Description
Data transmission:

Profibus DP

Single SCT temperature controller

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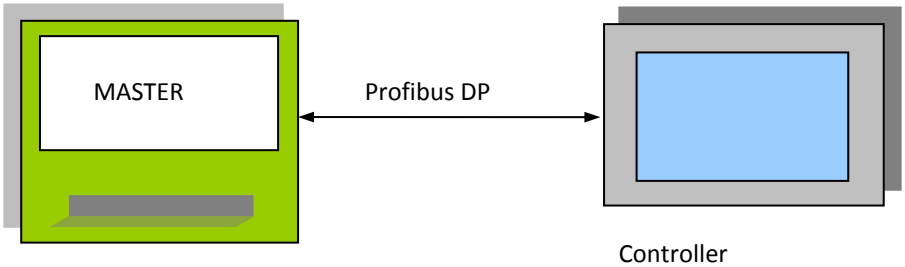
Preface

The greatest level of care was taken when compiling this description.
All information and values are up to date at the time of creating this document.
We reserve the right to enhance, expand and modify these for future product further development.

1 Interface

1.1 General description

The **SCT** temperature controller is equipped for connection to Profibus DP using the corresponding serial interface.



Using the interface, the temperature controller can be monitored and controlled by a master (such as an industrial or personal computer or a PLC) via Profibus DP according to EN 50170.

The communication process is always controlled by the master.
The downstream (control) device operates as "slave".
Each controller has its own device address.

If the controller discovers transmission errors or plausibility errors (e.g. exceeding range limits),
it does not accept these data.
The previous, already existing valid data are maintained.

Strictly observe the operating manual for the temperature controller.

GSD file:
This can be obtained from Single Temperiertechnik GmbH or
downloaded from www.single-temp.de.

1.2 Cable routing, shielding and measures against interference voltages

1.2.1 General information for cable routing

This chapter deals with the cable routing for bus, signal and power supply lines so that an EMC-compliant structure of your system should be achieved.

Inside and outside of cabinets:

To ensure EMC-compliant routing of the lines, it makes sense to divide the lines into the following line groups and to install these groups separately.

Group A:
- Shielded bus- and data lines (e.g. for PROFIBUS DP, RS232C, printers, etc.)
- Shielded analogue lines
- Unshielded lines for direct current voltages ≥60 V
- Unshielded lines for alternating current voltages ≥25 V
- Coaxial cables for monitors

Group B:
- Unshielded lines for direct current voltages ≥60 V and ≥400 V
- Unshielded lines for alternating current voltages ≥24 V and ≥400 V

Group C:
- Unshielded lines for direct current voltages ≥400 V

You can determine the conditions for laying the line groups using the combination of the individual groups based on the following table.

	Group A	**Group B**	**Group C**
Group A	1	2	3
Group B	2	1	3
Group C	3	3	1

Table 2: Cable routing guidelines, depending on the combination of line groups

1) Lines can be laid in common bundles or in cable ducts.
2) Lines can be laid in separate bundles or in cable ducts (without any minimum spacing).
3) Lines can be laid inside cabinets in separate bundles or cable ducts and outside cabinets but inside buildings on separate cableways spaced at least 10 cm apart.

1.2.2 Shielding of lines

Shielding is a measure taken to weaken (attenuate) magnetic, electrical or electromagnetic interference fields.

Interference currents on cable shields are discharged to earth via the conductive shield bus connected to the case. A low-impedance connection to the earth conductor is particularly important to prevent these interference currents themselves becoming an interference source.

Wherever possible, only use lines with braided shield. The coverage density of the shield should exceed 80%. Avoid the use of lines with foil shield as the foil can be damaged very easily as the result of tensile and compressive stress when it is attached. The consequence is reduction of the shielding effect.

You should usually always connect the shields of lines on both ends. The only way of achieving good interference suppression in the higher frequency range is by connecting the shields on both ends.
The shield may only be connected at one end in exceptional cases. However, then you only achieve damping of the lower frequencies.
A shield connection on one end can be more favourable if
• a potential equalisation line cannot be laid
• analogue signals (a few mV or mA) will be transmitted
• foil shields (static shields) are used.

In the case of data lines for serial couplings, always use metallic or metallised connectors.
Attach the shield of the data line to the connector case. Do not connect the shield to any pin on the connector strip!

If there are differences in potential between the earthing points, a compensating current can flow over the shield connected at both ends. In this case, you should lay an additional potential equalisation line.

Please observe the following points when performing shielding:
- Use metal cable clips to secure the shield braiding.
  The clips must surround the shield over a large area and must make good contact.
- Connect the shield to a shielding bus directly after the point of entry of the line into the cabinet. Continue the shield as far as the component; however
  do not connect it again at this point.

1.3 Profibus settings on the device

1.3.1 Remarks

The settings of the device with Profibus DP connection may only be made by trained personnel and while strictly observing all applicable and appropriate safety instructions.

It is essential that you have experience in handling Profibus DP.

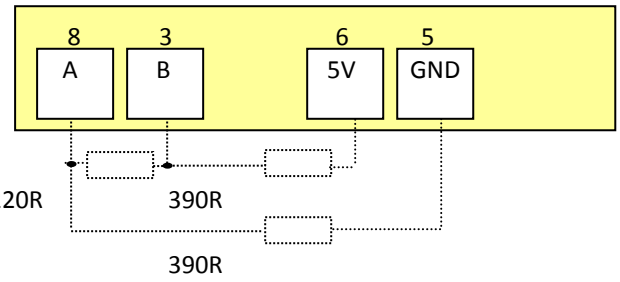
The following components are required:
- Connection plug for the PROFIBUS connection to the controller
- PROFIBUS-cable (this cable is usually already installed locally)
- GSD file
- Any project planning tool for PROFIBUS DP

In order to guarantee correct operation of the controller, the following steps must strictly be performed:

1.3.2 PROFIBUS connection

Connect the controller to the PROFIBUS. Note the connector assignments.

Terminal assignment at 9-pin Sub-D (X900) of the SCT:



The 5V and GND connections are used for activation of the optional terminating resistors. Any other load is not permitted.

Terminating resistors (tol. +/-2%)

1.3.3 Enable

The tempering machine must have a Profibus interface to communicate with the Profibus master. Therefore, it is necessary that the enable for the Profibus interface has been granted to the device.
This enable is usually preset at the factory and cannot be changed by the user.

1.3.4 Protocol selection

If the Profibus enable is granted, the interface must be selected using the protocol selection so that it is active. Once activated, a connection with the Profibus master is established automatically.
Thereby, the parametrisation (Wait_prm) as well as the configuration (Wait_cfg) are parsed by the master until the data exchange (Data_Exchange) is possible.

1.3.5 Bus address

The bus address must match so that the Profibus master can also address the required participant. The bus address corresponds to that of the Profibus slave address.

1.3.6 Interface operation

The interface operation can be activated or deactivated.
If the interface operation is activated, the Profibus master can control the device completely. Only values can be retrieved if the interface operation is deactivated.

2 Communication

The Profibus master sends data to the device.

The device sends a response in the opposite direction to the Profibus master. This process is carried out cyclically and is controlled by the master.

The device is configured using the GSD file.

The following modules are available for the control and information retrieval:

1)	Process image (standard):	Module: "SCT process data"
2)	Process image (standard)	
+ configuration channel:		Module: "SCT process data + param"

In the process image, certain parameters are transmitted according to a predefined scheme.

2.1 Process image "SCT process data + param"

2.1.1 Process image master to the controller

The master transmits the setpoint specification and the control word in the standard process image. The device status and various modes are specified in the control word.
An actual value can also be transferred.
If the remote actual value bit in the control word is set, this actual value specification is taken as control temperature.

If the Master sets the decimal adjustment bit in the control word 2, all temperatures values are in 1/10°C in the standard process display.

The slave takes over this setting und puts the decimal adjustment-bit in status 3 register..

The various control parameters can optionally be retrieved as well as changed via the configuration channel (+param).

The reserved fields in the process image are intended for future enhancements and should not be written to.

The last image is maintained; however the master must refresh this at least every second.

Process image Master to controller (Standard)			
Byte	Designation	Number	description
1	Remote Set value msb	2	Signed set temperature in degree or 1/10 degree Celsius
2	Remote Set value lsb		
3	Control word	1	Bit control (see table control word)
4	Remote Actuel value msb	2	Signed actual temperature in degree or 1/10 degree Celsius
5	Remote Actual value lsb		
6	Control word 2 msb	2	Bit control (see table control word)
7	Control word 2 lsb		
+ Configuration channel (optional)			
8-15	Configuration channel	8	individual Set and request possibilities of various Parameter (see table configuration channel)

A more detailed explanation for the configuration channel can be found in the following chapters.

The device is basically controlled by the control word register.

Control word of the		
Bit	Designation	Description
0	Device "on" / "off"	Switch device on / off 1: on 0: off (see truth table)
1	Device "cool down"	Cool down and switch off device 1: cool down 0: context-dependent (see truth table)
2	Sensor internal / external	Selection of the control temperature 1: external sensor 0: internal sensor
3	Leak-stop mode	Leak-stop mode 1: on 0: off
4	Draining	Cool down, drain and switch off device 1: drain 0: context-dependent (see truth table)
5	2nd setpoint	Selection of the setpoint temperature 1: 2nd setpoint temperature as setpoint 0: Remote setpoint temperature as setpoint
6	Optimisation	Self-optimisation 1: on 0: off
7	Remote actual value	Actual value specification 1: Remote actual value as control temperature 0: Internal control temperature selection

Control word 2 Masters		
Bit	Designation	Description
0-14	reserved	Not used 7 to be ignored
15	Decimal adjustment	Unit of submitted temperature value 1: in 1/10 centigrade Celsius 0: in centigrade Celsius

As not every combination of the bit states defines an individual device state, the following table shows the list.

Truth table / controller state			
Device	Cool down	Drain on/off	Function
0	X		Device "off"
1	0	0	Device "on" (only when device is switched off)
1	0	1	Cool down, drain and switch off device
1	1	X	Cool down and switch off device

The 'X' (Don’t care) means that the boolean value has no influence on the state.

2.1.2 Process image controller to the master

The tempering machine transmits its current state, status, temperatures and alarms to the master. If a request via the configuration channel has been initiated by the master, the device also responds via the configuration channel.

Process image controller to Master (Standard)			
Byte	Designation	Number Bytes	Description
1	Status 1	1	Shows an error of the set value limitations 1: Error in set value 0: Set value is o.k.
2-3	To process temperature msb/lsb	2	Signed control temperature in degree or 1/10 degree
4-5	From process temperature msb/lsb	2	Signed from process temperature in degree or 1/10 degree
6-7	Flow rate msb/lsb	2	Signed flow rate in liter
8-9	Pressure msb/lsb	2	Signed pressure in bar
10-11	Power msb/lsb	2	Signed heating power, calculated by to process and from process temp. in kW
12-13	Film temperature msb/lsb	2	Signed film temperature in degree or 1/10 degree
14	Regulation ration	1	Signed regulation ratio cooling and heating in percent (-100 bis +100)
15	Alarm 1	1	Error bit field (see table Alarm1)
16	Alarm 2	1	Error bit field (see table Alarm 2)
17	Status 2	1	Unit status (see table Status 2)
18-19	Status 3	2	Unit status (see table Status 3)
20-23	reserved	4	Not used / to be ignored
+ Configuration channel (optional)			
24-31	Configuration channel	8	Possibility of individual request of various parameter (see table configuration channel)

A more detailed explanation for the configuration channel can be found in the following chapters.

The current device status is transmitted to the master using the Status 2 register.
It can be recognised whether the specification has been applied by a comparison with this control word.

Status 2		
Bit	Designation	Description
0	Device "on" / "off"	Operating state of the device 1 : Device is on 0 : Device is cooling down, draining or is off
1	Device "cool down"	Cooling down state of the device 1 : Cooling down in progress 0 : No cooling down or cooling down finished
2	Sensor internal / external	Selection of the control temperature 1: External sensor 0: Internal sensor
3	Leak-stop mode	Leak-stop mode 1: Leak-stop in progress 0: Off
4	Draining	Draining of the device 1: Draining in progress 0: Off
5	2nd setpoint	Selection of the setpoint temperature 1: 2nd setpoint temperature as setpoint 0: Remote setpoint temperature as setpoint
6	Optimisation	Self-optimisation 1: Self-optimisation in progress 0: Off
7	Hand- / Remote operation	Operating condition 1: Hand 0: Remote

Status 3		
Bit	Bezeichnung	Beschreibung
0-14	Reserved	Not unsed / to be ignored
15	Decimal adjustment	Unit of submitted temperature value 1: in 1/10 degree Celcius 0: in degree Celcius

The alarm registers provide information whether any alarm / fault is present and its assignment.

Alarm 1		
Bit	Designation	Description
0	Group alarm	1: A fault is present
1	Alarm 1	not used / to be ignored
2	Reserved	not used / to be ignored
3	Alarm Pump	1: Rotary field error
4	Alarm Fill Level	1: Switch defective or completely empty
5	Alarm Flow	1: No flow
6	Alarm System	not used / to be ignored
7	Alarm Optimisation	not used / to be ignored

Alarm 2		
Bit	Designation	Description
0	Alarm Inlet	Temperature sensor in the inlet
1	Alarm Return	Temperature sensor in the return
2	Alarm Film	Film sensor fault
3	Alarm Control Sensor	Control temperature error
4	Alarm Pressure	Pressure monitor signals excessive pressure
5	Alarm Delta t	Temperature difference error between inlet and return
6	reserved	not used / to be ignored
7	reserved	not used / to be ignored

2.2 Configuration channel

The master can address the device parameters individually via the configuration channel.
It is thus possible to retrieve the parameters and, if permitted, to write to them as well. The configuration channel itself is a data block inside the module.

The transmission of commands or parameters is performed in both directions using a fixed format.

2.2.1 Request master to controller

The master must ensure that the values of the constants are set correctly. The command to be executed is specified by the command code.
The parameter code defines the parameter that the command will be performed on. In the case of a write command, the new value is specified using the parameter value. This consists of a mantissa and an exponent. It must be noted that the decimal places are not applied if the corresponding parameter only allows integer values.
The sequential number must be incremented or changed so that the device recognises a new command request.
This event causes the command to be executed by the controller.
The response of the device must be accepted before any further command should be initiated.

Configuration channel request master to controller		
Byte	Designation	Description
1	Sequential number	The master must prefix each new request with a new sequential number. Any change of the sequential number causes the command code to be executed by the controller.
2	Constant 1	Always 0x01
3	Command code (BC)	Command to be executed 0x10: Read parameter 0x20: Write parameter 0x21: Write parameter and save tool
4	Constant 2	Always 0x00
5	Parameter code (PC)	The parameters can be addressed using the parameter code (see table Parameter Code).
6-7	Parameter value msb/lsb	Signed mantissa
8	Decimal place	Signed exponent

2.2.2 Response controller to master

After the controller has received a command event, this is checked and executed. The command is discarded in the event of any error.
The success or failure of the command is communicated to the master using the command code. The parameter code defines the parameter that the command has been performed on.
The parameter is stored in the parameter value for a read process.
The implementation of the request is communicated to the master based on the sequential number. The reconciliation of the number with that from the request corresponds to a response event.

Configuration channel response controller to master		
Byte	Designation	Description
1	Sequential number	After the controller has recognised a new request and executed the command code, its sequential number is applied.
2	Constant 1	Always 0x01
3	Command code (BC)	Return value of the executed command 0x00: Command performed successfully 0x03: Invalid command code 0x04: Non-compliance with specified range 0x05: Constant error 1 or 2 0x06: Parameter is read-only 0x08: Invalid parameter code 0x09: Command cannot be executed 0xFE: Write error 0xFF: General error
4	Constant 2	Always 0x00
5	Parameter code (PC)	The parameters can be addressed using the parameter code .
6-7	Parameter value msb/lsb	Signed value of the read parameter
8	Decimal place	Always 0x00

2.2.3 Parameter list

The complete list of the available parameters is shown below.

Parameter codes		
Code	Attribute	Description
0x21	RW	Setpoint1 in degrees Celsius
0x38	RW	
0x22	RW	Setpoint2 in degrees Celsius
0x3a	RW	Alarm: maximum inlet temperature in degrees Celsius
0xa1	RW	Aquatimer start time in seconds
0xa0	RW	Drain time in seconds for equipment with tool draining
0x3b	RW	Alarm threshold for the minimum flow rate litres per minute
0x3e	RW	Warning threshold for pressure too high in bar
0x3f	RW	Warning threshold for pressure too low in bar
0xa7	RW	Switch leak-stop operation (cannot be saved) 1: on 0: off
0xaa		
0x60		
0x64	RW	Heating regulation ratio limit in percent
0x69	RW	Cooling regulation ratio limit in percent
0x40	RW	Control parameter XP heating
0x41	RW	Control parameter TV heating
0x42	RW	Control parameter TN heating
0x50	RW	Control parameter XP cooling
0x51	RW	Control parameter TY cooling
0x52	RW	Control parameter TN cooling
0x46	RW	Heating / cooling switching hysteresis in degrees Celsius
0x43	RW	Heating switching cycle time in seconds
0x53	RW	Cooling switching cycle time in seconds
0x2c	RW	Upper setpoint limit in degrees Celsius
0x2b	RW	Lower setpoint limit in degrees Celsius
0x39	RW	Film temperature limit value in degrees Celsius
0xa2	RW	System closing temperature in degrees Celsius
0xa3	RW	Inlet / return delta T monitoring in degrees Celsius
0x1b		
0x1c		
0x88	RW	Switch self-optimisation (cannot be saved) 1: on 0: off
0x3c	RW	Return limit value in degrees Celsius

0x2f	RW	Rising setpoint ramp in Kelvin per minute
0x2e	RW	Falling setpoint ramp in Kelvin per minute
0x3d		
0x5a	RW	Cooling hysteresis activation in Kelvin
0x59	RW	Cooling hysteresis deactivation in Kelvin
0x85	WR	Set a complete block
	RD	Retrieve block state 0x00: No block 0x01: Partial block 0x02: Complete block
0x33	RW	Delta T cascade control in degrees Celsius
0x93	RW	Shutdown temperature in degrees Celsius
0x87	RW	Actual value output upper value in degrees Celsius
0x89	RW	Actual value output lower value in degrees Celsius
0xa8		
0xa9	RW	Aquatimer start time in seconds
0xd8	RW	Plotter function sample time in seconds
0x90	RW	Restart lock 1: on 0: off
0xab	RW	Internal sensor actual value offset in Kelvin
0xac	RW	External sensor actual value offset in Kelvin
0xad	RW	Return sensor actual value offset in Kelvin
0xae	RW	Inlet sensor actual value offset in Kelvin
0xaf	RW	Film sensor actual value offset in Kelvin
0x10	RO	Control sensor temperature in degrees Celsius
0x12	RO	Return sensor temperature in degrees Celsius
0x13	RO	Inlet sensor temperature in degrees Celsius
0x14	RO	Film sensor temperature in degrees Celsius
0x15	RO	Flow circulation in litres
0x16	RO	Inlet pressure measuring input in bar
0x17		
0x20	RO	Setpoint sensor temperature in degrees Celsius
0x8F	RO	Device state 1: on 0: off, cooling, draining

3 Examples

3.1 Process image master to the controller

Hexadecimal	Decimal	Description
0x01 0x07	263 °C	Setpoint temperature
0x01		Control word: Device on
0x00 0x3b	59 °C	Actual temperature
0x00 0x00	---	Steuerwort2
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00	---	Configuration channel

Hexadecimal	Decimal	Description
0xff 0xf5	-11 °C	Setpoint temperature
0x21		Control word: Device on + second setpoint
0x00 0x3b	59 °C	Actual temperature
0x00 0x00	---	Steuerwort2
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00	---	Configuration channel

Hexadecimal	Decimal	Description
0x00 0x7b	123 °C	Setpoint temperature
0xa0		Control word: Device off + second setpoint + remote
0xff 0xff	-1 °C	Actual temperature
0x00 0x00	---	Control word 2
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00	---	Configuration channel

Hexadecimal	Decimal	Description
0x00 0x65	10.1 °C	Set temperature in 1/10 degree
0x80		Control word: Device off + remote actual value
0x04 0xd2	123.4 °C	Actual temperature in 1/10 degree
0x80 0x00		Control word 2: Decimal adjustment
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00	---	Configuration channel

3.2 Process image controller to the master

Hexadecimal	Decimal	Description
0x00	---	Status1: Setpoint OK
0x00 0x6c	108 °C	Inlet temperature
0x00 0xdf	223 °C	Return temperature
0x00 0x2a	42 l	Flow circulation
0x00 0x01	1 bar	Pressure
0xfe 0x22	-479 kW	Output
0x00 0x9e	158 °C	Film temperature
0x9c	-100%	Regulation ratio
0x00	---	Alarm1: ---
0x02	---	Alarm2: Return temperature error
0x02	---	Status2: Device is cooling down
0x00 0x00 0x00 0x00 0x00 0x00	---	Reserved
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00	---	Configuration channel

Hexadecimal	Decimal	Description
0x01	---	Status1: Setpoint not OK
0x00 0x60	96 °C	Inlet temperature
0x00 0x84	32 °C	Return temperature
0x00 0x00	0 l	Flow circulation
0x00 0x00	0 bar	Pressure
0x00 0x00	0 kW	Output
0x00 0xbc	158 °C	Film temperature
0x9c	-100%	Regulation ratio
0x01	---	Alarm1: Group fault
0x04	---	Alarm2: Film temperature error
0x01	---	Status2: Device on
0x00 0x00 0x00 0x00 0x00 0x00	---	Reserved
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00	---	Configuration channel

Hexadecimal	Decimal	Description
0x00	---	Status1: Setpoint OK
0x00 0x5f	95 °C	Inlet temperature
0x00 0x69	104 °C	Return temperature
0x00 0x11	17 l	Flow circulation
0x00 0x00	0 bar	Pressure
0x00 0x00	0 kW	Output
0x00 0x64	100 °C	Film temperature
0x64	100%	Regulation ratio
0x00	---	Alarm1: Group fault
0x00	---	Alarm2: Film temperature error
0x01	---	Status2: Device on
0x00 0x00 0x00 0x00 0x00 0x00	---	Reserved
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00	---	Configuration channel

Hexadezimal	Dezimal	Beschreibung
0x00	---	Status 1: Setpoint o.k.
0x04 0xd2	123.4 °C	To process temperature
0x01 0xe1	48,1 °C	From process temperature
0x00 0x0a	10 l	Flow rate (tool circuit)
0x00 0x05	5 bar	Pressure
0x00 0x1d	29 kW	Power
0x01 0x0c	26,8 °C	Film temperature
0x00	0 %	Regulation ratio
0x00	---	Alarm 1: ---
0x00	---	Alarm 2: --
0x00	---	Status 2: Unit on
0x80 0x00	---	Status 3: Decimal adjustment
0x00 0x00 0x00 0x00	---	Reserved
0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00	---	Configuration channel

Bibliographical reference

For a quick and intensive introduction to PROFIBUS DP, we recommend the book "Schnelleinstieg in PROFIBUS-DP" (Quick introduction to Profibus DP), author M.Popp.

The book is available from PROFIBUS Nutzerorganisation, Art. No 4.071.

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