SLE 3600 INOSYS

Service manual

Inhaled Nitric Oxide System

SLE

When the smallest thing matters

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Manual: SM0012 Issue 3

Contents

Introduction

1. Introduction

1.1 References and Related Documents

Although this manual has been designed to include all information necessary to maintain optimum performance of INOSYS, it does not attempt to cover all of the operating procedures contained in the User Manual. A good working knowledge of the operation of the INOSYS is essential in attempting to carry out maintenance or repair work. In addition all warnings and cautions in the User Manual also apply for the service manual. The User Manual should therefore be considered a reference document for the Service Manual.

1.2 Terms and Abbreviations

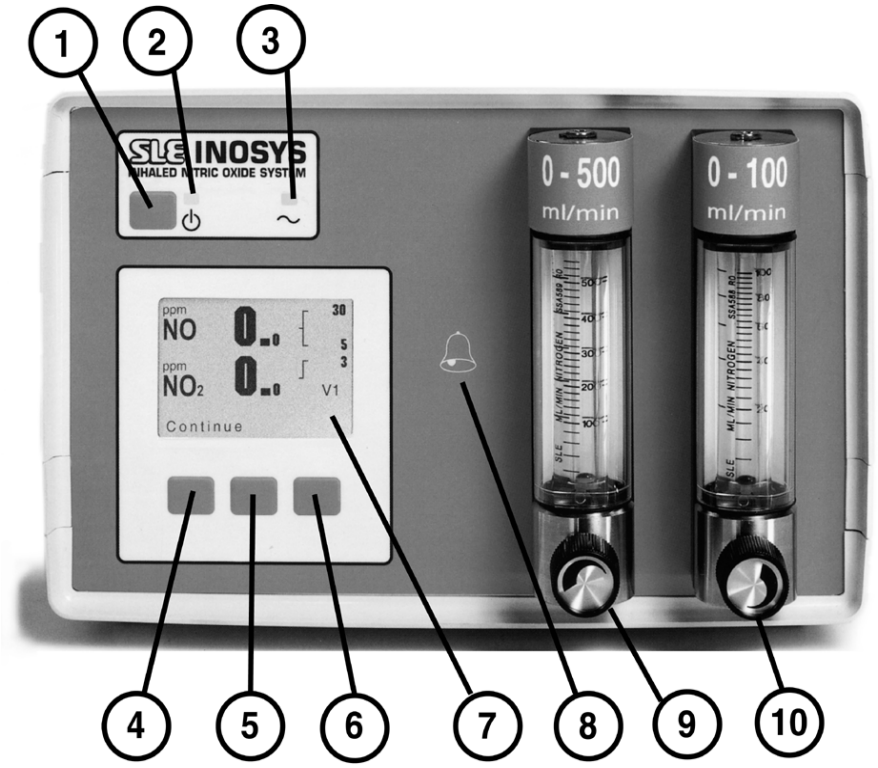
The following terms and abbreviations are used in this document:

PSU	Power Supply Unit
LCD	Liquid Crystal Display
LED	Light Emitting Diode
EPROM	Erasable/Programmable Read-Only Memory
DPST	Dual Pole Single Throw
ADC	Analogue to Digital Converter
PWM	Pulse Width Modulated
NO	Nitric Oxide
NO_2	Nitrogen Dioxide

INOSYS control description

2. Controls

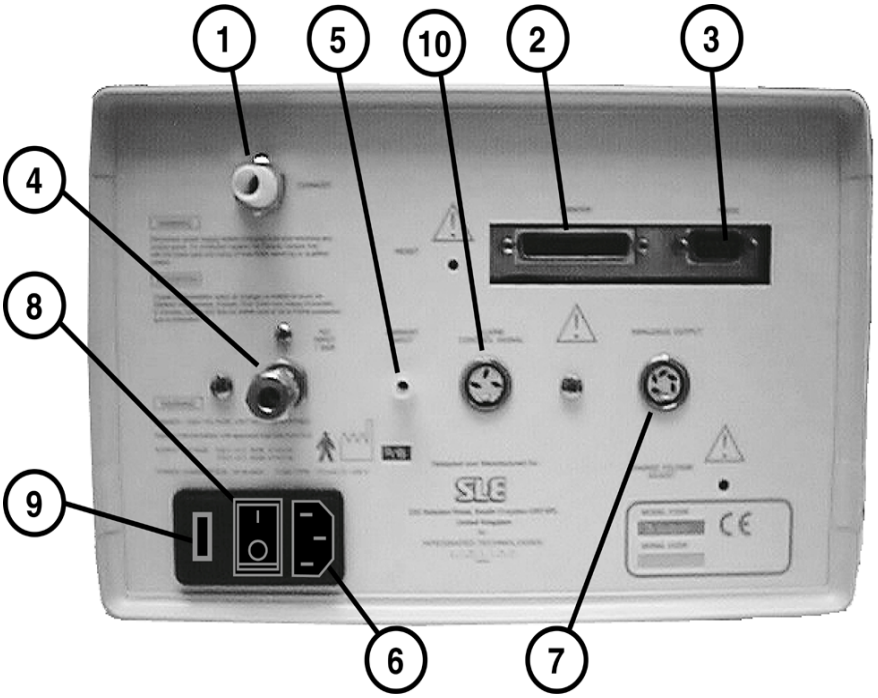
2.1 Front Panel Description



1. Standby switch.	6. Right Control Key.
2. Standby LED.	7. LCD Display.
3. Power LED.	8. Alarm Light Bar.
4. Left Control Key.	9. Flow control, (coarse). 0 to 500ml/ min.
5. Centre Control Key.	10. Flow control, (fine). 0 to 100ml/min.

Keys 4, 5 and 6 have multiple functions, the function of the key is displayed above the key on the LCD display. For the rest of this manual these keys will be referred to by their function and their position (LEFT, CENTRE and RIGHT).

2.2 Rear Panel Description



1. Exhaust.	6. Mains Connection.
2. Printer Port. ⚠	7. Analogue Output. ⚠
3. RS 232 Connector. ⚠	8. Power Switch.
4. NO Input 1bar.	9. Fuse Holder.
5. Ambient Air sampling port.	10. Alarm Control Signal from SLE Ventilator. ⚠

⚠

- The Inosys should only be connected to equipment that complies with IEC 601-1 or IEC 950 configured to comply with IEC 601-1-1.

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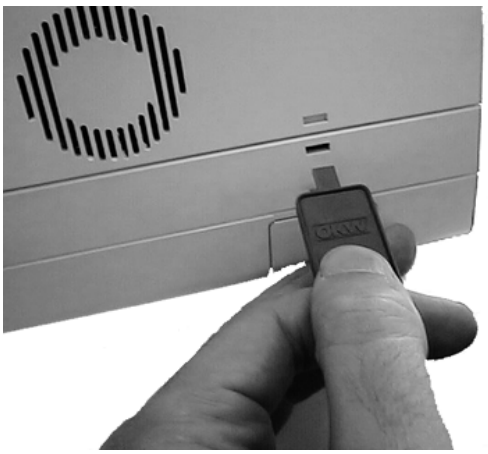
Access to internal components

3. Accessing the internal components of the INOSYS

1. Disconnect all gas and electrical supplies to the INOSYS.

2. Place the unit on a clean and level surface.

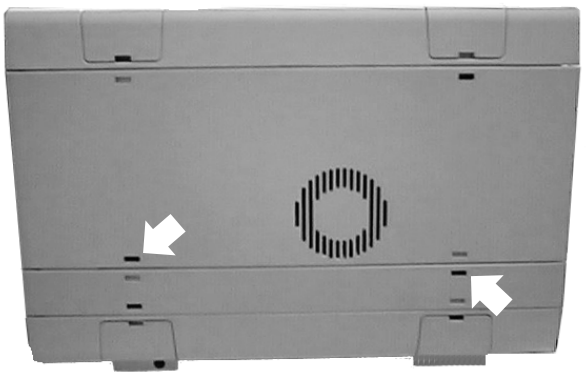
3. To remove the top cover a key has be inserted into slots to release the internal clips.



4. Insert the key into the indicated slots.

   View: Right hand side.

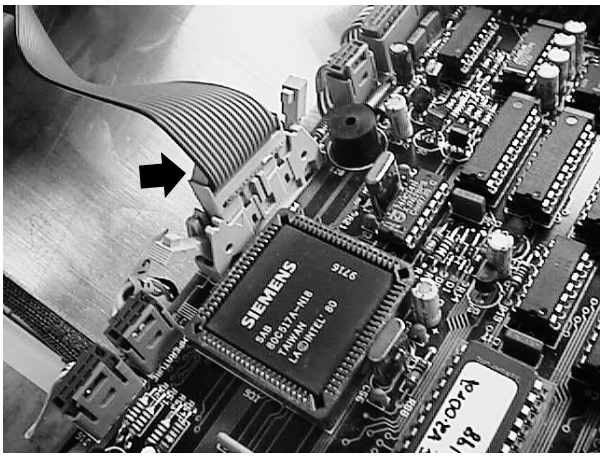
5. As the key is inserted apply gentle upward pressure on the case to separate the two halves.



6. Insert the key into the indicated slots.

   View: Left hand side

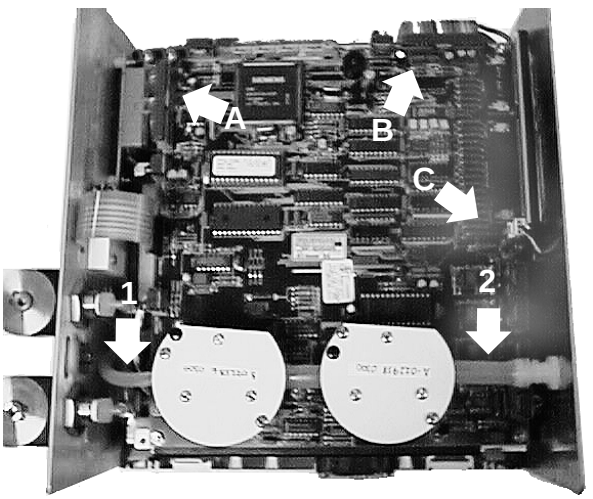
7. If the unit is fitted with a printer disconnect the printer ribbon cable before the cover is removed.



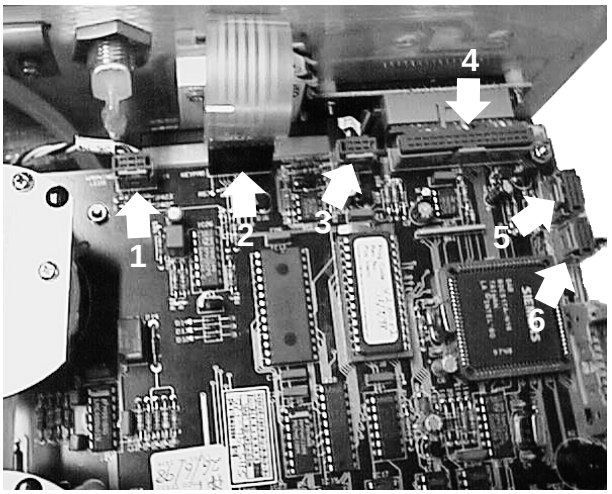
8. To remove the sensor cells see section 5.9 on page 37 for details.

9. To remove the PCB first disconnect the inlet (1) and outlet (2) tubing to the sensor cells.

10. Disconnect the connectors mounted in the following locations A, B and C.)



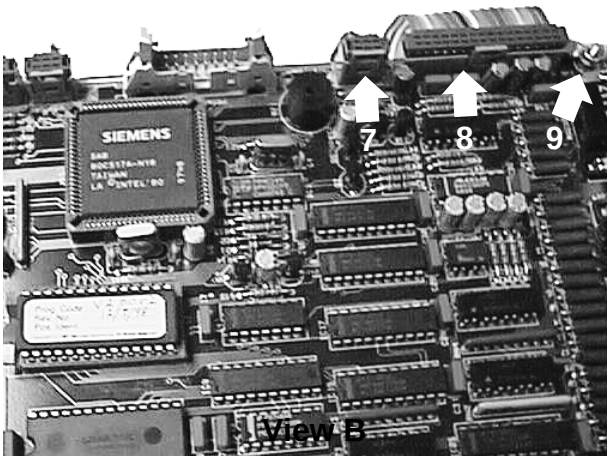
11. Disconnect the connectors at J14 (1), J15 (2), J12 (3), J13 (4), J16 (5), J19 (6) See 14.4 INOSYS Wiring Schematic. on page 67 for further details.



View A

12. Disconnect the connectors at J10 (7), J9 (8). See 14.4 INOSYS Wiring Schematic. on page 67 for further details.

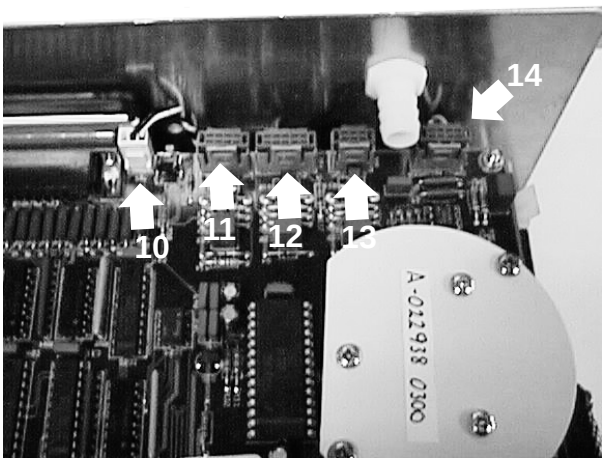
13. Remove the chassis earth strap (9)



View B

14. Disconnect the connectors at J25(10), J23 (11), J21 (12), J22 (13), J11 (14). See 14.4 INOSYS Wiring Schematic. on page 67 for further details.

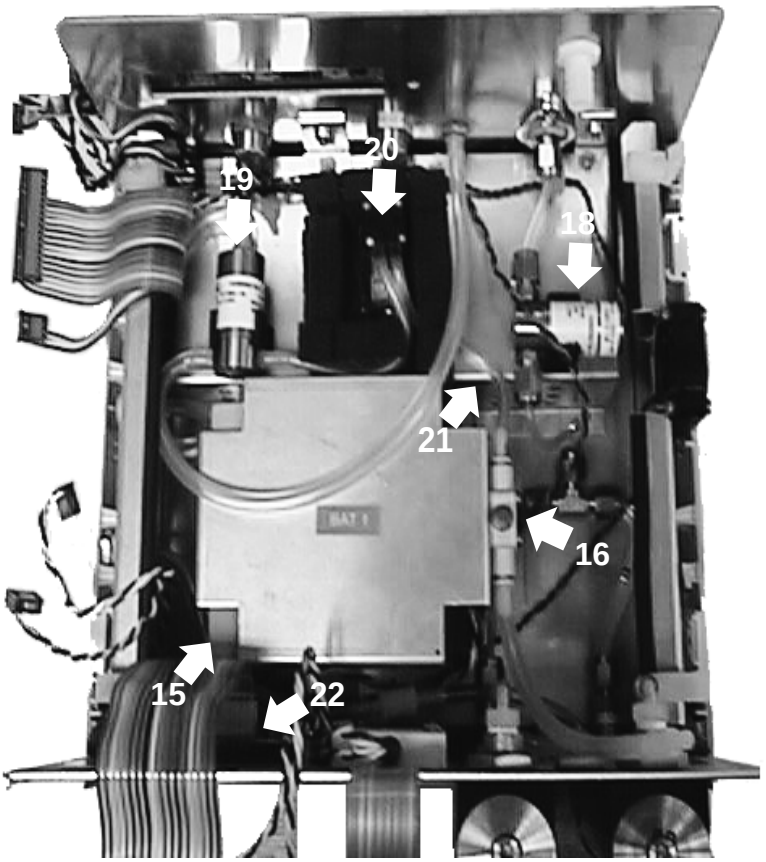
15. The PCB can now be lifted away.
Note The cables are attached to the rear of the PCB mounting plate and have to be released prior to complete removal of the PCB.



View C

16. With the PCB removed you now have access to the following components.

    Battery (15)
    Restrictor (16)
    Fan (17)
    Valve 1 (18)
    Valve 2 (19)
    Pump (20)
    Power supply (21)
    LCD Display (22)



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Calibration

4. Calibration

To calibrate the INOSYS the following equipment and gases are required.

A supply of medical grade air, regulated to give a flow of 1.5 Lpm, plus:

1. A gas cylinder with pressure regulator containing a certified NO/Nitrogen mixture of concentration between 20 and 30ppm (nominal 25ppm) in pure N_2.
2. A gas cylinder with pressure regulator containing a certified NO_2/Air mixture of concentration between 5 and 15ppm (nominal 10ppm) in pure Air.
3. Connection tubing.
4. T-Piece for connection tubing.
5. Plastic bodied flowmeter.
6. Scavenger.

These items are available in the form of SLE INOSYS calibration kit (part Nº: N4116).

SLE also supply a disposable calibration kit (part Nº: N4123). The disposable calibration kit contains the following components.

1. A disposable gas cylinder with a fixed flow regulator containing a certified NO/ Nitrogen mixture of concentration between 20 and 30ppm in pure N_2.
2. A disposable gas cylinder with a fixed flow regulator containing a certified NO_2/Air mixture of concentration between 5 and 15ppm in pure Air.
3. Calibration connection tubing.

When using the SLE INOSYS calibration kit, refer to the instructions with the kit.

It is recommended that calibration should be carried out in a well ventilated room and that the exhaust gas is fed into a scavenging system

If using a SLE calibration kit N4116 use the calibration procedure on page 20

If using a SLE calibration kit N4123 use the calibration procedure on page 26

Regardless of which kit is being used the INOSYS should have its flow through confirmed to be 300ml/minute. See “Flow Checking” on page 19.

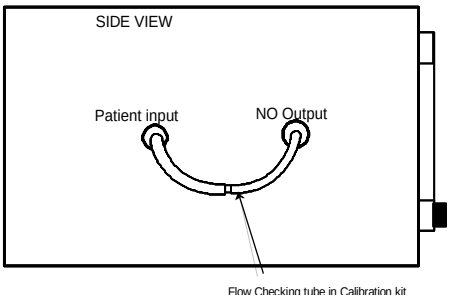
If you get ’lost’ at any time during calibration, switch the unit off and start again.

4.1 Flow Checking

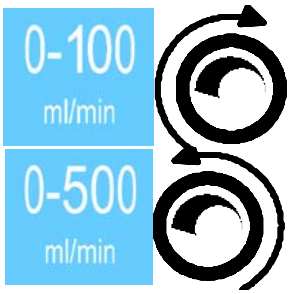
Before calibration the flow through the Inosys should be checked to be 300ml/minute.

Note: Either disconnect the delivery regulator or open the regulator fully to allow flow before attempting the 300ml/minute check.

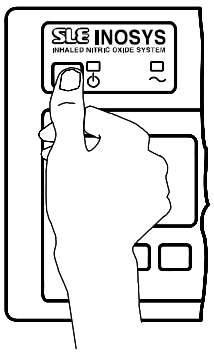
- Connect the NO OUTPUT to the PATIENT INPUT with the supplied tube.



- Fully close the fine flow control on the front of the unit (Clockwise).

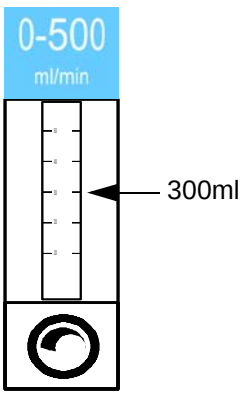


- Fully open the coarse flow control on the front of the unit (Anticlockwise)



- Switch on the Inosys and observe the flow rate on the coarse flow gauge. It will be necessary to reset the low alarm value of the NO to zero.

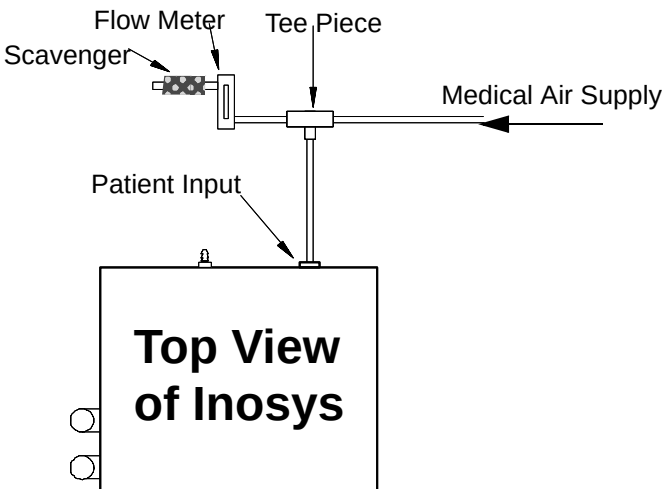
- The flow gauge should read approximately 300ml. If the flow gauge reads below 280ml or above 330ml adjust the internal flow valve, located on the battery housing beneath the PCB. See “Accessing the internal components of the INOSYS” on page 12.



4.2 Calibration procedure for SLE kit Nº: N4116

4.2.1 Zero Calibration

- With the unit switched off connect the medical grade air supply to the Patient Input via the flowmeter and the tee-piece.

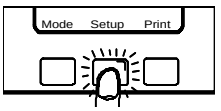
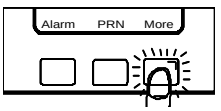
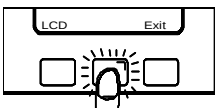


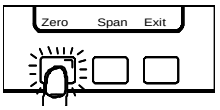
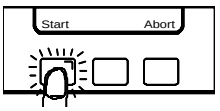
- Turn on the medical air supply and adjust the wall pressure regulator until the flow is 1.5LPM as read on the flowmeter.

- Connect the INOSYS to a suitably grounded power source.

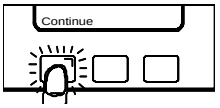
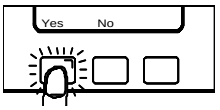
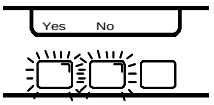
- Switch on the unit at the rear and then press the standby switch on the front (See “Front Panel Description” on page 8.).

- After 30 seconds the Connect Ventilator Alarm alarm will sound, when it does, press Continue (left) and then Yes (centre). The NO Low Alarm will then sound, press Reset (left)

Press the **Setup** button (centre).	
Press the **More** button (right).	
Press and hold the unmarked (centre) button for 5 seconds.	

Press the **Zero** button (left) The unit will display 'Purge System' Flush with air for 3 minutes.	
Press the **Start** button (left) The unit will display 'Zeroing'.	

- It is possible to abort by pressing abort before the unit displays 'Zeroing Done'.

Press the **Continue** button (left). The unit will ask if the user wishes to save the settings or not.	
Press the **Yes** button (left). The unit will then ask if the user wishes to restore the Low NO Alarm limit as this may be adjusted to avoid sounding alarms.	
'Restore NO Lim' Choose **Yes** button (left) or **No** button (centre). '**Yes**' is recommended.	

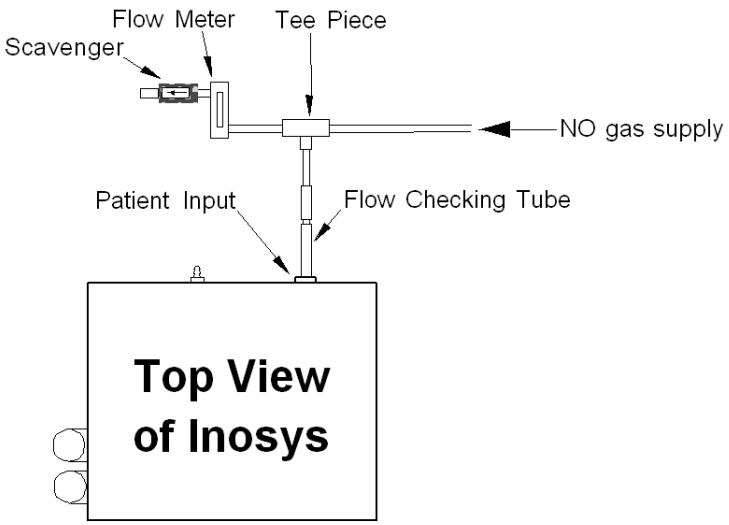
- Close the air supply.
- Once the tubing has de-pressurised, fully close the pressure regulator and disconnect supply.

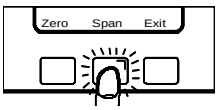
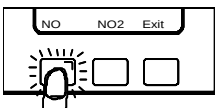
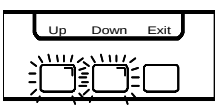
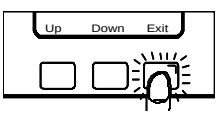
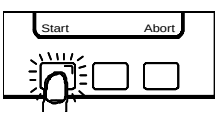
Zero Calibration is now complete.

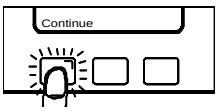
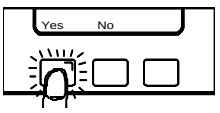
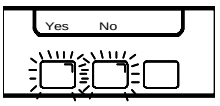
4.2.2 Nitric Oxide Calibration

- Use a certified NO/Nitrogen mixture of concentration between 20 and 30ppm NO in pure N_2
- Agitate or roll the cylinder for at least 5 minutes before use, to ensure that the gas is well mixed.
- Connect NO/Nitrogen mixture, turn on the gas cylinder and adjust the flow rate to 1.5LPM read on the plastic flow meter.
- Wait 1 minute for the instrument NO reading to stabilise.

Note: During NO calibration the NO_2 reading will fluctuate. Ignore this.



Press the **Span** button (centre).	
Press the **NO** button (left).	
Use the **Up** (left) and **Down** (centre) buttons to enter the concentration of the calibration gas.	
Press the **Exit** button (right).	
Press the **Start** button (left) The unit will display 'Calibrating NO' and then 'NO Span Done'. Or if incorrect gas is used the unit will display 'Cal out of range'.	

Press the **Continue** button (left) The unit will ask if the user wishes to save the settings or not.	
Press the **Yes** button (left).The unit will then ask if the user wishes to restore the High NO Alarm limit as this may be adjusted to avoid sounding alarms.	
'Restore NO Lim' Choose **Yes** button (left) or **No** button (centre). '**Yes**' is recommended.	

- Close the NO supply on the bottle.

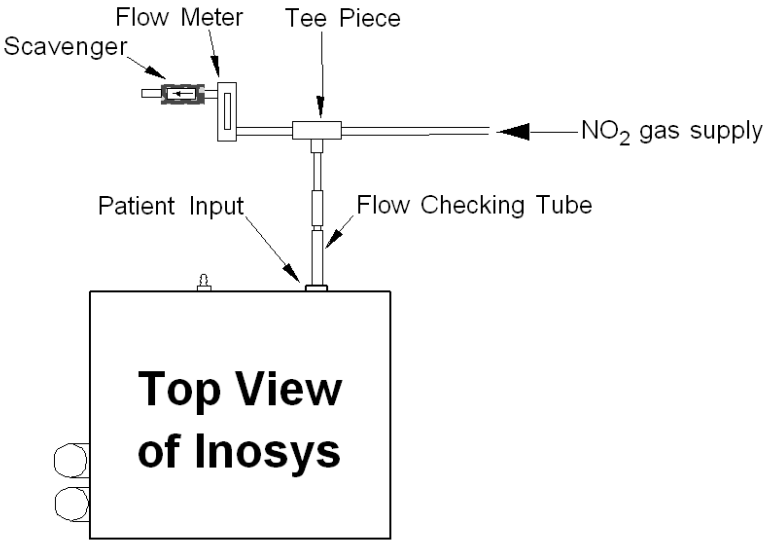
- Once the tubing has de-pressurised, fully close the pressure regulator and disconnect the NO bottle.

The Nitric Oxide is now calibrated.

4.2.3 Nitrogen Dioxide Calibration

- Flush the unit with air. (See “Zero Calibration” on page 20.)
- Use a certified NO_2/Air mixture of concentration between 5 and 15ppm NO in Air.
- Agitate or roll the cylinder for at least 5 minutes before use, to ensure that the gas is well mixed.
- Connect NO_2/Air mixture and adjust the flow with the pressure regulator to 1.5LPM read on the plastic flow meter.
- Because of the absorption characteristics of NO_2 , wait 3 minutes for the instrument reading to stabilise.

Note: During NO_2 calibration the NO readings will fluctuate. Ignore this



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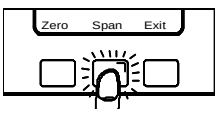
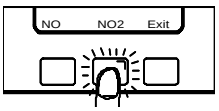
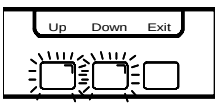
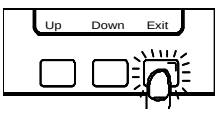
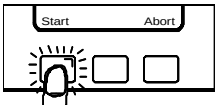
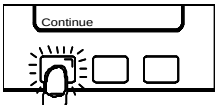
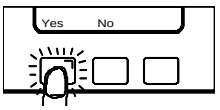
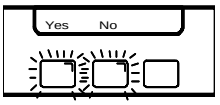
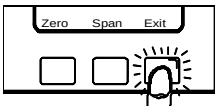
Press the **Span** button (centre).	
Press the **NO_2** button (centre).	
Use the **Up** (left) and **Down** (centre) buttons to enter the concentration of the calibration gas.	
Press the **Exit** button (right).	

Press the **Start** button (left) The unit will display 'Calibrating NO_2' and then 'NO_2 Span Done'.Or if incorrect gas is used the unit will display 'Cal out of range'.	
Press the **Continue** button (left) The unit will ask if the user wishes to save the settings or not.	
Press the **Yes** button (left). The unit will then ask if the user wishes to restore the NO_2 Alarm limit as this may be adjusted to avoid sounding alarms.	
'Restore NO_2 Lim?' Choose **Yes** button (left) or **No** button (centre) .'**Yes**' is recommended.	
Press the **Exit** button (right).	

Note: If a printer is attached the calibration information will be printed after completion of each calibration.

Close the NO_2 supply on the bottle.

Once the tubing has de-pressurised, fully close the pressure regulator and disconnect the NO_2 bottle.

The Nitrogen Dioxide is now calibrated.

Connect the supply of medical grade air, regulated to give a flow of 1.5LPM to the patient input and flush the unit with air.

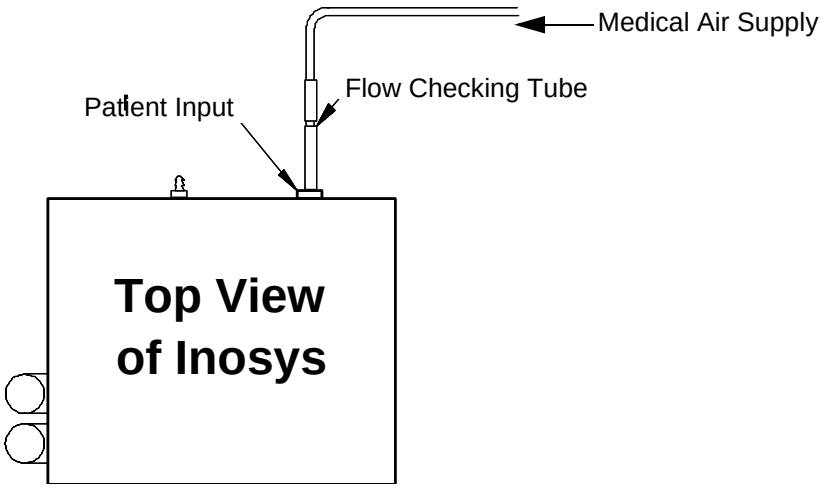
Disconnect air supply.

The unit is now ready for use.

4.3 Calibration procedure for SLE kit Nº: N4123

4.3.1 Zero Calibration

- With the unit switched off connect the medical air supply to the patient input via the flow checking tube.

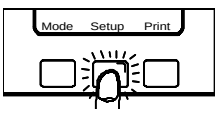
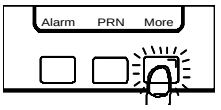
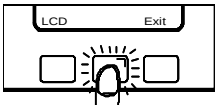


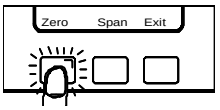
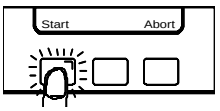
- Open the supply of medical grade air regulated to give a flow of 1.5 LPM to the patient input.

- Connect the INOSYS to a suitably grounded power source.

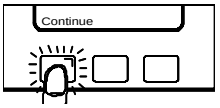
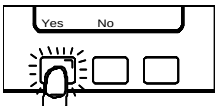
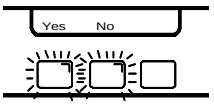
- Switch on the unit at the rear and then press the standby switch on the front. (See “Front Panel Description” on page 8.).

- After 30 seconds the Connect Ventilator Alarm alarm will sound, when it does, press Continue (left) and then Yes (centre). The NO Low Alarm will then sound, press Reset (left)

Press the **Setup** button (centre).	
Press the **More** button (right).	
Press and hold the unmarked (centre) button for 5 seconds.	

Press the **Zero** button (left) The unit will display 'Purge System' Flush with air for 3 minutes.	
Press the **Start** button (left) The unit will display 'Zeroing'.	

- It is possible to abort by pressing abort before the unit displays 'Zeroing Done'.

Press the **Continue** button (left) The unit will ask if the user wishes to save the settings or not.	
Press the **Yes** button (left). The unit will then ask if the user wishes to restore the Low NO Alarm limit as this may be adjusted to avoid sounding alarms.	
'Restore NO Lim' Choose **No** button (centre) if calibration procedure is to continue. Choose **Yes** button (left) if calibration procedure is complete.	

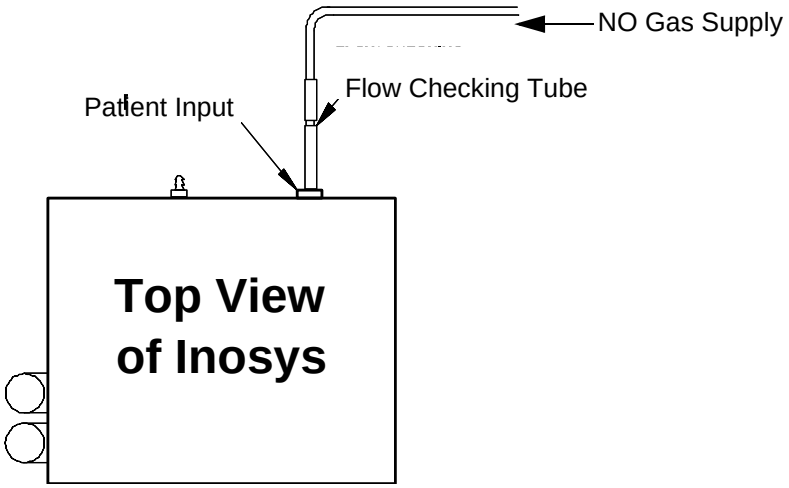
- Turn off and disconnect the supply of medical grade air.

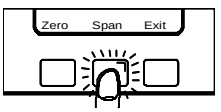
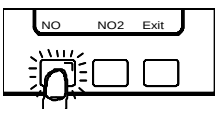
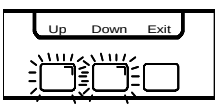
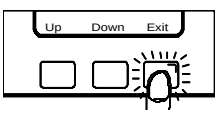
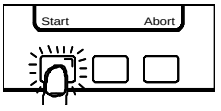
Zero Calibration is now complete.

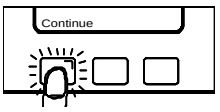
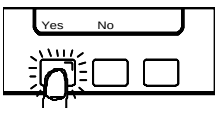
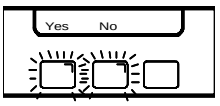
4.3.2 Nitric Oxide Calibration

- Use a certified NO/Nitrogen mixture of concentration between 20 and 30ppm NO in pure N_2
- Agitate or roll the cylinder for at least 5 minutes before use, to ensure that the gas is well mixed.
- Connect NO/Nitrogen mixture, turn on the gas cylinder and adjust the flow rate to 1.5LPM read on the plastic flow meter.
- Wait 1 minute for the instrument NO reading to stabilise.

Note: During NO calibration the NO_2 reading will fluctuate. Ignore this.



Press the **Span** button (centre).	
Press the **NO** button (left).	
Use the **Up** (left) and **Down** (centre) buttons to enter the concentration of the calibration gas. (Concentration of gas indicated on gas cylinder).	
Press the **Exit** button (right).	
Turn on the gas cylinder using the fixed flow regulator preset at 1.5 LPM. Wait 1 minute for the instrument NO reading to stabilise.	
Press the **Start** button (left) The unit will display 'Calibrating NO' and then 'NO Span Done'. Or if incorrect gas is used the unit will display 'Cal out of range'.	

Press the **Continue** button (left) The unit will ask if the user wishes to save the settings or not.	
Press the **Yes** button (left).The unit will then ask if the user wishes to restore the High NO Alarm limit as this may be adjusted to avoid sounding alarms.	
'Restore NO Lim' Choose **No** button (centre) if calibration procedure is to continue. Choose **Yes** button (left) if calibration procedure is complete.	

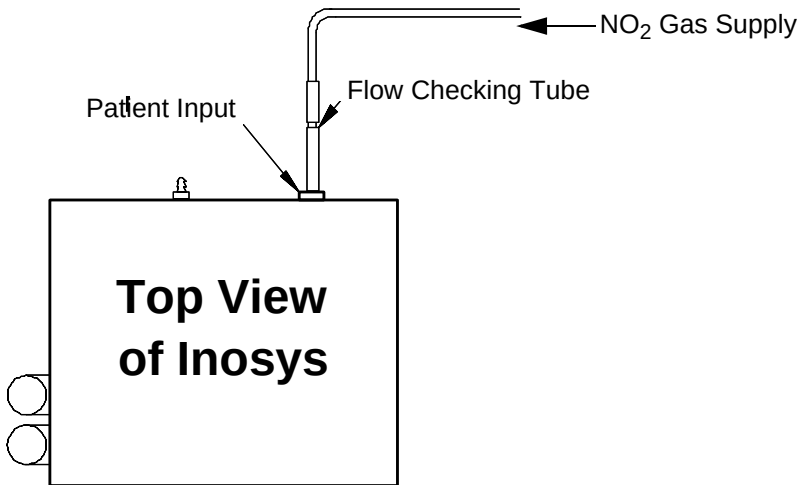
- Close the NO supply on the bottle.

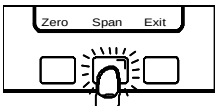
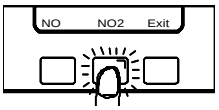
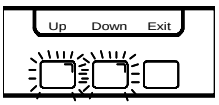
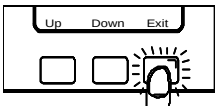
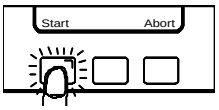
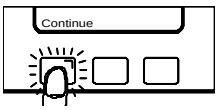
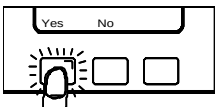
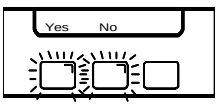
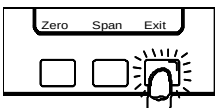
The Nitric Oxide is now calibrated.

4.3.3 Nitrogen Dioxide Calibration

- Flush the unit with air. Connect the supply of medical grade air, regulated to give a flow of 1.5LPM to the patient input. (See "Zero Calibration" on page 26.)
- Use a certified NO_2/Air mixture of concentration between 5 and 15ppm NO in Air.
- Agitate or roll the cylinder for at least 5 minutes before use, to ensure that the gas is well mixed.
- Connect NO_2/Air mixture and adjust the flow with the pressure regulator to 1.5LPM read on the plastic flow meter.
- Because of the absorption characteristics of NO_2, wait 3 minutes for the instrument reading to stabilise.

Note: During NO_2 calibration the NO readings will fluctuate. Ignore this.



Press the **Span** button (centre).	
Press the **NO_2** button (centre).	
Use the **Up** (left) and **Down** (centre) buttons to enter the concentration of the calibration gas.	
Press the **Exit** button (right).	
Press the **Start** button (left) The unit will display 'Calibrating NO_2' and then 'NO_2 Span Done'.Or if incorrect gas is used the unit will display 'Cal out of range'.	
Press the **Continue** button (left) The unit will ask if the user wishes to save the settings or not.	
Press the **Yes** button (left). The unit will then ask if the user wishes to restore the NO_2 Alarm limit as this may be adjusted to avoid sounding alarms.	
'Restore NO_2 Lim' Choose **No** button (centre) if calibration procedure is to continue. Choose **Yes** button (left) if calibration procedure is complete.	
Press the **Exit** button (right).	

Note: If a printer is attached the calibration information will be printed after completion of each calibration.

Close the NO_2 supply on the bottle.

Once the tubing has de-pressurised, fully close the pressure regulator and disconnect the NO_2 bottle.

The Nitrogen Dioxide is now calibrated.

Connect the supply of medical grade air, regulated to give a flow of 1.5LPM to the patient input and flush the unit with air.

Disconnect air supply.

The unit is now ready for use.

Maintenance

5. Maintenance

5.1 Electrical Interference

Note: All these tests should be carried out by a qualified engineer.

If the INOSYS is adversely affected by equipment emitting electromagnetic interference then that equipment should be switched off or removed from the vicinity of the INOSYS. Conversely, if the INOSYS is the source of the interference to other neighbouring equipment it should be turned off or taken to another location. Use of mobile phones or other high frequency sources in the vicinity of the INOSYS is not recommended. Care should be taken to ensure that cables leading to the INOSYS are not mixed with other equipment cabling.

5.2 Ventilator Alarm Checks

Please refer to the service manual for your ventilator.

5.3 Other Checks

All cables, tubes and fittings should be checked periodically. If they appear damaged or faulty they should be replaced.

The hydrophobic filter should be checked periodically and changed or emptied if required.

When the warning “Calibration Overdue” is displayed, the sensor(s) must be re-calibrated. See Calibration procedure on page 18.

When the warning “Replace Sensor” is displayed, the sensor(s) must be replaced.

Note: That this warning will be displayed at 12 monthly intervals and must be adhered to.

In the event of a low NO alarm, the cause (e.g. water in patient sampling tube, stuck patient/ ambient valve, blocked or kinked patient input tube), should be investigated prior to increasing the NO flowmeters to ensure that the concentrations of NO delivered to the patient is no higher than thought administered.

The flow meters on the front panel of the INOSYS can be inaccurate if they are not vertical or subject to acceleration.

5.4 Replacement of Fuses

Switch of the unit and remove the power cord. Insert a suitable screw driver in the slot provided and gently ease the fuse holder out. Replace the fuse with those of the same type and rating. Push the fuse holder back in position ensuring it is orientated for the correct voltage setting, 230V ac or 115V ac.

5.5 Cleaning

Before cleaning the exterior of the unit, the power cord should be disconnected from the mains supply. Also, disconnect the NO supply and any attached ventilator.

DO NOT use any strong solvent cleaners.

CUATION: Do not allow moisture to enter the inside of the unit. Electronic malfunction may result.

DO NOT wash or immerse in water, or other liquids.

5.6 Sensors

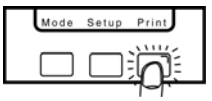
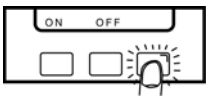
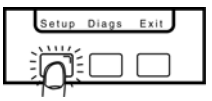
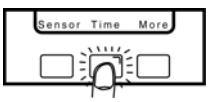
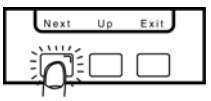
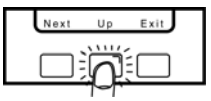
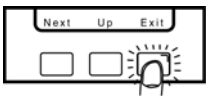
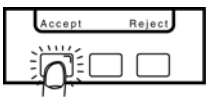
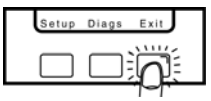
SLE recommend that the sensors are calibrated prior to each use or every 28 days, the unit will advise the user when this is necessary on the LCD start-up screen. See Calibration Procedure for details on page 18 for details.

The NO and NO_2 sensor cells must be replaced once a year. The unit will advise the user when this is necessary.

5.7 Setting Time/date

This feature allows for the setting of the battery backed up real time clock. This clock is necessary for the unit to trace time since the last calibration and sensor change.

To access the "Time /Date" menu Follow the following sequence:

From the main menu press the **Print** button (right)	
Press and hold the unmarked (right) button for 5 seconds	
Press the **Setup** (left) button	
Press the **Time** button. The menu displays the current time and date in the format "hh:mm dd/mmm/yy" hh = hour between 0 and 23 mm = minute between 0 and 59 dd = day between 1 and 31 mmm = month between "Jan" and "Dec" yy = year between 97 and 50. Values between 0 and 50 indicate 2000 to 2050	
Press the **Next** (left) button to step through the time and date	
The element selected for change flashes. Use the **UP** button to increase the selected value. When the desired value is reached use the "Next" button to select the next element to change.	
When the desired values are set press the **Exit** button to leave the "Time menu. If an invalid time or date has been entered the "Invalid Time Date" menu will be displayed. Press "continue" to re-enter the time and date.	
The "Confirm Time" menu will now be displayed. Pressing the **Reject** will return you to the "Time" menu where any further changes can be made. Pressing the **Accept** button will program the clock with the new time and date settings.	
Press the **Exit** (right) button	

5.8 Clock Dead

If the internal battery has been allowed to become flat, when the unit is turned on a alarm message **"Clock Dead"** will appear. This means the unit has no record of the current time or date. This also affects the calibration cycle of the unit and will cause the unit to prompt re-calibration of the sensors.

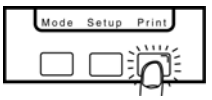
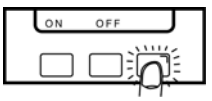
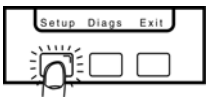
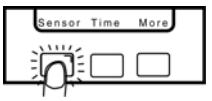
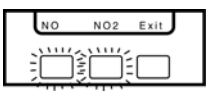
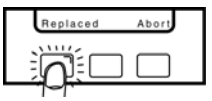
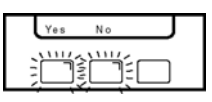
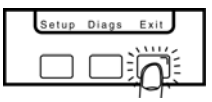
To clear the clock dead alarm use the following procedure.

Step 1. Connect the unit to a suitably grounded power supply and leave the unit in stand-by mode for 5 hours to recharge the battery.

Step 2. Turn on the unit and disable the VN alarm so you reach the main menu.

Step 3. Carry out the Time/Date setting procedure already described in section 5.7 on page 34.

Step 4. The unit will now display calibrate NO and NO_2 sensors as it no longer carries the last calibration date for the sensors. To restart the cycle the unit has to be told that the sensors have been replaced. To do this use the following procedure.

From the main menu press the **Print** button (right)	
Press and hold the unmarked (right) button for 5 seconds	
Press the **Setup** (left) button	
Press the **Sensor** (left) button	
Press the **NO** (left) or **NO_2** (centre) buttons to select the required sensor cell	
Press the **Replaced** (left) to indicate a new sensor cell has been fitted	
Press **Yes** (left) to confirm **NO** (centre) abort setting	
Press **Exit** (right) to return to the main menu	

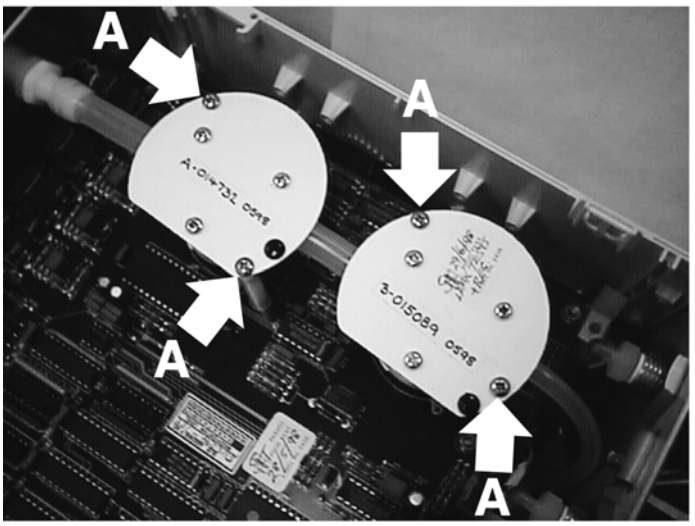
Step 5. The unit now has to be left in stand-by mode for 4 days after sensor replacement to allow the sensors to stabilize.

Step 6. The sensor cells must then be re-calibrated. See Calibration Procedure on page 18 for details.

5.9 Replacement of Sensor Cells

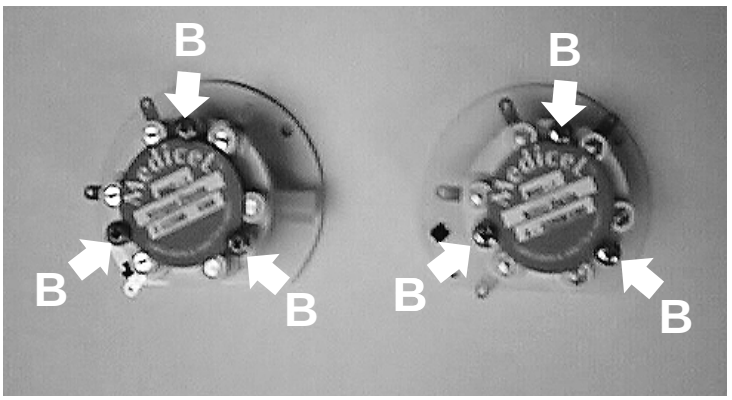
Step 1. Remove the top cover (Refer to “Accessing the internal components of the INOSYS” on page 12). The NO and NO_2 sensor cells are located on the left of the PCB and are clearly labelled. Disconnect the silicone tubing from each sensor. Undo the two outer screws (A) holding the polarising plate. The cells can be lifted clear.

.



A: The fixing screws for the NO and NO_2 sensor cells.

Step 2. Turn the sensor cells over and remove the three screws (B) that secures the cells to the manifold.

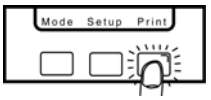
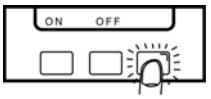
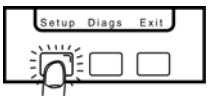
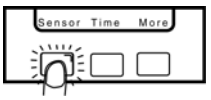
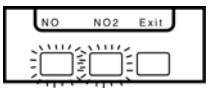
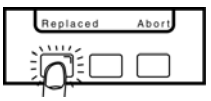
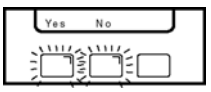
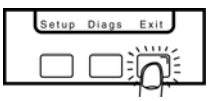


Step 3. Discard the sensor and refit the new sensor cell to the manifold.

Note: new sensors may have a link spring fitted between two of the electrical contacts. This link has to be removed as it will damage the sensor if it remains in place and the unit is powered up.

Step 4. Reconnect the silicone tubing to the sensors cells. Refit the cells to the PCB and reconnect the outlet and inlet connections. Replace the top cover.

Step 5. The INOSYS unit now has to be told that new sensor cells have been fitted. To do this use the following procedure.

From the main menu press the **Print** button (right)	
Press and hold the unmarked (right) button for 5 seconds	
Press the **Setup** (left) button	
Press the **Sensor** (left) button	
Press the **NO** (left) or **NO_2** (centre) buttons to select the required sensor cell	
Press the **Replaced** (left) to indicate a new sensor cell has been fitted	
Press **Yes** (left) to confirm **NO** (right) abort setting	
Press **Exit** (right) to return to the main menu	

Step 6. Do not use the unit for 4 days after sensor replacement to allow the sensors to stabilize. During this period the unit must be connected to the mains supply and left in stand-by mode.

The unit must then be re-calibrated. See Calibration Procedure on page 18 for details.

5.10 Battery

5.10.1 Charging

The unit should be connected to a suitable earthed hospital grade mains power supply and switched on at the rear for at least 5 hours every 2-3 months. However, SLE strongly recommend that the unit is left in stand-by mode and connected to the mains supply when in use and when stored.
If the battery is not charged on a regular basis, SLE recommend the battery be changed once a year.

5.11 Replacement of battery

Remove the top cover using the special key provided. Remove the exhaust tubing and the dual barb connector. Remove the tubing to the C sensor. Unclip the PCB assembly and lift it away. Undo the 4 screws holding the bracket marked BAT1 and remove the bracket. Disconnect the battery and install the replacement. Connect the battery and restore bracket marked BAT1. Re-seat PCB assembly ensuring it is held in place. Connect NO_2 tubing. Fit the dual bard connector and connect the exhaust tubing.

Note: After battery replacement or if the battery is allowed to become discharged the unit must be left in stand-by mode and connected to the mains supply for 4 days to allow the sensors to stabilize. Before use the unit must be re-calibrated. See Calibration Procedure for details on page 18 for details.

5.12 Service

It is recommended that the following checks are carried out once a year in accordance with BS EN 601-1:1990: Insulation Resistance, protective Earth continuity, Earth leakage current, Enclosure leakage current.

5.12.1 Regulator Test Procedure

Step 1. Ensuring that the regulator is fully off, (turned fully anti-clockwise), and the gas cylinder is NO gas with a pressure of 100 - 200 bar, nominal concentration 1000ppm NO. Connect regulator to gas cylinder, (hand tighten and then apply a quarter turn more with a spanner to ensure a good seal).

Step 2. Connect to INOSYS and switch the unit on. SET low NO alarm to zero, (see User Manual), and connect Patient Input to NO output with calibration kit tube.

Step 3. Vent the exhaust out of a window.

Step 4. Open the gas cylinder tap. If there is a leak, close the tap. Ensure the white seal is fitted, tighten the connection and open the tap again. Increase the output pressure to 14 psi maintaining a flow of 300 ml with the coarse flow regulator on the front of the INOSYS.

Step 5. Increase the output pressure and record the maximum. This should be no more than 3 bar. (if the regulator fails then replace)

Step 6. Close the gas cylinder tap. Once the tubing has de-pressurised, fully close the pressure regulator and disconnect from the INOSYS. Remove calibration kit tube.

Step 7. Block the end of the hose, that would normally connect the back of the INOSYS with the blocking cap.

Step 8. Open gas cylinder tap. If there is a leak, close tap, tighten connection and open the tap again.

Step 9. Set output pressure of regulator to 1 bar.

Step 10. Use the INOSYS as a “Sniffer” by applying the sniffer tube to the patient input and “Sniff” every joint on the regulator for at least 10 seconds. Any reading of NO concentration above ambient level indicates a leak that must be investigated and rectified.

Step 11. Close cylinder tap.

Step 12. Put the blocked end of the hose out of a window and remove the blocking cap. Once the gas has escaped remove the regulator from the cylinder.

Step 13. Close the regulator. Turn off the INOSYS and remove the sniffer tube.

Troubleshooting chart

6. INOSYS Trouble Shooting

Symptom	Possible cause	Action
INOSYS does not switch on	Power cable not plugged in	Plug cable into power inlet at rear of unit
	Rear panel power switch not on.	Switch to “ON” position.
	Front panel stand-by switch not on	Press stand-by switch.
	Battery flat.	Replace or recharge battery.
	Power supply module faulty.	Replace power supply module.
Stand-by LED not flashing	Battery flat.	Replace or recharge battery.
LCD screen blank	Internal power cable not connected	Check power cable and rectify.
	Internal data cable not connected.	Check data cable and rectify.
	Faulty main control PCB.	Replace main control PCB.
No response to keypad commands.	Internal cable not connected.	Check cable and rectify.
	Faulty main control PCB.	Replace main control PCB.
Internal printer not responding.	Internal cable not connected	Check cable and rectify.
	Paper not loaded	Load paper.
	Faulty printer unit.	Replace printer unit.
Fan not operating.	Internal cable not connected	Check cable and rectify.
	Faulty fan.	Replace fan.
Clock Dead	Battery flat	See section 5.8 on page 35

7. Alarm Messages

Alarms are warning signals displayed to the operator to indicate either that the NO or NO_2 levels have crossed programmable limits or that there is a problem with the unit.

The audible alarm may be temporarily silenced with the alarm mute button, however visual alarms may not.

If the NO or NO_2 high alarm is activated then the NO supply solenoid will cut-off the NO supply to the circuit, once the gas concentration has been returned to within the chosen parameters the user must press the alarm reset button to return to normal operation.

The software will prevent the user from setting illogical alarm threshold values. On powering up from Stand-by, limits will be reset to their defaults. In addition to an audio/visual indication of an alarm being triggered, the limit for the actual alarm triggered will flash on the LCD.

Fixed alarms

Fault condition	Warning	Action
Low battery.	:LCD and Audio	Charge Unit
System malfunction.	:Flashing Light Bar	Consult SLE or Distributor
Corruption of data held in non-volatile memory.	: LCD 'Checksum failed'	The User can choose to enter new values or use defaults
Calibration overdue (after a warning). This will not prevent instrument operation.	:LCD on startup 'Calib Due'	Calibrate sensors See "Calibration" on page 18.
Sensor replacement overdue (after a warning). This will not prevent instrument operation.	:LCD on startup 'Replace Sen'	Replace sensor Qualified, suitably trained personnel only

If an internal printer is present and selected, alarm events will be printed and date and time stamped.

7.1 Alarm State Table

Alarm	Current Condition:	Shut off valve	Message Displayed	Audible Warning	Limit Flash	Error Printout	Warning Bar
NO goes above limit.	No user intervention.	OFF after set delay.	NO High	ON	YES	YES	YES
NO above limit.	Mute key pressed.	OFF after set delay.	NO High	OFF after delay	YES	NO	YES
NO above limit.	Reset key pressed.	OFF after set delay.	None	OFF	YES	NO	YES
NO falls back below high limit.	Already reset.	ON	None	OFF	NO	NO	NO
NO falls back below high limit.	NOT reset.	OFF after set delay.	NO High	OFF	YES	NO	YES
NO Below low limit.	No user intervention.	ON	NO High	YES	YES	YES	YES
NO Below low limit.	Reset key pressed.	ON	None	NO	YES	NO	NO
NO returns above low limit.	Already reset.	ON	None	NO	NO	NO	NO
NO returns above low limit.	NOT reset.	ON	NO High	NO	YES	NO	YES
NO_2 goes above limit.	No user intervention.	OFF after set delay.	NO_2 High	ON	YES	YES	YES
NO_2 above limit.	Mute key pressed.	OFF after set delay.	NO_2 High	OFF after delay	YES	NO	YES
NO_2 above limit.	Reset key pressed.	OFF after set delay.	None	OFF	YES	NO	YES
NO_2 falls back below high limit.	Already reset.	ON	None	OFF	NO	NO	NO
NO_2 falls back below high limit.	NOT reset.	OFF after set delay.	NO_2 High	OFF	YES	NO	YES
NO returns above low limit.	NOT reset.	ON	NO High	NO	YES	NO	YES
NO Already above high limit, then NO_2 goes above limit.	No user intervention.	OFF after set delay.	NO_2 High Message overrides	YES	YES	YES	YES
NO Already above high limit, then NO_2 goes above limit.	Reset key pressed.	OFF after set delay.	NO High Message	YES	YES	YES	YES
NO and NO_2 both above high limit, NO_2 already reset.	Reset key pressed.	OFF after set delay.	None	NO	YES	NO	YES
Ventilator Low Flow Alarm	Display error until key pressed	Shut Off On Error	VENTILATOR ALARM	YES	NO	YES	YES

Alarm	Current Condition:	Shut off valve	Message Displayed	Audible Warning	Limit Flash	Error Printout	Warning Bar
NO Sensor calibration due.	Display error until key pressed.	Unaffected	NO Calib Due	NO	NO	YES	NO
NO_2 Sensor calibration due.	Display error until key pressed.	Unaffected	NO_2 Calib Due	NO	NO	YES	NO
NO Sensor Replacement due.	Display error until key pressed.	Unaffected	Replace NO SEN	NO	NO	YES	NO
NO_2 Sensor Replacement due.	Display error until key pressed.	Unaffected	Replace NO_2 Sen	NO	NO	YES	NO
Non-volatile memory corrupt.	Display error until key pressed.	Unaffected	Checksum Failed	NO	NO	YES	NO
Battery Volts below “Battery Low” threshold.	Display error until key pressed.	Unaffected	Battery Low	YES	NO	NO	YES
Battery Volts below “Battery Dead” threshold.	Display error until key pressed or, after 30 seconds unit goes to standby.	Unaffected	Charge Batt NOW	NO	NO	NO	NO
Internal Printer fault (i.e. paper jam).	Display error until key pressed.	Unaffected	Int Prn Fault	NO	NO	NO	NO
External Printer fault.	Display error until key pressed.	Unaffected	Ext Prn Fault	NO	NO	NO	NO
ADC Failed	Display error until key pressed.	Unaffected	ADC Failed	NO	NO	YES	NO
Clock stopped or dead	Display error until key pressed.	Unaffected	Clock Dead	NO	NO	YES	NO
Time fields outside range	Display error until key pressed	Unaffected	Time Date Corrupt	NO	NO	YES	NO
Shutoff valve failed	Display error until key pressed	Unaffected	Stop Valve Fault	NO	NO	YES	NO
PRN No Mains	Display error until key pressed	Unaffected	PRN mains needed	NO	NO	YES	NO
Ambient Valve Failed	Display error until key pressed	Unaffected	Amb Valve Fault	NO	NO	YES	NO
Pump Dead	Display error until key pressed	Unaffected	Pump Failure	NO	NO	YES	NO
Calibration outside limits	Display error until key pressed	Unaffected	Cal out of range	NO	NO	YES	NO
External printer out of paper	Display error until key pressed	Unaffected	Ext PRN No Paper	NO	NO	YES	NO

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Technical specification

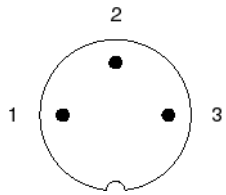
8. Specification

Accuracy	±4% of the reading or ±1ppm whichever is greater. To this must be added: -1% per fortnight for sensor drift, correctable via calibration. ≤25% cross sensitivity of NO to NO_2 E.g. +0.25 ppm for an NO_2 level of 1ppm.
Precision	2% CV or 0.5ppm SD whichever is greater
NO Sensor Range	0-200ppm Resolution@ 0.1 ppm for NO < 100ppm @1 ppm for NO ≥ 100ppm
NO_2 Sensor Range	0-50ppm Resolution 0.1ppm

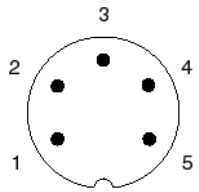
Input Voltage Range(s)	230V(AC) and 110V(AC)
Power	38VA
Internal Battery(5hrs battery use on a full charge for a fully operational battery)	Bat 1 YUASA Type NP4-12 12V 4Ah Sealed Lead Acid
Input Frequency Range	47- 63Hz
IEC Safety Category	Class l
Fuses 110/230V	Live & Neutral Fusing Type 315mA (T)-250V
Protection against electric shock	Class 1
Degree of protection against electric shock	Type B
Degree of protection against ingress of fluids	IPX0
Degree of protection against flammable anaesthetic mixtures with air, O_2 or NO	Not protected
Mode of operation	Continuous
Mains Interface	IEC 320 Style connector
PC connection	RS232 connection. The RS232 9600 baud, 8 data bits, 1 stop bit, no parity.
Internal Printer (Optional)	MTI Series Thermal printer

External Printer use	Hewlett Packard Deskjet or compatible printer. PCL 2
Dimensions	W260mm x D250mm x H180mm
Operating Conditions	Temperature 18 to 30°C Humidity 20 to 80% (non condensing) Atmospheric pressure 800 to 1200hPa
Transport and Storage conditions	Temperature -20 to 50°C not > 2.5 months Humidity 15 to 90% (non condensing) not > 2.5 months Atmospheric pressure 500 to 1060hPa not > 2.5 months
Instrument housing	Material type ABS (UL 94 HB)
Instrument Weight	6.8kg
EMC This unit complies with	EN601-1-2 1993 As per BSI Report No. 228/000102 BS5724 Pt 1:1989, IEC 601-1: 1988 and EN60601-1:1990 BS EN601-1-2(BS5724 1:2):1993:Electromagnetic compatibility.

Din Connections



Alarm Signal	Signal Name	Purpose
Pin 1	RX2	TTL compatible Active 'Low'
Pin 2	0VISOL	0 Volt, isolated signal ground
Pin 3	n/c	Not connected



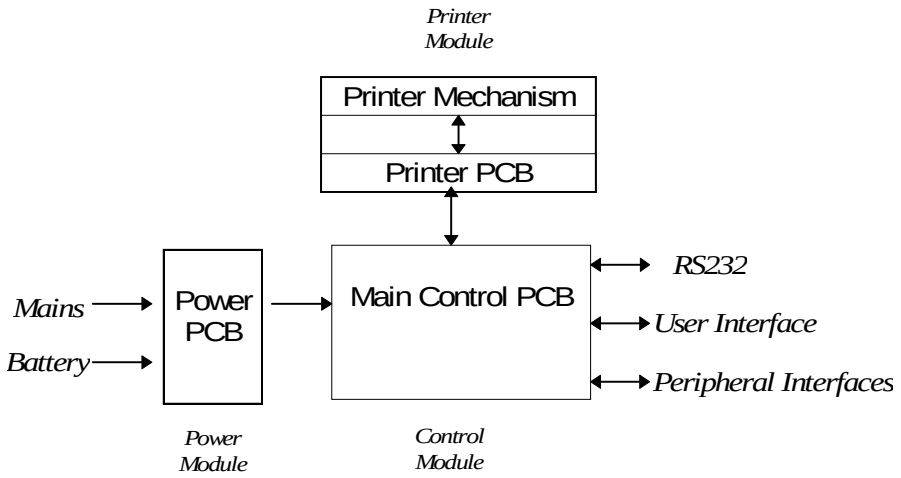
When viewed from the input side of the connector

Chart Recorder Outputs	Signal Name	purpose
Pin 1	NO	NO Analogue Output. 120mV to 5V dc for 0 to 200ppm
Pin 2	0VISOL	0 volt, isolated signal ground
Pin 3	NO_2	NO_2 Analogue Output. 120mV to 5V dc for 0 to 50ppm
Pin 4	0VISOL	0 Volt, isolated signal ground
Pin 5	n/c	Not connected

9. Hardware Overview

9.1 Functional Design Breakdown

The hardware has been broken down into three main sub-modules, consisting of a total of three printed circuit boards (PCBs): the power module, the control module and the printer module.



9.1.1 The Main Control Module

The Control PCB is the central hub of the unit, containing: the micro-controller (running the embedded software), the Real Time Clock, RS232 interface circuits, LCD and keypad interface, internal and external printer interfaces, Warning LED oscillator circuits, Pump and Solenoid drive circuits along with the Nitric Oxide and Nitrogen Dioxide Gas sensors and their associated amplifiers and analogue to digital converter.

9.1.2 Power Module

The power module converts either mains or the lead acid battery supply into switchable DC voltages. It also incorporates a fused battery charger and isolated +5 volt rail.
This module consists of the PSU PCB, a DPST line switch, fuse, mains inlet module incorporating a dual voltage selector and associated metal frame work.

9.1.3 Printer Module

This consists of the Printer PCB and support structure.

The Printer PCB has all the necessary power drivers and voltage regulation to drive the PCB mounted 7-head thermal printer module. The actual signal driving, however, is controlled by the micro-controller on the Main Control PCB.

9.2 External Interfaces

The unit has five external electrical interfaces, two pneumatic and four push buttons.

9.2.1 Mains Inlet Module

This is a standard IEC 3-pin A.C mains inlet module protected by 2 x 315mA fuses. This integrated module incorporates a 230 / 115 volt voltage selector, DPST switch, dual pole fusing as well as a medical mains filter.

9.2.2 RS232 Connector

This 9-way male D-connector J18 (See “INOSYS Wiring schematic” on page 67) allows the instrument to be connected to another device (e.g. PC) via a standard RS232 cable.

RS232	Signal Name	Purpose
Pin 1	n/c	Not connected
Pin 2	RXD	RS232 input serial data
Pin 3	TXD	RS232 output serial data
Pin 4	n/c	Not connected
Pin 5	GND	0V isolated signal ground
Pin 6	n/c	Not connected
Pin 7	n/c	Not connected
Pin 8	RTS	Ready To Send / Tx2
Pin 9	n/c	Not connected
CASE	CHASSIS	connector casing

9.2.3 Printer Port

This is a standard 25 way female D-connector J24 (See “Main Control PCB” on page 64) allowing the unit to interface with any printer supporting PCL3 protocol.

Printer Port	Signal Name	Purpose
Pin 1	STROBE	
Pin 2	D0	Data Bit 0
Pin 3	D1	Data Bit 1
Pin 4	D2	Data Bit 2
Pin 5	D3	Data Bit 3
Pin 6	D4	Data Bit 4
Pin 7	D5	Data Bit 5
Pin 8	D6	Data Bit 6
Pin 9	D7	Data Bit 7
Pin 10	ACK	Acknowledge
Pin 11	BUSY	
Pin 12	PAPER END	Out of paper
Pin 13	SELECT	
Pin 14	n/c	AUTOFEED
Pin 15	ERROR	
Pin 16	INITIALISE	
Pin 17	n/c	SELECT INPUT
Pin 18	0VISOL	0 volt, isolated signal ground
Pin 19	0VISOL	0 volt, isolated signal ground
Pin 20	0VISOL	0 volt, isolated signal ground
Pin 21	0VISOL	0 volt, isolated signal ground
Pin 22	0VISOL	0 volt, isolated signal ground
Pin 23	0VISOL	0 volt, isolated signal ground
Pin 24	0VISOL	0 volt, isolated signal ground
Pin 25	0VISOL	0 volt, isolated signal ground
CASE	CHASSIS	Connector Housing

9.2.4 Alarm Control Signal

This is a 180° 3-pin panel mounting DIN connector. Allowing the external interface cable to be screened as well as locking into position and thus preventing accidental removal. This cable connects internally with J25 (See “INOSYS Wiring schematic” on page 67)

Alarm Signal	Signal Name	Purpose
Pin 1	RX2	Alarm signal input
Pin 2	0VISOL	0 volt, isolated signal ground
Pin 3	n/c	Not connected

9.2.5 Chart Recorder Outputs

This is a 240° 5-pin panel mounting DIN connector. Allowing the external interface cable to be screened as well as locking into position and thus preventing accidental removal. This output internally connects to J11 (See “INOSYS Wiring schematic” on page 67)

Chart Recorder Outputs	Signal Name	Purpose
Pin 1	NO	No Analogue Output
Pin 2	0VISOL	0 volt, isolated signal ground
Pin 3	NO2	NO2 Analogue Output
Pin 4	0VISOL	0 volt, isolated signal ground
Pin 5	n/c	Not connected

9.2.6 Keypad Interface

The keypad forms part of the front panel membrane incorporating four buttons and two LEDs (namely Battery Status and Mains Power ON). It interfaces via a flexi-strip with J15n (See “INOSYS Wiring schematic” on page 67)

Front Panel Membrane	Signal Name	Purpose
Pin 1	POWERLED	A.C Power LED
Pin 2	/STANDBY	Stand-by Button
Pin 3	SW1	Menu Select
Pin 4	SW2	Menu Select
Pin 5	SW3	Menu Select
Pin 6	0V	Ground
Pin 7	BATLED	Battery Status LED
Pin 8	n/c	Not Connected

9.3 Internal Interfaces

There are fifteen internal interface cables. For the pin out and interconnection of these cables please see “INOSYS wiring schematic” on page 67.

10. The Main Control PCB (S115395 issue 2)

10.1 Functional Circuit Blocks

This sections breaks the circuit down into functional blocks, detailing their purpose.

10.1.1 Input Signal Conditioning

The Main Control PCB hosts both the Nitric Oxide and the Nitrogen Dioxide sensors. These are mounted on the PCB via gold pin sockets and are then clamped in place via a polarising plate. The polarising plate prevents the two sensors which share pin configurations from being wrongly located in the PCB.

10.1.1.1 The Gas Sensors

The simplest form of the sensor operating on electrochemical principles has two electrodes - Sensing and Counter - separated by a thin layer of electrolyte and connected by a low resistance external circuit. Gas diffusing into the sensor is reacted at the surface of the Sensing electrode, by oxidation or reduction, causing a current to flow between the electrodes through the external circuit. The current is proportional to the concentration of gas, this in turn causes a change in the potential of the Counter electrode (polarisation).

The INOSYS utilises a four electrode sensor. This has two additional electrodes namely , the Reference and the Auxiliary. The Reference overcomes non linearity effects caused by the Sensing electrode’s bias voltage being effected by high concentrations of gas, and thus high current flow. Where as the Auxiliary electrode overcomes temperature variations. The Auxiliary electrode is in effect in the same environment as the Sensing electrode. As it does not respond to gas any drift seen is due primarily to temperature.

10.1.1.2 The Nitric Oxide Sensor

The Inosys uses the MNO-1 sensor, the specification for which may be found in the accompanying Appendices.

The Sense Circuitry

This consists of an LMC6064 Quad Op-Amp (IC2) and its peripheral passive components. This circuit is designed to operate the sensor in a biased mode of operation. The Sense and Auxiliary electrodes are held at 300mV above the Reference electrode. To reduce long start up times the Op-Amp is supplied via +5VBACK, a supply which remains on even when the unit has been disconnected from Mains as long as the battery is in an operational state. (See “The PSU PCB (S115398 issue 3)” on page 61. The Op-Amp is configured to act as a current to voltage converter with the sensor acting as a current sink. The gain of the conversion is effectively controlled by the resistors R15 (for the Sense electrode) and R16 (for the Auxiliary electrode). The capacitors C42 and C49 offer a degree of filtering against noise spikes. The LMC6064 has an extremely low supply current (76mA for all four amplifiers) coupled with extremely low input offset voltage (100mV) and low input bias current (0.010pA).

10.1.1.3 The Nitrogen Dioxide Sensor

The Inosys uses the MND-1 sensor, the specification for which may be found in the accompanying Appendices.

The Sense Circuitry

This is a similar circuit to the Nitric Oxide sense circuit described above, utilising the same type of Op-Amp (IC2/3) powered via +5VBACK. The Op-Amp is configured to act as a current to voltage converter with the sensor acting as a current source. The Op-Amps negative input is biased with 3.5 volts in order for the output signal to remain positive and negate the need for bi-polar devices. The capacitors C50 and C51 offer a degree of protection against noise spikes/transients.

10.1.1.4 The Analogue to Digital Conversion

The voltage signals from the Sense and the Auxiliary sense circuits for each of the gas sensors are fed into the differential inputs of an ADC12138 (IC5). The ADC12138 is a 12-bit successive approximation Analogue to Digital converter with serial I/O and configurable 8 channel input multiplexor. The ADC has a conversion clock of 7.3728MHz giving a conversion time of approximately 6ms.

The ADC also receives signals from the each of the sense circuit reference voltages (3.5, 1.3 and 1 volt) along with the output from the ambient temperature sensor sense circuit (AMBTEMP).

10.1.1.5 The Battery Temperature Sensor

This is a precision centigrade temperature sensor (LM35DZ) which outputs a linear voltage with respect to temperature of 10mv/°C. The output signal is fed into a non inverting amplifier (IC3, LMC6064) which has a gain of 5.7. The output of this amplifier is then fed into the ADC (IC5). This gives an effective reading range of 0 → 87°C. The temperature sensor is currently used to measure the battery temperature.

10.1.2 The Micro controller and its peripherals

The micro-controller is clocked at a frequency of 7.3728MHz. The 8 bit data bus is also configured to act as the least significant 8-bits of the address bus. The chip interfaces via its address and data buses to 64K*8 of EPROM and up to 32K*8 of volatile RAM (8K*8 fitted as standard). Further static memory requirements are fulfilled in the 64*8 Timekeeper% SRAM (IC7, MK41T56) which interfaces with the micro-controller via a two wire serial bus (I2C). A constant power supply to the Timekeeper is provided in the form of +5VBACK, in the event of removal of this supply the contents of the SRAM will be kept for a few minutes via the charge stored on the capacitor C7. This device is clocked by a built in oscillator requiring a 32.768KHz crystal (XL2).

The micro-controller may be forced into reset by depressing the reset switch (SW1), accessible at the rear of the unit.

10.1.3 Serial Communications

The micro-controller is able to communicate with a host computer via its optically isolated RS232 port. Baud rates up to 19.2K Baud are possible in the format of 8 bits, no parity and 1 stop bit. This is achieved via the MAX232 chip (IC14).

10.1.4 The LCD

The LCD module (128 * 64 dots) interfaces with the Main Control PCB via connector J13. A PWM signal from the micro-controller (PWM_CON) allows the LCD's contrast to be controlled via the key pad. The back light is only lit during mains operation in order to reduce power consumption when the unit is operated in battery mode. The OP-AMP IC27 ensures that the supply to the back light is stable.

10.1.5 The Ventilator Alarm signal

The MAX232 chip (IC14) interfaces via J25 to an external SLE ventilator. In the event of the ventilator sending an alarm signal (Active high, +12 volts) the second receive channel of the MAX232 relays this information to the micro controller in order for it to take the appropriate action. In instances where an external connection to the ventilator is not provided the MAX232 chip internally pulls this input high via a 400kΩ resistor.

10.1.6 Audible Alarm

A miniature buzzer is incorporated in the circuit interfacing via Q3 to the micro controller. An active low signal will activate the alarm buzzer.

10.1.7 Warning Bar

A schmitt oscillator circuit (IC4) with a frequency of approximately 1 Hz is ANDed with the signal DEAD_LED from the processor to drive two high intensity Red LEDs which make up the warning bar at the front of the unit.

10.1.8 Hardware Power Down

This mode of operation is activated by the Stand-by button (momentary action) which when depressed (assuming the unit was previously active) will shut down all supply rails apart from +5VBACK. This supply rail is used to power all components relating to the gas sensor sense circuitry (IC2, 3, 5, 6, D10) as leaving the sensors unpowered can incur long start up times. In order to prevent possible current drains both the ADC (IC5) and the micro controller (IC6) are put into a 'sleep' mode via their power down pins. With the circuit in this mode of reduced activity the circuit draws approximately 1mA of current. The circuit is 'awoken' from this sleep mode by depressing the stand-by button again. The amber LED on the front panel flashes when the unit is in stand-by "sleep mode".

10.1.9 The Fan

Interfacing with the Main Control PCB via connector J16, the +5 volt low noise fan (ª 21dBA) is used to provide ventilation. It is powered only when mains is applied to the unit as a majority of power and therefore heat is dissipated in driving the peripherals energised during mains operation e.g LCD backlight, internal printer, battery charging etc.

10.1.10 Chart Recorder Outputs

The micro-controller under software control converts the input voltages from each of the gas sensors into Pulse Width Modulated (PWM) signals. These signals are optically isolated (IC9) and then smoothed before passing through a unity gain amplifier to connector J11 (Refer to “Chart Recorder Outputs” on page 54.). The effective chart recorder range is $0 \rightarrow 5$ volts.

10.1.11 Battery LED oscillator circuit.

During instances when the unit is in a stand-by ‘sleep’ mode (Refer to “Hardware Power Down” on page 58.) an amber LED flashes on the front panel of the unit in order to indicate to the user the condition of the battery. If the LED fails to flash the user will know that the sensors are no longer receiving power and as such long stability times may be incurred upon resubmitting power.

10.1.12 Pump Drive Circuit

An active low signal to the base of Q10 activates this transistor and thereby the pump. The pump drive voltage is $\approx$ 4.6 volts.

10.1.13 Solenoid Drive circuits.

There are two duplicate solenoid drive circuits present, one to drive the Gas Stop Valve and one to drive the Patient/Ambient Change over valve. Each is activated by applying an active low signal to the base of Q11 or Q12. The valves are energised at $\approx$ 4.6 volts.

Measuring the solenoid current gives the facility to determine whether a given solenoid is fitted and whether the electronics have successfully activated it.

10.1.14 External Printer Driver

Attached to the micro-controller data bus are the latches IC17, 18 and 19 which make up part of the optically isolated external printer port.

10.1.15 Internal printer

The Main Control PCB interfaces with the Printer PCB (S114641) via connector J20. The Printer PCB is driven from +5VMAINS and cannot be driven when the unit is powered purely from battery. Information is latched to the printer head via IC16.

11. The Internal Printer PCB (S114641 issue 1)

Refer to “Printer Driver PCB” on page 68 and section “3.1.15 internal printer” on page 59.

This PCB incorporates the MTP-201 series (Seiko) thermal character printer. The printer has the following specification :

Principle:	Heat sensitive serial dot system
Printing Direction:	Left to right with automatic end of line paper feed.
Home position detection:	Mechanical switch (used to generate the signal /PHOME)
Character size (W*H) mm:	2.4 * 1.4
Paper Width (mm):	57 $\rightarrow$ 58
Operating Voltage:	5 volts
Printing Speed (line/s):	0.8

The printer head is driven via two protected quad power drivers (IC1 and IC2, UDN2543B). These devices are over-current protected at currents above 1 Amp.

12. The PSU PCB (S115398 issue 3)

Reference should be made to “INOSYS PSU PCB” on page 66.

The PSU PCB converts raw mains A.C voltage into the D.C voltage levels required by the Main Control PCB in order to function. It also allows the operation of the unit purely from a battery supply during transportation or in the event of mains failure.

Note: when operating from the battery supply certain power rails are disabled to reduce current drain. The following table details the voltage levels provided by this PCB:

Signal Name	Function
+5VMAINS	+5 volt rail, only present when Mains is supplied, switchable via the stand-by button.
+5V	+5 volt rail, supplied by battery or Mains, switchable via the stand-by button.
+5VISOL	+5 volt isolated rail, supplied by battery or Mains, switchable via the stand-by button.
+5VBACK	+5 volt rail, supplied by battery or Mains, non-switchable.
-12V	-12 volt rail, supplied by battery or Mains, switchable via the stand-by button.
VCHARGE	Derived from VDC-CHRG, this potted down signal is used to measure battery charge voltage.
VBATT	Derived from BATT(+), this potted down signal is used to measure battery voltage when power is being supplied by the battery.
VMAINS	Derived from VDCRAW, this potted down signal is used to indicate the presence of Mains voltage.

13. RS232 Interface

Note: In order for the INOSYS RS232 interface to operate correctly firmware version 2.00, release 2 must be installed.

An RS232 connector is provided at the rear of the unit for connection to a PC.

The serial port is set to communicate at 9600 baud, 8 data bits, 1 start bit, 1 stop bit, no parity. The unit will output filtered time stamped Patient NO, Patient NO_2, Ambient NO and Ambient NO_2 as well as ADC raw data readings to the serial port every trend interval.

The trend interval for serial output will be as defined for the printer trend interval, however, the serial output will continue regardless of whether the printer output is enabled or not.

Unavailable results, (i.e. results obtained during the settling period of the sensor), will not be sent.

13.0.1 Data Collection

Connect the INOSYS to a PC running Windows 95/98 with a standard PC serial cable and start your Windows communications package. The example below describes data collection using Hyperterminal which is supplied as standard with Windows 95/98.

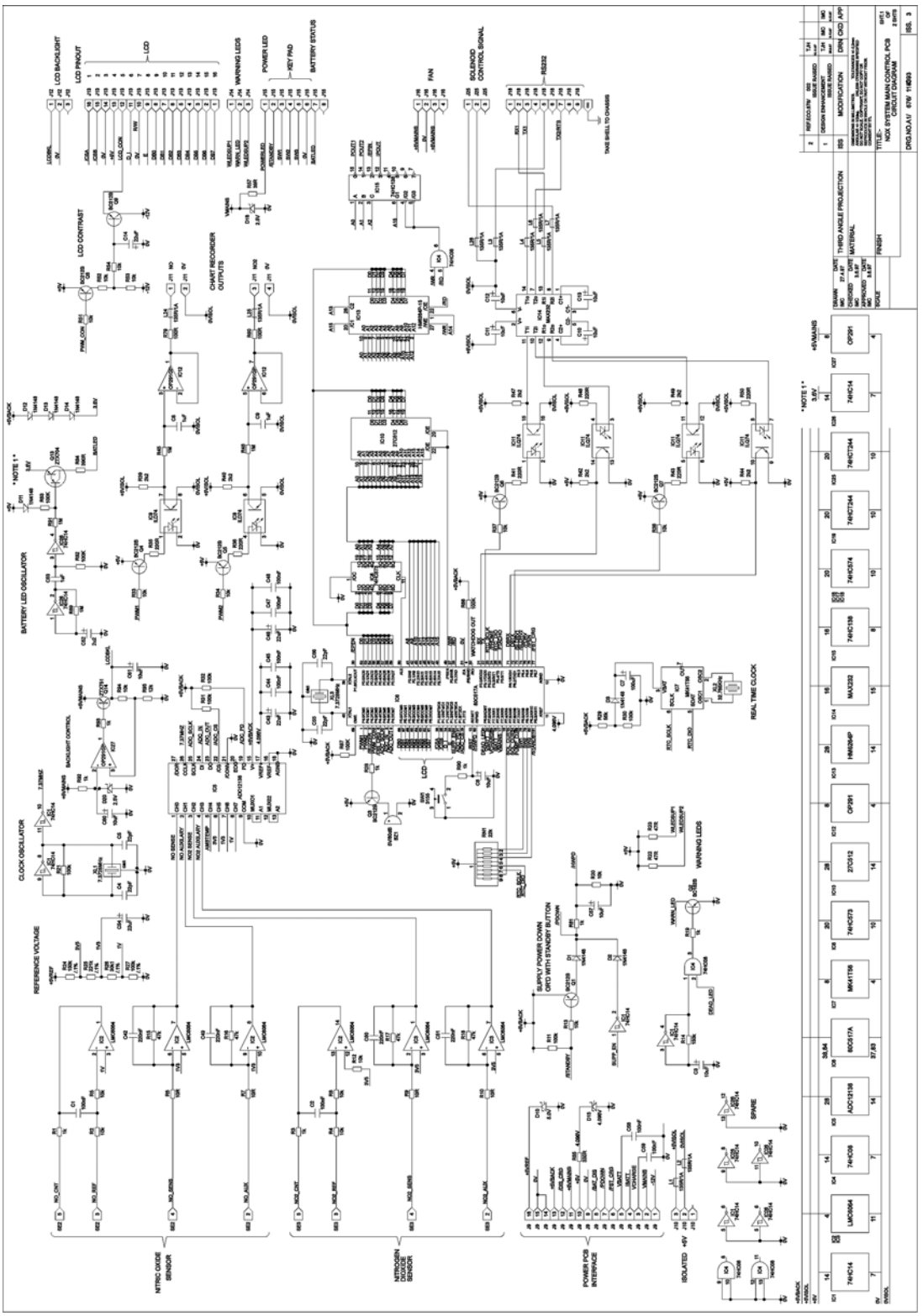
Start Hyperterminal, enter a session name and click ok. In the 'Phone Number' box click on the down arrow for 'Connect using' and select 'Direct to COM1'. Click ok. In the 'Port Settings' menu enter the settings as above, set 'Flow control' to 'Hardware'. Click ok. Data will automatically be collected. Once you have finished collecting, save the data to a file. Click 'File'/'Save as' and enter a file name.

Data is saved as ASCII text, delimited by tab characters, (ASCII code 8), and terminated by a carriage return and line feed, (ASCII codes 13 and 10). The data can be read by most of the popular spreadsheet packages, e.g. Microsoft Excel etc.

Circuit diagrams

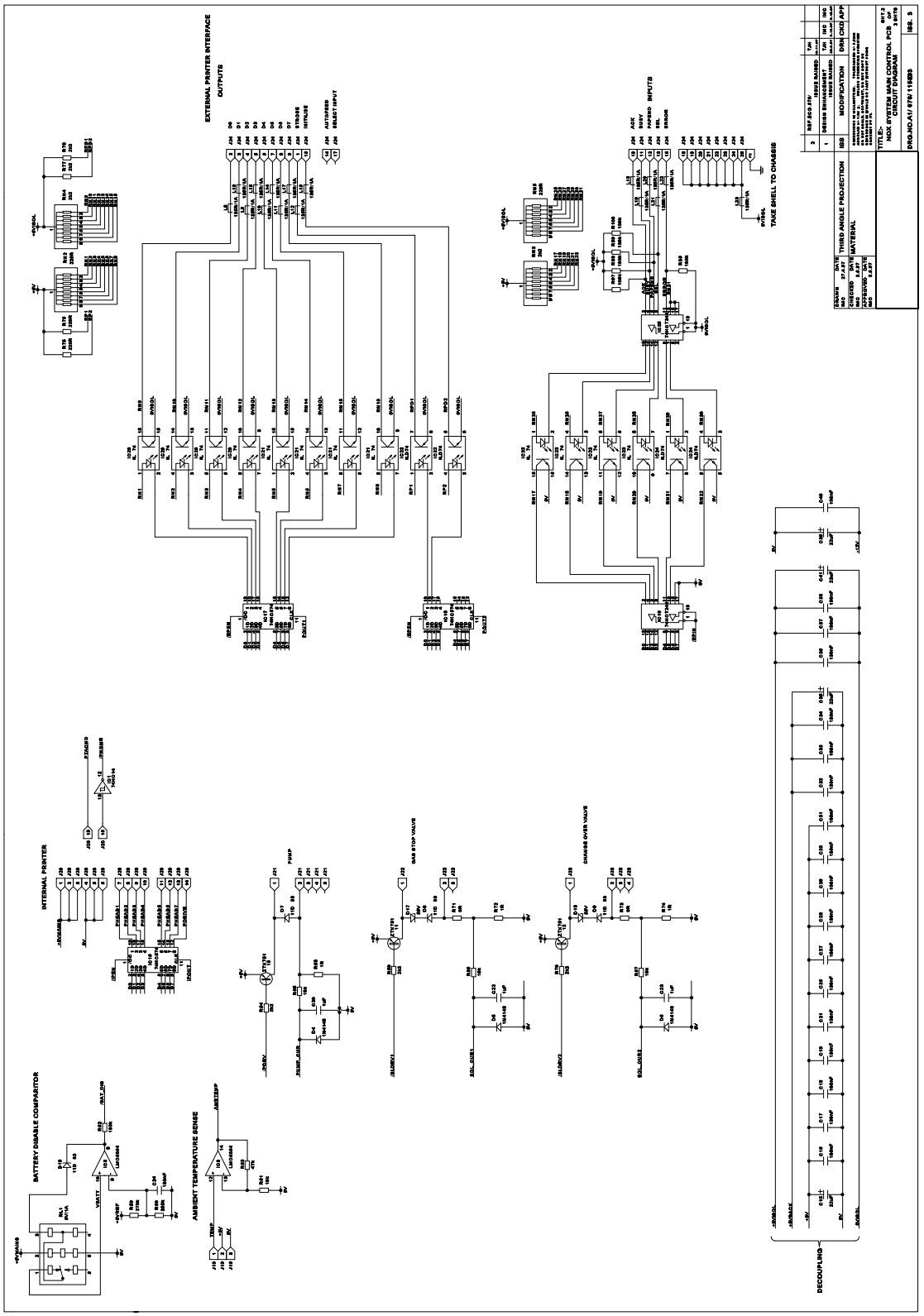
14. Circuit Diagrams

14.1 Main Control PCB circuit diagram. Sheet 1 of 2.



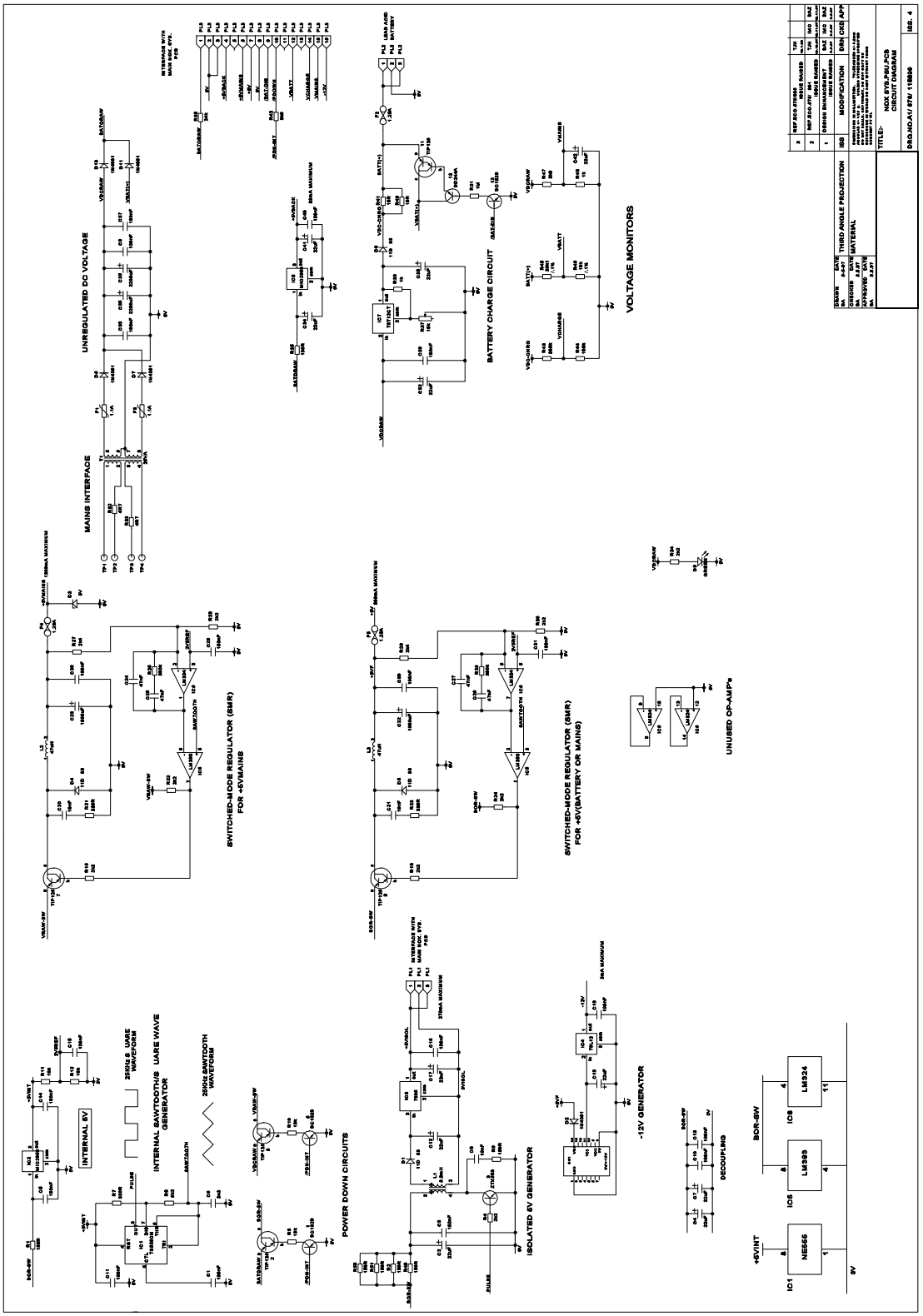
See A3 version on page 75

14.2 Main Control PCB circuit diagram. Sheet 2 of 2.



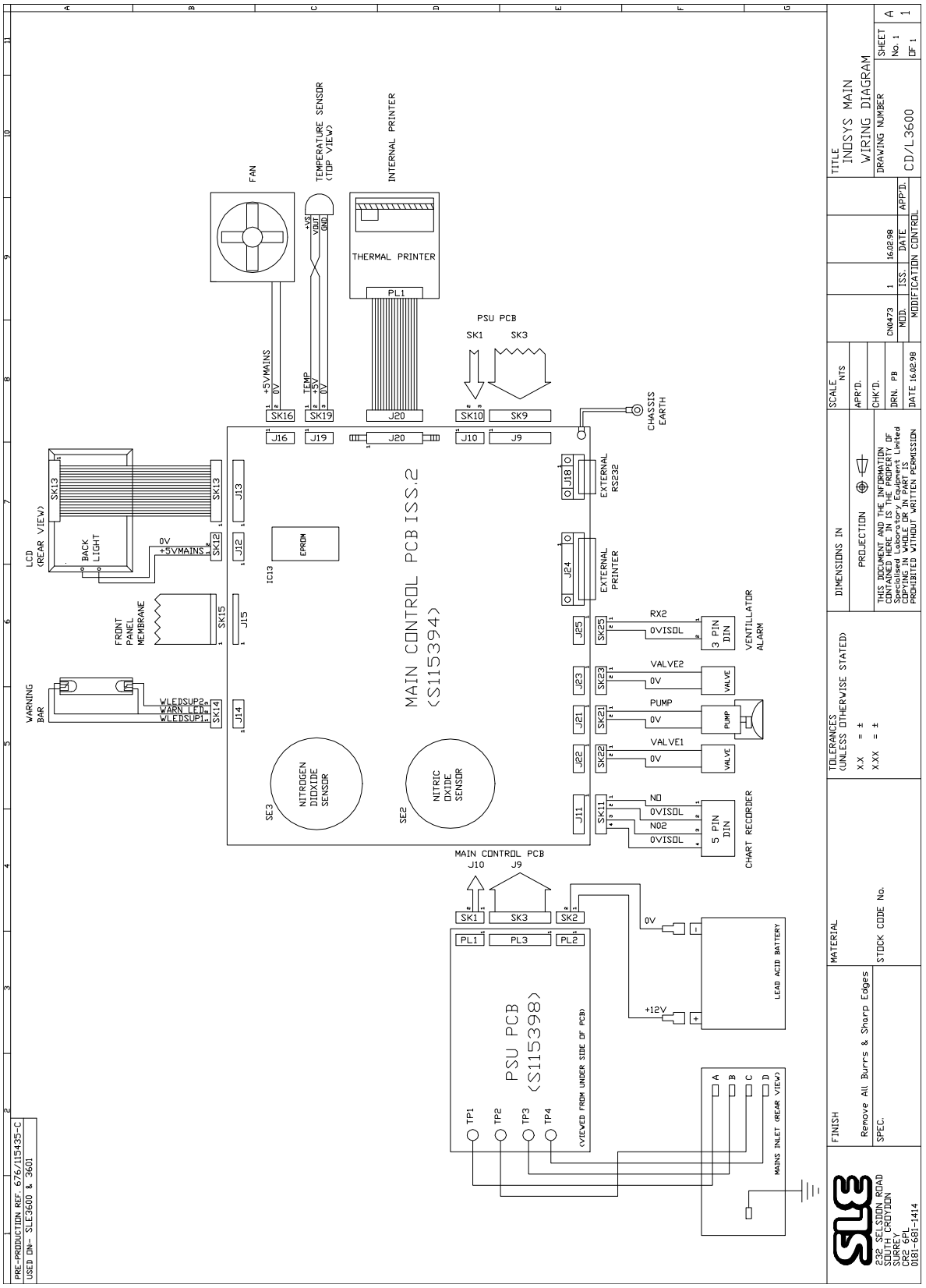
See A3 version on page 77

14.3 INOSYS PSU PCB circuit diagram.



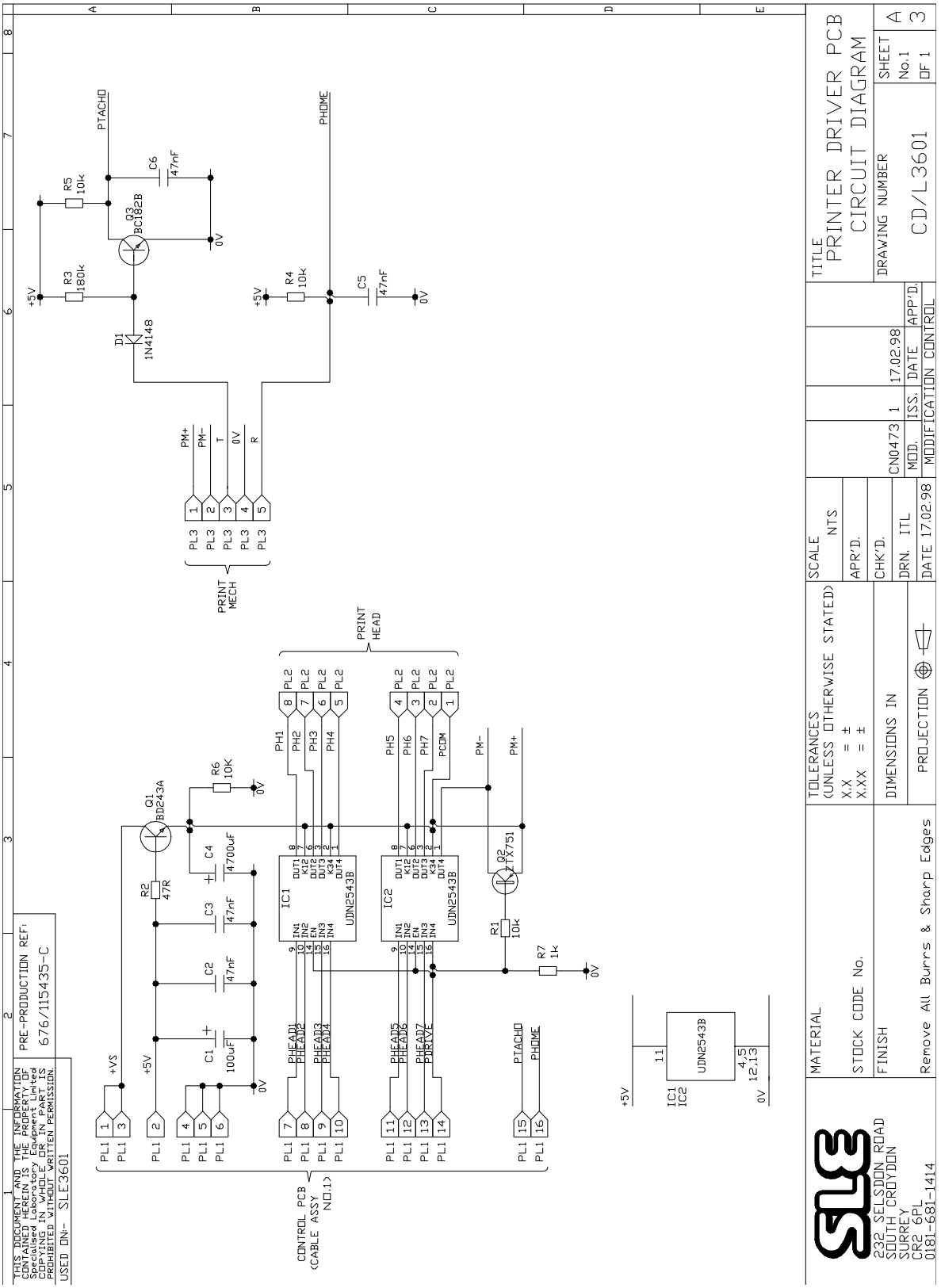
See A3 version on page 79

14.4 INOSYS Wiring Schematic.



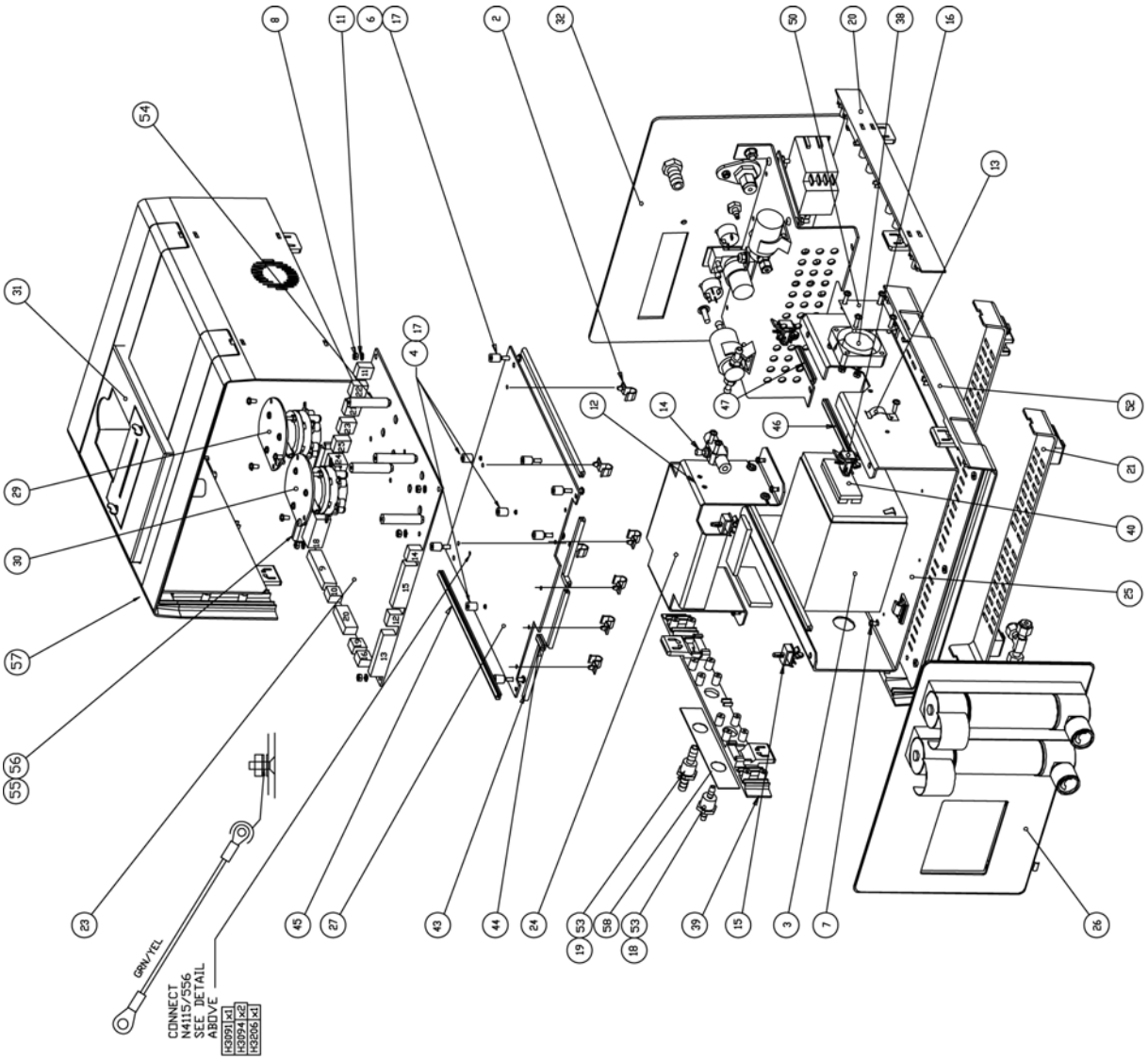
See A3 version on page 81

14.5 Printer Driver PCB circuit diagram.



See A3 version on page 83

14.6 INOSYS Exploded view.



ITEM	ITL PART No.	SAGE PART No.	DESCRIPTION	QTY
1	E050055	N4115/E05/055	CABLE_CLIP_SELF_ADHESIVE	1
2	E050063	N4115/E05/063	HALF_U_ROUTING_CLIP	7
3	E750010	N4117/25	LEAD_ACID_BATTERY	1
4		H3206	M3 x 6 CSK SCREW	3
5	F130040	H3106	SCREW_M3X6_PAN_RECD_SS	8
6	F130085	H3216	M3 x 16 CSK SCREW	6
7	F320002	H9101	NO_4_X_1-4_PAN_RECD_STL_ZCP	4
		H9102	NO4 x3/8" PAN SELF TAP	4
8	F410020	H3091	NUT_M3_FULL_SS	13
9	F420012	H3094	M3_INT_SPRDGE_WASHER_ST_ZCP	1
10	F420028	H3093	WASHER_M3_FIBRE_A_SS	1
11	F420031	H3094/01	CRINKLE_WASHER_BERYLLIUM_M3	6
12	F420041	H3094	M3_EXT_SPRDGE_WASHER_ST_ZCP	2
13	M180002	N4115/M18/002	EARTHING_STRIP	1
14	M360010	N4115/M36/010	RESTRICTOR	1
15	M550225	N4115/M55/225	HINGED_SUPPORT	2
16	M550226	N4115/M55/226	EDGE_HOLDER	2
17	M550230	T0564	NYLON SPACER NSV08-M3	9
18	M750280	N4115/M75/0280	4X4MM_PANEL_MOUNT_UNION	1
19	M750281	N4115/M75/281	10X10MM_PANEL_MOUNT_UNION	1
20	M920012	N4115/M92/012	SIDE_PANEL_8-SHE_NO_HANDLE_ANT	1
21	M920016	N4115/M92/016	SNAP_PANEL_VENTS_WITH_FEET	2
22	S	N4115/632	LABEL_PATIENT_INPUT-OUTPUT	1
23	S115394	N4115/394	MAIN_CONTROL_BOARD_PCB_ASSY	1
24	S115449	N4115/449	BATTERY_BRACKET	1
25	S115452	N4115/452	CHASSIS	1
26	S115670	N4115/670	FRONT_PANEL_ASSEMBLY	1
27	S115488	N4115/488	MAIN_BOARD_SUPPORT	1
28				
29	S115535	N4115/535	NO_SENSOR_ASSEMBLY	1
30	S115536	N4115/536	NO2_SENSOR_ASSEMBLY	1
31	S115542	N4115/542	UPPER_UNIT_ASSEMBLY	1
32	S115553	N4115/553	REAR_PANEL_ASSEMBLY	1
33	S115564	N4122/32	TUBE_SIL_3-ID_6-OD_250MM_LG	1
34	S115567	N4115/567	SV_ISOLATOR_ASSEMBLY_NO3	1
35	S115568	N4115/568	POWER_CABLE_ASSEMBLY_NO30	1
36	S115569	N4115/569	BATTERY_CABLE_ASSEMBLY_NO31	1
37	S115570	N4115/570	TEMP_SENSOR_CABLE_ASSEMBLY_NO32	1
38	S115573	N4115/573	MINIATURE_FAN_ASSEMBLY_NO35	1
39	S115581	N4115/581	SMALL_SIDE_PANEL_LEFT	1
40	S115582		FOAM_STRIP_LENGTH_5MM	7
41	S115588	N4115/M75/212	TUBE_SIL_5-SID_11-SOD_60MM_LG	1
42	S115589	N4115/M75/288	TUBE_PVC_5-SID_8-SOD_500MM_LG	1
43	S115595	N4115/E80/019	GROMMET_EDGE_STRIP_6MM_LG	3
44	S115596	N4115/E80/019	GROMMET_EDGE_STRIP_15MM_LG	2
45	S115597	N4115/E80/019	GROMMET_EDGE_STRIP_170MM_LG	3
46	S115598	N4115/E80/019	GROMMET_EDGE_STRIP_80MM_LG	1
47	S115599	N4115/E80/019	GROMMET_EDGE_STRIP_45MM_LG	1
48	S115605	N4115/E99/015	GASKET_RFL12-7_X_15.9_320MM_LG	2
49	S115606	N4122/32	TUBE_SIL_3-ID_6-OD_250MM_LG	1
50	S115607	N4115/607	GASKET_RFL_EXP METAL_40MM_SQ	1
51	S115608		CONDUCTIVE_TAPE_6-25MM_320MM_LG	2
52	S115635	N4115/635	BASE_PANEL_MACHINED	1
53		T2149	SPECIAL TAPPED SPACER	2
		N4112/16	M18 x 10 THIN NUT	2
54		N4115/M55/229	NYLON PILLAR M3 x 38mm	4
55		N4115/486	CONNECTOR COVER	1
56		N4115/003	GROMMET STRIP x 270mm	1
57		N4115/651	LABEL - LEFT PANEL	1
58		N4115/632	LABEL - PAT INPUT OUTPUT	1

See A3 version on page 85

15. INOSYS Spares

SLE Part No	Description
P0494/36	Mains inlet filter
M0779/01	315mA Time delay fuse
N4117/25	Lead Acid Battery
H3094/01	Crinkle washer Berylliumcu m3
N4115/M36/010	Restrictor
N4115/M55/225	Hinged support
N4115/M55/226	Edge Holder
N4115/05	Low Range Flowmeter
N4115/06	High Range Flowmeter
N4117/26	Sealing Washer
N4115/M92/012	Side Panel 0-5HE No Handle Mount
N4115/394	Main Control PCB
N4115/398	Power Supply PCB Assembly
N4115/535	NO Sensor Assembly
N4115/01	NO Sensor
N4115/536	NO_2 Sensor Assembly
N4117/02	NO_2 Sensor
N4115/542	Upper Unit assembly
N4115/557	(PL25) to 3 way DIN socket. Cable assembly Nº 4
N4115/558	(PL11) to 5 way DIN socket. Cable Assembly Nº 5
N4115/560	(PL23) to 3 way valve. Cable Assembly Nº 7
N4115/566	(PL21) to pump. Cable Assembly Nº 8
N4115/567	(PL10 to PL1) 5V isolator. Cable Assembly Nº 9
N4115/568	(PL9 to PL3) power cable. Cable Assembly Nº 10
N4115/569	(PL2) to battery cable. Cable Assembly Nº 11
N4115/569	(PL19) to temp sensor cable. Cable Assembly Nº 12
N4115/573	(PL13) to LCD miniature fan cable. Cable Assembly Nº 15

N4115/556	Earthing cable. Cable Assembly Nº 3
N4115/670	Front Panel Assembly
N4105/01	BS 14 regulator ptfe washer
N4105/11	Din 1 regulator ptfe washer
N4105/21	Din 8 regulator ptfe washer
N4105/31	Din 14 regulator ptfe washer
T2149	Special tapped spacer
N4112/16	Hexagon nut M18 x 10
N4117/11	Cover release key (green)

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A3 circuit Diagram Appendix

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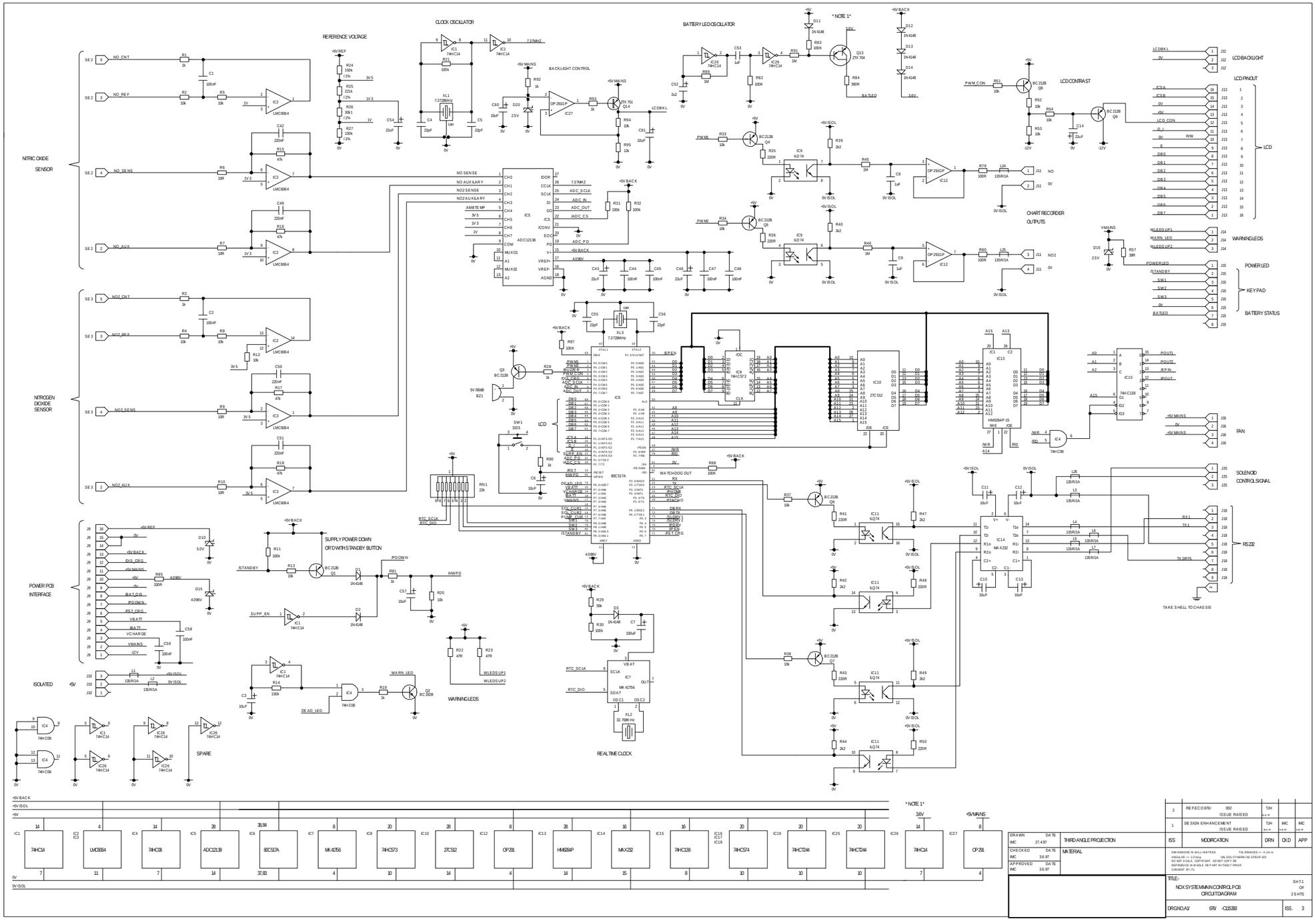
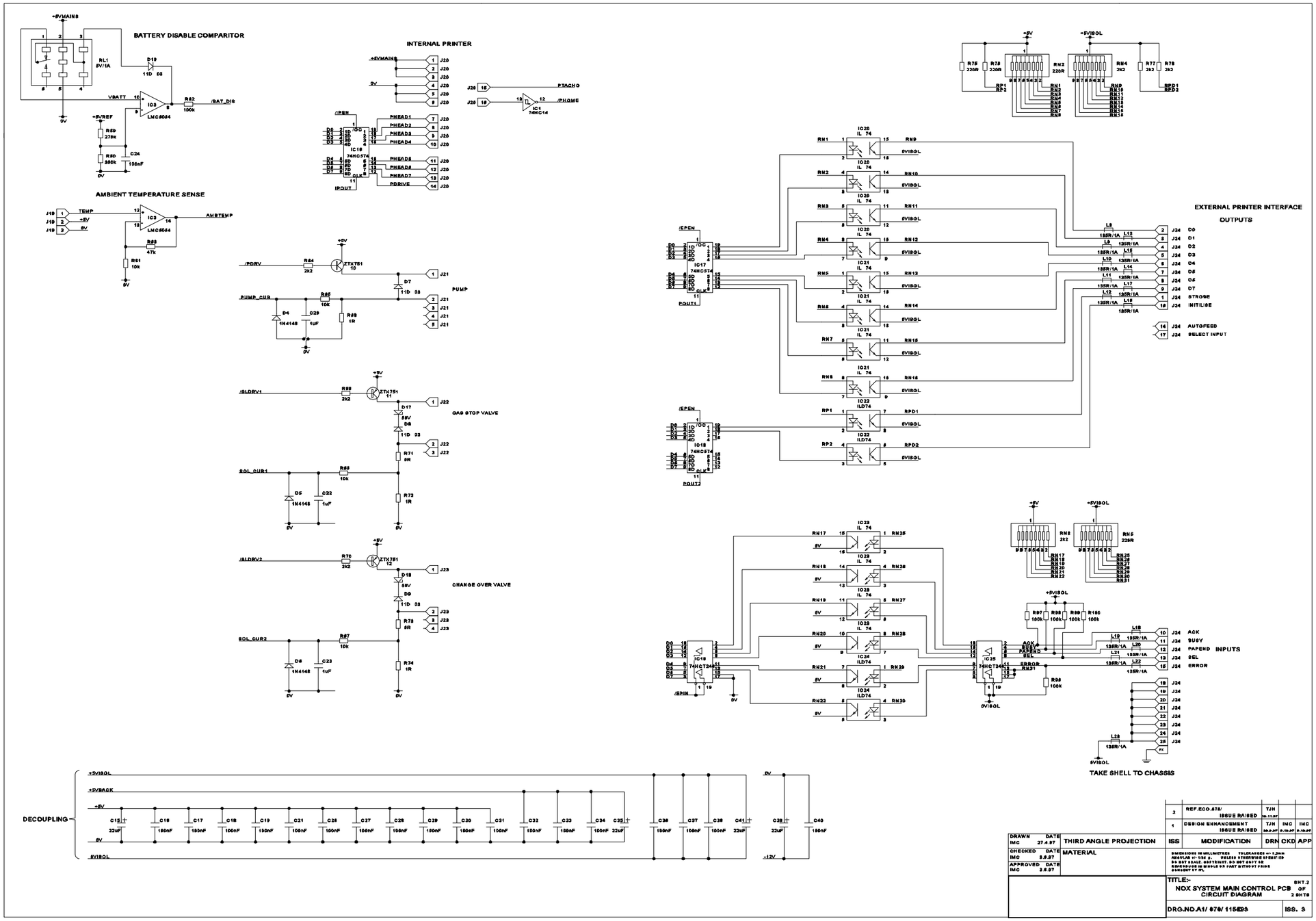
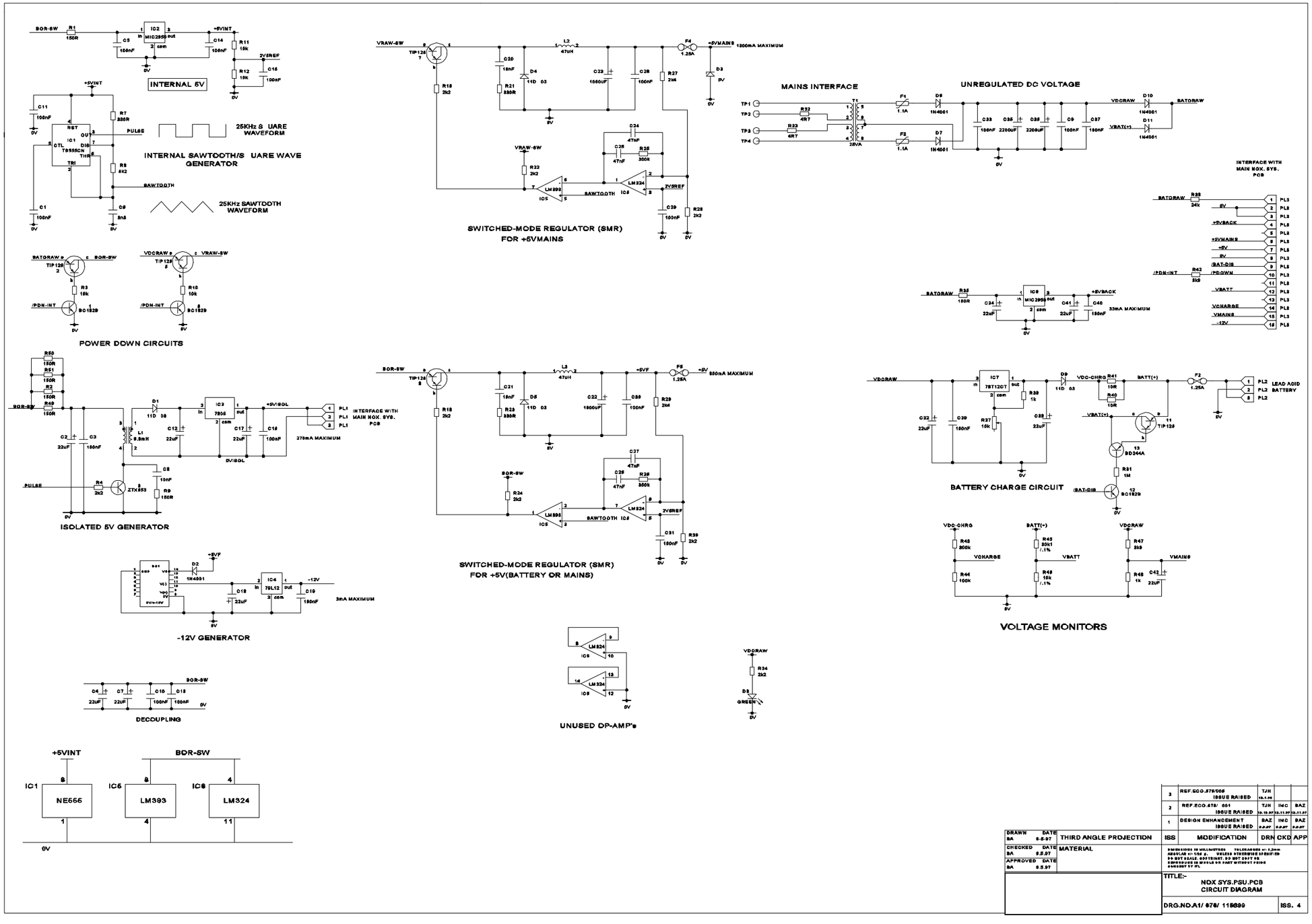
Main control PCB circuit diagram Sheet 1 of 2




BATTERY DISABLE COMPARITOR
INTERNAL PRINTER
AMBIENT TEMPERATURE SENSE
PUMP
GAS STOP VALVE
CHANGE OVER VALVE
EXTERNAL PRINTER INTERFACE
OUTPUTS
INPUTS
TAKE SHELL TO CHASSIS
DECOUPLING
NOX SYSTEM MAIN CONTROL PCB
CIRCUIT DIAGRAM
THIRD ANGLE PROJECTION
MATERIAL
ISS. 3


INTERNAL 5V
INTERNAL SAWTOOTH/S UARE WAVE GENERATOR
25KHz S UARE WAVEFORM
25KHz SAWTOOTH WAVEFORM
SWITCHED-MODE REGULATOR (SMR) FOR +5VMAINS
MAINS INTERFACE
UNREGULATED DC VOLTAGE
INTERFACE WITH MAIN NOX SYS. PCB
POWER DOWN CIRCUITS
ISOLATED 5V GENERATOR
SWITCHED-MODE REGULATOR (SMR) FOR +5V(BATTERY OR MAINS)
BATTERY CHARGE CIRCUIT
LEAD ACID BATTERY
-12V GENERATOR
VOLTAGE MONITORS
DECOUPLING
UNUSED OP-AMP's
NE555
LM393
LM324
THIRD ANGLE PROJECTION
MATERIAL
NOX SYS.PSU.PCB CIRCUIT DIAGRAM
DRG.NO.A1/ 674/ 115699
ISS. 4

PRE-PRODUCTION REF. 676/115435-C
USED ON- SLE3600 & 3601

WARNING BAR
LCD (REAR VIEW)
BACK LIGHT
FRONT PANEL MEMBRANE
SK13
SK14
SK15
SK12
SK13
J14
J15
J12
J13
W.LEDSUP1
WARN LED
W.LEDSUP2
+5VMAINS
0V

SE3
NITROGEN DIOXIDE SENSOR
SE2
NITRIC OXIDE SENSOR
IC13
EPROM

MAIN CONTROL PCB ISS.2
(S115394)

J16
SK16
+5VMAINS
0V
FAN

J19
SK19
TEMP
+5V
0V
+VS
VOUT
GND
TEMPERATURE SENSOR (TOP VIEW)

J20
PL1
THERMAL PRINTER
INTERNAL PRINTER

J10
SK10
J9
SK9
SK1
SK3
PSU PCB

MAIN CONTROL PCB
J10
J9

PSU PCB
(S115398)
TP1
TP2
TP3
TP4
PL1
PL3
PL2
SK1
SK3
SK2
(VIEWED FROM UNDER SIDE OF PCB)

J11
J22
J21
J23
J25
J24
J18
SK11
SK22
SK21
SK23
SK25
EXTERNAL PRINTER
EXTERNAL RS232
CHASSIS EARTH

0VISOL
NO2
0VISOL
NO
5 PIN DIN
CHART RECORDER
0V
VALVE1
VALVE
0V
PUMP
PUMP
0V
VALVE2
VALVE
0VISOL
RX2
3 PIN DIN
VENTILLATOR ALARM

+12V
0V
A
B
C
D
MAINS INLET (REAR VIEW)
LEAD ACID BATTERY

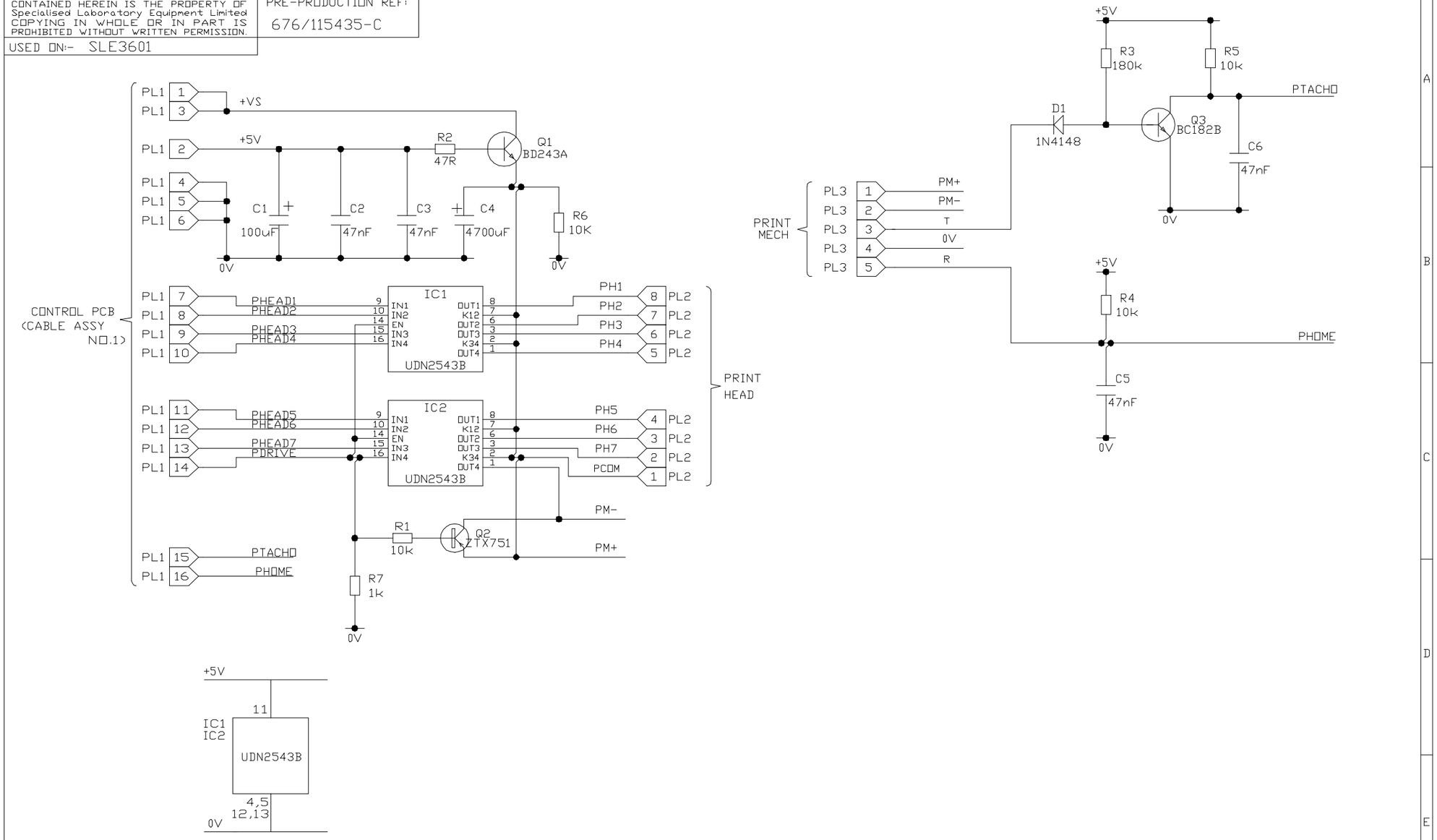
SLE 232 SELSDON ROAD SOUTH CROYDON SURREY CR2 6PL 0181-681-1414	FINISH: Remove All Burrs & Sharp Edges SPEC.	MATERIAL STOCK CODE No.	TOLERANCES (UNLESS OTHERWISE STATED) X.X = ± X.XX = ±	DIMENSIONS IN PROJECTION THIS DOCUMENT AND THE INFORMATION CONTAINED HERE IN IS THE PROPERTY OF Specialised Laboratory Equipment Limited COPYING IN WHOLE OR IN PART IS PROHIBITED WITHOUT WRITTEN PERMISSION	SCALE NTS APR'D. CHK'D. DRN. PB DATE 16.02.98	TITLE: INOSYS MAIN WIRING DIAGRAM DRAWING NUMBER: CD/L3600 SHEET No. 1 OF 1 A 1

MOD.	ISS.	DATE	APP'D.
CN0473	1	16.02.98	

MODIFICATION CONTROL

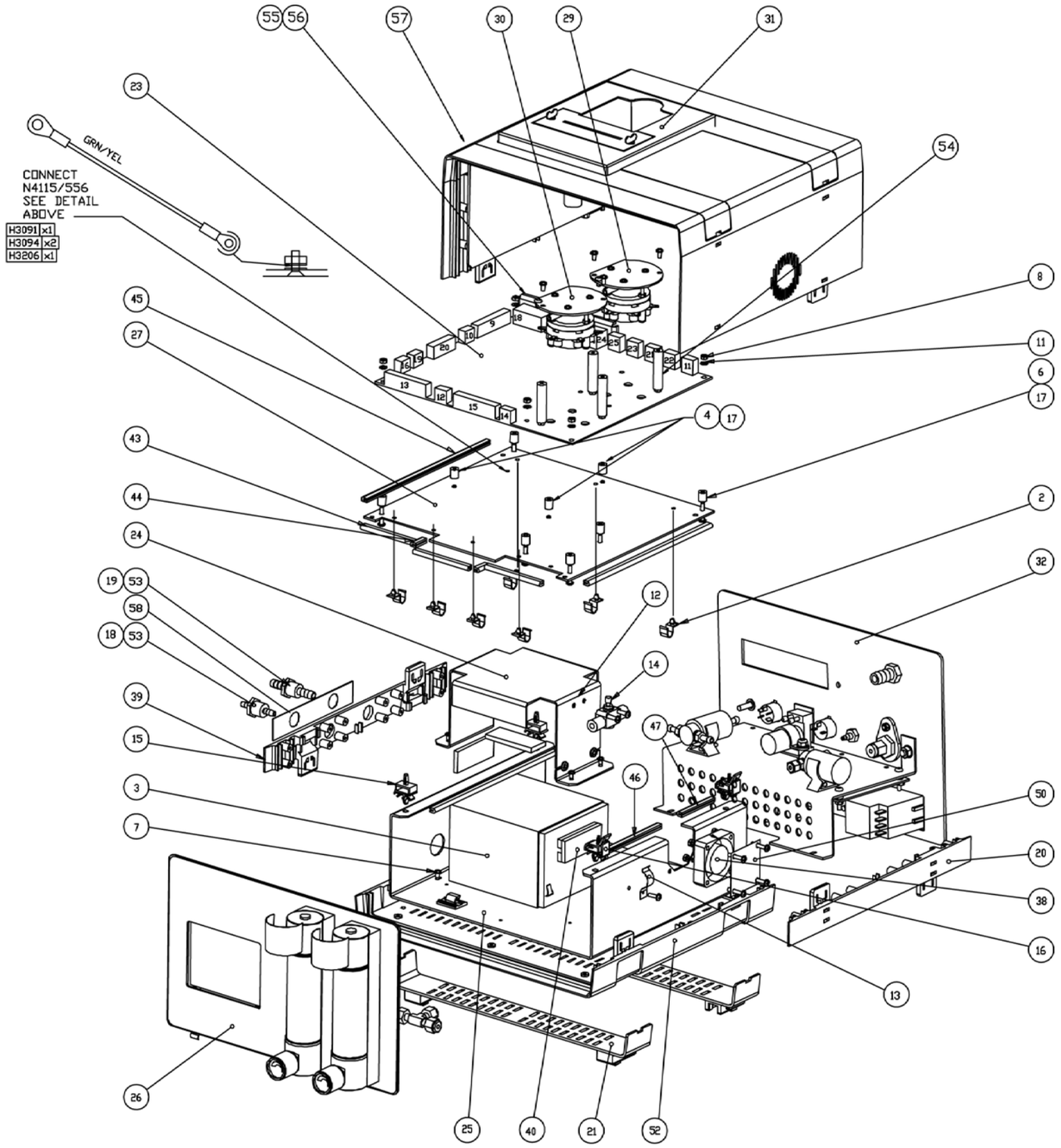
PRE-PRODUCTION REF: 676/115435-C

USED ON:- SLE3601



SLE 232 SELSDON ROAD SOUTH CROYDON SURREY CR2 6PL 0181-681-1414	MATERIAL STOCK CODE No.	TOLERANCES (UNLESS OTHERWISE STATED) X.X = ± X.XX = ±	SCALE NTS					TITLE PRINTER DRIVER PCB CIRCUIT DIAGRAM	
	FINISH Remove All Burrs & Sharp Edges	DIMENSIONS IN PROJECTION	APR'D. CHK'D. DRN. ITL DATE 17.02.98	CN0473	1	17.02.98		DRAWING NUMBER CD/L3601	SHEET No.1 OF 1 / A3
				MOD.	ISS.	DATE	APP'D.	MODIFICATION CONTROL	

ITEM	ITL PART No.	SAGE PART No.	DESCRIPTION	QTY
1	E050055	N4115/E05/055	CABLE_CLIP_SELF_ADHESIVE	1
2	E050063	N4115/E05/063	HALF_U_ROUTING_CLIP	7
3	E750010	N4117/25	LEAD_ACID_BATTERY	1
4		H3206	M3 x 6 CSK SCREW	3
5	F130040	H3106	SCREW_M3X6_PAN_RECD_SS	8
6	F130085	H3216	M3 x 16 CSK SCREW	6
7	F320002	H9101	NO.4_X_1-4_PAN_RECD_STL_ZCP	4
		H9102	NO.4 x3/8" PAN SELF TAP	4
8	F410020	H3091	NUT_M3_FULL_SS	13
9	F420012	H3094	M3_INT_SPROOF_WASHER_ST_ZCP	1
10	F420028	H3093	WASHER_M3_FORM-A_SS	1
11	F420031	H3094/01	CRINKLEWASHER_BERYLLIUMCU_M3	6
12	F420041	H3094	M3_EXT_SPROOF_WASHER_ST_ZCP	2
13	M180002	N4115/M18/002	EARTHING_STRIP	1
14	M360010	N4115/M36/010	RESTRICTOR	1
15	M550225	N4115/M55/225	HINGED_SUPPORT	2
16	M550226	N4115/M55/226	EDGE_HOLDER	2
17	M550230	T0664	NYLON SPACER NS08-M3	9
18	M750280	N4115/M75/0280	4X4MM_PANEL_MOUNT_UNION	1
19	M750281	N4115/M75/281	10X10MM_PANEL_MOUNT_UNION	1
20	M920012	N4115/M92/012	SIDE_PANEL_0-5HE_NO_HNDLE_MNT	1
21	M920016	N4115/M92/016	SNAP_PANEL_VENTS_WITH_FEET	2
22	S	N4115/632	LABEL_PATIENT_INPUT-OUTPUT	1
23	S115394	N4115/394	MAIN_CONTROL_BOARD_PCB_ASSY	1
24	S115449	N4115/449	BATTERY_BRACKET	1
25	S115452	N4115/452	CHASSIS	1
26	S115670	N4115/670	FRONT_PANEL_ASSEMBLY	1
27	S115488	N4115/488	MAIN_BOARD_SUPPORT	1
28				
29	S115535	N4115/535	NO_SENSOR_ASSEMBLY	1
30	S115536	N4115/536	NO2_SENSOR_ASSEMBLY	1
31	S115542	N4115/542	UPPER_UNIT_ASSEMBLY	1
32	S115553	N4115/553	REAR_PANEL_ASSEMBLY	1
33	S115564	N4122/32	TUBE_SIL_3-2ID_6-4OD_250MM.LG	1
34	S115567	N4115/567	5V_ISOLATOR_ASSEMBLY_NO9	1
35	S115568	N4115/568	POWER_CABLE_ASSEMBLY_NO10	1
36	S115569	N4115/569	BATTERY_CABLE_ASSEMBLY_NO11	1
37	S115570	N4115/570	TEMP_SENSOR_CABLE_ASSEMBLY_NO12	1
38	S115573	N4115/573	MINIATURE_FAN_ASSEMBLY_NO15	1
39	S115581	N4115/581	SMALL_SIDE_PANEL_LEFT	1
40	S115582		FOAM_STRIP_LENGTH_50MM	7
41	S115588	N4115/M75/212	TUBE_SIL_5-5ID_11-5OD_60MM.LG	1
42	S115589	N4115/M75/288	TUBE_PVC_5-0ID_8-0OD_500MM.LG	1
43	S115595	N4115/E80/019	GROMMET_EDGE_STRIP_60MM_LG	3
44	S115596	N4115/E80/019	GROMMET_EDGE_STRIP_15MM_LG	2
45	S115597	N4115/E80/019	GROMMET_EDGE_STRIP_170MM_LG	3
46	S115598	N4115/E80/019	GROMMET_EDGE_STRIP_80MM_LG	1
47	S115599	N4115/E80/019	GROMMET_EDGE_STRIP_45MM_LG	1
48	S115605	N4115/E99/015	GASKET_RFI_12-7_X_15_9_320MM.LG	2
49	S115606	N4122/32	TUBE_SIL_3-2ID_6-4OD_25MM.LG	1
50	S115607	N4115/607	GASKET_RFI_EXP_METAL_40MM_SQ	1
51	S115608		CONDUCTIVE_TAPE_6-35MM_320MM.LG	2
52	S115635	N4115/635	BASE_PANEL_MACHINED	1
53		T2149	SPECIAL TAPPED SPACER	2
		N4112/16	M18 x 1.0 THIN NUT	2
54		N4115/M55/229	NYLON PILLAR M3 x 38mm	4
55		N4115/486	CONNECTOR COVER	1
56		N4115/003	GROMMET STRIP x 270mm	1
57		N4115/651	LABEL - LEFT PANEL	1
58		N4115/632	LABEL - PAT INPUT OUTPUT	1



Service Information and Technical Bulletins

16. Service Information Letters and Technical Bulletin Index

Service Letter Nº

Si980701 NO shut off valve replacement. Serial Nº affected: 060101 to 060125

Si980702 Replacement of faulty side panels. Serial Nº affected: All

Si980707 Replacement procedure for gas stop valve. Serial Nº affected: All

Si980708 Replacement procedure for faulty side panels. Serial Nº affected: 060101 to 060125

Si980911 Instalment procedure of optional printer. For machines with no printer.

Si990304 Replacement procedure for NO and NO_2 sensors. Serial Nº affected: All

Si000301 Side wall strengthening. Serial Nº affected: All

Technical Bulletin Nº

TB980303 Software release version V2.00 r2. Serial Nº affected: 060101 to 060126 (excluding Serial Nº 060118)

All of these information letters and technical bulletins are available by contacting the SLE Service Department

17. Issue Revision Record

Issue 1: Initial issue.

Issue 2: CN 760

Issue 3: CN 1418

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SLE reserves the right to make changes without prior notice in equipment, publications and prices as may be deemed necessary or desirable.

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