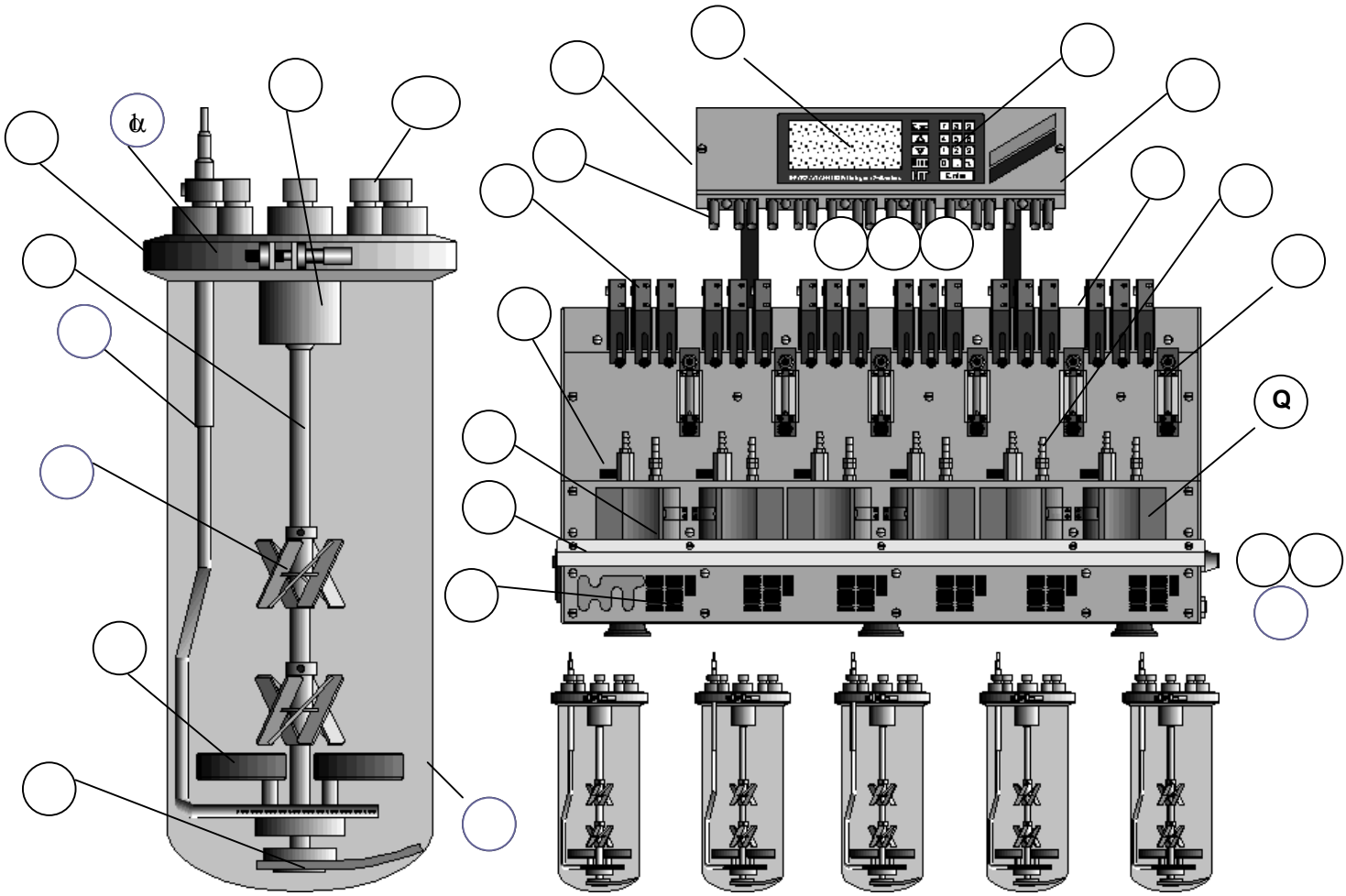
Sixfors®

Fermenters and Shakers
For over 30 years
INFORS AG ISO 9001

Service Manual



A= Display
B= Keypad
C= RS232 Port
D= Memory Card Slot
E= Peristaltic Pumps
F= Magnets in vessel
G= Pt-100 Electrode Cable
H= pH Electrode Cable
I= Oxygen Electrode Cable
J= Antifoam Probe Cable
K=Baffles (not shown, optional)
L= Air Inlet
M= Operational Amplifier
N= Rotameter
O= Water Pipe for Gas Cooler
P= Water Valve for Gas Cooler
Q= Base unit - Heater Block
R= Water Inlet
S= Spring to retain vessel
T= Vessel Support shelf
U= S. Steel Tray for Bottles
V= Magnetic Stirrer
W= Port Fittings
X= Top Plate Clamp
Y= Support for drive shaft
Z= Drive Shaft
1=Top Plate
2= Overflow Pipe to Drain
3= Vessel Glass
4= Impellors
5= Sparger

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SIXFORS SERVICE MANUAL Version 1.0

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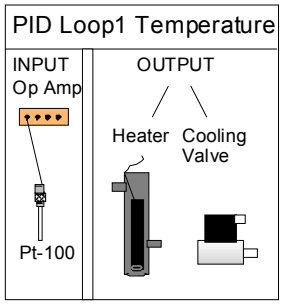
SPECIFIC INFORMATION AS INDIVIDUAL SHEETS

1. Dimensions, Technical Data and Services Requirements.

Working volume :	**Approx. 0.3 to 0.5L**
No. of vessels :	**Up to six, round or flat bottom**
No. parameters :	**^{o}C, rpm, pH (measure & PID control) pO_2 (measure & PID control + options), antifoam or substrate (cycle/dose control). Optional mass flow control and gas mix.**
No. reagent pumps:	**3 per base unit**
Temperature Control:	**Heater block temperature control (incl. cooling) with a single- walled vessel.**
Temperature Range:	**5^{o}C under coolant temp. to 60^{o}C**
Heating	**125W per station**
Stirrer	**Electronic, DC stepper motor with PWM control Bottom drive with magnetic coupling, Stirrer bar or impellors & baffles (option)**
Airflow	**24-60NL/Hr**
Speed range(s):	**approx. 20-1200 rpm**
Data connection	**RS232 (Tx, Rx and ground only)**
Profile storage	**Memory card (type PCMCIA)**
pH range:	**2-12pH**
pO_2 range:	**0-100%**
Antifoam:	**Total cycle time and dose time-30% max**
Feed Pump:	**Total cycle time and dose time-30% max Optional conductivity probe**
Dimensions (Length x Depth x Height)	**9000 x 400 x 710 mm**
Weight	**67Kg**
Services	**Electricity 230V, 50Hz 10A ("noise-free") Water > 1.5 bar Air ~1.5 bar***

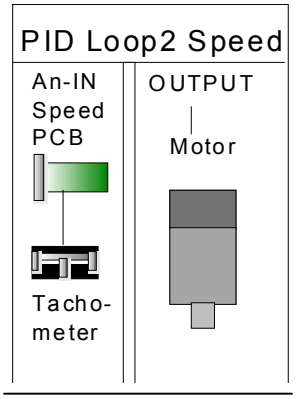
Overview of the SIXFORS Systems of Measurement & Control

TEMPERATURE



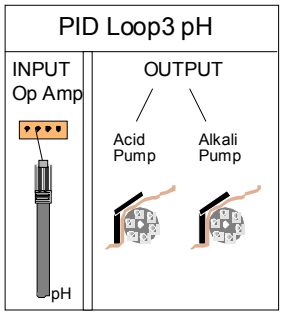
Temperature is controlled using an electrical heating block with in-built cooling coil. The range of control is approximately 5ºC above the cooling temperature to 60ºC. A signal from a Pt-100 temperature sensor in the culture is used for feedback control by the micro-processor to activate either the heater or the cooling valve. The main controller display shows actual value, setpoint PID control etc.

STIRRER SPEED



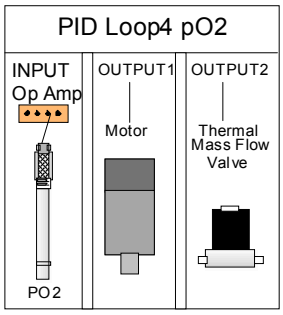
A setpoint is given to the control circuitry by the microprocessor. The PID control values are factory set for this parameter. The main display shows the actual value for speed. The level of dissolved oxygen can be cascaded to influence the stirrer speed. Speed range is typically 20-1200 rpm upper and lower limits depending on the EPROM installed for a specific application. No service adjustments can be made.

pH



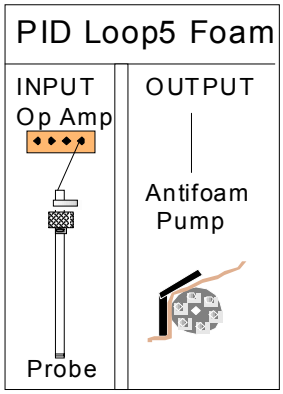
The pH measurement and control system consists of an electrode linked to a signal conditioning module which sends the measured value to the microprocessor. Calibration is digital and similar to the procedure for a bench meter. Range is typically pH 2-12.
Integrated peristaltic pumps deliver a timed dose of either acid or alkali reagent into the fermenter vessel. The total “on” time of each pump is recorded and can be used to measure how much reagent has been added.
Temperature compensation can be activated if required.
A gas valve for CO_2 may replace the acid pump.

DISSOLVED OXYGEN



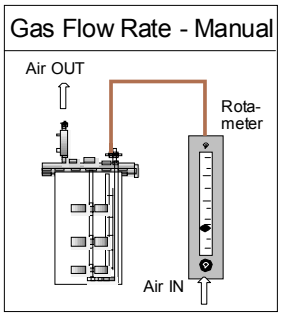
Measurement of dissolved oxygen is via an electrode linked to an integrated operational amplifier within the signal conditioning module. A polarising voltage is also supplied by this unit. Calibration is similar to a bench meter with zero and 100% values being set.
Control is by a PID loop acting on either the stirrer speed or by influencing an optional thermal mass flow control valve to adjust the air flow rate.
A gas-mixing unit can be used for special applications such as animal cell culture. Range 0-100%

ANTIFOAM (optional)



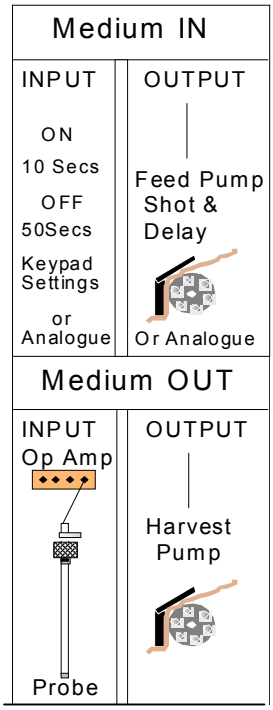
Control of foam is based on a conductivity probe above the culture surface detecting the build-up of foam by contact with the probe tip. The rest of the probe is insulated to prevent false signals.
After a user-selectable waiting time (delay) the integral peristaltic pump delivers a dose of antifoam reagent (shot).
The system then resets and will only add more reagent if foam is still present.
This arrangement can double as a level control system to remove culture.

GAS FLOW



Unless specified otherwise, control of gas flow into the fermenter is usually set manually. A separate pump or laboratory air supply is connected to the fermenter supply pipework which has an integral pressure regulator valve.
The flow rate is adjusted using a rotameter calibrated in litres per minute/hour.
The maximum air flow rate should be no more than 1.5 vessel volumes per minute.
A mass flow valve and/or gas mixing system may also be used.

CHEMOSTAT OR CONTINUOUS OPERATION (optional)



This relies on a balance being set between addition of fresh medium into the vessel and removal of culture. The correct rate matches the growth of the microbes so that a constant concentration in the vessel is maintained.
If the growth of the organism is limited by eg. a source of sugar in the medium then the fermenter is being operated as a chemostat.

Medium is added to the culture by a peristaltic pump which can be an integrated digital unit relying on shot and delay times or an external analogue pump with variable speed.

Harvest of culture can be achieved by using a level control system (antifoam pump used in reverse to withdraw culture), or a simple side-arm acting as an overflow (option).

Even if the fermenter is operated as a chemostat for a short time, large containers are needed for both fresh medium and harvest.

Antifoam reagent can be added to the fresh medium at a low concentration (eg. 1:20,000) if required)

2. Setup and Basic Operation

Transport

n view of the weight of the complete SIXFORS and packing materials it should never be carried by one person alone. For moving the packed system over long distances, a low trolley or palette raiser is recommended.

If the SIXFORS is to be transported by a fork lift truck, **it is vital it is secured in such a way that there is no chance of it falling off or otherwise being damaged!**

Packing and disposal

The SIXFORS is shipped in a wooden crate. All packing materials are environmentally friendly and can be re-cycled.

Unpacking and Checking.

Please make sure that no part of the SIXFORS sustains damage during unpacking. Use the delivery documentation to ensure that all parts are present. If there is a discrepancy between the list and the contentss and/or there are any signs of transport damage, please contact Infors **at once**.

If this advice is not followed promptly, any resulting costs will be the responsibility of the purchaser.

All accessories and flexible connection pipes are usually packed in a cardboard box placed on top of the fermenter base unit. The vessel is also packed in a separate cardboard box within the crate.

Location

The SIXFORS fermenter is best mounted on a laboratory bench of suitable working height.
Access to air, water and power services should be nearby along with a suitable drain / sink.
A free space of 50cm should be left all around the fermenter to make servicing both easier and quicker.
The unit should be sited away from potential sources of electrical noise.

Services

The final connection of the fermenter to the services will be made by INFORS if installation is requested by the customer.
This is aided greatly when all services outlets include the necessary pressure reduction system already installed by the customer.

Services Connections

Power

230V/10 A single-phase supply for standard SIXFORS

The power supply should be clean and constant - if not, it is recommend fitting of suitable filters and or a UPS to the mains power supply.
In addition to the plug fuse, 2 fuses can be found behind a cover above the location of the connecting socket in the mains inlet and On/Off switch.

Air

The air inlet can be found on the left side of the fermenter. Use only clean, dry oil and dust free air with a pressure of >= 2.0 bar.
A push-on Connector pipe is used with braided tubing. Fit a "jubilee clip" at each end of the pipe to secure it.
Inlet air is supplied through the rotameter (variable area flow meter) to each vessel. Ensure this is turned on using the black knob below the rotameter scale.
Calibration graphs are provided in the operating manual.

Water Inlet

Cold (& preferably soft, <50ppm suspended solids) water supplied at a pressure of >= 1,5 bar enters from the left side of the base unit of the fermenter.
Push-on connector pipes are supplied separately in a bag. Push one of these into place and fit braided tubing to the cold water tap. Use "jubilee clips" to secure pipe to fitting at **both** ends.

Water Drain

The drain outlet is on the left side of the fermenter. It requires a clear fall to the drain / sink without sharp bends or kinks.
Push fit onto metal barb connection.

Exit Air

The exit air leaves via the disposable filter attached to the exit gas cooler (if fitted).
If oxygen supplementation is used, take care to pipe the exit air away safely to avoid explosion risk.

Vessel connections:

Temperature control

The vessel needs only to be placed into the heater block by squeezing the smaller holder on the right hand side away and letting the vessel slide in. The block now acts like a heater jacket and allows heat exchange with the vessel contents.

Inlet of water into the heater block for cooling is controlled by an automatic valve inside the bottom section of the base unit.

Connect the inlet and outlet pipes of the exit gas cooler using the small rapid coupling connectors. Use the manual valve behind each vessel to turn the cooling water supply to the exit gas cooler ON.

The vessel top plate is equipped with a Pt-100 temperature probe. This is in a 10mm clamped port and a 2-pin Lemo connector. It is used for connecting to orange cable from the operational amplifier module. Push to fit when the red spots on cable and connector are aligned.

Gas supply

Fit a 0.22u filer to the top of the vessel sparger using braided tubing (long enough to allow a clamp to be placed between the filter and the metal sparger pipe).

Connect the air line from the rotameter to the air sparger in the vessel by braided tubing, pushing it onto the air filter.

If a gas mixing system is present, connect the gas supply bottles to the appropriate inlets either to the rear of the base unit or on the separate gas mixing box.

Initial Setup Checklist

1. Memory card in place
2. Water line connected
3. Drain line connected
4. Air line connected
5. Vessels connected to heating system
6. Rotameter outlet connected to sparger
7. Exit gas cooler inlet & drain connected
8. PT100 temperature sensor connected
9. Air supply turned on
10. Water supply turned on
11. Mains power on

This is purely for testing the basic functions of the fermenter. Connecting of probes etc. is covered in a separate section.

Drive System

The bottom drive is automatically connected when the vessel is placed in its holder. Ensure the drive shaft (if fitted) is located correctly in the bottom bearing support (the white teflon disk which is either in the centre of the ring sparger or in a separate triangular plate for round-bottom vessels).

A special version of the EPROM can be specified if uncoupling is likely to occur during operation.

Connection to a computer/Printer.

The SIXFORS has an RS232 serial port on the left side of the black support for the screen/keypad. If specified, a cable should be provided which connects to this port and a 9-pin serial port at the rear of the computer. Installation and use of IRIS software is the subject of another guide.

Printers must have a serial port or a parallel/serial converter in order to link directly to the SIXFORS.

Additional cables and equipment.

Reagent bottles are normally provided with the system. These are set up separately and for test purposes can be filled with water. See diagram for correct set-up.

Bringing into use (from a service viewpoint)

1. Check all O ring seals for wear and replace as necessary. Smear with a ***little*** high temp. grease.

2. Undo the clamping ring using the screw at the front of the vessel. The top plate can be lifted clear of the vessel glass, which remains in place.

3. Check the large "O" ring seal (10962) in the grooved flange of the vessel glass is lightly greased, not damaged and not wrinkled when in place.

4. Charge vessel with water to approximately the required working volume of the vessel.

5. Replace the top plate and tighten retaining clamp to finger tight. Take care not to accidentally clamp the autoclaving cover for the Pt-100 in the clamp.

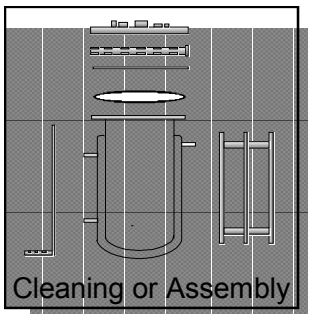
6. Equip any unused ports with a membrane, collar and port closure if the port is to be used for additions post-autoclaving. If not, a blanking port closure is sufficient.

7. Calibrate the pH electrode using the appropriate menu option in U-DDC and buffers of eg. pH 4 and 7. Follow the instructions to set a low and high reading.

8. The dissolved oxygen electrode low-value calibration can be set using the zeroing gel provided ***CARE-*** strongly alkaline solution.

9. Fit the pH and dissolved oxygen electrodes in the 13.5PG ports (they have a finer thread than standard), using adaptors if the electrodes are too long to fit without.

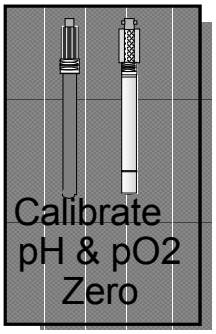
The other vessel fittings can be added such as sample pipe, exit gas cooler and acid/alkali inlets.



Check the electrode condition, then prepare the electrodes for first use according to the instructions given in the relevant appendix. i.e.

pH - remove white sealant over diaphragm completely.

pO2- unscrew base section, remove diaphragm cartridge and half fill with electrolyte. Replace.



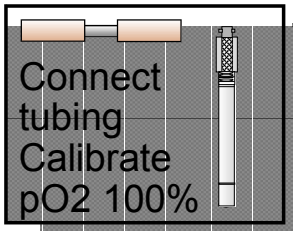
OPERATION

1. Air flow should be set to no more than 1.5 vessel volumes per minute eg. for a 0.5L working volume vessel the max. is 0.75NL/min.

2. Pass the tubing from the reagent bottles through the appropriate peristaltic pump, using the small connector in these lines to stop the tubing from being pulled through the pump. Unclamp the connection between the bottle and the vessel.

3. Calibrate the 100% dissolved oxygen high value by passing air through the vessel at maximum flow rate when the stirrer speed is also at the maximum to be used. At least 2-6 hours is needed before electrode is usable.

4. Complete the set-up by setting appropriate setpoint values. This should be sufficient for an installation check without autoclaving.



- **UDDC Instrumentation (basic points)**
- The UDDC2 instrumentation is based on a powerful industrial process controller which uses a memory card (type PCMCIA) to store data about Set-points, profiles etc.

- The keypad is splashproof and has several sections, each with keys which perform specific tasks:

Numeric keys [1]..[9] plus [.]	Data Entry
numbers 1..6 .	Select fermenter
[+/-]	"Toggles" options
[Enter]	Confirmation
[Esc]	Abort last action
[UP ARROW]	Moves upwards
[DOWN ARROW]	Moves downwards
[Menu]	Go to Main Menu

- The screen is a high-contrast LCD unit displaying 40 characters by 16 lines. Different areas of the screen provide different sorts of information:

Top Line	Fermenter data
Second line	Current option
Lines 4-13	Fermenter values
Lines 15-16	HELP information

- A square flashing cursor [] appears in a number of screens against something which can be changed.

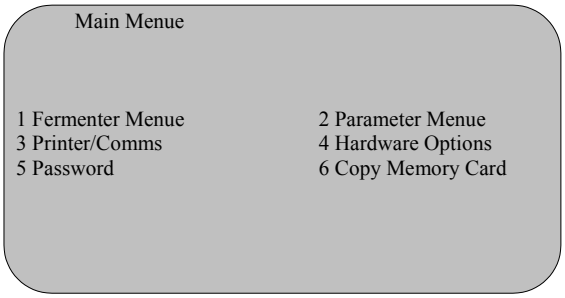
STARTING OR STOPPING A FERMENTER

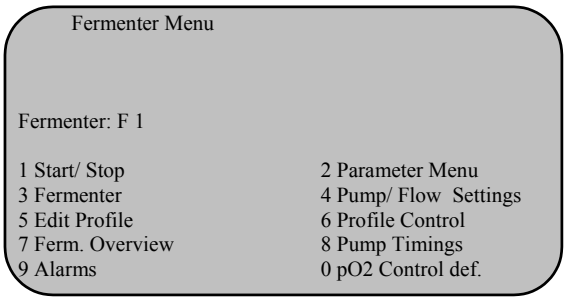
1. To start a fermenter from the Main Menu select Option 1, fermenter Menu.
2. The screen changes to allow you to select which fermenter (1..6) to start using the numeric keypad.
3. The Fermenter Menu is then displayed. Select Option1, Start/Stop.
4. In the start/Stop screen use the [DOWN ARROW] key to move through the options, deciding which parameters to keep On and which to switch Off using the [+/-] key.
5. Finally, use the [+/-] key to switch Start Fermenter to On and press either [Enter] or [Menu] to confirm.
6. [Menu] takes you back to Main Menu and pressing[Esc] will let you see the Values screen.
7. To stop an active fermenter, select Option 1, Start/Stop from the Fermenter Options menu and use the [+/-] key to toggle Stop fermenter to On & press Enter] or [Menu] to confirm the shutdown.

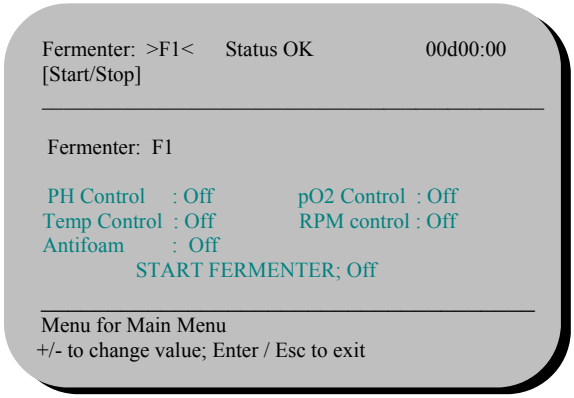
CHANGING A SETPOINT

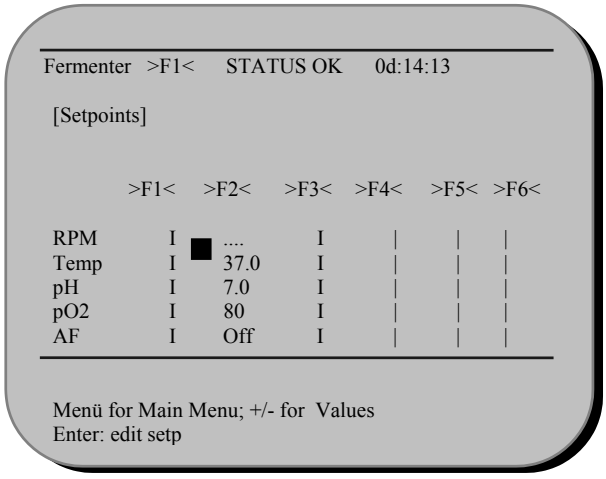
There are two ways to change a setpoint:

1. From the Values Screen - simply press [Enter] after first selecting the fermenter (1..6) and then the required parameter with the cursor using the UP/DOWN keys for navigation.
2. Alternatively, press [Menu] to show the Main Menu and press [1] to select the Fermenter Menu.
3. Press [2] for the Parameter Menu. The Parameter Selection sub-menu will allow you to choose the parameter you want to change eg.[1] RPM.
4. A new setpoint is entered using the numeric keys and confirmed with [Enter].
5. [DOWN ARROW] moves to the Alarm Lim. field where a symmetrical alarm limit value can be entered outside of which an alarm will be generated.
6. Press [Enter] to confirm the value **and [Enter] again** to return to the parameter menu.







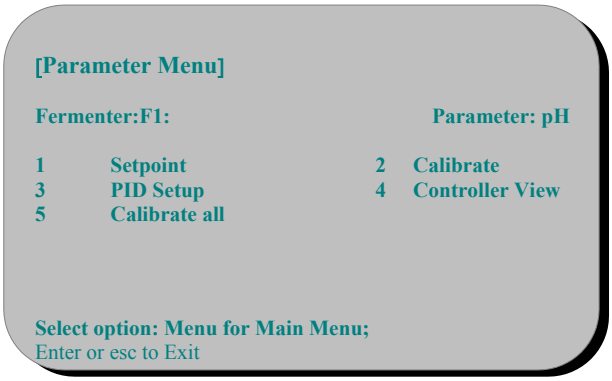


CALIBRATION

1. Calibration of parameters is possible for both active and closed down fermenters. The RPM parameter **cannot** be calibrated as this is factory set.

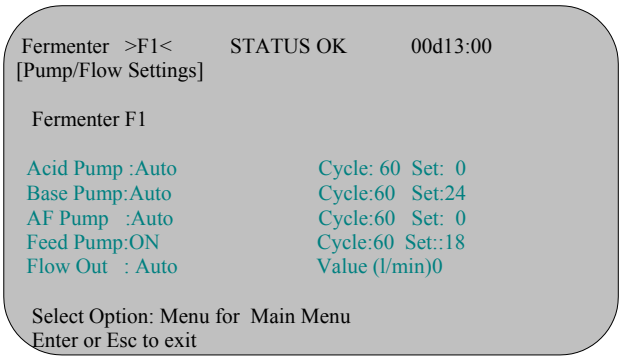
2. Press[Menu] to get to Main menu
3. [2] to select parameter menu
4. eg.[1] to select the fermenter (1..6)
5. eg.[2] to select the desired parameter
6. (1..5)
7. [2] to select the Calibrate screen

8. Enter the High Ref. values using the numeric keys eg. 60oC and press [Enter] to confirm.
9. Press [DOWN ARROW] to move on.
10. The High Read is a value generated by the A/D converter in the instrumentation - press [Enter] to allow the reading shown in the Act Read display to replace the current value in the High Read position.
11. Use the [DOWN ARROW] key to pass over the value.
12. Repeat the process for the Low Value and Low Reading.
13. Press ENTER to confirm or Menu.



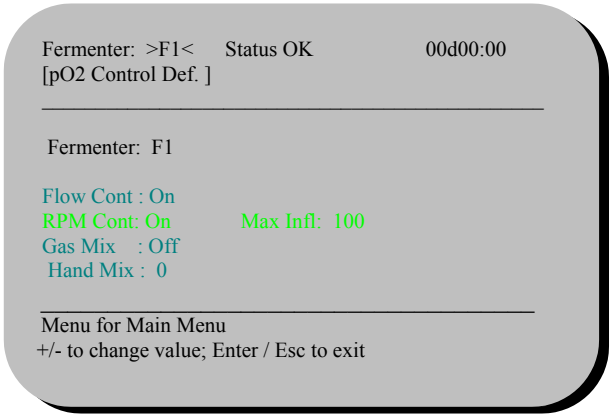
PUMP/FLOW CONTROL

1. This screen allows the built-in reagent and feed pumps to be set to ON. OFF or AUTO control.
2. Acid, Base and Feed pumps can be ON. OFF or AUTO eg. when the acid and base pumps are under the control of the pH control system.
3. The feed pump can only be set to ON or OFF.
4. The cycle and set values are in seconds and allow different flow rates to be achieved by varying the time a pump is active over time. The maximum duty cycle for any pump is 40% of the total cycle time eg. cycle=60, set=24 secs.
5. This screen is reached via the Fermenter Options Menu.
6. Use the [+/-] key to toggle On, Off or Auto options [DOWN ARROW] moves on to the next position.
7. Enter the cycle time in seconds and use [Enter] to confirm the new value. [DOWN ARROW] moves you on. Repeat for the Set time.
8. The flow setting allows the thermal mass flow valve (if fitted) to be controlled with a manual value for gas flow rate in litres per minute. This valve is usually under the automatic control of the pO2 control system.
9. A final [Enter] or [Menu] confirms the new values. [Esc] aborts the process



DEF PO2

1. This screen allows several options to be set for control of dissolved oxygen. It is accessed from the Fermenter Menu.
2. If Flow Control is set to On using the [+/-] key then oxygen control is via the optional thermal mass flow control valve.
3. If the RPM control is set to On, then speed is used to control pO2 - either in place of the flow valve or additional to it!
4. Max Influence sets a symmetrical limit in RPM in which control of pO2 can take place eg set point of 1000RPM with max. influence of 200 would give control of pO2 by stirrer speed from 1200 to 800 RPM only. **This is the only standard option!**
5. Gas Mix and hand Mix only apply to systems with a special gas Mix unit.



3. Cleaning

Before disconnecting the corrective reagent feed lines from the peristaltic pumps they should be clamped off. They can then be emptied manually after re-sterilization.

On safety grounds, the fermenter must be switched off and left for some minutes before removing the vessel(s) for cleaning of the base unit (heating block can get very hot to the touch).

Mains switch
On the right hand side of the base unit
OFF.

Cleaning the base unit and Master-Control panel.

1. Use a soft, damp (NOT WET) cloth and a neutral detergent to wipe away any stains or grime.
2. Clean the unit down with electrical power off and allow to dry completely before use.
3. Any spillages of reagents (especially acid or alkali) must be wiped up immediately - CARE NEEDED.

Cleaning of a recently-used system

Please note: sterilization of the vessel and peripherals MUST be done by the user prior to your starting work on the equipment!

1. The pH and dissolved oxygen electrodes should be removed and stored in suitable reagents according to the manufacturer's instructions which come with each electrode. Copies are included in the appendices of this operating manual.
2. Periodic cleaning and regeneration of the electrodes are also covered by these instructions.
3. The vessel should be rinsed several times in distilled water to remove any loose culture residues.
4. Growth of culture on the vessel walls may require disassembly and light brushing to completely clean the glass.

Examination of the vessel during cleaning

During cleaning of the vessel, an examination for any chips or cracks in the vessel glass can be made and faulty vessel glasses MUST be replaced.

Any O ring seals which appear flattened or dry should be replaced and the new seals lightly greased with a mineral compound such as eg. Edwards' high vacuum grease.

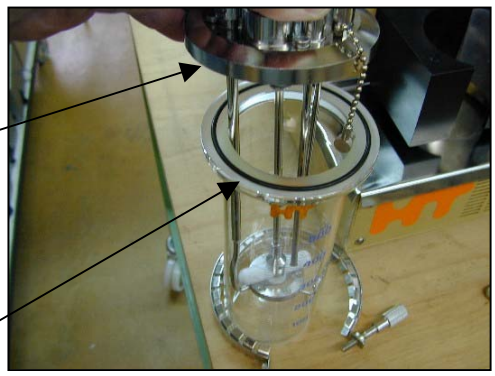
Membranes which have been pierced should be replaced.

4. Exchange of Consumable Parts

During a routine service inspection, a number of consumable parts may have to be exchanged.

4.1 Vessel seal

The vessel seal is critical for maintaining an uncontaminated environment for the culture.



1. Remove the clamping ring from the vessel to release the top plate.
2. Carefully lift the top plate upwards so the pipes etc. clear the lip of the glass section and place the top plate gently on its side away from the glass section. The glass section will continue to be supported by the

one.

4. The new seal is very lightly greased with silicone grease and placed in the groove. It must fit snugly without any wrinkles. If a good fit cannot be achieved, discard the seal and use a new one.
5. Re-assemble the top plate onto the vessel glass and replace the clamp using even pressure the clamping screw (finger tight only).

4.2 "O" rings on port fittings & Clamping Ports

The "O" rings seal the port closures against the top plate so no microbes can get in or out. If their effectiveness is compromised, the fermenter is functionally useless.

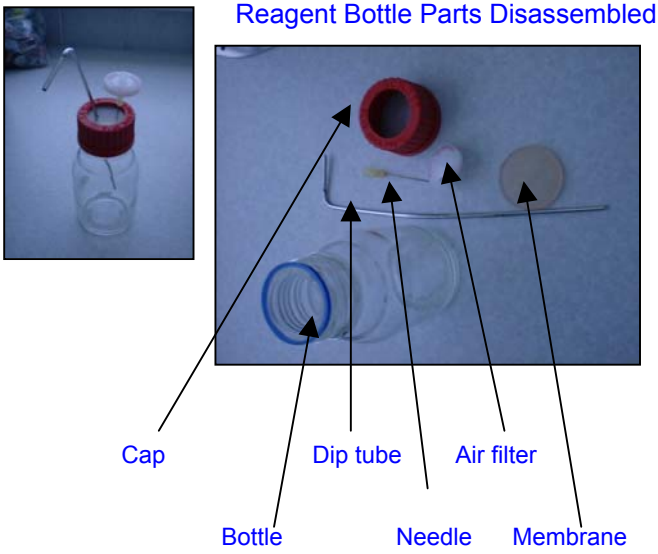
The port closure "O" rings are located in grooves in the closure and can be easily levered out for exchange. Remember to lightly grease the new "O" ring.

Port fittings which have pipes going through them

that fits over the length of the probe, leaving only the tip exposed.

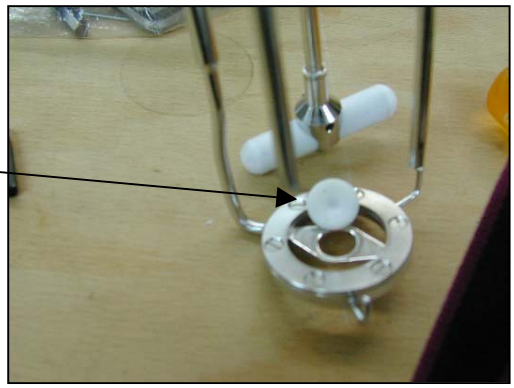
4.3 Membranes, filters, Reagent Bottle Fittings & Sampling Device.

These additional items are usually replaced by the user as necessary. However, as part of routine maintenance, it makes sense to check any fittings in these perpiheral items (eg. dip tubes) for corrosion and to replace clearly worn or damaged membranes and fittings.



4.4 Replacing drive bearings & removal of drive shaft/impelllors

1. Remove vessel top plate.
2. Undo nut holding the top of the drive shaft in place
3. Draw drive shaft past the top bearing support
4. Press on teflon bearing support to pop it out of its retaining metal frame
5. Replace with a new teflon bearing (18217)
6. Replace drive shaft and re-assemble
7. The bottom bearing support pops out of the centre of the ring sparger or triangular frame in the same way. This is more likely to wear and needs regular exchange as a consumable item. (22786)
8. The impellors are exchanged/moved by releasing the small grub screws holding them firmly onto the drive shaft using a small hexagonal key.



4.5 Battery on Memory Card

The memory card (AFC003) stores information about setpoints, calibration, PID setup, profiles and other preferences. A "watch" batttery preserves tha data on the card even when the SIXFORS is switched off. After a period of 1-2 years the battery loses power and the user reports a loss of settings every time the unit is switched off.

A further reason for wishing to remove the battery may be that a "PIN number" password has been set and the user has forgotten it. Removing the battery clears the memory.

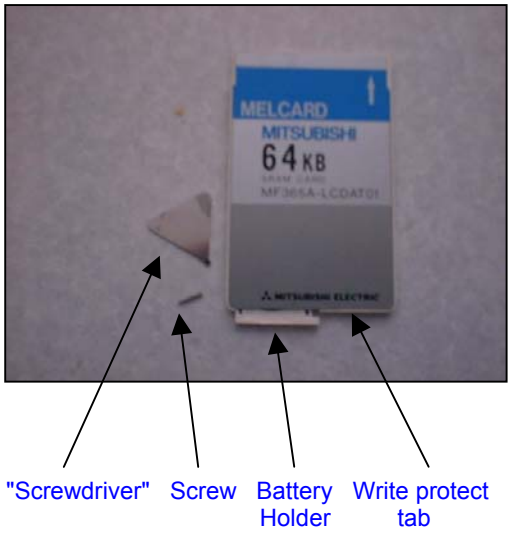
The user will normally exchange the batttery themselves but may well ask for it to be done as part of preventive maintenance.

1. Remove the card from the slot in the SIXFORS main pcb housing (noting the orientation of the card).
2. A small screw is found on the back edge of the card. Remove this with the special tool provided with the card or using a watchamaker's screwdriver.
3. Put your fingernail or eg. a thin penknife blade into the small crack above the area containing the screw hole and pull backwards.
4. A battery holder is revealed with the battery sitting in position. Note the orientation of the battery and exchange for a new one. TYPE: xxxxxxx
5. Ensure the write protect tab on the back edge of the card is seet towards the middle of the card in the "Write" position before replacing it in the SIXFORS.

The card will be "initialised" by the SIXFORS on first switching the fermenter on and all setpoint values set to zero with defaults for all other data.

If the customer has downloaded the current configuration to a PC, the data can be restored to the card using Option 6 in the Main Menu "Copy Memory Card".

Memory Card



5. Trouble-shooting the Sixfors

5.1 Basic Operation

Problem	Possible Causes	Remedy
Sixfors does not work at all **(No green mains power light)**	Power lead not plugged in or Mains power not turned ON Fuses blown Break in power connections	Plug in - switch mains ON Check plug fuse (10A+) Check fuse in base unit (10A) Check plug connections Test mains cable continuity Check connections at mains socket in base unit Check reset in plug socket
Mains power, but no display	Unit switched ON but not touched for longer than 30 minutes No 24V supply. *Can the red LED's indicating 24V supply be seen in the LED display in the base section of the Sixfors for each unit?* If NO No Back light. *Can figures be seen dimly in the LCD display?* If YES No 24V supply to pcb. Main pcb or back light faulty. *If 24V supply to main pcb OK, can peristaltic pumps be operated manually?* If YES If NO	Touch any key. LCD screen should now light. Check power supply to 24V feed from transformer. Replace transformer if necessary. Replace back light Check 24V feed to main pcb Replace screen panel Replace main pcb
LCD Screen halts at P.O.S.T. Screen (Power On Self Test) **Screen shows random characters and /or "odd" behaviour of pumps etc.** **System "hangs" or does not respond to inputs**	No Memory card. *Do all tests show pass and the display asks for memory card to be inserted?* If YES Processor Problem Memory card problem	Memory card should be inserted. *N.B. Never insert or remove a memory card if the unit is switched on* Switch On and OFF to clear fault. If no change, remove & replace processor or exchange it for a new one. Re-initialise card/remove battery briefly to clear mem.
Keys fail to work	Processor problem or fault with keypad	Switch On and Off. If no change replace keypad or processor (try processor first)

For general, random faults with operation, pumps etc. check earthing & "digital" pcbs If setpoint, calibration etc. data is not being retained, exchange memory card battery.

5.2 Speed Control System

Problem	Possible Causes	Remedy
Motor does not start	Speed controller OFF. *Is the speed control switched ON at "Start Fermenter" or "Fermenter Options" screens?* PO2 control switched on and set to work with stirrer Stirrer setpoint=0 Drive shaft not moving. *Can the drive shaft be turned by hand ?* If NO (unlikely) No power to motor. *Is power being supplied to motor ?* No power getting to motor from digital pcb	Switch ON. Switch pO2 Control by Stirrer OFF to test operation Check Stirrer set point >0 and deadband does not include zero rpm. Remove obstruction or replace bearings on drive shaft -usually bottom bearing Replace digital pcb or motor Check connections.
Drive motor runs slowly or erratically (pulses or "hunts")	Speed control malfunction. *Does speed match displayed value for speed? (visual estimation)* If NO Is more than one motor affected? If YES Motor bearings failure.	Check connections to digital controller pcb Check connections to motor on digital pcb for power supply etc. If PO2 control by stirrer is switched ON, turn it OFF Replace motor
Drive uncouples at high speed	Culture viscosity is too high	Reduce speed Fit special EPROM

5.3 Temperature System

Problem	Possible Causes	Remedy
No display or incorrect display of temperature	Faulty Pt-100 sensor	Check connections *Test calibration with eg. ice and hot water*
	Faulty amplifier module	Replace amplifier module Check connections
	Processor problem	Replace Pt-100 and re-test Switch OFF and ON again. Replace processor
No temperature control	Control not active	Ensure control is turned ON
	Control output not given - *Check indicator LED's, is the heater light ON?* If NO	Check connections Replace digital pcb
	Processor Fault *Check "Fermenter Overview" does this show heater/cooling valve active?* If No	Check connections Replace processor or main pcb
No heating or inadequate heating	*Does the vessel get hot?* If NO	
	Over-temp. cut out fault	Check connections Replace cut out
	Faulty heating element	Replace heater element
	Faulty "digital" pcb	Check operation
	Neg factor too high - *control biased towards cooling*	Check connections Replace heater Check power output to heater Replace pcb Adjust
No cooling or inadequate cooling	No Water or inadequate flow	Turn cooling water ON Check connections
	Set a low setpoint eg 5°C, Does the aluminium block and vessel contents begin to cool? If NO	Check connections Replace cooling valve
	Faulty cooling valve	Adjust *eg. if cooling water temperature is too high.*
	Incorrect Neg. Factor	
Temperature drifts up or down over time	PID settings incorrect	Adjust (esp. P term) - *default values available*

5.4 pH System

Problem	Possible Causes	Remedy
No display or incorrect display of pH	Faulty pH electrode	Check connections *Test calibration with pH 4 and ph7 buffers* *Check slope of electrode for signs of ageing* Replace or regenerate electrode
	Temp compensation OFF	Turn this to ON in normal use
	Faulty amplifier module	Check connections *Replace sensor or use simulator to test* Replace amplifier module
	Processor problem	Switch OFF and ON again. Replace processor
No pH Control	Control not active	Ensure control is turned ON
	Pumps not set to Auto	Check and set to Auto if necessary (*pumps submenu)*
	No control in dead band	Ensure this is OFF or small value
	No reagents	Ensure bottles full, line open & connected to vessel
	Pumps not operating properly	Check operation manually and prime pumps.
	If pump heads do not rotate Faulty pump motor	Check connections Check drive belt Replace pump motor
	Wrong tubing type	Check tubing type (not too hard) **and spring tension**
	Faulty Solenoid *Is only one pump effected?* If YES	Check connections to solenoid Replace solenoid
	Control output not given - *Adjust set points. Check indicator LED's, do the acid and base pumps lights ON?* If NO	Check connections Replace digital pcb in base section (*also for pump mal-functions)*
	Processor Fault *Check "Fermenter Overview" does this show acid/alkali pumps active?* If NO	Check connections Replace processor or pcb
pH drifts up or down over time or acid & alkali added almost continuously in turn	PID settings incorrect	Adjust (esp. P term) - *default values available*
	Incorrect strength of reagents	Check reagents ~0.1-2.0M

5.5 Dissolved oxygen system

Problem	Possible Causes	Remedy
No display or incorrect display of dissolved oxygen	Faulty pO2 electrode	Check connections *Test calibration with zeroing gel and max. speed + air flow* *Use simulator if available* *Check slope of electrode for signs of ageing. IS IT DRY?* Replace membrane or whole electrode
	Faulty amplifier module	Check connections *Replace sensor or use simulator to test* Replace amplifier module
	Processor problem	Switch OFF and ON again. Replace processor
No dissolved oxygen control	Control not active	Switch control ON
	Actuator not switched to ON	In "Po2 Def" screen, select stirrer, flow and/or gas mix as appropriate. Other settings must be made for flow and gas mix to work. *(only control by stirrer is available as standard, factory default is for flow control to be set ON, so this must be changed)*
	No gas flow into vessel	Check for bubbles in culture Check service supply
	Fault with Actuator	
	a) Drive Motor	Check as in 5.2 Replace if necessary
	b) Mass flow control valve	Check connections Replace if necessary
	c) Gas Mix unit	Check connections Check services supply of gas Check solenoid valve operation *(listen for activation, does valve get warm over time, test for flow with air)* Replace valve if necessary
Dissolved oxygen drifts up or down over time or stirrer "hunts"	PID settings incorrect	Adjust (esp. P term) - *default values available* Full 3-term control is often needed for good pO2 control

5.6 Antifoam/Feed Pump

Problem	Possible Causes	Remedy
Foam not sensed	Faulty Antifoam electrode *Check lead & amplifier by shorting cables together, does display show "AF ON" and/or pump operates* If YES If NO Processor fault	 Check connections Replace antifoam probe Replace amplifier module Check connections Replace
Foam always/frequently detected	Antifoam probe sheathing damaged (unlikely) Pump switched to ON Processor fault	Replace probe Switch pump to Auto Check connections Replace
Antifoam control does not work	Control not active Pumps not set to Auto No reagent (or inadequate) Pump not operating properly *If pump heads do not rotate* Faulty pump motor Wrong tubing type Faulty Solenoid *Is only one pump effected?* If YES Control output not given - *short out probe.. Check indicator LED's, does the antifoam pump lights ON?* If NO Processor Fault *Check "Fermenter Overview" does this show antifoam pump active?* If NO	Ensure control is turned ON Check and set to Auto if necessary (*pumps submenu)* Ensure bottles full, right reagent & connected. Line open to vessel. Check operation manually and prime pump. Check connections Check drive belt Replace pump motor Check tubing type (not too hard) and spring tension Check connections to solenoid Replace solenoid Check connections Replace digital pcb in the lower front of the base (*also for pump malfunctions)* Check connections Replace processor or pcb
Feed Pump does not work (see above for range of possible pump faults)	Pump not switched to ON (*same pump as antifoam)* No set value given	Switch pump ON Give cycle & set times (secs)

5.7 IRIS Software Connections to Sixfors (assumes prior correct installation by Infors)

Problem	Possible Causes	Remedy
No Data-logging or control	Cable not connected	Connect firmly at both ends
	Cable connected to wrong COM port	Check which COM port a fermenter is assigned to and swop if needed.
	Cable connected to wrong fermenter	Swop cable if necessary.
	Cable not earthed at one end	Ensure earth strap connected at the computer end to a case screw
	Fermenter not switched to remote operation	Select this option at the *Fermenter* instrumentation.
	COM port settings incorrect Fermenter mis-assigned	Check in Peripherals dialogue box (Extras, menu, devices sub-menu).
	Device model incorrect eg. set for ISF not Labfors	Check in Fermenter Properties dialogue box.
	Wrong protocol for comms. Eg. baud rate or parity mis-set.	Click on Settings button in Peripherals dialogue box and check settings re. fermenter manual.
	Conflict with other devices on COM port eg. a mouse	Ensure the fermenter COM port is not shared - check Control Panel settings in Windows
Error opening com port Message-box appears	COM port settings incorrect	Check in Peripherals dialogue box (Extras, menu, devices sub-menu)
	COM port not existing on this computer	Try different com-port
	Conflict with other devices on COM port eg. a mouse	Ensure the fermenter COM port is not shared - check Control Panel settings in Windows
Logging but no Control	Parameter not set for this	Click remote operation ON in the Edit Measured Parameter dialogue.
	Fermenter settings are not correct	Set accept remote on the fermenter control panel.
No change in logged value	Backup value may be ON - look in Text view table	Click backup value OFF in the Edit Measured Parameters dialogue

6. Repair Items

6.1 Testing of Process Parameters - setup, calibration actuators etc.

The Sixfors can be thought of as a single container for measurement and control using at least 5 different operational sub-systems i.e. temperature, speed, pH, dissolved oxygen and foam/feed. This applies for up to six separate vessels: *see Section 2 for explanations of standard functions.*

Part of fault diagnosis and repair requires that you have a knowledge of how each process parameter is controlled and setup for normal operation.

This requires familiarisation with the section of the operating manual dealing with the U-DDC instrumentation. A short guide is included in Chapter 2 for testing on installation but more detailed information is required for fault diagnosis.

If the Sixfors does not function at all on switching ON, check the cable fuse, laboratory earth trips and main fuse on the machine by the power indicator light. A fuse is also present on the motor controller pcb (**p**rinted **c**ircuit **b**oard).

Testing each parameter should follow a common pattern:

1. Ensure relevant probe is in place - look for signs of damage or eg. no electrolyte or physical dents,
2. Ensure correct services are switched ON eg. water
3. Ensure the parameter has a realistic setpoint for the test eg. to check the cooling valve, the temperature setpoint may be set to 5°C.
4. Check that control in Dead Band (BD) is switched to ON &/or the actual value for Deadband is near zero eg. <0.5
5. Check calibration of parameter before starting fermenter.
6. Check PID values for irregularities eg. large I value or no P value.
7. Start fermenter and ensure the parameter is turned ON
8. If pumps or valves are involved, make sure these are switched to Auto or have realistic manual set valves.
9. Monitor the action of controllers via the "Fermenter Overview" screen and LED indicators in the third section:
10. Use your senses for additional verification of actuators working eg. if the heater works, the vessel will get hot or you may be able to hear solenoid valves "click" on or off.
11. Some parameters take a long time to get to fully-operational condition eg. dissolved oxygen electrode needs at least 2 hours with power supplied. Don't take the first value as correct, especially soon after autoclaving.
12. Look at measured values and the raw A/D converter readings on the calibration page - do they roughly match eg. pH7= approx. 512 - an A/D reading of 100 or 1000 would suggest a fault (see addendum for more info.)
13. Unexpected values or odd behaviour from measurement probes can sometimes indicate an earth problem which may not show up on a conventional electrical test (eg. the dissolved oxygen electrode is very sensitive to a poor earth connection, leading to the value drifting high).

Default values for calibration and settings are provided within the EPROM for re-initialised cards and new installations - see separate addendum UDDC installation information sheet.
The next stage in fault investigation usually requires you gain access to the relevant actuator for more direct tests:
CHECK COMPONENTS BY SWAPPING WITH THOSE IN ANOTHER UNIT OF THE SAME TYPE IF POSSIBLE.

pH and Dissolved Oxygen Simulator

Calibration is best achieved using a certified simulator for pH and dissolved oxygen as this tests both the cable and amplifier (a suitable unit is made by the Valley Instrument Co Inc. of Exton, PA. USA) If calibration is successful using the simulator, incorrect readings can then almost certainly be attributed to a faulty probe or earthing problem.

A simulator can be used for temperature also but it is often cheaper and easier to carry a spare Pt-100 sensor known to be calibrated properly (ice water and boiling water provide 2 certain reference points at normal altitudes and atmospheric pressures).

If you do not have access to a simulator, useful tests can still be performed on site.

LED INDIC-ATOR	RELATES TO THE ACTION OF:
	Motor
	Acid Pump
	Base Pump
	Feed Pump
	Reserved
	Reserved
	Cooling Valve
	Heater
	Overtemp always ON
	24V Power always ON

Indicator LEDS in the Base section of the Sixfors

6.2 Removal of Covers -Main Sections of the Sixfors

The base unit of all Sixfors contains the following

Bottom Section rear:

1. 3 panels held by 4 screws each (flat head)
2. For left & right panels lift reagent bottle platform out of the way by lifting back and pulling backwards at an angle of approx. 30° to release front lugs
3. Remove panel(s)
4. The middle panel is "popped out" by moving it slightly left and pulling out and rightwards to get it free of the instrument support struts. This panel is replaced first

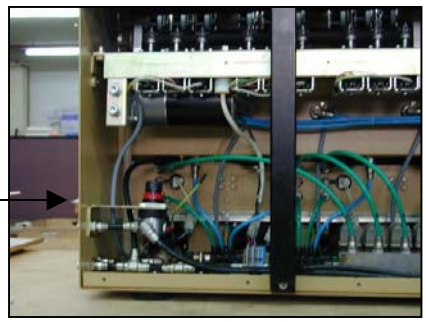
You have access to:
Left Side:

- Water outlet

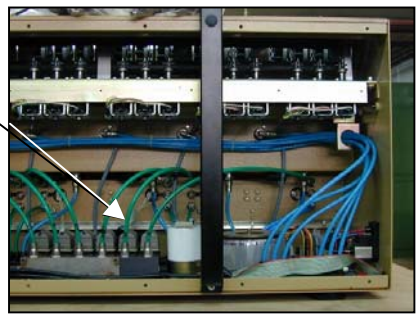
Middle:

- Solenoid valves x6 for cooling water

- Pcb cooling fans for each position



Bottom Section - Left rear



Bottom Section Right Rear

Bottom Section - lower front:

Undo the 10 screws along the length of the front bottom panel and lift forward and downwards gently to gain access to:

Bottom Section - upper front:

3. Rotameters for air flow control
4. Manual control valves for exit gas cooler water inlet
5. Three peristaltic pumps per station
6. .Peristaltic pump heads
7. Rollers x2
8. Solenoid valves to pull pump heads onto roller

Bottom Section front

6.3 Main pcb Housing, Screen and Keypad

From the front side you can gain access to:

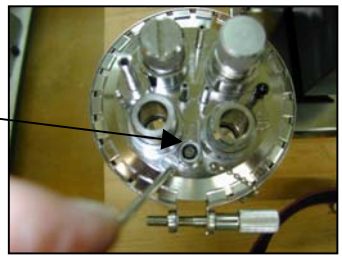
1. Memory card slot on left
2. RS232 serial port for printer/computer connection on back
3. Small instrument fan
4. Screen & keypad
5. Backlight & buzzer pcb

Top Section

The mains socket (main fuse), the hour counter, ID plate are at the right rear of the base unit.

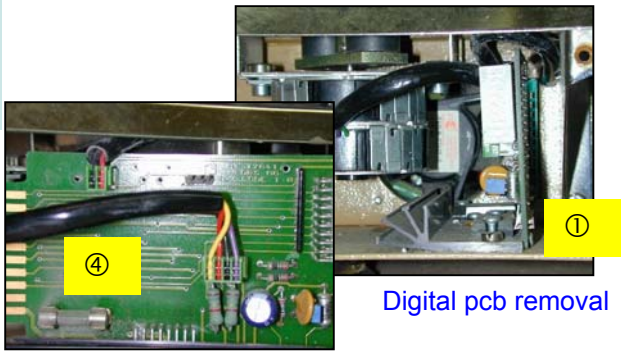
6.3 Exchange of Pt-100

1. Locate Pt-100 on vessel top plate (10mm port)



6.4 Exchange of the digital pcb in the lower, front base

1. Undo single screw (flat head) at front of pcb on heat sink
2. Pull pcb forwards **part way**
3. Remove 4 pin connector to the motor and the 2 pin connector to the small fan behind the pcb



Digital pcb removal

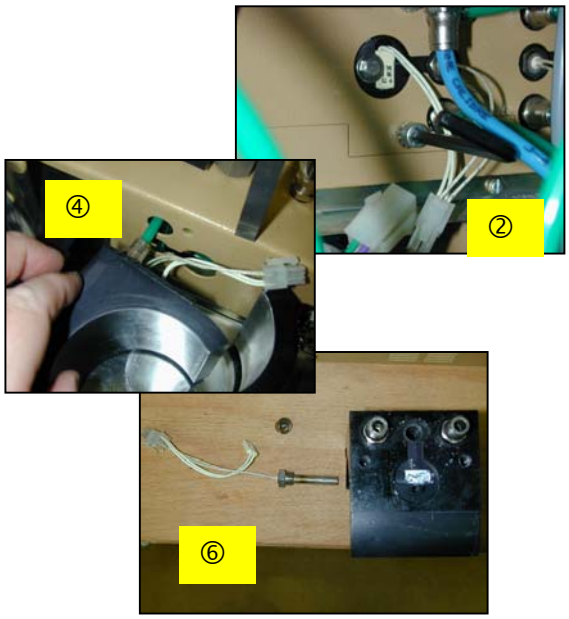
6.5 Exchange of Heating element & over-temperature sensor (supplied together)

The indication of a need for exchange will be:

1. No heating (maybe a dead short on the element also - check using a multi-meter).
2. The controller output indicates heating is called for
3. There is power entering and leaving the connections on the "digital pcb" to the heater

To exchange the heating element & overtemp. sensor:

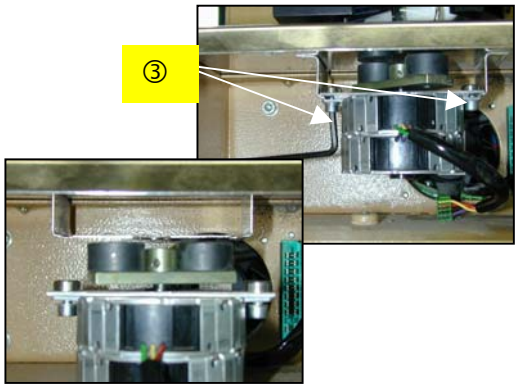
1) Remove rear covers
2) Disconnect heater/over-temperature sensor cable (white connector)
3) Undo the 2 x large screws (hexagon key needed) holding the support block to the base unit
4) Push the block forwards slightly from the back and push the heater/overtemp connector through.
5) Remove the green water tubing by pulling it backwards off the connector firmly.
6) The block is now free and can be upended so the heater and overtemp. sensor can be unscrewed and removed and replaced as necessary (Part no's 17648/22662).
7) On re-assembly, use a little heat conducting paste in the groove where the overtemp sensor is located.
8) When replacing cooling water pipes, check carefully for any leakage before replacing the covers.



Heating element & Ovetemp sensor

6.6 Replacement of the drive motor (17946)

1) Open front lower cover
2) Remove digital pcb
3) Loosen small screws (hexagon key needed) to left and right of the motor. Do not remove totally
4) Pull motor (on supporting bracket) forwards
5) Replacement is the reverse of this procedure



Removal of drive motor

Other electrical components can be exchanged:

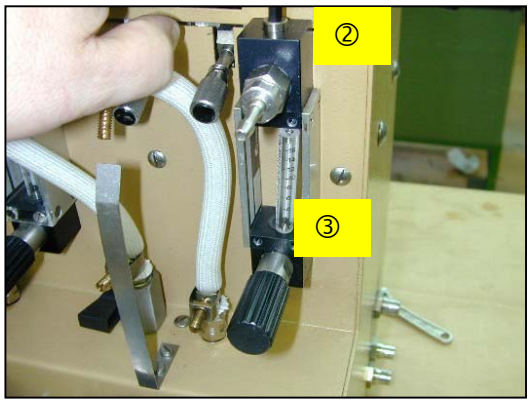
1. The 2-way magnetic cooling valves (group of six in middle) for cooling water distribution to support blocks
2. Mains power inlet socket and filter
3. Fuse 10A
4. Mains ON light and green cover
5. Operational hour counter
6. Transformer for 24V supply

6.7 Exchanging the rotameter inner cylinder

Calibration tables are included for each rotameter type in the Sixfors operating manual., The scale on the Vogtlin rotameters is calibrated in Newton litres/hr as standard and the type is given by the code after the manufacturer's name eg. V100-80.

To exchange the inner cylinder gauge glass (which is the actual variable area tube):

1. Undo the four screws (flat head) holding the transparent front cover
2. Undo the large screw at the top of the rotameter block using a hexagon key
3. The glass tube is now loose and can be replaced
4. Watch out that the front cover is the right way around when replacing as the screw holes are countersunk.



Rotameter glass loosened

6.8 Exchange of the operational amplifier pcb (17649)

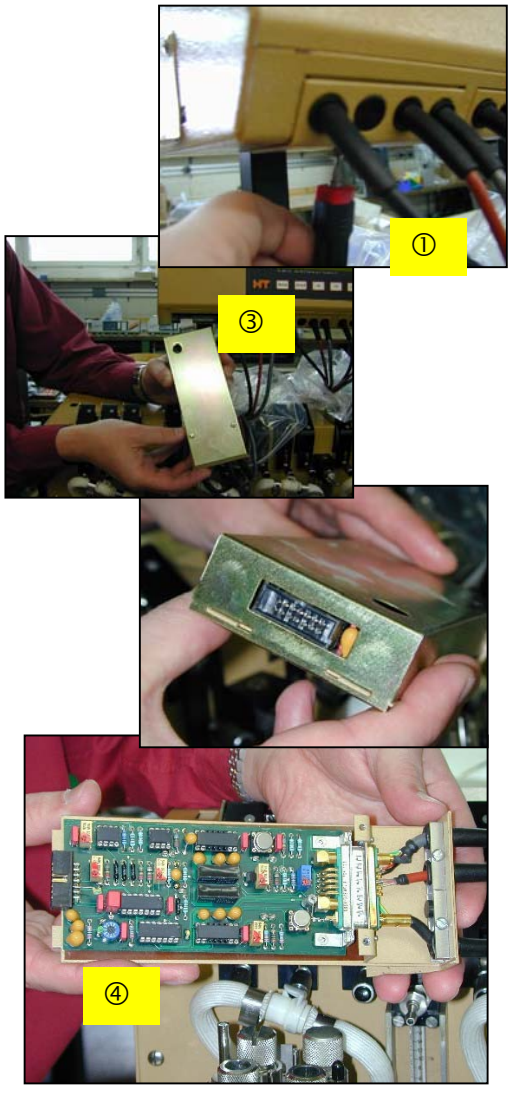
The purpose of the pcb is to digitise the analogue signals from the electrodes. Exchange may be necessary if eg. a sensor value cannot be calibrated properly even with a simulator. Check the connections from the electrode cap and cable wiring before reaching this conclusion!

To exchange the pcb:

1) Undo single screw (flat head) beneath individual op map module.
2) Pull forwards and down gently to partly withdraw module
3) Whilst supporting the module remove the ribbon cable at the rear (red wire to left hand end) to release the module
4) Undo the 2 screws (flat, cheese head) on top of the module casing. Pull back and then lift to expose the op amp pcb and cable connector
5) When replacing the cover, note the two lugs at the rear of the supporting part of the module which fit into slots in the back of the cover.

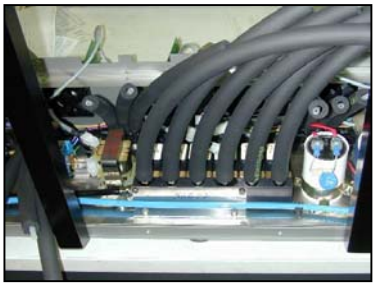
To adjust antifoam sensitivity:

1. Remove the Op amp board
2. Remove the top cover
3. Remove the ribbon cable to free the cover then replace
4. At the front of the module, where the cables are connected, is a blue potentiometer marked 1-9
5. When there is no foam, the diode above should be lit
6. To reduce sensitivity, turn the potentiometer away from the 9 until the light goes out
7. For the foam sensor in the vessel, ensure the black wire is connected to the vessel top plate and the red wire is connected to the probe itself.



Measurement module with operational amplifiers pcb

6.9 Exchange of an individual cooling valve (17801)



1. Remove the rear panels
2. Undo the two screws (flat head) holding the valve array to the right angled support bracket
3. Undo the electrical connector to the valves
4. Move valve for better access to the screws at the rear and remove the 4 small screws holding the valve body to the manifold
   Replace and reassemble

6.10 Exchange of peristaltic pump components.
The motor and drive belt for the peristaltic pumps can be accessed from the top rear of the base section. The single stepper motor drives two rollers which operates any (or all) of the 18 peristaltic pumps on demand. This is normally switched on permanently. Above this are housed the peristaltic pumps, the solenoid magnets which pull the pump heads onto the roller.

Access to the pumps & rollers:

1. Undo all pump clamping bars and lift out of the way
2. Undo a single screw at the back of the top section of the base unit and the 4 screws in front (all flat head)
3. Lever the top panel gently out of the way - lift towards the front then slide along to the left when free of the pump heads

Changing a solenoid (17955):

1. Remove the rear panels
2. Undo the two screws (flat head) at the top of each solenoid
3. Lift the solenoid forward to clear the claw of the lifting bar for the pump head
4. Pull down to free the solenoid
5. Cut or de-solder the wires to the solenoid
6. The block of three pumps for each vessel position can be disconnected using the white connector block below each pump grouping

Changing the pump drive belt (17814):

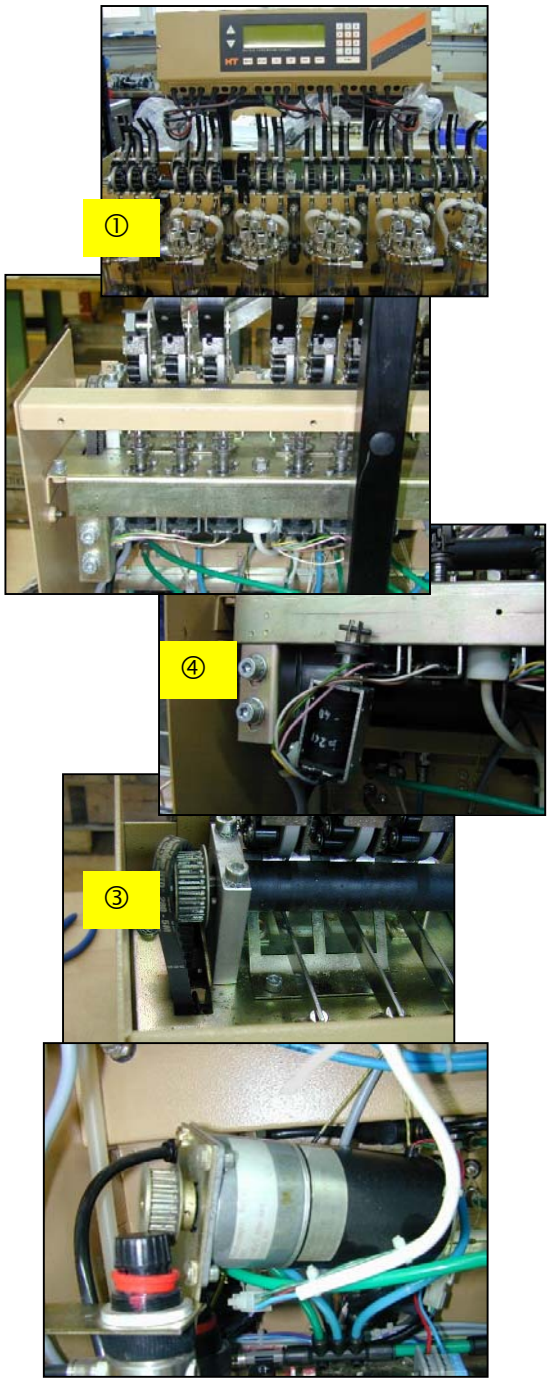
1) Loosen the two large screws holding the motor using a hexagon key
2) Lift the motor up slightly and support it
3) The drive belt is now loose enough to remove from the upper pulley

Removing the motor for the peristaltic pumps (17946):

1) Take out the two screws holding the motor
2) Remove the drive belt
3) Unclip the connector for the motor wiring
4) Cut the earth wire to the motor
5) The motor is now free for removal
6) Check the tension of the drive belt on replacing

There is no need for disassembly of the rollers other than in exceptional circumstances. Special instructions are in an appendix to this manual and an outline is given below.

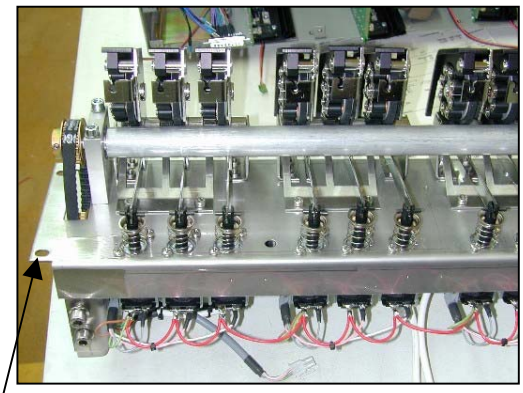
The rubber used for providing friction is now located on the pump heads and can be simply pushed off the individual roller and exchanged as necessary. This requires NO disassembly of the pump head system.



Pump motor without drive belt

Exchange of the roller bars.

1. Remove pump cover at the front
2. Remove rear panels
3. Loosen the two large screws holding the motor with a hexagon key (do not remove) and slide the drive belt over the top pulley to release it
4. Remove the screws holding the top of the supports for the rollers in the left, middle and right positions



so the drive belt can be slipped over the top pulley

5. Remove the 4 large screws (2 left, 2 right) with a hexagon key to allow the whole pump support frame to be lifted away. Place on the bench for further dismantling.
6. Remove the screws in the support frame (2 in each frame) for holding the individual group of three pumps.
7. Only one side need be removed to allow the pump heads to slide out individually.
8. Remove the relevant pump head and replace as necessary.
9. Reverse the procedure for re-assembly.

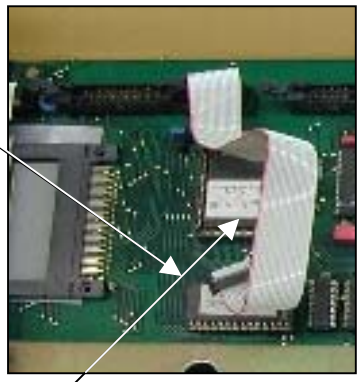
6.11 Removal of Top Cover & Main pcb Modification/ Replacement of Master Units

1. Remove memory card
2. Undo 3 screws (flat head) at top and three at front of the instrument panel to release the top cover
3. Lift cover up and back gently to reveal the OP amp modules (the top cover can be carefully rested on the back of the instrument housing)
4. Remove all six Op amp modules
5. The main pcb is now exposed for simple work such as exchange of processor or EPROM

Replacement of EPROM (22025 Sixfors A21)

upgrading to eg. add an analogue box or other additional facilities.

2. The EPROM is located to the left of the large, square microprocessor chip located in the top third of the pcb.
3. Removal can be achieved using a chip extractor or by gentle leverage with a penknife blade or fine screwdriver - CARE.
4. Before placing the new EPROM in the empty socket check the pins are all properly aligned and, if not, gently press the side on the chip onto a hard surface to cause all the pins on that side to move inwards fractionally.

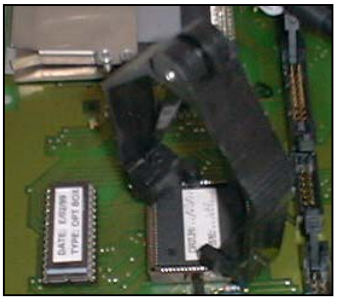


Location of EPROM & Processor

Replacement of the Microprocessor.

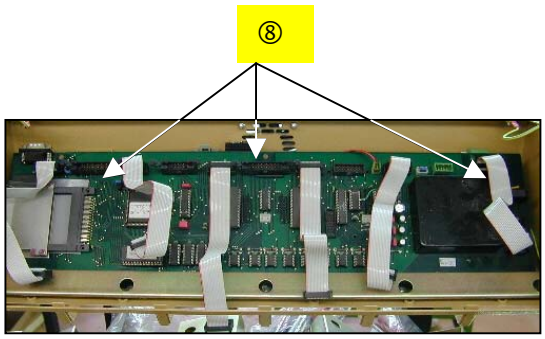
oriented.

Removal of Processor



Replacing the main pcb (21696)

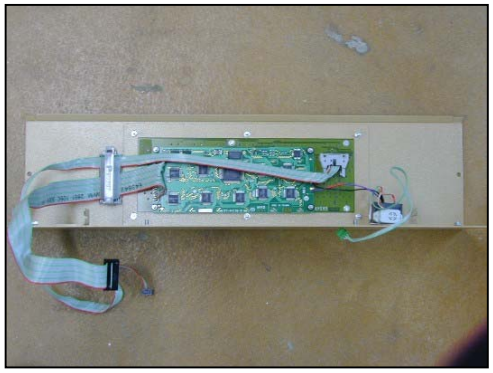
1. Note positions of all ribbon cables and connectors
2. Earth yourself for work on the main pcb
3. Take out the 2 ribbon cables and the 3 pin cable joining the screen/keypad unit to the main pcb
4. Undo the 2 earth leads on the front cover
5. Remove the screen and keypad section complete with the front cover. This can now be worked on separately.
6. There should now be free access to the main pcb
7. Remove ribbon cables for connection to the base, 24V power, and the connection to the small instrument fan at the rear of the instrument housing.
8. Undo the 3 screws (flat head) at the rear of the main pcb
9. Lift upwards and then back to remove the pcb



Replacing main pcb

6.12 Replacing Screen and/or Keypad (21557)

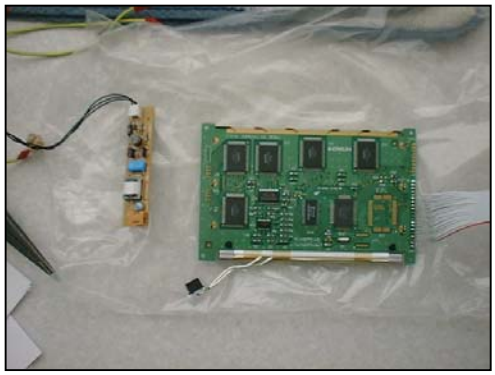
1. Place glass screen face down on a cloth for protection.
2. Undo the 6 small nuts holding the LCD screen pcb on right.
3. Retain all spacers and ceramic washers.
4. Undo the earth lead at the bottom of the housing.
5. Disconnect small connector at the bottom of the keypad pcb which links two white leads from the LCD pcb to the small, perpendicular pcb across the keypad area.
6. Lift LCD panel and remove/replace as necessary.
7. Remove the small perpendicular pcb by undoing two small retaining nuts. The keypad area can now be removed if required.



Screen & Keypad Interior

Re-assembly

1. Fit the earth lead to the lower left hand side of the housing
2. Put the 4 small spacers into place and replace the screen pcb.
3. Re-fit the perpendicular pcb and re-connect the white wires from the screen.
4. Fit and tighten the retaining nuts to hold the screen pcb into place.
5. Reconnect the earth leads.



LCD Screen & Light/Buzzer pcb (18335) removed

7.1 Linking to IRIS Software - Troubleshooting, Connection & Set-up

IRIS NT software provides data-logging, graphical display, archiving and supervisory set point control (SSPC) for Infors fermenters.

The software must be installed on a PC running Microsoft Windows 9x or NT4/2000. The link to the Sixfors is made via an RS232 serial cable which connects directly to a port on the main pcb.

Control of the type of output and communications protocol is handled by special settings available in the **"Printer/Comms"** menu option of the U-DDC instrumentation. Use of the Sixfors with a printer can also be controlled from here.

Details of installation of the IRIS software and operation with the Sixfors is given in the operating manual for IRIS NT. This section deals with the very basic physical set-up and simple troubleshooting for an installed system you may find already connected.

Troubleshooting for an installed system:

See chart in Section 5.8

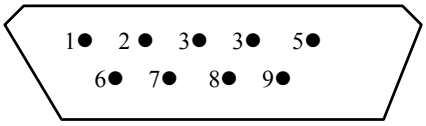
Connection (to a PC or a printer):

RS 232
On the side of the unit, a male, 9-pin connector is provided.

Pin Configuration

Pin 2 receive data (RD)
Pin 3 send data (TD)
Pin 5 Signal ground

Serial cable connections



Description	Computer Side 25 pins	Computer Side 9 pins	SDDC pins
Ground	7	5	5
Tx/Rx	3	2	3
Rx/Tx	2	3	2

No other connections are used by the SIXFORS. For a functional data connection, the cable must match this schematic. A cable (9 Pin female - 9 Pin female) is available from INFORS.
Should your serial connection be to a 25-pin socket, a standard 9-25 pin adaptor can be used to allow a direct connection.
It is possible to make your cable connections according to the table and schematic shown. **Note!** With 9-pin to 9-pin connecting plugs, the data lines 2 and 3 must be crossed.

If a printer is to be connected, this must be via a SERIAL connection or a serial to parallel converter must be used.
It needs no additional settings to be made. Also, when a terminal programme is used, it is not necessary to issue a command for data to be transmitted.

Setup:

1. Connect one end of the serial cable to the Sixfors
2. Connect the other end to the 9-pin serial port of the PC (Com1 or Com 2)
3. Connect the earth lead at one end to a good earth point eg. a casing screw.
4. Refer to IRIS manual for operation from this point.