PLUM XL^3 Series Multi-Line Infusion Systems

For use with list numbers 11781 and 11845

Technical Service Manual

430-94031-005 (A, 06/10)

Hospira

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Change History

Part Number	Description of Change
430-94031-001 (Rev. 09/94)	Original Issue
430-94031-002 (Rev. 05/96)	Second Issue
430-94031-A02 (Rev. 08/96)	Change Page Issue Update cover and copyright page Editorial corrections to Section 5
430-94031-003 (Rev. 04/98)	Third Issue
430-94031-004 (Rev. 03/10)	Fourth Issue Incorporate Hospira name change and update to current style Update Electrical Safety Test Update Section 5 and Section 7 Update graphics
430-94031-005 (Rev. 06/10)	Fifth Issue Add control knob gasket notes to Section 5 and Section 6

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Section 1

INTRODUCTION

The Plum XL3 and XL3 Micro/Macro multiline infusion systems are designed to meet the growing demand for hospital-wide device standardization. The XL3 and XL3M infusion systems consist of three component pumps which are designated line A, line B, and line C. By incorporating three lines into one unit, the infusion system provides three primary lines, three secondary lines, and piggyback fluid delivery capabilities.

The XL3 and XL3M infusion systems serve a wide range of general floor, critical care, and home care applications. Compatibility with LifeCare 5000 PlumSet administration sets and accessories make the XL3 and XL3M infusion systems convenient and cost-effective.

Note: The XL3M infusion system is available in a three-battery version and a single-battery version. Throughout this manual, references to each version are specified accordingly.

Note: References to the Plum XL3M infusion system apply to the LifeCare XL3M infusion system as well.

1.1 SCOPE

This 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 Repair
- ❏ Section 8 Specifications
- ❏ Section 9 Drawings
- ❏ Appendices
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- ❏ 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 devices are contained in the respective system operating manuals.

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 configuration.

The design of the infusion system facilitates its operation in many countries with slight modification to the product. Configurations presented in this manual are detailed in *Table 1-1*. The front panels of the English language and icon based system are shown in *Figure 1-1* and *Figure 1-2*.

Table 1-1. Global Product Configurations

Group	List Number	Country	Power Supply	Rear Case	LCD
Three-Battery 115 V	11781-04 11845-04	USA	100-130 VAC	Nondetachable AC power cord	English
Single-Battery 115 V	11781-04 11845-04	USA	100-130 VAC	Nondetachable AC power cord	English
Single-Battery 115 V	11845-88	Spanish (Latin America)	100-130 VAC	Nondetachable AC power cord	Icons
220 V	11845-27 11845-54	Australia UK	210-260 VAC	Detachable AC power cord	English
220 V	11845-09 11845-29 11845-36 11845-46	Spanish (Latin America) French Europe Swedish	210-260 VAC	Detachable AC power cord	Icons

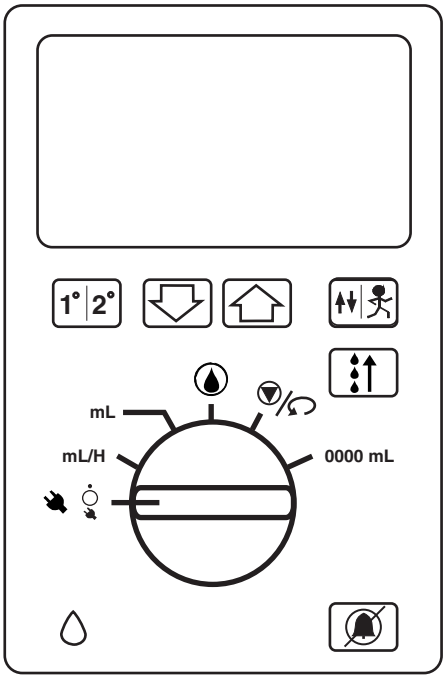

Figure 1-1. Plum XL3M Icon Based Front Panel

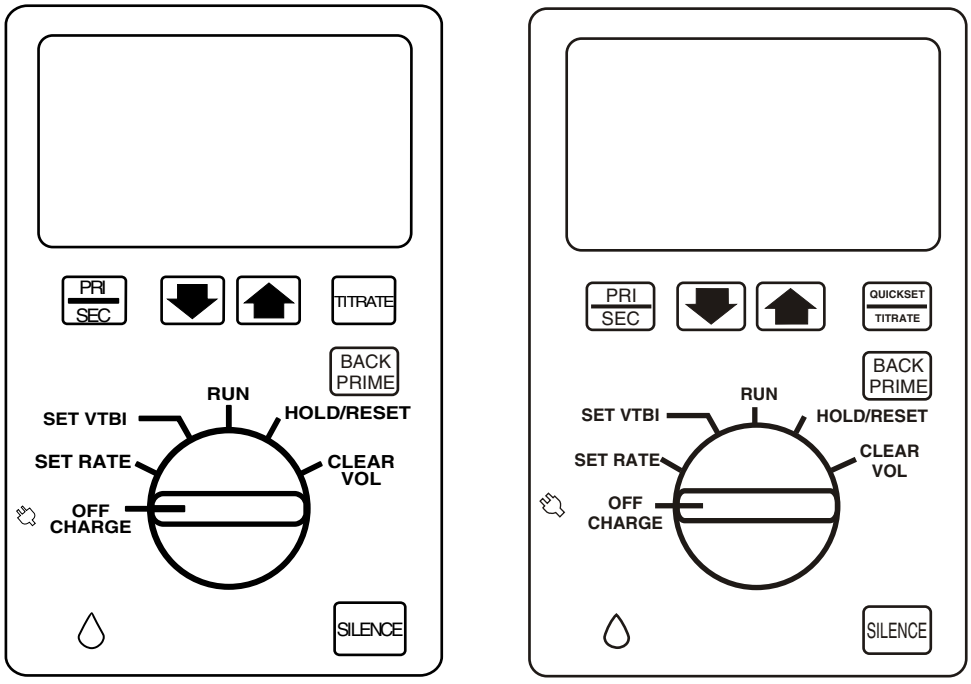

Figure 1-2. Plum XL3 and XL3M English Language Front Panels

1.2 CONVENTIONS

The conventions listed in *Table 1-2* are used throughout this manual.

Table 1-2. Conventions

Convention	Application	Example
Blue Italic	Reference to a section, figure, or table	*(see Section 6)*
[ALL CAPS] in brackets	Touchswitches, keys, buttons	**[START]**
ALL CAPS	Screens and displayed messages	**LOW BATTERY**
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 and 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:

Capacitor	**C**	Integrated Circuit	**U**	Transformer	**T**
Diode	**CR**	Resistor	**R**	Transistor	**Q**
Fuse	**F**	Switch	**SW**	Varistor	**V**

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

Note: Alpha-numeric designators may be followed with a dash (-) number that indicates a pin number for that component. For example, U4-9 is pin 9 of integrated circuit U4 on the power supply 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
B2.5V	2.5 V_{DC} reference signal
CMOS	Complementary metal-oxide semiconductor
dB	Decibel
DC	Direct current
DMM	Digital multimeter
ECG	Electrocardiograph
EEG	Electroencephalogram
EEPROM	Electrically erasable programmable read-only memory
EL	Electroluminescent
EMG	Electromyogram
EMI	Electromagnetic interference
ETO	Ethylene oxide
HKDC	Housekeeping DC
hr	Hour
Hz	Hertz
IC	Integrated circuit
IPB	Illustrated parts breakdown
IV	Intravenous
kHz	Kilohertz
KVO	Keep vein open
LCD	Liquid crystal display
LED	Light-emitting diode
mA	Milliampere
MCU	Microcontroller unit
MHz	Megahertz
mL	Milliliter
MOSFET	Metal oxide semiconductor field effect transistor
mV	Millivolt
PLL	Phase-lock loop
PVT	Performance verification test
PWA	Printed wiring assembly
RMS	Root mean square
SPST	Single-pole single-throw

V_{AC}	Volts AC
V_{CC}	Collector supply voltage
V_{CO}	Voltage-controlled oscillator
V_{DC}	Volts DC
VDIG	Digital voltage
VMOT	Motor voltage
V_{PP}	Volts peak-to-peak
VTBI	Volume to be infused
W	Watts
µA	Microampere
µL	Microliter
µs	Microsecond

1.5 USER QUALIFICATION

The 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 intravenous (IV) fluids. Training should emphasize preventing related IV complications, including appropriate precautions to prevent accidental infusion of air.

1.6 ARTIFACTS

Nonhazardous, low-level electrical potentials are commonly observed when fluids are administered using infusion devices. These potentials are well within accepted safety standards, but may create artifacts on voltage-sensing equipment such as ECG, EMG, and EEG machines. These artifacts vary at a rate that is associated with the infusion rate. If the monitoring machine is not operating correctly or has loose or defective connections to its sensing electrodes, these artifacts may be accentuated so as to simulate actual physiological signals.

To determine if the abnormality in the monitoring equipment is caused by the infuser instead of some other source in the environment, set the device so that it is temporarily not delivering fluid. Disappearance of the abnormality indicates that it was probably caused by electronic noise generated by the infuser. 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. The battery may not be fully charged upon receipt of the infusion system. Do not place the infusion system in service if it fails the self test.

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.

CAUTION: Before operating the infusion system next to, or in a stacked configuration with other electrical equipment, confirm the infusion system's operational performance in that configuration.

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

Note: Do not place the **three-battery** infusion system in service if the batteries are not fully charged. To make certain the batteries are fully charged, connect the infusion system to AC power for a minimum of eight hours with the control knob in the **OFF CHARGE** position.

Note: Do not place the **single-battery** 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 power for a minimum of six hours with the control knob in the **OFF CHARGE** position.

1.7.1 UNPACKING

Inspect the shipping container as detailed in *Section 1.7.2*. Use care when unpacking the infusion system. Retain the packing slip and save all packing materials in the event it is necessary to return the infusion system to the factory. Verify the shipping container includes a copy of the *System Operating Manual*.

1.7.2 INSPECTION

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

CAUTION: Do not use the infusion system if it appears to be damaged. Should damage be found, contact Hospira (*see Section 6.1*).

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.

When performing the self test, line A, line B, and line C must be tested. However, the self test may be performed on all lines concurrently.

If an alarm condition occurs during the self test, turn the control knob to **OFF CHARGE**, then to **SET RATE** to repeat the self test. If the alarm condition recurs, note the message, and take corrective action *(see Section 6)*, then repeat the self test. If the alarm condition continues to recur, remove the infusion system from service and contact Hospira.

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 perform the self test, proceed as follows:

1. Connect the AC power cord to a grounded AC outlet and confirm the AC power indicator is lit.
2. Lift the line A cassette door handle to open the door assembly.
3. Insert a primed cassette into the cassette door guides. Do not force the cassette into position. Close the cassette door handle to lock the cassette in place.
4. Turn the control knob to **SET RATE** to initiate the self test.
5. Verify the LCD backlight is illuminated and the screen is clearly readable at eye level from approximately three feet.
6. See *Figure 1-3*, *Figure 1-4*, or *Figure 1-5*, and verify the following screens display:
   - LCD test screen
   - Four backward Cs (for approximately two seconds)
   - **SET RATE** screen
7. LIsten for motor movement to confirm the cassette and valves are operating.
8. Disconnect the infusion system from AC power and confirm **BATTERY** displays on the LCD screen.
9. Turn the control knob to **OFF CHARGE** and remove the administration set.
10. Repeat the steps for line B and line C.

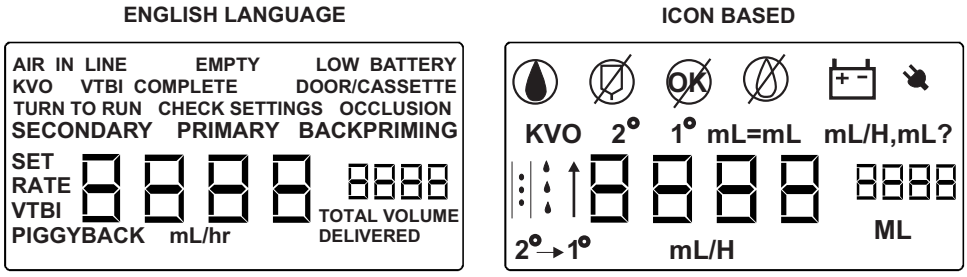

Figure 1-3. XL3 Domestic Self Test Screen

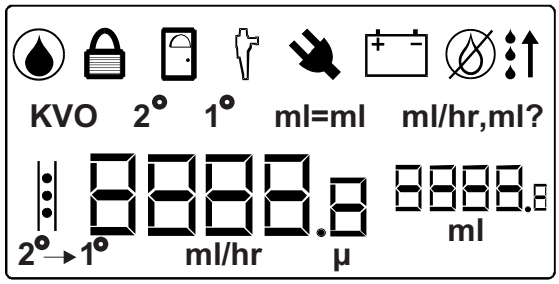

Figure 1-4. XL3M International Self Test Screen

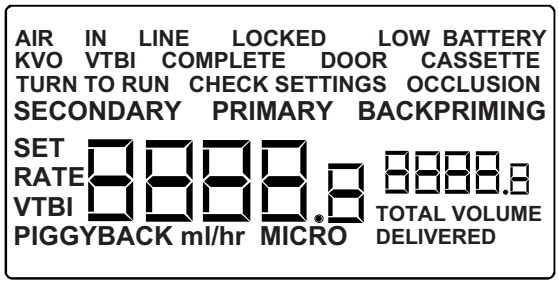

Figure 1-5. XL3M Domestic Self Test Screen

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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.

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Section 3

SYSTEM OPERATING MANUAL

A copy of the System Operating Manual is included with every Plum XL3/XL3M infusion system. If a copy is not available, contact Hospira *(see Section 6.1)*.

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Section 4

THEORY OF OPERATION

This section describes the theory of operation for the XL3 and XL3M infusion systems. The theory of operation details the general description, electronics overview, mechanical overview, and battery operation overview.

4.1 GENERAL DESCRIPTION

The XL3 and XL3M infusion system consists of three component pumps that are designated line A, line B, and line C. Each line includes the following features:

- ❑ Volume to be infused (VTBI) setting
- ❑ Safeguards to protect against overdelivery:
  - Motor speed is continuously monitored
  - Firmware senses malfunctions that could result in gravity flow
- ❑ Volume infused accumulation displays for primary and secondary solutions
- ❑ Flow rate selection
  - XL3: 1 to 999 mL/hr in 1 mL increments
  - XL3M: 0 to 99.9 mL in 0.1 mL/hr increments and 100 to 999 mL/hr in 1 mL increments
- ❑ Battery operation
- ❑ Self test
- ❑ Simple setup (one hand cassette loading)
- ❑ Automatic memory retention of all previous therapy settings and fluid delivery data until cleared by user
- ❑ Alarms include the following:

- Occlusion	- Turn to Run	- Door/Cassette (XL3)
- Air-in-Line	- Low Battery	- Door (XL3M)
- Check Settings	- Set Rate	- Cassette (XL3M
- VTBI Complete		- Locked (XL3M)

- ❑ Two-level adjustable alarm volume
- ❑ Lockout mode
- ❑ Quickset feature for setting rates and VTBI

4.2
ELECTRONICS OVERVIEW

This section describes the function and electronic circuitry of each printed wiring assembly (PWA) in the XL3 and XL3M infusion system:

- Power supply PWA
- Microcontroller unit (MCU)/piggyback assembly
- Display PWA
- Buzzer PWA
- Sensor PWA
- Bubble sensor PWA
- Motherboard

See *Section 1-3* for alphanumeric component designators.

4.2.1
POWER SUPPLY PWA (115 V THREE-BATTERY)

The power supply PWA for the three-battery infuser receives 100 to 130 V_{AC} line voltage to provide three semi-regulated direct current (DC) outputs: line A BUSS (+BUSSA), line B BUSS (+BUSSB), and line C BUSS (+BUSSC). +BUSSA, +BUSSB, and +BUSSC supply approximately 11 V_{DC} to the XL3 lines A, B, and C.

The power supply PWA also provides an 11 V_{DC} housekeeping DC (HKDC) signal to the infuser circuits that operate on AC only, such as the battery charger and main loop control. The power supply PWA also supplies a stable 2.5 V_{DC} reference signal (B2.5V) for the battery charger circuitry.

The power supply PWA consists of line input/switcher circuitry, +BUSS/HKDC/B2.5V circuitry, and main loop control and secondary loop control circuitry.

4.2.1.1
LINE INPUT/SWITCHER CIRCUITRY

The line input/switcher circuitry converts AC line power to three isolated 11 V_{DC} outputs: +BUSSA, +BUSSB, and +BUSSC. Varistor VR1 provides protection against high line voltage spikes. Capacitors C24, C25, and C29 through C32, and transformers T2 and T3 attenuate the conducted emissions. DC voltage required for conversion by the switcher circuitry is provided by bridge rectifier U7; R29, R30, and R39; and C17.

Supply voltage to the current-mode switcher-controller integrated circuit (IC) is provided by diodes CR3, CR6, CR12, and CR13; R3, R10, R12, R13, R19, and R20; C2 and C3; and transistors Q1 and Q3. Q5, T1, IC U4, and associated passive components are enclosed within a shield box to minimize radiated electromagnetic interference (EMI). U4 oscillates at approximately 80 kHz and controls the duty cycle of switcher Q5 through R22 and R25, and CR5.

In this configuration of U4, the DC voltage at pin 9 (ERR+) equals the peak voltage across R27. This DC voltage controls the delivered power through T1 to regulate the output voltage. Voltage at U4-9 is limited to +1.25 V_{DC} so that peak current through Q1 is approximately three amperes (A). This limit constitutes the output short protection.

Optocoupler U2 is part of the main regulation loop. U2, U3, T1 provide the UL-544 isolation barrier. CR4, R23, and C13 provide protection from T2 winding short by rectifying the peak voltage across resistor R27 and applying it to the U4 inhibit input. C13 and the input impedance at U4-4 determine the hiccup frequency, in the event of a T4 winding short.

CR7 and the clamp winding of transformer T1 (pins 1 and 4) provide interim energy transfer to C17 after Q5 is turned off and before one of the output diodes turns on. C17 and T1 also limit the peak voltage across Q5. At AC power up, C9 provides delayed timing to permit the voltage potential at U4-14 (V_{CC}) to reach its minimum level.

4.2.1.2
+BUSS/HKDC/B2.5V CIRCUITRY

+BUSSA, +BUSSB, and +BUSSC supply approximately 11 V_{DC} each to the XL3 lines A, B, and C. CR10, CR11, and CR14; C18 through C22; and C28 rectify energy transferred from T2 to create +BUSSA, +BUSSB, and +BUSSC.

HKDC is active only when the infuser is connected to AC line voltage. HKDC powers the main loop control circuitry. CR9 and C16 create a feed-forward-converted negative voltage across C16 that passes through R26 and CR8 to switch Q4 on. The Q4 output, HKDC, is at ground potential when AC is off. Zener diode CR12 blocks unnecessary battery power drain.

R21 and C15 filter HKDC. R14 and R16, C14, and U5 create and filter a stable B2.5V. R4 and U1A create FHKDC. B2.5V and HKDC are at ground when AC power is off.

4.2.1.3
MAIN LOOP CONTROL CIRCUITRY

Main loop control circuitry regulates +BUSSA, +BUSSB, and +BUSSC voltage when AC line voltage is connected. U1B and U2; R5, R6, R15, R35, and R36; and C8 constitute the main loop control circuitry. Q2, R1 and R7, and CR1 enable regulation only after +BUSS reaches 9 V_{DC} to eliminate circuit latch-up at AC power-up. R2 and R8 provide level shifting.

4.2.1.4
SECONDARY LOOP CIRCUITRY

Secondary loop circuitry provides backup regulation for +BUSSA, +BUSSB, and +BUSSC when AC line voltage is connected and the main loop control circuitry has failed. During a main loop control circuit failure, +BUSSA, +BUSSB, or +BUSSC voltage may rise. If a voltage level increase occurs, the corresponding Zener diode undergoes Zener breakdown and optoisolator U3 turns on. When U3 is on, the +BUSSA, +BUSSB, and +BUSSC output voltage level drops. The regulation voltage of the secondary loop circuitry is 12 V_{DC}. Because the regulation voltage routes through the soft start pin of U4 (pin 12), the 12 V_{DC} will have large voltage drops when a motor is activated.

4.2.2
POWER SUPPLY PWA (115 V SINGLE-BATTERY)

The 115 V power supply PWA for the single-battery infuser receives 100 to 130 V_{AC} line voltage to provide semi-regulated DC output. +BUSS supplies approximately 11 V_{DC} to the XL3M lines A, B, and C.

The power supply PWA also provides an 11 V_{DC} HKDC signal to the infuser circuits that operate on AC only, such as the battery charger and main loop control. The power supply PWA also supplies a stable 2.5 V_{DC} reference signal (B2.5V) for the battery charger circuitry.

The power supply PWA consists of line input/switcher circuitry, +BUSS/HKDC/B2.5V circuitry, and main loop control and secondary loop control circuitry.

4.2.2.1
LINE INPUT/SWITCHER CIRCUITRY

The line input/switcher circuitry converts AC line power to an isolated 11 V_{DC} output. VR1 provides protection against high line voltage spikes. C24, C25, and C27 through C30, and T2 and T3 attenuate the conducted emissions. R35 provides a path to ground for low frequencies in order to reduce noise that could be greatly amplified by nearby EKG monitors. C33 provides a high frequency path to ground for ESD interference currents. U7 and C17 provide DC voltage required for conversion by the switcher circuitry.

Supply voltage to the current mode switcher-controller IC U4 is provided by CR3, CR6, CR12, and CR13; R3, R10, R12, R13, R19, and R20; C2 and C3; and Q1 and Q3. Q5, T1, and U4, and associated passive components are enclosed within a shield box to minimize radiated EMI. U4 oscillates at approximately 80 kHz and controls the duty cycle of Q5 through R18, R22 and R25, and CR5.

In this configuration of U4, the DC voltage at pin 9 (ERR+) equals the peak voltage across R27. This DC voltage controls the delivered power through T1 to regulate the output voltage. Voltage at U4-9 is limited to +1.25 V_{DC} so that peak current through Q1 is approximately 3 A. This limit constitutes the output short protection.

U2 is part of the main regulation loop. U2, U3, and T1 provide the UL-544 isolation barrier. CR4, R23, and C13 provide protection from T2 winding short by rectifying the peak voltage across R27 and applying it to the U4 inhibit input. C13 and the input impedance at U4-4 determine the hiccup frequency, in the event of a T4 winding short.

CR7 and the clamp winding of T1 (pins 1 and 4) provide interim energy transfer to C17 after Q5 is turned off, and before one of the output diodes turns on. C17 and T1 also limit the peak voltage across transistor Q5. At AC power-up, C9 provides delayed timing to permit the voltage potential at U4-14 (V_{CC}) to reach its minimum level.

4.2.2.2
+BUSS/HKDC/B2.5V CIRCUITRY

+BUSS supplies approximately 11 V_{DC} each to the XL3M lines A, B, and C. CR10 and CR11, and C18 through C22 rectify energy transferred from T1 to create +BUSS.

HKDC is active only when the infuser is connected to AC line voltage. HKDC powers the main loop control circuitry. CR9 and C16 create a feed-forward-converted negative voltage across C16 that passes through R26 and CR8 to switch Q4 on. The Q4 output, HKDC, is at ground potential when AC is off. CR12 blocks unnecessary battery power drain. R21 and C15 filter HKDC to produce FHKDC.

R14 and R16, C14, and U5 create and filter a stable B2.5V. R4 and U1A create B2.5V. B2.5V, HKDC, and FHKDC are at ground when AC power is off.

4.2.2.3
MAIN LOOP CONTROL CIRCUITRY

Main loop control circuitry regulates +BUSS voltage when AC line voltage is connected. U1B and U2; R5, R6, and R15; and C8 constitute the main loop control circuitry. Q2, R1 and R7, and CR1 enable regulation only after +BUSS reaches 9 V_{DC} to eliminate circuit latch-up at AC power-up. R2 and R8 provide level shifting.

4.2.2.4
SECONDARY LOOP CIRCUITRY

Secondary loop circuitry provides backup regulation for +BUSS when AC line voltage is connected and the main loop control circuitry has failed. During a main loop control circuit failure, +BUSS voltage may rise. If a voltage level increase occurs, C2 undergoes Zener breakdown and U3 turns on. When U3 is on, the +BUSS output voltage level drops. The regulation voltage of the secondary loop circuitry is 12 V_{DC}. Because the regulation voltage routes through the soft start pin of U4 (pin 12), the 12 V_{DC} will have large voltage drops when a motor is activated.

4.2.3
POWER SUPPLY PWA (220 V)

The 220 V power supply PWA receives 210 to 260 V_{AC} line voltage to provide three semi-regulated DC outputs: line A BUSS (+BUSSA), line B BUSS (+BUSSB), and line C BUSS (+BUSSC). +BUSSA, +BUSSB, and +BUSSC supply approximately 11 V_{DC} to the XL3 lines A, B, and C.

The power supply PWA also provides an 11 V_{DC} HKDC signal to the infuser circuits that operate on AC only, such as the battery charger and main loop control. The power supply PWA also supplies a stable 2.5 V_{DC} reference signal (B2.5V) for the battery charger circuitry.

The power supply PWA consists of line input/switcher circuitry, +BUSS/HKDC/B2.5V circuitry, and main loop control and secondary loop control circuitry.

4.2.3.1
LINE INPUT/SWITCHER CIRCUITRY

The line input/switcher circuitry converts AC line power to three isolated 11 V_{DC} outputs: +BUSSA, +BUSSB, and +BUSSC. VR1 provides protection against high line voltage spikes. C24, C25, and C29 through C32, and T2 and T3 attenuate the conducted emissions. U7, R31 and R38, and C17 provide the DC voltage required for conversion by the switcher circuitry.

Supply voltage to the current-mode switcher-controller IC U4 is provided by CR3, CR6, CR12, and CR13; R3, R10, R12, R13, R19, and R20; C2 and C3; and Q1 and Q3. U4 oscillates at approximately 50 kHz and controls the duty cycle of switcher Q5 through R22 and R25 and CR5.

In this configuration of U4, the DC voltage at pin 9 (ERR+) equals the peak voltage across R27. This DC voltage controls the delivered power through T1 to regulate the output voltage. Voltage at U4-9 is limited to +1.25 V_{DC} so that peak current through Q1 is approximately 3 A. This limit constitutes the output short protection.

CR4, R23, and C13 provide protection from T2 winding short by rectifying the peak voltage across R27 and applying it to the U4 inhibit input. C13 and the input impedance at U4-4 determine the hiccup frequency, in the event of a T1 winding short.

CR7 and the clamp winding of T1 (pins 2 and 11) provide interim energy transfer to C17 after Q5 is turned off and before one of the output diodes turns on. C17 and T1 also limit the peak voltage across Q5. At AC power-up, C9 provides delayed timing to permit the voltage potential at U4-14 (V_{CC}) to reach its minimum level.

4.2.3.2
+BUSS/HKDC/B2.5V CIRCUITRY

+BUSSA, +BUSSB, and +BUSSC supply approximately 11V_{DC} each to the XL3 lines A, B, and C. CR10, CR11, and CR14, and C18 through C22, and C28 rectify energy transferred from T2 to create +BUSSA, +BUSSB, and +BUSSC.

HKDC is active only when the infuser is connected to AC line voltage. HKDC powers the main loop control circuitry. CR9 and C16 create a fee-forward-converted negative voltage across C16 that passes through R26 and CR8 to switch Q4 on. The Q4 output, HKDC, is at ground potential when AC power is off. CR8 blocks unnecessary battery power drain. R21 and C15 filter HKDC.

R14 and R16, C14, and U5 create and filter a stable B2.5V. R4 and U1A create FHKDC. B2.5V and HKDC are at ground when AC power is off.

4.2.3.3
MAIN LOOP CONTROL CIRCUITRY

Main loop control circuitry regulates +BUSSA, +BUSSB, and +BUSSC voltage when AC line voltage is connected. U1B and U2; R5, R6, R15, R35, and R36; and C8 constitute the main loop control circuitry. Q2, R1 and R7, and CR1 enable regulation only after +BUSS reaches 9 V_{DC} to eliminate circuit latch-up at AC power-up. R2 and R8 provide level shifting.

4.2.3.4
SECONDARY LOOP CIRCUITRY

Secondary loop circuitry provides backup regulation for +BUSSA, +BUSSB, and +BUSSC when AC line voltage is connected and the main loop control circuitry has failed. During a main loop control circuit failure, +BUSSA, +BUSSB, or +BUSSC voltage may rise. If a voltage level increase occurs, the corresponding Zener diode undergoes Zener breakdown and optoisolator U3 turns on. When U3 is on, the +BUSSA, +BUSSB, and +BUSSC output voltage level drops. The regulation voltage of the secondary loop circuitry is 12 V_{DC}. Because the regulation voltage routes through the soft start pin of U4 (pin 12), the 12 V_{DC} will have large voltage drops when a motor is activated.

4.2.4
MCU/MCU PIGGYBACK ASSEMBLY

The following sections describe the MCU PWA and MCU piggyback PWA.

4.2.4.1
MCU PWA

The MCU PWA consists of the following circuits:

- Watchdog
- Serial communication
- Alarm
- Alarm power backup
- Motor driver
- Pin detector

There is one MCU PWA for each XL3 infusion system line. Microcontroller U6 controls the operation of various circuitries resident to each line, and provides overall control for the line. U6 contain five digital data input/output (I/O) ports and one analog data I/O port. Each I/O port is eight bits wide.

4.2.4.1.1
Watchdog Circuitry

Watchdog circuitry contains U1 and continuously monitors the MCU PWA. U1 is strobed by U6 at a predetermined minimum frequency. Otherwise, the *RESET output becomes active. *RESET also becomes active if digital voltage (VDIG) is out of range. *RESET causes the MCU PWA to reset, blocks any signal to the motors, and activates the alarm.

4.2.4.1.2
Serial Communication Circuitry

The serial communication circuitry exchanges data between the MCU PWA and the LCD or the EEPROM. The circuitry consists of U7C, U7D, U8, U9B, U9C, and U9D. Although data is transmitted to the LCD screen and the EEPROM, the clock is diverted only to the selected receiver. If EE_CS is active, then *SCK appears as EE_CLK at U9C. If EE_CS is inactive, then *SCK is inverted to appear as LCD_CLK at U8B. Data is read from the LCD or the EEPROM. If EE_CS is active, then EE_DO appears as RXD at U7C. If EE_CS is inactive, then LCD_DO is inverted to appear as RXD at U7C.

4.2.4.1.3
Alarm Circuitry (XL3)

The alarm circuitry includes an oscillator circuit consisting of inverters U10C, U10B, and U10E, and piezo speaker BUZ1. The oscillator circuit generates acoustic power at a predetermined frequency based on the BUZ1 self resonance. Normally, the BUZZER signal is low, U9E-10 is high, and resistor networks RN8-7 and RN8-8 disable the oscillator. The alarm can be activated by the BUZZER or *RESET signals becoming active and pulling RN8-7 down. When SW1 is set to LO, R13 is electronically connected to the buzzer drive (BUZ1-3), and the decibel (dB) level decreases. U10D and U10F constitute a memory unit that disables the oscillator circuit when the U10F output is high.

At AC power-up, the POWERHOLD signal becomes active and changes the U10D/U10F memory unit to enable the oscillator circuit. At a voluntary power-off, DIST_AIR_EN and PROX_AIR_EN become momentarily active. This momentary activation of DIST_AIR_EN and PROX_AIR_EN allows the memory unit to change to an oscillator disabling state and the alarm does not sound. At a catastrophic failure, however, the memory unit remains enabled and the alarm sounds.

4.2.4.1.4
Alarm Circuitry (XL3M)

The alarm circuitry includes an oscillator circuit consisting of inverters U10C, U10B, and U10E, and piezo speaker BUZ1. The oscillator circuit generates acoustic power at a predetermined frequency based on the BUZ1 self resonance. Normally, the BUZZER signal is low, U9E-10 is high, and RN8-7 and RN8-8 disable the oscillator. The alarm can be activated by the BUZZER or *RESET signals becoming active and pulling RN8-7 down. U10D and U10F constitute a memory unit that disables the oscillator circuit when the U10F output is high.

At AC power-up, POWERHOLD becomes active and changes the U10D/U10F memory unit to enable the oscillator circuit. At a voluntary power-off, DIST_AIR_EN and PROX_AIR_EN become momentarily active. This momentary activation of DIST_AIR_EN and PROX_AIR_EN allows the memory unit to change to an oscillator disabling state and the alarm does not sound. At a catastrophic failure, however, the memory unit remains enabled and the alarm sounds.

This alarm circuitry functions only for the low level sound setting. For the high level sound setting, see *Section 4.2.5.1*.

4.2.4.1.5
Alarm Power Backup Circuitry

The alarm power backup circuitry is provided through supercap C34, which offers power backup in the event of a catastrophic failure. CR15, CR19, and CR20 route the power for alarm driver U10 from VDIG or C34.

4.2.4.1.6
Motor Driver Circuitry

The motor driver circuitry energizes three stepper motors: plunger, input/output, and primary/secondary. The MCU PWA microcontroller, U6, outputs motor phase 1 (MOTPHAS1) and motor phase 2 (MOTPHAS2) to inverters U9A and U9F to generate two additional signals: *MOTPHAS1 and *MOTPHAS2. These four signals are required to step the motors. The four motor stepping signals activate U2A, U3A, U3D, and U2D; or U2B, U3B, U3C, and U2C; or U5D, U5A, U4A, and U4D, to switch the power MOSFETs Q1 through Q4, Q5 through Q8, or Q9 through Q12. When active, *RESET disables motor activity.

Three motor enable signals manage the motor step width: motor plunger enable (MOTPLN_EN); motor input/output enable (MOTIO_EN); and motor primary/secondary enable (MOTPS_EN). The four motor stepping signals activate ICs U2A, U3A, U3D, and U2D; or U2B, U3B, U3C, and U2C; or U5D, U5A, U4A, and U4D to switch the power metal-oxide semiconductor field-effect transistors (MOSFETs) Q1 through Q4, Q5 through Q8, or Q9 through Q12. When active, *RESET disables motor activity.

4.2.4.1.7
Pin Detector Circuitry

The pin detector circuitry detects the primary and secondary valve pin motion. When PSV_EN is active, the signal *PSV_EN becomes active and a constant current flows through LED CR1 and LED CR2. CR1 and CR2 are located in the pin detector sensor assembly mounted on the bubble sensor PWA. If *P_S_EN is active, U11A is activated and U11B is de-activated, or vice versa. U11 serves as two hysteresis comparators. Its output, PS_VALVE, is edge detected by the MCU PWA. The positive edges are detected by the MCU PWA INT1 input. The negative edges are detected by the MCU PWA PC3 input.

4.2.4.2
MCU PIGGYBACK PWA

The MCU piggyback PWA serves as a signal interconnection between each line mechanism assembly of the XL3 infusion system and its respective MCU PWA. Signals transmitted between the MCU PWA and the motherboard PWA include motor signals and mechanism assembly signals. These signals are routed in both directions between the MCU PWA and the motherboard via the MCU piggyback PWA. Motor signals routed through the piggyback plugs P7, P8, P9, and P23. Mechanism assembly signals route through the piggyback plugs P5 and P24.

4.2.5
BUZZER PWA

The buzzer PWA is installed only on the XL3M, and includes high volume audible alarm circuitry and lockout switch circuitry.

4.2.5.1
HIGH VOLUME AUDIBLE ALARM

In addition to the MCU PWA alarm circuitries, a loud piezo alarm buzzer is installed on the buzzer PWA for high volume setting. The high volume setting is selected by lever switch SW1. The switch is located on the buzzer PWA, and, during normal operation, is accessible on the rear enclosure.

The BUZZER_HI signals from the three MCU PWAs connect on the motherboard, creating BUZZER_HI_ABC. The SPSTIN_BUZ signal from the three MCU PWAs connect on the motherboard, creating SPSTIN_BUZ_ABC, which is the battery charging voltage. When an alarm occurs in any of the three units, the processor of the corresponding unit activates BUZZER_HI_ABC. When SW1 is closed (high setting), the high volume piezo buzzer and the alarm circuitry on the MCU PWA activate. When SW1 is open (low setting), only the MCU PWA alarm circuitry activates.

4.2.5.2
LOCKOUT SWITCH

Lockout switch SW2 is located on the buzzer PWA and is accessible on the rear enclosure of the XL3M. The lockout switch is connected to the LOCKOUT1_A signal on the display PWA, to the LOCKOUT2_A signal on the MCU PWA of line A, and to lines B and C. LOCKOUT1_A connects to the collector of Q7 on the display PWA of line A. When SW2 is closed, and Q7 saturates, LOCKOUT2_A goes low and the LOCKED icons on the LCD and lines B and C illuminate.

4.2.6
DISPLAY PWA

The display PWA consists of the following circuits:

- Display
- Electroluminescent (EL) panel driver (XL3)
- LED backlight panel and driver (XL3M)
- Run indicator
- AC power indicator
- Control knob

The display PWA receives serial data from the MCU PWA and displays it on the LCD screen. There is one display PWA for each XL3 infusion system line, and regulates the operation of various circuitries resident to each line.

4.2.6.1
DISPLAY CIRCUITRY (XL3)

ICs U2 and U3 are master-and-slave-type serial input LCD drivers and are cascaded to form a 92-segment (4 backplane by 23 foreplane) driver. LCD panel U1 is designed to match the drivers and has 88 segments.Display data is serially clocked into U2 at pin 21. The clocking signal, LCD CLK, is received at U2-23 and U3-22. The drive frequency is asynchronous to the serial data input and is dictated by R7. To eliminate a false display during data updates, U2 and U3 are disabled by CR3 and C14, R8 and R9, and Q3.

4.2.6.2
DISPLAY CIRCUITRY (XL3M)

ICs U2, U3, and U16 are master-and-slave-type serial input LCD drivers and are cascaded to form a 136-segment (4 backplane by 34 foreplane) driver. LCD panel U1 is designed to match the drivers and has 124 segments.

Display data is serially clocked into U2 at pin 21. The clocking signal, LCD CLK, is received at U2-23, U3-22, and U16-22. The drive frequency is asynchronous to the serial data input and is dictated by R7. To eliminate a false display during data updates, U2, U3, and U16 are disabled by CR3 and C14, R8 and R9, and Q3.

4.2.6.3
EL PANEL DRIVER CIRCUITRY (XL3)

Transistor Q1 and transformer T1 windings 1-3 (primary) and 4-2 (feedback) constitute the main oscillator positive feedback. The T1 output winding (5 and 8) provides a large-turn ratio, compared to the T1 primary winding, that boosts the T1 output to 300 V_{PP}. The capacitance of EL panel EL1 and the inductance of the T1 output winding dictate the oscillation frequency of 300 to 500 Hz. As the capacitance of EL1 decreases because of aging, the oscillation frequency increases to maintain a constant brightness.

A control loop consisting of CR1; C10 and C13; R3, R4, R6, and R13; U10B; and Q2 maintains a constant output amplitude by rectifying the T1 output and comparing it to the ELON signal.

4.2.6.4
LED BACKLIGHT PANEL AND DRIVER (XLM)

The display backlight panel is an array of 60 LEDs arranged as parallel elements of two series LEDs. The required drive voltage of the panel equals two LED voltage drops of approximately 4.2 V_{DC}. The actual forward voltage changes with temperature and varies from panel to panel. Driving the panel with a constant current compensates for varying voltage requirements.

The XLM backlight panel requires approximately 200 mA for optimum brightness. The current is controlled utilizing a current mode switching technique enabling high efficiency operation with a wide power supply range of 7 to 11 volts. The signal VMOT is the supply voltage for the backlight constant current regulator.

Current through U17, LED panel, is regulated by Q1 operation until the voltage across current sensing resistors R12 exceeds a reference voltage of approximately 96 mV. The voltage drop across R12 is filtered by R11 and C12 and then compared to the turn-off threshold determined by the voltage divider R3 and R6. Comparator U18, pin 1, drives low when the current through R12 exceeds the turn-off threshold, discharging C1. U1 senses the quick discharge of C1 and then turns off Q1.

Q1 remains off while C1 charges via resistor R4. Q1 turns on when the charge on C1 exceeds the input voltage high threshold of U18, pin 2.

4.2.6.5
RUN INDICATOR CIRCUITRY

When active, LEDRUN turns on LED1. U10A (XL3) or Q8 (XL3M) functions as a constant current source to LED1 by maintaining constant voltage across R20. The voltage is approximately +3.33 V_{DC}.

4.2.6.6
AC (MAINS) LINE POWER INDICATOR CIRCUITRY

AC (mains) line power indicator circuitry is active when the XL3 is operating on AC power. HKDC activates the AC power indicator, LED2. HKDC brings the base voltage of Q4 to VDIG + Vf, where Vf equals the forward voltage of CR1 reduced by R15. The resultant voltage allows Q4 to conduct current through LED2. Current to LED2 equals the approximate voltage of VDIG (5 V_{DC}) divided by the value of R14.

4.2.6.7
CONTROL KNOB CIRCUITRY

Control knob circuitry consists of Q5; rotary switch Hall-effect sensors U11 through U15; reed switch S7; U4, U5, U7, U8, and (on XL3 only) U9; and associated passive components. The control knob circuitry senses the control knob position and sends position codes to the MCU PWA.

When active, the HSENSEN signal switches on Q5 and allows the output of Hall-effect sensors U11 through U15 to be gated through U4, U5, U7, U8 and (on XL3 only) U9. Resultant output conditions of rotary 0 (ROT0), ROT1, and ROT2 at U9B (XL3), U7D (XL3M), U7A, and U7B are sent to the MCU PWA as a three-bit binary code representing the control knob position. The S7 reed switch output, SPSTIN, is transferred to the power supply PWA. If more or less than one Hall-effect sensor position signal is active, ROT0, ROT1, and ROT2 become active simultaneously to signify a failure. If the control knob is set to the OFF CHARGE position, *SESTIN is enabled.

4.2.7
SENSOR PWA

The sensor PWA consists of the following circuits:

- Pressure amplifier/filter
- AC amplifier
- Voltage reference
- Opto interrupter
- EEPROM

The sensor PWA regulates the operation of various circuitries resident to each XL3 infusion system line. There is one sensor PWA for each line.

4.2.7.1
PRESSURE AMPLIFIER/FILTER CIRCUITRY

The pressure amplifier circuitry consists of: U7; R6, R11 through R16; C2 and C3. The circuitry is a differential amplifier with an approximate gain of 600 dB. C2 and C3 are part of an automatic-zero system within U7. The combination of R11 and R13 makes it possible for trimpot R12 to compensate for up to a 3 mV offset input from the strain gauge. In case of larger offsets, R13 must be removed from the sensor PWA. R12 is adjusted to approximately +0.7 V_{DC} at distal pressure (DISTPRES) so that negative pressure spikes can be read by the MCU PWA.

The filter circuitry consists of R1 and R3, C4 and C5, and U8A, and constitutes a two-pole, 30 Hz Bessel active filter. The filter circuitry alternates the 500 Hz automatic-zero switching frequency of U7 and other noise.

4.2.7.2
AC AMPLIFIER CIRCUITRY

AC amplifier circuitry consists of U8A, and processes negative spikes that may signify an occlusion on DISTPRES to a level manageable by the MCU PWA A/D converter. The AC amplifier blocks slow pressure changes and amplifies the voltage spikes to the required level. The AC amplifier circuitry output divides into the logarithmic compression circuit, consisting of: R7; CR1 and CR3; the bias/high-pass circuit, consisting of C8 and R10; and the amplifier circuit, consisting of U8B, R4 and R9, and C7. The logarithmic compression circuit limits the amplitude of the negative spikes at high back-pressure. The bias/high pass circuit blocks the slow pressure changes and biases the AC amplifier circuitry to +2.5 V_{DC}.

4.2.7.3
VOLTAGE REFERENCE CIRCUITRY

Voltage reference circuitry consists of: U1 and U6; Q1; CR2 and CR5; R17 through R20, R22, and R23; capacitors C9, C11, and C12. R22, C11, and C12 filter the motor voltage (VMOT). R18 biases the reference U1. U6B buffers the B2.5V. B2.5V is boosted by Q1, U6A, and associated components to generate the main +3.75 V_{DC} reference 3V75REF. CR2 limits 3V75REF to VDIG level to protect the MCU PWA microcontroller, U6. CR5 protects the base-emitter junction of Q1.

4.2.7.4
OPTO INTERRUPTER CIRCUITRY

When PSENSEN is active, transistors Q2 and Q3 drive all LEDs in U2, U3, and U4 with a constant current of approximately 22 mA. R24 limits the current.

4.2.7.5
EEPROM CIRCUITRY

EEPROM circuitry consists of U5, and serially communicates with the MCU PWA. U5 receives commands and data through pin 3 as TXD. Stored data is transferred through pin 4 as EE_DO. To enable the EEPROM circuitry, EE_CS must be active at pin 1 and EE_CLK at pin 2 must be synchronized with TXD.

4.2.8
BUBBLE SENSOR PWA

The bubble sensor PWA consists of the following circuits:

- Transmitter
- Receiver
- Pin detector flex

The bubble sensor PWA regulates the operation of various circuitries resident to each XL3 infusion system line. There is one bubble sensor PWA for each line.

> **Note:** Both the proximal sensor (X1) and the distal sensor (X2) can transmit or receive.

4.2.8.1
TRANSMITTER CIRCUITRY

Transmitter circuitry consists of a sweep oscillator, a voltage-controlled oscillator (VCO), and a driver.

The sweep oscillator oscillates at approximately 12 kHz with a 50 percent duty cycle. A CMOS gate within U2 provides rail-to-rail symmetrical signals for timing accuracy. The output of the sweep oscillator is between +2 V_{DC} and +3 V_{DC}. The output of C2 sweeps the VCO at U2-9.

U2, C7, and R21 constitute the VCO. U2 is a phase-lock loop (PLL) IC with the VCO portion sweeping output frequencies from 4 to 6 MHz. The VCO center frequency is determined by R21 and C7. Activating proximal air enable (PROX_AIR_EN) or distal air enable (DIST_AIR_EN) sets the VCO.

The driver consists of push-pull, emitter-follower complementary transistors Q4 and Q5 and supplies input to proximal sensor X1 and distal sensor X2.

4.2.8.2
RECEIVER CIRCUITRY

Receiver circuitry is a two-channel receiver circuit (proximal and distal) that consists of amplifier, detector, and buffer.

The amplifier consists of Q2, Q3, and Q6, and associated passive components. The amplifier is biased by 2V5REF and is designed for a wide power supply range. Q3 is biased by PROX_AIR_EN in order to receive signals from proximal sensor X1. Q6 is biased by DIST_AIR_EN to receive signals from distal sensor X2.

The detector is an emitter-follower transistor Q1. Q1 allows maximum input impedance. C1 and R4 constitute a time constant of 200 microseconds. Since the time between voltage peaks is approximately 40 microseconds, the output (*AIR_OPT) remains high, with a pronounced sawtooth ripple.

The buffer consists of U1A and R2 and R7, and amplifies the detected signal.

4.2.8.3
PIN DETECTOR FLEX CIRCUITRY

The pin detector flex circuitry detects movement of the primary and secondary valve pins through optical transmitters CR1 and CR2, and optical receivers Q1 and Q2. Light interrupters are attached to the pins. As the pins move, the appropriate valve movement signals are transferred to the MCU PWA through the bubble sensor PWA.

4.2.9
MOTHERBOARD PWA (THREE-BATTERY)

The motherboard for the three-battery configuration consists of pass-through connections, battery charger circuitry, and voltage regulators, and provides circuitry that allows for smooth transition from AC power operation to battery operation and vice versa.

The motherboard accepts three semi-regulated power outputs from the power supply PWA and provides motor voltage, digital voltage, and battery charging for each of the three channels of the XL3 infusion system.

4.2.9.1
PASS-THROUGH CONNECTIONS

The mechanism assembly has four cables that provide signal throughput between the mechanism assembly motors and sensor PWA, and the MCU PWA. These four cables access the motherboard PWA only. The MCU piggyback PWA provides signal pass-through connections between the mechanism assembly and the MCU PWA. Jack J23A is used for all motor signals and jack J24A is used for all electronic signals. The signals are routed to the trace side of the motherboard. On the trace side, jacks J7A, J8A, and J9A are used for the motor signals and jack J5A is used for the electronic signals. Jack J26 (XL3M only) provides signal pass-through connections between the MCU PWA and buzzer PWA.

Table 4-1 lists electrical connectors that are specific to the piggyback PWA-to-motherboard interface and motherboard-to-sensor PWA interface for each XL3 infusion system line.

Table 4-1. Pass-Through Connections

Line A	Line B	Line C
Jack J5A	Jack J5B	Jack J5C
Jack J7A	Jack J7B	Jack J7C
Jack J8A	Jack J8B	Jack J8C
Jack J9A	Jack J9B	Jack J9C
Jack J23A	Jack J23B	Jack J23C
Jack J24A	Jack J24B	Jack J24C

4.2.9.2
BATTERY CHARGER CIRCUITRY

The main function of the battery charger circuitry is to provide a constant current source. The primary components of the battery charger circuitry are Q1 and Q28, U1B, R40, and associated passive devices. Q1 is the current carrying device and R79 is the sense resistor. When AC power is off, Q28 is off and Q1 is on.

The battery is charged by two current levels and trickle current. The charge current control is achieved by controlling the voltage at U1-6. U2A and R31 and R32 control the voltage at U1-6 and hence, the current level.

U2A also offers overpower protection for Q1. When the voltage across Q6 generates more than +2.5 V_{DC} at U2-2, the lower charge current (0.8 A) is selected.

Line A low charge request (LOCHG_REQA) signals the MCU PWA of the battery voltage level. U1A, R54 through R9, and C8 constitute a differential amplifier that reads the battery voltage. The output of the differential amplifier is compared to a previously determined level by U2B. The output of U2B is the LOCHG_REQA signal.

Table 4-2 lists the battery charge current state as a function of the low charge and charge off control signals for each XL3 infusion line.

Table 4-2. Battery Charge Current States (Three-Battery)

LOCHRG - Lines A, B, C	CHRG_OFF - Lines A, B, C	Approximate Current
Low	Low	0.8 A
High	Low	0.16 A
X (Don't care)	High	Trickle = (11-Vbat)/475

4.2.9.3

VOLTAGE REGULATORS

Voltage regulators are provided by the AC/battery switching circuitry, the motor voltage regulators, and the 5 V_{DC} digital voltage regulator.

4.2.9.3.1

AC/Battery Switching Circuitry

When the infusion system operates on AC power, HKDC is approximately 11 V_{DC}. CR5, an 8.2 V_{DC} Zener diode, undergoes Zener breakdown and Q4 turns on through R19 and R20. As a result, line A power hold (POWERHOLDA) has no effect on the VMOTA regulator circuitry. When removing AC power, Q4 turns off at an HKDC level of approximately 9 V_{DC} to allow a smooth transition from AC operation to battery power.

4.2.9.3.2

VMOT Regulator Circuitry

VMOTA regulator circuitry consists of U3A, Q3 and Q6, and associated passive components, and provides a constant voltage output of 9.35 V_{DC} when AC power is on. This constant 9.35 V_{DC} output allows the VMOT regulator circuitry to reject the POWERHOLDA and line A single-pole single-throw in signals.

When DC power is on, Q4 is off and Q6 serves as a switch. Q6 is turned on momentarily by the SPSTINA signal, and permanently by POWERHOLDA. When on, Q6 switches the line A battery voltage to VMOTA and powers the necessary circuits, including the VDIG regulator circuitry.

4.2.9.3.3

VDIG Regulator Circuitry

Line A digital voltage (VDIGA) is generated by U4, the 5 V_{DC} low-drop voltage regulator.

4.2.10
MOTHERBOARD PWA (SINGLE-BATTERY)

The motherboard PWA for the single-battery configuration consists of pass-through connections, battery charger circuitry, and voltage regulators, and provides circuitry that allows for smooth transition from AC power operation to battery operation and vice versa.

The motherboard accepts the semi-regulated power output from the power supply PWA and provides motor voltage, digital voltage, and single battery charging for each of the three channels of the XL3M infusion system.

Note: The following information is specific to line A of the XL3M, but is also applicable to lines B and C.

4.2.10.1
PASS-THROUGH CONNECTIONS

The mechanism assembly has four cables that provide signal throughput between the mechanism assembly motors and sensor PWA, and the MCU PWA. These four cables access the motherboard PWA only. The MCU piggyback PWA provides signal pass-through connections between the mechanism assembly and the MCU PWA. Jack J23A is used for all motor signals and jack J24A is used for all electronic signals.

The signals are routed to the trace side of the motherboard. On the trace side, jacks J7A, J8A, and J9A are used for the motor signals and jack J5A is used for the electronic signals. Jack J26 provides signal pass-through connections between the MCU PWA and buzzer PWA.

See *Table 4-1* for pass-through connections.

4.2.10.2
BATTERY CHARGER CIRCUITRY

The main function of the battery charger circuitry is to provide a constant current source. The primary components of the battery charger circuitry are Q7 and Q8, U5B, R79, and associated passive devices. Q7 is the current carrying device, and R79 is the sense resistor. When AC power is off, Q8 is off and Q7 is on.

The battery is charged by two current levels and trickle current. Charge current level is achieved by controlling the voltage at U5-6. U6A and R70 and R71 control the voltage at U5-6, and hence, the current level.

IC U6A offers overpower protection for Q7. When the voltage across Q7 generates more than 2.5 V_{DC} at U6-2, the lower charge current is selected. This can occur if the battery voltage becomes less than 7.6 V.

Line A low charge request (LOCHG_REQ) signals the MCU PWA of the battery voltage level. U5A, R44 through R47, and C21 constitute a differential amplifier that reads the battery voltage. The output of the differential amplifier is compared to a previously determined level by U6B. The output of U6B is the LOCHG_REQ signal.

Table 4-3 lists the battery charge current state as a function of the low charge and charge off control signals for each XL3M infusion line.

Table 4-3. Battery Charge Current States (Single-Battery)

LOCHRG - Lines A, B, C	CHRG_OFF - Lines A, B, C	Current
Low	Low	1.05 A to 1.25 A
High	Low	0.13 A to 0.32 A
X (Don't care)	High	Trickle = (11-Vbat)/475

4.2.10.3
VOLTAGE REGULATORS

Voltage regulators are provided by the AC/battery switching circuitry, the motor voltage regulators, and the 5 V_{DC} digital voltage regulator.

4.2.10.3.1
AC/Battery Switching Circuitry

When the XL3M infusion system operates on AC power, HKDC is approximately 11 V_{DC}. CR5, an 8.2 V_{DC} Zener diode, undergoes Zener breakdown and Q4 turns on through R19 and R20. As a result, line A power hold has no effect on the VMOTA regulator circuitry. When removing AC power, Q4 turns off at an HKDC level of approximately 9 V_{DC} to allow a smooth transition from AC operation to battery power.

4.2.10.3.2
VMOT Regulator Circuitry

VMOTA regulator circuitry consists of U3A, Q3 and Q6, and associated passive components, and provides a constant voltage output of 9.35 V_{DC} when AC power is on. This constant 9.35 V_{DC} output allows the VMOT regulator circuitry to reject the POWERHOLDA and line A single-pole single-throw in signals. C47 and C48 provide a low impedance for high frequencies caused by ESD currents.

When DC power is on, Q4 is off and Q6 serves as a switch. Q6 is turned on momentarily by the SPSTINA signal, and permanently by POWERHOLDA. When on, Q6 switches the line A battery voltage to VMOTA and powers the necessary circuits, including the VDIG regulator circuitry.

4.2.10.3.3
VDIG Regulator Circuitry

Line A digital voltage (VDIGA) is generated by U4, the 5 V_{DC} low-drop voltage regulator.

4.3 MECHANICAL OVERVIEW

Note: The following information is specific to line A of the XL3, but is also applicable to lines B and C.

The principal mechanical elements of line A include the cassette and the mechanism assembly. When a cassette is locked into the operating position and the control knob is turned on, line A performs a self test to verify the integrity of the internal systems. The operation of the mechanism assembly moves a plunger, causing a pumping action. A valve motor selects the primary or secondary valve, depending on the command. An additional valve motor alternately opens and closes an inlet valve and outlet valve to control fluid flow through the cassette pumping chamber.

The following sections describe the cassette and the mechanism assembly.

4.3.1 CASSETTE

Note: Refer to the system operating manual for a description of the major cassette functions.

The cassette operates on a fluid displacement principle to deliver fluid volumetrically. The pumping cycle begins when the outlet valve is opened and the inlet valve is closed. The plunger extends to deflect the cassette diaphragm and expel fluid. At the end of the pumping stroke, the outlet valve closes, the inlet valve opens, the appropriate primary or secondary valve opens, and the plunger retracts to allow fluid to refill the pumping chamber. After the pumping chamber is filled, the inlet and outlet valves are reversed, the primary and secondary valves are closed, and the cycle is repeated.

The cassette contains two chambers: an upper air trap chamber and a pumping chamber. The two chambers are separated by an inlet valve and operate together to detect air. The upper air trap chamber receives fluid from the IV container through either the primary or secondary valve. The upper air trap chamber is designed to collect a substantial amount of air. It collects air bubbles from the IV line and container to prevent them from entering the pumping chamber. The MCU PWA tracks the amount of air collected in the upper air trap chamber. If a predetermined air collection threshold is exceeded, the MCU PWA initiates a line A backprime and activates a secondary display.

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

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

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

See *Figure 4-1* for major elements of the cassette, and *Figure 4-2* for fluid path in the cassette.

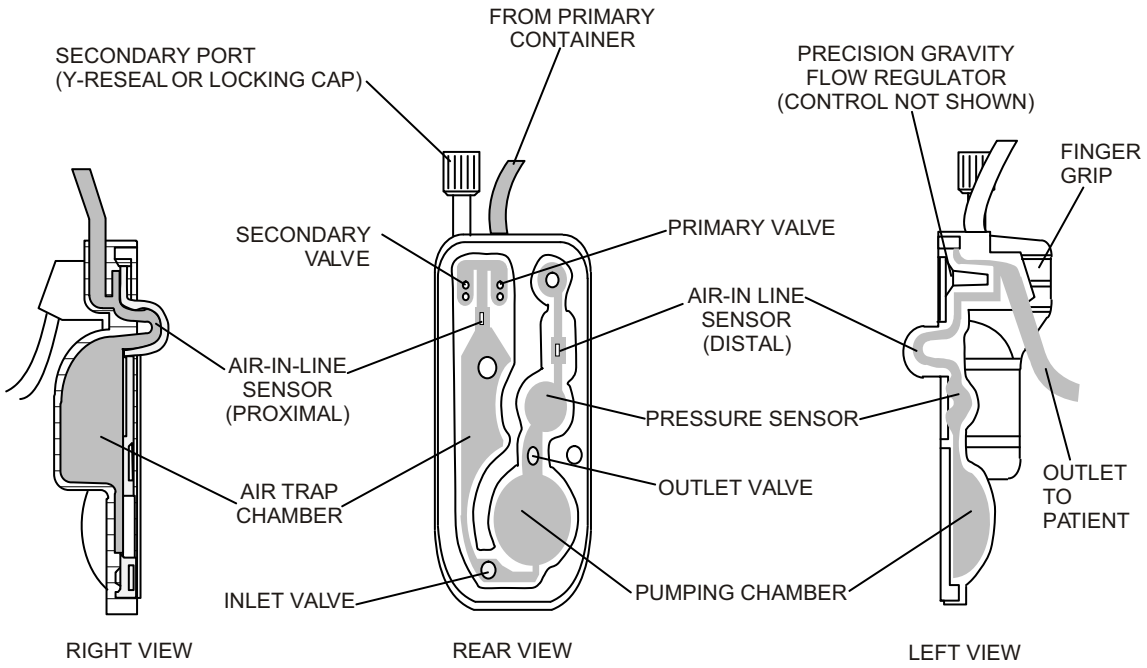

Figure 4-1. Major Elements of the Dual Channel Cassette

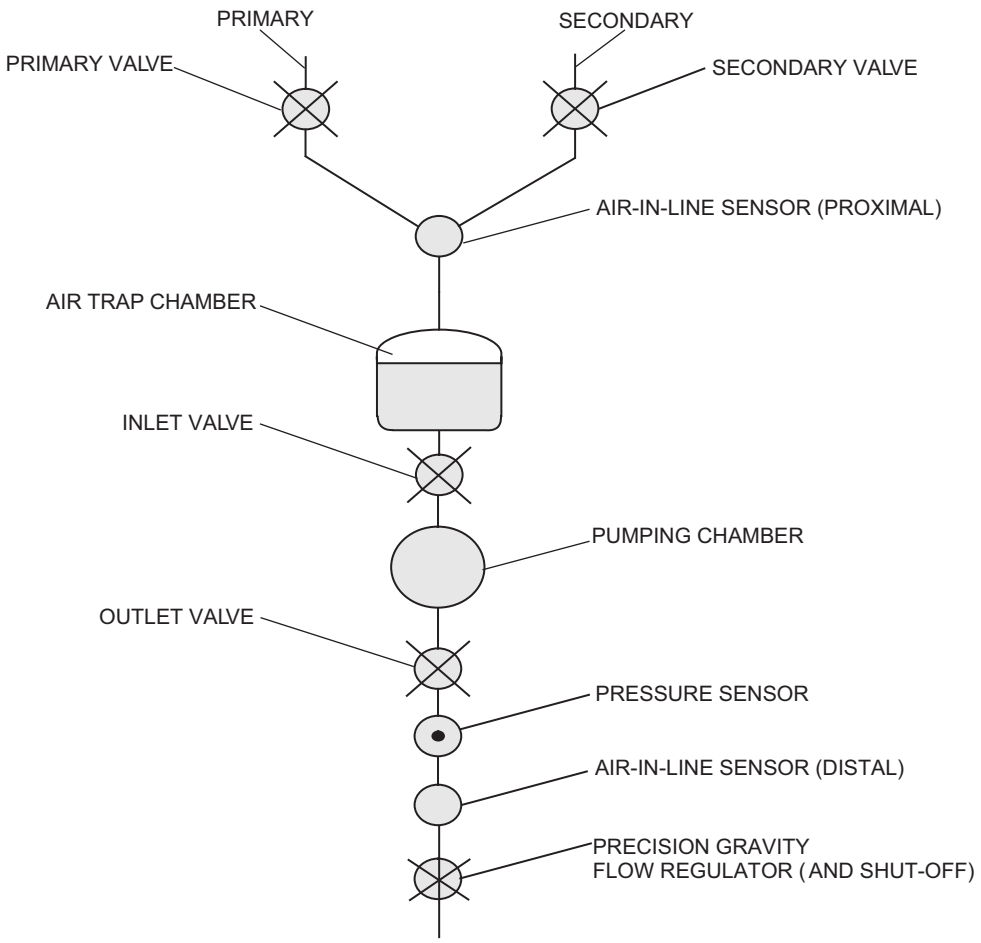

Figure 4-2. Fluid Path in the Cassette

4.3.2
MECHANISM ASSEMBLY

The mechanism assembly is a fully self-contained unit that consists of the following:

- Plunger motor
- Two valve motors and valve assemblies
- Primary/secondary valve subsystem
- Inlet/outlet valve subsystem
- Plunger drive subsystem
- Air bubble (ultrasonic) sensor assemblies
- Cassette door
- Pressure sensor assembly

During line A pumping operation, the plunger motor drives a lead screw that is coupled to a nut in the plunger. The plunger motor and lead screw move the plunger forward to cause a positive displacement of approximately 0.33 mL of fluid per cycle. The plunger motion is synchronized to the two valve motors to provide controlled fluid delivery.

4.3.2.1
VALVE MOTORS AND VALVE ASSEMBLIES

The mechanism assembly consists of two valve motors that operate in conjunction with the plunger motor and associated valve assemblies to control line A pumping action. The primary/secondary motor operates in conjunction with an associated valve assembly to activate the cassette primary or secondary valves, depending on input. The I/O motor operates in conjunction with an associated valve assembly to alternately open and close the inlet and outlet valves to control fluid delivery through the cassette pumping chamber.

4.3.2.2
PRIMARY/SECONDARY VALVE SUBSYSTEM

The primary/secondary valve subsystem consists of the following:

- Primary/secondary motor
- Attached cam and integral cam flag
- Primary and secondary rockers and valve pins
- Pin detector assembly

The primary/secondary motor is designed to rotate the attached cam. When the cam is positioned at the top dead center (home position), both primary and secondary valves are closed. When viewed from the motor side, clockwise rotation from the home position opens the primary valve, while the secondary valve remains closed. Counterclockwise rotation opens the secondary valve, while the primary valve remains closed. As the cam rotates, the cam flag passes through an interrupter module to determine the home position. If the cam flag passes through the interrupter module at an incorrect time sequence, a motor phase loss is detected. The cam flag/interrupter module time sequence combination is predetermined through pre-established calibration data.

The primary and secondary rockers are the connecting link between the cam and the primary and secondary valve pins. The primary and secondary valve pins each have a series of interrupters that are optically detected by the pin detector assembly to assure proper valve pin movement.

See *Figure 4-3* for mechanism assembly valve pins and sensor locations.

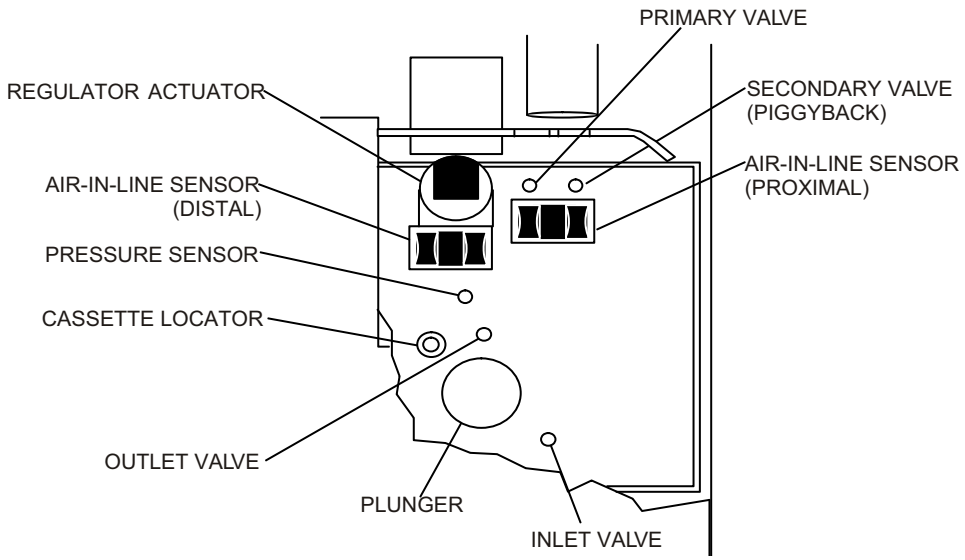

Figure 4-3. Mechanism Assembly Valve Pins and Sensor Locations

4.3.2.3
INLET/OUTLET VALVE SUBSYSTEM

The inlet/outlet valve subsystem is similar to the primary/secondary valve subsystem, and performs similar functions and contains similar parts. However, the inlet/outlet valve subsystem does not contain a series of interrupters or a pin detection assembly.

4.3.2.4
PLUNGER DRIVE SUBSYSTEM

The plunger drive subsystem consists of the following:

- Plunger motor
- Ball thrust bearing
- Screw/coupler assembly
- Plunger/support system

The plunger motor rotates approximately 1-2/3 revolutions per line A cycle to permit a 0.33 mL fluid displacement every cycle. The plunger motor then reverses and the plunger returns to home position. This cycle repeats for the duration of fluid administration. The ball thrust bearing is positioned against the mechanism assembly chassis. As the plunger extends into the cassette diaphragm to displace fluid, the resulting load (due to pumping action and back pressure) is transferred axially through the ball thrust bearing to the mechanism assembly chassis.

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

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Section 5

MAINTENANCE AND SERVICE TESTS

A complete maintenance program promotes infusion 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 infuser.

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 cassette door.

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
Manu-Klenz®	Steris	Per manufacturer's recommendation
Precise® Hospital Foam Cleaner Disinfectant	Caltech Industries	Per manufacturer's recommendation
Vesphene® II se	Steris	Per manufacturer's recommendation
Household Bleach (Sodium Hypochlorite)	Various	Use per hospital procedures Do not exceed one part bleach in ten parts water

Note: At the time of printing, Hospira recommends only the cleaning solutions in *Table 5-1*. For updated listings of approved cleaners, visit **www.hospiraparts.com**.

5.1.2
ICONS AND ENGLISH LANGUAGE EQUIVALENTS

International versions of the XL3M use icons in displays and labels *(see Figure 1-1)*. *Table 5-2* identifies the unique icons, the English language equivalent, and the function performed and/or displayed by each icon.

Table 5-2. Icons and English Language Equivalents		
Icon	**English Equivalent**	**Function**
	**TURN TO RUN**	Indicates the control knob is not in the OFF CHARGE or RUN position, and no other keys have been pressed for five minutes
	**LOCKED**	Indicates the lockout switch is ON
	**DOOR**	Indicates the cassette door is open
	**CASSETTE**	Indicates a problem with the cassette
	**OCCLUSION**	Indicates possible occluded tubing, closed clamp, or kinked tubing
	**BATTERY**	Indicates the XL3 is operating on battery power
	**LOW BATTERY**	Indicates approximately 30 minutes of battery power remains
KVO	**KEEP VEIN OPEN**	Indicates the XL3 is in the KVO delivery mode
2°	**SECONDARY**	Indicates the XL3 is in the secondary delivery mode
1°	**PRIMARY**	Indicates the XL3 is in the primary delivery mode

Table 5-2. Icons and English Language Equivalents		
Icon	**English Equivalent**	**Function**
ml = ml	**DOSE COMPLETE**	Indicates the programmed dose or doses have been delivered
ml/hr,ml ?	**CHECK SETTINGS**	Indicates a rate or dose limit has not been set
	**AIR IN LINE**	Indicates air in line
	**BACKPRIMING**	Indicates backpriming is occurring
2° → 1°	**PIGGYBACK**	Indicates piggyback operation
ml/hr	**MILLITERS PER HOUR**	Indicates the programmed rate or dose
μ	**MICRODELIVERY**	Indicates the micro dose delivery
ml	**MILLILITERS**	Indicates the total volume delivery
1° | 2°	**[PRIMARY/SECONDARY] KEY**	Toggles between primary and secondary during SET RATE and SET VTBI

Table 5-2. Icons and English Language Equivalents

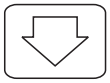
Icon	English Equivalent	Function
	**[DOWN ARROW] KEY**	Adjusts the fluid delivery rate or dose when the control knob is in the SET RATE or SET VTBI position
	**[UP ARROW] KEY**	Adjusts the fluid delivery rate or dose when the control knob is in the SET RATE or SET VTBI position
	**[TITRATE] KEY**	Adjusts the fluid delivery rate up or down while pumping is in progress
	**[QUICKSET] KEY**	Changes the rate in increments to preprogrammed levels
	**[BACKPRIME] KEY**	Cleans any air accumulated in the cassette Reprimes empty secondary tubing
	**OFF CHARGE KNOB**	Stops all active functions
ml/hr	**SET RATE KNOB**	With the [UP ARROW] and [DOWN ARROW] keys, sets the fluid delivery rate
ml	**SET VTBI KNOB**	With the [UP ARROW] and [DOWN ARROW] keys, sets the fluid delivery VTBI
	**RUN KEY**	Starts fluid delivery at the rate set by the user

Table 5-2. Icons and English Language Equivalents		
Icon	**English Equivalent**	**Function**
	**HOLD/RESET KEY**	Stops fluid delivery
0000 ml	**CLEAR VOLUME KNOB**	Zeros the total volume delivered display after a four second delay
	**AC POWER INDICATOR**	Indicates the infuser is connected to AC (mains) power
	**PUMP OPERATING INDICATOR**	Flashes green when pumping
	**SILENCE ALARM**	Temporarily silences the audible alarm

5.2
PERFORMANCE VERIFICATION TEST (XL3)

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 for the XL3 consists of the tests described in the following sections.

Conduct all tests with the infusion system connected to AC (mains) power unless otherwise specified.

Note: 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 6-4* for troubleshooting.

See *Section 5.3* for the PVT for the XL3M.

5.2.1
EQUIPMENT AND MATERIALS REQUIRED

The PVT requires the following equipment and materials, or equivalents:

- Safety analyzer
- Digital pressure meter (DPM), 0 to 50 psi (0 to 345 kPa)
- 18-gauge blunt cannula, or 21-gauge butterfly needle
- Three-way stopcock
- Digital multimeter (DMM)
- Two containers of sterile water
- Plum IV set
- Graduated cylinder, 25 mL, with 0.2 mL graduations (Class A)
- Special cassette with proximal bubble sensor tips removed
- Special cassette with distal bubble sensor tips removed
- Battery charger test box (optional)

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 areas for missing or damaged parts:

- Labels
- AC power cord
- Rubber foot pads
- Door assembly and handle
- Keypads and displays
- Control knobs
- External screws
- Pole clamp knob/shaft, extrusion, and tip insert
- Front and rear enclosures
- Battery doors

5.2.3
XL3 TEST SETUP

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

To set up the XL3 infusion system for the PVT, proceed as follows:

1. Confirm the infusion system and appropriate accessories are fully assembled.
2. Hang two water containers at a fluid level height of 18 to 24 inches (46 to 60 cm) above the infuser.
3. Connect the infusion system to AC (mains) power. Verify the AC power indicator illuminates within five seconds.

5.2.4
SELF TEST

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

When performing the self test, line A, line B, and line C must be tested. However, the self test may be performed on all lines concurrently.

If an alarm condition occurs during the self test, turn the control knob to **OFF CHARGE**, then to **SET RATE** to repeat the self test. If the alarm condition recurs, note the message, and take corrective action *(see Section 6)*, then repeat the self test. If the alarm condition continues to recur, remove the infusion system from service and contact Hospira.

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 perform the self test, proceed as follows:

1. Connect the AC power cord to a grounded AC outlet and confirm the AC power indicator is lit.
2. Lift the line A cassette door handle to open the door assembly.
3. Insert a primed cassette into the cassette door guides. Do not force the cassette into position. Close the cassette door handle to lock the cassette in place.
4. Turn the control knob to **SET RATE** to initiate the self test.
5. Verify the LCD backlight is illuminated and the screen is clearly readable at eye level from approximately three feet.
6. Verify the XL3 test screens display *(see Figure 5-1)*.
7. LIsten for motor movement to confirm the cassette and valves are operating.
8. Disconnect the infusion system from AC power and confirm **BATTERY** displays on the LCD screen.
9. Turn the control knob to **OFF CHARGE** and remove the administration set.
10. Repeat the steps for line B and line C.
11. Connect the infusion system to AC (mains) power for a minimum of eight hours with the control knob in the **OFF CHARGE** position to allow the battery to fully charge.

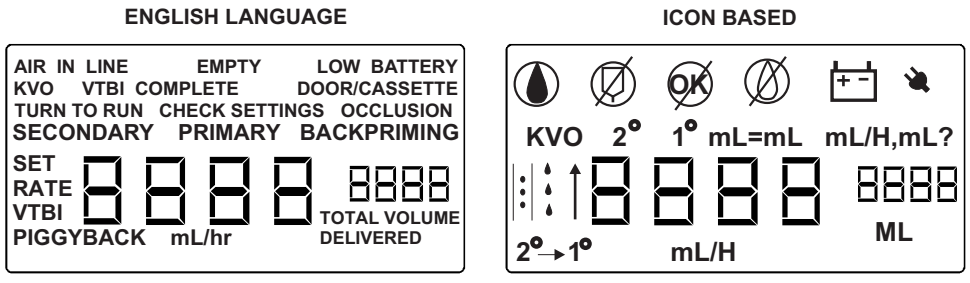


Figure 5-1. XL3 Test Screens

5.2.5
KEYPAD AND CONTROL KNOB TEST

To perform the keypad and control knob test, proceed as follows:

1. Turn the control knob on line A to **SET RATE**. Press the following keys to verify that each key activates and the screen responds accordingly:
   - **[PRI/SEC]** toggles the screen between PRIMARY and SECONDARY
   - [↑] raises the delivery rate
   - [↓] lowers the delivery rate
2. Turn the control knob to **SET VTBI**. Press the following keys to verify that each key activates and the screen responds accordingly:
   - [↑] raises the volume delivered
   - [↓] lowers the volume delivered
3. Turn the control knob to **RUN**. Press and hold the following key combinations simultaneously to verify that each key combination activates and the screen responds:
   - **[TITRATE]** and [↑] raises the delivery rate
   - **[TITRATE]** and [↓] lowers the delivery rate
4. Turn the control knob to **HOLD/RESET.** Press and hold **[BACKPRIME]** and verify pumping occurs from the primary line through the secondary inlet port.
5. Repeat the steps for line B and line C.

5.2.6
OPEN DOOR ALARM TEST

To perform the open door alarm test, proceed as follows:

1. Close the clamp on the line A secondary line to prevent fluid from mixing in containers.
2. Open the cassette door. Verify **DOOR/CASSETTE** is displayed and an alarm sounds.
3. Press **[SILENCE]** and verify the alarm mutes.
4. Close the cassette door and unclamp the secondary line.
5. Repeat the steps for line B and line C.

5.2.7
ALARM LEVEL TEST

To perform the alarm level test, proceed as follows:

1. Turn the control knob on line A to **SET RATE** and open the cassette door. Verify **DOOR/CASSETTE** is displayed and an alarm sounds.
2. Locate the audio switch on the bottom of the infusion system. Toggle the audio switch between the high and low settings, and verify two alarm levels sound.
3. Press **[SILENCE]** and verify the alarm mutes.
4. Close the cassette door, and turn the control knob to **OFF CHARGE**.
5. Repeat the steps for line B and line C.

5.2.8
FREE FLOW TEST

To perform the free flow test, proceed as follows:

1. Verify the installed cassette on line A is fully primed.
2. Turn the control knob to **SET RATE**.
3. With the cassette door closed, check the distal end of the tubing for fluid flow. Verify a minimal flow of fluid occurs (a few drops maximum).
4. Open the cassette door and check the distal end of tubing for fluid flow. Verify a minimal flow of fluid occurs (a few drops maximum).

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

5. Close the cassette door and check the distal end of the tubing for fluid flow. Verify a minimal flow of fluid occurs (a few drops maximum).
6. Turn the control knob to **OFF CHARGE**.
7. Repeat the steps for line B and line C.

5.2.9
DISTAL OCCLUSION TEST

To perform the distal occlusion test, see *Figure 5-2*, and proceed as follows:

1. Connect the distal tubing to the DPM through a three-way stopcock as illustrated in *Figure 5-2*. A reflux valve may be attached between the stopcock and the DPM to keep moisture out of the DPM.

   Note: The height of the DPM must be 0 to 6 inches (0 to 15 cm) from the midline of the cassette.

2. Turn the control knob to **SET RATE**. Set the rate to 40 mL/hr.
3. Turn the control knob to **SET VTBI**. Set the volume to 100 mL.
4. Open the three-way stopcock to air.
5. Turn the control knob to **RUN** and allow the infusion system to stabilize for one minute. Verify all air is cleared from the tubing.
6. Set the three-way stopcock to measure pressure.
7. Verify the occlusion alarm occurs when DPM indicates 10 ± 1.8 psi (69 ± 13.8 kPa).
8. Turn the control knob to **HOLD/RESET** to clear the occlusion alarm.
9. Disconnect the distal tubing from the three-way stopcock.
10. Repeat the steps for line B and line C.

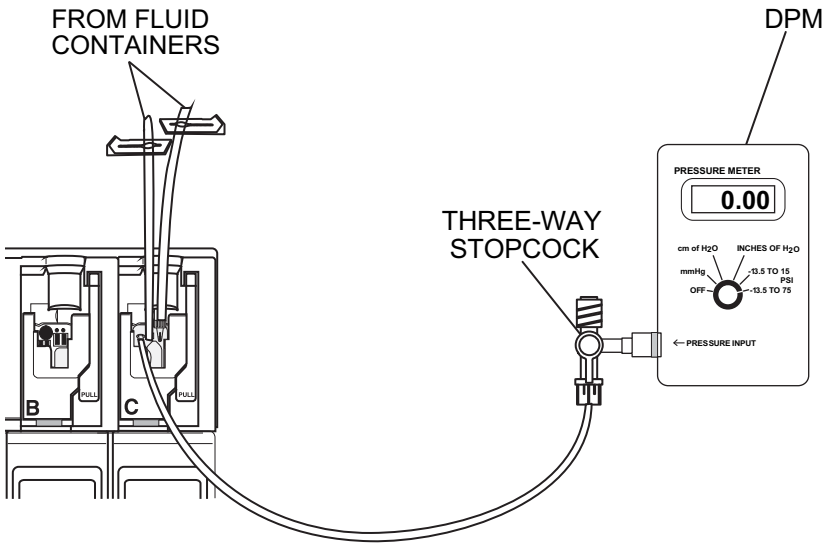


Figure 5-2. Distal Occlusion Test Setup

5.2.10
PROXIMAL OCCLUSION TEST

To perform the proximal occlusion test, proceed as follows:

1. Turn the control knob on line A to **RUN** to start pumping fluid.
2. After several pumping cycles, clamp the tubing proximal to the cassette. After drops stop falling through the sight chamber, verify that an occlusion alarm occurs within three pumping cycles.
3. Press **[SILENCE]** and unclamp the proximal tubing.
4. Turn the control knob to **OFF CHARGE**.
5. Repeat the steps for line B and line C.

5.2.11
DELIVERY ACCURACY TEST

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 infusion system to Hospira.

CAUTION: Do not remove the protective cover from the butterfly needle.

To perform the delivery accuracy test, proceed as follows:

1. Attach an 18-gauge blunt cannula or a 21-gauge needle to the distal end of the line A tubing. Verify the container fluid level is 18 to 24 inches (46 to 60 cm) above the cassette pumping chamber, and verify all lines are unclamped.
2. Prime the needle and tubing. Verify no air is in the tubing. Place the cannula or needle in a 25 mL graduated cylinder. Assure the graduated cylinder is dry.
3. Turn the control knob to **SET RATE** and set the primary rate to 400 mL/hr.

4. Press **[PRI/SEC]** to display **SECONDARY**. Set the secondary rate to 400 mL/hr.
5. Turn the control knob to **SET VTBI** and press **[PRI/SEC]** to display **PRIMARY**.
6. Set the primary volume to 10 mL.
7. Press **[PRI/SEC]** to display **SECONDARY**. Set the secondary volume to 10 mL.
8. Turn the control knob to **CLEAR VOL** to clear previous value. Verify four beeps sound.
9. Turn the control knob to **RUN** to start pumping fluid. Verify volume delivered is 20 ± 1 mL. After the VTBI is complete, confirm the line changes to KVO mode at a rate of 1 mL/hr.
10. Turn the control knob to **OFF CHARGE**.
11. Clamp both lines. Remove the cannula or needle from the distal tubing, and remove the cassette from the infuser.
12. Repeat the steps for line B and line C.

5.2.12
EMPTY CONTAINER/AIR-IN-LINE TEST

To perform the empty container/air-in-line alarm test, see *Figure 5-3*, and proceed as follows:

1. Install the special cassette with the proximal bubble sensor tips removed in line A.
2. Turn the control knob to **SET VTBI**. Set the volume to 100 mL.
3. Turn the control knob to **RUN** to start pumping. Verify that within three pumping cycles, the audible alarm sounds and **AIR IN LINE** and **BACKPRIMING** are displayed.
4. Turn the control knob to **HOLD/RESET**.
5. Open the cassette door and remove the cassette. Install the special cassette with the distal bubble sensor tips removed in line A.
6. Turn the control knob to **RUN** to start pumping. Verify that within three pumping cycles, the audible alarm sounds and **AIR IN LINE** is displayed.
7. Turn the control knob to **OFF CHARGE**.
8. Open the cassette door and remove the cassette.
9. Repeat the steps for line B and line C.

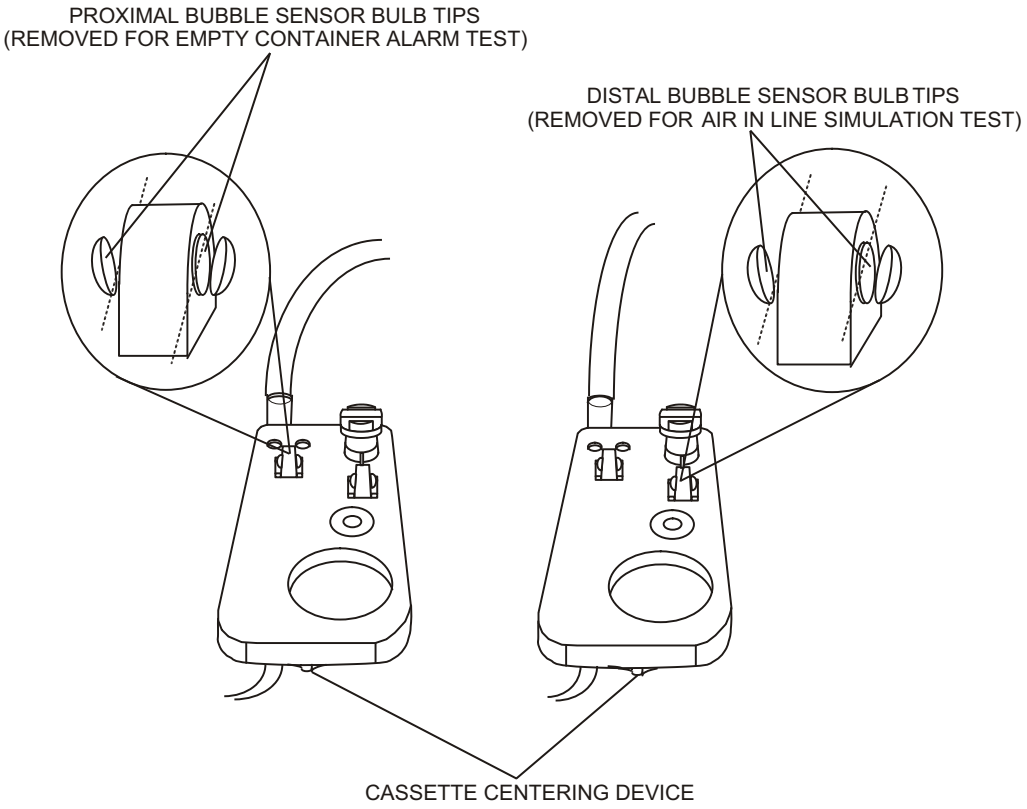


Figure 5-3. Special Cassettes with Bubble Sensor Tips Removed

5.2.13
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 (mains) power cord to the safety analyzer.
2. Connect the safety analyzer ground lead to the infusion system ground test-point screw located on the rear of the infusion system.
3. Check the leakage current with the safety analyzer. Leakage current must not exceed the specifications in *Table 5-3*.
4. Measure the resistance of the AC (mains) connector ground lug with the safety analyzer. Resistance should not exceed the specifications in *Table 5-3*.

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

Table 5-3. 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	0.1 Ω

5.2.14
END OF THE XL3 PVT

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

If all tests have been successful for line A, line B, and line C, clear the dose history, reset the infusion system to its original configuration, and return the XL3 to service.

5.3 PERFORMANCE VERIFICATION TEST (XL3M)

The Performance Verification Test for the XL3M consists of the tests described in the following sections.

Conduct all tests with the infusion system connected to AC (mains) power unless otherwise specified.

Note: 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 6-4* for troubleshooting.

5.3.1 EQUIPMENT AND MATERIALS REQUIRED

The PVT requires the following equipment and materials, or equivalents:

- Safety analyzer
- Digital pressure meter (DPM), 0 to 50 psi (0 to 345 kPa)
- 18-gauge blunt cannula, or 21-gauge butterfly needle
- Three-way stopcock
- Digital multimeter (DMM) (optional)
- Two containers of sterile water
- Plum IV set
- Syringe, 20 mL capacity
- Graduated cylinder, 25 mL, with 0.2 mL graduations (Class A)
- Special cassette with proximal bubble sensor tips removed
- Special cassette with distal bubble sensor tips removed
- Battery charger test box (optional)

5.3.2
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 areas for missing or damaged parts:

- Labels
- AC power cord
- Rubber foot pads
- Door assembly and handle
- Keypads and displays
- Control knobs
- External screws
- Pole clamp knob/shaft, extrusion, and tip insert
- Front and rear enclosures
- Battery doors

5.3.3
XL3M TEST SETUP

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

To set up the XL3M infusion system for the PVT, proceed as follows:

1. Confirm the infusion system and appropriate accessories are fully assembled.
2. Hang two water containers at a fluid level height of 18 to 24 inches (46 to 60 cm) above the infuser.
3. Connect the infusion system to AC (mains) power. Verify the AC power indicator illuminates within five seconds.

5.3.4
SELF TEST

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

When performing the self test, line A, line B, and line C must be tested. However, the self test may be performed on all lines concurrently.

If an alarm condition occurs during the self test, turn the control knob to **OFF CHARGE**, then to **SET RATE** to repeat the self test. If the alarm condition recurs, note the message, and take corrective action *(see Section 6)*, then repeat the self test. If the alarm condition continues to recur, remove the infusion system from service and contact Hospira.

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 perform the XL3M self test, proceed as follows:

1. Connect the AC power cord to a grounded AC outlet and confirm the AC power indicator is lit.
2. Lift the line A cassette door handle to open the door assembly.
3. Insert a primed cassette into the cassette door guides. Do not force the cassette into position. Close the cassette door handle to lock the cassette in place.
4. Turn the control knob to **SET RATE** to initiate the self test.
5. Verify the LCD backlight is illuminated and the screen is clearly readable at eye level from approximately three feet.
6. Verify the test screens display *(see Figure 5-4* or *Figure 5-5)*.
7. LIsten for motor movement to confirm the cassette and valves are operating.
8. Disconnect the infusion system from AC power and confirm **BATTERY** displays on the LCD screen.
9. Turn the control knob to **OFF CHARGE** and remove the administration set.
10. Repeat the steps for line B and line C.
11. Connect the infusion system to AC (mains) power for a minimum of eight hours with the control knob in the **OFF CHARGE** position to allow the battery to fully charge

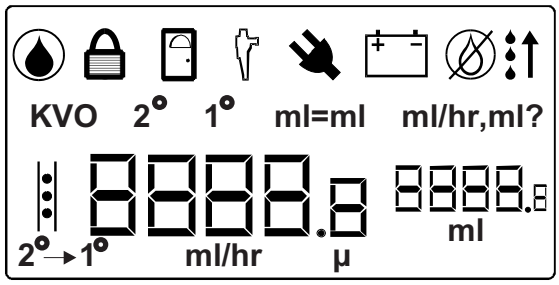


Figure 5-4. XL3M International Self Test Screen

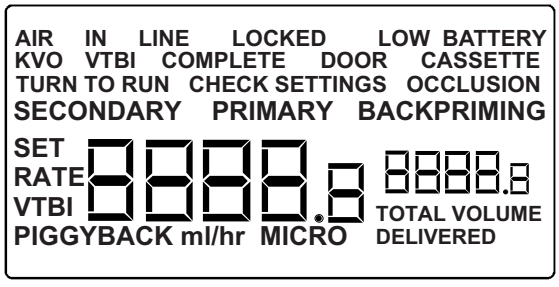


Figure 5-5. XL3M Domestic Self Test Screen

5.3.5
KEYPAD AND CONTROL KNOB TEST

To perform the keypad and control knob test, proceed as follows:

1. Turn the control knob on line A to **SET RATE**. Press the following keys to verify that each key activates and the screen responds accordingly:
   - **[PRI/SEC]** toggles the screen between PRIMARY and SECONDARY
   - [↑] raises the delivery rate
   - [↓] lowers the delivery rate
   - **MICRO** is displayed with the decimal value below 100 mL/hr
2. Turn the control knob to **SET VTBI**. Press the following keys to verify that each key activates and the screen responds accordingly:
   - [↑] raises the volume delivered
   - [↓] lowers the volume delivered
   - **MICRO** is displayed with the decimal value below 100 mL
3. Turn the control knob to **RUN**. Press and hold the following key combinations simultaneously to verify that each key combination activates and the screen responds:
   - **[TITRATE/QUICKSET]** and [↑] raises the delivery rate
   - **[TITRATE/QUICKSET]** and [↓] lowers the delivery rate
4. Turn the control knob to **SET RATE**. Press **[TITRATE/QUICKSET]** and verify a quick rate change occurs.
5. Turn the control knob to **HOLD/RESET**. Press and hold **[BACKPRIME]** and verify pumping occurs from the primary line through the secondary inlet port.
6. Repeat the steps for line B and line C.

5.3.6
OPEN DOOR ALARM TEST

To perform the open door alarm test, proceed as follows:

1. Close the clamp on the line A secondary line to prevent fluid from mixing in containers.
2. Open the cassette door. Verify the **DOOR** icon is displayed and an alarm sounds.
3. Press **[SILENCE]**, and verify the alarm mutes.
4. Close the cassette door and unclamp the secondary line.
5. Repeat the steps for line B and line C.

5.3.7
ALARM LEVEL AND LOCK FUNCTION TEST

To perform the alarm level test, proceed as follows:

1. Turn the control knob on line A to **SET RATE** and open the cassette door. Verify the **DOOR** icon is displayed and an alarm sounds.
2. Locate the audio switch on the rear panel. Toggle the audio switch between the high and low settings, and verify two alarm levels sound.
3. Press **[SILENCE]**, and verify the alarm mutes.
4. Close the cassette door. Turn the control knob to **HOLD/RESET**, then to **RUN**.
5. Press **[LOCK]**, and verify the **LOCKED** icon is displayed.
6. Turn the control knob to any position other than **RUN**. Verify the infuser stops pumping, and an alarm sounds with the **LOCKED** icon and backlight flashing.
7. Press **[LOCK]**, and verify the alarm condition clears and the **LOCKED** icon disappears.
8. Repeat the steps for line B and line C.

5.3.8
FREE FLOW TEST

To perform the free flow test, proceed as follows:

1. Verify the installed cassette on line A is fully primed.
2. Turn the control knob to **SET RATE**.
3. With the cassette door closed, check the distal end of the tubing for fluid flow. Verify a minimal flow of fluid occurs (a few drops maximum).
4. Open the cassette door and check the distal end of tubing for fluid flow. Verify a minimal flow of fluid occurs (a few drops maximum).

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

5. Close the cassette door and check the distal end of the tubing for fluid flow. Verify a minimal flow of fluid occurs (a few drops maximum).
6. Turn the control knob to **OFF CHARGE**.
7. Repeat the steps for line B and line C.

5.3.9
DISTAL OCCLUSION TEST

To perform the distal occlusion test, see *Figure 5-2*, and proceed as follows:

1. Connect the distal tubing to the DPM through a three-way stopcock as illustrated in *Figure 5-2*. A reflux valve may be attached between the stopcock and the DPM to keep moisture out of the DPM.

   Note: The height of the DPM must be 0 to 6 inches (0 to 15 cm) from the midline of the cassette.

2. Turn the control knob to **SET RATE**. Set the rate to 40 mL/hr.
3. Turn the control knob to **SET VTBI**. Set the volume to 100 mL.
4. Open the three-way stopcock to air.
5. Turn the control knob to **RUN** and allow the infusion system to stabilize for one minute. Verify all air is cleared from the tubing.
6. Set the three-way stopcock to measure pressure.
7. Verify the occlusion alarm occurs when DPM indicates 10 ± 1.8 psi (69 ± 13.8 kPa).
8. Turn the control knob to **HOLD/RESET** to clear the occlusion alarm.
9. Disconnect the distal tubing from the three-way stopcock.
10. Repeat the steps for line B and line C.

5.3.10
PROXIMAL OCCLUSION TEST

To perform the proximal occlusion test, proceed as follows:

1. Turn the control knob on line A to **RUN** to start pumping fluid.
2. After several pumping cycles, clamp the tubing proximal to the cassette. After drops stop falling through the sight chamber, verify that an occlusion alarm occurs within three pumping cycles.
3. Press **[SILENCE]** and unclamp the proximal tubing.
4. Turn the control knob to **OFF CHARGE**.
5. Repeat the steps for line B and line C.

5.3.11
DELIVERY ACCURACY TEST

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 infusion system to Hospira.

CAUTION: Do not remove the protective cover from the butterfly needle.

To perform the delivery accuracy test, proceed as follows:

1. Attach an 18-gauge blunt cannula or a 21-gauge needle to the distal end of the line A tubing. Verify the container fluid level is 18 to 24 inches (46 to 60 cm) above the cassette pumping chamber, and verify all lines are unclamped.
2. Prime the needle and tubing. Verify no air is in the tubing. Place the cannula or needle in a 25 mL graduated cylinder. Assure the graduated cylinder is dry.
3. Turn the control knob to **SET RATE**. Set the primary rate to 400 mL/hr.
4. Press **[PRI/SEC]** to display **SECONDARY**. Set the secondary rate to 400 mL/hr.
5. Turn the control knob to **SET VTBI** and press **[PRI/SEC]** to display **PRIMARY**. Set the primary volume to 10 mL.
6. Press **[PRI/SEC]** to display **SECONDARY**. Set the secondary volume to 10 mL.
7. Turn the control knob to **CLEAR VOL** to clear previous value. Verify four beeps sound.
8. Turn the control knob to **RUN** to start pumping fluid. Verify volume delivered is 20 ± 1 mL. After the VTBI is complete, confirm the line changes to KVO mode at a rate of 1 mL/hr.
9. Turn the control knob to **OFF CHARGE**.
10. Clamp both lines. Remove the cannula or needle from the distal tubing. Remove the cassette from the infuser.
11. Repeat the steps for line B and line C.

5.3.12
EMPTY CONTAINER/AIR-IN-LINE TEST

To perform the empty container/air-in-line alarm test, see *Figure 5-3*, and proceed as follows:

1. Install the special cassette with the proximal bubble sensor tips removed in line A.
2. Turn the control knob to **SET VTBI**.
3. Set the volume to 100 mL.
4. Turn the control knob to **RUN** to start pumping. Verify that within three pumping cycles, the audible alarm sounds and **AIR IN LINE** and **BACKPRIMING** are displayed.
5. Turn the control knob to **HOLD/RESET**.
6. Open the cassette door and remove the cassette. Install the special cassette with the distal bubble sensor tips removed in line A.
7. Turn the control knob to **RUN** to start pumping. Verify that within three pumping cycles, the audible alarm sounds and **AIR IN LINE** is displayed.

8. Turn the control knob to **OFF CHARGE**.
9. Open the cassette door and remove the cassette.
10. Repeat the steps for line B and line C.

5.3.13
CASSETTE ALARM TEST

To perform the cassette alarm test, proceed as follows:

1. Install the empty cassette in line A.
2. Turn the control knob to **RUN**.
3. Verify the **CASSETTE** alarm displays and the audible alarm sounds within three pumping cycles.
4. Turn the control knob to **OFF CHARGE** and remove the cassette.
5. Repeat the steps for line B and line C.

5.3.14
ELECTRICAL SAFETY TEST

To perform the electrical safety test, see *Section 5.2.13*. When the electrical safety test is completed, connect the device to AC power and assure the AC indicator light is lit.

5.3.15
END OF THE XL3M PVT

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

If all tests have been successful for line A, line B, and line C, clear the dose history, reset the infusion system to its original configuration, and return the XL3M to service.

5.4
PERIODIC MAINTENANCE INSPECTION

> **Note:** Due to normal use over time, the control knob gasket may become worn and/or damaged. A worn or damaged gasket may allow fluid ingress into the device. Hospira recommends periodic inspection, and if required, replacement of the control knob gasket *(see Section 7.2.18.3)*.

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. Product specifications for this inspection are listed in *Section 8*.

To perform a periodic maintenance inspection, complete the PVT in *Section 5.2* or *Section 5.3*.

5.5
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.

Connect the infusion system to AC (mains) power whenever possible to allow the battery to remain fully charged. When the infusion system is operating on battery power, the AC power indicator disappears and the **BATTERY** legend appears.

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 a battery is discharged and recharged, the sooner it will need replacement. The primary cause of battery 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, storage temperature, and 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.

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

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

5.5.1
BATTERY CHARGER CURRENT TEST (THREE-BATTERY) (OPTIONAL)

Note: Confirm the batteries are in good condition and charged. Connect the infusion system to AC power for a minimum of eight hours to fully charge the batteries.

To perform the three-battery charger current test, proceed as follows:

1. Disconnect the infusion system from AC power. Remove the battery access cover and disconnect the battery from the line A connector.
2. Connect the battery charger test box and DMM between the battery and the line A connector. Make certain switch S1 of the test box is in the **OFF** position. Set the DMM to measure current.

   There are two types of batteries that may be installed in the infusion system. On battery type 1, battery connector pins 3 and 4 are open. On battery type 2, a jumper wire is located between pins 3 and 4. Examine the battery connector to determine which type of battery is installed.
3. Connect the infusion system to AC power. Within 20 seconds of applying AC power, measure the current on the DMM. Verify the current is between the minimum and maximum values shown in *Table 5-4*.

   Note: If the reading is too low, the battery may be fully charged. Close switch S1 (ON), and repeat step 3.
4. Disconnect the battery test box and DMM from the battery and the line A connector. Reconnect the battery, and replace and secure the battery cover.
5. Repeat the steps for line B and line C.

Table 5-4. Battery Charger Current Test Parameters

Battery Type	Jumper between Battery Pins 3 and 4	Minimum Value	Maximum Value
1	No	1 A	1.4 A
2	Yes	.64 A	.92 A

5.5.2
BATTERY CHARGER CURRENT TEST (SINGLE-BATTERY) (OPTIONAL)

Note: Confirm the battery is in good condition and charged. Connect the infusion system to AC power for a minimum of six hours to fully charge the batteries.

To perform the single-battery charger current test, proceed as follows:

1. Disconnect the infusion system from AC power. Remove the battery access cover and disconnect the battery from connector.
2. Connect the battery charger test box and DMM between the battery and the connector. Make certain switch S1 of the test box is in the **OFF** position. Set the DMM to measure current.

   Note: The single-battery version of the XL3M is supplied with a type 1 battery only.

3. Connect the infusion system to AC power. Within 20 seconds of applying AC power, measure the current on the DMM. Verify the current is between the minimum and maximum values shown in *Table 5-4*.

   Note: If the reading is too low, the battery may be fully charged. Close switch S1 (ON), and repeat step 3.

4. Disconnect the battery test box and DMM from the battery and the line A connector. Reconnect the battery, and replace and secure the battery cover.
5. Repeat the steps for line B and line C.

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Section 6

TROUBLESHOOTING

This section contains information on technical assistance, alarm messages and error codes, and troubleshooting procedures.

Note: Prior to placing the device back into service, inspect the control knob gasket for wear and/or damage *(see Section 7.2.18.3)*.

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.**

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

Hospira, Inc.
755 Jarvis Drive
Morgan Hill, California 95037

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

6.2 ALARM MESSAGES AND ERROR CODES

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

There are two types of alarm conditions:

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

6.2.1
OPERATIONAL ALARM MESSAGES

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

Note: Operational alarm messages are displayed on the screen. Associated error codes are displayed in the alarm history.

Table 6-1. Operational Alarm Messages and Corrective Actions

Error Code	Alarm Message	Description	Possible Cause	Corrective Action
01-1	OCCLUSION 	Distal occlusion alarm	Distal pressure above 10 psi for five seconds	Unkink tubing, check IV site, or replace administration set If condition recurs, contact Hospira
01-2	OCCLUSION 	Distal occlusion alarm	Distal pressure above 10 psi for two plunger strokes	Unkink tubing, check IV site, or replace administration set If condition recurs, contact Hospira
01-3	OCCLUSION 	Distal occlusion alarm	Distal pressure above 13 psi	Unkink tubing, check IV site, or replace administration set If condition recurs, contact Hospira
01-4	OCCLUSION 	Distal occlusion alarm	Excessive distal pressure during valve leak test	Unkink tubing, check IV site, or replace administration set If condition recurs, contact Hospira
03-1	OCCLUSION 	Proximal occlusion alarm	Clamp closed, tubing kinked, possible occluded tubing, or defective administration set	Unkink tubing, check IV site, or replace administration set If condition recurs, contact Hospira
03-2	OCCLUSION 	Proximal occlusion on secondary during backpriming	Clamp closed, tubing kinked, possible occluded tubing, or defective administration set Defective pressure circuit	Unkink tubing, check IV site, or replace administration set If condition recurs, contact Hospira

Table 6-1. Operational Alarm Messages and Corrective Actions

Error Code	Alarm Message	Description	Possible Cause	Corrective Action
06-1	**AIR IN LINE BACKPRIMING** 	Air detected in cassette Proximal air-in-line	1000 µL of air has entered the cassette since last initialization	Backprime to expel air
07-1	**AIR IN LINE** 	Distal air-in-line	100 µL bolus of air detected at distal sensor	Remove and reprime cassette
07-2	**AIR IN LINE** 	Distal air-in-line	260 µL of air detected in the last 2.6 mL of fluid delivered	Remove and reprime cassette
08-1	**AIR IN LINE BACKPRIMING** 	Air detected in cassette	500 µL of air has entered the casette in the last two intake strokes	Backprime to expel air
10-1	**CHECK SETTINGS** **ml/hr,ml ?**	Check alarm settings	Rate and VTBI settings not correct	Turn control knob to SET RATE or SET VTBI to check settings or enter values
11-1	**TURN TO RUN** 	Turn to run alarm	Control knob not in OFF CHARGE or RUN position, or no key is pressed for five minutes	Turn control knob to RUN, OFF CHARGE, or HOLD/RESET
12-1	**VTBI COMPLETE** **ml = ml**	Primary VTBI complete	VTBI for primary channel has been delivered	Discontinue infusion, or change container and program new VTBI setting
12-2	**VTBI COMPLETE** **ml = ml**	Secondary VTBI complete	VTBI for secondary channel has been delivered	Discontinue infusion, or change container and program new VTBI setting

Table 6-1. Operational Alarm Messages and Corrective Actions

Error Code	Alarm Message	Description	Possible Cause	Corrective Action
13-1	**CASSETTE** 	Input/output valve leak test failure	Defective administration set	Turn control knob to OFF CHARGE, open and close cassette door, then restart Replace administration set
13-2	**CASSETTE** 	Primary/ secondary valve leak test failure	Defective administration set Fluid spillage around valve pins	Turn control knob to OFF CHARGE, open and close cassette door, then restart Clean valve pins Replace administration set
13-3	**CASSETTE** 	Valve leak test failure due to excessive signal noise	Distal tubing continuously moving	Immobilize distal tubing
14-1	**LOCKED** 	Lock violation	Control knob position changed while in LOCKED mode	Press LOCK button and reset settings
16-1	**TURN TO RUN** 	Control knob in between valid states for five seconds	Control knob not in OFF CHARGE or RUN position Defective control knob assembly	Turn control knob to RUN, OFF CHARGE, or HOLD/RESET Replace control knob assembly
17-1	**LOW BATTERY** 	Low battery	Low battery	Connect to AC power or turn control knob to HOLD/RESET, then to RUN
17-2	**LOW BATTERY** 	Low battery re-alarms after 15 minutes	Low battery	Connect to AC power or turn control knob to HOLD/RESET, then to RUN

Table 6-1. Operational Alarm Messages and Corrective Actions

Error Code	Alarm Message	Description	Possible Cause	Corrective Action
18-1	**LOW BATTERY** 	Discharged battery alarm	Fully discharged battery	Connect to AC power, turn control knob to OFF CHARGE, or replace battery
18-2	**Blank Display**	Infusion system shut down one minute after discharged battery alarm	Fully discharged battery	Connect to AC power, turn control knob to OFF CHARGE, or replace battery
19-1	**DOOR** 	Door open	Cassette door open Cassette not seated properly	Turn control knob to OFF CHARGE, or close cassette door Reseat cassette

6.2.2
ERROR CODES REQUIRING TECHNICAL SERVICE

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

Note: The error code is displayed on the screen. Associated malfunction descriptions are not displayed. If reference to alarm history is required, see *Section 6.2.3.1*.

Table 6-2. Error Codes Requiring Technical Service

Error Code	Malfunction Description	Possible Cause	Corrective Action
20-1	Stack overflow	MCU RAM error	Replace MCU/MCU piggyback assembly *(see Section 7.2.15)*
21-1	Critical data checksum failure at startup	MCU RAM error	Replace MCU/MCU piggyback assembly *(see Section 7.2.15)*
21-2	Critical data checksum failure during operation	MCU RAM error	Replace MCU/MCU piggyback assembly *(see Section 7.2.15)*
29-1	ROM checksum failure at startup	MCU ROM error	Replace MCU/MCU piggyback assembly *(see Section 7.2.15)*
29-2	ROM checksum failure during operation	MCU ROM error	Replace MCU/MCU piggyback assembly *(see Section 7.2.15)*

Table 6-2. Error Codes Requiring Technical Service

Error Code	Malfunction Description	Possible Cause	Corrective Action
29-3	ROM checksum test not being performed	MCU execution error	Replace MCU/MCU piggyback assembly *(see Section 7.2.15)*
34-1	EEPROM read/write test failure	Decode circuit failure EEPROM failure	Replace MCU/MCU piggyback assembly *(see Section 7.2.15)* Replace mechanism assembly *(see Section 7.2.19)*
35-1	Critical RAM values found incorrect	RAM error	Replace MCU/MCU piggyback assembly *(see Section 7.2.15)*
41-1	LCD driver chip test failure	Decode circuit failure Driver chip failure	Replace MCU/MCU piggyback assembly *(see Section 7.2.15)* Replace display PWA *(see Section 7.2.18.1)*
44-1	Audio BUZZER signal out of range	Audio buzzer or circuit failure	Replace MCU/MCU piggyback assembly *(see Section 7.2.15)*
44-2	Audio BUZZER signal out of range	Audio buzzer or circuit failure A/D converter malfunction on MCU IC A/D converter reference voltage is incorrect	Replace MCU/MCU piggyback assembly *(see Section 7.2.15)* Check motherboard fuses, or replace motherboard PWA *(see Section 7.2.16)* Replace mechanism assembly *(see Section 7.2.19)*
45-1	[PRI/SEC] key stuck in ON position	Display PWA switch shorted or stuck Front panel key insert stuck	Replace display PWA *(see Section 7.2.18.1)* Replace key insert *(see Section 7.2.18.2)* or replace front enclosure *(see Section 7.2.12)*
45-2	[UP ARROW] key stuck in ON position	Display PWA switch shorted or stuck Front panel key insert stuck	Replace display PWA *(see Section 7.2.18.1)* Replace key insert *(see Section 7.2.18.2)* or replace front enclosure *(see Section 7.2.12)*
45-3	[DOWN ARROW] key stuck in ON position	Display PWA switch shorted or stuck Front panel key insert stuck	Replace display PWA *(see Section 7.2.18.1)* Replace key insert *(see Section 7.2.18.2)* or replace front enclosure *(see Section 7.2.12)*

Table 6-2. Error Codes Requiring Technical Service

Error Code	Malfunction Description	Possible Cause	Corrective Action
45-4	[TITRATE] key stuck in ON position	Display PWA switch shorted or stuck Front panel key insert stuck	Replace display PWA *(see Section 7.2.18.1)* Replace key insert *(see Section 7.2.18.2)* or replace front enclosure *(see Section 7.2.12)*
45-5	[BACKPRIME] key stuck in ON position	Display PWA switch shorted or stuck Front panel key insert stuck	Replace display PWA *(see Section 7.2.18.1)* Replace key insert *(see Section 7.2.18.2)* or replace front enclosure *(see Section 7.2.12)*
45-6	[SILENCE] key stuck in ON position	Display PWA switch shorted or stuck Front panel key insert stuck	Replace display PWA *(see Section 7.2.18.1)* Replace key insert *(see Section 7.2.18.2)* or replace front enclosure *(see Section 7.2.12)*
59-1	Valve motor moving at the wrong time	Position sensor failure Motor drive circuit failure	Replace mechanism assembly *(see Section 7.2.19)* Replace MCU/MCU piggyback assembly *(see Section 7.2.15)*
60-1	Plunger motor position flag is continuous high during re-synchronization	Plunger motor not moving Position sensor failure	Replace mechanism assembly *(see Section 7.2.19)*
60-2	Plunger motor position signal is continuous low during re-synchronization	Enable circuit failure Position sensor failure Plunger motor not moving	Replace mechanism assembly *(see Section 7.2.19)*
61-1	I/O motor position flag is continuous high during re-synchronization	I/O motor not moving Position sensor failure	Replace mechanism assembly *(see Section 7.2.19)*
61-2	I/O motor position signal is continuous low during re-synchronization	Enable circuit failure Position sensor failure I/O motor not moving	Replace mechanism assembly *(see Section 7.2.19)*
62-1	Primary/secondary motor position flag is continuous high during re-synchronization	Primary/secondary motor not moving Position sensor failure	Replace mechanism assembly *(see Section 7.2.19)*
62-2	Primary/secondary motor position signal is continuous low during re-synchronization	Enable circuit failure Position sensor failure Primary/secondary motor not moving	Replace mechanism assembly *(see Section 7.2.19)*

Table 6-2. Error Codes Requiring Technical Service

Error Code	Malfunction Description	Possible Cause	Corrective Action
63-1	Plunger motor phase loss	Plunger motor does not have enough torque Mechanical assembly failure	Replace mechanism assembly *(see Section 7.2.19)*
64-1	I/O motor phase loss	I/O motor does not have enough torque Mechanical mechanism breakage	Replace mechanism assembly *(see Section 7.2.19)*
65-1	Primary/secondary motor phase loss	Primary/secondary motor does not have enough torque Mechanical mechanism breakage	Replace mechanism assembly *(see Section 7.2.19)*
71-1	Internal timers out of tolerance	MCU PWA timer error	Replace MCU/MCU piggyback assembly *(see Section 7.2.15)*
73-1	+2.5 V_{DC} A/D converter reference voltage out of tolerance	+2.5 V_{DC} reference to A/D converter missing or bad +3.75 V_{DC} reference to A/D converter missing or bad A/D converter malfunction on MCU	Check fuses on motherboard or replace motherboard PWA *(see Section 7.2.16)* Replace mechanism assembly *(see Section 7.2.19)* Replace MCU/MCU piggyback assembly *(see Section 7.2.15)*
73-2	+5 V_{DC} A/D converter reference voltage out of tolerance	+2.5 V_{DC} reference to A/D converter missing or bad +3.75 V_{DC} reference to A/D converter missing or bad A/D converter malfunction on MCU	Check fuses on motherboard or replace motherboard PWA *(see Section 7.2.16)* Replace mechanism assembly *(see Section 7.2.19)* Replace MCU/MCU piggyback assembly *(see Section 7.2.15)*
74-1	Air sensor self test failure Signal seen when sensors disabled	Air sensor or circuitry failure	Replace mechanism assembly *(see Section 7.2.19)*
74-4	Proximal air sensor signal too high	Air sensor or circuitry failure	Replace mechanism assembly *(see Section 7.2.19)*
74-5	Distal air sensor signal too high	Air sensor or circuitry failure	Replace MCU/MCU piggyback assembly *(see Section 7.2.15)*
81-1	MCU PWA signals HKDC and DHKDC are not identical	MCU PWA failure Power supply PWA failure	Replace MCU/MCU piggyback assembly *(see Section 7.2.15)* Replace power supply PWA *(see Section 7.2.14)*

Table 6-2. Error Codes Requiring Technical Service

Error Code	Malfunction Description	Possible Cause	Corrective Action
81-2	Power supply PWA signal HKDC out of tolerance	Power supply PWA failure	Replace power supply PWA *(see Section 7.2.14)*
		MCU PWA failure	Replace MCU PWA *(see Section 7.2.15)*
81-3	VMOT signal out of tolerance when AC power is applied	Motherboard PWA failure	Replace motherboard PWA *(see Section 7.2.16)*
		Power supply PWA failure	Replace power supply PWA *(see Section 7.2.14)*
		MCU PWA failure	Replace MCU PWA *(see Section 7.2.15)*
81-4	VMOT drops too much when motor is energized	Motherboard PWA failure	Replace motherboard PWA *(see Section 7.2.16)*
		Motor drawing excessive current	Replace mechanism assembly *(see Section 7.2.19)*
		Bad battery	Replace battery *(see Section 7.2.4)*
90-1	Calibration data in EEPROM checksum failure	EEPROM internal failure	Contact Hospira
		EEPROM decode circuitry failure	
94-1	Control knob signal present when control knob is disabled	Control knob circuitry failure	Replace display PWA *(Section 7.2.18.1)*
94-2	Illegal control knob signal present	Control knob circuitry failure	Replace display PWA *(Section 7.2.18.1)*
94-4	Reed switch does not match control knob signal	Control knob circuitry failure	Replace display PWA *(Section 7.2.18.1)*
		Reed switch failure	
95-1	Primary valve pin not moving	Pin detect circuitry failure	Replace mechanism assembly *(see Section 7.2.19)*
		Valve pin not present or not moving	
95-2	Secondary valve pin not moving	Pin detect circuitry failure	Replace mechanism assembly *(see Section 7.2.19)*
		Valve pin not present or not moving	
99-1	Failure of one or more internal software self tests	MCU PWA internal failure	Replace MCU/MCU piggyback assembly *(see Section 7.2.15)*
99-2	Failure of one or more internal software self tests	MCU PWA internal failure	Replace MCU/MCU piggyback assembly *(see Section 7.2.15)*

Table 6-2. Error Codes Requiring Technical Service			
Error Code	**Malfunction Description**	**Possible Cause**	**Corrective Action**
99-3	Failure of one or more internal software self tests	MCU PWA internal failure	Replace MCU/MCU piggyback assembly *(see Section 7.2.15)*
99-4	Failure of one or more internal software self tests	MCU PWA internal failure	Replace MCU/MCU piggyback assembly *(see Section 7.2.15)*
99-5	Failure of one or more internal software self tests	MCU PWA internal failure	Replace MCU/MCU piggyback assembly *(see Section 7.2.15)*
99-6	Failure of one or more internal software self tests	MCU PWA internal failure	Replace MCU/MCU piggyback assembly *(see Section 7.2.15)*

6.2.3
SERVICE MODE

The Service mode provides diagnostic and repair service information. On the XL3, the Service mode is accessed by simultaneously pressing and holding the **[TITRATE]** and **[SILENCE]** keys while turning the control knob from the **OFF CHARGE** position.

On the XL3M, the Service mode is accessed by simultaneously pressing and holding the **[TITRATE/QUICKSET]** and **[SILENCE]** keys while turning the control knob from the **OFF CHARGE** position.

These keys must be pressed until the end of the self test sequence, at which time normal infusion system operation is disabled and the Service mode is accessed.

The Service mode accesses the following functions:

- alarm history
- software revision number
- run time
- battery run time

Table 6-3 lists the control knob settings used during Service mode and provides information for each control knob setting.

Table 6-3. Service Mode Control Knob Settings	
Control Knob Setting	**Service Mode Information**
SET RATE	Alarm history
SET VTBI	Software revision number
RUN	Run time and battery run time

6.2.3.1
ALARM HISTORY

When the infusion system line is in service mode and the control knob is turned to **SET RATE**, the alarm history can be viewed. In the alarm history list, large digits indicate an alarm error number (i.e., **Er01**, **Er02**, **Er03**) and small digits indicate a four-digit alarm code. If there are no entries in the alarm history, the large digits indicate **Er**, and the small digits indicate **----**.

The [↑] and [↓] keys are used to scroll through the alarm history. The first entry displayed is the most recent alarm. To view a previous alarm, press the [↑] key. The large numerals increment to indicate the order of alarms. Pressing the [↑] key has no effect when the end of the alarm history is reached. To review the entries, press the [↓] key.

When service is performed on the infusion system, it may be desirable to clear the alarm history list. Clear the alarm history by simultaneously pressing and holding the **[PRI/SEC]** key and the **[BACKPRIME]** key for four seconds. The small digits flash and an audible tone sounds four times at a once-per-second rate. After four seconds, the alarm history list is cleared.

6.2.3.2
SOFTWARE REVISION NUMBER

When the infusion system is in service mode and the control knob is turned to **SET VTBI**, the software revision number is displayed. The decimal point does not display, but is implied after the first digit. For example, if the display shows 105, the software revision number is 1.05. The software revision number may be necessary when contacting Hospira.

6.2.3.3
RUN TIME AND BATTERY RUN TIME

When the infusion system is in service mode and the control knob is set to **RUN**, run time and battery run time is displayed. When run time and battery run time display, large digits indicate the total infuser run time in tens of hours, and the small digits indicate the battery run time in tens of hours. For example, if the large digits indicate 245 and the small digits indicate 79, the particular line has operated for a total of 2,450 hours and has also been operated on battery for 790 of those 2,450 hours.

When replacing a battery, it may be desirable to clear the battery run time. To clear battery run time, simultaneously press and hold the **[PRI/SEC]** key and the **[BACKPRIME]** key for four seconds. The small digits flash and an audible tone sounds four times at a once-per-second rate. After four seconds, the battery run time is cleared.

The total infuser line time cannot be cleared.

6.3 TROUBLESHOOTING PROCEDURES

Table 6-4 describes failures that may be detected during the PVT. If an error code displays, see *Section 6.2*.

Table 6-4. Troubleshooting with the PVT

Test Failure	Possible Cause	Corrective Action
Self Test *Section 5.2.4* *Section 5.3.4*	Cassette not properly installed	Reprime and re-insert cassette
	Defective MCU/MCU piggyback assembly	Replace MCU/MCU piggyback assembly
	Defective motherboard PWA	Replace motherboard PWA
	Defective fuse	Replace fuse
	Defective AC power cord	Replace AC power cord
	Defective display PWA or display/MCU cable	Replace display PWA or display/MCU cable
	Defective power supply PWA	Replace power supply PWA
Keypad and Control Knob *Section 5.2.5* *Section 5.3.5*	Defective display PWA or ribbon cable	Replace display PWA or ribbon cable
	Defective control knob	Replace control knob
Open Door Alarm *Section 5.2.6* *Section 5.3.6*	Cassette door open	Close cassette door
	Cassette not properly seated	Reseat cassette
	Defective sensor PWA	Replace mechanism
	Defective mechanism assembly	Replace mechanism
	Defective MCU/MCU piggyback assembly or sensor cable	Replace MCU/MCU piggyback assembly or sensor cable
	Defective display PWA or display/MCU cable	Replace display PWA or display/MCU cable
	Defective motherboard PWA	Replace motherboard PWA
Alarm Level *Section 5.2.7* *Section 5.3.7*	Defective MCU/MCU piggyback assembly	Replace MCU/MCU piggyback assembly
	Defective power supply PWA	Replace power supply PWA
Free Flow *Section 5.2.8* *Section 5.3.8*	Cassette not properly seated	Reseat cassette
	Defective cassette	Replace cassette
	Defective or dirty valve pins	Clean valve pins
Distal Occlusion *Section 5.2.9* *Section 5.3.9*	Cassette not properly primed	Reprime cassette
	Defective cassette	Replace cassette
	Dirty sensor pin	Clean sensor pin
	Defective sensor PWA	Replace mechanism

Table 6-4. Troubleshooting with the PVT

Test Failure	Possible Cause	Corrective Action
Proximal Occlusion *Section 5.2.10* *Section 5.3.10*	Closed proximal clamp Cassette not properly primed Defective cassette Dirty sensor pin Defective sensor PWA	Open clamp Reprime cassette Replace cassette Clean sensor pin Replace mechanism
Delivery Accuracy *Section 5.2.11* *Section 5.3.11*	Administration set not properly primed Damaged or faulty administration set Defective mechanism assembly	Reprime administration set Prime using new administration set Replace mechanism
Empty Container/ Air-in-Line Alarm *Section 5.2.12* *Section 5.3.12*	Defective special cassette Dirty bubble sensors Defective bubble sensor PWA Defective sensor PWA	Replace special cassette Clean bubble sensors Replace mechanism Replace mechanism
Electrical Safety *Section 5.2.13* *Section 5.3.14*	Insufficient ground connection Defective AC power cord Defective power supply PWA	Attach lead to equipotential post Replace AC power cord Replace power supply PWA
Battery Charger Current *Section 5.4.1*	Blown fuse Defective AC power cord Defective power supply PWA Defective motherboard PWA	Replace fuse Replace AC power cord Replace power supply PWA Replace motherboard PWA

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Section 7

REPLACEABLE PARTS AND REPAIRS

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

7.1 REPLACEABLE PARTS

Replaceable parts for the 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

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

> **Note:** Specific procedures will vary between the three-battery and single-battery configurations. The different steps for each version are specified within the replacement procedures.

7.2.1 SAFETY AND EQUIPMENT PRECAUTIONS

Before opening the front enclosure of the infuser, 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 ADJUSTMENT OR 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 on any surface.

7.2.2
REQUIRED TOOLS AND MATERIALS

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

- Set of nutdrivers
- Set of flat blade screwdrivers
- Set of Phillips screwdrivers
- Set of Allen wrenches
- Wide-head pliers
- Long needle nose pliers
- Fuse puller
- X-acto® knife
- Loctite® Black Max adhesive
- Tweezers
- Mild solvent
- Lint-free cloth

7.2.3
RUBBER FOOT PAD REPLACEMENT

Recommended tools and materials for this procedure are an X-acto knife, mild solvent, lint-free cloth, and Loctite adhesive.

The replacement part for this procedure is:

Pad, Foot, Rubber

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

1. Turn the control knob on line A, line B, and line C to **OFF CHARGE**.
2. Disconnect the infusion system from AC (mains) power.
3. Carefully place the infuser face down to access the bottom.

   Note: Each rubber foot pad is bonded in its recess. Do not damage the recess.

4. Using the X-acto knife, remove the rubber foot pad and scrape the enclosure recess to remove adhesive residue.
5. Using the mild solvent, clean the enclosure recess and dry thoroughly.
6. Using a small amount of adhesive, adhere the replacement foot pad to the enclosure recess. Clean the area of excess adhesive.
7. After approximately five minutes, verify the foot pad is secure.
8. Connect the infusion system to AC (mains) power.

Replacement of the rubber foot pad is routine maintenance and no verification procedure is normally required. However, if the infuser may have been damaged during these procedures, perform the PVT in *Section 5.2* or *Section 5.3*.

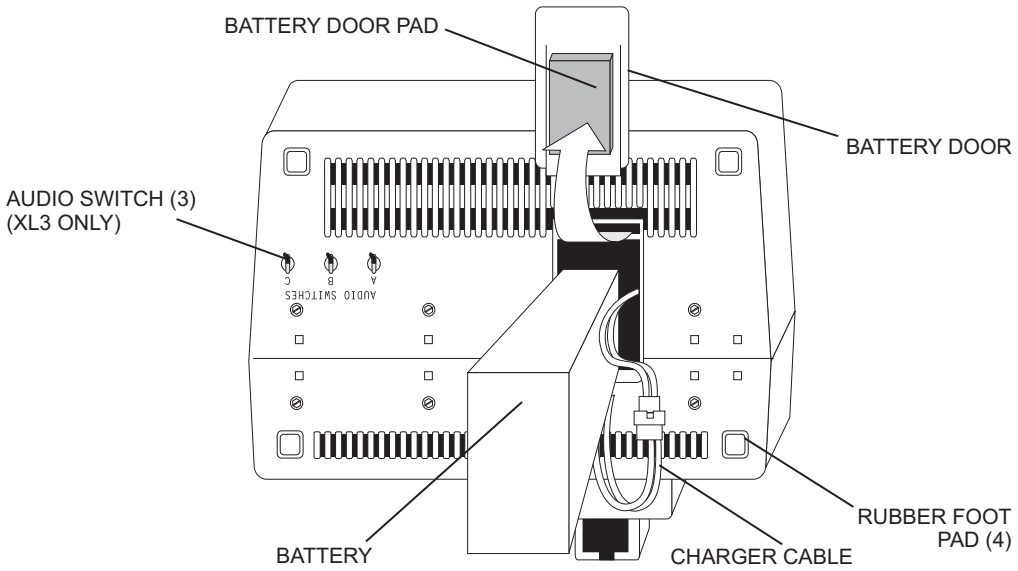

Figure 7-1. Bottom View

7.2.4
BATTERY, BATTERY DOOR, AND DOOR PAD REPLACEMENT

Recommended tools and materials for this procedure are a 1/4 inch nutdriver, X-acto knife, and mild solvent.

> **Note:** Each battery associated with the three-battery infuser is identified by the corresponding battery charger cable labeled A, B, or C.

Replacement parts for this procedure are:

Battery
Door, Battery
Pad, Door
Screw, 6-32 x 1/2, Hex Head, Slotted, with Washer

To replace the battery, battery door, and door pad, see *Figure 7-1* and *Figure 7-2*, and proceed as follows:

1. Turn the control knob on line A, line B, and line C to **OFF CHARGE**.
2. Disconnect the infusion system from AC power.
3. Carefully place the infuser face down to access the bottom.
4. Using the 1/4 inch nutdriver, remove the screws that secure the battery door to the infusion system, and remove the battery door.
5. Inspect the battery door and replace, if required.
6. Inspect the door pad. If the pad is damaged, remove it using the X-acto knife and mild solvent. Dry the battery door thoroughly. Remove the protective backing from the replacement door pad and install the pad on the battery door.

7. Remove the battery charger cable and battery from the enclosure. Disconnect the battery from the charger cable.

   Note: To replace a battery in the three-battery version, it may be necessary to remove all batteries from the enclosure.

8. Connect the replacement battery to the charger cable, and insert the battery into the enclosure. The cable connectors are keyed so that cables cannot be connected incorrectly.

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

9. Reinstall the battery door, using the screws that were removed in step 4.

10. Connect the infusion system to AC (mains) power.

To verify successful battery, battery door, and door pad replacement, perform the PVT in *Section 5.2* or *Section 5.3*.

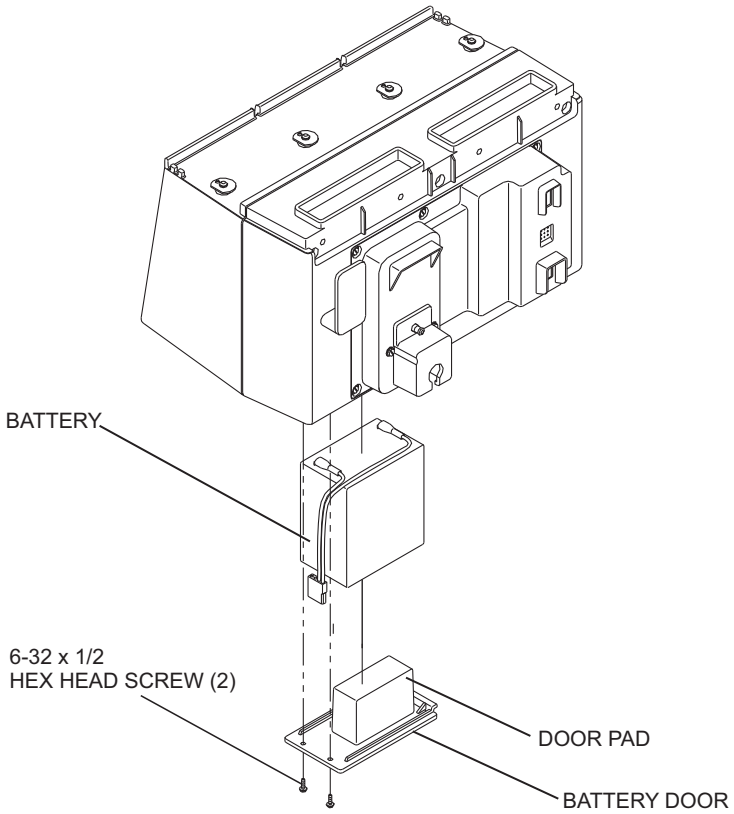

Figure 7-2. Battery, Battery Door, and Door Pad

7.2.5
AC POWER CORD REPLACEMENT (115 V)

The recommended tool for this procedure is a 1/4 inch nutdriver.

Replacement parts for this procedure are:

Cordset, AC Power, Hospital Grade
Cover, Control Access
Gasket, Control Access Cover
Screw, 6-32 x 3/8, Hex Head, Slotted

To replace the 115 V AC power cord, see *Figure 7-3*, and proceed as follows:

1. Turn the control knob on line A, line B, and line C to **OFF CHARGE**.
2. Disconnect the infusion system from AC power.
3. Using the 1/4 inch nutdriver, remove the screws that secure the control access cover to the control module. Remove the control access cover, sliding it partially down the AC power cord.

   Note: When removing the control access cover on the XL3M, carefully back off the cover two to three inches and disconnect the motherboard/ buzzer PWA cable.

4. Inspect the control access cover and gasket and replace, if required.
5. Disconnect the AC power cord from the AC connector and remove the power cord from the control access cover.
6. Insert the replacement AC power cord through the control access cover and connect the power cord to the AC connector.
7. Reinstall the control access cover, using the screws that were removed in step 3.
8. Connect the infusion system to AC power and verify the AC power light is on.

To verify successful 115 V power cord replacement, perform the Electrical Safety Test in *Section 5.2.13*.

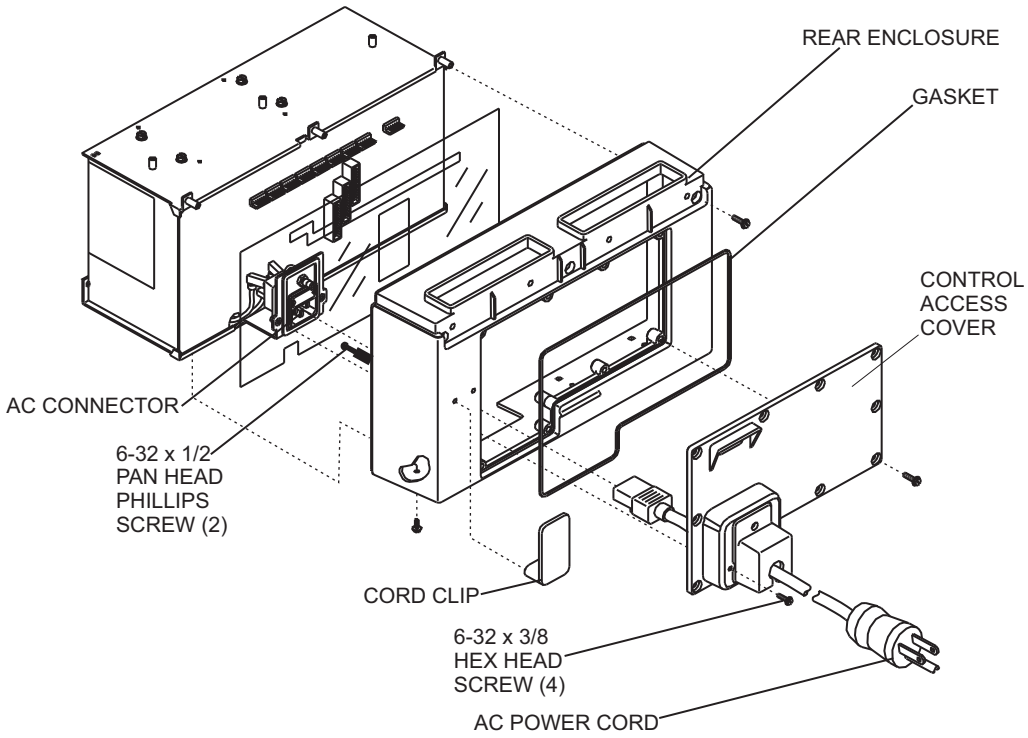

Figure 7-3. AC Power Cord Replacement

7.2.6
AC POWER CORD REPLACEMENT (220 V)

No tools are required for this procedure.

The replacement part for this procedure is:

Cordset, AC Power, Hospital Grade

To replace the 220 V power cord, proceed as follows:

1. Turn the control knob on line A, line B, and line C to **OFF CHARGE**.
2. Disconnect the infusion system from AC power.
3. Disconnect the AC power cord from the rear of the infuser and connect the replacement power cord.
4. Connect the infusion system to AC power and verify the AC power light is on.

To verify successful 220 V power cord replacement, perform the Electrical Safety Test in *Section 5.3.14*.

7.2.7
CORD CLIP REPLACEMENT

Recommended tools for this procedure are a 1/4 inch nutdriver, 5/64 Allen wrench, No. 2 Phillips screwdriver, and small flat blade screwdriver.

Replacement parts for this procedure are:

Clip, Cord
Screw, 6-32 x 1/2, Pan Head, Phillips

To replace the cord clip, see *Figure 7-3*, and proceed as follows:

1. Turn the control knob on line A, line B, and line C to **OFF CHARGE**.
2. Disconnect the infusion system from AC power.
3. Separate the control module front and rear enclosure assemblies as described in *Section 7.2.11*.
4. Using the Phillips screwdriver, remove the screws that secure the cord clip to the rear enclosure, and remove the cord clip.
5. Install the replacement cord clip using the screws that were removed in step 4.
6. Reassemble the front and rear enclosures in the exact reverse order of separation.
7. Connect the infusion system to AC power.

To verify successful cord clip replacement, perform the PVT in *Section 5.2* or *Section 5.3*.

7.2.8
FUSE REPLACEMENT (115 V)

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

Recommended tools for this procedure are a 1/4 inch nutdriver and fuse puller.

Replacement parts for this procedure are:

Fuse
Drawer, Fuse

To replace the fuses, see *Figure 7-4*, and proceed as follows:

1. Turn the control knob on line A, line B, and line C to **OFF CHARGE**.
2. Disconnect the infusion system from AC power.
3. Using the nutdriver, remove the control access cover as described in *Section 7.2.5*.
4. Replace the fuses with the fuse rating indicated on the fuse drawer.
5. Inspect the fuse drawer and replace, if required.
6. Inspect the AC connector, gasket, and equipotential post and replace, if required *(see Section 7.2.17)*.
7. Reinstall the control access cover.
8. Connect the infusion system to AC power.

To verify successful 115 V fuse replacement, perform the PVT in *Section 5.2* or *Section 5.3*.

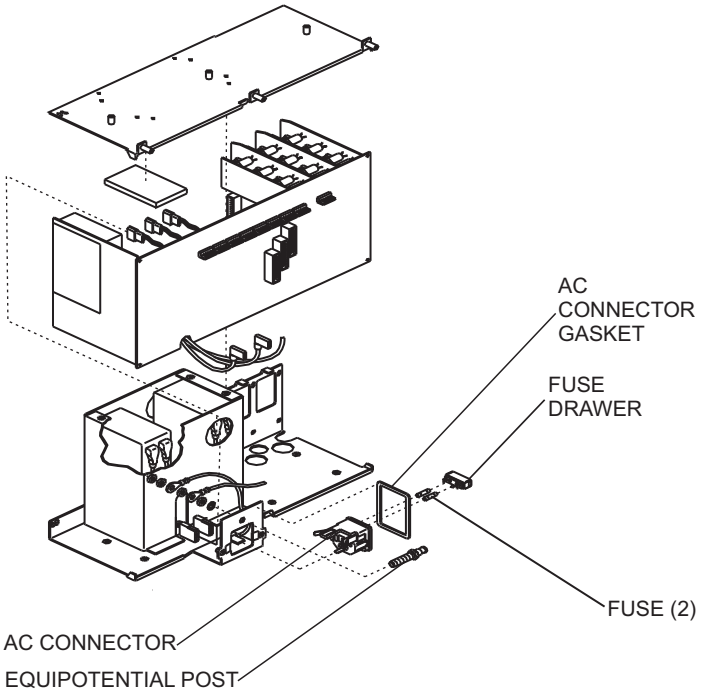

Figure 7-4. Fuses, Fuse Drawer, and AC Connector

7.2.9
FUSE REPLACEMENT (220 V)

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

The recommended tool for this procedure is a fuse puller.

Replacement parts for this procedure are:

Fuse
Drawer, Fuse

To replace the fuses, proceed as follows:

1. Turn the control knob on line A, line B, and line C to **OFF CHARGE**.
2. Disconnect the infusion system from AC power.
3. Replace the fuses with the fuse rating indicated on the fuse drawer.
4. Inspect the fuse drawer and replace, if required.
5. Inspect the AC connector, gasket, and equipotential post and replace, if required *(see Section 7.2.17)*
6. Connect the infusion system to AC power.

To verify successful 220 V fuse replacement, perform the PVT in *Section 5.2* or *Section 5.3*.

7.2.10
BUZZER PWA REPLACEMENT (XL3M)

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

Replacement parts for this procedure are:

PWA, Buzzer
Assembly, Cable, Buzzer PWA/Motherboard
Gasket, Lockout
Gasket, Audible Alarm
Screw, 6-32 x 3/8, Hex Head, Slotted

To replace the buzzer PWA in the XL3M, see *Figure 7-5*, and proceed as follows:

1. Turn the control knob on line A, line B, and line C to **OFF CHARGE**.
2. Disconnect the infusion system from AC power.
3. Using the nutdriver, remove the rear access cover.
4. Inspect the buzzer PWA cable and replace, if required.
5. Inspect the lockout and audible alarm gaskets and replace, if required.
6. Using the flat blade screwdriver, remove the screws that secure the buzzer PWA to the rear enclosure and remove the buzzer PWA.
7. Install the replacement buzzer PWA in the exact order of removal.

To verify successful buzzer PWA replacement in the XL3M, perform the PVT in *Section 5.2* or *Section 5.3*.

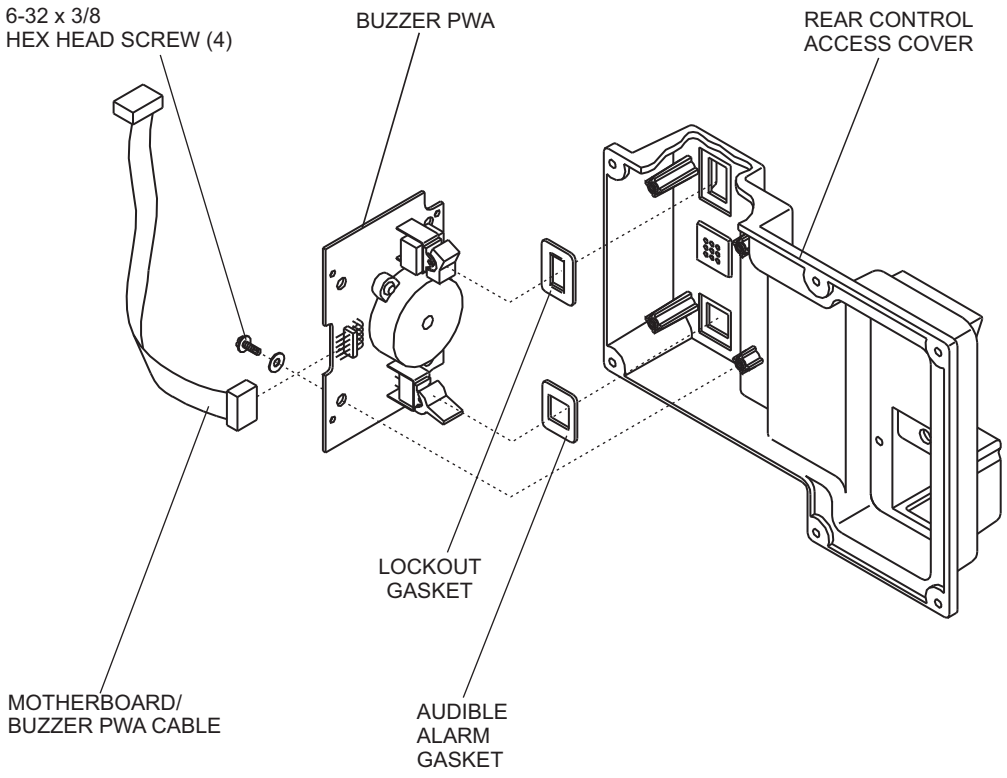

Figure 7-5. XL3M Rear Access Cover

7.2.11
SEPARATING THE CONTROL MODULE AND PUMP MODULE ASSEMBLIES

The recommended tool for this procedure is a 1/4 inch nutdriver.

To separate the control module and pump module assemblies, see *Figure 7-6*, and proceed as follows:

1. Turn the control knob on line A, line B, and line C to **OFF CHARGE**.
2. Disconnect the infusion system from AC power.
3. Remove the battery door and battery as described in *Section 7.2.4*.
4. Using the 1/4 inch nutdriver, remove the screws that secure the control access cover to the control module assembly. Partially separate the control access cover from the rear enclosure approximately six inches, sliding it down the AC power cord.
5. Disconnect the buzzer PWA cable from the motherboard (XL3M only), and remove the control access cover.
6. Disconnect the AC power cord from the AC connector.
7. Disconnect the connectors from the motherboard, as follows:
   - Sensor cable assemblies from J5A through J5C
   - Plunger motor cable assemblies from J7A through J7C
   - I/O motor cable assemblies from J8A through J8C
   - Primary/secondary motor cable assemblies from J9A through J9C
8. Using the nutdriver, remove the screws that secure the pump module assembly to the control module assembly.
9. Slide the pump module assembly rearward then upward to disengage it from the control module assembly.
10. Position the control module assembly to access its top, and remove the screws from the rear of the assembly.
11. Tilt the pump module assembly forward and pull all cables free from the control module assembly, then separate the pump module from the control module.
12. Assemble the control module and pump module assemblies in the exact reverse order of separation.
13. Replace the battery and battery door in the exact reverse order of removal.
14. Connect the infusion system to AC power.

To verify successful assembly of the control module and pump module, perform the PVT in *Section 5.2* or *Section 5.3*.

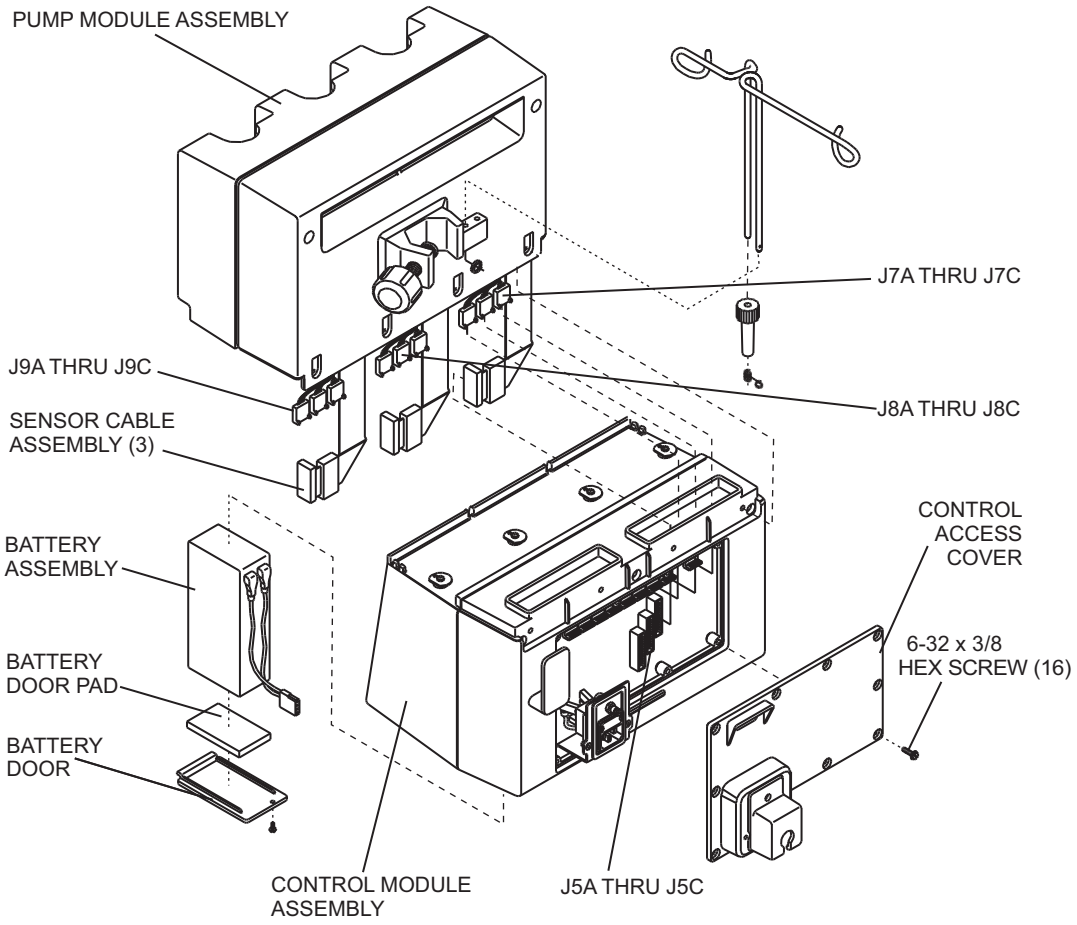

Figure 7-6. Control Module and Pump Module Assemblies

7.2.12
CONTROL MODULE FRONT AND REAR ENCLOSURE REPLACEMENT

Recommended tools for this procedure are a 1/4 inch nutdriver and 5/64 inch Allen wrench.

Replacement parts for this procedure are:

Assembly, Enclosure, Control Module, Front
Assembly, Enclosure, Control Module, Rear
Gasket, Control Module, Front/Rear
Plate, Backing
Screw, 6-32 x 3/8, Hex Head, Slotted

To replace the control module front and rear enclosures, see *Figure 7-7*, and proceed as follows:

1. Separate the control module and pump module assemblies as described in *Section 7.2.11*.
2. Using the 1/4 inch nutdriver, remove the screws from the top and rear of the control module.

3. Position the control module assembly to access the bottom. Using the nutdriver, remove the screws from the bottom of the front enclosure and the bottom of the rear enclosure, and separate the front and rear enclosures from the chassis assembly.
4. Disconnect the display/MCU cable from each MCU/MCU piggyback assembly at J3.
5. Inspect the front enclosure assembly components and replace, as required *(see Section 7.2.18)*.
6. Using the 5/64 Allen wrench, remove the backing plate and front/rear gasket from the front enclosure. Inspect the plate and gasket and replace, as required.
7. Reassemble the control module front and rear enclosures in the exact reverse order of disassembly.
8. Reassemble the control module and pump module assemblies in the exact reverse order of separation.
9. Connect the infusion system to AC power.

To verify successful control module front and rear enclosure replacement, perform the PVT in *Section 5.2* or *Section 5.3*.

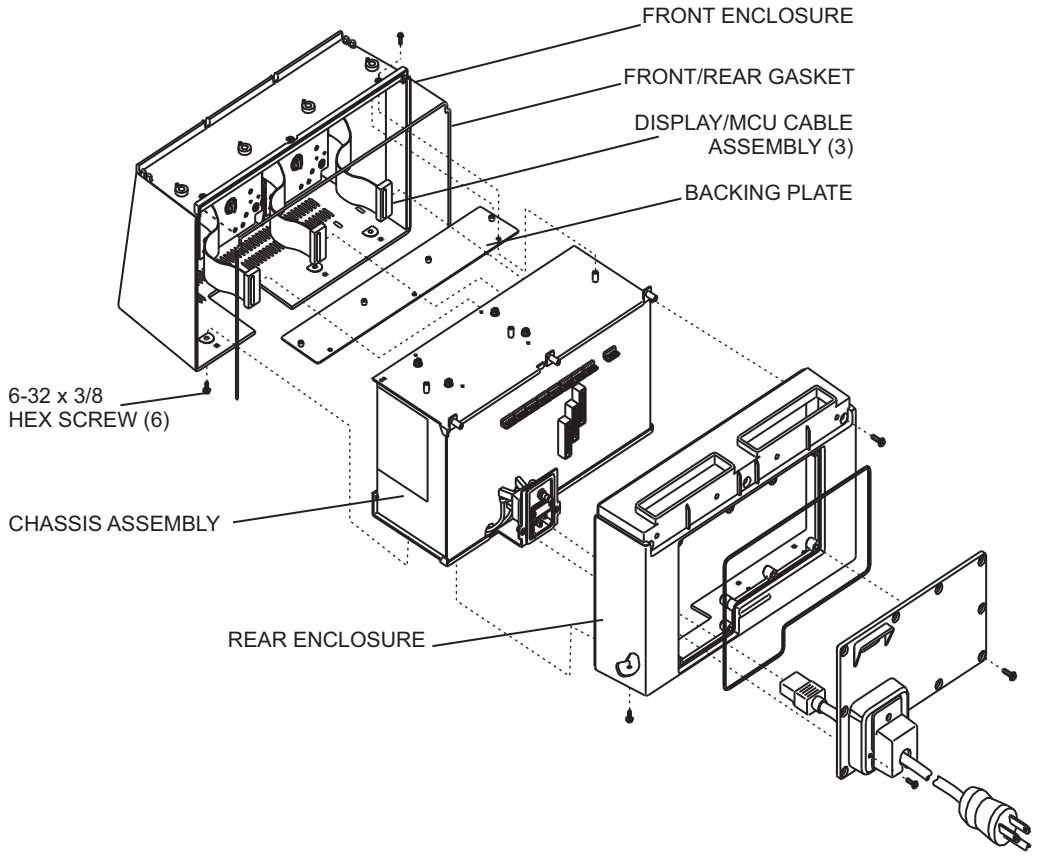

Figure 7-7. Control Module Assembly

7.2.13
PUMP MODULE FRONT AND REAR ENCLOSURE REPLACEMENT

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

Replacement parts for this procedure are:

Assembly, Enclosure, Pump Module, Front
Assembly, Enclosure, Pump Module, Rear
Gasket, Pump Module, Front/Rear
Screw, 6-32 x 3/8, Hex Head, Slotted
Screw, 6-32 x 3 1/4, Pan Head, Phillips

To replace the pump module front and rear enclosures, see *Figure 7-8*, and proceed as follows:

1. Separate the control module and pump module assemblies as described in *Section 7.2.11*.
2. Using the No. 2 Phillips screwdriver, remove the screws from the rear of the pump module.
3. Position the pump module assembly to access the bottom. Using the 1/4 inch nutdriver, remove the screws from the pump module, and separate the pump module front and rear enclosures from the pump module assembly.

   Note: Assure the motor and sensor cables pass freely through the rear enclosure openings.
4. Inspect the front/rear gasket, and replace, as required.
5. Remove and inspect the pole clamp assembly and backing plate and replace, as required *(see Section 7.2.22)*.
6. Reassemble the pump module front and rear enclosures in the exact reverse order of disassembly.
7. Reassemble the control module and pump module assemblies in the exact reverse order of separation.
8. Connect the infusion system to AC power.

To verify successful pump module front and rear enclosure replacement, perform the PVT in *Section 5.2* or *Section 5.3*.

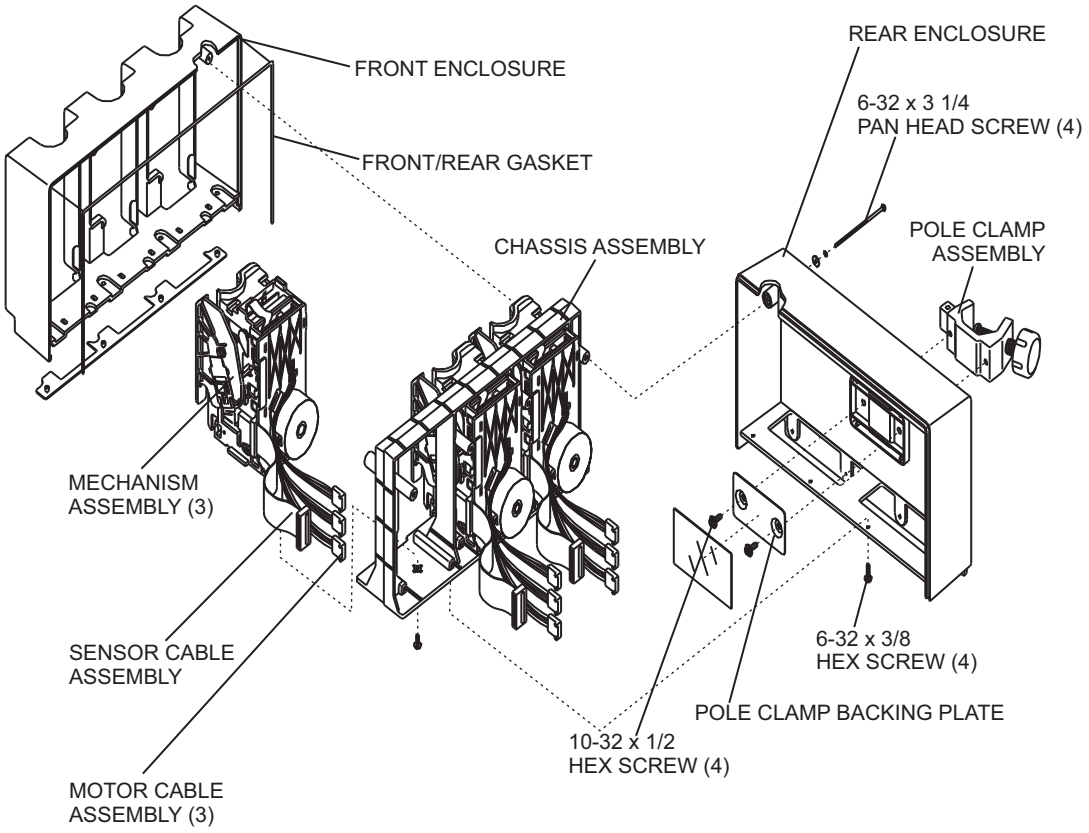

Figure 7-8. Pump Module Assembly

7.2.14
POWER SUPPLY PWA REPLACEMENT

Recommended tools for this procedure are a 1/4 inch nutdriver and long needle nose pliers.

The replacement part for this procedure is:

PWA, Power Supply

To replace the power supply PWA, proceed as follows:

1. Separate the control module front and rear enclosures as described in *Section 7.2.12*.
2. Using the 1/4 inch nutdriver, remove the screws that secure the top of the chassis assembly to the battery compartment.

   Note: In the single-battery version, remove the screws that secure the top to the bottom of the chassis assembly.

3. Remove the connectors from plugs P4 and P25, and remove the power supply PWA from the motherboard PWA *(see Figure 7-9)*.
4. Tilt the motherboard to access the power supply PWA. Using the needle nose pliers, removed the connectors from plugs P16, P17, and P18 *(see Figure 7-9)*.

5. Install the replacement power supply PWA in the exact reverse order of removal.
6. Reassemble the control module front and rear enclosures in the exact reverse order of separation.

   Note: In the single-battery version, assemble the control module top and bottom in the exact reverse order of separation.

7. Reassemble the control module and pump module assemblies in the exact reverse order of separation.
8. Connect the infusion system to AC power.

To verify successful replacement of the power supply PWA, perform the PVT in *Section 5.2* or *Section 5.3*.

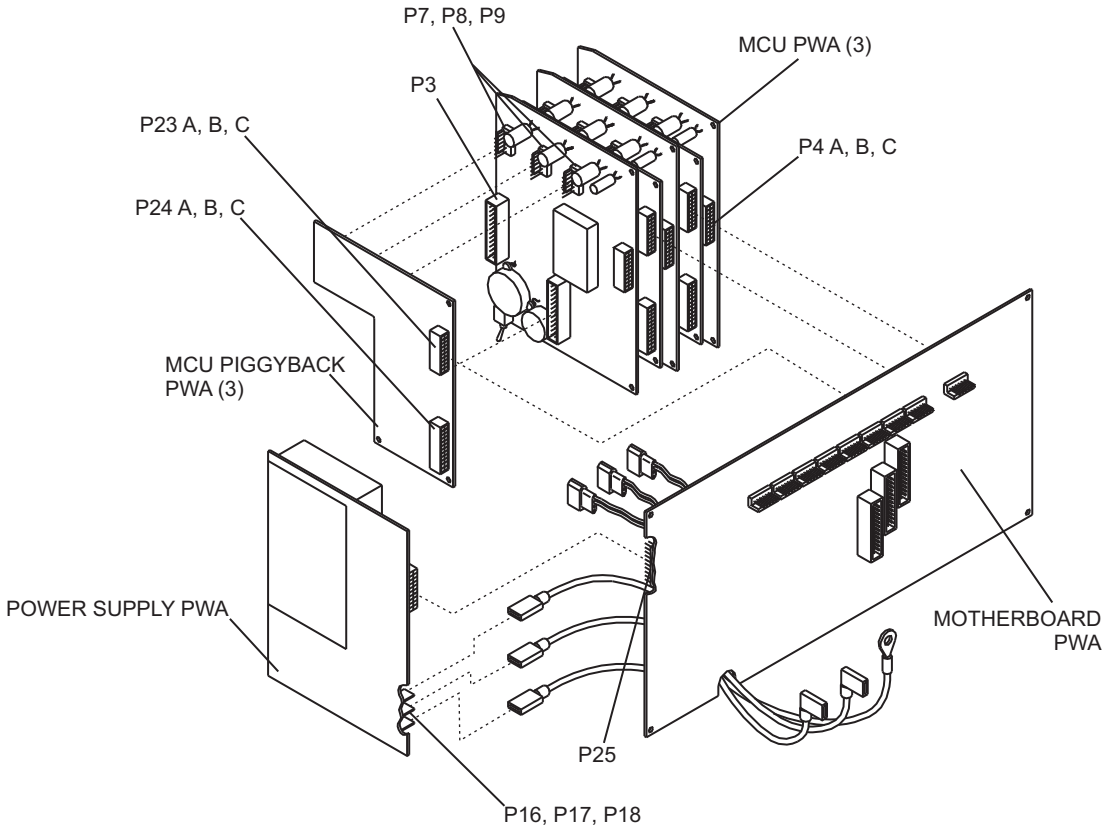

Figure 7-9. Power Supply, MCU, MCU Piggyback, and Motherboard PWAs

7.2.15
MCU/MCU PIGGYBACK ASSEMBLY REPLACEMENT

There are three MCU/MCU piggyback assemblies associated with the infusion system. Each MCU/MCU piggyback assembly is identified by corresponding line A, line B, or line C.

The recommended tool for this procedure is a 1/4 inch nutdriver.

Replacement parts for this procedure are:

PWA, MCU
PWA, MCU Piggyback

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

1. Separate the control module front and rear enclosures as described in *Section 7.2.12*.
2. Using the 1/4 inch nutdriver, remove the screws that secure the top of the chassis assembly to the battery compartment.

   Note: In the single-battery version, remove the screws that secure the top to the bottom of the chassis assembly.
3. Tilt the motherboard to access the three MCU piggyback assemblies.
4. Remove the line A MCU piggyback assembly by removing the connectors from plugs P3, P4A, P23A, and P24A.
5. Remove the line B MCU piggyback assembly by removing the connectors from plugs P3, P4B, P23B, and P24B.
6. Remove the line C MCU piggyback assembly by removing the connectors from plugs P3, P4C, P23C, and P24C.
7. Separate the MCU PWA from the MCU piggyback PWA by removing the connectors from plugs P5, P7, P8, P9, and P10.
8. Reassemble the MCU PWA and MCU piggyback PWA in the exact reverse order of separation.
9. Install the replacement MCU/MCU piggyback assembly in the exact reverse order of removal.
10. Reassemble the control module front and rear enclosures in the exact reverse order of separation.

    Note: In the single-battery version, assemble the control module top and bottom in the exact reverse order of separation.
11. Reassemble the control module and pump module assemblies in the exact reverse order of separation.
12. Connect the infusion system to AC power.

To verify successful replacement of the MCU/MCU piggyback assembly, perform the PVT in *Section 5.2* or *Section 5.3*.

7.2.16
MOTHERBOARD PWA REPLACEMENT

Recommended tools for this procedure are a 1/4 inch nutdriver and long needle nose pliers.

The replacement part for this procedure is:

PWA, Motherboard

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

1. Separate the control module front and rear enclosures as described in *Section 7.2.12*.
2. Remove the insulator from the rear of the motherboard PWA. Inspect the insulator and replace, if required.
3. Using the 1/4 inch nutdriver, remove the screws that secure the top of the chassis assembly to the battery compartment.

   Note: In the single-battery version, remove the screws that secure the top to the bottom of the chassis assembly.
4. Tilt the motherboard to access the PWAs, then remove the power supply PWA as described in *Section 7.2.14*.
5. Remove each MCU/MCU piggyback assembly as described in *Section 7.2.15*.
6. Lift and remove the motherboard PWA from the chassis assembly.

   Note: Assure the battery cables are clear of the battery compartment.
7. Install the replacement motherboard in the exact reverse order of removal.
8. Reinstall each MCU/MCU piggyback assembly in the exact reverse order of removal.
9. Reinstall the power supply PWA in the exact reverse order of removal.
10. Reinstall the motherboard PWA insulator.
11. Reassemble the control module front and rear enclosures in the exact reverse order of separation.

    Note: In the single-battery version, assemble the control module top and bottom in the exact reverse order of separation.
12. Reassemble the control module and pump module assemblies in the exact reverse order of separation.
13. Connect the infusion system to AC power.

To verify successful replacement of the motherboard PWA, perform the PVT in *Section 5.2* or *Section 5.3*.

7.2.17
AC CONNECTOR REPLACEMENT

The recommended tool for this procedure is long needle nose pliers.

Replacement parts for this procedure are:

Connector, AC
Gasket, AC Connector
Post, Equipotential

To replace the AC connector, see *Figure 7-4*, and proceed as follows:

1. Remove the AC power cord as described in *Section 7.2.5* or *Section 7.2.6*.
2. Remove the fuses and fuse drawer as described in *Section 7.2.8* or *Section 7.2.9*.
3. Separate the control module front and rear enclosures as described in *Section 7.2.12*.
4. Using the needle nose pliers, remove the three wire connectors from the AC connector.
5. Remove the AC connector from the chassis assembly by pressing in the two tabs on each side of the connector.
6. Install the replacement AC connector in the exact reverse order of removal.
7. Inspect the equipotential post and replace, if required.
8. Reassemble the control module front and rear enclosures in the exact reverse order of separation.
9. Reassemble the control module and pump module assemblies in the exact reverse order of separation.
10. Reinstall the fuses and fuse drawer in the exact reverse order of removal.
11. Reinstall the AC power cord in the exact reverse order of removal.
12. Connect the infusion system to AC power.

To verify successful AC connector replacement, perform the PVT in *Section 5.2* or *Section 5.3*.

7.2.18
CONTROL MODULE FRONT ENCLOSURE COMPONENT REPLACEMENT

Control module front enclosure components include the following:

- Display PWA
- Display/MCU cable assembly
- Key inserts
- Control knob, detent, washer, and snap retainer
- Front panel label

To replace the control module front enclosure components, see *Figure 7-10*, then perform the steps in the following sections.

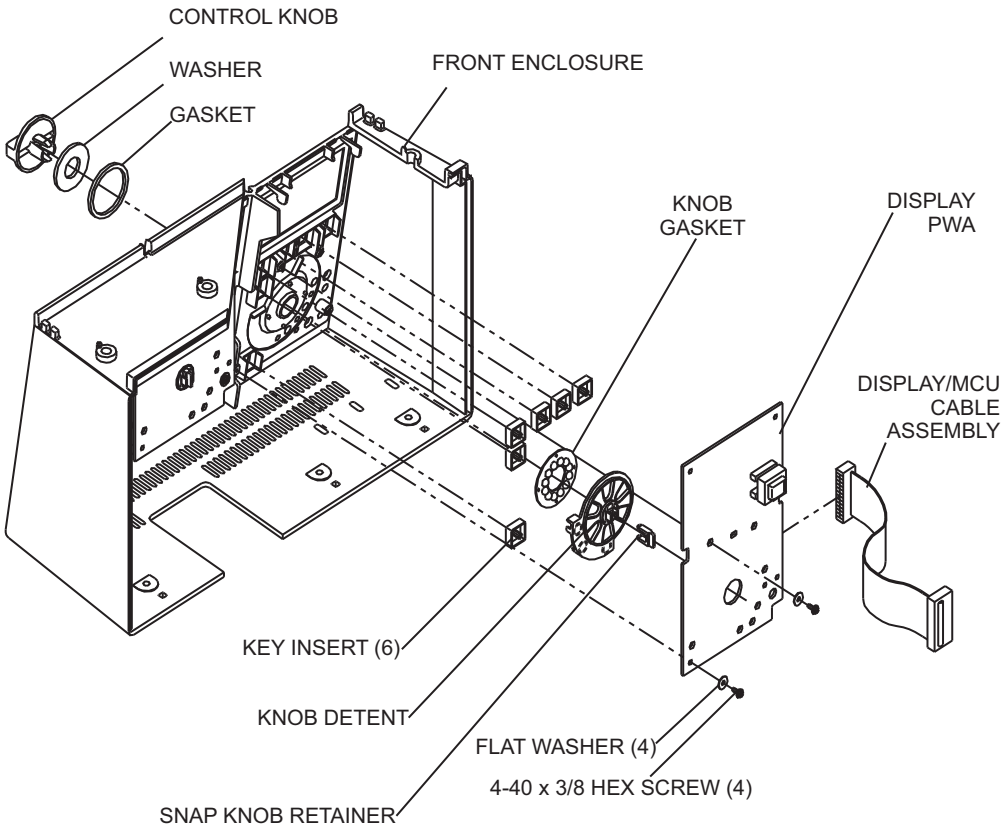

Figure 7-10. Control Module Front Enclosure Components

7.2.18.1
DISPLAY PWA AND DISPLAY/MCU CABLE REPLACEMENT

There are three display PWAs and three display/MCU cable assemblies associated with the infusion system. Each display PWA and display/MCU cable is identified by corresponding line A, line B, or line C.

The recommended tool for this procedure is a 1/8 inch nutdriver.

Replacement parts for this procedure are:

PWA, Display
Assembly, Cable, Display/MCU
Screw, 4-40 x 3/8, Hex Head, Slotted
Washer, Flat, #4

To replace the display PWA and display/MCU cable, see *Figure 7-10*, and proceed as follows:

1. Separate the control module front and rear enclosures as described in *Section 7.2.12*.
2. Using the nutdriver, remove the screws that secure the display PWA to the front enclosure.
3. Remove and inspect the display/MCU cable assembly and replace, as required.
4. Lift the display PWA from the front enclosure.
5. Install the replacement display PWA in the exact reverse order of removal.
6. Reassemble the control module front and rear enclosures in the exact reverse order of separation.
7. Reassemble the control module and pump module assemblies in the exact reverse order of separation.
8. Connect the infusion system to AC power.

To verify successful replacement of the display PWA and display/MCU cable, perform the PVT in *Section 5.2* or *Section 5.3*.

7.2.18.2
KEY INSERT REPLACEMENT

The recommended tool for this procedure is long needle nose pliers.

The replacement part for this procedure is:

Insert, Key

To replace the key inserts, see *Figure 7-10*, and proceed as follows:

1. Remove the display PWA that covers the key inserts as described in *Section 7.2.18.1*.
2. Using the needle nose pliers, carefully remove the key inserts, then install the replacement key inserts.
3. Replace the display PWA in the exact reverse order of removal.
4. Connect the infusion system to AC power.

To verify successful key insert replacement, perform the PVT in *Section 5.2* or *Section 5.3*.

7.2.18.3

CONTROL KNOB, GASKET, DETENT, DETENT RING, AND SNAP RETAINER REPLACEMENT

Recommended tools for this procedure are long needle nose pliers and a 1/8 inch nutdriver.

Replacement parts for this procedure are:

Knob, Control	**Detent, Knob**
Washer, Control Knob	**Ring, Detent**
Gasket, Control Knob	**Retainer, Snap**

To replace the control knob, gasket, detent, detent ring, and snap retainer, see *Figure 7-10*, and proceed as follows:

1. Remove the key inserts as described in *Section 7.2.18.2*.
2. Using the needle nose pliers, remove the snap retainer.
3. Remove and inspect the control knob, detent, washer, and gasket, and replace, as required.
4. Position the gasket into the circular recess on the front side of the front enclosure.
5. Install the washer onto the control knob, then install the control knob through the hole in the front enclosure.
6. Turn the control knob to **OFF CHARGE**.

   Note: When the control knob is in the **OFF CHARGE** position, the knob detent is positioned on the detent ring as shown in *Figure 7-10*.
7. Place the front enclosure face down. Position the detent ring on the four pins centered on the control knob.
8. Using the snap retainer, secure the detent to the control knob retainer clips and splines. Press the snap retainer firmly until secure.
9. Verify the control knob rotates through the full range of positions.
10. Reinstall the key inserts in the exact order of removal.

To verify successful replacement of the control knob, detent, detent ring, and snap retainer, perform the PVT in *Section 5.2* or *Section 5.3*.

7.2.18.4
FRONT PANEL LABEL REPLACEMENT

Recommended tools and materials for this procedure are an X-acto knife and mild solvent.

The replacement part for this procedure is:

Label, Front Panel

To replace the front panel label, proceed as follows:

1. Turn the control knob on line A, line B, and line C to **OFF CHARGE**.
2. Disconnect the infusion system from AC power.
3. Using the X-acto knife, remove the front panel label from the front enclosure.
4. Using the mild solvent, remove adhesive residue from the front panel recess.
5. Remove the protective backing from the replacement front panel label, then press the label into position on the front enclosure.

Replacement of the front panel label is routine maintenance and no verification procedure is normally required. However, if the infusion system may have been damaged during the procedure, perform the PVT in *Section 5.2* or *Section 5.3*.

7.2.19
CHASSIS ASSEMBLY, MECHANISM ASSEMBLY, AND SENSOR CABLE REPLACEMENT

The recommended tool for this procedure is a 1/4 inch nutdriver.

Replacement parts for this procedure are:

Assembly, Chassis
Assembly, Mechanism
Assembly, Cable, Sensor
Insulator, Adhesive-Backed
Screw, 6-32 x 3/8, Hex Head, Slotted

To replace the chassis assembly, mechanism assembly, and sensor cable, see *Figure 7-11*, and proceed as follows:

1. Separate the pump module front and rear enclosures as described in *Section 7.2.13*.
2. Identify the mechanism assembly or sensor cable to be replaced (line A, line B. or line C). Using the nutdriver, remove the screw from the bottom of the chassis assembly.
3. Slide the mechanism assembly forward from the chassis, then disconnect the sensor cable from the mechanism assembly.
4. Inspect the chassis assembly, mechanism assembly, and sensor cable, and replace, as required.
5. Remove the protective backing from the replacement adhesive-backed insulator, then press the insulator into position on the replacement mechanism assembly.

6. Install the replacement chassis assembly, mechanism assembly, and/or sensor cable in the exact reverse order of removal.
7. Reassemble the pump module front and rear enclosures in the exact reverse order of separation.
8. Reassemble the control module and pump module assemblies in the exact reverse order of separation.
9. Connect the infusion system to AC power.

To verify successful replacement of the chassis assembly, mechanism assembly, and sensor cable, perform the PVT in *Section 5.2* or *Section 5.3*.

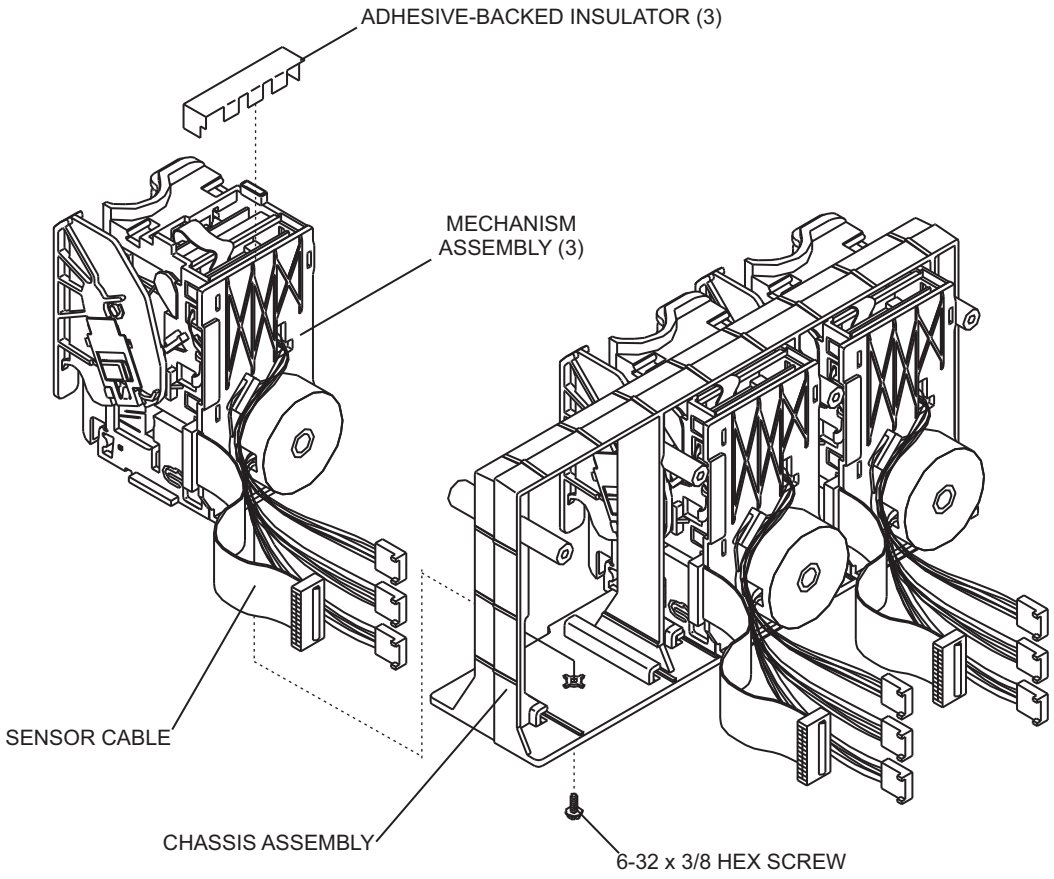

Figure 7-11. Chassis Assembly, Mechanism Assembly, and Sensor Cable

7.2.20
DOOR ASSEMBLY AND MECHANISM SHIELD REPLACEMENT

The recommended tool for this procedure is long needle nose pliers.

Replacement parts for this procedure are:

Assembly, Door
Shield, Mechanism
Retainer, Door Pivot
Clip, Spring, Door

To replace the door assembly and mechanism shield, see *Figure 7-12* and *Figure 7-13*, and proceed as follows:

1. Identify the mechanism assembly to be removed (line A, line B. or line C), then remove the mechanism assembly as described in *Section 7.2.19*.

   Note: When removing the door assembly, the left side door clip may fall free. Note the position of the left side door clip prior to door assembly removal.

2. Position the mechanism assembly to access the door. Open the door to disengage the door assembly from the opener/handle assembly, and fully open the door assembly.
3. Disengage the clips that secure the back of the mechanism shield to the upper portion of the mechanism assembly.
4. Pull the mechanism shield away from the top of the mechanism assembly at an approximate 15 degree angle, then pull the mechanism shield up and away, clearing the mechanism pins and plunger.
5. Inspect the shield, and replace, if required.
6. Close the door assembly and position the mechanism assembly to access its bottom.
7. Grasp the door assembly pivot retainer clip and squeeze it to free the flanges from the mechanism assembly. Once the flanges are free, grasp the pivot retainer clip with the needle nose pliers, pull and rotate the clip toward the door, and remove the clip.
8. Fully open the door assembly. Rotate and lift the door free of the left side door clip, and remove the door assembly from the hinge.
9. Install the replacement door assembly in the exact reverse order of removal.
10. Carefully align the mechanism shield with the mechanism assembly valve and sensor pins, then install the replacement mechanism shield in the exact reverse order of removal.
11. Reinstall the mechanism assembly in the exact reverse order of removal.

To verify successful replacement of the door assembly and mechanism shield, perform the PVT in *Section 5.2* or *Section 5.3*.

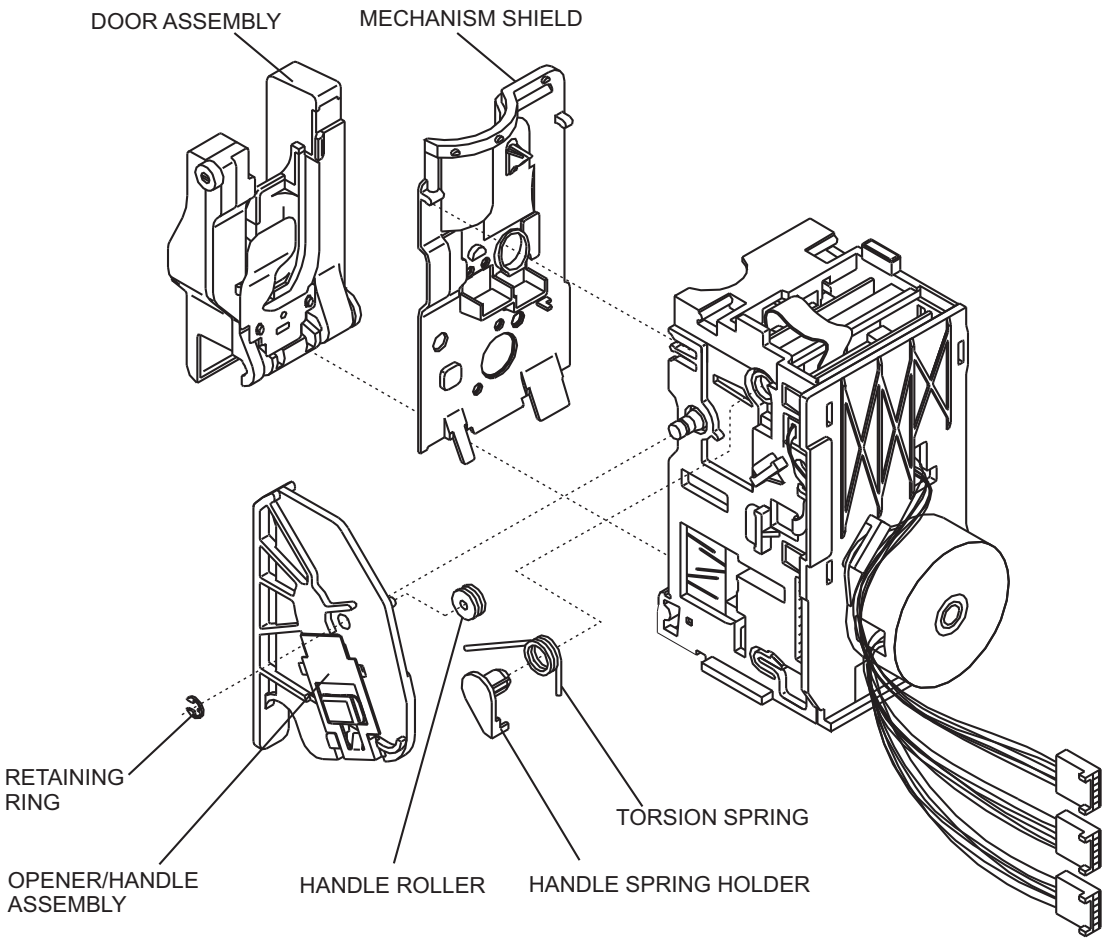

Figure 7-12. Door Assembly, Opener/Handle, and Mechanism Shield

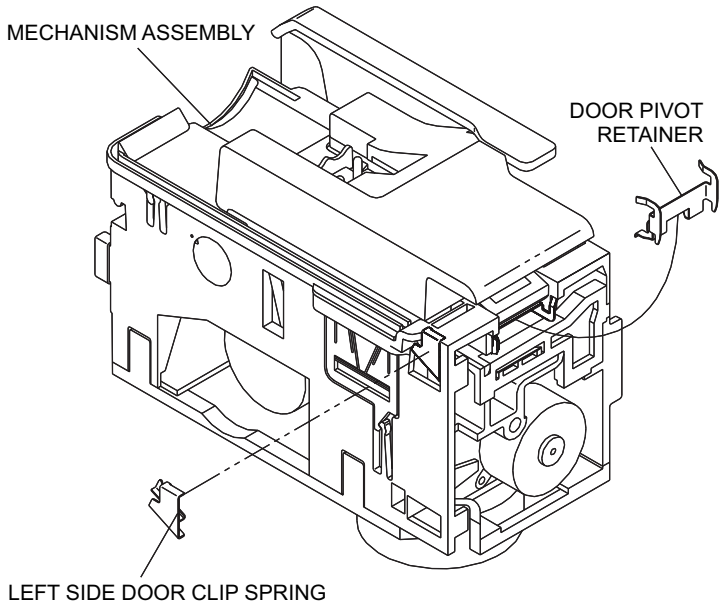

Figure 7-13. Mechanism Assembly Bottom View

7.2.21
OPENER/HANDLE ASSEMBLY REPLACEMENT

Recommended tools for this procedure are small and medium size flat blade screwdrivers.

Replacement parts for this procedure are:

Assembly, Opener/Handle
Ring, Retaining
Roller, Handle
Spring, Torsion
Holder, Handle Spring

To replace the opener/handle assembly, *Figure 7-12* and *Figure 7-13*, and proceed as follows:

1. Identify the mechanism assembly to be removed (line A, line B. or line C), then remove the mechanism assembly as described in *Section 7.2.19*.
2. Position the mechanism assembly to access the door. Open the door to disengage the door assembly from the opener/handle, then fully close the opener/handle assembly.
3. Using the small size screwdriver, remove the retaining ring from the handle shaft.
4. Insert the medium size screwdriver at the pry point between the opener/handle and the mechanism assembly, and pry the assemblies apart.
5. Remove the door roller from the back side of the opener/handle assembly.

   Note: The door pivot retainer and torsion spring may fall free.

6. Inspect the roller and retaining ring, and replace, if required.
7. Install the replacement opener/handle assembly in the exact reverse order of removal. Confirm the alignment marks on the opener/handle align with the mechanism assembly *(see Figure 7-13)*.
8. Reinstall the mechanism assembly in the exact reverse order of removal.
9. Reassemble the pump module front and rear enclosures in the exact reverse order of separation.
10. Reassemble the control module and pump module assemblies in the exact reverse order of separation.
11. Connect the infusion system to AC power.

To verify successful opener/handle assembly replacement, perform the PVT in *Section 5.2* or *Section 5.3*.

7.2.22
POLE CLAMP EXTRUSION, BACKING PLATE, AND INSULATOR REPLACEMENT

Recommended tools and materials for this procedure are an X-acto knife, a 5/16 inch nutdriver, and mild solvent.

Replacement parts for this procedure are:

Extrusion, Pole Clamp
Plate, Backing
Insulator, Adhesive-Backed
Screw, 10-32 x 1/2, Hex Head, Slotted

To replace the pole clamp extrusion, backing plate, and insulator, see *Figure 7-8* and *Figure 7-14*, and proceed as follows:

1. Separate the pump module front and rear enclosures as described in *Section 7.2.13*.
2. Using the X-acto knife, carefully remove the adhesive-backed insulator from the pole clamp backing plate.
3. Remove adhesive residue and thoroughly clean and dry the backing plate.
4. Using the nutdriver, remove the screws that secure the pole clamp backing plate to the pole clamp extrusion *(see Figure 7-8)*.
5. Thoroughly clean and dry the pump module rear enclosure.
6. Install the replacement pole clamp extrusion, backing plate, and adhesive-backed insulator in the exact order of removal.
7. Reassemble the pump module front and rear enclosures in the exact reverse order of separation.
8. Reassemble the control module and pump module assemblies in the exact reverse order of separation.
9. Connect the infusion system to AC power.

To verify successful pole clamp extrusion, backing plate, and insulator replacement, perform the PVT in *Section 5.2* or *Section 5.3*.

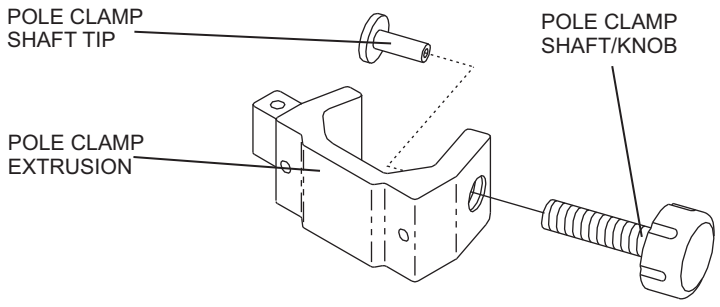

Figure 7-14. Pole Clamp Assembly

7.2.23
POLE CLAMP SHAFT/KNOB ASSEMBLY AND SHAFT TIP REPLACEMENT

The recommended tool for this procedure is wide head pliers.

Replacement parts for this procedure are:

Assembly, Shaft/Knob, Pole Clamp
Tip, Shaft

To replace the pole clamp shaft/knob assembly and shaft tip, see *Figure 7-14*, and proceed as follows:

1. Turn the control knob on line A, line B, and line C to **OFF CHARGE**, and disconnect the infusion system from AC power.
2. Turn the pole clamp shaft/knob assembly counterclockwise to remove it from the pole clamp extrusion, and loosen the pole clamp shaft tip.

   Note: The pole clamp shaft tip has a long shaft that is pressed into the threaded pole clamp shaft/knob assembly.

3. Turn the pole clamp shaft/knob clockwise into the pole clamp extrusion approximately one inch. Using the wide head pliers, grasp the shaft tip and remove it from the pole clamp shaft/knob.
4. Inspect the shaft tip and replace, if required.
5. Install the replacement pole clamp shaft/knob assembly by turning it clockwise into the pole clamp extrusion until the threaded portion of the shaft in visible.
6. Press the replacement pole clamp shaft tip into the screw hole recess on the pole clamp shaft/knob assembly. Using the wide head pliers, fully seat the shaft tip inside the pole clamp extrusion.
7. Connect the infusion system to AC power.

Replacement of the pole clamp shaft shaft/knob assembly and shaft tip is routine maintenance and no verification procedure is normally required. However, if the infusion system may have been damaged during the procedure, perform the PVT in *Section 5.2* or *Section 5.3*.

7.2.24
MINIPOLE ASSEMBLY REPLACEMENT

The minipole assembly is an accessory that attaches to the infusion system through two holes in the pole clamp assembly, and is held in place by a cotter ring. The cotter ring passes through a hole near the end of the longer vertical rod on the bag hanger and prevents the removal of the minipole from the pole clamp *(see Figure 7-15)*.

No tools are required for this procedure.

To replace the minipole assembly, see *Figure 7-15*, and proceed as follows:

1. Turn the control knob on line A, line B, and line C to **OFF CHARGE**, and disconnect the infusion system from AC power.
2. Place the infuser face down on a soft surface.
3. Grasp the cotter ring with thumb and finger. Twist, rotate, and remove the cotter ring from the rod hole.
4. Remove the bag hanger from the pole clamp rod holes, and remove the minipole.
5. 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 the procedure, perform the PVT in *Section 5.2* or *Section 5.3*.

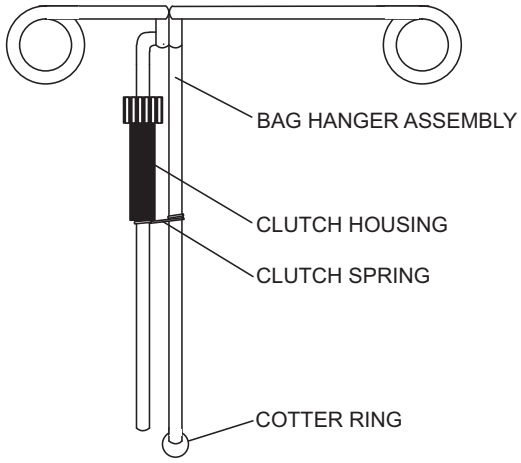

Figure 7-15. Minipole Assembly

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Section 8
SPECIFICATIONS

This section contains specifications for the 115 V_{AC} and 220 V_{AC} XL3 and XL3M infusion systems, in addition to physical and electrical specifications for the three-battery and single-battery versions.

8.1
PLUM XL3 AND XL3M

The following specifications apply to the Plum XL3 and XL3M infusion systems.

PHYSICAL	
Dimensions	Approximately 13.75 H x 12.2 W x 7.5 D inches (35 H x 31 W x 19 D centimeters) (excluding pole clamp)
Weight	**(Three-Battery)** Approximately 20 lbs (9 kg) with batteries **(Single-Battery)** Approximately 20 lbs (9 kg) with battery
Casing	High-impact plastic
ELECTRICAL	
Power Requirements	100 - 130 V_{AC}, 47 to 63 Hz; less than 60 W
Power Cord	Hospital-grade AC cord; 10 feet long; with transparent plug
Fuses	1 A, 250 V, Slow-Blow
Battery	**(Three-Battery)** Three sealed, rechargeable 8 V batteries; internal to the infusion system; accessible for ease of field replacement; with polarized connectors, labeled A, B, and C **(Single-Battery)** One sealed, rechargeable 8 V battery; internal to infusion system; accessible for ease of field replacement; with a polarized connector
Battery Life	**(Three-Battery)** A fully charged new battery provides approximately eight hours of operation at a cumulative rate of 125 or less mL/hr, or 1000 mL total volume delivered **(Single-Battery)** A fully charged new battery provides approximately four hours of operation at a cumulative rate of 375 or less mL/hr, or 1500 mL total volume delivered
Recharge	**(Three-Battery)** The batteries charge when the infusion system is connected to AC power. If a line is turned to **OFF CHARGE**, a full recharge for that particular line battery takes approximately eight hours, or longer if the line is operating **(Single-Battery)** The battery charges when the infusion system is connected to AC power. If a line is turned to **OFF CHARGE**, a full recharge takes approximately six hours, or longer if the line is operating

ENVIRONMENT

Operating Temperature 50° to 104° F (10° to 40° C); 10% to 90% relative humidity

DELIVERY RATE RANGE

Primary/Secondary Mode **(XL3)** 1 to 999 mL/hr (in 1 mL increments)

(XL3M) 0.1 to 99.9 mL/hr (in 0.1 mL increments)
100 to 999 mL/hr (in 1 mL increments)

KVO **(XL3)** 1 mL/hr

(XL3M) The lower of 1 mL/hr or the last rate delivered

DOSE LIMIT RANGE **(XL3)** 1 to 9999 mL/hr (in 1 mL increments)

(XL3M) 0.1 to 99.9 mL (in 0.1 mL increments)
100 to 9999 mL (in 1 mL increments)

OCCLUSION RANGE

Distal 10 psi (+5, -2 psi); 69 KpA (+34.5, - 13.8 kPa)

8.2
LIFECARE XL3M

The following specifications apply to the 220 V_{AC} LifeCare XL3M infusion system.

PHYSICAL	
Dimensions	35 H x 31 W x 19 D centimeters (excluding pole clamp)
Weight	Approximately 9 kg (with battery)
Casing	High-impact plastic
ELECTRICAL	
Mains Voltage	210 - 260 V_{AC}; 47 - 63 Hz; 35 W
Mains Fusing	Two each; T500 mA; 250 V; 5 x 20 mm
Mains Cord	IEC 60601-1-1 approved; removable; 3 meters long
Battery	One sealed, rechargeable 8 V battery; internal to the infusion system; accessible for ease of field replacement; with polarized connector
Battery Operating Time	With a new, fully charged battery, the infusion system provides approximately 1500 mL delivery volume or four hours of operation, whichever occurs first
Battery Recharge	The battery recharges when the infusion system is connected to mains power. If the infusion system is operating at 375 mL/hr, a full recharge takes approximately 16 hours. Recharge takes approximately four hours if the infusion system is turned to **OFF CHARGE**
Battery Charge Retention	A fully charged battery retains at least 20 % of its capacity after six months of storage at below 35° C (95° F) if an infusion system is not connected to mains power
ENVIRONMENT	
Operating Temperature	10° to 40° C (50° to 104° F); 10 % to 90 % relative humidity
Shipping and Storage	-20° to 60° C (-4° to 140° F); 10 % to 90 % relative humidity
DELIVERY RATE RANGE	
Primary/Secondary Mode	0.1 to 99.9 mL/hr (in 0.1 mL increments) 100 to 999 mL/hr (in 1 mL increments)
KVO	The lower of 1 mL/hr or the last rate delivered
DOSE LIMIT RANGE	0.1 to 99.9 mL (in 0.1 mL increments) 100 to 9999 mL (in 1 mL increments)
ELECTRONIC MEMORY	Rates, dose limits, and total volume delivered are maintained indefinitely
ELECTRICAL SAFETY	Designed to meet IEC 60601-1-1 standards
MAXIMUM OCCLUSION PRESSURE	99 kPa

OCCLUSION ALARM PRESSURE LIMIT	69 kPa (+34.5, -13.8 kPa)
MAXIMUM OVERINFUSION	25 % under single fault conditions
MAXIMUM STORED BOLUS VOLUME	
Delivery Rate	1 mL/hr = 0.6 mL 100 mL/hr = 0.6 mL 999 mL/hr = 0.6 mL
MAXIMUM TIME FROM OCCLUSION TO ALARM	
Delivery Rate	1 mL/hr = 40 minutes 100 mL/hr = 30 seconds 999 mL/hr = 2 seconds
DELIVERY RATE ACCURACY	±5 % in typical clinical use

Section 9
DRAWINGS

Figure 9-1 through *Figure 9-15* 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.

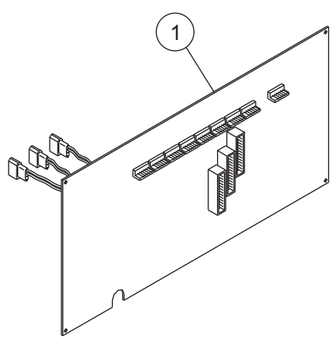
Table 9-1. Drawings

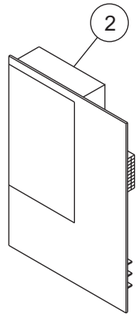
Figure Number	Title
9-1	Illustrated Parts Breakdown (3 sheets)
9-2	Control Front Enclosure Assembly
9-3	Printed Wiring Assemblies (XL3)
9-4	Printed Wiring Assemblies (XL3M Three-Battery)
9-5	Printed Wiring Assemblies (XL3M Single-Battery)
9-6	Control Chassis (XL3)
9-7	Control Chassis (XL3M Three-Battery)
9-8	Control Chassis (XL3M Single-Battery)
9-9	Control Enclosure Assembly (XL3)
9-10	Control Enclosure Assembly (XL3M)
9-11	Pump Enclosure Assembly
9-12	Control and Pump Enclosure Assemblies
9-13	Rear Control Access Cover (XL3M Domestic)
9-14	Rear Control Access Cover (XL3M International)
9-15	Mechanical Assembly (2 sheets)

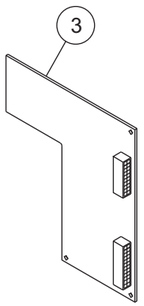
Table 9-2. Illustrated Parts Breakdown		
Index No.	**Nomenclature**	**Replacement Procedure**
1	PWA, Motherboard	*Section 7.2.16*
2	PWA, Power Supply	*Section 7.2.14*
3	PWA, MCU Piggyback	*Section 7.2.15*
4	PWA, MCU	*Section 7.2.15*
5	PWA, Display	*Section 7.2.18.1*
6	PWA, Buzzer	*Section 7.2.10*
7	Assembly, Door	*Section 7.2.20*
8	Shield, Mechanism	*Section 7.2.20*
9	Assembly, Opener Handle	*Section 7.2.21*
10	Assembly, Battery	*Section 7.2.4*
11	Pad, Battery Door	*Section 7.2.4*
12	Door, Battery	*Section 7.2.4*
13	Insulator, Adhesive-Backed	*Section 7.2.22*
14	Plate, Backing, Pole Clamp	*Section 7.2.22*
15	Extrusion, Pole Clamp	*Section 7.2.22*
16	Tip, Shaft, Pole Clamp	*Section 7.2.23*
17	Assembly, Shaft/Knob, Pole Clamp	*Section 7.2.23*
18	Gasket, AC Connector	*Section 7.2.17*
19	Assembly, Enclosure, Control Module, Front	*Section 7.2.12*
20	Assembly, Enclosure, Control Module, Rear	*Section 7.2.12*
21	Label, Front Panel	*Section 7.2.18.4*
22	Clip, Cord	*Section 7.2.7*
23	Knob, Front Panel	*Section 7.2.18.3*
24	Washer, Control Knob	*Section 7.2.18.3*
25	Gasket, Control Knob	*Section 7.2.18.3*
26	Ring, Detent	*Section 7.2.18.3*
27	Detent, Knob	*Section 7.2.18.3*
28	Retainer, Snap	*Section 7.2.18.3*
29	Gasket, Front/Rear, Control Module	*Section 7.2.12*
30	Gasket, Front/Rear, Pump Module	*Section 7.2.13*

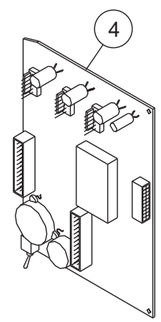
Table 9-2. Illustrated Parts Breakdown		
Index No.	**Nomenclature**	**Replacement Procedure**
31	Chassis, Pump Module	*Section 7.2.13*
32	Assembly, Enclosure, Pump Module, Front	*Section 7.2.13*
33	Assembly, Enclosure, Pump Module, Rear	*Section 7.2.13*
34	Gasket, Control Access Cover	*Section 7.2.5*
35	Cover, Control Access	*Section 7.2.5*
36	Chassis, Top	*Section 7.2.19*
37	Assembly, Cable, Buzzer PWA/Motherboard	*Section 7.2.10*
38	Assembly, Cable, Display/MCU	*Section 7.2.18.1*
39	Assembly, Cable, Sensor/MCU	*Section 7.2.19*
40	Chassis, Bottom	*Section 7.2.19*
41	Guide, Card	As applicable
42	Insulator, PWA	As applicable
43	Insulator, Adhesive-Backed	*Section 7.2.19*
44	Strap, Velcro, Black	*Section 7.2.5*
45	Disk, Interlock	As applicable
46	Grommet, Continuous	As applicable
47	Assembly, Minipole	*Section 7.2.24*
48	Assembly, Mechanism	*Section 7.2.19*
49	Cordset, AC Power, Hospital Grade, 220 V	*Section 7.2.6*
50	Cordset, AC Power, Hospital Grade, 115 V	*Section 7.2.5*
51	Plate, Interlock	*Section 7.2.9*
52	Plate, Backing	*Section 7.2.12*
53	Assembly, Wire, AC, Black	As applicable
54	Assembly, Wire, AC, White	As applicable
55	Assembly, Wire, AC, Ground	As applicable
56	Assembly, Cable, Power Supply/Ground	*Section 7.2.14*
57	Foot, Pad, Rubber	*Section 7.2.3*
58	Retainer, Door Pivot	*Section 7.2.20*
59	Clip, Spring, Door	*Section 7.2.20*
60	Insert, Key	*Section 7.2.18.2*

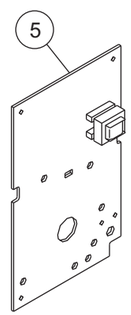
Table 9-2. Illustrated Parts Breakdown		
Index No.	**Nomenclature**	**Replacement Procedure**
61	Roller, Handle	*Section 7.2.21*
62	Spring, Torsion	*Section 7.2.21*
63	Holder, Handle Spring	*Section 7.2.21*
64	Ring, Retaining, .188 x .025	*Section 7.2.21*
65	Screw, 6-32 x 1/2, Hex Head, Slotted, with Washer	As applicable
66	Screw, 6-32 x 1/4, Hex Head, Slotted, with Washer	As applicable
67	Screw, 4-40 x 3/8, Hex Head, Slotted, with Washer	As applicable
68	Washer, Flat, #6	As applicable
69	Screw, 6-32 x 1/2, Pan Head, Phillips	As applicable
70	Screw, 6-32 x 3/8, Button Head, Black Oxide	As applicable
71	Washer, Lock, #6	As applicable
72	Washer, Flat, #6	As applicable
73	Washer, Lock, #6	As applicable
74	Screw, 6-32 x 3 1/4, Pan Head	*Section 7.2.13*
75	Screw, 6-32 x 1/2, Button Head, Socket	As applicable
76	Washer, Flat, .5 Dia.	As applicable
77	Screw, 10-32 x 1/2, Hex Head, Slotted, with Washer	*Section 7.2.22*
78	Nut, Hex, M6-1, SS	As applicable
79	Washer, Lock, 1/4, Internal Tooth	As applicable
80	Post, Equipotential	*Section 7.2.17*
81	Connector, AC Receptacle	*Section 7.2.17*
82	Fuse, 1 A, 250 V, Slow-Blow	*Section 7.2.8*
83	Fuse, Drawer	*Section 7.2.8*
84	Connector, 15-pin, Sub-D, Panel Mount, XL3M	As applicable
85	Gasket, Lockout, XL3M	*Section 7.2.10*
86	Gasket, Audible Alarm	*Section 7.2.10*
87	Ring, Cotter	*Section 7.2.24*
88	Screw, 6-32 x 3/8, Hex Head, Slotted, with Washer	As applicable
89	Assembly, Standoff, with Nuts and Washers, XL3M	As applicable

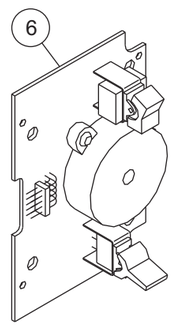


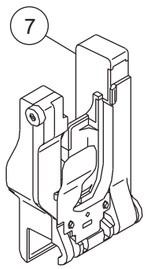


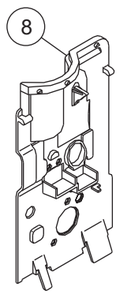


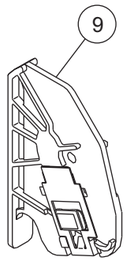


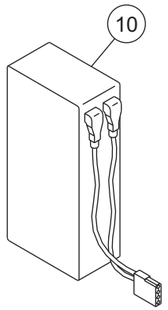


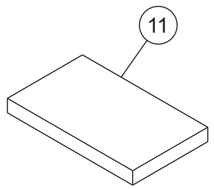


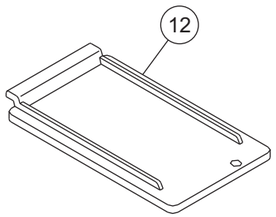


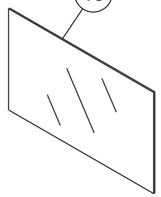


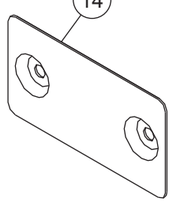


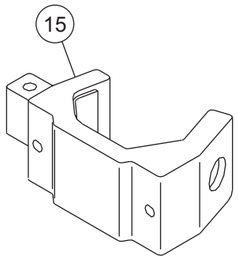


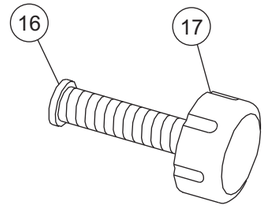


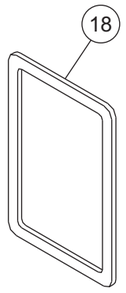


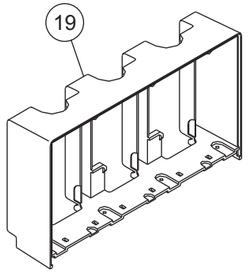


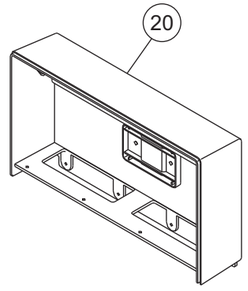


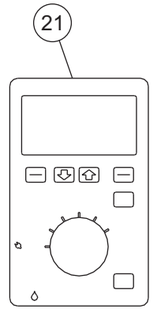


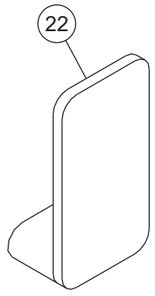


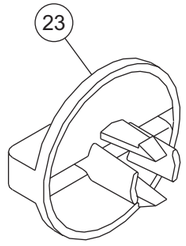


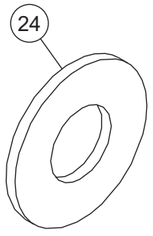


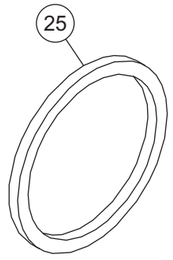


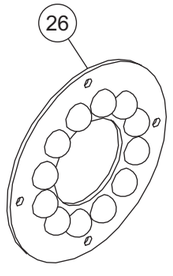


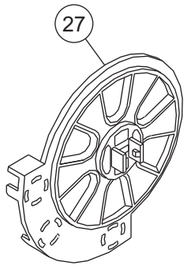


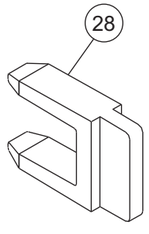


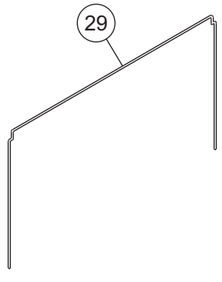


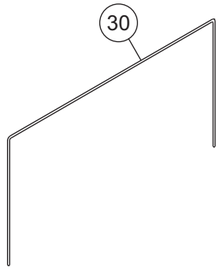


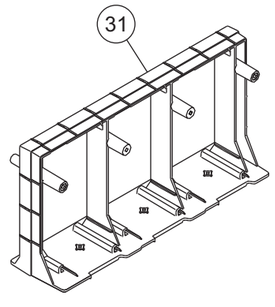












HOSPIRA, INC.	
Figure 9-1. Illustrated Parts Breakdown	
DRAWING NO. NOT APPLICABLE	Rev. N/A
	Sheet 1 of 3

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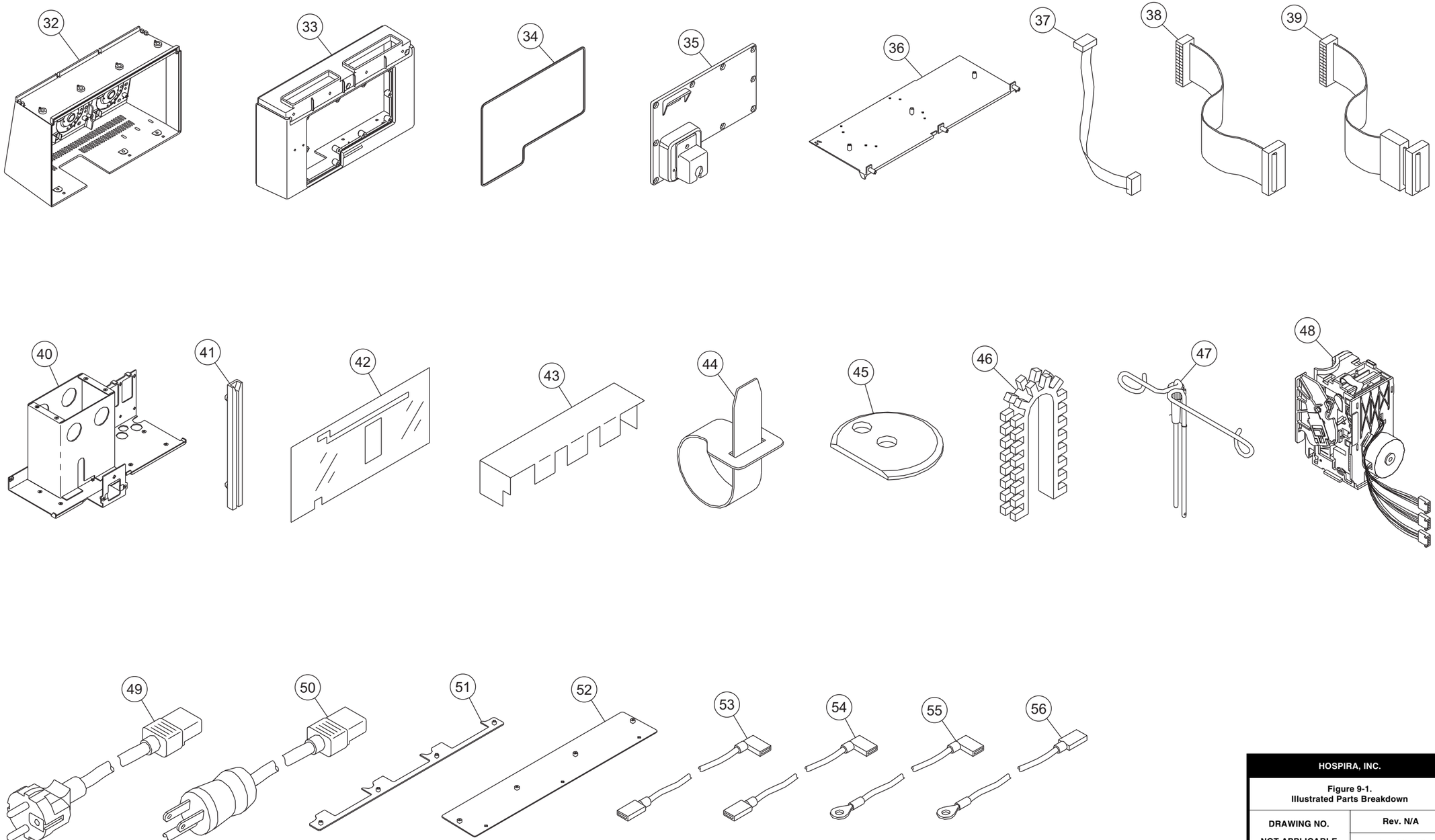

HOSPIRA, INC.	
Figure 9-1. Illustrated Parts Breakdown	
DRAWING NO. NOT APPLICABLE	Rev. N/A
	Sheet 2 of 3

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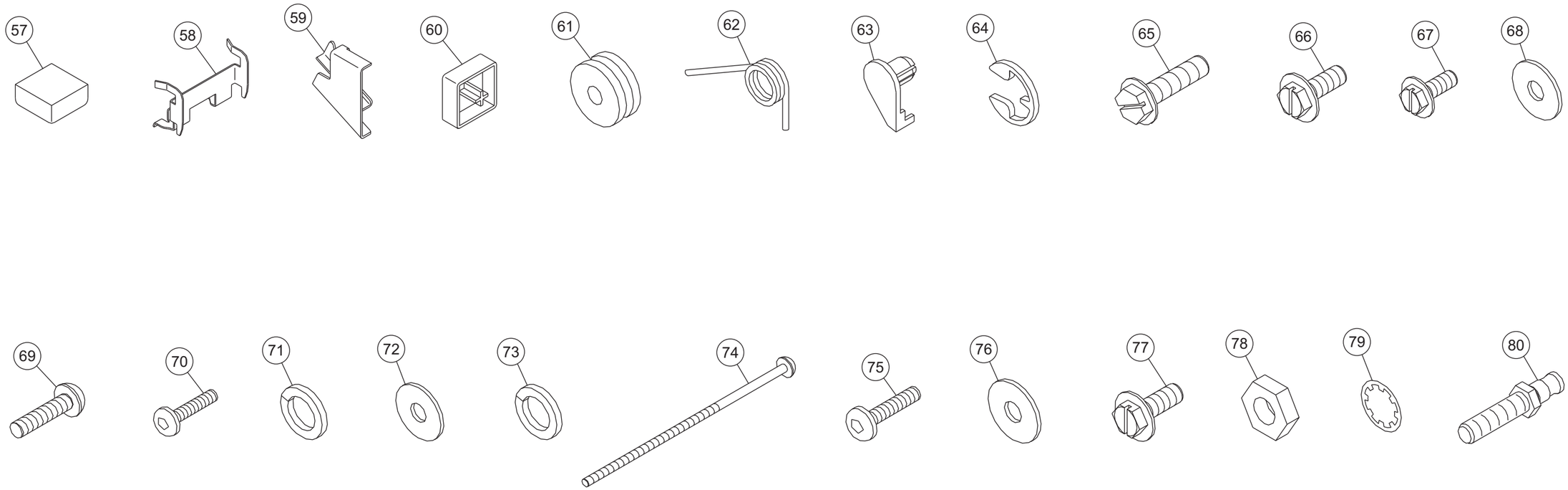

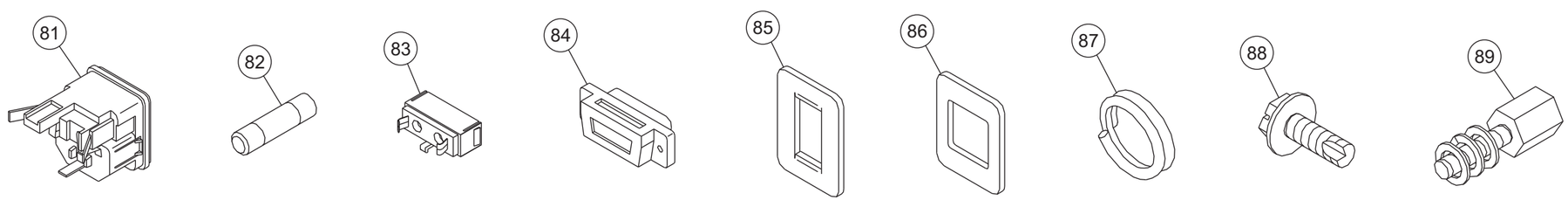

HOSPIRA, INC.	
Figure 9-1. Illustrated Parts Breakdown	
DRAWING NO. NOT APPLICABLE	Rev. N/A
	Sheet 3 of 3

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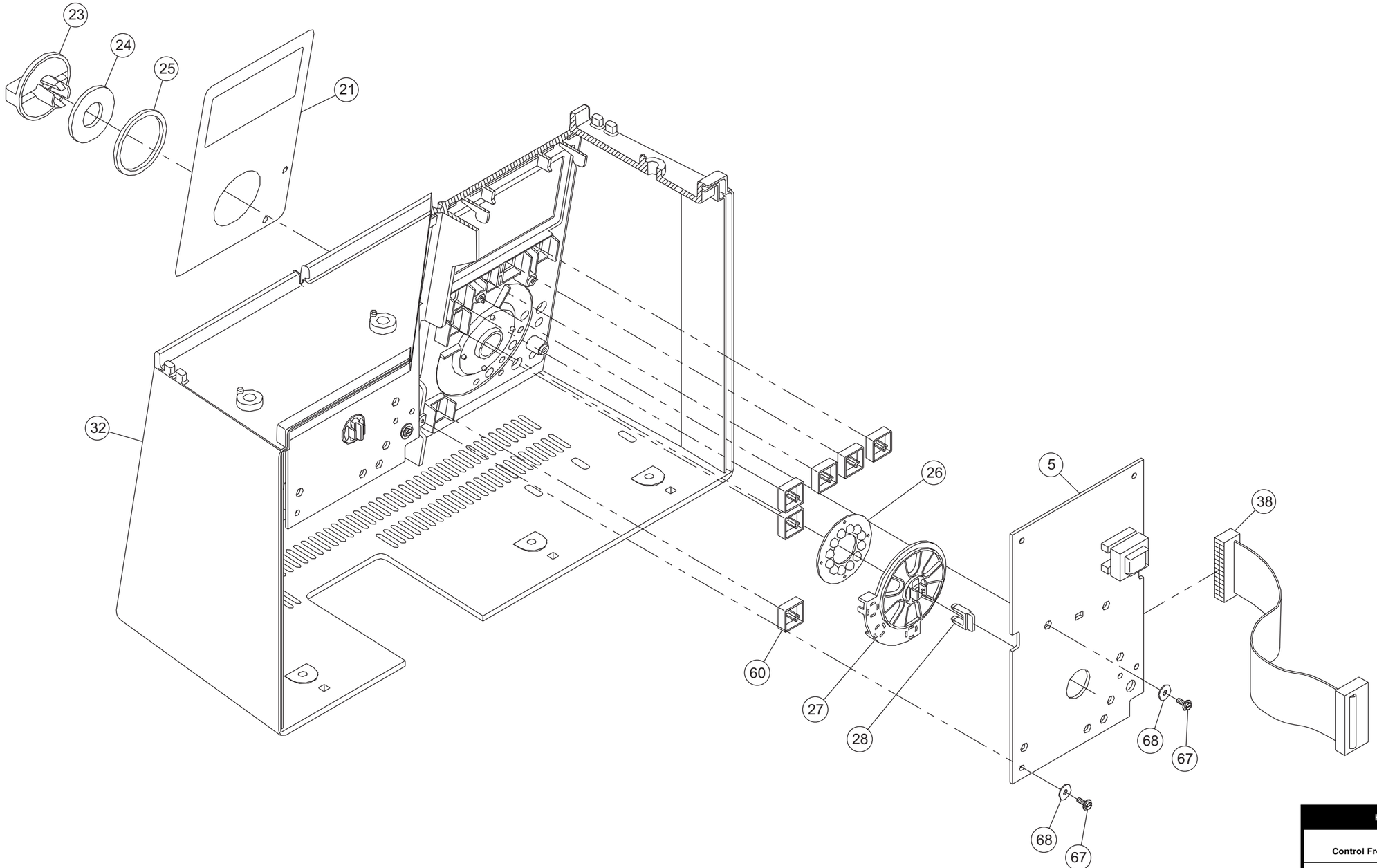

HOSPIRA, INC.	
Figure 9-2. Control Front Enclosure Assembly	
DRAWING NO. NOT APPLICABLE	Rev. N/A
	Sheet 1 of 1

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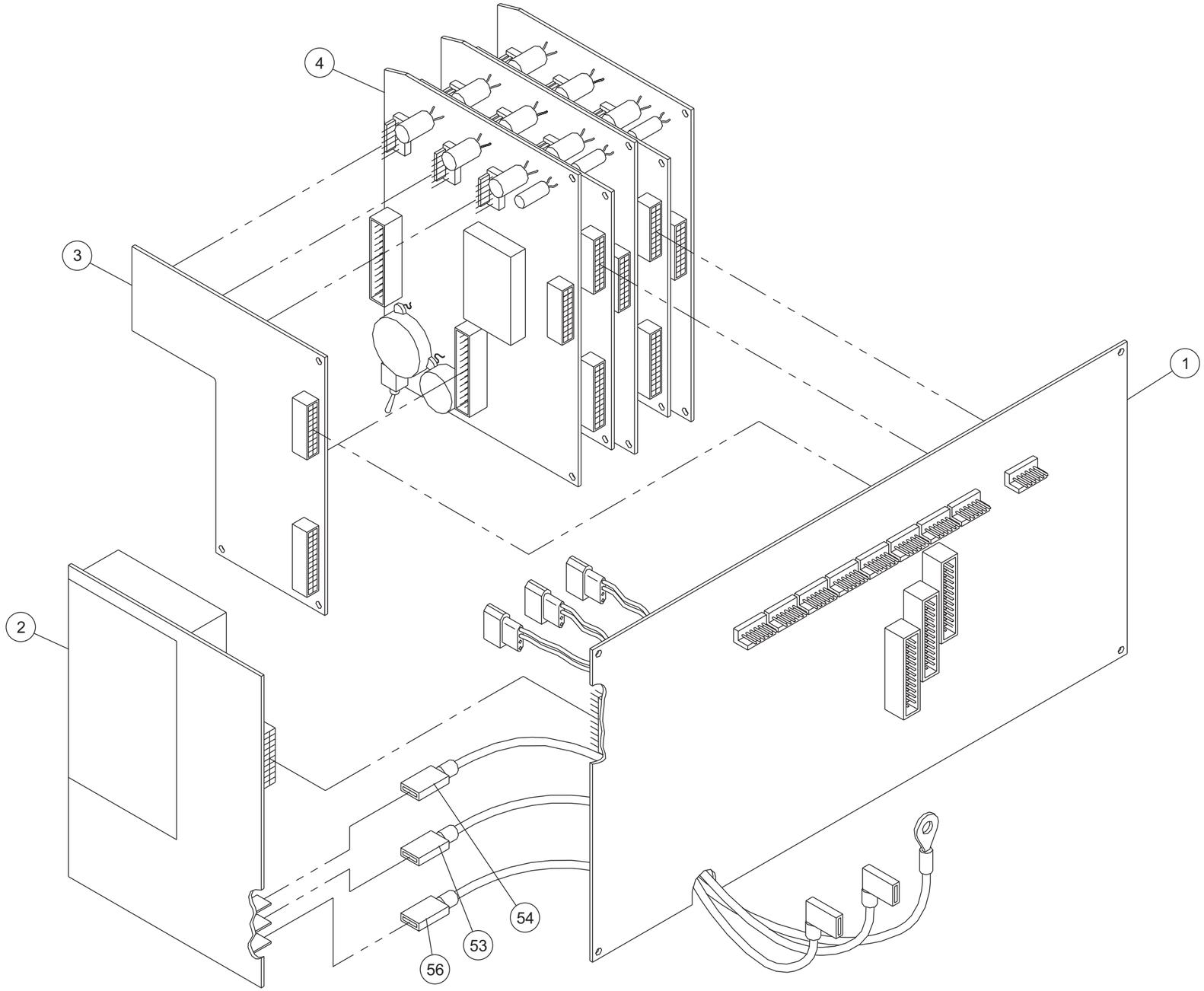

HOSPIRA, INC.	
Figure 9-3. Printed Wiring Assemblies (XL3)	
DRAWING NO. NOT APPLICABLE	Rev. N/A Sheet 1 of 1

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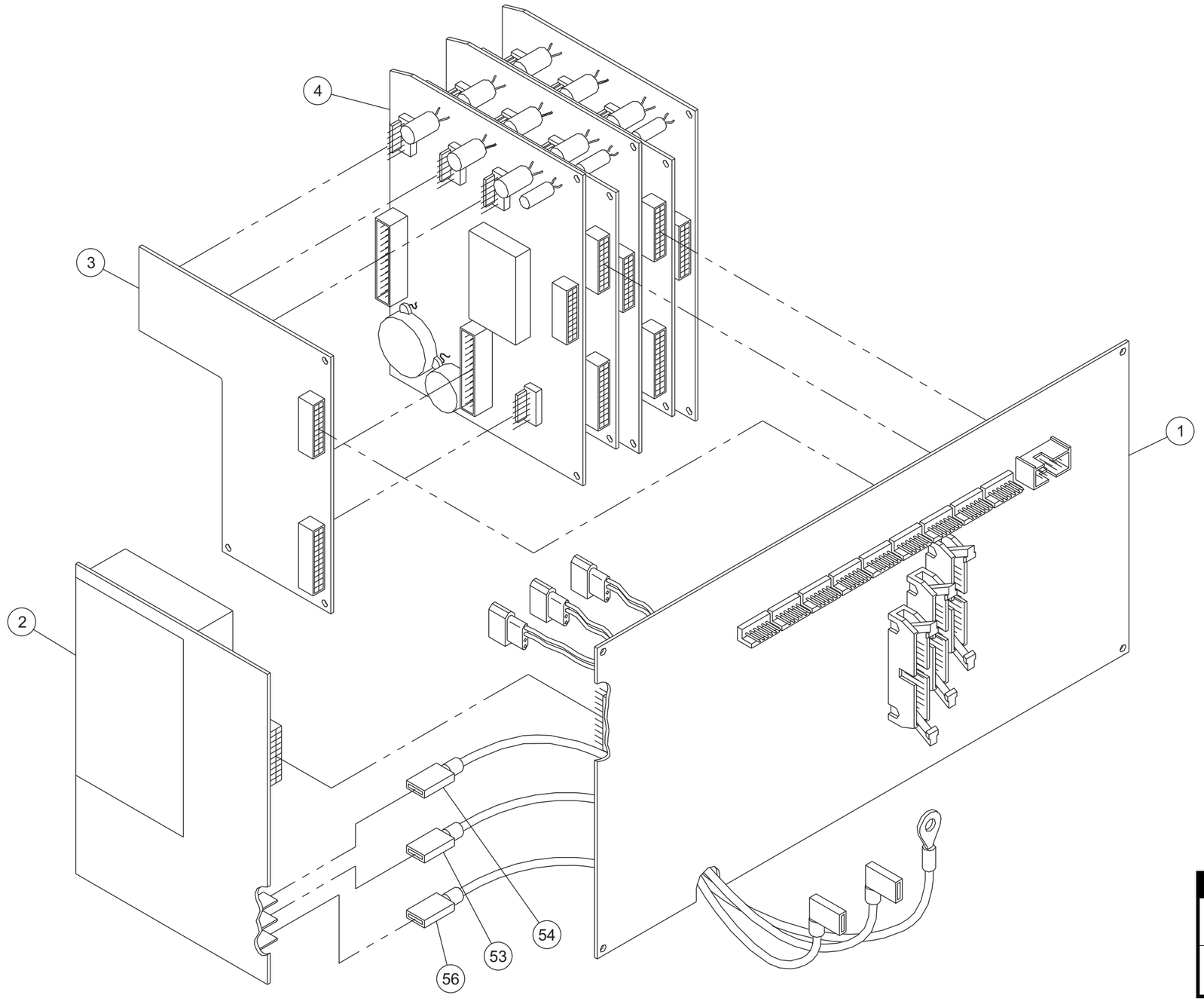

HOSPIRA, INC.	
Figure 9-4. Printed Wiring Assemblies (XL3M Three-Battery)	
DRAWING NO. NOT APPLICABLE	Rev. N/A Sheet 1 of 1

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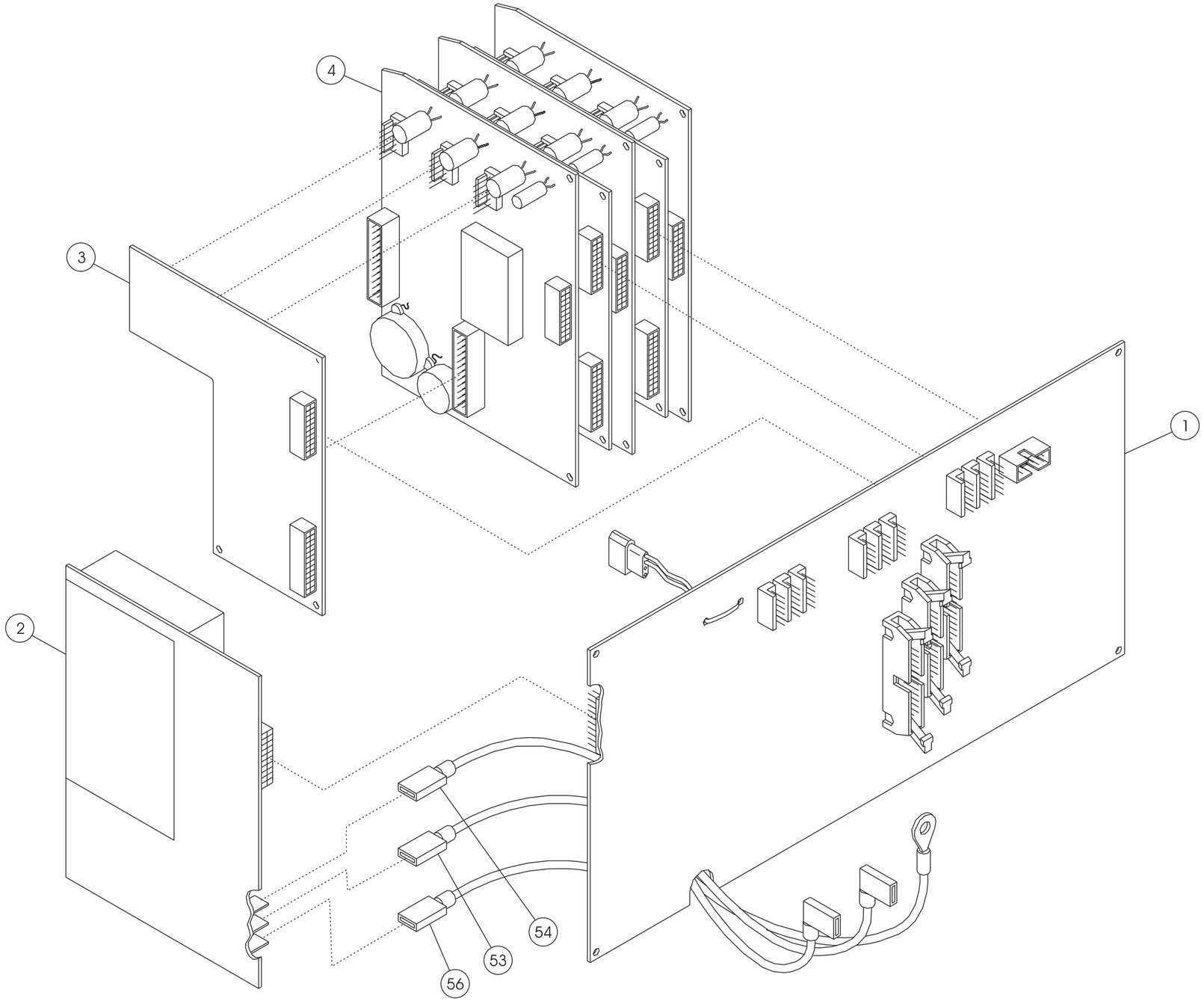

HOSPIRA, INC.	
Figure 9-5. Printed Wiring Assemblies (XL3M Single-Battery)	
DRAWING NO. NOT APPLICABLE	Rev. N/A Sheet 1 of 1

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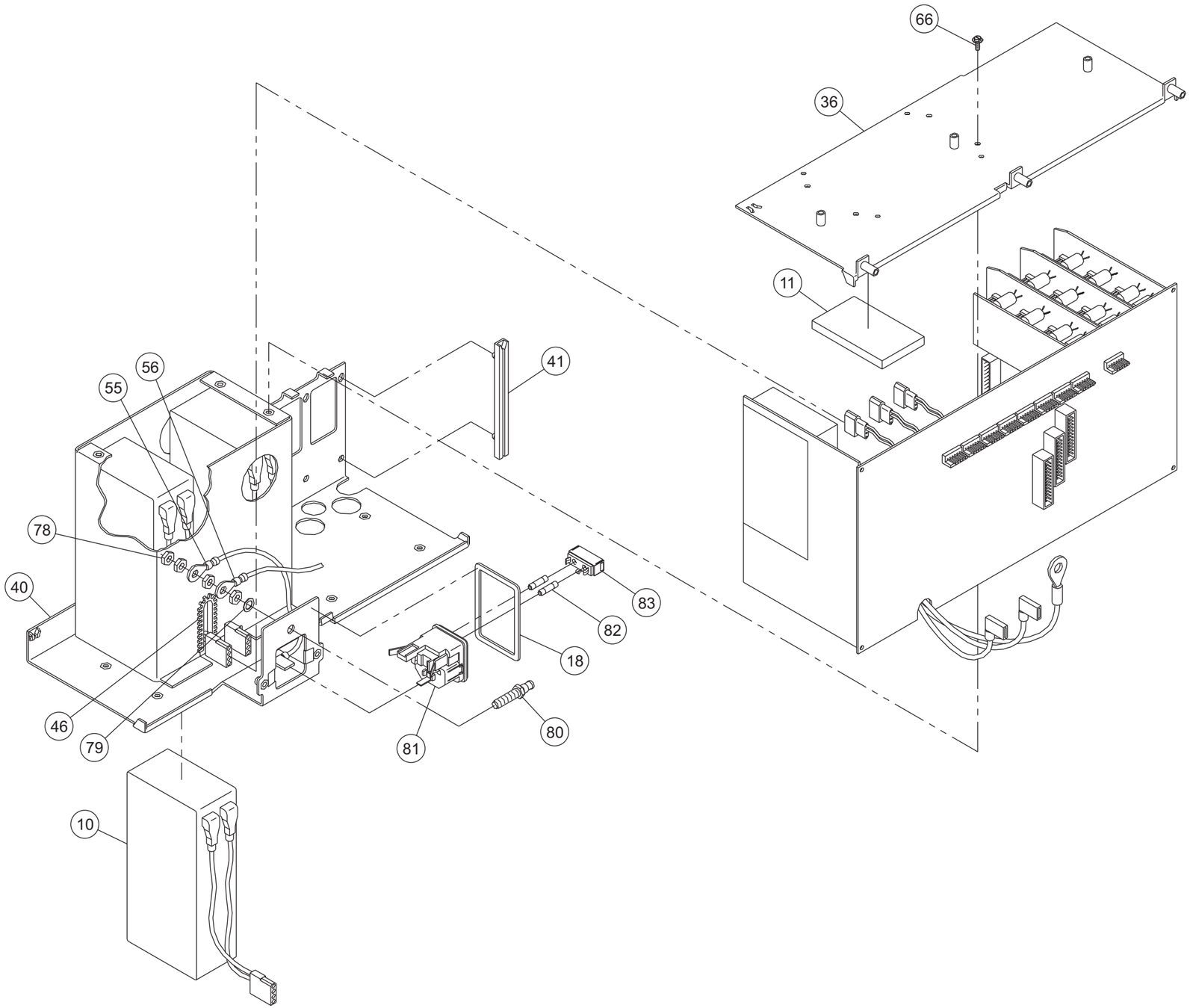

HOSPIRA, INC.	
Figure 9-6. Control Chassis (XL3)	
DRAWING NO. NOT APPLICABLE	Rev. N/A
	Sheet 1 of 1

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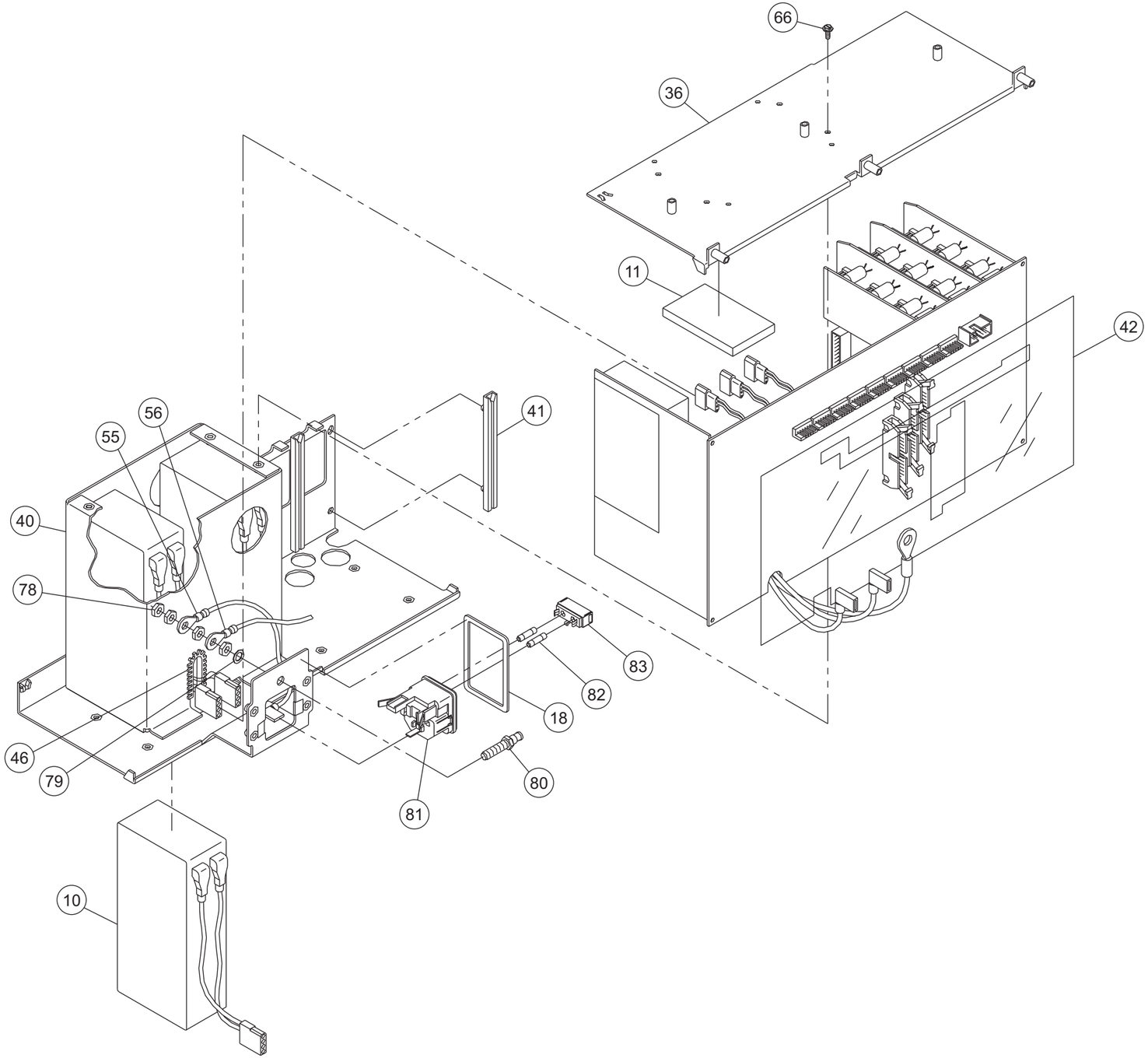

HOSPIRA, INC.	
Figure 9-7. Control Chassis (XL3M Three-Battery)	
DRAWING NO. NOT APPLICABLE	Rev. N/A Sheet 1 of 1

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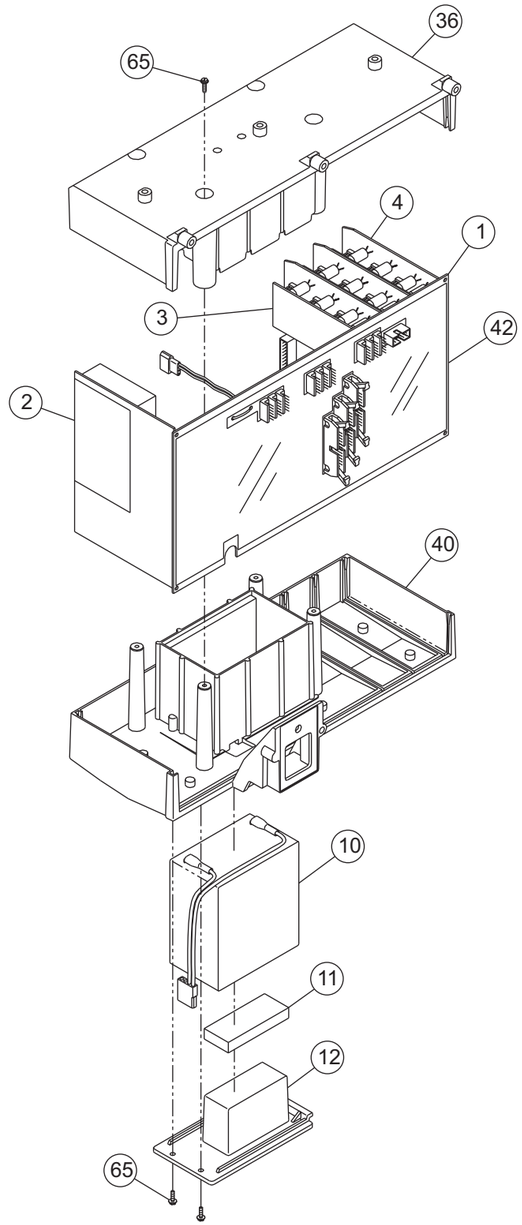

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Figure 9-8. Control Chassis (XL3M Single-Battery)	
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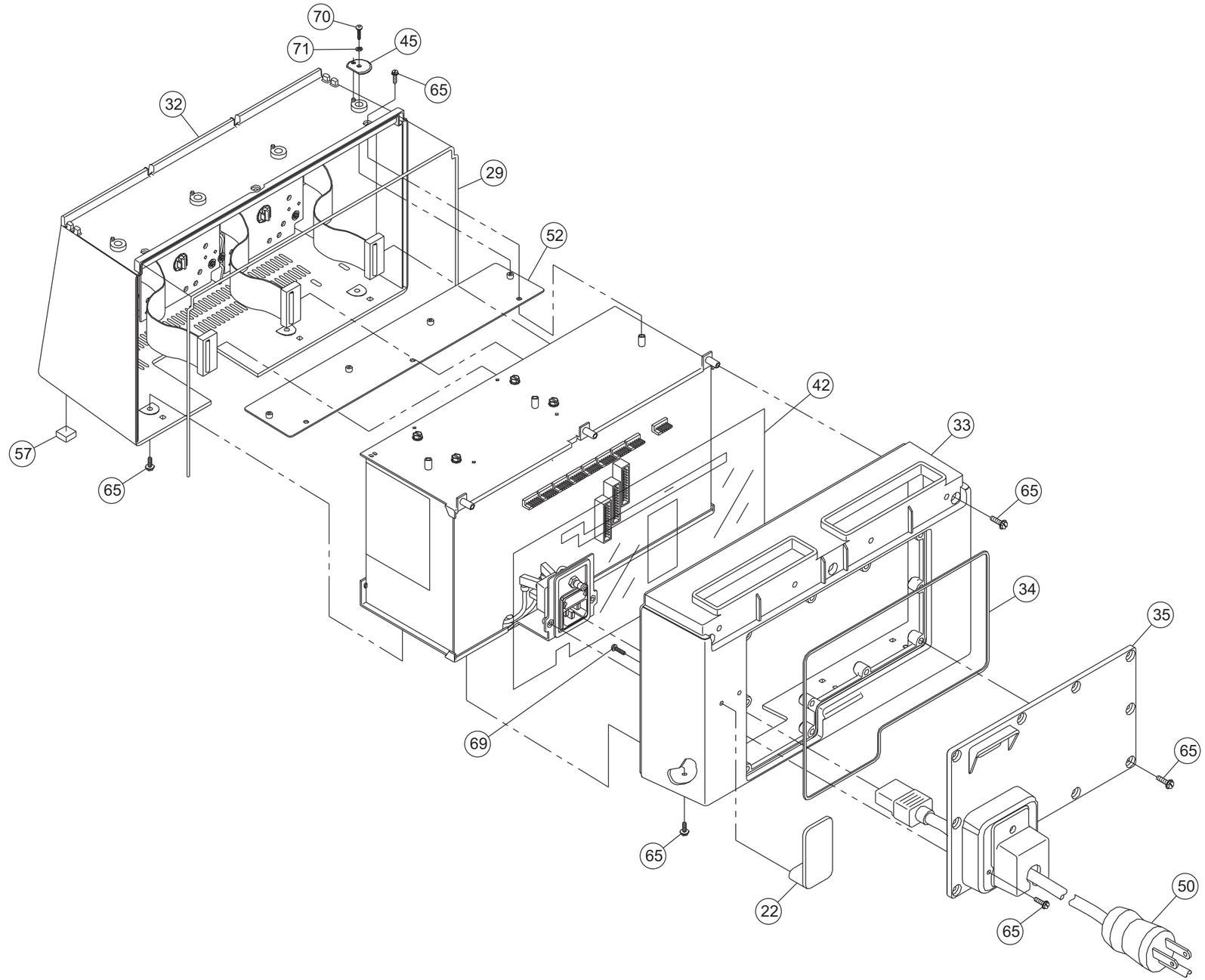

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Figure 9-9. Control Enclosure Assembly (XL3)	
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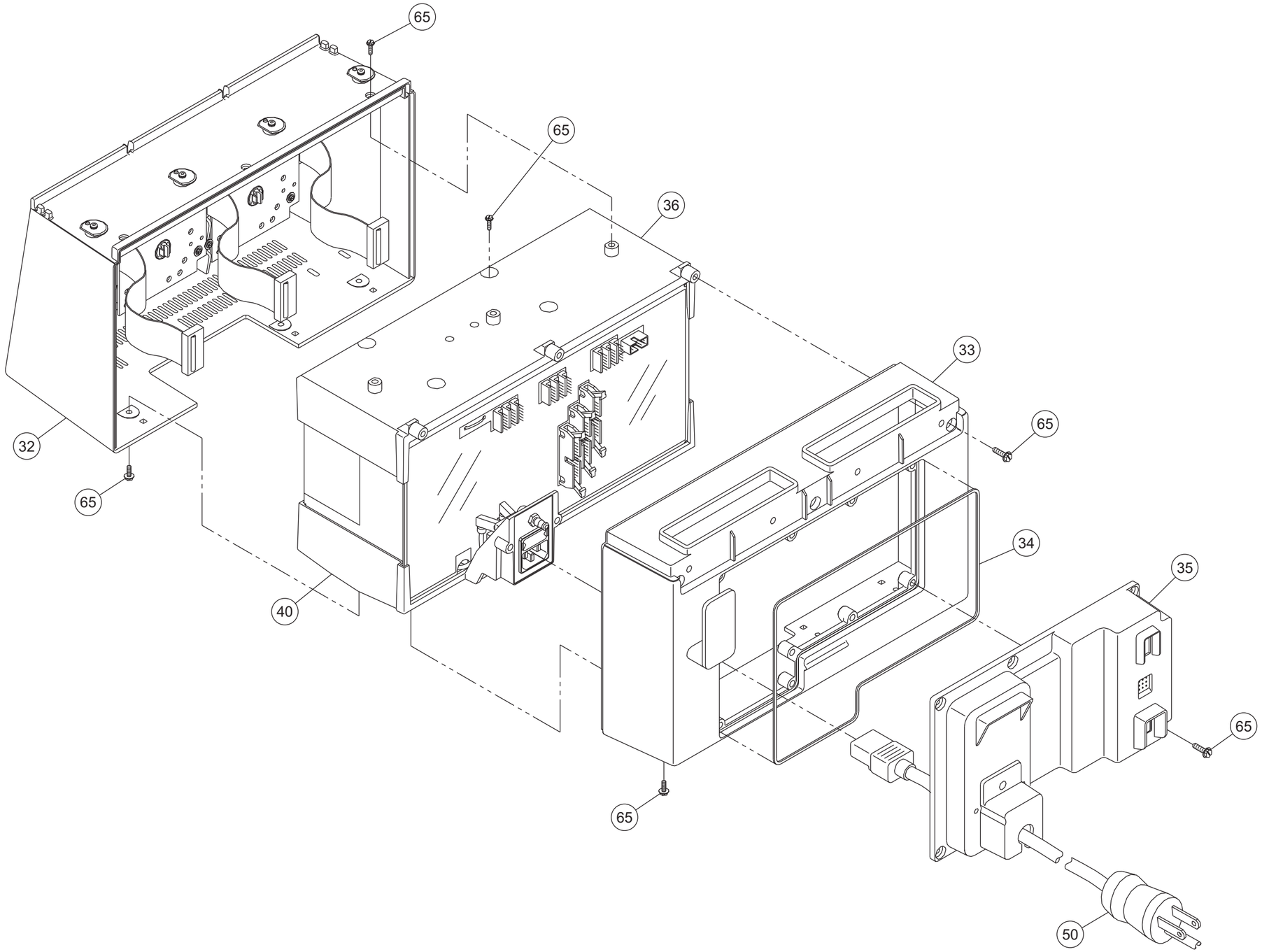

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Figure 9-10. Control Enclosure Assembly (XL3M)	
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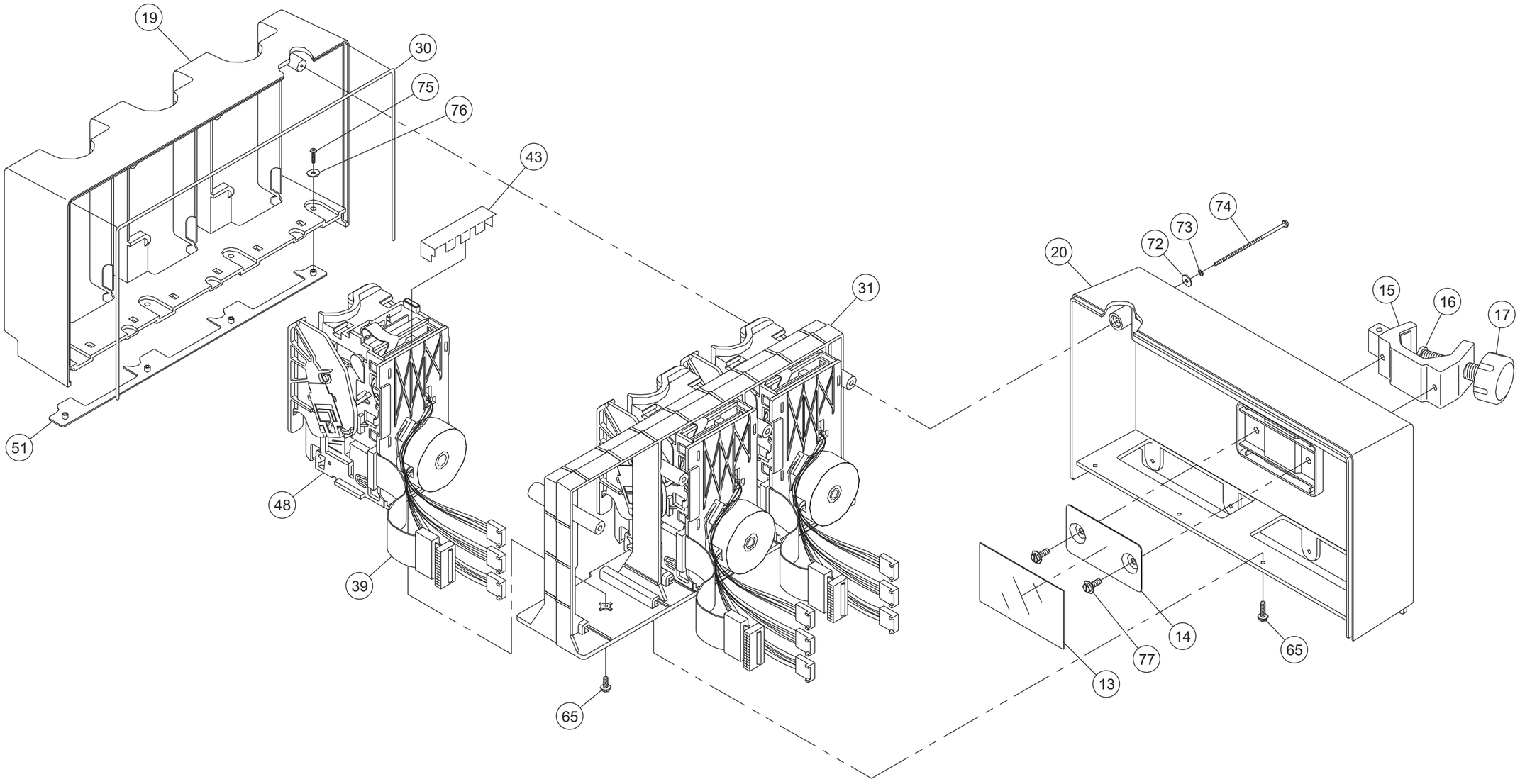

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Figure 9-11. Pump Enclosure Assembly	
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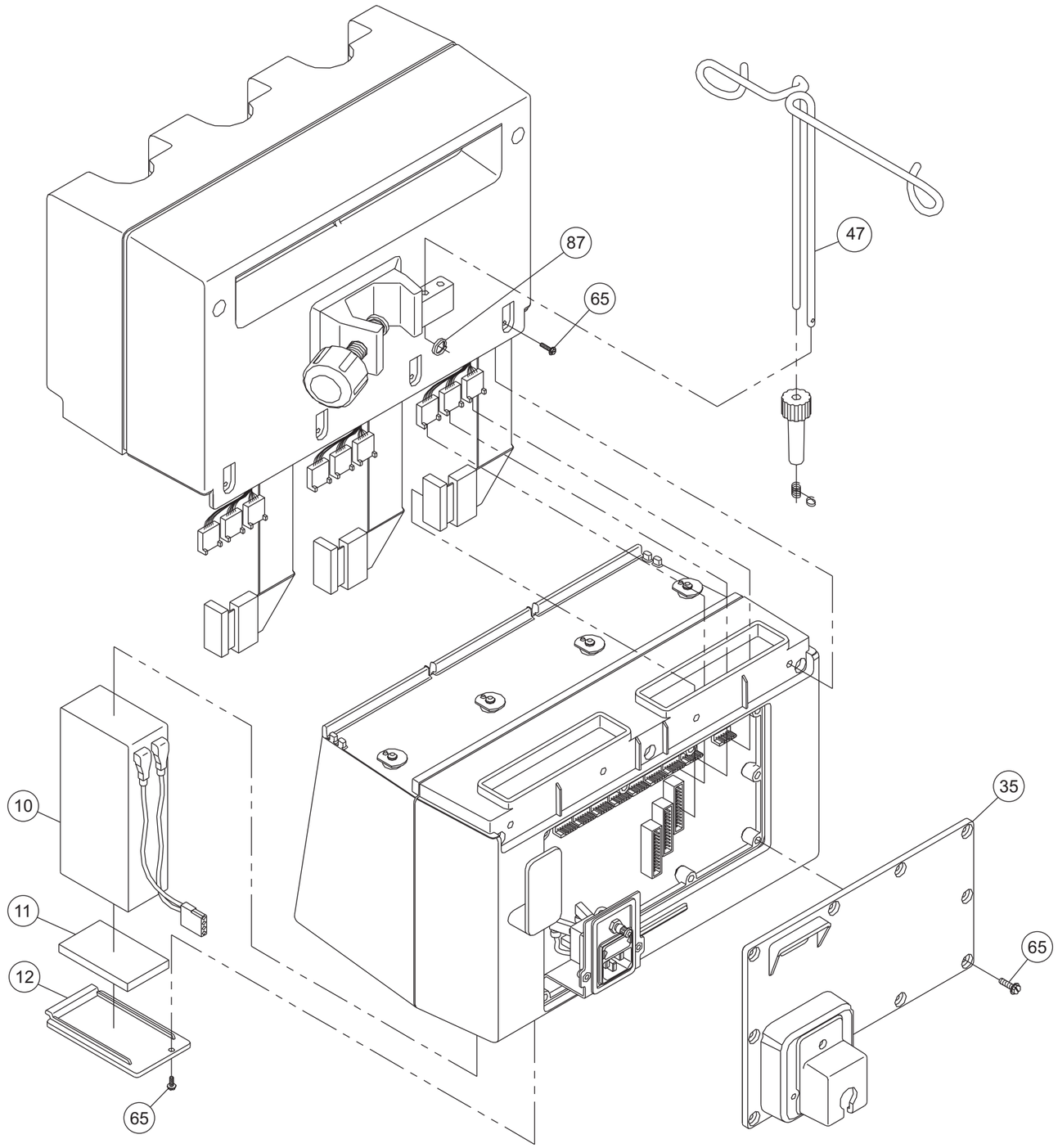

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Figure 9-12 Control and Pump Enclosure Assemblies	
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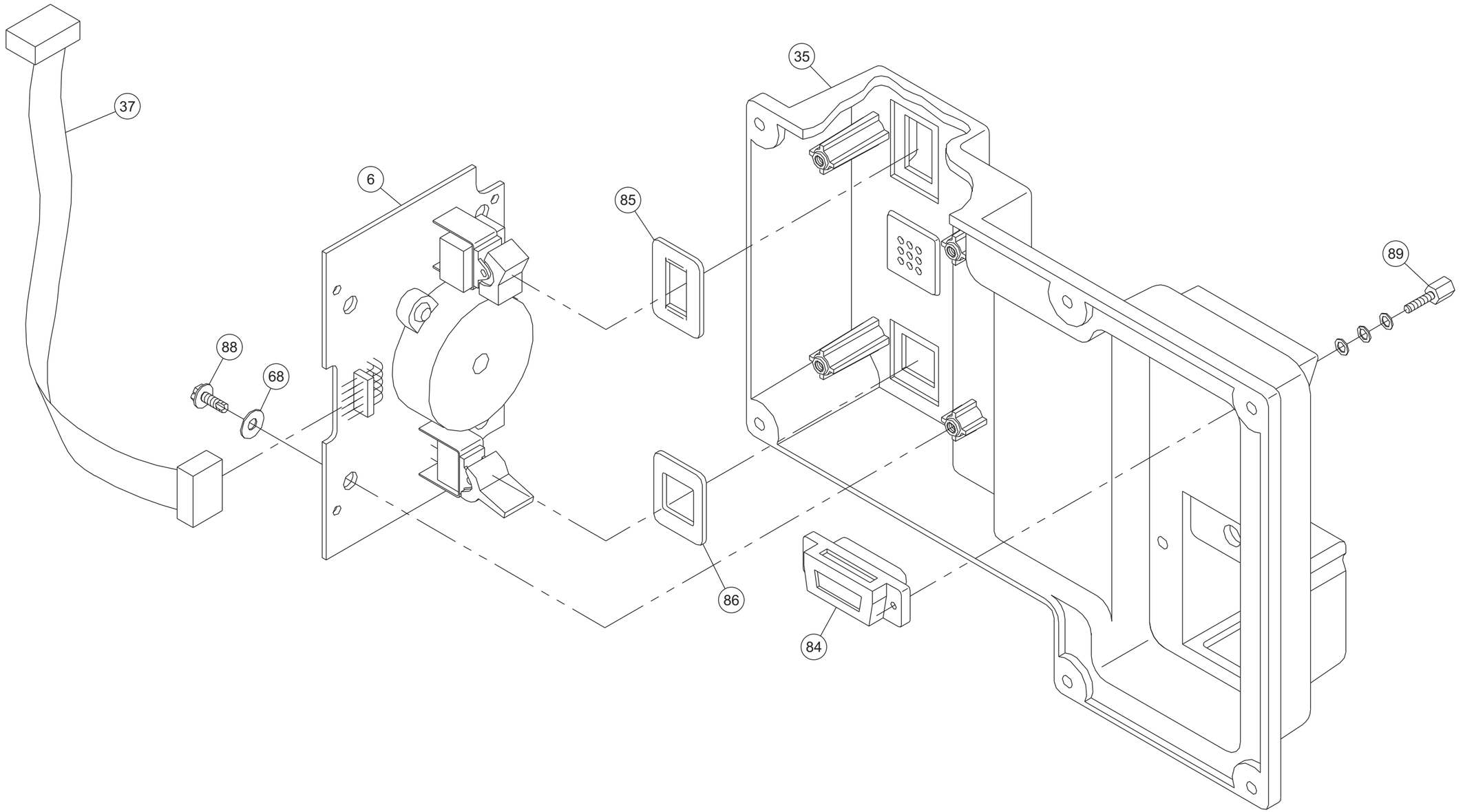

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Figure 9-13. Rear Control Access Cover (XL3M Domestic)	
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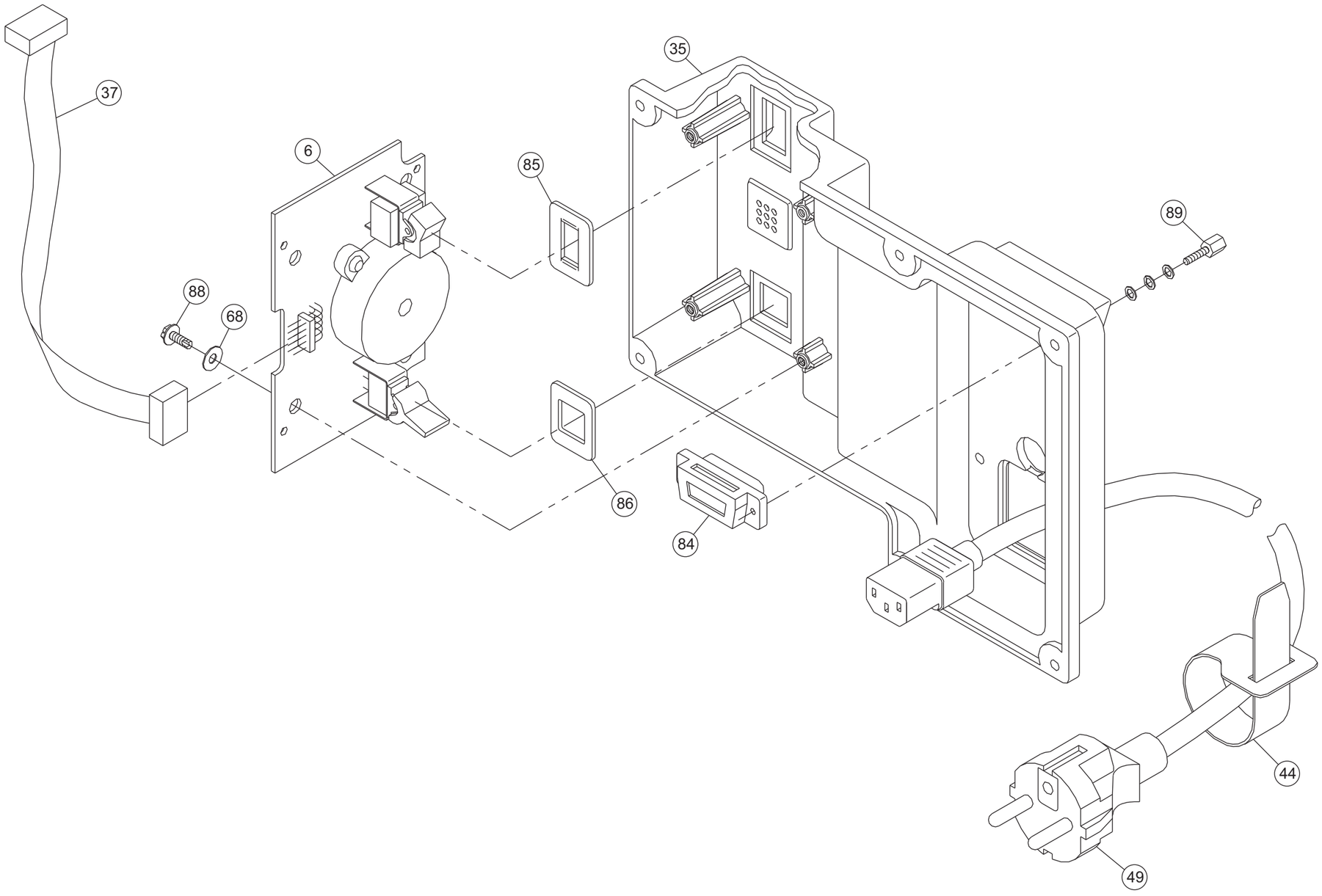

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Figure 9-14. Rear Control Access Cover (XL3M International)	
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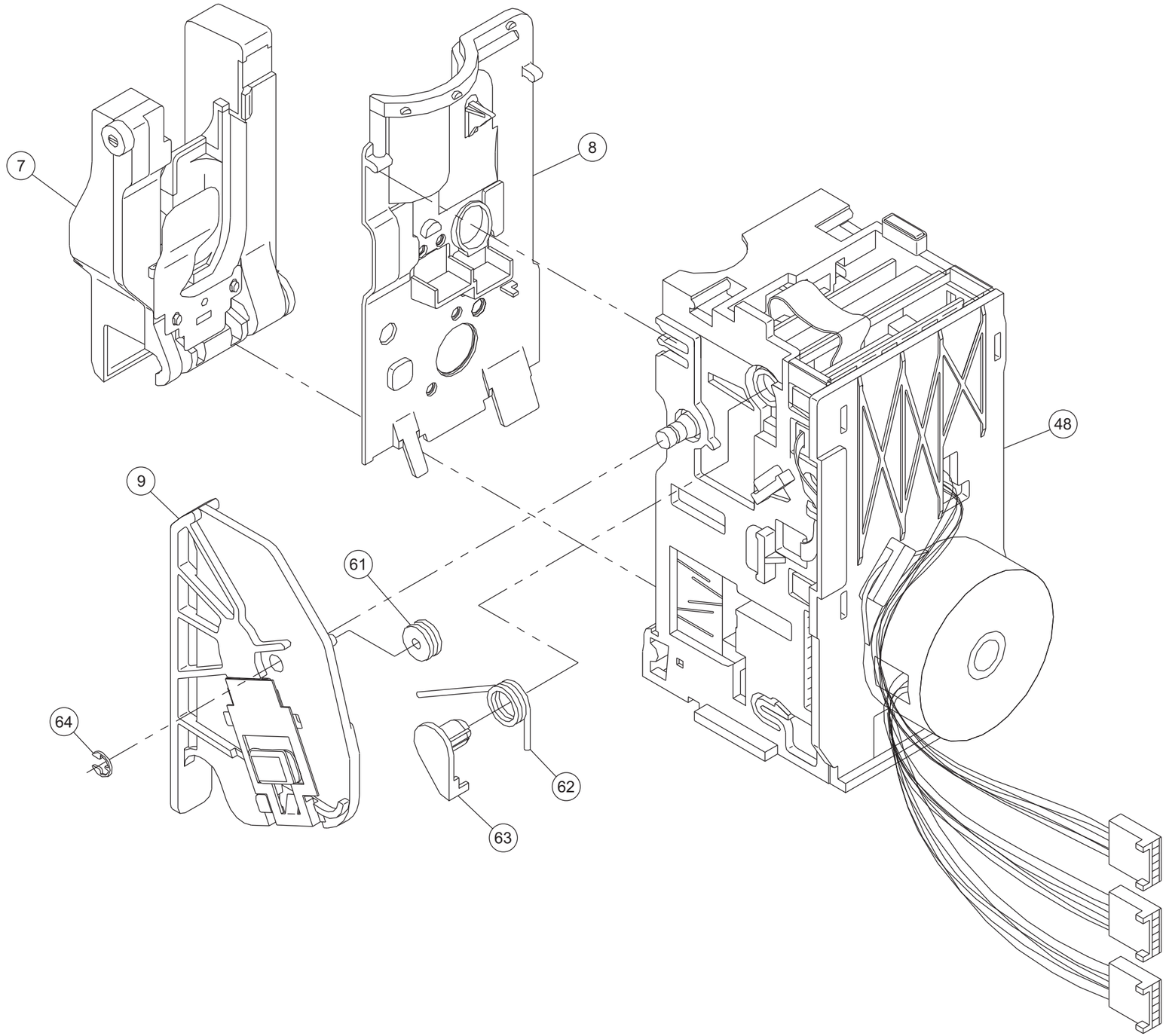

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Figure 9-15. Mechanical Assembly	
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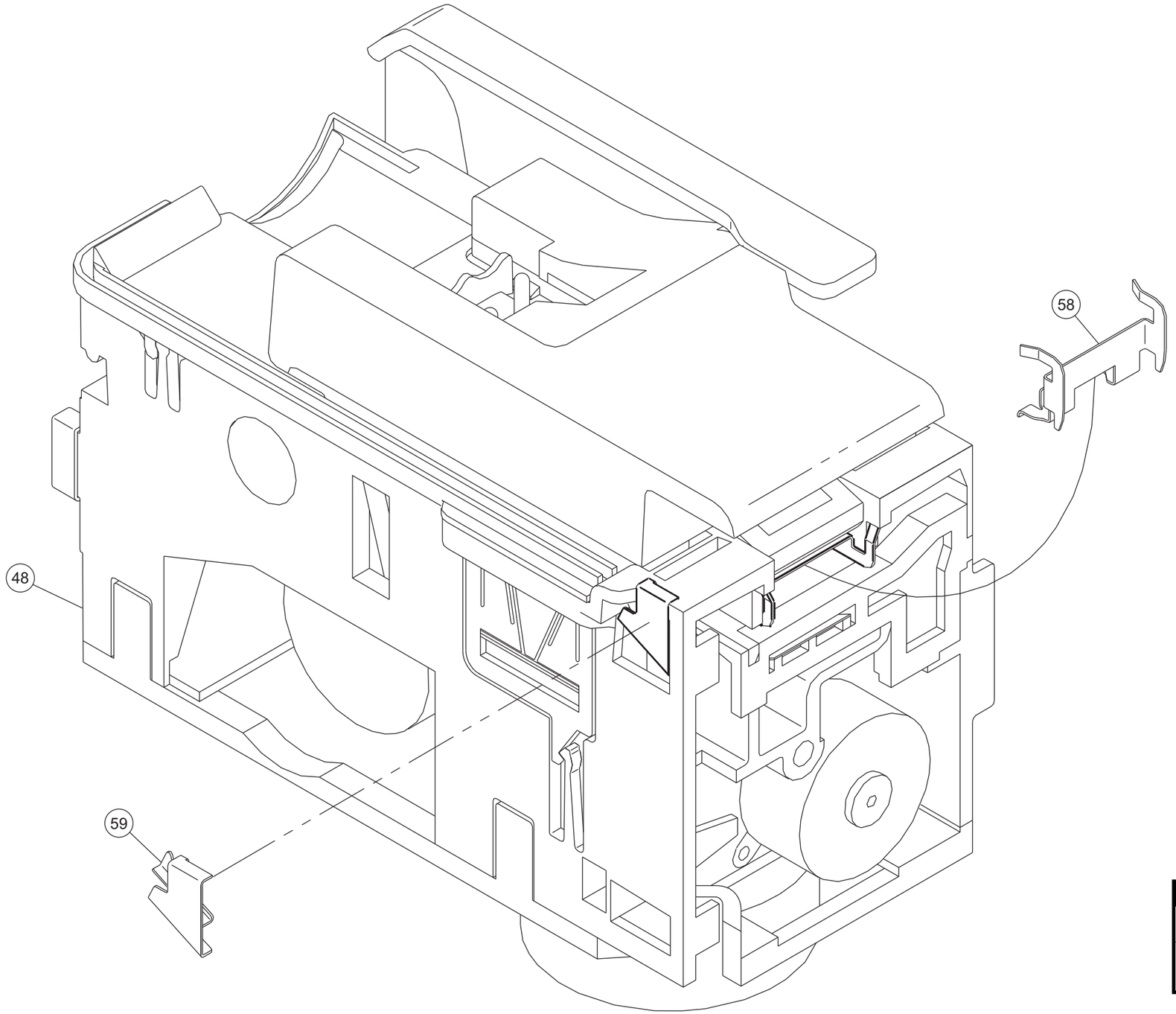

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