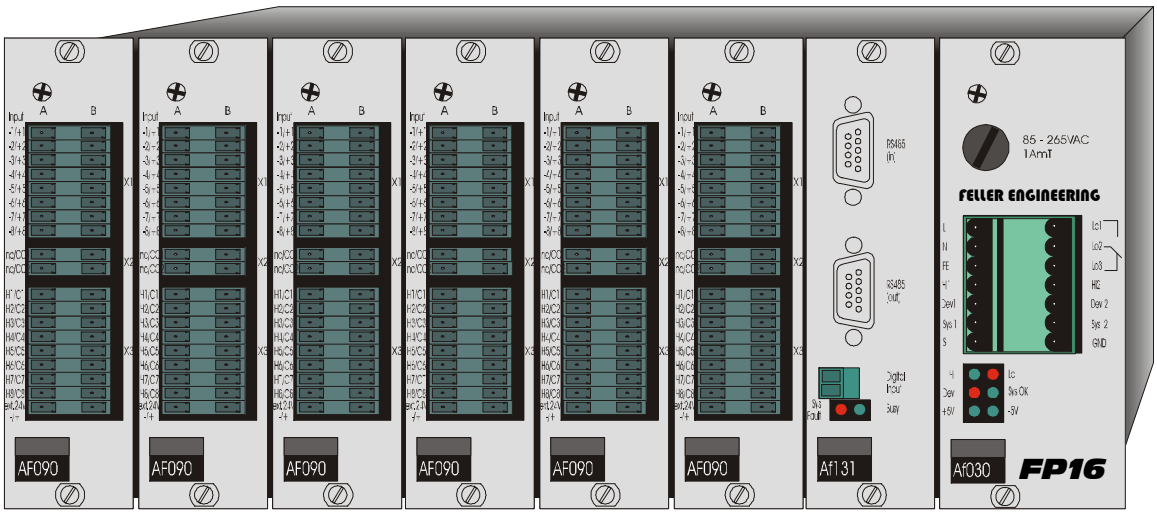
FELLER ENGINEERING GmbH

FP16+

Operating Manual



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1 Contents

2 Overview of the device

The series FP16 with the **FP16+** is designed as temperature controlling unit with plug-in boards. The referring assemblies allow even a lot of various functions for temperature supervision, process controlling and supervision. One of the available interfaces enable the link to a measuring data acquisition or visualisation.

2.1 Applications

This operator manual is reduced to the various variations of temperature controlling. The technical data of an assembly of the **FP16+** with other boards for further functions will be added to the manual.

2.2 Fitting and function

The rack of the **FP16+** is fit with 8 slots. 6 of these are prepared for input- and output-boards to contact the plant.
The measuring data, setpoints and parameters are transmitted via an electrical isolated interface RS485. Further interfaces are available in option or additionally at the processor board.
The power supply board is available in variations for AC and DC voltage. There are also isolated alarm contacts (relays) for:

- HI-alarm
- LO-alarm
- Deviation-alarm
- System-fault (self supervision of the hardware).

With the referring software in the processor, these alarms may have further functions than the temperature- alarms.

3 The temperature controller FP16+

The temperature controller **FP16+** is designed for max. 64 zones.
The safety against overheating works at:

- thermocouples
- Recognition of shorted Solid-State-Relays
- Optional heater current supervision
- 3 contacts for temperature alarms.

3.1 Control mode

The temperature controller works in 3-point mode -heating and cooling- in 2-point mode – only heating- with pulsed outputs. In case of temperature measuring the output boards are unnecessary.
With the refresh cycle of 1,5sec for all zones the controller is prepared even for fastest control loops.
A self-tuning based on FUZZY-logic is selectable for all zones.
The cycle time for heating and cooling may be set for each zone individually. This way an adaptation to slow actors like relays is possible.
The cooling medium is selectable for each zone: AIR or WATERINJECTION. The cooling bases on different routines. Rough steps can be set for the cooling blowers to avoid too short switch times.

3.1.1 Drop-set operation

Drop-set operation (control in production breaks) can be activated by two methods:

1. Drop-set for individual zones via parameter 19
2. Drop-set for all zones by connecting 24VDC to the drop-set input (X3 on the processor board) (depending on the software version)

3.2 Alarming

3.2.1 Recognition of shorted thermocouples

Shorted sensor is alarmed, if:

- the actual value lies below the deviation-alarm limit and
- the controller for which parameter 11, the configured diagnosis time, requires 99% or 100% controller output and
- within this time the temperature does not increase by at least 5°C and
- the zone is in controlled or drop-set operation and
- the set diagnosis time for the zone > 0 secs. and
- and the setpoint is not set to '0'.

This procedure also monitors wrong wired sensors and defective heater!

The consequences of such an alarm are the shut down of the heating and an activated BIT 4 in the status byte of the interface protocol. The LO-Alarm contact is activated simultaneously. Within FECON a flashing -S- is signalled in the respective zone.

As no sensor short circuit supervision is possible when the heating is inactive this alarm status can only be cancelled by external confirmation. This can be done by

- brief main supply ON/OFF (collective confirmation)

- RESET-command via the interface (collective confirmation)
- change or reset of the old setpoint for the disturbed zone, via the interface (selective confirmation).

The short circuit recognition can be deactivated by setting the internal DIP-switch 1 = OFF.

Attention !

The sensor short circuit alarm can also occur in zones in which the heating can be shut down by means of a main switch. Attention must be paid that the controller receives a confirmation in one of the above forms, when resetting the main switch.
The zone must have previously signalled DEV Alarm to avoid a sensor short circuit signal in normal operation when output rate =100%.

3.2.2 Recognition of defective (shorted) actuators

It is assumed there is a shorted actuator, if:

- the set DEV-Alarm threshold is exceeded and
- the calculated output rate accords to minimum (0% if without cooling, otherwise the max. cooling performance) and
- the actual value continues to rise by 5°C and
- the time for this temperature increase is the same as the diagnosis time set in parameter 11 and
- the zone is in control or drop-set operation and
- the set diagnosis time for the zone is > 0 secs. and
- and the setpoint is not set to '0'.

This supervision is also effective for zones which have been switched off via parameter 19. The alarm is signalled externally when the HI-Alarm contact is activated. A flashing -H-is signalled at the respective zone within FECON. As with the sensor short circuit this alarm can be confirmed by resetting the setpoint. It cancels itself however when the temperature returns to within the tolerance limits.

The short circuit recognition for actuators can be deactivated when the internal DIP switch 2 = OFF.

3.3 Self tuning

The **FP16+** self-tuning facility enables the analysis of the control loops connected, and the modification of the P- I- and D-parts via a suitable algorithm.

There are two different optimising processes integrated within FP16+. The first process optimises by means of an oscillating trial at 80% of the setpoint, the second process optimises the controller by determining the delay time and the heat-up speed at start.

The oscillating trial is more suitable for faster zones, for extremely slow zones the start trial is more suitable.

The decision which parametering mode to select is determined by the distance between the actual and setpoints. If the actual value is under 80% at the start of the tuning process the start tuning is selected, above 80% of the setpoint the controller attempts to find the parameter by an oscillation trial in the event that no cooling is activated.

3.3.1 Self- tuning of the heating via start-up trial

Self-tuning via start-up trial should always be selected in the case of slow, possibly mutually thermal-influenced, heating zones (e.g. extruder heater).
An actual value well under 80% of the setpoint is required to begin correct parametering in the start-up trial. Moreover, the temperature at start must be in a stable condition which means it may not be falling or rising. The best way to reach this is to disable all outputs (see global parameters).
At the start of the tuning process the output is first set to 100% performance whereby a rise in the resulting temperature can be observed. As soon as the increase has reached maximum (v_{max}) the control parameter can be derived from v_{max} and the delay time t_u.

The self-tuning process will be discontinued without changing the control parameter if:

- The actual value exceeds 80% of the setpoint and no v_{max} was found (risk of overheating)
- The actual value continues to drop despite 100% performance (wrong active direction)
- The actual temperature increase is > 1° / sec (risk of overshooting)

A false result is achieved when:

- The temperature was falling at the start of self-tuning i.e. by cooling the zone.
- The heating was still switched off externally at the start of self-tuning (results in a false delay time)
- The temperature was rising due to previous heating-up at the start of self-tuning (results in a too short delay time)

3.3.2 Self-tuning of the cooling via drop-set test

An actual value near the setpoint is required to begin correct parametering in the drop-set trial. Moreover, the temperature at start must be in a stable condition which means it may not be falling or rising.

At the start of the tuning process the output is first set to 100% performance (full cooling) whereby a rise in the resulting temperature can be observed. As soon as the increase has reached maximum (v_{max}) the control parameter can be derived from v_{max} and the delay time t_u .

The self-tuning process will be discontinued without changing the control parameter if:

- The actual value drops below 80% of the setpoint and no v_{max} was found.
- The actual value continues to rise despite 100% cooling (wrong active direction).

A false result is achieved when:

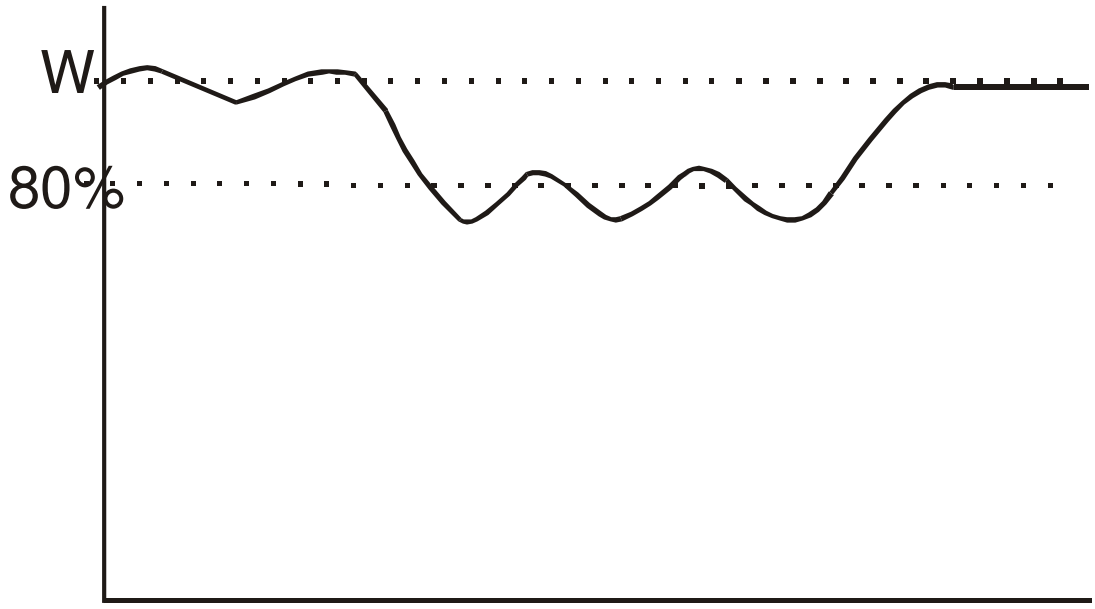
- The temperature was falling at the start of self-tuning i.e. by cooling the zone.
- The heating was still switched off externally at the start of self-tuning (results in a false delay time).
- The temperature was rising due to previous heating-up at the start of self-tuning (results in a too short delay time).

3.3.3 Self parametering via oscillation trial

An actual value near the setpoint is required to begin correct parametering via the oscillation trial. During self parametering the program evaluates the controlled process as follows:

- Internal drop of the reference temperature to 80%
- oscillation trial at full heating performance
- determining parameter from the form of the 2.temperature oscillator
- heating up to the old setpoint using the new parameters

Moreover the program questions the necessity of the PID control and transforms the control function, if required, into a PI function with starting ramp (FUZZY-function).



3.4 Heater current supervision

The **FP16+** can be optionally equipped or post equipped with heater current supervision (from software version 5.20). In order to activate the heater current supervision the DIP-switch number 5 on the 5-fold DIP-switch block of the processor circuit board must be set to „ON“ and the heater current input card **AF060** inserted into the 2. slide-in unit from the left. With the aid of this option the FP16 ensures a reliable supervision of the connected heater performance.

3.4.1 Number and function of the zones

With heater current supervision the number of temperature control zones is limited to a maximum of 32, the number of zones operated via the interface is always 64. Channel 33 is responsible for the current supervision of control zone 1, channel 34 for the control zone 2 and so on.

3.4.2 Function of the heater current supervision

Parallel to the control the actual flow current for all 32 current zones is measured and compared to the set current setpoint. Currents in reference and actual value areas are measured and evaluated with a resolution of **1/10 amperes**.

Recognition of heater current

As soon as the control zone demands heater power (output rate >0%), the heater current supervision tries to measure the current in this zone. This, however, can only be done from a minimum output rate of 5% as with a lower output rate the current flow is too temporary. If, after several tries by the heater current supervision the zone still shows too low output rate a temporary current flow of sufficient length is incited in the zone, (under heater current supervision). In this way a reliable current measurement is guaranteed even in the case of extremely low output rate.

Recognition of short circuited solid-state-relays

If the control zone demands no heater power (0% or zone cooling), the supervising facility monitors whether really no current is flowing (0 Amperes). The rest of the remaining current is reported as an actual value in this case. If the value measured in this way is > 0,9 A (maximum remaining current permitted), this is reported in the status word with an activated short circuit bit. This way a solid state relay, shorted at the output, can be recognised.

Behaviour directly after device activation

As there is no current flow guaranteed in the zones directly after switching on the actual value of these zones is held at „-1“ until the first real measurement. This special value can be indicated accordingly on the operating surface (e.g. as „---“ or completely blinded out). A premature alarm for „insufficient current“ is thus avoided.

3.4.3 Parameters of the heater current supervision

The current supervision occupies the device channels 33 to 64.

The same parameter are valid for configuring the heater current channels and for the temperature control:

Parameter 1 for the absolute LO-Alarm (in 0,1 A)
Parameter 2 for the absolute HI-Alarm (in 0,1 A)
Parameter 3 for the permissible deviation from the setpoint (in 0,1 A)
Parameter 21 is constantly set to 5 (characteristic for the heater current zone)

All other parameters are present and operable, they have however no influence on the current supervision.

3.4.4 Heater current supervision alarms

The alarms do not affect the external alarm contacts, they are only reported via interface.
The alarm bits correspond exactly to the significance of the control zones (Lo-Alarm, Hi-Alarm, DEV-Alarm). As soon as a heater current fault is recognised the fault bit 12 is additionally activated in the status word of the according temperature zone (=„current fault“).

In the event of a current flow being recognised although no triggering of this zone has taken place (short circuited solid state) bit 4 is activated in the status word (as with the temperatures „sensor short circuit“).
In the case of non-connected transformers and non-connected voltage sensors the actual value „0A“ is shown.

4 Parameters

There are two different types of parameters.

- Device specific parameters, responsible for the complete **FP16+** and
- Zone specific parameters, that can be set for each zone individually.

4.1 Reset to default parameters

This procedure effects a reset to the parameters set by the manufacturer. Loading the default parameter can be remotely controlled via the interface (see protocol description).
This may be done via interface (see protocol description) or by switching the processor board to address 0. The board has to be fit for about 1 min.
Hint:
Loading the default parameters does not only revert to the manufacturer`s setting but also returns all setpoints back to 0 (zone off).

4.2 Device specific parameters

Device specific parameters are all parameters which either affect all zones simultaneously or the device itself.

4.2.1 Highest adjustable temperature („HI-value“)

The HI-value allows limitation of the adjustable values to a max. final value.
This value, however, has a secondary function.
All control parameters relate to this HI-value. A setting of x_p = 5% produces, for example, an effective P-Band of 35°C.at a HI-value of 700°C.
Adjusting a HI-value has an affect on all controlled systems.

Limits: 20.. 999
Default value 700

PROTOCOL: G01?HIW=0400 400° HI-value

4.2.2 Selection of the net frequency

To suppress possible interferences to sensor circuits the mains frequency (50cps or 60cps) is adjustable as a parameter (default setting = 50Hz).

Limits: 0 (for 50cps) oder 1 (for 60cps)
Default value 0

PROTOCOL: G01?F60=0001 60cps operation
G01?F60=0000 50cps operation

4.2.3 Alarm delay

The controller may activate the alarms with a certain delay. The alarm must be true for the time that is set here (in seconds) to to give a report via contacts or interface. This way shortly appearing alarms can be ignored, if they result from e.g. badly screened sensor cables.

Limits: 0 ... 90s
Default value 0 (no delay)

PROTOCOL : G01?DLY=0005 (5s delay)

4.2.4 Disable of the controller outputs

This parameter is used to switch off all controller outputs without operation of the zones. It helps to prepare the zones for the self tuning or setting values without heating the different zones.

This way has to be preferred instead of the main switch to disable the heaters. The I-part will not be overloaded during this time and inhibits overheating after restart.

The start up tune should be started this way.

First set passive by 0.
Wait for a stable condition (cold) of the referring zones.
During this time the required setpoints may be entered and tuning cab be started.
When the zones are in stable conditions, set active by this parameter (=1). The internal tuning starts only now. This is the favourite way to reach a synchronous heating of thermal connected zones.

Limits: 0 or 1
Default value 1

PROTOCOL: G01?ENA=0000 (all off)
G01?ENA=0001 (all on)

4.2.5 Standby of all zones (drop set)

This parameter is used to set all zones to a standby value without individual operation of all zones.

Limits: 0 or 1
Default value 1

PROTOKOLL: G01?ABS =0000 (drop set off)
G01?ABS =0001 (drop set on)

4.2.6 Function of the digital input at the processor board

This parameter selects the function of the digital input.
Activation of drop set value from parameter 12 when the setting is „0“.
Disable the controller output when the setting is „1“.
Serial heater current supervision via module AT083, when the setting is „2“. In this case a single transmitter is required for all zones.
Enable the controller output when the setting is „3“.

Limits: 0 .. 3
Default value 0

PROTOKOLL: „G01?SPS=0000“ (Input for drop set)

4.3 Parameters of the temperature controlled zones

A series of operation parameters refers to each zone. They are explained in the following:

4.3.1 PARAMETER 1: LO-Alarm

Underpassing the value set for parameter 1 triggers the respective zone LO-alarm thus tripping the appropriate alarm contact, LED **L4** lights up.

Limits: 0...9999
Default value 0

The LO-alarm is not supervised when the setpoint = 0 !

4.3.2 PARAMETER 2: HI-Alarm

Exceeding the value set for parameter 2 triggers the respective zone Hi-alarm thus tripping the appropriate alarm contact, LED **L1** does **not** light up!

Limits: 0...9999
Default value 400 °C

The HI-Alarm is also supervised when the setpoint = 0 so that short-circuited solid state relays at output are safely supervised even when zones are inactive !

4.3.3 PARAMETER 3: Deviation-Alarm

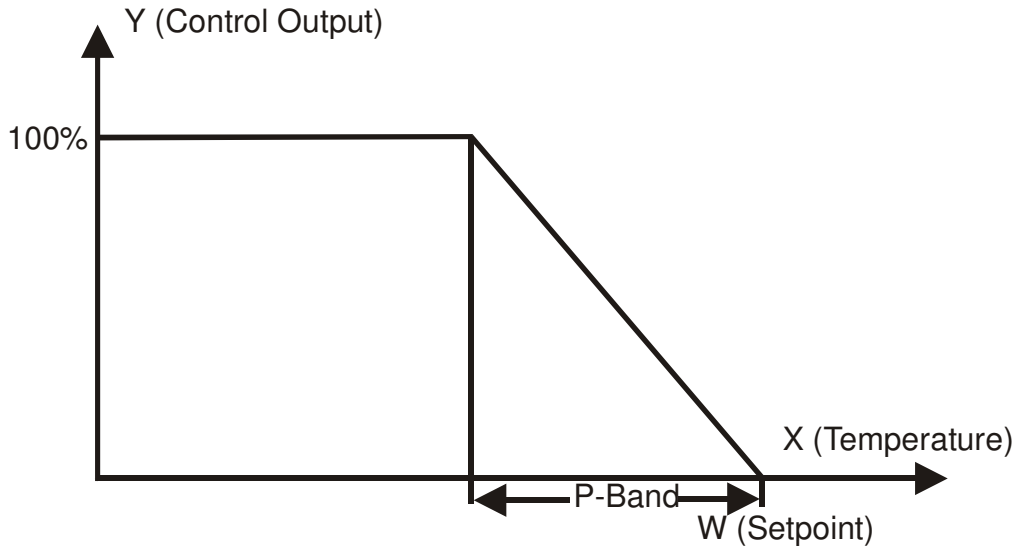
As soon as the actual value of a zone deviates from the setpoint by more than the setting here the respective zone deviation alarm is triggered. The appropriate alarm contact is tripped, LED **L2** lights up.

Limits: 1...999
Default value 15

The deviation alarm is not supervised when MODE=OFF!

4.3.4 PARAMETER 4: x_p of the control

Parameter 4 allows to set the **'xp'** of the controlled process in *Percent*. The resulting p-band derives from the set maximum value (default 500°C).
If, for example, a parameter value of 10 is set and the maximum value (adjustable at another position) is 500°C, the effective p-band is 50°C. For a P-controller this means that the output rate is slowly reduced at 50° before reaching the setpoint. At SETPOINT = ACTUAL it has been reduced to 0%. This results in the following curve:



Limits: 0...999 % (0=2-point controller)
Default value 5 %

4.3.5 PARAMETER 5-t_n (Integral part of the control)

Parameter 5 allows the setting of the integral part of the control system in seconds. In the event of deviations this control part modifies the controller output by a speed set here (up or down).

Limits: 0...999 s (0=I-part disabled)
Default value 80 s

4.3.6 PARAMETER 6-t_V (Differential part of the control)

Parameter 6 allows the setting of the differential part in **1**/**10** seconds. This part 'brakes' the output rate for a time which can be set here, in the event of the actual value approaching the setpoint at too high speed.

Limits : 0...99,9 s (0=D-part disabled)
Default value 20,0 s

4.3.7 PARAMETER 7-Ramp up

If a gradual heating up of the medium is required a heating ramp can be set via parameter 7. This is effective if:

- the device has just been activated
- the setpoint has been increased

The ramp effects gradual changing of the *INTERNAL* setpoint towards the set setpoint. As soon as the *INTERNAL* setpoint has reached the set setpoint the ramp becomes inactive until the next setpoint adjustment.
Controlling always applies to the *INTERNAL* setpoint!!
The ramp speed of the heating ramp is set in a unit of secs/°C , this means large values effect a slow ramp.

Limits : 0...999 sec/°C (0=Ramp disabled)
Default value 0

4.3.8 PARAMETER 8: Ramp down

In contrast to parameter 7 (ramp up) a down ramp can be programmed here, this means the ramp is only effective when decreasing the setpoint.

Limits : 0...999 sec/° (0=Ramp disabled)
Default value 0

4.3.9 PARAMETER 9: Cycle time for the heating

In order to reduce the speed of fast switching outputs to one which is suitable, for example, for contactors, parameter 9 is to be increased for the switching speed of the heating outputs. An increase in this parameter effects a slowing down of the outputs. The cycle time is always the sum of ON and OFF time. The shortest switching impulse results from a cycle time: 100!

Limits: 1...20 sec
Default value 1

4.3.10 PARAMETER 10: Maximum output for heating

This parameter limits the maximum output of the heating.

Limits : 0...100 %
Default value 100%

4.3.11 PARAMETER 11: Diagnosis time

For the plausibility test of the controller. (see below)

Limits : 0...999s
Default value 180s

Setting the value „0“ means the plausibility supervision for this zone is inactive.

4.3.12 PARAMETER 12: Temperature drop

During normal control operations this parameter can be used to set the temperature drop. The value is recognised as setpoint during temperature drop operation.
Limits : 0...999
Default value 0

4.3.13 PARAMETER 13: Cooling medium AIR / STEAM

This parameter allows to select the cooling medium (air or steam). The settings for air cooling (parameter 13 = 0) effects an equal output rate for ON and OFF according to the required cooling.
The steam cooling is always activated for the time set here. The variation of the cooling rate depends on different pauses between these pulses.
The parameter 13 sets cooling pulses in steps of 1/10sec (e.g. 4 = 40ms pulse).

Limits : 0 ... 60 [*10ms]

Default value 0 (AIR)

4.3.14 PARAMETER 14: *xp* of the cooling

Similar to parameter 4 (xp of the heating) the p-band can be set here for the cooling performance.

Limits: 1...99%
Default value 5%

4.3.15 PARAMETER 15: t_n of the cooling

Similar to parameter 5 (t_n of the heating) the I-part of the cooling performance can be set here.

Limits: 0...999s
Default value 20s

4.3.16 PARAMETER 16: Cycle time for the cooling

Limits: 1...100
Default value 1

Function of the mode „AIR-cooling“
If the mode „AIR-cooling“ (Parameter 13=0) is selected for this zone, then the cycle time of the cooling may be set similar to parameter 9.

Function of the mode „STEAM-cooling“
If the mode „steam-cooling“ (Parameter 13>0) is selected for this zone, then the pause between the injections may be set. The dimension is 1/10sec: so 60 is equal to 6,0sec.

4.3.17 PARAMETER 17: Maximum cooling performance

Similar to parameter 10 the maximum cooling performance can be set here.

Limits: 0...100%
Default value 0% (cooling disabled)

4.3.18 PARAMETER 18: Mean output rate

Parameter 18 defines itself during normal control operations. The mean ouput rate is kept here during control operation. The controller restarts the control process with this output rate after a short net supply interruption. This avoids temperature deviations after interruptions of the power supply.

Limits: READ ONLY !
Default value 0%

4.3.19 PARAMETER 19: Operation mode of the zone

Limits: 0...3
0 = outputs OFF
1 = Manual mode (=not controlled)
2 = Automatic (=controlled)

1 3 = Temperature drop
Default value 2

Note:

In the operation mode ‘0’ (outputs OFF) all supervisions of the zone are active (LO-, HI-alarms and plausibility check). To cancel these the diagnosis time has to be set to ‘0’.
Application of this mode: The zone is completely installed (sensor and heater) but actually not required. To turn off a zone generally, the setpoint should be set to ‘0’.

Behaviour during the change from Auto- (=control) mode to Manual- (= not controlled) mode

Depending on DIP switch 4 o the processor board (see AF131) a soft or thrust change of the operation is selected.
The soft change will go on with the mean output rate, that has been stored by the controller before. An other value may be set via interface later on. An order for setting the output rate will not be accepted in auto-mode.
The thrust change will use the value ,that has been preset in parameter 20 for the output rate. This does not refer to the previous controlled output rate.

4.3.20 PARAMETER 20: Preset output rate

Limits: -100% ... +100%
Default value 0

A preset for a later change to manual mode (thrust selection) may be prepared here already during the **controlled** operation.

4.3.21 PARAMETER 21: Sensor type

Limits: 0...5

Depending on the input card used, the type of sensor and thus the linearisation can be selected here. The value set here **must** accord with the component parts on the input card. The following codes are possible:

0 = Compensation channel
1 = Pt100
2 = NiCrNi
3 = FeCuNi
4 = 0..10V
5 = Heater current-supervision (is automatically set)
6 = 4..20mA
7 = 2-wire-Pt100, 1/10° resolution
8 = 4-wire-Pt100, 1/10° resolution

The compensation channel is only necessary with mixed component parts and may only be defined once per device.

4.3.22 PARAMETER 22: Offset actual value

Limits: -99 .. +99 °K
Default value 0

The measured temperatures may be adjusted by displacing of the curve.

4.3.23 PARAMETER 23: max. value

Limits: 0 .. +1999
Default value 0

For the connection of standard signals the value for the max. input signal will be set here. Even an adjustment of the zones is possible. There is no influence to temperature sensors.

4.3.24 PARAMETER 24: t_V of the cooling

Similar to parameter 6 (t_V of the heating) the D-part for the cooling may be set here.

Limits: 0...99,9s
Default value 0s

4.3.25 PARAMETER 25: Nominal current

This parameter sets the nominal current of the serial current supervision. The unit is 1/10 Amps.

Limits : 0...999,9 A
Default value 0 A

4.3.26 PARAMETER 26: Max. current tolerance.

This parameter sets the maximal permissible deviation of the nominal current for the serial current supervision. The unit is %.

Limits: 1...100 %
Default value 10 %

4.3.27 Parameter 27: Number of Steps for cooling power (from Version 7.2)

To protect the controlled cooling-fans of short pulses, this parameter sets the number of power steps for the referring output.

Example:
The setting of „4“ cuts the cooling output rate to 4 steps of 25%,50%,75% and 100%.
Controller rate of 0..25% result in 0, rates of 26..50% result in 25% and so on.
As reduced settings may protect the installed cooler but do not control the zone in the best

Limits: 1...100
Default value: 100

4.3.28 Parameter 28: Output rate for drying (from Version 7.2)

The setting of this parameter may limit the output rate during the heat up period.
Function:
As soon as the zone is started with a setpoint >100°C and the actual value is below 80°C, the drying routine is activated. The setting of this parameter limits the output rate to the selected value and increases the temperature to 100°C. 100°C will be kept for 4min before the heater start to reach the setpoint with full power.
The default setting is 100%, what disables this function.

Limits: 0...100
Default value: 100

5 Interface and protocol

5.1 Data interface RS485

The communication between the PC and the device is always incited by the 'MASTER', the PC., It demands certain data to be transmitted or certain actions to be executed by means of a transmission telegram. The device reacts with a reply telegram and possibly carries out the request.

Transmission parameters:

9600	baud
8	data bits
PARITY EVEN	if DIP-switch #6 of the device address is 'ON'
	otherwise
NO PARITY	
1	stop bits

The transmission happens in ASCII-format, the telegrams are secured by a checksum (hexadecimal, only capital letters) and concluded with the ETX-sign (03h). A device does not react to faulty checksums or incomplete telegrams. No additional signs such as 'SPACE' or CR-LF are permitted in the protocol.

5.2 Protocol description V3.03

As from protocol version 3.00 all setpoints and parameters which are transmitted from the PC to the device are checked for validity and ignored by the device if they do not conform and are subsequently answered with NAK.

All values to be transmitted are preceded by zeros. Negative values always have the sign first (i.e. **-010** for -10)

5.2.1 Checksum calculation

The checksum is calculated by adding the ASCII-values of all previous characters in the telegram. The last two characters of this number, hexadecimally speaking, are transmitted as a checksum in capitals. The device forms checksum for the answer in exactly the same way, however, not with confirmations such as 'ACK' or 'NAK'.

5.2.2 Time behaviour

Depending on the type of device, the max. answer time is approximately 120ms. If no answer from the controller arrives after 200ms the telegram should be repeated up to twice before a system alarm is triggered on the PC. This repeat transmission has proved itself to be a reliable way of achieving a fault-free data transmission.

5.2.3 Print mode of this protocol description

The telegram contents described here are in bold print.
Telegrams from the PC to the device are additionally underlined.
Variables in the telegrams are shown in small letters.
These are to be considered as place holders for values required by the user.

gg always stands for the device address, input would be 01 02

kk always stands for channel number, input would be 01 02
pp always stands for parameter number.

Special labelling for pp:

ØØ = Setpoint (as parameter number 0 !)
II = Actual value
YY = Output rate
SS = Status

wwww stands for a four digit variable numerical value
cc always comprises the calculated checksum

ETX corresponds to a transmitted 03h printed here as {etx} .
ACK (ACKnowledge) corresponds to a transmitted 06h, printed here as {ack}.
NAK (NegativeAcKnowledge) corresponds to a transmitted 15h, printed here as {ack}.

5.3 Channel specific telegrams

These refer just to one respective zone of the device and have the following layout:

5.3.1 Transmit value to controller

G*gg*K*kk*P*pp*=*wwwwcc*{etx}
to set the value wwww.

the device then replies with

G*gg*{ack}{etx} when the value was successfully set

or with

G*gg*{nak}{etx} if the value was not accepted
(poss. violation of marginal value)

5.3.2 Call up value from controller

G*gg*K*kk*P*pp*=*cc*{etx}
to inquire about parameter value pp of the channel kk.

the device then replies with

G*gg*=*wwwwcc*{etx}
whereby wwww shows the desired value

5.3.3 Request zone status:

G*gg*K*kk*PSS=*cc*{etx}

The device answer is once again
G*gg*=*wwwwcc*{etx}
whereby *wwww* contains the status of the zone, this can be seen BIT by BIT:

Bit 0 = 1	Zone ok, otherwise
Bit 1 = 1	-L- Alarm
Bit 2 = 1	-H- Alarm
Bit 3 = 1	-E- Alarm
Bit 4 = 1	-S- Alarm
Bit 5 =	LSB mode (mode: 0 =OFF 1=Man 2=Auto 3=Drop)
Bit 6 =	MSB mode
Bit 7 = 1	Tuning fault (is automatically set to 0 following successfull optimising at the start of optimising and, when re-starting the device)
Bit 8 = 1	Tuning active
Bit 9 = 1	- DEV Alarm
Bit 10= 1	+ DEV Alarm
Bit 11= 1	Alarm resulting from setpoint change
Bit 12= 1	Heater current fault

5.3.4 Select zone mode (r / w)

GggKkkMOD=wwwwcc{etx}

Setting/inquiring about operational mode (corresponds exactly to parameter 19 on the **FP16+**, has also been realised as a separate parallel command)

Mode = 0 --> Zone inactive
Mode = 1 --> Zone manual operation
Mode = 2 --> Zone control operation
Mode = 3 --> Zone drop-set operation

In manual operation the output performane can be set with
GggKkkPYY=wwwwcc{etx}
In the control mode the setting of a reference output rate is ignored.

5.3.5 Select zone tuning operation (r / w)

G*gg*K*kk*TUN=*wwwwcc*{etx}

When wwww=0001 the zone is switched to tuning operation, when *wwww*=0000 the running tuning mode can be stopped.
Special form for fast protocol of all zones

G*gg*KALP*pp*=*cc*{etx}

the device then answers with the transmission of the parameter pp of all zones at once in a single telegram.

G*gg*=*xxxxyyyy....zzzzcc*{etx}

xxxx = value of zone 1,
yyyy = value of zone 2,
zzzz = value of the last zone

5.3.6 Special form for fast programming of all zones

G*gg*KALP*pp*=*wwwwcc*{etx}

From device *gg* set the parameter *pp* of all zones to the value *wwww*

Attention must be paid to the fact that the device has to re-program all the zones resulting in a delayed reaction time (ACK) as opposed to single programming. Only numerical values are permissible for *pp*!

Request parameter thresholds

The thresholds of the individual parameters can be requested with following telegrams:

Lower threshold, command form:

G*gg*K*kk*MIN=*cc*{etx}

Upper threshold, command form:

G*gg*K*kk*MAX=*cc*{etx}

The reply telegram layout is as follows:

G*gg*=*xxxxyyyy.....zzzzcc*{etx}

xxxx=Threshold of parameter 1.
yyyy=Threshold of parameter 2.
zzzz=Threshold of the last parameter

The length of the reply telegram determines the number of parameters

5.4 List of device specific commands

Code	Definition	R=read, W=write P=Program *) - =Reserve	Index
STD	Loading default parameter (e.g. „STK“)	P	0
RES	Device -Reset	P	1
		-	2
STP	Reset to default parameters	P	3
STK	Reset to default configuration (MASTER-RESET)	P	4
DS1	DIP-switch 1	R	5
DS2	DIP-switch 2	R	6
SER	Serial number	R	7
AZ#	AZ-Softwarevariation	R	8
TYP	Device type, answer=8Byte-String	R	9
HIW	Upper operation value	R/W	10
PRV	Protocol version	R	11
VER	Software version	R	12
DAT	Software status (date), answer.=8ByteString	R	13
DAY	Software status (day)	R	14
MON	Software status (month)	R	15
YEA	Software status (year)	R	16
KAN	Number of zones	R	17
PRO	Setpoint program	R/W	18
STA	Status check for all zones **)	R/W	19
-	-	-	20
F60	0=50Hz supply, 1=60Hz supply	R/W	26
ENA	Selection of aktiv/passiv for all controller outputs	R/W	27
DLY	Alarm delay	R/W	32
HSE	Heater current supervision enabled (0=no, 1=yes)	R	95

*) The commands marked with P (program) effect a calling up of all device dependent sub-programs. In mnemonic script these respond to the paragraph "*Execute device specific sub-programs“*. In this index-script an attempt to read the appropriate parameter is sufficient.

**)When reading out a 32-bit word is transmitted (hexadecimal !), which shows a bit by bit status change of the individual zones (bit 0 = zone 1 ...bit 31=zone 32) the confirmation is with G*gg*?STA=00000000*cc{etx}*

Commands marked with reserved are not accessible.

5.4.1 Mnemonic script

These refer to all zones of the device and have the following format:

G*gg*?*xxx*=*wwwwcc*{etx} for setting values
the device then answers with

G*gg*{ack}{etx} if value was successfully set

or with

G*gg*{nak}{etx} if the value was not accepted
(poss. threshold violation)

G*gg*?*xxx*=*cc*{etx} for requesting values

the device then answers

G*gg*=*wwwwcc*{etx} whereby wwww shows the desired value.

xxx stands for the name according to the above table..

5.4.2 Index-script

Index-script is possible from protocol version 3.03 parallel to the mnemonic script.

For this reason a virtual channel 0 was introduced possessing a number of device specific parameters. The parameter number of this channel corresponds to the index number according to the above table.

The protocol syntax is then identical to the channel specific protocols i.e. request for serial numbers with

G01K00P01=cc{etx}

5.4.3 Execution of device specific sub-programs

Depending on the type of device, different device specific sub-programs can be activated by the interface.

Format:

G*gg*X*xxx*=*cc*{etx}

xxx here stands for the following possible commands:

loading the default parameter
depending on the DIP-switch position °F or °C, different values are loaded!

RES = executing a device re-set *)

! Attention!

Executing these commands always effects the running operation of the device.

5.5 Examples:

Device 10, channel 5 should be set to the setpoint 50.

the PC transmits:

G10K05P00=00500A{etx}

the controller replies

G10{ack}{etx}

The actual value should be requested from device 8 channel 11.

the PC transmits:

G08K11PII=7B{etx}

the controller replies

G08=0120AF{etx} (120 ° actual value)

5.6 Driver software:

FELLER ENGINEERING stocks driver software for the PC which operates under MS-DOS and in which a connection is made between the user program and the FE3-bus. The user program can be written in any of the common program languages. Drivers are available for the RS485/422 interface, in this case especially in connection with the **FELLER** RS485 PC-plug-in card, and also for the RS232 interface.

5.7 FECON

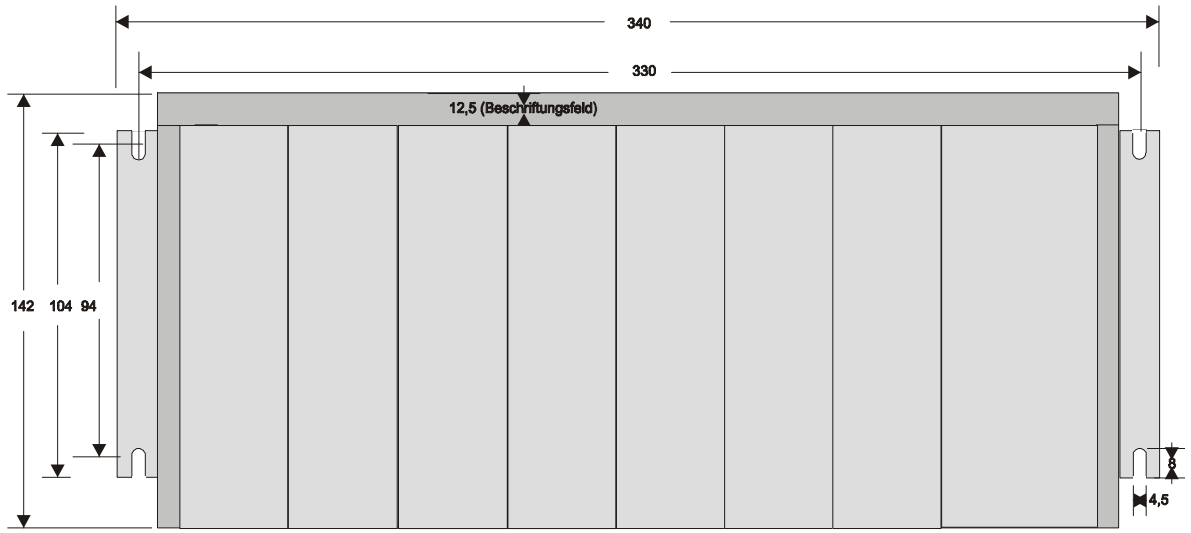
The general process visualisation **FECON** is available for visualisation, operation and measuring data acquisition for up to 30 devices from the **FELLER ENGINEERING**.

6 Technical data

Operation voltage:	AF030	85..265VAC, 50/60Hz
	AF023	24VDC
Power consumption:	depending on the variations	10-20W
Power fuse	AF030	1 x 1A mean inert (5 x 20mm)
	AF023	1 x 1A mean inert (5 x 20mm)
Thermocouple inputs	Fe-CuNi Typ J	0..700 °C
	Ni-CrNi Typ K	0..999 °C
	Deviation of temperature by cable resistance	< 1K / 10Ω
	Thermocouple compensation	for each input board, external
	Alignement	±0,25% v.E. ±1Digit
	Linearity	±0,2% v.E. ±1Digit
	Accuracy class	0,5%
Resistor sensors	Pt100/2-wire	0..600°C
	Measing current	0,5mA
controller outputs	per zone	bistable, electrically isolated
Commun alarm outputs :	Functions:	1 x systemalarm 3 x controlalarm
(Relay contacts)	max. voltage	250VAC
	max. current	4A at cosφ = 1 2A at cosφ = 0,5
control behaviour	P, PI, PD or PID with automatic and manual settings, control parameters for all zones separate	
Data storage (EEPROM)	Long time storage	min. 10 years
Interfaces	RS485 / RS422 / RS232 / Profibus / CANbus *)	electrical isolated
	Protocoll	FE3-Bus Version 3.03
Ambient conditions:	Ambient temperature acc. to EN 60204	+5°C bis 40°C bis 1000m above NN at a daily mean of max. 35°C.
	Housing temperature	max. 50°C when exceeding the ambient temperature
	Storage temperature	-25..+75 °C
	Humidity	< 95% rel. humidity, no dewing
Weight:	all slots used	3 kg

*) To be specified with the order

6.1 Dimensions



Frontview ***FP16+***

6.2 Hints to EMC (electro magnetic compatibility)

The rack ***AF013*** has to be connected in a conductive way to the conductive mounting plate, which has to be grounded according to the regulations.

Interference transmissions:

The unit is relieved according to **EN 55011** /**B** (interference transmissions).

Level of acceptance:

VDE 0839 Part 10

Reliability class	**Z2**
Ambient class	**S2, I4, E3**

Suppression:

VDE 0843 Part I 2,3,4

IEC 801 Part 2,4,5

Ambient class	**3**
Degree of strength	**3, with external filter 4**

7 Construction of a temperature controller

7.1 AF013 housing FP16+ with backplane

The basic casing is made out of 2mm aluminium chromated in yellow to ensure better EMV-compatibility and manufactured as a totally closed cabinet.

On the side there is an earthing bolt which serves as a safety earth for the whole system. (M4 screw thread).

The integrated bus circuit board is designed for the use of FP16+ plug-in boards. Various function boards (inputs, outputs, current supervisors) can be inserted in positions 1...6. Position 7 is reserved only for the processor board (e.g. AF131), position 8 is reserved for the power unit.

7.1.1 Variations for 3-point controlling

The following examples show different variations. A mix of input, output and combi cards is not allowed. Empty slots have to be closed by a cover. The current measuring has to be plugged to the slots on the right hand side.

16 Zones with heater current supervision:

Cover	16xCurrent Zone 1-16	Cover	Cover	16x H / C Zone 1-16	16 FeCuNi Zone 1-16	Processor	Power supply
ZD051	**AF060**	**ZD051**	**ZD051**	**AF080**	**AF040**	**AF131**	**AF030**

32 Zones with heater current supervision:

16xCurrent Zone17-32	16xCurrent Zone 1-16	16x H / C Zone 1-16	16 FeCuNi Zone 1-16	16x H / C Zone 1-16	16 FeCuNi Zone 1-16	Processor	Power supply
AF060	**AF060**	**AF080**	**AF040**	**AF080**	**AF040**	**AF131**	**AF030**

48 Zones:

16x H / C Zone33-48	16 FeCuNi Zone33-48	16x H / C Zone17-32	16 FeCuNi Zone17-32	16x H / C Zone 1-16	16 FeCuNi Zone 1-16	Processor	Power supply
AF080	**AF040**	**AF080**	**AF040**	**AF080**	**AF040**	**AF131**	**AF030**

32 Zones with heater current supervision with combi cards:

16xCurrent Zone17-32	16xCurrent Zone 1-16	8x H / C Zone25-32	8x H / C Zone17-24	8x H / C Zone 9-16	8x H / C Zone 1-8	Processor	Power supply
AF060	**AF060**	**AF090**	**AF090**	**AF090**	**AF090**	**AF131**	**AF030**

48 Zones with combi cards:

8x H / C Zone41-48	8x H / C Zone33-40	8x H / C Zone25-32	8x H / C Zone17-24	8x H / C Zone 9-16	8x H / C Zone 1-8	Processor	Power supply
AF090	**AF090**	**AF090**	**AF090**	**AF090**	**AF090**	**AF131**	**AF030**

7.1.2 Variations for 2-point controlling

32 Zones with Heater current supervision:

16xcurrent Zone17-32	16xcurrent Zone 1-16	Cover	32x H Zone 1-32	16 FeCuNi Zone17-32	16 FeCuNi Zone 1-16	Processor	Power supply
AF060	**AF060**	**ZD051**	**AF080**	**AF040**	**AF040**	**AF131**	**AF030**

64 Zones:

32x H Zone33-64	16 FeCuNi Zone49-64	16 FeCuNi Zone33-48	32x H Zone 1-32	16 FeCuNi Zone17-32	16 FeCuNi Zone 1-16	Processor	Power supply
AF080	**AF040**	**AF040**	**AF080**	**AF040**	**AF040**	**AF131**	**AF030**

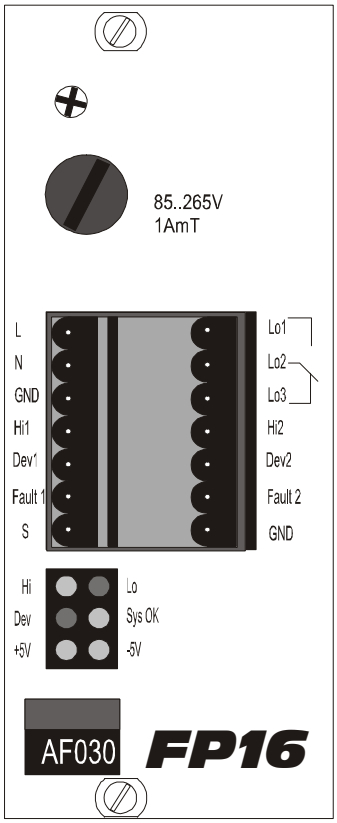
7.1.3 Variations for temperature measuring

96 Zones:

16 FeCuNi Zone81-96	16 FeCuNi Zone65-80	16 FeCuNi Zone49-64	16 FeCuNi Zone33-48	16 FeCuNi Zone17-32	16 FeCuNi Zone 1-16	Processor	Power supply
AF040	**AF040**	**AF040**	**AF040**	**AF040**	**AF040**	**AF131**	**AF030**

7.2 AF030 Supply, 85..265 VAC

Function	Terminal			Function	Terminal
	A			B	
Supply L		A1	L	B1	Lo-Alarm NO
Supply N		A2	N	B2	Lo-Alarm C
Net PE		A3	GND	B3	Lo-Alarm NC
Hi-Alarm C		A4	Hi1	B4	Hi-Alarm NO
Dev-Alarm C		A5	Dev1	B5	Dev-Alarm NO
Sys-Alarm C		A6	Fault 1	B6	Sys-Alarm NC
GND		A7	S	B7	Internal GND
	LED			LED	
OK	green	Hi	Hi	Lo rot	Lo-Alarm
Dev-Alarm	red	Dev	Dev	Sys OK green	System OK
Supply	green	+5V	+5V	–5V green	Supply



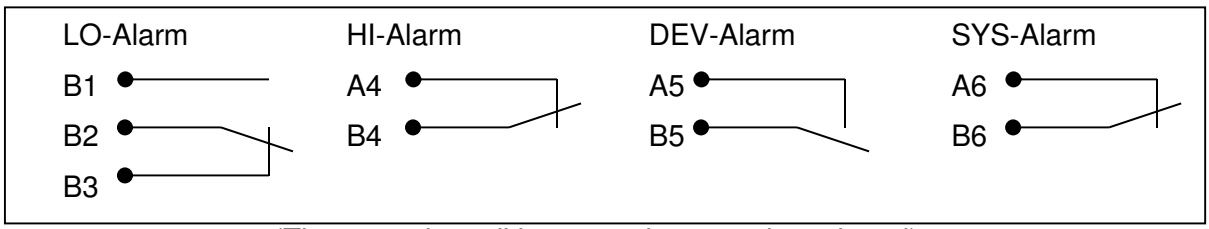
The supply is accepted from 85VAC to 265 VAC.
Frequency 50/60 cps
Fuse 1,0 A mT

7.2.1 Definition of the alarm contacts:

The alarm contacts Lo, Hi and Dev represent collective contacts, which means when one of the zones connected signals a respective fault the corresponding collective alarm is activated.

The "System-Fault Contact" is a supervision facility independent of the software version. This contact opens as soon as the program can no longer work properly e.g. defective hardware. This should lead to a general shut down of the device by switching off the main relay for the control.

7.2.2 Internal wiring for the alarm contacts



(The normal conditions are shown under voltage!)

The contacts are potential free and loadable up to 2 amps at 250volts.

7.2.3 Earthing regulations

The earth connection A3 on the power unit is to be wired, using a separate line, from the earthing bolt on the casing to the earthing bar in the control cabinet.

A bridge is to be wired between the earthing bolt on the casing and the mounting plate.

The terminals A7 and B7 are reserved for measuring purposes. They shall only get earthed, if required, to increase stability against disturbances.

7.3 AF131, 132, 134, 137, 139 Processor board

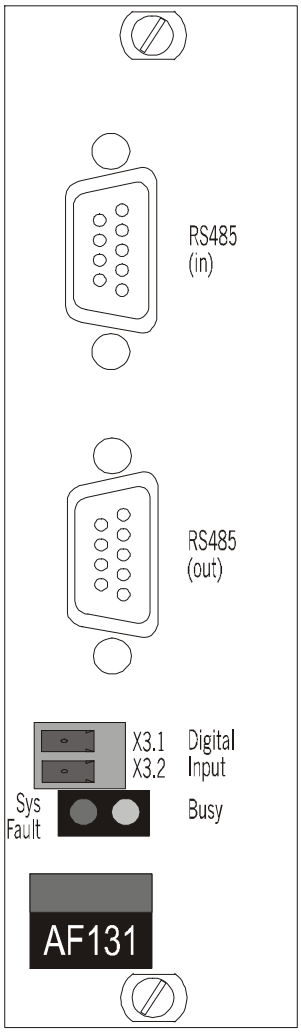
Type	COM1
AF131	RS485
AF134	RS485/A
AF137	RS422
AF139	RS485

Type	COM1
AF131	RS485
AF134	RS485/A
AF139	RS485

Type	COM2
AF132	RS232
AF134	RS485/B
AF137	RS485
AF139	RS232

Function	Terminal	
Dig. Input*)	X3	
24 VDC		1
0 VDC		2
	LED	
Sys-Fault		red

	LED	
	green	Busy



The interface COM1 is available at both plugs, it is linked internal.
*) Function according to parameter settings

Equal interfaces at COM1 and COM2 are separated by ~A und ~B.
The signification of the plugs is mentioned in the table.

7.3.1 General

The processor slide-in unit consists of a sandwich construction. The plugged-in circuit board (called MAC-module) comprises the actual controlling unit with controller, program memory module (EPROM) and the set value plus the parameter memory (EEPROM).
The basic circuit board comprises the interfaces and the driver modules for the remaining plug-in boards.

7.3.2 DIP-switch

Internal DIP-switches on the processor board (device addressing, plausibility test, °C/°F selection).
There are two DIP switch blocks on the processor slide-in unit which allow a basic setting of the devices::

5-fold DIP-switch block on the plugged-in circuit board (MAC-module):

	DIP1	DIP2	DIP3	DIP4	DIP5
ON	sensor short circuit monitoring active	solid state-supervision active	**temperature in ° Celsius**	thrust-free selection AUTO-MAN	with heater current supervision
OFF	**sensor short circuit monitoring passive**	**solid state-supervision passive**	temperature in ° Fahrenheit	**thrust selection AUTO-MAN**	**without heater current supervision**

6-fold DIP-switch block on the basic circuit board

D DIP-switch 1..5 for setting the bus address in binary for the RS485-connection

DIP1	DIP2	DIP3	DIP4	DIP5	resulting address
ON	OFF	OFF	OFF	OFF	1
OFF	ON	OFF	OFF	OFF	2
ON	ON	OFF	OFF	OFF	3
OFF	OFF	ON	OFF	OFF	4
ON	OFF	ON	OFF	OFF	5
OFF	ON	ON	OFF	OFF	6

(The table can be continued to address 30)

DIP6	Transmission rate
ON	19.200 Baud
OFF	9.600 Baud

7.3.3 LED functions

LED1 green BUSY-LED.
This flashes quickly when starting up the device, then it runs at normal operation at a frequency of approx. 0.5Hz.

LED2 red SYSTEM FAULT - LED.
When the LED is either permanently on or flashes irregularly, this is a sign of defective hardware. Simultaneously all outputs are shut down and the SYS-FAULT relay switches off at the power unit.

7.3.4 Variation B

The special variation „B“ of the processor board is available for 96 sensor inputs without temperature controller. Only boards AF040 or AF041 can be placed in this case.

7.3.5 Wiring of the bus-cable for the interface RS485

The link to the master device is done by the interface RS485 **X1** or **X2**. The pins **2** and **3** have to be linked to further controllers of the FELLER series (if installed). A well screened twisted 2 wire cable has to be used. The screening has to be done at both ends. To avoid earthing loops, the devices have to be connected by an additional PE wire.

To communicate with each device, the different addresses have to be set by the DIP-switches.

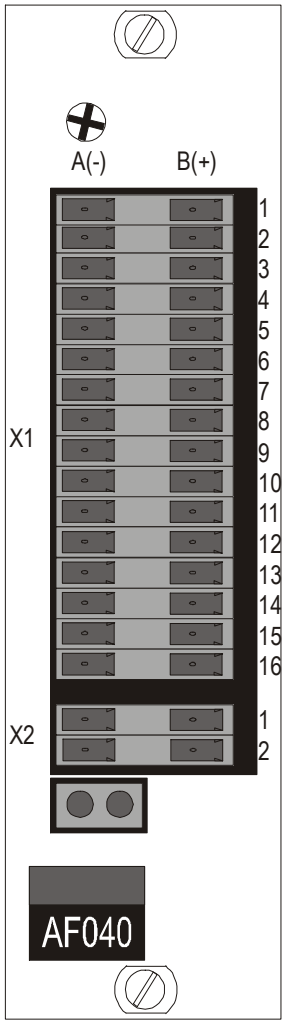
7.3.6 Interfaces

Interface		COM1					COM2				
Plug		X1 / X2					X2				
Pin		2	3	4	6		4	5	6	7	8
AF131	RS485	Rx/Tx +	Rx/Tx –								
AF132						RS232	TxD	GND	RxD		
AF134	RS485A	Rx/Tx +	Rx/Tx –			RS485B	Rx/Tx –		Rx/Tx +		
AF137	RS422	Rx	Tx	Rx	Tx	RS485	Rx/Tx –		Rx/Tx +		
AF139	RS485	Rx/Tx +	Rx/Tx –			RS232	TxD	GND	RxD		

The interface COM1 is available at both plugs, it is linked internal, except the board AF137.

7.4 AF040 Input board, 16-fold Thermocouple

Function	Terminal			Terminal	Function
Thermocouple Input	X1			X1	Thermocouple Input
1–		A1	1	B1	1+
2–		A2	2	B2	2+
3–		A3	3	B3	3+
4–		A4	4	B4	4+
5–		A5	5	B5	5+
6–		A6	6	B6	6+
7–		A7	7	B7	7+
8–		A8	8	B8	8+
9–		A9	9	B9	9+
10–		A10	10	B10	10+
11–		A11	11	B11	11+
12–		A12	12	B12	12+
13–		A13	13	B13	13+
14–		A14	14	B14	14+
15–		A15	15	B15	15+
16–		A16	16	B16	16+
	X2			X2	
Not used		A1	1	B1	Compensation KTY210
Not used		A2	2	B2	
Internal Supply-voltage	green	2 LED			

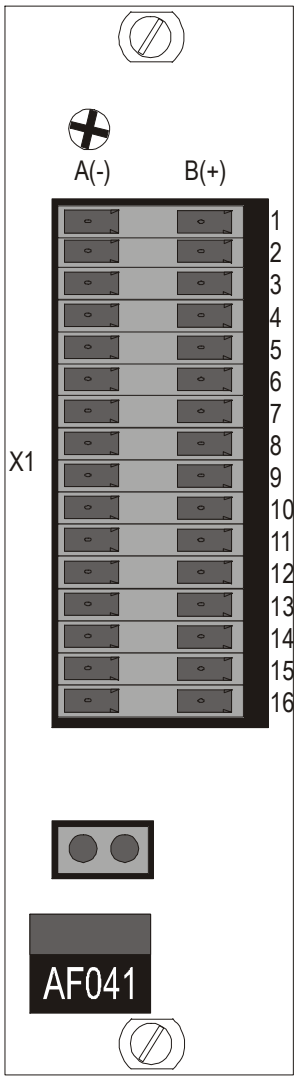


The inputs are counted synchronously with the zones. Multiples of 16 have to be added, if needed.

This slot is designed for operation in FP16 and FP16+. The jumper on the electronic board near the rear connector strip has to be set to the referring position, to recognize this slot in the rack.

7.5 AF041 Input board, 16-fold Pt100 / 2-wire

Function	Terminal			Terminal	Function
PT100 Input	X1			X1	Pt100 Input
1		A1	B1		1
2		A2	B2		2
3		A3	B3		3
4		A4	B4		4
5		A5	B5		5
6		A6	B6		6
7		A7	B7		7
8		A8	B8		8
9		A9	B9		9
10		A10	B10		10
11		A11	B11		11
12		A12	B12		12
13		A13	B13		13
14		A14	B14		14
15		A15	B15		15
16		A16	B16		16
Internal Supply-voltage	green	2 LED			



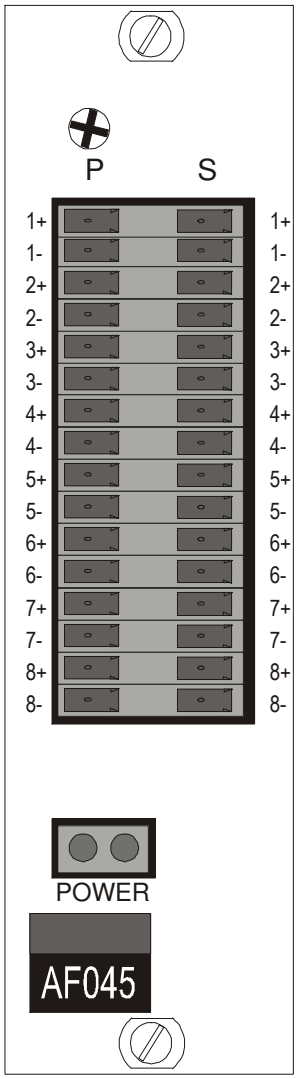
The inputs are counted synchronously with the zones. Multiples of 16 have to be added, if needed.

Not used inputs have to be shorted by a link.

This slot is designed for operation in FP16 and FP16+. The jumper on the electronic board near the rear connector strip has to be set to the referring position, to recognize this slot in the rack.

7.6 AF045 Input board, 8-fold Pt100 / 4-wire

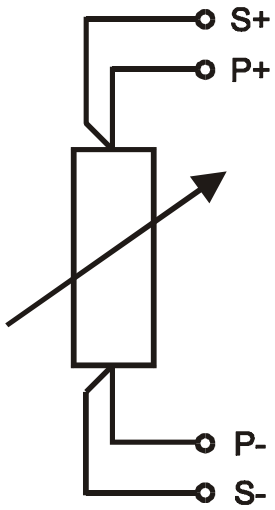
Function	Terminal		Terminal	Function
PT100 Input	P		S	Offset Input
1+	1+		1+	1+
1–	1–		1–	1–
2+	2+		2+	2+
2–	2–		2–	2–
3+	3+		3+	3+
3–	3–		3–	3–
4+	4+		4+	4+
4–	4–		4–	4–
5+	5+		5+	5+
5–	5–		5–	5–
6+	6+		6+	6+
6–	6–		6–	6–
7+	7+		7+	7+
7–	7–		7–	7–
8+	8+		8+	8+
8–	8–		8–	8–
Internal Supply-voltage	green	2 LED		



The inputs are counted synchronously with the zones. Multiples of 8 have to be added, if needed.

This slot is designed for operation in FP16 and FP16+. The jumper on the electronic board near the rear connector strip has to be set to the referring position, to recognize this slot in the rack.

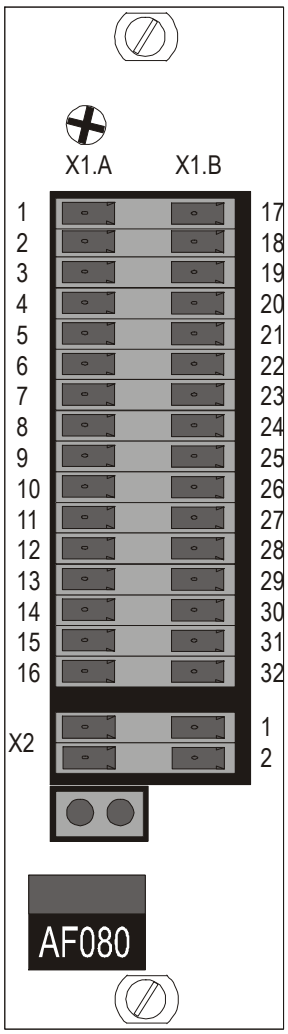
Circuit diagram of sensor Pt100 / 4-wire



The offset has to be wired to S+ and S-.

7.7 AF080/75mA Output board, 32-fold digital

Function	Terminal				Terminal	Function
Heating						Heating/cooling
Digital-output	X1				X1	Digital-output
1+		A1	1	17	B17	17+
2+		A2	2	18	B18	18+
3+		A3	3	19	B19	19+
4+		A4	4	20	B20	20+
5+		A5	5	21	B21	21+
6+		A6	6	22	B22	22+
7+		A7	7	23	B23	23+
8+		A8	8	24	B24	24+
9+		A9	9	25	B25	25+
10+		A10	10	26	B26	26+
11+		A11	11	27	B27	27+
12+		A12	12	28	B28	28+
13+		A13	13	29	B29	29+
14+		A14	14	30	B30	30+
15+		A15	15	31	B31	31+
16+		A16	16	32	B32	32+
	X2				X2	
0V		A1	X2 1		B1	24V
0V		A2	2		B2	24V
External Supply-voltage	green	2 LED				



According to the task the outputs are used for the function of heating or cooling.
The inputs are counted synchronously with the zones. Multiples of 16 have to be added, if needed.

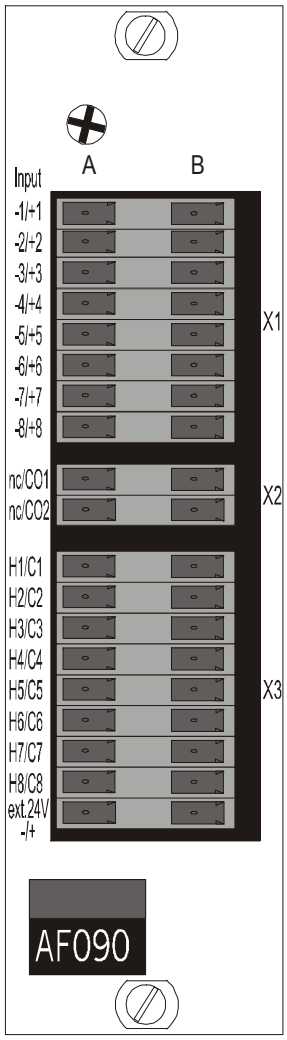
Output power: 24VDC, max. 75 mA

7.7.1 Outputs to trigger the solid-state relays

The 32 outputs of the combi-board are supplied by an external voltage (24VDC) which is switched by the software to the outputs. The maximum load of the outputs is 25 mA and is short circuit proofed by series resistors. In the event of long-term short circuiting of all the outputs component defects are possible through overheating. The outputs are electrically isolated from the rest of the device. Internal hardware supervision ensures a shut down of all outputs in the event of incorrect program functioning or gradual drop in mains voltage.

7.8 AF090 Combi board, 8-fold Thermocouple

Function	Terminal			Terminal	Function
Thermocouple Input	X1			X1	Thermocouple Input
1–		–1	-1/+1	+1	1+
2–		–2	-2/+2	+2	2+
3–		–3	-3/+3	+3	3+
4–		–4	-4/+4	+4	4+
5–		–5	-5/+5	+5	5+
6–		–6	-6/+6	+6	6+
7–		–7	-7/+7	+7	7+
8–		–8	-8/+8	+8	8+
	X2			X2	
Not used		nc	nc/CO1	C01	Compensation
Not used		nc	nc/CO2	C02	KTY210
H-output	X3			X3	C-output
		H1	H1/C1	C1	
		H2	H2/C2	C2	
		H3	H3/C3	C3	
		H4	H4/C4	C4	
		H5	H5/C5	C5	
		H6	H6/C6	C6	
		H7	H7/C7	C7	
		H8	H8/C8	C8	
0 VDC External Supply-voltage		ext 24V –	ext.24V -/+	ext 24V +	24 VDC External Supply-voltage



The inputs are counted synchronously with the zones. Multiples of 16 have to be added, if needed.
The outputs are used for the function of heating and cooling.

Output power: 24VDC, max. 25 mA

The combi board AF090 comprises 8 inputs for thermocouples and 16 outputs for triggering solid-state relays. This board can be plugged in at position 1..6 on the basic device. By subsequent equipping with combi boards the **FP16+** controller can be extended up to 32 control zones (heating/cooling). The outputs and inputs are electrically separated from the device potential.

This slot is designed for operation in FP16 and FP16+. The jumper on the electronic board near the rear connector strip has to be set to the referring position, to recognize this slot in the rack.

7.8.1 Sensor inputs

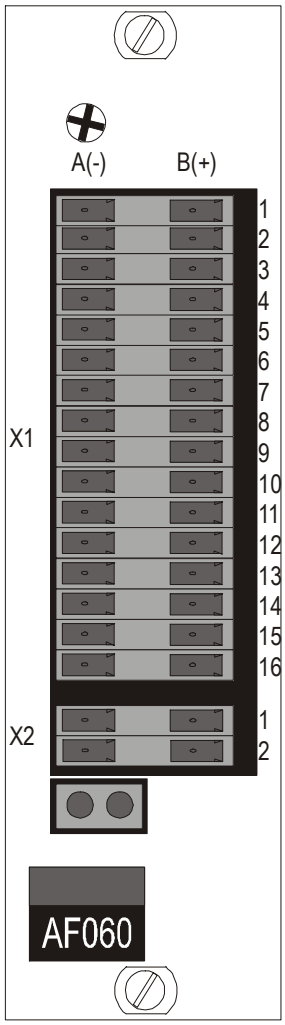
The thermocouple alignment for type FeCuNi (J-type) is set by the maker. An extremely good linearisation of the input characteristics is assured by software linearisation with a 0.25°C resolution from point to point. If required the inputs can be post-calibrated via 2 potentiometers. Filtering at every thermocouple input assures low interference risk. All input connections including the amplifier part and the AD-transformer are electrically isolated from the rest of the device.

7.8.2 Outputs to trigger the solid-state relays

The 32 outputs of the combi-board are supplied by an external voltage (24VDC) which is switched by the software to the outputs. The maximum load of the outputs is 25 mA and is short circuit proofed by series resistors. In the event of long-term short circuiting of all the outputs component defects are possible through overheating. The outputs are electrically isolated from the rest of the device. Internal hardware supervision ensures a shut down of all outputs in the event of incorrect program functioning or gradual drop in mains voltage.

7.9 AF060 Current-supervision-board, 16-fold

Function	Terminal			Terminal	Function
Heater-current-Input	X1			X1	Heater-current-Input
1–		A1	1	B1	1+
2–		A2	2	B2	2+
3–		A3	3	B3	3+
4–		A4	4	B4	4+
5–		A5	5	B5	5+
6–		A6	6	B6	6+
7–		A7	7	B7	7+
8–		A8	8	B8	8+
9–		A9	9	B9	9+
10–		A10	10	B10	10+
11–		A11	11	B11	11+
12–		A12	12	B12	12+
13–		A13	13	B13	13+
14–		A14	14	B14	14+
15–		A15	15	B15	15+
16–		A16	16	B16	16+
	X2			X2	
Not used		A1	1	B1	Net-comp.*) +
Not used		A2	2	B2	Net-comp.*) –
Internal Supply-voltage	green	2 LED			



The inputs are counted synchronously with the zones.
*) Compensation for the net supply voltage

This slot is designed for operation in FP16 and FP16+. The jumper on the electronic board near the rear connector strip has to be set to the referring position, to recognize this slot in the rack.

7.9.1 Compensation for the net supply voltage

The compensation of the net voltage happens at 2VDC. It has to be taken from the net of the heater supply. In case of dispense on the compensation, the inputs X2.1B and X2.2B have to be linked by a resistor of 68Kohm.
In this table n refers to the terminal no. and to the zone no.

8 Further equipment and functions

For **FP16+** further boards are available for further interfaces, input- and output-signals. The manuals of these are added to this document, if required.