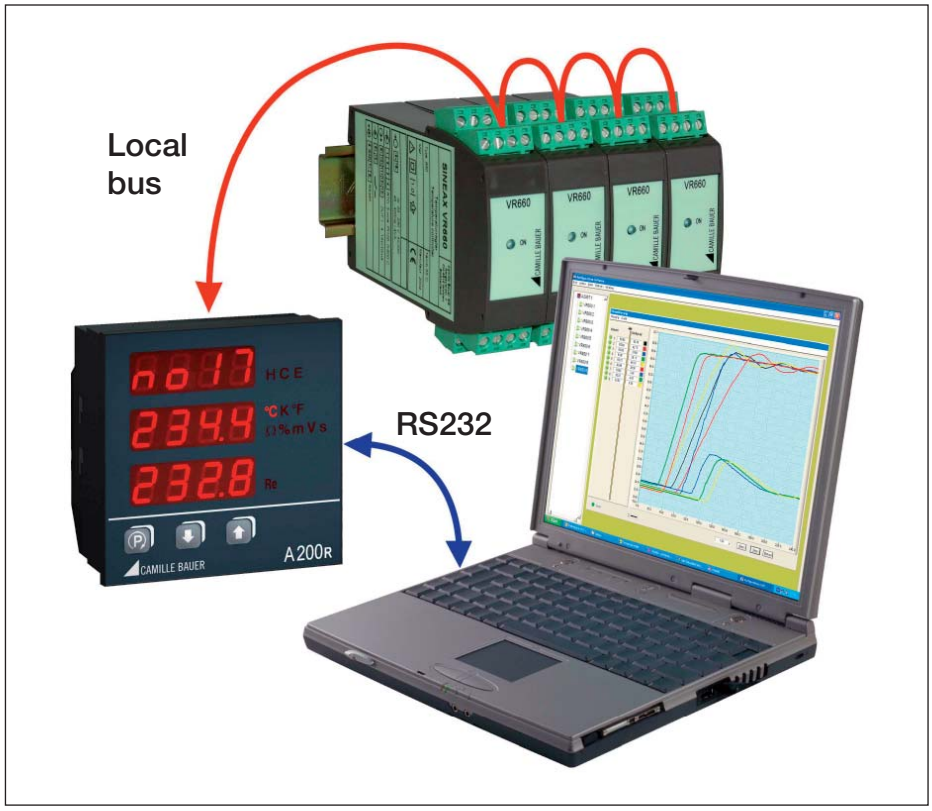
Description of functions
Controller system VR660 / A200R



VR660/A200R e 156 176-04 11.07

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Description of functions
Controller system VR660 / A200R

Read first and then …

Perfect and safe operation requires that this description of functions as well as the Safety Instructions A200R and VR660 (No. 156 118 and 156 019) have been read and understood!

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2. Technical features of temperature controller 4
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1. Overview of temperature controller system

The VR660/A200R combines the advantages of individual controllers with the efficiency of multichannel controllers.

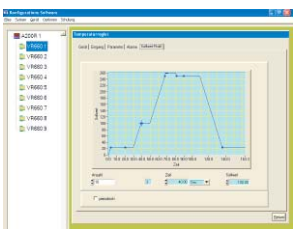
A system from one to 32 temperature controllers can be flexibly arranged. The A200R central display and operating unit combines the advantages of top-hat rail controllers with the clear process visualisation of compact controllers.

It permits commissioning, visualisation and setting of parameters on site. Large and clearly visible display elements provide an overview of the current situation at any time. Errors are immediately indicated in an event-oriented manner.

The system can be used cost-effectively since it is completely self-sufficient and does not need any higher-ranking distributed control system. On the other hand, A200R data transparency facilitates the connection to other systems.

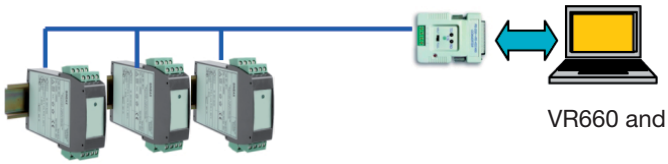
The temperature controllers themselves work independently and may also be used as individual instruments without the A200R. The system may be extended with little installation effort at any time. CB-Manager configuration software provides user-friendly commissioning of the individual controllers, the display module or the whole system.

1.1 Product overview

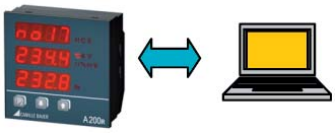
Product		
VR660 Temperature controller		VR660 is a single-channel, self-sufficient top-hat rail controller with plug-in terminals.
A200R Display and operating unit		Display and operating unit as well as BUS master of the temperature controller system. Up to 32 devices may be connected.
Converter **RS-232 - RS-485** or **USB-RS-485**		Direct access from the PC to VR660 controllers via RS-485. Common converters may be used.
CB-Manager Configuration software		Software for commissioning, visualisation of process data and configuration of the temperature controller and of the A200R display and operating unit. Configurations may be archived in files.

1.2 Systems

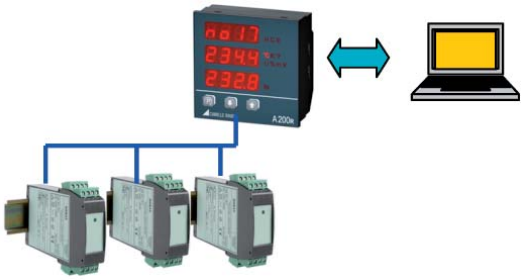
RS-232/RS-485 converter



VR660 and CB-Manager



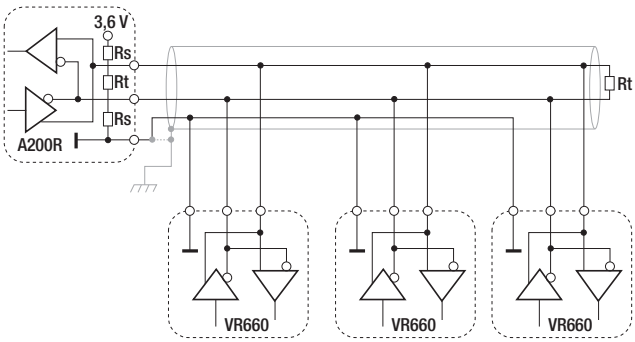
A200R and CB-Manager



Controller system and CB-Manager

Controller system (A200R and VR660)

BUS interface



Different settings are available:

a) Without terminating resistors.
   This arrangement is recommended for short leads and low interference signal levels.

b) With terminating resistors.

In long leads and increased interference safety, a resistor Rt = 120 Ω is arranged at both ends of the bus. If the A200R is situated at one end of the bus the internal terminating resistor may be connected instead of an external resistor (using the integrated jumper).

Bias resistors (Rs) are firmly installed in the A200R.

2. Technical features of Temperatur controller

Measuring input ⊕

Temperature with resistance thermometer

Measuring range limits:	See table 3, ΔR ≥ 10 Ω
Types of sensor resistors:	Type Pt 100 (IEC 60 751) also Pt 50 … 1000 Type Ni 100 (DIN 43 760) also Ni 50 … 1000
Wiring:	Two, three or four-wire connection
Measuring current:	0.2 mA
Lead resistance:	≤ 30 Ω for each lead, may be set or calibrated in two-lead measurement

Temperature with thermocouple

Measuring range limits:	See table 3, ΔU ≥ 2 mV	
Thermocouples:	Type B: Pt30Rh-Pt6Rh	(IEC 584)
	Type E: NiCr-CuNi	(IEC 584)
	Type J: Fe-CuNi	(IEC 584)
	Type K: NiCr-Ni	(IEC 584)
	Type L: Fe-CuNi	(DIN 43710)
	Type N: NiCrSi-NiSi	(IEC 584)
	Type R: Pt13Rh-Pt	(IEC 584)
	Type S: Pt10Rh-Pt	(IEC 584)
	Type T: Cu-CuNi	(IEC 584)
	Type U: Cu-CuNi	(DIN 43710)
	Type W5 Re/W26 Re	(ASTM
	Type W3 Re/W25 Re	E 988-90)

Cold junction compensation

Internal:	With integrated Pt 100
External:	Via cold junction thermostat – 30 … 90°C
Voltage input	– 1 … 1 V
Resistance measurement:	0 … 5 kΩ

Gain-/offset adjustment with A200R or CB-Manager

Binary input ⊕

Contact input, galvanicly connected to output, common negative connection.

Active:	< 5 kΩ
Inactive:	> 200 kΩ, leakage current < 0.1 mA
No-load voltage:	< 25 V

Short-circuit current: 3 mA

Function	Signal at binary input
Start stop autotuning	Impulse
Online / offline	Permanent signal
Second setpoint	Permanent signal
Feed forward control	Permanent signal
Limit value alarm suppression	Permanent signal
Start stop setpoint profile	Impulse

Duration of impulse: Min. 100 ms; the minimum time between the start and stop autotuning impulse amounts to two output cycles.

The function of the binary input can be inverted.

Outputs ⊕►

4 digital outputs, galvanicly connected, common negative connection.
Suitable for common semiconductor relays (SSR) or dig. PLC inputs (EN 61131 Types 1 and 3)

Active:	≥ 15 V DC at I ≤ 15 mA, short-circuit proof
Inactive:	< 1 V, < 0.1 mA
No-load voltage:	< 25 V
Output 1:	Heating
Output 2:	Cooling
Output 3:	Alarm
Output 4:	Alarm
Output cycle:	Heating/cooling 0.5 … 300 s
Effective direction:	Invertible

Accuracy (according to EN/IEC 60 770-1)

Reference conditions:

Ambient temperature:	23 °C
Power:	24 V DC ± 10%
Settings:	Pt100, 3-lead, 0 … 600 °C, cycle time 1 s
Reference value:	Span
Basic accuracy:	
Under reference conditions	≤ ± 0.5 K
TC type K, E, J, T, N, L, U	≤ ± 0.5 K, meas. value > – 100 °C
TC type R, S	≤ ± 2.5 K
TC type B	≤ ± 2.5 K, meas. value > 300 °C
TC type C, D	≤ ± 2.0 K

Additional error (additive)

Cold junction compensation:	± 3 K
Ambient temperature:	Type 0.1% + 0.1 K per 10 °C
Long-term drift:	± 0.1%
Common-mode/ series mode effect:	± 0.2%

Control properties

Control types and control parameters:

2-state PDPI controller:	Heating or cooling	Pb 1	proportional band
		Tv 1	rate time
		Tn 1	reset time
		Tc	output cycle time
3-state PDPI controller:	Heating	Pb 1	proportional band
		Tv 1	rate time
		Tn 1	reset time
	Cooling	Pb 2	proportional band
		Tv 2	rate time
		Tn 2	reset time
		Tc	output cycle time
		dbnd	dead band

Autotuning

Determination of the optimum PDPI control parameters in any operating state:

– Around setpoint (decrease or increase is adjustable)

– When increasing or decreasing temperature

Activation: Binary input or via A200R or CB-Manager

Regulated ratio
Regulated ratio limits, regulated ratio in case of an error or regulated ratio in case of interference may be set.

Setpoints

Setpoint, second setpoint: Activation by binary input or CB-Manager

Setpoint limits: Min./max. value

Ramp function to limit the temperature change (increase and decrease).

Set point profile

Number of values: 10 time and setpoint values, repeatable

Activation: Start control, binary input or via A200R or CB-Manager

Power H

Table 1: Nominal voltages and tolerances

Nominal voltage U_N	Tolerance
24 … 230 V DC/AC, 45 … 400 Hz	± 15%

Power consumption: ≤ 3 W or ≤ 5 VA

A voltage of > 125 V DC requires an external fuse in the power circuit.

LED

Green LED: Power On Anzeige. LED flashes if the device is addressed by A200R or CB-Manager.

Bus connection

Interface: RS-485

Bus distance: Max. 40 m

Installation

Electric terminals: Screw terminals with indirect wire clamping, for 0.14 mm² to 2.5 mm²

Galvanic isolation

All circuits (measuring input/output/power/bus) are galvanicly isolated

Regulations

Electromagnetic compatibility: EN 61000-6-2 / 61000-6-4

Ingress protection (according to IEC 529 or EN 60 529): Housing IP 40 terminals IP 20

Electric design: According to IEC or EN 61010

Operating voltages: < 300 V between all insulated circuits

Degree of pollution: 2

Overvoltage category according to IEC 664: II for all circuits

Double insulation: Between all insulated circuits

Test voltage: 2.3 kVrms, 50 Hz

Environmental tests: EN 60068-2-1/-2/-3/-6/-27

Ambient conditions

Operating temperature: – 25 to + 55 °C

Storage temperature: – 40 to + 70 °C

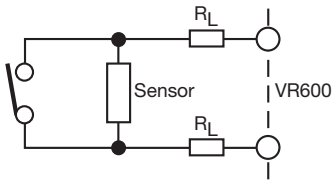
Relative humidity, annual average: ≤ 75%, no dew

Functional range: Indoors up to 2000 m above sea level

Lead resistance

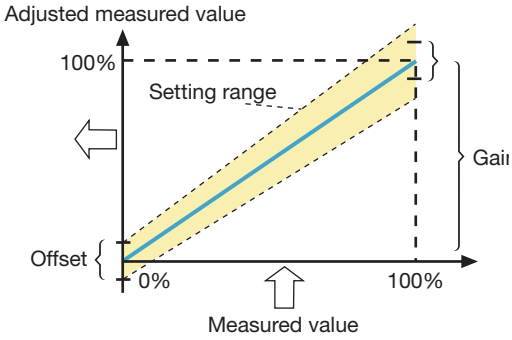
The maximum lead resistance amounts to 30 Ω per lead. The total lead resistance (sum of both resistances) may be entered as a parameter for the 2-wire connection type.

In addition, the lead resistance can be calibrated in the 2-wire connection type. The two ends are short circuited with each other and the calibration procedure is started. VR660 now measures independently the leads and stores the measured lead resistance in EEPROM. This lead resistance may be subsequently read from the device.



Calibration of measuring input

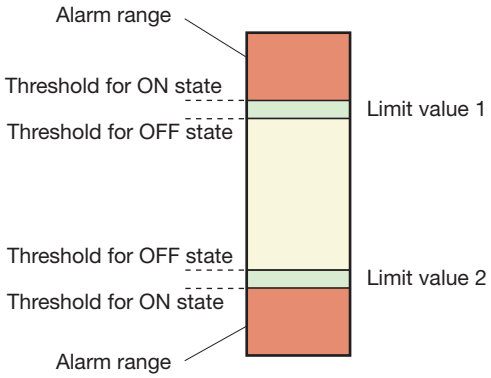
The measuring chain can be calibrated. The correction parameters (offset and gain) refer to the set measurin range (measuring range start and span).



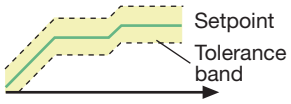
The sensor limits control the measured value irrespective of set offset and gain values. For example, a temperature above 850 °C is limited in Pt100 even if calibration results in a measured value below 850 °C. It is recommended not to use the full extent of sensor limits to protect the material.

Limit values

Two limit values may be set



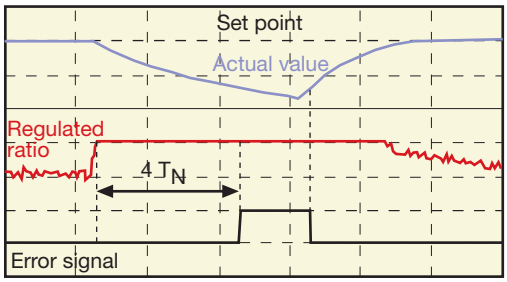
Limit values may be configured as absolute or relative limit values.
Using relative limit values a tolerance band may be placed around the setpoint which adjusts itself to the current setpoint.



The limit values are active when the device is online. Self-optimisation is also terminated if the limit values are not allocated to alarm outputs.

Monitoring

Heating loop monitoring:



The error message is issued after 4 TN – after the heating has been switched on 100%.

As soon as the temperature rises again, error signalling stops.

This monitoring system also signals an error, if the regulated ratio is 0% but the heating is permanently switched on.

– Polarity reversal monitoring of thermocouple.

The same is monitored as the input signal is measured
– Sensor breakage monitoring
– Sensor short-circuit monitoring
– Breakdown of periodical communication with A200R
– Autotuning error

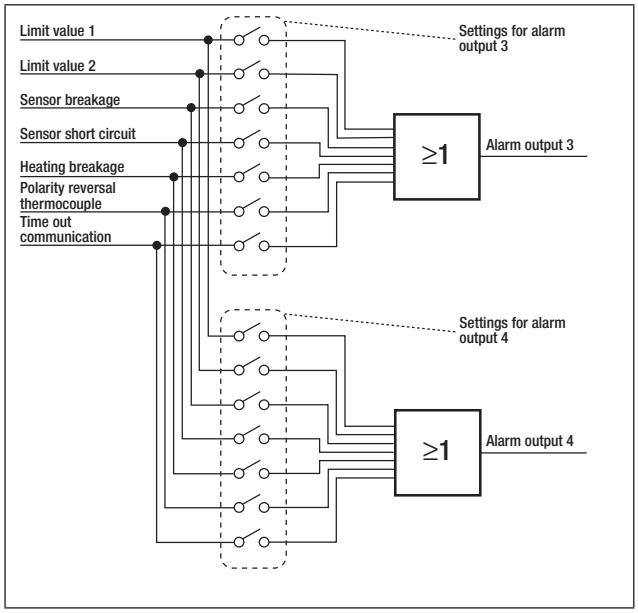
The behaviour in case of an error is shown in Table 2 (page 9) with different operating states.

Error monitoring is deactivated depending on the situation:

Sensor breakage:	No short-circuit signalling
Sensor breakage or short circuit:	No heating loop monitoring and no monitoring of polarity reversal of thermocouple

Alarms

Errors may be connected individually or combined to one of the two alarm outputs.



Alarm suppression

a) During start-up
Limit value alarms may be suppressed until the actual value is within the required limit value range. Subsequently, limit value monitoring is active. If the limit values have been incorrectly set, alarm suppression is cancelled after the setpoint has been reached (a limit value alarm should not occur at setpoint). The binary input is also capable of suppressing limit value alarms.

b) During self-optimisation
Limit values can be suppressed during self-optimisation.

Ouput cycles

The pulse rate (cycle time) may be configured (0.5…300s). The measuring accuracy is reduced from 0.5 to 1 s.

Filtering

Starting with the cycle time a low-pass filter is automatically set to compensate measuring fluctuations.

Mains hum suppression

The standard includes an active hum eliminator which suppresses the two frequencies of 50 Hz and 60 Hz.

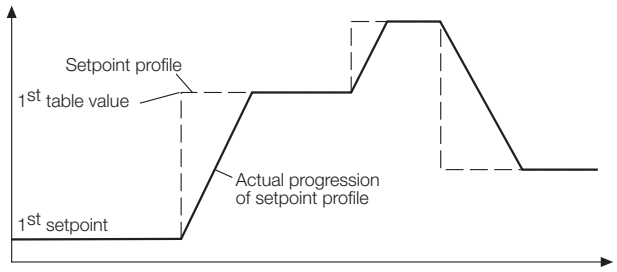
Setpoint specification

Processing of different stepoints is shown in the setpoint structure (see page 7).

The device can be set offline by specifying a minimum setpoint upon the respective activation.

Start of profiles

The ramp for rising and falling setpoints limits the setpoint rise.



There are several possibilities of starting the setpoint profile:

– With fixed configuration: The setpoint profile starts after a device set or after switching from offline to online.
– Through a binary input (in this case the setpoint profile may not be restarted after a reset).
– Externally by software

The second setpoint behaves with a setpoint profile exactly in the same way as with a 1st setpoint specified as a standard. By activating the 2nd setpoint (e.g. via the binary input) the 2nd setpoint is applicable instead of the setpoint profile (see setpoint structure).

Parameter monitoring:

The temperature controller monitors the most important parameters and corrects them to reasonable values. This monitoring operation becomes applicable as individual parameters are changed and depending parameters have to be subsequently corrected.

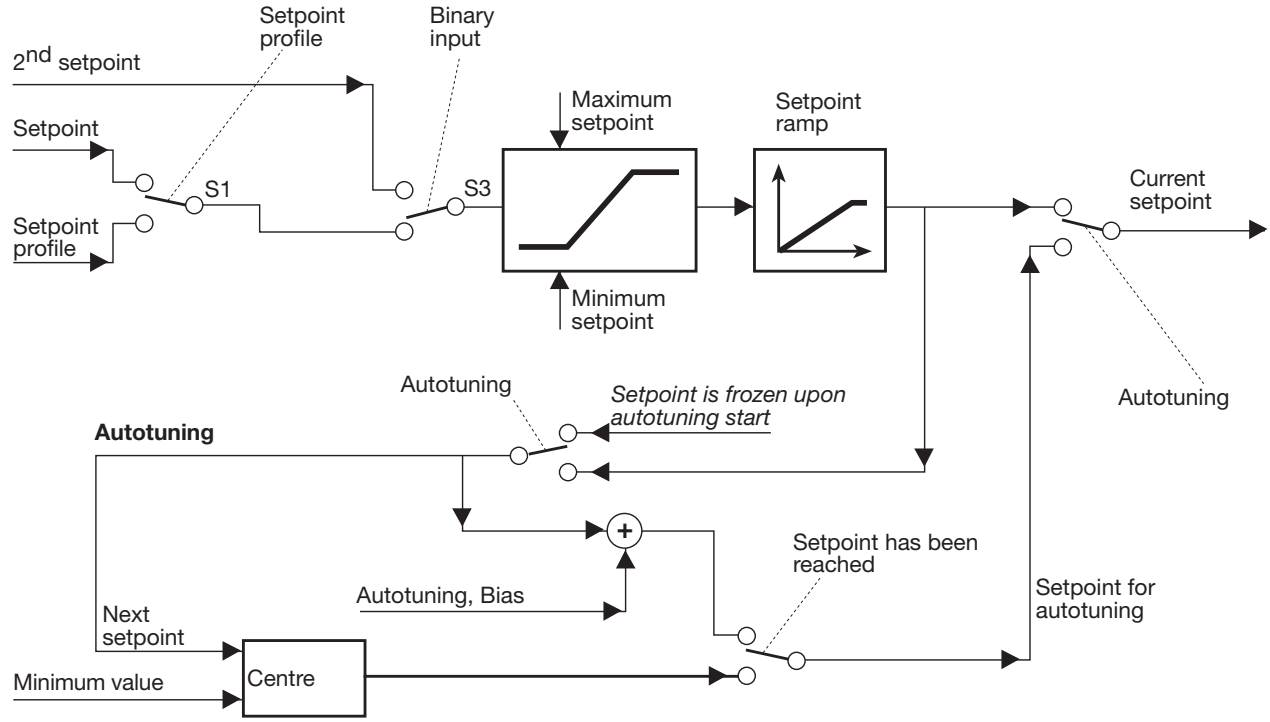
This is the case if parameters are changed by A200R..

It cannot occur if CB-Manager configuration software is used.

Device configuration

a) Using CB-Manager: All parameters
b) Using A200R: The most important set parameters

Structure of setpoint processing



After reaching the next setpoint, the minimum value becomes the reached setpoint

The setpoint which will finally be used for the control algorithm is the result of several processing steps. In the easiest case, it is the setpoint stored as 1st setpoint parameter in the device. The selection of setpoints starts with the selection of the setpoint profile or the 1st setpoint (S1). Irrespective of the previous setting, the binary input (S3) can be used to switch to the second setpoint.

One of the possible setpoints has been selected. This value is now limited in two steps: Firstly, the variable is limited to the setpoint range (minimum and maximum setpoint). Subsequently, the rise and fall of the setpoint is limited to the values defined in the setpoint ramp. The resulting value is now the setpoint in the control algorithm.

Autotuning requires additional setpoint processing. If the desired setpoint has already been reached, autotuning is performed at a decreased value (setpoint decrease by the adjustable “bias” value).

The mean value between two states is applicable to starting, decreasing or increasing the setpoint. In starting, the room temperature and the next setpoint, in a setpoint change, the previous and the next setpoint are used for the mean value calculation.

In autotuning, the setpoint which has been determined at the beginning of autotuning is not changed any more.

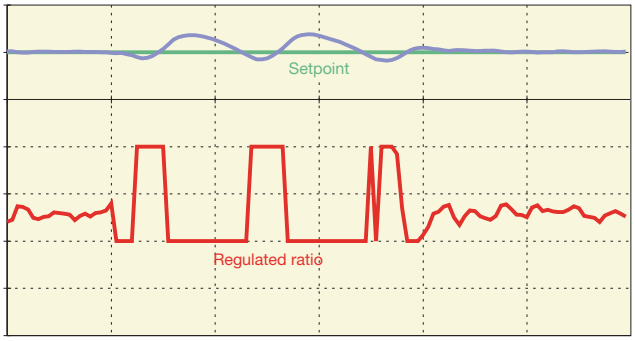
Autotuning:

Autotuning serves the determination of optimum control parameters (proportional band, rate time, reset time).

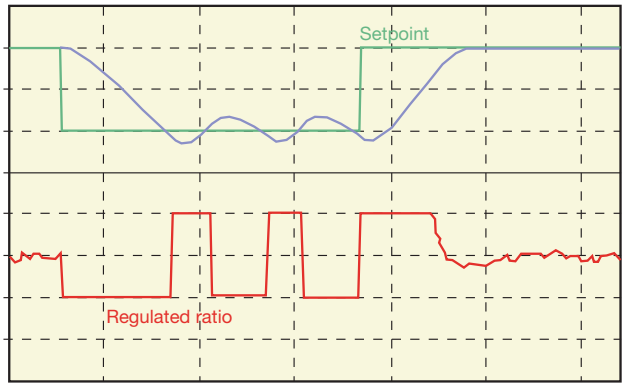
The controller causes the system to generate low oscillations. The desired parameters can be deduced from the measured signal.

Different procedures are conducted depending on the situation:

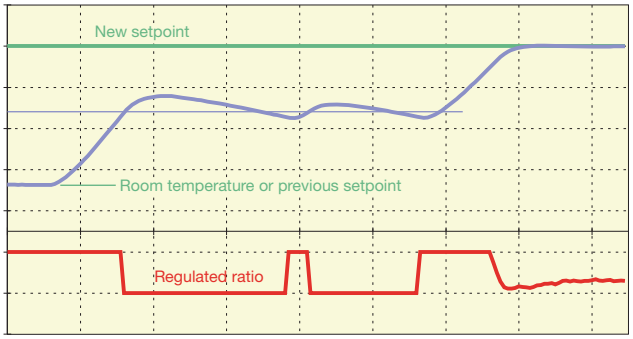
a) The temperature has reached the setpoint, no setpoint decrease



b) The temperature has reached the setpoint and a setpoint decrease has been configured



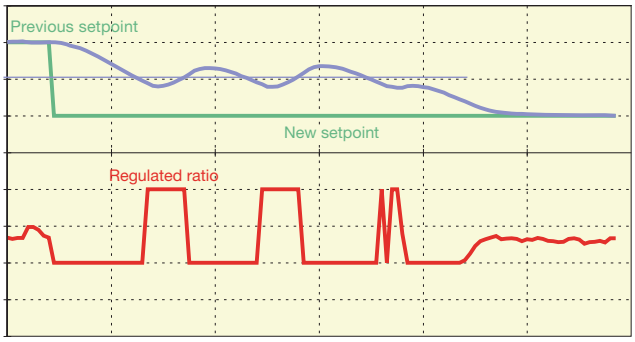
c) During start-up or as the temperature is increased



If a setpoint decrease has been set (the difference is negative), the lower value is decisive: Be it the value in the diagram or the setpoint minus the decrease.

If the value shown in the diagram has already been surpassed before the start of autotuning, this is conducted at the current actual value if the same is not below the setpoint minus the decrease.

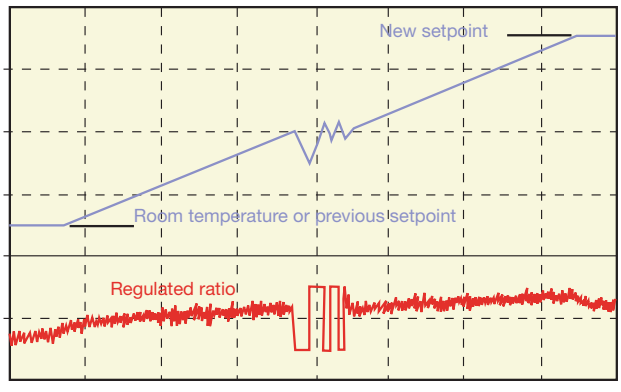
d) In temperature decrease



If a setpoint increase has been set (the difference is positive), the higher value is decisive: Be it the value in the diagram or the setpoint plus the increase.

If the value has already fallen below the one shown in the diagram before the start of autotuning, this is conducted at the current actual value if the same does not surpass the setpoint plus the increase.

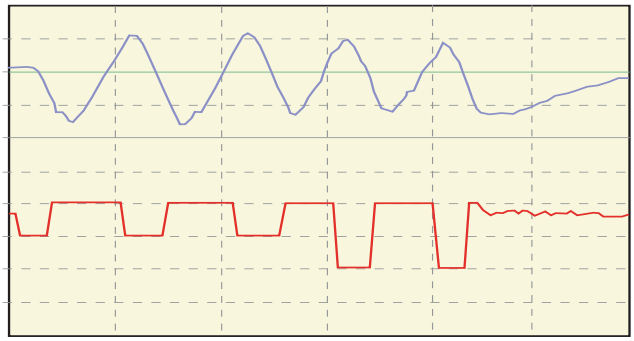
e) During start-up or as the temperature is increased with a setpoint ramp



If a setpoint ramp has been configurated for start-up or for decreasing the temperature, the same limits the setpoint

change until the point has been reached at which autotuning is supposed to be conducted. The oscillation test will then start at this point. The setpoint is never changed during autotuning.

f) 3-state setpoint autotuning



If an error occurs during autotuning, the same is stopped.

If the limit values are exceeded (3-state controller) cooling is immediately activated and a change to the heating/cooling method is effected. The controller must be set online to conduct autotuning, otherwise autotuning is stopped.

Using the limit value alarm suppression autotuning can also be performed if the actual value is not yet between the two limit values.

Table 2: Behaviour of temperature controller in different operating states:

Online Offline	Control state	Error	Specified regulated ratio (manually)	Confi-gured regulated ratio	Resulting regulated ratio
Offline			The regulated ratio is manually specified		0 % 0 % 0 %
Online	Setpoint has been reached	Breakage, short circuit, parameter error, device error	—	Maintain value	Last valid regulated ratio
	Setpoint has not yet been rea-ched	Breakage, short circuit, parameter error, device error		Maintain value	0 %
		Breakage, short circuit, parameter error, device error	—	The regulated ratio is specified in case of an error	Specified regulated ratio
		Heating defect	—		As in normal operation

The regulated ratio is not dependent on this setting.

In case of a parameter error it is assumed that the controller does not take on the desired behaviour. For this reason, the controller reacts in the same way as in case of an error. A200R and the PC software prevent the storage of incorrect parameters in VR660.

In case of a device error (invalid configuration values) VR660 behaves in the same way.

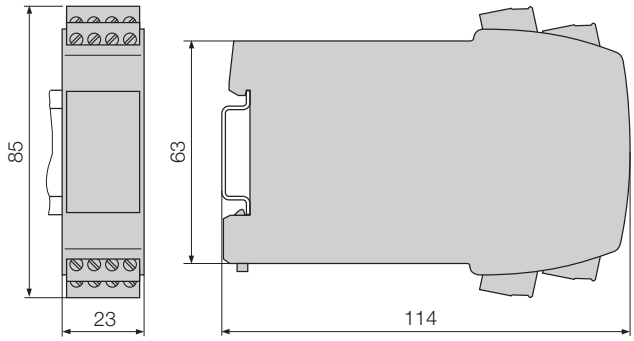
Autotuning is stopped in the following cases:

- Device is offline
- Limit values are exceeded (if not suppressed)
- Breakage, short circuit
- Incorrect regulated ratio limits

Table 3: Measuring input

Sensor	Measuring range	
Voltage input	– 1 … 1	V
RTD Pt 100 … 1000	– 200 … 850	°C
RTD Ni 100	– 60 … 250	°C
TC Type B	0 … 1820	°C
TC Type E	– 270 … 1000	°C
TC Type J	– 210 … 1200	°C
TC Type K	– 270 … 1372	°C
TC Type L	– 200 … 900	°C
TC Type N	– 270 … 1300	°C
TC Type R	– 50 … 1769	°C
TC Type S	– 50 … 1769	°C
TC Type T	– 270 … 400	°C
TC Type U	– 200 … 600	°C
TC Type C: W5Re / W26Re	0 … 2315	°C
TC Type D: W3Re / W25Re	0 … 2315	°C

Dimensions, dimensional sketch



VR660 in mounting rail housing P16/23 St on top-hat rail (35 x 15 mm or 35 x 7.5 mm, according to EN 50 022) snapped on, plug-in screw terminal.

Temperature controller parameters:

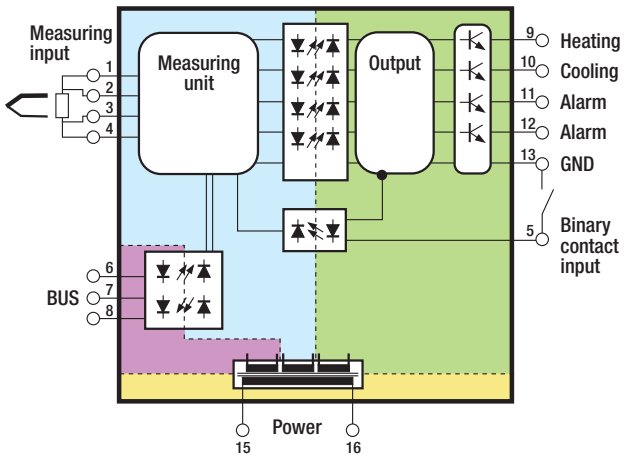
Description	Setting range	Default	Unit
Device information			
Firmware version	1.0 … 20.0	1.0	–
Settings			
Device address	1…32, delivery state	Delivery state	–
Device state	online/offline	Offline	–
Device information			
Informations TAG (8 bytes)		"VR660"	–
Date (DD,MM,YYYY) 4 bytes		1,1,2005	–
Measuring input			
Type of measurement	Voltage measurement Thermocouple internally compensated Thermocouple externally compensated Resistance thermometer 2-wire Resistance thermometer 3-wire Resistance thermometer 4-wire Resistance measurement 2-wire Resistance measurement 3-wire Resistance measurement 4-wire	Resistance thermometer 3-wire	mV °C °C °C °C °C Ω Ω Ω
Sensor type	linear RTD Pt100 RTD Pt1000 RTD Ni100 RTD Cu100 TC Type B TC Type E TC Type J TC Type K TC Type L TC Type N TC Type R TC Type S TC Type T TC Type U TC Type W5-W26Re TC Type W3-W25Re	RTD Pt 100	– – – – – – – – – – – – – – – – –
Sensor value at 0 °C (e.g. 100.0 for Pt100)	10 … 1000	100	Ω
Measuring range start	Sensor range	0	MRU
Measuring range end value	Sensor range	600	MRU
Calibration measuring range offset	– 10 … 10	0	%
Calibration measuring range Gain	90 … 110	100	%
Reference value: - RL for 2-wire	0 … 60	0	Ω
Reference value: Tref at TC ext. comp.	- 30 … 90	0	°C
Control parameter			
Controller Type	2-state heating 2-state cooling 3-state	2-state heating	– – –
Proportional band 1	0 … measuring range	50	MRU
Rate time 1	0 … 2000	25	s
Reset time 1	0 … 8000	100	s
Proportional band 2	0 … measuring range	50	MRU
Rate time 2	0 … 2000	25	s
Reset time 2	0 … 8000	100	s
Factor time constant derivative element	1 … 16	8	–
Cycle time	1 … 300	1	s
Dead band 3-state controller	0 … measuring range	0	MRU
Outputs			

Description	Setting range	Default	Unit
Regulated ratio in case of an error	– 100 … 100	0	%
Minimum regulated ratio	– 100 … 100	0	%
Maximum regulated ratio	– 100 … 100	100	%
Disturbance variable regulated ratio	– 100 … 100	0	%
Heating: ON state time	–	0	10 ms
Heating: Minimum OFF state time	–	0	10 ms
Cooling: ON state time	–	0	10 ms
Cooling: OFF state time	–	0	10 ms
Setpoints			
1st setpoint	Limit	0	MRU
2nd setpoint	Limit	0	MRU
Minimum setpoint	Measuring range	0	MRU
Maximum setpoint	Measuring range	600	MRU
Positive setpoint ramp (upwards)	0 … 100 000	0	MRU/ min
Negative setpoint ramp (downwards)	0 … 100 000	0	MRU/ min
Setpoint profile: Number of table values	0 … 10	0	–
Setpoint profile: Time values	≥ 0, min. increasing with cycle time	0	s
Setpoint profile: Setpoints	Measuring range	0	MRU
Setpoint bias in autotuning	–	0	MRU
Settings, limit values, alarms			
Limit value 1 switch-on point	Measuring range	0	MRU
Limit value 1 switch-off point	Measuring range	0	MRU
Limit value 2 switch-on point	Measuring range	0	MRU
Limit value 2 switch-off point	Measuring range	0	MRU
Configuration settings	Outputs 1 … 4 inverted Offline if min. setpoint Alarm suppression self-optimisation Relative limit values Regulated ration fixed value (Err) Profile periodical Profile is active Starting	0	– – – 0 – – – –
Alarm settings output 3	Timeout communication Polarity reversal thermocouple Heating breakage Sensor short circuit Sensor breakage Limit value 2 Limit value 1	0	– – – – – – –
Alarm settings output 4	Same as alarm output 3	0	–
Binary input settings	Autotuning Online/Offline Second setpoint Feed forward control Start connection Start setpoint profile	0	– – – – – –

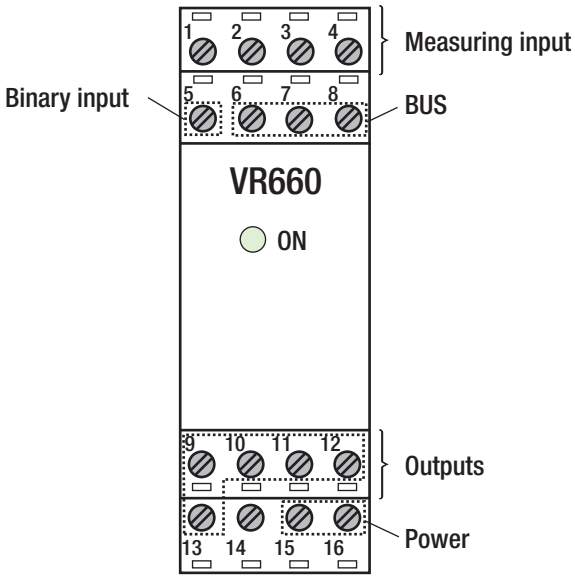
Abbreviation:
MRU = Unit of the measuring range (e.g. °C in temperature measurement)

Layout

Block diagram

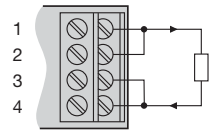
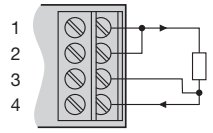
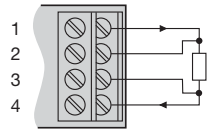
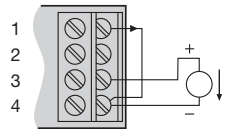
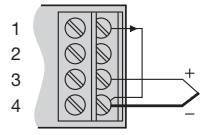
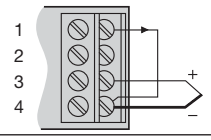


Terminal assignment



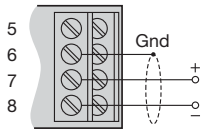
Electric connections

Measuring input

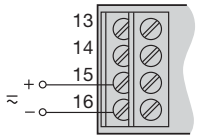
Resistance thermometer 2-lead	
Resistance thermometer 3-lead	
Resistance thermometer 4-lead	
Voltage input	
Thermocouple externally compensated	
Thermocouple internally compensated	

Bus connection

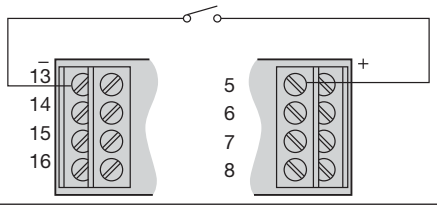
RS 485



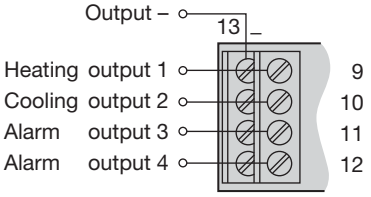
Power



Binary input



Outputs



3. Display device A200R

Mode of operationg

A200R in combination with the VR 660 top-hat rail controller serves visualising of measured values, parameterising of parameters and establishing as well as monitoring smaller bus systems.

A200R permits indirect access to connected devices via the installed RS-232 interface. A200R and every connected device may be configured with the CB-Manager configuration software.

After the device has been switched on it searches all bus participants. The parameters are updated and stored in A200R. After the initialising phase, the measured values of all bus participants are cyclically polled.

If a new device with a valid address is connected to the system during operation, it is immediately recognised and the system is extendet by this system. A newly added device (in delivery state) is automatically recognised – and a free address is allocated to the device.

An exchange of devices is also possible:

– The old device is removed from the system. A200R keeps all settings of the removed device.
– A new device (in delivery state) is added to the system. This device first receives the address of the old device and subsequently the same configuration which was stored in the old device.

A temperature controller in delivery state has a special device address: 7Fh

A system can be established with preconfigured temperature controllers. This system is automatically recognised after A200R has been switched on – even if another system had previously been stored.

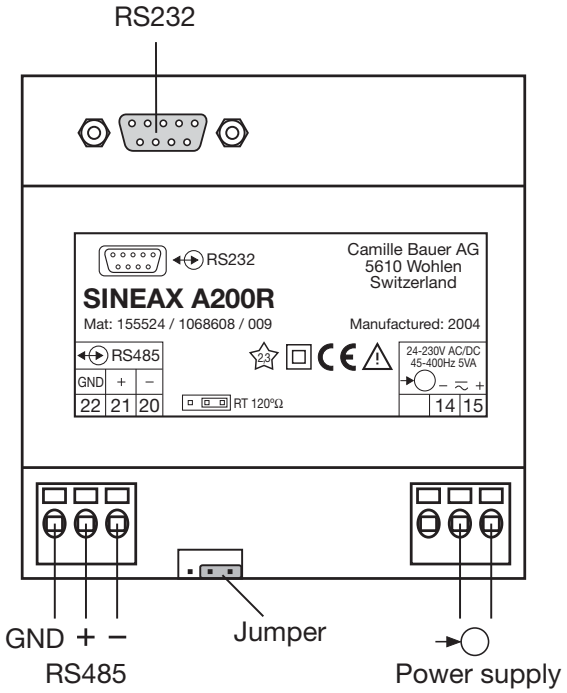
As soon as the system has been established, different actions can be performed. Autotuning may be started or stopped in individual controllers or all connected temperature controllers.

Under no circumstances may several VR660 devices be simultaneously connected to A200R. They must be connected to the bus one after the other!

Therefore, please read carefully about commissioning in Chapter “6. Operation” of the Operating Instructions before switching on the system.

Cyclical polling of the measured values is interrupted while the whole configuration of a device is read or written. This is for example, the case when a device is exchanged, a new device is added or during the starting procedure.

Connections:



The jumper serves the connection of the terminal resistor to the RS485 interface.

Interfaces: – Terminals with RS485
– DSUB: RS232

For further details see A200R Operating Instructions!