smiths

Graseby 3300
PCA Syringe Pump

Technical Service
Manual

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Introduction

This Technical Service Manual together with the accompanying Instruction Manual, contains all the information needed to maintain, repair and operate the Smiths Medical 3300 PCA pump. The contents of this Manual are intended to be read and used by suitably qualified personnel.

AC input power connecting

The AC input power socket that connects to the rear of the pump has three connections (live, neutral and earth) provided by a 3-way power cable. As the casing is doubly insulated, the AC input connector situated on the pump only utilises two connections (live and neutral), there is no third earth pin. This method of AC input enables similar AC input sockets (if required) to that supplied by Smiths Medical to be used.

Warnings

Warnings tell you about dangerous conditions that could lead to death or serious injury to the user or patient that can occur if you do not obey all of the instructions in this manual.

1. **WARNING: To avoid over- or under- infusion, always verify that the brand and size of the loaded syringe are the same as the brand and size displayed on the screen before starting an infusion. Failure to do so may result in an inaccurate delivery of medication, resulting in patient injury or death.**
2. **WARNING: To avoid incorrect or inappropriate configuration of the pump, the Configuration menu must only be selected by qualified persons or authorised personnel. Incorrect pump configuration could lead to inappropriate infusion resulting in patient injury or death.**
3. **WARNING: This equipment is not suitable for use in the presence of flammable anaesthetics, oxygen-enriched or explosive atmospheres. The use of the device in such atmospheres may lead to explosion or fire.**
4. **WARNING: To avoid possible malfunction of the pump, do *not* expose the pump to X- rays, gamma rays or ionizing radiation, or to the RF interference or strong electric/magnetic fields emitted (for example) by diathermy equipment or mobile telephones. If the pump is used in the presence of, or in combination with Magnetic Resonance Imaging (MRI) machines it must be protected from the magnetic field emitted by such equipment. Malfunction of the pump can cause incorrect infusion or loss of infusion resulting in patient injury or death.**
5. **WARNING: Operation of the pump outside the temperature limits defined in the specification may result in erroneous operation. Ensure that the temperature is within the specified limits. Failure to do so may result in patient injury or user injury.**
6. **WARNING: In order to ensure that the intended infusion is performed, data must be entered correctly. Likewise before confirming any displayed data the user should ensure that it is correct. Failure to do so may result in compromised function of the product, patient injury or user injury.**
7. **WARNING: Failure to respond promptly to an alarm may result in patient injury or death.**
8. **WARNING: Failure to follow the *Service Manual's* maintenance schedule recommendations may result in compromised function of the product and lead to patient injury or death.**
9. **WARNING: It is essential that clinical staff remain within visual and audible range of the pump so that critical alarms can be seen or heard and responded to.**
10. **WARNING: The user should ensure that the performance offered by the pump is fit for the intended purpose. Failure to do so may result in compromised function of the product, patient injury or user injury.**
11. **WARNING: When the pump is carrying out an infusion, to ensure that electrical safety is maintained only items of equipment that conform to EN60950 are to be connected to the RS232 connector situated at the base of the pump, otherwise patient safety may be compromised.**
12. **WARNING: Correct management of battery charging is essential to ensure that the pump can operate on batteries for the time specified. Failure to do so may lead to impaired functioning of the pump, resulting in patient injury or death.**
13. **WARNING: Do *not* use a faulty pump. If the pump develops a fault then an alarm will sound; the display will indicate a FAULT condition and the pump will fail to infuse. Incorrect performance of the pump can cause complications resulting in patient injury or death.**

    If the pump develops a fault then it must be referred to a suitably qualified engineer or returned to Smiths Medical in order to have the fault rectified.

14. **WARNING: Failure to use the mains lead clamp means that the pump may be accidentally or erroneously disconnected from the mains. Although there is battery backup in case this happens, the battery may not be sufficiently charged. Consequently there is a risk of the pump not functioning, which could lead to patient injury or death.**
15. **WARNING: If an occlusion alarm occurs, immediately clamp the line to eliminate the possibility of a bolus being delivered to the patient. Then inspect the fluid pathway for kinks, clogged catheter, etc. in order to remove the occlusion prior to restarting the infusion. An unintentional bolus of medication can result in patient injury or death.**
16. **WARNING: Use only the syringes and administration sets listed in the *Specification* at the end of this manual. Failure to do so may result in an inaccurate delivery. Smiths Medical does not guarantee performance of the pump if syringes other than those listed are used. Incorrect function or performance of the pump can cause complications resulting in patient injury or death.**
17. **WARNING: The volume of fluid contained in the connecting tubing is a residual amount and will *not* be infused. Hence this extra volume of fluid must be allowed for when initially filling the syringe and purging the system. Under-delivery of medication can cause complications resulting in patient injury or death.**
18. **WARNING: To avoid patient embolism, ensure that the patient tubing is purged of all air bubbles before administering any medication. The pump provides a purge facility to assist with this process. The presence of air within the medication can result in complications leading to patient injury or death.**
19. **WARNING: To avoid syphoning of the syringe contents (free flow), ensure that the syringe is correctly loaded into the pump, that the syringe plunger is properly engaged by the pump's actuator and that the pump is placed not more than 80cm above the infusion site. Syphoning can result in over-infusion leading to patient injury or death.**
20. **WARNING: To avoid over-infusion, do not purge the infusion line when the administration set is connected to the patient. Over-infusion of medication can result in patient injury or death.**
21. **WARNING: To avoid the pump becoming detached from an IV pole always make sure that the pump is securely fixed to the pole. Always check the security and stability of the assembly with the pump mounted.**

    If no IV pole is used make sure that the pump is completely stable on a horizontal surface. Failure to observe this warning may cause damage to the 3300 PCA pump and harm the operator or the patient. As a result, the operator or patient may suffer direct injury, or the 3300 PCA pump may fail to operate correctly, leading to patient injury or death.
22. **WARNING: Following a significant liquid spill onto the pump, it should be wiped dry and inspected by service personnel before being returned to service. Failure to do so may result in compromised functioning of the pump, leading to patient or user injury or death.**
23. **WARNING: When using a syringe smaller than 50/60 ml the occlusion pressure will increase as the diameter of the syringe decreases, i.e. the smaller the syringe the higher the pressure**
24. **WARNING: The patient history is lost when the clock is reset.**

Cautions

Cautions tell you about dangerous conditions that can occur and cause damage to the pump if you do not obey all of the instructions in this manual.

1. **CAUTION: Refer all service, repair and calibrations only to qualified technical personnel. Unauthorised modifications to the pump must *not* be carried out.**
2. **CAUTION: If, when turning the pump on, screens similar to those illustrated are not displayed, do *not* use the pump. Send the pump to a suitably qualified engineer or return it to Smiths Medical in order to have the fault rectified.**
3. **CAUTION: Do not use cleaning and disinfecting agents other than the approved ones specified here.**
4. **CAUTION: The pump must *not* be immersed in any liquids or exposed to strong organic solvents. Wipe off spills immediately, and do not allow fluid or residues to remain on the pump. Additionally, the pump is not designed to be autoclaved, steam-sterilised, ETO-sterilised or subjected to temperatures in excess of 45° C (113° F). Failure to observe this caution may cause serious damage to the pump.**
5. **CAUTION: If the pump is used in close proximity to a fluid bag(s), it should where possible, not be mounted directly underneath the fluid bag(s). This is to minimise the possible risk of damage to the pump from fluid ingress should the bag rupture or leak during use.**

U.S.A. and Canada

Federal law in the USA and Canada restricts this device to sale by or on the order of a licensed Medical Practitioner.

FOR THE ATTENTION OF USA USERS

Application Information required by FDA.

for *Epidural Applications* please note:

1. The device can be used for analgesic infusion.
2. Infusion may be short-term (up to 96 hrs.), or long-term in accordance with the catheter and drug labelling.
3. Use only catheters indicated for epidural administration.
4. Infusion sets with Y-connection sites should not be used for epidural applications.
5. The device must be used to administer only those analgesics which are approved for epidural administration as indicated by the drug labelling.

Abbreviations used

The following list shows the abbreviations that have been used at various places throughout this Chapter.

Abbreviation	Full name
A to D	Analogue to digital
AC	Alternating current
C	Capacitor
C	Centigrade
COP	Computer operating properly
cm	Centimetre
cNm	Centinewton metre
csk	Countersunk
DC	Direct current
deg.	Degrees
dia.	Diameter
Fig.	Figure
g	Gramme
Hg	Mercury symbol
HPa	Hectopascal
Hz	Hertz (cycles per second)
IC	Integrated circuit
Kg	Kilogram
Khz	Kilo Hertz (1,000 c/s)
LCD	Liquid crystal display
LED	Light emitting diode
mA	Milliampere
mg	Milligramme
ml	Millilitre
mm	Millimetre
µg	Microgramme
No.	Number
PCA	Patient controlled analgesia
PCB	Printed circuit board
Pl	Plug
R	Resistor
RAM	Random access memory
ROM	Read only memory
Stat	Maximum infusion rate for syringe being used
V	Volts
VFD	Vacuum fluorescent display

CHAPTER 1

INTRODUCTION, FEATURES and SPECIFICATION

Graseby 3300
PCA Syringe Pump

CHAPTER 1

INTRODUCTION, FEATURES AND SPECIFICATION

Introduction

The Graseby 3300 pump (see *Figures 1.1* and *1.2*) is a microcomputer controlled bedside syringe infusion pump. The pump can be set to give a continuous infusion, with an additional bolus if required, both programmed by the physician.

The patient is also able to initiate separately the delivery of a Patient Controlled Analgesia (PCA, a fixed bolus of drug) by pressing a button on a handset. A lockout period follows this delivery, during which time any further requests are denied. Both the PCA bolus size and the lockout period are programmed by the physician.

Access to the syringe is gained by inserting a special key into the pole clamp lock which is attached to the rear of the pump, this lock prevents tampering with the syringe. All the controls are clear and easy to use. The pump incorporates a back-lit dot matrix Liquid Crystal Display (LCD) that provides the user with a constant indication of its operation.

The pump can be programmed by the user to work with any one of a range of brands of syringe and automatically senses the syringe size which can be 20, 30 or 50/60 ml. The pump can also display the total mass and volume of drug infused since the totalisers were last reset; the number of PCA demands; and the number of good (successful) PCA demands.

Safety features have been built into the pump and its software. The pump carries out self test routines every time it is switched on. The users are warned of incidents such as 'occlusion' or 'power failure' by both visible and audible alarms.

The pump can be run from AC power or from internal rechargeable batteries which give more than eight hours of use. A battery recharging circuit is contained within the pump and the batteries will become fully charged when connected to the AC power for up to 14 hours, even though the pump itself may be switched off. The battery recharging time when a pump is connected to the mains *and* running can be much longer.

The pump makes use of a sophisticated micro-controller which combines microprocessor facilities with on-board non-volatile memory; Random Access Memory (RAM); an analogue to digital converter; communications circuitry and an internal watch-dog COP (Computer Operating Properly) monitor. These facilities normally require up to six separate silicon chips. The use of the single micro-controller greatly increases the reliability of the pump.

The pump's motor is under the direct control of the micro-controller and for added security, the micro-controller's action is monitored by a separate slave processor.

Security cover

The lockable security cover protects the syringe from tampering only; it provides no other security. It does not lockout the keypad or give audible or visual alarms when opened.

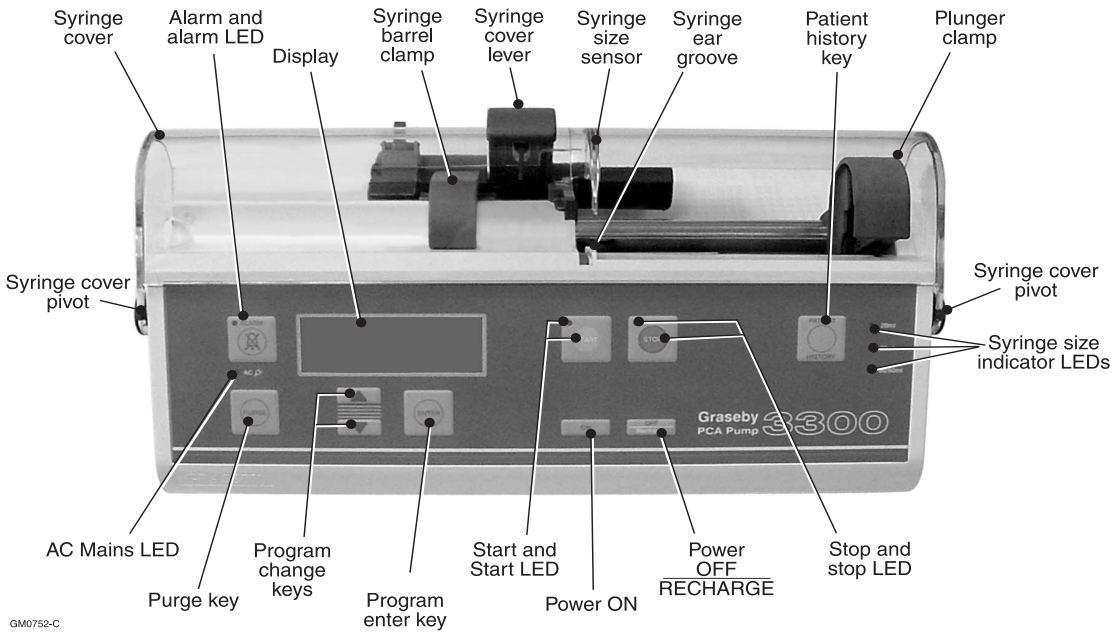


Figure 1.1 Front view of pump

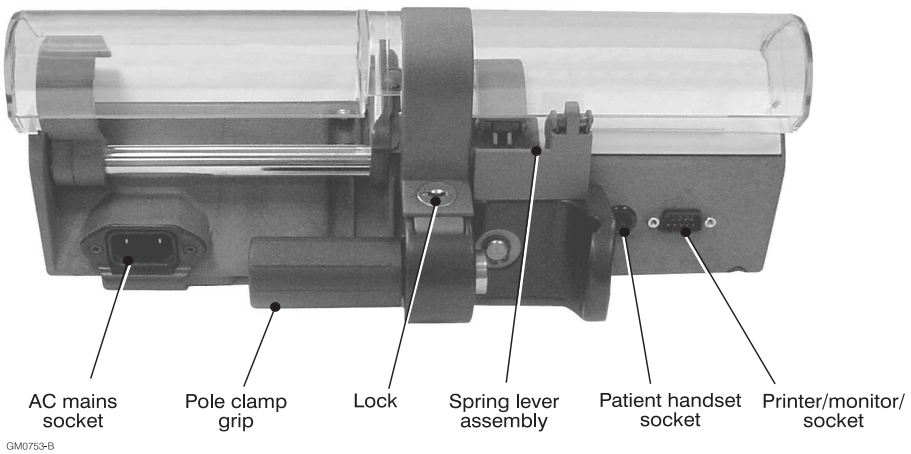


Figure 1.2 Rear view of pump

Features

The main features of the 3300 are:

- administration of a clinician controlled continuous infusion,
- administration of a clinician controlled bolus,
- administration of patient controlled bolus (PCA, handset),
- administration of a clinician override bolus,
- ergonomic styling, simple to use and to service,
- locked syringe cover to prevent tampering,
- AC or battery powered,
- caters for different brands of syringe, automatically sensed,
- a history of events may be displayed or printed out. An RS232 connector allows the pump to be interfaced with a suitable printer,
- fully programmable by the physician using optional program menu stages,
- comprehensive range of audible alarms and display warnings,
- drip proof from external moisture and no electrical connections to the patient,
- advanced safety features incorporating state-of-the-art electronics, and
- all materials used in this product are latex free.

Specification

Graseby pumps are subject to continual development and may, differ in detail from the following specification.

Dimensions:	335 mm x 195 mm x 130 mm (with pole clamp fitted and plunger clamp closed).
Weight:	Not exceeding 3.5 kg including batteries and pole clamp.
Concentration :	1 µg/ml to 99.5 mg/ml.
Loading dose :	0 µg to 99.5 mg.
PCA (bolus) dose :	1 µg to 99.5 mg.
Dose duration :	STAT or 1 to 15 minutes.
	STAT rates ... 200 ml/hr for 50 ml syringe.
	100 ml/hr for 30-35 ml syringe.
	60 ml/hr for 20 ml syringe.
Lockout period :	Zero to 360 minutes.
Total dose limit time :	1 to 8 hours.
Infusion rates:	Continuous, using a 50/60 ml syringe and no bolus, 0 to 99.9 ml/hour.
	Continuous with PCA bolus, 0 to 20 ml/hour in 0.1 ml/h steps.
	Maximum PCA bolus using 50/60 ml syringe, 1 to 200 ml/hour.
Supply voltage:	220-240 V or 110-120 V at 50/60 Hz, 15 VA.
Battery type:	Sealed lead acid, rechargeable (Cyclon, 3 off). Smiths Medical recommend that the batteries are checked at least annually (see page 5-8).
Battery life:	More than 8 hours of normal pump operation when the batteries are fully charged. With the AC supply connected, up to 14 hours will be required to fully recharge low voltage batteries. This time extends if the pump is connected to the mains and running.
Syringe brands:	BD Plastipak ... 20, 30 and 50/60 ml. Terumo ... 20, 30/35 and 50/60 ml. Braun Omnifix ... 20, 30 and 50/60 ml. Monoject ... 20, 30/35 and 50/60 ml. *IMS PumpJet ... 30 ml pre-filled syringe. Injectomat ... 50 ml. DBL Rapi-ject ... 50 ml pre-filled. Braun Perfusor ... 50 ml (conversion kit available, see Chap. 8).
	***The IMS syringe is accessed using the special key sequence: **ALARM, PURGE** and **OFF** when the Monoject syringe brand is displayed in the Configuration mode.
Temperature range:	Operating conditions ... +5° to +40° C, 30 to 75% Rh, 700 to 1060 hPa
	Storage conditions ... -40° to +70° C, 30 to 90% Rh, 700 to 1060 hPa
Drive accuracy:	± 2%

(contd.)

Occlusion pressure:	The occlusion pressure is factory set between 4.5 and 5.5 kg (i.e. between 608 and 740 mmHg).
Electrical safety	Class II; type CF and Drip-proof.
Design standards:	BS5724 Part 1.
	IEC601 Part 1.
	VFG1046/1984.
Language versions:	Danish, Dutch, English, Finnish, French, German, Italian,
	Norwegian, Portuguese, Spanish and Swedish.
Data retention:	All programmed values are retained following power off or AC failure.
History of events:	A facility exists that allows the operator to view or print out a history of the patient's past events.
RS232 connector:	The printer/monitor port utilises a D-type 9-way connector, and the Baud rate can be set via the Configuration mode to 9600, 4800, 2400 or 1200.

Brief history of Graseby bedside syringe pumps

MS2000

The first Graseby bedside syringe pump was the **MS2000**. This was a basic syringe pump capable of infusions within the range of 0.1 ml/hr to 99.9 ml/hr. It had a totaliser, a limited infusion capability, a built in pole clamp and was designed for vertical operation. The MS2000 was powered by an AC supply or its internal DC batteries. This pump is no longer manufactured by Smiths Medical.

PCAS

The **PCAS** pump was developed from the MS2000 to satisfy the growing interest in Patient Controlled Analgesia (PCA). The PCAS was very similar to the MS2000 in both appearance and mechanical design, but utilised a different microprocessor with the capability of running the extra features required for PCA and was eventually replaced by the 3300 pump. A printer port was also incorporated. This pump is no longer manufactured by Smiths Medical.

3000

The first pump in the 3000 Series of syringe pumps was the **3000** itself. This pump was designed as a low-cost alternative to the MS2000 and satisfied the need for a horizontally mounted pump. The 3000 did not have an internal battery supply. This pump is no longer manufactured by Smiths Medical.

3100

The **3100** syringe pump was developed from the 3000. It is very similar mechanically but the electronic design is superior. Dual processors were incorporated along with a vacuum fluorescent text display and internal batteries. The maximum infusion rate was increased to 199.9 ml/hr and different syringe sizes were able to be used (automatically sensed). Extra software features, such as the intelligent 'near end' alarm, were also incorporated. This is the only pump in the 3000 Series that is not fitted with an RS232 connector.

3300

The next bedside syringe pump to be developed was the **3300**. This was similar in mechanical and electronic design to the 3100 but the features were specifically for the now more mature PCA market. A lockable syringe cover was added for security against drug theft, a four line LC display was added, and internal history recording (1500 events) with printout was also added. With the growth in PCA knowledge in the medical community, many more software features were incorporated into the 3300 to aid PCA administration.

3400

The **3400** was developed (again from the 3100) to satisfy the need for a high speed infusion pump for intravenous anaesthesia. Advances in micro-controller technology allowed the use of a single device to control all the pumps features. The maximum infusion rate was raised to 1200.0 ml/hr and bolusing facilities were also added. Later, an infusion rate calculation facility was added to the software.

A larger liquid crystal display was used on the 3400 with the ability to display text in different sizes, also 'soft-keys' were used to make the user interface simpler. The range of syringe sizes that could be used was also increased. For more advanced applications the pump could be controlled by a computer.

3200

The 3200 was developed as a general purpose syringe pump. Wet-side pressure sensing, intermittent infusion capabilities, and computer interfacing were added. The wet-side occlusion pressure monitoring made the pump particularly suitable for use in intensive-care baby units. A large text vacuum fluorescent display was added, and the increased syringe size range of the 3400 remained.

A DC input supply (10 V to 28 V DC) version of the 3200 is also manufactured by Medical. This variant is primarily intended for use in an aviation environment.

(contd.)

Brief history (contd.)

3500

The 3500 was developed from the 3400 and retains all the 3400 facilities.

There are two versions of the 3500, as follows:

1. A Manually Controlled Infusion (MCI) *only* pump. This pump can easily be converted to a 'MCI plus TCI' pump at the Medical Customer Service Centre.
2. An MCI *plus* a Target Controlled Infusion (TCI) pump.

The 'MCI *plus* TCI' pump carries out a TCI using the Diprivan drug. This version of the 3500 incorporates a Diprifusor module manufactured by Zeneca Pharmaceuticals. A new main circuit board and new software allows the 3500 to interface with the Diprifusor module.

A 3500 non-TCI pump can be converted by Smiths Medical to become a 3500 MCI plus TCI pump.

3150

The 3150 is very similar to the 3200 general purpose pump. The main difference being that the In-line (wet-side) pressure sensing system in **not** available on the 3150, i.e. the pressure transducer is not fitted.

CHAPTER 2

CONFIGURATION and DIAGNOSTICS MODE, and THRUST ADJUSTMENTS

Graseby 3300
PCA Syringe Pump

CHAPTER 2

CONFIGURATION and DIAGNOSTICS MODE, and THRUST ADJUSTMENTS

Configuration mode

WARNING: The pump's Configuration or Diagnostic mode must only be used by personnel who have been adequately trained in how to use the 3300 and have been assigned to enter this mode.

The Configuration mode allows various parameters to be made available, which in turn allows various options within these parameters to be set to the settings required for the infusion.

Calling up the Configuration mode

With the pump syringe cover open and in its set-up mode (see Instruction Manual)

hold/press the following buttons:

hold down ▲ and ▼ buttons and then press the **PURGE** button.

The following display will appear...

CONFIGURATION MODE? (USE WITH CARE)

Within 5 seconds of the above display appearing press the **START** button. The following display will then appear...

PROGRAM VALUES: UNLOCKED ↑ OR ↓ TO ADJUST

NOTE:
If the **START** button is **not** pressed within 5 seconds the display will return to the set-up mode.

Selecting an option

Each option within a parameter may be selected by pressing either the ▲ or ▼ button.

Pressing the **ENTER** button will accept the selected option and will also advance the display to the next parameter.

Pressing **STOP** whilst in the Configuration mode will return the user to the set-up mode.

WARNING: The pump must be set to display the brand and size of syringe that is going to be used. Using a different brand or syringe size to that displayed could lead to the incorrect amount of drug being administered, thus resulting in injury or death.

Parameters and options Table 2.1 shows each parameter within the Configuration mode and also the options that are available.

Table 2.1 Configuration parameters and options

Parameters (display)	Brief description	Options
PROGRAM VALUES	Enables/disables pump programming.	Locked/unlocked.
SYRINGE SELECTED	Selection of brand of syringe.	Refer to page 1-4.
RS232 RATE	Selection of interface data rate (bauds).	9600, 4800, 2400, 1200.
HISTORY TYPE	Select either all history information (in time period) or totals only (during period).	Detailed or summarized.
HISTORY PERIOD	Select a fixed time period over which totals (not events) can be viewed. Summarised mode only.	15 minutes to 24 hours.
CONTINUOUS PRINT OUT OF EVENTS	Print events as they occur.	Enabled or disabled.
CHRONOLOGICAL HISTORY DISPLAY	Display or print events in chronological or reverse chronological order.	Forwards or backwards.
LOADING DOSE	Include loading dose in program (set-up) menu.	Enabled or disabled.
CONTINUOUS INFUSION	Include continuous infusion in program (set-up) menu.	Enabled or disabled.
CONTINUOUS INFUSION UNITS	Either fixed as volume or linked to drug concentration.	Ml/hr or mass/hr.
PATIENT ACTIVATED TIMED INFUSION	Continuous infusion has time limit after each bolus dose. Only applies when continuous infusion is enabled.	Enabled or disabled.
ZERO LOCKOUT PERIOD AVAILABLE	Allows a zero lockout time.	Enabled or disabled.
TOTAL DOSE LIMIT	Include total dose limit in program (set-up) menu.	Enabled or disabled.
TOTAL DOSE LIMIT OVER FIXED PERIOD	Selection of fixed or variable period in which to measure total dose limit. The total dose limit feature must be enabled.	Enabled (fixed period) or disabled (variable period).

(contd)

Table 2.1 Configuration parameters and options (contd)

Parameters (display)	Brief description	Options
TOTAL DOSE LIMIT CALCULATED OVER X HOURS	Selection of dose limit period. The total dose limit parameter must be enabled.	1 to 8 hours in 1 hour steps.
DOSE DELIVERED AT STAT RATE	If STAT rate is ENABLED then delivery is ... 200 ml/hr for 50/60 ml syringe, 100 ml/hr for 30 ml syringe, and 60 ml/hr for 20 ml syringe.	STAT rate ENABLED
	STAT rate delivery or ... variable rate delivery over 1 to 15 minutes.	STAT rate DISABLED
PATIENT DEMAND	Selection of single or double button press for patient demand.	Single press or double press.
CLINICIAN OVERRIDE BOLUS	Selection of whether or not to allow boluses to be given at any time by the operator.	Enabled or disabled.
BEEP ON UNSUCCESSFUL PATIENT DEMANDS	Selection of beep on all patient demands, or only good demands.	Enabled (all patient demands) or, disabled (only good demands).
DISPLAY REMAINING LOCKOUT	Selection of countdown of lockout period.	Enabled or disabled.

After the last parameter shown above has been displayed the following self explanatory message will appear:

END OF SEQUENCE
PRESS STOP TO EXIT
OR ENTER TO START
AGAIN

Setting the clock

WARNING:

The patient history will be lost when the clock is reset.

To set the clock from the set-up mode proceed as follows:

1. Hold down the...

   ALARM and **ENTER** buttons and then press the **PATIENT HISTORY** button.

   The following display will appear:

   ```
      SET CLOCK ?
   14:30:42 31-AUG-02
      WARNING:
   HISTORY WILL BE LOST
   ```

2. Within five seconds press the **START** button. The following display will appear and the hours digits will have a flashing highlight:

   ```
     SET THE CLOCK:
   14:30:45 31-AUG-02
    ↑ OR ↓ TO ADJUST
   START FOR MINUTES
   ```

3. Use the ▲ or ▼ buttons to set the hours to the current time.
4. Press the **START** button to highlight the minutes.
5. Use the ▲ or ▼ buttons to set the minutes to the correct time.
6. If necessary continue to use the ▲ or ▼ buttons and the **START** button until the time and the date are both as required.
7. To return the pump to its initial set-up mode, press the **STOP** button.

Disassembly and assembly of casing

WARNINGS:

1. **Only qualified personnel should maintain and repair a pump.**
2. **ELECTRIC SHOCK HAZARD**
   The pump must be disconnected from the AC power supply prior to opening the casing.

Taking the casing apart

Each time the casing has been separated and reassembled, the syringe size functional tests detailed on page 6-1 must be carried out.

1. Disconnect the AC power connector and using a scratch free flat surface, turn the pump over to gain access to the base of the pump.
2. Undo and retain the six screws that hold the halves of the pump casing together. One of the six screws is located in a channel in the rear cover.
3. Place the pump upright and using the key, unlock the pole clamp. Release the syringe cover, and push up the plunger clamp.
4. Carefully ease the halves of the casing apart, taking care not to put any strain on the internal connecting cable looms that form a hinge between the two halves of the casing.

Assembly

Being careful not to trap any leads, assemble the casing by reversing steps (2) and (4) detailed above, ensuring that the two case halves have 'snapped' together and that the front and rear mating edges are equal and parallel. The screws should be tightened to a torque of between 70 and 75 cNm, and in the order shown in *Figure 2.1.*

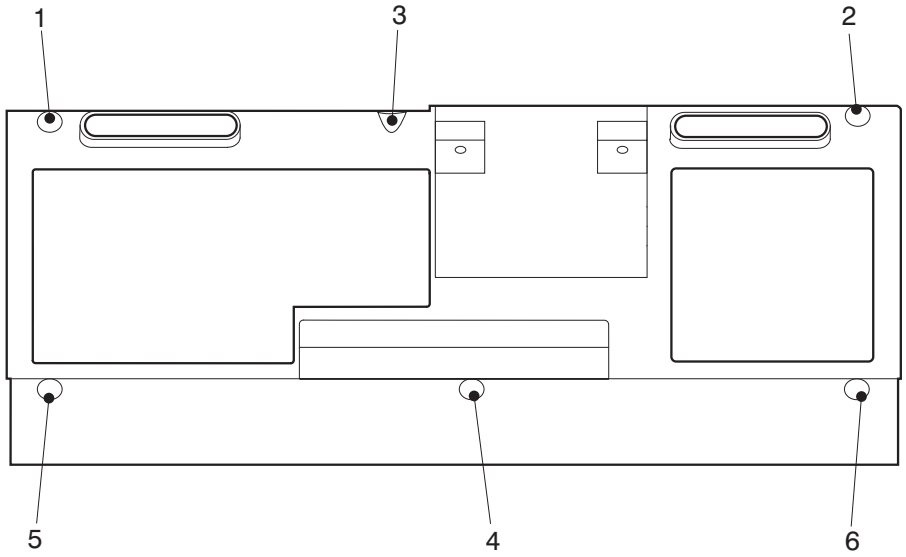


Figure 2.1 Case fixing screw tightening order

AC voltage and fuse adjustment

CAUTION: **If the pumps internal AC supply voltage setting is altered both the label on the underside of the pump must be changed (to indicate the correct AC voltage) and the correctly rated fuse must be fitted.**

The pump can be set to operate on a 220-240 V or 100-120 V AC voltage supply. To change the AC operating voltage settings (as fully detailed in the following sections) the casing has to be opened and two push-on connectors on the Regulator board adjusted. The AC supply fuse rating must also be changed.

AC voltage adjustment

1. Take the casing apart (see page 2-5).
2. Check/ alter the position of the two push-on connectors situated on the Regulator board (these connectors are attached to a black and a grey wire). The alternative settings are as follows:

220-240 V	**100-120 V**
Grey: PL4	Grey: PL7
Black: PL8	Black: PL3

3. Move the two blank connectors so that they cover the two unused alternative voltage terminals.

Fuse adjustment

2. Remove the cover that is placed over fuse FS2. If required fit the correct time delay fuse (T 50 mA for 220-240 V; T 100 mA for 100-120V). Replace the fuse cover ensuring that the cover goes outside all four spring connectors.
3. Taking care not to trap any leads, reassemble the casing (see page 2-5).
4. If necessary, stick a new adhesive voltage rating label over the existing label on the underside of the pump.

Diagnostic mode

The pump has a diagnostic mode which enables the following parameters to be checked:

- the version of software installed in the pump,
- the software Cyclic Redundancy Check (CRC),
- the slave processor software version, and
- the voltage of the power supply to the Main board.

The pump has been designed so that the diagnostic mode has to be specifically keyed in. This mode will not appear on the display accidentally.

By carrying out the following operations, the pump will be put into its diagnostic mode:

Keying in the diagnostic mode

1. Ensuring that the plastic syringe cover is fully open hold down both the ▲ and ▼ buttons and then press the **ALARM** button.
2. Within five seconds press the **START** button.
3. The four parameters that are listed above will appear on the display.
4. To return to the set-up mode press the **STOP** button.

Occlusion measurements

The two most frequently used methods to measure the point at which an occlusion occurs are the **thrust** and **pressure** methods.

Currently Smiths Medical set the occlusion by using a **thrust** measurement procedure. This method measures the plunger clamp thrust by using a set of weights (as described below), but has the slight disadvantage that the characteristics of the syringe have to be taken into account.

The occlusion **pressure** is obtained by measuring the pressure that occurs in the infusion line. This in-line method gives a good accuracy (better than 5%) over a wide range of pressures, but also has the slight disadvantage of requiring a disposable that is unique to the pump being measured.

The internal occlusion sensing system within the pump is always active.

The occlusion thrust checks must be carried out whenever the super nut assembly is dismantled.

$$T = \frac{P \times A}{732} + S$$

Thrust measurements

Translation of the thrust depends on the syringe diameter and the stiction of the syringe. The formula for calculating the thrust is given below:

where: **T** = is the thrust in kg,

P = is the delivery pressure in mmHg,

A = is the cross sectional area of the syringe in cm^2,

and **S** = is the syringe stiction in kg.

The occlusion thrust of the pump is factory set to be between two limits (i.e. a minimum and a maximum tolerance). The customer may reset the thrust for their own particular requirement. The thrust of a particular pump may, therefore, differ from the original factory set level.

The occlusion thrust of the **3300** pump is factory set at Smiths Medical to be between 4.5 kg and 5.5 kg (608 mmHg and 740 mmHg).

Syringe stiction

Stiction for a syringe varies from brand to brand as well as from batch to batch. Stiction can be as low as 0.1 kg and as high as 2 kg. The stiction of some syringe brands has been found to be particularly high.

Stiction can also vary along the plunger travel. It is usually lowest in small diameter syringes. Using a sample syringe and allowing for a safety margin for sticky syringes, adjustments can be made by measuring the thrust generated. If the stiction characteristics of a syringe are known, then the occlusion thrust can be set, using the formula above .

Thrust checks

The thrust checks detailed below use the weights that correspond to the factory set occlusion threshold levels for a 3300 (i.e. 4.5 and 5.5 kg). If a different occlusion level setting is required then the weights will have to be adjusted accordingly.

The thrust adjustment procedures are detailed on page 2-9.

1. Set the pump's plunger clamp to approximately mid-way along its support tube.
2. Remove the plunger from a spare BD 60 ml syringe. Modify the syringe by sawing off the pointed end. Place the modified syringe onto the pump so that it acts as a guide for the weight support rod (see *Figure 2.2*).
3. With the pump switched **ON**, set the infusion rate to STAT.
4. Place the pump in a vertical position, with its left hand side uppermost (see *Figure 2.2*).
5. Place the weight support rod through the modified 60 ml syringe and onto the pump's plunger clamp.
6. Place a weight of 4.5 kg on top of the weight support and check that the pump operates at least 30 seconds and does **not** occlude (i.e. the alarm does not sound). Remove the weight.
7. Place a weight of 5.5 kg on top of the weight support and check that within 60 seconds the pump does occlude (i.e. the alarm sounds).

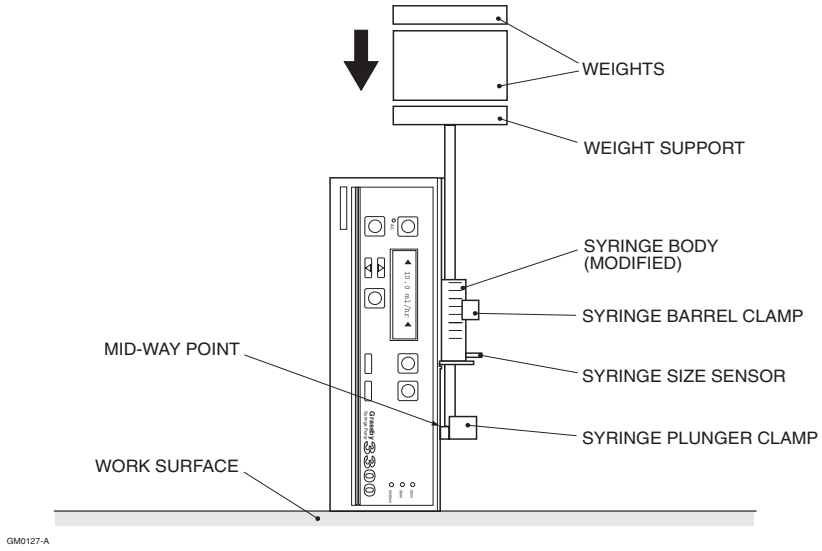


Figure 2.2 Thrust measuring set up

Thrust adjustments

If the occlusion thrust requires adjustment, the following procedures will have to be carried out:

1. Switch the pump off and disconnect the AC supply.
2. Take the casing apart (see page 2-5).
3. If necessary rotate the leadscrew to reveal the grub screw that is located on the occlusion adjusting nut. Loosen the grub screw with a 1.5 mm hexagonal key.
4. Alter the setting of the occlusion adjusting nut as necessary. One full turn of the adjusting nut gives approximately 2.73 kg (369 mmHg) of adjustment.

   To decrease the pump's occlusion setting, decrease the tension on the leadscrew spring by rotating the adjusting nut.

   Rotating the adjusting nut in order to increase the tension on the leadscrew spring will increase the pump's occlusion setting.
5. Tighten the grub screw to a torque of 15 ± 2 cNm.
6. Temporarily assemble the halves of the pump, being careful not to trap any leads.
7. Carry out a thrust check as detailed on page 2-8.
8. To obtain the thrust required it may be necessary to repeat steps (2) to (7) above.
9. Finalise the assembly of the pump casing (see page 2-5).
10. Carry out tests No. 10 and 11 detailed in the functional test procedures (see page 6-3).

CHAPTER 3

FUNCTIONAL DESCRIPTIONS

Graseby 3300
PCA Syringe Pump

CHAPTER 3

FUNCTIONAL DESCRIPTIONS

Introduction

This Chapter explains how the 3300 operates. Reading this chapter will help a technician to rectify any possible faults that may occur within the pump.

The functional descriptions of the pump may be divided into seven separate areas, and each of these functional descriptions have been detailed separately in the descriptions that follow:

- Drive system.
- Occlusion sensing system.
- Electro/mechanical control system.
- Patient control system.
- Monitor interfaces.
- Sensing (alarm) systems.
- Software.

Drive system

The motor, gearbox, leadscrew and associated components (*Figure 7.1*) are mounted on a glass reinforced polycarbonate casing. The strength of this casing enables a precise mechanical location to be achieved for the various components.

Both the inner and outer metal tubes are made of substantial material in order to eliminate all unwanted flexing.

DC motor and leadscrew

The drive system comprises a DC motor working through a gearbox in order to rotate a leadscrew. A super nut assembly engages onto the leadscrew, and the assembly is also connected to a steel tube. The steel tube is in turn connected to the plunger clamp.

As the motor spindle rotates, the *leadscrew* rotates and the *super nut assembly* travels to the left, along the *leadscrew*. The *super nut assembly* pulls the outer of two steel tubes to the left. This outer tube travels over and along a support tube; the support tube is the length of the pump. The plunger clamp moves with the outer tube pushing 'in' the syringe plunger.

The pulses applied to the stepper-motor are controlled by the signals from a microcomputer. The microcomputer and its associated software determines the speed of the stepper-motor. To ensure safe operation of the stepper-motor the microcomputer controls the stepper-motor directly.

Toggle mechanism

A spring-loaded toggle mechanism is attached to the bottom of the half nut. This toggle mechanism enables the plunger clamp to be physically swung 'in or out' thus rotating the outer metal tube so that the half nut is either fully 'engaged or disengaged' (respectively) from the leadscrew.

Plunger clamp

When the plunger clamp is pulled down the *super nut* engages with the *leadscrew,* and the clamp itself engages with the end of the syringe.

The syringe plunger slots into place behind a slotted pair of lips. These lips prevent the syringe plunger from moving forward in the event of negative pressure on the syringe.

A small push-button on the edge of the plunger clamp makes contact with the top of the syringe plunger. The push-button controls the operation of a *lever* which protrudes from the plunger clamp.

When the push-button is pressed in, by coming into contact with the top of the syringe, the *lever* becomes free and is able to retract into the plunger clamp. This retraction takes place when the plunger clamp is physically swung into its down operating position.

If the push-button is not pressed 'in' the *lever* will be locked in its protruding position thus preventing the plunger clamp from being pulled down. This in turn prevents the *half nut* from engaging on the *leadscrew*.

This push-button safety system prevents the *leadscrew* from being engaged unless the top of the syringe is correctly positioned in the plunger clamp.

If the plunger clamp is accidentally dislodged during an infusion the pump will automatically and safely stop infusing and an alarm will sound.

Occlusion sensing system

Clutch assembly and opto sensor

The occlusion sensing system consists of a clutch, spring mechanism, a rotating slotted disk and opto OPTO1 (see page 4-25). The clutch and spring mechanism comprise the back pressure system. The rotating slotted disc and OPTO1 comprise the rotation detector. The clutch, slotted disc and OPTO1 are located at the left hand end of the leadscrew, underneath the opto sensor board. The spring is located at the right hand end of the leadscrew.

Occlusion detection

The clutch is held engaged by the spring with a pressure sufficient to overcome any resistance from the syringe plunger and the normal back pressure from the infusion line. The rotation detector will generate an output that comprises a continuous set of pulses when the leadscrew rotates.

If there is an occlusion in the line then the back pressure will rise as the pump attempts to force fluid through the line. When there is sufficient pressure to overcome the spring pressure (factory set at 674 mm Hg) then the leadscrew moves to the right, losing contact with the clutch. The rotation detector will no longer generate an output which results in an occlusion alarm.

This method of occlusion detection is extremely sensitive as it is the lack of pressure on the clutch that generates the alarm, rather than the detection of the movement of the leadscrew as used in traditional designs. UK patent number 2249 497.

Electro/mech control system

The microcomputer produces the pulse train for the stepper-motor in order to produce a set flow rate. The rotation of the leadscrew slotted disc (described above) is monitored by the movement of the slots through the opto-detector. If the appropriate pulses are 'not' detected by the opto-sensor then an alarm signal is generated.

Brief mechanical characteristics of the system are given below:

- Motor step angle: 15 degrees.
- Gearbox reduction ratio: 210:1.
- Number of motor steps per revolution of leadscrew: 5,040 at all rates.
- Leadscrew pitch: 1.5 mm.
- Syringe characteristic: 1 ml/1.8 mm (BD 60 ml syringe).

Patient control system

The Patient control system consists of a handset containing a button which, when pressed, generates a short pulse of air pressure slightly above atmospheric pressure. This pulse travels down the attached flexible plastic system tube via a socket to a pressure sensing switch. Thus there are no electrical connections to the Patient. The operation of the sensing switch sends an interrupt request to the slave processor. This initiates the PCA (bolus) request which is logged, and the dose will be delivered if the request is valid.

Monitor interfaces

The pin-outs on the printer/respiration Monitor interfaces are designed to be similar to the serial interface on an IBM-PC.

Sensing (alarm) systems

Introduction

In addition to the occlusion sensing system (page 3-2) the following sensing systems are also operative within the pump.

Syringe nearly empty

A metal flag protrudes from the left hand side of the half nut (in parallel with the leadscrew); this is the nearly empty flag. When this flag de-activates OPTO 0 (see page 4-25) situated at the left hand side of the leadscrew, and the slotted disc is still rotating, the processor makes a calculation that depends on the infusion rate, and issues an alarm three minutes before the end of the infusion.
When the processor detects that OPTO 0 is de-activated and the slotted disc has also stopped rotating, a PUMP STOPPED alarm is generated.

End of infusion/ occlusion

Although the above condition has been termed an alarm state, the same conditions will occur when the syringe reaches the end of its travel at the end of a perfectly normal infusion.
If the slotted disc stops rotating and the nearly-empty flag has **not** moved a sufficient distance to the left to de-activate OPTO 0, the alarm condition will be that of occlusion, as explained on page 3-2.

AC power failure

The software sensing system will detect an AC power failure. The pump will continue to run after a power failure for a period of eight hours or more, by automatically switching to the internal battery supply.

Battery power low and OFF/RECHARGE

The sensing circuits incorporate a system that monitors the output of the batteries and registers an alarm if the voltage of the batteries drops below 5.75 V. If the voltage falls below 5.4 V the pump will turn itself off after an initial warning period.
If the AC power is connected but the pump is turned off by pressing the **OFF/RECHARGE** button then the pump's internal circuit will continue to recharge the batteries.

Self tests, pump malfunction

Various ‘self tests’ are carried out on the pump when it is first switched on**.** In addition to the self tests, the rotation of the slotted disc at the end of the leadscrew is monitored to ensure that the drive mechanism is operating correctly. The software continually checks itself for the validity of the calculations.

Drive disengaged, or syringe not fitted

The drive system is designed so that it is only engaged when the top of the syringe is correctly positioned in the plunger clamp. If the plunger clamp is knocked out of place during an infusion, the drive will automatically stop (the disengagement of the half nut is detected by an opto-sensor).
Trying to operate the pump without a syringe or with a syringe incorrectly fitted will cause the pump to go into an alarm state.

Syringe size system

The syringe sizing system comprises a flag moulding (*Figure 7.2*) that rests on the barrel of the syringe, and in conjunction with two size sensors (*Figure 7.6*) measures the diameter of the syringe being used. The flag moulding rotates about the outer of the two guiding tubes and moves an actuating flag between the two size sensors.
The flag is able to de-activate the size sensors as follows:

- bottom sensor,
- both sensors,
- top sensor.

Depending on the de-activation of the size sensors, the pump monitors the size of a syringe as being... (a) 20 ml, (b) 30 ml or (c) 50/60 ml.
Alternatively, if a syringe is not fitted or a syringe smaller than 20 ml is fitted, then neither sensor will be de-activated and the syringe invalid alarm will be given.

Cover not closed

A flag is fixed to the inside of the left hinge of the syringe cover. This flag rotates about the axis of the hinge and operates an opto-sensor on the Main board which informs the processor whether the cover is open or closed. This information is used for the following purposes:

- to stop an infusion both when the cover is open, and also when the cover is opened,
- to enable the initial set-up mode (cover open), and
- to enable the clinician override feature.

With the exception of the clinician override, the pump will only deliver an infusion when the cover is correctly closed.

Software

The software for the pump uses the latest structured design methods. The software incorporates many safety tests and consistency checks. The source code for the processor is written in Modula 2 which is particularly suitable for safety-critical design. The slave processor is programmed in assembler.

The self-tests include the following:

- CPU test,
- ROM test (16 bit CRC),
- RAM test,
- power supply voltage test,
- keyboard test (this test checks for shorted keys), and
- motor windings continuity test.

The Main processor carries out most of the safety critical functions and is solely responsible for the motor rate calculations.

The Slave processor generates the characters for the display, scans the keyboard and drives most of the Light Emitting Diodes (LED). It also runs a software watch-dog which checks the Main processor.
The configuration and settings are stored in EEPROM in the Main processor.
History information is stored in a dedicated RAM integrated circuit IC8 on the Main board.

CHAPTER 4

CIRCUIT DESCRIPTIONS

Graseby 3300
PCA Syringe Pump

CHAPTER 4
CIRCUIT DESCRIPTIONS

Introduction

This Chapter describes the action of the circuits that are used to operate the 3300 and also shows the associated circuit diagrams.

The 3300 contains four separate circuit boards:

- Main board.
- Regulator board.
- Syringe size sensors board.
- Opto sensors board.

The overall block diagram for the pump (*Figure 4.1)* is shown at the rear of this Chapter, (page 4-7).

The syringe size sensors board (*Figures 4.10* and *7.6*) and the Opto sensors board (*Figures 4.11* and *7.5*) provide a mounting base for the sensors, and also junction points for the board outputs, thus enabling the outputs to be connected to other circuits.

Main board

The Main board block diagram is shown in *Figure 4.2* and comprises the following sub-circuits described in the sections that follow:

- Processor core.
- Motor interface.
- Power control
- Sensors interface.
- Communications processor.
- RS232 serial interface.

Processor core

The Processor core forms part of the Main board and is used to process all the operating activities of the pump.

The microprocessor chip (IC11, *Figure 4.3*) has an on-board EEPROM which stores the programme settings of the pump. IC11 also incorporates an on-board RAM; an Analogue to Digital converter (A to D); timing circuitry; communications circuitry and an internal watch-dog.

The chip IC10 and its associated components C23, C24, R42 and R43 form a reset circuit. The output from this circuit is fed to pin 17 of the main processor. On power up the reset circuit holds pin 17 low to reset the chip. On power down it also holds pin 17 low to avoid spurious activity.

X2 and its associated components R44, C26 and C27 form an 8 MHz oscillator circuit that provides clock pulses for the main processor on pins 6 and 7.

IC8 is a 32 x 8 K RAM which is accessed by the processor one page (8K) at a time. This paging is controlled by pins 3 and 4 of IC13 which is a 4 bit parallel latch used to generate additional processor output ports. The RAM is used primarily for storing historical information and is battery backed to prevent losing this information.

IC9 ensures that IC8 is supplied with the necessary standby power (Vcc') when the pump is switched off. IC9 also disables IC8 when the pump is switched off, so that the historical data stored in the RAM of IC8 will be protected from corruption.

Pins 2 and 3 on the main processor control its mode of operation. Both pins are held high to set the processor to address the external EPROM, IC12. The EPROM chip IC12 stores the main operating program.

Pins 68 and 67 are held at Vcc and ground (respectively) as the reference inputs to the processor's built in A to D converter.

Pin 18 receives non-maskable interrupts generated by the slave processor in the event of a system fault being detected.

The main processor directly controls the outputs to the stepper motor via pins 36 to 39.

IC14 is a real time clock; X1 is a 32.768 kHz crystal which provides the reference signal for the clock. The supply to IC14 is also battery backed by IC9.

Motor interface

The motor interface circuit, *Figure 4.4* is controlled by pulses supplied from the main processor, in a set sequence.

Each of the four motor control lines is fed to a NOR gate. In turn, each NOR gate generates a high pulse. Each pulse switches one of a set of four power MOSFETS which in turn drive the stepper motor. The diodes provide a discharge path for current stored in the motor coils when the transistors are turned off.

R1 and R2 enable the main processor to detect current flow through Q1 and Q2 (MOTORSENSE 2) and Q3 and Q4 (MOTORSENSE 1).

If the slave processor detects a problem, it sends the DISABLE MOTOR line high (which also sends an NMI to the main processor). The output from each NOR gate is forced low, thus disabling the motor irrespective of control pulses from the processor.

Power control

Power from the Regulator board is routed to the power control circuit (PL3, *Figure 4.5*) . D6 is an AC power-on LED which lights whenever the AC power is applied. IC3 is a linear regulator which provides a 5 V DC supply (Vcc) for the logic circuits. C12, C13 and C14 are decoupling capacitors.

DCSW is an unregulated supply voltage from the power control switch, MOSFET Q6. This is used to supply high current components such as the motor thus avoiding overloading the regulator.

R14 and R15 derive VOLTAGE_SENSE from the DCSW supply. This is used by the Main Processor to monitor the battery voltage.

The circuit around Q9 generates Vcc' which is a reduced supply of 3 V, to provide battery backup to the RAM and the clock. IC5, IC6 and R19 form a shunt regulated reference source and Q9 is an emitter-follower series regulator. Vcc' is, therefore, the voltage across IC5 and IC6 less the Q9 base-emitter voltage.

IC4B and IC4D form a set/reset latch to operate the power control switch, MOSFET Q6. The latch is triggered by a high pulse from the main processor (POWER OFF), causing Q6 to turn off and disconnect the power. Once tripped, the latch cannot be reset by the processor, but must be reset by a high pulse from the keyboard ON button. Q7, R22, R23 and R24 form a logic level translator to translate 0-5 V logic levels into 0-7 V logic levels for IC4 which is powered from 7 V. C9 and C10 overcome the effects of any transients. D5 prevents C10 from discharging into IC4B.

R16, R17, R18 and Q8 enable the main processor to detect the presence or absence of AC power. If AC_SENSE is low it indicates that AC power is present.

Sensors interface

Terminal blocks PL4 and PL5 (*S*) connect to the syringe size opto-sensors and the status opto-sensors, respectively. OPTO1 is the cover sensor. When triggered by a sensor enable pulse from the main processor, Q10 turns on so that DCSW, limited by R28 and R29, is applied across the sensor emitters.

IC7 (B to F) are Schmitt inverters which add hysteresis to most of the opto outputs. ROTATION_SENSE is input to the A-D converter where the software provides hysteresis to the opto signal.

Communications processor

The communications processor circuit (*Figure 4.7*) handles the communication with the display; alarm; start and stop LED's; syringe size lamps; the sounder and the membrane switch panel. This circuit also runs a software watch-dog to monitor the operation of the Main processor.

R51, R52 and Q12 provide a buffer such that pin 1 of the Slave processor (IC16) can receive a reset pulse (low) from the reset controller. Internally generated reset pulses will not affect the Main processor. X3, R53, C35 and C36 form a 4 MHz oscillator, providing clock pulses for the processor.

Outputs on pins 10, 11 and 12 are used to strobe the switch panel (active low), which has a 3 x 3 matrix structure. Data from the switch panel is delivered to IC16 on pins 32, 33, and 39. IC18 buffers the processor inputs and outputs to the keyboard. Pin 2 is normally held high. Pressing the Patient handset button causes the pneumatic switch to operate, making pin 2 go low to request a PCA (bolus) dose. Diode D7 protects the processor input from static.

Outputs from pins 26 to 31 control the LED's for stop, start, alarm and the three sizes of syringe. Each output is fed to a controlling transistor. When the output goes high the associated transistor conducts, causing current to flow through an LED.

There is a serial link between the communications processor and the main processor. The main processor must supply a command every 40 ms. If this command is not received the slave processor's output on pin 38 disables the motor and creates a non-maskable interrupt which is fed to the main processor.

The slave processor also controls the operation of the sounder, connected via PL8. When pin 25 goes high, Q14 is turned on and DCSW is applied across the sounder to give a loud alarm. When pin 24 goes low, Q21 is turned on and a voltage of DCSW –3.9 V (the drop across Zener D22) is applied across the sounder to give a soft alarm. D23 provides protection to the circuit against extraneous reverse voltages generated by the sounder.

Pins 7 - 9 and 13 - 21 provide a display circuit interface. Pins 13 - 21 provide a data bus and pins 7 - 9 the control signals.

Q11 controls the display backlight. Q11 is turned on from pin 6 of the processor whenever mains power is on and, when on battery power, for two minutes after the operation of any key except **OFF**.

IC17 provides a temperature compensated contrast control. IC17 is a charge pump controller, with C37 and C38 as the charge pump elements. This derives –5 V from Vcc'. The potential divider RT1, R60, R63 and R64 ensures the correct bias voltage is applied to the LCD. RT1 compensates for the temperature characteristics of the LCD.

RS232 serial interface

WARNING: Only items of equipment that conform to EN60950 may be connected to the 9-pin RS232 connector that is situated at the rear of the pump. This conformity will prevent the safety of the patient being compromised.

IC2, together with C5 - C8 (*Figure 4.8*) forms two charge pumps which derive +10 V and –10 V from Vcc. This provides a voltage shifting buffer for the external printer.

Internal serial cable

The connections from the RS232 serial interface circuit (PL2, *Figure 4.8*) and the external nine pin 'D' connector are shown on *Figure 4.12*, and in *Table 4.1*.

Table 4.1 PL2 connections

PL2	DB9	Printer	External Monitor
1	5	Gnd	Gnd
2	9	-	Override
3	4	DTR	-
4	8	CTS	-
5	3	TxD	-
6	7	RTS	-
7	2	RxD	-
8	6	DSR	-
9	-	DCD	-
10	-	-	-

Printer dip switch settings

The dip switch settings for the Seiko DPU-411 printer are shown on *Table 4.2*.

Table 4.2 Seiko DPU-411 printer dip switch settings

SWITCH	SW1	SW2
1	Off	On
2	Off	On
3	On	On
4	Off	Off
5	Off	Off
6	Off	Off
7	Off	N\A
8	On	N\A

Regulator board

The Regulator board circuit is shown in *Figure 4.9*. This circuit is based around a TL594 chip which is a standard step-down switching regulator chip that operates at 40 kHz and acts as a pulse width modulating converter in order to provide 7 V DC for the motor and the LED's. This supply is also used to provide the 5 V DC supply to the logic circuits.

The Regulator circuit is protected by an AC power fuse (see page 5-3). The AC input power is filtered by C1. The primary terminals of the AC power transformer are PL3, PL4 and PL7 to PL10, and its secondary terminals are PL5 and PL6.

PL4 and PL8 are used when the AC input supply is between 220-240 V and PL3 and PL7 are used when the AC input supply is 110-120 V. L2 and D8 are used to suppress transients.

Diodes D4 to D7 provide a bridge rectifier the output of which is smoothed by capacitor C4 which has 25 to 35 V across it. Power is supplied to pin 12 of the Regulator chip via FS1 (500 mA). The frequency of the Regulators on-board oscillator is controlled by C6 and R3.

The output at pins 8 and 11 controls the operation of transistor Q1. Q1 cycles on and off such that the mean voltage produced is 7 V. As Q1 turns off the voltage across switching inductor L1 charges C3 via flyback diode D2. A feedback voltage is supplied to pin 1 of the Regulator by means of a potential divider comprising R1, TH1, R9, RV1 and R8. TH1 varies the output voltage according to temperature to compensate for the battery charging characteristics.

C2 acts as a decoupling capacitor and the Zener diode D1 acts as a protection diode for the remaining circuit if the regulator fails.
The output at PL11 is listed in *Table 4.3.*

Table 4.3 PL11 outputs

Pin	PL11 output
1 and 2	Ground.
3	7 V DC when on mains or battery supply.
4	7 V DC when on mains supply.

PL12 provides a link to the rechargeable batteries, protected by fuse FS3.
Potentiometer RV1 is set as follows:

1. Unplug PL11 and PL12 and connect a 68 ohm load across PL11 pins 2 and 3.
2. Switch on the AC power supply.
3. Set RV1 to give a voltage across the load according to the temperature, as shown in *Table 4.4*.

Table 4.4 Temperature/ voltage range for setting RV1

Ambient temp. (deg. C)	Voltage across load (volts)
28	7.015
27	7.027
26	7.038
25	7.050
24	7.062
23	7.073
22	7.085
21	7.096
20	7.108
19	7.120
18	7.131
17	7.143
16	7.154
15	7.166

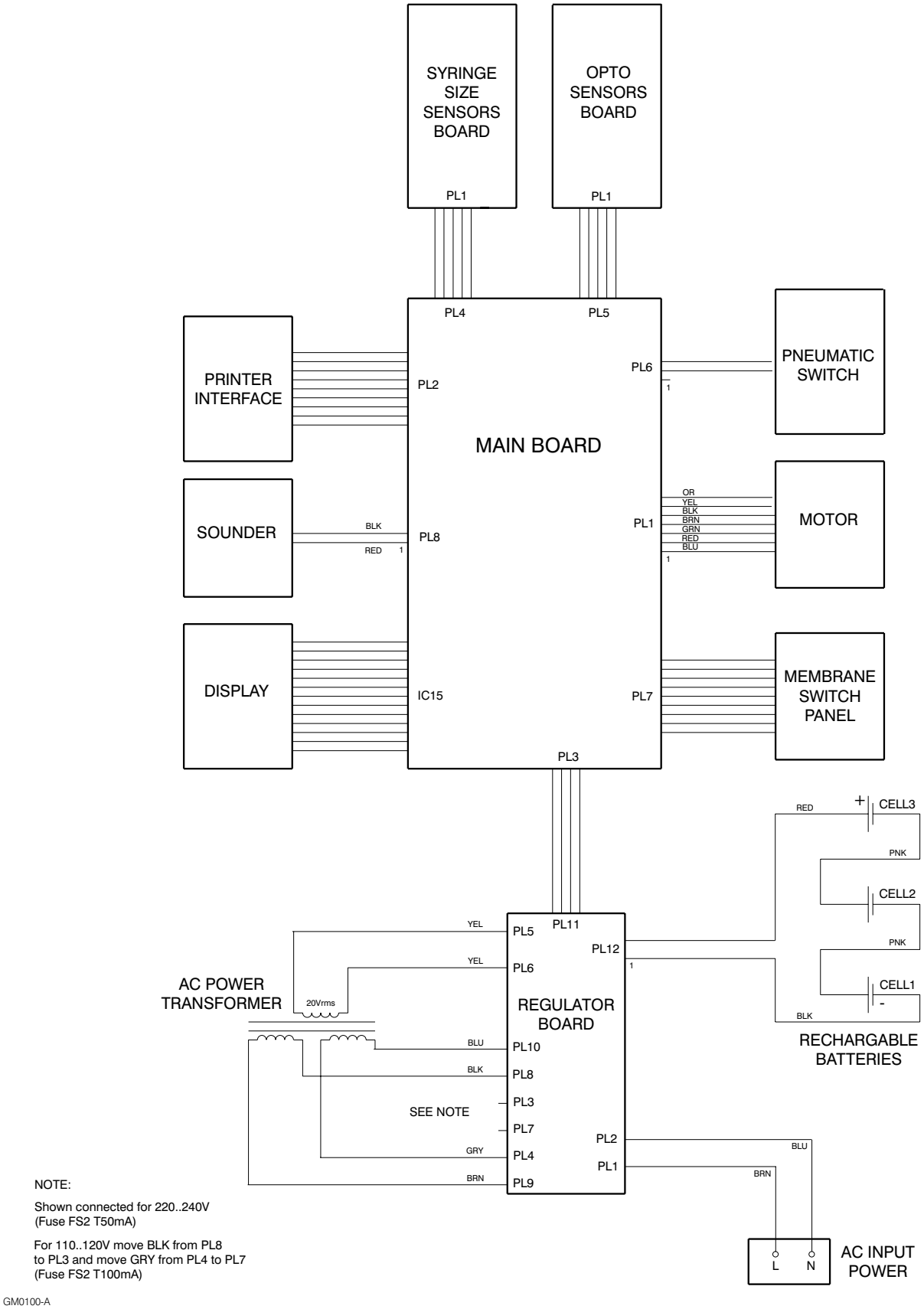


Figure 4.1 Overall block diagram for the 3300 system

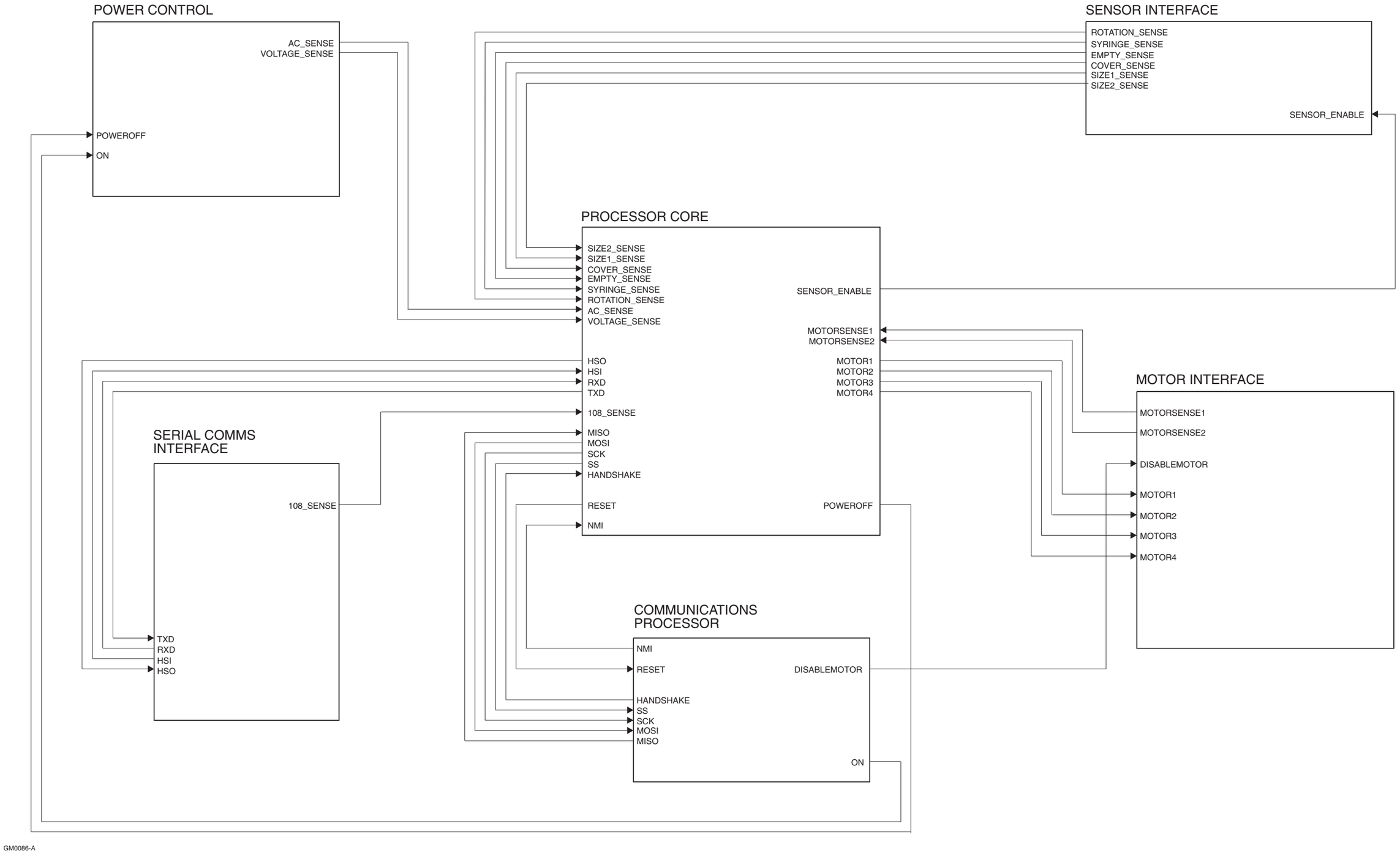


Figure 4.2 Main board block diagram

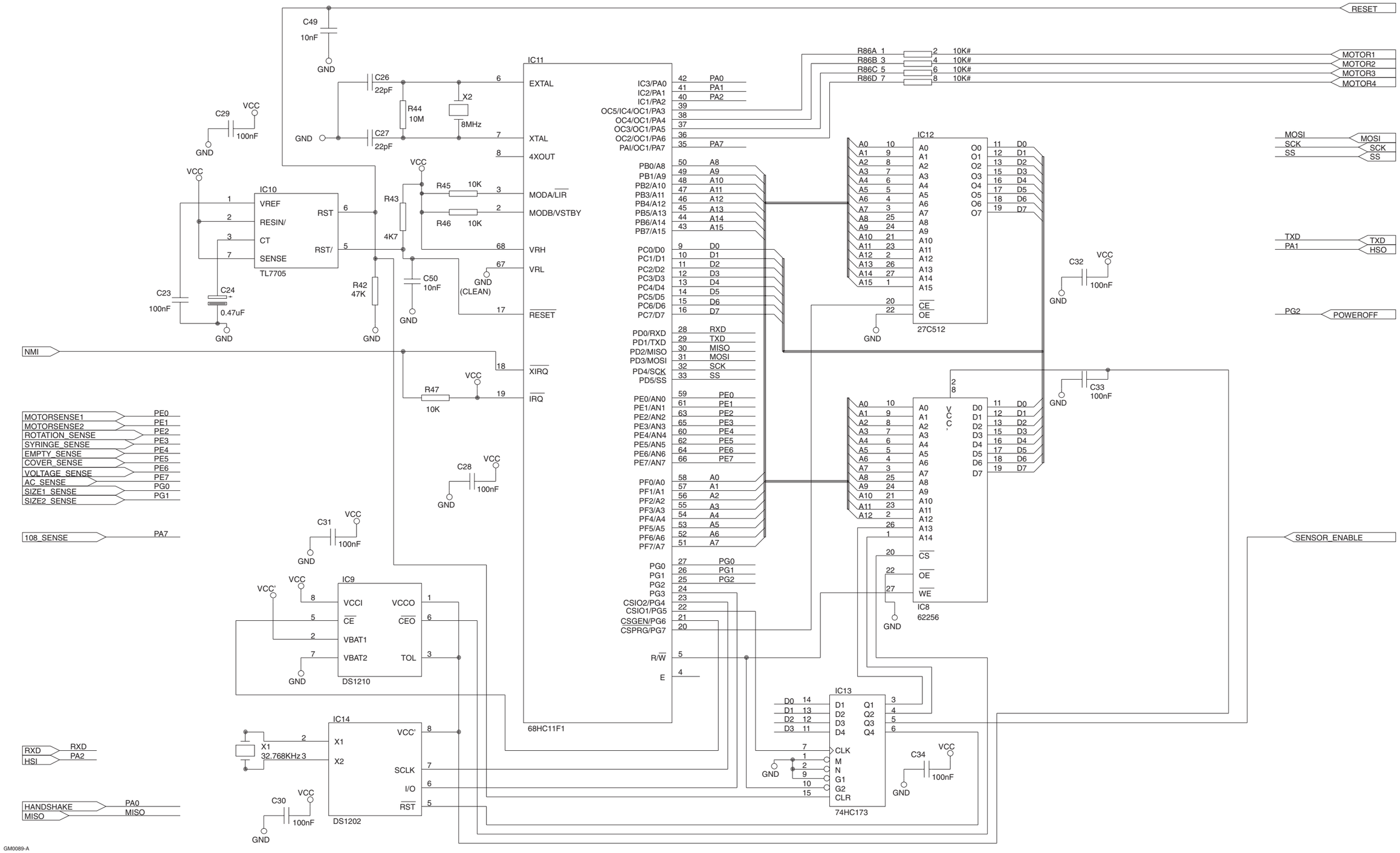


Figure 4.3 Processor core circuit diagram

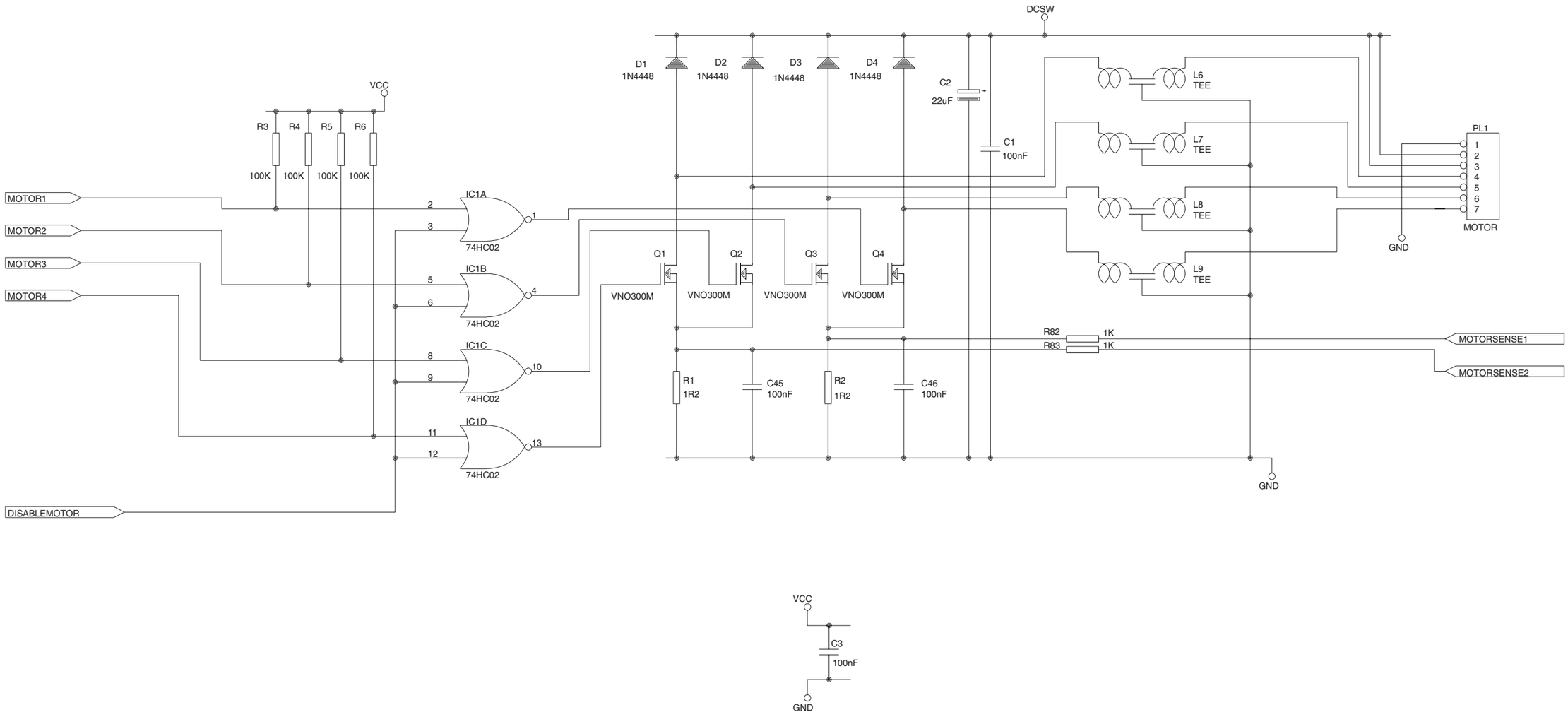
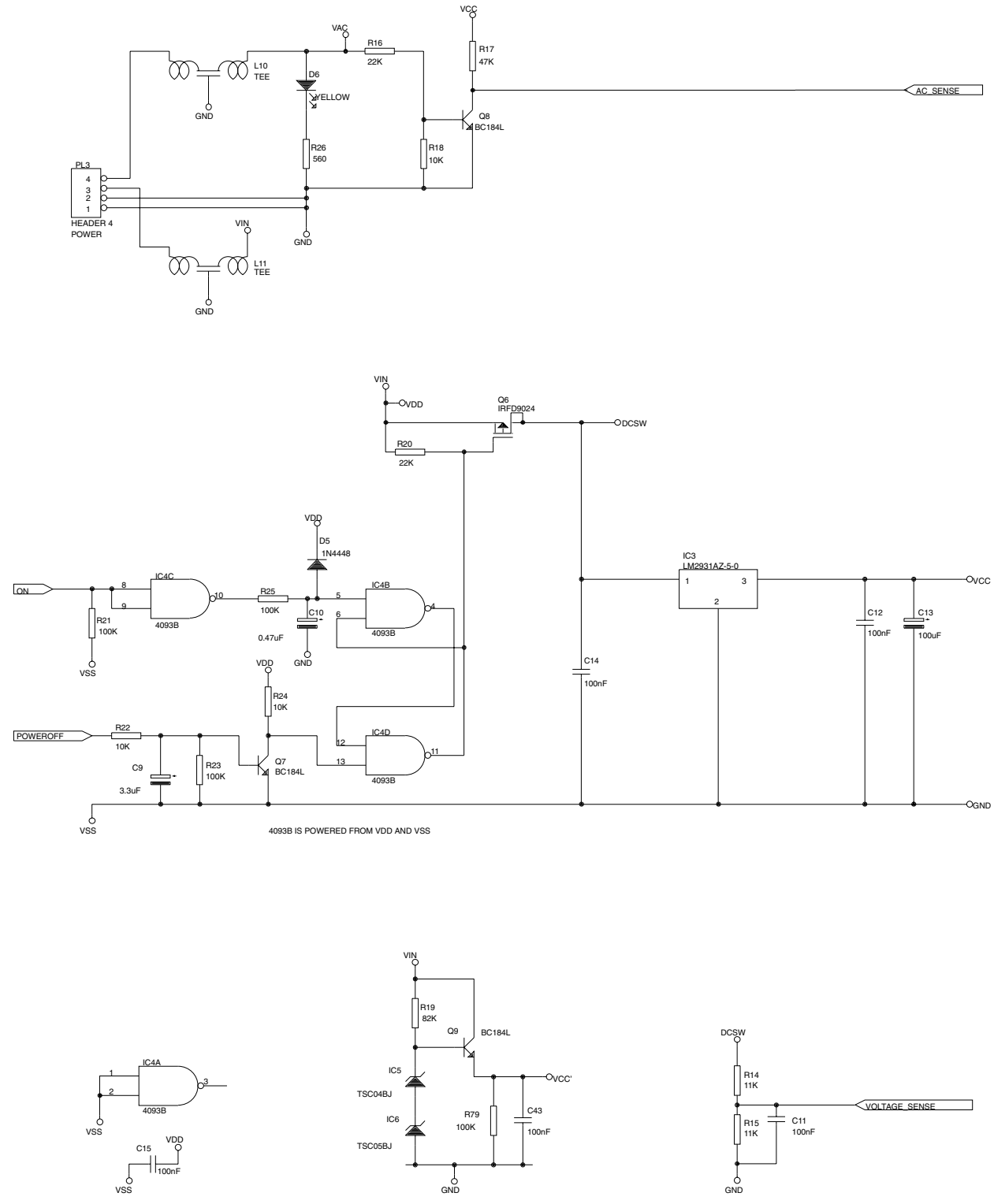
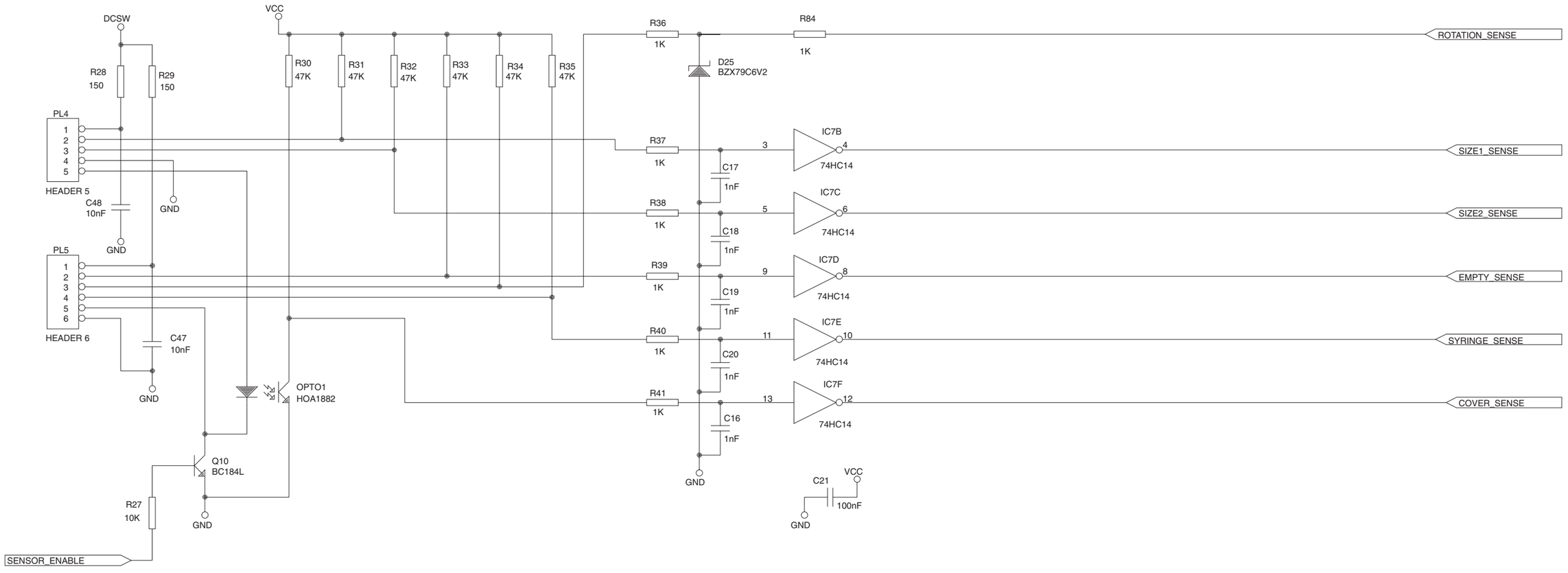


Figure 4.4 Motor interface circuit diagram



GM0088-A

Figure 4.5 Power control circuit diagram



GM0090-A

Figure 4.6 Sensors interface circuit diagram

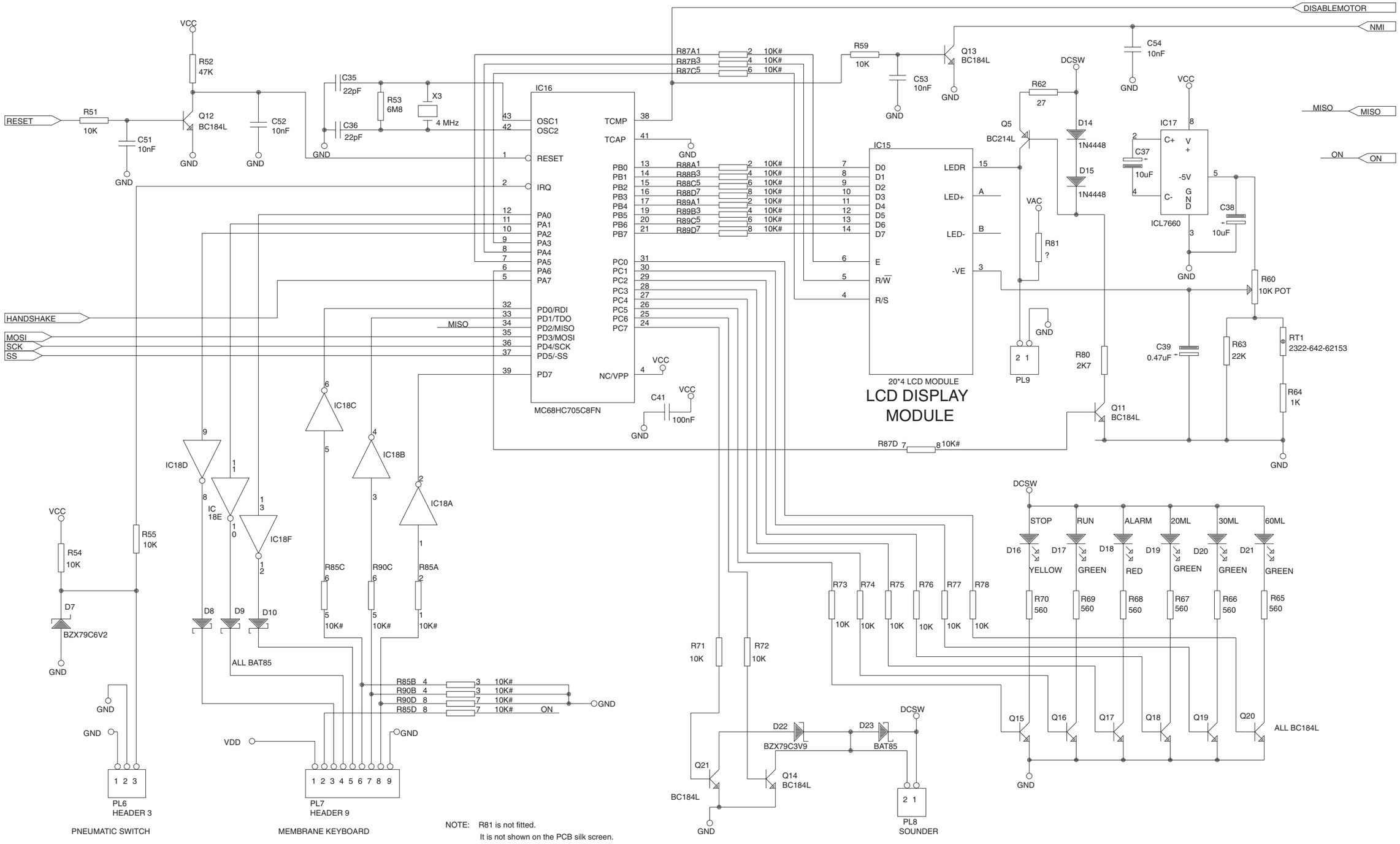
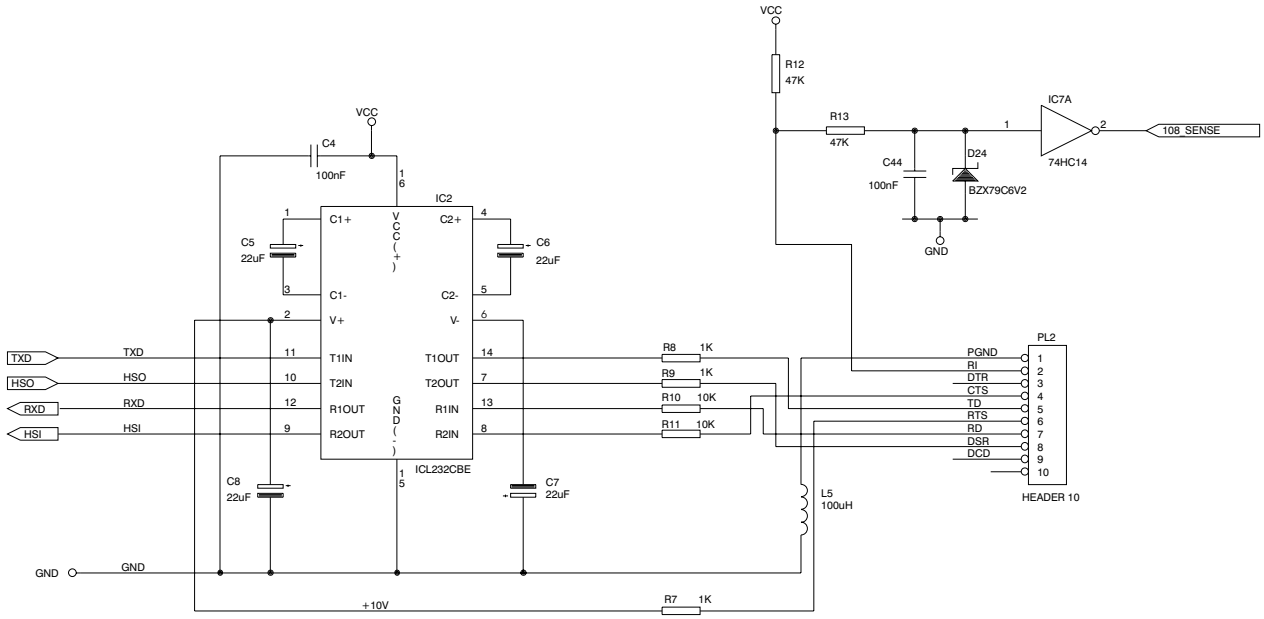


Figure 4.7 Communications processor circuit diagram



NOTE:

See Fig. 4.16 for the connections from PL2 to the rear (external) nine-pin "D" connector.

GM0087-B

Figure 4.8 RS232 serial interface circuit diagram

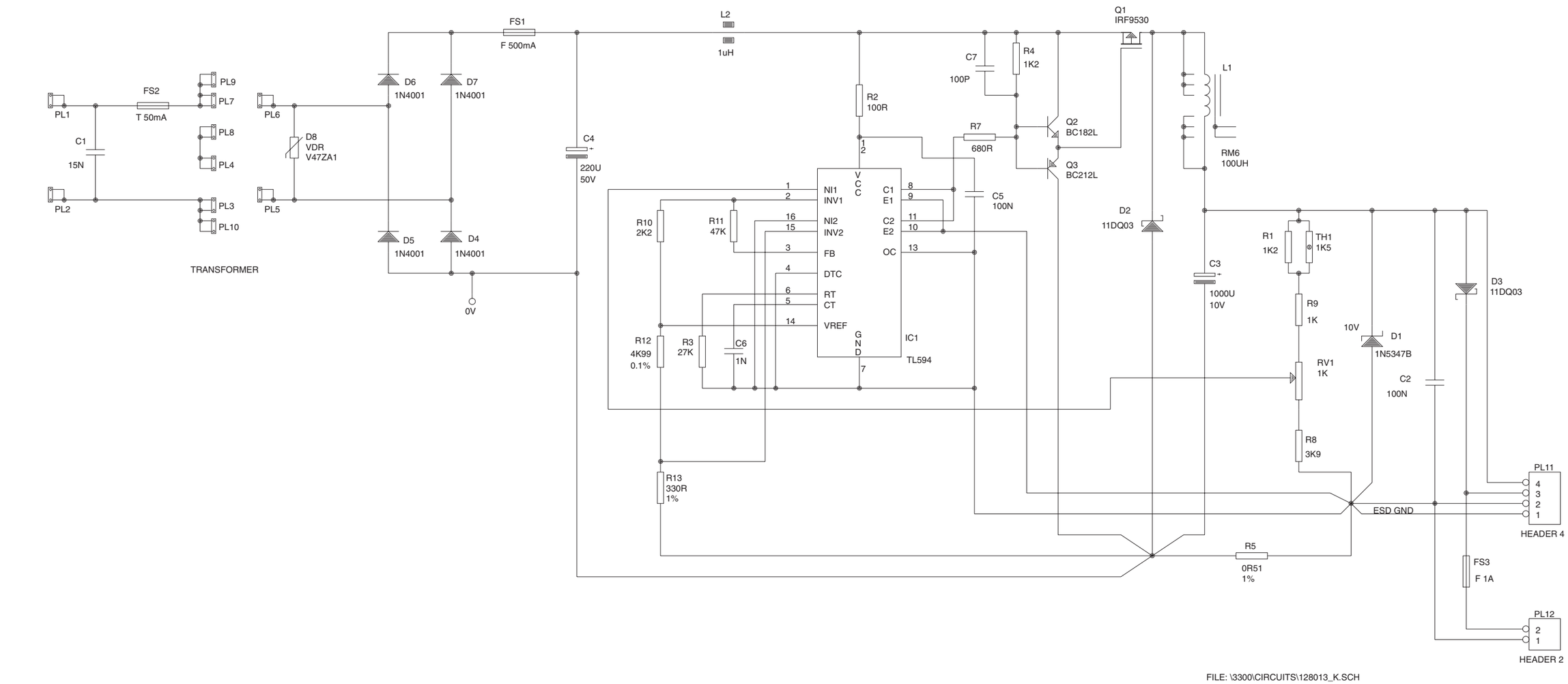


Figure 4.9 Regulator board circuit diagram

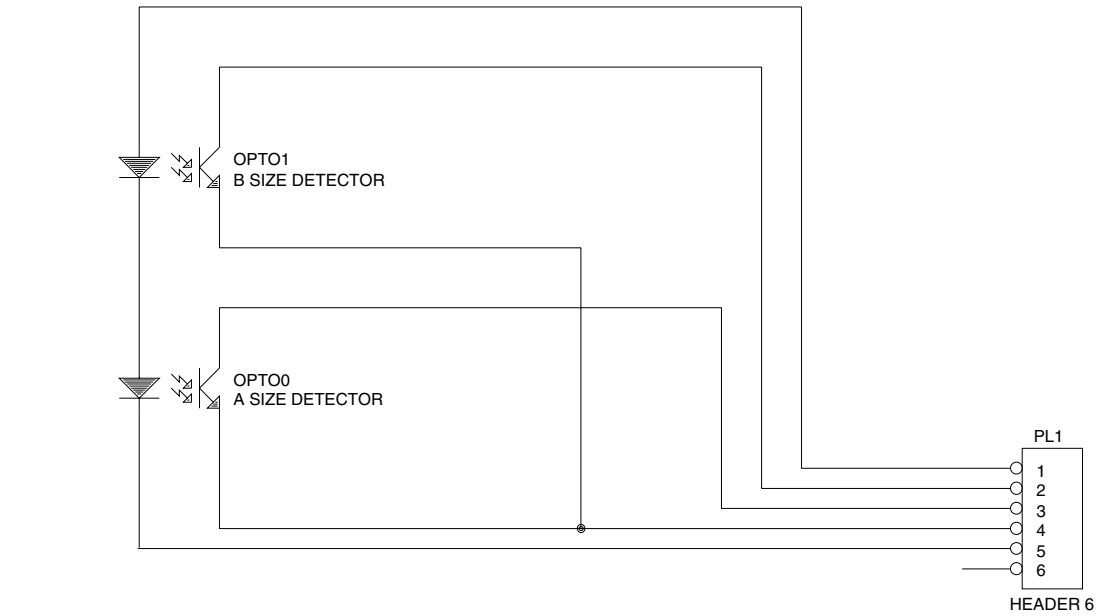


Figure 4.10 Syringe size sensors board circuit

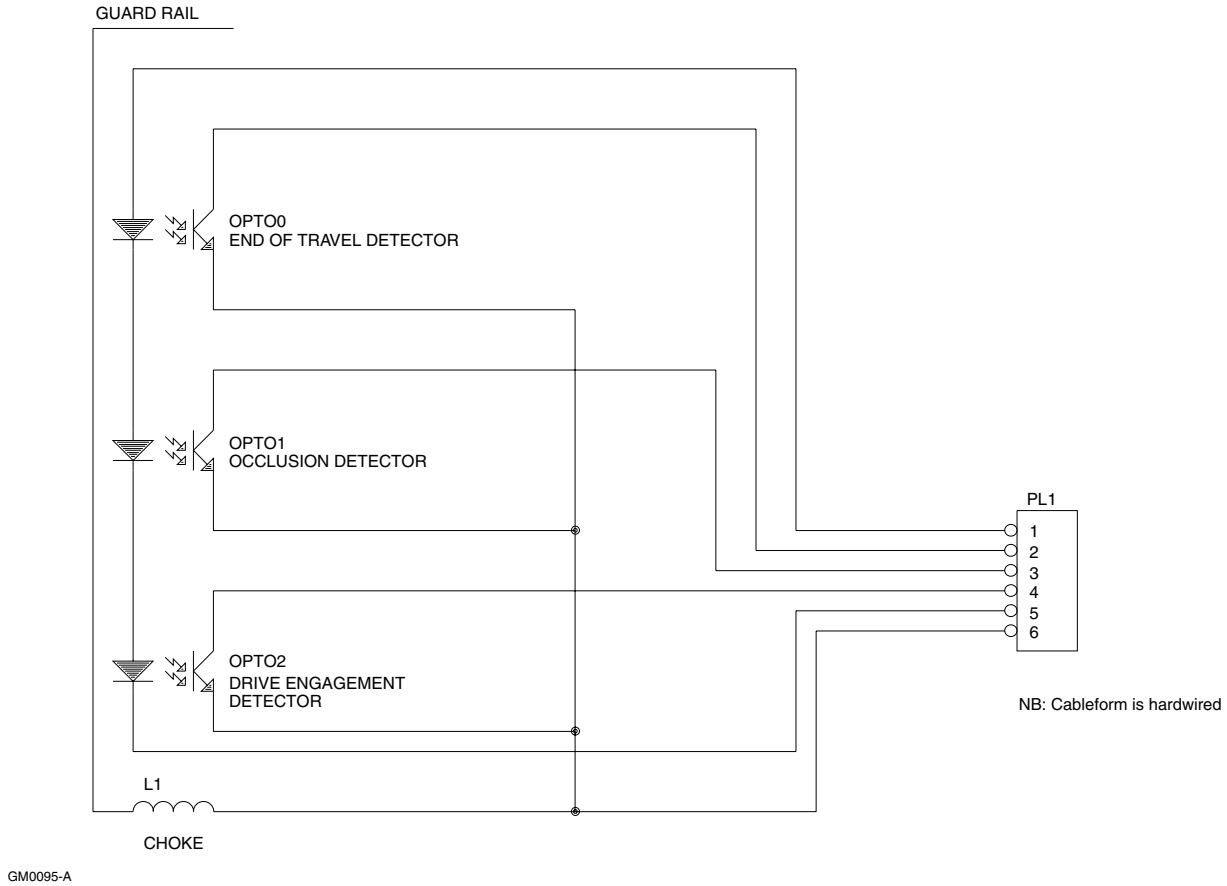
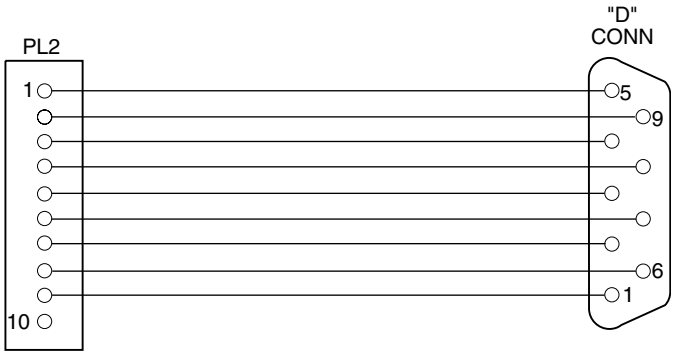


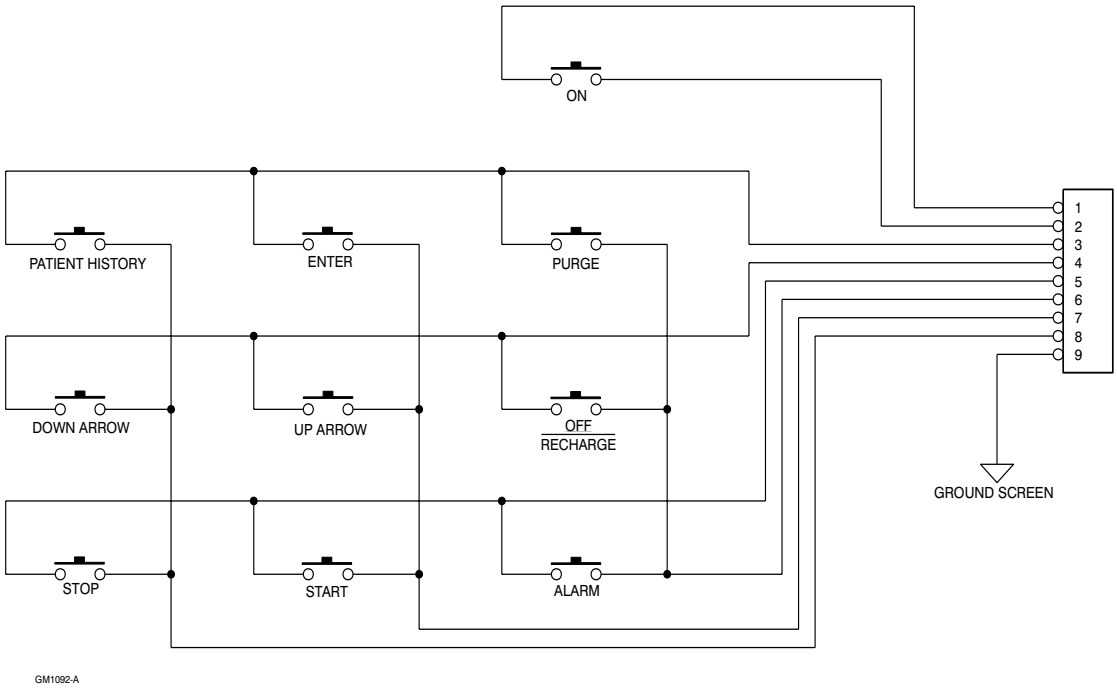
Figure 4.11 Opto sensors board circuit



NOTE:
The RS232 Serial Interface connections to PL2 are shown on Fig. 4-8

GM0187-A

Figure 4.12 Internal serial cable and ‘D’ connector connections



GM1092-A

Figure 4.13 Membrane switch panel circuit

CHAPTER 5

FAULT CODES, CLEANING and REPAIR PROCEDURES

Graseby 3300
PCA Syringe Pump

Chapter 5

FAULT CODES, CLEANING and REPAIR PROCEDURES

Fault codes

Comprehensive fault codes have been designed into the 3300 so that if a fault does occur it can be automatically identified. Fault codes are used by the pump to indicate the type of fault that has occurred.

Both processors on the pump are capable of recognising faults and generating fault codes. The main processor generates codes in the range 0 to 99 (*Table 5.1*) and the slave processor in the range 100 to 199 (*Table 5.2*). The fault codes are not expected to change for future software versions. The operational ALARMS and WARNINGS are detailed in the 3300 Instruction Manual.

Table 5.1 Main processor fault codes

Code	Description
07	RAM test failure.
08	Battery backed RAM test failure.
10	Leadscrew turning too fast.
11	XIRQ interrupt line asserted.
22	Unexpected interrupt.
25	Syringe size variable value illegal.
26	Syringe type variable value illegal.
30	Modula program returned to start up code.
31	Master state variable value illegal.
32	Master state action request illegal.
33	Too many master state events for size of buffer.
34	Difference detected between a variable and its duplicate.
35	Variable out of allowed range.
36	RTC illegal year value detected.
37	History Type variable value illegal.
39	Error with checking of dose size.
40	Stack pointer out of range.
42	EEPROM related variable out of range.
45	Illegal opcode detected.
46	Internal COP monitor timeout.
47	Internal clock monitor reported an error.
51	Foreground task operating without the background.
52	Background task operating without the foreground.
53	SPI foreground hasn't given the background a look in.
54	Motor interrupt running away.
55	Processing time ran out for task scheduler.
56	6811 CONFIG register not programmed correctly.
57	The checks on the motor module sums did not verify.
58	The checks on the sensors module sums did not verify.
61	A node check baton has the wrong value.
70	CPU test failure.
85	Power supply overvoltage during power on tests.
86	Motor is drawing the wrong current during power on tests.
87	ROM CRC failure.
90	EEPROM index corrupt or EEPROM expired.
91	Keyboard short during power on tests.

Table 5.2 Slave processor fault codes

Code	Description
100	Internal COP monitor timeout interrupt.
102	Main processor resetting software watchdog too frequently.
103	Processor not resetting software watchdog frequently enough.
109	Timeout while waiting for initialisation from main processor.
111	Unexpected interrupt asserted.
112	Program checksum failed (power on self test).

Cleaning

CAUTION
The pump must *not* be immersed in any liquids.
Immediately wipe off any liquid that may be spilt on the pump.

The outer surfaces of the pump can be cleaned by wiping them with a damp cloth (soapy if necessary).

Repair procedures

WARNINGS: The repair procedures detailed in the sections that follow, must only be carried out by qualified personnel.

Always disconnect the AC supply from the pump before opening the casing.

The safety and reliability of the pump may be compromised by the use of parts other than those specified in this Manual.

Introduction

In several of the repair procedures that follow, information has been given on how to remove and renew a complete assembly.

If a single component within an associated assembly is faulty and can be individually repaired, then reference to the appropriate illustrated parts exploded view will enable the single faulty component to be renewed.

If a leadscrew assembly or a half nut is repaired, then the following checks and if necessary the associated adjustments must be carried out:

- thrust check (see page 2-8).
- plunger clamp checks (see page 6-3).

Whenever the case halves are separated, the Syringe size sensors tests detailed on page 6-1 must be carried out.

Fuse renewal

WARNING: If the pumps internal AC supply voltage setting is altered, both the label on the underside of the pump must be changed (to indicate the correct AC voltage) and the correctly rated fuse must be fitted.

The pump has three safety fuses that are mounted on the Regulator board (see *Figure 7.8*). Details of the fuses are as follows:

- FS1 is a fuse located in a DC line and has a 500 mA rating.
- FS2 acts as a DC supply time delay fuse having the following alternative rating:
  T 50 mA for a 220-240 V AC supply.
  T 100 mA for a 100-120 V AC supply.
- FS3 is a fuse located in a DC line and has a 1 amp rating.

To renew a blown fuse, the pump casing must be disassembled (see page 2-5) to access all three fuses. If a fuse blows, it must be replaced by a new fuse of the correct rating. Reassemble the casing as detailed on page 2-5.

Main board renewal

1. Open the casing (see page 2-5).
2. Remove and retain the six pan head self tapping screws that are used to fix the Main board to the front casing.
3. Displace the faulty board. Disconnect the four top connectors and the three side connectors from the board.
4. Remove the faulty board.
5. Fit a new board by reversing steps (2) and (3) and close the casing (see page 2-5).

Regulator board renewal

1. Open the casing (see page 2-5).
2. Note of how the eight spade connectors are mounted on the Regulator board and then slide and lift the connectors off.
3. Prise open the two nylon retaining clips and release the four wires.
4. Remove and retain the two screws that hold the transformer in place. The left hand screw is 25 mm long and the right hand screw is 8 mm long. Lift out the faulty transformer.
5. Disconnect the two bottom left hand connectors (PL11 and PL12) from the board by prising the side retaining clip from each connector and then pulling the connector out.
6. Remove and retain the two screws that hold the board in place and then remove the faulty board.
7. Fit a new board by reversing steps (2) to (6) detailed above, and then close the casing (see page 2-5).

Status sensors board renewal

1. Open the casing (see page 2-5).
2. Lift the retaining clip on the side of ribbon cable connector PL5 (Main board) and then disconnect PL5.
3. Remove and retain the ribbon cable clip screw from beneath the board.
4. Remove and retain the two fixing screws from the front of the board.
5. Remove the faulty board.
6. Fit a new board by reversing steps (2) to (4) and then close the casing (see page 2-5).
7. Carry out test No. 10 (page 6-3) and the Plunger clamp alarm test (page 6-4).

Syringe size sensors board renewal

1. Open the casing (see page 2-5).
2. Unscrew the Main board (see page 5-4).
3. Disconnect the flexible loom connector PL4 from the Main board.
4. Remove and retain the two screws that hold the sensors board in place. Remove the board complete with its loom and connector. If there is a thin shim attached to the faulty board, remove and retain the shim.
6. Fit a new sensors board by reversing steps (2) to (4), close the casing as detailed on page 2-5, and then carry out the size sensors test (see page 6-1).

If the pump fails to pass the syringe size sensors test, it is recommended that the sensors kit (part number 0131-0214) should be obtained from Smiths Medical and fitted according to the instructions that are supplied.

AC power transformer renewal

1. Open the casing (see page 2-5).
2. Make a note of how the eight spade tags are connected to the Regulator board and then slide and lift off the tags.
3. Prise open the two nylon retaining clips and release the four wires.
4. Remove and retain the two screws and spacer that hold the transformer in place. The left hand screw is 25 mm long and the right hand screw is 8mm long.
5. Lift out the faulty transformer.
6. Fit a new transformer by reversing steps (2) to (4) detailed above and then close the casing (see on page 2-5).

Plunger clamp and super nut assembly renewal

This assembly is held in place within the casing by a narrow retaining spring, two clamp brackets and two circular guide tubes.

1. Open the casing (see page 2-5).
2. Unhook the top of the retaining spring (2 mm dia. by 2.5 cm long) from the syringe size sensor lever arm.
3. Remove and retain the three screws from the two clamp brackets that hold the square lay shaft in place. Remove and retain the two brackets.
4. Lift up the square shaft; toggle mechanism; super nut and the flag that is situated on the left of the square shaft.

5. Lift the two guide tubes off their respective seating and remove the entire assembly.

6. Fit the new assembly by reversing steps (2) to (5) detailed above and then close the casing (see page 2-5).

Pole clamp assembly renewal

The Pole clamp assembly is held in place by two specially manufactured assembly tamper proof screws and the assembly can only be removed with a special screwdriver (part number 6880-1420 for the shaft and 6880-1425 for the handle).

1. Insert the key, unlock and open the syringe cover.

2. Remove and retain the two special M4 screws that are inserted into the stainless steel bracket on the base of the pump.

3. Slide the pole clamp assembly away from the bottom catch.

4. Fit the new assembly by reversing steps (1) to (3).

Leadscrew assembly renewal

The leadscrew assembly is held in the rear casing by two bearing clamp plates. It is also kept under tension by a strong adjustable spring. The keyed coupling bush that screws into the right hand end of the lead screw has a 'left hand' thread.

1. Open the casing (see page 2-5).

2. If necessary run the motor (on battery power) in order to reveal the small grub screw situated in the occlusion adjusting nut on the right hand side of the leadscrew. Using a 1.5 mm hexagonal key loosen the grub screw[1] .

3. Ensuring that the leadscrew does not turn, move the occlusion adjusting nut counter-clockwise in order to relax the spring tension.

4. Remove and retain the two pan head self tapping screws that hold the right hand bearing clamp plate in place; remove and retain the plate.

5. Lift out the leadscrew, together with the motor and gear box. The motor and gear box are coupled at the right hand end of the leadscrew.

6. Uncouple the faulty leadscrew from the motor by pulling it away from the motor shaft.

7. Fit a new leadscrew assembly (see Note below) by reversing steps (2) to (6). Tighten the grubscrew to a torque of 15 ± 2 cNm. Alternatively, renew the motor and gear box assembly as detailed in the following section.

Note: During the fitting of the new leadscrew the spring assembly may have to be compressed to the left in order to fit it into the grooves in the rear casing.

8. Ensure that the groove on the syringe size sensor collar (through which the larger telescopic tube slides) fits correctly into the concaved rear casing.

9. Assemble the casing (see page 2-5).

10. Check the Occlusion pressure (see page 2-7).

11. Carry out the syringe plunger clamp adjustments (see page 5-8).

[1] If the l.h. thread coupling bush is removed, the torque required when refitted must not exceed 40 cNm.

Motor and gear box assembly renewal

1. Open the casing (see on page 2-5).
2. Remove the motor cable loom connector (PL1) from the Main board.
3. Remove the leadscrew assembly (see page 5-5). The motor and gearbox assembly is attached to the right hand end of the leadscrew assembly and, therefore, will be removed with the leadscrew assembly.
4. Detach the faulty motor and gear box assembly from the leadscrew assembly by pulling the two assemblies apart.
5. Fit the new motor and gear box assembly by reversing the steps (2) to (4) and then assemble the casing (see page 2-5).
6. Check the Occlusion pressure (see page 2-7).
7. Carry out the plunger clamp adjustments (see page 5-8).

Occlusion clutch and disc assembly renewal

The occlusion clutch and disc assembly is situated on the left hand side of the leadscrew assembly underneath the status sensors board.

1. Open the 3300 casing (see page 2-5).
2. Remove the Status sensors board (see page 5-4).
3. Remove the leadscrew assembly (see page 5-5). The motor and gearbox assembly is attached to the right hand end of the leadscrew assembly and, therefore, will be removed with the leadscrew assembly.
4. Remove and retain the two screws and the bracket that holds the clutch and disc assembly in place.
5. Remove the faulty clutch and disc assembly.
6. Fit a new clutch and disc assembly by reversing steps (2) to (4) and then assemble the casing (see page 2-5).
7. Check the Occlusion pressure (see page 2-7).
8. Carry out the plunger clamp adjustments (see page 5-8).

Membrane switch panel renewal

The Membrane switch panel has an adhesive backing which fixes it to the front casing. Take care not to bend the new panel, and carefully handle the flexible cable loom.

1. Open the casing (see page 2-5).
2. Disconnect the panel ribbon cable connector (PL7) from the Main board.
3. Starting by lifting a corner, peal the faulty panel away from the case. Then remove the panel by pulling the connector out through the slot in the front casing.
4. Remove traces of old adhesive from the front case recess (a cloth lightly dampened with white spirit may be used).
5. From the top of the new panel peel off the paper backing, approximately as far as the top of the display window.
6. Push the connector and flexible lead of the new panel through the slot in the case.
7. Align the top edge and sides of the panel with the top and sides of the case recess. Gently rub the top edge of the panel to give light adhesion to the case and then remove the remainder of the protective backing paper.
8. Working from the top downwards and using light pressure lay the panel into the case recess.
9. When the label is positioned correctly into the case recess (i.e. no over-hanging edges), use a soft cloth to rub the panel down firmly pushing out any air bubbles at the same time.
10. Connect PL7 to the Main board and assemble the casing (see page 2-5).

Super nut renewal

Early 3500 pumps (pre s/n 56905) were fitted with a half nut. From May 1999, the half nut was replaced with a three-quarter super nut. The following procedures refer to the super nut, which must replace the half nut.

Figure 5.1 Half nut (obsolete)/ Super nut

The super nut machined casting (see *Figure 7.2, item 3*) is clamped onto the left hand end of the outer metal tube by an M4 countersunk screw that is tightened into a recess positioned hexagonal nut. It is also attached to the toggle mechanism by a Spirol connecting pin.

1. Open the casing (see page 2-5).
2. Remove the syringe plunger clamp, super nut, toggle and square shaft assembly (see page 5-4).
3. Remove and retain the clamping screw and nut.
4. Lever the two sides of the super nut apart in order to disengage the casting pip from the locating hole in the metal tube.
5. Remove the Spirol connecting pin that holds the super nut to the toggle mechanism.
6. Fit a new super nut by reversing the steps (2) to (5) detailed above and assemble the casing (see page 2-5).
7. Carry out the plunger clamp adjustments (see pages 6-3 and 6-4).

Plunger clamp repair

The plunger clamp cover must be removed in order to reach the internally located lock or pin moulding. The outer casing of the clamp is fixed to the right hand end of the outer tube.

1. Remove and retain the two screws that hold the plunger clamp cover onto the outer casing, and then remove the cover.
2. The lock and pin moulding together with the associated spring will become accessible.
3. As required, fit a new lock and/or pin and assemble the clamp as detailed in paragraph 1 above.

Batteries. Checks and replacement

WARNING: The internal pump batteries must be disposed of in accordance with the manufacturers instructions. Lead acid batteries must *not* be placed in the normal waste stream.

Smiths Medical recommend that the condition of the three internal batteries is checked at least annually. The batteries will normally last several years. If they fail to charge, all three batteries must be replaced at the same time. The batteries are held in place in the front case by three-pronged flexible plastic mouldings.

Checks

Using a BD 60 ml syringe, set the pump as follows:-

Drug concentration:	1.0 mg/ml.
Loading dose:	0 µg.
PCA dose:	9.0 mg.
Dose duration:	STAT.
Continuous infusion:	0 ml/hr.

Set the syringe to mid-travel and press **START** to begin the pump (green light ON). Do *not* make any PCA demands.
If the **LOW BATTERY** alarm appears on the pump's display before 8 hours has elapsed then all three batteries should be replaced, as detailed below:

Replacement

1. Open the case (see page 2-5).
2. Noting their orientation, prise out the three faulty batteries. Also noting the connections, remove all six spade tags.
3. Connect three new fully charged 2 V, 2.5 AH, lead acid, D Cell batteries by reversing the steps detailed in (2) above, ensuring that the two rubber packing spacers that are attached to the pillars are still in place.
4. Close the casing (see page 2-5).

Replacement of transparent cover assembly

The transparent cover is held in place by two side insertion pins and two internally positioned circlips. A flag assembly is activated by the left hand insertion pin.

1. Open the casing (see page 2-5).
2. Unscrew and displace the Main board (see page 5-3).
3. Prise off and retain the two circlips that hold the two side insertion pins in place (see *Figure 7.5*).
4. Noting the position of the left hand cover flag withdraw and retain the two cover pins and the two compression rings.
5. Remove the transparent cover.
6. Fit a new transparent cover by reversing steps (2) to (5) and close the casing (see page 2-5).

Replacement of lock housing

The lock housing is an integral part of the pole clamp assembly and is held in position by a Spirol pin (*Figure 7.3*). The head of the Spirol pin can be seen from the right hand side only, it does not protrude from the left hand side.

A faulty or broken lock housing can be replaced as detailed in the following procedures:

1. Open the transparent cover and ensure that the lock housing key is removed.
2. Firmly grasp the faulty lock housing and using sufficient force press back and snap off the housing at its base.
3. Remove and retain the screw that holds the lock assembly in place.
4. Remove and retain the lock assembly.
5. Remove and retain the Spirol pin which will now be accessible.
6. Fit the lock assembly into the new lock housing.
7. Locate the lock housing in place and tap home the Spirol fixing pin.
8. Close the transparent cover.

Front and/or rear case repair

In March 1999 a new type strengthened and modified front and rear case moulding for their 3000 range of syringe pumps (see *Figure 5.2*) was introduced.

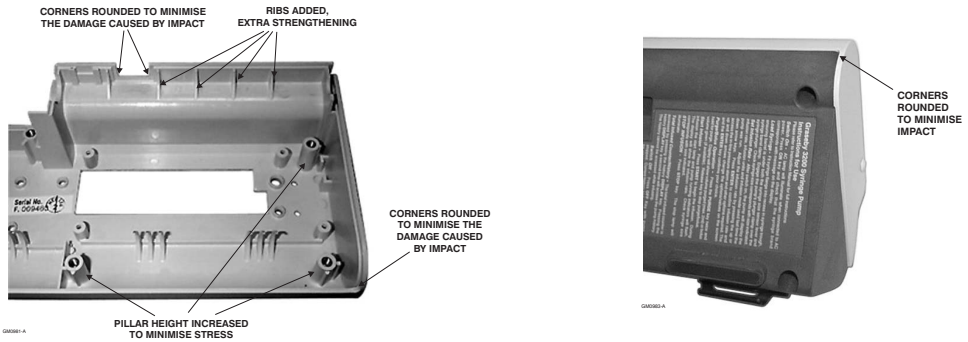


Figure 5.2 Strengthened front and rear case mouldings

If an old style front or rear case becomes damaged and requires replacing , an appropriate repair kit is available from Smiths Medical. There are two kits (front or rear case) which each contain all the necessary instructions and parts to carry out a repair

The contents of the repair kits are shown in *Table 5.3, 5.4* and *5.5*. The items marked with an asterisk (*) may be obtained separately.

Table 5.3 Front case spares kit

Description	Part No.	Remarks
Front case spares kit (English)	0128-0357	
Label, front panel (English)	0128-0028	
Front case spares kit (Other)	0128-0220	
Label, front panel (Other)	-	(see *Figure 7.1*)
Case front	0128-0216	
Syringe clamp assembly*	0131-0149	
Housing moulding	0128-0052	
Circlip	5030-4010	
Screw, M3 x 10, Pozi, pan hd	5017-9960	2 off
Button, moulded*	0131-0216	2 off
Instruction leaflet	0131-0156	
Size sensor flag spares kit*	0131-0214	See *Table 5.4*
Foam spacer type 3*	0131-0218	2 off
Case templates*	0131-0235	2 off
Radius gauge*, stainless steel	0131-0234	
Case screws, M4x12, pozi pan	5001-0345	6 off

***** These items may be obtained individually.

Note:

The front panel membrane is language dependent and supplied separately (see *Figure 7.1, item 3*). The English front panel membrane is supplied with the front case spares kit.

Table 5.4 Size Sensor Flag spares kit

Description	Part No.	Remarks
Size sensor flag spares kit*	0131-0214	
Size Sensor Flag moulding	0131-0135	
Size sensor shim (0.6 thick)*	0130-0107	
Size sensor shim (1.0 mm thick)*	0130-0108	
Size sensor shim (1.2 mm thick)*	0130-0190	
Size sensor shim (1.4 mm thick)*	0130-0185	
Screws, No. 4 x 5/8 ins. Self tap	5017-3410	2 off
Grub screw, M4 x 6, nylon*	0131-0144	
Instruction leaflet	0131-0217	
Tamper proof protective cap*	0131-0136	

Table 5.5 Rear case spares kit

Description	Part No.	Remarks
Rear case spares kit*	0128-0226	
Case, rear modified	0128-0218	
Foam spacer type 1*	0131-0204	
Foam spacer type 2*	0131-0205	3 off
Foot, rubber*	0126-0028	2 off
Instruction leaflet	0131-0156	
PCA bulkhead connector*	0128-0076	
Case screws M4x12, pozi pan	5001-0345	6 off
Clamp, cable	5366-2820	3 off
Catch, button	0128-0117	
Strip, retaining	0128-0188	
Screw, M3x10, pozi csk	5000-6317	
Screw, M3x6, slot pan	5000-6112	

***** These items may be obtained individually.
Note:
The Case rear label* will be Country dependent and can be supplied separately e.g. 0128-0184 English, 230 V

PCA handset repair

A PCA handset spares kit, part number 0128-0249 is available. It contains the plunger actuator arm (part number 0128-0081) and fitting instructions.
If required, the tube (part number 0128-0088) and bellows (part number 0128-0083) may also be ordered. These items are not supplied in the kit.

Repair procedure:

1. Undo the two screws at the back of the handset and separate the case halves.
2. Lift out the actuator arm.
3. Lift out the pressure plate.
4. Remove the bellows, tubing (and wrist strap).
5. Use sleeve-lubricating oil (e.g. Hellerman lubricating sleeve oil) to ease the tubing through the grommet and into the bellows (15 to 20 mm)
6. Clean off any excess oil.
7. Apply adhesive in 2 places - in the tube guides- using any fast cure instant adhesive.
8. Position bellows, ensuring that it is seated securely.
9. Fit the pressure plate.
10. Fit the actuator arm, ensuring that it moves freely when in position.
11. Fit the wrist strap.
12. Assemble the case halves, tightening each screw to a torque of 35 - 40 cNm.
13. Complete a functional test on any repaired handset by connecting it to a 3300 and simulating a demand. Ensure that the handset can generate at least two demands within a second.

CHAPTER 6

FUNCTIONAL TESTS
and MANUFACTURING SETTINGS

Graseby 3300
PCA Syringe Pump

CHAPTER 6

FUNCTIONAL TESTS and MANUFACTURING SETTINGS

Functional tests

The following functional tests have been designed to verify that the 3300 is safe to use. Carry out the tests prior to putting the pump into service for the first time and then as required.

Table 6.1 Functional Tests

Step	Test	Method	Correct result
1	Mechanical inspection.	Before applying power to the pump, check that the case and exposed mechanical parts are free from any damage.	No damage.
2	Electrical safety test.	Using a test voltage of 500V DC, measure the insulation resistance between the AC inlet and the exposed metal parts.	The insulation resistance must exceed 200 Meg ohm.
3	Initial power on.	Connect the AC supply. Press **ON**.	The **AC** LED lights. A bleep is heard and all LED's are briefly illuminated. Following this bleep, the message... **TESTING PLEASE WAIT**, and also the syringe brand is displayed. The pump then goes into the set-up mode and the **STOP** and **AC** LED's are illuminated.
4	Syringe size sensor.	Perform with plunger clamp 40 mm from RHS and also at extreme LHS. Insert the following rods (in turn) into the syringe trough: Insert a 20.5 mm diameter rod in syringe trough. Insert a 21 and then a 22.9 mm diameter rod in syringe trough. Insert a 23.7 and then a 26.2 mm diameter rod in syringe trough. Insert a 28.5 and then a 33.1 mm diameter rod in syringe trough.	 Invalid syringe condition. **20ml** LED lights for each rod. **30ml** LED lights for each rod. **50/60ml** LED lights for each rod.

Note:
Smiths Medical manufacture a set of 18 Syringe Size Sensor gauges, part no. 0131-0202 (see Appendix, page A-5). The Smiths Medical Customer Care Department is able to take orders for these gauges and will supply the current price. This set of gauges enables test No. 4 to be carried out on all of the Graseby Medical 3000 Series of pumps.

(contd)

Table 6.1 Functional tests (contd)

Step	Test	Method	Correct result
5	Keyboard tests.	Press **OFF**.	The display goes blank, but the **AC** LED remains lit.
		Press **ON.**	As in '3' (initial power **ON**).
		Check that the pump can be programmed by using the ▲ ▼ and **ENTER** buttons as described in the Instruction Manual.	The display shows the messages shown in the Instruction Manual and the keys change the settings as required.
		Check that the totaliser operates correctly as described in the Instruction Manual.	Display shows volume infused since last reset, then resets to zero when the ▼ button is pressed.
		Check that the purge facility operates as described in the Instruction Manual.	**ALARM** and **START** LED'S flash and the display shows the total delivery to a max. of 2 ml.
		With a syringe fitted, move the syringe plunger clamp to the closed position. Close the cover; lower and lock the cover clamp. Then press **START.**	The syringe size is displayed briefly and the pump starts with the message **PUMP STARTED** on the display, followed by a message as described in the Instruction Manual.
		Press **STOP.**	The pump enters its suspend mode.
		Open and close the cover and then press **START**. Move the syringe so that it is **not** seated correctly.	The loud pulsed alarm sounds, the red **ALARM** LED flashes and the message **PUMP STOPPED: SYRINGE REMOVED** is displayed.
		Open the cover then press **ALARM.**	The alarm is silenced and the pump enters its set-up mode.
		Refit the syringe.	
6	Cover sensor.	Press **START,** then open the cover.	A message including **INFUSION SUSPENDED** is displayed.
		Close the cover and press **START.**	The pump restarts the infusion.
7	AC power failure.	Press **START** to start the pump and then disconnect the AC supply.	The quiet chirping alarm sounds, the **AC** LED goes out and the display shows **WARNING: MAINS FAILURE PUMP NOW ON BATTERY**. The pump continues running under battery power.
		Reconnect the AC supply.	The **AC** LED lights.

(contd)

Table 6.1 Functional tests (contd)

Step	Test	Method	Correct result
8	Linear accuracy Use the linear accuracy gauge (see page 6-4).	Set the pump for a 60 ml BD syringe to deliver 9 ml boluses at the STAT rate. Insert a new BD 60 ml syringe and close the plunger clamp in mid position. Purge the pump to remove any backlash. Deliver a demand bolus.	Check that the plunger clamp has moved a distance of 16.2 ±0.3 mm in 161 to 163 seconds. See also page 6-4.
9	Occlusion	The occlusion thrust is factory set by applying an opposing force to the syringe plunger clamp. This is achieved by using weights.	Refer to page 2-8.
10	Plunger clamp alignment.	Close the clamp at mid-position. Run an infusion of at least 99.9 ml/h. After 5 secs. check clamp position.	Front edge of clamp must be between 8 and 10 mm above surface of top cover. See page 6-4, Taper Gauge.
	Note: If this test fails then the super nut will have to be loosened, this will allow the plunger clamp to be manipulated up or down a small distance, thus enabling the required 8.0 to 10 mm gap to be achieved.		
11	Plunger clamp open, leadscrew disengaged.	Load syringe and set an infusion rate. Open the plunger clamp. Press **START**.	The alarm ... **SYRINGE NOT FITTED** must be activated.
12	Syringe **NEARLY EMPTY**, and syringe **EMPTY** warnings	Use a BD 60 ml syringe. Then set the pump as follows ... Drug concentration: 1.0 mg/ml. Loading dose: 0 µg. PCA dose: 9.0 mg. Dose duration: STAT. Continuous infusion: 0 ml/hr. Set the syringe to 15 ml before the end of travel and run the pump for two PCA bolus demands.	Before the end of travel, check that the message… **WARNING: SYRINGE NEARLY EMPTY (LESS THAN 3.0mls)** appears, and a quiet chirping alarm sounds. At the end of travel the message… **PUMP STOPPED:EMPTY/OCCLUSION** appears, a loud pulsed alarm sounds and the pump stops infusing.
	(To override the lockout time, press **STOP** twice, open and close the syringe cover and restart the pump). **Note:** When carrying out test No. 12 on a Perfusor pump ensure that the syringe is set to a minimum of 18 ml.		

Linear accuracy

The linear accuracy gauge (*Figure 6.1,* part number 0131-0230) when placed on the pump, is able to check that the pump's plunger clamp moves a given distance in a specified time. Initially, the pump will have been preset to given parameters, then set to run for a specified time and the distance that the plunger moves being observed on the measurement dial of the gauge.

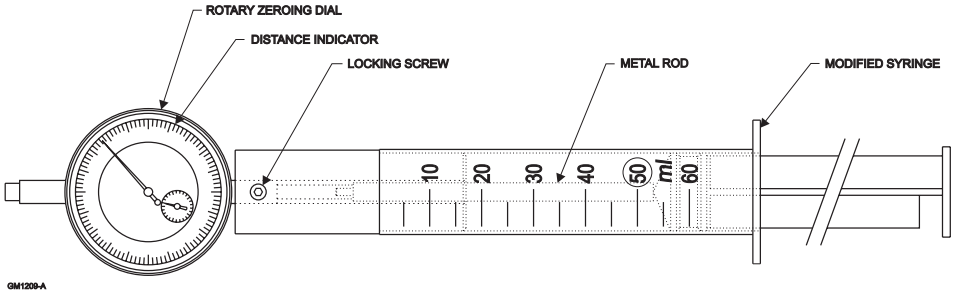


Figure 6.1 Linear accuracy gauge

Test procedures

Test No. 8, see page 6-3

1. Place the gauge onto the pump with the syringe plunger almost fully extended.
2. Move the pump's plunger clamp to the left until the gauge plunger is a short distance away from the metal rod that activates the dial indicator.
3. Turn the pump on and check that the pump shows that the syringe brand and size is BD 60 ml.
4. Press the **PURGE** button until the syringe plunger just activates the gauge indicator. This action will ensure that any pump backlash is removed.
5. Rotate the outer rim of the gauge to set both dial indicators to zero.
6. Deliver a demand bolus at 9 mg.
7. Check that the measurement dial records that the plunger has moved a distance of 16.2 ±0.3 mm in 161 to 163 seconds. See also page 6-3.

Plunger clamp alignment

The taper gauge (*Figure 6.2*, part number 0131-0227) enables the gap between the pump's plunger clamp and the case to be measured accurately. This measurement is important as it ensures that the plunger clamp engages correctly onto the flanges of the smaller sized syringes.

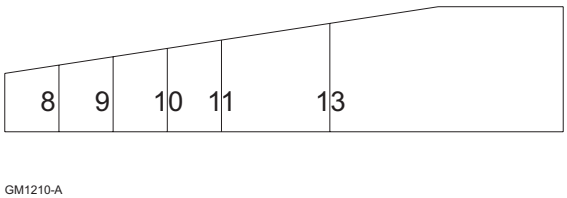


Figure 6.2 Taper gauge

Test procedures

Test No. 10, see page 6-3

1. Switch the pump on and set the rate to at least 99.9 ml/hour.
2. Close the plunger clamp at approximately its mid position.
3. Run the pump for 5 seconds.
4. Using the taper gauge check that the front edge of the plunger clamp is between 8.0 mm and 10.0 mm above the surface of the case.

Manufacturing settings

After the tests of Table 6.1 have been completed the pump can be returned to the Manufacturing settings (if required) as shown in sequence in Table 6.2 and 6.3.

Table 6.2 Manufacturing settings: Configuration mode

	Selection	Setting
1	Program values	UNLOCKED
2	Syringe selected	BD PLASTIPAK
3	RS232 Baud rate	9600
4	History type	DETAILED
5	Continuous printout of events	ENABLED
6	Chronological history display	FORWARDS
7	Loading dose	ENABLED
8	Continuous infusion	ENABLED
9	Continuous infusion units	ml/hr
10	Patient activated timed infusion	DISABLED
11	Zero lockout period available	DISABLED
12	Total dose limit	DISABLED
13	Dose delivered at STAT rate	DISABLED
14	Patient demand	SINGLE PRESS
15	Clinician override bolus	DISABLED
16	Beep on unsuccessful patient demands	ENABLED
17	Display time to PCA	ENABLED

Table 6.3 Manufacturing settings: Setup mode

	Selection	Setting
1	Drug concentration	1.0 mg/ml
2	Loading dose	0 µg
3	PCA dose	1 mg
4	Dose duration	STAT
5	Lockout period	1 minute
6	Continuous infusion	0.0 ml/hr
7	Totals since reset	To be reset

CHAPTER 7

ILLUSTRATED PARTS LIST

Graseby 3300
PCA Syringe Pump

CHAPTER 7
ILLUSTRATED PARTS LIST

Figure 7.1 3300 PCA Syringe Pump assembly

Item	Description	Part No.	No. off
1	Front case spares kit *Kit contains: Front case, Syringe barrel clamp assembly, Moulded buttons (x2), Foam spacers (x2), Size sensor flag spares kit, Instruction leaflet.* Front case spares kit (English only) *Kit contains: Front case, Syringe barrel clamp assembly, Moulded buttons (x2), Foam spacers (x2), Size sensor flag spares kit, Instruction leaflet, Front panel label (English).*	0128-0220 0128-0357	1
2	Rear case spares kit *Kit contains: Rear case, Foam spacers (x4), Rubber feet (x2), Housing moulding, Screws (x2), Circlip, Bulkhead connector, Size sensor flag spares kit, Instruction leaflet.*	0128-0226	1
3	Membrane front panel label – English, Dutch – France – Italian – French – German – Spanish	 0128-0028 0128-0094 0128-0092 0128-0094 0128-0095 0128-0093	1
4	Case screws - 6 required	5001-0345	6
5	Transparent cover	0128-0010	1
6	Cover hinge assembly kit *Kit contains: Cover pins (x2), Cover pin bearings (x2), Cover pin flag, Compression ring, Instruction leaflet.*	0128-0245	1
7	Rear panel instruction label - *see next table* **IMPORTANT: When ordering a CE marked rear label, please supply the serial number details of the Syringe Pump, if this information is not supplied then a Non CE marked label will be issued. It is the responsibility of the owner to ensure that the correct labels are replaced on the pump**		

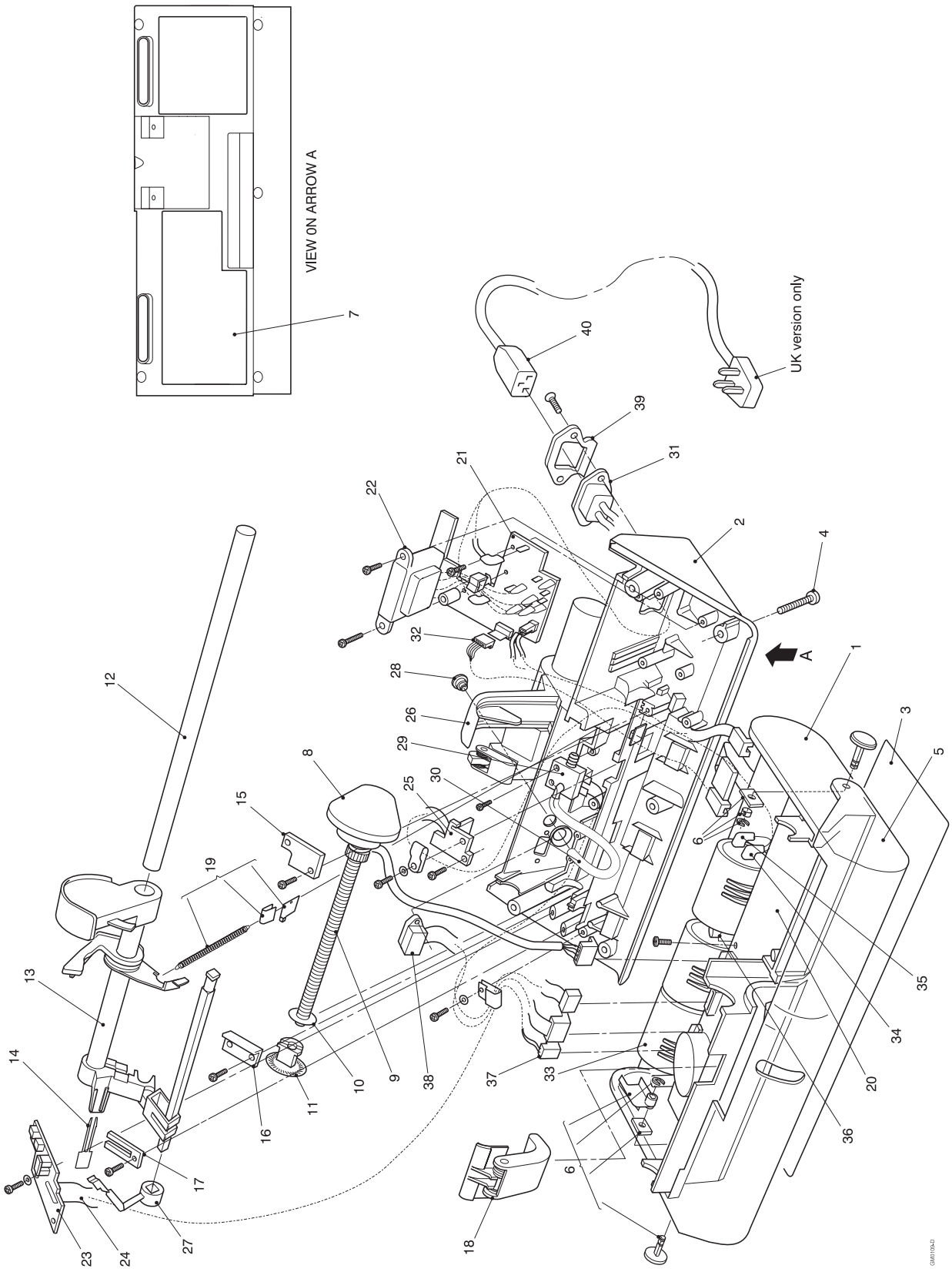


Figure 7.1 General assembly

3300 pump model numbers	Non CE marked Made in UK serial no's below 45643	CE marked Made in UK serial no's from 45643 to 89999	CE marked Made in Malaysia serial no's from 90000
0128-0001, English 240V 0128-0728, English (euro plug)	0128-0184	0128-0029	0128-0361
0128-0701, English 110V	0128-0235	0128-0059	0128-0362
0128-0703, France (only)	0128-0236	0128-0065	0128-0363
0128-0704, Italian	0128-0237	0128-0109	0128-0367
0128-0705, Spanish	0128-0239	0128-0115	0128-0368
0128-0706, French	0128-0242	0128-0103	0128-0364
0128-0707, German	0128-0238	0128-0107	0128-0366
0128-0708, French 110V	0128-0241	0128-0101	0128-0365
0128-0709, Dutch	0128-0240	0128-0195	0128-0369
0128-0710, Canadian English 110V	0128-0235	0128-0059	0128-0362
0128-0711, Canadian French 110V	0128-0241	0128-0101	0128-0365
0128-0714, German Perfusor	0128-0238	0128-0107	0128-0366
0128-0721, English (without plug)	0128-0184	0128-0029	not available
0128-0740, Australian	0128-0184	0128-0029	0128-0361

3300 PCA Syringe Pump assembly

Item	Description	Part No.	No. off
8	Motor and gearbox assembly	0131-0015	1
9	Leadscrew assembly	*see page 7 - 10*	1
10	Oil shim	0127-0084	1
11	Occlusion sensing assembly	0131-0067	1
12	Support tube	0127-0047	1
13	Plunger clamp assembly	*see page 7 - 7*	1
14	Near empty flag kit - 2 types of flag supplied	0131-0122	1
15	Bearing clamp bracket	0127-0053	1
16	Leadscrew bearing bracket	0127-0051	1
17	Square shaft bracket	0127-0052	1
18	Syringe barrel clamp assembly	0128-0217	1
19	Size sensor flag retainer kit *Kit contains: Anchor plate assembly, Size sensor spring.*	0131-0238	1
20	Main board assembly - *see page 7 - 12*	0128-0007	1
21	Regulator board assembly - *see page 7 - 14*	0128-0013	1
22	Transformer - AC power	0127-0030	1
23	Opto sensors board – 6 pin connector – 5 pin connector	 0128-0090 0127-0015	1
24	Opto sensor cable – Current version, 6 way – Early version, 5 way	 0053-0670 0053-0655	1
25	Size sensors board assembly	0128-0032	1
26	Pole clamp assembly - *see page 7 - 8* – Locking handle – Non locking handle	 0128-0136 0128-0135	1
27	Plunger clamp open flag	0127-0019	1
28	Bulkhead connector	0128-0076	1
29	Pressure switch PSF 100A-8C	4008-0420	1
30	Pneumatic switch tubing	0128-0055	1

3300 PCA Syringe Pump assembly

Item	Description	Part No.	No. off
31	Mains cable assembly - internal; 2-wire	0053-0646	1
32	Power cable assembly kit *Kit contains: Power cable assembly, Header.*	0131-0242	1
33	Battery - Cyclon *(was P/N 3420-2120),* 3 required	0151-0649	1
34	Cable assembly battery A	0053-0647	1
35	Cable assembly battery B	0053-0648	1
36	Cable assembly battery C	0053-0649	1
37	Cable assembly, pressure switch	0053-0656	1
38	Cable assembly, D connector	0053-0657	1
39	Cable clamp	0127-0043	1
40	Cordset - AC power – UK – 110 V English, French – Spanish, French, German, English with euro plug – Italian - without plug – Dutch – Australian	 3700-0046 3700-0230 3700-0035 3700-0025 3700-0044 3700-0056	1
41	Instruction manual - not illustrated – English – France – French – Italian – German – Spanish – Dutch	 0128-0044 0128-0114 0128-0105 0128-0113 0128-0108 0128-0169 0128-0137	1
42	Technical service manual - not illustrated	00SM-0128	1
43	PC interface cable - not illustrated	0053-0704	1
44	Size sensor gauge set - not illustrated *Kit contains: 18 size sensor gauges, Instruction leaflet for calibration.*	0131-0202	1
45	PCA handset - see page 7 - 11	0128-0078	1
46	5/10 ml adaptor plate - not illustrated	0132-0076	1
47	Braun Perfusor 50 ml conversion kit - not illustrated *Kit contains: Perfusor spacer tube, Nearly empty flag for Perfusor, Plunger clamp plate, P label procedure*	0131-0048	1

3300 PCA Syringe Pump assembly

Item	Description	Part No.	No. off
48	Linear accuracy gauge - not illustrated	0131-0230	1
49	Dual ramp gauge - not illustrated	0131-0084	1
50	Taper gauge - not illustrated	0131-0227	1

Figure 7.2 Plunger clamp assembly

Item	Description	Part No.	No. off
1	Plunger clamp and tube	0127-0044	1
2	Plunger clamp cover and internal kit *Kit contains: Plunger clamp cover, Plunger clamp lock, Plunger clamp pin, Plunger clamp conical spring, Plunger clamp finger spring.*	0131-0239	1
3	Half nut casting - *see page 7 - 10*	0131-0042	1
4	Toggle moulding	0127-0026	1
5	Toggle glide moulding	0127-0027	1
6	Toggle spring	5752-0010	1
7	Size sensor flag spares kit *Kit contains: Size sensor flag moulding, Protective cap, Grub screw M4 x 6, Size sensor shim, Size sensor moulding, Instruction leaflet.*	0131-0214	1
8	Square shaft	0127-0048	1

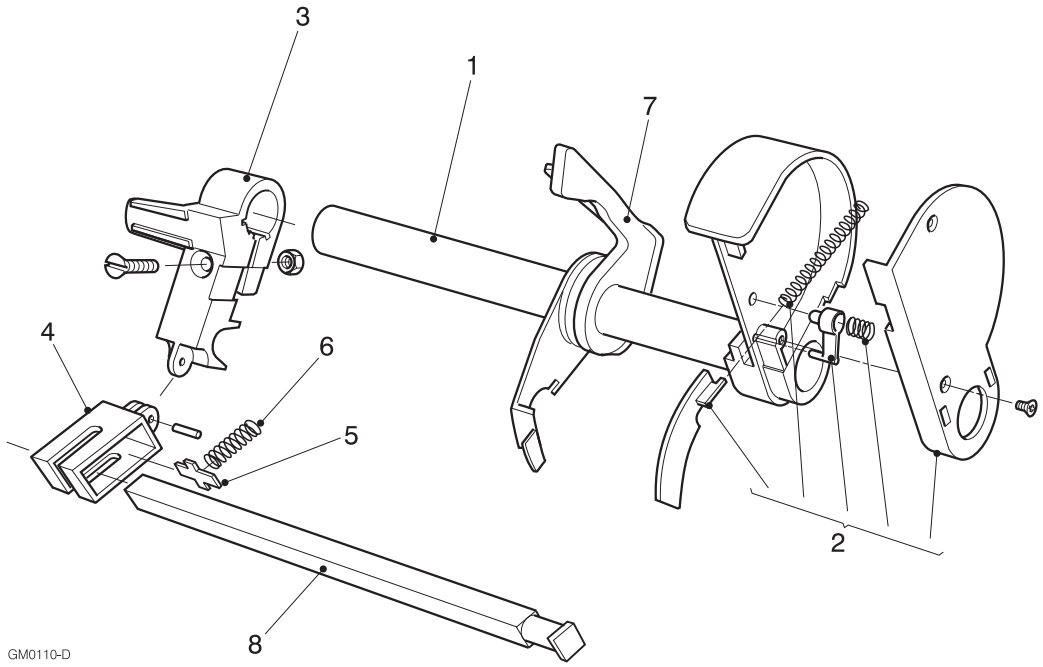


Figure 7.2 Plunger clamp assembly

Figure 7.3 Pole clamp assembly, locking and non locking

Item	Description	Part No.	No. off
	Pole clamp assembly (locking) Pole clamp assembly (non locking)	0128-0136 0128-0135	1
1	Handle	0127-0060	1
2	Securing plate	0131-0074	1
3	Crescent circlip	5030-5710	1
4	Pole clamp body	0128-0134	1
5	Spirol pin	5028-3408	1
6	Circlip	5030-4010	1
7	Clamp pad kit *Kit contains: Clamp bolt, Clamp pad, Spacer, End cap, Screw M3 x 12, Instruction sheet.*	0131-0052	1
8	Lock housing	0128-0018	1
9	Lock assembly *Kit contains the following items: Lock assembly, Key, Cam lock.*	0128-0183	1
10	Key for pole clamp	0128-0026	1
11	Spring lever assembly	0128-0360	
12	Pole clamp assembly retainer kit *Kit contains: Button catch, Pole clamp rear fixing, Retaining strip, Screws (x2), Instruction sheet.*	0128-0246	1
13	Pawl kit assembly *Kit contains: Pawl, Torsion springs (x2).*	0128-0247	1
14	Torx bit - not illustrated	6880-1425	1
15	Torx handle - not illustrated	6880-1420	1

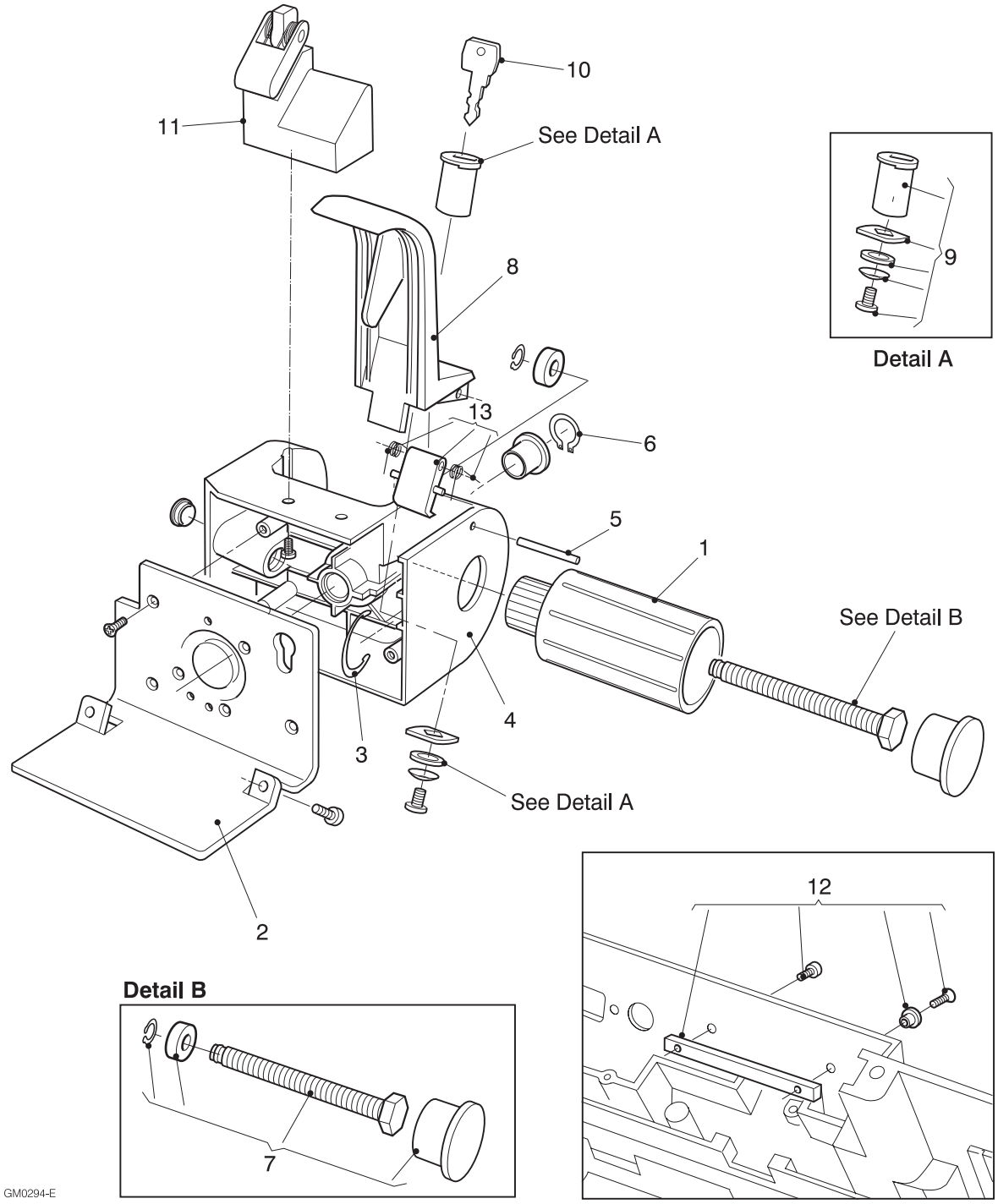


Figure 7.3 Pole clamp assembly

Figure 7.4 Leadscrew assembly

Item	Description	Part No.	No. off
	Leadscrew and half nut kit *Kit contains: Leadscrew assembly, Half nut casting, Near empty flag, Screw, Nut, Instruction sheet.*	0131-0236	1
1	Half nut casting	0131-0042	1
2	Leadscrew assembly	0131-0119	1
3	Leadscrew coupling	0127-0074	1

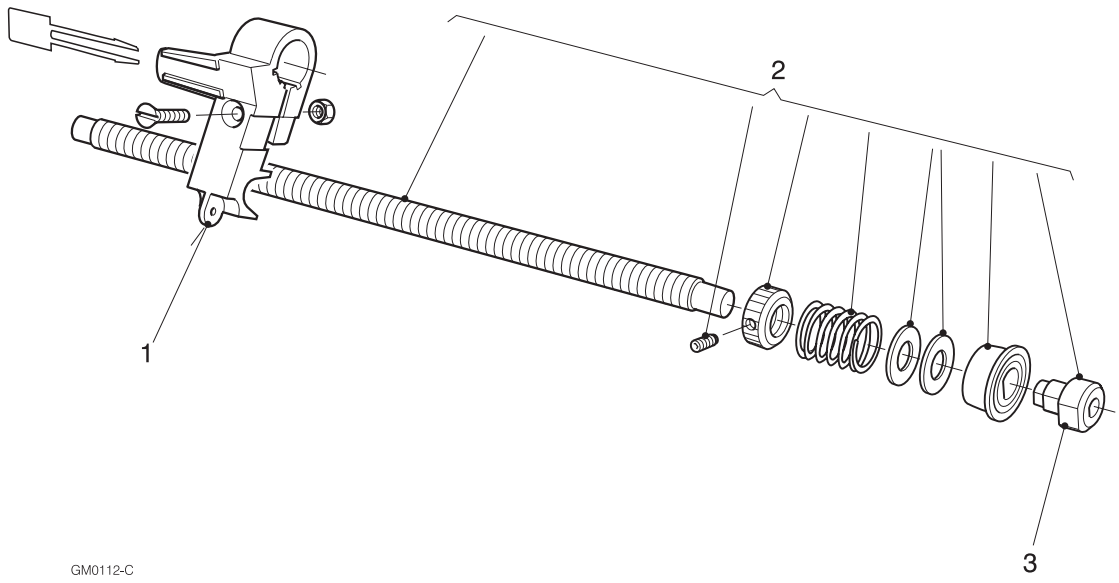


Figure 7.4 Leadscrew and half nut kit assembly

Figure 7.5 3300 PCA handset assembly

Item	Description	Part No.	No. off
	PCA handset	0128-0078	1
1	Tube for PCA handset	0128-0088	
2	Actuator handset spares kit - *Kit contains: actuator arm*	0128-0249	

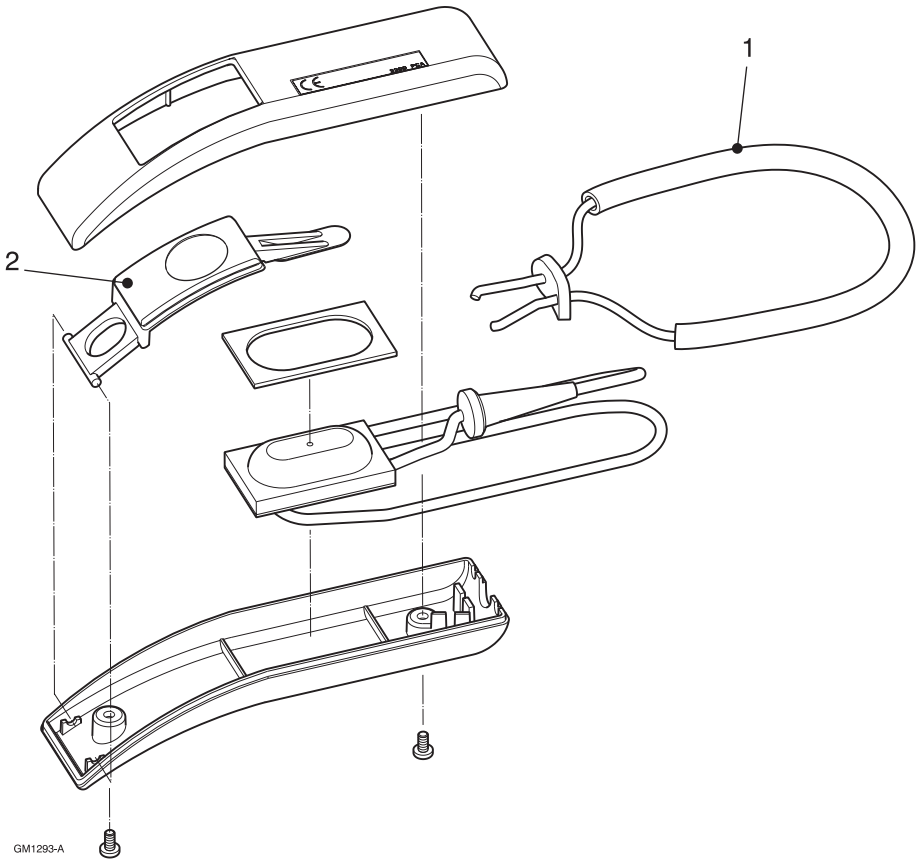


Figure 7.5 PCA handset assembly

Figure 7.6 Graseby 3300 Main board assembly

Item	Description	Part No.	No. off
	3300 Main board assembly	0128-0007	1
1	Sounder PKB5-3BO	3430-1205	1
2	Sounder restraint kit *Kit contains: Nuts M3 (x2), Screws M3 x 16 (x2), Pillars (x2).*	0131-0240	1
3	IC12, Programmed EPROM – English – German – French – Italian – Dutch – Spanish	 0128-0027 0128-0070 0128-0069 0128-0112 0128-0146 0128-0170	1
4	Display and connector assembly *Kit contains: LCD module IC15, Terminal strip, Socket strip.*	0128-0151	1
5	IC16, Secondary processor	0128-0042	1
6	IC11, MC68HC11F1FN	0131-0072	1

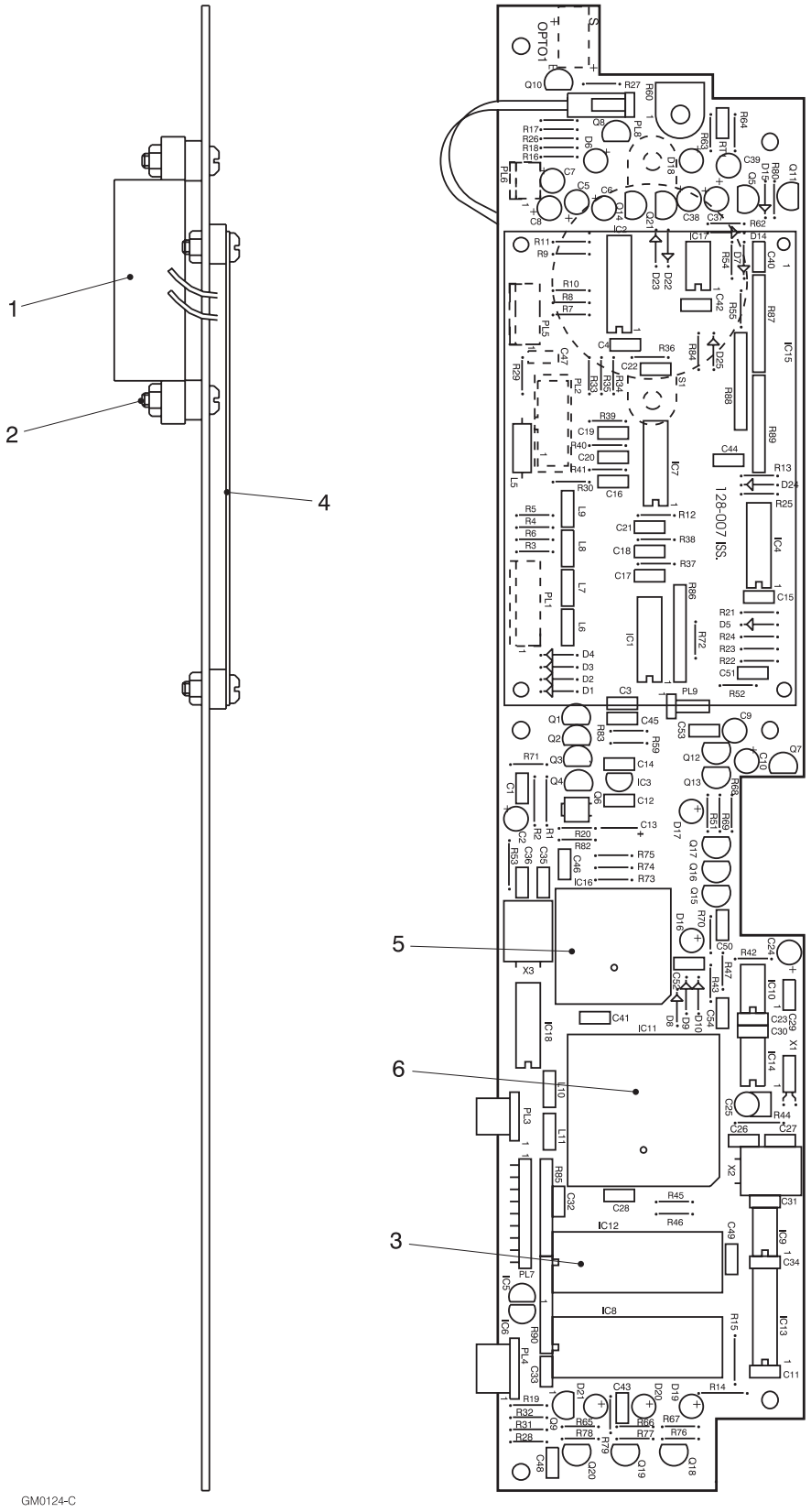


Figure 7.6 Graseby 3300 Main board assembly diagram

Figure 7.7 Regulator board assembly

Item	Description	Part No.	No. off
	Regulator board assembly	0128-0013	1
1	Fuse cover	5346-2010	1
2	FS1, Fuse 500 mA 5 x 20 mm	3410-3002	1
3	FS2, – Fuse 50 mA 5 x 20 mm - 240 V – Fuse 100 mA 5 x 20 mm - 110 V	 3410-1305 3410-1811	1
4	S3, Fuse 1 A 5 x 20 mm	3410-3703	1

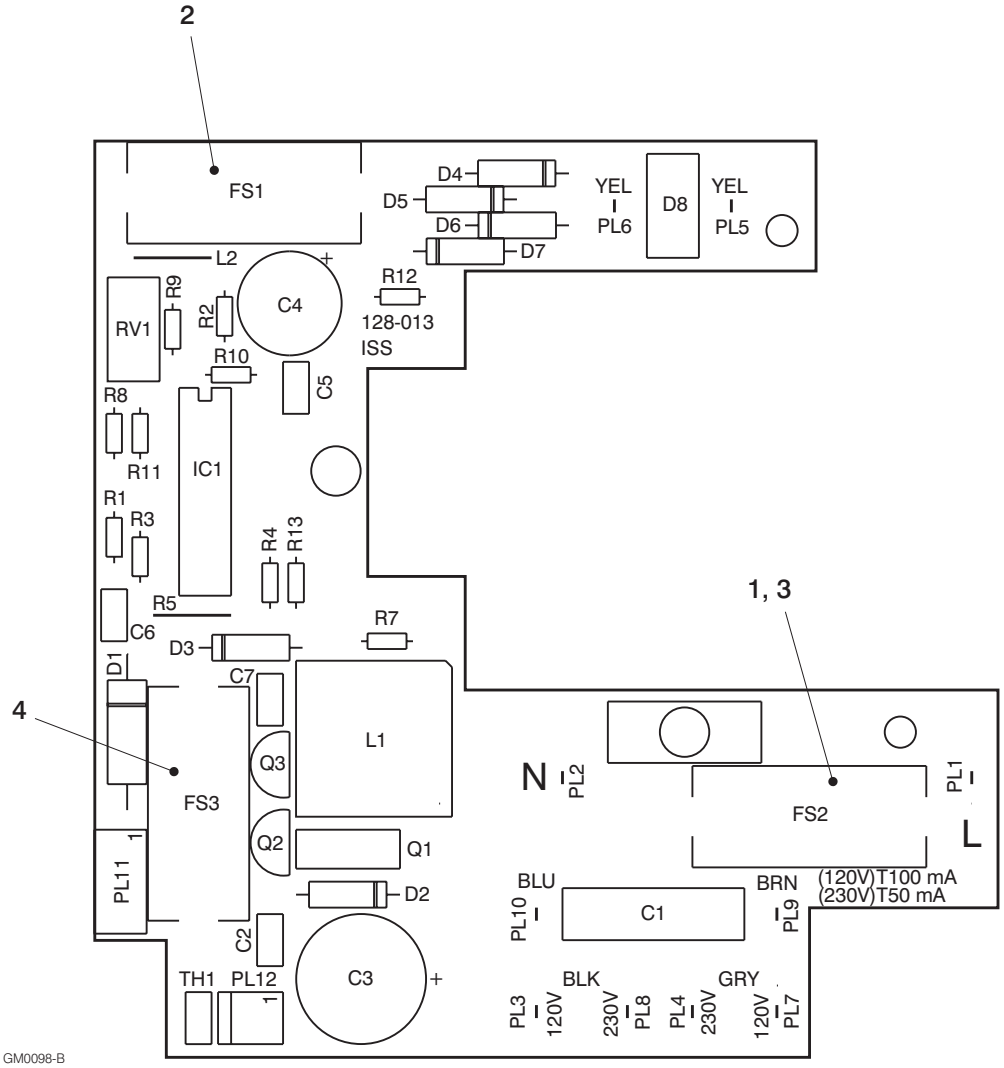


Figure 7.7 Regulator board assembly

CHAPTER 8

BRAUN PERFUSOR CONVERSION

Graseby 3300
PCA Syringe Pump

CHAPTER 8

BRAUN PERFUSOR CONVERSION

Syringe conversion procedures

Introduction

The 3300 can be converted to use the Braun Perfusor 50 ml syringe (conversion kit part number 0131-0048).

The conversion procedures are detailed below and are shown in *Figure 8.1.*

Near empty flag conversion

Open the pump case as detailed on page 2-5.

Remove the standard flag from the top of the half nut (retain the standard flag for possible future use). Fit the elongated Perfusor 50 ml nearly empty flag (see page 7-2) by inserting the flag into the grooves on the half nut (see *Figure 8.1*). Ensure that the flag is fitted so that the small amount of flag bias is in the direction of the arrow shown in *Figure 8.1*.

Note: If not already biassed, bend/bias the end of the flag in the direction of the arrow shown in *Figure 8.1* a distance of approximately 2 mm, this will ensure that the flag (when it moves fully to the left) does not touch the left hand post.

Spacer tube fitment

Carefully lift up the left hand end of the inner metal tube and fit the nylon spacer tube over the tube. The spacer tube acts as an end of travel stop when the half nut assembly is moved to the left.

Plunger clamp fitment plate

Fit the self adhesive half-round plunger clamp plate to the left hand side of the plunger clamp. It must be fitted to the vertical face of the plunger clamp so that it covers both quadrant vanes (*Figure 8.1*).

Reassemble the case as detailed on page 2-5.

Braun Perfusor selection

The Braun Perfusor 50 ml syringe is selected for use (on the pump) by using a special configuration command.

First select the configuration mode (see page 2-1) and then select the display that shows the **BRAUN OMNIFIX** syringe brand.

Simultaneously press the following three buttons:

ALARM, PURGE and **OFF.**

The pump will then switch to the Braun Perfusor syringe mode and other syringe brands will automatically be disabled. The pump syringe display will show:

SYRINGE SELECTED:
BRAUN PERFUSOR 50

and the ▲ adjust button, whilst in this mode is ineffective.

'P' label fitment

Fit the self adhesive 'P' label to the front of the pump in the area just above and to the right of the product name (*Figure 8.1*). This label acts as a visual reminder that the pump must only be used with the Braun Perfusor syringe.

Reselecting 'various' syringe brands

Mechanical procedures

To reselect the various syringe brands carry out the following mechanical and programming procedures:

1. Take the case apart (page 2-5).
2. Replace the original standard nearly empty flag.
3. Remove the nylon spacer from the left hand side of the inner metal tube.
4. Remove the adhesive plunger clamp plate.
5. Reassemble the case.
6. Remove the adhesive 'P' label from the front of the pump.

Programming procedures

1. With the pump switched on and

   BRAUN PERFUSOR 50

   displayed within the Configuration mode (page 2-1), simultaneously press the following three buttons:

   ALARM, PURGE and OFF

   in order to set the Configuration mode so that the various brands of syringe may be selected.

2. Set the pump to the brand of syringe that is going to be used and then press the **STOP** button in preparation for the next infusion.

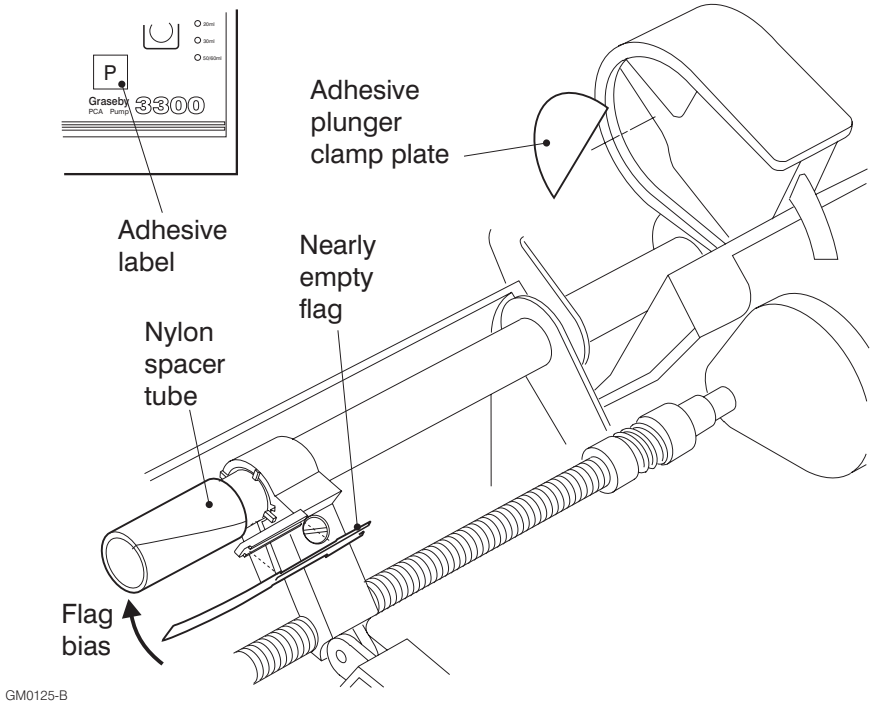


Figure 8.1 Braun Perfusor conversion: parts required

APPENDIX

FITTING a MODIFIED SIZE SENSOR FLAG

Graseby 3300
PCA Syringe Pump

APPENDIX

FITTING a MODIFIED SIZE SENSOR FLAG

INTRODUCTION

In a continual and ongoing programme of improvements, Smiths Medical engineers have introduced a modified Syringe Size Flag (SSF) for the 3300 pump (*Figure A.1)*. The modified flag allows the size sensor mechanism to be accurately aligned.

This appendix describes the procedures and tests that must be completed by a qualified Technician to fit the new SSF and shim/s.

The SSF and shims required to modify the pump are supplied in kit form (part no. 0131-0214). The kit includes the following:

- Syringe Size Flag (SSF), part no. 0131-0135 (see *Figure A.1*),
- 0.6 mm thick shim, part no. 0130-0107,
- 1.0 mm thick shim, part no. 0130-0108,
- 1.2 mm thick shim, part no. 0130-0190,
- 1.4 mm thick shim, part no. 0130-0185,
- screws, no. 4 x 5/8 inch, self-tap, 2 off, part no. 5017-3410,
- M4 x 6 nylon grub screw, part no. 0131-0144,
- tamper proof protective cap, part no. 0131-0136,
- instruction leaflet, part no. 0131-0217.

The screws, washers and associated items that are removed during the disassembly of the pump are required during the reassembly.

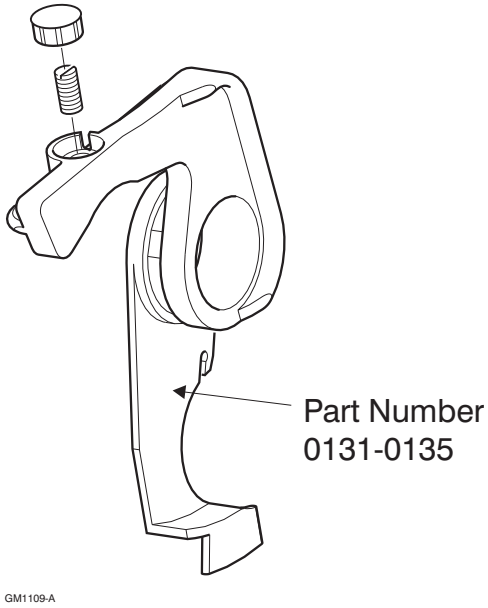


Figure A.1 New modified Syringe Size Sensor flag

WARNINGS: When a new Size Sensor Flag has been fitted, the pump must be tested using the Syringe Size sensor Gauges available from Smiths Medical (part number 0131- 0202). Details of the Final Testing procedures required are given in the Appendix, page 3.

Always disconnect the AC supply from the pump before opening the casing.

CAUTION: During the removal and replacement of a pump's components strict observance to Electro Static Discharge (ESD) rules must be observed at all times, i.e. an earthing strap must be worn. Failure to apply ESD protection may result in serious damage to the product and possible malfunction. Ensure that any replacement printed circuit board or other ESD sensitive items are stored in an anti-static container.

OPENING THE CASE

1. Utilising a scratch free flat surface, turn the pump over to gain access to the base of the pump.
2. Undo the six screws that hold the pump case halves together.
3. Place the pump upright and from the top carefully ease the casing halves apart. Ensure that no strain is placed on the internal connecting cable looms that form a hinge between the case halves.

FITMENT OF MODIFIED SSF

1. With the pump case open as detailed above, disconnect the long thin spiral spring from its slot in the SSF.
2. Remove the large half nut screw, and then prise the half nut apart and remove it from the support tube.
3. Lift the SSF and support tubes assembly up and away from the pump.
4. Remove the old SSF by sliding it to the left, over and away from the small diameter support tube, and then fit the new modified SSF.
5. Refit the half nut screw and replace the support tube assembly onto the pump.
6. Refit the spiral spring.
7. Displace the size sensor assembly by removing the two screws that hold it in position.
8. Remove any shim/s that were attached to the size sensor opto moulding. If required, clean the shim area with a suitable solvent. The shim sizes provided in the kit are **0.6, 1.0, 1.2** and **1.4 mm.**
   If necessary, use a combination of shims to obtain the thickness required, up to a maximum of 2.4 mm. During production, a 0.6 mm shim is initially fitted.

(contd.)

9. Using the two fixing screws refit the sensor assembly into the pump.

10. Taking care not to trap any leads assemble the casing ensuring that the two case halves have snapped together and that the front and rear mating edges are equal and parallel. The six case screws should be tightened to a torque of between 70 and 75 cNm in the order shown below:

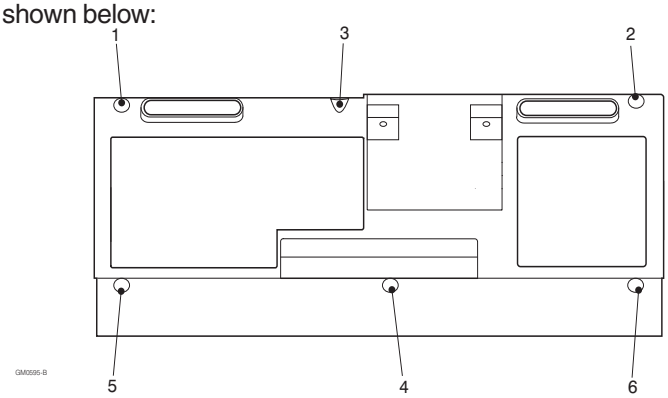


Figure A.2 Order of tightening the case screws

FINAL TESTING

When a new SSF has been fitted, the Functional Tests detailed in Chapter 6 must be completed.

Before carrying out the syringe size sensor tests, ensure that the pole clamp has been correctly fitted and the six case screws have been fully tightened (see *Figure A.2*).

The Syringe Size Sensor tests are performed with the pump's plunger clamp at each of the two following positions:

1. 40 mm from the right hand-side of the plunger clamp travel, and

2. At the extreme left hand-side of the plunger clamp travel.

Also, the pump must be Configured during the tests to operate with the 'BD Plastipak' syringe.

The small grub screw in the SSF must be correctly set (see page A-4) before carrying out the Syringe Size Sensor tests, and the small anti-tampering cap above the grub screw must then be fixed into place using a minimal amount of Loctite 414.

SETTING THE SIZE SENSOR FLAG

1. Using the 3400 size sensor test gauges (see page A-5) place the 20 ml minimum gauge (part number 0131-0170) into the pump's cradle.
2. If necessary, rotate the adjustment screw until **20** appears on the display, and then rotate the adjustment screw counter-clockwise until **10** appears on the display. Now turn the adjustment screw very carefully clockwise until **20** is once again displayed.
3. Using the fingers, alternately apply and release, several times, a gentle pressure at point **X**, see *Figure A.3*, on the size sensor flag, and ensure that the pump does **not** toggle between 10 and 20 ml. Fine tuning of the adjustment screw may be necessary to ensure that toggling does **not** occur.
4. Carry out the procedures outlined in paragraph (3) for each of the test gauges.
5. If during the tests the pump, toggles between **20** and **30** when the 30 ml minimum gauge is in the cradle, then turn the adjustment screw clockwise until the pump no longer toggles between these values. Repeat the full set of gauge tests.

Note:

If during the syringe invalid test, the pump toggles between **syringe invalid** and **5**, then this state is acceptable providing the pump detects **syringe invalid** when the pressure is released i.e. the flag is allowed to rest on the syringe invalid gauge.

The size sensor tests are complete when the correct display for each gauge appears and the pump does not toggle between sizes when pressure is applied to the flag.

Apply a small amount of Loctite 414 to the anti-tampering grub screw cap and fit it in place.

When the grub screw in the SSF has been set, the procedures required to complete the size sensor testing may be completed. Press and release the SSF each time a new gauge is placed in the pump's cradle.

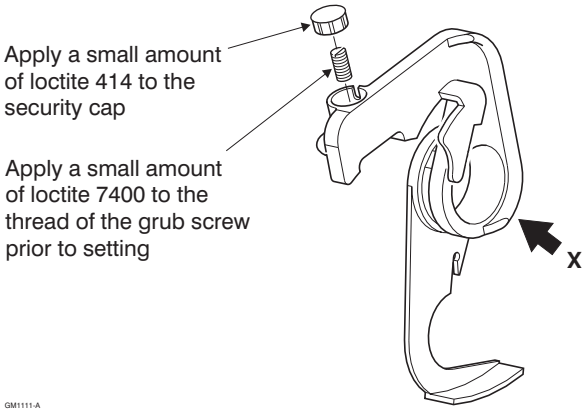


Figure A.3 Size Sensor Flag: general details

The Size Sensor Gauge set (part No. 0131-0202), contains the seven gauges that allow the Size Sensor tests on the 3300 to be carried out.
The seven gauges are listed in *Table A.1*.

Table A.1 3300 Syringe Size Sensor Gauges (black)

PART No.	GAUGE DIA. (mm)	CORRECT RESULT
0131-0158	20.50	No LED lit
0131-0159	21.00 - min.	**20ml** LED lights
0131-0160	22.90 - max.	**20ml** LED lights
0131-0161	23.70 - min.	**30ml** LED lights
0131-0162	26.20 - max.	**30ml** LED lights
0131-0163	28.50 - min.	**50ml** LED lights
0131-0164	33.10 - max.	**50ml** LED lights

The details given in this Manual are correct at the time of going to press. The company, however, reserves the right to improve the equipment shown.

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