Manual: Data transfer

Profinet
↕
Multizone Temperature Controller R4000

Content

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1 Disclaimer of liability

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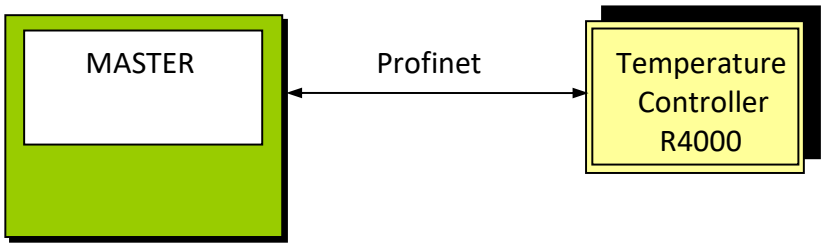
2 General (GDSML-File)

The ELOTECH – multizone temperature controller R4000 is equipped with a Profinet Interface.



The PROFINET-interface allows the slave to be monitored and controlled by a PROFINET master.
The data transfer between the slave and master takes place with the aid of the PROFINET-protocol.

The communication is always controlled by the PROFINET master. The temperature controller actuates as a slave. Each slave has its own IP-address. The IP-address of the slave has to be set by the master.

If there are transmission or other errors detected by the slave, it doesn't accept this data. The old parameter values are still valid.

Please take attention to the manual of the R4000 temperature controller.

GSDML - File:
Is available on: www.elotech.de (downloads)

FAQ's:
see www.elotech.de (downloads)

2.1 Connection Guide

Note: Only in PROFINET- technology trained personnel following the safety regulations may do the PROFINET - connections.
It is essential, that one has well experience in installing a Profinet device.
See also the FAQ – list.

You will require the following components to connect the slave:

- Ethernet cable
- GSDML file
- Project planning tool for the PROFINET- Master.

It is essential, that you perform the following during connecting to ensure that the slave operates correctly:

PROFINET- Connections: Connect the slave with the PROFINET.

PROFINET – Adjustments: Adjust the following parameters (slave):
Parameter „protocol“: Menu / Tools / Fieldbus-USB-LAN / Fieldbus to „Profinet“
Parameter „Remote”: Menu / Tools / Fieldbus-USB-LAN / Fieldbus / Remote to “On”

Diagnostic displays:
The following diagnostic information will be displayed in the parameter „Status“:

“Data Exchange”:	The slave is in the data-exchange-modus. The communication is OK.The data-exchange with the master takes place.
“Wait Parameter”:	The bus is detected. The slave is waiting until the master has programmed the slave. This happens automatically.
“No Connection”	The slave is not correct connected to the bus. E.g.:- Maybe there is a wiring error. - The master is not active. - The protocol isn't selected in the right way.
“PN HW-Err“:	Hardware error of the slave. No communication possible. Please return the slave. The controller-function of the slave itself is further possible.

If parameter “Remote” is turned “Off”, the R4000 does not accept any data sent by the Profinet Master, but the R4000 sends its own data to the Master (“Read-Only-Mode”).

3 Parameter transmission

3.1 Communication, general

The master sends its data to the slave. If parameter “Remote” is turned “on”, the slave adopts the data. After this, the slave sends an answer to the PROFINET - master. This takes place cyclic and will be controlled by the master.
The configuration of the slave takes place with the help of the GSDML- file.

3.1.1 Bit coded words/bytes

3.1.1.1 Control Byte

The control byte is used in process reflection master to slave (see 3.2 and 3.2). The master can control the behaviour of a zone by changing the bits as follows

Definition
Control byte:

Bit 0:	Zone on/off : 0 = on, 1 = off
Bit 1:	Auto-Tune: 0 = off, 1 = on Changing from „0“ to „1“ forces one auto tuning action. Before starting another auto tuning function, set bit 1 first to „0“ again. If Bit 1 is set to „0“, the running auto tuning circle stops.
Bit 2:	0 = Setpoint is saved in non-volatile memory 1 = Setpoint is saved in RAM
Bit 3:	act. setpoint: 0 = setpoint SP1, 1 = setpoint SP2 For all zones, where 2nd setpoint is not switched “OFF”.
Bit 4:	1 = Quit auto-tune error message in controller status
Bit 5:	0
Bit 6:	0
Bit 7:	1= quit message “system error”

3.1.1.2 Status Setpoint

The “status setpoint”- word comes with the first 2 bytes of the process reflection, slave to master (see 3.4)
Indicates, if a range error has been detected, when writing the setpoint:

Status Setpoint

Bit 0 = 0	Zone 1: 0 = setpoint value ok, 1 = setpoint value not ok (out of range?)
Bit 1	Zone 2
Bit 2	Zone 3
….	
Bit 15	Zone 16

3.1.1.3 Alarm Status

The alarm status byte is used in process reflection slave to master (see 3.4). Contains zone-related errors, warnings, and alarms.

Definition

"Alarm status" :

Bit 0 = Alarm 1 (overtemperature or undertemperature)
Bit 1 = Alarm 2 (overtemperature or undertemperature)
Bit 2 = undefined
Bit 3 = Alarm 1 undertemperature
Bit 4 = Alarm 2 undertemperature
Bit 5 = Restart lockout active
Bit 6 = Heater current alarm
Bit 7 = Heater current alarm short circuit

3.1.1.4 Controller Status

The controller status byte is used in process reflection slave to master (see 3.4). Contains zone-related and overall information, warnings, and alarms.

Definition

Controller status:

Bit 0: Zone on/off: 0=on, 1=off
Bit 1: Auto tune: 0=off, 1=on
Bit 2: remote: 0=on, 1=off=operation via touchscreen
Bit 3: Act. setpoint: 0= setpoint SP1, 1= setpoint SP2
Bit 4: 1 = auto tune error
Bit 5: 1 = setpoint ramp function active
Bit 6: 1 = sensor error
Bit 7: 1 = system error

3.1.2 Process reflection and configuration channel

The following module is available for the slave.

Module: „4 - channel process + parameter"

3.2 Process reflection and configuration channel, Master to Slave

Parameters and configuration sequence are transferred in one byte-string. If no configuration shall be done, the last 8 Bytes (Byte 13 to Byte 20) can be set to 0 or left untouched.

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	
Zone 1: **Setpoint 1** High Byte	Zone 1: **Setpoint 1** Low Byte	Zone 1: **Control Byte**	Zone 2: **Setpoint 1** High Byte	Zone 2: **Setpoint 1** Low Byte	Zone 2: **Control Byte**	. . .

	Byte 10	Byte 11	Byte 12
. . .	Zone 4: **Setpoint 1** High Byte	Zone 4: **Setpoint 1** Low Byte	Zone 4: **Control Byte**

Byte 13	Byte 14	Byte 15	Byte 16	Byte 17	Byte 18	Byte 19	Byte 20
Current Number	**Zone Number**	**Instruction Code BC**	always: 0x00	**Parameter-code PC**	**Parameter-value PWH** High Byte	**Parameter-value PWL** Low Byte	**Decimal point PWK**

3.3 Process reflection, master to slave

Transfer of Setpoint 1, Control word 1 for all zones (channel)

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	
Zone 1: **Setpoint 1** High Byte	Zone 1: **Setpoint 1** Low Byte	Zone 1: **Control Byte**	Zone 2: **Setpoint 1** High Byte	Zone 2: **Setpoint 1** Low Byte	Zone 2: **Control Byte**	. . .

etc.

	Byte 10	Byte 11	Byte 12
. . .	Zone 4: **Setpoint 1** High Byte	Zone 4: **Setpoint 1** Low Byte	Zone 4: **Control Byte**

Attention: **Every time the setpoint is changed, the new value is saved into the non-volatile memory. The maximum write cycles of the non-volatile memory is about 1.000.000.**
If the setpoint changes very often (for example when using setpoint-ramps etc.) we highly recommend setting Bit 2 of the control word to "1" (see section "Control Byte").

Setpoint / Act. value The parameter value in process reflection consists of two data byte. High-Byte comes first, low-byte comes second (Siemens / Motorola-Format).
Setpoint and actual value are always transferred with one decimal digit, independent of the configured measuring range.

Transmission of the data value takes place without decimal point.
If measuring range is with decimal digit: e.g. 230 means 23,0
If measuring range is without decimal digit: e.g. 230 means 230

Example:		°C	Dez.	Hex.	High-Byte	Low-Byte
Measuring range with dec. digit:	Act. value	23,0	230	00E6	00	E6
Measuring range with dec. digit:	Setpoint	170,0	1700	06A4	06	A4
Measuring range no dec. digit:	Act. value	23	230	00E6	00	E6
Measuring range no dec. digit:	Setpoint	170	1700	06A4	06	A4

3.4 Process reflection, Slave to Master:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
Status Setpoint High Byte	**Status Setpoint** Low Byte	Zone 1 **Act. value** High Byte	Zone 1 **Act. value** Low Byte	Zone 1 **Controller Status**	Zone 1 **Alarm Status**

Byte 7	Byte 8	Byte 9	Byte 10	
Zone 2 **Act. value** High Byte	Zone 2 **Act. value** Low Byte	Zone 2 **Controller Status**	Zone 2 **Alarm Status**	. . .

	Byte 15	Byte 16	Byte 17	Byte 18
. . .	Zone 4 **Act. value** High Byte	Zone 4 **Act. value** Low Byte	Zone 4 **Controller Status**	Zone 4 **Alarm Status**

3.5 Transmission example

3.5.1 Master to slave: Transmitting setpoint 1 and control byte

Byte 1 + 2: Zone 1, setpoint 1 = 50,0°C should be send to the slave.
Setpoint: 500 decimal = 0x01F4 hexadecimal as 16 Bit integer-value

Byte 3: Zone 1, slave zone 1 shall be switched “on” (Bit 0 = 0).

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	
Zone 1: **Setpoint 1** High Byte 0x01	Zone 1: **Setpoint 1** Low Byte 0xF4	Zone 1: **Control Byte** 0x00	Zone 2: **Setpoint 1** High Byte 0x..	Zone 2: **Setpoint 1** Low Byte 0x..	Zone 2: **Control Byte** 0x..	. . .

	Byte 10	Byte 11	Byte 12
. . .	Zone 4: **Setpoint 1** High Byte 0x..	Zone 4: **Setpoint 1** Low Byte 0x..	Zone 4: **Control Byte** 0x..

3.5.2 Answer of the slave device: Transmission of the process reflection

The slave sends the following parameter values

Byte 1 + 2: status setpoint transmission: the last instruction was OK (value = 0x0000).
Byte 3 + 4: Zone 1 Act. process temp. value:55,0°C 550dec.=0x0226hex., 16-bit integer-value
Byte 5: Zone 1 Controller status: zone = on
Byte 6: Zone 1 Alarm status: alarm = no alarm
Byte 7 + 8: Zone 2 Act. process temp. value:56,0°C 560dec.=0x0230hex, 16 -bit integer-value
Byte 9: Zone 2 Controller status: zone = on
Byte 10: Zone 2 Alarm status: alarm = Alarm 2 active
.
.
.
Byte 15 + 16: Zone 16 Act. process temp. value
Byte 17: Zone 16 Controller status
Byte 18: Zone 16 Alarm status

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
Status Setpoint High Byte 0x00	**Status Setpoint** Low Byte 0x00	Zone 1 **Act. value** High Byte 0x02	Zone 1 **Act. value** Low Byte 0x26	Zone 1 **Controller Status** 0x00	Zone 1 **Alarm Status** 0x00

Byte 7	Byte 8	Byte 9	Byte 10	
Zone 2 **Act. value** High Byte 0x02	Zone 2 **Act. value** Low Byte 0x3A	Zone 2 **Controller Status** 0x00	Zone 2 **Alarm Status** 0x02	. . .

	Byte 15	Byte 16	Byte 17	Byte 18
. . .	Zone 4 **Act. value** High Byte 0x..	Zone 4 **Act. value** Low Byte 0x..	Zone 4 **Controller Status** 0x..	Zone 4 **Alarm Status** 0x..

3.6 The configuration channel

With the help of the configuration channel each parameter can be addressed individually. The sequence of the described bytes is valid for „request“ and „answer“.

3.6.1 Data transmission, general

The Profinet – master is allowed to monitor and control all parameters of the slave. The transfer of instructions and parameter values takes place with the aid defined data blocks.

3.6.2 Terms

Instruction-code	**[BC]:**	"tells" the device/slave, what to do (1 byte)
Parameter-code	**[PC]:**	designates each individual parameter of the device (1 byte)
Parameter-value	**[PW]:**	shows the value of a parameter (3 bytes)

3.6.3 Parameter ranges

Instruction-code [**BC**]: 0x10, 0x20, 0x21
Parameter-code [**PC**]: 0x00...0xFF
Parameter-value [**PW**]: 16-bit integer, mantissa **PWH** and **PWL** and dec. point **PW** base 10

Parameter-value High-Byte [**PWH**]
Parameter-value Low- Byte [**PWL**]
Parameter-exponent [**PWK**]

3.6.4 Configuration of the parameters via configuration channel

Byte 13	Byte 14	Byte 15	Byte 16	Byte 17	Byte 18	Byte 19	Byte 20
Current number 0x00 ... 0xFF	**Number of zone** 0x01... 0xFF	**Instruction Code BC** 0x10, 0x20 or 0x21	**Always:** 0x00	**Parameter-code PC** 0x00 ... 0xFF	**Parameter-value PWH** High-Byte	**Parameter-value PWL** Low-Byte	**Decimal point PWK** 0x00 ... 0xFF

Byte 1

Current number: The master should preset a current number before every new task. This number will be repeated from the slave with every answer. So, it is possible to find out, which instruction and which answer belong together.

Byte 2

Number of zone: Number of controller zone of the addressed instrument. All parameters, which are necessary to configure the instrument, will be transmitted and addressed via zone no. 1.

Byte 3

Instruction code, BC: 0x10 : Read parameter
0x20 : Write parameter
0x21 : Write parameter and store with power fail protection
WARNING: The non-volatile memory allows only app. 1.000.000 write cycles!

Byte 4: Always 0x00

Byte 5

Parameter code, PC: **Request:**
Addresses the parameter which should be configured.
Answer:
If the read-proceeding to the slave was OK →in the answer of the slave, byte 5 shows the parameter-code PC.
If the write-proceeding to the slave was OK → in the answer of the slave, byte 5 shows the value 00H (acknowledge). If the communication was not OK., the following error-warnings are shown in byte 5:

03 H - Procedure error (instruction code not valid)
04 H - Non-compliance with specified range (value to low or to high)
05 H - Number of the zone not allowed
06 H - The addressed parameter is a read-only parameter
07 H - Writing of data not possible. Slave status is not „remote“.
08 H - Parameter-code not valid
09 H - It is not possible, to execute the instruction
(e.g., the auto tuning can´t be started)
FEH - Error during writing into the power fail storage
FFH - General error

Byte 6, 7 und 8
Parameter value: The parameter value comprises three data bytes:
2 data byte (mantissa), 1 data byte (decimal point).

Byte 6: Parameter value **PWH**
Byte 7: Parameter value **PWL**
Byte 8: Parameter value **PWK**

Examples: Dec. Hex. Mantissa Dec. point
Process value (°C): 215 00D7 00D7 00
Setpoint (°C): 230 00E6 00
Output ratio, cooling (%) -16 FFF0 FFF0 00
Setpoint ramp (°C/min.): 2,2 0016 0016 01
The parameter value is calculated as follows:
Dec.: 2,2 = 22 + 1 dec. point
Hex.: = 0016 (mantissa) = 01 (1 dec. point)

Negative values: Built binary two´s complement.

3.6.5 Parameter list

See instruction manual for detailed parameter descriptions. Depending on the device configuration not every parameter is available.

Parameter	**Parameter-Code**	**Access**
Act. values:		
Act. temperature value	0x10	**RO**
Act. heater current value	0x11	**RO**
Act. leakage current value	0x12	**RO**
Temperature offset value	0x18	RW
Sensor configuration	0x1a	RW
Measuring range, decimal point	0x1d	**RO**
Linear range, decimal point	0x1d	RW
Linear range, min. value	0x1e	RW
Linear range, max. value	0x1f	RW
Setpoints:		
Act. setpoint	0x20	**RO**
Setpoint 1	0x21	RW
Setpoint 2	0x22	RW
Setpoint limitation, low range	0x2b	RW
Setpoint limitation, high range	0x2c	RW
Setpoint ramp, rising	0x2f	RW
Setpoint ramp, falling	0x2d	RW

Parameter	Parameter-Code	Access
Alarms:		
Heater current, detect. Interval	0x31	RW
Min. leakage current value	0x32	RW
Alarm 1, Configuration	0x34	
Alarm 2, Configuration	0x35	
Alarm 1, Absolut/Relative	0x34	RW
Alarm 2, Absolut/Relative	0x35	RW
Alarm value 1 Overtemperature	0x38	RW
Alarm value 2 Overtemperature	0x39	RW
Alarm value 1 Undertemperature	0x36	RW
Alarm value 2 Undertemperature	0x37	RW
Switching behaviour A1	0x3c	RW
Switching behaviour A2	0x3d	RW
Delay time A1	0x3e	
Delay time heater current alarm	0x3e	RW
Delay time A2	0x3f	
PID parameters „heating“:		
Proportional range (P)	0x40	RW
Rate time (D)	0x41	RW
Reset time (I)	0x42	RW
Cycle time	0x43	RW
Control sensitivity	0x47	RW
Dead band / switch-point difference	0x46	RW
PID parameters „cooling“:		
Proportional range (P)	0x50	RW
Rate time (D)	0x51	RW
Reset time (I)	0x52	RW
Cycle time	0x53	RW
Control sensitivity	0x57	RW
Output ratio:		
Actual output ratio	0x60	**RO**
Manual output ratio	0x62	RW
Output ratio limit (heating)	0x64	RW
Output ratio limit (cooling)	0x69	RW
Softstart:		
Softstart output ratio	0x6a	RW

Parameter	Parameter-Code	Access
Softstart setpoint	0x6b	RW
Softstart hold time	0x6c	RW
Softstart function on/off	0x6d	RW
Controller configuration:		
Controller action (heating/cooling/...)	0x80	RW
Configuration digital output	0x81	RW
Configuration relay output	0x82	RW
Adjustment lock	0x85	RW
Auto tuning 0 = off 1 = on	0x88	RW
Zone offset	0x89	RW
Output ratio configuration 0 = control action 1 = auto 2 = manual operation (set output ratio by para. 0x62)	0x8b	RW
Controller unit	0x8d	RW
Sensor-Configuration	0x8e	
Zone off/on (0 = off; 1 = on)	0x8f	RW
Recorder function: Sample time	0x90	RW
Language selection	0x9b	RW
Setpoint switch (0=SP1; 1=SP2)	0x9C	RW
Reset of error bits Bit 0: System error Bit 1: Auto tune error Bit 2: Release of restart lockout Bit 8: Clear self-hold alarm 1 Bit 9: Clear self-hold alarm 2	0x9D	**WO**

3.6.6 Transmission Example for configuration channel, Instruction code 10 H

The slave is asked to send the parameter „Process value, 10 H“ of zone no. 1 to the master.
The process value is 225 °C. 225 (Decimal) = 0xE1 (Hex)

Master to slave	**Dec.**	**Hex**
Current number:	1	0x01
Zone no.:	1	0x01
Send parameter:	16	0x10
Always:	0	0x00
Parameter code (process value):	16	0x10
Parameter value (High-Byte):	0	0x00
Parameter value (Low -Byte):	0	0x00
Decimal point:	0	0x00

Transmission to slave: 0x01, 0x01 0x10, 0x00, 0x10, 0x00, 0x00, 0x00

Slave to master	**Dec.**	**Hex**
Current number of instruction:	1	0x01
Zone no.:	1	0x01
Send parameter:	16	0x10
Always:	0	0x00
Parameter code (process value):	16 *)	0x10
Parameter value (High-Byte):	0	0x00
Parameter value (Low -Byte):	225	0xE1
Decimal point	0	0x00

Transmission to master: 0x01, 0x01 0x10, 0x00, 0x10, 0x00, 0xE1, 0x00

*) Repetition of the parameter code (PC = 16), because the read-process was OK.

3.6.7 Transmission Example for configuration channel, Instruction code 20 H

The slave gets the instruction:
"Store parameter „prop.-band heating“ (parameter code: 40H, parameter value: 5,0 %) of zone no. 2
in RAM".

Master to slave	**Dec.**	**Hex**
Current number:	2	0x02
Zone no.:	2	0x02
Instruction code:	32	0x20
Always:	0	0x00
Parameter code:	64	0x40
Parameter value (High-Byte):	0	0x00
Parameter value (Low -Byte):	50	0x32
Decimal point	1	0x01

Transmission to slave: 0x02, 0x02, 0x20, 0x00, 0x40, 0x00, 0x32, 0x01

Slave to master	**Dec.**	**Hex**
Current number of instructions:	2	0x02
Zone no.:	2	0x02
Instruction code:	32	0x20
Always:	0	0x00
Parameter code (Prop-band, heating):		0 *) 0x00
Parameter value (High-Byte):	0	0x00
Parameter value (Low -Byte):	0	0x00
Decimal point	0	0x00

Transmission to master: 0x02, 0x02, 0x20, 0x00, 0x00, 0x00, 0x00, 0x00

*) If the writing-process was OK, the controller always answers with the parameter code (PC) = 00.
If there are transmission or other errors the slave answers with the corresponding error code.

3.6.8 Transmission Example for configuration channel, Instruction code 21 H

The slave gets the instruction:
" Store parameter setpoint 1 / SP1 = 200°C (parameter code: 21H) of zone no. 1 power fail safe in EEPROM“.

Master to slave	**Dec.**	**Hex**
Current number:	3	0x03
Zone no.:	1	0x01
Instruction code:	33	0x21
Always:	0	0x00
Parameter code (SP1):	33	0x21
Parameter value (High-Byte):	0	0x00
Parameter value (Low -Byte):	200	0xC8
Decimal point	0	0x00

Transmission to slave: 0x03, 0x01, 0x21, 0x00, 0x21, 0x00, 0xC8, 0x00

Slave to master	**Dec.**	**Hex**
Current number of instruction:	3	0x03
Zone no.:	1	0x01
Instruction code:	33	0x21
Always:	0	0x00
Parameter code:	0 *)	0x00
Parameter value (High-Byte):	0	0x00
Parameter value (Low -Byte):	0	0x00
Decimal point	0	0x00

Transmission to master: 0x03, 0x01, 0x21, 0x00, 0x00, 0x00, 0x00, 0x00

*) If the writing-process was OK, the controller always answers with the parameter code (PC) = 00.
If there are transmission or other errors the slave answers with the corresponding error code.