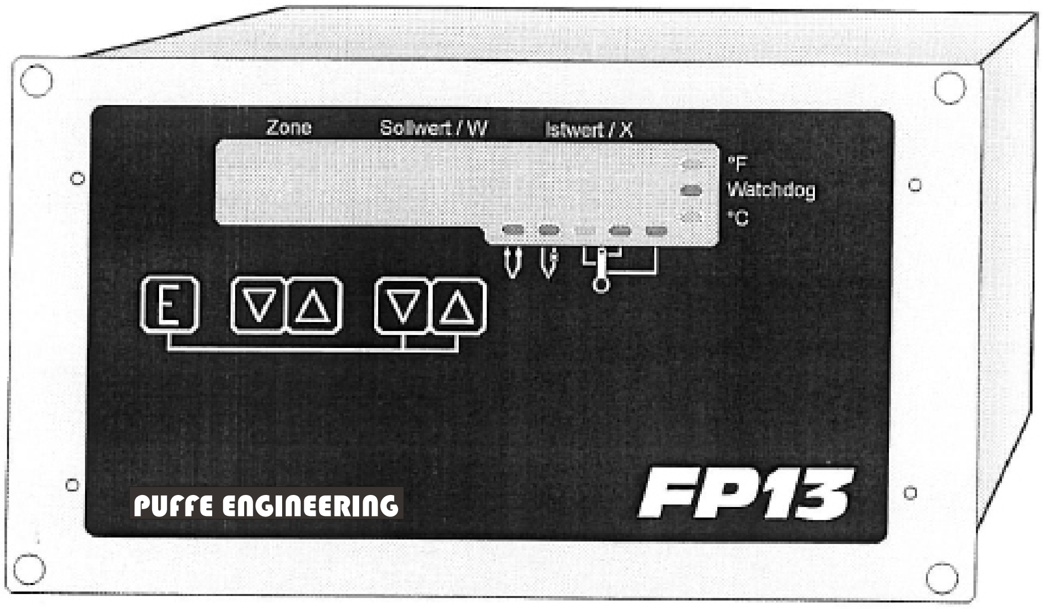
FP13
Operator Manual



CONTENTS

1.0 INTRODUCTION

1.1 HEATING - SENSING - CONTROLLING - OUTPUT

To achieve a controlled temperature using heat as the energy carrier, the implementation of certain components as well as complying with elemental principles is required.

- The HEATER delivering various amounts of heat depending on its design and size, the THERMOCOUPLE sensing temperature,
- the CONTROLLER which receives a signal from the thermocouple then compares it with a selected value and sends a command to the
- OUTPUT which regulates its behaviour to stabilize the processing temperature at the setpoint.

Within a closed circuit these elements are in direct contact with each other at all times. Important here is that all elements have an influence on the result "Temperature", in a good as well in a bad sense.

Unsuitable thermocouples, incorrect sensing locations, not enough or improper controllers, too small-large-slow-fast of an Output. All the above can cause unsatisfying results.

The following are a few elemental principles:

- The heating requirement should be 50 % of the max. output
- The thermocouple should be placed as close as possible to the controlled medium.
- The thermocouple should be located between heater and the controlled medium.
- A good heat contact of the heater and thermocouple is necessary.
- Use solid state relays if possible. This utilises the high control speed of microprocessor based controller such as the ***FP13***.
- The thermocouples and loads should be kept in separate cables.
- Do not use relay coils without RC circuitry.
- The thermocouple must not carry any other current. This would cause operating interruptions and safety hazards.

1.2 SHORT DESCRIPTION

The **PUFFE ENGINEERING** ***FP13*** is a micro-processor based multi-zone temperature controller capable of controlling up to 13 zones. The power and flexibility of the controller make it ideal for a wide variety of temperature regulations that are controlled by relay action.

The controller is equipped with insulated TRIAC-Power Outputs. The ***FP13*** supports thermocouples (NiCr-Ni, Fe-CuNi), semiconductors, (Polycrystalline PT100's) and %-On time. The sensor signal is amplified and bridge compensated for accurate control.

The outputs are switched on or off in the zero potential point. The arrangement of outputs into 3 groups allows the connection of 3 phases (Load Distribution). The short circuit protection is guaranteed by 3 very fast 16 A fuses. The net voltage is protected with a 0.5 A fuse.

User defined setpoints and operating parameters remain in memory even after powering down the controller. The memory unit is backed up by a lithium battery for at least 10 years.

The zones can be defined for both heating and cooling applications (max. of six 3 Point controls). This mode can be selected by changing dip-switches which are accessible through a window on top of the control module.

The unit displays simultaneously the zone number, setpoint and actual value per zone.

The ***FP13*** is capable of storing 4 different setpoint programs (per control circuit) and activating them if required.

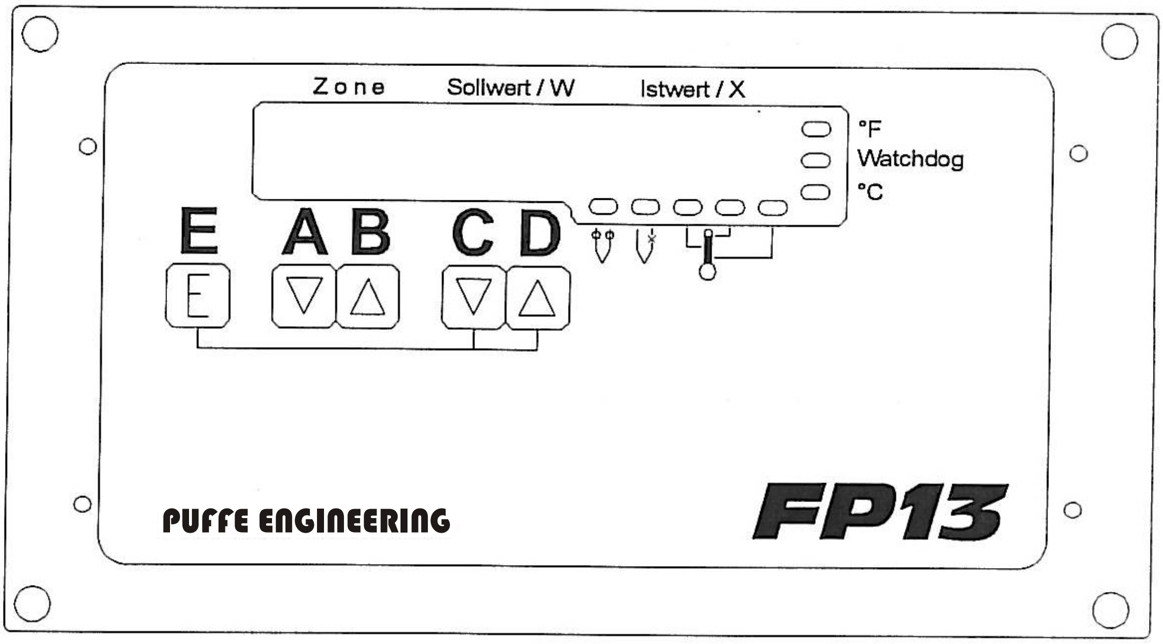
Every zone can be monitored independently for high and low temperature, where the respective output relay for each zone is activated. The contacts of these relays are maintained potential free.

In case of a broken or disconnected thermocouple the corresponding zone can be switched to a constant power output (%-On Time) and continue operation.

The control method is analogous to PID with ramp behaviour. The controller follows the DDC-Principle (Direct-Digital-Control). The selectable user parameters Xp, Tn, Tv are compatible with the parameters used in the linear control technology.

1.3 SHORT INSTRUCTION

The following key descriptions refer to the previous diagram of the front plate.



Setting Values

The brief pressing of keys [A] - [D] causes the value to change by one unit. If the key is held down longer, the value changes much quicker.

Selecting the zone number

with key [A] or [B] (Chapter 3.1.1)

Selecting the Setpoint

with key [C] or [D] the desired setpoint is selected, confirm by pressing [E] for Enter (chapter 3.1.3)

Selecting the OP-Value (Setting the first zone number)

with key [A] descend below zone 1, "*OP*" is displayed in zone display, with key [C] or [D] set the first zone number (Parameter Security must be unlocked - Chapter 2.2.4), confirm by pressing [E] (chapter 3.1.5)

Selecting the Setpoint Program

with key [A] descend below OP-Value, "*P*" is displayed in zone display, with key [C] or [D] select setpoint program (1..4) (Chapter 3.1.6), confirm by pressing [E]

Selecting the Max. Setpoint

with key [A] descend below P-Value, "*HI*" is displayed in zone display, with key [C] or [D] select max. setpoint (Parameter Security must be unlocked - Chapter 2.2.4), confirm by pressing [E] (Chapter 3.1.7)

Selecting the Min. Setpoint

with key [A] descend below HI-Value, "*LO*" is displayed in zone display, with key [C] or [D] select min. setpoint (Parameter Security must be unlocked - Chapter 2.2.4), confirm by pressing [E] (Chapter 3.1.8)

Turning off a control zone

A control zone is turned off by setting the setpoint to "*000*", ie. the value is dropped below the min. setpoint (*LO*-Value, Chapter 3.1.8).

Definitions of displays using examples

a) Control Level

Zone	Set W	Actual X	Explanation
01	060	060	Zone 01, Setpoint and actual Value = 60 Degrees (Normal Operation)
12.	100	100	Controller is in Scan Mode, currently at zone 12 (see Chapter 3.1.2)
07	060	-L-	Zone 07 has a Setpoint of 60 Degrees, but the Actual Value lies below the Low Temperature Alarm Limit (Set Point + Parameter 02) see Chapter 3.3.2
04	100	-H-	Zone 04 has Setpoint of 100 Degrees, but the Actual Value lies above the High Temperature Alarm Limit (Setpoint + Parameter 02)(see Chapter 3.3.1)
06	---	---	Zone 06 is turned off (see Chapter 3.1.3)
02	-HE	LP-	Zone 02 has exceeded the HI-Value by at least 10 degrees, the heaters are turned off, potential free contact (W = Watchdog) is open (see Chapter 4.3)
10	070	-S-	Zone 10 has a shorted thermocouple (Pt100 only) (see Chapter 3.2.7)
13	080	-E-	Zone 13 has a thermocouple break or disconnection (Chapter 3.2.6)
0P	010		Controller assigns No. 10 to first zone and numbers all other zones consecutively (see Chapter 3.1.5)
P	3		Setpoint Program No. 3 is selected (Chapter 3.1.6)
HI	200		HI-Value (max. selectable Set Point) is set at 200 degrees (see Chapter 3.1.7)
LO	050		LO-Value (min. selectable Set Point) is 50 degrees (see Chapter 3.1.8)
01		250	Zone 1 is in the Monitoring Mode (see Chapter 4.4)
08	2.0.0.	100	Zone 8 is in the Soft Start

11	180.	100	Zone 11 has an internal Set Point different from the displayed Setpoint, e.g. for ramp behaviour (see Chapter 3.3.7) and HI-Value Adjustments (Chapter 3.1.7)
--	HEL	P--	processor self monitoring check has occured a hardware fault, the heaters are turned off, potential free contact (W = Watchdog) is open (see Chapter 4.3)
HE	LP	--	standard parameters have to be set (see chapter 2.2.5)
SC	01		„Slowest channel " (only available in SAFE- Version)
AP AP AP	01 02 03		„Auto Power Mode " (only available in SAFE- Version)
06	100	-IL	the controller has registered a leakage current in channel 6, the channel will be dried-out and the internal setpoint will be fixed at 100 ° C (only available in SAFE- Version)

b) Parameter Level:

Zone	Set W	Actual X	Explanation
11	016	.0.0.2	Zone 11 has a Low Temperature Alarm Limit (Parameter 2) of 16 degrees

c) Diagnostics Program

Zone	Set W	Actual X	Explanation
01	12.0	. . .	Zone 1 has a diagnostics time of 120 sec. (routine is identified by flashing dots running from left to right on display)
02		E02	Zone 2 does not heat up in the preset time (Parameter 8) to cause the preset temperature rise (Parameter 9), diagnostics terminated
03		H05	Zone 3 is being tested but responses from zone 5 are detected, diagnostics terminated
00		P04	Zone 4 heats but none of the Zones are being tested, diagnostics terminated

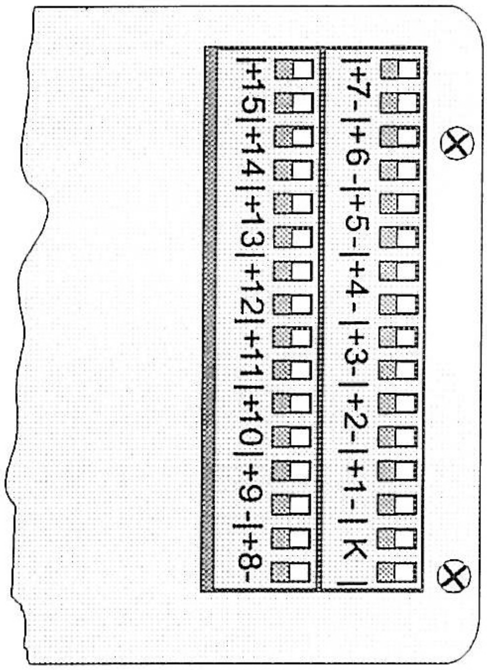
2.0 FIRST TIME START UP

Before the unit is started up for the first time, some important configurations and connections are to be made or observed.

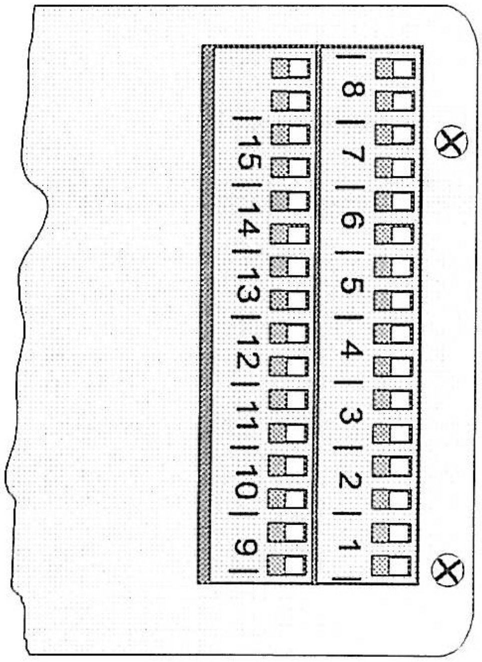
2.1 WIRING CONNECTIONS

2.1.1 Thermocouple Inputs (Fe-CuNi or Ni-CrNi)

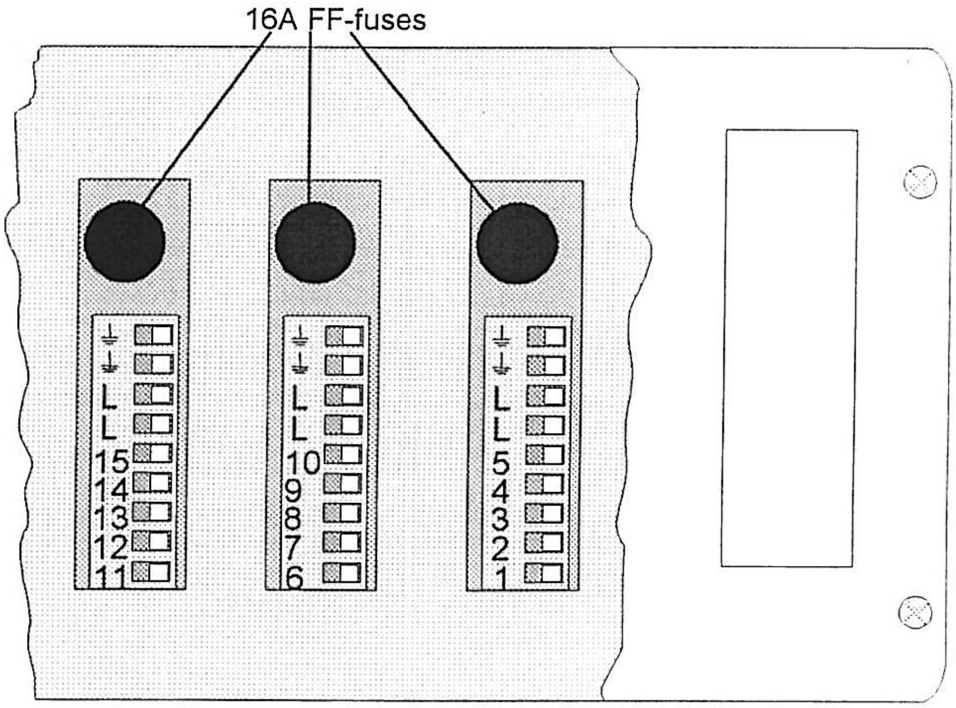
(K = compensating resistor; delivered with the unit if required. Some units have this resistor already built in and it is not accessible from the outside)



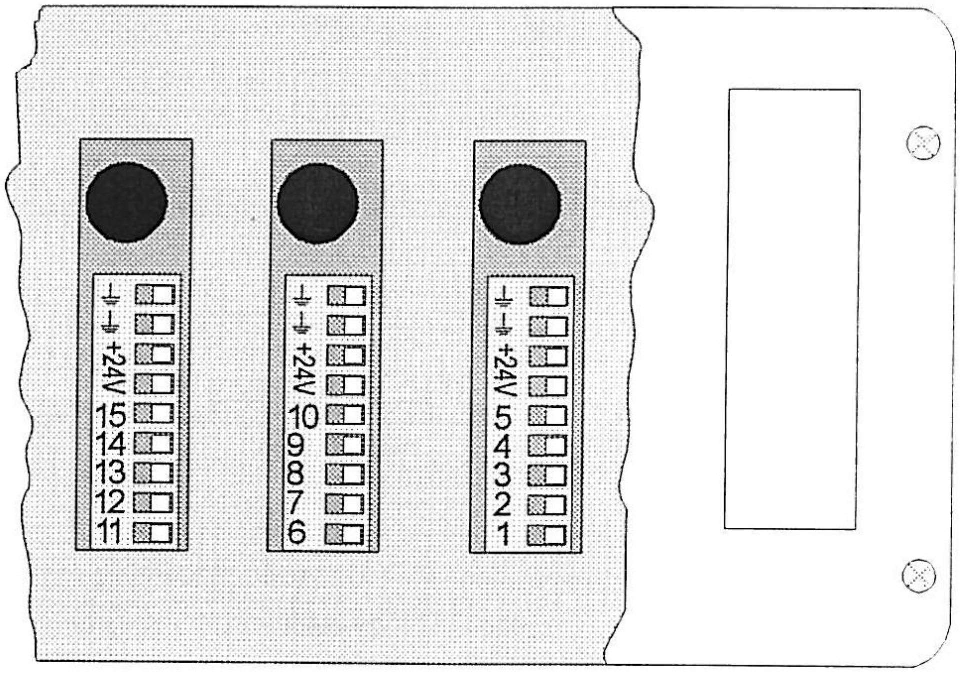
2.1.2 Thermal resistance Inputs (Pt100 - 2 wire-system)



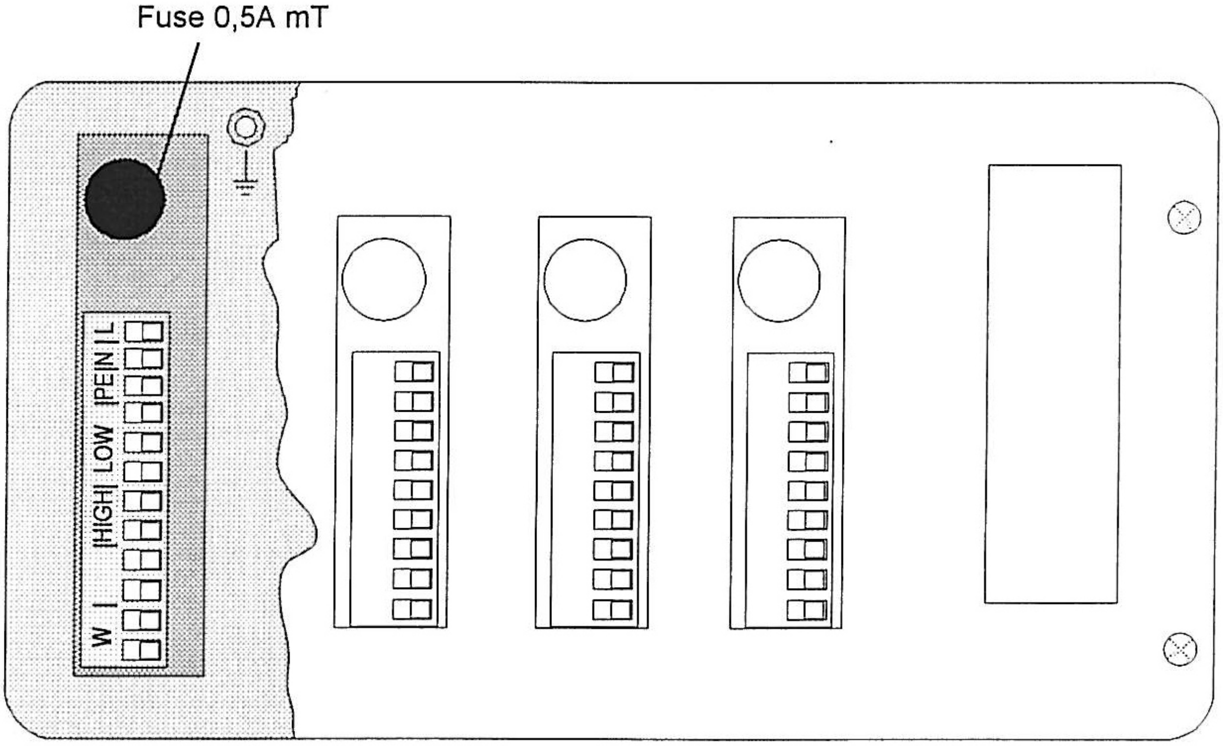
2.1.3 Power Outputs for 230VAC (Heating and Cooling)



2.1.4 Power Outputs for low voltage 24VDC (Heating and Cooling)



2.1.5 AC Power Supply 24 V, 115 V or 230 V and Alarm Outputs



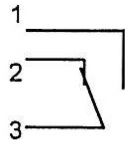
Power supply:

L = 230VAC or 115VAC or 24VAC
N = Neutral (MP)
PE = Potential Earth

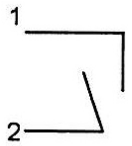
Alarm Contacts

LOW = Low Temperature
HIGH = High Temperature
W = Watchdog

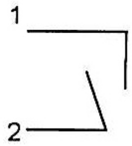
Low Temperature
aktiv due to low temperature,
normally 2-3 closed and 1-3 open



High Temperature
Aktiv due to high temperature,
normally open

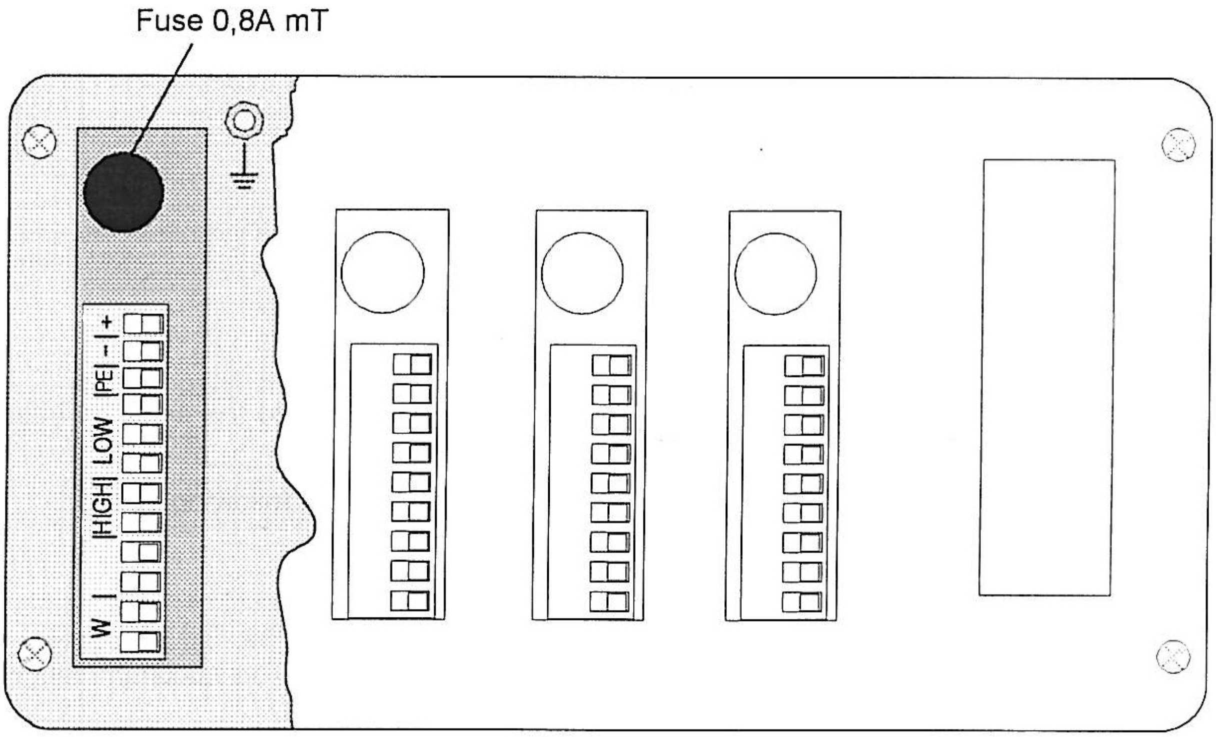


Watchdog
inaktiv due to watchdog,
normally closed



If the mains voltage does not run stabil, then it´s nessesary to use a voltage constanter!

2.1.6 DC Power Supply 24 V and Alarm Outputs



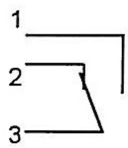
Power supply:

+ = 24VDC
- = 0V (Ground)
PE = Potential Earth

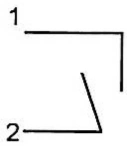
Alarm Contacts

LOW = Low Temperature
HIGH = High Temperature
W = Watchdog

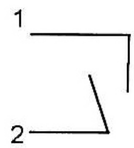
Low Temperature
aktiv due to low temperature,
normally 2-3 closed and 1-3 open



High Temperature
Aktiv due to high temperature,
normally open



Watchdog
inaktiv due to watchdog,
normally closed



2.1.7 Data Interfaces

The **FP13** will be delivered according to the customers requirements without or with individual data interfaces.

- RS232
- RS485
- RS422
- TTY 20mA / Current Loop
- PLC-parallel-inputs (see chapter 6.2)

The position of the plugs at the rear side may be different according to the selected interface in combination with the selected input board.

The function of the pins for the different interfaces is described on the following pages.

2.1.7.1 PC-Interface RS232

The unit may be controlled via a 3-core cable by the interface RS232. To guarantee a mostly undisturbed transmission you should use a twisted data cable. The maximum length is 15 meters.

Function of the interface plug:

FP 13			PC (9 pins)	
RXD	2	<-----	3	TXD
TXD	3	----->	2	RXD
GND	5	------	5	GND

PC (25 pins)	
2	TXD
3	RXD
7	GND

2.1.7.2 PC-Interface RS485

Up to 31 units may be controlled parallel via a 2-core cable by the interface RS485. To guarantee a mostly undisturbed transmission you should use a twisted data cable.

At both ends of this 2-core cable the wires „A“ and „B“ have to be linked by a 100 Ohm resistor. The resistor is fitted to the interface adapter SI13 and the PC board from Puffe ENGINEERING. The maximum length of the cable is 1200 meters.

Function of the interface plug:

The interface is wired to a 9-pins female Sub-D plug using the pins 2 and 3:

(2 = TX+ or "A"; 3 = TX- or "B").

FP 13	
A(TX+)	2
B(TX-)	3

2.1.7.3 RS422 and 20mA current-loop

Function of the pins of the 9-pins female Sub-D plug on the rear side:

RS422:

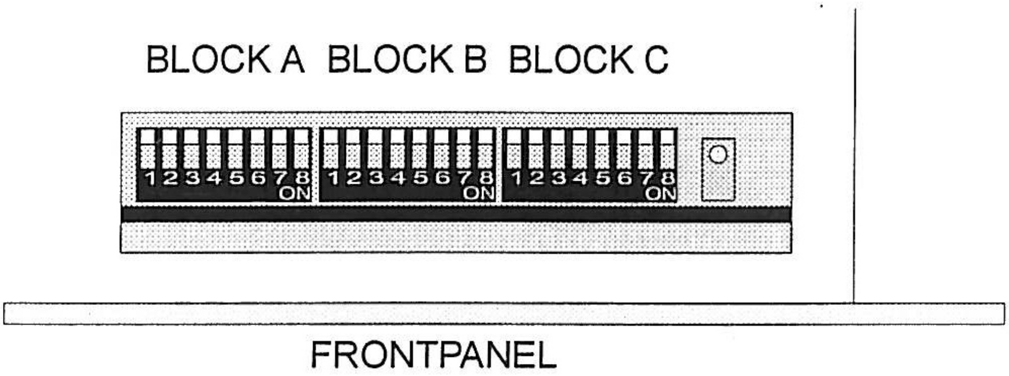
FP 13		
A(TX+)	2	----->
B(TX-)	3	----->
A(RX+)	4	<-----
B(RX-)	6	<-----

20mA current-loop:

FP 13		
I+	2	<---->
I-	3	<---->

2.2 DIP- SWITCH - FUNCTIONS

The top of the unit includes 2 screw tightened covers. Below the front one there are 3 blocks of DIP switches, each with 8 switches.



2.2.1 Setting of the device address

The DIP switch block „A" is relevant for data transmission with **FP13** via interface.
RS 485 allows the communication of 31 devices with a PC. As all the devices are linked parallel via the bus, they have to be distinguished by a specifical device address. It has to be set binary by the user via the DIP-switches.
1..31 are the valid device addresses. No address has to be set twice internally of an RS485 interface network. The according switches for the device address are 4..8 of the block „A".

DIP"A1"	DIP"A2"	DIP"A3"	DIP"A4"	DIP"A5"	DIP"A6"	DIP"A7"	DIP"A8"	Address
any	any	any	on	on	on	on	on	0 (unvalid)
any	any	any	on	on	on	on	off	1
any	any	any	on	on	on	off	on	2
any	any	any	on	on	on	off	off	3
any	any	any	on	on	off	on	on	4
any	any	any	on	on	off	on	off	5
any	any	any	on	on	off	off	on	6
any	any	any						
any	any	any	off	off	off	off	off	31

The address may be checked via the display, when you press both channel keys together.

- The original setting: address = "1"

2.2.2 Configuration for 2-/3-Point-Control (Heating/Cooling)

The DIP-Switches 1...8 of DIP-Switch block "B" and the DIP-Switches 1..5 of DIP-Switch block "C" designate for each zone whether that zone is used for 2- or 3-point control.

If the switch is in the "OFF" position (switch towards back of controller), that zone is switched to 2-point control. If the switch is in the "ON" position (switch towards front of controller), that zone is switched to 3-point control.

Please observe that the **FP13** only has 13 outputs. Every 3-point control needs two outputs (Heating + Cooling), but the 2-point control only needs one output (Heating).

This means that the outputs have different functions according to the position of the DIP-Switches. Following, the program determines the function of the various zones itself (see next diagram) as well as the number of usable zones.

This does not have any effect on the numbering of the thermocouple inputs (=control zones).

The output numbers of a zone can be checked in parameter 10 and 11 during operation (see chapter 3.3.10 + 3.3.11).

- Default Setting: all zones 2-point control

Two examples

Example 1: configuration for 15x 2-point controller (pure heater mode)

zone	function	DIP-Switch	sensor	output heat	output cool
1	Heat	B1=OFF	1	1	-
2	Heat	B2=OFF	2	2	-
3	Heat	B3=OFF	3	3	-
4	Heat	B4=OFF	4	4	-
5	Heat	B5=OFF	5	5	-
6	Heat	B6=OFF	6	6	-
7	Heat	B7=OFF	7	7	-
8	Heat	B8=OFF	8	8	-
9	Heat	C1=OFF	9	9	-
10	Heat	C2=OFF	10	10	-
11	Heat	C3=OFF	11	11	-
12	Heat	C4=OFF	12	12	-
13	Heat	C5=OFF	13	13	-

Example 2: configuration for mixed mode (2- and 3-point-mode)

Zone	function	DIP-switch	Sensor	output heat	output cool
1	Heating	B1=OFF	1	1	-
2	Heating/cooling	B2=ON	2	2	3
3	Heating	B3=OFF	3	4	-
4	Heating	B4=OFF	4	5	-
5	Heating	B5=OFF	5	6	-
6	Heating/cooling	B6=ON	6	7	8
7	Heating/cooling	B7=ON	7	9	10
8	Heating	B8=OFF	8	11	-
9	Heating	C1=OFF	9	12	-
10	Heating	C2=OFF	10	13	-
11	Heating	-	-	-	-
12	Heating	-	-	-	-
13	Not available	-	-	-	-

2.2.3 Selecting Celsius or Fahrenheit

The DIP-Switch No. 6 of block "C" changes the temperature unit from degrees C to F.

DIP-Switch in "ON" Position = Degrees Fahrenheit
DIP-Switch in "OFF" Position = Degrees Celsius

The switch in temperature unit changes all temperature values, even on the parameter level, to the new unit automatically.

- Default Setting: Degrees Celsius

2.2.4 Security Lock of Parameter Level

The DIP-Switch No. 7 of block "C" activates the security lock of the parameter level.

DIP-Switch in "ON" position = Change of parameter-, HI- and OP-Values using keys is allowed
DIP-Switch in "OFF" position = Change of parameter-, HI- and OP-Values using keys is not possible

- Default Setting: Parameter Level is locked

2.2.5 Resetting Standard Parameters

The **FP13** can be delivered from the factory with customer specific parameter setting. These values can be stored in the EPROM. The activation of these parameters is performed by switching DIP-Switch No. 8 of block "C".

DIP-Switch in "ON" position = Loading standard parameters stored in EPROM into RAM, all setpoints are set to zero.

DIP-Switch in "OFF" position = together with DIP-Switch No. 7 of block "C" in "ON" position, all parameter are user changeable.

Activating the standard Parameters:

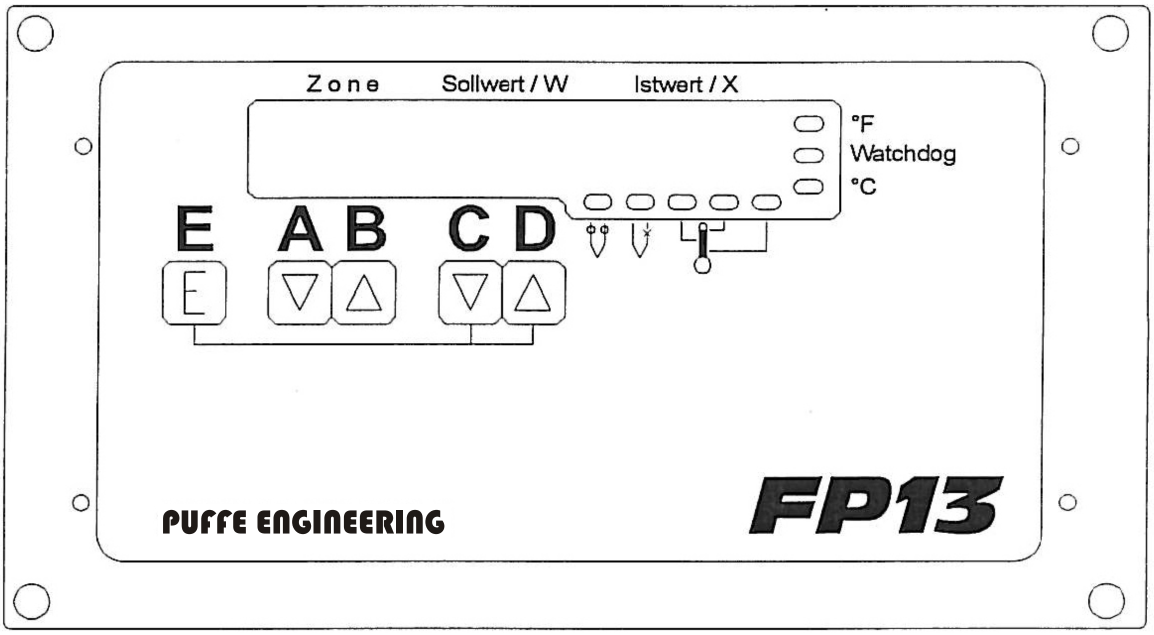
Additionally it is possible to load the standard parameters from the operating panel. These standard parameters are reloaded into the processor by pressing the buttons [E]+ [C] + [D] simultaneously for about 2 seconds.

- Default Setting: Standard Parameters are loaded (see chapter 3.3)

> **!!! Caution !!!** Every DIP-Switch change has to be confirmed while the unit is powered on by pressing the Enter key [E]. Otherwise, the display will flash 8 dashes "-- --- ---" and the outputs are disabled.

3. OPERATING INSTRUCTIONS

3.1 KEYS AND DISPLAY



After turning on the power of the **FP13** the display shows the software version number for a short time.

After that time zone 1 with its setpoint and measured value are displayed. Concurrently, there are several LED's which give information about the status of the controller.

As soon as the controller has reached the OK-Status, it will return to the scan mode (see chapter 3.1.2), which can be terminated by pressing key [A].

The digital display consists of 3 display sections:

- 1. Zone display (2-digit)
- 2. Setpoint display (3-digit)
- 3. Actual Value display (3-digit)

The **FP13** can be operated by 5 keys, which are based on an Increment-Decrement functionality, where keys [A]...[D] (see figure chapter 1.3) have a dual function:

1. short pressing = changes the value by 1
2. longer pressing = fast pass to the final value

Newly selected values (setpoint and actual values) flash in the display and have to be confirmed by pressing [E] for Enter.

3.1.1 Zone Selection

The zone number display is 2-digit and can display the following alphanumeric characters:

15	channel indication
14	channel indication
..	..
02	channel indication
01	channel indication
0P	sets the number of the first channel
P	setpoint programs
HI	HI-value (max. setpoint limit)
LO	LO-value (min. setpoint limit)

Pressing keys [A] or [B] changes the zone display to the desired number including the set-point and actual value display. The **FP13** disables the data entry if a larger than available zone number is chosen, or if the number of zones is limited by 3-point control.

3.1.2 Scan Mode

The scan mode can be triggered by holding down key B for about 1 second (starts after display has reached highest zone number).

In the scan mode the **FP13** cycles through each active zone for about 3 seconds. As a further indication of the scan mode, a decimal point is displayed in the zone display.

The scan mode is triggered automatically, if the controller has reached the OK-status.

As soon as one of the active control zones moves beyond the control limits the scan mode is terminated and the display remains at the first unstable zone.

The scan mode can be terminated manually by pressing key [A].

3.1.3 Changing Setpoints

The setpoint display shows with 3 digits the selected setpoint. The setpoint can be changed with keys [C] or [D] and entered with the Enter key [E].

During and after changing the setpoint the display flashes and the controller still controls, according to the old setpoint. Only after pressing key E is the new setpoint permanently accepted and responded to with control actions. The display stops flashing.

The permitted setpoint values range between minimum and maximum setpoint limits. These limits should be established before the first setpoints are entered (chapter 3.1.7 and 3.1.8).
Control Zone Termination:

If the setpoint is dropped below the minimum setpoint, the control zone will be disabled. As an indication for the terminated zone the display shows dashes "--- ---" beside the zone number.

The high and low temperature monitor is not activated (see chapter 3.3.1 and 3.3.2).
The Watchdog operation (Power down when HI-Value is exceeded) is still functional with terminated control zones (see chapter 3.2.2 and 4.3).

- Default Setting: Setpoint = Zero

3.1.4 Actual Value Display

During normal operation the actual value display shows with 3 digits the current actual temperature. Depending on the status of the controller, it is possible to observe other types of information in that display as well.

The actual value display alternates between the actual value and

-H- at high temperature	-S- with shorted sensor or wrong wiring
-L- at low temperature	-IL with leakage current (only in Safe-Version
-E- with broken sensor	HLP at exceeded HI-value

When the zones are turned off (see chapter 3.1.3) dashes "- - - - - -" are displayed instead of the actual value. The actual value display stays unlit when OP-, HI-, LO- or P-Number is selected (see chapter 3.1.5..8).

If the temperature is displayed in degrees Fahrenheit then the 3 digit display is limited to 999 degrees. If the value exceeds 999, a decimal point appears in front of the 3 digit display to replace the missing 1 (eg.: .230 = 1230 Degrees F).

3.1.5 Assigning A Number To The First Zone

The OP-Value assigns a number to the first zone. The OP-Value is located with key [A], and the number for the first zone is assigned with key [C] or [D]. The new value then flashes until it is confirmed with key [E].

Highest possible OP-Value (for zone 01) = 84.

The ***FP13*** numbers the remaining zones accordingly. This feature allows a continuous numbering system of control zones for several controllers.

- Default Setting: 01

3.1.6 Setpoint Programs

A setpoint program contains a group of 5, 9/10 or 13/15 (depending on the expansion level) temperature setpoints.

It is possible to store up to 4 different setpoint programs, that can be loaded in during a change in process such as a material change or a temperature drop during production interruptions. The setpoints change automatically to the new program.

The selection of setpoint programs is performed in zone identification *P* (below *0P*). The first digit of the setpoint display is used for the numbering of the program. There the digits 1-4 are shown. The program can be changed with key [C] or [D] and confirmed with key [E].

- Default Setting: Setpoint Program P1

3.1.7 Max Setpoint Limit (HI-Value)

The *HI*-Value can be displayed by lowering the zone number with key [A] to below the Setpoint Programs *P*. The *HI*-Value should be set regardlessly before the first setpoint is selected.

The *HI*-Value represents an integral factor of the control computations. The P-Band makes use of this value. Therefore, changes should only be made under consideration of the effects on the P-Band (chapter 3.3.4).

Changes are only possible, if the DIP-Switch security lock of the parameter level is unlocked (see chapter 2.2.4). Thereafter, *HI*-Value changes are performed using key [C] or [D] confirmed with key [E].

It is advisable to lock the parameter level after changes are made to avoid accidental *HI*-Value changes.

The *HI*-Value acts as a limiting value, which has the following functions:

- If one of the connected control circuits (valid also for turned off zones, ie. no setpoint entry) reaches the *HI*-Value, a high temperature warning is signalled. (see chapter 3.2.5).
- If one of the connected control circuits reaches a temperature of the *HI*-Value + 10 K, the watchdog alarm is immediately turned on (see chapter 3.2.2).
- *HI*-Value changes have priority over setpoint values. The lowering of the *HI*-Value below the setpoint also triggers the watchdog alarm. While the original set point remains in the display, the controller controls internally according to the new *HI*-Value. This internal deviation from the setpoint is indicated by a decimal point in the setpoint display, eg.: "250.". The first push of key [C] or [D] changes the setpoint to the new max. allowable setting = *HI*-Value.

The max. *HI*-Value depends on the type of sensor:

- Fe-CuNi and NiCr-Ni up to 700 degrees C,
- PT100 up to 250 degrees C.

FeCuNi = 500	**NiCr-Ni = 500**	**PT100 = 250**

3.1.8 Minimum Setpoint Limit (LO-Value)

The *LO*-Value can be displayed by lowering the zone number with key [A] to below the *HI*-Value.

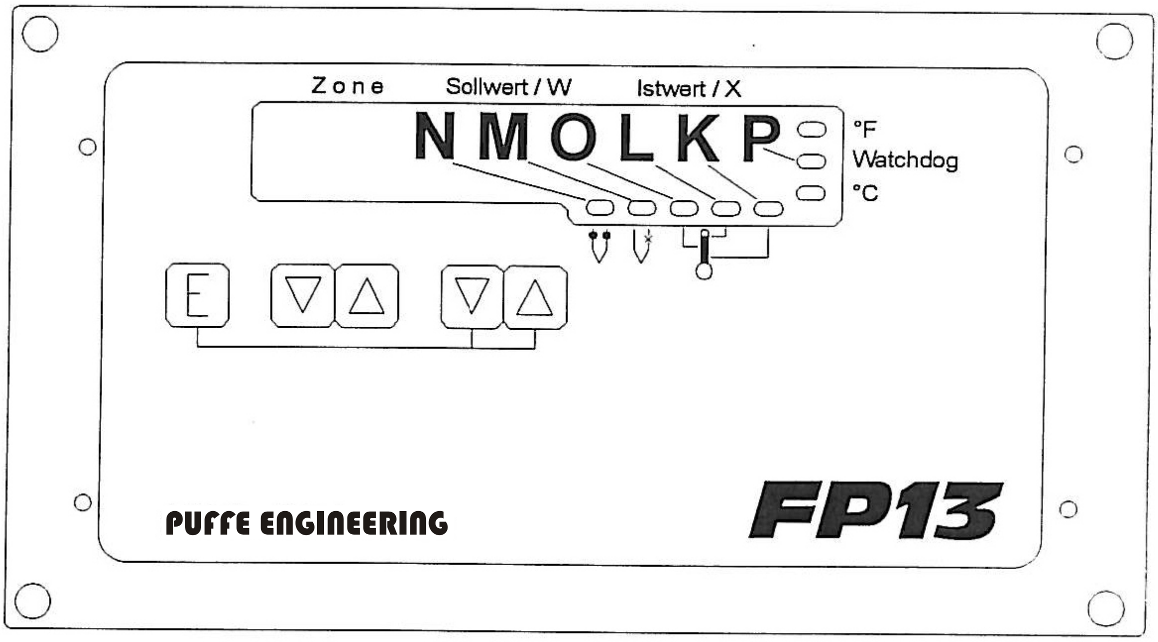
The *LO*-Value acts as a lower limiting value for setpoint selections. There is no alarm signals linked with the *LO*-Value. The lowering of the setpoint below the *LO*-Value disables that zone.

LO-Value changes have priority over setpoint values. Increasing the *LO*-Value above the setpoint will not alter the original set point in the display. Rather, the controller controls internally according to the new *LO*-Value. The first push of key [C] or [D] changes the setpoint to the new min. allowable setting = *LO*-Value.

- Default setting: 20 degrees C

3.2 LED DISPLAYS

With the use of eight different LED's the **FP13** displays controller status information. All signals are shown as summarized displays.



3.2.1 Fahrenheit and Celsius LED

The LED's indicating degrees Celsius and Fahrenheit are located to the right of the actual value display. Depending on the selected type of temperature display (degrees C or F), one of the two LED's displays the unit of temperature for setpoints and actual values.

The conversion from degrees C to degrees F is accomplished by switching a DIP-Switch (see chapter 2.2.3).

If the temperature is displayed in degrees Fahrenheit, the 3 digit display is limited to 999 degrees. If the value exceeds 999, a decimal point appears in front of the 3 digit display to replace the missing 1 (eg.: .230 = 1230 Degrees F).

3.2.2 Watchdog LED

The Watchdog LED (P) is triggered, if the following conditions occur:

- The HI-Value (see chapter 3.1.7) is exceeded by 10K
- Problems with the AC Power Supply
- The processor's own error detector finds a hardware component problem

All the above conditions cause a flashing -HELP- in the display, alternating with the set-point/measure value display. The Watchdog LED lights up. The potential free normally open contact (contact output W; see diagram 2.1.3) is opened at the back of the controller which, for example, could disconnect the heaters from the AC power supply through a safety switch.

This error message can also occur, if the HI-Value is lowered below a actual value.

3.2.3 Low Temperature LED

If the setpoint is not yet reached or if the actual value of one or more zones drops below the low temperature limit determined by parameter 2 (see chapter 3.3.2), the low temperature LED (K) lights up.

At the same time a potential free contact for external switching (contact output U, see diagram chapter 2.1.3) is activated. If the display is in the scan mode, the scan mode is terminated at the first zone which indicates low temperature. This zone is then displayed permanently.

The low temperature LED as well as the respective relay can also be triggered if the setpoint of a zone is raised. To utilize the contact of the low temperature relay for sending a clear signal to the machine a low temperature signal is transmitted during these events:

- Turning on power of the controller
- Thermocouple short (PT100)
- Thermocouple break
- Diagnostics program

3.2.4 High Temperature LED

If the actual value of one or more zones exceeds the setpoint by more than the predetermined value set in parameter 1 (see chapter 3.3.1), the LED (L) will light up after a short delay.

At the same time a potential free contact for external switching (contact output Ue, see diagram chapter 2.1.3) is activated. If the display is in the scan mode, the scan mode is terminated at the first zone which indicates high temperature. This zone is then displayed permanently.

3.2.5 OK LED

The green LED (O) signifies the normal, trouble free operation of the **FP13**. This LED always lights up, if the active zones have an actual value which ranges within the high/low temperature band.
The controller also switches to the scan mode automatically when the OK LED lights up.

3.2.6 Sensor Break LED

In the event of a thermocouple break of one or more zones, or if a zone with a disconnected thermocouple is turned on, the LED (M) will be activated.

The heater of the corresponding zone is turned off. This will cause the low temperature alarm (3.2.3) to signal due to the evident temperature drop.

When thermocouple break or disconnection is present, the zone can be switched to %-On Time (see chapter 4.2).

3.2.7 Sensor Short LED

(Relevant only for ***FP13*** units with PT100 inputs)

In the event of a thermocouple short of one or more zones, the LED (N) will be activated. The heater of the corresponding zone is turned off. This will cause the low temperature alarm (3.2.3) to signal due to the evident temperature drop.

3.3 PARAMETER LEVEL

The ***FP13*** possesses a parameter level which serves to adjust the controller to special control tasks. This level accommodates 10 different controller specific parameters.

The parameter level of a zone is accessed by first pressing [E] and then jointly pressing [A] (executable for each zone).

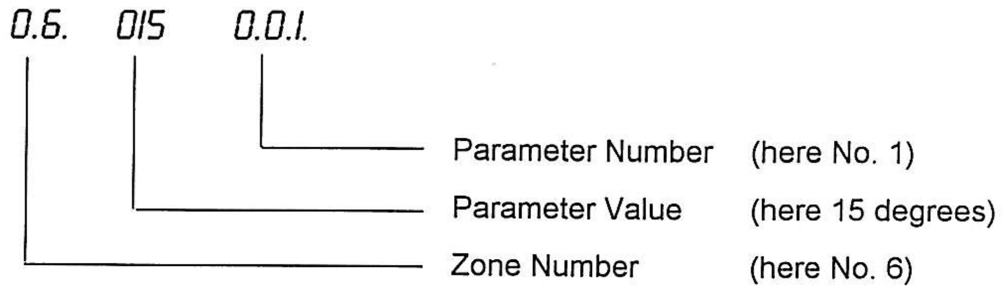
Periodic monitoring of Parameters:

All of the entered parameters are validated at periodic time intervals of 2 seconds. If it is determined that the parameter values are exceeding above or dropping below the limits, a flashing ---HELP HELP--- will indicate this on the display.

This must be resolved by loading the standard parameters.

Parameter Display:

After the level is accessed, decimal points appear in the zone number as well as actual value display. Eg.:



In this example, the high temperature alarm for zone no. 6 is activated at 15 degrees above setpoint.

Parameter Selection:

Parameters can be selected by using key [A] or [B]. Going above the last parameter for one channel will reach the first parameter of the following channel.

Parameter Change:

Changing parameter values is only possible if the parameter level is unlocked (see chapter 2.2.4). DIP-Switch No. 7 of DIP-Switch block "C" has to be in the "ON" position. The display shows flashing dashes "- - - - - - - -". After pressing key [E] once, the corresponding zone with its parameters appears in the display.

It is now possible to enter a new parameter value using key [C] or [D], confirm this value with key [E].

!!! Caution !!! The parameter level should be locked again after all the changes have been made

Exiting the parameter level:

The user can return to the normal display mode (Zone-Setpoint-Actual Value) by first pressing [E] and then jointly pressing [B].

The controller can be delivered with customer specific parameter settings. If there are no specific customer requests, the unit is delivered with the default settings (same for all zones):

3.3.1 PARAMETER 1: HIGH TEMPERATURE ALARM LIMIT

Parameter 1 sets the alarm limit for the high temperature response respective to the set-point. This limit can be adjusted for each zone.

Range	4 - 700 °C for FeCuNi/NiCrNi 4 - 250 °C for Pt100
Default setting	15 °C
Unit	Celsius or Fahrenheit

Function:

The high temperature alarm limit determines a range above the setpoint where, any overshoot above this range would trigger an alarm. There is an alarm on the display and a potential free relay contact at the rear of the device.

Example:

Setpoint = 100 degrees C
Parameter No.1 = 15 degrees C

Result:

When the zone attains a temperature of 115 degrees (100 + 15), the HI-temperature will be indicated by a (flashing) *-H-*. At the same time the lights the high temperature LED (H) and the high temperature relay (contact „HI") is activated to be used for external signalisation. The high temperature message remains until the value of the respective zone has dropped to

Setpoint + High Temperature Alarm Limit - 3 degrees C

(example: 100 + 15 - 3 = 112).

!!! Caution !!! The alarm value is not valid, if the sum of setpoint and the value of parameter No.1 is greater than the defined HI-value.

3.3.2 PARAMETER 2: LOW TEMPERATURE ALARM LIMIT

Parameter 2 sets the alarm limit for the low temperature in relation to the setpoint. This limit can be adjusted for each zone.

Range	3 - 700 °C for FeCuNi/NiCrNi 3 - 250 °C for Pt100
Default setting	15 °C
Units	Celsius or Fahrenheit

Function:

The low temperature alarm limit determines a range below the setpoint where any drop below this range would trigger an alarm. There is an alarm on the display and at the back of the controller as a potential free relay contact.

Example:

Setpoint = 100 degrees C
Parameter No. 2 = 15 degrees C

Result:

When the zone attains a temperature of 85 degrees (100 - 15), the LO-temperature will be indicated by a (flashing) -L-. At the same time the lights the low temperature LED (L) and the low temperature relay (contact „LO") is activated to be used for external signalisation The low temperature message remains until the value of the respective zone has risen to

Setpoint - Low Temperature Alarm Limit + 3 degrees

(example: 100 - 15 + 3 = 88).

3.3.3 PARAMETER 3: RELAY CYCLE TIME / INDICATION MODE

Parameter 3 has a dual function. It determines the switching time by setting power cycle times for each individual heater, as well as the definition of the indication mode of each channel separately.

Range	0 - 20
Default setting	1
Units	sec

Indication mode (Parameter value = 0): Attention! For the indication mode the settigs of parameters 1 and 2 are supervising absolute values.
Without alarms: parameter 1 = 700°C, parameter 2 = 3°C.

The indication mode deactivates the setpoint display. The controller measures the temperatures by the connected sensors and shows them in the display for each zone.

Control mode (Parameter value between 1 and 20):

The best control results are achieved when the electronic power output or the connected Solid State Relays switch at the highest speed. This is accomplished with a setting of "*001*". The switching time should be adjusted according to the rated relay cycles, power requirements and type of load to avoid premature wearing out of contact relays. Nevertheless, this setting has a direct influence on the control fluctuations with respect to the delay time of the control cycle.
However, a compromise between low switching frequency and low control fluctuations is required. The fast switching time (default setting) should be used with electronic power contacts.

3.3.4 PARAMETER 4: PROPORTIONAL BAND Xp

Parameter 4 determines the P-Band of the controller in terms of percentage of the HI-Value (see chapter 3.1.7).

Range	0 - 100
Default setting	5
Units	% from HI-value

Function:

The Xp-Value demands 100% heating output until the P-Band is reached. Within the P-Band range thereafter, the heating output is reduced linearly. When the setpoint is reached the heating output is zero.

Example:

max. setpoint (HI-value)	= 300 degrees C
Parameter No. 4 (P-Band)	= 10 %
setpoint for channel No. 4	= 100 degrees C

Result:

The P-Band encompasses 30 degrees C (from 70 to 100 degrees C). The controller, in this example, demands 100% power until the onset of the P-Band (70 degrees C).
The demanded power is entirely channelled to the outputs, provided the I- and D-portion is turned off (P-Controller).
If the temperature reaches above 70 degrees C, the demanded power is reduced linearly up to the setpoint (eg.: 100 C).

3.3.5 PARAMETER 5: INTEGRAL TIME T_n

Parameter 5 sets the Integral time (I-Portion) of the controller in units of seconds.

Range	0 - 999
Default setting	80
Units	seconds

Function:

To avoid a permanent control deviation, the controller increases the power output cyclic and proportional with respect to the current control deviation. The speed which is used for this action can be adjusted with parameter No.5.

Example:

Parameter No. 5 (I-Portion) = 30 sec.

Result:

The I-Portion increases by an amount equal to the Xp-Value within 30 seconds by the rate of the Xp band.

If the control deviation becomes negative (actual value is higher than the setpoint), the I-Portion is reduced in the same way.

If the setting is zero and parameter No. 4 (Xp) and No. 6 (D-Portion) is activated, the controller becomes a PD-Controller.

3.3.6 PARAMETER 6: DIFFERENTIAL TIME T_v

Parameter 6 sets the Differential Time (D-Portion) of the controller in units of $\frac{1}{10}$ seconds.

Range	0 - 99,9
Default setting	20,0
Units	Seconds

The decimal point will not be indicated in the display.

Function:

The D-Portion causes a reduction or an increase in heating power as an offset control depending on the current speed and direction of the temperature change. Tv compensates for the delay time in the heater.

Example:

Parameter No. 6 (D-portion) 50 = 5,0 seconds

Result:

The D-Portion causes a power output reduction during the one degree temperature rise which depends on the current Xp-Value and on the time required for that temperature rise.

This power output reduction is diminished to zero within the time span (eg.: 5 seconds) preset with parameter No. 6.

If the setting is zero and parameter No. 4 (Xp) and No. 5 (I-Portion) is activated, the controller then becomes a PI-Controller. It may be advantageous to use a PI-control structure if the control circuits are very fast or subject to strong interferences. This is in conjunction with the temperature ramp; parameter No. 7 (see chapter 3.3.7).

3.3.7 PARAMETER 7: START UP RAMP

Parameter 7 sets the Speed with each zone attains the setpoint.

Range	0 - 100
Default setting	0 (passiv)
Units	seconds per K

Function:

The start up ramp defines the internal 1 degree-setpoint-jump. The controller reaches the actual setpoint in 1 degree-leaps, in a sense setpoint driven.

This function is very valuable in achieving even heat-up of machines, tools etc. Furthermore, the ramp can be very useful, if a pure PI-control structure is required (parameter No. 6 = zero).

Example:

Actual value	= 30 degrees C
Parameter No. 7	= 5 (seconds per degree C)
Setpoint	= 100 degrees C

Result:

The controller leads the internal setpoint with a 5 second cycle from 30 to 100 degrees C. This process requires 350 seconds, temperature difference (70) x 5 sec. = 350 sec.

This condition, where the internal setpoint differs from the selected setpoint, is indicated with a decimal point behind the setpoint. The display would show, in our example, "100." for 350 seconds.

!!! Caution !!! The temperature ramp is also effective when the setpoint is lowered. This ensures a controlled cooling process as well.

3.3.8 PARAMETER 8: DIAGNOSTIC TIME

Parameter 8 sets the Diagnostic Time during which each zone in the diagnostic program awaits a temperature increase, as chosen in parameter No. 9.

Range	1 - 999
Default setting	180
Units	Seconds

Function:

The diagnostic program relates parameter No. 8 to No. 9. The program intends to realize a temperature increase (parameter No. 9) for each zone within the given time limit (parameter No. 8).
If the heater does not achieve the desired temperature increase within the given diagnostic time, the display will indicate an error message with a flashing E.

Example:

Zone 3, Parameter No. 8 = 240 seconds diagnostic time

Zone 3, Parameter No. 9 = 10 degrees diagnostic temp. increase

Diagnostic-program is initiated (see chapter 4.1)

Result:

When the test phase 03 is reached, the heater of zone 3 is turned on. Within 240 seconds (parameter No. 8) the heater has to produce the desired temperature rise of 10 degrees C (parameter No. 9).
Once this rise in temperature is achieved before the diagnostic time has run out, the diagnostic program switches to the next zone to be tested.
If the rise in temperature is not achieved within the preset diagnostic time, an error message flashing " 03 E03 " (for zone 3) is displayed.

There could be several reasons for this error, ie.:

- the diagnostic time for this zone may be too short (depending on the responsiveness of this zone)
- the thermocouple is broken or not connected (the controller receives no response in both cases)
- the load cable is defective, heater is not activated
- defective load cable, the heater can not get powered
- thermocouples or load cables could be crossed

3.3.9 PARAMETER 9: DIAGNOSTIC-TEMPERATURE INCREASE

Parameter 9 sets the Diagnostic Temperature Increase which each zone in the diagnostic program (see chapter 4.1) has to realize within the given diagnostic time, as chosen in parameter No. 8.

Range	5 - 10
Default setting	10
Units	°C

Function:

The diagnostic program relates parameter No. 8 to No. 9. The program intends to realize a temperature increase (parameter No. 9) for each zone within the given time limit (parameter No. 8).
If the heater does not achieve the desired temperature increase within the given diagnostic time the display would indicate an error message with a flashing "E". (see parameter No.8)

3.3.10 PARAMETER 10: HEATING OUTPUT RELAY NUMBER

Parameter 10 is not adjustable by key operation!
The program determines the division of outputs according to the DIP-Switch settings (2-/3-point control - heating/cooling).

For mixed heating/cooling applications it is absolutely necessary to obtain the proper output number for the heater of that zone from parameter No. 10. Hereby, the displayed number corresponds to the labelling of the outputs (see chapter 2.1.2 and 2.2.2).

3.1.11 PARAMETER 11: COOLING OUTPUT RELAY NUMBER

Parameter 11 is not adjustable by key operation and it is only present with activated 3-point control!
The program determines the division of outputs according to the DIP-Switch settings (2-/3-point control - heating/cooling).

For mixed heating/cooling applications it is absolutely necessary to obtain the proper output number for the heater of that zone from parameter No. 10. Hereby, the displayed number corresponds to the labelling of the outputs (see chapter 2.1.2 and 2.2.2).

3.3.12 PARAMETER 12: PROPORTIONAL BAND FOR COOLING

Parameter 12 (only when 3-point control is activated) determines the Cooling P-Band of the controller in terms of percentage of the HI-Value.

Range	0,1 - 99,9
Default setting	0,5
Units	% of HI-value

Function:

The cooling of a zone starts when the actual value exceeds the setpoint by + 3 degrees C. The Cooling P-Band governs the intensity of the cooling impact.

Example:

Setpoint = 100 degrees C
Hi-value = 200 degrees C
Parameter No. 12 = 5 %

Result:

The Cooling P-Band encompasses 10 degrees C (5 % of 200 degrees C HI-Value). The Cooling P-Band in this example starts at 103 degrees (setpoint + 3 degrees) and ends at 113 degrees C).
If the temperature reaches above the Cooling P-Band, the demanded cooling power is increased to 100 %.

4.0 FURTHER FUNCTIONS

4.1 DIAGNOSTIC PROGRAM

This program is mainly used for checking all the wiring connections when the system is first installed or after assembly work is done, eg. tooling change etc. The diagnostic program initiates an error check routine which examines wire-crossings, -breaks, -shorts and incorrect hook-up.
It is also valuable to start the diagnostic program when control irregularities during normal operation are observed because this function also monitors the correct operation of the heater (a certain temperature increase within a certain time has to be realized).

Sequence of the diagnostic program:

The diagnostic program is started by pressing keys [A] and [B] together while turning on the power. As an indication of the diagnostic mode, a decimal point runs from left to right on the display.
In this case, the three display sections zone, setpoint and actual value take on a different function compared to the normal control program !
On the left side appears the test phase of the diagnostic program instead of the zone number.
The remaining test time for the current test phase is displayed in the centre instead of the setpoint.
The right display section is only active if the diagnostic program has detected an error. The type of error is then indicated with corresponding codes (see following pages from this chapter). The program stops automatically at the first detected error.
The diagnostic program runs self-operating through all heating circuits. If some zones are switched to 3-point control, the controller first checks the heating circuits and then, examines the cooling circuits, which have to be stopped manually.
Pressing Key [D] will advance the diagnostics program to the next test phase.

The diagnostics program does not check a zone, if there is no setpoint entered for that zone (zone is turned off).

The diagnostics program can be terminated prematurely by briefly turning off the unit and turning it back on.
After the diagnostics program has completed the run without any detected errors, the controller operates according to the selected setpoint program.

As mentioned above, the diagnostic program runs through several phases. The current test sequence is indicated on the zone display.

<u>Phase 00:</u>
All heating circuits are turned off. The controller checks the response of the heaters. The diagnostic time is the sum of the longest diagnistic time, set by parameter No.8, plus 10 seconds. If one of the heaters causes the temperature increase preset in parameter No. 9 (without activation from the controller), the following (flashing) error message is displayed:

```
00 . . . P01
```

Interpretation: Zone 1 heats, but it is not activated.

<u>Phase 01 - 15:</u>
During these phases the working condition of each heater will be checked. The diagnostic time for each phases is max. as long as the time set with parameter No. 8. Within this time limit the temperature must have increased by a value set with parameter No. 9. As soon as the heater realized the temperature increase, the controller jumps to next test phase, even if the diagnostic time has not run out yet.
If the temperature increase is not realized, the following (flashing) error message is displayed:

```
02 . . . E02
```

Interpretation: Zone 2 has not achieved the desired temperature increase within the given time limit.

Possible causes:

- Defective heater
- Broken heater wires
- Defective sensor
- Sensor wires broken or wrongly connected
- Sensor wires crossed with a non-active zone
- Defective triac in the device
- Defective use in the device

If an other heater than the driven heater responds with a temperature increase, the following (flashing) error message is displayed:

```
03 . . . H04
```

Interpretation: Zone 3 is activated, but response is given by zone 4.
Possible causes:

- Heater wires crossed with an other zone
- sensor wires crossed with an other zone

In this case please compare the output numbers defined in parameter No. 10 and 11 with your installation at the rear of the device.

Phase "X.X - - -":

(Flashing decimal point in the zone display and three flashing dashes in the setpoint display)
The cooling circuits will be checked after the heating circuits have been checked.
The program requests the manual confirmation of each cooling circuit. The program stops at the first cooling circuit and displays a flashing decimal point in the zone display together with three dashes (" - - - ") in the setpoint display.

```
0.1 . . .   - - -
```

Please ensure, that the proper cooling circuit is actuated and confirm it with a short pressing of key [A].

> **!!! Caution !!!** After the diagnostics program has finished without any detected errors, the controller starts automatically the selected setpoint program.

4.2 MANUAL MODE

Each temperature control loop can be switched to manual mode. Prerequisite: The sensor is broken or not connected (sensor interruption). The indication is a flashing *-E-* in the display for the actual value.

The switching is done by pressing key [E] and [A] simultaneously for the referring channel. The letter *P* is displayed for the relevant zone on the right hand side of the display to indicate the manual mode. Now, the setpoint adjustment is not done in terms of degrees C or F, but rather as a percentage (0 - 100%) of output rate.

To leave the parameter level, press keys [E] and [B] together, and the percent-on time display of the respective zone is reached. A new setpoint is required for the controller. The defective sensor should have been replaced meanwhile.

4.3 WATCHDOG-FUNCTION

The watchdog function performs:

- processor self monitoring checks for hardware faults
- controller limit HI-value plus 10 K (see chapter 3.1.7)
- power supply check

Additional explanations are listed under chapter 3.2.2 WATCHDOG-LED.

4.4 INDICATOR MODE

The ***FP13*** can also be used as an indicator. If the relay cycle time is turned off, parameter No. 3 (see chapter 3.3.3) in position "000", the corresponding output is not activated any more. The setpoint display is turned off.
There are no effects on the operability of the controller. Reaching the parameter level, scan mode etc. is nonetheless applicable as described in the various chapters.

4.5 INTERNAL SETPOINT AND PERCENT OUTPUT INDICATION

Pressing keys [C] and [D] simultaneously the display shows instead of:

- the zone number ---> the No. of the current setpoint program
- the setpoint ---> the internal setpoint (see chapter 3.3.7 and 6.1)
- the actual value ---> the actual power output (in percent)

4.6 DISPLAY OF THE SOFTWARE IDENTIFICATION

Pressing keys [A] and [D] together displays a 4-stage display mode which presents the following information important to service personnel:

Zone	Setpoint	Actual X	Signification
01	---	3.21	Software-Version (here 3.21)
02	---	258	AZ-Number (Software Variant)
03	--8	529	EPROM Number (here 8529)
04	---	1.00	Interface Protocol Number

4.7 DISPLAY - HELP - 4802

With some older models or with faulty batteries this message may be displayed after turning on the **FP13**. This means that the battery supply in component MK48Z02B is insufficient to guarantee a long storage time.

The respective component should be replaced as soon as possible to avoid a loss of set-point and parameter data during turning on the power. There are no further effects of this message on the operation.

4.8 DISPLAY - HELP - 7109

The alternating display " HELP 7109 " can occur during turning on the unit or during operation of the **FP13**. It means that the processor ist not operable any more. The Watchdog-LED is permanently lit.

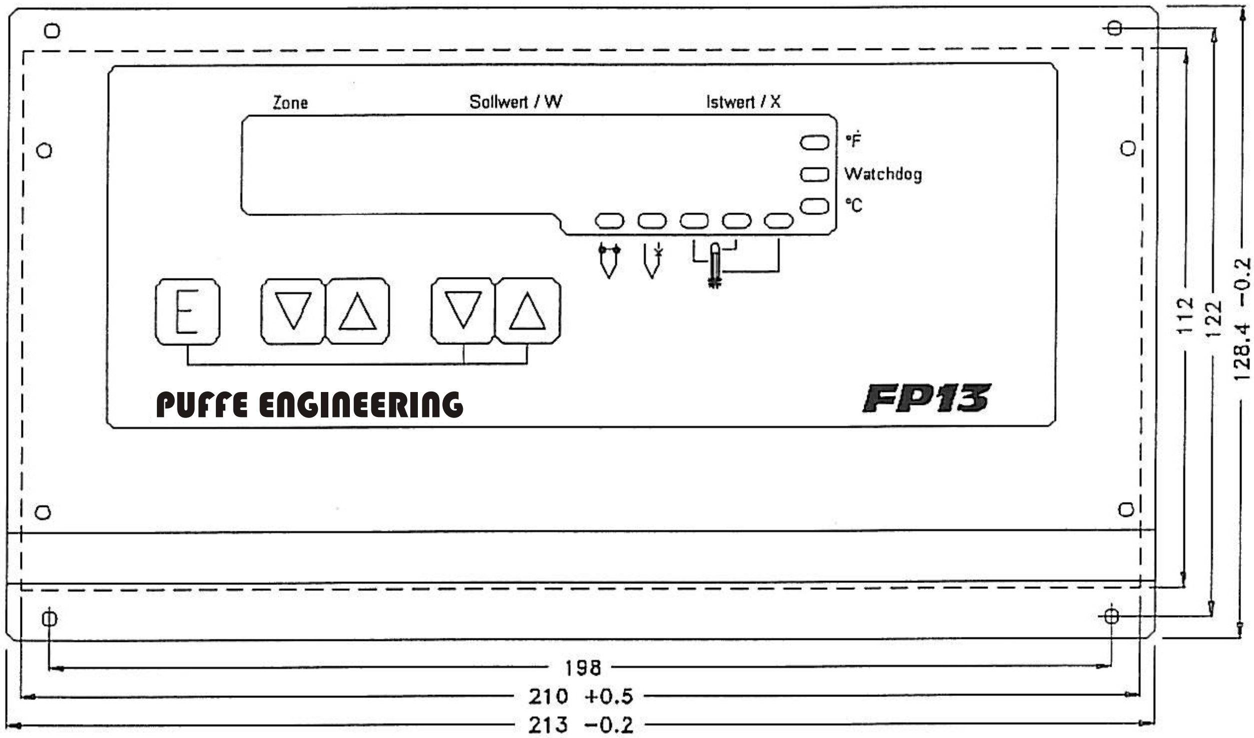
5.0 TECHNICAL DATA AND DIMENSIONS

5.1 Technical Data

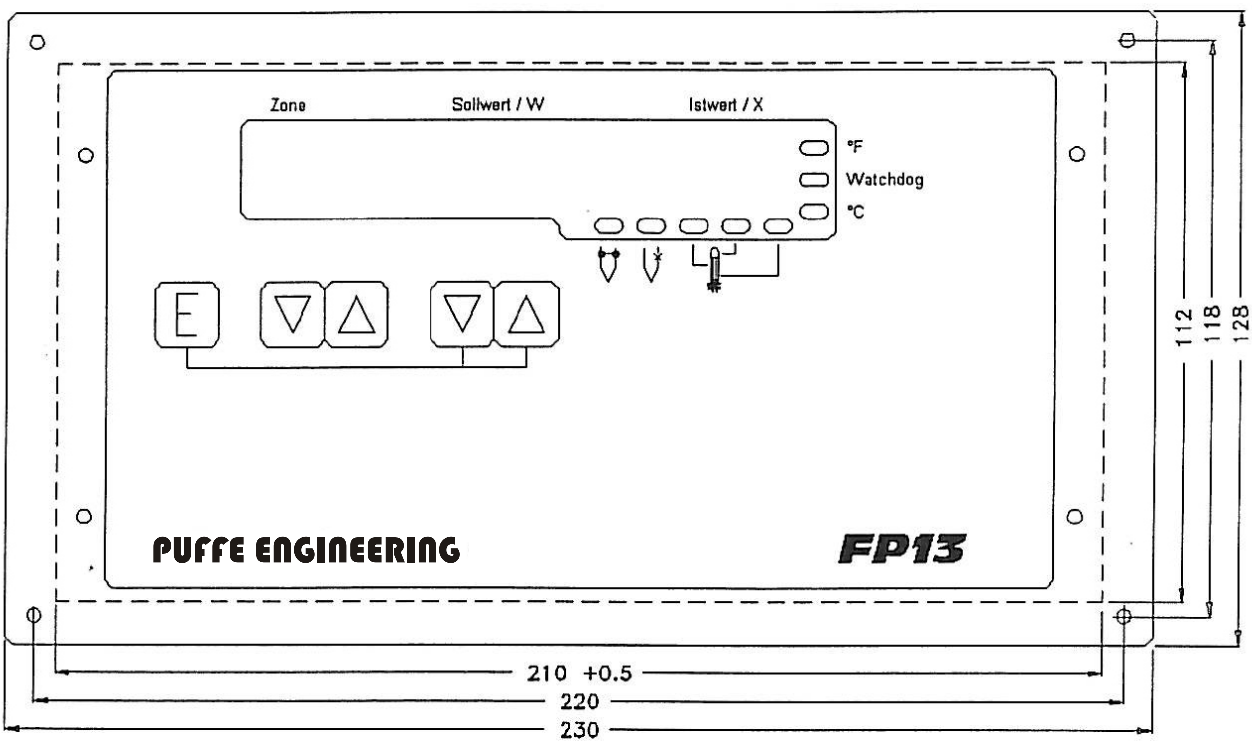
Number of control loops	5, 9/10 or 13/15 according to the type of device, 1, 2, or 3 groups may be connected to different phases, channel 1 is wired to each group and may be used in 3 lines at the 15 loops device
Outputs	Industrial TRIACS in binary controlled, max. 230V / 5A load for each channel, but max. 15 A for the group; max. 60 Degrees C device surface temperature
Temperature range	0-700 degrees C for thermocouples 0-999 degrees C for Ni-CrNi 0-250 degrees C for Pt100 Selection of degrees C or Grad F by DIP-switch
Sensor inputs	Fe-CuNi NiCr-Ni Pt100
Ambient temperature	max. 50 degrees C
Control algorythm	PI, PD or PID, with start up mode, control parameters adjustable for each channel separately
Floating limit alarms with relay contacts	1 x high temperature (max. 230 VAC / 3 A) 1 x low temperature (max. 230 VAC / 3 A)
Fix limit alarm with relay contact	1 x Watchdog function (HI-value + 10 K, HELP-function) (max. 230 VAC / 3 A)
Fuses	1, 2 or 3 x 16 A ff for the power outputs with TRIAC boards (6,35 x 32 mm) control voltage 1 x 0,5 A medium (6,35 x 32 mm)
Power supply	Power outputs 1, 2 or 3 x 230V/400V, 16A Control voltage 230V +5% / -10%, 20VA, optional 115 VAC, 24 VAC or 24 VDC

Dimensions	front - **Rack-version -** 3 HE = 128,4 mm 42 TE = 213,0 mm (19"-Version) front - **Control panel-version -** 3 HE = 128,4 mm width = 230,0 mm deapth - **Rack-version -** without terminals = 215,0 mm with terminals = 230,0 mm with interface plug, straight = 255,0 mm **panel break out** (H) 114,4 mm x (W) 212,0 mm
Weight	According to the type 2,5 to 3,0 kg

5.2 Frontview and sizes of FP13 - rack-version



5.3 Frontview and sizes of FP13 - control panel-version



6.OPTIONS

Special executions have been developed for different purposes of **FP13**. The most importent and interesting features are described in the following. Special functions that are not included in this manual will be described by an enclosure.

6.1 KEY LOCK SECURITY

On customer's request the **FP13** can be provided with a key lock. The locks are from the SIEMENS-Key Lock System, type KABA-MICRO.

This key switch prevents unauthorized changes of setpoints and parameters by blocking key [E]. All other keys and its functions remain operable.

Customer specific system numberings are possible, ie. every **FP13** sent out to the specific customer receives the same lock, or every **FP13** has a different lock.

6.2 PLC- PARALLEL INPUT

FP13 may be fitted with optional PLC parallel inputs. Therewith a remote start of the four different setpoint programs (see chapter 3.1.6) is possible.
This special version of **FP13** is provided with a 15-pin Sub-D plug (male) at the rear side.

Pin-functions:

1	- selection of setpoint program 1
2	- selection of setpoint program 2
3	- selection of setpoint program 3
4	- selection of setpoint program 4
10..15	- ground

The inputs are PLC compatible, means they are accepting a voltage range of 13..30 VDC at a mean current of 8,5 mA.
The selection of a program is done by putting the voltage (24 VDC against the ground) to the referring input (pin 1..4 for the desired program). A short time of 0,1 seconds is sufficient for the program change. As long as the voltage is put to the referring pin, the change of program by the operation keys is locked.

6.3 SAFE PAKET

6.3.1 COMPOUND HEATING

The controller recognises the slowest active zone independently. This is only possible when all active values are below 90°C (cold form) when activated. Once the slowest zone has been defined the "internal" set point of the remaining zones is determined by the actual value of the slower one. This guarantees a uniform heating up of the zones.
After the zone has been selected (the zone number is displayed as "SC" = slowest channel, directly below zone 1) it runs directly to the given set point. All other internal set points are

oriented according to the actual value of this zone. As soon as the slow channel is heated to within 100 of its set point, it is then determined as the leading zone and all the remaining zones run directly to their respective set points.

As soon as a ramp is programmed for a zone (parameter 7), it will no longer be braked by the leading zone. The programmed ramp has precedence.

6.3.2 AUTOMATIC CONTROLLER OUTPUT ACCEPTANCE

This option automatically switches a zone to manual operation (constant power output) in the event of a sensor defect. For this, a long-term averaging of the controller output is required. The resulting controller output is stored internally and in the event of a sensor defect, is emitted as a constant. This steady-state value reverts to "0" following set point changes, program changes, power failure or after leaving the P-band. Long-term averaging is only possible if the zone is located within the P-band for approximately 10 minutes.

The stored steady-state value can be read as controller output in the actual value window by depressing the [C] and [D] keys simultaneously.

The "*AP*" parameter (auto-power), located under zone 1, determines the effect of the defective sensor:

AP=0

- If the sensor is defective the zone signals a sensor break and shuts down

AP=1 (semi-automatic)

- If the sensor is defective the zone signals sensor break and shuts down. The recommended steady-state value flashes in the set point window, by depressing the [E] key this value is accepted and then constantly emitted.

AP=2 (fully-automatic)

- If the sensor is defective the zone automatically reverts to manual operation and adopts the latest controller output average. No user operation is required.

!!! Caution!!! We must point out that no temperature supervision is possible, if the sensor is defective. Even if a constant power output is emitted the actual temperature in the controlled process can vary due to external influences. Manual operation is only an emergency measure to maintain production temporarily. The defective sensor should be replaced as soon as possible by service staff.

6.3.3 LEAKAGE CURRENT SUPERVISION

The leakage current supervisory facility registers leaks from 50mA upwards. As soon as a leakage is registered in a zone and the set point is over 100°C, the value is reduced to 100°C. The actual value display flashes the actual value and "IL" alternately, parallel to this the contact for below-temperature is activated.

This status is retained until the controller no longer registers leakage in this zone.

Depending on the field of operation, the controller reaction to leakage current can be determined via the DIP-switch "A1". (see chapter 2.2)

DIP-switch "A1" on (front =standard)
To avoid "unbalanced loading" all zones with a set temperature of over 100°C are reduced.

DIP-switch "A1" off (rear)
Only the zone where leakage is registered is reduced to 100°C.

6.3.4 SHORTER DRY-OUT WITH GENTLE START

To avoid an unnecessarily long dry-out time the FP 13, with this option, has an actual value-dependent controller output threshold. The colder the tool the smaller the maximum controller output permitted. If the temperature approaches the 100°C dry-out limit the maximum controller output is increased step by step. This effects an acceleration of the dry-out phase as opposed to a constant controller output threshold of i.e. 45%. There is no longer a waiting time at 100°C.

7.0 DATA INTERFACE PROTOCOL

- **RS232 - FP13 to GA13 Interface**
- **RS232 - FP13 to IBM-PC Version 2.11**
- **RS485 - FP13 to IBM-PC Version 2.11**
- **RS422 and 20 mA (Current Loop)**

Informations about are available in the manual "SERIAL INTERFACE PROTOCOL".

Ask for this manual if you need it.

8.0 APPENDIX: NOTES ABOUT EMV

All devices in the ***FP13*** series accord with the following EMV-rules:

EN 55011 / 3

IEC 801/part 2, 4, 5

VDE 0839 part10

Reliability class	Z2
Surroundings class	S2, I4, E3

VDE 0843 part 2,3,4

Surrounding class	3
Focus rate	3

VG 95376 Teil 6 **"Expansive earthing"**

For optimal insulation the casing is manufactured out of yellow chromated (conductive) Aluminium (2mm thick), the front plate consists of 2,5 mm anodized Al. (yellow chromated for FP16).

In the 13 and 15 series the „expansive earthing" on the interior of the casing, accords to the MIL-regulation VG 95376 part 6, and provides excellent protection against interference by irradiation and radiation. In system „16" the internal supply is insulated and the earth connection is especially laid to the outside. This is an advantage for separate earthing systems in large plants.

Owing to the aforementioned characteristics an interference-free operation can be expected within normal industrial surroundings. However, the user can implement a series of extremely effective and inexpensive measures to achieve an interference-free operation even when the listed threshold regulations are exceeded.

The following are the individual proposals in the form of a checklist.

8.1 Mains voltage

Check the main feed-in is properly connected. In the case of the neutral point network attention must be paid to the connection between the N-wire and the main trafo and to faultless earthing (foundation earthing). See also VDE 0113 and VDE 0160.

8.2 Aux. supply voltage

When installing in the control cabinet control transformers are implemented to reduce the mains voltage between lines (e.g. 400V) to the device voltage (e.g. 230V, single sided earthing). Check the output voltage of the control trafo!
-10/+6% are permitted. Use a trafo with tapping.
Possibly use a second control trafo for inductive loads (contactors, ventilators, lamps etc.).

8.3 Aux. supply voltage with magnetic voltage regulators

A voltage regulator is extremely effective for feeding processor controls (PLC, too). In this case only these devices to be connected, no contactors!

8.4 Surrounding temperature

Warmth is produced in all wires and components through which electricity flows, especially electronic power switches and frequency converters - even those with dissipators. Further sources of warmth are contactors, circuit guards, fuses, feeders and electronic devices. If installed too closely heat accumulation may occur. Adittional ventilation, possibly heat exchangers.

8.5 Earthing and potential equalisation

All electronic consumers with screen casing should be connected to the potential equalisation bar by their own earth lines. The PE-terminal connections with separate lines should also be connected to the PE bar. For larger plants, connect all plant parts with PE lines (at least 16 mm²).

8.6 Interference elimination

Direct interference suppression at the known sources i.e. all switched inductive loads, is the most effective. All (AC-) contactor coils, ventilators and neon lamps with RC-members (poss. additionally with VDR-resistors, do not replace the RC-member!), all (DC-) contactor coils connected with diodes.
Principle: The interference suppression is better the closer it is to the source. RC-member parallel to the contact is not so efficient and leads to leakage current via the contactor which possibly does not release.

8.7 Sensor lines and SPS-Lines

Sensor lines as far as possible away from transmission lines! Keep lines as short as possible. Cross at right angles, twist and insulate!
Except in special cases all sensor inputs have insulation potential as a common connection pole. This also applies to all input filters. Therefore it is essential to pay attention to potential equalisation with non-insulated sensors (thermoelements). If this is not possible in the case of long lines (some 10-100 meters), take insulated sensors to reduce interference through insulated lines.(earth insulation at both ends). Resitance thermometers (Pt100) **must always** be insulated.
In extreme cases wire all sensor lines in their own (earthed) steel armoured pipe or possibly steel armoured hose.
It is **essential to avoid** all open lines (aerials !) when dealing with inputs.
Inputs which are not required should be short circuited.

8.8 Motor lines

Frequency converters are being implemented more and more for non-synchronous motors. The basic frequency of these converters, depending on the motor revolutions, lies at some 100 Hz, however, with modern devices high energy harmonics of over 100.000 Hz appear due to sinus modulation, inciting intensive interference to neighbouring plant parts. Motor lines of over 3 meters should be wired with insulated lines (earthed at both ends). Line lengths of over 30...50meters require additional feeder reactors. Moreover, attention should be paid to the converter manufacturer's recommendations.

8.9 Interface lines

The insulated 2-wire (RS485) and 4-wire (RS422) bus facile interface lines (e.g. INTERBUS, BIT-BUS, SINEC L2) are used more and more. Principally provide twisted pairs with insulation earthed at both ends. Possibly provide an additional potential equalisation (at least $4mm^2$). Otherwise the same principles apply as in „7. "Sensor lines".

8.10 Cable ducts

Cable bundling in cable ducts is frequently the cause of transformer stray pick-up, especially when transmission and data cable lay in a common duct over a length of 10 meters and more. This is a great disadvantage when, for example, against the converter manufacturer's regulations, non-insulated motor lines were chosen (e.g. when post-equipping a non-regulated drive with a frequency converter).
Transmission- and control cables should be wired in separate ducts. Metal ducts should be included in the potential equalisation. Field cabling not at low voltage level if possible. If necessary use decoupling relays.