

ABBOTT LABORATORIES - HPD
TECHNICAL SUPPORT OPERATIONS
ELECTRONIC TECHNICAL SERVICE MANUAL

Plum A+3
Infusion Pump

EPS-95424-001 (Rev. 09/03)



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For use with list number 12348-04

Technical Service Manual



Abbott Laboratories
North Chicago, IL 60064
USA

430-95424-001 (Rev. 09/03)

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Contents

Section 1

INTRODUCTION	1-1
1.1 SCOPE	1-1
1.2 CONVENTIONS.	1-2
1.3 COMPONENT DESIGNATORS	1-2
1.4 ACRONYMS AND ABBREVIATIONS	1-3
1.5 USER QUALIFICATION	1-5
1.6 ARTIFACTS	1-5
1.7 INSTRUMENT INSTALLATION PROCEDURE	1-6
1.7.1 UNPACKING	1-6
1.7.2 INSPECTION	1-6
1.7.3 SELF TEST.	1-7
1.8 BIOMED SETTINGS	1-9
1.8.1 IV PARAMETERS	1-10
1.8.2 ALARMS LOG	1-12
1.8.3 SETTING THE TIME AND DATE	1-13

Section 2

WARRANTY	2-1
--------------------	-----

Section 3

SYSTEM OPERATING MANUAL	3-1
-----------------------------------	-----

Section 4

THEORY OF OPERATION	4-1
4.1 GENERAL DESCRIPTION	4-1
4.2 ELECTRONIC SUBSYSTEM OVERVIEW.	4-3
4.2.1 CPU SUBSYSTEM	4-3
4.2.1.1 CPU	4-3
4.2.1.2 SYSTEM MEMORY ADDRESS MAP	4-4
4.2.1.3 PROGRAMMABLE READ-ONLY MEMORY	4-4
4.2.1.4 STATIC RANDOM ACCESS MEMORY	4-4
4.2.1.5 CONTROL LOGIC	4-4
4.2.1.6 LCD CONTROLLER	4-4
4.2.1.7 LCD BACKLIGHT CONTROL	4-5
4.2.1.8 LCD CONTRAST CONTROL.	4-5
4.2.1.9 REAL-TIME CLOCK	4-6
4.2.1.10 VOLTAGE MONITOR WATCHDOG TIMER	4-6
4.2.1.11 ANALOG-TO-DIGITAL CONVERTER	4-7
4.2.1.12 DIGITAL-TO-ANALOG CONVERTER	4-9
4.2.1.13 FRONT PANEL KEYPAD MATRIX	4-9
4.2.1.14 FRONT PANEL [ON/OFF] KEY	4-9
4.2.1.15 FRONT PANEL LED INDICATORS	4-9
4.2.1.16 KEYPAD LOCKOUT INTERFACE	4-10
4.2.1.17 NURSE CALL INTERFACE	4-10
4.2.1.18 AUDIBLE INDICATORS	4-10
4.2.1.19 BARCODE READER INTERFACE	4-10
4.2.1.20 DATAPORT INTERFACE	4-11
4.2.1.21 POWER SUPPLY INTERFACE	4-11
4.2.1.22 MECHANISM INTERFACE	4-12

4.2.2	POWER SUPPLY SUBSYSTEM	4-14
4.2.2.1	MAIN SWITCHING REGULATOR	4-14
4.2.2.2	MAIN REGULATOR FAULT DETECTION	4-15
4.2.2.3	SYSTEM POWER	4-15
4.2.2.4	AUXILIARY SUPPLIES	4-15
4.2.2.5	POWER CONTROL	4-16
4.2.2.6	BATTERY VOLTAGE MEASUREMENT	4-16
4.2.2.7	BATTERY CHARGE/DISCHARGE CURRENT MEASUREMENT	4-17
4.2.2.8	BATTERY CHARGER	4-17
4.2.3	MECHANISM SUBSYSTEM	4-17
4.2.3.1	MOTORS/MOTOR DRIVE	4-18
4.2.3.2	MOTOR POSITION SENSORS	4-19
4.2.3.3	V2_5 REFERENCE VOLTAGE	4-20
4.2.3.4	AIR SENSORS	4-20
4.2.3.5	PRESSURE SENSORS	4-21
4.2.3.6	PRESSURE SENSOR CALIBRATION	4-23
4.2.3.7	CASSETTE TYPE/PRESENCE SELECTION.	4-23
4.2.3.8	SERIAL EEPROM.	4-23
4.3	PRINTED WIRING ASSEMBLIES	4-24
4.3.1	POWER SUPPLY PWA	4-24
4.3.2	PERIPHERAL PWA	4-25
4.3.3	PERIPHERAL/INTERFACE PWA	4-25
4.3.4	CPU PWA	4-26
4.3.5	DRIVER PWA	4-26
4.3.6	SWITCH PWA	4-27
4.3.7	APP PWA	4-27
4.4	REMOTE MOUNTED PERIPHERALS	4-28
4.4.1	LCD	4-28
4.4.2	SEALED LEAD ACID BATTERY	4-28
4.4.3	BARCODE READER WAND	4-28
4.5	MECHANICAL OVERVIEW	4-28
4.5.1	CASSETTE	4-29
4.5.2	MECHANISM ASSEMBLY	4-31
4.5.2.1	MOTOR AND VALVE ASSEMBLIES.	4-31
4.5.2.2	A/B VALVE SUBSYSTEM.	4-32
4.5.2.3	INLET/OUTLET VALVE SUBSYSTEM	4-33
4.5.2.4	PLUNGER DRIVE SUBSYSTEM	4-33

Section 5

MAINTENANCE AND SERVICE TESTS.	5-1
5.1 ROUTINE MAINTENANCE	5-1
5.1.1 INSPECTING THE INFUSION PUMP	5-1
5.1.2 CLEANING THE INFUSION PUMP	5-1
5.1.3 SANITIZING THE INFUSION PUMP.	5-2
5.2 PERFORMANCE VERIFICATION TEST	5-3
5.2.1 EQUIPMENT REQUIRED	5-3
5.2.2 INSPECTION	5-4
5.2.3 TEST SETUP.	5-4
5.2.4 SELF TEST	5-4
5.2.5 CASSETTE ALARM TEST	5-6
5.2.6 FREE FLOW TEST.	5-7
5.2.7 DISPLAY TEST.	5-7
5.2.8 KEYPAD VERIFICATION/FUNCTIONAL TEST.	5-7
5.2.9 ALARM LOUDNESS TEST	5-8
5.2.10 LOCKOUT SWITCH TEST.	5-9

5.2.11 PROXIMAL OCCLUSION TEST	5-10
5.2.12 PROXIMAL AIR-IN-LINE TEST	5-10
5.2.13 DISTAL AIR-IN-LINE TEST	5-11
5.2.14 DISTAL OCCLUSION TEST	5-12
5.2.15 DELIVERY ACCURACY TEST	5-13
5.2.16 ELECTRICAL SAFETY TEST	5-14
5.2.17 END OF THE PVT	5-14
5.3 BARCODE READER WAND TEST (OPTIONAL)	5-15
5.4 NURSE CALL TEST (OPTIONAL)	5-15
5.5 PERIODIC MAINTENANCE INSPECTION	5-15
5.6 BATTERY OPERATION OVERVIEW	5-16

Section 6

TROUBLESHOOTING	6-1
6.1 TECHNICAL ASSISTANCE.	6-1
6.2 ALARM MESSAGES AND ERROR CODES	6-1
6.2.1 OPERATIONAL ALARM MESSAGES	6-2
6.2.2 ERROR CODES REQUIRING TECHNICAL SERVICE.	6-6
6.3 TROUBLESHOOTING PROCEDURES.	6-11

Section 7

REPLACEABLE PARTS AND REPAIRS	7-1
7.1 REPLACEABLE PARTS	7-1
7.2 REPLACEMENT PROCEDURES	7-3
7.2.1 SAFETY AND EQUIPMENT PRECAUTIONS	7-3
7.2.2 REQUIRED TOOLS AND MATERIALS	7-3
7.2.3 RUBBER FOOT PAD REPLACEMENT	7-4
7.2.4 BATTERY ASSEMBLY, BATTERY DOOR, AND BATTERY DOOR PAD REPLACEMENT.	7-5
7.2.5 AC (MAINS) POWER CORD, POWER CORD RETAINER, AND VELCRO RETAINER STRAP REPLACEMENT	7-6
7.2.6 SEPARATING THE FRONT ENCLOSURE, REAR ENCLOSURE, AND MAIN CHASSIS ASSEMBLY.	7-7
7.2.7 PERIPHERAL/INTERFACE ASSEMBLY REPLACEMENT	7-9
7.2.8 PERIPHERAL PWA REPLACEMENT	7-9
7.2.9 PERIPHERAL/INTERFACE ASSEMBLY COMPONENT REPLACEMENT	7-11
7.2.9.1 VOLUME CONTROL KNOB REPLACEMENT	7-11
7.2.9.2 PERIPHERAL ASSEMBLY COVER AND ESD SPRING REPLACEMENT	7-11
7.2.10 FRONT/REAR ENCLOSURE GASKET REPLACEMENT	7-13
7.2.11 LOWER FRONT ENCLOSURE ASSEMBLY GASKET REPLACEMENT.	7-13
7.2.11.1 EMI GASKET REPLACEMENT	7-14
7.2.11.2 KEYPAD GASKET REPLACEMENT	7-15
7.2.11.3 TOP SEAL GASKET REPLACEMENT	7-15
7.2.12 REAR ENCLOSURE ASSEMBLY COMPONENT REPLACEMENT	7-16
7.2.12.1 POLE CLAMP ASSEMBLY AND POLE CLAMP BACKING PLATE REPLACEMENT	7-17
7.2.12.2 INTERNAL AC POWER CORD REPLACEMENT	7-18
7.2.12.3 POLE CLAMP GROUND WIRE REPLACEMENT	7-18
7.2.12.4 AC (MAINS) CONNECTOR REPLACEMENT.	7-19
7.2.12.5 FUSE REPLACEMENT	7-19
7.2.12.6 REAR ENCLOSURE GASKET REPLACEMENT	7-20
7.2.13 MINIPOLE ASSEMBLY REPLACEMENT	7-20
7.2.13.1 COTTER RING REPLACEMENT	7-21

7.2.13.2	BAG HANGER REPLACEMENT	7-22
7.2.13.3	CLUTCH HOUSING REPLACEMENT	7-22
7.2.13.4	CLUTCH SPRING REPLACEMENT	7-22
7.2.14	MAIN CHASSIS ASSEMBLY COMPONENT REPLACEMENT	7-23
7.2.14.1	POWER SUPPLY PWA REPLACEMENT.	7-24
7.2.14.2	KEYPAD REPLACEMENT.	7-25
7.2.14.3	LCD REPLACEMENT	7-26
7.2.14.4	CPU/DRIVER CABLE REPLACEMENT	7-27
7.2.14.5	MOTOR POWER CABLE REPLACEMENT.	7-30
7.2.14.6	CPU PWA REPLACEMENT	7-30
7.2.14.7	PIEZO ALARM ASSEMBLY REPLACEMENT.	7-31
7.2.14.8	MECHANISM ASSEMBLY REPLACEMENT	7-32
7.2.14.9	CASSETTE DOOR AND FLUID SHIELD REPLACEMENT	7-32
7.2.14.10	OPENER HANDLE ASSEMBLY REPLACEMENT	7-34

Section 8

SPECIFICATIONS	8-1
--------------------------	-----

Section 9

DRAWINGS	9-1
--------------------	-----

Section 10

INDEX	10-1
-----------------	------

Figures

Figure 1-1.	LCD and Keypad	1-8
Figure 1-2.	Biomed Settings	1-9
Figure 1-3.	IV Parameters	1-11
Figure 1-4.	Alarms Log	1-12
Figure 1-5.	Setting the Time and Date.	1-13
Figure 1-6.	Common IV Parameters	1-14
Figure 1-7.	Macro IV Parameters	1-14
Figure 4-1.	Electronic Functional Diagram	4-2
Figure 4-2.	Serial Interface to ADC.	4-8
Figure 4-3.	System Startup and Shutdown Timing, Battery Powered.	4-16
Figure 4-4.	Stepper Motor Coils	4-18
Figure 4-5.	Air Sensor Block Diagram.	4-20
Figure 4-6.	Pressure Sensor Excitation and Amplifier Block Diagram	4-22
Figure 4-7.	Major Elements of the Dual-Channel Cassette	4-30
Figure 4-8.	Fluid Path in the Cassette	4-31
Figure 4-9.	Mechanism Valve Pins and Sensor Locations	4-32
Figure 5-1.	LCD and Keypad	5-6
Figure 5-2.	Rear Enclosure and Peripheral/Interface Assembly	5-9
Figure 5-3.	Special Cassettes with Bubble Sensor Tips Removed	5-11
Figure 5-4.	Distal Occlusion Test Setup	5-13
Figure 7-1.	Bottom View	7-4
Figure 7-2.	AC (Mains) Power Cord, Power Cord Retainer, Velcro Retainer Strap, and Battery Assembly Replacement	7-6
Figure 7-3.	Separating the Front Enclosure, Rear Enclosure, and Main Chassis Assembly	7-8

Figure 7-4.	Screw Placement Sequence	7-8
Figure 7-5.	Peripheral/Interface PWA and Peripheral PWA Replacement	7-10
Figure 7-6.	Peripheral/Interface Assembly Component Replacement.	7-12
Figure 7-7.	Lower Front Enclosure Gasket Replacement	7-14
Figure 7-8.	External Rear Enclosure Assembly Components	7-16
Figure 7-9.	Internal Rear Enclosure Assembly Components	7-17
Figure 7-10.	Minipole Assembly	7-21
Figure 7-11.	Main Chassis Components	7-23
Figure 7-12.	CPU/Driver Cable Routing	7-28
Figure 7-13.	Ferrite Tape Positioning	7-29
Figure 7-14.	Fluid Shield Replacement	7-33
Figure 7-15.	Cassette Door and Opener Handle Assembly Replacement	7-35
Figure 9-1.	Illustrated Parts Breakdown	9-5
Figure 9-2.	Front Enclosures, Rear Enclosure, and Main Chassis Assemblies	9-9
Figure 9-3.	Front Enclosure Assemblies	9-11
Figure 9-4.	Rear Enclosure Assembly	9-13
Figure 9-5.	Peripheral/Interface Assembly	9-17
Figure 9-6.	Main Chassis Assembly	9-19
Figure 9-7.	CPU PWA, LCD, and Keypad	9-23
Figure 9-8.	CPU PWA and Main Chassis	9-25
Figure 9-9.	AC Power Cord, Power Cord Retainer, Batteries, and Minipole Assembly.	9-27
Figure 9-10.	Mechanism Assembly	9-29
Figure 9-11.	Power Supply PWA Schematic	9-31
Figure 9-12.	Peripheral/Interface PWA Schematic	9-51
Figure 9-13.	Peripheral PWA Schematic	9-63
Figure 9-14.	CPU PWA Schematic.	9-71
Figure 9-15.	Driver PWA Schematic	9-91
Figure 9-16.	Switch PWA Schematic.	9-97
Figure 9-17.	APP PWA Schematic.	9-99

Tables

Table 1-1.	Conventions.	1-2
Table 1-2.	System Configuration Data	1-10
Table 4-1.	Analog Inputs	4-8
Table 4-2.	Keypad Map.	4-9
Table 4-3.	CPU-Power Supply Interface	4-11
Table 4-4.	CPU-Mechanism Interface Signals.	4-12
Table 4-5.	Power Supply PWA Interface Connections	4-24
Table 4-6.	Peripheral PWA Interface Connections	4-25
Table 4-7.	Peripheral/Interface PWA Interface Connections.	4-25
Table 4-8.	CPU PWA Interface Connections	4-26
Table 4-9.	Driver PWA Interface Connections.	4-27
Table 4-10.	APP PWA Interface Connections	4-27
Table 5-1.	Cleaning Solutions	5-2
Table 6-1.	Operational Alarm Messages and Corrective Actions	6-2
Table 6-2.	Error Codes Requiring Technical Service	6-6
Table 6-3.	Troubleshooting with the PVT	6-11
Table 9-1.	Drawings.	9-1
Table 9-2.	IPB for the Infusion Pump.	9-2

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Section 1

INTRODUCTION

The Plum A+3™ Infusion System is designed to meet the growing demand for hospital wide device standardization. The Plum A+3 consists of three component pumps which are designated line 1, line 2, and line 3. By incorporating three lines into one unit, the infusion system provides three primary lines, three secondary lines, and piggyback fluid delivery capabilities. The Plum A+3 serves a wide range of general floor and critical care needs. Compatibility with the LifeCare® 5000 PlumSet® administration sets and accessories make the Plum A+3 infusion system convenient and cost-effective.


1.1 SCOPE


This manual is organized into 11 sections:

- ❑ Section 1 Introduction
- ❑ Section 2 Warranty
- ❑ Section 3 System Operating Manual
- ❑ Section 4 Theory of Operation
- ❑ Section 5 Maintenance and Service Tests
- ❑ Section 6 Troubleshooting
- ❑ Section 7 Replaceable Parts and Repairs
- ❑ Section 8 Specifications
- ❑ Section 9 Drawings
- ❑ Section 10 Index
- ❑ Technical Service Bulletins

If a problem in device operation cannot be resolved using the information in this manual, contact Abbott Laboratories (*see Section 6.1, Technical Assistance*).

Specific instructions for operating the device are contained in the *Plum A+3 System Operating Manual*. Provision is made for the inclusion of the system operating manual in *Section 3* of this manual.

 **Note:** Figures are rendered as graphic representations to approximate actual product. Therefore, figures may not exactly reflect the product.

 **Note:** Screen representations in this manual are examples only, and do not necessarily reflect the most current software version.

1.2 CONVENTIONS


The conventions listed in *Table 1-1, Conventions*, are used throughout this manual.

Table 1-1. Conventions		
Convention	Application	Example
<i>Italic</i>	Reference to a section, figure, table, or publication	<i>(see Section 6.1, Technical Assistance)</i>
[ALL CAPS]	In-text references to keys and touchswitches	[START]
[Lowercase]	In-text references to softkeys	[Choose]
ALL CAPS	Screen displays	CASSETTE TEST IN PROGRESS
Bold	Emphasis	CAUTION: Use proper ESD grounding techniques when handling components.

Throughout this manual, warnings, cautions, and notes are used to emphasize important information as follows:

WARNING: A WARNING CONTAINS SPECIAL SAFETY EMPHASIS AND MUST BE OBSERVED AT ALL TIMES. FAILURE TO OBSERVE A WARNING MAY RESULT IN PATIENT INJURY AND BE LIFE-THREATENING.

CAUTION: A CAUTION usually appears in front of a procedure or statement. It contains information that could prevent hardware failure, irreversible damage to equipment, or loss of data.


 **Note:** A note highlights information that helps explain a concept or procedure.

1.3 COMPONENT DESIGNATORS

Components are indicated by alpha-numeric designators, as follows:

Battery	BT	Diode	D	Resistor	R
Capacitor	C	Fuse	F	Switch	SW
Crystal	Y	Integrated Circuit	U	Transistor	Q

The number following the letter is a unique value for each type of component (e.g., R1, R2).

 **Note:** Alpha-numeric designators may be followed with a dash (-) number that indicates a pin number for that component. For example, U15-13 is pin 13 of the encoder chip [U15] on the interface PWA.

1.4**ACRONYMS AND ABBREVIATIONS**

Acronyms and abbreviations used in this manual are as follows:

A	Ampere
AC	Alternating current
A/D	Analog-to-digital
ADC	Analog-to-digital converter
APP	Air, pressure, and pin
BCR	Barcode reader
CCFT	Cold cathode fluorescent tube
CMOS	Complementary metal-oxide semiconductor
CPU	Central processing unit
DAC	Digital-to-analog converter
DC	Direct current
DIP	Dual in-line package
DMA	Direct memory access
DMM	Digital multimeter
DPM	Digital pressure meter
ECG	Electrocardiograph
EEG	Electroencephalogram
EEPROM	Electrically erasable/programmable read-only memory
EMG	Electromyogram
EMI	Electromagnetic interference
ESD	Electrostatic discharge
ETO	Ethylene oxide
FPGA	Field programmable gate array
FSR	Force sensing resistor
hr	Hour
Hz	Hertz
ID	Identification
I/O	Input/output
IPB	Illustrated parts breakdown
IV	Intravenous
KB	Kilobyte
kHz	Kilohertz
KVO	Keep vein open
lbs	Pounds
LCD	Liquid crystal display

LED	Light emitting diode
L/S	Line select
mA	Milliampere
MB	Megabyte
MHz	Megahertz
min	Minute
mL	Milliliter
mL/hr	Milliliter per hour
MMIO	Memory-mapped input/output
MOSFET	Metal-oxide semiconductor field-effect transistor
ms	Millisecond
mV	Millivolt
N/A	Not applicable
Op-amp	Operational amplifier
PROM	Programmable read-only memory
psi	Pounds per square inch
PVT	Performance verification test
PWA	Printed wiring assembly
PWB	Printed wiring board
PWM	Pulse width modulator
RAM	Random-access memory
rms	Root-mean-square
ROM	Read-only memory
RTC	Real-time clock
SCC	Serial communication controller
SCP	Serial communication port
SLA	Sealed lead acid
SMT	Surface mount technology
SPI	Serial peripheral interface
SRAM	Static random access memory
TQFP	Thin quad flat pack
V	Volt
V_{AC}	Volts AC
V_{CC}	Collector supply voltage
VCO	Voltage-controlled oscillator
V_{DC}	Volts DC
VSC	5 V _{DC} supply circuitry
VSO	Voltage sweep oscillator
VTBI	Volume to be infused
WDI	Watchdog input

1.5 USER QUALIFICATION

The Plum A+3 infusion system is intended for use at the direction or under the supervision of licensed physicians or certified healthcare professionals who are trained in the use of the pump and the administration of parenteral and enteral fluids and drugs, and whole blood or red blood cell components. Training should emphasize preventing related IV complications, including appropriate precautions to prevent accidental infusion of air. The epidural route can be used to provide anesthesia or analgesia.

1.6 ARTIFACTS

Nonhazardous, low-level electrical potentials are commonly observed when fluids are administered using infusion devices. These potentials are well within accepted safety standards, but may create artifacts on voltage-sensing equipment such as ECG, EMG, and EEG machines. These artifacts vary at a rate that is associated with the infusion rate. If the monitoring machine is not operating correctly or has loose or defective connections to its sensing electrodes, these artifacts may be accentuated so as to simulate actual physiological signals. To determine if the abnormality in the monitoring equipment is caused by the pump instead of some other source in the environment, set the pump so that it is temporarily not delivering fluid. Disappearance of the abnormality indicates that it was probably caused by electronic noise generated by the pump. Proper setup and maintenance of the monitoring equipment should eliminate the artifact. Refer to the appropriate monitoring system documentation for setup and maintenance instructions.


1.7

INSTRUMENT INSTALLATION PROCEDURE

CAUTION: Infusion pump damage may occur unless proper care is exercised during product unpacking and installation. The battery may not be fully charged upon receipt of the infusion pump. Do not place the infusion pump in service if it fails the self test.

CAUTION: Infusion pump performance may be degraded by electromagnetic interference (EMI) from devices such as electrosurgical units, cellular phones, and two-way radios. Operation of the infusion pump under such conditions should be avoided.

The instrument installation procedure consists of unpacking, inspection, and self test.

 **Note:** Do not place the infusion pump in service if the battery is not fully charged. To make certain the battery is fully charged, connect the infusion pump to AC power for six hours (*see Section 8, Specifications*).

1.7.1

UNPACKING

Inspect the shipping container as detailed in *Section 1.7.2, Inspection*. Use care when unpacking the infusion pump. Retain the packing slip and save all packing material in the event it is necessary to return the Plum A+3 to the factory. Verify the shipping container contains a copy of the system operating manual.

1.7.2

INSPECTION


Inspect the infusion pump shipping container for shipping damage. Should any damage be found, contact the delivering carrier immediately.


CAUTION: Inspect the infusion pump for evidence of damage. Do not use the pump if it appears to be damaged. Should damage be found, contact Abbott Laboratories (*see Section 6.1, Technical Assistance*).

Inspect the infusion pump periodically for signs of defects such as worn accessories, broken connections, or damaged cable assemblies. Also inspect the infusion pump after repair or during cleaning. Replace any damaged or defective external parts.

1.7.3 SELF TEST

CAUTION: Do not place the infusion pump in service if the self test fails.

 **Note:** If an alarm condition occurs during the self test, cycle the power and repeat the self test. If the alarm condition recurs, note the message and take corrective action (*see Section 6, Troubleshooting*). Repeat the self test. If the alarm condition recurs, remove the Plum A+3 infusion system from service and **contact Abbott Laboratories**.

 **Note:** When performing the self test, line 1, line 2, and line 3 must be tested. However, if appropriate, the test may be performed on all lines concurrently.

To perform the self test, refer to *Figure 1-1, LCD and Keypad*, and proceed as follows:

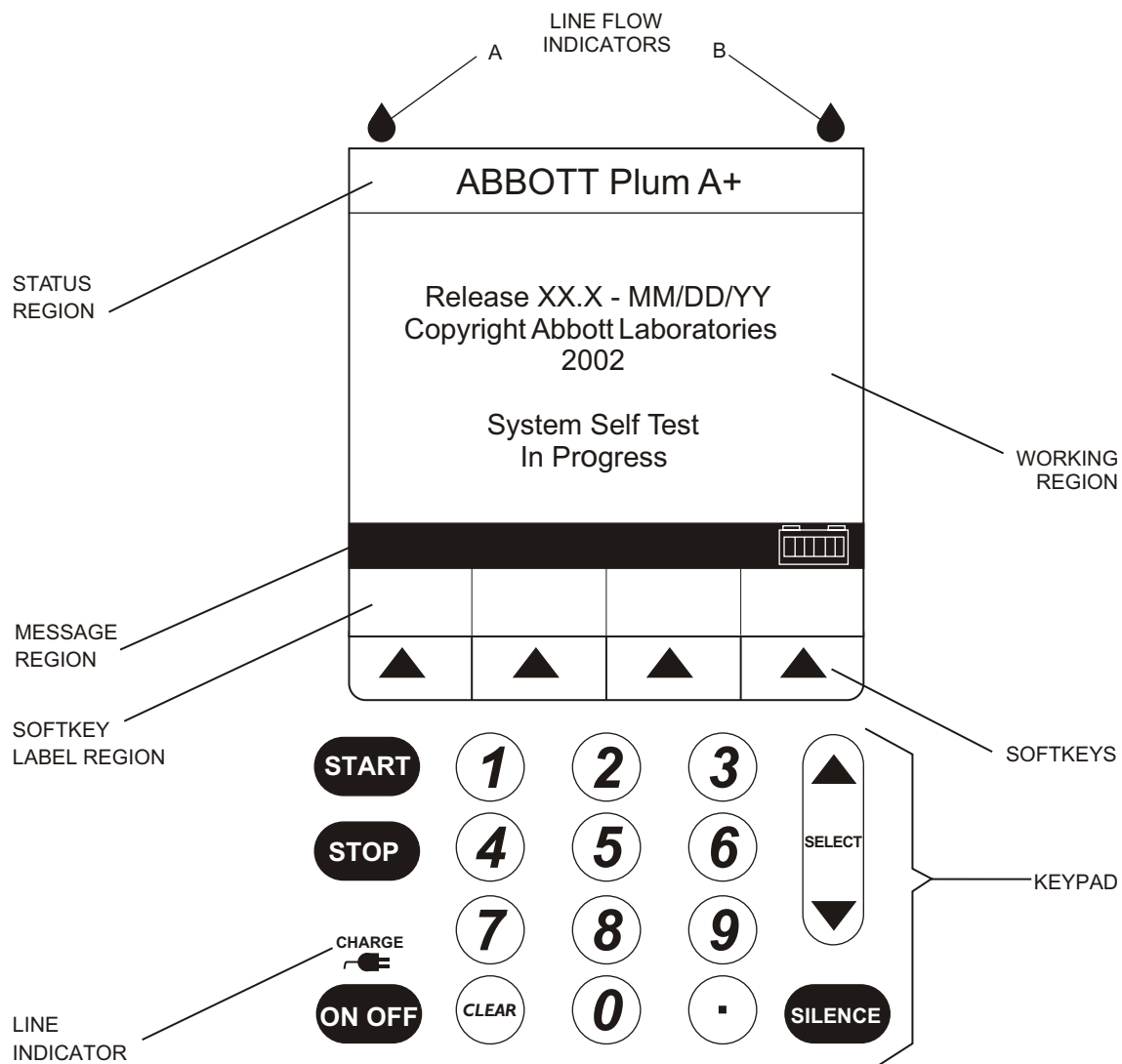
1. Connect the AC power cord to a grounded AC outlet. Verify the charging/line indicator **CHARGE** illuminates and an alarm beep sounds.
2. Without a cassette installed, press [ON/OFF] to turn on the pump.
3. The LCD briefly displays the **SELF TEST** screen. Verify the screen display matches *Figure 1-1*.

 **Note:** If the **SELF TEST** screen does not appear, **contact Abbott Laboratories**.

4. After the self test is complete, the message “INSERT PLUM SET CLOSE LEVER” appears. Press the decimal [.] key, then [START].
5. Using the [SELECT] arrow keys, select **Set Time and Date**, and press the [Choose] softkey.
6. Verify the time, year, month, and day are correct. If any parameters are incorrect, refer to *Section 1.8.3, Setting the Time and Date*.
7. Press [ON/OFF] to exit the **SET TIME AND DATE** screen.
8. Press [ON/OFF] to turn the pump back on.
9. Open the cassette door and insert a primed cassette. Close the cassette door. The cassette test is complete when the “CASSETTE TEST IN PROGRESS” message disappears.

 **Note:** The message “MECHANISM INITIALIZATION IN PROGRESS” may briefly appear prior to the “CASSETTE TEST IN PROGRESS” message.

10. If previously entered programming exists, the “CLEAR SETTINGS?” message appears. Press the [Yes] softkey to clear the settings.



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Figure 1-1. LCD and Keypad

1.8 BIOMED SETTINGS

The biomed settings screens contain the following options that can be changed or reviewed by qualified personnel:

- ☐ IV screen parameters
- ☐ Alarms log
- ☐ Set time and date

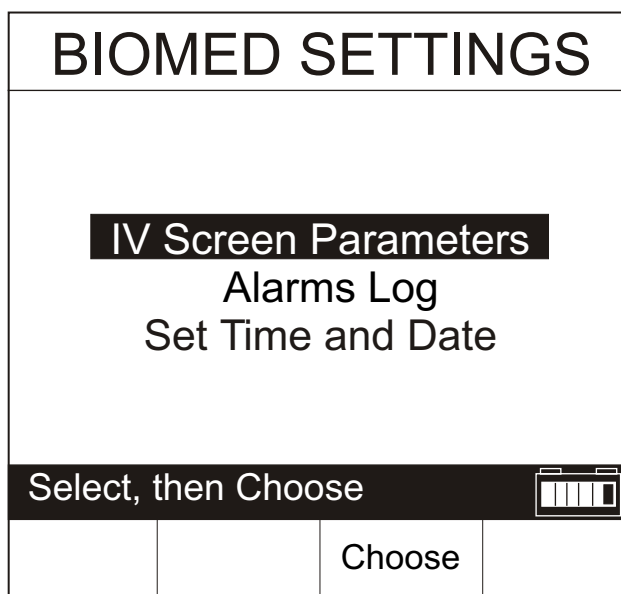
Note: All Plum A+3 infusion devices (new or refurbished) are shipped with factory settings (*see Table 1-2, System Configuration Data*).

Note: Biomed screens do not time out for the **Infuser Idle** alarm or **No Action** alarm.

Note: The battery will not be detected in the biomed service mode (*see Section 6.2.2, Error Codes Requiring Technical Service*).

To access the service mode, refer to *Figure 1-1*, then proceed as follows:

1. Open the door and press [ON/OFF] to turn on the pump.
2. After the self test is complete, the message “INSERT PLUM SET CLOSE LEVER” appears. Press the decimal [.] key, then [START], and verify the **BIOMED SETTINGS** screen is displayed (*see Figure 1-2, Biomed Settings*).



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Figure 1-2. Biomed Settings

Table 1-2. System Configuration Data

Data	Options Range	Factory Setting
Maximum macro IV mode delivery rate	0.1 - 99.9 mL/hr and 100 - 999 mL/hr	999 mL/hr
Macro distal occlusion alarm (pressure level)	1 to 15 psi	6.0 psi
Deliver together enable	Concurrent or Piggyback	Piggyback
Delayed start/standby enable	Yes or No	Yes
Continue rate	Rate or KVO	KVO
Nurse callback default	Yes or No	No
Time	(24 hr) 00:00 - 23:59 in one minute increments	Factory time
Date	1/1/2002 - 12/31/2098	Factory date


1.8.1**IV PARAMETERS**

Refer to *Figure 1-3, IV Parameters*. The IV parameters screen contains the following:

- ☐ Common IV parameters
- ☐ Macro IV parameters

To change the IV parameters, refer to *Figure 1-6, Common IV Parameters*, and *Figure 1-7, Macro IV Parameters*, then proceed as follows:

1. Access the biomed settings screen as described in *Section 1.8*.
2. Using the [SELECT] arrow keys, select **IV Screen Parameters**, and press [Choose].
3. Using the [SELECT] arrow keys, select the parameters to be changed, and press [Choose].
4. Using the [Change Value] softkey, select the desired value, and press [ENTER].
5. Repeat Steps 3 and 4 for each parameter to be changed.
6. If there are no other changes, press [ON/OFF] to power off the infusion device.

BIOMED SETTINGS			
IV Parameters			
Common IV Parameters			
Macro IV Parameters			
Select, then Choose			
		Choose	Back

00H03003

Figure 1-3. IV Parameters


1.8.2

ALARMS LOG

To view the alarms log, refer to *Figure 1-2* and *Figure 1-4, Alarms Log*, then proceed as follows:

1. Access the biomed settings screen as described in *Section 1.8*.
2. Using the [SELECT] arrow keys, select **Alarms Log**, and press [Choose].
3. Use the [Page Up] and [Page Down] softkeys to view the alarms log.
4. Press the [Back] softkey to exit the alarms log and return to the main biomed settings screen.

 **Note:** The alarms log will retain the latest 40 alarm and malfunction codes, listed in order from the most current to the oldest.

ALARMS LOG			
6/23/03 01:43 E437 S/W Failure # 202			
6/23/03 09:18 N190 Neg. Prox. Occl. A			
6/22/03 23:44 N102 Infuser Idle 2 minutes			
6/22/03 21:43 N161 Line A VTBI complete			
6/22/03 11:44 N106 Distal occlusion			
6/22/03 09:43 N161 Line A VTBI complete			
6/22/03 06:23 N160 Line B VTBI complete			
6/22/03 03:40 N101 No action alarm			
			
	Page Up	Page Down	Back


02H03008


Figure 1-4. Alarms Log

1.8.3


SETTING THE TIME AND DATE

To set the time and date, refer to *Figure 1-2* and *Figure 1-5, Setting the Time and Date*, then proceed as follows:

 **Note:** The Plum A+3 will automatically display February 29 on leap years.


 **Note:** Daylight savings and time zone changes must be made manually.

1. Access the biomed settings screen as described in *Section 1.8*.
2. Using the [SELECT] arrow keys, select **Set Time and Date**, and press [Choose].
3. Using the [SELECT] arrow keys, select the parameter to be changed.
4. Using the numerical keypad, enter the desired value, and press [Enter].
5. Repeat Steps 3 and 4 for each parameter to be changed.
6. If there are no other changes, press [ON/OFF] to power off the infusion device.

BIOMED SETTINGS			
Set Time and Date			
Time	21	: 15	hr:min
Year	2003		
Month	10		
Day	31		
Enter value using keypad			
		Enter	Cancel/ Back


00K13004

Figure 1-5. Setting the Time and Date

BIOMED SETTINGS			
Common IV Parameters			
Continue Rate		KVO	
Deliver Together		Concurrent	
Enable Delay/Standby		Yes	
Callback Default		No	
Select using Change Value			
Change Value		Enter	Cancel/Back

02K03004

Figure 1-6. Common IV Parameters

BIOMED SETTINGS			
Macro IV Parameters			
Default Distal Press		6.0 psi	
Max Rate		999 mL/hr	
Enter Value using keypad			
		Enter	Cancel/Back

00K13005

Figure 1-7. Macro IV Parameters

Section 2

WARRANTY

Subject to the terms and conditions herein, Abbott Laboratories, herein referred to as Abbott, warrants that (a) the product shall conform to Abbott's standard specifications and be free from defects in material and workmanship under normal use and service for a period of one year after purchase, and (b) the replaceable battery shall be free from defects in material and workmanship under normal use and service for a period of 90 days after purchase. Abbott makes no other warranties, express or implied, as to merchantability, fitness for a particular purpose, or any other matter.

Purchaser's exclusive remedy shall be, at Abbott's option, the repair or replacement of the product. In no event shall Abbott's liability arising out of any cause whatsoever (whether such cause be based in contract, negligence, strict liability, other tort, or otherwise) exceed the price of such product, and in no event shall Abbott be liable for incidental, consequential, or special damages or losses or for lost business, revenues, or profits. Warranty product returned to Abbott must be properly packaged and sent freight prepaid.

The foregoing warranty shall be void in the event the product has been misused, damaged, altered, or used other than in accordance with product manuals so as, in Abbott's judgment, to affect its stability or reliability, or in the event the serial or lot number has been altered, effaced, or removed.

The foregoing warranty shall also be void in the event any person, including the Purchaser, performs or attempts to perform any major repair or other service on the product without having been trained by an authorized representative of Abbott and using Abbott documentation and approved spare parts. For purposes of the preceding sentence, "major repair or other service" means any repair or service other than the replacement of accessory items such as batteries, flow detectors, detachable AC power cords, and patient pendants.

In providing any parts for repair or service of the product, Abbott shall have no responsibility or liability for the actions or inactions of the person performing such repair or service, regardless of whether such person has been trained to perform such repair or service. It is understood and acknowledged that any person other than an Abbott representative performing repair or service is not an authorized agent of Abbott.

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Section 3

SYSTEM OPERATING MANUAL

A copy of the system operating manual is included with every Plum A+3 infusion system. Insert a copy here for convenient reference. If a copy of the system operating manual is not available, **contact Abbott Laboratories Technical Support Operations** (*see Section 6.1, Technical Assistance*).

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Section 4

THEORY OF OPERATION

This section describes the Plum A+3 infusion system theory of operation. Related drawings are provided in *Section 9, Drawings*. The theory of operation details the general description, electronic subsystem overview, printed wiring assemblies (PWA), remote mounted peripherals, and mechanical overview of the infusion pump.

4.1

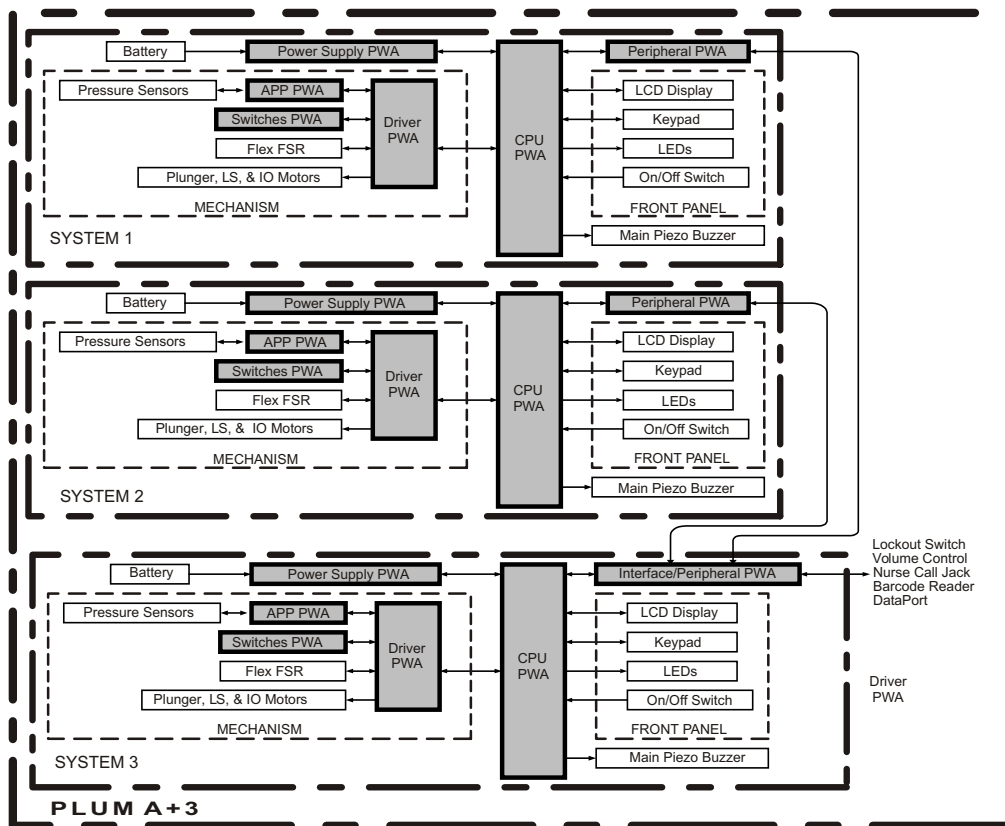
GENERAL DESCRIPTION

The infusion system consists of three component pumps which are designated line 1, line 2, and line 3. Each line includes the following features:

- Dose calculation
- Loading dose
- Multi-step programming
- Therapy selection
- Nurse call
- Delayed start setting
- Standby mode
- Drug label library
- Piggyback and concurrent delivery modes
- Titration
- 0.1-99.9 mL/hr flow rate range for both lines (in 0.1 mL/hr increments)
- 100-999 mL/hr flow rate range for both lines (in 1.0 mL/hr increments)
- Anti free-flow protection
- Air removal/backpriming
- Battery gauge
- Long battery life (6 hours) for emergency backup and temporary portable operation
- Air detection (proximal and distal)
- Serial communication
- Alarm history
- Plug-in barcode reader for drug identification (optional)
- Volumes infused (A, B, total volumes)
- KVO at dose end (1.0 mL/hr or less depending on delivery rate) or continue rate to continue
- Variable distal pressure setting
- Nonpulsatile volumetric accuracy
- Microprocessor control
- Large LCD
- Panel back illumination on mains power
- Lockout switch
- Standard fullfill, partfill, syringe, and vial use
- Enteral and parenteral fluid delivery
- Blood and blood product delivery
- Wide range of standard and specialty administration sets

Alarms include the following:

- Distal occlusion
- Proximal occlusion
- Proximal air-in-line
- Distal air-in-line
- Low battery
- Door open while pumping
- Lockout violation
- VTBI complete
- Valve/cassette test failure
- Nurse call
- No action alarm
- Infuser idle for two minutes




01K07015

Figure 4-1. Electronic Functional Diagram

4.2

ELECTRONIC SUBSYSTEM OVERVIEW

This section describes the function and electronic circuitry (see *Figure 4-1, Electronic Functional Diagram*) of three main subsystems in the infusion pump: CPU subsystem, power supply subsystem, and mechanism subsystem. Schematic diagrams of subsystem PWAs are in *Section 9, Drawings*.

 **Note:** An asterisk (*) denotes an active low or negative true logic signal.

4.2.1

CPU SUBSYSTEM

The CPU subsystem contains the main microcontroller, which is responsible for controlling the display/keyboard interface, external communications interfaces, barcode reader interface, and system management (see *Figure 9-12, Peripheral PWA Schematic*, and *Figure 9-14, CPU PWA Schematic*).

The CPU subsystem provides the following functions:

- External memory devices access
- LCD interfaces
- Real-time clock generator interface
- System watchdog
- Analog-to-digital and digital-to-analog converter interface
- Keypad interfaces
- Control and monitor status signals, such as LEDs, audible alarms, volume control, nurse call switch, and lockout switch
- Serial communication with host computer (DataPort) and barcode reader
- Power supply subsystem interface
- Mechanism subsystem interface

4.2.1.1

CPU

The central processing unit is a Motorola MC68302 CPU. The CPU has a closely coupled 16 bit data bus and 24 bit address bus, MC68000 microprocessor core, a system integration block for peripherals, and an RISC communications processor. The MC68302 is packaged in a 144 pin thin quad flat pack (TQFP) package and operates from a 3.3 V_{DC} power supply.

The on-chip peripheral devices are isolated from the system through the dual port RAM. The 1152 byte dual port RAM has 576 bytes of system RAM and 576 bytes of parameter RAM, which contains various peripheral registers, parameters, and the buffer descriptors for each of the three serial communication controller (SCC) channels and the serial communication port (SCP) channels. The 24 bit address bus is capable of accessing up to 16 MB of data.

4.2.1.2**SYSTEM MEMORY ADDRESS MAP**

The CPU has a 24 bit address bus when combined with UDS*/A0. The address bus is a bi-directional, three state bus capable of addressing 16 MB of data that is configured as 16 bits per word (including the IMP internal address space).

Each of the four programmable chip-select lines has two registers that define the starting address of a particular address space and the block size.

4.2.1.3**PROGRAMMABLE READ-ONLY MEMORY**

The CPU subsystem has two 512 K x 8 bit programmable read-only memory (PROM) memory devices, which provide a total of 1024 KB. The PROM space is expandable up to 2 MB. The PROM memory devices operate off the 3.3 V_{DC} supply.

The CPU chip-select 0 pin (CS0*), is connected to the PROM chip-enable (CE*) pin (signal CSROM*). This special chip-select signal can support bootstrap operation after reset. The interface to the CPU is the 16 bit data bus, and a 19 bit address bus. The address bus is connected to the ADDR<19:1> lines, and the data bus is connected to the DATA<15:0> lines.

4.2.1.4**STATIC RANDOM ACCESS MEMORY**

There are two 512 K x 8 bit CMOS static random access memory (SRAM) devices, which provide a total of 1024 KB of data memory. During an SRAM read or write cycle, the chip-enable (CE*) is controlled by the CPU chip-select pin 1 (CS1*, signal name (CSRAM*)). The SRAM space is expandable up to 2 MB. The SRAM operates off the 3.3 V_{DC} supply. The CPU subsystem includes the additional SRAM for video buffer and real-time clock. See [Section 4.2.1.6, LCD Controller](#), and [Section 4.2.1.9, Real-Time Clock](#).

4.2.1.5**CONTROL LOGIC**

The CPU PWA uses field programmable gate arrays (FPGA), which are high density, high speed, I/O intensive general purpose devices. They are used to implement all the digital control functions, including: memory-map address decoding; memory read-write enable; direct memory access (DMA) request; I/O status signals; chip-select control; motor control; sensor select; and power up/system reset control.

4.2.1.6**LCD CONTROLLER**

The liquid crystal display (LCD) controller is used to interface the LCD to the CPU. The device displays layered text and graphics, scrolls the display in any direction, and partitions the display into multiple screens. It stores bit-mapped graphic data in external frame buffer memory. The display controller functions include: transferring data from the controlling microprocessor to the buffer memory; reading memory data; converting data to display pixels; and generating timing signals for the buffer memory and LCD panel.

The LCD controller accesses 32 KB of frame buffer SRAM (video) via the controller's video address and data busses (VA<14:0> and VD<7:0>). The LCD controller external clock frequency is 8 MHz.

The interface to the CPU is through the lower 8 bits of the data bus, which is connected to DATA<7:0> lines, address line A1, and LCD chip-select signal CSLCD* (CS2*). This controller is also configured as 8080 family compatible interface device with all the control signals, such as WRLCD* (WR*) and RDLCD* (RD*), generated by the FPGA logic.

The LCD controller and the display memory are operated off the 3.3 V_{DC} supply. The output signal levels are shifted up to 5 V_{DC} by buffers for interface with the 5 V_{DC} LCD panel.

4.2.1.7

LCD BACKLIGHT CONTROL

The LCD panel is backlit by a cold cathode fluorescent tube (CCFT) lamp. The CCFT lamp requires 300 V_{rms} to operate; a current controlled DC to AC voltage inverter circuit is used to deliver a current regulated sine wave to the lamp. A switching regulator regulates the CCFT current by monitoring feedback pin 3, and varies its output duty cycle to drive a DC/AC inverter. Intensity control is achieved by superimposing a DC control signal with the feedback signal. The DC control signal is sourced by a voltage divider consisting of a digitally controlled non-volatile potentiometer and three series diodes.

The CPU can adjust LCD backlight intensity by selecting the digitally controlled non-volatile potentiometer and controlling TUBU/D and TUBINC* signals. The potentiometer has a five bit up/down counter with non-volatile memory. It is used to store one of 31 settings of the potentiometer. Each count represents 323 Ω with a range of 323 to 10 K Ω . The current counter value is stored in non-volatile memory after CSTUB* is returned high while the TUBINC* input is also high. The current counter value is not stored if CSTUB* is returned high and TUBINC* is low. The CCFT intensity is directly proportional to the CCFT current, where 0 mA_{rms} is minimum intensity and 5 mA_{rms} is maximum intensity. The CCFT current is inversely proportional to the counter value.

4.2.1.8

LCD CONTRAST CONTROL

A digitally adjustable LCD bias supply is used to control the LCD contrast over a range of -24 to -8 V_{DC}. It is digitally adjustable in 64 equal steps by an internal digital-to-analog converter (DAC). The CPU provides two signals, LCDADJ (ADJ) and LCDCTL (CTL), to interface with this device. On power up or after a reset, the counter sets the DAC output to the mid-range value.

Each rising edge of LCDADJ increments the DAC output. When incremented beyond full scale, the counter rolls over and sets the DAC to the minimum value. Therefore, a single pulse applied to LCDADJ increases the DAC set point by one step, and 63 pulses decrease the set point by one step.

4.2.1.9**REAL-TIME CLOCK**

The watchdog timekeeper chip includes a complete real-time clock/calendar (RTC), watchdog timer, alarm, and interval timer. The time/date information includes hundredths of seconds; seconds; minutes; hours; day; date; month; and year. The date at the end of the month is automatically adjusted for months with less than 31 days, including correction for leap year. The watchdog timekeeper operates in either 24-hour or 12-hour format with an AM/PM indicator. The device can be programmed to set up an interval timer, and it can generate an alarm every day, hour, or minute. These alarm functions may be used to schedule real-time related activities. A parallel resonant 32,768 Hz crystal oscillator drives the internal time base.

The external interface is a separate (non-multiplexed) 8 bit data bus and 6 bit address bus, with a contiguous address space of 64 bytes. When system power is turned off, a battery voltage input is available, which makes the RTC data non-volatile. The address bus is connected to the ADDR<6:1> lines, and the data bus is connected to DATA<7:0> lines. Since the CPU accesses are 16 bits wide, the RTC data is on the lower byte of the word.

The RTC chip-enable pin (CE*) is active low enabled for read and write operations. It is driven by the FPGA control logic, chip-select RTC signal (CSRTC*), which involves address decoding circuitry (*see Section 4.2.1.2*).

4.2.1.10**VOLTAGE MONITOR WATCHDOG TIMER**

It is important to protect the system during power transitions, and the CPU is reset after the V_{CC} power supply is applied. The microprocessor supervisory circuit generates an automatic reset output during power up, power down, or brownout conditions. When the V_{CC} falls below the reset threshold voltage of $2.90 V_{DC}$, the reset signal (RESET*) goes low and holds the microprocessor in reset for approximately 200 ms after V_{CC} rises above the threshold. The supervisory circuit includes a chip-select inhibit circuit, which is used to disable access to the real-time clock's non-volatile SRAM during power transitions and power down mode.

This device also provides a watchdog timer function to monitor the activity of the microprocessor. To service the watchdog timer immediately after reset, the device has a longer time-out period (1.6 second minimum) right after a reset. The normal time-out period (70 ms minimum) is effective after the first transition of watchdog input (WDI) after RESET* is inactive. If the microprocessor does not toggle WDI within the time-out period, both RESET* and watchdog out (WDO*) outputs are asserted low. The RESET* remains active low for a minimum of 140 ms and it resets the CPU. The WDO* remains low as long as the WDI remains either high or low for longer than the watchdog time-out period. After a reset, the software reads this memory-mapped bit to determine if the latest reset was a watchdog time-out.

4.2.1.11

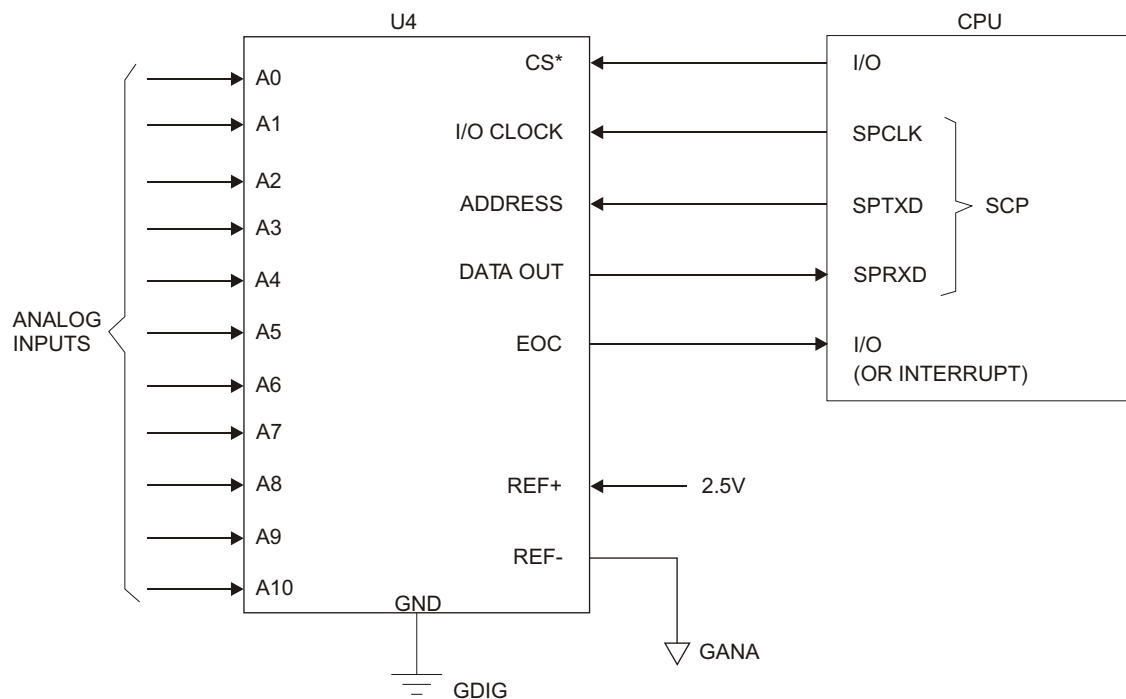
ANALOG-TO-DIGITAL CONVERTER

The analog-to-digital converter (ADC) monitors the proximal pressure sensor, distal pressure sensor, proximal air sensor, distal air sensor, battery charge/discharge current, battery voltage, buzzer test signal, LCD contrast voltage, CCFT test signal, and two chopper motor drive reference voltages. The ADC is an advanced 10 bit accurate, 11 channel, switched-capacitor, successive-approximation device. It has three inputs and a three-state output (chip-select, I/O clock, address input, and data out) that provide a direct four-wire interface to the serial communication port of the CPU. The ADC is designed to be used in conjunction with multiple serial devices on a common bus; consequently, the data-out pin is driven only when the chip-select (CS*) pin is asserted. *Figure 4-2, Serial Interface to ADC*, illustrates the serial interface between the ADC and the CPU.

In addition to a high-speed ADC and versatile control capability, this device has an on-chip 14 channel multiplexer that can select any one of 11 analog inputs or any one of three internal self test voltages. The sample-and-hold function is automatic. The end-of-conversion (EOC) output goes high to indicate that conversion is complete. The CPU polls the EOC signal.

Channel selection and conversion results are transferred through the SCP pins. A serial transfer synchronizing clock (SPCLK) must be fed into the I/O clock input pin when the CS* pin is driven low. The address to be converted is serially transmitted into the address pin, and the conversion results are serially shifted out the data-out pin. Typical access time is 21 microseconds. The air, pressure, and pin (APP) PWA is the source of the 2.5 V_{DC} reference voltage.

The analog inputs are selected by the channel multiplexer according to the input address (*see Table 4-1, Analog Inputs*). The input multiplexer is a break-before-make type to reduce input-to-input noise injection resulting from channel switching.



98K01022

Figure 4-2. Serial Interface to ADC

Table 4-1. Analog Inputs			
Signal Name	Analog Input	Address (hex)	Description
PRPRS	A0	\$00	Proximal pressure sensor
DIPRS	A1	\$01	Distal pressure sensor
PXAIR	A2	\$02	Proximal air sensor
DIAIR	A3	\$03	Distal air sensor
IBATT	A4	\$04	Battery current
VBATT	A5	\$05	Battery voltage
BUZTST	A6	\$06	Buzzer test voltage
LCDTST	A7	\$07	LCD contrast test voltage
TUBTST	A8	\$08	CCFT intensity test voltage
MI_STA	A9	\$09	Motor current A control
MI_STB	A10	\$0A	Motor current B control
		\$0B	$(V_{\text{ref}(+)} - V_{\text{ref}(-)}) / 2$
		\$0C	$V_{\text{ref}(-)}$
		\$0D	$V_{\text{ref}(+)}$

4.2.1.12**DIGITAL-TO-ANALOG CONVERTER**

The dual 8 bit digital-to-analog converter (DAC) generates two analog signals to control the phase A and phase B motor coil currents. The interface between the DAC device and the CPU is the 8 bit data bus, which is connected to DATA15:8. All the control signals for this DAC are generated by FPGA logic devices. Buffer amplifier/ground compensation circuits (U6 and U7) condition the DAC outputs.

4.2.1.13**FRONT PANEL KEYPAD MATRIX**

A 5 x 5 membrane switch keypad matrix is located on the front panel. The keypad column lines (COL4:0) are driven by open collector type memory mapped input ports, while the keypad row lines (ROW4:0), are read by memory mapped input ports. The keypad strobing, scanning, and switch de-bouncing is accomplished by software. The keypad interface is designed with ESD protection. Refer to *Table 4-2, Keypad Map*.

Table 4-2. Keypad Map					
	COL 0	COL 1	COL 2	COL 3	COL 4
Row 4	Softkey 1	Softkey 2	Softkey 3	Softkey 4	
Row 3	Start	1	2	3	[▲]
Row 2	Stop	4	5	6	
Row 1		7	8	9	[▼]
Row 0	On/Off	Clear	0	.	Silence

4.2.1.14**FRONT PANEL [ON/OFF] KEY**

The [ON/OFF] key on the front panel provides a start up (STRUP) signal to wake up the power supply when the system is shutdown. When activated during normal operation, the [ON/OFF] key interrupts (STRUPD*) the CPU, signaling a request for shutdown.

4.2.1.15**FRONT PANEL LED INDICATORS**

The CPU drives the three light emitting diode (LED) indicators embedded in the front panel. Two memory mapped I/O signals activate the two LED lights used to indicate which channel is in delivery mode (LEDAE*, LEDBE*). The AC power on LED indicates the status of AC power (LEDAC) and that the system is in the battery charge mode. A buffered AC on signal (BACON) drives the LED and is active only when AC power is present.

4.2.1.16**KEYPAD LOCKOUT INTERFACE**

A lockout switch (SW1) on the peripheral/interface PWA locks the front panel keypad for all three infusers. A memory mapped input port (LOTSW*) reads the switch. The switch serves as a lockout request and software performs the lockout.

4.2.1.17**NURSE CALL INTERFACE**

A nurse call relay switch on the peripheral/interface PWA indicates alarm conditions to a remote operator. A memory-mapped output signal (NURSE) activates the relay during alarm conditions. The relay has both normally open and normally closed contacts. A jumper on the peripheral/interface board selects the contact type. The factory setting is normally open.

4.2.1.18**AUDIBLE INDICATORS**

There are two audible indicators on the CPU subsystem. Three loud, main audible indicators are mounted on the main chassis, one per infuser. This main alarm is used for alerting the operator to alarm conditions. A keypad beeper (LS1), with lower power and a distinctly different tone, is used to provide audible feedback to the operator. The keypad beeper is driven by a memory-mapped output (KEYALM). It is used to indicate keypad activation, and confirmation to the operator.

The main alarm has an adjustable volume control on the peripheral/interface PWA (R2), mounted on the rear of the instrument. The main alarm can be activated by either a memory-mapped control (MAINALM), the reset pulse(s), or by a power failure alarm latch. The main alarm will sound a chirp for every reset pulse sent by the watchdog timer IC. Continuous chirping indicates a stuck processor.

The alarm is activated continuously during power failure. If the control software does not shut down power in a proper sequence, a latch on the CPU PWA (U2), powered by a backup supply (0.1 F supercap), will activate a continuous alarm. This continuous alarm sounds until either the backup supply is discharged or the user resets the latch by pressing the front panel [ON/OFF] key. Reliable operation of the main alarm is assured by software monitoring of a buzzer test signal (FBUZTST) via the ADC.

4.2.1.19**BARCODE READER INTERFACE**

The CPU communicates with a barcode wand that is connected to the peripheral/interface PWA from the rear of the infusion device. The barcode wand reads and decodes a Code 128 barcode symbology and outputs the barcode data via an RS-232 port using an asynchronous, serial ASCII format. The software controls power to the barcode reader and to the interface circuits via memory-mapped outputs BARPWR and COMPWR*. The barcode reader is isolated from the main system by an optical data path on the peripheral PWA (U10, U11, and U13) and an isolated power supply (U3 and T1).

4.2.1.20

DATAPORT INTERFACE

The CPU communicates with an external computer by way of a DataPort interface. The DataPort interface provides for remote monitoring of up to four pumps using a host computer with a modified RS-232-D serial interface. Pumps are either connected directly to the host or in a daisy chain configuration using junction boxes that provide a 5 bit hard ID via DIP switches on the junction box. The DIP switches are buffered (peripheral PWA U8) and read by the CPU via the memory-mapped input/output (MMIO) port.

The DataPort system conforms to the EIA-232-D standard, with the following exceptions:

- DataPort uses non-standard DB-15 and 6 pin modular connectors in addition to the standard DB-25 and DB-9 connectors
- With DataPort, more than one pump is allowed on the line
- The minimum line impedance is 2 K Ω (EIA-232-D standard: 3 K Ω min.)
- The maximum line impedance is 30 K Ω (EIA-232-D standard: 7 K Ω max.)
- The maximum line capacitance is 13 nF (EIA-232-D standard: 2,500 pF)

The communications default is 1200 BAUD, no parity, 8 data bits and 1 stop bit. The Plum A+3 BAUD rate is selectable (1200, 2400, 4800, and 9600). The data format on the serial port is a 10 bit frame with asynchronous start and stop. The CTS line is held high and the RTS line is disconnected.

The DataPort is isolated from the main system by an optical data path on the peripheral PWA (U10, U11, and U13) and an isolated power supply (U3 and T1).

4.2.1.21

POWER SUPPLY INTERFACE

The CPU subsystem interfaces the power supply subsystem by providing the MMIO signals needed for power control and battery management. Additionally, the CPU subsystem measures the battery terminal voltage and charge/discharge current via the ADC (*see Table 4-3, CPU-Power Supply Interface*).

Table 4-3. CPU-Power Supply Interface		
Signal Name	Type	Description
PWRHLD	D, O	Holds system power on
STRUP	A, I	Startup pulse from the [ON/OFF] key
STRUPD*	D, I	Digital startup pulse, used as interrupt to the CPU
V3_3	P	3.3 volt system power
V5_0/VANA	P	5.0 volt analog and interface power
VMOT	P	Raw, unregulated charger voltage or battery voltage
V2_7	P	2.7 volt backup power for RTC and non-volatile SRAM
VSC	P	Full time 5 volt supply, backed up by supercap
V12_0	P	12 volt, low current supply for audio alarm

Table 4-3. CPU-Power Supply Interface

Signal Name	Type	Description
OVRVLT*	D, I	Signal that indicates overvoltage, regulation problem on the power supply main regulator
BACON	D, I	Buffered AC on signal
IBATT	A, I	Voltage proportional to integration of battery charge/discharge current
VBATT	A, I	Divided battery terminal voltage
CHG*	D, O	Battery charger enable
VFLOAT*	D, O	Set the main regulator voltage to battery float charge level
ITGRST	D, O	Reset the charge current integrator

Legend: P = Power; A = Analog; D = Digital; I = Input; O = Output

4.2.1.22

MECHANISM INTERFACE

The CPU subsystem provides the MMIO ports for interface to the mechanism subsystem, in addition to the analog interface mentioned in the ADC and DAC sections (*see Section 4.2.1.11 and Section 4.2.1.12*). Refer to *Table 4-4* for CPU-mechanism interface signals.

Table 4-4. CPU-Mechanism Interface Signals

Signal Name	Type	Description
MI_STA	A, O	Motor current set for phase A
MI_STB	A, O	Motor current set for phase B
GDAC	A, O	Ground signal from chopper (for compensation)
M_PHA	D, O	Motor phase A
M_PHB	D, O	Motor phase B
M_SEL1, M_SEL0	D, O	Motor select bits
FLCAME	D, O	I/O and L/S cam flag sensors enable
FLPINE	D, O	L/S pin motion detectors enable
FLPLE	D, O	Plunger motor sensor pair enable
FLLS_C	D, I	Flag, L/S valve cam sensor
FLIO_C	D, I	Flag, I/O valve cam sensor
FLLS_A	D, I	Flag, L/S valve A pin detector
FLLS_B	D, I	Flag, L/S valve B pin detector
FLPLRO	D, I	Flag, plunger rotation sensor

Table 4-4. CPU-Mechanism Interface Signals		
Signal Name	Type	Description
FLPLTR	D, I	Flag, plunger translation sensor
PXPRE	D,O	Proximal pressure sensor enable
PXPRS	A, I	Proximal pressure sensor
DIPRE	D, O	Distal pressure sensor enable
DIPRS	D, O	Distal pressure sensor
PXARE	D, O	Proximal air sensor enable
PXAIR	A, I	Proximal air sensor
DIARE	D, O	Distal air sensor enable
DIAIR	A, I	Distal air sensor
CASPR*	D, I	Cassette present
CASS2*, CASS1*, CASSO*	D, I	Cassette type coding: Macro (111), Micro (010), all others are invalid
SPCLK	D, O	SCP clock output
SPRXD	D, I	SCP receive data
SPTXD	D, O	SCP transmit data
CSSEP*	D, O	Chip select, EEPROM
V5_0	P	5.0 volt supply for interface power
V3_3	P	3.3 volt supply for logic power
GDIG	P	Digital ground
VANA	P	5.0 volt supply for analog power
GANA	P	Analog ground
VMOT, GMOT	P	Motor power is directly from power supply PWA
V2_5	A, I	Reference voltage for ADC and DAC

Legend: P = Power; A = Analog; D = Digital; I = Input; O = Output

4.2.2

POWER SUPPLY SUBSYSTEM

The power supply subsystem provides DC power to system circuits and interface software controlled power and battery management (*see Figure 9-11, Power Supply PWA Schematic*). The power supply subsystem provides for the following functions:

- Main switching regulator
- AC power detection
- Main regulator fault detection
- System power (secondary regulators)
- Auxiliary supplies
- Power control
- Battery charging circuitry
- Battery terminal voltage measurement
- Battery charge/discharge current measurement

4.2.2.1

MAIN SWITCHING REGULATOR

The main source of power for the Plum A+3 is the AC line. The main switching regulator is a pulse width modulated, AC-to-DC converter which provides the system an isolated DC voltage of 6.9 V_{DC} (or 7.5 V_{DC} in battery charger boost mode). The main regulator is preceded by: line fuses F1 and F2, surge suppressor VR1, and a line filter (T3, T4, C54-56). The bridge rectifier U14 and capacitors C52 and C53 provide the DC voltage required for the switching circuit. Voltage regulator U13 provides the pulse width modulator (PWM) device U12 startup supply voltage. After startup, supply voltage for U12 is supplied by half wave rectifier circuitry CR14, R76, and C51.

The PWM oscillation frequency is approximately 40 kHz, determined by external resistor R72 and capacitor C45. U12 controls the power delivered by varying the duty cycle of the power metal-oxide-semiconductor field-effect transistor (MOSFET) Q9, which drives T2. A half-wave rectifier (CR9 and C37-C41) rectifies the transformer's secondary voltage, which provides the raw DC voltage for the battery charger and system power. There are three feedback mechanisms that maintain control: a main loop for normal control, a secondary loop for overvoltage protection, and a current limit loop.

4.2.2.1.1

Main Loop

The main loop uses an optical feedback path to regulate the charger voltage (BATPOS) at 6.9 V_{DC} (except during boost charge, when the limit is raised to 7.5 V_{DC} by software control of the VFLOAT* line). A shunt regulator and opto-isolator provide feedback to the PWM error amplifier.

4.2.2.1.2***Secondary Loop***

Diode CR10 and opto-isolator U10 provide overvoltage protection. CR10 conducts and activates U10 when secondary voltage exceeds approximately 10 V_{DC}. The duty cycle of U12 is reduced until the excessive voltage is removed.

4.2.2.1.3***Current Limit Loop***

The current limit loop is activated when the primary current, sensed by R71, exceeds 3.0 A. Resistor R70 and capacitor C46 filter the voltage across R71 and feed it back to the current sense input (1.5 V_{DC} threshold) of U12. The duty cycle of U12 is reduced until the excessive load is removed.

4.2.2.2**MAIN REGULATOR FAULT DETECTION**

If the switching regulator's main loop fails, the secondary voltage limit loop takes over. However, the battery charger and motors must be disabled, and an alarm must be generated. A comparator is used to monitor the raw DC (+BUSS) for overvoltage. A 3.3 V_{DC} logic signal (OVRVLT*) is provided to the CPU subsystem.

4.2.2.3**SYSTEM POWER**

Along with the unregulated VMOT supply, a secondary switching regulator provides system power. The secondary switching regulator includes IC U4, transformer T1, and transistors Q4 and Q5. The regulator is a triple output, wide supply range, fly-back converter that provides regulated 3.3 V_{DC}, 5.0 V_{DC}, and 12.0 V_{DC} outputs from the five winding transformer T1. The regulator operates over an input range of 4 to 10 V_{DC} and provides output current limit as well as voltage overshoot limit. Primary feedback is metered through a bias arrangement on transistor Q3. A Schottky rectifier diode CR4 provides feedback in the event of V3_3 or V12_0 failure, and transistor Q10 provides feedback in the event of V5_0 failure. The positive terminal of the battery provides the raw DC voltage, VMOT, for the motors and backlight of the display.

4.2.2.4**AUXILIARY SUPPLIES**

The power supply subsystem provides full time 5.0 V_{DC} and 2.7 V_{DC} supplies, which are active when battery or AC voltage is present. The full time 5.0 V_{DC} supply (VSC) uses a linear low dropout voltage regulator U6, whose power source is directly from the battery and is backed up by a 0.1 F capacitor. VSC is used for the ON/OFF switch and a power failure alarm latch. The full time 2.7 V_{DC} supply (V2_7) is derived from VSC and is used to supply the ultra-low current needed to power the real-time clock and non-volatile SRAM during shutdown.

4.2.2.5

POWER CONTROL

The infusion pump will operate in one of three modes: normal, standby, or shutdown. During normal operation, the user interface is active and either on battery or AC line power. During standby mode the user interface is inactive while the CPU is still operating, servicing the battery management and waiting for a startup interrupt. Shutdown mode is when system power is off. Shutdown mode only occurs during battery operation; otherwise, +BUSS holds the system power on.

The infusion pump is activated when the [ON/OFF] key is pressed or the AC line is plugged in. The [ON/OFF] key activates the STRTUP signal, triggering a three second one-shot circuit (C3, R10, CR1, and Q1) that will temporarily turn the system power on. This three second one-shot period allows the CPU enough time to power up, initialize, and turn on the PWRHLD signal. The CPU monitors the STRTUP signal, via interrupt, to signal a user request for turning off the infuser.

Figure 4-3, System Startup and Shutdown Timing, Battery Powered illustrates the system startup/shutdown sequence while battery powered. System power is always on while AC powered.

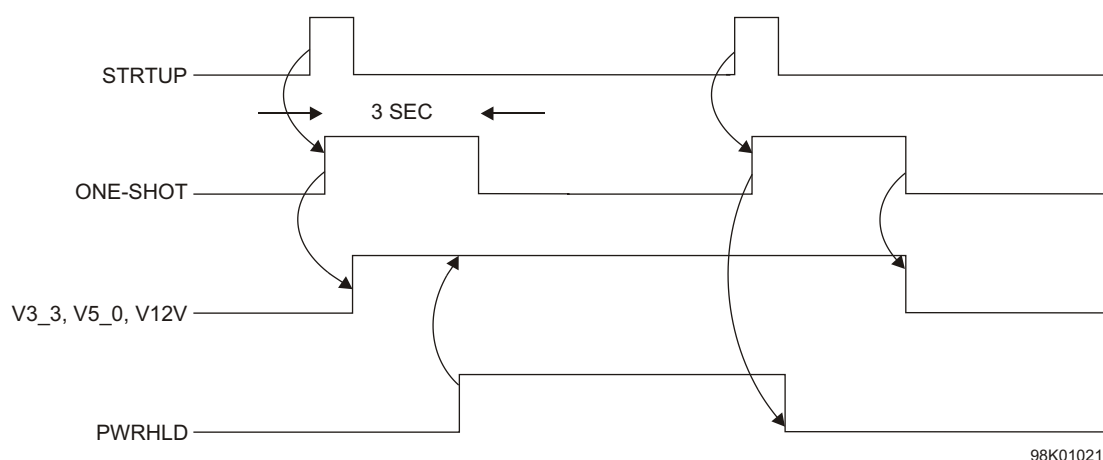


Figure 4-3. System Startup and Shutdown Timing, Battery Powered

4.2.2.6

BATTERY VOLTAGE MEASUREMENT

The battery terminal voltage (BATPOS - BATNEG) is measured with a differential amplifier consisting of U1, R1, R2, R4, R7, and R8. It has a gain of 0.317 to generate a single ended VBATT signal. The VBATT signal is then provided to the CPU A/D converter as input for the battery management algorithms.

4.2.2.7**BATTERY CHARGE/DISCHARGE CURRENT MEASUREMENT**

The battery management algorithms measure battery charge/discharge current for battery capacity estimation and charger control. The charge/discharge current is measured by integrating the voltage across current sense resistor R57. An operational amplifier (op-amp) integrator circuit, consisting of U2, C5, R12, R13, R19, and R20, provides a voltage proportional to the integration of battery current (IBATT) over a CPU controlled measurement period. The IBATT signal is fed to the CPU A/D converter, where it is sampled at the end of the measurement period. The battery management algorithm further accumulates the charge/discharge current for battery capacity estimation. The op-amp integrator is reset by the CPU system at the beginning of each measurement period by parallel analog switches U3, controlled by the CPU's ITGRST signal. The battery management algorithm periodically calibrates the op-amp integrator.

4.2.2.8**BATTERY CHARGER**

The software battery management algorithm controls the battery charger. The charging scheme is a current limit/two stage voltage limit charger. The charge current is limited to 1.3 A and the voltage is limited to either 6.9 V_{DC} or 7.5 V_{DC}.

The source of the charge current is power MOSFET transistor Q7 operating in the linear mode. Charge current passes through a current sense resistor R57, where it develops a feedback signal for the charger control amplifier consisting of U7, Q6, and associated parts. The feedback signal is compared against a 2.5 V_{DC} voltage reference U8. A .5 A fuse (F4) protects against damage due to a short circuit. The battery management algorithm maintains on/off control of the charger by the charger enable signal CHG*. When set high, CHG* activates a comparator U7, which overrides the feedback signal and disables the charger. Excessive voltage on the BATNEG terminal indicates that there is a shorted battery cell, and will disable the charger through the same comparator.

4.2.3**MECHANISM SUBSYSTEM**

The mechanism subsystem includes the electronics and electromechanical components that interface the Plum A+3 pumping mechanism (*see Figure 9-15, Driver PWA Schematic; Figure 9-16, Switch PWA Schematic; and Figure 9-17, APP PWA Schematic*). Refer to *Table 4-4* for mechanism interface signals.

The mechanism subsystem provides the following functions:

- Chopper motor drive for three stepper motors (plunger, L/S valve, I/O valve)
- Four motor position sensors (flag detectors)
- Precision voltage reference
- Two air sensors (distal, proximal)
- Two pressure sensors (distal, proximal)
- Cassette presence and type detection
- Serial electrically erasable PROM (EEPROM)

4.2.3.1

MOTORS/MOTOR DRIVE

The Plum A+3 infusion system uses three stepper motors for pumping: one for fluid displacement and two for cassette valve actuation. The stepper motors are driven, under step-by-step control from software, by a unipolar chopper drive.

4.2.3.1.1

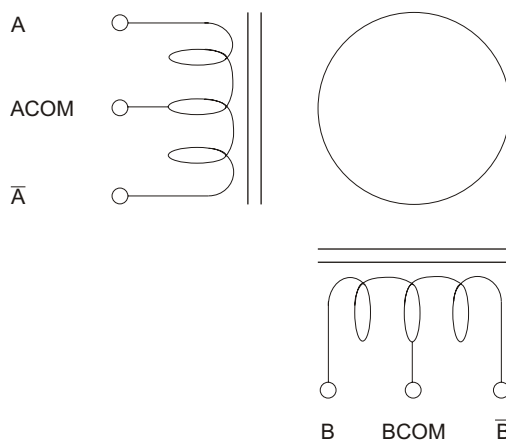
Stepper Motors

Each motor is named by its function:

- Plunger motor for driving the plunger screw
- I/O valve motor for moving the input-output valve pins
- L/S valve motor for moving the line select valve pins A and B

All three motors are four phase stepper types. One electrical revolution is accomplished after four motor steps (phases) are completed. The step-angle (the number of steps per shaft revolution) resolutions are 3.6 degrees/step (100 steps/rev) for the plunger motor, and 7.5 degrees/step (48 steps/rev) for the I/O and L/S valve motors.

The unipolar motor windings have a center tap connected on each of the two coils as shown in *Figure 4-4, Stepper Motor Coils*. Unidirectional current enters the center tap and is steered to one end of the coil or the other end by the driver electronics, creating positive or negative flux lines in the motor coil. With two coils each with a choice of flux polarity, four electrical combinations or phases are possible.



98K01020

Figure 4-4. Stepper Motor Coils

4.2.3.1.2***Chopper Motor Drive***

The Plum A+3 stepper motor drive is a chopper drive, which is a pulse width modulation of the coil current in each motor winding. Current is switched on and off to maintain a predetermined coil current independent of supply voltage and motor speed. The motor winding inductance acts as a filter to smooth out the switching currents, slowing the current rise when turned on and storing a decaying current when turned off.

Each motor coil is modulated independently, allowing different coil currents in the two motor windings. The coil current is sensed and compared to a reference input for each winding. Modulation circuits correct for any error between the sensed current and the reference. This reference input can be changed to set a different coil current.

4.2.3.2**MOTOR POSITION SENSORS**

Motor position is estimated by counting the motor steps, relative to a position reference. Optical switches and flags serve as position references, which are used to find the motor home positions and to verify proper motion. Flag positions are anticipated by software. Optical switch flag sensors are used for tracking the following:

- Plunger motor rotational position (coupler flag)
- Plunger translational (linear) position
- I/O valve motor rotational position (cam flag)
- L/S valve motor rotational position (cam flag)

Each optical switch consists of an infrared LED, which shines through a rectangular aperture, across a slot, to illuminate a photo-transistor. The photo-transistor is activated as long as the beam is on and not blocked (by a flag in the slot). The optical switches are distributed throughout the mechanism, near their associated flags. The motor rotational optical switches (U5, U9, and U10) are mounted on the driver PWA along with the control circuitry. The plunger translational optical switch is mounted remotely on the switch PWA. The switches are used intermittently to save power. There are two control signals that enable associated switch pairs:

- FLCAME flag, valve motor cam sensor enable
- FLPLE flag, plunger motor rotation and translation sensors enable

Each of these control signals enables a constant current source which turns on the associated switch's infrared LEDs. The photo transistor states are sensed by Schmidt trigger inverters (U11 on driver PWA) which provide a 3.3 volt logic high when the optical path is blocked or a logic low when the optical path is clear. The Schmidt trigger output is high when the sensor is disabled. The following output signals are provided to the CPU subsystem:

- FLIO_C flag I/O valve motor cam sensor
- FLLS_C flag L/S valve motor cam sensor
- FLPLRO flag plunger motor rotation sensor
- FLPLTR flag plunger motor transition sensor

4.2.3.3

V2_5 REFERENCE VOLTAGE

A precision 2.50 V_{DC} reference voltage is generated on the APP PWA for use by the pressure sensor excitation circuits, the air sensor amplifier circuits, and the ADC and DAC reference voltage. The precision 2.50 V_{DC} reference (U1) is buffered by a voltage follower (U3). The signal name is V2_5.

4.2.3.4

AIR SENSORS

The mechanism subsystem includes two air sensors, used to detect air passage into (proximal) or out of (distal) the cassette. Both sensors are piezoelectric crystal transmitter receiver pairs. Liquid between the transmitter and receiver will conduct the ultrasonic signal, while air will not (*see Figure 4-5, Air Sensor Block Diagram*).

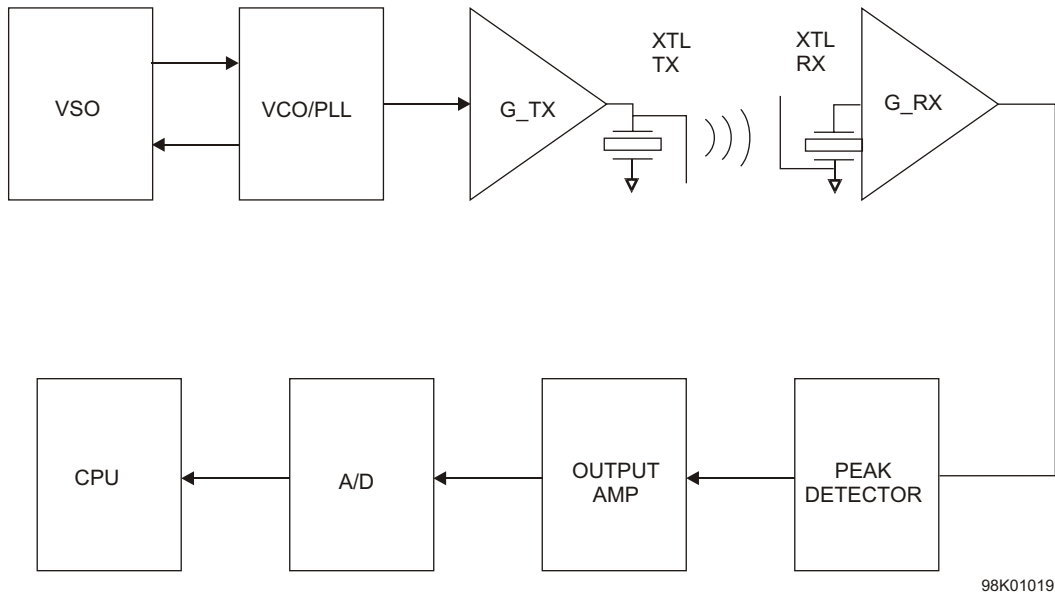


Figure 4-5. Air Sensor Block Diagram

4.2.3.4.1***Transmitter Circuitry***

The transmitter circuitry consists of a voltage sweep oscillator, a voltage-controlled oscillator (VCO), and a transmitter amplifier, and are located on the APP PWA.

The voltage sweep oscillator circuit (U10B, R24, C12, and part of U9) oscillates at approximately 12 kHz at 50 percent duty cycle. The output of the sweep oscillator is between $+2 V_{DC}$ and $+3 V_{DC}$, and is used to sweep the VCO. The VCO sweeps through the sensor's peak coupling frequency, which is between 3.0 and 6.0 MHz. A resistor and capacitor (R28 and C13) are used to configure the VCO center frequency. The VCO is enabled when the CPU asserts either DIARE or PXARE control signals.

The transmitter amplifier consists of a push-pull, emitter-follower, complementary pair of transistors (Q15 and Q16). The transmitter amplifier drives both proximal and distal sensors simultaneously.

4.2.3.4.2***Receiver Circuitry***

When the cassette's test port is filled with fluid, the transmitted signal will be coupled to an identical piezoelectric crystal, where it is amplified and detected by the receiver circuitry. The receiver circuitry consists of an amplifier, a peak detector, and an adjustable gain buffer stage. There is a separate, symmetrical receiver circuit for each channel (proximal and distal). Component references (called out in this design description) will be made to the distal channel only.

The first amplifier includes two, directly coupled common emitter stages (Q5 and Q7), biased from the V2_5 supply. DIARE and PXARE are used to enable the distal and proximal sensors, respectively.

The detector stage consists of an emitter follower (Q3), charging a 400 microsecond time constant, refreshed every 40 microseconds (twice per VCO sweep).

The peak detector output is buffered by an op-amp (U7) configured as a basic non-inverting amplifier with a trimming potentiometer (R31) for gain adjustment. Each sensor has an independent gain adjustment. The two air sensor, gain-trimming potentiometers are accessible for calibration in an assembled mechanism.

These final signals are read by the CPU subsystem via the ADC.

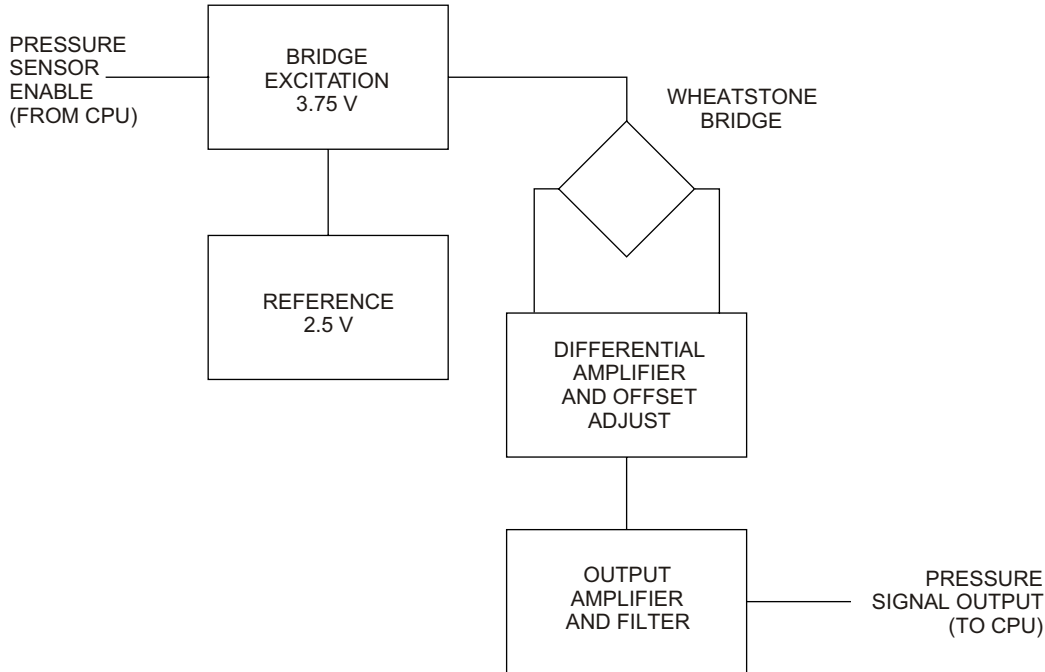
- PXAIR Proximal air sensor output
- DIAIR Distal air sensor output

4.2.3.5**PRESSURE SENSORS**

The mechanism subsection contains two strain gauge-type pressure sensors, one at the proximal and the other at the distal cassette ports. Electrically, the strain gauge is a Wheatstone bridge made of four strain gauge resistors. When the bridge is electrically excited, the bridge will output a millivolt level signal proportional to the applied pressure. The output signal is amplified and offset adjusted before being read by the ADC. Each pressure sensor circuit includes an excitation voltage supply, sensor amplifiers, and a low pass filter.

The pressure sensor circuitry is on the APP PWA. Each of the two channels has an identical topology, but different gain and filter response. A block diagram of this circuit is shown in *Figure 4-6, Pressure Sensor Excitation and Amplifier Block Diagram*.

Note: Component references are made to the distal channel only.



98G01018

Figure 4-6. Pressure Sensor Excitation and Amplifier Block Diagram

4.2.3.5.1

Bridge Excitation Supply

The bridge excitation voltage is 3.75 V_{DC}, and is derived from the 2.5 V_{DC} reference signal (V2_5), gained 1.5 times by amplifier (U8A, Q13). The CPU subsystem may independently enable power to each pressure sensor bridge.

These enable signals are active high 3.3 volt logic level inputs:

- PXPRES Proximal pressure sensor enable
- DIPRES Distal pressure sensor enable

4.2.3.5.2***Amplifier and Low Pass Filter***

The pressure sensor amplifiers include a high gain differential pre-amplifier (U4), followed by a second stage non-inverting amplifier (U6B) with low gain. A trimming potentiometer (R48) is adjusted to minimize any offset in the impedance of the bridge.

A two-pole filter is used to filter the pressure signals. The first pole is formed by a capacitor (C39, multiplied by 230 due to Miller effect) and a Thevenin resistance (seen at U4-2). The second pole is the RC filter at the ADC input, which is located on the CPU PWA.

These output signals to the A/D converter in the CPU PWA are:

- PXPRS Proximal pressure signal
- DIPRS Distal pressure signal

4.2.3.6**PRESSURE SENSOR CALIBRATION**

Pressure sensors are calibrated for offset and gain during mechanism calibration. A trimming potentiometer is used to adjust the initial, zero pressure offset. The proximal and distal pressure sensors have independent offset adjustments.

The final system gain (cassette pressure to corrected amplifier output) is adjusted in software. During mechanism calibration, each channel's gain (amplifier output/cassette pressure) will be measured, and stored in the serial EEPROM on the driver PWA.

4.2.3.7**CASSETTE TYPE/PRESENCE SELECTION**

The mechanism subsystem includes four force sensing resistor (FSR) switches, which are coupled to the cassette. Three FSRs are used for cassette type decoding and one is used for cassette present detection.

The FSR is a polymer thick film device, which exhibits a decrease in resistance with any increase in force applied to the active surface. The FSRs have a resistance that is either very large ($> 1 \text{ M}\Omega$) or relatively small ($< 100 \text{ K}\Omega$). The large resistance is defined as a logical '0', and the small resistance is defined as logical '1'. Each FSR is arranged in a voltage divider configuration with a fixed resistor, followed by a comparator with hysteresis. The comparator circuits are located on the CPU PWA. The comparators (CPU PWA: U8 and associated passives) are designed to trip as the FSR's resistance falls below $120 \text{ K}\Omega$.

4.2.3.8**SERIAL EEPROM**

The driver PWA holds the 8 K x 8 bit, serial EEPROM, which is used to store event, alarm, malfunction, and calibration data specific to the pumping mechanism. It is accessed through a serial peripheral interface (SPI) compatible interface, which is a high-speed serial interface to the CPU. The CPU PWA accesses this device through its SCP serial interface. This interface is a subset of the SPI, and consists of clock (SPCLK), data in (SPRXD), and data out (SPTXD) pins. This device is in the driver PWA to allow the calibration data to stay with the mechanism.

4.3

PRINTED WIRING ASSEMBLIES

The Plum A+3 electronics are packaged into six printed wiring assemblies (PWA) and several remote mounted peripherals (*see Section 4.4, Remote Mounted Peripherals*). The following sections provide a brief description of the functional interfaces of each PWA.

4.3.1

POWER SUPPLY PWA

The power supply PWA (*see Figure 9-11*) contains the following functions of the power supply subsystem:

- Main switching regulator
- AC power detection
- Main regulator fault detection
- System power
- Auxiliary supplies
- Power control
- Battery management

The power supply PWA is a four-layer printed wiring board (PWB), with primarily surface mount technology (SMT) components. The board is fully testable from the bottom side. An insulating tape covers the back of the power supply PWA. Open system troubleshooting should be done under battery power. If connection to the AC line is required, an isolation transformer should be used since AC line potentials are present on the power supply PWA.

See *Section 4.2.2* for a functional description, and refer to *Table 4-5* for power supply PWA interface connections.

Table 4-5. Power Supply PWA Interface Connections		
Connector	Type	Interface
P2	30 pin receptacle	Board-to-board connection to CPU PWA
J16	4 pin header	Motor power connection to driver PWA
J21	3 pin receptacle	AC power cord connection
J22	2 pin header	Battery cable connection

4.3.2

PERIPHERAL PWA

The peripheral PWA (*see Figure 9-13*) contains part of the CPU subsystem circuitry, including system program and data memories (PROM and SRAM), and external communication interface circuits. The peripheral PWA is designed to be field replaceable, to facilitate software upgrades or additional external interfaces. The peripheral PWA is a four-layer PWB, including one ground plane, one power plane, and two signal layers. In its initial configuration, all of the components are mounted on the top side.

See *Section 4.2.1* for a functional description, and refer to *Table 4-6* for peripheral PWA interface connections.

Table 4-6. Peripheral PWA Interface Connections		
Connector	Type	Interface
P1	96 pin receptacle	Board-to-board connection to CPU PWA
J26	15 pin D-sub	DataPort
J27	9 pin D-sub	Barcode reader connection
J28	3 pin phone jack	Nurse call jack

4.3.3

PERIPHERAL/INTERFACE PWA

The peripheral/interface PWA (*see Figure 9-12*) contains part of the CPU subsystem circuitry, including system program and data memories (PROM and SRAM), external communication interface circuits, and rear instrument user controls. The peripheral/interface PWA has internal logic to control selection of the barcode reader and lock out the selection of the barcode reader by another infuser until the operator completes the selection in process.

Refer to *Table 4-7* for peripheral/interface PWA interface connections.

Table 4-7. Peripheral/Interface PWA Interface Connections		
Connector	Type	Interface
P1	96 pin receptacle	Board-to-board connection to CPU PWA
J29 and J30	50 pin plug	Board-to-board connection to peripheral PWA
J26	15 pin D-sub	DataPort
J27	9 pin D-sub	Barcode reader connection
J28	3 pin phone jack	Nurse call jack

4.3.4

CPU PWA

The CPU PWA (*see Figure 9-14*) contains most of the CPU subsystem functions, with the exception of main memory and communications ports, which are located on the peripheral PWA. The CPU PWA also accommodates system interconnect. The CPU PWA is an eight-layer PWB, with one ground plane, one power plane, and six signal layers. The CPU PWA primarily contains SMT components. Most of the components are on the top side, while the bottom side holds wave-solder compatible SMT resistors and capacitors.

See *Section 4.2.1* for a functional description, and refer to *Table 4-8* for CPU PWA interface connections.

Table 4-8. CPU PWA Interface Connections		
Connector	Type	Interface
J7	96 pin header	Connection to peripheral PWA (CPU bus, rear panel I/O, and communication ports)
J2	30 pin header	Connection to power supply PWA
J3	50 pin SMT	Ribbon cable connection to driver PWA (mechanism)
J4	21 pin header	Front panel connector (keypad, LEDs, on/off switch)
J5	14 pin SMT	Flat flex cable to LCD panel
J20	4 pin header	CCFT backlight connector
J24	2 pin header	Main audible alarm connector

4.3.5

DRIVER PWA

The driver PWA (*see Figure 9-15*) contains the mechanism subsystem's motor drive circuitry, motor position sensors, and serial EEPROM. The driver PWA is mounted in the mechanism sub-chassis. The driver PWA is a four-layer PWB, with one ground plane, one power plane and two signal layers. The driver PWA primarily uses SMT components. Most of the components are located on the top side of the board, while the bottom side holds wave-solder compatible resistors and capacitors.

See *Section 4.2.3* for a functional description, and refer to *Table 4-9* for driver PWA interface connections.

Table 4-9. Driver PWA Interface Connections

Connector	Type	Interface
J7	6 pin header	Plunger motor
J8	6 pin header	Input/output motor
J9	6 pin header	Line select motor
J10	20 pin SMT	Flat flex cable to APP PWA
J11	50 pin header	Ribbon cable to CPU PWA
J12	6 pin SMT	FSR flex circuit
J13	4 pin header	Motor power, from power supply PWA
J14	8 pin SMT	Flat flex cable to switch PWA

4.3.6

SWITCH PWA

The switch PWA (*see Figure 9-16*) contains the plunger translation position sensor, which is one of four position sensors in the system. The switch PWA is located at the side of the mechanism sub-chassis, and connects to the driver PWA (*see Section 4.2.3.2*).

4.3.7

APP PWA

The APP (air, pressure, and pin) PWA (*see Figure 9-17*) is mounted in the mechanism sub-chassis. The APP PWA contains the following mechanism subsystem circuitry:

- Proximal and distal air sensors and circuitry
- Proximal and distal pressure sensor amplifiers and excitation
- V2_5 precision voltage reference
- Pin detector optical switch module

The APP PWA is a four-layer PWB, with one ground plane, one power plane and two signal layers. The APP PWA uses SMT components, mounted on both sides of the board. The air sensors and the pin detector module are board mounted.

See *Section 4.2.3* for a functional description, and refer to *Table 4-10* for APP PWA interface connections.

Table 4-10. APP PWA Interface Connections

Connector	Type	Interface
J15	20 pin SMT	Flat flex cable to driver PWA
J11	10 pin SMT	Pressure sensor connector

4.4

REMOTE MOUNTED PERIPHERALS

The following sections describe the major remote mounted peripherals.

4.4.1

LCD

The infusion pump uses a graphic LCD module with a CCFT. The CCFT provides a backlight source for the LCD. The LCD requires a nominal -16 V_{DC} supply for contrast control, which is controlled by the CPU. The pump's graphic display data is shifted out to the LCD by the CPU LCD controller, which interfaces directly with the CPU (*see Section 4.2.1.6*). The display is configured as a 240 x 240 dot matrix with a viewing angle of approximately 60 degrees.

4.4.2

SEALED LEAD ACID BATTERY

The infusion pump uses a nominal 6.0 V_{DC} rechargeable sealed lead acid battery with 4.0 amp-hour capacity.

4.4.3

BARCODE READER WAND

The barcode reader (BCR) wand connects to the BCR port J27 on the peripheral/interface PWA (*see Figure 9-12*). A PLD serving as a serial multiplexer installed in the peripheral/interface PWA determines which one of the three systems can use the BCR. The BCR wand interfaces through the infusion pump's optically isolated, TTL logic level, asynchronous interface. The BCR wand is also capable of interfacing at RS-232 levels. The infusion pump provides an isolated $+5.0\text{ V}_{\text{DC}}$ regulator to power the BCR wand. When the LED at the tip of the BCR wand is swiped across a barcode label, the reflected light is scanned and processed. After a successful scan, the data is sent over the communication interface to the CPU.

4.5

MECHANICAL OVERVIEW

The principal mechanical elements of the infusion pump include the cassette and the mechanism assembly. When a cassette is locked into the operating position and the [ON/OFF] switch is pressed, the infusion pump performs a self test to verify the integrity of the internal systems. The operation of the mechanism assembly moves a plunger, causing a pumping action. A valve motor selects the A or B valve, depending on the command. An additional valve motor alternately opens and closes an inlet valve and outlet valve to control fluid flow through the cassette pumping chamber.

The following sections detail the cassette and the mechanism assembly.

4.5.1 CASSETTE

The cassette operates on a fluid displacement principle to volumetrically deliver fluid (see *Figure 4-7, Major Elements of the Dual-Channel Cassette* and *Figure 4-8, Fluid Path in the Cassette*). Refer to the system operating manual for a description of the major cassette functions.

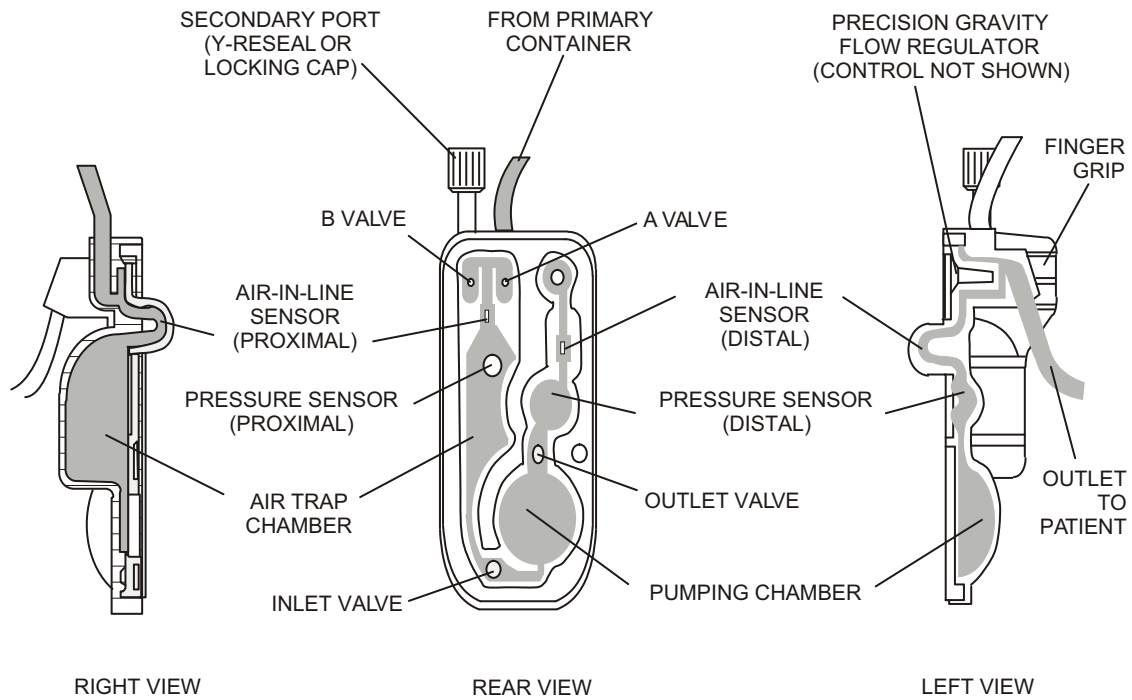
The pumping cycle begins when the outlet valve is opened and the inlet valve is closed. The plunger extends to deflect the cassette diaphragm and expel fluid. At the end of the pumping stroke, the outlet valve is closed, the inlet opens, the appropriate A or B valve opens, and the plunger retracts to allow fluid to refill the pumping chamber. After the pumping chamber is filled, the inlet and outlet valves are reversed, the A and B valves are closed, and the cycle repeats.

The cassette contains two chambers: an upper air trap chamber and a pumping chamber. The two chambers are separated by an inlet valve (see *Figure 4-7* and *Figure 4-8*) and operate together to detect air. The air trap chamber receives fluid from the intravenous (IV) container through either the A or B valve. The air trap chamber collects air bubbles from the IV line and container to prevent them from entering the pumping chamber and can collect a substantial amount of air.

A proximal air-in-line sensor (bubble detector) is located between the A/B valves and the upper air-trap chamber. The proximal air-in-line sensor detects air entering the upper air-trap chamber and initiates an audible alarm if the predetermined air collection threshold is exceeded. Similarly, a second air-in-line sensor located distal to the pumping chamber initiates an audible alarm if a predetermined amount of air is detected. The infusion pump expels air from the cassette.

The pumping chamber receives fluid from the upper air-trap chamber through an inlet valve. A pressure sensor located in the upper air-trap chamber monitors pressure on the proximal side of the cassette. When the diaphragm covering the pumping chamber is deflected by the plunger, the pumping chamber expels fluid through an outlet valve. A pressure sensor located distal to the pumping chamber monitors pressure on the distal side of the cassette.

A flow regulator is incorporated into the cassette distal end. This flow regulator is used to manually control flow when the cassette is not inserted in the infusion pump. When the cassette is properly inserted into the pump and the door is closed, a mechanism opens the flow regulator to allow the pump to control fluid flow. When the door is opened, the same mechanism closes the flow regulator to disable fluid flow.



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Figure 4-7. Major Elements of the Dual-Channel Cassette

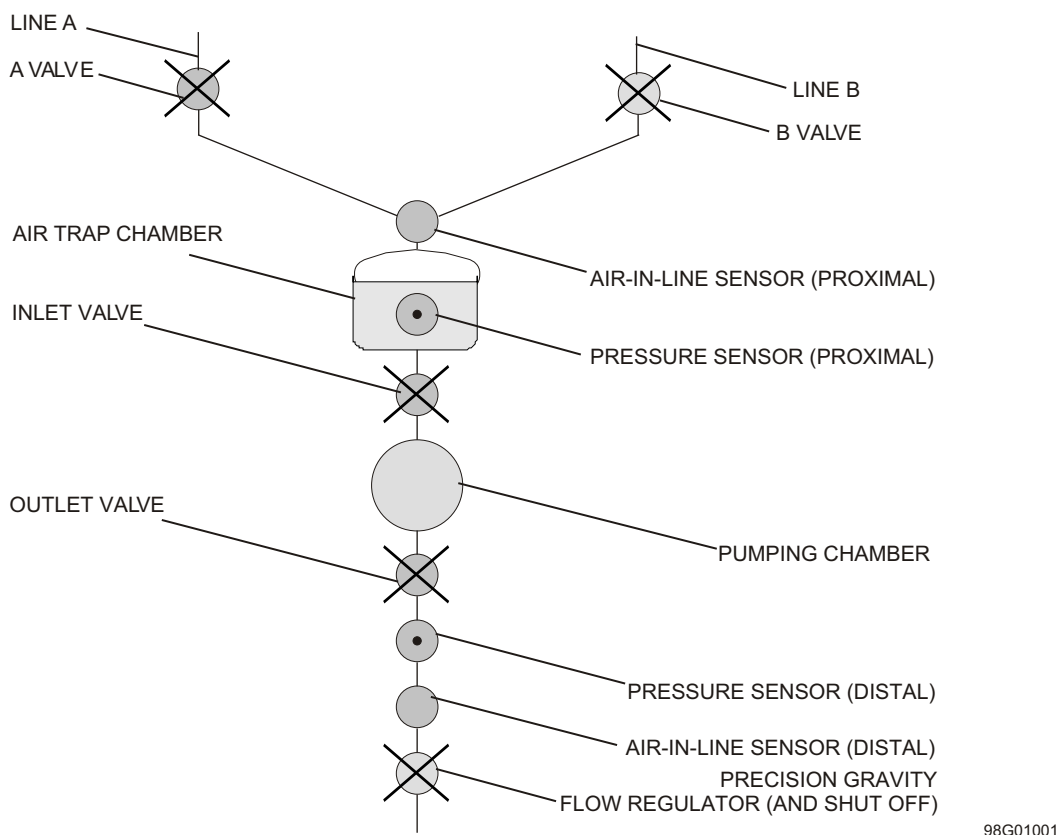


Figure 4-8. Fluid Path in the Cassette

4.5.2

MECHANISM ASSEMBLY

The mechanism assembly is a fully self-contained unit consisting of the motor and valve assemblies, A/B valve subsystem, inlet/outlet valve subsystem, plunger drive subsystem, air bubble (ultrasonic) sensor assemblies, cassette door, and pressure sensor assemblies. The motor and valve assemblies, A/B valve subsystem, inlet/outlet valve subsystem, and plunger drive subsystem are detailed in the following sections.

During pump operation, the mechanism assembly plunger motor drives a lead screw that is coupled to the plunger. The motor action and lead screw move the plunger forward to cause the delivery of approximately 0.33 mL of fluid per cycle. The plunger motion is synchronized to the valve motors to provide controlled fluid delivery.

4.5.2.1

MOTOR AND VALVE ASSEMBLIES

The mechanism assembly pumping action is controlled by three stepper motors. The first stepper motor, in conjunction with an associated valve assembly, activates the A or the B valve of the cassette, depending on the command. The second stepper motor alternately opens and closes the inlet and outlet valve to control fluid delivery through the cassette pumping chamber. A third stepper motor controls plunger movement.

4.5.2.2

A/B VALVE SUBSYSTEM

The A/B valve subsystem includes a motor designed to rotate a cam (see *Figure 4-9, Mechanism Valve Pins and Sensor Locations*). When the cam is positioned at top-dead-center (home position), both valves are closed. Clockwise rotation (when viewed from the motor side) from the home position opens the A valve, while the B valve remains closed. Counterclockwise rotation opens the B valve, while the A valve remains closed.

The A/B valve subsystem consists of a stepper motor with attached cam and integral cam flag, A and B rockers and valve pins, and a pin detector assembly. The cam flag passes through an interrupter module as it rotates with the cam. Valve home position is determined by this cam flag/interrupter module combination through predetermined factory calibration data. During operation, if the cam flag passes through the interrupter module at the incorrect time sequence, a motor phase loss is detected. The rocker is the connecting link between the cam and the valve pin.

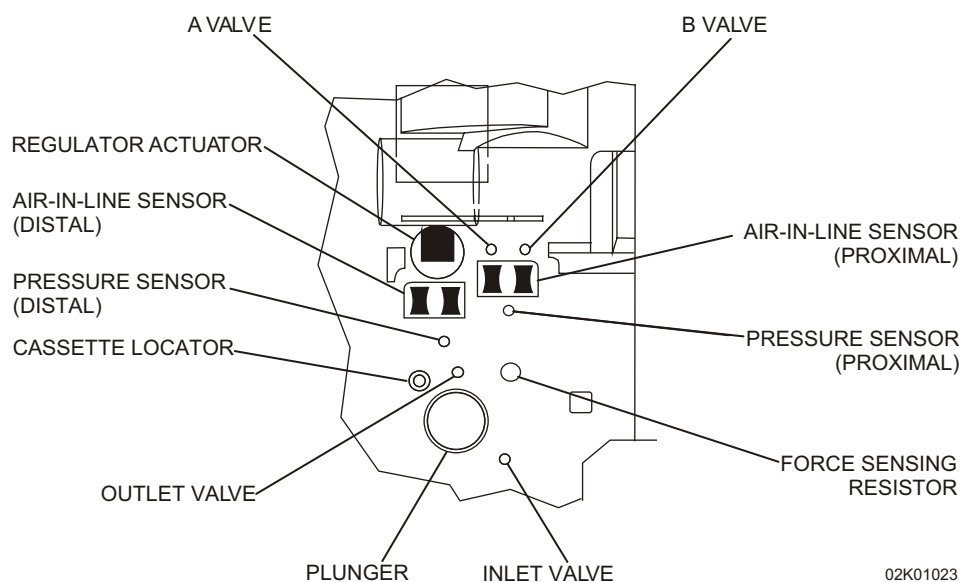


Figure 4-9. Mechanism Valve Pins and Sensor Locations

4.5.2.3

INLET/OUTLET VALVE SUBSYSTEM

The inlet/outlet valve subsystem is similar in function and build to the A/B valve subsystem (*see Section 4.5.2.2*).

4.5.2.4

PLUNGER DRIVE SUBSYSTEM

The main components of the plunger drive subsystem are: plunger, lead screw and coupler, and stepper motor. When the pump is turned on, the plunger moves from the retracted, PARK position to the HOME position. The cassette diaphragm is engaged. The stepper motor rotates approximately 1 2/3 revolutions per pump cycle to permit a 0.33 mL fluid displacement every pump cycle. The stepper motor then reverses and the plunger returns to HOME position. This cycle repeats for the duration of fluid administration.

The screw/coupler assembly links the motor and the plunger. This assembly includes a flag that passes through an interrupter module. This screw/coupler, flag/interrupter module combination is used in conjunction with predetermined factory calibration data to determine the plunger position. During operation, if the screw/coupler flag passes through the interrupter module at the incorrect time sequence, a motor phase loss is detected.

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Section 5

MAINTENANCE AND SERVICE TESTS

A complete maintenance program promotes infusion pump longevity and trouble-free instrument operation. Such a program should include routine maintenance, periodic maintenance inspection, and following any repair procedure, performance verification testing.

5.1 ROUTINE MAINTENANCE

Routine maintenance consists of basic inspection and cleaning procedures. As a minimum requirement, inspect and clean the infusion pump after each use. In addition, establish a regular cleaning schedule for the infusion pump.

5.1.1 INSPECTING THE INFUSION PUMP

Inspect the infusion pump periodically for signs of defects such as worn accessories, broken instrument connections, or damaged cables. In addition, inspect the infusion pump after repair or during cleaning. Replace any damaged or defective external parts. See *Section 5.2.2, Inspection*, for a detailed list of areas to be inspected.

5.1.2 CLEANING THE INFUSION PUMP

The following procedures are designed to maintain the infusion pump, sustain system longevity, and promote trouble-free instrument operation.

Follow hospital protocol for establishing the infusion pump cleaning schedule.

WARNING: DISCONNECT THE INFUSION PUMP FROM AC POWER PRIOR TO CLEANING THE INSTRUMENT. FAILURE TO COMPLY WITH THIS WARNING COULD RESULT IN ELECTRICAL SHOCK.

CAUTION: Do not immerse the infusion pump in liquids. Immersion could damage the instrument. Do not allow liquids to enter the infusion pump electronics compartment.

CAUTION: Do not spray cleaning solutions toward any openings in the infusion pump.

CAUTION: Certain cleaning and sanitizing compounds may slowly degrade components made from some plastic materials. Using abrasive cleaners or cleaning solutions not recommended by Abbott Laboratories may result in product damage and, potentially, void the product warranty. Do not use compounds containing combinations of isopropyl alcohol and dimethyl benzyl ammonium chloride.

CAUTION: Clean the exposed surfaces of the infusion pump with a soft, lint-free cloth dampened with one of the cleaning solutions listed in *Table 5-1, Cleaning Solutions*, or a mild solution of soapy water. Remove soap residue with clear water. Do not use solvents that are harmful to plastic, such as isopropyl alcohol or acetone. Do not use abrasive cleaners.


CAUTION: To avoid infusion pump damage, cleaning solutions should be used only as directed in *Table 5-1*. The disinfecting properties of cleaning solutions vary; consult the manufacturer for specific information.

Table 5-1. Cleaning Solutions		
Cleaning Solution	Manufacturer	Preparation
Coverage™ HB	Steris Corporation	Per manufacturer's recommendation
Dispatch™	Caltech Industries	Per manufacturer's recommendation
Formula C™	JohnsonDiversey	Per manufacturer's recommendation
Manu-Klenz®	Steris Corporation	Per manufacturer's recommendation
Precise™	Caltech Industries	Per manufacturer's recommendation
Sporicidin®	Sporicidin International	Per manufacturer's recommendation
Household bleach	Various	Per hospital procedures; do not exceed one part bleach in ten parts water

5.1.3

SANITIZING THE INFUSION PUMP

Sanitize the external surfaces of the infusion pump using a cleaning solution listed in *Table 5-1*.


 **Note:** Not all cleaning solutions are sanitizers. Check product labeling.


CAUTION: Do not sterilize the infusion pump using heat, steam, ethylene oxide (ETO), or radiation. These methods may cause the instrument to malfunction.

5.2

PERFORMANCE VERIFICATION TEST

The Performance Verification Test (PVT) consists of the tests described in the following sections. The PVT can be used for diagnostic purposes during the troubleshooting of a malfunctioning infusion pump. The PVT should be used for performance verification before an infusion pump is placed back in service after repair. If any malfunction is detected as a result of the PVT, refer to *Table 6-3, Troubleshooting with the PVT*.

 **Note:** The PVT must be performed exactly as described in this manual to assure effective and reliable product evaluation information.

 **Note:** When performing the PVT, all lines must be tested. However, if appropriate, the test may be performed on all lines concurrently.

5.2.1

EQUIPMENT REQUIRED

The PVT requires the following equipment (or equivalents):

- ☐ Graduated cylinder, 25 mL, with 0.2 mL graduations (Type A)
- ☐ Sterile water or tap water in an IV bag/container
- ☐ Digital pressure meter (DPM), 0 to 50 psi (Fluke® Biomedical DPM3)
- ☐ Three-way stopcock, latex-free (List No. 3233-01, or equivalent)
- ☐ IV Set (List No. 11419, or equivalent)
- ☐ 21-gauge butterfly needle, latex-free (List No. 4492-01, or equivalent), or 18-gauge blunt cannula
- ☐ Safety analyzer (Fluke Biomedical 232D)
- ☐ Stopwatch
- ☐ Digital multimeter (DMM), (Fluke Biomedical 8012A) (optional)
- ☐ Barcode directory (optional)
- ☐ Nurse call test cable (P/N 561-88416-001, or equivalent) (optional)

5.2.2

INSPECTION

Inspect the infusion pump periodically for signs of defects such as worn accessories or damaged cables. Also, inspect the infusion pump after repair or during cleaning. Replace any damaged or defective external parts.

Inspect the following areas for missing or damaged parts:

- | | |
|---------------------------------------|-----------------------------|
| - Labels | - External screws |
| - AC power cord | - Pole clamp assembly |
| - Velcro [®] retainer straps | - Front and rear enclosures |
| - Rubber foot pads | - Battery access cover |
| - Door assembly and handle | - LCD |
| - Keypad | - LEDs |

5.2.3

TEST SETUP

WARNING: A PATIENT SHOULD NEVER BE CONNECTED TO THE INFUSION PUMP DURING DEVICE TESTING.


To set up the infusion pump for the PVT, proceed as follows:

1. Confirm the infusion pump and appropriate accessories are assembled.
2. Hang two sterile water containers at a height of 18 ± 6 inches (46 ± 15.3 cm) above the pumping chamber of the device.
3. Connect the infusion pump to AC power. Conduct all tests with the pump connected to AC power unless otherwise specified.
4. Press [ON/OFF] to turn on the pump.
5. Verify the infusion pump is in the **unlocked** mode. Toggling the [LOCKOUT] switch alternates between **unlocked** [DOWN] and **locked** [UP] modes.
6. Press [ON/OFF] to turn off the pump.

5.2.4

SELF TEST


CAUTION: Do not place the infusion pump in service if the self test fails.

 **Note:** If an alarm condition occurs during the self test, cycle the power and repeat the self test. If the alarm condition recurs, note the message and take corrective action (*see Section 6, Troubleshooting*). Repeat the self test. If the alarm condition recurs, remove the Plum A+3 infusion system from service and **contact Abbott Laboratories**.

 **Note:** Screen representations are examples only, and do not necessarily reflect the most current software version.

To perform the self test, refer to *Figure 5-1, LCD and Keypad*, and proceed as follows:

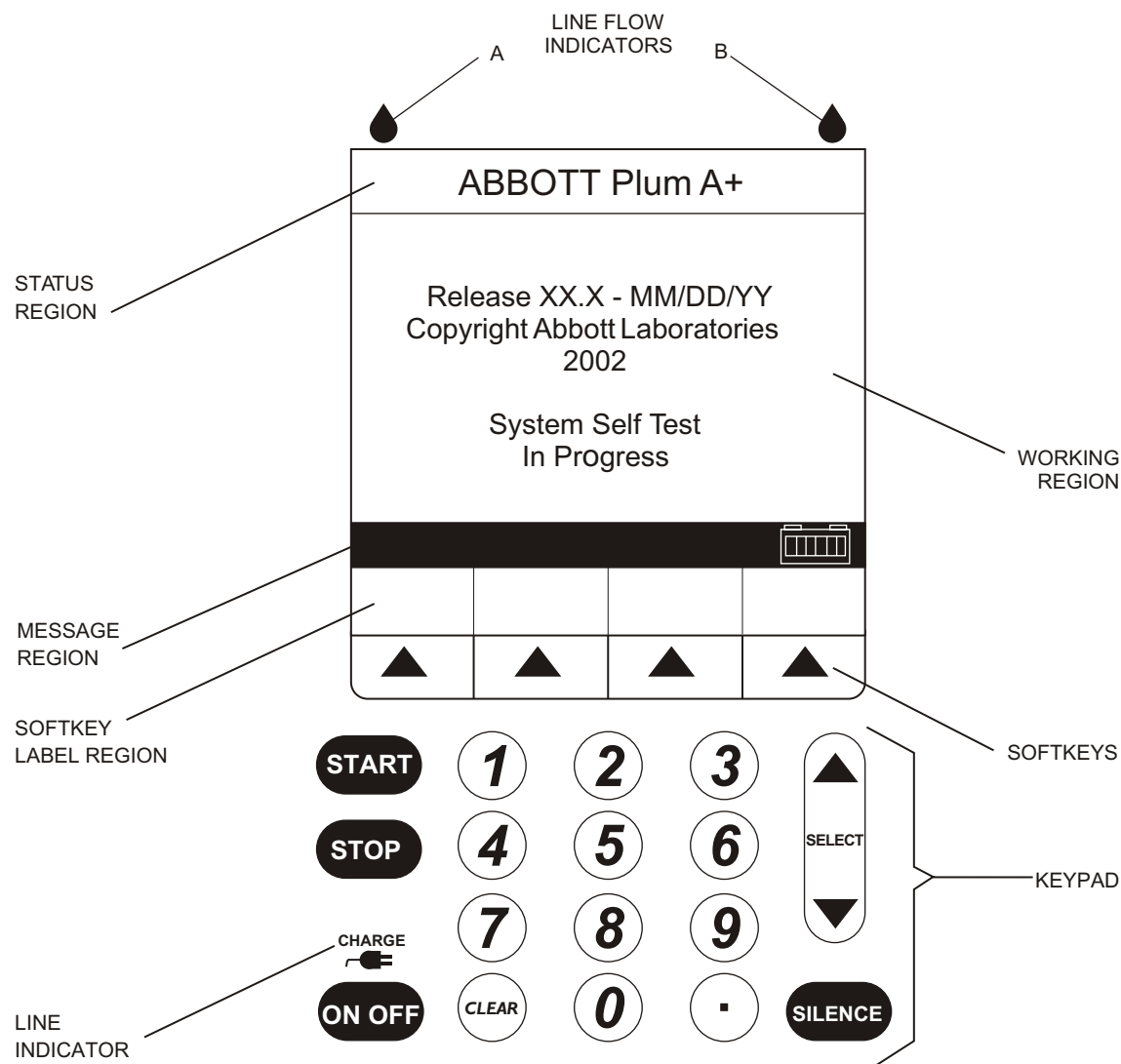
1. Connect the AC power cord to a grounded AC outlet. Verify the charging/line indicator **CHARGE** illuminates and an alarm beep sounds.
2. Without a cassette installed, press [ON/OFF] to turn on the pump.
3. The LCD screen briefly displays the **SELF TEST** screen. Verify the screen display matches *Figure 5-1*.

 **Note:** If the **SELF TEST** screen does not appear, **contact Abbott Laboratories**.

4. After the self test is complete, the message "INSERT PLUM SET CLOSE LEVER" appears. Press the decimal [.] key, then [START].
5. Using the [SELECT] key, select **Set Time and Date**, and press the [Choose] softkey.
6. Verify the time and date. To set the time and date, refer to *Section 1.8.3, Setting the Time and Date*.
7. Press [ON/OFF] to exit the **SET TIME AND DATE** screen.
8. Press [ON/OFF] to turn the pump back on.
9. Open the cassette door and insert a primed cassette. Close the cassette door. The cassette test is complete when the "CASSETTE TEST IN PROGRESS" message disappears.

 **Note:** The message "MECHANISM INITIALIZATION IN PROGRESS" may briefly appear prior to the "CASSETTE TEST IN PROGRESS" message.

10. If previously entered programming exists, the "CLEAR SETTINGS?" message appears. Press the [Yes] softkey to clear the settings.



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Figure 5-1. LCD and Keypad**5.2.5****CASSETTE ALARM TEST**


To perform the cassette alarm test, proceed as follows:

1. Verify the infusion pump is on. Insert an empty cassette and close the door.
2. Verify the "CASSETTE TEST FAIL" message is flashing on the display and the alarm sounds after the cassette test is complete.
3. Open the door and remove the cassette.
4. Press [ON/OFF] to turn off the pump.

5.2.6**FREE FLOW TEST**

To perform the free flow test, proceed as follows:

1. With a primed cassette installed, press [ON/OFF] to turn on the pump.
2. After the self test, press [Yes] to clear settings.
3. Place the distal end of tubing into a collection container a minimum of 36 inches below the cassette.
4. With the cassette door closed, check the distal end of the tubing for fluid flow. Verify a minimal flow of fluid occurs (a few drops maximum).
5. Open the cassette door and check the distal end of the tubing for fluid flow. Verify a minimal flow of fluid occurs (a few drops maximum).

 **Note:** A small amount of fluid may be expelled from the cassette when opening or closing the door.

6. Close the cassette door.

5.2.7**DISPLAY TEST**

To perform the display test, refer to *Figure 5-1*, then proceed as follows:

1. Verify the LCD backlight is illuminated and the display is clearly legible at eye level from approximately 18 inches.
2. With the pump in the **DELIVERY** screen, press the [Options/Vol Inf] softkey to select the **OPTIONS** screen.
3. Using the [SELECT] key, select **Lighting/Contrast**, and press [Choose].
4. Press the [Decrease Setting] and [Increase Setting] softkeys to change backlight intensity. Verify intensity decreases and increases.
5. Using the [SELECT] key, select **Display Contrast**.
6. Press [Decrease Setting] and [Increase Setting] to change display contrast. Verify the display contrast decreases and increases.
7. Press the [Cancel] softkey to return to the **OPTIONS** screen.
8. Press the [Back] softkey to return to the **DELIVERY** screen.

5.2.8**KEYPAD VERIFICATION/FUNCTIONAL TEST**

To perform the keypad verification/functional test, refer to *Figure 5-1*, then proceed as follows:

1. With the pump in the **DELIVERY** screen, press the [A] softkey to select **Line A**.
2. Verify the **PROGRAM** screen is displayed.
3. Using the numeric keypad, enter a rate of 123 mL/hr.
4. Using the [SELECT] key, select **VTBI**.
5. Using the numeric keypad, enter a VTBI of 4567 mL.
6. Press [START]. Verify fluid is pumping, the message "PUMPING" is displayed in the line A status bar, and the line A LED flashes.

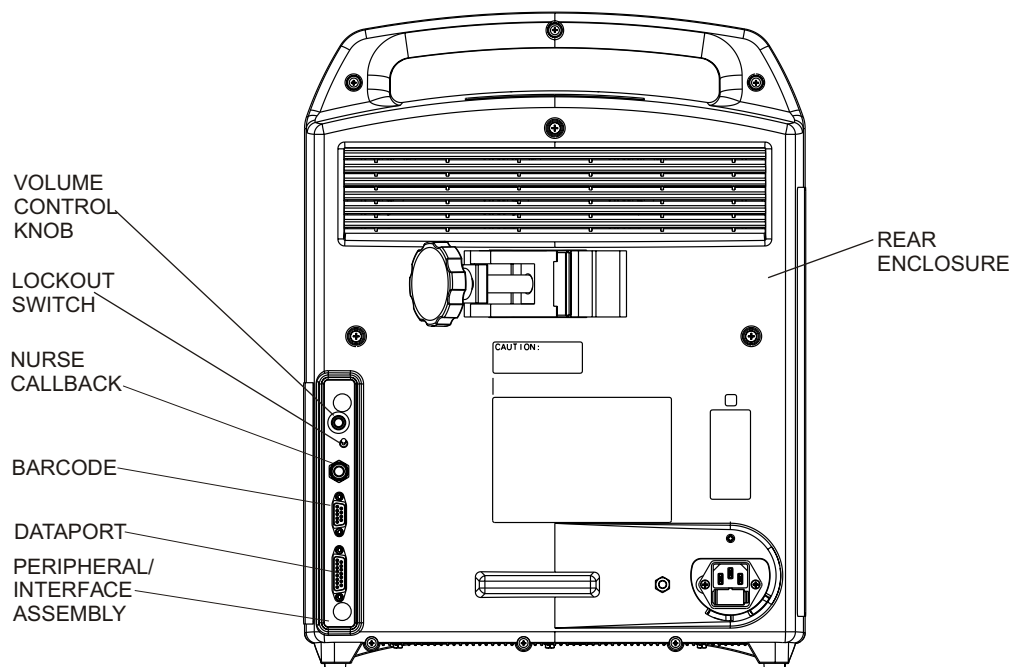
7. Press [STOP], then press and hold the [Backprime] softkey.
8. Verify the “BACKPRIMING” and “RELEASE BACKPRIME TO STOP” messages are displayed, and verify the pump is actually backpriming.
9. Release the [Backprime] softkey, press [START], and verify normal pumping operation.
10. Press the [B] softkey.
11. Verify **PIGGYBACK** is the displayed delivery mode. If necessary, change the delivery mode by pressing the [Change Mode] softkey.
12. Using the [SELECT] key, select **Rate**.
13. Using the numeric keypad, enter a rate of 890 mL/hr.
14. Using the [SELECT] key, select **VTBI**.
15. Using the numeric keypad, enter a VTBI of 2.0 mL.
16. Press [START] and verify fluid is pumping. Verify the message “PUMPING” is displayed in the line B status bar, the line B LED flashes, and line A goes into **Delayed** mode.
17. After 20 seconds, verify pumping has switched to line A.
18. Press [STOP].
19. Press [Options/Vol Inf]. Select **Volume Infused**, and press [Choose].
20. Using the [SELECT] key, select **Line A**.
21. Press the [CLEAR] key. Verify the line A volume is 0.0 mL and press [Enter].

5.2.9

ALARM LOUDNESS TEST

To perform the alarm loudness test, refer to *Figure 5-2, Rear Enclosure and Peripheral/Interface Assembly*, then proceed as follows:

1. Press the [A] softkey to select **Line A**.
2. Enter a rate of 400 mL/hr and a VTBI of 1 mL, then press [START].
3. Verify the alarm sounds when the dose has been delivered.
4. Turn the volume control knob between HIGH and LOW and verify the alarm loudness changes. The volume control knob is located on the peripheral/interface assembly.
5. Press the [SILENCE] key, and verify the alarm is silenced.
6. Press [STOP].



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Figure 5-2. Rear Enclosure and Peripheral/Interface Assembly

5.2.10 LOCKOUT SWITCH TEST

To perform the lockout switch test, refer to *Figure 5-2*, then proceed as follows:

1. Press the [A] softkey to select **Line A**.
2. Enter a rate of 400 mL/hr and a VTBI of 50 mL.
3. Press [START], and verify the pump is operating.
4. Toggle the lockout alarm switch up (ON) to engage the alarm. The lockout switch is located on the peripheral/interface assembly.
5. Press any key except [STOP], and verify an alarm sounds and the “HARD LOCKOUT ENABLED” message is displayed. Verify the pump continues to operate until [STOP] is pressed.
6. Press [STOP] and verify the “HARD LOCKOUT VIOLATION” message appears.
7. Toggle the lockout alarm switch down (OFF). Verify the “HARD LOCKOUT VIOLATION” message disappears and the alarm stops.
8. Press [START].
9. Open the door and verify the “DOOR OPEN WHILE PUMPING” message is displayed and the audio alarm activates.
10. Close the cassette door.
11. Press [No] at the “CLEAR SETTINGS?” prompt.

5.2.11

PROXIMAL OCCLUSION TEST


To perform the proximal occlusion test, proceed as follows:

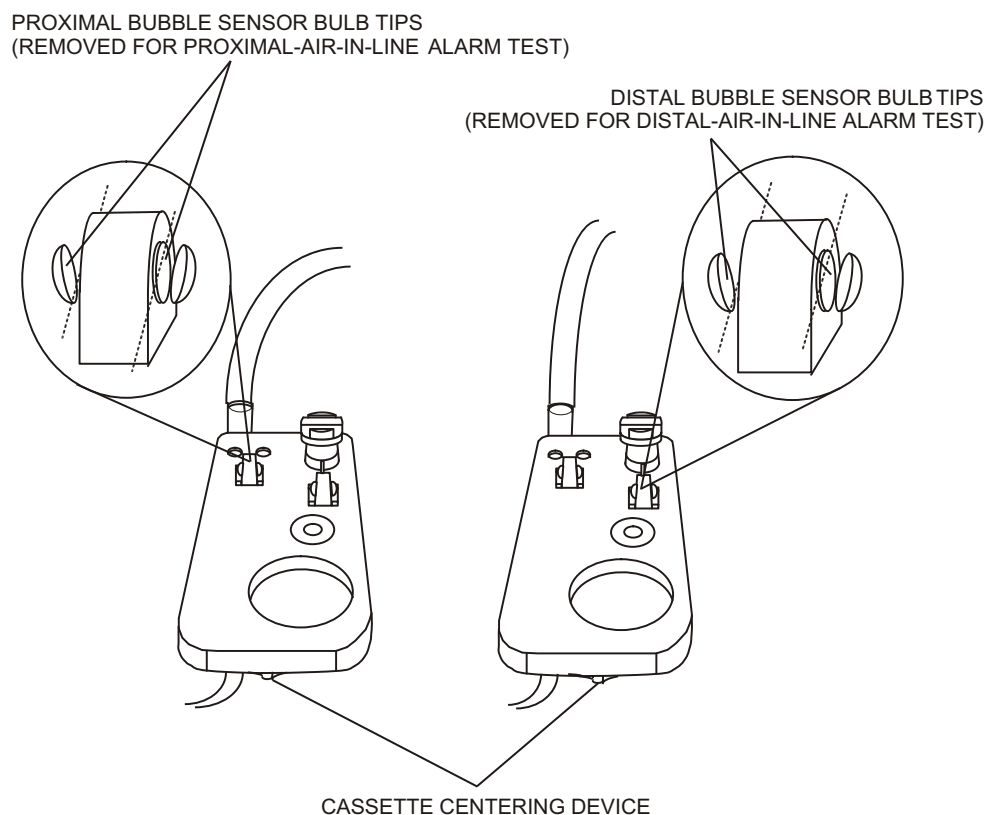
1. Press the [A] softkey to select **Line A**.
2. Enter a rate of 400 mL/hr and a VTBI of 50 mL.
3. Press [START].
4. After several pumping cycles, clamp line A tubing proximal to the cassette. Verify the “PROX OCCL A/AIR” message flashes and the alarm sounds before three pumping cycles are completed.
5. Press the [SILENCE] key and verify the alarm stops while the message on the display continues to flash.
6. Unclamp the proximal line and press [START]. Verify pumping resumes.
7. Press [STOP].

5.2.12

PROXIMAL AIR-IN-LINE TEST

To perform the proximal air-in-line alarm test, refer to *Figure 5-3, Special Cassettes with Bubble Sensor Tips Removed*, then proceed as follows:

1. Install the special cassette marked **proximal**, and close the cassette door.
 **Note:** Confirm the special cassette proximal bubble sensor tips are removed (*see Figure 5-3*).
2. Press [Yes] to clear settings.
3. Press the [A] softkey to select **Line A**.
4. Enter a rate of 400 mL/hr and a VTBI of 50 mL.
5. Press [START].
6. Before 1 mL of fluid is delivered, verify the alarm sounds and the “PROX AIR A. BACKPRIME” message is flashing on the display.
7. Press [STOP], open the door, and remove the special cassette.



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Figure 5-3. Special Cassettes with Bubble Sensor Tips Removed

5.2.13

DISTAL AIR-IN-LINE TEST

To perform the distal air-in-line alarm test, refer to *Figure 5-3*, then proceed as follows:

1. Install the special cassette marked **distal**, and close the cassette door.



 **Note:** Confirm the special cassette distal bubble sensor tips are removed (*see Figure 5-3*).

2. Press [Yes] to clear settings.
3. Press the [A] softkey to select **Line A**.
4. Enter a rate of 400 mL/hr and a VTBI of 50 mL.
5. Press [START].
6. Before 1 mL of fluid is delivered, verify the alarm sounds and the “DISTAL AIR” message is flashing on the display.
7. Press [STOP], open the door, and remove the special cassette.

5.2.14

DISTAL OCCLUSION TEST

To perform the distal occlusion test, refer to *Figure 5-4, Distal Occlusion Test Setup*, then proceed as follows:

1. Install the cassette and connect the distal tubing to the DPM through a three-way stopcock as illustrated in *Figure 5-4*. Close the cassette door.
 -  **Note:** A reflux valve may be attached between the stopcock and the DPM to keep moisture out of the DPM.
 -  **Note:** The height of the DPM must be 0 ± 12 inches from the midline of the pumping chamber.
2. Press [ON/OFF] to turn on the pump.
3. Press [Yes] to clear settings.
4. Press [Options/Vol Inf] to select the **OPTIONS** screen.
5. Using the [SELECT] key, select **Pressure/Post Infusion Rate**, and press [Choose].
6. Verify the distal pressure Limit is set at 6.0 psi. If the pressure limit is not 6.0 psi, use the numeric keypad to enter 6.0 and press [Enter].
7. Press the [A] softkey to select **Line A**.
8. Enter a rate of 40 mL/hr and a VTBI of 50.0 mL.
9. Open the three-way stopcock to air.
10. Press [START] and allow the infusion pump to stabilize for one minute. Verify all air is cleared from the tubing.
11. Set the three-way stopcock to measure pressure.
12. Verify the distal occlusion audible alarm occurs at 6.0 ± 2.0 psi. Verify the “DISTAL OCCLUSION” message is flashing on the screen.
13. Open the three-way stopcock to air.
14. Open and close the door. Press [No] at the “CLEAR SETTINGS?” prompt.
15. Press [Options/Vol Inf] to select the **OPTIONS** screen.
16. Using the [SELECT] key, select **Pressure/Post Infusion Rate**, and press [Choose].
17. Using the [SELECT] key, select **Distal Pressure Limit**.
18. Using the numeric keypad, enter 10.0 psi, and press [Enter].
19. Set the three-way stopcock to measure pressure, then press [START].
20. Verify the distal occlusion audible alarm occurs at 10.0 ± 2.0 psi. Verify the “DISTAL OCCLUSION” message is flashing on the screen.
21. Open the door and remove the cassette.

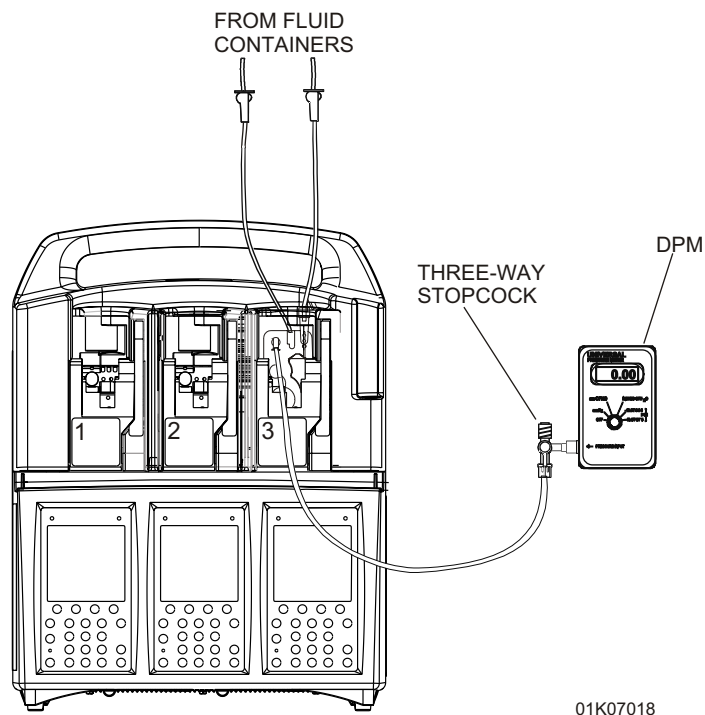


Figure 5-4. Distal Occlusion Test Setup

5.2.15

DELIVERY ACCURACY TEST


Note: Accuracy testing is for informational purposes only, and is not to be used as a re-release test. If there is any concern as to infusion pump accuracy, contact Abbott Laboratories.

CAUTION: Do not remove the protective cover from the 21-gauge needle.

To perform the delivery accuracy test, proceed as follows:

1. Install an 18-gauge blunt cannula or a 21-gauge needle to the distal end of the tubing. Verify the fluid container is 18 to 24 inches above the pumping chamber. Verify all lines are unclamped.
2. Place the distal output end of tubing into the graduated cylinder.
3. Press the [A] softkey to select **Line A**.
4. Enter a rate of 200 mL/hr and a VTBI of 10 mL. Start the stopwatch and press [START] simultaneously.
5. Press the [B] softkey to select **Line B**.
6. Verify the pump is in the **PIGGYBACK** delivery mode. Press [Change Mode] to change the delivery mode, if necessary.
7. Enter a rate of 200 mL/hr and a VTBI of 10 mL.

8. Press [START], and verify the pump switches to line B.
9. Verify the “KVO” message flashes on the display and an audible alarm sounds when total delivery is complete on line A.

 **Note:** When the “KVO” message appears, stop the stopwatch and press [STOP].

10. Verify the volume delivered is 20 mL ± 0.8 mL.
11. Use the following formula to calculate the delivery accuracy.

$$\frac{[(\text{Total volume delivered (mL)} \times (\text{18 sec/mL}))]}{\text{Total delivery time (sec)}}$$

An example:

$$\frac{[(20.4 \text{ mL}) \times (\text{18 sec/mL})]}{360 \text{ sec}} = 1.02$$

12. Verify the accuracy is 1.0 ± 0.04.

5.2.16

ELECTRICAL SAFETY TEST

To perform the electrical safety test, proceed as follows:

1. Connect the infusion pump AC power cord to a safety analyzer.
2. Connect the safety analyzer ground lead to the infusion pump ground test-point located on the rear of the pump.
3. Check the leakage current with the safety analyzer. Leakage current (both open and closed ground) must not exceed 100 microamperes AC_{rms}.
4. Measure the resistance of the AC connector ground lug with the safety analyzer. Resistance should not exceed 0.1 ohm.

5.2.17

END OF THE PVT

If all performance verification tests have been successful, proceed as follows:


1. Press [Options/Vol Inf]. Select **Volume Infused**, and press [Choose].
2. Press [CLEAR] to clear the volume infused.
3. Press [Enter].
4. Press the [A] softkey.
5. Press the [Clear Program] softkey.
6. Press [Yes] at the “CLEAR LINE A SETTINGS?” prompt.
7. Press [Cancel/Back] to return to the delivery screen.
8. Press the [B] softkey.
9. Press the [Clear Program] softkey.
10. Press [Yes] at the “CLEAR LINE B SETTINGS?” prompt

11. Reset the infusion pump to the original configuration.
12. Turn off the pump and return it to service.

 **Note:** If any tests fail, refer to [Section 6](#), or [contact Abbott Laboratories](#).

5.3

BARCODE READER WAND TEST (OPTIONAL)


 **Note:** The barcode reader wand test may be bypassed if the barcode reader function is not used.

To perform the barcode reader wand test, proceed as follows:

1. Remove the plastic cover from the 9-pin connector on the peripheral/interface assembly, and connect the barcode reader wand to the 9-pin connector.
2. Insert a primed cassette and close the door.
3. Press [ON/OFF] to turn on the infusion pump. Press [Yes] to clear settings.
4. Set the rate to 100 mL and the VTBI to 50 mL.
5. Verify the “WAND ACTIVE” message appears on the display.
6. Scan a barcode label from the barcode directory, and verify the corresponding drug name is displayed.

5.4

NURSE CALL TEST (OPTIONAL)

 **Note:** The nurse call test may be bypassed if the nurse call function is not used.

To perform the nurse call test, attach the nurse call test cable and proceed as follows:

1. Set the primary delivery rate to 400 mL/hr, and the primary dose limit to 1 mL.
2. Connect the DMM to the nurse call test cable.
3. Press [START] and verify pumping action.
4. After “DOSE END” and “KVO” appear on the display, observe a short circuit on the DMM (approximately 1 ohm on a scale of 0 to 100 ohms).

5.5

PERIODIC MAINTENANCE INSPECTION

Periodic maintenance inspections should be performed per hospital procedures for compliance to accreditation requirements. It is recommended that JCAHO and/or hospital protocol be followed for establishing an infusion pump periodic maintenance inspection schedule. Product specifications for this inspection are listed in [Section 8, Specifications](#).

To perform the periodic maintenance inspection, complete the PVT in [Section 5.2](#).

5.6

BATTERY OPERATION OVERVIEW

The Plum A+3 infusion pump is intended to operate on battery power on an exception basis only, such as emergency backup or temporary portable operation. Examples of emergency backup include AC power failure or inadvertent disconnection of the AC power cord. An instance of temporary portable operation includes patient transfer from one location to another.

The infusion pump should be connected to AC power whenever possible to allow the battery to remain fully charged. The line power indicator turns off and the **BATTERY** legend illuminates when the infusion pump is operating on battery power. The backlight extinguishes after one minute of pump operation on battery power.


Factors that most commonly affect battery life are the depth and frequency of discharge and the length of the recharge period. As a general rule, the more often the battery is discharged and recharged, the sooner it will need replacement. The primary cause of damage is leaving the battery in a less than fully charged state for any period of time. Battery damage can occur in a matter of hours and cause a permanent loss of battery capacity. The amount of lost capacity depends on the degree of discharge, the storage temperature, and the length of time the battery was stored in a discharged state.

 **Note:** A permanently damaged battery cannot be recharged to full capacity.

When the battery discharges below the acceptable level while the infusion pump is operating, the alarm sounds and the “LOW BATTERY” message displays. Although it is not recommended to continue operating the device on battery power at this point, the battery continues providing power until discharged. At this point, the infusion pump enters the battery discharged mode, a continuous audible alarm sounds and, after three minutes, operation ceases.

CAUTION: As soon as the LOW BATTERY alarm occurs, connect the infusion pump to AC power.

Recharging occurs any time the infusion pump is connected to AC power. It is recommended that the pump be connected to AC power whenever practical to maximize available battery charge during transport or ambulation. The device does not have to be on for the battery to recharge. Recharging while the infusion pump is operating is rate dependent.

 **Note:** The infusion pump should be operated on battery power for six continuous hours at least once every six months for optimum battery performance and life.

Section 6

TROUBLESHOOTING

This section contains information on technical assistance, alarm messages and error codes, and troubleshooting procedures for the Plum A+3 infusion system.

6.1

TECHNICAL ASSISTANCE

For technical assistance, product return authorization, and to order parts, accessories, or manuals within the United States, **contact Abbott Laboratories Technical Support Operations.**

1-800-241-4002

For additional technical assistance, including Technical Service Bulletins, technical training, and product information, visit the website at:

www.abbotthpd.com/service

Send all authorized, prepaid returns within the United States to the following address:

**Abbott Laboratories
Technical Support Operations
755 Jarvis Drive
Morgan Hill, California 95037**

For technical assistance, product return authorization, and to order parts, accessories, or manuals from outside the United States, contact the nearest Abbott Laboratories sales office.

6.2

ALARM MESSAGES AND ERROR CODES

Under most alarm conditions the infusion pump ceases normal operation, generates an audible alarm, and displays an alarm message or error code on the LCD screen.

There are two types of alarm conditions:


- alarm codes that can be cleared by the operator
- error codes that require qualified service personnel

See *Table 6-1, Operational Alarm Messages and Corrective Actions*, and *Table 6-2, Error Codes Requiring Technical Service*.

6.2.1

OPERATIONAL ALARM MESSAGES

Table 6-1 lists infusion pump alarm codes that can be cleared by the operator. Also listed in *Table 6-1* are the alarm messages, descriptions, possible causes, and corrective actions.

 **Note:** Operational alarm messages are displayed on the LCD screen. Associated error codes are displayed in the alarms log (*see Section 1.8.2*).

 **Note:** If an alarm message persists, **contact Abbott Laboratories**.

 **Note:** Air-in-line on either line applies to both lines.

Table 6-1. Operational Alarm Messages and Corrective Actions				
Alarm Code	Alarm	Description	Possible Cause	Corrective Action
N100 or E100 (URC)	Unrecognizable cassette	Incorrect cassette type	An incorrect cassette is inserted	Insert proper cassette
N101 or E101 (NAA)	No action	No operator action and no delivery for two minutes during delivery parameters entry	Interruption or a partial change to a program	Complete programming of the pump
N102 or E102 (RL)	Infuser idle 2 minutes	Infuser in reset or idle for over two minutes	Programming set without start for two minutes	Press [START]
N103 or E103 (SEEP CRC)	NV RAM lost thrpy data	Therapy data is lost	Infuser did not complete the previous non-volatile memory write successfully	Re-enter all programmed data
N104 or E104 (NC2)	Nurse Callback B	Delivery line B has changed (if alarm is enabled)	End of delivery step on line B other than VTBI complete while callback is enabled	Press[SILENCE]
N105 or E105 (NC1)	Nurse Callback A	Delivery line A has changed (if alarm is enabled)	End of delivery step on line A other than VTBI complete while callback is enabled	Press[SILENCE]
N160 or E160 (VTB2)	Line B VTBI complete	Programmed volume to be infused completed on line B	VTBI is complete on line B	Press[SILENCE] and replace IV bag, and restart line B

Table 6-1. Operational Alarm Messages and Corrective Actions

Alarm Code	Alarm	Description	Possible Cause	Corrective Action
N161 or E161 (VTB1)	Line A VTBI complete	Programmed volume to be infused completed on line A	VTBI is complete on line A	Press[SILENCE] and replace IV bag, and restart line A
N180 or E180 (OD1)	Distal Occl	Peak distal occlusion, non-delivery	Distal occlusion detected during non-delivery	Backprime the cassette and restart pump
N181 or E181 (OD1)	Distal Occl	Negative distal occlusion, non-delivery	Distal occlusion detected during non-delivery	Backprime the cassette and restart pump
N182 or E182 (OP2)	Prox. Occl B	Negative proximal occlusion B, non-delivery	Proximal occlusion detected on line B during non-delivery	Backprime the cassette and restart line B or Stop all lines, backprime the cassette, and restart all lines
N183 or E183 (OP2)	Prox. Occl B	Peak proximal occlusion B, non-delivery	Proximal occlusion detected on line B during non-delivery	Backprime the cassette and restart line B or Stop all lines, backprime the cassette, and restart all lines
N184 or E184 (OP1)	Prox. Occl A	Negative proximal occlusion A, non-delivery	Proximal occlusion detected on line A during non-delivery	Backprime the cassette and restart line A or Stop all lines, backprime the cassette, and restart all lines
N185 or E185 (OP1)	Prox. Occl A	Peak proximal occlusion A, non-delivery	Proximal occlusion detected on line A during non-delivery	Backprime the cassette and restart line A or Stop all lines, backprime the cassette, and restart all lines
N186 or E186 (OD1)	Distal Occl	Peak distal occlusion, delivery	Distal occlusion detected during delivery	Fix occlusion (closed clamps; kinked tubing), and restart pump

Table 6-1. Operational Alarm Messages and Corrective Actions

Alarm Code	Alarm	Description	Possible Cause	Corrective Action
N187 or E187 (OD1)	Distal Occl	Negative distal occlusion, delivery	Distal occlusion detected during delivery	Fix occlusion (closed clamps; kinked tubing), and restart pump
N188 or E188 (OP2)	Prox. Occl B	Negative proximal occlusion B, delivery	Proximal occlusion detected during delivery on line B	Fix occlusion (closed clamps; kinked tubing), and restart line B or Stop all lines, fix occlusion (closed clamps; kinked tubing), and restart pump
N189 or E189 (OP2)	Prox. Occl B	Peak proximal occlusion B, delivery	Proximal occlusion detected during delivery on line B	Fix occlusion (closed clamps; kinked tubing), and restart line B or Stop all lines, fix occlusion (closed clamps; kinked tubing), and restart pump
N190 or E190 (OP1)	Prox. Occl A	Negative proximal occlusion A, delivery	Proximal occlusion detected during delivery on line A	Fix occlusion (closed clamps; kinked tubing), and restart line A or Stop all lines, fix occlusion (closed clamps; kinked tubing), and restart pump
N191 or E191 (OP1)	Prox. Occl A	Peak proximal occlusion A, delivery	Proximal occlusion detected during delivery on line A	Fix occlusion (closed clamps; kinked tubing), and restart line A or Stop all lines, fix occlusion (closed clamps; kinked tubing), and restart pump

Table 6-1. Operational Alarm Messages and Corrective Actions

Alarm Code	Alarm	Description	Possible Cause	Corrective Action
N230 or E230 (APT)	Prox. Air Total	Proximal air-in-line total	500 microliters of air entered the cassette	Backprime the cassette and restart pump or Remove and manually reprime the cassette, and restart pump
N231 or E231 (APB)	Prox. Air on B	Proximal air-in-line on line B	500 microliters of air entered the cassette on line B	Backprime the cassette and restart line B or Remove and manually reprime the cassette and restart pump
N232 or E232 (APA)	Prox. Air on A	Proximal air-in-line on line A	500 microliters of air entered the cassette on line A	Backprime the cassette and restart line A or Remove and manually reprime the cassette and restart pump
N233 or E233 (ADC)	Distal Air Cumulative	Distal air cumulative	500 microliters of air detected in the last 5.3 mL of fluid delivered	Remove and manually reprime the cassette and restart pump
N234 or E234 (ADB)	Distal Air Bolus	Distal air bolus	100 microliters bolus of air detected at distal sensor	Remove and manually reprime the cassette and restart pump
N250 or E250 (DCO1)	Door opened while pumping	Door opened while pumping	Door opened while pumping	Turn off the pump or Insert the cassette and close the door
N251 or E251 (CS1)	Valve/Cass Test Fail	Valve/cassette test failure	Valve/cassette fails the leak test	Replace cassette and retest or backprime and retest
N252 or E252 (BDP)	Depleted Battery	Discharged battery	The battery is discharged to the recommended maximum discharge condition	Connect the pump to AC power or Recharge or replace the battery

Table 6-1. Operational Alarm Messages and Corrective Actions

Alarm Code	Alarm	Description	Possible Cause	Corrective Action
N253 or E253 (LOV)	Lockout Violation	Lockout violation	The use of the [STOP] key or an attempt to open the door while lockout switch is locked	Unlock the lockout switch
N254 or E254 (FPL)	Lockout Enabled	Keypad locked	Any action not resulting in stopping of the delivery while the lockout switch is locked	Unlock the lockout switch
N255 or E255 (SLV)	Soft lockout violation	Soft lockout violation	The use of the [STOP] key or an attempt to open the door while soft lockout is locked	Enter .963 key code
N256 or E256 (SLE)	Soft lockout enabled	Soft lockout enabled	Any action not resulting in stopping of the delivery while the soft lockout locked	Enter .963 key code

6.2.2

ERROR CODES REQUIRING TECHNICAL SERVICE

Table 6-2 lists infusion pump error codes that require technical service. Also listed in *Table 6-2* are malfunction descriptions, possible causes, and corrective actions.

Table 6-2. Error Codes Requiring Technical Service

Error Code	Malfunction	Possible Cause	Corrective Action
E300	ADC failure	Analog to digital converter failure	Replace CPU PWA (see Section 7.2.14.6) Reset time and date, if required (see Section 1.8.3)
E301	Audio alarm failure	Piezo is off but sensed on or Piezo is on but sensed off	Turn power off, then on, to reset the pump Replace CPU PWA (see Section 7.2.14.6) Reset time and date, if required (see Section 1.8.3)

Table 6-2. Error Codes Requiring Technical Service

Error Code	Malfunction	Possible Cause	Corrective Action
E302	Backlight failure	Backlight (CCFT tube) is not at the expected range	Turn power off, then on, to reset the pump Replace LCD (see Section 7.2.14.3) and/or CPU PWA (Section 7.2.14.6) Reset time and date, if required (see Section 1.8.3)
E320	Battery charge current out of range	Battery charge current is out of range after six hours	Replace battery (see Section 7.2.4) Replace power supply PWA (see Section 7.2.14.1) Reset time and date, if required (see Section 1.8.3)
E321	Battery not charging	Battery charging timed out Complete battery discharge has occurred	Charge battery for additional six hours Replace power supply PWA (see Section 7.2.14.1) Reset time and date, if required (see Section 1.8.3)
E322	Battery current calibration value out of range	Battery integrator calibration value is out of range	
E323	Battery trickle charge current out of range	Battery trickle charge current is out of range	
E324	Supply overvoltage	An overvoltage condition is detected in the charging circuit	
E325	Battery overvoltage	An overvoltage condition is detected in the battery	Check for loose battery connections Replace battery (see Section 7.2.4) Reset time and date, if required (see Section 1.8.3)
E326	Battery disconnected	Battery disconnected while pump is powered on	
E340	Critical instruction failure	Power-up CPU register test failed (no malfunction message displayed)	Replace CPU PWA (see Section 7.2.14.6) Reset time and date, if required (see Section 1.8.3)

Table 6-2. Error Codes Requiring Technical Service

Error Code	Malfunction	Possible Cause	Corrective Action
E341	Critical data memory failure	Critical data memory failure	Replace mechanism assembly (see Section 7.2.14.8) Reset time and date, if required (see Section 1.8.3)
E342	Display failure	Defective display	Replace LCD (see Section 7.2.14.3) and/or CPU PWA (Section 7.2.14.6) Reset time and date, if required (see Section 1.8.3)
E343	Distal air sensor failure 1	With the cassette removed, the distal air sensor self test detects liquid	Replace mechanism assembly (see Section 7.2.14.8) Reset time and date, if required (see Section 1.8.3)
E344	Distal air sensor failure 2	With the cassette inserted, the distal air sensor self test detects sensor out of range	
E345	Distal pressure sensor failure 1	Distal pressure sensor failed while pump is OFF	
E346	Distal pressure sensor failure 2	Distal pressure sensor failed while pump is ON	
E347	Hardware watchdog failure	Hardware watchdog failure	
E371	I/O valve motor failure 1	I/O valve motor malfunction when a total of four resynchronizations failed	
E372	I/O valve motor failure 2	I/O valve motor malfunction when three consecutive resynchronizations failed	
E373	L/S valve motor failure 1	L/S valve motor malfunction when a total of four resynchronizations failed	
E374	L/S valve motor failure 2	L/S valve motor malfunction when three consecutive resynchronizations failed	
E375	Motor position sensor failure	Motor position sensor failure	
E376	Plunger synch failure 1	Plunger malfunction when resynchronization has failed a total of four times	

Table 6-2. Error Codes Requiring Technical Service


Error Code	Malfunction	Possible Cause	Corrective Action
E377	Plunger synch failure 2	Plunger malfunction when three consecutive resynchronizations failed	Replace mechanism assembly (see Section 7.2.14.8) Reset time and date, if required (see Section 1.8.3)
E378	I/O valve phase loss	Generic I/O valve failure	Turn power off, then on, to reset infusion pump Replace mechanism assembly (see Section 7.2.14.8) Reset time and date, if required (see Section 1.8.3)
E379	L/S valve phase loss	Generic L/S valve failure	
E380	Plunger motor phase loss	Generic plunger motor failure	
E430	Proximal air sensor failure 1	Proximal air sensor ongoing test detects liquid with cassette removed	Replace mechanism assembly (see Section 7.2.14.8) Reset time and date, if required (see Section 1.8.3)
E431	Proximal air sensor failure 2	Proximal air sensor self test detects liquid with cassette removed	
E432	Proximal pressure sensor 1	Proximal pressure sensor failed while pump is OFF	
E433	Proximal pressure sensor 2	Proximal pressure sensor failed while pump is ON	
E434	RAM failure	RAM failure	Turn power off, then on, to reset infusion pump Replace CPU PWA (see Section 7.2.14.6) Reset time and date, if required (see Section 1.8.3)
E435	RTC fail	Real-time clock failure	
E436	ROM failure	ROM checksum failure	
E437	Software failure	Generic software failure	
E438	Stack out-of-range failure	Stack out-of-range failure	

Table 6-2. Error Codes Requiring Technical Service

Error Code	Malfunction	Possible Cause	Corrective Action
E439	Stuck key	A key is sensed as pressed for over two minutes	Replace LCD (see Section 7.2.14.3) and/or CPU PWA (Section 7.2.14.6) Reset time and date, if required (see Section 1.8.3)
E440	Power hold stuck	Power hold signal stuck Power cannot be turned off	
E441	Valve self test failure	I/O or L/S valve self test failed	Replace mechanism assembly (see Section 7.2.14.8) Reset time and date, if required (see Section 1.8.3)
E443	LCD failure	LCD bias is out of range	Replace LCD (see Section 7.2.14.3) and/or CPU PWA (Section 7.2.14.6) Reset time and date, if required (see Section 1.8.3)
E444	CPU timebase inaccurate	CPU timer 2 and RTC measured times disagree	Turn power off, then on, to reset infusion pump Replace CPU PWA (see Section 7.2.14.6) Reset time and date, if required (see Section 1.8.3)
E445	RTC memory failure	Real-time clock memory is corrupt	
E446	CPU timer failure	CPU timer 1 and timer 2 measured times disagree	
E447	Battery ADC reading failure	16 consecutive readings have been either all zero or the max value	
E448	SEEP write failure	SEEP data write failed	
E449	SEEP calibration data corrupted	Calibration data block corrupted	
E450	MMIO port read/write failure	I/O port read/write failure	
E451	Inaccurate delivery	Over/underdelivery detected	
E452	Software failure	Miscellaneous software failure	

Table 6-2. Error Codes Requiring Technical Service

Error Code	Malfunction	Possible Cause	Corrective Action
E453	Two SEEP CRC errors	NVRAM data block corrupted	Turn power off, then on, to reset infusion pump
E454	NVRAM over capacity	Software trying to write into non-existent NVRAM space	Replace CPU PWA (see Section 7.2.14.6) Reset time and date, if required (see Section 1.8.3)

 **Note:** Some error codes include sub-ID codes. These sub-ID codes are intended for Abbott Laboratories internal use only, and should be included when contacting **Abbott Laboratories Technical Support Operations** (see Section 6.1).

6.3

TROUBLESHOOTING PROCEDURES

This section details recommended procedures for problems not associated with malfunction alarms. Before performing any troubleshooting procedure, turn the infusion pump off, then on. Allow the self test to complete and proceed as follows:

1. If a malfunction exists, carefully inspect the infusion pump for damage as described in **Section 5.2.2**.
2. If an infusion pump inspection has not disclosed a malfunction, perform the PVT in **Section 5.2**. Refer to **Table 6-3, Troubleshooting with the PVT**, for section reference, probable cause, and corrective actions.
3. If, after completing Steps 1 and 2, a malfunction has not been located, or if the infusion pump persistently fails, **contact Abbott Laboratories Technical Support Operations**.

Table 6-3. Troubleshooting with the PVT

Test Failure	Probable Cause	Corrective Action
Self test <i>Section 5.2.4</i>	Cassette not properly installed	Reseat cassette
	Defective CPU PWA	Replace CPU PWA (see Section 7.2.14.6)
Cassette alarm test <i>Section 5.2.5</i>	Cassette not properly seated	Reseat cassette
	Defective cassette	Replace cassette

Table 6-3. Troubleshooting with the PVT

Test Failure	Probable Cause	Corrective Action
Free flow test <i>Section 5.2.6</i>	Cassette not properly seated	Reseat cassette
	Defective cassette	Replace cassette
	Defective or dirty valve pins	Clean valve pins
		Replace mechanism assembly (see Section 7.2.14.8)
Display test <i>Section 5.2.7</i>	Defective display/CPU assembly	Replace LCD (see Section 7.2.14.3) and/or CPU PWA (Section 7.2.14.6)
Keypad test <i>Section 5.2.8</i>	Defective display/CPU assembly	Replace LCD (see Section 7.2.14.3) and/or CPU PWA (Section 7.2.14.6)
Alarm loudness test <i>Section 5.2.9</i>	Defective CPU	Replace CPU PWA (see Section 7.2.14.6)
	Defective peripheral PWA	Replace peripheral PWA (see Section 7.2.8)
	Defective piezo alarm assembly	Replace piezo alarm assembly (see Section 7.2.14.7)
Lockout switch test <i>Section 5.2.10</i>	Defective peripheral PWA	Replace peripheral PWA (see Section 7.2.8)
Proximal occlusion test <i>Section 5.2.11</i>	Closed proximal clamp	Open clamp
	Cassette not properly primed	Re-prime cassette
	Defective cassette	Replace cassette
	Dirty sensor pin	Clean sensor pin
	Defective APP PWA	Replace mechanism assembly (see Section 7.2.14.8)
Proximal air-in-line test <i>Section 5.2.12</i>	Defective special cassette	Replace special cassette
	Dirty sensors	Clean sensors
	Defective APP PWA	Replace mechanism assembly (see Section 7.2.14.8)
Distal air-in-line test <i>Section 5.2.13</i>	Defective special cassette	Replace special cassette
	Dirty sensors	Clean sensors
	Defective APP PWA	Replace mechanism assembly (see Section 7.2.14.8)

Table 6-3. Troubleshooting with the PVT

Test Failure	Probable Cause	Corrective Action
Distal occlusion test <i>Section 5.2.14</i>	Cassette not properly primed	Re-prime cassette
	Defective cassette	Replace cassette
	Dirty sensor pin	Clean sensor pin
	Defective APP PWA	Replace mechanism assembly (see <i>Section 7.2.14.8</i>)
Delivery accuracy test <i>Section 5.2.15</i>	Set not properly primed	Re-prime cassette
	Damaged or faulty cassette	Replace cassette
	Defective mechanism assembly	Replace mechanism assembly (see <i>Section 7.2.14.8</i>)
Electrical safety test <i>Section 5.2.16</i>	Defective AC power cord	Replace AC power cord (see <i>Section 7.2.5</i>)

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Section 7

REPLACEABLE PARTS AND REPAIRS

This section itemizes all parts and subassemblies of the Plum A+3 infusion system that are repairable within the scope of this manual. In addition, this section details replacement procedures for all listed parts.

7.1

REPLACEABLE PARTS

Replaceable parts for the Plum A+3 are itemized in the spare parts price list and are identified in *Figure 9-1, Illustrated Parts Breakdown. Table 9-2, IPB for the Infusion Pump* identifies each part by an index number that correlates to *Figure 9-1*.

To request a copy of the current spare parts price list, **contact Abbott Laboratories** (*see Section 6.1, Technical Assistance*), or to view the catalog online, visit the website at:

www.abbotthpd.com/parts

For convenient reference, insert a copy of the spare parts price list here.

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7.2

REPLACEMENT PROCEDURES

This section contains safety and equipment precautions, required tools and materials, and step-by-step procedures for replacing parts in the infusion pump. Unless otherwise stated, always perform the PVT after a replacement procedure.

7.2.1

SAFETY AND EQUIPMENT PRECAUTIONS

Before opening the front enclosure of the infusion pump, take all necessary precautions for working on high-voltage equipment.

WARNING: POSSIBLE EXPLOSION HAZARD EXISTS IF THE INFUSION PUMP IS SERVICED OR REPAIRED IN THE PRESENCE OF FLAMMABLE ANESTHETICS.

WARNING: UNLESS OTHERWISE INDICATED, DISCONNECT THE INFUSION PUMP FROM AC POWER BEFORE PERFORMING ANY REPLACEMENT PROCEDURE.

CAUTION: Use proper ESD grounding techniques when handling components. Wear an antistatic wrist strap and use an ESD-protected workstation. Store PWAs in antistatic bags before placing them on any surface.

7.2.2

REQUIRED TOOLS AND MATERIALS

The following tools and materials, or equivalents, are required for the replacement procedures in this section. In addition, the beginning of each procedure lists tools and materials required for that specific procedure.

- ☐ Set of standard and metric nutdrivers
- ☐ Set of flat blade screwdrivers
- ☐ Set of Phillips® screwdrivers
- ☐ Custom nutdriver (P/N 519-95056-001)
- ☐ Long needle nose pliers
- ☐ X-acto® knife
- ☐ Mild solvent

7.2.3**RUBBER FOOT PAD REPLACEMENT**

The recommended tool for this procedure is a No. 2 Phillips screwdriver.

To replace the rubber foot pads, refer to *Figure 7-1, Bottom View*, then proceed as follows:

1. Press [ON/OFF] to turn off the infusion pump, and disconnect the pump from AC power.
2. Place the pump face down on a soft flat surface.
3. Using the Phillips screwdriver, remove the 6-32 x 1/2 screw securing the rubber foot pad.
4. Install the replacement rubber foot pad in the exact reverse order of removal.
5. Connect the infusion pump to AC power.

Replacement of the rubber foot pads is routine maintenance and no verification procedure is normally required. However, if the infusion pump may have been damaged during a rubber foot pad replacement, perform the PVT in *Section 5.2*.

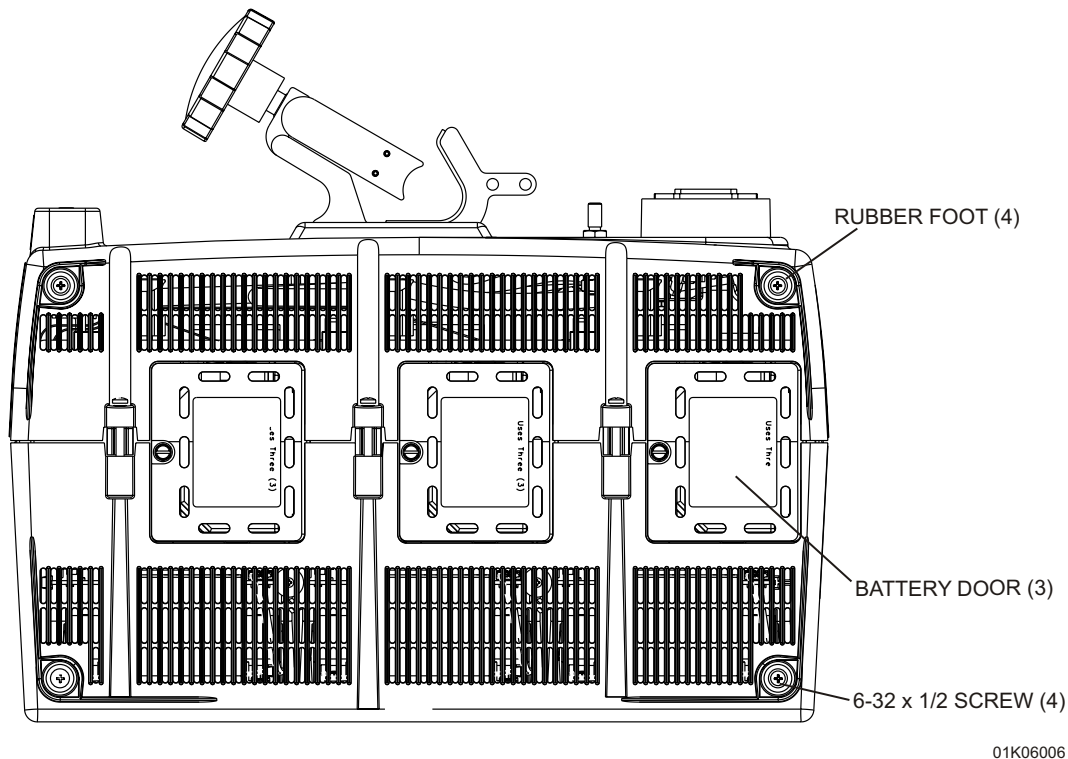


Figure 7-1. Bottom View


7.2.4


BATTERY ASSEMBLY, BATTERY DOOR, AND BATTERY DOOR PAD REPLACEMENT

Recommended tools for this procedure are a medium size flat blade screwdriver, an X-acto knife, and mild solvent.

To replace the battery, battery door, and battery door pad, refer to *Figure 7-1* and *Figure 7-2, AC (Mains) Power Cord, Power Cord Retainer, Velcro Retainer Strap, and Battery Assembly Replacement*, then proceed as follows:

1. Press [ON/OFF] to turn off the infusion pump, and disconnect the pump from AC power.
2. Place the pump face down on a soft flat surface.
3. Using the flat blade screwdriver, remove the 6-32 x 1/2 screw that attaches the battery door to the pump, and remove the door.
4. Inspect the battery door and door pad for damage. Replace the door, if necessary.
5. If the battery door pad is defective, remove it and clean the door with mild solvent. Dry the battery door thoroughly, and install the replacement pad on the door.
6. Disconnect the battery harness from the charger circuit cable. Carefully pull the battery harness wires and connector outside the enclosure, and remove the battery.
7. Connect the replacement battery harness to the charger circuit cable, and insert the replacement battery into the enclosure.

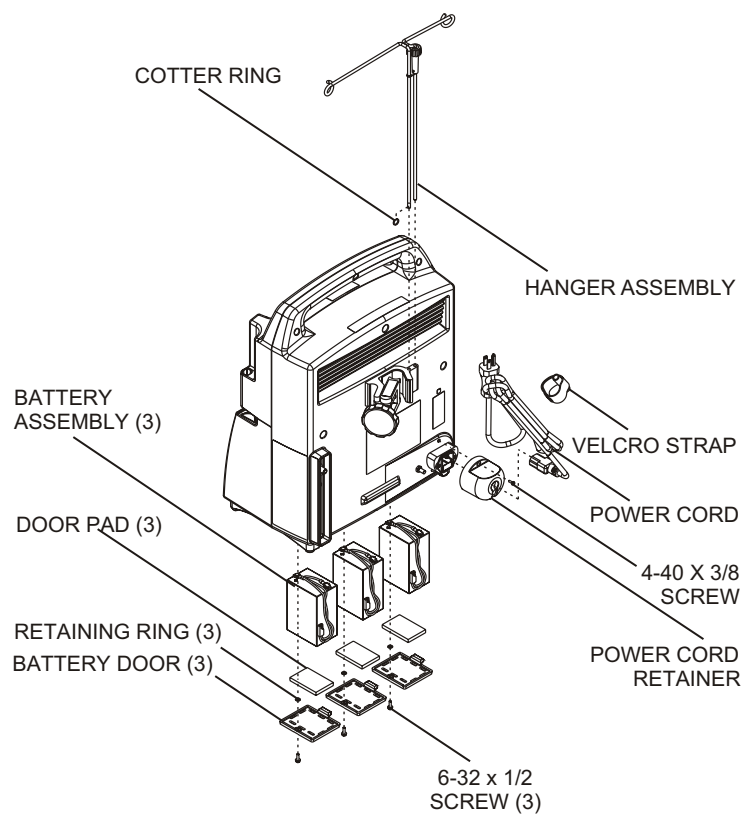
 **Note:** The cable connectors are keyed so that cables cannot be connected incorrectly.

 **Note:** Confirm the battery harness is not pinched between the battery and the enclosure.

8. Replace the battery door using the screw that was removed in Step 3.

To verify successful replacement of the battery, press [ON/OFF] with the infusion pump disconnected from AC power, and verify the front panel battery symbol illuminates.

Replacement of the battery door and battery door pad is routine maintenance and no verification procedure is normally required. However, if the infusion pump may have been damaged during these procedures, perform the PVT in *Section 5.2*.



01H06001

Figure 7-2. AC (Mains) Power Cord, Power Cord Retainer, Velcro Retainer Strap, and Battery Assembly Replacement

7.2.5

AC (MAINS) POWER CORD, POWER CORD RETAINER, AND VELCRO RETAINER STRAP REPLACEMENT

The recommended tool for this procedure is a No. 2 Phillips screwdriver.

Note: For Velcro retainer strap replacement only, proceed to Step 5.

To replace the AC power cord, power cord retainer, and Velcro retainer strap, refer to *Figure 7-2*, then proceed as follows:

1. Press [ON/OFF] to turn off the infusion pump, and disconnect the pump from AC power.
2. Using the Phillips screwdriver, remove the 4-40 x 3/8 screw from the power cord retainer. Turn the power cord retainer approximately 1/8 turn counterclockwise.
3. Unplug the power cord, and slide the plug through the retainer.

Note: Remove the AC power cord from its receptacle by grasping the plug. Do not pull the cord.

4. Remove the Velcro strap from the power cord. Inspect the Velcro strap for wear and replace the strap, if necessary.
5. Attach the Velcro strap to the replacement power cord.

6. Install the replacement AC power cord in the exact reverse order of removal.
7. Connect the infusion pump to AC power. Press [ON/OFF] and verify the pump powers on.


To verify successful AC power cord, power cord retainer, and Velcro retainer strap replacement, perform the PVT in [Section 5.2](#).

7.2.6

SEPARATING THE FRONT ENCLOSURE, REAR ENCLOSURE, AND MAIN CHASSIS ASSEMBLY


The recommended tool for this procedure is a No. 2 Phillips screwdriver.

CAUTION: Use proper ESD grounding techniques when handling components. Wear an antistatic wrist strap and use an ESD-protected workstation. Store PWAs in antistatic bags before placing them on any surface.

 **Note:** The front enclosure consists of an upper assembly and a lower assembly. The main chassis consists of an upper assembly and a lower assembly.

To separate the front enclosure, rear enclosure, and main chassis assembly, refer to [Figure 7-3, Separating the Front Enclosure, Rear Enclosure, and Main Chassis Assembly](#) then proceed as follows:

1. Remove the battery doors and batteries as described in [Section 7.2.4](#).
2. Using the Phillips screwdriver, remove the five 6-32 x 1 1/4 inch screws; three 8-32 x 3 1/2 inch screws; and one 6-32 x 1/2 inch screw from the rear enclosure ([see Figure 7-4, Screw Placement Sequence](#)).
3. Remove the rear enclosure by lifting it up and to the side.
4. Disconnect the three internal power connectors.
5. Using the Phillips screwdriver, remove the two 6-32 x 2 3/4 inch screws from the bottom corners of the center mechanism.
6. Set the pump upright and remove the front upper enclosure by pulling it away from the upper chassis assembly.
7. Remove the lower front enclosure by tilting the pump back approximately 10 degrees, being careful not to damage the peripheral/interface PWA. Pull the lower front enclosure away from the lower chassis assembly.
8. Reassemble the front enclosure, rear enclosure, and main chassis assembly in the exact reverse order of disassembly. Follow the screw placement sequence in [Figure 7-4](#).

 **Note:** When reassembling the upper front enclosure, lift all three door handles first.

To verify successful assembly, perform the PVT in [Section 5.2](#).

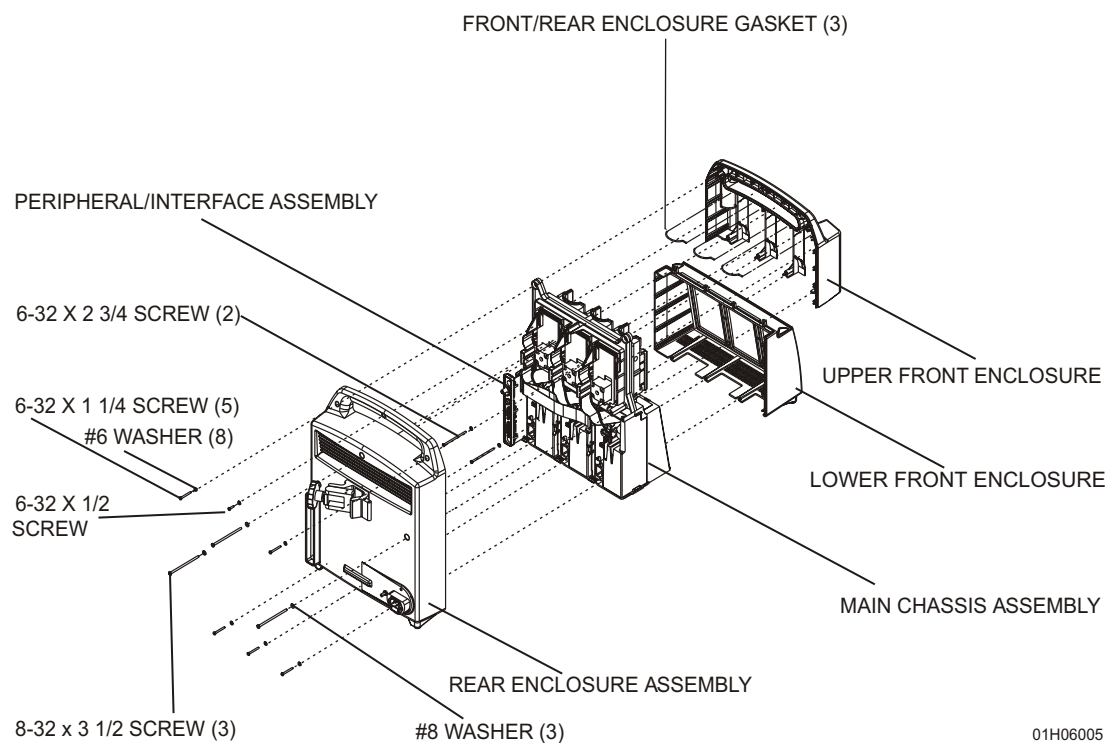


Figure 7-3. Separating the Front Enclosure, Rear Enclosure, and Main Chassis Assembly

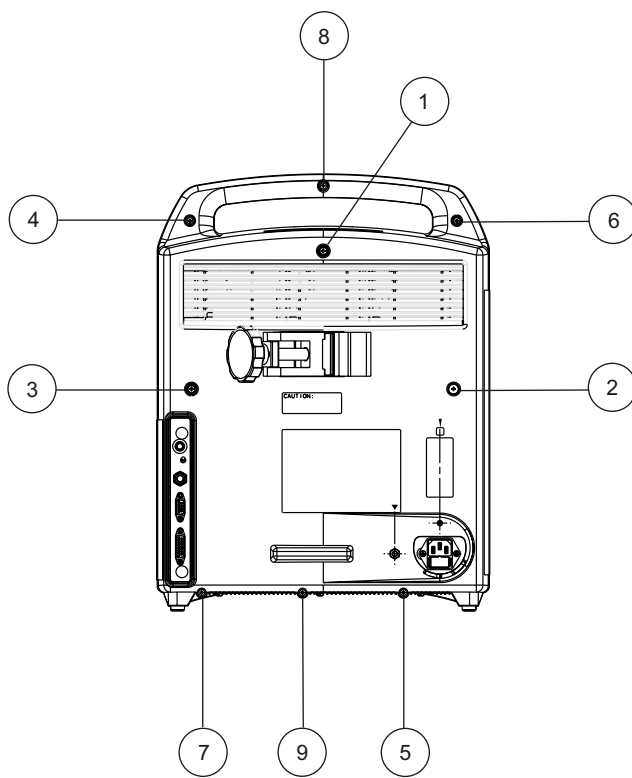



Figure 7-4. Screw Placement Sequence

7.2.7**PERIPHERAL/INTERFACE ASSEMBLY REPLACEMENT**

The recommended tool for this procedure is a No. 2 Phillips screwdriver.

CAUTION: Use proper ESD grounding techniques when handling components. Wear an antistatic wrist strap and use an ESD-protected workstation. Store the PWA in an antistatic bag before placing it on any surface.

 **Note:** Replacing the peripheral/interface assembly does not change the existing biomed settings.

To replace the peripheral/interface assembly, refer to *Figure 7-5, Peripheral/Interface PWA and Peripheral PWA Replacement*, then proceed as follows:

1. Remove the rear enclosure assembly as described in *Section 7.2.6*.
2. Disconnect peripheral cable #1 from J30 on the peripheral/interface PWA.
3. Disconnect peripheral cable #2 from J29 on the peripheral/interface PWA.
4. Remove the peripheral/interface PWA by depressing the retention clip and carefully pulling the peripheral/interface assembly away from the infusion pump.
5. Install the replacement peripheral/interface assembly in the exact reverse order of removal.

 **Note:** Verify the peripheral/interface assembly is placed properly between the guides and fits correctly into the CPU PWA.

6. Connect the infusion pump to AC power.


To verify successful peripheral/interface assembly replacement, perform the PVT in *Section 5.2*.

7.2.8**PERIPHERAL PWA REPLACEMENT**


The recommended tool for this procedure is a No. 2 Phillips screwdriver.

CAUTION: Use proper ESD grounding techniques when handling components. Wear an antistatic wrist strap and use an ESD-protected workstation. Store the PWA in an antistatic bag before placing it on any surface.

To replace the peripheral PWA, refer to *Figure 7-5*, then proceed as follows:

 **Note:** Replacing the peripheral PWA does not change the existing biomed settings.

1. Remove the rear enclosure assembly as described in *Section 7.2.6*.
2. Disconnect peripheral cable #1 from J22. To replace peripheral PWA #1, depress the retention clip and carefully pull the peripheral PWA away from the assembly.
3. Replace peripheral PWA #1 in the exact reverse order of removal.

 **Note:** Verify the peripheral PWA is placed properly between the guides and fits correctly.

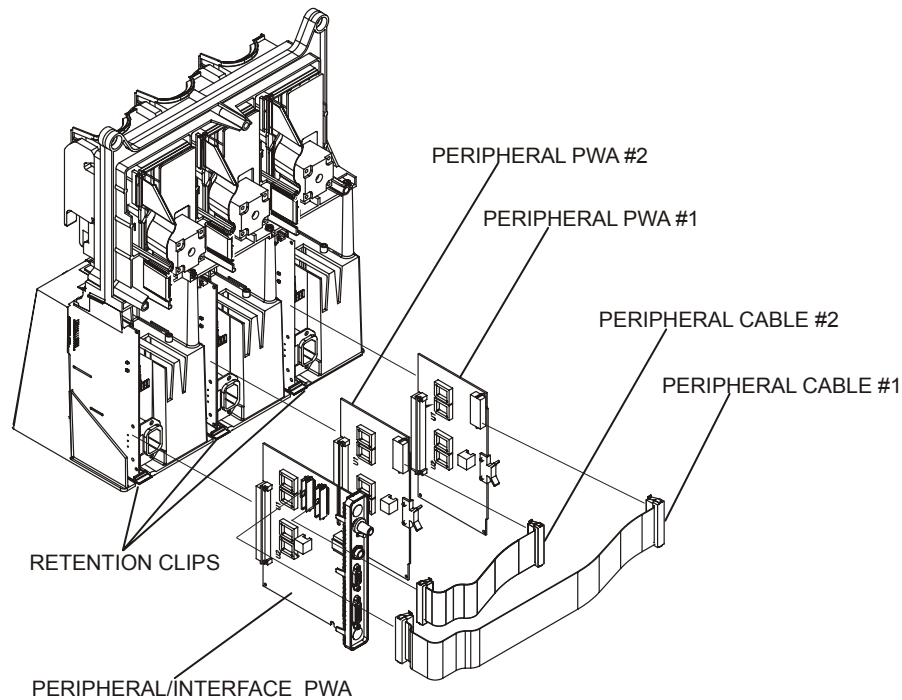
4. Disconnect peripheral cable #2 from J22 on peripheral PWA #2. Depress the retention clip and carefully pull peripheral PWA #2 away from the assembly.

5. Replace peripheral PWA #2 in the exact reverse order of removal.

Note: Verify the peripheral PWA is placed properly between the guides and fits correctly.

6. Connect the infusion pump to AC power.

To verify successful peripheral PWA replacement, perform the PVT in [Section 5.2](#).



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Figure 7-5. Peripheral/Interface PWA and Peripheral PWA Replacement

7.2.9**PERIPHERAL/INTERFACE ASSEMBLY COMPONENT REPLACEMENT**

Peripheral assembly component replacement includes the replacement of the following:

- ❑ Volume control knob
- ❑ Peripheral assembly cover

To replace the peripheral assembly components, refer to *Figure 7-6, Peripheral/Interface Assembly Component Replacement*, then proceed as detailed in the following sections.

7.2.9.1**VOLUME CONTROL KNOB REPLACEMENT**

Recommended tools for this procedure are a medium size flat blade screwdriver, an X-acto knife, and long needle nose pliers.

To replace the volume control knob, refer to *Figure 7-6*, then proceed as follows:

1. Using the X-acto knife, lift the volume control knob end cap away from the knob, exposing a flat head screw.
2. Using the flat blade screwdriver, remove the screw securing the gray knob. Remove the knob and plastic spacer with long needle nose pliers.
3. Install the replacement volume control knob in the exact reverse order of removal.
4. Connect the infusion pump to AC power.

To verify successful volume control knob replacement, perform the PVT in *Section 5.2*.

7.2.9.2**PERIPHERAL ASSEMBLY COVER AND ESD SPRING REPLACEMENT**

Recommended tools for this procedure are a No. 2 Phillips screwdriver; set of nutdrivers; an X-acto knife; custom nutdriver; and long needle nose pliers.

CAUTION: Use proper ESD grounding techniques when handling components. Wear an antistatic wrist strap and use an ESD-protected workstation. Store the PWA in an antistatic bag before placing it on any surface.

To replace the peripheral assembly cover, refer to *Figure 7-6*, then proceed as follows:

1. Remove the peripheral/interface assembly as described in *Section 7.2.7*.
2. Remove the volume control knob as described in *Section 7.2.9.1*.
3. Using a 5/16 nutdriver, remove the nut securing the potentiometer to the peripheral cover. Remove the washer with needle nose pliers.
4. Using the custom nutdriver, remove the nut securing the phone jack to the peripheral cover.
5. Using the Phillips screwdriver, remove the two 4-40 x 3/8 inch screws securing the peripheral/interface PWA to the cover.

6. Using a 3/16 nutdriver, remove the four male/female screws, two from the DataPort connector and two from the nurse call connector.
7. Remove and replace the ESD spring, if required.
8. Install the replacement peripheral cover in the exact reverse order of removal.
9. Connect the infusion pump to AC power.

To verify successful peripheral assembly cover and ESD spring replacement, perform the PVT in [Section 5.2](#).

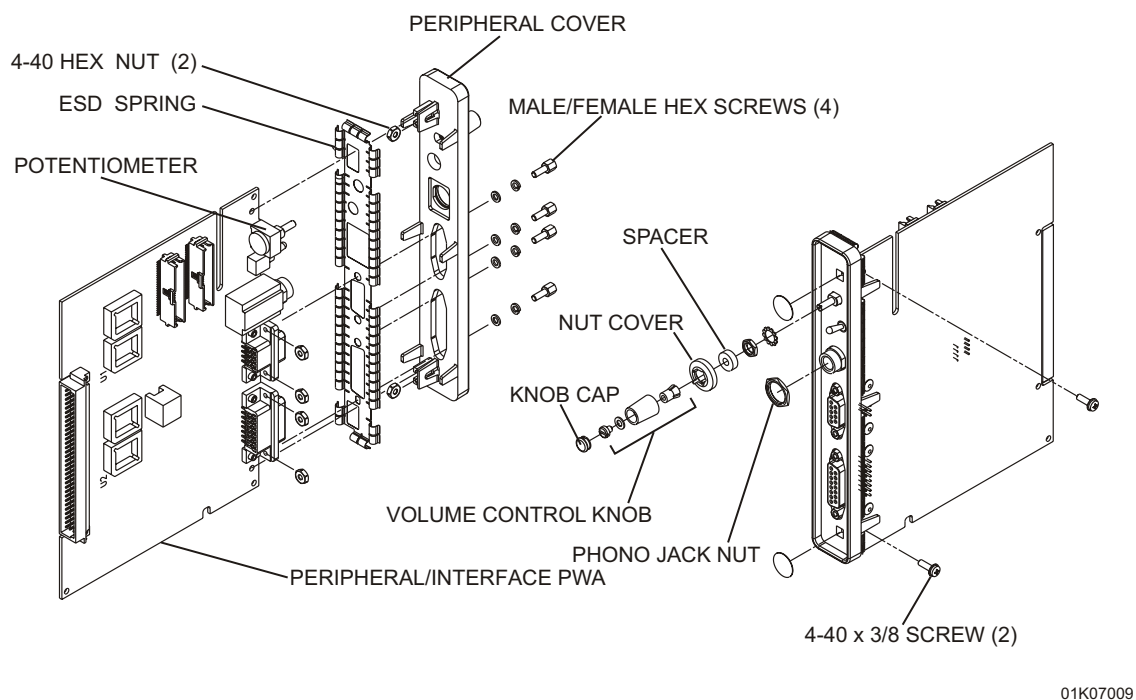


Figure 7-6. Peripheral/Interface Assembly Component Replacement

7.2.10

FRONT/REAR ENCLOSURE GASKET REPLACEMENT

The recommended tool for this procedure is needle nose pliers.

To replace the front/rear enclosure gaskets, refer to *Figure 7-3*, then proceed as follows:

1. Separate the front enclosure, rear enclosure, and main chassis assembly as described in *Section 7.2.6*.
2. Remove the front/rear enclosure gaskets from the upper front enclosure assembly as shown in *Figure 7-3*.
3. Install the replacement front/rear gaskets in the exact reverse order of removal.
4. Join the front enclosure, rear enclosure, and main chassis assembly in the exact reverse order of separation.
5. Connect the infusion pump to AC power.

To verify successful front/rear enclosure gasket replacement, perform the PVT in *Section 5.2*.


7.2.11

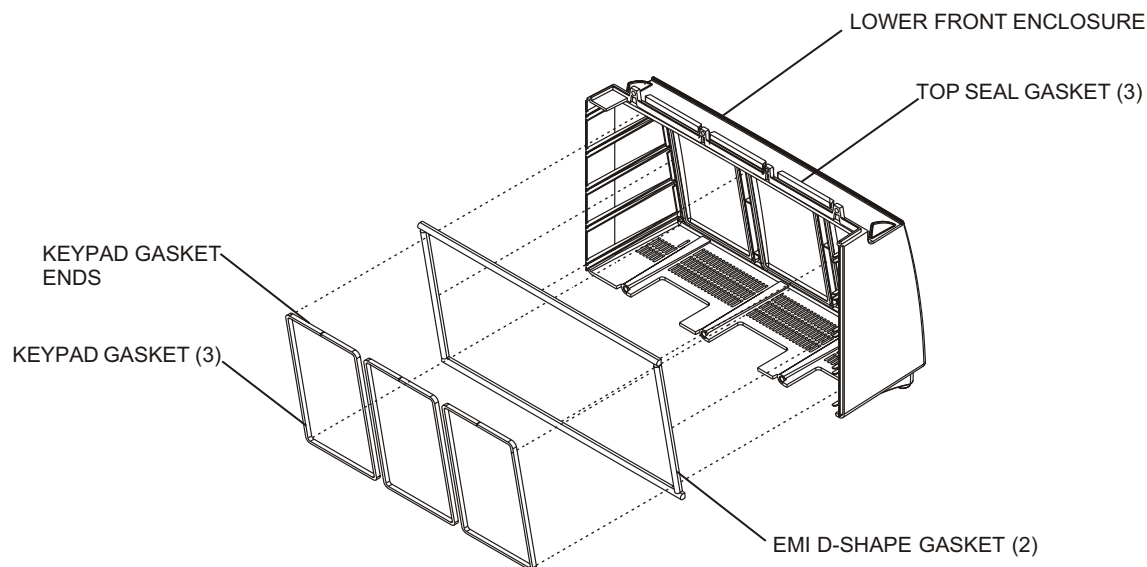
LOWER FRONT ENCLOSURE ASSEMBLY GASKET REPLACEMENT

Lower front enclosure assembly gasket replacement includes the replacement of the following:

- ☐ EMI gaskets, D-shape
- ☐ Keypad gaskets
- ☐ Top seal gaskets

To replace the lower front enclosure assembly gaskets, refer to *Figure 7-7, Lower Front Enclosure Gasket Replacement*, then proceed as detailed in the following sections.

 **Note:** Inspect the EMI coating on the inside of the lower front enclosure for extensive flaking or wear.



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Figure 7-7. Lower Front Enclosure Gasket Replacement

7.2.11.1

EMI GASKET REPLACEMENT

The recommended tool for this procedure is needle nose pliers.

To replace the EMI gaskets, refer to *Figure 7-7*, then proceed as follows:

1. Separate the front enclosure, rear enclosure, and main chassis assembly as described in *Section 7.2.6*.
2. Using the needle nose pliers, remove the EMI gasket to be replaced.
 -  **Note:** Clean and remove any foreign matter on the replacement gasket or in the space where the replacement gasket is to be installed.
3. Remove the backing from the replacement EMI gasket to expose the adhesive and press the gasket into place on the lower front enclosure.
4. Join the front enclosure, rear enclosure, and main chassis assembly in the exact reverse order of separation.
5. Connect the infusion pump to AC power.


To verify successful EMI gasket replacement, perform the PVT in *Section 5.2*.

7.2.11.2

KEYPAD GASKET REPLACEMENT

The recommended tool for this procedure is needle nose pliers.

To replace the keypad gaskets, refer to *Figure 7-7*, then proceed as follows:

1. Separate the front enclosure, rear enclosure, and main chassis assembly as described in *Section 7.2.6*.
2. Using the needle nose pliers, remove the keypad gasket to be replaced.
 **Note:** Clean and remove any foreign matter on the replacement gasket or in the space where the replacement gasket is to be installed.
3. Install the replacement keypad gasket in the gasket grooves. The gasket gap created by the ends of the gasket must be placed at the top of the keypad window.
4. Join the front enclosure, rear enclosure, and main chassis assembly in the exact reverse order of separation.
5. Connect the infusion pump to AC power.

To verify successful keypad gasket replacement, perform the PVT in *Section 5.2*.

7.2.11.3

TOP SEAL GASKET REPLACEMENT

The recommended tool for this procedure is an X-acto knife.

To replace the top seal gaskets, refer to *Figure 7-7*, then proceed as follows:

1. Separate the front enclosure, rear enclosure, and main chassis assembly as described in *Section 7.2.6*.
2. Using the X-acto knife, remove the gasket to be replaced.
3. Using a light solvent, clean the area of all foreign matter.
4. Remove the backing from the replacement top seal gasket to expose the adhesive and press the gasket into place on the lower front enclosure.
5. Join the front enclosure, rear enclosure, and main chassis assembly in the exact reverse order of separation.
6. Connect the infusion pump to AC power.

To verify successful top seal gasket replacement, perform the PVT in *Section 5.2*.

7.2.12

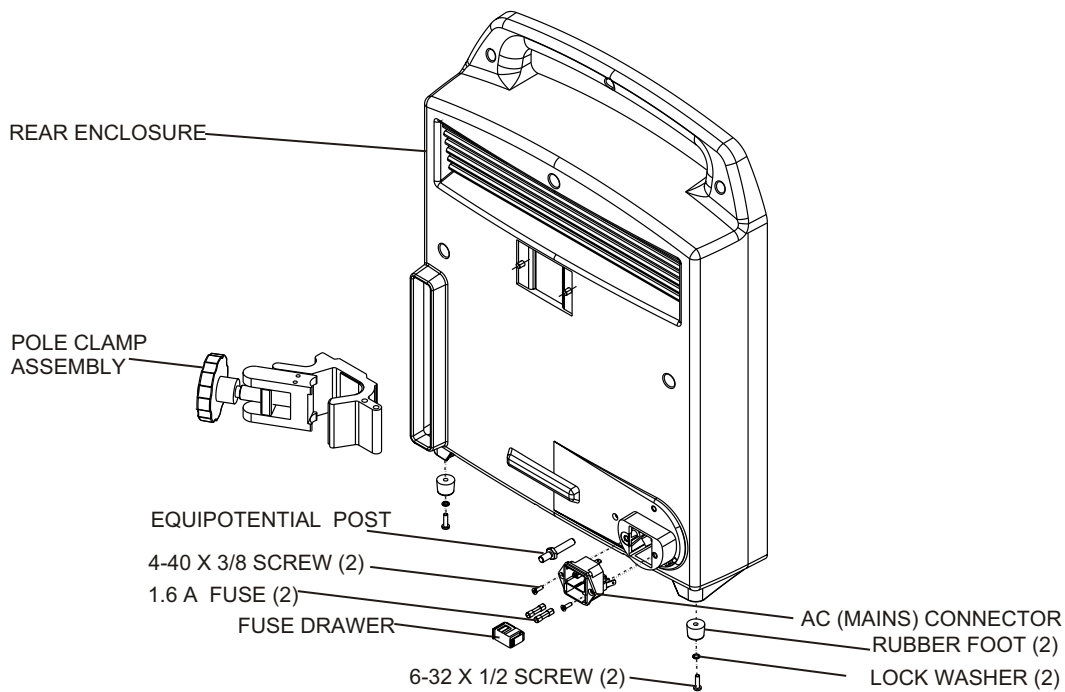
REAR ENCLOSURE ASSEMBLY COMPONENT REPLACEMENT

Rear enclosure assembly component replacement includes the replacement of the following:

- ❑ Pole clamp assembly
- ❑ Internal AC power cord
- ❑ Pole clamp ground wire
- ❑ AC connector
- ❑ AC line fuses
- ❑ Rear enclosure gaskets

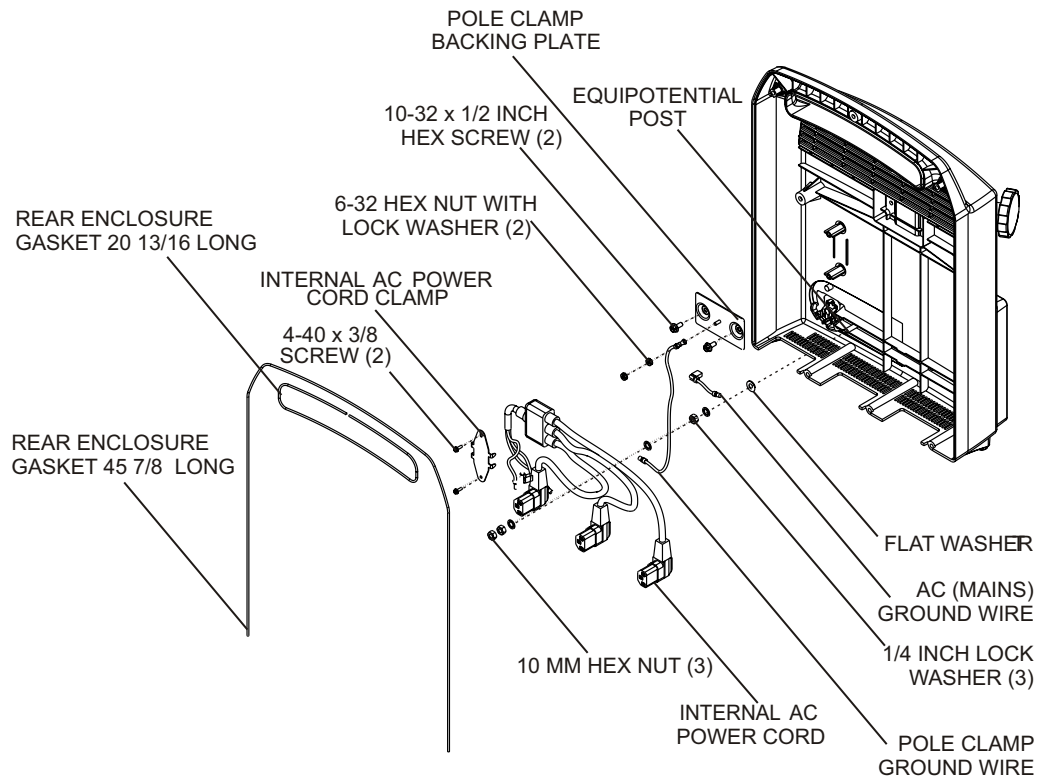
To replace the rear enclosure assembly components, refer to *Figure 7-8, External Rear Enclosure Assembly Components*, and *Figure 7-9, Internal Rear Enclosure Assembly Components*, then proceed as detailed in the following sections.

Note: Inspect the EMI coating on the inside of the rear enclosure for extensive flaking or wear.



02H06002

Figure 7-8. External Rear Enclosure Assembly Components



01K07003

Figure 7-9. Internal Rear Enclosure Assembly Components

7.2.12.1

POLE CLAMP ASSEMBLY AND POLE CLAMP BACKING PLATE REPLACEMENT

The recommended tool for this procedure is a 5/16 nutdriver.

To replace the pole clamp assembly and pole clamp backing plate, refer to *Figure 7-8* and *Figure 7-9*, then proceed as follows:

1. Separate the front enclosure and rear enclosure as described in *Section 7.2.6*.
2. Using the nutdriver, remove the two 6-32 hex nuts securing the ground wire to the pole clamp backing plate. Remove the ground wire.
3. Using the nutdriver, remove the two 10-32 x 1/2 inch hex screws securing the pole clamp and pole clamp backing plate to the rear enclosure.
4. Install the replacement pole clamp and/or pole clamp backing plate.
5. Secure the ground wire using the two 6-32 hex nuts that were removed in Step 2.

Note: Prior to mounting the infusion pump onto an IV pole, clean the neoprene (rubber) pad of the replacement pole clamp and the IV pole by wiping both with gauze or a lint-free cloth wetted with isopropyl alcohol.

6. Join the front enclosure and rear enclosure in the exact reverse order of separation.
7. Connect the infusion pump to AC power.

To verify successful pole clamp assembly and pole clamp backing plate replacement, perform the PVT in [Section 5.2](#).

7.2.12.2

INTERNAL AC POWER CORD REPLACEMENT

Recommended tools for this procedure are needle nose pliers and a set of nutdrivers.

To replace the internal AC power cord, refer to [Figure 7-9](#), then proceed as follows:

1. Separate the front enclosure and rear enclosure as described in [Section 7.2.6](#).
2. Using a 3/16 nutdriver, remove the two 4-40 x 3/8 inch hex screws from the internal power cord clamp.
3. Using the needle nose pliers, remove the brown and the blue wires from the AC connector.
4. Using a 10 mm nutdriver, remove the two hex nuts and washers securing the yellow/green internal AC ground wire to the equipotential post.
5. Install the replacement internal AC power cord in the exact reverse order of removal.
6. Join the front enclosure and rear enclosure in the exact reverse order of separation.
7. Connect the infusion pump to AC power.

To verify successful internal AC power cord replacement, perform the PVT in [Section 5.2](#).

7.2.12.3

POLE CLAMP GROUND WIRE REPLACEMENT

The recommended tool for this procedure is a set of nutdrivers.

To replace the pole clamp ground wire, refer to [Figure 7-9](#), then proceed as follows:

1. Separate the front enclosure and rear enclosure as described in [Section 7.2.6](#).
2. Using a 10 mm nutdriver, remove the three hex nuts and washers securing the ground wire to the equipotential post.
3. Using a 5/16 nutdriver, remove the two 6-32 hex nuts securing the ground wire to the pole clamp backing plate.
4. Install the replacement pole clamp ground wire in the exact reverse order of removal.
5. Join the rear enclosure assembly in the exact reverse order of separation.
6. Connect the infusion pump to AC power.


To verify successful pole clamp ground wire replacement, perform the PVT in [Section 5.2](#).

7.2.12.4**AC (MAINS) CONNECTOR REPLACEMENT**

Recommended tools for this procedure are needle nose pliers and a #2 Phillips screwdriver.

To replace the AC connector, refer to *Figure 7-8*, then proceed as follows:

1. Remove the AC power cord retainer and AC power cord as described in *Section 7.2.5*.

 **Note:** Remove the AC power cord from its receptacle by grasping the plug. Do not pull the cord.

2. Separate the rear enclosure and main chassis assembly as described in *Section 7.2.6*.
3. Using the needle nose pliers, remove the internal power cord wires and the AC ground wire from the AC connector.
4. Using the Phillips screwdriver, remove the two 4-40 x 3/8 inch screws securing the AC connector to the rear enclosure.
5. Install the replacement AC connector in the exact reverse order of removal.
6. Join the rear enclosure and main chassis assembly in the exact reverse order of separation.
7. Connect the infusion pump to AC power.


To verify successful AC (mains) connector replacement, perform the PVT in *Section 5.2*.

7.2.12.5**FUSE REPLACEMENT**

Recommended tools for this procedure are a No. 2 Phillips screwdriver and a small flat blade screwdriver.

To replace the fuses, refer to *Figure 7-8*, then proceed as follows:

1. Disconnect the pump from AC power.
2. Place the pump face down on a soft surface.
3. Remove the power cord retainer and power cord as described in *Section 7.2.5*.

 **Note:** Remove the AC power cord from its receptacle by grasping the plug. Do not pull the cord.

4. Locate the fuse drawer directly below the AC power receptacle. Insert the flat blade screwdriver between the right locking tab of the fuse drawer and the AC connector housing. Press the tab toward the center of the fuse drawer to release it. Verify the fuse drawer moves slightly outward.
5. Repeat Step 4 to release the left locking tab. Grasp both locking tabs and remove the fuse drawer from the AC connector.

CAUTION: Confirm the replacement fuse rating is identical to the rating indicated on the fuse drawer.

6. Remove the fuses and replace with approved fuses only (*see Section 8*). Do not use any other fuse types.
7. Insert the fuse drawer into the receptacle, then press the fuse drawer into the AC connector until it clicks into position.
8. Reinstall the power cord retainer and power cord in the exact reverse order of disassembly.

To verify successful fuse replacement, perform the PVT in *Section 5.2*.

7.2.12.6


REAR ENCLOSURE GASKET REPLACEMENT

The recommended tool for this procedure is needle nose pliers.

To replace the rear enclosure gaskets, refer to *Figure 7-9*, then proceed as follows:

1. Remove the rear enclosure as described in *Section 7.2.6*.
2. Using the needle nose pliers, remove the rear enclosure gasket to be replaced.
3. Install the replacement rear enclosure gasket by pressing it into the gasket channel.

 **Note:** Assure there are no foreign objects on the replacement gasket.

 **Note:** Inspect the EMI coating on the inside of the rear enclosure for extensive flaking or wear.

4. Join the front enclosure and rear enclosure in the exact reverse order of separation.
5. Connect the infusion pump to AC power.

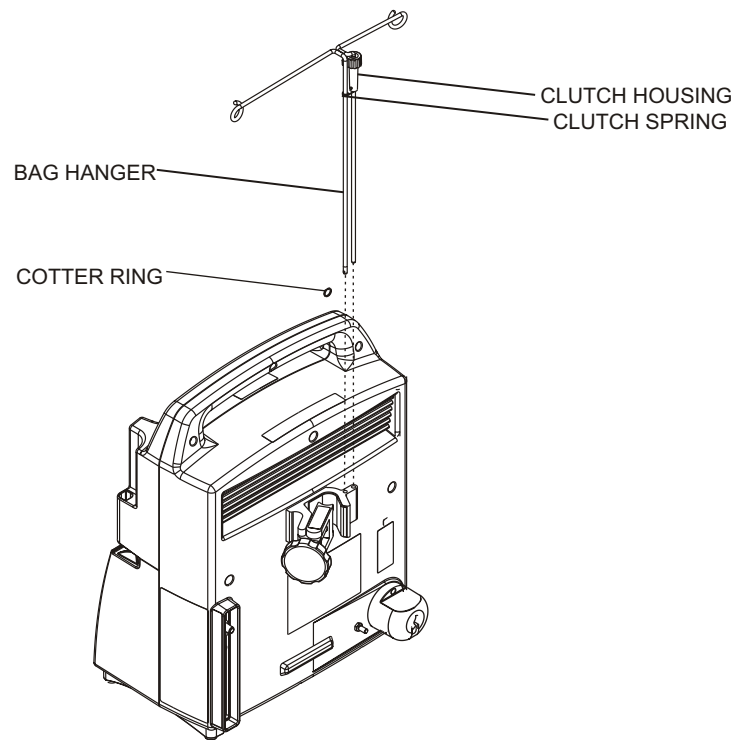
To verify successful rear enclosure gasket replacement, perform the PVT in *Section 5.2*.

7.2.13

MINIPOLE ASSEMBLY REPLACEMENT

There are no tools for this procedure.

The minipole assembly attaches to the infusion pump through two holes in the pole clamp and is held in place by a cotter ring. This cotter ring passes through a hole near the end of the longer of the two vertical rods on the bag hanger and prevents the removal of the assembly from the holes in the pole clamp (*see Figure 7-10, Minipole Assembly*).



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Figure 7-10. Minipole Assembly**7.2.13.1****COTTER RING REPLACEMENT**

To replace the cotter ring, refer to *Figure 7-10*, then proceed as follows:

1. Disconnect the infusion pump from AC power.
2. Grasp the cotter ring with thumb and finger. Twist, rotate, and remove the cotter ring from the rod hole.
3. Replace the cotter ring in the exact reverse order of removal.

Replacement of the cotter ring is routine maintenance and no verification procedure is normally required. However, if the infusion pump may have been damaged during this procedure, perform the PVT in *Section 5.2*.

7.2.13.2**BAG HANGER REPLACEMENT**

To replace the bag hanger, refer to *Figure 7-10*, then proceed as follows:

1. Remove the cotter ring as described in *Section 7.2.13.1*.
2. Remove the bag hanger from the pole clamp rod holes.
3. Insert the replacement bag hanger in the pole clamp rod holes.
4. Insert the cotter ring.

Replacement of the bag hanger is routine maintenance and no verification procedure is normally required. However, if the infusion pump may have been damaged during this procedure, perform the PVT in *Section 5.2*.

7.2.13.3**CLUTCH HOUSING REPLACEMENT**

To replace the clutch housing, refer to *Figure 7-10*, then proceed as follows:

1. Remove the bag hanger from the infusion pump as described in *Section 7.2.13.2*.
2. Turn the clutch housing knob counterclockwise to loosen the clutch spring. Slide the knob and spring downward to remove them.
3. Work the clutch spring free from the clutch housing hole and place it into the replacement clutch housing.
4. Install the replacement clutch housing by turning the clutch housing knob counterclockwise and sliding it up the short rod. Confirm the clutch spring slides up the long rod.
5. Install the cotter ring.

Replacement of the clutch housing is routine maintenance and no verification procedure is normally required. However, if the infusion pump may have been damaged during this procedure, perform the PVT in *Section 5.2*.

7.2.13.4**CLUTCH SPRING REPLACEMENT**

To replace the clutch spring, refer to *Figure 7-10*, then proceed as follows:

1. Remove the clutch housing as described in *Section 7.2.13.3*.
2. Work the clutch spring free from the clutch housing hole and install the replacement clutch spring.

Replacement of the clutch spring is routine maintenance and no verification procedure is normally required. However, if the infusion pump may have been damaged during this procedure, perform the PVT in *Section 5.2*.

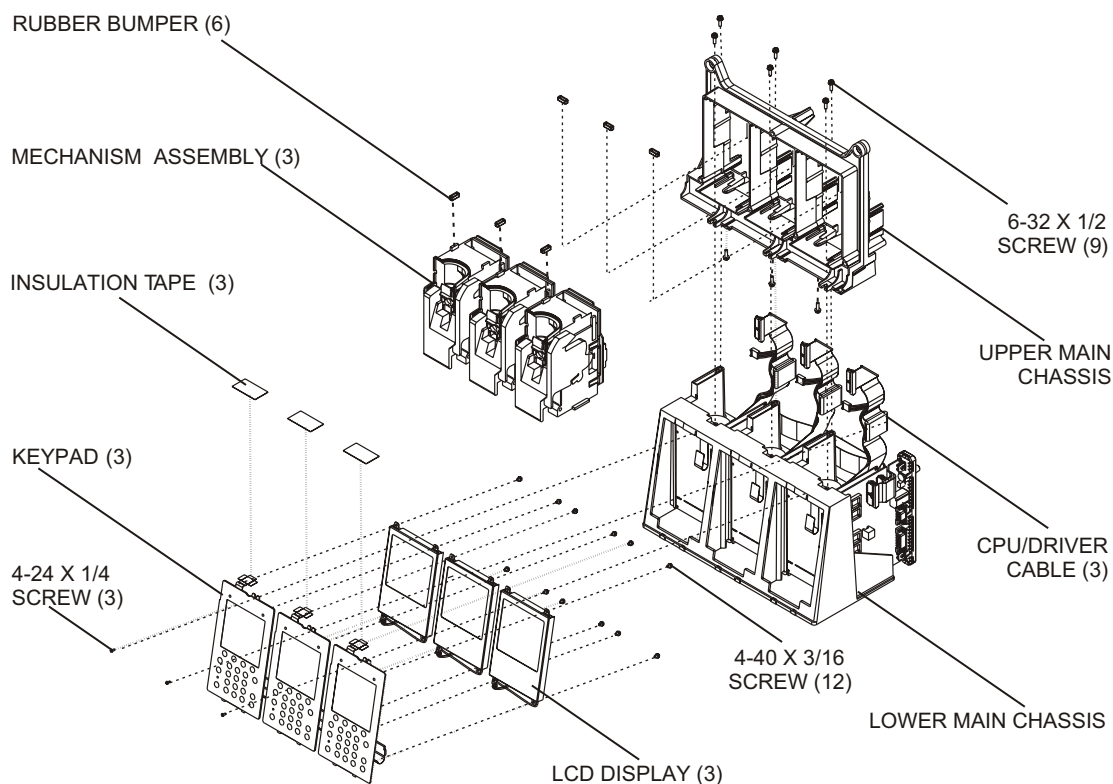
7.2.14

MAIN CHASSIS ASSEMBLY COMPONENT REPLACEMENT

Main chassis assembly component replacement includes the replacement of the following:

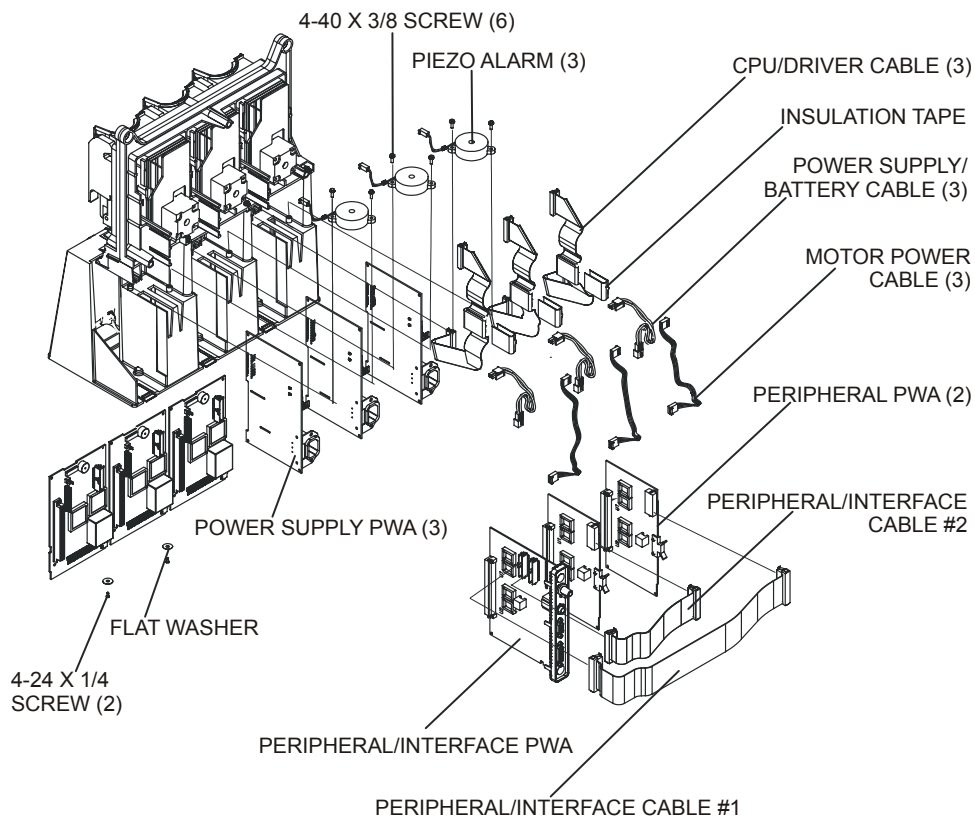
- ❑ Power supply PWA
- ❑ Keypad/LCD
- ❑ CPU/driver cable
- ❑ Motor power cable
- ❑ CPU PWA
- ❑ Piezo alarm assembly
- ❑ Mechanism assembly
- ❑ Cassette door and fluid shield
- ❑ Opener handle assembly

To replace the main chassis assembly components, refer to *Figure 7-11, Main Chassis Components (1 of 2)* and *Figure 7-11, Main Chassis Components (2 of 2)*, then proceed as detailed in the following sections.



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Figure 7-11. Main Chassis Components (1 of 2)



01H07022

Figure 7-11. Main Chassis Components (2 of 2)

7.2.14.1

POWER SUPPLY PWA REPLACEMENT


The recommended tool for this procedure is a medium size flat blade screwdriver.


CAUTION: Use proper ESD grounding techniques when handling components. Wear an antistatic wrist strap and use an ESD-protected workstation. Store the PWA in an antistatic bag before placing it on any surface.

To replace the power supply PWAs, refer to *Figure 7-11*, then proceed as follows:

1. Separate the rear enclosure assembly from the main chassis as described in *Section 7.2.6*.
2. Disconnect the power supply/battery cable from the power supply PWA.
3. Disconnect the power supply/mechanism cable from the power supply PWA.
4. Disconnect the peripheral/interface cables from the peripheral/interface PWAs.
5. Remove the power supply PWA by pressing down on the finger tab at the bottom front of the power supply PWA. Slide the power supply PWA away from the CPU PWA.

6. Install the replacement power supply PWA in the exact reverse order of removal

 **Note:** Verify the power supply PWA assembly is placed properly between the guides and fits correctly.

 **Note:** If an alarm sounds, press the [ON/OFF] key to deactivate the alarm.

7. Join the rear enclosure and main chassis assembly in the exact reverse order of separation.
8. Connect the infusion pump to AC power.

To verify successful power supply PWA replacement, perform the PVT in [Section 5.2](#).

7.2.14.2

KEYPAD REPLACEMENT

The recommended tools for this procedure are a No. 2 Phillips screwdriver, medium size flat blade screwdriver, and an X-acto knife.

CAUTION: Use proper ESD grounding techniques when handling components. Wear an antistatic wrist strap and use an ESD-protected workstation. Store the PWA in an antistatic bag before placing it on any surface.

To replace the keypad, refer to [Figure 7-11](#), then proceed as follows:

1. Separate the front enclosure, rear enclosure, and main chassis assembly as described in [Section 7.2.6](#).
2. Place the infusion pump on its side to gain access to the bottom of the pump.
3. Disconnect the keypad cable from J4 on the CPU PWA.
4. Disconnect the LCD cable from J20 on the CPU PWA.
5. Using the X-acto knife, lift the white insulation tape that secures the grounding tab to the lower main chassis.
6. Using the Phillips screwdriver, remove the 4-24 x 1/4 inch screw that secures the keypad/LCD assembly to the lower main chassis.
7. Carefully disconnect the 14 pin flex ribbon cable from the display assembly by pushing the connector locking tabs down.
8. Remove the keypad/LCD assembly from the main chassis assembly.
9. Using the flat blade screwdriver, separate the keypad and LCD by removing the four 4-40 x 3/16 inch hex screws securing the keypad to the LCD.
10. Install the replacement keypad in the exact reverse order of removal.
11. Install the keypad/LCD assembly in the exact reverse order of removal.
12. Join the front enclosure, rear enclosure, and main chassis assembly in the exact reverse order of separation.
13. Connect the infusion pump to AC power.

To verify successful keypad replacement, perform the PVT in [Section 5.2](#).

7.2.14.3**LCD REPLACEMENT**

The recommended tools for this procedure are a No. 2 Phillips screwdriver, medium size flat blade screwdriver, and an X-acto knife.

CAUTION: Use proper ESD grounding techniques when handling components. Wear an antistatic wrist strap and use an ESD-protected workstation. Store the PWA in an antistatic bag before placing it on any surface.

To replace the LCD, refer to *Figure 7-11*, then proceed as follows:

1. Separate the front enclosure, rear enclosure, and main chassis assembly as described in *Section 7.2.6*.
2. Place the infusion pump on its side to gain access to the bottom of the pump.
3. Disconnect the keypad cable from J4 on the CPU PWA.
4. Disconnect the LCD cable from J20 on the CPU PWA.
5. Using the X-acto knife, lift the white insulation tape that secures the grounding tab to the lower main chassis.
6. Using the Phillips screwdriver, remove the 4-24 x 1/4 inch screw securing the keypad/LCD assembly to the lower main chassis.
7. Carefully disconnect the 14 pin flex ribbon cable from the display assembly by pushing the connector locking tabs down.
8. Remove the keypad/LCD assembly from the main chassis assembly.
9. Using the flat blade screwdriver, remove the four 4-40 x 3/16 inch hex screws securing the LCD to the keypad.
10. Install the replacement LCD in the exact reverse order of removal.
11. Install the keypad/LCD assembly in the exact reverse order of removal.
12. Join the front enclosure, main chassis assembly, and rear enclosure assembly in the exact reverse order of separation.
13. Connect the infusion pump to AC power.

To verify successful LCD replacement, perform the PVT in *Section 5.2*.

7.2.14.4**CPU/DRIVER CABLE REPLACEMENT**

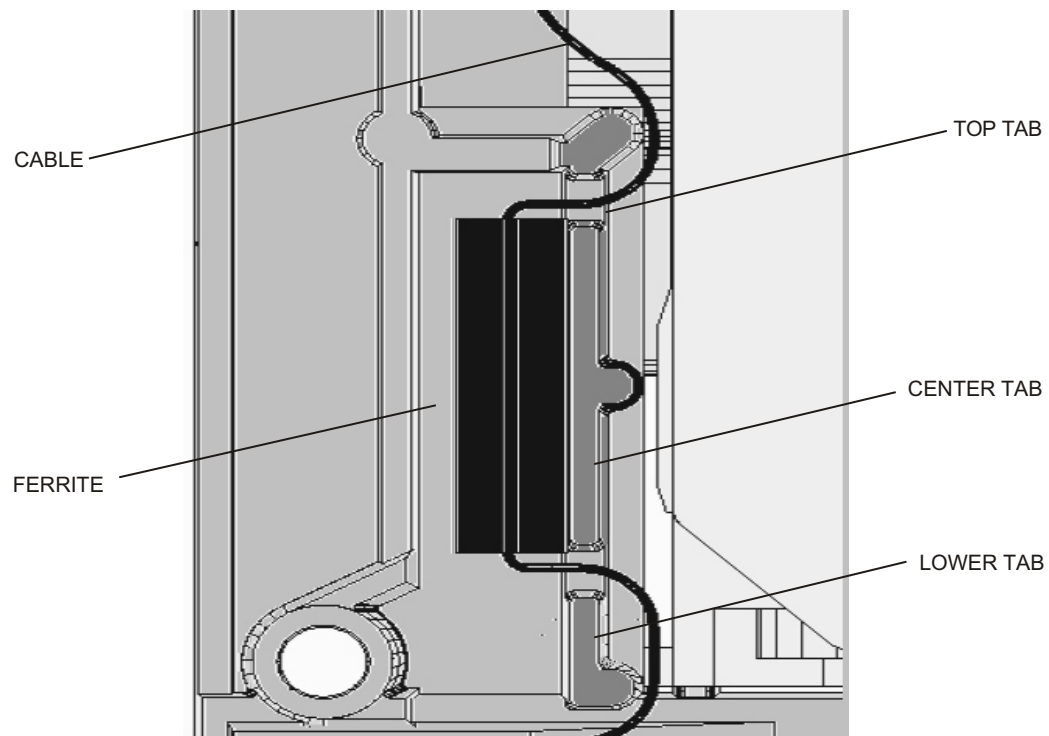
The recommended tool for this procedure is an X-acto knife.

CAUTION: Use proper ESD grounding techniques when handling components. Wear an antistatic wrist strap and use an ESD-protected workstation. Store PWAs in antistatic bags before placing them on any surface.

To replace the CPU/driver cable refer to *Figure 7-11, Main Chassis Components (1 of 2)*; *Figure 7-12, CPU/Driver Cable Routing*; *Figure 7-13, Ferrite Tape Positioning (1 of 2)*; and *Figure 7-13, Ferrite Tape Positioning (2 of 2)*, then proceed as follows:

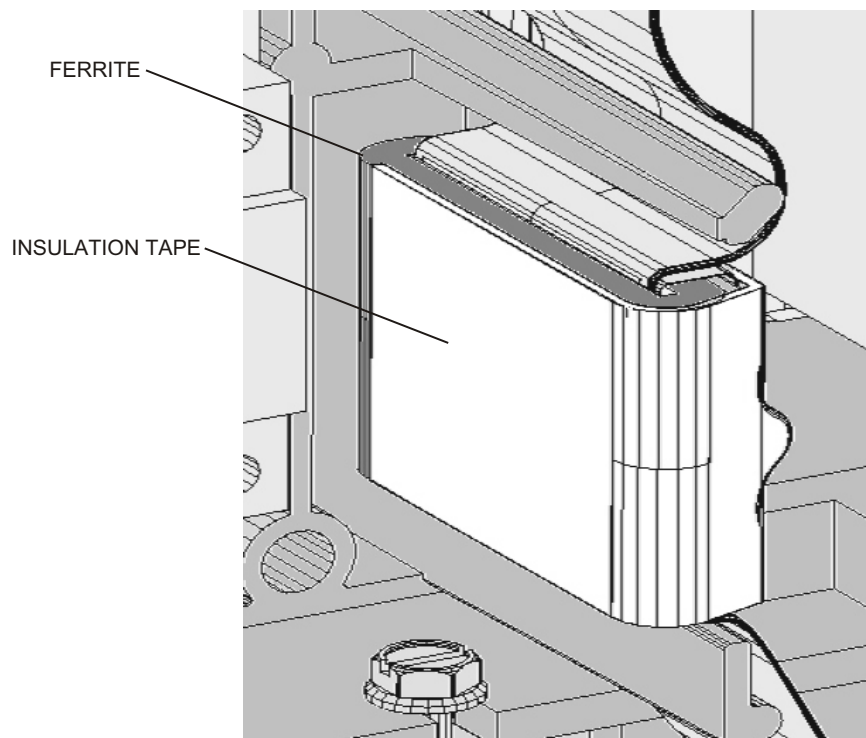
1. Separate the front enclosure, rear enclosure, and main chassis assembly as described in *Section 7.2.6*.
2. Remove the peripheral/interface PWA as described in *Section 7.2.7*.
3. Remove the peripheral PWA as described in *Section 7.2.8*.
4. Remove the power supply PWA as described in *Section 7.2.14.1*.
5. Disconnect the CPU/driver cable from the mechanism assembly.
6. Remove the insulating tape securing the CPU/driver cable and ferrite to the center tab (*see Figure 7-13*).
7. Remove both ends of ferrite tape from the center tab. Cut off the adhesive strip on one side of the ferrite tape and pull through the ferrite (*see Figure 7-13*).
8. Remove the CPU/driver cable from the center tab.
9. Remove the CPU PWA as described in *Section 7.2.14.6, CPU PWA Replacement*.
10. Disconnect the CPU/driver cable from J3 on the CPU PWA.
11. Insert ferrite tape through the ferrite of the replacement CPU/driver cable. Assure the adhesive side is facing away from the cable.
12. Position the ferrite between the two line marks on the cable.
13. Route the cable around the tabs as shown in *Figure 7-12*. Assure the pin 1 stripe of the cable faces the front of the infusion pump. Ferrite should be on the left side of the center tab and between the cable markings.
14. Remove the backing to expose the adhesive and apply both ends of tape completely to the surface of the center tab (*see Figure 7-13*).
15. Wrap insulation tape around the ferrite and center tab (*see Figure 7-13*).
16. Connect the CPU/driver cable to J11 of the mechanism assembly.
17. Reassemble the infusion pump in the exact reverse order of disassembly.

To verify successful CPU/driver cable replacement, perform the PVT in *Section 5.2*.

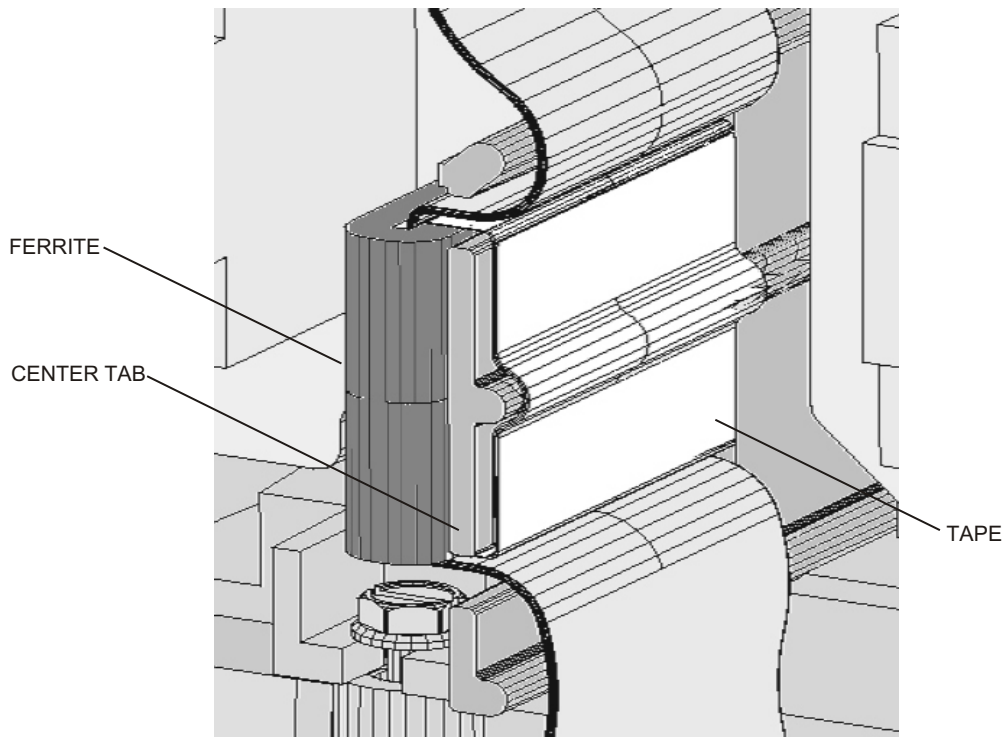


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Figure 7-12. CPU/Driver Cable Routing



02H07015

Figure 7-13. Ferrite Tape Positioning (1 of 2)

02H07013

Figure 7-13. Ferrite Tape Positioning (2 of 2)

7.2.14.5**MOTOR POWER CABLE REPLACEMENT**

The recommended tool for this procedure is a medium size flat blade screwdriver.

CAUTION: Use proper ESD grounding techniques when handling components. Wear an antistatic wrist strap and use an ESD-protected workstation. Store the PWA in an antistatic bag before placing it on any surface.

To replace the motor power cable, refer to *Figure 7-11*, then proceed as follows:

1. Separate the front enclosure, rear enclosure, and main chassis assembly as described in *Section 7.2.6*.
2. Disconnect the motor power cable from J16 on the CPU PWA.
3. Remove the mechanism assembly as described in *Section 7.2.14.8, Mechanism Assembly Replacement*.
4. Disconnect the motor power cable from J11 on the mechanism assembly.
5. Install the replacement motor power cable in the exact reverse order of removal.

To verify successful motor power cable replacement, perform the PVT in *Section 5.2*.

7.2.14.6**CPU PWA REPLACEMENT**

Recommended tools for this procedure are a medium size flat blade screwdriver and No. 2 Phillips screwdriver.

CAUTION: Use proper ESD grounding techniques when handling components. Wear an antistatic wrist strap and use an ESD-protected workstation. Store PWAs in antistatic bags before placing them on any surface.

To replace the CPU PWA, refer to *Figure 7-11*, then proceed as follows:

1. Separate the front enclosure, rear enclosure, and main chassis assembly as described in *Section 7.2.6*.
2. If necessary, remove the peripheral/interface PWA as described in *Section 7.2.7*.
3. If necessary, remove the peripheral PWAs as described in *Section 7.2.8*.
4. Place the main chassis assembly on its side.
5. Remove the power supply PWA as described in *Section 7.2.14.1*.
6. Disconnect the keypad ribbon cable from J4 on the CPU PWA.
7. Disconnect the display cable from J20 on the CPU PWA.
8. Disconnect the CPU/driver cable from the mechanism assembly (*see Section 7.2.14.4*).
9. Inspect the CPU/driver cable for damage and replace, if necessary.
10. Disconnect the piezo alarm cable from J24 on the CPU PWA.
11. Using the Phillips screwdriver, remove the 4-24 x 1/4 inch screw and flat washer from the bottom of the lower main chassis assembly.
12. Slide the CPU PWA out of the main chassis until J5 on the CPU PWA is accessible.
13. Using the flat blade screwdriver, release the locking tabs holding the 14 pin flex cable to J5 of the CPU PWA.

14. Install the replacement CPU PWA in the exact reverse order of removal.
15. Join the front enclosure, rear enclosure, and main chassis assembly in the exact reverse order of separation.
16. Connect the infusion pump to AC power.

To verify successful CPU PWA replacement, perform the PVT in [Section 5.2](#).

7.2.14.7


PIEZO ALARM ASSEMBLY REPLACEMENT

Recommended tools for this procedure are a set of nutdrivers and medium size flat blade screwdriver.

CAUTION: Use proper ESD grounding techniques when handling components. Wear an antistatic wrist strap and use an ESD-protected workstation. Store the PWA in an antistatic bag before placing it on any surface.

To replace the piezo alarm assembly, refer to [Figure 7-11](#), then proceed as follows:


1. Separate the front enclosure, rear enclosure, and main chassis assembly as described in [Section 7.2.6](#).
2. Using a 1/4 nutdriver, separate the upper and lower main chassis assemblies by removing the six hex head screws from the upper main chassis.
3. Expose the piezo alarm by lifting the upper main chassis. Place the chassis on the work surface.
4. Using a 3/16 nutdriver, remove the two hex screws securing the piezo alarm to the lower main chassis assembly.
5. Disconnect the piezo alarm cable from J24 on the CPU PWA.


Note: When installing, route the piezo alarm cable above the CPU/driver cable.
6. Install the replacement piezo alarm assembly in the exact reverse order of removal.
7. Join the front enclosure, rear enclosure, and main chassis assembly in the exact reverse order of separation.
8. Connect the infusion pump to AC power.

To verify successful piezo alarm assembly replacement, perform the PVT in [Section 5.2](#).

7.2.14.8**MECHANISM ASSEMBLY REPLACEMENT**

The recommended tools for this procedure are a 1/4 nutdriver and medium size flat blade screwdriver.

 **Note:** Replacing the mechanism changes the biomed settings to those stored in the replacement mechanism assembly.

To replace the mechanism assembly, refer to *Figure 7-11*, then proceed as follows:

1. Separate the upper and lower front enclosures, rear enclosure assembly, and main chassis assembly as described in *Section 7.2.6*.
2. Disconnect the CPU/driver cable from the mechanism assembly.
3. Disconnect the motor power cable from J16 on the power supply PWA.
4. Using the nutdriver, separate the upper and lower main chassis assemblies by removing the six 6-32 x 1/2 inch hex screws.
5. Lift the upper main chassis assembly and place it on the work surface.
6. Using the nutdriver, remove the 6-32 x 1/2 inch hex screw securing the mechanism assembly to the upper main chassis assembly. Slide the mechanism assembly away from the main chassis assembly.
7. Disconnect the motor power cable from the mechanism assembly. Inspect the cable and replace if required.
8. Inspect the rubber bumpers and replace, if required.
9. Install the replacement mechanism assembly in the exact reverse order of removal.
10. Join the upper and lower main chassis assembly in the exact reverse order of separation.
11. Using fingers, tighten the remaining front two 6-32 x 1/2 inch screws.
12. Using the nutdriver, tighten the remaining front two 6-32 x 1/2 inch screws another 1/4 to 3/8 turn.
13. Join the front enclosure, rear enclosure, and main chassis assembly in the exact reverse order of separation.
14. Connect the infusion pump to AC power.


To verify successful mechanism assembly replacement, perform the PVT in *Section 5.2*.

7.2.14.9**CASSETTE DOOR AND FLUID SHIELD REPLACEMENT**

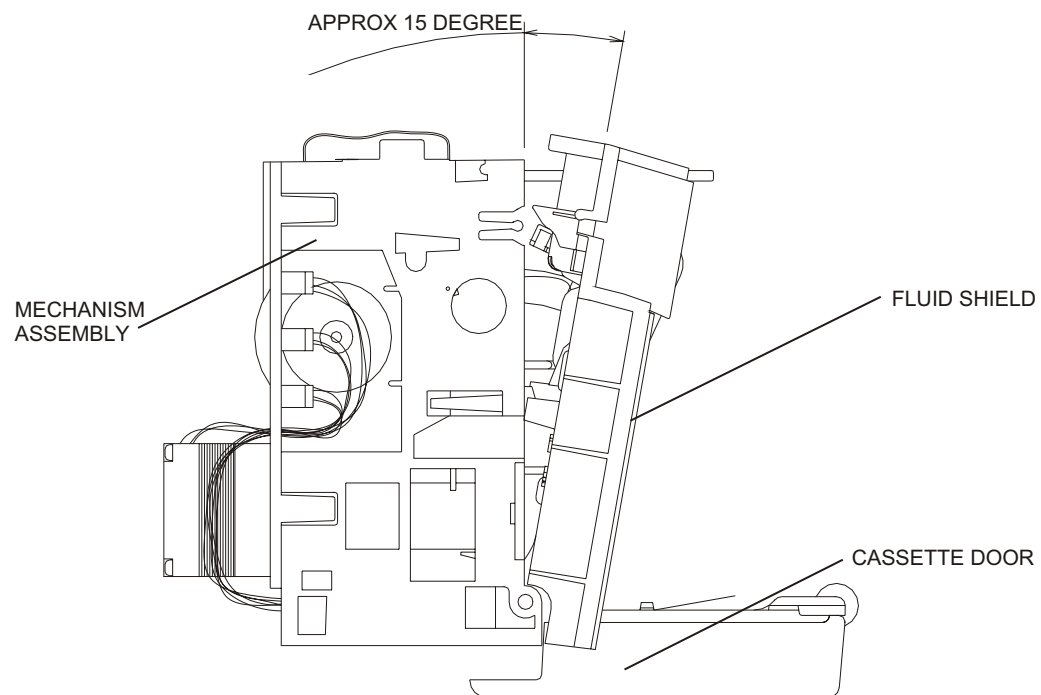
The recommended tool for this procedure is a medium size flat blade screwdriver.

To replace the cassette door and fluid shield, refer to *Figure 7-14, Fluid Shield Replacement*, and *Figure 7-15, Cassette Door and Opener Handle Assembly Replacement*, then proceed as follows:

1. Separate the upper and lower front enclosure assemblies, rear enclosure assembly, and main chassis assembly as described in *Section 7.2.6*.
2. Remove the mechanism assembly as described in *Section 7.2.14.8*.
3. Using the flat blade screwdriver, remove the hex head screw securing the door pivot cap to the mechanism assembly. Disengage the cassette door from the opener handle assembly and remove the door.

4. On the back side of the fluid shield, disengage the clips that retain the upper portion of the fluid shield to the mechanism assembly.
 5. Lift the locking pins of J12 to release the flex connector and disconnect from the driver PWA.
 6. Pull the shield away from the top of the mechanism assembly at an approximate 15-degree angle. Pull the shield up and away, clearing the mechanism assembly pins and plunger.
-  **Note:** Prior to fluid shield replacement, verify the mechanism assembly valve pins are positioned in the alignment grooves.
7. Install the replacement fluid shield in the exact reverse order of removal.
 8. Install the replacement cassette door in the exact reverse order of removal.
 9. Install the mechanism assembly in the exact reverse order of removal.
 10. Join the front enclosure, rear enclosure, and main chassis assembly in the exact reverse order of separation.
 11. Connect the infusion pump to AC power.

To verify successful cassette door and fluid shield replacement, perform the PVT in [Section 5.2](#).



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Figure 7-14. Fluid Shield Replacement

7.2.14.10**OPENER HANDLE ASSEMBLY REPLACEMENT**

The recommended tool for this procedure is a medium size flat blade screwdriver.

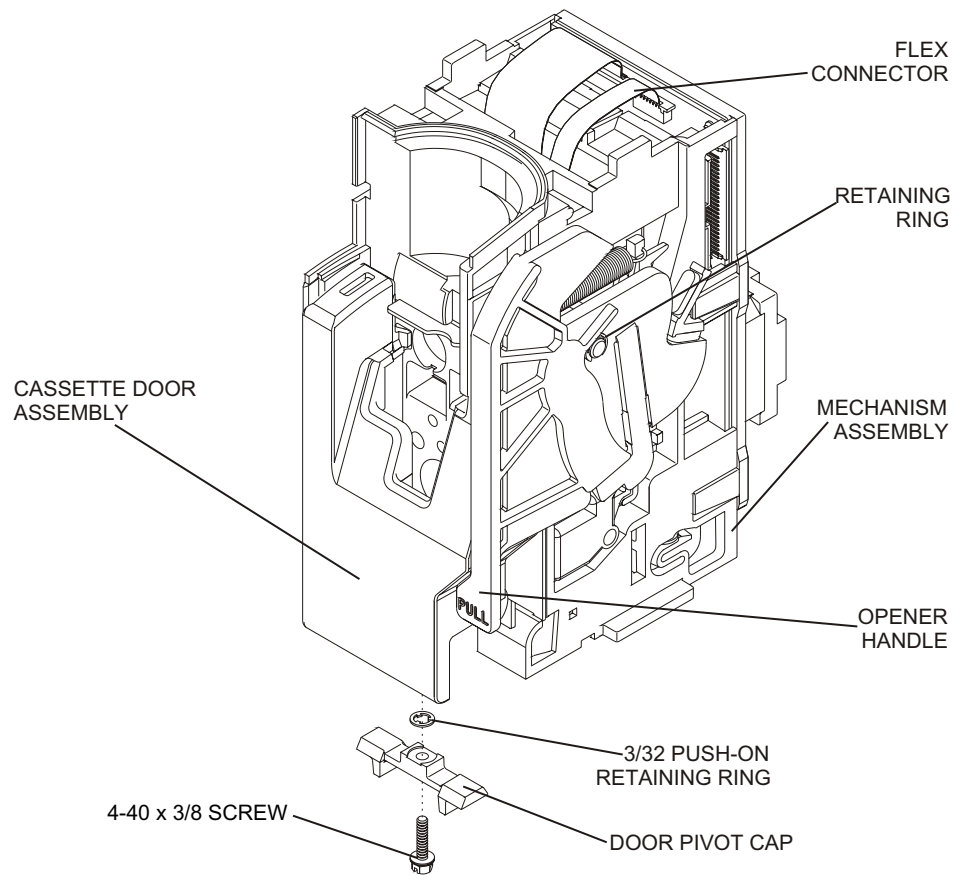
To replace the opener handle assembly, refer to *Figure 7-15*, then proceed as follows:

1. Separate the front enclosure, rear enclosure, and main chassis assembly as described in *Section 7.2.6*.
2. Remove the mechanism assembly as described in *Section 7.2.14.8*.
3. Open the cassette door. Disengage and fully open the cassette door from the opener handle assembly (*see Figure 7-15*). Close the opener handle assembly.
4. Remove the retaining ring.
5. Insert the flat blade screwdriver between the opener handle assembly and the mechanism assembly. Carefully pry the assemblies apart.

 **Note:** The torsion spring may fall free.

6. Install the replacement opener handle assembly in the exact reverse order of removal. Confirm the opener handle is aligned properly.
7. Replace the mechanism assembly in the exact reverse order of removal.
8. Join the front enclosure, rear enclosure, and main chassis assembly in the exact reverse order of separation.
9. Connect the infusion pump to AC power.

To verify successful opener handle assembly replacement, perform the PVT in *Section 5.2*.



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Figure 7-15. Cassette Door and Opener Handle Assembly Replacement

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Section 8

SPECIFICATIONS

PHYSICAL

Dimensions: Approximately 19.0 H x 15.0 W x 14.0 D inches (excluding pole clamp and power cord storage)

Weight: Approximately 28 lbs (with batteries)

Casing: High-impact plastic

ELECTRICAL

Power Requirements: 95-132 V_{AC}, 47-62 Hz, 90 W

Power Cord: Hospital-grade AC cord; 10 feet with transparent plug and retainer plate

Fuses: 0.5 A, 250 V_{AC}

Battery: Three sealed, lead-acid, rechargeable 6 V batteries, internal to the infusion pump

Battery Operation: A fully charged new battery provides six hours of operation at 125 mL/hr, or delivers 500 mL on one line, whichever occurs first. Operation time is measured from initial pumping to the Depleted Battery alarm. The infusion pump should be operated on battery power for six continuous hours every six months for optimum performance and battery life.

Recharge: The battery charges whenever the infusion pump is connected to AC power. If the infusion pump is operating at 125 mL/hr or less on one line, a full recharge takes less than six hours.

Self-Discharge: 50% of charge is retained for a minimum of one month when the infusion pump is not connected to AC power or is not operating.

Nurse Call System: Circuitry Ratings: Voltage - 30 V_{DC} max
Current - 0.25 A max
Contact Rating - 3 W max

Default: Normally-open (NO)

Note: Contact Abbott Laboratories Technical Support Operations to make an internal adjustment to change the device from normally-open to normally-closed (NC).

ENVIRONMENT

Operating:	41° to 104° F (5° to 40° C) 10% to 90% relative humidity
Transporting and Storage:	-4° to 140° F (-20° to 60° C) 10% to 90% relative humidity
Atmospheric Pressure:	0 - 10,000 feet (0 - 3000 meters) or equivalent atmospheric pressure
Relative Humidity:	10 - 90% (104° F max)

DELIVERY RATE RANGE

Lines A and B:	0.1 to 99.9 mL/hr (in 0.1 mL/hr increments) 100 to 999 mL/hr (in 1 mL/hr increments), cassette type dependent
Concurrent Delivery:	0.5 mL/hr minimum for each line
PlumSet:	500 mL/hr cumulative (A+B) maximum
KVO:	1.0 mL/hr or the last primary delivery rate, whichever is less
VTBI RANGE:	0.1 to 99.9 mL (in 0.1 mL/hr increments) 100 to 9999 mL (in 1 mL/hr increments)

OCCLUSION ALARM AND LIMITS

Distal:	The distal occlusion alarm sounds after the distal tubing or set outlet fitting becomes occluded.
Proximal:	The proximal occlusion alarm sounds within three pumping cycles when the tubing proximal to the cassette becomes occluded.
Distal Pressure Limit (without alarm):	1 to 15 psi. The maximum pressure limit is user-selectable. Factory default is 6 psi.
Maximum Infusion Pressure:	20 psi

AIR-IN-LINE ALARM

PlumSet (Distal):	
Delivery rates less than 500 mL/hr:	Bolus: 0.1 mL of air or larger for rates less than 500 mL/hr Cumulative: 0.25 mL of air out of 2.6 mL of fluid for rates less than 500 mL/hr
Delivery rates equal to or greater than 500 mL/hr:	Bolus: 0.5 mL of air or larger for rates equal to or greater than 500 mL/hr. Cumulative: 0.5 mL of air out of 5.3 mL of fluid for rates equal to or greater than 500 mL/hr
PlumSet (Proximal):	Bolus at 0.5 mL, Total 1.0 mL (0.5 mL concurrent)

Section 9

DRAWINGS

Figure 9-1 through *Figure 9-17* show the illustrated parts breakdown (IPB), infusion pump assembly diagrams, and PWA schematic diagrams. *Table 9-1, Drawings*, lists drawings by figure number, title, and part number. *Table 9-2, IPB for the Infusion Pump*, identifies parts by index numbers which correlate to *Figure 9-1*.


 **Note:** Drawings and schematics in *Section 9* are provided as information only. Drawings and schematics may not exactly reflect current product configuration.

Table 9-1. Drawings

Figure No.	Title	Part Number
9-1	Illustrated Parts Breakdown	Not Applicable
9-2	Front Enclosures, Rear Enclosure, and Main Chassis Assembly	
9-3	Front Enclosure Assemblies	
9-4	Rear Enclosure Assembly	
9-5	Peripheral/Interface Assembly	
9-6	Main Chassis Assembly	
9-7	CPU PWA, LCD, and Keypad	
9-8	CPU PWA and Main Chassis	
9-9	AC Power Cord, Power Cord Retainer, Batteries, and Minipole Assembly	
9-10	Mechanism Assembly	
9-11	Power Supply PWA Schematic (10 Sheets)	249-95005-012
9-12	Peripheral/Interface PWA Schematic (6 Sheets)	249-95430-004
9-13	Peripheral PWA Schematic (4 Sheets)	249-95431-002
9-14	CPU PWA Schematic (10 Sheets)	249-95007-008
9-15	Driver PWA Schematic (3 Sheets)	249-95018-006
9-16	Switch PWA Schematic (1 Sheet)	249-95022-004
9-17	APP PWA Schematic (3 Sheets)	249-95034-007

Table 9-2. IPB for the Infusion Pump

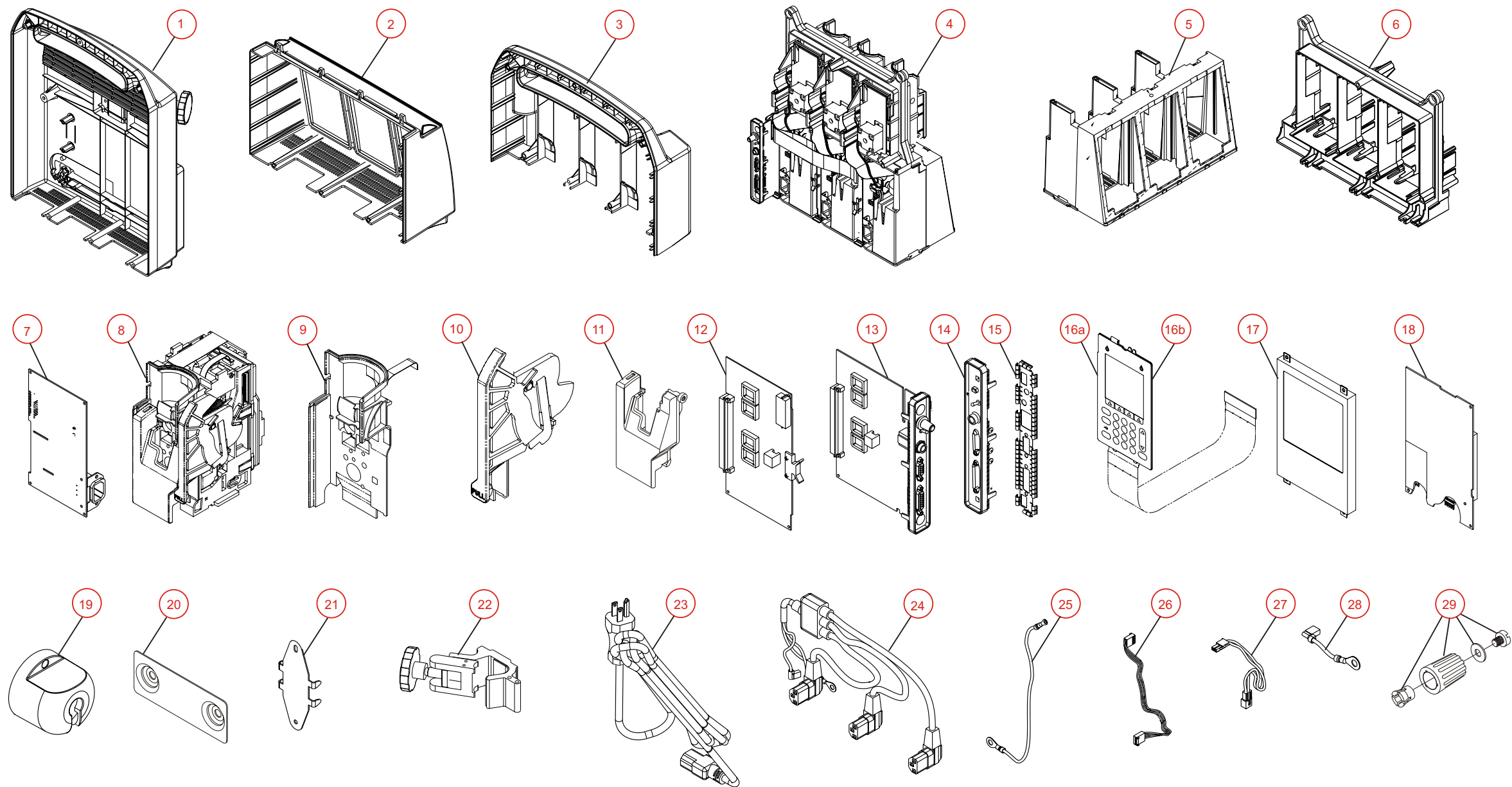
Index No.	Nomenclature	Replacement Procedure
1	Enclosure, Rear	<i>Section 7.2.12</i>
2	Enclosure, Lower Front	<i>Section 7.2.11</i>
3	Enclosure, Upper Front	<i>Section 7.2.10</i>
4	Chassis, Main	<i>Section 7.2.14</i>
5	Chassis, Lower	<i>Section 7.2.14</i>
6	Chassis, Upper	<i>Section 7.2.14</i>
7	PWA, Power Supply	<i>Section 7.2.14.1</i>
8	Assembly, Mechanism	<i>Section 7.2.14.8</i>
9	Shield, Fluid	<i>Section 7.2.14.9</i>
10	Handle, Opener	<i>Section 7.2.14.10</i>
11	Assembly, Cassette Door	<i>Section 7.2.14.9</i>
12	PWA, Peripheral	<i>Section 7.2.8</i>
13	Assembly, Peripheral/Interface	<i>Section 7.2.7</i>
14	Cover, Peripheral	<i>Section 7.2.9.2</i>
15	Spring, ESD, Peripheral Cover	<i>Section 7.2.9.2</i>
16a	Assembly, Keypad, A+	<i>Section 7.2.14.2</i>
16b	Assembly, Keypad, A+3	<i>Section 7.2.14.2</i>
17	LCD	<i>Section 7.2.14.3</i>
18	PWA, CPU	<i>Section 7.2.14.6</i>
19	Retainer, Power Cord	<i>Section 7.2.5</i>
20	Plate, Backing, Pole Clamp	<i>Section 7.2.12.1</i>
21	Clamp, Internal AC Power Cord	<i>Section 7.2.12.2</i>
22	Assembly, Pole Clamp	<i>Section 7.2.12.1</i>
23	Cordset, AC Power, Hospital Grade, Detachable	<i>Section 7.2.5</i>
24	Cord, AC Power, Internal	<i>Section 7.2.12.2</i>
25	Wire, Ground, Pole Clamp	<i>Section 7.2.12.3</i>
26	Assembly, Cable, Motor Power	<i>Section 7.2.14.5</i>
27	Assembly, Cable, Power Supply/Battery	<i>Section 7.2.14.1</i>
28	Wire, Ground	<i>Section 7.2.12.3</i>
29	Assembly, Knob, 1/8 in., Shaft, Gray, Matte	<i>Section 7.2.9.1</i>
30	Assembly, Cable, Peripheral/Interface #2	<i>Section 7.2.7</i>

Table 9-2. IPB for the Infusion Pump

Index No.	Nomenclature	Replacement Procedure
31	Assembly, Cable, Peripheral/Interface #1	Section 7.2.7
32	Assembly, Cable, CPU/Driver	Section 7.2.14.4
33	Alarm, Piezo	Section 7.2.14.7
34	Assembly, Battery	Section 7.2.4
35	Assembly, Minipole	Section 7.2.13
36	Strap, Retainer, Velcro, 1 3/4 in. x 10 in., Black	Section 7.2.5
37	Tape, Insulating, 2 Mil, White, 1.2 in.	Section 7.2.14.2
38	Tape, Ferrite	Section 7.2.14.4
39	Gasket, EMI, D-Shape, 6.62 in., with Adhesive	Section 7.2.11.1
40	Gasket, EMI, D-Shape, 13.0 in., with Adhesive	Section 7.2.11.1
41	Gasket, Front/Rear Enclosure	Section 7.2.10
42	Gasket, Rear Enclosure, 45.83 in. L	Section 7.2.12.6
43	Gasket, Rear Enclosure, 20.81 in. L	Section 7.2.12.6
44	Gasket, Keypad	Section 7.2.11.2
45	Battery Pad	Section 7.2.4
46	Gasket, Top Seal	Section 7.2.11.3
47	Cap, Pivot, Door	Section 7.2.14.9
48	Connector, AC, Panel	Section 7.2.12.4
49	Connector, AC, Fuse Drawer	Section 7.2.12.5
50	Fuse, 1.6 A, Slo-Blo, 250 V	Section 7.2.12.5
51	Terminal, Equipotential Post	Section 7.2.12.3
52	Screw, 4-40 x 3/8, Flat Head, Phillips, SS	Not Applicable
53	Screw, 6-32 x 1 1/4, Pan Head, Phillips, SS	
54	Screw, 6-32 x 2 3/4, Pan Head, Phillips, SS	
55	Screw, 4-24 x 1/4, Pan Head, Phillips, SS	
56	Screw, 4-40 x 3/8, Pan Head, Phillips, SS	
57	Screw, 6-32 x 1/2, Pan Head, Phillips, SS	
58	Screw, 4-40 x 3/16, Hex Head, Slotted, with Washer	
59	Screw, 4-40 x 3/8, Hex Head, Slotted, with Washer	
60	Screw, 6-32 x 1/2, Hex Head, Slotted, with Washer	
61	Screw, 8-32 x 3 1/2, Pan Head, Phillips, SS	

Table 9-2. IPB for the Infusion Pump

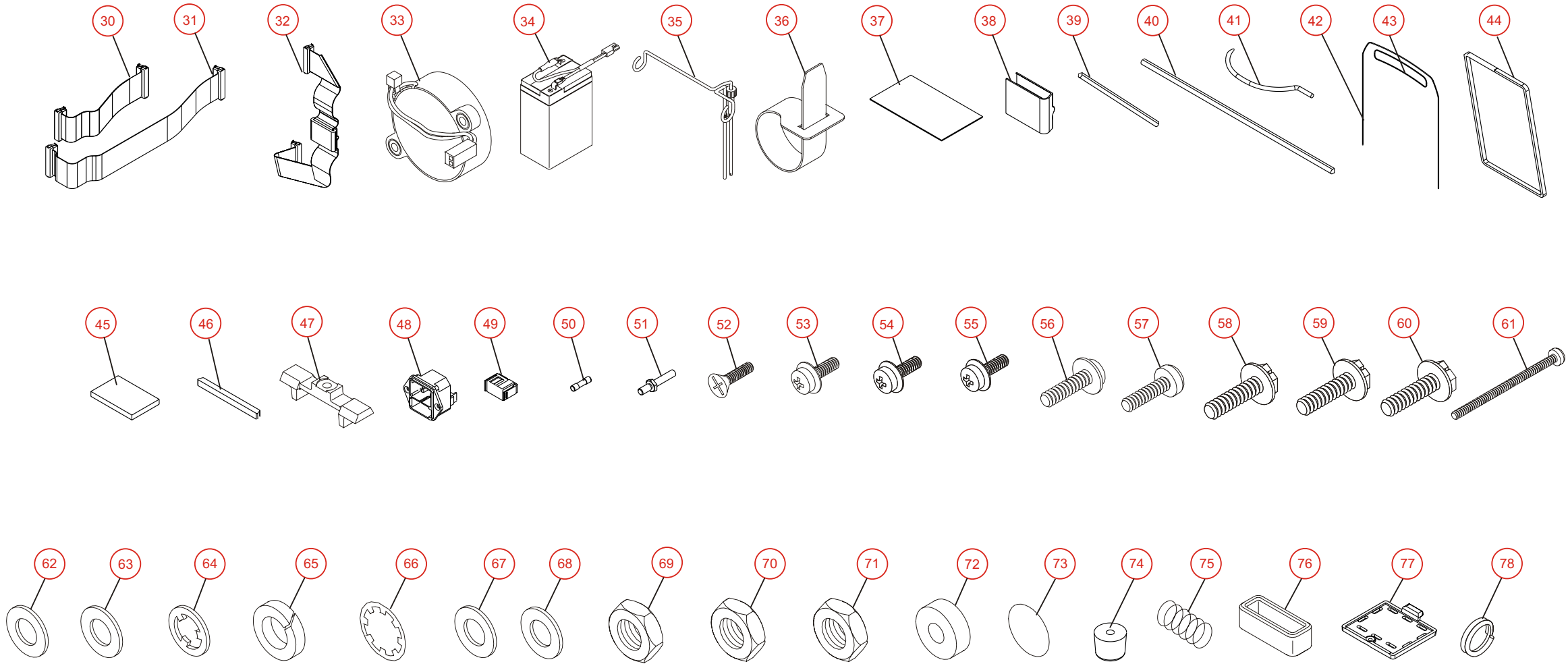
Index No.	Nomenclature	Replacement Procedure
62	Washer, #6, SS	Not Applicable
63	Washer, #8, SS	
64	Ring, Retaining, .125 Shaft, Push-On	
65	Washer, Lock, #6, .031 Thk., Split, Steel	
66	Washer, Lock, 1/4, .025 Thk., Internal Tooth	
67	Washer, Flat, .500 OD, SS	
68	Washer, Flat, .255 x .030 Thk., SS	
69	Nut, 4-40, Hex, Steel, Cad/Zinc Plate	
70	Nut, Hex, Metric, DIN 934, 10 mm	
71	Nut, 6-32, Kep, with Lock Washer, SS	
72	Spacer, Round, .375 x .140 x .125, Nylon	
73	Seal, Round	
74	Foot, Rubber	<i>Section 7.2.3</i>
75	Spring, External, 1.0 L, SS	Not Applicable
76	Bumper, Chassis/Mechanism	<i>Section 7.2.14.8</i>
77	Door, Battery	<i>Section 7.2.4</i>
78	Ring, Cotter	<i>Section 7.2.13.1</i>



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ABBOTT LABORATORIES HOSPITAL PRODUCTS DIVISION - MH	
Figure 9-1. Illustrated Parts Breakdown	
DRAWING NO. NOT APPLICABLE	Rev. N/A
	Sheet 1 of 2

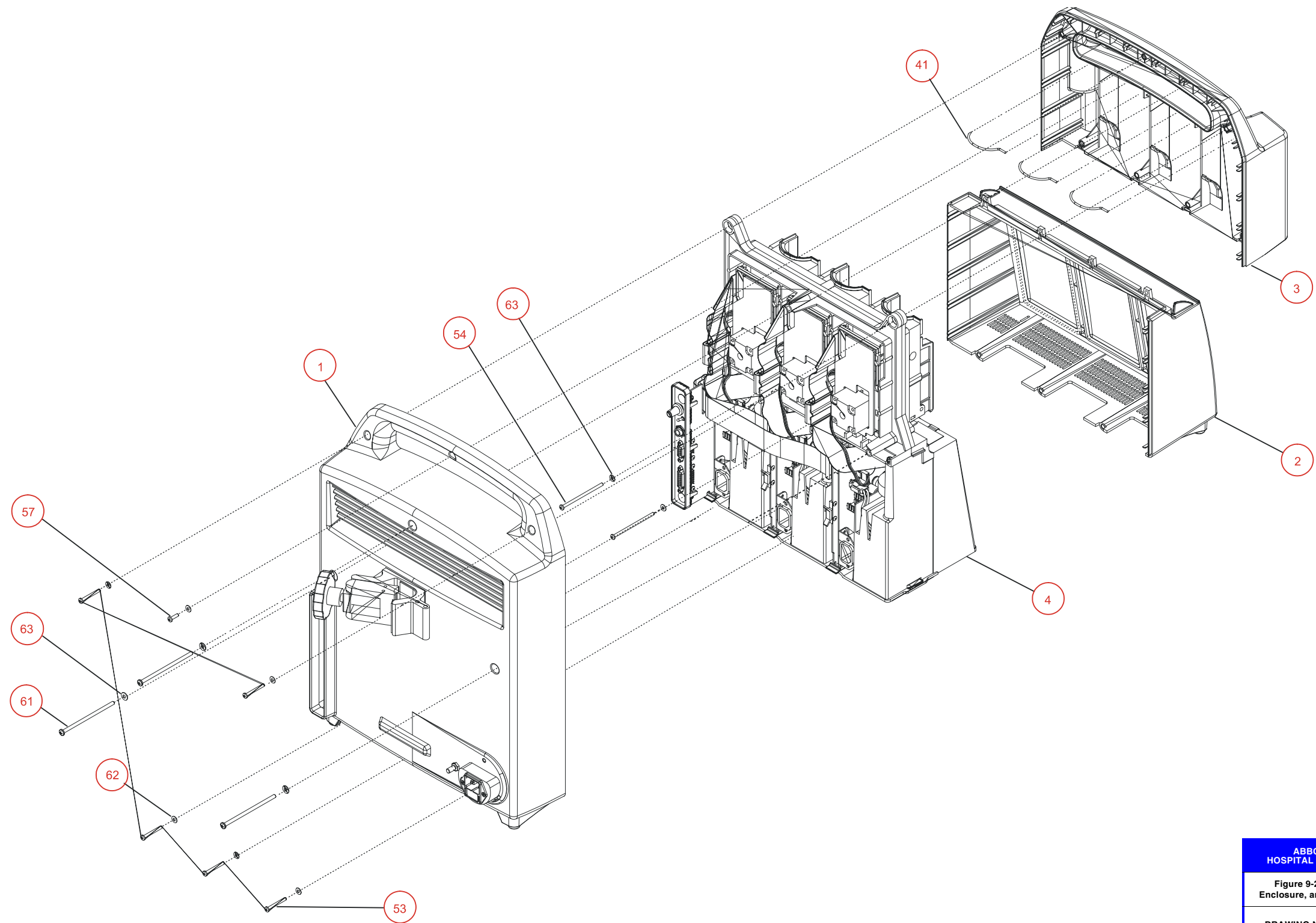
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Figure 9-1. Illustrated Parts Breakdown	
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	Sheet 2 of 2

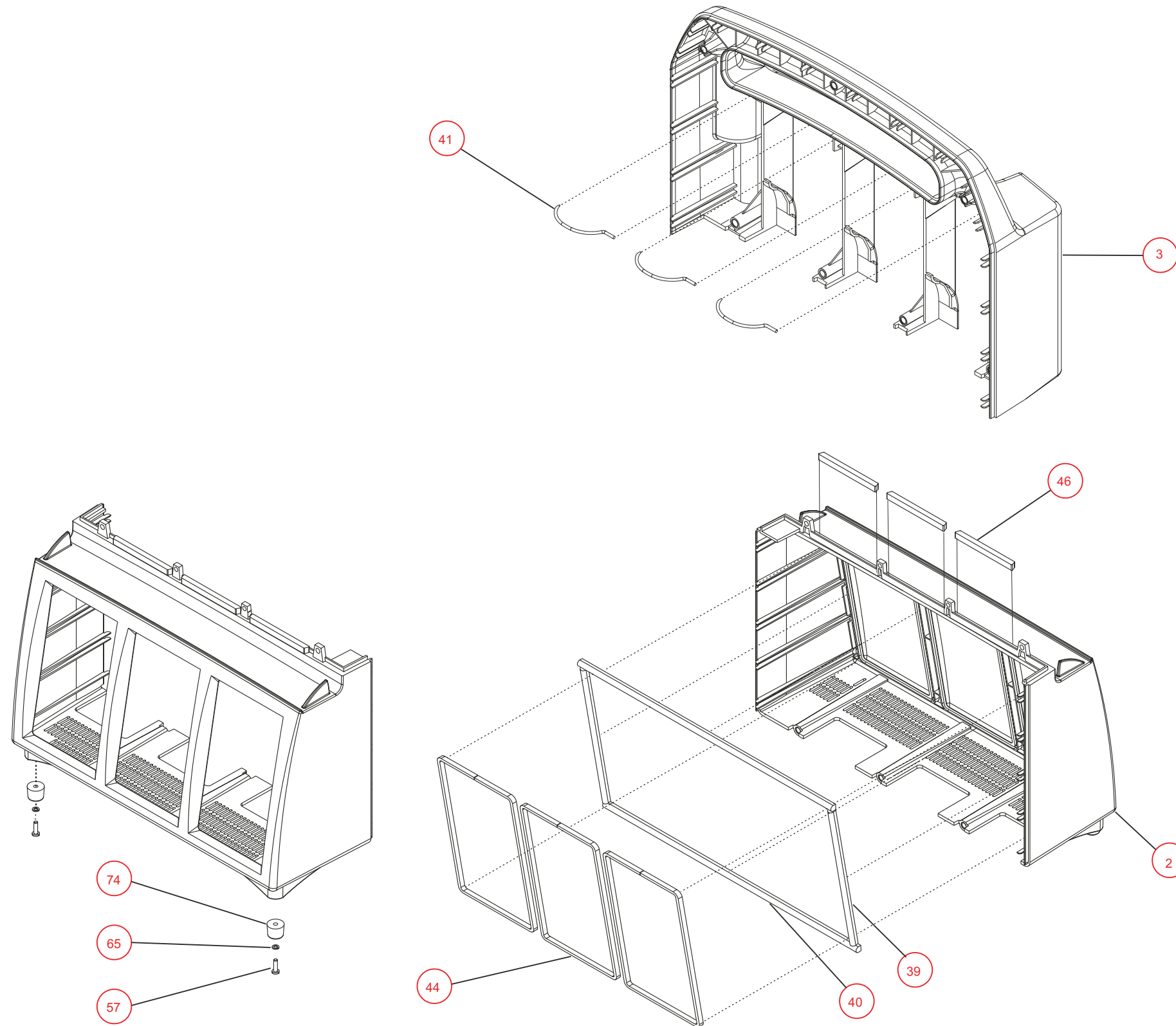
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Figure 9-2. Front Enclosures, Rear Enclosure, and Main Chassis Assemblies	
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	Sheet 1 of 1

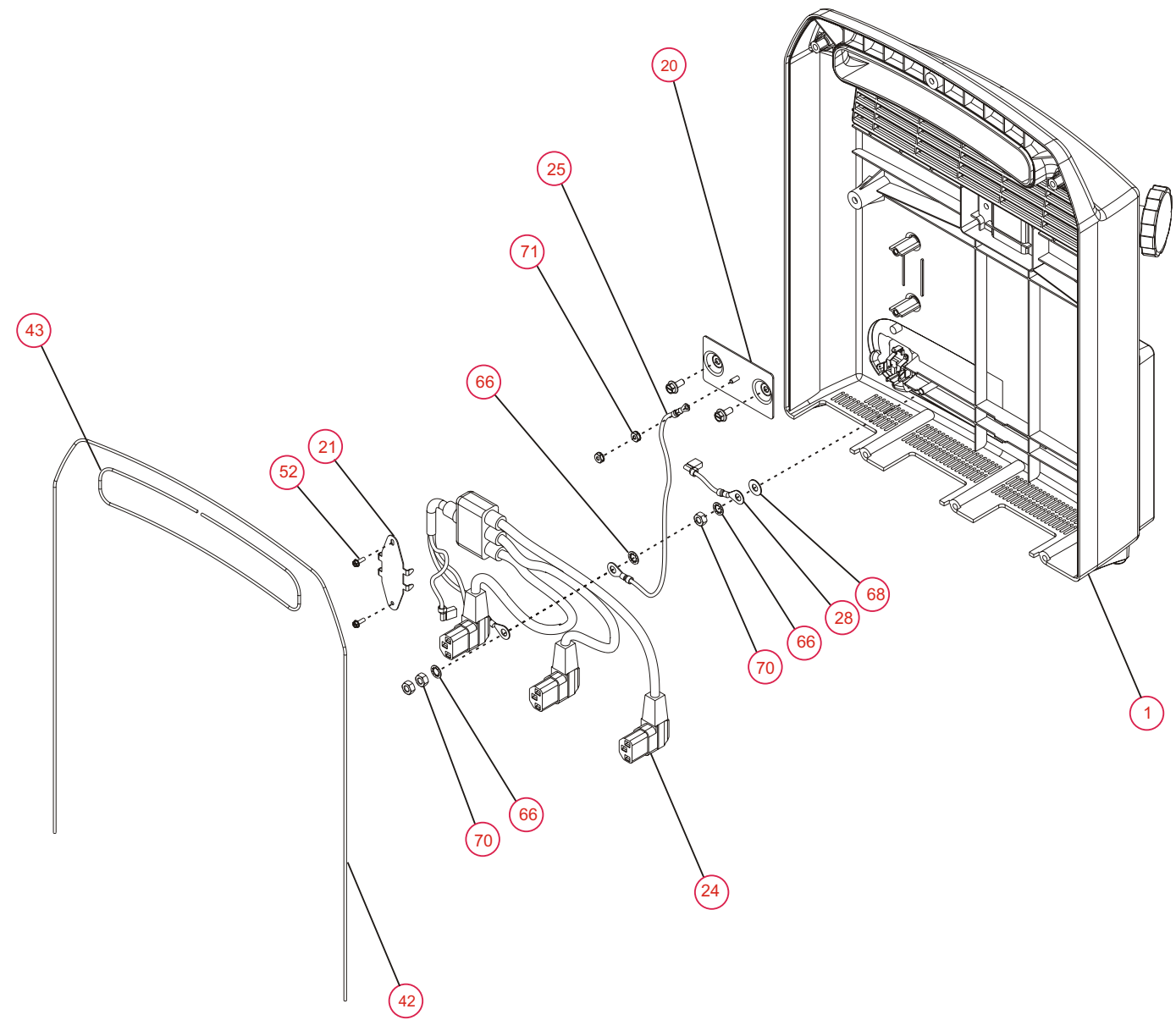
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ABBOTT LABORATORIES HOSPITAL PRODUCTS DIVISION - MH	
Figure 9-3. Front Enclosure Assemblies	
DRAWING NO. NOT APPLICABLE	Rev. N/A Sheet 1 of 1

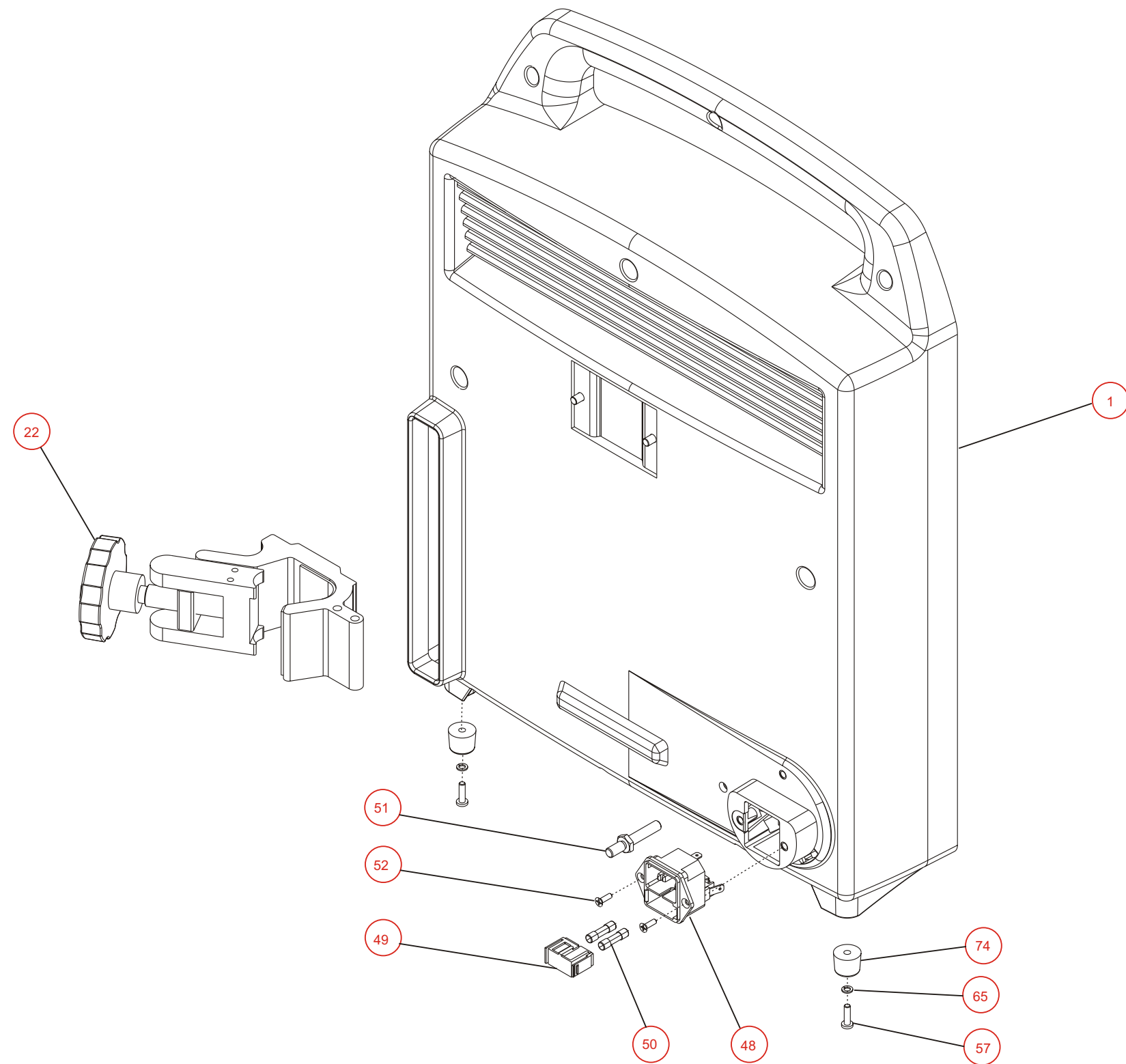
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ABBOTT LABORATORIES HOSPITAL PRODUCTS DIVISION - MH	
Figure 9-4. Rear Enclosure Assembly	
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	Sheet 1 of 2

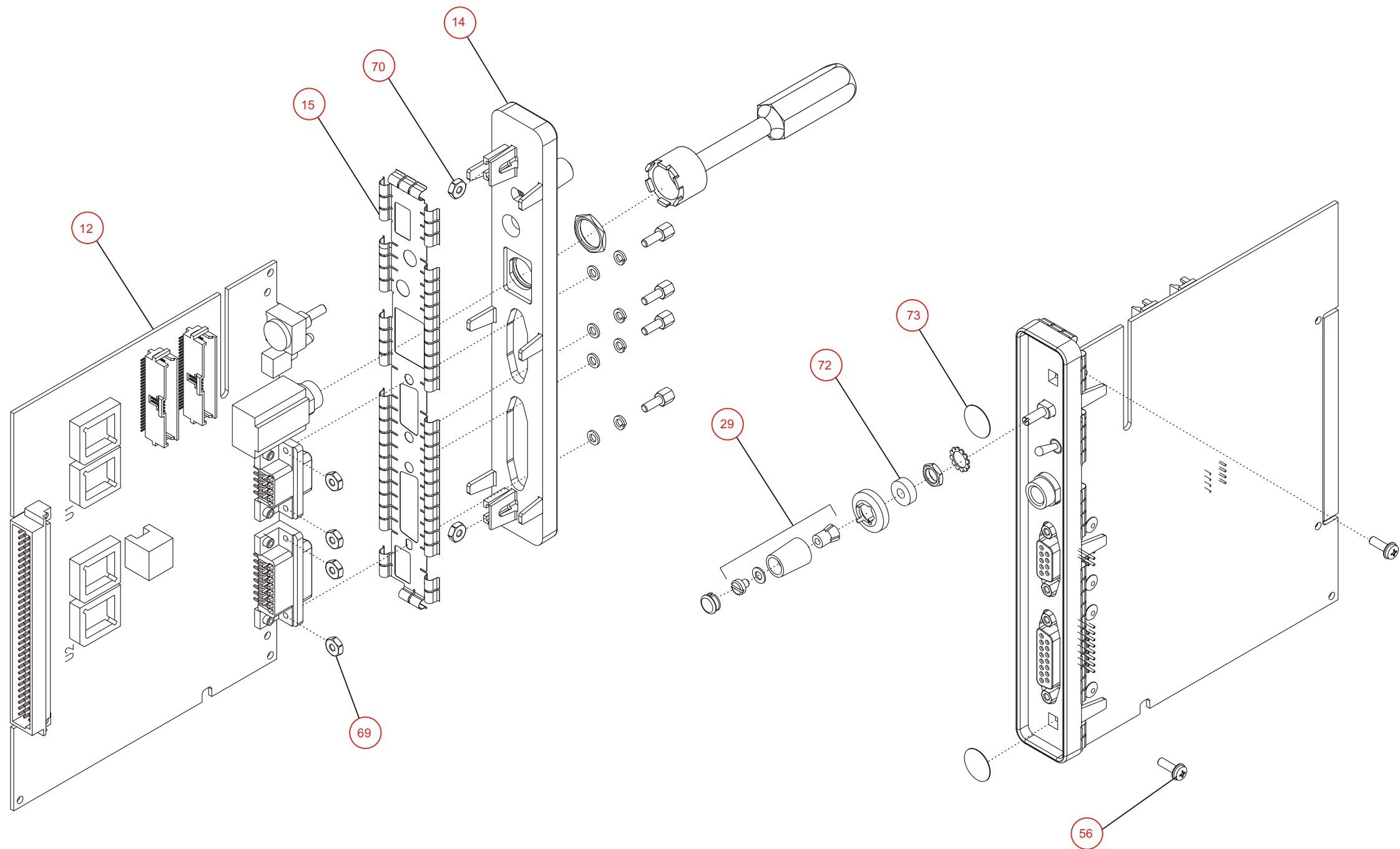
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Figure 9-4. Rear Enclosure Assembly	
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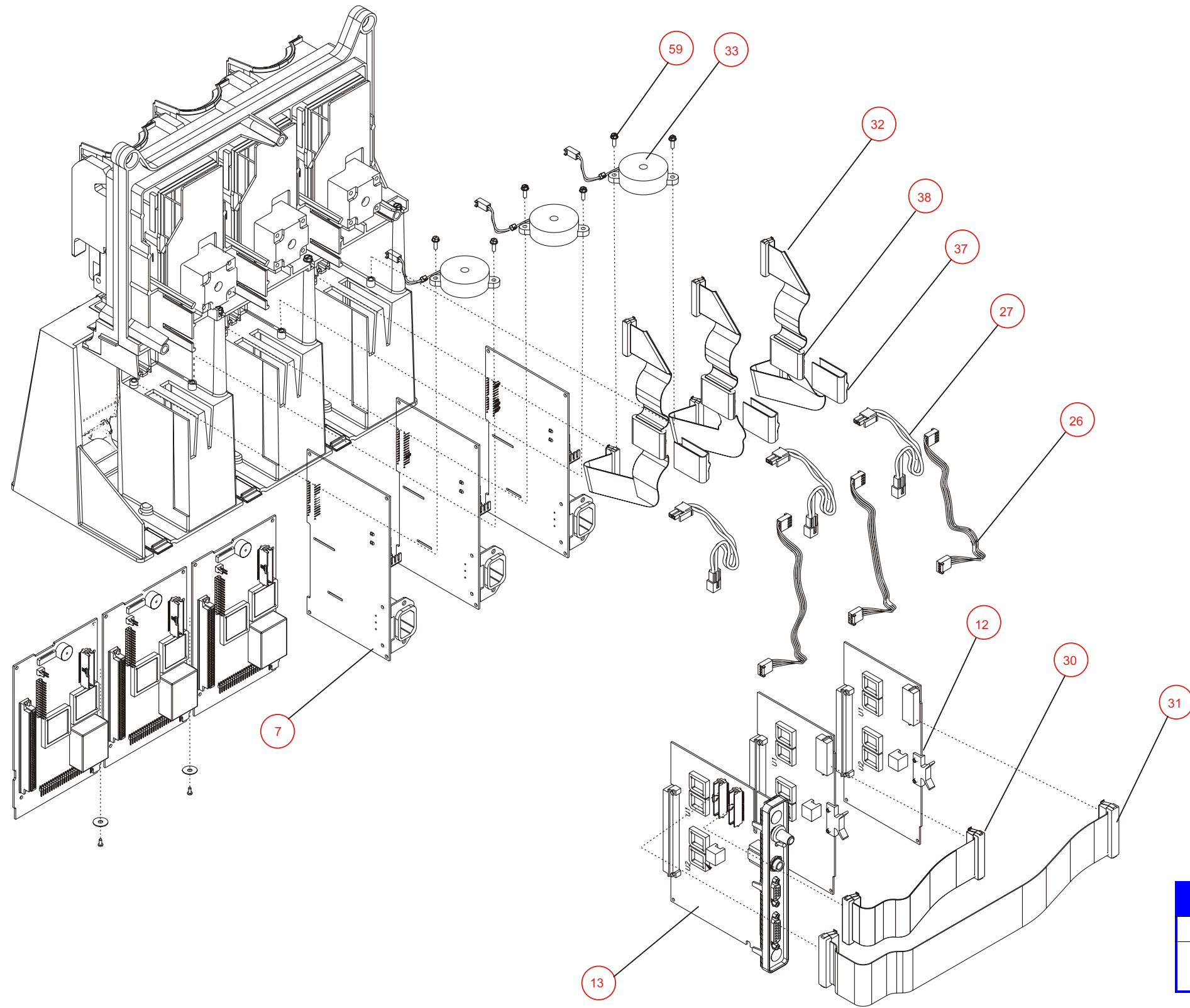
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Figure 9-5. Peripheral/Interface Assembly	
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	Sheet 1 of 1

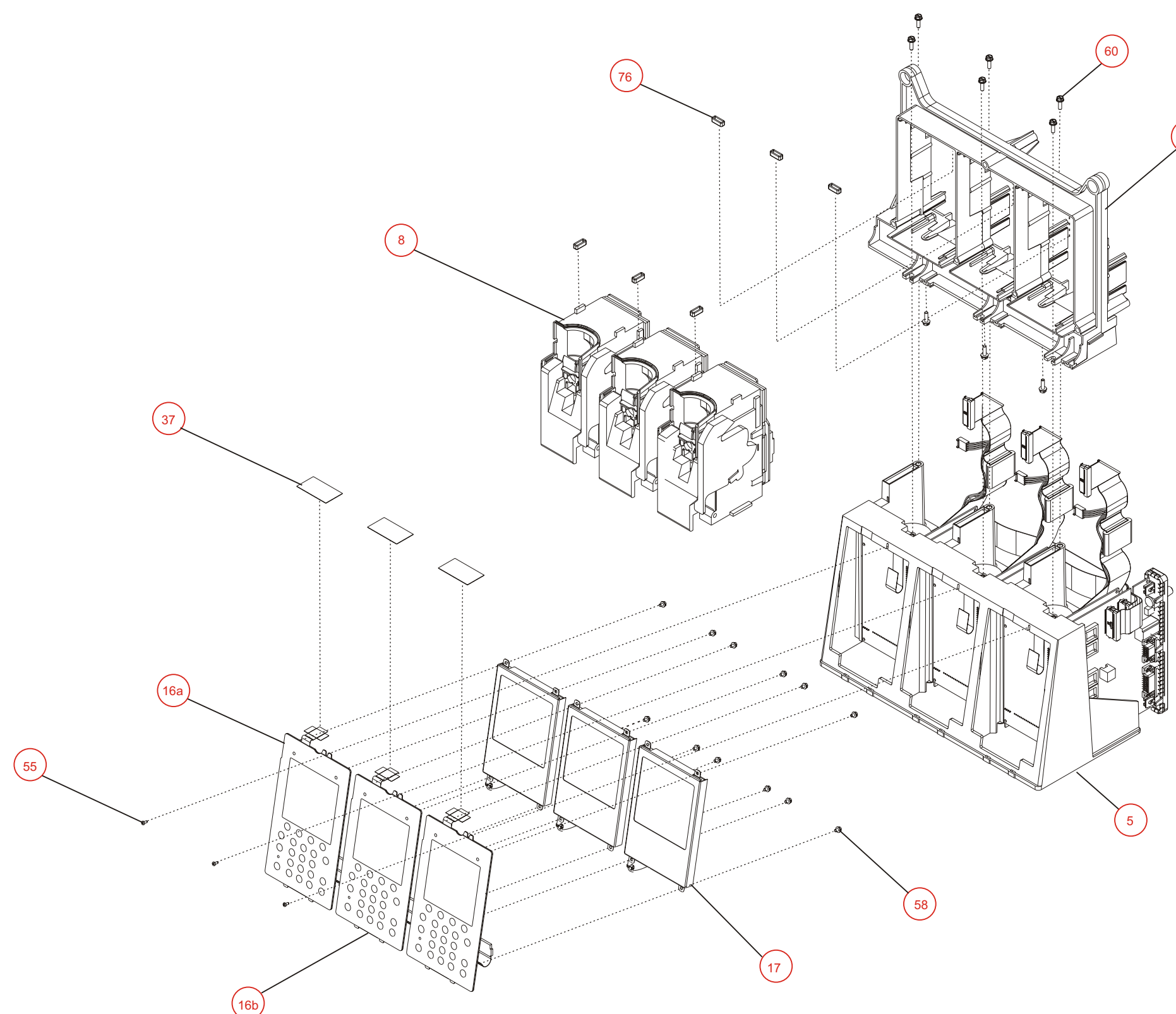
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ABBOTT LABORATORIES HOSPITAL PRODUCTS DIVISION - MH	
Figure 9-6. Main Chassis Assembly	
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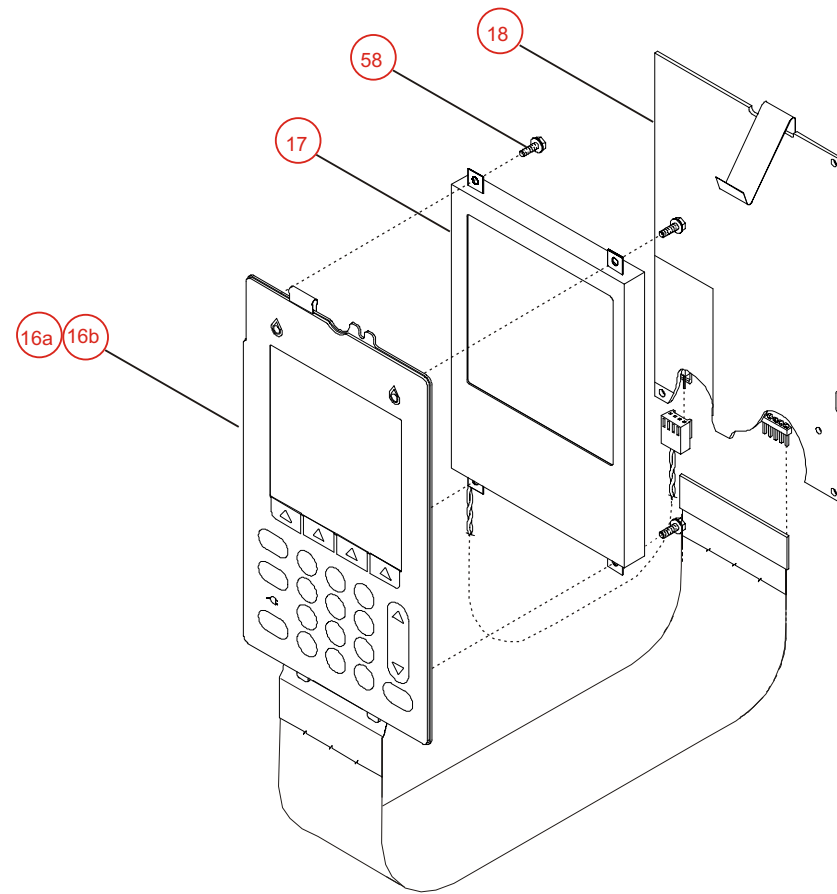
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Figure 9-6. Main Chassis Assembly	
DRAWING NO. NOT APPLICABLE	Rev. N/A Sheet 2 of 2

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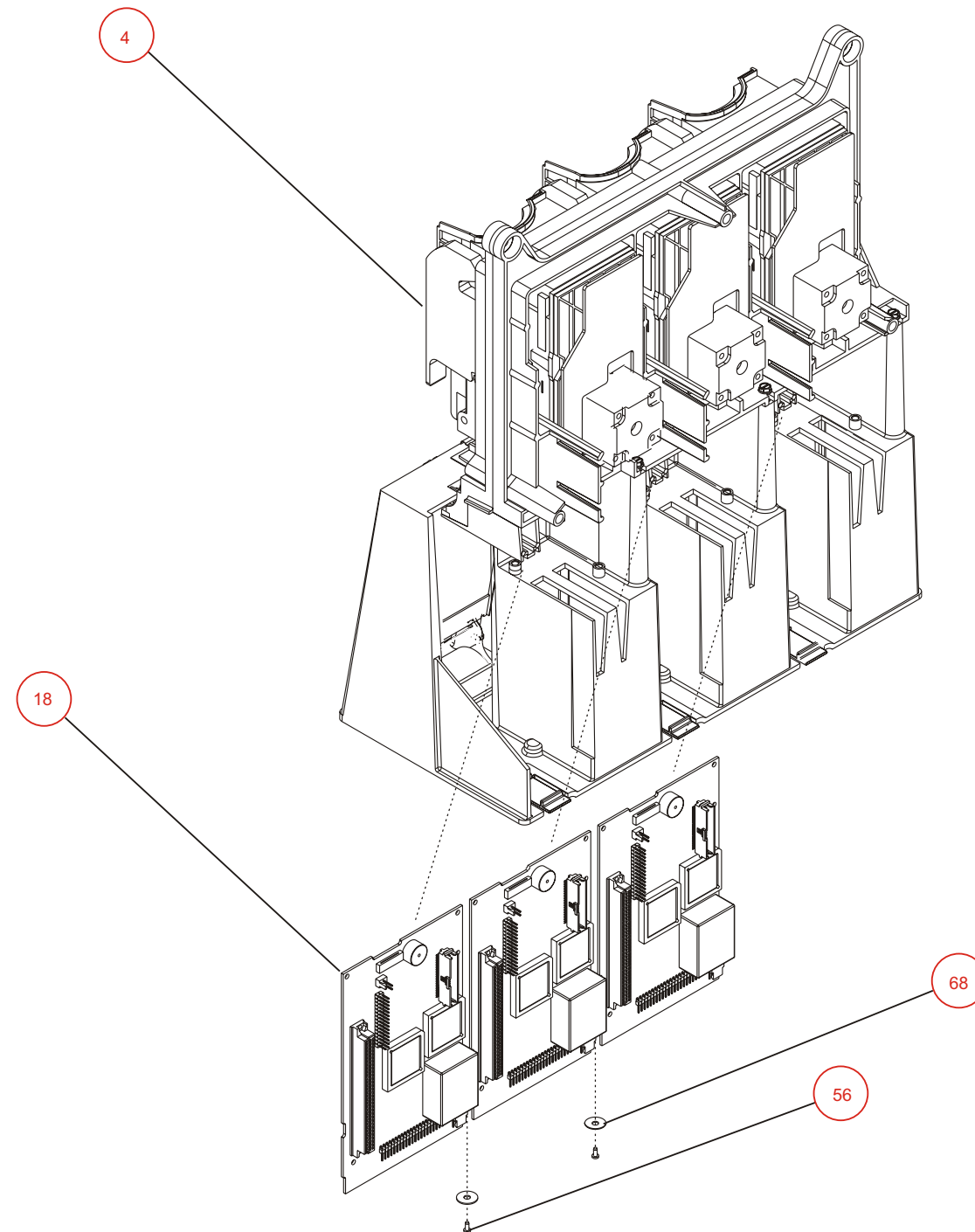
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ABBOTT LABORATORIES HOSPITAL PRODUCTS DIVISION - MH	
Figure 9-7. CPU PWA, LCD, and Keypad	
DRAWING NO. NOT APPLICABLE	Rev. N/A Sheet 1 of 1

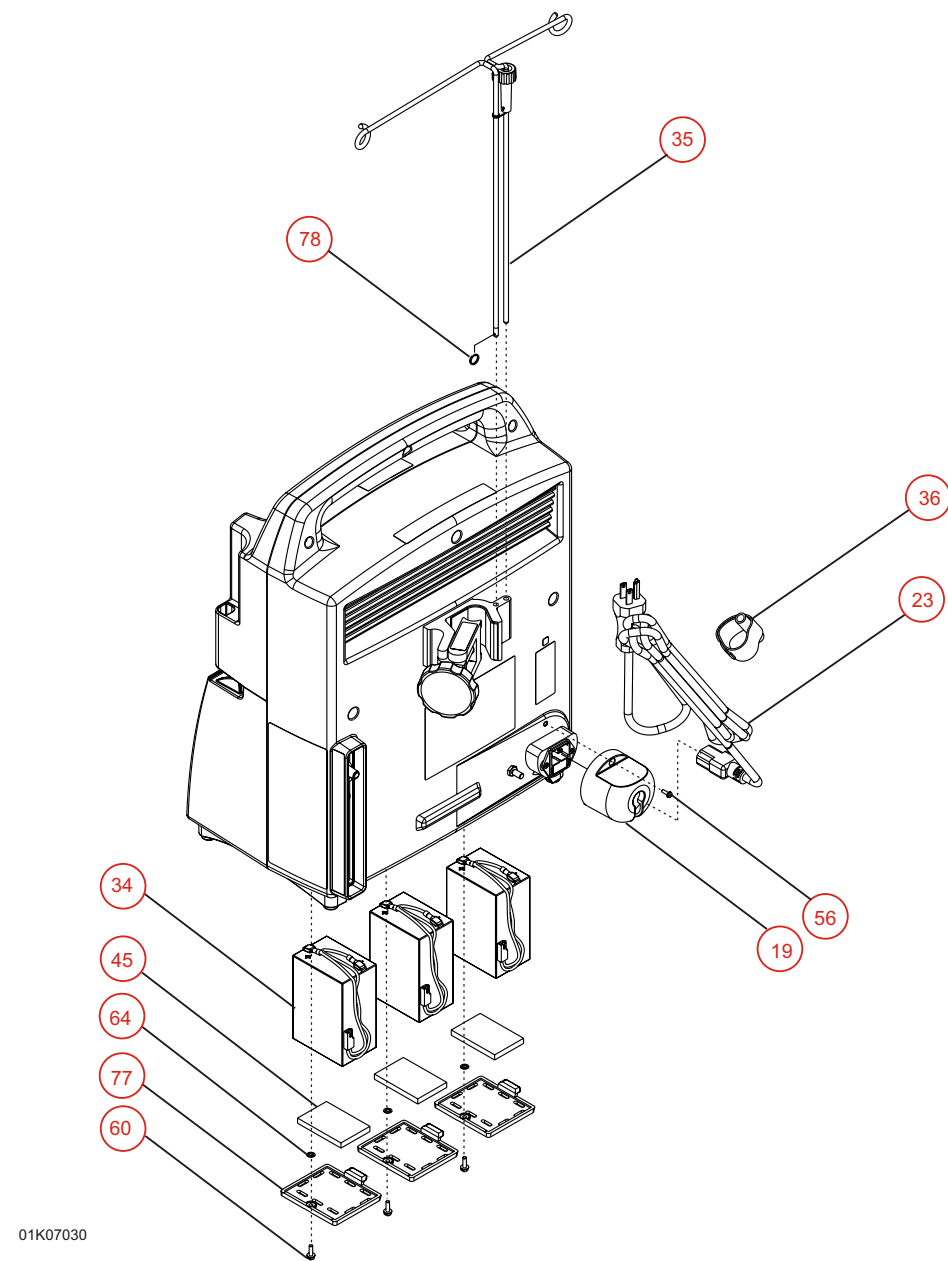
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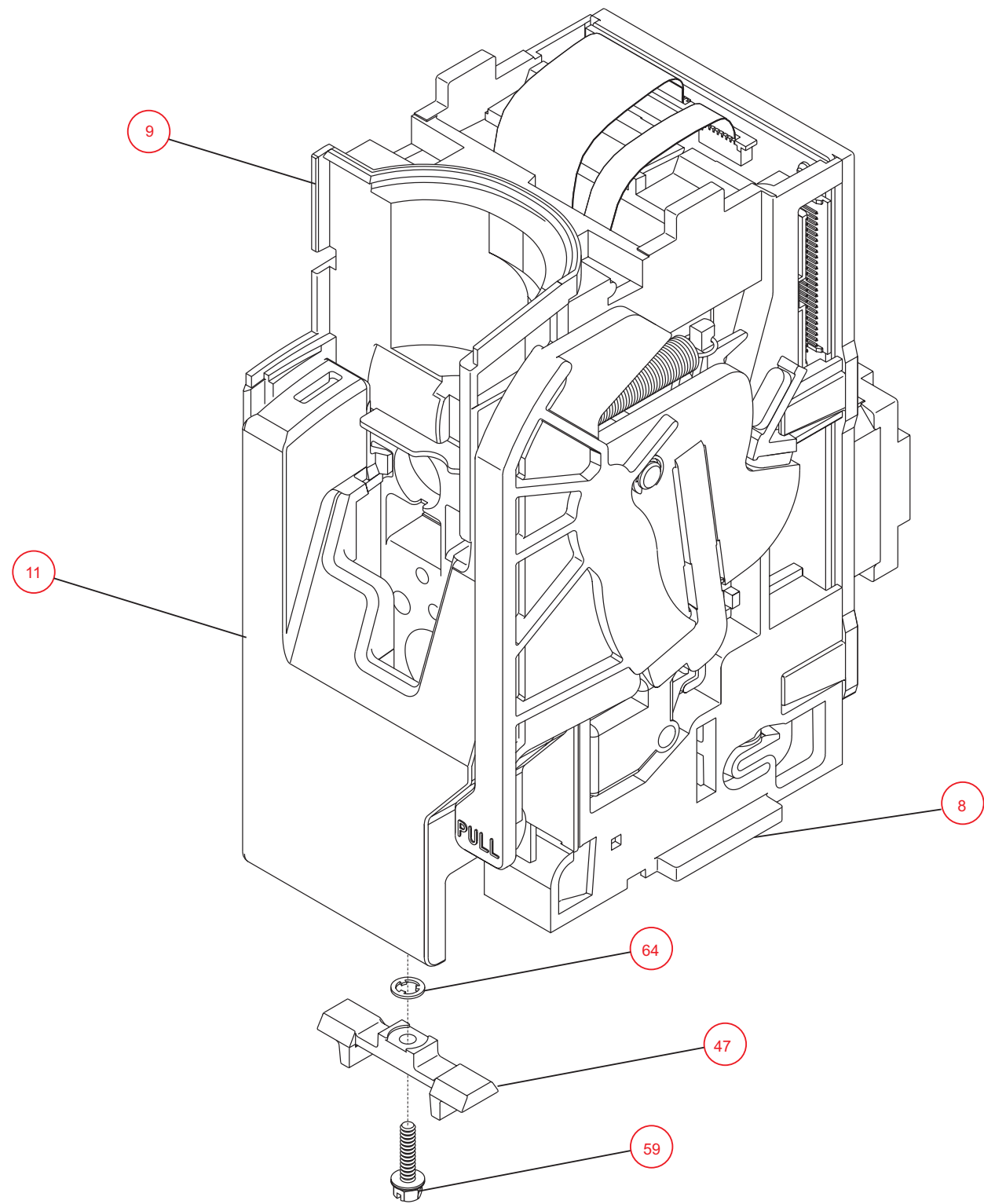
ABBOTT LABORATORIES HOSPITAL PRODUCTS DIVISION - MH	
Figure 9-8. CPU PWA and Main Chassis	
DRAWING NO. NOT APPLICABLE	Rev. N/A Sheet 1 of 1

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ABBOTT LABORATORIES HOSPITAL PRODUCTS DIVISION - MH	
Figure 9-9. AC Power Cord, Power Cord Retainer, Batteries, and Minipole Assembly	
DRAWING NO. NOT APPLICABLE	Rev. N/A
	Sheet 1 of 1

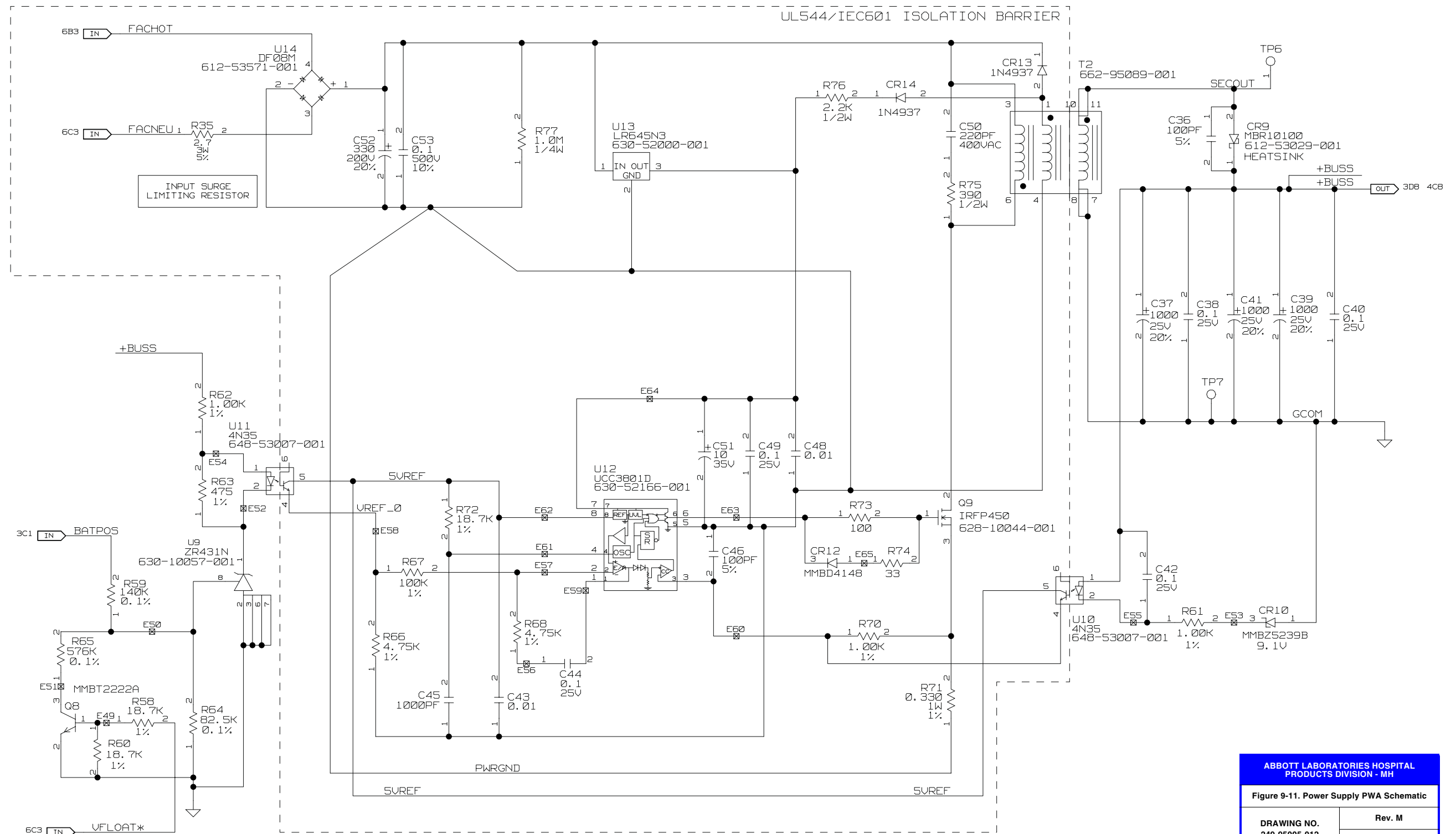
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ABBOTT LABORATORIES HOSPITAL PRODUCTS DIVISION - MH	
Figure 9-10. Mechanism Assembly	
DRAWING NO. NOT APPLICABLE	Rev. N/A Sheet 1 of 1

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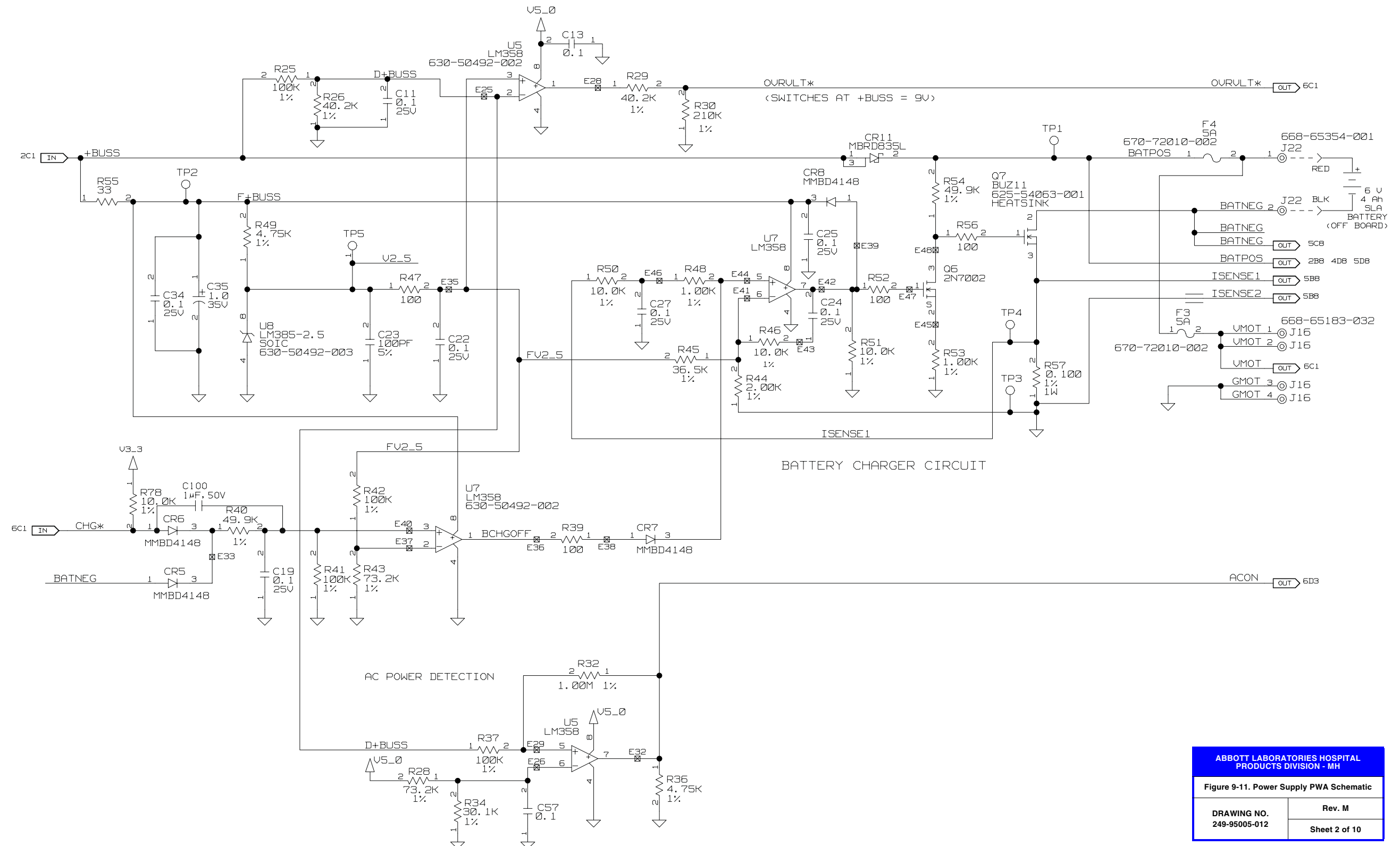


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PRODUCTS DIVISION - MH

Figure 9-11. Power Supply PWA Schematic

DRAWING NO. 249-95005-012	Rev. M
	Sheet 1 of 10

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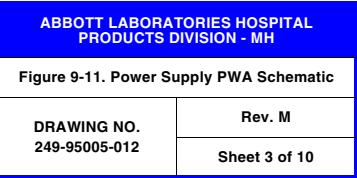


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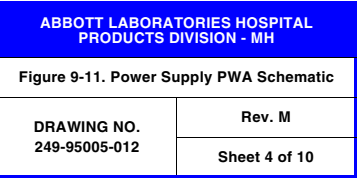
Figure 9-11. Power Supply PWA Schematic

DRAWING NO. 249-95005-012	Rev. M
	Sheet 2 of 10

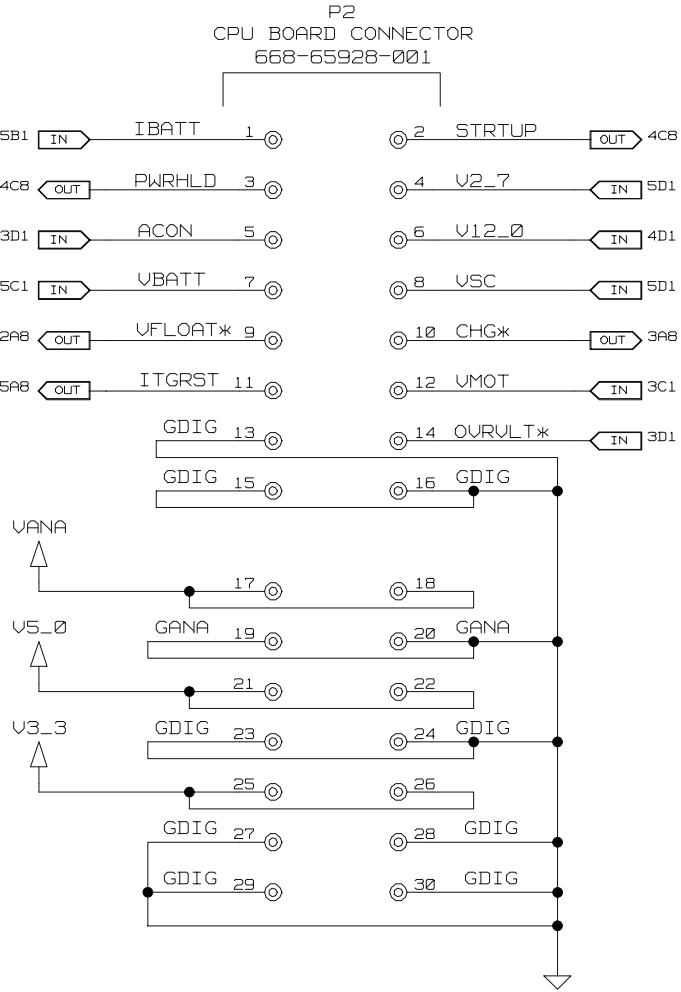
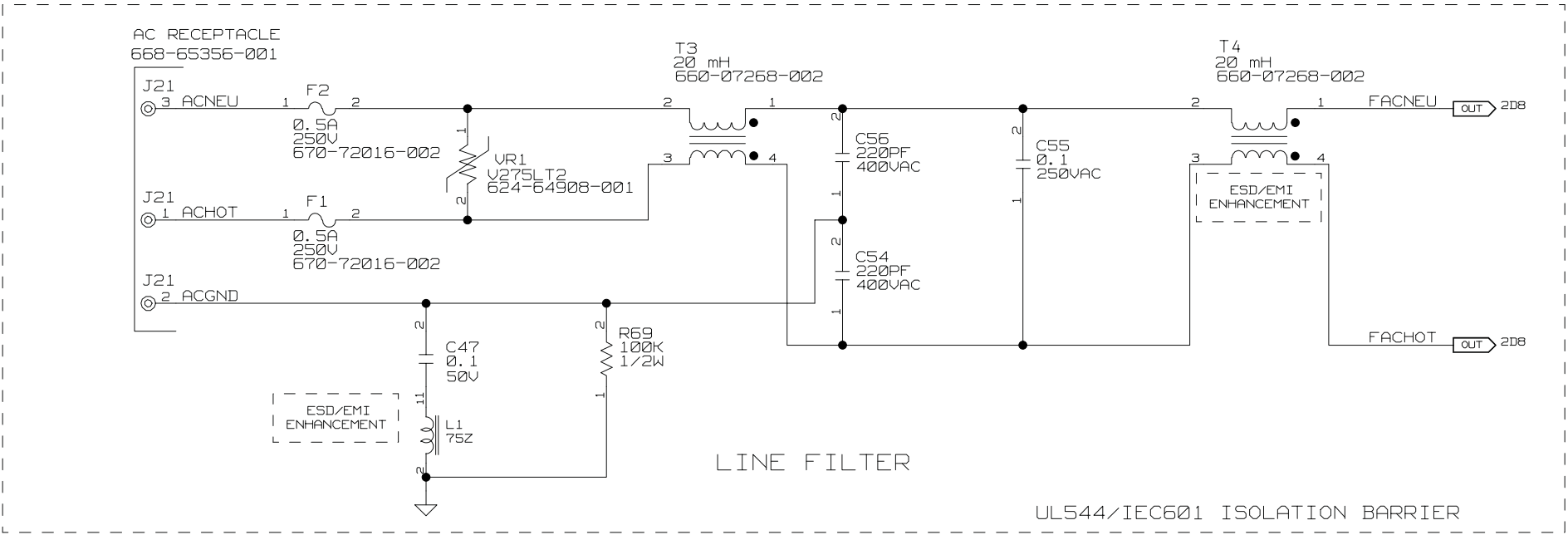
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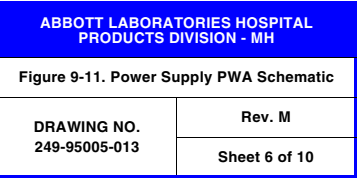
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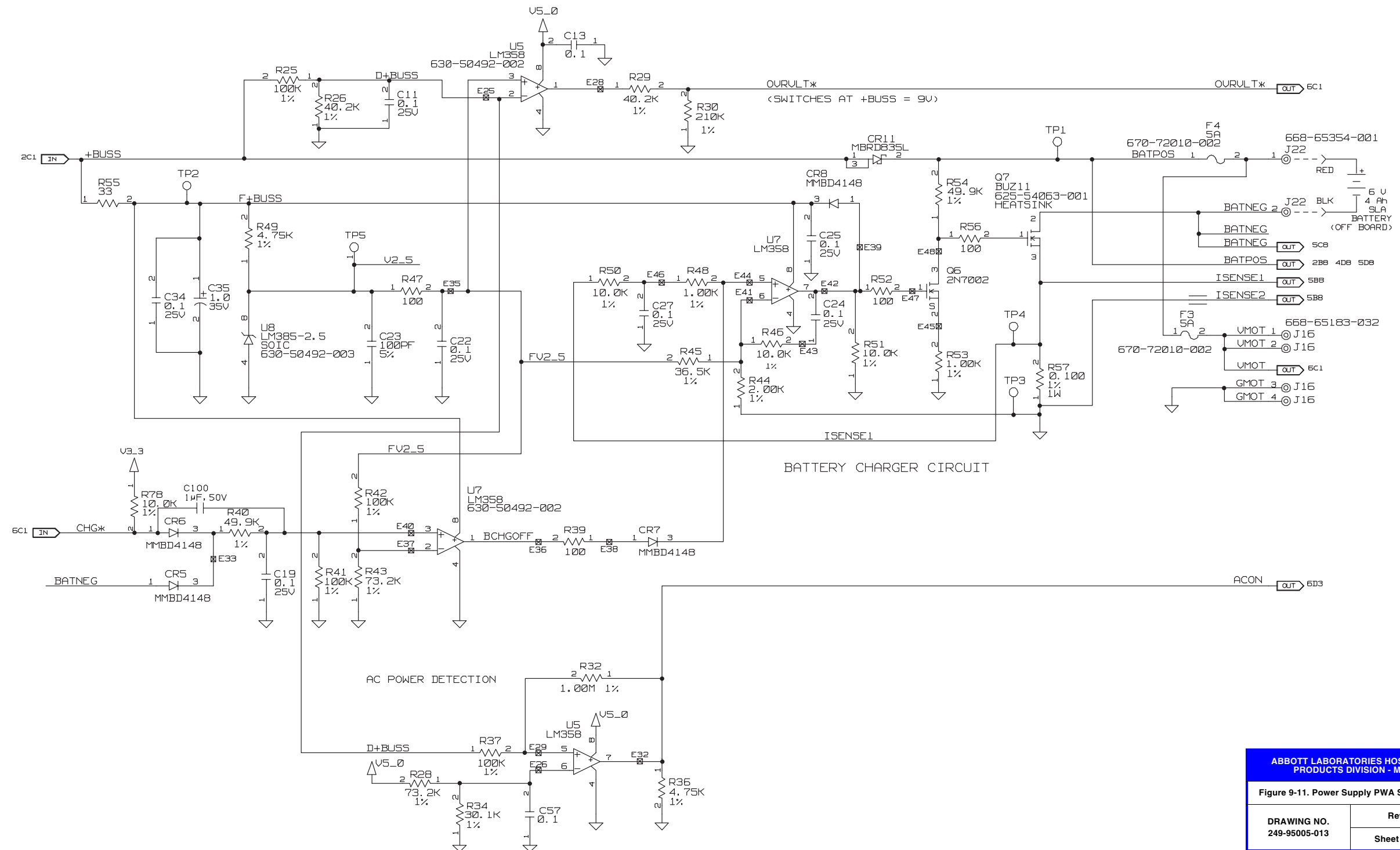
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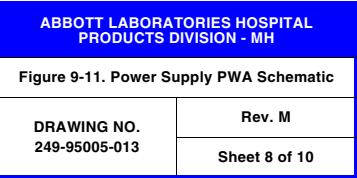
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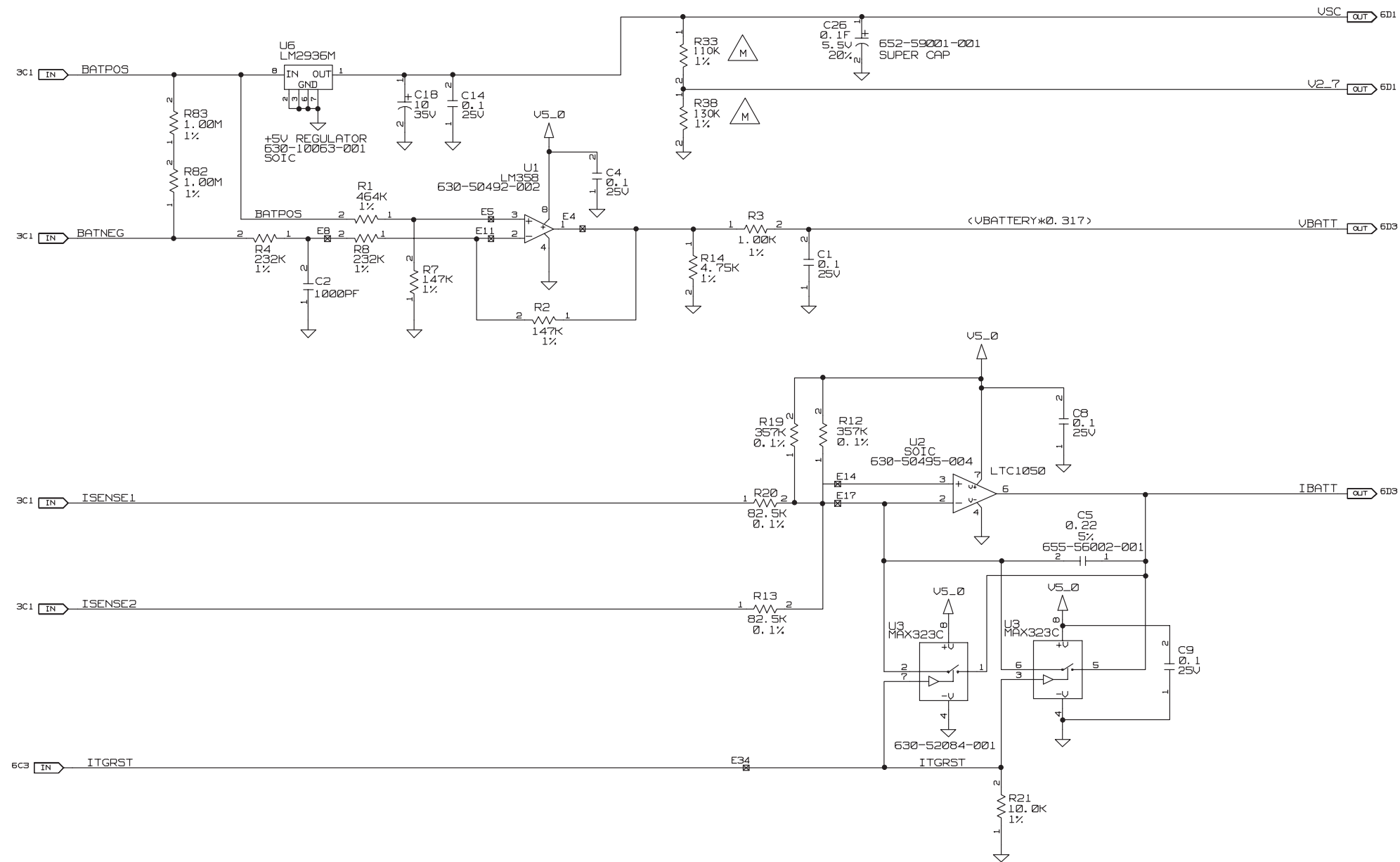
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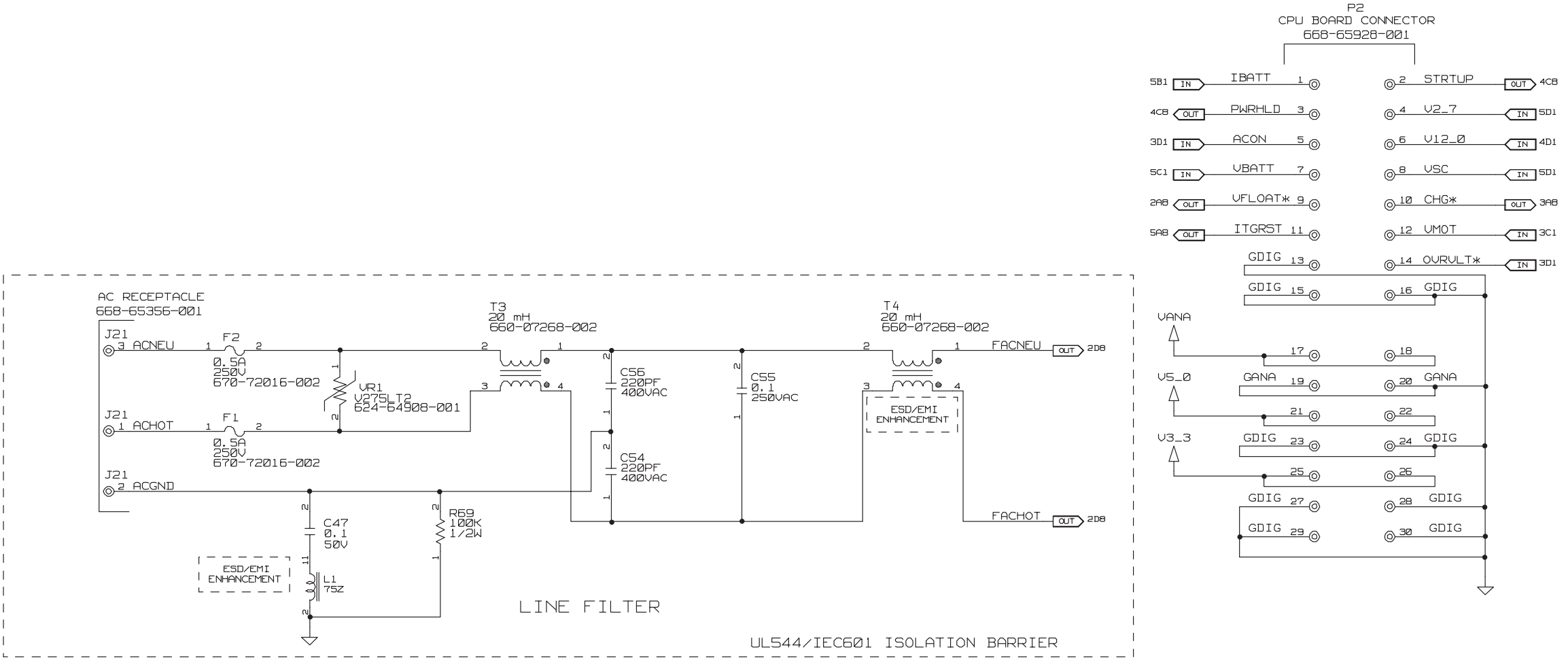


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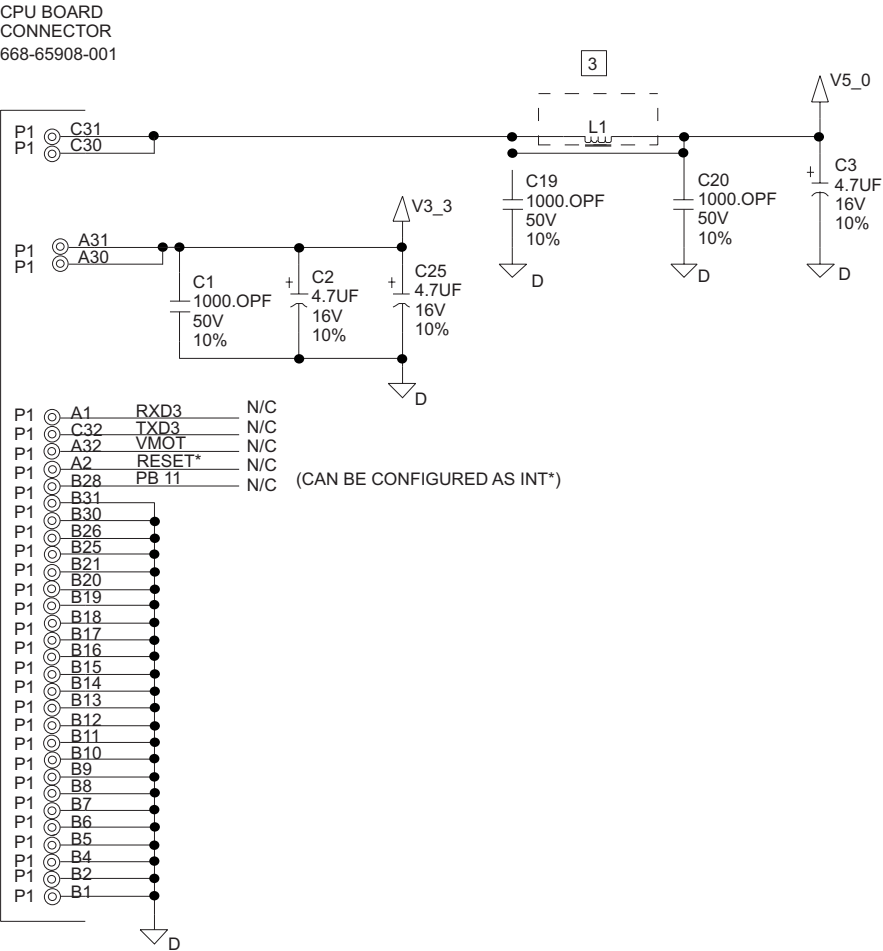
Figure 9-11. Power Supply PWA Schematic

DRAWING NO. 249-95005-013	Rev. M
	Sheet 9 of 10

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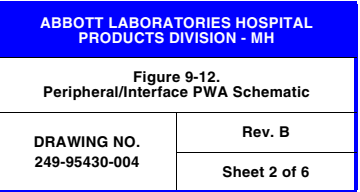


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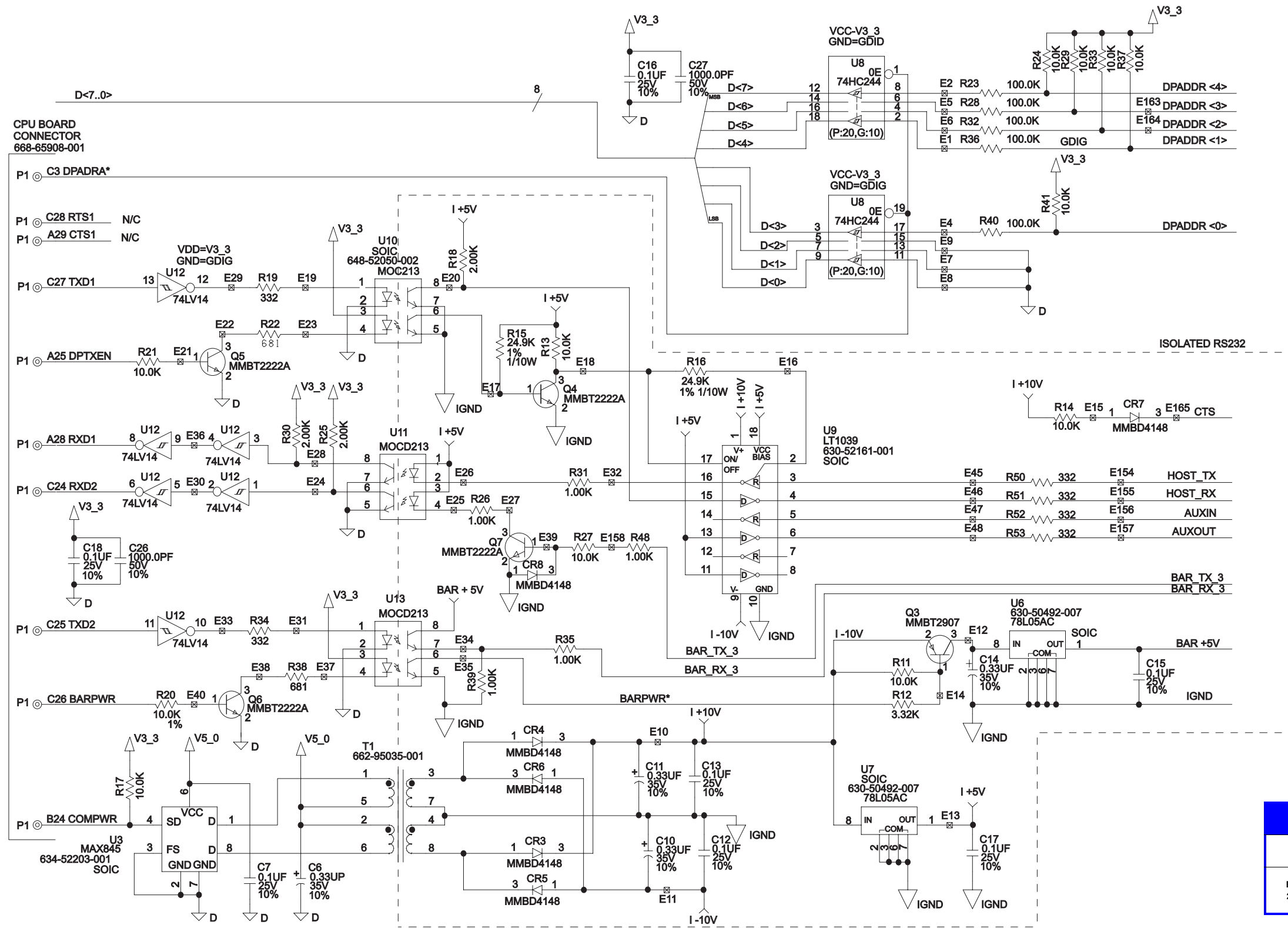


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Figure 9-12. Peripheral/Interface PWA Schematic	
DRAWING NO. 249-95430-004	Rev. B
	Sheet 1 of 6

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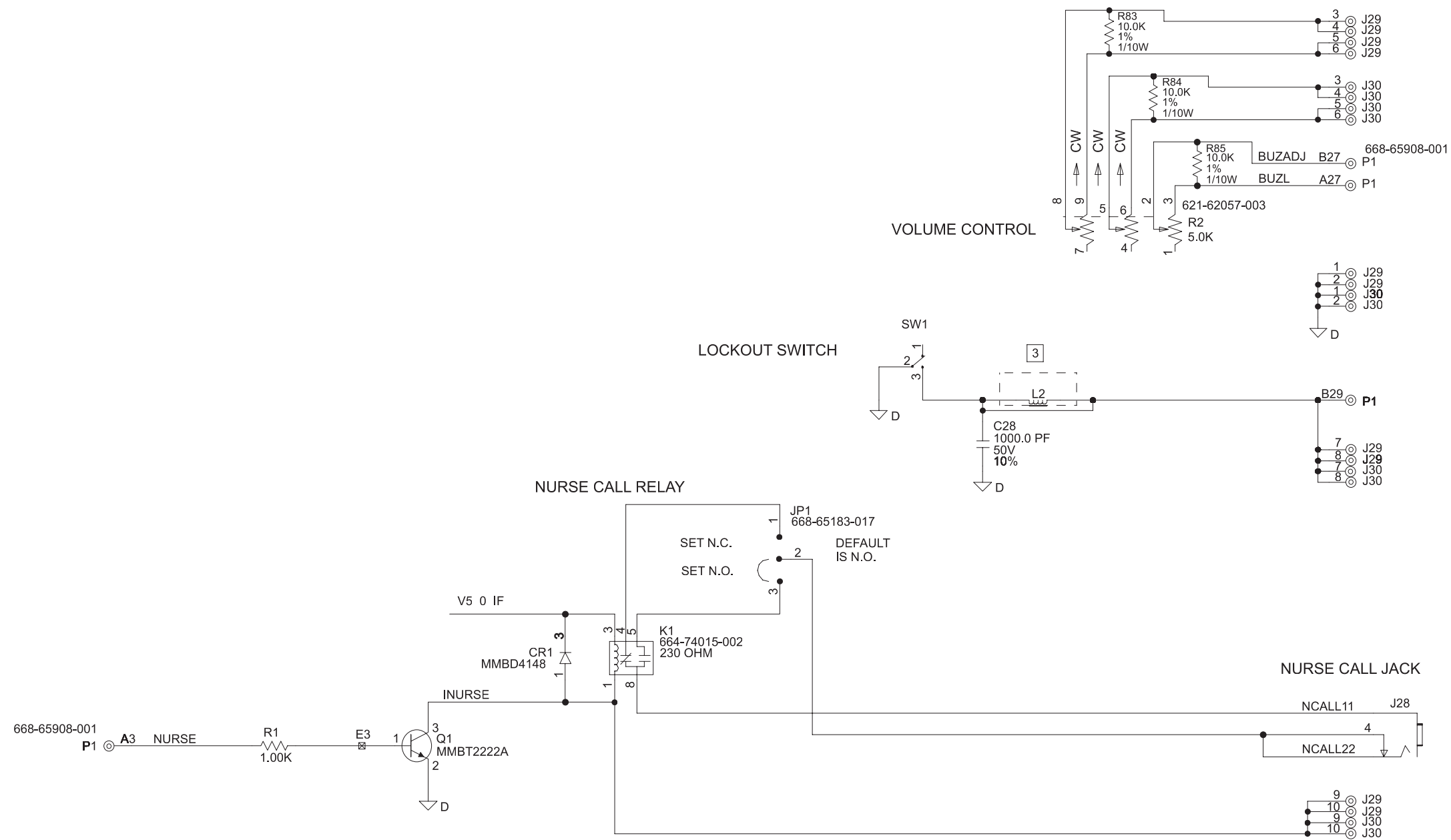


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PRODUCTS DIVISION - MH

Figure 9-12.
Peripheral/Interface PWA Schematic

DRAWING NO. 249-95430-004	Rev. B
Sheet 3 of 6	

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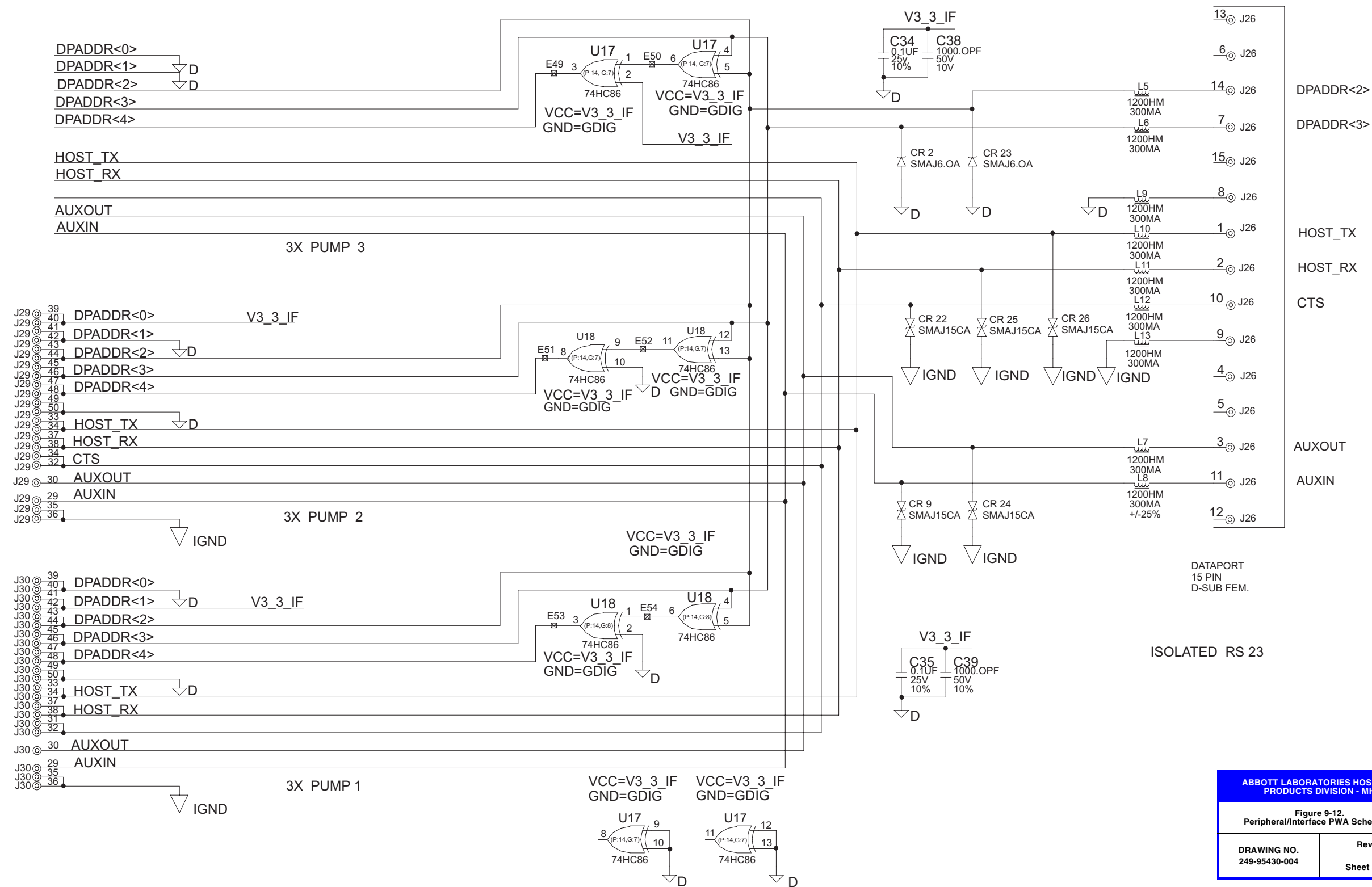


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Figure 9-12.
Peripheral/Interface PWA Schematic

DRAWING NO. 249-95430-004	Rev. B
	Sheet 4 of 6

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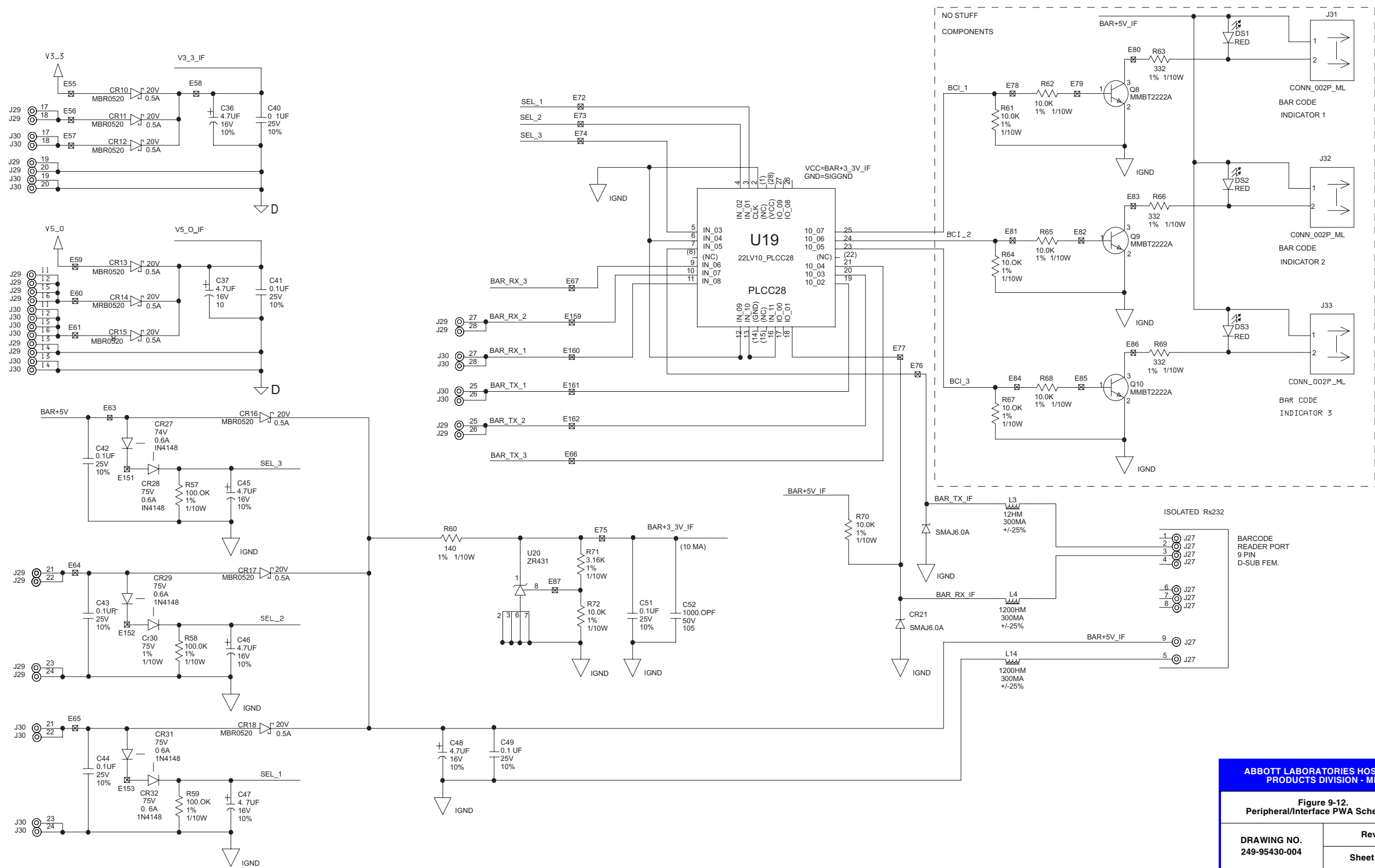


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Figure 9-12.
Peripheral/Interface PWA Schematic

DRAWING NO. 249-95430-004	Rev. B
Sheet 5 of 6	

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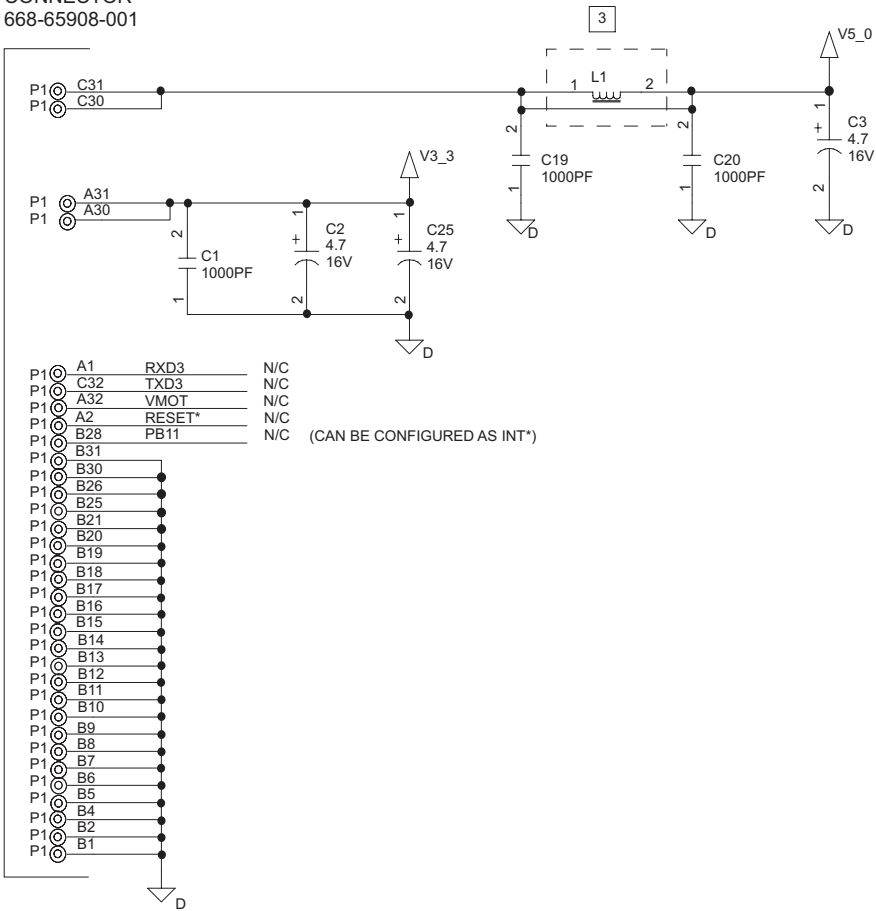
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Figure 9-12.
Peripheral/Interface PWA Schematic

DRAWING NO. 249-95430-004	Rev. B
	Sheet 6 of 6

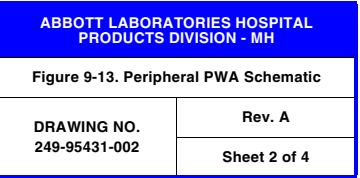
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CPU BOARD
CONNECTOR
668-65908-001

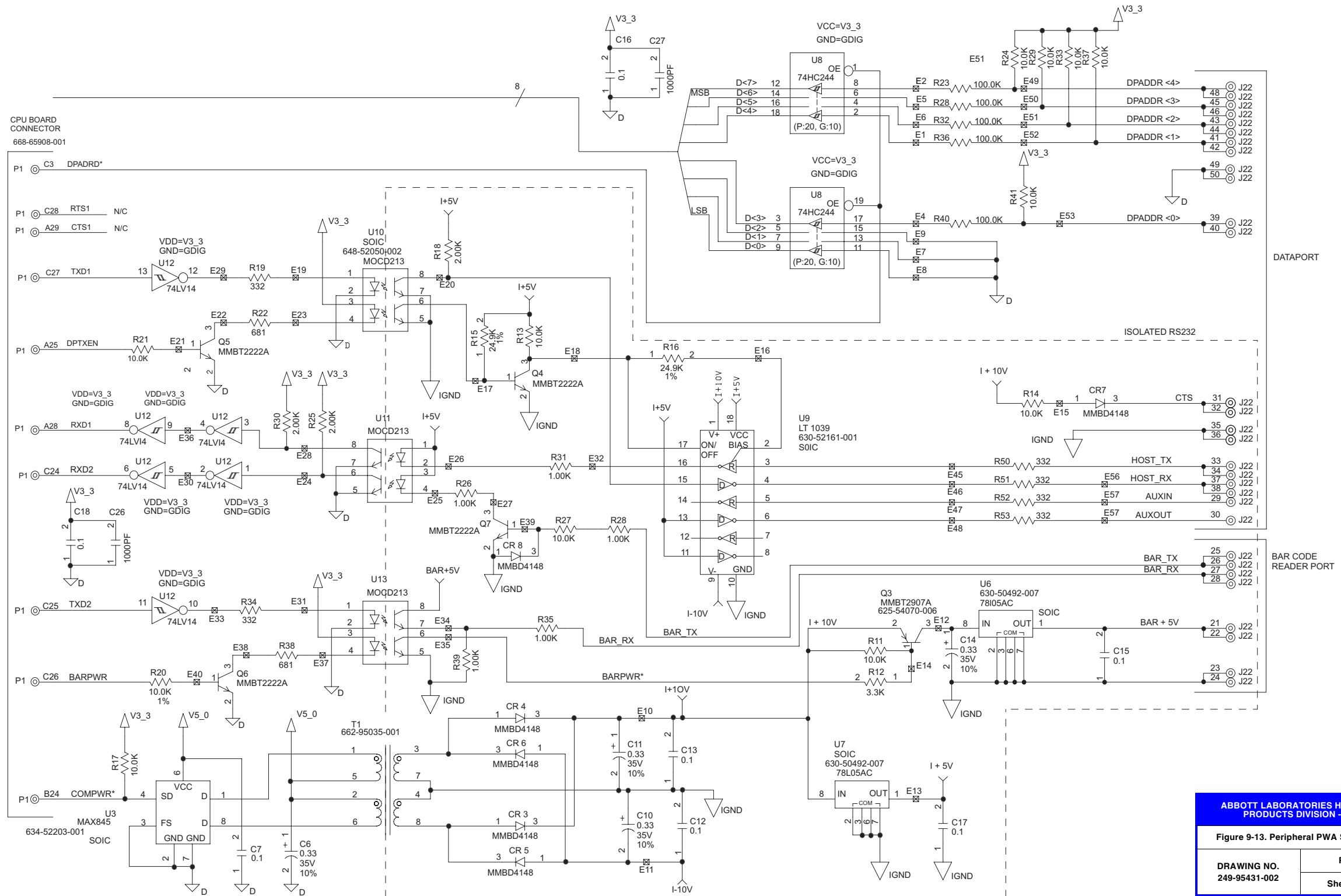


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Figure 9-13. Peripheral PWA Schematic	
DRAWING NO. 249-95431-002	Rev. A
	Sheet 1 of 4

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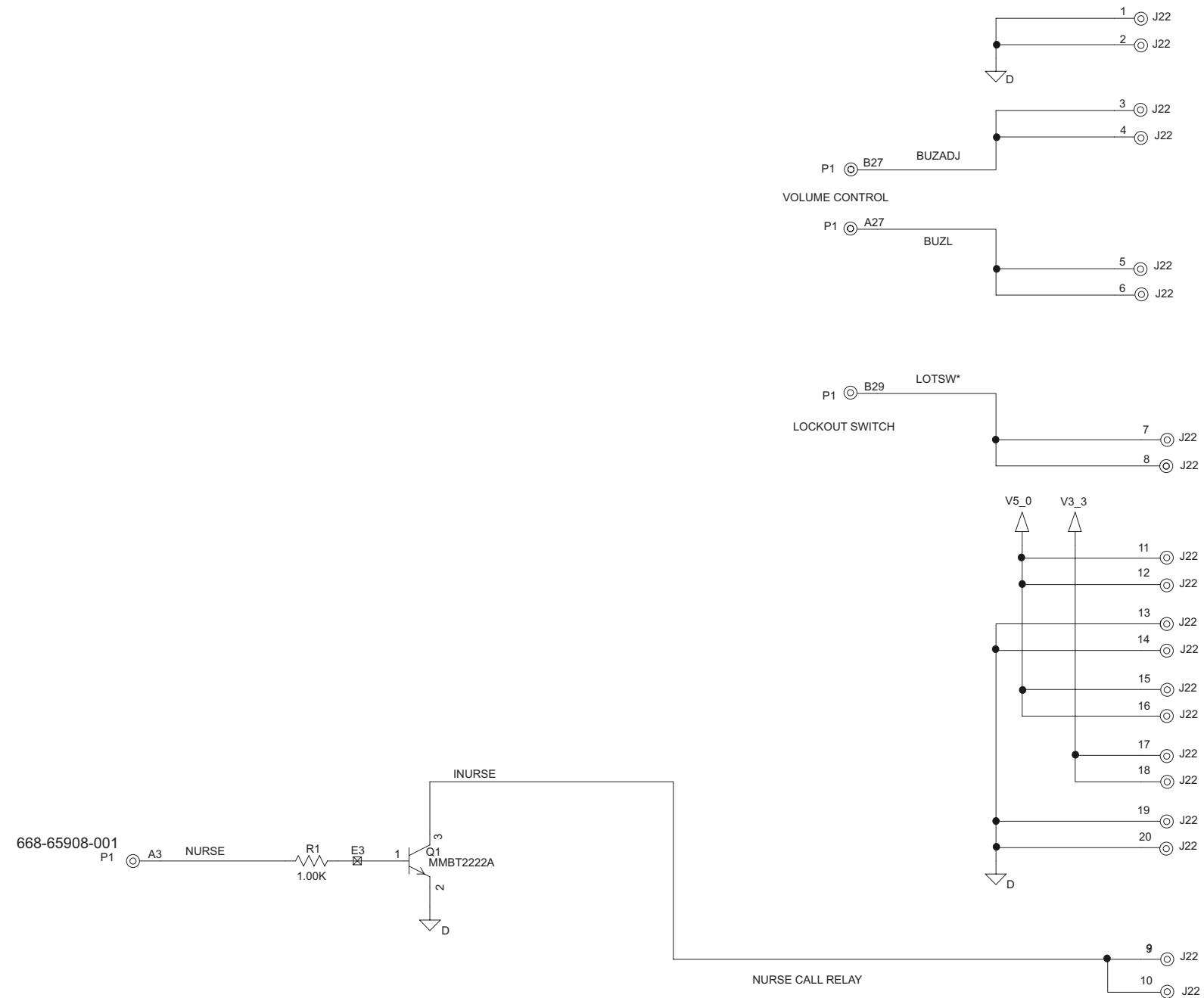


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PRODUCTS DIVISION - MH

Figure 9-13. Peripheral PWA Schematic

DRAWING NO. 249-95431-002	Rev. A
	Sheet 3 of 4

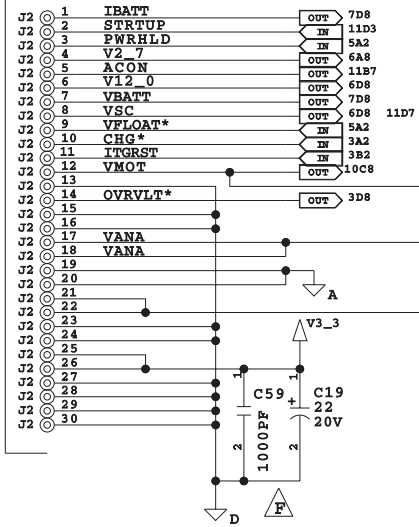
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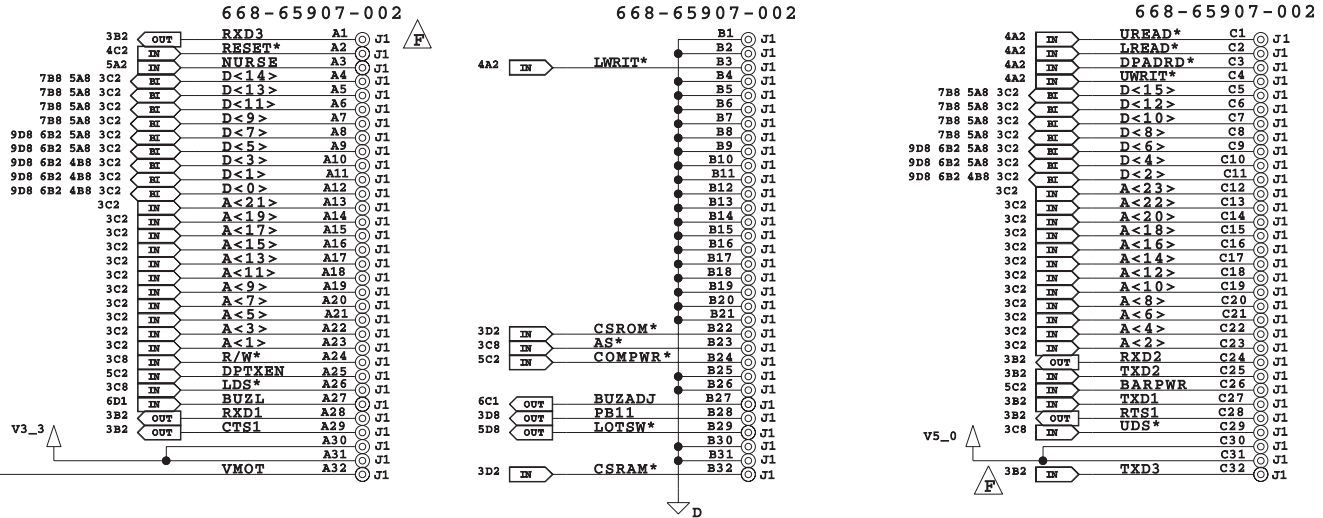
ABBOTT LABORATORIES HOSPITAL PRODUCTS DIVISION - MH	
Figure 9-13. Peripheral PWA Schematic	
DRAWING NO. 249-95431-002	Rev. A
	Sheet 4 of 4

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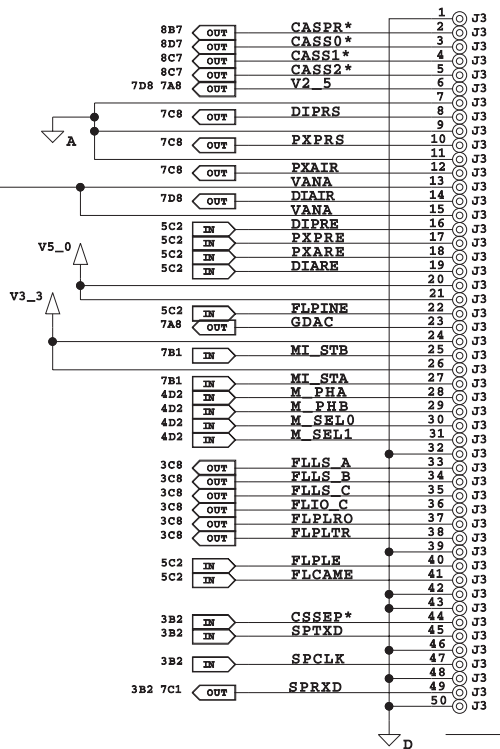
POWER SUPPLY CONNECTOR
668-65183-035



PERIPHERAL CONNECTOR



DRIVER PWA CONNECTOR
668-65923-002



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Figure 9-14. CPU PWA Schematic

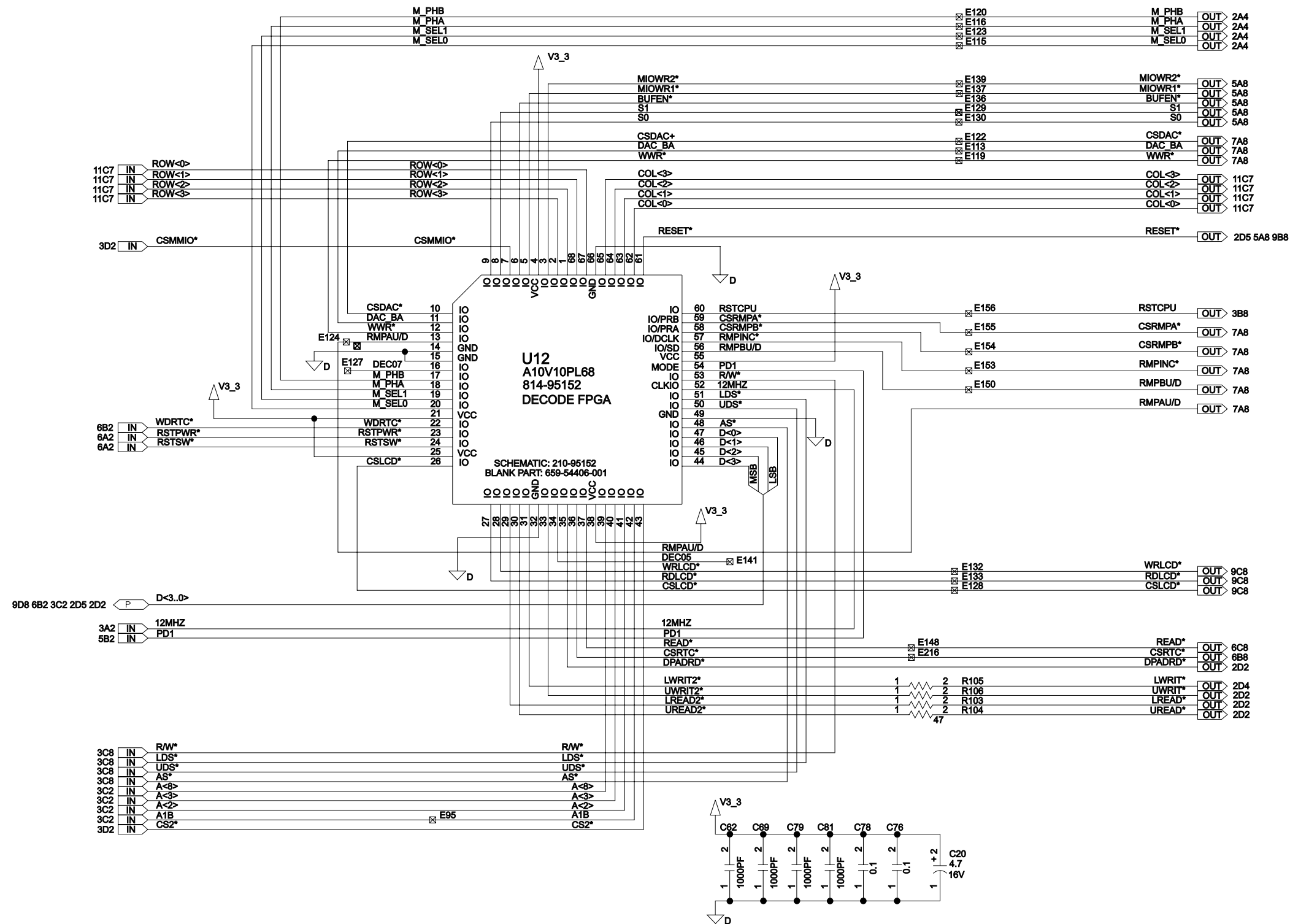
DRAWING NO.
249-95007-008

Rev. J

Sheet 1 of 10

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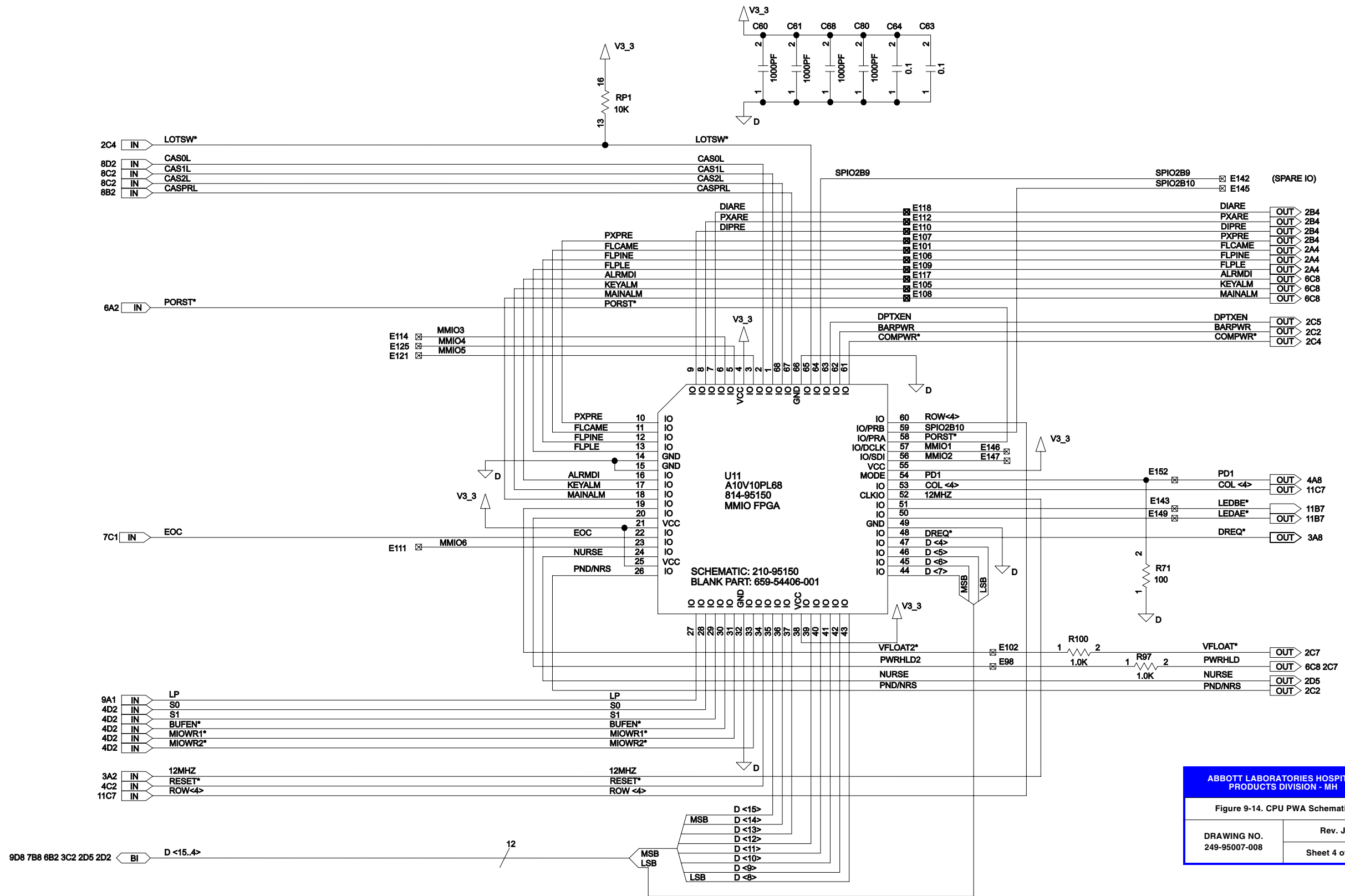


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 PRODUCTS DIVISION - MH

Figure 9-14. CPU PWA Schematic

DRAWING NO. 249-95007-008	Rev. J
	Sheet 3 of 10

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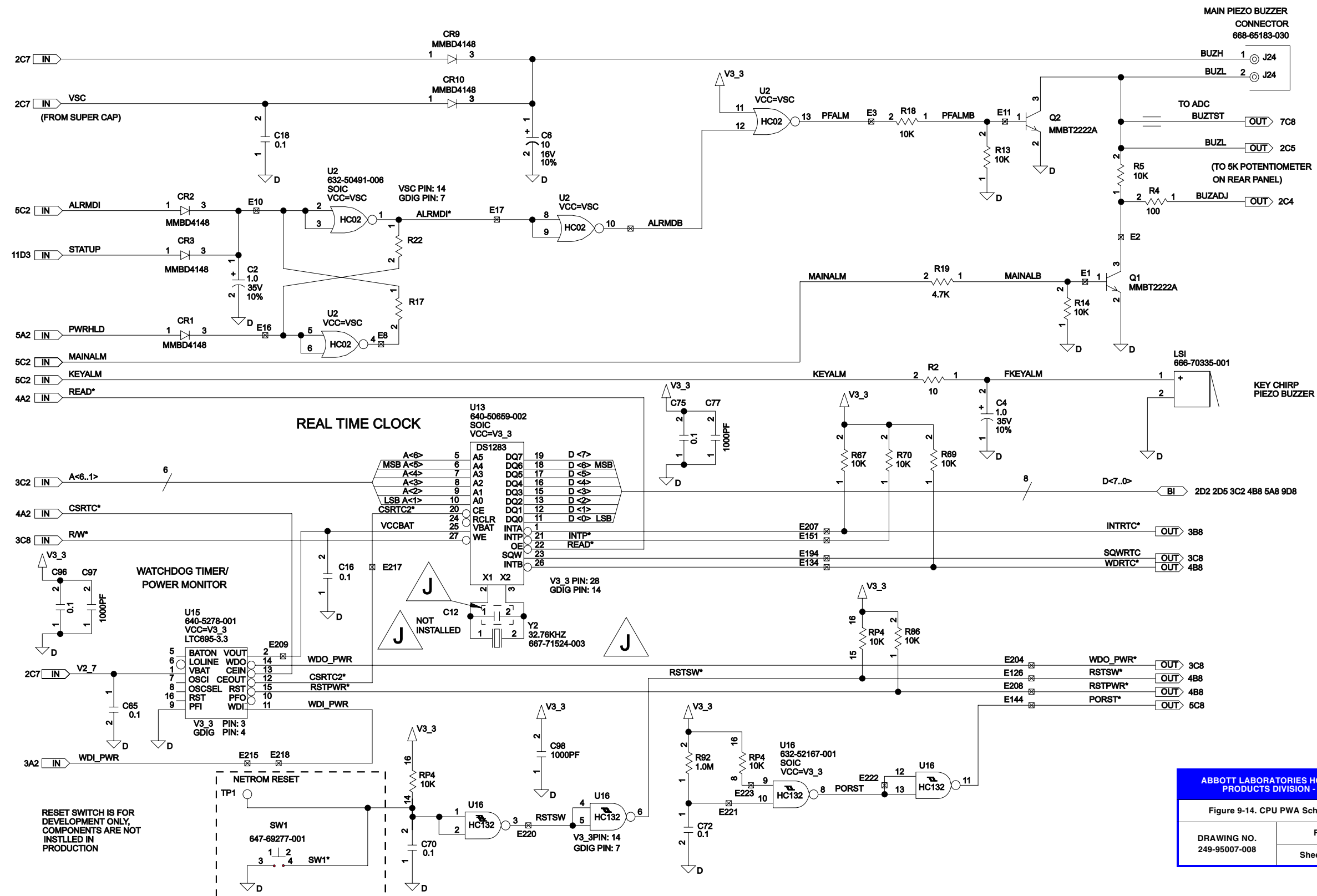


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PRODUCTS DIVISION - MH

Figure 9-14. CPU PWA Schematic

DRAWING NO. 249-95007-008	Rev. J Sheet 4 of 10
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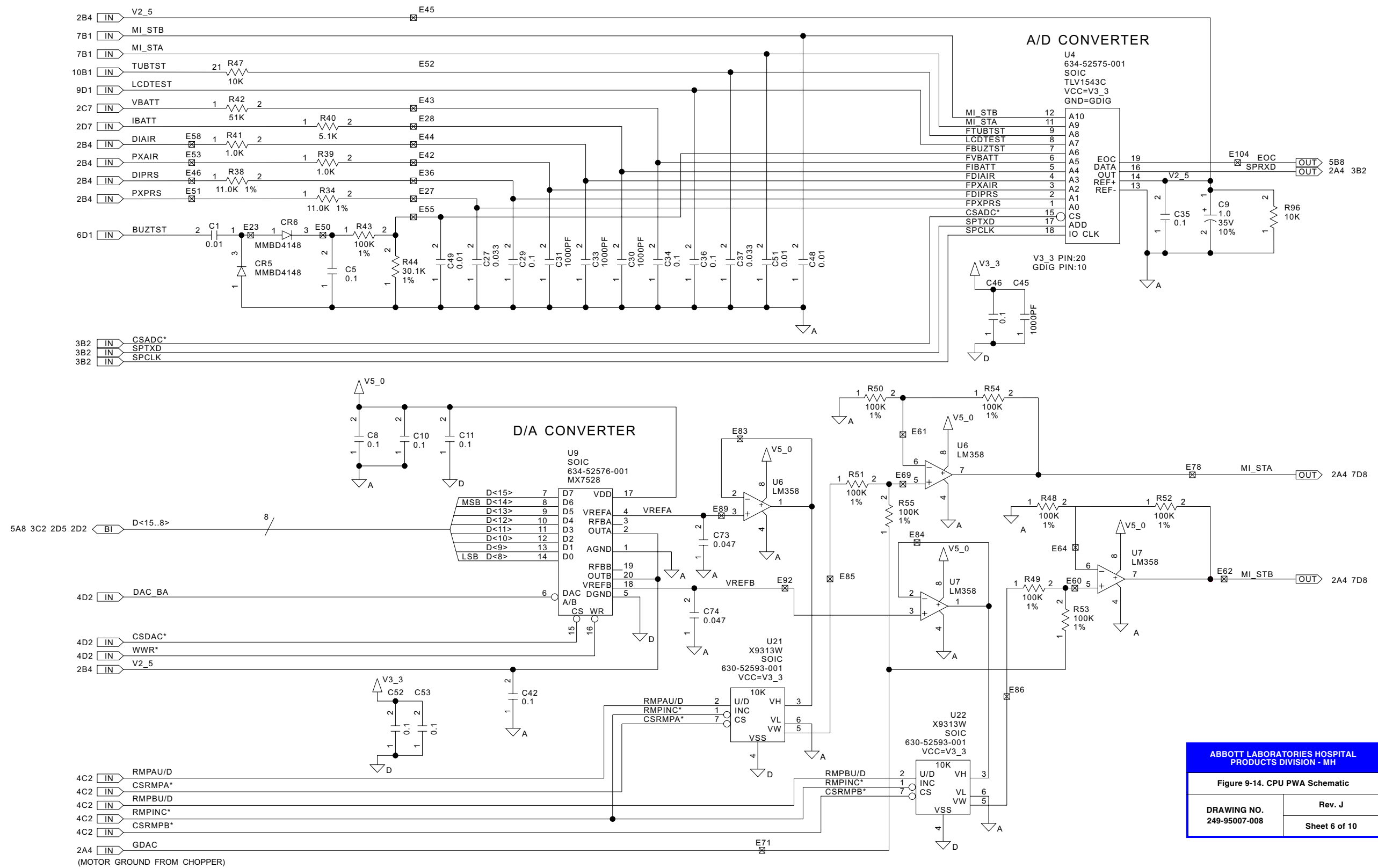


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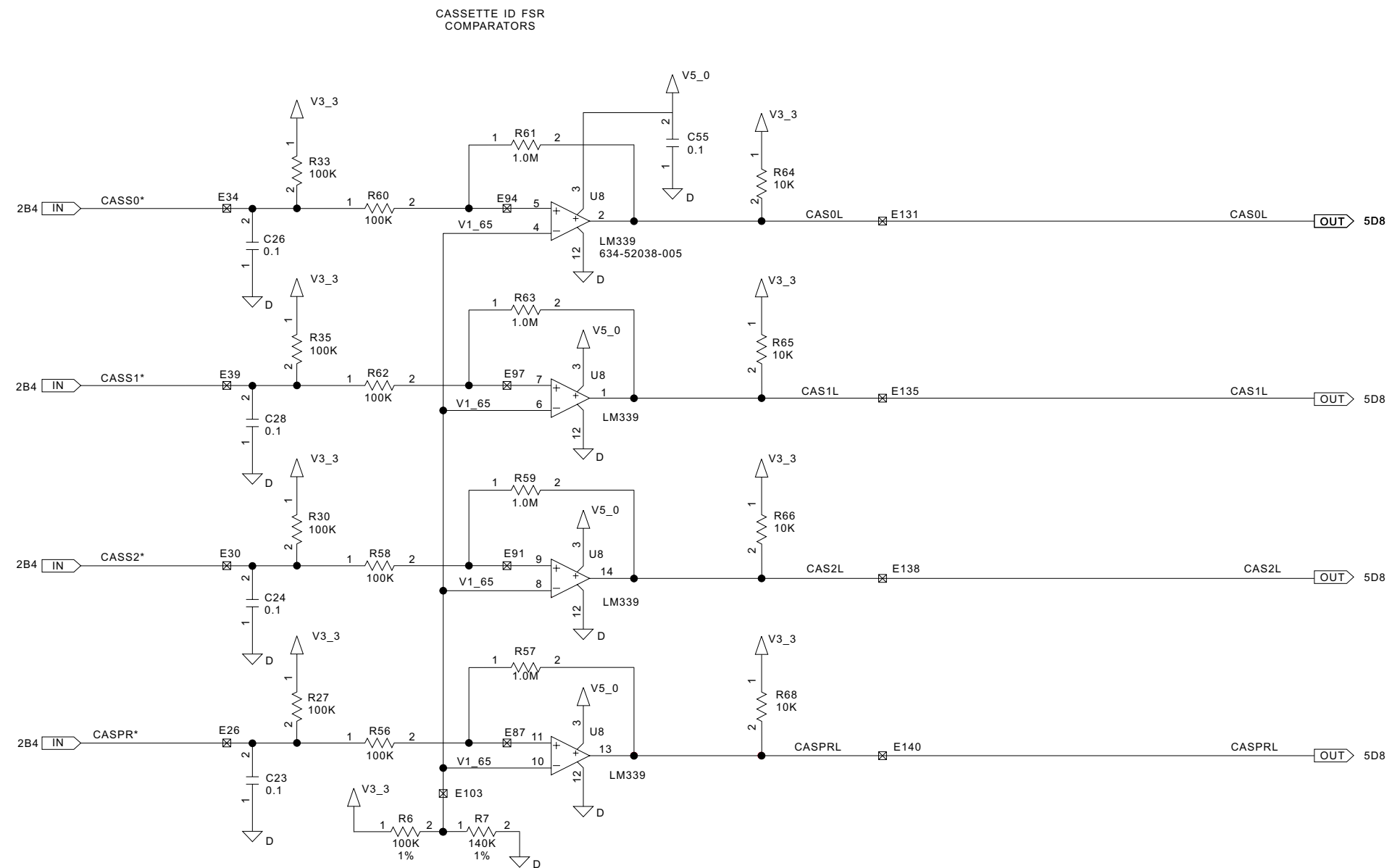
Figure 9-14. CPU PWA Schematic

DRAWING NO. 249-95007-008	Rev. J Sheet 5 of 10
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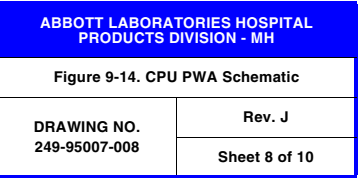


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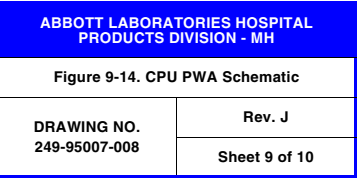


ABBOTT LABORATORIES HOSPITAL PRODUCTS DIVISION - MH	
Figure 9-14. CPU PWA Schematic	
DRAWING NO. 249-95007-008	Rev. J
	Sheet 7 of 10

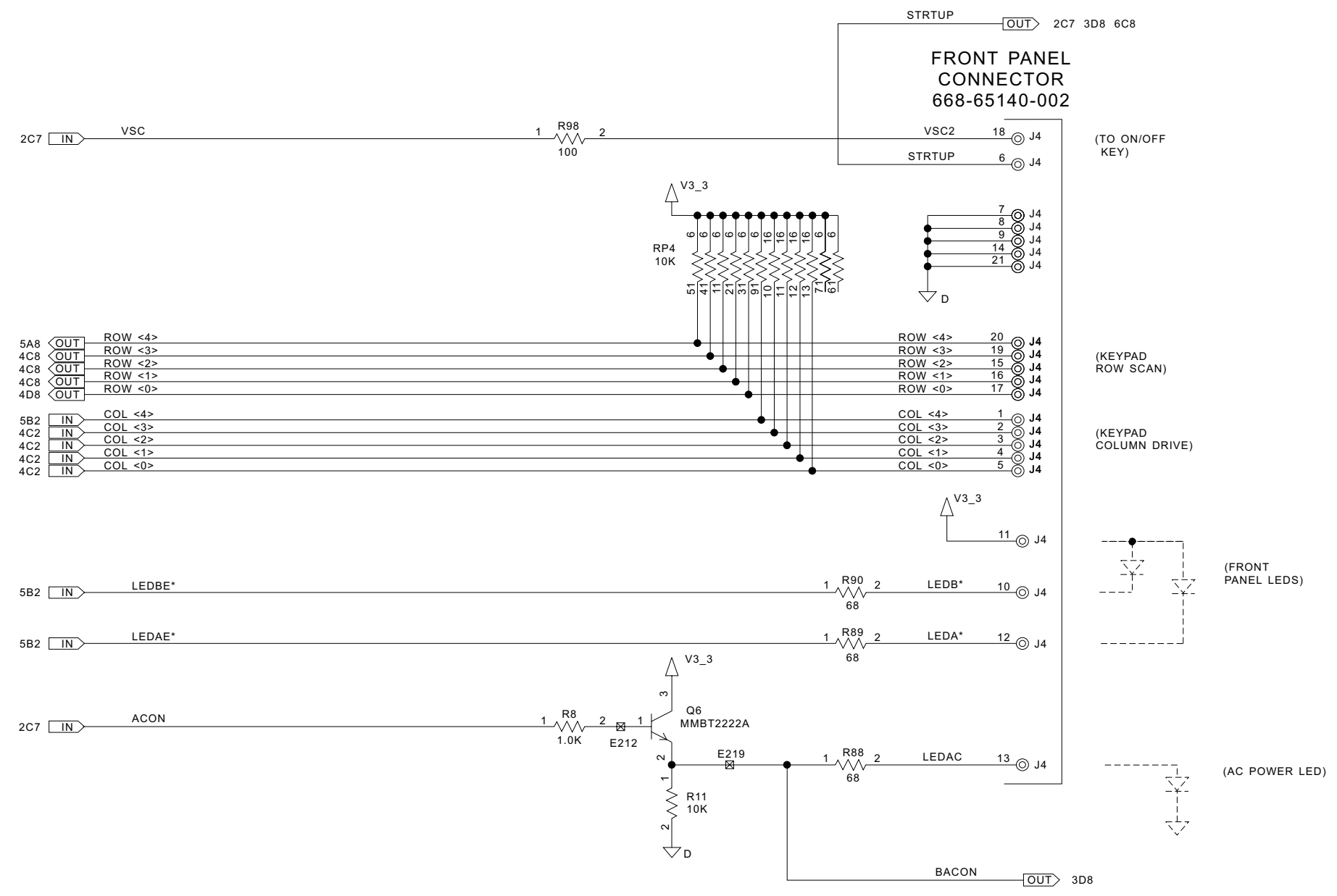
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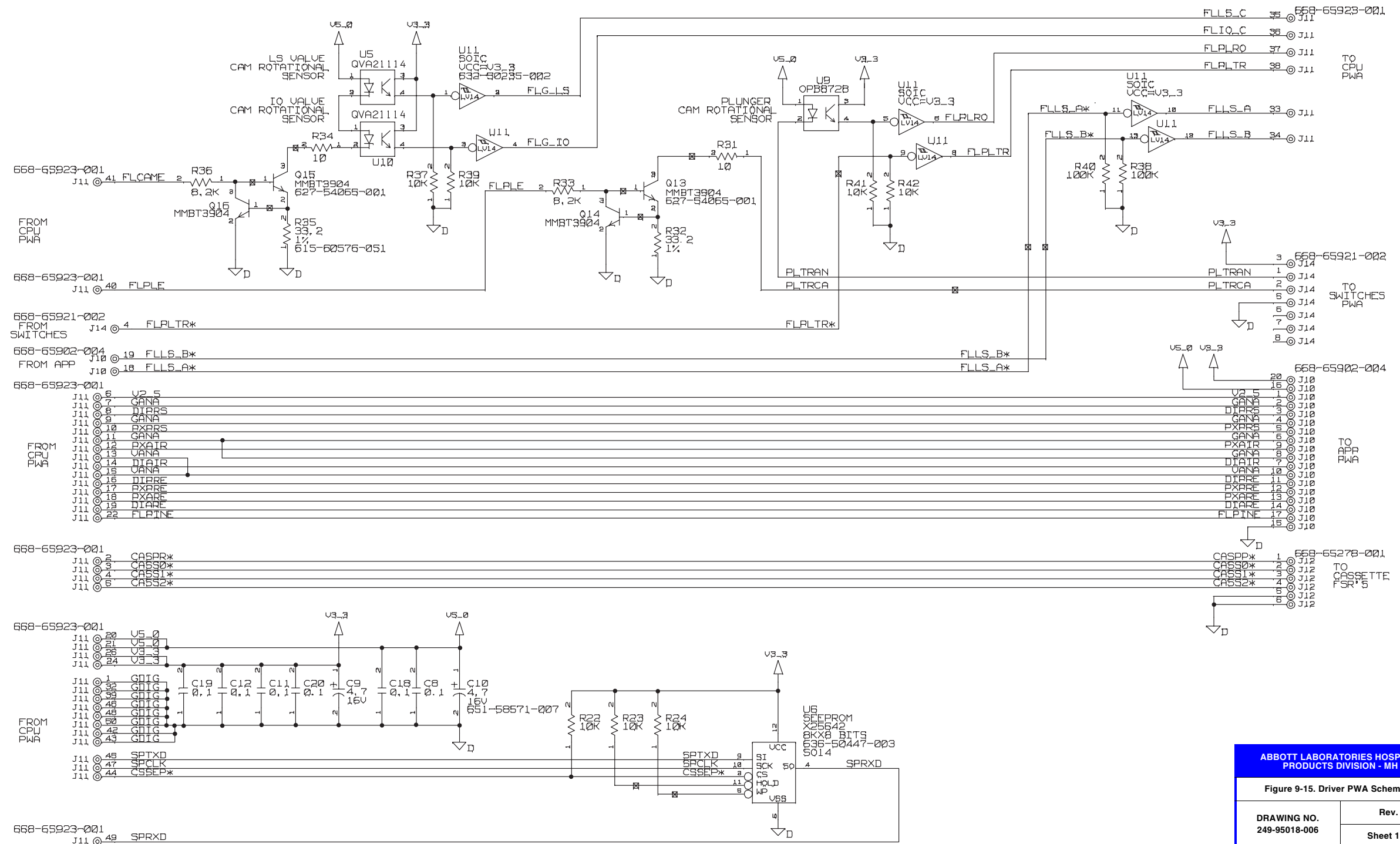


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Figure 9-14. CPU PWA Schematic	
DRAWING NO. 249-95007-008	Rev. J Sheet 10 of 10

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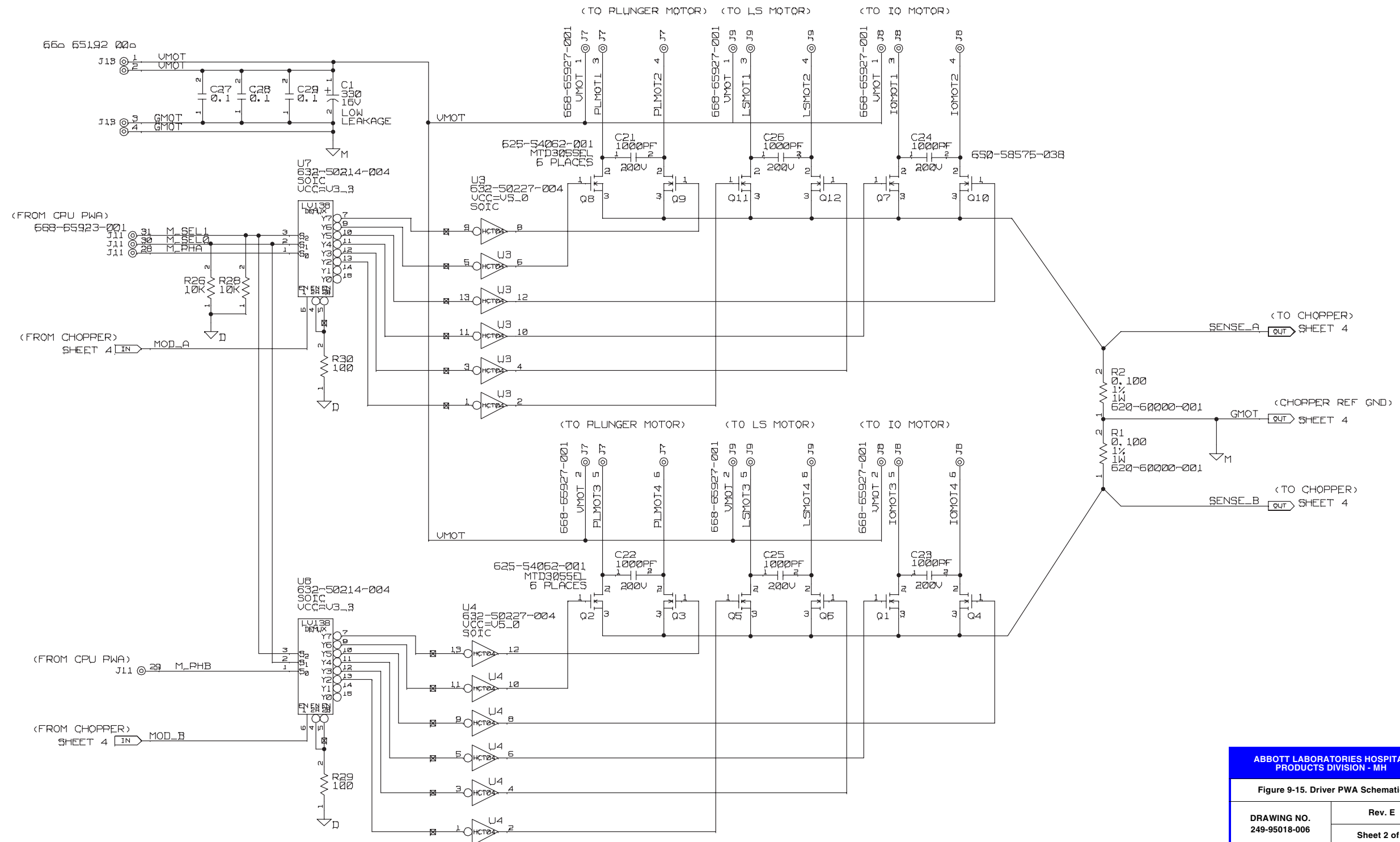


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Figure 9-15. Driver PWA Schematic

DRAWING NO. 249-95018-006	Rev. E Sheet 1 of 3
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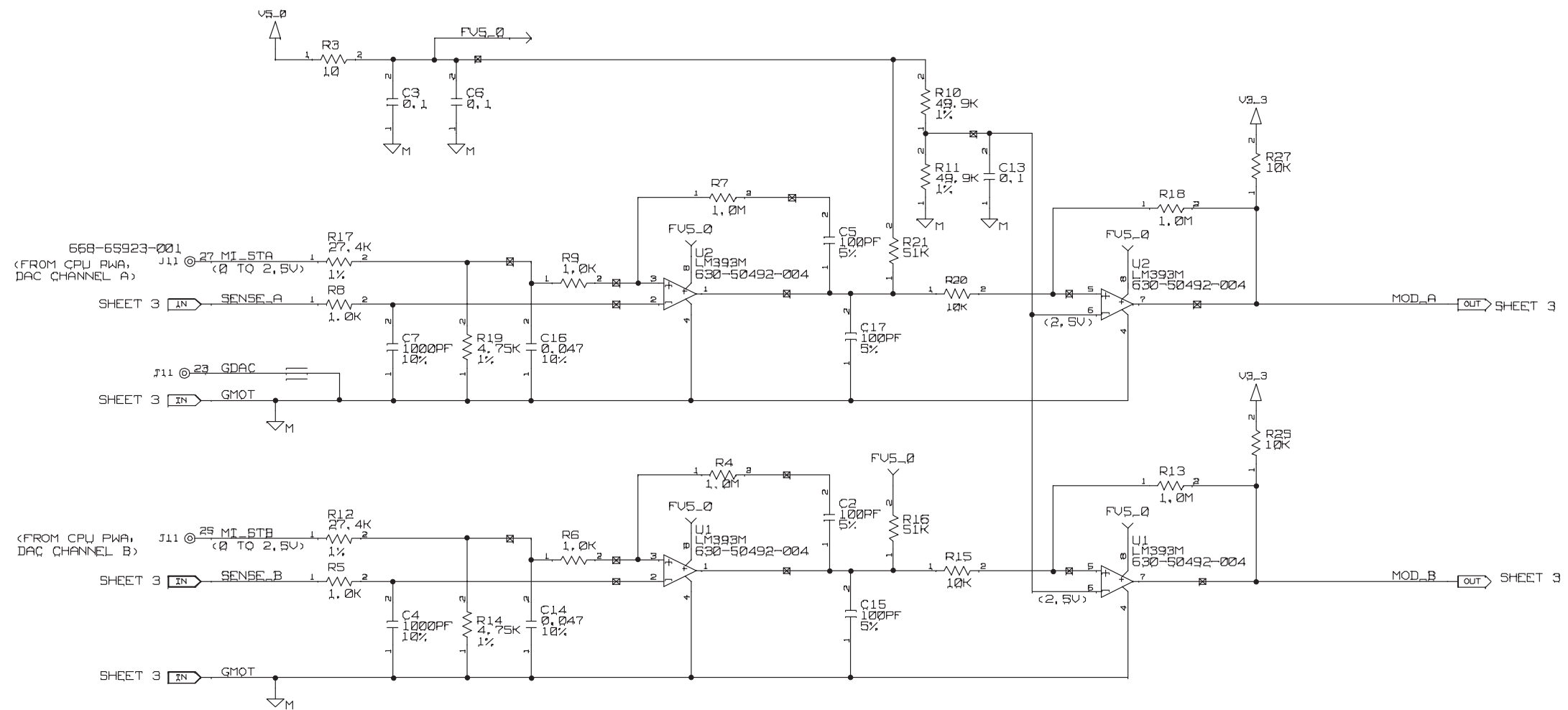


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Figure 9-15. Driver PWA Schematic

DRAWING NO. 249-95018-006	Rev. E
	Sheet 2 of 3

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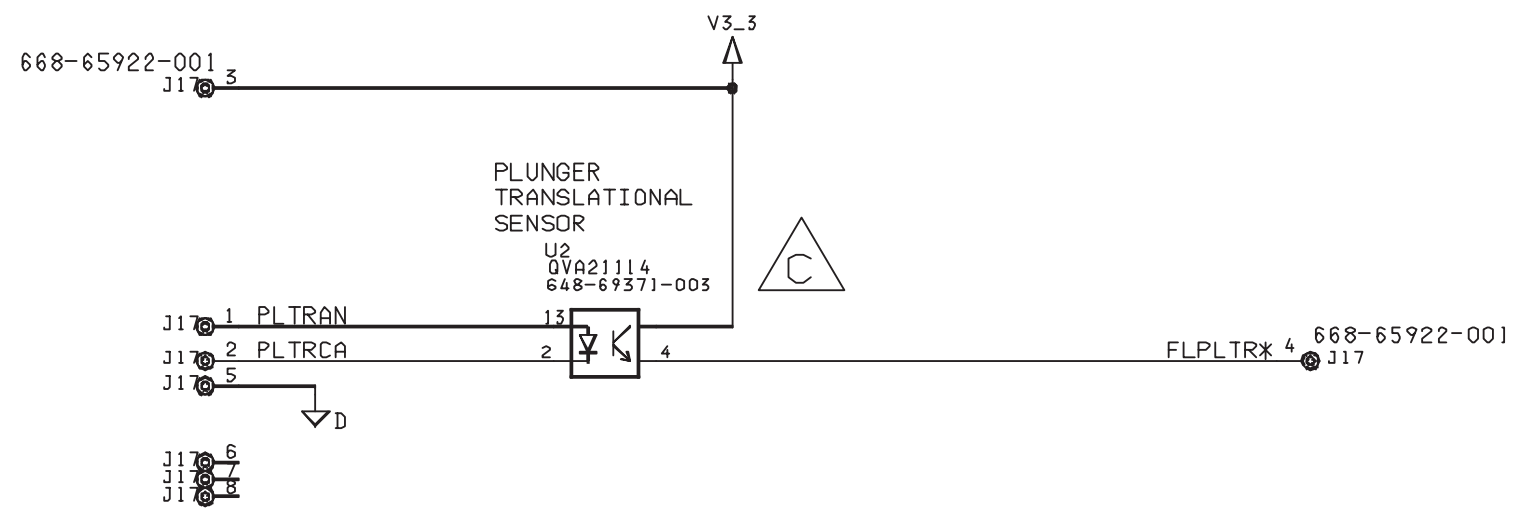


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PRODUCTS DIVISION - MH

Figure 9-15. Driver PWA Schematic

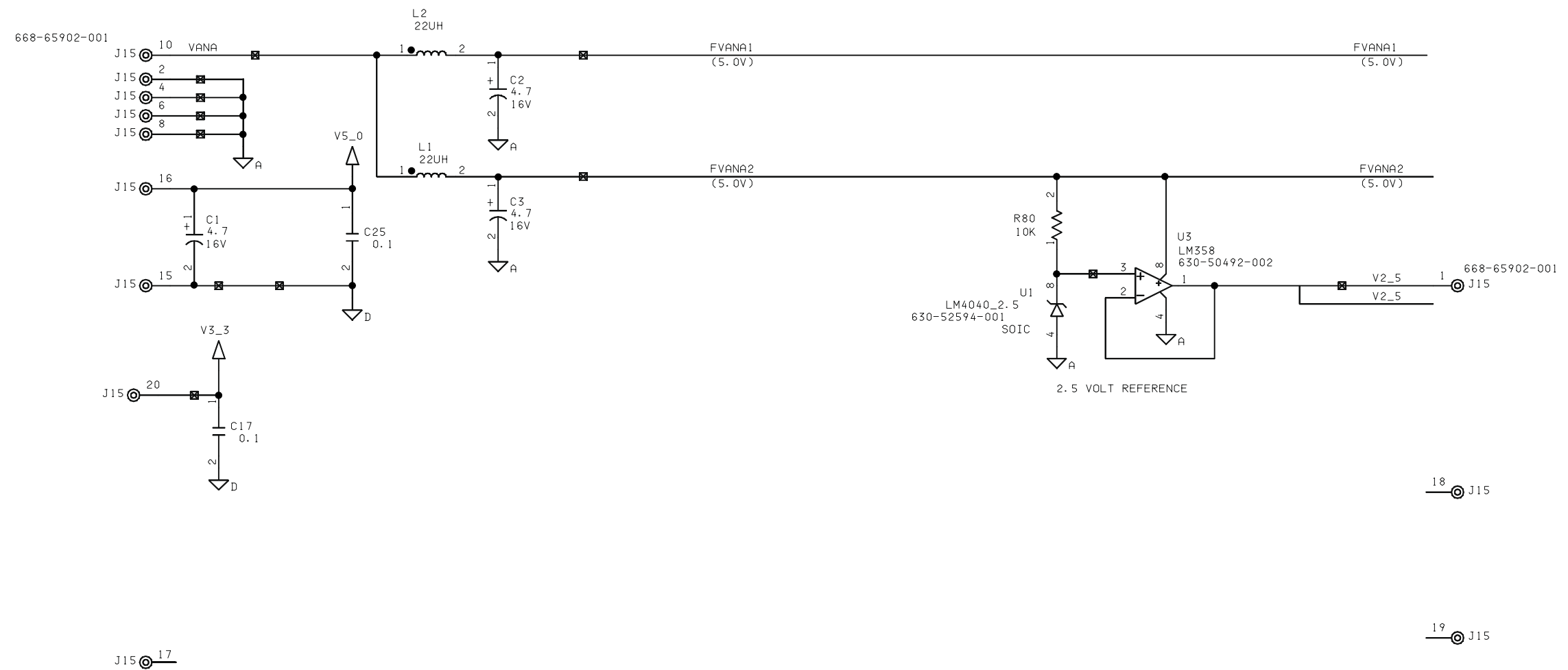
DRAWING NO. 249-95018-006	Rev. E
	Sheet 3 of 3

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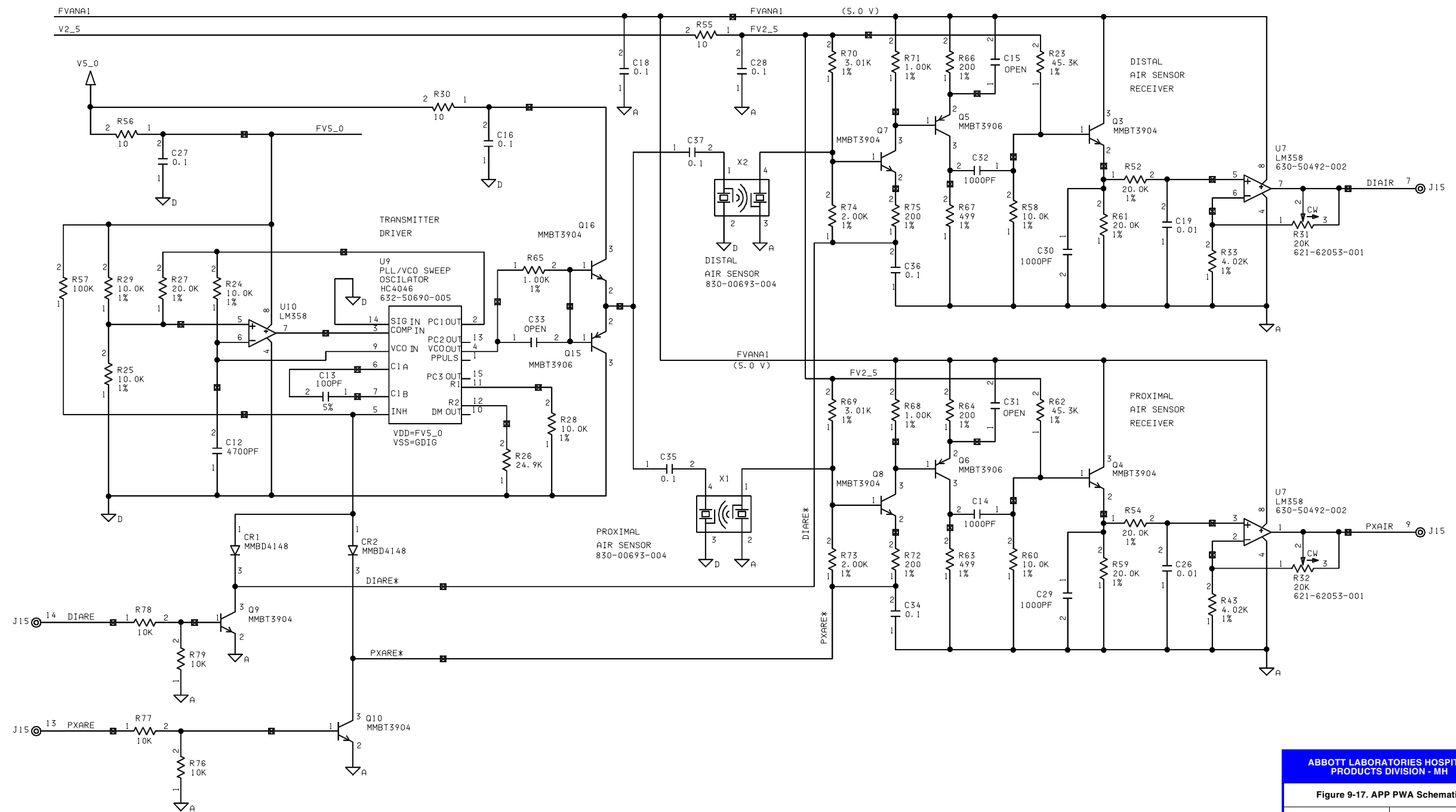
ABBOTT LABORATORIES HOSPITAL PRODUCTS DIVISION - MH	
Figure 9-16. Switch PWA Schematic	
DRAWING NO. 249-95022-004	Rev. C
	Sheet 1 of 1

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Figure 9-17. APP PWA Schematic	
DRAWING NO. 249-95034-007	Rev. F
	Sheet 1 of 3

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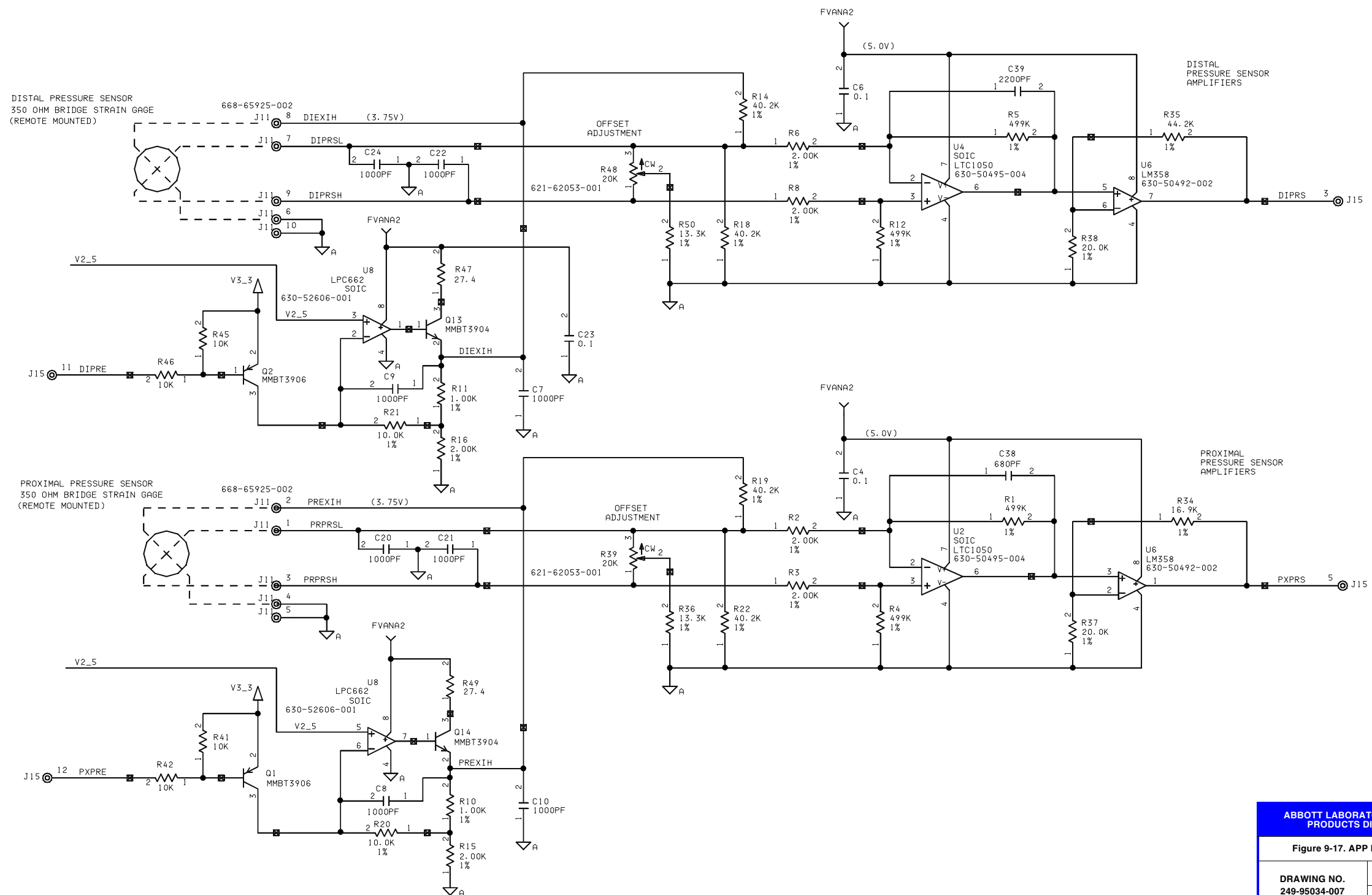


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Figure 9-17. APP PWA Schematic

DRAWING NO. 249-95034-007	Rev. F
	Sheet 2 of 3

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PRODUCTS DIVISION - MH

Figure 9-17. APP PWA Schematic

DRAWING NO. 249-95034-007	Rev. F
	Sheet 3 of 3

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Section 10

INDEX

A

- A/B valve subsystem, 4-32
- Abbott Laboratories, 6-1
- AC (mains) connector replacement, 7-19
- AC (mains) power cord replacement, 7-6
- AC power cord retainer replacement, 7-6
- Acronyms and abbreviations, 1-3
- Air sensors, 4-20
 - Receiver circuitry, 4-21
 - Transmitter circuitry, 4-21
- Air-in-line test
 - Distal, 5-11
 - Proximal, 5-10
- Alarms log, 1-12
- Alarm loudness test, 5-8
- Alarm messages and error codes, 6-1
 - Error codes requiring technical service, 6-6
 - Operational alarm messages, 6-2
- Amplifier and low pass filter, 4-23
- Analog-to-digital converter, 4-7
- APP PWA, 4-27
- Artifacts, 1-5
- Assemblies
 - Mechanism, 4-31
 - Motor and valve, 4-31
 - Printed wiring, 4-24
- Audible indicators, 4-10
- Auxiliary supplies, 4-15

B

- Bag hanger replacement, 7-22
- Barcode reader
 - Interface, 4-10
 - Wand, 4-28
 - Wand test, 5-15
- Battery assembly, battery door, and battery door pad replacement, 7-5
- Battery charge/discharge current measurement, 4-17
- Battery charger, 4-17
- Battery operation overview, 5-16
- Battery voltage measurement, 4-16

- Biomed settings, 1-9
 - Alarms log, 1-12
 - IV parameters, 1-10
 - Setting the time and date, 1-13
- Bridge excitation supply, 4-22

C

- Cassette, 4-29
 - Alarm test, 5-6
 - Door replacement, 7-32
 - Fluid shield replacement, 7-32
 - Type/presence selection, 4-23
- Chopper motor drive, 4-19
- Cleaning solutions, 5-2
- Cleaning the infusion pump, 5-1
- Clutch housing replacement, 7-22
- Clutch spring replacement, 7-22
- Component designators, 1-2
- Control logic, 4-4
- Conventions, 1-2
- Corrective actions, 6-2
- Cotter ring replacement, 7-22
- CPU, 4-3
- CPU PWA, 4-26
 - Replacement, 7-30
- CPU subsystem, 4-3
 - Analog-to-digital converter, 4-7
 - Audible indicators, 4-10
 - Barcode reader interface, 4-10
 - Control logic, 4-4
 - CPU, 4-3
 - DataPort interface, 4-11
 - Digital-to-analog converter, 4-9
 - Front panel keypad matrix, 4-9
 - Front panel LED indicators, 4-9
 - Front panel ON/OFF key, 4-9
 - Keypad lockout interface, 4-10
 - LCD backlight control, 4-5
 - LCD contrast control, 4-5
 - LCD controller, 4-4
 - Mechanism interface, 4-12
 - Nurse call interface, 4-10

- Power supply interface, 4-11
- Programmable read-only memory, 4-4
- Real-time clock, 4-6
- Static random access memory, 4-4
- System memory address map, 4-4
- Voltage monitor watchdog timer, 4-6
- CPU/driver cable replacement, 7-27
- Current limit loop, 4-15

D

- DataPort interface, 4-11
- Delivery accuracy test, 5-13
- Digital-to-analog converter, 4-9
- Display test, 5-7
- Distal
 - Air-in-line test, 5-11
 - Occlusion test, 5-12
- Drawings, 9-1
- Driver PWA, 4-26

E

- Electrical safety test, 5-14
- Electronic subsystem overview, 4-3
 - CPU subsystem, 4-3
 - Mechanism subsystem, 4-17
 - Power supply subsystem, 4-14
- EMI gasket replacement, 7-14
- End of the PVT, 5-14
- Equipment precautions, 7-3
- Equipment required, 5-3
- Error codes requiring
 - technical service, 6-6
- ESD spring, 7-11

F

- Ferrite tape, 7-29
- Fluid shield replacement, 7-32
- Free flow test, 5-7
- Front panel
 - Keypad matrix, 4-9
 - LED indicators, 4-9
 - ON/OFF key, 4-9
- Front/rear enclosure gasket
 - replacement, 7-13
- Fuse replacement, 7-19

G

- General description, 4-1

I

- Illustrated parts breakdown, 9-2
- Inlet/outlet valve subsystem, 4-33
- Inspection, 1-6, 5-1, 5-4
- Instrument installation procedure, 1-6
- Internal AC power cord replacement, 7-18
- Introduction, 1-1
- IV parameters, 1-10

K

- Keypad
 - Gasket replacement, 7-15
 - Lockout interface, 4-10
 - Replacement, 7-25
 - Verification/functional test, 5-7

L

- LCD, 4-28
 - Backlight control, 4-5
 - Contrast control, 4-5
 - Controller, 4-4
 - Replacement, 7-26
- Lockout switch test, 5-9
- Lower front enclosure assembly
 - gasket replacement, 7-13

M

- Main chassis assembly
 - Component replacement, 7-23
 - Separating, 7-7
- Main loop, 4-14
- Main regulator fault detection, 4-15
- Main switching regulator, 4-14
 - Current limit loop, 4-15
 - Main loop, 4-14
 - Secondary loop, 4-15
- Maintenance and service tests, 5-1
 - Barcode reader wand, 5-15
 - Battery operation overview, 5-16
 - Nurse call, 5-15
 - Performance verification test, 5-3
 - Periodic maintenance inspection, 5-15
 - Routine maintenance, 5-1

- Mechanical overview, 4-28
 - Cassette, 4-29
 - Mechanism assembly, 4-31
- Mechanism assembly, 4-31
 - A/B valve subsystem, 4-32
 - Inlet/outlet valve subsystem, 4-33
 - Motor and valve assemblies, 4-31
 - Plunger drive subsystem, 4-33
 - Replacement, 7-32
- Mechanism interface, 4-12
- Mechanism subsystem, 4-17
 - Air sensors, 4-20
 - Cassette type/presence selection, 4-23
 - Motor position sensors, 4-19
 - Motors/motor drive, 4-18
 - Pressure sensor calibration, 4-23
 - Pressure sensors, 4-21
 - Serial EEPROM, 4-23
 - V2_5 reference voltage, 4-20
- Minipole assembly replacement, 7-20
 - Bag hanger, 7-22
 - Clutch housing, 7-22
 - Clutch spring, 7-22
 - Cotter ring, 7-21
- Motor and valve assemblies, 4-31
- Motor position sensors, 4-19
- Motor power cable replacement, 7-30
- Motors/motor drive, 4-18
 - Chopper motor drive, 4-19
 - Stepper motors, 4-18

N

- Nurse call
 - Interface, 4-10
 - Test, 5-15

O

- Opener handle assembly
 - replacement, 7-34
- Operational alarm messages, 6-2
- Overview
 - Battery operation, 5-16
 - Electronic subsystem, 4-3
 - Mechanical, 4-28

P

- Performance verification test, 5-3
 - Air-in-line test
 - Distal, 5-11
 - Proximal, 5-10
 - Alarm loudness test, 5-8
 - Cassette alarm test, 5-6
 - Delivery accuracy test, 5-13
 - Display test, 5-7
 - Distal occlusion test, 5-12
 - Electrical safety test, 5-14
 - End of the PVT, 5-14
 - Equipment required, 5-3
 - Free flow test, 5-7
 - Infusion pump test setup, 5-4
 - Inspection, 5-4
 - Keypad verification/
 - functional test, 5-7
 - Lockout switch test, 5-9
 - Proximal occlusion test, 5-10
 - Self test, 5-4
- Periodic maintenance inspection, 5-15
- Peripheral/interface assembly
 - Component replacement, 7-11
 - Replacement, 7-9
 - Peripheral assembly cover
 - replacement, 7-11
 - Volume control knob
 - replacement, 7-11
- Peripheral PWA, 4-25
 - Replacement, 7-9
- Peripheral/interface PWA, 4-25
- Piezo alarm assembly replacement, 7-31
- Plunger drive subsystem, 4-33
- Pole clamp
 - Assembly replacement, 7-17
 - Backing plate replacement, 7-17
 - Ground wire replacement, 7-18
- Power control, 4-16
- Power supply interface, 4-11
- Power supply PWA, 4-24
 - Replacement, 7-24
- Power supply subsystem, 4-14
 - Auxiliary supplies, 4-15
 - Battery charge/discharge current
 - measurement, 4-17
 - Battery charger, 4-17
 - Battery voltage measurement, 4-16
 - Main regulator fault detection, 4-15
 - Main switching regulator, 4-14
 - Power control, 4-16
 - System power, 4-15
- Pressure sensor calibration, 4-23

Pressure sensors, 4-21
 Amplifier and low pass filter, 4-23
 Bridge excitation supply, 4-22
 Printed wiring assemblies, 4-24
 Procedures
 Instrument installation, 1-6
 Replacement, 7-3
 Troubleshooting, 6-11
 Programmable read-only memory, 4-4
 Proximal
 Air-in-line test, 5-10
 Occlusion test, 5-10
 PWAs
 APP, 4-27
 CPU, 4-26
 Driver, 4-26
 Peripheral, 4-25
 Peripheral/interface, 4-25
 Power supply, 4-24
 Switch, 4-27

R

Real-time clock, 4-6
 Rear enclosure assembly component replacement, 7-16
 Rear enclosure gasket replacement, 7-20
 Receiver circuitry, 4-21
 Remote mounted peripherals, 4-28
 Barcode reader wand, 4-28
 LCD, 4-28
 Sealed lead acid battery, 4-28
 Replaceable parts and repairs, 7-1
 Replacement procedures, 7-3
 AC (mains) connector, 7-19
 AC (mains) power cord, 7-6
 AC power cord retainer, 7-6
 Battery assembly, 7-5
 Battery door, 7-5
 Battery door pad, 7-5
 Cassette door, 7-32
 CPU driver cable, 7-27
 CPU PWA, 7-30
 EMI gasket, 7-14
 ESD spring, 7-11
 Fluid shield, 7-32
 Front/rear enclosure gasket, 7-13
 Fuse, 7-19
 Internal AC power cord, 7-18
 Keypad, 7-25
 Keypad gasket, 7-15
 LCD, 7-26
 Lower front enclosure assembly gaskets, 7-13

Main chassis assembly components, 7-23
 Mechanism assembly, 7-32
 Minipole assembly, 7-20
 Bag hanger, 7-22
 Clutch housing, 7-22
 Clutch spring, 7-22
 Cotter ring, 7-21
 Motor power cable, 7-30
 Opener handle assembly, 7-34
 Peripheral assembly cover, 7-11
 Peripheral components, 7-11
 Peripheral/interface assembly, 7-9
 Peripheral PWA, 7-9
 Piezo alarm assembly, 7-31
 Pole clamp assembly, 7-17
 Pole clamp backing plate, 7-17
 Pole clamp ground wire, 7-18
 Power supply PWA, 7-24
 Rear enclosure assembly components, 7-16
 Rear enclosure gasket, 7-20
 Required tools and materials, 7-3
 Rubber foot pad, 7-4
 Safety and equipment precautions, 7-3
 Separating the front enclosure, rear enclosure, and main chassis assembly, 7-7
 Top seal gasket, 7-15
 Velcro retainer strap, 7-6
 Volume control knob, 7-11
 Required tools and materials, 7-3
 Routine maintenance, 5-1
 Cleaning the infusion pump, 5-1
 Inspecting the infusion pump, 5-1
 Sanitizing the infusion pump, 5-2
 Rubber foot pad replacement, 7-4

S

Safety precautions, 7-3
 Sanitizing the infusion pump, 5-2
 Schematics
 APP PWA, 9-99
 CPU PWA, 9-71
 Driver PWA, 9-91
 Peripheral PWA, 9-63
 Peripheral/interface PWA, 9-51
 Power supply PWA, 9-31
 Switch PWA, 9-97
 Scope, 1-1
 Sealed lead acid battery, 4-28
 Secondary loop, 4-15
 Self test, 1-7, 5-4

Separating the front enclosure,
 rear enclosure, and main chassis
 assembly, [7-7](#)
 Serial EEPROM, [4-23](#)
 Setting the time and date, [1-13](#)
 Specifications, [8-1](#)
 Static random access memory, [4-4](#)
 Stepper motors, [4-18](#)
 Subsystems
 CPU, [4-3](#)
 Mechanism, [4-17](#)
 Power supply, [4-14](#)
 Switch PWA, [4-27](#)
 System memory address map, [4-4](#)
 System operating manual, [3-1](#)
 System power, [4-15](#)

T

Technical assistance, [6-1](#)
 Test setup, [5-4](#)
 Tests
 Air-in-line
 Distal, [5-11](#)
 Proximal, [5-10](#)
 Alarm loudness, [5-8](#)
 Barcode reader wand, [5-15](#)
 Cassette alarm, [5-6](#)
 Delivery accuracy, [5-13](#)
 Display, [5-7](#)
 Distal occlusion, [5-12](#)
 Electrical safety, [5-14](#)
 Free flow, [5-7](#)
 Keypad verification/functional, [5-7](#)
 Lockout switch, [5-9](#)
 Nurse call, [5-15](#)
 Performance verification, [5-3](#)
 Proximal occlusion, [5-10](#)
 Self, [1-7](#), [5-4](#)
 Theory of operation, [4-1](#)
 Electronic subsystem overview, [4-3](#)
 General description, [4-1](#)
 Mechanical overview, [4-28](#)
 Printed wiring assemblies, [4-24](#)
 Remote mounted peripherals, [4-28](#)
 Top seal gasket replacement, [7-15](#)
 Transmitter circuitry, [4-21](#)
 Troubleshooting, [6-1](#)
 Alarm messages and error codes, [6-1](#)
 Procedures, [6-11](#)
 Technical assistance, [6-1](#)
 With the PVT, [6-11](#)

U

Unpacking, [1-6](#)
 User qualification, [1-5](#)

V

V2_5 reference voltage, [4-20](#)
 Velcro retainer strap replacement, [7-6](#)
 Voltage monitor watchdog timer, [4-6](#)
 Volume control knob replacement, [7-11](#)

W

Warranty, [2-1](#)

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