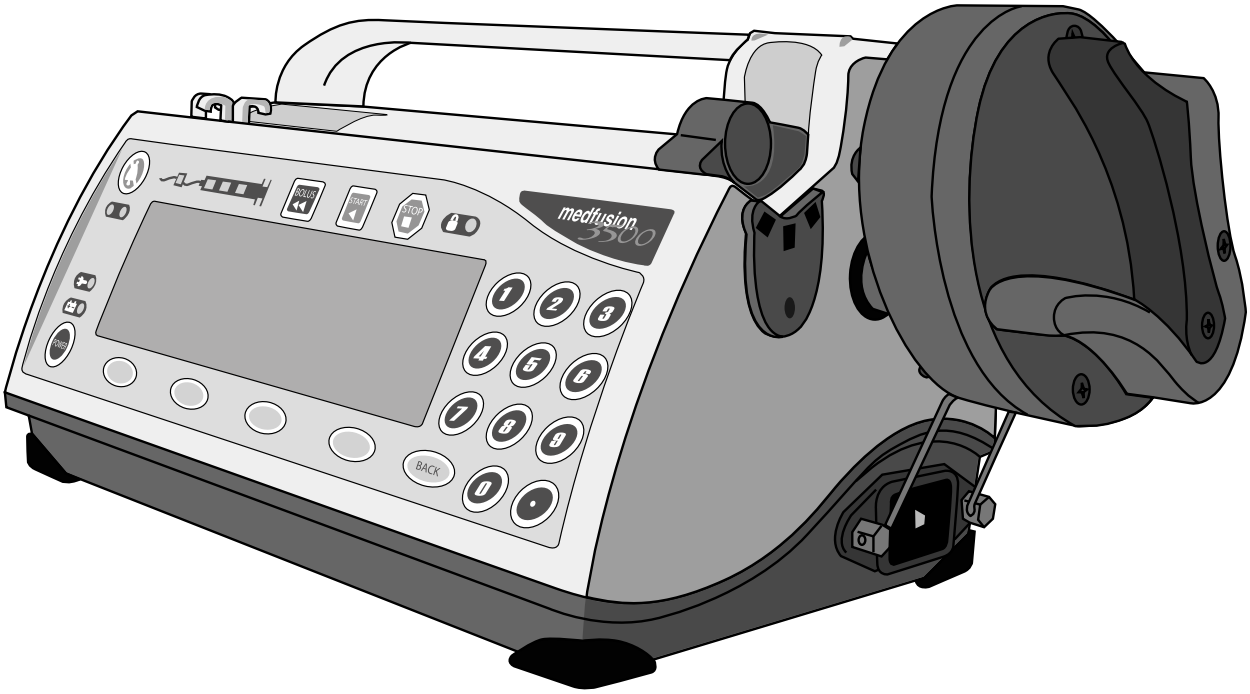
medfusion™



Medfusion®

3000 Series

Technical Service Manual

smiths medical

Table of Contents

Table of Contents

Important Information

WARNING: Read this entire manual before attempting and service or repair on a Medfusion® 3000 Series Syringe Infusion 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.

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.
- **Repair Pump in ESD Controlled Work Area:** The pump case should only be opened at a workstation with Electrostatic controls, including a grounded mat and wrist-strap.
- ***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.
- ***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.
- ***Safety Class II with functional earth, Type CF Medical Equipment:*** The pump is listed as Safety Class II with functional earth, 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 utilizes a third wire ground (earth ground) lead of the power cord as earth return for electromagnetic energy and does not serve as a safety function. Therefore it is neither possible nor 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.
- **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.
- **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® 3000 Series infusion pump you should wear safety glasses as it contains springs and other small parts which may be a hazard.

Cautions

- ***Avoid Organic Solvents:*** Never use organic solvents (e.g., acetone), quarternary ammonia compounds, strong acids or strong bases to clean any portion of the pump.
- ***Not Waterproof:*** The Medfusion® 3000 Series is "spray resistant" but not "water proof". Never spray cleaning or other fluids directly into openings on the bottom of the pump. Never immerse the pump in water or other fluids.
- ***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 or Gas Sterilize:*** Never sterilize the pump in a steam autoclave or gas. Using an autoclave or gas sterilization can seriously damage the Medfusion® 3000 Series pump and void the warranty.
- **Disconnect AC Mains & External DC Power:** Always disconnect the pump from AC Mains and from External DC power before disassembling the pump for maintenance.
- **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, you should 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, you may return battery packs to Smiths Medical for recycling.
- ***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® 3000 Series Syringe Infusion 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® 3000 Series. Such information is found in manuals specific to each individual model, (e.g., *Medfusion® 3500 Operations Manual* and *Medfusion® 3500 Configuration Manual*). The sections of this manual are:

Introduction

- Overview of contents and purpose of this manual.

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 Medfusion® 3000 Series 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 parts of Medfusion® 3000 Series pump.

Calibration

- Detailed procedures for calibration of Medfusion® 3000 Series pump.

Schematics and PCB Assemblies

- Contains board level schematics & PCB assembly drawings.

Assembly Drawings and Parts Lists

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

Appendices

- Contains technical information relevant to Medfusion® 3000 Series pumps.

Authorized use of this manual

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

WARNINGS:

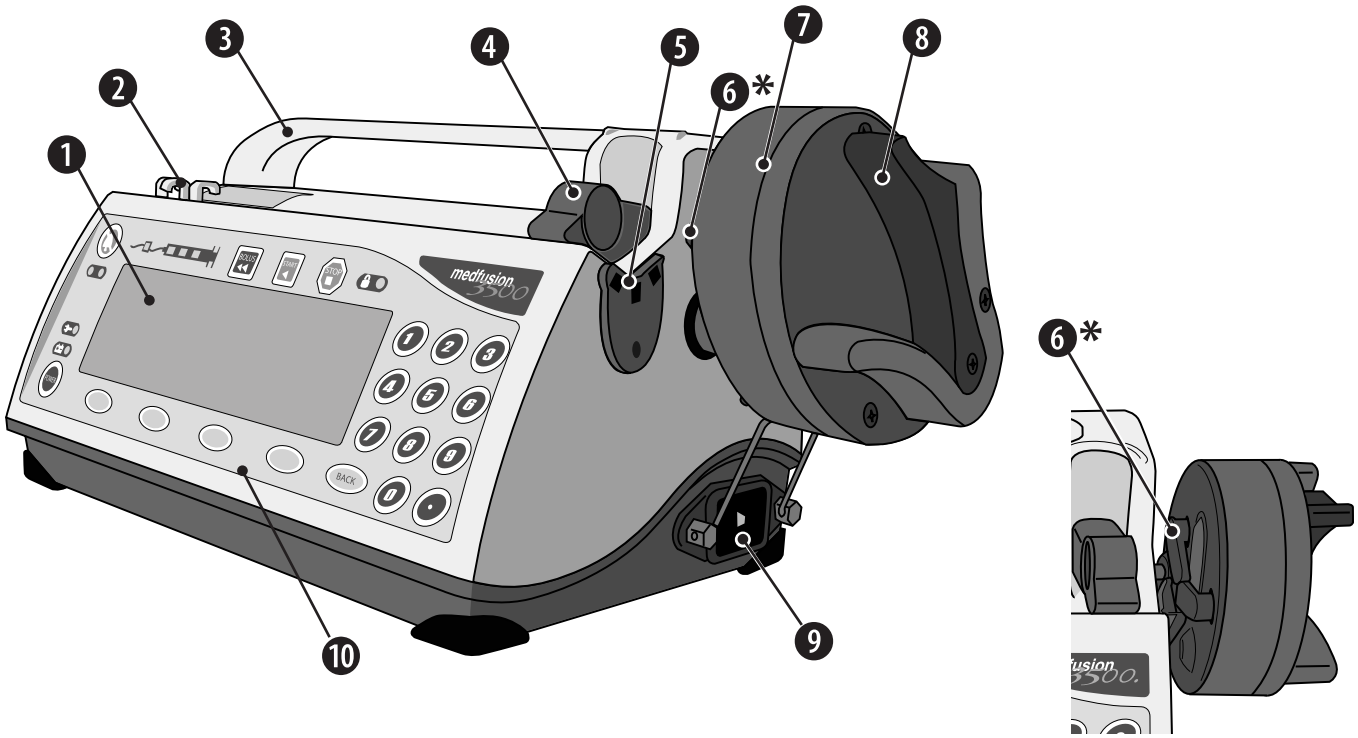
• Attempts to repair or maintain a pump by personnel without proper qualifications or training may create a major hazard which could result in serious injury or death to the patient or the user.

• 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® 3000 Series pump.



1 *LCD Display:* All pump operating and status information appears on the LCD display. The upper portion of the display provides instructions and alarm information. The middle portion of the display shows the current status of the operation in progress or the state of the data entry for pump programming. 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.

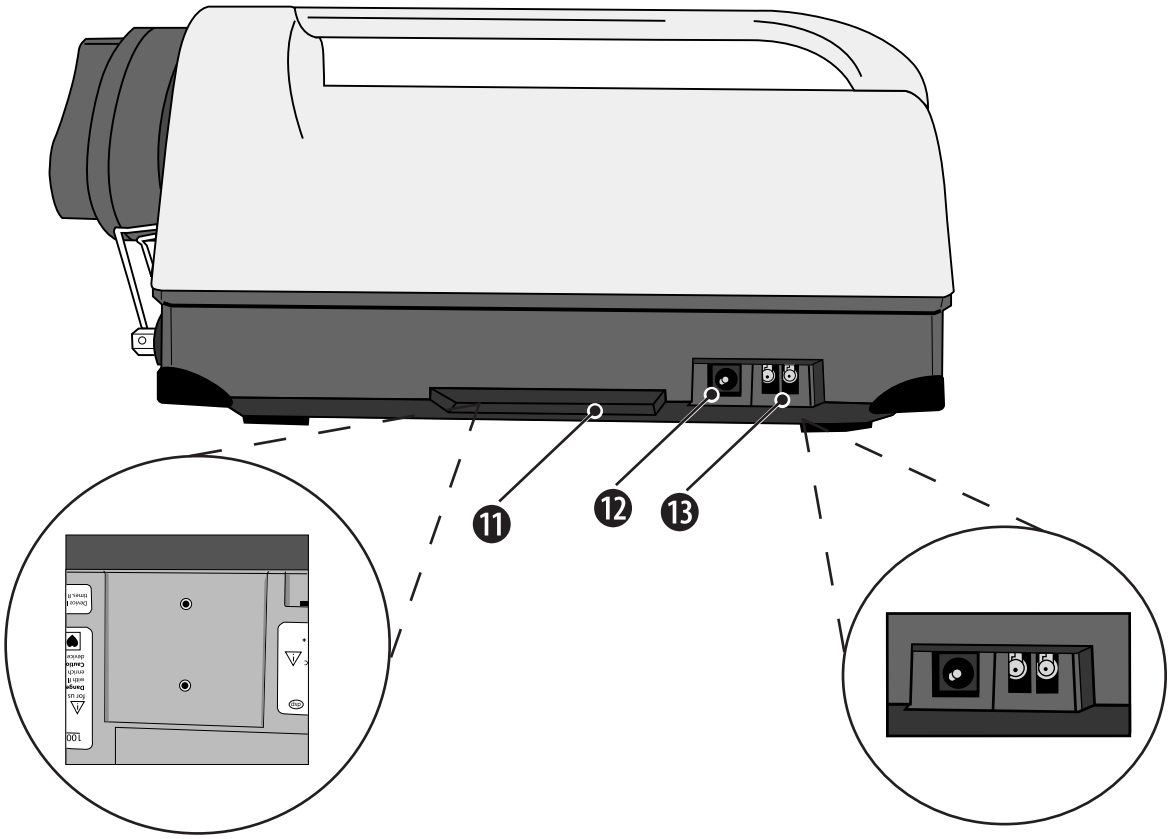
6 *Syringe Plunger Holders:* Holds the syringe plunger securely in place.

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 down to allow placement of the syringe plunger onto the holder during loading, or to remove it during unloading.

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

10 *Keypad:* See **Keypad closeup** for identification of the individual keypad buttons and what they are used for.

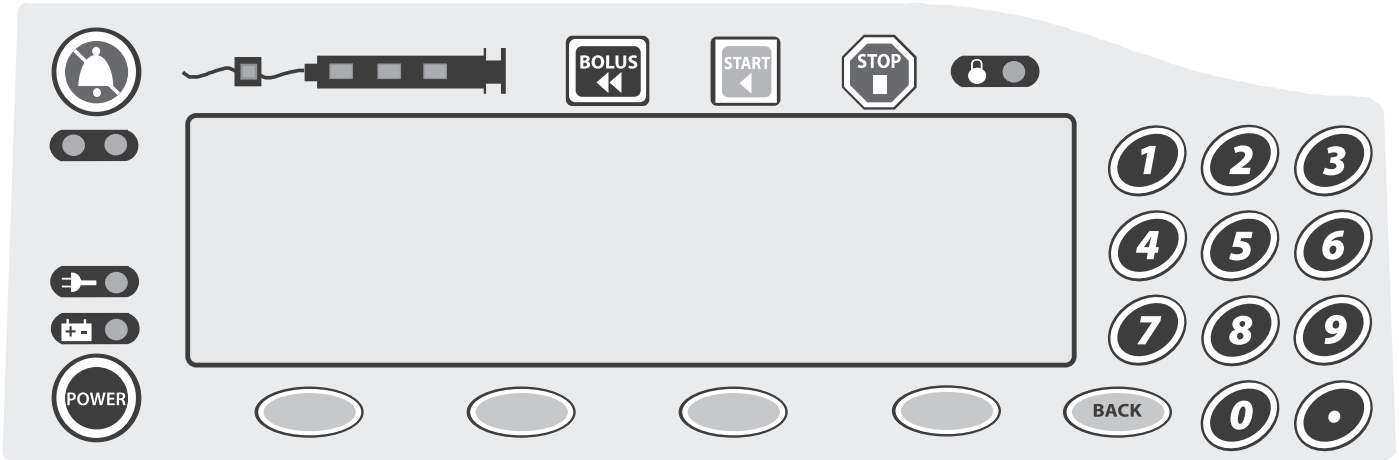


11 Optional Poleclamp Mount: If desired, attach the optional poleclamp here.

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

13 RS232 Connection Port: Plug RS232 connector into the port to allow upload of data from and download of data to a pump from a PC. This port is also used to load the pump software.

Keypad closeup



Button	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.	Silences audible alarm. Allows operator to switch the display backlight from bright to dim or dim to bright.
Power (POWER)	Push and hold to turn pump Off.	Push and release, then push and hold to turn pump Off.
Menu buttons	Function is defined on the display.	Function is defined on the display.
Back (BACK)	Reverts to a previous step or level.	Reverts to a previous step or level if adjusting settings.
Numbers & Decimal	Set number values or select options.	Set number values or select options.
Stop (STOP)	N/A	Stops delivery (pump remains On).
Start (START)	Starts delivery.	N/A
Bolus (BOLUS)	Begins priming after confirmation.	Begins delivery of programmed bolus after confirmation.

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 tells you the pump has been locked into its current operational mode. While this indicator is lighted, 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 advisory message.
- Infusing	The **Infusing** indicators are 3 green lights, which illuminate in sequence right to left when the pump is delivering fluid (the 4th LED indicator on the far left - on the tubing - is not used at this time). During intermittent 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® 3000 Series infusion 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.

- Biomed has its own security access code.
- Biomed is for calibration of the pump's sensors.
- Biomed is for diagnosis of digital and analog sensors contained in the pump.
- Biomed allows access to infusion history log and alarm history log stored in the pump.
- Biomed is for testing of the pump's drive systems.
- Biomed is for monitoring the status of the pump battery.
- Biomed is for setting the pump's last (V3) or next (V4) preventive maintenance date.
- Biomed is for setting the time and date.

Authorized biomed access

Never use Biomed features unless you are trained in maintenance on the Medfusion® 3000 Series pumps and have been authorized by your facility to use the Biomed program.

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
cal size and position
cal force sensor
cal pressure sensor
cal plunger position
cal syringe size sensor
adjust contrast
view calibration data
save changes and exit</td>
<td>Diagnostics
Audio test
Display test
Indicator test
Keypad test
Monitor analog sensors
Monitor digital sensors
Monitor battery status
Drive Train Test (V4)
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 rowspan="2">Utilities
set/view last pm date OR set/view next pm date
set time/date
view alarm history
view infusion history
view software crcs
view software versions
view service data
view EEPROM size (V4)</td>
<td>Update Firmware
(Special use only for software update - Not available on all pumps)</td>
</tr>
<tr>
<td>Set Language
(Medfusion® 3500 Only)</td>
</tr>
</table>

Symbols

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

SN	Serial number
⚠	Attention, See instructions for use
♥	Type CF equipment (protection from electric shock)
□	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. *Medfusion® 3500BC pumps:* The earth ground of the power cord serves the purpose of providing a "functional earth" return for electromagnetic energy.
	Date of manufacture
Rx ONLY	CAUTION: Federal (USA) law restricts this device to sale by or on the order of a physician.
REF	Catalog number
	Collect Separately
LATEX	Latex free
	Do not reuse
	Use by
EC REP	Authorized representative in the European Community
AUS REP	Australian representative
CE	Indicates the product was designed and manufactured in accordance with applicable standards/guidelines and may be sold in the EU (European Union).
C UL US	UL Mark for Canada and the United States. Indicates the product was manufactured in accordance with the requirements of UL (Underwriter's Laboratory).
	Temperature limitation
	Humidity limitation
	Atmospheric pressure limitation
	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. (See warning that follows.)
	Symbol for infrared serial communications port on pump.
V ~	Operating voltage range for alternating current (i.e. AC or mains) power source
F2	*Medfusion® 3500BC pumps:* The designation "F2" indicated on the label, which is located on the AC input module connector assembly for the pump, is indicating a non-replaceable fuse that is part of the input module assembly. The fuse is located on the neutral side of the AC line.
⏚	*Medfusion® 3500BC pumps:* The "ground" symbol indicated on the label, which is located on the AC input module connector assembly for the pump, is indicating that the earth ground connection is providing a functional ground and not a safety ground.
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 (Medfusion® 3500BC pumps are listed as Safety Class II with functional earth, 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. *Medfusion® 3500BC:* The third wire ground (earth ground) serves a functional and not a safety purpose. Therefore, it is neither necessary nor 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® 3000 Series pump achieves protection by double-isolating secondary power and exposed metal from AC power. The Medfusion® 3000 pump satisfies the UL requirement that 4000 volts can be applied between AC side and exposed metal without causing significant current to flow.
Alarm History	*See "view alarm history".*
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 *Watchdog Alarm*, 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.

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)* – This the learned capacity of the battery by the gauge following a calibration cycle. Replace the battery when this is < 1600 mA-hours.
- *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.

Biomed Calibration

A set of functions for calibration/adjustment of the sensors within the Medfusion® 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. You may 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. You may 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.

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.

Depleted Battery Monitor

The circuitry which measures present battery charge status against stored battery capacity data to determine a "depletion" situation.

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.

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 Board — The interconnect printed circuit board interfaces to an intelligent NiMH Battery (or NiCad on older model pumps), the system speaker, the internal DC supply and supply conditioning for an external DC supply and the 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.

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 limits preset rates assigned to syringes by size & manufacturer.

- The limit priority alarms sound a tone and display an advisory message on-screen for 3 seconds. To re-display the message press .

LMD (Last Measured Discharge) — This the learned capacity of the battery by the gauge following a calibration cycle. Replace the battery when this is < 1600 mA-hours.

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***.

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 board senses the movement of the motor worm shaft.
"Neglected Pump" or User Call Back	The "Neglected Pump" or user call back alarm is a low priority alert which simply reminds you to finish what you started. Once you begin programming any infusion, the pump expects you to continue until programming is complete. If you leave the pump paused too long (30 seconds) on any data entry screen, then the pump begins sounding a low priority alert.
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	The plunger PCB provides pre-amplification of the force sensor output to the Main board, and contains two photo-interrupters with supporting circuitry for sensing each plunger flipper.
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 board 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. This is where you also set the date 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.
Primary Speaker	The main speaker located in the bottom housing of the pump. All normal alarm/alert tones are generated through this speaker.
Update Firmware	The firmware is the software installed in Medfusion® 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.
View Alarm History	This is a troubleshooting feature. In **Biomed > Utilities**, you may page backward and forward through the stored alarms in order to identify possible malfunctions.
View Infusion History	This is a troubleshooting feature. In **Biomed > Utilities**, you may 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	This is where you identify both the bootbank version and the main version of the operational software installed in the Medfusion® 3000 Series pump. (Pumps with V4.1.5 software also shows 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_WATCH-DOG.

Section 1: Scheduled Maintenance of the service manual defines the required preventive maintenance for keeping the Medfusion® 3000 Series syringe infusion pump in good operating condition.

Preventive Maintenance Planning

The recommended preventive maintenance plan allows you to service pumps in batches as their anniversary dates arrive. For example, if you have numerous pumps to service over the course of a year you may want to 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 software**: enter the ***next*** PM date. An example of a plan for the maintenance of pumps with V4 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® 3000 Series infusion pumps, you will need the following:

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

1 ea – new 50 or 60 cc 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

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

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

Electrostatic-controlled workstation

Whenever you work on the Medfusion® 3000 Series pump – *specifically whenever you open the pump for service* – you **must** work in an electrostatic-controlled environment. This ensures you will not damage the electronic components in the pump.

WARNING: 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.

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® 3000 Series pumps.

The Medfusion® 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 buttons to choose **Biomed** (press **More** for second page, if needed). Use the number buttons to enter passcode "***2580***", then use the number buttons 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 software:*** Set the date to the date you ***want*** the PM alert to occur.

  This 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.
- ☐ 8) After the completion of these tests the pump be should 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® 3000 series pumps

Follow your institution's guidelines for cleaning and disinfecting of devices. The syringe pump can be safely cleaned with the following agents:

- ***Common chlorine bleach diluted with water.***
- ***Mild detergent mixed with water.***
- ***Isopropyl alcohol 70% solution.***
- ***Other surface disinfectants which are compatible with plastic materials.***

For best results: Clean by spraying or pouring cleanser directly ***onto a soft cloth*** (not directly onto the pump) and then wiping surfaces until dry.

Cleaning cautions

Below are standard cautions you should follow when cleaning Medfusion® 3000 Series pump:

CAUTIONS:

• ***Avoid Organic Solvents:*** Never use organic solvents (e.g., acetone), quarternary ammonia compounds, strong acids or strong bases to clean any portion of the pump.

• ***Not Waterproof:*** The Medfusion® 3000 Series is "spray resistant" but not "water proof".
Never spray cleaning or other fluids directly into openings on the bottom of the pump.
Never immerse the pump in water or other fluids.

• ***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 or Gas Sterilize:*** Never sterilize the pump in a steam autoclave or gas. Using an autoclave or gas sterilization can seriously damage the Medfusion® 3000 Series pump and void the warranty.

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® 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 any damaged components.
- ☐ 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) Verify the Serial Number label is legible and intact. Replace if label is damaged.
- ☐ 9) Verify the Warning label is legible and intact. Replace if label is damaged.
- ☐ 10) Verify four rubber feet are attached to the bottom housing of the pump. Replace missing feet.
- ☐ 11) Turn the pump on all sides and check for any loose parts internally and externally.
- ☐ 12) 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:

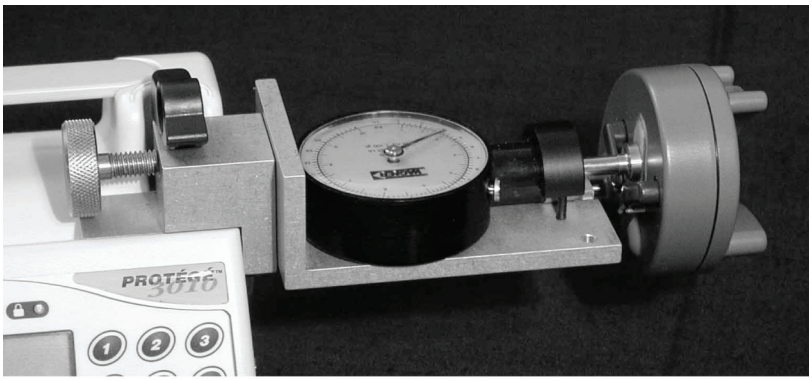
- ☐ 1) Verify alarm beeps.
- ☐ 2) Verify all the LED indicators are turn on and off (except AC and battery).
- ☐ 3) Verify that battery capacity shown on screen is greater than 0%.
- ☐ 4) Verify that no self-tests fail.
- ☐ 5) Verify the display is legible and contrast is acceptable.
- ☐ 6) Unplug the 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** buttons to choose **Biomed** (press **More** to find it, if needed). Enter the passcode (numbers ***2580***), then press **Enter**. Use the number buttons to choose **Diagnostics**, then **Monitor Analog Sensors**.

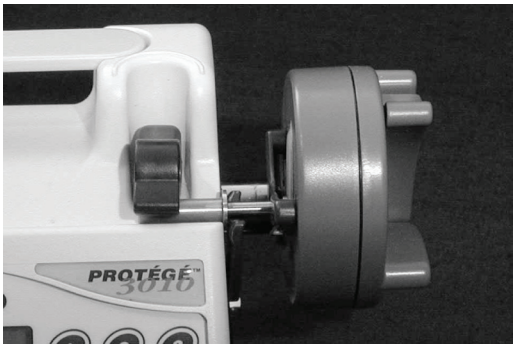
Force sensor check



- ☐ 1) Ensure that no syringe is loaded in the pump. Verify that the force reading on the screen is between –0.2 and +0.2 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 14.0 and 16.0 pounds.

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

Syringe size sensor check



- ☐ 1) 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 0.256" and 0.272", inclusive.
- ☐ 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 1.244" and 1.260", inclusive.

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

Plunger position sensor check

☐ 1) Load the small Calibration Slug into the barrel clamp.
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 0.680" and 0.720", inclusive. Unload the slug.

☐ 2) Load the large Calibration Slug into the barrel clamp.
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 4.680" and 4.720", inclusive. Unload the slug.

If either reading is out of specification, re-calibrate the sensor 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 cc syringe into the pump. Use the number buttons 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

Connect a three-way stopcock to an empty 50cc or 60cc Luer-lock syringe. Load the syringe with the syringe filled with approximately 30cc of air.

☐ 1) Use the number buttons 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**, use the number buttons to choose **Override Occl Limit**, choose **High**, then press **Enter**.

☐ 3) Press **Options**, then use the number buttons to choose **Disable Rapid Occl Detect**, if available. (If not available, press BACK.)

☐ 4) Press START to begin the infusion.

☐ 5) Verify the pump operates until an occlusion alarm occurs.
Open the stopcock to release the pressure, then remove 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 buttons to choose **ml/hr**. Select a syringe manufacturer. Load a 50/60 cc Luer-lock syringe (air-filled) into the pump – use a syringe from the table below. Enter a rate of 300 ml/hr.

☐ 1) From the **Begin Infusion** screen, press **Options** and use number buttons 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 ensure 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 60cc syringe, consult table below for other syringes.

Manufacturer	Minimum travel	Nominal travel	Maximum travel
B Braun Perfusor 50cc	**3.146" (79.92mm)**	3.211" (81.55mm)	**3.275" (83.18mm)**
B Braun Ominifix 50cc	**3.146" (79.92mm)**	3.211" (81.55mm)	**3.275" (83.18mm)**
B-D 60cc	**3.473" (88.22mm)**	3.544" (90.02mm)	**3.615" (91.82mm)**
Fresenius 50cc	**2.904" (73.76mm)**	2.964" (75.27mm)	**3.023" (76.77mm)**
Monoject 60cc	**3.473" (88.22mm)**	3.544" (90.02mm)	**3.615" (91.82mm)**
Terumo 60cc	**2.901" (73.70mm)**	2.961" (75.20mm)	**3.020" (76.70mm)**

Table of acceptable syringe travel for 50 and 60 cc 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.

AC line leakage test - *Medfusion® 3500BC*

☐ 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) Enclosure Leakage - Using the ground reference probe of the Analyzer, make contact with 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].

☐ 3) Earth Leakage - Use the Safety Analyzer, to measure the leakage current flowing through the earth conductor of the AC power cord.

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 both the normal and reversed settings 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 with functional earth, Type CF Medical Equipment:*** The pump is listed as Safety Class II with functional earth, 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 utilizes a third wire ground (earth ground) lead of the power cord as earth return for electromagnetic energy and does not serve as a safety function.
Therefore it is neither possible nor 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 2100 mAH Nickel Hydride (NiMH) cells (older pumps may have Nickel Cadmium [NiCad] batteries) 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.*

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** buttons to choose **Biomed**; use the **number** button to choose **Diagnostics**; use the number buttons to choose **Monitor Battery Status** option.

   a) **LMD (Last Measured Discharge) –** 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 < *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). You can interrupt the discharge test by turning the pump off and continue discharge at a later time – as long as you do not plug the pump 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 60cc syringe. This takes approximately *10 hours* from a full charge.

   b) A quicker method is holding open the clutch lever with an a clamp or vise grips 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 board.*

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 (last measured discharge) value is greater than 1600 ma-hours.
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 is greater than *1600 mA-hours*. At 1600 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 than 1600 mA-hours.

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 you may return the battery pack 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.

Section 2: Theory of Operation of the manual contains definitions and descriptions of standard operation of the Medfusion® 3000 Series pumps.

Overview of operation

The Medfusion® 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 Operation Manual.

Controlling motor functions

A stepper motor driving the plunger driver controls the infusion rate. The motor receives electrical pulses from 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 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.

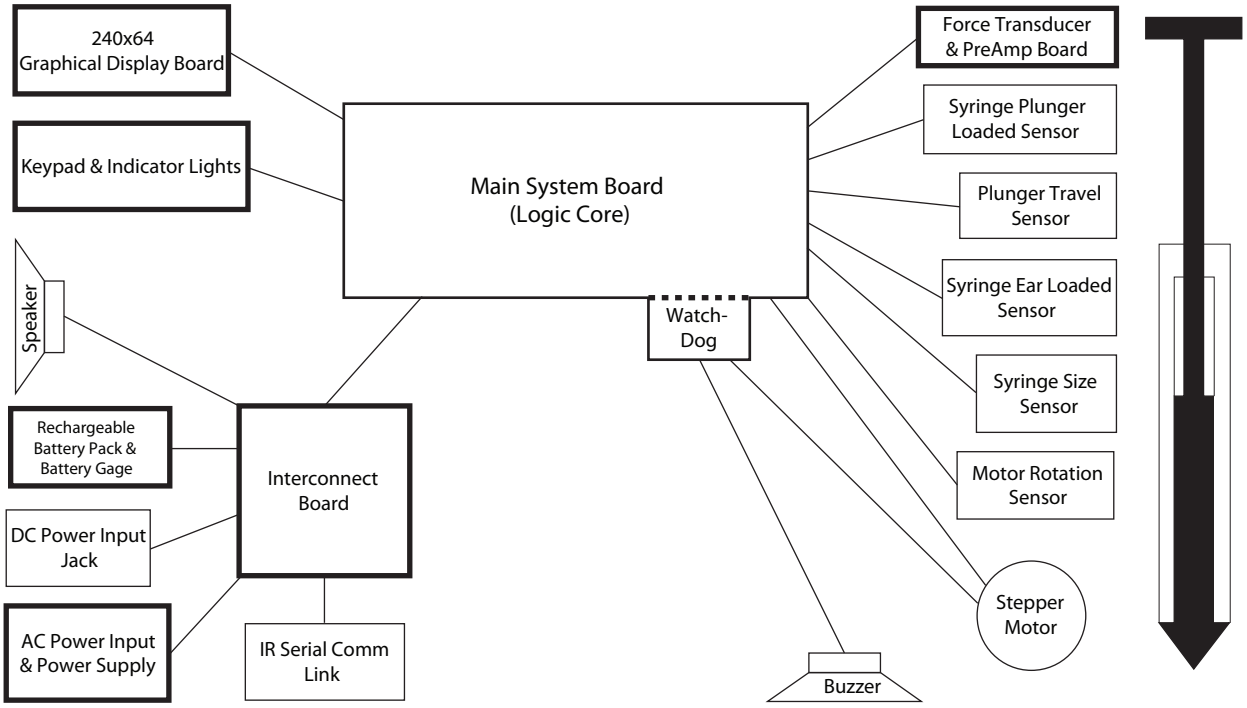
A Watchdog device checks for microcontroller malfunction including timebase errors, and can shutdown the motor and generate an alarm independent of the microcontroller operation. An internal power source (*i.e.,* 1 Farad super-capacitor) allows the pump to alarm should failure occur in the pump's power 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 of Medfusion® 3000 Series pumps

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



Block Diagram for Medfusion® 3000 Series Infusion Pump

Main circuit board

Main microprocessor

The *main circuit board* 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, then 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 board. This power source can be either battery power, or AC power, or external DC power. 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 buttons 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 <u>not</u> 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.

- Reports a logic state to the microprocessor to indicate proper syringe flange loading.
- 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. 10cc, 20cc etc.) or syringe not loaded.

Interconnect printed circuit board

Receives and directs the power source, either internal 12VDC power supply, internal battery, or external DC power to the "Main" board.

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

b) Contains battery charger for charging the battery.

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

d) Supplies the audio drive signal, originating from the "Main" board, 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

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 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

This *plunger printed circuit board (PCB)* provides connection and pre-amplification of sensors in the plunger driver to the main microprocessor board. 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 which generates a voltage proportional to the force applied by the plunger driver to push the syringe plunger. The allows the microprocessor to measure:

- Voltage proportional to force applied to the syringe plunger (i.e. occlusion detection).
- Uses 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.

- Reports a logic state to the microprocessor to indicate proper syringe plunger loading.
- Uses self test signal to verify the sensor is not in an electrically "stuck" state.

Main Board – Schematic Level

The Main printed circuit board design has the following sub-circuits:

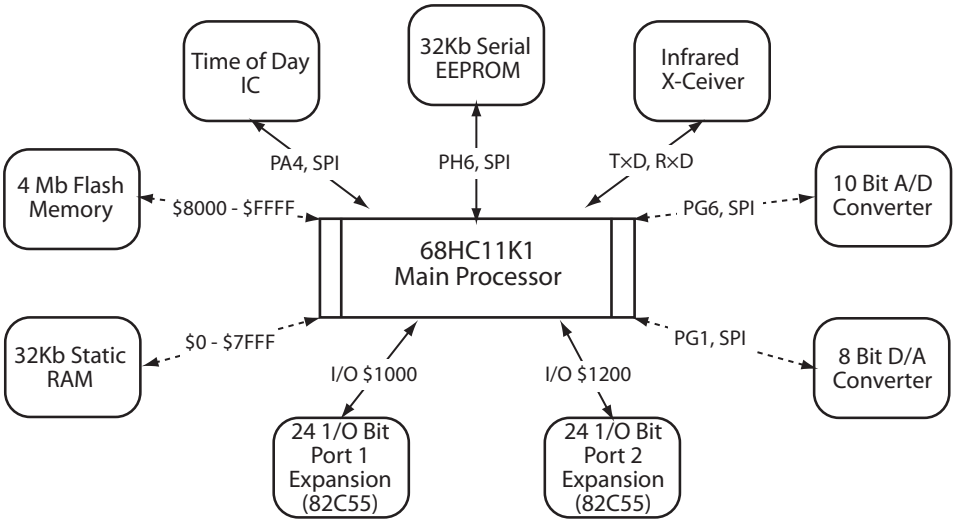
- Logic kernel
- Power control
- DC-DC Converter
- Front panel interface
- Graphic display interface
- Motor drive
- Motor speed detection
- Syringe sensing
- Plunger position sensor
- Force sensing
- Speaker drive

Each of the sub-circuit descriptions is presented in the order of the schematic pages of the Medfusion® 3000 Series "Main Printed Circuit Board". The signal names marked with the asterisk symbol on the schematic indicate that those signals are "active-low".

In the block diagrams for each section, the arrows indicate data flow direction referenced to the main microprocessor. In some cases, the arrows will identify a device other than the microprocessor to which the signal directly interfaces, (*e.g.*, analog to digital converter).

Logic Kernel Description

The Medfusion® 3000 Series Logic Kernel Main PC flowchart is below. It shows linkage between the 68HC11K1 microprocessor and the main components of the system:



Flowchart of Logic Kernel for Medfusion® 3000 Series infusion pump

68HC11K4 Main Microprocessor Interface, U19

The main microprocessor's direct signal interfaces are described in clockwise order taken from the Medfu-

sion® 3000 Series Main PC Schematic of the microprocessor. The following table summarizes some of the microprocessor input / output signals.

Signal name	Processor port	Description
IR_XMT_DATA	PD1/TxD	The IR_XMT_DATA is used for transmitting asynchronous serial data.
IR_RCV_DATA	PD0/RxD	The IR_RCV_DATA is used for receiving asynchronous serial data.
SPEAKER_FREQUENCY	PH0/PW1	Sets the audio frequency of the main speaker. Generated as a fixed 50% duty cycle (square wave) with a variable frequency.
SPEAKER_VOLUME	PH1/PW2	Fixed frequency variable pulse widths signal that the speaker- driver hardware converts into a DC voltage for volume control.
MTRPHA_IREF	PH2/PW3	Pulse-width modulated output transformed by hardware into a DC level representing motor current for coil "A" of the motor.
MTRPHB_IREF	PH3/PW4	Pulse-width modulated output transformed by hardware into a DC level representing motor current for coil "B" of the motor.
ADC_CS*	PG6	Chip select signal for SPI communication to the 10-bit analog to digital converter. This signal is active low.
DAC_CS*	PG1	Chip select signal for SPI communication to the 8-bit digital to analog converter. This signal is active low.
RESET_PIO	PG0	Allows the main processor to independently reset the two 24 bit I/O expansion devices. The reset is active high.
POWER_STROBE	PD5	Controls the power state of the system. Must be an AC signal to maintain the power on state. A stuck state of either logic high or low, is one of the conditions for enabling the power off state.
PLUNGER_DETECT1	PA6/OC2	Logic sense signal for detecting the respective plunger flipper state. A logic high indicates a syringe is loaded.
PLUNGER_DETECT2	PA5/OC3	Logic sense signal for detecting the respective plunger flipper state. A logic high indicates a syringe is loaded.
ACU_PWR_STRB_ON	PA4/OC4	This feedback signal to check that ACU is still controlling power to the system. When power is on, ACU_PWR_STRB_ON measures > 4.0 volts nominally.
ASYNC_BATTERY_DATA	PA3/IC4/OC5	The single wire asynchronous data communication between the main processor and the battery gauge located on the battery pack. This port pin is bi-directional, both input & output.
IO_CS*	CSIO	Chip select for the two 24 bit I/O expansion devices. This signal is active low.
RAM_CS*	CSGP1	Chip select for the main processor's external random access memory (RAM). This signal is active low.
EEPROM1_CS*	PH6	Chip select for SPI communication to the serial E2 PROM #1. This signal is active low.
FLASH_CS*		Chip select for access to the main processor's programmed memory (Flash). This signal is active low.

Signal name	Processor port	Description
WRITE*, E_CLOCK, XADDR[15:18], ADDR[0:14], DATA[0:7]	R/w*, E, XADDR15 - XADDR18, ADDR0 - ADDR14, and DATA0 - DATA7	The main processor control bus signals that route to the memory and I/O expansion devices. The address line addr15 is not used.
SPI_CLOCK, SPI_MOSI, and SPI_MISO	SCK, MOSI, MISO	These signals are used for SPI bus communication to the Serial EEPROM, Time of Day Clock, Analog to Digital Converter, and the Digital to Analog Converter.
ATOD_REF_BFRD	AN0	Input for main processor to verify the reference voltage used by the 10-bit analog to digital converter and system reference. The nominal measured reference voltage is 2.048 volts.
SUPERCAP_DETECT	AN1	Analog signal proportional to the Super Capacitor voltage. When fully charged, SUPERCAP_DETECT measures 2.5 volts nominally. The main processor read SUPERCAP_DETECT to verify the Super capacitor is present.
PWR_STRB_ON	AN2	Feedback signal is to check the proper operation of the power control circuit. When power is on, PWR_STRB_ON measures > 4.0 volts nominally.
MOTOR_SPLY_MEAS	AN3	Signal is proportional to the motor supply voltage. The nominal DC voltage for this signal is 1.09 volts, exactly a sixteenth of the motor supply voltage.
ANALOG_SPLY_MEAS	AN4	Signal is proportional to the analog supply voltage. The nominal DC voltage for this signal would be 2.5 volts nominally, exactly one half of the analog supply voltage.
FORCE_PSV_ADJ	AN5	Feedback signal proportional to the offset voltage used on the force sensor pre-amplifier. Its voltage range dependent upon the offset voltage setting (a calibration value).
SPEAKER_DETECT	AN6	Feedback signal proportional to the current through the main speaker. Its level depends on the volume setting for the speaker.
VPOS_SPLY_MEAS	AN7	Signal is proportional to the positive supply voltage. The nominal DC voltage for this signal is 2.397 volts, exactly one fourth of the VPOS_SPLY supply voltage.
MTR_TIMER	PA7/OC1	Time base used by the main processor to control motor step timing and an input to the highest, maskable interrupt source.
MOTION_DETECT	PA2/IC1	Signal is the encoded output from the optical motor rotation detector.
BUZZER_DETECT	PA1/IC2	Feedback signal from the audio buzzer detection circuit. This signal is logic high whenever the audio buzzer is active.
TOD_INTRPT	PA0/IC3	An independent time base provided by the time of day clock. This is a 1 Hz frequency signal.
	MOD_A, MOD_B	These inputs configure special processor operational modes.

Signal name	Processor port	Description
RESET*	Reset	Provided from the system-reset circuit located in the Power Control Logic section of the Main PCB.
	VRH	4.096V A/D reference.
	AVDD, AVSS, and VRL	The main processor's analog to digital conversion supply and reference pins.

Flash memory, U22

Flash program memory is 512 K × 8. It is addressed as 16 pages of 32 K × 8 each.

Flash memory can be reprogrammed within the system.

Software upgrade method for programming flash memory

The re-programmable feature of Flash Memory provides for software upgrades. The pump is placed in a special Biomed mode which allows reprogramming of the software through the infrared serial port.

Static random access memory, U17

Static RAM is 32 K × 8 bit.

Serial EEPROM, U2 and U4

The serial EEPROMs are used for storing manufacturing, calibration, configuration, libraries, the history event log, the PharmGuard® Safety Data, and the service data requiring non-volatile random access.

Medfusion® 3000 series pumps may have two 8K x 8 bit EEPROMs, two 16K x 8 EEPROMs, or two 32K x 8 EEPROMs.

Time of day, U8

The time of day, including calendar, is maintained by the RS5C316B which is continually powered as long as AC, external DC voltage, or internal battery is present, or the super capacitor is charged.

Infrared transceiver

An IR transceiver, located on the Interconnect board, provides an electrically isolated asynchronous serial communication link between the pump and an external system. The infrared link is intended for short distances of less than a few inches.

Analog to digital converter, U13

A four channel, unipolar, 10-bit converter obtains high resolution analog measurements.

The high resolution measurements in ascending channel order are:

- *pressure sensing amplifier*
- *plunger force sensing amplifier*
- *syringe size sensing amplifier*
- *plunger travel sensor*.

The converter uses precision 4.096-volt reference equating to a bit resolution of *4 millivolts*. The converter interfaces to the Serial Peripheral Interface of the 68HC11.

Digital to analog converter, U20

A dual channel 8 bit *digital-to-analog* converter:

- Generates the contrast voltage for the Liquid Crystal display,
- Generates an offset to the force sensing amplifier.

Uses precision 4.096-volt reference equating to a nominal bit resolution of 16 millivolts. Channel A is the source for the force amplifier, and channel B is the contrast voltage reference.

I/O port expansion, U3, U33

There are two 82C55 input/output port devices providing the additional input/output requirements for the microprocessor. They are accessed through the I/O chip selects PORT1_CS* and PORT2_CS*.

Expansion port # 1 (PORT1_CS)

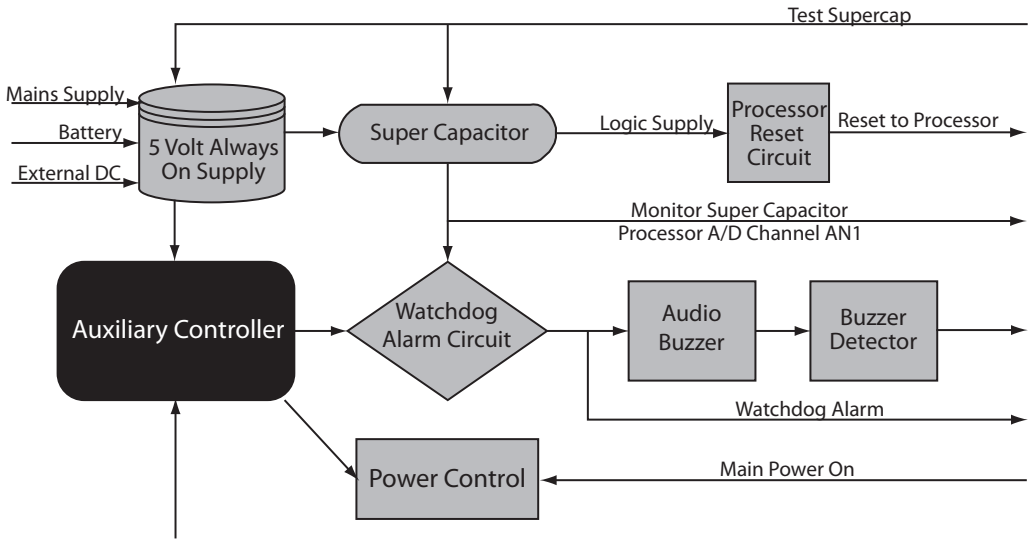
Signal name	Port location	Description
EEPROM2_CS*	PB7	A logic low enables accessing the 2nd serial EEPROM.
PET_WATCHDOG	PB6	A logic signal used as a handshake for indicating valid operational status to the auxiliary controller.
SUPERCAP_TEST	PB5	A logic high enables testing the super-capacitor, (i.e., backup power source).
TOD_CS	PB4	A logic high enables accessing the time of day IC.
TOD_WR_ENBL*	PB3	A logic low enables writing data to the time of day IC.
SPEAKER_ENVELOPE3	PB2	A logic high selects the audio envelope time constant of 35 milliseconds. Refer to the Main Speaker Drive description section.
SPEAKER_ENVELOPE2	PB1	A logic high selects the audio envelope time constant of 11 milliseconds. Refer to the Main Speaker Drive description section.
SPEAKER_ENVELOPE1	PB0	A logic high selects the audio envelope time constant of 2.5 milliseconds. Refer to the Main Speaker Drive description section.
WARNING_LED_ON*	PC7	A logic low turns the “Caution” LED indicator on.
INFUSING_LEDL_ON*	PC6	A logic low turns the left most (when viewing the keypad) “Infusing” LED indicator on.
INFUSING_LEDM_ON*	PC5	A logic low turns the middle “Infusing” LED indicator on.
INFUSING_LEDR_ON*	PC4	A logic low turns the right most “Infusing” LED indicator on.
PCELL_LED_ON*	PC3	A logic low turns the “Pressure Cell” LED indicator on.
BATTERY_LED_ON	PC2	A logic high turns the “Battery” LED indicator on.
CAUTION_LED_ON*	PC1	A logic low turns the “Caution” LED indicator on.
LOCKOUT_LED_ON*	PC0	A logic low turns the “Tamper Feature Active” LED indicator on.
KEYPAD_IN_COL(0-5)	PA0-PA5	Senses 1 of 6 columns of the keypad matrix. When the sense value is logic low, the indication is the corresponding button for the column is being pressed.
PWR_SW_MCU	PA6	Sense signal for the power switch. The signal is at a logic high when the power switch is being pressed.
MTR_CURRENT_DETECT*	PA7	Sense signal from the motor current detector circuit. If the motor is energized with sufficient current in any coil, this signal is at logic low.

Expansion port # 2 (PORT2_CS)

Signal name	Port Location	Description
SET_IN_SNSR_ENBL*	PB6	Set to logic low to enable the "set in" detector to sense the pressure cell being installed.
SYRINGE_EAR_SNSR_ENBL	PB5	Set to logic high to enable the "syringe" detector to sense the syringe flange (ears) being installed.
PLUNGER_SNSRS_ENBL	PB4	Set to logic high to enable the "plunger" detectors to sense the plunger flippers being properly engaged.
MOTION_SNSR_ENBL	PB3	Set to logic high to enable the motion sensor monitoring the motor speed.
FORCE_SNSR_TEST*	PB2	Set to logic low to activate the force sensor test circuit. This signal causes the sensor to generate a known offset if the sensor is operating properly.
PRESSURE_SNSR_TEST*	PB1	Set to logic low to activate the pressure sensor test circuit. This signal causes the sensor to generate a known offset if the sensor is operating properly.
LCD_RESET*	PB0	Allows the main processor to reset the LCD display independently of other system devices. The reset signal is active low.
MTR_PHB_DIR	PC7	Controls the direction (phase) of motor current in coil "B" of the stepper motor.
MTR_PHB_ENBL*	PC6	Set to logic low to enable motor current in coil "B".
MTR_PHA_DIR	PC5	Controls the direction (phase) of motor current in coil "A" of the stepper motor.
MTR_PHA_ENBL*	PC4	Set to logic low to enable motor current in coil "A".
KEYPAD_SEL_ROW3*	PC3	Control signal to select row 4 of the four-row keypad matrix. To select the row requires a logic low and only one row at a time.
KEYPAD_SEL_ROW2*	PC2	Control signal to select row 3 of the four-row keypad matrix. To select the row requires a logic low and only one row at a time.
KEYPAD_SEL_ROW1*	PC1	Control signal to select row 2 of the four-row keypad matrix. To select the row requires a logic low and only one row at a time.
KEYPAD_SEL_ROW0*	PC0	Control signal to select row 1 of the four-row keypad matrix. To select the row requires a logic low and only one row at a time.
BUZZER_ARMED	PA0	A logic high indicates the backup audio buzzer is ready to alarm should the "watchdog" alarm state become true. A series resistor is provided to prevent latching.
WATCHDOG_ALARM	PA1	A logic high indicates the "watchdog" alarm state is true.
EXTRNL_PWR_DETECT	PA2	A logic high indicates an external power source is connected to the pump. A series resistor is provided to prevent latching.
AC_PWR_DETECT	PA3	A logic high indicates AC line power is connected to the pump. A series resistor is provided to prevent latching.
SYRINGE_EAR_DETECT	PA5	A logic high indicates the syringe flange (ears) are installed properly in the pump and SYRINGE_EAR_SNSR_ENBL is active.
SET_IN_DETECT	PA6	A logic high indicates the pressure cell is installed and SET_IN_SNSR_ENBL is active.
VLOW_BATTERY	PA7	A logic high indicates the battery voltage has fallen below a fixed voltage level, independent of the battery being charged.

Power control description

The power control logic provides two functions, power management, and triggers alarms when the main microprocessor fails. Refer to the Power Control Logic section of the Main PC Schematic for details.



Flowchart of Power Control Description.

Always on supply, U7

A 5-volt linear regulator provides power to the time of day clock and auxiliary controller, while maintaining a charge on the super capacitor.

- This supply is always active provided a power source is present be it the regulated mains AC power, battery, or external DC.

Backup super capacitor, C11

This device provides backup power to the audio buzzer in the loss of the primary power source, a *1 Farad Super Capacitor* is part of the power control design.

- The super capacitor voltage SUPERCAP_DETECT, is monitored through the microprocessor's A/D converter channel by the microprocessor asserting SUPERCAP_TEST when the pump is turned on.

Backup audio buzzer, XD1

The audio buzzer provides a means to generate a backup audible alarm during:

- *instrument power loss* (while the instrument was on)
- *malfunction of the main microprocessor*
- or *failure of the primary speaker*.

The audio buzzer is enabled when the pump is turned on, and when the WATCHDOG_ALARM signal activates. The WATCHDOG_ALARM signal (from the auxiliary controller) activates anytime there is a malfunction of the main microprocessor. The main microprocessor can activate this buzzer indirectly by not providing the PET_WATCHDOG strobe to the auxiliary controller which causes a watchdog alarm.

- During power-up, the buzzer is tested by the watchdog alarm state being active, and the buzzer response verified through the BUZZER_DETECT signal.

System reset, U43

On startup, the microprocessor comes out of reset when the logic supply exceeds 4.6 volts plus the built-in delay of the reset IC.

Power management, U39

An embedded Auxiliary controller oversees the power control management, and serves as the main microprocessor watchdog. The behavior of the power management system depends on pump states:

- *Power Off*
- *Power On*
- *Watchdog Alarm*
- and a *Battery Disconnect*.

Power OFF state

You must press, hold, and release the power switch to turn OFF the power. In normal operation, both the auxiliary controller and the main microprocessor control power-off.

Power ON state

To enter the *power on* state the POWER_ENBL signal is initially set active by the auxiliary controller. This requires the auxiliary controller provide an AC strobe to the POWER_ENBL circuit. This POWER_ENBL signal also arms the backup audio buzzer. The POWER_ENBL signal is verified by the main microprocessor monitoring the BUZZER_ARMED signal.

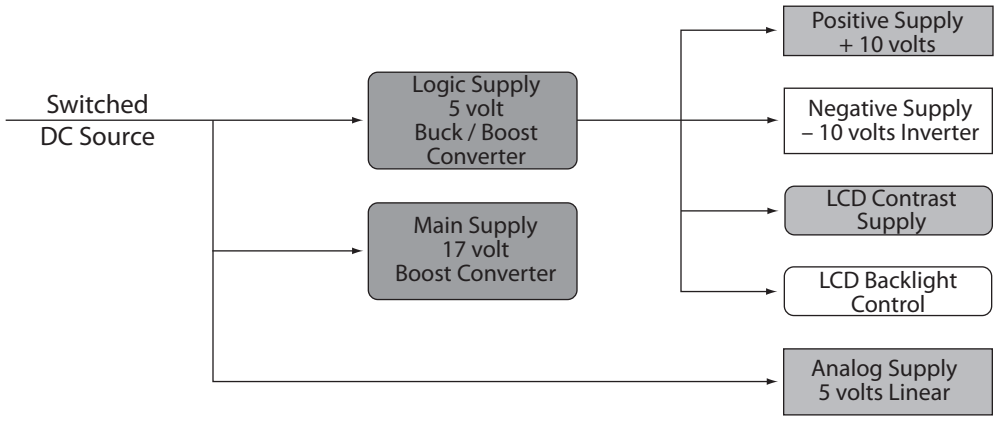
Watchdog

During a watchdog alarm, the auxiliary controller has sole control of power-off.

DC to DC converter

The circuits for the DC-DC Converter provide all regulated voltages required by the hardware sub-circuits.

- A switched DC source, (battery, regulated mains supply, or external DC) powers the converter section under the control of the Power Control circuitry.
- The converter design provides stable supply operation from an unregulated DC source, simplifying the requirements for the switched sources.
- Refer to the DC-DC Converter section of the Main PCB schematic for details.



Flowchart of DC & DC Converter Operation

Logic supply, U12

The Logic Supply current-mode switching regulator provides a regulated output voltage of 5 volts (±5%) for the system logic.

Motor supply, U34

The Motor Supply is a current-mode switching regulator provides a regulated output voltage of *17 volts* for the motor current regulators.

Analog supply, U21

The Analog Supply is provided specifically for low noise signal processing circuits. Being a linear supply, inherent noise rejection removes source input switching noise from it's regulated output.

Positive & negative supply, U36

The negative supply is a charge pump DC-DC converter doubles the input voltage, then inverts the doubled voltage.

- Provides the contrast voltage to the graphic LCD display. The low current load for the contrast voltage allows use of an operation amplifier controlled by the D/A converter through the SPI bus.
- Provides negative supply for the amplifiers used in force and pressure sensing.
- The charge pump doubles the "Logic Supply" voltage to achieve a *10V nominal positive supply voltage*. This supply is used for analog circuits needing a supply voltage higher than the "Analog Supply".

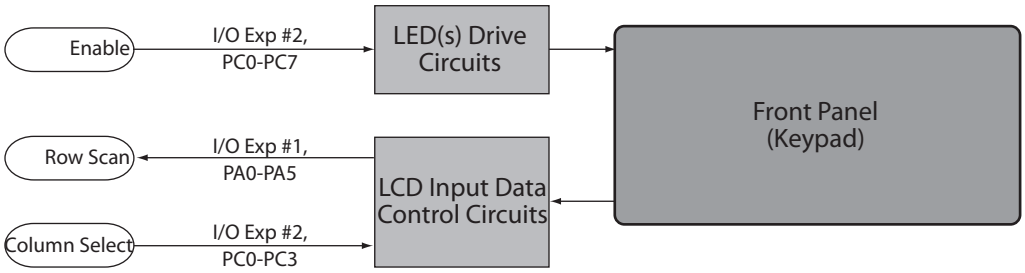
LCD backlight supply, U1

A constant current regulator controls the primary LED back light for the LCD display. On the Medfusion® 3500 pump, the secondary LED for the backlight is controlled by Q45.

Front panel interface description

The keypad interface has two circuits:

- the interface to the LED's
- the interface to the keypad switch matrix, and power switch.



Flow Chart of Front Panel Function

LED drive circuit, Q26, Q27, Q40, Q33 - Q37

Each LED drive circuit has a logic controlled switch providing a pseudo-current source to the LED when activated.

- All LED's except the "Warning", "Battery Charge", and "AC Power" LEDs, are controlled exclusively by the main microprocessor.

Keypad matrix interface

A 4 row by 6 column scan matrix senses the front panel keys:

- A pressed button is read from column signals, KEYPAD_IN_COLx, through the 82C55 port expander #1. A button press is sensed as a logic low.
- The keypad row signals are output from port C of the 82C55 port expander #2.

Power switch interface

The power switch has a circuit separate from the keypad matrix because it is monitored by both the main microprocessor and the auxiliary controller.

Graphic display interface description

The graphic display interface circuits have the main microprocessor control signals, read write, the device select signal LCD_CS*, a data output latch, a data input buffer, and a device reset.

Data output to LCD, U32 / data input from LCD, U6

The data from the LCD to the main microprocessor is buffered by U32 and U6.

LCD contrast

The contrast control is created from the 8-bit digital to analog converter buffered with a 2.5 gain amplifier to provide minus contrast voltage.

- The full scale range of 255 (FF hexadecimal) counts equals approximately *minus 10 volts*.

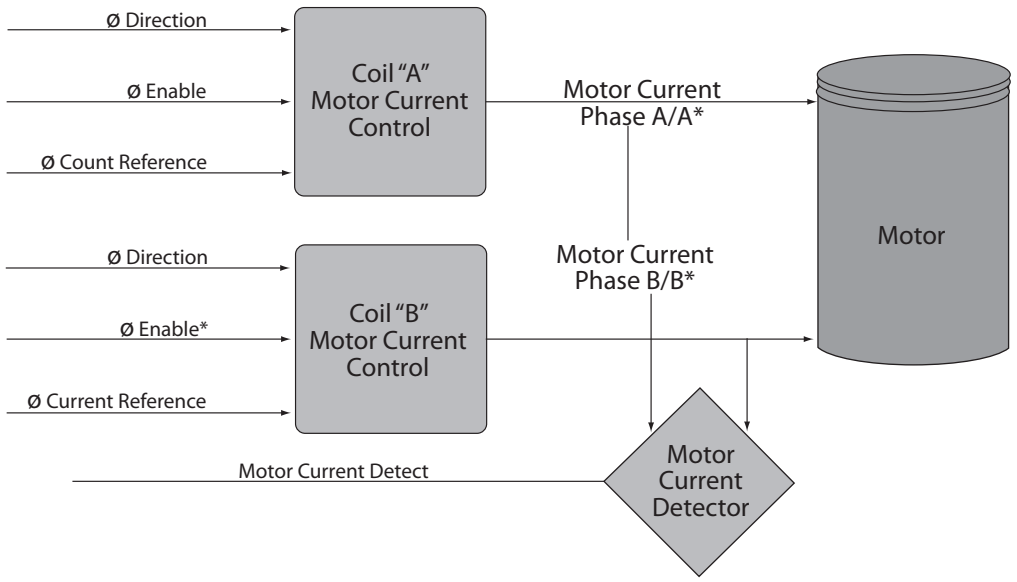
LCD backlight

The primary *backlight* for the LCD is an LED driven by a constant current source. This backlight is *always on* whenever the pump is on.

The secondary backlight is not present on Medfusion® 3010 and 3010a pumps. Its on-off state is controlled by the CPU. During normal conditions, it is off when the pump is powered via the internal battery.

Motor drive description

A two-phase bipolar stepper motor drives the syringe plunger. The motor control interface drives the stepper motor.



Flowchart of Motor Drive Description

The main microprocessor controls which motor winding is active, designated as A or B, the direction of current in each winding, and the magnitude of the current.

Coil A & B PWM current references

The pulse-width modulated signals from the main microprocessor are low pass filtered to create an analog voltages for control of motor current in each coil.

Motor current regulators, U26, U35

Two regulator ICS independently regulate the current for windings A and B.

- The WATCHDOG_ALARM signal activates the N-channel MOSFET to disable the motor current in both windings through the "BRAKE" pin of the regulator IC.

Motor current detector, U40

The watchdog alarm function is tested at power-up by verifying the MTR_CURRENT_DETECT* signal is at a logic high when the watchdog alarm condition is active.

- Similarly, the MTR_CURRENT_DETECT* signal should be at a logic low when either motor winding has sufficient current and the watchdog alarm condition is not present.

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 printed circuit function.

Syringe size sensing

Syringe sensing is accomplished by using a potentiometer which changes its resistance with the barrel diameter. The potentiometer is excited with a precision 4.096v voltage reference and the potentiometer's output is monitored through channel 2 of the system A/D.

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

Syringe flange (ear) sensing

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.

- The emitter is enabled by the signal SYRINGE_EAR_SNSR_ENBL when set to logic low.
- The sensor output, SYRINGE_EAR_DETECT, produces a high logic state when the flange is properly loaded.
- The state should be logic low anytime the syringe ear (flange) is not installed or SYRINGE_EAR_SNSR_ENBL is inactive.

Plunger position sensing description

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

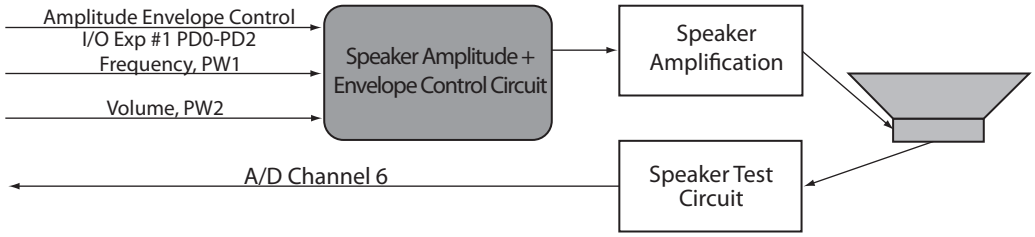


Illustration of Speaker Drive

Speaker control

- Tone duration is controlled by the interval the amplitude level is applied.
- The SPEAKER_FREQUENCY signal is a fixed 50% duty cycle (square wave) with a variable frequency to *1 kHz*.
- The SPEAKER_VOLUME is a pulse-width modulated signal converted by hardware to an analog voltage which controls the speaker volume.
- The rise and fall times of the volume are controlled by input signals from: SPEAKER_ENVELOPE_1, SPEAKER_ENVELOPE2, and SPEAKER_ENVELOPE_3.

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.

- The amplified output is demodulated by the analog switch which creates a peak and hold circuit.
- The SPEAKER_DETECT output signal from the conditioning circuitry goes to the microprocessor's analog input.

Plunger board – schematic level

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

The referenced schematic signals of the main board electronics are identified using names in SMALLCAPS.

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.

- The Main printed circuit board provides a fixed 4.096-volt excitation to the force sensor.
- The Main printed circuit board trims this offset range using the signal FORCE_PREAMP_OSADJ.
- The Main PCB provides additional gain to maximize measurement resolution.

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*

- FORCE_SNSR_EXH provides a constant voltage excitation of *4.096 volts DC* to the sensor.
- Auto-Zero Adjustment Circuit provides a voltage to zero the pre-amplifier, FORCE_OSV_ADJ, from the 8 bit system D/A converter.
- Sensor Post Filter Amplifier is a second order low-pass filter with a 3.68x gain.
- The signal FORCE_SNSR_TEST* when set active low causes Q2 to apply a resistance parallel to the force sensor's bridge resulting in a positive shift of the sensor output.
- The sensing system requires calibration to determine zero adjustment, offset, and gain. Calibration values are stored in non-volatile (serial EEPROM) memory.

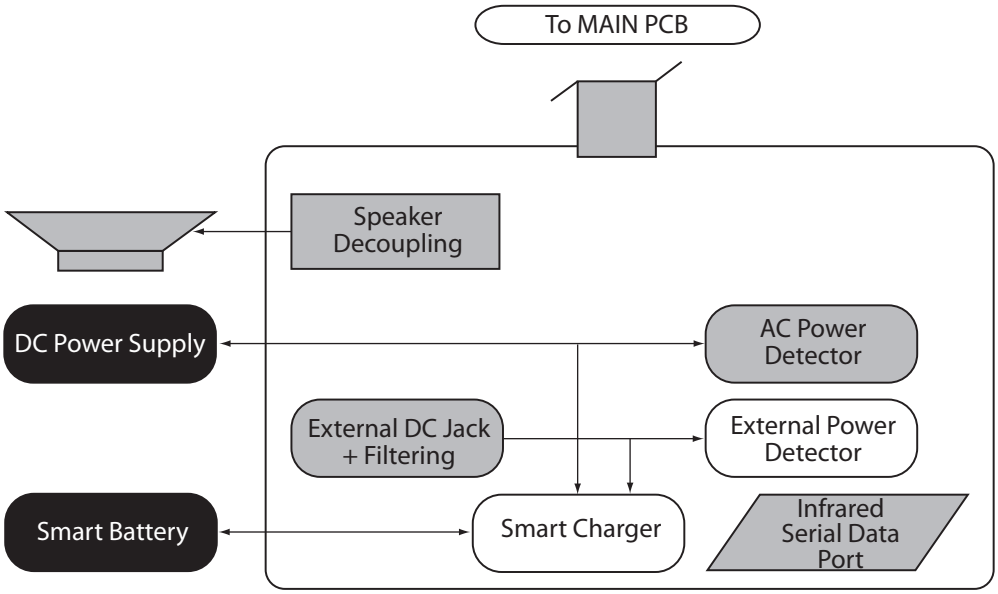
Plunger flipper sensor function

Plunger flipper sensing requires each sensor 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.

- Output from each *photo-interrupter* is monitored individually so each sensor is independently checked.
- When a syringe plunger is correctly loaded, both PLUNGER_SNSR1_OUT and PLUNGER_SNSR2_OUT are at a *logic high*.
- The transistor Q1 allows the sensor output to be tested by turning the transmitter from both sensors on and off. This is controlled by the signal PLUNGER_SNSRS_ENBL from the Main PCB.

Interconnect board – schematic level

The interconnect printed circuit design interfaces to an intelligent rechargeable Battery, the system speaker, the internal DC supply, connection for an external DC supply and the main PCB.



Flowchart of Interconnect Board at Schematic Level

Each sub-circuit description is presented in the order of the schematic pages of the Medfusion® 3000 Series "Interconnect Printed Circuit".

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, requires the DC input voltage (from the AC power supply) 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

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

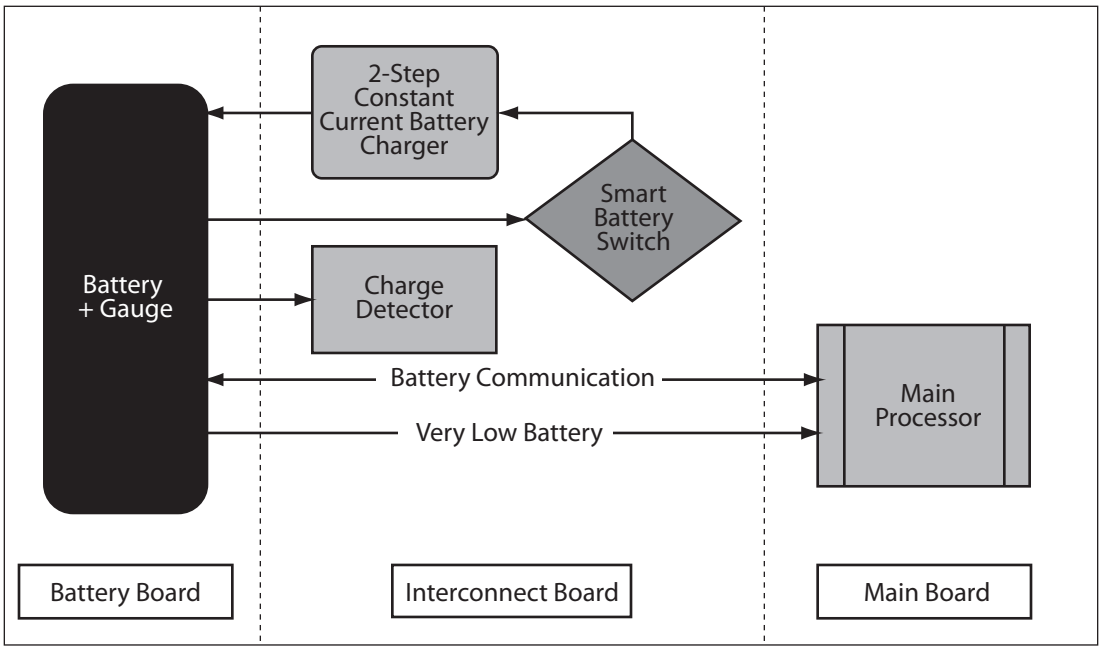
The *infrared serial port* interfaces directly with the main microprocessor's asynchronous serial communication pins. The infrared port supports short transmission distances of approximately *3" or less* and a maximum baud rate of 9600.

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 board interfaces to a 6 cell NiMH battery pack (NiCad battery pack on older model pumps) with a "smart" battery gauge.



Flowchart of Battery Management Description

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 is present. 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 board – schematic level

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

- 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.

The referenced schematic signal nets of the main board electronics are identified using names in SMALLCAPS.

Battery gauge function

The gauge IC, BQ2012, monitors direction and magnitude of current flowing through the battery.

- The current is sensed by the gauge as a voltage across R4.
- 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 PC board, 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.

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.

Problem solving alarms / alerts

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

Types of alarms / alerts

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

Type	Definition and Remedy
High priority	A *high priority alarm* results from any condition which halts an ongoing infusion, or any pump system fault which affects infusion. 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.
Medium priority	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 silences the audible alarm for the programmed alarm silence period.
Low priority	A *low priority alarm* indicates any condition not requiring immediate operator intervention. Low Priority alarms are signaled with a continuous yellow indicator and an intermittent audible signal. Pressing permanently silences this alarm.
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 advisory message onscreen.
Neglected pump	The *Neglected Pump alarm* is a medium priority alarm. It is simply reminding you to finish what you started. Once you begin programming any infusion delivery setting, the pump expects you to continue until setup is complete. If you leave the pump paused too long (>30 seconds) on a data entry screen, then the pump sounds a medium priority alarm tone with the yellow indicator flashing.

Note: The Neglected Pump 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 alarm message, alarm priority, and cause for each alarm condition:

Alarm message	Alarm priority programming	Alarm priority infusing	Cause or corrective action
Battery Communication Timeout (System Advisory)	Low	Low	Pump has sensed battery current present, but the battery gauge on the battery pack is not communicating. Check connections from main board, to interconnect, to battery pack.
Battery Not Charging (System Advisory)	Low	Low	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 board.
Battery Not Working (System Advisory)	Medium	Medium	Pump has found no battery present – no charge current and no battery gage communication. Battery may be unplugged.
Calculated Rate Out of Range	High	–	The calculated rate is not valid. Verify that all infusion parameters have been entered correctly.
Check Clutch / Plunger Lever	–	High	Normal alarm message. Software uses position potentiometer to monitor motion of the plunger driver during delivery. If the motion is not correct this alarm is generated. May be caused because pump was not primed and clutches took too long to engage, or may occur when user squeezes the plunger lever and moves plunger head. 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.
Check Syringe Barrel Clamp	Medium	–	Certain syringe brands and sizes may cause the barrel clamp sensor to have difficulty in verifying the clamp is in position. Use **Biomed** > **Diagnostics** and run **Monitor Digital Sensors** to check function of barrel sensor.
Check Syringe Flange Sensor	High	–	At power-up, software has sensed the flange is loaded when no syringe is loaded in the pump (as sensed by the barrel clamp size sensor). Use **Biomed** > **Diagnostics** and run **Monitor Digital Sensors** to check function of flange sensor.

Alarm message	Alarm priority programming	Alarm priority infusing	Cause or corrective action
Check Syringe Plunger Sensor	High	–	At power-up, software has sensed the plunger is loaded when no syringe is loaded in the pump (as sensed by the barrel clamp size sensor). Use **Biomed > Diagnostics** and run **Monitor Digital Sensors** to check function of both plunger sensors.
Clear TVD to Start Infusion	Limit	–	Normal advisory message. Total volume delivered (TVD) or total dose delivered (TDD) needs to be cleared to start an infusion when TVD/TDD exceeds the volume limit setting.
Completing System Initialization	Limit	–	Normal advisory message. At power-up, if all settings are entered by the user and START is pressed before background self-tests are completed, then this message appears. Wait a few seconds until self-testing is completed and then press START to begin infusion.
Data Does Not Match Previous Entry	Limit	–	Normal advisory message. In cases where confirmation of user entered data is required, the confirmation value did not match. Re-enter the value.
Depleted Battery (System Failure)	High	High	Normal alarm message. 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, cycle power on the pump, then use **Recall Last Settings** to recall delivery settings and resume delivery. If problem is chronic, check battery pack function or perform battery calibration.
Force Sensor Bgnd Test	High	High	Normal alarm message. Press POWER to turn the pump off. Background self-test has found the force sensor signal out-of-range or the force sensor signal did not change when 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 board. Replace plunger board, plunger cable or force sensor.
Infusion Complete	–	High	Normal alarm message. Infusion has reached the set volume limit and delivery has stopped.
Input Out of Range - Greater Than Max Value	Limit	–	Normal advisory message. User attempted to enter a number greater than the maximum value allowed. (See also "maximum rate" in general problems below). Try a lower value.

Alarm message	Alarm priority programming	Alarm priority infusing	Cause or corrective action
Input Out of Range - Less Than Min Value	Limit	–	Normal Advisory Message. User attempted to enter a number less than the minimum value allowed. Try a higher value.
Invalid Infusion Parameter Combination	Low	–	Normal advisory message. The user has attempted to set a combination of infusion values that does not allow a valid flow rate to be calculated. Press BACK and enter a different set of values.
Invalid Library Entry	Limit	–	Normal advisory message. The library entry was not defined correctly when it was created. Review the library entry using the PharmGuard® Toolbox and correct the problem.
Invalid Syringe Size	High	High	Syringe size (barrel clamp potentiometer sensor) does not match selected manufacturer or when barrel clamp is lifted during delivery, this alarm occurs. If there is any question about this sensor's function perform PM check of barrel clamp calibration.
Invalid Rate for Syringe Size (V3 pumps only)	High	–	Normal advisory message. When using E-plates library entries, the library stores syringe size. Changing this size may cause this message to appear (refer to the *Operation Manual* for syringe size/rate tables).
KVO in Progress	–	Medium	Normal alarm message. Infusion has reached the set volume limit and delivery changed to KVO rate.
Limits Adjusted - Cannot Delivery All Doses	Limit	–	Normal alarm message. The limits on the parameter to be entered were adjusted to keep the resulting rate inside allowable limits.
Low Battery (each 1% drop in capacity following initial signal if power cord is not plugged in)	Low	Low	Normal advisory message. Battery gauge has measured the capacity of the battery is less than 10%. The infusion rate will determine the run time remaining on the battery.
Low Battery (initial signal)	Medium	Medium	Normal advisory message. Plug in the power cord and run the pump on AC Mains while recharging battery.
Motor Rate Error	High	High	Normal advisory message. The stepper motor moving at the wrong speed. Clear any obstructions to proper motor operation. If the message reoccurs, you may need to replace the motor.

Alarm message	Alarm priority programming	Alarm priority infusing	Cause or corrective action
Occlusion - Check Infusion Line	–	High	Normal alarm message. The force sensor in the plunger driver has sensed occlusion of the infusion line when the force value exceeds the set limit. If this is a chronic problem review: (a) the configured occlusion limit – the setting appears on graph on delivery screen as VL, L, N, H - ***pumps with v3 software:*** use *Configuration Manual* to change settings; ***pumps with v4 software:*** use the PharmGuard® Software to change settings or (b) change the infusion set up (high rates through micro-bore tubing can cause high backpressures).
Outside Range Limit - Silence Alarm to Continue	Medium	-	Normal alarm message. The user entered a rate which is outside of the library limits. The user has the option to override the limit and use the questioned value or press BACK and change values so that the infusion stays inside the established limits.
Periodic Callback - Silence Alarm to Continue	–	Medium	Normal alarm message. User programmed callback alarm - no remedy required.
PharmGuard Data Transfer is Recommended	Medium	Medium	Normal alarm message. PharmGuard® Safety Data on the pump is nearly full, and continued use may result in lost PharmGuard® event data. Use the PharmGuard® software to download the event data to computer. This alarm can be enabled or disabled using the PharmGuard® Toolbox.
Pressure Increasing - Check Infusion Line	–	Medium	Normal alarm message. Backpressure in the infusion line is increasing. User should attempt to clear blockage in infusion line. If blockage is not cleared occlusion alarm will result.
Profile Does Not Match Last Settings Profile	Limit	–	Normal alarm message. The "Recall Last Settings" feature only works for the profile under which the settings were programmed. Change the profile and try again.
Pump is Locked	–	Limit	Normal advisory message. Press **Unlock** before changing settings during delivery.
Rate Below Recommended Min for Syringe Size	Limit	–	Normal advisory message. Reminds user that the programmed rate is below that recommended for the syringe size. No remedy required.
Restricted Flow - Bolus Cancelled	–	Medium	Normal alarm message. During bolus rate reduction, the rate fell below the main infusion rate or the time was extended past the maximum bolus time of 59 minutes. The bolus dose has been cancelled.

Alarm message	Alarm priority programming	Alarm priority infusing	Cause or corrective action
Restricted Flow - Loading Cancelled	–	Medium	Normal alarm message. During loading dose rate reduction, the rate fell below the main infusion rate or the time was extended past the maximum loading dose time of 59 minutes. The loading dose has been cancelled.
Restricted Flow - Rate Reduced	–	Medium	Normal alarm message. Due to high backpressure during delivery of a bolus dose or loading dose, the Medfusion® 3500 software reduces the infusion rate in an attempt to successfully delivery the bolus. If the user presses Silence, the audible tone will not reactivate, even though the software may continue to reduce the rate. If the software cannot successfully overcome the backpressure, the bolus dose or loading dose will be cancelled.
Set Volume Limit Before KVO	Limit	–	Normal Alarm Message. In order to set a KVO rate, you must first set a volume limit.
Syringe Does Not Match Library Entry	Limit	–	Normal advisory message. When using E-plates library entries, the library stores syringe size. Here, this is advisory message that syringe does not match the library entry.
Syringe Empty	–	High	Normal alarm message. The plunger driver position potentiometer has sensed that the syringe is empty. This position (in a software table) is different for each syringe manufacturer and syringe size.
Syringe Empty - Manual	–	High	Normal alarm message. After reaching **Syringe Empty** position, the user can press START to resume infusion – in cases where there is a small amount of fluid left in the syringe. Here, the pump delivers until the force sensed on the plunger driver reaches the set occlusion limit – as the plunger pushes against the end of the syringe barrel.
Syringe Flange Not in Place	High	High	Pump has sensed the flange is not loaded when syringe is loaded in the pump (as sensed by the barrel clamp size sensor). User may not have loaded syringe correctly. If necessary, use **Biomed** > **Diagnostics** and run **Monitor Digital Sensors** to check function of flange sensor.
Syringe Near Empty	–	Medium or Low*	Normal advisory message. Notice that only a few minutes of fluid remain in the syringe. This alarm is configurable for the number of minutes notice or may be turned off entirely. *The alarm priority is configurable using the PharmGuard® Toolbox software.

Alarm message	Alarm priority programming	Alarm priority infusing	Cause or corrective action
Syringe Plunger Not in Place	High	High	Pump has sensed the plunger is not loaded when syringe is loaded in the pump (as sensed by the barrel clamp size sensor). User may not have loaded syringe correctly. 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.
Neglected Pump (User Call-back)	Medium	Medium	If pump is left in a user input screen (e.g. set rate or titrate rate) for more than 30 seconds the pump alarms. Go to pause screen or main screen to get longer alarm silence intervals.

System Advisory Alarms

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

System advisory alarm	Cause or remedy
Backup Critical Data Corrupted	Configuration and library settings are stored redundantly in non-volatile serial EEPROM on the main board. This message will occur if backup data was lost, and primary data was used to restore back-up values. No action is required.
Default Configuration Restored	Configuration settings are stored redundantly in non-volatile serial EEPROM on the main board. 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 board. This message may appear when a new main board is installed.
History Data Corrupted	Infusion history log is stored in non-volatile serial EEPROM on the main board. This message will occur if this data is lost. 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.
Non Critical Data Corrupted	Other settings are stored in non-volatile serial EEPROM on the main board. This message will occur if this data was lost. No action is required.
PharmGuard Data Corrupted	The PharmGuard® Safety Data is stored in non-volatile serial EEPROM on the main board. This message will ocur if this data is lost. No action is required.
Primary Critical Data Corrupted	Configuration and library settings are stored redundantly in non-volatile serial EEPROM on the main board. This message will occur if primary data was lost, 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 board supply totally discharged – the super-capacitor on main board should keep up the clock for many days after a depleted battery is reached. Use **Biomed** > **Utilities** and run **Set Time/Date** to restore date and time settings. No functionality of pump is affected by date/time setting.
Maintenance Is Recommended	This is a reminder to the user to conduct the Annual Maintenance Testing (section 1, page 19). To clear this alarm, reset the PM Maintenance date (see section 5, Quick Maintenance Check-out Test and follow the instructions).

System Failure Alarms

This section discusses the diagnosis of system failure alarms in the Medfusion® 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 board 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 board – disconnect AC power, open pump, disconnect battery, short super-cap through ~100 ohm load; then reassemble pump and retest. Replace main board 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 board.
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 board 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 board.
Background CRC Test Timeout	Software timing failure. A transient failure may have occurred in the software; if problem recurs, replace the main board.
Background Self Test Timeout	Software timing failure. A transient failure may have occurred in the software; if problem recurs, replace the main board.
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 board or replace the main board.
Calibration Required	Calibration values stored in non-volatile serial EEPROM memory are invalid. This message appears whenever a new main board is installed. 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	Key on keypad was found stuck on during power-on self-test. 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 board. 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 board.

System failure alarm	Cause or remedy
Critical Data Block Post	Configuration and library settings are stored redundantly in non-volatile serial EEPROM on the main board. This message will occur if backup data and primary data are both good, but fail to agree. Use pump **Custom Program** > **Teach/Learn** to copy configuration from a known good pump to restore settings. Replace main board 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 board.
D2A Offset Voltage BGND Test	Background self-test found failure in force sensor offset signal. Probably a failure in the main board digital-to-analog converter or a failure in the plunger cable/board. Use **Biomed** > **Diagnostics** to check force sensor voltage readings.
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.
Display Controller Post	Failure detected in testing the LCD display. Check cabling between main board 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® 3000 Series external RS232 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 board, and main board 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 board, and main board 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 board. Replace plunger board, 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 board. Replace plunger board, 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. May be problem on main board offset circuit, plunger board, plunger cable, or force sensor. Check cabling first.
Input Task Timeout	Software timing failure. A transient failure may have occurred in the software; if problem recurs, replace the main board.
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 board.
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 board.
Logic Supply Voltage BGND Test	Background self-test measured an invalid range on logic supply voltage. Use **Biomed > Diagnostics** to check the voltage. Replace the main board 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 board if problem recurs.
Monitor Task Timeout	Software timing failure. A transient failure may have occurred in the software; if problem recurs, replace the main board.
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 board. 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 board if sensor has failed.
Motor Not Running Error	Motor sensor did not detect any rotation of the stepper motor. Sensor (on main board) may have failed, or worm/gear/leadscrew may be jammed.
Motor Rate Error	Motor sensor did not measure the correct rotation rate for the stepper motor. Sensor (on main board) may have failed, or the force sensor may be inoperative and the stepper motor stalled when an occlusion occurred.
Motor Supply Voltage BGND Test	Background self-test measured an invalid range on motor supply voltage. Use **Biomed > Diagnostics** to check the voltage. Replace the main board 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.
Positive Supply BGND Test	The power supply has malfunctioned. Check the outputs of the supply.

System failure alarm	Cause or remedy
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 board to interconnect and from interconnect board 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 board to interconnect and from interconnect board to speaker. Replace speaker if wiring is intact.
Pump Motor Drive Off Post	Power-up self-test sensed no current in the stepper motor. 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 board.
Pump Motor Drive Phase A Post	Power-up self-test found the stepper motor winding open. 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. 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 board. Cycle power and run rerun power-up self test which executes more extensive RAM test. If failure recurs, then check the main board to ensure no cable or contamination is shorting the board, then replace the main board.
Serial EEPROM Timeout	Software test showed failure of a serial EEPROM on the main board. Check the main board to ensure no cable or contamination is shorting the board, then replace the main board.
SPI BUS Timeout	Software test showed failure of some component on the SPI bus. Check the main board to ensure no cable or contamination is shorting the board, then replace the main board.
Supercap Post	Power-up self-test sensed insufficient charge in the super-capacitor. This problem can occur with a new main board 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 board.
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.
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 board.
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 board.
Time of Day Clock Timeout	Time of day clock failed to communicate. If problem recurs, replace main board.

General troubleshooting

This section discusses some potential problems which may be encountered with the Medfusion® 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. Use **Custom Program** to change the audio alarm volume to a higher level. b) Use **Biomed > Diagnostics** and run the **Audio Test** on Speaker and Alarm Style. Replace speaker if audio alarm does not work correctly.
Problem: 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 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 board. b) Use **Biomed > Diagnostics** and run the **Monitor Battery Status** test. If no information appears then replace the battery pack.
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 board. 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 Board. 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. Use **Custom Program** to reset the audio to a higher level.
Keypad button 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.
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 board.

Problem	Remedy or solution
Libraries not available	Libraries may have been turned off or cleared in pump configuration. Use **Custom Program**, **Teach** mode or **Learn** mode to copy the Libraries from a correctly configured pump. See Configuration Manual.
Maximum rate not available	Maximum rate may be set low in pump configuration. Use **Custom Program**, **Set Max Flow Rate** to configure the pump's maximum flow rate. See *Configuration Manual*.
Occlusion alarms occur frequently	Occlusion alarm limit may be set too low in pump configuration. Use **Custom Program**, **Set Occlusion Limit** to configure the pump's occlusion alarm level. See *Configuration Manual*.
Pump won't turn on	Plug into AC power (pump will not turn on with a dead battery) then push and hold power key to turn on. Otherwise, open case and check: • Connections of main to interconnect ribbon cable • AC power connections. • Battery connections. • Keypad cable connections.
Syringe Manufacturer not available	Syringe manufacturer may have been turned off or cleared in pump configuration. 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	1 214.618.0218
In Europe, Contact:	Your local distributor or: **Smiths Medical International Ltd.** +44 (0)1923 246434

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 will give suggestions in an attempt to help solve the problem.

Returning a pump for repair

When a pump problem cannot be solved, 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 you are unsure of who your local distributor is, contact Smiths Medical International Ltd. at the address and/or phone number listed below.

1. If the problem cannot be resolved through the assistance of the Technical Service Department, then you will be assigned a Return Authorization (RA) number.
2. Clean and decontaminate the pump and accessories 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.
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. Ship the carefully packaged infusion pump to either of the addresses listed below:

United States Service	Smiths Medical ASD, Inc. 1265 Grey Fox Road St. Paul, Minnesota 55112 1 800.258.5361 www.smiths-medical.com
European Service	Your local distributor or: **Smiths Medical International Ltd.** WD24 4LG UK +44 (0)1923 246434

Using Biomed for troubleshooting

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

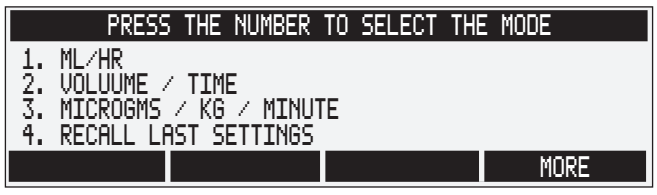
Two features within **Utilities** are very useful for investigating user complaints on the pump: **View Infusion History** and **View Alarm History**. **View Infusion History** allows review of infusion pump settings, delivery information, and alarms with each entry date and time stamped. **View Alarm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

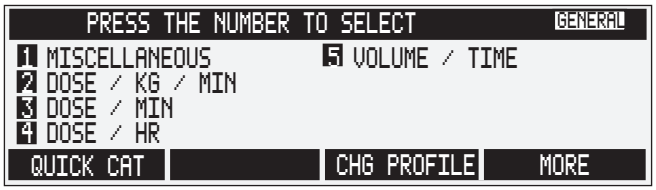
There are many features under **Diagnostics** which allow the examination of various sensors and components within the pump. The speaker, motor, keypad, indicators and display may be tested individually through this program. The battery gauge status information and charging/discharging current may be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

Accessing Biomed

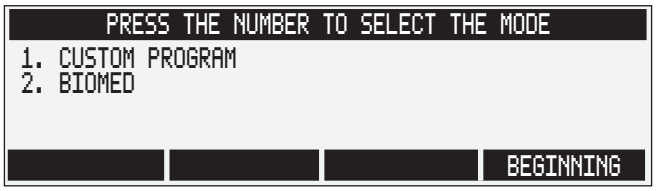
Note: *The following screens are slightly different depending on the version you have. For this reason, version 3-type screens are shown first, followed by version 4-type screen (if they are different). Also, depending on the personalization performed on your pump, the items listed in some of the menus may be different than those shown.*

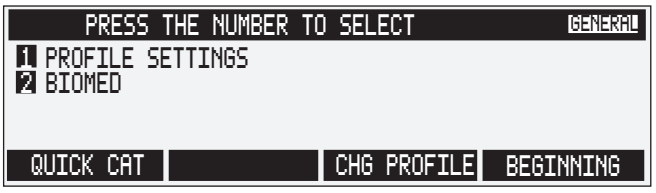
1. Turn the pump on and allow the power-on, self-testing to complete. (If there is a system failure detected in power-on testing, then the pump will directly go to **Enter Biomed Passcode** screen - see item 4.)



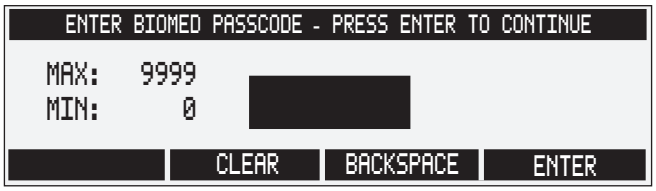


2. Press **More** until the **Biomed** appears onscreen. (If E-Plates/Libraries are enabled, you will have to press **Main Menu** before using **More** to locate **Biomed**.) (For v4 software, if **Profiles** are displayed you must select a profile then choose **Biomed** - you may need to press **More** to find it.)

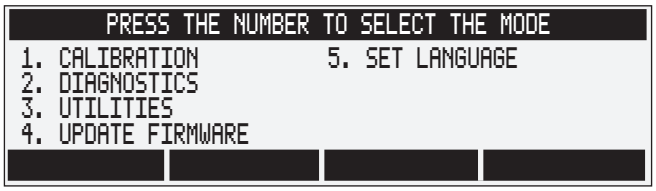


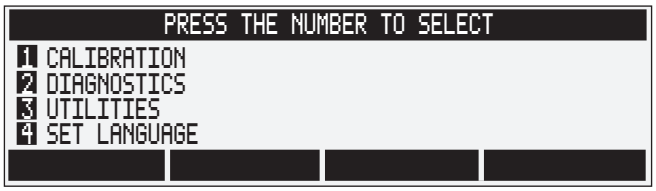


3. Use the **number** button to choose **Biomed**.
4. Use the **number** buttons to enter the **Biomed Passcode** (***2580***) then press **Enter**.



Now you may select:



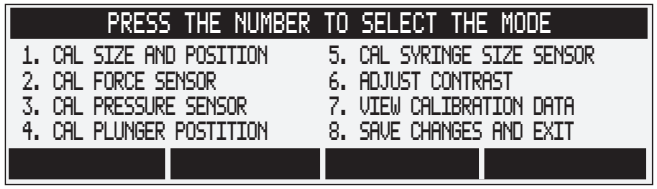


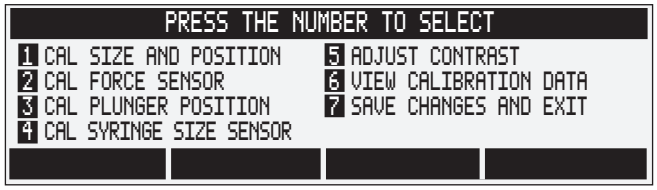
- **Calibration** to check calibration values, recalibrate sensors or set display contrast.
- **Diagnostics** to examine analog and digital signal readings, or test the speaker, motor or display function.

- **Utilities** to review alarm history, to review infusion history, to set time and date, to update periodic maintenance timestamp.
- **Update Firmware** to reprogram the pump's software version through the serial interface (only available with service upgrade software diskette and instructions). [**Not available on Medfusion® 3500 pumps version 4.1 and above**.]
- **Set Language** to change the national language displayed. [**Available on Medfusion® 3500 pumps**.]

Biomed > Calibration

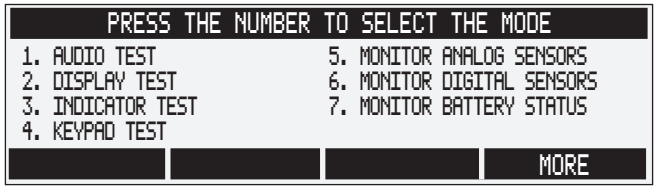
Within **Biomed > Calibration** the following selections are available. See the *Calibration* section of this manual for further details.

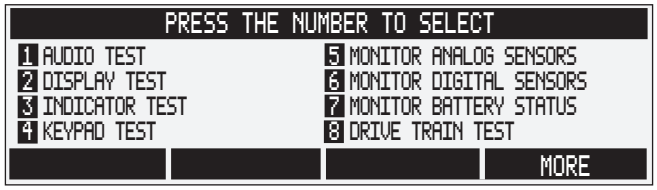




Biomed > Diagnostics (screen 1 of 2)

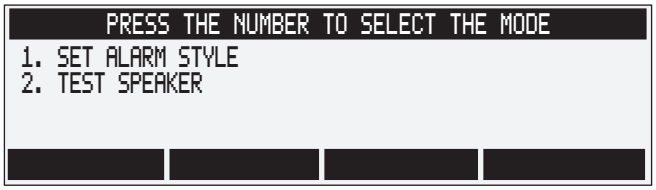
Within **Biomed > Diagnostics** the following selections are available (one of two screens). Use the **number** buttons to select the test.

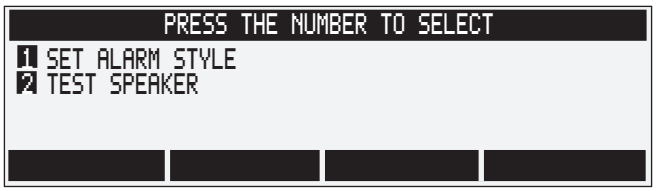




Audio Test

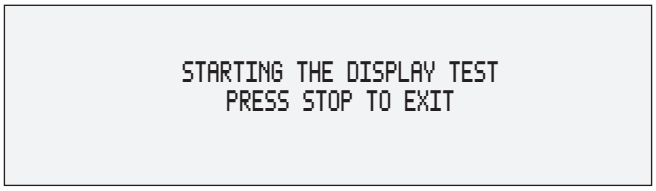
Use the **number** buttons to select the test. **Set Alarm Style** allows testing of the various alarm tones. **Test Speaker** is a factory/engineering test.

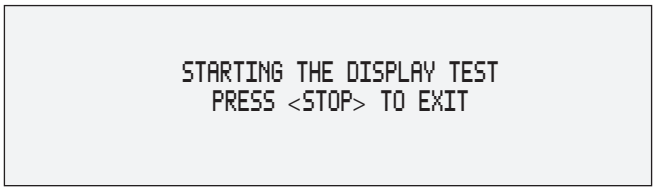




Display Test

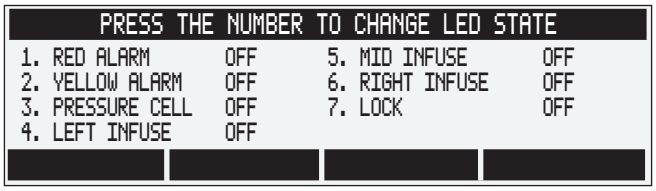
Display Test repeats blank, all pixels on, vertical lines, horizontal lines, and checkerboard patterns across the LCD display. This test may only be exited by use of the Stop button.

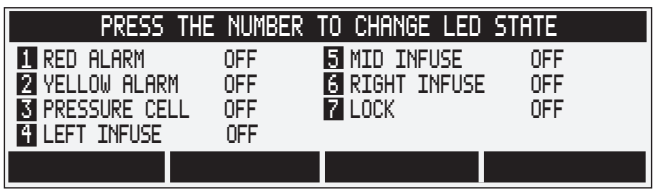




Indicator Test

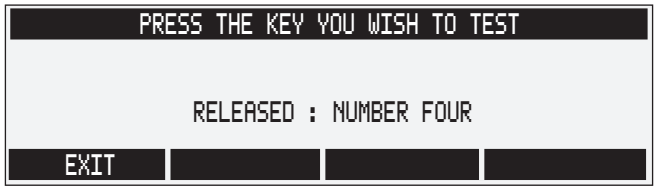
The **Indicator Test** allows the individual control and testing of each indicator on the front panel (except battery and AC). Use the **number** button for the indicator to toggle on or off.





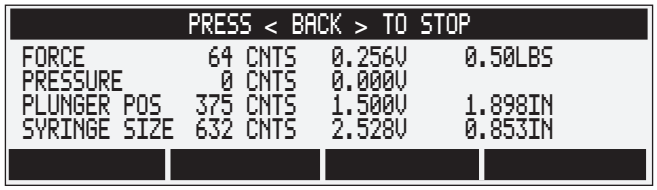
Keypad Test

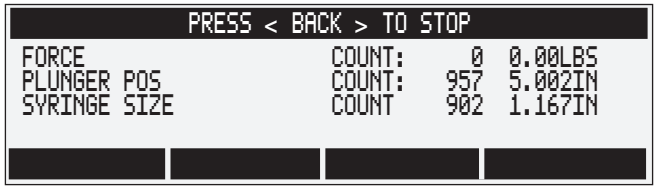
The **Keypad Test** allows each key to be tested (except POWER; pressing POWER turns the pump off) to be tested. The only exit from this test is to press **Exit**.



Monitor Analog Sensors

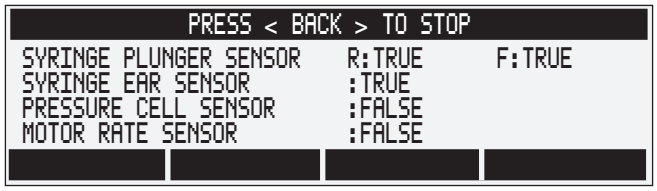
Monitor Analog Sensors allows viewing the high resolution analog signals in the pump. These are force, pressure (future option), plunger position, and syringe size. The first data column is analog to digital converter counts (0 to 1023), the second column is the voltage equivalent to counts, and the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

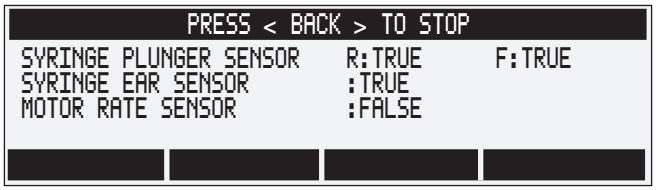




Monitor Digital Sensors

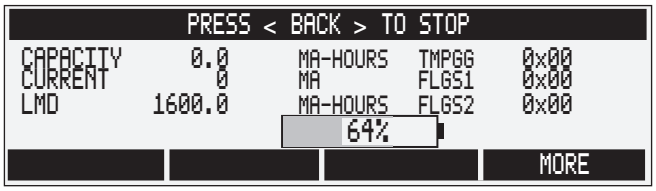
Monitor Digital Sensors allows viewing the state of the digital sensors in the pump. Syringe plunger sensor is the state of the flippers on the plunger head where open is true. Syringe ear (flange) sensor indicates true when the ear clip (flange) is pulled out. Pressure cell is future option. The motor rate sensor with 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 visa versa. If current is positive the battery is charging; thus negative is discharging. See schedule maintenance for discussion of battery gauge.

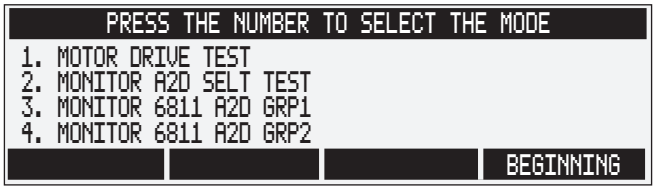


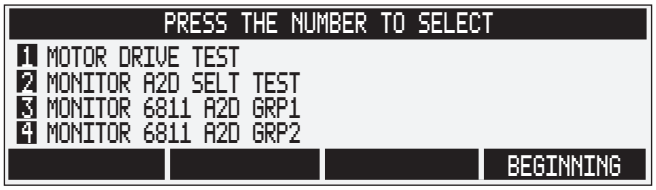
Drive Train Test

This feature is for factory/engineering use.

Biomed > Diagnostics (screen 2 of 2)

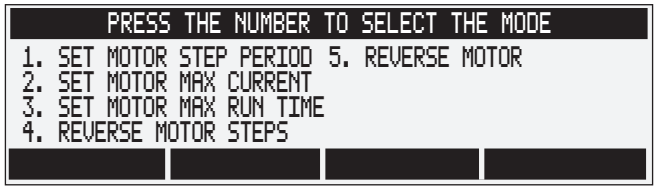
Within Biomed Diagnostics the following selections are available (second of two screens). Use the **number** buttons to select the test.

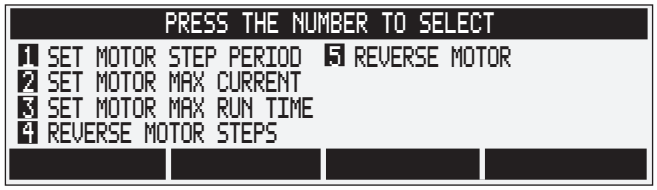




Motor Drive Test

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.



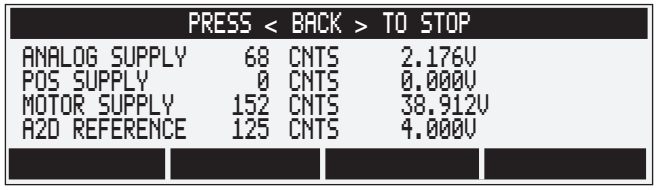


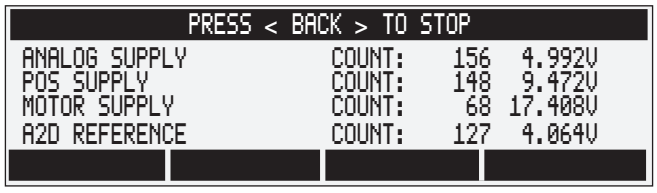
Monitor a2d Selftest

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

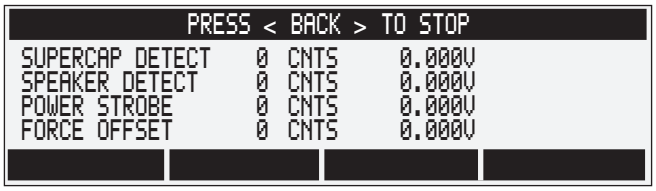
This **Monitor Analog Sensors** allows viewing the low resolution analog signals in the pump. These are analog supply, positive supply, motor supply, and a2d reference. The first data column is analog to digital converter counts (0 to 255), the second column is the "normalized" voltage equivalent to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

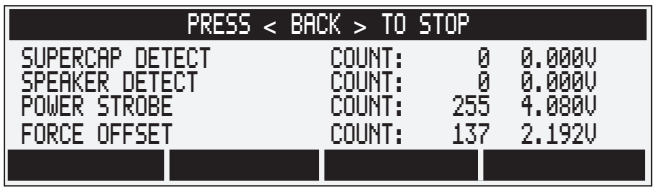




Monitor 6811 A2D Group2

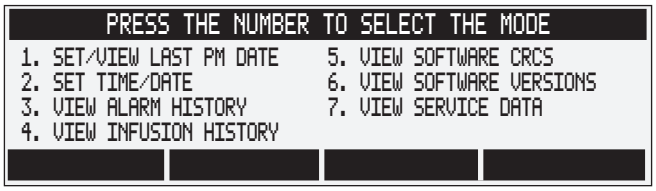
This **Monitor Analog Sensors** allows viewing the low resolution analog signals in the pump. These are supercap detect, speaker detect, power strobe, and force offset. The first data column is analog to digital converter counts (0 to 255), the second column is the "normalized" voltage equivalent to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

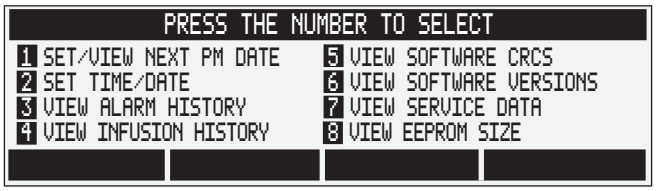




Biomed > Utilities

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





Set/View Last [Next] PM Date

Depending on your pump version, this feature will either be **Set/View Last PM Date** or **Set/View Next PM Date** (Medfusion® 3500 software version 4 and above). This feature should be used every time that 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, then 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.

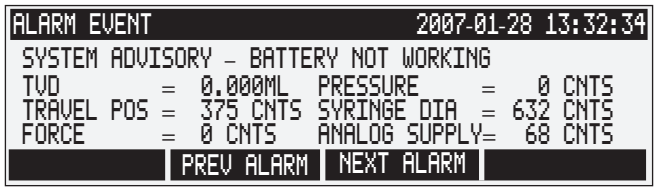
[**Note: ensure current date and time are correct in Set Time/Date.**]

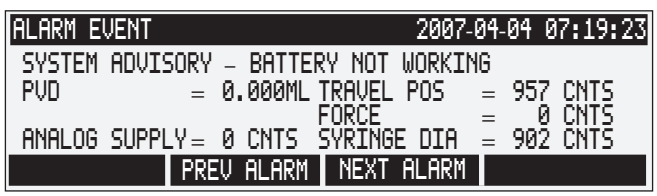
Set Time/Date (Current)

This feature allows setting the current date and time. This setting is stored in a clock/calendar chip on the main board. [**Note: if all power is removed from the main board and the super-capacitor is drained, the clock will be reset to 1998 and PM advisory message may appear until the clock is set.**]

View Alarm History

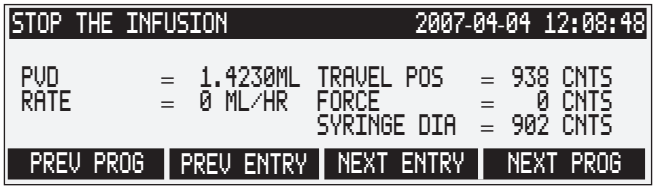
This feature allows review from the most recent alarm backwards in time. Each alarm is date and time stamped. [**Note: see latest power-on record in view infusion history to check current clock/calendar settings.**]





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 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.

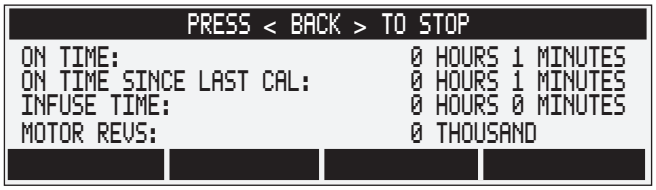


View Software CRCs & View Software Versions

These features are for factory/engineering use.

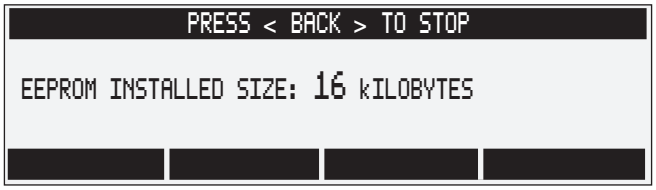
View Service Data

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



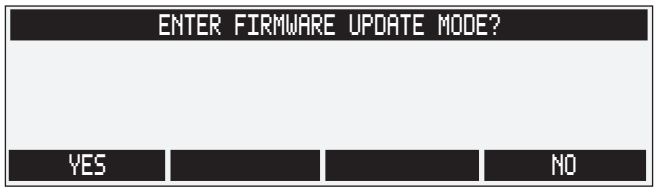
View EEPROM Size [available only on Medfusion® 3500 pumps version 4 and higher)

This feature allows you to view the size (in kilobytes) of the EEPROM installed on the pump.



Biomed > Update Firmware [not available on Medfusion® 3500 pumps, version 4 and higher]

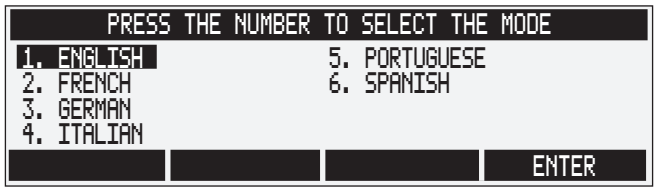
Do Not Use this feature unless specifically authorized by Smiths Medical to update the software of the pump. Review the documentation provided with the software update. Follow the instructions provided with the software update and ensure the update is compatible with the pump model before performing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

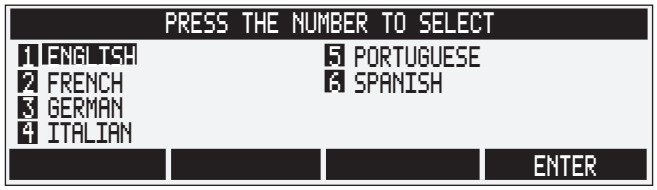


[Note: pressing **Yes** does not erase any software in the pump. The pump must be connected to a host personal computer running a Medfusion® 3000 Series download program and a download must be initiated on the PC in order to update the pump's software.]

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

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 button 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 selected.

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

Section 4: Parts Replacement provides procedures for disassembly, parts replacement & re-assembly of the pump.

Maintenance warnings/ cautions

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

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

Service warnings

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

- **Disconnect AC Mains & External DC Power:** Always disconnect the pump from AC Mains and from External DC power before disassembling the pump for maintenance.
- **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, you should 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, you may return battery packs to Smiths Medical for recycling.

Opening & closing the pump housing

Tools needed

For this disassembly procedure you will need:

- 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, you must remove it before disassembling the pump. Remove the 2 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 battery pack from its compartment, and disconnect its cable from the interconnect board.
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 board (in most cases the other end of this ribbon cable is glued or soldered into the interconnect board).

Closing the pump housing

1. Before closing the pump housing, be sure the AC and external DC power are disconnected, and the battery pack is removed.
2. Reconnect the ribbon cable joining the interconnect board and the main board 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 these 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 board. Slide the battery into the compartment.
8. Replace battery cover and secure it with 2 flathead screws. Torque these screws to 60 in oz (0.42 Nm).
9. If using the pole clamp, reattach it to the pump with the 2 flathead screws. Torque these 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

This section defines the steps for removing and replacing the battery pack for the Medfusion® 3000 Series pump.

Tools needed

For this disassembly procedure you will need:

- 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 are disconnected.
2. Remove the 2 flat head screws from the battery compartment cover, and then remove the cover.
3. Carefully remove battery pack from the compartment, and gently disconnect (pull) its ribbon cable from the interconnect board.

Replacing the 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 battery cable into the interconnect board. Slide the battery into the compartment.
4. Replace battery cover and secure it with 2 flathead screws. Torque these screws to 60 in oz (0.42 Nm).

Verifying battery function after new battery replacement

Before returning the Medfusion® 3000 Series pump to service, you must verify the new battery is functioning nominally.

1. Connect the pump to AC power and verify the battery charge indicator is on.
2. Turn ON the pump. From the Main screen, select Biomed program Diagnostics and go to 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, then check battery connection on battery pack, or connection on the interconnect board.
6. Turn off the pump, 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 board

This section defines the steps for removing and replacing the interconnect board for the Medfusion® 3000 Series infusion pump.

Tools needed

For this disassembly procedure you will need:

- Torque screwdriver with a Phillips head

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

Removing the interconnect board

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

Replacing the interconnect board

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

1. Align the interconnect board 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 board function

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

Speaker

This section defines the steps for removing and replacing the speaker for the Medfusion® 3000 Series pump.

Tools Needed

For this disassembly procedure you will need:

- 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 battery pack, and separate the top and bottom halves.
3. Disconnect the speaker cable from the interconnect board 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 replacement

[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 board.
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, you only need to execute power-up testing to verify speaker function.

1. Connect the pump to AC power.
2. Turn ON the pump.
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

This section defines the steps for removing and replacing the AC Power Supply for the Medfusion® 3000 Series infusion pump.

Tools needed

For this disassembly procedure you will need:

- 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 battery pack, and separate the top and bottom halves.
3. Remove the power supply shield.
4. Disconnect the interconnect board cable from power supply board 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 board at J1.
6. Remove the 2 pan head screws securing board to bottom housing, and remove AC Power Supply Board.

Replacing the AC power supply

1. Align the AC Power Supply Board over the threaded bosses, with J1 in line with the AC input cable.
2. Secure the board with 2 pan head screws. *Medfusion® 3500BC: The earth wire from the AC inlet is to be secured at the AC supply mounting post furthest from the AC inlet.* Torque to 60 in oz (0.42 Nm).
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 board 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. Torque to 60 in oz (0.42 Nm).
7. Replace the battery pack, battery cover, and secure with 2 flat head screws. Torque to 60 in oz (0.42 Nm).

Verify AC power supply function

After you replace the AC Power Supply, you must 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

This section defines the steps for removing and replacing the AC Input Assembly.

Tools Needed

For this disassembly procedure you will need:

- 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 AC input module assembly

1. Disconnect the pump from AC power source.
2. Open the pump housing, remove 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. *Medfusion® 3500BC: Remove screw holding earth ground connection.*
6. Slide the AC Input Module Assembly from the case.

Replacing AC input module assembly

1. Install AC Input Module Assembly with 2 power

wires oriented toward the bottom of the housing. *Medfusion® 3500BC: Install AC Input Module Assembly with 3 wires, mains wires oriented toward the bottom of the housing, earth wire oriented toward the top.*

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. *Medfusion® 3500BC: Reinstall the earth wire from the A/C inlet to the A/C supply mounting post furthest from the A/C inlet.* Torque to 60 in oz (0.42 Nm).
5. Reinstall the Power Supply Shield by sliding it into the notched tabs.
6. Close the housing and secure with 2 pan head screws. Torque to 60 in oz (0.42 Nm).
7. Replace the battery pack, battery cover, and secure with 2 flat head screws. Torque to 60 in oz (0.42 Nm).

Verifying AC input assembly module function

1. After you replace or repair the AC Input Assembly Module, you must 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 plastic

Tools Needed

For this disassembly procedure you will need:

- 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 battery pack, and separate the top and bottom halves.
3. Unplug the ribbon cable from J9 on the main board (in most cases the other end of this ribbon cable is glued or soldered directly into the interconnect board).
4. Remove the Interconnect Board, the speaker, the Power Supply Shield, the AC Power Supply, and the AC Input Assembly using the procedures listed above.

Replacing the bottom housing

1. The new case bottom should have rubber feet, and IR lens already installed; however, new labels (included) need to be applied.
2. Record the serial number from the old case bottom. Take the new serial number label and type the serial number into the blank field on this label. Take the overlay supplied with the label, remove the backing and apply this overlay to cover/protect the typed serial number label.
3. Remove the backing on the typed serial number label, and apply this to the new case bottom.
4. Attach all new labels to the new case bottom, use the old bottom as a guide for label application.
5. Install the AC Power Supply, the AC Input Assembly, the Power Supply Shield, the speaker, and the Interconnect Board into the replacement housing using the procedures listed above.
6. Reconnect the ribbon cable to J9 on the main board in the top housing.
7. Close and secure the two halves of the housing,

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 board

This section defines the steps for removing and replacing the Main Board for the Medfusion® 3000 Series pump.

Tools needed

For this disassembly procedure you will need:

- Torque screwdriver with Phillips head & small flat head

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

Removing the main board

1. Disconnect the pump from AC power source.
2. Open the pump housing, remove battery pack, and separate the top and bottom halves.
3. Disconnect the interconnect ribbon cable from the main board at J9.
4. Loosen the 2 terminal block screws connecting the fiber optic back light to the main board, then pull the fiber cable assembly from the terminal block.
5. Disconnect all cable connections on the main board. 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 main board, and carefully remove the main board from housing.

Replacing the main board

1. Place the new main board 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 board with the 2 pan head screws. Torque to 60 in oz (0.42 Nm).

3. Reconnect all cable and wire connections on the main board. 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. If a 2nd fiber optic tail is present on the backlight, connect its cable to J8 on the main board. If you are replacing an older main board (with a black connector at J8), you can discard the backlight adapter cable. After completing the next step, anchor both fiber optic tails to the main board with a wire tie.
5. Insert the backlight wires into the main board terminal block. 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 you reverse the leads during installation, the backlight will not turn on. You may wish to loosely reassemble the case halves, plug in the battery, and power up pump to check the backlight.*

6. Close and secure the two halves of the housing and reinstall the battery pack.
7. Complete recalibration and reconfiguration is required when replacing main board.

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

Drive train assembly

Tools Needed

For this disassembly procedure you will need:

- 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 pump housing per pump housing section above, and set up the case top section with the handle down and main board facing up.
2. Remove the main board per section above.
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 motor mount screws are accessible.

Disassemble motor unit as required:

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

Replacement

Reassemble motor unit

1. For motor/worm, 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 board. Secure motor with two pan head screws and Nylock nuts. Torque to 100 in oz (0.71 Nm).

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 board per main board section above.
10. Close pump housing per housing section above.

Position potentiometer

Removal

1. Open pump housing per pump housing section above, and setup the case top section with the handle down and main board facing up.
2. Remove the main board per section above.
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 three flat head screws holding motor assembly on extrusion and rotate out of way.
9. Slide position pot out of the extrusion.

Replacement

1. Slide new position pot into extrusion.
2. Clean small flat head screw (or use a new screw), apply Loctite 242 (mild thread-locking adhesive) to screw, and secure pot to right end plate of extrusion assembly. Torque only to 16 in oz (0.12 Nm).
3. Secure motor assembly on extrusion with three flat head screws. Torque to 100 in oz (0.71 Nm).
4. Slide post of position pot up to carriage. Insert pan head screw through hole in carriage arm, then through washer. Start the Nylock nut onto the screw. Insert 0.002" shim between pot's post and the washer, then tighten the nut until slack is removed. Do not over-tighten nut. Remove shim and check if flat washer can move (spin) freely, if not loosen nut slightly.
5. Carefully slide the extrusion (drive train assembly) back into case.
6. Ensure right end plate on extrusion does not damage ear clip sensor.
7. Ensure plunger cable comes out between middle boss and boss by the motor.
8. Slide keypad ground tab (black side toward extrusion) between 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 main board per main board section above.
12. Close pump housing per housing section above.

Clutch assembly

Tools needed

For this disassembly procedure you will need:

- 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.

Leadscrew

Removal

1. Open pump housing per pump housing section above, and setup the case top section with the handle down and main board facing up.
2. Remove the main board per section above.
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 Nylock nut holding leadscrew on right end plate is accessible.
6. Pull the plastic worm gear off the end of leadscrew near motor.
7. Remove three flat head screws holding motor assembly on extrusion, and pull off motor assembly.
8. Slide 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 Nylock nut holding leadscrew and the flat brass washer.
10. Slide extrusion in slightly until leadscrew clears right end plate, then pull off the thrust bearings.
11. Squeeze the plunger lever to open clutch and pull leadscrew out of carriage.

Replacement

1. Apply light coating of STP poly-plus (lithium) grease to leadscrew. Squeeze plunger lever to open clutch and insert leadscrew until it sticks slightly through the carriage.
2. Install thrust bearing assembly (flat washer, bearings, flat washer) onto end of leadscrew and pull on plunger head to feed leadscrew through the right end plate. Ensure nylon shoulder washer is still in place on right end plate.
3. Place brass washer over the leadscrew and start Nylock nut. Insert .002" shim between the brass washer and shoulder washer and tighten the nut. Do not over-tighten nut. Remove shim and check if brass washer can move (spin) freely, if not loosen nut slightly.
4. Slide carriage rod through carriage and seat into hole in right end plate.
5. Slide motor assembly over leadscrew and align carriage rod with motor assembly bracket. Secure motor assembly on extrusion with three flat head screws. Torque to 100 in oz (0.71 Nm).
6. Align "D" of worm gear with leadscrew shaft and press onto leadscrew until gear is centered over the motor worm.
7. Carefully slide the extrusion (drive train assembly) back into case.
8. Ensure right end plate on extrusion does not damage ear clip sensor.
9. Ensure plunger cable comes out between middle boss and boss by the motor.
10. Slide keypad ground tab (black side toward extrusion) between boss by the motor and extrusion.
11. Secure 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 main board per main board section above.
14. Close pump housing per housing section above.

Clutch or clutch cam

Tools needed

For this disassembly procedure you will need:

- Safety glasses

- Needle nose pliers

Removal

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

Replacement

1. For replacement of:
   - the cam, first ensure 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 e-ring over cam sticking through carriage plate.
4. Replace leadscrew per procedure above.

Plunger cable

Removal

1. Remove leadscrew per procedure above.
2. Using ¼" open end wrench and Phillips screw driver, remove three pan head screws with Nylock nuts holding the carriage plate. Pull plate with cam and square shaft attached.
3. Open plunger case right per procedure below.
4. Unplug the plunger cable from plunger board and pull cable out of slot in force mount and plunger tube.
5. At the carriage, turn plunger cable connector in line with the cable, and pull cable out through plunger head.

Replacement

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 board, 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 carriage plate with clutch cam and shaft into 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 plunger case per procedure below.
7. Replace lead screw per procedure above.

LCD and backlight

This section defines the steps for removing and replacing the LCD Display and Backlight for the Medfusion® 3000 Series pump.

Tools Needed

For this disassembly procedure you will need:

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

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

Removing 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.
3. Disconnect the display cable from the main board at J12.
4. Use small flat blade screwdriver to loosen the 2 screws connecting the fiber optic back light to the main board. Then pull the fiber cable assembly from the terminal block.
5. If the back light 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 back light and spacer from the display assembly.

Replacing the LCD and/or backlight assembly

1. Remove the protective plastic film from the new display's glass.
2. Remove the tape which holds the plastic spacer inside the new display, and slide out the spacer. Discard the white plastic spacer.
3. If the backlight has one fiber optic tail, then you will use two clear plastic spacers in the next step. If your backlight has two fiber optic tails, then you will use only one clear plastic spacer in the next step.
4. Place the clear plastic spacer(s) on top of the backlight with the white side of the back light facing up and the silver side down.
5. Gently slide the back light and spacer together into the display with the clear plastic spacer toward the display glass.
6. Orient the display with the back light tail on the side with the keypad cables. Verify there is not lint or dirt on the display.
7. 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.
8. Reconnect the display cable to the main board at J12.
9. If a 2nd fiber optic tail is present on the backlight, clip the lead on the LED of the shorter fiber optic tail to match the length of the shorter tail's LED on the removed backlight. Note: the longer fiber optic tail's LED requires longer leads. Connect the 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 board with a wire tie.
10. Insert the back light wires into the main board terminal block. (When replacing the back light, trim the LED leads to about ½" in length.] 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 you reverse the leads during installation, the backlight will not turn on. You may wish to loosely reassemble the case halves, plug in the battery, and power up pump to check the backlight.*

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

Verify LCD & backlight assembly function

1. Plug the pump into AC power and turn it ON.
2. Watch the screen during startup and self-testing. [Note: you may wish to adjust the display contrast, see chapter on calibration and adjustment.]
3. After self-testing completes, set the pump in a darkened area and verify the back light is functioning.

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

Keypad

This section defines the steps for removing and replacing the Keypad.

Tools needed

For this disassembly procedure you will need:

- 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.
3. Disconnect the interconnect ribbon cable from J9 on the main board.
4. Loosen the 2 terminal block screws connecting the fiber-optic backlight to the main board. Then, carefully pull the leads from the connector. If a 2nd backlight LED is present, disconnect its cable at the main board and clip the wire tie securing it to the main board.
5. Disconnect the keypad cables at J10 on the main board.
6. Disconnect the display cable at J12 on the main board.
7. Remove the 2 pan head screws securing the main board, and then loosen the main board. It is not necessary to remove the main board, or disconnect all cables from it, to access the keypad.
8. With ¼" open end wrench, remove the 2 Nylock nuts securing the display board, and remove the display from the top housing.
9. With ¼" open end wrench, remove one 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 inside of clear lens (window) to loosen keypad and peel keypad from top housing.

Replacing the keypad

CAUTION: ***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 inside of new keypad window is clear of lint or fingerprints.
3. Remove 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 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 board and secure with 2 pan head screws. Torque to 60 in oz (0.42 Nm).
8. Reconnect display cable to J12, keypad cables to J10.
9. Insert the back light wires into the main board terminal block. (When replacing the back light, trim the LED leads to about ½" in length.] 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). If present, connect the 2nd backlight LED's cable to J8.

Note: *If you reverse the leads during installation, the backlight will not turn on. You may wish to loosely reassemble the case halves, plug in the battery, and power up pump to check the backlight.*

10. If a 2nd backlight LED is present, secure the fiber optic cable to the main board with a wire tie.
11. Close the pump case and reinstall the battery pack.

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

For this disassembly procedure you will need:

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

Replacement

1. Align the hole in the barrel clamp rod with the barrel clamp head, and press the head onto the rod.
2. Secure the barrel clamp head with the 1/16" hex head screw. Torque to 60 in oz (0.42 Nm)

Verify Function

1. Verify 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 barrel clamp head per above.
2, Open pump housing per pump housing section above.
3. Using a ¼" wrench and Phillips screwdriver, remove two 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 board.
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 small screw holding the pot to the barrel clamp assembly.
7. Carefully lift pot up off alignment bosses and out of fingers on the slide.

Replacement

1. Align new pot into fingers of slide on the barrel clamp assembly and press onto bosses.
2. Secure pot with small screw. Tighten until screw is flush with pot. [Do not over-tighten.]
3. Carefully slide barrel clamp body assembly into case. Push the rod through the hole in top of the case.
4. Secure barrel clamp assembly with two pan head screws with Nylock nuts. Torque to 100 in oz (0.71 Nm).
5. Plug barrel clamp flex circuit into J4 of the main board.
6. Close pump housing per housing section above.
7. Replace barrel clamp head and verify function per above.

Ear clip, handle & guide

Tools Needed

For this disassembly procedure you will need:

- 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 pump housing per pump housing section above, and setup the case top section with the handle down and main board 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 sleeve is not present, so use 1st set of pliers to pull spring towards the case wall.]
3. Slide the ear clip out of the top housing assembly.

Replacement

1. Partially insert new ear clip through side of case, then slide the spring onto shaft of ear clip.
2. Slide sleeve over ear clip with hollow end of 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 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 pump housing per housing section above.

Ear clip optical sensor

Removal

1. Open pump housing per pump housing section above, and setup the case top section with the

handle down and main board facing up.

2. Remove the main board per section above.
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 ear clip sensor is visible.
6. Remove pan head screw holding sensor and remove the ear clip optical sensor.

Replacement

1. On the new ear clip sensor, look at the old sensor then use wire cutters to carefully cut a portion of the plastic tab/mounting hole to allow clearance for the display connector.
2. Slide ear clip sensor onto post in case top, with grey side of 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 right end plate on extrusion does not damage ear clip sensor.
6. Ensure plunger cable comes out between middle boss and boss by the motor.
7. Slide keypad ground tab (black side toward extrusion) between boss by the motor and extrusion.
8. Secure 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 main board per main board section above.
11. Close pump housing per housing section above.

Handle

Removal

1. Open pump housing per pump housing section above, and setup the case top section with the handle down and main board facing up.
2. Remove the main board per section above.
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 two handle screws are visible.
6. Remove two pan head screw holding handle and remove the handle.

Replacement

1. Place new handle on case top and secure with two pan screws with washers through the inside of 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 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 board per main board section above.
10. Close pump housing per housing section above.

Tubing guide

Removal

1. Open pump housing per pump housing section above, and setup the case top section with the handle down and main board facing up.
2. Remove the main board per section above.
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 three tubing guide screws are visible.
6. Remove pan head screw holding tubing guides and remove the tubing guides. Note orientation of each tubing guide.

Replacement

1. Place each tubing guide onto 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 right end plate on extrusion does not damage ear clip sensor.
4. Ensure plunger cable comes out between middle boss and boss by the motor.
5. Slide keypad ground tab (black side toward extrusion) between boss by the motor and extrusion.
6. Secure 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 main board per main board section above.
9. Close pump housing per housing section above.

Plunger case assembly

Tools needed

For this disassembly procedure you will need:

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

Replacement

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

Plunger case disassembly

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

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 three 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 plunger case right; if so, pull the shaft out of the lever gear and slide the shaft down the plunger tube into gently press into the cam.

Reassembly

1. Remove any slack in movement of square shaft by

turning counter-clockwise. With plunger lever positioned up against long rib on plunger case right, join the two case halves together pressing the lever gear over the square shaft.

2. Start the three 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® 3000 Series infusion pump you should wear safety glasses as it contains springs and other small parts which may be a hazard.

Removal

1. Open the plunger case halves per above.
2. Lift cam gear off of pin.
3. Remove push block.
4. Press timing plate upward and lift carefully to remove timing plate spring and timing plate. Note, the timing plates are asymmetrical (left and right handed).

Replacement

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 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 board – while lining up the gears.
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 cam gear over pin (check assembly drawing for orientation) and up against push block.
7. Close plunger case halves per above.

Flipper and flipper gear

Removal

1. Disassemble plunger case and remove timing plates per above.
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 replace if damaged; otherwise, clean with soap and water.)

Replacement

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

Plunger board

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

Additional tools needed

For this disassembly procedure you may also need:

- .002" (.051mm) shim

Removal

1. Disassemble plunger case and remove timing plates per above.
2. Gently pull on the plunger cable unplugging it from connector J2. Unplug force sensor cable from J1 on plunger board.
3. Using a Phillips screwdriver, remove 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 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 float plate seal with pliers (or hemostats) and pull off from plunger case left. (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 plunger case left toward pump until plunger board is accessible, then remove plunger board.

Replacement

1. Insert new plunger board into plunger case left. (Ensure board sits on two guide pins and does not interfere with flipper gears.)
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 force sensor cable to the plunger board at connector J1 and press excess cable flat against board.
4. Connect plunger cable to plunger board connector J2, and check to ensure cable remains in slot through force mount and plunger tube.
5. If you did not remove float plate/seal skip to step 7; otherwise, place float plate into opening in plunger case left and start 2.5mm hex screw into this assembly. Slide a .002" shim between float plate and the wall of the plunger case. Tighten screw and torque to 100 in oz (0.71 Nm), then remove shim.
6. Use sharp tool or knife to clean slot for seal. If seal was damaged, replace 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 timing plates and reassemble plunger case per above.

Force sensor

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

Additional tools needed

For this disassembly procedure you will also need:

- .002" (.051mm) shim

Removal

1. Disassemble plunger case and remove timing plates per above.
2. Gently pull on the plunger cable unplugging it from connector J2. Unplug force sensor cable from J1 on plunger board.
3. Using a Phillips screwdriver, remove 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 float plate seal.
5. Grab float plate seal with pliers or hemostats and pull off from plunger case left. (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 plunger case left toward 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.

Replacement

1. Install the new 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 force sensor cable to the plunger board at connector J1 and press excess cable flat against board.
4. Connect plunger cable to plunger board connector J2, and check to ensure cable remains in slot through force mount and plunger tube.
5. If you did not remove float plate seal skip to step 7; otherwise, use sharp tool or knife to clean slot for seal. Place the float plate into opening in plunger case left and start 2.5mm hex screw into this as-

sembly. Slide a .002" shim between float plate and the wall of the plunger case. Tighten screw and torque to 100 in oz (0.71 Nm), then remove shim.

6. If seal was damaged, replace 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 timing plates and reassemble plunger case per above.

Left plunger case

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

Additional tools needed

For this disassembly procedure you will also need:

- .002" (.051mm) shim

Removal

1. Disassemble plunger case and remove timing plates per above.
2. Remove plunger flippers and gears per above.
3. Gently pull on the plunger cable unplugging it from connector J2. Unplug force sensor cable from J1 on plunger board.
4. Using a Phillips screwdriver, remove 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 plunger case left towards the pump. If it comes apart skip to step 8 below, otherwise remove float plate seal.
6. Grab float plate seal with pliers or hemostats and pull off from plunger case left. (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 plunger case left toward pump until the two small flat head screws are accessible on the force mount. Unscrew two flat head screws on force mount. Pull plunger cable out of slot on force mount bracket and plunger tube. Slide off the force mount assembly from the plunger tube.
9. Slide plunger case left off of plunger tube.

Replacement

1. Install flippers and flipper gears per above into new plunger case left.
2. Transfer plunger board into new plunger case.
3. Slide new plunger case left onto plunger tube. (Ensure case is correctly oriented.)
4. Thread plunger cable through force mount assembly and slide assembly onto plunger tube align screw holes and cable slot. Apply (mild threadlocking adhesive) Loctite 242 to 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 force sensor cable to the plunger board at connector J1 and press excess cable flat against board.
7. Press plunger cable into slot though plunger tube, force mount, and plunger case left. Ensure exposed braid of cable touches metal on force mount or plunger tube.
8. Connect plunger cable to plunger board connector J2, and check to ensure cable remains in slot through force mount and plunger tube.
9. If you did not remove the float plate seal, skip to step 11. Place the float plate into opening in plunger case left and start 2.5mm hex screw into this assembly. Slide a .002" shim between float plate and the wall of the plunger case. Tighten screw and torque to 100 in oz (0.71 Nm), then remove 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 timing plates and reassemble plunger case per above.

Using Biomed > Calibration

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

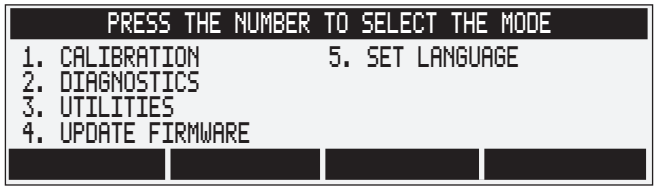
Biomed > Calibration

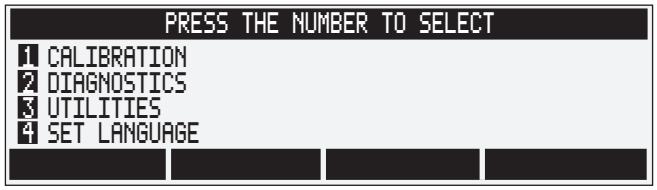
In order to complete the calibration of the Medfusion® 3000 Series infusion pumps, you need the *Smiths Medical Medfusion® 3000 Series Calibration Kit*. This kit contains one (each) of the following:

- Small Calibration Slug
- Large Calibration Slug
- Force Gauge

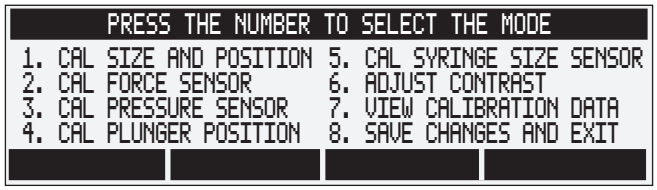
Note: *The equipment supplied in the Calibration Kit should be added to your annual calibration and maintenance schedule.*

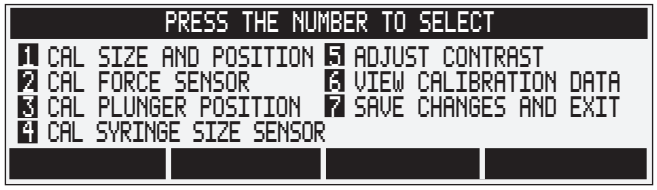
To access **Biomed** > **Calibration**, from the Main menu use the **number** buttons to choose **Biomed** (you may need to press **More** to find it; if libraries are enabled you may need to press **Main Menu**, then **More**). Enter the Passcode (***2580***) then press **Enter**.





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





Below is table which summarizes the options available for calibration.

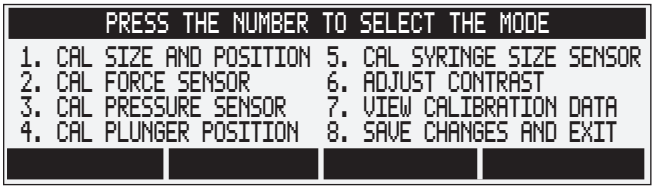
Calibration Option	What it Controls
Calibrate (Syringe) Size and Position	Performs concurrent adjustment of syringe size & position sensors settings. This requires Smiths Medical "calibration slugs".
Calibrate Force Sensor	Performs adjustment of force sensor settings.
Calibrate Pressure Sensor	This is a future option of the Medfusion® 3000 Series pumps.
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. You may set it 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.

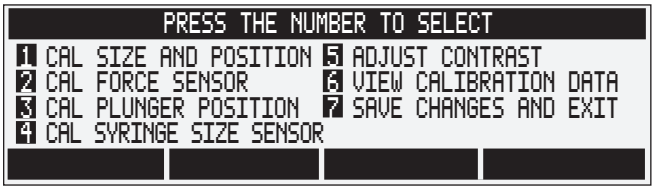
Calibrate (Syringe) size and position

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.

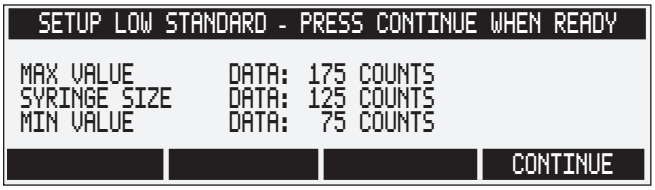
Performing both size & position calibration

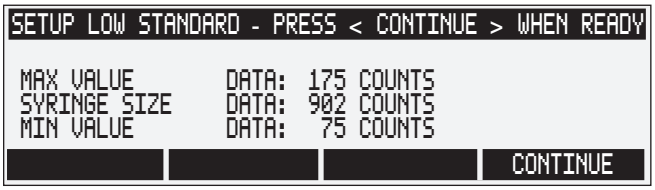
1. From the **Calibration** Menu, use the number buttons to choose **Cal Size and Position**.

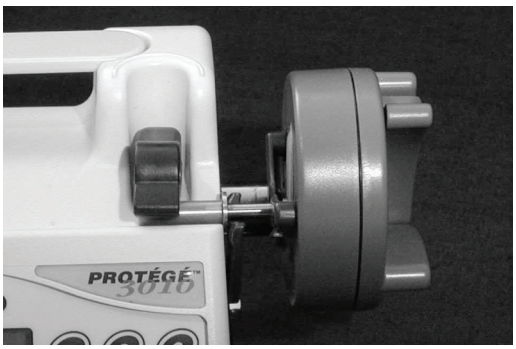




2. Load the small calibration slug into the barrel clamp. Keeping the barrel clamp perpendicular to the slug, move the clamp slightly back and forth to find the lowest size reading, then press **Continue** to calibrate the small size.





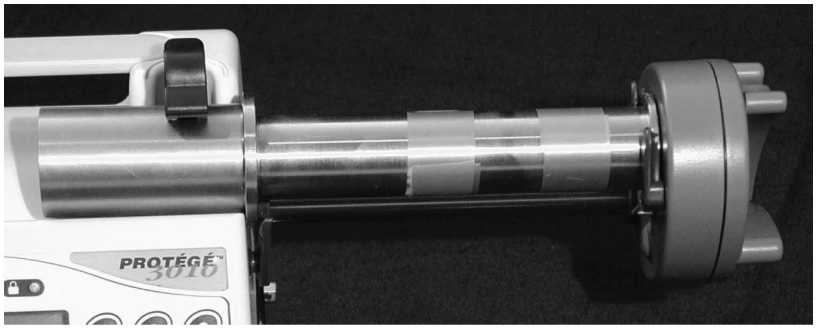


3. Squeeze the plunger lever to hold the flippers open, move the plunger head against the small slug, and press **Continue** to calibrate the low position.

```
SETUP LOW STANDARD - PRESS CONTINUE WHEN READY

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

                                  CONTINUE
```

```
SETUP 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
```

```
SETUP HIGH STANDARD - PRESS < CONTINUE > WHEN READY

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

                                  CONTINUE
```

5. 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.

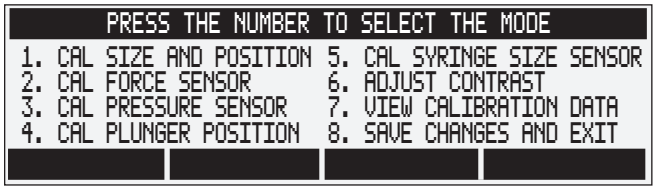
```
SETUP HIGH STANDARD - PRESS CONTINUE WHEN READY

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

                                  CONTINUE
```

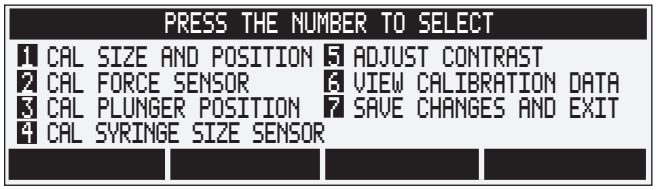
```
SETUP HIGH STANDARD - PRESS < CONTINUE > WHEN READY

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

                                  CONTINUE
```

6. You return to the **Calibration** menu. You may calibrate another mode, choose **Save Changes and Exit** to exit calibration, or press BACK to return to the **Biomed** menu.

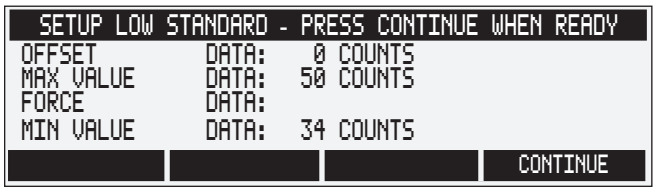
Calibrate force sensor

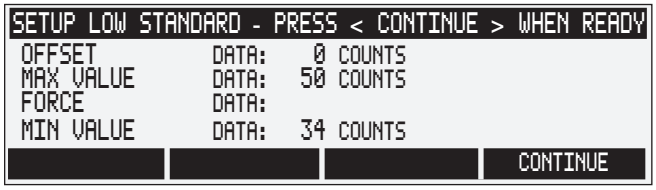
1. From the **Calibration** menu, choose **Cal Force Sensor**.



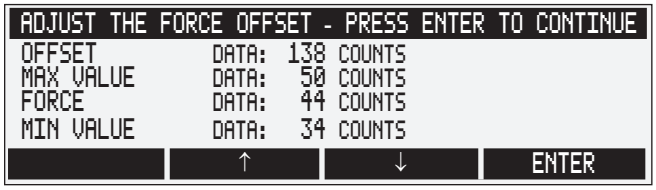


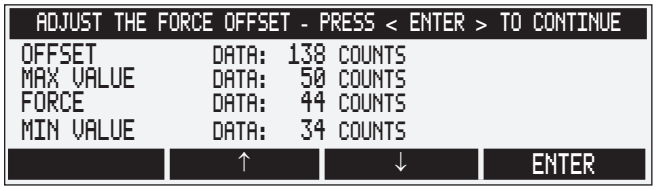
2. Ensure nothing is loaded in the plunger head, press **Continue** and wait until force sensor zero is finished.





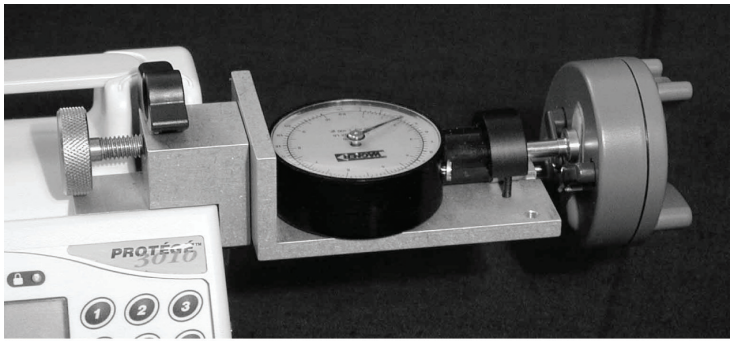
3. The pump then auto-zeroes the force sensor's offset (this takes about 40 seconds). [***Do not use arrow keys***.]





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) the force gage head, and use the thumbscrew to adjust the gauge to 10 lbs. ±0.2, then press **Continue**. The force calibration is complete.
6. You return to the **Calibration** menu. You may calibrate another mode, choose **Save Changes and Exit** to exit calibration, or press BACK to return to the **Biomed** menu.

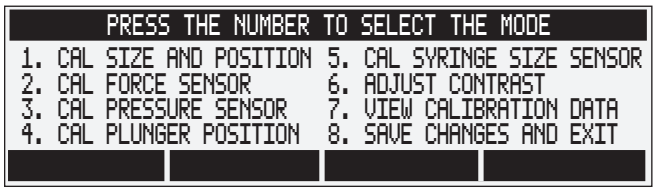


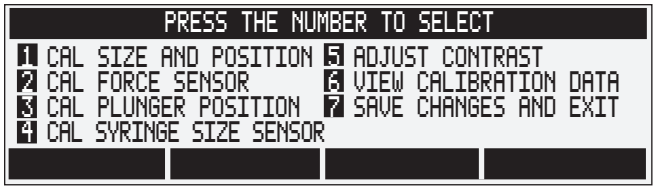
Calibrate pressure sensor (future option)

Do not use, this is a "future option" of the Medfusion® 3000 Series.

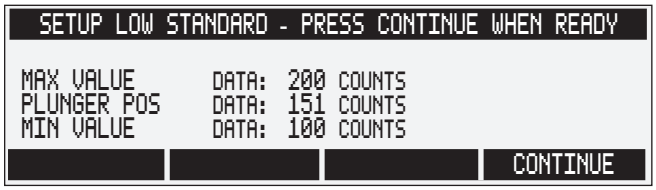
Calibrate plunger position

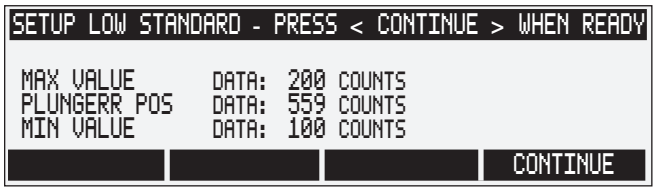
1. From the **Calibration** menu, choose **Cal Plunger Position**.



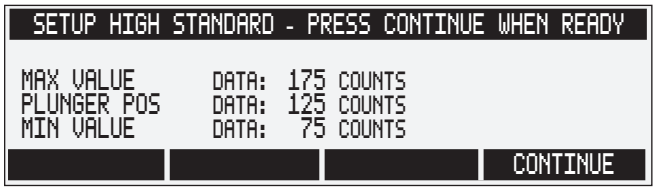


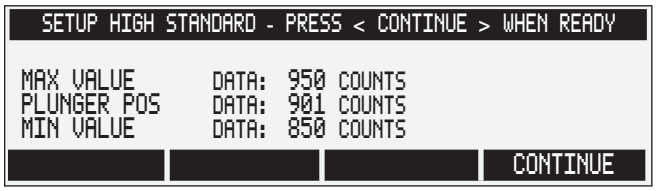
2. Load the small calibration slug into the barrel clamp. Squeeze the plunger lever to hold the flippers open, move the plunger head against the small slug, and press **Continue** to calibrate the low position.





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.

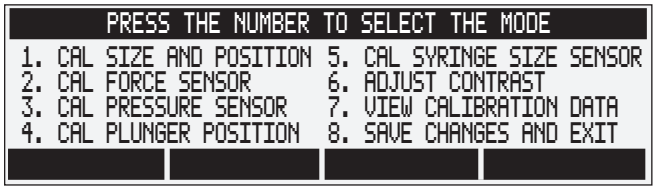


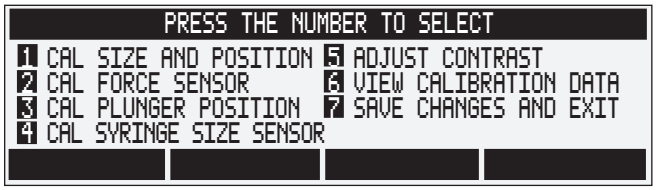


4. You return to the **Calibration** menu. You may calibrate another mode, choose **Save Changes and Exit** to exit calibration, or press BACK to return to the **Biomed** menu.

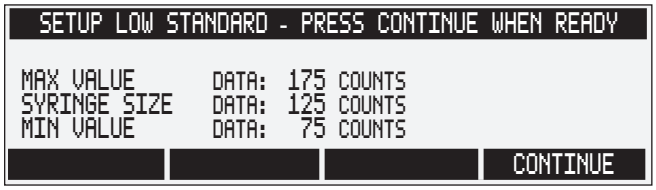
Calibrate syringe size sensor

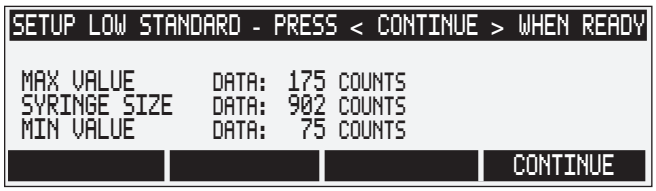
1. From the **Calibration** menu, choose **Cal Syringe Size Sensor**.



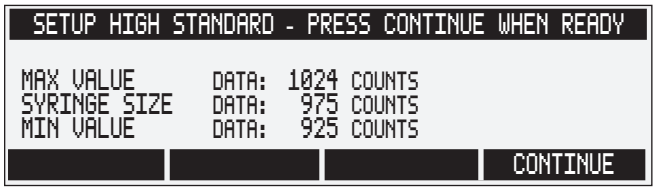


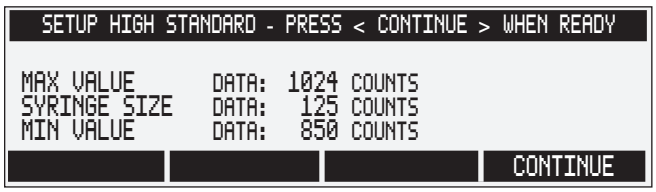
2. Load the small calibration slug into the barrel clamp. Keeping the barrel clamp perpendicular to the slug, move the clamp slightly back and forth to find the lowest size reading, then press **Continue**.





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.



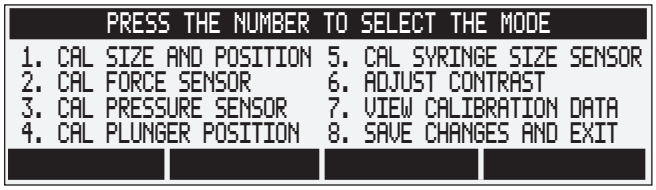


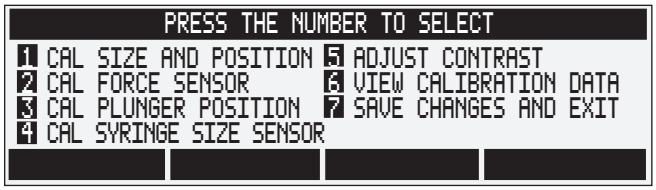
4. You return to the **Calibration** menu. You may calibrate another mode, choose **Save Changes and Exit** to exit calibration, or press (BACK) to return to the **Biomed** menu.

Adjust contrast (voltage) setting

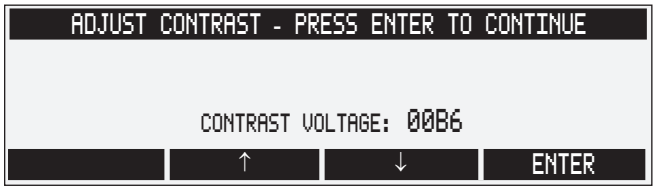
The factory default contrast voltage setting is 00BF (however this value may vary for different LCD display manufactures). This is the nominal setting for most lighting conditions and may be adjusted higher or lower.

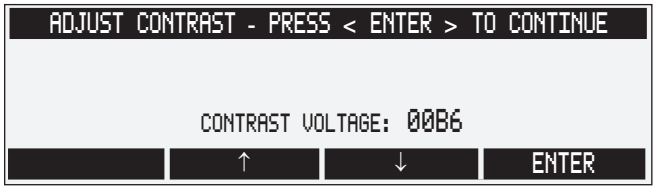
1. From the **Calibration** menu, choose **Adjust Contrast**.





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



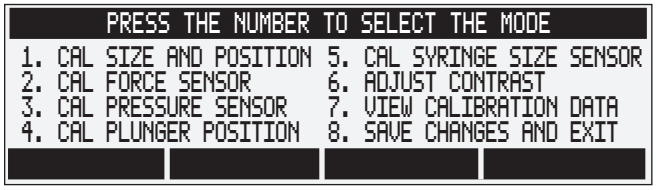


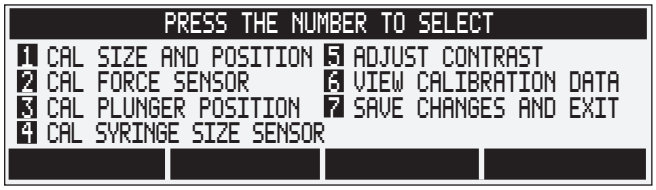
3. When ready, press **Enter** to accept the new contrast voltage setting and return to the **Calibration** menu. You may calibrate another mode, choose **Save Changes and Exit** to exit calibration, or press (BACK) to return to the **Biomed** menu.

View calibration data

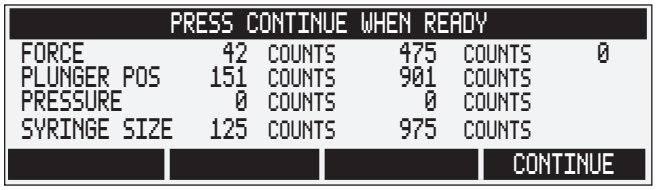
This feature allows you to display the pump's calibration data onscreen. This screen is generally used in factory service or for troubleshooting.

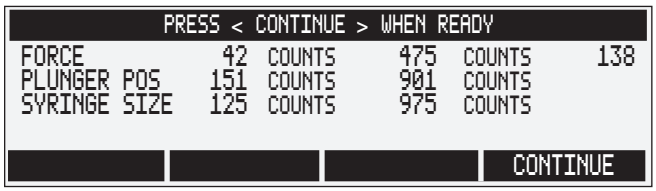
1. From the **Calibration** menu, choose **View Calibration Data**.





2. When ready, press **Continue** to return to the **Calibration** menu. You may calibrate another mode, choose **Save Changes and Exit** to exit calibration, or press (BACK) to return to the **Biomed** menu.

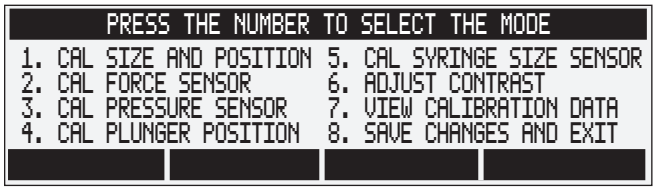


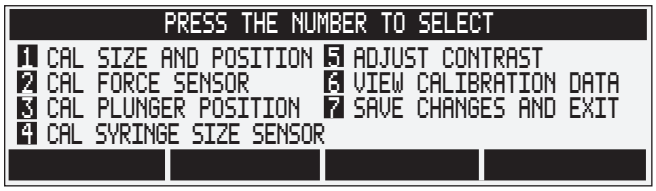


Save changes and exit

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

You may exit the **Calibration** menu at any time – without saving your 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.

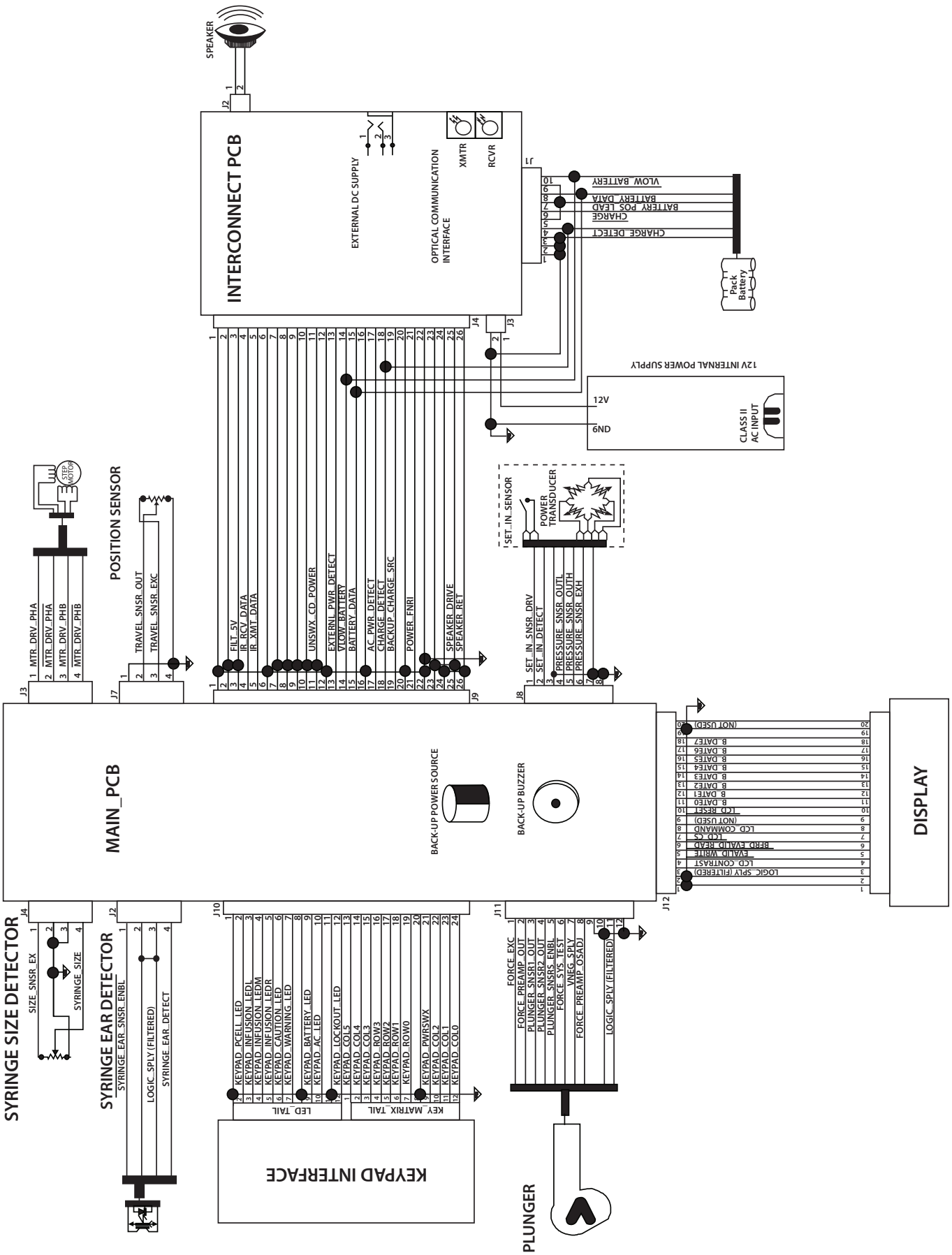
Retest guidelines

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, lead-screw, 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 board	None	Quick Check-out
Replace keypad, display or backlight	None	Quick Check-out & Calibration Verification
Replace main board/ component	Recalibrate all sensors	Complete Mandatory Annual Maintenance Testing
Replace plunger board/ component	Recalibrate force	Quick Check-out & Calibration Verification
Software Updates		
Reprogramming	See update instructions	See update instructions
Repair case or case parts		
Replace case bottom	None	Quick Check-out

Replace case top	Recalibrate all sensors	Complete Mandatory Annual Maintenance Testing
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

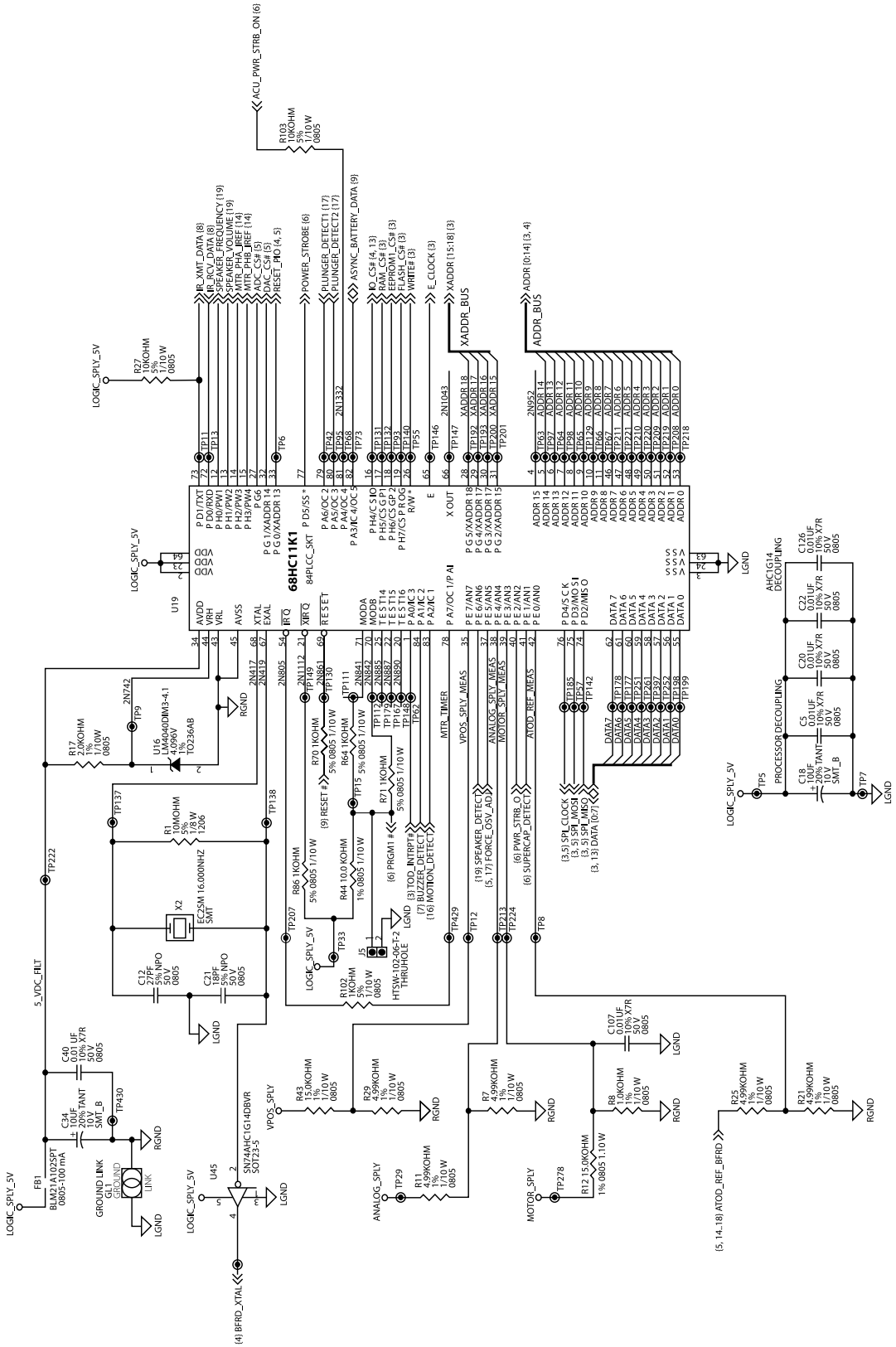
System layout



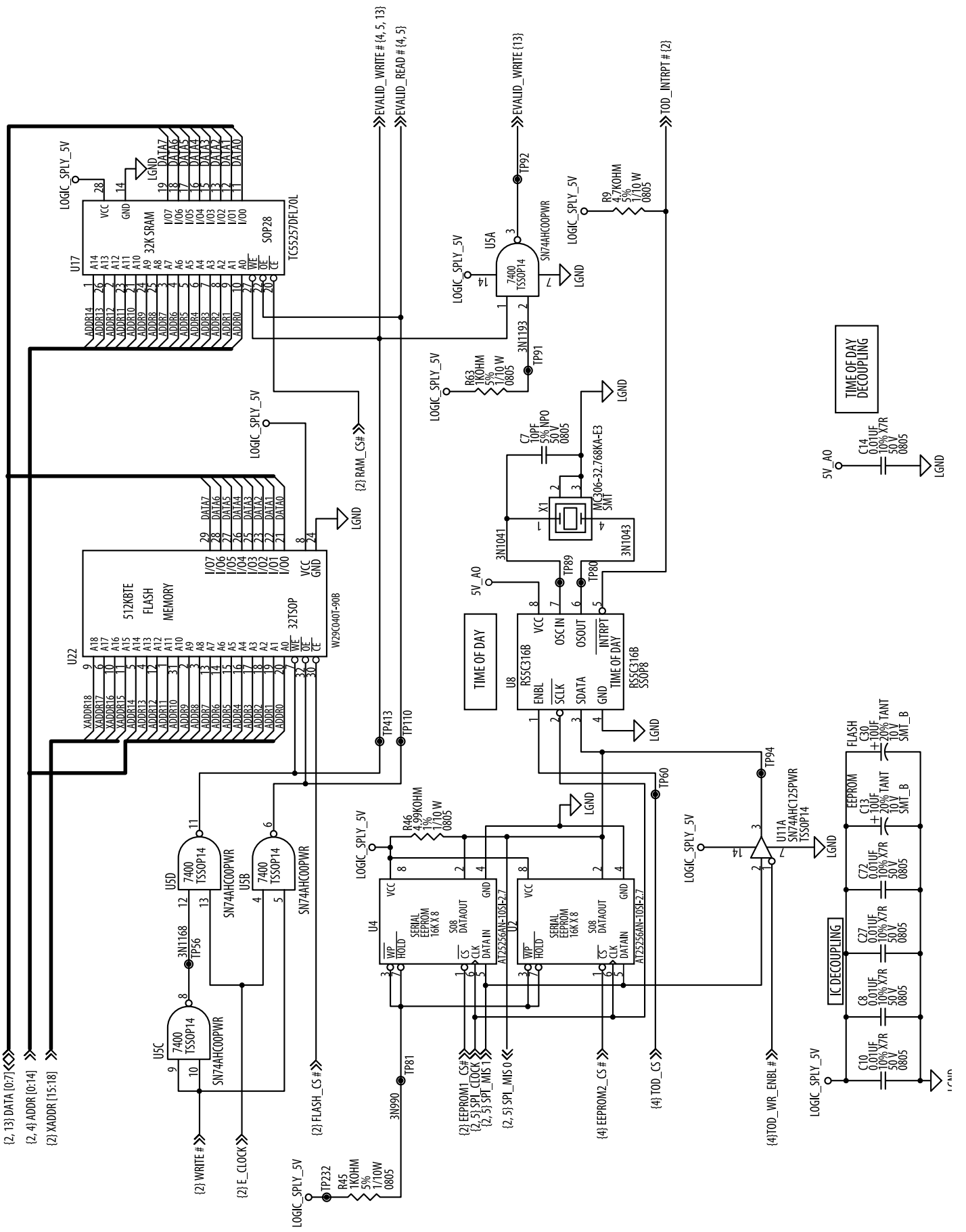
Main board schematics

The following are the main board schematics if the Medfusion® 3000 Series pump.

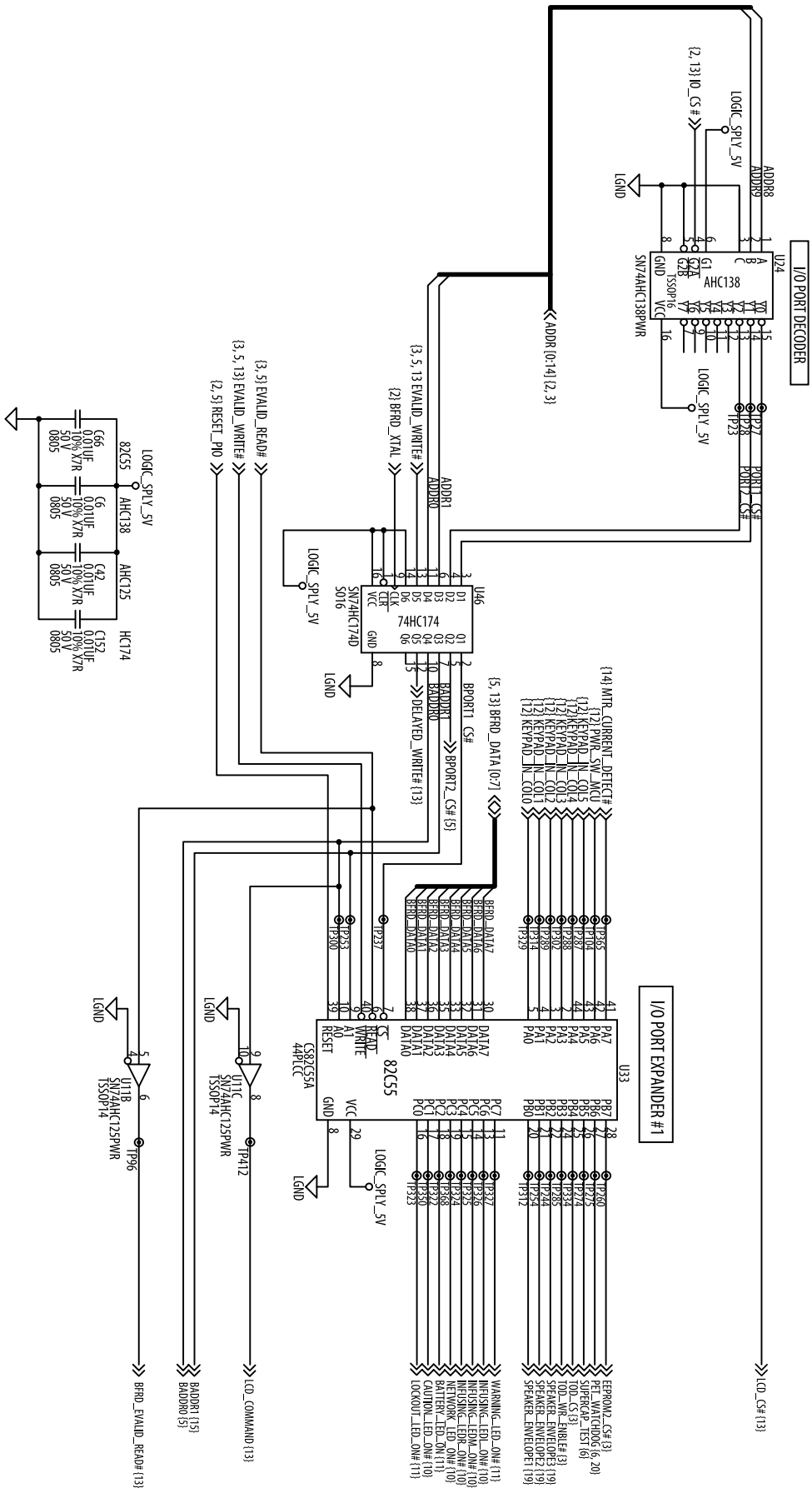
Main board / logic kernel



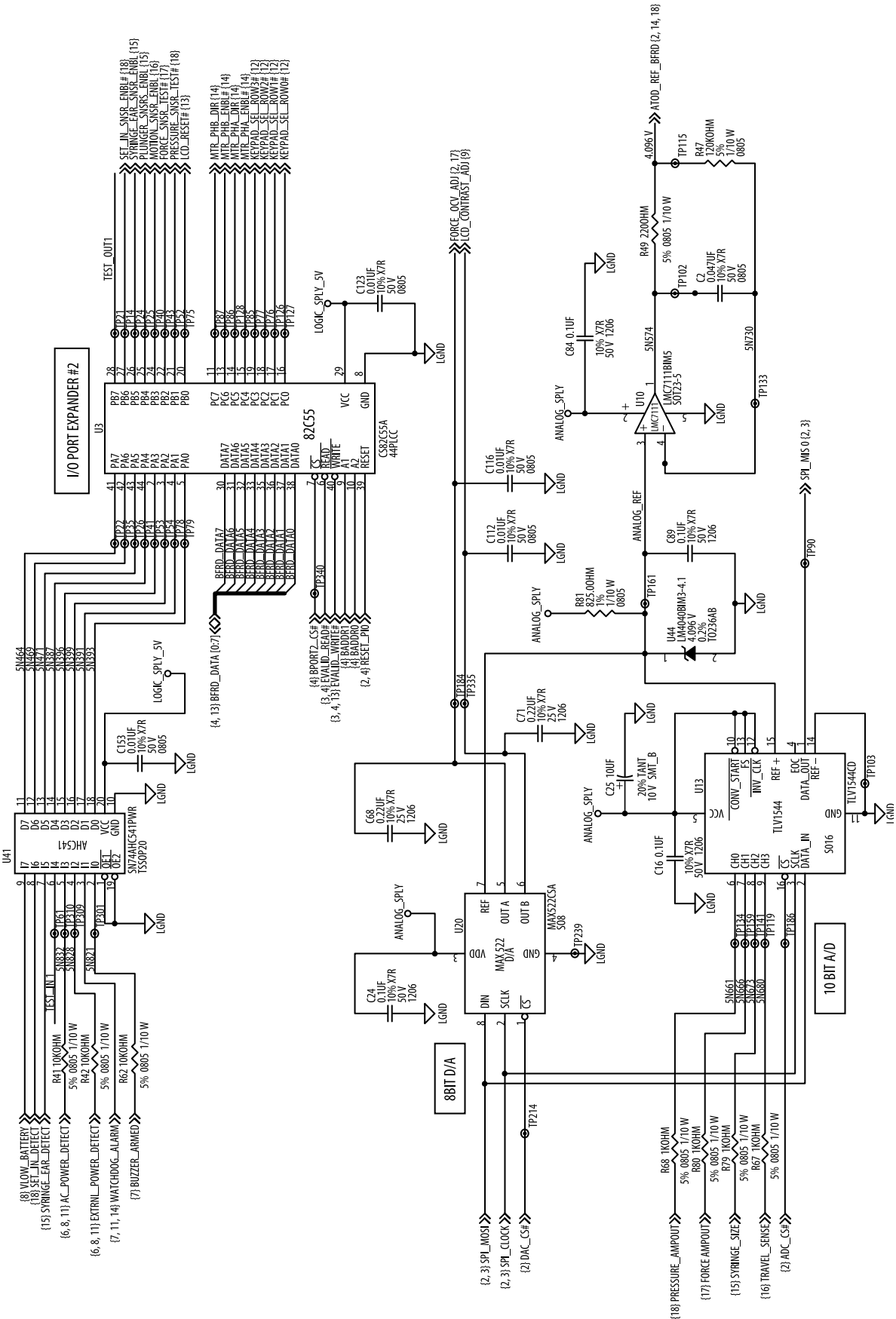
Main Board / Logic Kernel -- Continued



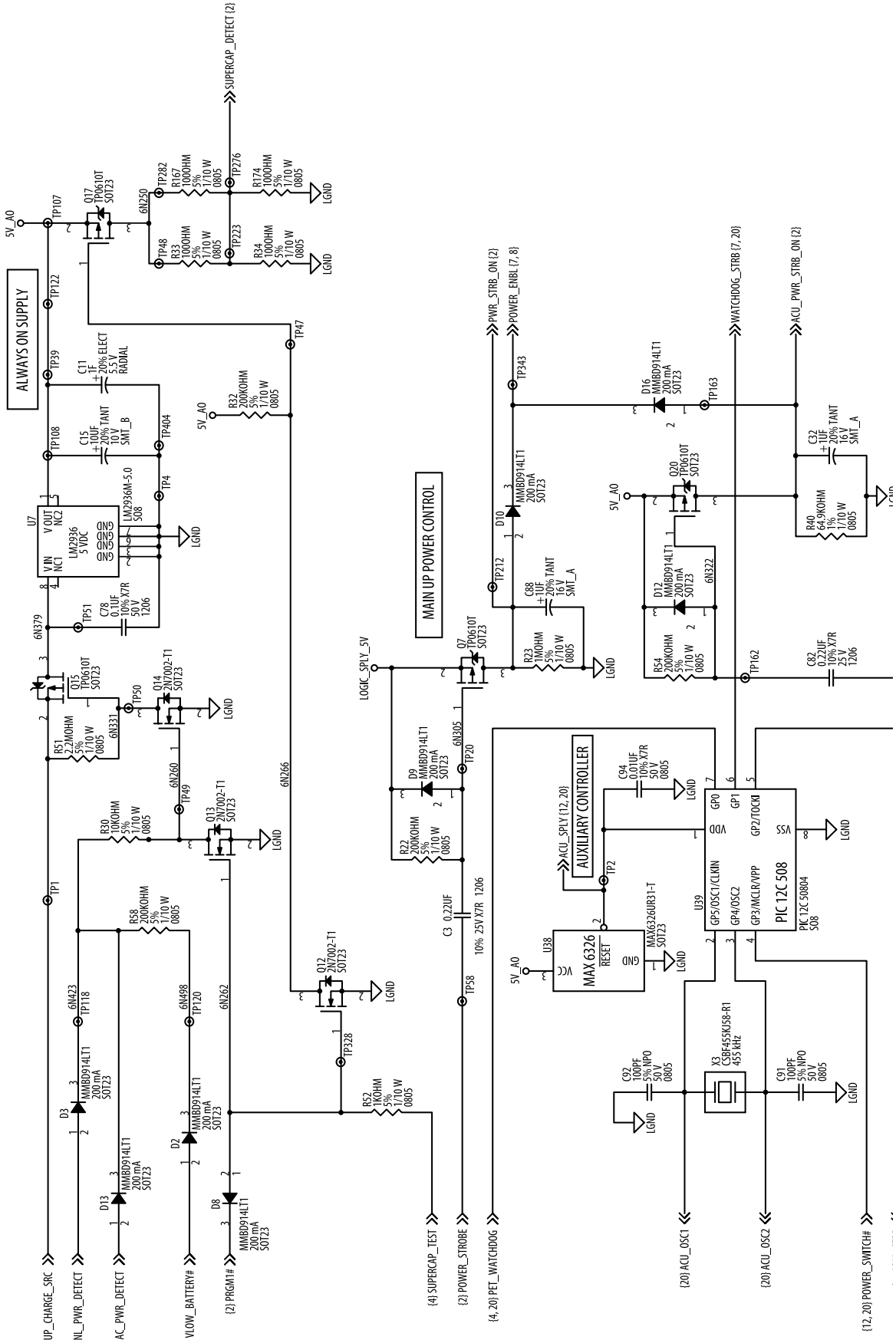
Main Board / Logic Kernel -- Continued



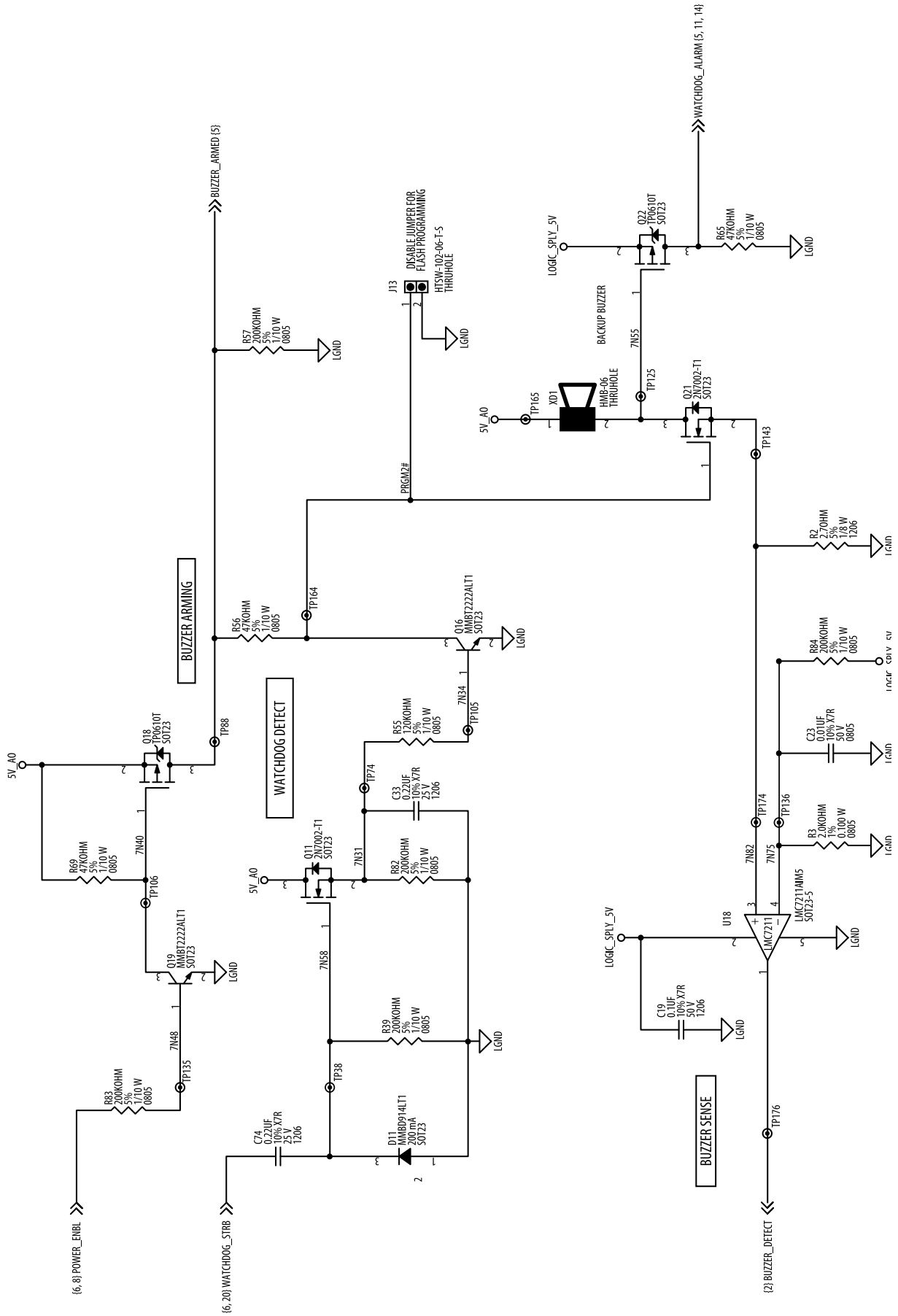
Main Board / Logic Kernel -- Continued



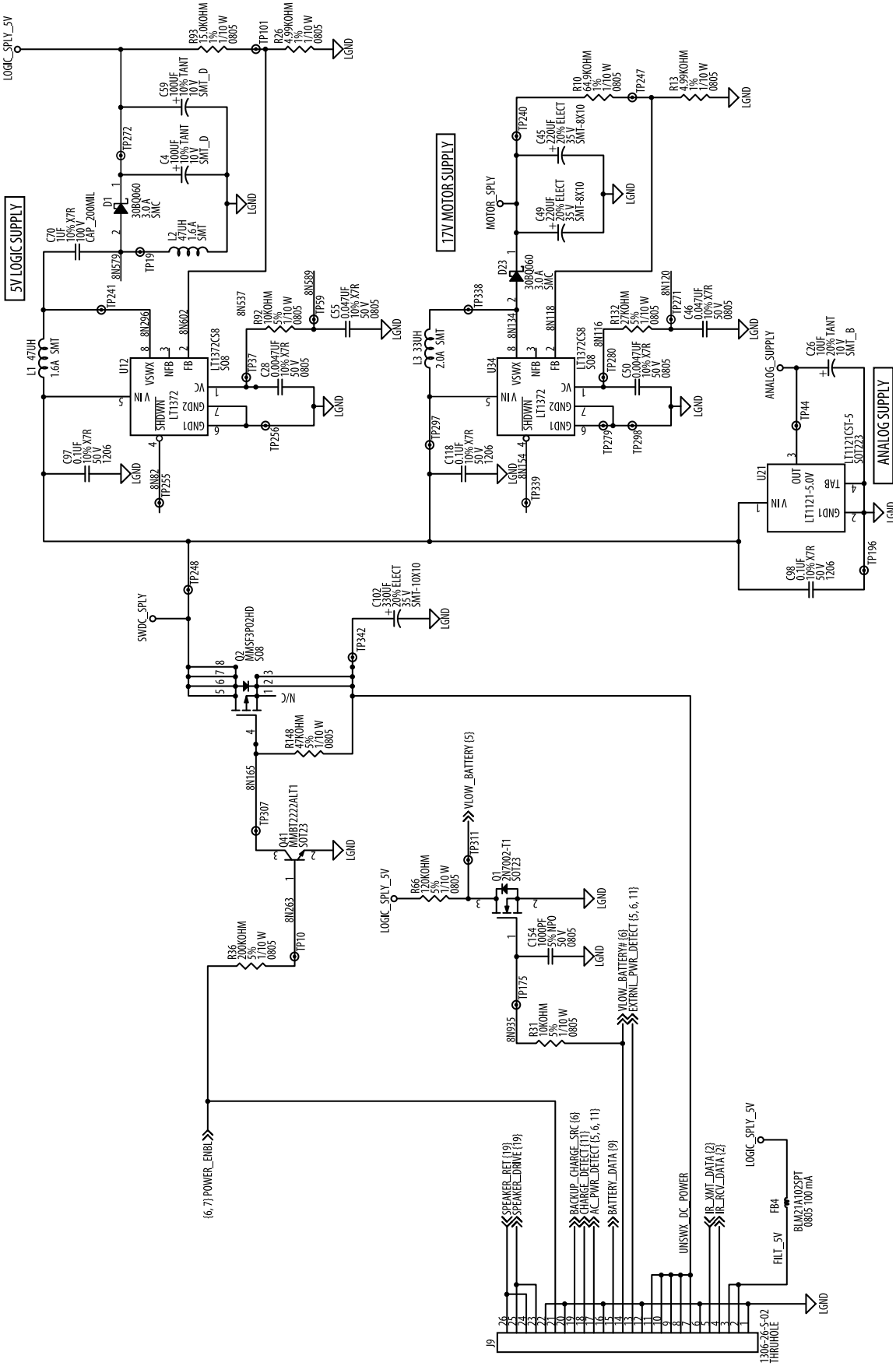
Main Board / Power Control Logic Core



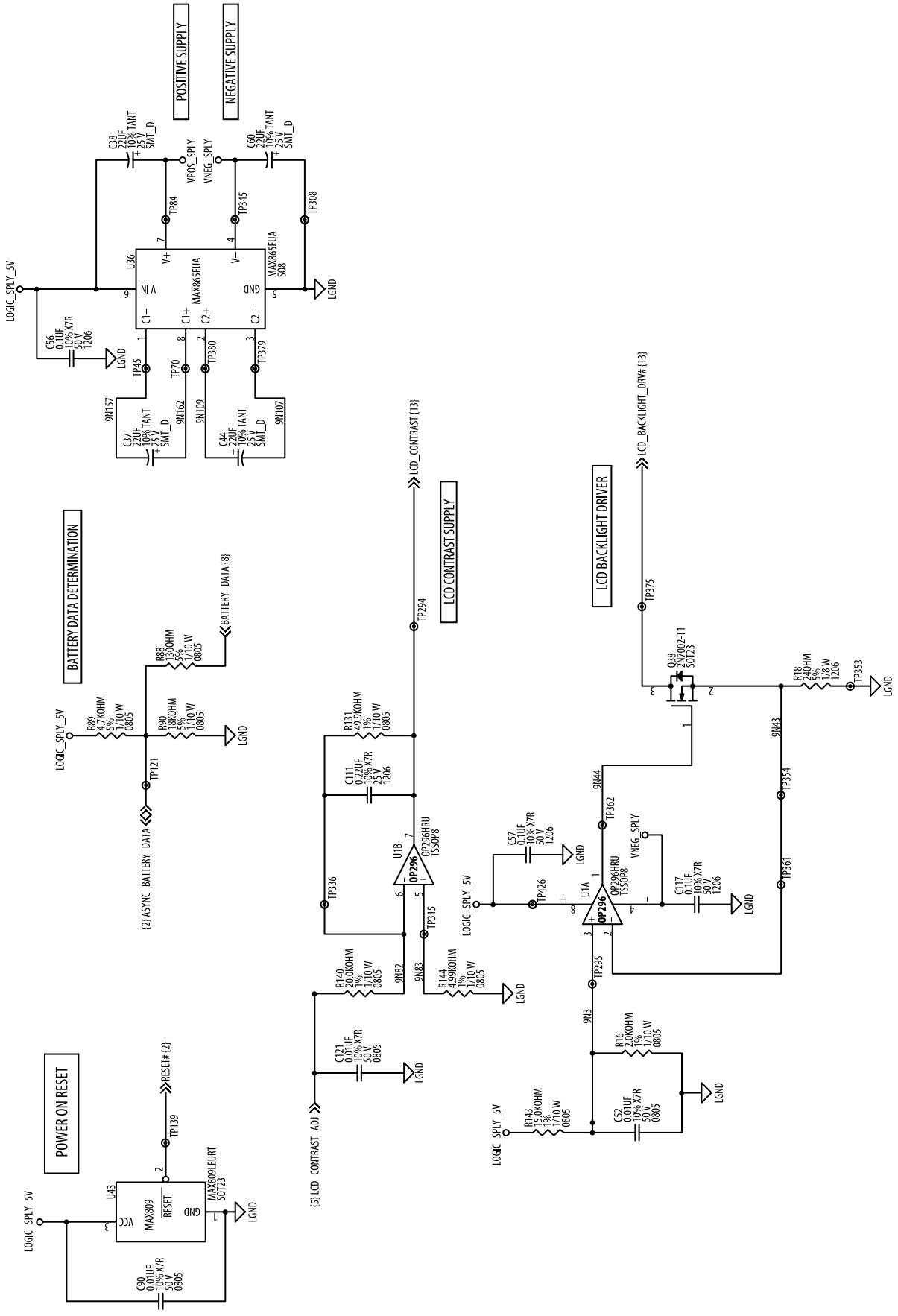
Main Board / Power Control Logic Core -- Continued



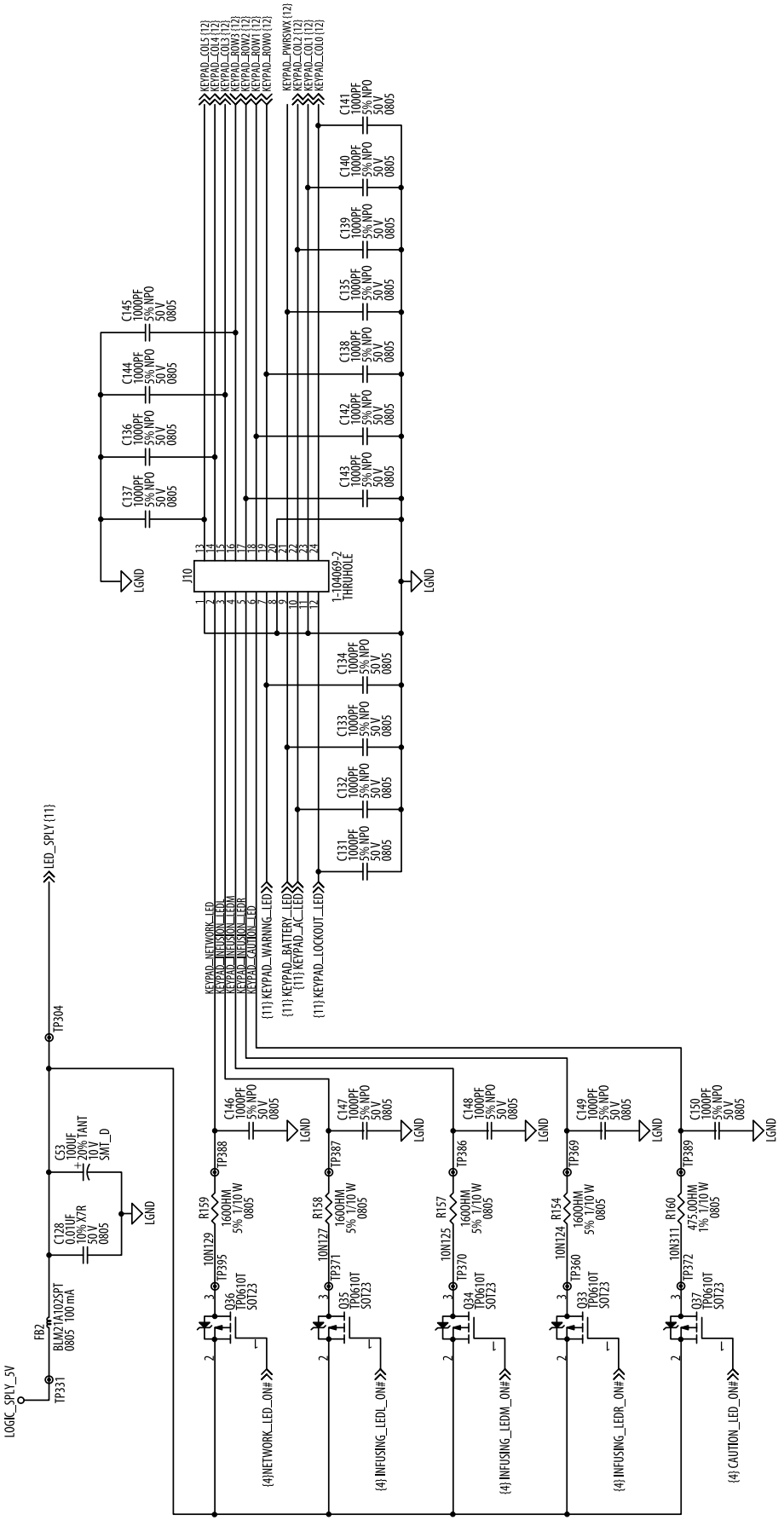
Main Board / DC-DC Converter



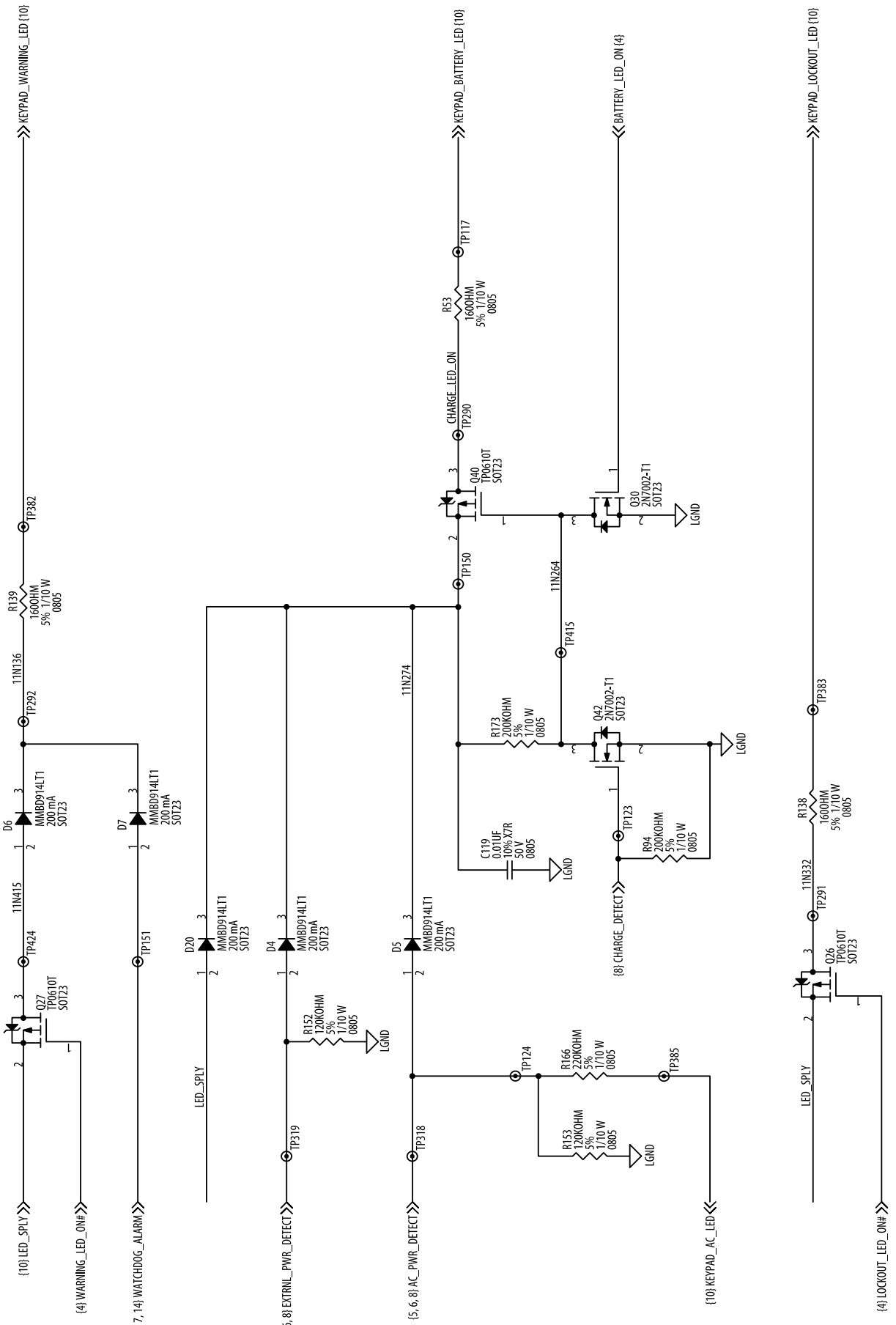
Main Board / DC-DC Converter -- Continued



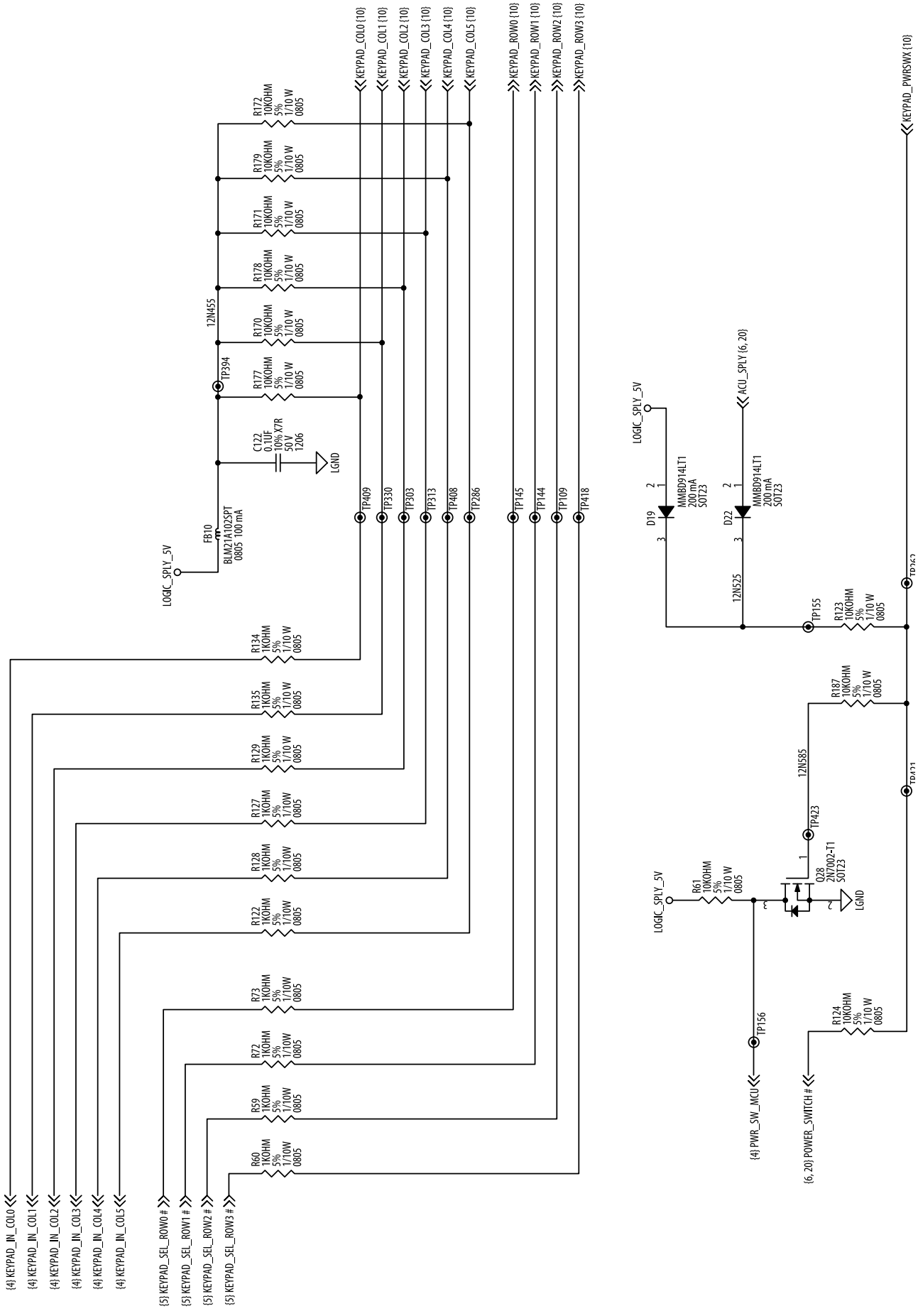
Main Board / Keypad Interface



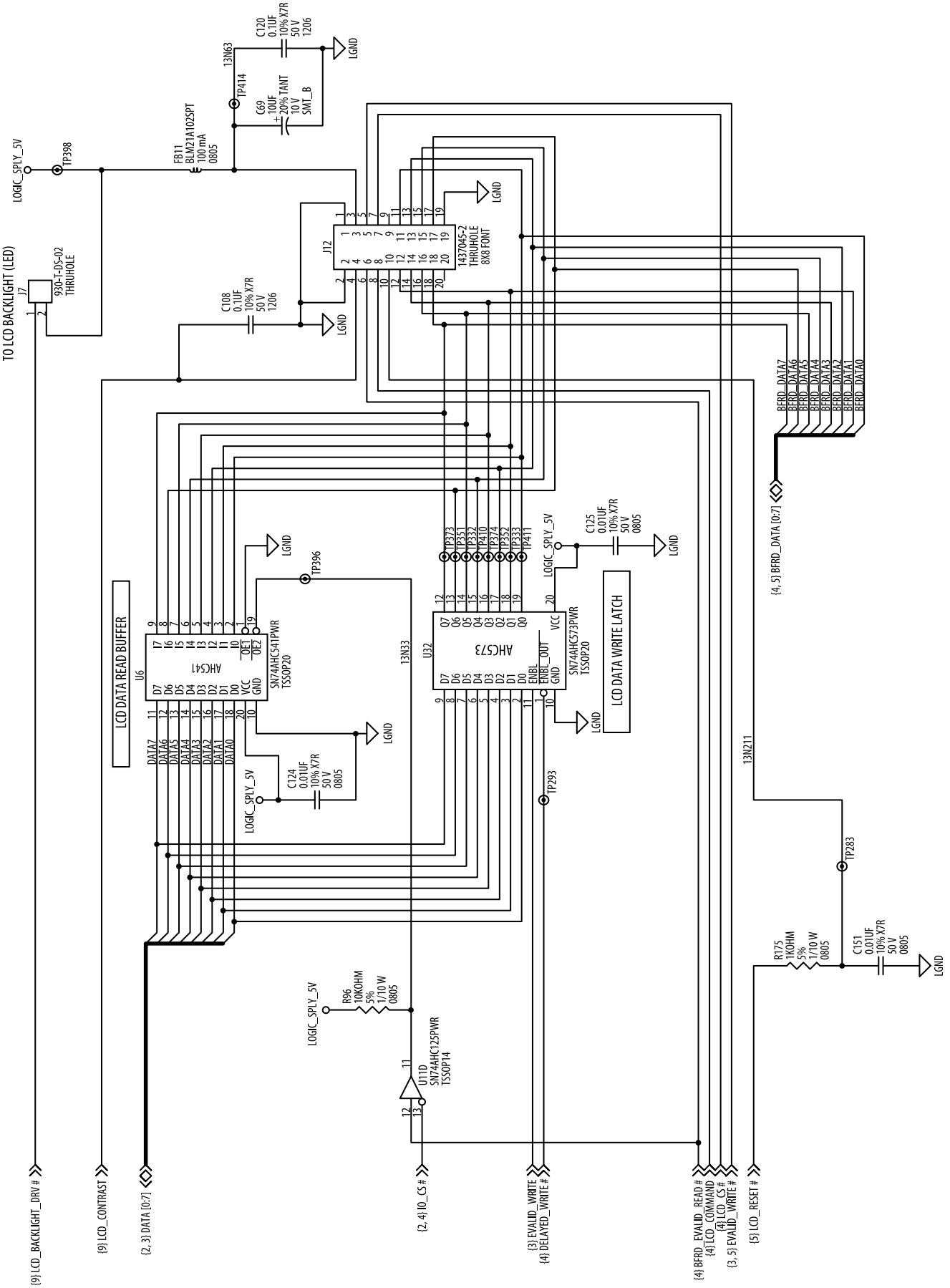
Main Board / Keypad Interface -- Continued



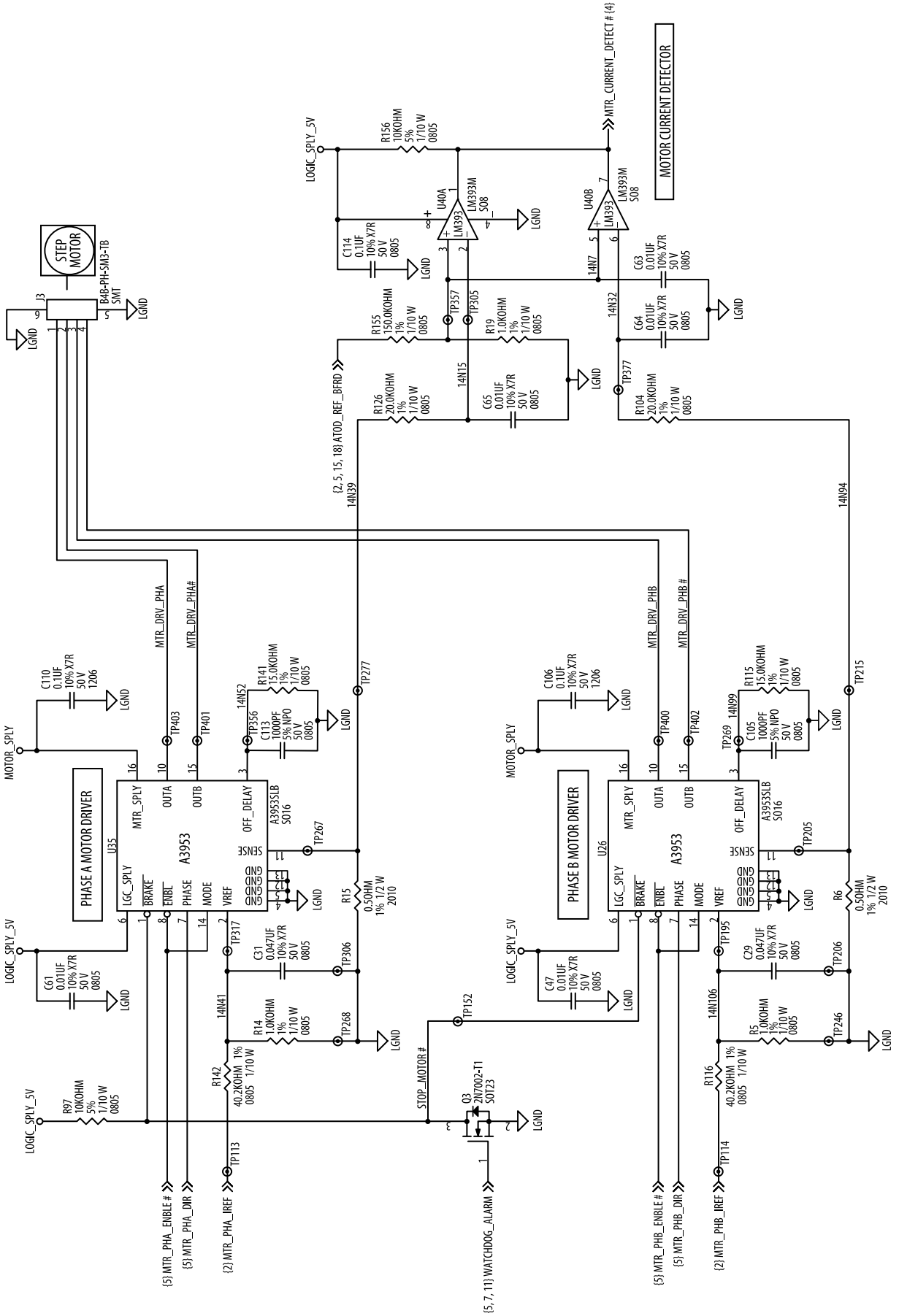
Main Board / Keypad Interface - Continued



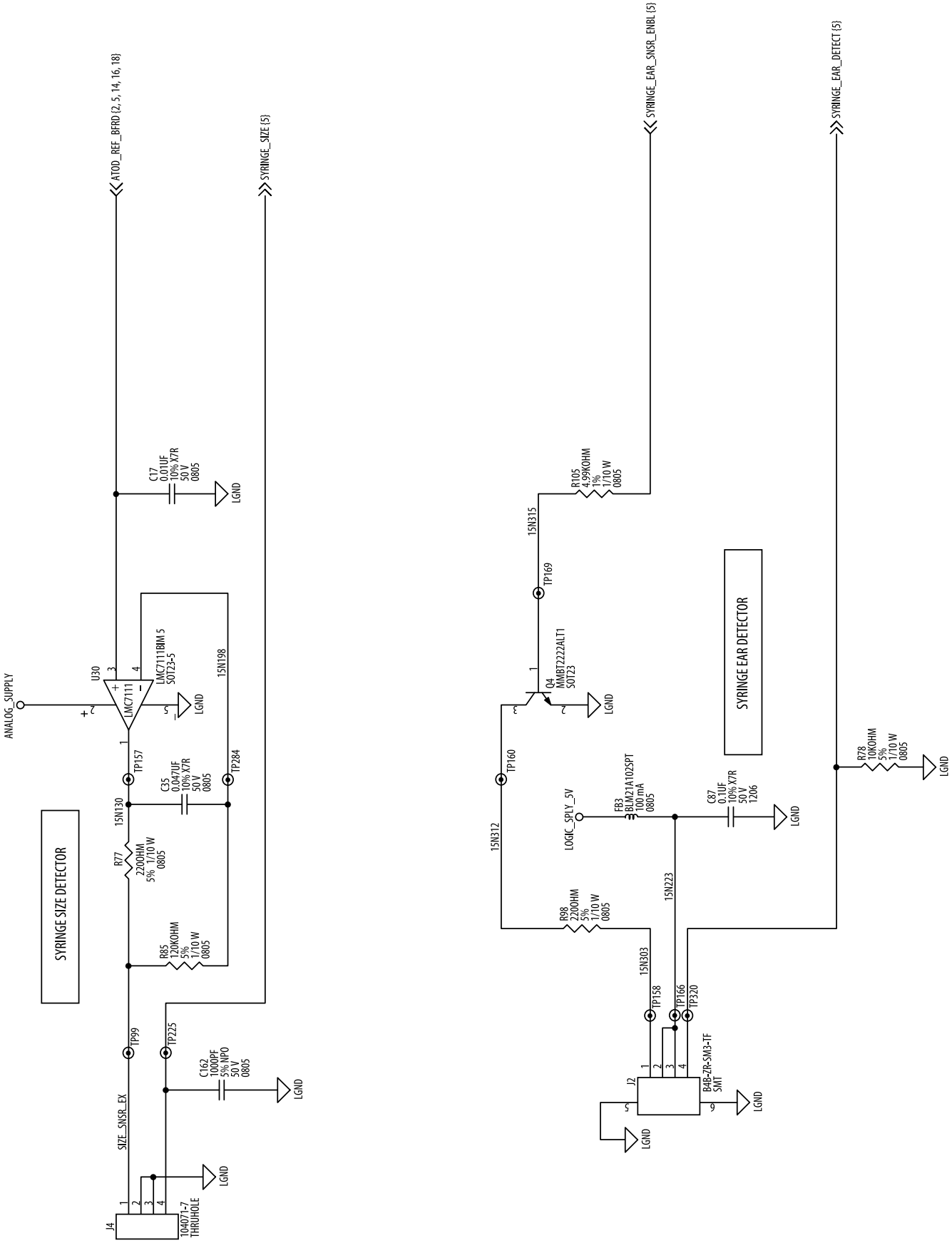
Main Board / Graphic Display Interface



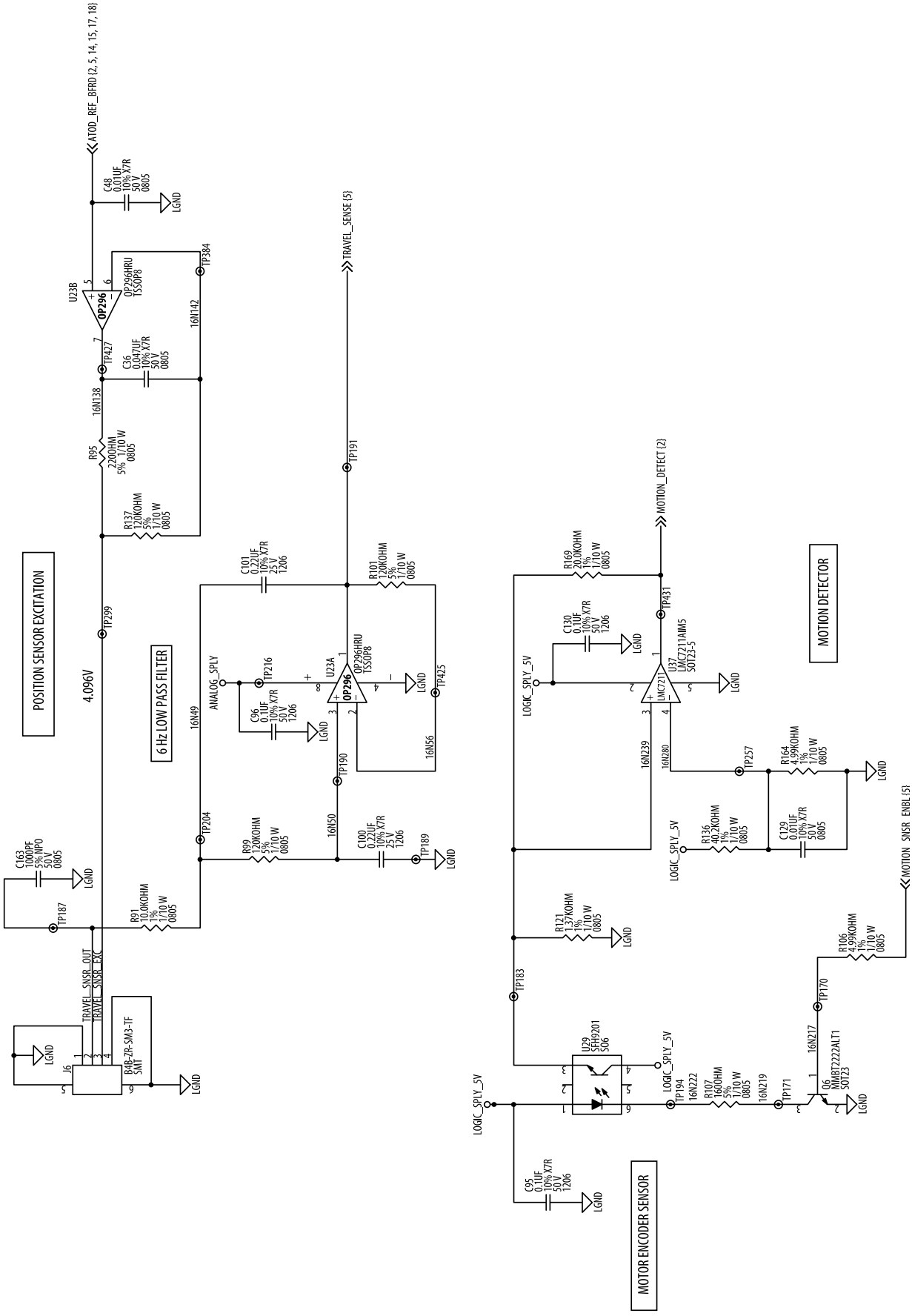
Main Board / Motor Drive



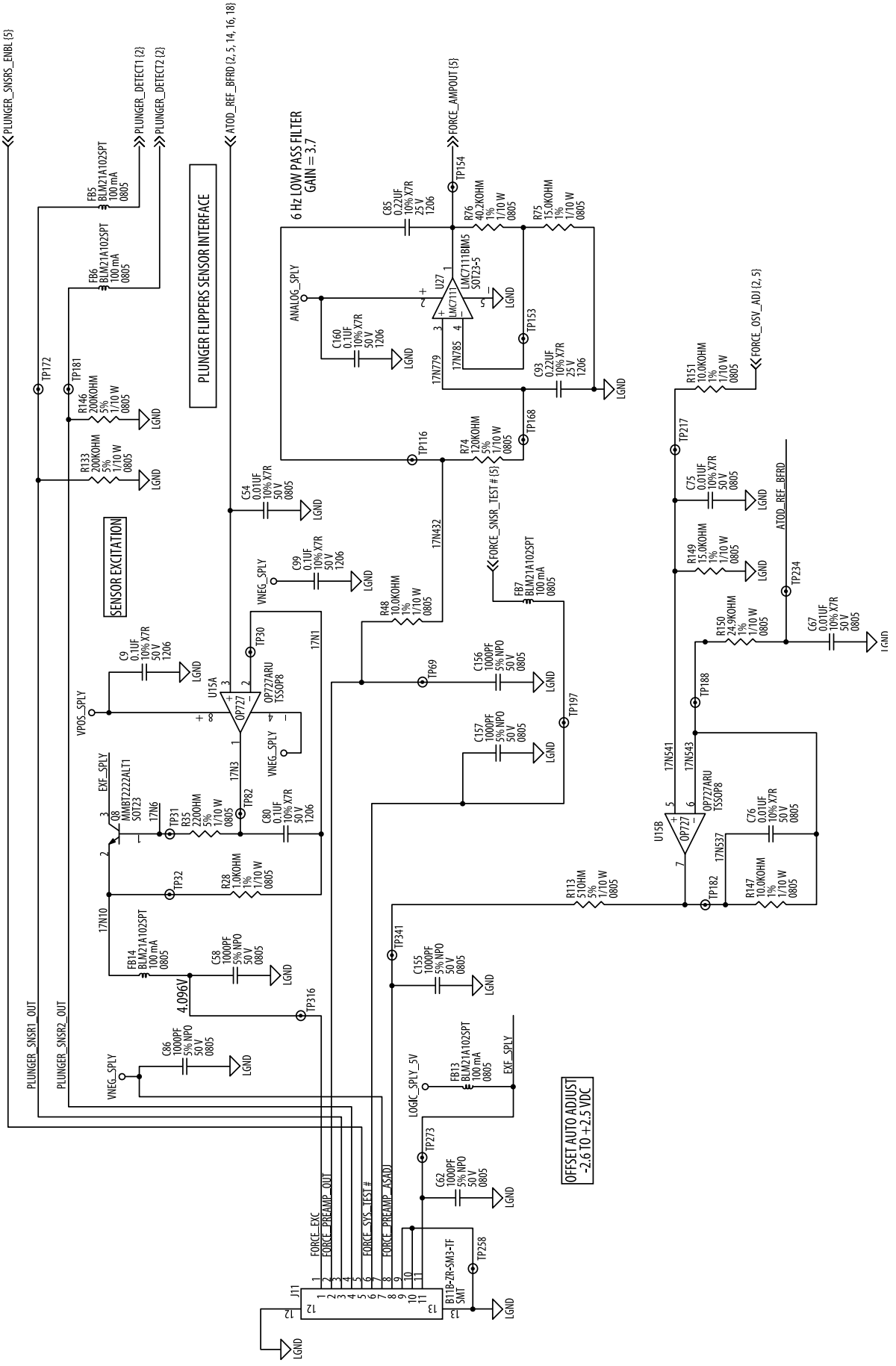
Main Board / Syringe Sensing



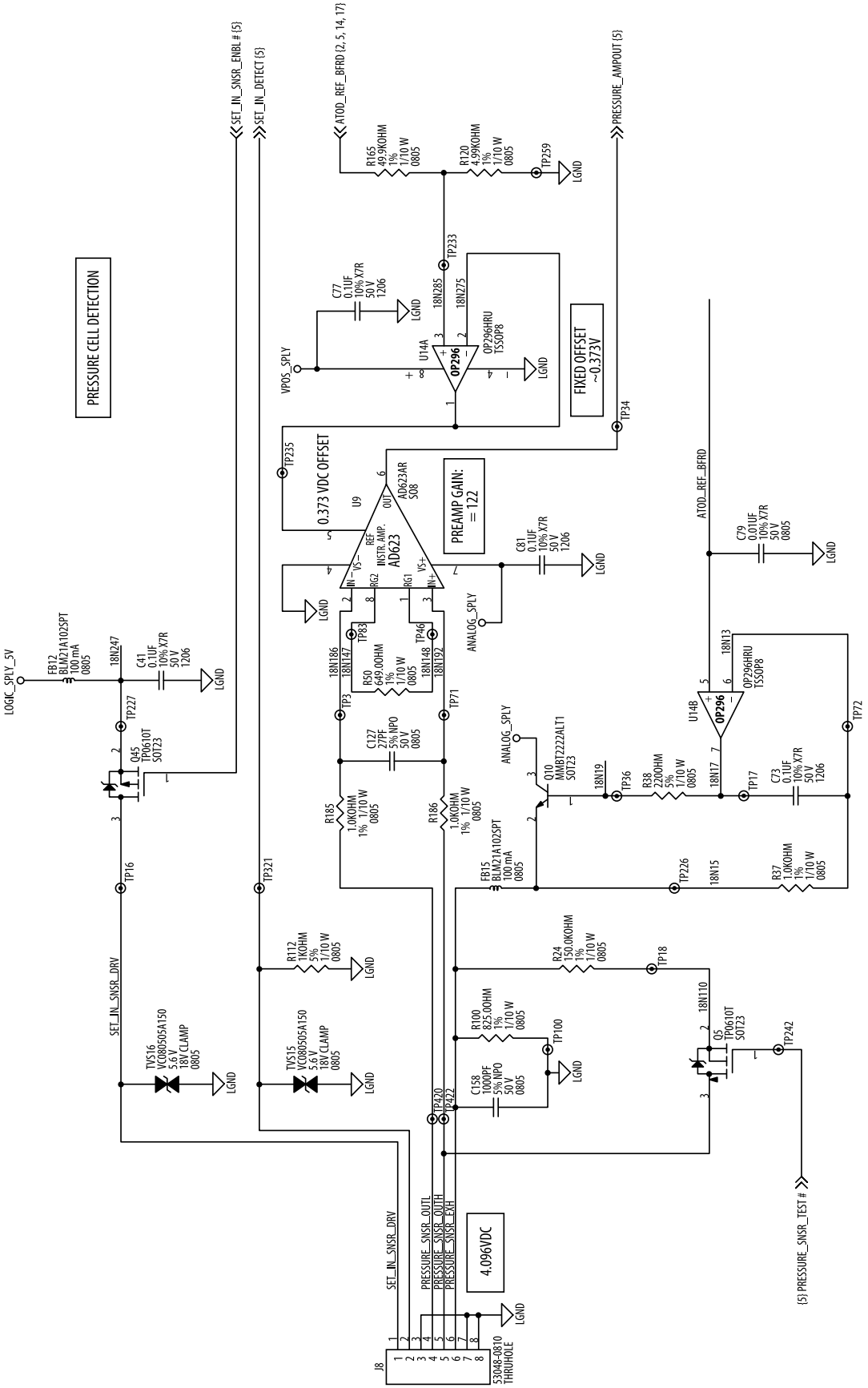
Main Board / Position Sensing



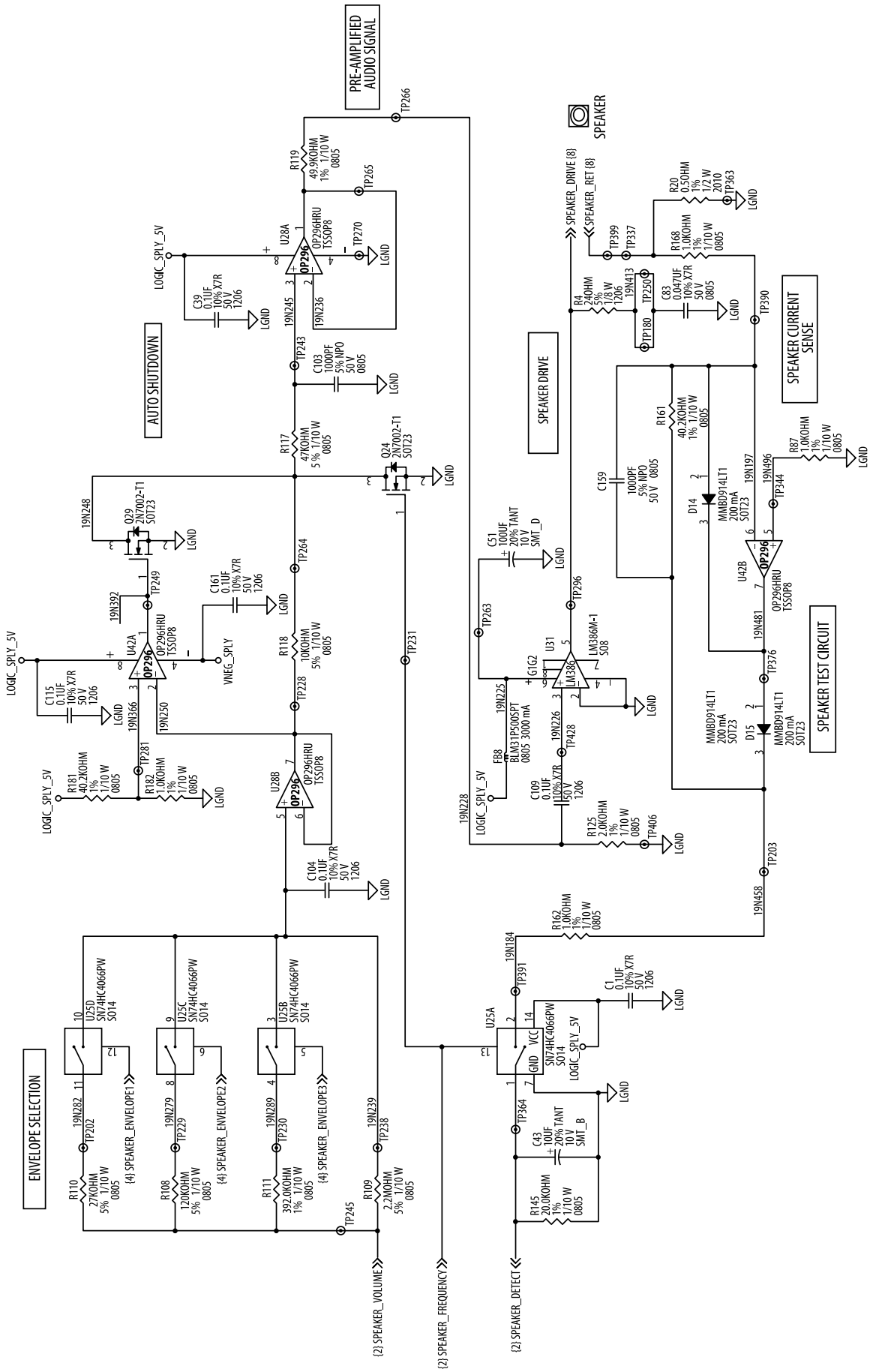
Main Board / Force Sensing



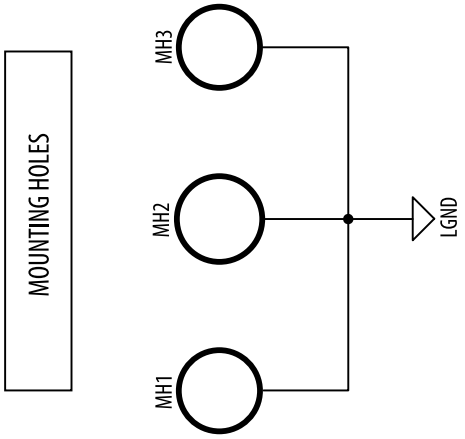
Main Board / Pressure Sensing

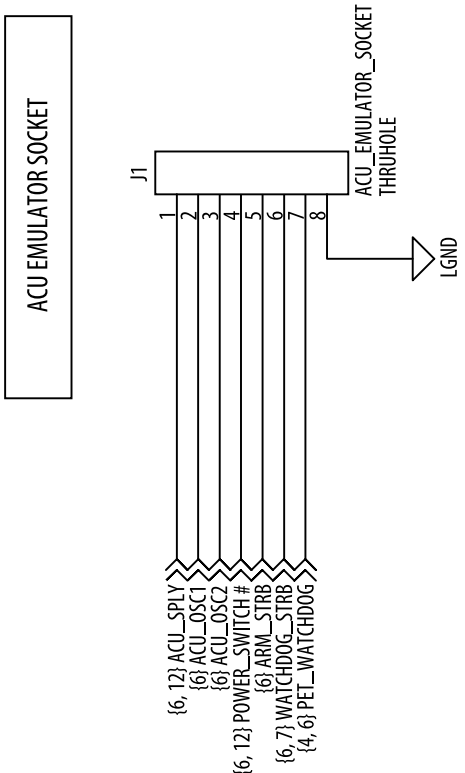


Main Board / Speaker Drive

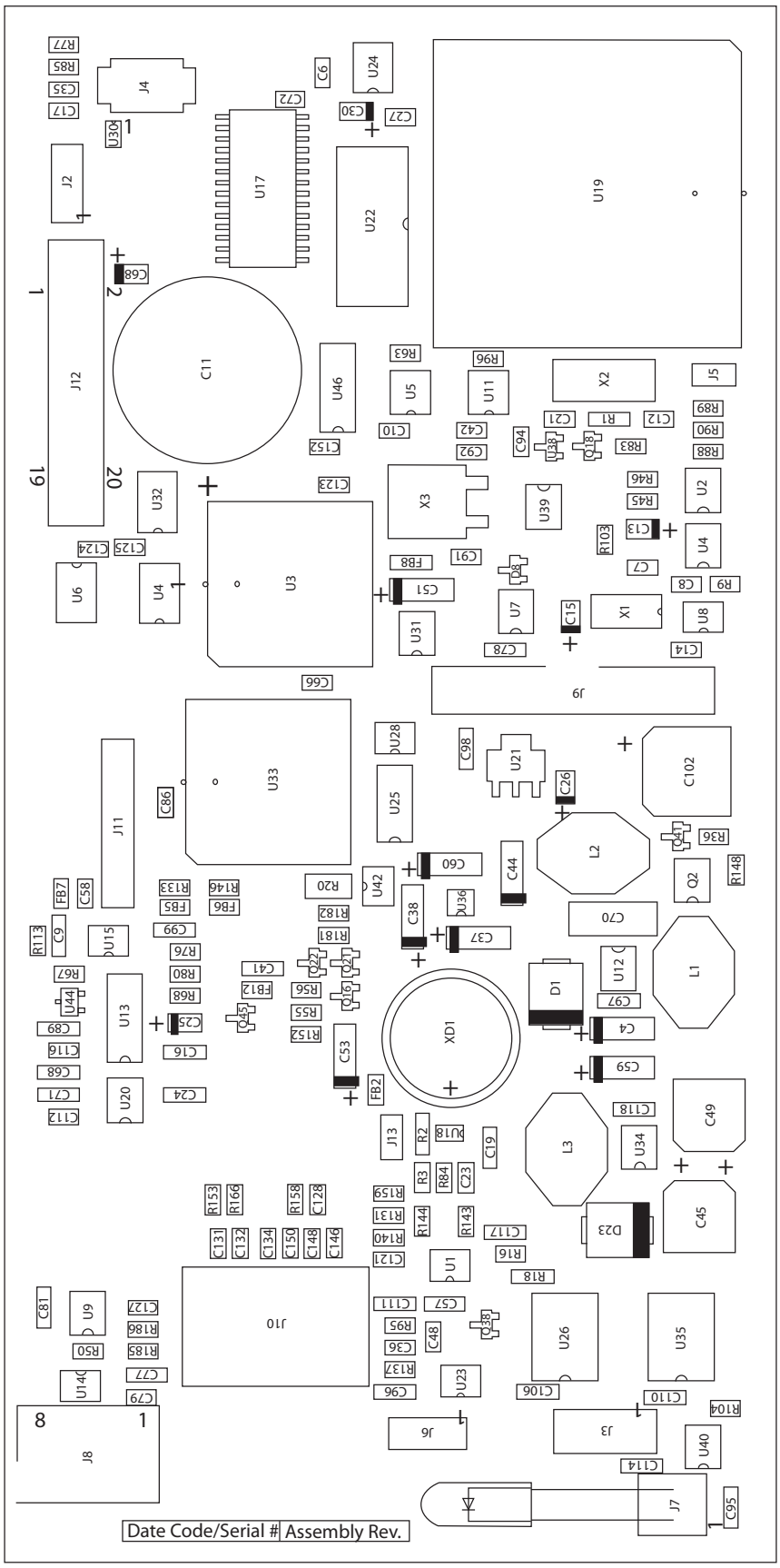


Main Board / ACU-ICE Socket

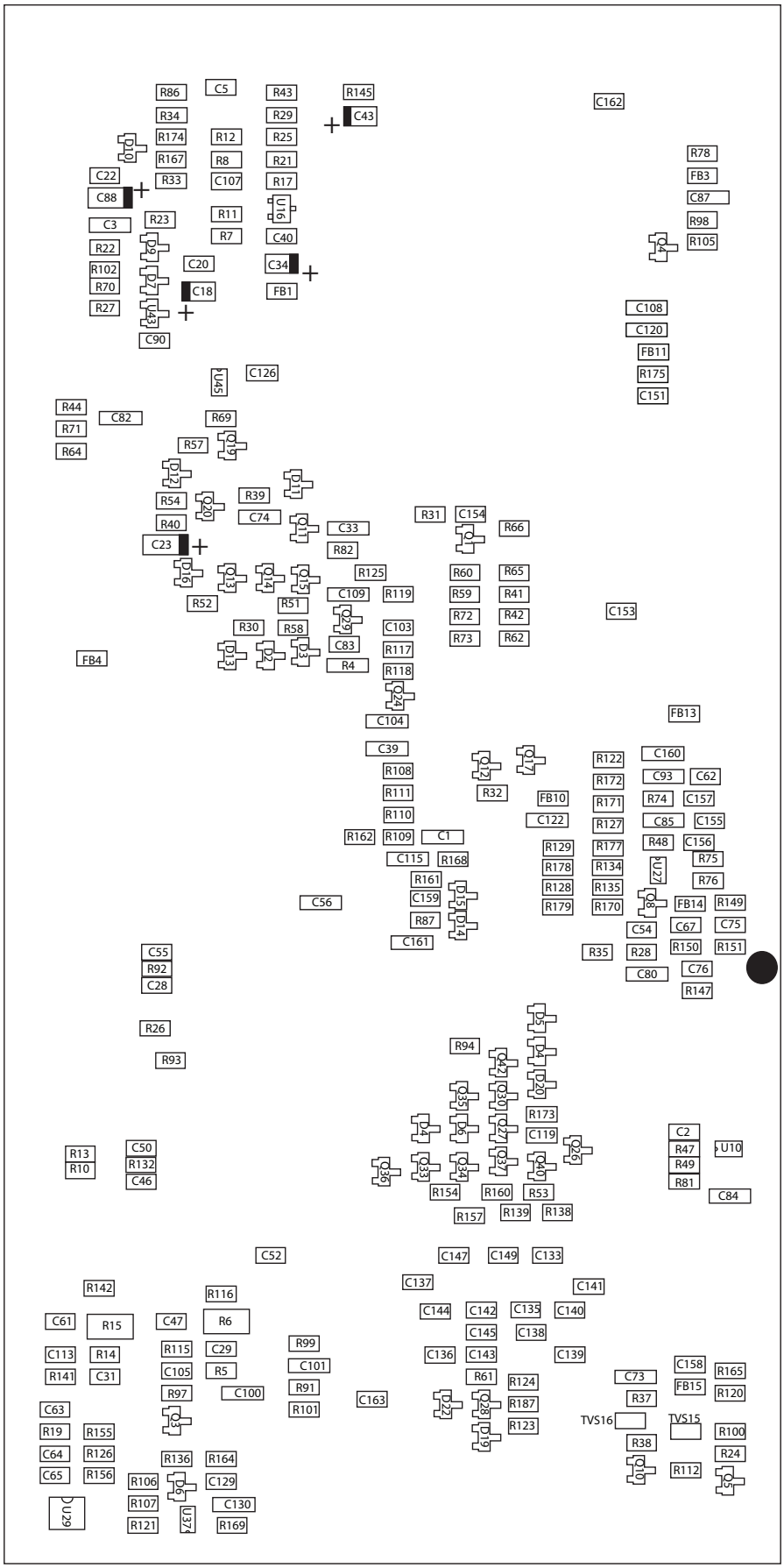




Main Board Assembly Drawing – Top Side



Main Board Assembly Drawing – Bottom Side



Main Board Assembly – Parts list

#	QTY	REF. Designator	Package	Value	Part Spec
1	36	C1, C9, C16, C19, C24, C39, C41, C56, C57, C73, C77, C78, C80, C81, C84, C87, C89, C95, C96, C97, C98, C99, C104, C106, C108, C109, C110, C114, C115, C117, C118, C120, C122, C130, C160, C161	1206W	0.1UF	CAPACITOR, 50V, X7R, 10%, 1206; GMC31X7R104K50NT, CAL-CHIP 12065C104KAT2A AVX
2	8	C2, C29, C31, C35, C36, C46, C55, C83	0805W	.047UF	CAPACITOR, 50V, X7R, 10%, 0805; GMC21X7R473K50NT, CAL-CHIP
3	11	C3, C33, C68, C71, C74, C82, C85, C93, C100, C101, C111	1206W	0.22UF	CAPACITOR, 25V, X7R, 10%, 1206; GMC31X7R224K25NE, CAL-CHIP 12063C224KAT2A AVX
4	2	C4, C59	TANT_D	100UF	CAPACITOR, 10V, TANT, 10%, SMT_D; TPSD107K010R0100, AVX; T495D107K010AS, KEMET
5	42	C5, C6, C8, C10, C14, C17, C20, C22, C23, C27, C40, C42, C47, C48, C52, C54, C61, C63, C64, C65, C66, C67, C72, C75, C76, C79, C90, C94, C107, C112, C116, C119, C121, C123, C124, C125, C126, C128, C129, C151, C152, C153	0805W	.01UF	CAPACITOR, 50V, X7R, 10%, 0805; GMC21X7R103K50NT, CAL-CHIP
6	1	C7	0805W	10PF	CAPACITOR, 50V, NPO, 5%, 0805; GMC21CG100J50NT, CAL-CHIP
7	1	C11	SUPERCAP	1F	CAPACITOR, 5.5V, ELECT, 20%, RADIAL; FYD0H105Z; TOKIN
8	2	C12, C127	0805W	27PF	CAPACITOR, 50V, NPO, 5%, 0805; GMC21CG270J50NT, CAL-CHIP
9	9	C13, C15, C18, C25, C26, C30, C34, C43, C69	TANT_B	10UF	CAPACITOR, 10V, TANT, 20%, SMT_B; TCMIA106BT, CAL-CHIP; TAJB106M010R, AVX; T491B106M010AS, KEMET
10	1	C21	0805W	18PF	CAPACITOR, 50V, NPO, 5%, 0805; GMC21CG180J50NT, CAL-CHIP
11	2	C28, C50	0805W	.0047UF	CAPACITOR, 50V, X7R, 10%, 0805; GMC21X7R472K50NT, CAL-CHIP
12	2	C32, C88	TANT_A	1UF	CAPACITOR, 16V, TANT, 20%, SMT_A; TCMIC105AT, CAL-CHIP; TAJA105M016R, AVX
13	4	C37, C38, C44, C60	TANT_D	22UF	CAPACITOR, 25V, TANT, 10%, SMT_D; TPSD226M025R0200, AVX; T495D226M025AS, KEMET
14	2	C45, C49	SMT_8X10_8	220UF	CAPACITOR, 35V, ELECT, 20%, RADIAL; NACZ221M35V8X10.8TR13, NIC; 35VCV220GX, SURGE COMPONENTS

#	QTY	REF. Designator	Package	Value	Part Spec
15	2	C51, C53	TANT_D	100UF	CAPACITOR, 10V, TANT, 20%, SMT_D; TCMIA107DT, CAL-CHIP; TAJD107M010R, AVX; T491D107M010AS, KEMET
16	13	C58, C62, C86, C103, C105, C113, C155, C156, C157, C158, C159, C162, C163	0805W	1000PF	CAPACITOR, 50V, NPO, 5%, 0805; GMC21CG102J50NT, CAL-CHIP
17	1	C70	CAP_200MIL	1UF	CERAMIC, 100V, X7R, 10%, LEADED; SR401C105KAA, AVX; RPE114X7R105K100V, MURATA ERIE
18	2	C91, C92	0805W	100PF	CAPACITOR, 50V, NPO, 5%, 0805; GMC21CG101J50NT, CALCHIP
19	1	C102	SMT_10X10_8	330UF	CAPACITOR, 35V, ELECT, 20%, RADIAL; NACZ331M35V10X10.8TRHIL, NIC
20	21	C131, C132, C133, C134, C135, C136, C137, C138, C139, C140, C141, C142, C143, C144, C145, C146, C147, C148, C149, C150, C154	0805W	1000PF	CAPACITOR, 50V, NPO, 5%, 0805;GMC21CG102J50NT, CAL-CHIP
21	2	D1,D23	SMC		CMSH3-60, CENTRAL SEMI; 30BQ060, INTERN. RECTIFIER
22	18	D2,D3,D4,D5,D6, D7,D8,D9,D10,D11, D12,D13,D14,D15, D16,D19,D20,D22	SOT23		MMBD914LT1, MOTOROLA
23	13	FB1,FB2,FB3,FB4, FB5,FB6,FB7, FB10,FB11,FB12, FB13,FB14,FB15	0805W		BLM21A102SPT, MURATA ERIE
24	1	FB8	1206W		BLM31P500SPT, MURATA ERIE
25	1	GL1	GNDLNK		N/A
26	2	J2,J6	4P_059SMTH-DR		B4B-ZR-SM3-TF, JST
27	1	J3	4P_079SMTH-DR		B4B-PH-SM3-TB, JST
28	1	J4	4P_050THHDR		104071-7, AMP
29	2	J5,J13	2P_THJMPR		HTSW-102-06-T-S, SAMTEC
30	1	J7	2PINTH_ TERMBLK		30.870.002 OR 930-T-DS-02, WECO
31	1	J8	8P_050RATH-HDR		53048-0810 molex
32	1	J9	26P_ 079THDRHDR		1306-26-S-02, SINGATRON
33	1	J10	24P_050RATH-DRHDR		1-104069-2, AMP
34	1	J11	11P_059SMTH-DR		B11B-ZR-SM3-TF, JST
35	1	J12	20P_100THH-DR		609-2027, THOMAS & BETTS
36	2	L1, L2	SMT_POT-CORE		DT3316P-473, COILCRAFT
37	1	L3	SMT_POT-CORE		DT3316P-333, COILCRAFT

#	QTY	REF. Designator	Package	Value	Part Spec
38	13	Q1,Q3,Q11,Q12, Q13,Q14,Q21,Q24, Q28,Q29,Q30,Q38, Q42	SOT23		2N7002T1, SILICONIX (TEMIC); CENTRAL SEMICONDUCTOR
39	1	Q2	SO8		MMSF3P02HDR2G, On Semi
40	7	Q4,Q6,Q8,Q10,Q16, Q19,Q41	SOT23		MMBT2222ALT1, MOTOROLA
41	16	Q5,Q7,Q15,Q17, Q18,Q20,Q22,Q26, Q27,Q33,Q34,Q35, Q36,Q37,Q40,Q45	SOT23		TP0610T, Supertex; TP0610T, Vishay SILICONIX (TEMIC) [obsolete]
42	1	R1	1206W	10MOHM	RESISTOR, 1/8W, TCR=400PPM, 5%, 1206; RM12J106CT, CAL-CHIP
43	1	R2	1206W	2.70OHM	RESISTOR, 1/8W, TCR=400PPM, 5%, 1206; RM12J2R7CT, CAL-CHIP; IRC WCR1206
44	4	R3, R16, R17, R125	0805W	2.0KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F2001CT, CAL-CHIP
45	2	R4, R18	1206W	24OHM	RESISTOR, 1/8W, TCR=400PPM, 5%, 1206; RM12J240CT, CAL-CHIP; ERJ-8GEYJ240V, PANA-SONIC
46	12	R5, R8, R14, R19, R28, R37, R87, R162, R168, R182, R185, R186	0805W	1.0KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F1001CT, CAL-CHIP
47	3	R6, R15, R20	2010	0.5OHM	RESISTOR, 1/2W, TCR=100PPM, 1%, 2010; WSL2010R500F, DALE; LR201001R500F, IRC
48	13	R7, R11, R13, R21, R25, R26, R29, R46, R105, R106, R120, R144,R164	0805W	4.99KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F4991CT, CAL-CHIP
49	24	R27, R30, R31, R41, R42, R61, R62, R78, R92, R96, R97, R103, R118, R123, R124, R156, R170, R171, R172, R177, R178, R179, R187	0805W	10KOHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J103CT, CAL-CHIP
50	2	R10, R40	0805W	64.9KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F6492CT, CAL-CHIP
51	8	R12, R43, R75, R93, R115, R141, R143, R149	0805W	15.0KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F1502CT, CAL-CHIP
52	14	R22, R32, R36, R39, R54, R57, R58, R82, R83, R84, R94, R133, R146, R173	0805W	200KOHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J204CT, CAL-CHIP
53	1	R23	0805W	1MOHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J105CT, CAL-CHIP
54	2	R24, R155	0805W	150.0KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F1503CT, CAL-CHIP
55	4	R33, R34, R167, R174	0805W	100OHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J101CT, CAL-CHIP

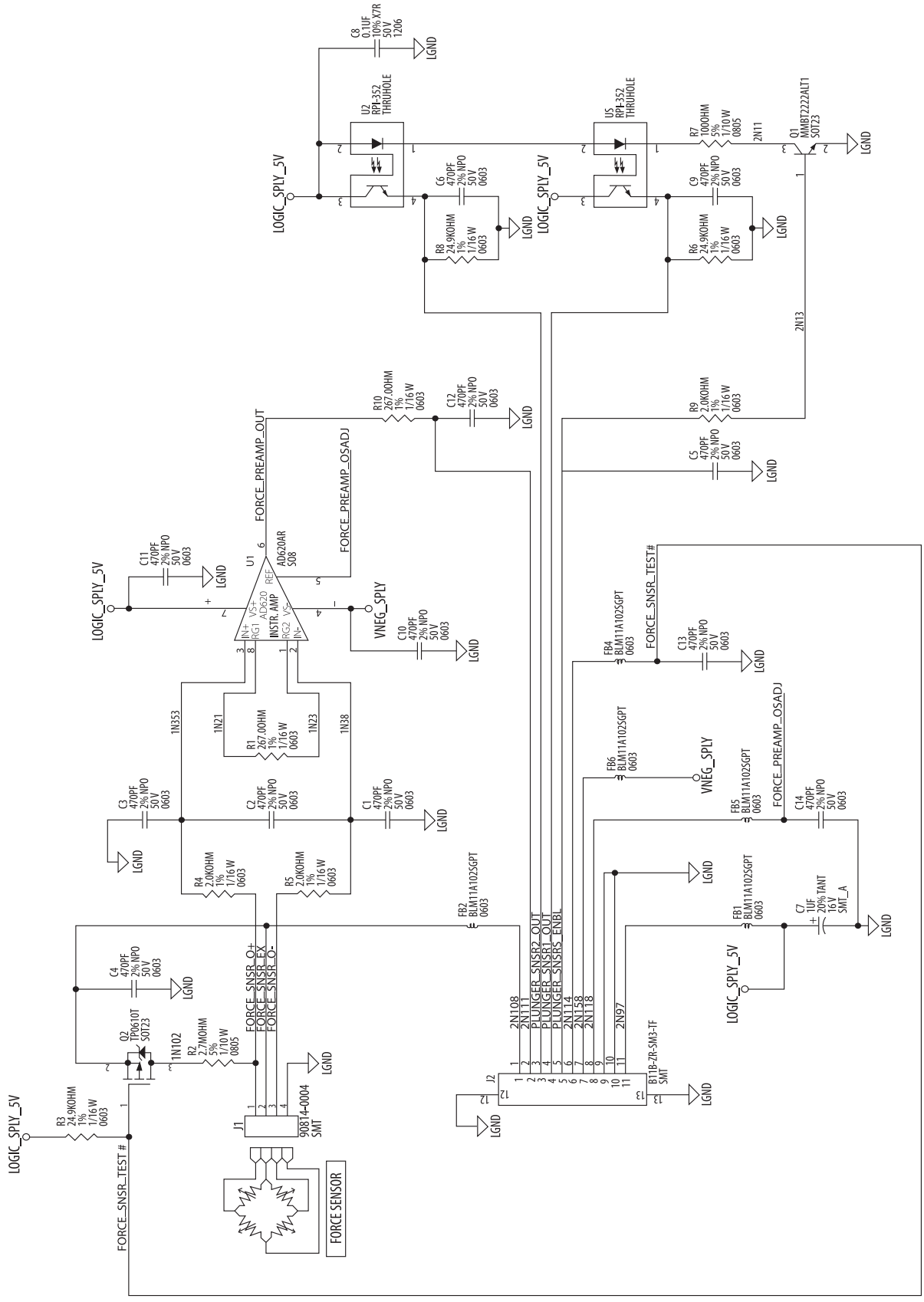
#	QTY	REF. Designator	Package	Value	Part Spec
56	7	R35, R38, R49, R77, R95, R98, R166	0805W	220OHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J221CT, CAL-CHIP
57	7	R44, R104, R126, R140, R145,R169	0805W	20.0KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F2002CT, CAL-CHIP
58	26	R45, R52, R59, R60, R63, R64, R67, R68, R70, R71, R72, R73, R79, R80, R86, R102, R112, R122, R127, R128, R129, R134, R135, R175	0805W	1KOHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J102CT, CAL-CHIP
59	12	R47, R55, R66, R74, R85, R99, R101, R108, R137, R152, R153	0805W	120KOHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J124CT, CAL-CHIP
60	4	R48, R91, R147, R151	0805W	10.0KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F1002CT, CAL-CHIP
61	1	R50	0805W	649.0OHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F6490CT, CAL-CHIP
62	2	R51, R109	0805W	2.2MOHM	RESISTOR, 1/10W, TCR=400PPM, 5%, 0805; RM10J225CT, CAL-CHIP
63	8	R53, R107, R138, R139, R154, R157, R158, R159	0805W	160OHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J161CT, CAL-CHIP
64	5	R56, R65, R69, R117, R148	0805W	47KOHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J473CT, CAL-CHIP
65	6	R76, R116, R142, R161, R181, R136	0805W	40.2KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F4022CT, CAL-CHIP
66	2	R81, R100	0805W	825.0OHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F8250CT, CAL-CHIP
67	2	R110, R132	0805W	27KOHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J273CT, CAL-CHIP
68	1	R111	0805W	392.0KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F3923CT, CAL-CHIP
69	1	R113	0805W	51OHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J510CT, CAL-CHIP
70	3	R119, R131, R165	0805W	49.9KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F4992CT, CAL-CHIP
71	1	R150	0805W	24.9KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F2492CT, CAL-CHIP
72	1	R160	0805W	475.0OHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F4750CT, CAL-CHIP

#	QTY	REF. Designator	Package	Value	Part Spec
73	412	TP1, TP2, TP3, TP4, TP5	TESTPOINT		N/A
74	2	TVS15, TVS16	0805W		VC080505A150, AVX
75	5	U1,U14,U23, U28, U42	TSSOP8		OP296HRU, ANALOG DEVICES
76	2	U2, U4	SO8		AT25256AN-10SU-2.7, Atmel; M95256-WMN6TP ST Microelectronics; M95256-WMN6-TGST Microelectronics
77	2	U3, U33	44PLCC		CS82C55A, HARRIS/INTERSIL; MSM82C55A-2VJS, OKI
78	1	U5	TSSOP14		SN74AHC00PWR, TEXAS INSTR
79	2	U6, U41	TSSOP20		SN74AHC541PWR, TEXAS INSTR
80	1	U7	SO8		LM2936M-5.0; NATIONAL SEMI
81	1	U8	SSOP8		RS5C316B, RICOH
82	1	U9	SO8		AD623AR, ANALOG DEVICES
83	3	U10, U27, U30	SOT23-5		LMC7111BIM5, NATIONAL SEMICONDUCTOR; MIC7111BM5, MICREL
84	1	U11	TSSOP14		SN74ACH125PWR, TEXAS INSTR
85	2	U12, U34	SO8		LT1372CS8, LINEAR TECH
86	1	U13	SO16		TLV1544CD, TEXAS INSTR
87	1	U16	TO236AB		LM4040DIM3-4.1, NATIONAL SEMICONDUCTOR, MICREL SEMICONDUCTOR
88	1	U17	SOP28		TC55257DFL85L, TOSHIBA; TC55257DFL70L, TOSHIBA; M5M5256DFP-70LL, Mitsubishi; LH52256CN-70LL, Sharp
89	2	U18, U37	SOT23-5		LMC7211AIM5, NATIONAL SEMICONDUCTOR; MIC7211BM5, MICREL
90	1	U19	84PLCC_SKT		68HC11K1CFN4 OR 68HC11K0CFN4, MOTOROLA
91	1	U20	SO8		MAX522CSA, MAXIM
92	1	U21	SOT223		LT1121CST-5, LINEAR TECH
93	1	U22	32TSOP		AT29C040A-12TU Atmel
94	1	U24	TSSOP16		SN74AHC138PWR, TEXAS INSTR
95	1	U25	SO14		MC74HC4066AD, OnSemi; SN74HC4066PW, TEXAS INSTR
96	2	U26, U35	SO16W		A3953SLB, ALLEGRO
97	1	U29	SO6		SFH9201-2/3, Osram (***Smiths Medical catalog number G6000157***)
98	1	U31	SO8		LM386M-1, NATIONAL SEMICONDUCTOR; NJM386BM, NEW JAPAN RADIO
99	1	U32	TSSOP20		SN74AHC573PWR, TEXAS INSTR

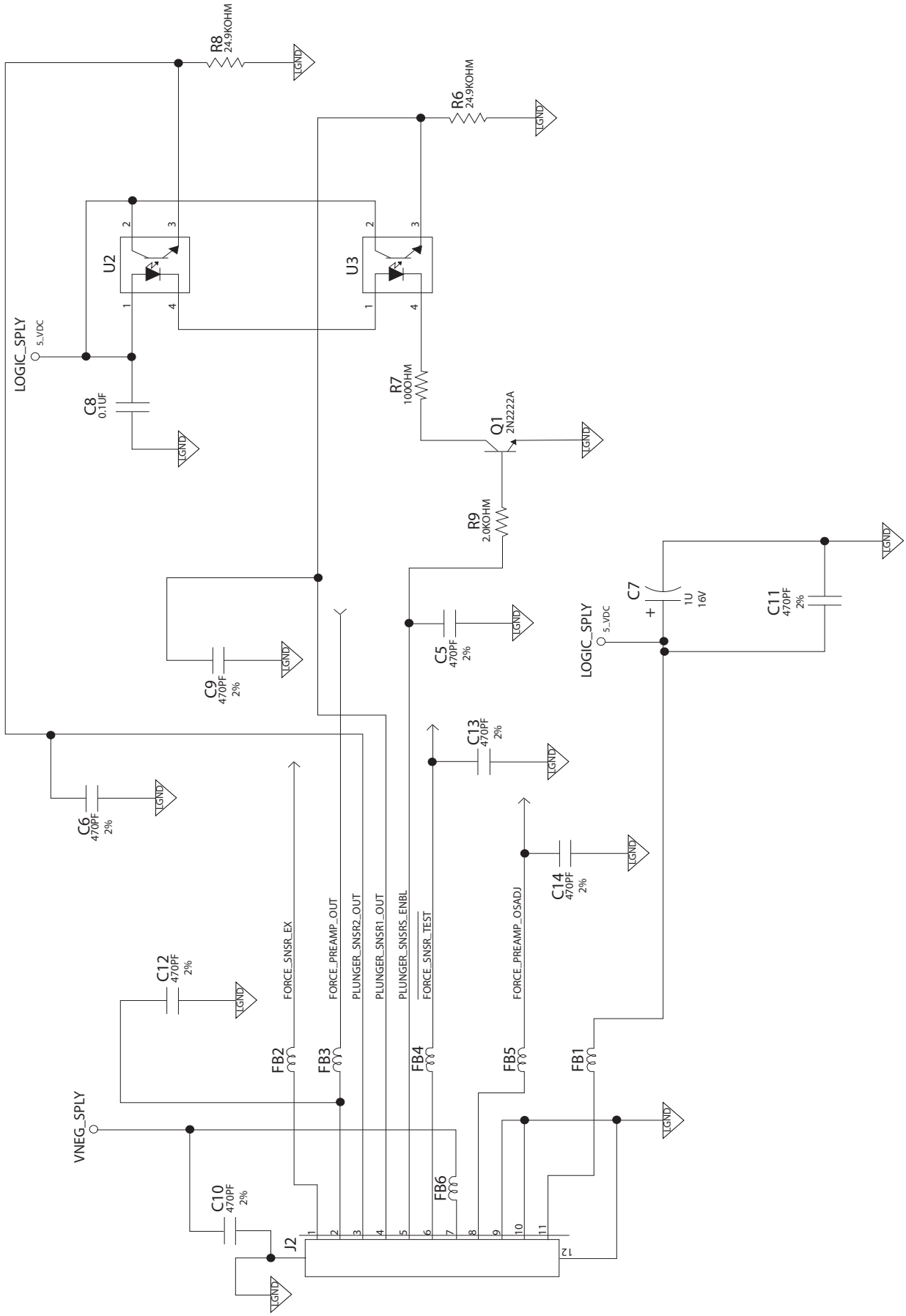
#	QTY	REF. Designator	Package	Value	Part Spec
100	1	U36	SSO8		MAX865EUA, MAXIM
101	1	U38	SOT23		MAX6326UR31-T, MAXIM
102	1	U39	SO8W		PIC12C50804/SM, MICROCHIP (programmed)
103	1	U40	SO8		LM393M, NATIONAL SEMI; LM393D, TEXAS INSTR
104	1	U43	SOT23		MAX809LEURT, MAXIM; ADM-809LART, ANALOG DEVICES
105	1	U44	TO236AB		LM4040BIM3-4.1, NATIONAL SEMI
106	1	U45	SOT23-5		SN74AHC1G14DBVR, TEXAS INSTR
107	1	U46	SO16		MC74HC174AD, MOTOROLA; SN74HC174D, TEXAS INSTR.; 74HC174D, PHILIPS; M74H-C174M1R, SGS
108	1	X1	SMT_32KHZX-TAL	32KHZ	MC306-32.768KA-E3, EP-SON; ECPSM29T-32.768KTR, ECLIPTEK; SX1555-32.768KT/R, MTRON
109	1	X2	SMT_16MHZX-TAL	16MHZ	EC2SM 16.000MHZ T&R, ECLIPTEK
110	1	X3	SMT_455KHZ-XTAL	455KHZ	CSBFB455KJ58-R1, MURATA ERIE
111	1	XD1	TH_BUZZER		HMB-06, STAR MICRONIX (***Smiths Medical catalog number 6940000100***)
112	1	PCB	N/A		RAW, PRINTED CIRCUIT BOARD
113	1	PRESS_IN NUT	N/A		PRESS-IN NUT , 2-56 THREAD, 0.219" DIA., STAINLESS STEEL; P/N 4860, KEYSTONE; KFS2-256, PEM
114	1	U15	TSSOP8		OP727ARU Analog Devices
115	1	R121	0805W	1.37KOHM	CRCW08051371F50 Vishay, RK-73GC2ATTD1371F KOA
116	2	R9, R89	0805W	4.7KOHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; CRCW0805472J, Vishay Dale; RK73B2ATTD472J KOA Speer
117	1	R88	0805W	130OHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; CRCW0805131JRT6, Vishay Dale; RK73B2ATTD131J KOA Speer
118	1	R90	0805W	18KOHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; CRCW0805183J, Vishay Dale; RK73B2ATTD183J KOA Speer

Plunger Board Schematic

Plunger Board / Force Preamplifier

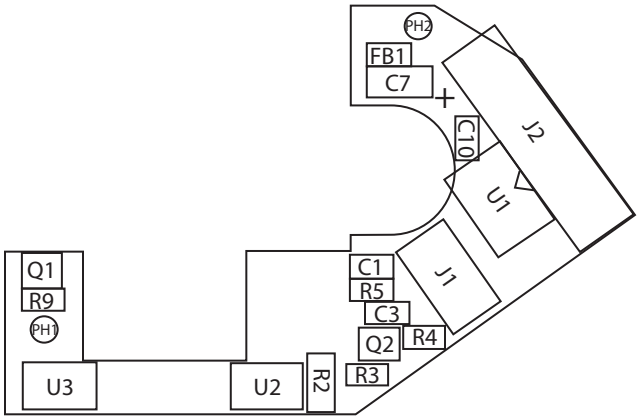


Plunger Board / Flipper Sensor

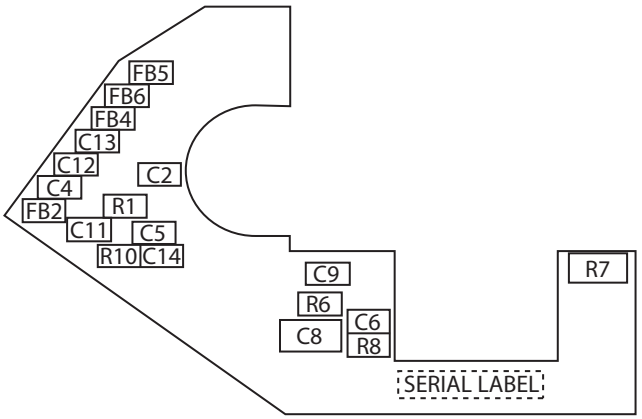


Plunger Board Assembly Drawing

Top Side:



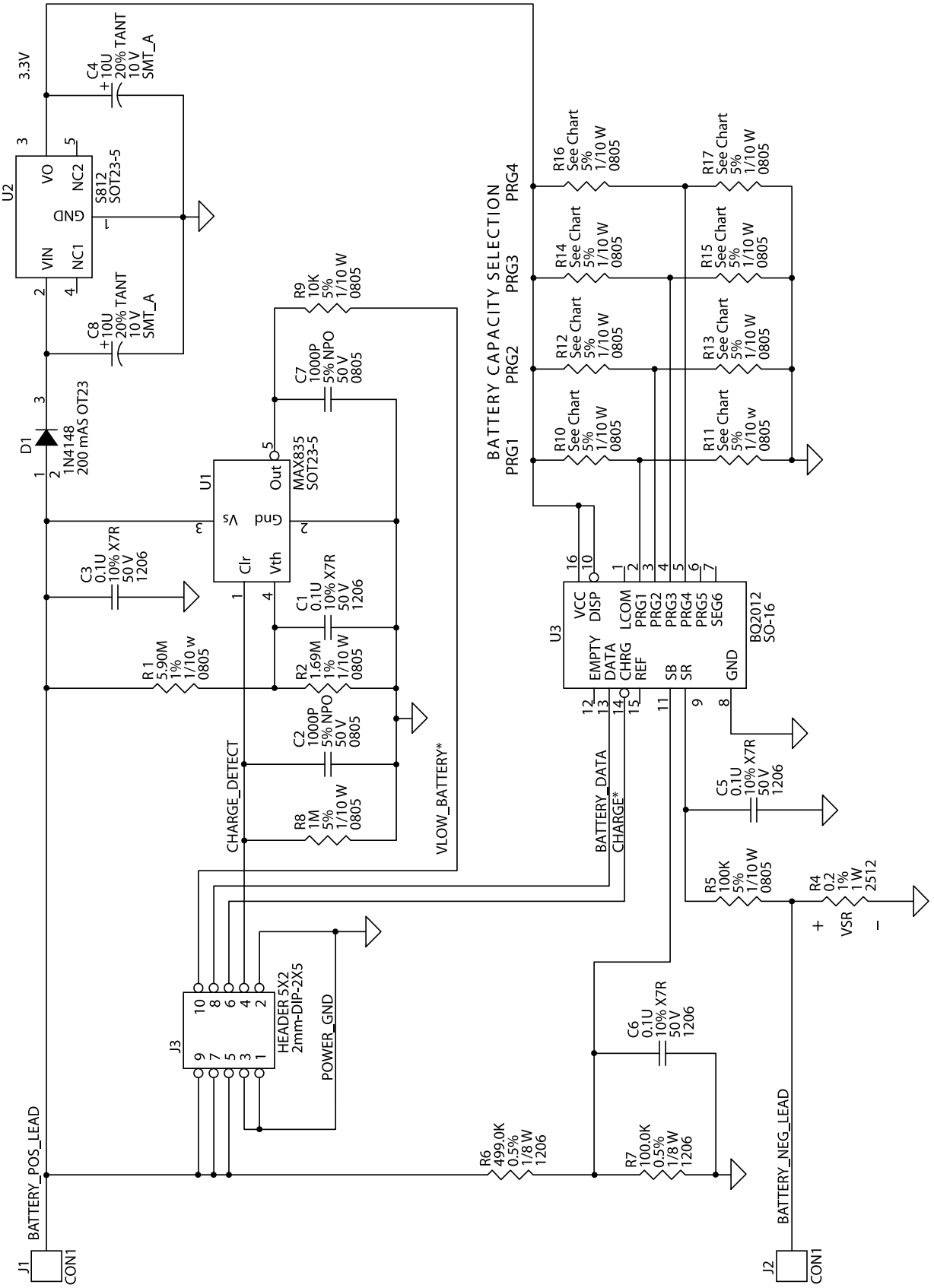
Bottom Side:



Plunger Board Assembly – Parts list

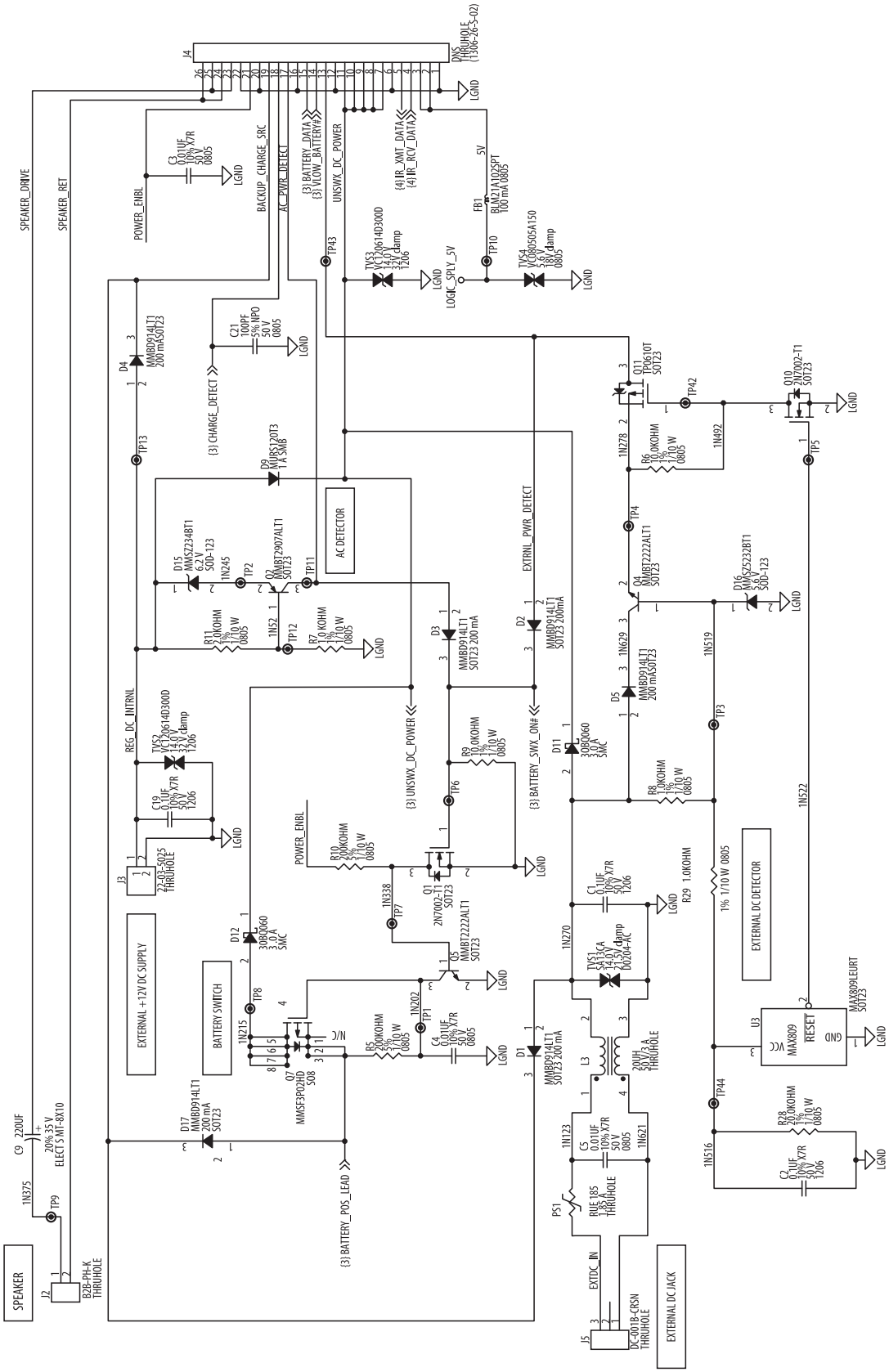
#	QTY	REF. Designator	Package	Value	Part Spec
1	12	C1, C2, C3, C4, C5, C6, C9, C10, C11, C12, C13, C14	0603	470PF	CERAMIC, 50V, NP0, 2%, 0603; GMC10CG471G50NT, CAL-CHIP
2	1	C7	TANT_A	1U	CAPACITOR, 16V, TANT, 20%, SMT_A; TCMIC105AT, CAL-CHIP; TAJA105M016R, AVX
3	1	C8	1206	0.1UF	CAPACITOR, 50V, X7R, 10%, 1206; GMC31X7R104K50NT, CAL-CHIP 12065C104KAT2A; AVX
4	5	FB1, FB2, FB4, FB5, FB6	0603		BLM11A102SGPT, MURATA ERIE
5	1	J1	4PINSMTHDR_WBOSS		90814-0004, MOLEX
6	1	J2	11PIN_1_5MMSMTHDR		B11B-ZR-SM3-TF, JST
7	1	Q1	SOT23		MMBT2222ALT1, ON SEMICONDUCTOR; CMPT 2222ATR or TR13 CENTRAL SEMICONDUCTOR
8	1	Q2	SOT23		TP0610T, Supertex, Vishay Silconix (TEMIC) - (obsolete)
9	2	R1, R10	0603	267.0OHM	RESISTOR, 1/16W, TCR=100PPM, 1%, 0603; RM06F2670CT, CAL-CHIP
10	1	R2	0805	2.7MOHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J275CT, CAL-CHIP
11	3	R3, R6, R8	0603	24.9KOHM	RESISTOR, 1/16W, TCR=100PPM, 1%, 0603; RM06F2492CT, CAL-CHIP
12	3	R4, R5, R9	0603	2.0KOHM	RESISTOR, 1/16W, TCR=100PPM, 1%, 0603; RM06F2001CT, CAL-CHIP
13	1	R7	0805	100OHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J101CT, CAL-CHIP
14	1	U1	SO8		LT1167CS8, LINEAR TECHNOLOGY; AD620AR, ANALOG DEVICES
15	2	U2, U3	RPI_LEADEDOPTO		RPI-352, ROHM
16	1	PCB	N/A		PCB RAW

Battery Gauge Schematic

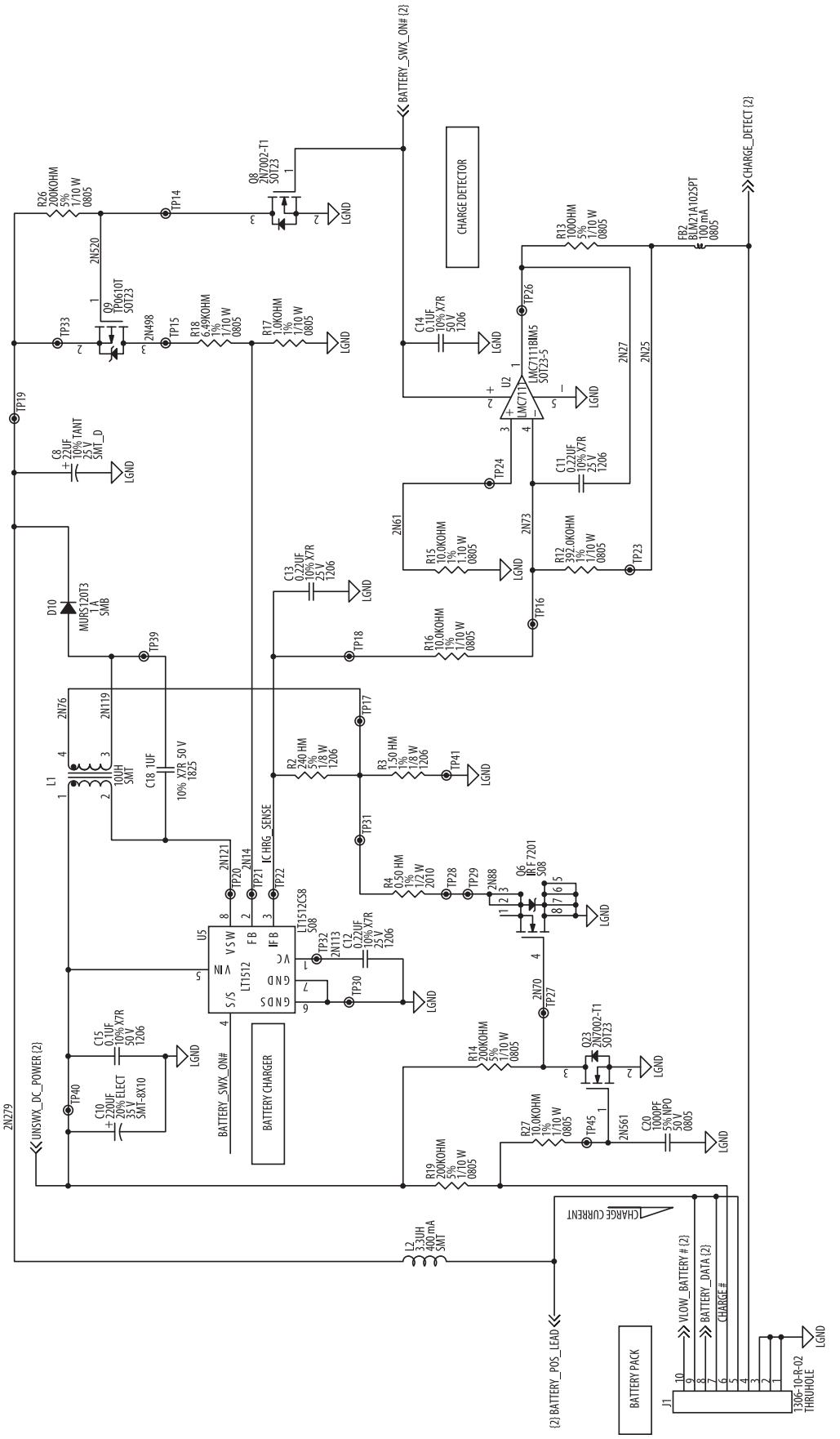


Interconnect Board Schematic

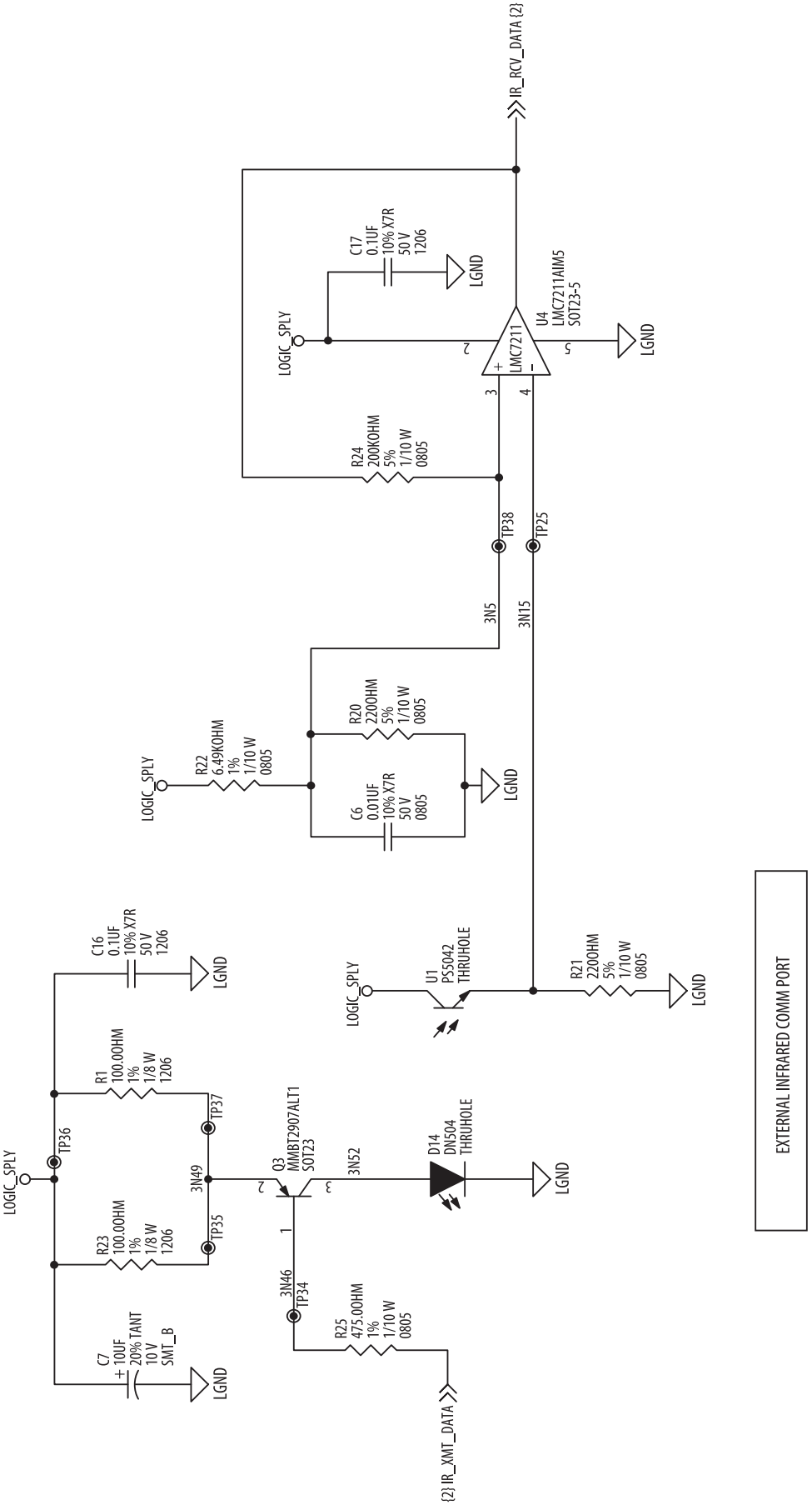
Interconnect Board / Power Control



Interconnect Board / Battery Management

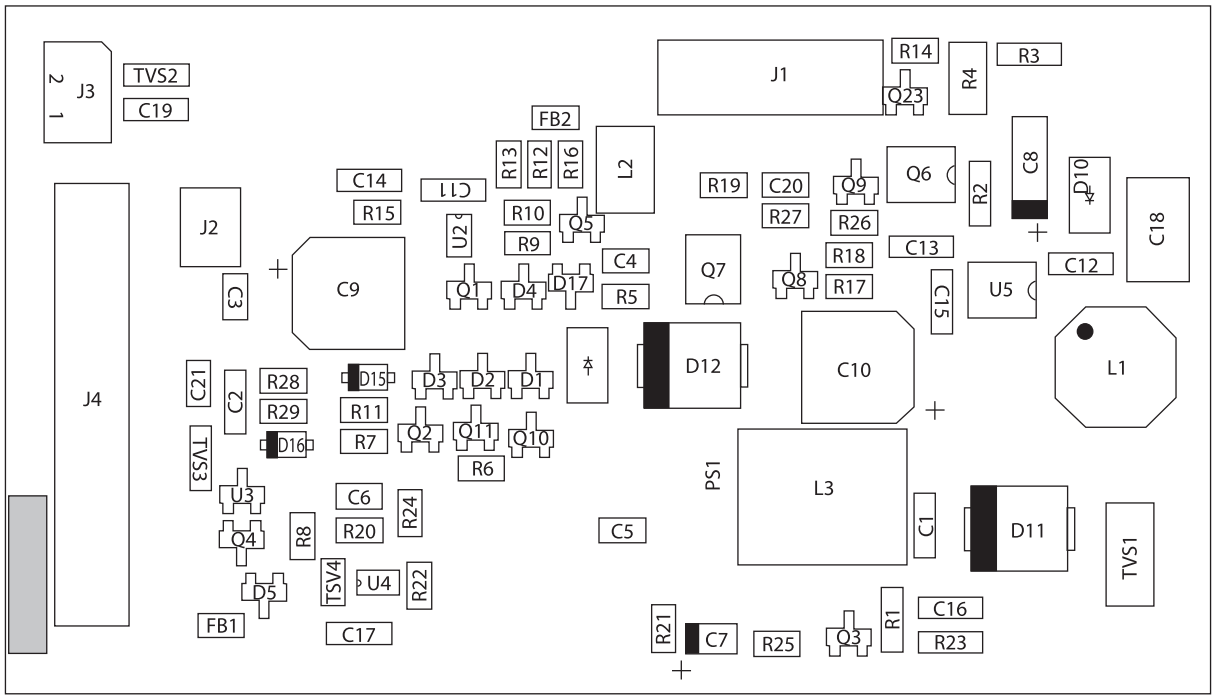


Interconnect Board / Infrared Serial Communications

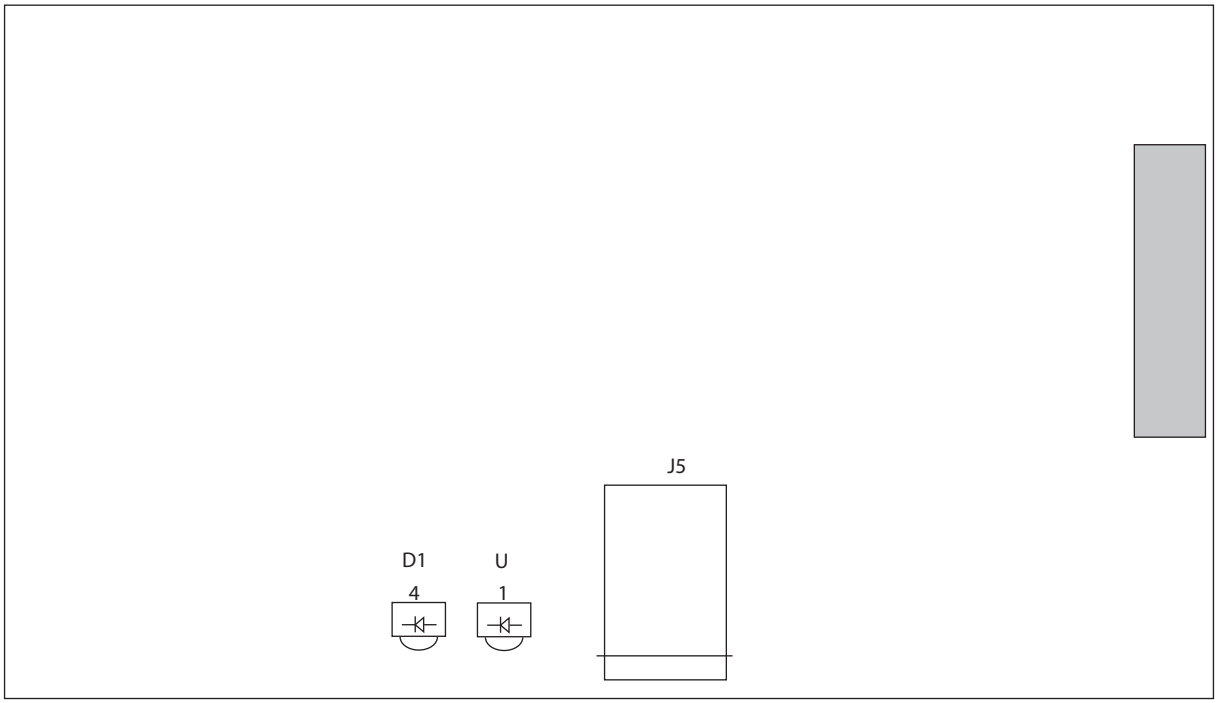


Interconnect Board Assembly Drawing

Top Side:



Bottom Side:



Interconnect board assembly – parts list

#	QTY	REF. Designator	Package	Value	Part Spec
1	7	C1,C2,C14,C15,C16, C17,C19	1206W	0.1UF	CAPACITOR, 50V, X7R, 10%, 1206; GMC31X7R104K50NT, CAL-CHIP
2	4	C3, C4, C5, C6	0805W	.01UF	CAPACITOR, 50V, X7R, 10%, 0805; GMC21X7R103K50NT, CAL-CHIP
3	1	C7	TANT_B	10UF	TCMIA106BT, CAL-CHIP; TAJB106M010R, AVX; T491B-106M010AS, KEMET
4	1	C8	TANT_D	22UF	CAPACITOR, 25V, TANT, 10%, SMT_D; TPSD226M025R0200, AVX; T495D226M025AS, KEMET
5	2	C9, C10	SMT_8X10_8	220UF	CAPACITOR, 35V, ELECT, 20%, RADIAL; NACZ221M35V8X10.8TR13, NIC; 35VCV220GX, SURGE COMPONENTS
6	3	C11, C12, C13	1206W	0.22UF	CAPACITOR, 25V, X7R, 10%, 1206; GMC31X7R224K25NE, CAL-CHIP
7	1	C18	1825	1UF	CERAMIC, 1UF, 50V, X7R, 10%, 1825; GMC45X7R105K50NT, CAL-CHIP
8	1	C20	0805W	1000PF	CAPACITOR, 50V, NPO, 5%, 0805; GMC21CG102J50NT, CAL-CHIP
9	1	C21	0805W	100PF	CAPACITOR, 50V, NPO, 5%, 0805; GMC21CG101J50NT, CALCHIP
10	6	D1, D2, D3, D4, D5, D17	SOT23		MMBD914LT1, MOTOROLA
11	2	D9, D10	SMB_X		MURS120T3, MOTOROLA; CMR1U-02, CENTRAL SEMICONDUCTOR
12	2	D11,D12	SMC		CMSH3-60, CENTRAL SEMI; 30BQ060, INTERN. RECTIFIER
13	1	D14	LEADED_IR		DN504, STANLEY
14	1	D15	SOD-123	6.2V	MMSZ5234BT1, MOTOROLA
15	1	D16	SOD-123	5.6V	MMSZ5232BT1, MOTOROLA
16	2	FB1,FB2	0805W		BLM21A102SPT, MURATA ERIE
17	1	J1	10P_079RATH-HDR		1306-10-R-02, SINGATRON
18	1	J2	2P_079THHDR		B2B-PH-K, JST
19	1	J3	2P_100THHDR		22-03-5025, MOLEX
20	1	J4	Cable 26 pin		12121-09-A, Singatron
21	1	J5	DC_JACK		DC-001-B-CRSN, POWER DYNAMICS
22	1	L1	SMT_TOROID	10U	10UH, +/-20%, SMT TOROID; CTX10-1, COILTRONIX; 618-100M-01, C&K MAGNETICS

#	QTY	REF. Designator	Package	Value	Part Spec
23	1	L2	SMT_INDUC-TOR1	3.3UH	NL453232-3R3K, CAL-CHIP; IMC-1812 3.3UH 10%, DALE
24	1	L3	TH_10MMX7_5MM		PLT2003C, MURATA ERIE
25	1	PS1	POLYSWX_RA-DIAL		RUE185, RAYCHEM
26	4	Q1, Q8, Q10, Q23	SOT23		2N7002-T1, TEMIC; CENTRAL SEMICONDUCTOR
27	2	Q2, Q3	SOT23		MMBT2907ALT1, MOTOROLA
28	2	Q4, Q5	SOT23		MMBT2222ALT1, MOTOROLA
29	1	Q6	SO8		IRF7201, INTERN. RECTIFR; SI9410DY, TEMIC
30	1	Q7	SO8		MMSF3P02HD,MOTOROLA; SI9430DY,SILICONIX (TEMIC)
31	2	Q9, Q11	SOT23		TP0610T, Supertex, Vishay SILI-CONIX (TEMIC) (Obsolete)
32	2	R1, R23	1206W	100.0OHM	RESISTOR, 1/8W, TCR=100PPM, 1%, 1206; RM10F1000CT, CAL-CHIP
33	1	R2	1206W	24OHM	RESISTOR, 1/8W, TCR=400PPM, 5%, 1206; RM12J240CT, CAL-CHIP; ERJ-8GEYJ240V, PANA-SONIC
34	1	R3	1206W	1.5OHM	RESISTOR, 1/8W, TCR=400PPM, 1%, 1206; ERJ8RQF1R5V, PANA-SONIC; RM12F1R5CT, CAL-CHIP; WCR12062R49F, IRC
35	1	R4	2010	0.5OHM	RESISTOR, 1/2W, TCR=100PPM, 1%, 2010; WSL2010R500F, DALE; LR2010001R500F, IRC
36	6	R5, R10, R14, R19, R24, R26	0805W	200KOHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J204CT, CAL-CHIP
37	5	R6, R9, R15, R16, R27	0805W	10.0KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F1002CT, CAL-CHIP
38	4	R7, R8, R17, R29	0805W	1.0KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F1001CT, CAL-CHIP
39	1	R11	0805W	2.0KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F2001CT, CAL-CHIP
40	1	R12	0805W	392.0KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F3923CT, CAL-CHIP
41	1	R13	0805W	100OHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J101CT, CAL-CHIP
42	2	R18, R22	0805W	6.49KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F6491CT, CAL-CHIP

#	QTY	REF. Designator	Package	Value	Part Spec
43	2	R20, R21	0805W	220OHM	RESISTOR, 1/10W, TCR=200PPM, 5%, 0805; RM10J221CT, CAL-CHIP
44	1	R25	0805W	475.0OHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F4750CT, CAL-CHIP
45	1	R28	0805W	20.0KOHM	RESISTOR, 1/10W, TCR=100PPM, 1%, 0805; RM10F2002CT, CAL-CHIP
46	1	TVS1	DO_204AC		SA13CA, On Semiconductor SA13CA Vishay Semiconductor
47	2	TVS2, TVS3	1206W		VC120614D300D, AVX
48	1	TVS4	0805W		VC080505A150, AVX
49	1	U1	LEADED_IR		PS5042, STANLEY
50	1	U2	SOT23-5		LMC7111BIM5, NATIONAL SEMICONDUCTOR; MIC7111BM5, MICREL
51	1	U3	SOT23		MAX809LEURT, MAXIM; ADM809LART, ANALOG DEVICES
52	1	U4	SOT23-5		LMC7211AIM5, NATIONAL SEMICONDUCTOR; MIC7211BM5, MICREL
53	1	U5	SO8		LT1512CS8, LINEAR TECH
54	1	PCB	N/A		INTERCONNECT PCB RAW, Medfusion® 3000 Series

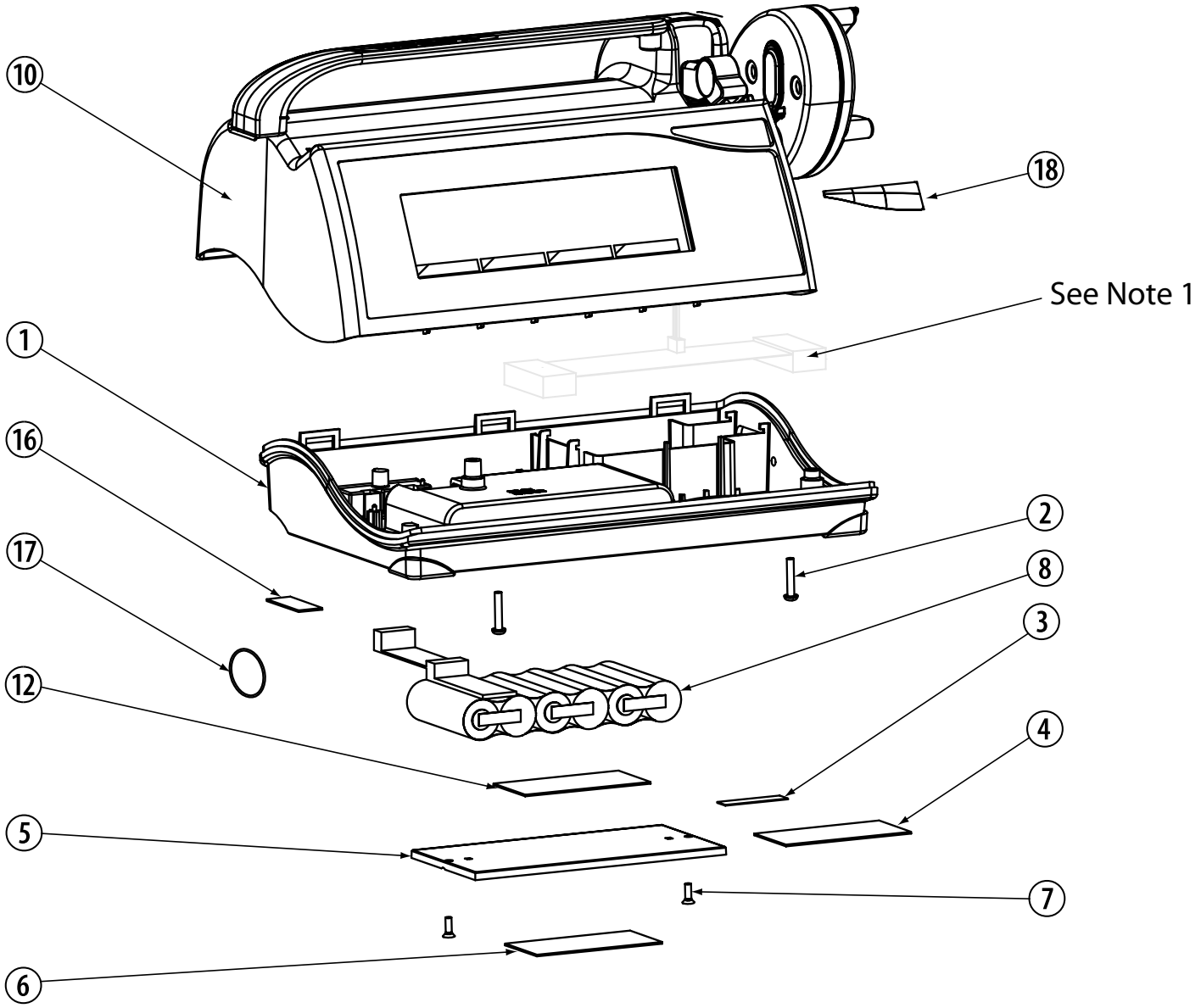
Assembly drawings

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® 3000 Series pump.

Note: *Part numbers and pricing are subject to change without notice. See the website at www.smiths-medical.com.*

Medfusion® 3000 series main pump assembly



Medfusion® 3000 series main pump assembly – parts list

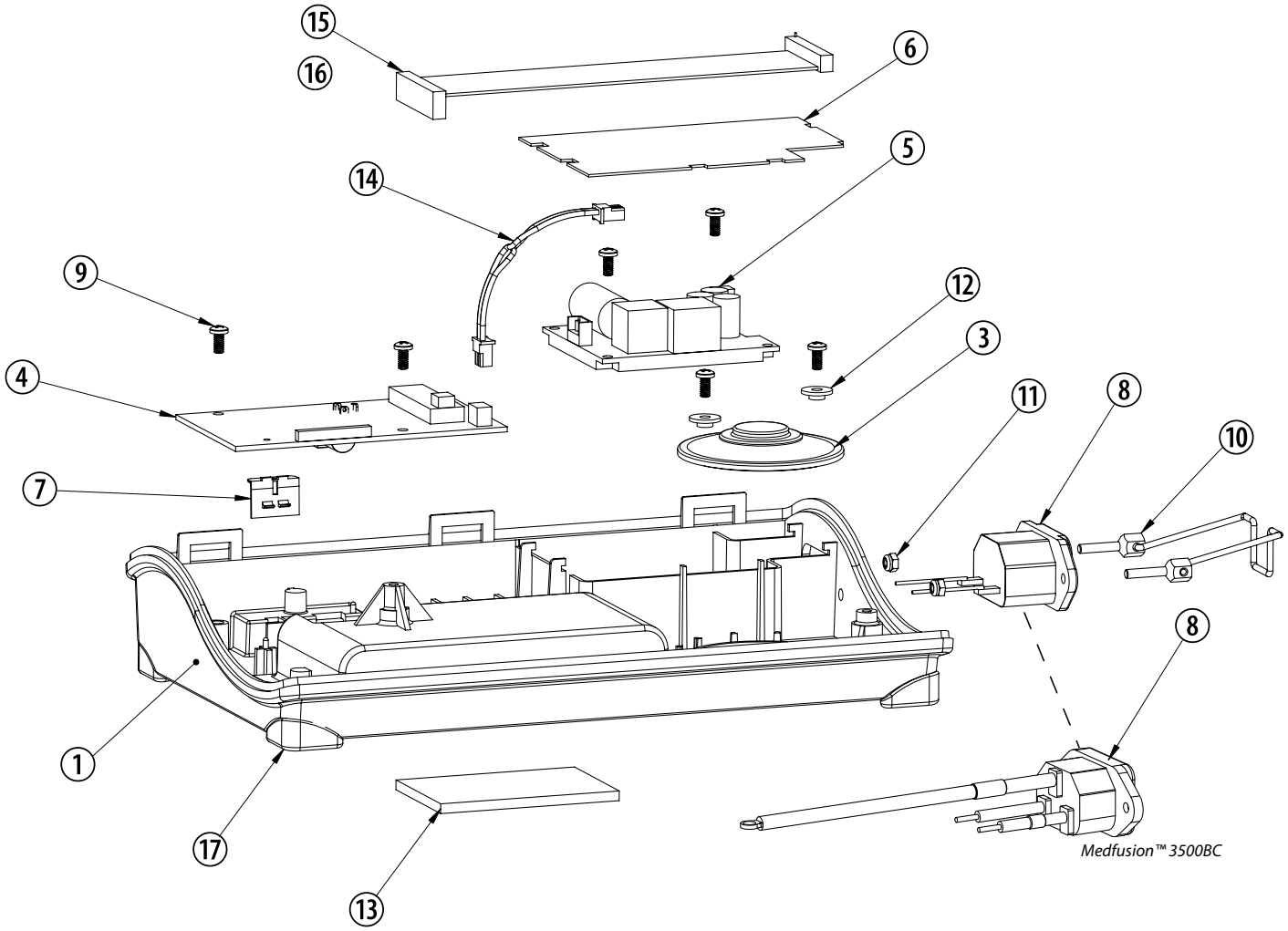
Ref. #	Part Number	Description	Quantity
1	See following drawing	Assembly Case Bottom	1 ea.
2	G6000059	Screw, 4-40 × .62 PH Phillips	2 ea.
3	No longer required	Label, Device Tracking	1 ea.
4	G6000775	Label, Warning	1 ea.
	G6000763	Label, Warning, CE Mark	1 ea.
	G6000354	Label, Warning, German	1 ea.
5	G6000112	Door, Battery Bay	1 ea.
6	G6002083	Label, Serial Number (Blank)	1 ea.
7	G6000117	Screw 4-40 × .31 FH SS	2 ea.
8	G6001392	Battery Assy, 3000	1 ea.
10	See following drawing	Assembly Case Top w/Plunger Head	1 ea.
12	G6000979	Label, Battery Warning	1 ea.
16	See note 2	Label, Date of Manufacture	1 ea.
17	G6000418	Label, MRI Warning	1 ea.
	G6000623	Label, MRI Warning, German	1 ea.
	G6000631	Label, MRI Warning, Spanish	1 ea.
18	G6000142	Label, Protege Logo	1 ea.
	G6000541	Label, Medfusion® 3010A Logo	1 ea.
	G6000605	Label, Medfusion® 3500 Logo	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 changes yearly. Please specify the manufacturing year shown on your pump when communicating with the Service Center.

Case bottom assembly



Case bottom assembly – parts list

See also case bottom service assembly, note 4 below.

To obtain replacement labels with the CE mark and national language, international customers must order the International Case Bottom Assy. See note 4 below.

Ref. #	Part Number	Description	Quantity
1	G6000094	Case Bottom - No Feet (See note 4)	1 ea.
	G6000754	Case Bottom - With Feet (See note 4)	1 ea.
3	G6000014	Speaker Assembly	1 ea.
4	G6000312	PCB Assembly, Interconnect (see note 6)	1 ea.
5	G6000773	Power Supply, Conformal Coated	1 ea.
6	G6000016	Shield, Power Supply	1 ea.
7	G6000017	Lens, IR Window	1 ea.
8	G6000276	Cable, AC Power	1 ea.
	G6000102	Cable, AC Power, Medfusion® 3500E	1 ea.
	G6000695	Cable, AC Power, Medfusion® 3500BC (See note 9)	1 ea.
9	G6000693	Screw, 4-40 × .31 PH Phillips	6 ea.
10	G6000220	Clamp, Cord Retainer	1 ea.
11	G6000192	Locknut, 6BA Nylock	2 ea.
12	G6000410	Washer, Shoulder, Nylon	2 ea.
13	G6000118	Pad, Battery Bay	1 ea.
14	G6000012	Cable, DC Power	1 ea.
15	G6000387	Cable	1 ea.
16	0340IF1400	Solder	
17	G6000706	Feet, Rubber (glue type) (See note 5) (See note 7)	4 ea.
18	G6000694	Label, Functional Ground (See note 8)	1 ea.

Notes:

1. *In newer assemblies, the interconnect PCB assembly (item 4) P/N G6000312 has superseded the older assembly P/N G6000234.*

2. *In older assemblies, items 10 & 11 are Screw, 4-40 × .38 FH SS (G6000127) and Nut, 4-40 Nylock (G6000043).*

3. *In newer assemblies, the shoulder washer (item 12) has superseded the flat washer, Smiths Medical P/N G6000058.*

4. *Items 1, 17 (four pieces), 7, 13 and labels are available as a service subassembly part number:*

English: *G6000438, Case Bottom Assembly – Service (USA)*

International: *G6000622, Case Bottom Assy German – Service*

5. *Use with Loctite® 401, part number 036LT40100.*

Notes (continued):

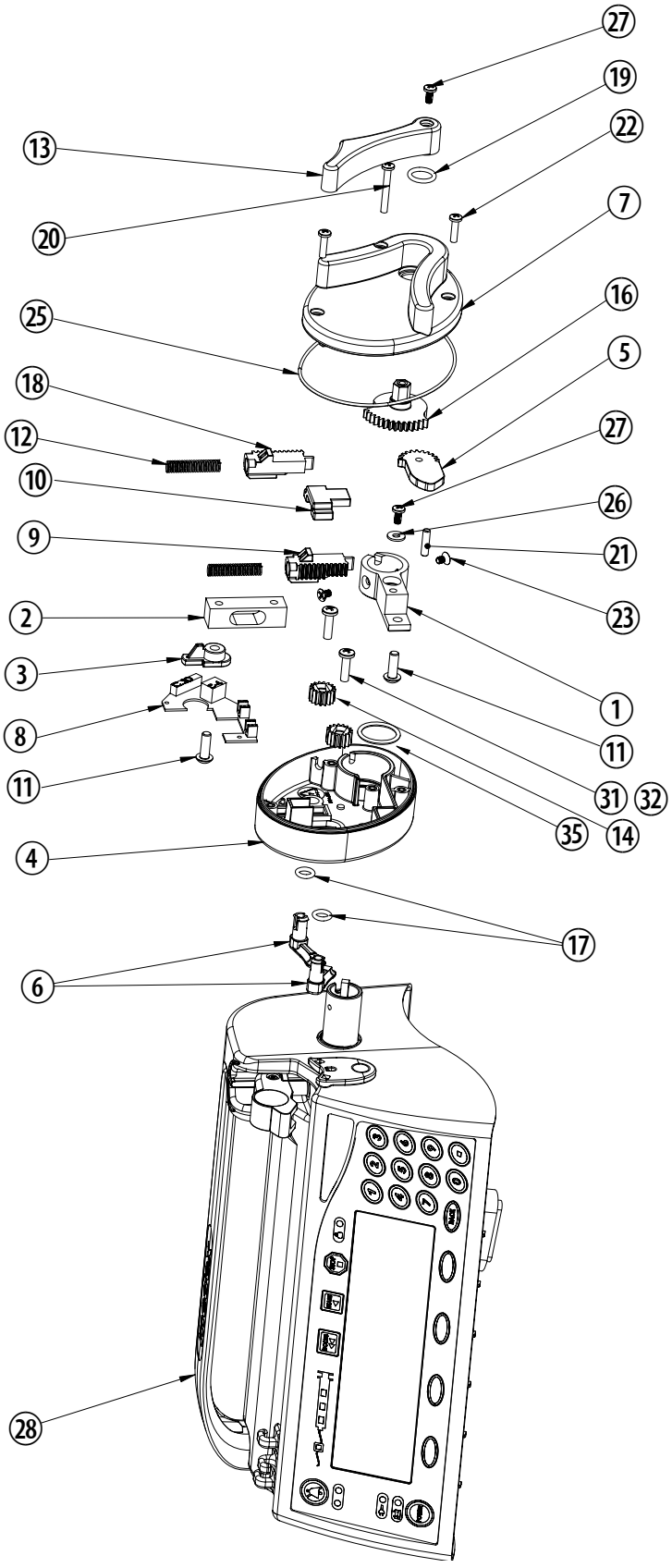
6. Board comes with cable (#G6000387) attached.

7. Older models use Enlarged rubber foot (#G6000287).

8. Item 18 is adhered to the top of the AC power cable.

9. Item 8 ring terminal is secured at secondary-side mounting post of power supply.

Case top assembly w/plunger



Case top assembly w/plunger – parts list

See also plunger case left service assembly, note 1 below.

Ref. #	Part Number	Description	Quantity
1	G6000067	Mount, Plunger Head	1 ea.
2	G6000068	Force Sensor	1 ea.
3	G6000069	Plate, Plunger Float	1 ea.
4	G6000755	Case Left, Plunger (See note 1)	1 ea.
5	G6000071	Cam Gear, Plunger	1 ea.
6	G6000725	Flipper, Plunger	2 ea.
7	G6000074	Case Right Plunger	1 ea.
8	G6000180	Assy PCB Plunger, Tested Service	1 ea.
9	G6000925	Timing Plate Left	1 ea.
10	G6000926	Push Block	1 ea.
11	G6000085	Screw, M4 × 12, Button Head	2 ea.
12	G6000086	Spring, .21 OD × 1.5	2 ea.
13	G6000669	Lever, Plunger	1 ea.
14	G6000089	Gear, Plunger Flipper	2 ea.
16	G6000087	Gear, Plunger Lever	1 ea.
17	G6000082	Seal, Flipper	2 ea.
18	G6000927	Timing Plate Right	1 ea.
19	G6000083	Seal, Lever	1 ea.
20	G6000103	Screw 4-40 × ⅞ Pan Phil SS	1 ea.
21	G6000110	Pin, Dowel	1 ea.
22	G6000105	Screw, 4-40 × $^{7}/_{16}$ Pan Phil SS	2 ea.
23	G6000749	Screw, 4-40 × .18 FH SS	2 ea.
25	G6000090	Seal, Plunger Case	1 ea.
26	G6000474	Washer, Flat #4, SS	1 ea.
27	G6000693	Screw, Pan Phil, 4-40 1/4 SS	2 Ea.
28	See following drawing	Assy, Case Top w/o Plunger	1 ea.
31	G6000544	Screw, 6-19 × ½ (See note 3)	2 ea.
32	G232100076	Loctite Black Max	
35	G6001656	O-ring (See note 2)	1 ea.

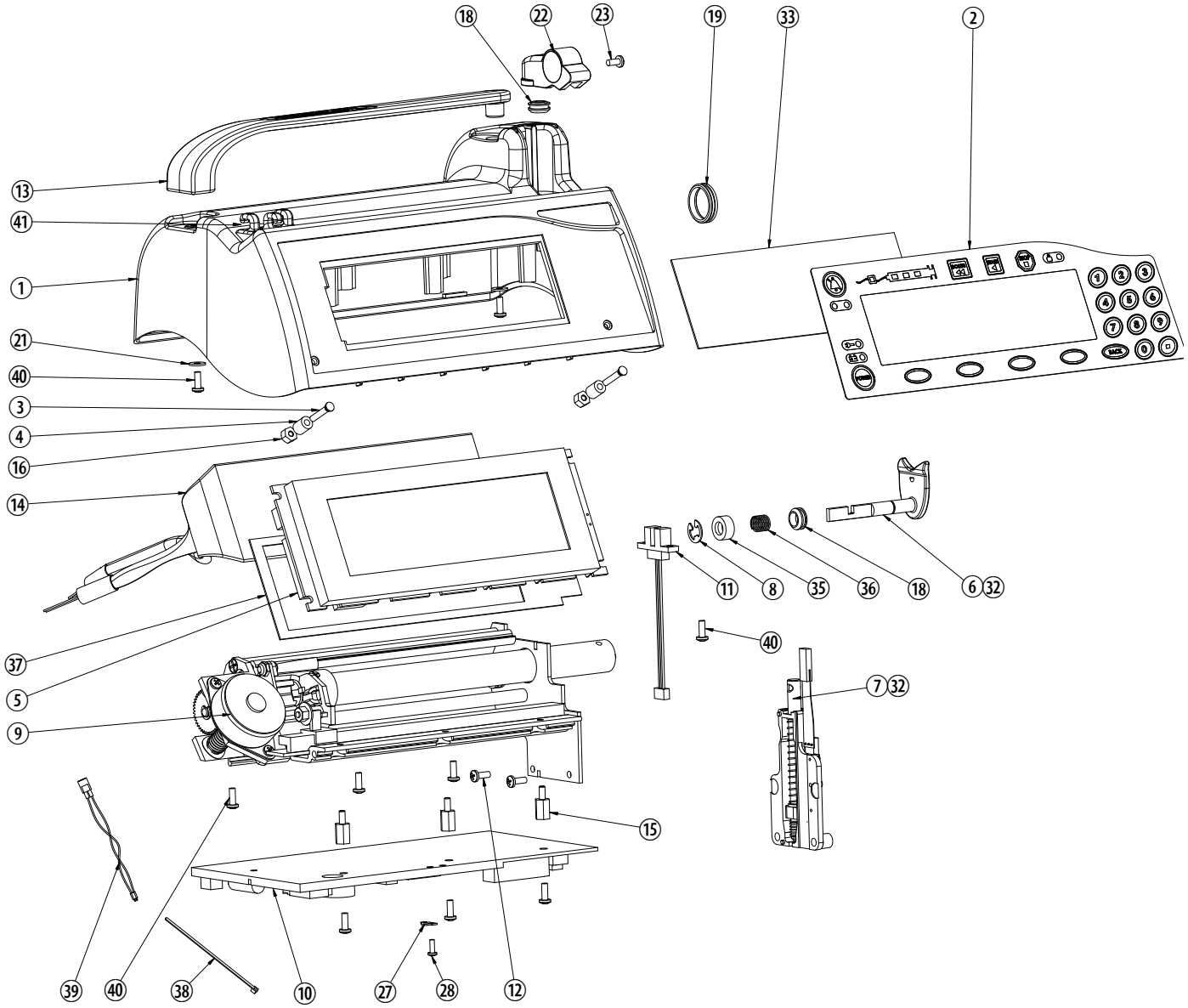
Notes:

1. *Items 3, 4, 6 (two pieces), 14 (two pieces), and 17 (two pieces), and 31 (two pieces) are available as a service subassembly part number* ***G6000439, Plunger Case Left Assembly - Service****.*

2. *New style plunger case requires o-ring (older models do not require this part).*

3. Use with Loctite® Black Max, part number G232100076 (Item 32).

Case top assembly without plunger



Case top assembly without plunger – parts list

See also case top service assembly, note 2 below.

Ref. #	Part Number	Description	Quantity
1	See note 2.	Case Top, With Tubing Holders	1 ea.
2	See note 4.	Keypad 3000	1 ea.
3	G6000021	Stud Self Clench 4-40 × 625	2 ea.
4	G6000022	Spacer, .25 OD × .31, Nylon	2 ea.
5	G6001457L	Display, Liquid Crystal	1 ea.
6	G6000023	Ear Clip	1 ea.
7	See following drawing	Assembly Barrel Clamp	1 ea.
8	G6000034	E-Ring	1 ea.
9	See following drawing	Assembly Drive Train	1 ea.
10	See note 3	Assy 3000 Main PCB	1 ea.
11	G6000010	Optocoupler Assembly	1 ea.
12	G6000692	Screw 4-40 × .31 Phillips	10 ea.
13	G6001999	Case Handle	1 ea.
14	G6000101	Backlight Fiber Optic (Medfusion® 3010A Series)	1 ea.
	G6000582	Backlight Fiber Optic Dual LED (Medfusion® 3500 Series)	1 ea.
15	G6000064	Standoff Hex 4-40 × .38	3 ea.
16	G6000043	Nut 4-40 Nylock	4 ea.
18	G6000122	Seal, Barrel Clamp/Ear Clip	2 ea.
19	G6000077	Tube Seal	1 ea.
21	G6000474	Washer, #4 Flat	2 ea.
22	G6000715	Barrel Clamp Head	1 ea.
23	G6000802	Screw 4-40 × .25 BH Black	1 ea.
27	G6000257	Clamp, Stainless Steel	1 ea.
28	G6000903	Screw, Pan Phil 2-56 $^{3}/_{16}$ SS Nylock	1 ea.
32	0382000000	Grease, Silicone 111	0.1 oz.
33	G6000339	Lens, Keypad Support	1 ea.
35	G6000393	Sleeve, Ear Clip	1 ea.
36	G6000397	Spring, Ear Clip	1 ea.
37	G6000583	Spacer, LCD, Backlight (see note 5)	1-2 ea.
38	039TT10200	Wire Tie (Medfusion® 3500 Series)	1 ea.
39	G6000585	Cable, Backlight Dual LED (Medfusion® 3500 Series)	1 ea.
40	G6000692	Nylok Screw	3 ea.
41	G6000238	Tube Holder	3 ea.

- continued on next page -

Notes:

1: *Item 35 does not appear in older pumps.*

2: *Items 1, 2, 3 (two pieces), 13, 18, 19 and 33 are available as a service subassembly part number:*

For Medfusion® 3010 and 3010a:
G6000437, Case Top Protege Assembly - Service (old style barrel clap head and no keyway)
G6000736, Case Top Protoge Assembly - Service (new style barrel clamp with keyway)

For Medfusion® 3500 (English):
G6000610, Case Top 3500 – Service (old style barrel clamp head and no keyway)
G6000737, Case Top 3500 - Service (new style barrel clamp with keyway)

For Medfusion® 3500 (International): *G6000624, 3500 International Case Top - Service*
English: *G6000438, Case Bottom Assembly – Service*

International: *G6000622, Case Bottom Assy International – Service*

3: *Items 10 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

G6001561, 3500 Main PCB Assembly – Software Version 3.0.9 - Service

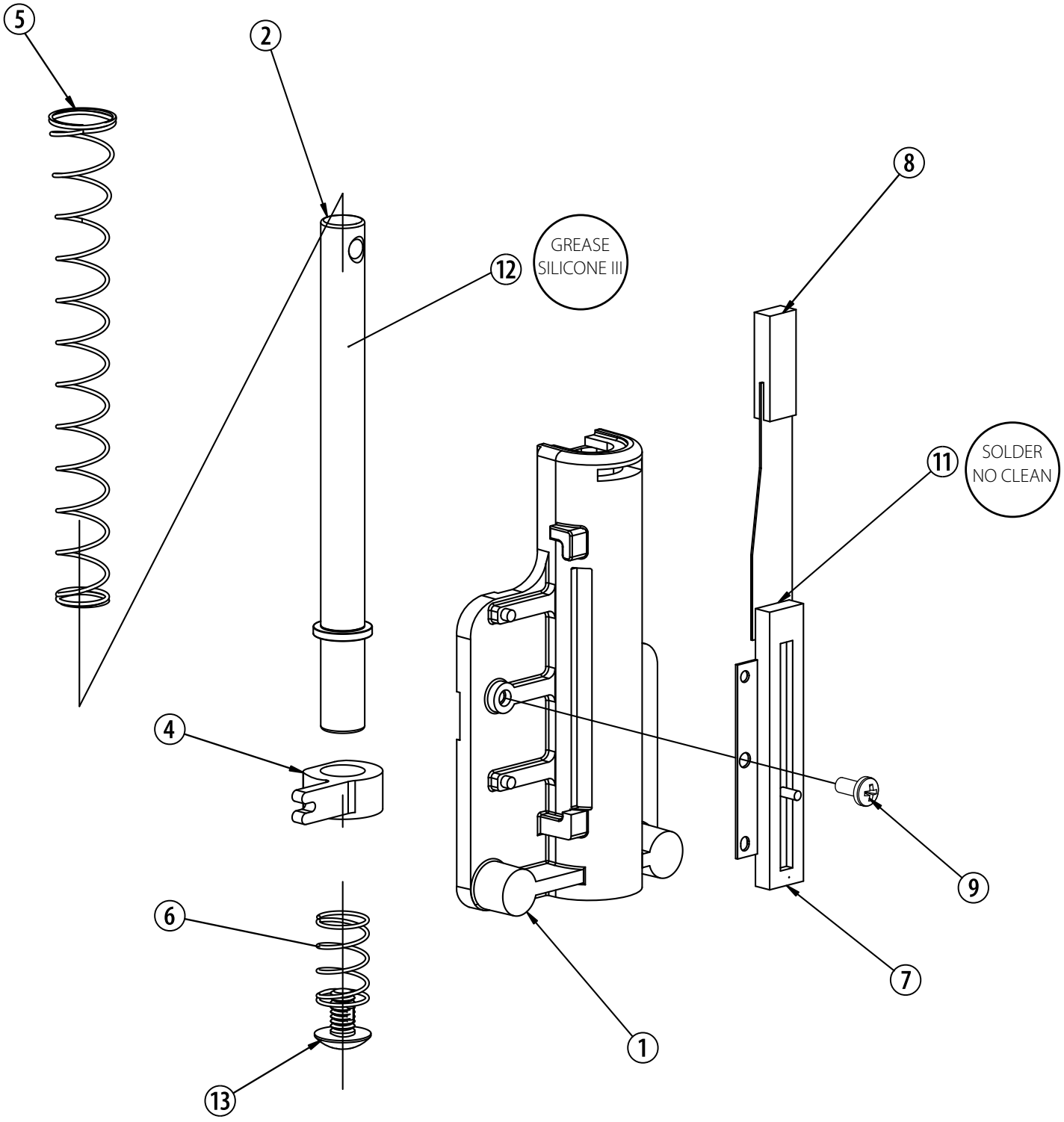
G6001562, 3500 Main PCB Assembly - Software Version 4.1.4 -Service

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

4: *Item 2, for Medfusion® 3010 English Text Keypad use G6000005. For Medfusion® 3500 English Text keypad use G6000607. For Medfusion® 3500 International Keypad use G6000912.*

5: *Early Medfusion® 3010 pumps have no spacer, later Medfusion® 3010 pumps have 2 spacers. All Medfusion® 3500 and later pumps have 1 spacer.*

Barrel clamp assembly

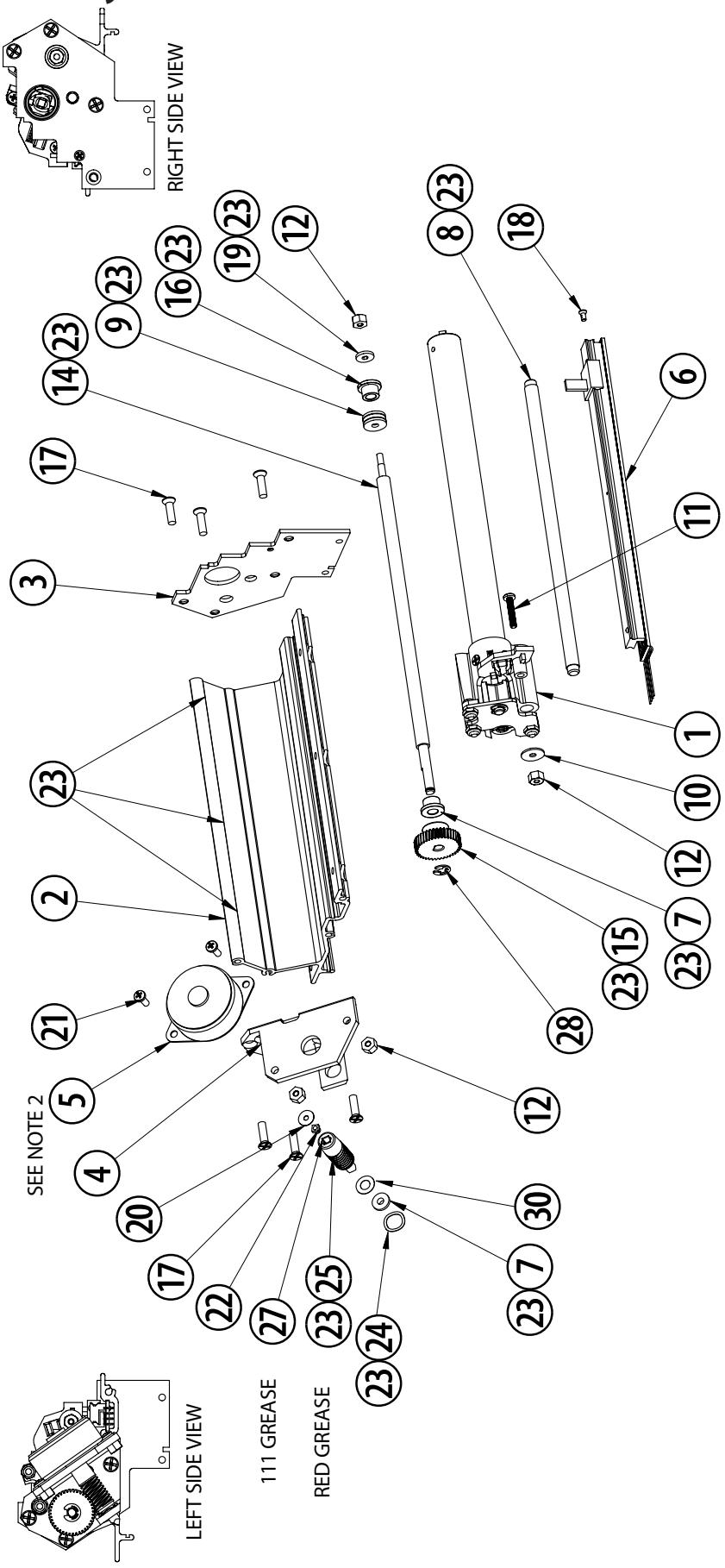


Barrel clamp assembly – parts list

Ref. #	Part Number	Description	Quantity
1	G6000716	Guide Barrel Clamp	1 ea.
2	G6000904	Rod Barrel Clamp	1 ea.
4	G6000031	Barrel Clamp Slide	1 ea.
5	G6000032	Spring, Barrel Clamp	1 ea.
6	G6000024	Spring .265 ID × .5	1 ea.
7	G6000186 - See note 1	Pot Size Sensor, 10K	1 ea.
8	G6000096 - See note 1	Flex Cable Size Pot	1 ea.
9	G6000121	Screw #2 × .18 Plastite	1 ea.
11	0340IF1400 - See note 1	.030 DIA, Spool Solder	0.01 oz.
12	0382000000	Grease, Silicon 111	0.1 oz.
13	G6000906	Screw, 6-32 ¼" Truss Nylock	1 ea.

Notes:
1: *These items 7, 8 and 9 are available as a service subassembly part number G6000436, Size Sensor Pot Assembly - Service.*

Drive train assembly

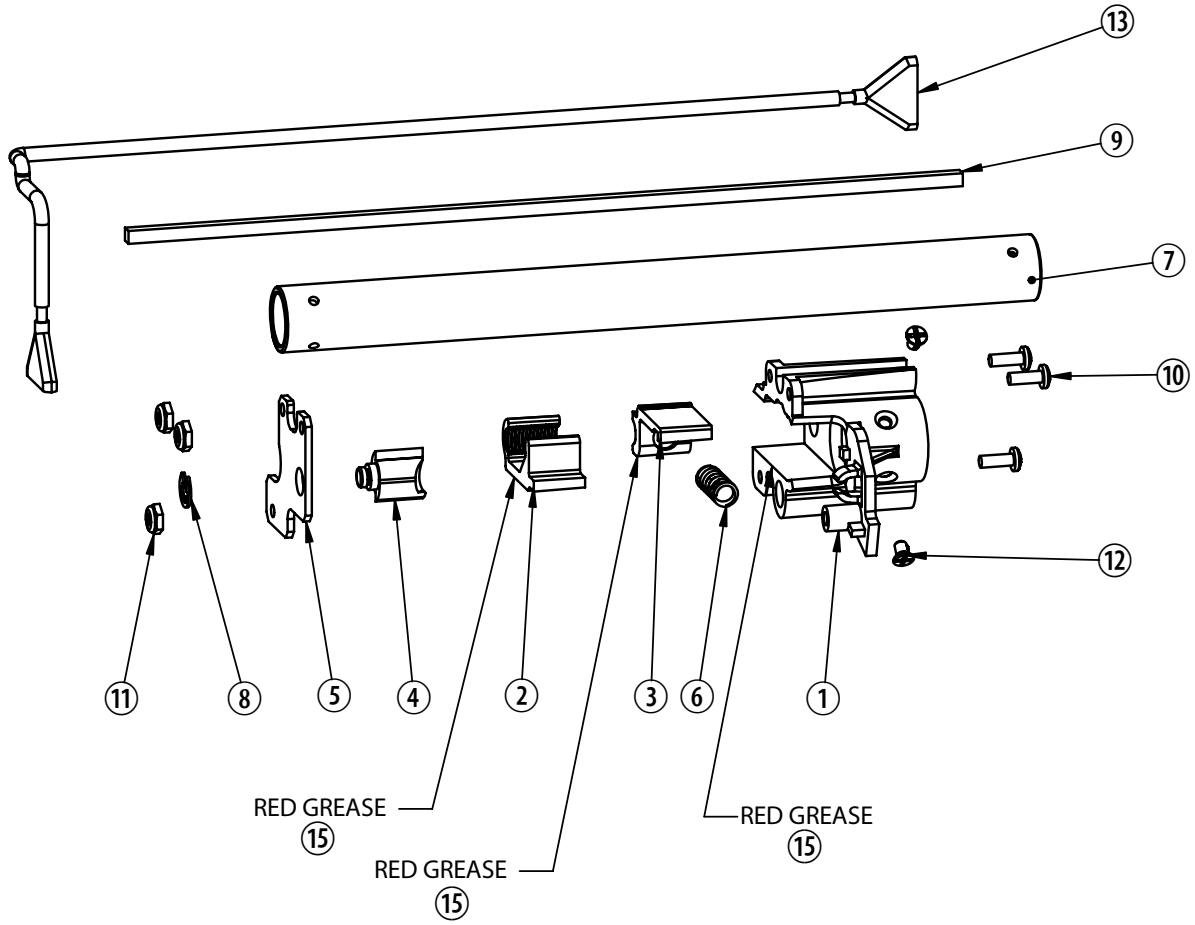


Drive train assembly – parts list

Ref. #	Part Number	Description	Quantity
1	See following drawing	Assembly Clutch	1 ea.
2	G6000931	Extrusion Main	1 ea.
3	G6000717	Assy Right End Plate	1 ea.
4	G6000049	Plate Motor Mount	1 ea.
5	See note 2	Motor Stepper 7.5 Degree	1 ea.
6	G6001599	Pot Position 10K, 20%	1 ea.
7	G6000053	Bushing .19 ID × .25 Delron	2 ea.
8	G6000055	Rod, Guide, Precision	1 ea.
9	G6000056	Thrust Bearing	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.
13	See note 1	Worm	1 ea.
14	G6001459	Leadscrew	1 ea.
15	G6000051	Gear, Worm	1 ea.
16	G6000057	Bushing, Leadscrew, Right	1 ea.
17	G6000075	Screw 6-20 × .5 FH Thread Form	7 ea.
18	G6000902	Screw, 2-56 × .19 FH SS	1 ea.
19	G6000072	Washer Brass .340 × .117 × .050	1 ea.
20	See note 2	Washer, Teflon®, .312 × .093 × .010	1 ea.
21	G6000063	Screw, 4-40 × .31 PH Phillips	2 ea.
22	See note 2	Shaft Driver	1 ea.
23	07020STP00	Grease, STP	0.1 oz.
24	G6000791	Washer, Wave Spring, .490 × .326 × .010	1 ea.
26	036LT24200	Loctite® 242	0.01 oz.
27	See note 1	Coupling, Worm	1 ea.
28	0391331800	E-Clip	1 ea.
30	G60001223	Washer, Teflon®	A/R

Notes:
1: *Items 13 and 27 are bonded together to form a worm assembly, in older pumps these may appear as a single machined part. These items are available as a service subassembly part number G6001480, Worm/ Coupling Assembly - Service.*
2: *Items 22, 20, and 5 are available as a service subassembly part number G6000431, Motor Service Assembly - Service.*

Clutch assembly



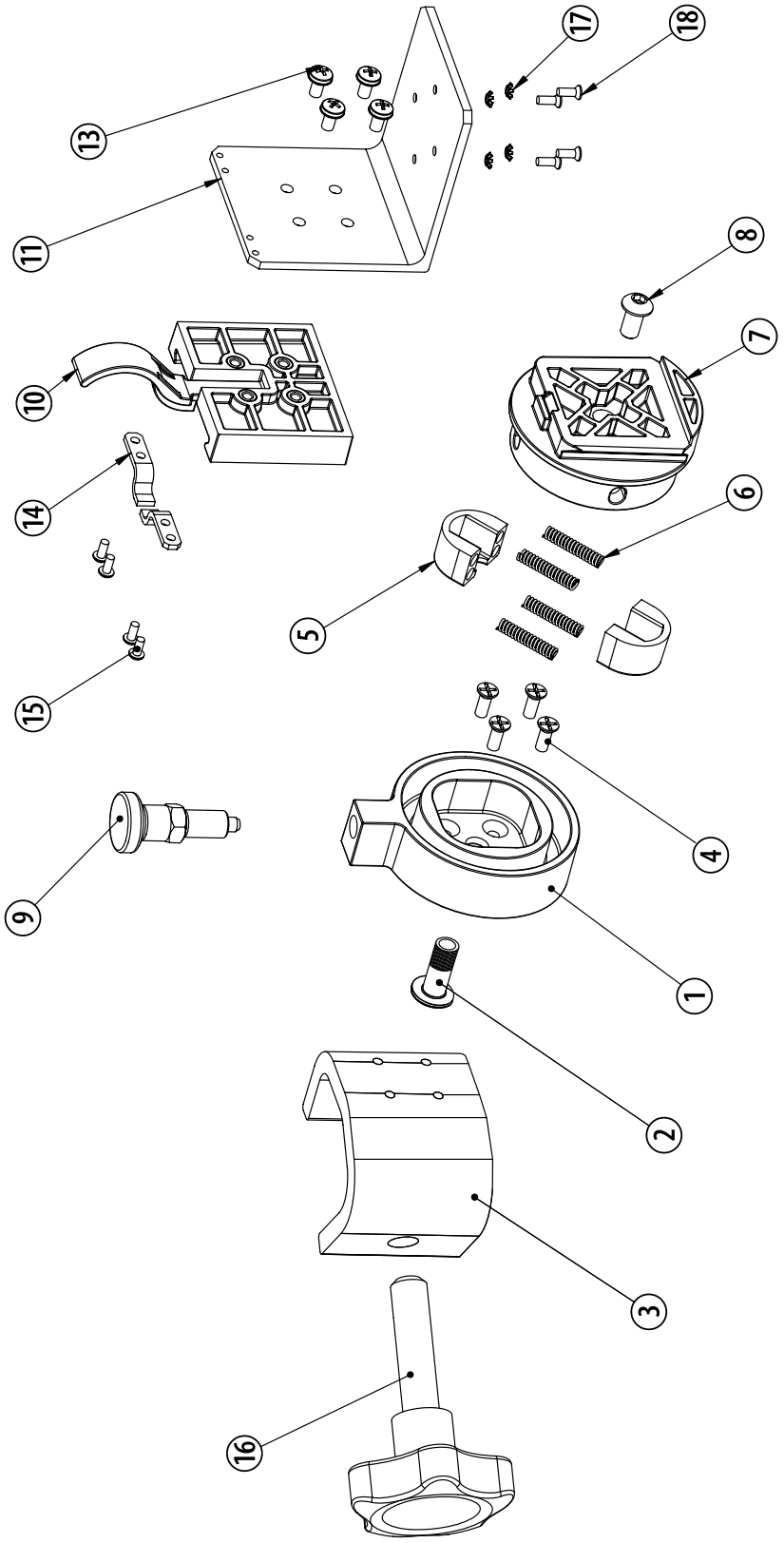
Clutch assembly – parts list

Ref. #	Part Number	Description	Quantity
1	G6000099	Carriage	1 ea.
2	G6000928	Clutch, Left	1 ea.
3	G6000929	Clutch, Right	1 ea.
4	G6000924	Cam, Clutch	1 ea.
5	G6000905	Plate, Carriage	1 ea.
6	G6000044	Spring, Clutch	1 ea.
7	G6000045	Tube Plunger	1 ea.
	G6000738	Insulated Tube	1 ea.
8	0391331800	E-Clip	1 ea.
9	G6000378	Square Shaft (See note below)	1 ea.
10	G6000063	Screw 4-40 × .31 PH Phillips	3 ea.
11	G6000310	Nut, Nylock, 4-40, SS, Small	3 ea.
12	G6000749	Screw 4-40 × .18 FH SS	2 ea.
13	G6000159	Assembly, Plunger Cable	1 ea.
15	07020STP00	Grease, STP	0.1 oz.

Notes: *In newer pumps, square shaft (item 9) is being superseded by SS Square Shaft, P/N G6000378.*

Accessories – parts list

Poleclamp assembly



Poleclamp parts

(Catalog number 3000PC)

Ref. #	Part Number	Description	Quantity
3	G6000284	Poleclamp "C" Bracket	1 ea.
11	G6000286	Poleclamp "L" Bracket	1 ea.
13	G6000774	Screw, #8-32 × $^{5}/_{16}$", Pan Head with Washer, Stainless	4 ea.
16	G6001456	Knob, ½-13 × 2", Stainless	1 ea.
18	G6000345	Screw, #4-40 × $^{5}/_{16}$", Flat Head, Stainless	4 ea.

Rotating poleclamp parts

(Catalog number 3000RPC)

Ref. #	Part Number	Description	Quantity
1	G6000496	Mount, Rotor Rotating	1 ea.
2	0502003100	Shoulder Bushing	1 ea.
3	G6000284	Poleclamp "C" Bracket	1 ea.
4	G6000499	Screw, #8-32 × $^{7}/_{16}$ Flat	4 ea.
5	0482004400	Index Cam	2 ea.
6	0502002400	Compression Spring	4 ea.
7	G6000497	Rotor Base	1 ea.
8	046L050200	¼-20 × .5 Button Head Hex	1 ea.
9	G6000505	Indexing Plunger ⅜-24 Thread	1 ea.
10	G6000538	Assy, Plate Back	1 ea.
11	G6000286	Poleclamp "L" Bracket	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, 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.

Miscellaneous parts

Part Number	Description	Quantity
G6000329	AC Line Cord, North American, Class II	1 ea.
G6000193	AC Line Cord, North American 3-Wire	1 ea.
G6000330	AC Line Cord, United Kingdom, Class II	1 ea.
G6000331	AC Line Cord, Continental European, Class II	1 ea.

Calibration & repair – parts list

Medfusion® 3000 series calibration kit

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

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

- 1 ea. – 50 or 60cc syringe (see *Operations Manual* for list of acceptable types)
- 1 ea. – Medium bore tubing set, Smiths Medical 53-60-225 or equivalent
- 1 ea. – 3 Way Stopcock
- 1 ea. – Torque Screwdriver with #1 Phillips bit, #0 Flat bit, & 2.5mm Hex bit
- 1 ea. – $^{3}/_{16}$" 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

Index

A

B

C

D

E

F

G

H

I

K

L

M

N

O

P

R

S

T

U

V

W

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