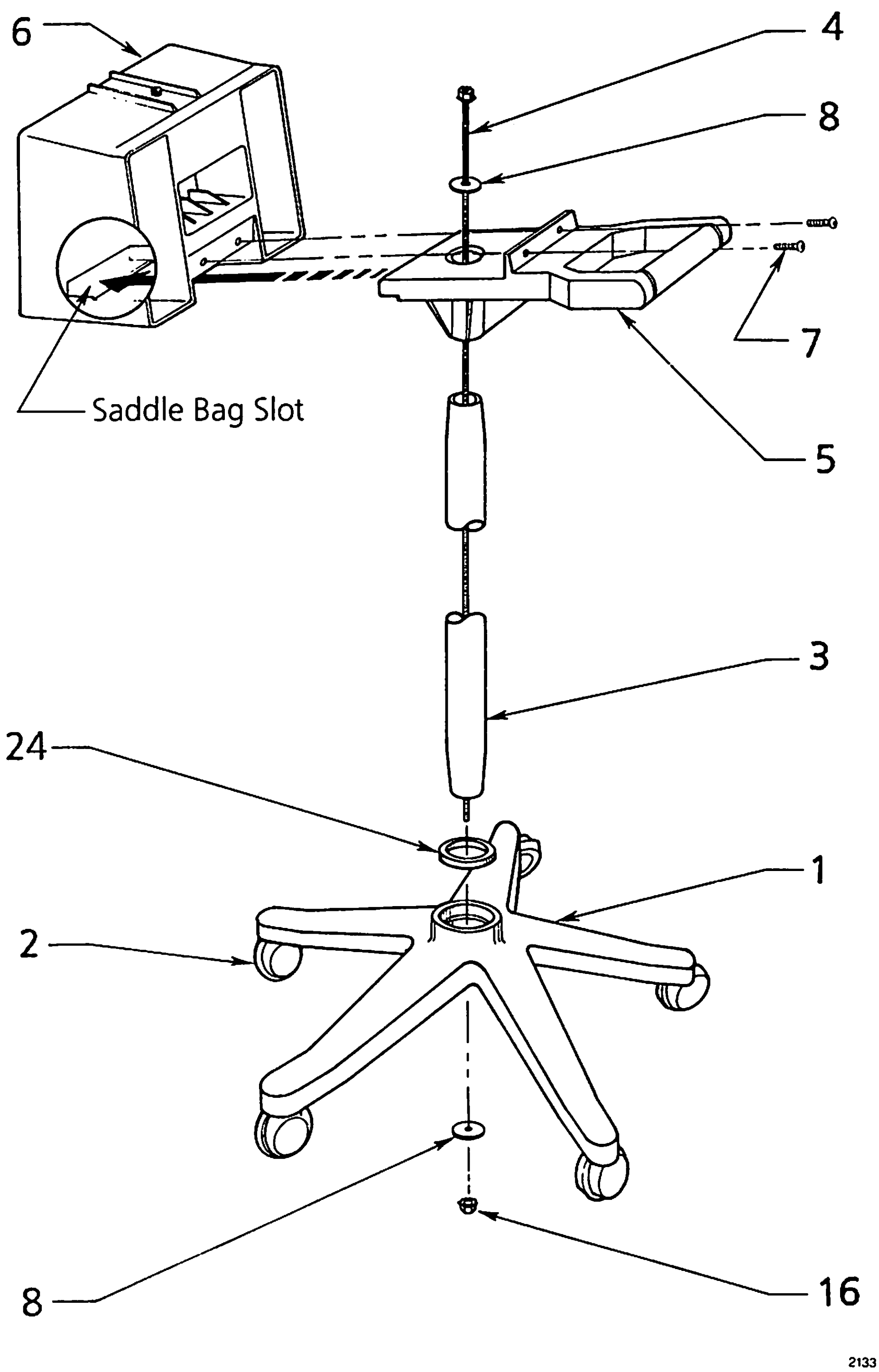


Figure 8-18A. Model 1042 Instrument Stand Final Assembly

NOTES:

1. ITEM NUMBERS FOR STAND PARTS ON PAGE 8-47.

⚠2 APPLY LOCTITE 271 THREAD ADHESIVE TO INDICATED AREAS.

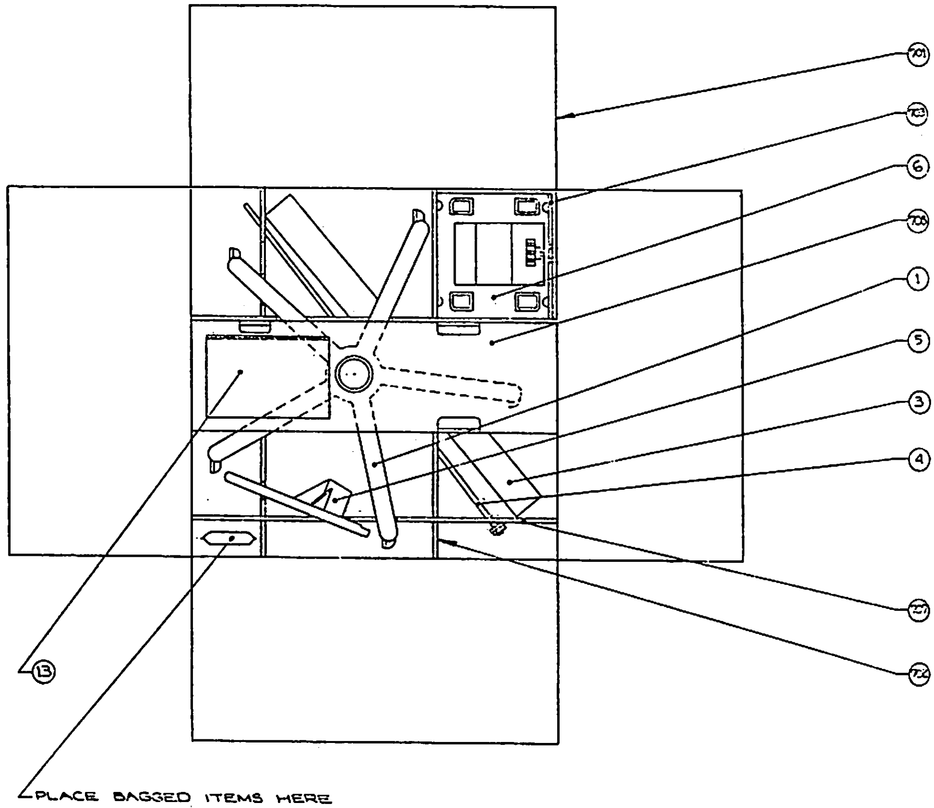


Figure 8-18B. Model 1042 Instrument Stand Final Assembly

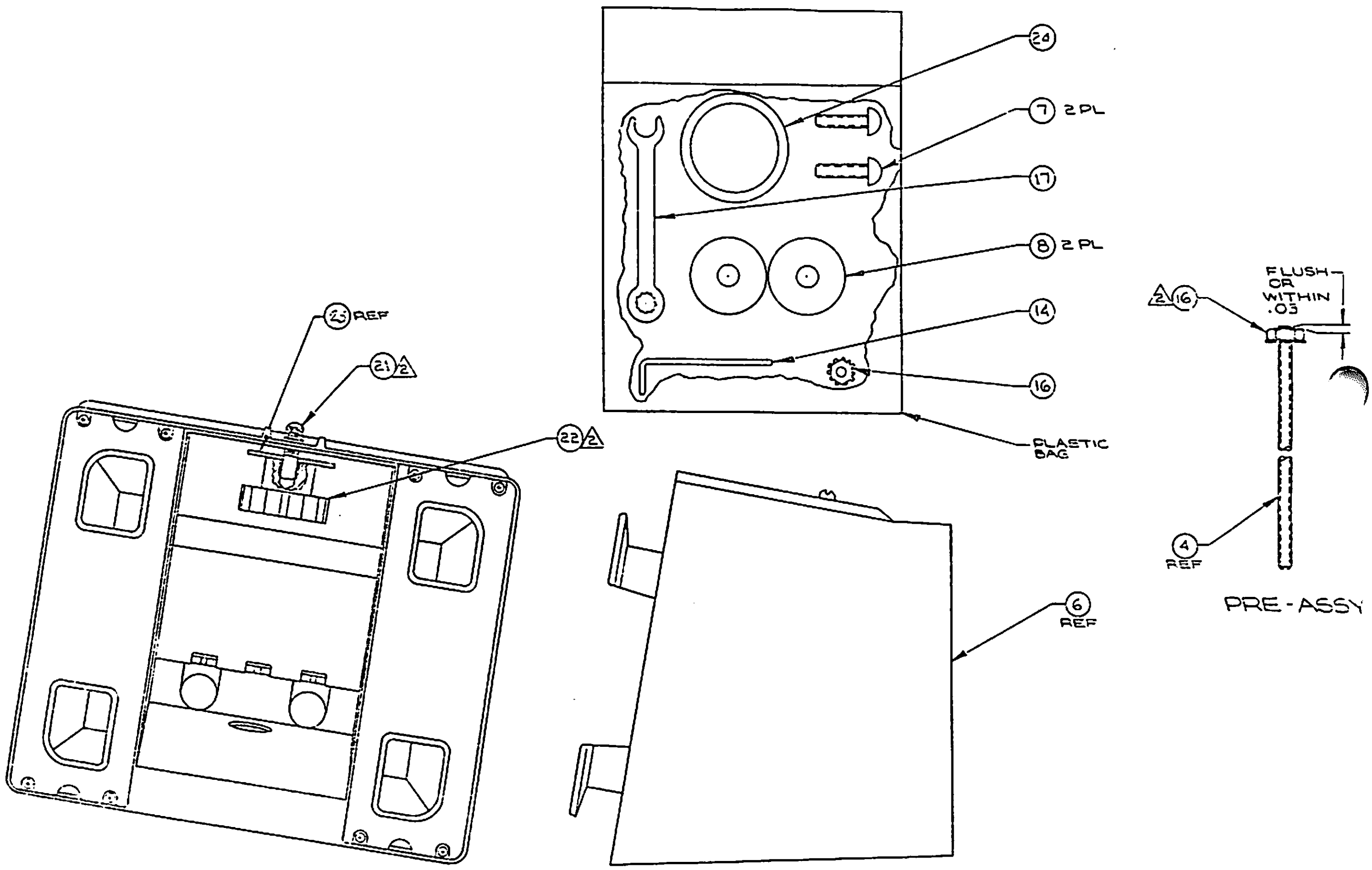


Figure 8-18C. Model 1042 Instrument Stand Final Assembly

1042 - INSTRUMENT STAND

ITEM	PART NUMBER	DESCRIPTION	QTY	ISS UOM	REF DES
001	303854	BASE,CHAIR,22",W/O CASTERS	1	EA	
002	303853	CASTER,3" WHEEL,RUBBER TREAD	5	EA	
003	303858	TBG,STL,16 GA,1.75" DIA.	1	EA	
004	130852	ROD,PED POLE,1042	1	EA	
005	130847	HANDLE,1042	1	EA	
006	131490	ASSY,SADDLEBAGS,1042	1	EA	
	130850	COVER,PL (P/O ITEM 6)	2	EA	
	303823	SCREW, 4-20 X 5/8 (P/O ITEM 6)	8	EA	
007	303925	SCREW,1/4-20 X 5/8,BTHD CAP	2	EA	
008	303883	WSHR,1/4 X 1.5 X 0.63	2	EA	
011	130850	PL,COVER REAR	2	EA	
012	303823	SCREW 4-20 X 5/8	8	EA	
013	132174	INSTC,SETUP,1042	1	EA	
014	303253	WRENCH,HEX 5/32 ACR FL	1	EA	
016	300824	NUT,KEP 1/4-20 S PL	2	EA	
017	303894	WRENCH,COMBO,7/16",3"-5" LONG	1	EA	
021	126527	STUD,POL	1	EA	
022	303839	KNOB,FLUTED,BLK,1 3/4 DIA.	1	EA	
024	303852	TETRASEAL	1	EA	
025	303923	WASHER	2	EA	
701	131491	BOX,SHPG,1042	1	EA	
702	131492	INS,PKG,BASE,1042	1	EA	
703	131064	INS,PKG,SADDLEBAG,1042	1	EA	
707	132147	INS,BASE(#2),PKG,1042	1	EA	
708	132148	INS,BASE OVERCAP,PKG,1042	1	EA	

APPENDIX A

PARTS FOR COMPUTER INTERFACE MODULE II

FIGURE ITEM	PART NUMBER	DESCRIPTION	QTY	ISS UOM	REF DES
A		PARTS,CIMII,LGC/ANLG,4200	AR	EA	
001	303259	IC,MC146818P/L CLK/RAM 24 DIP	1	EA	U029
002	300161	RES,CF 1/4W 10K 5%	1	EA	R014
003	301453	DIODE,SW IN4148	1	EA	CR004
004	301979	CAP,CER .10UF 20% 50V	1	EA	C033
006	303155	CRYSTAL OSC,LXO-32.768	1	EA	Y002
007	302185	TERM HDR,72/P 0.100 SP	1	EA	J004
B		PARTS,CIMII,DSPL/THERM,4200	AR	EA	
001	303260	IC,D8741A PER CONTR 40 DIP	1	EA	U010
002	303114	IC,CD4098BE CMOS VBRTR 16 DIP	1	EA	U011
003	300137	RES,CF 1/4W 1.0K 5%	1	EA	R081
004	300209	RES,CF 1/4W 1M 5%	1	EA	R082
005	303288	RES NTWK,10 SIP 9R 1K 2%	1	EA	RN008
006	302713	RES NTWK,6 SIP 5R 4.7K 2%	1	EA	RN009
007	301979	CAP,CER .10UF 20% 50V	1	EA	C026
008	302824	CAP,M PLY AX .001UF 10% 100VDC	1	EA	C030
009	302158	SKT,IC 40/DIP L PF TIN	1	EA	XU010