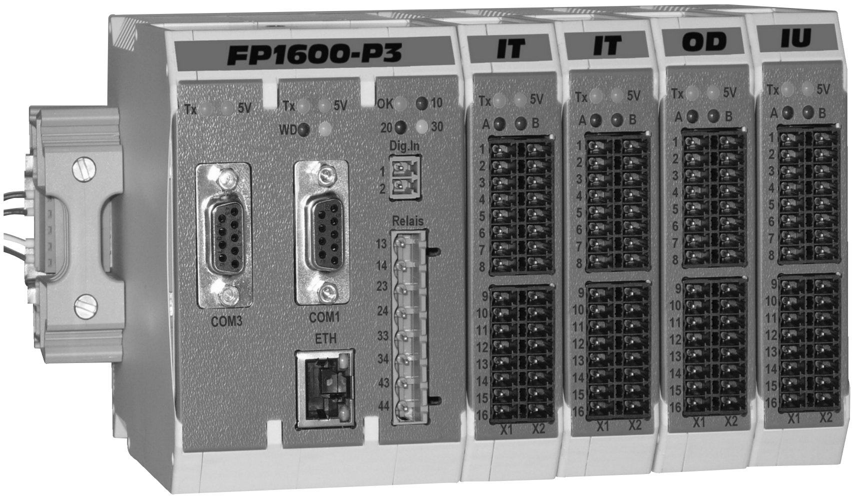
FP1600

User manual



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Status 07/2024

Contents

1 Features and functions

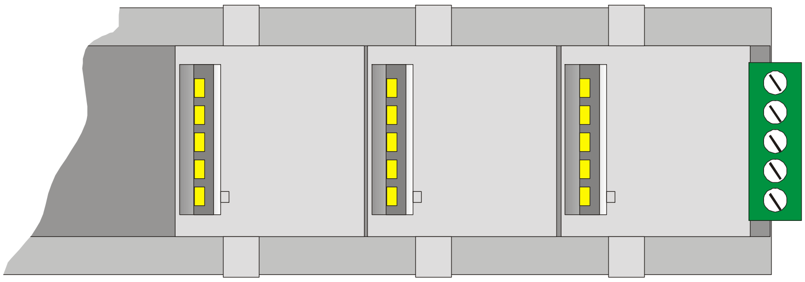
- Different methods for calculating the output power for each zone:
  * Manually adjustable, constant output or manual mode
  * PID temperature control for heating / cooling *
  Takeover of the output of a neighboring zone in the event of a sensor fault
  * Comparator function (see parameter 4, Xp)
  * Permanently switching off limiter as a safety function (see parameter 2, HI)
- Self-optimization of the zones on request
- Energy-saving economy heating
- Grouped switching of the heaters to reduce the total connected load.
- Mains voltage monitoring
- Correction of the output power via voltage compensation
- Serial, 3-phase current monitoring
- Solid state relay monitoring (TRIAC short circuit)
- Integrated date and time function
- Event log on standard SD memory card
- HTML web interface for remote diagnostics
- FTP interface for firmware updates
- FE3 bus via Ethernet-UDP for parameterization / visualization (e.g. VISUAL FECON)
- Short-circuit-proof outputs for controlling solid state relays

2 Module overview

The **FP1600** temperature controller consists of various system modules that can be snapped onto a top-hat rail.

2.1 Top-hat rail system

All modules of the **FP1600** system are mounted on a top-hat rail. The modules are supplied with power and communicate internally via a 5-pole terminal system, which can be mounted by simply press-ing it into a standard top-hat rail.

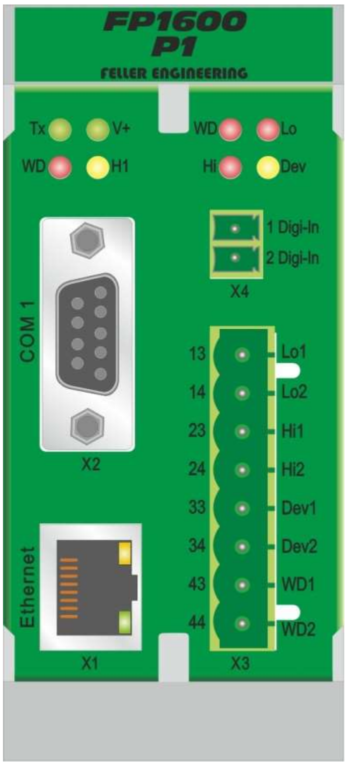


Supply
+24VDC
GND
-/-
CAN H
CAN L
Communication

Illustration with 3 T-Bus-connectors and 5-pin connection socket

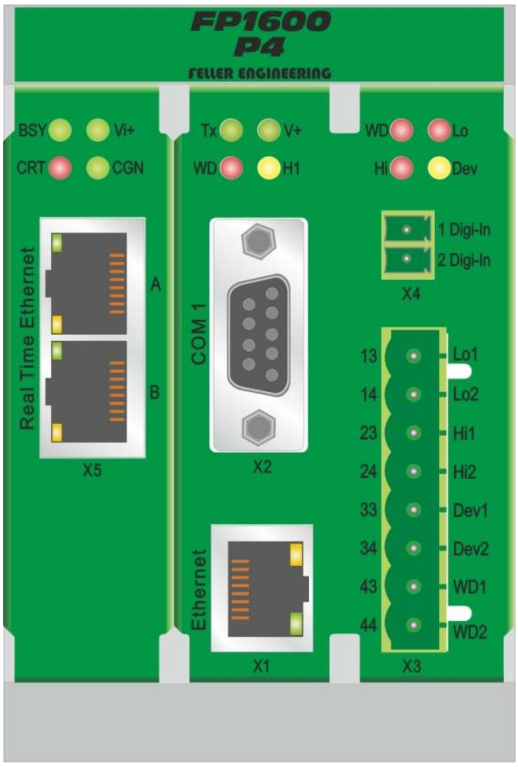
To terminate the CAN bus, a 120 Ohm terminating resistor must be connected between the CAN H and CAN L connections

2.2 FP1600-P1: Processor module RS485, Ethernet



Module width for 2 T-bus-connector

2.3 ***FP1600-P4***: Processor module RS485, ProfiNet, Sercos III, Ethernet



Module width for 3 T-Bus-connectors

2.3.1 Function of the processor modules

All processor modules

LED designation		Function
WD	red	Lights up when the→ WD contact is open
Lo	red	Lights up when the→ LO contact is open
Hi	red	Lights up when the→ HI contact is open
Dev	yellow	Lights up when the→ DEV contact is open
Tx	green	Flashes at 500ms intervals and indicates communication with the modules
V+	green	Lights up permanently and indicates the supply voltage present.
H1	yellow	-
WD	red	-

Processor modules P3 and P4

BSY	green	
Vi+	green	
CRT	red	
CON	green	

2.3.2 Contacts

Depending on the data described in chapter 4.1.28 the processor card contacts have different functions:

2.3.2.1 Function of the contacts with system parameter {RQI} = 0 (delivery status ex works)

Plug X3			
Contact number	Contact Designation		Function: Normally closed (good status).
13	Lo1		... the contact opens as long as one of the zones signals an LO alarm, sensor break or short circuit.
14	Lo2		
23	Hi1		... the contact opens as long as one of the zones signals HI alarm or triac closure (SSR→ chap. 4.2.24).
24	Hi2		
33	Dev1		... the contact opens as long as one of the zones reports a deviation alarm. is reported. If there is a system error→ {ERR}, it switches on and off at a rate of 1Hz.
34	Dev2		
43	WD1		... the contact is normally closed. If a hardware error occurs, it opens.
44	WD2		

2.3.2.2 Function of the contacts with system parameter {RQI} = 1

Plug X3			
Contact number	Contact Designation		Function: Normally closed (good status).
13	Lo1		... the contact opens when one of the zones reports an LO alarm, sensor break or short circuit. The alarm must be reset to the OK state via the acknowledgement *) . This is also possible if the cause triggering the alarm is still present.
14	Lo2		
23	Hi1		... the contact opens when one of the zones signals HI alarm or triac closure (SSR→ chap. 4.2.24). The alarm must be reset to the OK state by acknowledging *) . This is also possible if the cause triggering the alarm is still present.
24	Hi2		
33	Dev1		... the contact opens when one of the zones reports a deviation alarm. is reported. The alarm must be reset to the OK state via the acknowledgement*) . This is also possible if the cause triggering the alarm is still present. If there is a system error→ {ERR}, it switches on and off at a rate of 1Hz.
34	Dev2		
43	WD1		... the contact is normally closed. If a hardware error occurs, it opens.
44	WD2		

*) Acknowledgement see chapter 4.1.23

2.3.3 Function input

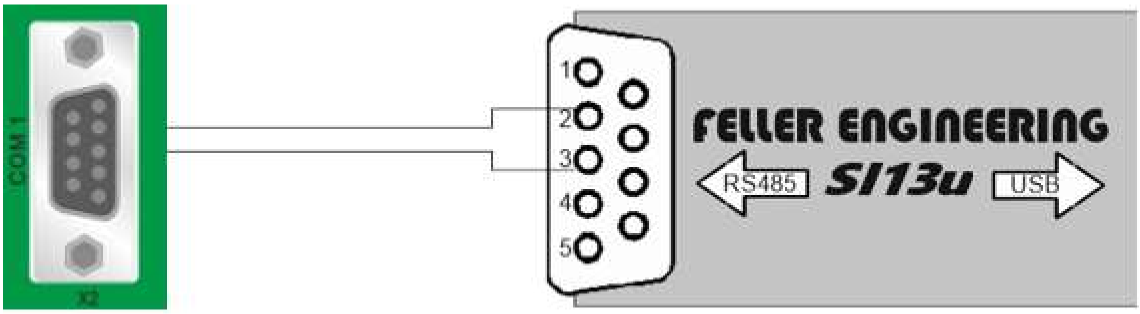
Plug X4			
Contact number	Contact Designation		Function
1	+24VDC		Connecting the function input with 24V can cause different reactions. These are described as parameters {FSE} (chapter 4.1.30) can be selected.
2	GND		

2.3.4 RS485

Plug X2			
Contact number	Contact Designation		Function

2	A		PIN2 (A) and PIN3 (B) are connected to an RS485 interface. interface is led out. This allows up to 30 devices to be connected to a two-wire bus. The device address can be set using the DIP switches on the underside of the housing.
3	B		

To parameterize the controller via RS485, the free PARACON software is available at
www.fellereng.de/downloads
is available for download. For the connection between the FP1600 and PARACON, an interface converter SI13U (USB → RS485) with galvanic isolation is also required, which must be ordered separately. The SI13U interface converter establishes a connection between its pins 2 and 3 and those of connector X2 of the FP1600:



2.3.5 Ethernet TCP/IP

Plug X1			
Contact number	Contact Designation		Function
1	Tx+		Via Ethernet communication to the ***FP1600*** takes place via various protocols such as http, UDP, TELNET and FTP. The processor is factory set to dynamic IP addresses (DHCP).
2	Tx-		
3	Rx+		
4	-		
5	-		
6	Rx-		
7	-		
8	-		

The ***IP Config*** tool, which can be downloaded free of charge from www.fellereng.de, can be used to adjust the network settings of the controllers integrated in the local Ethernet. A table lists all devices available in the network. The number shown in the "Serial" column corresponds to the "SN-IPC" number on the type plate of the processor. After selecting an entry in the table, a window opens in which the IP address can be adjusted or the DHCP setting can be changed.

2.3.6 Real Time Ethernet ProfiNet, Sercos III (FP1600-P4 only)

Plug X1			
Contact number	Contact Designation		Function
1	Tx+		Via Ethernet communication to the **FP1600** takes place via various protocols such as http, UDP, TELNET and FTP. The processor is factory set to dynamic IP addresses (DHCP).
2	Tx-		
3	Rx+		
4	-		
5	-		
6	Rx-		
7	-		
8	-		

The ***IP Config*** tool, which can be downloaded free of charge from www.fellereng.de, can be used to adjust the network settings of the controllers integrated in the local Ethernet. A table lists all devices available in the network. The number shown in the "Serial" column corresponds to the "SN-IPC" number on the type plate of the processor. After selecting an entry in the table, a window opens in which the IP address can be adjusted or the DHCP setting can be changed.

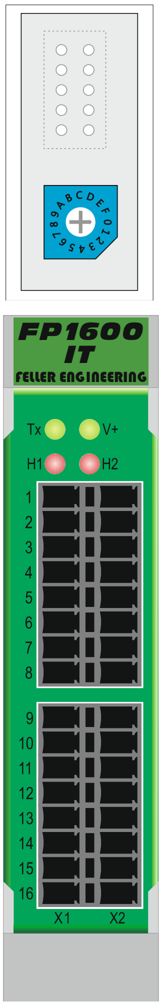
2.3.7 SD memory card

An SD memory card is inserted at the top. This must be regarded as an integral part of the controller and must not be removed under any circumstances. SDHC and SDXC memory cards are not supported.

2.4 Technical data

Alarm contacts:	U max.	250	VAC
	U max.	30	VDC
	I max.	3	A
Current consumption (24VDC)	I b	230	mA
Ambient temperature	T max.	50	°C
Digital input (Digi-In)	UDi	12-30	VDC
Number of T-Bus-connectors P1, P2	2		
Module width P1, P2		45	mm
Number of T-Bus-connectors P3, P4	3		
Module width P3, P4		67,5	mm
Module depth without plug		115	mm
Module height		100	mm
Minimum distance on bottom and top		25	mm

2.5 Input module ***FP1600-IT***: 16x thermocouple



2.5.1 Function of the module

This module amplifies the signals from connected thermocouples and transmits the temperatures determined via the rear CAN bus to the processor in 1/10° resolution.

2.5.2 Thermocouple inputs

The inputs are calibrated for type J thermocouples. Temperature compensation takes place within the module. The measured value resolution is in 1/10 K

2.5.3 LEDs

LED designation		Function
●	**V+**	Lights up permanently in normal operation and indicates the supply voltage.
●	**Tx**	Flashes in time with the busy LED of the processor card and thus indicates communication with it. As an alternative to regular flashing, a "blink code" can provide information about various errors:
		. . . . . ✓ module functions and communicates with the control unit.
		– – ⚠ No communication with the control unit
		– – – ⚠ Inputs must be calibrated
		– – – – ⚠ ADC hardware error
●	**H1**	An illuminated H1 indicates that at least one of the outputs has or had a short circuit. After eliminating the short circuit, the module must be briefly disconnected from the power supply.
●	**H2**	Lights up in the event of a serious hardware error

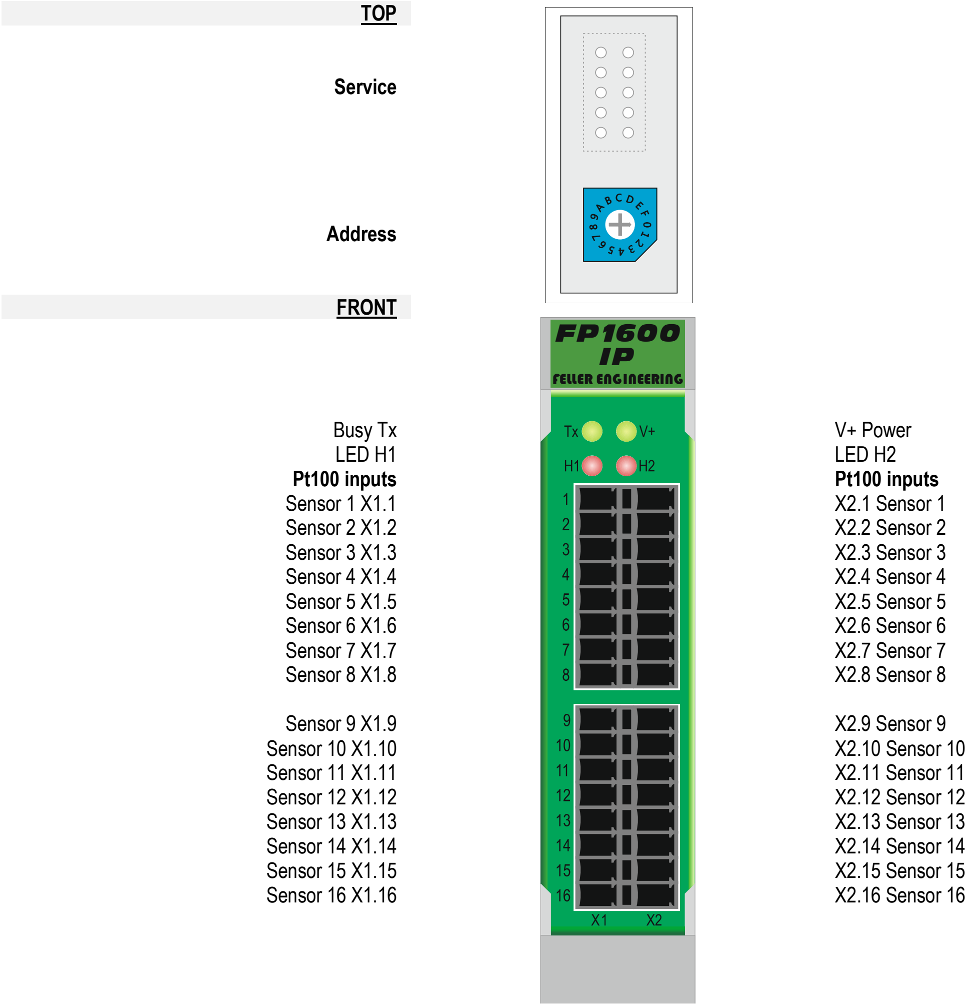
2.5.4 Address setting

The module is addressed via the BCD rotary switch on the top of the housing. Permissible addresses are from 1 to F (corresponds to decimal 15). The setting of address 0 is not permitted. The modules must be assigned different address settings. The assignment of the inputs to the zones is set via the respective zone parameter→ P29.

2.5.5 Technical data

Current consumption (24VDC)	I b	110	mA
Ambient temperature	T max.	50	°C
Power loss	max.	2,6	W
Number of T-Bus-connectors	1		
Module width **FP1600**-IT		22,5	mm
Module depth without plug		115	mm
Module height		100	mm
Minimum distance on bottom and top		25	mm

2.6 Input module FP1600-IP: 16x Pt100/2-wire



2.6.1 Function of the module

This module amplifies the signals from connected PT100 sensors and transmits the temperatures determined via the rear CAN bus to the processor in 1/10° resolution.

2.6.2 PT100 inputs

The inputs are calibrated for PT100 sensors. The measured value resolution is in 1/10 K

2.6.3 LEDs

LED designation		Function
	V+	Lights up permanently in normal operation and indicates the supply voltage.
	Tx	Flashes in time with the busy LED of the processor card and thus indicates communication with it. As an alternative to regular flashing, a "blink code" can provide information about various errors: . . . . . — module functions and communicates with the control unit. – – — No communication with the control unit – – – — Inputs must be calibrated – – – – — ADC hardware error
	H1	An illuminated H1 indicates that at least one of the outputs has or had a short circuit. After eliminating the short circuit, the module must be briefly disconnected from the power supply.
	H2	Lights up in the event of a serious hardware error

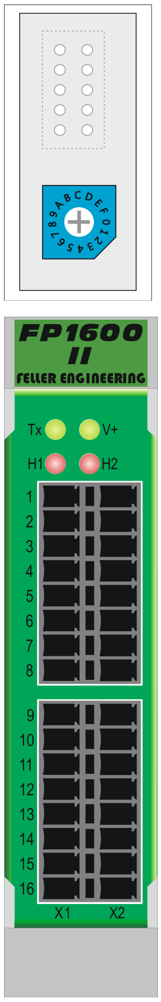
2.6.4 Address setting

The module is addressed via the BCD rotary switch on the top of the housing. Permissible addresses are from 1 to F (corresponds to decimal 15). The setting of address 0 is not permitted. The modules must be assigned different address settings. The assignment of the inputs to the zones is set via the respective zone parameter→ P29.

2.6.5 Technical data

Current consumption (24VDC)	I b	110	mA
Ambient temperature	T max.	50	°C
Power loss	max.	2,6	W
Number of T-Bus-connectors	1		
Module width **FP1600**-IT		22,5	mm
Module depth without plug		115	mm
Module height		100	mm
Minimum distance on bottom and top		25	mm

2.7 Input module ***FP1600***-II: 16x current input 0..20mA DC



2.7.1 Function of the module

This module digitizes the incoming 0..20mA (DC) signals and passes them on to the processor via the rear CAN bus. to the processor.

2.7.2 Analog current inputs

The inputs are calibrated for 0..20mA DC. The measured value resolution is in 0.1mA
Through optional parameterization (see chapter 4.2.42), each input can be reconfigured as a wire-breakage-proof 4..20mA signal.

2.7.3 LEDs

LED designation		Function
(green)	**V+**	Lights up permanently in normal operation and indicates the supply voltage.
(green)	**Tx**	Flashes in time with the busy LED of the processor card and thus indicates communication with it. As an alternative to regular flashing, a "blink code" can provide information about various errors: . . . . . ✓ module functions and communicates with the control unit. – – ⚠ No communication with the control unit – – – ⚠ Inputs must be calibrated – – – – ⚠ ADC hardware error
(red)	**H1**	An illuminated H1 indicates that at least one of the outputs has or had a short circuit. After eliminating the short circuit, the module must be briefly disconnected from the power supply.
(red)	**H2**	Lights up in the event of a serious hardware error

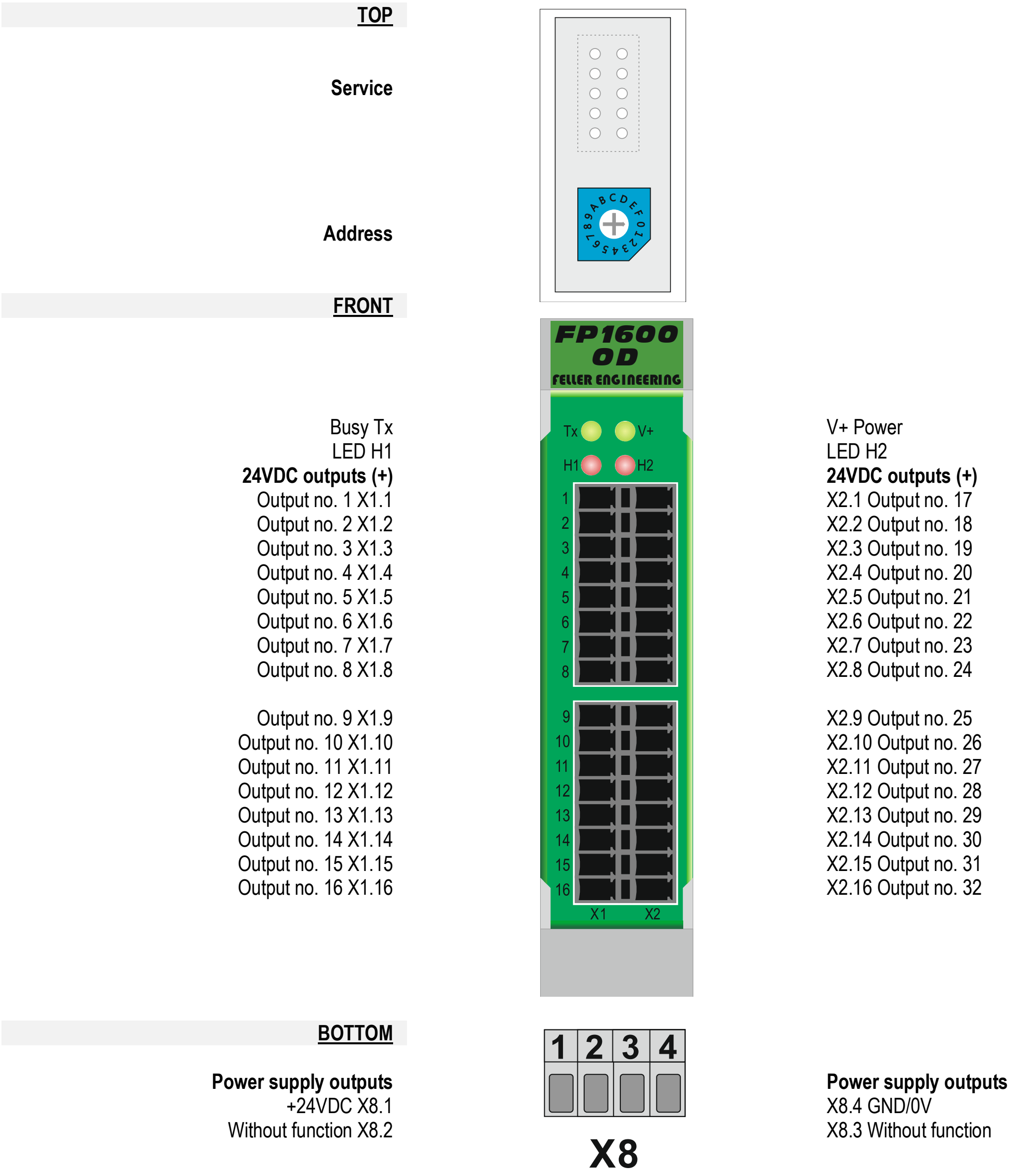
2.7.4 Address setting

The module is addressed via the BCD rotary switch on the top of the housing. Permissible addresses are from 1 to F (corresponds to decimal 15). The setting of address 0 is not permitted. The modules must be assigned different address settings. The assignment of the inputs to the zones is set via the respective zone parameter→ P29.

2.7.5 Technical data

Input impedance	R_i	2	Ohm
Current consumption (24VDC)	I b	110	mA
Ambient temperature	T_{max}	50	°C
Power loss	max.	2,6	W
Number of T-Bus-connectors		1	
Module width ***FP1600***-II		22,5	mm
Module depth without plug		115	mm
Module height		100	mm
Minimum distance on bottom and top		25	mm

2.8 Output module ***FP1600***-OD: 32x output 24VDC



2.8.1 Function of the module

This module has 32 digital 24VDC outputs. These outputs can be used via corresponding power stages (solid state relays), e.g. to control heating or cooling systems. The assignment of each output to the desired function can be determined via the→ zone parameters P30 and P31. The module requires a separate 24VDC power supply for the output circuit. The power is switched via pulse width modulation.

2.8.2 LEDs

LED designation		Function
	V+	Lights up permanently in normal operation and indicates the supply voltage.
	Tx	Flashes in time with the busy LED of the processor card and thus indicates communication with it.
	H1	An illuminated H1 indicates that at least one of the outputs has or had a short circuit. After eliminating the short circuit, the module must be briefly disconnected from the power supply.
	H2	Lights up in the event of a serious hardware error

2.8.3 Address setting

The module is addressed via the BCD rotary switch on the top of the housing. Permissible addresses are from 1 to F (corresponds to decimal 15). The setting of address 0 is not permitted. The modules must have different address settings from one another. The output modules have a separate address range from the input modules and can be operated independently of these from address 1. The assignment of the inputs to the zones is set via the respective zone parameter→ P29.

2.8.4 Technical data

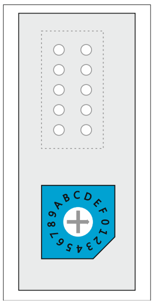
Outputs, resistively loaded	I max.	75	mA
Outputs, inductive (protective diode required on relay)	I max.	75	mA
Max. Capacity of the connected load	C max.	100	nF
Current consumption (24VDC)	I b	95	mA
Ambient temperature	T max.	50	°C
Power loss	max.	1,8	W
Number of T-Bus-connectors	1		
Module width **FP1600**-OD		22,5	mm
Module depth without plug		115	mm
Module height		100	mm
Minimum distance on bottom and top		25	mm

2.9 Combi module ***FP1600-CT***: 8x thermocouple + 16x output 24VDC

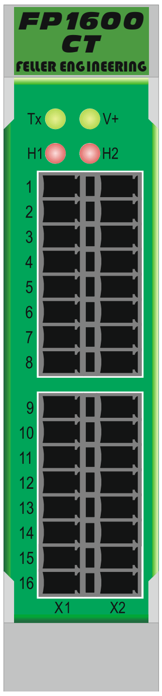
TOP

Service

Address



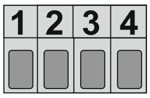
FRONT



Busy Tx
LED H1
Thermocouple inputs
T/C 1(-) X1.1
T/C 2(-) X1.2
T/C 3(-) X1.3
T/C 4(-) X1.4
T/C 5(-) X1.5
T/C 6(-) X1.6
T/C 7(-) X1.7
T/C 8(-) X1.8
24VDC outputs (+)
Output no. 1 X1.9
Output no. 2 X1.10
Output no. 3 X1.11
Output no. 4 X1.12
Output no. 5 X1.13
Output no. 6 X1.14
Output no. 7 X1.15
Output no. 8 X1.16

V+ Power
LED H2
Thermocouple inputs
X2.1 T/C 1(+)
X2.2 T/C 2(+)
X2.3 T/C 3(+)
X2.4 T/C 4(+)
X2.5 T/C 5(+)
X2.6 T/C 6(+)
X2.7 T/C 7(+)
X2.8 T/C 8(+)
24VDC outputs (+)
X2.9 Output no. 9
X2.10 Output no. 10
X2.11 Output no. 11
X2.12 Output no. 12
X2.13 Output no. 13
X2.14 Output no. 14
X2.15 Output no. 15
X2.16 Output no. 16

BOTTOM



X8

Power supply outputs
+24VDC X8.1
Without function X8.2

Power supply outputs
X8.4 GND/0V
X8.3 Without function

2.9.1 Function of the module

This module amplifies the signals from 8 connected thermocouples and transmits the temperatures determined via the rear CAN bus to the processor in 1/10° resolution.

16 digital 24VDC outputs can be used via corresponding power stages (solid state relays), e.g. to control heating or cooling systems. The assignment of each output to the desired function can be determined via the→ zone parameters P30 and P31. The module requires a separate 24VDC power supply for the output circuit. The power is switched via pulse width modulation.

2.9.2 Thermocouple inputs

The inputs are calibrated for type J thermocouples. Temperature compensation takes place within the module. The measured value resolution is in 1/10 K

2.9.3 LEDs

<table>
<tr><th>LED designation</th><th>Function</th></tr>
<tr><td>V+</td><td>Lights up permanently in normal operation and indicates the supply voltage.</td></tr>
<tr><td>Tx</td><td>Flashes in time with the busy LED of the processor card and thus indicates communication with it. As an alternative to regular flashing, a "blink code" can provide information about various errors:
<table>
<tr><td>. . . . .</td><td></td><td>module functions and communicates with the control unit.</td></tr>
<tr><td>– –</td><td></td><td>No communication with the control unit</td></tr>
<tr><td>– – –</td><td></td><td>Inputs must be calibrated</td></tr>
<tr><td>– – – –</td><td></td><td>ADC hardware error</td></tr>
</table></td></tr>
<tr><td>H1</td><td>An illuminated H1 indicates that at least one of the outputs has or had a short circuit. After eliminating the short circuit, the module must be briefly disconnected from the power supply.</td></tr>
<tr><td>H2</td><td>Lights up in the event of a serious hardware error</td></tr>
</table>

2.9.4 Outputs for heating / cooling

The outputs actively supply 24VDC. The required voltage must be supplied as an auxiliary voltage. The power is switched via pulse width modulation.

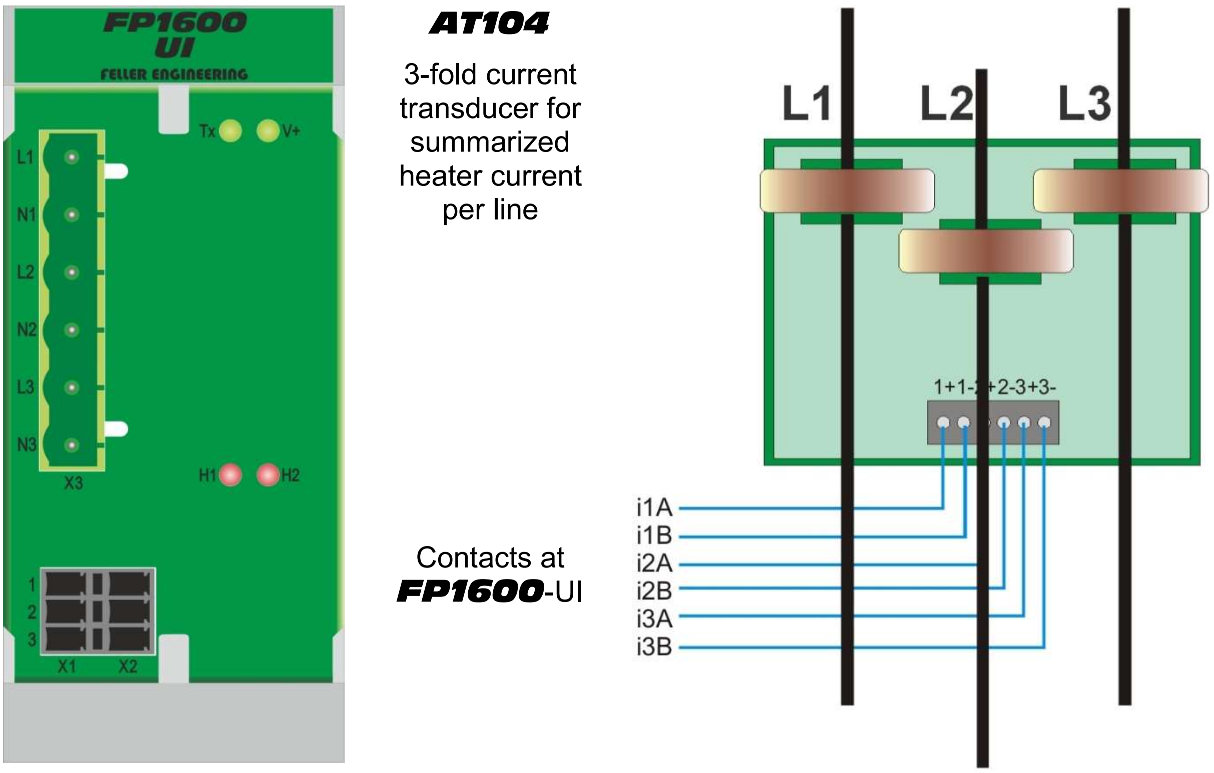
2.9.5 Address setting

The combination module is addressed via the BCD rotary switch on the top of the housing. Ensure that all modules from 1 onwards are addressed consistently.

2.9.6 Technical data module FP1600-CT

Outputs, resistively loaded	I max.	75	mA
Outputs, inductive (protective diode required on relay)	I max.	75	mA
Max. Capacity of the connected load	C max.	100	nF
Current consumption (24VDC)	I b	100	mA
Ambient temperature	T max.	50	°C
Power loss	max.	1,8	W
Number of T-Bus-connectors	1		
Module width FP1600-CT		22,5	mm
Module depth without plug		115	mm
Module height		100	mm
Minimum distance on bottom and top		25	mm

2.10 ***FP1600***-UI: Module for net voltage- and current-monitoring



2.10.1 Function of the Module

The ***FP1600-UI*** mains voltage and current monitoring module cyclically monitors the level and frequency of the supply voltage. A connection for a 3-phase current transformer enables the function of a "serial" heating current measurement.

Voltage detection for monitoring of the voltage compensation
Detection of the net voltage facilitates the report of fail. Variations of the power in reason of the variability at the voltage will be adjusted with the voltage-compensation by adjusting the output rate. This is not valid in comparator mode (P-part > 0).

Current measurement for serial heater current detection
Heater current measurement takes place during a short period of forced heater output for the referring zone, while all the others are disabled.

2.10.2 LEDs

LED Signification	Function
V+	Lights permanently to indicate the power supply voltage.
Tx	Flashes by the cycle rate of the Busy-LED of the processor module and indicates the communication this way.
H1	Not used
H2	Lights in case of a serious hardware fault.

2.10.3 Technical Data

Net-/ input-voltage	U in max.	400	VAC
Net-frequency	f	50/60	Hz
Current consumption (24VDC)	I b	110	mA
Ambient temperature	T max.	50	°C
Power consumption	max.	2,6	W
Number of T-Bus-Connectors	3		
Width of the module		45	mm
Depth of the module without connector		115	mm
Height of the module		100	mm
Minimum distance top and bottom side		25	mm

2.11 Current Transducer Module AT104

2.11.1 Function of the Module

The current transducer module consists of 3 independent isolated coils for AC-current. The current will be measured, when the referring wire is put through the coil. To achieve measured values within the linear range of the coil, the current should not exceed the values for max. and min. current of the data table below. Wired with a load <5A should be winded manifold through the coil. The numbers of winds “n” multiple the measured values. The signal at the contact-terminals is AC.

2.11.2 Contacts

Contact-Signification X1		Function
1+ / 1-		~ signal coil 1
2+ / 2-		~ signal coil 2
3+ / 3-		~ signal coil 3

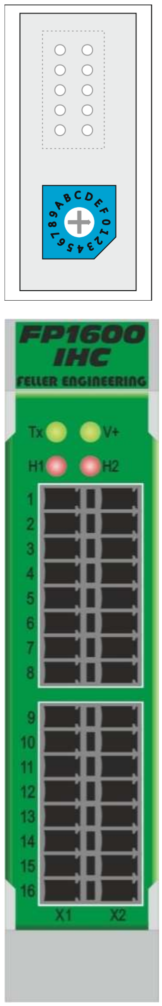
2.11.3 Technical Data AT104

Max. measurable current *)	I max.	30	A /AC
Min. measurable current *)	I min.	0,1	A /AC
Ambient temperature	T max.	50	°C
Coil, inner-∅ , for wires up to 70mm²		19	mm
Width		104	mm
Height		78	mm
Depth		72	mm
Mounting at 35mm rails			

*) Linear measuring is not possible out of the range between 1A (AC) and 120A (AC).

2.12 Input module **FP1600**-IHC: 16x current input from the converter

TOP	
Service	
Address	
FRONT	
Busy Tx	V+ Power
LED H1	LED H2
Inputs	**Inputs**
Current signal 1(GND) X1.1	X2.1 Current signal 1(0..10V)
Current signal 2(GND) X1.2	X2.2 Current signal 2(0..10V)
Current signal 3(GND) X1.3	X2.3 Current signal 3(0..10V)
Current signal 4(GND) X1.4	X2.4 Current signal 4(0..10V)
Current signal 5(GND) X1.5	X2.5 Current signal 5(0..10V)
Current signal 6(GND) X1.6	X2.6 Current signal 6(0..10V)
Current signal 7(GND) X1.7	X2.7 Current signal 7(0..10V)
Current signal 8(GND) X1.8	X2.8 Current signal 8(0..10V)
Current signal 9(GND) X1.9	X2.9 Current signal 9(0..10V)
Current signal 10(GND) X1.10	X2.10 Current signal 10(0..10V)
Current signal 11(GND) X1.11	X2.11 Current signal 11(0..10V)
Current signal 12(GND) X1.12	X2.12 Current signal 12(0..10V)
Current signal 13(GND) X1.13	X2.13 Current signal 13(0..10V)
Current signal 14(GND) X1.14	X2.14 Current signal 14(0..10V)
Current signal 15(GND) X1.15	X2.15 Current signal 15(0..10V)
Current signal 16(GND) X1.16	X2.16 Current signal 16(0..10V)



2.12.1 Function of the module

This module records the signals from connected current transformer modules and forwards the measured values to the processor via the rear CAN bus to the processor in 1/10A resolution.

2.12.2 Current transformer inputs

The inputs are designed for the connection of AT096 (single), AT097 (triple) or AT098 (quadruple) current transformer modules (with 200Ohm load resistance). The signals are linearized by the IHC module. The measured value resolution is 1/10 A.

2.12.3 LEDs

LED designation		Function
green	**V+**	Lights up permanently in normal operation and indicates the supply voltage.
green	**Tx**	Flashes in time with the busy LED of the processor card and thus indicates communication with it. As an alternative to regular flashing, a "blink code" can provide information about various errors: . . . . . ✓ module functions and communicates with the control unit. – – ⚠ No communication with the control unit – – – ⚠ Inputs must be calibrated – – – – ⚠ ADC hardware error
red	**H1**	An illuminated H1 indicates that at least one of the outputs has or had a short circuit. After eliminating the short circuit, the module must be briefly disconnected from the power supply.
red	**H2**	Lights up in the event of a serious hardware error

2.12.4 Address setting

The module is addressed via the BCD rotary switch on the top of the housing. Permissible addresses are from 1 to F (corresponds to decimal 15). The setting of address 0 is not permitted. All IHC modules must have different address settings. The IHC modules have a separate address range from the input modules and can be operated independently of these from address 1. The assignment of the inputs to the zones is set via the respective zone parameter→ P32.

2.12.5 Technical data

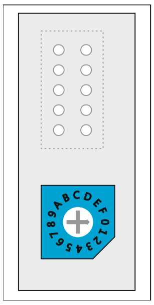
Current consumption (24VDC)	I b	110	mA
Ambient temperature	T max.	50	°C
Power loss	max.	2,6	W
Module width ***FP1600***-IT		22,5	mm
Module depth without plug without bending radius		115	mm
Module height		100	mm
Minimum distance on bottom and top		25	mm

2.13 Input module **FP1600**-ID: 32 x 24V DC

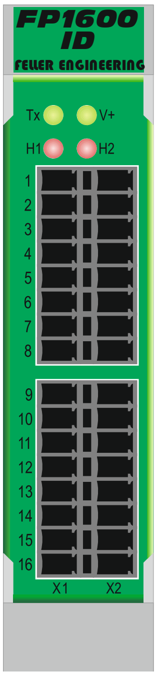
TOP

Service

Address



FRONT



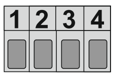
Busy Tx
LED H1
24V inputs
Input 1 X1.1
Input 2 X1.2
Input 3 X1.3
Input 4 X1.4
Input 5 X1.5
Input 6 X1.6
Input 7 X1.7
Input 8 X1.8

Input 9 X1.9
Input 10 X1.10
Input 11 X1.11
Input 12 X1.12
Input 13 X1.13
Input 14 X1.14
Input 15 X1.15
Input 16 X1.16

V+ Power
LED H2
24V inputs
X2.1 Input 1
X2.2 Input 2
X2.3 Input 3
X2.4 Input 4
X2.5 Input 5
X2.6 Input 6
X2.7 Input 7
X2.8 Input 8

X2.9 Input 9
X2.10 Input 10
X2.11 Input 11
X2.12 Input 12
X2.13 Input 13
X2.14 Input 14
X2.15 Input 15
X2.16 Input 16

BOTTOM



X8

Without function X8.1
Without function X8.2

X8.4 GND/0V (reference ground dig. input)
X8.3 Without function

2.13.1 Function of the module

This module records 32 digital control inputs (24V DC) and transmits their status to the central unit via the internal data bus.

2.13.2 LEDs

LED designation		Function
	V+	Lights up permanently in normal operation and indicates the supply voltage.
	Tx	Flashes in a cycle of approx. 500ms . . . . . ✓ module functions and communicates with the control unit.
	H1	Without function
	H2	Without function

2.13.3 Address setting

The module is addressed via the BCD rotary switch on the top of the housing. Permissible addresses are from 1 to F (corresponds to decimal 15). The setting of address 0 is not permitted. The modules must be assigned different address settings.

Depending on the desired function of the inputs, these must be set accordingly via parameters 37 and 28.

2.13.4 Technical data

Current consumption (24VDC)	I b	110	mA
Ambient temperature	T max.	50	°C
Power loss	max.	2,6	W
Number of T-Bus-connectors	1		
Module width **FP1600**-ID		22,5	mm
Module depth without plug		115	mm
Module height		100	mm
Minimum distance on bottom and top		25	mm

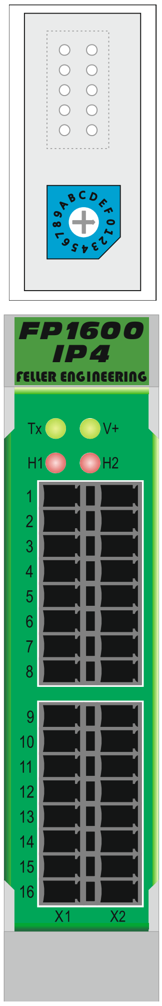
2.14 Input module **FP1600**-IP4: 8x Pt100 / 2- 3- or 4-wire

TOP

Service

Address

FRONT

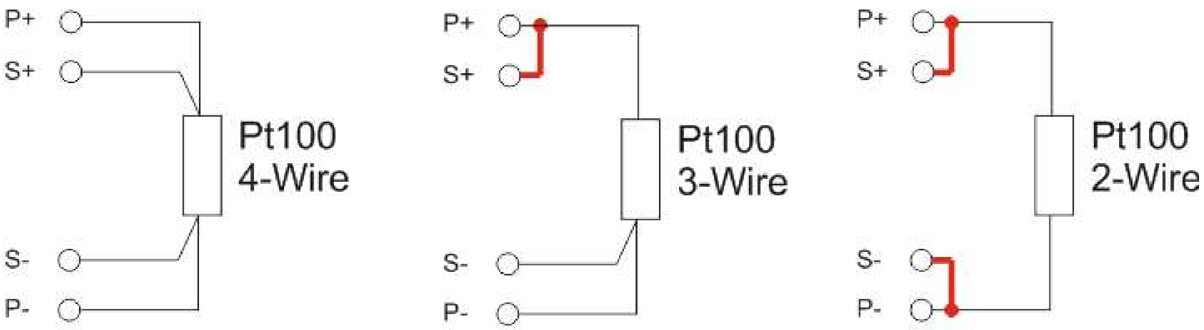


Busy Tx	V+ Power
LED H1	LED H2
Pt100 inputs	**Pt100 inputs**
P+ Sensor 1 X1.1	X2.1 S+ Sensor 1
P- Sensor 1 X1.2	X2.2 S- Sensor 1
P+ Sensor 2 X1.3	X2.3 S+ Sensor 2
P- Sensor 2 X1.4	X2.4 S- Sensor 2
P+ sensor 3 X1.5	X2.5 S+ Sensor 3
P- Sensor 3 X1.6	X2.6 S- Sensor 3
P+ sensor 4 X1.7	X2.7 S+ Sensor 4
P- Sensor 4 X1.8	X2.8 S- Sensor 4
P+ sensor 5 X1.9	X2.9 S+ Sensor 5
P- sensor 5 X1.10	X2.10 S- Sensor 5
P+ sensor 6 X1.11	X2.11 S+ Sensor 6
P- Sensor 6 X1.12	X2.12 S- Sensor 6
P+ sensor 7 X1.13	X2.13 S+ Sensor 7
P- sensor 7 X1.14	X2.14 S- Sensor 7
P+ sensor 8 X1.15	X2.15 S+ Sensor 8
P- Sensor 8 X1.16	X2.16 S- Sensor 8

2.14.1 Function of the module

This module amplifies the signals from connected PT100 sensors and transmits the temperatures determined via the rear CAN bus to the processor in 1/10° resolution.

If 2- or 3-wire sensors are connected, corresponding external bridges must be wired to the module.



2.14.2 LEDs

LED designation		Function
(green)	**V+**	Lights up permanently in normal operation and indicates the supply voltage.
(green)	**Tx**	Flashes in time with the busy LED of the processor card and thus indicates communication with it. As an alternative to regular flashing, a "blink code" can provide information about various errors:
		. . . . . ✓ module functions and communicates with the control unit.
		– – ⚠ No communication with the control unit
		– – – ⚠ Inputs must be calibrated
		– – – – ⚠ ADC hardware error
(red)	**H1**	An illuminated H1 indicates that at least one of the outputs has or had a short circuit. After eliminating the short circuit, the module must be briefly disconnected from the power supply.
(red)	**H2**	Lights up in the event of a serious hardware error

2.14.3 Address setting

The module is addressed via the BCD rotary switch on the top of the housing. Permissible addresses are from 1 to F (corresponds to decimal 15). The setting of address 0 is not permitted. The modules must be assigned different address settings. The assignment of the inputs to the zones is set via the respective zone parameter→ P29.

2.14.4 Technical data

Current consumption (24VDC)	I b	110	mA
Ambient temperature	T max.	50	°C
Power loss	max.	2,6	W
Number of T-Bus-connectors	1		
Module width **FP1600**-IT		22,5	mm
Module depth without plug		115	mm
Module height		100	mm
Minimum distance on bottom and top		25	mm

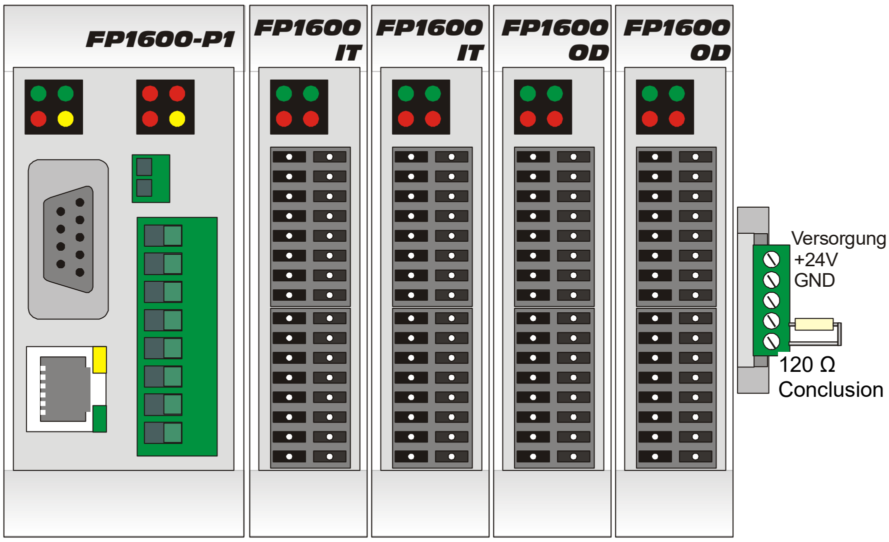
3 Exemplary composition of a 32-way controller

The following example illustrates how a 32-way temperature controller with outputs for heating and cooling can be set up.

3.1 Sequence of the modules on the mounting rail

The order of the modules on the top-hat rail is irrelevant. The numbering shown here is only used for clearer documentation.

Module				
1	2	3	4	5



Module 1: Processor module

The RS485 can be operated at 19200 baud. The standard address of the controller is "1".
The collective alarm contacts should be used on the processor module.

All modules are supplied via the bus terminals, which are clamped into the mounting rail beforehand. The 24VDC supply voltage is applied via a 5-pin connector plug.

Module 2: 16-fold thermocouple input.

Set address 1 using the BCD rotary switch on the top of the housing.
From zones 1..16
→ Parameter 29 {AIN} should be set to values ascending from 101..116.
This allows inputs 1..16 of the module to be used for temperature detection of zones 1..16.

Module 3: 16-fold thermocouple input.

Set address 2 via the BCD rotary switch on the top of the housing.
From zones 17..32
→ Parameter 29 {AIN} should be set to values ascending from 201..216.
This allows inputs 1..16 of the module to be used for temperature detection of zones 17..32.

Module 4: 32-fold 24V digital output

Set address 1 via the BCD rotary switch on the top of the housing and apply 24VDC auxiliary voltage to the bottom. From zones 1..16
→ Parameter 30 {AHO} to values ascending from 101..116,
→ Parameter 31 {ACO} should be set to values ascending from 117..132.
This means that for zones 1..16,
outputs 1..16 of the module
can be used
to control the heating of zones 1..16 and
outputs 17..32 of the module can be used to control the cooling of zones 1..16.

Module 5: 32-fold 24V digital output

Set address 2 via the BCD rotary switch on the top of the housing and apply 24VDC auxiliary voltage on the bottom. From zones 17..32
→ Parameter 30 {AHO} to values ascending from 201..216,
→ Parameter 31 {ACO} should be set to values ascending from 217..232.
This means that for zones 17..32,
outputs 1..16 of the module
can be used
to control the heating of zone 17..32 and
outputs 17..32 of the module can be used to control the cooling of zone 17..32

The number of zones (parameter {KAN}) must be set to 32 on the processor.

4 Parameterization

By default, the device is delivered with parameter settings that correspond to the general control requirements. User specifications such as setpoints, alarm limits, operating modes, etc. must be set individually. A reset to factory settings is carried out via the system parameter **StP.**

4.1 System parameters

These general parameters may be required when operating and commissioning the ***FP1600*** device. They have no reference to individual zones.

4.1.1 Switching off all control outputs {ENA}

Setting limits: 0 or 1
Default value 0

FE3 protocol:
G01**?ENA**=00001

MODBUS data address:
20480

This parameter is used to achieve the general deactivation of all control outputs without operating individual zones. This is useful for parameterizing the controller "at rest" without immediate effects on the heating.

This method is preferable to a hardware-based power cut-off via the main contactor, as the controller "freezes" the zones and does not unnecessarily charge the integral component (risk of overshoot when switching on).

This parameter is also helpful for carrying out self-optimization. For details, see chapter 0 can be found here.

4.1.2 Nominal voltage {VOL}

Setting limits: 0..380V
Default value 0V

FE3 protocol:
G01**?VOL**=00230

MODBUS data address:
20481

The mains voltage recorded by the ***FP1600-UI*** module is constantly compared with the value specified here. If the measured mains voltage deviates, the calculated output power is adjusted to minimize the influence of voltage fluctuations on the temperature control.
The measured heating currents are also adjusted in the event of voltage fluctuations in order to avoid unnecessary alarms.
With the "0" setting, voltage compensation is switched off. is switched off.
The power correction function is not active in comparator and limiter mode.
NOTE! Only adjust parameters if an ***FP1600-UI*** module is also connected. Otherwise, an error message will be generated on the bus.

4.1.3 Heating mode {HUM}

Setting limits: 0..2
Default value 0

FE3 protocol:
G01**?HUM**=00000

MODBUS data address:
20482

Three different heating methods can be selected via this global parameter:

Setting "0" (default)

After the controller is switched on, the set target values of the zones are approached without delay.

Setting "1" (synchronous)

All zones heat evenly to the set temperature. The controller automatically adjusts the heating speed of all zones to that of the slowest zone. This ensures an even temperature rise in the zones and prevents thermal stresses.

Setting "2" (Economy)

The zones heat to the set setpoint value one after the other. The slowest zone is started first, the fastest zone last. The aim is to heat up so that the setpoint value of all zones is reached at the same time. This method avoids unnecessary energy consumption that would otherwise occur if the faster zones were already at operating temperature and waiting for the slower zone to heat up.

4.1.4 Behavior in case of sensor break {APM}

Setting limits: 0..4
Default value 0

FE3 protocol:
G01**?APM**=00000

MODBUS data address:
20483

This global parameter can be used to define the behavior of the zones if a sensor break occurs in control mode:

Setting "0" (default)

With this setting, the power of the zone is switched off in the event of a sensor break. The zone remains in control mode. As soon as the temperature sensor is working again, the previously set setpoint is is regulated.

Setting "1"

The controller switches from control mode to actuator mode and uses the previously calculated average output level of the zone as a constant output power.

Setting "2"

For reasons of compatibility, this setting is identical to the setting "1"

Setting "3"

The controller switches from control mode to actuator mode and uses the parameter number 17 entered as the output setpoint as the constant output power.

Setting "4"

The controller switches from control mode to actuator mode. The output level of the reference zone, which was specified as parameter P26, is also used as the output power for the defective zone.

4.1.5 Standby mode {SBY}

Setting limits: 0..1
Default value 0

FE3 protocol:
G01**?SBY**=00000

MODBUS data address:
20484

This global parameter can be used to set all zones in control mode to standby mode at the same time. These zones then control to the value set as the 2nd setpoint set in→ P11.

4.1.6 Alarm delay {DLY}

Setting limits: 0..60s
Default value 0s (off)

FE3 protocol:
G01**?DLY**=00000

MODBUS data address:
20485

This parameter is used to suppress alarms that occur briefly. Only if a zone alarm (e.g. LO, HI or DEV alarm) is present for longer than the time set here in seconds, it is reported via the alarm contacts and via the data interface.

4.1.7 System time "Day" {DAY}

Setting limits: 1..31
Default value -

FE3 protocol:
G01**?DAY**=00000

MODBUS data address:

The calendar day of the current date can be set and read out here.

4.1.8 System time "Month" {MON}

Setting limits: 1..12
Default value -

FE3 protocol:
G01**?MON**=

MODBUS data address:

The calendar month of the current date can be set and read out here.

4.1.9 System time "Year" {YEA}

Setting limits 2014..2030
Default value -

FE3 protocol:
G01**?YEA**=

MODBUS data address:

The calendar year of the current date can be set and read out here.

4.1.10 System time "Hour" {HOR}

Setting limits: 0..23
Default value -

The hour of the current time can be set and read out here.

FE3 protocol:
G01**?HOR**

MODBUS data address:

4.1.11 System time "Minute" {MIN}

Setting limits: 0..59
Default value -

The minute of the current time can be set and read out here.

FE3 protocol:
G01**?MIN**

MODBUS data address:

4.1.12 System time "Second" {SEC}

Setting limits: 0..59
Default value -

The second of the current time can be set and read out here.

FE3 protocol:
G01**?SEC**

MODBUS data address:
20485

4.1.13 Switch-on delay of the outputs { PDL}

Setting limits: 0..60s
Default value 0s (off)

FE3 protocol:
G01**?PDL**=00000

MODBUS data address:
20486

This parameter is used to prevent the heaters from being activated simultaneously after the **FP1600** is switched on or the outputs are enabled.

The zones then only switch on the outputs one after the other with the delay set here.

This reduces the current surge load on the overall supply line, for example if the heaters used have a low cold resistance.

4.1.14 Load standard parameter {STD}

Setting limits: 0..1
Default value 0 (off)

FE3 protocol:
G01**?STD**=00001

MODBUS data address:**-**

Writing this system parameter once to the value "1" triggers the loading of the set standard parameters.

This corresponds to the factory setting of the controller.

4.1.15 Save commissioning parameter {SSU}

Setting limits: 0..1
Default value 0 (off)

FE3 protocol:
G01**?SSU**=00001

MODBUS data address:**-**

Writing this system parameter once to the value "1" causes the currently set parameters to be saved internally as "Commissioning parameters". This should be done after the first successful set-up of the controller so that this status can be easily restored at any time if problems occur later.

4.1.16 Load commissioning parameter {LSU}

Setting limits: 0..1
Default value 0 (off)

Writing this system parameter once to the value "1" causes the commissioning parameters to be loaded.

FE3 protocol:
G01**?LSU**=00001

MODBUS data address:

4.1.17 Query the software identifier {AZ#}

Setting limits: -
Default value -

In order to identify the correct firmware, its ID can be queried here.

FE3 protocol:
G01**?AZ#**=

The firmware identifier is a number from 00001 ... 99999.

MODBUS data address:**-**

For example, the standard ***FP1600*** reports with the AZ number 01600

4.1.18 Query the number of control zones (channels) {KAN}

Setting limits: 1..120
Default value 8

The number of control zones must be entered here.

FE3 protocol:
G01**?KAN**=

MODBUS data address:
20487

4.1.19 Query the software version {VER}

Setting limits: -
Default value -

The software version of the controller can be queried here for information.

FE3 protocol:
G01**?VER**=

MODBUS data address:**-**

4.1.20 Query the 3 phase voltages {UL1} {UL2} {UL3}

Setting limits: -
Default value -

The phase voltages (in volts) measured by the ***FP1600-UI*** mains module can be queried here.

FE3 protocol:
G01**?UL1**=
G01**?UL2**=
G01**?UL3**=

MODBUS data address:

4.1.21 Query the 3 phase frequencies {FL1} {FL2} {FL3}

Setting limits: -
Default value -

The phase frequencies (in Herz) measured by the **FP1600-UI** mains module can be queried here.

FE3 protocol:
G01**?FL1**=
G01**?FL2**=
G01**?FL3**=

MODBUS data address:

4.1.22 Query system errors {ERR}

Setting limits: -
Default value -

FE3 protocol:
G01**?ERR**=

MODBUS data address:
20489

System faults are faults that do not relate to an individual zone. Each fault is reported back with a unique error code. If there is no fault, the **FP1600** responds to the ERR query with "0". There can also be several faults at the same time. These are read out one after the other by repeatedly querying ERR.

Most errors must be acknowledged with the→ QIT command. This prevents errors that have occurred briefly from being overlooked. If the error code is still present after acknowledgement, the cause of the error has not yet been eliminated.

Table of defined system error codes

Code			Acknowledge
00000		There is no error	
00001		***FP1600*** has restarted (Power On).	Yes
		This is not actually an error but merely a message which may indicate an unintentional restart.	
010xx		Input module with address *xx* (xx=1..15) does not report on the system bus.	Yes
		Check whether the module is set with the correct address and is properly snapped onto the top-hat rail.	
011xx		Input module with address *xx* (xx=1..15) is not calibrated.	Yes
		Sending the module to the factory for calibration	
020xx		Output module with address *xx* (xx=1..15) does not report on the system bus.	Yes
		Check whether the module is set with the correct address and is properly snapped onto the top-hat rail.	
021xx		Output module with address *xx* (xx=1..15) reports a short circuit at one of the outputs.	no
		Check whether there is a permanent short circuit on one of the module's outputs. An excessively high connection capacitance can also lead to this error. To reset the error message, briefly de-energize the affected module	
03001		Mains monitoring module does not report on the system bus.	Yes
		Check whether the module is set with the correct address and is properly snapped onto the top-hat rail.	
03011		No mains voltage on phase 1	
03012		No mains voltage on phase 2	
03013		No mains voltage on phase 3	
050xx		Heating current monitoring module IHC with address xx does not report on the system bus.	Yes
		Check whether the module is set with the correct address and is properly snapped onto the top-hat rail.	
051xx		Heating current monitoring module IHC with address xx has uncalibrated zones.	

4.1.23 Acknowledging system errors {QIT}

Setting limits: -
Default value -

FE3 protocol:
G01**?QIT**=00001

MODBUS data address:
20490 (writing only)

This command deletes any pending system errors. If they still occur immediately after acknowledgement, the actual cause of the error has not been rectified.

See also {ERR}

From firmware version 2016/10/17: In addition to acknowledgement via the bus, this is also possible by connecting the control input with 24V. See chapter 2.3.3

4.1.24 Query the firmware version {DAT}

Setting limits: -
Default value -

FE3 protocol:
G01**?DAT**=

MODBUS data address:

4.1.25 Reference value {REF}

Setting limits: 10..999
Default value 500

FE3 protocol:
G01**?REF**=00500

MODBUS data address:

This parameter is the reference value for the XPH and XPC zone parameters.

See also {XPH} and {XPK}

4.1.26 Suppress Dev-Alarm {SDV}

Setting limits: 0..1
Default value 0

FE3 protocol:
G01**?SDV**=00001

Modbus data address:

Setting this parameter to the value 1 suppresses all deviation alarms after a setpoint change or a device restart. The alarm is only reactivated when the actual value is within +/-2° of the setpoint for the first time. This allows the alarms to be suppressed during the heating process.

See also {DEV}

4.1.27 Make deviation alarm dependent on internal setpoint {DVI}

Setting limits: 0..1
Default value 0

FE3 protocol:
G01**?DVI**=00001

Modbus data address:

Value = 0: All deviation alarms are related to the setpoint.
Value = 1: All deviation alarms are related to the internal setpoint. This is useful if an alarm is not necessarily required during heating up or cooling down via ramp.

See also {DEV}, ramp up {RP+}, ramp down {RP-}

4.1.28 Alarm contacts (relays) must be acknowledged {RQI}

Setting limits: 0..1
Default value 0

FE3 protocol:
G01**?RQI**=00001

Modbus data address:

This parameter is available from firmware version 2016/10/17.

It defines the switching behavior of the devices described in chapter 2.3.2 described in chapter 2.3.2.

Value = 0: As soon as one of the zones reports an alarm, the corresponding relay (LO or HI or DEV) switches to the fault state and the contact opens. If all zones are in the good state, the relay switches back automatically and the contact is closed.

Value = 1: As soon as one of the zones reports an alarm, the corresponding relay (LO or HI or DEV) switches to the error state and the contact opens. This error status must be acknowledged. This is done either via the bus command {QIT}→ Chapter 4.1.23 or the function input of the processor module→ Chapter 2.3.3.
The contact then immediately switches to the good state (contact closes), even if the cause of the fault is still present. As soon as a new fault occurs, the contact opens again and must be confirmed again.

4.1.29 Switch-off delay of the limiter {BDL}

Setting limits: 0..60
Default value 0

FE3 protocol:
G01**?BDL**=

Modbus data address:

This parameter is available from firmware version 2017/01/18.

The parameter is used to delay the switch-off of a zone if it is working as a limiter.

The delay time can be set in seconds.

See also chapter 4.2.3

4.1.30 Function of the control input {FSE}

Setting limits: 0..4
Default value 0

FE3 protocol:
G01**?FSE**=

Modbus data address:
20488

This parameter is available from firmware version 2018/07/09.

The parameter determines which function the 24V control input available on the processor module (see chapter 2.3.3) has.

Value = 0 (standard)
Connecting the function input with 24V causes pending faults to be acknowledged (see also chapter 4.1.23)

Value = 1
Connecting the function input with 24V causes the outputs to be switched off permanently by setting parameter {ENA} (chapter 4.1.1) is set to 0.

It is not possible to switch the heaters back on with the control input; parameter {ENA} must be set to 1 via the data interface.

Value = 2
The function input must be wired with 24V in order to activate the outputs via the parameter {ENA} (chapter 4.1.1) to be able to switch on the outputs.
A short 0V level at the control input switches the outputs off permanently.
To switch the heaters back on, the control input must be reconnected with 24V and parameter {ENA} must be set to 1 via the data interface.

Value = 3
This value can be set from firmware version 2019/09/06.

The input is used to enable the outputs.

0V = outputs are switched off
24V = outputs are enabled.

This function can be used, for example, to query the status of a main contactor. If the main contactor is switched off (0V), the heaters and thus also the plausibility monitoring are switched off (chapter 4.2.22).
The respective status of the hardware enable can be queried via {FRE}. See also chapter 4.1.31.

Value = 4
This value can be set from firmware version 2020/04/16.
The input is used to activate standby mode for all zones.

0V	All zones operating in control mode regulate to their setpoint value
24V	All zones operating in normal mode regulate to their set-back value

With the setting value "4", parameter {SBY} (see chapter 4.1.5) becomes read-only. The function of the control input has priority and can only be read back via {SBY}.

4.1.31 Request for release {FRE}

Setting limits: -
Default value -

FE3 protocol:
G01**?FRE**=

Modbus data address:

This value is available from firmware version 2019/09/06.

It describes the hardware enable status of the control outputs. The hardware enable can optionally be switched on or off via the digital control input.

See also chapter 4.1.30

4.2 Zone parameters

Each individual zone has a parameter set of 32 parameters.

4.2.1 P00: Setpoint {SET}

Setting limits: 0...{WMX}
Default value: 0°C

Modbus data address:
0000h + zone number

Setpoints are entered in 1/10 of a degree.

Example : 123 = 12.3°

4.2.2 P01: Lo-Alarm {LO_}

Setting limits: 0...9999°C
Default value: 0°C

Modbus data address:
0100h + zone number

If the value falls below the value set as parameter 1, the respective zone reports LO **alarm**. The low temperature LED on the processor module is also activated and the collective alarm contact is activated (the contact is normally closed).

4.2.3 P02: Hi-Alarm {HI_}

Setting limits: 0...9999°C
Default value: 400°C

Modbus data address:
0200h + zone number

If the value set as parameter 2 is exceeded, the respective zone reports HI **alarm**. The overtemperature LED on the processor module is also activated and the collective alarm contact is activated (the contact is normally closed).
Note: Monitoring also takes place with setpoint "0". Deactivation is only possible with the "OFF" operating mode for this zone.
Special case: When HI=0 is set, the zone operates as a **limiter**. The power is fully switched on until the setpoint value (=limiter value) is reached. If the **setpoint** is exceeded, a HI alarm is generated is generated and the zone switches off permanently (operating mode = OFF). Once the value falls below the setpoint, the zone can be restarted manually. This method can protect another control zone from overheating by connecting the output actuators in series. Further safety is achieved if the controller and limiter are set up as separate hardware components (each with its own processor). The zone can optionally be switched off with a delay. A global parameter is provided for this purpose→ See chapter 4.1.29

4.2.4 P03: Deviation alarm {DEV}

Setting limits: 1...9999K
Default value: 15K

Modbus data address:
0300h + zone number

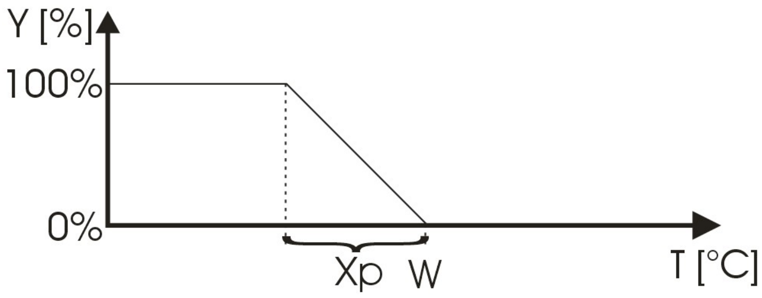
As soon as the actual value of a zone deviates from the set value by more than the value set here set here, the corresponding zone reports a deviation alarm. The DEV alarm-LED is activated and the corresponding collective alarm contact is activated (the contact is normally closed). The system parameter {DEV} can be used to suppress these alarms during the heating process.

4.2.5 P04: Proportional band of the heating {XPH}

Setting limits: 0...999%
Default value: 5%

Modbus data address:
0400h + zone number

The P component changes the output power of the controller in proportion to the deviation between setpoint and actual value. The proportional band (xp) is the range of the process variable in which this linear relationship occurs before the output power reaches its minimum or maximum.



With the ***FP1600,*** 100% is defined by the system parameter {REF}. (With a default value of 500°C, 1% therefore corresponds to 5K).
If the proportional band is too large, the adjustment will be very slow. If the proportional band is too small, the reaction to small deviations is very strong, so that the controller tends to oscillate.
If only P controllers are used (without I and D components), the control deviation cannot be fully eliminated.
Special case: If xP=0 is set, the controller is in **comparator mode**. The power is switched on and off with hysteresis. The hysteresis can be set via parameter 34.
Note: The voltage-dependent output level correction is deactivated in comparator mode.

4.2.6 P05: Integral part of the heating {TNH}

Setting limits: 0...9999s
Default value: 80s

Modbus data address:
0500h + zone number

The integral component of the controller prevents a permanent control deviation. This is achieved by constantly changing the output power until the control deviation is regulated to zero. The speed at which this change takes place depends on the time set here. A small value means a rapid change in power with a control deviation. A long time has the opposite effect.
With the "0" setting, the effect of the I component is switched off completely.

4.2.7 P06: Differential component of the heating {TVH}

Setting limits: 0...9999s
Default value: 20s

Modbus data address:
0600h + zone number

The differential component reacts to the rate of change of the control deviation. The control component 'brakes' the output level for a time that can be set here if the actual value approaches the setpoint value at too high a speed. at too high a speed.
With the "0" setting, the effect of the D component is switched off completely.

4.2.8 P07: Proportional band of the cooling {XPK}

Setting limits: 0...999%
Default value: 5%

Modbus data address:
0700h + zone number

See→ P04
However, the parameter is effective for previously negatively calculated outputs, i.e. when cooling of the zone has been requested.
With the ***FP1600,*** 100% is defined by the system parameter {REF}. (With a default value of 500°C, 1% therefore corresponds to 5K).

4.2.9 P08: Integral part of the cooling {TNK}

Setting limits: 0...9999s
Default value: 80s

Modbus data address:
0800h + zone number

See→ P05
However, the parameter is effective for previously negatively calculated outputs, i.e. when cooling of the zone has been requested.

4.2.10 P09: Differential component of cooling {TVK}

Setting limits: 0...9999s
Default value: 20s

Modbus data address:
0900h + zone number

See→ P06
However, the parameter is effective for previously negatively calculated outputs, i.e. when cooling of the zone has been requested.

4.2.11 P10: Operating mode of the zone {MOD}

Setting limits: 0...3
Default value: 0

Modbus data address:
0A00h + zone number

The 3 available operating modes can be changed via this parameter.
0 = OFF (OFF)
1 = Manual mode (constant output power) (→ P17)
2
= Control mode (P04..P09) 3 = Standby mode (P11)→)
(→ P11)
4 = Tuning

4.2.12 P11: Standby-setpoint {SBY}

Setting limits: 0...999
Default value: 0

Modbus data address:
0B00h + zone number

This parameter can be used to specify a set-back temperature in normal control mode. This value is used as the setpoint in setback mode (→ P10). is used.
The value is shown in 1/10°, just like the setpoint.
Example 200 = 20.0°

4.2.13 P12: Maximum adjustable setpoint {WMX}

Setting limits: 0...999
Default value: 400

Modbus data address:
0C00h + zone number

This value makes it possible to limit the maximum adjustable setpoint in zones.

4.2.14 P13: Ramp up {RP+}

Setting limits: 0...500 s/K
Default value: 0 s/K

Modbus data address:
0D00h + zone number

If gentle heating of the medium is required, a heating ramp can be set via P13. This is effective if:
- the device has just been switched on
- the setpoint was raised

The ramp causes the *INTERNAL setpoint* value to change slowly in the direction of the setpoint value. As soon as the *INTERNAL* setpoint has reached the set setpoint, the ramp has no effect until the next setpoint change.
Control is always based on the *INTERNAL* setpoint value !!
The ramp speed in the heating ramp is set here in the unit sec/K, i.e. large values result in a slow ramp.

4.2.15 P14: Ramp down {RP-}

Setting limits: 0...500
Default value: 0 s/K

Modbus data address:
0E00h + zone number

In contrast to P13 (upward ramp), a downward ramp can be programmed here, i.e. this ramp only becomes effective when the setpoint is lowered.

4.2.16 P15: Minimum output power {YMI}

Setting limits: -100...0%
Default value: 0%

Modbus data address:
0F00h + zone number

To activate the cooling function of a zone, the minimum output power must be adjusted with this parameter (-100% corresponds to maximum cooling power)

4.2.17 P16: Maximum output power {YMX}

Setting limits: 0...100%
Default value: 100 %

Modbus data address:
1000h + zone number

This parameter limits the maximum output power of the heaters.

4.2.18 P17: Output power setpoint {YST}

Setting limits: -100...100
Default value: 0

Modbus data address:
1100h + zone number

a) In actuator mode (parameter P10 = 1), the value entered here is used directly as the constant output power.

b) In control mode (parameter P10 = 2 or 3), the target output level can be can be specified in preparation for a later switchover to control mode (intermittent switchover). In control mode, changing this parameter has no effect on the control.

4.2.19 P18: Average output power {YAV}

Setting limits: -
Default value: 0

Modbus data address:
1200h + zone number

This parameter is used to read the average output power of a controlled zone. This is only calculated as long as the zone is in the OK state (without temperature deviation). It is not possible to change this value manually (read only). In the event of a sensor break, the zone can be set to controller mode and the value read here can be output as constant power.

4.2.20 P19: Cycle time for heaters {CYH}

Setting limits: 1...20s
Default value: 1s

Modbus data address:
1300h + zone number

In order to reduce the very fast switching outputs to a speed that is compatible with contactors, for example, this parameter for the switching speed of the heating outputs must be changed upwards. Increasing this parameter causes the outputs to slow down. The cycle time is always the sum of the switch-on time + switch-off time. The shortest switching pulse results from the cycle time : 100 !

4.2.21 P20: Cycle time for cooling {CYC}

Setting limits: 1...20s
Default value: 1s

Modbus data address:
1400h + zone number

In order to reduce the very fast switching outputs to a speed that is compatible with contactors, for example, this parameter for the switching speed of the cooling outputs must be changed upwards. Increasing this parameter causes the outputs to slow down. The cycle time is always the sum of the switch-on time + switch-off time. The shortest switching pulse results from the cycle time : 100 !

4.2.22 P21: Diagnostic time, heating and sensor monitoring {DIA}

Setting limits: 0...9999 s
Default value: 0 (off)

Modbus data address:
1500h + zone number

If the zone is operating at more than 97% heat output in control mode, it must experience a temperature increase of 5°K within the time set as P21.
If this is not the case, the zone is switched off permanently for safety reasons. This could be due to

- Short-circuited thermocouple
- Temperature sensor not connected to the heater
- Defective fuse or
- Defective heating

The zone can only be switched back on manually by setting the setpoint of the faulty zone again.

A setting of "0" means that the plausibility check for this zone is switched off.

4.2.23 P22: Heating current Setpoint value {I_W}

Setting limits: 0...999.9
Default value: 0

Modbus data address:
1600h + zone number

The rated current of the zone can be set here in 1/10 ampere.

4.2.24 P23: Heating current Tolerance {ITO}

Setting limits: 0...100
Default value: 100 %

Modbus data address:
1700h + zone number

Here you can set the maximum permissible deviation from the nominal current of the zone can be set here in %. The setting value "100" switches off all current monitoring, including the SSR monitoring described below.

SSR monitoring:
The heating current is also monitored when the zones are switched off. As soon as a heating current >1.0 A flows although the output is switched off, a heating current alarm is also generated (SSR error).

From firmware version 2016/4/4 (chapter →4.1.24) applies in the event of an SSR error:

- In addition to bit12, bit14 is also set in the zone status. → Chapter 9.8
- The HI alarm contact of the controller is activated.
- Bit14 does not reset itself, but must be acknowledged. → Chapter 4.1.23
- In the event of an error, "ISSR" is displayed in the status of the relevant zone on the web interface.

4.2.25 P24: Offset {OFS}

Einstellgrenzen: -999..9999
Default value: 0

Modbus data address:
1800h + zone number

By setting an offset, the measured value can be corrected by a fixed amount. This may be necessary, for example, for precise line balancing of 2-wire PT100 Pt100s. The value must be set in 1/10°K (30 = 3.0°K)

4.2.26 P25: max. value {GAI}

Einstellgrenzen: -999..9999
Default value: 1000

Modbus data address:
1900h + zone number

If the measured value of a zone is recorded as a 0..10V or 0..20mA signal, the display value can be scaled with this. (the value to be displayed at the maximum measurement signal).

4.2.27 P26: Guide zone {FZO}

Setting limits: 0..128
Default value: 0

Modbus data address:
1A00h + zone number

In the event of a sensor break, the calculated output level can be of the zone number entered here. A global parameter→ {APM} previously set to "4" is required.

4.2.28 P27: Service group {LGR}

Setting limits: 0..8
Default value: 0

Modbus data address:
1B00h + zone number

To avoid all zones being switched on at the same time, they can be divided into power groups 1..8. The controller enables the zones assigned to the same group to be switched on one after the other. This takes place every 5 seconds.

This method can be used to reduce the maximum connected load of the machine when heating up.

Zones in group "0" (default setting) may heat at any time.

4.2.29 P28: Heating speed {AHZ}

Setting limits: 0..999.9
Default value: 0 [s/°C]

Modbus data address:
1C00h + zone number

The controller measures the duration of heating up to operating temperature and enters the determined value in the unit [s/°C] as parameter P28. The prerequisite for automatic determination is the previous setting to the value "0". The heat-up speed is required if the controller is operated in economy heat-up mode.

4.2.30 P29: Address of the input signal {AIN}

Setting limits: 0..9999
Default value: 0

Modbus data address:
1D00h + zone number

Here you can set from which input module and from which terminal the actual value signal is used for the respective zone. The parameter value is calculated from the (module address * 100) + input terminal number.

4.2.31 P30: Address of the output signal for the heating power {AHO}

Setting limits: 0..9999
Default value: 0

Modbus data address:
1E00h + zone number

The output module on which the heating power for the respective zone is output is set here. The parameter value is calculated from the (module address * 100) + output number.

4.2.32 P31: Address of the output signal for the cooling capacity {ACO}

Setting limits: 0..9999
Default value: 0

Modbus data address:
1F00h + zone number

The output module and the output on which the cooling capacity for the respective zone is output is set here. The parameter value is calculated from the (module address * 100) + output number.

4.2.33 P32: Address of the input signal for heating current monitoring {AHC}

Setting limits: 0..9999
Default value: 0

Here you can set from which IHC input module and from which terminal the heating current signal is used for the respective zone. The parameter value is calculated from

Modbus data address:
2000h + zone number

the (module address * 100) + input terminal number.
Special case:
If the parameter value is set to 1, the zone receives its current value from the current transformer connected to the ***FP1600-UI.***

Group current monitoring:
As an alternative to individual current monitoring (one current transformer per zone), any number of zones can be combined into a "current group" and then monitored with a common current transformer. The transformer must then be connected to the common supply line of these zones. All zones of such a current group must therefore have an identically set parameter 32: the input to which the summation current transformer is connected.
The heating currents of a heating current group are determined separately for each zone using a special control sequence. To do this, all zones in the group are switched off for approx. 200ms with the exception of one zone, whose heating current is then correctly assigned.

Three-phase current monitoring:
If the heating of a zone or zone group is divided into several phases, the phases must be recorded with separate converters - and combined into a sum signal by connecting their output signals in series. This sum signal is then fed to the IHC or UI module. Separate measurement of the individual phase currents is not provided.

4.2.34 P33: Number of cooling power levels {STC}

Setting limits: 1..100
Default value: 100

Modbus data address:
2100h + zone number

To avoid very short pulses on the cooling output in order to protect any connected fans, this parameter can be used to set the number of output power levels.
Example:
If the value "4" is set, the controller outputs the cooling capacity in 4 stages, namely 25%, 50%, 75% and 100%. If the control algorithm calculates cooling capacities < 25%, no cooling is activated, with calculated cooling capacities between 25% and 50%, 25% is output, etc.
As this reduction is gentle on any connected fans, but possibly disadvantageous for the control (coarser staging), the controller is supplied with the setting "100" as standard.

4.2.35 P34: Hysteresis for comparator operation {HYS}

Setting limits: 1..100
Default value: 4

Modbus data address:
2200h + zone number

If this zone operates in comparator mode via parameter P04 {XPH} = 0 it can be set here at which deviation from the setpoint the heating should switch on or off.
With the default value HYS = 4, the heating switches off when the setpoint is exceeded by 2° (HYS/2) and switches on again when the setpoint is undershot by 2° (HYS/2).

4.2.36 P35: Winding factor {WIF}

Setting limits: 1..10
Default value: 1

Modbus data address:
2300h + zone number

Very low heating currents can be detected more accurately if the supply cable to the heater is wound several times through the associated current transformer.
This results in a multiple of the measurement signal at the input of the current detection module corresponding to the number of feedthroughs. To compensate for this signal increase for the display, the current value recorded at the input is divided by the value entered here.

4.2.37 P36: Switch-on sequence {ESR}

Setting limits: 1..120
Default value: Number of the installed zone

Modbus data address:
2400h + zone number

In conjunction with the system parameter {PDL} (switch-on delay of the outputs), the switch-on sequence of the individual zones can be defined here.
This delay takes effect when the ***FP1600 is*** switched on via the power supply and when the outputs are enabled via {ENA}. By default, the outputs of the zones are activated one after the other with the set delay {PDL}. However, if this results in an unbalanced load of the supply phases, the sequence can be adapted according to the existing wiring.

4.2.38 P37: Address of a digital input {ADI}

Setting limits: 0..9999
Default value: 0

Modbus data address:
2500h + zone number

This parameter is only available from firmware version 2016/7/29.

If a digital input is required for the function of a control zone, its assignment can be determined here. Digital inputs are recorded by the FP1600-ID module. The parameter value describes from which FP1600-ID input module and from which terminal the input signal is to be used. The parameter value to be set is calculated from the (module address * 100) + input terminal number. (Example "203" = module address 2, input 3). The desired function of the input is described via the following parameter {FDI}.

4.2.39 P38: Function of the digital input {FDI}

Setting limits: 0..3
Default value: 0

Modbus data address:
2600h + zone number

This parameter is only available from firmware version 2016/7/29.

If a digital input has been assigned to the zone via parameter 37 {ADI}, its function can be defined here.

Setting value {FDI}	Function of the assigned digital input
0	No function
1	If input=0, zone is switched to "OFF" operating mode
2	If input=1, zone is switched to "OFF" operating mode
3	If input=1, a current fault is displayed for the zone. If the zone is not switched OFF, the summary HI alarm contact on the processor module is also switched.

4.2.40 P39: Address of a function output {AFA}

Setting limits: 0..9999
Default value: 0

This parameter is available from firmware version 2016/10/17.

Modbus data address:
2700h + zone number

If a digital function output is required for the function of a control zone, its assignment can be determined here. Digital 24V outputs are output (just like heating or cooling outputs) on the FP1600-OD module or on *FP1600-Cx* combination modules. The parameter value {AFA} describes to which output module and there to which terminal the function is to be output. The parameter value to be set is calculated from the (module address * 100) + output terminal number. (Example "203" = module address 2, output 3). The output must not be used to control heating or cooling at the same time. See parameters P30 {AHO} and P31 {ACO}. The desired function of the output is described via the following parameter {FFA}.

4.2.41 P40: Function of the digital output {FFA}

Setting limits: 0..1
Default value: 0

This parameter is only available from firmware version 2016/10/17.

Modbus data address:
2800h + zone number

If a function output has been assigned to the zone via parameter 39 {AFA}, its desired function can be defined here.

Setting value { FFA }	Function of the assigned digital input
-1	**-1** is automatically entered by the FP1600 if the value set in P39 refers to an output that is already assigned to another heating or cooling function.
0	No function, output is switched off.
1	As soon as the zone reports an error such as a sensor fault, deviation alarm, limit value exceeded, etc., the output defined in P39 is switched off. The output can be switched on again with an acknowledgement*) , even if the triggering error is still present. *) (See chapter 4.1.23)

4.2.42 P41: Make analog input wire-breakage-proof (4..20mA, 2..10V) {IFS}

Setting limits: 0..1
Default value: 0

Modbus data address:
2900h + zone number

This parameter is only available from firmware version 2017/09/21.

If the measured value of the zone is addressed to a module with a scalable analog input (0..10V or 0..20mA) (see chapter 4.2.26, 4.2.30), this parameter can be used to determine whether the input should be wire breakage-proof.

Setting value { IFS }	Function of the assigned digital input
0	Input range 0..10V or 0..20mA
1	Input range 2..10V or 4..20mA

If wire break safety is activated, a sensor break fault of the zone is triggered for signals < 1V or < 2mA.

4.3 Self-optimization of control zones (tuning, autotuning)

The controller can determine its control parameters XP (P04), TN (P05) and TV (P06) independently. This is done via a one-off procedure to be carried out by the user. The controller calculates the aforementioned parameters based on the heating speed and the detected temperature delay of the connected heater.

In order to avoid misinterpretation as far as possible, a specific procedure must be followed for the optimization process:

1. First, the control outputs must be switched off globally. See chapter 4.1.1
2. The initial situation is expected to be a heating system that has cooled down to room temperature as far as possible. The temperature curve should be constant, i.e. the zones should neither be cooling down nor heating up.
3. The zones to be optimized should be in control mode. To do this, set parameter {MOD} to 2 if necessary. See chapter 4.2.11
4. For the zones to be optimized, the temperature setpoint that is to be reached later during operation must be specified. See chapter 4.2.1
5. The zones to be optimized must now be set to 4 in the {MOD} parameter. See chapter 4.2.11
6. The actual optimization of all zones prepared in this way begins with the activation of the heaters. To do this, the control outputs must be switched on globally. See chapter 4.1.1

The controller now controls the heaters with the maximum output. Bit8 of the zone status is set while the optimization process is running. See chapter 5.3.5 and 9.8

The control parameters are determined on the basis of the resulting delay in the temperature rise and the detected gradient.

As soon as the control parameters of a zone have been successfully determined, bit8 is reset and the determined parameter values are automatically entered.

If 80% of the set target value is exceeded without the controller being able to determine a constant gradient, optimization is aborted for safety reasons. This is to prevent overheating. In this case, bit8 is reset in the status, but bit7 is also set. The previously set control parameters are retained.

5 FE3 protocol

Communication between a PC (master) and a device (slave) with
FE3 bus is based on the master-slave principle in the form of data request / response. The master controls the data exchange, the slaves have a pure response function. They are identified by their device address.

The ***FP1600*** can be fully operated and queried via the FE3 protocol.

The protocol is a pure ASCII protocol. The telegrams begin with a fixed start character "G" and end with an {etx} character. Faulty protocols can be detected via a checksum. Data values to be transmitted are sent in 5-digit blocks.

5.1 Protocol framework:

Request from the Master:

G	0	1	xxxxx	cs	cs	{etx}
0x47	0x30	0x31				0x03
Initial sign	Device address (for example 1)		Data	Checksum HI-Nibble	Checksum LO-Nibble	End indicator

Response from the slave:

G	0	1	=	xxxxx	cs	cs	{etx}
0x47	0x30	0x31					0x03
Initial character	Device address (for example 1)			Data	Checksum HI-Nibble	Checksum LO-Nibble	End indicator

5.2 Checksum calculation:

The checksum is formed from the addition of all ASCII characters to be transmitted, starting with the "G", with the exception of the checksum itself and the etx *character*. After addition, the checksum is rounded with 0xFF and thus shortened to a single byte. The checksum is then converted to hexadecimal and the two resulting characters are transferred in ASCII.

Example for calculating the checksum:

G	1	0	K	0	5	P	0	0	=	0	0	0	5	0	3	A	{etx}
0x47	0x31	0x030	0x4B	0x30	0x35	0x50	0x30	0x30	0x3D	0x30	0x30	0x30	0x35	0x30	0x33	0x41	0x03

a) 0x47+0x31+0x030+0x4B+0x30+0x35+0x50+0x30+0x30+0x3D+0x30+0x30+0x30+0x35+0x30 = 0x33A
b) 0x33A & 0xFF = 0x3A (→ only the LO byte of the checksum is to be considered)
c) Checksum to be transmitted = "3" and "A"

5.3 Zone-related values

Individual values are addressed via a two-digit zone number and the two-digit parameter number (see parameter description). The zone number is preceded by a "**K**" and the parameter number by a "**P**".

G 0 1 K 0 5 P 0 1 = ... therefore causes the LO alarm to respond (parameter 1) of zone 5 for device with address 1.

5.3.1 Set individual zone-related values

To set a value, it is transferred as a 5-digit ASCII number with leading zeros. The value must be preceded by an "**=**". If the value described above is to be set to 20, it must be transmitted:

`G01K05P01=0002038{etx}` *(The checksum in this case is 38)*

The controller then responds with

`G01{ack}` if the value has been accepted and set

or

`G01{nak}` if the value was rejected by the controller.

☝ For negative values, a "-" must be placed first. So -47 is transmitted as **"-0047"**. Not "0-47" and not "-47" !!!

5.3.2 Query individual zone-related values

To query a value on the controller, the checksum and the *{etx}* are sent directly after the "**=**".

`G01K05P01=46{etx}` *(The checksum in this case is 46)*

The controller then responds with

`G01=00020D7{etx}` to report that the LO alarm (parameter 1) of zone 5 is set to 20

or

`G01{nak}` if the request is invalid.

5.3.3 Query a parameter value from all zones

If "**AL**" is sent instead of the two-digit zone number, the controller responds with the desired values for all zones in a single telegram.

`G01KALP01=6E{etx}` *(The checksum in this case is 6E)*

The controller then responds with

`G01=00020000200002000020000200002000020000200002000020000200002059{etx}`

The values of the zones are to be interpreted as 5-digit ASCII numbers. The length of the telegram depends on the number of zones existing in the controller.

☝ It is not possible to set values for several zones in one telegram.

5.3.4 Query process values (actual values, alarms...) from zones

Changing process values can only be queried on the controller, not set. The following is transferred instead of the parameter number:

PII for querying actual values

PYY to query the currently output power

PSS for querying the zone status

`PIX` for querying the heating current value of the zone

G01KALPII= therefore requests all actual values of the controller.

5.3.5 The zone status

The zone status contains information about various warnings, alarms and states of a zone. Like all other values, the status is queried by the controller as a decimal number and must then be interpreted bit by bit.

<table>
<tr><td>Bit 0</td><td colspan="8">0 = There is a zone alarm, 1 = Zone OK</td></tr>
<tr><td>Bit 1</td><td colspan="8">1 = LO alarm</td></tr>
<tr><td>Bit 2</td><td colspan="8">1 = HI alarm</td></tr>
<tr><td>Bit 3</td><td colspan="8">1 = Sensor break alarm</td></tr>
<tr><td>Bit 4</td><td colspan="8">1 = Sensor short-circuit alarm</td></tr>
<tr><td>Bit 5</td><td>0</td><td rowspan="2">Operating mode OFF</td><td>1</td><td rowspan="2">MAN operating mode</td><td>0</td><td rowspan="2">AUTO operating mode (PID)</td><td>1</td><td rowspan="2">STANDBY operating mode</td></tr>
<tr><td>Bit 6</td><td>0</td><td>0</td><td>1</td><td>1</td></tr>
<tr><td>Bit 7</td><td colspan="8">1 = Error during tuning (self-optimization)</td></tr>
<tr><td>Bit 8</td><td colspan="8">1 = Tuning active</td></tr>
<tr><td>Bit 9</td><td colspan="8">1 = Negative temperature deviation from the setpoint (-DEV)</td></tr>
<tr><td>Bit 10</td><td colspan="8">1 = Positive temperature deviation from the setpoint (+DEV)</td></tr>
<tr><td>Bit 11</td><td colspan="8">1 = Alarm due to a setpoint change</td></tr>
<tr><td>Bit 12</td><td colspan="8">1 = Heating current alarm</td></tr>
<tr><td>Bit 13</td><td colspan="8">1 = HIHI alarm exceeded</td></tr>
<tr><td>Bit 14</td><td colspan="8">1 = SSR alarm (a current flows without activation) [from 4.4.2016]</td></tr>
<tr><td>Bit 15</td><td colspan="8">-</td></tr>
</table>

Examples:

Queried status of the zone = 00065 (dec) = 0000 0000 0100 0001 (bin)

Bit 0 set→ Zone OK,

Bit 5=0 and bit 6=1→ AUTO operating mode

Queried status of the zone = 0068 (dec) = 0000 0000 0100 0100 (bin)

Bit 0=0→ Zone has an ALARM,

Bit 2=1→ HI alarm

Bit 5=0 and bit 6=1→ AUTO operating mode

5.4 System parameters

In addition to the parameters that affect individual zones, there are also "global" settings whose values affect the entire device.

The following protocol frame is used to query and set these device-related parameters:

5.4.1 Query system parameters

Request from the Master:

G	0	1	?	*x*	*x*	*x*	=	cs	cs	*{etx}*
0x47	0x30	0x31	0x3F				0x3D			0x03
Initial charac-ter	Bus address (for example 1)			Abbreviation of the Global Parameter-name				Checksum HI-Nibble	Checksum LO-Nibble	End indica-tor

"x x x" must be replaced by the 3-character abbreviation of the global parameter.
This abbreviation is given in the description of the parameter in the respective chapter.

Response from the slave:

G	0	1	=	*w*	*w*	*w*	*w*	*w*	cs	cs	*{etx}*
0x47	0x30	0x31	0x3D								0x03
Initial cha-racter	Bus address (for example 1)			Parameter value					Checksum HI-Nibble	Checksum LO-Nibble	End indica-tor

5.4.2 Setting system parameters

Request from the Master:

G	0	1	?	*x*	*x*	*x*	=	*w*	*w*	*w*	*w*	*w*	cs	cs	*{etx}*
0x47	0x30	0x31	0x3F				0x3D								0x03
Initial character	Bus address (for exa-mple 1)			Abbreviation of the global pa-rameter name				Para-meter value					Checksum HI-Nibble	Checksum LO-Nibble	End in-dicator

"x x x" must be replaced by the 3-character abbreviation of the global parameter. This abbreviation is given in the description of the parameter in the respective chapter in the manual.

The controller then responds with

`G01{ack}` if the value has been accepted and set
or

`G01{nak}` if the value was rejected by the controller.

Example: Switching on all control outputs of device with address 5: `G05?ENA=00001`

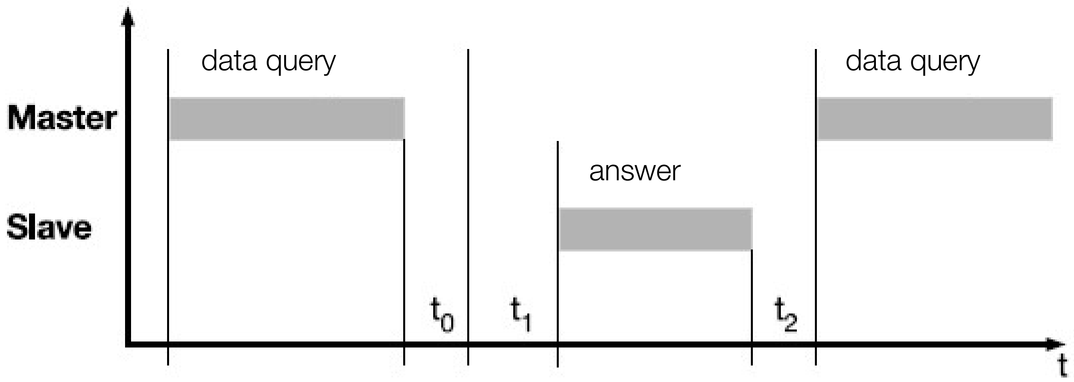
6 Modbus

Communication between a PC (master) and a device (slave) with Modbus takes place according to the master-slave principle in the form of data request / response. The master controls the data exchange, the slaves have a pure response function. They are identified by their device address.

RTU mode (Remote Terminal Unit) is used as the transmission mode. The data is transmitted in binary format with 8 bits. The LSB is transmitted first. ASCII mode is not supported.

Modbus communication in the ***FP1600*** is possible via RS232, RS485 and Ethernet can be used.

The beginning and end of a data block are marked by transmission pauses. A maximum of three times the time required to transmit a character may elapse between two consecutive characters.
The character transmission time (time for transmitting a character) depends on the baud rate and the data format used (stop bits and parity bit).



t0: End indicator = 3 characters (the time depends on the baud rate)

t1: This time depends on the internal processing.

t2: The controller needs this time to switch from transmitting back to receiving.
The master must observe this time before making a new data request. It must always be observed, even if the new data request is sent to a different device.

All data blocks have the same structure:

Slave address	Function code	Data field	CRC16
1 byte	1 byte	*n* byte(s)	2 bytes

Slave address: Device address of a specific slave
Function code: Function selection: Read and write words, see below.
Data field: Contains the information:
- Word address
- Word count
- Word value

CRC16 checksum: Detection of transmission errors, see below.

6.1 Function codes

The following Modbus functions are available for the ***FP1600:***

0x03 / 0x04Read from n words

0x06 Writing a word

0x08 Loopback

6.2 Checksum calculation (CRC16)

```
CRC = 0xFFFF
        CRC = CRC XOR byte
        For (1 to 8)
            CRC = SHR (CRC)
            If (flag pushed out to the right = 1)
            then                    else
            CRC=CRC XOR 0xA001
            While not all bytes are processed.
```

Example:

07	**03**	**00**	**CE**	**00**	**02**	**A5**	**92**
						CRC16 checksum	

6.3 Reading words (function code 3 or 4)

This function can be used to read up to 127 words from a specific address.

Request from the Master:

Slave address	Function	Address from the first word	Number of words to be read	CRC16
1 byte	1 byte (0x03 or 0x04)	2 bytes	2 bytes	2 bytes

Response from the slave:

Slave address	Function	Number of bytes read	Word value(s)	CRC16
1 byte	1 byte (0x03 or 0x04)	1 byte	*n* bytes	2 bytes

Example: Reading 4 setpoints from zone 7 from device with slave address 1

(Setpoints are in the ***FP1600*** from data address 0x0001)

Request from the Master:

0x01	0x03	0x07	0x00	0x04	crc16
Slave address	Function 3	Setpoint Zone 7 is at data address 7		4 Transfer words	

Response from the controller:

0x01	0x03	0x08	0x01	0x00	0x02	0x00	0x03	0x00	0x04	0x00	crc16
Slave address	Function 3	8 bytes of data	Setpoint Zone 7		Setpoint Zone 8		Setpoint Zone 9		Setpoint Zone 10		

6.4 Writing a value (function code 6)

Request from the Master:

Slave address	Function	Address of the word	Word value	CRC16
1 byte	1 byte (0x06)	2 bytes	2 bytes	2 bytes

Response from the slave (is identical to the request):

Slave address	Function	Address of the word	Word value	CRC16
1 byte	1 byte (0x06)	2 bytes	2 bytes	2 bytes

Example:
Writing the LO alarm of zone 9 for device with slave address 1 to the value 100.

(Lo alarms are in the ***FP1600*** from data address 0x0101)

Request from the Master:

0x01	0x06	0x01	0x09	0x064	crc16
Slave address	Function 3	LO alarm of zone 9 is at address 0x0109		Value = 100	

Response from the controller

0x01	0x06	0x01	0x09	0x064	crc16
Slave address	Function 3	LO alarm of zone 9 is at address 0x0109		Value = 100	

6.5 Modbus data addresses in the FP1600

The Modbus data addresses of the setting parameters are documented in the corresponding parameter descriptions of the controller (chapter 4.0). The following applies to reading out the process values:

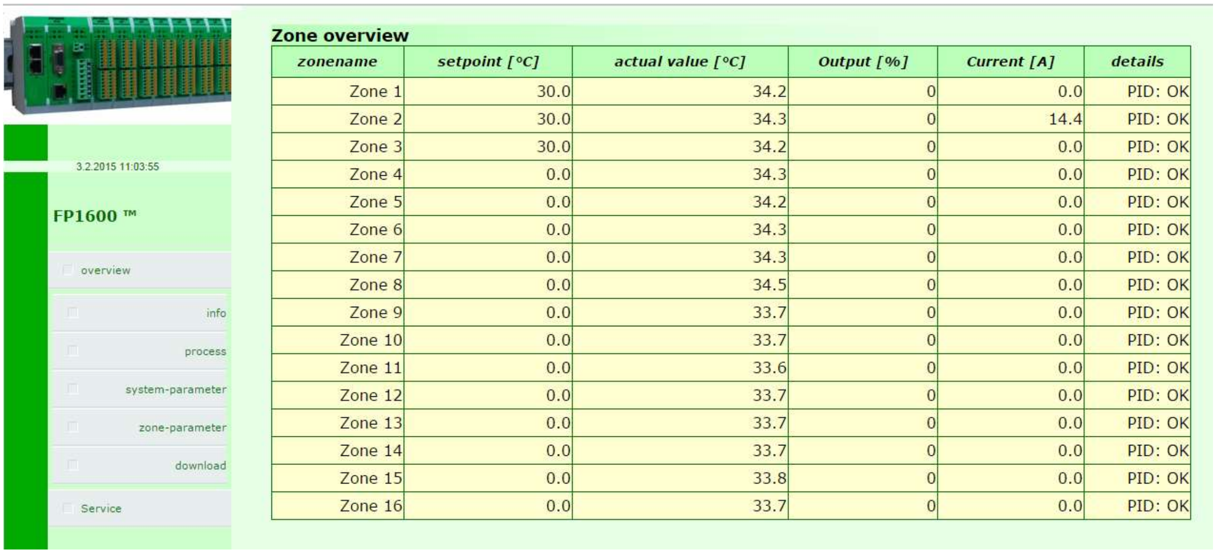
Data address	Function
4000h + zone number	Actual values in 1/10 °
4100h + zone number	Output ratio in %
4200h + zone number	Zone status
4300h + zone number	Heating current in 1/10 A
4400h + zone number	Internal setpoint in 1/10 ° (as of firmware version 2018/07/09)

7 Access via a web browser

7.1 Process values

The ***FP1600*** has an integrated WEB server that allows dynamic visualization of the process values via a standard WEB browser. To do this, enter the IP address of the ***FP1600*** in the address line of the browser.

Menu Overview

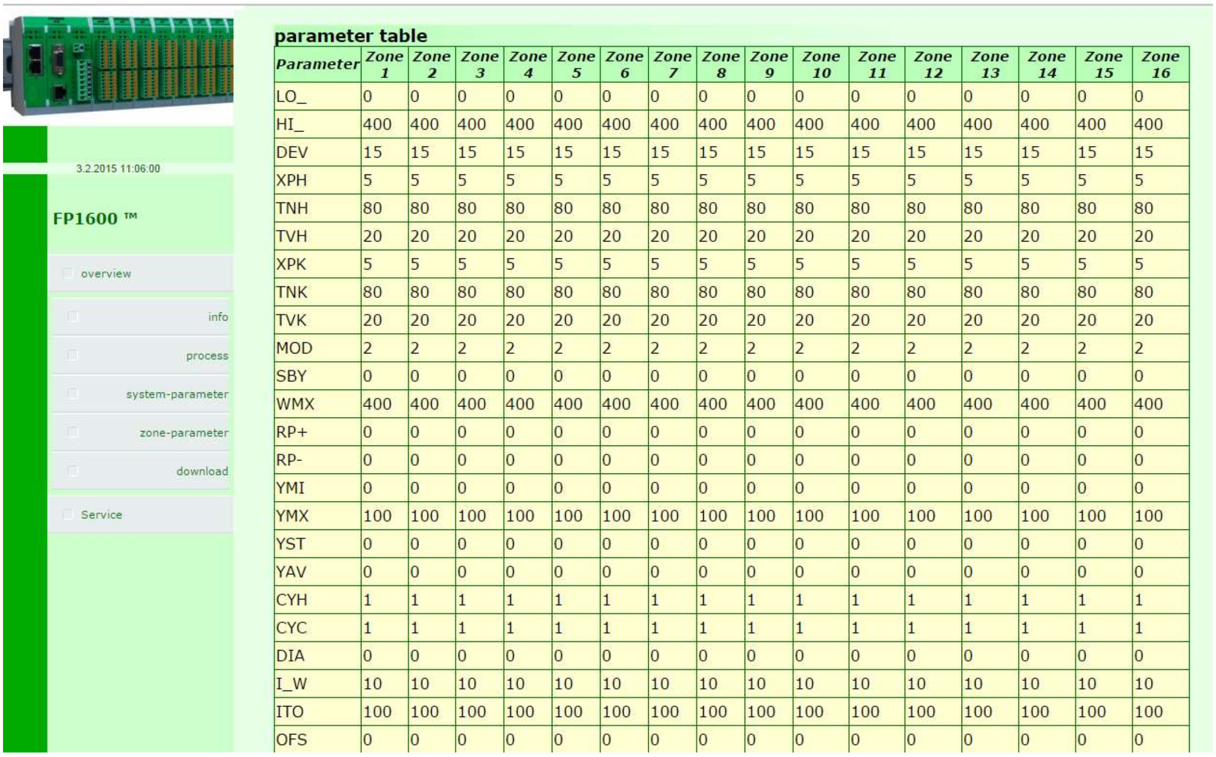


Zone overview

zonename	setpoint [°C]	actual value [°C]	Output [%]	Current [A]	details
Zone 1	30.0	34.2	0	0.0	PID: OK
Zone 2	30.0	34.3	0	14.4	PID: OK
Zone 3	30.0	34.2	0	0.0	PID: OK
Zone 4	0.0	34.3	0	0.0	PID: OK
Zone 5	0.0	34.2	0	0.0	PID: OK
Zone 6	0.0	34.3	0	0.0	PID: OK
Zone 7	0.0	34.3	0	0.0	PID: OK
Zone 8	0.0	34.5	0	0.0	PID: OK
Zone 9	0.0	33.7	0	0.0	PID: OK
Zone 10	0.0	33.7	0	0.0	PID: OK
Zone 11	0.0	33.6	0	0.0	PID: OK
Zone 12	0.0	33.7	0	0.0	PID: OK
Zone 13	0.0	33.7	0	0.0	PID: OK
Zone 14	0.0	33.7	0	0.0	PID: OK
Zone 15	0.0	33.8	0	0.0	PID: OK
Zone 16	0.0	33.7	0	0.0	PID: OK

7.2 Zone parameters

Menu Overview

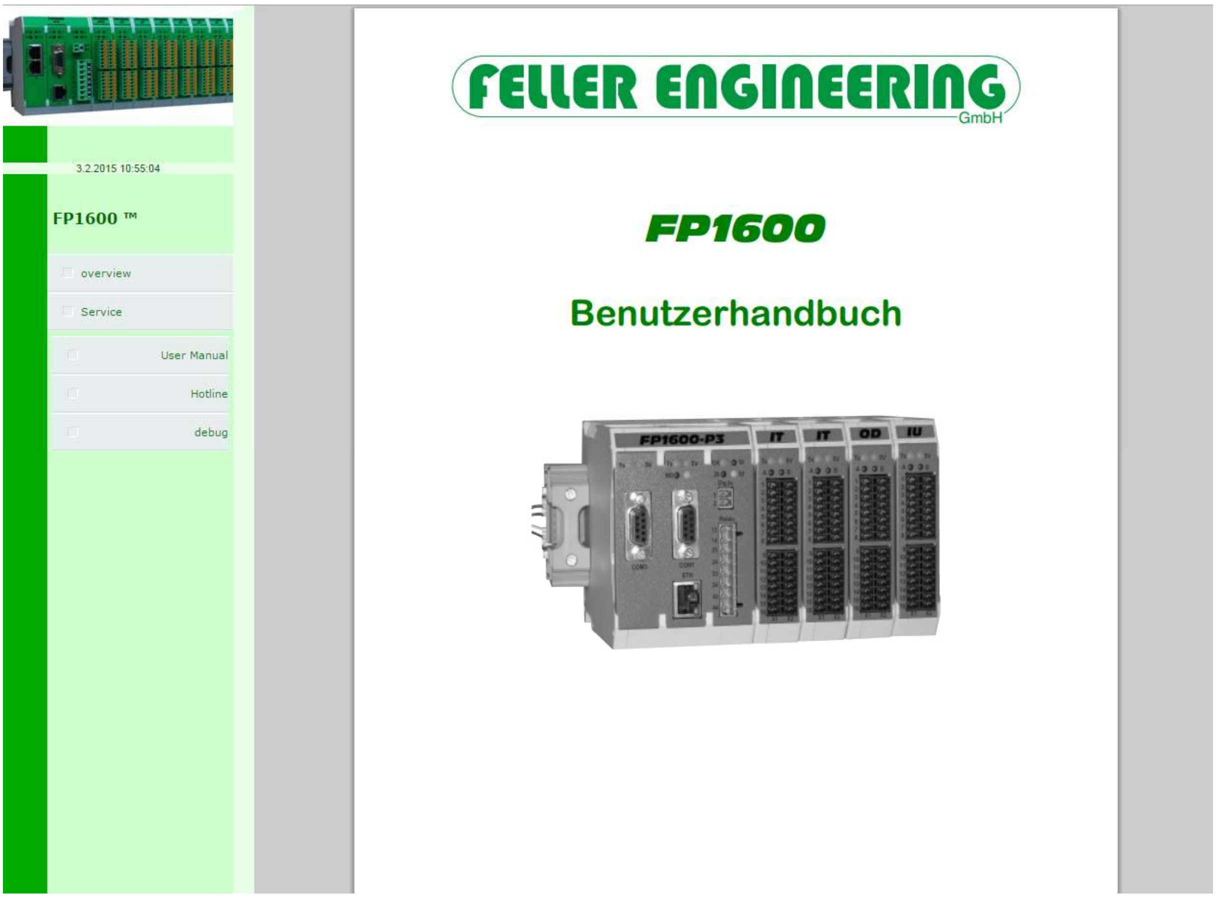


parameter table

Parameter	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9	Zone 10	Zone 11	Zone 12	Zone 13	Zone 14	Zone 15	Zone 16
LO_	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HI_	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
DEV	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
XPH	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
TNH	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
TVH	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
XPK	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
TNK	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
TVK	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
MOD	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
SBY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WMX	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
RP+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RP-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YMI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YMX	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
YST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
YAV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CYH	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CYC	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
DIA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I_W	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
ITO	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
OFS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

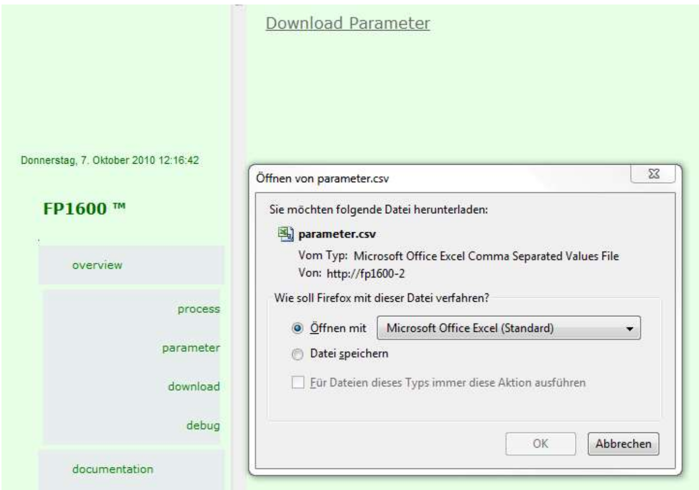
7.3 Service

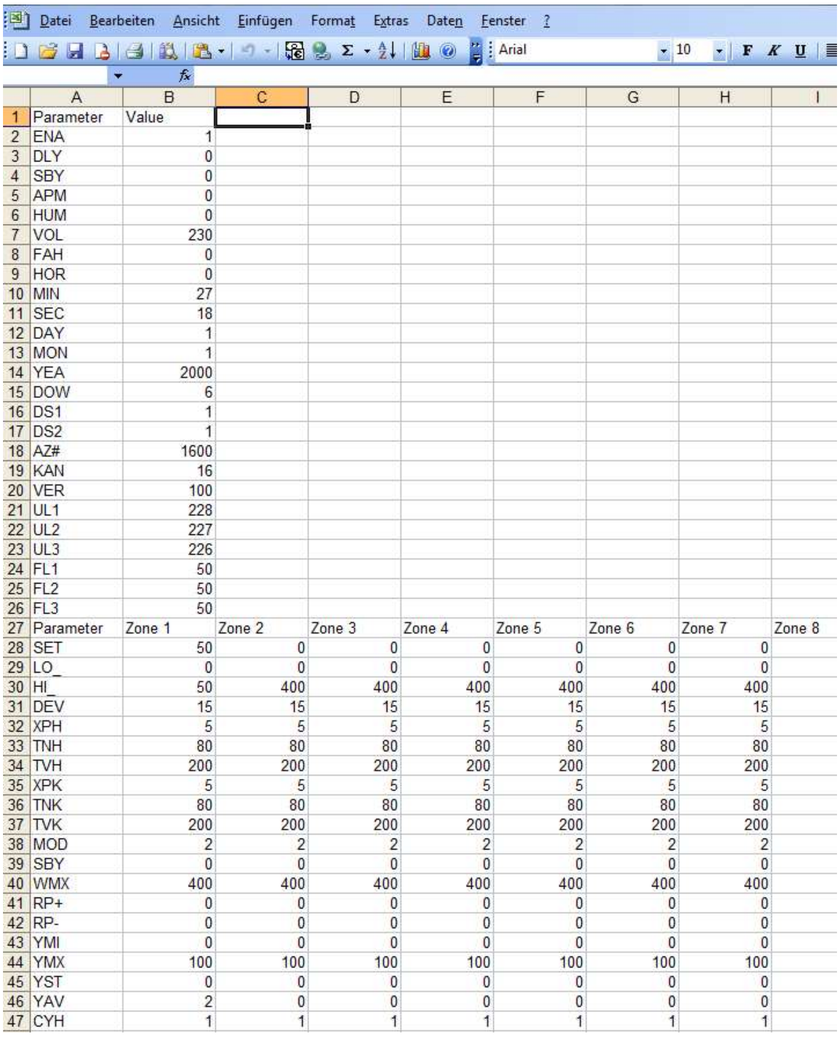
Service menu



7.4 Parameter values

All parameters set in the controller can be downloaded as a CSV file and opened directly in a spread-sheet (e.g. EXCEL). The 3-digit abbreviations mentioned in the manual appear as parameter names.





	A	B	C	D	E	F	G	H	I
1	Parameter	Value							
2	ENA	1							
3	DLY	0							
4	SBY	0							
5	APM	0							
6	HUM	0							
7	VOL	230							
8	FAH	0							
9	HOR	0							
10	MIN	27							
11	SEC	18							
12	DAY	1							
13	MON	1							
14	YEA	2000							
15	DOW	6							
16	DS1	1							
17	DS2	1							
18	AZ#	1600							
19	KAN	16							
20	VER	100							
21	UL1	228							
22	UL2	227							
23	UL3	226							
24	FL1	50							
25	FL2	50							
26	FL3	50							
27	Parameter	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8
28	SET	50	0	0	0	0	0	0	
29	LO_	0	0	0	0	0	0	0	
30	HI_	50	400	400	400	400	400	400	
31	DEV	15	15	15	15	15	15	15	
32	XPH	5	5	5	5	5	5	5	
33	TNH	80	80	80	80	80	80	80	
34	TVH	200	200	200	200	200	200	200	
35	XPK	5	5	5	5	5	5	5	
36	TNK	80	80	80	80	80	80	80	
37	TVK	200	200	200	200	200	200	200	
38	MOD	2	2	2	2	2	2	2	
39	SBY	0	0	0	0	0	0	0	
40	WMX	400	400	400	400	400	400	400	
41	RP+	0	0	0	0	0	0	0	
42	RP-	0	0	0	0	0	0	0	
43	YMI	0	0	0	0	0	0	0	
44	YMX	100	100	100	100	100	100	100	
45	YST	0	0	0	0	0	0	0	
46	YAV	2	0	0	0	0	0	0	
47	CYH	1	1	1	1	1	1	1	

8 Communication via Ethernet

8.1 FE3 protocol via UDP

UDP communication for data exchange in real time can be operated via port number 12345. Our "VISU-AL FECON" process visualization uses this option for fast data transfer.

8.2 Modbus via Ethernet

Modbus communication via Ethernet can be realized via the standard port 502. can be realized.

8.3 Firmware update via FTP

A firmware update of the **FP1600** can be carried out via the integrated FTP server. The access data for this will be provided on request.

9 Realtime Ethernet (ProfiNet / Sercos)

9.1 Technical details

Sercos III and ProfiNet are "Real Time Ethernet" protocols and are routed to X5, Port A and Port B.

9.1.1 GSDML file (ProfiNet)

The GSDML file required for bus configuration on the master is available for download on our homepage www.fellereng.de.

9.1.2 SDDML file (Sercos)

The SDDML file required for bus configuration on the master is available for download at on our homepage www.fellereng.de.

9.2 User data exchange

The device has a certain number of setting values for each individual zone, such as the setpoint value, alarm limits and various control parameters. There is also information about the current status of the zones (actual values, alarm messages, output power) as well as global, cross-zone setting values.

With the Feller Engineering bus profile, all these settings can be accessed to make the controller as transparent as possible.

However, it is impossible (and also nonsensical) to send all this user data simultaneously in a single telegram. Therefore, the desired data must be requested from the control system by the bus master.

The data exchange from and to the controller takes place via an input area and an output area of 20 bytes each.

Each area consists of 4 bytes of "header" and 16 bytes (=8 words) of "user data".

The bus master requests certain data from the controller by writing to its output area, which the controller then stores in the input area of the bus master.

This makes the configuration of a connection somewhat more complex than for "smaller" participants such as scales and valves, which can hold all available data in a single area.

When processing the transmission steps, the programmer
of the bus master must take a few important things into account:

9.3 Ensuring consistency

In the first program step, before the rest of the output data area is written, the consistency byte must be written to "0". This initially declares all telegrams transmitted to the controller as "invalid".

The consistency byte must only be written as the last action after the output data area has been completely written in order to mark the data set as "valid".

The background to this is that many bus masters operate their data transmission asynchronously to the user program and data packets are transmitted that have not yet been completely compiled (because the user program is currently executing this).

Such errors then occur rarely and sporadically and are extremely difficult to isolate. It is therefore essential to ensure that the sequence is adhered to!

9.4 Check after data request for desired data in the input area

The requested data is not immediately available in the input area after the request, as it must first be compiled by the addressed slave and then sent as a response. The user program must therefore "wait" until the requested data has arrived by checking bytes 1 and 2 of the input area.

9.5 Note the format of the user data

All user data is always saved as an integer number. The "INTEL FORMAT" is used, i.e. first the LO byte, then the HI byte.

Some Profibus masters (e.g. those from Siemens) use the "MOTOROLA FORMAT" for word representation, in which the HI byte precedes the LO byte.

The user must swap the bytes before access.

9.6 Transfer settings only when changed

To reduce the processor and bus load, the setting values should only ever be transmitted to the device when a change is made. It makes no sense to cyclically send the same, unchanged values to the controller again and again. The controller saves the values once sent permanently and independently of the mains in its EEPROM.

9.7 Definition of ProfiNet / Sercos input and output ranges

9.7.1 The output range in the bus master (sent from the master to the slave)

Byte no.	Name	Function (content)	
0	*aAction*	**1** = Read values from slave **2** = Write values to the slave	HEADER
1	*aGroup*	A "group" is defined as 8 consecutive zones. **1 = Zones** 1..8 **2 =** Zones 9..16 **3** = ... etc. Special group: **0** = Access to global setting values (see below)	HEADER
2	*aSignification*	The number of the desired parameter is transferred here. **0** = setpoint **1** = Parameter 1 (see controller manual for function) **2** = Parameter 2 (see controller manual for function) ... etc. ... **252** = Heating current (optional) **253** = Output level **254** = Actual value **255** = Zone status (see below for description)	HEADER
3	*aConsistency*	As described above, the consistency byte must first be set to **0** before any further changes are made to the output range. Only after all data in the output range has been written by the user program should the consistency byte be set as the <u>last action.</u> The consistency byte consists of 8 bits, which individually identify the validity of the following data words 1..8. A set bit indicates a valid data word (bit 0 for data word 1, bit 7 for data word 8). This makes it possible to apply write commands to individual or multiple zones.	HEADER
4 5	*aDataword 1*	Value to be set for the 1st zone within the group. In the case of a read command (byte 0 = 1), the content has no meaning	BENEFIT DATA
6 7	*aDataword 2*	Value to be set for the 2nd zone within the group In the case of a read command (byte 0 = 1), the content has no meaning	BENEFIT DATA
8 9	*aDataword 3*	Value to be set for the 3rd zone within the group In the case of a read command (byte 0 = 1), the content has no meaning	BENEFIT DATA
10 11	*aDataword 4*	Value to be set for the 4th zone within the group In the case of a read command (byte 0 = 1), the content has no meaning	BENEFIT DATA
12 13	*aDataword 5*	Value to be set for the 5th zone within the group In the case of a read command (byte 0 = 1), the content has no meaning	BENEFIT DATA
14 15	*aDataword 6*	Value to be set for the 6th zone within the group In the case of a read command (byte 0 = 1), the content has no meaning	BENEFIT DATA
16 17	*aDataword 7*	Value to be set for the 7th zone within the group In the case of a read command (byte 0 = 1), the content has no meaning	BENEFIT DATA
18 19	*aDataword 8*	Value to be set for the 8th zone within the group For a read command (byte 0 = 1), the content is meaningless	BENEFIT DATA

9.7.2 The input area in the bus master (sent from the slave to the master)

Byte no.	Name	Function (content)	
0	*eAction*	**3** = Values were accepted by the slave **4** = Slave reports range exceeded, one or more values have not been set. **5** = Slave reports invalid request (requested group or identifier does not exist or action neither 1 nor 2).	HEADER
1	*eGroup*	The slave stores the number of the group here as it was requested in the output area of the master. The requested user data should only be evaluated if the group number in the input area matches the group number in the output area.	
2	*eSignification*	The slave stores the identifier here as it was requested in the out-put area of the master. The requested user data should only be evaluated if the identifier in the input area matches the identifier of the output area.	
3	*eConsistency*	The subsequent user data may only be evaluated when bit 0 of the consistency is set. Bit1 toggles from 0 to 1 in the slave's data processing cycle.	
4 5	*eDataword 1*	Value read out for the 1st zone within the group	BENEFIT DATA
6 7	*eDataword 2*	Value read out for the 2nd zone within the group	
8 9	*eDataword 3*	Value read out for the 3rd zone within the group	
10 11	*eDataword 4*	Value read out for the 4th zone within the group	
12 13	*eDataword 5*	Value read out for the 5th zone within the group	
14 15	*eDataword 6*	Value read out for the 6th zone within the group	
16 17	*eDataword 7*	Value read out for the 7th zone within the group	
18 19	*eDataword 8*	Value read out for the 8th zone within the group	

9.8 Zone status

The read status of a zone must be viewed bit by bit.

Here, 16 bits are transmitted per zone, which have the following meaning in detail:

BIT	Meaning			
0	Bit0 = 1 : Zone ok Bit0 = 0 : Zone faulty			
1	Bit1 = 0 : O.K. Bit1 = 1 : LO alarm			
2	Bit2 = 0 : O.K. Bit2 = 1 : HI alarm			
3	Bit3 = 0 : O.K. Bit3 = 1 : Sensor break / overflow			
4	Bit3 = 0 : O.K. Bit4 = 1 : Sensor closure			
5 6	0 Zone off 0	1 actuator operation 0	0 Regular operation 1	1 Lowering 1
7	Bit7 = 0 : O.K. Bit7 = 1 : Error during optimization			
8	Bit8 = 0 : Bit8 = 1 : Self-optimization requested			
9	Bit9 = 0 : O.K. Bit9 = 1 : negative deviation alarm			
10	Bit10 = 0 : O.K. Bit10 = 1 : positive deviation alarm			
11	Bit11 = 0 : O.K. Bit11 = 1 : Alarm due to setpoint change			
12	Bit12 = 0 : O.K. Bit12 = 1 : Heating current error			
13	Bit13 = 0 : O.K. Bit13 = 1 : HiHi alarm			
14	Bit14 = 0 : O.K. Bit14 = 1 : Heating current error due to triac short circuit (SSR) [from 4.4.2016]			
15	always 0			

9.9 Global values

As soon as a "0" is entered by the master in byte 1 ("Group"), device-specific values - so-called global values - are exchanged rather than zone-specific values. Some can be operated as READONLY, others as READ / WRITE parameters (see column R / RW). Byte 2 ("identifier") is used to determine which of the global values are to be transferred.

Byte 1 "Group"	Byte 2 "Identifier"	Byte 6..19 "Values"		R / RW
0	0	Firmware ID number (AZ number)	{AZ#}	R
		Firmware date (TAG)	{DAY}	R
		Firmware date (MONTH)	{MON}	R
		Firmware date (YEAR)	{Yea}	R
		Serial number	{SN#}	R
		Reserve		R
		Reserve		R
		Reserve		R
0	1	Query the next system error	{ERR}	R
		Status of the HW release (as of 6.9.2018)	{FRE}	R
		Reserve		R
		Reserve		R
		Reserve		R
		Reserve		R
		Reserve		R
		Reserve		R
0	2	Enabling the control outputs	{ENA}	RW
		Alarm-Delay in seconds	{DLY}	RW
		Number of zones in the controller	{KAN}	RW
		Lowering mode	{SBY}	RW
		Suppression DEV alarm	{SDV}	RW
		Control input function *(from 6.9.2018)*	{FSE}	RW
		Reserve		RW
		Reference value	{REF}	RW
0	3	*Digital inputs 1..16 bitwise FP1600-ID address #1*		R
		Digital inputs 17..32 bitwise FP1600-ID address #1		R
		Digital inputs 1..16 bitwise FP1600-ID address #2		R
		Digital inputs 17..32 bitwise FP1600-ID address #2		R
		Reserve		R
		Reserve		R
		Reserve		R
		Reserve		R
0	4 *)	0 = no reaction 1 = Load standard parameters 2 = Execute device reset 3 = Save commissioning parameters 4 = Load commissioning parameters 5 = Reset all system errors		W
		Reserve		W
		Reserve		W
		Reserve		W
		Reserve		W
		Reserve		W
		Reserve		W
		Reserve		W

*) Special routines can be executed in the device via group 0, identifier 4. When these routines are called, the system causes a transmission pause in the device, which may last several seconds.

9.9.1 Examples:

The bus master would like to read the actual values of zones 9..16:

1. Set ***aConsistency*** to 0
2. ***aAction*** to 1 (it should be read)
3. ***aGroup*** to 2 (request zones 9..16)
4. ***aSignification*** to 254 (Request the actual values)
5. Set ***aConsistency*** to 255 (all 8 bits = 1)
6. Wait until ***eGroup*** = ***aGroup*** = 2
7. Wait until ***eSignification*** = ***aSignification*** = 254
8. Wait until Bit0 of ***eConsistency*** is set
9. Now the
   desired actual values of zones 9..16 can
   be read from ***eDataword1*** ... ***eDataword8.***

The bus master would like to set the setpoint of zone 2 to 300°C. All other setpoints should not be changed.

1. Set ***aConsistency*** to 0
2. Set ***aAction*** to 2 (it should be written)
3. Set ***aGroup*** to 1 (zone 2 is within group 1)
4. Set ***aSignification*** to 0 (parameter 0=setpoint value)
5. Set ***aDataword2*** to 300 (byte 6= 44, byte 7 = 1. Note LO byte first!)
6. Set ***aConsistency*** to binary *00000010* = 2. This means that only data word 2 is valid.
7. Wait until ***eGroup*** = ***aGroup*** = 3
8. Wait until ***eSignification*** = ***aSignification*** = 0
9. Wait until Bit0 of ***eConsistency*** is set.
10. Is ***eAction*** = 3 ? Then the value was accepted.
    If ***eAction* = 4**, the range would have been exceeded

With *eDataword2,* the new setpoint can already be can already be read out again as a check.

10 Keyword Index