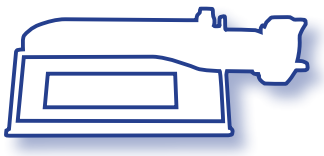
medfusion™

Medfusion® Syringe Infusion Pump Model 3000 Series

Technical Service Manual



smiths medical

Technical Assistance

The issue date of this manual is included on the back cover. If your manual is a year or more old, contact Smiths Medical to see if a newer manual is available.

If you have comments or questions concerning the operation of the Medfusion® Syringe Pump, Series 3000 (Medfusion® Model 3000 series pump), please call the appropriate number given below. When calling, please specify your pump's software version. This information is located on the start-up screen.

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1265 Grey Fox Road
St Paul, MN 55112 USA
Tel: 1 800 258 5361 (US/CA)
Tel: +1 614 210 7300

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A printed copy of this manual is available upon request.

IMPORTANT: When a pump is returned to the Smiths Medical Service Center for repair, the pump may be defaulted so the default Configuration is installed on the pump. This enables the Service Center to access all of the pump's internal service/biomed functions during the repair process. Once the pump is returned, a custom Configuration will need to be re-installed on the pump prior to its return to use.

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Important Information

WARNING: Read this entire manual before attempting service or repair on a Medfusion® Model 3000 Series pump. Failure to follow the instructions and important information contained in this manual, or improper/inadequate testing, service, repair or troubleshooting can lead to death or serious injury. Warnings, cautions and other important safety information can be found in this section, and throughout the manual (they are contained within lines at top and bottom).

The term WARNING is used to indicate a hazard that has the potential to cause injury or death to a technician, patient or user. The term CAUTION is used to indicate a hazard that has the potential to cause damage to the product or other property.

Note: This manual supersedes all previous revisions.

IMPORTANT: Pumps displaying the CE mark built after 22-July-2014 are RoHS (Restriction of Hazardous Substances) compliant and contain RoHS compliant parts.

Warnings

- The unauthorized modification of this product may constitute a safety hazard, which could lead to patient injury or death, as well as the potential for property damage (including the risk of fire). Use only Smiths Medical supplied service/replacement parts, including the battery pack. Unauthorized modification and/or the use of unauthorized service/replacement parts will also void the Limited Warranty.
- Medical Electrical Equipment needs special precautions regarding EMC and needs to be installed and put into service according to the EMC information provided.
- Attempts to repair or maintain a pump by personnel without proper qualifications or training may create a major hazard which could result in serious injury or death to the patient or the user.
- Use only approved parts and procedures for repair and maintenance of this pump. Failure to follow this manual may create a major hazard which could result in serious injury or death to the patient or the user.
- ***Pump Maintenance:*** **Only trained biomedical service personnel may service this pump**. Service personnel should disconnect the AC power cord before servicing the pump.
- ***AC Power:*** **The only means of removing AC power is to disconnect the AC power cord.** While the AC power cord is attached to the pump and plugged into an AC outlet, live mains voltage is present within the pump.
- ***Manufacturer Recommended Maintenance:*** **Always maintain this pump following *manufacturer recommended instructions*** in this Service Manual. An improperly maintained pump may cause serious injury to a patient or user.
- ***Power Source:*** To avoid electric shock, before cleaning, always switch electrically operated equipment off and disconnect from AC power source.
- ***Safety Class II, Type CF Medical Equipment:*** The pump is listed as Safety Class II, Type CF equipment. Protection against electrical shock does not rely only upon basic insulation, but instead relies on double or reinforced insulation. As such, this equipment does not utilize a third wire ground (earth ground). Therefore, when doing line leakage test it is not necessary to measure leakage in both the open ground and closed ground setting. Nor is it necessary to perform a ground resistance test.
- **Battery Replacement:** Observe ESD handling precautions when replacing the battery. Replace battery only with same Smiths Medical part/model number. Recycle batteries in compliance with applicable local regulations.
- ***Collect Separately***. There are potential health hazards associated with improper disposal of batteries, electronics, and contaminated (used) infusion sets and syringes. Dispose of used batteries, infusion sets, syringes, and other used accessories, or a pump that has reached the end of its useful life, in an environmentally safe manner, and according to any regulations that may apply.
- **Disconnect AC Power & Turn Pump Off:** The only means of removing AC power is to disconnect the AC power cord. While the AC power cord is attached to the pump and plugged

into an AC outlet, live mains voltage is present inside the pump. Make sure the pump is turned off before performing any disassembly.

- **Battery Replacement:** For continued protection against fire hazard, always replace battery pack with same type and model of battery specified in the labeling on the pump.
- **Clean the Pump:** Always clean the pump thoroughly before performing maintenance on it. This is recommended by the United States Occupational Safety & Health Administration (OSHA) as a protection from potential biohazard.
- **Pump Maintenance:** Only trained biomedical service personnel may repair, calibrate, and maintain this pump.
- **Follow Manufacturer's Maintenance Procedures:** Always repair and maintain this pump following the manufacturer's recommended instructions in this Service Manual.
- **External DC Power:** Any power source connected to the external DC jack must be IEC 60601-1 certified for medical equipment: Type CF, Safety Class II. Connecting external power to the pump creates a medical system; therefore, the user is responsible for compliance with IEC 60601-1 standards. Refer all questions to Smiths Medical Technical Service department.
- While servicing the Medfusion® Model 3000 Series pump, wear safety glasses as it contains springs and other small parts which may be a hazard.

Cautions

- **Repair Pump in ESD Controlled Work Area:** The pump case should only be opened at a work-station with Electrostatic controls, including a grounded mat and wrist-strap.
- **DO NOT USE** cleaning solutions containing:

  acetone, ammonia, ammonium chloride (including Hyamine 1622), *aromatic solvents* (such as paint thinner, toluene, methylbenzene), *chlorinated solvents* (such as methyl ethyl ketone (MEK), trichloroethane), *ether* (such as ethylene glycol monobutyl ether, diethylene glycol butyl ether) or *oxidizing acids* (such as phosphoric acid, sulfuric acid or accelerated hydrogen peroxide).

  Use of the solutions or solvents listed as DO NOT USE could damage plastic parts and cause premature failure or device malfunction.
- ***Use only the recommended cleaning/disinfecting agents and method.*** Use of cleaning/disinfecting agents and method other than those listed may cause damage to the pump and will void the warranty.
- ***Spray Resistant:*** The pump is "spray resistant" from the top and sides but not "water proof ". NEVER spray cleaning or other fluids directly into openings on the bottom of the pump.
- ***Not Waterproof:*** The pump is not certified "water proof". Never spray cleaning or other fluids directly into openings on the bottom of the pump.
- ***Avoid Spray Oils:*** Never use light spray oils (e.g., WD40®) to clean or lubricate pump. These chemicals can damage the plastic of the pump.
- ***Never Autoclave:*** NEVER sterilize the pump in a steam autoclave or using gas. Using an autoclave or gas sterilization can seriously damage the infusion pump and void the warranty.
- **Handle Batteries with Care:** Always handle the pump's battery pack with care.
- **Don't Over-tighten Screws:** Never over-tighten any screws in the pump. Unless otherwise specified, torque all screws to 60 in- oz (0.42 Nm).
- **Battery Disposal:** Always dispose of exhausted NiMH batteries in compliance with all pertinent local, state, national, and international regulations. If unsure of correct methods for compliance, battery packs may be returned to Smiths Medical for recycling.
- ***The Keypad is NOT Flexible:*** Whenever handling the keypad, always ensure it remains flat. Bending the keypad can damage keys or break LED contacts.

Contents of this manual

This is the technical service manual for Medfusion® Model 3000 Series pumps manufactured by Smiths Medical. Its purpose is to provide the technical information necessary for maintenance, troubleshooting and repair of these pumps.

- This manual ***does not*** contain information on operating or configuring various models within the Medfusion® Model 3000 Series pump. Such information is found in manuals specific to each individual model, (e.g., *Medfusion® Model 3500 Operations Manual* and *Medfusion® Model 3500 Configuration Manual* [where applicable]). The sections of this manual are:

Introduction

- Overview of contents and purpose of this manual.

Teaching, Learning & Cloning

- Discussion of the methods used to 'Teach' a Configuration from a PC to a pump, to 'Learn' history from a pump to a PC, as well as the pump-to-pump 'Cloning' procedure.

Scheduled Maintenance

- List of tests for required annual maintenance, and the procedure for completing each test.

Theory of Operations

- Descriptions of the systems which control the operation of the pump.

Troubleshooting

- Tables of failure messages together with problem descriptions and possible solutions. Also includes an overview of Biomed Diagnostics & Utilities.

Parts Replacement

- Detailed procedures for removal and replacement of pump parts.

Calibration

- Detailed procedures for calibration of the pump.

System Layout

- Contains a diagram of the system layout.

Assembly Drawings and Parts Lists

- Contains mechanical assembly parts lists and replacement parts lists for repairs.

Authorized use of this manual

This manual is intended for use only by trained biomedical technicians who are authorized by their institution to perform maintenance and repair of critical medical devices.

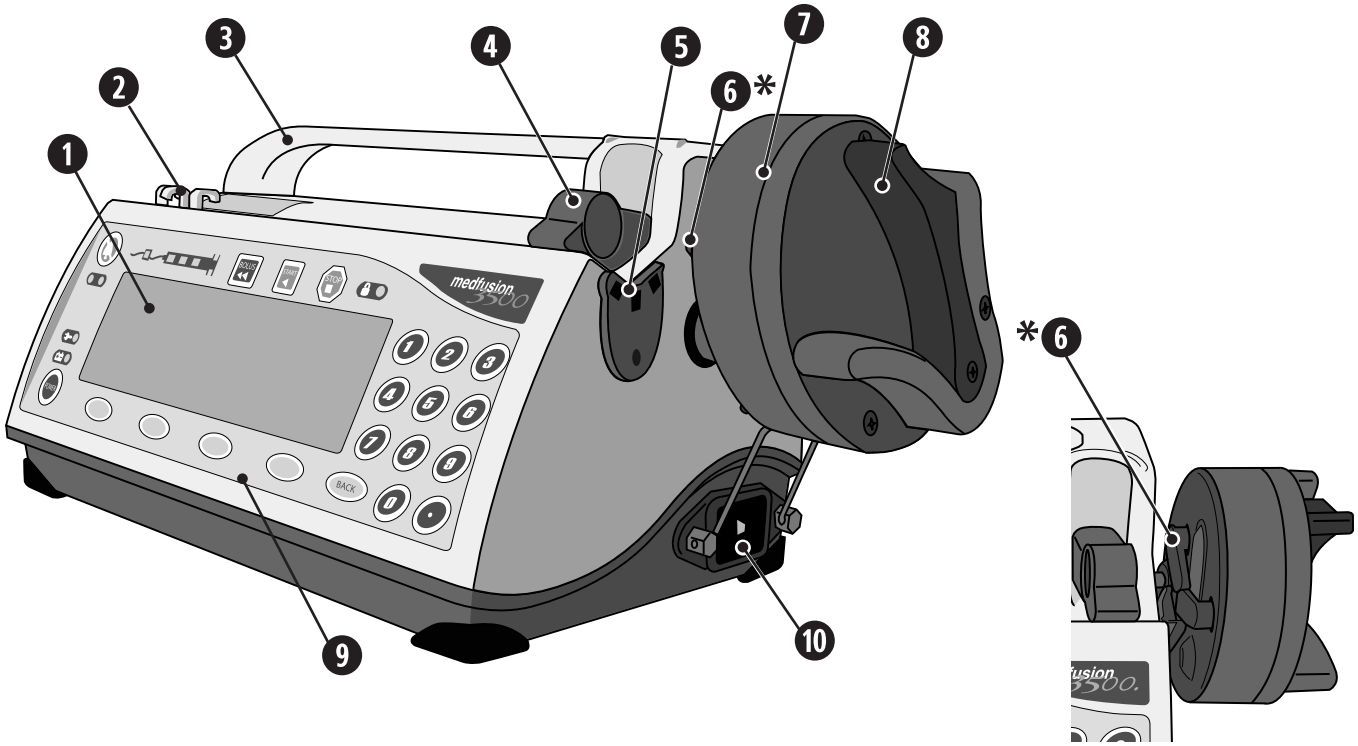
WARNINGS:

- Attempts to repair or maintain a pump by personnel without proper qualifications or training may create a major hazard which could result in serious injury or death to the patient or the user.
- Use only approved parts and procedures for repair and maintenance of this pump. Failure to follow this manual may create a major hazard which could result in serious injury or death to the patient or the user.

About the pump

Features and Controls

Following are several illustrations showing the various controls, connectors and features of the Medfusion® Model 3000 Series pump.



1 *LCD Display:* All pump operating and status information appears on the LCD display. The lower portion of the display corresponds with the 4 'softkeys' (their function changes depending on where you are in a pump program) on the keypad.

2 *Tubing Holders:* Thread infusion set tubing between holders to prevent kinking at syringe tip.

3 *Carrying Handle*

4 *Syringe Barrel Clamp:* The clamp holds the syringe barrel securely in place.

5 *Syringe Barrel Flange Clip:* When loading a syringe, slide the syringe flange into the clip.

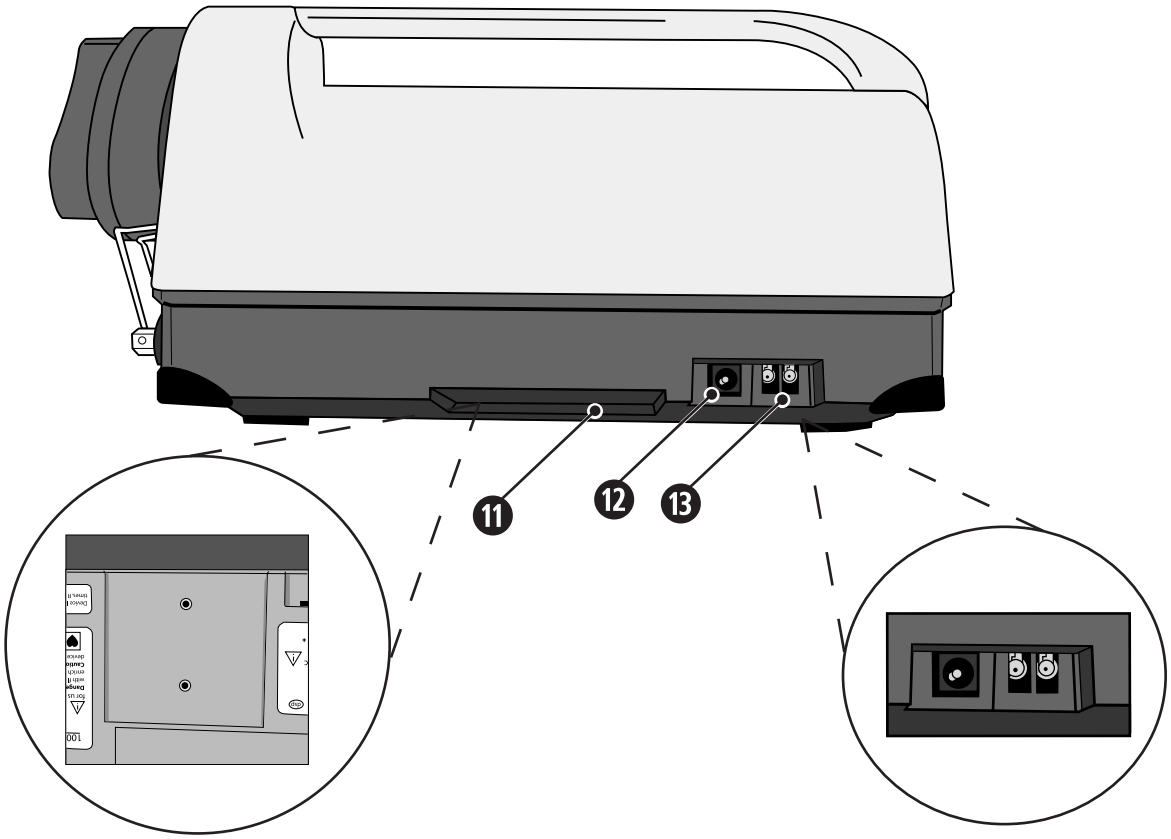
6 *Syringe Plunger Holders:* Holds the syringe plunger securely in place.

7 *Syringe Plunger Driver:* Once loaded and delivery is started, the driver pushes the syringe plunger forward at a controlled, precise rate to deliver fluid.

8 *Syringe Plunger Release Lever:* Squeeze the release lever to allow placement of the syringe plunger onto the holder during loading, or to remove it during unloading.

9 *Keypad:* See **Keypad closeup** (page 7) for identification of the individual keypad keys and what they are used for.

10 *AC Power Connection Port:* Plug the AC power cord into connection port to allow pump to operate on AC (mains) power.



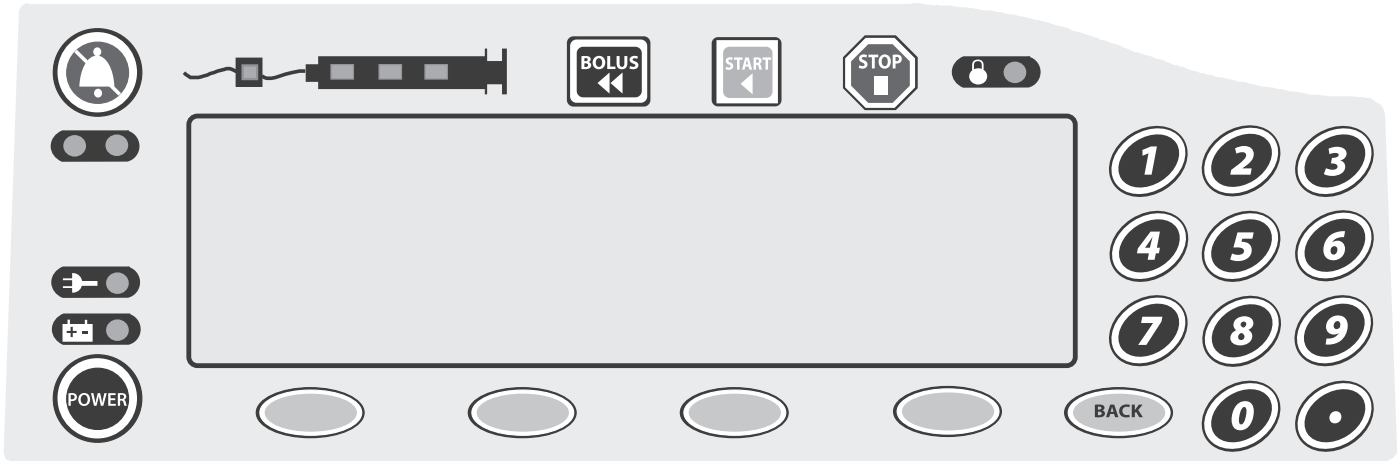
11 *Optional Poleclamp Mount:* If desired, attach the optional poleclamp here.

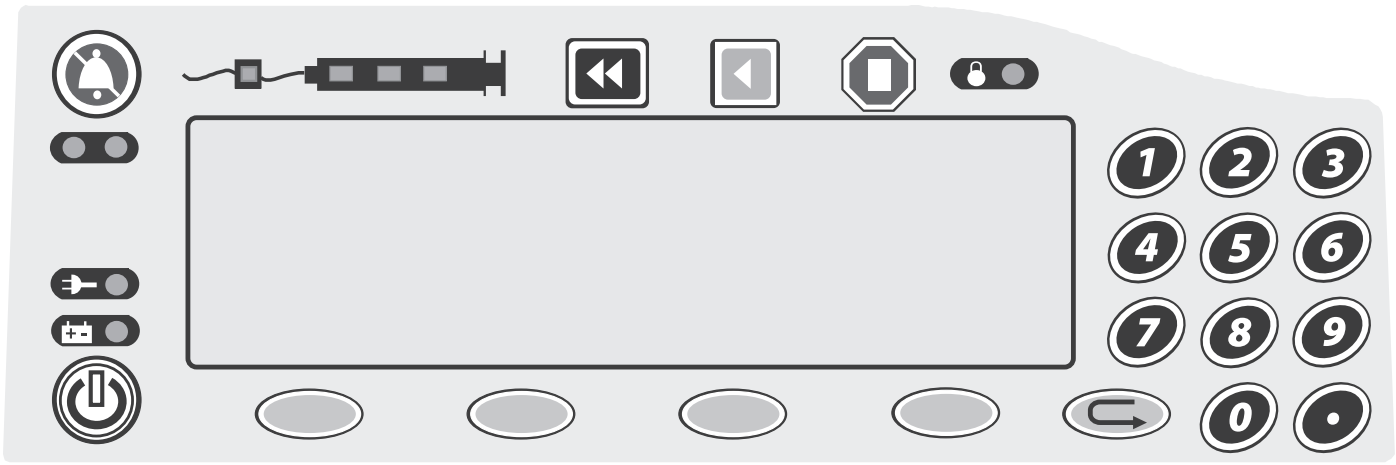
12 *External DC Power Input Jack:* Plug approved external DC power supply into jack.

Note: The DC Connector Port is functional only on pumps where the External DC Jack Connection symbol (-⊖+) appears on the pump serial number label (located on the bottom of the pump).

13 *Infrared Connection Port:* Align RS232 converter box (catalog number 3000RS232) or IR-to-USB (catalog number 22-1060-51) with the infrared (IR) port to allow upload of data from and download of data to a pump from a PC.

Keypad closeup





Key	When pump is paused	When pump is delivering
Alarm Silence ( )	Silences audible alarm. Allows operator to switch the display backlight from bright to dim or dim to bright. Allows redisplay of the text for the last active alarm.	Silences audible alarm. Allows operator to switch the display backlight from bright to dim or dim to bright.
Power (or)	Silence certain active alarms. Push and hold to turn pump off.	Silence certain active alarms (some alarms must be silenced with before ( ) will function). Push and release, then push and hold to turn pump off.
Menu keys (softkeys)	Function is defined on the display.	Function is defined on the display.
Back (or)	Reverts to a previous step or level.	Reverts to a previous step or level if adjusting settings.
Numbers & Decimal	Set number values or select menu items.	Set number values or select menu items.
Stop (or)	N/A	Stops delivery (pump remains On).
Start (or)	Starts delivery.	N/A
Bolus (or)	Begins priming after confirmation.	Displays the programmed bolus programming or confirmation/**Begin Delivery** screen.

Indicator	What it means
- Alarm	The **Alarm** indicators (yellow or red) are on whenever the pump is in an alarm condition. The specific details of each alarm are covered in the Troubleshooting section later in this manual.
- AC Line	The **AC Line** indicator (green) is on whenever the pump is connected to "mains" line power. It is off when the pump is not connected to an active AC line.
- Battery	The **Battery** indicator (green) blinks on & off whenever the pump is operating on internal battery power, and remains on when the battery is charging.
- Lock	The **Lock** indicator indicates the pump has been locked into its current operational mode. While this indicator is lit, the keypad is locked and no changes can be made to settings. Attempting to stop or change an infusion while locked will result in an alarm and an informational message.
- Infusing	The **Infusing** indicators are 3 green lights, which illuminate in sequence right to left when the pump is infusing. During intermittent volume over time delivery mode, a single Infusing indicator lights during the time between infusions. When the pump is off or stopped, the Infusing indicator is not lit.

Understanding "Biomed" mode

Periodic maintenance and troubleshooting on Medfusion® Model 3000 Series pumps are aided by use of the "Biomed" software interface.

What is biomed?

The Biomed feature is the *special utility* intended for use only by trained biomedical service technicians. The Biomed menu:

- has its own security access code;
- contains a **Calibration** menu for use in calibration of the pump's sensors and allows some error codes to be reset;
- contains a **Diagnostics** menu for use in diagnosis of digital and analog sensors contained in the pump, as well as testing the pump's drive systems, monitoring the status of the pump battery;
- contains a **Utilities** menu that allows access to infusion history log and alarm history log stored in the pump, and can be used to view or set the pump's last (V3) or next (V4 and later) preventive maintenance date or to view/set the time and date.

Authorized biomed access

Never use Biomed features unless you are trained in maintenance on the Medfusion® Model 3000 Series pumps and have been authorized by your facility to use the Biomed program. A passcode (2580) is required to access the Biomed menu.

Biomed software program – major options

The Biomed utility has four major modes on its **Select the Mode** screen. These are:

1. *Calibration* to check calibration values, re-calibrate sensors or set display contrast.
2. *Diagnostics* to examine analog and digital signal readings, or test the speaker, motor or display function.
3. *Utilities* to review alarm history, to review infusion history, to set time and date, to update periodic maintenance timestamp.
4. *Update Firmware* to reprogram the pump's software version through the serial interface (only available with service upgrade software diskette and instructions on certain models).

The following is an outline of the Biomed software:

<table>
<tr>
<td>Calibration
Calibrate size and position
Calibrate force sensor
Calibrate pressure sensor*
Calibrate plunger position
Calibrate syringe size sensor
Adjust contrast
View calibration data
Save changes and exit
* Some software versions; non-functional</td>
<td>Diagnostics
Audio test
Display test
Indicator test
Keypad test
Monitor analog sensors
Monitor digital sensors
Monitor battery status
Drive Train Test (V4 and higher)
Motor drive test
Monitor a2d self test
Monitor 6811 a2d group1
Monitor 6811 a2d group2
Force sensor test (V3)
Pressure sensor test (V3)</td>
</tr>
<tr>
<td>Utilities
Set/view last pm date OR Set/view next pm date
Set time/date OR View time/date
View alarm history
View infusion history
View software CRCs
View software versions
View service data
View EEPROM size (V4 and higher)</td>
<td>Update Firmware
(Special use only for software update - Not available on all pumps)
Set Language
(Medfusion® Model 3500 pump Only)</td>
</tr>
</table>

Symbols

The following is a list of symbols which may appear on the pump (or on its labeling or accessories), as well as certain technical terms, along with an explanation of what they mean.

	Caution
	Do not reuse
	Catalog number
	Serial number
	Use by
	Date of manufacture
	Manufacturer
	Not made with natural rubber latex
Rx ONLY	CAUTION: Federal (USA) law restricts this device to sale by or on the order of a physician.
EC REP	Authorized representative in the European Community
	Temperature limitation
	Humidity limitation
	Atmospheric pressure limitation
	Type CF equipment (protection from electric shock)
	Collect Separately
	MR (Magnetic Resonance) Conditional
	Equipment in which protection against electric shock relies on double or reinforced insulation instead of basic insulation. Accessible metal components of pump enclosure use this higher level of insulation instead of safety grounding.
CE	Indicates the product was designed and manufactured in accordance with applicable standards/guidelines and may be sold in the EU (European Union).
	UL Mark for Canada and the United States. Indicates the product was manufactured in accordance with the requirements of UL (Underwriter's Laboratory).

	Electrostatic sensitive devices (Pins of connectors and other areas identified with this ESD Warning symbol should not be touched. Connections should only be made when ESD precautionary measures are used.)
	External DC jack connection. Tip (negative sign) is for power ground and ring (positive sign) is for positive power connection.
	Symbol for infrared serial communications port on pump.
V ~	Operating voltage range for alternating current (i.e. AC or mains) power source
IPX3	Equipment that is ingress protected from fluid spraying at vertical angle from above, and from angles to 60° on either side of vertical

Infusion Class 4	An infusion pump that combines the functions of continuous infusion flow, intermittent flow, and discrete bolus delivery
Infusion Class 5	An infusion pump that functions as a profile pump, providing a programmed sequence of delivery rates

Glossary of Technical Terms

This is a glossary of technical terms relating to the Medfusion® 3000 Series pumps.

Term	Definition
AC Line Leakage Test	The pump is listed as Safety Class II, Type CF equipment Protection against electrical shock does not rely only upon basic insulation, but instead relies on double or reinforced insulation. As such, this equipment does not use a third wire ground (earth ground). Therefore, when doing line leakage test it is not necessary to measure leakage in both the open ground and closed ground setting. Nor is it necessary or relevant to perform a ground resistance test. Protection against leakage current is the concern for any device (be it Class I or Class II) deriving power from AC mains. Leakage current is what flows from mains side to device component(s) that is conductive and accessible by the user or patient. Safety grounding of exposed metal does not protect the user from leakage current. Safety grounding causes a circuit breaker or fuse to open should a short occur between wall AC side and grounded metal. The Medfusion® Model 3000 Series pump achieves protection by double-isolating secondary power and exposed metal from AC power. The Medfusion® Model 3000 pump satisfies the UL requirement that 4000 VAC can be applied between AC side and exposed metal without causing significant current to flow.
Alarm History	*See "View Alarm History"* (page 14).
Alarm Message	The onscreen text which appears to indicate situations or circumstances requiring user attention.
Backup Audio Buzzer	The backup audio buzzer provides a means of generating an alarm during: • instrument power loss (while the instrument was on) • malfunction of the main microprocessor • or failure of the primary speaker. The backup audio buzzer activates during a *Watchdog Alarm*, and anytime there is a malfunction of the main microprocessor. During power-up self-tests, the buzzer function is verified by briefly allowing the watchdog alarm to activate.
Backup Super Capacitor	A one (1) Farad Super Capacitor is part of the power control design to provide backup power to the audio buzzer in the loss of the primary power source.
Battery Gauge	The gauge circuits monitor direction and magnitude of current flowing through the battery. The battery current is sensed by the gauge. The gauge then computes capacity. To control charging the battery, the gauge uses battery temperature and battery voltage. The gauge changes to trickle charge in the event the battery temperature exceeds 50°C or if the battery voltage is lower than 5.7 volts.

Term	Definition
Battery Parameters	There are two battery parameters requiring periodic inspection to maintain good battery performance. They can be accessed by selecting **Biomed > Diagnostics > Monitor Battery Status**. • *LMD (Last Measured Discharge) (V5 and lower) or Full-Capacity (V6)* – This the learned capacity of the battery by the gauge following a calibration cycle. Replace the battery when the LMD/Full-Capacity is below the indicated value (see page 28). • *CPI (Capacity Inaccurate)* – This is the number of shallow discharge cycles since the last calibration. Always recalibrate the battery when CPI is > 80 Hex. Refer to the *Battery Calibration* section of this manual (page 28).
Biomed Calibration	A set of functions for calibration/adjustment of the sensors within the Medfusion® Model 3000 Series pump. Steps and processes for using **Biomed > Calibration** functions are found in the *Adjustment & Calibration* section.
Biomed Diagnostics	A set of functions which allow the detailed examination of the pump's systems, sensors, indicators, and controls. Steps for using **Biomed > Diagnostics** functions are found in the *Scheduled Maintenance* and *Troubleshooting* sections.
Biomed Utilities	The set of **Biomed > Utilities** contain a mixture of adjustment and troubleshooting options. These are: • *Set / View Last PM Date (*or *Set / View Next PM Date)* – Used to view and set the Preventive Maintenance (PM) date. • *Set Time / Date* – Used to set date and time for built-in real time system clock. • *View Alarm History* – Used to view alarm and alert history stored in pump memory. This is a troubleshooting feature. Page backward and forward through stored alarms in order to identify possible malfunction patterns. • *View Infusion History* – Used to view programming and infusion information stored in pump memory. This can be a troubleshooting feature. Page backward and forward through stored record of infusion types in order to identify how the pump has been used. • *View Software CRCs* – For "factory use" only. Allows view of CRCs for each code bank. • *View Software Versions* – Used to view both bootbank version and main version of software installed within the pump (V4 and higher).
Configuration Cloning	Two pumps can communicate through their built-in infrared serial communications interface, with one teaching and the other learning, to copy pump configuration settings, and libraries.
CPI (Capacity Inaccurate)	This is the number of shallow discharge cycles since the last calibration. Always recalibrate the battery when CPI is > 80 Hex. Refer to the *Battery Calibration* section of this manual (page 28).
Depleted Battery Monitor	The circuitry which measures present battery charge status against stored battery capacity data to determine a "depletion" situation.

Term	Definition
EN 475 Alarms	The EN 475 alarms use tones designed for use by customers following European standards. These generate High, Medium & Low Priority Alarms.
External Power Detector	Circuitry which determines when and if external power (whether AC or DC) has been or is connected to the pump.
Flash Memory	The pump uses flash memory, which is re-programmable through the infrared (IR) port and a remote computer.
Full-Capacity	This is the learned capacity of the battery by the gauge following a calibration cycle. Replace the battery when the capacity is below the indicated value (see page 28).
High Priority Alarms	A high priority alarm results from either any condition which halts an ongoing infusion, or any pump system fault which affects infusion. If the front panel controls are locked when a high priority alarm occurs, ***the pump controls unlock***. High Priority alarms are signaled by a flashing red indicator and an audible signal. Press to pause the audible alarm for the preset alarm silence period.
Infrared Serial Data Port	The infrared serial port interfaces directly with the main microprocessor's asynchronous serial communication pins. The infrared port supports short transmission distances of 2" or less and a maximum baud rate of 9600.
Infusion Class 4	An infusion pump which combines the functions of continuous infusion flow, intermittent flow, and discrete bolus delivery.
Infusion Class 5	An infusion pump which functions as a profile pump, providing a programmed sequence of delivery rates.
Interconnect Printed Circuit Board (PCB)	The Interconnect PCB receives and directs the power source, either internal 12VDC power supply, the internal battery or an external DC power supply (if applicable, see page 108) to the speaker system and Main PCB.
IPX3	Equipment which is ingress protected from fluid spraying at a vertical angle from above, and from angles to 60° on either side of vertical.
Keypad Test	Verifies individual function of each key on the keypad. Nonfunctioning keys indicate need for keypad replacement.
LCD	Liquid Crystal Display.
LCD Backlight	The LED fiber optic light source which illuminates the LCD display (older pumps) **OR** a self-contained light source in the LCD (newer pumps).
Limit Priority Alarms	A limit priority alarm is generated whenever a preset minimum or maximum limit has been violated. For example: when programming an infusion there are minimum and maximum preset rates assigned to syringes by size & manufacturer. The limit priority alarms sound a tone and display an advisory message onscreen for 3 seconds. To re-display the message press .
LMD (Last Measured Discharge)	This is the learned capacity of the battery by the gauge following a calibration cycle. Replace the battery when the LMD is below the indicated LMD value (see page 28).
Low Priority Alarms	A low priority alarm indicates any condition not requiring immediate operator intervention. Low Priority alarms are announced with a continuous yellow indicator and an intermittent audible signal. Pressing permanently silences this alarm. If the front panel controls are locked when a low priority alarm occurs, ***the pump controls do not unlock***.

Term	Definition
Medium Priority Alarms	A medium priority alarm indicates any condition requiring operator intervention but does not halt infusion. Medium Priority alarms are signaled with a flashing yellow indicator and an audible signal. Pressing  will silence the audible alarm for the programmed alarm silence period. If the front panel controls are locked when a medium priority alarm occurs, ***the pump controls do not unlock***.
Motor Rotation Sensor	A optical sensor on the Main PCB senses the movement of the motor worm shaft.
"Neglected Pump" Alarm	See *"User Call Back Alarm"* (below).
Occlusion	The blockage of the infusion line during delivery. Here, the pump detects an occlusion by sensing excessive force on the syringe plunger driver.
Plunger Printed Circuit Board (PCB)	The plunger PCB provides pre-amplification of the force sensor output to the Main PCB, and contains two photo-interrupters with supporting circuitry for sensing each plunger flipper.
Primary Speaker	The main speaker located in the bottom housing of the pump. All normal alarm/alert tones are generated through this speaker.
Safety Class II, Type CF Equipment	See *"AC Line Leakage Test"*.
Serial EEPROM	A non-volatile storage device (electrically-erasable programmable read-only memory) which is used on the Main PCB to store calibration, configuration, and infusion history.
Set / View Last (Next) PM Date	This allows viewing the last (or Next on V4 pumps) recorded preventive maintenance date. You also set the date here when completing annual preventive maintenance.
Stepper Motor	A sequentially stepping motor used to drive the plunger head of the pump.
System Failure	A high priority alarm indicating that the pump self-tests have detected a failure in pump operation.
Update Firmware	The firmware is the software installed in Medfusion® Model 3000 Series pumps V3 or lower, and which is used to operate the pumps. The software may only be updated with a software kit provided by Smiths Medical. The **Biomed > Update Firmware** option is the utility provided for reinstalling software used to operate pumps. This can be used to upgrade to a newer version of system software. (Only available on pumps with the V3 software combined with the V1.6 boot loader provides this option.) **Note:** Instructions for updating pump operational software are not included in this technical service manual. Instead, they are part of individual software upgrade kit.
User Call Back Alarm	The User call back alarm is a low priority alert which simply reminds you to finish what you started. Once programming of any infusion is begun, the pump expects programming to continue until it is complete. If the pump pauses too long (30 seconds) on any data entry screen, then the pump begins sounding a low priority alert.
View Alarm History	This is a troubleshooting feature. In **Biomed > Utilities**, page backward and forward through the stored alarms in order to identify possible malfunctions.

Term	Definition
View Infusion History	This is a troubleshooting feature. In **Biomed > Utilities**, page backward and forward through the stored record of infusions in order to identify how the pump has been used. The history will contain roughly 50 events.
View Software CRCs	For "factory use" only.
View Software Versions	Identifies both the bootbank version and the main version of the operational software installed in the Medfusion® Model 3000 Series pump. (Pumps with V4.1.5 software and higher also identify the build number.)
Watchdog Circuit	While in the power on state, the auxiliary controller prevents the watchdog Alarm State from occurring by maintaining the AC signal, WATCHDOG_STRB. The main microprocessor periodically issues the AC signal, PET_WATCHDOG.

This section discusses the methods used to Teach (or download) a Configuration from a PC to a pump, Learn (or upload) History and other information from a pump to a PC, as well as the Configuration Cloning feature.

Teaching, Learning & Configuration Cloning

Configuration and Settings, Options, Drug Programs and Syringe Data can be copied electronically from one pump to another through the serial communications interface. The process is called *"Configuration Cloning"* and involves one pump *"Teaching"* and the other pump *"Learning"*.

What is Configuration Cloning?

Configuration Cloning is the ability to transfer configuration settings from one Medfusion® Model 3500 pump to another pump of the same software version (V5 pump to V5 pump, V6 pump to V6 pump, etc.).

This cloning transfers the complete settings of the *"Teaching"* pump, including all library data. The pump that *"Learns"* thereafter functions the same as the Teaching pump.

This cloning process is especially useful when there are large groups of pumps that must be customized for various units and departments within an organization or hospital.

Teaching & Learning

Configurations are created either directly on a single pump (V3.0.6 only), or using the PharmGuard® Toolbox Software installed on a PC (all other pump software versions).

Using either method, the process involves one pump being configured according to the needs of a specific unit, department, organization or hospital.

Pumps with Software Version V3.0.6

On V3.0.6 pumps, a single pump is configured directly on the pump in the **Custom Program** menu, then that pump becomes the "Teacher". See the Configuration Manual supplied with the pump for specific instructions on creating a Configuration and library on a V3.0.6 pump, and for using the Teach, Learn, and Cloning process specific to the V3.0.6 pump (which is slightly different than that shown below).

Pumps with Software Version V4 and higher

On V4 and higher pumps, the PharmGuard® Toolbox Teach process is used to download the Configuration to a single pump, which becomes the "Teacher". See the PharmGuard® Toolbox *User's Manual* for specific instructions on its Teach function. Follow the instructions below to use the Configuration Cloning feature.

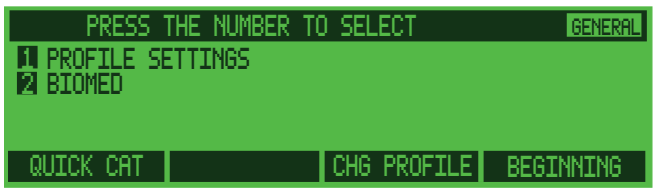
IMPORTANT: ***V5 and Higher Software:*** When teaching a new Configuration to pumps with V5 and higher software, all History and PharmGuard® Safety Data stored in the pump is automatically cleared. If it is necessary to save the history and data, Configuration cloning should not be used. Instead, use the appropriate version of PharmGuard® Toolbox to first open and save the pump's history/data, then Teach the new Configuration to the pump.

Cloning

The Smiths Medical Cloning Block (catalog number G6000200) may be used for the cloning procedure, but is not required.

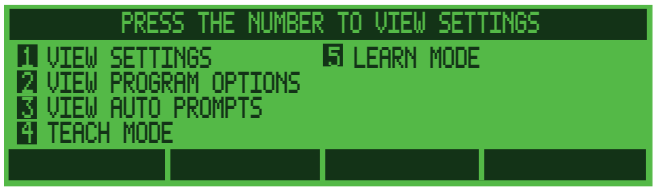
Enable the Teacher pump:

1. From the pump's **Main** menu, press the **number** key to select **Profile Settings** (if necessary, press **More** to find it; if a custom Configuration is installed on the pump, you may need to first select a *Profile*, then select **Profile Settings**). (Pump versions 3.x or lower, select **Custom Program**.)



2. Use the **number** keys to enter the ***passcode*** (***3000***).

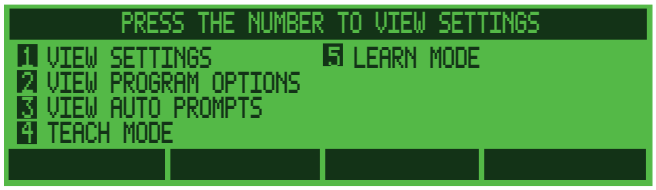
3. Press the **number** key to select **Teach Mode**.



The pump is now ready to clone its Configuration to the Learning pump until **Exit** is pressed.

Enable the Learning pump:

1. Follow the same procedure as indicated above to access the **Profile Settings** menu. Once in the menu, press the **number** key to select **Learn Mode**.



2. Place the pump back to back with the *Teacher* pump so the infrared RS232 ports are aligned facing each other (or use the Smiths Medical Cloning Block to align the pumps, catalog number G6000200). The pump is now ready to learn.
3. At the confirmation screen:

- press **Yes** to confirm the choice;
- press **No** to cancel and return to the previous screen;

4. When **Yes** is pressed, the Teach/Learn process begins. When complete, press POWER (⏻) to turn the Learning pump off.
6. Repeat for each Learning pump.

Troubleshooting the "Learn Error - Remote Not in Teach Mode" error Message

If a Teaching/Learning session is started and there is no pump set in the Teach mode, with the infrared port aligned and ready with the Learning pump, the Learning pump displays the following error message:

LEARN ERROR - REMOTE NOT IN TEACH MODE

Clear this message by pressing **Exit**, then set up and align the Teacher pump.

If the error message displays even though the Teacher pump is set and aligned with the Learning pump, it may mean some other sort of issue. Check the following:

Type of Problem	Remedy
Alignment	The two pumps may not be properly aligned, preventing communications via the infrared port. Readjust the alignment of the pumps. If the optional Smiths Medical Cloning Block is available, use it to align the pumps.
Incorrect Teaching Setup	The Teacher pump may not be set up correctly. Exit the **TEACH MODE** and try again. Verify both the Teacher and Learning pump have the same software version.
Incorrect Learning Setup	The Learning pump may not be set up correctly. Exit the **LEARN MODE** and try again. Verify both the Teacher and Learning pump have the same software version.
Damaged Pump	One or the other of the pumps may be damaged or malfunctioning. Determine which by performing the following: • Select and set up another pump for Learning and try again. If this succeeds, the first Learning pump is malfunctioning. Inspect and repair it as needed. • Select and set up another pump as the Teacher. If this succeeds, the first Teacher pump is malfunctioning. Inspect and repair it as needed. If either the Learning pump or Teaching pump is malfunctioning, it is likely a problem with the Interconnect PCB.

This section defines the required preventive maintenance for keeping the Medfusion® Model 3000 Series pump in good operating condition.

Preventive Maintenance Planning

Smiths Medical recommends a preventive maintenance plan that allows servicing pumps in batches as their anniversary dates arrive. For example, with numerous pumps to service over the course of a year, set the date on each pump so that 10 pumps are due for service each week of the year (this will prevent all pumps from giving the alert reminder at the same time).

Pumps with **V3 software**: enter the ***last*** PM date (the pump will calculate the next PM date). An example of a plan for the maintenance of pumps with V3 software is shown in the following table:

Serial Numbers	Scheduled PM	Enter Last PM	Date of Alarm
M001001 to M001010	7/24/2007	**7/24/2005**	7/25/2007
M001011 to M001020	7/31/2007	**7/31/2005**	8/1/2007

Pumps with **V4 and higher software**: enter the ***next*** PM date. An example of a plan for the maintenance of pumps with V4 and higher software is shown in the following table:

Serial Numbers	Enter Next PM Date	Last PM	Date of Alarm
M001001 to M001010	**7/24/2008**	7/25/2007	7/25/2008
M001011 to M001020	**7/31/2008**	8/1/2007	8/1/2008

The best approach is to set the date so that the alarm occurs only if a pump is missed in the normal PM schedule.

Biomed maintenance tools

In order to complete maintenance, parts replacement, diagnosis and calibration of Medfusion® Model 3000 Series pumps, the following are required (see page 125 for part numbers):

1 ea – Calibration Kit (see service parts list): Small Calibration Slug, Large Calibration Slug & Force Gauge

1 ea – new 50 or 60 mL syringe (note: the lubrication in syringes evaporates, change "test" syringes monthly)

1 ea – 3-way Stopcock

1 ea – Electrical Safety Analyzer

1 ea – Torque Screwdriver w/Phillips & Standard bits.

1 ea – ¼" open end wrench

1 ea – 6" calipers with resolution of 0.001"

Using a torque screwdriver

A *Torque Screwdriver* **must** be used when re-assembling any Medfusion® Model 3000 Series pump. Where screws are used to secure components, over-tightening can strip threads or crack standoffs in the case.

- Unless otherwise specified, always torque all screws to 60 in-oz (approximately 0.42 Nm).

Electrostatic-controlled workstation

Whenever working on the Medfusion® Model 3000 Series pump – *specifically whenever opening the pump for service* – you **must** work in an electrostatic-controlled environment in order to prevent damage to the electronic components in the pump.

CAUTION: Repair Pump in ESD Controlled Work Area: The pump case should only be opened at a work-station with Electrostatic controls, including a grounded mat and wrist-strap.

Storage/Transport and Operating Condition Requirements

As listed in the pump *Operator's Manual, Technical Specifications*, the requirements for storing/transporting and operating the pump are as follows:

Storage/Transport Conditions	
Temperature	-20° to 50°C (-4° to 122°F)
Relative Humidity	20% to 95% non-condensing
Ambient Pressure	70 kPa to 106 kPa (10.2 psia to 15.4 psia)

Operating Conditions	
Temperature	5° to 40°C (41° to 104°F)
Relative Humidity	20% to 95% non-condensing
Ambient Pressure	70 kPa to 106 kPa (10.2 psia to 15.4 psia)

The pump may not meet the performance specifications when stored, transported or used outside the ranges given in the above.

Service warnings

WARNINGS:

- ***Pump Maintenance:*** **Only trained biomedical service personnel may service this pump**. Service personnel should disconnect the AC power cord before servicing the pump.
- ***AC Power:*** **The only means of removing AC power is to disconnect the AC power cord.** While the AC power cord is attached to the pump and plugged into an AC outlet, live mains voltage is present within the pump.
- ***Manufacturer Recommended Maintenance:*** **Always maintain this pump following *manufacturer recommended instructions*** in this Service Manual. An improperly maintained pump may cause serious injury to a patient or user.

Periodic maintenance

This maintenance is ***required*** for the continued safe operation of Medfusion® Model 3000 Series pumps.

The Medfusion® Model 3000 Series pump must be tested annually, or whenever the pump has been damaged or dropped. Always check all sensor calibrations as a standard part of annual maintenance. No calibration is required to maintain pump flow delivery accuracy.

Installation/quick check-out

Each pump is inspected and tested prior to shipment from the factory. Some institutions require that devices entering a hospital be functionally checked before being placed into service. The following procedure is provided to meet this need.

Quick check-out test

☐ 1) Plug AC power cord into AC receptacle on side of pump, then plug pump into an AC power (100 to 240 VAC) source. Verify AC indicator and battery charge indicator are lit.

☐ 2) Press POWER (⏻). Verify the following on power-up:

- Verify alarm beeps.
- Verify all the LED indicators are turned on & off (except AC and battery).
- Verify that no self-tests fail.
- Verify the display is legible and contrast is acceptable.

☐ 3) Unplug the AC power cord and verify that within several seconds the battery indicator begins to flash and AC indicator goes off. Re-plug the AC power cord into the unit.

☐ 4) Perform the "Flow Delivery Accuracy Test" from *Annual Maintenance* (which follows).

☐ 5) From the pump's **Main** screen, use the **number** keys to choose **Biomed** (a Profile may need to be opened first; press **More** for second page, if needed). Use the **number** keys to enter passcode "***2580***", then use the **number** keys to choose **Utilities**. Then:

Set/view Last PM Date. ***Pumps with V3 software:*** Set the PM date to today's date. (Setting this PM date means that an advisory message will appear on the pump two years from this date.) - ***OR*** -

Set/view Next PM Date. ***Pumps with V4 and higher software:*** Set the date to the date you ***want*** the PM alert to occur.

The "Maintenance Required" message does not prevent normal operation of the pump, but advises the user that maintenance is recommended.) [**Note:** pumps are shipped from the factory with the date/time set to USA Central Standard Time; use the **Set Time/Date** utility to modify this if desired.]

☐ 6) Perform the "AC Line Leakage Test" from *Annual Maintenance* (which follows).

☐ 7) Consult the troubleshooting guide or contact Smiths Medical should the pump fail any steps in this test.

- continued -

☐ 8) After the completion of these tests the pump should be plugged into AC power to recharge the battery. [This is recommended when the battery capacity is less than 90% – look at battery gauge displayed on the bottom of the power-up screen.]

Cleaning and care

Standard cleaning of Medfusion® Model 3000 Series pumps

Below are common methods and cautions relating to cleaning and caring for the pump.

WARNING: ***Power Source:*** To avoid electric shock, before cleaning, always switch electrically operated equipment off and disconnect from AC power source.

CAUTIONS:

- **DO NOT USE** cleaning solutions containing:

  acetone, ammonia, ammonium chloride (including Hyamine 1622), *aromatic solvents* (such as paint thinner, toluene, methylbenzene), *chlorinated solvents* (such as methyl ethyl ketone (MEK), trichloroethane), *ether* (such as ethylene glycol monobutyl ether, diethylene glycol butyl ether) or *oxidizing acids* (such as phosphoric acid, sulfuric acid or accelerated hydrogen peroxide).

  Use of the solutions or solvents listed as DO NOT USE could damage plastic parts and cause premature failure or device malfunction.
- ***Use only the recommended cleaning/disinfecting agents and method.*** Use of cleaning/disinfecting agents and method other than those listed may cause damage to the pump and will void the warranty.
- ***Spray Resistant:*** The pump is "spray resistant" from the top and sides but not "water proof ". NEVER spray cleaning or other fluids directly into openings on the bottom of the pump.
- ***Not Waterproof:*** The pump is not certified "water proof". Never spray cleaning or other fluids directly into openings on the bottom of the pump.
- ***Avoid Spray Oils:*** Never use light spray oils (e.g., WD40®) to clean or lubricate pump. These chemicals can damage the plastic of the pump.
- ***Never Autoclave:*** NEVER sterilize the pump in a steam autoclave or using gas. Using an autoclave or gas sterilization can seriously damage the infusion pump and void the warranty.

Note: If possible, avoid wiping grease off of plunger tube and barrel clamp rod. If this cannot be avoided, apply a light layer of silicone grease (Grease, Silicone, 111 Compound, Smiths Medical part number 0382000000) to these areas to ensure proper operation.

1. The following agents have been tested and can be used to safely clean the syringe pump without damaging the pump housing when the procedure listed in item 2, below, is used:
   - Isopropyl alcohol 70% solution
   - Household bleach (Sodium Hypochlorite), (6% solution diluted to 1:6) or 1.0%
   - Sani-Cloth® Bleach by PDI
   - Mild detergent mixed with water (has no disinfection properties)
2. Clean by spraying cleaning agent directly onto a soft cloth (or use wipes/cloths listed) and wipe pump, then wipe surfaces dry. Never allow cleaning agents to pool on the device as prolonged contact could damage the pump and its components.

Mandatory annual maintenance testing

All tests on this *Required Annual Maintenance List* must be performed annually in order to ensure the continued safe operation of the Medfusion® Model 3000 Series pump.

General inspection

- ☐ 1) If not already performed, clean and disinfect the pump as described in the "*Cleaning and Care*" section (see previous page).
- ☐ 2) Inspect for obvious physical damage, including cracked housings or torn keypads. Repair any physical damage.
- ☐ 3) Verify smooth operation of syringe plunger driver, syringe release lever, syringe flange clip, and syringe barrel clamp. Clean and/or repair/replace any damaged components. Apply a light layer of silicone grease (Grease, Silicone, 111 Compound, Smiths Medical part number 0382000000) to the plunger tube and barrel clamp rod.
- ☐ 4) Verify the three tubing guides (hooks) on top left side are intact, and fully secured to pump housing. Replace any damaged guides.
- ☐ 5) Verify force sensor seal, located behind flippers on plunger driver head, is intact and not punctured. Replace damaged seal.
- ☐ 6) Inspect power cord for damage and wear. Replace damaged or worn power cord before performing any leakage current testing.
- ☐ 7) Inspect pole clamp for proper operation. Verify that the screws holding pole clamp components are tight.
- ☐ 8) Inspect all pump labels for legibility and damage, and replace as needed.
- ☐ 9) Verify four rubber feet are attached to the bottom housing of the pump. Replace missing feet.
- ☐ 10) Turn the pump on all sides and check for any loose parts internally and externally.
- ☐ 11) Plug AC power cord into AC receptacle on side of pump, then plug pump into an AC power (100 to 240 VAC) source. Verify AC indicator and battery charge indicator are lit. Consult troubleshooting for any failed indicator.

Power-up test

Ensure that no syringe is loaded in the pump and the barrel clamp is fully down. Press POWER (⏻). Verify the following on power-up:

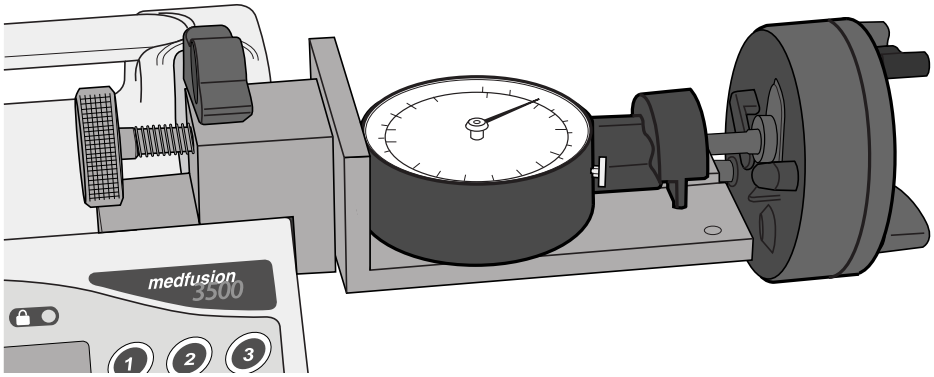
- ☐ 1) Verify two distinct alarm beeps.
- ☐ 2) Verify all the LED indicators turn on and off (except AC and battery).
- ☐ 3) Verify that battery capacity shown on screen is greater than 0%.
- ☐ 4) Verify that no self-tests fail.
- ☐ 5) Verify the display is legible and contrast is acceptable. Press 🔔 and verify the backlight goes from normal to extra-bright; press 🔔 again and verify the backlight returns to normal.
- ☐ 6) Unplug the AC power cord and verify that within several seconds the battery indicator begins to flash and AC indicator goes off. Re-plug the power cord into the unit.

Consult troubleshooting for any failed steps in this test.

Calibration verification

From the pump's **Main** menu, use the **number** keys to choose **Biomed** (press **More** to find it, if needed). Enter the passcode (numbers ***2580***), then press **Enter**. Use the **number** keys to choose **Diagnostics**, then **Monitor Analog Sensors**.

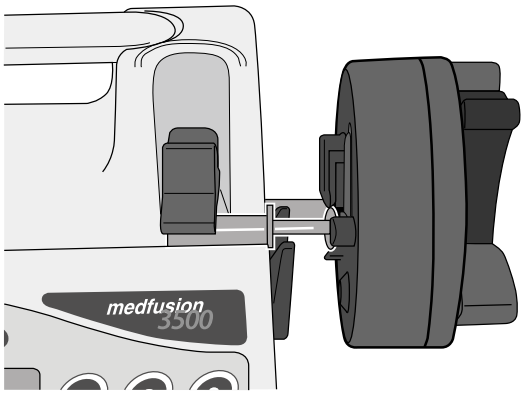
Force sensor check



- ☐ 1) Ensure that no syringe is loaded in the pump. Verify that the force reading on the screen is between –0.7 and +0.7 pounds.
- ☐ 2) Load the force gauge with the foot of the gauge positioned towards the head of the plunger driver. Zero the force gauge. Using the thumbscrew of the force gauge bracket, increase the force applied until the force gauge reads 15 pounds (6.8 kilograms). Verify that the force reading on the screen is between 12.6 and 17.4 pounds.

If either reading is out of specification, re-calibrate the sensor (page 91) and then retest readings.

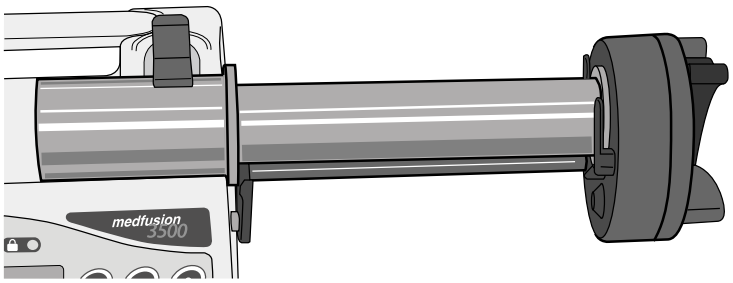
Small syringe size and position sensor check



- ☐ 1) Load the plunger driver onto the end of the slug with flippers open, and about 0.1 lbs. applied to force sensor (as read from the screen). Verify that the position reads between 0.660" and 0.740", inclusive. Unload the slug.
- ☐ 2) Load the small Calibration Slug into the barrel clamp (do not load the plunger driver). Keeping the barrel clamp perpendicular to the slug, move the barrel clamp head slightly back and forth to find the lowest size reading. Verify that the size reads between 0.234" and 0.294", inclusive.

If either reading is out of specification, re-calibrate the sensor (pages 89 or 95) and then retest readings.

Large syringe size and position sensor check



- ☐ 1) Load the plunger driver onto the end of the slug with flippers open, and about 0.5 lbs. applied to force sensor (as read from the screen). Verify that the position reads between 4.660" and 4.740", inclusive. Unload the slug.
- ☐ 2) Load the large Calibration Slug into the barrel clamp (do not load the plunger driver). Keeping the barrel clamp perpendicular to the slug, move the barrel clamp head slightly back and forth to find the lowest size reading. Verify that the size reads between 1.222" and 1.282", inclusive.

If either reading is out of specification, re-calibrate the sensor (pages 89 or 95) and then retest readings.

Note: Use a new syringe for the following tests as the lubrication within syringes evaporates. Change "test" syringes at least monthly.

Plunger travel test

Return the pump to the **Main** menu (press BACK (↪) to exit Biomed mode). Load an air-filled 50 or 60 mL syringe into the pump. Use the **number** keys to choose **mL/hr** delivery mode and set the flow rate to 20 mL/hr. Clear the total infused. Press START (◄).

- ☐ 1) Verify the three green infusing indicators are lit in a repeating sequence from right to left. Continue running until at least 0.033 mL has been infused.
- ☐ 2) Press **Lock** and verify the Lock indicator lights. Press **Unlock** and verify the Lock indicator turns off.
- ☐ 3) Press **CHG Rate** and set a rate to the maximum rate available on the mL/hr control screen. Allow the unit to drive for the full length of the syringe.
- ☐ 4) When the syringe is empty, verify the **Syringe Empty** alarm message is displayed and the red alarm indicator lights. Verify the alarm tone quality. Press 🔔 to silence alarm.

If other alarms or system failures occur during this test use the troubleshooting guide for corrective actions.

Motor drive & occlusion operational test

The motor, drive train and occlusion sensors are all tested using this procedure.

Connect a three-way stopcock to an empty 50mL or 60mL Luer lock syringe filled with approximately 50 or 60 mL of air (depending on syringe size in use). Load the syringe on the pump.

☐ 1) Use the **number** keys to choose **mL/hr** mode and set the flow rate to the maximum rate as displayed on the mL/hr entry screen. From the **Begin Delivery** screen, press BOLUS (◀◀) to access the **Prime** screen. Press and hold BOLUS (◀◀) to prime the tubing set for at least 0.2 mL priming volume. Press **Exit**. Close the stopcock to the syringe.

☐ 2) Press **Options**, then use the **number** keys to choose **Override Occl Limit**, choose **High**, then press **Enter**.

☐ 3) Press START (◀) to begin the infusion.

☐ 4) Verify the pump operates until an occlusion alarm occurs. After the occlusion alarm occurs and the motor stops reversing, open the stopcock to release the pressure, then re-close the stopcock. Press START (◀) and allow the pump to run until another occlusion alarm occurs. Repeat the above occlusion testing until the plunger reaches the end of the syringe.

If any alarm other than occlusion occurs during this test, see troubleshooting for corrective action.

Flow delivery accuracy test

Return the pump to the **Main** menu. Use the **number** keys to choose **mL/hr**. Select a syringe manufacturer. Load a 50/60mL Luer-lock syringe (air-filled) into the pump – use a syringe from the table on the next page. Enter a rate of 300 mL/hr.

☐ 1) From the **Begin Infusion** screen, press **Options** and use **number** keys to choose **Volume Limit**. Enter a volume limit of 50 mL. (**Note:** if volume limit is not configured, press STOP (■) when TVD reaches 50.0 mL.) From the **Begin Infusion** screen, press BOLUS (◀◀) to access the **Prime** screen. Press and hold BOLUS (◀◀) to prime the tubing set for at least 0.2 mL priming volume. Press **Exit**. Use calipers to measure the distance from the outside of the syringe flange to the inside of the syringe plunger. **Record this measurement as the starting position**. _____

☐ 2) Press START (◀) and verify delivery begins. Wait until the pump volume limit is reached in 10 minutes. (Press STOP (■) if volume limit is not active.) Press 🔔 to silence the audible alarm. Use a set of calipers to measure the distance from the outside of the syringe flange to the inside of the syringe plunger. **Record this measurement as the ending position**. _____

☐ 3) Subtract the ending position from the starting position. Verify that this result is between 3.473" and 3.615" (inclusive) for a B-D 60mL syringe, consult on the next page for other syringes.

Manufacturer	Minimum travel	Nominal travel	Maximum travel
B Braun Perfusor 50mL	**3.146" (79.92mm)**	3.211" (81.55mm)	**3.275" (83.18mm)**
B Braun Ominifix 50mL	**3.146" (79.92mm)**	3.211" (81.55mm)	**3.275" (83.18mm)**

Manufacturer	Minimum travel	Nominal travel	Maximum travel
B-D 60mL	**3.473" (88.22mm)**	3.544" (90.02mm)	**3.615" (91.82mm)**
Monoject 60mL	**3.473" (88.22mm)**	3.544" (90.02mm)	**3.615" (91.82mm)**
Terumo 60mL	**2.901" (73.70mm)**	2.961" (75.20mm)	**3.020" (76.70mm)**

Table of acceptable syringe travel for 50 and 60 mL syringes.

If this test fails use the troubleshooting guide for corrective action.

AC line leakage test

☐ 1) Connect the AC power cord to the Safety Analyzer. Set Safety Analyzer to Line Leakage mode of operation. Press POWER (⏻) to turn the pump on.

☐ 2) Using the ground reference probe of the Analyzer, make contact with either the plunger driver tube or the center post of the DC input jack. Verify the leakage in the normal setting is less than 100 micro-amps [note, this is equivalent to BF rating for this device].

If you wish to verify the CF rating of the pump, then fill a beaker with normal (0.9%) saline solution and load the pump with a syringe and tubing filled with normal saline. The saline-filled tubing should be in contact with the saline in the beaker. Place the ground reference of the leakage current Analyzer in contact with the saline in the beaker and verify the leakage current in the normal setting is less than 10 micro-amps. [This procedure is specified in IEC 60601-2-24, clause 19.]

Turn off pump and disconnect from safety analyzer.

WARNING: ***Safety Class II, Type CF Medical Equipment:*** The pump is listed as Safety Class II, Type CF equipment. Protection against electrical shock does not rely only upon basic insulation, but instead relies on double or reinforced insulation. As such, this equipment does not utilize a third wire ground (earth ground). Therefore, when doing line leakage test it is not necessary to measure leakage in both the open ground and closed ground setting. Nor is it necessary to perform a ground resistance test.

Battery maintenance

This chapter discusses battery maintenance as recommended to ensure good battery performance.

1. The battery pack contains six Nickel Hydride (NiMH) cells (older pumps may have a Nickel Cadmium [NiCad] battery pack providing 1700, 2100 or 2300 mAH) with a smart gauge for monitoring battery charge information.

Notes:

- The gauge is built into the battery pack, and the pump reads the battery capacity from the gauge on the pack.
- The battery pack has a shelf life of 4 months, after which it will require recharging. Once installed into a pump, the shelf life is 2 months, after which it will require recharging.

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2. There are two measured battery parameters that must be reviewed to maintain good battery performance and accuracy of the battery gauge. From the **Main** menu, use the **number** keys to choose **Biomed**; use the **number** key to choose **Diagnostics**; use the **number** keys to choose **Monitor Battery Status** option.

   a) **LMD (Last Measured Discharge)** ***(V5 software and lower)*** or **Full-Capacity** ***(V6 software)*** – This the *learned capacity* of the battery by the gauge following a calibration cycle. It is recommended the battery be replaced when this value is:

   NiCad (Nickel Cadmium) battery pack: < *1400 mA-hours*

   NiMH (Nickel Metal Hydride) battery pack: < *1600 mA-hours*.

   b) **CPI (Capacity Inaccurate)** – This is the *number of shallow discharge cycles* since the last calibration. It is recommended that you recalibrate the battery when CPI is > *80 hex (i.e. >128 decimal)*. Refer to the battery calibration section below.

Shallow discharge (CPI) record

The battery gauge records the number of shallow discharges. A *shallow discharge* happens whenever the battery is *partially* discharged and then returned to AC power. The number of the shallow discharges appears on page two of the **Monitor Battery Status** menu in the **Biomed** > **Diagnostics** menu.

- This displays CPI as 0×DD, where 0×DD is a hexadecimal number representing the number of shallow discharges cycles.
- The value is reset to zero each time the battery is calibrated. It increments to a maximum count of 0×FF hex (255 decimal).

During the annual periodic maintenance if the number of shallow discharges, CPI, is 0×80 hex or higher [e.g. 0×90, 0×A5, 0×BB, etc.], then the battery should be re-calibrated.

Battery calibration procedure

The *battery calibration* procedure ensures the battery calibrates (or "re-learns") the battery capacity. It does this by measuring the actual charge & discharge rates to determine the true capacity of the battery. With this correct information, the pump calculates "percentage of battery charge" and determines "low battery alarm".

1. Connect the pump to AC power.
2. Turn the pump on and select **Biomed** > **Diagnostics** > **Monitor Battery Status**.
3. After the Charge Level gauge reaches 99 to 100%, wait at least 1 more hour, then remove AC power.
4. Using one of the methods listed here, fully drain the battery pack, until the pump sounds the **Battery Depleted** alarm (not the **Low Battery** alarm). Interrupt the discharge test by turning the pump off and continue discharge at a later time – as long as the pump is not plugged into AC power during the discharge cycle.

   a) The battery can be discharged by operating the pump on battery power and infusing at 5 mL/hr using a 60mL syringe. This takes approximately *10 hours* from a full charge.

   b) A quicker method is holding open the clutch lever with a clamp to prevent the plunger flipper and clutch from closing. Then use **Biomed** > **Diagnostics** > **Motor Drive Test**, and set motor step period to 2 msec, and press START (◄). This should deplete the battery within approximately *3 hours* .

   c) A third method is to disconnect AC power, turn the pump on, and run **Biomed** > **Diagnostics**

> **Monitor Battery Status**. This discharges the battery at about 130 ma, and takes approximately *13 hours* from full charge.

5. Once the **Battery Depleted** alarm sounds, turn the pump off and plug into AC. This begins recharging the battery. [**Do not unplug AC power until charging is complete.**]

   If left in "Depleted" alarm condition, the pump will draw power from the battery until its voltage drops to a level which disconnects the battery gauge. ***The pump then loses all its calibration information****. From the time the* **Battery Depleted** *alarm occurs, the pump has approximately 5 minutes of operation on battery before the "fully-depleted disconnect" condition occurs. At this point, the audible alarm continues running from the super-capacitor on the Main PCB.*

6. After several minutes of recharging the gauge will show the learned capacity of the battery.
7. Turn the pump on and select **Biomed** > **Diagnostics** > **Monitor Battery Status**.
8. Verify LMD (V5 and lower) or Full-Capacity (V6) value (see item 2a under Battery Maintenance, previous).
9. Press **More** and verify CPI is 0×00 or 0×01.
10. Turn the pump off and continue to charge pump until battery charge is complete (approximately 10 hours).
11. Turn on pump and select **Biomed** > **Diagnostics** > **Monitor Battery Status**.
12. Verify the LMD/Full-Capacity value. At 1600 mA-hours/1400 mA-hours battery, the pump's battery life is approximately 7-8 hours. It is recommended that the battery be replaced if its capacity is less.

Requirements for battery pack replacement

The battery must be replaced only by a trained Biomedical or service technician. Always dispose of depleted or defective batteries in compliance with all applicable regulations, or the battery pack can be returned to Smiths Medical for recycling.

WARNING: ***Battery Replacement:*** Observe ESD handling precautions when replacing the battery. Replace battery only with same Smiths Medical part/model number. Recycle batteries in compliance with applicable local regulations.

Collect Separately

This product contains electrical and electronic components (including batteries) that may contain materials, which if disposed of with general waste, could be damaging to the environment.

In accordance with Directive 2002/96/EC Waste Electrical and Electronic Equipment, residents of the European Union must follow specific disposal or recycling instructions for this product. Contact your local distributor, or visit the following web site for specific instructions:

http://www.smiths-medical.com/recycle/index.html

Non-European Union residents must dispose of or recycle this product (including batteries) in accordance with the local laws or regulations that apply.

WARNING: ***Collect Separately***. There are potential health hazards associated with improper disposal of batteries, electronics, and contaminated (used) infusion sets and syringes. Dispose of used batteries, infusion sets, syringes, and other used accessories, or a pump that has reached the end of its useful life, in an environmentally safe manner, and according to any regulations that may apply.

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This section defines and describes the standard operation of the Medfusion® Model 3000 Series pumps.

Overview of operation

The Medfusion® Model 3000 Series pump design allows the precise control of the infusion rates over a wide range of syringe sizes and manufacturers as specified in the *Operator's Manual* supplied with the product.

Controlling motor functions

A stepper motor driving the plunger driver controls the infusion rate. The motor receives electrical pulses from the microcontroller with pulse frequency determined from the programmed flow rate.

- Forty-eight motor pulses turn the motor one full revolution.
- Five hundred and sixty full motor revolutions move the plunger driver one inch.
- Therefore, 26,880 motor steps move the plunger driver 1 inch (or 0.000037 inches per motor step) – providing very good flow continuity and precise delivery.

Infusion control & safety functions

Two sensors are used to verify that the infusion proceeds at the programmed rate. Specifically, the microcontroller uses:

a) the *motor rotation sensor* to verify proper motor speed;

b) the *position sensor* to verify proper syringe plunger driver motion over time.

If the microcontroller determines either the motor or syringe plunger driver is running at a speed not equivalent to the programmed flow rate, then the infusion stops and a system fault alarm warns the user.

Four additional sensors verify the syringe parameters:

a) The plunger sensor, in the head of the plunger driver, detects proper engagement of syringe plunger with syringe plunger driver.

b) The flange clip detects the proper position of the syringe flange.

c) The syringe barrel clamp detects both *syringe presence* and *syringe size*.

d) A force sensor in the plunger driver head detects and reports the amount of force exerted on syringe plunger head. A large amount of force indicates an occlusion in the patient line to the microcontroller.

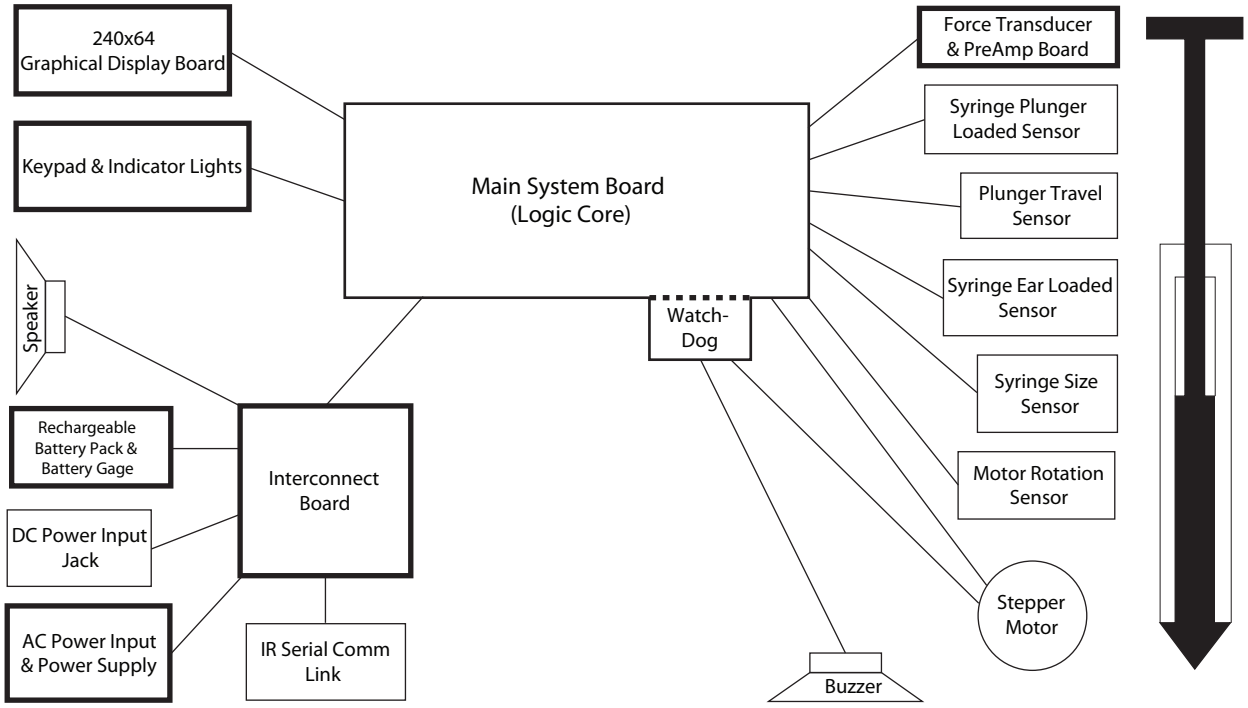
A Watchdog device checks for microcontroller malfunction including timebase errors, and can shut down the motor and generate an alarm independent of the microcontroller operation. An internal power source (1 Farad super-capacitor) allows the pump to alarm should failure occur in the pump's power system or internal battery.

Pump design description

Listed in this chapter are descriptions of each functional block and its role in pump operation and system safety.

Logic core

The block diagram below shows the interrelation between the different assemblies of the Medfusion® Model 3000 Series pump.



Block Diagram for Medfusion® Model 3000 Series Pump

Main printed circuit board (PCB)

Main microprocessor

The *Main PCB* has one main microprocessor, 68HC11, with responsibilities for the following tasks:

a) Controlling the graphical display of information.

b) Responding to the keypad and controlling visual indicators on the keypad.

c) Controlling the primary speaker.

d) Controlling the stepper motor which drives the syringe plunger.

e) Monitoring syringe sensors: syringe size, syringe flange (ear) loaded, syringe plunger loaded, syringe plunger position, and syringe plunger force.

f) Communicating with the smart battery gauge.

g) Controlling the external serial communication.

Watchdog circuit

A *watchdog circuit* has a separate power supply and separate (PIC) microcontroller/clock which monitors the main microprocessor. The watchdog circuit detects microprocessor timing failures and initiates a watchdog alarm through a dedicated "back-up" audible alarm which is separate from the primary speaker.

If a watchdog or "**System Failure**" alarm is generated, the watchdog circuit turns on the red alarm indicator and backup audible alarm, and turns off the motor current.

DC power converter

The *DC Power Converter* generates required system DC voltages from the available power source coming from the Interconnect PCB. This power source can be either battery power or AC power, or if available, external DC power (capability to use external DC power is not available with Interconnect PCB 70-0420). The main microprocessor monitors these voltages and will detect failures in any system voltages.

Real time clock

A separate *Real Time* clock source provides the microprocessor with date and time information. The date and time are used for time-stamping records in alarm history and infusion history, and for determining the next recommended Periodic Maintenance date.

Graphical display circuit board (LCD)

A 240 × 64-pixel *liquid crystal display* provides the primary visual interface for pump operation. An *always on* LED driven back light in the LCD enhances viewing in low light areas.

Keypad

The *keypad* is a multi-layer polyester laminate providing keys for controlling the pump, and indicator lights for identification of pump status.

Plunger (driver) travel sensor

The *plunger travel sensor* is a precision potentiometer producing a change in voltage (resistance) with the motion of the syringe plunger driver. This allows the microprocessor to determine:

- plunger speed
- near end of plunger travel (i.e., near empty alarm)
- end of plunger travel (i.e., empty alarm)

The microprocessor uses sensor output to verify plunger travel against set flow delivery rate. The sensor output is ***not*** used for rate correction.

Motor rotation sensor

The *motor rotation sensor* is an optical reflective sensor which senses 4 pulses per motor rotation. The microprocessor measures the frequency of this signal to verify rotation speed against the set flow delivery rate. It is ***not*** used for speed correction.

Stepper motor

The *stepper motor* drives the syringe plunger driver. Each motor step is controlled by the microprocessor using an open loop control method.

Syringe flange loaded sensor

The *syringe flange sensor* requires the flange be installed in the flange locating device on the pump. It reports a logic state to the microprocessor to indicate proper syringe flange loading, and uses self test signal to verify the sensor is not in an electrically "stuck" state.

Syringe size sensor

The *syringe size sensor* is a precision potentiometer which produces a voltage (resistance) proportional to the outside barrel diameter of the syringe loaded into the pump. This allows the microprocessor to measure voltage proportional to syringe barrel outside diameter to determine the syringe size (e.g. 10mL, 20mL etc.) or syringe not loaded.

Note: Pharmacy labels placed on the syringe may interfere with the pump's sensor. To avoid interference, make sure pharmacy labels are at least 1 inch from the flange (so the syringe barrel clamp does not rest on the label), and orient the syringe so the label faces upward and does not rest on the pump.

Interconnect printed circuit board (PCB)

The *Interconnect PCB* receives and directs the power

source, either internal 12VDC power supply, the internal battery or if available, external DC power to the "Main" PCB (capability to use external DC power is not available with Interconnect PCB 70-0420).

a) Generates status signals to Main PCB indicating source of power supplied.

b) Contains battery charger for charging the battery.

c) Contains infrared drivers for serial communication interface with the pump.

d) Supplies the audio drive signal, originating from the Main PCB, to power the speaker.

AC power input & power supply board

This *AC Power Input* provides a receptacle for connecting an IEC 320-type AC power cord to the internal, universal input power supply. This *Power Supply Board* provides 12 VDC to operate the pump and charge the batteries.

DC power input jack

Note: This item is non- functional on pumps with Interconnect PCB 70-0420.

The *DC Power Input Jack* connects external DC power into the pump from external DC sources. This input is protected from over-voltage and reverse polarity. Always observe all cautions and warnings for connecting DC power to this input.

Speaker

The primary *speaker* serves as the primary audio source for generating alarms. The microprocessor senses speaker current to determine if the speaker is operational.

Rechargeable battery pack & battery gauge

A *rechargeable NiMH battery pack* (NiCad battery pack on older model pumps) allows operation on battery, which also serves to provide backup power with the loss of externally applied AC or DC power

A gauge residing on the battery pack maintains present battery capacity during charge and discharge conditions. The gauge monitors battery temperature and controls the battery charger in setting the charge rate. The pack contains a resettable fuse which limits the current flowing through the battery.

Plunger printed circuit board (PCB)

The *Plunger PCB* provides connection and pre-amplification of sensors in the plunger driver to the Main microprocessor PCB. The plunger PCB contains the force sensor amplifier and the plunger loaded sensors.

Plunger force sensor

The *plunger force sensor* is a full bridge strain gauge that generates a voltage proportional to the force applied by the plunger driver to push the syringe plunger. It allows the microprocessor to measure voltage proportional to force applied to the syringe plunger (i.e. occlusion detection), and uses a self test control line to verify force sensor and circuitry are operating properly.

Plunger Loaded Sensors

The two *plunger loaded sensors* are located on the Plunger PCB, and sense the state of each "flipper" on the plunger driver. The sensors report a logic state to the microprocessor to indicate proper syringe plunger loading, and use a self test signal to verify the sensor is not in an electrically "stuck" state.

Sensors interface description

Motor speed detection

The digital sense signal is created by using a reflective infrared optical sensor to sense a motor-coupled encoder as the motor rotates. The microprocessor measures the period of the signal created by the encoder.

Syringe sensing description

The syringe sensing system senses the syringe barrel size, senses the plunger end cap is secured by the mechanical flippers, and the syringe flange (ears) are located in the pump's syringe flange locating device. The circuit for sensing the plunger flippers is part of the Plunger PCB function.

Syringe size sensing

Syringe sensing is accomplished by using a potentiometer which changes its resistance with the barrel diameter.

The sensing system requires calibration to determine offset and gain. Calibration values are stored in nonvolatile (serial EEPROM) memory.

Syringe flange (ear) sensing

The Syringe flange (or ear) sensor is used to detect if the syringe flange is installed in the flange-holder on the side of the pump.

An infrared optical interrupter detects when the flange-locating device is in a valid position. A properly loaded flange causes the optical path to become uninterrupted allowing a direct path from the infrared emitter to the detector.

Plunger position sensing description

Sensing syringe plunger position is required for the detection of an incorrect plunger speed, detecting near end of syringe, and detecting end of plunger travel.

The travel sensing circuits perform excitation and signal processing of the travel sensor. The travel sensor uses a *linear potentiometer* which produces a change in resistance with the motion of the syringe plunger.

The sensing system requires calibration to determine offset and gain. Calibration values are stored in non-volatile (serial EEPROM) memory.

Speaker drive description

The speaker sounds the warning and caution alarm tones for the pump. The interface circuit controls the frequency and amplitude of the signal driving the speaker, and provides feedback for verifying speaker function.

Speaker test

The return signal from the speaker detects whether current is flowing in the Speaker from analog conditioning circuitry. The half-wave rectifier circuit uses the *negative half-cycle* of the sense signal to invert and amplify it.

Plunger printed circuit board (PCB)

The *Plunger PCB* provides pre-amplification of the force sensor output to the Main PCB, and contains two photo-interrupters with supporting circuitry, one for each plunger flipper.

Force preamplifier function

The force sensing system provides a measurement of the force required in moving the syringe plunger. The interface to the force sensor has an excitation source, test signal, and pre-amplification.

Force sensing interface description

The force sensing element is a full bridge strain gage, and the Plunger PCB pre-amplifies and filters the output of this bridge. The interface has: *sensor excitation, electronic zero-offset adjustment, amplification and filtering, and a sensor test control signal.*

The sensing system requires calibration to determine zero adjustment, offset, and gain. Calibration values are stored in non-volatile (serial EEPROM) memory.

Plunger flipper sensor function

Plunger flipper sensing requires each sensor to detect its respective flipper position. Each infrared optical interrupter provides a high logic state when the flipper is in a valid position determined by a loaded syringe plunger. The transmitters for both photo-interrupters are driven in series; however, the optical receivers are read in parallel.

Interconnect printed circuit board (PCB)

The *Interconnect PCB* design interfaces to an intelligent rechargeable battery, the system speaker, the internal DC supply, connection for an external DC supply (if available) and the Main PCB (capability to use external DC power is not available with Interconnect PCB 70-0420).

AC power detection description

The *AC power detector* uses a *zener diode regulator* to provide a constant voltage to the signal AC_PWR_DETECT anytime AC power is provided to the pump. The regulated voltage is required for logic detection of AC power and is used to regulate the current through the AC LED indicator and the battery charge LED indicator. For AC_PWR_DETECT to be active, the DC input voltage (from the AC power supply) is required to exceed *10 volts*.

The AC_PWR_DETECT signal is also used to generate the signal BATTERY_SWX_ON* which controls a battery switch to turn ON using battery power when AC power and external DC power are removed.

The other effect of BATTERY_SWX_ON* is delaying the battery charger from starting until the internal DC power supply reaches 10 volts.

A transient voltage suppressor protects the detection circuitry on the REG_DC_INTRNL.

External DC power conditioning / detection description

Note: This section is applicable only to pumps with Interconnect PCB G6000312 or G6000234.

The *external DC power* input section limits current through a resettable fuse, both common and differential mode noise suppression and transient voltage protection. The *resettable fuse* limits current into the pump from an external DC source. Noise filtering is performed by input and output capacitors on the conditioning circuit together with a common mode choke.

The external power detector uses a *zener diode* to provide a valid logic high level when external DC power is applied. The active voltage for EXTRNL_PWR_DETECT is nominally *5 volts*. The threshold detector U3 provides immediate detection, through the signal BATTERY_SWX_ON*, of the external DC source being removed.

A battery switch toggles to internal battery if both AC and external DC power are removed.

The threshold detector also prevents the battery charger from charging the internal battery until the external DC power exceeds 5 volts.

Infrared serial data port description

The *infrared serial port* interfaces directly with the main microprocessor's asynchronous serial communication pins. The infrared port supports short transmission distances of *2" or less* and a maximum baud rate of 9600.

The Infrared Receiver signal from U1 is conditioned by the comparator circuit of U4 to generate a valid logic state to the microprocessor.

The Infrared Transmitter signal IR_XMT_DATA is at a logic high during its inactive state. A logic low on IR_XMT_DATA enables the transmitting IR diode through the transistor Q3.

Battery management description

The *battery management circuits* are a 2-stage constant current battery charger, a charge detector, and a battery switch over control circuit. The Interconnect PCB interfaces to a 6 cell NiMH battery pack (NiCad battery pack on older model pumps) with a "smart" battery gauge.

Battery gauge interface

The main microprocessor communicates to the battery through BATTERY_DATA – a single bi-directional serial data line.

A very low battery capacity status, VLOW_BATTERY*, signal protects the battery pack by disconnecting the battery. This signal is at a logic low when the battery is depleted.

Battery charger

The *battery charger* allows charging a battery with an input supply voltage either above or below the battery voltage. Battery charging takes place when either the internal DC supply or external DC (if available) is present (capability to use external DC power is not available with Interconnect PCB 70-0420). The charger provides a charge current determined from three conditions:

- In normal operation the charge current is controlled by the gauge, providing two levels of constant charge current. If the battery capacity is less than 94% of its known capacity, the gauge will set CHARGE* to a logic low. This results in a charge current rate of C/6, approximately 270 *milliampere* giving a 6-8 hour recharge time.
- The gauge sets CHARGE* to logic high when the battery has been charged to 94% (or greater) of the battery's capacity, this lowers the charge rate to 65 *milliampere*, or C/25.
- A separate charge control circuit is the voltage limit for the battery; here a battery voltage monitoring circuit in the charger limits the charger to a voltage limit of 1.55 *volts per cell* (nominal). The charger keeps reducing the charge current in order to remain below this voltage limit. This prevents damage to the cells from excessive battery voltage.

Charge detector

A *charge detector circuit* generates the control signal CHARGE_DETECT to control the illumination of a battery charge LED indicator and to reset the very low battery detector circuit located within the battery pack.

The main microprocessor does not monitor the CHARGE_DETECT signal. However, the main microprocessor communicates with the gauge to determine charge status.

Battery switchover

A smart switch selects a reliable source of power for the system power supplies. This switches to internal battery power when AC power and external DC power are removed from the pump (or when these sources are below acceptable thresholds detailed above).

In normal operation, the battery voltage can be at a higher voltage than the external DC – especially during battery charging.

Battery printed circuit board (PCB)

The battery reports present status and controls battery charge from the Interconnect PCB to the "Main" system microprocessor.

The battery PCB contains a 3-volt Linear Regulator, a Gauge IC and a Depleted Battery Monitor IC.

The local circuit allows the battery to maintain its current capacity regardless of where the battery resides.

Battery gauge function

The gauge IC monitors direction and magnitude of current flowing through the battery. Current is sensed by the gauge as a voltage across R4, and the gauge computes capacity.

To control charging the battery, the gauge uses battery temperature and battery voltage to update the battery capacity – which is a function of current and temperature.

The CHARGE* signal from the gauge controls the battery charger, located on the Main PCB, to charge at different rates depending on the state of the battery.

The gauge terminates standard charge in the event of the battery temperature exceeding 50°C or if the battery pack voltage is less than 5.7 volts.

The initial full capacity of the battery is equal to the PFC (Programmed Full Count) until the battery "learns" a new capacity and updates the LMD (Last Measured Discharge) (V5 and lower) or Full-Capacity (V6). Allowing a long charge cycle conditions the battery to properly report and accept the maximum charge.

Severely depleted battery monitor

The *depleted battery monitor IC* senses the battery voltage to prevent an over-discharged battery. When the battery pack voltage reaches a nominal voltage of 5 volts, the IC sets the VLOW_BATTERY signal to a logic low, which disconnects all battery loads with the exception of the battery monitor circuit.

The battery charger provides the signal CHARGE_DETECT, which resets this monitor IC reconnecting the battery back to the system.

Monitor Battery Status Screens, V5 and lower

The values on the **DIAGNOSTICS > MONITOR BATTERY STATUS** screens display values retrieved from the Gauge IC. These parameters are:

Capacity: The amount of available charge, determined by monitoring the charge/discharge current and estimating the amount of self discharge and temperature.

Current: Calculated current in the system based on the remaining battery capacity.

LMD: Last Measured Discharge, LMD = PFC on Initialization (application of VCC or battery replacement). The LMD is updated with the latest measured capacity in the Discharge Count Register (DCR).

TMPGG: A temperature and gas gauge register. The register bits 0-3 are gas gauge register bits and provide the available charge information after calculating the

available charge as a function of NAC, temperature, and a full reference (either LMD or PFC). The bits 4-7 corresponds to TMP0-TMP3 fields of the table on the next page, providing battery temperature information.

Bit	TMP3	TMP2	TMP1	TMP0	Temperature	Battery Temperature Description
0x0-	0	0	0	0	T< -30°C	Below -30 degrees Celsius
0x1-	0	0	0	1	-30°C<T<-20°C	Greater than -30 and less than -20 degrees Celsius
0x2-	0	0	1	0	-20°C<T<-10° C	Greater than -20 and less than -10 degrees Celsius
0x3-	0	0	1	1	-10°C<T<0° C	Greater than -10 and less than 0 degrees Celsius
0x4-	0	1	0	0	0°C<T<10° C	Greater than 0 and less than 10 degrees Celsius
0x5-	0	1	0	1	10°C<T<20° C	Greater than 10 and less than 20 degrees Celsius
0x6-	0	1	1	0	20°C<T<30° C	Greater than 20 and less than 30 degrees Celsius
0x7-	0	1	1	1	30°C<T<40° C	Greater than 30 and less than 40 degrees Celsius
0x8-	1	0	0	0	40°C<T<50° C	Greater than 40 and less than 50 degrees Celsius
0x9-	1	0	0	1	50°C<T<60° C	Greater than 50 and less than 60 degrees Celsius
0xA-	1	0	1	0	60°C<T<70° C	Greater than 60 and less than 70 degrees Celsius
0xB-	1	0	1	1	70°C<T<80° C	Greater than 70 and less than 80 degrees Celsius
0xC-	1	1	0	0	T>80°C	Greater than 80 degrees Celsius

FLGS1: Contains primary bq2012 flags such as:

- CHGS -charge status flag
- BRP - battery replaced flag
- BRM - battery removed flag
- CI - capacity inaccurate flag
- VDQ - valid discharge flag
- CHG - charge control flag
- EDV1 - first end-of-discharge warning flag
- EDVF - final end-of-discharge warning flag

FLGS2: Contains the secondary bq2012 flags such as:

- CR - Charge Rate flag
- DR0-2 - Discharge Rate flag
- OVLD – Discharge Overload flag

BATID: The read/write BATID register (address=04h) is available for use by the system to determine the type of battery pack. The contents of BATID have no effect on the operation of the bq2012. There is no default setting for this register.

PPD: Contains the programming pin information of battery bq2012. The segment drivers, SEG1–6, have a corresponding PPD register location, PPD1–6. A given location is set if a pull-down resistor has been detected on its corresponding segment driver.

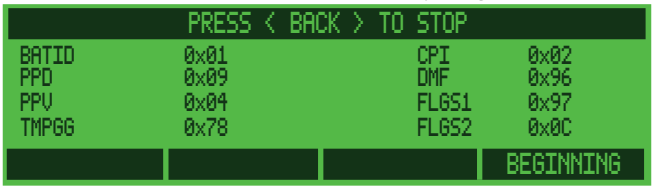
PPU: Contains the programming pin information of battery bq2012. The segment drivers, SEG1–6, have a corresponding PPU register location, PPU1–6. A given location is set if a pull-up resistor has been detected on its corresponding segment driver.

CPI: This register is used to indicate the number of times a battery has been charged without an LMD update. Because the capacity of a rechargeable battery varies with age and operating conditions, the bq2012 adapts to the changing capacity over time. The CPI register is incremented every time a valid charge is detected if NAC < 0.94 * LMD. When NAC ≥ 0.94 * LMD, the CPI register increments on the first valid charge; CPI does not increment again for a valid charge until NAC is discharged below 0.94 * LMD. NAC is a Nominal Count Charge and it counts up during charge to a maximum value of LMD and down during discharge and Self-discharge to 0.

DMF: The Digital Magnitude Filter register can be configured to change the default settings of DMF of the system.

Monitor Battery Status Screens, V6 and higher

- ***Capacity:*** Graphic and numeric value, in percent, of the current state of battery charge.
- ***Full-Capacity:*** Indicates the capacity of a fully charged battery. This value will slowly decrease with use. When the value drops below the indicated value (see page 28), the battery must be replaced.
- ***Remaining:*** Current state of charge in the battery pack in units of mA-hours.
- ***Current:*** Calculated current in the system based on the remaining battery capacity.
- ***Softkeys:***
  - **More** - Press to display page 2
  - **Beginning** - Press to redisplay page 1



- ***BATID:*** The read/write BATID register (address=04h) is available for use by the system to determine the type of battery pack. The contents of BATID have no effect on the operation of the bq2012. There is no default setting for this register.
- ***PPD:*** Contains the programming pin information of battery bq2012. The segment drivers, SEG1–6, have a corresponding PPD register location, PPD1–6. A given location is set if a pull-down resistor has been detected on its corresponding segment driver.
- ***PPU:*** Contains the programming pin information of battery bq2012. The segment drivers, SEG1–6, have a corresponding PPU register location, PPU1–6. A given location is set if a pull-up resistor has been detected on its corresponding segment driver.
- ***TMPGG:*** A temperature and gas gauge register.

The register bits 0-3 are gas gauge register bits and provide the available charge information after calculating the available charge as a function of NAC, temperature, and a full reference (either learned Full-Capacity or PFC). The bits 4-7 corresponds to TMP0-TMP3 fields of the table on the next page, providing battery temperature information.

Bit	TMP3	TMP2	TMP1	TMP0	Temperature	Battery Temperature Description
0x0-	0	0	0	0	T< -30°C	Below -30 degrees Celsius
0x1-	0	0	0	1	-30°C<T<-20°C	Greater than -30 and less than -20 degrees Celsius
0x2-	0	0	1	0	-20°C<T<-10° C	Greater than -20 and less than -10 degrees Celsius
0x3-	0	0	1	1	-10°C<T<0° C	Greater than -10 and less than 0 degrees Celsius
0x4-	0	1	0	0	0°C<T<10° C	Greater than 0 and less than 10 degrees Celsius
0x5-	0	1	0	1	10°C<T<20° C	Greater than 10 and less than 20 degrees Celsius
0x6-	0	1	1	0	20°C<T<30° C	Greater than 20 and less than 30 degrees Celsius
0x7-	0	1	1	1	30°C<T<40° C	Greater than 30 and less than 40 degrees Celsius
0x8-	1	0	0	0	40°C<T<50° C	Greater than 40 and less than 50 degrees Celsius
0x9-	1	0	0	1	50°C<T<60° C	Greater than 50 and less than 60 degrees Celsius
0xA-	1	0	1	0	60°C<T<70° C	Greater than 60 and less than 70 degrees Celsius
0xB-	1	0	1	1	70°C<T<80° C	Greater than 70 and less than 80 degrees Celsius
0xC-	1	1	0	0	T>80°C	Greater than 80 degrees Celsius

- ***CPI:*** This register is used to indicate the number of times a battery has been charged without a learned Full-Capacity (LFC) update. Because the capacity of a rechargeable battery varies with age and operating conditions, the bq2012 adapts to the changing capacity over time. The CPI register is incremented every time a valid charge is detected if NAC < 0.94 * LFC. When NAC ≥ 0.94 * LFC, the CPI register increments on the first valid charge; CPI does not increment again for a valid charge until NAC is discharged below 0.94 * LFC. NAC is a Nominal Count Charge and it counts up during charge to a maximum value of LFC and down during discharge and Self-discharge to 0.
- ***DMF:*** The Digital Magnitude Filter register can be

configured to change the default settings of DMF of the system.

- ***FLGS1:*** Contains primary bq2012 flags such as:
  - CHGS -charge status flag
  - BRP - battery replaced flag
  - BRM - battery removed flag
  - CI - capacity inaccurate flag
  - VDQ - valid discharge flag
  - CHG - charge control flag
  - EDV1 - first end-of-discharge warning flag
  - EDVF - final end-of-discharge warning flag
- ***FLGS2:*** Contains the secondary bq2012 flags such as:
  - CR - Charge Rate flag
  - DR0-2 - Discharge Rate flag
  - OVLD – Discharge Overload flag

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Problem solving alarms / alerts

This section defines basic problems and provides some standard problem solving procedures.

Pump alarms are logged into the pump's *Alarm History* (viewable in the **BIOMED** menu, and may be included in various reports via PharmGuard® Toolbox).

Types of alarms / alerts

The following table defines the alarms and alerts generated by the Medfusion® Model 3000 Series pumps, with suggested remedies and solutions.

Type	Definition and Remedy
Watchdog Failsafe	The *Watchdog Fail-Safe* subsystem is an error handler of last resort, and occurs to indicate failure of the system which may include power, electronics, hardware or software. When a *Watchdog Fail-Safe* alarm occurs, the subsystem immediately: • stops the motor (if running); • trips the 'watchdog' alarm tone; • starts flashing the LEDs; • displays error information, including the file and line number of the call to the fail_safe function, the 8-bit fail-safe code, and an 8-bit value for use by the caller for any further diagnostic information; • maintains the power strobe (in case the ACU is not) until POWER (⏻) is pressed and held to turn the pump off; • stops all other activity on the HC11 (tasks, interrupts, etc). Since *Watchdog Fail-Safe* is only activated when the system is known to be inconsistent, these functions are performed using the minimum possible system resources in order to maximize the chances of successfully putting the pump into a safe state in the face of serious hardware or software faults, errors, or failures. **Press POWER (⏻) to turn the pump off**. There is no other method for ending a *Watchdog Fail-Safe* alarm. If the alarm persists when the pump is turned back on, the pump must be removed from service for inspection and repair.
System Fault Priority	A *System Fault* alarm is initiated when one of the system fault conditions occur. Fluid delivery stops. *System Fault* alarms are signaled with a flashing red indicator, repeating audible signal and a viewing screen backlight that oscillates between bright and dim; the pump will return to the **MAIN** menu and show the **BIOMED** menu as the only choice. **Press 🔔 to silence the audible alarm, then press POWER (⏻) to turn the pump off**. There is no other method for ending a *System Fault* alarm. If the alarm persists when the pump is turned back on, or if the **MAIN** menu shows only the **BIOMED** menu, the pump must be removed from service for inspection and repair. If the front panel controls are ***locked*** when a System Fault alarm occurs, the pump controls ***do*** unlock. **Note:** System faults may result in subsequent faults being logged in the pump's *Alarm History*, however only the initial fault is displayed on the pump (due to the fact that the only method for ending the alarm is to turn the pump off).

Type	Definition and Remedy
High priority	A *high-priority* alarm is initiated by any condition that halts an ongoing infusion. *High-priority* alarms are signaled with a flashing red indicator, a viewing screen backlight that oscillates between bright and dim, and a repeating audible signal. Press to return the viewing screen backlight to bright and silence the audible alarm for the programmed alarm silence period. During a *high-priority* alarm condition, all keys except are locked. **Silence the alarm by pressing before any other action can be taken**. If the front panel controls are locked when a *high-priority* alarm occurs, the pump controls ***do*** unlock.
Medium priority	A *medium-priority* alarm indicates any condition requiring intervention but does not halt infusion. *Medium-priority* alarms are signaled with a flashing yellow indicator, a viewing screen backlight that oscillates between bright and dim, and a repeating audible signal. Pressing will return the viewing screen backlight to bright and silence the audible alarm for the programmed alarm silence period. During a *medium-priority* alarm condition, all keys except are locked. **Silence the alarm by pressing before any other action can be taken**. If the front panel controls are ***locked*** when a *medium-priority* alarm occurs, the pump controls ***do not*** unlock.
Low priority	A *low-priority* alarm indicates any condition not requiring immediate intervention. *Low-priority* alarms are announced with a continuous yellow indicator, a viewing screen backlight that oscillates between bright and dim and a non-repeating audible signal. During a *low-priority* alarm condition, all keys except are locked. **Silence the alarm by pressing before any other action can be taken**. If the front panel controls are ***locked*** when a *low-priority* alarm occurs, the pump controls ***do not*** unlock.
Limit priority	A *limit alarm* occurs whenever an invalid entry is attempted on a numerical entry screen. The invalid entry alarm sounds a brief tone with an instructional message onscreen. **Note:** The audio part of a *Limit-priority* alert is tied to "Key Click loudness", which is set in PharmGuard® Toolbox. If key click loudness is set to *Off*, there will be no audible tone accompanying *Limit priority* alerts (visual alerts will still appear in the display). The volume will otherwise sound at the loudness level selected for key clicks - Level 2 (quietest), Level 3, Level 4, or Level 5 (loudest). A *limit-priority* alarm sounds a three tone, non-repeating audible signal and displays an instructional message on screen for 3 seconds. If the front panel controls are ***locked*** when a *limit-priority* alarm occurs, the pump controls ***do not*** unlock.

Note: The User Callback alarm, the Periodic Callback alarm, the Improper Shutdown alarm, the Check Syringe Barrel Clamp alarm, and all Limit Priority alarms are not recorded in the pump's alarm history record.

Alarm messages & priorities

The following table defines the alarm message, alarm priority, and cause for each alarm condition. For a complete list of operation-related alarms, see the alarm descriptions in the *Operator's Manual* supplied with the pump.

Alarm message	Alarm priority		Cause and corrective action
	programming	infusing	
Calculated Rate Out of Range	High	High	Based on the values entered, the pump has calculated a rate that is not valid and cannot be delivered based on physical limits (such as syringe parameters). Press 🔔. Verify that all infusion parameters have been entered correctly. If the invalid combination is part of a Drug Program, contact the PharmGuard® Toolbox Administrator, who will have to review and correct the problem.
Check Clutch / Plunger Lever	–	High	The Software uses a position potentiometer to monitor motion of the plunger driver during delivery. If the potentiometer senses that the plunger driver is not moving correctly, this alarm occurs. This may be caused by a variety of issues such as the Prime function was not used before starting delivery (leaving slack in the drive system), the plunger levers are moved, the clutch is not properly engaged, the syringe in use is overfilled (causing the syringe plunger to reposition itself once the plunger driver begins moving forward), or there is a problem with the pump hardware. Press 🔔 and check the plunger lever and ensure the lever moves freely and is capturing the syringe plunger. Always use the Prime feature when loading a new syringe. May also occur if position pot is not calibrated or is contaminated – use **Biomed > Utilities** and run **View Alarm History** to check if failure occurs at same position reading. If the failure occurs in the same place every time, replace the position potentiometer. If the failure occurs at different positions, replace the clutches. Check drive train parts for signs of wear, and replace as necessary.

Alarm message	Alarm priority programming	Alarm priority infusing	Cause and corrective action
Check Syringe Barrel Clamp	Medium	–	Certain syringe models and sizes may cause the barrel clamp sensor to have difficulty in verifying the clamp is in position. When this alarm occurs press (bell), verify that the barrel clamp is indeed in place, then press **Confirm**. **OR** During power-up the syringe barrel clamp was lifted up and resting on the pump handle, this alarm will occur once the syringe model is selected during programming. Press (bell), press **Confirm** and continue loading the syringe. Use **Biomed > Diagnostics** and run **Monitor Digital Sensors** to check function of barrel sensor.
Check Syringe Flange Sensor	High	High	Sensor is active when a syringe is not loaded correctly (as sensed by the syringe flange sensor). Check the syringe flange holder. Ensure the syringe barrel clamp, flange holder, and plunger holders are properly engaged and the flange holder pulls back to the side of the case. Use **Biomed > Diagnostics** and run **Monitor Digital Sensors** to check function of flange sensor.
Check Syringe Plunger Sensor	High	High	Sensor is active when syringe is not loaded correctly (as sensed by the syringe plunger sensor) **OR** the Syringe Plunger Driver was being moved during the pump startup process. Check the syringe plunger holders. Ensure the syringe barrel clamp, flange holder, and plunger holders are properly engaged and the holders move freely. Use **Biomed > Diagnostics** and run **Monitor Digital Sensors** to check function of both plunger sensors.
Force Sensor Bgnd Test	High	High	A self-test was performed on the force sensor, and the test failed due to a sensor malfunction **OR** the Syringe Plunger Driver was being moved during the pump startup process, **OR** if the Syringe Plunger Driver receives a hard bump during the pump startup process. The user must press (bell), then (POWER) ((power)) to turn the pump off. Use **Biomed > Diagnostics > Monitor Analog Sensors** to check operation of plunger force sensor. If the alarm was due to movement of the Syringe Plunger Driver during startup, you may need only to recalibrate the force sensor (**Biomed > Calibration > Calibrate Force Sensor**). Otherwise you may need to open plunger head, and check plunger cable and force sensor cable on the plunger PCB, and possibly replace Plunger PCB, plunger cable or force sensor.

Alarm message	Alarm priority programming	Alarm priority infusing	Cause and corrective action
Infusion Complete	–	High	The programmed infusion (based upon the values entered in the pump) has been delivered.
Invalid Infusion Parameter Combination	Low	–	The combination of infusion parameters attempted by the user does not allow a valid flow rate to be calculated, or user attempted to use a syringe size other than that specified in the Drug Program. The user must press BACK (⮌) and verify all infusion settings. If the invalid combination is part of a Drug Program, contact the PharmGuard® Toolbox Administrator, who will have to review and correct the problem.
Invalid Library Entry	Limit	–	There is a problem with the Drug Program selected, and the pump cannot deliver it. Contact the PharmGuard® Toolbox Administrator, who will have to review and correct the problem.
Invalid Syringe Size	High	High	Syringe size not recognized for the model selected, or the syringe barrel clamp was lifted during delivery (as sensed by the barrel clamp potentiometer sensor). Instruct user to review syringe sizes in the technical specifications section, and not to lift the syringe barrel clamp during delivery. If there is any question about this sensor's function perform PM check of barrel clamp calibration.
Limits Adjusted - Cannot Delivery All Doses	Limit	–	The PharmGuard® Toolbox specified soft limit values and syringe specified during programming would allow values to be entered that result in a rate outside the allowable limits. The pump has adjusted the limits to keep the rate inside allowable limits. If the invalid combination is part of a Drug Program, contact the PharmGuard® Toolbox Administrator, who will have to review and correct the problem.
Motor Not Running	-	High	The motor is not running, which may be due to an erroneous (possibly transient) sensor signal, or a mechanical and/or electrical failure. Sensor (on Main PCB) may have failed, or worm/gear/leadscrew may be jammed, or drive train parts may be worn.
Motor Rate Error	High	High	The motor is not running at the programmed rate (speed), which may be due to an erroneous (possibly transient) sensor signal, or a mechanical and/or electrical failure. If the message reoccurs, you may need to replace the sensor and/or the worm gear, worm coupling, motor bracket, motor assembly or parts on the drive train.

Alarm message	Alarm priority programming	Alarm priority infusing	Cause and corrective action
Occlusion - Check Infusion Line	–	High	The force sensor in the plunger driver has sensed occlusion of the infusion line when the force value exceeds the set limit. If this alarm occurs frequently and an actual occlusion has been ruled out, the infusion set tubing may be too small for the rate or fluid viscosity; consider enabling FlowSentry™ pressure monitoring, or consider choosing a different occlusion alarm setting in the Configuration (the setting appears on the graph on the delivery screen as VL, L, N, H). If recurring occlusion alarms occur on a pump, ensure proper occlusion detection by calibrating the force sensor (**Biomed > Calibration > Calibrate Force Sensor**).
PharmGuard Data Transfer is Recommended	Medium	Medium	PharmGuard® Safety Data on the pump is nearly full, and continued use may result in lost PharmGuard® event data. Use PharmGuard® Toolbox to upload the event data to computer. This alarm can be enabled or disabled using PharmGuard® Toolbox.
Syringe Flange Not in Place	High	High	The user may not have loaded the syringe correctly (as sensed by the barrel clamp size sensor), or the sensor has failed. Make sure the syringe flange is properly inserted into the flange clip. If necessary, use **Biomed** > **Diagnostics** and run **Monitor Digital Sensors** to check function of flange sensor.
Syringe Plunger Not in Place	High	High	The user may not have loaded the syringe correctly (as sensed by the barrel clamp size sensor), or the sensor has failed. Make sure the syringe flange is properly inserted into the flange clip. If necessary, use **Biomed** > **Diagnostics** and run **Monitor Digital Sensors** to check function of both plunger sensors.
System Advisory – "Description"	Low	–	See detailed descriptions in section below.
System Failure – "Description"	High	High	See detailed descriptions in section below.

System Advisory Alarms

This section explains the system advisory alarms in the Medfusion® Model 3000 Series pump, and suggests possible causes and remedies for these alarms.

System advisory alarm	Cause or remedy
Backup Critical Data Corrupted	Configuration settings are stored redundantly in non-volatile serial EEPROM on the Main PCB. This message will occur if backup data was lost, and primary data was used to restore backup values. No action is required.
Battery Communication Timeout	Pump has sensed battery current present, but the battery gauge on the battery pack is not communicating. Check connections from Main PCB to Interconnect PCB to battery pack.
Battery Not Charging	Pump has sensed AC or DC external power is present, but the battery is not charging. Use **Biomed** > **Diagnostics** and run **Monitor Battery Status** to review battery function. Check battery connections and battery charge circuit on the Interconnect PCB.
Battery Not Working	Pump software has detected the very low battery signal while the pump is connected to AC power. The pump will zero out the battery capacity remaining on the battery gauge. Check all battery connections. If charging the battery does not clear the condition, replace the battery. Use the biomed battery screens to evaluate battery behavior.
Default Configuration Restored	Configuration settings are stored redundantly in non-volatile serial EEPROM on the Main PCB. If both primary and backup are lost, the configuration is defaulted. Use pump **Custom Program** > **Teach/ Learn** to copy configuration from a known good pump to restore settings. If problem persists, there may be a problem with the Main PCB. This message may appear when a new Main PCB is installed.
History Data Corrupted	The infusion history log is stored in non-volatile serial EEPROM on the Main PCB. This message will occur if this data is lost (the software has been unable to retrieve history in 6 consecutive attempts). No action is required.
Improper Shutdown	This alarm is recorded to history when the pump is turned on if the last power-down did not occur through pressing the POWER ( ) key. Check for possible causes for a pump power failure.
Invalid Interrupt & System Advisory: Improper Shutdown	Replace the Main PCB.
Maintenance Is Recommended	This is a reminder to conduct the Annual Maintenance Testing (page 23). To clear this alarm, reset the PM Maintenance date (see section 5, Quick Maintenance Check-out Test and follow the instructions).
Non Critical Data Corrupted	Other settings are stored in non-volatile serial EEPROM on the Main PCB. This message will occur if this data was lost. No action is required.
PharmGuard Data Corrupted	The PharmGuard® Safety Data buffer is stored in non-volatile serial EEPROM on the Main PCB. This message will occur if a CRC (Cyclic Redundancy Check) error is detected when reading the data. No action is required.

System advisory alarm	Cause or remedy
Primary Critical Data Corrupted	Configuration settings are stored redundantly in non-volatile serial EEPROM on the Main PCB. This message will occur if primary data was corrupted (computed CRC [Cyclic Redundancy Check] does not match saved CRC), and backup data was used to restore primary values. No action is required.
Set Time and Date	Advisory message that real time clock has reset on the pump. This may occur if the battery is depleted and the Main PCB supply totally discharged – the super-capacitor on Main PCB should keep up the clock for many days after a depleted battery is reached. Use **Biomed** > **Utilities** > **Set Time/Date** to restore date and time settings.

System Failure Alarms

This section discusses the diagnosis of system failure alarms in the Medfusion® Model 3000 Series pump, and suggests possible causes and remedies for these alarms.

System failure alarm	Cause or remedy
A2D Reference Voltage BGND Test	Background self-test measured an invalid range on analog-to-digital converter reference voltage. Use **Biomed** > **Diagnostics** to check the voltage. Replace the Main PCB if invalid voltage found.
ACU Power Strobe Failure	Self-test has found that the ACU processor is not maintaining its power strobe. If this failure repeats, then try full reset of Main PCB – disconnect AC power, open pump, disconnect battery, short super-cap through ~100 ohm load; then reassemble pump and retest. Replace Main PCB if problem persists.
ACU Watchdog Failure	Self-test has found that the ACU watchdog alarm signal active. This alarm may occur if processor failed to pet watchdog within allotted time (e.g. a software failure occurred). If problem recurs, replace the Main PCB. This alarm will be added to the history log (below the primary failure) whenever a system failure occurs (the reason being that should the primary audible alarm fail, the watchdog will still be able to trip an audio alarm).
Analog Supply BGND Test	Background self-test measured an invalid range on analog supply voltage. Use **Biomed** > **Diagnostics** to check the voltage. Replace the Main PCB if invalid voltage found.
Aux Controller Unit Post	Power-up self-test has found that the ACU processor failed to shut down motor current during the watchdog alarm test. If problem recurs, replace the Main PCB.
Background CRC Test Timeout	Software timing failure. A transient failure may have occurred in the software; if problem recurs, replace the Main PCB.
Background Self Test Timeout	If monitoring of background testing is enabled and a background self-test has taken more than 8 seconds, this alarm is activated. A transient failure may have occurred in the software; if problem recurs, replace the Main PCB.

System failure alarm	Cause or remedy
Backup Audible Alarm Post	Power-up self-testing has found that the backup audible alarm (controlled by ACU) is not working at correct power (current) or frequency. Replace the alarm buzzer on the Main PCB or replace the Main PCB.
Calibration Required	The sensor calibration data test failed during pump power-up or during a calibration Save operation in the Biomed mode. This message appears whenever a new Main PCB is installed, and may also be triggered following installation of a Software Update. Calibrate all the sensors in the pump.
Control Key Switch BGND Test	Key on keypad was found stuck on during continuous background self-test. Use **Biomed** > **Diagnostics** to determine which key is stuck. If stuck key is found, replace keypad.
Control Key Switch Post	If during an operation the keypad electronics indicate a single key is pressed for longer than 7 seconds, or if the keypad is LOCKED and a single key is pressed for longer than 1 minute, this alarm is activated. Use **Biomed** > **Diagnostics** to determine which key is stuck. If stuck key is found, replace keypad.
Critical Data Block BGND Test	Delivery settings are stored in a critical data block of RAM on the Main PCB. This message will occur if background self-test showed the critical data block was corrupted (i.e. a RAM cyclic redundancy test failed). Run power-on self test which executes extensive RAM testing – if problem recurs, replace the Main PCB.
Critical Data Block Post	Configuration settings are stored redundantly in non-volatile serial EEPROM on the Main PCB. This message will occur if backup data and primary data fail to agree with the saved CRC (critical redundancy check) for the data in question. Use pump **Custom Program** > **Teach/Learn** (V3) or **Profile Settings** > **Teach/Learn** (V4 and higher) to copy configuration from a known good pump to restore settings. Replace Main PCB if serial EEPROM has failed.
Critical Data Failure	After settings are programmed into the pump, the pump performs a reverse calculation to ensure all settings are correct. Using incompatible ranges of settings may cause this alarm (e.g. using concentration of 1000 mg/mL and trying to set a rate of 0.1 microgram/hour). Review pump settings. Alternatively, this alarm may indicate a software data failure where critical flags are found invalid. If problem recurs, replace the Main PCB.
D2A Offset Voltage BGND Test	Background self-test found failure in force sensor offset signal. Probably a failure in the Main PCB digital-to-analog converter or a failure in the plunger cable/PCB. Use **Biomed** > **Diagnostics** to check force sensor voltage readings.

System failure alarm	Cause or remedy
Depleted Battery	Battery is fully discharged below low voltage threshold. Plug in the pump to AC power or external DC power to recharge the battery. Battery voltage measured by the gauge on the battery pack is too low. Software then stops delivery and allows watchdog to generate alarm. Plug pump into AC power and allow battery to recharge for at least two minutes, cycle power on the pump; if the pump alarms again, turning the pump off then back on once more may clear the alarm. If problem is chronic, check battery pack function or perform battery calibration. The Battery Depleted alarm may be logged twice in alarm history. The second occurrence is related to the battery regaining voltage and the microprocessor starting the power on sequence again. This second occurrence can be disregarded.
Display Controller Post	Failure detected in testing the LCD display. Check cabling between Main PCB and display. Replace LCD display.
External COM Task Timeout	External computer or device connected to the pump is sending too many commands too quickly, or sending too many invalid commands and this causes the software to timeout. Remove the Medfusion® Model 3000 Series pump external RS232 adapter or IR-to-USB adapter and observe if the problem is corrected.
Flash Memory BGND Test	CRC failure found in program memory during background self-tests. Failure may occur during external re-programming of the pump software. Otherwise failure is in flash memory of the Main PCB, and Main PCB should be replaced.
Flash Memory Post	CRC failure found in program memory during power-up self-tests. Failure may occur during external re-programming of the pump software. Otherwise failure is in flash memory of the Main PCB, and Main PCB should be replaced.
Force Sensor BGND Test	Background self-test has found the force sensor signal out-of-range or the force sensor did not change when the bridge-test signal was asserted. Use **Biomed > Diagnostics > monitor analog sensors** to check operation of plunger force sensor. Open plunger head and check plunger cable and force sensor cable on the Plunger PCB. Replace Plunger PCB, plunger cable or force sensor.
Force Sensor Bridge Test	Software sensed no voltage change when sensor test signal was asserted. The force sensor bridge (strain gage) may be unplugged or have an open connection. Use **Biomed > Diagnostics > Monitor Analog Sensors** to check operation of plunger force sensor. Open plunger head and check plunger cable and force sensor cable on the Plunger PCB. Replace Plunger PCB, plunger cable, or force sensor.

System failure alarm	Cause or remedy
Force Sensor Test	Power-up self test found that the force sensor output did not change when the DAC offset voltage was changed. This alarm may be caused by loading a syringe while the pump's power-up self tests are in process (either install the syringe before or after the self-tests to avoid this issue). Or it may be a problem on the Main PCB offset circuit, Plunger PCB, plunger cable, or force sensor. Check cabling first.
Internal A2D Failure	Software self-test identified a failure in the 10-bit analog to digital converter. Use **Biomed > Diagnostics > Check Analog Sensor** readings. If they are abnormal, replace the Main PCB.
Invalid Interrupt	Software/hardware failure. Software attempted to execute invalid interrupt, may be caused by main processor hardware failure, bus failure, or software flash memory failure.
LED Task Timeout	Software timing failure. A transient failure may have occurred in the software; if problem recurs, replace the Main PCB.
Logic Supply Voltage BGND Test	Background self-test measured an invalid range on logic supply voltage (voltage should measure 5V ± 5%). Use **Biomed > Diagnostics** to check the voltage. Replace the Main PCB if invalid voltage found.
MCU Power Strobe Failure	Failure in self-test of power strobe (output port) signal from the main processor. Replace the Main PCB if problem recurs.
Monitor Task Timeout	Software timing failure. A transient failure may have occurred in the software; if problem recurs, replace the Main PCB.
Motor Failed to Stop Error	Software sensed motor rotation after stop pump motor was executed. This could be caused by failing motor rotation (photo-reflective) sensor on the back of the Main PCB. Use **Biomed > Diagnostics** to run **Motor Drive Test** (set motor step period to ~100 msec) then use **Monitor Digital Sensors** to check motor rate sensor. Stop motor and rate sensor should stop changing. Replace the Main PCB if sensor has failed.
Motor Not Running Error	Motor sensor did not detect any rotation of the stepper motor. Sensor (on Main PCB) may have failed, or worm/gear/leadscrew may be jammed, or parts on the drive train may be worn.
Motor Rate Error	Motor sensor did not measure the correct rotation rate for the stepper motor. Sensor (on Main PCB) may have failed, or the force sensor may be inoperative and the stepper motor stalled when an occlusion occurred, or parts on the drive train may be worn.
Motor Supply Voltage BGND Test	Background self-test measured an invalid range on motor supply voltage (voltage should measure 17V). Use **Biomed > Diagnostics** to check the voltage. Replace the Main PCB if invalid voltage found.
Motor Volume Limit Error	The motor has run more steps than should have been required to deliver the set volume limit.
Plunger Sensor Failure	Software sensed plunger sensor voltage out of range. The plunger position sensor (potentiometer) may be unplugged or have an open connection. Use **Biomed > Diagnostics > Monitor Analog Sensors** to check operation of plunger position sensor. Open pump case and check connections to plunger sensor. Replace plunger position sensor.

System failure alarm	Cause or remedy
Positive Supply BGND Test	The power supply on the Main PCB has malfunctioned. Check the outputs of the supply by using **BIOMED > Diagnostics > Monitor 6811 A2D Group 1**. Value should be 9.472 +-5 %. Replaced Main pcb board if invalid voltage.
Primary Audible Alarm BGND Test	Background self-test sensed no current flowing in the primary speaker. Speaker may be unplugged or wire came loose from connector. Check connections from Main PCB to Interconnect PCB and from Interconnect PCB to speaker. Replace speaker if wiring is intact.
Primary Audible Alarm Post	Power-up self-test sensed no current flowing in the primary speaker. Speaker may be unplugged or wire came loose from connector. Check connections from Main PCB to Interconnect PCB and from Interconnect PCB to speaker. Replace speaker if wiring is intact.
Pump Motor Drive Off Post	Power-up self-test sensed no current in the stepper motor. This alarm can occur if the pump is operating on battery power, and the battery is nearly depleted; if this is the case, plug the pump in to AC power before turning the pump on. Or the motor supply or motor driver circuit may have failed. Verify motor connections are correct, then use **Biomed >Diagnostics > Motor Drive Test** to check motor operation. If motor does not run replace the motor or the Main PCB.
Pump Motor Drive Phase A Post	Power-up self-test found the stepper motor winding open. This alarm can occur if the pump is not plugged into AC power during power up, and the battery is nearly depleted; if this is the case, plug the pump in to AC power before turning the pump on. Or the motor may be unplugged or wire came loose from winding. Replace motor if wiring is intact.
Pump Motor Drive Phase B Post	Power-up self-test found the stepper motor winding open. This alarm can occur if the pump is not plugged into AC power during power up, and the battery is nearly depleted; if this is the case, plug the pump in to AC power before turning the pump on. Or the motor may be unplugged or wire came loose from winding. Replace motor if wiring is intact.
RAM BGND Test	Software test showed failure of a RAM on the Main PCB. Cycle power and rerun power-up self test which executes more extensive RAM test. If failure recurs, then check the Main PCB to ensure no cable or contamination is shorting the board; replace the Main PCB, if necessary.
Serial EEPROM Timeout	Software test showed failure of a serial EEPROM on the Main PCB. Check the Main PCB to ensure no cable or contamination is shorting the board; replace the Main PCB, if necessary.
SPI BUS Timeout	Software test showed failure of some component on the SPI bus. Check the Main PCB to ensure no cable or contamination is shorting the board; replace the Main PCB, if necessary.
Supercap Post	Power-up self-test sensed insufficient charge in the super-capacitor. This problem can occur with a new Main PCB or when a pump battery is totally dead. Plug pump into AC power for at least two minutes then cycle power. If problem is not corrected, then replace the Main PCB.

System failure alarm	Cause or remedy
Syringe Flange Sensor Failure	Software sensed syringe sensor voltage out of range. The sensor (potentiometer) may be unplugged or have an open connection. Use **Biomed > Diagnostics > Monitor Analog Sensors** to check operation of syringe sensor. Open pump case and check connections to syringe sensor. Replace syringe sensor, if necessary.
Time Base BGND Test	Background self-test found the system (MCU) time base did not agree with the time of day clock tick. Problem with oscillator for MCO or oscillatory for real time clock. If problem recurs, replace Main PCB.
Time of Day Clock Post	Power-up self-test found the system (MCU) time base did not agree with the time of day clock tick. Problem with oscillator for MCO or oscillatory for real time clock. If problem recurs, replace Main PCB.
Time of Day Clock Timeout	Time of day clock failed to communicate. If problem recurs, replace Main PCB.

General troubleshooting

This section discusses some potential problems which may be encountered with the Medfusion® Model 3000 Series pump, and suggests remedies for those problems.

Problem	Remedy or solution
Alarms do not sound (either loudly or at all)	a) If the alarms sound faintly, they may have been configured to their lowest level. On V3 pumps, use **Custom Program** to change the audio alarm volume to a higher level. On V4 and higher pumps, access **Profile Settings > View Settings > Alarm Loudness** to check setting. To change the setting, the Configuration must be changed using PharmGuard® Toolbox. b) Verify the speaker grid holes on the bottom of the pump are not obstructed. c) Use **Biomed > Diagnostics** and run the **Audio Test** on Speaker and Alarm Style. Replace speaker if audio alarm does not work correctly.
No charge light	a) Connect to AC power. Turn on pump and allow to complete startup self-testing. If both AC indicator and charge lights are off then see "Indicators Lights Do Not Flash" below. b) Use **Biomed > Diagnostics** and run the **Monitor Battery Status** test. Determine whether battery is charging at 50 MA or greater.
Battery Problem: **Battery not working message**	a) Open the battery door in the case bottom and check the connection of the battery ribbon cable to the Interconnect PCB. b) Use **Biomed > Diagnostics** and run the **Monitor Battery Status** test. If no information appears then replace the battery pack.

Problem	Remedy or solution
Battery Problem: **Battery does not hold charge**	a) Open the battery door in the case bottom and check the connection of the battery ribbon cable to the Interconnect PCB. b) **Connect to AC power**. Turn on pump and allow to complete startup self-testing. Use **Biomed > Diagnostics** and run the **Monitor Battery Status** test. Check whether battery is charging at least +50 MA (wait at least 1 minute from power-on for charge current reading to stabilize). • Unplug AC power if pump immediately shuts down then replace battery pack. • If pump continues to operate and gauge shows normal discharge current -100 to -200 ma, then perform a battery calibration.
Indicator lights do not flash	If the indicator lights do not flash during startup, or along with their appropriate function or alarm, then: • Open the case and check the keypad connection to the Main PCB. If any connections are loose, reconnect and re-test. • Otherwise, replace keypad.
Keyclick (Beep) is faint or not present	If the keyclicks (beeps) sound faintly, or not at all, they may have been Configured to their lowest level or turned off. On V3 pumps, use **Custom Program** to reset the audio to a higher level. On V4 and higher pumps, access **Profile Settings > View Settings > Keyclick Loudness** to check setting. To change the setting, the Configuration must be changed using PharmGuard® Toolbox.
Keypad key does not work	Use **Biomed > Diagnostics** and run the **Keypad Test**. If any keys do not pass this test, open the case and check connections for the keypad. Replace keypad, if necessary.
Liquid Crystal Display (LCD) has poor contrast	Use **Biomed > Calibration** and run the **Adjust Contrast**. If the LCD contrast cannot be adjusted, then check LCD negative supply, and consider replacing display or Main PCB.
No Libraries / Profiles available	There are no Profiles, Categories or Drug Programs available on the pump. On V3 pumps, use **Custom Program**, to create a Configuration (see *Configuration Manual*). On V4 and higher pump, use PharmGuard® Toolbox to create a Configuration, and **Teach** the Configuration to the pump.
Maximum rate not available	Maximum rate may be set low in pump Configuration. Access **Profile Settings > View Settings** to view the **Max Delivery Rate** setting. (Individual Profiles may have a maximum rate setting lower than this, and will supercede the Maximum Delivery rate.) On V3 pumps, use **Custom Program**, **Set Max Flow Rate** to configure the pump's maximum flow rate. See *Configuration Manual*. On V4 and higher pumps, the Configuration must be changed using PharmGuard® Toolbox.

Problem	Remedy or solution
Occlusion alarms occur frequently	Occlusion alarm limit may be set too low in pump Configuration. The infusion line setup can also have a significant effect on backpressure within the infusion line. For instance, small- or micro-bore tubing, thick medications, and small bore IV catheters with high delivery rates can cause significant backpressure, and therefore require a higher occlusion alarm limit. On V3 pumps, use **Custom Program**, **Set Occlusion Limit** to configure the pump's occlusion alarm level. See *Configuration Manual*. On V4 or higher pumps, to change the setting the Configuration must be changed using PharmGuard® Toolbox. If available in the Configuration, you may be allowed to change the occlusion limit for individual profiles by pressing the **Options** key and selecting **Override Occl Limit**. Calibrate the force sensor (**Biomed** > **Calibration** > **Calibrate Force Sensor**).
Pump option or feature not available	Option or feature is not enabled in the pump Configuration. See *Operator's Manual*. Options and features can be enabled or disabled on V3 pumps using **Custom Program**, or on V4 or higher pumps using PharmGuard® Toolbox.
Pump won't turn on	Plug into AC power and allow the battery to charge for at least two minutes (pump will not turn on with a dead battery), then push and hold POWER (⏻) to turn on. Otherwise, open case and check: • Connections of Main PCB to Interconnect PCB ribbon cable • AC power connections. • Battery connections. • Keypad cable connections.
Syringe Manufacturer not available	Syringe manufacturer is not present in pump Configuration. Syringes can be made available for the Configuration using **Custom Program** on V3 pumps, or using PharmGuard® Toolbox on V4 or higher pumps. See *Configuration Manual* (if available) or *Operations Manual*.

Smiths Medical service and support

Using Smiths Medical service assistance

Use the following steps to make use of Smiths Medical technical service assistance:

1. Contact Smiths Medical Technical Service Department at one of the following telephone numbers:

Toll-free in the United States	1 800 258 5361
Outside the continental United States	+1 614 210 7300
In Europe, Contact:	Your local distributor or: **Smiths Medical International Ltd.** +44 (0)1233 722100

2. When calling any of these numbers, please have the following ready:
   - Model name / number of pump
   - Pump serial number
   - Purchase date if pump is within warranty period
   - Description of problem in as much detail as possible
3. The service representative may give suggestions in an attempt to help solve the problem.

Returning a pump for repair

When a pump problem cannot be solved over the telephone, it becomes necessary to return the infusion pump for service.

Note: The following instructions apply primarily to product within the United States. If you are outside the United States, contact your local distributor for specific instructions. If unsure of who your local distributor is, contact Smiths Medical International Ltd. at the phone number listed above.

1. If the problem cannot be resolved through the assistance of the Technical Service Department, a Return Authorization (RA) number will be assigned.
2. Clean and decontaminate the pump prior to returning items to Smiths Medical. This is required before shipment according to United States Occupational Safety & Health Administration (OSHA) regulations.
3. **Remove the power cord and poleclamp assembly before shipping the pump. Return ONLY the pump, not the accessories. Smiths Medical will not be responsible for lost poleclamp parts or power cords**.
4. Package the infusion pump carefully for shipment (ensure packaging is adequate to prevent damage during shipment).
5. Smiths Medical will not accept returns for service without the assigned RA number clearly printed on the shipping package. Mark the Return Authorization (RA) number clearly on the outside of the shipping package used to return the pump.
6. The shipment method must meet the environmental conditions of:

	Shipping	Storage
Temperature	–40° to 60° C (–40° to 140° F)	–20° to 50° C (–4° to 122° F)
Relative humidity	5 to 95% non-condensing	5 to 95% non-condensing
Atmospheric pressure	50 to 108 kPa (7.3 to 15.4 psia)	50 to 108 kPa (7.3 to 15.4 psia)

6. In the USA, ship the carefully packaged infusion pump to:

Smiths Medical ASD, Inc.
1265 Grey Fox Road
St. Paul, Minnesota 55112
Tel: 1 800 258 5361

Using Biomed for troubleshooting

The primary tools for troubleshooting the Medfusion® Model 3000 Series pumps are available through the **Biomed** menu which contains **Diagnostics**, **Calibration**, **Utilities** and for all versions below 4.1.x, **Update Firmware** features. All version of the Medfusion® Model 3500 pump also contains **Set Language**, which may allow the ability to change the displayed language.

Two features within **Utilities** are very useful for investigating user complaints on the pump: **View Infusion History** and **View Alarm History**. **View Infusion History** allows review of infusion pump settings, delivery information, and alarms with each entry date and time stamped. **View Alarm History** allows review of pump alarms (together with sensor data) with each entry date and time stamped.

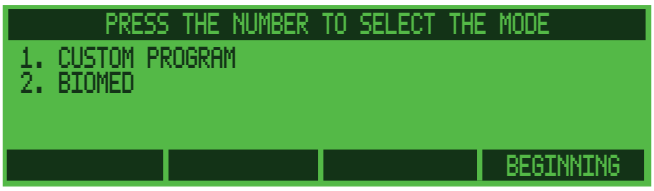
There are many features under **Diagnostics** which allow the examination of various sensors and components within the pump. The speaker, motor, keypad, indicators and display may be tested individually through this program. The battery gauge status information and charging/discharging current may be viewed. Numerous digital and analog inputs may also be viewed.

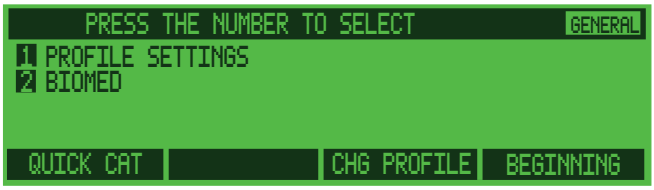
Accessing Biomed

Note: The following screens are slightly different depending on the pump version. For this reason, V3-type screens are shown first, followed by V4 and higher-type screen (if they are different). Also, depending on the personalization performed on a pump, the items listed in some of the menus may be different than those shown.

1. Turn the pump on and allow the power-on self-testing to complete. (If a system failure is detected in power-on testing, the pump will directly go to **Enter Biomed Passcode** screen - see item 4.)

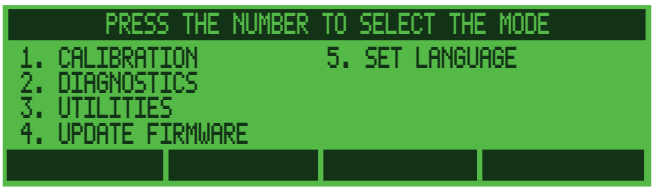
2. Press **More** until **Biomed** appears onscreen. (If E-Plates/Libraries are enabled, press **Main Menu** before using **More** to locate **Biomed**.) (For V4 software, if **Profiles** are displayed, select a profile then choose **Biomed** - if necessary, press **More** to find it.)





3. Use the **number** key to choose **Biomed**.
4. Use the **number** keys to enter the **Biomed Passcode** (*2580*) then press **Enter**.

The **Biomed menu** is displayed:

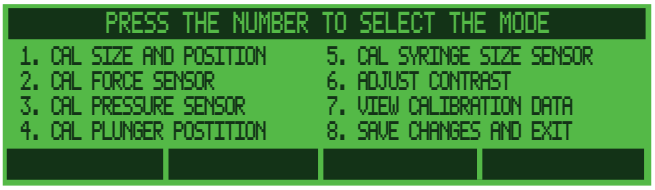


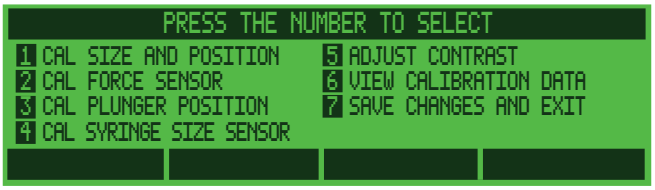
- **Calibration** is used to check calibration values, re-calibrate sensors or set display contrast.
- **Diagnostics** is used to examine analog and digital signal readings, or test the speaker, motor or display function.

- **Utilities** is used to review alarm history, to review infusion history, to set time and date, to update periodic maintenance timestamp.
- **Update Firmware** is used to reprogram the pump's software version through the serial interface (only available with service upgrade software diskette and instructions). [**Not available on Medfusion® Model 3500 pumps V4.1 and above**.]
- **Set Language** is used to specify the language displayed. [**Available on Medfusion® Model 3500 pumps**.]

Biomed > Calibration

Within **Biomed** > **Calibration** the following selections are available. See the *Calibration* section of this manual for further details.



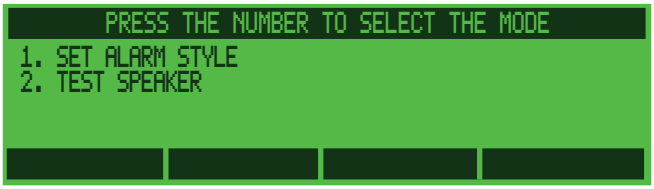


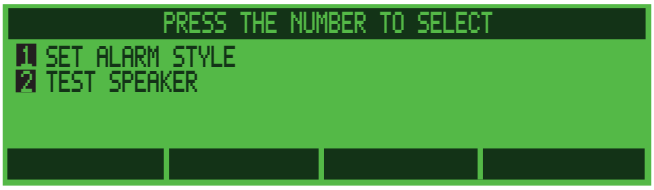
Biomed > Diagnostics (screen 1 of 2)

Within **Biomed** > **Diagnostics** the following selections are available (one of two screens). Use the **number** keys to select the test.

Audio Test

Use the **number** keys to select the test. **Set Alarm Style** allows testing of the various alarm tones (to stop the test press BACK (↩)). **Test Speaker** is a factory/engineering test (to stop the test, press **Exit**).



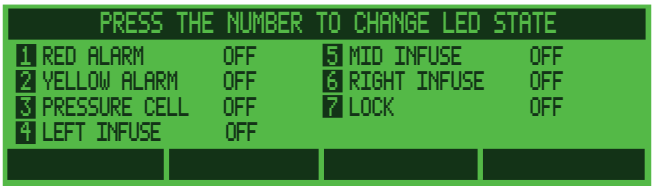


Display Test

Display Test repeats blank, all pixels on, vertical lines, horizontal lines, and checkerboard patterns across the LCD display. Exit (and stop the test) by pressing STOP (■).

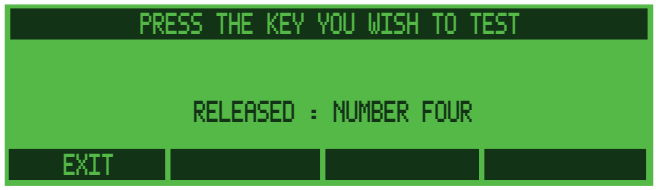
Indicator Test

The **Indicator Test** allows the individual control and testing of each indicator on the front panel (except battery and AC). Use the **number** key for the indicator to toggle on or off.



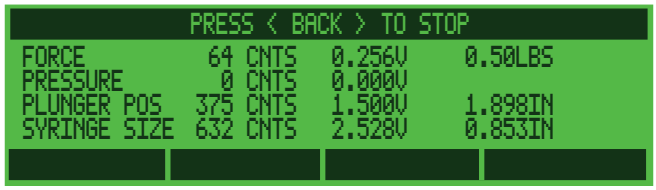
Keypad Test

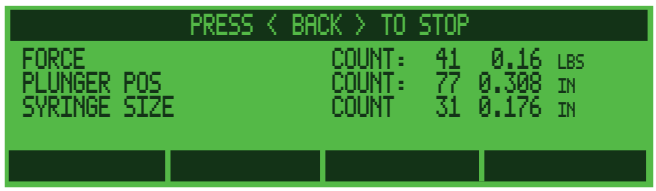
The **Keypad Test** allows each key to be tested (except POWER (⏻); pressing POWER (⏻) turns the pump off). The only exit from this test is to press **Exit**.



Monitor Analog Sensors

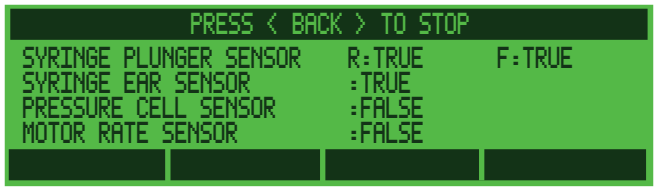
Monitor Analog Sensors allows viewing the high resolution analog signals in the pump. These are force, pressure (future option), plunger position, and syringe size. The first data column is analog to digital converter counts (0 to 1023), the second column is the voltage equivalent to counts, and the third column is the reading with calibration values applied.

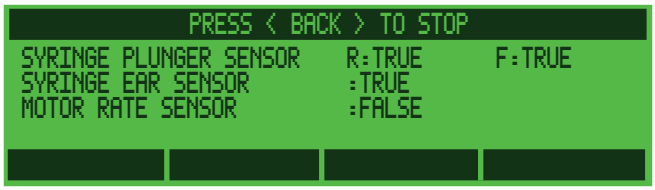




Monitor Digital Sensors

Monitor Digital Sensors allows viewing the state of the digital sensors in the pump. Syringe plunger sensor is the state of the flippers on the plunger head where open is true. Syringe ear (flange) sensor indicates true when the ear clip (flange) is pulled out. Pressure cell, an unused option, is always false. The motor rate sensor will show true or false depending upon the position of the reflective surface on the end of the motor/worm shaft.



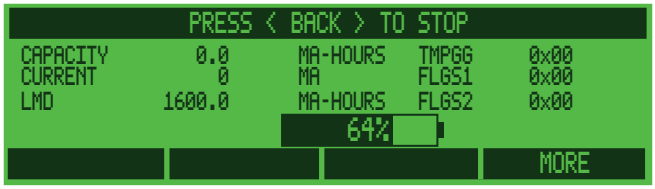


Monitor Battery Status

Monitor Battery Status shows the information from the battery gauge. It may take up to 1 minute for current readings to stabilize when changing from charge to discharge or vice-versa. If current is positive the battery is charging; thus negative is discharging. See schedule maintenance for discussion of battery gauge.

NiMH battery pack (G6001392 or 67-2515):

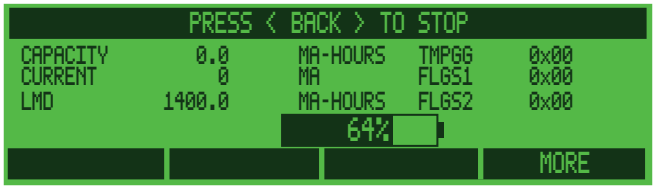
V5 and lower:



V6:

NiCad battery pack (G6000244):

V5 and lower:



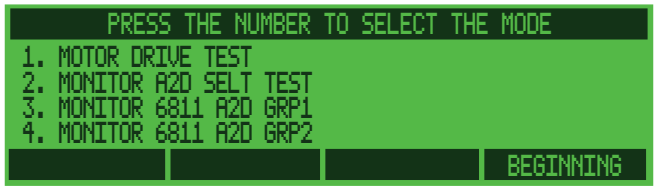
V6:

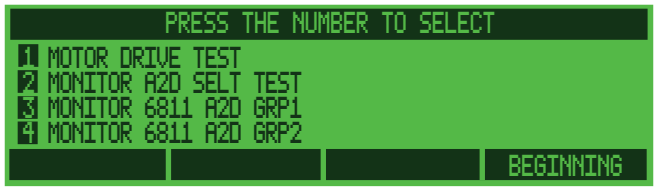
Drive Train Test

This feature is for factory/engineering use.

Biomed > Diagnostics (screen 2 of 2)

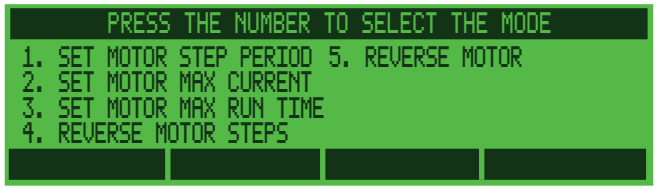
Within Biomed Diagnostics the following selections are available (second of two screens). Use the **number** keys to select the test.

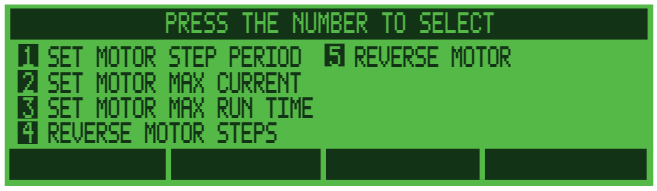




Motor Drive Test

The **Motor Drive Test** allows running the motor without any alarms (position, rotation, etc.) being active. ***Only use the* Set Motor Step Period *feature***. Enter a motor step period where 2 millisec is the fastest rate and 1000 millisec is the slowest rate, then press START (◀) to start the motor and STOP (■) to stop. All other features are for factory/engineering use.



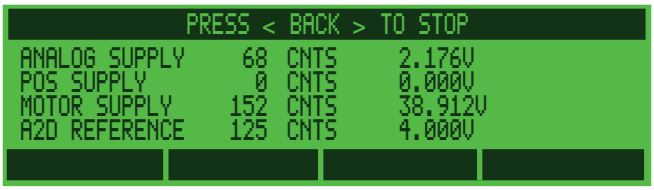


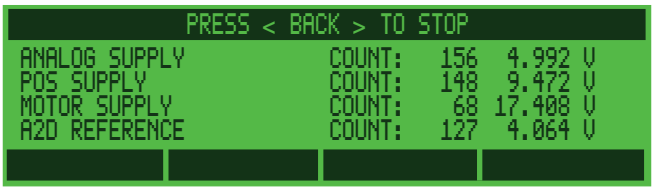
Monitor a2d Selftest

These are self-test values within the high-resolution analog to digital converter. This feature is for factory/engineering use. The normal readings are full scale equals 1023, midrange equals 512, and zero equals 0.

Monitor 6811 a2d Group1

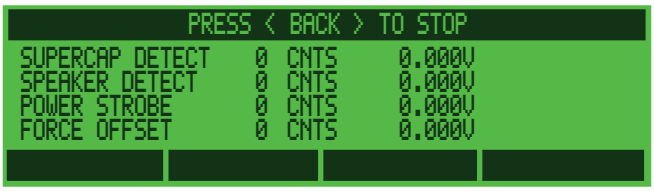
Monitor Analog Sensors allows viewing the low resolution analog signals in the pump. These are analog supply, positive supply, motor supply, and a2d reference. The first data column is analog to digital converter counts (0 to 255), the second column is the "normalized" voltage equivalent to counts multiplied by the resistor divider feeding that channel. See Main PCB theory of operation for definition of signals and values.

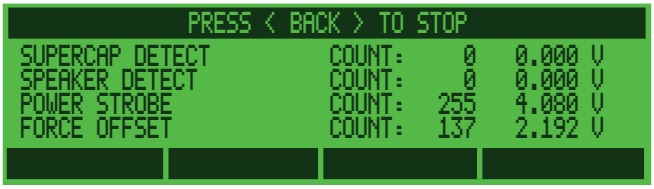




Monitor 6811 a2d Group2

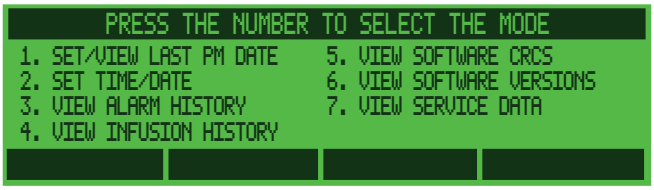
Monitor Analog Sensors allows viewing the low resolution analog signals in the pump. These are supercap detect, speaker detect, power strobe, and force offset. The first data column is analog to digital converter counts (0 to 255), the second column is the "normalized" voltage equivalent to counts multiplied by the resistor divider feeding that channel. See Main PCB theory of operation for definition of signals and values.





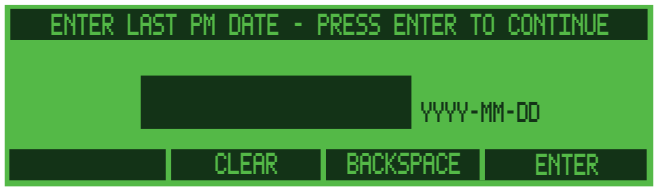
Biomed > Utilities

Within **Biomed > Utilities** the following selections are available. Use the **number** keys for selection.



Set/View Last [Next] PM Date

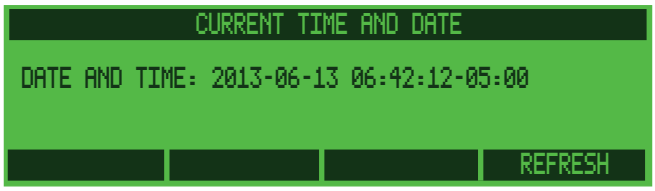
Depending on the pump version, this feature will either be **Set/View Last PM Date** or **Set/View Next PM Date** (Medfusion® Model 3500 software V4 and above). This feature should be used every time Periodic Maintenance is performed on the pump. Use the **number** keys to enter the date of the current or next maintenance date into the pump (this value is stored in non-volatile memory). When two years elapse from this date, or when it reaches this date, an advisory message (low priority alarm) appears on-screen for annual maintenance to be performed. [**Note: ensure current date and time are correct**.]



Set Time/Date (Current) (V5 and lower) or View Time/Date (V6)

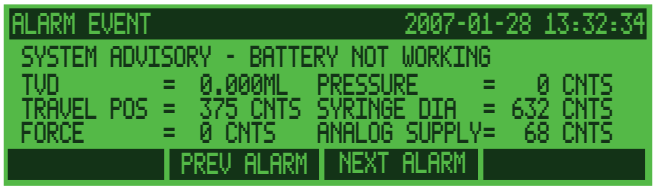
This feature allows setting or viewing the current date and time. This setting is stored in a clock/calendar chip on the Main PCB. [**Note: if all power is removed from the Main PCB and the super-capacitor is drained, the clock will be reset to 1999 and PM advisory message may appear until the clock is set**.]

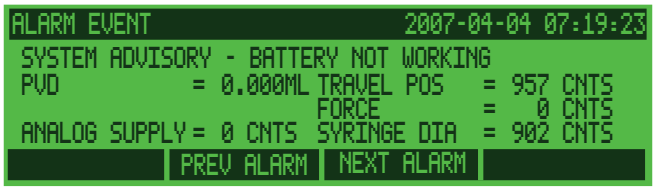
Note: On the V6 pump, you will only be able to view the time and date, not set them. Setting the time and date can only be accomplished using PharmGuard® Toolbox 2, Version 3.

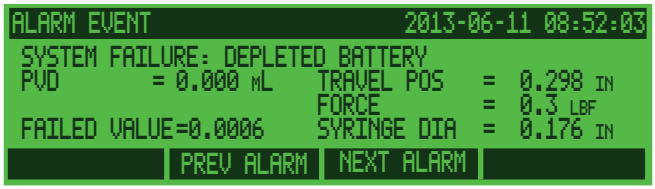


View Alarm History

This feature allows review from the most recent alarm backwards in time. Each alarm is date and time stamped. [**Note: see latest power-on record in view infusion history to check current clock/calendar settings**.]



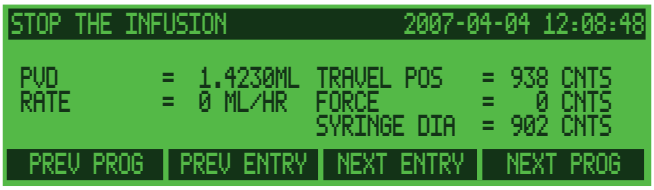


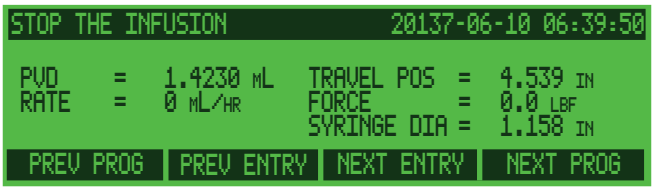


View Infusion History

This feature allows the review of infusion history from the most recent time backwards. Each entry is date and time stamped. The infusion history is "event" driven with entries made for start infusion, stop infusion, change rate, alarms, etc. Depending upon the complexity of infusions, the infusion history stores approximately 8 or more complete infusions. Press **Prev Entry** to step backwards one event at a time, or press **Prev Prog** to step back one infusion at a

time. Here, **Next Entry** and **Next Prog** step forwards in time one event or one infusion respectively.





View Software CRCs

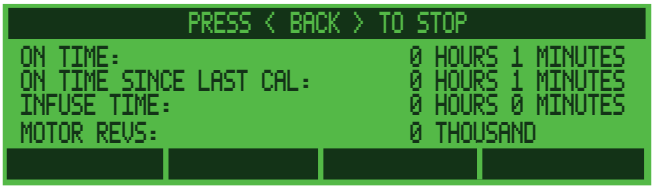
This feature is for factory/engineering use.

View Software Versions [available only on Medfusion® Model 3500 pumps V4 and higher]

This feature is used to view the pump's current software version, as well as the boot loader.

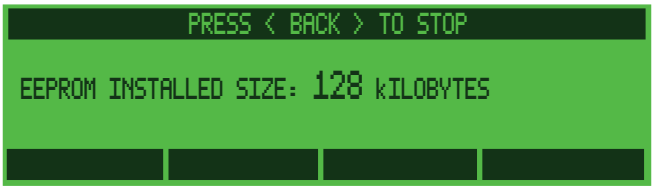
View Service Data

This feature is for factory service and allows the service department to review the data on pump usage.



View EEPROM Size [available only on Medfusion® Model 3500 pumps V4 and higher]

This feature allows viewing the size (in kilobytes) of the EEPROM installed on the pump.



Biomed > Update Firmware [not available on Medfusion® Model 3500 pumps, V4 and higher]

Do Not Use this feature unless specifically authorized by Smiths Medical to update the software of the pump. Review the documentation provided with the software update. Follow the instructions provided with the software update and ensure the update is compatible with the pump model before performing a software update.

Note: Pressing **Yes** does not erase any software in the pump. The pump must be connected to a host PC running a Medfusion® Model 3000 Series download program and a download must be initiated on the PC in order to update the pump's software.

Set Language [Not available on Medfusion® Model 3010 and 3010a pumps]

Selecting this option permits changing the displayed language on the pump. All messages are displayed using the new language.

To select a language, press the **number** key corresponding to the language, and press **Enter**. The display will immediately change to the selected language. Some pumps may not have all languages implemented; selecting an unimplemented language will result in English being displayed.

Note: Do not select a language unless you know how to read and understand that language.

This section provides procedures for disassembly, parts replacement & re-assembly of the pump and many of its components.

Maintenance warnings/ cautions

Observe the following warnings and cautions while disassembling, replacing parts, and reassembling any Medfusion® Model 3000 Series pump.

After reassembling pump, use Retest Guidelines listed in the Calibration and Adjustment section (starting on 87) to find any re-calibration or re-testing required before returning pump to use.

Service warnings

- **Disconnect AC Power & Turn Pump Off:** The only means of removing AC power is to disconnect the AC power cord. While the AC power cord is attached to the pump and plugged into an AC outlet, live mains voltage is present inside the pump. Make sure the pump is turned off before performing any disassembly.
- **Battery Replacement:** For continued protection against fire hazard, always replace battery pack with same type and model of battery specified in the labeling on the pump.
- **Clean the Pump:** Always clean the pump thoroughly before performing maintenance on it. This is recommended by the United States Occupational Safety & Health Administration (OSHA) as a protection from potential biohazard.
- **Pump Maintenance:** Only trained biomedical service personnel may repair, calibrate, and maintain this pump.
- **Follow Manufacturer's Maintenance Procedures:** Always repair and maintain this pump following the manufacturer's recommended instructions in this Service Manual.
- **External DC Power:** Any power source connected to the external DC jack must be IEC 60601-1 certified for medical equipment: Type CF, Safety Class II. Connecting external power to the pump creates a medical system; therefore, the user is responsible for compliance with IEC 60601-1 standards. Refer all questions to Smiths Medical Technical Service department.
- ***Collect Separately***. There are potential health hazards associated with improper disposal of batteries, electronics, and contaminated (used) infusion sets and syringes. Dispose of used batteries, infusion sets, syringes, and other used accessories, or a pump that has reached the end of its useful life, in an environmentally safe manner, and according to any regulations that may apply.

Service cautions

- **Repair Pump in ESD Controlled Work Area:** The pump case should only be opened at a work-station with Electrostatic controls, including a grounded mat and wrist-strap.
- **Handle Batteries with Care:** Always handle the pump's battery pack with care.
- **Don't Over-tighten Screws:** Never over-tighten any screws in the pump. Unless otherwise specified, torque all screws to 60 in- oz (0.42 Nm).
- **Battery Disposal:** Always dispose of exhausted NiMH batteries in compliance with all pertinent local, state, national, and international regulations. If unsure of correct methods for compliance, battery packs may be returned to Smiths Medical for recycling.

Opening & closing the pump housing

Tools needed

- Torque screwdriver with a #1 Phillips head

Always work at an electrostatic-controlled work station when disassembling the pump.

Opening the pump housing

1. Unplug the AC power cord (also disconnect any external DC power, if in use).
2. If the poleclamp is attached to the pump, remove it before disassembling the pump. Remove the 2 (4 on newer pumps) flat head screws attaching the poleclamp bracket to bottom housing of the pump.
3. Remove the 2 flat head screws from the battery compartment cover, and then remove the cover.
4. Carefully remove the battery pack from its compartment, and disconnect its cable from the Interconnect PCB.
5. Remove the 2 pan head screws from the bottom housing of the pump.
6. Carefully separate the two halves of the pump housing (there are three snap tabs across the back).
7. Unplug the ribbon cable from J9 on the Main PCB (in most cases the other end of this ribbon cable is glued or soldered into the Interconnect PCB).

Closing the pump housing

1. Before closing the pump housing, be sure the AC and external DC power (if connected) are disconnected, and the battery pack is removed.
2. Reconnect the ribbon cable joining the Interconnect PCB and the Main PCB at J9.
3. Be sure all wires are clear of pinch points when rejoining the housing halves.
4. There are 3 snap fit tabs and slots along the backside of the housing. Align them and close the top & bottom housings together.
5. Screw in the 2 pan head screws which connect the top & bottom housings. Torque screws to 60 in oz (0.42 Nm).
6. Orient the battery pack with the circuit board and cable facing the rectangular cutout in the battery compartment.
7. Connect battery cable to the Interconnect PCB. Slide the battery into the compartment.
8. Replace battery cover and secure it with 2 flathead screws. Torque screws to 60 in oz (0.42 Nm).
9. If using the poleclamp, reattach it to the pump with the 2 (or 4) flathead screws. Torque screws to 160 in oz (1.13 Nm).

Follow retest guidelines listed in the Calibration and Adjustment section to verify pump functionality before returning it to use.

Battery pack

Tools needed

- Torque screwdriver with a Phillips head

Always work at an electrostatic-controlled work station when disassembling the pump.

Removing the battery pack

1. Before removing the battery pack, be sure the AC mains and external DC power (if connected) are disconnected, and the pump is turned off (press POWER (⏻) to turn the pump off, if required).
2. Remove the 2 flat head screws from the battery compartment cover, and then remove the cover.
3. Carefully remove the battery pack from the compartment, and gently disconnect (pull) its ribbon cable from the Interconnect PCB.

Installing a battery pack

1. Unpack and carefully inspect the battery pack for physical damage.
2. Orient the battery pack with the circuit board and cable facing the rectangular cutout in the battery compartment.
3. Connect the battery cable to the Interconnect PCB. Slide the battery into the compartment.
4. Replace the battery cover and secure it with 2 flathead screws. Torque screws to 60 in oz (0.42 Nm).

Verifying battery function after new battery replacement

When replacing an old battery with a new one, verify the new battery is functioning nominally before returning the pump to service.

1. Connect the pump to AC power and verify the battery charge indicator lights.
2. Press POWER (⏻) to turn the pump on. From the **Main** menu, use the **number** keys to select **Biomed > Diagnostics > Monitor Battery Status**.
3. Wait several minutes from power-on for readings to stabilize and then verify battery charge current is greater than 160 ma (if battery charge reading is greater than 95%, then charge current is reduced to 50 ma or greater).
4. If < 0 ma, then check connections to AC power. [**Note:** negative current means the battery is discharging.]
5. If there is no battery information on the **Monitor Battery Status** screen, check the battery connection on the battery pack, or the connection on the Interconnect PCB.
6. Turn the pump off, but leave it connected to AC power. Allow pump to recharge battery for at least 10 hours.

Follow retest guidelines listed in the Calibration and Adjustment section to verify pump functionality before returning it to use.

Interconnect PCB

Tools needed

- Torque screwdriver with a Phillips head

Always work at an electrostatic-controlled work station when disassembling the pump.

Removing the interconnect PCB

1. Disconnect the pump from AC power source.
2. Open the pump housing, remove the battery pack, and separate the top and bottom halves.
3. Unplug the ribbon cable from J9 on the Main PCB (in most cases the other end of this ribbon cable is glued or soldered directly into the Interconnect PCB).
4. Disconnect the speaker cable from the Interconnect PCB at J2.
5. Disconnect power supply cable from Interconnect PCB at J3.
6. Remove the 2 pan head screws holding the board, and carefully remove the Interconnect PCB from housing.

Installing an interconnect PCB

[Torque all screws to 60 in oz (0.42 Nm).]

IMPORTANT: If the Interconnect PCB is part number 70-0420, the pump serial number label may need to be replaced (this is due to the functionality of the external DC power jack not being present on this PCB, and there being a symbol for that feature on certain serial number labels). Follow the instructions provided in Service Bulletin No. 14, provided with the pump bottom housing and Interconnect PCB replacement kits.

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1. Align the Interconnect PCB with the threaded bosses, and press firmly into place.
2. Secure it with the 2 pan head screws.
3. Attach the speaker cable to connector J2, and the power supply cable to connector J3.
4. Close the housing and secure with 2 pan head screws.
5. Replace the battery pack, battery cover, and secure with 2 flat head screws.

Verify interconnect PCB function

Follow retest guidelines listed in the Calibration and Adjustment section to verify pump functionality before returning it to use.

Speaker

Tools Needed

- Torque screwdriver with a Phillips head

Always work at an electrostatic-controlled work station when disassembling the pump.

Speaker removal

1. Disconnect the pump from AC power source.
2. Open the pump housing, remove the battery pack, and separate the top and bottom halves.
3. Disconnect the speaker cable from the Interconnect PCB at J2.
4. Remove the 2 pan head screws & shoulder (or flat) washers holding the speaker to the case, and remove the speaker from housing.

Speaker installation

[Torque all screws to 60 in oz (0.42 Nm).]

1. Align the speaker on the round holder, and orient the cable to run toward the Interconnect PCB.
2. Insert the 2 pan head screws & shoulder (or flat) washers and secure the speaker to the housing.
3. Close the housing and secure with 2 pan head screws.
4. Replace the battery pack, battery cover, and secure with 2 flat head screws.

Verifying speaker function

After installing the new speaker, execute power-up testing to verify speaker function.

1. Connect the pump to AC power.
2. Press POWER (⏻) to turn the pump on.
3. Listen for power-on tones. Allow power-on self-tests to complete. If no system failure messages appear, then the speaker is good.

Follow retest guidelines listed in the Calibration and Adjustment section to verify pump functionality before returning it to use.

AC power supply

Tools needed

- Torque screwdriver with a Phillips head & small flat blade
- 5mm open end wrench
- ¼" nut driver

Always work at an electrostatic-controlled work station when disassembling the pump.

Removing AC power supply

1. Disconnect the pump from AC power source.
2. Open the pump housing, remove the battery pack, and separate the top and bottom halves.
3. Remove the power supply shield.
4. Disconnect the Interconnect PCB cable from Power Supply PCB at J2.
5. Use small flat blade screwdriver to loosen the terminals on the AC input wires, and disconnect the AC input wires from the Power Supply PCB at J1.
6. Remove the 2 pan head screws securing board to bottom housing, and remove AC Power Supply PCB.

Installing an AC power supply

[Torque all screws to 60 in oz (0.42 Nm) except as otherwise indicated.]

1. Align the AC Power Supply PCB over the threaded bosses, with J1 in line with the AC input cable.
2. Secure the board with 2 pan head screws.
3. Connect the AC Input Wires to J1 and tighten the 2 terminal screws. Torque to 32 in oz (0.23 Nm).
4. Reconnect the Interconnect PCB cable to J2.
5. Reinstall the Power Supply Shield by sliding it into the notched tabs.
6. Close the housing and secure with 2 pan head screws.
7. Replace the battery pack, battery cover, and secure with 2 flat head screws.

Verify AC power supply function

After replacing the AC Power Supply, verify its function with the following steps:

1, Plug the pump into AC power.

2. Verify the AC power indicator lights.

Follow retest guidelines listed in the Calibration and Adjustment section to verify pump functionality before returning it to use.

AC input assembly

Tools Needed

- ¼" open end wrench
- Torque screwdriver with a Phillips head & small flat blade

Always work at an electrostatic-controlled work station when disassembling the pump.

Removing an AC input module assembly

1. Disconnect the pump from AC power source.
2. Open the pump housing, remove the battery pack, and separate the top and bottom halves.
3. Remove power supply shield.
4. Use small flat blade screwdriver to loosen the 2 screws on the Terminal Block of the power supply.
5. With screwdriver & open end wrench, remove the 2 flathead screws & Nylock nuts.
6. Slide the AC Input Module Assembly from the case.

Installing an AC input module assembly

[Torque all screws to 60 in oz (0.42 Nm) except as otherwise indicated.]

1. Install AC Input Module Assembly with 2 power wires oriented toward the bottom of the housing.
2. Insert the 2 wires into the Terminal block on the power supply.
3. Tighten the 2 screws of the Terminal block. Torque to 32 in oz (0.23 Nm).
4. Secure with the 2 flathead screws & Nylock nuts.

5. Reinstall the Power Supply Shield by sliding it into the notched tabs.
6. Close the housing and secure with 2 pan head screws.
7. Replace the battery pack, battery cover, and secure with 2 flat head screws.

Verifying AC input assembly module function

1. After replacing or repairing the AC Input Assembly Module, verify its nominal function with the following steps:
2. Plug the pump into AC power.
3. Verify the AC power indicator lights.

Follow retest guidelines listed in the Calibration and Adjustment section to verify pump functionality before returning it to use.

Bottom housing

Tools Needed

- ¼" open end wrench
- Torque screwdriver with a Phillips head and small flat blade

Always work at an electrostatic-controlled work station when disassembling the pump.

Removing the bottom housing

1. Disconnect the pump from AC power source.
2. Open the pump housing, remove the battery pack, and separate the top and bottom halves.
3. Unplug the ribbon cable from J9 on the Main PCB (in most cases the other end of this ribbon cable is glued or soldered directly into the Interconnect PCB).
4. Remove the Interconnect PCB, the speaker, the Power Supply Shield, the AC Power Supply, and the AC Input Assembly using the procedures listed previously.

Installing a bottom housing

Note: A new bottom housing should have rubber feet, and IR lens already installed; however, new labels (included) need to be applied.

1. Record the serial number from the old bottom housing. Determine the appropriate serial number label to use, based on the Interconnect PCB installed in the pump (the difference between the labels is one shows a symbol related to the External DC power jack, and one does not):
   a) If installed Interconnect PCB is 70-0420, select replacement serial number label 40-6790-51[current revision] (No DC jack symbol);
   b) If installed Interconnect PCB is any other part number, select replacement serial number label 40-6090-51[current revision] (with DC jack symbol).
2. Type (or print) the serial number into the blank field on the appropriate replacement serial number label. Take the overlay supplied with the label, remove the backing and apply this overlay

to cover/protect the typed/printed serial number label.

2. Remove the backing on the typed/printed serial number label, and apply this to the new case bottom.
3. Attach all new labels to the new bottom housing, use the old bottom as a guide for label application.
4. Install the AC Power Supply, AC Input Assembly, Power Supply Shield, speaker, and Interconnect PCB into the bottom housing using the procedures listed previously.
5. Reconnect the ribbon cable to J9 on the Main PCB in the top housing.
6. Close and secure the two halves of the pump, and reinstall the battery pack.

Follow retest guidelines listed in the Calibration and Adjustment section to verify pump functionality before returning it to use.

Main PCB

Tools needed

- Torque screwdriver with Phillips head & small flat head

Always work at an electrostatic-controlled work station when disassembling the pump.

IMPORTANT: When replacing the Main PCB on P.A.S.S. (PharmGuard® Anesthesia Software Service) pumps, the pump serial number and Configuration version number (displayed on the pump startup screen) must be communicated to the Service department when ordering a replacement PCB, as they must install both on the PCB prior to shipment.

Removing the Main PCB

1. Disconnect the pump from AC power source.
2. Open the pump housing, remove the battery pack, and separate the top and bottom halves.
3. Disconnect the interconnect ribbon cable from the Main PCB at J9.
4. Loosen the 2 terminal block screws connecting the fiber optic backlight to the Main PCB, then pull the fiber cable assembly from the terminal block.
5. Disconnect all cable connections on the Main PCB. These include:
   - Keypad ribbon cables at J10.
   - Motor cable at J3.
   - Position pot cable at J6.
   - Display cable at J12.
   - Ear clip sensor cable at J2.
   - Barrel clamp flex circuit at J4.
   - Plunger cable at J11 and unscrew the cable clamp.
6. If present, clip the wire tie securing the 2nd backlight cable.
7. Remove the 2 pan head screws securing the Main PCB, and carefully remove the Main PCB from the housing.

Installing a Main PCB

1. Place the new Main PCB into the housing. It should rest in the slot on the extrusion, and align the mounting holes with the 2 stand-offs.

2. Secure the Main PCB with the 2 pan head screws. Torque to 60 in oz (0.42 Nm).
3. Reconnect all cable and wire connections on the Main PCB. These include:
   - Keypad ribbon cables at J10.
   - Motor cable at J3.
   - Position pot cable at J6.
   - Display cable at J12.
   - Ear clip sensor cable at J2.
   - Barrel clamp flex circuit at J4.
   - Plunger cable at J11. Install the cable clamp over the exposed braid of the plunger cable and secure with small pan head screw. Torque screw to 16 in oz (0.12 Nm).
4. *Old-style LCD with backlight pigtail(s):* If a 2nd fiber optic tail is present on the backlight, connect its cable to J8 on the Main PCB. If replacing an older Main PCB (with a black connector at J8), discard the backlight adapter cable. After completing the next step, anchor both fiber optic tails to the Main PCB with a wire tie. *New-style LCD with built-in backlight:* Disconnect red backlight wire from J8 on Main PCB.
5. *Old-style LCD with backlight pigtail(s):* Insert the backlight wires into the Main PCB terminal block. *New-style LCD with built-in backlight:* Connect red backlight wire to J8 on Main PCB. Screw the terminal connector onto the leads with the flat edge of the LED lens toward the outside edge of the board. Torque terminal block screws to 32 in oz (0.23 Nm).

Note: If the leads are reversed during installation, the backlight will not turn on. Loosely reassemble the case halves, plug in the battery, and power up pump to check the backlight before completely closing the housing.

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6. Close and secure the two halves of the housing and reinstall the battery pack.

IMPORTANT: Complete recalibration and reconfiguration is required when replacing the Main PCB.

Follow retest guidelines listed in the Calibration and Adjustment section to verify pump functionality before returning it to use.

Drive train assembly

Tools Needed

- Torque screwdriver with a Phillips head & ¼" nut drive
- ¼" wrench
- .002" (.051mm) shim

Always work at an electrostatic-controlled work station when disassembling the pump.

Motor unit (motor, worm, worm gear)

Removal

1. Open the pump housing (as described on previous pages), and set up the case top section with the handle down and Main PCB facing up.
2. Remove the Main PCB as instructed previously.
3. Squeeze the plunger lever and fully extend the plunger head away from the case.
4. Remove pan head screws and standoffs holding the extrusion (drive train assembly). Remove the pan head screws and Nylock nuts holding the barrel clamp assembly to the extrusion.
5. Partially slide the extrusion out of the case until the motor mount screws are accessible.

Disassemble motor unit as required:

1. For motor or worm, remove the 2 pan head screws and Nylock nuts holding the motor. Remove the motor and worm. The worm pulls straight off of the motor shaft.
2. For the worm gear (the plastic gear on leadscrew), remove the e-clip. Pull the gear straight off of the leadscrew shaft.

Installation

Reassemble motor unit

1. Fill worm hole with Dow 111 Silicone Grease Compound (P/N 0382000000). Slide worm onto motor shaft. Rotate motor to align mounting holes with holes in motor plate. Ensure the motor is positioned for the wires to properly reach the Main PCB. Secure motor with 2 pan head screws and Nylock nuts. Torque to 100 in oz (0.71 Nm).

Note: TEFLON® threaded worms do not require any grease on the outer threads.

Note: Greasing the inside of the worm works as a noise dampener.

2. For worm gear, align "D" with shaft and press onto leadscrew until centered over worm. Attach e-clip.
3. Carefully slide the extrusion (drive train assembly) back into case.
4. Ensure right end plate on extrusion does not damage ear clip sensor.
5. Ensure plunger cable comes out between middle boss and boss by the motor.
6. Slide keypad ground tab (black side toward extrusion) between boss by the motor and extrusion.
7. Secure extrusion with 3 standoffs and 3 pan head screws. Torque to 100 in oz (0.71 Nm).
8. Secure the barrel clamp assembly to the extrusion with 2 pan head screws and Nylock nuts. Torque to 100 in oz (0.71 Nm).
9. Reinstall Main PCB as instructed previously.
10. Close the pump housing as instructed previously.

Follow retest guidelines listed in the Calibration and Adjustment section to verify pump functionality before returning it to use.

Position potentiometer

Removal

1. Open pump housing (as described on previous pages), and set up the case top section with the handle down and Main PCB facing up.
2. Remove the Main PCB as instructed previously.
3. Squeeze the plunger lever and fully extend the plunger head away from the case.
4. Remove pan head screws and standoffs holding the extrusion (drive train assembly). Remove pan head screws and Nylock nuts holding barrel clamp assembly to extrusion.
5. Partially slide extrusion out of case until flat head screw in right end plate is accessible.
6. Remove small flat head screw holding position potentiometer (pot).
7. On the carriage remove pan head screw, washer, and Nylock nut holding the post of the pot. (It may be necessary to reposition carriage by moving the plunger head.)
8. Remove 3 flat head screws holding motor assembly on extrusion and rotate out of way.
9. Slide position pot out of the extrusion.

Installation

1. Slide new position pot into extrusion.
2. Clean small flat head screw (or use a new screw), apply Loctite® 242 (a mild thread-locking adhesive) to the screw, and secure the pot to the right end plate of the extrusion assembly. Torque to 16 in oz (0.11 Nm).
3. Secure the motor assembly on the extrusion with the 3 flat head screws. Torque to 100 in oz (0.71 Nm).
4. Slide the post of the position pot up to the carriage. Insert the pan head screw through the hole in the carriage arm, and then through the washer. Start the Nylock nut onto the screw. Insert a 0.002" shim between the pot's post and the washer, then tighten the nut until slack is removed. **Do not over-tighten nut**. Remove the shim and check if the flat washer can move (spin) freely; if not loosen the nut slightly.
5. Carefully slide the extrusion (drive train assembly) back into the case.
6. Ensure the right end plate on the extrusion does not damage the ear clip sensor.
7. Ensure the plunger cable comes out between the middle boss and the boss by the motor.
8. Slide the keypad ground tab (black side toward the extrusion) between the boss by the motor and extrusion.
9. Secure extrusion with 3 standoffs and 3 pan head screws. Torque to 100 in oz (0.71 Nm).
10. Secure the barrel clamp assembly to the extrusion with 2 pan head screws and Nylock nuts. Torque to 100 in oz (0.71 Nm).
11. Reinstall the Main PCB as instructed previously.
12. Close pump housing as instructed on previous pages.

Follow retest guidelines listed in the Calibration and

Adjustment section to verify pump functionality before returning it to use.

Clutch assembly

Tools needed

- Torque screwdriver with a Phillips head & ¼" nut drive
- ¼" wrench

Always work at an electrostatic-controlled work station when disassembling the pump.

Leadscrew

Removal

1. Open pump housing (as described on previous pages), and set up the case top section with the handle down and Main PCB facing up.
2. Remove the Main PCB as instructed previously.
3. Squeeze the plunger lever and fully extend the plunger head away from the case.
4. Remove the pan head screws and standoffs holding the extrusion (drive train assembly). Remove the pan head screws and Nylock nuts holding the barrel clamp assembly to extrusion.
5. Partially slide extrusion out of the case until the Nylock nut holding the leadscrew on the right end plate is accessible.
6. Pull the plastic worm gear off the end of the leadscrew near the motor.
7. Remove the 3 flat head screws holding the motor assembly on the extrusion, and pull off the motor assembly.
8. Slide the carriage rod out of the carriage.
9. Move the plunger head/carriage in about 1" (2.5cm) from the right end plate. Hold onto the "D" side of the leadscrew and use ¼" wrench to remove the Nylock nut holding the leadscrew and the flat brass washer.
10. Slide extrusion in slightly until the leadscrew clears the right end plate, then pull off the thrust bearings.
11. Squeeze the plunger lever to open the clutch and pull the leadscrew out of the carriage.

Installation

1. For non-TEFLON® leadscrews, apply a light coating of STP poly-plus (lithium) grease to the threads. For TEFLON® threaded leadscrews, do not apply grease to the threads. Squeeze the plunger lever to open the clutch and insert the leadscrew until it sticks slightly through the carriage.
2. Install the thrust bearing assembly (flat washer, bearings, flat washer) onto the end of the leadscrew and pull on the plunger head to feed the leadscrew through the right end plate. Ensure the nylon shoulder washer is still in place on the right end plate.
3. Place the brass washer over the leadscrew and start the Nylock nut. Torque the nut to 60 in oz (0.42 Nm), then loosen nut by ¼ turn. Check if the brass washer can move; if not loosen nut slightly.
4. Slide the carriage rod through the carriage and seat it into the hole in the right end plate.
5. Slide the motor assembly over the leadscrew and align the carriage rod with the motor assembly bracket. Secure the motor assembly on the extrusion with 3 flat head screws. Torque to 100 in oz (0.71 Nm).
6. Align "D" of the worm gear with the leadscrew shaft and press onto the leadscrew until the gear is centered over the motor worm.
7. Carefully slide the extrusion (drive train assembly) back into case.
8. Ensure the right end plate on the extrusion does not damage the ear clip sensor.
9. Ensure the plunger cable comes out between the middle boss and the boss by the motor.
10. Slide the keypad ground tab (black side toward extrusion) between the boss by the motor and the extrusion.
11. Secure the extrusion with 3 standoffs and 3 pan head screws. Torque to 100 in oz (0.71 Nm).
12. Secure the barrel clamp assembly to the extrusion with 2 pan head screws and Nylock nuts. Torque to 100 in oz (0.71 Nm).
13. Reinstall the Main PCB as instructed previously.
14. Close pump housing as instructed on previous pages.

Follow retest guidelines listed in the Calibration and Adjustment section to verify pump functionality before returning it to use.

Clutch or clutch cam

Tools needed

In addition to the tools listed under "Clutch Assembly", these tools are required:

- Safety glasses
- Needle nose pliers

Removal

1. Remove the leadscrew as instructed on previous pages.
2. Use needle nose pliers (or hemostats) to remove the e-ring from the cam in the carriage plate.
3. Using ¼" open end wrench and Phillips screw driver, remove 3 pan head screws with Nylock nuts holding the carriage plate.
4. Use the needle nose pliers to remove either:
   - the clutches; **use caution in separating the clutches because of the spring**.
   - the cam; pull straight out and separate from the square shaft.

Installation

1. For replacement of:
   - the cam: first verify the shaft is seated to the plunger lever, then press the cam gear on the shaft.
   - the clutches: put the clutch halves together (closed) and press the spring into place, then slide the clutch halves into the carriage.
2. Feed the pan head screws though the carriage then the carriage plate, then secure with nylon nuts. Nuts should be on top of the carriage plate not the carriage. Torque to 100 in oz (0.71 Nm).
3. Snap the e-ring over the cam sticking through the carriage plate.
4. Replace the leadscrew as instructed on previous pages.

Follow retest guidelines listed in the Calibration and Adjustment section to verify pump functionality before returning it to use.

Plunger cable

Removal

1. Remove the leadscrew as instructed on previous pages.
2. Using ¼" open end wrench and Phillips screw driver, remove the 3 pan head screws with Nylock nuts holding the carriage plate. Pull the plate with the cam and square shaft attached.
3. Open the plunger case right as instructed on page 82.
4. Unplug the plunger cable from the Plunger PCB and pull the cable out of the slot in the force mount and plunger tube.
5. At the carriage, turn the plunger cable connector in line with the cable, and pull the cable out through the plunger head.

Installation

1. Take the new plunger cable, with the smaller exposed braid area towards the carriage, turn connector in line with the cable, then thread the cable through the plunger tube.
2. Plug the cable into the Plunger PCB, then press the braided portion into the slot of the force mount and plunger tube. This should leave about 2" (5cm) of cable sticking out the notched end of the plunger tube.
3. Press the square shaft on the cam, the cam through the carriage plate (check orientation of plate) and snap the e-ring on the cam.
4. Slide the carriage plate with clutch cam and shaft into the plunger tube.
5. Feed the pan head screws though the carriage then the carriage plate, then secure with nylon nuts. Nuts should be on top of the carriage plate not the carriage. Torque to 100 in oz (0.71 Nm).
6. Close the plunger case as instructed on page 82.
7. Replace the lead screw as instructed previously.

Follow retest guidelines listed in the Calibration and Adjustment section to verify pump functionality before returning it to use.

LCD and backlight

Tools Needed

- ¼" open end wrench
- Torque screwdriver with Phillips head & small flat head

Always work at an electrostatic-controlled work station when disassembling the pump.

Important: Model 3500 pumps manufactured more recently have a new LCD display that does not require the backlight, LED cable or spacer. As such, separate instructions for removing and installing both the old-style and new-style are provided.

Removing old-style LCD and/or backlight assembly

1. Disconnect the pump from AC power source.
2. Open the pump housing, remove battery pack, and separate the top and bottom halves (as described on previous pages).
3. Disconnect the display cable from the Main PCB at J12.
4. Use a small flat blade screwdriver to loosen the 2 screws connecting the fiber optic backlight to the Main PCB (J7). Pull the fiber cable assembly from the terminal block.
5. If the backlight has a 2nd fiber optic tail, cut the wire tie anchoring its connecting cable and separate the 2nd tail from the connecting cable.
6. With ¼" open end wrench, remove the 2 Nylock nuts securing the display.
7. Carefully lift the display assembly from the top housing.
8. Slide the backlight and spacer from the display assembly.

Removing new-style LCD display (70-0311 or 70-0513)

1. Disconnect the pump from AC power source.
2. Open the pump housing, remove battery pack, and separate the top and bottom halves (as described on previous pages).
3. Disconnect the display cable from the Main PCB at J12. Disconnect the red blacklight wire from the Main PCB at connector J8.
4. With ¼" open end wrench, remove the 2 Nylock nuts securing the display.
5. Carefully lift the display assembly from the top housing.

Re-installing an old-style LCD and/or backlight assembly

Note: If any part of the display or backlight assembly is damaged, the entire LCD and backlight assembly must be replaced with the new-style LCD display.

Note: If the backlight has 1 fiber optic tail, use two clear plastic spacers in the next step. If the backlight has 2 fiber optic tails, use only one clear plastic spacer in the next step.

1. Place the clear plastic spacer(s) on top of the backlight with the white side of the backlight facing up and the silver side down.
2. Gently slide the backlight and spacer together into the display with the clear plastic spacer toward the display glass.
3. Orient the display with the backlight tail on the side with the keypad cables. Verify there is no lint or dirt on the display.
4. Slide the display onto the ribs in the top of the top housing and over the spacers/studs. Secure the display assembly with the 2 Nylock nuts and tighten with ¼" wrench.
5. Reconnect the display cable to the Main PCB at J12.

   Connect the backlight's shorter fiber optic tail to the round connector on the cable. Be sure to orient the lead closest to the flat edge of the LED into the terminal touching the MELF resistor embedded in the round connector. After completing the next step, anchor both fiber optic tails to the Main PCB with a wire tie.
6. Insert the backlight wires into the Main PCB terminal block (J7). Screw the terminal connector onto the leads with the flat edge of the LED lens toward the outside edge of the PCB. Torque terminal block screws to 32 in oz (0.23 Nm).

Note: If the leads are reversed during installation, the backlight will not turn on. Loosely reassemble the case

halves, plug in the battery, plug pump into AC power and power up pump to check the backlight(s) before completely closing the housing.

7. Close the pump housing as instructed on previous pages.

Installing new-style LCD display (70-0311 or 70-0513)

1. Remove protective plastic from LCD display.
2. Orient the display with the red backlight wire on the same side as the keypad cables. Verify there is no lint or dirt on the display
3. Slide the display onto the ribs in the top of the top housing and over the spacers/studs. Secure the display assembly with the 2 Nylock nuts and tighten with ¼" wrench. Do not over-tighten Nylock nuts.
4. Connect the red backlight wire to the Main PCB at connector J8. On the Main PCB, tighten the screws on terminal block J7.
5. Verify the LCD PCB is secure against the spacers and locknuts. Connect the LCD cable to connector J12.
6. Close the pump housing as instructed on previous pages.

Verify LCD/backlight function

1. Plug the pump into AC power and press POWER (⏻) to turn it on.
2. Watch the screen during startup and self-testing.

Note: To adjust the display contrast, see the section on calibration and adjustment.

3. After self-testing completes, set the pump in a darkened area and verify the backlight is functioning.

Follow retest guidelines listed in the Calibration and Adjustment section to verify pump functionality before returning it to use.

Keypad

Tools needed

- ¼" open end wrench
- Torque screwdriver with a Phillips head & small flat blade

Always work at an electrostatic-controlled work station when disassembling the pump.

Removing the keypad

1. Disconnect the pump from AC power source.
2. Open the pump housing, remove battery pack, and separate the top and bottom halves (as described on previous pages).
3. Disconnect the Interconnect ribbon cable from J9 on the Main PCB.
4. *Old-style LCD with backlight pigtail(s):* Loosen the 2 terminal block (J7) screws connecting the fiber-optic backlight to the Main PCB. Then, carefully pull the leads from the connector. If a 2nd backlight LED is present, disconnect its cable at the Main PCB and clip the wire tie securing it to the Main PCB. *New-style LCD with built-in backlight:* Disconnect red backlight cable from J8 on Main PCB.
5. Disconnect the keypad cables at J10 on the Main PCB.
6. Disconnect the display cable at J12 on the Main PCB.
7. Remove the 2 pan head screws securing the Main PCB, and then loosen the Main PCB. It is not necessary to remove the Main PCB, or disconnect all cables from it, to access the keypad.
8. With ¼" open end wrench, remove the 2 Nylock nuts securing the Display PCB, and remove the display from the top housing.
9. With ¼" open end wrench, remove 1 hex head standoff nearest to the motor, and carefully slide out the keypad ground tab from between the top housing boss and the extrusion.
10. Press on the inside of the clear lens (window) to loosen the keypad and peel the keypad from the top housing.

Replacing the keypad

CAUTION: ***The Keypad is NOT Flexible:*** Whenever handling the keypad, always ensure it remains flat. Bending the keypad can damage keys or break LED contacts.

1. Clean the clear lens with a soft cloth. Ensure there is no lint or fingerprints on the lens.
2. Ensure the inside of the new keypad window is clear of lint or fingerprints.
3. Remove the backing from the keypad. Feed the 3 keypad cables through the housing window. Slide the clear lens into the cutout of the case top.
4. Align the keypad and carefully press into the recess in the case top. Keep the keypad as flat as possible.
5. Slide the keypad ground tab between the extrusion and the top housing boss. Be sure the black side of the tab faces toward the extrusion. Replace the hex head standoff into the extrusion securing the ground tab. Torque to 100 in oz (0.71 Nm).
6. Slide the display assembly into the ribs on the top housing, and secure it with 2 Nylock nuts.
7. Reposition the Main PCB and secure with 2 pan head screws. Torque to 60 in oz (0.42 Nm).
8. Reconnect the display cable to J12, the keypad cables to J10.
9. *Old-style LCD with backlight pigtail(s):* Insert the backlight wire(s) into the Main PCB terminal block (J7). Screw the terminal connector onto the leads with the flat edge of the LED lens toward the outside edge of the PCB. Torque terminal block screws to 32 in oz (0.23 Nm). If present, connect the 2nd backlight LED's cable to J8. *New-style LCD with built-in backlight:* Connect red backlight cable to J8 on Main PCB.

Note: If the leads are reversed during installation, the backlight will not turn on. Loosely reassemble the case halves, plug in the battery, and power up pump to check the backlight before completely closing the housing.

10. *Old-style LCD with backlight pigtail(s):* If a 2nd backlight LED is present, secure the fiber optic cable to the Main PCB with a wire tie.
11. Close the pump case and reinstall the battery pack as instructed on previous pages.

Follow retest guidelines listed in the Calibration and Adjustment section to verify pump functionality before returning it to use.

Syringe barrel clamp assembly

Tools Needed

- Torque screwdriver with a Phillips head & 1/16" hex head
- ¼" wrench
- Small vise-grip pliers

Always work at an electrostatic-controlled work station when disassembling the pump.

Barrel clamp head

Removal

1. Lift the barrel clamp head until the screw is accessible, then use a vise grips to clamp near the base of the barrel clamp rod to hold it in place.
2. Using a 1/16" hex wrench, remove the hex head screw from the barrel clamp head.
3. Pull the barrel clamp head off of the barrel clamp rod.

Installation

1. Align the hole in the barrel clamp rod with the barrel clamp head, and press the head onto the rod; insert the Phillips head Nylock screw and partially tighten it. Apply a light layer of silicone grease (Grease, Silicone, 111 Compound, Smiths Medical part number 0382000000) to the rod to ensure proper operation.
2. "Hook" the barrel clamp head on the pump handle on the top of the pump housing and tighten the screw to 100 in.-oz. (0.71 Nm) torque.

Verify Function

1. Verify the barrel clamp head moves up and down, and will rotate when fully extended.

Follow retest guidelines listed in the Calibration and Adjustment section to verify pump functionality before returning it to use.

Barrel clamp body assembly

Removal

1. Remove the barrel clamp head as instructed previously.

2, Open the pump housing and separate the top and bottom halves (as described on previous pages).
3. Using a ¼" wrench and Phillips screwdriver, remove 2 pan head screws with Nylock nuts which hold the barrel clamp assembly. These screws are located on the right end plate of the drive train assembly.
4. Unplug the barrel clamp flex circuit from J4 of the Main PCB.
5. Gently slide barrel clamp assembly out of the case avoiding the fingers extending from the right end plate around the plunger tube.
6. Remove the small screw holding the pot to the barrel clamp assembly.
7. Carefully lift the pot up off alignment bosses and out of the fingers on the slide.

Installation

1. Align a new pot into the fingers of the slide on the barrel clamp assembly and press onto the bosses.
2. Secure the pot with the small screw. Tighten until the screw is flush with the pot. **Do not over-tighten**.
3. Carefully slide the barrel clamp body assembly into the case. Push the rod through the hole in top of the case.
4. Secure the barrel clamp assembly with 2 pan head screws with Nylock nuts. Torque to 100 in oz (0.71 Nm).
5. Plug the barrel clamp flex circuit into J4 of the Main PCB.
6. Close the pump housing as instructed on previous pages.
7. Replace the barrel clamp head and verify its function as described on the previous page.

Ear clip, handle & guide

Tools Needed

- Torque screwdriver with a Phillips head & ¼" nut drive
- Needle nose pliers (two pairs)

Always work at an electrostatic-controlled work station when disassembling the pump.

Ear clip

Removal

1. Open the pump housing (as described on previous pages), and set up the case top section with the handle down and Main PCB facing up.
2. Use one pair of needle nose pliers to press the ear clip sleeve towards the case wall, then use a second set of pliers (or hemostats) to pull the e-ring off of the ear clip.

Note: On older pumps the sleeve is not present, so use the 1st set of pliers to pull the spring towards the case wall.

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3. Slide the ear clip out of the top housing assembly.

Installation

1. Partially insert the new ear clip through the side of the case, then slide the spring onto the shaft of the ear clip.
2. Slide the sleeve over the ear clip with the hollow end of the sleeve towards the spring.
3. Ensure the ear clip faces the "V" groove in the case top, then press the ear clip into the case. Use one pair of needle nose pliers to compress the sleeve (and/or spring) and use a second set of needle nose (or hemostats) to snap e-ring into the groove on the ear clip.
4. Pull on the ear clip and release it. Verify that the ear clip moves smoothly out and is pulled back flush to the case by the spring when released.
5. Close the pump housing as instructed on previous pages.

Ear clip optical sensor

Removal

1. Open the pump housing (as described on previous pages), and set up the case top section with the handle down and Main PCB facing up.
2. Remove the Main PCB as described previously.
3. Squeeze the plunger lever and fully extend the plunger head away from the case.
4. Remove the pan head screws and standoffs holding the extrusion (drive train assembly). Remove the pan head screws and Nylock nuts holding the barrel clamp assembly to the extrusion.

5. Partially slide the extrusion out of the case until the ear clip sensor is visible.
6. Remove the pan head screw holding the sensor and remove the ear clip optical sensor.

Installation

1. Look at the old ear clip sensor, then use a wire cutters to carefully cut a similar portion of the plastic tab/mounting hole in the new sensor to allow clearance for the display connector.
2. Slide the ear clip sensor onto the post in the case top, with the grey side of the sensor away from the display.
3. Secure the sensor with the pan head screw. Torque to 100 in oz (0.71 Nm).
4. Carefully slide the extrusion (drive train assembly) back into case.
5. Ensure the right end plate on extrusion does not damage the ear clip sensor.
6. Ensure the plunger cable comes out between the middle boss and the boss by the motor.
7. Slide the keypad ground tab (black side toward extrusion) between the boss by the motor and the extrusion.
8. Secure the extrusion with 3 standoffs and 3 pan head screws. Torque to 100 in oz (0.71 Nm).
9. Secure the barrel clamp assembly to the extrusion with 2 pan head screws and Nylock nuts. Torque to 100 in oz (0.71 Nm).
10. Reinstall the Main PCB as described previously.
11. Close the pump housing as instructed on previous pages.

Handle

Removal

1. Open the pump housing (as described on previous pages), and set up the case top section with the handle down and Main PCB facing up.
2. Remove the Main PCB as described previously.
3. Squeeze the plunger lever and fully extend the plunger head away from the case.
4. Remove the pan head screws and standoffs holding the extrusion (drive train assembly). Remove the pan head screws and Nylock nuts holding the barrel clamp assembly to the extrusion.
5. Partially slide the extrusion out of the case until the two handle screws are visible.
6. Remove 2 pan head screws holding the handle and remove the handle.

Installation

1. Place a new handle on the case top and secure with 2 pan screws with washers through the inside of the case.
2. Carefully slide the extrusion with plunger tube back into the case.
3. Carefully slide the extrusion (drive train assembly) back into case.
4. Ensure the right end plate on the extrusion does not damage the ear clip sensor.
5. Ensure the plunger cable comes out between the middle boss and the boss by the motor.
6. Slide the keypad ground tab (black side toward extrusion) between the boss by the motor and the extrusion.
7. Secure the extrusion with 3 standoffs and 3 pan head screws. Torque to 100 in oz (0.71 Nm).
8. Secure the barrel clamp assembly to the extrusion with 2 pan head screws and Nylock nuts. Torque to 100 in oz (0.71 Nm).
9. Reinstall the Main PCB as described previously.
10. Close the pump housing as instructed on previous pages.

Tubing guide

Removal

1. Open the pump housing (as described on previous pages), and set up the case top section with the handle down and Main PCB facing up.
2. Remove the Main PCB as described previously.
3. Squeeze the plunger lever and fully extend the plunger head away from the case.
4. Remove the pan head screws and standoffs holding the extrusion (drive train assembly). Remove the pan head screws and Nylock nuts holding the barrel clamp assembly to the extrusion.

5. Partially slide the extrusion out of the case until the 3 tubing guide screws are visible.
6. Remove the pan head screw holding the tubing guides and remove the tubing guides. Note the orientation of each tubing guide.

Installation

1. Place each tubing guide onto the case top and secure with a pan head screw and nylon washer. The bumps on the case top help ensure correct orientation of each guide. Torque to 60 in oz (0.42 Nm).
2. Carefully slide the extrusion (drive train assembly) back into case.
3. Ensure the right end plate on the extrusion does not damage the ear clip sensor.
4. Ensure the plunger cable comes out between the middle boss and the boss by the motor.
5. Slide the keypad ground tab (black side toward extrusion) between the boss by the motor and the extrusion.
6. Secure the extrusion with 3 standoffs and 3 pan head screws. Torque to 100 in oz (0.71 Nm).
7. Secure the barrel clamp assembly to the extrusion with 2 pan head screws and Nylock nuts. Torque to 100 in oz (0.71 Nm).
8. Reinstall the Main PCB as described previously.
9. Close the pump housing as instructed on previous pages.

Plunger case assembly

Tools needed

- Torque screwdriver with a Phillips head & 2.5mm hex head
- Needle nose pliers
- Safety glasses

Always work at an electrostatic-controlled work station when disassembling the pump.

Plunger lever

Removal

1. Remove the pan head screw from the lever.
2. Pull the plunger lever off the lever gear.

Installation

1. Position a new plunger lever onto the lever gear and secure with the pan head screw. Torque to 60 in oz (0.42 Nm).

Plunger case disassembly

WARNING: While servicing the Medfusion® Model 3000 Series pump, wear safety glasses as it contains springs and other small parts which may be a hazard.

Important: The plunger PCB provides pre-amplification of the force sensor output to the Main PCB, and contains two photo-interrupters with supporting circuitry for sensing each plunger flipper position. Whenever opening the plunger case assembly, always verify the Plunger PCB is secured to the plunger case assembly. Additionally, if the timing plate is not properly positioned, syringe (including size) sensing may be compromised.

Disassembly

1. Stand the pump up on its left side so that the plunger assembly points vertically up. Squeeze the plunger lever and position the plunger driver for disassembly.
2. Remove 3 pan head screws holding the plunger case halves together (do not remove screw on lever).
3. Remove the plunger case right and remove the plunger case seal. The lever gear will be attached to the plunger case right. The square shaft may come out with the plunger case right; if so, pull the shaft out of the lever gear and slide the shaft down the plunger tube to gently press into the cam.

Reassembly

1. Remove any slack in the movement of the square shaft by turning it counterclockwise. With the plunger lever positioned up against the long rib on the plunger case right, join the two case halves together pressing the lever gear over the square shaft.
2. Start the 3 pan head screws into the plunger case halves, with the long screw into the tall rib of the case.

3. Before tightening, press the plunger case seal into the gaps between the case halves. Ensure the seal is positioned properly between the halves then tighten the plunger case screws. Torque to 60 in oz (0.42 Nm).

Follow retest guidelines listed in the Calibration and Adjustment section to verify pump functionality before returning it to use.

Cam gear and timing plate

WARNING: While servicing the Medfusion® Model 3000 Series pump, wear safety glasses as it contains springs and other small parts which may be a hazard.

Removal

1. Open the plunger case halves as described previously.
2. Lift the cam gear off of the pin.
3. Remove the push block.
4. Press the timing plate upward and lift it carefully to remove timing plate spring and timing plate.

Note: The timing plates are asymmetrical (left and right handed).

Installation

1. Rotate the right flipper until it stops against the "V" groove on the plunger case.
2. Insert the spring into the timing plate right. Slide the spring over the post in the side wall of the plunger case.
3. Slowly lower timing plate into the plunger case slot – as far down the slot as possible toward the optical sensor on the Plunger PCB – while lining up the gears. The gear should engage with the third space on the timing plate.
4. Repeat this process for the left flipper and left timing gear.
5. Place the push block on top of the timing plate.
6. Place the cam gear over the pin (check assembly drawing for orientation) and up against push block.
7. Verify timing plate placement and that the flippers are in sync (see below).
8. Close plunger case halves as previously described.

Verify timing plate placement and flipper gears are in place

1. While holding the two flippers fully open in a "V" shape, check the position of the left and right flipper gears with the left and right timing plates.
2. With the flippers held down, count three spaces from the top of the timing plate. Both gears should be engaged with the third slot on both timing plates to be synchronized.
3. Use the **Biomed > Diagnostic > Monitor Digital Sensors** menu on the pump to verify that both timing plates move the same distance at the same time. If the diagnostic test fails, reposition the timing plates according to the instructions above, and re-perform the verification.

Flipper and flipper gear

Removal

1. Disassemble the plunger case and remove the timing plates as previously described.
2. Use the needle nose pliers to compress the flipper shaft inside the flipper gear. Gently pull on the flipper while compressing the shaft.
3. Slide the O-ring seal off of the flipper. (Inspect the O-ring and replace if damaged; otherwise, clean with soap and water.)

Installation

1. Slide the O-ring seal over the flipper.
2. Insert the flipper through the plunger case and snap onto the flipper gear. (Ensure gear recess faces out from case – if the gear is installed incorrectly then flipper will not snap in place. If the flipper gear is damaged replace flipper gear.)
3. Install the timing plates as described previously and reassemble the plunger case halves.

Plunger PCB

Note: Ensure plunger head is fully extended away from the pump housing before starting.

Additional tools needed

- .002" (.051mm) shim
- Loctite® Adhesive

- Activator (Smiths Medical P/N 30-2693)

Removal

1. Disassemble the plunger case and remove the timing plates as previously described.
2. Gently pull on the plunger cable unplugging it from connector J2. Unplug force sensor cable from J1 on Plunger PCB.
3. Using a Phillips screwdriver, remove the pan head screw with washer from the force mount assembly.
4. **On newer assemblies it is not necessary to remove float plate seal and float plate**. Gently try to pull the plunger case left towards the pump. If it comes apart skip to step 7 below, otherwise remove float plate seal and float plate.
5. Grab the float plate seal with a pliers (or hemostats) and pull off from the plunger case left. (The float plate seal is glued in place and may be damaged in removal.)
6. Using a metric 2.5mm hex wrench, remove the screw holding the float plate.
7. Slide the plunger case left toward the pump until the Plunger PCB is accessible, then remove the Plunger PCB.

Installation

1. Insert a new Plunger PCB into the plunger case left (ensure the PCB sits on the two guide pins and does not interfere with the flipper gears).
2. Apply a small amount of adhesive between the edge of the Plunger PCB and the case assembly. Hold the Plunger PCB so it is parallel to the bottom of the plunger case and apply the activator. **IMPORTANT:** Adhesive must not be above the timing plate ridge.
3. Slide the plunger case left up and over the force mount assembly. Secure in place with the flat washer and pan head screw. Torque to 100 in oz (0.71 Nm).
4. Connect the force sensor cable to the Plunger PCB at connector J1 and press the excess cable flat against the PCB.
5. Connect the plunger cable to the Plunger PCB connector J2, and check to ensure the cable remains in the slot through the force mount and plunger tube.
6. If the float plate/seal was not removed, skip to step 7; otherwise, place the float plate into the opening in the plunger case left and start the 2.5mm hex screw into this assembly. Slide a .002" shim between the float plate and wall of the plunger case. Tighten the screw and torque to 100 in oz (0.71 Nm), then remove the shim.
7. Use a sharp tool or knife to clean the slot for the seal. If the seal was damaged, replace it with a new seal. Place small drops of Loctite® 454 (cyanoacrylate adhesive) at four points in the slot and then press the seal into place.
8. Install the timing plates and reassemble the plunger case as previously described.

Force sensor

Note: Ensure plunger head is fully extended away from the pump housing before starting.

Additional tools needed

- .002" (.051mm) shim

Removal

1. Disassemble the plunger case and remove the timing plates as previously described.
2. Gently pull on the plunger cable, unplugging it from connector J2. Unplug the force sensor cable from J1 on the Plunger PCB.
3. Using a Phillips screwdriver, remove the pan head screw with washer from the force mount assembly.
4. **On newer assemblies it is not necessary to remove float plate seal.** Gently try to pull plunger case left towards the pump. If it comes apart, skip to step 6 below, otherwise remove the float plate seal.
5. Grab the float plate seal with pliers or hemostats and pull off from the plunger case left. (The float plate seal is glued in place and may be damaged in removal.)
6. Using a metric 2.5mm hex wrench, remove the screw holding the float plate.
7. Slide the plunger case left toward the pump until

the hex head screw is accessible on the force mount assembly.

8. Using a metric 2.5mm hex wrench, remove the screw holding the force sensor onto the force mount. Note the orientation of the cable on the force mount.

Installation

1. Install the force sensor onto the force mount bracket with the 2.5mm hex screw. (Ensure the cable of the force sensor faces towards the Plunger PCB and connector J1.) Torque to 100 in oz (0.71 Nm).
2. Slide the plunger case left up and over the force mount assembly. Secure in place with the flat washer and pan head screw. Torque to 100 in oz (0.71 Nm).
3. Connect the force sensor cable to the Plunger PCB at connector J1 and press the excess cable flat against PCB.
4. Connect the plunger cable to the Plunger PCB connector J2, and check to ensure the cable remains in the slot through the force mount and plunger tube.
5. If the float plate seal was not removed, skip to step 7; otherwise, use a sharp tool or knife to clean the slot for the seal. Place the float plate into the opening in the plunger case left and start the 2.5mm hex screw into this assembly. Slide a .002" shim between the float plate and wall of the plunger case. Tighten the screw and torque to 100 in oz (0.71 Nm), then remove shim.
6. If the seal was damaged, replace it with a new seal. Place small drops of Loctite® 454 (cyanoacrylate adhesive) at four points in the slot and then press the seal into place.
7. Install the timing plates and reassemble the plunger case as previously described.

Left plunger case

Note: Ensure plunger head is fully extended away from the pump housing before starting.

Additional tools needed

- .002" (.051mm) shim

Removal

1. Disassemble the plunger case and remove the timing plates as previously described.
2. Remove the plunger flippers and the gears as previously described.
3. Gently pull on the plunger cable, unplugging it from connector J2. Unplug the force sensor cable from J1 on the Plunger PCB.
4. Using a Phillips screwdriver, remove the pan head screw with washer from the force mount assembly.
5. **On newer assemblies it is not necessary to remove float plate seal.** Gently try to pull the plunger case left towards the pump. If it comes apart skip to step 8 below, otherwise remove the float plate seal.
6. Grab the float plate seal with pliers or hemostats and pull off from the plunger case left. (The float plate seal is glued in place and may be damaged in removal.)
7. Using a metric 2.5mm hex wrench, remove the screw holding the float plate.
8. Slide the plunger case left toward the pump until the two small flat head screws are accessible on the force mount. Unscrew 2 flat head screws on the force mount. Pull the plunger cable out of the slot on the force mount bracket and plunger tube. Slide off the force mount assembly from the plunger tube.
9. Slide the plunger case left off of the plunger tube.

Installation

1. Install the flippers and flipper gears into plunger case left as previously described.
2. Transfer the Plunger PCB into the plunger case.
3. Slide the plunger case left onto the plunger tube. (Ensure the case is correctly oriented.)
4. Thread the plunger cable through the force mount assembly and slide the assembly onto the plunger tube; align screw holes and cable slot. Apply Loctite® 242 (a mild thread-locking adhesive) to the flat head screws and secure the force mount to the plunger tube. Torque to 100 in oz (0.71 Nm). **Be careful not to cross-thread screws**.

5. Slide the plunger case left up and over the force mount assembly. Secure in place with the flat washer and pan head screw. Torque to 100 in oz (0.71 Nm).
6. Connect the force sensor cable to the Plunger PCB at connector J1 and press the excess cable flat against the PCB.
7. Press the plunger cable into the slot though the plunger tube, force mount, and plunger case left. Ensure the exposed braid of the cable touches metal on the force mount or plunger tube.
8. Connect the plunger cable to the Plunger PCB connector J2, and check to ensure the cable remains in the slot through the force mount and plunger tube.
9. If the float plate seal was not removed, skip to step 11. Place the float plate into the opening in the plunger case left and start the 2.5mm hex screw into this assembly. Slide a .002" shim between the float plate and wall of the plunger case. Tighten screw and torque to 100 in oz (0.71 Nm), then remove the shim.
10. Use a new seal. Place small drops of Loctite® 454 (cyanoacrylate adhesive) at four points in the slot and then press the seal into place.
11. Install the timing plates and reassemble the plunger case as previously described.

Using Biomed > Calibration

This section explains the use of **Biomed Calibration** for the calibration of internal sensors of the Medfusion® Model 3000 Series pumps.

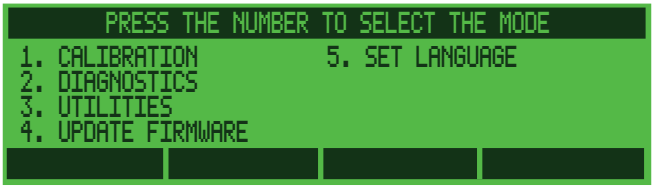
Biomed > Calibration

In order to complete the calibration of the Medfusion® Model 3000 Series pumps, the *Smiths Medical Medfusion® Model 3000 Series Calibration Kit* is required. This kit contains one (each) of the following:

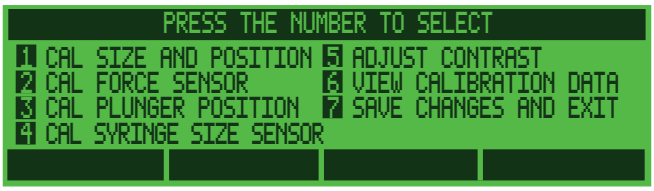
- Small Calibration Slug
- Large Calibration Slug
- Force Gauge

Note: The equipment supplied in the Calibration Kit should be added to the facility's annual calibration and maintenance schedule.

To access **Biomed** > **Calibration**, from the **Main** menu use the **number** keys to choose **Biomed** (if necessary, press **More** to find it; if a custom Configuration is installed, you may need to press **Main Menu**, then **More**). Enter the Passcode (***2580***) then press **Enter**.



Use the **number** keys to select **Calibration**.



Below is table which summarizes the options available for calibration.

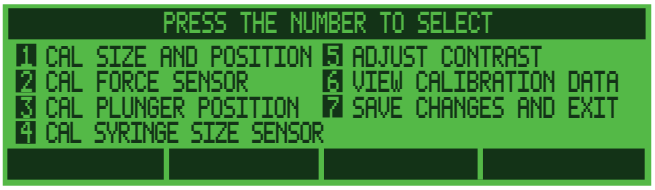
Calibration Option	What it Controls
Calibrate (Syringe) Size and Position	Performs concurrent adjustment of syringe size & position sensors settings. This requires Smiths Medical "calibration slugs".
Calibrate Force Sensor	Performs adjustment of force sensor settings.
Calibrate Pressure Sensor	Not used.
Calibrate Plunger Position Sensor	Performs adjustment of plunger position sensor settings.
Calibrate Syringe Size Sensor	Performs adjustment of syringe size sensor setting.
Adjust Contrast	Varies the onscreen contrast of the LCD. The pump is shipped with a "factory average" default. It can be set above or below for "comfortable" viewing.
View Calibration Data	Displays the "current" calibration data settings.
Save Changes and Exit	Saves the new calibration settings and then returns to the main **BIOMED** menu.

Calibrate (Syringe) size and position

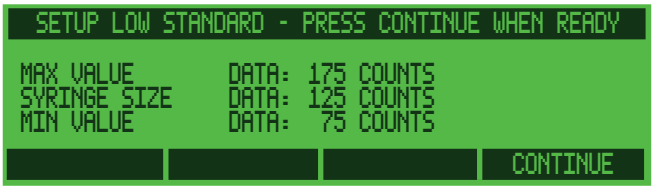
This procedure calibrates both the syringe size sensor and the syringe position sensor. The syringe size sensor is part of the barrel clamp assembly and measures the syringe barrel external diameter allowing the software to determine the syringe size loaded onto the pump. The syringe position sensor is part of the drive train assembly and measures the plunger head position allowing the software to determine the empty position and plunger head travel.

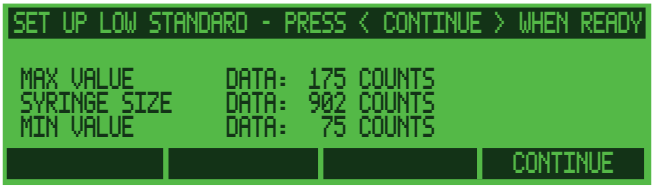
Performing both size & position calibration

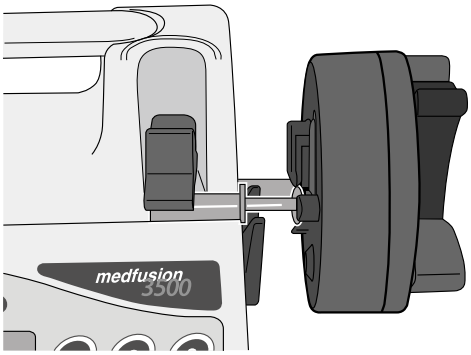
1. From the **Calibration** menu, use the **number** keys to choose **Cal Size and Position**.



2. Load the small calibration slug into the barrel clamp. Keeping the barrel clamp perpendicular to the slug, move the clamp slightly back and forth to find the lowest size reading, then press **Continue** to calibrate the small size.





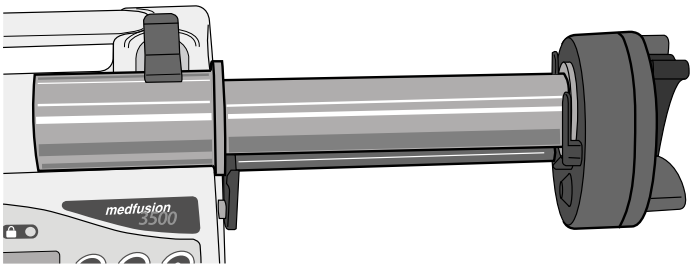


3. Squeeze the plunger lever to hold the flippers open, move the plunger head against the small slug, and press **Continue** to calibrate the low position.

```
SETUP LOW STANDARD - PRESS CONTINUE WHEN READY

MAX VALUE      DATA: 200 COUNTS
PLUNGER POS    DATA: 151 COUNTS
MIN VALUE      DATA: 100 COUNTS

                              CONTINUE
```

```
SET UP LOW STANDARD - PRESS < CONTINUE > WHEN READY

MAX VALUE      DATA: 200 COUNTS
PLUNGERR POS   DATA: 559 COUNTS
MIN VALUE      DATA: 100 COUNTS

                              CONTINUE
```

4. Load the large calibration slug into barrel clamp. Keeping the barrel clamp perpendicular to the slug, move the clamp slightly back and forth to find the lowest size reading, then press **Continue** to calibrate large size.




```
SETUP HIGH STANDARD - PRESS CONTINUE WHEN READY

MAX VALUE      DATA: 1024 COUNTS
SYRINGE SIZE   DATA:  975 COUNTS
MIN VALUE      DATA:  925 COUNTS

                              CONTINUE
```

```
SET UP HIGH STANDARD - PRESS < CONTINUE > WHEN READY

MAX VALUE      DATA: 1024 COUNTS
SYRINGE SIZE   DATA:  125 COUNTS
MIN VALUE      DATA:  850 COUNTS

                              CONTINUE
```

5. Squeeze the plunger lever to hold the flippers open, move the plunger head against the large slug, and press **Continue** to calibrate high position.

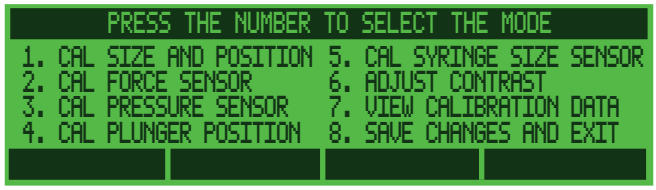
```
SETUP HIGH STANDARD - PRESS CONTINUE WHEN READY

MAX VALUE      DATA: 175 COUNTS
PLUNGER POS    DATA: 125 COUNTS
MIN VALUE      DATA:  75 COUNTS

                              CONTINUE
```

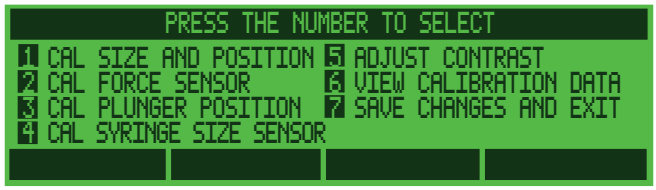
```
SET UP HIGH STANDARD - PRESS < CONTINUE > WHEN READY

MAX VALUE      DATA: 950 COUNTS
PLUNGER POS    DATA: 901 COUNTS
MIN VALUE      DATA: 850 COUNTS

                              CONTINUE
```

6. Return to the **Calibration** menu. Calibrate another mode, choose **Save Changes and Exit** to exit calibration, or press BACK (↩) to return to the **Biomed** menu ***without saving***.

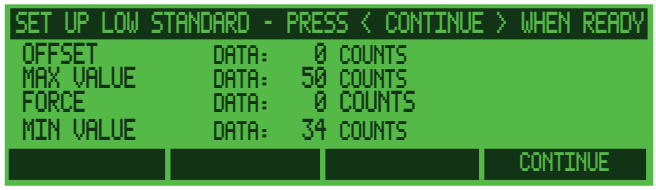
Calibrate force sensor

1. From the **Calibration** menu, choose **Cal Force Sensor**.

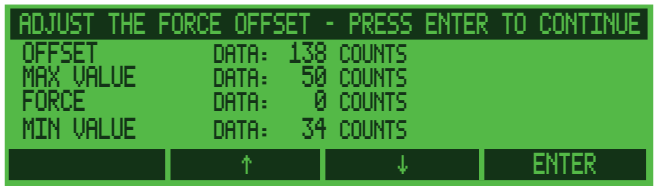


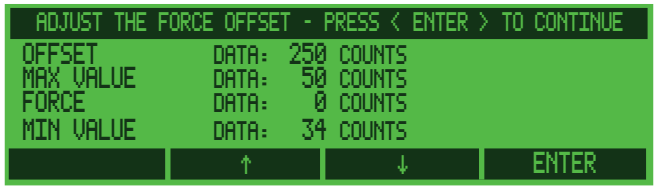


2. Make sure nothing is loaded in the plunger head, press **Continue** and wait until force sensor zero is finished.



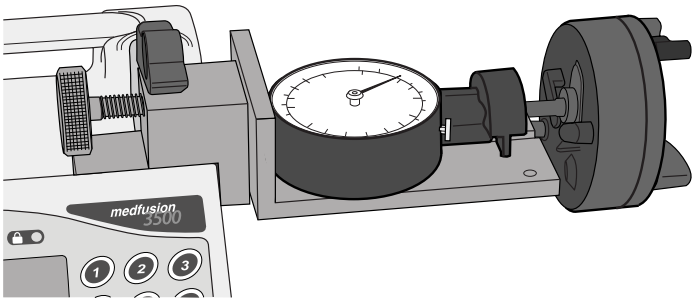
3. The pump then auto-zeroes the force sensor's offset (this takes about 40 seconds). ***Do not use arrow keys***.





4. Press **Enter** when zeroing is complete.

5. Press the zero button on the force gauge. Load the force gauge under the barrel clamp resting flush on the case top. Ensure the flippers are below (closed under) the force gauge head, and use the thumbscrew to adjust the gauge to 10 lbs. ±0.2, then press **Continue**. The force calibration is complete.
6. Return to the **Calibration** menu. Calibrate another mode, choose **Save Changes and Exit** to exit calibration, or press BACK (↩) to return to the **Biomed** menu ***without saving***.

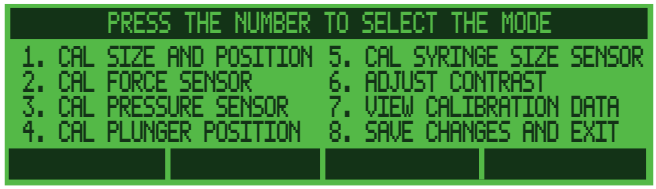


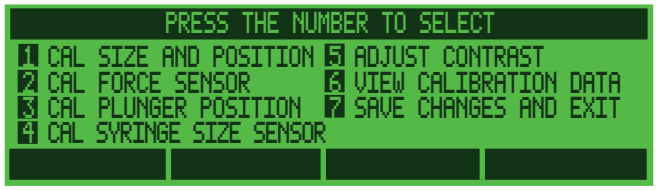
Calibrate pressure sensor (unused option)

Do not use, this is an "unused option" of the Medfusion® Model 3000 Series pump.

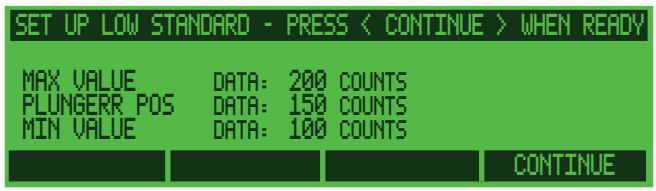
Calibrate plunger position

1. From the **Calibration** menu, choose **Cal Plunger Position**.

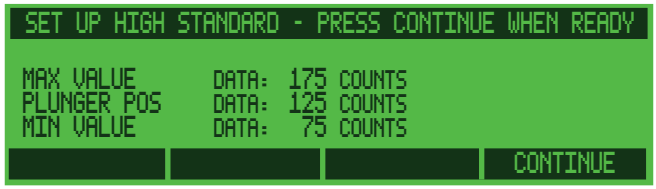


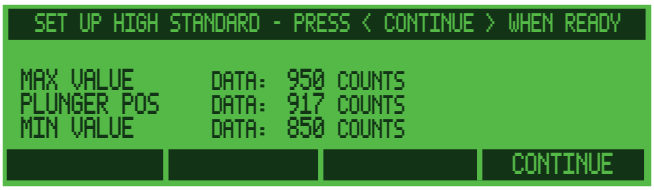


2. Load the small calibration slug into the barrel clamp. Squeeze the plunger lever to hold the flippers open, move the plunger head against the small slug, and press **Continue** to calibrate the low position.



3. Load the large calibration slug into barrel clamp. Squeeze the plunger lever to hold the flippers open, move the plunger head against the large slug, and press **Continue** to calibrate high position.

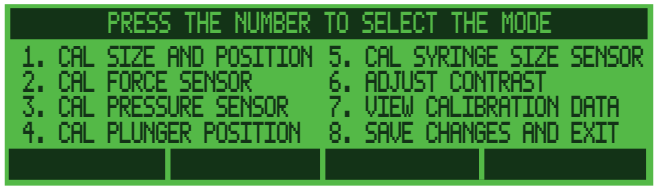


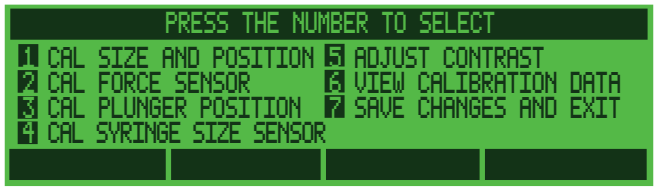


4. Return to the **Calibration** menu. Calibrate another mode, choose **Save Changes and Exit** to exit calibration, or press BACK ( ) to return to the **Biomed** menu ***without saving***.

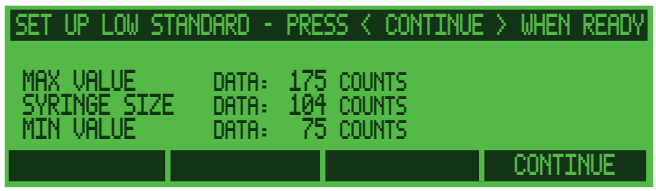
Calibrate syringe size sensor

1. From the **Calibration** menu, choose **Cal Syringe Size Sensor**.

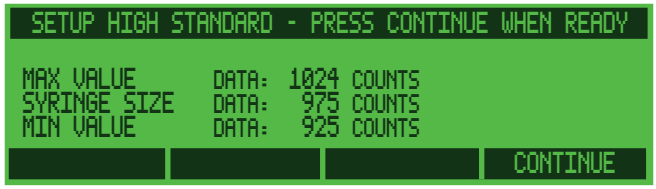


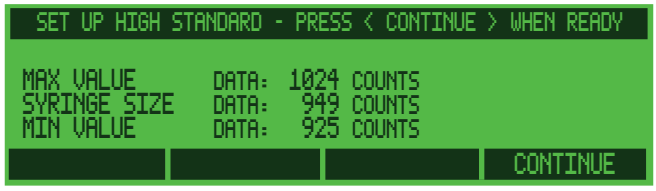


2. Load the small calibration slug into the barrel clamp. Keeping the barrel clamp perpendicular to the slug, move the clamp slightly back and forth to find the lowest size reading, then press **Continue**.



3. Load the large calibration slug into barrel clamp. Keeping the barrel clamp perpendicular to the slug, move the clamp slightly back and forth to find the lowest size reading, then press **Continue** to calibrate large size.



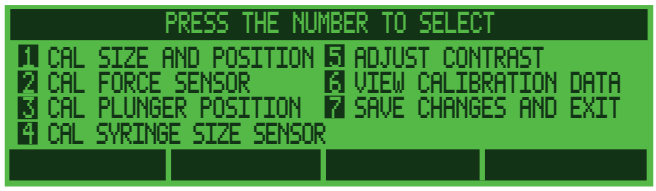


4. Return to the **Calibration** menu. Calibrate another mode, choose **Save Changes and Exit** to exit calibration, or press BACK ( ) to return to the **Biomed** menu ***without saving***.

Adjust contrast (voltage) setting

The factory default contrast voltage setting is 00BF (however this value may vary for different LCD display manufactures). This is the nominal setting for most lighting conditions and may be adjusted higher or lower.

1. From the **Calibration** menu, choose **Adjust Contrast**.



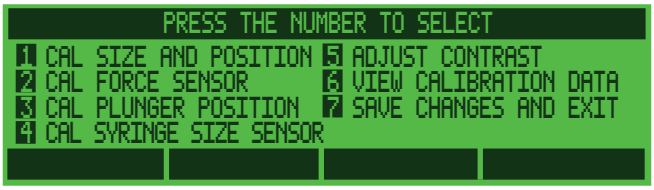
2. Use the "↑" and "↓" keys to set up the contrast voltage. "↑" increases contrast.

3. When ready, press **Enter** to accept the new contrast voltage setting and return to the **Calibration** menu. Calibrate another mode, choose **Save Changes and Exit** to exit calibration, or press BACK (↩) to return to the **Biomed** menu ***without saving***.

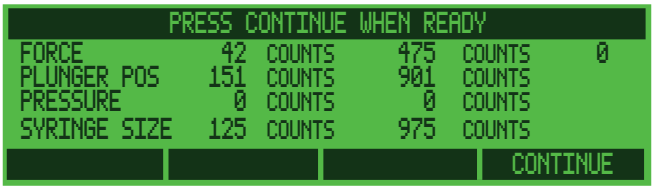
View calibration data

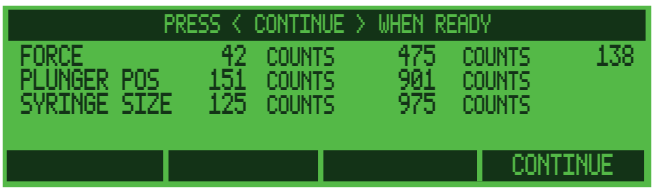
This feature displays the pump's calibration data onscreen. This screen is generally used in factory service or for troubleshooting.

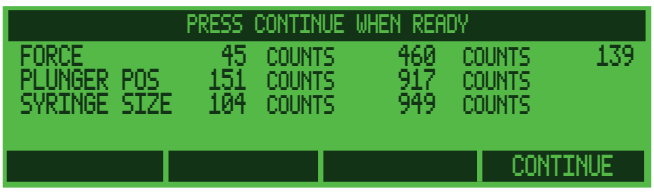
1. From the **Calibration** menu, choose **View Calibration Data**.



2. When ready, press **Continue** to return to the **Calibration** menu. Calibrate another mode, choose **Save Changes and Exit** to exit calibration, or press BACK (↩) to return to the **Biomed** menu ***without saving***.



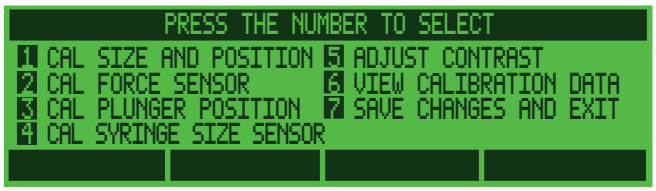




Save changes and exit

This feature is the normal path to save the new calibration values when exiting **Biomed > Calibration**. ***If a mistake occurred in the calibration process press*** BACK (↩) ***to exit*** **Biomed > Calibration** ***without saving any new calibration values.***

1. From the **Calibration** menu, choose **Save Changes and Exit**.



2. Press BACK (↩) to exit **Biomed** and return to the main menu.

Exit calibration without saving changes

The **Calibration** menu can be exited at any time – without saving changes – by pressing BACK (↩).

1. To exit without saving changes, press BACK (↩) to exit and the following screen appears.

2. Press **No** to exit without saving new calibration values.

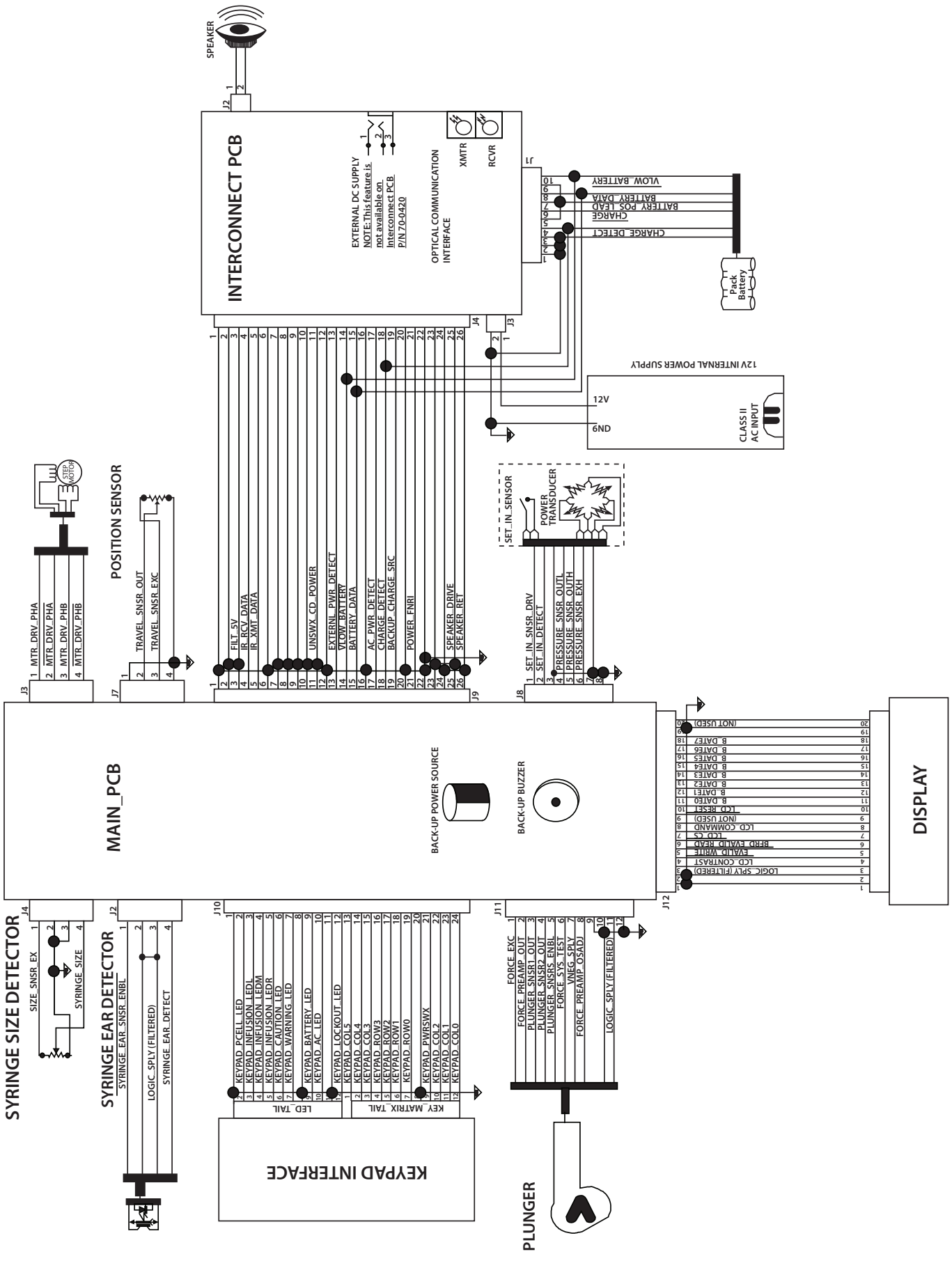
Retest guidelines

The following are minimum guidelines for re-calibration and re-testing after repair.

Repair Type	From Biomed > Calibration, perform:	From Periodic Maintenance, perform:
Pump Opened	None	Quick Check-out
Repair drive-train		
Replace motor	None	Complete Mandatory Annual Maintenance Testing
Replace clutches, square rod, leadscrew, or plunger cable	Recalibrate position & size	Complete Mandatory Annual Maintenance Testing
Repair sensors		
Replace ear clip or ear clip sensor	Recalibrate size	Quick Check-out & Calibration Verification
Replace barrel clamp assy or size pot.	Recalibrate size	Quick Check-out & Calibration Verification
Replace force sensor	Recalibrate force	Quick Check-out & Calibration Verification
Replace position pot	Recalibrate position & size	Quick Check-out & Calibration Verification & Plunger Travel Test
Repair electronics		
Replace speaker	None	Quick Check-out
Replace Interconnect cable	None	Quick Check-out
Replace AC supply	None	Quick Check-out
Replace battery	None	Quick Check-out & after AC charging run Power-up Tests
Replace Interconnect PCB	None	Quick Check-out
Replace keypad, display or backlight	None	Quick Check-out & Calibration Verification
Replace Main PCB	Recalibrate all sensors	Complete Mandatory Annual Maintenance Testing (a Configuration must be created on/sent to the pump following Main PCB or EEPROM replacement)
Replace Plunger PCB	Recalibrate force	Quick Check-out & Calibration Verification
Software Updates		
Reprogramming	See update instructions	See update instructions

Repair Type	From Biomed > Calibration, perform:	From Periodic Maintenance, perform:
Repair case or case parts		
Replace case bottom	None	Quick Check-out
Replace case top	Recalibrate all sensors	Complete Mandatory Annual Maintenance Testing (if Main PCB is replaced with case top assembly, a Configuration must be created on/sent to the pump)
Replace case handle	Recalibrate position & size	Quick Check-out & Calibration Verification
Replace plunger head, or flippers	Recalibrate force	Quick Check-out & Calibration Verification
Replace IR lens	None	Quick Check-out
Replace plunger lever	None	Quick Check-out
Replace pump labels	None	Quick Check-out
Replace feet	None	Quick Check-out
Replace tubing holders	Recalibrate size	Quick Check-out & Calibration Verification

System layout



Circuit diagrams and PCB schematics

Smiths Medical does not allow component-level repairs on printed circuit board assemblies; therefore, circuit diagrams and schematics are not included in this manual.

Assembly drawings

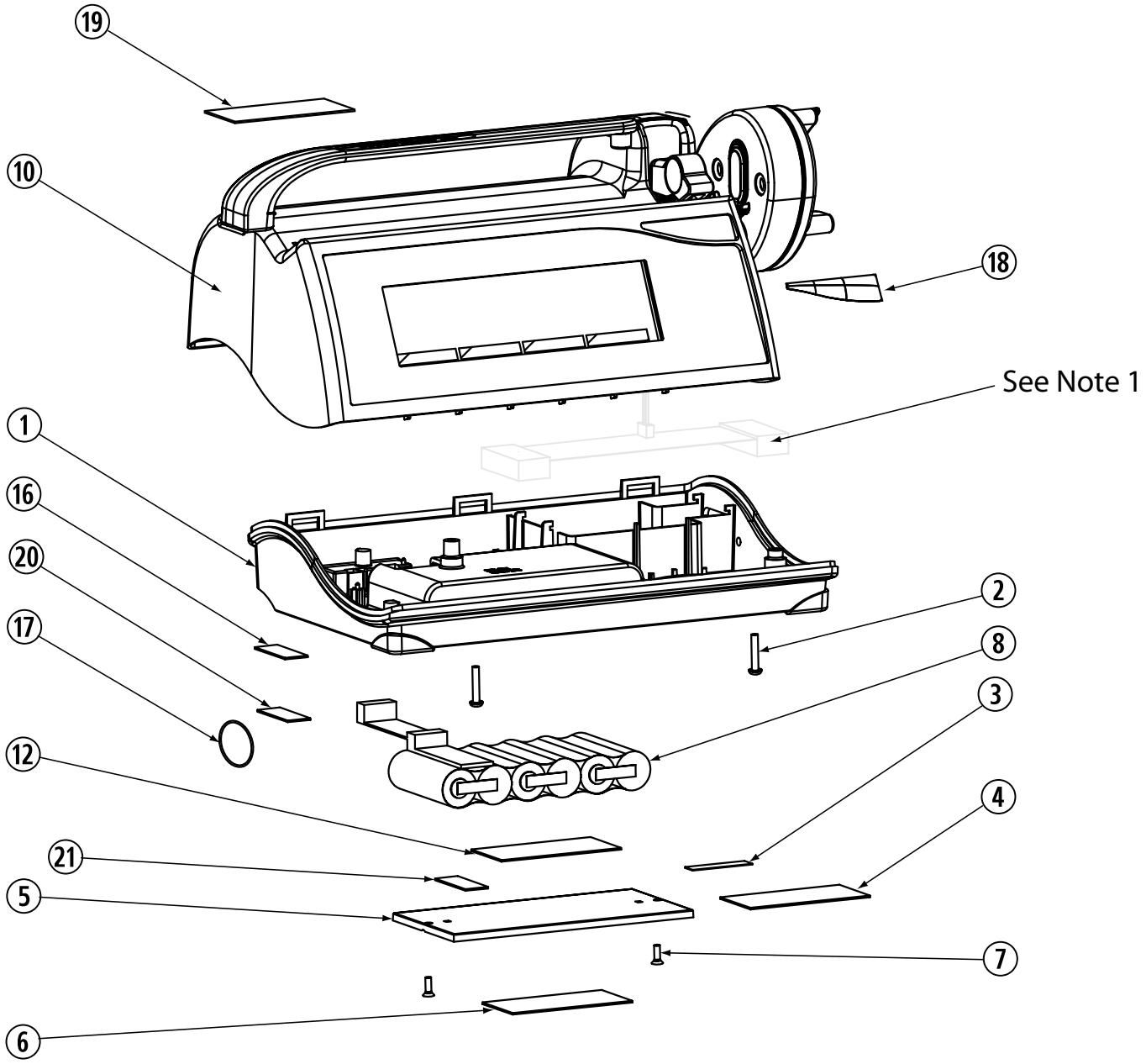
The following section provides assembly drawings – exploded views, and detailed parts lists including Smiths Medical part numbers.

Always follow the procedures (including warnings/cautions) in "Parts Replacement" section of this manual while disassembling, replacing parts, and reassembling any Medfusion® Model 3000 Series pump.

Note: Part numbers and pricing are subject to change without notice. See the website at:

www.smiths-medical.com.

Medfusion® Model 3000 series main pump assembly



Medfusion® Model 3000 series main pump assembly – parts list

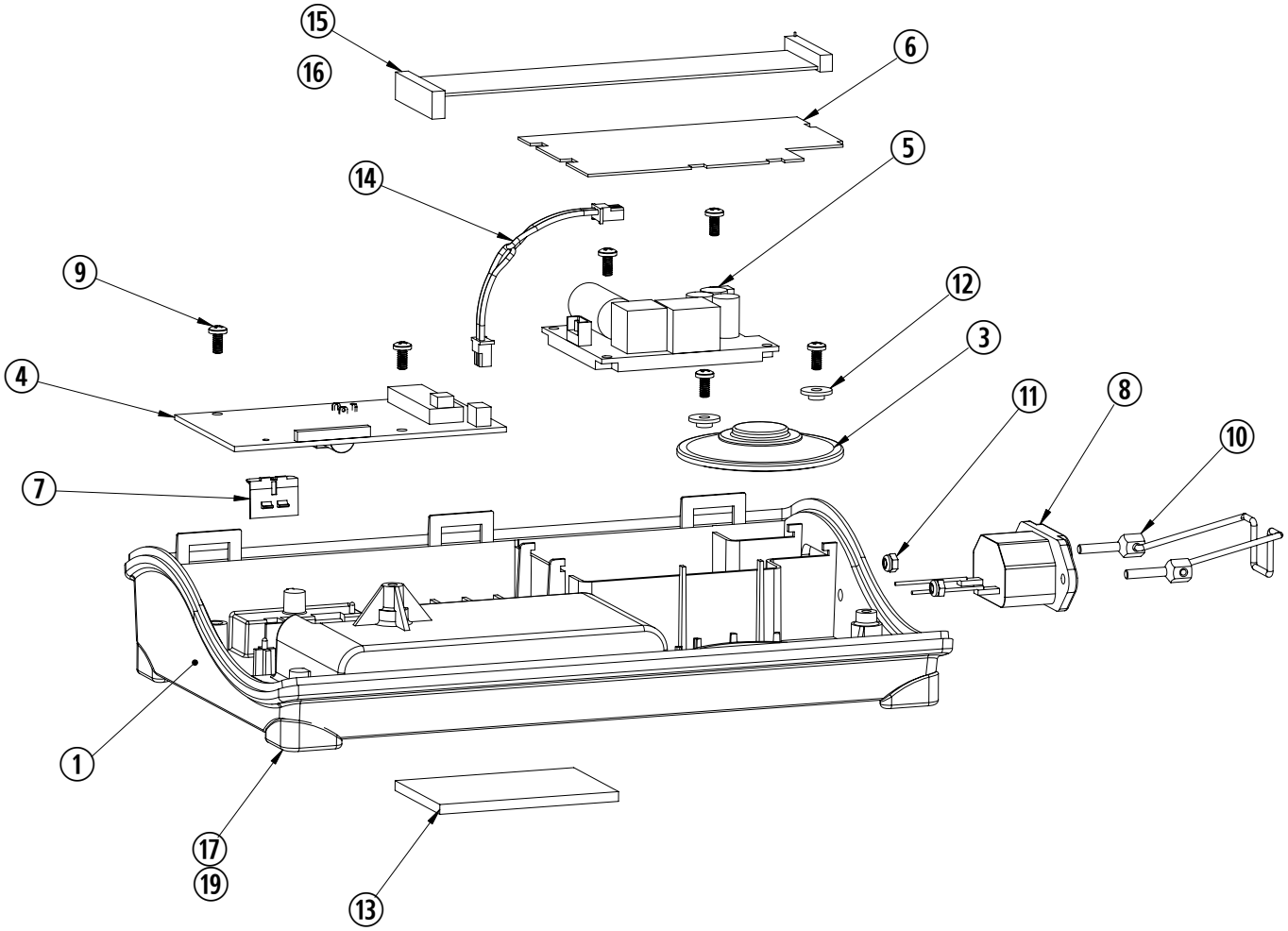
Ref. #	Part Number	Description	Quantity
1	See following drawing	Assembly Case Bottom	1 ea.
2	G6000059	Screw, 4-40 × .62 PH Phillips	2 ea.
3	No longer required	Label, Device Tracking	1 ea.
4	40-5793-01 (current revision)	Label, Warning	1 ea.
	40-5793-50 (current revision)	Label, Warning, CE Mark	1 ea.
	40-5793-03 (current revision)	Label, Warning, German	1 ea.
	40-5793-51 (current revision)	Label, Warning, RX Only/CE Mark	1 ea.
5	G6000112	Door, Battery Bay	1 ea.
6	40-6090-51 (current revision)	Label, Serial Number (Blank) (see Note 4)	1 ea.
	40-6790-51 (current revision)	Label, Serial Number (Blank), No DC (see Note 4)	1 ea.
7	G6000345	Screw, #4-40 × 5⁄16 FH, Locking, SS	2 ea.
8	67-2515-51	Assembly, Battery Pack, 3000	1 ea.
10	See following drawing	Assembly Case Top w/Plunger Head	1 ea.
12	(See Note 3)	Label, Battery Warning	1 ea.
16	PC-6196-24 (current revision)	Label, Year Manufactured (see Note 2)	1 ea.
17	G6000418	Label, MRI Warning	1 ea.
	40-5959-51 (current revision)	Label, MRI Warning, Medfusion (V6 pumps)	1 ea.
	G6000623	Label, MRI Warning, German	1 ea.
18	G6000605	Label, Medfusion® Model 3500 pump Logo	1 ea.
19	G6000733	Label, ECMO Warning	1 ea.
20	Not Available for Purchase	Label, Tamper Evident	2 ea.
21	40-5956-24 (current revision)	Label, ESD Warning	1 ea.
Not Shown	G6000780	Label, ESD Sensitive	1 ea.

Notes:

1. Older model pumps may have this connector cable. In current pumps this cable is connected to the Interconnect PCB.
2. This label contains variable information, dependent on the year of manufacture. Please specify the manufacturing year shown on the pump when communicating with the Service Center.
3. Item 12 (battery warning label) is part of the battery assembly (item 8), and cannot be ordered separately.

4. Correct label is dependent upon Interconnect PCB; see page 108. Label 40-6090-51 is used with P/N G6000234 or G6000312; label 40-6790-51 is used only with P/N 70-0420.

Case bottom assembly



Case bottom assembly – parts list

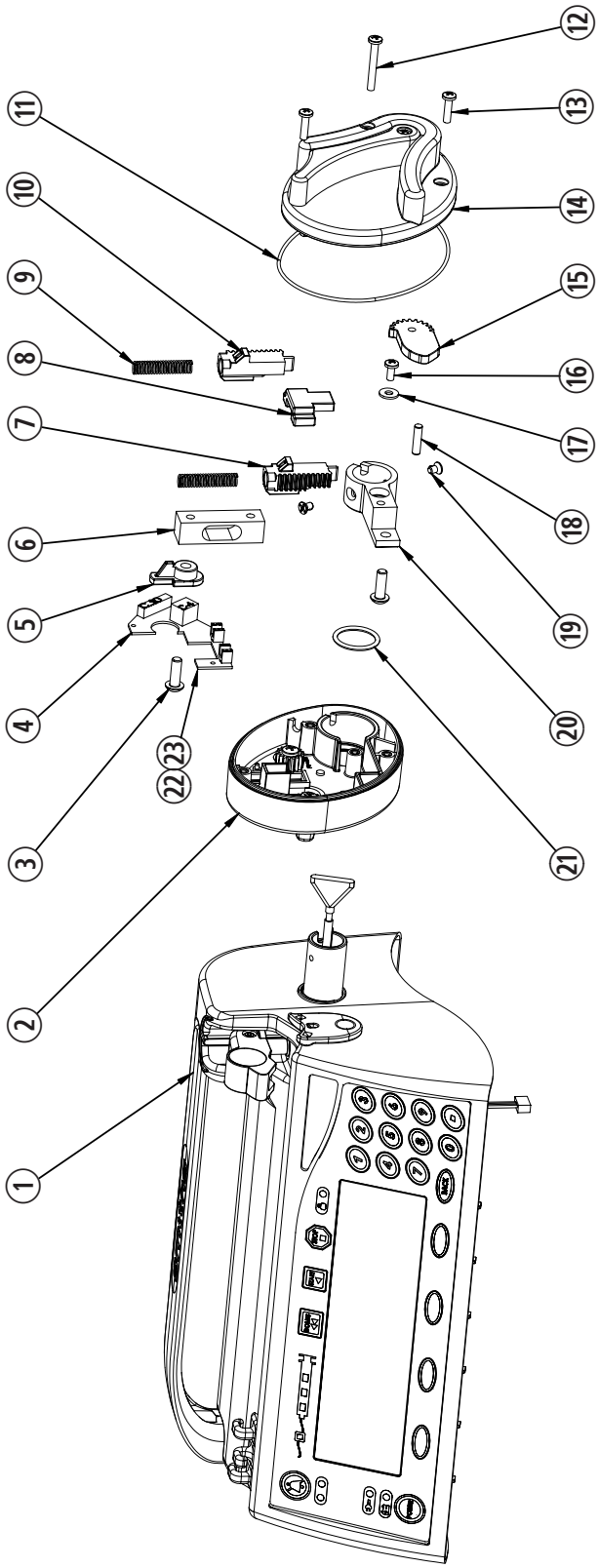
See also case bottom service assembly, note 4 below.

Ref. #	Part Number	Description	Quantity
1	No longer available for purchase	Case Bottom - No Feet (see Note 4)	1 ea.
	67-2513	Case Bottom - With Feet and seal (see Note 4)	1 ea.
3	G6000014L	Speaker Assembly, RoHS Compliant	1 ea.
4	70-0420	PCB Assembly, Interconnect, RoHS Compliant (see Notes 1, 6)	1 ea.
5	G6000773L	Power Supply, DC, 12V, 10W, RoHS	1 ea.
6	G6000016	Shield, Power Supply	1 ea.
7	G6000017	Lens, IR Window	1 ea.
8	30-4735	Cable, AC Power	1 ea.
	G6000102L	Cable, AC Power, Medfusion® Model 3500E/3500G	1 ea.
9	G6000693	Screw, #4-40 × ¼ PH Phillips SS	6 ea.
10	G6000220	Clamp, Cord Retainer (see Note 2)	1 ea.
11	G6000192	Locknut, 6BA Nylock (see Note 2)	2 ea.
12	G6000410	Washer, Shoulder, Nylon (see Note 3)	2 ea.
13	G6000118	Pad, Battery Bay	1 ea.
14	G6000012	Cable, DC Power	1 ea.
15	G6000387	Cable (see Note 6)	1 ea.
16	30-3191	Solder, Lead Free	
17	G6000706	Feet, Rubber (glue type) (see Notes 5, 7)	4 ea.
18	G6000694	Label, Functional Ground (see Note 8)	1 ea.
19	036LT40100	Loctite® 401	

Notes:

1. In newer assemblies, the Interconnect PCB assembly (item 4) P/N 70-0420 has replaced the older assembly (P/N G6000234 or G6000312), which are no longer available. The DC connector port on this PCB is non-functional, so is also supplied in a service kit (P/N 67-2523) with SN label for placement on the pump bottom when replacing the Interconnect PCB.
2. In older assemblies, items 10 & 11 are Screw, 4-40 × .38 FH SS (P/N G6000127) and Nut, 4-40 Nylock (P/N G6000043).
3. In newer assemblies, the shoulder washer (item 12) has replaced the flat washer, Smiths Medical P/N G6000058, which is no longer available.
4. A bottom housing service kit (P/N G600438) is available containing items 1, 7 and 13, above, along with items 4, 5, 6, 7, 17 and 21 (components and labels) from the main pump assembly.
5. Use with Loctite® 401, part number 036LT40100.
6. Interconnect PCB comes with cable (P/N G6000387, item 15 above) attached.
7. Older models use Enlarged rubber foot (P/N G6000287).
8. Item 18 is adhered to the top of the AC power cable.

Case top assembly w/plunger



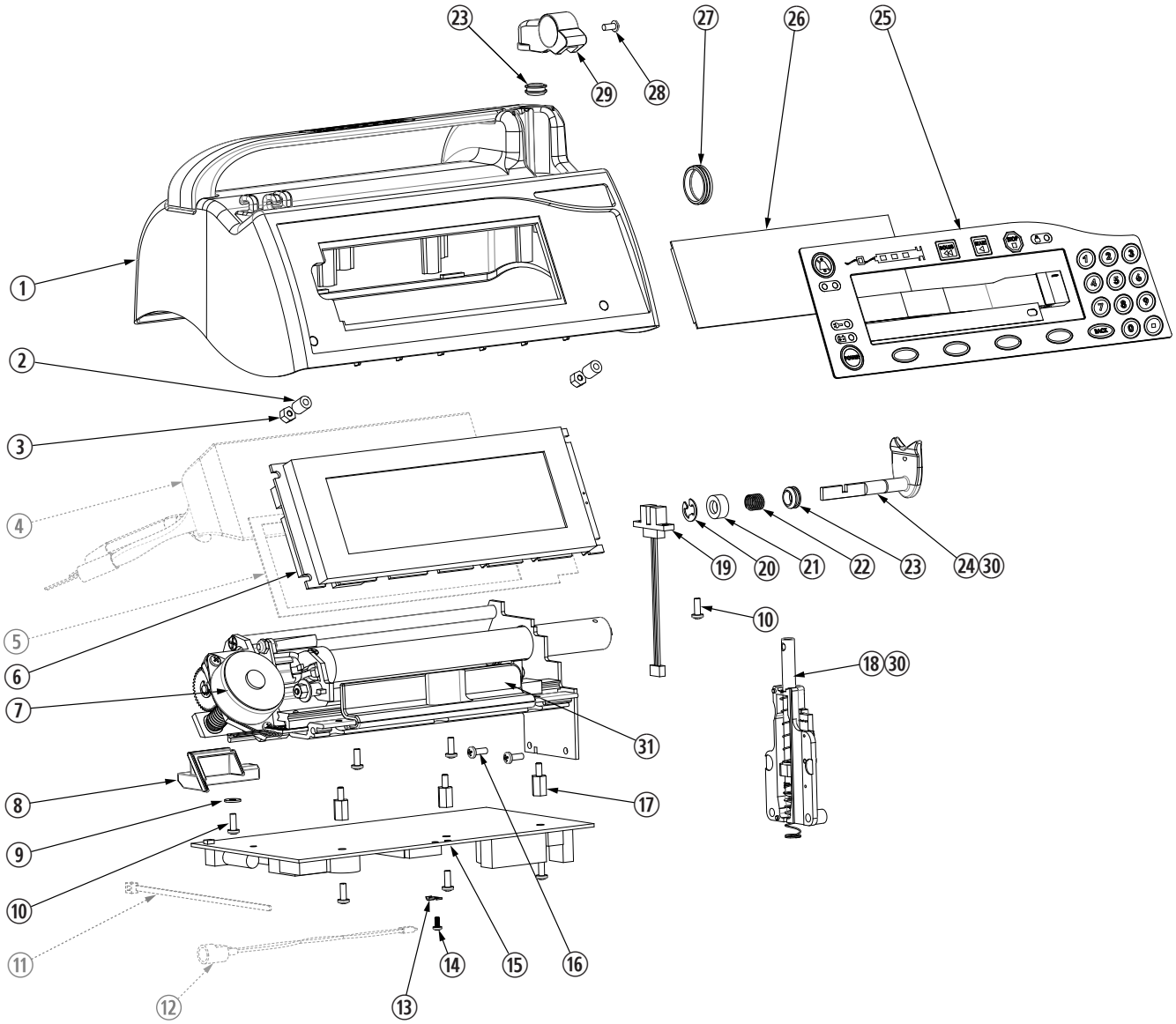
Case top assembly w/plunger – parts list

Ref. #	Part Number	Description	Quantity
1	See following drawing	Assembly, Case Top Without Plunger	1 ea.
2	G6000439	Assembly, Plunger Case Left	1 ea.
3	G6000085	Screw, M4 X 12 Button Head	2 ea.
4	70-0422	Assy, PCB Plunger	1 ea.
5	G6000069	Plunger Float Plate	1 ea.
6	G6000068	Force Sensor	1 ea.
7	G6000925	Timing Plate Left	1 ea.
8	G6000926	Push Block	1 ea.
9	G6000086	Spring, Plunger	2 ea.
10	G6000927	Timing Plate Right	1 ea.
11	G6000090	Seal, Plunger Case	1 ea.
12	G6000103	Screw 4-40 × ⅞ Pan Phil SS	1 ea.
13	G6000105	Screw, 4-40 × 7/16 Pan Phil SS	2 ea.
14	G6001588	Assembly, Plunger Case Right	1 ea.
15	G6000071	Cam Gear Plunger	1 ea.
16	G6000693	Screw, Pan Phil, 4-40 × ¼ SS	2 Ea.
17	G6000474	Washer, Flat #4, SS	1 ea.
18	G6000110	Pin, Dowel	1 ea.
19	G6000749	Screw, 4-40 × 3/16 Nylok Flat, Phillips SS	2 ea.
20	G6000067	Plunger Head Mount	1 ea.
21	G6001656	O-ring (See Note 1)	1 ea.
22	30-2824	Loctite® 411 (See Note 2)	A/R
23	30-2693	Accelerator, TakPak® (See Note 2)	A/R

Note:

1. New style plunger case requires o-ring (older models do not require this part).
2. Loctite® 411 and TakPak® Accelerator (used to accelerate the cure speed of Loctite® 411) are used to glue Plunger PCB in place; see Plunger PCB Installation, page 84.

Case top assembly without plunger



Case top assembly without plunger – parts list

See also case top service assembly, note 2 on the following page.

Ref. #	Part Number	Description	Quantity
1	G6000289	Case Top, With Tubing Holder (old style barrel clamp head and no keyway) (see Note 2)	1 ea.
	30-4403	Top Case Assembly (see Note 2)	1 ea.
2	G6000022	Spacer, .25 OD × .31 LG	2 ea.
3	G6000043	Nut, #4-40 Nylock	2 ea.
4	See Note 6	Backlight, Fiberoptic Dual LED, 3 Layer	1 ea.
5	See Note 6	Spacer, LCD Bracket (see Note 5)	1 ea.
6	70-0513	Display, LCD, 240×64, Integral Backlight, LCD Cable Ferrite (see Note 5)	1 ea.
7	See page 116	Assembly, Drive Train	1 ea.
8	G6000938	Shield, IR	1 ea.
9	G6000474	Washer, #4 Flat SS	1 ea.
10	G6000692	Screw, #4-40 × 5/16 Pan Head, Phillips, Nylock, SS	3 ea.
11	See Note 6	Wire Tie	1 ea.
12	See Note 6	Cable, Backlight Dual LED	1 ea.
13	G6000257	Clamp, Stainless Steel	1 ea.
14	G6000903	Screw, #2-56 × 3/16, Nylock, Pan Head, Phillips, SS	1 ea.
15	See Note 3	Assembly PCB Main	1 ea.
16	G6000693	Screw, #4-40 × ¼ Pan Head, Phillips, Nylock, SS	12 ea.
17	G6000064	Standoff, ¼ Hex 4-40 × 3/8	3 ea.
18	See page 114	Assembly, Barrel Clamp	1 ea.
19	G6000010	Optocoupler	1 ea.
20	G6000034	E-Ring	1 ea.
21	30-4172	Sleeve, Ear Clip -V2 (see Note 1)	1 ea.
22	G6000397	Spring, Ear Clip	1 ea.
23	30-4626	Barrel/ Ear Clamp Seal	2 ea.
24	G6000023	Ear Clip	1 ea.
25	G6000005 (current revision)	Keypad, Model 3010/3010A English	1 ea.
	G6000771	Keypad, Model 3500 English (USA)	1 ea.
	G6000912	Keypad, Model 3500 International	1 ea.
26	G6000339	Lens, Support, Keypad Window	1 ea.
27	G6002832	Seal, Plunger Rod	1 ea.
28	G6000802	Screw #4-40 × ¼ Nylok Panhead Phillips, Black	2 ea.
29	G6000715	Barrel Clamp, Head	1 ea.
30	0382000000	Grease, Silicone, 111 Compound	A/R
31	30-4169	Guard, Position Pot	1 ea.

- continued on next page -

Notes:

1. Item 21 does not appear in older pumps.
2. Items 1, 23, 25, 26 and 27 (along with various labels) are available as a service subassembly part number:

   For Medfusion® Model 3500 pump (English): G6000737, Case Top 3500 - Service (new style barrel clamp with keyway) (includes keypad item 25, and labeling items 18 and 19 shown in main pump assembly)
3. Item 15 is available as service subassembly part numbers:

   G6000435, 3010 Main PCB Assembly – ***Software Version 2.0.6*** - Service

   G6000361, 3500 Main PCB Assembly – ***Software Version 3.0.6*** - Service

   G6001260, 3500 Main PCB Assembly – ***Software Version 4.0.2*** - Service

   G6001560, 3500 Main PCB Assembly – ***Software Version 4.1.5*** - Service

   G6002728, 3500 Main PCB Assembly – ***Software Version 5.0.0*** - Service

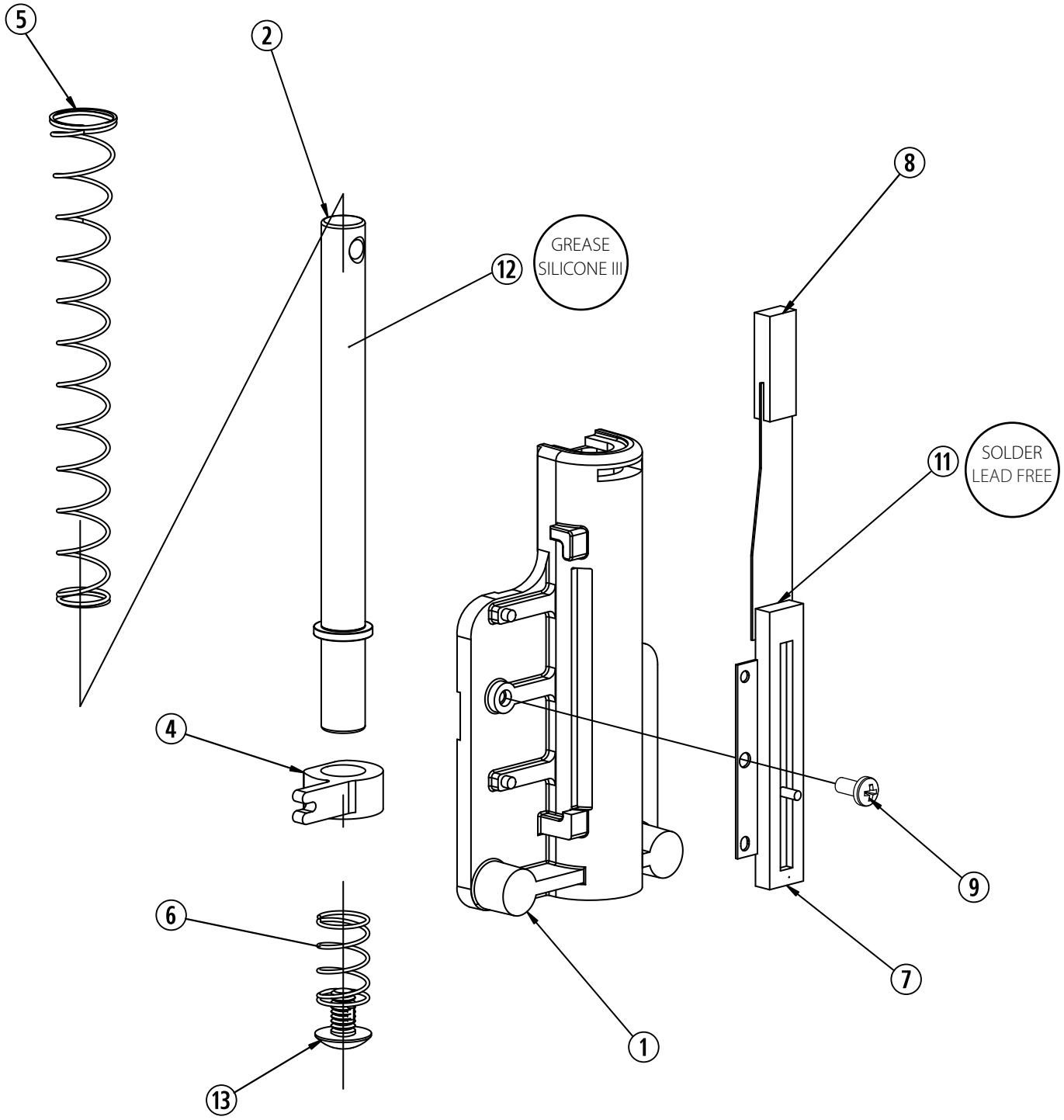
   67-2535, 3500 Main PCB Assembly – ***Software Version 6.0.0*** - Service

IMPORTANT: When replacing the Main PCB on P.A.S.S. (PharmGuard® Anesthesia Software Service) pumps, the pump serial number and Configuration version number (displayed on the pump startup screen) must be communicated to the Service department when ordering a replacement PCB, as they must install both on the PCB prior to shipment.

Check with the Smiths Medical service department for other software versions.

4. Item is part of item 1 assembly (G6000625), but can be purchased separately for service/repair uses.
5. Older pumps use an LCD with separate spacers and backlight cables. These are no longer available, and if they require replacement, order the new LCD instead (see item 6 and Note 5).

Barrel clamp assembly

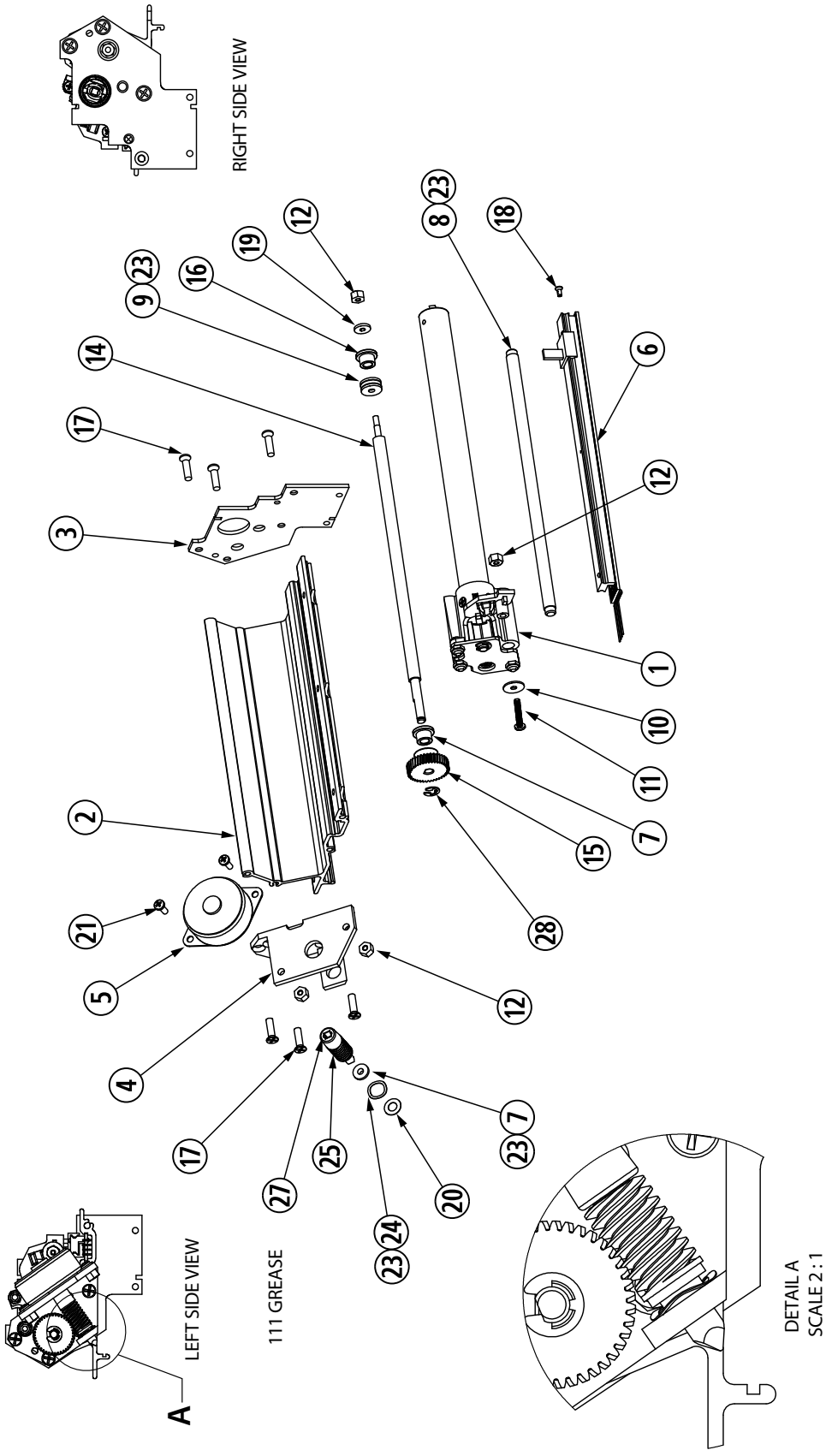


Barrel clamp assembly – parts list

Ref. #	Part Number	Description	Quantity
1	G6000716	Guide Barrel Clamp	1 ea.
2	30-4174	Rod Barrel Clamp -V2	1 ea.
4	G6000031	Barrel Clamp Slide	1 ea.
5	G6000032	Spring, Barrel Clamp	1 ea.
6	G6000024	Spring Barrel Clamp Short Blue	1 ea.
7	G6000186 - See note	Pot Size Sensor, 10K ± 30%	1 ea.
8	G6000096 - See note	Flex Cable Size Pot	1 ea.
9	G6000121 - See note	Screw #2 × .18 Plastite	1 ea.
11	30-3191	Solder, Lead Free	0.01 oz.
12	0382000000	Grease, Silicon, 111 Compound	0.1 oz.
13	G6000906	Screw, 6-32 ¼" Truss Head Phillips Nylok SS	1 ea.

Note: Items 7, 8 and 9 are available as a service subassembly part number G6000436, Size Sensor Pot Assembly - Service.

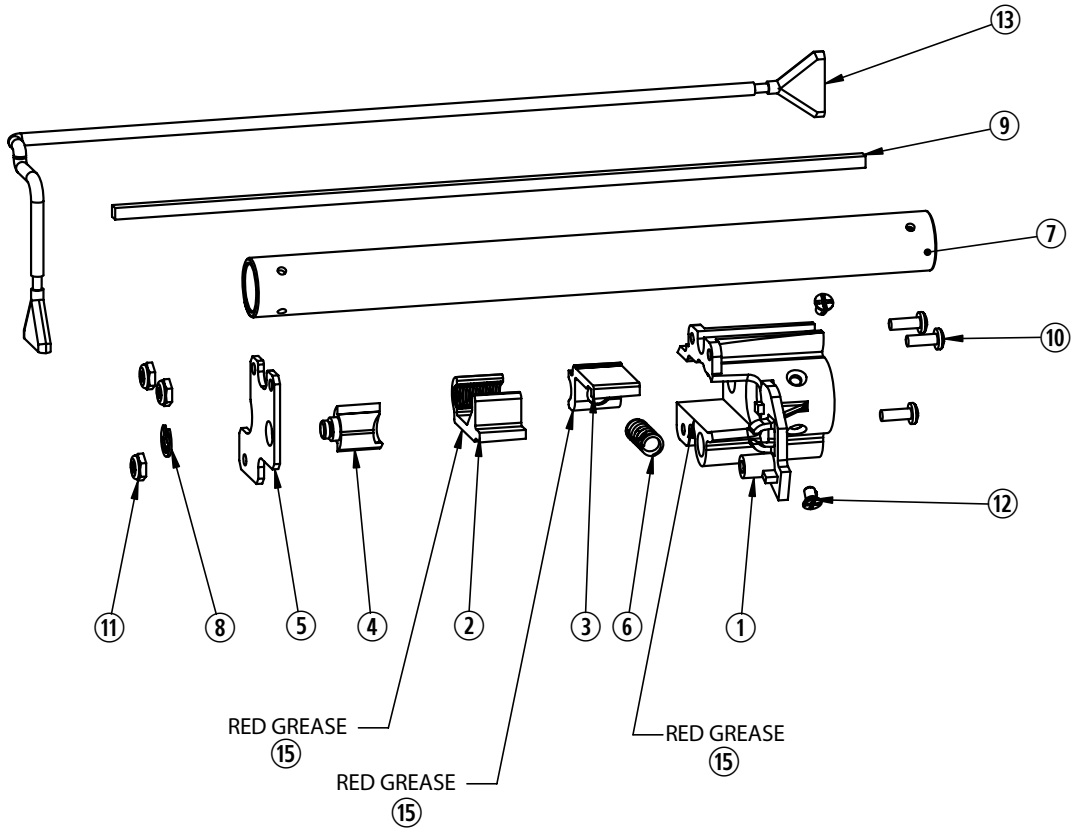
Drive train assembly



Drive train assembly – parts list

Ref. #	Part Number	Description	Quantity
1	See following drawing	Assembly Clutch	1 ea.
2	G6000931	Extrusion Main	1 ea.
3	G6000717	Plate, Right End	1 ea.
4	30-4177	Bracket, Motor Mount -V2	1 ea.
5	G6001569	Assembly, Stepper Motor	1 ea.
6	70-0450	Sensor, Position Potentiometer	1 ea.
7	G6000053	Bushing .19 ID × .25 Delron	2 ea.
8	30-4176	Rod, Carriage -V2	1 ea.
9	G6000056	Thrust Bearing SS	1 ea.
10	G6000058	Washer Steel .438 × .125 × .031	1 ea.
11	G6000059	Screw 4-40 × .62 PH Phillips	1 ea.
12	G6000043	Nut 4-40 Nylock	4 ea.
14	G6001459	Leadscrew	1 ea.
15	30-4170	Worm Gear -V2	1 ea.
16	G6000057	Bushing, Leadscrew, Right	1 ea.
17	G6000075	Screw 6-20 × .5 FH Thread Form	6 ea.
18	G6000902	Screw, 2-56 × 3⁄16 Nylock, FH Phillips SS	1 ea.
19	G6000072	Washer Brass .340 × .117 × .050	1 ea.
20	30-4160	Delrin Washer .010 TH × .434” OD × .322 ID	1 ea.
21	G6000063	Screw, 4-40 × .31 PH Phillips	2 ea.
23	07020STP00	Grease, Sta Plex Red	0.1 oz.
24	G6000791	Washer, Wave Spring, .420 × .322 × .006	1 ea.
25	G6001480	Worm Coupling	1 ea.
27	0382000000	Grease, Silicone, 111 Compound	0.1 oz.
28	0391331800	E-Clip	1 ea.

Clutch assembly



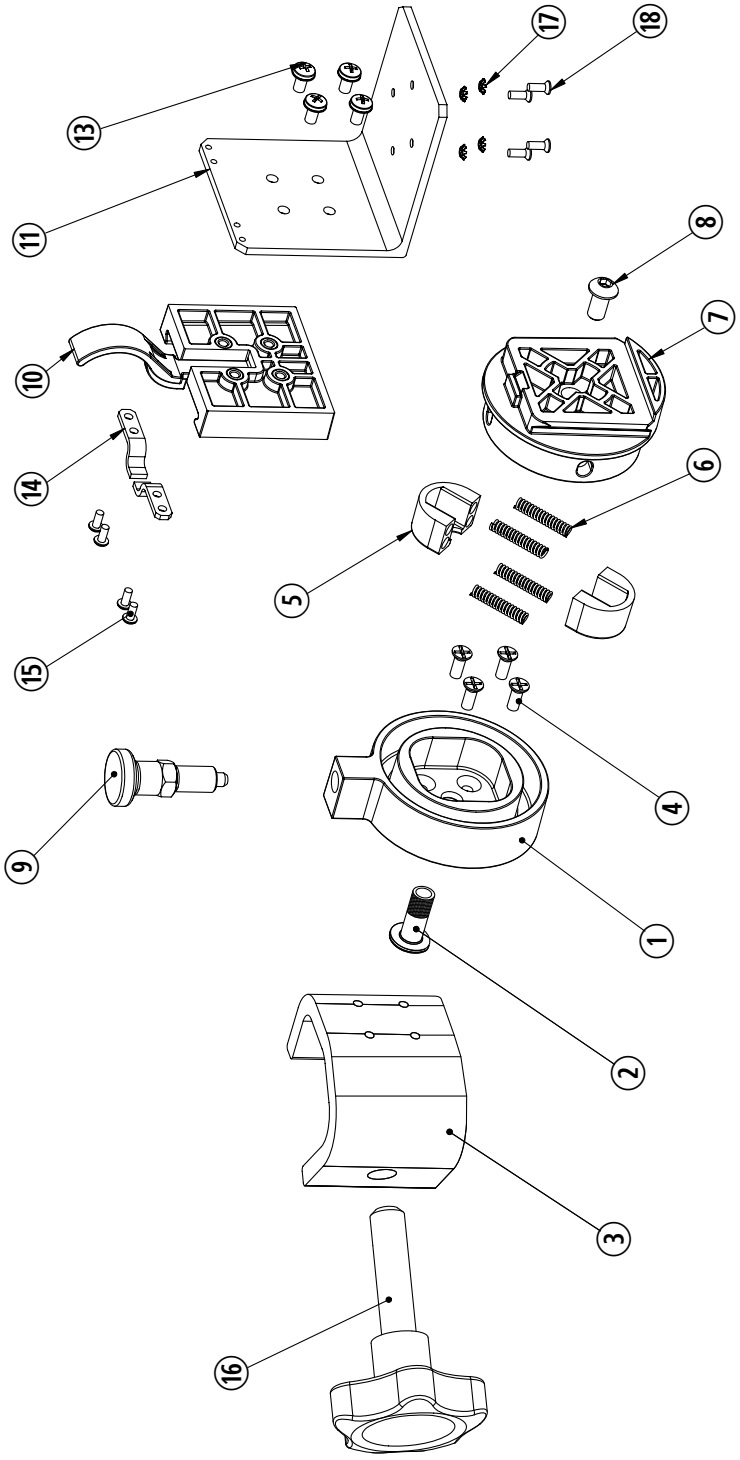
Clutch assembly – parts list

Ref. #	Part Number	Description	Quantity
1	G6000099	Carriage	1 ea.
2	30-4375	Clutch, Left -V2	1 ea.
3	G6001461	Clutch, Right New Mold	1 ea.
4	G6000924	Cam, Clutch	1 ea.
5	G6000905	Plate, Carriage	1 ea.
6	G6000044	Spring, Clutch	1 ea.
7	30-4173	Tube Plunger -V2	1 ea.
	G6001057	Insulated Tube Plunger (Models 3500E, 3500G)	1 ea.
8	0391331800	E-Clip	1 ea.
9	30-4175	Shaft, Square, Stainless -V2	1 ea.
10	G6000063	Screw 4-40 × .31 PH Phillips	3 ea.
11	G6000310	Nut, Nylock, 4-40, SS, Small Pattern	3 ea.
12	G6000749	Screw 4-40 × 3⁄16 Nylok Flat Phillips SS	2 ea.
13	G6000159	Assembly, Cable Plunger	1 ea.
15	07020STP00	Grease, Sta Plex Red	0.1 oz.

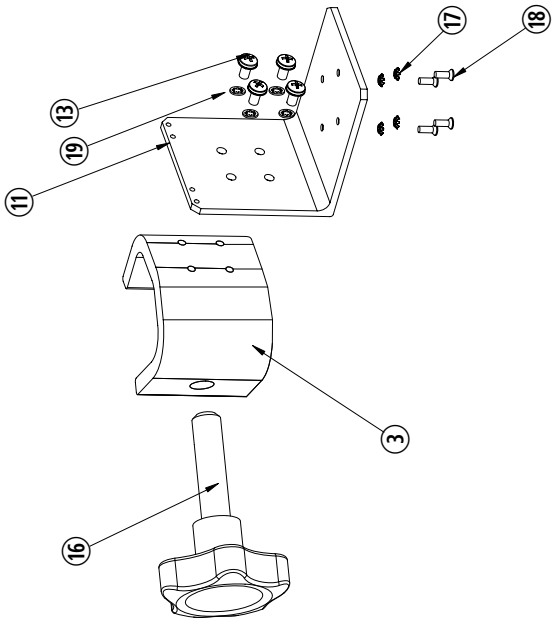
Accessories – parts list

Poleclamp assembly

3000RPC:



3000PC:



3000RPC Rotating poleclamp parts

(Being phased out; contact Smiths Medical for availability)

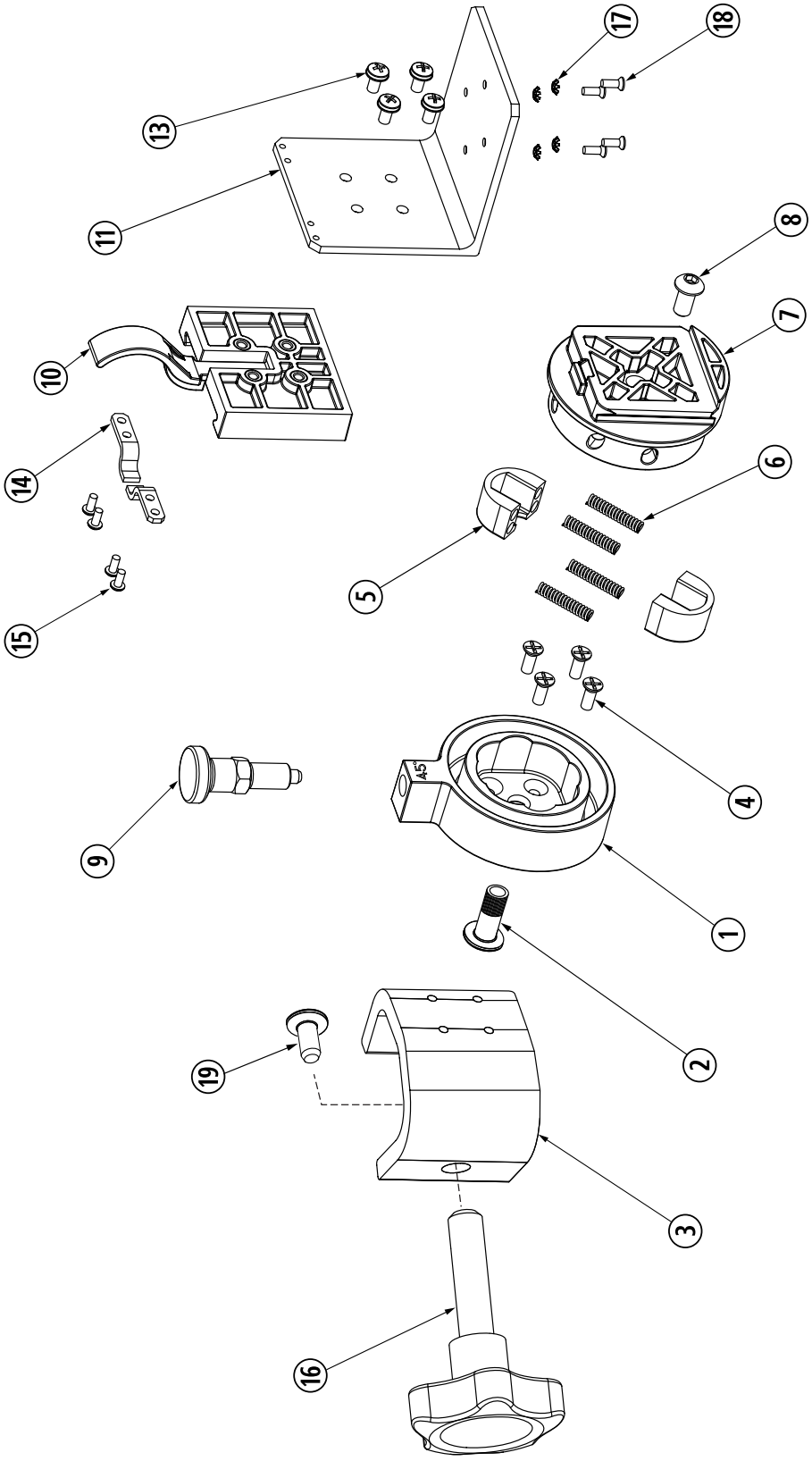
Ref. #	Part Number	Description	Quantity
1	G6000496	Mount, Rotor Rotating	1 ea.
2	0502003100	Shoulder Bushing	1 ea.
3	G6000284	Bracket, Poleclamp	1 ea.
4	G6000499	Screw, #8-32 × 7/16 Flat Head Phillips Nylok SS	4 ea.
5	0482004400	Index Cam	2 ea.
6	0502002400	Compression Spring	4 ea.
7	G6000497	Rotor Base	1 ea.
8	046L050200	Screw, ¼-20 × .5 Button Head Hex	1 ea.
9	30-4668	Plunger, Indexing, RPC, Medfusion	1 ea.
10	G6000538	Assy, Plate Back	1 ea.
11	G6000286	Bracket, Polemount	1 ea.
13	G6000774	Screw, #8-32 × 5/16 Pan Head Phillips w/Washer Nylock SS	4 ea.
14	G6000551	Bracket, Poleclamp Stop	2 ea.
15	G6000104	Screw 4-40 × .25 BH Black	4 ea.
16	G6001456	Knob, Plastic Solid	1 ea.
17	G6000288	#4 External Conical Tooth Lockwasher	2 ea.
18	G6000345	Screw, #4-40 × 5/16, FH, Locking, SS	2 ea.

Poleclamp parts

(Catalog number 3000PC)

Ref. #	Part Number	Description	Quantity
3	G6000284	Bracket, Poleclamp	1 ea.
11	G6000286	Bracket, Polemount	1 ea.
13	G6000506	Screw, #8-32 × 5/16", Pan Head, Phillips Nylock, SS	4 ea.
16	G6001456	Knob, Plastic Solid	1 ea.
17	G6000288	#4 External Conical Tooth Lockwasher	4 ea.
18	G6000345	Screw, #4-40 × 5/16, FH, Locking, SS	4 ea.
19	G6000303	#8 Internal Lockwasher SS	4 ea.

90-Degree poleclamp assembly

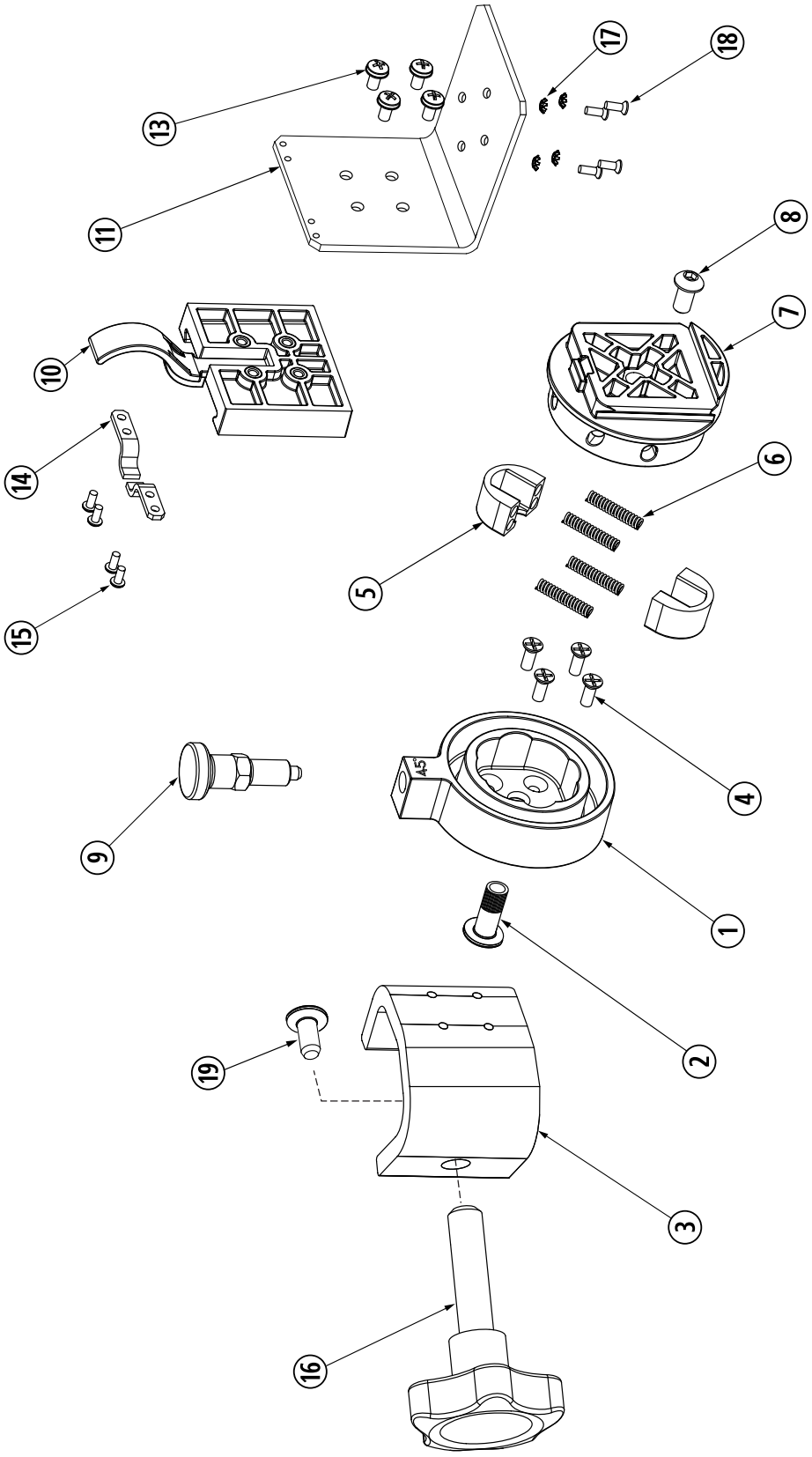


90-Degree rotating poleclamp parts

(Contact Smiths Medical for availability - catalog number 22-1050-51)

Ref. #	Part Number	Description	Quantity
1	30-4196	Mount, Rotor Rotating, 45 Deg. Positioning	1 ea.
2	0502003100	Shoulder Bushing	1 ea.
3	G6000284	Bracket, Poleclamp	1 ea.
4	G6000499	Screw, #8-32 × 7⁄16 Flat Head Phillips Nylok SS	4 ea.
5	0482004400	Index Cam	2 ea.
6	0502002400	Compression Spring	4 ea.
7	30-4197	Rotor Base, 45 Deg. Positioning	1 ea.
8	046L050200	Screw, ¼-20 × .5 Button Head Hex	1 ea.
9	30-4668	Plunger, Indexing, RPC, Medfusion	1 ea.
10	30-4198	Assy, Backplate	1 ea.
11	G6000286	Bracket, Polemount	1 ea.
13	G6000774	Screw, #8-32 × 5⁄16 PAN Head Phillips w/Washer Nylock SS	4 ea.
14	G6000551	Bracket, Poleclamp Stop	2 ea.
15	G6000104	Screw 4-40 × .25 BH Black	4 ea.
16	30-4200	Knob, ½-13 × 2”, Stainless	1 ea.
17	G6000288	#4 External Conical Tooth Lockwasher	2 ea.
18	G6000345	Screw, #4-40 × 5⁄16, FH, Locking, SS	2 ea.
19	788098-2890-4	Cap, Knob	1 ea.

100-Degree poleclamp assembly



100-Degree rotating poleclamp parts

(Contact Smiths Medical for availability - catalog number 22-1051-51)

Ref. #	Part Number	Description	Quantity
1	30-4196	Mount, Rotor Rotating, 45 Deg. Positioning	1 ea.
2	0502003100	Shoulder Bushing	1 ea.
3	G6000284	Bracket, Poleclamp	1 ea.
4	G6000499	Screw, #8-32 × 7⁄16 Flat Head Phillips Nylok SS	4 ea.
5	0482004400	Index Cam	2 ea.
6	0502002400	Compression Spring	4 ea.
7	30-4197	Rotor Base, 45 Deg. Positioning	1 ea.
8	046L050200	Screw, ¼-20 × .5 Button Head Hex	1 ea.
9	30-4668	Plunger, Indexing, RPC, Medfusion	1 ea.
10	30-4198	Assy, Backplate	1 ea.
11	30-4203	Bracket, Polemount, 100 Deg	1 ea.
13	G6000774	Screw, #8-32 × 5⁄16 PAN Head Phillips w/Washer Nylock SS	4 ea.
14	G6000551	Bracket, Poleclamp Stop	2 ea.
15	G6000104	Screw 4-40 × .25 BH Black	4 ea.
16	30-4200	Knob, ½-13 × 2”, Stainless	1 ea.
17	G6000288	#4 External Conical Tooth Lockwasher	2 ea.
18	G6000345	Screw, #4-40 × 5⁄16, FH, Locking, SS	2 ea.
19	788098-2890-4	Cap, Knob	1 ea.

Miscellaneous parts

Part Number	Description	Quantity
21-5816-51	AC Line Cord, North American, Class II	1 ea.
21-5817-20	AC Line Cord, United Kingdom, Class II	1 ea.
G6000331	AC Line Cord, Continental European, Class II	1 ea.
3000RS232	Infrared - RS232 Converter Box (not RoHS [Restriction of Hazardous Substances] compliant and being phased out; contact Smiths Medical for availability)	1 ea.
22-1060-51	Infrared - USB Connector (22-1060-51) (RoHS [Restriction of Hazardous Substances] Compliant; contact Smiths Medical for availability)	1 ea.
G6000200	Cloning Block	1 ea.

Calibration & repair – parts list

Medfusion® Model 3000 series pump calibration kit

The *Biomed Medfusion® Model 3000 Series pump Calibration Kit* contains the tools necessary for performing the periodic maintenance and calibration of the Medfusion® Model 3000 Series pumps.

Order kit number **3000CAL**.

This kit contains the following items :

- 1 ea. – Small Calibration Slug, G6000216
- 1 ea. – Large Calibration Slug, G6000215
- 1 ea. – Analog Force Gauge, G6000294

Other tools & equipment required to service Medfusion® Model 3000 series pumps

The following tools are necessary for performing the maintenance, parts replacement, and diagnosis of the Medfusion® Model 3000 Series pumps.

- 1 ea. – 50 or 60mL syringe (see *Operator's Manual* for list of acceptable types)
- 1 ea. – 3 Way Stopcock
- 1 ea. – Torque Screwdriver with #1 Phillips bit, #0 Flat bit, & 2.5mm Hex bit
- 1 ea. – $\frac{3}{16}$" nut driver
- 1 ea. – ¼" open end wrench or nut driver
- 1 ea. – .002" shim or feeler gauge
- 1 ea. – Pliers, standard & needle nose
- 1 ea. - Calipers

Notes

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2015-03 40-5648-51F

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