LifeCare™ 5000

plum™

Infusion System

For use with List Number 02507-04

Technical Service Manual

430-03714-006 (A, 12/10)

Hospira

This page intentionally left blank.

Change History

Part Number	Description of Change
430-03714-001 (Rev. 4/92)	Original issue
430-03714-A01 (Rev. 1/93)	Change Page Issue Revise part number and title Section 1.1: Delete obsoleted information pertaining to Level 1 and Level 2 repairs Section 2: Revise warranty Section 7: Delete obsolete information pertaining to servicing qualifications Section 7.2.1: Correct battery pack and minipole assembly part numbers
430-03714-002 (Rev. 1/93)	Second Issue
430-03714-A02 (Rev. 4/93)	Change Page Issue Update cover and add copyright information Update Change History Update Contents Add Section 1.2 Section 1.6.1: Remove Table 1-4
430-03714-B02 (Rev. 12/93)	Not issued
430-03714-C02 (Rev. 1/94)	Change Page Issue Update Cover, Copyright, Change History, Contents, and Back Page Update Table 5-1 Update Section 5.2 Update Section 5.2.9 Update Section 5.3 Update Section 5.3.7 Update Section 6.2 Update Table 6-1 Update Section 7.2 Update Section 7.2.1.2 Remove reference to white lithium grease in Sections 7.2.7, 7.2.7.2, 7.2.23, 7.2.23.2, 7.2.23.3, and 7.2.23.4 Add Section 7.2.29 Add Figure 7-14
430-03714-003 (Rev. 8/94)	Third issue

Part Number	Description of Change
430-03714-A03 (Rev. 3/95)	Change Page Issue Update Cover, Copyright, Change History, Contents, and Back Page Update Section 1.1 Update Section 1.6 Update Section 4.1.2.1 Update Section 4.8 Update Table 5-1 Reorder Sections 5.2 and 5.3 Update Section 5.5 Update Table 6-1 Add Tables 6-3 and 6-4 Update Sections 7.2, 7.2.1.1, and 7.2.1.2 Update Figure 7-6 Revise Section 7.2.17.2 Revise Section 7.2.29 Add Section 7.2.31 Update Section 8 Update Section 9 Update Section 10
430-03714-004 (Rev. 8/96)	Fourth issue
430-03714-005 (Rev. 6/06)	Fifth issue Update manual to Hospira style Hospira name change Update Electrical Safety Test
430-03714-006 (Rev. 12/10)	Sixth issue Update Electrical Safety Test Update Section 5, Section 6, and Section 7 Update graphics

Contents

Section 1

INTRODUCTION 1-1
1.1 SCOPE. 1-1
1.2 CONVENTIONS 1-2
1.3 COMPONENT DESIGNATORS 1-3
1.4 ACRONYMS AND ABBREVIATIONS 1-3
1.5 USER QUALIFICATION 1-5
1.6 ARTIFACTS. 1-5
1.7 INFUSION SYSTEM INSTALLATION 1-5
1.7.1 UNPACKING 1-5
1.7.2 INSPECTION 1-6
1.7.3 SELF TEST 1-6
1.8 OBTAINING THE SOFTWARE VERSION NUMBER 1-7
1.9 SERIES SPECIFIC FEATURES 1-7
1.10 SETTING THE DELIVERY MODE 1-8

Section 2

WARRANTY 2-1

Section 3

SYSTEM OPERATING MANUAL 3-1

Section 4

THEORY OF OPERATION 4-1
4.1 SEQUENCE OF OPERATIONS 4-1
4.1.1 OFF STATUS 4-1
4.1.2 ON STATUS. 4-2
4.1.2.1 SELF TEST 4-3
4.1.2.2 CASSETTE LEAK TESTS 4-3
4.1.2.3 MAIN PROGRAM SOFTWARE FUNCTIONS 4-4
4.1.2.4 SETUP 4-5
4.1.2.5 OPERATION 4-5
4.2 ALARM CONDITIONS 4-6
4.3 BATTERY OVERVIEW 4-6
4.3.1 DEPTH OF DISCHARGE 4-7
4.3.2 BATTERY RECHARGE 4-7
4.3.3 OPERATIONAL REQUIREMENTS 4-7
4.3.3.1 BATTERY OPERATION 4-8
4.3.3.2 BATTERY CHARGER OPERATION 4-9
4.4 SYSTEM MALFUNCTION DETECTION 4-9
4.4.1 CORE FAILURE STATE 4-9
4.4.2 PERIPHERAL FAILURE STATE. 4-9
4.4.3 EXITING FROM FAILURE STATE. 4-10
4.5 DATA RETENTION 4-10
4.5.1 CRITICAL DATA RETENTION 4-10
4.5.2 ALARM HISTORY ERROR CODES 4-11
4.6 MONITORS AND DETECTORS 4-11
4.6.1 PRESSURE SENSING SYSTEM 4-11
4.6.1.1 DISTAL OCCLUSION 4-11
4.6.1.2 PROXIMAL OCCLUSION 4-12

4.6.2 AIR-IN-LINE DETECTION 4-12
4.6.2.1 PROXIMAL AIR-IN-LINE DETECTION 4-12
4.6.2.2 DISTAL AIR-IN-LINE DETECTION 4-12
4.6.3 MALFUNCTION DETECTION 4-12
4.6.4 FLOW DETECTOR 4-13
4.6.4.1 FLOW DETECTOR CONNECTED DURING RESET . . . 4-13
4.6.4.2 FLOW DETECTOR NOT USED 4-13
4.6.4.3 FLOW DETECTOR DISCONNECTED. 4-13
4.7 SYSTEM INTERFACE DESCRIPTION 4-13
4.7.1 POWER INTERFACE 4-15
4.7.1.1 AC POWER INTERFACE 4-15
4.7.1.2 DC POWER INTERFACE 4-15
4.7.1.3 POWER SUPPLY PWA INTERFACE 4-15
4.7.1.4 BATTERY CHARGER PWA INTERFACE 4-15
4.7.2 USER INTERFACE 4-15
4.7.2.1 FRONT PANEL INTERFACE 4-16
4.7.2.2 NURSE CALL INTERFACE. 4-16
4.7.2.3 DATAPORT INTERFACE 4-16
4.7.3 MOTORS AND VALVES INTERFACE 4-16
4.7.4 SENSOR INTERFACE 4-16
4.7.4.1 PRESSURE SENSOR INTERFACE 4-17
4.7.4.2 FLOW DETECTOR INTERFACE. 4-17
4.7.5 DISPLAY INTERFACE 4-17
4.7.6 MAIN AND I/O INTERFACE 4-17
4.8 PWA FUNCTIONAL DESCRIPTION 4-17
4.8.1 MAIN PWA 4-17
4.8.1.1 MPU AND CLOCK 4-19
4.8.1.2 SECOND CLOCK SOURCE 4-19
4.8.1.3 EPROM, RAM, AND MEMORY PROTECTION 4-19
4.8.1.4 CUSTOM LOGIC IC 4-20
4.8.1.5 A/D CONVERSION 4-20
4.8.1.6 -5 VOLT GENERATION. 4-20
4.8.2 I/O PWA 4-20
4.8.2.1 CUSTOM I/O IC 4-21
4.8.2.2 MOTOR DRIVERS 4-22
4.8.2.3 NURSE CALL RELAY CONTROL 4-22
4.8.2.4 DELIVERY MODE SELECTION 4-22
4.8.2.5 DATAPORT OPTION 4-23
4.8.2.6 FLOW DETECTOR. 4-23
4.8.2.7 MISCELLANEOUS I/O CIRCUITRY 4-23
4.8.3 POWER SUPPLY PWA 4-24
4.8.3.1 UNREGULATED DC POWER SUPPLY 4-24
4.8.3.2 AC (MAINS) LINE AND BATTERY POWER INDICATION . 4-24
4.8.3.3 POWER CONTROL 4-26
4.8.3.4 +5 VDC SUPPLY CONTROL 4-26
4.8.3.5 VMEM SUPPLY CONTROL 4-26
4.8.3.6 MOTOR POWER SUPPLY CONTROL 4-27
4.8.3.7 OVERVOLTAGE PROTECTION 4-27
4.8.3.8 AUDIBLE ALARM BACKUP 4-27
4.8.3.9 AUDIBLE ALARM CONTROL 4-28
4.8.3.10 AUDIBLE ALARM SELF TEST 4-28
4.8.3.11 BATTERY PACK CHARGING 4-29
4.8.3.12 BATTERY VOLTAGE DETECTION 4-30

4.8.4 BATTERY CHARGER PWA 4-30
4.8.4.1 AC (MAINS) OPERATION 4-31
4.8.4.2 DC OPERATION 4-32
4.8.5 SENSOR PWA 4-32
4.8.5.1 CASSETTE INSTALLATION RECOGNITION 4-32
4.8.5.2 AIR-IN-LINE DETECTION IN CASSETTE 4-34
4.8.5.3 PRESSURE AMPLIFICATION. 4-34
4.8.5.4 OPTICAL INTERRUPTERS. 4-35
4.8.6 BUBBLE SENSOR PWA 4-35
4.8.6.1 PREAMPLIFIER 4-37
4.8.6.2 AM AND THRESHOLD DETECTORS. 4-37
4.8.7 LED DISPLAY PWA 4-38
4.8.7.1 CHARACTER LEDS AND DRIVERS 4-38
4.8.7.2 CURRENT SENSING AMPLIFIER 4-39
4.8.7.3 ANALOG MULTIPLEXER 4-39
4.8.8 FLOW DETECTOR PWA 4-39
4.8.9 LCD ASSEMBLY 4-40
4.8.10 JUNCTION BOX ASSEMBLY (DATAPORT OPTION) 4-41
4.9 MECHANICAL FUNCTIONAL DESCRIPTION 4-42
4.9.1 CASSETTE 4-42
4.9.2 MECHANISM ASSEMBLY 4-43
4.9.2.1 MOTORS AND VALVES 4-43
4.9.2.2 CASSETTE DOOR SUBASSEMBLY 4-44
4.9.2.3 PRIMARY/SECONDARY VALVE ASSEMBLY 4-44
4.9.2.4 PLUNGER DRIVE ASSEMBLY 4-45

Section 5

MAINTENANCE AND SERVICE TESTS 5-1
5.1 ROUTINE MAINTENANCE 5-1
5.1.1 CLEANING AND SANITIZING 5-1
5.2 PERFORMANCE VERIFICATION TEST 5-3
5.2.1 EQUIPMENT AND MATERIALS REQUIRED 5-3
5.2.2 INSPECTION 5-4
5.2.3 STARTUP TEST 5-4
5.2.4 BUBBLE SENSOR LOCATION TEST 5-5
5.2.5 NURSE CALL TEST 5-6
5.2.6 EMPTY CONTAINER TEST 5-6
5.2.7 AIR-IN-LINE TEST 5-8
5.2.8 CONCURRENT DELIVERY TEST 5-9
5.2.9 DELIVERY ACCURACY TESTING 5-9
5.2.9.1 DELIVERY ACCURACY TEST (MACRO) 5-9
5.2.9.2 DELIVERY ACCURACY TEST (MICRO) 5-10
5.2.10 PRESSURE SENSOR TEST 5-11
5.2.11 ELECTRICAL SAFETY TEST 5-13
5.2.12 DATAPORT COMMUNICATION TEST 5-13
5.2.13 END OF THE PVT. 5-15
5.3 PERIODIC MAINTENANCE INSPECTION 5-16
5.4 BATTERY OPERATION OVERVIEW 5-16
5.4.1 BATTERY CHARGER CURRENT TEST 5-17

Section 6

TROUBLESHOOTING 6-1
6.1 TECHNICAL ASSISTANCE 6-1
6.2 AUDIBLE ALARMS 6-1
6.2.1 ALARM MESSAGES 6-1
6.2.2 OBTAINING AN ALARM HISTORY 6-14
6.3 ALARM AND MALFUNCTION CODES 6-14
6.3.1 ALARM CODES 6-14
6.3.2 MICROPROCESSOR OR SYSTEM ALARM CODES 6-14
6.3.3 DISPLAY, AUDIBLE, AND TOUCHSWITCH ALARM CODES . . . 6-14
6.3.4 INFUSION PUMPING MECHANISM ALARM CODES 6-14
6.3.5 MISCELLANEOUS ALARM CODES 6-14
6.4 INFUSION SYSTEM TROUBLESHOOTING 6-15
6.5 TROUBLESHOOTING WITH THE PVT 6-17

Section 7

REPLACEABLE PARTS AND REPAIRS 7-1
7.1 REPLACEABLE PARTS 7-1
7.2 REPLACEMENT PROCEDURES 7-1
7.2.1 SAFETY AND EQUIPMENT PROCEDURES 7-1
7.2.2 REQUIRED TOOLS AND MATERIALS. 7-2
7.2.2.1 ACCESSORIES 7-2
7.2.3 BATTERY PACK REPLACEMENT 7-3
7.2.4 AC (MAINS) POWER CORD REPLACEMENT (115 V) 7-4
7.2.5 AC (MAINS) POWER CORD REPLACEMENT (220 V) 7-5
7.2.6 FUSE AND FUSE DRAWER REPLACEMENT 7-6
7.2.7 VELCRO STRAP AND RETAINING PLATE REPLACEMENT . . . 7-6
7.2.8 POLE CLAMP COMPONENT REPLACEMENT 7-7
7.2.8.1 POLE CLAMP KNOB REPLACEMENT 7-7
7.2.8.2 POLE CLAMP SHAFT AND POLE CLAMP SCREW REPLACEMENT 7-8
7.2.8.3 POLE CLAMP FRICTION PLATE REPLACEMENT 7-8
7.2.9 DIP SWITCH COVER REPLACEMENT 7-9
7.2.10 RUBBER FOOT PAD AND FOOT INSERT REPLACEMENT 7-9
7.2.11 FLOW DETECTOR REPLACEMENT 7-9
7.2.12 NURSE CALL CABLE REPLACEMENT 7-10
7.2.13 MINIPOLE ASSEMBLY REPLACEMENT 7-10
7.2.14 SEPARATING THE FRONT AND REAR COVERS. 7-10
7.2.15 EMI SHIELD REPLACEMENT 7-12
7.2.16 LCD SCREEN CONTRAST ADJUSTMENT 7-13
7.2.17 FRONT PANEL ASSEMBLY REPLACEMENT 7-14
7.2.17.1 DISPLAY PWA REPLACEMENT. 7-15
7.2.17.2 LCD ASSEMBLY REPLACEMENT 7-16
7.2.17.3 FRONT PANEL REPLACEMENT 7-16
7.2.18 MAIN PWA AND I/O PWA REPLACEMENT 7-17
7.2.18.1 MAIN PWA REPLACEMENT 7-17
7.2.18.2 I/O PWA REPLACEMENT 7-18
7.2.19 POWER SUPPLY PWA, MECHANISM ASSEMBLY, AND BATTERY CHARGER PWA REPLACEMENT 7-20
7.2.19.1 POWER SUPPLY PWA REPLACEMENT 7-21
7.2.19.2 MECHANISM ASSEMBLY REPLACEMENT 7-22
7.2.19.3 BATTERY CHARGER PWA REPLACEMENT 7-22
7.2.20 DOOR HANDLE REPLACEMENT 7-23

7.2.21 DOOR MECHANISM LEAF SPRING REPLACEMENT 7-24
7.2.22 DOOR RETAINER LEAF SPRING REPLACEMENT 7-24
7.2.23 DOOR ASSEMBLY REPLACEMENT 7-25
7.2.23.1 DOOR COVER REPLACEMENT 7-25
7.2.23.2 DOOR HINGE LOADING SPRING REPLACEMENT . . . 7-26
7.2.23.3 CASSETTE DOOR SHAFT REPLACEMENT 7-27
7.2.23.4 DOOR BASE CASTING REPLACEMENT 7-28
7.2.24 I/O PORT PLATE REPLACEMENT 7-29
7.2.25 PIEZOELECTRIC ALARM ASSEMBLY REPLACEMENT 7-30
7.2.26 AC RECEPTACLE ASSEMBLY REPLACEMENT. 7-31
7.2.27 JUNCTION BOX REPLACEMENT (1.6 SERIES WITH DATAPORT) . 7-32
7.2.28 DATAPORT ACCESSORY CABLE REPLACEMENT (1.6 SERIES WITH DATAPORT) 7-32
7.2.29 MECHANISM ASSEMBLY CLEANING AND LUBRICATION . . . 7-34
7.2.30 DISTAL PRESSURE SENSOR ELECTRICAL ADJUSTMENT 7-36
7.2.31 DOOR SHIELD REPLACEMENT 7-37

Section 8

SPECIFICATIONS 8-1
8.1 LIFECARE 5000 SERIES DOMESTIC 8-1
8.2 LIFECARE 5000 SERIES INTERNATIONAL 8-4

Section 9

DRAWINGS 9-1

Index I-1

Figures

Figure 1-1. Self Test Screens. 1-6
Figure 1-2. DIP Switch Settings for Each Delivery Mode. 1-9
Figure 4-1. Fluid Path in the Cassette 4-2
Figure 4-2. LifeCare 5000 System Interface Block Diagram 4-14
Figure 4-3. Main PWA Functional Block Diagram 4-18
Figure 4-4. I/O PWA with DataPort Option Functional Block Diagram. 4-21
Figure 4-5. Power Supply PWA Functional Block Diagram 4-25
Figure 4-6. Battery Charger PWA Functional Block Diagram 4-31
Figure 4-7. Sensor PWA Functional Block Diagram 4-33
Figure 4-8. Bubble Sensor PWA Functional Block Diagram. 4-36
Figure 4-9. Major Elements of the Dual-Channel Cassette 4-37
Figure 4-10. LED Display PWA Functional Block Diagram 4-38
Figure 4-11. Flow Detector PWAs Schematic Diagram 4-40
Figure 4-12. Junction Box PWA Functional Block Diagram 4-41
Figure 4-13. Elements of the Mechanism Assembly 4-43
Figure 5-1. Mechanical Elements Behind the Cassette Door. 5-2
Figure 5-2. Gauge Dial Indicator 5-6
Figure 5-3. Recirculating Set Test Setup 5-7
Figure 5-4. Cassettes with Bubble Sensor Tips Removed 5-8
Figure 5-5. Pressure Sensor Test Setup 5-12
Figure 7-1. Battery Pack Replacement 7-4
Figure 7-2. Fuses, AC Power Cord, Velcro Strap, and Retaining Plate 7-5
Figure 7-3. Pole Clamp and Minipole Assembly Replacement. 7-7
Figure 7-4. Front and Rear Cover Replacement 7-11
Figure 7-5. EMI Shield Replacement 7-12
Figure 7-6. LCD Screen Contrast Adjustment. 7-13

Figure 7-7. Front Panel Assembly Replacement 7-15
Figure 7-8. Main PWA and I/O PWA Replacement 7-18
Figure 7-9. Mechanism Assembly, Power Supply PWA, and Battery Charger PWA . . 7-20
Figure 7-10. Door Assembly and Door Handle Assembly Replacement 7-23
Figure 7-11. I/O Port Plate, Piezoelectric Alarm, and AC Receptacle Assembly 7-30
Figure 7-12. DataPort Accessory Cable Schematics 7-33
Figure 7-13. Plunger Shaft Threads and Plunger Nut Lubrication 7-35
Figure 7-14. Mechanism Assembly Lubrication Points 7-36
Figure 7-15. Door Shield Replacement 7-37
Figure 9-1. Illustrated Parts Breakdown 9-5
Figure 9-2. Main PWA 9-9
Figure 9-3. Mechanism Assembly 9-11
Figure 9-4. Heatsink Assembly 9-13
Figure 9-5. Main Chassis, Mechanism, and PWAs 9-15
Figure 9-6. Exterior Assembly 9-17

Tables

Table 1-1. Conventions 1-2
Table 1-2. LifeCare 5000 Infusion Mode Configurations 1-10
Table 5-1. Cleaning Solutions 5-2
Table 5-2. Electrical Safety Measurements 5-13
Table 6-1. Alarm Codes and Corrective Actions 6-2
Table 6-2. Troubleshooting DataPort Systems (1.6 DataPort Only) 6-15
Table 6-3. Troubleshooting with the PVT 6-17
Table 7-1. Accessories for LifeCare 5000 Infusion Systems 7-2
Table 9-1. Drawings 9-1
Table 9-2. Illustrated Parts Breakdown 9-2

Section 1
INTRODUCTION

The LifeCare™ 5000 Series Drug Delivery System is a microprocessor-based, dual-channel infusion system that provides consistent delivery of two different fluids, at two different flow rates, from two containers, through the same cassette and into a common administration line.

The LifeCare 5000 provides two methods of delivery: Macro and Micro. Each delivery method allows a choice of non-concurrent or concurrent rate and dose delivery selection *(see Table 1-1)*.

Through microprocessor-based firmware, the infusion system features self-prompting for all setup and operating sequences, continual updates of operating and delivery status, nurse-selectable callback for secondary dose, and continual line pressure monitoring and read-out. Infusion system design also accommodates flow detector option on primary, 10 pounds per square inch (psi), 68.9 kPa adjustable occlusion pressure, and syringe or vial delivery capability.

The infusion system administers a variety of medical fluids, from 5 percent dextrose injection, USP, to enteral feeding products and blood. Primary and secondary doses of compatible drugs may be delivered concurrently. The DataPort™ 1.6 Series allows continuous infusion system monitoring when connected to a properly configured host computer.

For additional information, see the *LifeCare 5000 System Operating Manual*.

1.1
SCOPE

This Technical Service Manual applies to LifeCare 5000 1.6 Series infusion systems only. The manual is organized into the following 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
- ❏ Index
- ❏ Technical Service Bulletins

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

Specific instructions for operating the device are contained in its respective *System Operating Manual*.

The terms “infusion system”, “infuser”, and “device” are used interchangeably throughout the manual.

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

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

1.2
CONVENTIONS

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

Table 1-1. Conventions

Convention	Application	Example
Italic	Reference to a section, figure, table, or website	*(see Section 6.1)*
[ALL CAPS] Bold	Touchswitches	Press **[START]**
ALL CAPS **Initial Caps with lowercase**	Screen displays	**CONCURRENT DELIVERY** **Cassette test in progress**
Red Bold	Warnings and Cautions	**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). 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
AM	Amplitude modulator
CMOS	Complementary metal-oxide semiconductor
COMM	Communication
CPU	Central processing unit
CTS	Clear to send
DC	Direct current
DIP	Dual in-line package
DMM	Digital multimeter
DPM	Digital pressure meter
ECG	Electrocardiograph
EEG	Electroencephalogram
EMG	Electromyogram
EPROM	Erasable/programmable read-only memory
ESD	Electrostatic discharge
FET	Field-effect transistor
HI-Z	High impedance
hr	Hour
IC	Integrated circuit

ID	Identification
I/O	Input/output
IPB	Illustrated parts breakdown
IV	Intravenous
kHz	Kilohertz
kPa	Kilopascal
KVO	Keep vein open
lbs	Pounds
LCD	Liquid crystal display
LED	Light emitting diode
mA	Milliampere
MHz	Megahertz
mL/hr	Milliliter per hour
MOSFET	Metal-oxide-semiconductor field-effect transistor
MPU	Microprocessor unit
ms	Millisecond
mV	Millivolt
NC	Normally closed
NO	Normally open
PSI	Pounds per square inch
PSIG	Pounds per square inch gauge
PVT	Performance verification test
PWA	Printed wiring assembly
RAM	Random access memory
RF	Radio frequency
RMS	Root-mean-square
RN	Resistor network
ROM	Read-only memory
RTC	Real time clock
SCI	Serial communication interface
SW	Switch
TP	Test point
V	Volt
VCO	Voltage-controlled oscillator
XMIT	Transmit
µA	Microampere
µL	Microliter
µV	Microvolt

1.5 USER QUALIFICATION

The LifeCare 5000 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 infusion system and the administration of parenteral and enteral fluids and drugs, and whole blood or red blood cell components. Training should emphasize preventing 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 systems. 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 infusion system instead of some other source in the environment, set the infusion system so that it is temporarily not delivering fluid. Disappearance of the abnormality indicates that it was probably caused by electronic noise generated by the infusion system. 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 INFUSION SYSTEM INSTALLATION

CAUTION: Infusion system damage may occur unless proper care is exercised during product unpacking and installation.

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

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

1.7.1 UNPACKING

Inspect the shipping container for damage prior to opening. Should any damage be found, contact the delivering carrier immediately. Use care when unpacking the infusion system. Retain the packing slip and save all packing material in the event it is necessary to return the infusion system to the factory. Verify the shipping container contains a copy of the *System Operating Manual*.

1.7.2
INSPECTION

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

1.7.3
SELF TEST

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

Note: Do not place the infusion system in service if the battery is not fully charged. To make certain the battery is fully charged, connect the infusion system to AC (mains) power for 16 hours.

Note: When plugging the device into an AC power outlet, grasp the AC power cord plug and use a forward motion into the socket. Do not use a sideways motion. When unplugging the device, grasp the AC power cord plug and pull straight out. Do not pull out using the power cord cable and do not pull out at an angle.

To conduct the self test, proceed as follows:

1. Connect the AC power cord to a grounded, hospital-grade receptacle and confirm the AC power symbol on the front panel is lit.
2. Lift the door latch. Hold a primed cassette by its finger grip and insert the set into the door guides. Do not force the cassette. It should slide into the guides easily.
3. Close the door latch to lock the cassette in place.
4. If a flow detector is used, confirm that it is securely connected to the accessory jack (labeled **ACC**) on the back of the infuser.
5. The infusion system automatically initiates a self test to check internal systems. When the self test completes, verify the screen displays match *Figure 1-1*.

   Note: If any malfunction is detected by the self test, an alarm sounds and the screen displays a malfunction code. If the alarm sounds, do not place the infusion system in service. Note the malfunction code and contact Hospira.

6. After the infusion system self test successfully completes, set the delivery mode *(see Section 1-10)*.

Figure 1-1. Self Test Screens

1.8 OBTAINING THE SOFTWARE VERSION NUMBER

To obtain the infusion system software version number, proceed as follows:

1. Connect the infusion system to AC (mains) power.
2. Lift the door latch and insert a primed cassette into the cassette door holder.
3. Close the door latch to lock the cassette in place.

   Note: The infusion system automatically initiates a self test when the cassette is in place and the door latch is closed.

4. When the **SELF TEST:OK** screen appears on the LCD, press the **[REVIEW/CHANGE]** touchswitch. The screen displays the software version number.

   Note: The **SELF TEST:OK** screen appears for only three seconds.

1.9 SERIES SPECIFIC FEATURES

Features specific to the 1.6 series infusion system are as follows.

- Flow detector (optional)
- Proximal pressure sensor
- Battery charger PWA
- I/O PWA with DataPort (on selected infusion systems)

1.10
SETTING THE DELIVERY MODE

The infusion system allows a selection of six delivery modes, as follows:

- Macro (single channel)
- Macro Secondary (dual channel, single dose)
- Macro Multidose (dual channel, multidose)
- Micro (single channel)
- Micro Secondary (dual channel, single dose)
- Micro Multidose (dual channel, multidose)

Delivery mode selection is determined by a dual in-line package (DIP) switch located under the DIP switch cover on the back of the infuser. *Figure 1-2* illustrates the settings, and *Table 1-1* lists the flow parameters for each delivery mode.

To reset the delivery mode, proceed as follows:

1. Open the cassette door and remove the cassette.
2. Using a small flat-blade screwdriver, remove the screw from the DIP switch cover. Remove the cover to expose the DIP switches.
3. Set the DIP switch to the appropriate position for the desired delivery mode.
4. Verify the new delivery mode by closing the cassette door with a primed cassette properly installed.
5. Attach the DIP switch cover.

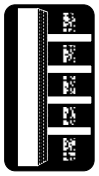
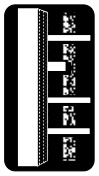
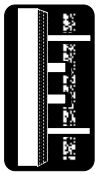
DELIVERY MODE	DIP SWITCH SETTING	DISPLAY LEGEND CONFIRMATION
MACRO Single Channel		LIFECARE 5000
MACRO SECONDARY Dual Channel Single Dose		LIFECARE 5000 DUAL CHANNEL
MACRO MULTIDOSE Dual Channel Multidose		LIFECARE 5000 MULTIDOSE
MICRO Single Channel		LIFECARE 5000 MICRO MODE
MICRO SECONDARY Dual Channel Single Dose		LIFECARE 5000 MICRO MODE DUAL CHANNEL
MICRO MULTIDOSE Dual Channel Multidose		LIFECARE 5000 MICRO MODE MULTIDOSE

Figure 1-2. DIP Switch Settings for Each Delivery Mode

Table 1-2. LifeCare 5000 Infusion Mode Configurations

	Non-Concurrent		Concurrent (Combined)		No. of Sec Doses	Dose Interval
	Rate	Dose	Rate	Dose		
Macro	1-999 mL/hr	1-9999 mL	N/A	N/A	N/A	N/A
Macro Secondary						
Macro Multidose						
Micro	0.1-99.9 mL/hr	0.1-999 mL	N/A	N/A	N/A	N/A
Micro Secondary	0.1-99.9 mL/hr	0.1-999 mL	1.0-99.9 mL/hr	0.2-1998 mL	1	N/A
Micro Multidose	0.1-99.9 mL/hr	0.1-999 mL	1.0-99.9 mL/hr	0.2-1998 mL	2-24	15 minutes to 24 hours
Variable Pressure Limit Selection	User selectable from 0.1 to 10.0 psi (6.9 to 68.9 kPa)					

Section 2

WARRANTY

Subject to the terms and conditions herein, Hospira, Inc., hereinafter referred to as Hospira, warrants that (a) the product shall conform to Hospira'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. Hospira makes no other warranties, express or implied, and specifically disclaims the implied warranties of merchantability and fitness for a particular purpose.

Purchaser's exclusive remedy shall be, at Hospira's option, the repair or replacement of the product. In no event shall Hospira'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 Hospira be liable for incidental, consequential, or special damages or losses or for lost business, revenues, or profits. Warranty product returned to Hospira 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 Hospira'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 Hospira and using Hospira 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 and detachable AC power cords.

In providing any parts for repair or service of the product, Hospira 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 a Hospira representative performing repair or service is not an authorized agent of Hospira.

This page intentionally left blank.

Section 3

SYSTEM OPERATING MANUAL

A copy of the System Operating Manual is included with every LifeCare 5000 Series infusion system. If a copy is not available, contact Hospira *(see Section 6.1)*.

This page intentionally left blank.

Section 4

THEORY OF OPERATION

This section describes the infusion system theory of operation.

The theory of operation describes the following:

- Sequence of operations
- Alarm conditions
- Battery operation
- System malfunction detection
- Data retention
- Monitors and detectors
- System interface description
- Printed wiring assembly (PWA) functional description
- Mechanical functional description

4.1 SEQUENCE OF OPERATIONS

This section describes **OFF** status and the sequence of operations associated with **ON** status of the infusion system.

4.1.1 OFF STATUS

The infusion system is off when the cassette door is open, or when the door is closed with no cassette in place.

When the infusion system is off, the infuser does not operate, LCD and LED screen displays are deactivated, and the nurse call alarm circuit is disabled.

In **OFF** status, the pumping mechanism valve and plunger motors are returned to home position, as follows:

- The plunger is fully retracted
- The inlet valve is open and the outlet valve is closed
- The primary valve is open and the secondary valve is closed

Figure 4-1 shows fluid path in the cassette.

Under normal conditions, critical data and setup data are retained in memory for four hours after the infusion system is turned off. Alarm history is retained for an extended time, and the distal occlusion pressure limit is retained for an extended time at user option, unless the battery pack is completely discharged or is disconnected.

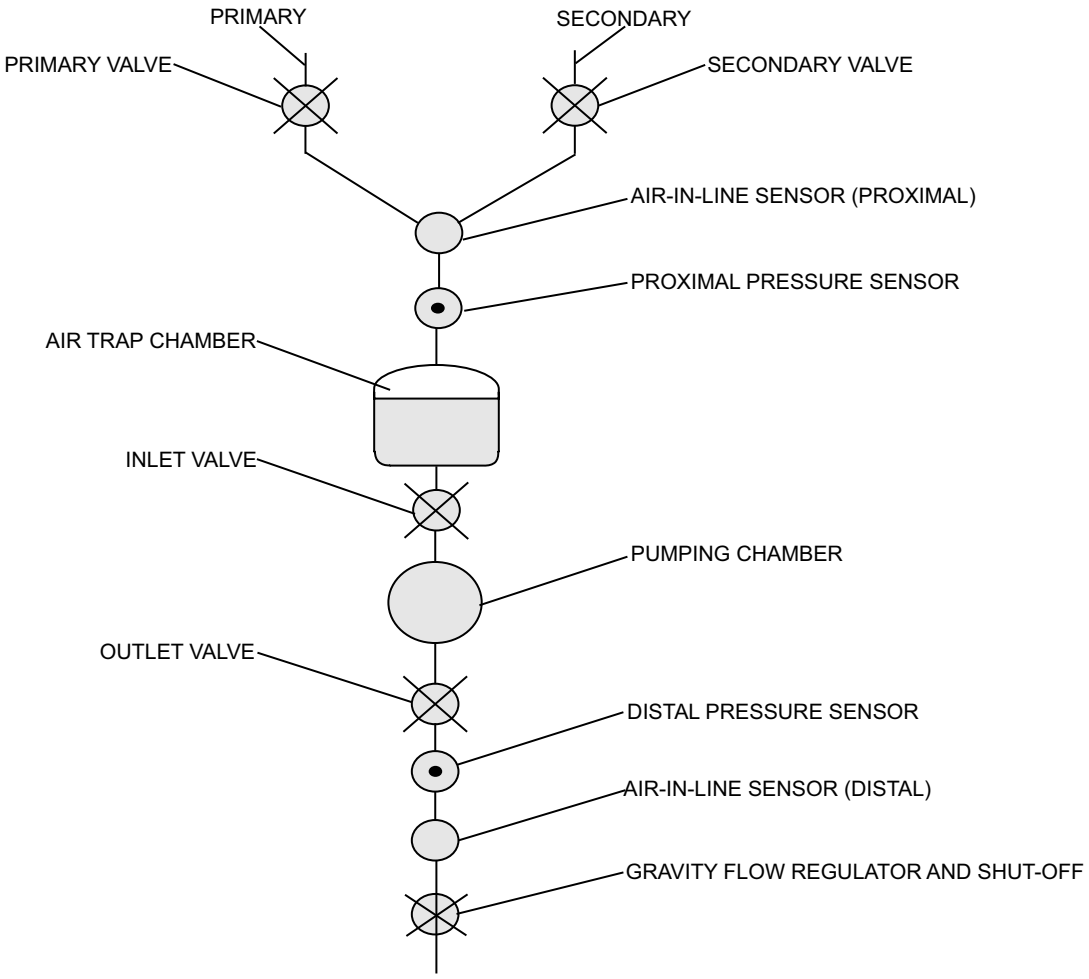


Figure 4-1. Fluid Path in the Cassette

4.1.2
ON STATUS

The infusion system is on when a cassette is installed and the door latch is closed.

When the door is closed, the following occurs:

- +5 VDC power supply is turned on
- LCD and LED screen displays are activated
- The infusion system performs the self test, followed by a cassette leak test

Upon successful completion of the self test, the touchswitches are activated and the system is ready for setup and operation.

The following sections describe the self test, cassette leak tests, main program software functions, and operational procedures that occur when the infusion system is turned on.

4.1.2.1
SELF TEST

The infusion system self test performs the following functions:

- Tests random access memory (RAM) and read only memory (ROM)
- Checks failure monitor circuit status
- Tests LED and LCD screen displays
- Tests the audible alarm
- Checks critical data integrity

The self test initializes all data except the following:

- Alarm history data
- User selected occlusion pressure limit setting, unless a data retention interval of greater than four hours has elapsed, at which time the default pressure setting is initialized

When the self test successfully completes, the screen displays **SELF TEST: OK**. The cassette leak tests follow immediately. If the self test or the cassette leak tests fail, the infusion system is in a system malfunction condition *(see Section 4.4)*.

4.1.2.2
CASSETTE LEAK TESTS

> **Note:** If the **[START]** touchswitch is pressed during the cassette leak tests, the screen displays **SELF TEST IN PROGRESS PLEASE WAIT**.

In LifeCare 5000 infusers, cassette valve integrity is tested by the leak tests. Leak tests immediately follow the self test.

Cassette leak tests consist of three stages, as follows:

1. The primary and secondary valves and the outlet valve close. The plunger moves forward until proximal pressure increases by approximately 2 psi (13.8 kPa). If proximal pressure does not reach 2 psi (13.8 kPa) within 40 steps, the test fails. The plunger again moves forward 110 steps or until proximal pressure reaches 8 psi (55.1 kPa). If proximal pressure does not increase to the proper level, the test fails.

   > **Note:** Failure of proximal pressure to reach 8.0 psi (55.1 kPa) may be caused by excessive air in the air trap chamber.

   After five seconds, the pressure drop is measured. If the pressure drops more than 2.0 psi (13.8 kPa), the test fails. At this point, the primary and secondary valves and the outlet valve have been tested.

2. All four valves close. The plunger is retracted, creating a vacuum in the pumping chamber. Proximal pressure drop is checked, then verified again in five seconds. A drop in pressure during this time indicates a failed inlet valve.

3. The inlet valve opens and the plunger retracts to the home position, relieving pressure within the cassette. The primary valve opens and the plunger advances 78 steps. The amount of air flowing past the proximal air detector is monitored, and the value is used to compute the delivery compensation for concurrent fluid delivery. The plunger again retracts to the home position. The motors are initialized, the outlet valve closes, and the inlet and primary valves open.

If any of the leak tests fail, the screen displays **STOPPED SYSTEM RETEST REQUIRED PRESS RESET**. After the **[RESET]** touchswitch is pressed, the screen displays **STOPPED OPEN DOOR AND REPRIME SET**. Reprime the cassette and close the door to start a new self test routine. If the leak test fails again, replace the cassette. If the leak test fails with a new cassette, remove the infusion system from service and contact Hospira.

Note: An alarm code is stored in the alarm history for any leak test failure.

At the successful conclusion of cassette leak tests, the infusion system is ready for setup and operation.

4.1.2.3

MAIN PROGRAM SOFTWARE FUNCTIONS

Upon successful completion of the self test and cassette leak tests, the touchswitches become active and the main program software performs the following functions:

- Activates the 10 millisecond (ms) clock and other timers
- Activates the watchdog monitor
- Updates I/O flag information
- Activates the audio processor
- Monitors the cassette sensor
- Monitors dose delivery against dose limit
- Monitors the system for alarm conditions; generates audible alarm if condition exists
- Activates the three motors for pumping
- Activates the keyboard
- Activates message and numeric displays
- Checks motor rate against selected rate
- Activates the nurse call relay
- Activates rolling data routine
- Checks microprocessor operation
- Performs RAM memory test
- Performs ROM checksum test
- Monitors accumulated volume data
- Monitors DataPort functions

4.1.2.4
SETUP

If a flow detector is attached, see *Section 4.6.4*.

During the operational sequence, press the **[RESET]** touchswitch to return the infusion system to setup. When the touchswitches are active, the infusion system is ready for setup.

During setup, the following occurs:

- The pumping mechanism is inactive and the plunger retracts from the cassette to home position
- The LCD message panel prompts the user to enter therapy settings through a sequence of menus *(see the System Operating Manual)*. When infusion system setup is complete, the screen displays **SETTING COMPLETE PRESS START OR REVIEW/CHANGE**
- An audible alarm beeps once per minute if there is no touchswitch activity
- The cassette door can be opened without an audible alarm
- If setup activity exceeds five minutes, the infusion system sounds an alarm
- All alarms are prevented during setup, except **STOPPED, DEAD BATTERY**, **CHECK SET**, and malfunction alarms

Upon setup completion, previous settings may be changed and current settings and delivery mode can be reviewed.

4.1.2.5
OPERATION

The normal operating cycle can begin only after appropriate therapy settings have been entered and the **[START]** touchswitch is pressed.

Pressing **[START]** initiates the following:

- The pumping mechanism drives the cassette at the user-set delivery rate
- User-set delivery rate and total volume are displayed continuously
- Front panel touchswitch controls are inhibited, except **[REVIEW/CHANGE]**, **[RESET]**, **[SILENCE]**, and the Titration function
- Alarm circuits are active

See the *System Operating Manual* for additional information.

Infusion system operation is interrupted whenever the system detects an alarm, malfunction, or open door. Opening the door during setup, normal operation, or after completion of operation initiates a wait period of ten seconds (sleep mode). At the end of the wait period, the +5 VDC power supply is turned off and the LCD displays are deactivated.

4.2
ALARM CONDITIONS

When the infusion system detects an alarm condition, the following occurs:

- The pumping mechanism either drives the cassette at the keep vein open (KVO) rate or it stops, depending on the alarm type *(see Table 6-1)*

  The KVO rate is the lesser of 1 mL/hr or the user-set primary delivery rate when operating in primary mode. When operating in secondary or concurrent mode, the infusion system reverts to the KVO rate if primary dose end is reached prior to secondary dose end.

  If secondary dose end is reached prior to primary dose end, the infusion system reverts to primary rate and continues to primary dose end, then reverts to KVO rate. If the callback feature is enabled, an alarm sounds when delivery of the secondary dose ends.

  The alarm condition allows the user to change the secondary container, if required. See the *System Operating Manual* for detailed instructions.

- The screen displays the appropriate alarm message *(see Table 6-1)*
- If active, the nurse call circuit signals that an alarm condition exists for all alarms except the **POWER FAILURE** alarm
- An audible alarm sounds
- If the audible alarm can be silenced, the **[SILENCE/NO]** touchswitch is activated

An alarm condition can be exited by pressing the **[RESET]** touchswitch or opening the cassette door. See *Section 6* for alarm and malfunction code information.

4.3
BATTERY OVERVIEW

Proper battery use and maintenance are essential for optimum infusion system operation. To replace the battery pack, see *Section 7.2.2*.

Factors that most commonly affect battery life are the depth and frequency of discharge and the length of the recharge period. Storage time and room temperature may also affect battery life. When the infusion system is neither connected to AC (mains) power, nor operating, the battery pack retains 50 percent of a full charge for at least one month.

The sealed battery pack can be damaged by misuse. The primary cause of damage is leaving the battery pack in a less than fully charged state. Battery damage can occur in a matter of hours. Damage results in 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.

4.3.1
DEPTH OF DISCHARGE

When the battery pack is discharged below 7.4 VDC while the infusion system is operating, the alarm sounds and the **LOW BATTERY** message displays on the LCD screen. Although continuing to operate the infusion system is not recommended, the battery pack provides power until discharged to approximately 7 VDC. At approximately 7 VDC, the **DEAD BATTERY** alarm activates and infusion system operation ceases.

CAUTION: When the LOW BATTERY alarm sounds, connect the infuser to AC (mains) power.

If the battery pack is frequently discharged to the dead battery threshold, battery life is compromised due to sulfation, a reduction in charge carrying ability, and the formation of a lead precipitate.

4.3.2
BATTERY RECHARGE

Battery recharge occurs any time the infusion system is connected to AC (mains) power. It is recommended that the infusion system be connected to AC (mains) power whenever practicable to maximize available battery charge during patient transport or ambulation. The power switch does not have to be on for the battery to recharge.

A discharged battery pack may be recharged to 80 percent of its previous capacity during a 16 hour recharging period while the infusion system operates at a delivery rate of 125 mL/hr or lower.

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

4.3.3
OPERATIONAL REQUIREMENTS

The infusion system is intended to operate on battery power on an exception basis only. The battery pack provides emergency backup power during AC (mains) power failure, or inadvertent disconnection of the AC power cord. The battery pack also allows temporary portable operation during short periods while a patient is moved from one location to another.

If the infusion system is used frequently on battery power, battery life may be significantly reduced. As a general rule, the more often the battery pack is discharged and recharged, the sooner it needs replacement.

The infusion system should be connected to AC (mains) power whenever possible to assure the battery pack is always in a charging condition. To prolong battery life, keep the infusion system connected to AC (mains) power when available.

If the infusion system operates on battery power until the **LOW BATTERY** message appears, the battery pack may be permanently damaged. If the **LOW BATTERY** message appears, connect the infusion system to AC (mains) power immediately to minimize the risk of battery damage.

Note: The battery pack quickly degrades if repeatedly cycled from a charged state to a deeply discharged state.

4.3.3.1

BATTERY OPERATION

CAUTION: Minimize the time the infusion system operates on battery power. Recharge the battery pack as soon as possible after battery operation.

When the infusion system operates on battery power, the red LED battery symbol on the front panel is lit. The microprocessor monitors battery voltage to prevent excessive battery discharge. The infusion system alerts the user to any battery alarm condition.

If the infusion system operates on continuous battery power, the following sequence of alarm conditions can occur:

1. Upon detecting a low battery threshold, the screen displays **LOW BATTERY**. This message alternates with routine status messages. An intermittent alarm sounds. The infuser continues pumping.

   Note: The low battery alarm stops if the infusion system is connected to AC (mains) power. The battery pack is in a discharged state, but is being recharged.

2. If the infusion system is not connected to AC (mains) power, approximately 30 minutes after the **LOW BATTERY** message appears (for a new, fully charged battery), the screen displays **STOPPED - DEAD BATTERY**, and the audible alarm sounds.

   In addition, the following occurs:

   - The infusion system stops pumping
   - The plunger retracts to the home position
   - The primary valve opens and secondary valve closes
   - The outlet valve closes and the inlet valve opens
   - The LCD backlight is deactivated

   Note: If the infusion system is connected to AC (mains) power, the **STOPPED - DEAD BATTERY** alarm ceases. The battery pack is in a discharged state, but is being recharged.

3. If the infusion system is not connected to AC (mains) power, the LCD screen goes blank approximately 10 minutes after displaying the **STOPPED - DEAD BATTERY** message, and the audible alarm sounds.

   Note: When the continuous audible alarm sounds, the infusion system is in hardware shutdown. Critical data in infusion system memory is lost. If the infuser door is opened, the alarm stops immediately.

4.3.3.2
BATTERY CHARGER OPERATION

This section describes the battery charging function of the battery charger PWA.

When the battery pack is discharged (terminal voltage falls below +8 VDC), charging occurs at the one ampere (A) limit for as long as required. As the terminal voltage increases to +9.4 VDC, the current decreases until a current of 220 milliamperes (mA) is reached. The charge current is maintained at a constant 220 mA level and the terminal voltage again continues to increase toward +10 VDC. Upon reaching the +10 VDC level, a 60-minute timer is activated. The 220 mA charging rate is maintained during the 60-minute period, then shuts off. The terminal voltage immediately moves towards the voltage of a fully charged battery (approximately 8.6 V). Because less than 20 mA charging current is now required, the float charger remains off. If AC (mains) power is disconnected during the 60-minute, 220 mA charge period, charging continues for the balance of this time after reconnecting AC (mains) power.

When the battery pack is partially discharged (terminal voltage is greater than +8 VDC), charging occurs at the constant voltage of +9.4 VDC. When the charging current reduces to between 20 and 25 mA, the charger shuts off.

When battery charging is interrupted prior to full charge, the charger continues to charge the battery pack upon reconnection to AC (mains) power.

4.4
SYSTEM MALFUNCTION DETECTION

The core failure state and the peripheral failure state can occur when the system detects a malfunction.

4.4.1
CORE FAILURE STATE

A core failure state occurs when the failure monitor detects a malfunction that causes a system failure. During the core failure state, the pumping mechanism stops, a continuous alarm sounds, and the system-prompting function is inhibited.

4.4.2
PERIPHERAL FAILURE STATE

A peripheral failure state occurs when any one of the following malfunctions are detected:

- Monitor circuit failure
- Mechanical malfunction
- Noncritical electronic circuitry malfunction
- Short duration, nonpermanent memory failure
- Control override by the failure monitor circuit

During the peripheral failure state, the pumping mechanism stops, an alarm code is displayed and the LCD screen flashes **MALFUNCTION**, an audible alarm sounds, and the nurse call circuit is activated.

4.4.3
EXITING FROM FAILURE STATE

Exiting from failure state is accomplished by opening the cassette door, or discharging the battery pack.

> **Note:** If the alarm is not silenced by opening the cassette door, replace the battery pack *(see Section 7.2.2)*.

4.5
DATA RETENTION

The following sections describe critical data and alarm history data, and how they are retained in memory.

4.5.1
CRITICAL DATA RETENTION

Critical data is held in infusion system memory for four hours after the infuser enters the off status condition.

Critical data includes status condition, activity state, dose functions, volume delivered, delivery rates, dose limits, and doses delivered.

Memory hold time is restored by returning the infusion system to the setup/operating status condition *(see Section 4.1.2)*.

Any of the following events results in critical data loss:

- Four hours elapse after the infusion system is shut off
- Battery pack is completely discharged or is disconnected
- System malfunction occurs

A user-selected occlusion pressure limit setting is retained in memory unless the battery pack discharges or is disconnected.

Once critical data has been lost, the infuser reverts to default values in the setup/operating mode.

4.5.2
ALARM HISTORY ERROR CODES

Alarm history is a rolling history of alarms and malfunctions. To display alarm history, press the **[REVIEW/CHANGE]** touchswitch twice during the first three-to-five seconds after the screen displays **SELF TEST: OK**.

The alarm history screen displays up to 15 alarm and malfunction codes, with the most recent appearing in the lower right corner of the screen. Alarm history is retained in memory until any one of the following occurs:

- The infuser is disconnected from AC (mains) power and the battery pack is disconnected
- The infuser is not connected to AC (mains) power and the battery pack reaches the dead battery alarm condition
- An AC (mains) power failure occurs, and the infusion system operates on battery power until the dead battery alarm condition is reached

4.6
MONITORS AND DETECTORS

The monitoring and detection system consists of fluid sensors in the mechanism assembly, two bubble sensors in the cassette, microprocessor-controlled flow alarm algorithms, and associated electronics. The ultrasonic bubble sensors detect air at the inlet and outlet of the cassette pumping chamber.

4.6.1
PRESSURE SENSING SYSTEM

The pressure sensing system senses occlusions from the distal and the proximal pressure sensors, as described in the following sections.

4.6.1.1
DISTAL OCCLUSION

Distal occlusion is defined as an occlusion in the administration set distal to the cassette. Pressure within the cassette is measured by sensing the strain in a four element strain gauge bridge that is bonded to a steel leaf spring. The microprocessor monitors absolute pressure. If the absolute pressure limit is exceeded, a distal occlusion alarm occurs and pumping ceases.

The distal occlusion alarm is triggered by any one of the following conditions:

- Measured pressure exceeds 10 psi (68.9 kPa) for approximately 1.2 seconds
- Measured pressure exceeds the user-selected pressure limit for approximately 12 seconds
- Instantaneous pressure exceeds 10 psi (68.9 kPa) and the plunger motor slips
- Measured pressure exceeds user selected pressure limit at the time the **[START]** touchswitch is pressed

4.6.1.2
PROXIMAL OCCLUSION

Proximal occlusion is defined as an occluded primary or secondary administration set proximal to the cassette. Proximal occlusion is sensed by measuring the output of the proximal sensor. If the proximal line is occluded, a vacuum forms in the air trap chamber, which is sensed by the proximal sensor. If the proximal occlusion is present after three cycles, the proximal occlusion alarm sounds.

4.6.2
AIR-IN-LINE DETECTION

Air-in-line detection takes place both proximal and distal to the cassette, as described in the following sections.

4.6.2.1
PROXIMAL AIR-IN-LINE DETECTION

A proximal air-in-line alarm is triggered if air is detected by the proximal air sensor for a continuing bolus of air equivalent to approximately 600 microliters (µL), or if air is sensed for intermittent cumulative boluses of air equivalent to approximately 1.2 mL.

When cumulative air boluses equivalent to approximately 600 µL are registered, and the infusion system is programmed for secondary delivery, autobackpriming is triggered in order to backprime excess accumulated air into the secondary container.

4.6.2.2
DISTAL AIR-IN-LINE DETECTION

A distal air-in-line alarm is triggered if air is detected by the distal air sensor for a continuing bolus of air equivalent to approximately 100 µL, or if air is sensed for intermittent cumulative boluses of air equivalent to approximately 240 µL out of 2 mL total volume. When the cassette door is opened, the sensor is reset.

Before the distal air-in-line alarm is activated, the infusion system pushes the air bubble approximately 20 motor steps forward to a position where it is visible in the tubing.

4.6.3
MALFUNCTION DETECTION

The infusion system diagnoses hardware malfunctions detected during the self test and those that occur during normal operation.

See *Section 6* for a list of alarm and malfunction codes. See *Table 6-1* for LCD messages, possible causes, and recommended corrective actions where applicable.

Malfunction codes can be reviewed by pressing the **[REVIEW/CHANGE]** touchswitch twice during the first three-to-five seconds after closing the door. The screen displays the last 15 alarm or malfunction codes, with the most recent appearing in the lower right corner of the screen.

4.6.4
FLOW DETECTOR

Use of a flow detector is optional for the LifeCare 5000 series.

The flow detector clips around the drip chamber and optically senses drops falling within the chamber. The device consists of a set of three phototransistors and two infrared LEDs, together with infrared and limited acceptance angle filters, all of which are contained in a plastic housing.

4.6.4.1
FLOW DETECTOR CONNECTED DURING RESET

If a flow detector is connected to the infusion system during reset or setup, no dose limit setting is required. If no dose limit is set, the infuser runs until the primary container empties. The flow detector then senses the absence of flow, generates an audible alarm, and the screen displays **EMPTY CONTAINER PRIMARY**. The pumping rate is decreased to KVO.

4.6.4.2
FLOW DETECTOR NOT USED

If a flow detector is not connected to the infusion system, a dose limit must be set for primary delivery during reset. Otherwise, the infusion system will not leave setup when the **[START]** touchswitch is pressed.

4.6.4.3
FLOW DETECTOR DISCONNECTED

If the flow detector is disconnected while the infusion system is operating, a **FLOW DETECTOR DISCONNECTED** alarm is generated and the infuser stops pumping. To silence the alarm, press the **[RESET]** touchswitch. Follow the screen prompts to set a dose limit for primary delivery. Press **[START]** to continue delivery.

4.7
SYSTEM INTERFACE DESCRIPTION

The interfaces between the principal hardware subassemblies in the infusion system are categorized as power interface, user interface, motors and valve interface, sensor interface, display interface, and main and I/O interface *(see Figure 4-2)*.

The following sections describe the interfaces and the signal flow between them.

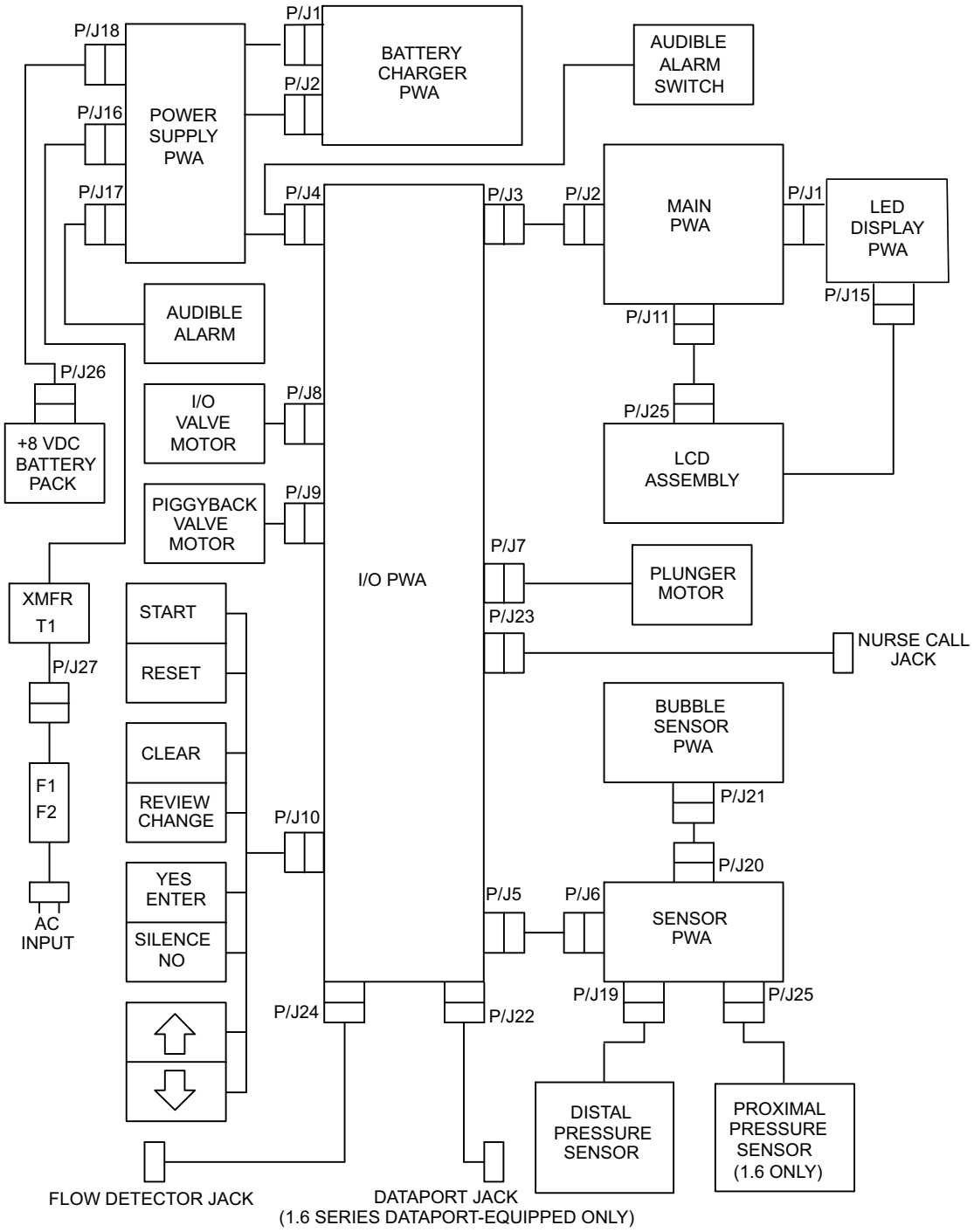


Figure 4-2. LifeCare 5000 System Interface Block Diagram

4.7.1
POWER INTERFACE

Both AC (mains) input power and +8 VDC battery power are inputs to the power supply PWA. The power supply PWA provides audio signal power to the audible alarm and DC power levels, in addition to supplying various control signals to the I/O PWA. The following section describe these interfaces.

4.7.1.1
AC POWER INTERFACE

The infusion system is connected to AC (mains) power through the power cord, which connects into the back of the infuser. The AC (mains) input is routed to F1 and F2 and then to a power transformer (T1) through connector P/J27. From the output of T1, AC (mains) power is connected to the power supply PWA through connector P/J16.

4.7.1.2
DC POWER INTERFACE

The +8 VDC rechargeable battery pack is connected to the power supply PWA through the connector P/J26, which routes battery power to P/J18 on the power supply PWA. When the infusion system operates on AC (mains) power, output of the charging circuitry on the power supply PWA recharges the battery pack. When the infusion system operates on battery power, the battery pack supplies the infusion system with +8 VDC power through the same interface.

4.7.1.3
POWER SUPPLY PWA INTERFACE

The power supply PWA provides an audio drive signal to the audible alarm assembly through P/J17. The power supply PWA also provides power and signal interfaces with the I/O PWA through P/J4.

4.7.1.4
BATTERY CHARGER PWA INTERFACE

The battery charger PWA connects to two cables, and is routed to the power supply PWA through connectors P/J1 and P/J2. Connector P/J1 connects the power supply PWA to the voltage detector and current limiter circuitry on the battery charger PWA. Connector P/J2 connects the power supply PWA to the current sensing circuitry on the battery charger PWA.

4.7.2
USER INTERFACE

The user interface consists of front panel touchswitches, the nurse call jack located on the infuser's back panel, and the DataPort interface located on the back panel. The following sections describe these interfaces.

4.7.2.1
FRONT PANEL INTERFACE

The front panel interface consists of inputs to the I/O PWA from the eight front panel touchswitches through P/J10.

4.7.2.2
NURSE CALL INTERFACE

The nurse call jack on the back panel (labeled **NURSE CALL**) interfaces with the I/O PWA through P/J23.

4.7.2.3
DATAPORT INTERFACE

The DataPort interface makes it possible to connect from 1 to 15 DataPort-equipped infusers to a host computer through a system of communication cables. A separate junction box attaches to the back I/O port panel on the infusion system through a DB-15 connector, P/J22. Two six-pin modular jacks (J1 and J2) on the junction box connect to the communication bus and to another infuser.

An infuser may be removed from the communication bus without breaking the bus connection by disconnecting the junction box from the infusion system.

DIP switches in the junction box create a hard identification (ID), or location, for each infuser. Hard ID values between 1 and 15 are supplied by the attached junction box. The hard ID may be written on a label on the exterior of the junction box. The host computer identifies the location of the infusion system using this hard ID.

> **Note:** DIP switch setup instructions are described on the insert accompanying the junction box.

4.7.3
MOTORS AND VALVES INTERFACE

The motors and valves in the infusion system are powered and controlled by the I/O PWA. The plunger motor receives +6.5 VDC power and motor drive signals through P/J7.

The I/O valve motor receives +6.5 VDC power and motor drive signals through P/J8. The primary/secondary valve motor receives +6.5 VDC power and motor drive signals through P/J9.

4.7.4
SENSOR INTERFACE

The sensor interface includes the following interfaces:

- Distal pressure sensor interface with sensor PWA
- Proximal pressure sensor interface with sensor PWA
- Bubble sensor PWA interface with sensor PWA
- Flow detector interface with I/O PWA
- I/O PWA interface with sensor PWA

4.7.4.1
PRESSURE SENSOR INTERFACE

The distal, proximal, and bubble sensors connect to the sensor PWA that connects to the I/O PWA. Bubble sensing is performed by the bubble sensor PWA that interfaces with the sensor PWA through connectors P/J21 on the bubble sensor PWA and P/J20 on the sensor PWA. Distal and proximal pressure sensor signals are routed directly to the sensor PWA through P/J19 and P/J25, respectively, on the sensor PWA. The sensor PWA interfaces with the I/O PWA through connector P/J6 on the sensor PWA and connector P/J5 on the I/O PWA.

4.7.4.2
FLOW DETECTOR INTERFACE

See *Section 4.6.4* for flow detector information. The flow detector connector on the back of the infuser interfaces with the I/O PWA connector P/J24.

4.7.5
DISPLAY INTERFACE

The display interface consists of the LED display and the LCD screen. The display interface involves the main PWA that connects directly to the LED PWA through P/J1 and to the LCD screen display through P/J11 on the main PWA and P/J25 on the LCD screen display. The LED display PWA provides power to the LCD PWA through connector P/J15.

4.7.6
MAIN AND I/O INTERFACE

The main PWA receives power through connector P/J3 on the I/O PWA directly into connector P/J2 on the main PWA.

4.8
PWA FUNCTIONAL DESCRIPTION

This section provides a functional description and a functional block diagram of the infusion system PWAs.

4.8.1
MAIN PWA

The main PWA provides microprocessor control for the infusion system *(see Figure 4-3)*.

Basic circuitry on the main PWA is as follows:

- Microprocessor unit (MPU) and 8 MHz clock
- 455 kHz second clock source
- 48K bytes of erasable/programmable read only memory (EPROM)

- 2K bytes of RAM
- Custom integrated circuit (IC) logic for selection of various memory functions
- Analog-to-digital (A/D) converter
- DC-to-DC converter

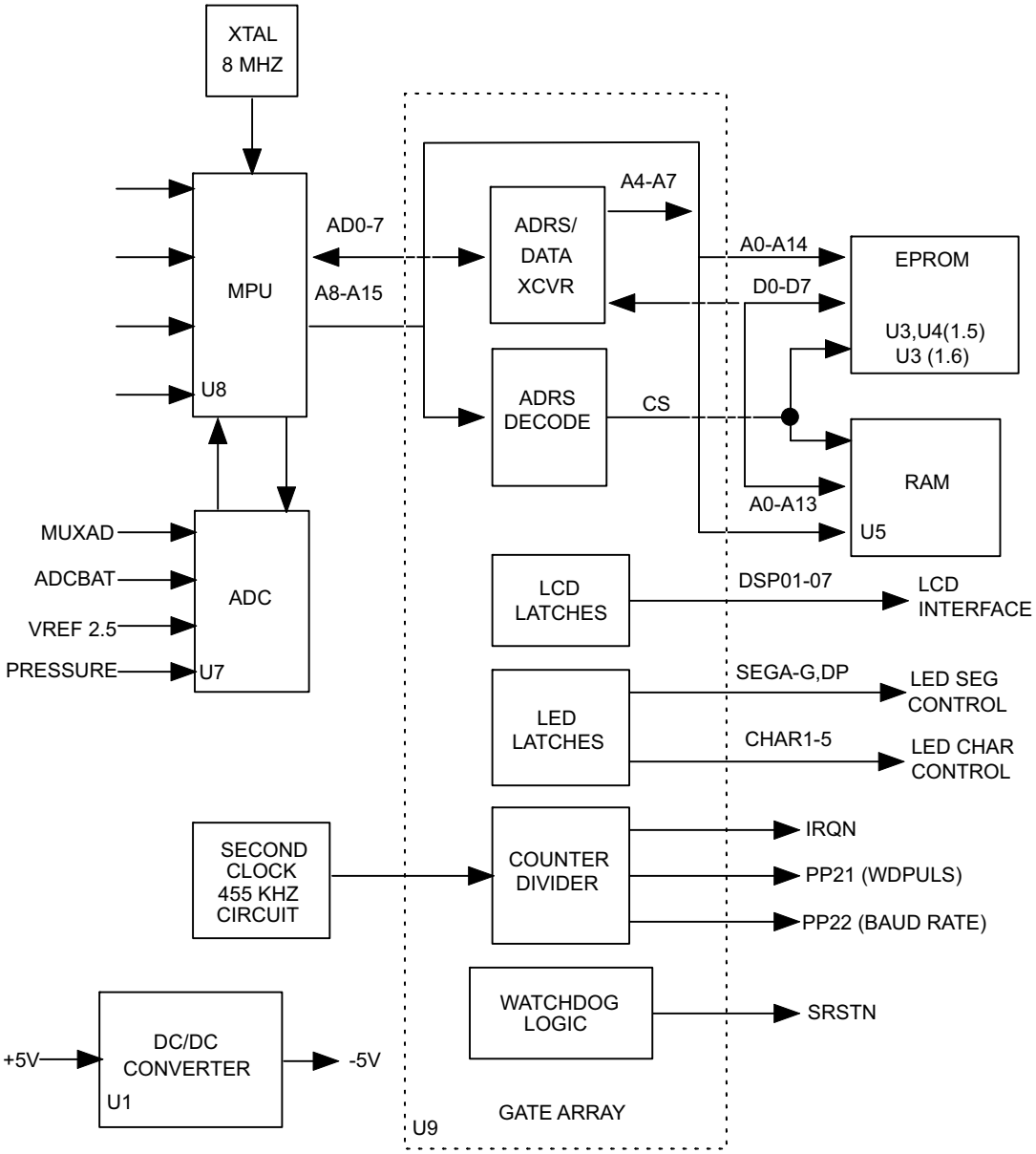


Figure 4-3. Main PWA Functional Block Diagram

4.8.1.1
MPU AND CLOCK

The 40-pin Hitachi HD63B03R complementary metal-oxide-semiconductor (CMOS) MPU on the main PWA is the central processing unit (CPU). The CPU contains 128 bytes of RAM, the serial communication interface (SCI), the parallel input/output (I/O) ports, and a multifunction timer. The CPU is address and data bus compatible with the Motorola MC6800 family of microprocessors. In addition, RAM can be expanded to 64K bytes.

The MPU clock consists of the 8 MHz crystal Y2 and capacitors C10 and C11. Y2 is internally divided by four to give a 2 MHz system cycle frequency.

4.8.1.2
SECOND CLOCK SOURCE

The second clock source contains the 455 kHz resonator Y1, the inverter U2, and capacitors C8 and C9.

The second clock source provides the following:

- Watchdog pulse source
- LED refresh interrupt timer
- Baud rate generator

4.8.1.3
EPROM, RAM, AND MEMORY PROTECTION

Program memory resides in the 27C512 EPROM, U3. U3 has 64K byte capacity of which 56K is used. The remaining address space is used for RAM and I/O mapping.

2K bytes of system RAM are provided by the MK48T128 U5 that also provides real-time clock (RTC) capability. The 48T128 contains an internal battery that provides power for memory retention and clock functions when the system 5 V supply is off.

Memory block decoding is performed by the custom logic IC U9, and by NOR gate U4A.

RAM memory is decoded from $20_{(16)}$ to $7FF_{(16)}$. I/O space is decoded between $1000_{(16)}$ and $1FFF_{(16)}$. EPROM space is decoded from $2000_{(16)}$ to $FFFF_{(16)}$.

RAM memory is protected from spurious writes by NAND gate U6A during system power down. The RAMSEL signal from U9 is AND gated with REGON. This allows writes to the RAM only when +5 V is available. REGON, provided by the power supply, is brought low immediately when the infusion system is turned off. RAMSEL is forced low by a system reset and during power up.

4.8.1.4
CUSTOM LOGIC IC

The custom IC, U9, is a HCMOS 84-pin gate array that provides address decoding, bus interfacing, timing control, LED/LCD interfacing, and power up/system reset control.

4.8.1.5
A/D CONVERSION

IC U7 is an 8 bit A/D converter with four multiplexed inputs. Channel 0 (pin 3) converts the distal pressure amplifier output. Channel 1 (pin 4) converts the proximal pressure amplifier output.

Channel 2 (pin 5) measures the ADCBAT and the 2.5V reference (VREF2.5). Signal switching is performed by U4 on the I/O PWA. The reference voltage is tested at power up self test only.

Channel 3 converts the output voltage from the analog multiplexer on the display PWA. The multiplexer switches between the LED test voltage or current, the OVPREF signal from the power supply, and the output of the flow detector (DROPFB).

4.8.1.6
-5 VOLT GENERATION

Voltage converter U1 and associated components generate -5 VDC from the 5 V supply. A negative voltage set by potentiometer R1 is used to adjust the LCD screen viewing angle.

4.8.2
I/O PWA

The I/O PWA provides interface between the MPU and infusion system hardware such as the front panel, motors, alarms, sensors, and nurse-call relay *(see Figure 4-4)*. The I/O PWA contains the custom I/O IC, motor drivers, nurse call relay and control circuits, configuration switches, and communications port (on selected units).

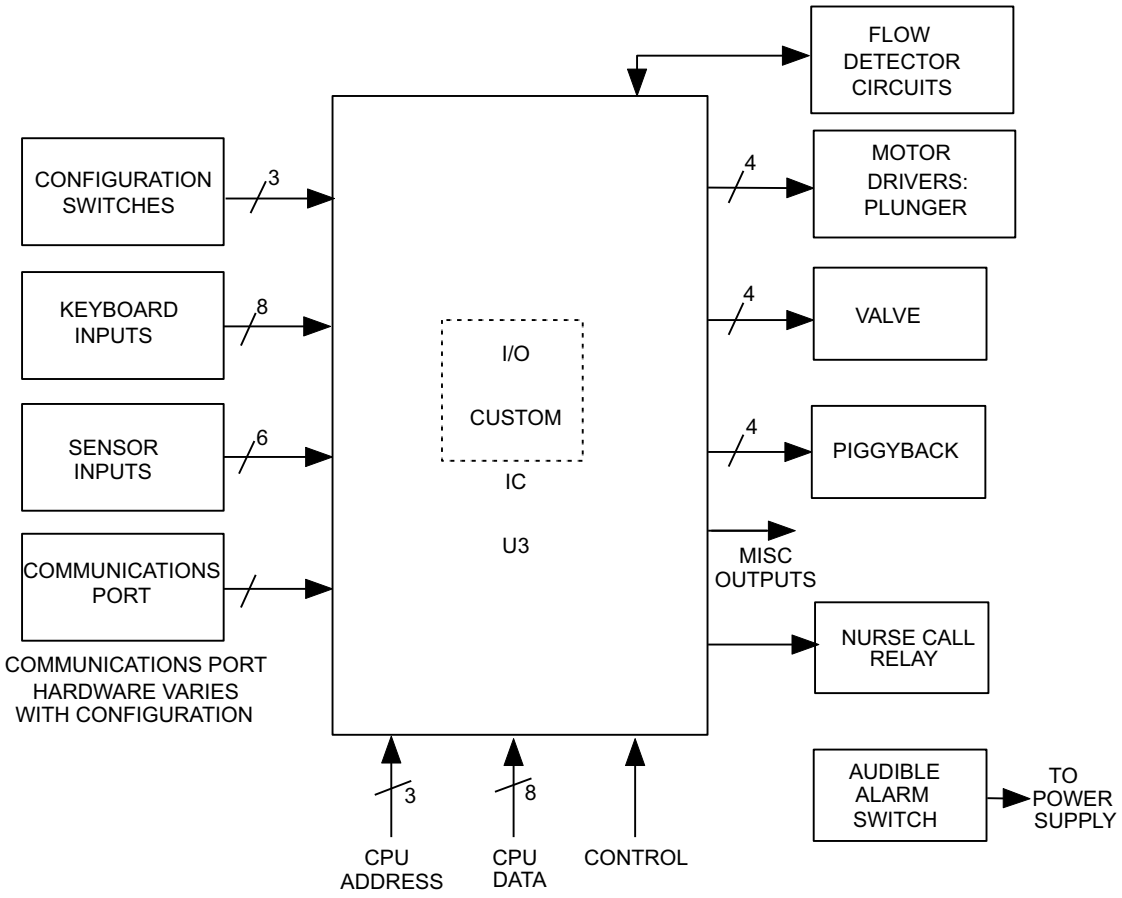


Figure 4-4. I/O PWA with DataPort Option Functional Block Diagram

4.8.2.1
CUSTOM I/O IC

U3 is a custom CMOS IC that provides I/O expansion for the MPU. Addresses from 1030(16) through 1033(16) are decoded into output latches or input buffers in this IC.

The custom I/O IC contains the following circuitry:

- Bus interface
- Hardware watchdog
- Reset and power control logic
- Sensor interface
- Touchswitch interface
- Motor control latches
- Communication port interface

The hardware watchdog monitors the software integrity by posting a message to the CPU and then waiting for the CPU to respond. If the CPU fails to respond intelligently, a system reset occurs.

During run-time, the CPU monitors the watchdog clock input (6303, pin 9, P21) and matches it with the watchdog bit (6303, pin 8, P29) when the watchdog clock changes its state from high to low. The CPU generates the matching bit within 27 ms after transition has occurred. The matching pattern consists of 8 bits, as 10110100(2) after power up reset.

The watchdog circuit triggers the system reset within 81 ms after power up if the CPU fails to match the watchdog pattern.

4.8.2.2
MOTOR DRIVERS

N-channel metal oxide semiconductor field-effect transistor (MOSFET) Q1 through MOSFET Q12, along with resistor network (RN) 2 through RN4, comprise the driver circuits for the plunger motor, valve motor, and primary/secondary motor. When turned on, these transistors sink current from the stepper motor windings. Gate drive for these transistors is provided by the outputs M1D0 through M3D3, through the resistor networks. Only one set of transistors is installed in any board. the two sets of holes allow a choice of transistor packages.

4.8.2.3
NURSE CALL RELAY CONTROL

Operation of nurse-call relay K1 is controlled by Q15 and Q16. Q15 is turned on under processor control during any alarm condition. Q16 is turned off by the soft switch (SOFTSW) line during the power-on self test to prevent unwanted relay activation.

JP3 is a jumper that selects NO or NC operation of the nurse call circuit. JP3 is configured at the factory for NO operation. J23 is the back panel connector for the nurse call system.

4.8.2.4
DELIVERY MODE SELECTION

Switch (SW)2 is a DIP switch used to set infusion system delivery modes. For DIP switch configurations, see *Section 1-10* and *Figure 1-2*.

4.8.2.5
DATAPORT OPTION

The DataPort is a computer interface port similar to an RS-232 port, with significant changes: a hardware address is provided for each infusion system, and the receive (RX) line is modified to allow multiple infusion systems on a single channel.

The DataPort circuitry on the I/O PWA performs the following three functions:

1. The DataPort power supply circuit generates 10 V from the +5 V supply. The IC, U6, (MAX680) is a power supply converter, with capacitors C18, C19, C21 and C22 converting the +5 V to the 10 V. Capacitor C20 decouples the 5 V line.

2. The driver/receiver circuit inverts signals from CMOS levels to EIA standard RS-232-D levels, and from RS-232-D levels to CMOS levels, respectively. The driver IC, U5, (LT1039) enables RX line when transmit enable (TXEN) is high, and permits data transmission. When TXEN is low, the U5 driver is in a high impedance (HI-Z) state. The receiver portion of IC U5 is turned on at all times. The receiver input impedance is 30K Ω. (When 15 devices are on line, line impedance is lowered to 2K Ω, which is high enough to be driven by the host computer.)

3. The clear-to-send (CTS) circuit raises the line high when it is connected to the communication bus and the infusion system is turned on. Diode CR7 creates an OR signal with the rest of the infusion systems on the line. Transistors Q17, Q18, and resistors R17 and R18 provide a current limit circuit.

4.8.2.6
FLOW DETECTOR

The flow detector circuit consists of a switchable LED driver (R5, R6, and Q13) and load/sensing circuitry (R3, R4, C1, CR1, and CR2) for the phototransistors in the flow sensor.

DROPFB is an input to the A/D converter on the main PWA.

See *Section 4.8.8* for a complete description of the flow detector.

4.8.2.7
MISCELLANEOUS I/O CIRCUITRY

Analog switches U4A and U4B select the scaled ADCBAT or the VREF 2.5 as inputs to the A/D converter on the main PWA. VREF 2.5 is tested during power up. At all other times, the A/C channel is used to measure the battery state of charge.

4.8.3
POWER SUPPLY PWA

The power supply PWA converts AC voltage to DC voltage and provides power control circuitry for AC (mains) power or battery operation of the infusion system *(see Figure 4-5)*.

The power supply PWA circuitry includes the following:

- Unregulated DC power supply
- AC (mains) line and battery power indication
- Power control
- +5 VDC supply
- VMEM supply
- Motor power supply
- Overvoltage protection
- Audible alarm backup
- Audible alarm control
- Audible alarm self test
- Battery pack charging
- Battery voltage detection

4.8.3.1
UNREGULATED DC POWER SUPPLY

The unregulated DC power supply is composed of the power transformer T1, in conjunction with the rectifier and filter. The AC (mains) power voltage is supplied to T1 through the power cord and fuses F1 and F2, located on the back panel. The secondary of T1 is center-tapped for full wave rectifying by diodes CR7 and CR8. Under no-load conditions, the T1 secondary delivers 22 VAC root-mean-square (RMS). Capacitor C11 filters ripple voltage that appears between +RDC and -RDC.

4.8.3.2
AC (MAINS) LINE AND BATTERY POWER INDICATION

Operating the infusion system on battery power causes the green LED (AC power indicator on the display PWA) to deactivate and the red LED (battery power indicator) to activate.

The line/battery indicator circuit consists of Q17, CR11, and resistors RN10 (1,2), R21, and R23.

The BPLEDA signal at P4, pin 37, sources current to the battery power LED indicator anode on the display PWA through the parallel combination of resistor network RN10 [1,2] and resistor R21.

When operating on AC (mains) power, Q17 is turned on and shunts current around the red LED through diode CR11 to turn off the battery power LED indicator. The +RDC supply sources current through resistor R23 and LPLEDA at P4, pin 38, to the anode of the AC (mains) power green LED; the cathode of this LED returns to -RDC through P4, pin 40.

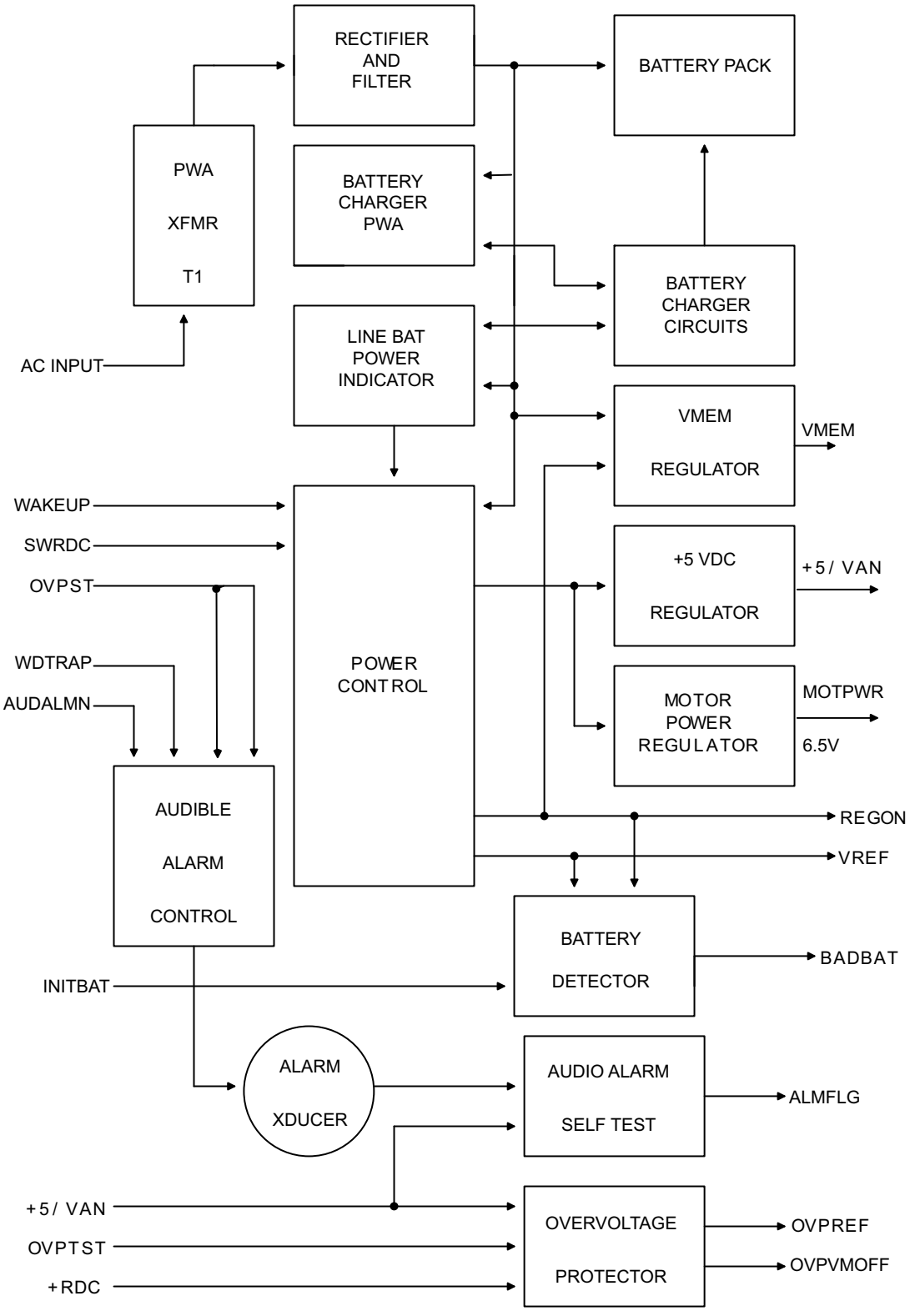


Figure 4-5. Power Supply PWA Functional Block Diagram

4.8.3.3
POWER CONTROL

When the infusion system is on, the cassette switch on the sensor PWA is actuated, causing SWRDC at P4, pin 1, to go high. When SWRDC goes high, a positive pulse is placed on the base of Q9, through C19 and resistor networks RN7 (1,2) and RN10 (4,5). The base of Q18 is pulled low by Q9. the Q18 collector brings the REGON line (P4, pin 32) high.

The REGON line enables both the +5 VDC and motor regulators. REGON is also used as a RAM enable signal (U6, pin 1) on the main PWA. After the processor is started, the WAKEUP line is held high, which holds REGON high, for as long as the infusion system is in operation.

If the battery is completely discharged, the BADBAT signal causes the custom IC on the main PWA to bring WAKEUP low, which causes the infusion system to go into shutdown.

CR12 prevents the base of Q9 from being driven below ground.

4.8.3.4
+5 VDC SUPPLY CONTROL

For the +5 VDC power supply, reference diode U2 adjusts precisely to +2.5 VDC through potentiometer R2, and connects to the noninverting input at U3-A, through R10 and RN7 (9,10). U2 also sets the +2.5 VDC reference for the +6.5 VDC motor power regular power supply. U2 receives power from REGON.

The voltage divider, consisting of RN4 (6,7) and RN4 (5,6), feeds back one half of the +5/VAN output to the inverting input of U3. This input is amplified to drive the base of Q10.

If the +5/VAN output is too low, U3A output (pin 1) goes higher, providing more base drive to Q10. Q10 then draws more base current from series pass transistor Q13, raising the output voltage.

U3-B operates as a voltage comparator to limit current. The dividers, consisting of RN4 (8,9) RN4 (9,10), and RN4 (9,11), provide a +135 mV reference to the inverting input of U3-B. Should the load return current through R6 exceed 1.35 A, the output of U3-B goes high to turn on Q7 through R11. The collector of Q7 clamps the noninverting input of U3-B to ground, removes the +2.5 VDC reference, and disables the +5/VAN supply.

4.8.3.5
VMEM SUPPLY CONTROL

The VMEM supply (P4, pin 19) is the +2.3 VDC memory backup supply for RAM U5 on the main PWA. When the infusion system is on, REGON is high and turns on Q14 through RN8 (1,8). Q14 supplies the VMEM line with +5 VDC. Schottky diode CR17 blocks this +5 VDC from the +2.5 VDC reference produced by the voltage comparator U6.

When the infusion system is off, the REGON line goes low to turn off Q14. +RDC is regulated to 2.5 V by U6 and RN9 (5,6) that flows through CR17 to become VMEM.

4.8.3.6
MOTOR POWER SUPPLY CONTROL

The +6.5 VDC motor supply is regulated similarly to the +5 VDC supply. U2 supplies +2.5 VDC to the noninverting input of U3C. The dividers, consisting of RN3 (3,4), RN3 (4,5), and R9, apply a fraction of the MOTPWR voltage to the inverting input of U3-C. When the MOTPWR line is +6.5 VDC, U3-C provides the necessary reference voltage as shown in the following equation: (0.385) X (6.5) = 2.5.

Any variance from the +2.5 VDC reference is continuously corrected as U3-C varies the current through transistor Q6 through Q4.

U3-D operates as a voltage comparator to limit current. The dividers, consisting of RN3 (8,9), RN3 (9,10), and RN3 (9,11) source a 293 mV reference to the inverting input of U3D. Should the motor return current through R4 exceed 2.93 A, U3-D output goes high to turn on transistor Q12. The collector of Q12 clamps the noninverting input of U3-D to ground, removes the +2.5 VDC reference, and disables the +6.5 VDC motor supply.

The VMOFF line at P4, pin 4, is a control signal from the I/O PWA. Operating under software control, a logic high at P4, pin 4, turns on transistor Q12 and disables the +6.5 VDC motor supply, the same as the current limit.

> **Note:** The motor supply can also be disabled by the OVPVMOFF signal from the overvoltage protector through transistor Q12.

4.8.3.7
OVERVOLTAGE PROTECTION

A faulty +5 VDC power supply can damage the MPU on the main PWA. When a +5 VDC supply malfunction occurs, the pumping mechanism motors cease operation.

Pumping ceases as follows:

Operational amplifier U5-B senses the +5/VAN supply line through the divider, consisting of RN9 (8,9) and RN9 (7,9). These resistors divide the +5/VAN level by a factor of 0.452 for comparison with the +2.5 VDC reference from U6.

Should the +5/VAN level exceed +5.5 VDC, (e.g., +2.5 VDC divided by 0.452), the output of U5-B goes high to activate the OVPVMOFF line through CR16 and RN9 (3,4), shutting off the +6.5 VDC motor supply. The OVPALM signal from U5-B output also triggers the audible alarm, indicating an overvoltage situation.

Signals OVPREF (P4, pin 16) and OVPTST (P4, pin 13) are available for monitoring and testing by the I/O PWA.

4.8.3.8
AUDIBLE ALARM BACKUP

Capacitor C3 serves as a temporary audible alarm backup power source. Should the supply voltage drop to zero due to a complete battery discharge, or should a catastrophic failure of logic circuitry occur during on status, the capacitor C3 automatically provides backup power for several minutes to enable the audible alarm.

Capacitor C3 is charged from the +5 VDC supply through diode CR5. Diodes CR3 and CR4 isolate the charged capacitor unless the cassette switch SW1 is activated.

4.8.3.9

AUDIBLE ALARM CONTROL

The audible alarm is a self contained piezoelectric crystal and oscillator circuit that emits sound when a DC voltage is applied.

The alarm can be triggered by the following signals:

- AUDALM line from the I/O PWA custom IC (under processor control
- OVPALM signal from the over-voltage protect circuit
- WDTRAP signal from the I/O PWA custom IC
- Absence of -5 V supply from the main PWA

Positive voltage for the beeper is supplied by SWRDC, through RN10 (6,7). The level of drive current is set by the volume switch (S1 on the I/O PWA) that switches additional resistance, as necessary. In the high position, the total resistance is 200 Ω (RN10 (6,7)). In the medium position, S1 is open and the resistance is 2500 Ω (RN10 (6,7) + RN10 (7,8) + R30). In the low position, the beeper is shunted by 480 Ω (R31 + RN 10 (9,10)).

AUDALMN is the normal means for the processor to sound an alarm. AUDALMN goes low, turning off Q3, which allows Q2 to be turned on. Q2 provides a current path to ground from the beeper.

OVPALM goes high if the over-voltage protection circuit trips; this turns Q1 on, providing a current path.

WDTRAP is wire-ORed with the OVPALM signal.

If the 5 V supply goes to zero due to a flat-battery shutdown or circuit failure, the -5 V supply also goes to zero. This allows enhancement-mode field-effect transistor (FET) Q19 to turn on, providing a path from SWRDC through RN10 (6,7) to the beeper.

4.8.3.10

AUDIBLE ALARM SELF TEST

Audible alarm operation is tested by comparator U5, transistor Q11, and associated passive components. A low on alarm flag (ALMFLG)* (P4, pin 7) informs the MPU of proper alarm operation.

The audible alarm self test is performed by bringing OVPTST (P4, pin 13) high, and turning on transistor Q21, which turns off transistor Q5. This controlling action removes the shunt across the piezoelectric alarm during a low volume setting of SW1.

With sufficient piezoelectric alarm output, the AC voltage produced by the piezoelectric alarm transducer is verified. The AC frequencies above 1.5 kHz are extracted by the high-pass filter consisting of capacitors C1, C2, resistor R7, and resistor network RN1 (9,10). Such signals are applied to the noninverting input of U5-C with diode CR1 clamping the negative excursion to -0.7 VDC. A reference of +0.1 VDC is provided by resistor networks RN5 (5,6) and RN5 (6,7) at the inverting input of U5-C. If the output is greater than the reference, the output of U5-C goes high to turn on Q11. The ALMFLG line (P4, pin 7) is clamped low by Q11 to indicate normal piezoelectric alarm operation.

4.8.3.11

BATTERY PACK CHARGING

A battery charger PWA is installed and connected to the power supply PWA. The interface consists of nine wires that connect the battery charger PWA through P/J1 and P/J2 to the power supply PWA *(see Figure 4-2)*. The nine wires connect to the battery charger circuitry on the power supply PWA.

The battery charger circuit consists of the following components:

- Transistors Q8, Q15, Q16, and Q20
- Diodes CR6, CR9, CR26, and CR27
- Reference U1
- Operational amplifiers U4-A and U4-B
- Associated passive components

Since battery terminal voltage is a function of both state of charge and temperature, the end-of-charge reference voltage is temperature compensated. A trickle charge current is also supplied to maintain the battery between normal charge and discharge cycles. The positive battery terminal J18, pin 1, is the common line (+RDC) for the charger, the battery, and the raw DC supply. The inverting input of comparator U4-A is supplied with -2.32 VDC reference relative to +RDC. This reference derives from U1 through resistors R26 and R29, and potentiometer R28, with diodes CR26 and CR27, to lower the charging voltage -4 mVDC per degree centigrade.

The battery terminal voltage is sensed through diode CR6 and the divider network, consisting of resistors RN2 (1,2) and RN2 (2,3). The noninverting input of U4-A recognizes [-VBATT - 0.5(CR6 Vf)]/4.2 = 2.3 V relative to +RDC when the battery is fully charged. CR6 disables the charger during battery operation. Current sources Q15, Q16, and RN6 (1,2) keep the forward drop of CR6 constant. The U4-A output is high when VBATT is less than +9.2 VDC (+2.3 VDC per cell), turning on FET transistor Q20 through resistor network RN2 (8,9). Charging current flows through the diode CR10 and the 0.1 ohm sensing resistor R18 to -RDC.

The current loop uses IC U4-B to compare the voltage drop across sensing resistor R18 to approximately 0.1 V from the divider network, which consists of resistor networks RN5 (1,2), RN6 (2,3), RN6 (3,4), and resistor R8. Should the load current exceed (0.1 V/0.1 ohm) = 1 A, U4-7 goes high, turning on transistor Q8 through RN6 (6,7). Q8 clamps the non-inverting input of U4-A to -RDC to send U4-1 low, turning off transistor Q20. The charger is protected against excessive load current.

When the battery pack is supplying power, the battery return current path of transistor Q20 is through the source to the drain. Resistor networks RN2 (7,8) and RN2 (8,9) forward bias the gate of transistor Q20 with respect to its drain, causing the FET to operate in the inverted mode.

4.8.3.12
BATTERY VOLTAGE DETECTION

The sealed battery may be damaged if it is drained to less than approximately +1.6 VDC per cell (a four cell battery pack equals +6.5 VDC). The battery detector circuit detects this state of discharge, terminates battery operation, and sounds an alarm. The battery detector consists of U5-A, diodes CR13 through 15, and associated passive components.

The REGON line equals the battery voltage minus the approximate +0.6 VDC drop across the source to drain of transistor Q20 and the collector to emitter drop of Q18. This voltage is divided by the resistor networks RN8 (1,2), RN8 (2,3), RN8 (3,4) and RN8 (4,5), to yield (0.388)(REGON) = (0.388)(6.50-0.6) = +2.5 VDC, at the inverting input of U5-A, when the battery is discharged. U5-A compares this to the +2.5 VDC reference at its noninverting input, so that its output goes high, signaling a discharged battery. This activates BADBAT (P4, pin 17), setting a latch on the custom I/O chip, which returns a low WAKEUP signal to the power control circuit, disabling both the +5 VDC (logic) and +6.5 VDC (motor) supplies.

CR13 clamps the inverting input of U5-A to +5.5 VDC with a fully charged battery. CR15 clamps the BADBAT line to +5.5 VDC, to be compatible with logic levels on the I/O PWA. R22 supplies a positive input bias for the inverting input of U3-A.

When the infusion system is turned on, INITBAT (P4, pin 30) is set high for approximately 50 ms by the resistor R14, capacitor C14, and the custom I/O chip on the I/O PWA. The signal charges C20 through CR14 to avoid a false bad battery indication before REGON is able to charge capacitor C20 through resistor network RN8 (1,2). INITBAT goes low and remains low during infusion system operation.

4.8.4
BATTERY CHARGER PWA

The battery charger PWA contains the following circuitry *(see Figure 4-6)*:

- Differential amplifier (U3) and 20 mA shutoff circuitry
- Transistor (Q8)
- Window comparator with hysteresis (U1)
- 60 minute battery charger timer (U2)
- 200 mA constant current source (transistors Q6 and Q7) and associated logic (transistors Q3, Q4, Q5, Q9)
- AC (mains) detector (transistor Q1)

The battery charger PWA functions during infusion system AC (mains) power and battery power operation, as described in the following sections.

4.8.4.1

AC (MAINS) OPERATION

Voltage detector U1, with associated capacitors and resistors, functions as a window comparator with hysteresis. When the battery is initially connected, the output of U1 is at logic high. After the battery voltage reaches 10 VDC, this output goes low, disabling transistors Q3 and Q4 and triggering the timer, U2. The clock frequency of timer U2 is determined by C5 and R9; time-out is pending the biasing of the U2 program inputs A, B, C, and D. Upon time-out, the DECODE signal on output pin 13 of U2 goes high. This disables Q5, since Q4 is already disabled, removing the supply to Q9 and causing battery charging to stop. The DECODE signal also locks in the timer, U2, preventing operation by placing a logic high on the SET input, pin 1, of U2.

The AC/DC detector consists of transistor Q1 and associated resistors. When the infusion system operates on AC (mains) power, the collector of Q1 is at logic low, enabling the timer U2 and transistors Q2 and Q9. During DC operation, the -RDC signal goes positive, and the collector of Q1 goes logic high. Current is limited to 200 mA by the quotient of the VBE of transistor Q6 divided by R14. Transistor Q7 acts as a power switch that is enabled and disabled by transistor Q9. Q7 functions in parallel with Q20 in the battery charging circuitry of the power supply PWA.

IC U3-B acts as a noninverting amplifier with a gain of 51. Current is sensed across resistor R18 in the battery charging circuitry of the power supply PWA. When current drops below approximately 20 mA, the output of U3-B, pin 7 (which is also the input to comparator U3-A, pin 2) is at 100 mV or below. Pin 3 of U3-A is referenced at 100 mV from the battery charger circuitry on the power supply PWA. At this point, U3-A switches to a logic high and turns on transistor Q8. Q8 shorts the gain network to the voltage regulator on the battery charger circuitry in the power supply PWA. Resistor R19 and capacitor C6 act as a noise filter to Q8.

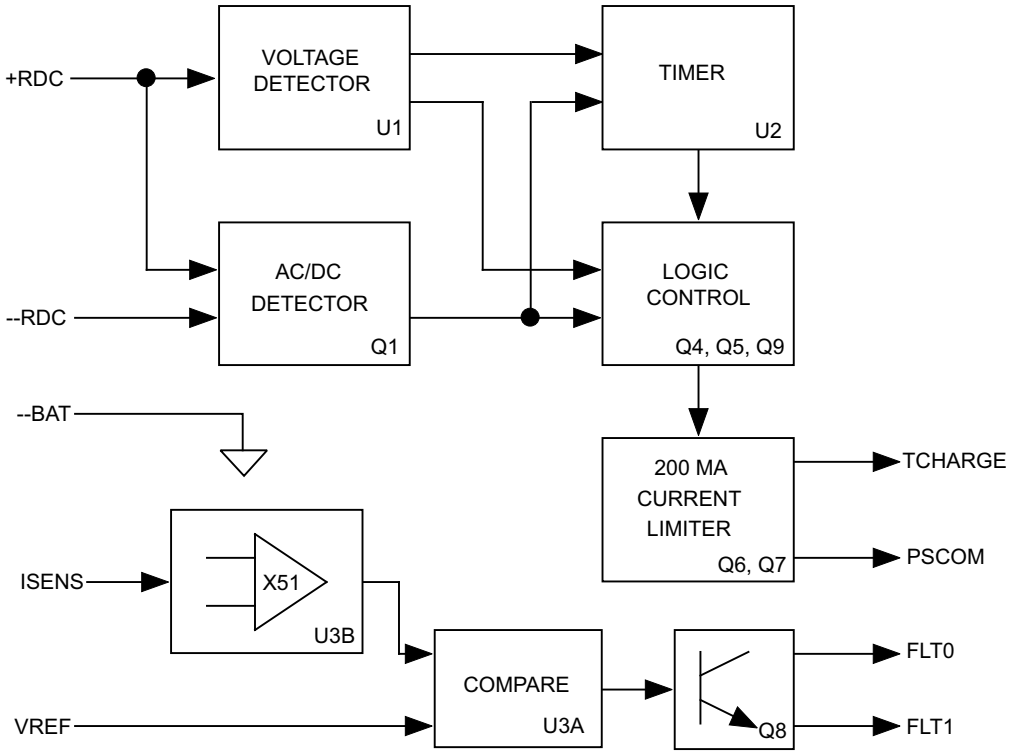


Figure 4-6. Battery Charger PWA Functional Block Diagram

4.8.4.2
DC OPERATION

When the infusion system operates on battery power and the battery pack drains to approximately 8 VDC, pin 4 of the voltage detector U1 switches to logic high. This resets the timer U2, enabling transistors Q3, Q4, and Q5. Transistor Q9 remains disabled because Q1 is disabled. Transistor Q2 discharges capacitor C6 through diode CR2 and resistor R22 into PSCOM, which becomes circuit ground.

4.8.5
SENSOR PWA

The sensor PWA supplies the following functions *(see Figure 4-7)*:

- Cassette installation recognition
- Air-in-line detection in the cassette sensing areas
- Pressure amplification for proximal and distal strain gauges
- Optical interrupters to sense the state of the pumping mechanism

4.8.5.1
CASSETTE INSTALLATION RECOGNITION

S1 is activated when the infusion system door is closed with a cassette installed. This raises the voltage on SWRDC (J6, pin 18) line to the level of RAWDC (J6, pin 20). RAWDC varies from minimum of +6.4 VDC (when operating from a low battery) to approximately +15 VDC (when operating from AC (mains) line voltage). SWRDC enables the main power regulator to start the infusion system from the off status. SWRDC is an input to the custom IC on the main PWA, signaling the processor that a cassette is installed in the receptacle of the door.

Transistors Q5 and Q6, with associated passive components, allow the processor to bypass switch S1. Bypass condition occurs when the door is opened without first pressing the [RESET] touchswitch (S1 is shunted to allow the audible alarm to sound). Bypass also occurs when the processor is performing power up self testing (S1 is shunted to prevent loss of +5 VDC power during the watchdog test).

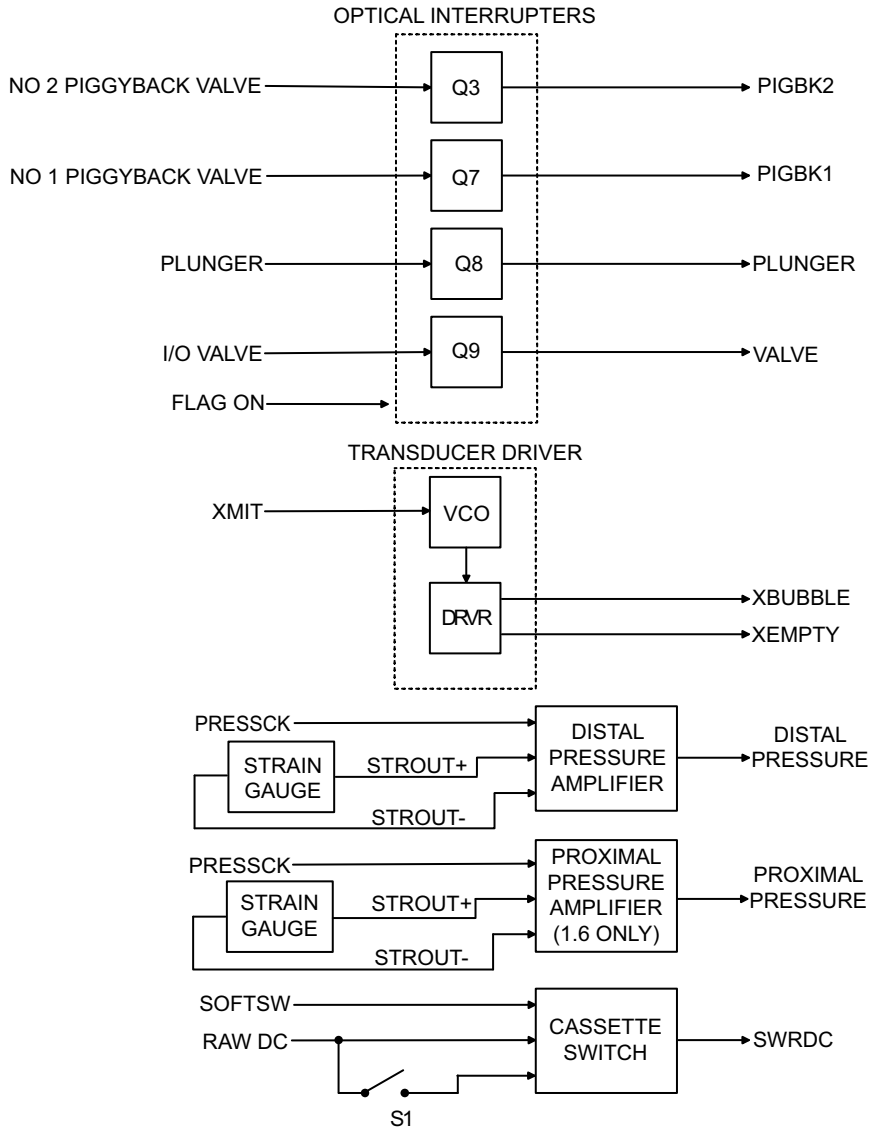


Figure 4-7. Sensor PWA Functional Block Diagram

4.8.5.2
AIR-IN-LINE DETECTION IN CASSETTE

Air may be detected in the cassette where fluid enters the cassette (proximal) and where fluid exits the cassette (distal).

The air-detection mechanism is similar in both locations. The presence of air in the sensing area of the cassette interrupts the signal paths of the ultrasonic piezoelectric transducer pairs (driven by circuitry on the sensor PWA).

The voltage-controlled oscillator (VCO) section of the 74HCT4046 (U1) phase-locked loop integrated circuit, and a single FET (Q1), drive both transmitting transducers through the XEMPTY (J20, pin 5) line. A 5 kHz triangle wave oscillator, formed by operational amplifier U3-B and an exclusive OR (XOR) gate inside U1, sweeps the VCO output at U1-4 between 4.5 Mhz and 6.5 Mhz to assure that this output passes through the resonant frequency of the transducers.

Sweeping the VCO output is accomplished as follows: the XOR U1-B works as an inverting buffer, charging C14 through R16 until the negative input of U3-B reaches the positive level established by the divider resistors R17 and R18. R2, along with this divider, provides +0.9 VDC of switching hysteresis for U3-B. When its negative input reaches the positive level, U3-7 and U1-2 (the XOR buffer output) go low to discharge C14 through R16 and start another charging cycle. The resulting input to VCO (U1-9) is a triangular waveform of amplitude +0.9 VDC centered at +2.5 VDC.

When the MPU enables the bubble detection system, the VCO center frequency is set by a circuitry network consisting of C7 and R1. U1-5 is then pulled low by the XMIT (J6-13) line from the I/O PWA. A high on this line shuts off the VCO and holds U1-4 high. The output is coupled through capacitor C5 and resistor R5 to the gate of driver FET Q1. R4 and CR1 prevent false turn-on of Q1 by discharging C6, when U1, pin 4 is held high or when the tank circuit (consisting of L1 and C4) rings. Ringing of the L1 and C4 tank circuit allows peak voltages of more than twice the +5 VDC supply developed at the XEMPTY (J20, pin 1) output.

4.8.5.3
PRESSURE AMPLIFICATION

Pressure sensing is accomplished with a four element strain gauge bridge, that is bonded to a steel leaf spring. Element resistance is 350 Ω and the bridge is excited by the +5 VDC supply. When pressure within the cassette causes the spring to be deflected by force, the voltage across the bridge output arms varies by a nominal 735 microvolts (µV) per psi (107 µV per kPa).

The bridge output is linked to the chopper-stabilized amplifier U4, which has a low and temperature-independent offset voltage. Resistor R19 sets the gain on U4-10 at 350. In combination with C10, R19 rolls off this gain at frequencies above 10 Hz for noise suppression; this yields a sensitivity of 260 mV/psi (38 mV/kPa) at U4-10, which is attenuated by a nominal factor of 0.6 through resistor R14 and resistor network RN3 (7,8). Amplifier U3-A further amplifies and filters this output with a DC gain of 1.5, set by resistor networks RN1 (7,8) and RN3 (8,9). The resulting sensitivity at test point (TP) 1 is 195 millivolts (mV)/psi (28 mV/kPa).

The system gain adjustment by R14 allows correction for gauge-to-gauge sensitivity variation. Resistor R15 is adjusted to balance the bridge offset, with R13 setting the range of adjustment. The bridge is balanced for an output of 1.400 V at TP1 using a cassette with zero pressure. The A/D converter on the main PWA reads the pressure (J6, pin 4) output signal. Proximal pressure sensing is performed by a system similar to that described above. The proximal strain gauge is extended by increasing proximal pressure so that the sense of the gauge outputs must be reversed. The mechanical sensitivity of the proximal pressure system is approximately half that of the distal sensor, so that the resulting pressure signal (at TP4) is about 110 mV/psi (16 mV/kPa). The offset is different for the proximal sensor; at 0 psi (kPa), the voltage at TP4 is approximately 2 V.

4.8.5.4
OPTICAL INTERRUPTERS

Transistors Q3, Q7, Q8, and Q9 act as optical interrupters, sensing the position of the three stepper motors that actuate the valves and the plunger. Attached to each motor shaft is an opaque flag. The flag breaks the light path of the interrupter at specific motor positions. Transistor Q4 sinks the load current of the interrupters when the FLAGON (J6, pin 2) enabling signal is applied to its gate through the I/O PWA.

4.8.6
BUBBLE SENSOR PWA

The bubble sensor PWA contains circuitry for the preamplifier (transducer preamplifier and piezoelectric transducer transmit/receive channels) as well as circuitry for the amplitude modulator (AM) and threshold detectors *(see Figure 4-8)*.

The two sensor bulbs in the cassette fluid path are shown in *Figure 4-1* and *Figure 4-9*. With a cassette installed and the door closed, these sensors are straddled by the transducer pairs. The presence of fluid permits passage of an ultrasonic sound wave (approximately 5 Mhz) from the transmit crystal to the receive crystal (X1 for empty and X2 for bubble). This ultrasonic coupling is prevented by the presence of air in the path. Either the absence of a cassette or the presence of air in the cassette is detected through the loss of a signal at the receive crystal. With the exception of the threshold-detection reference level, bubble sensing is identical for proximal and distal lines. The following sections describe only the X1 channel.

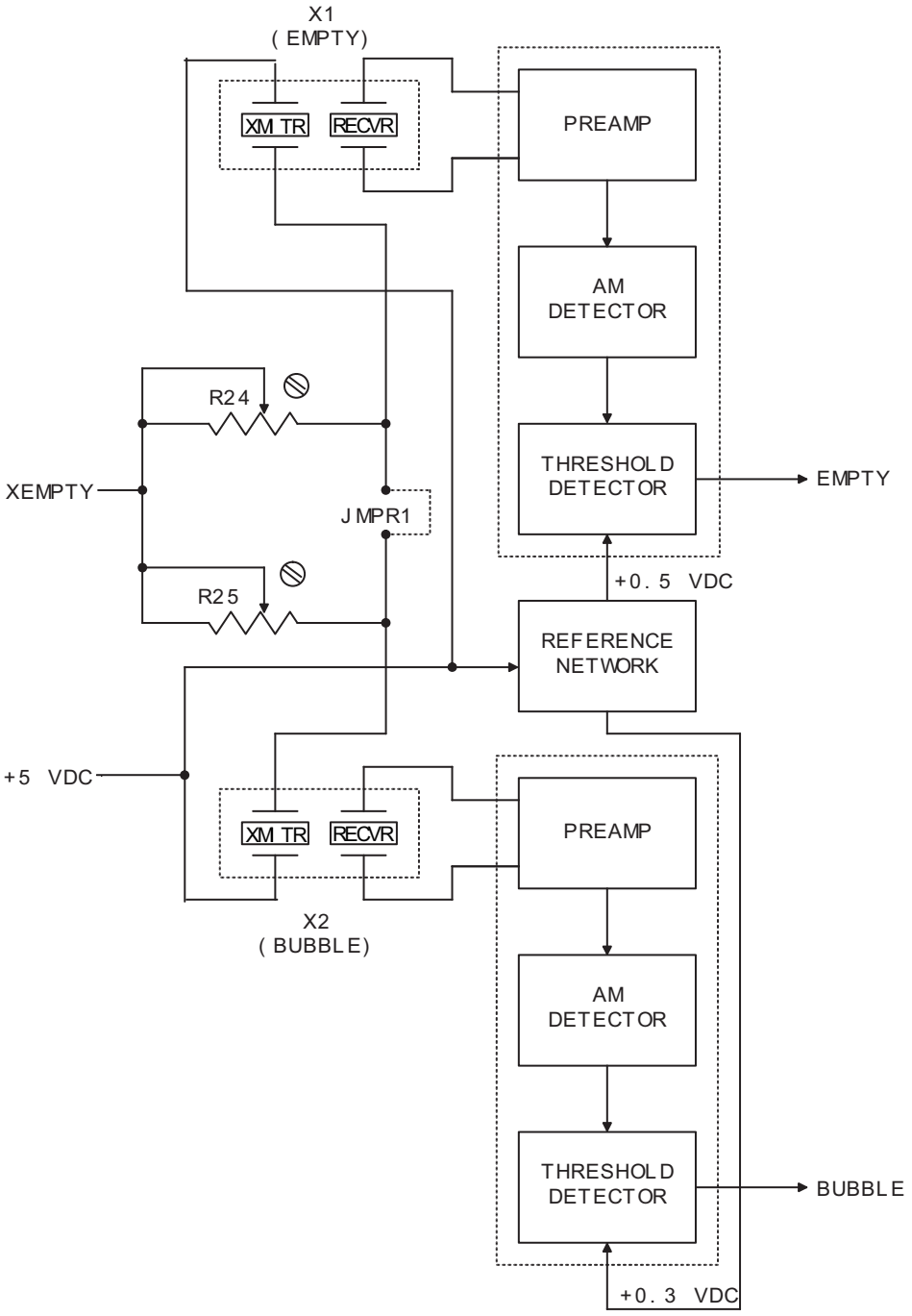


Figure 4-8. Bubble Sensor PWA Functional Block Diagram

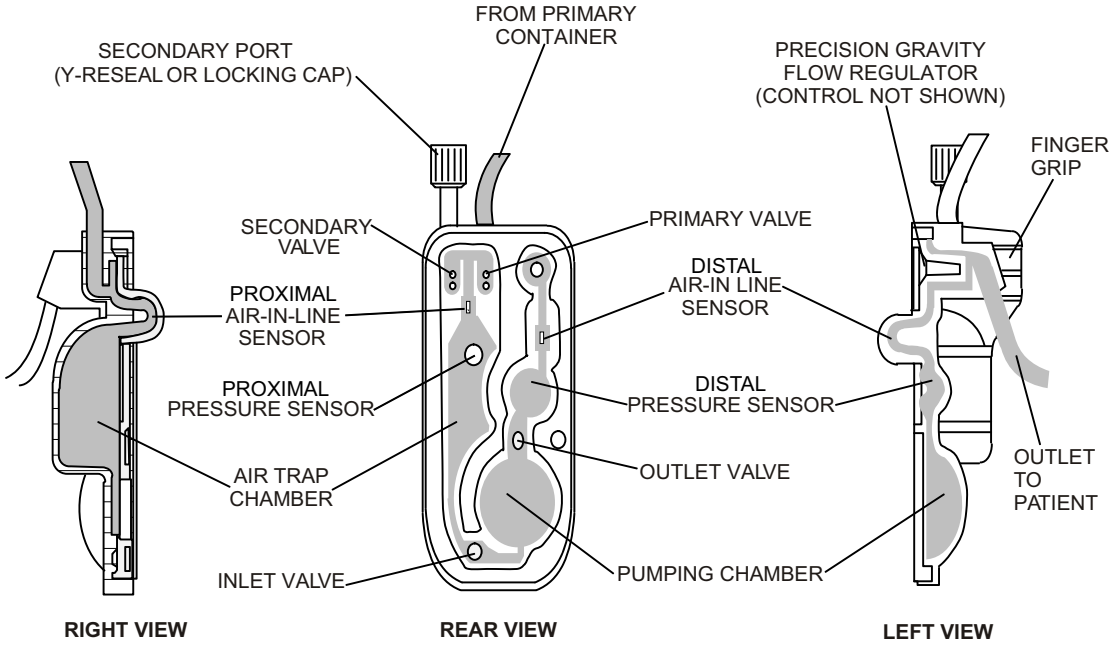


Figure 4-9. Major Elements of the Dual Channel Cassette

4.8.6.1
PREAMPLIFIER

Potentiometer R24 sets the power level driving the empty X1 crystal, allowing correction for variations in transducer pair sensitivity. A swept radio frequency (RF) signal (J21, pin 1) from the sensor PWA excites the crystal at its resonant frequency for maximum ultrasonic output.

The receive crystal is coupled to the common emitter amplifier Q4. Resistors R18, R22, and R23 bias the collector of Q4 at approximately +2.6 VDC, for maximum linear swing. Resistors R14, R19, and the emitter resistance of Q4 set the gain to approximately -22.

4.8.6.2
AM AND THRESHOLD DETECTORS

The RF output of the preamplifier is amplitude modulated by the fluid or air in the ultrasonic path. This signal must be converted to a DC level to permit threshold detection. Resistors R13 and R15 bias transistor Q2 on the edge of conduction, rectifying the output of Q4 with only a small voltage drop. The 4.7 ms time constant of resistor R9 and capacitor C4 hold the peak DC level between RF sweeps for the threshold detector input. Resistors R24 and R25 are adjusted to give +1.5 VDC in both the proximal and distal channels using an installed water-filled cassette. The comparator U1-A compares the DC level from transistor Q2 to a +0.5 VDC reference, to signal the presence of air by sending the EMPTY (J21, pin 5) line high. If fluid is present, the input of U1-A is higher than the reference, and the output is low. Resistors R1 and R2 provide about 20 mV of switching hysteresis for noise immunity. The EMPTY (J21, pin 5) and BUBBLE (J21, pin 6) lines are routed through the sensor PWA to the I/O PWA. Resistors R3, R6, and R7 provide the threshold reference network for both the proximal and the distal channels. The empty reference is +0.5 VDC and the bubble level reference is +0.3 VDC.

4.8.7
LED DISPLAY PWA

The LED display PWA consists of character LEDs and drivers, a current sensing amplifier, and analog multiplexer *(see Figure 4-10)*.

Character LEDS and drivers include segment and character control, display drivers, five seven-segment common cathode LEDS, and AC, battery, and decimal point LEDs.

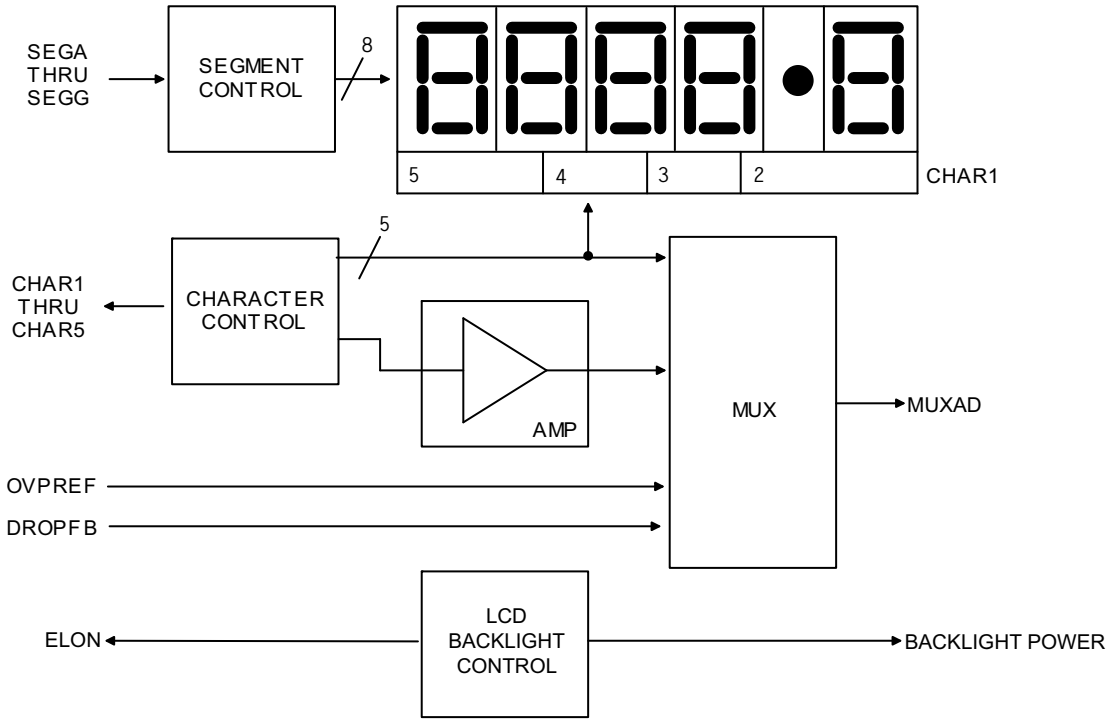


Figure 4-10. LED Display PWA Functional Block Diagram

4.8.7.1
CHARACTER LEDS AND DRIVERS

The LED characters U1 through U5 are driven by transistor arrays U7, U8, and U9. Digit drivers are multiplexed through U9, with the MPU refreshing a new digit every three ms. A custom IC on the main PWA provides the segment drive signals (SEGDA through SEGDP, P1, pins 1 through 8) and character drive signals (CHAR1 through CHAR5, P1, pins 12 through 16).

When SEGDA through SEGDP goes low, U7 and U8 source current through the resistor networks RN1 and RN2 to energize the segments of the active character LED. The active character is selected by the CHAR1 through CHAR5 line that is low, sinking the segment currents through one of the transistors in U9.

LED 1 and LED 2 are driven by the power supply PWA through LPLEDA (P1, pin 23) and BPLEDA (P1, pin 24) to indicate AC (mains) line or battery power.

4.8.7.2
CURRENT SENSING AMPLIFIER

Total display current flows to ground through the 1 ohm, current-sensing resistor R3. The operational amplifier U6-A is configured as an amplifier with a noninverting gain of 11, through resistor networks RN3 (7,8) and RN3 (8,9) with input dividers RN3 (4,5) and RN3 (5,6) giving 10 times the voltage drop across R3. The output of U6-A is a 10 mV/mA representation of the current flowing through the active LED character.

4.8.7.3
ANALOG MULTIPLEXER

The collector voltages of U9 and the current sense amplifier output comprise six out of the eight inputs to multiplexer U10. The remaining inputs are the flow monitor circuit, and the OVPREF (P1, pin 22) line from the power supply PWA.

The multiplex signals MUX0 through MUX2 (P1, pins 9 through 11), are outputs from the custom IC on the main PWA. Output MUXAD (P1, pin 20) is delivered to the A/D converter on the main PWA, allowing the display devices to be tested when the infusion system is turned on.

Module T1 is a 90 V power supply that generates drive voltage for the LCD screen module backlight. T1 is energized when the ELON line from the main PWA is high.

4.8.8
FLOW DETECTOR PWA

The flow detector contains a photo emitter PWA and a photo sensor PWA *(see Figure 4-11)*. Flow detector diodes DS1 and DS2 on the photo emitter PWA emit narrow beams of infrared light toward the phototransistors on the photo sensor PWA. The resulting currents are summed at the sensor output and represent the total infrared energy incident on the transistors Q1, Q2, and Q3. When a drop falls through the infrared beam, the amount of light incident on the transistors is reduced, resulting in a corresponding reduction in output current, which forms the drop signal.

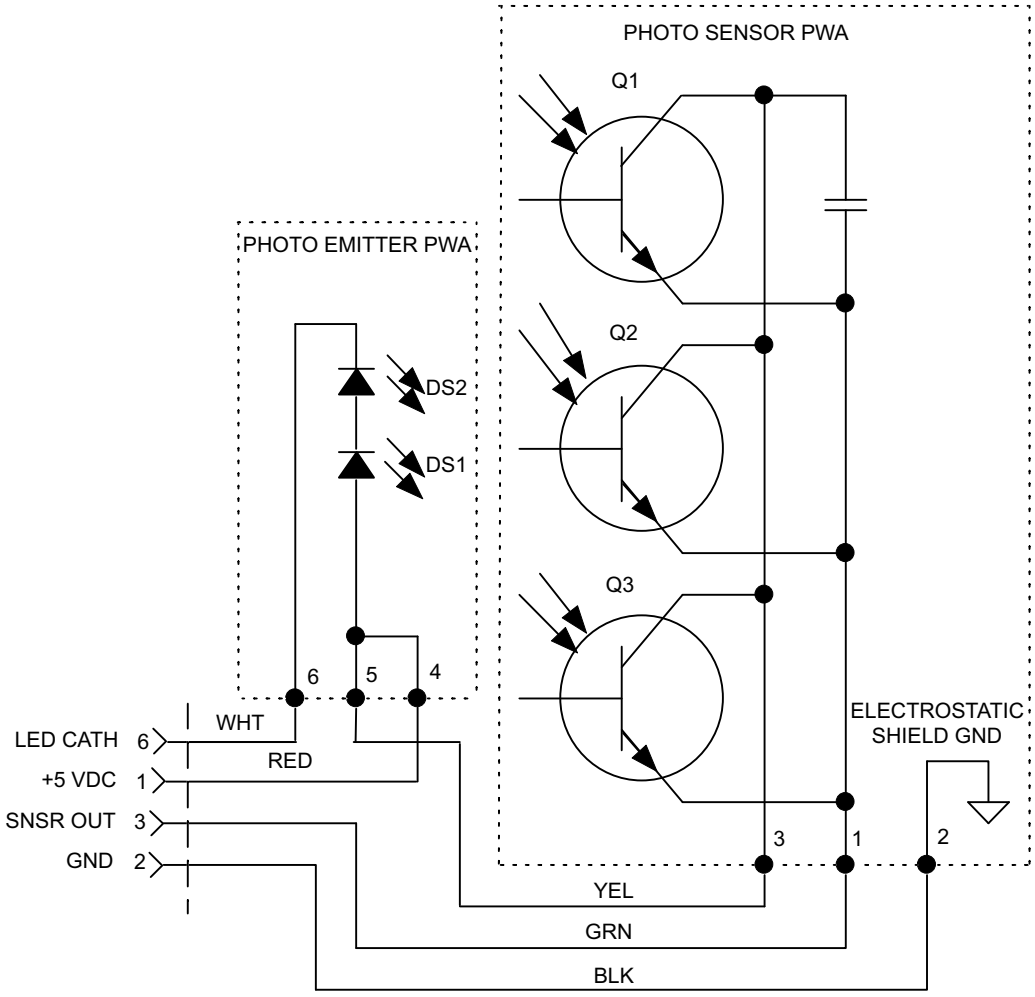


Figure 4-11. Flow Detector PWAs Schematic Diagram

4.8.9
LCD ASSEMBLY

The LCD assembly is mounted directly behind the LCD window on the infusion system front panel. The LCD assembly provides a 4-line-by-16-character display for alarm and status messages. Since the LCD display PWA is an integrated module, no functional block diagram or schematic is furnished.

The LCD assembly module consists of the 4-line-by-16-character dot matrix display, an electroluminescent backlight panel, and a PWA containing SMD-integrated circuitry that performs display interfacing and drive functions. Support circuits on the main PWA and the display PWA provide contrast control and backlight power, respectively.

Characters are written to and read back from the LCD through line display data (DSPD)0 through DSPD7. LCDRS and LCDWR provide read and write control, respectively. The read capability allows the system to confirm that data latches in the LCD module are functioning correctly.

4.8.10
JUNCTION BOX ASSEMBLY (DATAPORT OPTION)

The junction box assembly permits interconnection and communication between a host computer and up to 15 DataPort-equipped infusion systems on one channel *(see Figure 4-12)*.

The junction box PWA consists of the following circuitry:

- The main communication lines entering the junction box are TX, communication (COMM), RX, and CTS. Signals are routed through six-pin modular jacks J1 and J2 and the DB-15 connector P22 in the junction box.
- Connectors J1 and J2 are identical and interchangeable. Connector P22 interfaces with J22 on the I/0 PWA on the back of the infusion system.
- Diodes CR1 through CR6 are low-capacity, unidirectional transient voltage suppressors, two of which perform a bidirectional protection function. The diodes protect the TX, RX, and CTS signal lines, relative to the COMM signal, from static discharge. A maximum voltage of 23.6 V is allowed on the transient suppressors before they conduct. The driver/receiver IC, U5, located on the I/O PWA, tolerates 30 V without sustaining damage.
- When properly configured, the DIP switch SW1 assigns a hard ID to each infusion system. Poles 1 through 4 assign the binary code, and pole 5 is the parity function. The hard ID circuit is isolated from the COMM lines through digital ground (DGND).

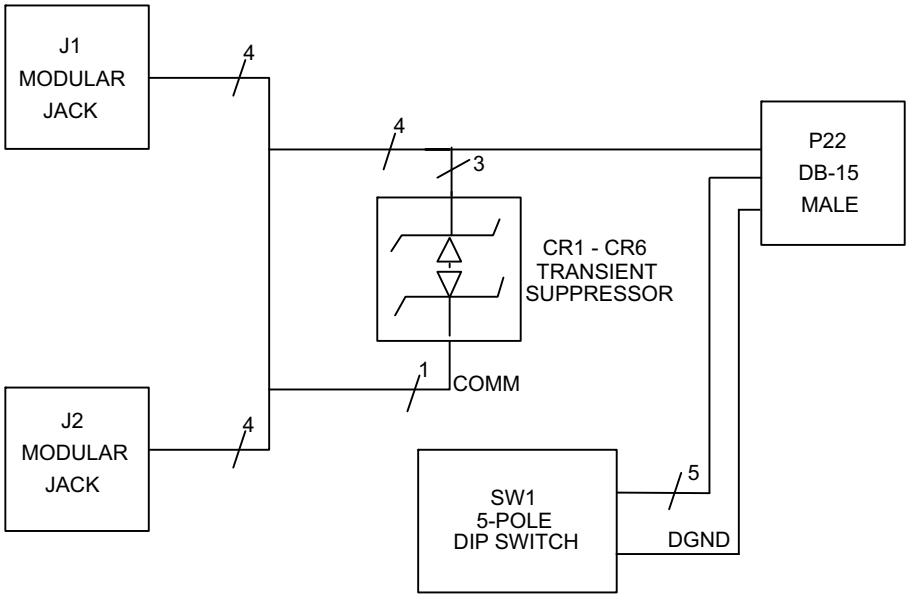


Figure 4-12. Junction Box PWA Functional Block Diagram

4.9 MECHANICAL FUNCTIONAL DESCRIPTION

Principal mechanical elements of the infusion system include the cassette, three-motor pumping mechanism, cassette sensor switch, fluid sensors, regulator, and interconnect/ interface electronics.

The following sections detail the cassette and the pumping mechanism. When a cassette is properly installed, the infuser performs a 15 second self test to verify the integrity of internal systems. The properly-installed cassette and closed door activate the cassette sensor switch that applies power to the infusion system.

4.9.1 CASSETTE

The infusion system cassette operates on a fluid displacement principle to deliver fluid volumetrically *(see Figure 4-1)*. See the *System Operating Manual* for a description of the major cassette functions.

The pumping cycle begins when the outlet valve is opened and the diaphragm is deflected by the plunger expelling the fluid. At the end of the pumping stroke, the outlet valve is closed, the inlet opens, and the plunger retracts, allowing fluid to refill the pumping chamber. After the pumping chamber is filled, the inlet and outlet valves are reversed and the cycle repeats.

Air detection operates as follows: The cassette contains two chambers separated by an inlet valve. The upper chamber is an air trap that receives fluid from the IV container through either the primary or secondary valve. The upper chamber collects air bubbles from the IV line and container, and prevents them from entering the pumping chamber. The air-trap chamber can collect a substantial amount of air before the cassette needs to be reprimed. The MPU tracks the amount of air collected in the air-trap chamber. If the limit is reached, it calls for a backprime.

A proximal air-in-line sensor (bubble detector), located between the primary valves and the air trap, detects air entering the air trap. A proximal air-in-line alarm sounds when a predetermined amount of air is detected. Similarly, a second air-in-line sensor (bubble detector), located distal to the pumping chamber, initiates an alarm if a predetermined amount of air is detected. The distal air-in-line sensor prevents air from reaching the patient.

A pressure sensor located distal to the pumping chamber monitors pressure on the distal side of the cassette. A proximal pressure sensor located above the air trap also monitors proximal pressure.

A flow regulator is incorporated in the cassette distal end. This flow regulator can be used to control flow manually when the cassette is not inserted in the pump.

When the cassette is properly inserted and the door is closed, a mechanism opens the regulator to allow flow to be controlled by the pump. When the door is opened, the same mechanism closes the regulator, assuring there is no flow to the patient.

The pumping chamber receives fluid from the air-trap chamber through the inlet valve. When the diaphragm covering the pumping chamber is deflected by the plunger, the pumping chamber expels fluid through the outlet valve.

4.9.2
MECHANISM ASSEMBLY

When a cassette is properly installed and the door is closed, the mechanism assembly turns the cassette **[ON/OFF]** switch on that activates the plunger. The motors are phased and matched for proper operation *(see Figure 4-13)*.

During the pumping cycle, the plunger motor drives a nut coupled to a lead screw. The motor action and screw move the plunger forward, delivering 0.33 mL of fluid per cycle (0.17 mL for concurrent). The plunger motion synchronizes with the valve motor action to provide controlled fluid delivery.

The mechanism assembly is a self-contained assembly that consists of motors and valves, cassette door subassembly, bubble sensor PWA, and sensor PWA. Motors and valves include the primary/secondary valve subassembly, inlet/outlet valve subassembly, and plunger drive subassembly.

4.9.2.1
MOTORS AND VALVES

Pumping action of the mechanism is controlled by three stepper motors. One motor and associated valve assembly activates either the primary or the secondary valves of the cassette, depending on command input. The second motor opens or closes the inlet or outlet valves to control fluid delivery into the cassette chamber. A third motor moves the plunger, which causes a pumping action that increases pressure to the cassette fluid pumping chamber.

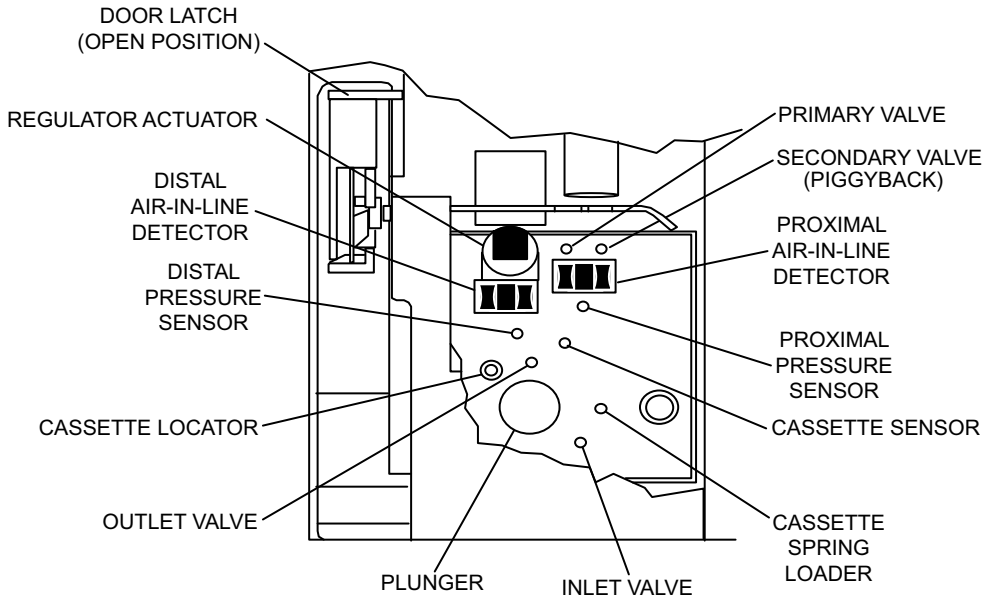


Figure 4-13. Elements of the Mechanism Assembly

4.9.2.2
CASSETTE DOOR SUBASSEMBLY

The cassette door subassembly consists of the door handle subassembly and the cassette door holder subassembly. The cassette door holder subassembly is activated by lifting the door handle, which opens the cassette door holder. The open cassette door holder permits the installation of a cassette. A mechanism in the mechanism assembly opens the regulator to allow controlled flow through the cassette. When the door is opened, the regulator closes to prevent flow to the patient.

4.9.2.3
PRIMARY/SECONDARY VALVE ASSEMBLY

> **Note:** The inlet/outlet valve assembly is similar in design, but opposite in function to the primary/secondary valve assembly. Because the assemblies are similar, only the primary/secondary valve assembly description follows.

The primary/secondary valve assembly consists of a stepper motor with attached ball bearing, flag, two levers, and associated valve pins. The motor is designed to rotate an eccentrically mounted ball bearing. When positioned at top dead center (home position), this bearing can rotate 12 steps (90 degrees) left or right. Rotation causes one valve to open and the other to close. Rotation clockwise from the home position opens the primary valve and closes the secondary valve.

The flag passes through an interrupter module as it rotates with the shaft of the motor.

The lever is the connecting link between the eccentrically mounted ball bearing and the valve pin. The lever also serves as an actuator device in the event of a broken main valve loading spring. If the spring should break, a small-diameter spring mounted to the bottom of each lever acts as a safety spring. The safety spring positions the primary lever in the interrupter module, causing infusion system shutdown and activating alarm code 79 *(see Table 6-1)*.

To determine home position when the infusion system turns on, a pin on the motor eccentric (combination of shaft, bearing, and cam), comes in contact with a finger attached to the motor plate.

4.9.2.4

PLUNGER DRIVE ASSEMBLY

The plunger drive assembly consists of the following components:

- Stepper motor
- Thrust ball bearing
- Coupling assembly
- Lead screw
- Plunger and plunger guide leaf spring

The stepper motor is designed to rotate one and two-thirds revolutions per cycle. Each rotation of the motor displaces 0.333 mL of fluid. The motor reverses, the plunger returns to home position, and the cycle repeats for the duration of fluid administration.

The thrust ball bearing rests against the motor mounting base. As the cassette displaces fluid, the resulting load is absorbed axially by the bearing.

The coupling assembly provides the mechanical linkage for a fixed dead-center location of the plunger by holding the plunger in true position. A plastic nut is retained within the coupling assembly, and moves freely on its axis regardless of any misalignment between the motor and plunger. A wave washer applies a constant spring load against the nut, confirming the plunger's fixed location, and allows the nut to move freely in any angular direction. The coupling assembly also contains a flag that passes through an interrupter module, determining the plunger home position. The flag, passing through the interrupter module, also determines the number of pumping steps.

Each time the infusion system turns on, the motor automatically reverses until home position is determined. From home position, the pumping cycle starts. As the motor rotates, the flag passes twice through the interrupter module, the motor stops momentarily, returns to the home position, and repeats the pumping cycle.

The lead screw converts motor rotation into linear pumping motion. The lead screw is contained on one end by a nut, and on the other end by a plunger guide leaf spring. The plunger guide leaf spring and the plunger act as a single unit that cannot be separated. The plunger guide leaf spring operates in conjunction with the coupling assembly, so the plunger moves freely in a linear direction.

This page intentionally left blank.

Section 5

MAINTENANCE AND SERVICE TESTS

A complete maintenance program promotes infusion system longevity and trouble-free operation. Such a program should include routine maintenance, periodic maintenance inspection, and the Performance Verification Test.

5.1 ROUTINE MAINTENANCE

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

5.1.1 CLEANING AND SANITIZING

Follow the cleaning and sanitizing guidelines in this section. Observe hospital protocol for establishing the infuser cleaning schedule.

Before cleaning, turn off the infuser and disconnect from AC power.

Clean the exposed surfaces of the infuser with a soft, lint-free cloth moistened with one of the cleaning solutions recommended in *Table 5-1*, or with a mild solution of soapy water. Remove soap residue with clear water. Use a small, non-abrasive brush to aid in cleaning the infuser housing and subsystem chassis components.

To thoroughly clean the cassette receptacle, disengage the cassette door from the door latch by pressing the door release tab *(see Figure 5-1)*.

Clean the flow detector with a soft cloth dampened with an approved cleaning solution or soapy water.

Carefully clean the sensor windows with a cotton swab. After cleaning, thoroughly dry the windows. Use cotton swabs to clean the pins.

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

CAUTION: To avoid mechanical or electronic damage, do not immerse the infuser in fluids or cleaning solutions. Do not spray cleaning solutions toward any openings in the device or directly on the device.

CAUTION: Use only recommended cleaning solutions and follow manufacturers' recommendations. Using cleaning solutions not recommended by Hospira may result in product damage. Do not use compounds containing combinations of isopropyl alcohol and dimethyl benzyl ammonium chloride.

CAUTION: Never use sharp objects such as fingernails, paper clips, or needles, to clean any part of the infuser. Use only soft cloths or sponges. Do not sterilize by heat, steam, ethylene oxide (ETO), or radiation.

Note: Disinfecting properties of cleaning solutions vary, and not all cleaning solutions are sanitizers. Check product labeling or consult the manufacturer for specific information.

Table 5-1. Cleaning Solutions

Cleaning Solution	Manufacturer	Preparation
Dispatch® Hospital Cleaner Disinfectant with Bleach	Caltech Industries	Per manufacturer's recommendation
Formula C™	JohnsonDiversey	Per manufacturer's recommendation
Precise® Hospital Foam Cleaner Disinfectant	Caltech Industries	Per manufacturer's recommendation
Sporicidin®	Sporicidin	Per manufacturer's recommendation
Household Bleach	Various	Use per hospital procedures Do not exceed one part bleach in ten parts water

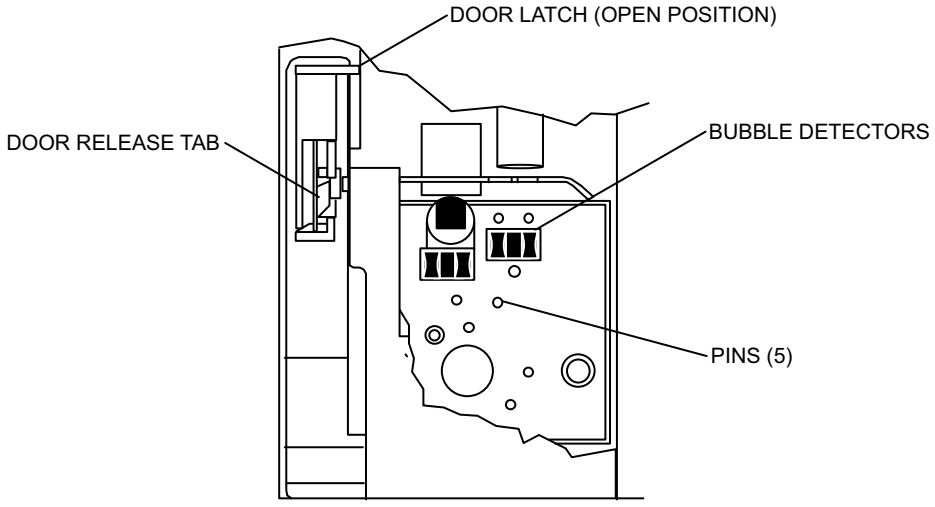


Figure 5-1. Mechanical Elements Behind the Cassette Door

5.2 PERFORMANCE VERIFICATION TEST

The Performance Verification Test (PVT) is designed to assure the infusion system is operating properly, and can also be used for diagnostic purposes during troubleshooting. The PVT should be used for performance verification before an infuser is placed back in service after repair.

The PVT consists of the tests described in the following sections. Conduct all tests with the infusion system connected to AC power unless otherwise specified. Perform the PVT exactly as described in this manual to assure effective and reliable product evaluation information.

If any malfunction is detected as a result of the PVT, see *Table 6-3* for troubleshooting.

5.2.1 EQUIPMENT AND MATERIALS REQUIRED

The PVT requires the following equipment and materials (or equivalents):

- Safety analyzer
- Digital pressure meter (DPM)
- Blunt cannula or 21-gauge needle
- Nurse call test cable (P/N 561-88416-001), with 1/4 inch phone jack and banana plug
- Three-way stopcock, latex-free
- Optional reflux valve (P/N 711-38272-001)
- 470 ohm/100 microfarad, resistor/capacitor parallel network (P/N 561-88419-001)
- Digital multimeter (DMM)
- Two containers of sterile water or tap water
- Primary macro set with matching secondary macro set
- Graduated cylinder, 25 mL, with 0.2 mL graduations (Class A)
- No. 2 Phillips screwdriver
- Set of nutdrivers
- Stopwatch
- Gauge dial indicator, 2 ea.
- Recirculating set, with proximal sensor bulb tips removed from cassette, and marked EMPTY on the cassette
- Recirculating set, with distal sensor bulb tips removed from cassette, and marked AIR on the cassette
- Compatible computer, to perform the PVT on infusers with DataPort
- DataPort-to-PC cable
- Bubble sensor location fixture (P/N 561-81402-001)
- Bubble sensor location calibration block (P/N 561-81402-006)

  The bubble sensor location fixture and calibration block are required only when performing the bubble sensor location test.

5.2.2
INSPECTION

Inspect the infusion system periodically for signs of defects such as worn accessories, broken connections, or damaged cables. In addition, inspect the infusion system after repair or during cleaning. Replace any damaged or defective external parts.

Inspect the following for missing or damaged parts and for cosmetic defects:

- All cords, plugs, and cables
- Case
- Pole clamp and pad
- All switches
- Accessory jacks
- Faceplate
- Pressure pads (feet)
- Velcro® strap
- Minipole and clutch
- Door assembly (open and unlatch door; check valve pins and air sensor behind door)
- Valve pins move freely in the guide holes
- Flow detector (as applicable)
- Junction box (as applicable)

5.2.3
STARTUP TEST

WARNING: DO NOT CONNECT A PATIENT TO THE INFUSION SYSTEM DURING DEVICE TESTING.

The startup test is conducted with the infusion system in the **MACRO SECONDARY MODE** (dual channel, single dose). When the infuser is in this mode, the screen displays: **LIFECARE 5000 DUAL CHANNEL**.

Before starting the PVT, note the configuration of the DIP switches and place the infusion system in the **MACRO SECONDARY MODE**. See *Section 1.10* and *Figure 1-2* for DIP switch settings for the desired mode. At the conclusion of the PVT, reset DIP switches to the previous settings.

Note: If testing in **MACRO SECONDARY MODE**, the maximum delivery rate is 99.9 mL/hr.

Note: For all testing, the vertical distance from the top of the fluid in the flexible container to midline of the cassette must be 18 ± 6 inches (46 ± 15 cm) as shown in *Figure 5-3*.

To perform the startup test, proceed as follows:

1. Insert the primed IV set, with a 21-gauge needle attached to the distal line end, into the door. Close the door and verify the red battery power symbol illuminates.
2. Connect the infusion system to an AC (mains) outlet and verify the green AC (mains) power symbol illuminates.

   Note: Complete the remainder of the PVT with the infuser connected to AC (mains) power, except as specified.

3. To verify that all touchswitches emit one short tone or flutter, press each touchswitch in the following sequence:

   [START]

   [RESET]

   [REVIEW/CHANGE]

   [SILENCE/NO]

   [▼]

   [▲]

   [YES/ENTER]

   [CLEAR]

4. Press all touchswitches again except **[START]** and **[CLEAR]** in the same sequence described in Step 3. Verify that no tones sound, then press **[CLEAR]** and listen for flutter.
5. Press all touchswitches again as described in Step 3, and listen for tone or flutter.
6. **Optional:** Open and close the door, and observe that all LEDs and the LED decimal point illuminate immediately. When the **SELF TEST:OK** prompt appears, press **[REVIEW]** to view software revision. Press **[REVIEW]** again to view alarm history.)

5.2.4
BUBBLE SENSOR LOCATION TEST

To perform the bubble sensor location test, proceed as follows:

1. Standardize the gauge of the bubble sensor location fixture as follows:
   - Place the calibration block (boss end) of the bubble sensor location fixture over each contact pin, holding the block flush to the base of fixture.
   - Check the gauge dial indicators for 0 reading on outer scale and 1 inner revolution indicator *(see Figure 5-2)*. Adjust the bezel to 0 as necessary by loosening the bezel clamp. Tighten the clamp after the adjustment is made.
2. After standardizing the fixture, insert the bubble sensor location fixture into the cassette door and close the door.
3. Verify that both dial indicators read 1 revolution ± 0.010.
4. Open the cassette door and remove the fixture.

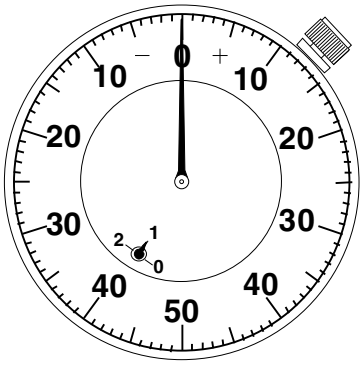


Figure 5-2. Gauge Dial Indicator

5.2.5
NURSE CALL TEST

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 cable to the infuser, then proceed as follows:

1. Set primary delivery rate to 400 mL/hr and primary dose limit to 1 mL.
2. Connect the DMM to the nurse call cable.
3. Press **[START]** and verify pumping action.
4. **DOSE END** and **KVO** appear on the screen. Observe a short circuit on the DMM (approximately 1 Ω on 0 to 100 Ω scale).

5.2.6
EMPTY CONTAINER TEST

To perform the empty container test, proceed as follows:

1. Insert the special cassette marked **EMPTY**, with the proximal bubble sensor bulb tips removed, then close the door *(see Figure 5-3* and *Figure 5-4)*.
2. Set **RATE** to 400 mL/hr and press **[ENTER]**.
3. Set **DOSE LIMIT** to 10 mL and press **[ENTER]**.
4. Press **[NO]** in response to **SET SECONDARY**.
5. Press **[START]**, confirm that pumping occurs, and verify an alarm sounds. Within 30 seconds, confirm the **STOPPED AIR IN PROXIMAL LINE PRESS RESET** message appears.
6. Open the door and remove the cassette.

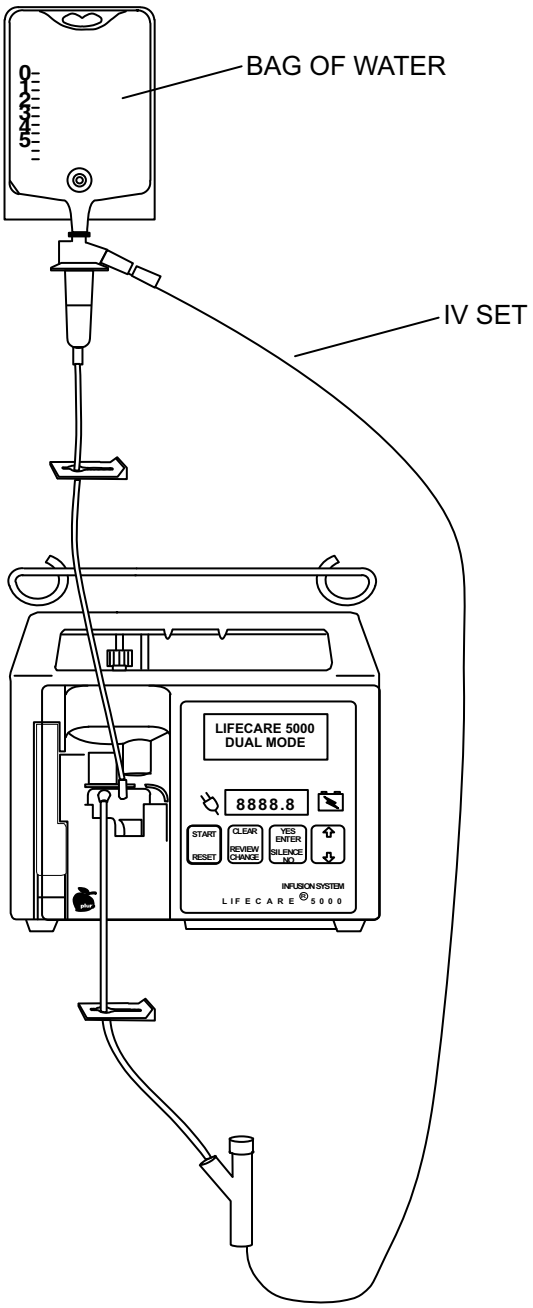


Figure 5-3. Recirculating Set Test Setup

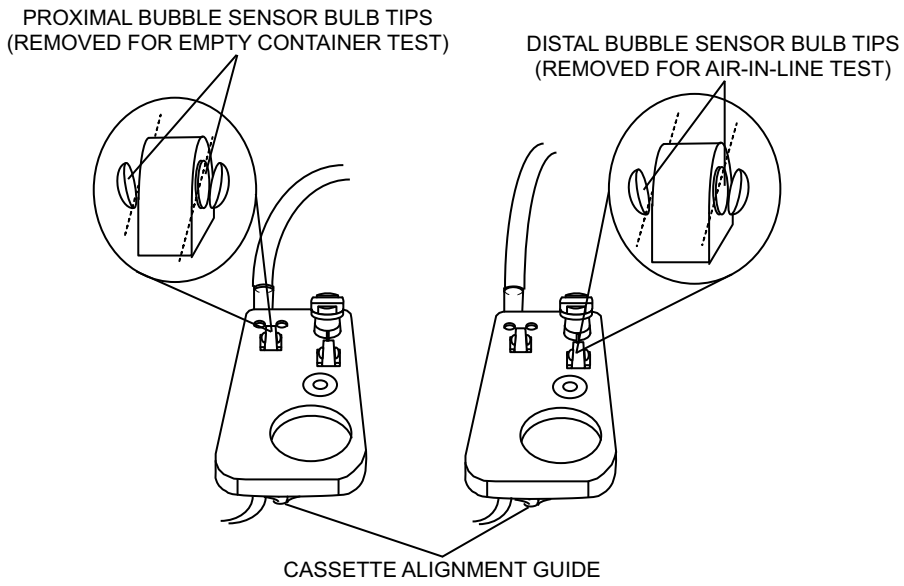


Figure 5-4. Cassettes with Bubble Sensor Tips Removed

5.2.7
AIR-IN-LINE TEST

To perform the air-in-line test, see *Figure 5-3* and *Figure 5-4*, and proceed as follows:

1. Insert the recirculating set with cassette marked **AIR**, and with distal bubble sensor bulb tips removed.
2. Close the cassette door and press **[YES]** in response to **SAVE SETTINGS**.
3. Press **[YES]** in response to **FINISH PRIMARY DOSE**, then press **[START]**. Confirm an alarm sounds.
4. Verify the **STOPPED AIR IN DISTAL LINE PRESS RESET** message appears within 30 seconds.
5. Press **[RESET]**, and open and close the door.
6. Press **[NO]** in response to **SAVE SETTINGS**.
7. Press **[NO]** in response to **RETAIN VOLUME**.

5.2.8
CONCURRENT DELIVERY TEST

To perform the concurrent delivery test, proceed as follows:

1. Set the following operating parameters:
   - Primary delivery rate at 400 mL/hr
   - Primary dose limit at 100 mL
   - Press **[YES]** in response to **SET SECONDARY**
   - Press **[YES]** in response to **SET CONCURRENT DELIVERY**
   - Secondary delivery rate at 200 mL/hr
   - Secondary dose limit at 50 mL
2. Press **[START]** and verify the screen displays **PUMPING-CONCURRENT**.
3. Verify that pumping occurs alarm-free for one minute.

5.2.9
DELIVERY ACCURACY TESTING

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 system accuracy, return the device to Hospira.

5.2.9.1
DELIVERY ACCURACY TEST (MACRO)

To perform the delivery accuracy test in macro secondary mode, proceed as follows:

1. Insert the needle or adapter of a primed secondary set into the cassette secondary inlet.
2. Confirm the infuser DIP switches are set for **MACRO SECONDARY MODE** (dual channel, single dose), as described in *Section 5.2.3*.
3. Set the following operating parameters:
   - Primary delivery rate at 400 mL/hr
   - Primary dose limit at 10 mL
   - Press **[YES]** in response to **SET SECONDARY**
   - Press **[NO]** in response to **CONCURRENT DELIVERY**
   - Secondary delivery rate at 400 mL/hr
   - Secondary dose limit at 10 mL
4. Press **[YES]** in response to **CALL BACK AT SECONDARY DOSE END**.
5. Press **[NO]** in response to **CONTINUE SECONDARY AT DOSE END**.
6. Press **[NO]** in response to **DELIVER SECONDARY OVERFILL**.
7. Place a distal cannula or needle into a graduated cylinder and press **[START]**.
8. If a flow detector is used, attach it to the primary drip chamber and connect the cable to the port on the back of the infuser. Verify pumping action.

9. At the end of secondary, the **SEC DOSE END PUMPING PRIMARY PRESS SILENCE** message appears.
10. Press **[SILENCE]**. Press **[NO]** in response to **REPEAT SECONDARY**.
11. If testing the flow detector, verify infuser operation is alarm-free during primary delivery.
12. After **DOSE END** and **KVO** appear on the screen, a flashing **1** appears and an alarm sounds. Press **[RESET]**.
13. To observe total volume, press **[YES]** in response to **REPEAT PRIMARY**.
14. Press **[CLEAR]**, and observe total volume of 20 mL.
15. Press **[YES]** to clear. The volume in the graduated cylinder should be 20 mL ± 1 mL.

Note: If the infuser fails to deliver properly, reprime the cassette and repeat the test. If the infuser again fails to deliver properly, contact Hospira.

5.2.9.2

DELIVERY ACCURACY TEST (MICRO)

Note: This test need only be performed if the DIP switches were set to **MICRO SECONDARY MODE** on the device when it was received.

To perform the delivery accuracy test in micro secondary mode, proceed as follows:

1. Insert the needle or adapter of a primed secondary set into the cassette secondary inlet.
2. Set the infuser DIP switches to **MICRO SECONDARY MODE** (dual channel, single dose), as described in *Section 5.2.3*.
3. Set the following operating parameters:
   - Primary delivery rate at 99.9 mL/hr
   - Primary dose limit at 10 mL
   - Press **[YES]** in response to **SET SECONDARY**
   - Press **[NO]** in response to **CONCURRENT DELIVERY**
   - Secondary delivery rate at 99.9 mL/hr
   - Secondary dose limit a 10 mL
4. Press **[NO]** in response to **SECONDARY OVERFILL**.
5. Place a distal cannula or needle into a graduated cylinder and press **[START]**.
6. Verify pumping action.
7. After **DOSE END** and **KVO** appear on the screen, a flashing **1** appears and an alarm sounds. Press **[RESET]**.
8. To observe total volume, press **[YES]** in response to **REPEAT PRIMARY**.
9. Press **[CLEAR]** and observe total volume of 20 mL.
10. Press **[YES]** to clear. The volume in the graduated cylinder should be between 19 and 21 mL.

11. Disconnect the infusion system from AC (mains) power.
12. Open the door and start the stopwatch. If the battery symbol remains illuminated for more than 10 seconds, memory reserve is functional.
13. Reconnect the infusion system to AC (mains) power, and close the door.
14. At end of the self test, clear all operating parameters by pressing **[SILENCE/NO]** and **[YES/ENTER]**.
15. Set the infuser DIP switches to **MACRO SECONDARY MODE** (dual channel, single dose) as described in *Section 5.2.3*.

Note: If the infuser fails to deliver properly, reprime the cassette and repeat the test. If the infuser again fails to deliver properly, contact Hospira.

5.2.10 PRESSURE SENSOR TEST

To perform the pressure sensor test, proceed as follows:

1. Set the following operating parameters:
   - Primary delivery rate at 40 mL/hr
   - Primary dose limit at 100 mL
   - Press **[NO]** in response to **SET SECONDARY**
   - Press the **[REVIEW/CHANGE]** touchswitch to set occlusion pressure at 4 psi (27.6 kPa)
2. Connect distal tubing to DPM through a three-way stopcock, as shown in *Figure 5-5*. Install a reflux valve between the stopcock and the DPM to prevent moisture from entering the meter.

   Note: The height of the DPM must be 0 ± 6 in. (0 ± 15 cm) from the midline of the cassette.
3. Open the stopcock to air.
4. Press **[START]** and allow the infuser to stabilize for at least one minute.
5. Set the stopcock to measure pressure.
6. Press **[REVIEW/CHANGE]** until the screen displays the pressure according to the infusion system under test.
7. Verify the **STOPPED DISTAL LINE OCCLUSION** alarm status on the screen.
8. The DPM should display 4 ± 1 psi (27.6 ± 6.9 kPa).
9. While the infusion system is in occlusion, turn the audible alarm switch to all three positions and confirm that audible levels operate correctly.
10. Press **[RESET]**.
11. Set infusion system pressure to 8 psi (55 kPa) and repeat Step 4 through Step 10. At occlusion, the DPM should display 8 ± 1.5 psi (55.1 ± 10.3 kPa).
12. Remove the distal tubing from the stopcock. Place distal tubing in waste receptacle or recirculate.
13. Open and close the door, then press **[NO]** to save settings.

14. Set the following operating parameters:
    - Primary delivery rate at 200 mL/hr
    - Primary dose limit at 10 mL
    - Press **[YES]** in response to **SET SECONDARY**
    - Press **[YES]** in response to **CONCURRENT**
    - Secondary delivery rate at 200 mL/hr
    - Secondary dose limit at 10 mL
    - Press **[NO]** in response to **CALLBACK AT SECONDARY DOSE END**
    - Press **[NO]** in response to **DELIVER SECONDARY OVERFILL**
15. Press **[START]** and allow the system to stabilize for at least one minute.
16. After a minimum of two cycles, clamp the proximal primary tubing just below the drip chamber. The screen displays **STOPPED PROX. OCCLUSION PRIMARY**, and an alarm sounds within three pumping cycles.
17. Press **[RESET],** unclamp the tubing, and open the door.

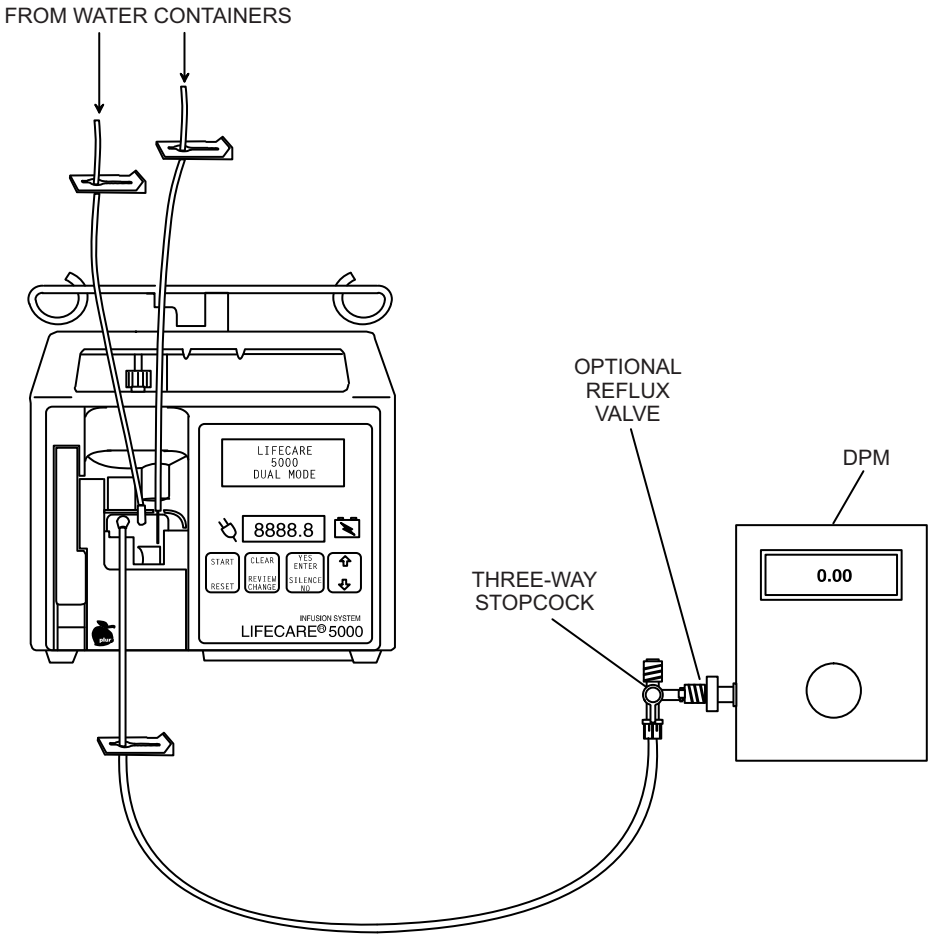


Figure 5-5. Pressure Sensor Test Setup

5.2.11
ELECTRICAL SAFETY TEST

Note: The electrical safety test must be performed in accordance with the instructions contained in the safety analyzer user's guide.

To perform the electrical safety test, proceed as follows:

1. Connect the infusion system AC power cord to the safety analyzer.
2. Connect the safety analyzer ground lead to the device equipotential post.
3. Check the leakage current with the safety analyzer. Leakage current must not exceed the specifications in *Table 5-2*.
4. Measure the resistance of the AC connector ground lug with the safety analyzer. Resistance should not exceed the specifications in *Table 5-2*.

Note: Connect the device to AC power and confirm the AC indicator is lit.

Table 5-2. Electrical Safety Measurements

Measurement	Not to Exceed
Enclosure leakage current normal condition (ground intact)	300 µA
Enclosure leakage current (open)	500 µA
Earth leakage current (ground intact)	500 µA
Earth leakage current (open ground)	1000 µA
Chassis ground resistance	0.2 Ω

5.2.12
DATAPORT COMMUNICATION TEST

This procedure may be bypassed if the DataPort communications feature is not used.

The following program, written in BASIC, tests the DataPort communications hardware of the infusion system.

To perform the DataPort communication test, connect the DataPort host computer directly to the infusion system DataPort connector and run the following program. See *Figure 7-12* and *Table 7-1* for proper hardware connections.

```
10 REM ************************************************************
20 REM ***
30 REM * Program:      LCTEST.BAS          REV:1.01
40 REM * Description:
50 REM    This program will test the hardware of the LC5000
60 REM    DATAPORT system. A single packet will be sent to the
70 REM    pump and one will be expected in reply. The CRC is
80 REM    pre-calculated. This program will communicate with only
90 REM    one pump--communication with multiple pumps on a single
100 REM   bus line will not function with this program.
110 REM * Interpreter : IBM BASIC Version 2.0
120 REM ***
130 REM ************************************************************
140 REM *** Beginning of program.
150 REM *** Clear computer screen.
160 CLS
170 REM *** Indicate "no packets received".
180 LCSTR$ = ""
190 LCLEN = 0
200 REM *** If error then report failure of computer port.
210 ON ERROR GOTO 450
220 REM *** Activate communication port on the computer:
230 REM ***  port = 1, baud rate = 1200, parity = none,
240 REM ***  data bits = 8, stop bits =1.
250 COM(1) ON
260 ON COM(1) GOSUB 530
270 OPEN "COM1:1200,N,8,1" AS #1
280 REM *** Send packet to pump:
290 REM *** Flush and ask for status from Hard-ID 0.
300 PRINT #1,CHR$(3);
310 PRINT #1,"T@0;ISTA;2FAD"
320 REM *** Wait for a reply packet from pump.
321 REM *** To reduce the waiting period for the reply packet
322 REM *** to be sent from the pump to the PC, the loop
323 REM *** counter (25000) in line 330 may be reduced as
324 REM *** required to a minimum of 1500.
```

```
330 FOR I=I TO 25000
340 NEXT
350 REM *** Test for a received packet. If received packet is empty
360 REM *** then test FAILS. Otherwise, test PASSes and the received
370 REM *** packet is printed.
380 REM ***
390 IF LCLEN = 1 THEN GOTO 400 ELSE GOTO 420
400 PRINT "** TEST PASSED, received packet:";LCSTR$
410 GOTO 500
420 PRINT "** TEST FAILED, no communication from pump."
430 GOTO 500
440 REM *** Communication port error.
450 PRINT CHR$(13);CHR$(13);CHR$(13)
460 PRINT "Communication ERROR on COM1 port--check cable connections."
470 GOTO 510
480 REM *** Close communication port.
490 COM(1) OFF
500 CLOSE
510 END
520 REM *** Receive the packet.
530 INPUT #1,LCSTR$
540 COM(1) OFF
550 LCLEN = 1
560 RETURN
570 REM *** End of program.
```

If **TEST PASSED** is displayed at the end of the program, the infusion system communication hardware and software are functioning properly.

If **TEST FAILED** is displayed at the end of the program, re-enter the program. If **TEST FAILED** is still displayed, see *Table 6-2* or contact Hospira.

5.2.13
END OF THE PVT

When the PVT is completed, clear dose history, then open and close the door. When **SAVE SETTINGS** appears on the screen, press the **[NO]** touchswitch. Reset DIP switches to previous configuration.

If any tests fail, see *Section 6*, or contact Hospira.

If all tests have been successful, return the device to service.

5.3
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 a periodic maintenance inspection schedule for the infusion system.

To perform a periodic maintenance inspection, complete the PVT in *Section 5.2*.

5.4
BATTERY OPERATION OVERVIEW

The infusion system 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 (mains) power failure or inadvertent disconnection of the AC (mains) power cord. An instance of temporary portable operation includes patient transfer from one location to another.

The infusion system should be connected to AC (mains) power whenever possible to allow the battery to remain fully charged. The line power indicator disappears and the **BATTERY** legend appears when the infusion system is operating 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 system is operating, the alarm sounds and the **LOW BATTERY** message displays. Although it is not recommended to continue operating the infusion system on battery power at this point, the battery will continue providing power until discharged. At this point, the infusion system enters the battery discharged mode and operation ceases.

CAUTION: As soon as the LOW BATTERY alarm occurs, connect the infusion system to AC (mains) power.

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

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

5.4.1
BATTERY CHARGER CURRENT TEST

To perform the battery charger test, proceed as follows:

1. Clear all rates and volumes then disconnect the infuser from AC (mains) power.
2. Open the door and confirm the display dims completely and the battery symbol deactivates in approximately 30 seconds.
3. Remove the cassette and close the door.
4. Remove the battery pack cover and disconnect the battery pack from the charger *(Section 7.2.2)*.
5. Connect a resistor-capacitor network to the charger connector at one end and to the DMM at the other end.
6. Connect the infuser to AC (mains) power and measure voltage across network with DMM set to 0 to 100 voltage scale. The DMM should display 13 2 VDC.
7. Disconnect the resistor-capacitor network and AC (mains) power.
8. Reconnect the battery pack and replace the battery pack cover.

This page intentionally left blank.

Section 6

TROUBLESHOOTING

This section contains information on technical assistance, alarm messages and error codes, and troubleshooting procedures. All alarm and malfunction codes detailed in this section can be monitored by a host computer connected to infusers with the DataPort communications feature.

6.1 TECHNICAL ASSISTANCE

For technical assistance, product return authorization, and to order parts, accessories, or manuals within the United States, contact Hospira.

1-800-241-4002

For additional technical assistance, technical training, and product information, visit the website at **www.hospira.com**.

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

6.2 AUDIBLE ALARMS

The infusion system alerts the user to an abnormal condition with an audible alarm. An audible alarm sounds either a continuous alarm tone, indicating a power failure, or a tone sequence of short-long-short-long. These short-long-short-long tones indicate the infusion system is in the alarm state *(see Section 4.2)*.

The infusion system automatically enters an alarm state whenever it detects an alarm condition. Infusion is prohibited during all audible alarm conditions unless otherwise indicated.

The following sections briefly describe alarm messages, alarm conditions, and obtaining an alarm history for the LifeCare 5000 infusion system.

6.2.1 ALARM MESSAGES

Under certain alarm conditions, the infusion system stops operating, generates an audible alarm, displays an alarm code, and an alarm message on the LCD screen. Alarm codes 06, 07, 08, 09, 0A, 12, 13, 14, and 15 display an initial alarm message on the LCD screen, followed by a secondary alarm message.

There are two categories of alarm codes: codes that can be cleared by the operator and codes that require the assistance of qualified service personnel.

Table 6-1 lists alarm codes, LCD screen messages, possible causes, corrective actions, and DataPort codes. Alarm codes listed in *Table 6-1* are hexadecimal in value from 00(16) to FF(16). The LCD screen message column differentiates alarm codes as operator-cleared messages or malfunction codes requiring the assistance of qualified service personnel. Operator alarm messages are corrected using corrective actions described in the *System Operating Manual*. DataPort codes apply only to 1.6 series infusion systems with DataPort.

CAUTION: If excessive alarms occur, contact Hospira.

Note: (*) indicates international devices only.

Table 6-1. Alarm Codes and Corrective Actions

Alarm Code	Message	Possible Cause	Corrective Action	Dataport Code
00	No message No alarm alarm code history Displays all zeros	New infusion system No alarms recorded System disconnected from AC (mains) power and battery pack removed	None Replace battery pack	OK
01	STOPPED DISTAL LINE OCCLUSION PRESS RESET	Distal line occlusion; excessive line pressure	Check clamps	OD1
		Distal line kinked; distal clamp closed; clotted IV site	Examine distal line for kinks in tubing or internal obstructions	
		Infusion system positioned incorrectly	Reposition infusion system at or above patient mid-axillary line	
		Pressure limit set too low	Raise pressure limit if therapy permits	
		Pressure sensor out of calibration	Replace mechanism assembly	
02	Code not used No alarm			
03	STOPPED PROX. OCCLUSION PRIMARY PRESS RESET	Primary proximal line occlusion	Check clamps and filters; check for kinks in tubing, or internal obstructions; verify 19-gauge or larger needle is used	OP1
		Defective administration set	Replace set	

Table 6-1. Alarm Codes and Corrective Actions

Alarm Code	Message	Possible Cause	Corrective Action	Dataport Code
04	STOPPED PROX. OCCLUSION SECONDARY PRESS RESET	Secondary proximal line occlusion	Check clamps and filters; check for kinks in tubing and internal obstructions; verify 19-gauge or larger needle is used	OP2
		Single channel administration set used for dual delivery	Replace with dual channel administration set	
05	STOPPED PRESSURE OUT OF RANGE PRESS RESET	Distal line pressure outside of range	Position infusion system at patient mid-axillary line	PR1
		Distal line pressure too low	Reprime set	
		Defective administration set	Replace set If problem recurs, discontinue infusion system use	
		Pressure sensor out of calibration	Replace mechanism assembly	
06	STOPPED AIR IN PROXIMAL LINE PRESS RESET Secondary alarm message: BACKPRIME TO CLEAR AIR INTO SECONDARY YES OR NO?	Air-in-line, proximal sensor	Single channel administration set: reprime using standard techniques If alarm repeats, replace set	AP1
		Empty container	Replace container and reprime set using standard techniques	
		Cumulative air-in-line volume exceeded due to outgassing or successive air segments introduced by underfilled secondaries	Dual channel administration set: use backpriming techniques or standard repriming techniques	
		Defective administration set or adapter	Replace set if defective and reprime	
		Defective bubble sensor(s)	Replace mechanism assembly	

Table 6-1. Alarm Codes and Corrective Actions

Alarm Code	Message	Possible Cause	Corrective Action	Dataport Code
07	STOPPED AIR IN DISTAL LINE PRESS RESET Secondary alarm message: IN RESET OPEN DOOR CHECK SET AND RETEST	Air-in-line, distal sensor: excessive air in air trap; incomplete priming outgassing	Reprime administration set using standard techniques If alarm repeats, replace set	AD1
		Defective administration set or adapter	Replace set if defective and reprime	
		Defective bubble sensor(s)	Replace mechanism assembly	
09	EMPTY CONTAINER PRIMARY KVO #### ML/HR PRESS RESET Secondary alarm message: REFILL/REPLACE PRI CONTAINER PRESS START OR REVIEW/CHANGE	No flow detected: empty container on primary line	Replace with new container on primary line	FLF
		Occluded primary proximal	Clear alarm	
		Flow detector connected but not attached to the primary drip chamber	Attach flow detector to the primary drip chamber	
		Overfilled drip chamber	Adjust fluid level in drip chamber	
09*	EMPTY CONTAINER PRIMARY KVO #### ML/HR PRESS RESET Secondary alarm message: REFILL/REPLACE PRI CONTAINER PRESS START OR REVIEW	No flow detected: empty container on primary line	Replace with new container on primary line	FLF
		Occluded primary proximal line	Clear alarm	
		Flow detector connected but not attached to the primary drip chamber	Attach flow detector to the primary drip chamber	
		Overfilled drip chamber	Adjust fluid level in drip chamber	

Table 6-1. Alarm Codes and Corrective Actions

Alarm Code	Message	Possible Cause	Corrective Action	Dataport Code
0A	CONNECT FLOW DETECTOR OR PRESS RESET TO SET DOSE LIMIT Secondary alarm message: DOSE LIM #### ML PRESS AND ENTER	Flow detector disconnected while infusion system is pumping	Press [RESET]; reconnect flow detector; press [START] or Press [RESET]; enter a dose limit; press [START]	FDF
0B	FLOW DETECTOR CONNECTED PRESS RESET	Flow detector connected while infusion system is pumping	Press [RESET]; reconnect flow detector; press [START] or Press [RESET]; enter dose limit; press [START]	FDT
0C	MALFUNCTION CODE 0C	Defective flow detector	Press [RESET]; replace flow detector	MAL
		Defective I/O PWA	If problem repeats with new flow detector, replace I/O PWA	
0D to 10	Code not used No alarm			
11	STOPPED FOR 5 MINUTES PRESS RESET OR REMOVE CASSETTE	Door has been closed for five minutes without further programming; infusion system in RESET longer than five minutes	Press [RESET]; complete setup; press [START], or open door and remove set	RL
12	DOSE END KVO RATE #### ML/HR PRESS RESET Secondary alarm message: REPEAT PRIMARY RATE #### ML/HR DOSE LIM #### ML YES OR NO?	Dose end	Discontinue delivery or set another primary dose	DE1

Table 6-1. Alarm Codes and Corrective Actions

Alarm Code	Message	Possible Cause	Corrective Action	Dataport Code
13	STOPPED SYSTEM RETEST REQUIRED PRESS RESET Secondary alarm message: IN RESET OPEN DOOR CHECK SET AND RETEST	Cassette check failed: Occlusion or air in administration set detected at start up	Open all clamps; prime out excess air If alarm repeats, replace set, close door to retest If alarm repeats, discontinue use	CS1
		Defective administration set	Replace set; close door to retest	
		Valve pins binding	Clean mechanism front	
		Pressure sensor out of calibration	Replace mechanism assembly	
14	STOPPED SYSTEM RETEST REQUIRED PRESS RESET Secondary alarm message: IN RESET OPEN DOOR CHECK SET AND RETEST	Cassette check failed: occlusion or air in administration set detected at start up	Open all clamps; prime out excess air If alarm repeats, replace set, close door to retest If alarm repeats, discontinue use	CS1
		Defective administration set	Replace set; close door to retest	
		Defective mechanism	Replace mechanism assembly	
15	STOPPED SYSTEM RETEST REQUIRED PRESS RESET Secondary alarm message: IN RESET OPEN DOOR CHECK SET AND RETEST	Cassette check failed: Occlusion or air in administration set detected at start up	Open all clamps; prime out excess air If alarm repeats, replace set, close door to retest If alarm repeats, discontinue use	CS1
		Defective administration set	Replace set; close door to retest	
		Empty primary container	Replace container	
		Defective mechanism; administration set fails backprime check	Replace mechanism assembly	

Table 6-1. Alarm Codes and Corrective Actions

Alarm Code	Message	Possible Cause	Corrective Action	Dataport Code
16	STOPPED CHECK CASSETTE REPRIME SET	Cassette check failed: occlusion or air in administration set detected at start up	Open all clamps; prime out excess air If alarm repeats, replace set, close door to retest If alarm repeats, discontinue use	CS1
		Defective administration set	Replace set; close door to retest	
17	LOW BATTERY PLUG PUMP INTO AC CIRCUIT IMMEDIATELY	Low battery **Note:** LCD message alternates with current operating message	Connect infuser to AC power	BLO
17*	LOW BATTERY PLUG PUMP INTO MAINS CIRCUIT IMMEDIATELY	Low battery **Note:** LCD message alternates with current operating message	Connect infuser to AC power	BLO
18	STOPPED DEAD BATTERY	Battery is fully discharged	Connect infuser to AC power Replace battery pack	BLS
19	STOPPED DOOR OPENED WHILE PUMPING PRESS RESET	Door opened while infuser is pumping	Close door Press [RESET] and [START] to resume	DCO1
1A to 1F	Code not used No alarm			
20	MALFUNCTION CODE 20	Stack runaway error: Defective ROM, RAM, processor, or custom logic	Replace main PWA	MAL20
21	MALFUNCTION CODE 21	Critical data corrupted: defective RAM ; defective VMEM circuit	Replace main PWA Replace power supply PWA	MAL21
22	MALFUNCTION CODE 22	Watchdog frequency too low	Replace main PWA	MAL22
23	MALFUNCTION CODE 23	Watchdog frequency too high Defective CPU or custom logic IC	Replace main PWA	MAL23
24	MALFUNCTION CODE 24	Watchdog detected processor failure	Replace battery pack	MAL24

Table 6-1. Alarm Codes and Corrective Actions

Alarm Code	Message	Possible Cause	Corrective Action	Dataport Code
25	MALFUNCTION CODE 25	Watchdog does not reset processor Defective CPU or custom logic IC	Replace battery pack Replace main PWA	MAL25
26	MALFUNCTION CODE 26	Processor internal malfunction: defective CPU	Replace main PWA	MAL26
27	MALFUNCTION CODE 27	Illegal instruction trap: defective CPU	Replace main PWA	MAL27
28	MALFUNCTION CODE 28	RAM check error: defective RAM	Replace main PWA	MAL28
29	MALFUNCTION CODE 29	Low ROM checksum error: defective EPROM	Replace main PWA	MAL29
2A to 2F	Code not used No alarm			
30	MALFUNCTION CODE 30	High ROM checksum error: defective EPROM	Replace main PWA	MAL30
31	MALFUNCTION CODE 31	Revision numbers do not match: incorrect EPROM	Replace main PWA	MAL31
32	MALFUNCTION CODE 32	RTC chip failure: defective RTC chip in U5 socket	Replace main PWA	MAL32
33	MALFUNCTION CODE 33	Serial I/O system failure: defective I/O PWA	Replace I/O PWA	MAL33
		Defective main PWA	Replace main PWA	
34 to 40	Code not used No alarm			
41	MALFUNCTION CODE 41	LCD message display read/write failure: loose cable P/J11	Check cable connection	MAL41
		Defective LCD assembly	Replace LCD assembly	
42	MALFUNCTION CODE 42	Message display RAM failure: loose cable P/J11	Check cable connection	MAL42
		Defective LCD assembly	Replace LCD assembly	

Table 6-1. Alarm Codes and Corrective Actions

Alarm Code	Message	Possible Cause	Corrective Action	Dataport Code
43	MALFUNCTION CODE 43	Numeric display digit driver failure: loose cable P/J1	Check cable connection	MAL43
		Defective LED PWA	Replace display PWA	
44	MALFUNCTION CODE 44	Audible alarm failure: defective piezoelectric alarm	Replace piezoelectric alarm assembly	MAL44
		Defective alarm driver or test circuit	Replace power supply PWA	
45	MALFUNCTION CODE 45	Touchswitch failure: touchswitch closed longer than two minutes and 40 seconds	Do not close touchswitch longer than specified limit	MAL45
		Defective front panel	Replace front panel	
46 to 5F	Code not used No alarm			
60	MALFUNCTION CODE 60	Plunger motor will not home	Lubricate plunger motor shaft	MAL60
		Plunger motor jammed by cassette	Check administration set; replace if defective	
		No power to motor	Replace power supply PWA	
		Defective motor drivers	Replace I/O PWA	
		Defective sensor PWA	Replace mechanism assembly	
61	MALFUNCTION CODE 61	I/O valve motor will not home: valve motor jammed by cassette	Check administration set; replace if defective	MAL61
		No power to motor	Replace power supply PWA	
		Defective motor drivers	Replace I/O PWA	
		Defective sensor PWA	Replace mechanism assembly	

Table 6-1. Alarm Codes and Corrective Actions

Alarm Code	Message	Possible Cause	Corrective Action	Dataport Code
62	MALFUNCTION CODE 62	Primary/secondary valve motor will not home: valve motor jammed by cassette	Check administration set; replace if defective	MAL62
		No power to motor or faulty 2.5 VDC reference voltage	Replace power supply PWA	
		Defective motor drivers	Replace I/O PWA	
		Defective sensor PWA	Replace mechanism assembly	
63	MALFUNCTION CODE 63	Plunger motor slipping or stuck	Lubricate plunger motor shaft	MAL63
		Plunger motor jammed by cassette	Check administration set; replace if defective	
		No power to motor	Replace power supply PWA	
		Defective motor drivers	Replace I/O PWA	
		Defective sensor PWA	Replace mechanism assembly	
64	MALFUNCTION CODE 64	I/O valve motor slipping or stuck: valve motor jammed by cassette	Check administration set; replace if defective	MAL64
		No power to motor	Replace power supply PWA	
		Defective motor drivers	Replace I/O PWA	
		Defective sensor PWA	Replace mechanism assembly	
65	MALFUNCTION CODE 65	Primary/secondary valve motor slipping or stuck: valve motor jammed by cassette	Check administration set; replace if defective	MAL65
		No power to motor or faulty 2.5 VDC reference voltage	Replace power supply PWA	
		Defective motor drivers	Replace I/O PWA	
		Defective sensor PWA	Replace mechanism assembly	
66	MALFUNCTION CODE 66	Motor failure: internal timers unsynchronized	Note circumstances and contact Hospira	MAL66

Table 6-1. Alarm Codes and Corrective Actions

Alarm Code	Message	Possible Cause	Corrective Action	Dataport Code
67	MALFUNCTION CODE 67	Software motor watchdog confused; motor not running	Note circumstances and contact Hospira	MAL67
68 to 69	Code not used No alarm			
6A	MALFUNCTION CODE 6A	Motor failure; internal timers unsynchronized	Note circumstances and contact Hospira	MAL6A
6B	MALFUNCTION CODE 6B			MAL6B
6C	MALFUNCTION CODE 6C			MAL6C
6D	MALFUNCTION CODE 6D			MAL6D
6E	MALFUNCTION CODE 6E			MAL6E
6F to 70	Code not used No alarm			
71	MALFUNCTION CODE 71	Software not executed in 10 ms period	Note circumstances and contact Hospira	MAL71
72	MALFUNCTION CODE 72	Defective pressure sensor or A/D converter	Replace mechanism assembly or main PWA	MAL72
73	MALFUNCTION CODE 73	A/D converter failure (0, 2.5 and 5 V tests): defective A/D converter IC	Replace main PWA	MAL73
		Defective custom logic IC	Replace I/O PWA	
74	MALFUNCTION CODE 74	Ultrasound transmitter or receiver failure: defective sensor or bubble PWA	Replace mechanism assembly	MAL74
75	MALFUNCTION CODE 75	Overvoltage protection failure: defective overvoltage protection circuitry	Replace power supply PWA	MAL75
		Defective custom logic IC	Replace I/O PWA	
76	MALFUNCTION CODE 76	Distal air sensor failed on-going check: defective bubble sensor or sensor PWA	Replace mechanism assembly	MAL76

Table 6-1. Alarm Codes and Corrective Actions

Alarm Code	Message	Possible Cause	Corrective Action	Dataport Code
77	MALFUNCTION CODE 77	Proximal air sensor failed on-going check: defective custom logic IC	Replace I/O PWA	MAL77
78	MALFUNCTION CODE 78	Proximal air sensor is off when it should be on	Replace I/O PWA or mechanism assembly	MAL78
79	MALFUNCTION CODE 79	Primary/secondary valve safety spring broken: defective mechanism assembly	Replace mechanism assembly	MAL79
7A	MALFUNCTION CODE 7A	Proximal pressure sensor failed	Replace mechanism assembly	MAL7A
7B	MALFUNCTION CODE 7B	Software motor watchdog is confused: motor not running	Note circumstances and contact Hospira	MAL7B
7C	MALFUNCTION CODE 7C			MAL7C
7D	MALFUNCTION CODE 7D			MAL7D
7E	MALFUNCTION CODE 7E			MAL7E
7F	MALFUNCTION CODE 7F			MAL7F
80 to 89	Code not used No alarm			
8A	MALFUNCTION CODE 8A	Software motor watchdog is confused: motor not running	Note circumstances and contact Hospira	MAL8A
8B to 90	Code not used No alarm			
91	MALFUNCTION CODE 91	Overflow compensation table in PRI_OR_SEC_NXT	Note circumstances and contact Hospira	MAL91
92	MALFUNCTION CODE 92	RATEMATH calculation error from table overflow	Note circumstances and contact Hospira	MAL92
93	MALFUNCTION CODE 93	No synchronization; failed flag set after failing synchronization	Note circumstances and contact Hospira	MAL93
94 to 96	Code not used No alarm			
97	MALFUNCTION CODE 97	Rate checking failure within RATSEL routine	Note circumstances and contact Hospira	MAL97

Table 6-1. Alarm Codes and Corrective Actions

Alarm Code	Message	Possible Cause	Corrective Action	Dataport Code
98	MALFUNCTION CODE 98	Rate equals zero or division by zero	Note circumstances and contact Hospira	MAL98
99	MALFUNCTION CODE 99	Division by zero (used by S_DIV)	Note circumstances and contact Hospira	MAL99
9A	MALFUNCTION CODE 9A	New alarm without setting alarm bit in ALMBRD	Note circumstances and contact Hospira	MAL9A
9B	MALFUNCTION CODE 9B	OCR timer interrupt error trap at IHANDR routine. Defective CPU	Replace main PWA	MAL9B
9C to A1	Code not used No alarm			
A2	MALFUNCTION CODE A2	Motor power up not detected	Replace power supply PWA	MALA2
A3	MALFUNCTION CODE A3	Motor power down not detected	Replace power supply PWA	MALA3
A4	MALFUNCTION CODE A4	Illegal BCD digit in DRATE	Note circumstances and contact Hospira	MALA4
A5	MALFUNCTION CODE A5	Executive code in infinite loop	Note circumstances and contact Hospira	MALA5
A6	MALFUNCTION CODE A6	Unknown failure type, motor related	Note circumstances and contact Hospira	MALA6
A7	MALFUNCTION CODE A7	Potential PURGE runaway hazard detected	Note circumstances and contact Hospira	MALA7
A8 to FF	Code not used No alarm			

6.2.2
OBTAINING AN ALARM HISTORY

A rolling history of alarm codes may be obtained by accessing the alarm history data screen. The alarm history screen appears on the LCD when the **[REVIEW/CHANGE]** touchswitch is pressed twice during the first three-to-five second interval after the door is closed and the **SELF TEST:OK** screen is displayed. The alarm history data screen displays 15 alarm codes with the most recent code appearing at the lower right hand corner of the screen.

6.3
ALARM AND MALFUNCTION CODES

Alarm and malfunction codes are listed in *Table 6-1*. For malfunction codes requiring corrective action beyond the scope of this manual, contact Hospira.

6.3.1
ALARM CODES

Alarm codes **01 through 19** may typically be corrected by the system operator. See *Table 6-1* for a definition and appropriate corrective action for each of these codes.

6.3.2
MICROPROCESSOR OR SYSTEM ALARM CODES

Alarm codes **20 through 33** are microprocessor or system alarm codes. See *Table 6-1* for a definition and appropriate corrective action for each of these codes.

6.3.3
DISPLAY, AUDIBLE, AND TOUCHSWITCH ALARM CODES

Alarm codes **41 through 45** are display, audible, and touchswitch alarm codes. See *Table 6-1* for a definition and appropriate corrective action for each of these codes.

6.3.4
INFUSION PUMPING MECHANISM ALARM CODES

Alarm codes **60 through 67** are infusion pumping mechanism alarm codes. See *Table 6-1* for a definition and appropriate corrective action for each of these codes.

6.3.5
MISCELLANEOUS ALARM CODES

Alarm codes **6A through A7** are miscellaneous alarm codes. See *Table 6-1* for a definition and appropriate corrective action for each of these codes.

6.4 INFUSION SYSTEM TROUBLESHOOTING

Before troubleshooting an alarm, open and close the infuser door and allow the self test to complete. If an alarm persists, carefully inspect the infusion system for signs of damage as described in *Section 5.1.1*, and perform the corrective action specified in *Table 6-1* or *Table 6-2*.

Failures listed in *Table 6-2* that do not cause an alarm are detected by observation only when using the DataPort communications feature.

Note: Some corrective actions listed in *Table 6-1* and *Table 6-2* are beyond the scope of this manual. In such instances, contact Hospira.

Table 6-2. Troubleshooting DataPort Systems (1.6 DataPort Only)

Code or Symptom	Possible Cause	Corrective Action
Infusion system does not reply to packet sent by host computer	Infusion system not connected to cable or DataPort bus	Check all cable and junction box connections
	Host computer defective	Run the DataPort communication program in *Section 5.2.12* If the program passes, see the *LifeCare 5000 Concurrent Flow Infusion System with DataPort Programmer's Guide* to check software
	Infuser is turned off or malfunctioning	Turn on the infuser Run the DataPort communication program in *Section 5.2.12* If the infusion system fails the test, contact Hospira
	Defective junction box	Bypass the junction box and connect the host computer directly to the infuser If the problem is corrected, replace the junction box If problem is not corrected, replace the I/O PWA
	Infusion system with incorrect software revision connected to DataPort bus	Check software revision

Table 6-2. Troubleshooting DataPort Systems (1.6 DataPort Only)

Code or Symptom	Possible Cause	Corrective Action
Packets are received incorrectly by the infusion system or host computer	Junction box DIP switches not set correctly	Check DIP switch setting for hard ID
	Host computer defective	Run the DataPort communication program in *Section 5.2.12* If the program passes, see the *LifeCare 5000 Concurrent Flow Infusion System with DataPort Programmer's Guide* to check software
	Cable disconnected while transmission in progress	Check the condition of the connector and replace, if necessary
	Electromagnetic interference from adjacent equipment	Remove or repair the source of interference If the problem persists, contact Hospira
	Bus traffic resulting from connection to a non-LifeCare 5000 infuser with DataPort	Disconnect nonconforming equipment
	Bus wire length or electrical signals do not meet EIA-232D standards; leads may be open or shorted	Use port that conforms to EIA-232D standard and DataPort cables
Host computer receives garbled responses to messages sent to infusion system	Host computer defective	Run the DataPort communication program in *Section 5.2.12* If the program passes, see the *LifeCare 5000 Concurrent Flow Infusion System with DataPort Programmer's Guide* to check software
Host computer detects infusion systems that are not present	Defective junction box	Bypass the junction box and connect the host computer directly to the infuser If the problem is corrected, replace the junction box If problem is not corrected, replace the I/O PWA

6.5 TROUBLESHOOTING WITH THE PVT

Table 6-3 lists failures that may be detected during the PVT. If an error code displays, see *Section 6.2.1*.

Table 6-3. Troubleshooting with the PVT

Test Failure	Possible Cause	Corrective Action
Startup Test *Section 5.2.3*	Cassette not properly installed	Reprime and properly insert cassette
	Faulty cassette	Replace administration set
	Defective power supply PWA	Replace power supply PWA *(see Section 7.2.18.1)*
	Defective touchswitch panel	Replace touchswitch panel
Bubble Sensor Location Test *Section 5.2.4*	Bubble sensor location fixture not calibrated	Calibrate bubble sensor location fixture calibration block
	Calibration block not calibrated to required specifications	Verify valid calibration date
Nurse Call Test *Section 5.2.5*	Defective nurse call cable	Replace nurse call cable
	Defective I/O PWA	Replace I/O PWA *(see Section 7.2.17.2)*
Empty Container Test *Section 5.2.6*	Defective special cassette	Replace special cassette
	Dirty bubble sensors	Clean bubble sensors
	Defective bubble sensor PWA	Replace mechanism assembly *(see Section 7.2.18.2)*
	Proximal bubble sensor tips removed incorrectly	Recut proximal bubble sensor tips
	Distal bubble sensor tips removed incorrectly	Recut distal bubble sensor tips
Air-in-Line Test *Section 5.2.7*	Defective special cassette	Replace special cassette
	Dirty bubble sensor	Clean bubble sensors
	Defective bubble sensor PWA	Replace mechanism assembly *(see Section 7.2.18.2)*
Concurrent Delivery Test *Section 5.2.8*	Damaged or faulty administration set	Replace administration set and reprime cassette
	Defective mechanism assembly	Replace mechanism assembly *(see Section 7.2.18.2)*

Table 6-3. Troubleshooting with the PVT

Test Failure	Possible Cause	Corrective Action
Delivery Accuracy Test *Section 5.2.9*	Cassette not properly primed	Reprime cassette
	Damaged or faulty administration set	Replace administration set and reprime cassette
	Defective mechanism assembly	Replace mechanism assembly *(see Section 7.2.18.2)*
Pressure Sensor Test *Section 5.2.10*	Cassette not properly primed	Reprime cassette
	Defective cassette	Replace cassette
	Dirty sensor pin	Clean sensor pin
	Defective sensor PWA	Replace mechanism assembly *(see Section 7.2.18.2)*
Electrical Safety Test *Section 5.2.11*	Insufficient ground connection	Check electrical safety analyzer return line
	Defective AC power cordset	Replace AC power cordset
	Defective power supply PWA	Replace power supply PWA *(see Section 7.2.18.1)*
DataPort Communication Test *Section 5.2.12*	Damaged or faulty DataPort accessory cable	Replace DataPort accessory cable
	Test program written incorrectly	Verify correct program entry
	Defective I/O PWA	Replace I/O PWA *(see Section 7.2.17.2)*

Section 7

REPLACEABLE PARTS AND REPAIRS

This section describes replacement procedures for parts and subassemblies of the infusion system that are repairable within the scope of this manual.

7.1 REPLACEABLE PARTS

Replaceable parts for the infusion system are itemized in the Illustrated Parts Breakdown (IPB) and are identified in *Figure 9-1*. *Table 9-2* identifies each part by an index number that correlates to *Figure 9-1*.

To view the online replacement parts list, visit the website at **www.hospiraparts.com**.

7.2 REPLACEMENT PROCEDURES

The following sections contain step-by-step procedures for replacing parts in the infuser. Unless otherwise stated, always perform the PVT after a replacement procedure.

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

7.2.1 SAFETY AND EQUIPMENT PRECAUTIONS

Take all necessary precautions for working on high-voltage equipment.

WARNING: EXPLOSION HAZARD EXISTS IF THE INFUSER IS SERVICED IN THE PRESENCE OF FLAMMABLE SUBSTANCES.

WARNING: UNLESS OTHERWISE INDICATED, DISCONNECT THE INFUSER FROM AC POWER BEFORE PERFORMING REPLACEMENT PROCEDURES.

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

- Set of Phillips screwdrivers
- Set of flat blade screwdrivers
- Set of Allen wrenches
- Set of nutdrivers
- X-acto knife
- Wire cutter
- Wire stripper
- Electrician's knife
- Long needle nose pliers
- 1/4 in. right angle socket wrench
- External retaining ring pliers
- Grease extension
- Digital multimeter (DMM)
- PlumSet, List No. 6426
- Large bore needle, 18 gauge
- Syringe, 20 cc
- Digital pressure meter (DPM)
- Three-way stopcock
- Grease, Braycote 804
- Red GLPT insulating varnish
- Lint-free cloth or cotton swabs
- Isopropyl alcohol or Electro-Wash 2000
- Small six-inch brush

7.2.2.1
ACCESSORIES

The accessories required for repair of optional features on 1.6 series infusion systems are listed in *Table 7-1*. See *Figure 7-12* for cable schematics.

Table 7-1. Accessories for LifeCare 5000 Infusion Systems

Part Description	List/Part Number
DataPort cable assembly, infusion system to PC, 8 ft., male DB-15 to female DB-9 connector	11431-01
DataPort cable assembly, infusion system to PC, 8 ft., male DB-15 to female DB-25 connector	11431-02
DataPort cable assembly, junction box to PC, 8 ft., 6-pin modular connector to female DB-9 connector	11431-03
DataPort cable assembly, junction box to PC, 8 ft., 6-pin modular connector to female DB-25 connector	11431-04
DataPort cable assembly, junction box to junction box, 2 ft., 6-pin modular connector to 6-pin modular connector	11431-06
DataPort cable assembly, junction box to junction box, 4 ft., 6-pin modular connector to 6-pin modular connector	11431-07
DataPort cable assembly, junction box to junction box, 8 ft., 6-pin modular connector to 6-pin modular connector	11431-08

Table 7-1. Accessories for LifeCare 5000 Infusion Systems	
Part Description	**List/Part Number**
Flow detector	1907-25
Junction box assembly	11429
LifeCare 5000 Concurrent Flow Infusion System with DataPort Programmer's Guide	430-03681-001

7.2.3
BATTERY PACK REPLACEMENT

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

Note: Before replacing the battery pack, check the fuse and battery charger circuits for proper operation.

To replace the battery pack, see *Figure 7-1*, and proceed as follows:

1. Disconnect the infusion system from AC (mains) power.
2. Place the infuser on its side on a soft surface.
3. Using a No. 2 Phillips screwdriver, remove the screws and washers that secure the battery pack cover to the bottom of the infuser.
4. Slide the battery pack cover toward the rear of the infuser to disengage the cover tabs, then remove the battery pack cover.
5. Remove the battery pack. Disconnect the female connector from the male connector.
6. Connect the female connector of the replacement battery pack to the male connector.

   Note: The connectors are keyed to eliminate misconnections.
7. Insert the replacement battery pack into its compartment and position until seated properly.
8. Verify the battery pack top is positioned toward the center of the infuser and the battery pack cable end is positioned toward the outside of the infuser.
9. Place the cable and connector into the battery compartment on top of the battery pack. Do not kink the cable.
10. Replace the screws and washers that secure the battery pack cover to the infuser.
11. Insert a cassette in the infuser, and close the cassette door.
12. Confirm the red battery symbol illuminates and the self test successfully completes.
13. To assure the battery pack is charged, connect the infuser to AC (mains) power for 24 hours.

    Note: The battery pack recharges to 80 percent of the prior charge in 16 hours when the infuser is operating at a delivery rate of 125 mL/hr or lower.

To verify successful replacement of the battery pack, perform the PVT in *Section 5.2*, then perform the battery charger current test as described in *Section 5.4.1*.

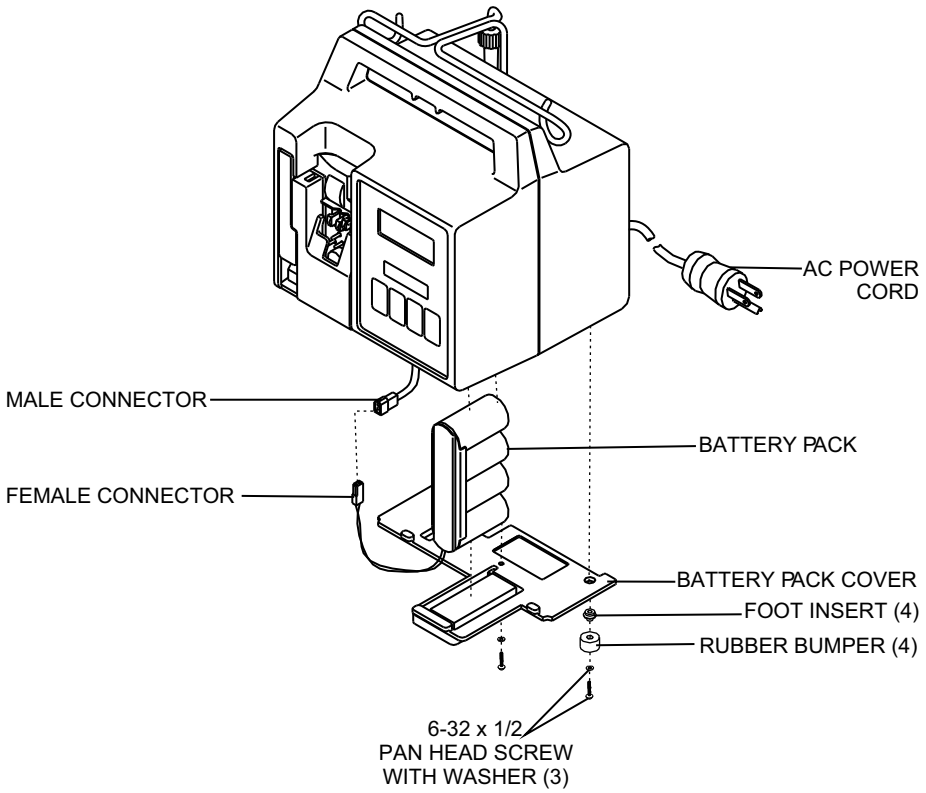


Figure 7-1. Battery Pack Replacement

7.2.4
AC (MAINS) POWER CORD REPLACEMENT (115 V)

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

To replace the AC (mains) power cord, see *Figure 7-2*, and proceed as follows:

1. Disconnect the infusion system from AC (mains) power.
2. Using a No. 2 Phillips screwdriver, remove the screws and washers that secure the AC (mains) power cord retaining plate to the rear housing. Remove and inspect the retaining plate, and replace, if required.
3. Grasp the power cord plug and remove it from the AC (mains) power receptacle. Do not disconnect the power cord by pulling on the cable.
4. Connect the replacement AC (mains) power cord to the AC (mains) power receptacle. The plug is keyed to eliminate misconnections.
5. Secure the retaining plate to the rear housing using the screws and washers that were removed in Step 2.

To verify successful replacement of the 115V AC (mains) power cord, perform the Electrical Safety Test in *Section 5.2.11*, then perform the battery charger current test in *Section 5.4.1*.

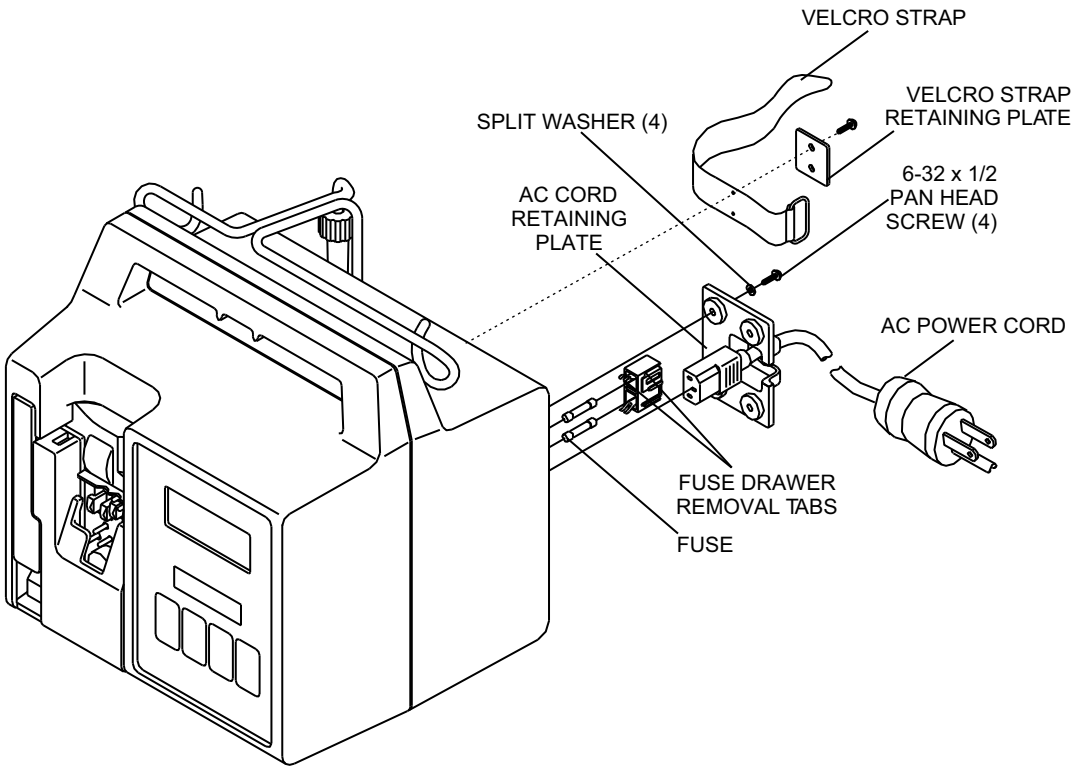


Figure 7-2. Fuses, AC Power Cord, Velcro Strap, and Retaining Plate

7.2.5
AC (MAINS) POWER CORD REPLACEMENT (220 V)

No tools are required for this procedure.

To replace the AC (mains) power cord, disconnect the power cord from the rear of the infuser and connect the new power cord.

To verify successful replacement of the 220V AC (mains) power cord, perform the Electrical Safety Test in *Section 5.2.11*.

7.2.6
FUSE AND FUSE DRAWER REPLACEMENT

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

To replace the fuses or fuse drawer, see *Figure 7-2*, and proceed as follows:

1. Disconnect the infusion system from AC (mains) power.
2. Using a No. 2 Phillips screwdriver, remove the AC (mains) power cord retaining plate to access the fuse drawer.
3. Using a small flat blade screwdriver, wedge the screwdriver tip between each removal tab and the side of the fuse drawer compartment to loosen the fuse drawer. Compress the removal tabs until the fuse drawer unlatches, then slide the fuse drawer from the compartment.
4. Remove the fuses from the fuse drawer. Inspect the fuse drawer, and replace, if required. Replace the fuses.
5. Insert the fuse drawer into the compartment. Push the fuse drawer until it clicks securely in place.
6. Install the AC (mains) power cord retaining plate.
7. Connect the infusion system to a hospital grade AC (mains) outlet and verify the AC (mains) symbol illuminates.

To verify successful replacement of the fuses or fuse drawer, perform the PVT in *Section 5.2*

7.2.7
VELCRO STRAP AND RETAINING PLATE REPLACEMENT

Recommended tools for this procedure are a No. 2 Phillips screwdriver and an X-acto knife.

To replace the Velcro strap and the retaining plate, see *Figure 7-2*, and proceed as follows:

1. Remove the screws that attach the Velcro strap and retaining plate to the rear of the infuser, then remove the retaining plate and strap. Do not discard the strap. Inspect the retaining plate and replace, if required.

   Note: The replacement Velcro strap does not have holes for mounting screws. The holes must be punched at the time of installation.

2. Set the replacement Velcro strap on the work surface with the fuzzy side down. Place the retaining plate on the replacement strap in the exact location as on the old strap. Using the old strap as a template, mark hole locations on the replacement strap.
3. Using an X-acto knife, punch holes in the replacement strap at the marked locations.
4. Install the replacement strap and retaining plate using the screws that were removed in Step 1.

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

7.2.8
POLE CLAMP COMPONENT REPLACEMENT

Recommended tools for this procedure are a set of Allen wrenches, No. 1 Phillips screwdriver, external retaining ring pliers, and grease.

The following sections describe replacement procedures for the pole clamp knob, shaft and screw, and friction plate.

7.2.8.1
POLE CLAMP KNOB REPLACEMENT

To replace the pole clamp knob, see *Figure 7-3*, and proceed as follows:

1. Disconnect the infusion system from AC (mains) power.
2. Using a 5/64 inch Allen wrench, loosen the set screw from the pole clamp knob. Separate the pole clamp knob from the pole clamp screw by pulling on the pole clamp knob.
3. Replace the knob, then secure and tighten the set screw.

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

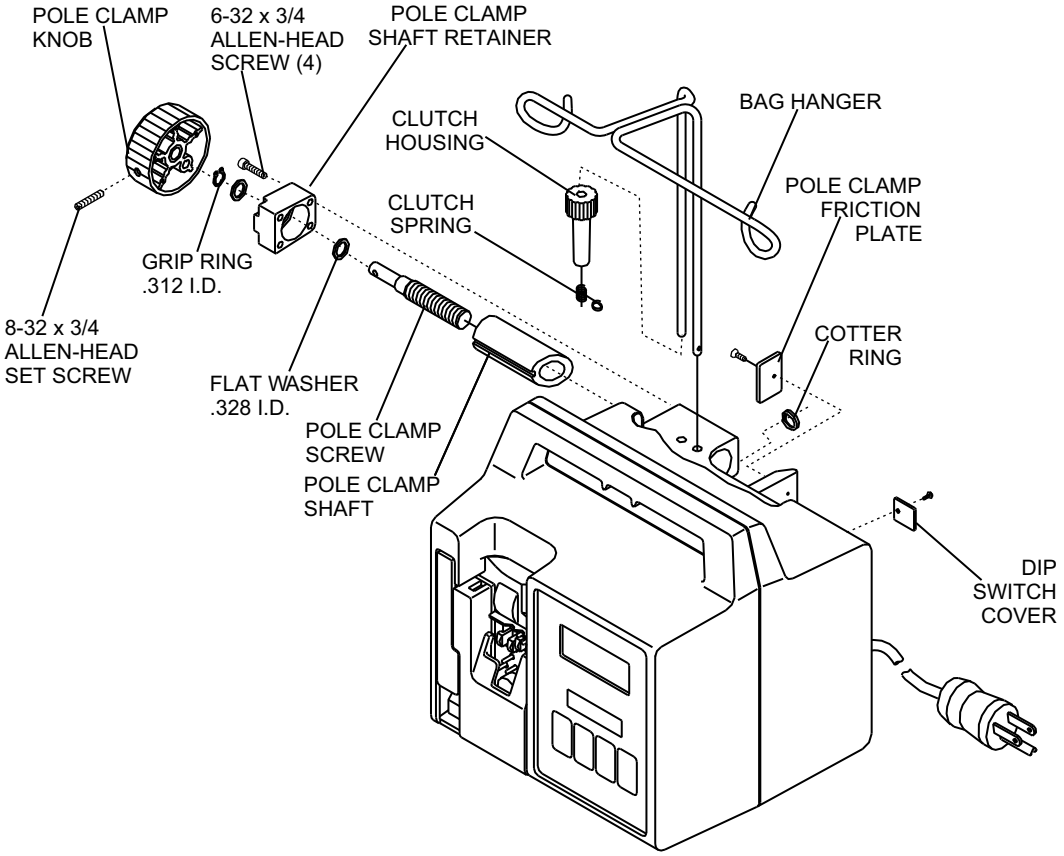


Figure 7-3. Pole Clamp and Minipole Assembly Replacement

7.2.8.2
POLE CLAMP SHAFT AND POLE CLAMP SCREW REPLACEMENT

To replace the pole clamp shaft and pole clamp screw, see *Figure 7-3*, and proceed as follows:

1. Remove the pole clamp knob as described in *Section 7.2.8.1*.
2. Using the external retaining ring pliers, remove the grip ring and flat washer.
3. Using a 7/64 inch Allen wrench, remove the screws that secure the pole clamp shaft retainer to the rear case.
4. Remove the pole clamp shaft. Rotate the shaft counterclockwise to separate it from the pole clamp screw.
5. Replace the pole clamp screw in the shaft. Lubricate with grease if necessary.
6. Insert the pole clamp shaft and screw in the rear case. Verify the shaft bevel is positioned toward the inside of the casing.
7. Using a 7/64 inch Allen wrench, secure the pole clamp shaft retainer to the rear case, using the screws that were removed in Step 3. Reassemble the grip ring and washer.
8. Clamp the infuser to an IV pole, and verify the infuser does not slide on the pole.

Replacement of the pole clamp shaft and screw is routine maintenance and no verification procedure is normally required. However, if the infusion system may have been damaged during this procedure, perform the PVT in *Section 5.2*.

7.2.8.3
POLE CLAMP FRICTION PLATE REPLACEMENT

To replace the pole clamp friction plate, see *Figure 7-3*, and proceed as follows:

1. Remove the pole clamp knob as described in *Section 7.2.8.1*, and the shaft and screw as described in *Section 7.2.8.2*.
2. Using a No. 2 Phillips screwdriver, remove the screw that secures the friction plate to the rear case.
3. Attach the replacement friction plate with the screw that was removed in Step 2.
4. Reassemble the pole clamp components in exact reverse order of disassembly.
5. Clamp the infuser to an IV pole, and verify the infuser does not slide on the pole.

Replacement of the pole clamp friction plate is routine maintenance and no verification procedure is normally required. However, if the infusion system may have been damaged during this procedure, perform the PVT in *Section 5.2*.

7.2.9
DIP SWITCH COVER REPLACEMENT

The DIP switch cover is located in the recessed I/O port panel on the left rear of the infuser. In 1.6 series infusion systems with DataPort accessory cables, the DIP switch cover is located below the DataPort accessory cable connector. In other models, the DIP switch cover is located at the top of the I/O port panel.

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

To replace the DIP switch cover, see *Figure 7-3*, and proceed as follows:

1. Disconnect the infusion system from AC (mains) power.
2. Using the small flat blade screwdriver, remove the screw that secures the DIP switch cover to the recessed I/O port panel, and remove the cover.
3. Attach the replacement DIP switch cover using the screw that was removed in Step 2.

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

7.2.10
RUBBER FOOT PAD AND FOOT INSERT REPLACEMENT

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

To replace rubber foot pads and foot pad inserts, see *Figure 7-1*, and proceed as follows:

1. Disconnect the infusion system from AC (mains) power.
2. Place the infuser on its side with the bottom of the device facing the technician.
3. Using the No. 2 Phillips screwdriver, remove the screw that secures the rubber foot pad and foot insert on each corner of the infuser, and remove the foot pads and inserts.
4. Position the rubber foot pads and inserts, and secure the pads and inserts with the screws that were removed in Step 3.

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

7.2.11
FLOW DETECTOR REPLACEMENT

The flow detector connects to the ACC jack that is located in the recessed I/O port panel on the left rear of the infuser.

To replace the flow detector, disconnect the detector from the ACC jack and connect the replacement flow detector.

7.2.12
NURSE CALL CABLE REPLACEMENT

The nurse call cable connects to the NURSE CALL jack in the recessed I/O port panel on the left rear of the infuser.

To replace the nurse call cable, disconnect the cable from the NURSE CALL jack and connect the replacement cable. Verify the new cable is operational by performing the nurse call test in *Section 5.2.5*.

7.2.13
MINIPOLE ASSEMBLY REPLACEMENT

The minipole assembly is an accessory that attaches to the infuser through two holes in the pole clamp extrusion and is held in place by a cotter ring. The 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 minipole from the holes in the pole clamp.

No tools are required for this procedure.

To replace the minipole assembly, see *Figure 7-3*, and proceed as follows:

1. Disconnect the infusion system from AC (mains) power.
2. Place the infuser face down on a soft surface.
3. Grasp the cotter ring with thumb and finger, and twist and rotate the cotter ring to remove it from the rod hole.
4. Remove the minipole assembly from the rod holes, and install the replacement minipole assembly in the exact reverse order of removal.

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

7.2.14
SEPARATING THE FRONT AND REAR COVERS

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

To separate the front and rear covers, see *Figure 7-4*, and proceed as follows:

1. Disconnect the infusion system from AC (mains) power.
2. Remove the battery pack as described in *Section 7.2.3*.
3. Remove the minipole assembly as described in *Section 7.2.13*.
4. Using a No. 2 Phillips screwdriver, remove the screws and washers from the infuser handle.
5. Remove the two screws from the lower rear of the infuser cover, and remove the rear cover.

6. Place the infuser face down on a soft surface.
7. Remove the rubber foot pads and foot inserts as described in *Section 7.2.10*.
8. Using a flat blade screwdriver, wedge the front cover so that it clears the hex head screws on the bottom of the infuser, then remove the front cover.
9. Reassemble the front and rear covers in the exact reverse order of separation.

To verify successful replacement of the front and rear covers, perform the PVT in *Section 5.2*.

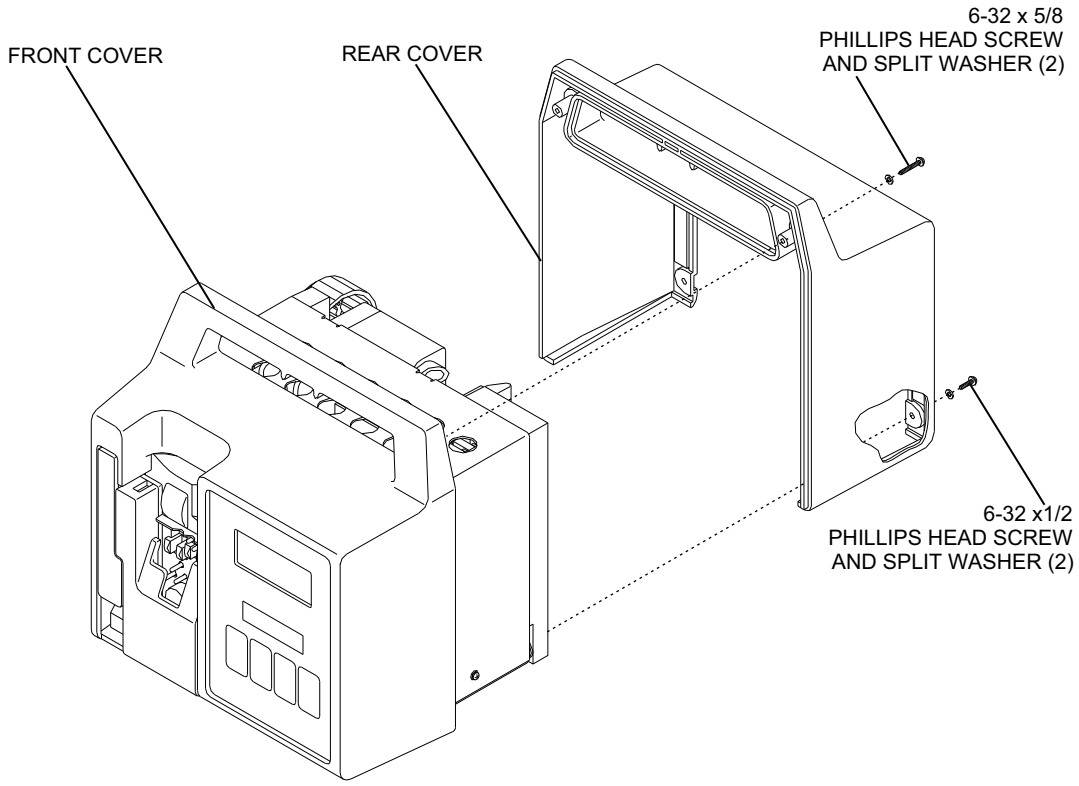


Figure 7-4. Front and Rear Cover Replacement

7.2.15
EMI SHIELD REPLACEMENT

Recommended tools for this procedure are a medium flat blade screwdriver, No. 2 Phillips screwdriver, and 1/4 inch nutdriver.

To replace the EMI shield, see *Figure 7-5*, and proceed as follows:

1. Disconnect the infusion system from AC (mains) power.
2. Separate the front and rear covers as described in *Section 7.2.14*.
3. Position the infuser on its base, with the rear of the device facing the technician.
4. Using the No. 2 Phillips screwdriver, remove the screws on the left side of the infuser. Set the screws and washers aside for reassembly.
5. Using the 1/4 inch nutdriver, loosen the screws at the top rear of the infuser and the screw at the top right of the infuser. Set the screws aside for reassembly.

   Note: To remove the EMI shield, tilt the shield up to the left to avoid damaging the PWAs.

6. Remove the EMI shield, and install the replacement EMI shield. The two tabs on the front of the shield fit into slots at the top of the front panel.
7. Reassemble the infusion system in the exact reverse order of disassembly.

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

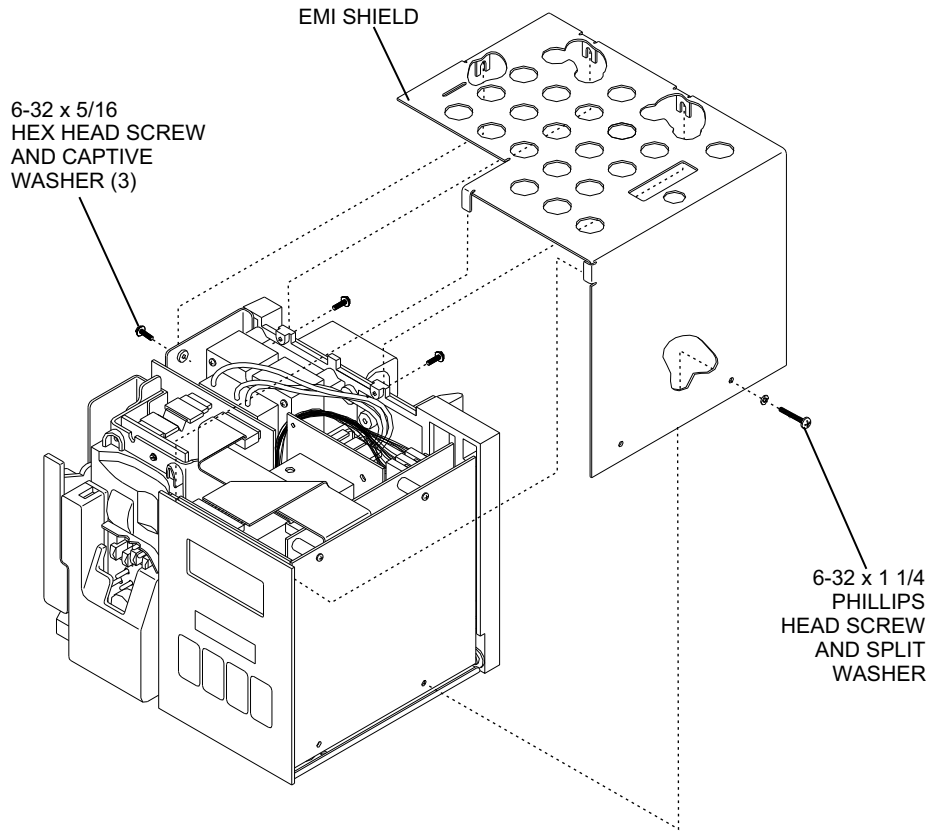


Figure 7-5. EMI Shield Replacement

7.2.16
LCD SCREEN CONTRAST ADJUSTMENT

Recommended tools for this procedure are a small flat blade screwdriver, a No. 2 Phillips screwdriver, and 1/4 inch nutdriver.

To adjust the LCD screen contrast, see *Figure 7-6*, and proceed as follows:

1. Disconnect the infusion system from AC (mains) power.
2. Separate the front and rear covers as described in *Section 7.2.14*.
3. Remove the EMI shield as described in *Section 7.2.15*.
4. Position the infuser on its base with the front of the device facing the technician.
5. Locate the main PWA and potentiometer R1. Using a small flat blade screwdriver, turn the LCD adjustment screw to achieve optimum contrast of the LCD screen.
6. Reassemble the infusion system in the exact reverse order of disassembly.

To verify correct LCD screen contrast adjustment, inspect the contrast and perform the PVT in *Section 5.2*.

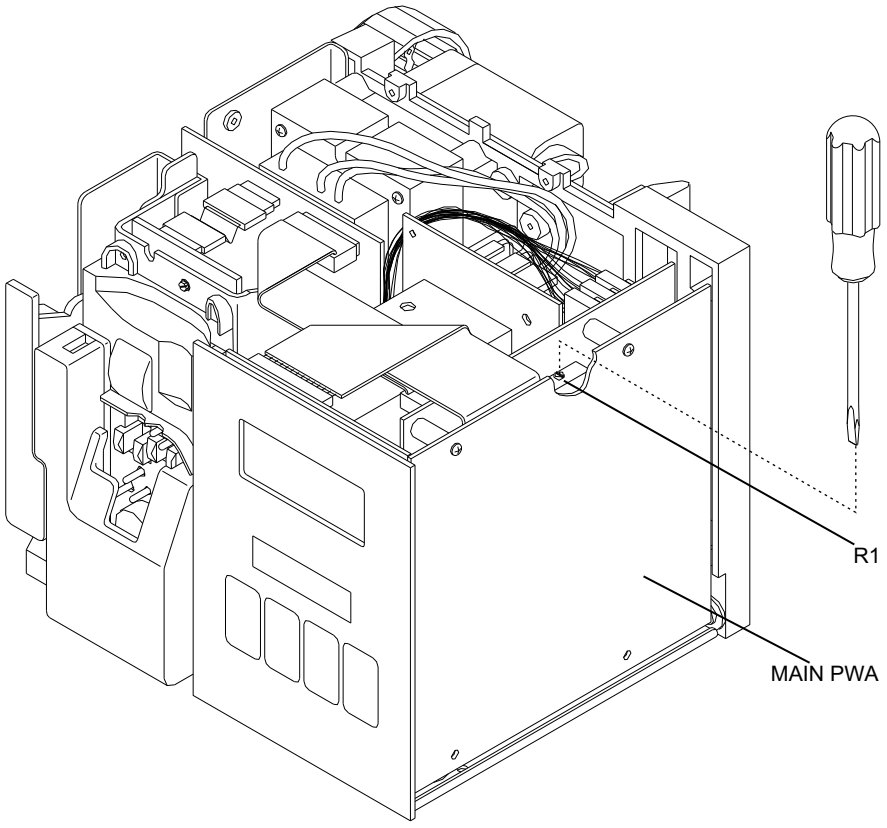


Figure 7-6. LCD Screen Contrast Adjustment

7.2.17
FRONT PANEL ASSEMBLY REPLACEMENT

Recommended tools for this procedure are a No. 2 Phillips screwdriver, medium flat blade screwdriver, set of nutdrivers, X-acto knife, and long needle nose pliers. A mild solvent is required if the front panel is to be removed and replaced.

The front panel assembly consists of the display PWA, LCD assembly, and front panel. The following sections describe replacement procedures for these front panel components.

> **Note:** The front panel assembly must be removed in order to replace any front panel assembly component. In addition, the front panel assembly must be removed in order to access the main PWA or the I/O PWA.

To replace the front panel assembly, see *Figure 7-7*, and proceed as follows:

1. Disconnect the infusion system from AC (mains) power.
2. Separate the front and rear covers as described in *Section 7.2.14*.
3. Remove the EMI shield as described in *Section 7.2.15*.

   > **Note:** Use caution when handling the ribbon cable and connector pins. A protective covering may be attached to the ribbon cable and the solder side of the main PWA.

4. Using the long needle nose pliers to support the ribbon cable, disconnect the ribbon cable ends that connect the main PWA to the LCD assembly. Gently pull the ribbon cable connector pins back and free from the main PWA.

   > **Note:** Support the main PWA while disconnecting the display PWA.

5. Disconnect the two-row connector (located at the bottom right of the display PWA) that connects to the main PWA by grasping the front panel assembly and pulling the left side clear of the mechanism assembly. Gently rock the front panel assembly until the display PWA is free from the connector.
6. Disconnect the front panel assembly from the infuser.
7. At the I/O PWA, disconnect the ribbon cable connector joining the front panel to the I/O PWA.
8. Replace the front panel assembly in exact reverse order of removal.
9. Prior to reassembling the front and rear covers, connect the infusion system to AC (mains) power and verify successful completion of the self test.
10. Disconnect the AC (mains) power, then reassemble the front and rear covers in the exact reverse order of separation.

To verify successful replacement of the front panel assembly, perform the PVT in *Section 5.2*.

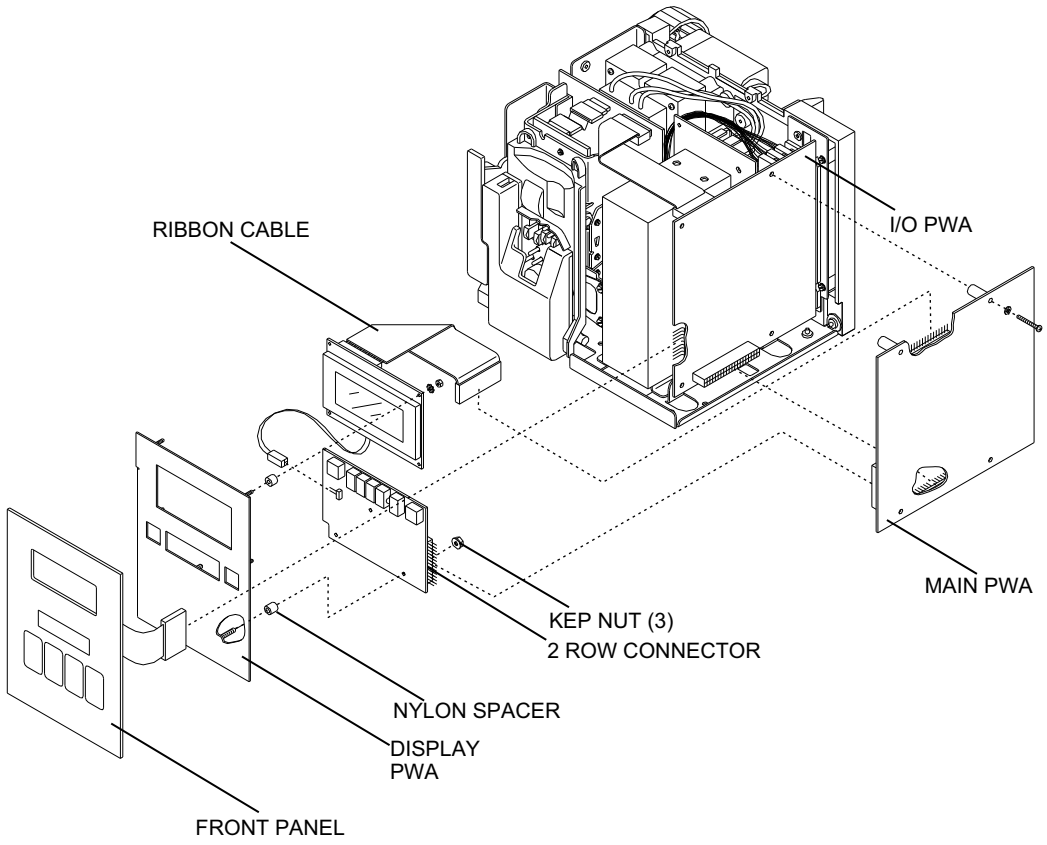


Figure 7-7. Front Panel Assembly Replacement

7.2.17.1
DISPLAY PWA REPLACEMENT

To replace the display PWA, see *Figure 7-7*, and proceed as follows:

1. Remove the front panel assembly as described in *Section 7.2.17*.
2. Using a 1/4 inch nutdriver, remove the KEP nuts from the display PWA. Remove the clear acetate insulator and set aside for reassembly.
3. Lift the display PWA from the studs and disconnect the two-pin connector that connects the display PWA to the LCD assembly. Set the nylon spacers (located under the display PWA) aside for reassembly.
4. Reconnect all cables and wire harnesses to the replacement display PWA, then connect the infusion system to AC (mains) power and verify the self test successfully completes.
5. Disconnect AC (mains) power. Install the display PWA in the exact reverse order of removal. Verify the two-pin connector wires are retained in the insulator loop retainer.
6. Replace the front panel assembly in the exact reverse order of disassembly.
7. Reassemble the infusion system in the exact reverse order of disassembly.

To verify successful replacement of the display PWA, perform the PVT in *Section 5.2*.

7.2.17.2
LCD ASSEMBLY REPLACEMENT

To replace the LCD assembly, see *Figure 7-7*, and proceed as follows:

1. Remove the front panel assembly as described in *Section 7.2.17*.
2. Using a 1/4 inch nutdriver, remove the three KEP nuts from the display PWA. Remove the clear acetate insulator and set aside for reassembly.
3. Lift the display PWA from the studs and disconnect the two-pin connector that connects the display PWA to the LCD assembly. Set the nylon spacers (located under the display PWA) aside for reassembly. Verify the two-pin connector is removed from the display PWA.
4. Using a 5/32 inch nutdriver, remove the hex nuts and lock washers that secure the LCD assembly to the display PWA.
5. Lift the LCD assembly from the studs and set the spacers aside for reassembly. Remove and replace the LCD assembly.
6. Reconnect all headers, cables, and wire harnesses. Connect the infusion system to AC (mains) power and verify successful completion of the self test.
7. Disconnect AC (mains) power. Replace the LCD assembly on studs and spacers.
8. Using a 5/32 inch nutdriver, replace the four hex nuts and lock washers that secure the LCD assembly to the display PWA. Verify the two-pin connector is reconnected to the display PWA and that the display PWA is secured.
9. Reassemble the infusion system in the exact reverse order of disassembly.

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

7.2.17.3
FRONT PANEL REPLACEMENT

To replace the front panel, see *Figure 7-7*, and proceed as follows:

1. Remove the front panel assembly as described in *Section 7.2.17*.
2. Using an X-acto knife, pry the front panel loose from the sub panel.
3. Using a mild solvent, remove adhesive residue from the sub panel and dry thoroughly.
4. Remove the protective paper backing from the front panel, then carefully center the front panel on the sub panel surface and press the front panel into place.
5. Connect the infusion system to AC (mains) power and verify successful completion of the self test.
6. Disconnect AC (mains) power. Reassemble the front panel assembly in the exact reverse order of disassembly.

To verify successful replacement of the front panel, perform the PVT in *Section 5.2*.

7.2.18
MAIN PWA AND I/O PWA REPLACEMENT

The following sections describe replacement procedures for the main PWA and the I/O PWA.

Recommended tools for these procedures are a medium flat blade screwdriver, No. 2 Phillips screwdriver, 1/4 inch nutdriver, and long needle nose pliers.

To replace the main PWA or the I/O PWA, proceed as follows:

7.2.18.1
MAIN PWA REPLACEMENT

To replace the main PWA, see *Figure 7-8*, and proceed as follows:

1. Disconnect the infusion system from AC (mains) power.
2. Remove the front panel assembly and EMI shield.
3. Using a No. 2 Phillips screwdriver, remove the screws and lock washers that secure the I/O PWA to the main PWA.
4. Using a slight rocking motion, gently pull the main PWA from the infuser side to disconnect the main PWA from the I/O PWA 40-pin connector (located at I/O PWA bottom) and the display PWA two-row connector.
5. Remove the main PWA and install the replacement PWA.
6. Reconnect all cables, headers, and wire harnesses in exact reverse order of removal.
7. Locate the potentiometer R1 *(see Figure 7-6)*. Using a small flat blade screwdriver, turn the LCD adjustment screw to achieve optimum contrast of the LCD screen.
8. Connect the infusion system to AC (mains) power and verify successful completion of the self test.
9. Disconnect AC (mains) power.
10. Reassemble the front panel assembly and EMI shield in the exact reverse order of removal.
11. Reassemble the infusion system in the exact reverse order of disassembly.
12. To verify successful replacement of the main PWA, perform the PVT in *Section 5.2*.

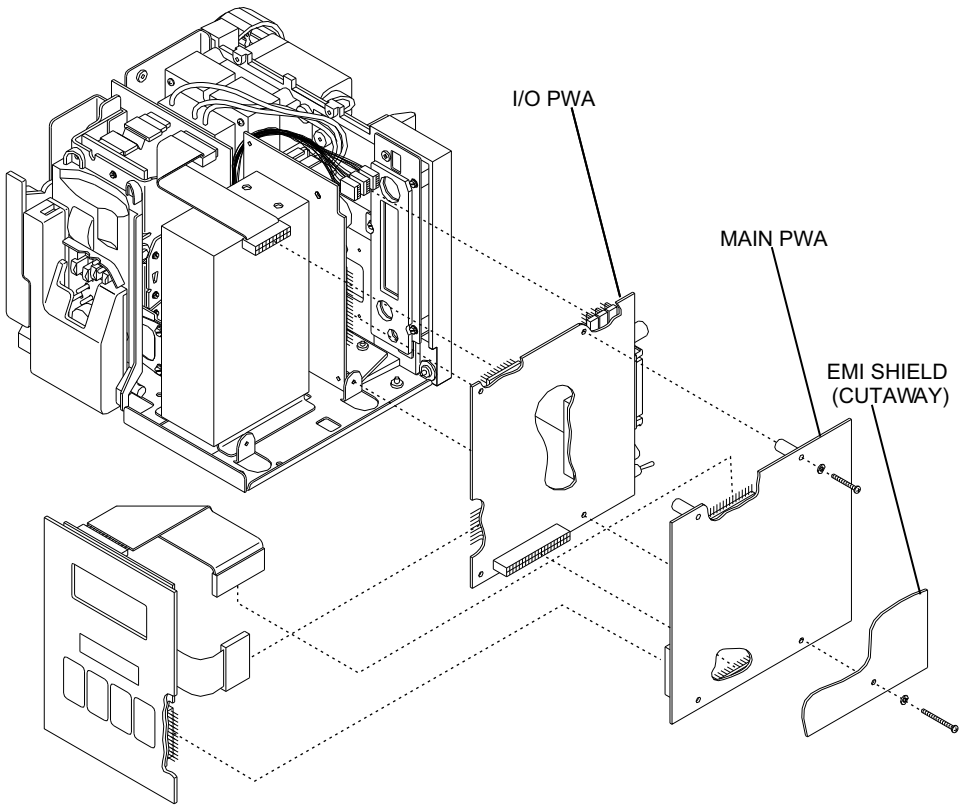


Figure 7-8. Main PWA and I/O PWA Replacement

7.2.18.2
I/O PWA REPLACEMENT

The nurse call jack, DIP switches and cover, audible alarm level switch, and flow detector jack are integral components of the I/O PWA. In 1.6 series infusion systems with DataPort accessory cables, a DB-15 interface connector is also included on the I/O PWA.

The location of the DIP switch cover on the recessed I/O port panel varies according to the presence or absence of the DataPort connector.

To replace the I/O PWA, see *Figure 7-8*, and proceed as follows:

1. Disconnect the infusion system from AC (mains) power.
2. Remove the front panel assembly and EMI shield.
3. Using a No. 2 Phillips screwdriver, remove the screws and lock washers that secure the I/O PWA to the main PWA, then separate the main PWA from the I/O PWA.
4. Using a slight rocking motion, gently pull out the 40-pin, 2-row, right-angle connector that connects the I/O PWA to the power supply PWA.
5. At the top of the I/O PWA, disconnect the ribbon cable connecting the I/O PWA to the sensor PWA. Pull the I/O PWA from the infuser, removing the I/O panel connectors from panel cutouts.

Note: Mark mating reference designations to facilitate reconnection.

6. At the top of the I/O PWA, disconnect the motor cable plugs P7 through P9. Remove the I/O PWA and record the DIP switch settings.
7. Install the replacement I/O PWA. Reconnect all cables, headers, and wire harnesses in the exact reverse order of removal.
8. Reinstall the main PWA in the exact reverse order of removal
9. Connect the infusion system to AC (mains) power.
10. Load a primed cassette into the cassette door, close the door, and verify successful completion of the self test.
11. Open the cassette door, then disconnect the infusion system from AC (mains) power.
12. Reassemble the front panel assembly and EMI shield in the exact reverse order of removal.
13. Reassemble the infuser in the exact reverse order of disassembly.
14. Using a No. 2 Phillips screwdriver, remove the screw from the DIP switch cover, then remove the cover to expose the DIP switches. Set the DIP switches to the macro (single channel) configuration *(see Figure 1-2)*.
15. Load a primed cassette into the cassette door and close the door, Verify the delivery mode displayed on the LCD screen corresponds to the DIP switch setting LCD display listed in *Figure 1-2*.
16. Open the cassette door. Set the DIP switches to the next delivery mode configuration listed in *Figure 1-2*. Repeat Step 13 until all delivery modes are verified.
17. Set the DIP switches to the delivery mode configuration that was recorded in Step 6.

To verify successful replacement of the I/O PWA, perform the PVT in *Section 5.2*.

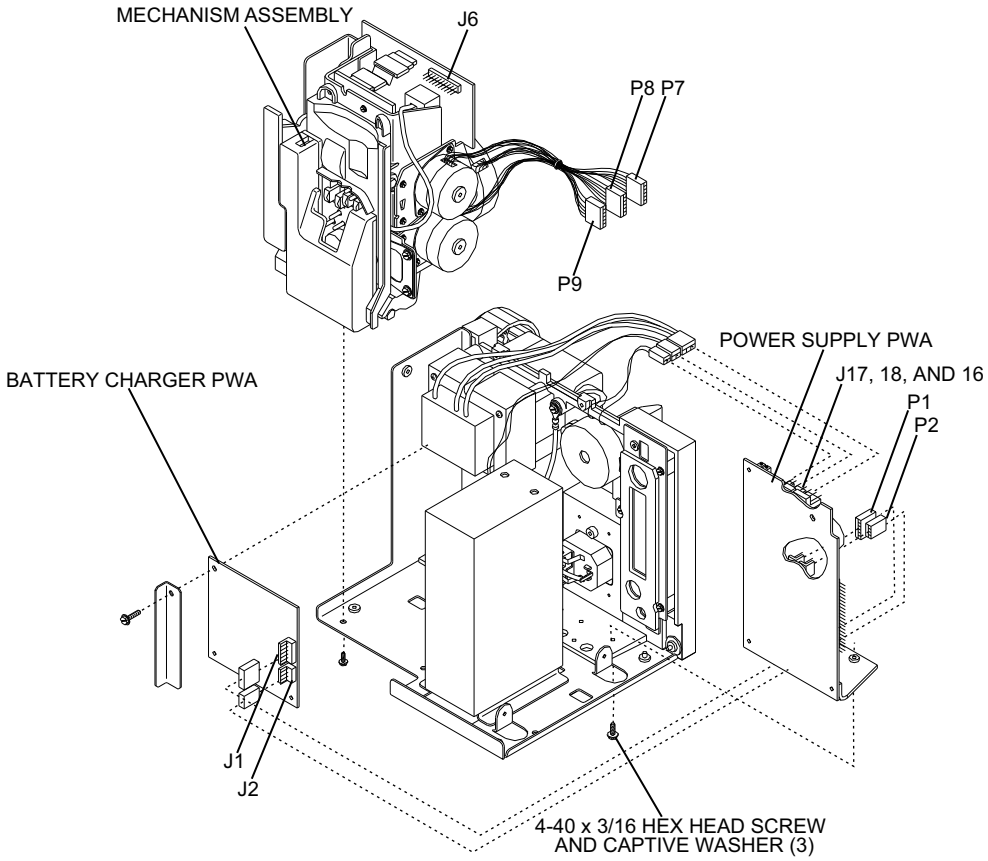


Figure 7-9. Mechanism Assembly, Power Supply PWA, and Battery Charger PWA

7.2.19
POWER SUPPLY PWA, MECHANISM ASSEMBLY, AND BATTERY CHARGER PWA REPLACEMENT

The following sections describe replacement procedures for the power supply PWA, mechanism assembly, and battery charger PWA.

> **Note:** If a defective battery charger PWA is to be replaced, the mechanism assembly must first be removed.

Recommended tools for these procedures are a medium flat blade screwdriver, No. 2 Phillips screwdriver, set of nutdrivers, X-acto knife, and needle nose pliers.

7.2.19.1
POWER SUPPLY PWA REPLACEMENT

To replace the power supply PWA, see *Figure 7-9*, and proceed as follows:

1. Disconnect the infusion system from AC (mains) power.
2. Remove the front panel assembly as described in *Section 7.2.17*.
3. Remove the main PWA and I/O PWA as described in *Section 7.2.18*.
4. Place the infuser face down on soft surface with base facing technician.
5. Using a 3/16 inch nutdriver, remove the five closely grouped hex head screws that secure the power supply PWA to the chassis bottom.
6. Place the infuser upright on its base.
7. Disconnect the connectors from J16, J17, and J18.
8. Disconnect connectors P1 and P2 to the battery boost PWA.

   Note: Confirm that all cables and wires are moved away from the power supply PWA.
9. Using the needle nose pliers, disconnect the power supply PWA harness connectors from J1 and J2 on the battery charger PWA.
10. Viewing the infuser from the main PWA side, grasp the top of the power supply PWA and lift it, tilting the top toward the power transformer. Slide the power supply PWA out toward the main PWA.
11. Remove and install the replacement power supply PWA. Reconnect all cables, headers, and wire harnesses in exact reverse order of removal.
12. Connect the infusion system to AC (mains) power and verify successful completion of the self test.
13. Disconnect the infusion system from AC (mains) power.
14. Replace the front panel assembly and EMI shield in exact reverse order of removal.
15. Reassemble the infusion system in the exact reverse order of disassembly.

To verify successful replacement of the power supply PWA, perform the PVT in *Section 5.2*.

7.2.19.2
MECHANISM ASSEMBLY REPLACEMENT

The mechanism assembly includes the bubble sensor PWA, the sensor PWA, and the pumping mechanism. The entire mechanism assembly is field-replaceable only as a single unit.

To replace the mechanism assembly, see *Figure 7-9*, and proceed as follows:

1. Disconnect the infusion system from AC (mains) power.
2. Remove the front panel assembly, as described in *Section 7.2.17*.
3. Using a 1/4 inch nutdriver, remove the three closely grouped hex head screws that secure the mechanism assembly to the chassis bottom. Support the mechanism assembly until all three screws are removed.

   Note: Two screws are located just under the cassette door. The third screw is toward the rear of the infuser.

4. Disconnect plugs 7, 8, and 9 from the I/O PWA, and remove the mechanism assembly.
5. Install the replacement mechanism assembly using the screws that were removed in Step 3. Support the mechanism assembly until all three screws are secured.
6. Connect plugs 7, 8, and 9 to the I/O PWA.
7. Connect the infusion system to AC (mains) power and verify successful completion of the self test.
8. Disconnect AC (mains) power, then reassemble the infusion system in the exact reverse order of disassembly.

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

7.2.19.3
BATTERY CHARGER PWA REPLACEMENT

To replace the battery charger PWA, see *Figure 7-9*, and proceed as follows:

1. Disconnect the infusion system from AC (mains) power.
2. Remove the front panel assembly, as described in *Section 7.2.17*.
3. Using a 3/16 inch nutdriver, remove the hex head screw that secures the hold-down bracket to the infuser chassis and heatsink, then remove the battery charger PWA.
4. Install the replacement battery charger PWA, then install the hex head screw that secures the hold-down bracket to the infuser chassis and heatsink.
5. Connect the infusion system to AC (mains) power and verify successful completion of the self test.
6. Disconnect AC (mains) power, then reassemble the infusion system in the exact reverse order of disassembly.

To verify successful replacement of the battery charger PWA, perform the PVT in *Section 5.2*, then perform the battery charger current test in *Section 5.4.1*.

7.2.20
DOOR HANDLE REPLACEMENT

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

To replace the door handle, see *Figure 7-10*, and proceed as follows:

1. Disconnect the infusion system from AC (mains) power.
2. Separate the front and rear covers as described in *Section 7.2.14*.
3. With the cassette door closed, use a No. 2 Phillips screwdriver to remove the screws that secure the door handle to the door mechanism.
4. Open the cassette door and remove the Phillips screw, then remove the door handle.
5. Install the replacement door handle in the exact reverse order of removal.
6. Open and close the door handle several times to confirm that it is operational.
7. Reassemble the infusion system in the exact reverse order of disassembly.

To verify successful replacement of the door handle, perform the PVT in *Section 5.2*.

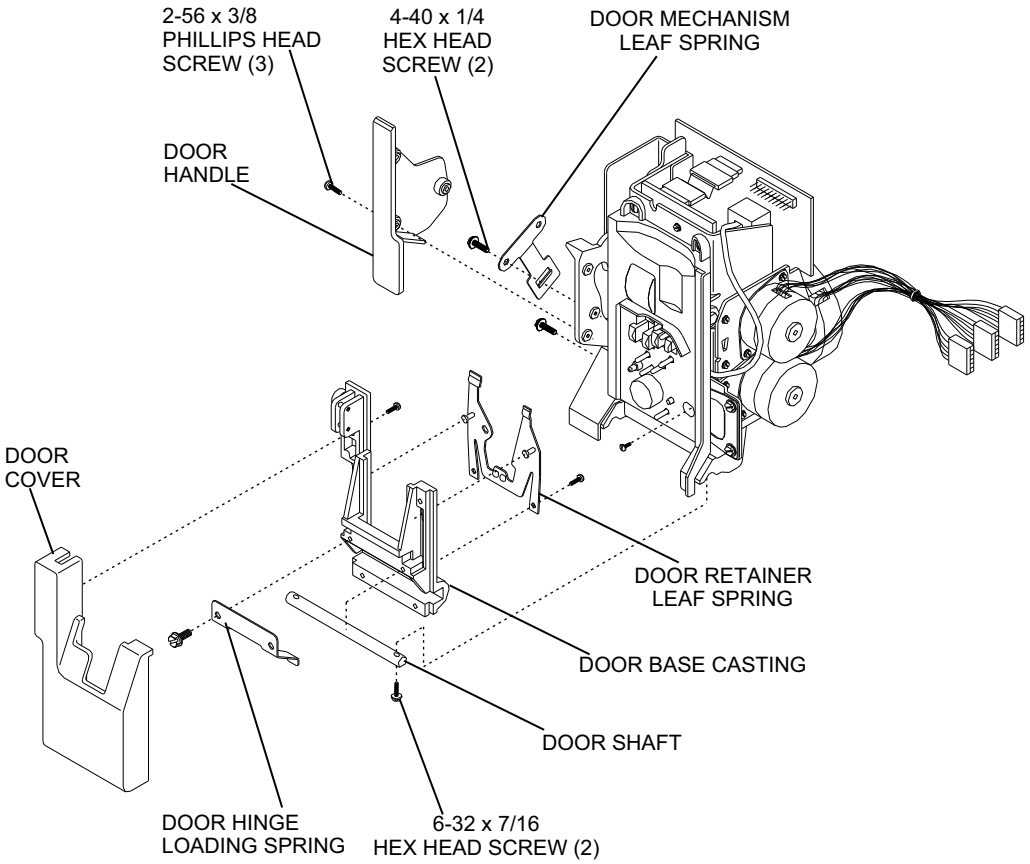


Figure 7-10. Door Assembly and Door Handle Assembly Replacement

7.2.21
DOOR MECHANISM LEAF SPRING REPLACEMENT

Recommended tools for this procedure are a 3/16 inch nutdriver or medium flat blade screwdriver and No. 1 Phillips screwdriver.

To replace the door mechanism leaf spring, see *Figure 7-10*, and proceed as follows:

1. Disconnect the infusion system from AC (mains) power.
2. Separate the front and rear covers as described in *Section 7.2.14*.
3. With the cassette door closed, use a No. 2 Phillips screwdriver to remove the screws that secure the door handle to the door mechanism.
4. Open the cassette door and remove the Phillips screw, then remove the door handle.
5. Using a 3/16 inch nutdriver or medium flat blade screwdriver, remove the hex head screws that secure the door mechanism leaf spring to the door mechanism, then remove the leaf spring.
6. Install the replacement door mechanism leaf spring and door handle in the exact reverse order of removal.
7. Open and close the door handle several times to confirm that it is operational.
8. Reassemble the infusion system in the exact reverse order of disassembly.

To verify successful replacement of the door mechanism leaf spring, perform the PVT in *Section 5.2*.

7.2.22
DOOR RETAINER LEAF SPRING REPLACEMENT

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

To replace the door retainer leaf spring, see *Figure 7-10*, and proceed as follows:

1. Disconnect the infusion system from AC (mains) power.
2. Lift the door handle, then compress the door mechanism leaf spring and pull down the cassette door assembly.
3. Using a small flat blade screwdriver, remove the screws that secure the door retainer leaf spring to the door assembly, then remove the leaf spring.
4. Replace the door retainer leaf spring by guiding the two locator pins on the bottom of the leaf spring into the slotted holes on the cassette door assembly. Position the leaf spring to align the screw holes.
5. Using a small flat blade screwdriver, install the screws that secure the leaf spring to the door assembly.
6. Compress the door mechanism leaf spring and lift the cassette door assembly into the locked position. Close the door handle to secure the door.

To verify successful replacement of the door retainer leaf spring, perform the PVT in *Section 5.2*.

7.2.23
DOOR ASSEMBLY REPLACEMENT

This procedure details replacing the door assembly. The following sections describe replacement procedures for the door assembly components.

Note: Replace the door assembly only if the entire assembly is defective.

Recommended tools for this procedure are a set of Phillips screwdrivers, set of flat blade screwdrivers, 1/4 inch nutdriver, and grease.

To replace the door assembly, see *Figure 7-10*, and proceed as follows:

1. Disconnect the infusion system from AC (mains) power.
2. Separate the front and rear covers as described in *Section 7.2.14*.
3. Using a 1/4 inch nutdriver, remove the hex head screws located on the cassette door shaft.
4. Place the infuser on its back. Grasp the cassette door, pull up on the door handle and remove the door assembly.
5. Verify the flat side of the cassette door shaft is facing the technician and the shaft is centered with the shaft hole. Position the cassette door shaft in the infuser frame shaft cradle. Verify the door base casting ball bearing snaps into position behind the door mechanism leaf spring.
6. Align the cassette door shaft screw holes with the cradle screw holes.
7. Using a 1/4 inch nutdriver, install the hex head screws located on the cassette door shaft.
8. Reassemble the infusion system in the exact reverse order of disassembly.

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

7.2.23.1
DOOR COVER REPLACEMENT

To replace the door cover, see *Figure 7-10*, and proceed as follows:

1. Disconnect the infusion system from AC (mains) power.
2. Separate the front and rear covers, as described in *Section 7.2.14*.
3. Using a 1/4 inch nutdriver, remove the hex head screws located on the cassette door shaft.
4. Place the infuser on its back. Grasp the cassette door, pull up on the door handle, and remove the door assembly.
5. Using a No. 1 Phillips screwdriver, remove the Phillips screws from the door base casting, then separate the door cover from the door base casting.
6. Install the replacement door cover by guiding the door base casting into the door cover cavity.

7. Using a No. 1 Phillips screwdriver, install the Phillips screws in the door base casting.

   CAUTION: Do not overtighten the screws. Overtightening may strip the threads.

8. Install the door assembly. Confirm the flat side of the cassette door shaft is facing the technician and the shaft is centered within the shaft hole.
9. Place the cassette door shaft into the infuser frame shaft cradle. Confirm the door base casting ball bearing snaps into position behind the door mechanism leaf spring.
10. Reassemble the door assembly in the exact reverse order of disassembly.
11. Reassemble the infusion system in the exact reverse order of disassembly.

To verify successful replacement of the door cover, perform the PVT in *Section 5.2*.

7.2.23.2
DOOR HINGE LOADING SPRING REPLACEMENT

To replace the door hinge loading spring, see *Figure 7-10*, and proceed as follows:

1. Disconnect the infusion system from AC (mains) power.
2. Separate the front and rear covers as described in *Section 7.2.14*.
3. Using a 1/4 inch nutdriver, remove the hex head screws located on the cassette door shaft.
4. Place the infusion system on its back. Grasp the cassette door, pull up on the door handle, and remove the door assembly.
5. Using a No. 1 Phillips screwdriver, remove the screws from the door base casting, then separate the door cover from the door base casting.
6. Using a medium flat blade screwdriver, remove the hex head screws that secure the door hinge loading spring to the cassette door shaft, then lift the loading spring free from the door base casting.
7. Apply a small amount of grease to the door hinge loading spring at areas of contact with the cassette door shaft. Install the replacement door hinge loading spring.
8. Align the door hinge loading spring screw holes with the screw holes in the door base casting. Using a medium flat blade screwdriver, install the hex head screws that secure the door hinge loading spring to the door base casting.
9. Install the cover by guiding the door base casting into the door cover cavity.
10. Reassemble the door cover and door base casting in the exact reverse order of disassembly.

    CAUTION: Do not overtighten the screws. Overtightening may strip the threads.

11. Reassemble the door assembly in the exact reverse order of disassembly.
12. Reassemble the infusion system in the exact reverse order of disassembly.

To verify successful replacement of the door hinge loading spring, perform the PVT in *Section 5.2*.

7.2.23.3

CASSETTE DOOR SHAFT REPLACEMENT

To replace the cassette door shaft, see *Figure 7-10*, and proceed as follows:

1. Disconnect the infusion system from AC (mains) power.
2. Separate the front and rear covers as described in *Section 7.2.14*.
3. Using a 1/4 inch nutdriver, remove the hex head screws located on the cassette door shaft.
4. Place the infuser on its back. Grasp the cassette door, pull up on the door handle, and remove the door assembly.
5. Using a No. 1 Phillips screwdriver, remove the screws from the door base casting, then separate the door cover from the door base casting.
6. Using a medium flat blade screwdriver, remove the hex head screws that secure the door hinge loading spring to the cassette door shaft, then lift the loading spring free from the door base casting.
7. Clean the grease from the door hinge loading spring.
8. Remove the cassette door shaft by lifting it free of the door base casting.
9. Clean the grease from the cassette door shaft cradle. Apply a small amount of grease 5/8 inch inward from each end of the cassette door shaft cradle.
10. Insert the cassette door shaft and center it in the cradle.
11. Apply a small amount of grease to the door hinge loading spring at areas of contact with the cassette door shaft.
12. Install the door hinge loading spring in the exact reverse order of disassembly.
13. Reassemble the door cover to the door base casting in the exact reverse order of disassembly.

    CAUTION: Do not overtighten the screws. Overtightening may strip the threads.

14. Install the door assembly in the exact reverse order of disassembly.
15. Reassemble the infusion system in the exact reverse order of disassembly.

To verify successful replacement of the cassette door shaft, perform the PVT in *Section 5.2*.

7.2.23.4

DOOR BASE CASTING REPLACEMENT

The door base casting has two roll pins, ball bearing, and a set screw that are factory installed.

To replace the door base casting, see *Figure 7-10*, and proceed as follows:

1. Disconnect the infusion system from AC (mains) power.
2. Separate the front and rear covers as described in *Section 7.2.14*.
3. Using a 1/4 inch nutdriver, remove the hex head screws located on the cassette door shaft.
4. Place the infuser on its back. Pull up on the cassette door handle and remove the door assembly.
5. Using a No. 1 Phillips screwdriver, remove the screws from the door base casting, then separate the door cover from the door base casting.
6. Using a medium flat blade screwdriver, remove the hex head screws that secure the door hinge loading spring to the cassette door shaft. then lift the loading spring free from the door base casting.
7. Clean the grease from the door hinge loading spring.
8. Remove the cassette door shaft by lifting it free of the door base casting.
9. Clean the existing grease from the cassette door shaft and the door base casting.
10. Using a small flat blade screwdriver, remove the screws that secure the door retainer leaf spring to the door base casting, then slide the leaf spring from the door base casting.
11. Install the door retainer leaf spring on the replacement door base casting. Guide the two locator pins into the slotted holes on the door assembly. Slide the leaf spring back until the screw holes are aligned.
12. Using a small flat blade screwdriver, install the screws that secure the door retainer leaf spring to the door base casting.
13. Apply a small amount of grease 5/8 inch inward from each end of the cassette door shaft cradle.
14. Insert the cassette door shaft and center it in the cradle.
15. Apply a small amount of grease to the door hinge loading spring at areas of contact with the cassette door shaft.
16. Install the door hinge loading spring.
17. Align the door hinge loading spring screw holes with the screw holes in the door base casting. Using a medium flat-blade screwdriver, install the hex head screws that secure the door hinge loading spring to the cassette door shaft.
18. Replace the door cover by guiding the door base casting into the door cover cavity.
19. Using a No. 1 Phillips screwdriver, replace the screws in the door base casting.

CAUTION: Do not overtighten the screws. Overtightening may strip the threads.

20. Place the infuser upside down with the front facing the technician and the door handle in the open position.
21. Install the door assembly with the door assembly cover facing the technician. Confirm the flat side of the cassette door shaft is facing up and the shaft is centered within the shaft hole.
22. Place the cassette door shaft into the infuser frame shaft cradle. Verify the door base casting ball bearing snaps into position behind the door retainer leaf spring.
23. Adjust the cassette door shaft so the screw holes are aligned with the screw holes in the cradle. Insert the hex head screws that were removed in Step 3.
24. Close the door handle. Using a 1/4 inch nutdriver, secure the hex head screws.
25. Reassemble the infusion system in the exact reverse order of disassembly.

To verify successful replacement of the door base casting, perform the PVT in *Section 5.2*.

7.2.24
I/O PORT PLATE REPLACEMENT

> **Note:** Although the I/O port plate does not wear, the foam gasket attached to the plate may need to be replaced. If the gasket is defective, the I/O port plate must also be replaced.

Recommended tools for this procedure are a medium flat blade screwdriver, No. 2 Phillips screwdriver, set of nutdrivers, X-acto knife, and needle nose pliers.

To replace the I/O port plate, see *Figure 7-11*, and proceed as follows:

1. Disconnect the infusion system from AC (mains) power.
2. Separate the front and rear covers as described in *Section 7.2.14*.
3. Remove the front panel assembly as described in *Section 7.2.17*.
4. Remove the main PWA and I/O PWA as described in *Section 7.2.18*.
5. Remove the power supply PWA as described in *Section 7.2.19.1*.
6. Place the infuser on its base. Using a 1/4 inch nutdriver, remove the hex head screws that attach the I/O port plate to the rear casting.
7. Remove the I/O port plate, and install the replacement I/O port plate.
8. Reassemble the power supply PWA, the main PWA, and the I/O PWA in the exact reverse order of removal.
9. Reconnect all cables, headers, and wire harnesses in the exact reverse order of removal.
10. Connect the infusion system to AC (mains) power and verify successful completion of the self test.
11. Disconnect AC (mains) power.
12. Reassemble the infusion system in the exact reverse order of disassembly.

To verify successful replacement of the I/O port plate, perform the PVT in *Section 5.2*.

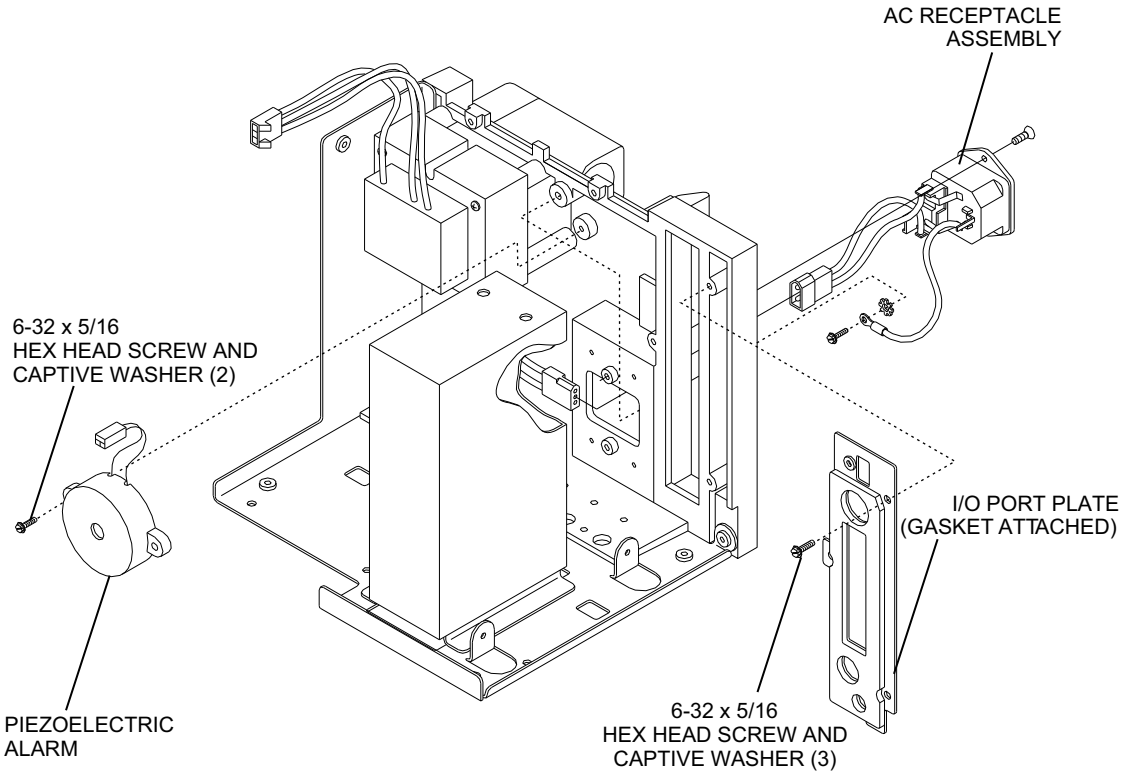


Figure 7-11. I/O Port Plate, Piezoelectric Alarm, and AC Receptacle Assembly

7.2.25
PIEZOELECTRIC ALARM ASSEMBLY REPLACEMENT

Recommended tools for this procedure are a medium flat blade screwdriver, No. 2 Phillips screwdriver, set of nutdrivers, X-acto knife, needle nose pliers, and 1/4 inch right angle socket wrench.

To replace the piezoelectric alarm assembly, see *Figure 7-11*, and proceed as follows:

1. Disconnect the infusion system from AC (mains) power.
2. Separate the front and rear covers as described in *Section 7.2.14*.
3. Remove the front panel assembly, as described in *Section 7.2.17*.
4. Remove the main PWA and I/O PWA as described in *Section 7.2.18*.
5. Remove the power supply PWA as described in *Section 7.2.19.1*.
6. Place the infuser upright. Using a 1/4 inch right-angle socket wrench, remove the hex head screws securing the piezoelectric alarm assembly to the rear casting.
7. Remove and replace the piezoelectric alarm assembly.
8. Replace the power supply PWA, main PWA, and I/O PWA in the exact reverse order of removal.

9. Reconnect all cables, headers, and wire harnesses in the exact reverse order of removal.
10. Connect the infusion system to AC (mains) power and verify successful completion of the self test.
11. Disconnect AC (mains) power.
12. Reassemble the infusion system in the exact reverse order of disassembly.

To verify successful replacement of the piezoelectric alarm assembly, perform the PVT in *Section 5.2*.

7.2.26
AC RECEPTACLE ASSEMBLY REPLACEMENT

Recommended tools for this procedure are a medium flat blade screwdriver, No. 2 Phillips screwdriver, set of nutdrivers, X-acto knife, needle nose pliers, and 1/4 inch right-angle socket wrench.

To remove the AC (mains) receptacle assembly, see *Figure 7-11*, and proceed as follows:

1. Disconnect the infusion system from AC (mains) power.
2. Separate the front and rear covers as described in *Section 7.2.14*.
3. Remove the front panel assembly, as described in *Section 7.2.17*.
4. Remove the main PWA and I/O PWA as described in *Section 7.2.18*.
5. Remove the power supply PWA as described in *Section 7.2.19.1*.
6. Using a 1/4 inch right-angle socket wrench, remove the hex head screw and lock washer that secure the ground (earth) wire to the rear casting.
7. Using a No. 2 Phillips screwdriver, remove the screws that secure the AC (mains) receptacle assembly and wire harness to the rear casting. Pull the receptacle assembly and wire harness through the rear casting opening until the T1 power transformer connector is visible.
8. Disconnect the power transformer connector from the power transformer leads, then remove the AC (mains) receptacle assembly.
9. Install the replacement AC (mains) receptacle assembly.
10. Install the power transformer connector through the receptacle opening. If the power transformer connector has moved inside the rear casting opening, retrieve the connector with needle nose pliers.
11. Connect the plug end of the AC (mains) receptacle assembly to the power transformer connector. Push the AC (mains) receptacle assembly and wire harness through the rear casting opening.
12. Using a 1/4 inch right-angle socket wrench, install the hex head screw and lock washer that secure the ground (earth) wire to the rear casting.

    Note: For proper grounding, the star lock washer must be positioned between the ground lug and the rear casting housing.

13. Replace the power supply PWA, main PWA, and I/O PWA in the exact reverse order of removal.

14. Connect all cables, headers, and wire harnesses in the exact reverse order of removal.
15. Connect the infusion system to AC (mains) power and verify successful completion of the self test.
16. Disconnect AC (mains) power.
17. Reassemble the infusion system in the exact reverse order of disassembly.

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

7.2.27
JUNCTION BOX REPLACEMENT (1.6 SERIES WITH DATAPORT)

No tools are required for this procedure.

To replace the junction box, proceed as follows:

1. Place the infuser with the rear facing the technician.
2. Loosen the jackscrews that secure the junction box to the infuser connector, then remove the junction box.
3. Install the replacement junction box. Tighten the jackscrews that secure the junction box to the infuser connector.

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

7.2.28
DATAPORT ACCESSORY CABLE REPLACEMENT (1.6 SERIES WITH DATAPORT)

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

See *Table 7-1* for DataPort accessory cable part descriptions and associated list numbers. See *Figure 7-12* for connector information.

To replace a DataPort accessory cable that contains a six-pin modular connector at the junction box, compress the tab on the connector and disconnect the cable.

To replace a DataPort accessory cable that contains a connector type other than six-pin modular at the junction box, use a small flat blade screwdriver or compress the tabs as appropriate.

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

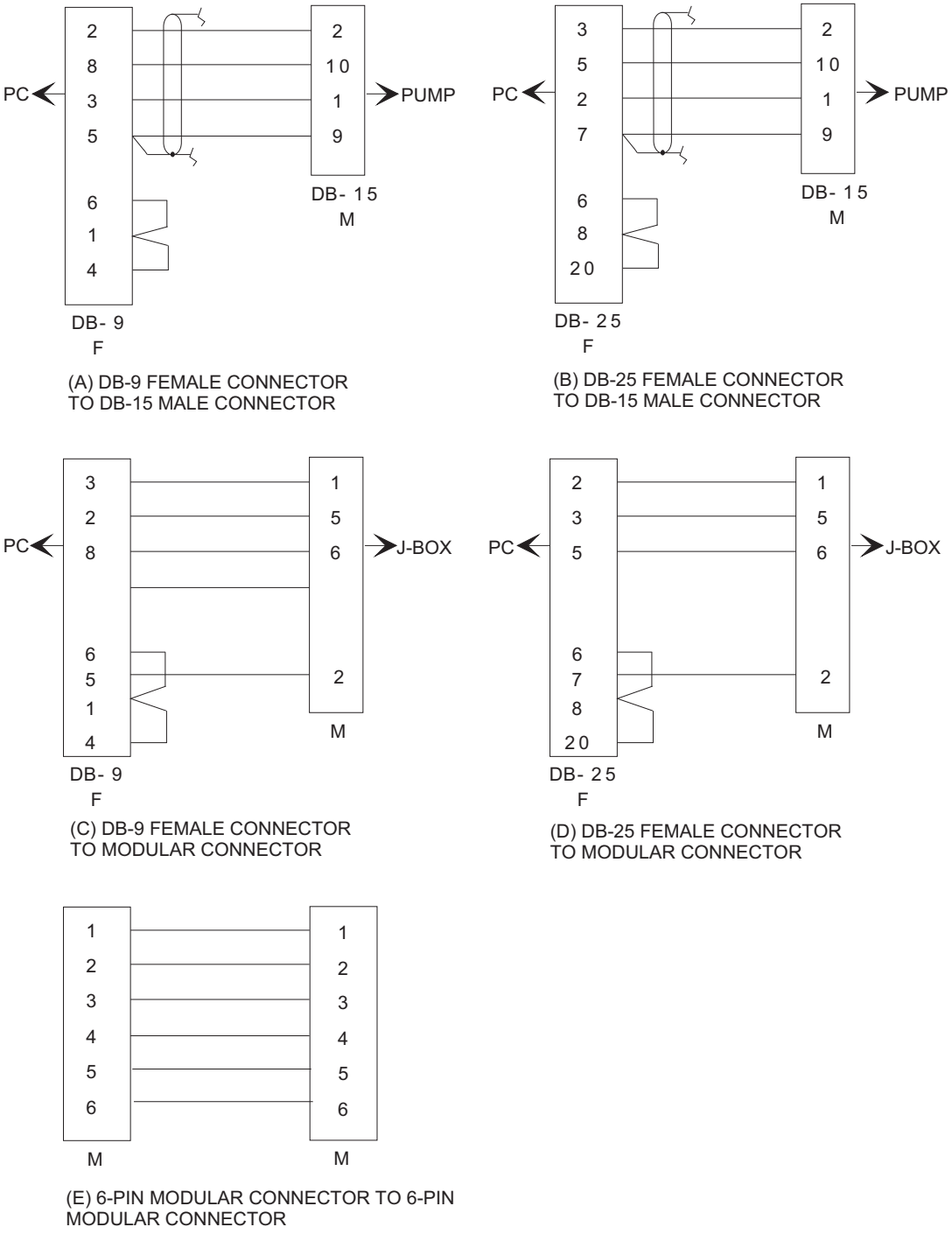


Figure 7-12. DataPort Accessory Cable Schematics

7.2.29
MECHANISM ASSEMBLY CLEANING AND LUBRICATION

Recommended tools for this procedure are a set of flat blade screwdrivers, 1/4 inch nutdriver, small six-inch brush, PlumSet, Electro-Wash 2000 or isopropyl alcohol, cotton swabs, and Braycote 804 grease.

Note: If using isopropyl alcohol, assure that all residual lubricant is removed.

To clean and lubricate the mechanism assembly, see *Figure 7-13* and *Figure 7-14*, and proceed as follows:

1. Remove the mechanism assembly as described in *Section 7.2.19.2*. Do not remove the power supply PWA.
2. Load a cassette into the cassette door. Close the cassette door.
3. Remove the infuser cables that connect the sensor PWA to the I/O PWA, bubble sensor PWA, and pressure sensor.
4. Using a 1/4 inch nutdriver, remove the hex head screws that secure the sensor PWA to the mechanism assembly. Unclip the connectors on the component side of the sensor PWA, and remove the sensor PWA.
5. Using a 1/4-inch nutdriver, remove the hex head screws that secure the plunger motor to the mechanism assembly.
6. Grasp the plunger motor and rotate the plunger motor coupling counterclockwise until the motor and coupling disengage from the plunger shaft.

   CAUTION: Do not remove the plunger motor coupling from the plunger motor. Do not remove the brass nut.

7. Inspect the door shield for foreign matter. Remove the door shield, if required, as described in *Section 7.2.31*.
8. Using Electro-Wash 2000 or isopropyl alcohol, clean the mechanism assembly, as follows:
   - Clean the plunger shaft. Use a small six-inch brush to remove the existing grease.
   - Clean the inside of the plunger nut. Use a cotton swab to remove the existing grease.
   - Clean any foreign matter from the component side of the bubble sensor PWA, the component side of the sensor PWA, each mechanism assembly lubrication point *(see Figure 7-13)*, and behind the door shield (if removed).

   Note: If isopropyl alcohol is used, verify the alcohol evaporates prior to application of Braycote 804 grease.
9. Apply grease to the first 1/2 inch of the plunger shaft threads. Use enough grease to fill the threads, as well as the threads inside the plunger nut *(see Figure 7-14)*.
10. Apply an adequate amount of grease (approximately 0.1 cc) to each of the mechanism assembly lubrication points.
11. If the door shield was removed, replace it in the exact reverse order of removal.

12. Grasp the plunger motor, motor wires up, and insert the plunger motor coupling on the plunger shaft. Rotate the plunger motor coupling clockwise until the plunger motor is flush against the mechanism assembly.
13. Using a 1/4 inch nutdriver, install the hex head screws that secure the plunger motor to the mechanism assembly. Confirm the screws are fully tightened.
14. Using a small size flat blade screwdriver, rotate the I/O flags to the full up position.
15. Open the cassette door and remove the cassette. Close the cassette door.
16. Install the sensor PWA. Do not force it into position. Use a small size flat blade screwdriver to compress the microswitch lever located on the sensor PWA.

    Note: Press the primary valve pin while seating the sensor PWA to reposition the I/O flags and allow the sensor PWA to be seated more easily.

17. Verify that the sensor PWA is fully seated in the motor base notches. Using a 1/4 inch nutdriver, install the hex head screws that secure the sensor PWA to the mechanism assembly.
18. Inspect the four optical interrupters. Verify the four optical interrupter motor flags rotate freely and have adequate sensor clearance.
19. Install the cables that connect the sensor PWA to the I/O PWA, bubble sensor PWA, and pressure sensor.
20. Replace the mechanism assembly in exact reverse order of removal.

To verify successful cleaning and lubrication of the mechanism assembly, perform the PVT in *Section 5.2*.

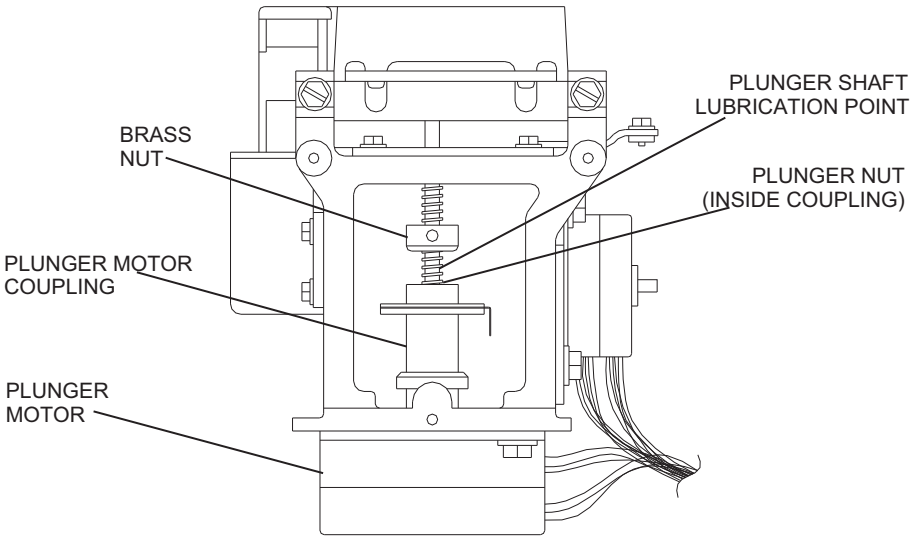


Figure 7-13. Plunger Shaft Threads and Plunger Nut Lubrication

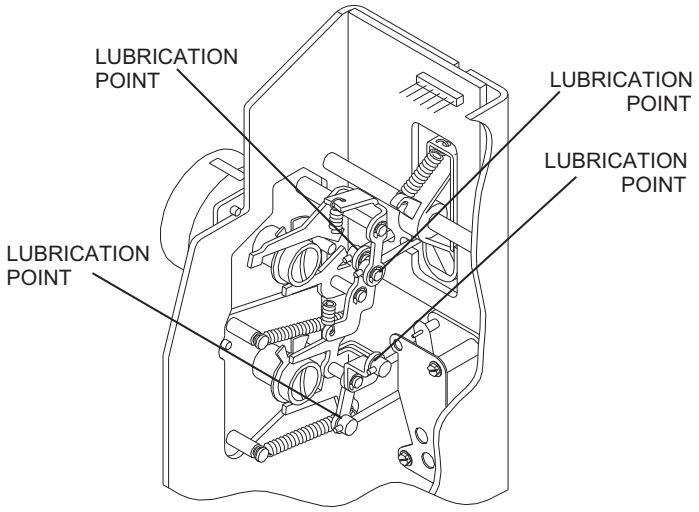


Figure 7-14. Mechanism Assembly Lubrication Points

7.2.30
DISTAL PRESSURE SENSOR ELECTRICAL ADJUSTMENT

Recommended tools, or equivalents, for this procedure are as follows:

- Small flat blade screwdriver
- DMM
- Red GLPT insulating varnish
- PlumSet, List No. 6426
- Large bore needle, 18-gauge, or blunt cannula
- 20 cc syringe with the volume limited at 20 cc
- DPM
- Three-way stopcock

For all testing, the vertical height distance from the top of the fluid in the flexible container to midline of the cassette must be 18 ± 6 inches (46 ± 15 cm).

Note: Cassettes used in this procedure should be replaced daily.

To perform the distal pressure sensor electrical adjustment, proceed as follows:

1. Remove the front and rear covers as described in *Section 7.2.14*.
2. Remove the EMI shield as described in *Section 7.2.15*.
3. Insert a primed cassette and close the door. Attach the negative lead of the DMM to TP0 and the positive lead to TP1 on the sensor PWA.
4. Connect the distal tubing to the three-way stopcock and attach to the DPM.
5. Attach the 18-gauge needle or blunt cannula into the lower Y site of the distal tubing.
6. Open the stopcock to air.
7. Verify the DPM reads 0 psi. Adjust R15 to obtain 1.37 ± 0.015 V on the DMM.

8. Move the stopcock to read the pressure. Using the 20 cc syringe, create a back pressure of 8 psi.
9. While holding 8 psi of pressure, adjust R14 to obtain 2.97 ± 0.015 V.
10. Repeat Steps 5 through 7 until the specified voltages are within limits.

    Note: If the voltage cannot be adjusted within specifications, return the infusion system to Hospira for mechanical adjustment of the sensors *(see Section 6.1)*.

11. Add one drop of red GLPT insulating varnish to R14 and R15.
12. Reassemble the infusion system in the exact reverse order of disassembly.

To verify successful digital pressure sensor electrical adjustment, perform the PVT in *Section 5.2*.

7.2.31
DOOR SHIELD REPLACEMENT

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

To replace the door shield, see *Figure 7-15*, and proceed as follows:

1. Remove the door assembly as described in *Section 7.2.23*.
2. Using a medium flat blade screwdriver, remove the four screws that secure the door shield to the mechanism assembly.
3. Remove the door shield by pulling it straight out.
4. Install the door shield and door assembly in the exact reverse order of removal.

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

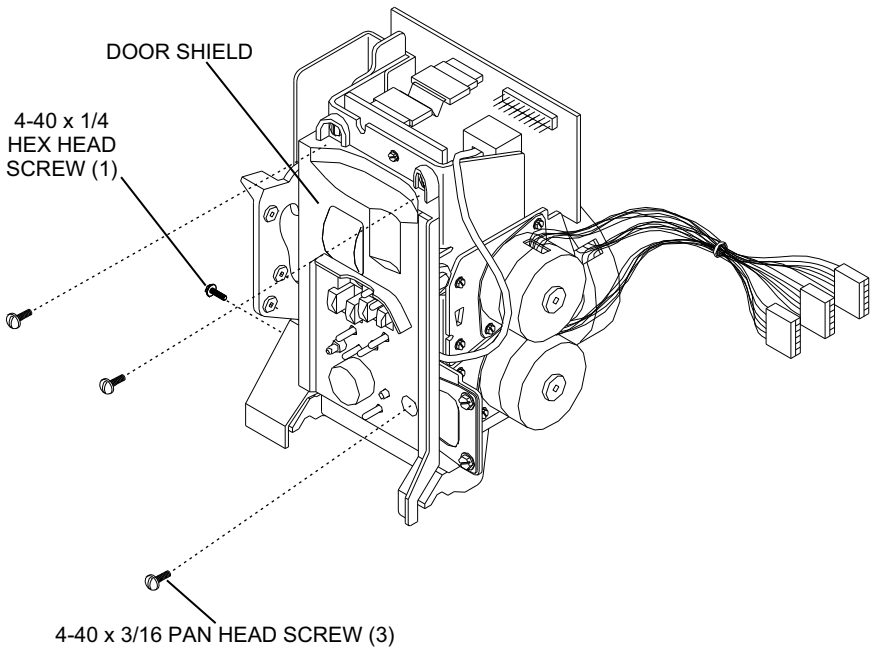


Figure 7-15. Door Shield Replacement

This page intentionally left blank.

Section 8
SPECIFICATIONS

This section contains specifications for the LifeCare 5000 domestic and international infusion systems.

8.1
LIFECARE 5000 SERIES DOMESTIC

The following specifications apply to the domestic infusion system only.

PHYSICAL	
Dimensions:	Approximately 7 in. x 9 in. x 9 in. (18 cm x 23 cm x 23 cm), excluding pole clamp and power cord storage
Weight:	Approximately 13 lbs. (6 kg), with battery
Casing:	High-impact plastic
ELECTRICAL	
Power Requirements:	110 to 120 AC, 50/60 Hz, 30 W
Power Cord:	Hospital-grade AC (mains) power cord; 8 ft.; with transparent plug, and retainer plate on infuser
Fuses:	0.5 A, 250 V, Slo-Blo
Battery:	One sealed, rechargeable, 8 V; internal; accessible for ease of field replacement; with color-coded leads and polarized connector Battery life (new batteries, full charge at 20 C): approximately 500 mL total volume delivered at 125 mL/hr, or six hours of operation, whichever occurs first
Battery Recharge:	Battery is on recharge any time the infusion system is connected to AC (mains) power Recharge rate: to 80% of prior charge in 16 hours while operating at a delivery rate of 125 mL/hr or less
Battery Self-Discharge:	50% of charge retained for at least one month when the infusion system is neither connected to AC (mains) power nor operating
Electrical Leakage:	Risk current limits meet ANSI/AAMI ES1-1985 (ungrounded) standard
Delivery Rate Accuracy:	± 5% in typical clinical use

ENVIRONMENT

Temperature: 50 to 104 F (10 to 40 C)

Relative Humidity: 10% to 90%, noncondensing

Pressure: Equivalent altitudes from 0 to 10,000 feet

SHIPPING AND STORAGE:

Temperature (infusion system only): -34 to 60 C (-29.2 to 140 F)

Temperature (set only): -34 to 55 C (-29.2 to 131 F)

Relative Humidity: 10% to 90% noncondensing at temperatures up to 104 F (40 C); maximum of 15% noncondensing at temperatures from 41 to 60 C (105.8 to 140 F)

DELIVERY RATE RANGE

Micro Mode: 0.1 to 99.9 mL/hr (in 0.1 mL increments; total primary rate plus secondary rate cannot exceed 99.9 mL/hr)

In concurrent mode, the rates for either primary or secondary cannot be less than 0.5 mL/hr

Macro Mode: 1 to 999 mL/hr (in 1 mL increments)

In concurrent mode, total primary rate plus secondary rate cannot exceed 700 mL/hr

DOSE LIMIT RANGE

Micro Mode: 0.1 to 999 mL (in 0.1 mL increments)

Macro Mode: 1 to 9999 mL (in 1 mL increments)

SECONDARY DOSES

Dual Channel Delivery: A single dose of a secondary fluid may be administered

Multidose Delivery: 1 to 24 doses of a secondary fluid may be administered at intervals from 15 minutes to 24 hours

OPERATING BACKPRESSURE: -2 to 10 psi (-14 to 69 kPa)

OCCLUSION ALARM: Maximum pressure is user selectable from 0.1 to 10 psi (0.7 to 69 kPa), through the front panel touchswitches

Distal: DISTAL OCCLUSION alarm sounds within two pumping cycles after the distal set tubing or set outlet fitting becomes occluded

Proximal: PROXIMAL OCCLUSION alarm sounds if the tubing proximal to the cassette becomes occluded

AIR-IN-LINE ALARM

Distal: STOPPED AIR IN DISTAL LINE alarm sounds if a bubble 100 microliters or larger passes the distal air-in-line sensors (alarm may sound at detection of a bubble as small as 50 microliters)

Proximal: STOPPED AIR IN PROXIMAL LINE alarm sounds if a bubble approximately 1200 microliters or larger passes through the proximal air-in-line sensors

DELIVERY ACCURACY System +/- 5%

NURSE CALL SYSTEM The NURSE CALL alarm is factory set for normally open (NO)

Contact Hospira to make an internal adjustment to change the infusion system from a normally open (NO) to normally closed (NC) system

FLOW DETECTOR: (Optional) Detects drops when attached to the primary site

Used to identify empty container conditions

DataPort: (Optional) The DataPort communication system provides monitoring of up to 15 infusion systems connected to the same communication signal lines

Hardware configuration is a modified version of the EIA-232-D configuration

8.2
LIFECARE 5000 SERIES INTERNATIONAL

The following specifications apply to the international infusion system only.

PHYSICAL

Size:	18 x 23 x 23 cm (7 x 9 x 9 inches) excluding pole clamp
Weight:	Approximately 6.0 kg (13 lbs.), with battery
Mains Voltage:	110 to 120 V, 50/60 Hz, 30 VA 220 to 240 V, 50/60 Hz, 35 VA 100 V, 50/60 Hz, 35 VA
Mains Fusing:	(110 to 120 V) Two each: T500 mA, 250 V, 5 x 20 mm (100 V) Two each: T630 mA, 250 V, 5 x 20 mm (220 to 240 V) Two each: T200 mA, 250 V, 5 x 20 mm
Mains Cord	(110 to 120 V) UL hospital-grade AC (mains) power cord; 2.5 ± 0.5 m (8 ft.) (220 to 240 V) IEC 601-1 approved detachable cord; 2.5 ± 0.5 m (8 ft.)
Battery	One sealed, rechargeable 8 V; internal; accessible for ease of field replacement; with color-coded leads and polarized connector
Battery Operating Time:	Battery life (new batteries, full charge at 20 C): approximately 500 mL total volume delivered, or six hours of operation, whichever occurs first With a new, fully charged battery, at a delivery rate of 125 mL/hr, the infusion system displays a LOW BATTERY alarm at least 15 minutes prior to shutdown If a LOW BATTERY alarm occurs, immediately connect the infusion system to AC (mains) power Gradual degradation over extended periods of use decreases the operational capacity of the battery. Typical battery life is three years. A yearly check is recommended to verify performance. When capacity drops to an unacceptable level, replace the battery. Battery replacement must be performed by qualified technical personnel
Battery Recharge:	Battery recharges when the infusion system is connected to AC (mains) power Battery recharges to 80% of prior charge in 24 hours
Battery Charge Retention:	A fully charged battery will retain at least 50% of its capacity after one month when the infusion system is neither connected to mains power nor operating

Nurse Call System: The NURSE CALL alarm is factory set for normally open (NO) systems. An internal adjustment may be made by qualified technical personnel

Electronic Memory: Settings are retained for four hours after power is turned off

Electrical Safety: (110 to 120 V) meets UL 544 standards

(100 and 220 to 240 V) meets IEC 601-1 standards

Operating Environment: 10 to 40 C (50 to 104 F), 10% to 90% relative humidity

Shipping/Storage Environment: -20 to 60 C (-4 to 140 F), 10% to 90% relative humidity

Occlusion Alarm Pressure Limit: Selectable from 7 to 55 kPa (1 to 8 psi)

Maximum Occlusion Pressure: 128 kPa (18 psi, approximate)

Delivery Rate Accuracy: ± 5% in typical clinical use

DELIVERY RATE RANGE

Micro Mode: 0.1 to 99.9 mL/hr (in 0.1 mL increments; total primary rate plus secondary rate cannot exceed 99.9 mL/hr)

In concurrent mode, the rates for either primary or secondary cannot be less than 0.5 mL/hr

Macro Mode: 1 to 999 mL/hr (in 1 mL increments)

In concurrent mode, total primary rate plus secondary rate cannot exceed 700 mL/hr

DOSE LIMIT RANGE

Micro Mode: 0.1 to 999 mL (in 0.1 mL increments)

Macro Mode: 1 to 9999 mL (in 1 mL increments)

AIR-IN-LINE ALARM

Distal: STOPPED AIR IN DISTAL LINE alarm sounds if a bubble 100 microliters or larger passes the distal air-in-line sensors (Alarm may sound at detection of a bubble as small as 50 microliters)

Proximal: STOPPED AIR IN PROXIMAL LINE alarm sounds if a bubble approximately 1200 microliters or larger passes through the proximal air-in-line sensors

This page intentionally left blank.

Section 9
DRAWINGS

Figure 9-1 through *Figure 9-6* show the Illustrated Parts Breakdown (IPB) and assembly drawings. *Table 9-1* lists drawings by figure number and title. *Table 9-2* identifies parts by index numbers which correlate to *Figure 9-1*.

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

Table 9-1. Drawings

Figure Number	Title
9-1	Illustrated Parts Breakdown (2 Sheets)
9-2	Main PWA
9-3	Mechanism Assembly
9-4	Heatsink Assembly (International)
9-5	Main Chassis, Mechanism, and PWAs
9-6	Exterior Assembly

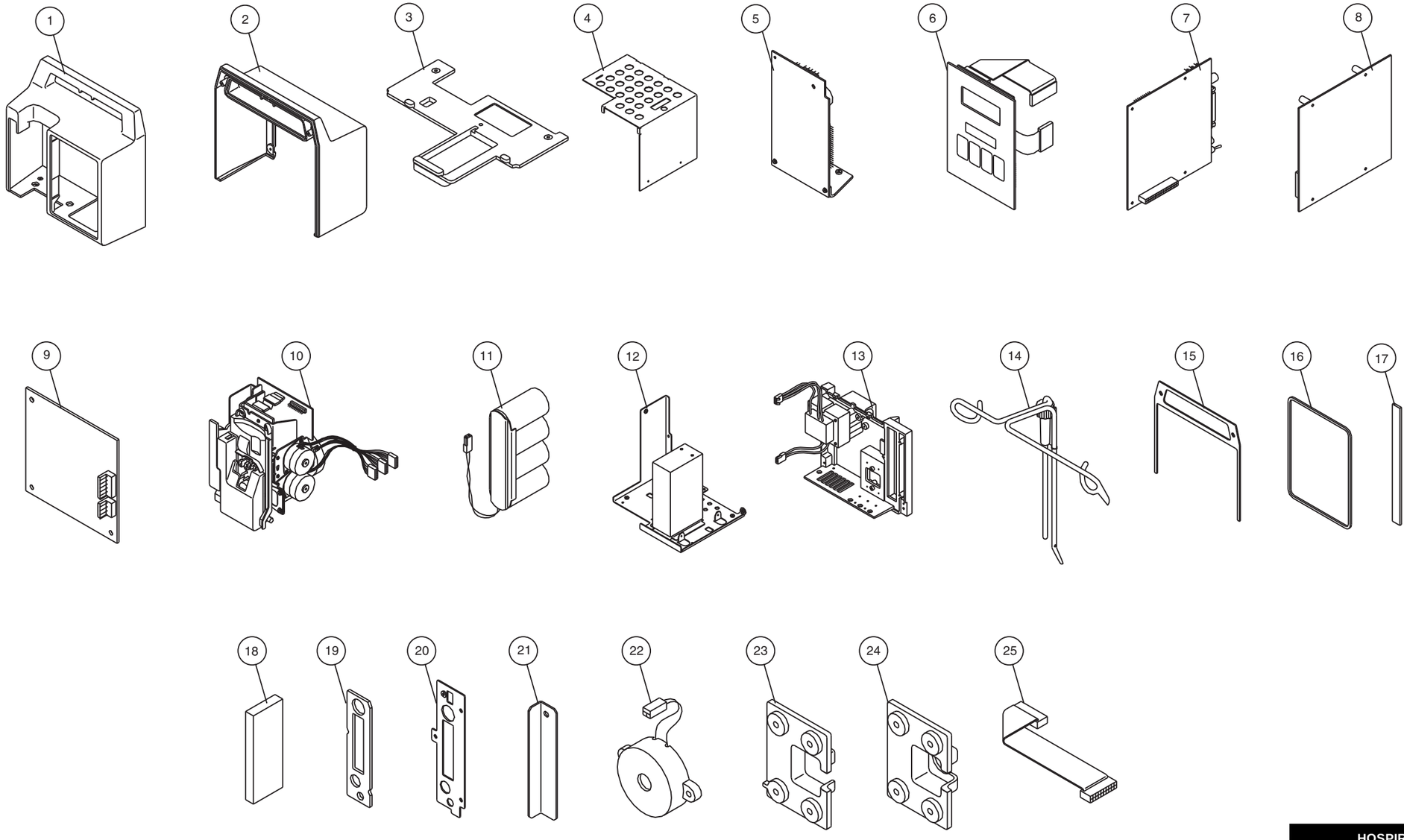
Table 9-2. Illustrated Parts Breakdown

Index Number	Nomenclature	Replacement Procedure
1	Cover, Front	*Section 7.2.13*
2	Cover, Rear	*Section 7.2.13*
3	Cover, Battery Pack	*Section 7.2.2*
4	Shield, EMI	*Section 7.2.14*
5	PWA, Power Supply	*Section 7.2.18.1* *Section 7.2.19.1*
6	Assembly, Front Panel	*Section 7.2.16*
6A	Assembly, LCD	*Section 7.2.16.2*
6B	PWA, Display	*Section 7.2.16.1*
6C	Sub Panel	As applicable
6D	Panel, Front	*Section 7.2.16*
6E	Spacer, Round, .187 x .091 x .20	As applicable
6F	Spacer, Round, .250 x .140 x .25	As applicable
7	PWA, DataPort	*Section 7.2.17.2*

Table 9-2. Illustrated Parts Breakdown		
Index Number	**Nomenclature**	**Replacement Procedure**
8	PWA, Main	*Section 7.2.17.1*
9	PWA, Battery Charger	*Section 7.2.19.3*
10	Assembly, Mechanism	*Section 7.2.18.2* *Section 7.2.19.2*
10A	Handle, Door	*Section 7.2.20*
10B	Leaf Spring, Door Mechanism	*Section 7.2.21*
10C	Shield, Door	*Section 7.2.31*
10D	Assembly, Leaf Spring/Retainer, Door	*Section 7.2.21*
10E	Base, Door Casting	*Section 7.2.23.4*
10F	Shaft, Cassette Door	*Section 7.2.23.3*
10G	Spring, Loading, Door Hinge	*Section 7.2.23.2*
10H	Cover, Door	*Section 7.2.23.1*
11	Assembly, Battery Pack, w/Wire Harness	*Section 7.2.2*
12	Assembly, Main Chassis	As applicable
13	Enclosure, Heatsink	As applicable
14	Assembly, Minipole	*Section 7.2.12*
14A	Hanger, Bag	*Section 7.2.12.2*
14B	Housing, Clutch	*Section 7.2.12.3*
14C	Spring, Clutch	*Section 7.2.12.4*
15	Gasket, Front Cover	As applicable
16	Gasket, Front Panel	As applicable
17	Gasket, Heatsink, Rear Cover	As applicable
18	Pad, Battery	As applicable
19	Gasket, I/O Port	As applicable
20	Panel, I/O Port	*Section 7.2.8*
21	Bracket, Hold Down	*Section 7.2.19.3*
22	Assembly, Piezoelectric Alarm	*Section 7.2.25*
23	Cover, Line Plug, International	*Section 7.2.3*
24	Cover, Line Plug	*Section 7.2.3*
25	Assembly, Cable, Ribbon, Sensor-to-I/O	*Section 7.2.24*
26	Cordset, AC, Hospital Grade, Detachable	*Section 7.2.3*
27	Cordset, AC, Hospital Grade, Detachable, International	*Section 7.2.3.1*
28	Strap, Velcro, Light Gray	*Section 7.2.6*

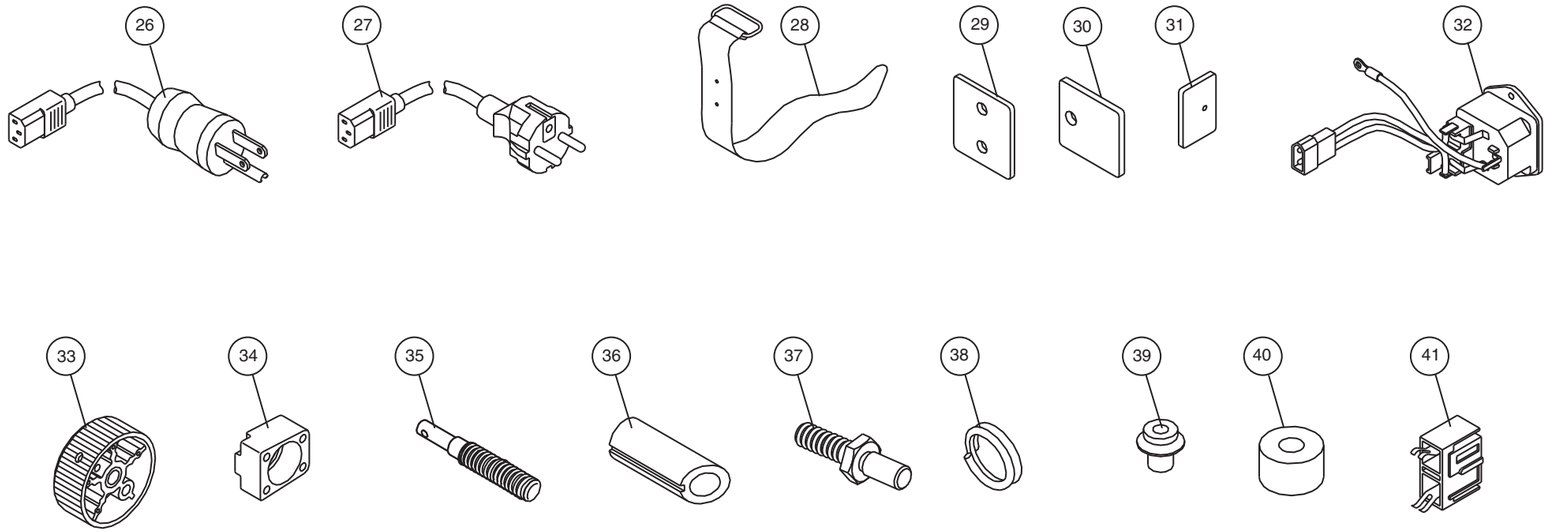
Table 9-2. Illustrated Parts Breakdown		
Index Number	**Nomenclature**	**Replacement Procedure**
29	Plate, Backing, Cord Retainer	*Section 7.2.3* *Section 7.2.6*
30	Cover, DIP Switch	*Section 7.2.8*
31	Assembly, Friction Plate, Pole Clamp	*Section 7.2.7.3*
32	Assembly, AC Receptacle	*Section 7.2.26*
33	Knob, Pole Clamp	*Section 7.2.7.1*
34	Retainer, Shaft, Pole Clamp	*Section 7.2.7.2*
35	Screw, Pole Clamp	*Section 7.2.7.2*
36	Clamp, Shaft	*Section 7.2.7.2*
37	Terminal, Equipotential	As applicable
38	Ring, Cotter	*Section 7.2.12.1*
39	Insert, Foot	*Section 7.2.9*
40	Bumper, Rubber, .563 x .383	As applicable
41	Drawer, Fuse, 2-Pole	*Section 7.2.5*
42	Fuse, .5A, 250V, Slo-Blo	*Section 7.2.5*
43	Screw, 6-32 x .50, Pan Head, Phillips	As applicable
44	Screw, 6-32 x .25, Pan Head, Phillips	As applicable
45	Screw, Cap, 6-32 x .75, Socket head	As applicable
46	Screw, 4-40 x .375, Flat Head, Phillips	As applicable
47	Screw, 4-40 x 5/16 Hex Head, Slotted, w/Washer	As applicable
48	Screw, 6-32 x .875, Pan Head, Phillips	As applicable
49	Screw, 6-32 x 5/16, Hex Head, Slotted, w/Washer	As applicable
50	Screw, 6-32 x 1.25, Pan Head, Phillips	As applicable
51	Screw, 6-32 x .375, Pan Head, Phillips	As applicable
52	Screw, 4-40 x 3/8, Pan Head, Phillips	As applicable
53	Screw, 4-40 x 1/4, Hex Head, Slotted, w/Washer	As applicable
54	Screw, 4-24 x .312, Dual, Pan Head, Phillips	As applicable
55	Screw, 4-40 x 3/16, Pan Head, Slotted	As applicable
56	Screw, 6-32 x 7/16, Hex Head, Slotted, w/Washer	As applicable
57	Screw, 6-32 x 3/8, Flat Head, Phillips	As applicable
58	Screw, Set, 8-32 x .75	As applicable
59	Grip-Ring, .312 Shaft	As applicable
60	Washer, Flat, .328 x .567 x .06 Thk.	As applicable

Table 9-2. Illustrated Parts Breakdown		
Index Number	**Nomenclature**	**Replacement Procedure**
61	Washer, Lock, Split, Helical Spring	As applicable
62	Washer, Lock, Split, #2, .020 Thk.	As applicable
63	Washer, Lock, #6, External Tooth	As applicable
64	Washer, Lock, 1/4, .025 Thk., Internal Tooth	As applicable
65	Nut, M6-1, Hex, Steel	As applicable
66	Nut, 2-56, Hex, Cad	As applicable
67	Nut, 4-40, KEP, w/Conical Washer	As applicable



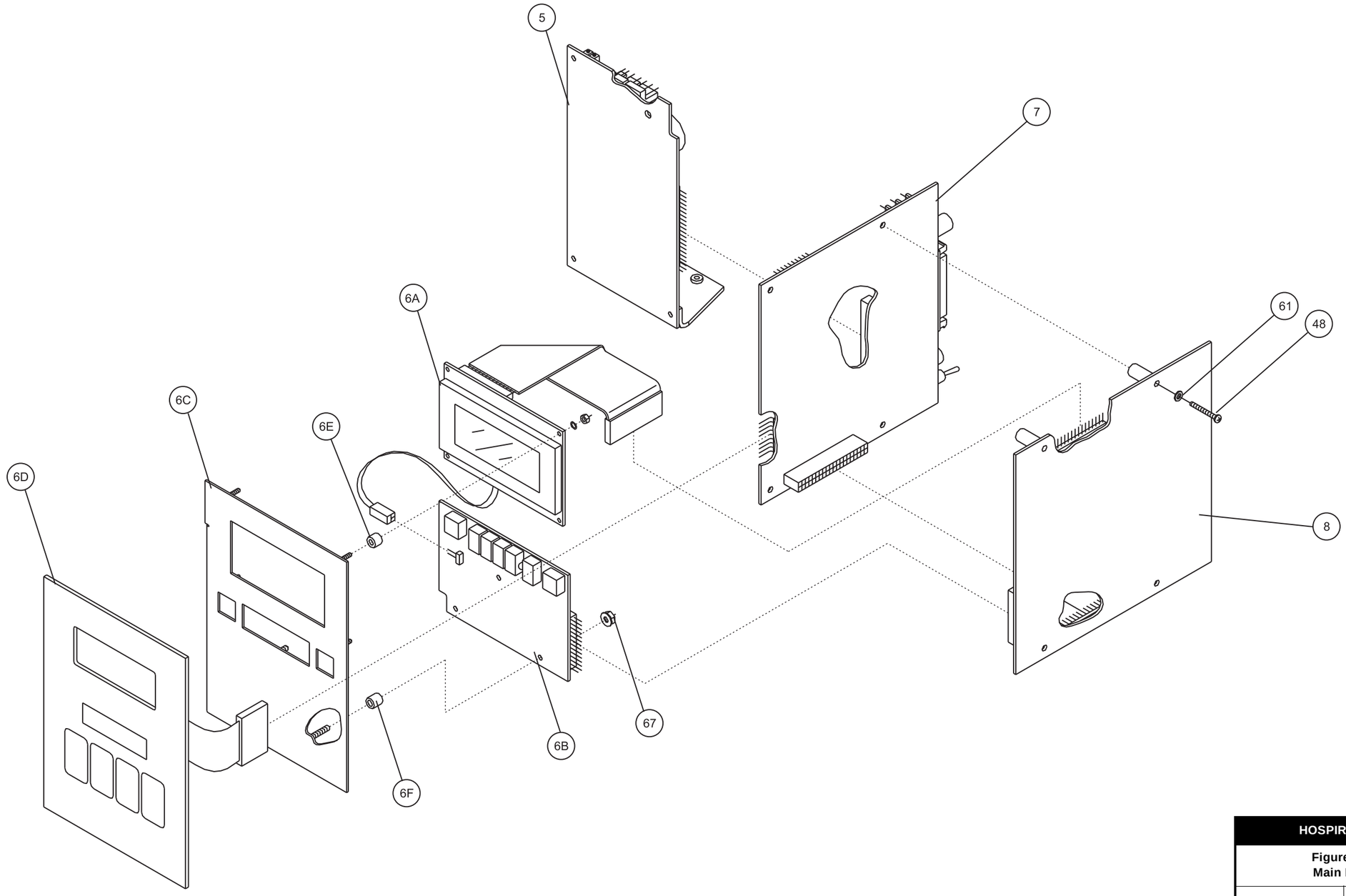
HOSPIRA, INC.	
Figure 9-1. **Illustrated Parts Breakdown**	
DRAWING NO. **N/A**	**Rev. N/A**
	Sheet 1 of 2

This page intentionally left blank.



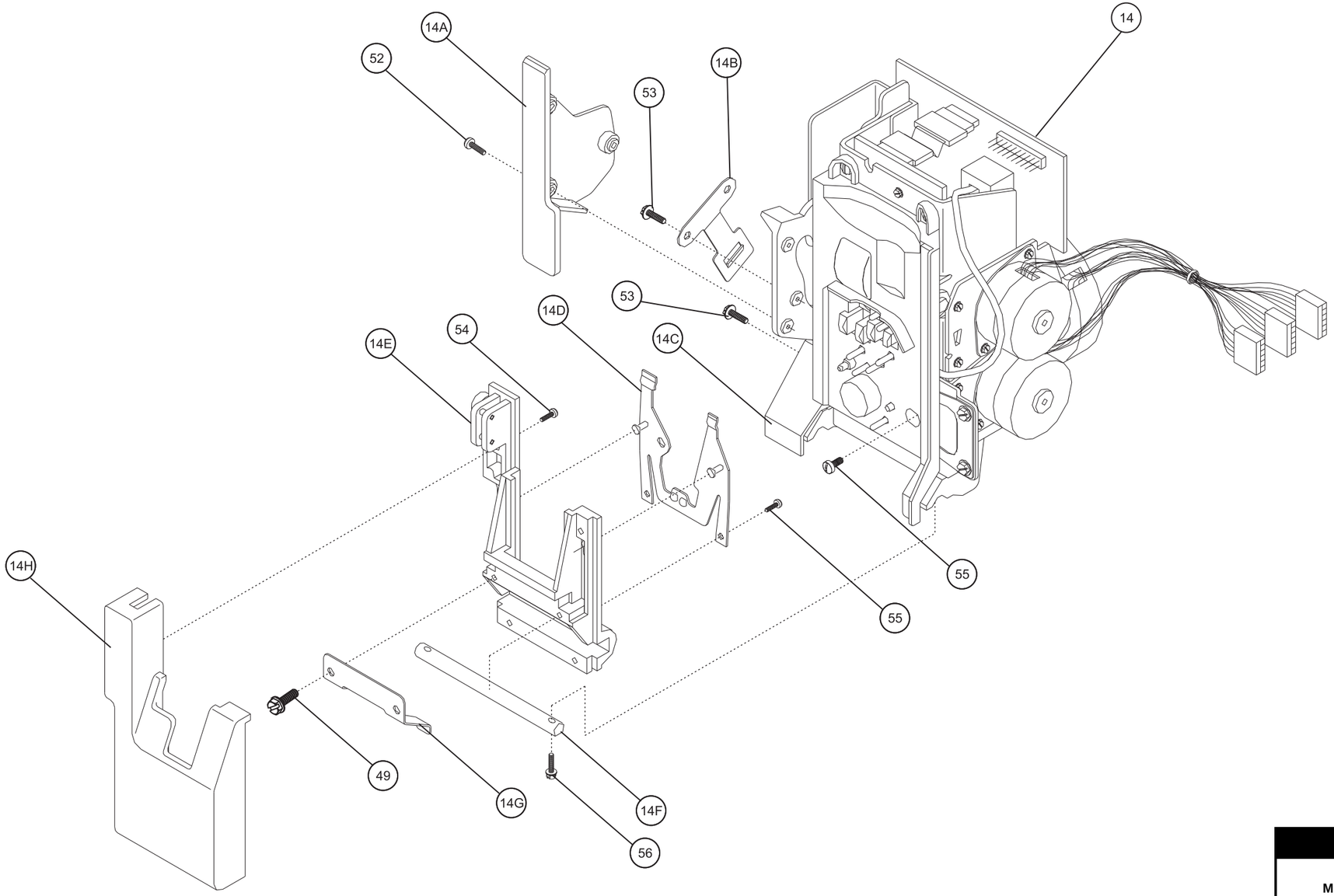
HOSPIRA, INC.	
Figure 9-1. **Illustrated Parts Breakdown**	
DRAWING NO. **N/A**	**Rev. N/A**
	Sheet 2 of 2

This page intentionally left blank.



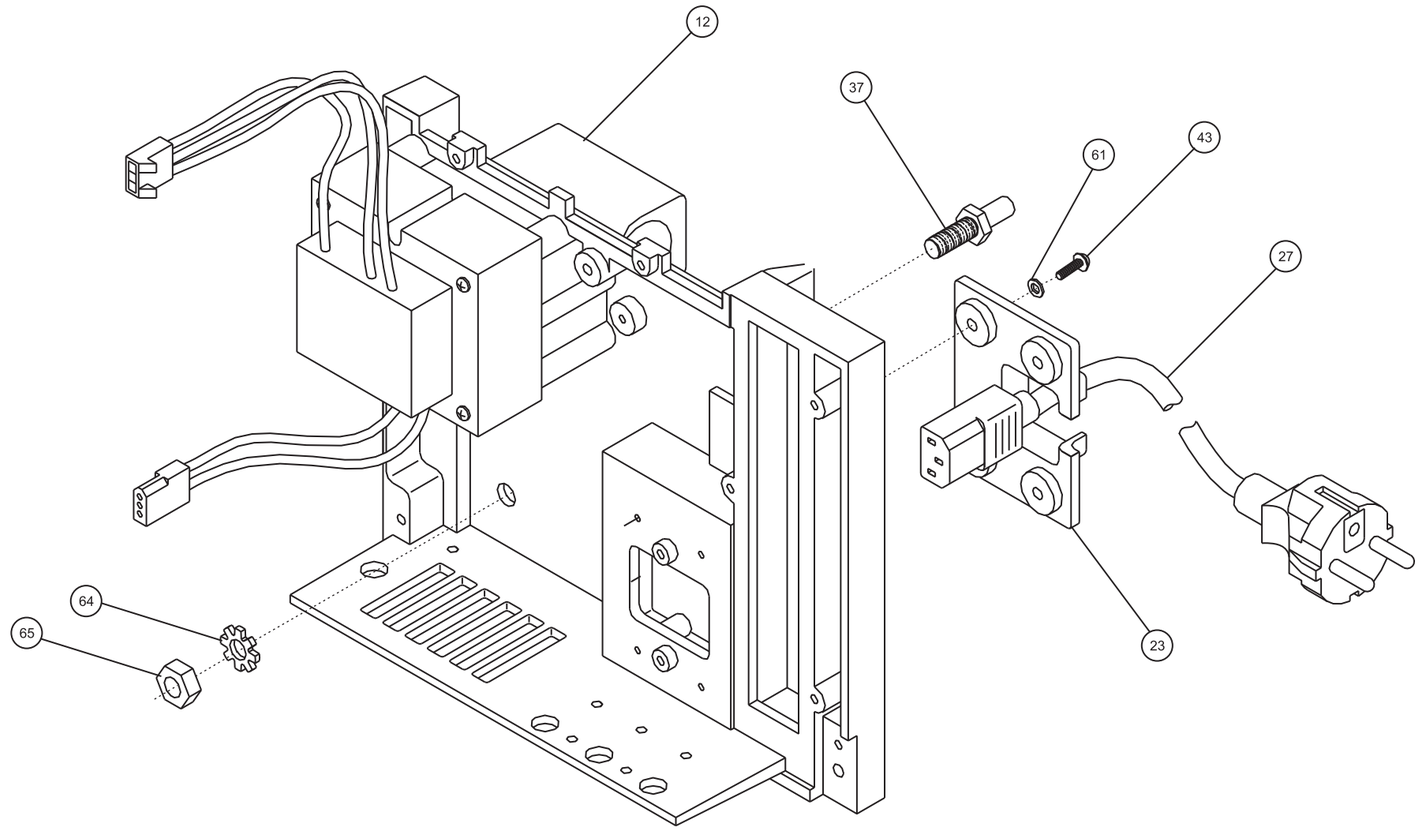
HOSPIRA, INC.	
Figure 9-2. Main PWA	
DRAWING NO. N/A	Rev. N/A
	Sheet 1 of 1

This page intentionally left blank.



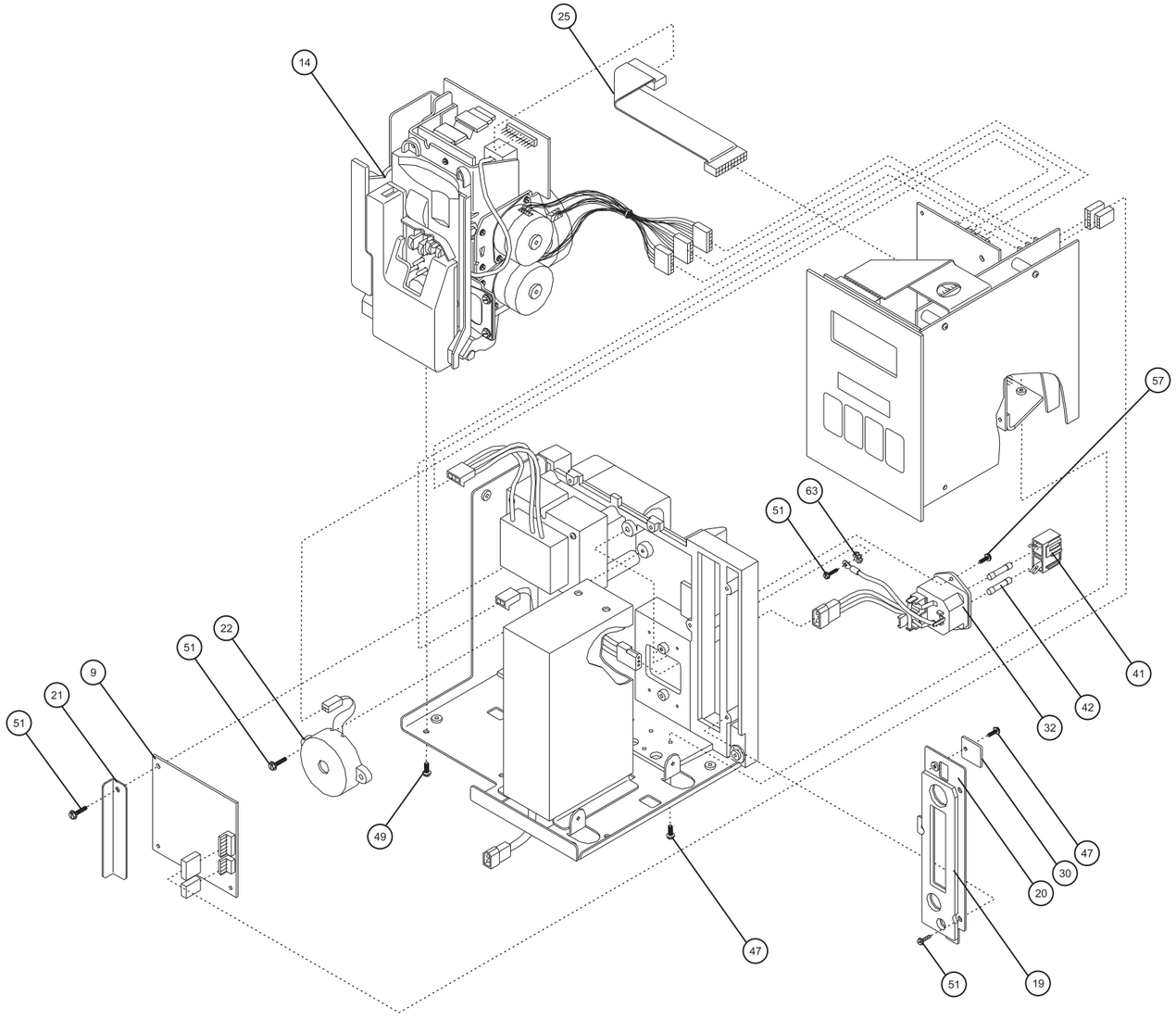
HOSPIRA, INC.	
Figure 9-3. Mechanism Assembly	
DRAWING NO. N/A	Rev. N/A
	Sheet 1 of 1

This page intentionally left blank.



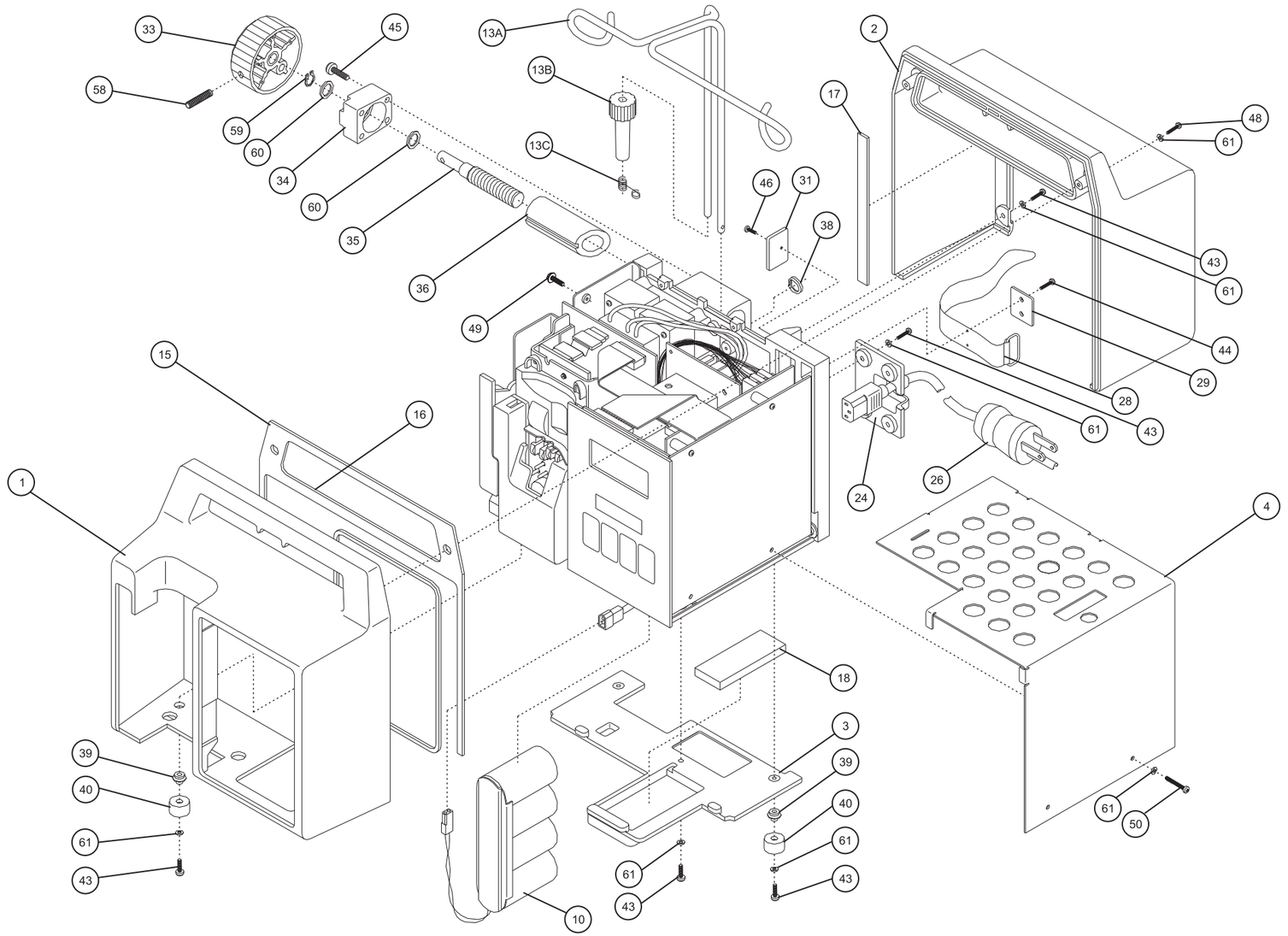
HOSPIRA, INC.	
Figure 9-4. Heatsink Assembly	
DRAWING NO. N/A	Rev. N/A
	Sheet 1 of 1

This page intentionally left blank.



HOSPIRA, INC.	
Figure 9-5. **Main Chassis, Mechanism, and PWAs**	
DRAWING NO. **N/A**	**Rev. N/A**
	Sheet 1 of 1

This page intentionally left blank.



HOSPIRA, INC.	
Figure 9-6. Exterior Assembly	
DRAWING NO. N/A	Rev. N/A
	Sheet 1 of 1

This page intentionally left blank.

INDEX

A

A/D conversion, 4-22
AC (mains) line and battery power indication, 4-29
AC (mains) operation, 4-31
AC (mains) power cord replacement, 7-4, 7-5
AC power interface, 4-16
AC receptacle assembly replacement, 7-31
Accessories, 7-2
Acronyms and abbreviations, 1-3
Air-in-line detection, 4-12
    Distal air-in-line detection, 4-12
    Proximal air-in-line detection, 4-12
Air-in-line detection in cassette, 4-34
Air-in-line test, 5-8
Alarm and malfunction codes, 6-14
    Alarm codes, 6-14
    Display, audible, and touchswitch alarm codes, 6-14
    Infusion pumping mechanism alarm codes, 6-14
    Microprocessor or system alarm codes, 6-14
    Miscellaneous alarm codes, 6-14
Alarm conditions, 4-6
Alarm history error codes, 4-11
Alarm messages, 6-1
AM and threshold detectors, 4-37
Analog multiplexer, 4-39
Artifacts, 1-5
Audible alarms, 6-1
    Alarm messages, 6-1
    Backup, 4-31
    Control, 4-31
    Obtaining an alarm history, 6-14
    Self test, 4-32

B

Battery charger current test, 5-17
Battery charger operation, 4-9
Battery charger PWA, 4-30
    AC (mains) operation, 4-31
    DC operation, 4-32
    Interface, 4-15
    Replacement, 7-22
Battery operation overview, 5-16
    Battery charger current test, 5-17
Battery operation, 4-8
Battery overview, 4-6
    Battery recharge, 4-7
    Depth of discharge, 4-7
    Operational requirements, 4-8
Battery pack
    Charging, 4-29
    Replacement, 7-3
Battery recharge, 4-7
Battery voltage detection, 4-30
Bubble sensor location test, 5-5
Bubble sensor PWA, 4-35
    AM and threshold detectors, 4-37
    Preamplifier, 4-37

C

Cassette, 4-46
    Door shaft replacement, 7-27
    Door subassembly, 4-44
    Installation recognition, 4-32
    Leak tests, 4-3, 4-4
Character LEDs and drivers, 4-39
Cleaning and sanitizing, 5-1
    Cleaning solutions, 5-2
Clutch housing replacement, 7-13
Clutch spring replacement, 7-14
Component designators, 1-3
Concurrent delivery test, 5-9
Contact Hospira, 6-1
Conventions, 1-2
Core failure state, 4-10
Critical data retention, 4-11
Current sensing amplifier, 4-39
Custom I/O IC, 4-23
Custom logic IC, 4-22

D

Data communication test, 5-21
Data retention, 4-10
  Alarm history error codes, 4-11
  Critical data retention, 4-10
DataPort
  Interface, 4-17
  Option, 4-25
Dataport accessory cable replacement, 7-32
DataPort communication test, 5-13
DC operation, 4-32
DC power interface, 4-16
Delivery accuracy test, 5-9, 5-10
Delivery mode selection, 4-24
Depth of discharge, 4-7
DIP switch cover replacement, 7-11
Display interface, 4-17
Display PWA replacement, 7-15
Display, audible, and touchswitch alarm codes, 6-14
Distal air-in-line detection, 4-13
Distal occlusion, 4-12
Distal pressure sensor electrical adjustment, 7-36
Door
  Base casting replacement, 7-28
  Cover replacement, 7-25
  Handle replacement, 7-23
  Hinge loading spring replacement, 7-26
  Mechanism leaf spring replacement, 7-24
  Replacement, 7-25
  Retainer leaf spring replacement, 7-24
  Shield replacement, 7-37
Drawings, 9-1

E

Electrical safety test, 5-13
EMI shield replacement, 7-12
Empty container test, 5-6
End of the PVT, 5-15
EPROM, RAM, and memory protection, 4-21
Equipment and materials required, 5-3
Exiting from failure state, 4-10

F

Flow detector replacement, 7-12
Flow detector, 4-13, 4-23
  Connected during reset, 4-13
  Disconnected, 4-13
  Interface, 4-17
  Not used, 4-13
  Replacement, 7-9
Flow detector PWA, 4-39
Front panel
  Replacement, 7-16
  Interface, 4-17
  Replacement, 7-20
Fuse and fuse drawer replacement, 7-6

I

I/O port plate replacement, 7-29
I/O PWA, 4-22
  Custom I/O IC, 4-21
  DataPort option, 4-23
  Delivery mode selection, 4-22
  Flow detector, 4-23
  Miscellaneous I/O circuitry, 4-23
  Motor drivers, 4-22
  Nurse call relay control, 4-22
  Replacement, 7-17
Illustrated parts breakdown, 9-2, 9-5
Infusion pumping mechanism alarm codes, 6-14
Infusion system installation, 1-5
  Inspection, 1-6
  Self test, 1-6
  Unpacking, 1-5
Infusion system troubleshooting, 6-15
Inspection, 1-6, 5-4
Introduction, 1-1
  Acroynyms and abbreviations, 1-3
  Artifacts, 1-5
  Component designators, 1-3
  Conventions, 1-2
  Infusion system installation, 1-5
  Obtaining the software version number, 1-7
  Scope, 1-1
  Series specific features, 1-7
  Setting the delivery mode, 1-8
  User qualification, 1-5

J

Junction box assembly, 4-41
Junction box replacement, 7-32

L

LCD assembly, 4-40
    Replacement, 7-16
LCD screen contrast adjustment, 7-13
LED display PWA, 4-38
    Analog multiplexer, 4-39
    Character LEDs and drivers, 4-38
    Current sensing amplifier, 4-39

M

Main and I/O interface, 4-17
Main program software functions, 4-5
Main PWA replacement, 7-17
Main PWA, 4-17
    -5 volt generation, 4-20
    A/D conversion 4-20
    Custom logic IC, 4-20
    EPROM, RAM, and memory protection, 4-19
    MPU and clock, 4-19
    Second clock source, 4-19
Maintenance and service tests, 5-1
    Battery operation overview, 5-16
    Performance verification test, 5-3
    Periodic maintenance inspection, 5-16
    Routine maintenance, 5-1
Malfunction detection, 4-12
Mechanical functional description, 4-42
    Cassette, 4-42
    Mechanism assembly, 4-43
Mechanism assembly, 4-43
    Cassette door subassembly, 4-44
    Cleaning and lubrication, 7-34
    Motors and valves, 4-43
    Plunger drive assembly, 4-45
    Primary/secondary valve assembly, 4-44
    Replacement, 7-22
Microprocessor or system alarm codes, 6-14
Minipole assembly replacement, 7-10
Miscellaneous alarm codes, 6-14
Miscellaneous I/O circuitry, 4-25, 4-26
Monitors and detectors, 4-11
    Air-in-line detection, 4-13
    Flow detector, 4-14
    Malfunction detection, 4-13
    Pressure sensing system, 4-11
    Proximal occlusion, 4-12
Motor drivers, 4-24
Motor power supply control, 4-30
Motors and valves, 4-43
    Interface, 4-16
MPU and clock, 4-20

N

Nurse call
    Interface, 4-17
    Relay control, 4-24
    Test, 5-6
Nurse call cable replacement, 7-10

O

Obtaining an alarm history, 6-14
Obtaining the software version number, 1-7
Off status, 4-1
On status, 4-2
    Cassette leak tests, 4-3
    Main program software functions, 4-4
    Operation, 4-5
    Self test, 4-3
    Setup, 4-5
Operation, 4-6
Operational requirements, 4-8
    Battery charger operation, 4-9
    Battery operation, 4-8
Optical interrupters, 4-35
Overvoltage protection, 4-31

P

Performance verification test, 5-13
    Air-in-line test, 5-8
    Bubble sensor location test, 5-5
    Concurrent delivery test, 5-9
    DataPort communication test, 5-13
    Delivery accuracy test, 5-9, 5-10
    Electrical safety test, 5-13

Empty container test, 5-6
End of the PVT, 5-15
Equipment and materials required, 5-3
Inspection, 5-4
Nurse call test, 5-6
Pressure sensor test, 5-11
Startup test, 5-4
Periodic maintenance inspection, 5-16
Peripheral failure state, 4-10
Piezoelectric alarm assembly replacement, 7-30
Plunger drive assembly, 4-45
Pole clamp
Component replacement, 7-7
Friction plate replacement, 7-8
Knob replacement, 7-7
Shaft and screw replacement, 7-8
Power control, 4-29
Power interface, 4-15
AC power interface, 4-15
Battery charger PWA interface, 4-15
DC power interface, 4-15
Power supply PWA interface, 4-15
Power supply PWA replacement, 7-26
Power supply PWA, 4-24
+5 VDC supply control, 4-26
AC (mains) line and battery power indication, 4-24
Audible alarm backup, 4-27
Audible alarm control, 4-28
Audible alarm self test, 4-28
Battery pack charging, 4-29
Battery voltage detection, 4-30
Interface, 4-15
Motor power supply control, 4-27
Overvoltage protection, 4-27
Power control, 4-24
Replacement, 7-20
Unregulated DC power supply, 4-24
VMEM supply control, 4-30
Preamplifier, 4-37
Pressure amplification, 4-34
Pressure sensing system, 4-11
Distal occlusion, 4-11
Proximal occlusion, 4-12
Pressure sensor
Interface, 4-18
Test, 5-11
Primary/secondary valve assembly, 4-44
Proximal air-in-line detection, 4-13
Proximal occlusion, 4-12, 4-13
PWA functional description, 4-17
Battery charger PWA, 4-30
Bubble sensor PWA, 4-35
Flow detector PWA, 4-39
I/O PWA, 4-20
Junction box assembly (dataport option), 4-41
LCD assembly, 4-40
LED display PWA, 4-42
Main PWA, 4-17
Power supply PWA, 4-24
Sensor PWA, 4-32

R

Replaceable parts and repairs, 7-1
Replacement procedures, 7-1
AC (mains) power cord, 7-4, 7-5
AC receptacle assembly, 7-31
Battery charger PWA, 7-22
Battery pack, 7-3
DataPort accessory cable, 7-32
DIP switch cover, 7-9
Display PWA, 7-15
Distal pressure sensor electrical adjustment, 7-36
Door assembly, 7-25
Door handle, 7-23
Door mechanism leaf spring, 7-24
Door retainer leaf spring, 7-24
Door shield, 7-37
EMI shield, 7-12
Flow detector, 7-9
Front panel, 7-16
Fuse and fuse drawer, 7-6
I/O port plate, 7-29
I/O PWA, 7-18
Junction box, 7-32
LCD assembly, 7-16
LCD screen contrast adjustment, 7-13
Main PWA, 7-17
Mechanism assembly, 7-22
Cleaning and lubrication, 7-34
Minipole assembly, 7-10
Nurse call cable, 7-10
Piezoelectric alarm assembly, 7-30
Pole clamp components, 7-7
Power supply PWA, 7-21
Required tools and materials, 7-2
Rubber foot pad and foot insert, 7-9
Separating the front and rear covers, 7-10
Velcro strap and retaining plate, 7-6

Required tools and materials, 7-2
Accessories, 7-2
Routine maintenance, 5-1
Cleaning and sanitizing, 5-1
Rubber foot pad and foot insert replacement, 7-9

S

Safety and equipment precautions, 7-1
Scope, 1-1
Second clock source, 4-21
Self test, 1-6, 4-3
Sensor interface, 4-16
Flow detector interface, 4-17
Pressure sensor interface, 4-17
Sensor interface description, 4-13
Display interface, 4-17
Main and I/O interface, 4-17
Motors and valves interface, 4-16
Power interface, 4-15
Sensor interface, 4-16
User interface, 4-15
Sensor PWA, 4-32
Air-in-line detection in cassete, 4-34
Cassette installation recognition, 4-32
Optical interrupters, 4-35
Pressure amplification, 4-34
Separating the front and rear covers, 7-10
Sequence of operations, 4-1
Off status, 4-1
On status, 4-2
Series specific features, 1-7
Setting the delivery mode, 1-8
Setup, 4-5
Specifications, 8-1
Startup test, 5-4
System interface description, 4-14
Display interface, 4-18
Main and I/O interface, 4-18
Motors and valve interface, 4-17
Power interface, 4-16
Sensor interface, 4-18
User interface, 4-17
System malfunction detection, 4-9
Core failure state, 4-9
Exiting from failure state, 4-10
Peripheral failure state, 4-9
System operating manual, 3-1

T

Technical assistance, 6-1
Theory of operation, 4-1
Alarm conditions, 4-6
Battery overview, 4-6
Data retention, 4-10
Mechanical functional description, 4-42
Monitors and detectors, 4-11
PWA functional description, 4-17
Sequence of operations, 4-1
System interface description, 4-13
System malfunction detection, 4-9
Troubleshooting, 6-1
Alarm and malfunction codes, 6-14
Audible alarms, 6-1
Infusion system troubleshooting, 6-15
Technical assistance, 6-1
Troubleshooting with the PVT, 6-17

U

Unpacking, 1-7
Unregulated DC power supply, 4-29
User interface, 4-15
DataPort interface, 4-16
Front panel interface, 4-16
Nurse call interface, 4-16
User qualification, 1-5

V

Velcro strap and retaining plate replacement, 7-6
VMEM supply control, 4-30

W

Warranty, 2-1

This page intentionally left blank.

For technical assistance, product return authorization, and to order parts, accessories, or manuals within the United States, contact Hospira.

1-800-241-4002

For additional services and technical training courses, visit the website at **www.hospira.com**.

For technical assistance and services outside the United States, contact the local Hospira sales office.

CAUTION: Federal (USA) law restricts this infuser to sale by or on the order of a physician or other licensed practitioner.

WARNING: EXPLOSION HAZARD EXISTS IF THE INFUSION SYSTEM IS USED IN THE PRESENCE OF FLAMMABLE SUBSTANCES.

CE 0050

Authorized Representative:
Hospira
Finisklin Business Park
Sligo, Republic of Ireland

Type CF

Provides adequate degree of protection against electrical shock and suitable for application to patient

IPX1 Protected against dripping water

Class 1 Mains supply equipment using protective earth

✓EN-2 Infusion system has been assessed and complies with IEC/EN 60601-1-2 (2001)

WEEE waste from electrical electronic equipment

UL 60601-1
CSA 601.1
MCN 160992

C US
IEC 60601-1
IEC 60601-2-24

The 'C' and 'US' indicators adjacent to the CSA Mark signify that the product has been evaluated to the applicable CSA and ANSI/UL Standards, for use in Canada and the U.S., respectively. This 'US' indicator includes products eligible to bear the 'NRTL' indicator. NRTL (National Recognized Testing Laboratory), is a designation granted by the U.S. Occupational Safety and Health Administration (OSHA) to laboratories which have been recognized to perform certification to U.S. Standards.

Hospira, Inc.
Lake Forest, IL 60045 USA