HS500 HEADSPACE SAMPLER

Operating Manual

Printing History

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1. Introduction

Automation of laborious, tedious, repetitive tasks in analytical laboratories has received a great deal of attention in the last decade. One area that still has to catch up is the automation of sample preparation. Even though the analysis of a sample is a standardized procedure, sample preparation has been left with many uncertainties and variations. Analytical methods normally start as hand-methods. Automatic analysers have been developed, but sample preparation and the loading of samples are still plagued with many uncontrolled variables, which hamper higher reproducibility and productivity.

CTC Analytics is making a substantial contribution to the areas of sample preparation and injection. The Headspace Autosampler HS500 has become the autosampler of choice for many commercial testing, pharmaceutical research and chemical industry laboratories. The HS500 provides a great deal of flexibility and fits onto practically all GC brands and models that have vertical injection ports. This hardware adaptability is combined with user selectable parameters, which provide full optimization of the injection method for each application. The basic parameters are sample volume, syringe flushing, syringe plunger speeds, and pre and post injection delays.

This manual is designed to:

- familiarize the operator with all the features of this versatile instrument
- indicate caution and warning where hazards and problems exist for the operator
- provide a clear terminology for the instrument to simplify communication with the support organization
- serve as a handbook enabling the operator to access the complete range of the instrument's programmability and to perform service and maintenance functions.

Note: If a special software option has been purchased, check supplement to this manual!

The HS500 Headspace Sampler is built very ruggedly, and therefore has a very good service record. As long as the regular maintenance is done (see chapter 5 - Maintenance and Service, page 5–1), and the user of the instrument follows the instructions in this manual and those given by the qualified installer, a surprisingly high uptime level can be expected for many years. The safety of anybody coming in contact with this instrument has been a major concern of the designer and manufacturer.

2. Description

The HS500 has a modular design. The Injection Head, the Crossrail, the Instrument Base Unit with the vial tray drive and the electronics and the Control Terminal are the four main modules. Each module is described in this chapter. Numbers in brackets refer to positions in the figures in Appendix A.

The HS500 Headspace Sampler is available in two versions: The HS500-32 has a 32 positions vial tray and a six position incubation heater for temperatures up to 150°C. The HS500-50 has a sample capacity of 50 vials and a two position incubation heater with a unique sample agitation device and allows temperatures up to 120°C.

Injection Head

2.1 Injection Head

The injection head's function is to transport headspace gases from the sample vial to the GC injection port. The injection head carries the syringe cartridge and provides the two essential motions of the syringe. It lowers the whole syringe cartridge to let the syringe needle pierce through the vial septum until the needle tip is well within the vials' headspace. And it also provides for the syringe plunger motion that causes aspiration or dispensing of the gases. In addition it allows flush gas to enter the back of the syringe barrel, when the plunger is in its uppermost position.

The syringe is held in the **Syringe Heater (7)**.The needle tip of the syringe is held by the **Needle Guide (54)**. The needle guide is pushed all the way down by spring loaded **Needle Guide Rods (53)** when not pushed up by resistance, such as a vial cap or the injection nut of a GC. The syringe plunger is clamped into the **Plunger Holder (48)** and fixed by the **Plunger Fixing Thumb Screw (49)**. The flush gas line is connected to the heater cartridge by the **Flush Gas Connector (42)**. The electrical connection to the heater and temperature sensor are made automatically when the cartridge is inserted.

There are two mounting holes in the back wall of the injection head through which the injection head is mounted to the **Cross Slide (62)**.The two holes with the hex wrench screws become visible when the syringe carrier is moved up or down until the hole in the syringe carrier back wall lines up with one of the mounting positions.

The **Needle Guide (54)** is screwed into the **Sample Vial Holder Magnet (55)**. The holder magnet has the function of a sample vial detector and sample vial holder (electro magnet). If there is no vial in a position of the range to be processed, the instrument will automatically skip to the next vial. The sampler also checks if a vial really has

been transported and signals an error on the terminal if the vial is not at the target position.

The **Injection Head Top Cover (11)** is fastened with two Phillips head screws. Motor and electronic switch connections can be checked when removing that cover or by reaching in through the open bottom side of the head.

The head contains the syringe Z-motor and the plunger motor. It also contains two proximity switches and their electronics, one each for the syringe carrier and the plunger home positions.

There is only one electrical connection between the injection head and the Main Control Board. The **Flat Cable to Injection Head (14)** is supported by a **Metal Flex Band (13)**. The **Flush Gas Line (35)** connects the **Flush Gas Valve (38)** and the gas connector on the injection head.

Crossrail

2.2 Crossrail

The crossrail provides the movement along a tray and incubator row, the gas flush and injection positions. The **Cross Slide (62)** is driven by the **Cross Motor (21)** via a **Toothed Belt (67)**. One end of the crossrail has a simple metal **End Cover on Injection Side (57)**, on the other end the cover also provides for the mounting of the **Control Terminal (4)**. The **Dust Cover (56)** are attached to the two end covers of the crossrail and on each side of the cross-slide. These accordion dust covers have to be detached from the end covers for some of the cross motion adjustments. The control terminal can be mounted on either side of the cross rail to accommodate left or right hand injection. The crossrail contains the cross motion **Home Position Switch (66)** and **Inject Position Switch (58)**. For right hand injection the two switches change their function.

The crossrail is attached to the **Instrument Body Cross Member (78)** by 5 **Mounting Screws for Cross Rail (77)**. The Cross Member itself is fastened to the two **Side Panel (60)** by four **Cross Member Mounting Screws (37)**. The crossrail can be removed at either connection. There are five electrical connections between the crossrail and the instrument main body: from the Main Control Board a **Flat Cable to Control Terminal (81)**, a **Flat Cable to Injection Head (75)** fixed by a **Flat Cable Bracket (16)**, two connections to the end position switches and one four wire cable to the **Cross Motor (21)**.

Instrument Base Unit

2.3 Instrument Base Unit

The black **Base Plate (59)** of the instrument also provides the mounting flange normally used to mount the instrument to an adaptor plate that interfaces with the GC top. The base plate has the vial tray motion (Y-drive) mounted to it. The **Tray Drive Motor (91)** hidden behind the **Back Panel (30)** of the instrument main body moves the **Sample Tray 32x10ml (5)** and the **Sample Incubation Heater 6x10ml (6)** (or **Sample Tray 50x10 ml (9)** only for HS500-50 version) in and out via a belt and worm gears on the right and left sides. The motion is transmitted to the **Cooling Plate (63)**, which is partially hollow to allow cooling fluid circulation to cool the tray and vials. The cooling inlet and outlet tubing is fastened to **Cooling Inlet (26)** and **Cooling Outlet (31)** on the instrument Back Panel. The lid of the **Sample Incubation Heater 6x10ml (6)** can be held back by the **Holding Magnet Incubation Heater Lid (HS500-32) (65)**, depending on the need to open the sample heater or not. The **Tray Home Position Switch (89)** is located inside the base unit. A small grey flat cable for the Tray Home Position Switch and a four wire cable to the **Tray Drive Motor (91)** are the connections between the Tray Drive Unit and the **Main Control Board (80)**.

The instrument main body provides the vertical carrying structure for the crossrail. It also houses all power distribution and most of the electronics. The inside of the body is accessible through a **Top Cover (29)** and a **Back Panel (30)**. These covers are fastened with Phillips head screws. Removing the top cover gives access to the front side of the **Main Control Board (80)** and the **Transformer (74).**

The Back Panel holds the **AC Power Connector (27)** with **Power Switch (28)** and **Voltage Selector (25)**, the **GC Interface Connector (19)**, the **RS 232 Connector (32)** and the **Parallel Connector for BCD Sample Number (18)** which is optional.

Control Terminal

2.4 Control Terminal

The operator communicates with the control program of the HS500 Autosampler via a control terminal.

Parameter values and messages are displayed on a two line liquid crystal display (LCD). On the first line, and sometimes at the beginning of the second line there is a description of the menu or the parameter. Values are displayed on the second line below the corresponding description. A selected parameter value (i.e. a value that can be changed) is displayed as blinking.

All input is done by using eight push button keys. The keys are arranged in two groups. On the left side there are four keys to access

different functions (UTL, MET, INJ and CLR key). On every function key there is a light emitting diode (LED). They are used to mark an operating state when constantly lit or that a key may be pressed when blinking.

Four keys labelled with arrows are used to input values. The parameter to be changed is selected by pressing the left arrow key (LEFT key) or the right arrow key (RIGHT key) until it is displayed as blinking. The value is increased with the up arrow key (UP key) and decreased with the down arrow key (DOWN key). If a low or high limit is reached, the value wraps around to the other end of the valid range. If a value having a valid range of 1 to 200 is 10 and should be set to 180, it is faster and more convenient to use the DOWN key so that the value wraps around to 200.

- Move selection (blinking value) to the left. Display scrolls horizontally if currently at leftmost value if more than one display is available, otherwise selection skips to the rightmost value.
- Move selection (blinking value) to the right. Display scrolls horizontally if currently at rightmost value if more than one display is available, otherwise selection skips to the leftmost value.
- Increment the selected value by the smallest increment when pressed once. Keep pressed to continuously change value - the longer the key is pressed, the greater is the increment.
- Decrement the selected value by the smallest increment when pressed once. Keep pressed to continuously change value - the longer the key is pressed, the greater is the decrement.
- UTL Access utility functions.
- INJ Start processing of samples - often also used to accept an input (YES, ENTER, OK).
- MET Access parameters describing the processing of samples.
- CLR Stop processing of samples - often also used to deny an input (STOP, NO, CLEAR, DISREGARD).

3. Installation

Unpacking

3.1 Unpacking

When unpacking, please check very carefully that all items listed on the packing list are included in the shipment.

Position the main body of the instrument on a flat table and go through the following check list.

Check that the instrument is set at 220V, 240V, 110V or 120V. The arrow within the small window on the AC power connection box (25) points to one of those settings.

WARNING:
Measure the voltage level on the outlet that you are using to power your instrument !

If voltage is below 240V or 120V, the instrument should be set for 220V or 110V. There is a little drawer in the AC power connection box that holds the fuses and the voltage switch element. With the use of a small flat head screw driver, the drawer can be pried outwards. The green square element can be pulled out and turned to select the correct voltage.

WARNING:
If you change voltage insert the appropriate fuse as indicated on the back panel !

Unpack the **Injection Head (1)**. Remove the **Syringe Heater (7)**. Push the **Cross Slide (62)** all the way to the opposite side of the control terminal. Take off the two mounting screws that are stored on the cross-slide front side. Keep one of the screws on the Hex wrench and line up the hole on the **Syringe Carrier (45)** with the upper hole of the back casing of the injection head. The two holes in turn need to be aligned with the upper hole on the cross-slide front and the **Injection Head Mounting Screw (44)** has to be pushed through and tightened to mount the injection head. Now slide the syringe carrier downward until the hole lines up with the lower hole in the injection head back casing. The second mounting screw can be inserted and tightened.

Unpack the sample vial tray and insert it into the **Cooling Plate (63)**. A vial with a crimp cap should be placed into the last position in row #1. Make sure the **Power Switch (28)** is in the off position. First plug the power cord into the instrument **AC Power**

Connector (27), then into the AC wall outlet. Turn on the power switch. The installed software version number is shown for some seconds. Then the instrument initializes all motors and the display shows the main menu (see 4.2).

Selecting Injection Side

3.2 Selecting Injection Side

Depending on the GC model, the autosampler is mounted on either the left or right hand side of the GC injection port. In some cases it's possible to set it up either way. But in other cases such as when the two injection ports are positioned front and back, the autosampler needs to be setup with the crossrail running front to back and the vial tray from left to right, so that both ports can be accessed. For this case an angle bracket may be used to mount the control terminal so that it is visible from the GC's front side. See special installation instruction for this case.

The autosampler can be setup with the injection point on the right or left hand side. To switch from one to the other side, some hardware and software changes are necessary.

The control terminal needs to be moved from one side of the instrument to the other. Then the **Home Position Switch (66)** (which has been the **Inject Position Switch (58)** before) has to be adjusted for proper alignment to vial position.

Two **Control Terminal Mounting Screw (33)** hold the control terminal to the **End Cover on Terminal Side (69)** of the crossrail. Loosen them and unplug the **Flat Cable to Control Terminal (22)**.

Take off the **End Cover on Injection Side (57)** and **End Cover on Terminal Side (69)** and swap their position. Also move the **Control Terminal End Cover (68)** to the other side of the control terminal. The flat cable for the control terminal is already installed to both sides of the crossrail. The flat cable connector not used needs to be stored in the provided **Socket for Unused Terminal Cable End (20)** on the back side of the crossrail. Plug the flat cable into the control terminal.

Selection of injection side, number of injection points and adjustment of home position switch will follow in paragraphs 3.4, 3.5 and 3.6.

Mounting on Gas Chromatograph

3.3 Mounting on Gas Chromatograph

The CTC HS500 comes standard with the instrument bottom plate extending into mounting flanges. In some cases the autosampler can be mounted directly onto the GC cover plate. In many cases it is advisable to use an adaptor plate that is specifically furnished by CTC Analytics or by its authorized representative.

Marking the Mounting Holes

3.3.1 Marking the Mounting Holes

In cases where the autosampler can be mounted directly onto the GC cover plate position the completely assembled autosampler on top of the GC, beside the GC injection port. Optimize the position of the autosampler in such a way that at least two, ideally all, flange mounting holes are resting on the GC cover. The crossrail, with the injection head mounted, has to be aligned with the injection ports of the GC. Mark the flange holes on the GC cover with a soft pencil. Take the autosampler off the GC top. Unscrew the GC cover. When taking the cover off make sure you follow all instructions in the GC manual. Before the mounting holes can be drilled into the GC cover, it is very important that you carefully inspect that the mounting bolts that will be used will not touch or push against any inside parts in the GC. It might be necessary to re-assess the exact positioning of the autosampler in order to avoid any physical interference between the mounting bolts and GC parts. Also at this point, it is important to assess the path of any interface wiring between the autosampler and the GC.

Drill Holes and Mount the GC Cover

3.3.2 Drill Holes and Mount the GC Cover

Once the holes are drilled, the autosampler should be mounted onto the GC cover before positioning the cover on top of the GC. For mounting, it's ideal to use a sturdy bolt of appropriate length and a serrated washer that is placed between the bolt head and the underside of the GC cover. Insert flat washers before the nuts are put onto the bolts.

Positioning the Autosampler

3.3.3 Positioning the Autosampler

Once the cover plate with the autosampler is mounted on top of the GC, the fine adjustments can be made. With the autosampler still off, position the injection head with the syringe mounted over the injection port. Manually push the syringe down until the syringe needle is as close to the injection port nut as possible without touching it. Should the position in the Y-direction (perpendicular to the crossrail) be off, you need to slightly loosen the instrument mounting bolts and move the instrument the needed amount in the Y-direction (make sure you move the instrument parallel to its square position). After properly positioning the instrument the mounting bolts need to be tightened. A proper positioning allows the syringe needle to smoothly penetrate the injection port at exactly the centre of the injection port hole.

Note: Make initial position adjustments without a syringe in place.

Setting System Parameters

3.4 Setting System Parameters

The selection of the setup parameters has to be done through the System Setup Program (see 4.6.1). Take the syringe off. Hold down the MET key on the control terminal while you turn on the instrument. You have entered the System Parameter and Adjustments level of the sampler program. The display shows SET PARAMETERS blinking (see Diagram 3). Push INJ to enter that option. SYRINGE SIZE is displayed on the first line of the display. The second line shows either 1000 µl or 2500 µl. In order to switch, the up or down arrow key will toggle to the other option. From the SYRINGE SIZE menu position use the right arrow key to get to INJECTION SIDE. Choose between LEFT and RIGHT corresponding to your configuration. Pressing right arrow again leads to NO OF INJ POINTS. If your GC has two injectors that are accessible by the autosampler choose 2. In case you chose 2 ports, push again the right arrow key to specify the position of the second port. For the inner port, a so called INJ PNT X-DIFF has to be entered. X-DIFF is the distance from the outer port to the inner port in 0.1 mm units.

The next three parameters let you choose the desired start condition for the autosampler. For several combinations of sampler and GC information about cabling and start parameter setup is available from your dealer.

Now you can leave SET PARAMETERS program by pushing CLR. The SET PARAMETERS line blinks again.

Adjustments in Cross Direction

3.5 Adjustments in Cross Direction

If you have changed injection side the home position switch must be adjusted. Even though the CTC Autosampler HS500 coming from CTC Analytics or an authorized dealer has been properly adjusted **double check this alignment**.

The adjustment is made on the cross home position switch. This switch is on the opposite side of the injection port side. The proper positioning is checked against the outermost vial position on the injection side in the first row of the sample vial tray.

Remove the top **Control Terminal Mounting Screw (33)** and slightly loosen the bottom screw. Remove the **Dust Cover Screws (34)** to get access to the **Home Position Switch (66)**. Push the right arrow key once. ADJ SAMPLE POS blinks. Push INJ to select this function and follow section 4.6.2. Then leave this function with CLR, push right key until ADJ INJECTION is displayed blinking. Again select with INJ, then adjust the injection point in cross direction by moving the inject position switch as described in section 4.6.6.

Adjusting Injection Depths

3.6 Adjusting Injection Depths

Your GC manual will indicate (either in the operating instructions or in some technical drawings) the optimum injection depth, i.e. the position of the needle tip in relationship to the top of the injection port. Follow 4.6.6 for adjustment. You may also adjust depth for sample pickup (see 4.6.3).

Preparing the Syringe Cartridge

3.7 Preparing the Syringe Cartridge

Make sure all 3 green **O-Ring Viton/PTFE (130)** are in place inside the **Syringe Heater Cartridge (117)**. The O-rings can be removed and treated or replaced. Put a **Flange Protection O-Ring (123)** over the **Syringe Glass Body with Flush Gas Sideport (122)**. Insert the **Syringe (125)**, without the **Plunger (124)**, from the top into the **Syringe Heater Cartridge (117)**. It's best to line-up the side hole in the syringe relative to the gas inlet inside the cartridge. Once the syringe is completely pushed down into the cartridge the threaded white **Syringe Retaining Nut (50)** needs to be screwed down onto the heater cartridge. Do not make it too tight (finger tight only!). Last insert the plunger.

Now the whole **Syringe Heater (7)** has to be inserted into the **Injection Head (1)**. Use the UTL function key to access the CHANGE SYRING function. Hit INJ to put the syringe carrier into a convenient position for the cartridge to be mounted. Moving from above, at a slight angle, aim the syringe needle through the white holding plate's hole and into the **Needle Guide (54)**. When the cartridge's square, red box rests completely on the white holding plate, the cartridge can be pushed at its top edge back into its snap-in holding fixture. Push the red **Flush Gas Connector (42)** down, no twisting is necessary. Turn the red **Plunger Fixing Thumb Screw (49)** to fix the syringe plunger head. Hit INJ again. The plunger is moved down until it mechanically stops, then the syringe carrier is moved to the reset position.

Warning:
Gastight syringes of that capacity have very tight plungers when new. After a short operating time at elevated temperature the plunger cap adjusts its diameter. Should the syringe be used later at lower temperatures the risk for leakage exists. The teflon cap never expands at lower temperatures. Therefore a particular syringe should always be used at the same or higher temperatures.

4. Operation

Overview

4.1 Overview

The operator communicates with the instrument software through the control terminal. In case a remote control operation is indicated, please read Chapter 6.

The **Control Terminal (4)** is an 8 key keypad with a two line LCD display. The keypad has two groups of keys, 4 function keys and 4 arrow keys. The structure of the software can be depicted as a horizontal arrangement of all the programmable parameters. Therefore, the left and right arrow keys give access to the individual parameters. Once the parameter is chosen the value itself can be changed with the use of the up and down arrow keys. For the horizontal arrows, the display will wrap around when the last or first parameter, for the vertical arrows when the maximum or minimum value is reached. The software diagrams in appendix B show this concept graphically.

The three function keys MET, UTL and INJ access particular segments of the software. MET gives access to parameters that define a complete injection method. It is possible to store up to 9 individual sets of parameters in method storage slots. UTL gives access to useful functions, e.g. cleaning a syringe. The INJ key triggers the start of a run, or is used as an ENTER key in some cases. It also enters a lower menu level in the System Setup Program.

The CLR key stops a run. On the different programming levels, the CLR key is also used to terminate a particular function and return to the next higher menu.

The operator has four access levels to the software after the instrument is installed on a GC:

- Method Execution (see 4.3)
  Start and stop of a run; select first and last sample position and repetitions
- Method Parameters (see 4.4)
  Affects parameters that can be different from method to method
- Utility Functions (see 4.5)
  For daily routine functions
- System Setup Program (see 4.6)
  Affects parameters valid for all methods, defines machine setup values and gives access to test procedures and adjustments

In order to reduce the risk of accidentally changing system parameters and adjustments, the system parameter portion of the software has a special access. Turn the instrument off, then hold the MET key down as the instrument is switched back on, to access the system parameter level. Once all parameters are set, the system parameter level can be left by pressing the CLR key.

When the main power is turned on, the HS500 enters the STANDBY state. In this state the sampling range and the method to process a sample are selected at the control terminal. The parameters describing the processing of a sample are stored in an injection method. By changing the method number, a different parameter set is recalled. The operator can change individual parameters of the selected injection method with the MET key (see 4.4).

The samples to be analyzed are prepared, and the vials put into the sample tray. Then the sampling range (FST, LST) is defined corresponding to inserted samples. After a clean syringe is inserted into the injection head the HS500 is ready for operation.

Pressing the INJ key changes the operating state from STANDBY to PROCESSING. The first sample is inserted into the incubation heater. The next sample number, the injection count for this sample and the injection method number used are indicated on the control terminal. The headspace of the sample is injected as soon as the incubation time has expired and the GC is ready. If the incubation time is longer than the GC cycle time several samples are inserted consecutively into the heater so that constant incubation time is maintained for every sample and the throughput of the analysis system is optimized.

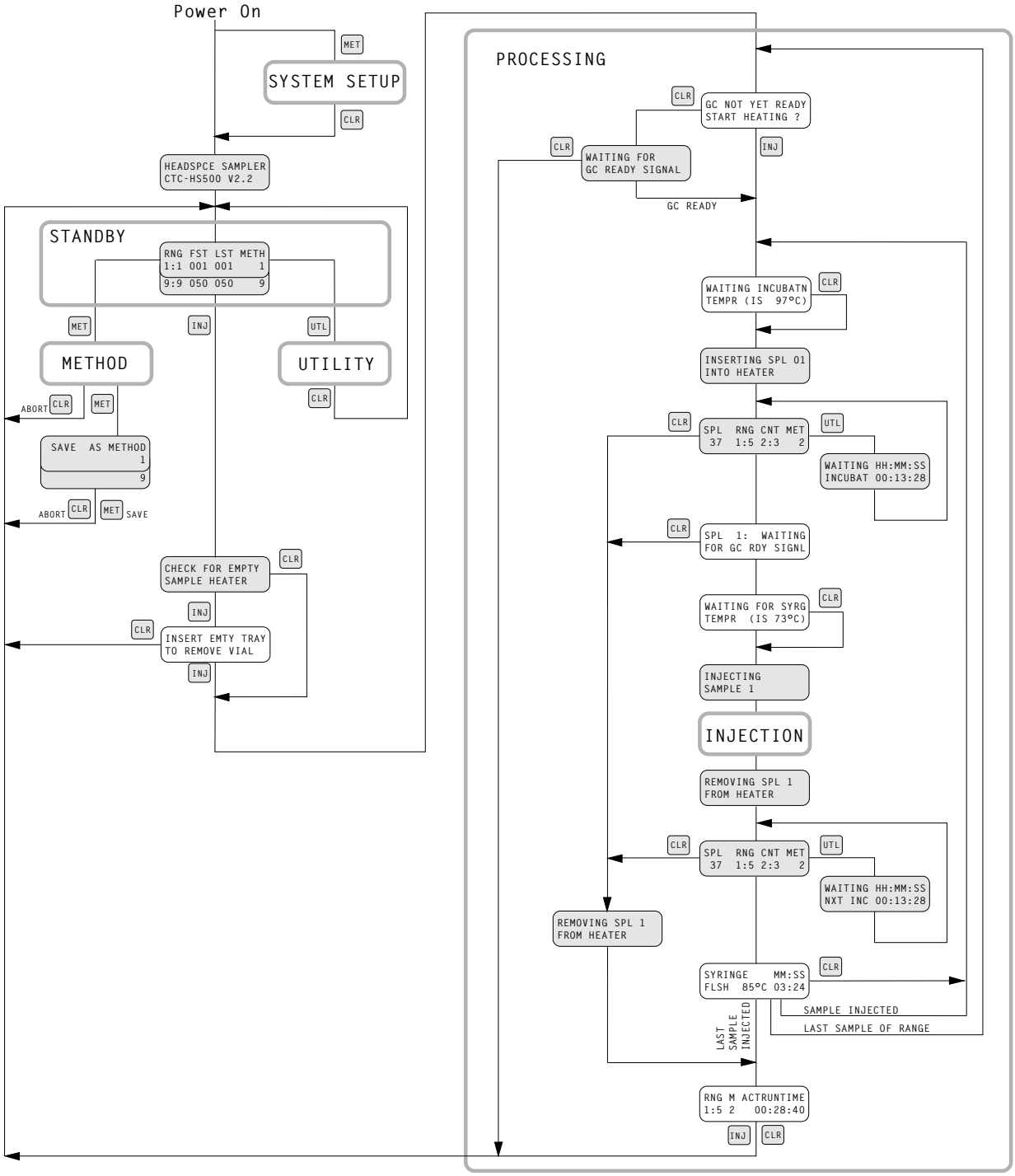
When processing the selected sample range, the control program detects and skips missing vials, so that no empty cycles are performed. After the sample has been injected the vial is removed from the incubation oven, the syringe is cleaned and the injection head is moved to the home position.

The injection cycle may be aborted in any phase by pressing the CLR key and confirming with a second keystroke. If the syringe is already contaminated or filled, it will be cleaned for the next sampling cycle.

The PROCESSING state is changed back to STANDBY after all samples of the selected injection range have been processed, or by pressing the CLR key twice while the autosampler is waiting for the start command.

Operating States 4.2 Operating States

In the following diagram, the different operating states are represented by circles. The possible changes from one state to another are marked by lines with the associated action next to it. State transitions resulting from host system commands are not indicated in this diagram (see chapter 6. - Remote Control).



Characteristics of the different Operating States:

INITIALIZING:

Entered when power is turned on or after terminating the System Setup Program. All movements are initialized to home position.

STANDBY:

Entered after initializing, or after an injection range has been processed. All key LEDs are off. On the control terminal screen the first and last sample number of the sampling range, the injection count per sample, and the actual method number are displayed.

PROCESSING:

Entered by pressing the INJ key. In this state the HS500 is ready to inject the next sample of the injection range as soon as the GC READY line gets active. The LED on the INJ key is turned on to mark this state.

UTILITY:

This state is entered by pressing the UTL key while in STANDBY state. Utility functions are available to. The LED on the UTL key is turned on to indicate the state; LEDs on INJ and CLR key are blinking to mark valid input keys (see 4.5).

CHANGE METHOD:

By using the MET key the parameter values of the actual method number are displayed and may be changed. All changes are only valid if this state is left by pressing the MET key a second time. If the CLR key is pressed, the actual method is left unchanged. The LEDs of both keys are blinking in this state. This state may be entered from the standby state (see 4.4).

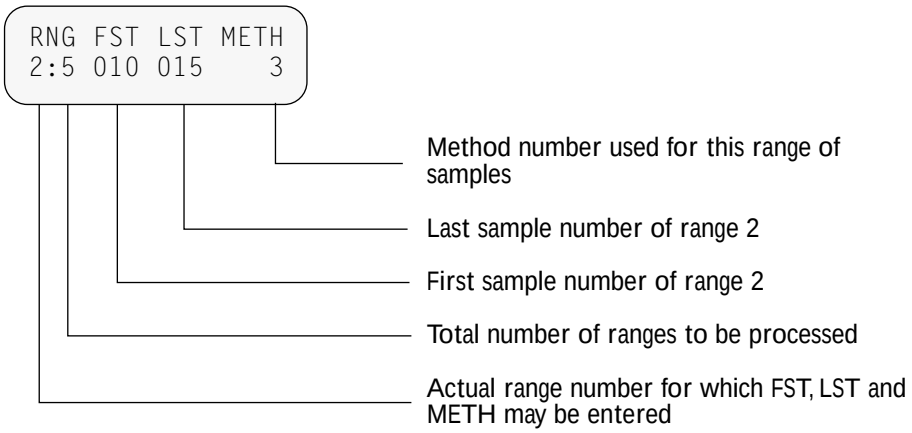
Method Run

4.3 Method Run

When you read this chapter, please use the diagram in chapter 4.2 to follow the description of the sample processing sequence.

The number of ranges used, the range of samples injected automatically, and the injection method for the actual range are shown on the control terminal and may be altered while the HS500 is in the STANDBY state.

Example of a control terminal display in STANDBY state:



The samples to be processed are divided into up to 9 ranges which are specified by the first and last sample number and the corresponding processing method number. How many ranges are actually used are selected with the second value under the RNG entry. In the example above 5 ranges are used and for range number 2 first and last sample number and the method number are displayed. Sample numbers for different ranges may be selected completely free - they can be different, overlapping or the same. The program checks if the last sample number is equal to or higher than the first one and adjusts the values accordingly. To make entry of values easier for many ranges the actual range number is incremented automatically when the right arrow key is used after selecting the method.

Using different ranges it is possible to assign to every range another method number. With this feature it is possible to change parameters (i.e. incubation time, injection volume, injection port) within the processing of one sample tray without operator intervention. Using the possibility of method copy this allows easy method optimization.

All parameters specifying how a sample is processed and injected are stored in 9 different methods. A whole parameter set is recalled by selecting only the appropriate method number. With this feature different injection methods for routine analysis are selected just by

choosing the corresponding method number. The user does not have to worry about programming a method before each run.

Before the HS500 is ready to automatically inject a range of samples, the following steps described in the previous chapters have to be done:

- Prepare samples, cap and insert vials into the sample tray
- Select sample ranges and injection method for each range (see above)
- If necessary set the processing parameters of the selected methods (see chapter 4.4 - Method Parameters)
- Insert syringe into heater and heater into the injection head (see chapter 3.7 - Preparing the Syringe Cartridge)
- Clean syringe by starting a cleaning cycle (see chapter 4.5.3 - Clean Syringe)

To start processing of samples the INJ key is pressed. The operating state is changed from STANDBY to PROCESSING and the LED on the INJ key is lit to indicate this state.

First the incubation heater is checked against vials left in the heater from a previous run. This should never happen in normal operation unless the sampler is switched off during processing or a power loss has occurred.

```
CHECK FOR EMPTY
SAMPLE HEATER
```

If any sample vials are found within the heater, following warning message appears:

```
INSERT EMTY TRAY
TO REMOVE VIAL
```

A sample tray with the first 2 (HS500-50) or 6 (HS500-32) sample positions empty has to be put into the sampler. Press INJ, the vials left in the incubation heater are then moved back to the sample tray.

At the moment when you start the processing, the GC might not be ready yet. Because the sampler can not know how long it will take the GC to get ready, following warning message is displayed in this case:

```
GC NOT YET READY
START HEATING ?
```

The time it takes the GC to get ready may be used to incubate the first sample. Press the INJ key if the incubation time is longer then the GC startup time - the first sample will be inserted immediately into the heater. Otherwise press the CLR key. Following message shows that the GC Ready signal is not yet activated:

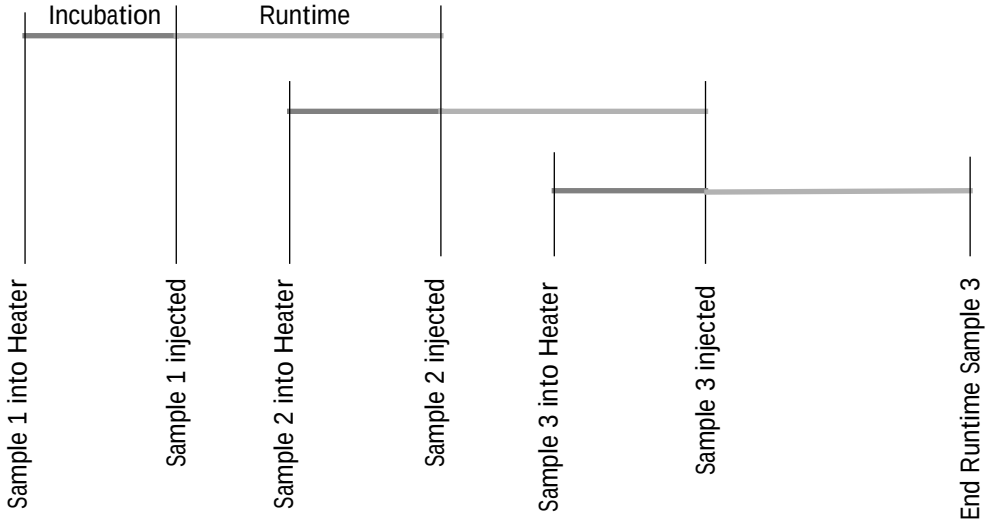
```
WAITING FOR
GC READY SIGNAL
```

The last condition which has to be satisfied is that the temperature of the incubation heater has stabilized at the selected level:

```
WAITING INCUBATN
TEMPR (IS  59°C)
```

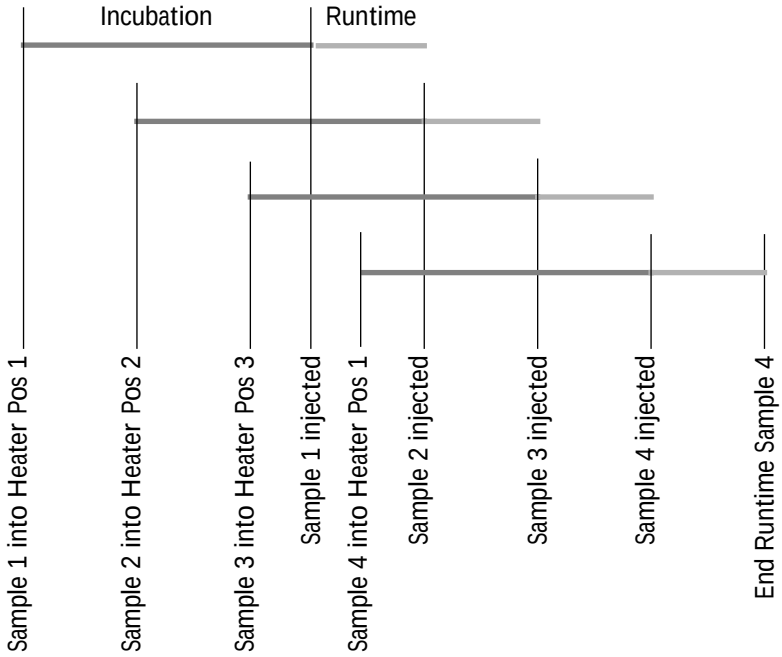
Now the first sample is inserted into the incubation heater. The HS500 maintains constant incubation time for every sample of a range. If more samples are inserted into the heater before the first one is injected depends on the relation between incubation time and runtime. Runtime means a complete analysis cycle including cool down until the GC is ready again. In the case that the incubation time is shorter than the runtime there is always only one sample incubated. But the next sample is inserted before the GC is again ready for the next injection so that maximum throughput of the system is achieved.

The diagram below illustrates the time staggered events when the incubation time is shorter than the GC runtime:

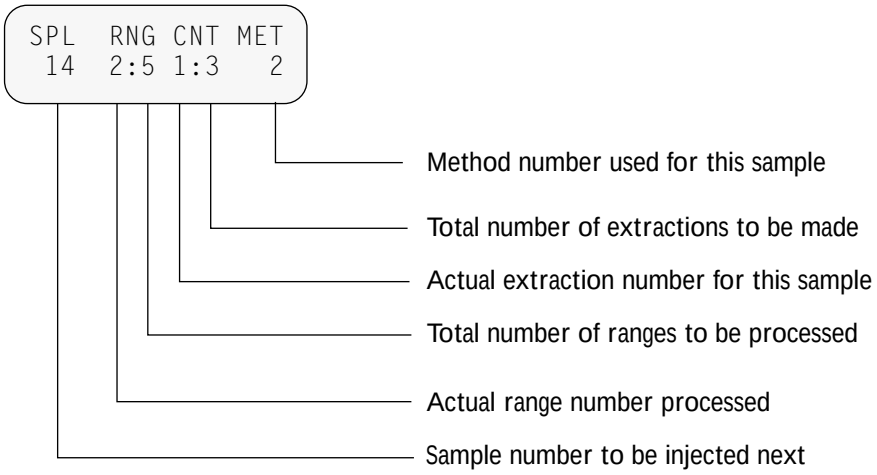


In cases where the incubation time is longer than the GC runtime the samples are positioned into the incubator on a time staggered sched-

ule - for the HS500-32 up to 6 samples and for the HS500-50 up to 2 samples. The diagram below depicts a case where the incubation time is longer than the run time by a factor of 2.5.:



During incubation of samples the processing display indicates the next sample number to be injected, the actual range number which is being processed, the extraction number for multiple extractions and the actual processing method being used:



As soon as the incubation time has expired and the START INJECT command is received the autosampler starts the injection cycle for the sample number indicated. The start command is either an activation of the GC READY input or a GC READY signal together with a start

command sent from the connected host system. The active mode is selected in the System Setup Program (see 4.6.1.5). The syringe temperature must be at the set level before sample is extracted. If long bakeout cycles with high temperature increase are selected, it is possible that following message is displayed until the set temperature is reached:

```
WAITING FOR SYRG
TEMPR (IS  73°C)
```

If for any reason the running injection cycle has to be stopped, press the CLR key. This doesn't stop the cycle immediately. The actual movement finishes, then the HS500 stops and the following message appears on the control terminal display:

```
CONFIRM "CLR"
TO ABORT CYCLE
```

Press the CLR key again to abort this injection cycle or proceed with the INJ key. If the cycle is aborted, the actual sample is skipped.

The remaining time until the next sample is injected can be displayed by pressing the UTL key.

```
WAITING HH:MM:SS
INCUBAT 00:13:28
```

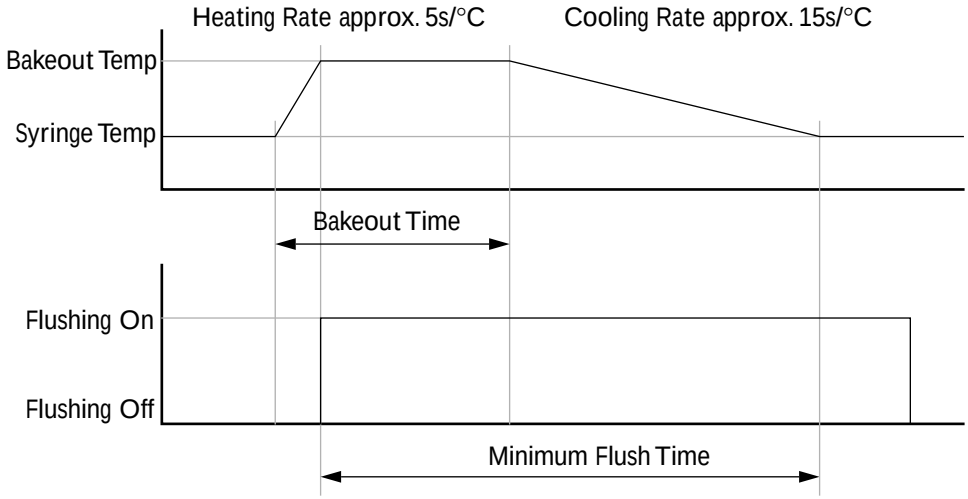
The display returns automatically to the processing display after some seconds.

As soon as the incubation time is complete and the GC is ready the heated gastight syringe removes the specified amount of sample from the vial headspace. To definitely avoid condensation in the syringe the syringe temperature should be kept a few degrees higher than the incubator temperature.

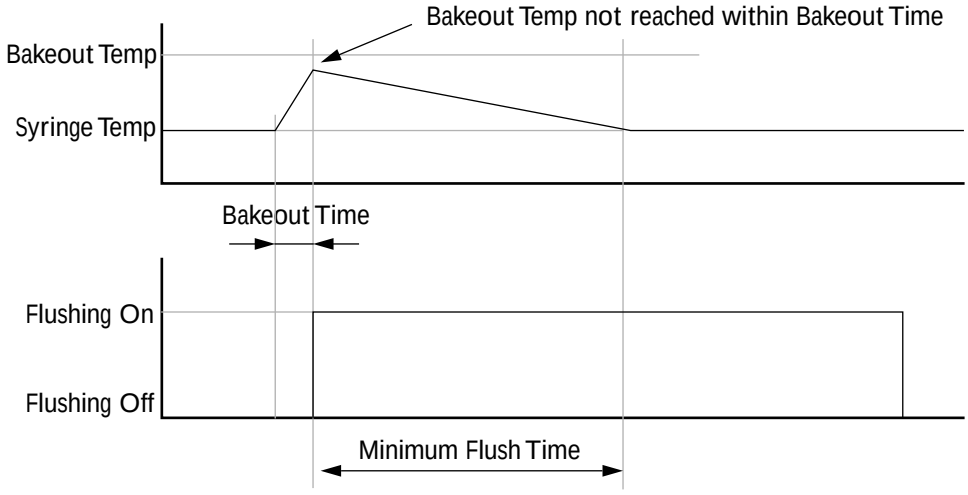
After the sample is injected into the GC, the sample vial is removed from the incubator and put back into the tray. The cleaning cycle for the syringe follows. It consists of flush gas flowing from the back of the syringe through syringe and needle and of an increase of the syringe temperature. For some special cases the syringe needle can be heated

in the optional **Needle Heater** to avoid any condensation in the needle. However, for most applications the needle is sufficiently cleaned and heated while in the GC injection port.

The diagram below shows the interdependence of the timing for gas flush and bakeout:

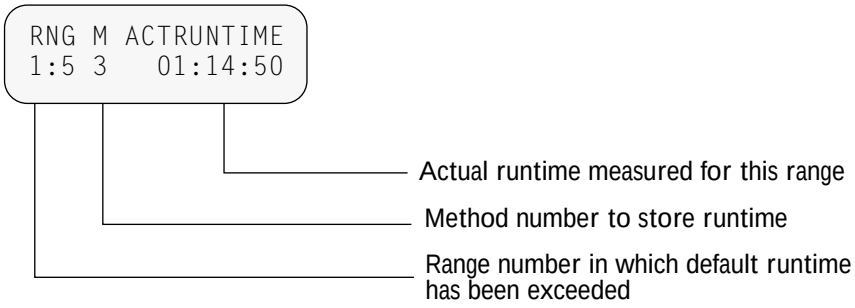


Syringe flushing starts when the bakeout temperature is reached and lasts at least until the normal syringe operating temperature is reached again. This minimum flush time is governed by the following parameters: temperature difference for bakeout, bakeout time and the speed of heating and cooling. Cooling rate depends on ambient and operating temperature - the value of 15s/°C is a mean value in the normal operating range. At very low operating temperature close to ambient temperature the cooling rate may drastically increase. The flush time also affects the minimum value for the run time and therefore can reduce the throughput on the GC. In case where the bakeout temperature cannot be reached within the selected bakeout time, the situation as shown below exists:



Should the total cleaning cycle time interfere with the next sample injection, the gas flush will be cut short. The bakeout time, however, will always be kept.

If for any reason the default runtime stored in the method is exceeded during processing, the following display appears after the last sample of the last range has been injected:



Press INJ to store the actual runtime within the method as the new default runtime. Press CLR to leave the method unchanged.

This display cycles through all ranges which had a runtime exceeding the default runtime of the used method.

Method Parameters

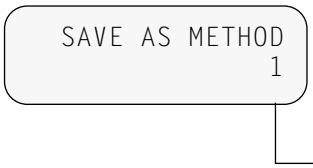
4.4 Method Parameters

An injection method is the set of all parameters specifying the sample incubation and the injection cycle. With this concept in mind, it is much easier to change from one application to another requesting a different processing of samples. There are 9 different methods available, which are maintained even if the power to the HS500 is switched off. Diagram 1, “Processing Method Parameters”, on page B–1 shows a graphic representation of all parameters accessible within a method.

Each of the 9 methods contains default values (see Table 1 in Appendix C). Even though the 9 methods are stored in a battery buffered memory, use Table 1, “Method Default Values”, on page C–1 to write down each method! In case of a software update it is possible that all values are reset to default.

The method to be used is selected in STANDBY state by setting the METH value for each range of samples. The individual parameters of the selected method are checked or changed by pressing the MET key. Then the different injection parameters are displayed. Use the MET key to leave the method change program if you want all changed values to be saved, or the CLR key to discard all changes made. The MET LED and the CLR LED blink to indicate the valid keys to leave this state.

After pressing the MET key to store all changes made, following message is displayed:



Method number to which the changes made have to be stored

By changing the actual method number it is possible to store the modified method to a different number. With this feature it is conveniently possible to generate methods which differ only in one parameter. Together with multiple ranges method optimization can be done with minimum programming effort.

Since there are many more parameters than would fit onto one screen, several screens are used to display the parameters. Pressing the horizontal arrow keys moves through the different screens.

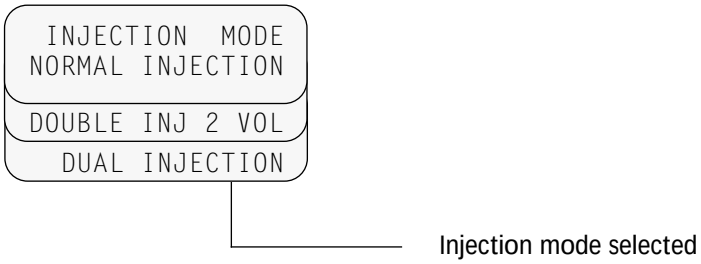
If no key has been touched during one minute the method change function is automatically aborted and any changes made have no effect. This is done for safety so that the HS500 can not be left for a longer time with a method opened.

To protect fully developed methods against inadvertent changes it is possible to lock all methods at the system setup level (see 4.6.1.11). When methods are locked it is possible to examine all parameter values but they can not be changed.

Injection Mode

4.4.1 Injection Mode

Different injection modes make the CTC HS500 Autosampler even more versatile. The Dual Injection Mode gives twice the throughput without adding a GC and a second autosampler. It may only be selected if two injectors are specified in System Setup Program (see 4.6.1.3)

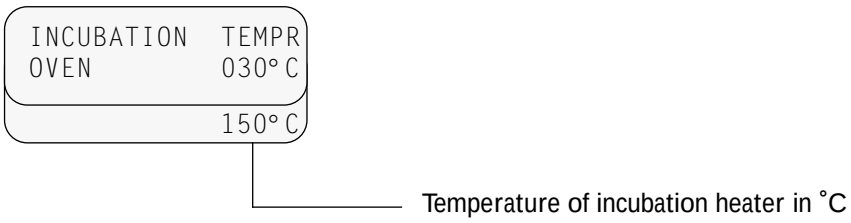


If DOUBLE INJ 2 VOL or DUAL INJECTION is selected some additional parameters are displayed which define the syringe cleaning cycle between the two injections. It may be advisable to make the cleaning times between injections shorter than for the normal cleaning cycle.
For DUAL INJECTION mode all odd vial positions (e.g. 1, 3, 5) will be injected into the outer port, whereas the even vial positions are injected into the inner port.
For DOUBLE INJ 2 VOL mode two consecutive injections will take place out of the same vial. The first injection will be made into the outer port and the second into the inner port.

Incubation Heater Temperature

4.4.2 Incubation Heater Temperature

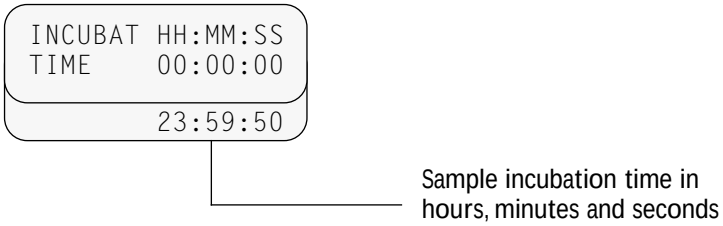
For any headspace separation, the appropriate incubation temperature is a most important parameter. Here the temperature is selected from 30˚C to 150˚C in increments of 1˚C. The agitator version allows temperatures up to 120˚. The lower limit is about 10˚C above ambient temperature.



Incubation Time

4.4.3 Incubation Time

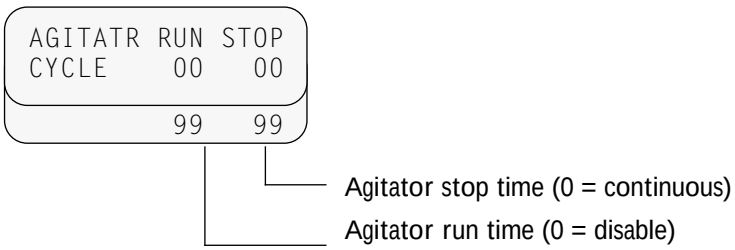
The incubation time in hours, minutes and seconds can be entered for a specific method.



Agitator Cycle

4.4.4 Agitator Cycle (only for HS500-50)

The sample vial is rotated within the agitator in a selectable interval. It runs in one direction for RUN seconds, waits for STOP seconds and then changes direction.

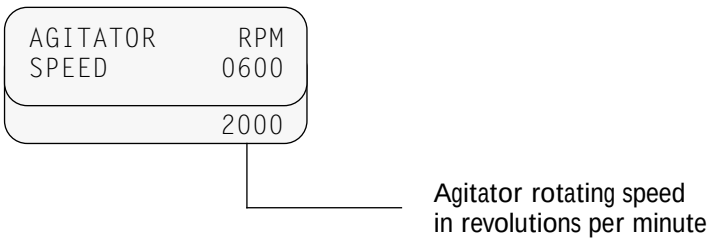


If RUN = 0, the samples are not agitated, if STOP = 0 the agitator rotates continuously in one direction.

Agitator Speed

4.4.5 Agitator Speed (only for HS500-50)

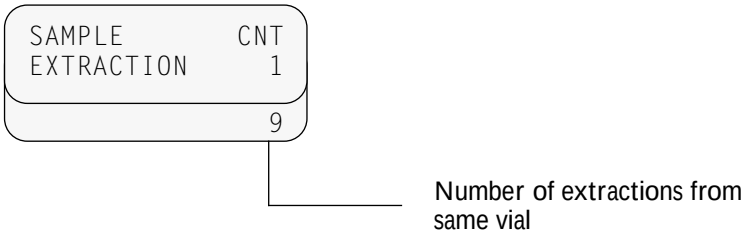
The agitator spinning speed may be selected in a wide range. It has to be set as high as possible, but not too high so the liquid does not move up to the septum. Check the right speed by inserting something below the vial into the agitator so the liquid level is visible. Run the agitator using the service function CHECK AGITATOR (see 4.6.17) using different speeds and monitor the liquid level.



Sample Extraction Count

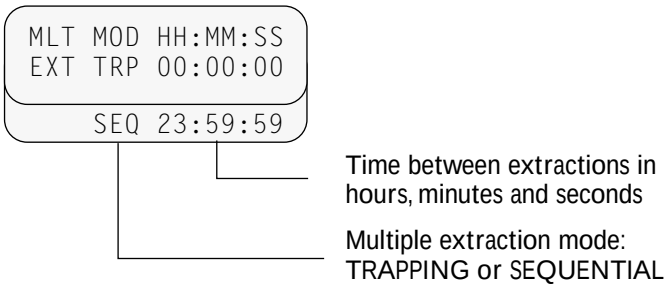
4.4.6 Sample Extraction Count

It is possible to take gas out of the same vial more then one time. With this parameter the number of extractions is selected. A count of one is the usual mode for headspace analysis. If a value greater than one is selected two more displays are available which specify the mode of multiple headspace extraction and some more parameters.



Multiple Extraction Mode

4.4.7 Multiple Extraction Mode (Sample Extraction Count >1)



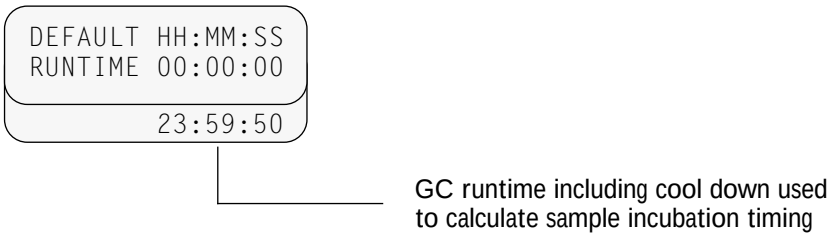
If sample extraction count is set to a value greater than one, two different modes of multiple headspace extraction are available: trapping of headspace gas in the GC for higher sensitivity. The sequential mode starts a separate GC run for each extraction. The results can then be combined in a regression analysis. For both modes the time between extractions is selected within this display. For trapping the minimum injection time difference is given by the sampler cycle time, for sequential mode the minimum is the GC runtime including cool down and sampler cycle time.

Default Runtime

4.4.8 Default Runtime

The Default Runtime is an estimated runtime that will be used to calculate the time at which a sample has to be inserted into the incubator so that constant incubation time is maintained. After a batch, if the default time is not in agreement with the actual run time, the display will prompt the operator to accept the actual runtime as future default time, or to stay with the default time that was entered before the run was started. It should be noted that in order to have consis-

tent and reproducible timing of incubation time the actual runtime should be established by running one sample ahead of your first batch. At the end of that run, accept and store the actual runtime by pushing the INJ button twice. If you guessed the runtime accurately, the unit will not prompt you to make the choice between the existing default and the actual runtime. Only in cases where the runtime varies from run to run it is advisable to enter and continue using a default time that corresponds to an average or maximum runtime.



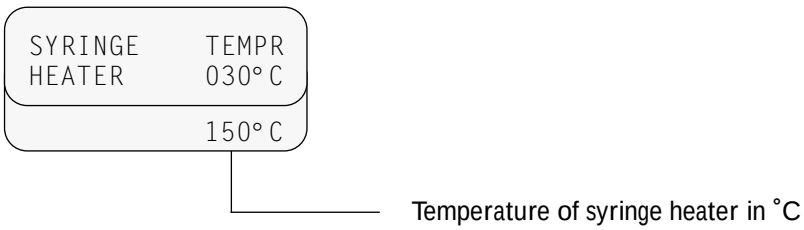
If the runtime is entered shorter than actual, the first samples have a longer incubation time than selected in the method. Longer default runtimes than actual runtimes lead to less throughput but do not influence the incubation time.

The minimum runtime that may be selected is dependent on the method parameters which influence the injection cycle time of a sample. These are for instance plunger speeds, filling cycles, syringe bakeout time and temperature.

Syringe Temperature

4.4.9 Syringe Temperature

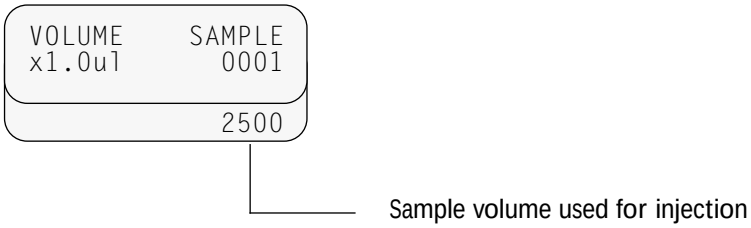
Since a heated syringe is being used to transfer headspace gases from a vial to the injection port of the GC, the temperature of that syringe can be closely controlled. The range is 30˚C to 150˚C. One degree is the smallest increment.



Sample Volume (Normal Injection Mode)

4.4.10 Sample Volume (NORMAL injection mode)

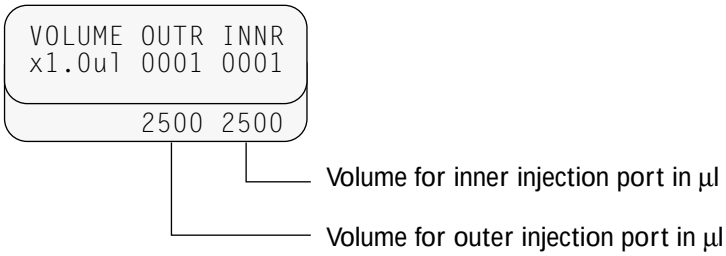
In this display the sample volume to fill the syringe before injection is specified. If a very small sample volume must be injected, multiple filling strokes ensure better reproducibility.



Sample Volume (Double/Dual Injection Mode)

4.4.11 Sample Volume (DOUBLE INJ 2 VOL and DUAL INJECTION mode)

If double or dual injection mode is used sample volume for outer and inner injection port may be specified separately.



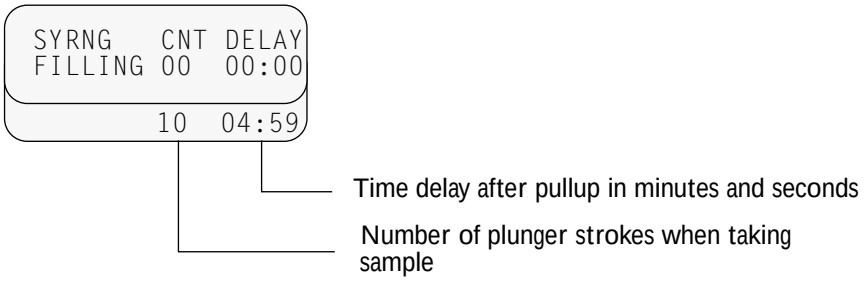
Syringe Filling Delay and Count

4.4.12 Syringe Filling Delay and Count

This parameter serves to control the filling of the syringe. In some cases using filling strokes (CNT) results in better reproducibility. The dead volume in the needle is completely mixed with the headspace gas giving less of a dilution effect for the sample pulled.

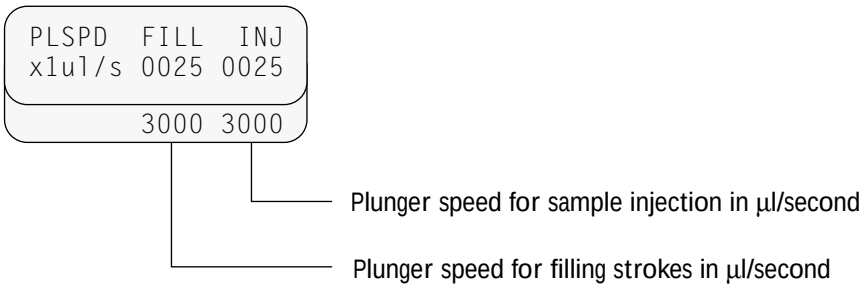
The delay function also acts as a pullup delay when the sample volume is pulled. It is active even though no filling strokes (CNT=0) are chosen. This is also an effective tool for high reproducibility, since the headspace gas in the syringe and needle will be able to completely

relax and reach an equilibrium with the gas in the vial headspace before the needle is pulled out of the vial.



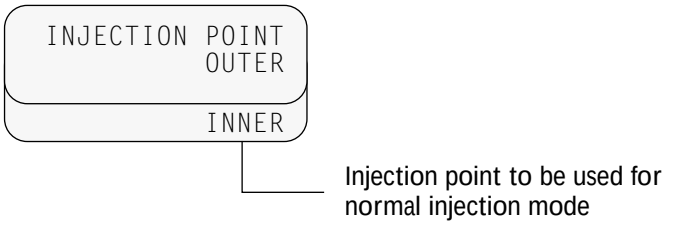
Plunger Speed 4.4.13 Plunger Speed

The speed of the plunger movement can be selected for the filling strokes and for sample injection.



Injection Point 4.4.14 Injection Point

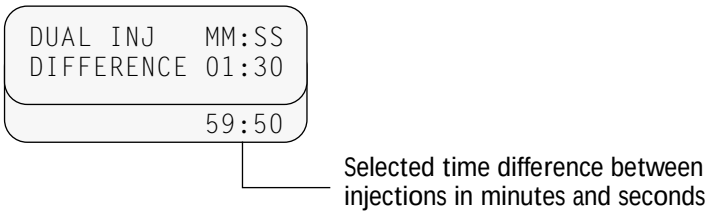
This parameter is only displayed for normal injection mode and if two injection points are selected in the service program. Switch between OUTER and INNER by using the UP and DOWN key.



Injection Time Difference

4.4.15 Injection Time Difference
(DOUBLE INJ 2 VOL and DUAL INJECTION mode)

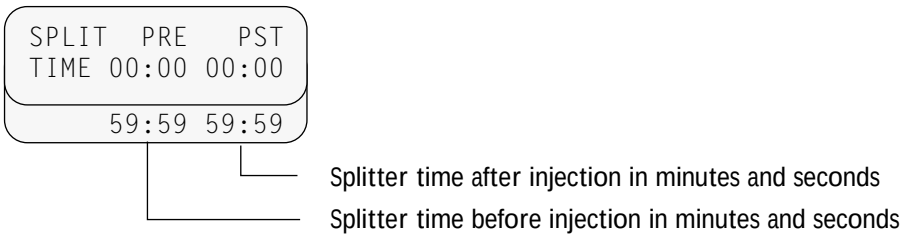
This parameter is used to fix the delay time between injections in double and dual injection modes. A fixed time difference between the two injections may be of interest where the peaks in the two chromatograms are compared to each other. The minimum time difference is limited by the cycle time of the sampler and is dependent on several method parameters.



Splitter Valve Control Times

4.4.16 Splitter Valve Control Times

The CTC-HS500 makes split/splitless injection possible with gas chromatographs not supporting this feature. An output which controls a valve is activated at a selectable time before injection (PRE), and remains activated until a selectable time after injection (PST). In the systems parameter program you can choose to have the valve engaged or disengaged during this interval (see 4.6.1.7).



If the PRE time is greater than zero and the HS500 receives the GC Ready signal (in a remote controlled configuration also a Host Ready command is needed), the splitter valve is activated at the selected time before injection. Because the time from the cycle start until the HS500 is ready for injection may vary, PRE time should be longer than the maximum injection cycle time. The cycle time until injection depends on Sample Volume (4.4.10/4.4.11), Syringe Filling Delay and Count (4.4.12), Plunger Speed (4.4.13) and Pre Injection Delay (4.4.17)

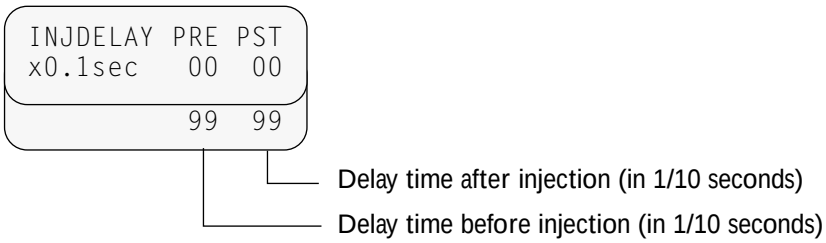
The POST time specifies the activated splitter time after injection. If it is longer than the default runtime, the splitter valve is deactivated at the end of default runtime.

The splitter function may also be used to control a valve in cold trap applications. For multiple extractions in TRAP mode the splitter output remains activated between the first and last injection.

Injection Delay Times

4.4.17 Injection Delay Times

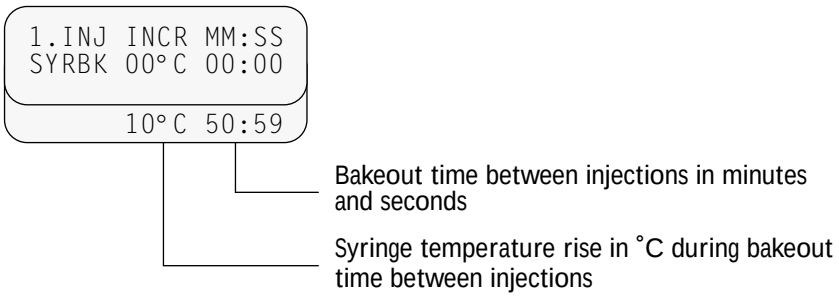
After the needle of the syringe is moved down into the injector of the gas chromatograph, it may be desirable to wait a certain time so that the needle warms up before the sample is injected (PRE) (hot needle injection technique). After the injection it is possible to wait for evaporation of the needle content before it is pulled out of the injection block (PST). Both parameters might be used for increase in reproducibility.



Syringe Bakeout after First Injection

4.4.18 Syringe Bakeout after First Injection (DOUBLE INJ 2VOL and DUAL INJECTION mode)

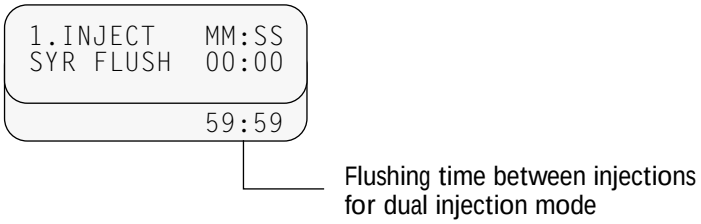
For double and dual injection it is possible to specify syringe flush time between injections and after second injections separately. This enables to keep the time difference between injections as low as possible. The minimum Syringe Flushing after First Injection (4.4.19) and the minimum Injection Time Difference (4.4.15) are influenced.



Syringe Flushing after First Injection

4.4.19 Syringe Flushing after First Injection (DOUBLE INJ 2 VOL and DUAL INJECTION mode)

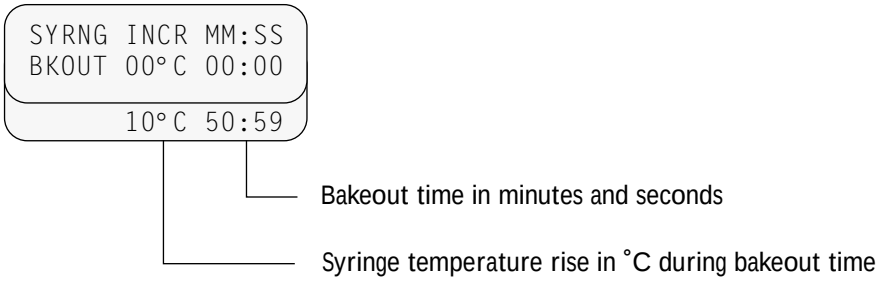
For double and dual injection it is possible to specify syringe flush time between injections and after second injections separately. This enables to keep the time difference between injections as low as possible. The minimum Injection Time Difference (4.4.15) and the minimum Default Runtime (4.4.8) are influenced.



Syringe Bake-Out Cleaning

4.4.20 Syringe Bakeout Cleaning

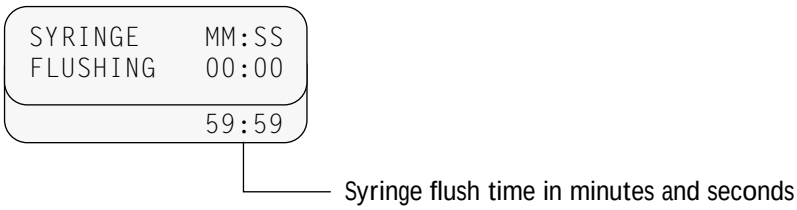
Besides keeping the syringe temperature 5-10˚C higher than the sample vial in the incubator, baking the syringe is the most essential part of keeping the syringe clean, and therefore cross-contamination low. Adsorbed volatiles are de-sorbed when the syringe temperature is raised to higher than the sampling temperature. The minimum Syringe Flushing (4.4.21) and the minimum Default Runtime (4.4.8) are influenced.



Syringe Flushing

4.4.21 Syringe Flushing

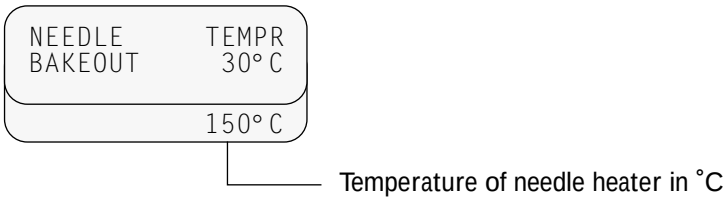
Part of an effective cleaning process for the syringe and needle is the gas flush option. Either helium, nitrogen or compressed zero-air is used. Should the syringe flushing time interfere with the next sample injection, the cleaning cycle will be aborted.



Needle Bakeout (Needle Heater Option)

4.4.22 Needle Bakeout (Needle Heater Option)

The syringe needle is the only element which comes into contact with the headspace gas and which is not enclosed within a heater. With this option the needle is inserted into the needle heater during the syringe cleaning time. This may be necessary for very special applications with high boiling compounds. See 4.6.4 and 4.6.5 for clean position adjustments.



Utilities

4.5 Utilities

Besides the standard operation of the HS500, several special functions are available. All these utility functions are activated by pressing the UTL key while in the STANDBY state. The functions to be executed are selected by using the RIGHT or LEFT key until the desired function is displayed on the control terminal screen. Several functions need parameters. Their value is selected by using the UP or DOWN key as usual.

While the sampler is processing samples the normal utility functions are not available. Instead pressing the UTL key displays the remaining incubation time of the next sample to be injected or the time until the next sample will be inserted into the heater.

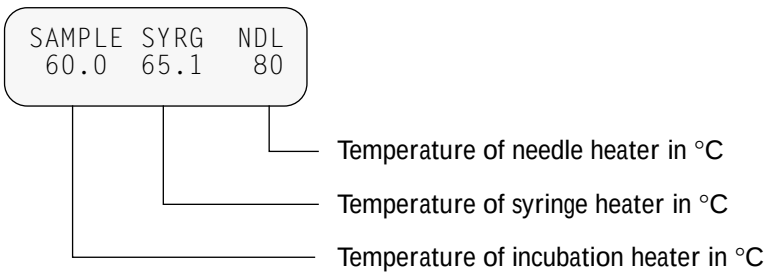
Diagram 2, "Utility Functions", on page B–3 shows a graphic representation of the utility functions. In order to get oriented about the location of the various functions, this figure is very helpful.

Temperature Display

4.5.1 Temperature Display

The temperatures for incubation heater, syringe heater and needle heater (if installed) are displayed.

- Press UTL key to enter utility functions.
- The CLR LED flashes and the temperatures of all heaters are displayed on the screen:



- The CLR key aborts this function and returns to the STANDBY state.

Syringe Change

4.5.2 Syringe Change

- At the home position the **Syringe Heater (7)** can not be removed because it is partially hidden behind the injection unit tube. Use this function to move to a convenient position and initiate a reset of the plunger zero position.

- Press UTL key to enter utility functions.
- Press RIGHT key to skip the temperature display function and to get to the CHANGE SYRINGE function.
- The INJ and CLR LEDs flash and the following message is displayed on the screen:.

```
CHANGE SYRINGE
INJ = POS SYR
```

- Pressing the INJ key moves the syringe drive to a position where the **Flush Gas Connector (42)** is accessible and the **Syringe Heater (7)** may be removed.The display shows following message:

```
CHANGE SYRINGE
THEN PRESS INJ
```

- Push the red **Flush Gas Connector (42)** upwards until the flush gas line is disconnected.
- Turn the red **Plunger Fixing Thumb Screw (49)** to the right to release the syringe plunger.
- Pull gently at the upper edge of the **Syringe Heater (7)** housing until the cartridge snaps off the vertical slider.
- Take the cartridge out.
- Unscrew the **Syringe Retaining Nut (50)**. Remove **Plunger with PTFE Tip (124)** and **Syringe Retaining Nut (50)**.
- Remove the old syringe with **Flange Protection O-Ring (123)**. Use insulating gloves, syringe may be hot !
- Check that the three **O-Ring Viton/PTFE (130)** inside the **Syringe Heater Cartridge (117)** are in place and in good condition.
- Follow section 3.7 "Preparing the Syringe Cartridge" to insert the new syringe. Do not forget to slide the **Flange Protection O-Ring (123)** over the syringe body to avoid cracking of the syringe flange.
- Pressing INJ adjusts plunger to zero volume and resets sampler to the home position.

Clean Syringe

4.5.3 Clean Syringe

To condition the syringe before a range of samples is processed or after a new syringe has been installed, this utility function can be used. It is also useful for measuring and adjusting the flush gas flow.

- Press UTL key to enter utility functions.
- Press RIGHT key twice to skip temperature display and syringe change functions to get to the CLEAN SYRINGE function.
- The INJ and CLR LEDs flash and the following message is displayed on the screen:

```
SYRINGE FLUSHING
INJ = START
```

- Press INJ to move the syringe to the cleaning position, move the plunger to the flush position and open the flush gas valve. The flush time may not be changed - it displays as 00:00 to indicate a “forever” condition.

```
SYRINGE    MM:SS
FLSH 065°C 00:00
```

- The CLR key aborts this function and returns to the STANDBY state.

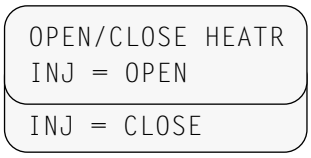
Opening Incubation Heater

4.5.4 Opening Incubation Heater (only for HS500-32)

The lid of the **Sample Incubation Heater 6x10ml (6)** is opened when the sample tray moves out and the **Holding Magnet (65**) is activated at the same time. This may not be done manually. Use this function if access to the heater vial positions is necessary.

- Press UTL key to enter utility functions.
- Press RIGHT key three times to skip temperature display, syringe change and syringe flush functions to get to the OPEN/CLOSE HEATER function.

- The INJ and CLR LEDs flash and the following message is displayed on the screen:



- Press INJ to open the heater. Pressing INJ again closes the heater lid.
- The CLR key aborts this function and returns to the STANDBY state.

System Setup Program

4.6 System Setup Program

Diagram 3, “System Setup and Maintenance Functions”, on page B–5 shows a graphic representation of the System Setup Program. In order to get oriented about the location of the various functions, this figure is very helpful.

Even though the different values are stored in a battery buffered memory, use Table 2, “System Setup Default Values”, on page C–3 to write down each value that is changed from default! In case of a software update it is possible that all values are reset to default.

To start the System Setup Program proceed as follows:

- Turn off main power switch.
- Press the MET key and turn on power again while still holding down the key.
- As soon as the following message is displayed the System Setup Program is started

(BLINKING)

- Release the MET key

The blinking indicates that this function has not yet been selected. To select the desired function:

- Press LEFT or RIGHT key until the desired function appears in the display (still blinking)
- Press INJ key to actually select the function. Either the function name remains on the display (blinking stopped) or a special function related message is displayed.
- Leave the function by pressing the CLR key. The function name blinks and another function may be selected by using LEFT or RIGHT keys.

The System Setup Program is abandoned by pressing the CLR key while no function has been selected.

The control terminal keys sometimes have special meanings depending on the selected function. The arrow keys are often used to start a movement in the corresponding direction, and the INJ key to store a position or start an action (like a computer’s ENTER key). The CLR key always terminates the selected function.

Set Parameters

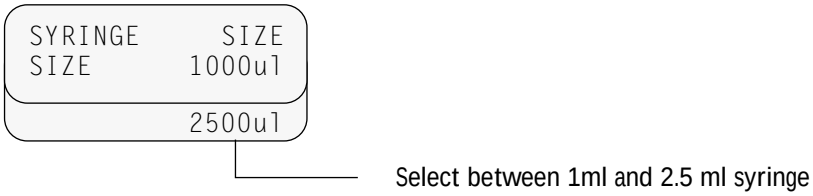
4.6.1 Set Parameters

The HS500 is adaptable to a wide range of gas chromatographs and applications. This makes it necessary to set some parameters to select the proper operating mode. After selecting SET PARAMETERS function by pressing the INJ key, the LEFT and RIGHT keys move through several displays to show the different parameters (see Diagram 3).

Syringe Size

4.6.1.1
Syringe Size

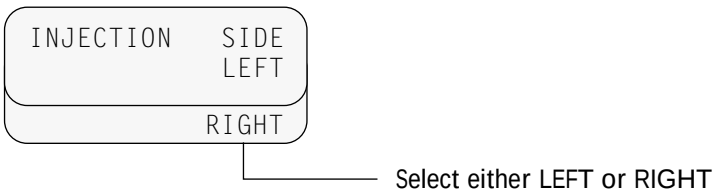
Two types of syringes may be used with the HS500 sampler: 1ml and 2.5 ml. The selection must be done on the system setup level because all method parameters are reset to default values when the syringe type is changed. This is necessary because several method parameters are dependent on the syringe size and have to be set within valid range (e.g. plunger speeds).



Injection Side

4.6.1.2
Injection Side

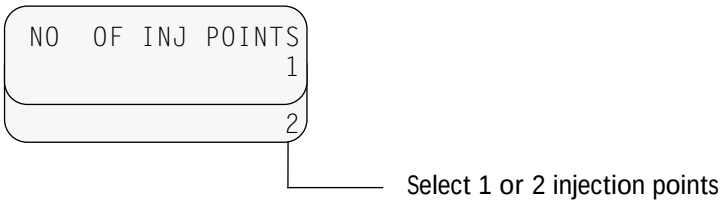
The HS500 may be converted to either left or right hand injection. The program must be set to the injection side that corresponds with the mechanical setup of the sampler in order to operate properly. See chapter 3.2 for instructions how to change the injection side



Number of Injection Points

4.6.1.3
Number of Injection Points

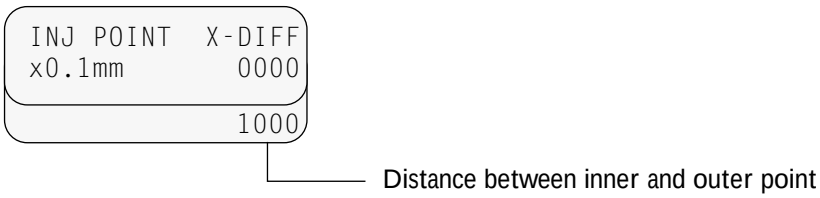
Sometimes it is necessary to alternatively inject at two different injection points of the GC. If two is selected for this parameter, this feature is enabled. The injection method then contains one additional parameter which selects the inner or outer point for injection. Selecting two injection points also enables double and dual injection mode (see 4.4.1).



Second Injection Point Position

4.6.1.4
Second Injection Point Position

This parameter is only displayed if NO OF INJ POINTS is two. Select the horizontal distance between the two injection points in tenth of millimeters.The position of the inner injection point is defined relative to the outer point. Only the outer point is adjusted by using the limit switch (see 4.6.6).

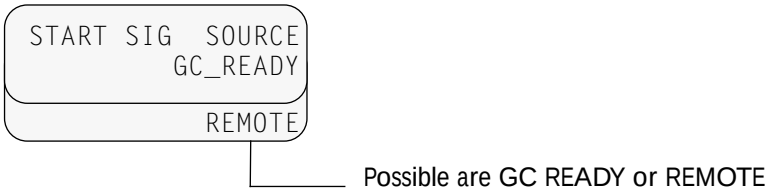


Start Signal Source

4.6.1.5
Start Signal Source

An injection cycle may be started by a contact closure or logic signal from the GC only or together with a message sent from a remote control system. Select the corresponding signal source as GC READY

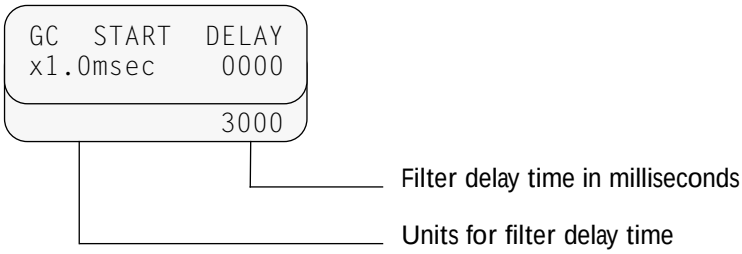
or REMOTE. If your installation does not make use of the GC Ready signal, short pins 7 and 8 at the **GC Interface Connector (19)**



GC Start Delay

4.6.1.6
GC Start Delay

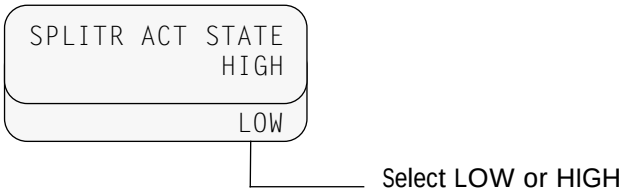
In case it is not possible to receive a clean GC-Ready signal, e.g. false signal spikes cause the autosampler to start an injection cycle, this option acts as an additional "filter". The selected delay time (10 msec - 3 sec) allows the autosampler to start an injection cycle only if the signal is stable for the time set.



Splitter Valve Active State

4.6.1.7
Splitter Valve Active State

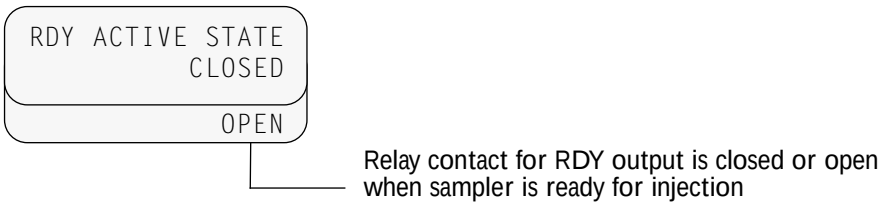
The state of the splitter valve output while the sampler is in STANDBY state is selected to be either activated (HIGH, 42V DC on splitter valve connector) or de-activated (LOW, output open).



Ready Signal Active State

4.6.1.8
Ready Signal Active State

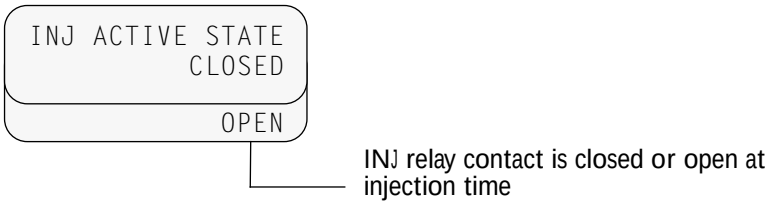
When the autosampler is ready to accept a GC ready signal a relay is activated (see chapter 4.2 - Operating States). Select if the ready state is represented by an open or closed contact.



Injected Signal Active State

4.6.1.9
Injected Signal Active State

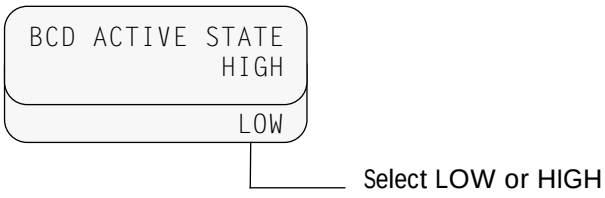
When the autosampler injects a sample it sends a start signal to the GC or data system. A relay contact is activated at injection time. Setting the value to closed means the contact will be closed at injection time.



BCD Output Active State

4.6.1.10
BCD Output Active State

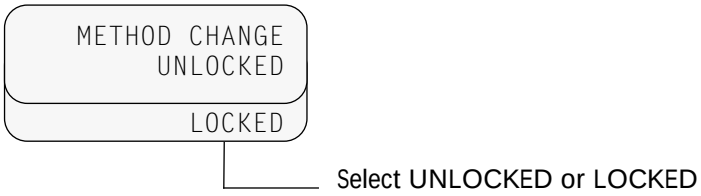
Select the logic polarity used for sending sample numbers through the BCD output (the optional BCD-board needs to be installed for the HS500-32). An active state of LOW means that a sample number of zero is represented as all zeros at the **Parallel Connector for BCD Sample Number (18)**.



Method Locking

4.6.1.11
Method Locking

For routine analysis it is advisable that the operator may not change methods at the normal operating level. If method locking is set to LOCKED method parameters can be examined but changes can not be saved.



Adjusting Vial Position

4.6.2 Adjusting Vial Position

Function display:

(BLINKING)

If the alignment of the syringe needle tip seems to be outside the center of the vial cap, sample vial position adjustment is necessary. The initial adjustment is done at the factory and should be double checked during installation, so normally the adjustment should be correct. However if the injection side has been changed or the **Home Position Switch (66)** has been replaced, adjustment becomes necessary. Adjustments must be done very carefully to prevent the needle from crashing due to misaligned home position switch.

After activation the following display appears:

The keys have the following meanings in this function:

- ← Move **Injection Head (1)** above sample vial
- → Reset **Injection Head (1)** to home position
- ↑ Reset sample tray to home position at row one
- ↓ Move sample tray out to last row
- MET Tray move test (abort with CLR key)
- CLR Terminate this function

Note: The description below assumes left hand injection side (see 4.6.1.2). If the instrument is set up for right hand injection, the LEFT and RIGHT keys and the home and inject position switches exchange their function.

4.6.2.1
Sample Vial X-Position

The distance between home position and sample tray is fixed. By shifting the limit switch at home position to the left or right, the position of the injection unit relative to the sample vial is adjusted.

1. Insert vial into sample tray.
2. Remove **Syringe Heater (7)**
3. Remove the upper **Control Terminal Mounting Screw (33)** and slightly loosen the lower one. Turn down the **Control Terminal (4)** to get access to the **Dust Cover (56)**.
4. Remove the two **Dust Cover Screws (34)** connecting the dust cover to the **End Cover on Terminal Side (69)**.
5. Move the **Injection Head (1)** to the vial by pressing LEFT key.
6. Measure the difference in X-direction from center of the **Sample Vial Holder Magnet (55)** to the center of the vial cap. Take care that only a proper crimped vial cap is used for this alignment.
7. Slightly loosen the hex screw and shift the **Home Position Switch (66)** for the difference measured in step 6.
8. Tighten the hex screw and move the injection head to home position by pressing RIGHT key and back to vial by pressing LEFT key.
9. Recheck adjustment as described in step 6, and repeat steps 7 and 8 until adjustment is satisfactory.
10. Mount the **Dust Cover (56)** and the **Control Terminal (4)**.

4.6.2.2
Sample Vial Y-Position

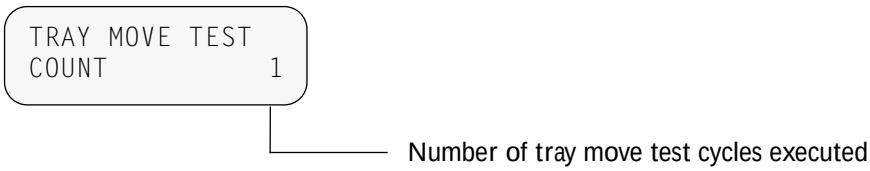
The sample vial position in the Y-direction is adjusted by shifting the **Tray Switch Activator (61)** on the left side of the sample tray. To get better access to the screw holding the switch activator, the **Cooling Plate (63)** is moved out by using the DOWN key. The procedure to adjust the activator is as follows:

1. Insert a vial into the sample tray.
2. Move the **Injection Head (1)** to the vial by pressing LEFT key.
3. Measure the difference in Y-direction from center of the **Sample Vial Holder Magnet (55)** to the center of the vial cap. Take care that only a proper crimped vial cap is used for this alignment.
4. Move the injection head to home position by pressing RIGHT key.
5. Move the sample tray to last row by pressing DOWN key.
6. Adjust **Tray Switch Activator (61)** according to the difference measured in step 3.
7. Move sample tray back to row 1 by pressing UP key.
8. Repeat steps 2 to 7 until the adjustment is satisfactory.

Note: The sample vial X-position may also be verified at the last sample position with the sample tray moved out to the last row.

4.6.2.3
Sample Tray Movement Test

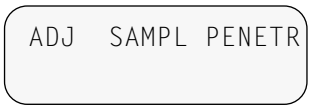
Sample tray movement may be tested by pressing the MET key. The following display appears showing the number of executed cycles:



Sample Penetration Depth

4.6.3 Sample Penetration Depth

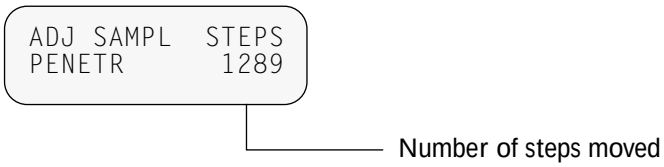
Function display:



(BLINKING)

For headspace analysis the needle tip has to be within the headspace area with enough safety distance to the liquid level. This point is adjusted by moving the needle down step by step while checking the needle tip position within the vial. This adjustment is done in a vial on the sample tray because the penetration into vials which are in the sample heater is not visible. When the desired point is reached the position is stored by pressing INJ.

Activate this function with the INJ key. Following display appears:



The keys have the following meanings in this function:

- ← Move **Injection Head (1)** above sample vial
- → Reset **Injection Head (1)** to home position
- ↑ Move **Syringe Carrier (45)** up to limit switch
- ↓ Move **Syringe Carrier (45)** down one step (keep key pressed for several steps to move)
- UTL Move **Syringe Carrier (45)** down one large step (about 3 mm)
- INJ Store current position of **Syringe Carrier (45)** in memory
- MET Reset **Syringe Carrier (45)** to limit switch and move down to stored position to double check the penetration depth adjustment.
- CLR Terminate this function

Note: The description assumes left hand injection side (see 4.6.1.2). If the instrument is set up for right hand injection, the LEFT and RIGHT keys and the home and inject position switches exchange their function.

Proceed as follows to set the sample penetration depth:

1. Insert vial into sample tray.
2. Move **Injection Head (1)** to vial by pressing LEFT key.
3. Move **Syringe Carrier (45)** down in large steps by using UTL key until the needle tip approaches the desired position.
4. Move further down by using DOWN key until the needle tip reaches the desired position (keep pressed for several steps to move). Be sure to have the needle tip positioned well below the vial septum and enough above the liquid level.

   Note: The **Syringe Carrier (45)** may not be moved up by single steps. If it is moved down too far, use UP key to reset the syringe to the limit switch and start again with step 3.

5. Press INJ to store the set position.
6. Check the set position by pressing the MET key. This moves the syringe up to the limit switch and then down to the stored position.
7. Write down the indicated value for the steps moved into Table 2, "System Setup Default Values", on page C–3.

Adjust Clean Position

4.6.4 Adjust Clean Position

Function display:

```
ADJ CLEAN POS
```

(BLINKING)

After the injection cycle, the syringe moves to the clean position. The clean position may be defined anywhere between home and inject position. With the optional **Needle Heater** installed, make sure that the **Injection Head (1)** lines up exactly with the needle heater to prevent the needle from crashing.

After activation of this function with the INJ key, the following display appears:

```
ADJ CLEAN  STEPS
POSITION    2716
```

Number of steps moved

The keys have the following meanings in this function:

- ← Move **Injection Head (1)** to clean position
- → Reset **Injection Head (1)** to home position
- ↑ Move **Injection Head (1)** to inject side direction (keep key pressed for several steps to move)
- ↓ Move **Injection Head (1)** to home side direction (keep key pressed for several steps to move)
- UTL Move **Syringe Carrier (45)** down to stored clean penetration position
- INJ Store current **Injection Head (1)** position in memory
- MET Reset **Injection Head (1)** to home position and back to stored clean position to double check the adjustment
- CLR Terminate this function

Note: The description assumes left hand injection side (see 4.6.1.2). If the instrument is set up for right hand injection, the LEFT and RIGHT keys and the home and inject position switches exchange their function.

Proceed as follows to adjust the clean position:

1. Remove the **Syringe Heater (7)**.
2. Move the **Injection Head (1)** to the clean position by pressing LEFT key.
3. Move to the left or right by pressing the UP or DOWN key, until the **Injection Head (1)** reaches the desired position.

   Note: Use the UTL key to lower or raise the **Syringe Carrier (45)** (acts as a toggle) to check the alignment of the **Needle Guide (54)** with the needle heater. Careful adjustment has to be done to prevent needle crashes.

4. Press INJ to store the position
5. Check the set position by pressing the MET key. This resets the **Injection Head (1)** to the home position and back to the stored position.
6. Write down the indicated value for the steps moved into Table 2, “System Setup Default Values”, on page C–3.

Adjust Clean Penetration

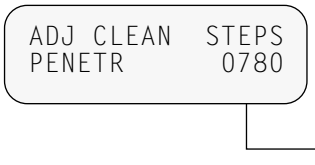
4.6.5 Adjust Clean Penetration

Function display:

(BLINKING)

This function is used to define the penetration depth at the cleaning position. The set position may be defined anywhere on the Z-axis. With the optional **Needle Heater** installed, the needle should penetrate as much as possible into the heater, so that needle bakeout (see 4.4.22) becomes most effective.

After activation of this function with the INJ key, the following display appears:



Number of steps moved

The keys have the following meanings in this function:

- ← Move **Injection Head (1)** to clean position
- → Reset **Injection Head (1)** to home position
- ↑ Move **Syringe Carrier (45)** up to limit switch
- ↓ Move **Syringe Carrier (45)** down one step (keep key pressed for several steps to move)
- UTL Move **Syringe Carrier (45)** down one large step (about 3 mm)
- INJ Store current position of **Syringe Carrier (45)** in memory
- MET Reset **Syringe Carrier (45)** to limit switch and move down to stored position to double check the penetration depth adjustment.
- CLR Terminate this function

Note: The description assumes left hand injection side (see 4.6.1.2). If the instrument is set up for right hand injection, the LEFT and RIGHT keys and the home and inject position switches exchange their function.

Proceed as follows to adjust the clean position:

1. Move the **Injection Head (1)** to the clean position by pressing LEFT key.
2. Move the **Syringe Carrier (45)** down in large steps by using UTL key until the needle tip approaches the desired position.
3. Move further down by using DOWN key until the needle tip reaches the desired position (keep pressed for several steps to move).

   Note: The **Syringe Carrier (45)** may not be moved up by single steps. If it is moved down too far, use UP key to reset the syringe to the limit switch and start again with step 2.

4. Press INJ to store the set position.
5. Check the set position by pressing the MET key. This moves the syringe up to the limit switch and then down to the stored position.
6. Write down the indicated value for the steps moved into Table 2, "System Setup Default Values", on page C–3.

Adjust Injection Point

4.6.6 Adjust Injection Point

Function display:

```
ADJ INJECTION
```

(BLINKING)

This function is used to adjust the outer injection position of the injection unit in X-direction and to set the penetration depth of the needle when injecting into the GC for both injection points.

After activation of this function with the INJ key, the following display appears:

```
ADJ INJ    STEPS
             1065
```

Number of steps moved

The keys have the following meanings in this function:

- ← Move **Injection Head (1)** to inject position
- → 1 Injection Point: Reset **Injection Head (1)** to home position
  2 Injection Points: move **Injection Head (1)** to inner point
- ↑ Move **Syringe Carrier (45)** up to limit switch
- ↓ Move **Syringe Carrier (45)** down one step (keep key pressed for several steps to move)
- UTL Move **Syringe Carrier (45)** down one large step (about 3 mm)
- INJ Store current position of **Syringe Carrier (45)** in memory
- MET Reset **Syringe Carrier (45)** to limit switch and move down to stored position to double check the penetration depth adjustment.
- CLR Terminate this function

Note: The description assumes left hand injection side (see 4.6.1.2). If the instrument is set up for right hand injection, the LEFT and RIGHT keys and the home and inject position switches exchange their function.

4.6.6.1
Injection Position

For safety reasons the injection unit is not moved to the injection point by counting steps. Instead, a limit switch is used to detect this position. Proceed as follows to adjust the **Inject Position Switch (58)**:

1. Remove the two **Dust Cover Screws (34)** on the injection side to get access to the **Inject Position Switch (58)**.
2. Move the **Injection Head (1)** to inject position by pressing LEFT key.

   Note: Set injection depth to a value that the **Sample Vial Holder Magnet (55)** is close to the injector but does not touch it. See 4.6.6.2 below for this adjustment.

3. Move the **Syringe Carrier (45)** down to the GC injector by using the MET key.
4. Measure the difference in X-direction from the center of the **Needle Guide (54)** to the center of the injector.
5. Move **Injection Head (1)** back to home position by using RIGHT key to get access to the **Inject Position Switch (58)** holding screw.

If two injection points are selected, the **Injection Head (1)** moves to the inner point.

6. Slightly loosen the hex screw and shift the **Inject Position Switch (58)** for the difference measured in step 4.
7. Repeat steps 2 to 6 until the adjustment is satisfactory.
8. Tighten the **Inject Position Switch (58)** holding screw and fix the **Dust Cover (56)**.
9. If two injection points are selected, check the inner position by pressing RIGHT key and adjust accordingly (see 4.6.1.4).

4.6.6.2
Injection Depth

The needle penetration into the injection block of the GC may be adjusted anywhere on the Z-axis by using the following procedure:

1. Move the **Injection Head (1)** to the injection point by pressing LEFT key.
2. Move the **Syringe Carrier (45)** in large steps by using UTL key.
3. Continue moving down with DOWN key until the syringe needle penetrates as desired into the injection block.
4. Press INJ to store the set position.
5. Check the stored position by pressing the MET key. This moves the syringe up to the limit switch and then down to the stored position.
6. Write down the indicated value for the steps moved into Table 2, “System Setup Default Values”, on page C–3
7. If two injection points are selected, press RIGHT key to move to the inner point and repeat steps 2 to 5. The depth is stored separately for both points.

Calibrate Temperatures

4.6.7 Calibrate Temperatures

Function display:

(BLINKING)

This menu provides a service function for the equipment manufacturer and service people. A re-calibration is not necessary unless

some critical components of the **Heater Control Board (93)** have been exchanged. Even when a complete board is exchanged the calibration has not to be done because the calibration values are stored locally on the board itself.

To perform this adjustment a special **Calibration Plug** is needed to simulate the temperatures. Calibration should be done at room temperature (20°C). The sampler has to be prepared as follows:

1. Turn the instrument off and unplug the power cord.
2. Let the instrument sit for 5 minutes so that all voltages can discharge.
3. Remove the **Top Cover (29)**.
4. Carefully unplug all cables from the **Heater Control Board (93)**.
5. Connect the **Calibration Plug** with its zero degree side to the **Connector for Temperature Adjustment (95)**.
6. Power on the unit while holding down the MET key to enter the System Setup Program. Select the CAL TEMPERATURES function by pressing the INJ key. The following display appears:

```
INSTALL ZERO DEG
CALIBR RESISTORS
```

7. As the **Calibration Plug** has already been installed in step 5, press INJ to continue.

```
T0 = + 0.3  6849
T1 = + 0.3  6808
```

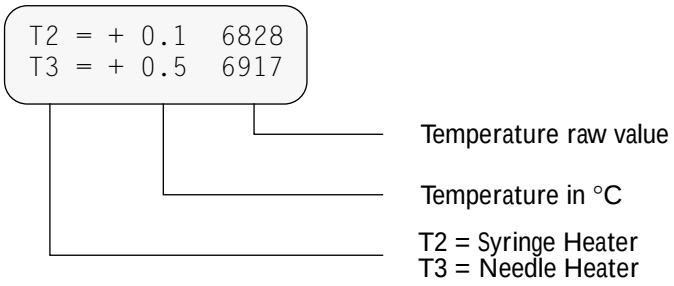
Temperature raw value

Temperature in °C (mean value of T0 and T1)

T0 and T1 for Incubation Heater

8. Wait for at least 30 seconds until the temperature raw values read stable.

9. Press INJ to continue.



10. Check temperature raw values for T2 and T3 read stable.
11. Press INJ to continue.

```
INSTALL  150 DEG
CALIBR RESISTORS
```

12. Turn the **Calibration Plug** by 180° and reconnect it with its 150°C side to the **Connector for Temperature Adjustment (95)**.
13. Press INJ to continue.

```
T0 = 149.4 30693
T1 = 149.4 30631
```

14. Wait for at least 30 seconds until the temperature raw values read stable.
15. Press INJ to continue.

```
T2 = 149.9 30842
T3 = 149.7 30811
```

16. Check temperature raw values for T2 and T3 read stable.
17. Press INJ to continue.

```
SAVE CALIBRATION
IN EEPROM ?
```

18. Press INJ to store the new calibration values in the local memory of the **Heater Control Board (93)**. Pressing CLR at this step or all

steps before keeps the old calibration values.The prompt for the writing of the new values appears:

```
WRITING DATA
TO EEPROM
```

19. Wait until the calibration data has been stored and the program returns to the function display.
20. If the procedure above did not succeed, e.g. a CHANNEL FAILED has been detected during calibration or the data can not be stored in EEPROM call for service help.
21. Turn the instrument off and wait for 5 minutes so that all voltages can discharge.
22. Remove the **Calibration Plug** and reconnect all cables to the **Heater Control Board (93)**.
23. Double check all cable connections for proper seat and mount the **Top Cover (29)**.

Checking Plunger Operation

4.6.8 Checking Plunger Operation

Function display:

```
CHECK PLUNGER
```

(BLINKING)

This function is used to check the operation of the plunger drive motor and the movement of the plunger. After the plunger check function is selected, the following display appears:

```
PLUNGER MOVE  CNT
TEST           12
```

Number of cycles executed

The plunger test speed may be altered in SET MOTOR SPEED (see 4.6.19). Change PLUNG FLUSH for pullup and PLUNG EJCT SAMPL for eject speed.

Checking Connection to Remote System

4.6.9 Checking Connection to Remote System

Function display:

```
CHK REMOTE LINK
```
(BLINKING)

It is possible to control the HS500 by a remote system connected to the RS232 serial port. Selecting the proper physical format of an RS232 connection (number of data and stop bits, parity, baud rate) and connecting the right pins on the interconnection cable can be very time consuming. A simple connection check is very helpful.

For this test an ASCII terminal or a computer using a terminal emulation program is connected to the RS232 port. It has to be set to the following data format:

8 data bits
1 stop bit
no parity
9600 bits/second

Terminal and HS500 are connected by pins 2, 3 and 7 only. The HS500 has its sending line (Tx) on pin 3, and the receiving line (Rx) on pin 2. The terminal must not use hardware handshake signals, or the requested handshake signals have to be short circuited in the terminal connector (usually pin 20 to pin 5 and 8).

To start the test, press the INJ key. The following display appears:

```
INJ:XMIT TO HOST
```

All characters typed in at the terminal are displayed on the control display and are echoed back to the sending terminal. If every typed character appears on both the HS500 display and the terminal screen, the following points are checked:

- Connection between HS500 and terminal
- Terminal RS232 data protocol setup
- Communication part of the sampler hardware

If this doesn't work as described, there is a possibility to check the HS500' sending line separately. Press the INJ key on the control unit. This sends some text to the connected terminal. If it appears on the terminal's screen, the HS500' sending link is working and the trouble must be within the receiving path.

Checking Limit Switches

4.6.10 Checking Limit Switches

Function display:

```
CHECK SWITCHES
```

(BLINKING)

This function is used for maintenance purposes. All the motor output stages are disabled. This allows to drive the individual axis manually to its corresponding limit switch. The state of all limit switches is displayed on one screen:

```
L R  T  S P  H A
0 0  1  0 1  0 0
1 1  0  1 0  1 1
```

- Agitator rotation detector (HS500-50 only)
- 0 = 6 x 10ml heater (HS500-32)
- 1 = 2 x 10 ml agitated heater (HS500-50)
- Plunger down
- Syringe up
- Sample tray on row one
- Injection head at right side
- Injection head at left side

0: Switch not activated
1: Switch activated

Check Magnets

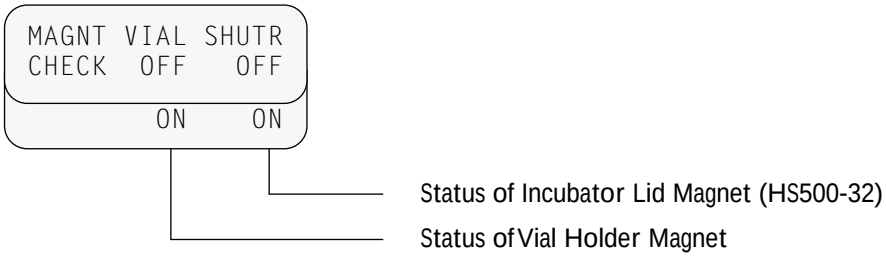
4.6.11 Check Magnets

Function display:

```
CHECK MAGNETS
```

(BLINKING)

This function checks the **Holding Magnet Incubation Heater Lid (HS500-32) (65)** and the **Sample Vial Holder Magnet (55)** Select the magnet to be tested with LEFT and RIGHT keys. The UP and DOWN keys toggle the selected magnet on and off. To test the holding force of the **Sample Vial Holder Magnet (55)**, put a vial underneath while switching the magnet on and off.



Warning:
Do not let a magnet be activated for a longer time because it may overheat.

Check Vial Detector

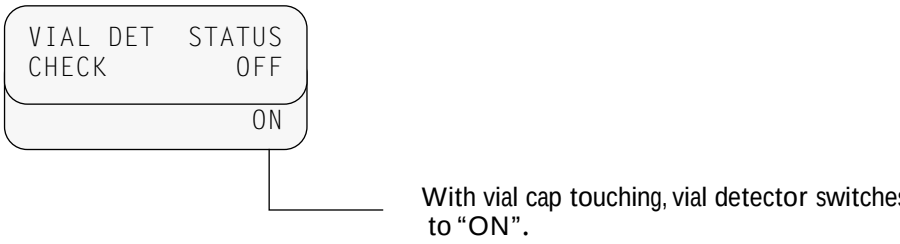
4.6.12 Check Vial Detector

Function Display:

The **Sample Vial Holder Magnet (55)** detects the presence of a sample vial with steel cap in the sample tray or in the incubation heater, and is also used to hold the vial during transportation.

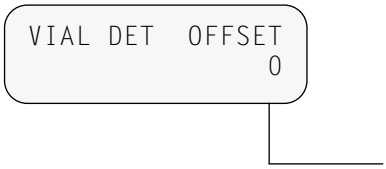
Make sure there is no vial underneath the **Sample Vial Holder Magnet (55)** when entering this function, since the unit performs a reference measurement at the moment INJ is pressed.

After activation with the INJ key, the following display appears:



The detection circuit can now be checked by placing a vial with steel cap underneath the **Sample Vial Holder Magnet (55)**. The measurement is repeated 10 times per second and you feel a slight pulsing attraction of the steel cap.

If the detection is not satisfactory the adjustment of the detection circuit can be checked. Press INJ again and the following display appears:



With vial cap touching, vial detector switches to "ON".

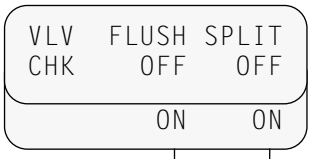
Remove the vial from the **Sample Vial Holder Magnet (55)**. If OUT OF RANGE is displayed instead of an offset value, the detection circuit needs adjustment. Call for service in this case.

Check Valves 4.6.13 Check Valves

Function display:

(BLINKING)

This function checks the **Flush Gas Valve (38)** and the optional **Splitter Valve** connected to the **Splitter Valve Connector (17)**. Select the valve to be tested with the LEFT and RIGHT key.The UP and DOWN key toggle the selected valve on and off.



Splitter valve activation state

Flush valve activation state

Check for the clicking noise of the solenoid while switching the valve on and off. If the gas lines are hooked up and under pressure, gas flow can be detected on the syringe needle tip or appropriate output gas line on the splitter valve.

Note: The Operating voltage for the splitter valve is 42 V DC.

Check Incubation Heater

4.6.14 Check Incubation Heater

Function display:

```
CHECK INC HEATER
```

(BLINKING)

This service function is considered to be used mostly for trouble shooting. The display shows the set temperature, the actual temperature and the heater power level in %. The set temperature can be varied by using the UP and DOWN keys.

After activation of this function with the INJ key, the following display appears:

```
°CSET  °CIS  PWR
 30.0  30.0   0%
150.0 150.0 100%
```

Power level set by temperature regulator

Actual temperature

Set temperature

Check Syringe Heater

4.6.15 Check Syringe Heater

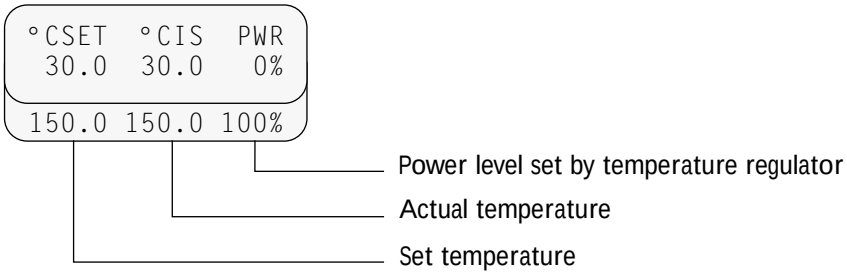
Function display:

```
CHECK SYR HEATER
```

(BLINKING)

This service function is considered to be used mostly for trouble shooting. The display shows the set temperature, the actual temperature and the heater power level in %. The set temperature can be varied by using the UP and DOWN keys.

After activation of this function with the INJ key, the following display appears:



Check Needle Heater

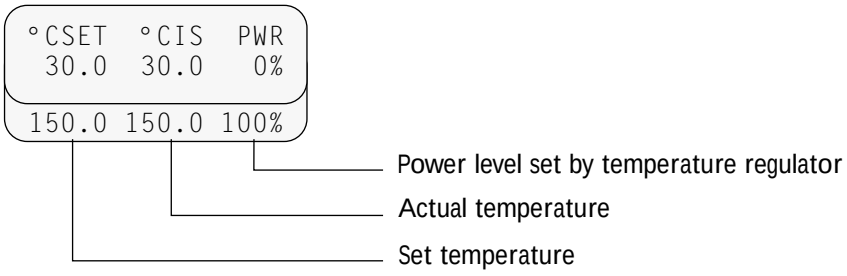
4.6.16 Check Needle Heater (Only if needle heater installed)

Function display:

(BLINKING)

This service function is considered to be used mostly for trouble shooting. The display shows the set temperature, the actual temperature and the heater power level in %. The set temperature can be varied by using the UP and DOWN keys.

After activation of this function with the INJ key, the following display appears:



Check Agitator

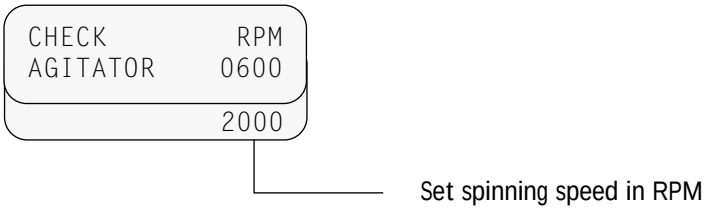
4.6.17 Check Agitator

Function display:

(BLINKING)

This function is used to check the spinning motion of the **Agitator/ Incubation Heater 2x10ml (10)**.

After activation of this function with the INJ key, the following display appears:



Select the desired speed with UP and DOWN key and start the agitator by pressing either INJ key for counter clockwise or UTL for clockwise rotation.

Check BCD Output

4.6.18 Check BCD Output

Function display:

(BLINKING)

This function is used to check the output signals at the **Parallel Connector for BCD Sample Number (18)**. The logic polarity may be selected in the System Setup Program (see 4.6.1.10).

After activation of this function with the INJ key, the following display appears:

Sample number output at BCD connector

Change the sample number by pressing UP or DOWN key. The displayed number is output in BCD code at the **Parallel Connector for BCD Sample Number (18)**

Setting Motor Speeds

4.6.19 Setting Motor Speeds

Function display:

(BLINKING)

This function allows to change the motor speeds for each axis. The syringe and plunger speeds may be selected individually for each state of the injection cycle. The default values are proven to be optimum and should only be changed if necessary.

The display value is a delay time between motor steps. Therefore a higher value results in a slower speed. (except plunger speeds which are in µl/s units).

Note: Use Table 2, “System Setup Default Values”, on page C–3 to note the changes from default values that were found to be most appropriate.

After activation of this function with the INJ key, the first speed is displayed. Use the RIGHT or LEFT key to select the different speeds and the UP or DOWN key to change the value.

Delay value to move the **Syringe Carrier (45)** up:

Delay value to move the **Syringe Carrier (45)** down at clean position:

```
SYRING WASH DOWN
          00400
          04000
```

Delay value to move the **Syringe Carrier (45)** down to pick up sample:

```
SYRG SAMPLE DOWN
          00400
          04000
```

Delay value to move the **Syringe Carrier (45)** down to inject:

```
SYRG INJECT DOWN
          00400
          04000
```

Speed to move the **Plunger Holder (48)** up to flush position (to enable the flush gas flow):

```
     PLUNG FLUSH
x1ul/s      0025
            3000
```

Note: The sample pullup speed is defined in the method (see 4.4.13).

Speed to move the **Plunger Holder (48)** down to zero at sample pick up and clean position:

```
PLUNG EJCT SAMPL
x1ul/s      0025
            3000
```

Note: The injection speed is defined in the method (see 4.4.13).

Delay value to move the **Injection Head (1)** left and right:

```
      UNIT CROSS
            0600
            1800
```

Delay value to move the **Sample Tray** in and out:

```
SAMPLE TRAY
0400

1500
```

Resetting To Default Values

4.6.20 Resetting To Default Values

Function display:

```
RESET TO DEFAULT
```

(BLINKING)

With this function all changeable parameters are reset to a default value (see Table 1, “Method Default Values”, on page C–1 and Table 2, “System Setup Default Values”, on page C–3). All user set values are lost. BE CAREFUL WHEN USING THIS FUNCTION. Its only use is to reset all parameters to a safe value after making changes. (e.g. sample penetration depth too deep so that the syringe needle may be damaged.) Use this function if the HS500 is reinstalled on another GC before setting up new values.

```
ARE YOU SHURE ??
“INJ” TO CONFIRM
```

If you are sure that you want to reset all parameters, including injection methods, confirm by pressing the INJ key. The program now enters a cold start routine and it looks as if the HS500 lost its parameters due to a weak backup battery or a hardware failure. Confirm the following messages with the INJ key, and the program enters the service program again.

```
WARNING: SAMPLER
SETUP LOST
```

Continue with INJ:

```
CHECK BATTERY  ON
CPU MODULE
```

Continue with INJ:

```
OPERATING VALUES
ARE RESET
```

Continue with INJ:

```
INITIALIZING
```

After you have confirmed above messages with the INJ key, the System Setup Program is restarted:

```
SET PARAMETERS
```

(BLINKING)

Now you can proceed by selecting sampler operating modes and setting up parameters as described in the previous paragraphs.

5. Maintenance and Service

Maintenance

5.1 Maintenance

The required routine maintenance operations are explained below.

Daily

5.1.1 Daily

- If the autosampler has not been used overnight or for several days check the syringe for any build-up of particles on the glass barrel. Wash the syringe with a mild solvent. Use the utility function for syringe cleaning (see 4.5.3).

Weekly

5.1.2 Weekly

- Check syringe for any build-up.
- Check if injection head is solidly bolted to the cross slide.
- Check if flush gas flow is still adequate.

Service

5.2 Service

Almost all problems that could occur with the CTC HS500 Headspace Sampler can be fixed by the operator. The modular design allows technically inclined people to troubleshoot and exchange modules with the help of trained professionals associated with authorized dealers of the manufacturer. This chapter covers the troubleshooting approach and two levels of interventions for correcting a problem. In general Minor Services Cases don't involve much more than a hardware or software adjustment. In a few cases that could involve exchanging a readily accessible part. Major Service Cases involve exchanging modules, or require dismounting of a module and exchange of parts hard to reach.

Troubleshooting

5.2.1 Troubleshooting

Symptom:
No reaction by the instrument when powering up

1. Check power connection (fuse of AC outlet, power cord)
2. Check **Voltage Selector (25)** at **AC Power Connector (27)**
3. Check fuse in **AC Power Connector (27)**
4. Check connections for **Flat Cable to Injection Head (14)**, **Flat Cable to Control Terminal (22)** and **Flat Cable to Agitator (23)**
5. If 1 - 4 does not reveal the source of the problem, call for service!

Warning: Sampler Setup Lost

Symptom:
Error message:

```
WARNING: SAMPLER
SETUP LOST
```

This message is displayed if the checksum calculated over all system values in non volatile memory is bad. This may be caused by a week battery on the control module or if the control program (EPROM) has been updated to a new version.

1. If you have changed control software ignore this message and proceed with INJ key. Restore system parameters and injection methods.
2. If control software has not been changed, call for service to replace **Backup Batteries (82)** on **Main Control Board (80)**.

Calibration Data not Valid

Symptom:
Error message:

```
CALIBRATION DATA
NOT VALID
```

An invalid checksum has occurred during startup while reading the local memory on the **Heater Control Board (93)**. By pressing INJ, default values are used instead of actual calibration values.

After pressing the INJ key, the following display appears:

```
DEFAULT VALUES
ARE USED
```

Warning:
Using default temperature calibration values may result in temperature errors for all heaters. See chapter 4.6.7, "Calibrate Temperatures" on page 4–41. Call for service help.

Error Reading/ Writing EEPROM Data

Symptom:
Error message:

```
ERROR READING
EEPROM DATA
```

```
ERROR WRITING
EEPROM DATA
```

The calibration values stored in the EEPROM memory located on the **Heater Control Board (93)** can not be read or written. The writing error can only occur during the calibration procedure (see 4.6.7).

1. Turn the instrument off and unplug the power cord.
2. Remove the **Top Cover (29)**.
3. Check if all the pins of the integrated circuits on the **Heater Control Board (93)** are firmly seated in their sockets.
4. If the problem persists, call for service help.

Tray Back Switch not Detected/ Always Closed

Symptom:
Error message:

```
TRAY BACK SWITCH
NOT DETECTED
```

```
TRAY BACK SWITCH
ALWAYS CLOSED
```

Every time a motor moves towards a switch, the distance moved is checked against the maximum possible travelling distance. If the switch is not activated after this distance either the switch is defective or the motor does not move due to a mechanical or electronic failure.

Any of the switches can show two erroneous states:
“NOT DETECTED” or “ALWAYS CLOSED”.

1. Remove the **Sample Tray (5)** and check for any parts on the **Base Plate (59)** behind the **Cooling Plate (63)** which could block the movement.
2. Check if the **Tray Switch Activator (61)** is not adjusted too far backwards so that the tray drive blocks mechanically before the switch is activated.This may happen intermittently and only if the sample tray is inserted.
3. Check if the **Tray Position Switch Connector (83)** is firmly seated in the socket on the **Main Control Board (80)**.
4. Check if cable to the **Tray Drive Motor (91)** is firmly connected.
5. Check switches by entering System Setup Program (see 4.6.10).
6. If unit shows same symptom after turning the unit off and back on call for service.

Cross Left/Right Switch not Detected/Always Closed

Symptom:
Error message:

```
CROSS LFT SWITCH
NOT DETECTED
```

```
CROSS RGT SWITCH
NOT DETECTED
```

```
CROSS LFT SWITCH
ALWAYS CLOSED
```

```
CROSS RGT SWITCH
ALWAYS CLOSED
```

1. Check if **Flat Cable to Injection Head (14)** is firmly plugged into the socket on **Injection Head (1)** and **Main Control Board (80)**.

2. Check if cable to **Cross Motor (21)** is firmly connected to the **Main Control Board (80)**.
3. Check if **Position Switch Connector (83)** is firmly seated in the socket on the **Main Control Board (80)**.
4. Check switches by entering System Setup Program (see 4.6.10) and observe switch indicator changing from "0" to "1" and back under "L" for left side switch or "R" for right side switch when moving the **Injection Head (1)** on and off the switch.
5. If switch does not seem to respond at this point call for service help. The switch including its cable most likely needs replacing.

Plunger Down Switch not Detected/Always Closed

Symptom:
Error message:

```
PLUNG DWN SWITCH
NOT DETECTED
```

```
PLUNG DWN SWITCH
ALWAYS CLOSED
```

1. Turn unit off. Push plunger down as far as possible.
2. Check if **Flat Cable to Injection Head (14)** is firmly plugged into socket on **Injection Head (1)** and into socket on **Main Control Board (80)**.
3. Check that syringe needle is not plugged. Check with hand motion if syringe can pull up and eject liquid.
4. Check switches by entering System Setup Program (see 4.6.10).
5. Check plunger operation by entering System Setup Program (see 4.6.8) and check plunger motion with and without syringe mounted in the heater cartridge.
6. If unit shows same symptom after turning the unit off and back on, call for service help.

Syringe Up Switch not Detected/Always Closed

Symptom:
Error message:

```
SYRING UP SWITCH
NOT DETECTED
```

```
SYRING UP SWITCH
ALWAYS CLOSED
```

1. Check if **Flat Cable to Injection Head (14)** is firmly plugged into socket on injection head and into socket on **Main Control Board (80)**.
2. Check switches by entering System Setup Program (see 4.6.10) and manually moving the syringe carrier up and down.
3. If the error occurs always after making injection, the injection depth should be set higher (see 4.6.6).
4. If all connections are checked and the error persists, call for service help.

Warning:
The Main Control Board Fuse (73) is connected to the stepper motor drivers. Even when the fuse has been blown it is possible that a driver has been damaged ! Never change that fuse with the instrument powered ! Never power up the instrument with a shorted fuse !

Vial Detection Error

Symptom:
Error message:

```
VIAL DETECTION
ERROR
```

1. Check if **Flat Cable to Injection Head (14)** is firmly plugged into **Injection Head (1)** and into socket for**Flat Cable Syringe Heater and Vial Magnet (94)** on **Heater Control Board (93)**.
2. Manually move the **Injection Head (1)** to the position as shown in Figure 1. Make sure there is no vial underneath the **Sample Vial Holder Magnet (55)**.
3. Check vial detection cirquits by entering System Setup Program (see 4.6.12).Verify the vial status ON/OFF with a vial cap touching the **Sample Vial Holder Magnet (55)**.
4. If the display reads OUT OF RANGE, or the ON/OFF status is incorrect, call for service help.

Vial Transport Error

Symptom:
Error message:

```
VIAL TRANSPORT
ERROR
```

Sample vial jams in **Sample Incubation Heater 6x10ml (6)** or **Agitator/Incubation Heater 2x10ml (10)** (depending on your Headspace Model).

1. Turn the instrument off and let the incubation heater cool down.
2. Manually remove the jammed vial from the heater, and carefully clean the heater position.

   Note: With the**Agitator/Incubation Heater 2x10ml (10)** the **Spinning Heater Bushing (110)** may be removed for cleaning purposes (see Figure 11).

3. Check for smooth moveability with a vial in the corresponding heater place.
4. If the vial still jams, call for service help.

Agitator not Running

Symptom:
Error message:

```
AGITATOR NOT
RUNNING
```

1. Manually rotate one **Spinning Heater Bushing (110)** and check if the second one also moves. If not, the agitator driving belt is either broken or has run off the driving wheels. Follow 5.2.2.6 to replace the belt. One spare belt has been delivered with the instrument.
2. Check if **Flat Cable to Agitator (23)** is firmly plugged into socket on **Agitator/Heater Connector (115)** and **Connector for Agitator/Incubation Heater (102)**.
3. Check if **Feed Through Cable for Incubation Heater (103)** is connected both to the **Agitator/BCD Output Board (104)** and the **Heater Control Board (93)**.
4. Enter "Check Agitator" by access of the System Setup Program (see 4.6.17). Use UP and DOWN keys to change the speed. Start with slow speeds and then increase to the upper limit. If the agitator runs, keep it running for 10 minutes at maximum speed.
5. Call for service help if agitator cannot be re-activated.

Error #n

Symptom:
Error message: ERROR #n

This message indicates a software error and should never happen.

1. Switch the unit off and on again, then write down all method and system parameter settings using section Table 1: "Method Default Values" and section Table 2: "System Setup Default Values".
2. Reset all values to default using the System Setup Program (see 4.6.20).
3. Restore system and method parameters from the tables.
4. If the error happens again call your dealer for support. Report software revision number (indicated for some seconds on the display when power is switched on) and your method and system parameter setup.

Does not Hold Syringe Needle Penetration Depth

Symptom:
Does not hold syringe needle penetration depth after adjustment (sample, inject position)

A common error is that the adjusted penetration depth is not actually stored with the INJ key and the old depth is retained. Follow descriptions in section 4.6.3 and 4.6.6 to adjust penetration depth at sample and inject position.

Does not Start Sample Injection Cycle

Symptom:
Does not start sample injection cycle

The start signal for a sampling cycle may come from two different sources: A GC Ready signal connected to the **GC Interface Connector (19)** or a start command sent from a remote control system via the **RS 232 Connector (32)**. Which one is active depends on your installation.

1. Check setting of start signal source (see 4.6.1.5) depending on your installation.
2. If GC Ready start signal is active and the remote start command without a sample and method number is used (# 990000CR), the sampler must be in the Ready state to accept the start signal, i.e. the INJ LED is lit and the next sample number is displayed (see 4.2).
3. If GC Ready start signal is used, check value for GC Start Delay (see 4.6.1.6). Disconnect the **GC Interface Connector (19)**. Switch on the autosampler and change to Ready state by pressing INJ. Manually

short pins 7 and 8 at the **GC Interface Connector (19)**. If the sampler starts processing, the error must be within the connection to the GC. If it does not start, check the **GC Interface Connection Cable (87)**. If it is OK, exchange the **Main Control Board (80)**.

4. If remote control start is used, check the connection to the host system using a terminal emulation program on the host side. Refer to section 4.6.9 for instructions.

Excessive Motor Noise

Symptom:
Excessive noise from syringe plunger or any other drive

1. Turn the instrument off and check if syringe plunger, syringe carrier or injection head (X-slide), when being moved by hand, let you feel any resistance. If smooth and even movement results there is no indication that any of the motors are faulty or any excessive mechanical resistance exists.
2. Since certain frequencies of the stepper motors can cause a resonance in the different instrument parts, change the speed of the motor, where the noise originates (see 4.6.19). A change up or down will most likely eliminate the noise problem. It should be noted that this problem, even though it is a nuisance, will not hurt the instrument.
3. In case step 2 does not remedy the problem, call for service help.

Low Detector Signal

Symptom:
Results show no or very low detector signal (no peaks)

A clogged syringe needle might be the reason for very low or even no detector signal. Coring of soft septa or sample penetration depth that is set too high have often turned out to be the problem.

1. Choose higher sample volume to be injected.
2. If you are using very low sample volumes check sample penetration depth (see 4.6.3). Adjust to a deeper level if necessary, but do not touch the liquid level in the vial with the needle tip.
3. Check the syringe needle tip. If it is bent (tip looks like a hook), change the syringe. Any restrictions which can easily be caused by a burred needle side port will cause excessive pressure differences that cannot be equalized with normal parameter settings.
4. Check that the method you are using has the proper sample volume entered (The incremental unit is 1.0 µl. Set value to 100 for 100 µl)

Low Reproducibility

Symptom:
Results show lower reproducibility than normal

1. Use long enough syringe flush and bakeout time after injection to assure a clean syringe.
2. Make sure the red **Plunger Fixing Thumb Screw (49)** is tightened down to the plunger button.
3. Check the gas flow. Any restrictions, which can easily be caused by a burred needle side port, will cause excessive pressure differences that cannot be equalized with normal parameter settings.
4. Check your method for delay times (see 4.4.12). A longer delay and slower pull up speed allows better pressure equilibrium.
5. If you are injecting very low sample volumes check if you can achieve better results with the optional 1 ml syringe.
6. Determine if the caps are being crimped properly by attempting to rotate the cap by hand. Loose caps may cause selective loss of lighter components from a sample. Adjust crimping tool correctly.

Cross Contamination

Symptom:
Results show cross contamination between samples

1. Use an appropriate flushtime and bakeout temperature. Increase both of them to see if it helps.
2. Make sure that there is flush gas flow. Use the clean syringe utility function to check the flow (see 4.5.3).

Minor Service Cases

5.2.2 Minor Service Cases

Installing the Optional Parallel Board (BCD)

5.2.2.1
Installing the Optional Parallel Board (BCD)

1. Turn the instrument off and disconnect the power cord and all accessory cables from the **Back Panel (30)**.
2. Let the instrument sit for 5 minutes so that all voltages can discharge.
3. Remove the **Top Cover (29)**.
4. Carefully unplug all cables from the **Heater Control Board (93)**,and remove it either from the **Agitator/BCD Output Board (104)** (HS500-50) or from the **Main Control Board (80)** (HS500-32).
5. If you have a HS500-50, skip step 6.
6. Mount the **BCD Output Board** on the **Main Control Board (80)** with two **Agitator Board Mounting Bolts (101)** as shown in Figure 9.
7. Remove the cover plate and mount the **Parallel Connector for BCD Sample Number (18)** with two enclosed mounting bolts, lock washer and nut to the **Back Panel (30)**. Connect the other end of the BCD Output flat cable to the **BCD Output Connector (105)**.
8. Reinstall the **Heater Control Board (93)** with two **Fixing Screws M3x8 (107)** and two **Fixing Screws M3x25 (108)**. Reconnect cables.
9. Double check cable connections for proper seat.
10. Reinstall the **Top Cover (29)** and all accessory cables to the instrument.
11. Check the BCD Output Function by entering the System Setup Program (see 4.6.18).

Exchanging the EPROM

5.2.2.2
Exchanging the EPROM

1. Write down all method and system parameters into Table 1 and Table 2.
2. Turn the instrument off and disconnect the power cord.
3. Wait for 5 minutes so that all voltages can discharge.
4. Remove the **Top Cover (29)**
5. For HS500-50 remove the **Fixing Screws (107)**, **(108)** holding the **Agitator/BCD Output Board (104)** and the **Agitator Board**

Mounting Bolts (101) to remove the **Heater Control Board (93)**.
For HS500-32 remove the **Fixing Screws (92)** holding the **Heater Control Board (93)**.

6. With a chip puller remove the **EPROM (84)**.
7. Before inserting the replacement, make sure the two rows of pins are all straight and in line. Insert the EPROM and push all the way in. Always make sure notch of EPROM points towards the inside of the board (left). In many cases the small **PAL Chip (86)** needs to be changed to be compatible with the EPROM.
8. Double check if all pins are in their sockets.
9. Reinstall the control boards which have been removed in step 5 and double check cable connections.
10. Place the **Top Cover (29)** back onto the instrument.
11. Plug in the power cord and turn on the instrument.
12. Check the control terminal for any unusual indications. If the message WARNING: SAMPLER SETUP LOST is displayed, restore all system and method parameters.

Exchanging the Injection Head

5.2.2.3
Exchanging the Injection Head

1. Turn the instrument off and unplug the power cord.
2. Remove the **Syringe Heater (7)**.
3. Push the **Injection Head (1)** to a place where it is not over the tray or injection port.
4. Disconnect the **Flat Cable to Injection Head (14)** by pushing the two snap clips of the black cable socket towards the outside.
5. Use the larger hex wrench that was provided with the instrument in the accessory bag to loosen the two **Injection Head Mounting Screw (44)**. The upper and the lower screw can be exposed by moving the syringe carrier by hand up or down so that the hole in the syringe carrier is lined up with one of the screws.
6. To mount the replacement injection head proceed in the reverse order through steps 2 - 5.

Exchanging the Control Terminal

5.2.2.4
Exchanging the Control Terminal

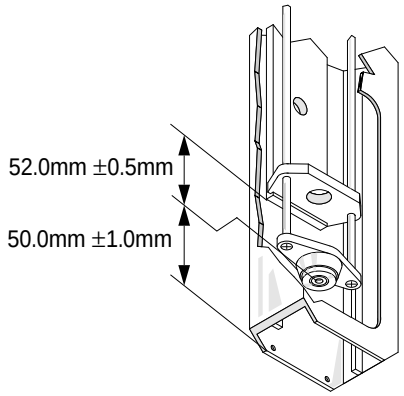
1. Turn the instrument off and disconnect the power cord.

2. Disconnect the **Flat Cable to Control Terminal (22)** by pushing the two snap clips of the black cable socket on the control terminal towards the outside.
3. Loosen the two **Control Terminal Mounting Screw (33)** to remove the control terminal.
4. To mount the replacement control terminal proceed in the reverse order through steps 2 - 3.

Adjusting Needle Guide Position

5.2.2.5
Adjusting Needle Guide Position

1. Remove the **Syringe Heater (7)**.
2. Measure the distance from the bottom of **Syringe Carrier (45)** to the bottom of the **Sample Vial Holder Magnet (55)**.
   If the measured distance is 52.0mm ±0.5mm no adjustment is needed; proceed with step 4.



3. If the measured distance is out of tolerance, turn the instrument off. Loosen the two screws of the **Needle Guide Stop (43)** with the 1.3mm hex key and correct the distance accordingly by moving the **Sample Vial Holder Magnet (55)** up or down. Tighten the screws after double checking the distance.
4. Turn the instrument on and wait until the sampler reaches the STANDBY STATE.
5. Manually move the **Injection Head (1)** to a position, where you can hold a depth gauge to the bottom of the Injection Head.
6. Measure the distance from the bottom of the **Injection Head** to the **Sample Vial Holder Magnet (55)**. If the measured distance is 50.0mm ±1.0mm the adjustment is correct. Otherwise call for service because the syringe up switch trip point is out of tolerance or the syringe up switch carrier has to be exchanged.
7. Check all penetration depth adjustments (see 4.6.3, 4.6.5, 4.6.6).

Replacing Agitator Driving Belt

5.2.2.6
Replacing Agitator Driving Belt (HS500-50)

1. Turn the instrument off and disconnect the power cord.
2. Remove the **Agitator Bottom Cover (114)**. If the two screws at the bottom can not be accessed, remove the **Agitator/Incubation Heater 2x10ml (10)** from the instrument by removing the 3 hex screws from inside the **Side Panel (60)**.
3. Replace the driving belt.
4. Mount the **Agitator Bottom Cover (114)**.
5. If the complete agitator has been removed in step 2, check alignment of the **Spinning Heater Bushing (110)** with the **Sample Vial Holder Magnet (55)** by moving the **Injection Head (1)** above the agitator and pushing the **Syringe Carrier (45)** down manually.

Major Service Cases

5.2.3 Major Service Cases

Exchanging Processor Board

5.2.3.1
Exchanging Processor Board

1. Turn the instrument off and disconnect the power cord.
2. Remove the **Top Cover (29)**.
3. Remove the **Agitator/BCD Output Board (104)** (for HS500-50) and the **Heater Control Board (93)** (HS500-50 and HS500-32).
4. Disconnect all the cable connections from the **Main Control Board (80)**.
5. Loosen the three **Mounting Screws for Processor Board (72)** along the top edge of the board.
6. Use the long stem hex wrench to loosen the four bottom **Mounting Screws for Processor Board (72)** that hold the board to the black instrument body cross member.
7. Carefully lift the **Main Control Board (80)** vertically out of the housing.
8. To install the replacement board proceed in reverse order through steps 2 - 6. Even though all plugs and sockets are keyed, and therefore prevent mix-ups of wires, it is advisable to double check these connections before turning on the instrument.

Exchanging Crossrail

5.2.3.2
Exchanging Crossrail

1. Turn the instrument off and disconnect the power cord.
2. Remove the **Injection Head (1)** and **Control Terminal (4)** (see 5.2.2.3 and 5.2.2.4).
3. Remove **Top Cover (29)**
4. Remove **Heater Control Board (93)**, **Agitator/BCD Output Board (104)** (HS500-50) and **Main Control Board (80)** as described in 5.2.3.1.
5. Remove three **Mounting Screws for Cross Rail (77)** on the top edge and two on the bottom of the **Instrument Body Cross Member (78)** within the instrument main body.
6. Take the **Cross Motor Cable (88)** out of the **Side Panel (60)** including the rubber bushing.
7. Take the **Crossrail (2)** off including **Cross Motor (21)**, **Flat Cable to Injection Head (14)** and the **Flat Cable to Control Terminal (22)**.
8. To mount the replacement crossrail proceed in reverse order through steps 2 - 7.

Exchanging Bottom Plate with Vial Tray Drive

5.2.3.3
Exchanging Bottom Plate with Vial Tray Drive

1. Turn the instrument off and disconnect the power cord.
2. Remove the **Top Cover (29)**.
3. Remove the two lower screws holding the **Back Panel (30)**. The panel can't be completely removed because of the cables connected to it. Carefully pull it back off the **Cooling Inlet (26)** and **Cooling Outlet (31)**.
4. Disconnect the **Tray Home Position Switch (89)** and the **Tray Drive Motor (91)** cables from the **Main Control Board (80)**.
5. Remove the six **Tray Drive Holding Screws (24)** on the instrument housing **Side Panel (60)**.
6. The **Base Plate (59)** with the **Tray Drive Motor (91)** and **Cooling Plate (63)** can be dropped out by lifting up the upper part of the instrument.
7. To install the replacement module proceed in reverse order through steps 2 - 6.

6. Remote Control

General

6.1 General

The HS500 autosampler may be controlled by a remote system connected to the serial interface. The control program is not changed to a remote control operating mode, operation is possible by using the control terminal or by the remote system via the serial connection at the same time.

The host or the user can change operating parameters. The operator needs to be careful not to mix controlling the HS500 with the keyboard and the host system. However, in special circumstances the parameters can be changed directly at the control terminal, or the sampling cycle can be stopped by using the CLR key. And the utility functions can still be used. While the operator is changing a method or is using a utility function, the host parameter setting commands are not accepted. The host gets a LOCKED status to detect this situation.

The START SAMPLING signal can be generated by either the external GC READY switch or by the host system. This has to be set up in the System Parameters Program (see 4.6.1 Start Signal Source).

Autosampler - Host Connection

6.2 Autosampler - Host Connection

For communication between the host system and the HS500 an RS232 serial connection is used. Only pins 2, 3 and 7 are necessary for operation. The HS500 has its sending line (Tx) on pin 3, and the receiving line (Rx) on pin 2. In this case software handshake (XON/XOFF) is used for data flow control.

If your installation does not make use of the GC Ready signal, short pins 7 and 8 at the **GC Interface Connector (19)**.

Data Transmission Format

6.3 Data Transmission Format

Both data directions, from host to sampler and from sampler to host, use the same data format. Data is coded in ASCII and is transmitted by using the following data transmission format:

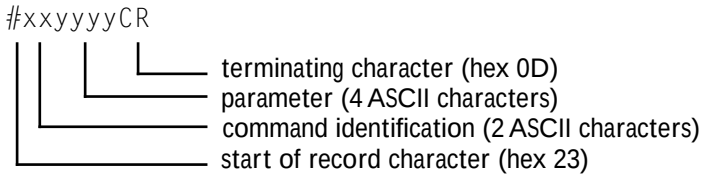
start bit
8 data bits
1 stop bit
no parity
9600 bps

A control or status record consists of 8 characters. The first character is always # (hex 23) and the terminating character is always a carriage return character (hex 0D). The second and third characters identify the command, and the fourth to seventh characters contain a parameter value.

Command Syntax

6.4 Command Syntax

A control or status record consists of 8 characters. The first character is always # (hex 23) and the terminating character is always a carriage return (hex 0D). The second and third characters identify the command, and the fourth to seventh characters contain a parameter value.



Commands from Host to HS500

6.4.1 Commands from Host to HS500

xx	yyyy	Function
00	00zz	Request variable set by command number zz.The value yyyy is returned in the form #zzyyyyCR from the HS500 to the host
01	0000	Request status of HS500
02	0000	Request status of GC (GC READY signal) (3)
03	0000	Request sampler type and software version
04	0000	Request sampler configuration 1
05	00es	Set system parameters e=1: always enabled for HS500 s=0: start signal source GC READY; 1: REMOTE
07	0000	Request solvent and waste vial position
08	0000	Request number of injection points
09	0000	Request number of samples per row and column
10	0001-0050	Set first sample number of actual range
11	0001-0050	Set last sample number of actual range
13	0001-0009	Set injection method of actual range.This is also the actual method for parameter setting
15	0001-0009	Set actual sample processing range number Must be less or equal to last range number.This is also the active range for parameter setting
16	0001-0009	Set last sample processing range number
20	0001-2500	Set sample volume of actual method in 1µl units. Maximum value depends on syringe size
24	0000-0010	Set sample pullup count of actual method
25	0000-3599	Set minimal splitter time before injection of actual method in seconds Max value of 3599 seconds = 59:59
26	0000-3599	Set splitter time after injection of actual method in seconds Max value of 3599 seconds = 59:59
27	0000-0099	Set delay time from needle punch to sample injection of actual method in 0.1 second units
28	0000-0099	Set delay time from sample injection to needle pullout of actual method in 0.1 second units
29	0000-0299	Set pullup delay time of actual method in seconds Max value of 299 seconds = 4:59
30	0001-2500	Set filling volume of actual method in 1 µl units. Maximum value depends on syringe size
31	0000-0001	Set injection point of actual method 0 = OUTER 1 = INNER

xx	yyyy	Function
34	0000-0001	Set injection mode of actual method 0 = NORMAL INJECTION 1 = DBL 2VOL INJECTION 2= DUAL INJECTION
35	0025-3000	Set sample pullup speed of actual method in µl per second units Maximum value depends on syringe size
36	0025-3000	Set injection speed of actual method in µl per second units Maximum value depends on syringe size
40	0001-2500	Set sample volume of second injection for DBL 2 VOL and DUAL INJECTION mode Maximum value depends on syringe size
46	0000-3590	Set the time difference to be used between two injections for DBL 2VOL and DUAL INJECTION mode for actual method in 1.0 second units. Max value of 3590 seconds = 59:50
50	0030-0150	Set sample incubation temperature in °C Maximum value is 0120 (120°C) for HS500-50
51	0000-8639	Set sample incubation time in 10 sec units Max value of 8639 = 86390 seconds = 23:59:50
52	0000-0099	Set run time of agitator in seconds 0 disables agitator spinning
53	0000-0099	Set pause time of agitator in seconds 0 = running without pause and direction change
54	0006-0020	Set agitator speed in 100 rpm units
55	0001-0009	Set headspace extraction count
56	0000-0001	Set multiple extraction mode 0 = trapping; 1 = sequential
57	0000-8639	Set extraction time difference for multiple extraction modes (extraction count > 1) in 10 second units Max value of 8639 = 86390 seconds = 23:59:50
60	0006-8639	Set default runtime in 10 second units Max value of 8639 = 86390 seconds = 23:59:50
61	0030-0150	Set syringe temperature in °C
62	0000-0010	Set syringe bakeout temperature difference in °C 0 = no syringe bakeout used
63	0000-3059	Set syringe bakeout time in seconds Max value of 3059 seconds = 50:59
64	0000-3599	Set syringe flush time in seconds Max value of 3599 seconds = 59:59
65	0000-0010	Set syringe bakeout temperature difference in °C between injections for DBL 2VOL and DUAL INJECTION mode

xx	yyyy	Function
66	0000-3059	Set syringe bakeout time in seconds between injections for DBL 2VOL and DUAL INJECTION mode Max value of 3059 seconds = 50:59
67	0000-3599	Set syringe flush time in seconds between injections for DBL 2VOL and DUAL INJECTION mode Max value of 3599 seconds = 59:59
68	0030-0150	Set needle heater temperature in °C
90	0000	Abort processing of actual range - return from PROCESSING to STANDBY state
91	0000	Change state to PROCESSING
95	0000-0001	Set keyboard lock: 0 = UNLOCK 1 = LOCK If locked, a corresponding message is displayed at the terminal
99	0000	Start injection of next sample in range (4)

Notes:

1. The active method and method variables can be changed only while in STANDBY state, but not while the HS500 is processing a range of samples.
2. The status code returned reflects the last terminated working phase.
3. Requesting GC status makes sense only when the sampler is setup for remote start operation.
4. Start command from remote system is only accepted if the HS500 is set up for remote start operation. In addition to a start command the GC status must be ready in order to start the next sampling sequence. Short pins 7 and 8 at the **GC Interface Connector (19)** if no GC Ready signal is available or is checked directly by the remote system.
5. Every command sent is answered by the HS500. Requests return the corresponding response; parameter setting commands are echoed back if accepted, injection commands are responded by a code describing the sampler action. Invalid commands or parameters are responded by the code #0000xxCR with the command number in xx. If a parameter range has been exceeded and the invalid parameter message has been received, the actual limit value set should be requested by the command #0000xxCR.

Status Reports from HS500 to Host

6.4.2 Status Reports from HS500 to Host

xx	yyyy	Message
00	00zz	Command zz is not valid for this software version or has passed invalid parameter
01	ssss	Return sampler status requested by command #010000CR (see below for definition)
02	000r	Return GC status requested by command #020000CR r=0: GC not ready r=1: GC ready for injection
03	tvre	Return sampler type t (always 3 for HS500), software version v, revision r and edition e
04	s000	Return sampler configuration 1 s = 0: 1 ml syringe; 1: 2.5 ml syringe
05	001s	Return system setup values s = 0: start signal source GC READY; 1: REMOTE
08	000i	Return number of injection points (i = 1 or 2)
09	rrcc	Return number of samples per row (rr) and per column (cc)
10-68	yyyy	Return variable set with corresponding command or requested by command #0000xxCR
82	00nn	Vial nn got stuck in tray
83	00nn	Vial nn got stuck in incubator
84	nnnn	Runtime has been adjusted to nnnn (10 sec units)
85	00nn	Vial nn has been lost during transportation
86	00nn	Sample nn incubation finished, ready to inject if GC-Ready + Host-Ready
87	00nn	Sample nn has been put into heater for incubation
95	000k	Return keyboard status set by command #95000kCR k=0: UNLOCKED k=1: LOCKED
98	0nnn	Sample number nnn not in tray
99	mnnn	Sample number nnn has been injected using method m

Status code ssss:

0001	HS500 is in STANDBY state
0w02	HS500 is in PROCESSING state
0003	HS500 is LOCKED by user action (Changing method, executing utility function)
0004	HS500 is in ERROR state.The display on the control terminal shows an error message. Recover from host with a standby request (#900000).
1w00	Selecting sample number
2w00	Cleaning syringe
3w00	Incubating sample
4wnn	Pulling up sample; pulled up nn times
5w00	Injecting sample
6w00	Exchanging headspace
w < 7:	HS500 is working
w = 7:	waiting for command #990000CR from Data System
w = 8:	waiting for GC READY
w = 9:	HS500 is waiting because CLR key has been pressed

7. Parts List

7.1 Accessories

10-CV	Sample vial 10 ml
20-ACF	Cap 20mm for HS500
20-ST3	Septum Silicon/PTFE 3mm thick
CR-20	Crimping tool for caps 20mm
HO-207	Decrimping tool for caps 20mm
KIT VIAL HS500	Vial kit for Headspace Sampler HS500 50 ea vials 10-CV, caps 20-ACF, seals 20-ST3
SYR HS2.5-22-5	Syringe 2.5 ml for HS500 Sideport for gas flushing Fixed needle gauge 22 Sideport needle pointstyle 5
SYR HS2.5-26S-5	Syringe 2.5 ml for HS500 Sideport for gas flushing Fixed needle gauge 26S Sideport needle pointstyle 5
SYR HS1.0-22-5	Syringe1.0 ml for HS500 Sideport for gas flushing Fixed needle gauge 22 Sideport needle pointstyle 5
VENT2/2 42VDCSt	Splitter valve 2/2 way 42 V DC

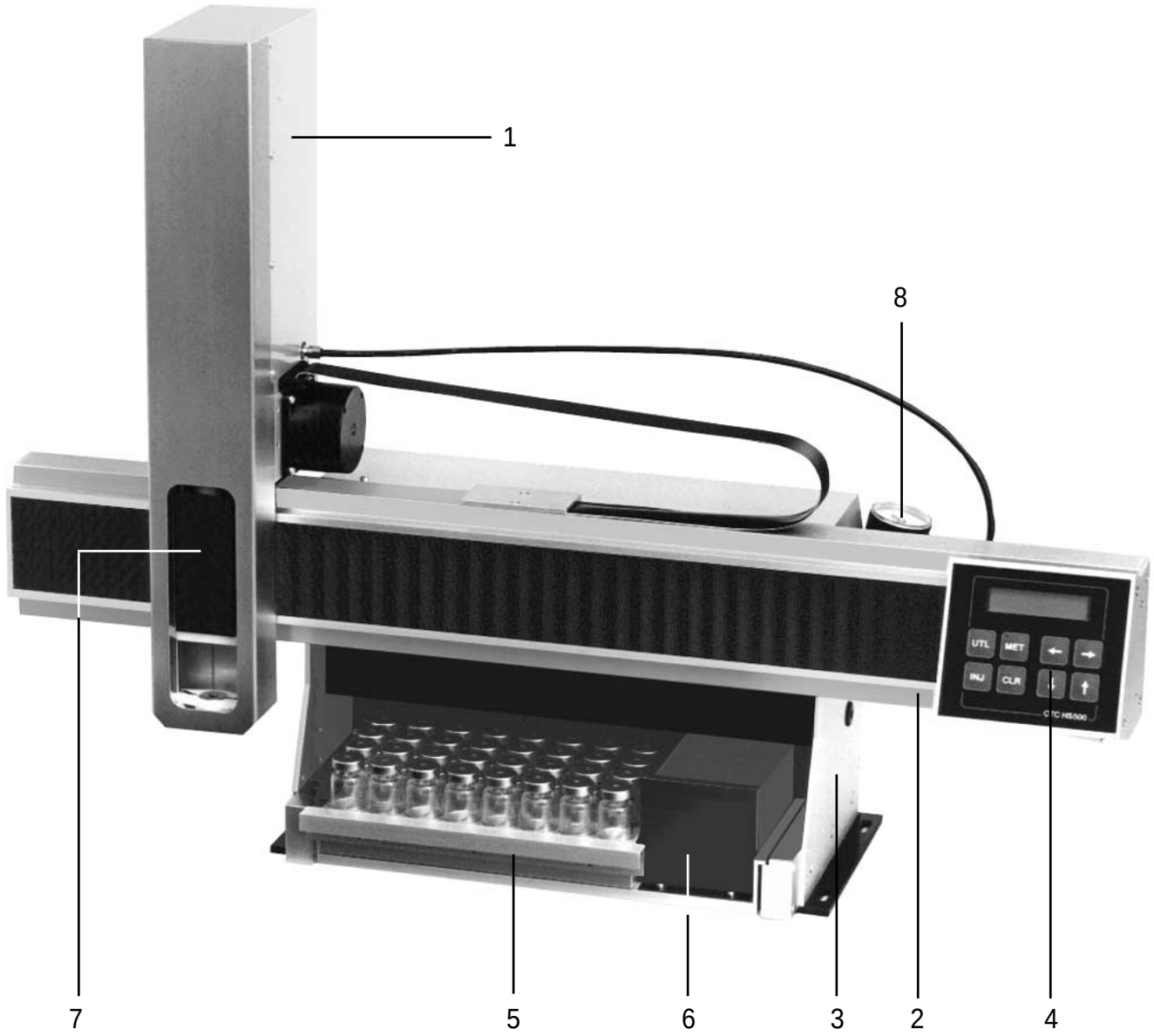
7.2 Options

HS500-1700A	Needle Heater
HS500-3501	Syringe heater for syringe 1 ml gastight
HS500-5100A	Sample tray 32 x 10 ml for HS500-32
HS500-5200A	Sample tray 50 x 10 ml for HS500-50

7.3 Spare Parts

HS500-1000	Instrument Base Unit (3)
HS500-1100	Base plate with sample tray drive
HS500-1500A	Sample Incubation Heater 6x10ml (6)
HS500-1600B	Agitator/Incubation Heater 2x10ml (10)
HS500-2000	Crossrail (2)
HS500-2220A	Toothed Belt (67)
HS500-2300	Dust Cover (56) (Inside width of guide is 12.0 mm)
HS500-2300A	Dust Cover (56) (Inside width of guide is 12.5 mm)
HS500-2901A	Cross Motor (21)
HS500-2912	Metal Flex Band (13) for injection head cable
HS500-3000	Injection Head (1), complete with motors, without syringe heater
HS500-3210	Syringe driving belt
HS500-3500	Syringe Heater (7) for gastight syringe 2.5 ml
HS500-3501	Syringe Heater (7) for gastight syringe 1.0 ml
HS500-3901A	Syringe Motor (15)
HS500-3921A	Plunger Drive Motor
HS500-6100A	Power module, consisting of AC Power Connector (27), Voltage Selector (25), Power Switch (28) and Transformer (74)
HS500-AGIDRV	Agitator/BCD Output Board (104)
HS500-CHEAD	Flat Cable to Injection Head (14)
HS500-CTRL	Main Control Board (80)
HS500-DRV	Heater Control Board (93)
SNS1-205	Switch 205mm
SNS1-310	Switch 310mm
SNS1-530	Switch 530mm

Figure 1: Front View HS500-32 with 6 x 10ml Incubation Oven

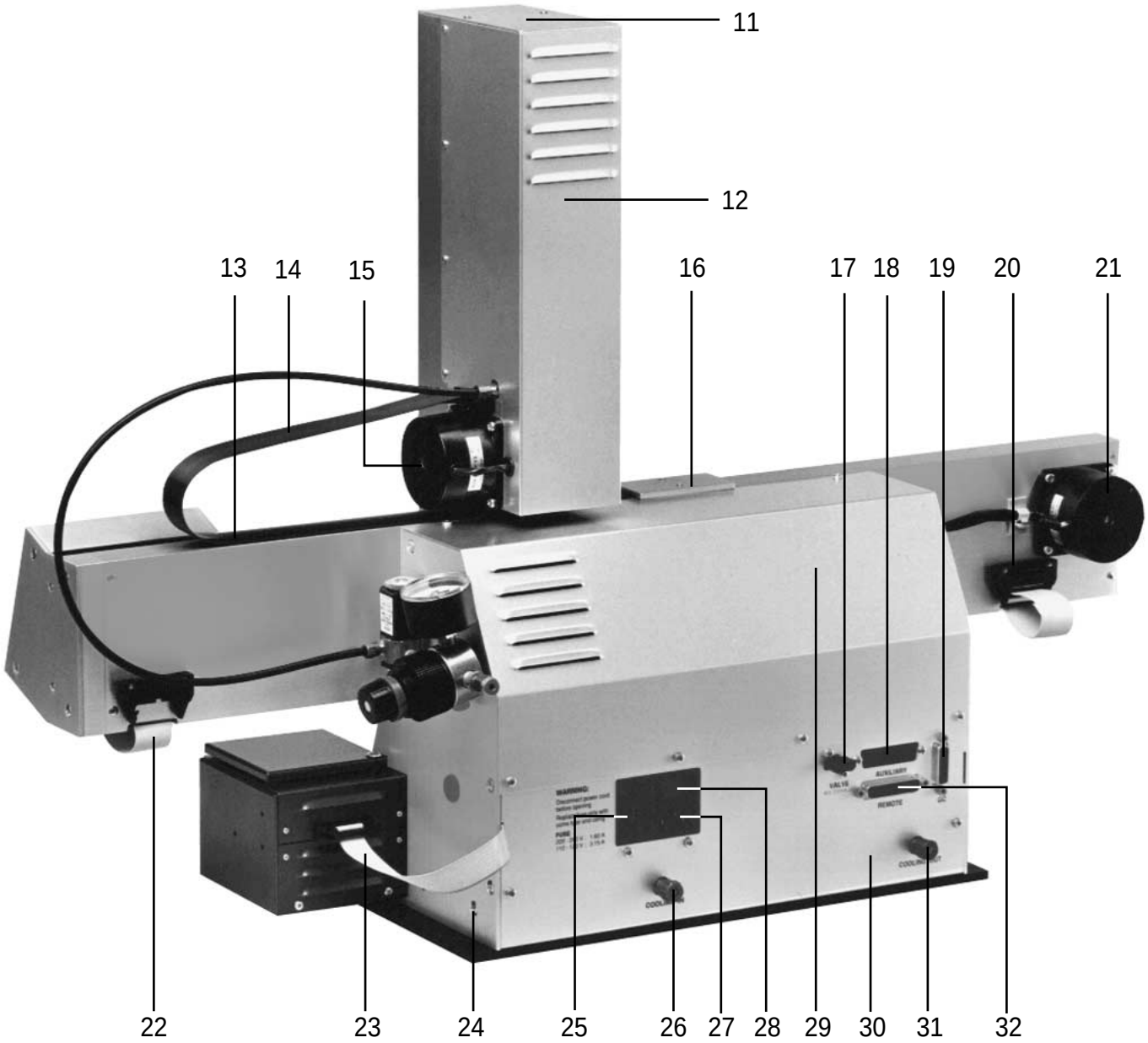


1 Injection Head
2 Crossrail
3 Instrument Base Unit
4 Control Terminal
5 Sample Tray 32x10ml
6 Sample Incubation Heater 6x10ml
7 Syringe Heater
8 Syringe Flush Gas Supply

Figure 2: Front View HS500-50 with 2 x10ml Agitator/Incubation Oven

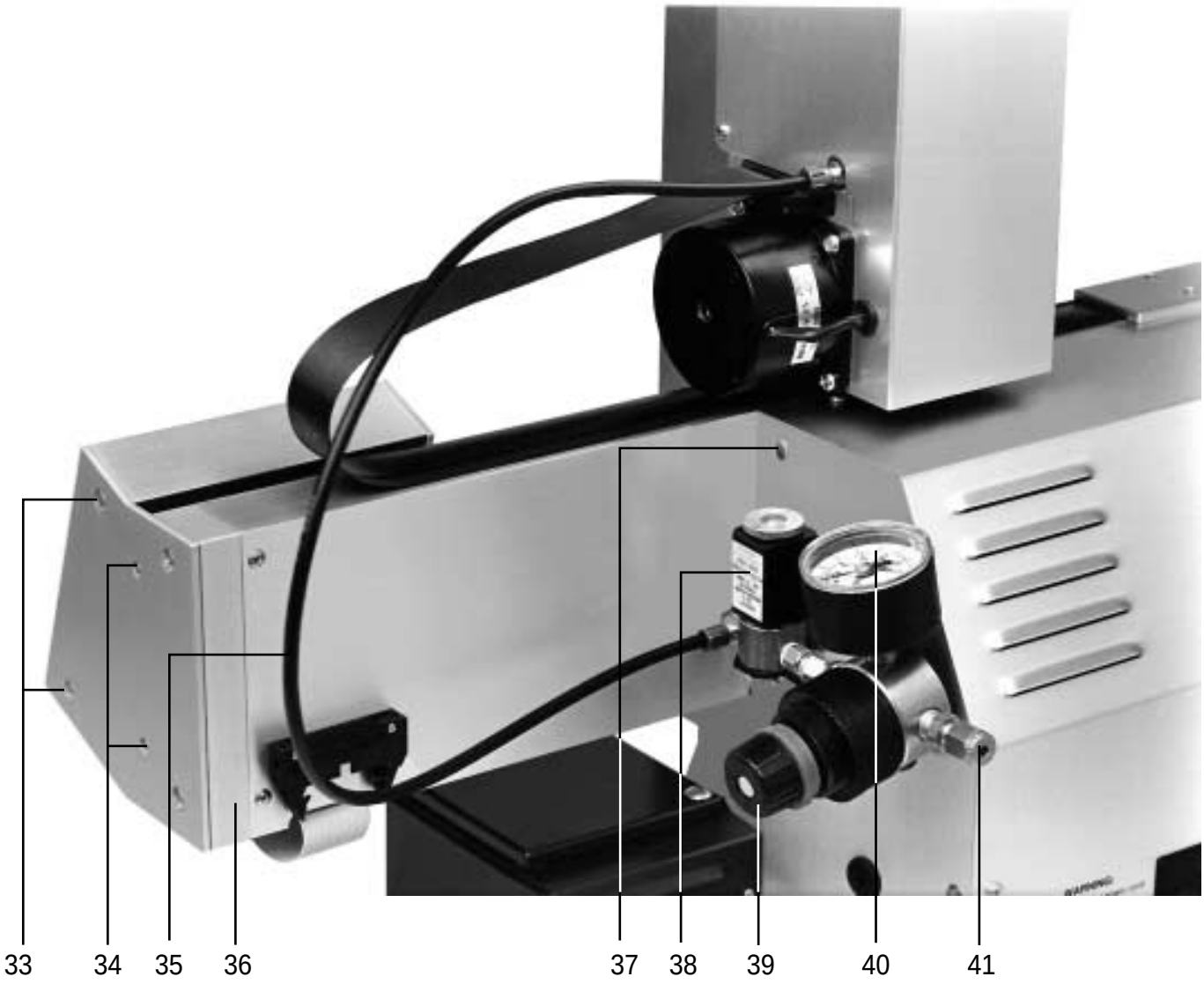
9 Sample Tray 50x10 ml
10 Agitator/Incubation Heater 2x10ml

Figure 3: Back and Side View



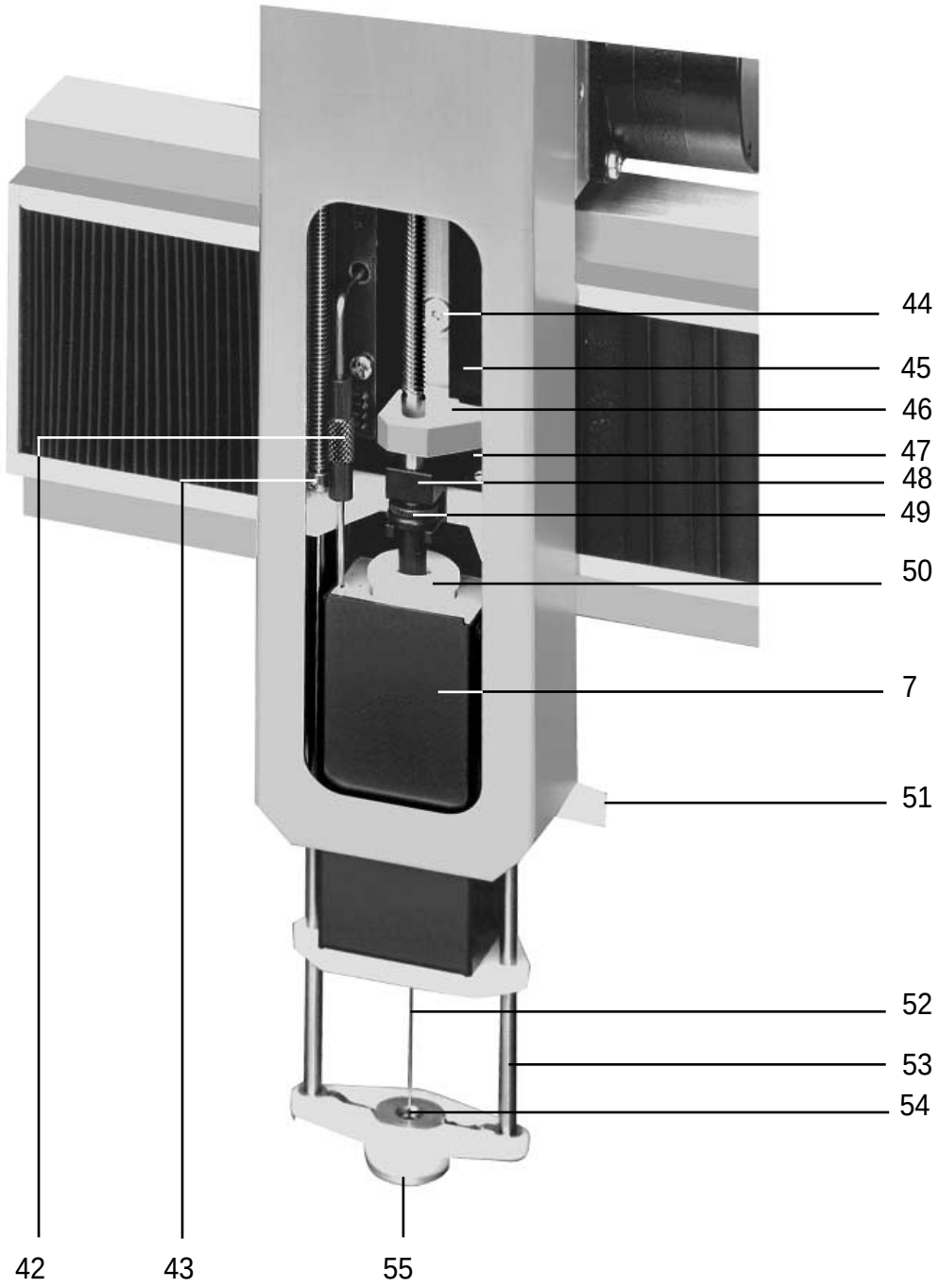
11 Injection Head Top Cover
12 Injection Head Cover
13 Metal Flex Band
14 Flat Cable to Injection Head
15 Syringe Motor
16 Flat Cable Bracket
17 Splitter Valve Connector
18 Parallel Connector for BCD Sample Number
19 GC Interface Connector
20 Socket for Unused Terminal Cable End
21 Cross Motor
22 Flat Cable to Control Terminal
23 Flat Cable to Agitator
24 Tray Drive Holding Screws
25 Voltage Selector
26 Cooling Inlet
27 AC Power Connector
28 Power Switch
29 Top Cover
30 Back Panel
31 Cooling Outlet
32 RS 232 Connector

Figure 4: Flush Gas Supply



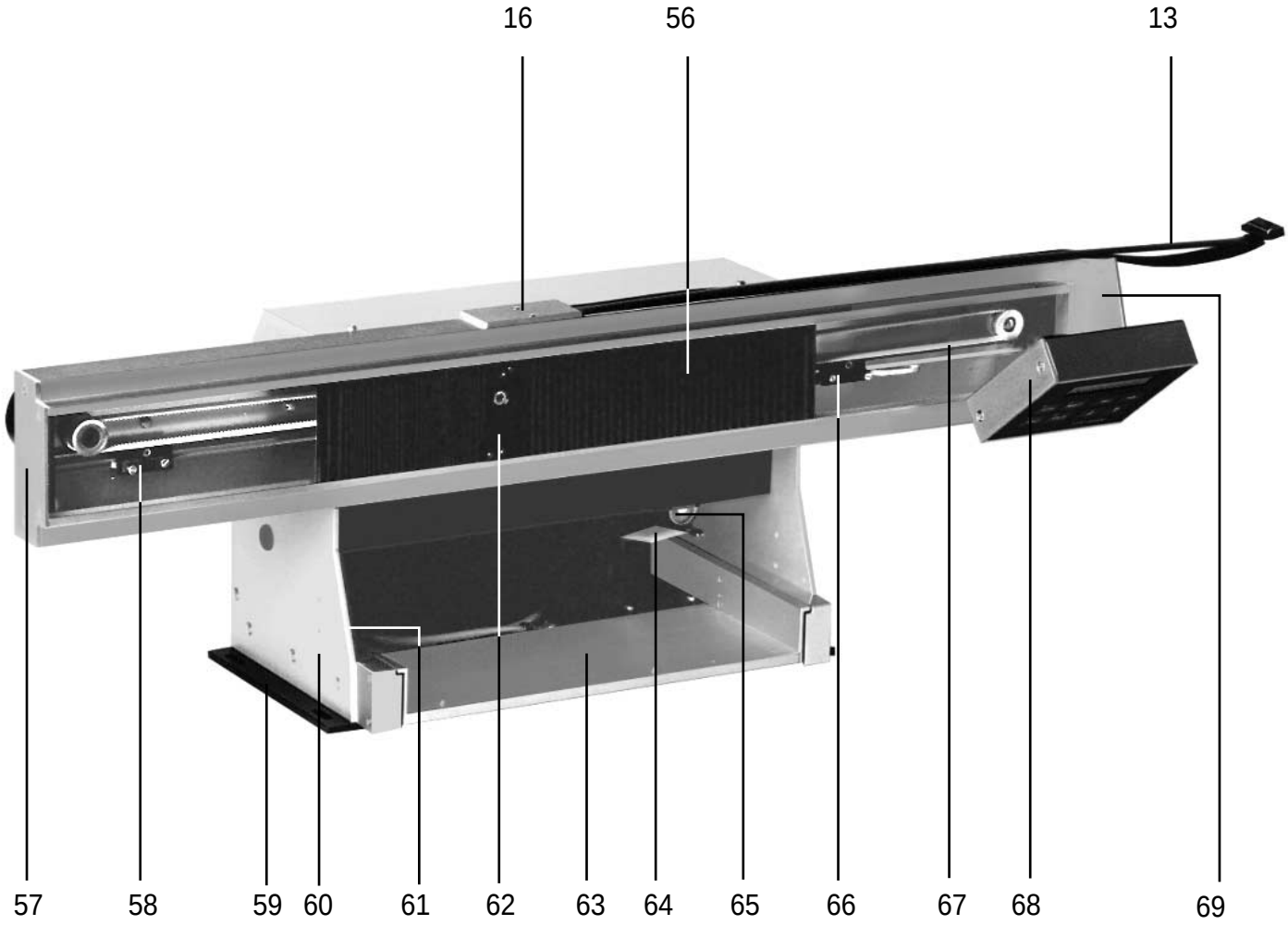
33 Control Terminal Mounting Screw
34 Dust Cover Screws
35 Flush Gas Line
36 Crossrail Extension Plate
37 Cross Member Mounting Screws
38 Flush Gas Valve
39 Flush Gas Pressure Adjustment
40 Flush Gas Pressure Gauge
41 Flush Gas Connection Fitting

Figure 5: Injection Head with Syringe Heater Cartridge



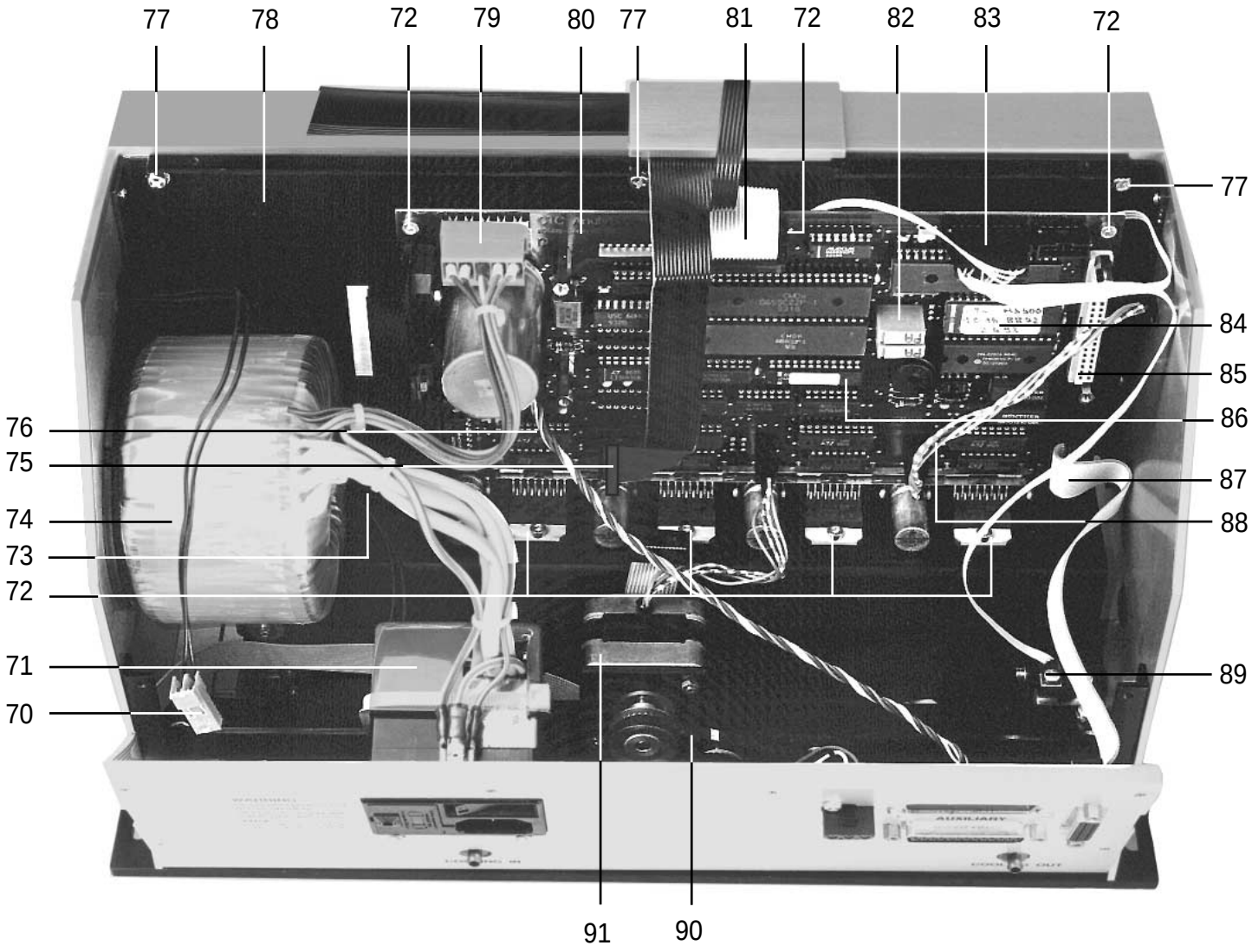
42 Flush Gas Connector
43 Needle Guide Stop
44 Injection Head Mounting Screw
45 Syringe Carrier
46 Plunger Down Switch Activator
47 Plunger Down Switch
48 Plunger Holder
49 Plunger Fixing Thumb Screw
50 Syringe Retaining Nut
51 Agitator Lid Activator
52 Syringe Needle
53 Needle Guide Rods
54 Needle Guide
55 Sample Vial Holder Magnet

Figure 6: Crossrail Front View



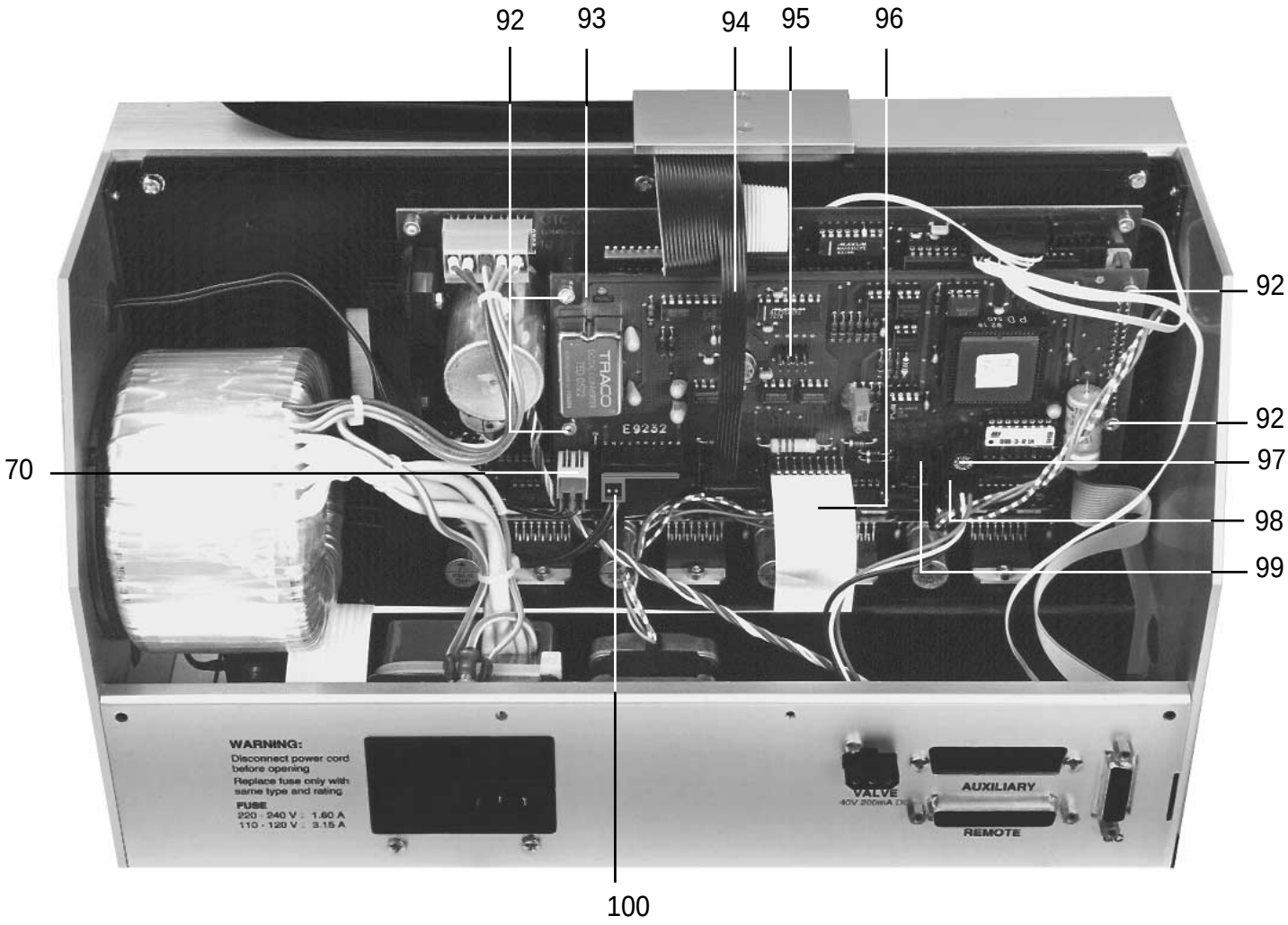
56 Dust Cover
57 End Cover on Injection Side
58 Inject Position Switch
59 Base Plate
60 Side Panel
61 Tray Switch Activator
62 Cross Slide
63 Cooling Plate
64 Flexible Connector Incubation Heater (HS500-32)
65 Holding Magnet Incubation Heater Lid (HS500-32)
66 Home Position Switch
67 Toothed Belt
68 Control Terminal End Cover
69 End Cover on Terminal Side

Figure 7: Main Control Board



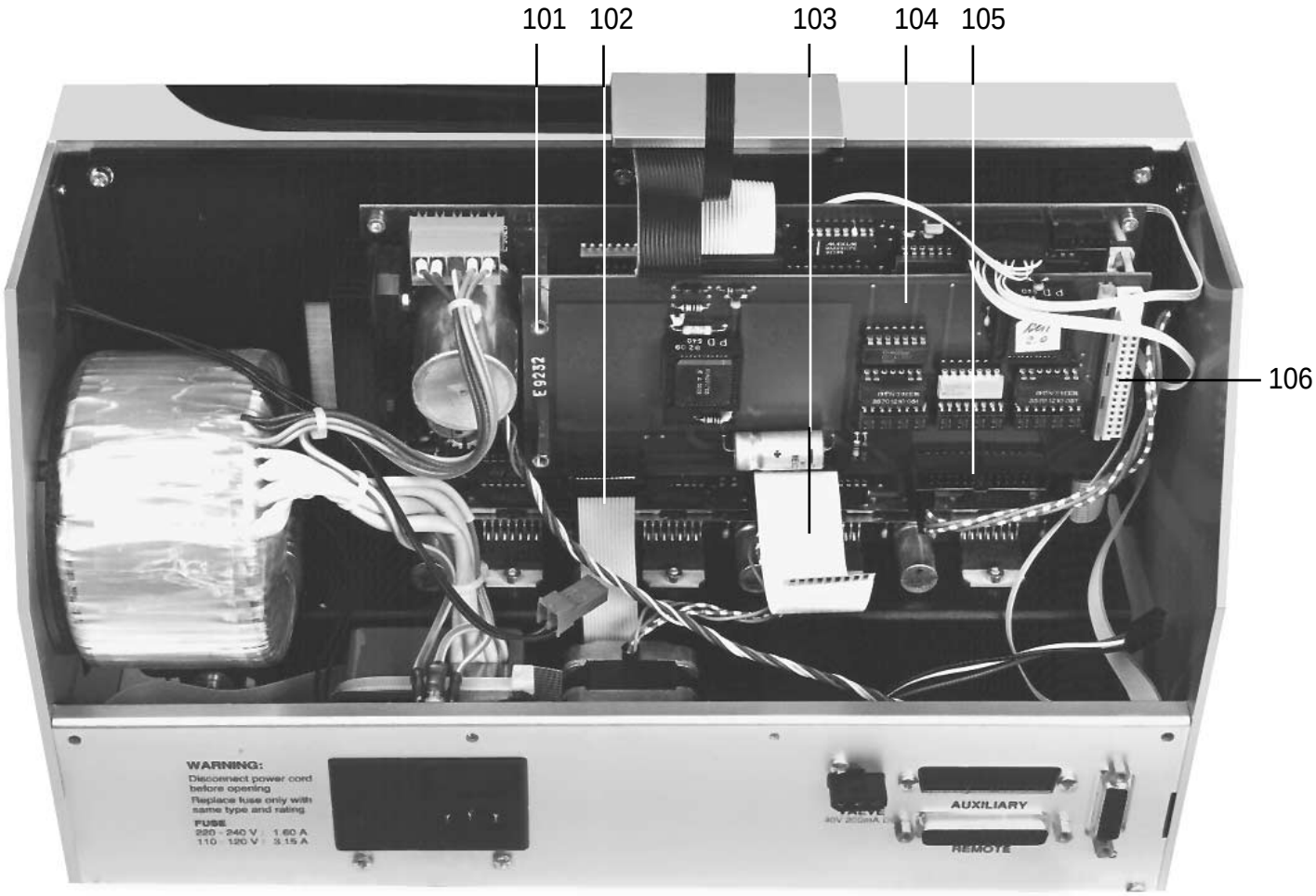
70 Flush Valve Connector
71 Protective Cover for Power Connector
72 Mounting Screws for Processor Board
73 Main Control Board Fuse
74 Transformer
75 Flat Cable to Injection Head
76 Serial Interface Connector
77 Mounting Screws for Cross Rail
78 Instrument Body Cross Member
79 Transformer Connector
80 Main Control Board
81 Flat Cable to Control Terminal
82 Backup Batteries
83 Position Switch Connector
84 EPROM
85 Extension Connector
86 PAL Chip
87 GC Interface Connection Cable
88 Cross Motor Cable
89 Tray Home Position Switch
90 Tray Driving Belt
91 Tray Drive Motor

Figure 8: Control Boards for 6x10ml Version



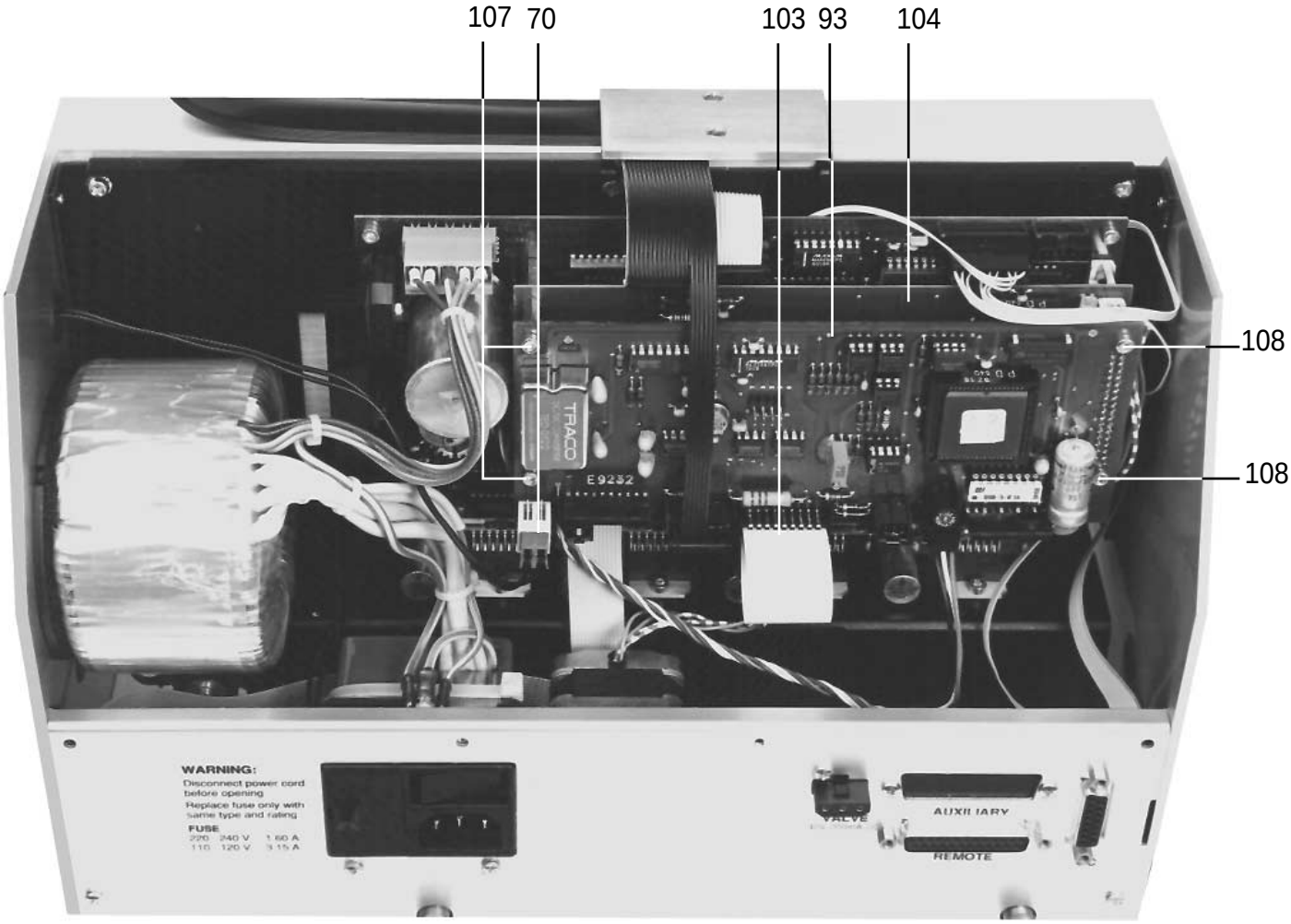
92 Fixing Screws M3x8 (4x)
93 Heater Control Board
94 Flat Cable Syringe Heater and Vial Magnet
95 Connector for Temperature Adjustment
96 Flexible Cable Incubation Heater (6x10ml)
97 Fuse for Splitter Valve
98 Splitter Valve Connector
99 Connector for Needle Heater
100 Lid Holding Magnet Connector

Figure 9: Control Boards for Agitator Version (Heater Control Board Removed)



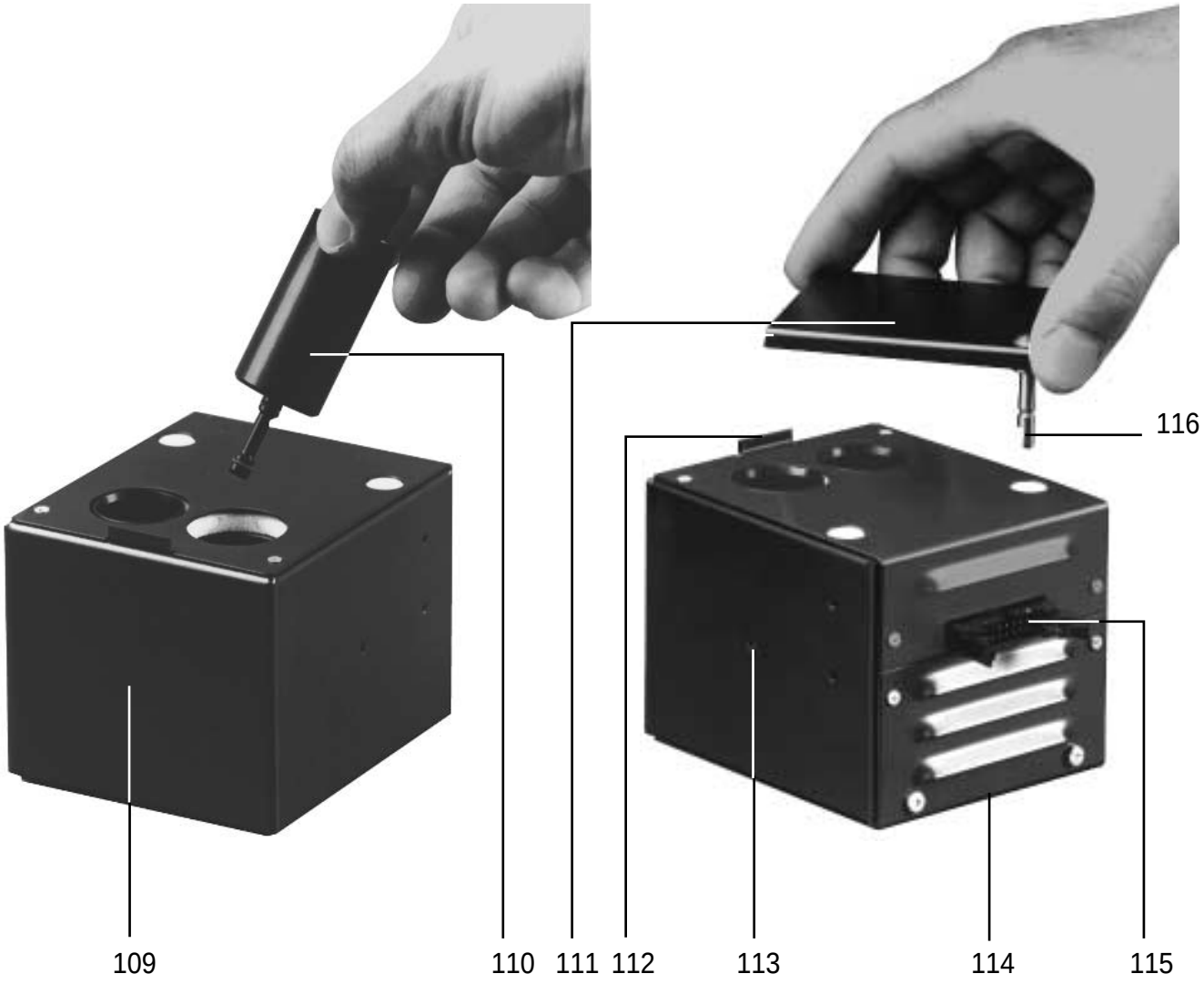
101 Agitator Board Mounting Bolts
102 Connector for Agitator/Incubation Heater
103 Feed Through Cable for Incubation Heater
104 Agitator/BCD Output Board
105 BCD Output Connector
106 Feed Through Extension Connector

Figure 10: Control Boards for Agitator Version



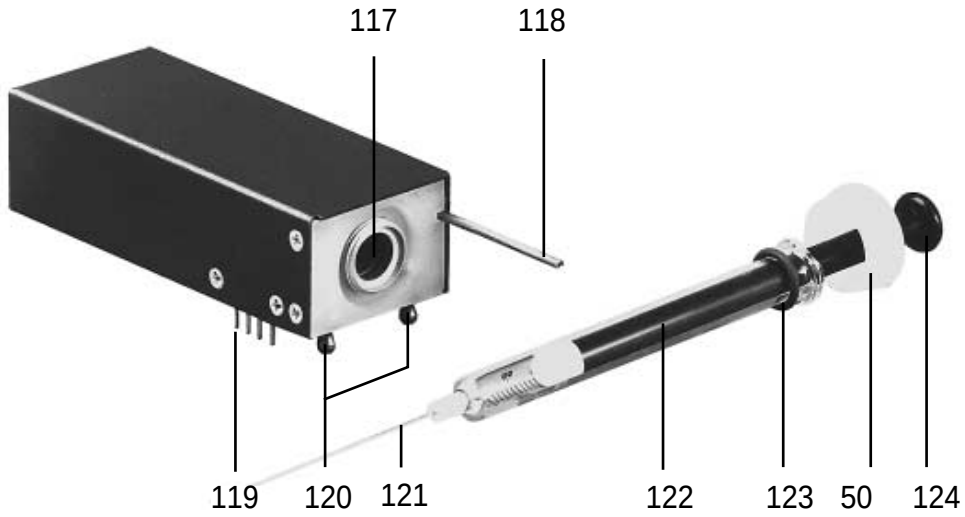
107 Fixing Screws M3x8
108 Fixing Screws M3x25

Figure 11: Agitator/Heater 2x10ml



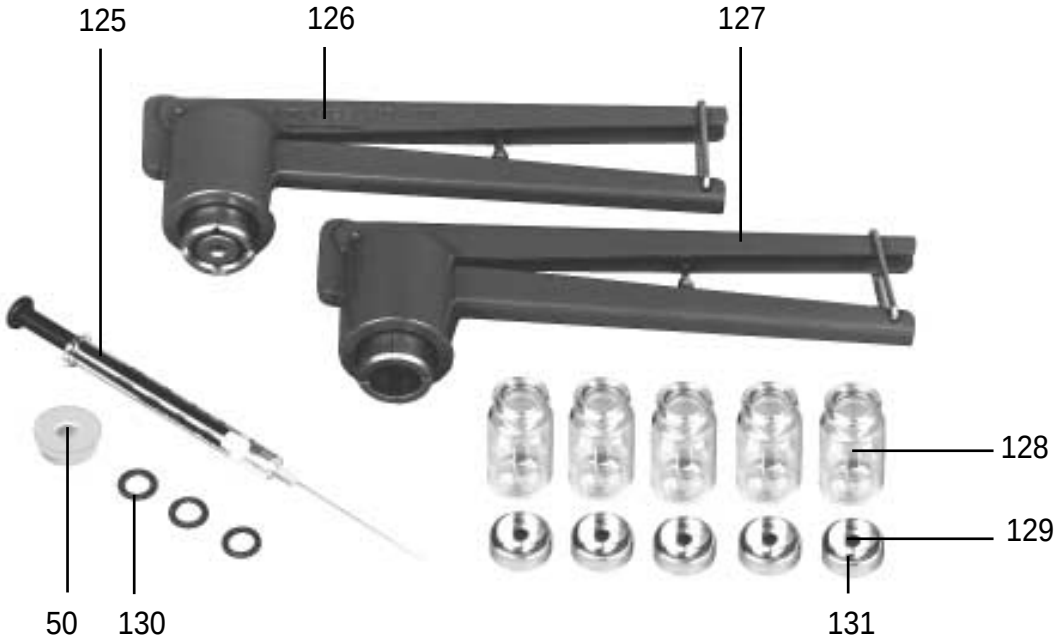
109 Agitator Base Unit
110 Spinning Heater Bushing
111 Agitator Protective Lid
112 Lid Stop
113 Mounting Threads
114 Agitator Bottom Cover
115 Agitator/Heater Connector
116 Lid Closing Spring Coupling

Figure 12: Syringe Heater Cartridge with Syringe



117 Syringe Heater Cartridge
118 Flush Gas Line
119 Electric Connector for Heater
120 Snap-In Bolts
121 Fixed Syringe Needle
122 Syringe Glass Body with Flush Gas Sideport
123 Flange Protection O-Ring
124 Plunger with PTFE Tip

Figure 13: Spare Parts and Consumables



125 Gastight Syringe with Sideport
126 Decapper 20 mm
127 Crimper 20 mm
128 10ml Vials with Rounded Bottom
129 Septum Silicone/PTFE 3mm
130 O-Ring Viton/PTFE
131 Metal Crimp Cap

Diagram 1: Processing Method Parameters

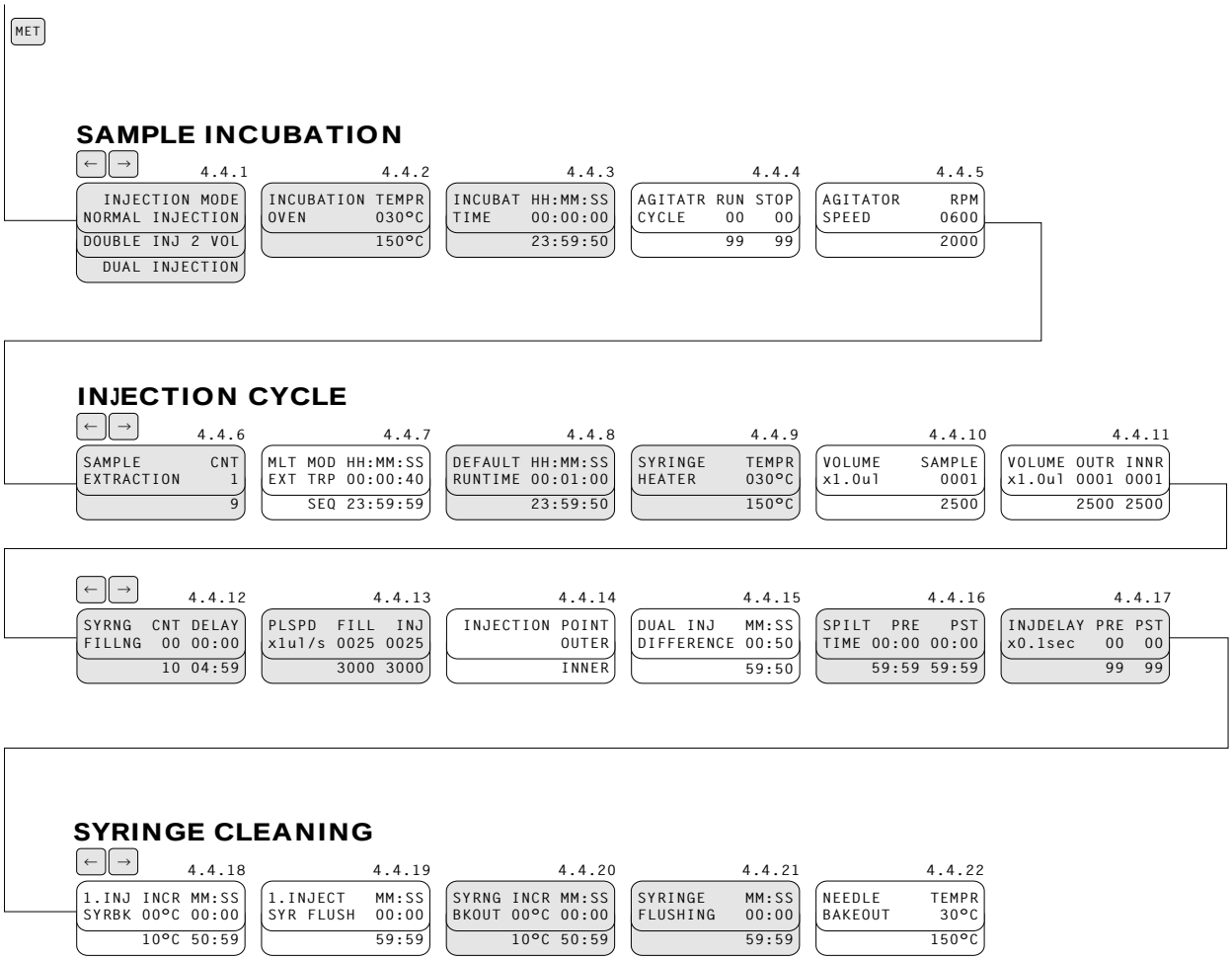


Diagram 2: Utility Functions

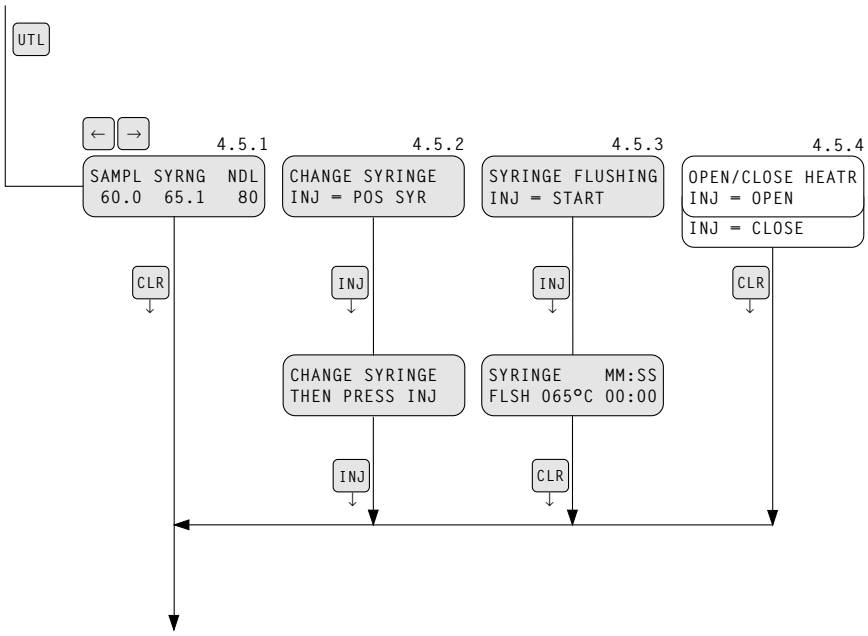


Diagram 3: System Setup and Maintenance Functions

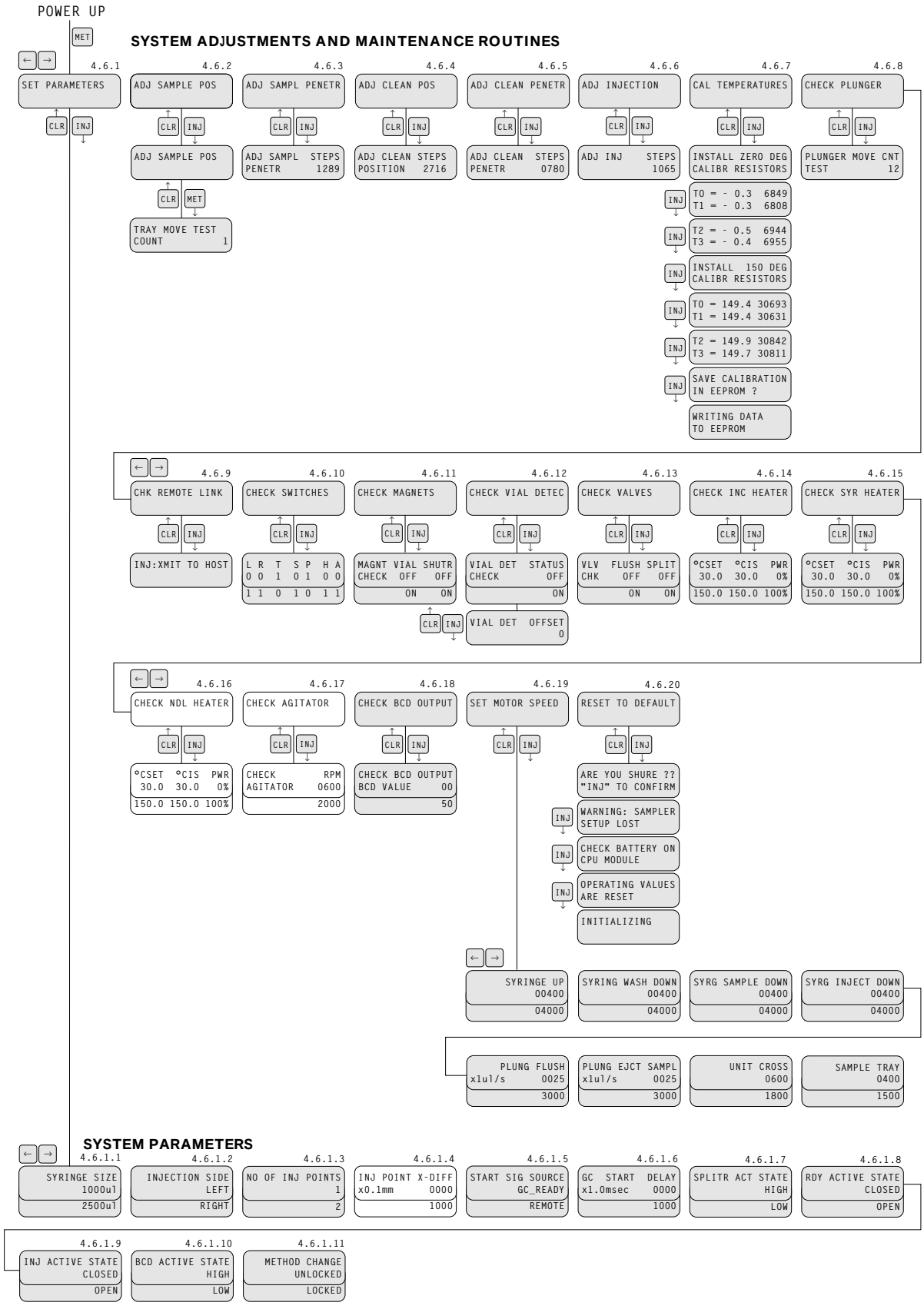


Diagram 4: Wiring Diagram Main Control Board

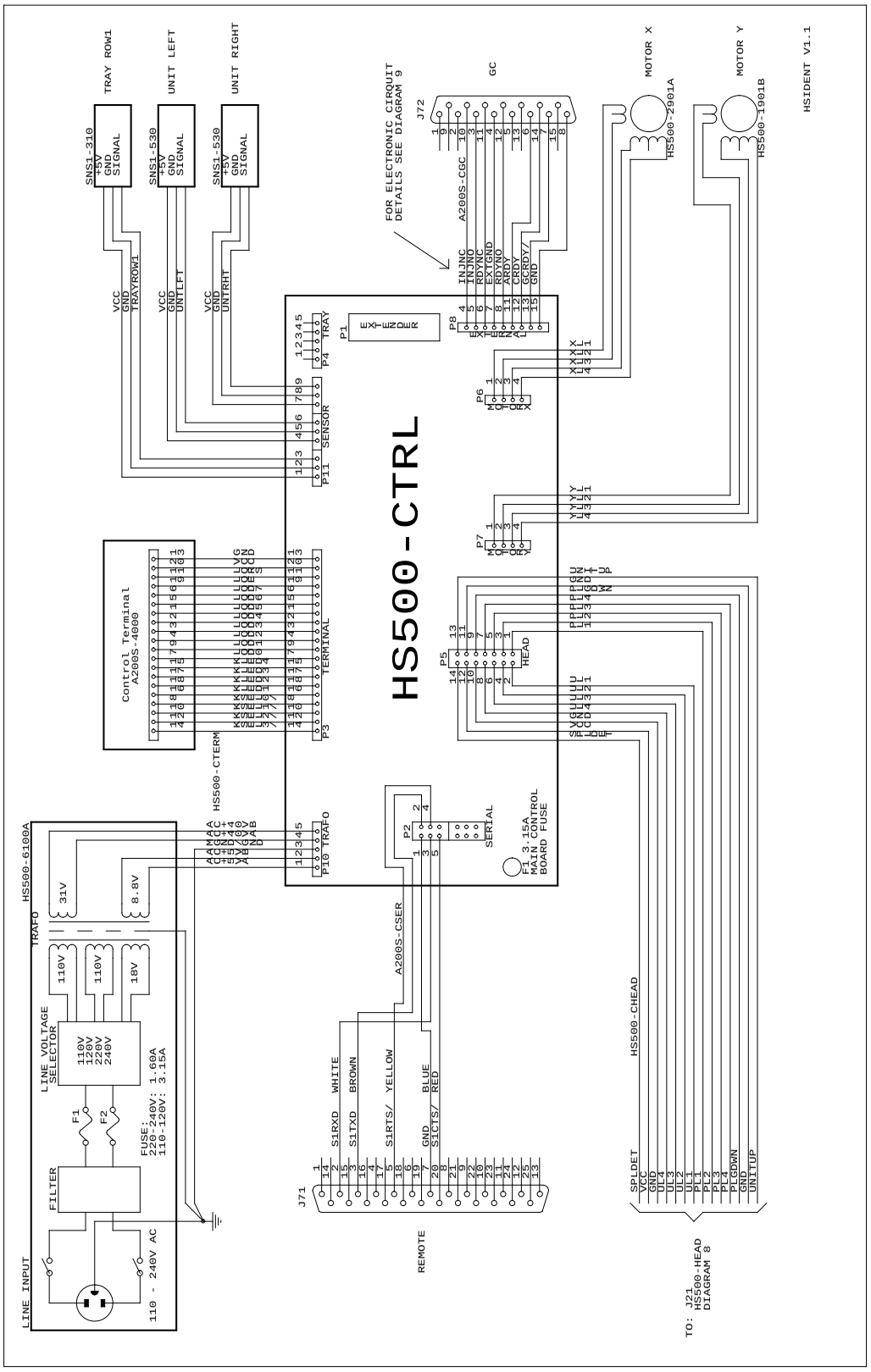


Diagram 5: Wiring Diagram Heater Control Board (HS500-32)

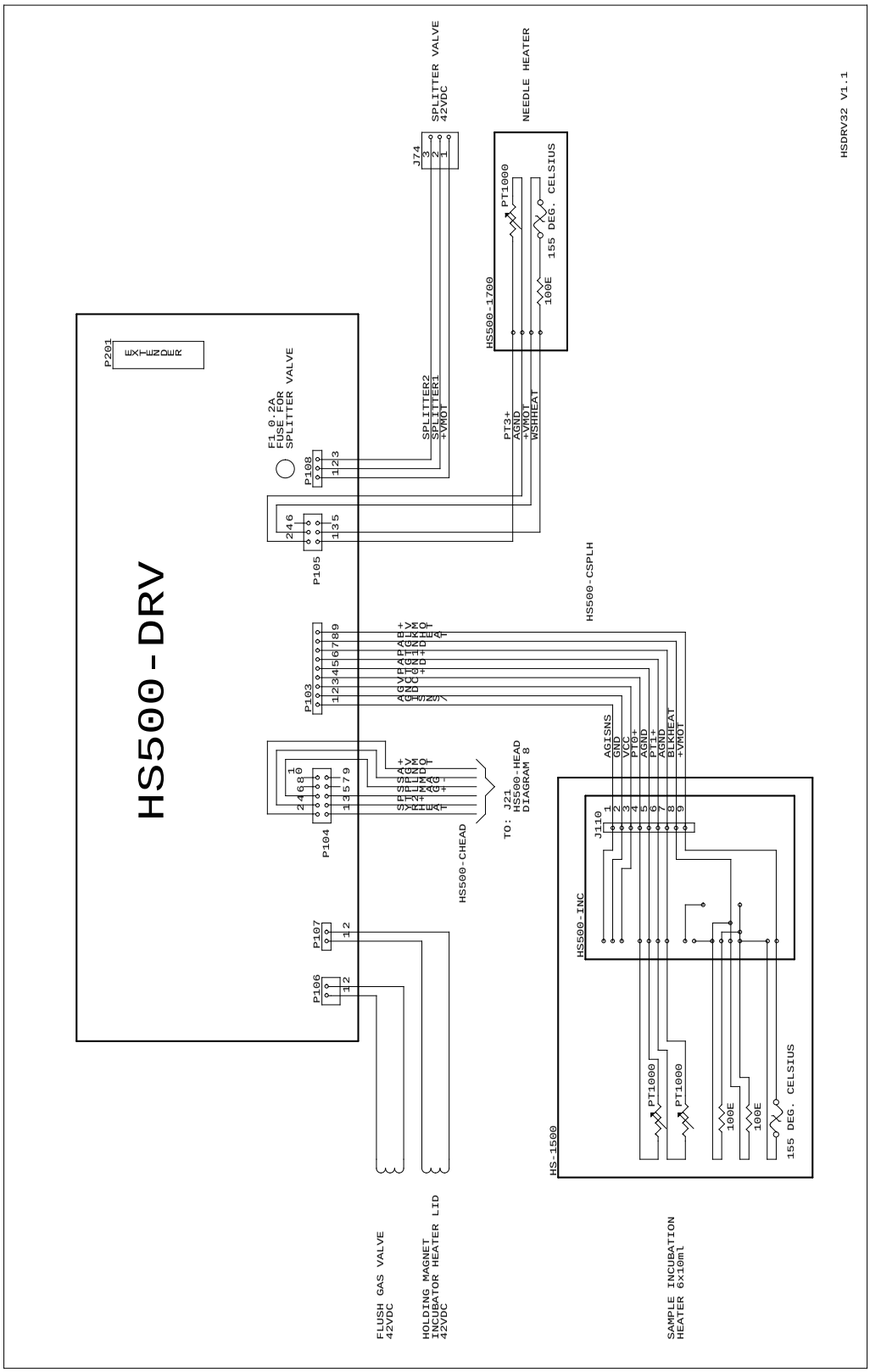


Diagram 6: Wiring Diagram Heater Control Board (HS500-50)

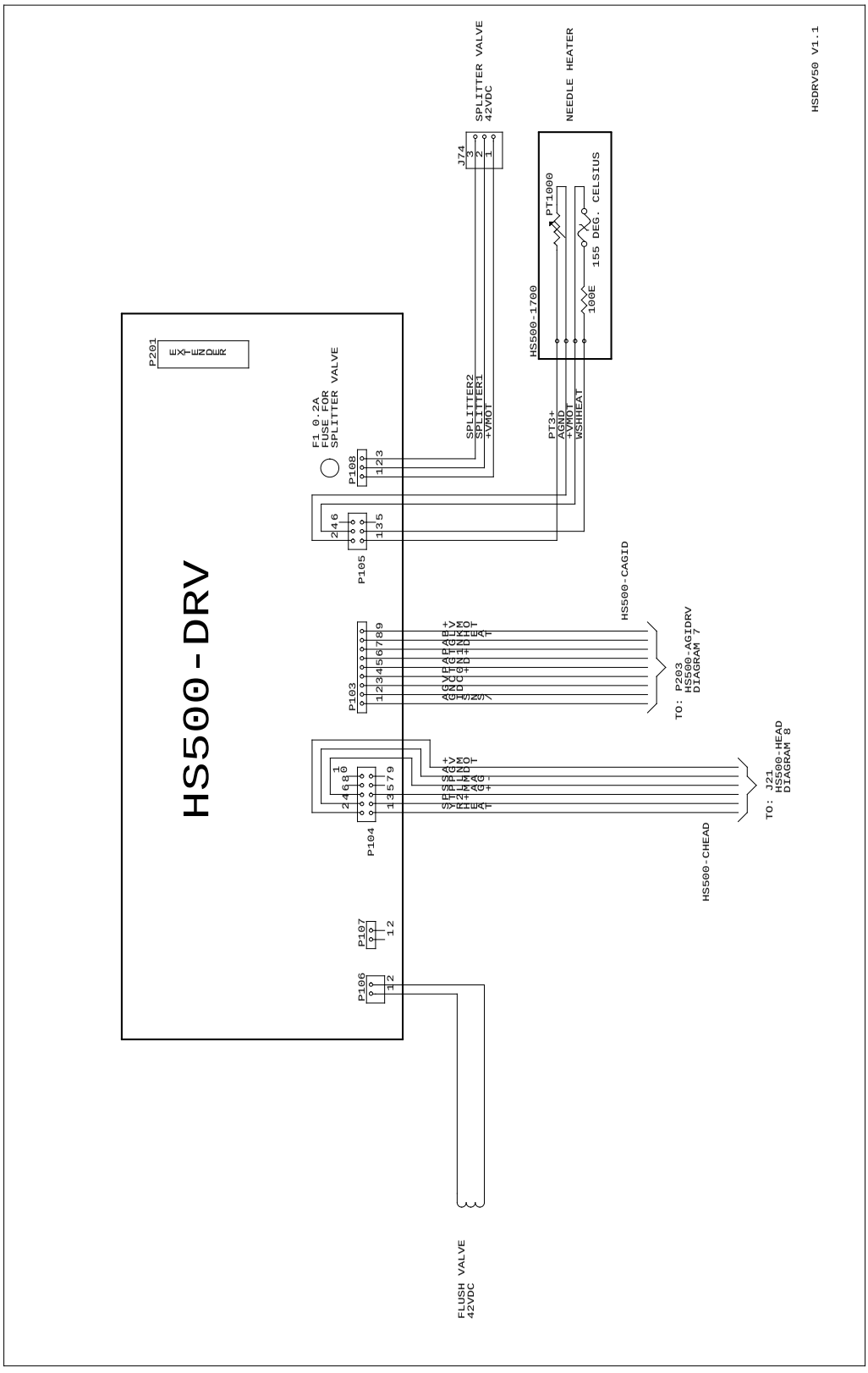


Diagram 7: Wiring Diagram Agitator/BCD Output Board (HS500-50)

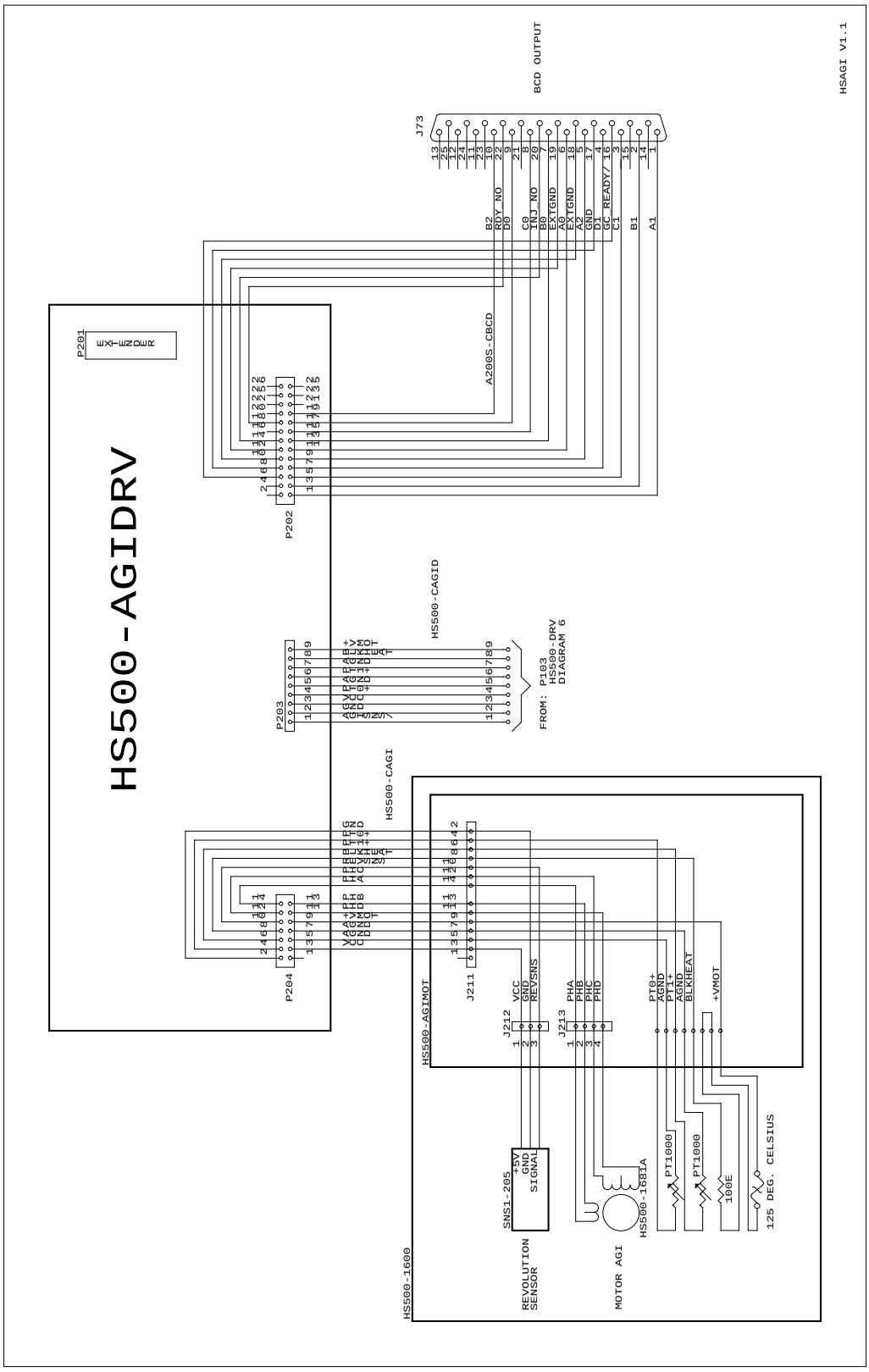


Diagram 8: Wiring Diagram Injection Head

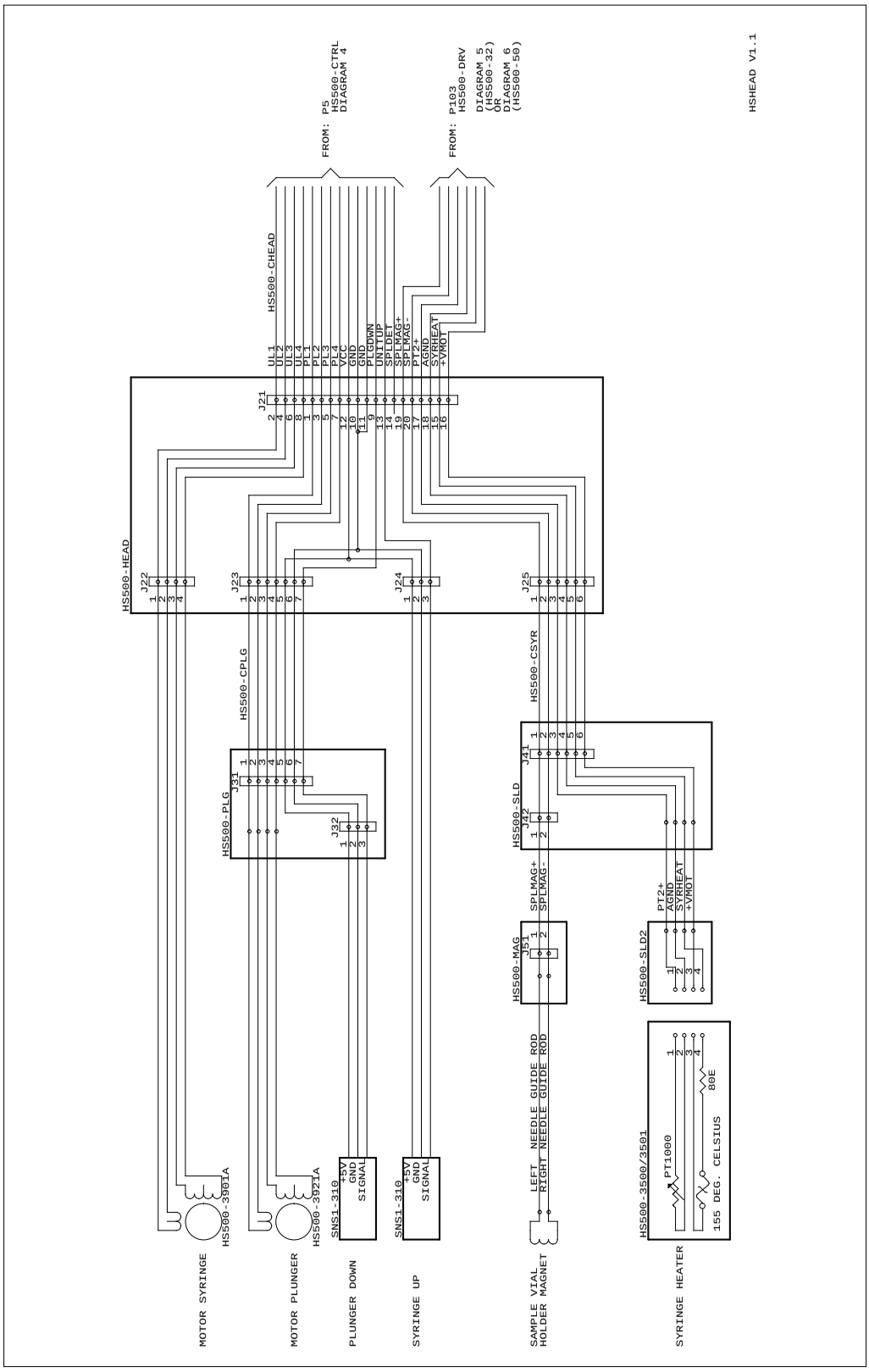


Diagram 9: External Input/Output Circuit

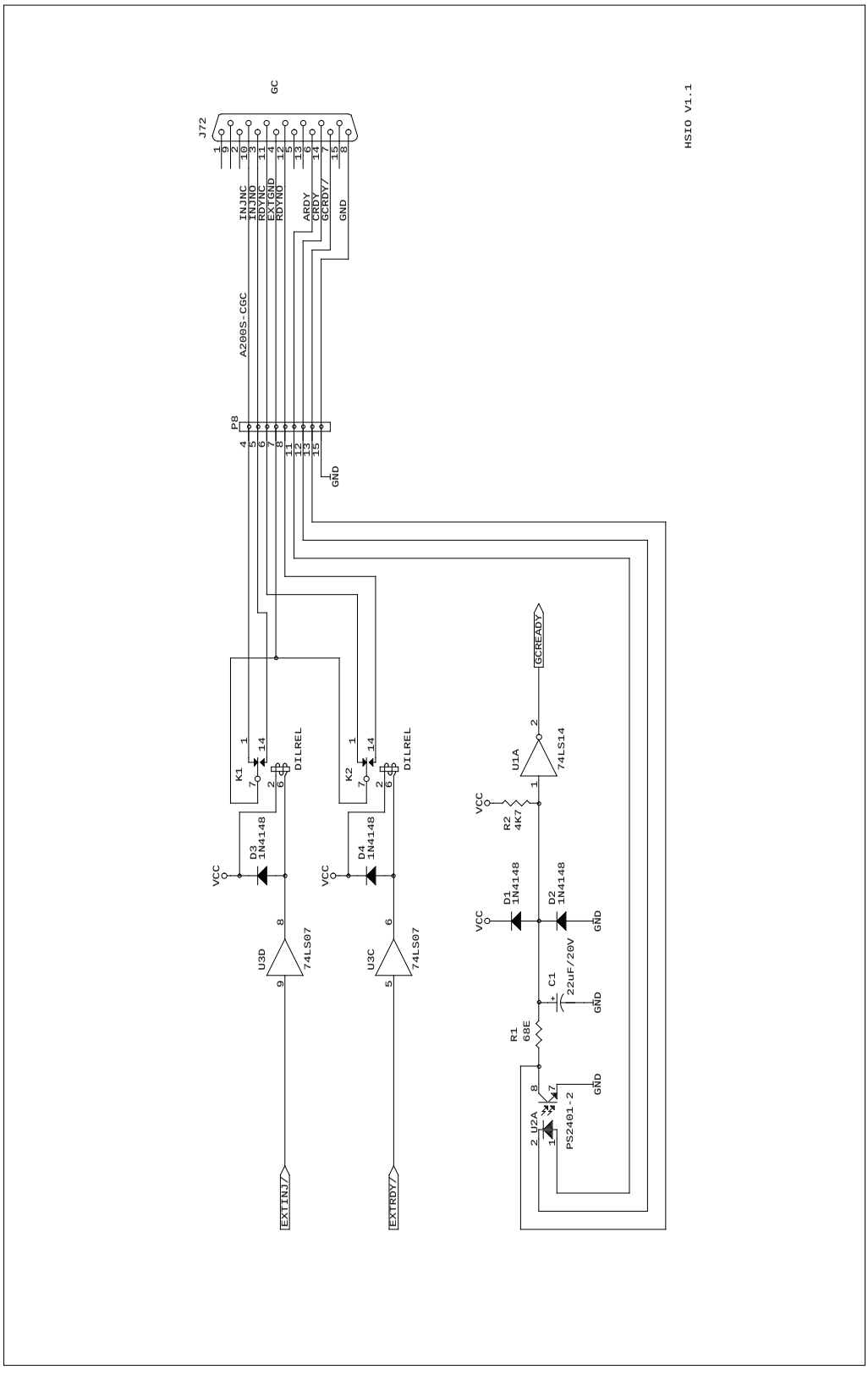


Table 1: Method Default Values

Description	Display Title	Default	Meth 1	Meth 2	Meth 3	Meth 4	Meth 5	Meth 6	Meth 7	Meth 8	Meth 9
Injection Mode		NORMAL									
Incubation Oven	TEMPR	60°C									
Incubation Time	HH:MM:SS	00:20:00									
Agitator Cycle	RUN STOP	05 03									
Agitator Speed	RPM	1600									
Sample Extraction	CNT	01									
Mult. Extraction Mode	MOD	SEQ									
Mult. Extraction Time	HH:MM:SS	00:15:00									
Default Runtime	HH:MM:SS	00:10:00									
Syringe Heater	TEMPR	65°C									
Volume (1 Injector)	SAMPLE	1250									
Volume (2 Injectors)	OUTR INNR	1250 1250									
Syringe Filling	CNT DELAY	0 00:02									
Plunger Speed	FILL INJ	300 300									
Injection Point	POINT	OUTER									
Dual Injection Diff	MM:SS	01:00									
Splitter Time	PRE PST	00:00 00:00									
Injection Delay	PRE PST	00 00									
1. Inj Syringe Bakeout	INCR MM:SS	00 00:00									
1. Inject Syringe Flush	MM:SS	00:10									
Syringe Bakeout	INCR MM:SS	5 00:10									
Syringe Flushing	MM:SS	1:25									
Needle Bakeout	TEMPR	80°C									

Table 2: System Setup Default Values

System Parameter	Display Title	Default	Actual
Syringe Size	SYRINGE SIZE	2500	
Injection Side	INJECTION SIDE	LEFT	
Number of Injection Points	NO OF INJ POINTS	1	
Injection Point X-Difference	INJ POINT X-DIFF	0000	
Start Signal Source	START SIG SOURCE	GC_READY	
GC Start Delay	GC START DELAY	0020	
Splitter Output Active State	SPLITR ACT STATE	HIGH	
Ready Output Active State	RDY ACTIVE STATE	HIGH	
Injected Output Active State	INJ ACTIVE STATE	CLOSED	
BCD Output Active State	BCD ACTIVE STATE	HIGH	
Method Change Locking	METHOD CHANGE	UNLOCKED	

Motor Speed			
Syringe Up	SYRINGE UP	0800	
Syringe Down at Clean Pos.	SYRING WASH DOWN	0800	
Syringe Down at Sample Pos.	SYRG SAMPLE DOWN	0800	
Syringe Down at Injection	SYRG INJECT DOWN	0800	
Plunger when Flushing Syringe	PLUNG FLUSH	1300	
Plunger Down at Sample Filling	PLUNG EJCT SAMPL	0400	
Injection Head X-Direction	UNIT CROSS	0800	
Sample Tray In and Out	SAMPLE TRAY	0500	

Penetration Depth			
Sample Penetration (HS500-50)	ADJ SAMPL PENETR	1289	
Sample Penetration (HS500-32)	ADJ SAMPL PENETR	1114	
Clean Position (HS500-50)	ADJ CLEAN POS	2716	
Clean Position (HS500-32)	ADJ CLEAN POS	2447	
Clean Penetration	ADJ CLEAN PENETR	780	
Injection	ADJ INJECTION	1065	