Manual

HIMatrix®F

Combustion Safeguard
HIMatrix CSG 04

Contact

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Table of Contents

1 Introduction

This manual describes the technical characteristics of the HIMatrix Combustion Safeguard CSG 04 and its use. It provides information on how to install, start up and configure the HIMatrix CSG 04.

The components of the HIMatrix CSG are used for simplified control of individual burners for gaseous and liquid fuels. Due to the unalterable implementation of a burner control system function, the safety-related PES becomes a hard-wired functional unit with process-related parameters that are adjusted to the combustion process by means of a control panel (HMI).

1.1 Target Audience

This document is aimed at the engineers and developers of automation systems as well as the persons qualified and authorized to start up, operate and maintain the devices and systems concerned.

1.2 Product-Dependent Requirements

- Only devices that are safely separated from the power supply may be connected to the system.
- The safe electrical power supply separation must be guaranteed within the 24 V system supply. Only power supply units of type PELV or SELV may be used.

1.3 Writing Conventions

To ensure improved readability and comprehensibility, the following writing conventions are used in this document:

Bold	To highlight important parts. Names of buttons, menu functions and tabs that can be clicked.
Italics	For parameters and system variables.
`Courier`	Literal user inputs.
RUN	Operating states are designated by capitals.
(→ Chapter 1.3, page 7)	Cross-references are hyperlinks even if they are not particularly marked. When the cursor hovers over a hyperlink, it changes its shape. Click the hyperlink to jump to the corresponding position.

1.3.1 Safety Notices

Safety notices must be strictly observed to ensure the lowest possible risk.

1.3.1.1 Meaning of Signal Words

- Warning: Hazard which could result in death or serious injury.
- Caution: Hazard which could result in minor or moderate injury.
- Notice: Information to avoid damage to property.

1.3.1.2 Structure of Warnings

⚠ SIGNAL WORD

Type and source of risk!
Consequences arising from non-observance.
Risk prevention.

NOTICE

Type and source of damage!
Damage prevention.

1.3.2 Operating Tips

1.3.2.1 Structure of Additional Information

i The text giving additional information is located here.

1.3.2.2 Structure of Tips

TIP The tip text is located here.

2 Safety

All safety information, notes and instructions specified in this document must be strictly observed. The product may only be used if all guidelines and safety instructions are adhered to.

The product is operated with SELV or PELV. No imminent risk results from the product itself.

The following requirements must be met to safely install and start up the HIMatrix CSG 04 systems and ensure safety during their operation and maintenance:

- Knowledge of regulations.
- Proper technical implementation of the safety instructions detailed in this manual performed by qualified personnel.

HIMA will not be held liable for severe personal injuries, damage to property or the environment caused by any of the following:

- Unqualified intervention in the devices.
- De-activation or bypassing of safety functions.
- Failure to comply with the instructions detailed in this manual.

HIMA develops, manufactures and tests the HIMatrix CSG 04 systems in compliance with the pertinent safety standards and regulations. The use of the devices is only allowed if the following requirements are met:

- They are only used for the intended applications.
- They are only operated under the specified environmental conditions.
- They are only operated in connection with the approved external devices.

2.1 Calculating the PFD and the PFH Values

The PFD and the PFH values for the HIMatrix systems have been calculated in accordance with IEC 61508.

For SIL 3, IEC 61508-1 defines a PFD value of 10^{-4}...10^{-3} and a PFH value of 10^{-8}...10^{-7} per hour.

15 % of the limit for PFD and PFH specified in the standard is assumed for the HIMatrix CSG 04 systems.

The limits resulting for the controller portion are thus:
PFD = 1.5×10^{-4} and PFH = 1.5×10^{-8} per hour.

A proof test interval (→ IEC 61508-4, Offline Proof Test, Paragraph 3.8.5) of 10 years has been defined for the HIMatrix controllers, remote I/Os and modules (→ Chapter 11.2, page 72).

2.2 Intended Use

The HIMatrix CSG 04 is a safety-related controller system for burners with gaseous fuels. The controller may only be used for this purpose. All other applications are prohibited.

The HIMatrix CSG 04 system can be used up to safety integrity level SIL 3 in accordance with IEC 61508.

When using the HIMatrix CSG 04 system, comply with the following general requirements.

2.2.1 Environmental Conditions

All the environmental conditions specified in this manual must be observed when operating the HIMatrix CSG 04 system. The environmental conditions are listed in the product data.

2.2.2 ESD Protective Measures

Only personnel with knowledge of ESD protective measures may modify or extend the system or replace components.

NOTICE

Damage to the HIMatrix CSG 04 system due to electrostatic discharge!

- **When performing the work, make sure that the workspace is free of static, and wear a grounding strap.**
- **If not used, ensure that the components are protected from electrostatic discharge, e.g., by storing them in their packaging.**

2.3 Residual Risk

Causes for damage to the HIMatrix CSG 04:

- Faults related to engineering.
- Faults related to the wiring.

2.4 Safety Precautions

Observe all local safety requirements and use the protective equipment required on site.

2.5 Emergency Information

The HIMatrix CSG 04 system is a part of the safety equipment of an automatic burner control system. If the controller fails, the burner enters the safe state.

In case of emergency, no action that may prevent the HIMatrix CSG 04 system from operating safely is permitted.

2.6 Certification

The safety-related HIMatrix CSG 04 system has been tested and is certified by TÜV for functional safety in accordance with CE and the standards listed below.

This manual represents the "Original instructions" as of Machinery Directive (Directive 2006/42/EC).

The "Original documentation" for the HIMatrix CSG 04 system is written in German language. The statements made in the German documentation shall apply.

2.6.1 EU Type Approval Test

TÜV Rheinland Industrie Service GmbH
Automation, Software and Information Technology
Am Grauen Stein
51105 Köln

EC Type Test Certificate
Safety PES System Family HIMatrix CSG

2.6.2 Current Standards

International standards:	Safety level
EN/IEC 61508, Parts 1-7:2010	SIL 3
IEC 61511:2016 + Corr. 1:2016	SIL 3
EN ISO 13849-1:2015	Performance Level e
EN 62061:2005 +AC:2010 +A1:2013 + A2:2015	SIL CL 3
EN 50156-1:2015	SIL 3
EN 12067-2:2004	
EN 298:2012	
NFPA 85:2015	
NFPA 86:2015	
EN 61131-2:2007	
EN 61131-6:2012	
EN 61326-3-1:2008	
EN 61326-3-2:2008	
EU directives (according to declarations of conformity)	

Table 1: International Standards and Safety Levels

2.6.3 Test Conditions

The HIMatrix CSG 04 systems have been tested for compliance with the EMC, climatic and environmental requirements of the following standards:

Test standards	Content
IEC/EN 61131-2: 2007	Programmable controllers, Part 2 Equipment requirements and tests
IEC/EN 61131-6: 2012	Programmable controllers, Part 6 Functional safety
IEC/EN 61000-6-2: 2005	Electromagnetic Compatibility (EMC) Part 6-2: Generic standards. Immunity for industrial environments
IEC/EN 61000-6-4: 2007 + A1:2011	Electromagnetic Compatibility (EMC) Part 6-4: Generic standards. Emission standard for industrial environments

Table 2: Standards for EMC, Climatic and Environmental Requirements

2.6.3.1 Climatic Conditions

The following table lists the most important tests and limits for climatic conditions:

Test standard	Climatic tests
IEC/EN 61131-2	Ambient temperature: 0...+60 °C (Test limits: -10...+70 °C)
	Storage temperature: -40...+85 °C
	Dry heat and cold; withstand tests: +70 °C/-40 °C, 16 h, +85 °C, 1 h, power supply not connected
	Temperature changes, withstand test: Fast temperature changes: -40 °C/+70 °C, power supply not connected
	Immunity test Slow temperature changes: -10 °C/+70 °C, power supply not connected
	Cyclic damp-heat; withstand tests: +25 °C/+55 °C, 95 % relative humidity, power supply not connected

Table 3: Climatic Conditions

2.6.3.2 Mechanical Conditions

The following table lists the most important tests and limits for mechanical requirements:

Test standard	Mechanical tests
IEC/EN 61131-2	Vibration immunity test: 5...8.4 Hz, 3.5 mm 8.4...150 Hz, 1 g, EUT in operation, 10 cycles per axis
	Shock immunity test: 15 g, 11 ms, EUT in operation, 3 shocks per axis and direction (18 shocks)

Table 4: Mechanical Tests

2.6.3.3 EMC Conditions

In accordance with IEC 61131-2, the interference levels specified in Table 5 are required for programmable controllers used in zone C. HIMatrix CSG 04 systems meet those requirements.

Test standards	Interference immunity tests
IEC/EN 61000-4-2	ESD test: 4 kV contact discharge, 8 kV air discharge
IEC/EN 61000-4-3	RFI test (10 V/m): 80 MHz...1 GHz, 80 % AM RFI test (3 V/m): 1.4 GHz...2 GHz, 80 % AM RFI test (1 V/m): 2.0 GHz...2.7 GHz, 80 % AM
IEC/EN 61000-4-4	Burst test Supply voltage: 2 kV Signal lines: 2 kV Shielded communication lines: 1 kV
IEC/EN 61000-4-5	Surge: Supply voltage: 2 kV CM, 1 kV DM Signal lines (AC): 2 kV CM, 1 kV DM Shielded lines: 2 kV CM Other: 1 kV CM
IEC/EN 61000-4-6	High frequency, asymmetrical 10 V, 150 kHz...80 MHz, 80 % AM
IEC/EN 61000-4-18	Damped oscillatory wave test 2.5 kV L-, L+/PE 1 kV L+/L- Signal lines (AC): 2.5 kV CM, 1 kV DM Shielded lines: 0.5 kV CM Other: 1 kV CM, 0.5 kV DM

Table 5: Interference Immunity Tests in Accordance with IEC 61131-2, Zone C

Test standards	Noise emission tests
IEC/EN 61000-6-4, EN 55011 Class A, Group 1	Emission test: radiated, conducted

Table 6: Noise Emission Tests

HIMatrix CSG 04 systems meet the EMC requirements in accordance with the following standards:

- EN 298
- EN 61000-6-2

2.6.3.4 Supply Voltage

The following table lists the most important tests and limits for the supply voltage of the HIMatrix CSG 04 systems:

Test standard	Supply voltage failures immunity test
IEC/EN 61131-2	Voltage range test: 24 VDC, -15...+20 %, $r_p \leq 5$ %
	Momentary external current interruption immunity test: DC, PS 2: 10 ms
	Reversal of DC power supply polarity test: Tested for 10 s

Table 7: Supply Voltage Failures Immunity Test

3 Product Description

The safety-related controller HIMatrix CSG 04 includes sequential controls that ensure the safe start-up, shutdown and operation of a main burner. The main burner is started using an igniter. Prior to starting the igniter and the main burners, pre-purging of the combustion chamber is monitored.

A detailed flow chart in tabular form can be found in the manual's appendix. (→ Applicable document: HIMatrix CSG 04 Sequence CSG HI 800 761 E).

3.1 Function

The HIMatrix CSG 04 controller includes the following functions:

- Start-up of the main burner.
- Shutdown of the main burner.
- Operation of the main burner.

The start-up process of the main burner consists of two phases:

1. Monitoring of the main burner pre-purging.
2. Starting of the main burner by means of an electric ignition system.

These sequences are based on the interaction of two individual sequence chains in two function macros:

1. X_BMS_Purge
2. X_BMS_Igniteburner

The sequence description (→ Table 8, page 15) shows an example of the overall progression of the sequence chains. The sequence chains or error codes are displayed on the control panel of the HIMatrix CSG 04 (→ Chapter 8.2, page 43).

The resulting overall sequence is shown in the following simplified flow chart and can be tracked in the operating graphs:

Action	Description	Purge	Burner
1	Start igniter and main burner (E17)		1
2	Main burner, position of SSV1 and SSV2		2
3	Main burner, position of pressure relief valve		3
4	Main burner, flame simulation test		4
5	Main burner, ignition power test		5
6	Main burner, ignition lance retracted		6
7	Main burner, pressure relief valve closed		7
8	Main burner, tightness test		8
9	Main burner, tightness test		9
10	Main burner, tightness test		10
11	Main burner, tightness test		11
12	Main burner, tightness test		12
13	Main burner, tightness test		13
14	Main burner, tightness test		14
15	Main burner, tightness test		15
16	Main burner, operational readiness 1 hour	1	16
17	Pre-purging, preparations	2	
18	Pre-purging, air pressure check	3	
19	Pre-purging, air pressure check	4	
20	Pre-purging, pre-processing time 5 min.	5	
21	Pre-purging	6	
22	Pre-purging	7	
23	Pre-purging	8	
24	Pre-purging, post-processing time 5 min.	9	
25	Pre-purging, ready for ignition (seq. no. 5)	10	
26	Main burner, spark transformer (seq. no. 6)		17
27	Main burner, 1st ignition		18
28	Main burner, re-ignition delay time (seq. no. 16)		19
29	Main burner, re-ignition time (seq. no. 17)		20
30	Main burner, spark transformer (seq. no. 6)		21
31	Main burner, 2nd ignition		22
32	Main burner, ignited		27
33	Main burner, flame stabilization		28
34	Main burner, FARC delay (seq. no. 18)		29
35	Main burner in operation	11	30
36	Main burner, manual stop (E19)		31
37	Main burner, not in operation	12	32
38	Main burner, tightness test	17	33
39	Main burner, tightness test		34
40	Main burner, tightness test		35
41	Main burner, tightness test		36
42	Main burner, not in operation		37
43	CSG restart delay (seq. no. 3)		

Table 8: Sequence Description

The sequences can change depending on the configuration (→ Chapter 5.2, page 27).

Steps 12 and 17 of the sequence description (pre-purging) do not run synchronously with steps 32 through 37 of the sequence description (main burner). This seeming relation is the result of the chosen representation of the sequences.

The time required to achieve the pre-purge conditions in action 20 and return to the pre-purge conditions in action 24 is 5 minutes. The time of 5 minutes cannot be changed.

Further details on the functions performed by **HIMatrix CSG 04** are provided in the functional description (→ Chapter 7, page 30) and the detailed flow chart (→ Applicable document: HIMatrix CSG 04 Sequence CSG HI 800 761 E).

3.2 Structure of the HIMatrix Combustion Safeguard CSG 04

This chapter describes the layout and function of the controller and the connections for communication.

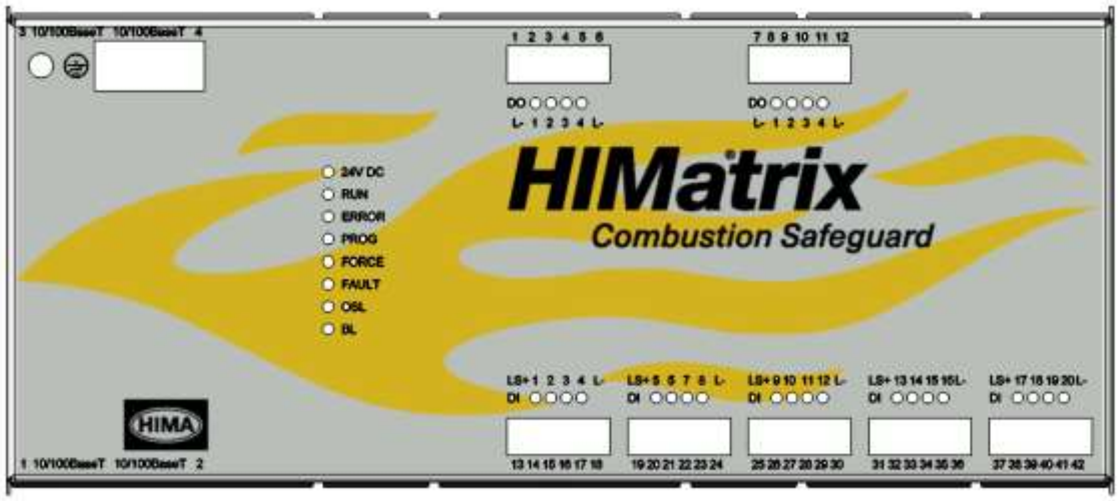
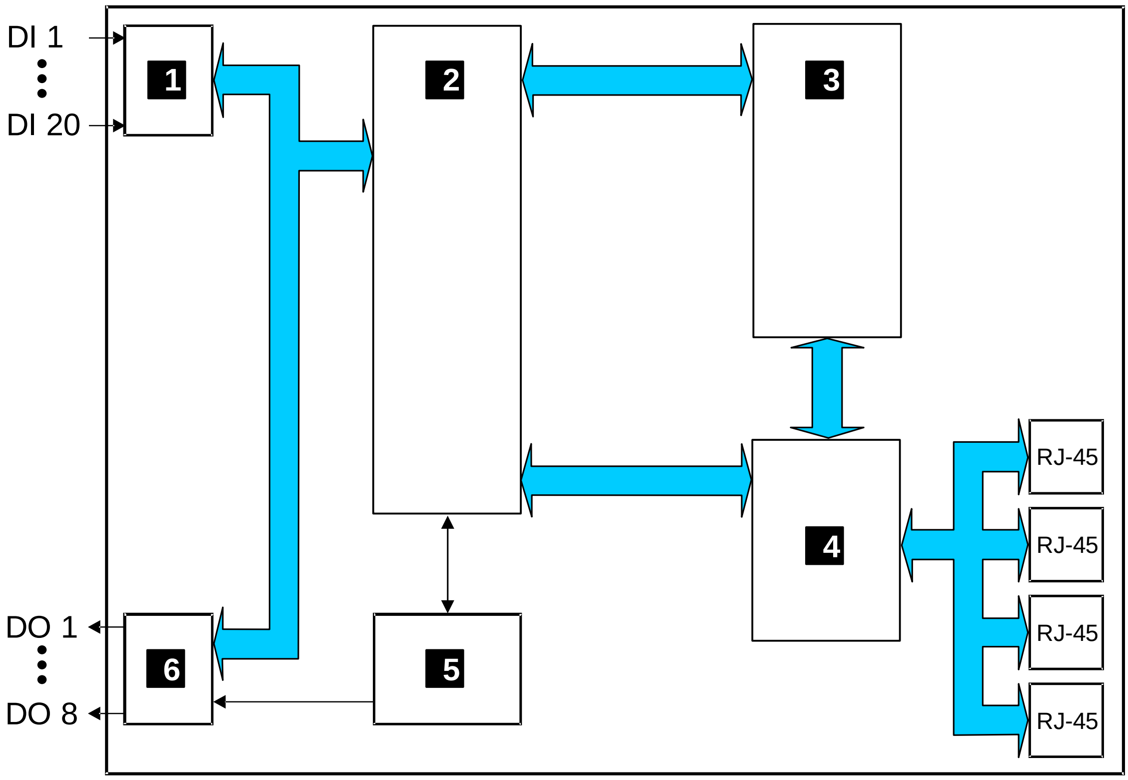


Figure 1: Front View



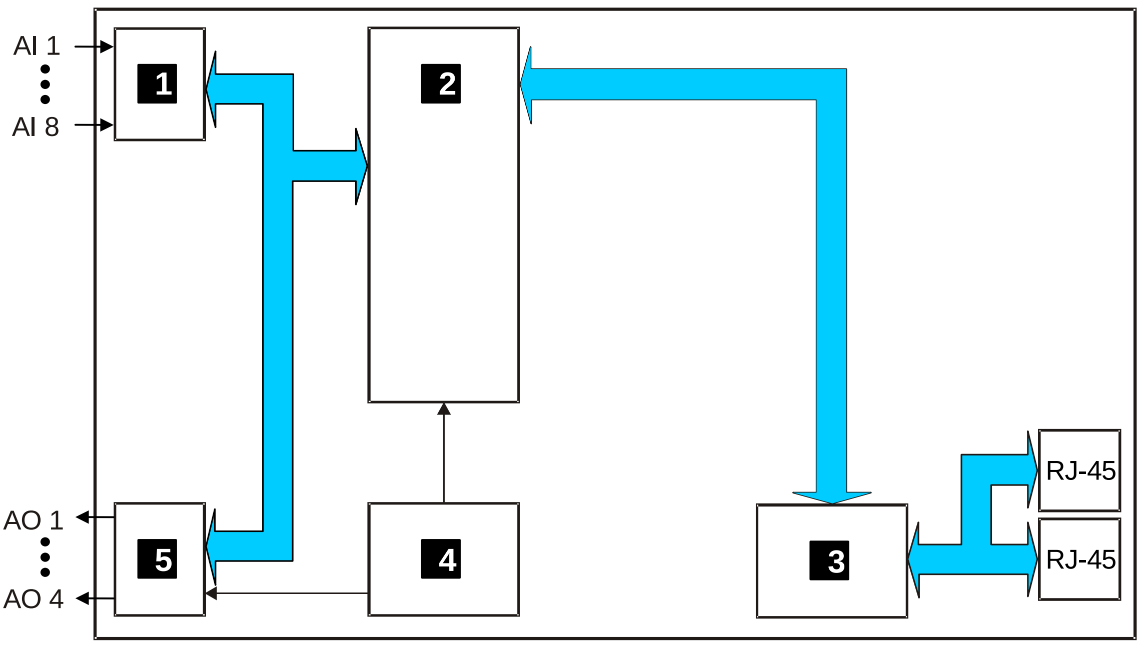
1 Digital inputs
2 Safety-related processor system (CPU)
3 Communication system (COM)
4 Switch
5 Watchdog
6 Digital outputs

Figure 2: Block Diagram

3.3 Structure of the HIMatrix Combustion Safeguard F3 AIO CSG

This chapter describes the layout and function of the remote I/Os, and communication via safe**ethernet**.

Figure 3: Front Viewt



- **1** Analog inputs
- **2** Safety-related processor system (CPU)
- **3** Switch
- **4** Watchdog
- **5** Analog outputs

Figure 4: Block Diagram

3.3.1 LED Indicators

The light-emitting diodes (LEDs) indicate the operating state of the controller. The LEDs are classified as follows:

- Operating voltage LED
- System LEDs
- Communication LEDs
- I/O LEDs

When the supply voltage is connected, an LED test is performed and all LEDs are briefly lit.

Definition of blinking frequencies

The following table defines the blinking frequencies of the LEDs:

Definition	Blinking frequencies
Blinking 1	Long (approx. 600 ms) on, long (approx. 600 ms) off.
Blinking-x	Ethernet communication: Blinking synchronously with data transfer

Table 9: Blinking Frequencies of LEDs

3.3.2 Operating Voltage LED

The LED signals the following states:

LED	Color	Status	Description
24 VDC	Green	On	24 VDC operating voltage present.
		Off	No operating voltage.

Table 10: Operating Voltage LED

3.3.3 System LEDs

While the device is being booted, all LEDs are lit simultaneously.

LED	Color	Status	Description
RUN	Green	On	▪ The device is in RUN, normal operation. ▪ Emergency loader active
		Blinking 1	Device in STOP
		Off	The device is not in the RUN or STOP state.
ERR	Red	On	System warning, for example: Temperature warning.
		Blinking 1	System error, for example: ▪ The device is in the ERROR STOP state. The self-test has detected internal faults, e.g., hardware or voltage supply faults. ▪ Emergency loader active
		Off	No faults detected
PROG	Yellow	On	▪ Emergency loader active ▪ Duplicate IP address check
		Blinking 1	Duplicate IP address detected 1)
		Off	None of the described events occurred
FORCE	Yellow	On	Emergency loader active
		Blinking 1	Duplicate IP address detected 1)
		Off	No event occurred
FAULT	Yellow	On	▪ Emergency loader active ▪ Warning related to the field zone
		Blinking 1	Duplicate IP address detected 1)
		Off	None of the described faults occurred
OSL	Yellow	Blinking 1	▪ Operating system emergency loader active ▪ Duplicate IP address detected 1)
		Off	No event occurred
BL	Yellow	On	Warning related to external process data communication
		Blinking 1	▪ Errors related to external process data communication ▪ Duplicate IP address detected 1)
		Off	No event occurred
1) If all the LEDs PROG, FORCE, FAULT, OSL and BL are blinking simultaneously.			

Table 11: System LEDs

3.3.3.1 Communication LEDs

All RJ-45 connectors are provided with a green and a yellow LEDs. The LEDs signal the following states:

Color	Status	Description
Green	On	Full duplex operation.
	Blinking 1	IP address conflict, all communication LEDs are blinking.
	Blinking-x	Collision.
	Off	Half duplex operation, no collision.
Yellow	On	Connection available.
	Blinking 1	IP address conflict, all communication LEDs are blinking.
	Blinking-x	Interface activity.
	Off	No connection available.

Table 12: Ethernet Indicators

3.3.3.2 I/O LEDs

The LEDs signal the following states:

LED	Color	Status	Description
DI 1…20	Yellow	On	The related channel is active (energized).
		Off	The related channel is inactive (de-energized).
DO 1…8	Yellow	On	The related channel is active (energized).
		Off	The related channel is inactive (de-energized).

Table 13: I/O LEDs

3.4 Product Data

3.4.1 General

Supply voltage L+	24 VDC, –15...+20 %, $r_P \leq 5$ %, from a power supply unit with safe insulation, in accordance with IEC 61131-2
Maximum supply voltage	30 V
Current consumption	Max. 8 A (with maximum load) Idle: 0.5 A at 24 V
Microprocessor	PowerPC
Response time	< 250 ms
Ethernet interfaces	4 x RJ-45, 10BASE-T/100BASE-Tx with integrated switch
Protection class	Protection class III in accordance with IEC/EN 61131-2.
Ambient temperature	0...+60 °C
Storage temperature	–40...+85 °C
Pollution	Pollution degree II in accordance with IEC/EN 61131-2
Altitude	< 2000 m
Degree of protection	IP20
Maximum dimensions HIMatrix CSG 04 (without plug)	Width: 257 mm (with housing screws) Height: 114 mm (with fixing bolt) Depth: 66 mm (with grounding screw)
Maximum dimensions HIMatrix F3 AIO CSG (without plug)	Width: 207 mm (with housing screws) Height: 114 mm (with fixing bolt) Depth: 97 mm (with grounding screw)
Weight	Approx. 1.2 kg

Table 14: General Product Data of HIMatrix CSG 04

3.4.2 Digital Inputs

Number of inputs	20 (not galvanically separated)
High level: ▪ Voltage ▪ Current consumption	 15...30 VDC ≥ 2 mA at 15 V
Low level: ▪ Voltage ▪ Current consumption	 Maximum 5 VDC Maximum 1.5 mA (1 mA at 5 V)
Switching point	typ. 7.5 V
Supply	5 x 20 V/100 mA (at 24 V), short-circuit-proof

Table 15: Specifications for Digital Inputs

3.4.3 Digital Outputs

Number of outputs	8 (not galvanically separated)
Output voltage	≥ L+ minus 2 V
Output current	Channels 1...3 and 5...7: 0.5 A at ≤ 60 °C The output current of channels 4 and 8 depends on the ambient temperature. Ambient temperature: Output current < 50 °C: 2 A 50...60 °C: 1 A
Minimum load	2 mA for each channel
Internal voltage drop	Maximum 2 V at 2 A
Leakage current (with low level)	Maximum 1 mA at 2 V
Behavior upon overload	The affected output is switched off and cyclically switched on again.
Total output current	Maximum 7 A Exceeding the maximum output current causes all outputs to be switched off, and then cyclically switched on again.

Table 16: Specifications for the Digital Outputs

3.4.4 Analog Inputs

Number of inputs	8 (not galvanically separated)
Nominal range	0...+100 VDC 0/4...+20 mA with shunt 500 Ω
Operating range	-0.1...+11.5 VDC 0/4...+20 mA with shunt 500 Ω
Input resistance	> 2 MΩ
Internal resistance of the signal source	≤ 500 Ω
Digital resolution	12-bit
Metrological accuracy at 25 °C	Max. ±0.1 % of full scale
Metrological accuracy across the temperature range 0...+60 °C	Max. ±0.5 % of full scale
Temperature coefficient [1)]	Max. ±0.011 % K of full scale
Measured value refresh	Once per cycle of the controller
Sampling time	Approx. 45 µs
[1)] for the permissible temperature range	

Table 17: Specifications for the Analog Inputs

3.4.5 Supply Outputs

Number of supply outputs	8
Nominal voltages	8.2 VDC/26 VDC, switchable
Tolerance	±5 %
Monitored limits: ▪ 8.2 V range ▪ 26 V range	 7.6...8.8 V (tolerance range: 7.3...9.1 V) 24.3...27.7 V (tolerance range: 24.0...28.0 V)
Current limiting	> 200 mA, output is switched off

Table 18: Specifications for the Transmitter Supply

3.4.6 Analog Outputs

Number of outputs	4, not galvanically separated Not safety-related Common safe shutdown
Nominal value	4...20 mA
Operating value	0...21 mA
Digital resolution	12-bit
Load impedance	Max. 600 Ω
Metrological accuracy at 25 °C	Max. ±0.1 % of full scale
Metrological accuracy on the temperature range 0...60 °C	Max. ±0.5 % of full scale
Temperature coefficient [1)]	Max. ±0.011 % K of full scale
[1)] for the permissible temperature range	

Table 19: Specifications for the Analog Inputs

4 Process Signals

4.1 Digital Inputs

Input	Function	Terminal	Low	High
1	Main interlock fulfilled	X:14	0…5 VDC	15…30 VDC
2	Start enable fulfilled	X:15	0…5 VDC	15…30 VDC
3	Pre-purging/no pre-purging	X:16	0…5 VDC	15…30 VDC
4	Combustion air pressure > MIN	X:17	0…5 VDC	15…30 VDC
5	Pre-purge conditions fulfilled	X:20	0…5 VDC	15…30 VDC
6	Not used	X:21	0…5 VDC	15…30 VDC
7	Ignition lance in ignition position	X:22	0…5 VDC	15…30 VDC
8	Not used	X:23	0…5 VDC	15…30 VDC
9	Main burner flame available	X:26	0…5 VDC	15…30 VDC
10	Tightness pressure > MAX (optional)	X:27	0…5 VDC	15…30 VDC
11	Tightness pressure < MIN (optional)	X:28	0…5 VDC	15…30 VDC
12	Main burner ignition power position	X:29	0…5 VDC	15…30 VDC
13	Main burner SSV1 closed	X:32	0…5 VDC	15…30 VDC
14	Main burner SSV2 closed	X:33	0…5 VDC	15…30 VDC
15	Main burner pressure relief valve closed	X:34	0…5 VDC	15…30 VDC
16	Main burner fuel air ratio	X:35	0…5 VDC	15…30 VDC
17	Push-button Start main burner	X:38	0…5 VDC	15…30 VDC
18	Not used	X:39	0…5 VDC	15…30 VDC
19	Push-button Do not stop main burner	X:40	0…5 VDC	15…30 VDC
20	Error reset	X:41	0…5 VDC	15…30 VDC

Table 20: Process Signals of Digital Inputs

The behavior described in the Function column corresponds to the active input (high level).

i To filter out the contact bounce and the test pulses of other safety-related controllers in the internal signal processing of the HIMatrix CSG 04, the inputs are delayed by 50 ms for the signal changes 0 to 1 and 1 to 0.

4.2 Analog Inputs

Input	Function	Signal	GND	26 VDC	500 Ω	Process
1	Fuel operating flow	X:2	X:3	X:1	4…20 mA	0…100 %
2	Fuel operating temperature	X:5	X:6	X:4	4…20 mA	0…100 °C
3	Fuel operating pressure	X:8	X:9	X:7	4…20 mA	0…1 bar
4	Combustion air operating flow	X:11	X:12	X:10	4…20 mA	0…100 %
5	Combustion air operating temperature	X:14	X:15	X:13	4…20 mA	0…500 °C
6	Combustion air operating pressure	X:17	X:18	X:16	4…20 mA	0…1 bar
7	Not used	X:20	X:21	X:19	4…20 mA	0…100 %
8	Pressure transmitter tightness test	X:23	X:24	X:22	4…20 mA	0…100 %

Table 21: Process Signals of Analog Inputs

4.3 Digital Outputs

Output	Function	Terminal	High level	Load
1	HIMatrix CSG 04 is ready to operate	X:2	L+ (- 2 VDC)	2…500 mA
2	Start pre-purging	X:3	L+ (- 2 VDC)	2…500 mA
3	Check of combustion air pressure	X:4	L+ (- 2 VDC)	2…500 mA
4	Igniter ignition system/transformer	X:5	L+ (- 2 VDC)	2…1000 mA
5	Retract the ignition lance	X:8	L+ (- 2 VDC)	2…500 mA
6	Main burner SSV1	X:9	L+ (- 2 VDC)	2…500 mA
7	Main burner SSV2	X:10	L+ (- 2 VDC)	2…500 mA
8	Main burner pressure relief valve	X:11	L+ (- 2 VDC)	2…1000 mA

Table 22: Process Signals of Digital Outputs

4.4 Analog Outputs

Output	Function	Signal	GND	≤ 600 Ω	Process
1	Standard fuel flow	X:25	X:26	4…20 mA	0…100 %
2	Standard combustion air flow	X:27	X:28	4…20 mA	0…100 %
3	Fuel air ratio	X:29	X:30	4…20 mA	0…10 λ
4	Pressure transmitter tightness test	X:31	X:32	4…20 mA	0…100 %

Table 23: Process Signals of Analog Outputs

4.5 Cable Plugs

Cable plugs attached to the pin headers of the devices are used to connect to the HIMatrix CSG 04 system and the field zone. The cable plugs are included within the scope of delivery of the HIMatrix CSG 04 devices and modules.

The power supply connections of the HIMatrix CSG 04 system feature the following properties:

Connection to the power supply	
Cable plugs	4 poles, screw terminals
Wire cross-section	▪ 0.2...2.5 mm² (single-wire) ▪ 0.2...2.5 mm² (finely stranded) ▪ 0.2...2.5 mm² (with wire end ferrule)
Stripping length	10 mm
Screwdriver	Slotted 0.6 x 3.5 mm
Tightening torque	0.4…0.5 Nm

Table 24: Power Supply Cable Plugs

Connection to the field zone	
Number of cable plugs	7 items, 6 poles, screw terminals
Wire cross-section	▪ 0.2...1.5 mm² (single-wire) ▪ 0.2...1.5 mm² (finely stranded) ▪ 0.2...1.5 mm² (with wire end ferrule)
Stripping length	6 mm
Screwdriver	Slotted 0.4 x 2.5 mm
Tightening torque	0.2…0.25 Nm

Table 25: Input and Output Cable Plugs

5 Parameters

5.1 Process Adjustments

Seq. no.	Function	Low	Default	High
1	Password	10000	11111	65535
2	HIMatrix CSG 04 configuration	0	0	65535
3	Restart delay time for HIMatrix CSG 04	1 s	10 s	900 s
4	Pre-purge time	20 s	180 s	900 s
5	Ready for ignition time after pre-purging	0 s	300 s	900 s
6	Igniter pre-ignition time	0 s	1 s	10 s
7	Igniter trials for ignition	1	1	3
8	Igniter safety time	0 s	3 s	5 s
9	Igniter re-ignition delay time (pre-purge)	0 s	10 s	60 s
10	Igniter re-ignition time	0 s	30 s	60 s
11	Igniter and main burner overlapping time	0 s	2 s	10 s
12	Main burner tightness test time	0 s	20 s	60 s
13	Main burner de-pressurizing time	2 s	3 s	10 s
14	Main burner trials for ignition	1	1	2
15	Main burner safety time	0 s	2 s	10 s
16	Main burner re-ignition delay time (pre-purging)	0 s	10 s	60 s
17	Main burner re-ignition time	0 s	30 s	60 s
18	Release delay time of fuel air ratio control	0 s	5 s	60 s
19	Fuel calibration temperature	0 °C	20 °C	100 °C
20	Fuel calibration pressure	0 bar	0.25 bar	1 bar
21	Combustion air calibration temperature	0 °C	20 °C	500 °C
22	Combustion air calibration pressure	0 bar	0.05 bar	1 bar
23	Fuel air ratio maximum (air factor λ)	0	1.65	10
24	Fuel air ratio minimum (air factor λ)	0	1.05	10
25	Tightness test, pressure test limit	30.1 %	50 %	100 %
26	Tightness test, de-pressurizing test limit	0 %	10 %	30 %
27	Tightness test, sensitivity value (EN 1643)	0 %	2 %	10 %
28	Ignition lance runtime monitoring	1 s	20 s	900 s

Table 26: Safety-Relevant Parameters

i The safety-related parameter values must be defined separately (risk analysis). They must be tested and enabled accordingly!

5.2 Settings for HIMatrix CSG 04

Bit	HIMatrix CSG 04 configuration (seq. no. 2)	Signal	Default	Value
0 LSB	Stop of igniter: ▪ Automatic, after ignition of main burner ▪ Manual	0/1 0 1	0	1
1	Tightness test: ▪ Activated ▪ Deactivated	0/1 0 1	0	2
2	Number of main burner safety valves: ▪ SSV1, SSV2 and pressure relief valve ▪ SSV1 and SSV2	0/1 0 1	0	4
3	Pressure relief valve: ▪ Active closed ▪ Active open	0/1 0 1	0	8
4	Test valve for no air false alarm ▪ Test valve available ▪ Test valve not available	0/1 0 1	0	16
5	Remote control ▪ Deactivated ▪ Activated	0/1 0 1	0	32
6	Igniter SSV1 and SSV2 end position closed ▪ Switch available ▪ Switch not available	0/1 0 1	0	64
7	Main burner SSV1 and SSV2 end position closed: ▪ Switch available ▪ Switch not available	0/1 0 1	0	128
8	Main burner pressure relief valve end position closed ▪ Switch available ▪ Switch not available	0/1 0 1	0	256
9	Tightness test: ▪ With pressure transmitter (AI 08) ▪ With pressure switch (DI 10 and DI 11)	0/1 0 1	0	512
10	Fuel flow (measuring procedure): ▪ With differential pressure measurement (dP) ▪ With other measurement processes (turbines, coriolis, vortex, etc.)	0/1 0 1	0	1024
11	Fuel flow (dP): ▪ 4-20 mA linear to the flow ▪ 4-20 mA linear to the differential pressure (square root extraction)	0/1 0 1	0	2048
12	Fuel flow (PT correction): ▪ PT correction activated ▪ PT correction deactivated	0/1 0 1	0	4096
13	Combustion air flow control (measurement procedure): ▪ With differential pressure measurement ▪ With other measurement processes (turbines, coriolis, vortex, etc.)	0/1 0 1	0	8192
14	Combustion air flow control (if dP is selected): ▪ 4-20 mA linear to the flow ▪ 4-20 mA linear to the differential pressure (square root extraction)	0/1 0 1	0	16384
15	Combustion air flow control (PT correction) ▪ PT correction activated ▪ PT correction deactivated	0/1 0 1	0	32768

Table 27: Configuration of CSG Settings

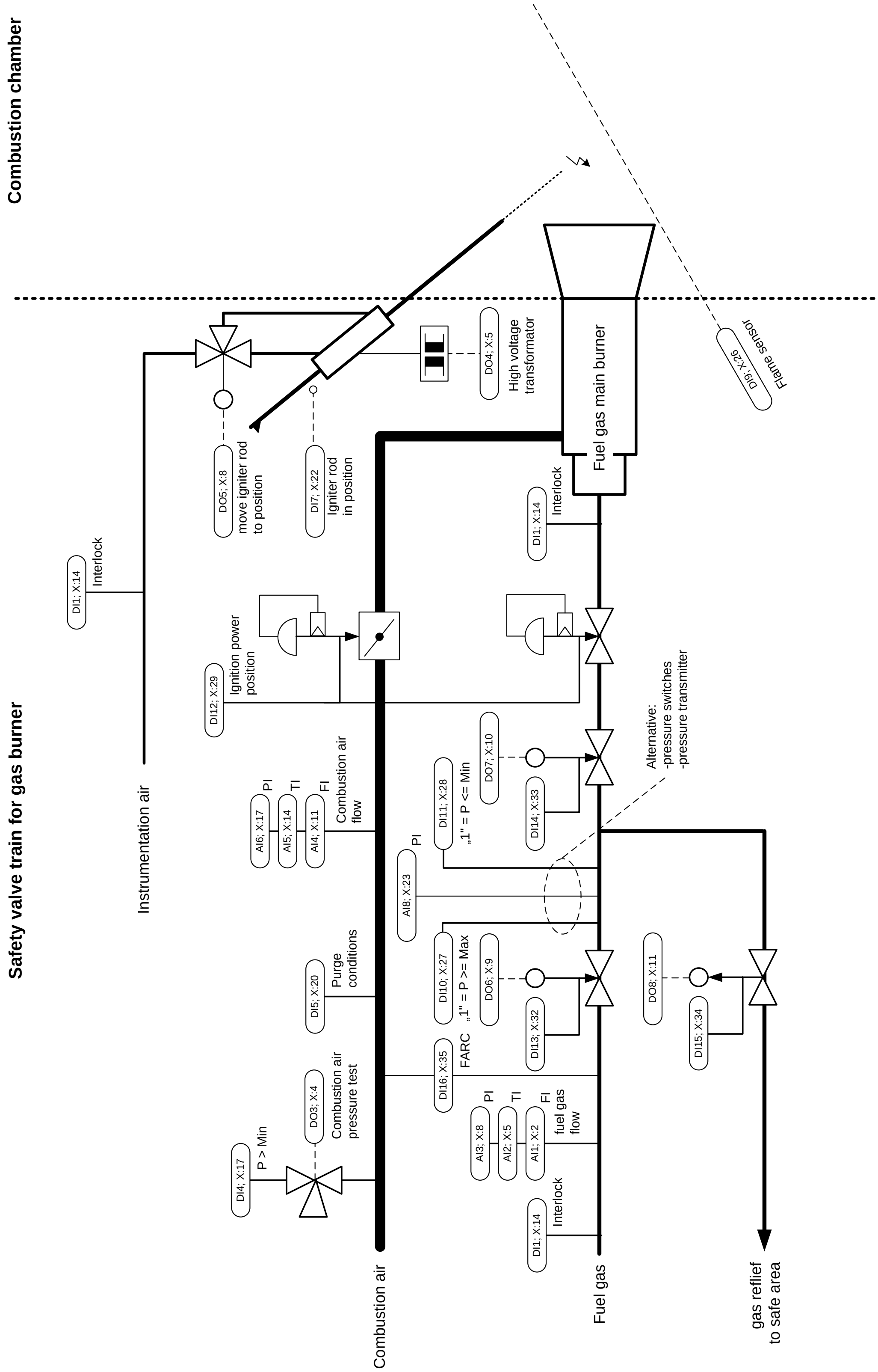
Sample Configuration

i The value of the HIMatrix CSG 04 configuration parameter is the sum of the individual values contained in the Value column of the individual functions with activated 1-signal.

Bit	HIMatrix CSG 04 configuration (seq. no. 2)	Signal	Value
0	Stop igniter: Automatic, after main burner ignition	0	0
1	Tightness test: Activated	0	0
2	Number of main burner safety valves: SSV1 and SSV2	1	4
3	Pressure relief valve: Not relevant	0	0
4	Test valve for no air false alarm: Test valve not available	1	16
5	Remote control: Deactivated	0	0
6	Igniter SSV1 and SSV2 end position closed: Not available	1	64
7	Main burner SSV1 and SSV2 end position closed: Available	0	0
8	Main burner pressure relief valve end position closed: Not relevant	0	0
9	Tightness test: With pressure transmitter (AI 08)	0	0
10	Fuel flow (measuring procedure): Vortex frequency measurement	1	1024
11	Fuel flow (dP): Not relevant	0	0
12	Fuel flow (PT correction): Not relevant	0	0
13	Combustion air flow control (measurement procedure): With differential pressure (dP)	0	0
14	Combustion air flow control (if dP is selected): Square root extraction required	1	16384
15	Combustion air flow control (PT correction): PT correction not required	1	32768
	Value in the CSG configuration parameter		50260

Table 28: Example of a HIMatrix CSG 04 Configuration

6 R&I Diagram


Combustion chamber
Safety valve train for gas burner
Instrumentation air
DI1; X:14
Interlock
DO5; X:8
move igniter rod
to position
DI7; X:22
Igniter rod
in position
DO4; X:5
High voltage
transformator
Fuel gas main burner
DI9; X:26
Flame sensor
DI12; X:29
Ignition power
position
Alternative:
-pressure switches
-pressure transmitter
DO7; X:10
DI14; X:33
DI11; X:28
„1" = P <= Min
AI6; X:17
AI5; X:14
AI4; X:11
PI
TI
FI
Combustion air
flow
AI8; X:23
DI10; X:27
„1" = P >= Max
DO6; X:9
DI13; X:32
DO8; X:11
DI15; X:34
DI5; X:20
Purge
conditions
DI16; X:35
FARC
DO3; X:4
Combustion air
pressure test
DI4; X:17
P > Min
AI3; X:8
AI2; X:5
AI1; X:2
fuel gas
flow
Combustion air
Fuel gas
gas reflief
to safe area

7 Functional Description

7.1 Safety Shutdowns

Input 1 shows the sum of all safety shutdowns in the plant, e.g., serial disconnection of disabling contacts.

The following shutdown signals must be integrated in the safety shutdown:

- Fuel pressure (flow) > minimum
- Fuel pressure (flow) < maximum
- Combustion air supply is operating without faults
- Combustion air pressure (flow) > minimum
- Combustion air pressure (flow) < maximum
- Current supplies and auxiliary energies are ready for use
- Heat medium pressure (flow) > minimum
- Heat medium pressure (flow) < maximum
- Heat medium is fault-free
- Exhaust system is operating without faults
- Fuel air ratio > minimum
- Fuel air ratio < maximum
- Combustion chamber pressure > minimum
- Combustion chamber pressure < maximum
- Combustion chamber temperature < maximum
- Operating temperatures of heat exchangers < maximum
- Boiler (firetube boiler, watertube boiler, etc.) is failure-free

i The list is not exhaustive since it can only be completed based on the specific plant. To complete the list, suitable measures must be implemented such as the creation of a hazard and risk analysis.

7.1.1 Fuel Air Ratio Monitoring

Fuel air ratio monitoring requires flow measurements for the fuel (analog input 01) and for the combustion air (analog input 04). In the HIMatrix CSG 04, both analog inputs are scaled within a range of 0 to 100 %. The stoichiometric state is represented by identical milliampere values (percentages) in the fuel and combustion air flow measurements.

In a stoichiometric combustion, the quotient **AI04/AI01** corresponds to an air factor (lambda λ) of 1. If the air factor is < 1, the combustion is fuel rich. If the air factor is > 1, the combustion is fuel lean.

The calibration values of the pressure measurements must be set to the calibration values of the instruments through the following parameters:

- Seq. no. 21 *Fuel calibration temperature*
- Seq. no. 22 *Fuel calibration pressure*
- Seq. no. 23 *Combustion air calibration temperature*
- Seq. no. 24 *Combustion air calibration pressure*

The current process values for temperature and pressure are read by the following analog inputs:

Input	Process Value
2	Fuel operating temperature
3	Fuel operating pressure
5	Combustion air operating temperature
6	Combustion air operating pressure

Table 29: Process Values for the Analog Inputs

- The measuring ranges are listed in the table for analog inputs (→ Table 21, page 24).

i The measuring ranges mentioned here are not variable. The measuring ranges must be configured on the temperature and pressure transmitters.

7.1.1.1 Compensation Calculations

The values measured for pressure and temperature are relative values. The compensation calculation is performed with absolute values. The compensation calculations for fuel flow are specified in the following table:

CSG configuration parameter	Bit	Signal	Compensation calculation for the fuel flow
Seq. no. 2 (→ Chapter 5.2, page 27)	10 11 12	1 0 0	$AO01 = AI01 \text{ x } \frac{1.013 + AI03}{1.013 + seq.no.22} \text{ x } \frac{273.15 + seq.no.21}{273.15 + AI02}$
	10 11 12	0 0 0	$AO01 = AI01 \text{ x } \sqrt{\frac{1.013 + AI03}{1.013 + seq.no.22}} \text{ x } \sqrt{\frac{273.15 + seq.no.21}{273.15 + AI02}}$
	10 11 12	0 1 0	$AO01 = \sqrt{AI01 \Big\|_{0\%}^{100\%}} \text{ x } \sqrt{\frac{1.013 + AI03}{1.013 + seq.no.22}} \text{ x } \sqrt{\frac{273.15 + seq.no.21}{273.15 + AI02}}$
	10 11 12	0 1 1	$AO01 = \sqrt{AI01 \Big\|_{0\%}^{100\%}} \text{ x } \sqrt{\frac{1.013 + seq.no.22}{1.013 + seq.no.22}} \text{ x } \sqrt{\frac{273.15 + seq.no.21}{273.15 + seq.no.21}}$
	10 11 12	0 0 1	$AO01 = AI01 \text{ x } \sqrt{\frac{1.013 + seq.no.22}{1.013 + seq.no.22}} \text{ x } \sqrt{\frac{273.15 + seq.no.21}{273.15 + seq.no.21}}$

Table 30: Compensation Calculations for Fuel Flow

In case of inconsistent setting of the configuration parameter seq. no. 2, bit 10 = 1 and bit 11 = 1 (non-dP-based flow measurement and square root extraction), the square root extraction, i.e., bit 11 = 1, is dominant. The CSG 04 system is based on a differential pressure measurement (dP-based) with a differential pressure linear value at the AI01 input *Fuel Flow.*

CSG configuration parameter	Bit	Signal	Compensation calculation for the combustion air flow control
Seq. no. 2 (→ Chapter 5.2, page 27)	13 14 15	1 0 0	$AO02 = AI04 \times \dfrac{1.013 + AI06}{1.013 + seq.no.24} \times \dfrac{273.15 + seq.no.23}{273.15 + AI05}$
	13 14 15	0 0 0	$AO02 = AI04 \times \sqrt{\dfrac{1.013 + AI06}{1.013 + seq.no.24}} \times \sqrt{\dfrac{273.15 + seq.no.23}{273.15 + AI05}}$
	13 14 15	0 1 0	$AO02 = \sqrt{AI04 \Big\|_{0\%}^{100\%}} \times \sqrt{\dfrac{1.013 + AI06}{1.013 + seq.no.24}} \times \sqrt{\dfrac{273.15 + seq.no.23}{273.15 + AI05}}$
	13 14 15	0 1 1	$AO02 = \sqrt{AI04 \Big\|_{0\%}^{100\%}} \times \sqrt{\dfrac{1.013 + seq.no.24}{1.013 + seq.no.24}} \times \sqrt{\dfrac{273.15 + seq.no.23}{273.15 + seq.no.23}}$
	13 14 15	0 0 1	$AO02 = AI04 \times \sqrt{\dfrac{1.013 + seq.no.24}{1.013 + seq.no.24}} \times \sqrt{\dfrac{273.15 + seq.no.23}{273.15 + seq.no.23}}$

Table 31: Compensation Calculations for Combustion Air Flow

In case of inconsistent setting of the configuration parameter seq. no. 2, bit 13 = 1 and bit 14 = 1 (non-dP-based flow measurement and square root extraction), the square root extraction, i.e., bit 14 = 1, is dominant. The CSG 04 system is based on a differential pressure measurement (dP-based) with a differential pressure linear value at the AI01 input *Fuel Flow.*

The fuel air ratio is calculated from the two standard flows determined above, as follows:

Seq. no. 23 > AO02/AO01 > step. no. 24.

The fuel air ratio must be in the range between parameter seq. no. 23 *Air Factor Maximum* and parameter seq. no. 24 *Air Factor Minimum*. If the fuel air ratio is out of range, a non-changeable lock-out occurs.

The fuel air ratio monitoring can also be set up externally, e.g., to meet increased SIL instrumentation requirements. The shutdown signal for the second or third independent fuel air ratio monitoring can be integrated through input 16 *Main Burner Fuel Air Ratio*. The mentioned input must be activated after ignition of the main burner. If a second fuel air ratio monitoring is not required, input 16 can be permanently loaded with 24 VDC.

7.2 Lock-Out

To initiate a new burner start after a lock-out, implement the following measures:

To remove the lock-out

1. Remove the cause of the lock-out.
2. The HIMatrix CSG 04 is unlocked by activating input 20 *Error reset*.

► The lock-out is removed.

For details on the burner start, see Chapter Burner Start (→ Chapter 7.4, page 34).

7.3 Start Pre-Conditions

After connecting the signals described in section Process Signals (→ Chapter 4, page 24), the following signals must be present at the inputs and outputs before starting the burner:

7.3.1 Inputs

Input	Function	Signal	Volt
1	Main interlock fulfilled	1	24 VDC
2	Start enable fulfilled	1	24 VDC
3	Pre-purging/no pre-purging	1 [1)]	0 VDC
4	Combustion air pressure > MIN	1	24 VDC
5	Pre-purge conditions fulfilled	0	0 VDC
6	Not used	0	0 VDC
7	Ignition lance in ignition position	1 [1)]	24 VDC
8	Not used	0[)]	24 VDC
9	Main burner flame available	0	0 VDC
10	Tightness pressure > MAX	0 [1)]	0 VDC
11	Tightness pressure < MIN	1[1)]	24 VDC
12	Main burner ignition power position	1	24 VDC
13	Main burner SSV1 closed	1 [1)]	24 VDC
14	Main burner SSV2 closed	1 [1)]	24 VDC
15	Main burner pressure relief valve closed	0	0 VDC
16	Main burner fuel air ratio	0	0 VDC
17	Push-button Start main burner	0	0 VDC
18	Not used	0	24 VDC
19	Push-button Do not stop main burner	1	24 VDC
20	Error reset	0	0 VDC
[1)] Alternative operation is possible			

Table 32: Start Pre-Conditions at the Inputs

7.3.2 Outputs

Output	Function	Signal	Volt
1	HIMatrix CSG 04 is ready to operate	1	L+ (- 2 VDC)
2	Start pre-purging	0	0 VDC
3	Check of combustion air pressure	0	0 VDC
4	Igniter ignition system/transformer	0	0 VDC
5	Retract the ignition lance	0	0 VDC
6	Main burner SSV1	0	0 VDC
7	Main burner SSV2	0	0 VDC
8	Main burner pressure relief valve	0	0 VDC

Table 33: Start Pre-Conditions at the Outputs

Additionally, the following start conditions must be ensured:

- The displayed step numbers must be < 128 (→ Chapter 8.2.3, Page 45).
- The parameter setting time must have expired.
- The main burner must be ready for ignition (→ Chapter 8.2.3.2, page 47).

7.4 Burner Start

The burner can only start if the signal layer at the HIMatrix CSG 04 matches the signals described in section Start Pre-Conditions (→ Chapter 7.3, page 33).

7.4.1 Tightness Test with Pressure Switches

For the tightness test of the safety shutoff valves (EN 746/1643), two pressure switches can be installed between the safety shutoff valves SSV1 and SSV2.

To activate the pressure switch test, bit 9 of the HIMatrix CSG 04 configuration parameter must be activated (→ Chapter 5.2, page 27).

The maximum pressure switch activates input 10 if the measured pressure is **above** the maximum limit configured for the switch.

The minimum pressure switch activates input 11 if the measured pressure is **below** the minimum limit configured for the switch.

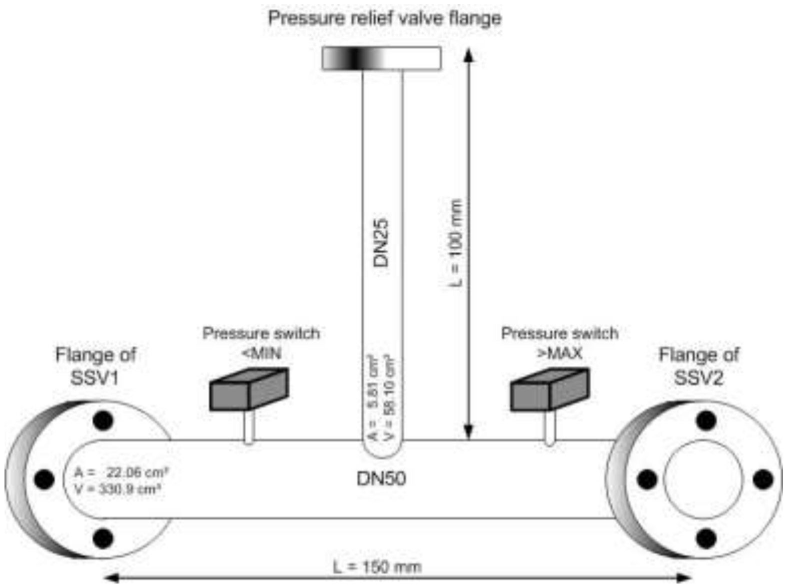


Figure 5: Pressure Switches between SSV1, SSV2 and Pressure Relief Valve

7.4.1.1 Sample Calculation for Pressure Switch

At a normative leakage rate E of 0.1 x 50 dm^3/h = 5000 cm^3/h (in accordance with EN 1643), the leakage in the previous example with a test duration of 20 s is calculated as follows:

0.1 x 50 dm^3/h = 5000 cm^3/h x (20 s / 3,600 s) = 27.778 cm^3.

According to the ideal gas law [$V_1 \times p_1 = (V_1 + E) \times p_2$] the resulting minimum pressure limit **<u>$dp_{(min)}$ = 67.5 mbar</u>**, at a total tube volume of 389 cm^3 (→ Figure 5, page 34) and an absolute pressure p_1 = 101325 Pa, is as follows:

- $p_{2(min)}$ = (389 cm^3 x 101325 Pa)/(389 cm^3 + 27.778 cm^3)
- $dp_{(min)}$ = $|p_{2(min)}$ - 101325$|$ x (1 mbar/100 Pa) = 67.5 mbar

At an operating pressure of 500 mbar (50000 Pa), the resulting maximum pressure limit of **<u>$dp_{(max)}$ = 399.14 mbar</u>** is as follows:

- $p_{2(max)}$ = (389 cm^3 x (101325 Pa + 50000 Pa))/(389 cm^3 + 27.778 cm^3)
- $dp_{(max)}$ = $|p_{2(max)}$ - 101325$|$ x (1 mbar/100 Pa) = 399.14 mbar

The pressures p_1 and p_2 are absolute pressures (e.g., p_{Rel} + 101325 [Pa]).

7.4.1.2 Tightness Test Sequence

After activating input 17 *Start igniter and main burner*, the position feedbacks of the main burner safety valves are checked for plausibility. Subsequently, flame simulation monitoring is carried out (active input 9 *Main burner flame available*). After a successful valve and flame simulation test, a tightness test with pressure switches is performed in the following sequence:

1. Close the pressure relief valve (activate output 8).
2. Check whether input 10 > *MAX* is deactivated and input 11 < *MIN* is activated.
3. Start the tightness test time, parameter seq. no. 12.
4. After the tightness test time has expired, check whether input 10 has retained the status < *MAX deactivated*.
5. After the tightness test time has expired, check whether input 11 has retained the status < *MIN activated*.
6. Open safety valve SSV1 (activation of output 6) for 3 seconds.
7. Make sure that input 10 > *MAX* is activated after SSV1 has closed.
8. Make sure that input 11 < *MIN* is deactivated after SSV1 has closed.
9. Start the tightness test time time, parameter seq. no. 12.
10. After the tightness test time has expired, check whether input 10 has retained the status > *MAX activated*.
11. After the tightness test time has expired, check whether input 11 has retained the status < *MIN deactivated*.

The pressure relief valve (output 8) remains energized (closed) over the operating time of the main burner.

The main burner is now ready to operate and must be started by the igniter within a time window (310 seconds + seq. no. 4 *Pre-purge time* + seq. no. 5 *Ready for ignition time*).

7.4.2 Tightness Test with Pressure Transmitter

For the tightness test of the safety shutoff valves (EN 746/EN 1643), a pressure transmitter can be installed between the safety shutoff valves SSV1 and SSV2.

To activate the pressure transmitter test, bit 9 of the HIMatrix CSG 04 configuration parameter must be deactivated (→ Chapter 5.2, page 27).

In the HIMatrix CSG 04, the measuring range of the pressure transmitter (4-20 mA) must be scaled within a range of 0 to 100 %. With the configuration parameter seq. no. 27 (→ Chapter 5.1, page 26), the sensitivity value (permissible pressure loss over the tightness test time, seq. no. 12) must be set for each individual main burner safety shutoff valve (SSV).

To differentiate between de-pressurized and pressurized state of the safety shutdown valve, parameter 25 *Pressure test limit* and parameter 26 *De-pressurizing test limit* must be configured (→ Chapter 5.1, page 26).

If the pressure at analog input 8 *Pressure transmitter tightness test* is less than or equal to the pressure value of parameter seq. no. 26, the state is de-pressurized (→ Chapter 5.1, page 26).

If the pressure at analog input 8 *Pressure transmitter tightness test* is greater than or equal to the pressure value of parameter seq. no. 25, the state is pressurized (→ Chapter 5.1, page 26).

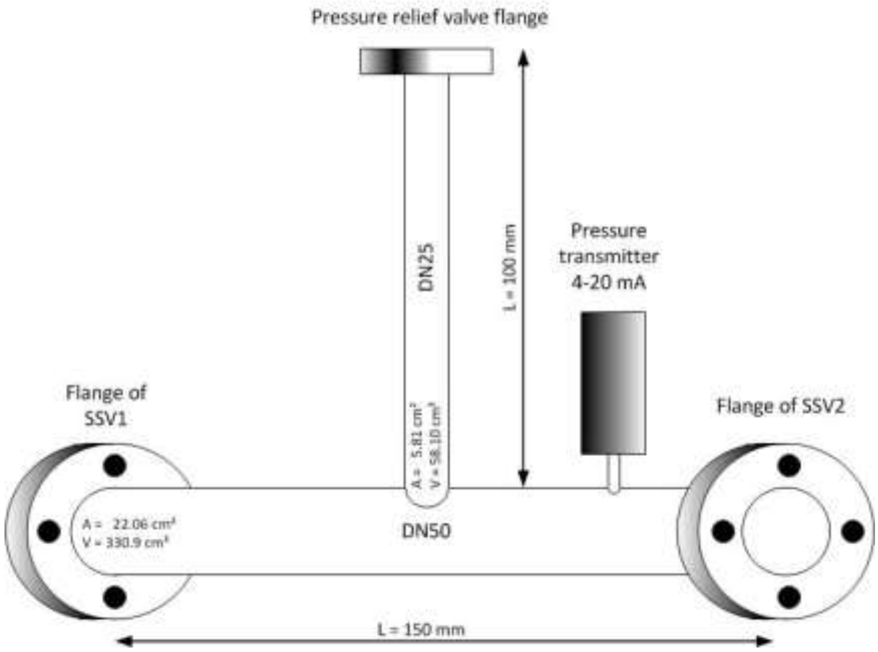


Figure 6: Pressure Transmitter between SSV1, SSV2 and Pressure Relief Valve

7.4.2.1 Pressure Transmitter Calculation

If suitable data is available for the tightness test, the procedure described in the corresponding section of the next chapter can start.

7.4.2.2 Basic Settings

To allow a monitored start-up of the burner, the tightness test must be deactivated.

The following calibration settings must be configured in the HIMatrix CSG 04 control panel while adjusting the tightness test.

Parameters	Calibration setting
Seq. no. 26	50 % of the minimum fuel pressure
Seq. no. 25	Minimum fuel pressure
Seq. no. 27	Maximum operating pressure
Seq. no. 12	30 seconds

Table 34: Calibration Settings for Adjusting the Tightness Test

The tightness test is deactivated for these calibration settings. The burner start-up phase can be monitored.

7.4.2.3 Collection of Operating Data

During the monitored start-up of the burner, the values for tightness test pressure and operating pressure must be recorded.

Parameter Seq. no. 26 *De-pressurizing test limit*

The tightness test pressure is present during the first phase of the tightness test after de-pressurizing through the pressure relief valve or safety shutoff valve 2 between the safety shutoff valves SSV1 and SSV2.

Under underpressure conditions within the combustion chamber after de-pressurizing, the pressure transmitter could provide a value less than 4 mA. Calibration or instrumentation must be set up so that the measured value can never be less than 4 mA.

Based on an individual assessment and adding a feasible hysteresis, the recorded tightness test pressure must be written in parameter seq. no. 26 as a positive value (→ Chapter 8.4, page 49). This value is underrun by the measured pressure value during the first phase of the tightness test after de-pressurizing.

Parameter Seq. no. 25 *Pressure test limit*

After a short opening (three seconds) of the safety shutoff valve SSV1, during the second phase of the tightness test, the operating pressure is applied between the shutoff valves SSV1 and SSV2.

Based on an individual assessment and subtracting a feasible hysteresis, the recorded operating pressure must be written in parameter seq. no. 25 (→ Chapter 8.4, page 49). This value is overrun in the second phase of the tightness test, shortly after opening of the safety shutoff valve SSV1.

Parameter Seq. no. 27 *Sensitivity value*, Empirical Procedure 1:

The pressure loss during the test time must be determined during commissioning. The tightness test for the main burner must be set using parameter seq. no. 12.

Based on an individual assessment and adding a feasible hysteresis (e.g., a slightly larger value), the recorded pressure loss must be written in parameter seq. no. 27 as a positive value.

The configured pressure loss must not be overrun in any of the three phases of the tightness test.

Parameter Seq. no. 27 *Sensitivity value*, Empirical Procedure 2

Reduce the value preset at the parameter seq. no. 27 (→ Chapter 7.4.2.2, page 36) from burner start to burner start until a lock-out is triggered due to leakage.

Based on an individual assessment and adding a feasible hysteresis (e.g., a slightly larger value), the recorded pressure loss must be written in the parameter seq. no. 27 as a positive value (→ Chapter 8.4, page 49).

The configured pressure loss must not be overrun in any of the three phases of the tightness test.

7.4.2.4 Calculating the Leakage

The value of parameter seq. no. 27 *Sesitivity value* resulting from the two empirical procedures must be mathematically verified. For the calculation, the chamber volume V_1 between the following valves must be known:

- Safety shutoff valve SSV1.
- Safety shutoff valve SSV2.
- Pressure relief valve (if available).

Refer to EN 1643 for the permissible sensitivity (volume loss due to leakage). The permissible leakage is considered in the calculation as the volume increase E to the chamber volume V_1.

Parameter Seq. no. 27 *Sensitivity value*, Calculation

Initial formula according to ideal gas law:

$$\mathbf{p_1 \times V_1 = p_2 \times V_2}$$

The pressures p_1 and p_2 represent the changed pressures after expiration of the test time (parameter seq. no. 12). Volume V_2 corresponds to the volume change E and V_1 to the chamber volume.

At a constant test temperature, the value of pressure p_2, which has changed after expiration of the test time, is calculated as follows:

$$\mathbf{p_2 = (p_1 \times V_1) / (V_1 + E)}$$

Symbols	Description
p_1	Pressure before triggering of the test time Tght_Tst_T
p_2	Pressure upon expiration of the test time Tght_Tst_T
V_1	Chamber volume between SSV1, SSV2 and pressure relief valve (if available)
E	Sensitivity value (e.g., in accordance with EN 1643)

Table 35: Ideal Gas Law Symbols

The values of p1 and p2 must have the same physical unit (mbar or Pa).

The values of V1 and E must have the same physical unit (cm^3 or dm^3).

Parameter seq. no. 27 *Sensitivity value* is calculated as follows:

Sensitivity value E = |p1 – p2|

The value calculated for parameter seq. no. 27 muss be greater than or equal to the value determined empirically (→ Chapter 7.4.2.3, page 36). Based on an individual calculation and adding a feasible hysteresis (e.g., a slightly larger value), the value must be written in the parameter seq. no. 27 as a positive value (→ Chapter 8.4, page 49).

7.4.2.5 Tightness Test Sequence

After activating input 17 *Start main burner*, the position feedbacks of the main burner safety valves are checked for plausibility. Subsequently, flame simulation monitoring is carried out (active input 9 *Main burner flame available*). After a successful valve and flame simulation test, a tightness test with pressure transmitter is performed in the following steps:

1. Close the pressure relief valve (activate output 8).
2. Check whether the pressure value at analog input 8 is ≤ the value of parameter seq. no. 26.
3. Start the tightness test time, parameter seq. no. 12.
4. Upon expiration of the tightness test time, measure the pressure value at analog input 8. Compare this value with the value in step 2. The difference must be less than the value of parameter seq. no. 27.
5. Open the safety shutoff valve SSV1 (activation of output 6) for 3 seconds.
6. Check whether, after the safety shutoff valve SSV1 has closed, the pressure value at analog input 8 is ≥ the value of parameter seq. no. 25.
7. Start the tightness test time time, parameter seq. no. 12.
8. Upon expiration of the tightness test time, measure the pressure value at analog input 8. Compare this value with the value in step 7. The difference must be less than the value of parameter seq. no. 27.

The pressure relief valve (output 8) remains energized (closed) over the operating time of the main burner.

The main burner is now ready to operate and must be started by the igniter within a time window (310 seconds+ seq. no. 4 *Pre-purge time* + seq. no. 5 *Ready for ignition time*).

7.4.3 Pre-Purging

Before starting up the main burner, the position acknowledgments of the main burner safety shutoff valves are checked for plausibility. The tightness test of the main burner safety shutoff valves is carried out (position 7.4.1) after flame simulation monitoring (active input 9 *Main burner flame available*).

Before pre-purge is started, proper operation of the no air pressure switch, for which the signal is present at input 4 *Combustion air pressure > MIN,* is tested. To this end, output 3 *Testing of combustion air pressure* is activated. The assumption is made that the corresponding safety pressure switch is de-pressurized in the system. Input 4 must be deactivated! After deactivation of the mentioned test output 3, input 4 must be re-activated.

After the air pressure test, the ignition lance is retracted into the combustion chamber by activating output 5 *Retract the ignition lance*. Input 7 *Ignition lance in ignition position* indicates that the ignition lance is ready to operate.

Pre-purging is now automatically triggered through activation of output 2 *Start pre-purging*. Inputs 4 *Combustion air pressure > MIN* (start condition) and 5 *Pre-purge conditions fulfilled* must be activated within 5 minutes. The pre-purge time (parameter seq. no. 4) runs as long as the mentioned inputs are activated. The ignition release time (parameter seq. no. 5) is started after the pre-purge time has expired.

7.4.4 Igniting the Main Burner

If pre-purging was successfully completed, output 4 *Spark transformer* is activated. Once the ignition time has expired (parameter seq. no. 6), output 6 *Main burner SSV1* and output 7 *Main burner SSV2* are triggered causing the main burner's safety shutoff valves (SSV1 and SSV2) to open. Within the main burner safety time (parameter seq. no. 15) a flame must be detected through activation of input 9 *Main burner flame available*.

If the first trial for ignition fails and the permissible number of trials for ignition (parameter seq. no. 14) is limited to one attempt, a lock-out is performed. If a second trial for ignition is permitted, a re-ignition delay time (parameter seq. no. 16) is started, which makes it possible to purge the main burner. The re-ignition time (parameter seq. no. 10) is started after the re-ignition delay time is started. A new main burner start must be triggered within the re-ignition time by activating input 17 *Start main burner.* If the trigger is not given within the re-ignition time, a lock-out is performed.

After igniting the main burner, the ignition lance is extracted from the combustion chamber by deactivating output 5 *Retract the ignition lance*. The release delay time for fuel air ratio monitoring is started (parameter seq. no. 18). The input 16 *Main burner fuel air ratio* must be activated after this time has expired. The mentioned inputs must be now active for the entire operating time of the main burner. If this inputs is deactivated, an immediate lock-out occurs.

Additionally, the fuel air ratio (see Chapter 7.1.1., page 29) determined with analog outputs 1 through 6 (see Chapter 4.2, page 23 and Chapter 4.4, page 24) must move within the operating limits. These are defined with parameter seq. no. 23 *Maximum* and parameter seq. no. 24 *Minimum*. Overrun or underrun causes a lock-out.

The ignition process described for the main burner, including all re-ignition events, must be completed within the ready for ignition time (parameter seq. no. 5), which is started after successful completion of pre-purging. If this is not the case, a lock-out is carried out.

i The main burner operation deactivates the time limitation of the "ready for ignition" function through the ready for ignition time (parameter seq. no. 5).

This relation must match the system situation!

7.5 Burner Shutdown

Deactivating input 19 *Do not stop main burner*, the main burner can be stopped by closing safety shutoff valves SSV1 and SSV2 (deactivation of inputs 6 and 7).

After SSV1 and SSV2 are closed, a pressurized tightness test is carried out (→ Chapter 7.4.2.5, page 38).

After shutting down the main burner without faults, a re-ignition delay time is started (parameter seq. no. 3). The burner may only be started again after expiration of this time (→ Chapter 7.4, page 34).

After deactivation of input 19 *Do not stop main burner* outside operating step 30, a sequence abort is generated. The sequence abort corresponds to a lock-out and must be reset as such (→ Chapter 7.2, page 32).

7.6 Burner Operation

After a fault-free start-up of the the main burner and possibly of the igniter, combustion operation is ensured through the following information at the inputs:

Input	Function	Signal	Volt
1	Main interlock fulfilled	1	24 VDC
4	Combustion air pressure > MIN	1	24 VDC
9	Main burner flame available	1	24 VDC
15	Main burner pressure relief valve closed	1	24 VDC
16	Main burner fuel air ratio	1	24 VDC
*If the igniter continued operation together with the main burner.			

Table 36: Statuses at the Inputs

If one of the mentioned signals is deactivated, a lock-out is immediately generated.

7.7 Special Operations

Configuration of the HIMatrix CSG 04 can be adapted to different operating modes of gas burners. Configuration variable *HIMatrix CSG 04 Configuration* (parameter seq. no. 2) must be used to adjust the configuration.

7.7.1 Control Bits

Control bit	Control bit function
0	Decommissioning of the igniter (→ Chapter 7.4.4, page 39).
1	Activate and/or deactivate the tightness test.
2	The igniter and the main burner must be equipped with two safety shutoff valves each. Additionally, the main burner can be provided with a pressure relief valve between the safety shutoff valves. Selection of the valve configuration for the main burner must be performed with control bit 2. The following operating settings are possible: ▪ 3 valves without tightness test (bit 1 = 1, bit 2 = 0). ▪ 3 valves with tightness test, passive de-pressurizing (bit 1 = 0, bit 2 = 0, bit 3 = 0). ▪ 3 valves with tightness test, active de-pressurizing (bit 1 = 0, bit 2 = 0, bit 3 = 1). ▪ 2 valves without tightness test (bit 1 = 1, bit 2 = 1). ▪ 2 valves with tightness test (bit 1 = 0 and bit 2 = 1). The de-pressurizing time (parameter seq. no. 13) defines the opening time of the pressure relief valve. The de-pressurizing time is normatively between 0 and 3 seconds.
3	Response to different behaviors of the pressure relief valves. Control bit 3 can be activated or deactivated in accordance with the characteristics of the lack of energy, e.g., open or closed.
4	If the test of input 4 *Combustion air pressure > MIN* is dispensable in the system thanks to corresponding instrumentation, control bit 4 can be used to deactivate the function (→ Chapter 7.4.3, page 38).
5	Control bit 5 must be activated to allow a higher-level system to start and stop the igniter and main burner. **Caution:** This function is an option. It must be agreed upon with the responsible approval authorities.
6	Depending on the equipment of the igniter's safety shutoff valves, the end position signal "closed" must be activated or deactivated. HIMA recommends installing the end position switch "closed".
7	Depending on the equipment of the main burner's safety shutoff valves, the end position signal "closed" must be activated or deactivated. HIMA recommends installing the end position switch "closed".
8	Depending on the equipment of the main burner's relief valve, the end position signal "closed" must be activated or deactivated. HIMA recommends installing the end position switch "closed".
9	Depending on the equipment of the main burner's safety shutoff valve group, the tightness test can be carried out with pressure switches or pressure transmitters. Inputs 10 (> MAX) and 11 (< MIN) are intended for the pressure switches (→ Chapter 7.4.1, page 34). The pressure transmitter must be connected to the analog input 8 (→ Chapter 7.4.2, page 35).
10	For fuel air ratio monitoring, the differential pressure dP or another measurement process (e.g., turbine, ultrasound, vortex frequency, oval wheel meter, etc.) can be used. When choosing the procedure for the differential pressure dP, control bit 11 must also be taken into account.

Control bit	Control bit function
11	For fuel air ratio monitoring, the fuel flow measurement is carried out by a differential pressure dP measurement, as described for control bit 10 in this table. In differential pressure measurement, the differential pressure is physically in a square relationship to the flow. For this reason, the square root of the measuring signal must be extracted. The square root extraction must be activated in the transmitter if it provides a flow signal that is linear to the flow. The square root extraction must be activated in the HIMatrix CSG 04 if the transmitter provides a flow signal that is square to the flow rate, and the raw differential pressure is forwarded without square root extraction. The limit values of the square root extraction in the HIMatrix CSG 04 are in the range 4...20 mA (0…100 %).
12	For fuel air ratio monitoring, the fuel flow measurement depends on the calibration values of the measurements. The calibration values are matched to the used measuring facility through parameters seq. no. 19 (temperature) and 20 (pressure). The operating conditions are very often different from the calibration values of the measurement. Operating temperature and operating pressure often need to be corrected. The correction for ideal gases must be activated and deactivated using control bit 12.
13	For fuel air ratio monitoring, the combustion air flow can be measured via the differential pressure dP or another measurement process (e.g., turbine, ultrasound, vortex frequency, oval wheel meter, etc.). When choosing the procedure for measuring the differential pressure dP, control bit 14 must also be taken into account.
14	For fuel air ratio monitoring, the air flow measurement is carried out by a differential pressure dP measurement, as described for control bit 13 in this table. In differential pressure measurement, the differential pressure is physically in a square relationship to the flow. For this reason, the square root of the measuring signal must be extracted. The square root extraction must be activated in the transmitter if it provides a flow signal that is linear to the flow. The square root extraction must be activated in the HIMatrix CSG 04 if the transmitter provides a flow signal that is square to the flow rate, and the raw differential pressure is forwarded without square root extraction. The limit values of the square root in the HIMatrix CSG 04 are in the range 4...20 mA (0…100 %).
15	For fuel air ratio monitoring, the air flow measurement depends on the calibration values of the measurements. The calibration values are matched to the used measuring facility through parameters seq. no. 21 (temperature) and 22 (pressure). The operating conditions are very often different from the calibration values of the measurement. Operating temperature and operating pressure often need to be corrected. The correction for ideal gases must be activated and deactivated using control bit 15.

Table 37: Control Bits for Special Operations

8 Operation and Supervision

The control panel (HMI) can be used to monitor the operating functions of the HIMatrix CSG 04 and set the project-specific parameters (→ Chapter 5.2, page 27).

The HIMatrix CSG 04 is configured as Modbus TCP slave.

The fixed IP address of the HIMatrix CSG 04 is 192.168.0.117 (SRS117).

Four RJ-45 interfaces are available, which are internally connected through a 100-Mbit switch.

8.1 Monitoring Functions

For monitoring functions, different signals are stored in the import and export area of the Modbus TCP protocol (→ Applicable document: HIMatrix CSG 04 COM List HI 800 762 E).

By accessing the import and export data of the HIMatrix CSG 04 via Modbus TCP, various control panels can be used to monitor the HIMatrix CSG 04.

8.2 Control Panel

A standard control panel for the HIMatrix CSG 04 should include the following indicators and operating fields:

- Pre-purging
- Igniter
- Main burner
- Step number
- Error number
- Lock-out
- Ready for ignition
- Re-ignition time
- Parameter seq. no.
- Configuration
- Password
- Diagnostics

8.2.1 Standard Operating Graph Displayed in a Control Panel

The contents of the various indicators are described in the following sections under Pre-purging, Igniter and Main Burner.

The structure of a standard control panel could look like this:

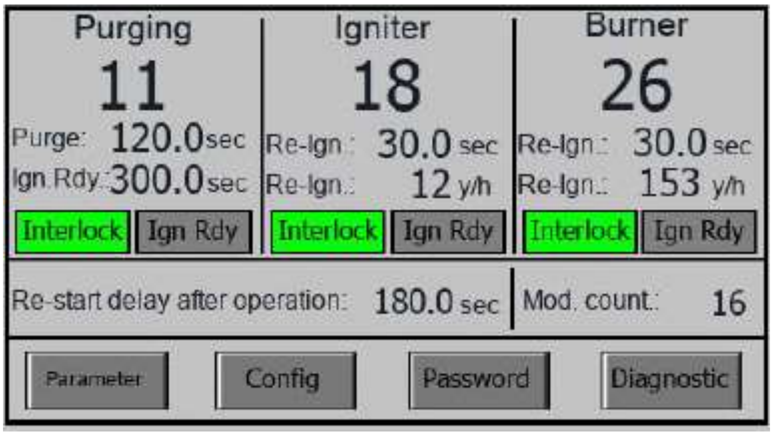


Figure 7: Example of a Standard Control Panel

8.2.1.1 Pre-Purging

Pre-purging includes the following indicators:

Indicators	Description
Purging	Current step or error number during pre-purging.
Purge	Pre-purge time (parameter seq. no. 4).
Ign.Rdy	Ready for ignition time (parameter seq. no.5)
Ign_Rdy	After successful pre-purging, this indicates that the igniter is ready for ignition.
Interlock	Indicates that a severe switch-off (lock-out) has occurred in the pre-purge area. Refer to the error numbers for details on the lock-out (→ Chapter 8.2.3.1, page 46).

Table 38: Pre-Purge Indicators

8.2.1.2 Igniter

The igniter includes the following indicators:

Indicators	Description
Igniter	Not used
Re-Ign.	Not used
Opr.-Tmr.	Not used
Ign_Rdy	Not used
Interlock	Not used

Table 39: Igniter Indicators

8.2.1.3 Main burner

The main burner includes the following indicators:

Indicators	Description
Burner	Current step or error number of the main burner.
Re-Ign.	Re-ignition time (parameter seq. no. 17).
Opr.-Tmr.	Cumulated main burner operating time, expressed in hours.
Ign_Rdy	Indicates that the main burner is ready for ignition. For a re-ignition, the indicator indicates that the main burner can be ignited again by pressing the start push-button.
Interlock	Indicates that a severe switch-off (lock-out) has occurred in the igniter area. Refer to the error number for details on the lock-out (→ Chapter 8.2.3.2, page 47).

Table 40: Main Burner Indicators

8.2.2 HIMatrix CSG 04 Indicators

The HIMatrix CSG 04 restart is delayed due to the lock-out of the main burner. The current delay value is shown in the **Re-start delay** indicator.

The operating times of the main burner are displayed with the indicators **Opr.-Tmr.** The display value changes every 2 seconds between the number of operating years and the operating hours.

The number of parameter changes is displayed by the indicator **Mod.Count**.

If an error is present, the control field **Diagnostic** changes from green to red. To call the diagnostic panel, use the operating field **Diagnostic**.

The following tables contain the operating and diagnostic indicators of the function macros.

8.2.3 Step Number/Error Number

To increase the reliability of the HIMatrix CSG 04, function blocks tested and approved by the TÜV were used for programming.

The following macros have been used:

- Pre-purge macro X_BMS_Purge
- Main burner macro X_BMS_Igniterburner

The integrated operating and error information of these function macros is available in the operating graphs.

Further information on the function macros is provided in section Function (→ Chapter 3.1, page 14).

8.2.3.1 Pre-Purging

Operation Indicators

Step number	Description
Step_No 0	Initial step
Step_No 3	No combustion air error message test
Step_No 4	No combustion air error message test
Step_No 6	Pre-purging without recirculation
Step_No 9	Preparing for ignition
Step_No 10	Ignition release
Step_No 11	Burner in operation
Step_No 12	Burner **not** in operation
Step_No 16	Monitor acknowledgments
Step_No 17	Wait for restart

Table 41: Operation Indicators for Pre-Purging

Error Indicators

Error number	Description
Step_No 256	Initial interlock "Intlck" not fulfilled or burner error "Brn_Err" present
Step_No 512	Re-start of HIMatrix CSG 04 (after voltage return)
Step_No 1024	Flame fault "Flm_On" during pre-purging phases
Step_No 8192	Purge conditions "Prge_On" fault during pre-purging, or fault in flue gas system "Flue_On"

Table 42: Pre-Purge Error Indicators

For details on the sequence-dependent error indicators, refer to the detailed chart (→ Applicable document: HIMatrix CSG 04 Sequence CSG HI 800 761 E).

8.2.3.2 Main Burner

Operation Indicators

Step number	Operating details
Step_No 0	Initial step
Step_No 1	Position test of SSV1 and SSV2
Step_No 2	Position test of pressure relief valve
Step_No 3	Flame simulation test
Step_No 4	Ignition load signal from control valves
Step_No 5	Ignition lance in ignition position
Step_No 6	1st phase of tightness test (de-pressurized)
Step_No 7	1st phase of tightness test (de-pressurized)
Step_No 8	1st phase of tightness test (de-pressurized)
Step_No 9	1st phase of tightness test (de-pressurized)
Step_No 10	2nd phase of tightness test (pressurized)
Step_No 11	2nd phase of tightness test (pressurized)
Step_No 12	2nd phase of tightness test (pressurized)
Step_No 13	2nd phase of tightness test (pressurized)
Step_No 14	2nd phase of tightness test (pressurized)
Step_No 15	2nd phase of tightness test (pressurized)
Step_No 16	2nd phase of tightness test (pressurized)
Step_No 17	1st ignition, triggering of ignition system
Step_No 18	1st ignition, triggering of SSV1 and SSV2 for 1st ignition
Step_No 19	1st ignition aborted, re-ignition delay time
Step_No 20	2nd ignition, ready for re-ignition
Step_No 21	2nd ignition, triggering of ignition system
Step_No 22	2nd ignition, triggering of SSV1 and SSV2 for 2nd ignition
Step_No 27	Flame available
Step_No 28	Gas burner in operation
Step_No 29	Gas burner with fuel air ratio monitoring in operation
Step_No 30	Gas burner with load control in operation
Step_No 31	Gas burner with load reduction in operation
Step_No 32	Gas burner not in operation
Step_No 33	3rd phase of tightness test (pressurized)
Step_No 34	3rd phase of tightness test (pressurized)
Step_No 35	3rd phase of tightness test (pressurized)
Step_No 36	3rd phase of tightness test (pressurized)
Step_No 37	Wait for restart

Table 43: Main Burner Operation Indicators

Error Indicators

Error number	Error information
Step_No 256	Initial interlock "Intlck" not fulfilled, or "Trl_f_Ign" is < 1 or > 3
Step_No 512	Re-start of HIMatrix CSG 04 (after voltage return)
Step_No 1024	Loss of flame in burner operation
Step_No 2048	Fuel air ratio disturbed
Step_No 4096	Burner sequence manually aborted

Table 44: Main Burner Error Indicators

For details on the sequence-dependent error indicators, refer to the detailed chart (→ Applicable document: HIMatrix CSG 04 Sequence CSG HI 800 761 E).

8.3 Diagnostics

The controller separately monitors the signals within the burner (→ Chapter 7.6, page 40) to localize the first switching off signals. The operating graph shows the first switch-off signal in red.

The graph for the diagnostic display could look like this:

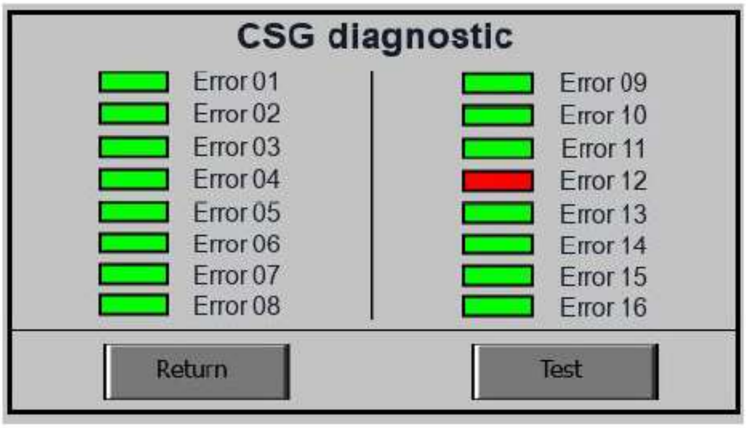


Figure 8: Example of Diagnostic Panel

The cause of the lock-out can be recognized through the color of a signal field changing from green to red. The signal behavior corresponds to a first-up value message, i.e., the first fault that occurred is displayed in red, all subsequent faults are suppressed.

The error description is as follows:

Error	Description
01	HIMatrix CSG 04 parameter error
02	HIMatrix CSG 04 system fault (CPU and/or I/O area)
03	Main interlock engaged (input 1)
04	Combustion air pressure < MIN (input 4)
05	Without function
06	Main burner flame lost (input 9)
07	Fuel air ratio fault (input 16)
08	Pressure relief valve open in operation (input 15)
09	Fuel air ratio > MAX (analog inputs 1 through 6)
10	Fuel air ratio < MIN (analog inputs 1 through 6)
11	Fuel flow fault (analog input 1)
12	Air flow fault (analog input 4)
13	PT correction, fuel flow fault (analog inputs 2 and 3)
14	PT correction, air flow fault (analog inputs 5 and 6)
15	Pressure transmitter tightness test fault (analog input 8)
16	Start conditions for main burner lost after pre-purging

Table 45: Error Description

The operating field **Test** can be used to test the first-up value indicators and the proper operation of the first-up value detection in the HIMatrix CSG 04.

8.4 Changing the Parameters

The parameters can be changed after the password has been activated. The parameters that may be changed are specified in section Process Adjustments (→ Chapter 5.1, page 26).

The following system state is required for activating the password:

- The fuel valves of the igniter are closed.
- The fuel valves of the main burner are closed.
- No lock-out is present (step number > 128). Exception: step number 512 after re-start of the HIMatrix CSG 04.

For further details, refer to section Activating the password (→ Chapter 8.4.2.1, page 52).

8.4.1 Changing the Parameters via the Control Panel

The graph for changing the parameters could look like this:

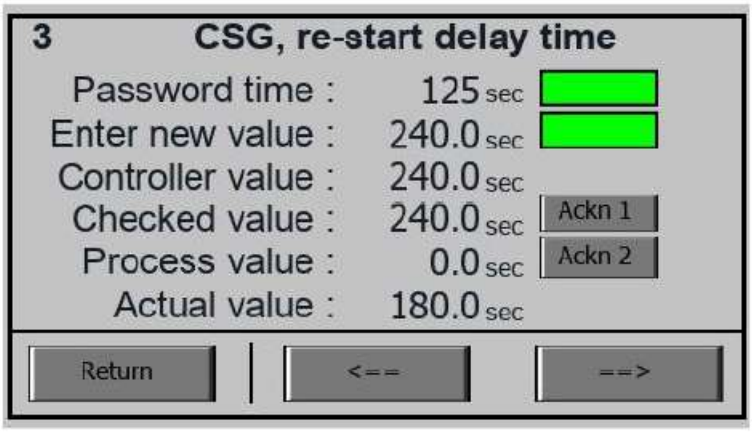


Figure 9: Example of Control Panel for Changing Parameters

The control panel for changing the parameters contains the following elements:

Indicators	Operating field	Field for entering values	Designation
X			**Password time**
X			Color indicator **Password time**
X		X	**Enter new value**
X			Color indicator **Enter new value**
X			**Controller value**
X			**Checked value**
X			**Process value**
X			**Actual value**
	X		**Ackn 1**
	X		**Ackn 2**
	X		Return
	X		Backward
	X		Forward

Table 46: HIMatrix CSG 04 Control Panel, Re-Start Delay Time

The **Password time** indicator displays how much time is left to change the parameters. The color indicator **Password time** is lit green until the password release time has expired. **Actual value** displays the value of the current parameter.

Change the parameters as follows:

1. Enter the new value in the field **Enter new value**.
   ☑ **Controller value** must immediately display the value shown in **Enter new value**.

The HIMatrix CSG 04 has read in the new value if it is immediately displayed in **Controller value.** If the entry is incorrect, the entered value is ignored and the color indicator behind the time of **Enter new value** is lit in red.

2. Press the push-button **Ackn 1**.
   ☑ The new value is displayed in **Checked value**.
3. Check the value in **Checked value**.
4. Press the push-button **Ackn 2**.
   ☑ The new value is displayed in **Process Value**.

► The HIMatrix CSG 04 then starts operating with the new value.

8.4.2 Password

This chapter describes how to:

- Activate the password.
- Change the password.
- Reset the password to the factory settings.

i Prior to starting up the HIMatrix CSG 04, users must change the default password "11111" to prevent unauthorized changes to the safety parameters.

The graph for entering the password could look like this:

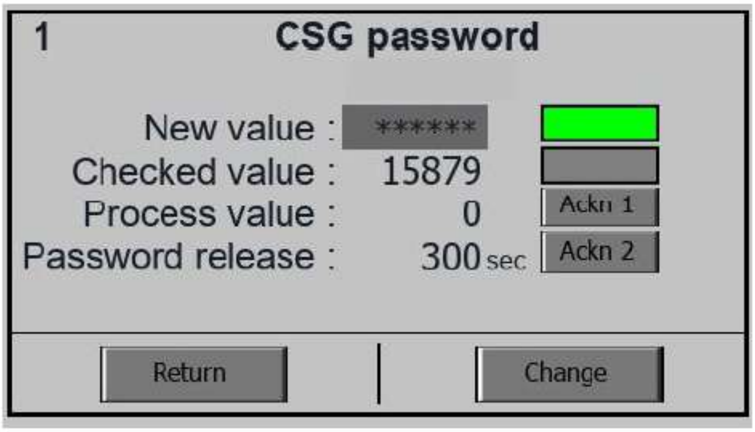


Figure 10: Example of Control Panel for Entering the Password

8.4.2.1 Activating the Password

To activate the releases time of 300 seconds to change the parameters, the current password must be entered and confirmed.

1. Enter the password in the field **New value**.
   If the entry is incorrect, the password in **New value** is ignored and the indicator for **New value** is lit in red.
2. Press the push-button **Ackn 1**.
   ☑ The password is displayed in **Checked value**.
3. Press the push-button **Ackn 2**.
   ☑ If the test was successful, the password is briefly displayed in **Process value**.
   ☑ The release time (300 s) allowing the user to change the process parameter starts. The remaining time is displayed by the indicator **Password release**.

► The release for changing the parameters is activated.

8.4.2.2 Modifying the Parameters for Changing the Password in the Control Panel

The parameters are changed in 2 phases:

1. Activation of the release for parameter changes. The time limit for changing the parameters is 300 seconds.
2. Changing the parameters within the release time via the control panel (→ Chapter 8.4.1, page 50).

---

i During the release time for changing the parameters, the sequence chains cannot be started. The burner start is blocked.

If the entry field **New value** cannot be configured as a write/read field, the entered password muss be overwritten by a wrong password, e.g., 0. The proceeding described above can only be repeated after the correct password has been entered again (this procedure must be run using a HIMA standard panel).

If the entry field **New value** can be configured as a write/read fields, e.g., when a DCS or a SCADA station is used, the communication variable CSG_COM_DO_38A could be used for overwriting the password variable CSG_COM_DI_38.

8.4.2.3 Changing the Password

To activate the release for changing the password, the following requirements must be met:

- Activate input 20 **Error reset** for 5 seconds.
- The following signals are present:
  - Deactivate input 1 **Main interlock fulfilled**.
  - Activate input 17 **Start igniter and main burner**.
  - Deactivate input 18 **Do not stop igniter**.
  - Deactivate input 19 **Do not stop main burner**.
  - Activate the password (→ Chapter 8.4.2.1, page 52)

---

i The password must be between 10000 and 65535.

---

1. Click the **Change** button in the graph for entering the password.
   ☑ The dialog box for changing the password appears.
2. Perform the parameter change (→ Chapter 8.4.1, page 50).

► From now on, the HIMatrix CSG 04 uses the new password.

8.4.2.4 Resetting the Password to the Factory Settings

To activate the release for resetting the password of HIMatrix CSG 04, the following requirements must be met:

- Activate input 20 **Error reset** for 5 seconds.
- The following signals are present:
  - Deactivate input 1 **Main interlock fulfilled**.
  - Activate input 17 **Start igniter and main burner**.
  - Deactivate input 18 **Do not stop igniter**.
  - Deactivate input 19 **Do not stop main burner**.
  - Activate the password (→ Chapter 8.4.2.1, page 52).

To reset the password

1. Activate input 2 **Start enable fulfilled** 3 times.
   ☑ The default password, "11111", is set.

The previous process values are overwritten and lost.

The password reset ist only performed via the signals on the HIMatrix CSG 04 hardware.

9 Communications Information

A Modbus TCP master can send binary control commands to the HIMatrix CSG 04 via one of four RJ-45 interfaces and receive feedbacks from the HIMatrix CSG 04.

The tables in this chapter specify the Modbus TCP offset addresses for the IP address 192.168.0.117 with their specific bit assignments.

For further digital details, refer to the annexed communication list (→ Applicable document: HIMatrix CSG 04 COM list HI 800 762 E).

To achieve the greatest possible flexibility when using different control panels, all communication variables (addresses) are defined in "unsigned WORD" data format. This applies to reading and writing communication variables.

To obtain a resolution of one or two decimal places for process and process time values (1/10 second, 1/10 process value, 1/100 process value), the range of values for the communication variables is limited. In the HIMatrix CSG 04, the read value is internally divided by 10 for one decimal place and by 100 for two decimal places. The value is further processed with the data format REAL (FLOAT).

9.1 Controller Commands from Control Panel (HIMatrix CSG 04 Reading)

9.1.1 Modbus TCP Register Address 0

Offset address	Function	Logic signal
Register.Bit 1.0	Acknowledgment 1, password entry	1/0
Register.Bit 0.1	Acknowledgment 2, password entry	1/0
Register.Bit 0.2	Acknowledgment 1, HIMatrix CSG 04 configuration	1/0
Register.Bit 0.3	Acknowledgment 2, HIMatrix CSG 04 configuration	1/0
Register.Bit 0.4	Acknowledgment 1, restart delay time	1/0
Register.Bit 0.5	Acknowledgment 2, restart delay time	1/0
Register.Bit 0.6	Acknowledgment 1, pre-purge time	1/0
Register.Bit 0.7	Acknowledgment 2, pre-purge time	1/0
Register.Bit 0.8	Acknowledgment 1, ready for ignition time	1/0
Register.Bit 0.9	Acknowledgment 2, ready for ignition time	1/0
Register.Bit 0.10	Acknowledgment 1, ignition system pre-ignition time	1/0
Register.Bit 0.11	Acknowledgment 2, ignition system pre-ignition time	1/0
Register.Bit 0.12	Without function	1/0
Register.Bit 0.13	Without function	1/0
Register.Bit 0.14	Without function	1/0
Register.Bit 0.15	Without function	1/0

Table 47: Modbus TCP Register Address 0

- The behavior described in the Function column corresponds to signal 1 (high level).

- The register is organized as WORD with 16 bits.

9.1.2 Modbus TCP Register Address 1

Offset address	Function	Logic signal
Register.Bit 1.0	Without function	1/0
Register.Bit 1.1	Without function	1/0
Register.Bit 1.2	Without function	1/0
Register.Bit 1.3	Without function	1/0
Register.Bit 1.4	Without function	1/0
Register.Bit 1.5	Without function	1/0
Register.Bit 1.6	Acknowledgment 1, main burner tightness test time	1/0
Register.Bit 1.7	Acknowledgment 2, main burner tightness test time	1/0
Register.Bit 1.8	Acknowledgment 1, main burner de-pressurizing time	1/0
Register.Bit 1.9	Acknowledgment 2, main burner de-pressurizing time	1/0
Register.Bit 1.10	Acknowledgment 1, main burner trials for ignition	1/0
Register.Bit 1.11	Acknowledgment 2, main burner trials for ignition	1/0
Register.Bit 1.12	Acknowledgment 1, main burner safety time	1/0
Register.Bit 1.13	Acknowledgment 2, main burner safety time	1/0
Register.Bit 1.14	Acknowledgment 1, main burner, re-ignition delay time	1/0
Register.Bit 1.15	Acknowledgment 2, main burner, re-ignition delay time	1/0

Table 48: Modbus TCP Register Address 1

- The behavior described in the Function column corresponds to signal 1 (high level).
- The register is organized as WORD with 16 bits.

9.1.3 Modbus TCP Register Address 2

Offset address	Function	Logic signal
Register.Bit 2.0	Acknowledgment 1, main burner, re-ignition time	1/0
Register.Bit 2.1	Acknowledgment 2, main burner, re-ignition time	1/0
Register.Bit 2.2	Acknowledgment 1, fuel air ratio delay time	1/0
Register.Bit 2.3	Acknowledgment 2, fuel air ratio delay time	1/0
Register.Bit 2.4	Acknowledgment 1, password change	1/0
Register.Bit 2.5	Acknowledgment 2, password change	1/0
Register.Bit 2.6	Acknowledgment 1, fuel calibration temperature	1/0
Register.Bit 2.7	Acknowledgment 2, fuel calibration temperature	1/0
Register.Bit 2.8	Acknowledgment 1, fuel calibration pressure	1/0
Register.Bit 2.9	Acknowledgment 2, fuel calibration pressure	1/0
Register.Bit 2.10	Acknowledgment 1, combustion air calibration temperature	1/0
Register.Bit 2.11	Acknowledgment 2, combustion air calibration temperature	1/0
Register.Bit 2.12	Acknowledgment 1, combustion air calibration pressure	1/0
Register.Bit 2.13	Acknowledgment 2, combustion air calibration pressure	1/0
Register.Bit 2.14	Acknowledgment 1, maximum fuel air ratio	1/0
Register.Bit 2.15	Acknowledgment 2, maximum fuel air ratio	1/0

Table 49: Modbus TCP Register Address 2

- The behavior described in the Function column corresponds to signal 1 (high level).
- The register is organized as WORD with 16 bits.

9.1.4 Modbus TCP Register Address 3

Offset address	Function	Logic signal
Register.Bit 3.0	Acknowledgment 1, minimum fuel air ratio	1/0
Register.Bit 3.1	Acknowledgment 2, minimum fuel air ratio	1/0
Register.Bit 3.2	Acknowledgment 1, main burner tightness maximum	1/0
Register.Bit 3.3	Acknowledgment 2, main burner tightness maximum	1/0
Register.Bit 3.4	Acknowledgment 1, main burner tightness minimum	1/0
Register.Bit 3.5	Acknowledgment 2, main burner tightness minimum	1/0
Register.Bit 3.6	Acknowledgment 1, main burner tightness tolerance	1/0
Register.Bit 3.7	Acknowledgment 2, main burner tightness tolerance	1/0
Register.Bit 3.8	Acknowledgment 1, ignition lance runtime monitoring	1/0
Register.Bit 3.9	Acknowledgment 2, ignition lance runtime monitoring	1/0
Register.Bit 3.10	Without function	1/0
Register.Bit 3.11	Without function	1/0
Register.Bit 3.12	Without function	1/0
Register.Bit 3.13	Without function	1/0
Register.Bit 3.14	Without function	1/0
Register.Bit 3.15	Without function	1/0

Table 50: Modbus TCP Register Address 3

- The behavior described in the Function column corresponds to signal 1 (high level).
- The register is organized as WORD with 16 bits.

9.1.5 Modbus TCP Register Address 4

Offset address	Function	Logic signal
Register.Bit 4.0	Without function	1/0
Register.Bit 4.1	Without function	1/0
Register.Bit 4.2	Without function	1/0
Register.Bit 4.3	Without function	1/0
Register.Bit 4.4	Without function	1/0
Register.Bit 4.5	Without function	1/0
Register.Bit 4.6	Without function	1/0
Register.Bit 4.7	Without function	1/0
Register.Bit 4.8	Without function	1/0
Register.Bit 4.9	Without function	1/0
Register.Bit 4.10	Without function	1/0
Register.Bit 4.11	Without function	1/0
Register.Bit 4.12	Without function	1/0
Register.Bit 4.13	Without function	1/0
Register.Bit 4.14	Adoption of the parameter substitute values	1/0
Register.Bit 4.15	Functional test of first-up alarming	1/0

Table 51: Modbus TCP Register Address 4

- The behavior described in the Function column corresponds to signal 1 (high level).
- The register is organized as WORD with 16 bits.

9.2 Control Command from Higher Automation Level

9.2.1 Modbus TCP Register Address 40

Offset address	Function	Logic signal
Register.Bit 40.0	Start main burner	1/0
Register.Bit 40.1	Without function	1/0
Register.Bit 40.2	Stop burner	1/0
Register.Bit 40.3	Error reset	1/0
Register.Bit 40.4	Without function	1/0
Register.Bit 40.5	Without function	1/0
Register.Bit 40.6	Without function	1/0
Register.Bit 40.7	Without function	1/0
Register.Bit 40.8	Without function	1/0
Register.Bit 40.9	Without function	1/0
Register.Bit 40.10	Without function	1/0
Register.Bit 40.11	Without function	1/0
Register.Bit 40.12	Without function	1/0
Register.Bit 40.13	Without function	1/0
Register.Bit 40.14	Without function	1/0
Register.Bit 40.15	Without function	1/0

Table 52: Modbus TCP Register Address 40

- The behavior described in the Function column corresponds to signal 1 (high level).

- The register is organized as WORD with 16 bits.

- Additional and separate release required for these signals in the HIMatrix CSG 04 configuration.

9.3 Feedback to the Control Panel (HIMatrix CSG 04 Writing)

9.3.1 Modbus TCP Register Address 0

Offset address	Function	Logic signal
Register.Bit 1.0	Parameter setting error, password entry	1/0
Register.Bit 0.1	Parameter setting error, HIMatrix CSG 04 configuration	1/0
Register.Bit 0.2	Parameter setting error, restart delay time	1/0
Register.Bit 0.3	Parameter setting error, pre-purge time	1/0
Register.Bit 0.4	Parameter setting error, ready for ignition time	1/0
Register.Bit 0.5	Parameter setting error, ignition system pre-ignition time	1/0
Register.Bit 0.6	Without function	1/0
Register.Bit 0.7	Without function	1/0
Register.Bit 0.8	Without function	1/0
Register.Bit 0.9	Without function	1/0
Register.Bit 0.10	Without function	1/0
Register.Bit 0.11	Parameter setting error, main burner tightness test time	1/0
Register.Bit 0.12	Parameter setting error, main burner de-pressurizing time	1/0
Register.Bit 0.13	Parameter setting error, main burner trials for ignition	1/0
Register.Bit 0.14	Parameter setting error, main burner safety time	1/0
Register.Bit 0.15	Parameter setting error, main burner re-ignition delay time	1/0

Table 53: Modbus TCP Register Address 0

- The behavior described in the Function column corresponds to signal 1 (high level).
- The register is organized as WORD with 16 bits.

9.3.2 Modbus TCP Register Address 1

Offset address	Function	Logic signal
Register.Bit 1.0	Parameter setting error, main burner re-ignition time	1/0
Register.Bit 1.1	Parameter setting error, main burner fuel air ratio	1/0
Register.Bit 1.2	Parameter setting error, password	1/0
Register.Bit 1.3	Parameter setting error, fuel calibration temperature	1/0
Register.Bit 1.4	Parameter setting error, fuel calibration pressure	1/0
Register.Bit 1.5	Parameter setting error, combustion air calibration temperature	1/0
Register.Bit 1.6	Parameter setting error, combustion air calibration pressure	1/0
Register.Bit 1.7	Parameter setting error, maximum fuel air ratio	1/0
Register.Bit 1.8	Parameter setting error, minimum fuel air ratio	1/0
Register.Bit 1.9	Parameter setting error, main burner tightness maximum	1/0
Register.Bit 1.10	Parameter setting error, main burner tightness minimum	1/0
Register.Bit 1.11	Parameter setting error, main burner tightness tolerance	1/0
Register.Bit 1.12	Parameter setting error, ignition lance runtime monitoring	1/0
Register.Bit 1.13	Without function	1/0
Register.Bit 1.14	Without function	1/0
Register.Bit 1.15	Without function	1/0

Table 54: Modbus TCP Register Address 1

- The behavior described in the Function column corresponds to signal 1 (high level).
- The register is organized as WORD with 16 bits.

9.3.3 Modbus TCP Register Address 2

Offset address	Function	Logic signal
Register.Bit 2.0	Release for parameter changes	1/0
Register.Bit 2.1	Main interlock is available	1/0
Register.Bit 2.2	Burner interlock available	1/0
Register.Bit 2.3	Pre-purge sequence running	1/0
Register.Bit 2.4	Pre-purge sequence fault	1/0
Register.Bit 2.5	Pre-purge conditions available	1/0
Register.Bit 2.6	Ready for ignition after pre-purging	1/0
Register.Bit 2.7	Without function	1/0
Register.Bit 2.8	Without function	1/0
Register.Bit 2.9	Without function	1/0
Register.Bit 2.10	Without function	1/0
Register.Bit 2.11	Without function	1/0
Register.Bit 2.12	Main burner sequence running	1/0
Register.Bit 2.13	Main burner sequence fault	1/0
Register.Bit 2.14	Main burner ready to ignite	1/0
Register.Bit 2.15	Main burner in operation	1/0

Table 55: Modbus TCP Register Address 2

- The behavior described in the Function column corresponds to signal 1 (high level).
- The register is organized as WORD with 16 bits.

9.3.4 Modbus TCP Register Address 3

Offset address	Function	Logic signal
Register.Bit 3.0	Release for load and combined control	1/0
Register.Bit 3.1	Burner not in operation	1/0
Register.Bit 3.2	Release for password change	1/0
Register.Bit 3.3	Release for password entry	1/0
Register.Bit 3.4	Common alarm	1/0
Register.Bit 3.5	Without function	1/0
Register.Bit 3.6	Without function	1/0
Register.Bit 3.7	Without function	1/0
Register.Bit 3.8	Without function	1/0
Register.Bit 3.9	Without function	1/0
Register.Bit 3.10	Without function	1/0
Register.Bit 3.11	Without function	1/0
Register.Bit 3.12	Without function	1/0
Register.Bit 3.13	Without function	1/0
Register.Bit 3.14	Without function	1/0
Register.Bit 3.15	Without function	1/0

Table 56: Modbus TCP Register Address 3

- The behavior described in the Function column corresponds to signal 1 (high level).
- The register is organized as WORD with 16 bits.

9.3.5 Modbus TCP Register Address 4

Offset address	Function	Logic signal
Register.Bit 4.0	First-up alarm, parameter setting error	1/0
Register.Bit 4.1	First-up alarm, HIMatrix CSG 04 system fault	1/0
Register.Bit 4.2	First-up alarm, main interlock engaged	1/0
Register.Bit 4.3	First-up alarm, air pressure < MIN	1/0
Register.Bit 4.4	Without function	1/0
Register.Bit 4.5	First-up alarm, main burner flame disturbed	1/0
Register.Bit 4.6	First-up alarm, fuel air ratio disturbed	1/0
Register.Bit 4.7	First-up alarm, pressure relief valve disturbed	1/0
Register.Bit 4.8	First-up alarm, fuel air ratio disturbed > MAX	1/0
Register.Bit 4.9	First-up alarm, fuel air ratio disturbed < MIN	1/0
Register.Bit 4.10	First-up alarm, fuel flow transmitter error	1/0
Register.Bit 4.11	First-up alarm, air flow transmitter error	1/0
Register.Bit 4.12	First-up alarm, fuel PT correction error	1/0
Register.Bit 4.13	First-up alarm, air PT correction error	1/0
Register.Bit 4.14	First-up alarm, pressure transmitter tightness error	1/0
Register.Bit 4.15	First-up alarm, no start pre-conditions after pre-purging	1/0

Table 57: Modbus TCP Register Address 4

- The behavior described in the Function column corresponds to signal 1 (high level).
- The register is organized as WORD with 16 bits.

9.4 Feedbacks to the Higher Automation Level (HIMatrix CSG 04 Writing)

9.4.1 Modbus TCP Register Address 147

Offset address	Function	Logic signal
Register.Bit 147.0	DI 1, main interlock fulfilled	1/0
Register.Bit 147.1	DI 2, start enable fulfilled	1/0
Register.Bit 147.2	DI 3, pre-purging/no pre-purging	1/0
Register.Bit 147.3	DI 4, combustion air pressure > MIN	1/0
Register.Bit 147.4	DI 5, pre-purge conditions fulfilled	1/0
Register.Bit 147.5	DI 6, igniter flame available	1/0
Register.Bit 147.6	DI 7, igniter SSV1 closed	1/0
Register.Bit 147.7	DI 8, igniter SSV2 closed	1/0
Register.Bit 147.8	DI 9, main burner flame available	1/0
Register.Bit 147.9	DI 10, tightness pressure > MAX	1/0
Register.Bit 147.10	DI 11, tightness pressure < MIN	1/0
Register.Bit 147.11	DI 12, main burner ignition power position	1/0
Register.Bit 147.12	DI 13, main burner SSV1 closed	1/0
Register.Bit 147.13	DI 14, main burner SSV2 closed	1/0
Register.Bit 147.14	DI 15, main burner pressure relief valve closed	1/0
Register.Bit 147.15	DI 16, main burner fuel air ratio	1/0

Table 58: Modbus TCP Register Address 147

- The behavior described in the Function column corresponds to signal 1 (high level).
- The register is organized as WORD with 16 bits.

9.4.2 Modbus TCP Register Address 148

Offset address	Function	Logic signal
Register.Bit 148.0	DI 17, push-button Start igniter and main burner	1/0
Register.Bit 148.1	DI 18, push-button Do not stop igniter	1/0
Register.Bit 148.2	DI 19, push-button Do not stop main burner	1/0
Register.Bit 148.3	DI 20, error reset	1/0
Register.Bit 148.4	Without function	1/0
Register.Bit 148.5	Without function	1/0
Register.Bit 148.6	Without function	1/0
Register.Bit 148.7	Without function	1/0
Register.Bit 148.8	Without function	1/0
Register.Bit 148.9	Without function	1/0
Register.Bit 148.10	Without function	1/0
Register.Bit 148.11	Without function	1/0
Register.Bit 148.12	Without function	1/0
Register.Bit 148.13	Without function	1/0
Register.Bit 148.14	Without function	1/0
Register.Bit 148.15	Without function	1/0

Table 59: Modbus TCP Register Address 148

- The behavior described in the Function column corresponds to signal 1 (high level).
- The register is organized as WORD with 16 bits.

9.4.3 Modbus TCP Register Address 149

Offset address	Function	Logic signal
Register.Bit 149.0	DO 1, HIMatrix CSG 04 is ready to operate	1/0
Register.Bit 149.1	DO 2, start pre-purging	1/0
Register.Bit 149.2	DO 3, check of combustion air pressure	1/0
Register.Bit 149.3	DO 4, igniter ignition system/transformer	1/0
Register.Bit 149.4	DO 5, igniter SSV1 and SSV2	1/0
Register.Bit 149.5	DO 6, main burner SSV1	1/0
Register.Bit 149.6	DO 7, main burner SSV2	1/0
Register.Bit 149.7	DO 8, main burner pressure relief valve	1/0
Register.Bit 149.8	Without function	1/0
Register.Bit 149.9	Without function	1/0
Register.Bit 149.10	Without function	1/0
Register.Bit 149.11	Without function	1/0
Register.Bit 149.12	Without function	1/0
Register.Bit 149.13	Without function	1/0
Register.Bit 149.14	Without function	1/0
Register.Bit 149.15	Without function	1/0

Table 60: Modbus TCP Register Address 149

- The behavior described in the Function column corresponds to signal 1 (high level).
- The register is organized as WORD with 16 bits.

9.4.4 Modbus TCP Register Address 150

Offset address	Function	Logic signals
Register.Bit 150.0	Parameter setting error, password entry	1/0
Register.Bit 150.1	Parameter setting error, HIMatrix CSG 04 configuration	1/0
Register.Bit 150.2	Parameter setting error, restart delay time	1/0
Register.Bit 150.3	Parameter setting error, pre-purge time	1/0
Register.Bit 150.4	Parameter setting error, ready for ignition time	1/0
Register.Bit 150.5	Parameter setting error, ignition system pre-ignition time	1/0
Register.Bit 150.6	Without function	1/0
Register.Bit 150.7	Without function	1/0
Register.Bit 150.8	Without function	1/0
Register.Bit 150.9	Without function	1/0
Register.Bit 150.10	Without function	1/0
Register.Bit 150.11	Parameter setting error, main burner tightness test time	1/0
Register.Bit 150.12	Parameter setting error, main burner de-pressurizing time	1/0
Register.Bit 150.13	Parameter setting error, main burner trials for ignition	1/0
Register.Bit 150.14	Parameter setting error, main burner safety time	1/0
Register.Bit 150.15	Parameter setting error, main burner re-ignition delay time	1/0

Table 61: Modbus TCP Register Address 150

- The behavior described in the Function column corresponds to signal 1 (high level).
- The register is organized as WORD with 16 bits.

9.4.5 Modbus TCP Register Address 151

Offset address	Function	Logic signal
Register.Bit 151.0	Parameter setting error, main burner re-ignition time	1/0
Register.Bit 151.1	Parameter setting error, main burner fuel air ratio	1/0
Register.Bit 151.2	Parameter setting error, password	1/0
Register.Bit 151.3	Parameter setting error, fuel calibration temperature	1/0
Register.Bit 151.4	Parameter setting error, fuel calibration pressure	1/0
Register.Bit 151.5	Parameter setting error, combustion air calibration temperature	1/0
Register.Bit 151.6	Parameter setting error, combustion air calibration pressure	1/0
Register.Bit 151.7	Parameter setting error, maximum fuel air ratio	1/0
Register.Bit 151.8	Parameter setting error, minimum fuel air ratio	1/0
Register.Bit 151.9	Parameter setting error, main burner tightness maximum	1/0
Register.Bit 151.10	Parameter setting error, main burner tightness minimum	1/0
Register.Bit 151.11	Parameter setting error, main burner tightness tolerance	1/0
Register.Bit 151.12	Parameter setting error, ignition lance runtime monitoring	1/0
Register.Bit 151.13	Without function	1/0
Register.Bit 151.14	Without function	1/0
Register.Bit 151.15	Without function	1/0

Table 62: Modbus TCP Register Address 151

- The behavior described in the Function column corresponds to signal 1 (high level).
- The register is organized as WORD with 16 bits.

9.4.6 Modbus TCP Register Address 152

Offset address	Function	Logic signal
Register.Bit 152.0	Release for parameter changes	1/0
Register.Bit 152.1	Main interlock is available	1/0
Register.Bit 152.2	Burner interlock available	1/0
Register.Bit 152.3	Pre-purge sequence running	1/0
Register.Bit 152.4	Pre-purge sequence fault	1/0
Register.Bit 152.5	Pre-purge conditions available	1/0
Register.Bit 152.6	Ready for ignition after pre-purging	1/0
Register.Bit 152.7	Without function	1/0
Register.Bit 152.8	Without function	1/0
Register.Bit 152.9	Without function	1/0
Register.Bit 152.10	Without function	1/0
Register.Bit 152.11	Without function	1/0
Register.Bit 152.12	Main burner sequence running	1/0
Register.Bit 152.13	Main burner sequence fault	1/0
Register.Bit 152.14	Main burner ready to ignite	1/0
Register.Bit 152.15	Main burner in operation	1/0

Table 63: Modbus TCP Register Address 152

- The behavior described in the Function column corresponds to signal 1 (high level).
- The register is organized as WORD with 16 bits.

9.4.7 Modbus TCP Register Address 153

Offset address	Function	Logic signal
Register.Bit 153.0	Release for load and combined control	1/0
Register.Bit 153.1	Burner not in operation	1/0
Register.Bit 153.2	Release for password change	1/0
Register.Bit 153.3	Release for password entry	1/0
Register.Bit 153.4	Common alarm	1/0
Register.Bit 153.5	Without function	1/0
Register.Bit 153.6	Without function	1/0
Register.Bit 153.7	Without function	1/0
Register.Bit 153.8	Without function	1/0
Register.Bit 153.9	Without function	1/0
Register.Bit 153.10	Without function	1/0
Register.Bit 153.11	Without function	1/0
Register.Bit 153.12	Without function	1/0
Register.Bit 153.13	Without function	1/0
Register.Bit 153.14	Without function	1/0
Register.Bit 153.15	Without function	1/0

Table 64: Modbus TCP Register Address 153

- The behavior described in the Function column corresponds to signal 1 (high level).

- The register is organized as WORD with 16 bits.

10 Mounting and Electrical Installation

The safety-related HIMatrix CSG 04 systems can be installed on mounting surfaces, as well as in closed enclosures such as control stations, terminal boxes and control cabinets. They have been developed in compliance with the relevant standards for EMC, climate and environmental requirements.

The specified current standards (→ Chapter 2.6.2, page 11) must be observed.

The protection class of the HIMatrix CSG 04 systems (IP20) can be increased by installing them in an appropriate enclosure in accordance with the requirements. In doing so, appropriate heat dissipation must be ensured (→ Chapter 10.2, page 69).

i Only personnel with knowledge of ESD protective measures may modify or extend the system wiring.

10.1 Mounting and Removing HIMatrix CSG 04 Systems

i To ensure efficient cooling, the device must be mounted on a horizontal DIN rail.

A free space of at least 100 mm above and below the device must be maintained.

The device must not be mounted above heating equipment or any heat source.

The location for installing a HIMatrix CSG 04 system must be chosen observing the operating requirements to ensure smooth operation.

The HIMatrix systems are mounted on a 35 mm DIN rail and not directly on a base.

Horizontal (with reference to the label on the front plate) is the mandatory mounting position to ensure sufficient ventilation. Vertical mounting requires additional measures to ensure sufficient ventilation.

The dimensions of the various devices are specified in the product data
(→ Chapter 3.4.1, page 21).

The minimum clearances of the devices among one another, to external devices and to the control cabinet enclosure are:

- Vertical clearance: 100 mm
- Horizontal clearance: 20 mm

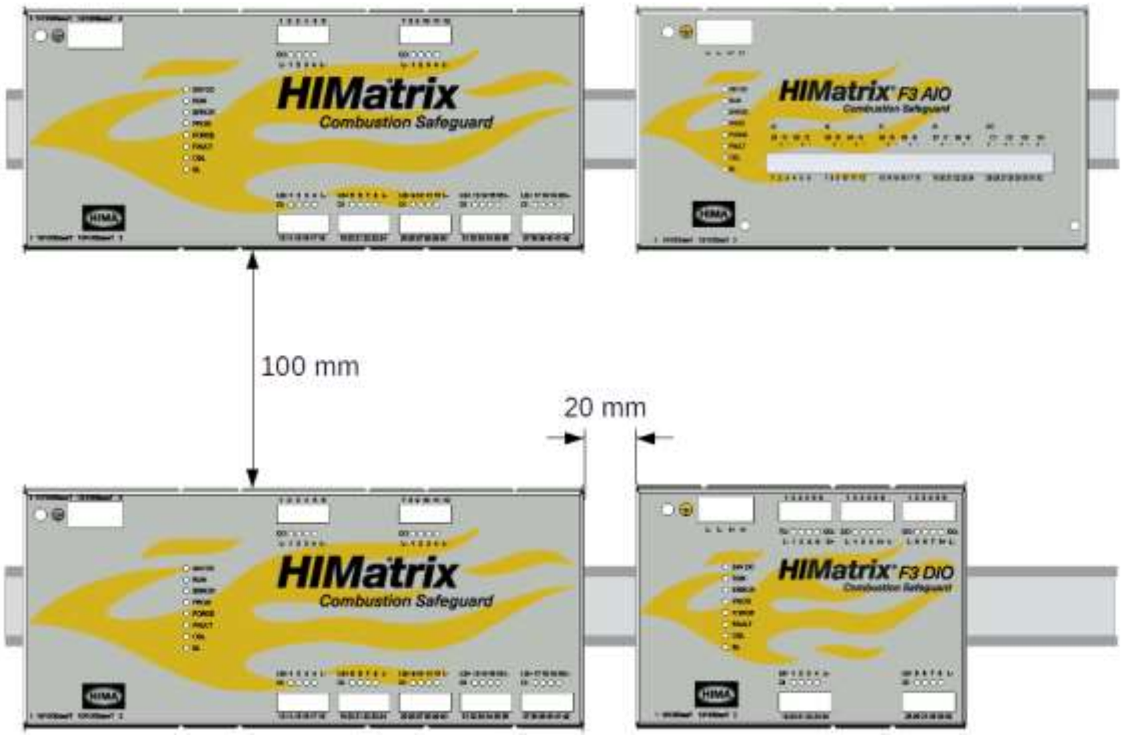


Figure 11: Example of Minimum Clearances for HIMatrix CSG

The mounting space (construction depth) must also be taken into account for attaching the connectors for inputs and outputs, and for communication.

10.1.1 Mounting the Device on the DIN Rail

1. Shift the latch on the rear side of the device downwards, press it against the housing frame and snap it into position.
2. Attach the guiding rail located on the rear side of the device to the upper edge of the DIN rail.
3. Press the device against the rail and release the latch again to secure the device to the rail.

► The device is attached to the DIN rail.

10.1.2 Remove the Device from the DIN Rail

1. Insert a flathead screwdriver into the gap between the housing and the latch, using it as a lever to move the latch downward and simultaneously lift the device from the rail.

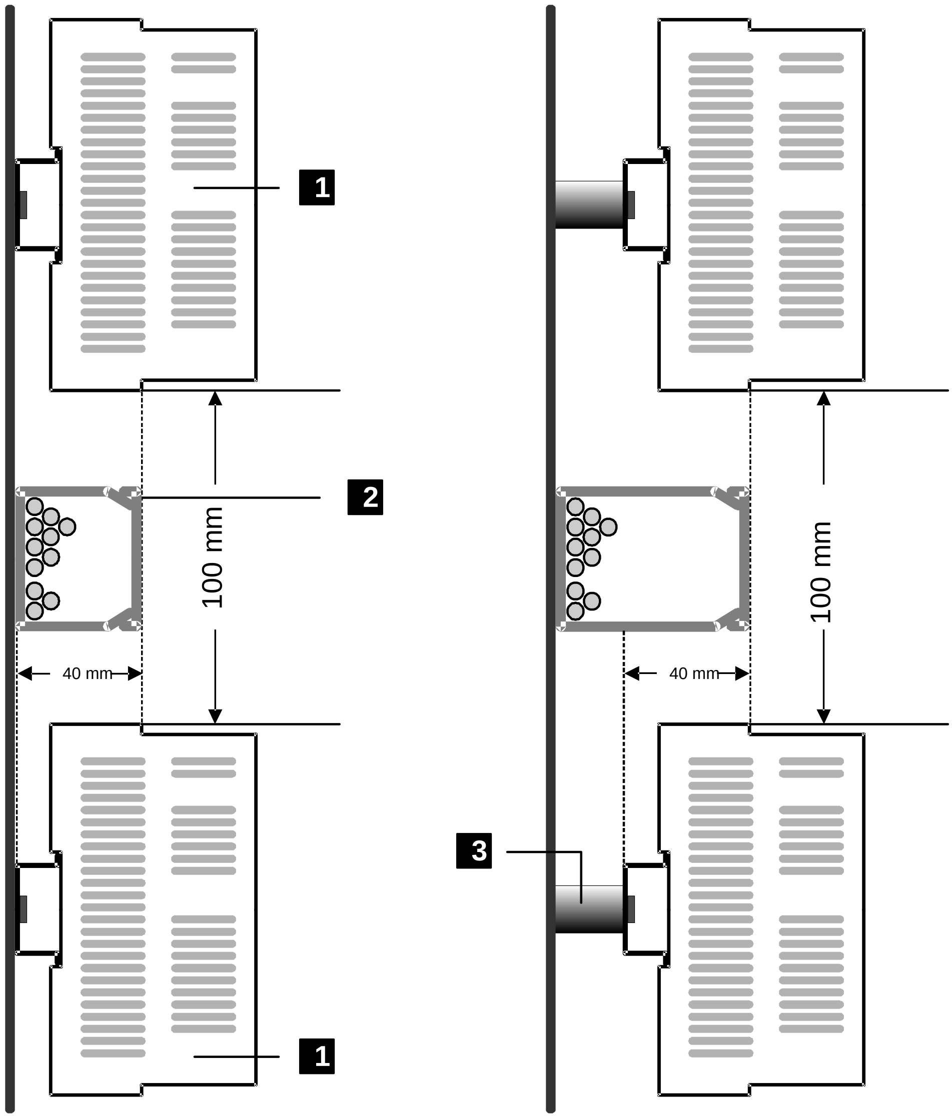
► The device is removed from the DIN rail.

10.1.3 Routing Cables

Keep the cable connections from the cable channel to the HIMatrix CSG 04 systems as short as possible. Avoid routing cables across the front plates of the system.

10.1.4 Air Circulation

The ventilation slots in the housing must not be obstructed. For this reason, when mounting cable ducts at the same level, the cable ducts are limited to a height of 40 mm. If the cable ducts are higher, the mounting rails must be placed on spacers:

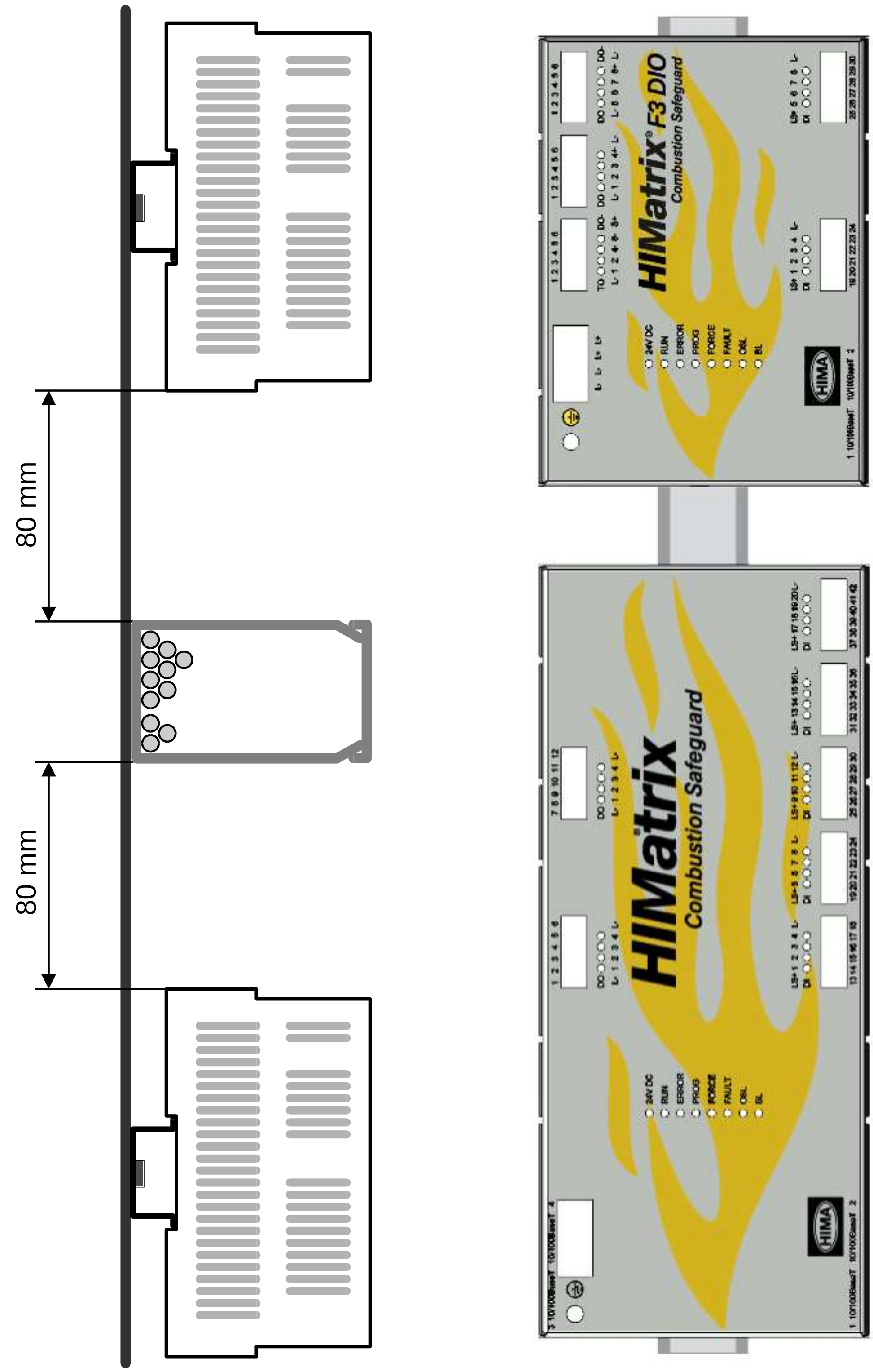


1 Compact System
2 Cable Duct
3 Spacer

Figure 12: Mounting of HIMatrix CSG 04 Systems with Cable Channels and Spacers

If more than two HIMatrix CSG 04 systems are mounted one on top of the other (even if the minimum vertical clearance of 100 mm is maintained), additional ventilation measures must be implemented to ensure uniform temperature distribution.

The picture below (on the left side) shows the minimum clearances if no spacers are used for the mounting rails:



Mounting clearances without spacers

Vertical Mounting of HIMatrix CSG 04 Systems

Figure 13: Mounting without Spacers and Vertical Mounting

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i HIMatrix CSG 04 systems may only be mounted vertically if sufficient ventilation is ensured. With open mounting surfaces, it is not difficult to remain within the maximum operating temperature limits provided that the minimum clearances are maintained and air circulation is not obstructed.

10.1.5 Connecting the Input and Output Circuits

The input and output circuits must be connect using pluggable terminals located on the front plate of the device.

NOTICE

Short-circuits caused by plugging output circuit terminals under load are possible.

Failure to comply with these instructions can damage the terminals.

- **Plug the terminals for output circuits without a load.**

To attach the shielding to the shield contact plate with a clamp, lead the shielded cables from underneath the HIMatrix F3 AIO CSG. To this end, place the clamp over the surface of the stripped cable shielding and press it from both sides into the oblong holes of the shield contact plate until it snaps into position.

10.1.6 Grounding and Shielding

10.1.6.1 Grounding the 24 VDC System Voltage

All HIMatrix CSG 04 systems must be operated with power supply units that comply with SELV (safety extra low voltage) or PELV (protective extra low voltage) requirements. Functional ground is prescribed to improve the electromagnetic compatibility (EMC).

All HIMatrix CSG 04 systems can be operated with grounded reference potential L- or ungrounded.

Ungrounded Operation

The advantage of ungrounded operation is a better EMC behavior.

Some applications have specific requirements for the ungrounded operation of controllers, e.g., in accordance with the VDE 0116-1:2016-03 standard, ground fault monitoring is required for ungrounded operation.

Grounded Operation

Grounding must be implemented in accordance with the standard (VDE 0116-1:2016-03) and must have a separate ground connection through which no power-dependent interference currents may flow. Only grounding of negative pole (L-) is permitted. The positive pole (L+) must not be grounded since a potential ground fault on the sensor wire would bridge the affected sensor.

The negative pole can only be grounded in one place within the system. The negative pole is usually grounded directly behind the power supply unit, e.g., on the busbar. The grounding should be easily accessible and well separable. The grounding resistance must be ≤ 2 Ω.

10.1.6.2 Grounding Connectors

All HIMatrix CSG 04 systems have labeled screws for grounding. The wire cross-section for the connection to the screw is 2.5 mm^2. The ground lines must be as short as possible. The tightening torque of the grounding screw is 1.6 Nm.

Provided that the DIN rail is grounded in accordance with the standards, mounting the HIMatrix CSG 04 systems on the DIN rail already ensures a sufficient ground connection.

These measures ensure a reliable earth ground and compliance with the current EMC requirements for HIMatrix CSG 04 systems.

i The shield clamp must not be used as a strain relief for the connected cable.

10.1.6.3 EMC Protection

Windows in the enclosure, in which the HIMatrix CSG 04 system is installed, are permitted.

A number of electromagnetic interferences outside the standard limit values require appropriate measures.

i For improved EMC, ground the housing.
The connection to the next grounding point must be as short as possible to achieve a low grounding resistance.

Sensor or actuator wires for analog inputs and outputs used in HIMatrix CSG 04 systems with shrouds must be laid as shielded cables. The shielding must be connected to the HIMatrix CSG 04 system and the sensor and actuator housing and grounded only on the HIMatrix CSG 04 system side to form a Faraday cage.

To ground the cable shielding, the HIMatrix F3 AIO CSG is equipped with a front rail that is electrically connected to the housing potential. A clamp is used to connect the cable shielding to the rail.

In all other devices, the shielding must be positioned in the controller housing, terminal box, control cabinet, etc.

If surges on digital inputs cannot be excluded through the burner design, suitable measures must be implemented, e.g., shielded input lines.

10.2 Considerations about Heat

The increased integration level of electronic components causes a corresponding heat loss. This depends on the external load of devices. For this reason, the device installation and ventilation are relevant in connection with the structure.

Lowering the ambient temperature increases the lifetime and the reliability of the electronic components within the systems.

i Considerations about heat must take **every** device within a cabinet or enclosure into account!
Take the environmental conditions into account when mounting the respective devices.

10.2.1 Heat Dissipation

A closed enclosure or a closed cabinet must be designed such that the heat generated inside can be dissipated through its surface.

Choose the mounting type and position such that heat dissipation is ensured.

The power dissipation of the installed equipment is decisive for determining the fan components. Uniform distribution of the heat load and unhindered natural convection are assumed (→ Chapter 10.2.1.3, page 71).

10.2.1.1 Definitions

Size	Description	Unit
P_V	Power dissipation (heat capacity) of the electronic devices within the enclosure	W
A	Effective enclosure surface (→ Chapter 10.2.1.2, page 70)	m²
W	Enclosure width	m
H	Enclosure height	m
D	Enclosure depth	m
k	Coefficient of heat transfer of the enclosure	W/m² K
	Example: steel plate	Approx. 5.5 W/m² K

Table 65: Definitions for Calculating the Power Dissipation

10.2.1.2 Installation Type

The effective enclosure surface area A as a function of the mounting or installation type is determined as follows:

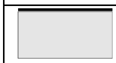
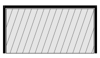
Enclosure installation type in accordance with VDE 0660, Part 5		Calculation of A [m²]
	Individual enclosure, free-standing on all sides	A = 1.8 x H x (W + D) + 1.4 x W x D
	Individual enclosure for wall mounting	A = 1.4 x W x (H + D) + 1.8 x H x D
	First or last enclosure in a suite, free-standing	A = 1.4 x D x (W + H) + 1.8 x W x H
	First or final enclosure, for wall mounting	A = 1.4 x H x (W + D) + 1.4 x W x D
	Central enclosure, free-standing	A = 1.8 x W x H + 1.4 x W x D + H x D
	Central enclosure, for wall mounting	A = 1.4 x W x (H + D) + H x D
	Central enclosure, for wall mounting, with covered roof surface	A = 1.4 x W x H + 0.7 x W x D + H x D

Table 66: Calculation of the Enclosure Installation

10.2.1.3 Natural Convection

When natural convection is applied, the lost heat is dissipated through the enclosure walls. Requirement: The ambient temperature must be lower than the temperature within the enclosure.

The maximum temperature increase $(\Delta T)_{max}$ of all electronic devices within the enclosure is calculated as follows:

$$(\Delta T)_{max} = \frac{P_V}{k * A}$$

The power dissipation P_V can be calculated based on the specifications for the electric power rating of the system and its inputs and outputs.

The temperature within an enclosure can also be calculated in accordance with VDE 0660, Part 507 (HD 528 S2).

11 Maintenance

No maintenance measures are required during normal operation.

If the HIMatrix CSG 04 is faulty, replace it with an identical type and configure it in accordance with the requirements.

Interventions in the HIMatrix CSG 04 or repairs may only be carried out by the manufacturer.

11.1 Faults

Fault response of digital inputs:

If the device detects a fault on a digital input, the user program processes a low level in accordance with the de-energize to trip principle.
The device activates the FAULT LED.

Fault response of digital outputs:

If the device detects a faulty signal on a digital output, the affected output is set to the safe (de-energized) state using the safety switches.
If a device fault occurs, all digital outputs are switched off.
In both cases, the device activates the FAULT LED.

If the test harness detects safety-critical faults, the module enters the STOP_INVALID state and will remain in this state. The input signals are no longer processed by the device and the outputs switch to the de-energized, safe state.

11.2 Maintenance Measures

The HIMatrix CSG 04 must be subject to a proof test.

11.2.1 Proof Test (in Accordance with IEC 61508)

The objective of the proof test is to detect dangerous hidden failures in a safety-related system so that, if necessary, a repair can restore the system to a proper state (**as-new condition**).
After a successful proof test, safe operation including the safety functions are ensured again.

The proof test execution depends on the following:

- The system characteristics (EUC = equipment under control).
- The system's risk potential.
- The standards used for operating the system.
- The standards applied by the test authority for the system's approval.

According to IEC 61508 1-7, IEC 61511 1-3, IEC 62061 and VDI/VDE 2180, Sheets 1 to 4, the operator of the safety-related systems is responsible for proof testing. The complete safety functions within the HIMA safety-related system must be checked during the proof test.

For safety-related HIMA systems complying with safety integrity level 3 (SIL 3), the proof test must be performed in intervals of 10 years.

In practice, the proof test interval required for the sensors and actuators (field devices) is shorter (e.g., every 6 or 12 months) than that required for the HIMA controller. Testing the entire safety loop together with a field device automatically includes the test of the HIMA controller. There is therefore no need to additionally proof testing the HIMA controller.

If the proof test of the field devices does not include the HIMA controller, the HIMA controller must be tested at least once every 10 years. This can be achieved by restarting the HIMA controller.

12 Decommissioning

The HIMatrix CSG 04 is decommissioned by removing the supply voltage. Afterwards, the pluggable screw terminals for inputs and outputs and the Ethernet cables can be removed.

13 Transport and Storage

To avoid mechanical damage, the device and components must be transported in the original product packaging and in additional packaging suitable for transportation.

The devices and components must always be stored in their original product packaging. This packaging also provides optimal protection against electrostatic discharge (ESD).

14 Disposal

Industrial customers are responsible for correctly disposing of decommissioned hardware. Upon request, a disposal agreement can be arranged with HIMA.

Devices, components and packaging materials must be delivered in accordance with the applicable local regulations for reuse or must be properly disposed of.

15 Appendix

15.1 List of Abbreviations

Abbreviation	Description
AI	Analog input
AO	Analog output
BMS	Burner management system
COM	Communication system
CSG	Combustion safeguard
DI	Digital input
DO	Digital output
EMC	Electromagnetic compatibility
EN	European standard
ESD	Electrostatic discharge
FARC	Fuel air ratio control
HMI	Human machine interface
IEC	International Electrotechnical Commission
NFPA	National Fire Protection Association (USA)
PELV	Protective extra low voltage
PES	Programmable electronic system
PFD	Probability of dangerous failure on demand, probability of a dangerous failure on demand of a safety function
PFH	Probability of a dangerous failure per hour
RFI	Radio frequency interference
RJ-45	Registered Jack 45: standardized connector
SELV	Safety extra low voltage
SIL	Safety integrity level (IEC 61508/IEC 61511)
SRS	System rack slot, addressing of a module
SSV	Safety shutoff valve

Table 67: Abbreviations

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