Honeywell

krom// schröder

Protective system controls FCU 500, FCU 505

Technical Information · GB
6 Edition 06.16

- For monitoring and controlling central safety functions in multiple burner systems on industrial furnaces
- Valve proving system for a valve system leak tightness check (optional)
- Safety temperature monitor (STM) or safety temperature limiter (STL) (optional)
- Long service life due to replaceable power module for fail-safe outputs
- Visualization and adaptation to the specific application via the PC programming and diagnostic software BCSoft to simplify logistics management

Contents

1 Application

FCU with plug-in connection terminals

Protective system control FCU 500 is designed to monitor and control central safety functions, e.g. $gas_{min.}$, $gas_{max.}$, $air_{min.}$, pre-purge, tightness test, high temperature operation or start enable for burner control units, in multiple burner systems on industrial furnaces. In a furnace and zone control system, the FCU 500 assumes central functions. The FCU 505 is used to monitor local safety functions and to control the zone capacity. If the centrally checked safety requirements, e.g. pre-purge, flow detector and pressure switch check, have been met, the FCUs issue the start enable signal to the burner control units.

The FCU is optionally available with integrated safety temperature monitor or safety temperature limiter, integrated tightness control and with an interface for controlling the capacity of actuators or a frequency converter interface.

The program status and device parameters can be read directly from the unit. The FCU can be activated manually using the integrated Manual mode for setting and diagnostic purposes.

Thanks to the optionally integrated valve proving system, the valves can be checked for leaks by querying an external gas pressure switch or it can be checked whether the gas valve on the inlet side is closed.

Using the BCSoft program, the parameters, analysis and diagnostic information can be read from the FCU via the optionally available opto-adapter. All valid parameters are saved on an integrated parameter chip card. The parameter chip card can be removed from the old unit and inserted into a new FCU to transfer the parameters, for example when replacing the unit.

The monitored outputs for the actuator and valves are accommodated in a plug-in power module. This can simply be replaced if necessary.

Once the plug-in power module has been removed, the parameter chip card and fuses are accessible.

The FCU can be installed on a DIN rail in the control cabinet. Plug-in connection terminal strips on the FCU make it easier to install and remove.

The external operator-control unit OCU is available as an option for the protective system controls. The OCU can be installed in the control cabinet door instead of standard control units. The program status, statistics, parameter values or fault messages can be read on the OCU. For burner adjustment, the operating points can be approached conveniently in Manual mode using the operator-control unit.

Thanks to the operator-control unit OCU, display functions and operation of the FCU can be relocated to the control cabinet door.

The optional bus module BCM 500 makes it possible to connect the FCU to a fieldbus interface in a Profinet network. Networking via the fieldbus enables multiple FCUs to be controlled and monitored by an automation system (e.g. PLC). The bus module is prepared for DIN rail installation. It is pushed on to the FCU from the side.

The address for the fieldbus communication is set using three code switches.

Application

Roller hearth kiln in the ceramics industry
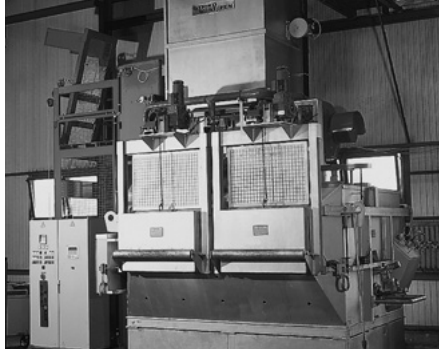
Shaft melting furnace
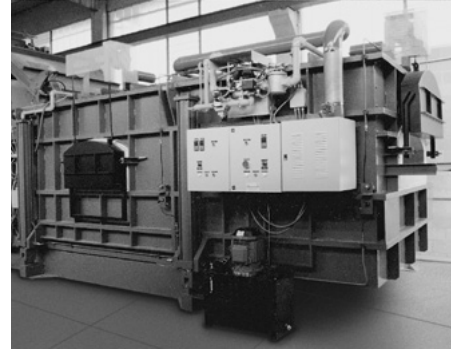
Smelting and holding furnace
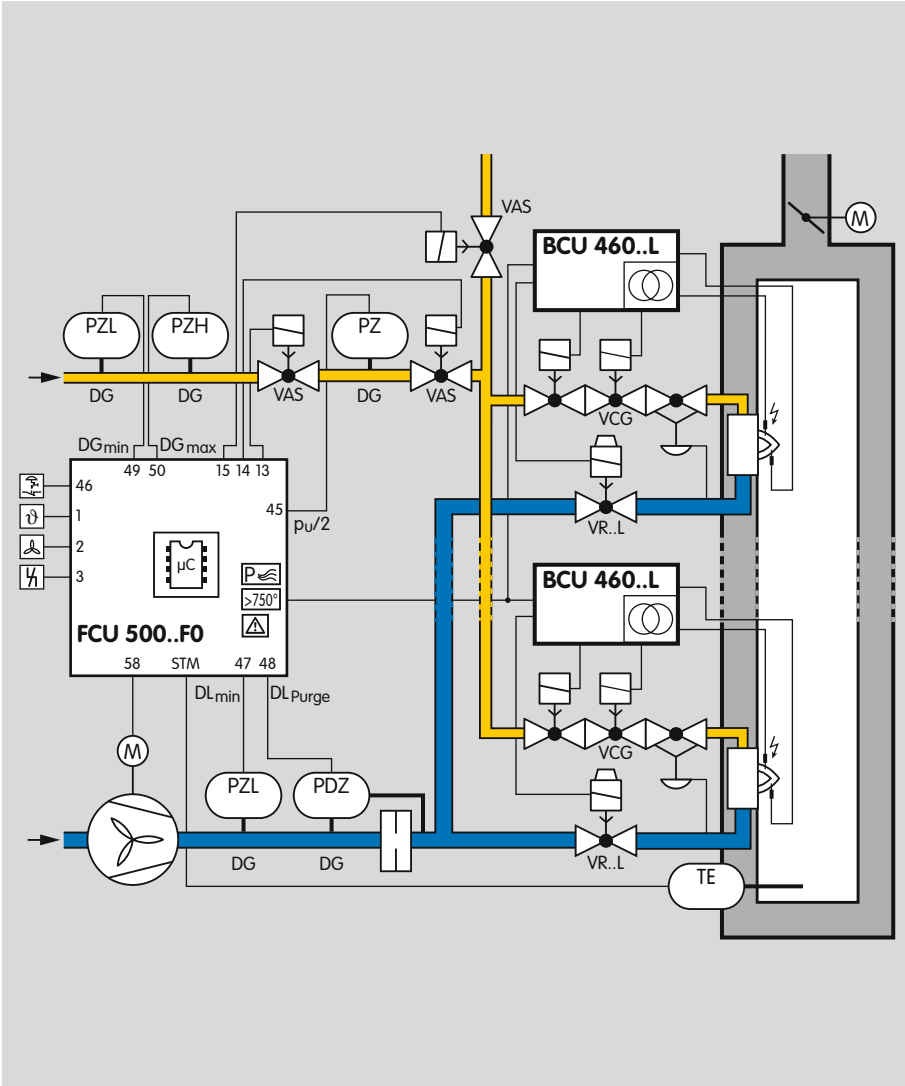
1.1 Application examples

1.1.1 ON/OFF rotary impulse control

For processes which require a turn-down of more than 10:1 and/or those which require heavy circulation of the furnace atmosphere to ensure a uniform temperature, e.g. heat treatment furnaces operating at low and medium temperatures in the metallurgical industry.

With ON/OFF cyclic control, the capacity supplied to the process is controlled by means of a variable ratio of the operating time to the pause time. In this type of control, the burner output pulse frequency always maintains full momentum and results in maximum convection in the furnace chamber, even with regulated heating.

The pneumatic ratio control system controls the gas pressure on the burner proportionally to the air pressure and thus maintains a constant air/gas ratio. At the same time, it acts as a low air pressure protection device.
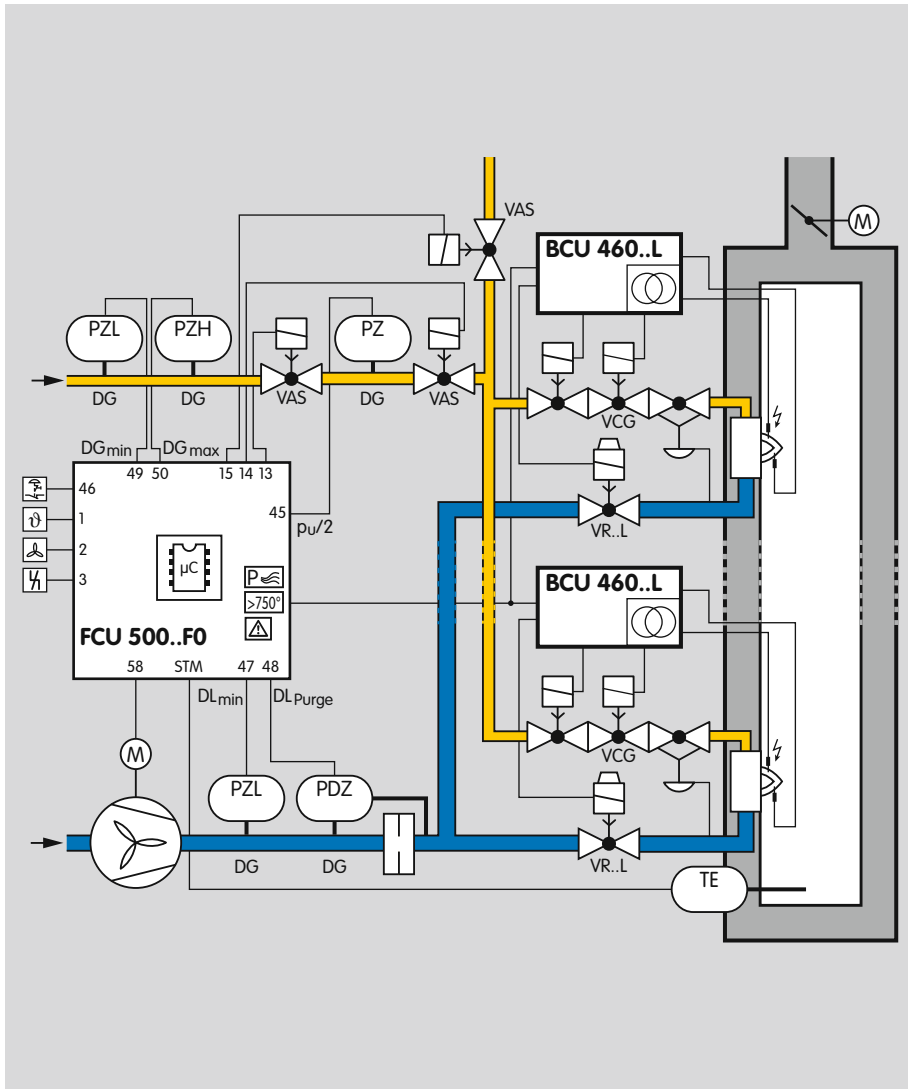
The ignition and monitoring of the individual burners is ensured by burner control unit BCU 460..L.

The centrally checked safety functions such as pre-purge, tightness test, flow detector and pressure switch check (gas$_{min.}$, gas$_{max.}$, air$_{min.}$) are provided by the FCU 500.
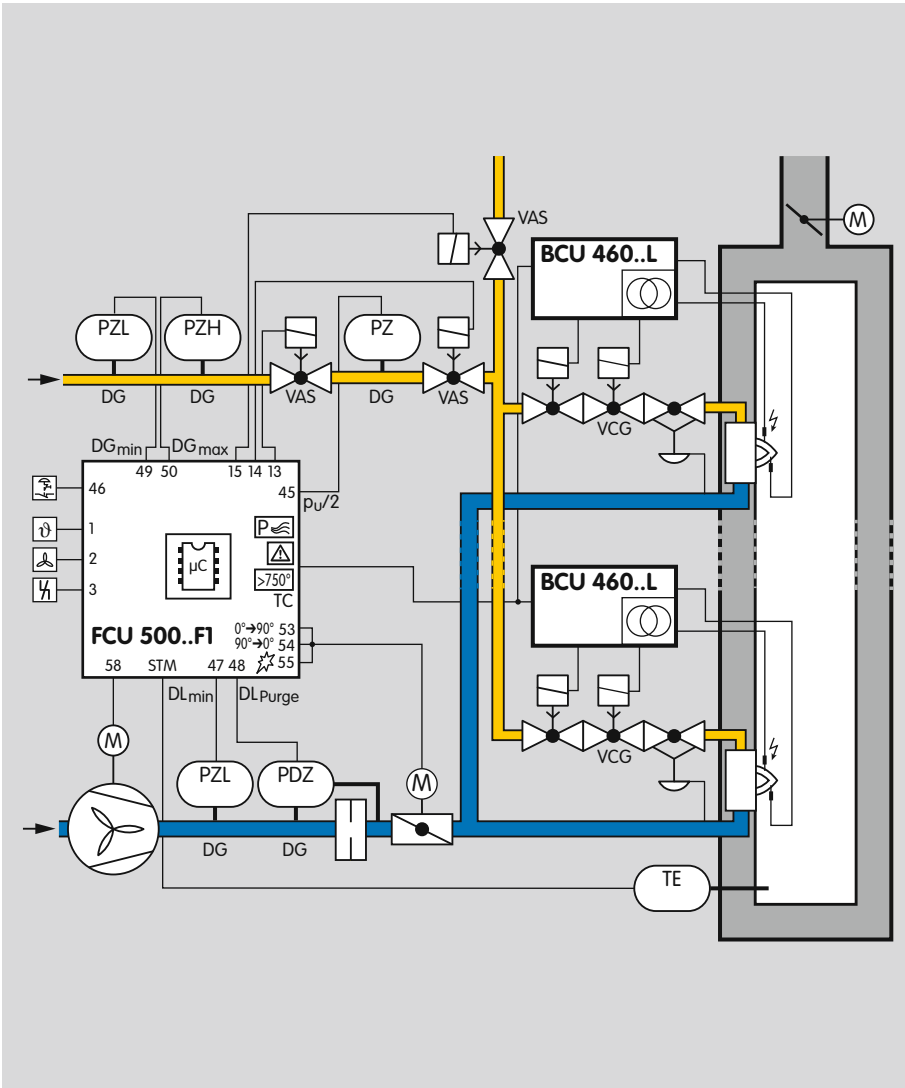
1.1.2 Modulating burner control

For processes that do not require heavy circulation in the furnace, e.g. aluminium smelting furnaces.

This system is suitable for processes in which infiltrated air may flow into the furnace through switched off burners. The capacity can be adjusted continuously by activating the air control valve (analogue or 3-point step signal). The pneumatic ratio control system controls the gas pressure proportionally to the air pressure and thus maintains a constant air/gas ratio. At the same time, it acts as a low air pressure protection device.

One burner control unit per burner is required for ignition and monitoring.

The centrally checked safety functions such as pre-purge, setting the valve to ignition position via a butterfly valve control system, tightness test, flow detector and pressure switch check ($gas_{min.}$, $gas_{max.}$, $air_{min.}$) are provided by the FCU 500.
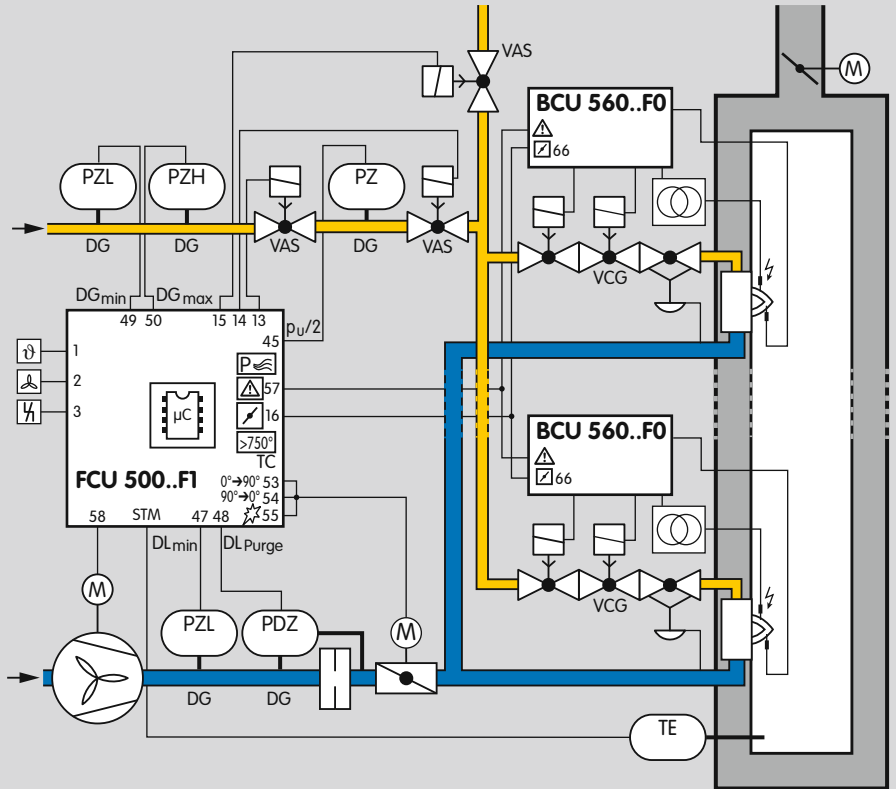
1.1.3 Safety limits (LDS) for modulating burner control

The centrally checked safety functions such as pre-purge, setting the valve to ignition position via a butterfly valve control system, tightness test, flow detector and pressure switch check ($gas_{min.}$, $gas_{max.}$, $air_{min.}$) are provided by the FCU 500. The capacity can be adjusted continuously by activating the control element (analogue or 3-point step signal).

To ensure that the correct air volume is available for ignition (start fuel flow rate) when starting the burners, the FCU sends the burner start enable signal to the BCUs via the "LDS (limits during start-up)" output.

The circuit design of the safety interlock and LDS outputs on the FCU and the corresponding inputs on the BCUs ensures that the burners can only start if the safety interlocks and the LDS output have enabled burner start-up.

1.1.4 Flame control using the temperature
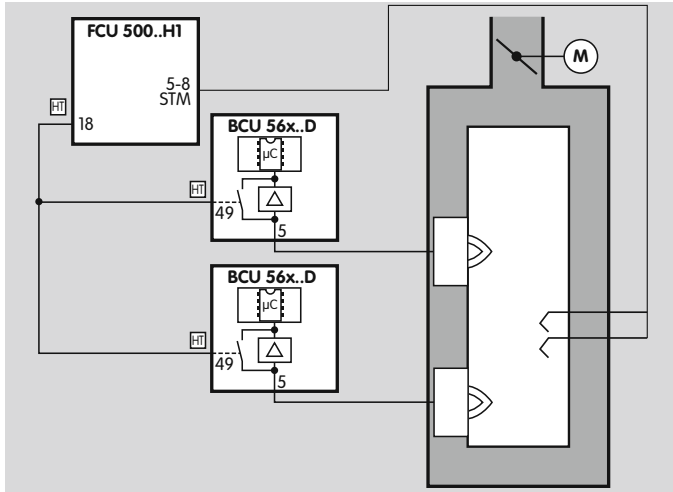
In high temperature systems (temperature > 750°C), the flame may be controlled indirectly via the tempera‐ ture. As long as the temperature in the furnace chamber is below 750°C, the flame must be controlled by con‐ ventional methods.

If the temperature in the furnace chamber rises above the spontaneous ignition temperature of the gas/air mixture (> 750°C), the FCU signals to the burner control units via the fail‐safe HT output that the furnace sys‐ tem is in High temperature mode (HT). When the HT in‐ put is activated, the burner control units switch to High temperature mode. They operate without evaluation of the flame signal and their internal flame control system is non‐functional.

If the furnace temperature falls below the spontaneous ignition temperature (< 750°C), the FCU disconnects the HT output from the electrical power supply. There is no active signal at the HT inputs of the burner control units. The flame signals are monitored once again by the UV sensor or flame rod.

In the event of a fault in a temperature monitoring com‐ ponent (e.g. sensor discontinuity, sensor short‐circuit) or in the event of a mains failure, the flame control task is transferred to the burner control units.
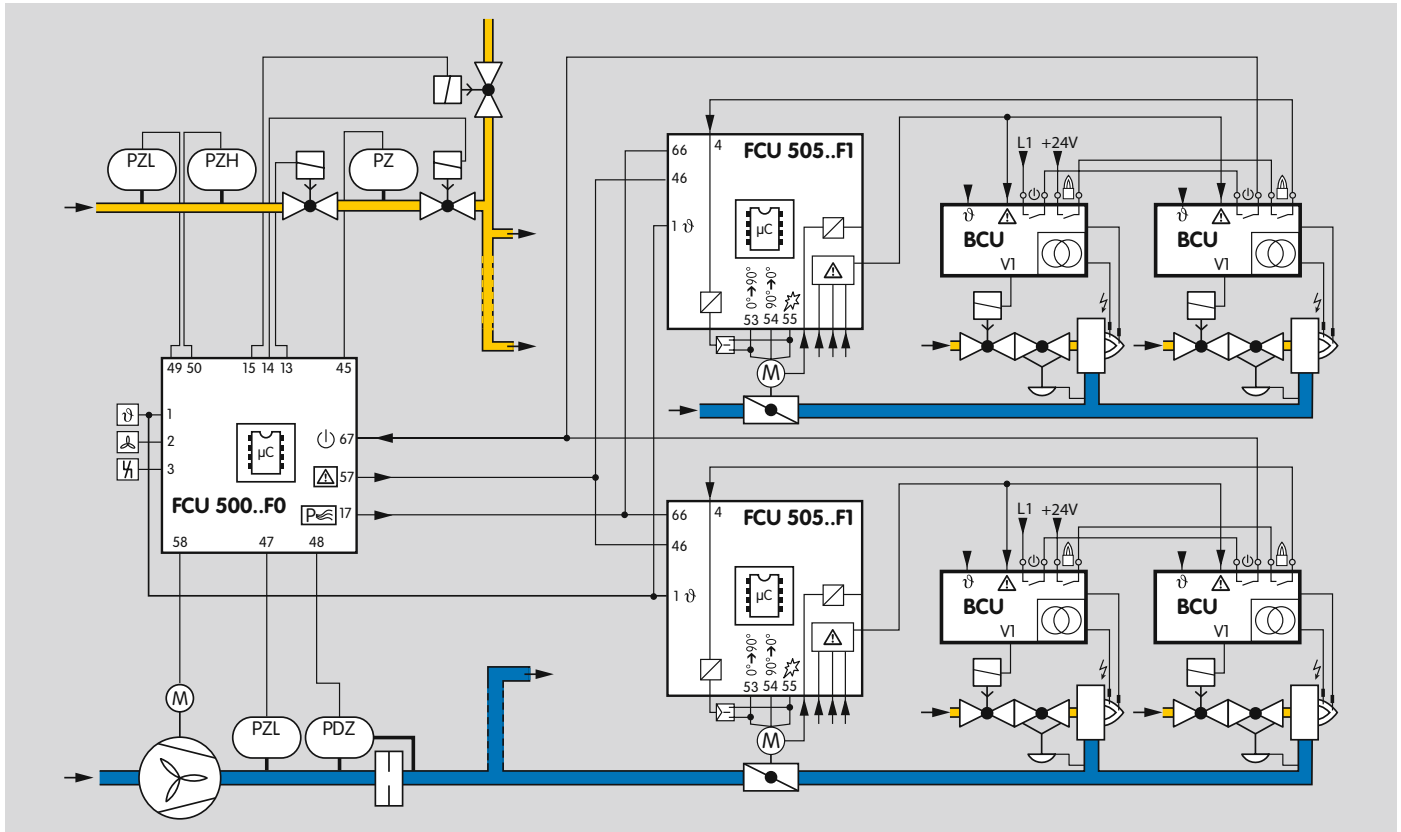
1.1.5 Furnace and zone control

The FCU 500 (furnace FCU) performs central tasks such as checking the safety interlocks, fan control, system leak tightness check and pre-purge.

It signals to the FCU 505 in the zones that the butterfly valves can be moved to the purge position. Signals are sent to the butterfly valves by the FCU 505. The butterfly valves move into position. A signal is sent to the FCU 505 via their safety interlock input that the central FCU 500 has issued the enable signal for the burners.

2 Certification

Certificates – see Docuthek.

Certified pursuant to SIL

For systems up to SIL 3 pursuant to EN 61508.

Pursuant to EN ISO 13849-1:2006, Table 4, the FCU can be used up to PL e.

EU certified pursuant to

– Gas Appliances Directive (2009/142/EC) in conjunction with EN 298, EN 1643

Meets the requirements of the
– Low Voltage Directive (2006/95/EC),
– EMC Directive (2004/108/EC).

FM approved

Factory Mutual Research Class: 7610 "Combustion Safeguards and Flame Sensing Systems". Suitable for applications pursuant to NFPA 86. www.approvalguide.com

ANSI/CSA approved

American National Standards Institute/Canadian Standards Association – ANSI Z21.20/CSA C22.2, No. 199
www.csagroup.org – Class number: 3335-01 (natural gas, propane), 3335-81 (natural gas, LPG).

Eurasian Customs Union

The product FCU 500 meets the technical specifications of the Eurasian Customs Union.

3 Function

3.1 Connection diagram

3.1.1 FCU 500

Detailed connection diagrams for actuators and frequency converters, see from page 91 (Capacity control)

Electrical connection, see page 120 (Project planning information)

Explanation of symbols, see page 144 (Legend)
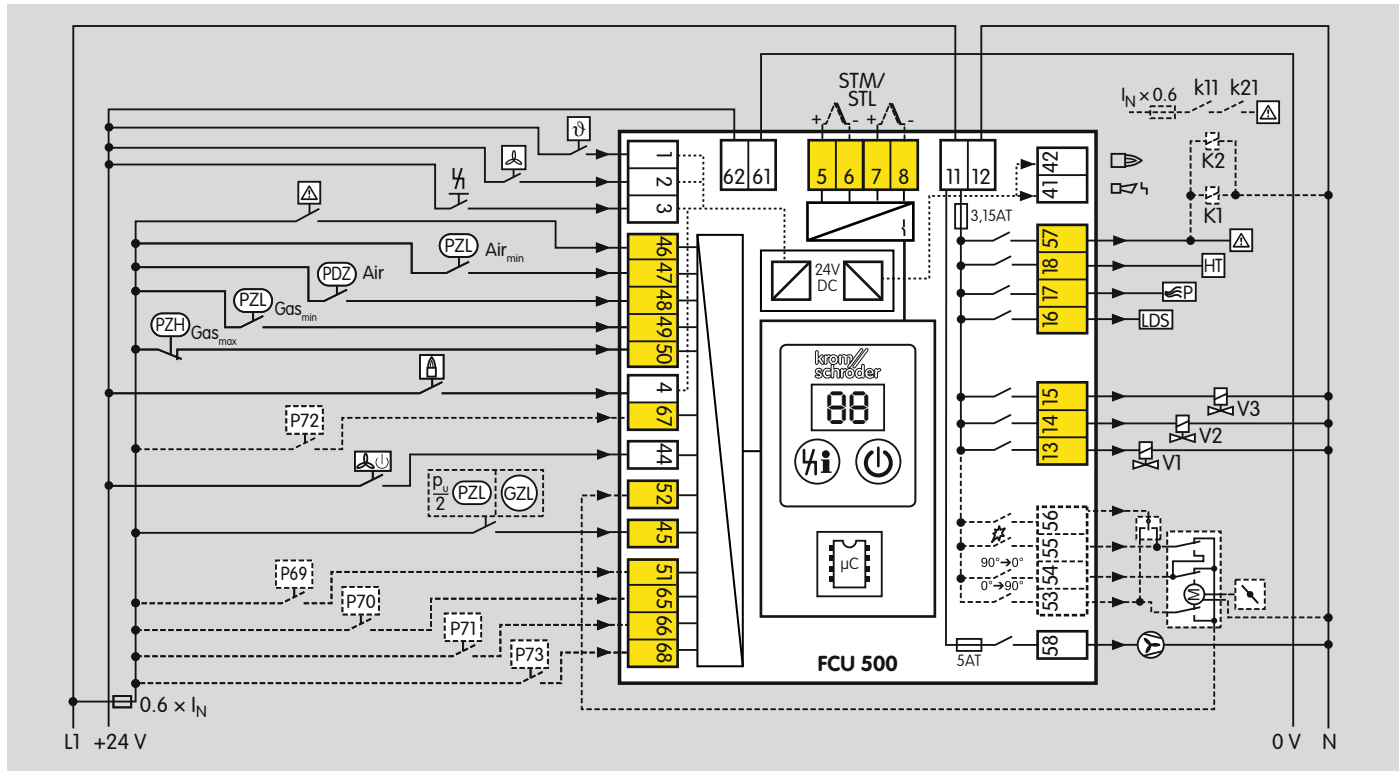
3.1.2 FCU 505

Detailed connection diagrams for actuators and frequency converters, see from page 91 (Capacity control)

Electrical connection, see page 120 (Project planning information)

Explanation of symbols, see page 144 (Legend)
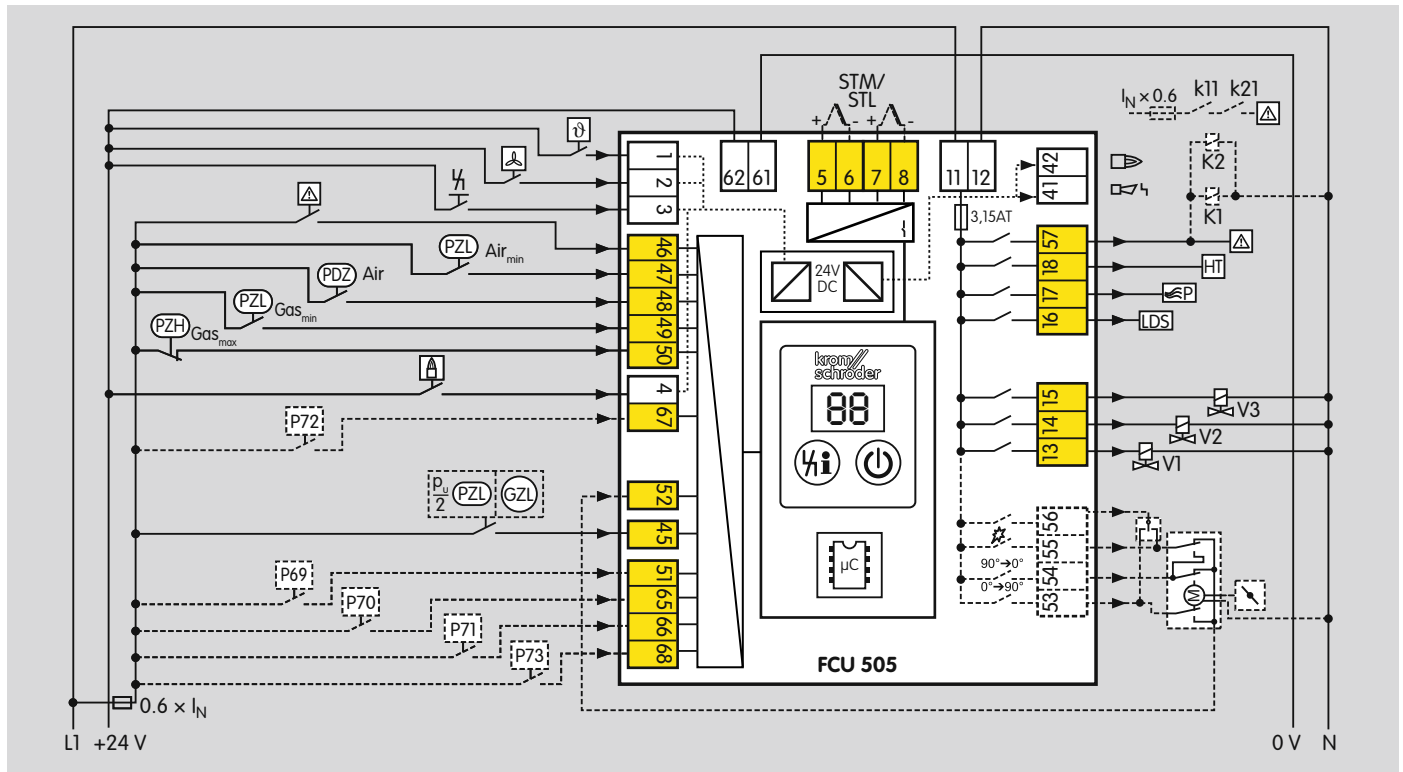
3.1.3 Assignment of connection terminals

Terminal	Type	Designation	Function
1	24 V DC input	Start-up signal	Signal applied: FCU start; no signal: FCU stop
2		Controlled air flow	Signal applied: fan is started to supply air to the combustion chamber for cooling, for example. Only functional in standby. The function is deactivated as soon as a signal is received at terminal 1 (FCU start).
3		Remote reset	Input for external signal (button) to reset the unit after a fault lock-out
4		Operating signal	Signal from the burner control units to inform the FCU that a sufficient number of burners is available for temperature control
5, 6 and 7, 8	Double thermocouple	Safety temperature monitor and/or safety temperature limiter	Monitor the spontaneous ignition temperature of the gas/air mixture in High temperature mode and/or the maximum furnace or flue gas temperature using the integrated temperature module of the FCU..H1
11, 12	V AC input	Supply voltage	Voltage to operate the FCU, 11 = phase (L1), 12 = neutral conductor (N)
13	Safety circuit output	Gas valve V1	Connection of phase for gas valve V1
14		Gas valve V2	Connection of phase for gas valve V2
15		Gas valve V3	Connection of phase for gas valve V3
57		Safety interlocks (limits)	Safety enable signal to the burner control units
16		Safety limits (limits during start-up)	To ensure that the correct air volume is available for ignition (start fuel flow rate) when starting the burners, the FCU sends the burner start enable signal to the burner control units via this output.
17		Purge	Signal to FCU 505 or burner control units to inform them that purge is in process
18		High temperature operation	Enable signal from the FCU indicating that the furnace system is in High temperature mode
41	24 V DC output	Fault	Fault signalling output, 24 V DC, max. 0.1 A
42		Operating signal	Operation signalling output, 24 V DC, max. 0.1 A
44	24 V DC input	Fan ready for operation	Feedback signal from fan indicating readiness for operation, see Parameter 31

▼

Terminal	Type	Designation	Function
45	Safety circuit input	Valve proving system	Connection for the sensor of the valve proving system (tightness control pressure switch or POC switch for checking the closed position).
46		Controller enable/emergency stop	Connection for higher-level safety devices and interlocks (e.g. emergency stop, safety temperature monitor), see Parameter 10
47		Minimum air pressure	Connection for pressure switch to monitor the minimum air pressure, see Parameter 15
48		Minimum air flow	Connection for a sensor to monitor the minimum air flow during pre-purge or post-purge, see Parameters 35, 38
49		Minimum gas pressure	Connection for pressure switch to monitor the minimum gas pressure, see Parameter 13
50		Maximum gas pressure	Connection for pressure switch to monitor the maximum gas pressure, see Parameter 12
51, 65, 66, 67, 68		Programmable inputs	The terminals can be assigned a function using parameters. To do so, logical AND gatings with terminals 46, 47, 48, 49 or 50 are possible.
52		Feedback from actuator/frequency converter	Connection for the position feedback signal from the actuator/frequency converter
53, 54, 55, 56	V AC output	Capacity control	Connection for capacity control using an actuator or frequency converter, see Parameter 40 to 47
58		Fan	Connection for fan control. Alternatively, this output can be used to activate a valve to check the function of the air pressure switch.

3.2 Program sequence

3.2.1 FCU 500..F0

Example of application, see page 8 (ON/OFF rotary impulse control)

	Switch on the FCU
	▼
	In the event of fault signal: reset
	▼
00	Start-up position/standby
	▼
H0	Start-up with ϑ signal
	▼
	Switch-on delay time t_E running (parameter 63) Safety interlocks check
	▼
01	Fan run-up time t_{GV} running (parameter 30) Pre-purge starts
	▼
d1	Air flow monitoring
	▼
P1	Pre-purge time t_{PV} running (parameter 34) Tightness test (if equipped with TC)
	▼
08	Gas enable via valves V1 and V2 Enable signal to burner control units for the burner start via the "safety interlock" output
	▼
	Operation

3.2.2 FCU 500..F1, FCU 500..F2

Example of application, see page 10 (Modulating burner control)

	Switch on the FCU
	▼
	In the event of fault signal: reset
	▼
00	Start-up position/standby
	▼
H0	Start-up with ϑ signal
	▼
	Switch-on delay time t_E running (parameter 63) Safety interlocks check
	▼
01	Fan run-up time t_{GV} running (parameter 30) Pre-purge starts
	▼
Ao	Actuator moves to the position for maximum capacity
	▼
d1	Air flow monitoring
	▼
P1	Pre-purge time t_{PV} running (parameter 34) Tightness test (if equipped with TC)
	▼
Ai	Actuator moves to the position for ignition capacity
	▼
H7	Gas enable via valves V1 and V2 Enable signal to burner control units for the burner start via the "safety interlock" output
	▼
H8	Controller enabler signal delay time t_{RF} running
	▼
08	Operation/controller enable

3.2.3 FCU 505..F1, FCU 505..F2

Example of application, see page 13 (Furnace and zone control)

	Switch on the FCU
	▼
	In the event of fault signal: reset
	▼
00	Start-up position/standby
	▼
H0	Start-up with ϑ signal
	▼
	Switch-on delay time t_E running (parameter 63) Safety interlocks check
	▼
01	Fan run-up time t_{GV} running (parameter 30) Pre-purge starts
	▼
A0	Actuator moves to the position for maximum capacity
	▼
P1	FCU 500 pre-purge time t_{PV} running Tightness test (if equipped with TC)
	▼
Ai	Actuator moves to the position for ignition capacity
	▼
H8	Controller enabler signal delay time t_{RF} running
	▼
08	Operation/controller enable

3.3 Animation

The interactive animation shows the function of the protective system control FCU 500.

Click on the picture. The animation can be controlled using the control bar at the bottom of the window (as on a DVD player).

To play the animation, you will need Adobe Reader 9 or a newer version. If you do not have Adobe Reader on your system, you can download it from the Internet. Go to www.adobe.com, click on "Adobe Reader" at the bottom of the page and follow the instructions.

If the animation does not start to play, you can download it from the document library (www.docuthek.com) as an independent application.

4 Temperature monitoring

The FCU..H1 is fitted with an integrated temperature module.

This module can be used as a safety temperature monitor (STM) to monitor the spontaneous ignition temperature of the gas/air mixture or as a safety temperature limiter (STL) to monitor the maximum furnace/flue gas temperature. Double thermocouples are connected to the temperature module to measure the temperature.

The functions STM and STL can also be combined. In this case, the connected double thermocouple must reliably detect whether the spontaneous ignition temperature (> 750°C) has been exceeded and also whether the maximum permitted furnace temperature has been exceeded.

The safety temperature monitor and safety temperature limiter functions can be adjusted to the requirements of the system using parameters 20, 22, 23, 24 and 25, see page 82 (High temperature operation).

4.1 High temperature operation with safety temperature monitor function (STM function)

As soon as the temperature in the furnace chamber is above the spontaneous ignition temperature of the gas/air mixture (> 750°C), the FCU signals to the downstream burner control units via the fail-safe HT output that the furnace system is in High temperature mode (HT). When the HT input is activated, the burner control units switch to High temperature mode. They operate without evaluating the flame signal and their internal flame control is non-functional.

If the furnace temperature falls below the spontaneous ignition temperature (< 750°C), the FCU disconnects the HT output from the electrical power supply. As soon as the signal to the HT inputs of the burner control units is no longer present, the flame signals are once again monitored by a UV sensor or flame rod.

In the event of a fault in a temperature monitoring component (e.g. sensor discontinuity, sensor short-circuit) or in the event of a mains failure, the flame control task is transferred to the burner control units.

Either the temperature module integrated in the FCU.. H1 or an external safety temperature monitor (STM) can be used for High temperature mode. Pre-purge can be disabled for both versions in High temperature mode, see page 86 (Pre-purge during high temperature operation).

4.1.1 With integrated STM

The integrated temperature module (STM) can be used for high temperature operation. Pre-purge can be disabled in High temperature mode, see page 86 (Pre-purge during high temperature operation).
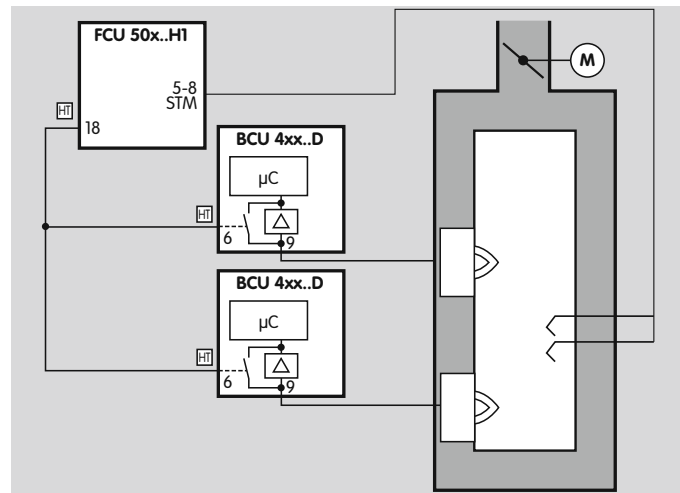
4.1.2 With external STM

An external safety temperature monitor (STM) can be used for high temperature operation. Pre-purge can be disabled in High temperature mode, see page 86 (Pre-purge during high temperature operation).
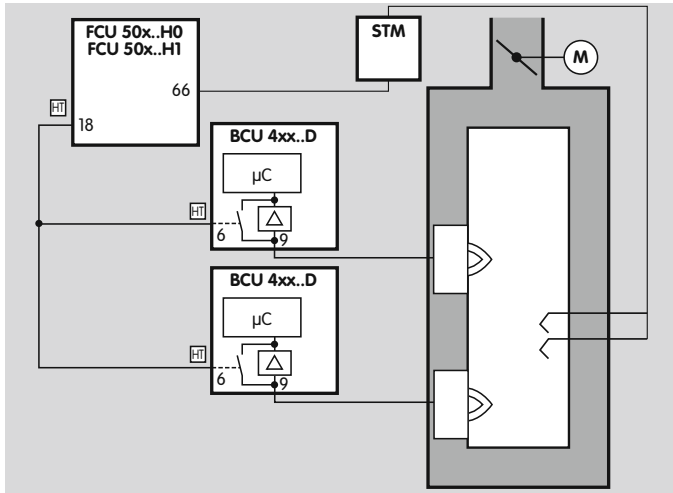
4.1.3 With integrated and external STM

The integrated temperature module can also be used in conjunction with an external safety temperature monitor (STM). The spontaneous ignition temperature can then be monitored at two different points in the furnace.
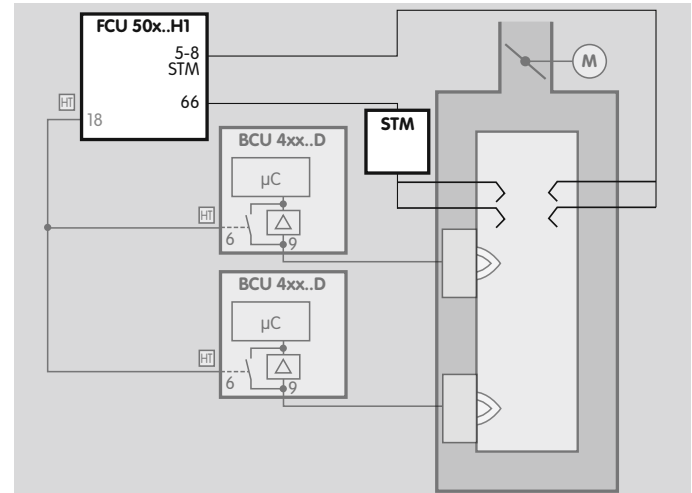
4.2 Maximum temperature monitoring with (flue gas) safety temperature limiter (STL/FSTL function)

As soon as the maximum permitted temperature limit is reached in the furnace or in the flue gas or an error occurs on the monitoring equipment within the permitted temperature range (e.g. sensor discontinuity, sensor short-circuit), the FCU will perform a fault lock-out. The safety interlock output will no longer be set.

The temperature module integrated in the FCU..H1 or an external safety temperature limiter (STL) can be used for this function.

4.2.1 With integrated STL/FSTL
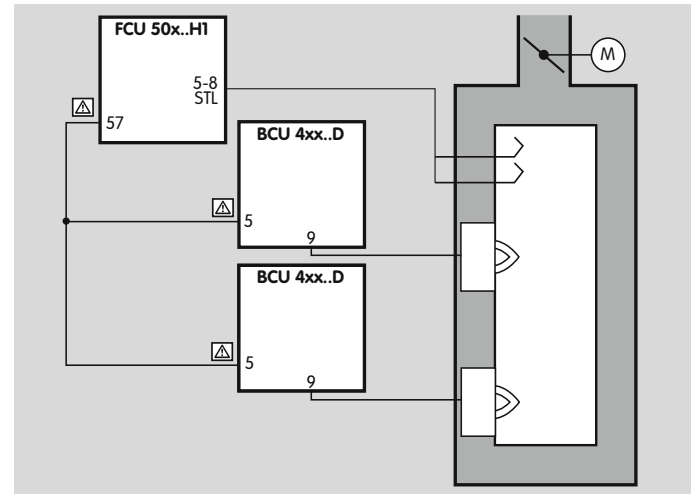
4.2.2 With external STL/FSTL
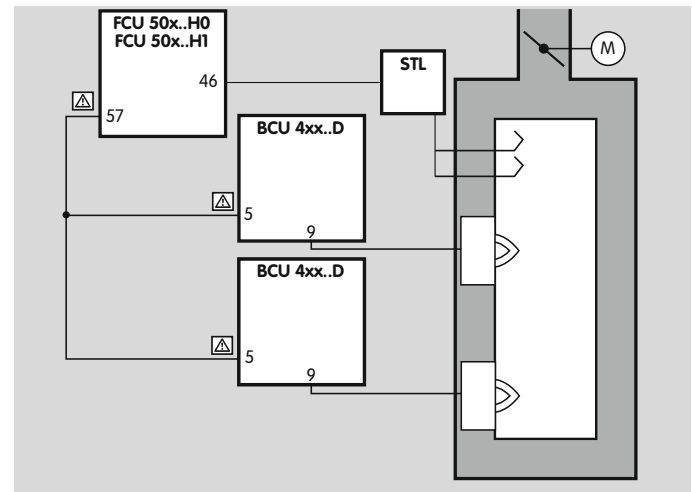
5 Air control

Acting as the furnace protective system, the FCU 500 assumes the task of central air control on a furnace. It controls and monitors the required air volume for start-up, during operation and after the furnace has been shut down. The fan is activated by the FCU for this purpose. The static air pressure and the air volume for pre-purge can be monitored by pressure switches.

The capacity control function provided by the FCU 500.. F1/F2 and FCU 505..F1/F2 allows an additional central actuator or a frequency-controlled fan to be controlled and monitored. While the furnace is starting up, the capacity control system controls and monitors the required air volumes for purging and for starting the burners. During operation, the FCU enables the external temperature control system for capacity control.
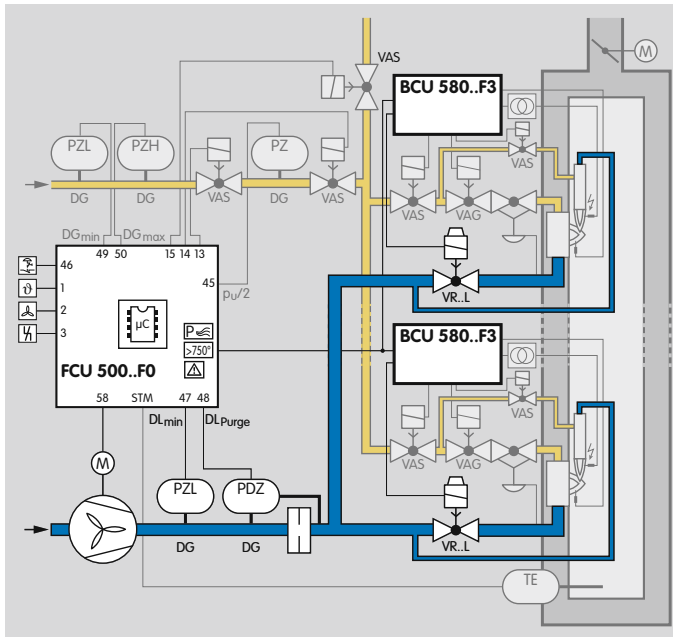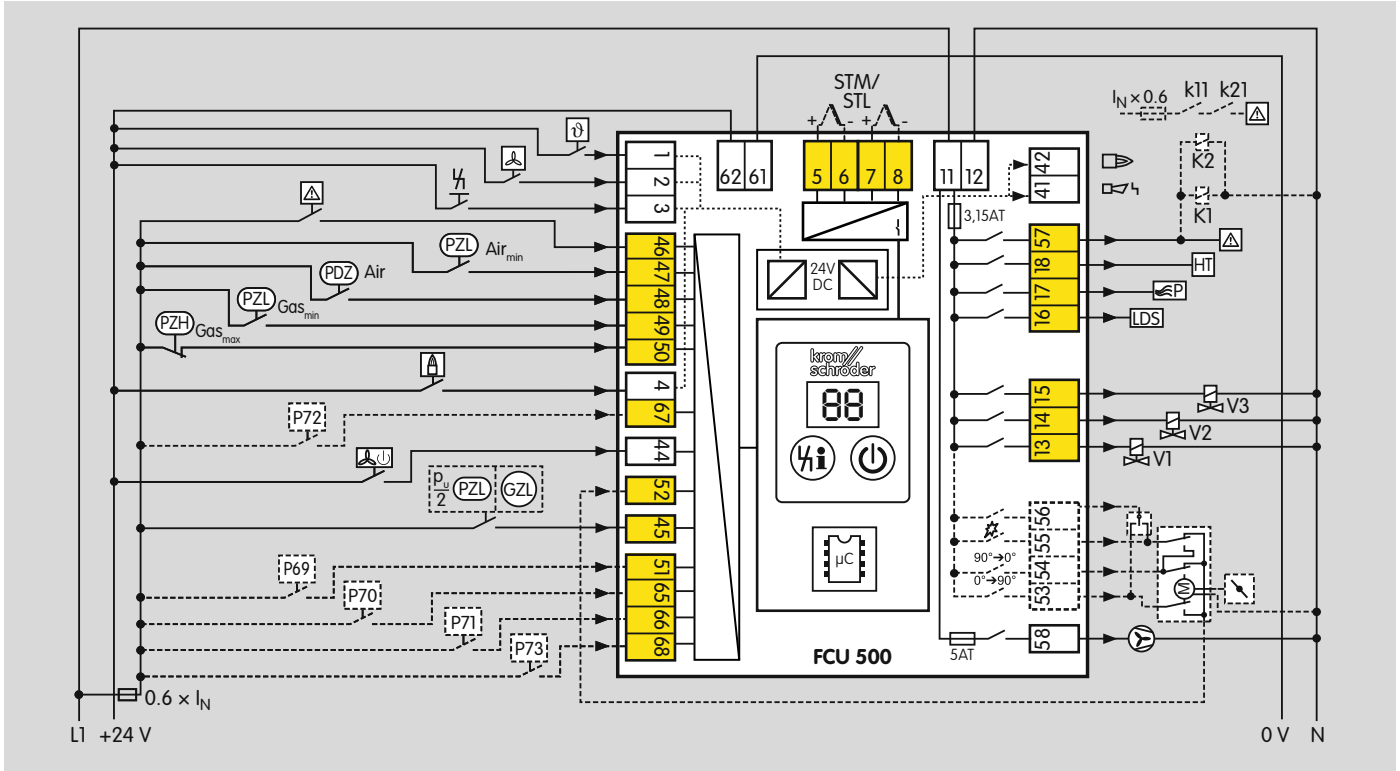
5.1 Controlled air flow

On FCU 500, actuation of the input at terminal 2 activates the controlled air flow function. The fan (terminal 58) is started in standby (with no start-up signal). Air is fed to the combustion chamber, e.g. for cooling.

The FCU starts the fan depending on the functions defined using parameters, see also page 81 (Low air pressure protection), page 88 (Air monitoring during controlled air flow) and page 89 (Air flow monitoring during pre-purge).

The controlled air flow function is no longer performed once the start-up signal has been received at terminal 1.

5.2 Capacity control

As soon as a start-up signal has been received by the FCU..F1/F2 (terminal 1), the fan of an FCU 500..F1/F2 is started via terminal 58 after the switch-on delay time has elapsed. The air volume for pre-purge is requested via the outputs for central capacity control (terminals 53 to 56). Air flow monitoring (terminal 48) starts. The pre-purge time starts if there is adequate air flow.

After the elapse of the pre-purge time, the air volume for ignition is requested. After the program has ended (limits during start-up, pre-purge and also tightness test for FCU..C1), the gas enable signal is issued via the valve outputs V1 (terminal 13) and V2 (terminal 14) and the burner start enable signal is issued to the burner control units via the "safety interlock" output (terminal 57).

The correct air volume for ignition (start fuel flow rate) must be available for each burner start, restart or start-up attempt. To this end, the FCU sends the burner start enable signal to the BCUs via the "LDS (limits during start-up)" output.

A corresponding circuit design between the FCU and the BCUs ensures that the burners can only start if the safety interlocks and the LDS output are active.
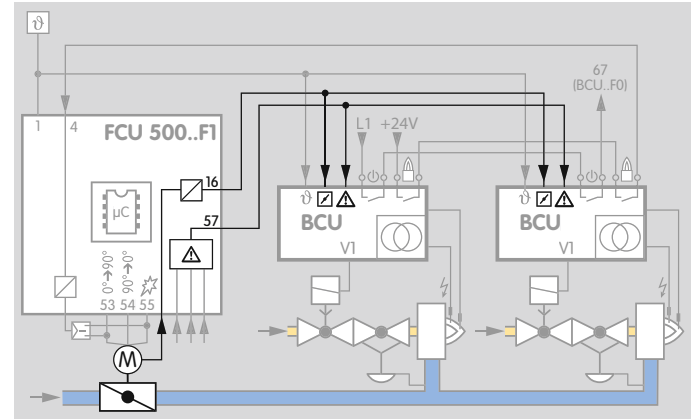
After the burner operating signal from the burner control units has been received, the FCU enables the control system for operation. For pertinent parameter settings, see page 101 (Burner operating signal).
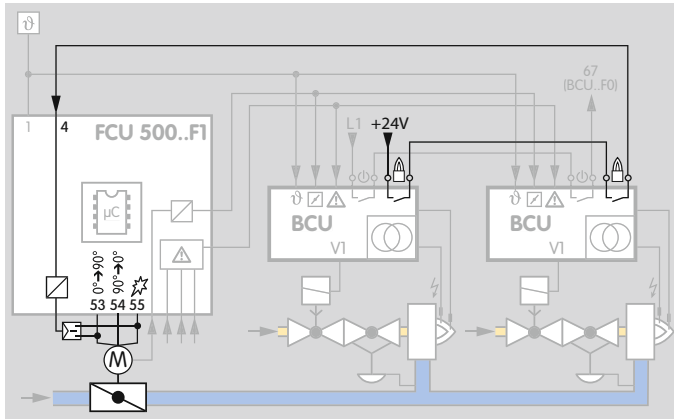
Depending on parameter 40, actuators IC 20 and IC 40, an actuator with an RBW interface or a fan controlled by a frequency converter can be actuated via the outputs for central capacity control, see page 91 (Capacity control).
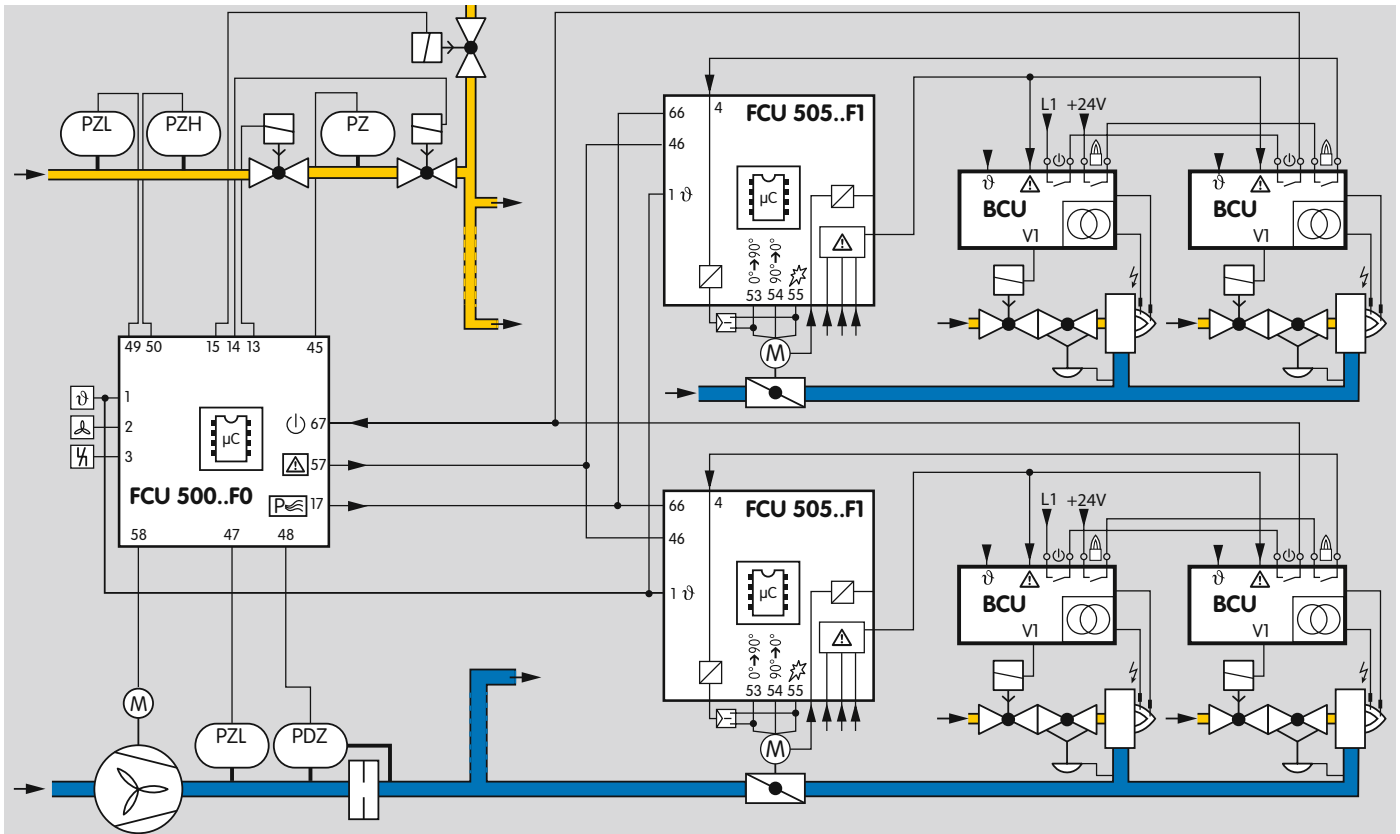
6 Furnace zone control

For furnace zone control, one FCU 500 is used to control the furnace and several FCU 505 are used to control the individual modulating zones (FCU 505..F1 or FCU 505..F2). When connecting several FCUs in a circuit, a hierarchical operating structure is applied.

The furnace FCU (FCU 500) performs central tasks such as checking the central safety functions, fan control, system leak tightness check and pre-purge.

The zone FCUs (FCU 505) control the zone capacity.

After checking the safety interlocks (after expiry of the switch-on delay time) and when the fan run-up time is started, the furnace FCU signals to the zone FCUs via the input at terminal 66 that they should move the actuators to purge position. After the purge (and the tightness test if applicable) has been ended, the furnace FCU signals to the zone FCUs via the input at terminal 46 that burner start is enabled. When they receive this signal, the zone FCUs move the valves to ignition position for starting the burners and then issue the enable signal to the burner control units to start the burners.

7 Valve proving system

The FCU..C1 is fitted with an integrated valve proving system. This allows the tightness of two or more gas solenoid valves and the pipework to be checked, see page 34 (Tightness control). Alternatively, the closed position of a gas solenoid valve can be checked using a POC switch, see page 57 (Proof of closure function).

Once the test has been carried out successfully, the furnace is enabled for start-up.

The tightness function satisfies the requirements of EN 1643 (Valve proving systems for automatic shut-off valves for gas burners and gas appliances).

By checking the closed position using the proof of closure function, the FCU complies with the requirements of NFPA 85 (Boiler and Combustion Systems Hazards Code) and NFPA 86 (Standard for Ovens and Furnaces).

7.1 Tightness control

The aim of the tightness control is to identify an in-admissible leak on one of the gas solenoid valves and to prevent burner start. European standards EN 746-2 and EN 676 stipulate tightness controls for capacities over 1200 kW (NFPA 86: from 117 kW or 400,000 Btu/h).

The FCU offers several ways of testing tightness:

1. Between 2 gas solenoid valves with one test volume (parameter 53 = 1):
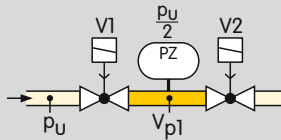
2. The system tightness of a complete gas inlet section with one test volume and pressure reduction using a relief valve (parameter 53 = 2):
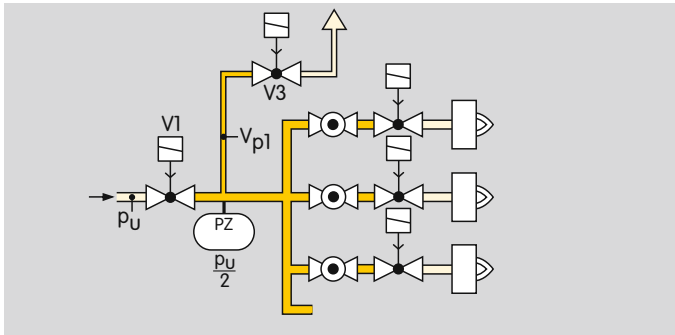
3. The system tightness of a complete gas inlet section with two test volumes and pressure reduction using a relief valve (parameter 53 = 3):
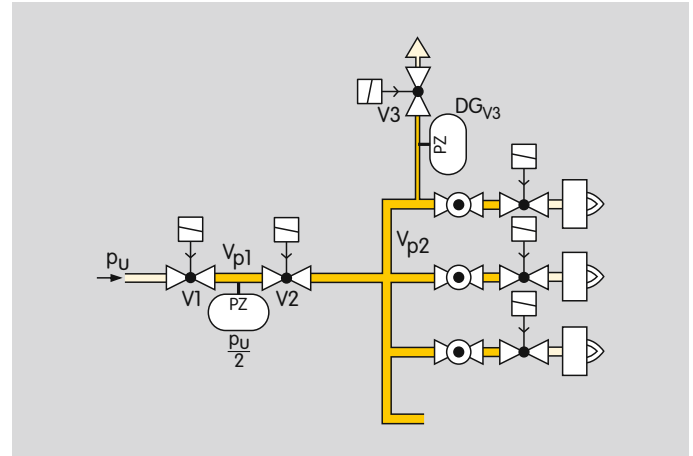
The valves and the pipework between the valves are tested.

7.1.1 Test instant

Depending on the parameter setting, the tightness control checks the tightness of the pipework and the gas solenoid valves before each start-up and/or after each shut-down of a furnace system, see page 108 (Valve proving system).

The gas line is always safeguarded by a gas solenoid valve during this check.

Before furnace start-up
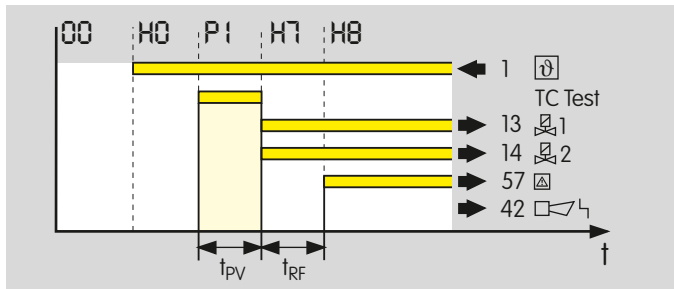
The FCU starts testing the tightness of the gas solenoid valves and pipework between the valves parallel to the pre-purge time. The gas line is always safeguarded by a gas solenoid valve during this check. When pre-purge is finished and the tightness has been checked successfully, the safety valves for operating the system are opened after the safety interlocks have been enabled.

After furnace shut-down
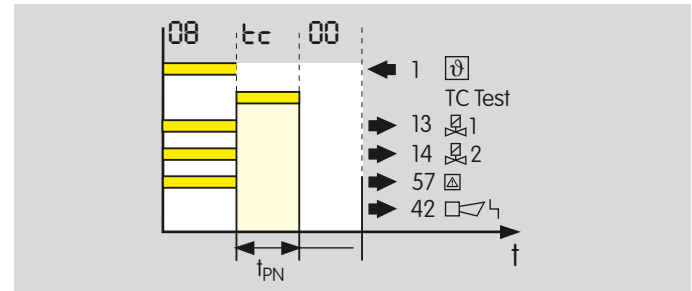
After the furnace has been shut down, the FCU starts testing the tightness of the gas solenoid valves and pipework between the valves. After the tightness has been checked successfully, the next furnace start is enabled as regards the tightness criteria.

Each time the FCU is reset or connected to mains voltage, a tightness test is performed immediately. The testing time can be reduced for large volumes, see page 111 (Large test volumes).

7.1.2 One test volume between 2 gas solenoid valves
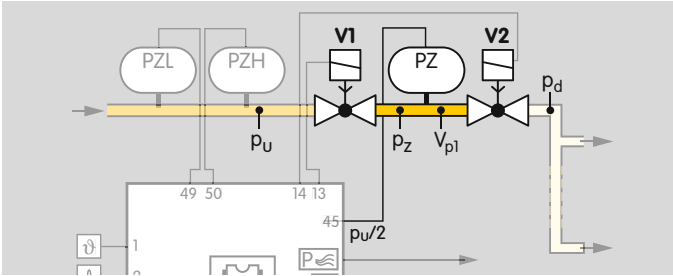
The tightness control checks the tightness of the test volume V_{p1} between gas solenoid valves V1 and V2.
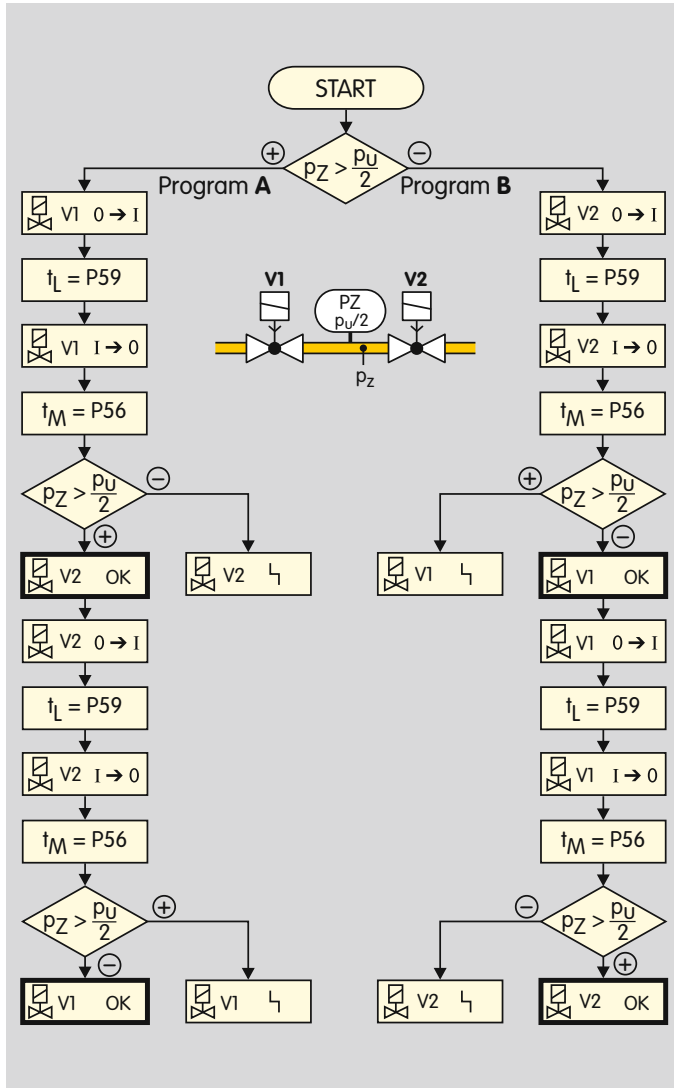
Program sequence

The tightness test starts by checking the external pressure switch. If pressure $p_Z > p_u/2$, program A starts.

If pressure $p_Z < p_u/2$, program B starts, see page 38 (Program B).

Program A

Valve V1 opens for the opening time t_L set in parameter 59. V1 closes again. During the measurement time t_M, the tightness control checks the pressure p_Z between the valves.

If pressure p_Z is less than half the inlet pressure $p_u/2$, valve V2 is leaking.

If pressure p_Z is greater than half the inlet pressure $p_u/2$, valve V2 is tight. Valve V2 is opened for the set opening time t_L. V2 closes again.

During the measurement time t_M, the tightness control checks the pressure p_Z between the valves.

If pressure p_Z is greater than half the inlet pressure $p_u/2$, valve V1 is leaking.

If pressure p_Z is less than half the inlet pressure $p_u/2$, valve V1 is tight.

The tightness test can only be performed if pressure p_d downstream of V2 is around atmospheric pressure.
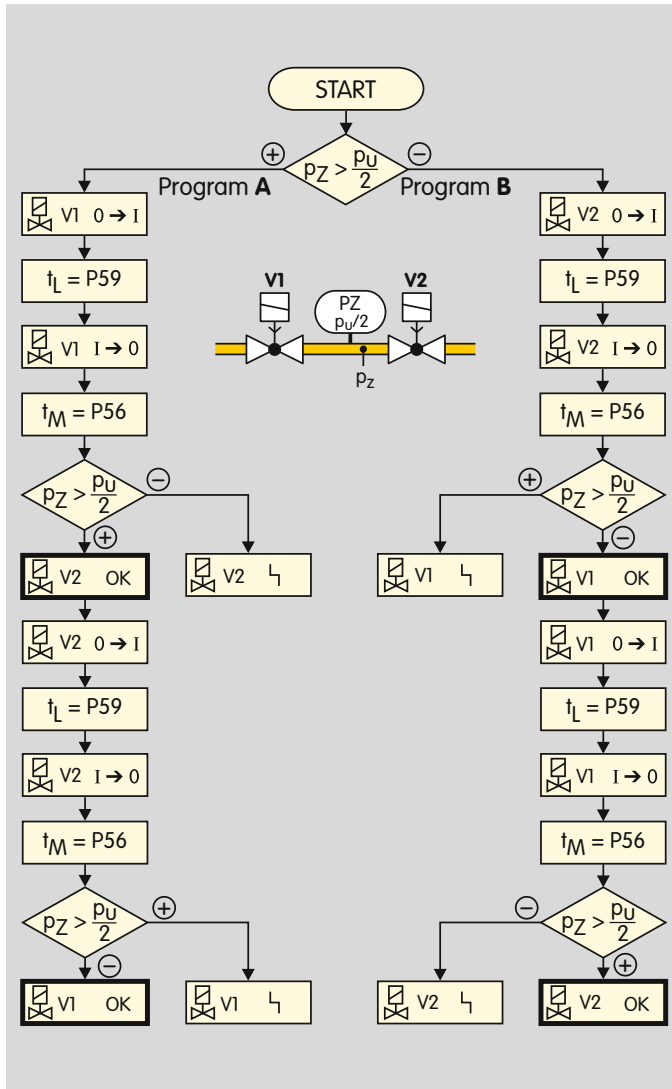
Program B

Valve V2 opens for the set opening time t_L. V2 closes again. During the measurement time t_M, the tightness control checks the pressure p_Z between the valves.

If pressure $p_Z > p_u/2$, valve V1 is leaking.

If pressure $p_Z < p_u/2$, valve V1 is tight. Valve V1 is opened for the set opening time t_L. V1 closes again.

During the measurement time t_M, the tightness control checks the pressure p_Z between the valves.

If pressure $p_Z < p_u/2$, valve V2 is leaking.

If pressure $p_Z > p_u/2$, valve V2 is tight.

The tightness test can only be performed if pressure p_d downstream of V2 is around atmospheric pressure.

7.1.3 One test volume for system tightness

The tightness control checks the system tightness of the test volume V_{p1} between the central shut-off valve V1, relief valve V3 and the burner valves. The opening times of the relief valve V3 and the shut-off valve V1 are identical.

Program sequence

The tightness test starts by checking the external pressure switch. If pressure $p_Z > p_u/2$, program A starts. If pressure $p_Z < p_u/2$, program B starts, see page 41 (Program B).

Program A

Valve V1 opens for the opening time t_L set in parameter 59. V1 closes again. During the measurement time t_M, the tightness control checks the pressure p_Z between the valves.

If pressure p_Z is less than half the inlet pressure $p_u/2$, test volume V_{p1} is leaking.

If pressure p_Z is greater than half the inlet pressure $p_u/2$, test volume V_{p1} is tight. Valve V3 is opened for the set opening time t_L. V3 closes again.

During the measurement time t_M, the tightness control checks the pressure p_Z between the valves.

If pressure p_Z is greater than half the inlet pressure $p_u/2$, valve V1 is leaking.

If pressure p_Z is less than half the inlet pressure $p_u/2$, valve V1 is tight.

The tightness test can only be performed if pressure p_d downstream of V3 is around atmospheric pressure.
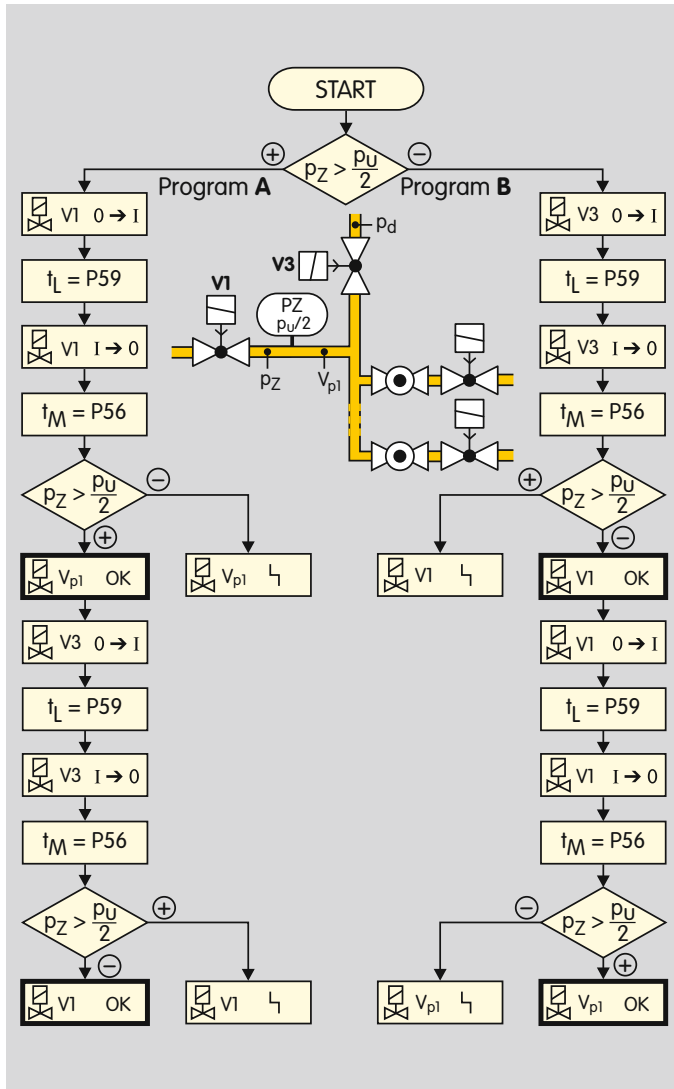
Program B

Valve V3 opens for the set opening time t_L. V3 closes again. During the measurement time t_M, the tightness control checks the pressure p_Z between the valves.

If pressure $p_Z > p_u/2$, valve V1 is leaking.

If pressure $p_Z < p_u/2$, valve V1 is tight. Valve V1 is opened for the set opening time t_L. V1 closes again.

During the measurement time t_M, the tightness control checks the pressure p_Z between the valves.

If pressure $p_Z > p_u/2$, test volume V_{p1} is tight.

If pressure $p_Z < p_u/2$, test volume V_{p1} is leaking.

The tightness test can only be performed if pressure p_d downstream of V3 is around atmospheric pressure.
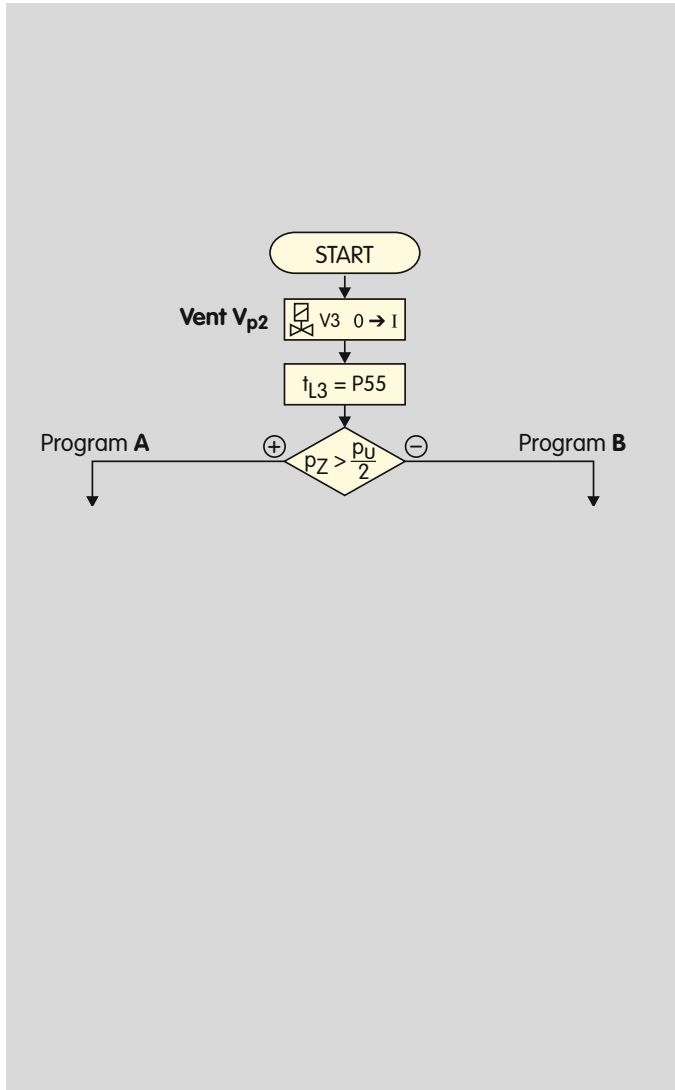
7.1.4 Two test volumes for system tightness
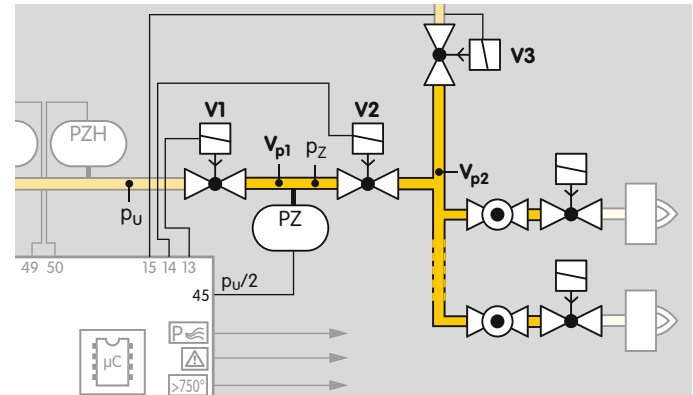
The test volumes V_{p1} and V_{p2} (gas solenoid valves V1 and V2, relief valve V3, the burner valves and the pipework) are checked to test the system tightness of the entire gas inlet section.

Program sequence

At the start of the tightness test, the relief valve V3 is opened to reduce the pressure of the test volume V_{p2} to around atmospheric pressure. The opening time for V3 can be defined using parameter 55, see page 110 (Opening time relief valve V3). The tightness control queries the pressure p_Z using the external pressure switch to check the first test volume. If pressure $p_Z > p_U/2$, program A starts, see page 43 (Program A). If pressure $p_Z < p_U/2$, program B starts, see page 44 (Program B).

Program A
Program A
$\oplus$ $p_Z > \frac{p_u}{2}$ $\ominus$
Program B

V1 0 → I		V2 0 → I
t_L = P59		t_L = P59
V1 I → 0		V2 I → 0
t_M = P56		t_M = P56

Test of valve 1
V_{p1}

$p_Z > \frac{p_u}{2}$ $\ominus$ $\oplus$ $p_Z > \frac{p_u}{2}$
$\oplus$ $\ominus$

| V2 OK | V2 ⌐ | V1 ⌐ | V1 OK |

V2 0 → I	Program A	Program B	V1 0 → I
t_L = P59			t_L = P59
V2 I → 0	**Test of valve 2**		V1 I → 0
t_M = P56	**V_{p1}**		t_M = P56

$p_Z > \frac{p_u}{2}$ $\oplus$ $\ominus$ $p_Z > \frac{p_u}{2}$
$\ominus$ $\oplus$

| V1 OK | V1 ⌐ | V2 ⌐ | V2 OK |

V_{p1} OK
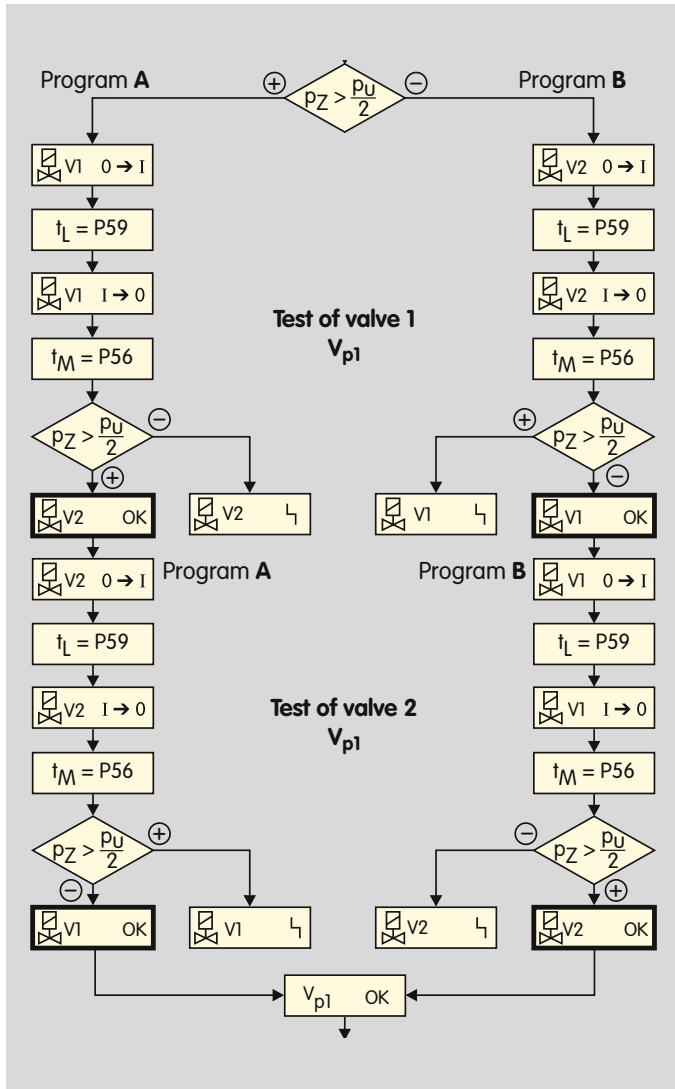
Program A

Valve V1 opens for the opening time t_L set in parameter 59. Valve V1 closes again. During the measurement time t_M set in parameter 56, the tightness control checks the pressure p_Z between the valves V1 and V2.

If pressure $p_Z < p_u/2$, valve V2 is leaking.

If pressure $p_Z > p_u/2$, valve V2 is tight.

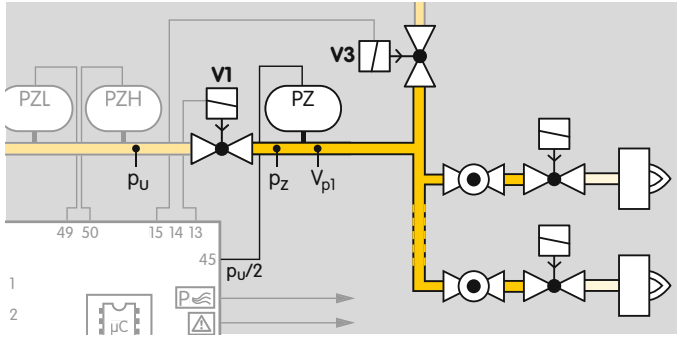Valve V2 opens for the opening time t_L set in parameter 59. V2 closes again. During the measurement time t_M, the tightness control checks the pressure p_Z between the valves.
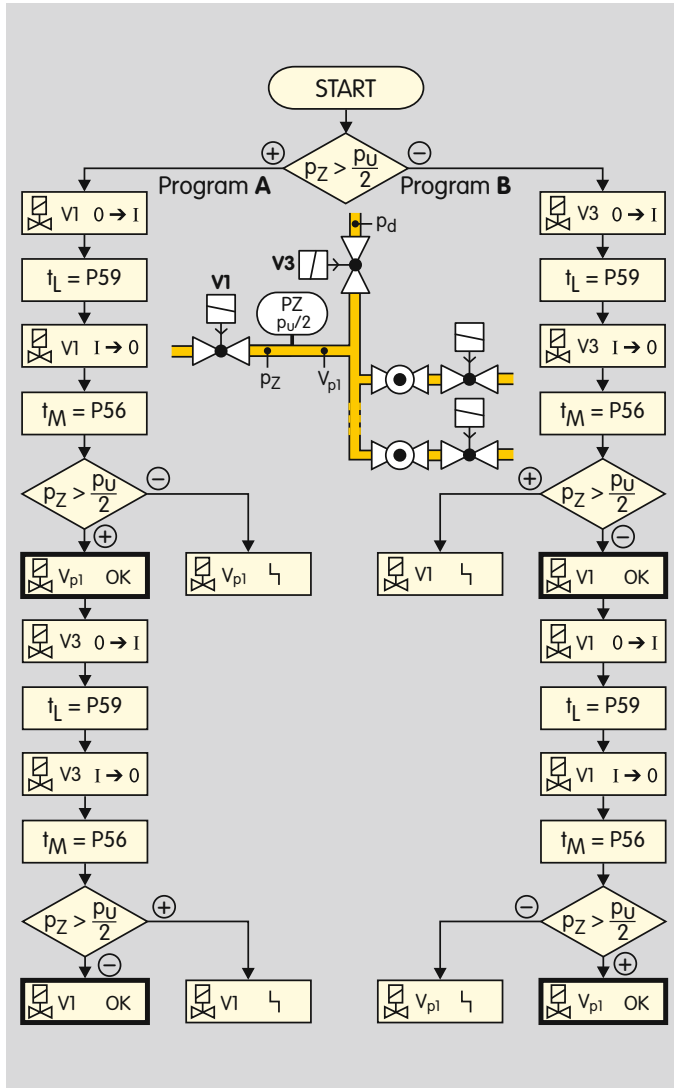
If pressure $p_Z > p_u/2$, valve V1 is leaking.

If pressure $p_Z < p_u/2$, valve V1 is tight.

The test volume V_{p1} has been successfully checked for tightness.

For checking the second test volume, see page 45 (Checking the first and second test volumes ($V_{p1} + V_{p2}$)).

Program B

Valve V2 opens for the opening time t_L set in parameter 59. Valve V2 closes again. During the measurement time t_M set in parameter 56, the tightness control checks the pressure p_Z between the valves V1 and V2.

If the pressure $p_Z < p_u/2$, valve V1 is leaking.

If the pressure $p_Z > p_u/2$, valve V1 is tight.

Valve V1 opens for the opening time t_L set in parameter 59. V1 closes again. During the measurement time t_M, the tightness control checks the pressure p_Z between the valves.

If pressure $p_Z > p_u/2$, valve V2 is tight.

If pressure $p_Z < p_u/2$, valve V2 is leaking.

The test volume V_{p1} has been successfully checked for tightness.

For checking the second test volume, see page 45 (Checking the first and second test volumes ($V_{p1} + V_{p2}$)).

Flowchart:

V_{p1} OK

V3 I → 0 | V2 0 → I

Wait for 1 s

V1 0 → I

t_L = P59

V1 I → 0

t_M = P57

$p_Z > \dfrac{p_u}{2}$ ⊖

⊕

V_{p2} OK V_{p2} ⌐

END

Test of valve V3 and burner-side valves $V_{p1} + V_{p2}$

Checking the first and second test volumes ($V_{p1} + V_{p2}$)

To check the test volume V_{p2}, relief valve V3 is closed and valve V2 is opened. The two test volumes V_{p1} and V_{p2} are connected to each other. After a waiting time of 1 s, valve V1 opens for the opening time t_L set in parameter 59. Valve V1 then closes and the measurement time set in parameter 57 starts to elapse, see page 110 (Measurement time V_{p1} and Vp2). After the measurement time has elapsed, the tightness control checks pressure p_Z. If $p_Z < p_u/2$, the test volume V_{p2} is leaking (relief valve V3, the burner valves or the pipework are leaking). If $p_Z > p_u/2$, test volume V_{p2} has been successfully checked for tightness.

Valves V1, V2 and V3, the burner valves and the pipework are tight.

7.1.5 Large test volumes with reduced testing time

The testing time for the tightness test can be reduced for a large test volume. Two pressure switches are required for this, see page 111 (Large test volumes). The first pressure switch is set to ¼ of the inlet pressure p_u, the second one to ¾ of the inlet pressure. Parameter 70 must be set to 1 for this purpose, see page 116 (Function of terminal 65).

Program sequence

The tightness control queries pressure p_Z using the first pressure switch ($p_u/4$). If pressure $p_Z > p_u/4$, program A starts, see page 47 (Program A (reduced testing time)). If pressure $p_Z < p_u/4$, program B starts, see page 47 (Program B (reduced testing time)).
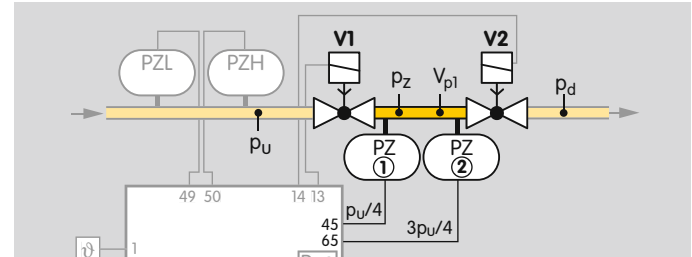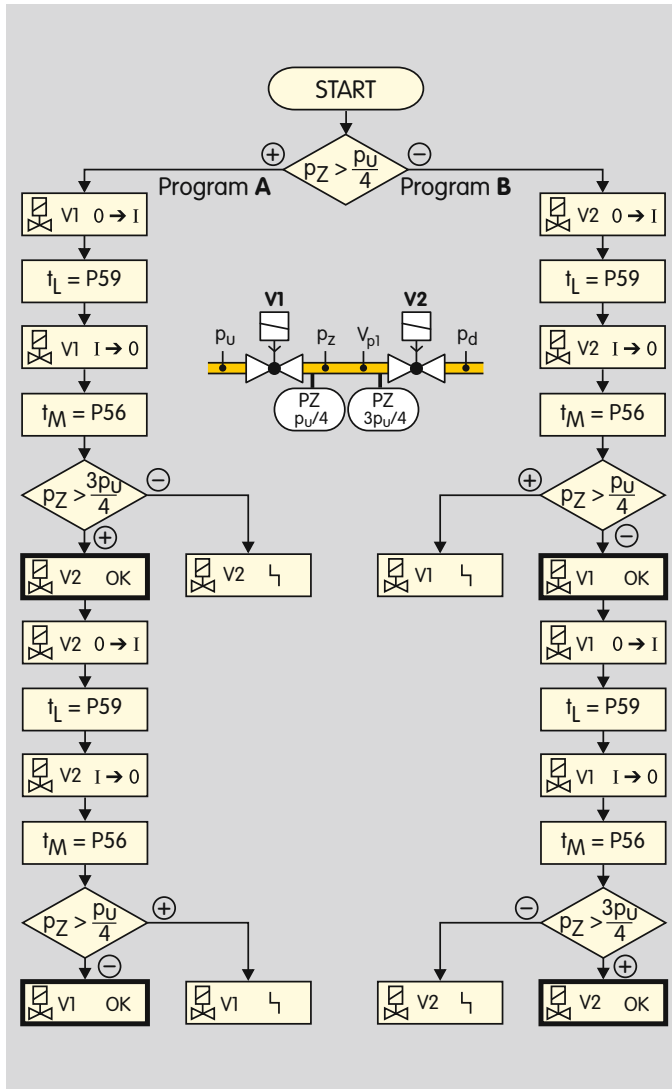
Program A (reduced testing time)

Valve V1 opens for the opening time t_L set in parameter 59. V1 closes again. During the measurement time t_M, the tightness control checks the pressure p_Z between the valves.

If pressure $p_Z < 3p_u/4$, valve V2 is leaking.

If pressure $p_Z > 3p_u/4$, valve V2 is tight. Valve V2 is opened for the set opening time t_L. V2 closes again.

During the measurement time t_M, the tightness control checks the pressure p_Z between the valves.

If pressure $p_Z < p_u/4$, valve V1 is tight.

If pressure $p_Z > p_u/4$, valve V1 is leaking.

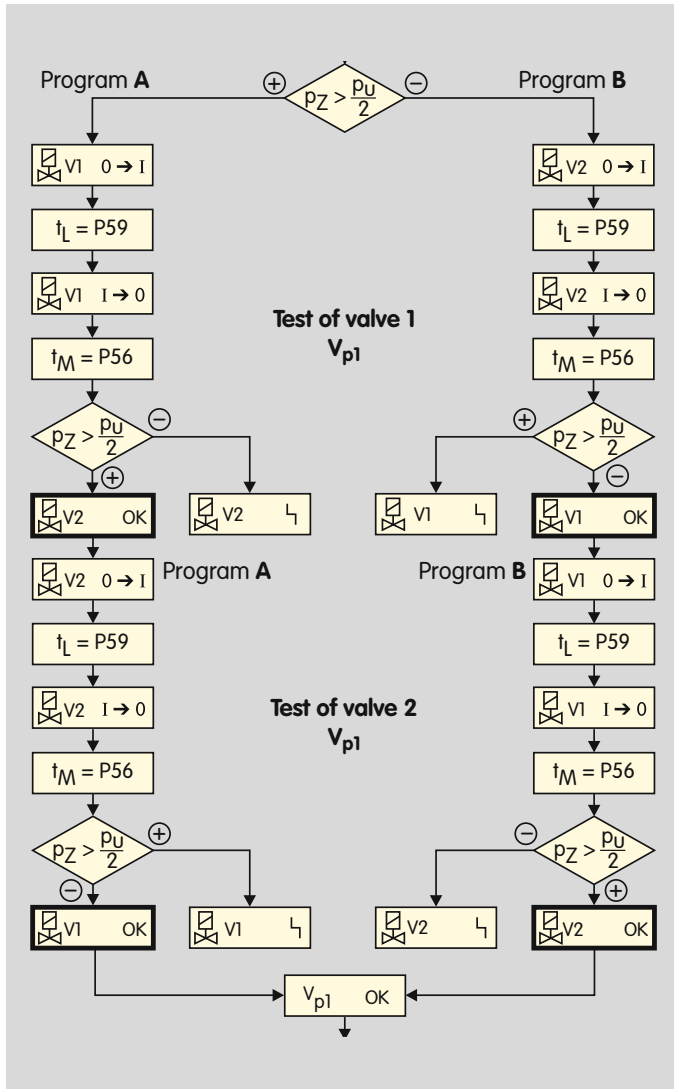## Program B (reduced testing time)

Valve V2 opens for the opening time t_L set in parameter 59. V2 closes again. During the measurement time t_M, the tightness control checks the pressure p_Z between the valves.

If pressure $p_Z > p_u/4$, valve V1 is leaking.
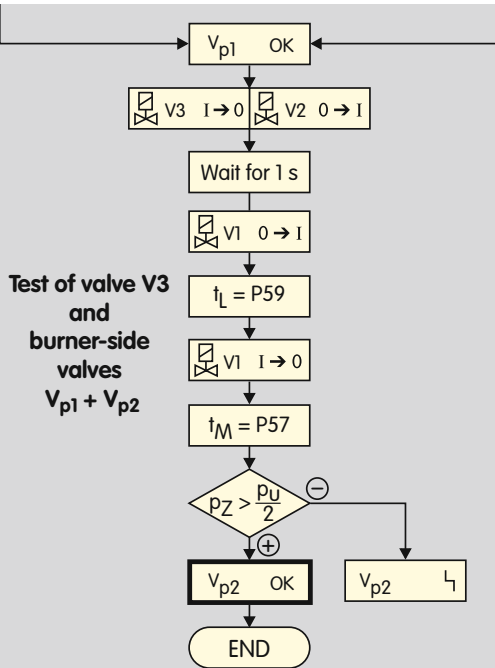
If pressure $p_Z < p_u/4$, valve V1 is tight. Valve V1 is opened for the set opening time t_L. V1 closes again.

During the measurement time t_M, the tightness control checks the pressure p_Z between the valves.

If pressure $p_Z < 3p_u/4$, valve V2 is leaking.

If pressure $p_Z > 3p_u/4$, valve V2 is tight.

7.2 Test period t_P

The test period for the tightness test varies depending on the selected function (parameter 53).

7.2.1 For one test volume V_{p1} between 2 gas solenoid valves
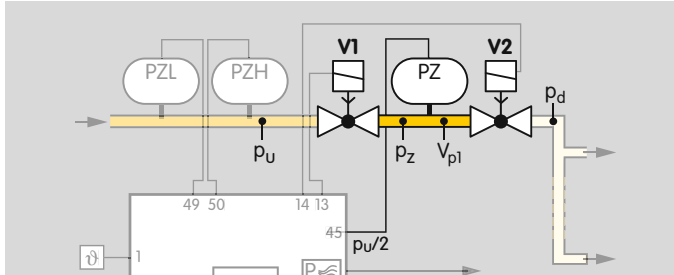
The test period t_P is calculated from:

– Opening times t_L for V1 and V2,
– Measurement times t_M for V1 and V2.

$$t_P \, [s] = 2 \times t_L + 2 \times t_M$$

7.2.2 For one test volume V_{p1} for system tightness
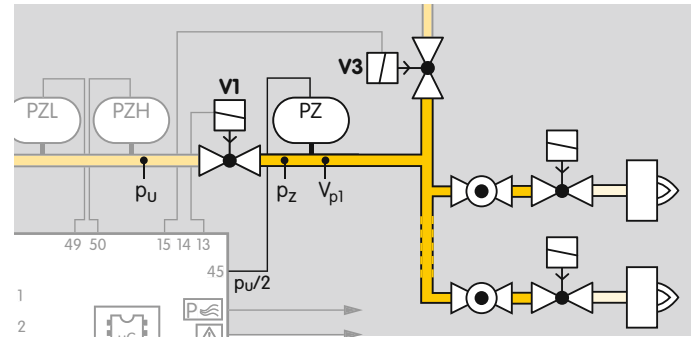
The test period t_P is calculated from:

– Opening times t_L for V1 and V3,
– Measurement times t_M for V1 and V3.

$$t_P \, [s] = 2 \times t_L + 2 \times t_M$$

7.2.3 For two test volumes for system tightness ($V_{p1}+V_{p2}$)

The test period t_P is calculated from:

– Opening time of relief valve V3 to reduce the pressure of V_{p2}, see page 42 (Two test volumes for system tightness) and page 110 (Opening time relief valve V3),

– Opening times t_L for V1 and V2 to check the test volume V_{p1} and test volumes $V_{p1} + V_{p2}$, see page 42 (Two test volumes for system tightness),

– Measurement times t_M for V1 and V2 to check the test volume V_{p1} (parameter 56), see page 110 (Measurement time V_{p1}),

– Waiting time 1 s,

– Measurement time t_M to check the test volumes $V_{p1} + V_{p2}$ (parameter 57), see page 110 (Measurement time V_{p1} and Vp2).

$$t_P \text{ [s]} = t_{L3} + 3 \times t_{L\,(P59)} + 2 \times t_{M(P56)} + t_{M(P57)} + 1$$

7.2.4 Extended valve opening time 1 t_{L1}

Standard EN 1643:2000 allows a maximum opening time of 3 s for the tightness test if the main gas valves are actuated directly. If the gas can flow into the combustion chamber when a valve is opened, the gas volume must not exceed 0.05% of the maximum flow rate.

If the pre-set opening time t_L = 3 s is inadequate (e.g. if slow opening motorized valves VK are used) to build up or reduce the test volume pressure, bypass valves with an extended opening time may be used (e.g. VAS 1 or bypass valves with an additional orifice).

1. Tightness test between 2 gas solenoid valves with one test volume (parameter 53 = 1):
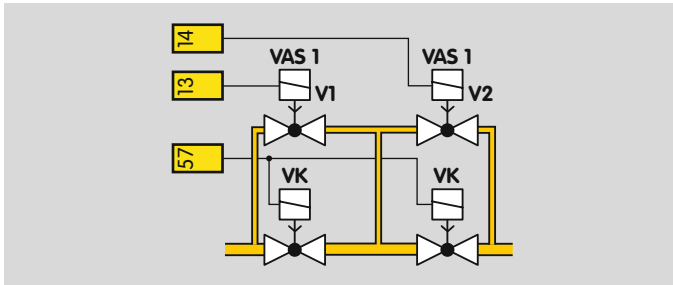
2. System leak tightness check with one test volume and pressure reduction using relief valve (parameter 53 = 2):
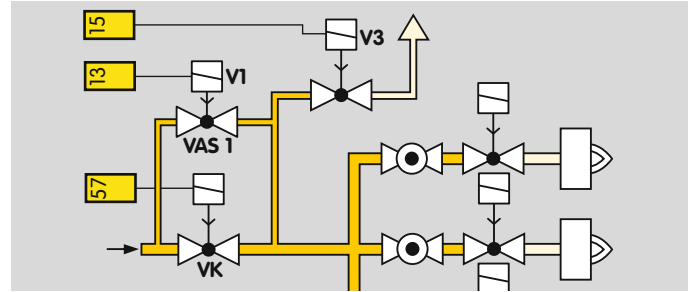
3. System leak tightness check with two test volumes and pressure reduction using relief valve (parameter 53 = 3):
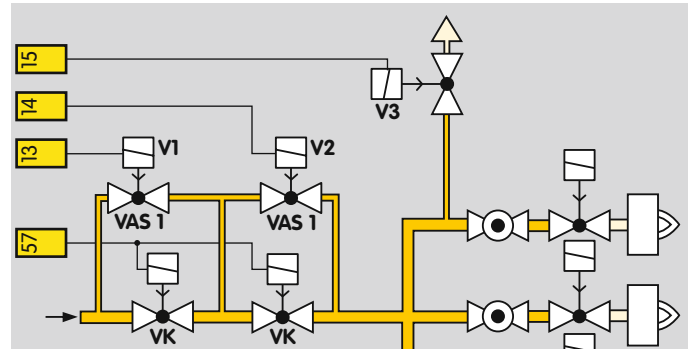
Current rating of safety interlock output (terminal 57): max. 0.5 A, see also page 127 (Safety interlock output in the case of higher power requirement)

Calculation example

Nominal flow rate $Q_{(N)}$:

P (kW): capacity = 1000 kW
H_u (kWh/m^3):
lower calorific value of gas type = 10 kW/m^3

$$Q_{(N)}\ (m^3/h) = \frac{P\ (kW)}{H_u\ (kWh/m^3)}$$

$$Q_{(N)}\ (m^3/h) = \frac{1000\ kW}{10\ kWh/m^3} = 100\ m^3/h$$

Max. gas volume in combustion chamber V_O:

$$V_O\ (l/h) = Q_{(N)} \times 0.05\%$$

$Q_{(N)}$ (m^3/h): nominal flow rate = 100 m^3/h
(100,000 l/h)

$$V_O\ (l/h) = 100{,}000\ l/h \times 0.05\% = 50\ l/h$$

Required opening time t_L:

$$t_L\ (s) = \frac{400 \times V_O}{\pi \times d^2 \times 0.7} \times \sqrt{\frac{\rho}{2 \times p_u}}$$

V_O (l/h):
max. gas volume in combustion chamber = 50 l/h,
d (mm): orifice diameter of bypass valve = 9.45 mm,
flow factor = 0.7,
p_u (mbar): inlet pressure = 20 mbar,
ρ (kg/m^3): density of gas = 0.8 kg/m^3

$$t_L\ (s) = \frac{400 \times 50\ l/h}{3.14 \times 9.45^2 \times 0.7} \times \sqrt{\frac{0.8\ kg/m^3}{2 \times 20\ mbar}} = 14.26\ s$$

Enter the next lowest value for parameter 59 (P59 = 14) to set the opening time, see page 112 (Valve opening time 1 t_{L1}).

Calculation module for calculating the opening time t_L, see page 52 (Calculating the extended valve opening time)

Calculating the extended valve opening time

Metric	Imperial
	Gas type
Lower calorific value	
	Density ρ
	Capacity P
Inlet pressure p_u	
Nominal flow rate $Q_{(N)}$	
	Max. gas volume in combustion chamber V_O
	VAS 1 on main valve or orifice diameter d
	Opening time t_L

The calculation module can be used to calculate the opening time t_L for the bypass valves (e.g. VAS 1 or bypass valves with additional orifice) by entering the gas type, calorific value, density, capacity, inlet pressure and orifice diameter.

Set the next lowest value for parameter 59 to set the opening time, see page 112 (Valve opening time 1 t_{L1}).

7.2.5 Measurement time t_M

The sensitivity of the tightness control in the FCU can be adjusted for each individual system by adapting the measurement time t_M. The longer the measurement time t_M, the greater the sensitivity of the tightness control. The measurement time is set using parameters 56 and 57 to a value between 3 and 3600 s – see page 110 (Measurement time V_{p1}) and page 110 (Measurement time V_{p1} and Vp2).

The required measurement time t_M is calculated from:
Inlet pressure p_u [mbar]
Leakage rate Q_L [l/h]
Test volume $V_{p1} + V_{p2}$ [l]
Calculation of the test volume – see page 54 (Test volume Vp)

For one test volume V_{p1} (between 2 gas solenoid valves or for system tightness)

Adjustable using parameter 56

$$t_M \, [s] = \left(\frac{2 \times p_u \times V_{p1}}{Q_L} \right)$$

For a large test volume V_{p1} with reduced testing time

Adjustable using parameter 56

$$t_M \, [s] = \left(\frac{0.9 \times p_u \times V_{p1}}{Q_L} \right)$$

For two test volumes for system tightness ($V_{p1} + V_{p2}$)

Adjustable using parameter 57

$$t_M \, [s] = \left(\frac{2 \times p_u \times (V_{p1} + V_{p2})}{Q_L} \right)$$

For two large test volumes ($V_{p1} + V_{p2}$) with reduced testing time

Adjustable using parameter 57

$$t_M \, [s] = \left(\frac{0.9 \times p_u \times (V_{p1} + V_{p2})}{Q_L} \right)$$

Conversion into US units – see page 142 (Converting units)

Leakage rate

The FCU tightness control makes it possible to check a specific leakage rate Q_L. Within the scope of the European Union, the maximum leakage rate Q_L is 0.1% of the maximum flow rate $Q_{max.}$ [m³/h].

$$\text{Leakage rate } Q_L \, [l/h] = \frac{Q_{max.} \, [m^3/h] \times 1000 \, [l/h]}{1000 \times 1 \, [m^3/h]}$$

Test volume V_p

Test volume V_p is calculated from the valve volume V_V, added to the volume of the pipe V_R for each additional metre in length L.

$$V_P = V_V + L \times V_R$$
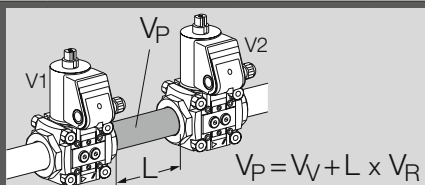
Valves		Pipework	
Type	Volume V_V [l]	DN	Volume per metre V_R [l/m]
VAS 1	0.25	10	0.1
VAS 2	0.82	15	0.2
VAS 3	1.8	20	0.3
VAS 6	1.1	25	0.5
VAS 7	1.4	40	1.3
VAS 8	2.3	50	2
VAS 9	4.3	65	3.3
VG 10	0.01	80	5
VG 15	0.07	100	7.9
VG 20	0.12	125	12.3
VG 25	0.2	150	17.7
VG 40/VK 40	0.7	200	31.4
VG 50/VK 50	1.2	250	49
VG 65/VK 65	2		
VG 80/VK 80	4		
VK 100	8.3		
VK 125	13.6		
VK 150	20		
VK 200	42		
VK 250	66		

The measurement time required for test volumes V_{p1} and V_{p2} must be set on the basis of the calculation using parameters 56 and 57. For the calculation, see page 55 (Calculation examples).

The measurement time can be set to a value between 3 and 3600 seconds for the test volume V_{p1}, and for $V_{p1} + V_{p2}$.

Calculation examples

2 valves VAS 665,
distance L = 9.5 m,
inlet pressure p_u = 50 mbar,
max. flow rate $Q_{max.}$ = 200 m³/h.
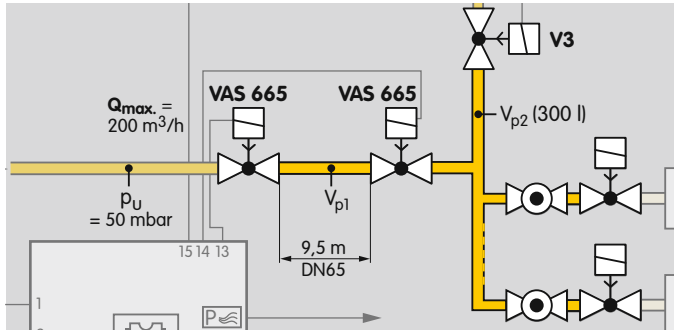
Leakage rate $Q_L = \dfrac{200 \text{ m}^3/\text{h} \times 1000 \text{ l/h}}{1000 \times 1 \text{ m}^3/\text{h}} = 200 \text{ l/h}$

Test volume V_{p1} = 1.1 l + 9.5 m x 3.3 l/m = 32.45 l
see page 54 (Test volume Vp)

Test volume V_{p2} = 300 l (assumed as an example)

Measurement time for one test volume V_{p1} (between 2 gas solenoid valves or for system tightness)

Parameter 53 = 1 (between 2 gas solenoid valves),
parameter 53 = 2 (for system tightness, venting via V3),
parameter 70 = 0

$$t_M \text{ [s]} = \frac{2 \times 50 \text{ mbar} \times 32.45 \text{ l}}{200 \text{ l/h}} = 16.23 \text{ s}$$

Set the next highest value (20 s) using parameter 56,
see page 110 (Measurement time V_{p1}).

Measurement time for two test volumes for system tightness (V_{p1} + V_{p2})

Parameter 53 = 3, parameter 70 = 0

$$t_M \text{ [s]} = \frac{2 \times 50 \text{ mbar} \times (32.45 \text{ l} + 300 \text{ l})}{200 \text{ l/h}} = 166.23 \text{ s}$$

Set the next highest value (170 s) using parameter 57,
see page 110 (Measurement time V_{p1} and Vp2).

Measurement time for a large test volume V_{p1} with reduced testing time

Parameter 53 = 1 or 2, parameter 70 = 1

$$t_M \, [\text{s}] = \frac{0.9 \times 50 \text{ mbar} \times 32.45 \text{ l}}{200 \text{ l/h}} = 7.3 \text{ s}$$

Set the next highest value (10 s) using parameter 56, see page 110 (Measurement time V_{p1}).

Measurement time for two large test volumes $(V_{p1} + V_{p2})$ with reduced testing time

Parameter 53 = 3, parameter 70 = 1

$$t_M \, [\text{s}] = \frac{0.9 \times 50 \text{ mbar} \times (32.45 \text{ l} + 300 \text{ l})}{200 \text{ l/h}} = 74.8 \text{ s}$$

Set the next highest value (80 s) using parameter 57, see page 110 (Measurement time V_{p1} and Vp2).

7.3 Proof of closure function

The proof of closure function monitors the function of the gas solenoid valve V1. The proof of closure function can be activated using parameter 51 = 4, see page 108 (Valve proving system).

A limit switch on gas solenoid valve V1 signals the closed position of the valve to the FCU (terminal 45) for this purpose.
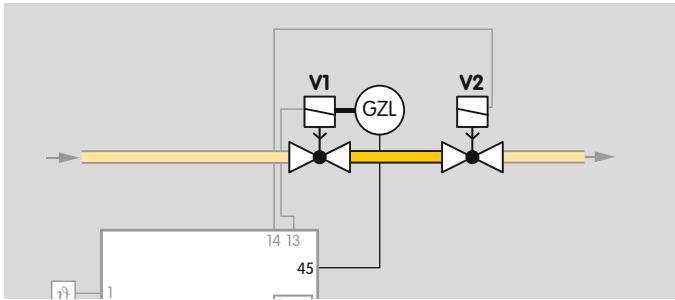
By checking the closed position using the proof of closure function, the FCU complies with the requirements of NFPA 85 (Boiler and Combustion Systems Hazards Code) and NFPA 86 (Standard for Ovens and Furnaces).

Program sequence

Parallel to the fan run-up time (see page 19 (Program sequence)), the FCU checks that valve V1 is in its closed position using the POC switch. If a signal is not received at terminal 45 from the POC switch after a timeout time of 10 s (valve V1 is closed), the FCU performs a fault lock-out with fault message c1.

As soon as the FCU has opened valve V1, it queries the open position of the valve via the POC switch. If a signal is still received at terminal 45 from the POC switch after a timeout time of 10 s, the FCU performs a fault lock-out with fault message c8.

8 BCSoft

The BCSoft engineering tool provides extended access to the FCU. BCSoft makes it possible to set device parameters on Windows-based PCs in order to adjust the FCU to the specific application. In addition, BCSoft provides extended access to the individual statistics and protocol functions.
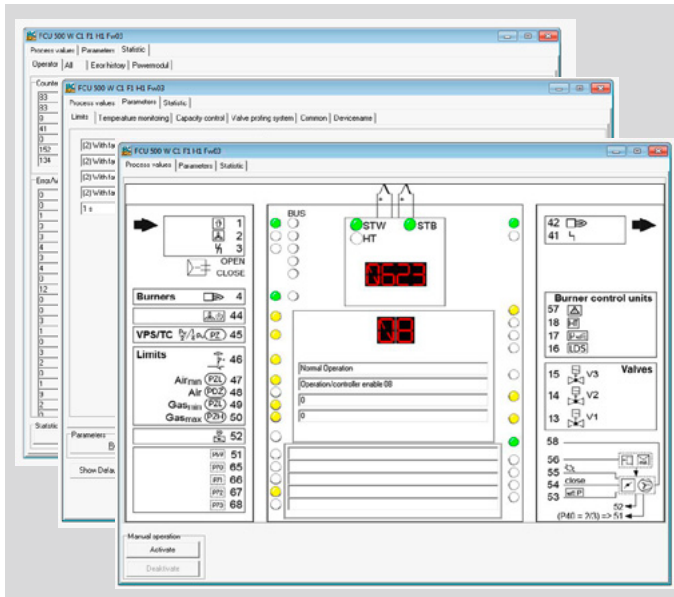
In addition to the engineering tool BCSoft, an opto-adapter or Bluetooth adapter is required to read the device parameters in and out, see also page 131 (BCSoft).

9 Profinet

Profinet is a manufacturer-independent, open standard for industrial Ethernet. It covers the requirements for automation technology (manufacturing automation, process automation, drive applications with or without functional safety).

Profinet is a bus variant for fieldbus communication, optimized for speed and low connection costs.
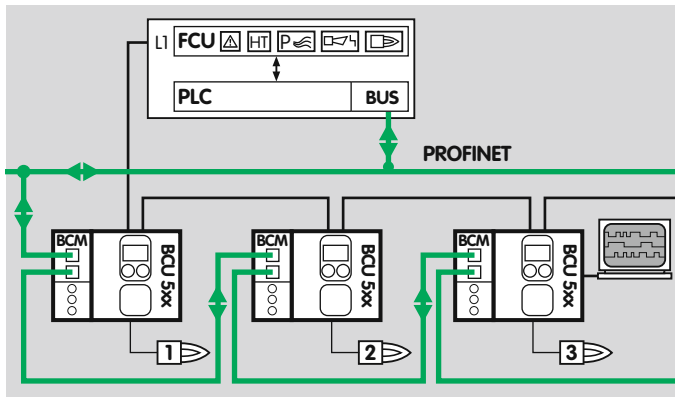
The basic function of Profinet is the exchange of process and required data between an IO controller (e.g. PLC) and several distributed IO devices (e.g. BCU/FCU).

The signals from the IO devices are read into the IO controller cyclically. There, they are processed and are then output to the IO devices again.

In addition to cyclic data exchange, Profinet also provides acyclic data exchange for events which are not constantly repeated such as sending parameter settings and configuration data when the IO devices start up or sending a diagnostic message from the IO device to the IO controller during operation. The data read or written acyclically by read/write services are specified by an index, see page 68 (Indexes for acyclic communication).

The technical properties of an IO device are described by the manufacturer in a device master data file (GSD file). The GSD file contains the device image, the communications properties and all fault messages from the IO device in text form which are important for the configuration of the Profinet network and the data exchange. The configuration is completed using an engineering tool which is supplied by the manufacturer of the IO controller. Modules defined in the GSD file may be selected for configuration to include them in the system, see also page 61 (GSD file for PLC configuration).

9.1 FCU and bus module BCM

The optional bus module BCM 500 is required to integrate the FCU in the Profinet system.

Control signals (for start, reset and air actuator control), signal states from the device inputs and outputs and information about the device status (operating states and current program step), warnings and faults can be transferred via the bus module between the FCU (IO device) and PLC (IO controller).

Bus module BCM 500 has two RJ45 connection sockets for connection to the fieldbus on its front. The connection sockets are combined with an internal 2-port switch. This allows the BCM 500 together with the FCU to be integrated in various network topologies (star, tree or line topology). Requirements such as Auto Negotiation and Auto Crossover are satisfied.

Safety-related signals and interlocks (e.g. safety interlock) must be routed independently of the fieldbus communication direct from the FCU to the burner control units (e.g. BCU) and vice versa.
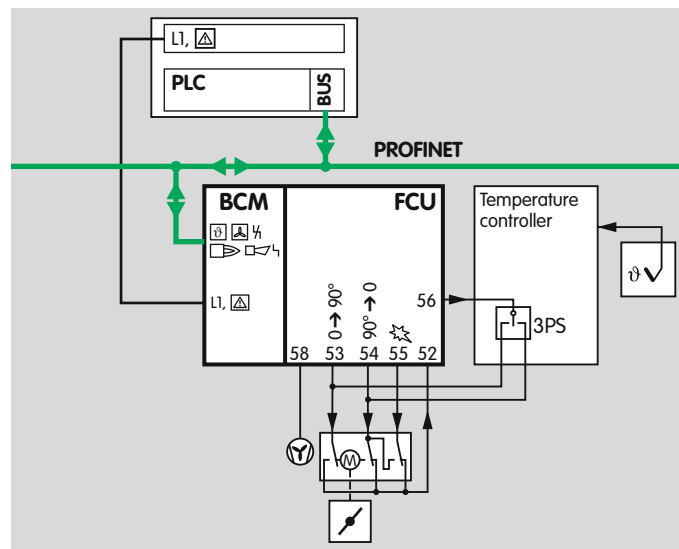
All network components which connect the automation system and the field devices must be certified for Profinet use.

For information on planning and the structure of a Profibus network and the components to be used (e.g. cables, lines and switches), see Profinet Installation Guide at www.profibus.com.

9.2 GSD file for PLC configuration

Before commissioning, the Profinet system must be configured for data exchange using an engineering tool.

The device master data file (GSD) is required for the integration of the FCU in the configuration of the PLC. The GSD file contains the device image and communications properties of the FCU. Modules defined in the GSD file may be selected to integrate the FCU, see page 62 (Modules for cyclic data exchange).

The GSD file for the bus module can be ordered at www.docuthek.com. The steps required to integrate the file are described in the instructions for the engineering tool for your automation system.

For parameter settings on the FCU and code switch settings on the BCM, see page 118 (Fieldbus communication).

9.2.1 Modules for cyclic data exchange

The modules for cyclic data exchange are defined in the GSD file for the bus module BCM 500. All modules required for data exchange between the controller and the protective system controls FCU 500/FCU 505 are shown in the following table. The modules are assigned to the slots.

Module	Slot	Input address	Output address
Inputs/outputs	1	n...n+1	n
Status signal	2	n	
Fault and warning signals	3	n...n+1	
Remaining times	4	n...n+1	
TC remaining times[1]	5	n...n+1	
PLC output information	6	n	
FCU input terminal information	7	n...n+2	
FCU output terminal information	8	n...n+1	
STM/STL temperature	9	n...n+4	

[1] *Only for FCU..C1. Slot 5 is not transferred with other device versions.*

"Inputs/outputs" module – slot 1

The digital input and output signals from the protective system controls FCU 500 and FCU 505 are included in this module.

Input bytes (device ➜ controller)

The input bytes describe the digital signals which are transferred from the FCU (IO device) to the digital inputs of the PLC (IO controller). The digital signals take up 2 bytes (16 bits).

Bit	Byte n	Byte n+1	Format
0	Operating signal	Max. capacity reached[1]	BOOL
1	High temperature operation	Min. capacity reached[1]	BOOL
2	FCU system fault	Free	BOOL
3	Fault lock-out	Free	BOOL
4	Safety shut-down	Free	BOOL
5	Warning	Free	BOOL
6	ON	Free	BOOL
7	Manual mode	Free	BOOL

[1] *Only with three-point step control via bus.*

Output byte (controller ➜ device)

The output byte describes the digital signals which are output by the PLC (IO controller) to the FCU (IO device). The digital signals to control the protective system control FCU occupy 1 byte (8 bits).

Parallel to the bus communication, terminals 1 to 4, 44 and 50 of the FCU can be wired. This allows the FCU to be controlled using the digital signals of the bus communication or the inputs at the terminals.

In the event that the bus communication is faulty or interrupted and during the initialization of the bus communication after switching on, the digital signals are interpreted as "0". If the FCU is controlled using the inputs at the terminals during this time, the normal program runs even if the bus communication is faulty or interrupted.

Bit	Byte n	Format
0	Reset[1]	BOOL
1	Start[1]	BOOL
2	Controlled air flow[1]	BOOL
3	Burner operation[1]	BOOL
4	Free	BOOL
5	Free	BOOL
6	Open control element, three-point step Open[2]	BOOL
7	Close control element, three-point step Close[2]	BOOL

[1] *Parallel to the bus communication, terminals 1 to 4 can be wired.*
[2] *Only with three-point step control via bus.*

"Status signal" module (device ➔ controller) – slot 2

This module transfers the status signals from the FCU to the PLC. The status signals occupy one byte (0 to 255). Every status signal is allocated a code. The allocation is described in the code table "GSD Codes FCU 50x".

Bit	Byte n	Data type	Format	Value
0 1 2 3 4 5 6 7	Status signals	Byte	DEC	0 – 255 (see Code table "GSD_Codes_ FCU_50x.xlsx" at www.docuthek.com)

"Fault and warning signals" module (device ➔ controller) – slot 3

The fault and warning signals are transferred from the FCU to the PLC using this module. The fault and warning signals occupy one byte each (0 to 255).

The allocation of the output codes to the fault and warning signals is described in the code table "GSD Codes FCU 50x". The same allocation table applies to the fault signals and the warning signals.

Bit	Byte n	Data type	Format	Value
0 1 2 3 4 5 6 7	Fault signals	Byte	DEC	0 – 255 (see Code table "GSD_Codes_ FCU_50x.xlsx" at www.docuthek.com)

Bit	Byte n+1	Data type	Format	Value
0 1 2 3 4 5 6 7	Warning signals	Byte	DEC	0 – 255 (see Code table "GSD_Codes_ FCU_50x.xlsx" at www.docuthek.com)

"Remaining times" module (device ➔ controller) – slot 4

This module transfers the remaining times of various processes from the FCU to the PLC. The remaining time occupies 2 bytes.

Bit	Byte n	Byte n+1	Data type	Format	Value
0					
1					
2					
3	Remaining times		Word	DEC	0 – 6554 (0 to 6554 s)
4					
5					
6					
7					

"Remaining times of the valve proving system" module (device ➔ controller) – slot 5

Only for FCU..C1.

The module in FCU..C0 contains no information.

This module transfers the remaining time of the valve proving system from the FCU..C1 to the PLC. The remaining time occupies 2 bytes.

The valve check runs parallel to other time-related processes, e.g. pre-purge. To display the remaining time of the valve proving system separately, it is transferred separately.

Bit	Byte n	Byte n+1	Data type	Format	Value
0					
1					
2					
3	Remaining times of the valve proving system		Word	DEC	0 – 6554 (0 to 6554 s)
4					
5					
6					
7					

"PLC output information" module (device ➔ controller) – slot 6

This module transfers information on signals which the PLC uses to control the FCU back to the PLC. This allows the signal transfer from the PLC to the FCU to be checked.

Bit	Byte n	Format
0	Reset	BOOL
1	Start	BOOL
2	Controlled air flow	BOOL
3	Operating signal	BOOL
4	Free	BOOL
5	Free	BOOL
6	Open control element, three-point step Open[1]	BOOL
7	Close control element, three-point step Close[1]	BOOL

[1] Only with three-point step control via bus.

"FCU input terminal information" module (device ➔ controller) – slot 7

This module transfers the signal states of the digital inputs on the FCU (input terminals) to the PLC.

Bit	Byte n	Byte n+1	Byte n+2	Format
0	Terminal 1	Terminal 48	Terminal 68	BOOL
1	Terminal 2	Terminal 49	Free	BOOL
2	Terminal 3	Terminal 50	Free	BOOL
3	Terminal 4	Terminal 51	Free	BOOL
4	Terminal 44	Terminal 52	Free	BOOL
5	Terminal 45	Terminal 65	Free	BOOL
6	Terminal 46	Terminal 66	Free	BOOL
7	Terminal 47	Terminal 67	Free	BOOL

"FCU output terminal information" module (device ➔ controller) – slot 8

This module transfers the signal states of the digital outputs on the FCU (output terminals) to the PLC.

Bit	Byte n	Byte n+1	Format
0	Terminal 13	Terminal 53	BOOL
1	Terminal 14	Terminal 54	BOOL
2	Terminal 15	Terminal 55	BOOL
3	Terminal 16	Terminal 56	BOOL
4	Terminal 17	Terminal 57	BOOL
5	Terminal 18	Terminal 58	BOOL
6	Terminal 41[1]	Free	BOOL
7	Terminal 42	Free	BOOL

[1] Only for FCU..F2: terminal 53 is used as an input.
Bit 6 has no function.

"STM/STL temperature" module (device ➜ controller) – slot 9

This module transfers the STM temperature values (for high temperature operation) and STL temperature values (for maximum temperature monitoring) from the protective system control FCU..H1 to the PLC.

Bytes 1 and 2 are used to transfer the lower of the two temperature values measured by the double thermocouple to the PLC. The measured temperature must be higher than the set limit value, see page 84 (STM limit value (high temperature operation)).

Bit	Byte n	Byte n+1	Data type	Format	Value
0					
1					
2					
3	STM temperature		Word	DEC	0 – 65535 (0 to 65,535K)
4					
5					
6					
7					

Bytes 3 and 4 are used to transfer the higher of the two temperature values measured by the double thermocouple to the PLC. The measured temperature must be higher than the set limit value, see page 84 (STL/FSTL limit value (system protection)).

Bit	Byte n+2	Byte n+3	Data type	Format	Value
0					
1					
2					
3	STL temperature		Word	DEC	0 – 65535 (0 to 65,535K)
4					
5					
6					
7					

Conversion of temperature values, see www.adlatus.org

Byte 5 is used to send confirmation of whether the values are in the valid range after checking the plausibility of the STL/STM temperature values.

Bit	Byte n	Format
0	STM, temperature valid	BOOL
1	STL, temperature valid	BOOL
2	Free	BOOL
3	Free	BOOL
4	Free	BOOL
5	Free	BOOL
6	Free	BOOL
7	Free	BOOL

Indexes for acyclic communication

With the help of acyclic communication between the PLC (IO controller) and BCU/FCU (IO devices), it is possible to read information on parameters, statistics and fault history on an event basis (e.g. using system function block Siemens FSB 52 RDREC).

The available data records differ in terms of their indexes.

Index	Description
1001	Parameters
1002	Device statistics, counter
1003	Device statistics, faults/warnings
1004	Operator statistics, counter
1005	Operator statistics, faults/warnings
1006	Fault history
1007	Power module statistics

The contents and description of the indexes are described in the code table "GSD Codes FCU 500" (download from www.docuthek.com).

10 Program step/status

DISPLAY	Program step/status
00	Start-up position/standby
H0	Delay
H1	Delay
H2	Delay
Ac	Approaching minimum capacity
d0	"No flow" state check
01	Fan run-up time t_{GV}
Ao	Approaching maximum capacity
d1	Low air pressure protection check
P1	Pre-purge
Ai	Approaching ignition capacity
tc	Valve check
H7	Delay
H8	Delay
08	Operation/controller enable
P9	Post-purge
C1	Controlled air flow
U1	Remote control (with OCU)
⅃⌐	Data transfer (programming mode)
X. X.	High temperature operation
– –	Device Off

In Manual mode, two dots blink on the display.

11 Fault signalling

Fault message (blinking)	DISPLAY	Description
Too many remote resets	10	Remote reset activated > 5 × in 15 min.; faulty input actuation
Controller enable output (trm. 56)	20	Controller enable output incorrectly connected/supplied with power from an external source
Simultaneous activation (trm. 51, 52)	21	"Maximum capacity" and "Ignition capacity" position feedback from butterfly valve set simultaneously
Actuator wiring (trm. 52-55)	22	Faulty wiring of terminals 52 to 55
Actuator feedback (trm. 52)	23	Maximum or ignition capacity is not constantly signalled back to terminal 52
Simultaneous Min./Max. bus command	24	"Open actuator" and "Close actuator" bus signals set simultaneously
Inconsistent NFS (non-fail-safe) parameters	30	Abnormal data change in the parameters set for the FCU
Inconsistent FS (fail-safe) parameters	31	Abnormal data change in the parameters set for the FCU
Mains voltage	32	Supply voltage too low or too high
Faulty parameterization	33	Parameter set contains illegal settings or internal device error
Incompatible bus module	35	Bus module and control unit are incompatible
Power module defective	36	Relay contact error
Contactor function check (trm. 68)	37	Faulty feedback from contactors
Fan not ready for operation	38	No signal at the "Fan feedback" input (terminal 44); fan defective
Fuse defective	39	Short-circuit on one of the outputs of the safety circuit
Inlet valve(s) leaking	40	Leak found on inlet valve(s)
Outlet valve(s) leaking	41	Leak found on outlet valve(s)
Burner valve(s) leaking	42	Leak found on burner valves
Pressure switch/gas valve wiring	44	Test volume (V_{p1} or V_{p2}) cannot be supplied or vented; faulty pressure switch/gas valve wiring
Gas valve wiring	45	Reversed valve connection
Controller enable/emergency stop	50	Interruption of signal at the "Controller enable/Emergency stop" input (terminal 46)
Fuse defective	51	Device fuse F1 is defective

Fault message (blinking)	DISPLAY	Description
Permanent remote reset	52	Remote reset input activated > 25 s
STL overtemperature	60	The safety temperature limiter (STL) has detected an overtemperature condition.
Thermocouple 1 cable discontinuity	62	Thermocouple 1 (terminals 5 and 6) defective
Thermocouple 2 cable discontinuity	63	Thermocouple 2 (terminals 7 and 8) defective
Thermocouple 1 short-circuit	64	Sensor short-circuit in thermocouple 1
Thermocouple 2 short-circuit	65	Sensor short-circuit in thermocouple 2
Temperature difference limit value	66	Set temperature difference between thermocouples exceeded (parameter 23)
Furnace temperature outside range	67	Operation outside temperature range
Burner control unit operating signal	70	No operating signal within the period defined in parameter 47
Burner control units not ready	72	Burner control units do not signal Standby mode
Internal error	89	Error in processing internal data
Temperature monitoring	90	Internal fault in module
Internal error	94	Error at digital inputs
Internal error	95	Error at digital outputs
Internal error	96	Error when checking the SFR
Internal error	97	Error when reading the EEProm
Internal error	98	Error when writing to the EEProm
emBoss	99	Shut-down without application error
Minimum capacity not reached	Ac	Closed position not reached after 250 s
Maximum capacity not reached	Ao	Purge position not reached after 250 s
Ignition capacity not reached	AI	Ignition position not reached after 250 s
Communication with bus module (display bE)	bE	Internal communication with bus module has suffered a fault

Fault message (blinking)	DISPLAY	Description
Parameter chip card (PCC) (display bc)	bc	Incorrect or defective PCC
POC valve open (display c1)	c1	No input signal for the valve proof of closure switch (POC) during standby
POC valve closed (display c8)	c8	Input signal for the valve proof of closure switch (POC) does not drop out after burner start-up
Air monitor "no flow" state (display d0)	d0	Fault Air monitor break contact check; signal from the pressure switches at terminals 47, 48
Low air pressure (display d1)	d1	Fault Air monitor make contact check; no signal from pressure switch at terminal 48
Low air pressure (display d2, d3, d4, d5, d6, d7, d8 or d9)	d2 d3 d4 d5 d6 d7 d8 d9	No input signal from pressure switch or failure in air supply during program step 2, 3, 4, 5, 6, 7, 8 or 9
Air flow during pre-purge (display dP)	dP	No input signal from pressure switch or failure in air supply during pre-purge
High gas pressure (display o0, o1, o2, o3, o4, o5, o6, o7, o8 or o9)	o0 o1 o2 o3 o4 o5 o6 o7 o8 o9	No input signal from pressure switch at terminal 50 during program step 0, 1, 2, 3, 4, 5, 6, 7, 8 or 9
Bus (display Pb)	Pb	Bus fault

Fault message (blinking)	ᴅɪꜱᴘʟᴀʏ	Description
Low gas pressure (display u1, u2, u3, u4, u5, u6, u7, u8 or u9)	u1, u2, u3, u4, u5, u6, u7, u8, u9	No input signal from pressure switch at terminal 49 during program step 1, 2, 3, 4, 5, 6, 7, 8 or 9

12 Parameters

Any changes to parameters will be saved to the parameter chip card.

Name	Parameter	Value range	Description	Factory default settings
Emergency stop	10	0 1 2	Off With safety shut-down With fault lock-out	2
High gas pressure protection	12	0 1 2	Off With safety shut-down With fault lock-out	2
Low gas pressure protection	13	0 1 2	Off With safety shut-down With fault lock-out	2
Low air pressure protection	15	0 1 2	Off With safety shut-down With fault lock-out	2
Safety time during operation tSB	19	0; 1; 2	Time in seconds	1
Temperature monitoring mode	20	0 1 2 3	Off STM function STL function STM and STL function	FCU..H0 = 0 FCU..H1 = 2
Thermocouple	22	1 2 3	Type K Type N Type S	1
Temperature difference limit value	23	10 – 100	Temperature in °C	50
STM limit value (high temperature operation)	24	650 – 1200	STM limit value (high temperature operation) in °C	750
STL/FSTL limit value (system protection)	25	200 – 1600	STL/FSTL limit value in °C	350
Temperature hysteresis	26	10 – 100	Temperature in °C	50
Pre-purge during high temperature operation	27	0 1	Off On	1
Fan in the event of fault	29	0 1	Off On	1
Fan run-up time tGV	30	0 – 6000	Time in seconds	0
Fan ready for operation	31	0 1 2	Off With safety shut-down With fault lock-out	2

Name	Parameter	Value range	Description	Factory default settings
Air monitoring during controlled air flow	32	0 1 2	Off; maximum capacity On; maximum capacity Off; controller enable	1
Pre-purge time tPV	34	0 – 6000	Time in seconds	6000
Air flow monitoring during pre-purge	35	0 1 2	Off With safety shut-down With fault lock-out	2
Post-purge time tPN	37	0 – 6000	Time in seconds	6000
Air flow monitoring during post-purge	38	0 1 2 3	On; control element to maximum capacity Off; control element to maximum capacity Off; control element to ignition capacity Off; control element controller enable	1
Capacity control	40	0 1 2 3 4	Off With IC 20 With IC 40 With RBW With frequency converter	FCU..F0 = 0 FCU..F1 = 1 FCU..F2 = 3
Running time selection	41	0 1 2 3	Off; checking the positions for minimum/maximum capacity On; for approaching the positions for minimum/maximum capacity On; for approaching the position for maximum capacity On; for approaching the position for minimum capacity	0
Running time	42	0 – 250	Running time in seconds if parameter 41 = 1, 2 or 3	30
Controller enable signal delay time tRF	44	0 – 250	Time in seconds	0
Minimum enable time	45	0 – 250	Actuator in ignition position, waiting for enable signal, time in seconds	0
Burner operating signal	46	0 1	Off On; controller enable	0 (if P40 = 0) 1 (if P40 ≠ 0)

Name	Parameter	Value range	Description	Factory default settings
Controller enable time limit	47	0 – 60	Time in minutes during which the burner must reach its operating position	60
Valve proving system	51	0 1 2 3 4	Off Tightness test before start-up Tightness test after shut-down Tightness test before start-up and after shut-down Proof of closure function	0
Relief valve (VPS)	52	2 3 4	V2 V3 V4	3
Tightness control test volume	53	1 2 3	V_{p1} V_{p1}; pressure reduction via V3 $V_{p1} + V_{p2}$; pressure reduction via V3	1
Pressure reduction Vp2	54	0 1	In standby Upon start-up	0
Opening time relief valve V3	55	0 – 6000	Time in seconds	0
Measurement time Vp1	56	3 5 – 25 30 – 3600	Time in seconds (in 5 s steps) (in 10 s steps)	10
Measurement time V_{p1} and Vp2	57	3 5 – 25 30 – 3600	Time in seconds (in 5 s steps) (in 10 s steps)	10
Valve opening time 1 tL1	59	2 – 25	Time in seconds	2
Valve opening time 2 tL2	60	2 – 25	Time in seconds	2
Minimum pause time tMP	62	0 – 3600	Time in seconds	0
Switch-on delay time tE	63	0 – 250	Time in seconds	0
Filling time before start-up	65	0 – 25	Time in seconds	0
Operating time in Manual mode	67	0 1	Unlimited 5 minutes	1

Name	Parameter	Value range	Description	Factory default settings
Function of terminal 51	69	0 1 2 3 4 5 6	Off Feedback of position for maximum capacity (IC 40/RBW) AND with emergency stop (trm. 46) AND with air min. (trm. 47) AND with air flow monitoring (trm. 48) AND with gas min. (trm. 49) AND with gas max. (trm. 50)	0
Function of terminal 65	70	0 1 2 3 4 5 6	Off Reduced DG test duration AND with emergency stop (trm. 46) AND with air min. (trm. 47) AND with air flow monitoring (trm. 48) AND with gas min. (trm. 49) AND with gas max. (trm. 50)	0
Function of terminal 66	71	0 1 2 3 4 5 6 7	Off FCU as zone control unit External HT signal AND with emergency stop (trm. 46) AND with air min. (trm. 47) AND with air flow monitoring (trm. 48) AND with gas min. (trm. 49) AND with gas max. (trm. 50)	0
Function of terminal 67	72	0 1 2 3 4 5 6 7	Off BCU ready; if not, safety shut-down BCU ready; if not, fault lock-out AND with emergency stop (trm. 46) AND with air min. (trm. 47) AND with air flow monitoring (trm. 48) AND with gas min. (trm. 49) AND with gas max. (trm. 50)	2
Function of terminal 68	73	0 1 2 3 4 5 6	Off Contactor feedback AND with emergency stop (trm. 46) AND with air min. (trm. 47) AND with air flow monitoring (trm. 48) AND with gas min. (trm. 49) AND with gas max. (trm. 50)	0

Name	Parameter	Value range	Description	Factory default settings
Capacity control (bus)	75	0 1 2 3 4 5	Off MIN. to MAX. capacity; standby in position for MIN. capacity MIN. to MAX. capacity; standby in CLOSED position IGNITION to MAX. capacity; standby in CLOSED position MIN. to MAX. capacity; standby in position for MIN. capacity; burner quick start IGNITION to MAX. capacity; standby in CLOSED position; burner quick start.	0
Password	77	0000 – 9999	Four-digit number code	1234
Fieldbus communication	80	0 1 2	Off With address check No address check	1

12.1 Scanning the parameters

During operation, the 7-segment display shows the program status.

All the parameters of the FCU can be scanned in numerical order by repeatedly pressing the Reset/Information button (for 1 s).

The parameter display is ended 60 seconds after the last time the button is pressed or by switching off the FCU.

The FCU indicates $\boxed{\text{--}}$ when the mains switch has been switched off. The parameters cannot be scanned when the FCU is switched off or when a fault message is displayed.

12.2 Safety limits

Parameters 10, 12, 13, 15 and 19 can be used to adjust the safety limits (emergency stop, high gas pressure protection, low gas pressure protection, air monitoring and safety time during operation) to the system requirements.

12.2.1 Emergency stop

Parameter 10

Function of the controller enable/emergency stop input (terminal 46)

This input is the safety interlock input of the FCU. The properties of this function can be activated/deactivated using parameter 10. If there is no input signal, the FCU will perform a shut-down, depending on the function selected in parameter 10.

On FCU 505 (zone FCU), the function of the controller enable/emergency stop input is different and is not determined by parameter 10.

Parameter 10 = 0: OFF; the function is not required

Parameter 10 = 1: with safety shut-down

A safety shut-down will be performed if there is no signal at the controller enable/emergency stop input (terminal 46).

Parameter 10 = 2: with fault lock-out

A fault lock-out will be performed if there is no signal at the controller enable/emergency stop input (terminal 46).

12.2.2 High gas pressure protection

Parameter 12

Function of the $gas_{max.}$ input (terminal 50)

If the gas pressure exceeds a specified value, the high gas pressure protection device will prevent a start-up and trigger a safety shut-down or fault lock-out.

A gas pressure switch DG (high gas pressure protection device) safeguards the maximum permitted gas pressure. The properties of this function can be activated or deactivated using parameter 12.

Parameter 12 = 0: OFF; the function is not required

Parameter 12 = 1: with safety shut-down

A safety shut-down will be performed if there is no signal at the $gas_{max.}$ input (terminal 50).

Parameter 12 = 2: with fault lock-out

A fault lock-out will be performed if there is no signal at the $gas_{max.}$ input (terminal 50).

12.2.3 Low gas pressure protection

Parameter 13

Function of the $gas_{min.}$ input (terminal 49)

The low-pressure cut-off provides verification of the gas pressure when the fan run-up time t_{GV} starts to elapse. If the gas pressure falls below a specified value, the FCU performs a shut-down, depending on the function selected in parameter 13.

Parameter 13 = 0: OFF; the function is not required

Parameter 13 = 1: with safety shut-down

A safety shut-down will be performed if there is no signal at the $gas_{min.}$ input (terminal 49).

Parameter 13 = 2: with fault lock-out

A fault lock-out will be performed if there is no signal at the $gas_{min.}$ input (terminal 49).

12.2.4 Low air pressure protection
Parameter 15

Equipment fitted with forced or induced draught burner(s) shall be fitted with devices for proving adequate air flow during pre-purge, ignition and operation of the burner. Any failure of the air flow must trigger a safety shut-down or fault lock-out at any time during pre-purge, ignition or operation of the burners, depending on the requirement of the standard.

The air monitor must be checked when there is no flow before start-up, for example by stopping the combustion air supply or by interrupting the air signal $air_{min.}$ to terminal 47 of the FCU (using a 2/3-way valve). As soon as the combustion air supply is stopped or the signal is interrupted, the fan will start. To start pre-purge, the air monitor must indicate adequate flow for purging. The flow must be detected within a timeout (250 s). After the elapse of this timeout, the FCU will perform a shut-down, depending on the function selected in parameter 15.

Parameter 15 = 0: OFF; the function is not required

Parameter 15 = 1: with safety shut-down

A safety shut-down will be performed if there is no input signal.

Parameter 15 = 2: with fault lock-out

A fault lock-out will be performed if there is no input signal.

Air flow monitoring during the post-purge time can only be selected if it has also been activated for pre-purge.

For further information on the function of the signal inputs to monitor the minimum air pressure ($air_{min.}$, terminal 47) and air flow (terminal 48) during pre-purge, see page 89 (Air flow monitoring during pre-purge).

12.2.5 Safety time during operation t_{SB}
Parameter 19

This parameter can be used to adjust the reaction time of the FCU to the failure of the flow detectors for air and gas to the requirements of the system.

When selecting the reaction, compliance with the requirements of the relevant system standard must be ensured.

12.3 High temperature operation

The safety temperature limiter (STL) and safety temperature monitor (STM) functions can be adjusted to the requirements of the system using parameters 20, 22, 23, 24, 25 and 27.

These parameters are only available in conjunction with the STM function (FCU..H1).

12.3.1 Temperature monitoring mode

Parameter 20

Parameter 20 = 0: Off

Temperature monitoring using STL or STM is deactivated.

Parameter 20 = 1: High temperature operation with STM

Temperature recording to detect high temperature operation (HT operation) of a system without locks, STM function, automatic reset on return to the permitted range.

The required double thermocouple must be positioned at the coldest point in the combustion chamber for this function so that it can reliably detect whether the spontaneous ignition temperature (> 750°C) has been exceeded.

Parameter 20 = 2: Maximum temperature monitoring using STL

Maximum temperature monitoring with fault lock-out, reset after the fault has been eliminated by pressing the button on the front panel or using an externally connected remote reset device.

The required double thermocouple must be positioned at the warmest point in the combustion chamber for this function so that it can reliably detect whether the maximum permitted temperature has been exceeded.

Parameter 20 = 3: High temperature operation with STM and maximum temperature monitoring with STL

Combination of maximum temperature monitoring with STL function and high temperature operation with STM function. This function may only be used if the position of the double thermocouple is suitable for both functions. The double thermocouple must reliably detect whether the spontaneous ignition temperature (> 750°C) has been exceeded and also whether the maximum permitted furnace temperature has been exceeded.

12.3.2 Thermocouple
Parameter 22

The type of double thermocouple can be selected using parameter 22.

The following Class 1 double thermocouples may be used. The thermocouple should be selected on the basis of the switching point for high temperature operation and the maximum furnace temperature that can be reached.

Parameter 22 = 1: Type K double thermocouple NiCr-Ni
(0 to 1200°C)

Parameter 22 = 2: Type N double thermocouple NiCrSi-NiSi
(0 to 1200°C)

Parameter 22 = 3: Type S double thermocouple Pt10Rh-Pt
(0 to 1600°C)

Thermocouples connected to the integrated temperature module for the safety temperature limiter (STL) and safety temperature monitor (STM) are monitored for cable discontinuity or short-circuit. This is only possible with double thermocouples.

It is not permitted to use single thermocouples and connect the inputs in parallel using wire straps. If separate sensor fittings are used, they must be installed next to each other so that they both record the same temperature.

12.3.3 Temperature difference limit value
Parameter 23

The maximum temperature difference (0 to 100K) between the two double thermocouples is defined using this parameter.

If the temperature difference is exceeded, the FCU will perform a fault lock-out.

12.3.4 STM limit value (high temperature operation)
Parameter 24

This parameter is used to define the lower limit for high temperature operation.

The FCU has a fail-safe HT output at terminal 18. This output is used to signal to the downstream burner control units or automatic burner control units that the system is in High temperature mode (HT).

The FCU does not issue the High temperature mode enable signal to the burner control units until the lower limit for high temperature operation (parameter 24) plus the set hysteresis (parameter 26) is exceeded. This activates High temperature mode on the burner control units. The burner control units start the burners, without monitoring the presence of the flame.

If the temperature in the furnace chamber falls below the value defined in parameter 24, the FCU disconnects the HT output from the electrical power supply. High temperature mode is deactivated on the burner control units. The furnace is operated with flame control – see also page 123 (High temperature operation).

12.3.5 STL/FSTL limit value (system protection)
Parameter 25

This parameter is used to define the upper limit of the furnace or flue gas temperature at which safe operation of the furnace is ensured, depending on the thermocouple used (parameter 22):
Type K, Type N: 200 to 1200°C,
Type S: 200 to 1600°C.

If the maximum permitted temperature limit is reached or if an error occurs on the monitoring device within the permitted temperature range (e.g. sensor discontinuity, sensor short-circuit or cable discontinuity), the safety temperature limiter (STL) or flue gas safety temperature limiter (FSTL) will perform a fault lock-out. The safety interlock output will no longer be set.
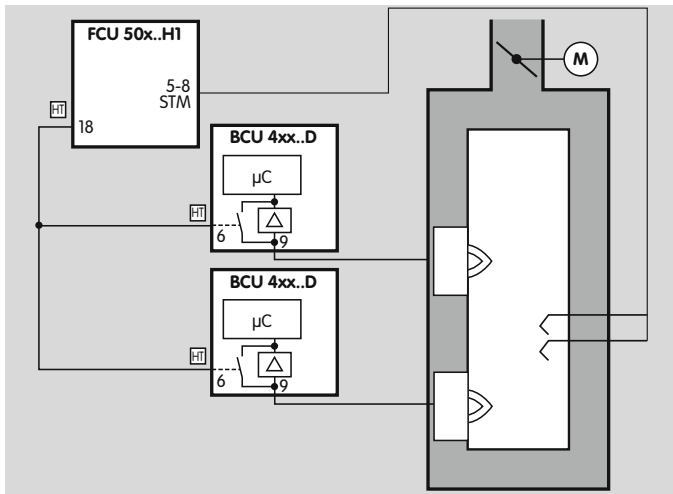
12.3.6 Temperature hysteresis
Parameter 26

Using the integrated temperature module, the FCU decides either using the safety temperature monitor (STM) whether the conditions for high temperature operation have been met or using the safety temperature limiter (STL) whether the furnace temperature is too high.

To avoid frequent switching in the limit range, a hysteresis can be set using parameter 26 for switching the function selected in parameter 20 (High temperature operation with STM or Maximum temperature monitoring using STL) on and off.

High temperature operation with STM

High temperature mode is reactivated as soon as the temperature exceeds the STM limit value and the defined temperature hysteresis.

If the temperature falls below the STM limit value (lower limit for high temperature operation), High temperature mode is ended.

Maximum temperature monitoring with STL
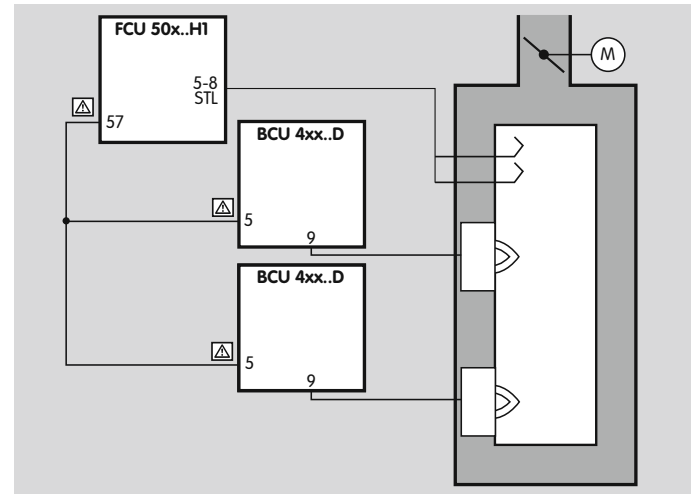
If the limit value of the safety temperature limiter is exceeded (excessive temperature in furnace), the FCU will perform a lock-out. The fault lock-out cannot be reset until the temperature falls below the STL limit value and the defined temperature hysteresis.

12.3.7 Pre-purge during high temperature operation
Parameter 27

Parameter 27 can be used to define whether the furnace start is performed with or without pre-purge in High temperature mode. The internal or an external STM can be used to detect the high temperature.

With the internal STM (FCU..H1), the FCU detects high temperature operation using the limit value defined in parameter 24.

With the external STM, the FCU detects high temperature operation by means of a high signal at terminal 66.

On FCUs with capacity control (FCU..F1, FCU..F2), the actuator must be moved to ignition position or, if a frequency converter is used, the fan must be accelerated to ignition speed to start the burner. If the FCU..F1 is used in conjunction with actuator IC 20, the ignition position is approached via the purge position.

Parameter 27 = 0: OFF; no pre-purge is performed upon furnace start-up

Parameter 27 = 1: ON; a pre-purge is performed at every start regardless of the furnace temperature

12.4 Air control

12.4.1 Fan in the event of fault
Parameter 29

This parameter defines how the fan should act in the event of a safety shut-down or fault lock-out.

Parameter 29 = 0: OFF; the fan is switched off

Parameter 29 = 1: ON; the fan runs until the start-up signal is received at terminal 1

12.4.2 Fan run-up time t_{GV}
Parameter 30

This parameter defines the time between the activation of the fan output (terminal 58) and the start of the FCU program sequence (display $\mathit{01}$).

The fan run-up time can be parameterized in a range between 0 and 250 s.

12.4.3 Fan ready for operation
Parameter 31

Using this parameter, it is possible to select whether a feedback from the ready fan is to be taken into consideration by the FCU. The fan sends a binary feedback signal to terminal 44 of the FCU if it is available for operation. If there is no signal, the FCU will perform a shut-down, depending on the function selected in parameter 31.

Parameter 31 = 0: OFF; the function is not required

Parameter 31 = 1: with safety shut-down

A safety shut-down will be performed if there is no input signal.

Parameter 31 = 2: with fault lock-out

A fault lock-out will be performed if there is no input signal.

12.4.4 Air monitoring during controlled air flow

Parameter 32

Air control is activated by actuating the controlled air flow input (terminal 2).

After a "no flow" state check of the purging air input (terminal 47, optionally terminal 48), the FCU starts the fan.

Parameter 32 = 0: OFF; maximum capacity.

The actuator is moved to the position for maximum capacity during controlled air flow. The air flow is not monitored.

Parameter 32 = 1: ON; maximum capacity.

The actuator is moved to the position for maximum capacity during controlled air flow. The air flow is monitored and taken into account in the subsequent burner start. If the air flow fails, a shut-down will be performed in the same way as during pre-purge.
Flow monitoring only works if air monitoring has been activated in parameter 15 or parameter 35, see also page 81 (Low air pressure protection) and page 89 (Air flow monitoring during pre-purge).

Parameter 32 = 2: OFF; controller enable.

The controller enable signal (terminal 56) is issued. The position of the actuator can be changed using an external temperature controller (controlled cooling). The air flow is not monitored.

Controlled air flow is only possible in standby (with no start-up signal).

12.4.5 Pre-purge time t_{PV}

Parameter 34

A burner start may only occur if it has been ensured that the concentration of inflammable components in all sections of the combustion chamber and the connected areas and the flue gas ducts is less than 25% of the lower flammability limit of the fuel gas. A pre-purge is generally performed to ensure compliance with these requirements.

Parameter 34 is used to parameterize the pre-purge time t_{PV} in a range between 0 and 6500 s.

The pre-purge time t_{PV} is to be set on the basis of the relevant application standard (e.g. EN 676, EN 746-2, NFPA 85 or NFPA 86).

If air monitoring has been activated in parameter 15 or 35, the pre-purge time t_{PV} starts as soon as the air monitor detects an adequate flow for purging, see page 81 (Low air pressure protection) and page 89 (Air flow monitoring during pre-purge).

FCU 505 (zone FCU)

The duration of the pre-purge started by the FCU 505 is determined by the FCU 500 (furnace FCU). The FCU 505 opens the zone's butterfly valve for purging, depending on the input signals at terminal 46 and terminal 66.

12.4.6 Air flow monitoring during pre-purge
Parameter 35

This parameter can be used to select additional differential pressure monitoring of the air flow during pre-purge. The FCU is informed that there is an adequate air flow via a signal from the differential pressure switch to terminal 48 during pre-purge.
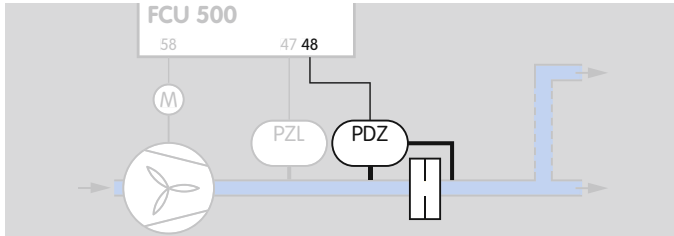
Parameter 35 = 0: OFF; the function is not required

Parameter 35 = 1: with safety shut-down

A safety shut-down will be performed if there is no input signal.

Parameter 35 = 2: with fault lock-out

A fault lock-out will be performed if there is no input signal.

Air flow monitoring is to be set on the basis of the relevant application standard (e.g. EN 676, EN 746-2, NFPA 85 or NFPA 86).

12.4.7 Post-purge time t_{PN}
Parameter 37

The post-purge time defines the period during which air for purging fuel gas residues out of the combustion chamber continues to be supplied to the combustion chamber after furnace operation has been terminated.

Parameter 37 is used to parameterize the post-purge time in a range between 0 and 6500 s (0 to 100 min.).

The conditions set in parameter 38 must be satisfied for the post-purge time to be started.

12.4.8 Air flow monitoring during post-purge
Parameter 38

Parameter 38 defines whether post-purge takes place with or without air flow monitoring. Air flow monitoring during the post-purge time can only be selected if it has also been activated for pre-purge (parameter 15 or parameter 35).

Parameter 38 = 0: ON; control element to maximum capacity.

The actuator is moved to the position for maximum capacity during the post-purge time. The air flow is monitored.

Parameter 38 = 1: OFF; control element to maximum capacity.

The actuator is moved to the position for maximum capacity during the post-purge time. The air flow is not monitored.

Parameter 38 = 2: OFF; control element to ignition capacity.

The actuator is moved to the position for ignition capacity during the post-purge time. If the position of the actuator at this time is less than the position for ignition capacity, this position is not changed. The air flow is not monitored.

Parameter 38 = 3: OFF; control element controller enable.

The controller enable signal (terminal 56) is issued. The position of the actuator can be changed using an external temperature controller (controlled cooling). The air flow is not monitored.

12.4.9 Capacity control

Parameter 40

FCU..F1 and FCU..F2 are fitted with an interface for connecting air actuators.

They activate a control element or frequency converter via the outputs for capacity control (terminals 53 to 56) for purging, cooling or starting the burners. The air actuator moves to the required position for the relevant operating situation.

Using parameter 40, you can set which actuator is used for capacity control.

Capacity control via bus, see page 103 (Capacity control (bus)).

Parameter 40 = 0: OFF; no capacity control (no air actuator)

Parameter 40 = 1: with IC 20

The interface is configured to the requirements of actuators IC 20, IC 20..E, IC 50 or IC 50..E.

Alternatively, comparable three-point step actuators may be used.

IC 20
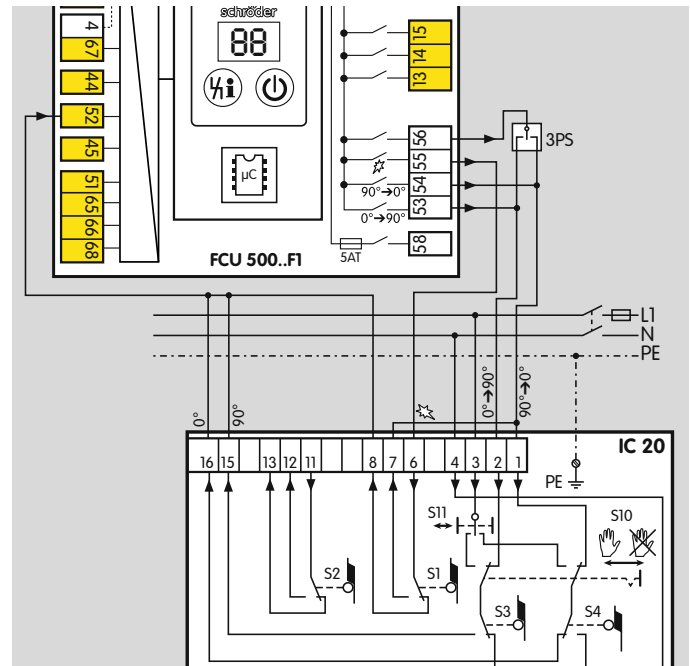
The positions for maximum capacity, ignition capacity and minimum capacity can be set using the actuator. It is checked whether the relevant position has been reached using terminal 52. If the position is not reached within the timeout time of 255 s, the FCU will display fault message A_c, A_o or A_i (minimum, maximum or ignition capacity not reached), see page 70 (Fault signalling).

In the event of a fault, the actuator is moved to the position set via cam S4 for minimum capacity via the output at terminal 54.

Control range between the positions for minimum and maximum capacity
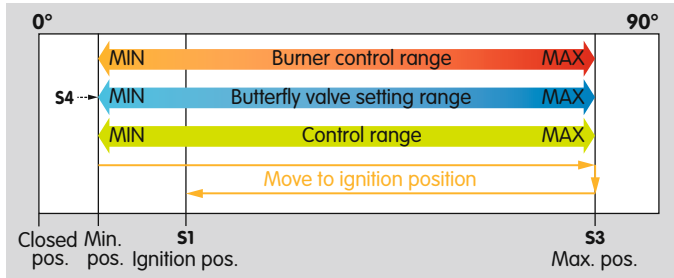
Closed Min. **S1** **S3**
pos. pos. Ignition pos. Max. pos.

The control system is enabled for operation via the controller enable output (terminal 56). During the controller enable procedure, the actuator can be adjusted infinitely between the positions for maximum and minimum capacity by an external three-point step controller. There is no timeout active in this case.

Control range between the positions for maximum capacity and ignition capacity
The wiring between the FCU and the 3-point step controller can be adjusted so that the control range of the actuator is between the positions for maximum and ignition capacity.
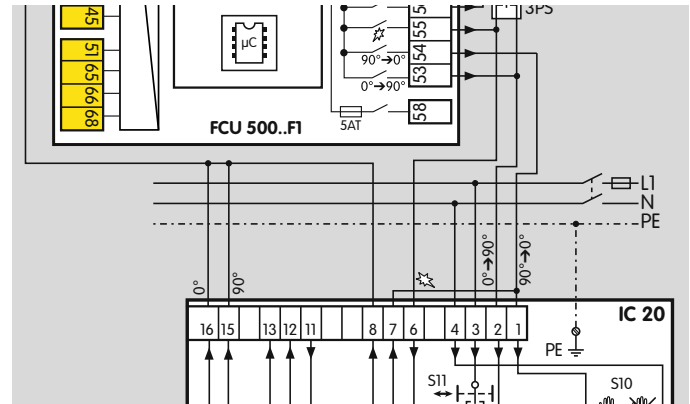
The minimum position which can be reached is the closed position.
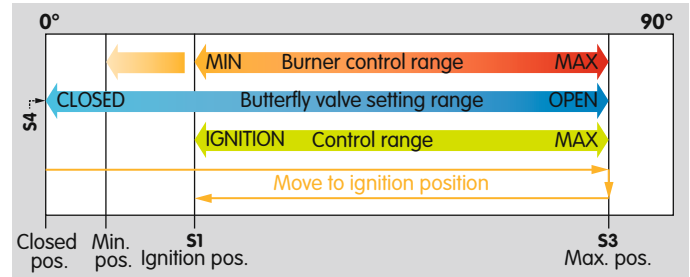
Closed Min. **S1** **S3**
pos. pos. Ignition pos. Max. pos.

Manual mode
In Manual mode, the actuator can be moved between the positions for maximum and minimum capacity in 3-point step operation. No timeout is active when approaching these positions. The controller enable output (terminal 56) is not active and not checked.

IC 20..E
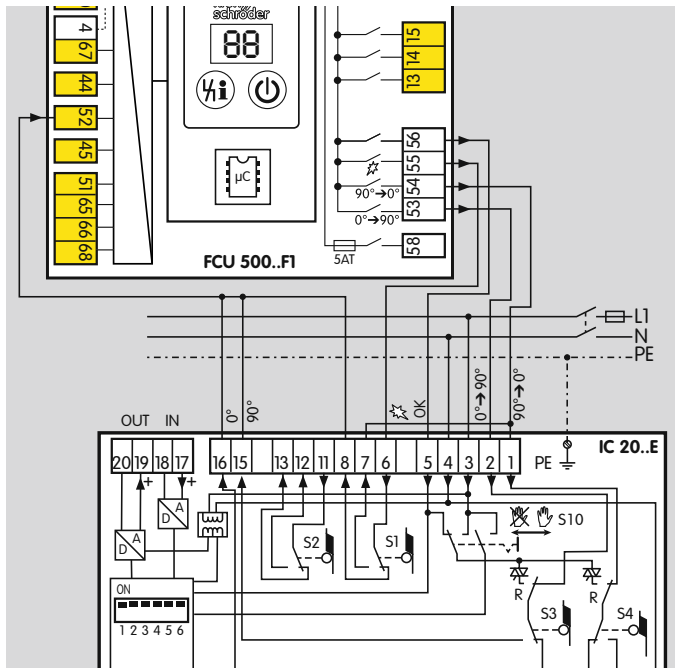
The positions for minimum capacity, maximum capacity and ignition capacity can be set using the actuator. When the appropriate position has been reached, this information is signalled back via terminal 52.

If no signal is received that the position has been reached within the timeout time of 255 s, a fault lockout of the FCU will be performed and a fault message (R_c, R_a or R_i) will be displayed, see page 70 (Fault signalling).

Control range between the positions for minimum and maximum capacity
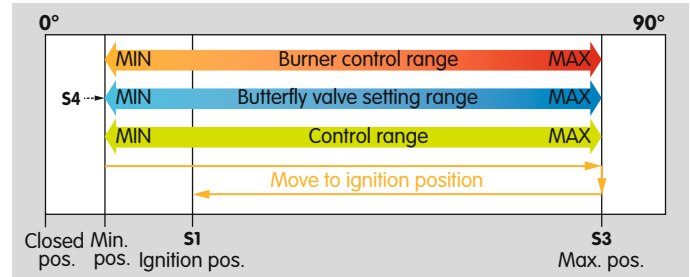
The control system is enabled during operation via the controller enable output (terminal 56). During the controller enable procedure, the actuator can be adjusted infinitely between the positions for maximum and minimum capacity using its analogue input (terminals 17 and 18). There is no timeout active in this case.

Manual mode

In Manual mode, the actuator can be moved between the positions for maximum and minimum capacity in 3-point step operation. No timeout is active when approaching these positions. The controller enable output (terminal 56) is not active and not checked.

IC 40

Parameter 40 = 2: with IC 40

The interface is configured according to the requirements of actuator IC 40 with an optional analogue input. Operating mode 27 must be parameterized on the IC 40 to ensure communication with the FCU.
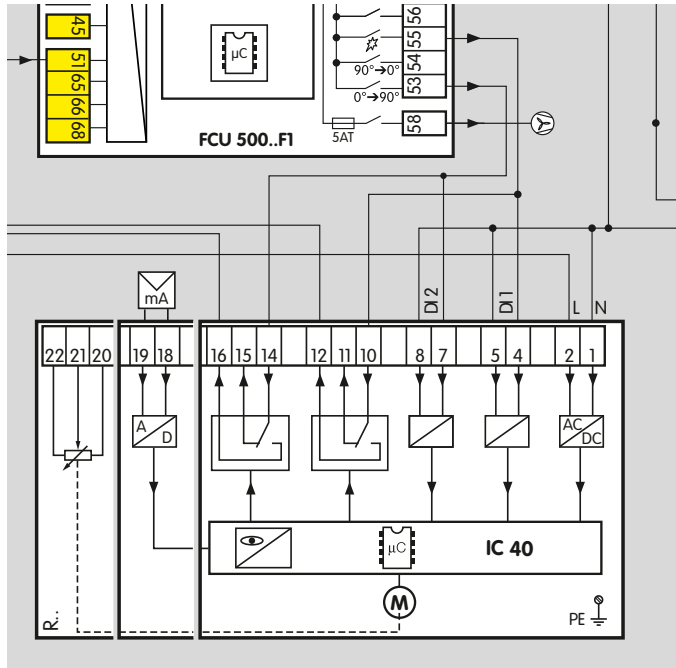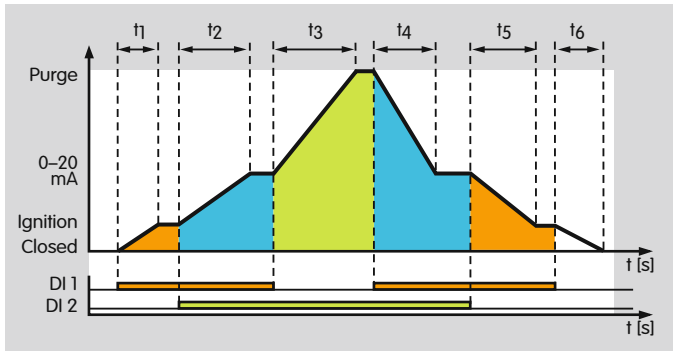

The positions for maximum capacity and ignition capacity can be set using the actuator. Terminal 51 checks whether the position for maximum capacity has been reached. Terminal 52 checks the position for igni-

tion capacity. If the position is not reached within the timeout time of 255 s, a fault lock-out of the FCU will be performed. A fault message (Ac, Ao oder Ai) will be displayed, see page 70 (Fault signalling).

If a controller enable is active, the control system is enabled for operation via the outputs at terminals 53 and 55.

During the controller enable procedure, the actuator IC 40 can be adjusted infinitely between the positions for maximum and minimum capacity using its analogue input (terminals 18 and 19). There is no timeout active in this case.

FCU		IC 40	
Signal at terminal		**Position**	**Butterfly valve position**
55	**53**		
Off	Off	Closed	Closed
On	Off	Ignition	Minimum/Ignition capacity
On	On	0 – 20 mA	Any position between minimum and maximum capacity
Off	On	Open	Maximum capacity

In the event of a fault, there will be no signal at terminals 53 and 55 so that the actuator moves to the closed position. When approaching the closed position, no timeout of 255 s is active since no feedback input is checked. This may result in a situation where the program is continued in the case of a request for the closed position, without the butterfly valve being closed. The outputs at terminals 56 (controller enable) and 54 (closed position) on the FCU are non-functional and are not activated.

Manual mode

In Manual mode, no external controller is enabled. The actuator can be moved to the positions for maximum capacity or ignition capacity by the user. 3-point step operation is not possible. No timeout is active when approaching these positions.

RBW

Parameter 40 = 3: with RBW

The actuator can be moved to the positions for maximum capacity (contact COM to HI) and minimum capacity (contact COM to LO) using the interface and by closing the various contacts.
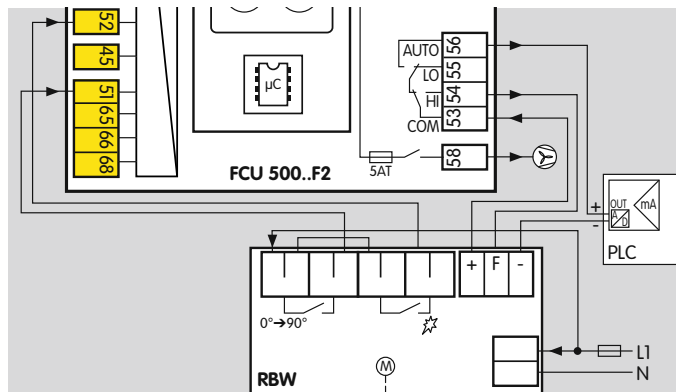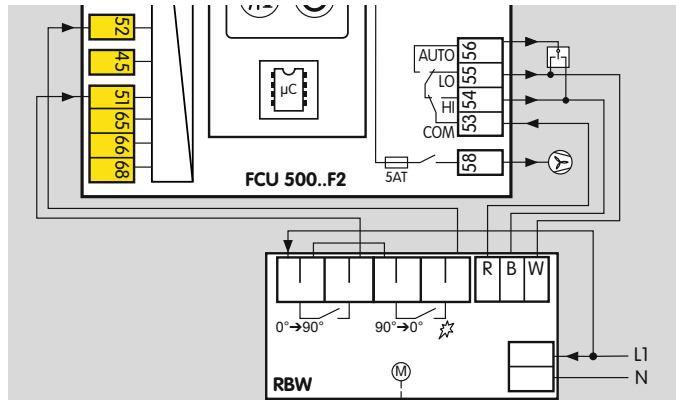
The RBW actuator reports that it has reached the position for maximum capacity via a signal to terminal 51. The actuator reports that it has reached the position for minimum capacity via a signal to terminal 52. The simultaneous activation of terminals 51 and 52 results in a fault lock-out of the FCU.

If parameter 41 = 0, the system monitors the movement to the positions for maximum and minimum capacity with a timeout time of 255 s. Reaching the relevant position immediately triggers the program continue switch conditions. If reaching the position is not signalled within the timeout time of 255 s, a safety shutdown of the FCU will be performed. A fault message (Ac or Ao) will be displayed, see page 70 (Fault signalling).

If parameter 41 = 1, the system does not monitor whether the positions for minimum and maximum capacity are reached. In this case, a running time of up to 250 s must be defined using parameter 42, see page 100 (Running time). The program continue switch conditions are then controlled dependent on this time.

If a fault occurs, the actuator is moved to the position for minimum capacity.

| FCU		RBW (three-point step control)	
Contact between terminals		Position	Butterfly valve position
53	55	Ignition	Minimum/Ignition capacity
53	56	0 – 20 mA	Any position between minimum and maximum capacity
53	54	Purge	Maximum capacity

Manual mode

In Manual mode, no external controller is enabled during the controller enable procedure. The actuator can be moved to the positions for maximum capacity or ignition capacity by the user. 3-point step operation is not possible. No timeout is active when approaching these positions.

Frequency converter

Parameter 40 = 4: with frequency converter

The interface is configured according to the requirements of a frequency converter for fans.
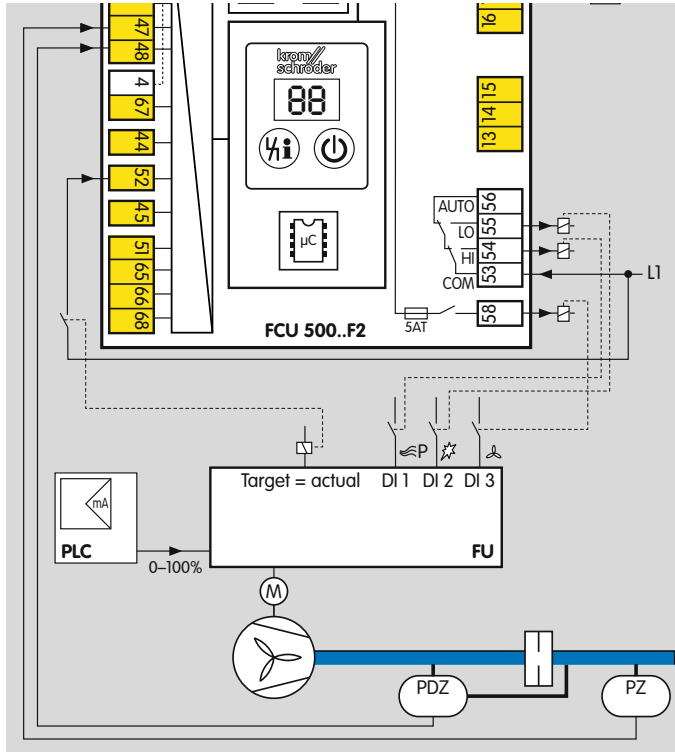
The FCU bridges the connections at terminals 53 and 54 (COM – HI bridge) for pre-purge. The frequency converter accelerates the fan to the speed for maximum capacity with a timeout of 255 s.

The frequency converter reports that the speed for maximum capacity has been reached by a signal (target = actual) to the FCU via terminal 52.

After the elapse of the pre-purge time, the FCU bridges the connections at terminals 53 and 55 (COM – LO bridge). The frequency converter accelerates the fan to the speed for minimum capacity (ignition capacity) with a timeout of 255 s. The frequency converter reports that the speed for minimum capacity (ignition capacity) has been reached by a signal (target = actual) via terminal 52. As soon as the burner operating signal has been received, the FCU bridges the connections at terminals 53 and 56 (COM – AUTO bridge). This disconnects the outputs at terminals 54 and 55 from the voltage supply to issue the controller enable signal to the frequency converter. During the controller enable procedure, the speed of the fan can be adjusted infinitely between minimum and maximum capacity using the analogue input of the frequency converter. There is no timeout active in this case.
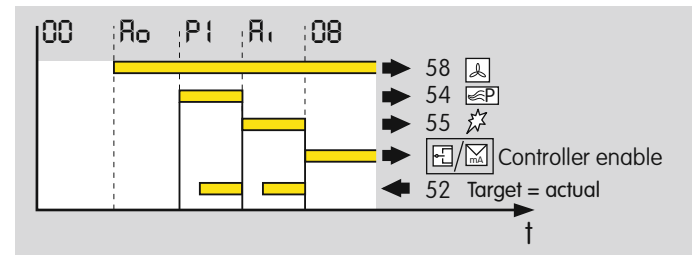
FCU		Frequency converter		
Contact between terminals		Signal to	Position	Fan speed
53	55	DI 2/DI 3	Ignition	Minimum/Ignition capacity
53	56	DI 3	0 – 20 mA	Any speed between minimum and maximum capacity
53	54	DI 1/DI 3	Purge	Maximum capacity

Manual mode

In Manual mode, the frequency converter can be set
to the speed for maximum air volume or minimum air
volume (pilot air volume). Adjustment by the control
system is not possible. No timeout is active when accel-
erating to these speeds.

12.4.10 Running time selection

Parameter 41

Parameter 41 is only active if parameter 40 = 3 (actuator with RBW function).

Parameter 41 = 0: Off; checking the positions for minimum/maximum capacity. A signal that the positions for minimum and maximum capacity have been reached is returned and monitored with a timeout time of max. 255 s. When the position has been reached, the FCU will initiate the next program step.

Parameter 41 = 1: On; for approaching the positions for minimum/maximum capacity. The Running time set using parameter 42 is activated for approaching these positions. After this time has elapsed, the FCU will initiate the next program step.

Parameter 41 = 2: On; for approaching the position for maximum capacity. The Running time set using parameter 42 is activated for approaching the position for maximum capacity. After this time has elapsed, the FCU will initiate the next program step. Approaching the position for minimum capacity is signalled and monitored.

Parameter 41 = 3: On; for approaching the position for minimum capacity. No signal is returned that the position for minimum capacity has been reached. The Running time set using parameter 42 is activated for approaching the position for minimum capacity. After this time has elapsed, the FCU will initiate the next program step. Approaching the position for maximum capacity is signalled and monitored.

12.4.11 Running time

Parameter 42

Parameter 42 is only active if parameter 40 = 3 and parameter 41 = 1, 2 or 3.

This parameter sets the running time of the RBW actuator (0 to 250 s). Feedback for maximum or minimum capacity position (HI or LO) is not queried.

The actuator can be moved by bus signals or an external controller during the controller enable procedure. There is no timeout active in this case.

In Manual mode, no external controller is enabled during the controller enable procedure. The actuator can be moved to the positions for maximum or minimum capacity by the user. 3-point step operation is not possible. No timeout is active when approaching these positions.

12.4.12 Controller enable signal delay time t_{RF}

Parameter 44 (only on FCU..F1/F2)

The controller enable signal is delayed by 0, 10, 20 or 30 up to 250 s using parameter 44.

After the furnace control unit has checked the safety functions, external temperature control can be enabled. The enable signal can be delayed by up to 250 s using parameter 44. The FCU displays program status *H8* (safety interlocks enable). After the delay time t_{RF} has elapsed, the FCU signals "Operation" status via the 24 V DC output (terminal 42) and activates the controller enable output (terminal 56).

12.4.13 Minimum enable time

Parameter 45

On units with capacity control (FCU..F1/F2), parameter 45 can be used to set a minimum enable time (0 to 250 s) for the burner start during which the actuator or frequency converter stays in the position for minimum capacity. The minimum enable time must be selected so that the downstream burners can be started safely.

The burner operating signal (terminal 4) is not evaluated until the minimum enable time has elapsed if parameter 46 = 1.

12.4.14 Burner operating signal

Parameter 46

Can only be programmed on FCU..F1 and FCU..F2.

A successful burner start can be reported to the FCU via the burner operating signal (terminal 4). As soon as a signal is received at terminal 4 and parameter 46 = 1, the FCU will issue the controller enable signal.
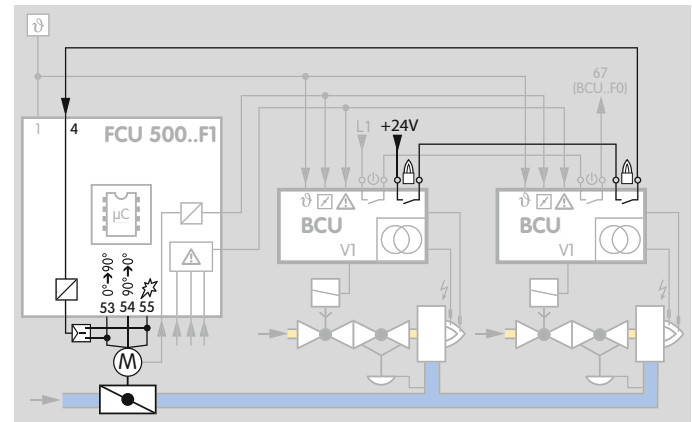
Parameter 46 = 0: Off

Parameter 46 = 1: On; controller enable; parameter 47 is activated.

12.4.15 Controller enable time limit

Parameter 47

Can only be programmed on FCU..F1 and FCU..F2.
Parameter 46 = 1 must be selected.

The FCU is informed by the burner operating signal (terminal 4) that the burners have started up.
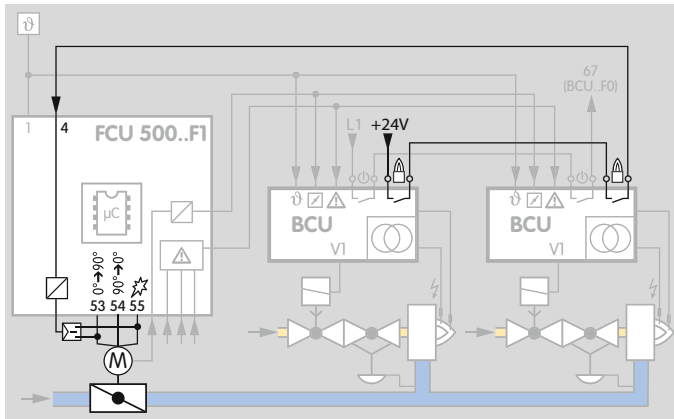
To ensure that the furnace control unit does not endlessly wait for the enable signal, a time (0 to 60 min.) can be defined using parameter 47 by which the burners must reach their operating position. If no feedback signal is received during this time, the FCU performs a fault lock-out. The time does not start until the minimum enable time has elapsed.

12.4.16 Capacity control (bus)

Parameter 75

Controlling the burner capacity using the fieldbus is only possible with bus module BCM 500 connected and enabled (P80 = 1 or 2).

The output at terminal 56 has a different function.

Parameter 75 = 0: OFF. No capacity control possible using the fieldbus.

Parameter 75 = 1: MIN. to MAX. capacity; standby in position for MIN. capacity. The control range while the burner is operating is between the positions for minimum capacity (S4) and maximum capacity (S3). The burner is ignited in the position for ignition capacity (S1). When the burner is switched off, the actuator is moved to the position for minimum capacity (S4).

This operating mode can be achieved with an actuator IC 20, RBW or with a comparable three-point step actuator.

If the air supply is stopped on a heated furnace with the burner switched off, the controls may be damaged by the hot furnace atmosphere as a result of the lowest possible position of the butterfly valve, limited by S4.

IC 20

Switching cam setting for ignition capacity, minimum and maximum capacity as well as pre-purge and standby:

S1: for ignition capacity of the burner.

S3: for maximum capacity of the burner and pre-purge.

S4: for minimum capacity of the burner and standby.
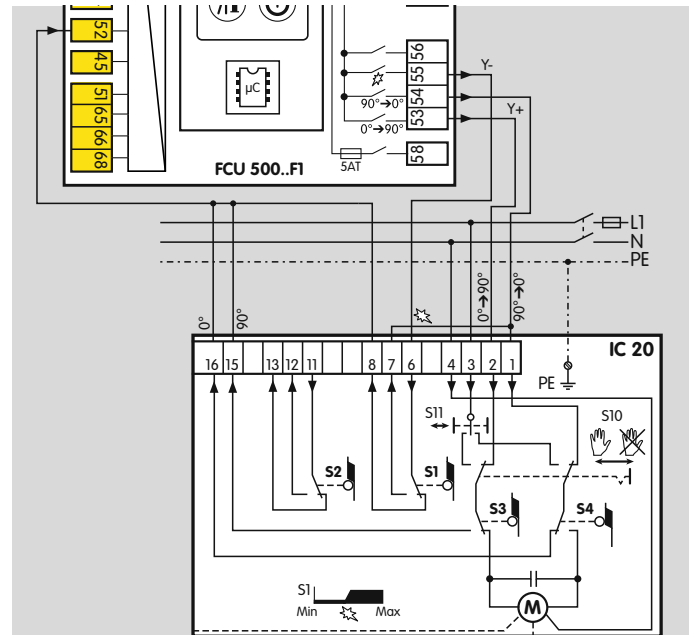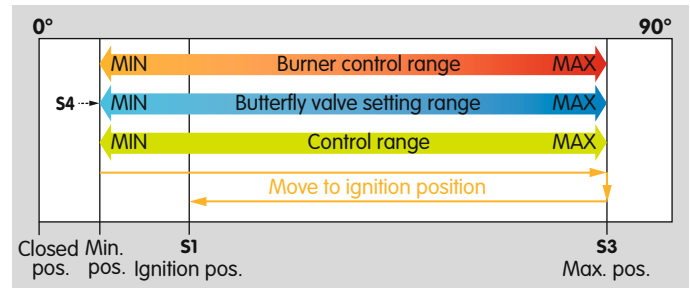
Parameter 75 = 2: MIN. to MAX. capacity; standby in CLOSED position. The control range while the burner is operating is between the positions for minimum capacity (S2) and maximum capacity (S3). The burner is ignited in the position for ignition capacity (S1). When the burner is switched off, the actuator is moved to the closed position (S4).

This operating mode can be achieved with an actuator IC 20 or alternatively with a comparable three-point step actuator.

If the air supply is stopped on a heated furnace with the burner switched off, the controls are protected from the hot furnace atmosphere as a result of the butterfly valve being in the closed position (limited by S4). Check whether the burner can cope without cooling in this situation.

IC 20

Switching cam setting for ignition capacity, minimum and maximum capacity as well as pre-purge and stand-by:

S1: for ignition capacity of the burner.

S2: for minimum capacity of the burner.

S3: for maximum capacity of the burner and pre-purge.

S4: for the closed position of the butterfly valve and standby.
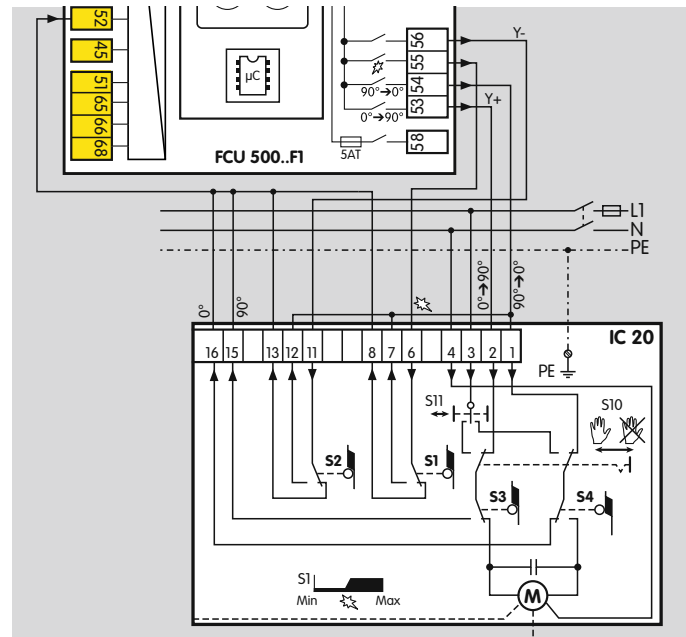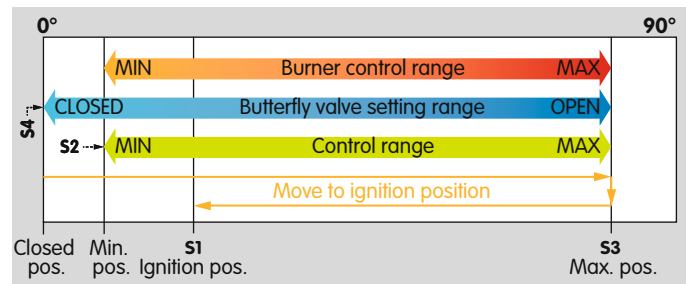
Parameter 75 = 3: IGNITION to MAX. capacity; standby in CLOSED position.

The control range while the burner is operating is between the positions for minimum capacity (S1) and maximum capacity (S3). The burner is ignited in the position for minimum capacity (S1). When the burner is switched off, the actuator is moved to the closed position (S4).

This operating mode can be achieved with an actuator IC 20 or alternatively with a comparable three-point step actuator.

If the air supply is stopped on a heated furnace with the burner switched off, the controls are protected from the hot furnace atmosphere as a result of the butterfly valve being in the closed position (limited by S4). Check whether the burner can cope without cooling in this situation.

IC 20

Switching cam setting for ignition capacity, minimum and maximum capacity as well as pre-purge and standby:

S1: for minimum capacity and ignition capacity of the burner.

S3: for maximum capacity of the burner and pre-purge.

S4: for the closed position of the butterfly valve and standby.
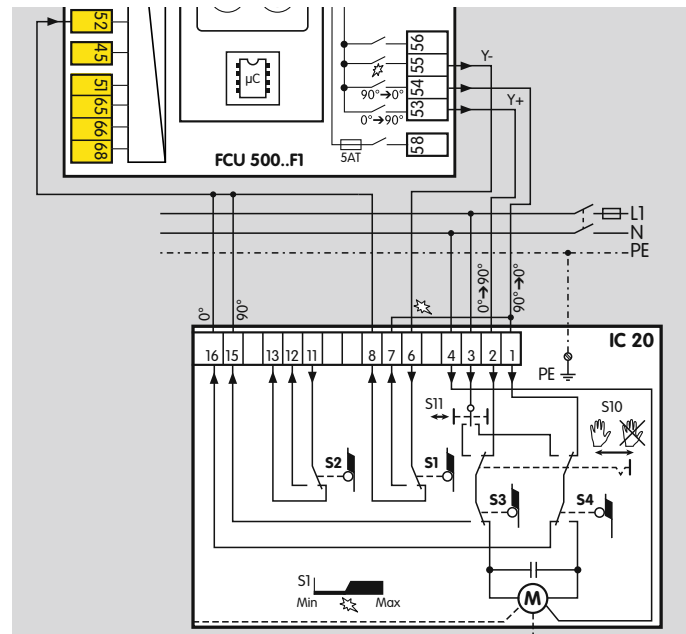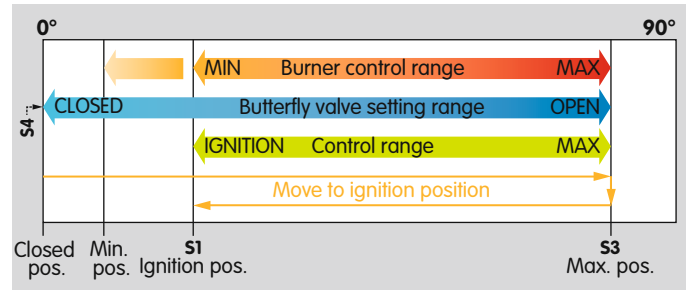
Parameter 75 = 4: MIN. to MAX. capacity; standby in position for MIN. capacity; burner quick start.

The control range while the burner is operating is between the positions for minimum capacity (S4) and maximum capacity (S3). The burner is ignited in the position for ignition capacity (S1). Switching cam S2 (reverse direction of rotation) ensures that the position for ignition capacity is approached without pre-purging first (quick start). When the burner is switched off, the actuator is moved to the position for minimum capacity (S4).

This operating mode can be achieved with an actuator IC 20 or alternatively with a comparable three-point step actuator.

If the air supply is stopped on a heated furnace with the burner switched off, the controls may be damaged by the hot furnace atmosphere as a result of the lowest possible position of the butterfly valve, limited by S4. If pre-purge is active, considerably lower air capacity than the maximum air capacity will be used for purging.

IC 20

Switching cam setting for ignition capacity, minimum and maximum capacity and reverse direction of rotation to approach the position for ignition capacity:

S1: for ignition capacity of the burner.

S2: for reversing the direction of rotation to approach the position for ignition capacity.

S3: for maximum capacity of the burner and pre-purge.

S4: for the closed position of the butterfly valve and standby.
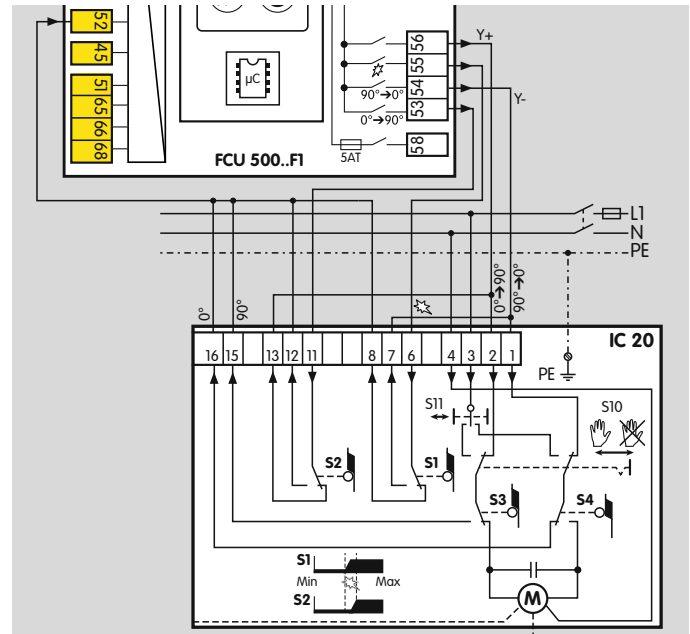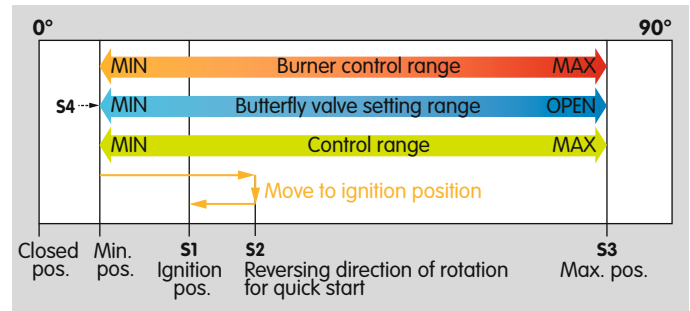
Parameter 75 = 5: IGNITION to MAX. capacity; standby in CLOSED position; burner quick start.

The control range while the burner is operating is between the positions for ignition capacity (S1) and maximum capacity (S3). The burner is ignited in the position for ignition capacity (S1). Switching cam S2 (reverse direction of rotation) ensures that the position for ignition capacity is approached without pre-purging first (quick start). When the burner is switched off, the actuator is moved to the closed position (S4).

This operating mode can be achieved with an actuator IC 20 or alternatively with a comparable three-point step actuator.

If the air supply is stopped on a heated furnace with the burner switched off, the controls are protected from the hot furnace atmosphere as a result of the butterfly valve being in the closed position (limited by S4). Check whether the burner can cope without cooling. If pre-purge is active, considerably lower air capacity than the maximum air capacity will be used for purging.

IC 20

The position for maximum capacity is achieved by the controller enable output (terminal 56).

Switching cam settings S1, S2, S3 and S4:

S1: for minimum capacity and ignition capacity of the burner.

S2: for reversing the direction of rotation to approach the position for ignition capacity. The actuator will move to the position for ignition capacity without reaching the position for maximum burner capacity.

S3: for maximum capacity of the burner and pre-purge.

S4: for the closed position of the butterfly valve and standby.
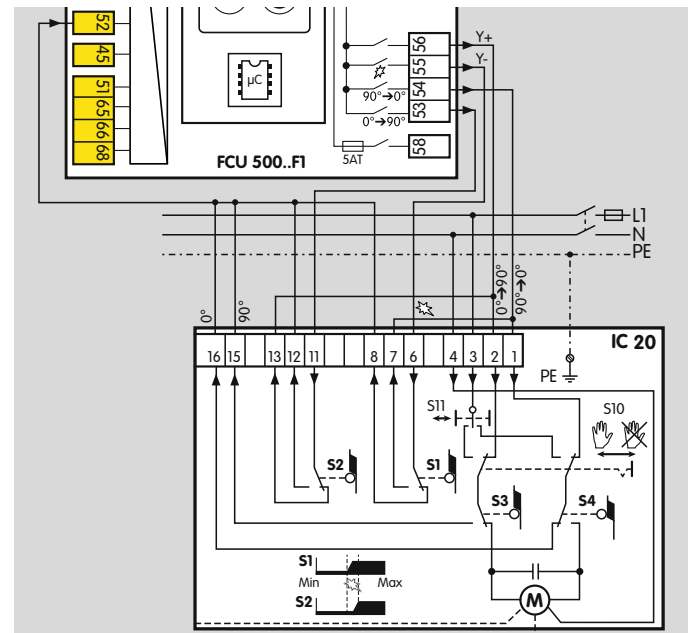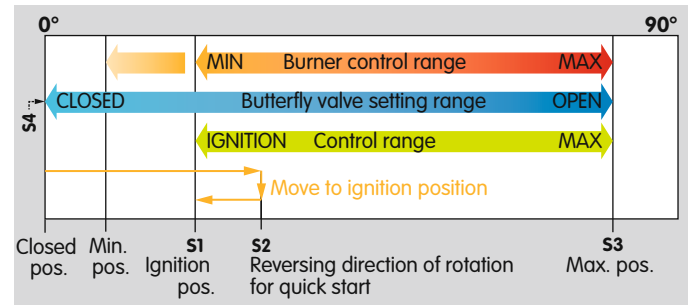
12.5 Valve check

12.5.1 Valve proving system

Parameter 51

Parameter 51 is used to define whether and at what time in the FCU program sequence the valve check is activated. This allows either the tightness of the gas solenoid valves and the pipework between them to be checked (tightness test) or the closed position of a solenoid valve (proof of closure function) to be checked. If the proof of closure function is activated, the closed position of the gas solenoid valve on the inlet side is checked using a POC switch.

Parameter 51 = 0: Off. No valve check is activated.

Parameter 51 = 1: tightness test before start-up.

Parameter 51 = 2: tightness test after shut-down. With this setting, a tightness test is also performed after a fault is reset and after mains on.

Parameter 51 = 3: tightness test before start-up and after shut-down.

An additional bypass/relief valve must be fitted in gas sections with an air/gas ratio control, see also page 108 (Relief valve (VPS)). The valve allows the closed air/gas ratio control to be bypassed during the tightness test.

Parameter 51 = 4: proof of closure function (POC).
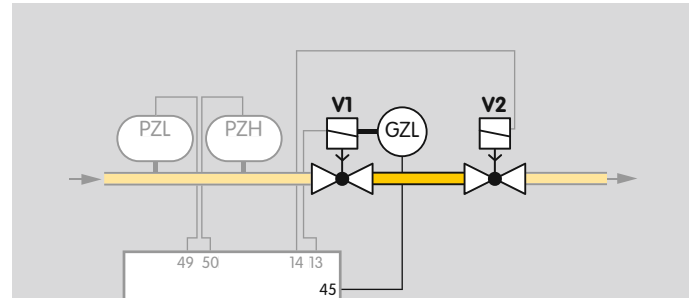
A signal is sent to the FCU via the POC switch on the gas solenoid valve on the inlet side before burner start-up stating that the valve is closed. After burner start-up, the signal must drop out to indicate to the FCU that the valve is open.

12.5.2 Relief valve (VPS)

Parameter 52

One of the valves connected to terminal 14, 15 or 57 can be selected to discharge the test volume during a tightness test.

Parameter 52 = 2: V2. The test volume is discharged via the valve connected to terminal 14.

Parameter 52 = 3: V3. The test volume is discharged via the valve connected to terminal 15.

Parameter 52 = 4: V4. The test volume is discharged via the valve connected to terminal 57.
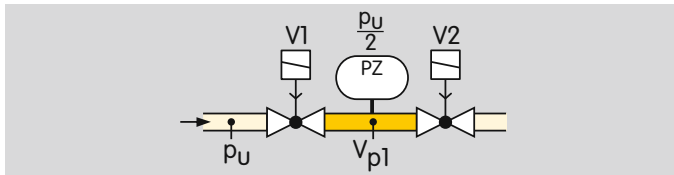
12.5.3 Tightness control test volume

Parameter 53

Parameter 53 is used to define whether one or two test volumes are checked for tightness and whether a safety valve or a relief valve is used for reducing the pressure.
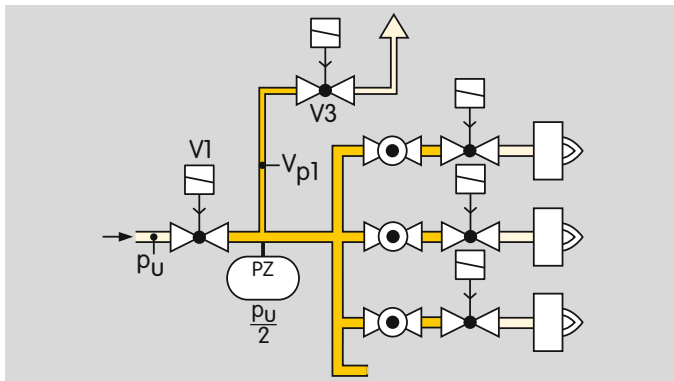
Parameter 53 = 1: V_{p1}.

A test volume (V_{p1}) between two safety valves (V1, V2) is checked for tightness.

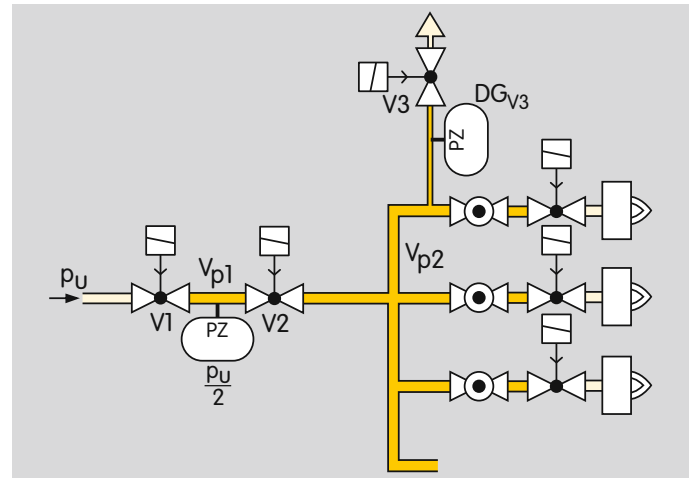Parameter 53 = 2: V_{p1}; pressure reduction via V3.

The system tightness is checked with one test volume (V_{p1}) between two safety valves. The relief valve V3 is opened to reduce the pressure in the test volume by venting to a safe area.

Parameter 53 = 3: V_{p1} + V_{p2}; pressure reduction via V3.

The system tightness is checked with two test volumes V_{p1} and V_{p2}. During the tightness test of V_{p1}, almost atmospheric pressure must prevail in the test volume V_{p2}. Relief valve V3 is opened to reduce the pressure in test volume V_{p2}. Pressure switch DG_{V3} is used for the controlled pressure reduction of test volume V_{p2}. For the circuit design, see page 130 (System leak tightness check).

The time and the duration of the pressure reduction of the test volume can be adjusted using parameters 54 and 55 for checking the system tightness, see page 110.

12.5.4 Pressure reduction V_{p2}
Parameter 54

Can only be programmed if P53 = 3.

To check the system tightness with two test volumes (V_{p1} and V_{p2}), the time when the pressure of test volume V_{p2} should be reduced is defined in parameter 54.

Parameter 54 = 0: in standby

Parameter 54 = 1: upon start-up

12.5.5 Opening time relief valve V3
Parameter 55

Can only be programmed if P53 = 3.

Parameter 55 is used to define the time (0 to 6500 s) required to reduce the pressure of test volume V_{p2} before the valve check of test volume V_{p1} is started.

12.5.6 Measurement time V_{p1}
Parameter 56

The required measurement time must be determined according to the requirements of the appropriate application standards, e.g. EN 1643.

The required measurement time for the tightness test of V_{p1} can be set using parameter 56. The possible settings are 3 s, 5 to 25 s (in 5 s steps) or 30 to 3600 s (in 10 s steps).

See also page 53 (Measurement time t_M).

12.5.7 Measurement time V_{p1} and V_{p2}
Parameter 57

For a system leak tightness check, the pressure of test volume V_{p2} is first reduced. The test volume V_{p1} is then tested. Valve V2 is opened to check the test volume V_{p2}, thus making a connection between V_{p1} and V_{p2}. V_{p1} and V_{p2} are then filled via V1.

The required measurement time for the tightness test of V_{p1} and V_{p2} (checking relief valve V3, the burner valves and the pipework) can be set using parameter 57. The possible settings are 3 s, 5 to 25 s (in 5 s steps) or 30 to 3600 s (in 10 s steps).

Large test volumes

If large test volumes are to be checked for tightness, it is possible to reduce the testing time. A second pressure switch is required for this purpose to monitor the test volume V_{p1}. The first pressure switch (at terminal 45) is set so that it monitors ¼ of the inlet pressure p_u, the second pressure switch (at terminal 65) monitors ¾ of the inlet pressure p_u.

The "Reduced DG test duration" function is activated by setting parameter 70 to 1. Terminal 65 is thus assigned the function "Input for $3p_u/4$ pressure switch for tightness test". Terminal 45 is thus assigned the function "Input for $p_u/4$ pressure switch for tightness test".

12.5.8 Valve opening time 1 t_{L1}
Parameter 59

This parameter is used to define the opening time for the valves (2 to 25 s) which are opened to fill or discharge the test volumes between the gas valves.

If the preset opening time t_L = 2 s is inadequate (e.g. if slow opening valves are used) to fill the test volume or reduce the pressure between the valves, bypass valves can be used instead of the main valves.
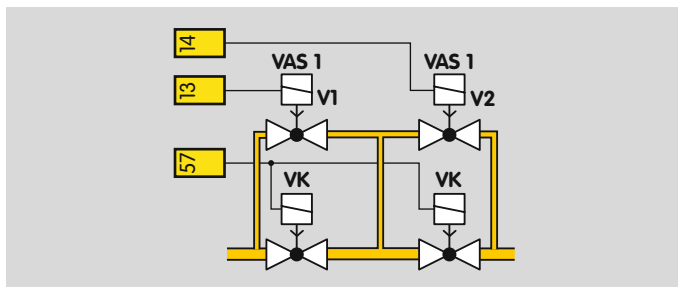
On condition that the gas volume which flows into the combustion chamber is no larger than 0.05% of the maximum flow rate, the bypass valves may be open for longer than the 3 s permitted by the standard (EN 1643:2000). The required volume limit can be achieved by fitting a restrictor or orifice, for example. The opening time to be set is then calculated on the basis of this restrictor or orifice.

Current rating of safety interlock output (terminal 57): max. 0.5 A, see also page 127 (Safety interlock output in the case of higher power requirement)

Calculating the opening time, see page 52 (Calculating the extended valve opening time)

12.5.9 Valve opening time 2 t_{L2}
Parameter 60

Only available if P53 = 3 (V_{p1} + V_{p2}; pressure reduction via V3)

This parameter is used to define the opening time for the valves (2 to 25 s) which are opened to build up or reduce the gas pressure in the test volumes V_{p1} and V_{p2}.
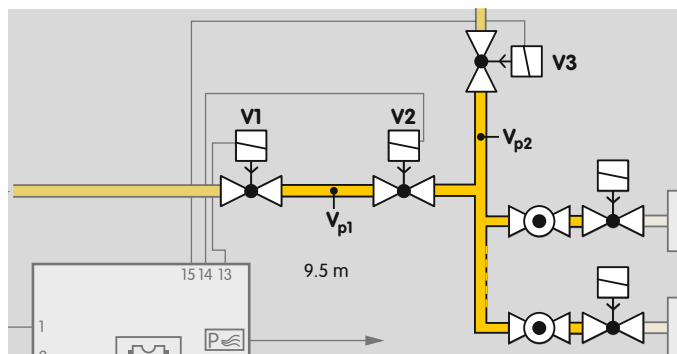
12.6 Behaviour during start-up

12.6.1 Minimum pause time t_{MP}
Parameter 62

A minimum pause time t_{MP} (0 to 3600 s) can be defined to achieve stable operation of the heating equipment.

If the post-purge time t_{PN} (parameter 37) has elapsed and no signal (ϑ) is received at terminal 1 (furnace shut down), a restart is prevented for the duration of the minimum pause time t_{MP}.

12.6.2 Switch-on delay time t_E
Parameter 63

Defines the time between applying the start-up signal (start) and initiating the furnace start (0 to 25 s).

When several FCU 505 (zone FCUs) are activated simultaneously, setting different switch-on delay times t_E prevents the fans from starting at the same time and reduces the load on the power supply. The switch-on delay also applies to the TC function.

12.6.3 Filling time before start-up
Parameter 65

The filling time for the pressure build-up in the gas line before start-up is defined using this parameter. This allows the tripping of the safety shut-off valve to be prevented after the main gas valves have been released. Bypass valves V3 and V4 are required for the slow pressure build-up in test volume V_{p2}.
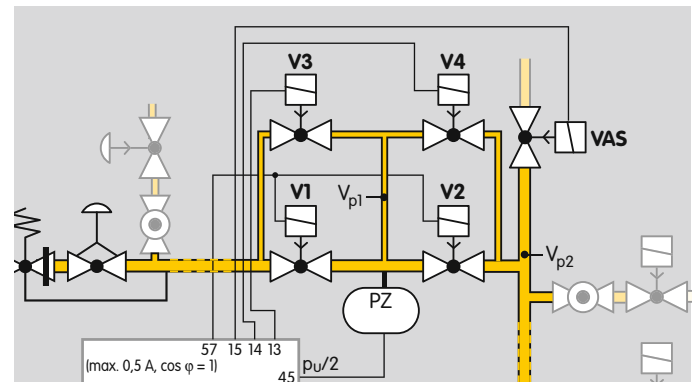

The filling time can be set from 0 to 25 s.

The current supplied via terminal 57 to control valves V1 and V2 is max. 0.5 A. In the event that a higher output current is required, the output current can be increased by the additional connection of 2 contactors with forced-guided contacts, see also page 127 (Safety interlock output in the case of higher power requirement).

12.7 Manual mode

If the Reset/Information button is pressed for 2 s during switch-on, the FCU reverts to Manual mode. Two dots blink on the display. The FCU is now operating in Manual mode independently of the status of the inputs of the start-up signal (terminal 1), controlled air flow (terminal 2) and remote reset (terminal 3). The function of the controller enable/emergency stop input (terminal 46) is retained. The manual start-up of the FCU can be started in Manual mode by pressing the Reset/Information button. Each time the button is pressed again, the FCU moves to the next step of the program sequence and stops there, for example for adjusting a butterfly valve or the gas/air mixture.

Actuator IC 20, IC 40, RBW

Following controller enable (status display $\boxed{08}$), a connected actuator can be opened and closed as required. By holding the button, the actuator is first opened further. The FCU indicates $\boxed{Ao}$ with blinking dots. Once the button has been released, the actuator stops in the relevant position. Pressing it again will result in closing the actuator to the position for minimum capacity. The FCU indicates $\boxed{Ac}$ with blinking dots. A change of direction takes place each time the button is released and pressed again. When the actuator has reached its final position, the dots disappear.

Frequency converter

Following controller enable (status display $\boxed{08}$), the frequency converter can be set to the speed for maximum air volume or minimum air volume (pilot air volume) by pressing the button.

12.7.1 Operating time in Manual mode

Parameter 67

Parameter 67 determines when Manual mode is terminated.

Parameter 67 = 0: Manual mode is not limited in time.

If this function has been selected, operation of the furnace may be continued manually in the event of failure of the control system or the bus.

Parameter 67 = 1: the FCU will terminate Manual mode 5 minutes after the last time the button is pressed. It then moves abruptly back to the start-up position/standby.

If the unit is switched off or a power failure occurs, Manual mode on the FCU will be terminated regardless of parameter 67.

12.8 Functions of terminals 51, 65, 66, 67 and 68

Terminals 51, 65, 66, 67 and 68 can each be assigned a logical AND gating with one of the inputs for the safety functions (terminals 46 – 50) using an appropriate parameter. If AND gating is required, the input concerned can be enabled.

In addition, the terminals can be assigned a given function.

12.8.1 Function of terminal 51

Parameter 69

The terminal can be set to the function "IC 40/RBW max. air volume feedback" to query the position for maximum capacity of an IC 40/RBW actuator, see page 96 (Parameter 40 = 3: with RBW).

Parameter 69 = 0: Off

Parameter 69 = 1: Max. capacity position feedback (IC 40/RBW)

Parameter 69 = 2: AND with emergency stop (terminal 46)

Parameter 69 = 3: AND with $air_{min.}$ (terminal 47)

Parameter 69 = 4: AND with air flow monitoring (terminal 48)

Parameter 69 = 5: AND with $gas_{min.}$ (terminal 49)

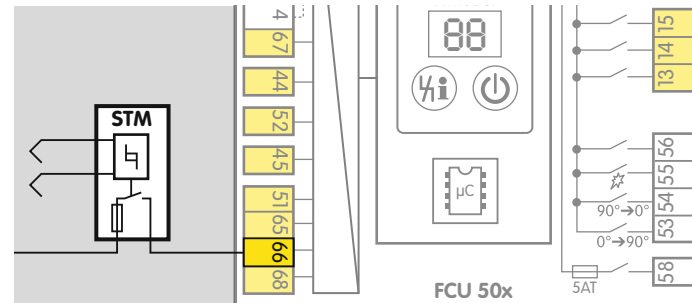Parameter 69 = 6: AND with $gas_{max.}$ (terminal 50)

12.8.2 Function of terminal 65

Parameter 70

If large test volumes are to be checked for tightness, it is possible to reduce the testing time. A second pressure switch is required for this purpose to monitor the test volume V_{p1}. The first pressure switch (at terminal 45) is set so that it monitors ¼ of the inlet pressure p_u, the second pressure switch (at terminal 65) monitors ¾ of the inlet pressure p_u.

The "Reduced DG test duration" function is activated by setting parameter 70 to 1. Terminal 65 is thus assigned the function "Input for $3p_u/4$ pressure switch for tightness test". Terminal 45 is thus assigned the function "Input for $p_u/4$ pressure switch for tightness test".
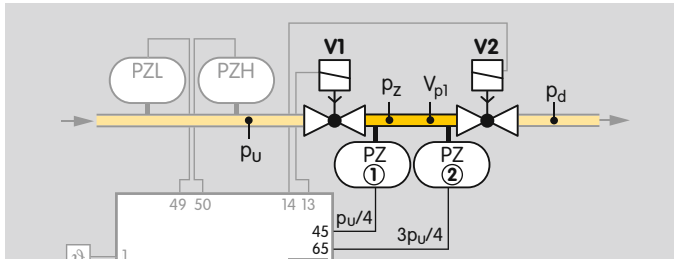
Parameter 70 = 0: Off
Parameter 70 = 1: Reduced DG test duration
Parameter 70 = 2: AND with emergency stop (terminal 46)
Parameter 70 = 3: AND with $air_{min.}$ (terminal 47)
Parameter 70 = 4: AND with air flow monitoring (terminal 48)
Parameter 70 = 5: AND with $gas_{min.}$ (terminal 49)
Parameter 70 = 6: AND with $gas_{max.}$ (terminal 50)

12.8.3 Function of terminal 66

Parameter 71

An external safety temperature monitor module (STM module) can be connected to terminal 66 to signal High temperature mode. The input is activated for this function with parameter 70 = 2.

Parameter 71 = 0: Off

Parameter 71 = 2: external HT signal. High temperature mode is signalled by an external safety temperature monitor (STM).

Parameter 71 = 3: AND with emergency stop (terminal 46)
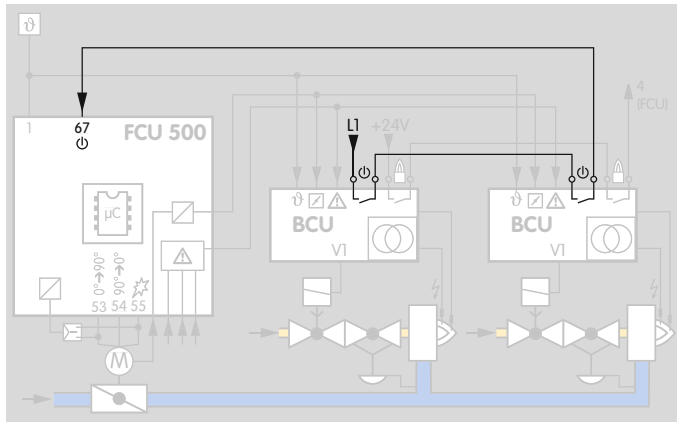Parameter 71 = 4: AND with $air_{min.}$ (terminal 47)
Parameter 71 = 5: AND with air flow monitoring (terminal 48)
Parameter 71 = 6: AND with $gas_{min.}$ (terminal 49)
Parameter 71 = 7: AND with $gas_{max.}$ (terminal 50)

12.8.4 Function of terminal 67

Parameter 72

The terminal can be assigned the function "BCU ready". The FCU is informed via terminal 67 that there are sufficient burner control units for operation. If there is no "BCU ready" signal, the FCU will perform a safety shut-down or fault lock-out, depending on the function selected in parameter 72.

Parameter 72 = 0: Off

Parameter 72 = 1: BCU ready; if not, safety shut-down

If there is no feedback signal, a safety shut-down will be performed, see page 145 (Safety shut-down).

Parameter 72 = 2: BCU ready; if not, fault lock-out

If there is no feedback signal, a fault lock-out will be performed, see page 145 (Fault lock-out).

Parameter 72 = 2: AND with emergency stop (terminal 46)

Parameter 72 = 3: AND with $air_{min.}$ (terminal 47)

Parameter 72 = 4: AND with air flow monitoring (terminal 48)

Parameter 72 = 5: AND with $gas_{min.}$ (terminal 49)

Parameter 72 = 6: AND with $gas_{max.}$ (terminal 50)

12.8.5 Function of terminal 68

Parameter 73

The terminal can be assigned the function "Contactor feedback".

Parameter 73 = 0: Off

Parameter 73 = 1: contactor feedback, see page 127 (Safety interlock output)

Parameter 73 = 2: AND with emergency stop (terminal 46)

Parameter 73 = 3: AND with $air_{min.}$ (terminal 47)

Parameter 73 = 4: AND with air flow monitoring (terminal 48)

Parameter 73 = 5: AND with $gas_{min.}$ (terminal 49)

Parameter 73 = 6: AND with $gas_{max.}$ (terminal 50)

12.9 Password

Parameter 77

The password is designed to protect the parameter settings.To prevent changes to parameter settings, a password is stored in parameter 77 (0000 to 9999). Changes to parameter settings can only be made once this number has been entered. The password can be changed using BCSoft. Note the effect of parameter settings on the safe functioning of your system.

12.10 Fieldbus communication

Parameter 80

Fieldbus communication can be activated using parameter 80 when bus module BCM 500 is connected.

A device name must be entered in the automation system for the unique identification of the control unit (BCU/FCU) in the Profinet IO system.

Parameter 80 = 0: OFF. Parameterization access using BCSoft via Ethernet is still possible.

Parameter 80 = 1: with address check. The device name on delivery is "not-assigned-fcu-500-xxx". The expression "not-assigned-" must be deleted or may be replaced with an individual name. The sequence xxx must be identical to the address set on the BCM 500 using the code switches (xxx = address in the range 001 to FEF).
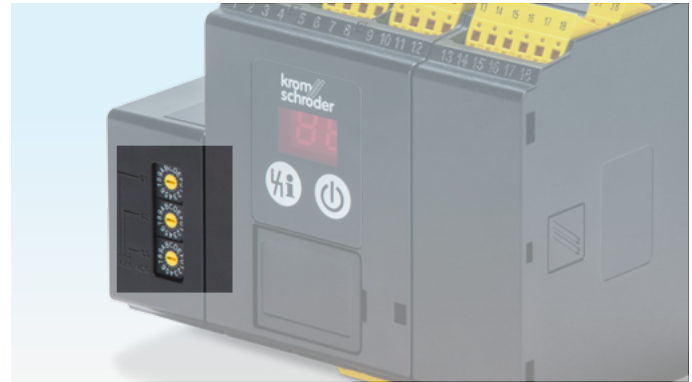
Parameter 80 = 2: no address check. The device name can be selected as specified by the automation system.

13 Selection

	Q	W	CO	C1	F0	F1	F2	H0	H1	K0	K1	K2
FCU 500	●	●	●	○	●	○	○	●	○	○	●	○
FCU 505	●	●	●	○	○	●	○	●	○	○	●	○

● *= standard,* ○ *= available*

Order example

FCU 500WC1F1H0K1

13.1 Type code

Code	Description
FCU 500	Protective system control
FCU 505	Furnace zone control
	Mains voltage:
Q	120 V AC, 50/60 Hz
W	230 V AC, 50/60 Hz
	Integrated tightness control or POC:
C0	none
C1	with integrated tightness control or POC
	Capacity control:
F0	none
F1	modulating with interface for actuator IC
F2	modulating with interface for RBW
	Temperature monitoring:
H0	none
H1	with temperature monitoring
	Connection terminals:
K0	none
K1	screw terminals
K2	spring force terminals

14 Project planning information

14.1 Installation

Installation position as required.

The FCU mounting is designed for horizontally aligned 35 × 7.5 mm DIN rails.
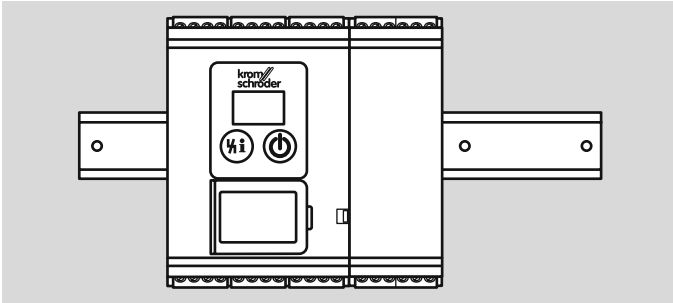
If the DIN rail is aligned vertically, end clamps are required (e.g. Clipfix 35 by Phoenix Contact) to prevent the FCU from slipping.
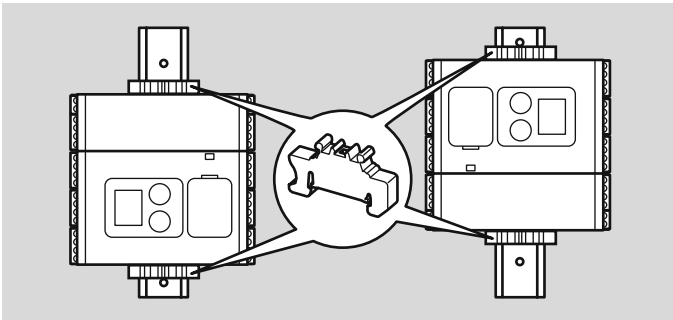
Environment

Install in a clean environment (e.g. a control cabinet) with an enclosure ≥ IP 54, whereby no condensation is permitted.

14.2 Commissioning

Do not start the FCU until the parameter settings and wiring are correct and the faultless processing of all input and output signals complies with the local standards.

14.3 Electrical connection

The FCU is designed for connection to a 1-phase system. All inputs and outputs have a one-phase mains supply. Connected burner control units must use the same phase of the mains supply.

The FCU is only to be used in grounded mains.

Wire the safety circuit inputs via relay contacts only.

Signal and control line for screw terminals max. 2.5 mm^2 (AWG 12), for spring force terminals max. 1.5 mm^2 (AWG 16).

Do not route FCU cables in the same cable duct as frequency converter cables or cables emitting strong fields.

Control lines must satisfy the requirements of EN 60204-1, Chapter 12.

External electrical interference must be avoided.

14.3.1 OCU
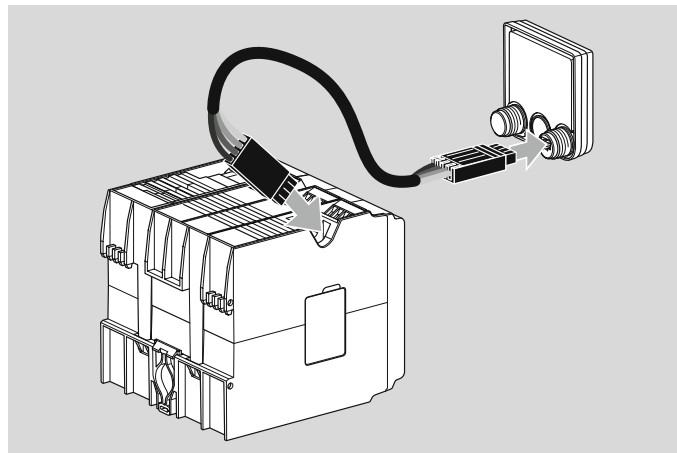
Cables for signalling and telecommunications systems are recommended for wiring the supplied plug connectors:

Cable length max. 10 m, 4-pin,

min. 0.25 mm^2 (AWG 24),

max. 0.34 mm^2 (AWG 22).

14.3.2 Safety current inputs

Actuation of the safety current inputs only with switch-gear featuring mechanical contacts. If switchgear with semi-conductor contacts is used, the safety current inputs must be connected using relay contacts.

To safeguard the safety current inputs, the fuse must be designed so that the sensor with the lowest switching capacity is protected.

The cabling outside enclosed installation spaces must be protected from mechanical damage and stress (e.g. vibration or bending) as well as short-circuits, short-circuits to ground and cross-circuits.
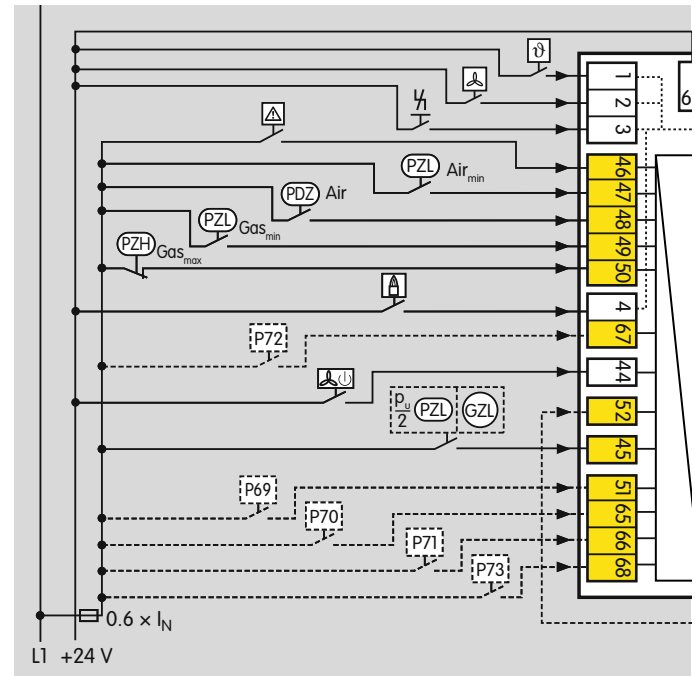
Calculation

I_N = current of the sensor/contactor with the lowest switching capacity

Suitable fuse = $0.6 \times I_N$

14.4 High temperature operation

If firing systems are operated above 750°C (1400°F), the system is considered to be an item of high temperature equipment (see EN 746-2/NFPA 86). Flame control must be in operation until the furnace wall temperature has exceeded 750°C. Frequently, flame control is dispensed with so as to achieve a particularly high flexibility of the installation. This means that no incorrect flame signals, e.g. signals from a UV sensor which interprets reflected UV radiation as extraneous signals, may lead to faults.

When a burner control unit's HT input is activated, the burner control unit switches to High temperature mode. This means: the burner control unit operates without evaluation of the flame signal. The safety function of the device-internal flame control system is deactivated.

In High temperature mode, the gas valves are opened by the burner control unit without flame control. The precondition for this operating mode is that an external flame supervision device ensures the presence of the flame in a fail-safe manner indirectly via the temperature. This is performed by the safety temperature monitor fitted in the temperature module in conjunction with an external double thermocouple (DIN 3440). Sensor discontinuity, sensor short-circuit, failure of a component or mains failure must set the installation to a safe state. Voltage may be applied to the HT input of a burner control unit so as to activate High temperature mode only if the temperature at the furnace wall has exceeded 750°C (1400°F). The burner control unit then starts the burner, without monitoring the presence of the flame.

If the temperature in the furnace chamber drops below 750°C (1400°F), the HT input must be disconnected from the electrical power supply and the furnace must then be operated with flame control.

Comply with the local safety regulations.

14.4.1 Safety temperature monitor (STM)

The FCU signals to the connected burner control units via the fail-safe HT output that the system is in High temperature mode (≥ 750°C pursuant to EN 746-2, ≥ 1400°F pursuant to NFPA 86). The HT output is only enabled together with the safety interlocks.

When the HT inputs on the burner control units are activated, the burners are started without flame control (UV or ionization).

The double thermocouples must be positioned at the coldest point in the combustion chamber so that they can reliably detect whether the spontaneous ignition temperature (≥ 750°C, ≥ 1400°F) has been exceeded.

14.4.2 Safety temperature limiter (STL)

If the maximum temperature limit value set in parameter 25 is exceeded or if an error occurs on the double thermocouple (e.g. sensor discontinuity or short-circuit), the safety temperature limiter will trigger a fault lock-out on the FCU. The safety interlock output will no longer be set.

The double thermocouples must be positioned at the warmest point in the combustion chamber so that they can reliably detect whether the maximum temperature limit value has been exceeded.

14.4.3 Temperature sensors (double thermocouples)

The FCU monitors connected temperature sensors for cable discontinuity or short-circuit. For thermocouples, this is only possible with double thermocouples. It is not permitted to use single thermocouples and connect the inputs in parallel using wire straps.

The temperature module (STM/STL) is designed so that thermocouples of Types K, N and S can be connected.

Class 1 double thermocouples must be used to ensure usage complies with the standards:

Thermocouple	Application temperature [°C]	Class 1 temperature range [°C]
Type K	-270 to +1372	0 to +1200
Type N*	-270 to +1300	0 to +1200
Type S	-50 to +1768	0 to +1600

* Can be used as a substitute for Type K.

14.4.4 Thermocouples

Materials which are used for thermocouples are defined in EN 60584. The temperature ranges for the various materials and the expected voltages are also listed there.

Type K: nickel-chromium/nickel-aluminium (NiCr-Ni)

This thermocouple is frequently used in industrial measuring systems. The max. permanent operating temperature is 1100°C. Type K can be used in the low temperature range as low as -250°C. Type K features lower stability and long-term drift at high temperatures caused by oxidation.

Its accuracy is limited in the temperature range between 250°C and 600°C if temperatures change quickly. In high temperatures, an adequately large wire diameter should be selected to compensate for possible oxidation.

Type N: nickel-chromium-silicon/nickel-silicon (NiCr-Si-NiSi)

Compared to Type K, this thermocouple has similar thermo-electric properties but is more resistant to oxidation. This means that Type N features better resistance to long-term drift and vastly improved stability between 250°C and 600°C. Type N can be used in the extended range from 0 to 1200°C. Type N thermocouples are the highest quality thermocouples among the non-precious types.

Type S: 90%platinum-10%rhodium/platinum (Pt10Rh-Pt)

This thermocouple can be used permanently in temperatures up to 1600°C in oxidizing or inert atmospheres. The thermocouple must be enclosed air-tight to protect it from gases which contain sulphur or phosphorus. Continuous operation in temperatures over 1000°C results in wear since the platinum is contaminated with rhodium by diffusion. In addition, metal vapours may diffuse into the device at these temperatures. This contamination causes a change in the thermo-electric voltage towards negative values over the course of time. The positive leg can become unstable due to the effect of neutrons.

Connection

The spatial distance between the thermocouple and temperature module (STM/STL) may be large depending on the application. Generally, the two legs of a thermocouple have different thermal coefficients. To avoid errors at the transition points, the thermocouples are connected to the temperature module using thermo-cables or compensating cables.

Thermo-cables KX have the same chemical composition as Type K thermocouples. This means they act like an attached thermocouple.

Compensating cables KCA, KCB, NC, SCA or SCB are made of a substitute material which is not identical to the thermocouple material but has similar properties in certain temperature ranges.

The resistance of a thermocouple together with the thermo-cable or compensating cable should be ≤ 1000 Ω. Select the following thermo-cable or compensating cables for this purpose:

Up to length [m]	Minimum dia. [mm]
Thermo-cable KX (NiCr-Ni) for Type K	
7	0.1
30	0.2
100	0.4
Compensating cable KCA (Fe-CuNi) for Type K	
10	0.1
50	0.2
150	0.4
Compensating cable KCB, NC, SCA, SCB (Cu-CuNi) for Type K, N, S	
12	0.1
60	0.2
200	0.4

Reversing the polarity of the thermocouple may result in measurement errors. We therefore recommend that the cables are colour-coded pursuant to EN 60584:

Thermocouple	Colour	
	+ pole	– pole
Type K	green	white
Type N	pink	white
Type S	orange	white

14.4.5 PFH$_D$ value for STM/STL temperature module and thermocouple

This is determined pursuant to standard EN 13611:2007+A2:2011, Section J, with a 1oo2 calculation.

The dangerous failure rate for a thermocouple is as follows:

$$\lambda_{DU\ thermocouple} = FIT_{discontinuity} \times (1 - DC_{discontinuity})$$
$$+$$
$$FIT_{short\text{-}circuit} \times (1 - DC_{short\text{-}circuit})$$
$$+$$
$$FIT_{drift} \times (1 - DC_{drift})$$

λ_{DU}: Dangerous failure rate ($\times 10^{-9}$ 1/h)

$FIT_{discontinuity}$, $FIT_{short\text{-}circuit}$, FIT_{drift}: see information from the manufacturer

$DC_{discontinuity}$ = 0.99 (99%),
$DC_{short\text{-}circuit}$ = 0.6 (66%),
DC_{drift} = 0.6 (66%)

The total failure rate for the thermocouple and STM/STL temperature module of the FCU..H1 is calculated as follows:

$$PFH_{D\ total} = \lambda_{DU\ thermocouple} + PFH_{D\ STM/STL\ temperature\ module}$$

$PFH_{D\ STM/STL\ temperature\ module}$ = 5.84×10^{-9} 1/h

See also page 141 (Mean probability of dangerous failure PFHD of individual safety functions) and page 147 (Probability of dangerous failure PFHD)

Calculation

Enter the manufacturer's information for the FIT values of the thermocouple for discontinuity, short-circuit and drift (0 = FIT value unknown):

$FIT_{discontinuity}$	$\times 10^{-9}$ 1/h
$FIT_{short\text{-}circuit}$	$\times 10^{-9}$ 1/h
FIT_{drift}	$\times 10^{-9}$ 1/h

Determine the designed lifetime (service life) of the thermocouple:

Thermocouple lifetime	years
$\lambda_{DU\ thermocouple}$	$\times 10^{-9}$ 1/h
$PFH_{D\ total}$	$\times 10^{-9}$ 1/h

14.5 Safety interlock output

The burner start enable signal is issued to the connect-ed burner control units via the safety interlock output (terminal 57).

For units whose safety interlock input has a current consumption of ≤ 2 mA, the available power (max. 0,5 A, cos φ = 1) of the FCU is sufficient to directly activate the burner control units.

14.5.1 Safety interlock output in the case of higher power requirement

In the event that a higher output current is required, the output current can be increased by the additional con-nection of 2 contactors.
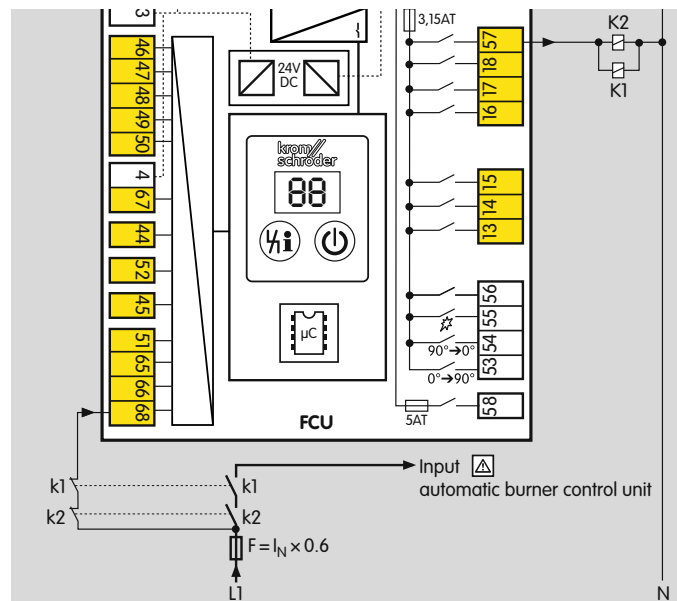
Use contactors with forced-guided contacts in this case. The two NC contacts in the contactors are con-nected in series to the safety interlock check signal input (terminal 68); the contacts must be protected with a factor ≤ 0.6 x I_N, see page 122 (Safety current inputs).

With this circuit design, the function "Contactor feedback" at terminal 68 must be activated by setting parameter 73 to 1.

Before sending the pick-up signal to the contactors via terminal 57, the FCU checks whether there is a signal at the check signal input (terminal 68). If there is a signal, the FCU issues the safety enable signal via terminal 57 to the connected burner control units. The contact change is checked by the FCU, depending on the output signal of terminal 57 (safety interlocks). If the FCU detects a malfunction, a fault lock-out will occur with fault message 37.

14.5.2 BCU with power supply for valves and ignition transformer via safety interlocks
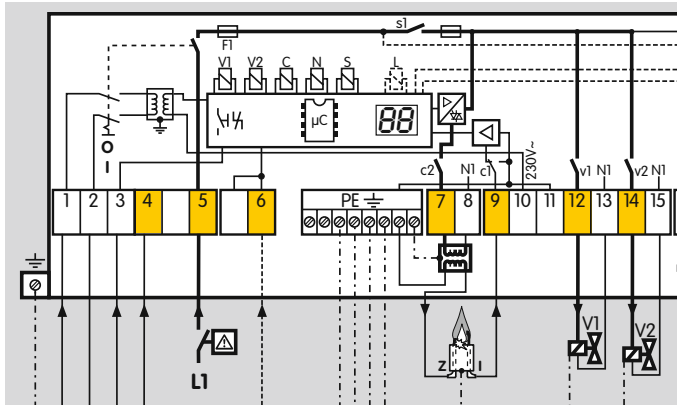
In the event that a higher output current is required, the output current can be increased by means of a contact multiplier using 3 contactors.
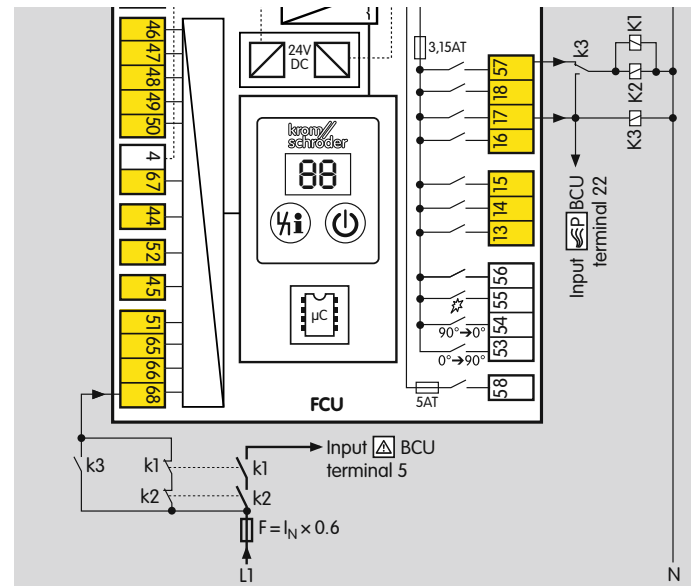
Use contactors with forced-guided contacts in this case. The two NC contacts of K1 and K2 in series and parallel to them the NO contact of K3 are connected to the safety interlock check signal input (terminal 68). The contacts must be protected with a factor of $\leq 0.6 \times I_N$, see page 122 (Safety current inputs).

Before sending the pick-up signal to the contactors K1 and K2 via terminal 57, the FCU checks whether there is a signal at the check signal input (terminal 68). If there is a signal, the FCU issues the safety enable signal via terminal 57 to the connected burner control units. The contact change is checked by the FCU, depending on the output signal of terminal 57 (safety interlocks). If the FCU detects a malfunction, a fault lock-out will occur with fault message 37.

The function "Contactor feedback" can be activated by setting parameter 73 to 1.

14.6 Actuators

If actuators are used, the start gas rate of the burners must be limited for SIL 3 applications in compliance with the standard.

14.6.1 IC 20

The FCU..F1 checks the position to which the actuator IC 20 has moved using terminal 52 (feedback) by lifting the signal to terminal 53, 54 or 55, see page 146 (Lifting).

To ensure this check is possible, FCU..F1 and actuator IC 20 must be wired as shown in the connection diagram.
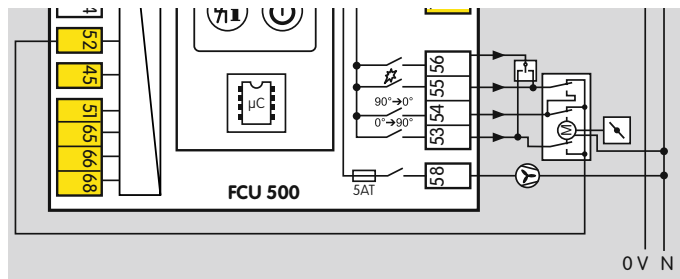
14.7 Air control

Starting the fan with the butterfly valve closed reduces the start-up current of the fan motor.

14.8 Parameter chip card

The parameter chip card must be installed in the unit for the FCU to operate. The parameter chip card contains the valid parameter settings for the FCU. If an FCU is replaced, the parameter chip card can be removed from the old unit and inserted into the new FCU. The FCU must be disconnected from the electrical power supply for this purpose. The valid parameters are then adopted by the new FCU. The old device and the new FCU must have an identical type code.

14.9 System leak tightness check
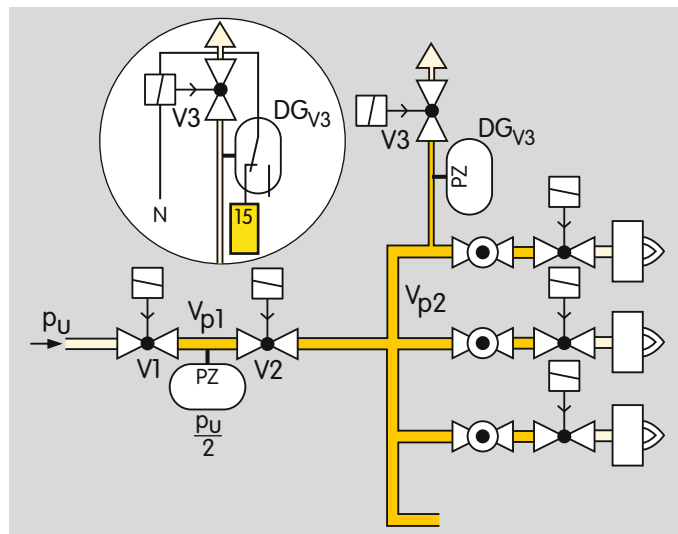
A pressure switch DG_{V3} can be connected between V3 and terminal 15 of the FCU for the controlled pressure reduction of the test volume V_{p2} via a relief valve.

15 Accessories

15.1 BCSoft

The current software can be downloaded from our Internet site at http://www.docuthek.com. To do so, you need to register in the DOCUTHEK.

15.1.1 Opto-adapter PCO 200

Including BCSoft CD-ROM,
Order No.: 74960625.

15.1.2 Bluetooth adapter PCO 300

Including BCSoft CD-ROM,
Order No.: 74960617.

15.2 OCU

For installation in the control cabinet door in standard grid dimensions. The program step/status or fault messages can be read on the OCU. In Manual mode, the OCU can be used to proceed through the sequence of operating steps.

For details, see from page 133 (OCU).

OCU 500-1, Order No.: 84327030,
OCU 500-2, Order No.: 84327031.

15.3 Connection plug set

For wiring the FCU.
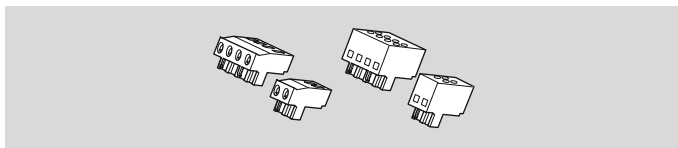
Connection plugs with screw terminals,
Order No.: 74923998.

Connection plugs with spring force terminals, 2 con-
nection options per terminal,
Order No.: 74924000.

15.4 Stickers for labelling
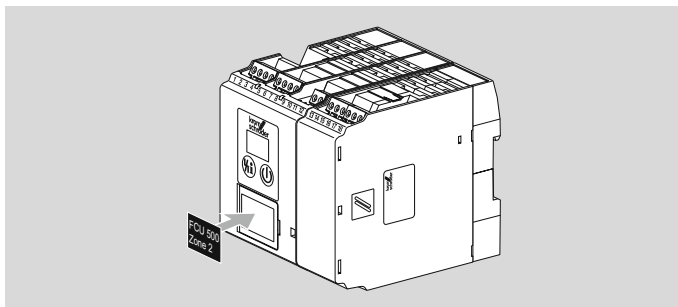
For printing with laser printers, plotters or engraving
machines, 27 × 18 mm or 28 × 17.5 mm.

Colour: silver.

15.5 "Changed parameters" stickers
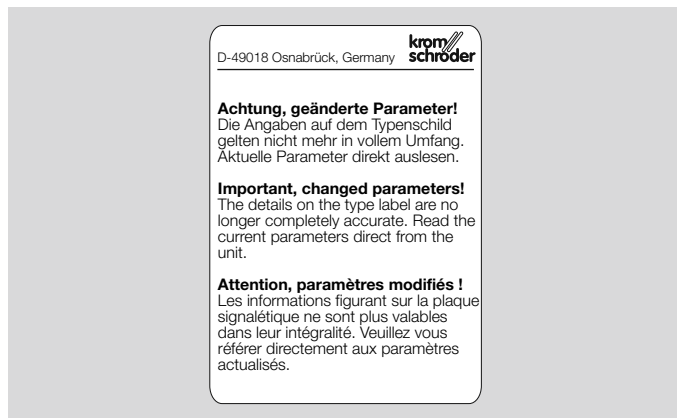
Affix on the connection diagram of the FCU following
changes to device parameters set at the factory.

100 pcs,
Order No.: 74921492.

16 OCU

16.1 Application

The OCU is an external operator-control unit which can be connected to a control unit of the FCU 500/BCU 500 series. The external operator-control unit OCU is installed in the door of a control cabinet. Thus, the control cabinet does not need to be opened to read out process values, statistics, flame signal intensities or parameter values, to change settings on the OCU or to control or adjust connected valves in Manual mode.

16.2 Function

The OCU features an illuminated plain-text display. The lighting is switched on when a control key is pressed and switches off automatically after 5 minutes. In case of a fault lock-out or safety shut-down of the control unit, the OCU light starts blinking.

You can choose between the indicating ranges status display and Service mode.

The status display shows the program status or a fault message which has occurred in text form with the appropriate code.

The Service mode allows you to read out process values, parameter settings, information on the OCU or the statistics. In addition, you can operate connected control units in Manual mode.

There are five control keys for the OCU and the control unit connected to it:

⏻	**ON/OFF** Use the ON/OFF key to switch the control unit on or off.
⚡	**Reset** Use the Reset key to reset the control unit to its starting position in the event of a fault.
(OK)	**OK** Press the OK key to confirm a selection or query. Starting from the status display, you can use the OK key to change to Service mode.
◀	**Back** In Service mode, you can use the Back key to switch from one setting level to the next higher one. By holding down the key for a certain time, you can change directly to the status display.
▲▼	**Navigation UP/DOWN** In Service mode, the navigation keys can be used to select individual functions on one level. In Manual mode, those keys can be used to open and close an activated valve.

16.2.1 Manual mode

In Manual mode, the control unit works with capacity control (FCU..F1/F2 or BCU..F1/F2) regardless of the status of its inputs. The inputs for start-up signal (terminal 1), controlled air flow (terminal 2) and remote reset (terminal 3) are ignored. The function of the controller enable/emergency stop input (terminal 46) is retained.

The positions for maximum capacity, minimum capacity and ignition capacity of an actuator can be adjusted using the OCU. The OCU supports the process by means of a cyclic, automatic repeat approach to the selected position. The actuator can be moved within the menu to make changes to the cam settings.

After start-up has been completed, the navigation keys can be used, for example, to open or close a valve in program step $\mathit{08}$.

16.3 Electrical connection

The OCU is to be connected to the control unit using the two plugs provided.

Required signal and control line:
cable length max. 10 m, 4-pin, min. 0.25 mm^2 (AWG 24), max. 0.34 mm^2 (AWG 22).

Wire each conductor on both plugs to the same contact.
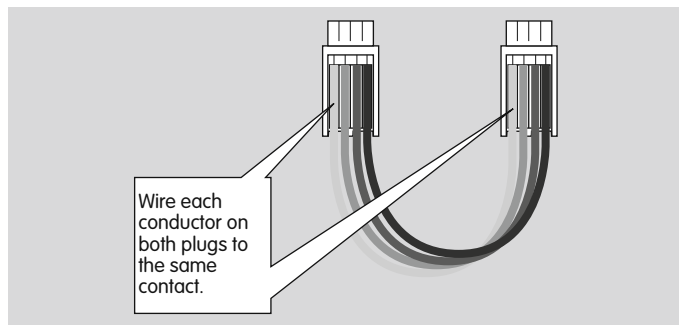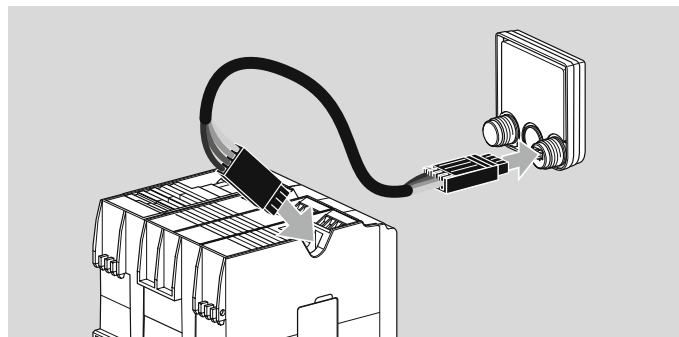
16.4 Installation

The threaded adapters of the OCU are suitable for 23 mm boreholes which are drilled at intervals of 30 mm.
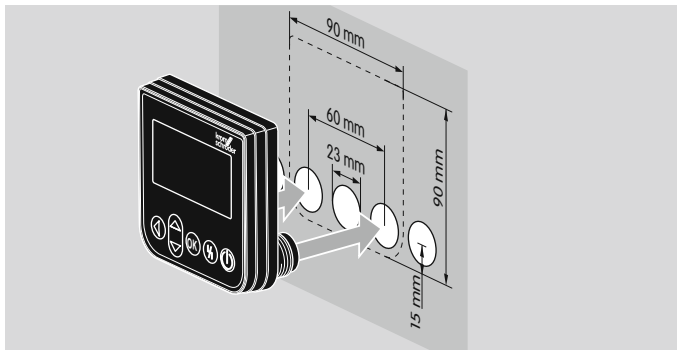
16.5 Selection

The OCU can be supplied with various language kits.

Type	Languages	Order No.
OCU 500-1	German, English, French, Dutch, Spanish, Italian	84327030
OCU 500-2	English, Danish, Swedish, Norwegian, Turkish, Portuguese	84327031
OCU 500-3	English, US English, Spanish, Brazilian Portuguese, French	84327032
OCU 500-4	English, Russian, Polish, Croatian, Romanian, Czech	84327033

16.6 Technical data for OCU

Ambient temperature: –20 to +60°C.

Relative humidity:
30% to 95% (no condensation permitted).

Enclosure:
IP 65, NEMA 3 when fitted (control cabinet door).

Dimensions of the operator-control unit:
90 x 90 x 18 mm (W x H x D).

Electrical connection

Connection data:
wire cross-section flexible min. 0.25 mm²,
wire cross-section flexible max. 0.34 mm²,
wire cross-section AWG min. 24,
wire cross-section AWG max. 22.

Cable length: inside control cabinet max. 10 m.

17 BCM 500

17.1 Application

The bus module BCM 500 is used as a communications interface for devices of the BCU/FCU 500 product family for connection to a Profinet network. Networking via Profinet enables the FCU or BCU to be controlled and monitored by an automation system (e.g. PLC).

17.2 Function

The bus system transfers the control signals for start-ing, resetting and for controlling the air valve to purge the furnace or kiln or for cooling in start–up position and heating during operation from the automation system (PLC) to the BCM. In the opposite direction, it sends operating status, the level of the flame signal and the current program step.

17.3 Electrical connection

Use only cable and plug components which comply with the appropriate Profinet specifications.

Use shielded RJ45 plugs.

Cable length between 2 Profinet stations: max. 100 m.

Profinet installation guidelines, see www.profibus.com.

17.4 Installation

Installation position: vertically upright, horizontal or tilted to the left or right.

The BCM mounting is designed for horizontally aligned 35 × 7.5 mm DIN rails.
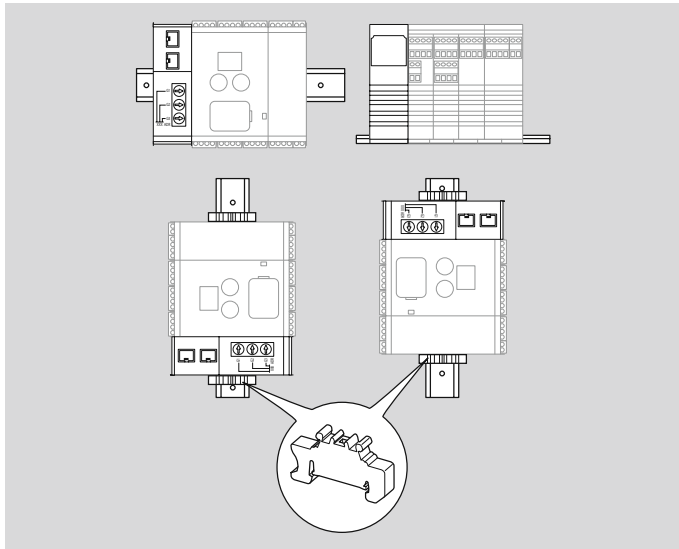
If the DIN rail is aligned vertically, end clamps are required (e.g. Clipfix 35 by Phoenix Contact) to prevent the control unit from slipping.

Install in a clean environment (e.g. a control cabinet) with an enclosure ≥ IP 54, whereby no condensation is permitted.

17.5 Selection

Code	Description
BCM	Bus module
500	Series 500
S0	Standard communication
B2	Profinet
/3	Two RJ45 sockets
-3	Three-point step control via bus

Order No.: 74960663

17.6 Technical data

Electrical data
Power consumption: 1.2 VA.

Power loss: 0.7 W.

Mechanical data
Dimensions (W × H × D): 32.5 × 115 × 100 mm.

Weight: 0.3 kg.

Environment
Ambient temperature: –20 to +60°C (–4 to +140°F).

Storage temperature:
–20 to +60°C (–4 to +140°F).

Climate: no condensation permitted.

Enclosure: IP 20 pursuant to IEC 529.

Installation location: min. IP 54 (for installation in a control cabinet).

18 Technical data

18.1 Electrical data

Mains voltage
FCU..Q: 120 V AC, –15/+10%, 50/60 Hz, ± 5%,
FCU..W: 230 V AC, –15/+10%, 50/60 Hz, ±5%,
for grounded mains only.

Power consumption
FCU..Q: at 120 V AC approx. 3 W/5.5 VA plus power consumption per AC input of approx. 0.08 W/0.2 VA,
FCU..W: at 230 V AC approx. 6 W/11 VA plus power consumption per AC input of approx. 0.15 W/0.4 VA.

Contact rating
– Control outputs LDS (terminal 16), purge (terminal 17), HT (terminal 18), safety interlocks (terminal 57): max. 0.5 A, cos φ = 1.
– Valve outputs V1, V2 and V3 (terminals 13, 14 and 15): max. 1 A, cos φ = 1.
– Actuator outputs (terminals 53, 54 and 55): max. 50 mA, cos φ = 1.
– Total current for the simultaneous activation of control outputs HT, purge, LDS and safety interlocks, valve outputs V1, V2 and V3 and the actuator: max. 2.5 A.
– 24 V DC signalling contact for fault/operation (terminal 41, 42): max. 0.1 A.
– Fan: max. 3 A (start-up current: 6 A < 1 s).

Number of operating cycles
FCU:
24 V DC signalling contact for fault/operation: max. 10,000,000,
On/Off button, Reset/Information button: 1000,
power module:
control outputs LDS (terminal 16), purge (terminal 17), HT (terminal 18), safety interlocks (terminal 57), gas valves V1 (terminal 13), V2 (terminal 14), V3 (terminal 15),
butterfly valve control element (terminals 53, 54 and 55),
fan (terminal 58): max. 250,000.

Input voltage of signal inputs:

Rated value	120 V AC	230 V AC
Signal "1"	80 – 132 V	160 – 253 V
Signal "0"	0 – 20 V	0 – 40 V

Rated value	24 V DC
Signal "1"	24 V, ± 10%
Signal "0"	< 1 V

Signal input current:

Signal "1"	max. 5 mA

Fuses, replaceable,
F1: T 3.15A H,
F2: T 5A H, pursuant to IEC 60127-2/5.

18.2 Mechanical data

Weight: 0.7 kg

Connections

– Screw terminals:
  nominal cross-section 2.5 mm^2,
  wire cross-section rigid: min. 0.2 mm^2, max. 2.5 mm^2,
  AWG: min. 24, max. 12.
  Contact rating: 12 A.

– Spring force terminals:
  nominal cross-section 2 × 1.5 mm^2,
  wire cross-section: min. 0.2 mm^2, max. 1.5 mm^2,
  AWG: min. 24, max. 16,
  Contact rating: 10 A (for UL 8 A).

18.3 Environment

Ambient temperature: –20 to +60°C (-4 to +140°F), no condensation permitted.

Enclosure: IP 20 pursuant to IEC 529.

Installation location: min. IP 54 (for installation in a control cabinet).

18.4 FCU..H1

Terminals 5, 6, 7 and 8: Maximum voltage: ± 5 V, input voltage range for double thermocouples:
Type K: 0 to 54.9 mV,
Type N: 0 to 47.5 mV,
Type S: 0 to 18.7 mV.

Function of Type 2 to EN 14597, type of action: 2B, 2K and 2P, with STL also 2A and 2N.

ESD protection of terminals 5 to 8: Level 4 to IEC 61000-4.2 (ESD).

Maximum deviation of temperature values of STM/STL module when using Class 1 thermocouples:
Type K: 0.63% at 25°C, ± 340 ppm/K at ambient temperature,
Type N: 0.55% at 25°C, ± 340 ppm/K at ambient temperature,
Type S: 1.38% at 25°C, ± 1570 ppm/K at ambient temperature.

18.5 Dimensions
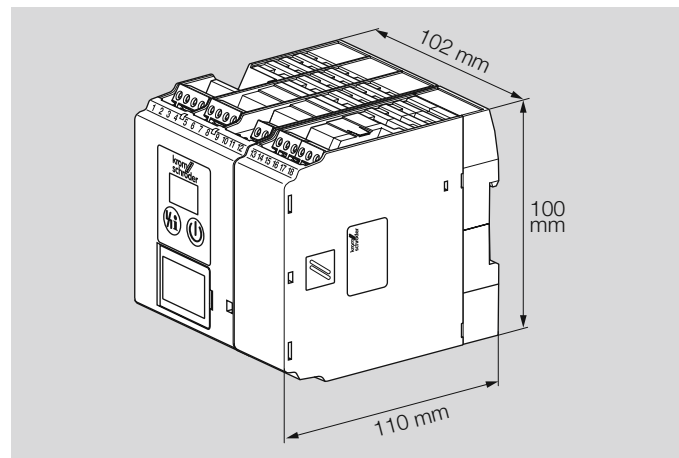
18.6 Safety-specific characteristic values

Suitable for Safety Integrity Level	Up to SIL 3
Diagnostic coverage DC	98.2%
Type of subsystem	Type B to EN 61508-2, 7.4.3.1.4
Operating mode	High demand mode pursuant to EN 61508-4, 3.5.12
Mean probability of dangerous failure PFH_D	15.5 x 10^{-9} 1/h
Mean time to dangerous failure $MTTF_d$	$MTTF_d = 1/PFH_D$
Safe failure fraction SFF	99.6%

Mean probability of dangerous failure PFH_D of individual safety functions

Tightness control	4.8 x 10^{-9} 1/h
Large test volumes with reduced testing time	4.9 x 10^{-9} 1/h
Emergency stop	4.9 x 10^{-9} 1/h
Low air pressure protection	4.9 x 10^{-9} 1/h
Ready feedback	5.9 x 10^{-9} 1/h
IC 20 ignition position feedback	6.7 x 10^{-9} 1/h
RBW Low position feedback	6.7 x 10^{-9} 1/h
Low gas pressure protection	4.9 x 10^{-9} 1/h
High gas pressure protection	4.9 x 10^{-9} 1/h
Contactor feedback	4.8 x 10^{-9} 1/h
STM/STL temperature module*	5.8 x 10^{-9} 1/h

* see page 126 (PFHD value for STM/STL temperature module and thermocouple)

SIL 3 is not achieved in conjunction with actuators IC 20 or RBW because there are no PFH_D values for the actuators.

Relationship between the Performance Level (PL) and the Safety Integrity Level (SIL)

PL	SIL
a	–
b	1
c	1
d	2
e	3

Pursuant to EN ISO 13849-1:2006, Table 4, the FCU can be used up to PL e.

Max. service life under operating conditions: 20 years after date of production.

For a glossary of terms, see page 145 (Glossary).

For further information on SIL/PL, see www.k-sil.de

18.7 Converting units

See www.adlatus.org

19 Maintenance

The fail-safe outputs (valve outputs V1, V2 and V3) of the power module are monitored for correct functioning. In the event of a fault, the system is set to a safe status using a second shut-down method (isolation of the valve outputs from the mains). In the event of a defect (e.g. fault 36), the power module must be replaced.

See www.partdetective.de
(optimized for smartphones)
for a replacement/order option for the power module.

The device and user statistics can be displayed using the operator-control unit OCU or engineering tool BC-Soft for further diagnostics and troubleshooting. The user statistics can be reset using engineering tool BC-Soft.

20 Legend

⏻	Ready for operation
⚠	Safety interlocks (limits)
HT	High temperature operation
⊡	Safety limits (limits during start-up = LDS), control element position check
⛛	Gas valve
⛛	Air valve
⛛	Air/gas ratio control valve
▷	Burner
P⛛	Purge
⛛A	External air valve control
⛛	Controlled air flow
▭▷	Operating signal
▭⏚	Fault signal
ϑ	FCU start-up signal
⛛	Emergency stop
PZL	Pressure switch for tightness control (TC)
PZL	Pressure switch for maximum pressure
PZL	Pressure switch for minimum pressure
PZL	Differential pressure switch
Pxx	Input signal depending on parameter xx
Ⓜ⛛	Control element with butterfly valve
TC	Tightness control
$p_u/2$	Half of the inlet pressure
$p_u/4$	A quarter of the inlet pressure

$3p_u/4$	Three-quarters of the inlet pressure
p_u	Inlet pressure
p_d	Outlet pressure
V_p	Test volume
⛛GZL	Valve with proof of closure switch
⊘	Fan
⊡	Three-point step switch
▯	Input/Output, safety circuit
I_N	Current consumption of sensor/contactor
t_{SB}	Safety time during operation
t_{MP}	Minimum pause time
t_L	Tightness control opening time
t_M	Measurement time during tightness test
t_P	Tightness control test period (= 2 x t_L + 2 x t_M)
t_{PN}	Post-purge time
t_{GV}	Fan run-up time
t_E	Switch-on delay
t_{PV}	Pre-purge time
t_{RF}	Controller enable signal delay time

21 Glossary

21.1 Safety shut-down

The burner control unit performs a safety shut-down immediately after receiving a signal from a safety device or after a fault is detected (e.g. flame or air pressure failure). The safety shut-down prevents operation of the burner by closing the fuel shut-off valves and deactivating the ignition device.

For this, the FCU disconnects the gas valves from the electrical power supply. The controller enable signal is deactivated. The fault signalling contact remains open. The display blinks and displays the current program step, see page 70 (Fault signalling).

After a safety shut-down, the FCU can restart automatically.

21.2 Fault lock-out

A fault lock-out is a safety shut-down with subsequent fault lock-out. The system can only be restarted following manual reset. The protective system cannot be reset by mains failure.

In the event of a fault lock-out of the FCU, the fault signalling contact closes, the display blinks and shows the current program step, see page 70 (Fault signalling). The gas valves are disconnected from the electrical power supply. The fault signalling contact opens if the mains voltage fails.

In order to restart, the FCU can only be reset manually using the button on the front panel, the OCU or the remote reset input (terminal 3).

21.3 Warning signal

The FCU reacts to operating faults, e.g. in the case of permanent remote resets, with a warning signal. The display blinks and shows the corresponding warning message. The warning signal ends once the cause has been eliminated.

The program sequence continues. No safety shut-down or fault lock-out occurs.

21.4 Timeout

For some process faults, a timeout phase elapses before the FCU reacts to the fault. The phase starts as soon as the FCU detects the process fault and ends after 0 to 250 s. A safety shut-down or fault lock-out is then performed. If the process fault ends during the timeout phase, the process continues as before.

21.5 Lifting

After positioning the actuator IC 20, the FCU checks by means of brief lifting whether its feedback input (terminal 52) has been activated by the correct output signal from the actuator. The signal of the relevant control output (ignition, OPEN, CLOSE) is switched off briefly for this purpose. While the signal is switched off, the FCU may not detect a signal at the feedback input.

21.6 Diagnostic coverage DC

Measure of the effectiveness of diagnostics, which may be determined as the ratio between the failure rate of detected dangerous failures and the failure rate of total dangerous failures

NOTE: Diagnostic coverage can exist for the whole or parts of a safety-related system. For example, diagnostic coverage could exist for sensors and/or logic system and/or final elements. Unit: %.

from EN ISO 13849-1:2008

21.7 Operating mode

EN 61508 describes two modes of operation for safety functions. These are low demand mode and high demand or continuous mode.

In low demand mode, the frequency of demands for operation made on a safety-related system is not greater than one per year and is not greater than twice the proof-test frequency. In high demand mode or continuous mode, the frequency of demands for operation made on a safety-related system is greater than one per year or greater than twice the proof-test frequency.

See also EN 61508-4

21.8 Safe failure fraction SFF

Fraction of safe failures related to all failures, which are assumed to appear
from EN 13611/A2:2011

21.9 Probability of dangerous failure PFH$_D$

Value describing the likelihood of dangerous failure per hour of a component for high demand mode or continuous mode. Unit: 1/h.
from EN 13611/A2:2011

21.10 Mean time to dangerous failure MTTF$_d$

Expectation of the mean time to dangerous failure
from EN ISO 13849-1:2008

Feedback

Finally, we are offering you the opportunity to assess this "Technical Information (TI)" and to give us your opinion, so that we can improve our documents further and suit them to your needs.

Clarity
Found information quickly
Searched for a long time
Didn't find information
What is missing?
No answer

Comprehension
Coherent
Too complicated
No answer

Scope
Too little
Sufficient
Too wide
No answer

Use
To get to know the product
To choose a product
Planning
To look for information

Navigation
I can find my way around
I got "lost"
No answer

My scope of functions
Technical department
Sales
No answer

Remarks

Contact

The current addresses of our international agents are available on the Internet:
www.kromschroeder.de/Weltweit.20.0.html?&L=1

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