

# **IsoBar<sup>TM</sup> Circulator MasterModule**

## **Operating Instructions for IsoBar<sup>TM</sup> 3-100, 4-75, 5-88, 5-120, 6-95, 6-110 and 8-100**

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# 1. QUICK GUIDE

## MasterModule

The purpose of this Quick Guide is to describe the basic programming of an IsoBar™ Circulator for operation in ISOBAR mode (self-regulating proportional pressure). By following the instructions you will soon be familiar with the basic operating principles. The graphical guide on pages 4 – 9 provides you with a general overview.

- Use the “+” and “-” keys to switch from one main menu to the next/previous.
- Use the “\*” key to enter/leave a menu.

Setting the IsoBar™ Circulator to ISOBAR operation with a pre-selected set-point (pressure) is performed as follows:

- Adjust TIME
- Enter factory settings
- Adjust PRESSURE SET (set-point) [0 – 100 %]

From the factory, the pump is pre-set to run proportional pressure regulation with a set-point of 50 %. By set-point is meant the desired pressure in percent of the maximum pump pressure at a flow equal to zero.

**Note:** As the internal communication has a higher priority than data entry, **it may be necessary to press a key several times before the master module responds.**

### Adjustment of time

Always start from a MAIN MENU. Please refer to the graphical guide (pages 4 to 9).

- Press the “+” or “-” key until MAIN MENU <TIME FUNCTIONS> appears on the display.
- Press the “\*” key. EXIT TIME FUNCTIONS appears.
- Press the “+” key until SET TIME xx:xx appears.
- Press the “\*” key to initiate adjustment. A “\*” appears furthest to the right indicating that adjustment can be performed.
- Press the “+” key to adjust the hour setting and the “-” key to adjust the minute setting.
- Press the “\*” key to accept the setting. The “\*” disappears from the display and the clock is started.
- Return to the main menu by first pressing the “+” key until EXIT TIME FUNCTIONS appears, then press the “\*” key. MAIN MENU <TIME FUNCTIONS> appears on the display.

### Entry of factory settings

- Press the “+” or “-” key until MAIN MENU <TIME FUNCTIONS> appears.
- Press the “\*” key. EXIT FUNCTIONS appears.
- Press the “+” key until FACTORY RESET appears in the top line.
- Press the “\*” key to perform resetting. A “\*” will appear briefly indicating that the factory settings are in place.
- Press the “-” or “+” key until EXIT FUNCTIONS appears.
- Return to MAIN MENU <TIME FUNCTIONS> by pressing the “\*” key.

### ISOBAR setting

- Press the “+” or “-” key until MAIN MENU <SETTINGS> appears.
- Press the “\*” key until EXIT SETTINGS appears.
- Press the “+” key again. PRESSURE SET appears in the top line.
- Press the “\*” key. A “\*” appears furthest to the right in line 2.
- Adjust the pressure (in %) by means of the “+” and “-” keys.
- Press the “\*” to accept the value.
- Press the “-” key until EXIT SETTINGS appears.
- Press the “\*” key. MAIN MENU <SETTINGS> appears.

Now the pump is programmed to run in ISOBAR mode (proportional pressure). For detailed information, please refer to the relevant sections in the Operating Instructions.

## **2. INTRODUCTION TO THE MasterModule**

This manual is divided into chapters and sections according to functions and operating tasks. If you are using the module for the first time, we recommend that you read chapters 2, 3 and 4 thoroughly. Here the general pump features and general operating principles of the keyboard and display are described.

Since many of the functions of the master module are related to time, it is important to set the built-in clock as soon as the MasterModule has been connected. Please refer to Section 4c, “The TIME FUNCTIONS menu” and/or Section 2a. “Graphical Guide, Setting Time”.

It is only necessary to set the time once. When the master module has been connected for approx. 10 minutes, the built-in 72 hours reserve power will support the time function. The clock will also continue functioning, despite a power failure.

Please refer to Chapter 5 “Pump Features” after the time has been set. In this chapter, the different features are described, and you are guided through the menu options required to achieve your actual task.

If you wish to set the pump as quickly as possible, the “Graphical Guide” (pages 4-9) provides you with step-by-step procedures. By reading the complete manual, you will get a better understanding of the pump and all its functions.

## 2a. GRAPHICAL GUIDE

The purpose of this Graphical Guide is to provide you with step-by-step procedures for starting up the IsoBar™ Circulators 3-100, 4-75, 5-88, 5-120, 6-95, 6-110 and 8-100 as ISOBAR pumps (self-adjusting proportional pressure pumps).

- Switch between the main menus by pressing the “+”- and “-” keys.
- Press the “\*” key to enter the chosen menu.

To adjust the IsoBar™ Circulator to ISOBAR operation with a pre-set set-point, proceed as follows:

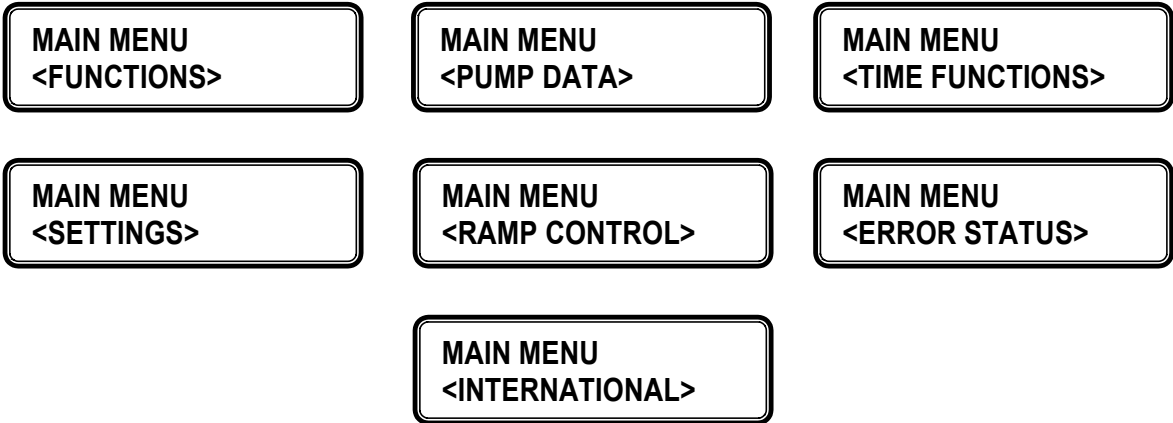
- Adjust TIME
- Enter factory settings
- Adjust PRESSURE SET (set-point)

From the factory the pump has been adjusted in order to run proportional pressure regulation with 50 % as set-point value. The set-point is the desired pressure setting in % of the maximum pump pressure at zero flow.

**Note:** As the internal communication has a higher priority than data entry, **it may be necessary to press a key several times before the master module responds.**

When you start programming, one of the 7 main menus in Fig. 1 should be displayed.

Fig. 1



If the display does not show one of these main menus, you can reset the module by turning off the pump for at least 5 seconds.

### Setting time



Fig. 2

If the display differs from Fig. 2, then press the “+” or “-” key until it appears.



Fig. 3

If the display in Fig. 3 is shown, then press the “-” key until the display shown in Fig. 4 appears.



**Fig. 4**

Press the “\*” key and then the “+” key until the display in Fig. 5 appears.



**Fig. 5**

Press the “+” key until the display in Fig. 6 appears.



**Fig. 6**

Press the “+” key until the display in Fig. 7 appears.



**Fig. 7**

Press the “+” key until the display in Fig. 8 appears.



**Fig. 8**

Press the “+” key until the display in Fig. 9 appears.



**Fig. 9**

Then press the “\*” key until the display in Fig. 10 appears (with “\*”).



**Fig. 10**

In this state, the time setting can be adjusted. As an example the adjustment to 15:01 is shown below.

**Adjusting the minutes**



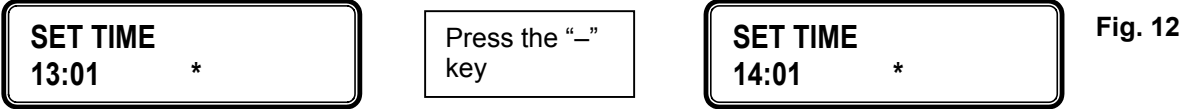
Press the “+”  
key



**Fig. 11**

Press the “+” key to adjust the minute display (minutes will switch from 59 to 00).

**Adjusting the hours**



Press the “-” key to adjust the hour display (hours will switch from 23 to 00). When the correct time is displayed, press the “\*” key until the “\*” disappears. Now the clock is running.

Press the “+” key until the display in Fig. 13 appears.



Then press the “\*” key until the display in Fig. 14 appears.



**Factory settings**

Press the “-” key until the display in Fig. 15 appears.



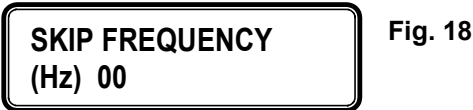
Press the “\*” key until the display in Fig. 16 appears.



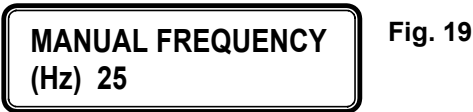
Press the “+” key until the display in Fig. 17 appears.



Press the “+” key until the display in Fig. 18 appears.



Press the “+” key until the display in Fig. 19 appears.



Press the “+” key until the display in Fig. 20 appears.



**Fig. 20**

Press the “+” key until the display in Fig. 21 appears.



**Fig. 21**

Press the “+” key until the display in Fig. 22 appears to enter the factory settings.



Press the “\*” key



**Fig. 22**

Watch for the displayed “\*” carefully, as it only appears for a moment.



Press the “+” key until the display in Fig. 23 appears.



**Fig. 23**

Press the “+” key until the display in Fig. 24 appears.



**Fig. 24**

The pump has now been reset to factory settings.

Press the “\*” key until the display in Fig. 25 appears to return to the main menu.



**Fig. 25**

## ISOBAR setting

The pump can now be programmed to ISOBAR mode. The desired pressure (in %) is set in this menu.

Press the “-” or “+” key until the display shown in Fig. 26 appears.



Fig. 26

Press the “\*” key until the display in Fig. 27 appears.



Fig. 27

Press the “+” key until the display shows the PRESSURE SET option. See Fig. 28.



Fig. 28

Press the “\*” key to initiate the adjustment. See Fig. 29.



Press “+” to increase  
Press “-” to decrease

Fig. 29

In this state the pressure (in %) can be adjusted. Fig. 30/31 shows displays when adjusting from the factory setting (50 %) to 25 %.



Press the  
“-” key



Fig. 30

**Hint:** The adjustment will be sped up when the key is pressed continuously.

Stop adjustment when 25% has been reached. See Fig. 31. (The value can be adjusted between 0 and 99 %).



Fig. 31

Accept the adjustment by pressing the “\*” key. The display in Fig. 32 appears.

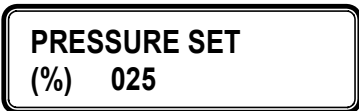


Fig. 32

Now the pump is running in ISOBAR mode. Press the “-” key until EXIT SETTINGS is displayed. See Fig 33.



Fig. 33

Then press the “\*” key until the menu MAIN MENU <SETTINGS> appears. See Fig 34.



**Fig. 34**

Now you have returned to the main menu. For detailed information about the different settings, please refer to the following chapters.

## **3. KEYBOARD AND DISPLAY**

### **The keyboard**

The keyboard on the master module consists of 3 keys: “-”, “\*” and “+”.

The “-” key is used to adjust parameters or to switch from one menu option to the previous.

The “+” key is used to adjust parameters or to switch from one menu option to the next.

The “\*” key is used to execute a displayed function or to activate a parameter before adjustment with the “+”- and “-” keys.

When an adjustment has been completed, then press the “\*” key to save the changes.

When the displayed menu option is a function, you can execute the function by pressing the “\*” key. Resetting of a parameter or adjustment of a parameter with a very low maximum value are possibilities. In the last-mentioned option, the parameter will be increased each time the “\*” key is actuated. It can be increased until reaching its maximum value upon which the value will be reset to the start value.

When you exit a parameter option by means of the “+” or “-” keys, the current value will be saved.

### **The display**

The master module is provided with a 2-line display. Each line can display up to 16 characters.

The display is a back illuminated display of LCD type (liquid crystal display).

The light intensity is lowered to an energy-saving level when the keyboard has not been in use for 30 sec. At the same time, data read-out to the display will be stopped.

When a key is actuated, the data read-out starts again and the light intensity will be intensified.



## 4a. The FUNCTIONS menu

The FUNCTIONS menu includes a number of basic settings for the pump.

The purpose and the possibilities for the different settings are described for each option.

### Menu option 1

EXIT FUNCTIONS

EXIT FUNCTIONS is the first menu option. In this state you can return to the main menu by pressing the “\*” key.

### Menu option 2

PUMP # x

The identification number of the pump can be changed by pressing the “\*” key. The setting only concerns the pump function of a pump that is communicating with external units via the optical fibre interfaces.  
Range: #1 to #8  
Factory setting: #2

### Menu option 3

SKIP FREQUENCY (Hz) xx

Setting of motor frequency to be avoided during operation. Frequencies should typically be avoided if they result in noise from the hydraulic system. Pressing the “\*” key activates the value.  
Press the “+” / “-” keys to adjust the value.  
Press the “\*” key to save the value.  
A “\*” is shown on the display during adjustment.  
Range: 0 to 50 Hz ± 0.5 Hz.  
Factory setting: 0 Hz (disconnected).

### Menu option 4

MANUAL FREQUENCY (Hz) xxx

Adjustable, fixed frequency for manual pump operation.  
Press the “\*” key to activate the value.  
Press the “+” / “-” keys to adjust the value.  
Press the “\*” key to save the value.  
A “\*” is shown on the display during adjustment.  
Range: 0 to 50 Hz.  
Factory setting: 25 Hz

### Menu option 5

ALTERNATE HOURS xxx

Time interval at which two pumps should alternate. This option is used in master mode.  
Pressing the “\*” key activates the value.  
The “+” / “-” keys are used to adjust the value.  
Press the “\*” key to save the value.  
A “\*” is shown on the display during adjustment. If the pump is alternated, a “\*” is permanently shown in the top right side of the display.  
Set ALTERNATE HOURS to 0 in order to take the pump out of alternation.  
Range: 0 to 254 hours. Selecting 255 hours will immediately force the master pump to alternate. (See Section 5e).  
Factory setting: 0 hours

### Menu option 6

DATA SAVE

Option to save actual settings in the permanent memory.  
The option is activated by pressing the “\*” key. A “\*” appears on the display for a moment to indicate that the data are saved. Pump data are automatically saved every hour.

**Menu option 7**  
FACTORY RESET

The FACTORY RESET procedure will enter a set of well defined pump data. “Reasonable” values will be entered for all relevant parameters. The factory settings are indicated under the description of the individual parameters. Pressing the “\*” key will reset the data. A “\*” appears on the display to indicate that resetting has been accomplished.

## 4b. The PUMP DATA menu

In the PUMP DATA menu various pump data are available.

### Menu option 1

EXIT PUMP DATA

EXIT PUMP DATA is the first menu option. In this state you can return to the main menu by pressing the “\*” key.

### Menu option 2

PRESSURE

Current pump pressure read-out.  
The output is active in ISOBAR mode.  
IsoBar™ 5-120, 6-110, 8-100, 4-75, 5-88 and 6-95: 0 to 100 %  
IsoBar™ 3-100: data not available.

### Menu option 3

FLOW

Current pump flow read-out.  
The output is active in ISOBAR mode.  
IsoBar™ 5-120, 6-110 and 8-100: m<sup>3</sup>/h  
isobar™ 4-75, 5-88 and 6-95: 0 to 100 % (tendency steps of 10, 25, 50, 75 and 100 %).  
IsoBar™ 3-100: data not available.

### Menu option 4

DIGITAL INPUT STATUS X

Status read-out for the digital input (night setback input).  
Options: 0 and 1  
0 = inactive. 1 = active

### Menu option 5

CURRENT

Read-out of the actual pump power consumption in ampere.  
Range: 0 to 9.9 A  
Resolution: 0.1 A - 3-phase (real value of current only).  
0.01 A - 1-phase.

### Menu option 6

FREQUENCY

Read-out of current pump frequency in Hz  
Range: 0 to 50 Hz  
Resolution: 1 Hz

### Menu option 7

ENERGY MEASURED

Read-out of the pump energy input during a period of time.  
The measurement can be reset by pressing the “\*” key.  
The reading is updated each time the pump has consumed 1 kWh.  
Range: 0 to 99 \* 10<sup>6</sup> kWh  
Resolution: 1 kWh

### Menu option 8

TOTAL ENERGY

Read-out of the total energy input up to date.  
Updated each time the pump has consumed 1 kWh.  
Range: 0 to 99 \* 10<sup>6</sup> kWh  
Resolution: 1 kWh

### Menu option 9

OPERATING TIME

Read-out of the updated pump operation time.  
Range: 0 to 99 \* 10<sup>6</sup> hours  
Resolution: 1 hour

## 4c. The TIME FUNCTIONS menu

In the TIME FUNCTIONS menu, all data related to time can be displayed and adjusted.

### Menu option 1

EXIT TIME FUNCTIONS

EXIT TIME FUNCTIONS is the first menu option. In this state you can return to the main menu by pressing the “\*” key.

### Menu option 2

TIME: hh.mm.ss

Displays the actual time.

**Note!** Pressing the “\*” key in this state will reset the keyboard lock, if it has been activated.

### Menu option 3

SETBACK ON TIME: hh.mm

Time at which the built-in, night setback function is to be activated.

Press the “\*” key to initiate adjustment.

Press the “+” key to adjust the minutes.

Press the “-” key to adjust the hours.

Press the “\*” key to save the setting.

A “\*” is shown on the display during adjustment.

Range: 00.00 to 23.59

This option is only active if SETBACK ACTIVE has been selected in the SETTINGS menu.

### Menu option 4

SETBACK OFF TIME: hh.mm

Time at which the built-in night setback is to be deactivated.

Press the “\*” key to initiate adjustment.

Press the “+” key to adjust the minutes.

Press the “-” key to adjust the hour value.

Press the “\*” key to save the setting.

A “\*” is shown on the display during adjustment.

Range: 00.00 to 23.59

This option is only active if SETBACK ACTIVE has been selected as active in the SETTINGS menu.

### Menu option 5

SETBACK FREQ.

Frequency used during night setback operation.

Press the “\*” key to initiate adjustment.

Press the “+ / -” keys to adjust the value.

Press the “\*” key to save the setting.

A “\*” is shown on the display during adjustment.

Range: 0 to 50 Hz

Factory setting: 25 Hz

### Menu option 6

SET TIME hh.mm

Setting of built-in clock.

Press the “\*” key to initiate adjustment.

Press the “+” key to adjust the minutes.

Press the “-” key to adjust the hours.

Press the “\*” key to save the setting.

A “\*” is shown on the display during adjustment.

Range: 00.00 to 23.59

Battery backup: 72 hours

## 4d. The SETTINGS menu

The SETTINGS menu facilitates adjustment of pump functions and pump settings.

### Menu option 1

EXIT SETTINGS

EXIT SETTINGS is the first menu option. In this state you can return to the main menu by pressing the “\*” key.

### Menu option 2

PRESSURE SET xxx %

Setting of the desired set-point for pressure regulation in ISOBAR mode. The set-point refers to the pressure at a flow equal to 0. Press the “\*” key to initiate adjustment and adjust the setting by means of the “+” and “-” keys. Press the “\*” key to save the value. A “\*” is shown on the display during adjustment. Range: 0 to 100 %  
0 % = minimum pressure curve.  
100 % = maximum pressure curve.  
Factory setting: 50 %

### Menu option 3

RAMP ACTIVE STATUS

Selection of active/not active ramp regulator and analogue input. Press the “\*” key to change setting. Options: 0 and 1  
1 = ramp regulator activated.  
0 = ramp regulator deactivated.  
Factory setting: 0

### Menu option 4

EXT. SETBACK STATUS

This option facilitates night setback by activation by an external signal. Press the “\*” key to change setting. Options: 0 and 1  
1 = external night setback possible.  
0 = external night setback deselected.  
Factory setting: 0

### Menu option 5

SETBACK ACTIVE STATUS

This option facilitates night setback activated by the internal clock. Press the “\*” key to change setting. Options: 0 and 1  
1 = internal night setback selected.  
0 = internal night setback deselected.  
Factory setting: 0

### Menu option 6

COMMUNICATION STATUS

Option to activate the fibre optical serial communication interfaces which facilitate communication between the pump and external units. Press the “\*” key to change setting. Options: 0 and 1  
1 = communication possible.  
0 = communication deselected.  
Factory setting: 0

**Menu option 7**

MULTIMODE STATUS

Option to activate the pump functions that make it possible to communicate with another pump via the fibre optical interfaces.

Press the "\*" key to change setting.

Options: 0 and 1

1 = multiple operation possible.

0 = multiple operation inactivated.

Factory setting: 0

**Menu option 8**

MASTER MODE STATUS

Option to activate the pump functions enabling it to control another pump via fibre optical interfaces.

Press the "\*" key to change setting.

Options: 0 and 1

1 = master pump mode

0 = slave pump mode

Factory setting: 0

**Menu option 9**

KEYBOARD LOCK STATUS

By means of this option, you can lock the keyboard. When activated it is impossible to change (or display) data.

Press the "\*" key to activate.

Please refer to option 2 in the TIME FUNCTIONS menu for deactivating.

Options: 0 and 1

1 = keyboard locked.

0 = keyboard unlocked.

Factory setting: 0

**Menu option 10**

MANUEL MODE STATUS

Option available for operating the pump at a fixed frequency.

Options: 0 and 1

1 = manual operation active.

0 = manual operation deactivated.

Factory setting: 0

## 4e. The RAMP CONTROL menu

In the RAMP CONTROL menu, you can enter data for pump regulation in accordance with an external analogue signal.

### Menu option 1

EXIT RAMP CONTROL

EXIT RAMP CONTROL is the first menu option. In this state you can return to the main menu by pressing the "\*" key.

### Menu option 2

SETPOINT (SP) xxx %

Setting for pump regulation of the analogue input by increasing or decreasing the pump performance.

Press the "\*" key to initiate adjustment and adjust the value by means of the "+" or "-" key.

Press the "\*" key to save the value.

A "\*" is shown during adjustment.

Range: 0 to 100 %

0 % = minimum set-point = 0 mA input.

100 % = maximum set-point = 20 mA input.

Factory setting: 50 %

If the set-point is set to 0 %, the rotational speed of the motor will run synchronously with the analogue input (0 - 100 %).

### Menu option 3

INPUT (PV) xxx %

Read-out of analogue input in %.

Range: 0 to 100 %

0 % = minimum set-point = 0 mA input

100 % = maximum set-point = 20 mA input

Resolution: 0.2 mA

### Menu option 4

RAMP TIME

Setting of the regulation rate for the ramp regulator. The ramp time expresses how fast the frequency, i.e. the pump speed, will change if the set-point (SP) and the input (PV) differ.

Press the "\*" key to initiate adjustment, and adjust the value by means of the "+" or "-" key.

Press the "\*" key to save the value.

A "\*" is shown during adjustment.

Range: 0 - 100 sec/Hz

Factory setting: 10 sec/Hz

### Menu option 5

HYSTERESIS SPAN

Setting of the hysteresis span (dead span) for the ramp regulator. The hysteresis span is the acceptable deviation between the set-point (SP) and the input (PV). Within this span the pump is not regulating the pump performance.

The setting is used when the input signals are "noisy".

Press the "\*" key to initiate adjustment and adjust the value by means of the "+" or "-" key.

Press the "\*" key to save the value.

A "\*" is shown during adjustment.

Range: 0 - ± 10 %

Factory setting: ± 1 %

**Menu option 6**  
BROKEN WIRE

Frequency setting for a pump if the input signal disappears because of a defective transmitter or a broken wire.

Without this function, the pump would run at maximum performance if one of the above errors occur.

Press the "\*" key to initiate adjustment, and adjust the value by means of the "+" or "-" key.

Press the "\*" key to save the value.

A "\*" is shown during adjustment.

Range: 0 to 50 Hz

Factory setting: 10 Hz

Triggers at an input < 5 %

## 4f. The ERROR STATUS menu

Possible errors can be displayed and handled from the ERROR STATUS menu.

### Menu option 1

EXIT ERROR STATUS

EXIT ERROR STATUS is the first menu option. In this state, you can return to the main menu by pressing the “\*” key.

### Menu option 2

ERROR 1.

Read-out of the last recorded error.

### Menu option 3

ERROR 2.

Read-out of the second last recorded error.

-  
-  
-  
-  
-

### Menu option 11

ERROR 10.

Read-out of the 10<sup>th</sup> last recorded error.

### Menu option 12

RESET INVERTER ERROR

Option for resetting and restart of frequency changer after an error. Executed by pressing the “\*” key.

**Note:** If an error occurs during operation, the display will automatically change to:

ERROR 1 and the actual error code.

If an error occurs, switch to menu option 12 for resetting. DO NOT CONTINUE if the error situation persists. In this case the pump must be checked for possible damage.

### Error codes:

E01 = Undervoltage  
 E02 = Overvoltage  
 E03 = Motor short-circuit  
 E04 = Internal power supply error  
 E05 = Motor overload  
 E06 = Overheated electronics  
 E07 = Memory error  
 E08 = Overheated motor  
 E09 = Program error  
 E10 = Program error

## 4g. The INTERNATIONAL menu

The INTERNATIONAL menu facilitates selection of language.

### **Menu option 1**

EXIT INTERNATIONAL

EXIT INTERNATIONAL is the first menu option. In this state you can return to the main menu by pressing the “\*” key.

### **Menu options 2 .....**

Options for selection of language of the displayed texts. The following languages are available:

ENGLISH  
DANISH  
GERMAN  
SPANISH  
POLISH

Press the “\*” key to select the displayed language. Switch from language to language by means of the “+” or “-” keys.

## 5. PUMP FEATURES

The master module is especially designed for operation with isobar™ Circulators. Together with the pump, the master module forms a complete system for universal operation of the pump and frequency converter.

The number of built-in features is one of the advantages of the master module. No additional units are required for regulatory tasks by means of external signals or for establishing of communication between a pump and external units. All functions are integrated.

The pump features can be described with respect to three, partly overlapping, main operational categories, i.e., cascade operation, multiple pump operation and alternating operation.

The operating features for a single pump include:

- ISOBAR operation, i.e. automatic regulation in accordance with a fixed pressure curve.
- Manual operation, i.e. operation with a fixed, user selected frequency (fixed speed).
- Night setback by means of the built-in clock or an external 10 V DC signal. In this case the pump is running at a fixed, user selected frequency. Night setback operation has higher priority than other operating modes.
- Regulation in proportion to an external, analogue signal by means of the built-in ramp regulation. The signal is typically obtained from a pressure transmitter.
- Direct control of motor speed regulation by means of the analogue input (0 to 100 %).
- External control of pump functions and pump settings via the fibre optical interfaces.

The master module facilitates co-ordinated pump operation. The term “co-ordinated operation” means, that the pumps are communicating to solve specific operation tasks. As the optical fibre communication interface is a self-contained communication system between the pumps, simultaneous pump control from a main fibre optical net cannot be performed. However, the pump status can still be controlled via the built-in status relay.

The two main reasons for using co-ordinated operation are:

- Reliability of supply. If a pump failure occurs, another pump will automatically take over. This is also called alternated operation.
- Periods with extended load may in some heating installations require more than one pump. In such cases, one of the pumps is running as the master pump and the pumps are connected by means of fibre optical cables. The master pump will then perform the regulation in accordance to an external transmitter signal and will automatically engage pump 2 whenever required, in order to obtain the required pressure. When the pressure load is normalised, the assisting pump will be disengaged and then be available as a standby pump. This type of operation is also called “cascade operation”.

The installation is quite simple as it only involves adaptation of two pieces of optical fibre and their connection to the fibre interfaces on the two pumps. The required pump settings are described step by step in Section 5e “**Multiple pump operation**”.

### **Regulation possibilities for alternating operation:**

ISOBAR operation.

Regulation with ramp regulator.

Night setback operation.

If a failure occurs, the defective pump will be disengaged and the back-up pump will take over. (The error situation will be signalled from the pump status relay).

**Regulation possibilities for cascade operation:**

Regulation with ramp regulator.  
Night setback operation.

If a failure occurs, the defective pump will be disengaged and the back-up pump will take over. (The error situation will be signalled from the pump status relay).

Fibre optically controlled pumps combine the advantages of the individual pumps and the possibilities for co-ordinated pump operation. At the same time, the single pump will be totally immune from interference from other pumps as they are not electrically connected. Each master module is equipped with two, fibre optical interfaces - a transmitter and a receiver. (See Chapter 8).

By connecting the transmitter on pump 1 to the receiver on pump 2, the transmitter on pump 2 to the receiver on pump 3, etc, and in the end connect the two ends of the “ring” in an IsoCom™ interface (computer coupling module), you can individually control up to 8 pumps.

Each pump has its individual ID number (see Section 4a, option 2), and can be controlled independently. In this way, you can construct a network of pumps in a heating plant, and control them from a central unit.

## 5a. DISPLAY READINGS

The display of the master module is capable of displaying 32 figures, signs or letters. Easy operation is obtained by using menus and relevant messages during operation.

Data read-out is obtained by selecting the menu option of interest (see Chapter 3). Some of the data are static, i.e. constant, but adjustable values.

Some of the data are dynamic, i.e. they will change according to the function of the pump operations (e.g., power consumption and pressure).

The rate at which the data are updated on the display will vary according to the actual pump settings and pump performance.

If one of the special functions has been selected, the display may show blank data sections and it is impossible to adjust displayed data.

This will be the case when:

- The keyboard has been locked. In this case no data will appear on the display and adjustments cannot be performed. The unlocking procedure is described in Section 4d (menu option 9).
- The pump is in communication mode. The pump is externally controlled and the parameters cannot be adjusted from the master module. The data can be changed as soon as the communication mode status is deactivated.

## **5b. PROPORTIONAL PRESSURE REGULATION (ISOBAR OPERATION)**

Adjustment of proportional pressure operation is easily performed in the following manner:

- 1) Switch to the FUNCTIONS menu and execute FACTORY RESET.
- 2) Adjust PRESSURE SET (in % of the maximum pump performance) in the SETTINGS menu. The pump will now operate in order to maintain this pressure. However, note that the pressure will have a tendency to increase with increased flow. (Please refer to the curve chart).
- 3) The actual pressure can be read in the PUMP DATA menu (option 2). If the obtained pressure remains lower than desired, the pump will probably not be able to obtain the desired pressure at the actual flow.
- 4) The frequency value is located in the PUMP DATA menu. In this case it will read 50 Hz.

When the pump is running in ISOBAR mode, the following functions have first priority (change of mode):

Night setback by internal clock.

Night setback by external signal.

Both functions will force the pump to operate at the selected night frequency until this function is deactivated. Then the pump will return to the previous mode and run at the selected pressure.

## 5c. RAMP REGULATION, EKSTERNAL TRANSMITTER OPERATION

The master module has a built-in ramp regulator. This makes it possible to place a pressure transmitter (pressure measuring unit) in the hydraulic piping system, and then use the measuring signal from the transmitter to regulate pump performance.

The transmitter has to be of a type that supplies a measuring signal of either 0 - 20 mA or 4 - 20 mA. The output from the transmitter is connected to terminal 4 on the master module and the neutral wire is connected to terminal 5. (See Chapter 8).

Adjust the ramp regulation parameters as described below, when the electrical connections have been performed.

- Switch to the FUNCTIONS menu and perform FACTORY RESET.
- Switch to the RAMP CONTROL menu and enter the desired SETPOINT in % of the maximum transmitter measuring range.

### Example

The measuring range of the transmitter is 0 to 1 bar.

The output of the transmitter ranges from 0 to 20 mA.

With above data, 100 % corresponds to 20 mA or 1 bar.

If the regulation should result in a pressure of 0.75 bar at the transmitter, the set-point should be set to 75 %.

- Enter the RAMP TIME in the RAMP CONTROL menu (Option 4), i.e. the time during which the regulator adjusts the frequency (motor speed) 1 Hz up.  
The factory setting of this value is 10 sec/Hz, and will in most cases be appropriate. Oscillation can occur if the transmitter has been placed a long distance from the pump (pump performance fluctuates up and down). In this case the value should be increased.
- Adjust the HYSTERESIS SPAN (dead span) in the RAMP CONTROL menu (option 5), i.e. the deviation between set-point and transmitted, measured value, before adjustment of the motor speed is to be performed. The value is in  $\pm x\%$ ; factory setting =  $\pm 1\%$ . If a very noisy transmitter signal is obtained, you can increase the span in order to obtain more smooth regulation.
- In the RAMP CONTROL menu (option 6) the BROKEN WIRE frequency (Hz) can be adjusted in order to obtain an appropriate reaction if the transmitted signal disappears. This will occur in the case of a broken wire or a transmitter power failure. The function is very simple, as the pump will operate at a fixed speed (selected by operator) if the transmitter signal is reduced to less than 20 %.  
Without this function, the pump would increase the pump performance in order to reach the set-point. By doing so, it would expose the hydraulic system to an unnecessary load.  
Factory setting = 10 Hz.  
Now all the relevant parameters have been adjusted and the ramp regulator can be activated.
- To initiate pump regulation, switch to option 3 in the SETTINGS menu and set RAMP ACTIVE STATUS to "1".  
In the RAMP CONTROL menu (option 3), you can read the actual pressure (measured signal from the transmitter). After a period of time, it will reach a value close to the set-point (RAMP CONTROL, option 2).

When the pump is running with ramp regulation, the following functions have first priority (change of operating mode):

Night setback by internal clock.

Night setback by external signal.

Both functions will force the pump to operate at the selected night frequency until night setback is deactivated. Then the pump will return to ramp regulation.

## 5d. NIGHT SETBACK

The master module is equipped with two built-in functions for night setback (reduction of the pump speed for a period of time).

A 24 hour clock giving the actual time is built-in into the master module. In addition to displaying the time, the clock can control the pump mode. By using the clock, the pump can switch modes and operate at a fixed (operator selected) speed at a certain time, and then return to the previous operating mode at a later, pre-determined time. This feature is, for example, useful if a reduced performance is required during the night.

A similar function is obtainable by using the digital input. By using this, an external unit can activate night setback operation by supplying 10 V DC to terminal 3 and 0 V DC to terminal 5. (See Chapter 8). The previous operating mode will be resumed as soon as the signal is removed.

### Night setback by means of the built-in clock

- Adjust SETBACK ON TIME (option 3 in the TIME FUNCTIONS menu) to the time at which the pump has to reduce the speed.
- Adjust SETBACK OFF TIME (option 3 in the TIME FUNCTIONS menu) to the time at which the pump is to resume the preceding, operational mode.
- Adjust the SETBACK FREQ. (option 5 in the TIME FUNCTIONS menu), i.e. the frequency at which the pump has to run during setback operation.
- Set SETBACK STATUS to “1” (option 5 in the SETTINGS menu) to complete the adjustment.

With these settings, the night setback function will be activated/deactivated at the entered times. In case of a power failure, the built-in clock will be supported by 72 hours of reserve power.

### Night setback by means of external signal

- Adjust the SETBACK FREQ. (option 5 in the TIME FUNCTIONS menu), i.e. the frequency at which the pump has to run during setback operation.
- Adjust the EXT. SETBACK STATUS to “1” (option 4 in the SETTINGS menu) to complete the setting.
- When a voltage of 10 V DC is supplied to terminal 3 and 0 V DC is supplied to terminal 5 (See Chapter 8), the pump will switch over and run at the specified setback frequency. When the signal is removed, the pump will switch back to the previous operating mode.

## 5e. MULTIPLE PUMP OPERATION

Multiple pump operation is an important feature, and because of our many years of experience with pumps and pump systems, we can offer the master module with multiple-operation competency.

Co-ordinated pump operation means, that two pumps can communicate about a specific pump task. During operation, they assist each other in error situations and in periods requiring high performance.

Based on our experiences of wall-mounted pump controllers, the master module has been designed with a number of well proven functions.

In principle, two types of control systems exist:

- Pump control of one active pump and one stand-by pump. The Pump Controller Type 7000-20 is the wall-mounted version for this control task. This kind of control is also called alternating control.
- Pump control of one active pump and one assisting pump. The assisting pump assists in periods with extended pump load. The Pump Controller Type 7000-22 is the wall-mounted controller for this task.

In order to perform a control similar to 7000-20 or 7000-22, two uniform IsoBar™ pumps equipped with serial optical fibre interfaces are required.

The pumps are connected by means of two optical fibres. The transmitter fibre (white) from pump 1 is connected to the receiver connector on pump 2. In a similar way, the pump 1 receiver (black) is connected to the pump 2 transmitter (white).

Carefully push a fibre the whole way into its connector before fastening the coupling nut. By doing so for each connection, the optical connection is easily performed.

### Adjustments for two alternating pumps

The procedure below describes the adjustment procedure for two alternating pumps in ISOBAR mode. Each pump is running 24 hours before alternation. Select one of the pumps to be the master pump and the other to be the slave pump.

#### The master pump

1. FACTORY RESET the master pump in the FUNCTIONS menu.
2. Set MANUAL FREQUENCY to "0" in the FUNCTIONS menu (option 4).
3. Set PUMP # (no.) to "1" in the FUNCTIONS menu (option 2).
4. Adjust ALTERNATE HOURS to "24" in the FUNCTIONS menu (option 5).
5. Enter the desired pressure set-point for the ISOBAR pump in the SETTINGS menu (option 2)
6. Set MULTIMODE STATUS to "1" in the SETTINGS menu (option 7).
7. Set MASTER MODE STATUS to "1" in the SETTINGS menu (option 8).
8. Set COMMUNICATION STATUS to "1" in the SETTINGS menu (option 6).
9. Make a DATA SAVE in the FUNCTIONS menu (option 6).

#### The slave pump

1. FACTORY RESET the slave pump in the FUNCTIONS menu.
2. Set MANUAL FREQUENCY to "0" in the FUNCTIONS menu (option 4).
3. Set PUMP # to "2" in the FUNCTIONS menu (option 2).
4. Set MULTIMODE STATUS to "1" in the SETTINGS menu (option 7).
5. Set MASTER MODE STATUS to "0" in the SETTINGS menu (option 8).
6. Set COMMUNICATION STATUS to "1" in the SETTINGS menu (option 6).
7. Make a DATA SAVE in the FUNCTIONS menu (option 6).

With these settings the pumps will alternate. After the first 24 hours, the slave pump will be engaged for 24 hours. If a pump failure occurs, the back-up pump will automatically take over and the status relay on the defective pump will signal error.

The clock controlling the alternation will be reset after an error, and you must reprogram.

## **Adjustments for 2 alternating pumps with ramp control**

The procedure below describes the adjustment procedure for two pumps operating with ramp regulation. Each pump runs for a period of 72 hours. Select one of the pumps as the master pump and the other as the slave pump.

### **The master pump**

1. FACTORY RESET the master pump in the FUNCTIONS menu.
2. Set PUMP # (no.) to "1" in the FUNCTIONS menu (option 2).
3. Set ALTERNATE HOURS to 72 hours in the FUNCTIONS menu (option 5).
4. Set MULTIMODE STATUS to "1" in the SETTINGS menu (option 7).
5. Set MASTER MODE STATUS to "1" in the SETTINGS menu (option 8).
6. **NOTE!!** Perform the ramp regulator adjustments in accordance with Section 4c, but **without** performing the factory reset.
7. Set COMMUNICATION STATUS to "1" in the SETTINGS menu (option 6).
8. Make a DATA SAVE in the FUNCTIONS menu (option 6).

### **The slave pump**

1. FACTORY RESET the slave pump in the FUNCTIONS menu.
2. Set PUMP # to "2" in the FUNCTIONS menu (option 2).
3. Set MULTIMODE STATUS to "1" in the SETTINGS menu (option 7).
4. Set MASTER MODE STATUS to "0" in the SETTINGS menu (option 8).
5. Set COMMUNICATION STATUS to "1" in the SETTINGS menu (option 6).
6. Make a DATA SAVE in the FUNCTIONS menu (option 6).

With the above settings, the pump will operate in alternation mode and be regulated in accordance with the external transmitter. After the first 72 hours, the slave pump will be engaged and run for 72 hours. If a pump failure occurs, the back-up pump will automatically take over and the status relay on the defective pump will signal error. The clock controlling the alternation will be reset after an error, and you must reprogram.

## **Adjustments for 2 pumps in cascade with ramp regulation**

The procedure below describes the adjustment procedure for two pumps operating in cascade with ramp regulation, i.e. the slave pump is engaged if the performance of the master pump is not sufficient. Select one of the pumps to be the master pump and the other to be the slave pump.

### **The master pump**

1. FACTORY RESET the master pump in the FUNCTIONS menu.
2. Set PUMP # (no.) to "1" in the FUNCTIONS menu (option 2).
3. Set ALTERNATE HOURS to "0" in the FUNCTIONS menu (option 5).
4. Set MULTIMODE STATUS to "1" in the SETTINGS menu (option 7).
5. Set MASTER MODE STATUS to "1" in the SETTINGS menu (option 8).
6. **NOTE!!** Perform the ramp regulator adjustments in accordance with Section 4c, but **without** performing the factory reset.
7. Set COMMUNICATION STATUS to "1" in the SETTINGS menu (option 6).
8. Make a DATA SAVE in the FUNCTIONS menu (option 6).

### **The slave pump**

1. FACTORY RESET the slave pump in the FUNCTIONS menu.
2. Set PUMP # (no.) to "2" in the FUNCTIONS menu (option 2).
3. Set MULTIMODE STATUS to "1" in the SETTINGS menu (option 7).
4. Set MASTER MODE STATUS to "0" in the SETTINGS menu (option 8).
5. Set COMMUNICATION STATUS to "1" in the SETTINGS menu (option 6).
6. Make a DATA SAVE in the FUNCTIONS menu (option 6).

If the master pump runs at a frequency of 50 Hz for more than one minute, the slave pump will be engaged as a supplementary pump (at 50 Hz) and the master pump will be regulated in accordance with the set-point.

If, however, the slave pump and the master pump are running at minimum performance simultaneously, the master pump will take over and the slave pump will be disengaged.

## 5f. COMMUNICATION WITH THE PUMP, THE OPTICAL FIBRE INTERFACE

The master module can communicate with a central control unit by means of the built-in optical fibre interfaces. The communication is performed using a serial protocol that makes it possible to control the pump from an ordinary PC and an optical fibre interface for the PC.

The system with optical fibres and interface is called IsoCom™ (ISOLated COMMunication). It refers to the total electrical separation between both the individual pumps and the central control unit. Furthermore, the optical fibre connections are totally immune to irradiated electrical noise and the so-called "spikes" (strong current impulses), which normally cause problems in traditional pump environments.

Each master module is equipped with two connection points for optical fibres; a black connection (the receiver) and a white connection (the transmitter).

The principle for coupling the pumps is in fact very simple. You adapt a piece of optical fibre, so that it can reach between a pump and the next unit in the ring (pump or interface).

The fibre is inserted into the pump transmitter Tx (white connection) and the clasp nut is fastened by hand. The other end of the fibre is now inserted in the receiver Rx (black connection) of the next unit - it is also fastened by hand. From this unit's transmitter you continue with the same pattern until you have constructed the ring of units (pumps) you want to control. All units are connected with optical fibres from transmitter to receiver, i.e. an optical fibre network. (See Chapter 8).

One of the units in the ring must be the serial IsoCom™ interface, which makes it possible to control up to 8 pumps from a central control unit (PC or CTS/SRO).

The IsoCom™ interface has a standard RS-232-C interface.

The pumps communicate with the following protocol:

Baud rate: 4800  
Data bits: 7  
Parity: Even  
Stop bit: 1

### Setting of the pumps for communication

In order to control the individual pumps in the optical fibre network independently, each pump has to be identified by a specific ID number. The ID number is set as follows:

1. FACTORY RESET is performed in the FUNCTIONS menu (option 7).
2. The PUMP # (no.) is set to a value between 1 and 8 in the FUNCTIONS menu (option 2). There must NOT be 2 pumps with the same pump ID in the same optical fibre network. The pumps can be placed in random sequence irrespective of their number. When the pumps have been given an ID number, they are ready for communication as follows:
3. COMMUNICATION STATUS = 1 is selected in the SETTINGS menu (option 6).

The pump is now ready to be controlled through the optical fibres.

As the complete control of the pump is now performed via the optical fibres, manual change of certain data is not possible. This remains the case until COMMUNICATION STATUS is set to "0".

The above setting has to be made for all units in the optical fibre network.

In order to communicate with the pumps, you have to know a set of commands and obtainable data from the pump.

**Possible read-outs**

Pressure set-point  
 Actual pressure  
 Actual flow  
 Manual frequency set-point  
 Actual frequency  
 Analogue set-point (SP)  
 Actual analogue input (PV)  
 Trip code (alarm code)  
 Actual pump status

**Possible settings**

Operating modes: ISOBAR OPERATION  
 MANUAL OPERATION  
 RAMP CONTROL OPERATION

**The command set for the master module**

The commands, which can be given to the master module from the serial optical canal, can be divided into 3 groups:

Parameter settings  
 Parameter read-outs  
 Status and operation control

Commands for the master module are built up in a structure which must fulfil the following:

- The command must be identified by the master module as being valid data.
- The master module chosen to receive the command must be able to identify it.

For identification of valid data, a start character (sign) and a stop character are used before and after a command, respectively:

Start character: CHR\$(4)  
 Stop character: CHR\$(3)

A command for the master module is constructed as follows: **CHR\$(4) + "COMMAND" + CHR\$(3)**

The command will then be checked for identification by the master module.

The command itself is built up according to the following structure:

- A character indicating the type of command
- A figure indicating the type of equipment (is always the figure one "1")
- A figure indicating the identification number of the pump (is always between 1 and 8)
- A character indicating the type of parameter being handled

Furthermore, the command can consist of 3 numbers for setting of a parameter.

**Command type characters**

S = SETTING = Setting of a parameter  
 I = INQUIRY = Inquiry for a parameter  
 T = TOGGLE = Change of operation form

**Parameter type characters**

P = PRESS = Set-point for pressure  
 R = REFERENCE = Ramp control reference  
 M = MANUAL = Set-point for manual frequency  
 F = FREQUENCY = Actual frequency  
 Q = FLOW = Actual flow  
 H = PRESS = Actual pressure  
 S = STATUS = Actual operational status  
 T = TRIP = Last registered error

The command for choosing ISOBAR operation for pump 3 looks, for example, like this:

**CHR\$(4) + T13A + CHR\$(3)**

The master modules in the fibre optical network will now examine the command. When one pump receives a command for another pump, the command will be passed on to the fibre optical network.

When a pump receives a correctly identified command, the pump carries out the command and signs for reception by sending the sign CHR\$(6) to the fibre optical network. If the command requires return data from the pump, the pump will pass on the command with attached answer to the fibre optical network. In this case, the CHR\$(6) is left out as the answer is given.

Should a pump receive wrong data, it will send out the character CHR\$(21), which means "not understood". If pump 3 receives the command correctly, it changes to ISOBAR operation and sends out CHR\$(6) to the fibre optical network. The central control unit will now receive this character and control that the command has been carried out. This is done by sending the command:

**CHR\$(4) + I13S + CHR\$(3):** "read status on pump 3"

and the pump will answer:

**CHR\$(4) + I13SAUT + CHR\$(3):** "status on pump 3 is: AUT = ISOBAR"

The command is correctly understood, and the pump is in ISOBAR operation.

**Following types of operation can be chosen under command type "T":**

- T1xA: choose pump x in ISOBAR operation, A = ISOBAR
- T1xM: choose pump x in MANUAL operation, M = MANUAL
- T1xE: choose pump x in RAMP operation, E = EXTERNAL TRANSMITTER

**You have the following possibilities under command type "S":**

- S1xPzzz: Set pump x to pressure zzz %
- S1xM0zz: Set pump x to the manual frequency 0zz Hz
- S1xEzzz: Set pump x to the ramp input reference zzz %

**You have the following possibilities under inquiry commands type "I":**

- I1xP: Reads out the pressure set-point of the pump
- I1xM: Reads out the manual frequency set-point of the pump
- I1xE: Reads out the ramp reference set-point of the pump
- I1xF: Reads out the actual pump frequency (speed)
- I1xQ: Reads out the pump flow (in ISOBAR operation)
- I1xH: Reads out the pump pressure (in ISOBAR operation)
- I1xS: Reads out the actual pump mode (AUT, MAN or ANL)
- I1xT: Reads out the last occurring error code for the pump

## 5g. DIGITAL INPUT/OUTPUT

The master module is equipped with two voltage-free, digital (relay) outputs and a digital input (night setback input).

### **The digital outputs**

The first digital output is the status relay (the alarm relay). It makes use of terminals 1 and 2 in the terminal block to which the power supply is connected.

The status relay is a contact that is closed during operation and open only in case of a frequency converter error or a power failure. The maximum load of the status relay is 250 V AC / 150 W.

The second digital output is the mode relay. It makes use of terminals 6 and 7 in the terminal block on the master module. This output is a contact, which is open while the pump is alternated (see Section 4e) and if a voltage failure occurs. The maximum load of the mode relay is 125 V AC / 30 W.

### **The digital input**

The master module is equipped with one digital input, which is used for night setback operation controlled by an external signal (see Section 4d). The input voltage is supplied to terminal 3; the earth to terminal 5.

Input specifications: 0 to 10 V DC,  $R_{in} > 1 \text{ k}\Omega$ .

Logical "0" =  $V_{in} < 5 \text{ V DC}$

Logical "1" =  $V_{in} > 8 \text{ V DC}$

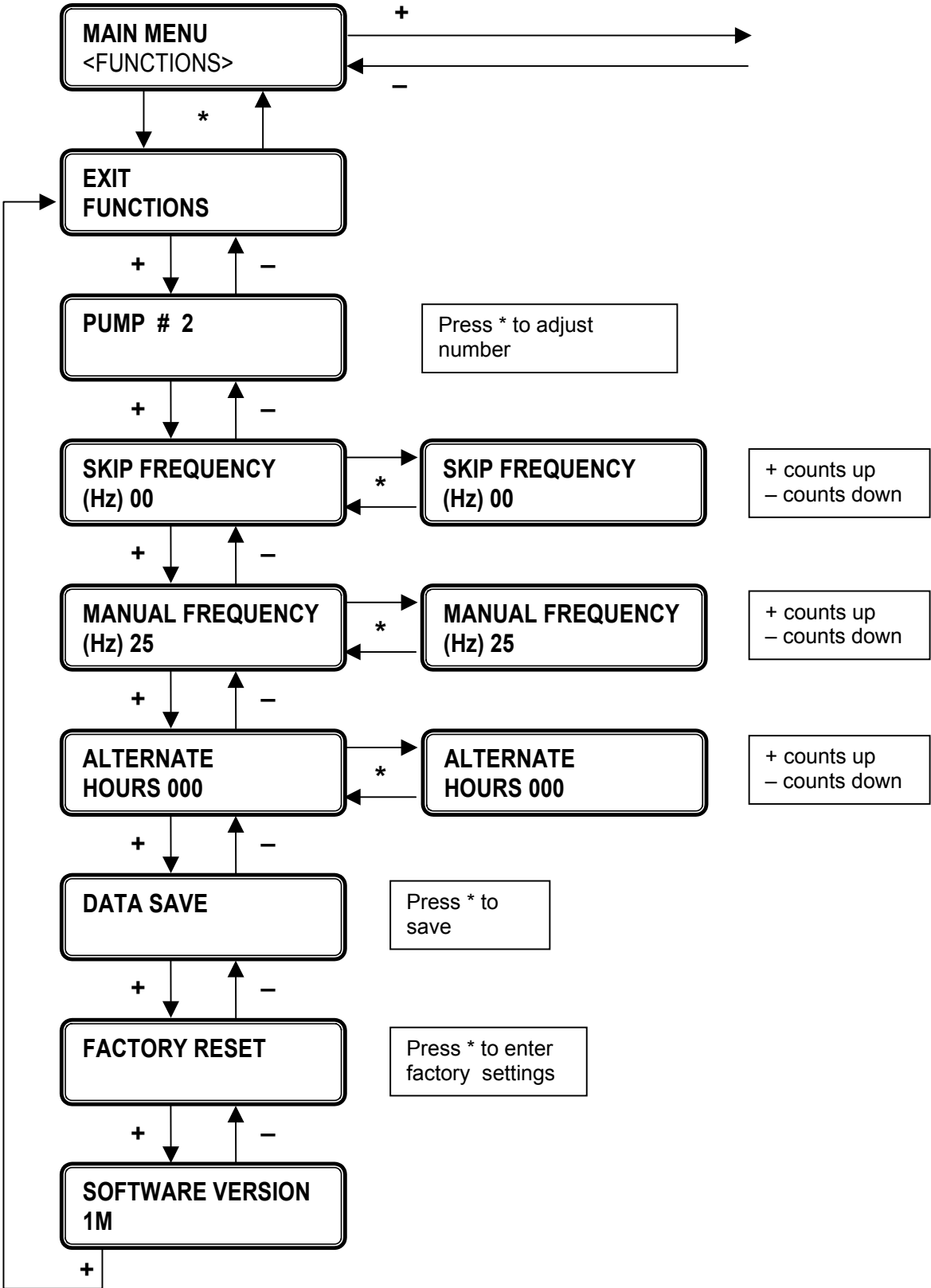
To control the status of the input, please refer to "The PUMP DATA menu" (option 4).

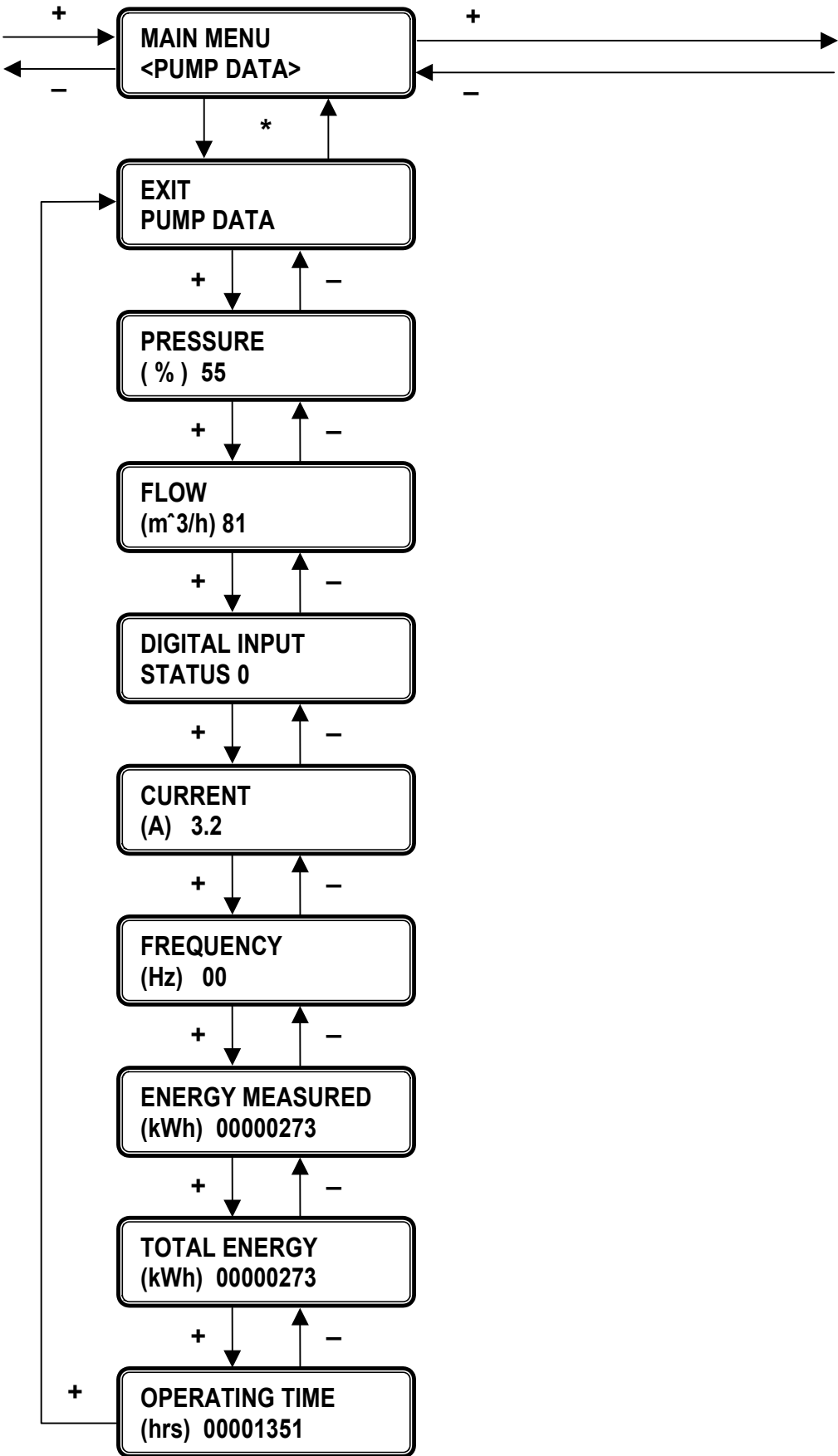
## 6. TROUBLESHOOTING

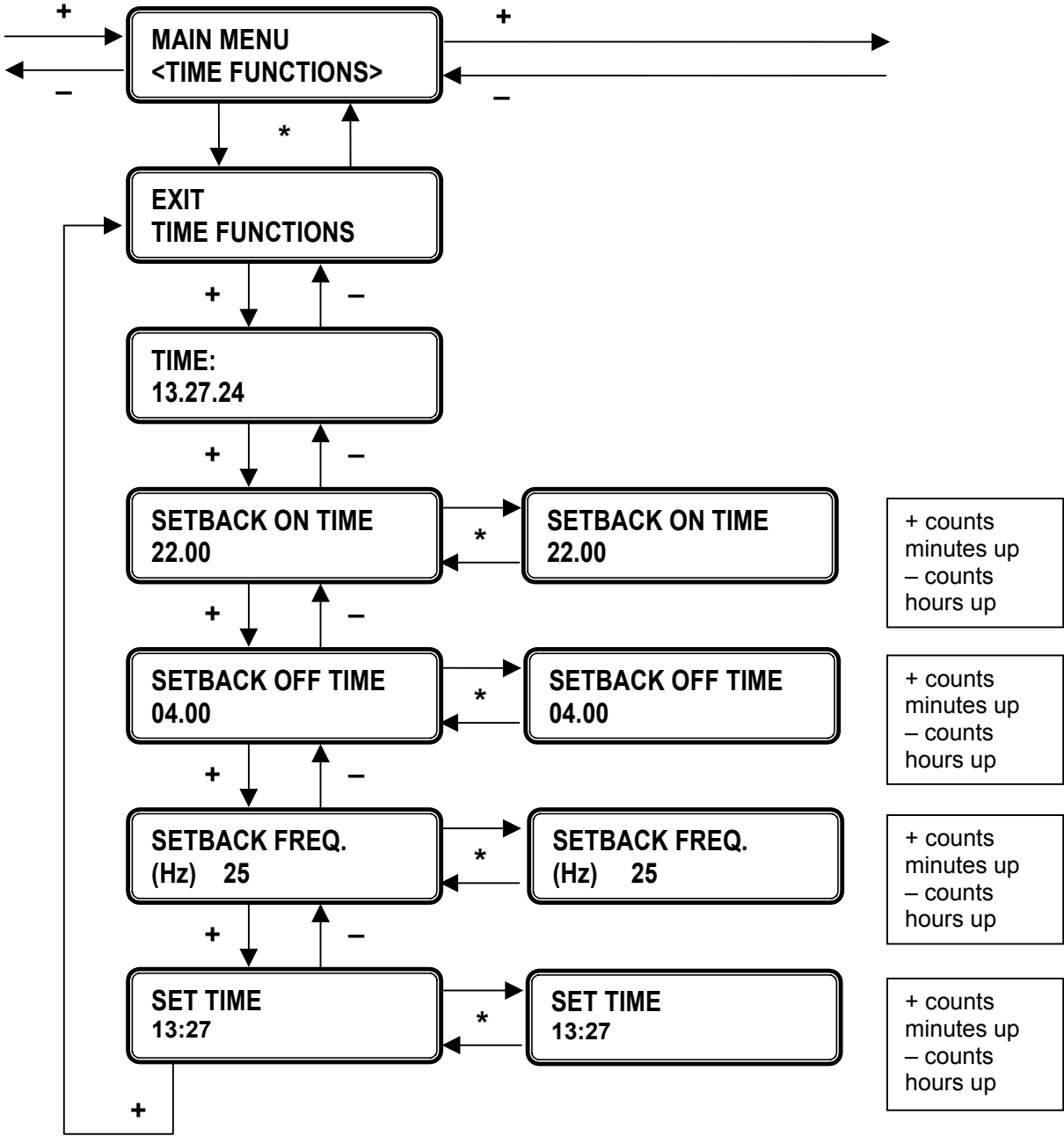
Below you will find answers to a number of questions that might come up when installing or operating IsoBar™ pumps utilising the master module.

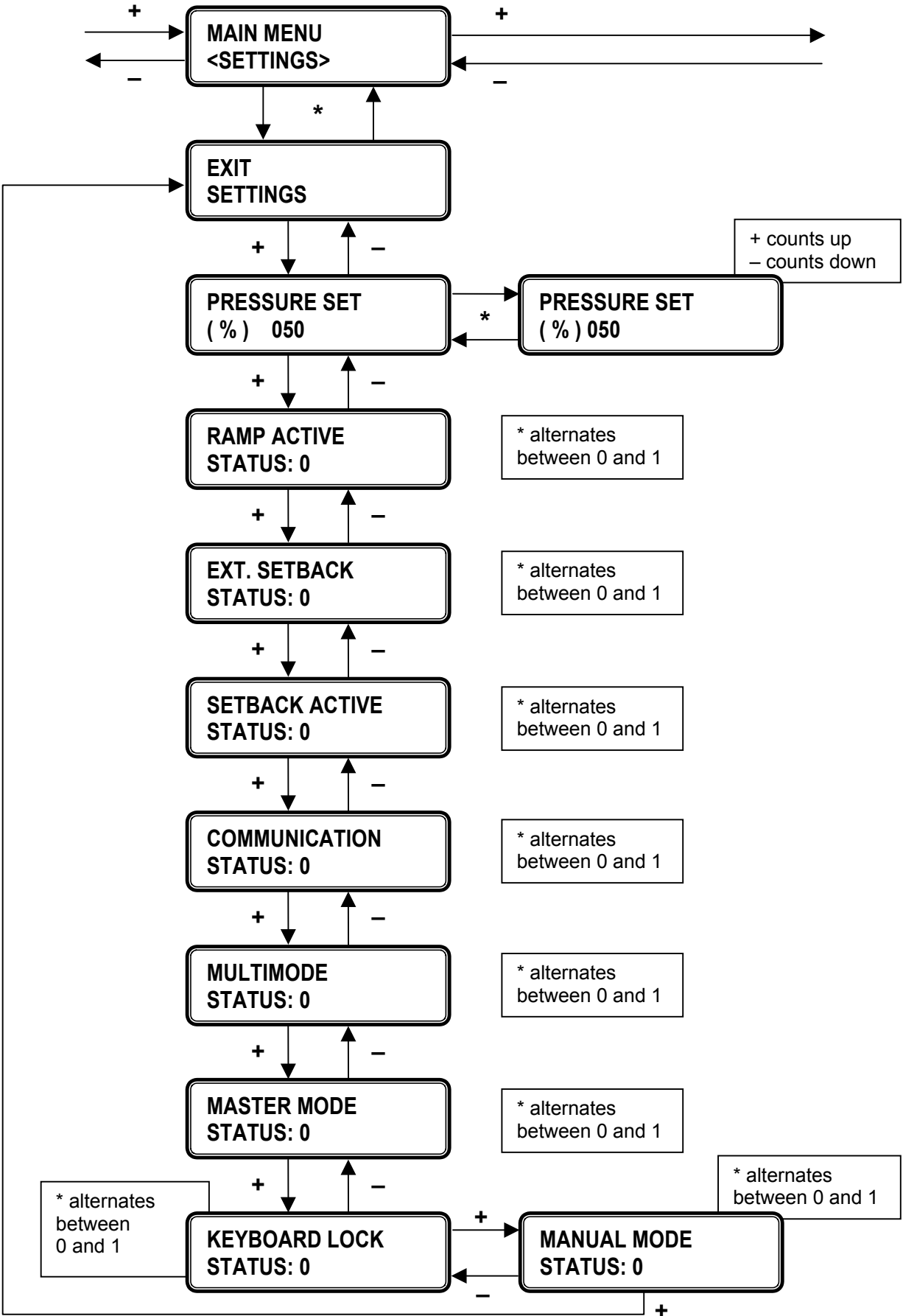
Error/symptom	Suggested remedy
Displayed data is not adjustable.	The pump is in communication mode or the keyboard has been locked. Please refer to Section 3d or 3c in order to change the settings.
The ERROR STATUS menu appears frequently on the display without operator intervention. The pump is not running.	<p>A pump failure has occurred. Switch to the menu option RESET INVERTER ERROR and press the “*” key. The pump should now resume operation. If it does not, an authorised technician must service the pump.</p> <p>Alternatively you can turn off the voltage supply and check if the pump is stuck. Proceed as follows: remove the bleed screw and turn the motor shaft by means of a screw driver.</p> <p><b>WARNING:</b> A large amount of hot water or steam can be released through the bleed screw.</p> <p>When the bleed screw has been closed and the voltage supply has been re-established, then RESET INVERTER ERROR.</p>
The pump cannot reach the set pressure during ISOBAR operation.	The pump has been regulated as far as possible on the 50 Hz pump chart. Due to this, it cannot increase the operating performance in order to obtain the desired pressure.
The pump is operating at a fixed speed and does not respond to a change of the pressure set-point.	The pump is operating in manual or night setback mode. Perform FACTORY RESET in the FUNCTIONS menu and set the pump to the desired operating mode.
The pump is not running and a “*” is permanently displayed in the ALTERNATE HOURS display.	The pump has been alternated during multimode operation and pump 2 is the active pump. In order to reset alternation, please refer to the FUNCTIONS menu (option 5).
The pump should regulate by means of ramp control, but is permanently running at a fixed speed.	The pump is using the BROKEN WIRE frequency because the transmitter signal (PV) is 0 %. Please refer to Section 3e (menu option 6). Alternatively, the pump is running in night setback mode (controlled by the built-in clock or external 10 V DC input).
The pump is connected to power, but the display is blank.	The power supply has been connected to the wrong terminals or the power supply has been switched off. Switch off the power supply and check the installations. Switch on the power supply again. If the display remains blank, an authorised technician must check the pump.

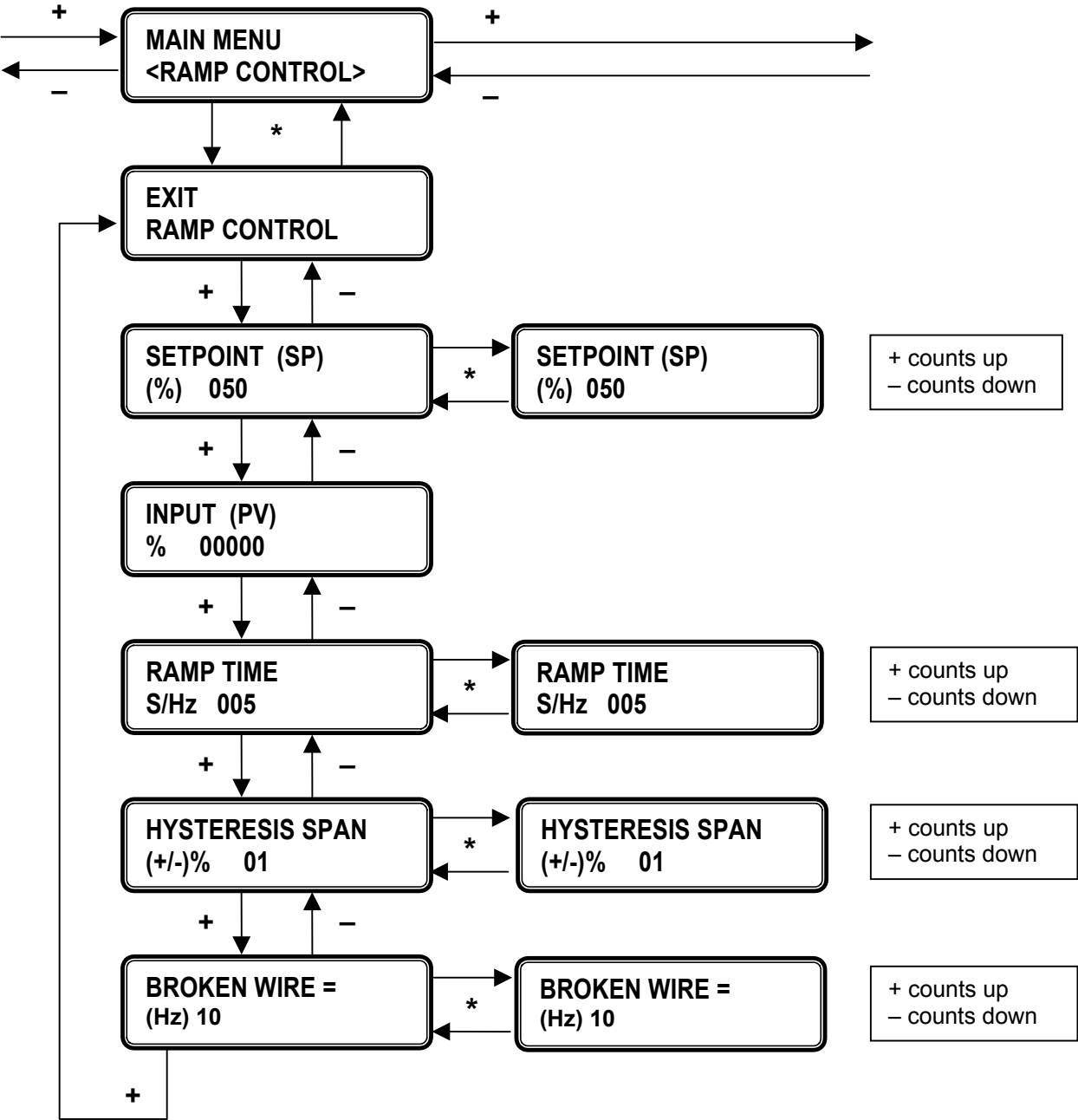
# 7. MENU OVERVIEW

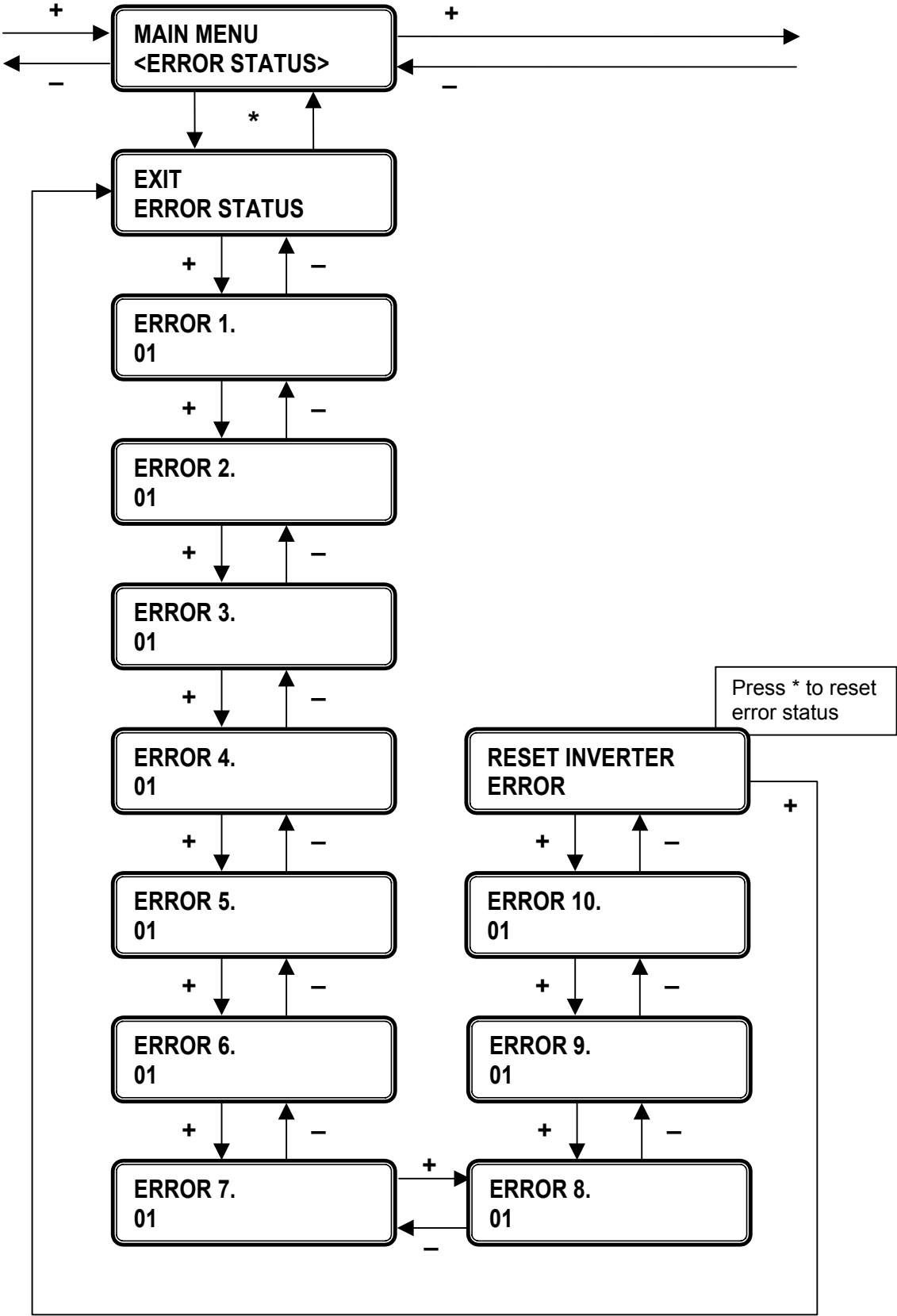


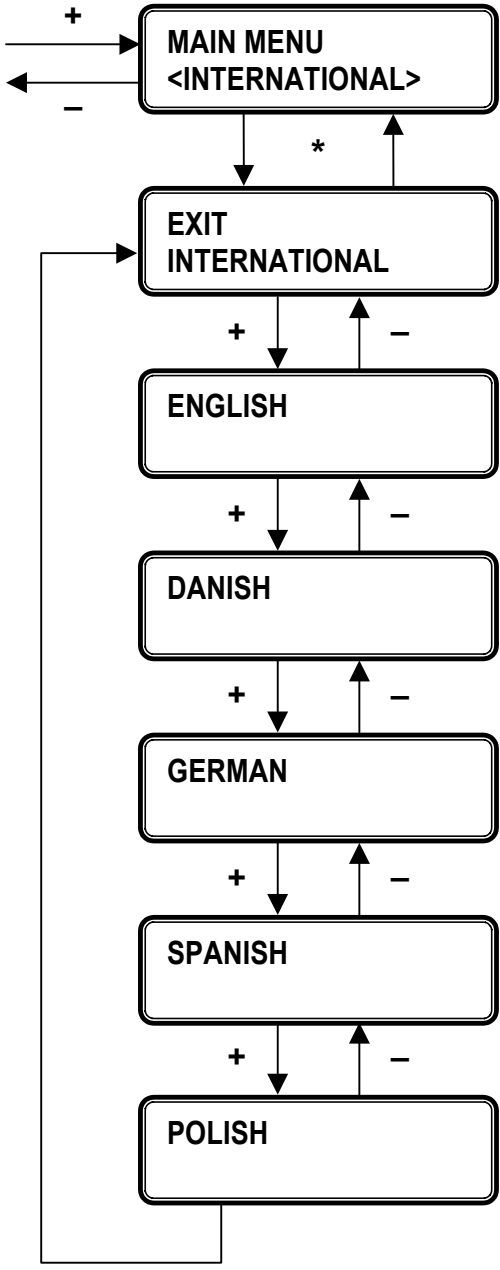












# 8. EXTERNAL CONNECTIONS

