Burner application example for TIA Portal (Burner library)

Safety Basic / Safety Advanced

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Table of Contents

1 Burner technology and Burner library

This chapter shows the generic security functions to occur within a gas or oil burner.
The function example is orientated on fulfilling the requirements of the following standards:

- EN 746-2
- EN 298
- ISO 13577
- EN 676
- EN 267
- EN 1643
- EN 12952-8
- EN 12953-7
- NFPA 85 & 86

The safety requirements are divided into individual functions that are independently implemented in the program.

1.1 Overview of the Library

What do you get?

This document describes a library containing code for SIMATIC S7 1200F / 1500F and 300F systems with clearly defined interfaces. The functionality generally corresponds to the functionality of a burner management system, provided that all parts of the library are used.

All parts of the library are described individually. Due to the complexity for integrating the library, a step by step instruction will be omitted. Instead interconnection examples are shown, which describe the most important interactions between the individual parts of the library.

Using the functions in this example does not automatically lead to compliance with legal regulations.

1.2 Technological layout

The technology scheme shows simplified the construction of a furnace, and the relevant components for controlling a burner.

Figure 1-1 Technological layout

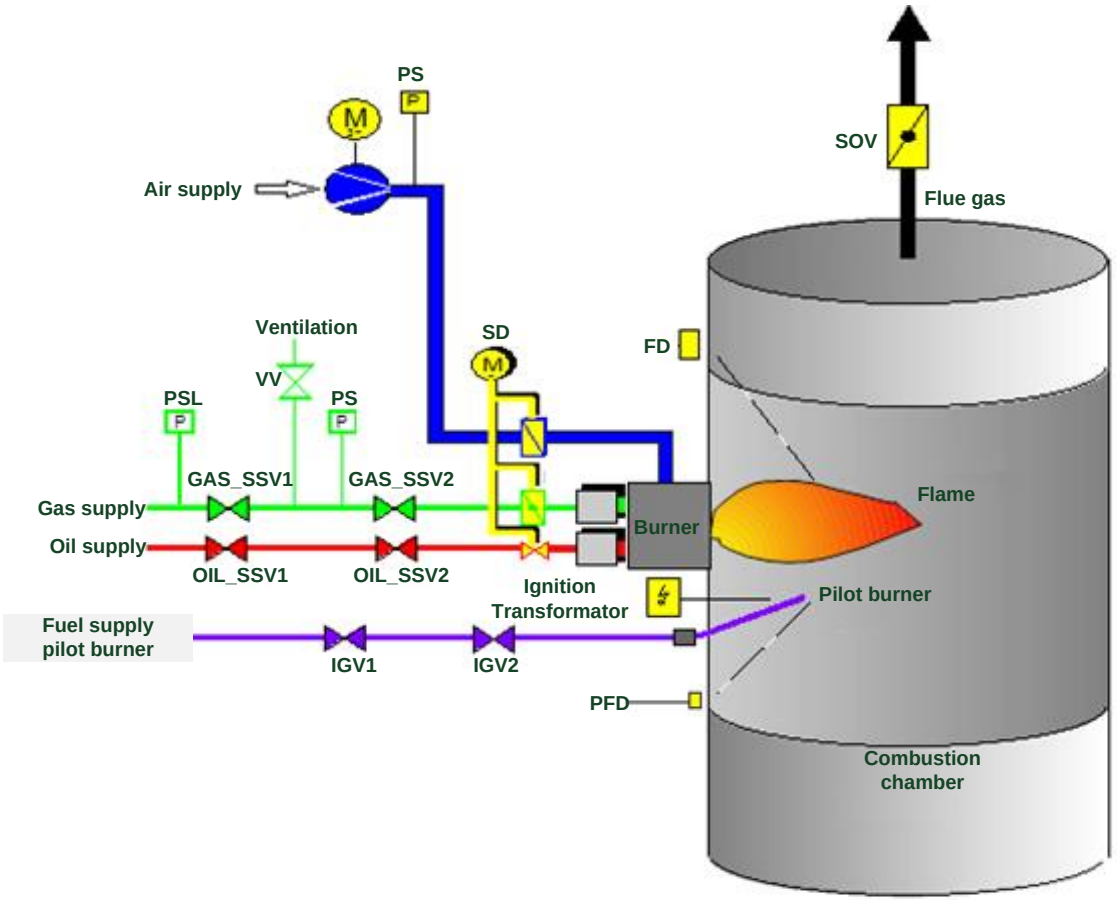


Table 1-1 Designitions used in the graphic

Designitions	Definition
IGV1	Pilot gas valve 1
IGV2	Pilot gas valve 2
OIL_SSV1	Oil safety shut-off valve 1
OIL_SSV2	Oil safety shut-off valve 2
GAS_SSV1	Gas safety shut-off valve 1
GAS_SSV2	Gas safety shut-off valve 2
PSL	Gas pressure sensor lower limit
VV	Vent valve
FD	Flame detector
SD	Servo drive
PS	Pressure sensor
SOV	Shut-off valve
PFD	Pilot flame detector

General structure of a combustion plant

- Supply to the gas burner with two safety shut-off valves
  - contains pressure switch (and possibly vent valve) for the implementation of the gas tightness test
- Supply to the oil burner with two safety shut-off valves
- Supply to the pilot burner with two safety shut-off valves
- Supply fresh air with a fan
- Flue gas outlet with shut-off flap
- Ignition transformer for igniting the pilot flame
- Ignition flame detector for monitoring the pilot flame
- Main flame detector for monitoring the main flame
- Actuator for controlling the gas or oil-air mixture

Generic sequence of a burner

Before the burner is ignited, depending on the application (from 1200 kW burner capacity according to EN 746-2), a tightness test of the safety shut-off valves of the gas supply has to be carried out.

Before each start-up of the gas or oil burner the combustion chamber and flue gas outlet pipes need to be cleaned from oil or gas residues.

For this purpose a pre-purge is required, which is carried out by means of air pressure. The duration of the pre-purge depends on the burner type and is calculated according to the requirements of EN 746-2 and EN 676 or EN 267. It has to be continuously monitored to ensure that the pressure and mass / volume flow does not fall below the minimum value while purging.

The ignition of the first burner should be initiated immediately after completion of the pre-purge. For this purpose, the gas valves are opened and the flowing gas ignited by the ignition transformer.

Within a safety time defined in the standards, a pilot flame has to be detected by the igniton flame detector. If, in addition, the safety conditions for starting up are fulfilled (e.g. gas / oil conditions and air conditions are met), the safety shut-off valves can be opened. Otherwise, the ignition must be stopped.

The main burner should ignite within the safety time, defined by EN 746-2. Otherwise a safety shutdown must be initiated (immediate closing of the safety valves with ventilation).

During startup and burner operation, the safety conditions that are relevant for the particular application must be monitored. The safety conditions result from a risk assessment conducted with the assistance of the relevant standards (e.g. EN 746-2, EN 12952, EN 12953, etc.).

If the necessary safety conditions do not exist at a given time, the fuel supply is not enabled or interrupted (error shutdown).

An automatic restart is not allowed after an error shutdown. The error must be acknowledged manually and the start-up process then initiated anew.

The fuel and air flow are regulated via the air damper or fuel control valves. If the main flame detector indicates a presence of the flame, the flow rate of the fuel quantity can be increased, depending on the required heating energy. The increase or decrease shall be in the form of a monitored fuel ratio. It is important to ensure that at no time a dangerous air deficiency exists. For example, a lack of air can arise when the gas control valve opens faster than the air damper, upon an increase of power. For this reason, the Norm EN 12067-2 requires that with an

increase of power the air damper must open first and afterwards the gas control valve.

In chapter 4 the document examples for the interconnections between the different functions are provided.

2 System- and Software-requirements

2.1 General

The functions described in the following chapters can be used in conjunction with the Fail Safe automation system SIMATIC for control of gas and oil burners. With proper connection of the function blocks (see chapter 4) and using the appropriate peripherals (see chapter 2.3) a Safety class up to SIL3 according to IEC 61508: 2011 can be achieved.

The functions of the library have been developed in regard to individual sub-functions in order to ensure a modular application when controlling multiple burners. The functionality of a burner control is available when using all parts of the library.

The library contains safety function blocks that represent the basic functions and the safety aspect of a burner management system (see chapters 3.3 to 3.10). The complete automation of the burner (e.g. control of the fuel supply / quality control / temperature control) must be implemented by the user.

2.2 Standard Specification

The functions of the burner library have been developed under consideration of the following standards:

- EN 746-2:2010
- EN 267:2011
- EN 676:2008
- EN 298:2012
- EN 1643:1014
- EN 12952-8:2002
- EN 12953-7:2002
- ISO13577-2:2014
- ISO 13577-4:2014
- NFPA 85:2011
- NFPA 86:2015
- IEC 61508:2011

The above standards may be fulfilled through proper interconnection of the function (for examples see chapter 4). The user is responsible for correct logic interconnection of these signals, so that every unsafe state detected by the library blocks will result in an appropriate reaction or safety shutdown of the burner.

For correct function of the function blocks, it is necessary that the safety program is called in a cyclic interrupt OB (e.g. in OB35 of a S7-300F / S7-400F), which has a defined call interval. A call in OB1 is not sufficient.

The specific configuration of the times and limits depend on the requirements of the user performed risk assessment and the specifications in the standards / guidelines for each plant at which the blocks are to be used. The user is responsible for a correct implementation of the risk assessment and the corresponding configuration of times.

A final functional test of the system in accordance with the directive(s) has to be performed by the user.

In General, the safety relevant times must not be exceeded. However, the indicated safety times should be considered as nominal values, which underlie the execution times of the cyclic calls in the PLC. Therefore, there is a permissible tolerance in the configured safety times of ± 2 cycles.

2.3 System & Hardware

The functions in this example can be used with SIMATIC S7-1200F / 1500F and S7-300F systems in conjunction with fail-safe signal modules. However, not every PLC can be used for every application. Whether a PLC is suitable for an application can be determined with the help of Table 2-1 Required RAM for the function blocksand should be checked by the user before implementation.

Table 2-1 Required RAM for the function blocks

Function Block	Required RAM S7-1200F/1500F (in kB)*	Every further instance (in kB)*	Required RAM S7-300F (in kB)*	Every further instance (in kB)*
F_AIRD	2,44 / 2,73	0,46 / 0,61	2,12	0,29
F_GAS_BU	7,86 / 8,32	0,67 / 0,84	5,74	0,35
F_IGNTR	9,06 / 9,53	0,81 / 0,99	6,19	0,42
F_OIL_BU	10,66 / 11,13	0,99 / 1,18	7,66	0,52
F_OIL_CLEAN	9,43 / 9,93	0,68 / 0,86	6,48	0,36
F_POS_CH	18,50 / 18,77	0,94 / 1,09	10,95	0,67
F_PRE_PURGE	8,20 / 8,66	0,66 / 0,83	5,82	0,34
F_TIGHTN	6, 63 / 6,91	0,92 / 1,08	4,35	0,53

* The times are only typical values. They may vary, depending on the way the blocks are called (e.g. single or Multi-Instance)

In addition, the following components are required to meet the standards' requirements:

- Safety valves (SSV) that comply with the following standards (EN161, EN 263)
- Control valves that comply with the corresponding standard
- F-DO module to control the (Ignite-) SSV and the ignition transformer (controlled by DC 24V / 2A)
- F-RO module to control the (Ignite-) SSV and the ignition transformer (controlled by DC24V / 2A)
- F-DI module for reading the flame detector and fail-safe signals (e.g. position sensors of the air damper)
- F-AI module for monitoring values (temperature, pressure, etc.)
- DI module for reading mirror contacts or position feedback (e.g. the SSV)
- Ignition transformer which fulfill the process
- Flame detector including flame probe which are certified and fulfill the requirements
- Sensors and actuators which fulfill the requirements

The connection of the sensors / actuators with the above mentioned modules is to implement according to the respective manuals.

2.4 Software

The following Siemens SIMATIC software must be installed in order to use the functions in this example:

- STEP 7 V 14 or higher
- Safety Advanced or Safety Basic, V14 or higher

3 Functionality for Burner Technology

3.1 Functionalities

The library contains the following functionalities:

Table 3-1 Library of the functions

Name	Function	Remark
F_AIRD	Function for controlling the air damper / exhaust gas damper / fuel valves	The position of the damper / valve during ignition and during operation can be controlled with this function This feature requires discrete feedback from e.g. Position sensors.
F_TIGHTN	Function for controlling the gas tightness test	The tightness control for safety shut-off in gas supply occurs via this function. It can be used for systems with and without vent valve between the safety shut-off valves.
F_IGNTR	Function for controlling the ignition of the burner / a pilot burner	The ignition is controlled with the functions F_IGNTR and F_GAS_BU (for gas burners) or F_IGNTR and F_OIL_BU (for oil burners). The functions check the ignition conditions, monitor the safety time for ignition and control the ignition transformer and the ignition gas and safety shut-off valves. If safety conditions for start-up or operation of the burner are not met, the fuel supply of the functions F_GAS_BU or F_OIL_BU will not be released or interrupted.
F_POS_CH	Function for position monitoring	This function monitors the position of the analog actuators for air and fuel.
F_OIL_CLEAN	Function to clean the oil burner	Oil burners can be cleaned or purged with this function. A carried out cleaning has an impact on the length of the safety time for ignition in the F_OIL_BU function. If necessary, the function automatically initiates a controlled shutdown of the burner.
F_GAS_BU	Function for controlling the functions of a gas burner	Main module for controlling a gas burner
F_OIL_BU	Function for controlling the functions of an oil burner	Main module for controlling an oil burner
F_PRE_PURGE	Function to perform the pre-purge / pre-ventilation	Oil and gas burners can be (pre-) purged /ventilated with this function. This is possible before ignition or after a shutdown.

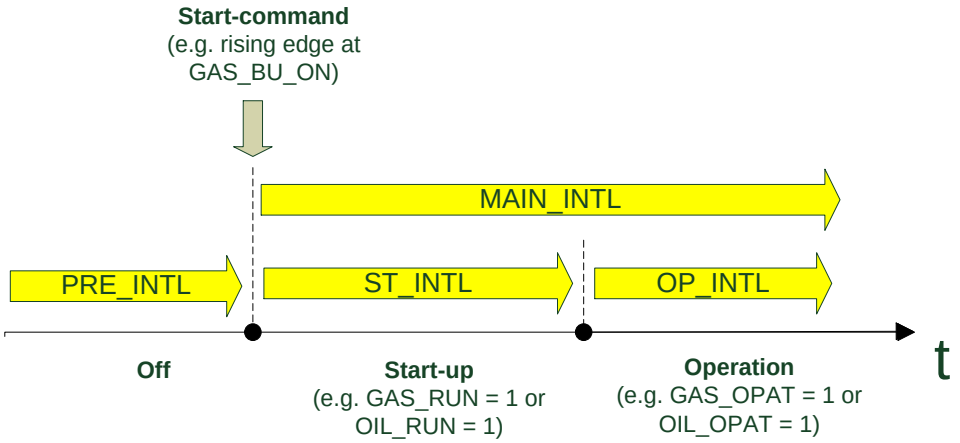
Using the functions in this example does not automatically lead to compliance with legal regulations.

3.2 Interlocks

- The functions explained in the following have various input interlocks that are to be interconnected by the user. These include:
- **MAIN_INTL**: Must be fulfilled for the entire duration of the function from the start
- **PRE_INTL**: Must only be fulfilled before start-up of the function
- **ST_INTL**: Must be fulfilled for the duration of the start-up
- **OP_INTL**: Must be fulfilled after the start-up phase and during operation of the burner

At these interlocks, conditions can be queried, which are relevant for the behavior of the function at different times and are not explicitly requested by another input of the function. Not every function has every kind of interlock. But if a function does have one of the aforementioned inputs then this input need to be TRUE for the period of time shown in Figure 3-1. Otherwise the function is aborted or not started.

Figure 3-1 Validity of the various locks / Interlocks



At **PRE_INTL** conditions are to be interconnected, which are only relevant for the start of the function. Once the function has been started, this input is no longer scanned.
Example: Pre-purge was successful, air pressure switch ok, safety shut-off valve(s) closed, etc.

With **ST_INTL** conditions must be linked, which are only relevant during start-up. The conditions must be fulfilled from the start-up phase, up to the transition to the operational phase (e.g. change from GAS_RUN to GAS_OPAT of F_GAS_BU). After that the input is no longer scanned.

If there are conditions which only need to be fulfilled in the operation phase of the function, then these signals are to be connected to **OP_INTL**. The value is evaluated from the transition to the operational phase (e.g. GAS_OPAT, IGN_OPAT, etc.) until the end of the function.

MAIN INTL must be fulfilled for the entire duration of the function. A 0-signal at this input terminates the corresponding function or the function cannot be started at all.

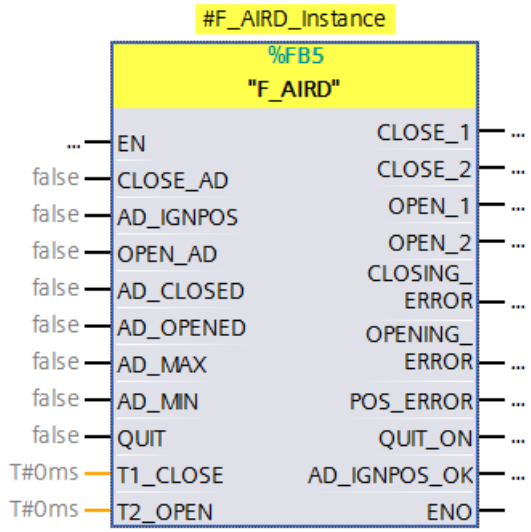
3.3 Function for controlling the air damper(s) (F_AIRD)

3.3.1 Introduction

The fail-safe function for air damper control F_AIRD takes over the control of the air dampers using feedback from position sensors. It can also be used to control and monitor fuel valves and exhaust dampers.

This control function can be used to fully open or close air dampers, fuel valves and exhaust dampers and to bring them into ignition positon.

Figure 3-2 Function block F_AIRD



NOTE When using this function, the function block F_TON must exist in the system block folder (FB 185).

3.3.2 Connections

The default value for all inputs of data type BOOL is 0-Signal
The default value for all inputs of data type TIME is T#0ms.

Table 3-2 Inputs / Outputs parameter description of the function F AIRD

Name	Data type	Description
Inputs		
CLOSE_AD	BOOL	**Close the air-damper** • 1-Signal = Command issued to close air damper • 0-Signal = A command to open the air damper can be placed through OPEN_AD CLOSE_AD commands are ignored if AD_IGNPOS is set
AD_IGNPOS	BOOL	**Drive air damper in ignition position** • 1-Signal = Command issued for starting the ignition position • 0-Signal = A command to open or close the air damper can be placed through OPEN_AD or CLOSE_AD CLOSE_AD and OPEN_AD commands are ignored if AD_IGNPOS is set
OPEN_AD	BOOL	**Open the air damper** • 1-Signal = Command issued to open the air damper • 0-Signal = A command to close the air damper can be placed through CLOSE_AD OPEN_AD commands are ignored if AD_IGNPOS is set
AD_CLOSED	BOOL	**Air damper in closed position** • 1-Signal = Air damper closed • 0-Signal = Air damper is not fully closed
AD_OPENED	BOOL	**Air damper in open position** • 1-Signal = Air damper is open • 0-Signal = Air damper is not fully opened
AD_MAX	BOOL	**Air damper in ignition position <MAX** • 1-Signal = Air damper is below or at the maximum ignition position • 0-Signal = Air damper is above the maximum ignition position
AD_MIN	BOOL	**Air damper in ignition position >MIN** • 1-Signal = Air damper is above or at the minimum ignition position • 0-Signal = Air damper is below the minimum ignition position
QUIT	BOOL	**Error acknowledgment** • Error messages are reset at this input parameter • Acknowledgement requires a rising edge

Name	Data type	Description
T1_CLOSE	TIME	**Actuating time close air damper** • Within this time the air damper must be closed, otherwise an error signal at the output CLOSING_ERROR is set • Reference value : 0min < T1_CLOSE < 10min
T2_OPEN	TIME	**Actuating time open air damper** • Within this time the air damper must be opened, otherwise an error signal at the output OPENING_ERROR is set • Reference value : 0min < T2_OPEN < 10min
Output		
CLOSE_1	BOOL	**Close air damper** • 1-Signal = Close air damper until feedback is available • 0-Signal = Don't close air damper This ouput ist set if: • AD_IGNPOS=0, OPEN_AD=0 und CLOSE_AD=1. • AD_IGNPOS=1 und AD_MAX=0 und AD_MIN=1
CLOSE_2	BOOL	**Close air damper** • 1-Signal = Air damper closing regardless of the feedback • 0-Signal = Air damper not closing This output is set if: • AD_IGNPOS=0, OPEN_AD=0 und CLOSE_AD=1 **This output is activated in case of an error of the function, and can be used to bring the air damper to the safe position (see chapter 4.3.4)**
OPEN_1	BOOL	**Open air damper** • 1-Signal = Open air damper until the feedback signal is available • 0-Signal = Don`t open air damper This output is set if: • AD_IGNPOS=0, OPEN_AD=1 und CLOSE_AD=0. • AD_IGNPOS=1 und AD_MAX=1 und AD_MIN=0
OPEN_2	BOOL	**Open air damper** • 1-Signal = Open air damper regardless of the feedback signal • 0-Signal = Don`t open air damper This output is set if: • AD_IGNPOS=0, OPEN_AD=1 und CLOSE_AD=0 **This output is activated in case of an error of the function, and can be used to bring the air damper to the safe position (see chapter 4.3.4)**
CLOSING_ ERROR	BOOL	**Error when closing the air damper** • 1-Signal = An error is detected when closing the air damper • 0-Signal = There is no error
OPENING_ ERROR	BOOL	**Error when opening the air damper** • 1-Signal = An error is detected when opening the air damper • 0-Signal = There is no error available

Name	Data type	Description
POS_ERROR	BOOL	**Error AD_MIN / AD_MAX or AD_OPENED / AD_CLOSED** • 1-Signal = A plausibility error of the feedback signals was detected • 0-Signal = There is no error
QUIT_ON	BOOL	**Acknowledgment on** • 1-Signal: A 1-signal is available at the input QUIT • 0-Signal: A 0-signal is available at the input QUIT
AD_IGNPOS_OK	BOOL	**Air damper is in ignition position** • 1-Signal: Air damper is in a position between AD_MIN and AD_MAX (AD_MIN = 1 and AD_MAX = 1) and the ignition position is controlled (AD_IGNPOS = 1) • 0-Signal: Air damper is not in ignition position (AD_MIN = 0 and / or AD_MAX = 0) or the ignition position is not controlled (AD_IGNPOS = 0)

Note	**Please note that the parameterized safety times comply with the relevant standards.**

3.3.3 Functionality

Basic Interconnections

At **T1_CLOSE** the time is parameterized, which the damper needs to fully close.

At **T2_OPEN** the time is parameterized, which the damper needs to fully open.

The output **AD_IGNPOS_OK** is connected to the inputs AD_IGNPOS or V_IGNPOS of the blocks F_GAS_BU or F_OIL_BU.

The error outputs (**CLOSING_ERROR, OPENING_ERROR** and **POS_ERROR**) need to be negated and connected to the enable-inputs (ST_INTL or OP_INTL) of the blocks F_GAS_BU or F_OIL_BU.

Open Air Damper

Air damper open is initiated if the input OPEN_AD has high signal. At the same time the outputs OPEN_1 and OPEN_2 are set to 1 signal.

The open command (OPEN_1 = TRUE) is carried out until the feedback signal AD_OPENED is detected (AD_OPENED = TRUE).

If the command to open the air damper is true (OPEN_AD = TRUE), the timer T2_OPEN is started. The output OPEN_1 is reset if the air damper is reported as open (AD_OPENED=TRUE) within time of T2_OPEN. The output OPEN_2 remains set to 1-signal as long as the command to open air damper is true (OPEN_AD = TRUE).

If the air damper doesn`t open within the parameterized time, the output OPENING_ERROR is set to 1-signal to display an error at the air damper and fuel valves.

Close Air Damper

Air damper close is initiated if the input CLOSE_AD has high signal. At the same time the outputs CLOSE_1 and CLOSE_2 are set to 1-Signal.

The close command (CLOSE_1 = TRUE) is carried out until the feedback signal AD_CLOSED is detected (AD_CLOSED = TRUE).

If the command to close the air damper is TRUE (CLOSE_ AD = TRUE), the timer T1_CLOSE is started.

The output CLOSE_1 is reset if the air damper is closed (AD_CLOSED = TRUE) within the parameterized time of T1_CLOSE. The output CLOSE_2 remains set to 1-Signal as long as the command to close air damper remains true (CLOSE_AD = TRUE).

If the air damper doesn`t close within the parameterized time, the output CLOSING_ERROR is set to 1-Signal to display an error at the air damper and fuel valves.

Drive to Ignition Position

If AD_IGNPOS is set, the inputs CLOSE_AD and OPEN_AD are not evaluated. The command for controlling the ignition position of the output OPEN_1 is set when the damper has taken a position below the defined maximum but not above the defined minimum (AD_MAX = TRUE and AD_MIN = FALSE). If the position of the damper is above the defined maximum and above the defined minimum (AD_MAX = FALSE and AD_MIN = TRUE), the output CLOSE_1 is set.

If the ignition position is reached (AD_MIN = TRUE and AD_MAX = TRUE), and the ignition position is energized (AD_IGNPOS = TRUE), and no error exists (POS_ERROR = FALSE, CLOSING_ERROR = FALSE and OPENING_ERROR = FALSE).then this is shown at the output AD_IGNPOS_OK

Error Detection and Reaction

If closing or opening of the (air) damper is not possible within the parameterized time (T1_CLOSE or T2_OPEN), the output CLOSING_ERROR or OPENING_ERROR is set to indicate an error at the dampers / fuel valves.

POS_ERROR is set if at least one of the following conditions is met:

- The open and closed status of the dampers/valves is reported at the same time (AD_OPENED und AD_CLOSED at the same time TRUE)
- The ignition positon is energized (AD_IGNPOS = TRUE) and both AD_MIN and AD_MAX have 0-Signal

If an error was detected (POS_ERROR, CLOSING_ERROR or OPENING_ERROR have 1-Signal), the outputs OPEN_1 and CLOSE_1 are no longer activated and set to 0-Signal until the error is corrected. CLOSING_ERROR blocks CLOSE_1, OPENING_ERROR blocks OPEN_1 and POS_ERROR blocks both CLOSING_ERROR and OPEN_ERROR.

OPEN_2 and CLOSE_2 are not affected by errors. The air damper can be moved in a safe state by the outputs OPEN_2/CLOSE_2 in case of an error (see chapter 4.3.4).

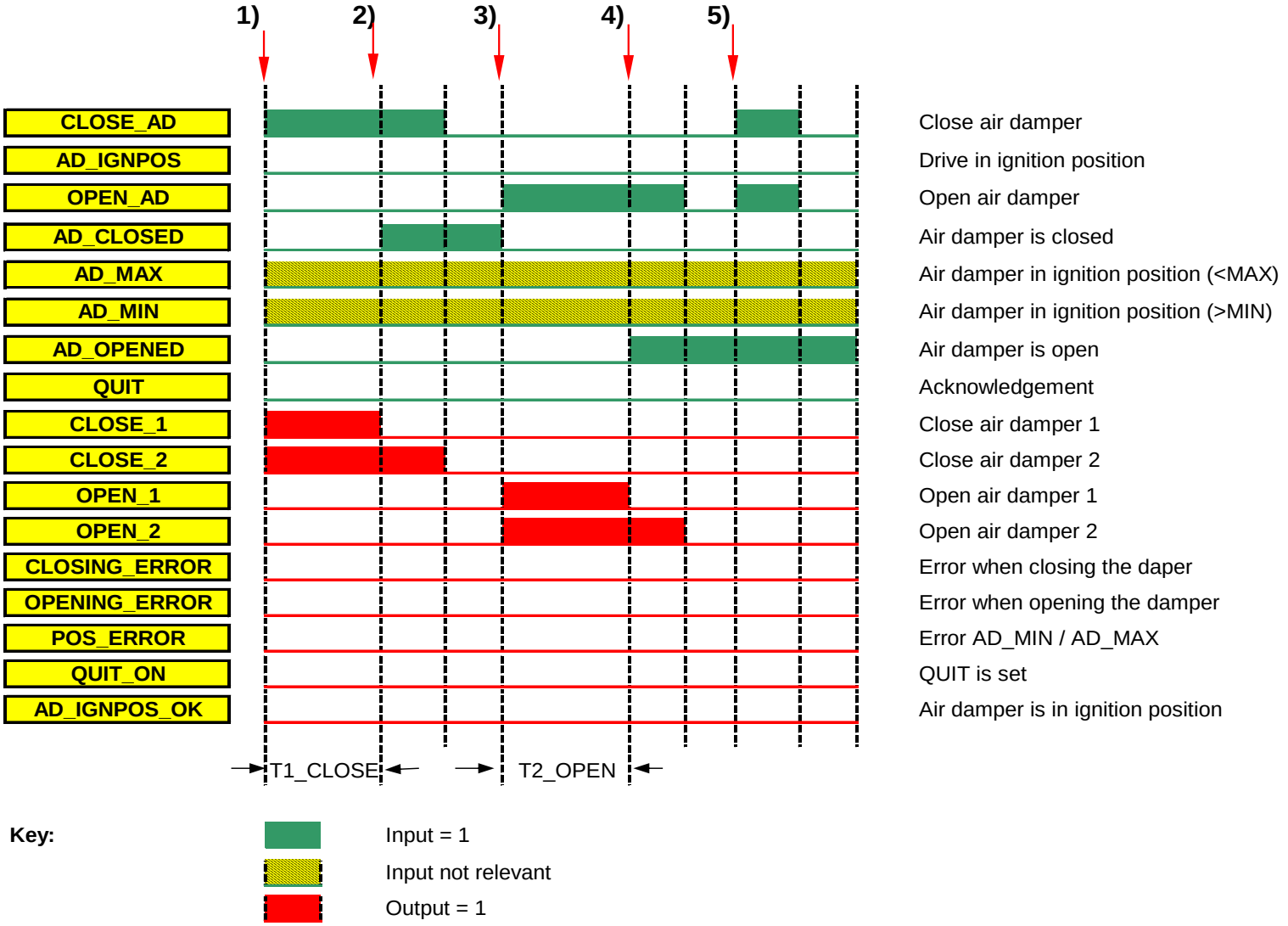
Quit

If the system has detected an error, the error has to be acknowledged. The error messages are reset by a rising edge at the input QUIT (CLOSING_ERROR = FALSE, OPENING_ERROR=FALSE and POS_ERROR = FALSE).

3.3.4 Time diagram

The figure below illustrates the signal sequence of the function F_AIRD.

Figure 3-3 Time diagram of the function F_AIRD



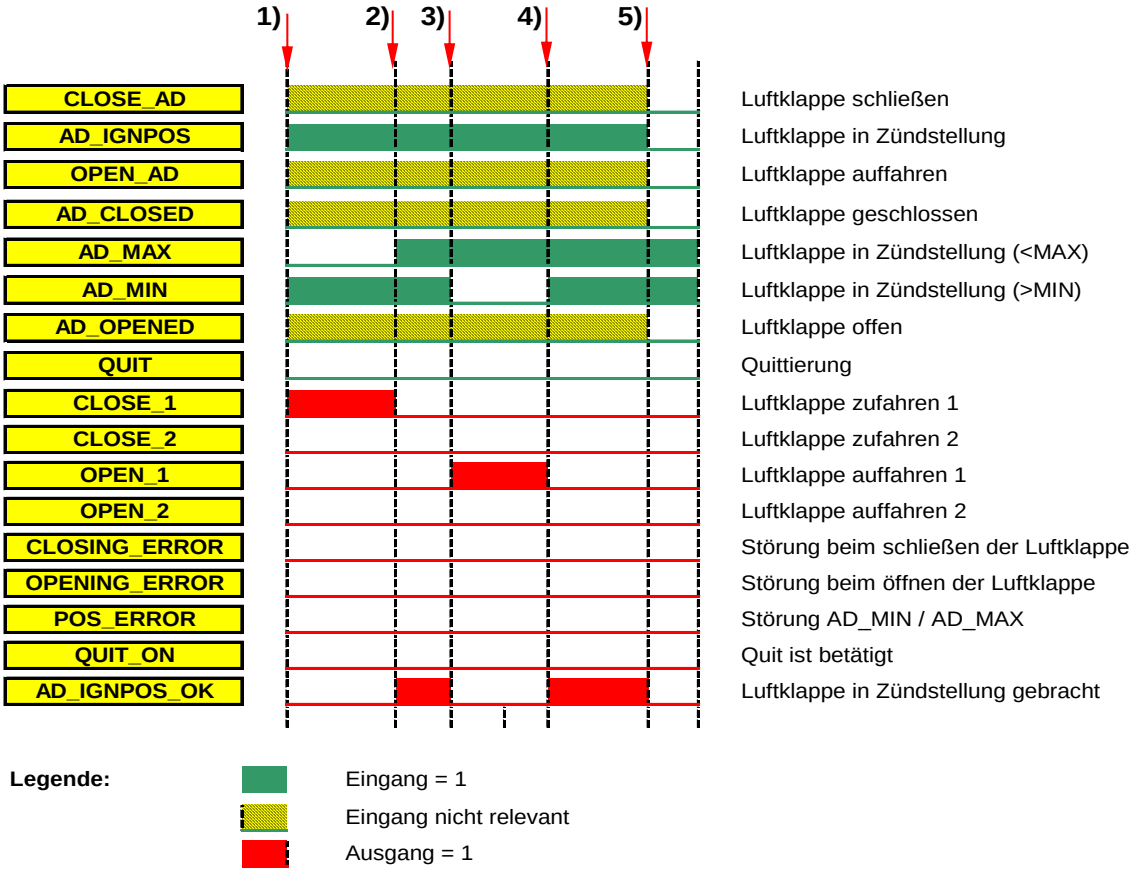
Description of the signal sequence:

1. Command to close air damper (CLOSE_AD=1)
   Air damper is closed (CLOSE_1=1, CLOSE_2=1)
   Timer T1_CLOSE is started
2. Air damper closed within T1_CLOSE,
   Output CLOSE_1 is reset, CLOSE_2 remains 1-Signal (until CLOSE_AD=0)
3. Command open air damper (OPEN_AD=1)
   Air damper is opened (OPEN_1=1, OPEN_2=1)
   Timer T2_OPEN started
4. Air damper is open within T2_OPEN
   Output OPEN_1 is reset, OPEN_2 remains 1-Signal (until OPEN_AD=0)
5. The inputs CLOSE_AD and OPEN_AD are interlocked, if both get a 1-Signal , no reaction takes place at the output

Signal sequence for ignition position of the air damper

The figure below illustrates the signal sequence of the function F_AIRD for ignition position of the air damper.

Figure 3-4 Time diagram of the function F_AIRD for the ignition position of the air damper

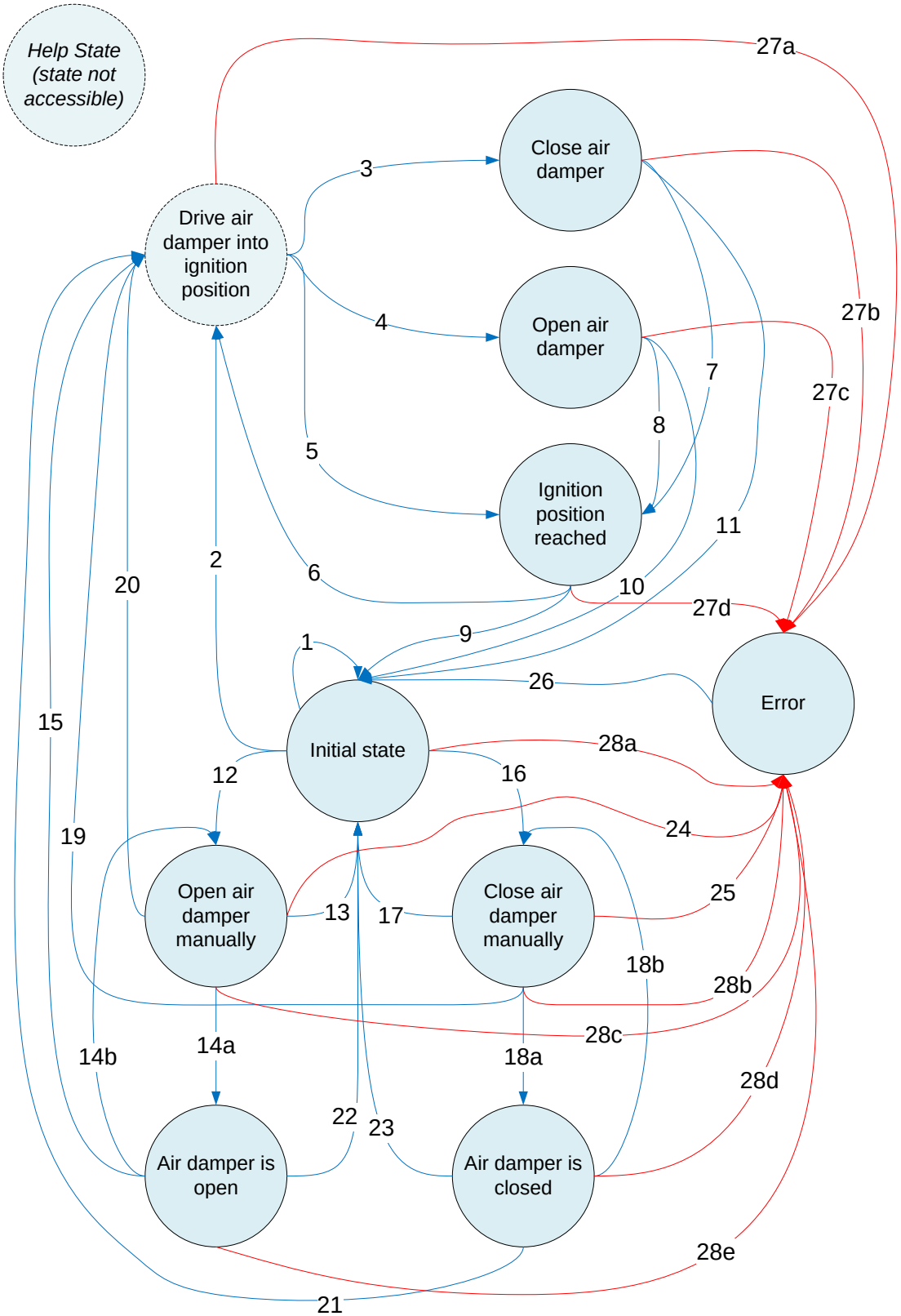


Description of the signal sequence for the ignition position of the air damper:

1. Command to drive the air damper in ignition position (AD_IGNPOS=1)
   Air damper is above the maximum (AD_MAX = 0)
   Air damper is closed (CLOSE_1 = 1)
2. Air damper is below the maximum (AD_MAX = 1)
   Air damper is above the minimum (ADMIN = 1)
   Air damper is in ignition position (AD_IGNPOS_OK = 1)
3. Air damper is below the minimum (ADMIN = 0)
   Air damper opens (OPEN 1 = 1)
4. Air damper is below the maximum (AD_MAX = 1)
   Air damper is above the minimum (ADMIN = 1)
   Air damper is in ignition position (AD_IGNPOS_OK = 1)
5. “Air damper in ignition position” is no longer available (AD_IGNPOS = 0)
   AD_IGNPOS_OK = 0

3.3.5 Status graph

Figure 3-5 Status graph of the function F_AIRD



Explanation of the Status graph

Table 3-3 Status graph of the function F_AIRD Transition

Transition	Condition for Transition
1	OPEN_AD == 1 **AND** CLOSE_AD == 1
2	AD_IGNPOS == 1
3	AD_MAX == 0 **AND** AD_MIN == 1
4	AD_MIN == 0 **AND** AD_MAX == 1
5	AD_MAX == 1 **AND** AD_MIN == 1
6	AD_MIN == 0 **OR** AD_MAX == 0
7	AD_MAX == 1
8	AD_MIN == 1
9,10,11	AD_IGNPOS == 0
12	OPEN_AD == 1 **AND** AD_IGNPOS == 0
13,22	OPEN_AD == 0
14a	AD_OPENED == 1
14b	AD_OPENED == 0
15,19,20,21	AD_IGNPOS == 1
16	CLOSE_AD == 1 **AND** AD_IGNPOS == 0
17,23	CLOSE_AD == 0
18a	AD_CLOSED == 1
18b	AD_CLOSED == 0
24	T2_OPEN elapsed
25	T1_CLOSE elapsed
26	QUIT == 1
27a-d	AD_MIN == 0 **AND** AD_MAX == 0
28a-e	AD_CLOSED == 1 **AND** AD_OPENED == 1

Table 3-4 Status graph of the function F_AIRD Outputs

Status	Outputs, which are switched
Initial State	No outputs switched
Help state: Drive air damper in ignition position	No outputs switched
Close air damper	CLOSE_1:= TRUE
Open air damper	OPEN_1:= TRUE
Igniton position reached	AD_IGNPOS_OK := TRUE
Open air damper manually	OPEN_1 := TRUE OPEN_2 :=TRUE Timer T2_OPEN started
Close air damper manually	CLOSE_1 := TRUE CLOSE_2 :=TRUE Timer T1_CLOSE started
Air damper is open	OPEN_2 :=TRUE OPEN_1 := FALSE

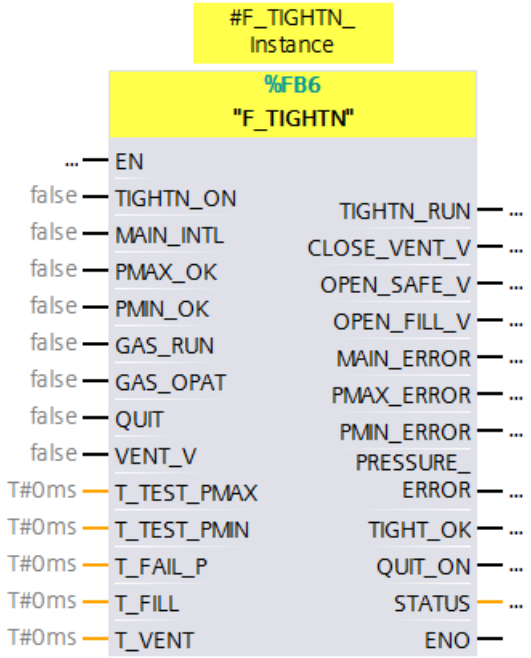
Status		Outputs, which are switched
Air damper is closed		CLOSE_2 :=TRUE CLOSE_1 := FALSE
Error	from 25	CLOSING_ERROR := TRUE
	from 24	OPENING_ERROR := TRUE
	from 27 a-d	POS_ERROR := TRUE
	from 28 a-e	POS_ERROR := TRUE

3.4 Function for tightness test (F_TIGHTN)

3.4.1 Introduction

The F_TIGHTN function controls the tightness test of the safety shut-off valves of the supply lines, where gaseous fuels are used. Before the start of the gas burner, depending on the application, it is required to perform a gas tightness test. This is the case as soon as the burner exceeds a certain predetermined power limit given by the standards. As long as the gas tightness test was not successful, the gas burner may not be started. Whether the gas tightness test must be performed before every start of the associated burner depends on the requirements of the relevant standards and the must be adapted onto the application.

Figure 3-6 Function block F_TIGHTN



Note When using this function, the function block F_TON must exist in the system block folder (FB 185).

3.4.2 Conncetions

The default value for all inputs of data type BOOL is 0-Signal

The default value for all inputs of data type TIME is T#0ms.

Table 3-5 Inputs/Outputs Parameter description of the function F_TIGHTN

Name	Data type	Description
Inputs		
TIGHTN_ON	BOOL	**Start command tightness test** • A rising edge at this input will start the gas tightness test • After a successful test, the stored 1-Signal at the output TIGHT_OK will be reset with a rising edge at TIGHTN_ON • During operation of a burner (GAS_RUN=1), the gas tightness test cannot be started
MAIN_INTL	BOOL	**Main interlock fulfilled** • The gas tightness test can be started if there is a 1-Signal at this input • The test is interrupted or not started if there is a 0-Signal at this input
PMAX_OK	BOOL	**Pressure monitoring tightness test of the 2nd SSV** • For a 1-Signal at this input, the measured pressure is above the parameterized threshold value • For a 0-signal at this input, the value at the pressure switch is below the parameterized value or the pressure switch itself has an error
PMIN_OK	BOOL	**Pressure monitoring tightness test of the 1st SSV** • For a 1-Signal at this input, the measured pressure is below the parameterized threshold value • For a 0-signal at this input, the parameterized value at the pressure switch is exceeded or the pressure switch itself has an error
GAS_RUN	BOOL	**Gas start-up program is running** • A 1-Signal at this input will prevent the tightness test to start • This input queries whether the burner is in start-up phase and a test of the valves is therefore not possible/permitted
GAS_OPAT	BOOL	**Gas burner in operation** • Once the gas burner is in operation, the output parameter "gas tightness test successful" (TIGHT_OK = 1) is reset to zero • If the gas burner is running, the 1-Signal at GAS_OPAT prevents the gas tightness test from starting • If GAS_OPAT becomes "1", during the tightness test the gas tightness test will be interrupted
QUIT	BOOL	**Error acknowledgement** • Error messages are reset at this input • Acknowledgement requires a rising edge

Name	Data type	Description
VENT_V	BOOL	**System with or without venting valve** • Apply 0-Ssignal when a ventilation valve is located between the two SSV • Apply 1-Signal if **NO** ventilation valve is located between the two SSV
T_TEST_ PMAX	TIME	**Test time for checking the tightness of the first safety shut-off valve** • Within the specified period of time, the tightness of SSV 1 is checked • Reference value: 0,5min < T_TEST_PMAX < 2min
T_TEST_ PMIN	TIME	**Test time for checking the tightness of the second safety shut-off valve and the vent valve** • Within the specified period of time, the tightness of SSV 2 and the vent valve is checked • Reference value: 0,5min < T_TEST_PMIN < 2min
T_FAIL_P	TIME	**Error time** • An error occurs if both PMIN_OK and PMAX_OK simultaneously get a 1-Signal longer than T_FAIL_P • Reference value: 0s < T_FAIL_P < 3s
T_FILL	TIME	**Filling time** • The SSV 1 remains open for the time T_FILL for filling the space between the safety shut-off valve and vent valve • Reference value: 0s < T_FILL < 3s
T_VENT	TIME	**Venting time before test phase 1** • T_VENT sets the value, how long SSV 2 or the vent valve remains open for venting of the space between SSV 1 and SSV2 • Reference value 0s < T_VENT < 3s
Outputs		
TIGHTN_RUN	BOOL	**Gas tightness test in operation** • The gas tightness test has been started successfully and is in operation if the output TIGHT_RUN is TRUE
CLOSE_ VENT_V	BOOL	**Control of the vent valve** • The vent valve will be closed (normally open) if the output CLOSE_VENT_V get 1-Signal
OPEN_SAFE_V	BOOL	**Control of the 2. SSV** • The 2nd SSV will be opened if the output OPEN_SAFE_V is TRUE
OPEN_ FILL_V	BOOL	**Control of the 1. SSV** • The 1st SSV will be opened if the output OPEN_FILL_V gets 1-Signal
MAIN_ERROR	BOOL	**Main Interlock no longer fulfilled during the test** • Error message occurs, if in operation the gas tightness test is canceled due to a drop of the main interlock (MAIN_INTL = 0) • The message can be reset via the input QUIT

Name	Data type	Description
PMAX_ ERROR	BOOL	**1st SSV is leaking** • Error message, if the first safety shut-off valve is leaking • The message can be reset via the input QUIT
PMIN_ ERROR	BOOL	**2nd SSV or vent valve is leaking** • Error message, if the second safety shut-off valve or the vent valve is leaking • The message can be reset via the input QUIT
PRESSURE_ERROR	BOOL	**Error PMIN_OK/ PMAX_OK** • An Error occurs, if PMIN_OK and PMAX_OK get 1-Signal simultaneously longer than T_FAIL_P • The message can be reset via the input QUIT
TIGHT_OK	BOOL	**Tightness test successful** • Indicates that the gas tightness test has been carried out successfully • TIGHT_OK is reset by the input GAS_OPAT or a rising edge at TIGHTN_ON
QUIT_ON	BOOL	**Acknowledgment aktive** • 1-Signal: Input QUIT has 1-Signal • 0-Signal: Input QUIT has 0-Signal
STATUS	INT	**Status of the function** • The number at this output indicates the current status of the function block (see chapter 0) **This output is for information only and may not be used for fail-safe connection!**

NOTE	**Please note that the parameterized safety times comply with the relevant standards**

3.4.3 Functionality

The pressure switches / sensors shown in the following pictures monitor the pressure in the different test phases. There are several ways to detect the pressure for testing the tightness of the safety shut-off valves:

- Two pressure switch P1 and P2, which each indicate on exceeding a maximum pressure rise and pressure drop
- A pressure switch P1 which is set to half of the gas pipe's nominal pressure ($P_n/2$)
- An analog pressure sensor P1, which indicates the exceeding of a parameterized pressure rise or pressure drop

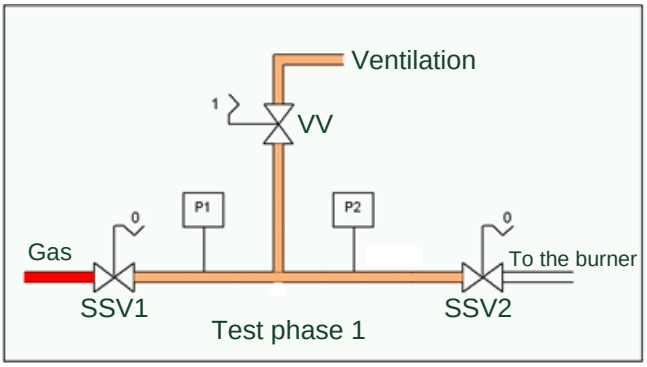
In the example with a vent valve, option1 is shown (two pressure switches). In the example without the vent valve, only one pressure monitor is used (option 2 or 3).

Functionality of the gas tightness test with vent valve (VENT_V = FALSE)

NOTE	The vent valve is open when de-energized

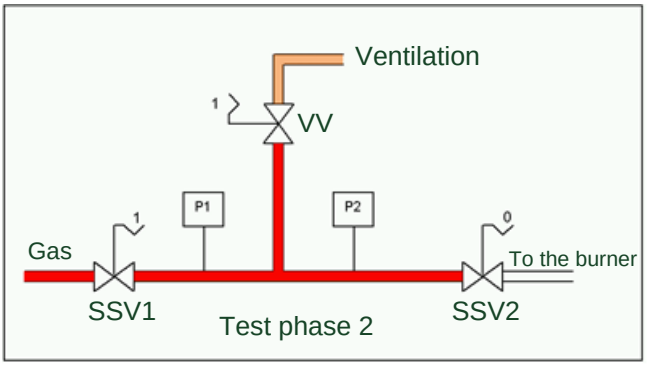
1. Before the test is started, both safety shut-off valves (SSV1 and SSV2) are closed and the vent valve (VV) is opened while the vent time T_VENT runs down. In the space between the two safety shut-off valves there now is a pressure equal to the atmospheric pressure.
2. At the start of test phase 1, the vent valve VV is closed. During the test period (T_TEST_PMAX) the two safety shut-off valves SSV1 and SSV2 and the vent valve VV remain closed. If the pressure rises because of a possible leak of safety shut-off valve SSV1 then this is indicated at pressure switch P1.

Figure 3-7 Test phase 1 of the tightness test with vent valve



3. If the first safety shut-off valve (SSV1) is tight, then SSV1 will be opened for the time T_FILL. The gas pressure is now in between the three valves. In the next step it is tested, with P2, whether the pressure in the space between the three valves declines. If the pressure drops, either the safety shut-off valve SSV2 or the vent valve VV is leaking.

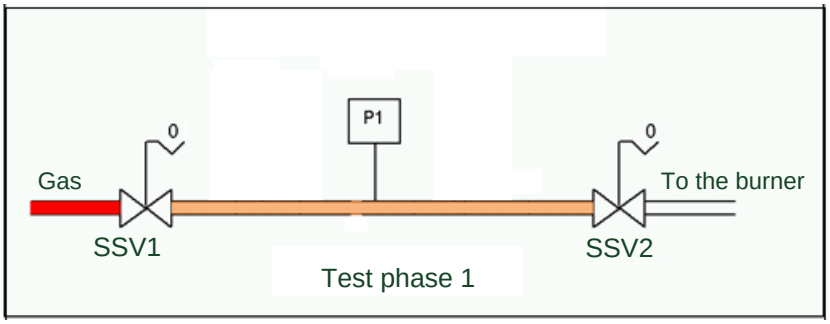
Figure 3-8 Test phase 2 of the tightness test with vent valve



Functionality of the gas tightness test without vent valve (VENT_V = TRUE)

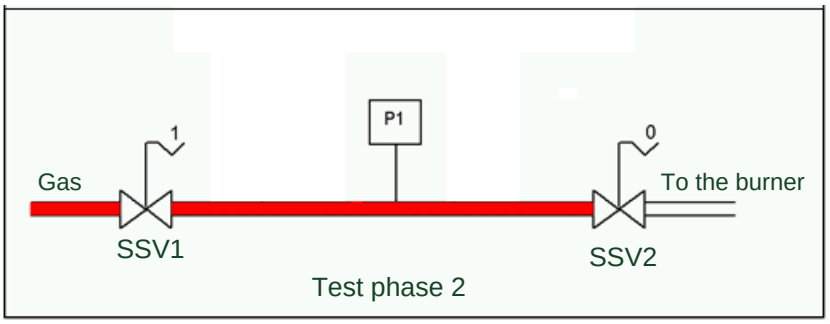
1. At the start of the test, the area between the two safety shut-off valves SSV1 and SSV2 is first vented into the combustion chamber. For this purpose, the second safety shut-off valve SSV2 is opened for the venting time T_VENT. The prerequisite is that the burner is not in operation. Between the two valves now exists a pressure equal to the atmospheric pressure or the pressure in the combustion chamber.
2. Test phase 1 is started as soon as the second shut-off valve SSV2 is closed. The two safety shut-off valves SSV1 and SSV2 remain closed during the test period T_TEST_ PMAX. If the pressure increases because due to a leak of safety shut-off valve SSV1, then this is indicated via the pressure switch P1.

Figure 3-9 Test phase 1 without vent valve



3. If the first safety shutoff valve (SSV1) is not leaking, it is opened for the time T_FILL. The gas pressure is now between the two valves. Next it is tested, with P1, whether the pressure declines during the time T_TEST_PMIN. If there is a pressure drop, the safety shut-off valve SSV2 is leaking.

Figure 3-10 Test phase 2 without vent valve



Basic interconnections

At the input **VENT_V** it is specified whether there is a vent valve between the two safety shut-off valves. The input (static signal) needs to be TRUE (no vent valve) or FALSE (with vent valve). If the input is not connected, VENT_V is initialized with FALSE signal. If the tightness test is started (TIGHTN_RUN = TRUE) then a change of the signal at VENT_V has no effect until the function has finished.

GAS_OPAT and **GAS_RUN** are to be interconnected with the corresponding outputs of F_GAS_BU and prevent the function from starting when the burner is running (1- signal).

At **MAIN_INTL** the conditions for starting and operating the gas tightness tests are to be interconnected (e.g. gas pressure within the limits, air pressure within the limits)

Depending on the plant requirements, the output **TIGHT_OK** has to be connected with the input PRE_INTL of the block F_GAS_BU.

Control / Interconnection of the valves

If a vent valve (**VENT_V = FALSE**) is available, then, for the duration of the gas tightness test, F_TIGHTN takes over control of the first safety shut-off valve (SSV1) and the vent valve (VV). After successful completion of the gas tightness test the control of the safety shut-off valve is taken over from the function F_GAS_BU.

If, instead, it is vented into the combustion chamber (**VENT_V = TRUE**) then, for the duration of the test, F_TIGHTN takes over control of both safety shut-off valves (SSV1 and SSV2). After successful completion of the gas tightness test the control of the safety shut-off valves is taken over from the function F_GAS_BU.

Basic interconnection proposals to control the valves are shown in Figure 3-11 and Figure 3-12.

It is recommended to control and monitor the valves with the system block FDBACK.

An example for connections without a vent valve for an application is shown in the chapter 4.3.1 in Figure 4-2.

Figure 3-11 Interconnection of safety shut-off valves for tightness test with existing vent valve (VENT_V = FALSE)

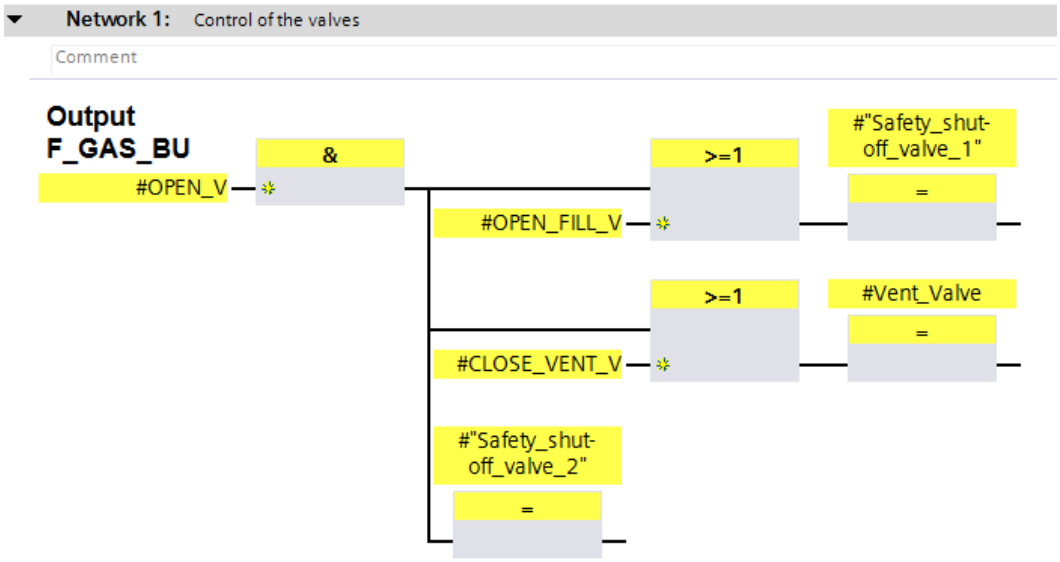
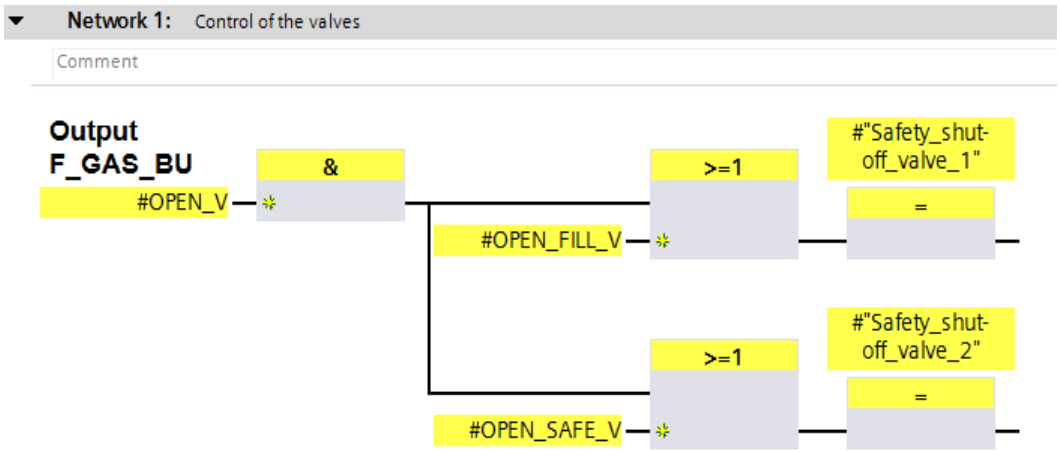


Figure 3-12 Interconnection of safety shut-off valves for tightness test without vent valve (VENT_V = TRUE)



Start tightness test

The gas tightness test is started by a rising edge at input TIGHTN_ON when the main interlocks are fulfilled (MAIN_INTL = 1). After that the message is shown that the tightness test is in operation (TIGHTN_RUN = 1) the ventilation phase starts.

Venting

Once the tightness test is started, the space between the valves is initially vented.

If VENT_V = FALSE, venting is done via the vent valve. The two safety shut-off valves (SSV1 and SSV2) remain closed (OPEN_FILL_V = FALSE and OPEN_SAFE_V = FALSE) while the time T_VENT runs down. Subsequently, the vent valve will be closed (CLOSE_VENT_V = TRUE) and test phase 1 is started.

If VENT_V is TRUE, venting is done into the combustion chamber. For the duration of the venting time (T_VENT) the second safety shut-off valve opens (OPEN_SAFE_V = TRUE). After the venting time has elapsed, the safety shut-off valve SSV2 is closed and test phase 1 is started.

Operation of tightness test

After expiration of the venting phase (T_VENT expired), **testing phase 1** is started. If the pressure does not exceed the parameterized threshold value (PMAX_OK remains TRUE) during T_TEST_PMAX, the first safety shut-off valve (SSV1) is tight.

If the pressure exceeds the parameterized threshold value (PMAX OK = FALSE) during T_TEST_PMAX, an error is displayed to PMAX_ERROR and the test will be aborted (TIGHTN_RUN = FALSE).

If test phase 1 was successful (no error message), the first safety shut-off valve (SSV1) is opened for the time T_FILL (OPEN_FILL_V = TRUE) and the space between the valves filled with gas. After the time T_FILL has elapsed the valve is closed again and test phase 2 is started.

If, in test phase 2, the pressure does not drop below the parameterized threshold value (PMIN_OK remains TRUE for the time T_TEST_PMIN), the second valve (SSV2) and the vent valve (VV) are tight and TIGHT_OK is set. The tightness test is successfully performed.

If the pressure drops below the parameterized threshold value during T_TEST_PMIN (PMIN_OK = FALSE), an error is displayed to PMIN_ERROR and the test will be aborted (TIGHTN_RUN = FALSE).

If a 1-Signal is detected at GAS_OPAT during the test, the test is aborted (TIGHTN_RUN = FALSE).

Error

If one of the conditions of the main interlock is no longer fulfilled during the test (MAIN_INTL = FALSE), the test is aborted and an error is displayed (MAIN_ERROR = TRUE). The test must then be restarted.

If there is a 1-signal available at inputs PMIN_OK and PMAX_OK at the same time for longer than T_FAIL_P (implausible state), PRESSURE_ERROR is set and the test will be stopped (TIGHTN_RUN = FALSE).

If an error is detected, the safety shut-off valves will be closed (OPEN_FILL_V = FALSE and OPEN_SAFE_V = FALSE) and the vent valve will be opened (CLOSE_VENT_V = 0).

Acknowledge

If the system has detected an error, the error remains until the error has been acknowledged. An error can be acknowledged by a rising edge at the input QUIT. The corresponding error messages are then reset (PMAX_ERROR = FALSE, PMIN_ERROR=FALSE, PRESSURE_ERROR = FALSE, MAIN_ERROR = FALSE).

Withdrawal of the ignition release

The enable signal to ignite the burner (TIGHT_OK) will be reset if:

- The burner has been successfully ignited and is in operation (GAS_OPAT = TRUE)
- A plausibility error was detected at the pressure sensors (PRESSURE_ERROR = TRUE)
- The tightness test is restarted (rising edge at TIGHTN_ON)

3.4.4 Status Display

The STATUS of the current state of the function can be seen at the output Status. The outputs are used solely for the information and may not be used for fail-safe interconnections.

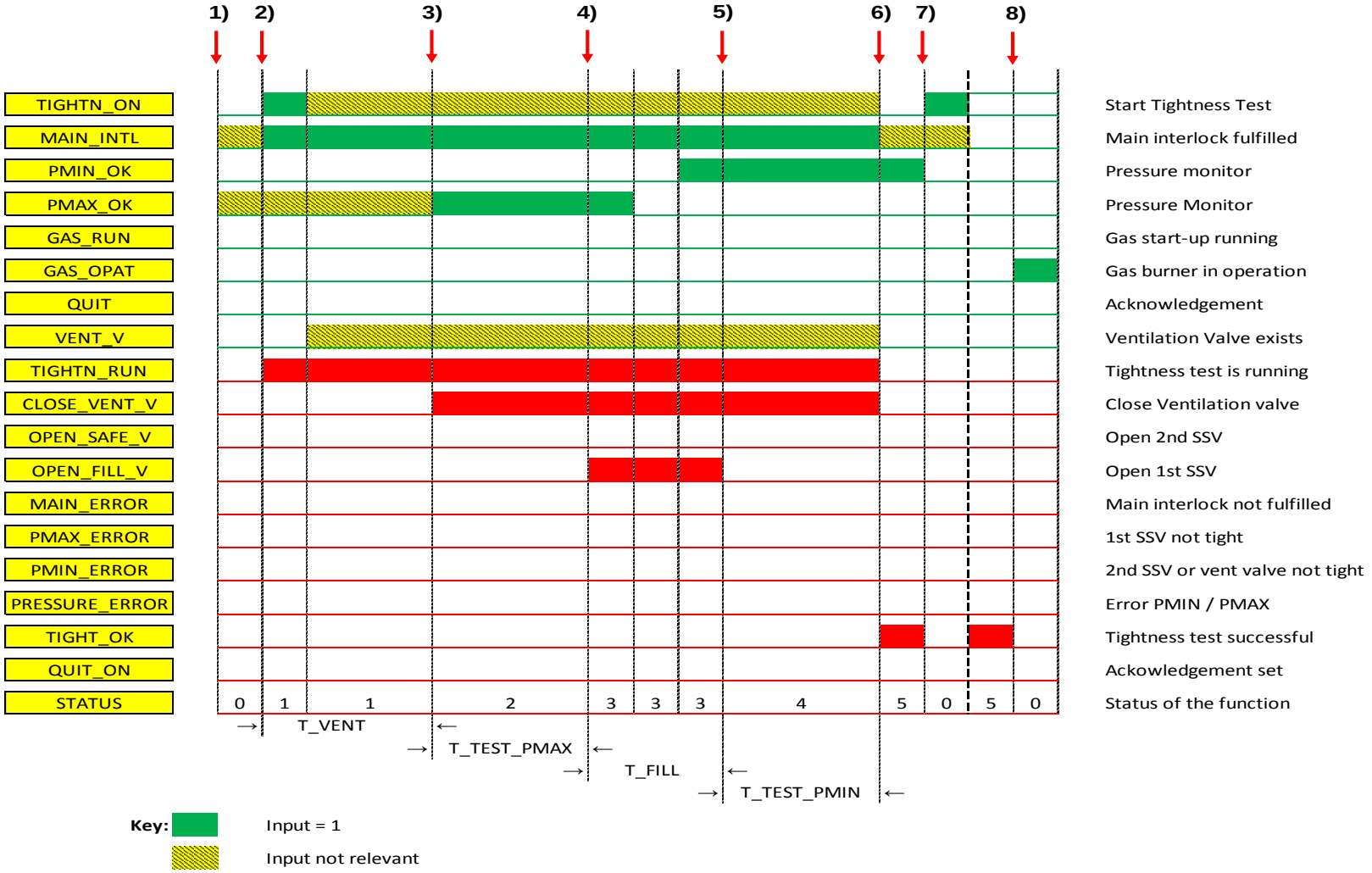
Table 3-6 Status of the function F_TIGHTN

No.	Status	Description
0	Initial State	The function is in the initial state. To start the test, a rising edge at input TIGHTN_ON is required
1	Ventilation	The gas tightness test has been started successfully The valve space is vented (Duration: T_VENT)
2	Test phase 1: Tightness test SSV 1 Monitoring for pressure rise	The first safety shut-off valve is checked for leaks. The pressure must not rise above P_MAX during T_PMAX
3	Filling the space between the valves	The tightness test of the first safety shut-off valve was successful. The first safety shut-off valve is opened and the valve space is filled with gas
4	Test phase 2: Tightness test SSV 2 Monitoring for pressure drop	The second safety shut-off valve (and if equipped with the vent valve) is checked for leaks. The pressure must not drop below PMIN_OK during T_PMIN
5	Tightness test successful	The tightness test has been successfully completed. The output TIGHT OK is set. The initial state is achieved by a 1 signal at GAS_OPAT
7	Error	The system has detected an error. The test was aborted or cannot be started. These outputs provide information about the error situation. The error can be reset with a rising edge at QUIT (if the error does not exist anymore).

3.4.5 Time diagram

In the pictures below, the time sequence of the function F_TIGHTN is shown during operation. Once with vent valve (VENT_V = FALSE) and once without vent valve (VENT_V = TRUE).

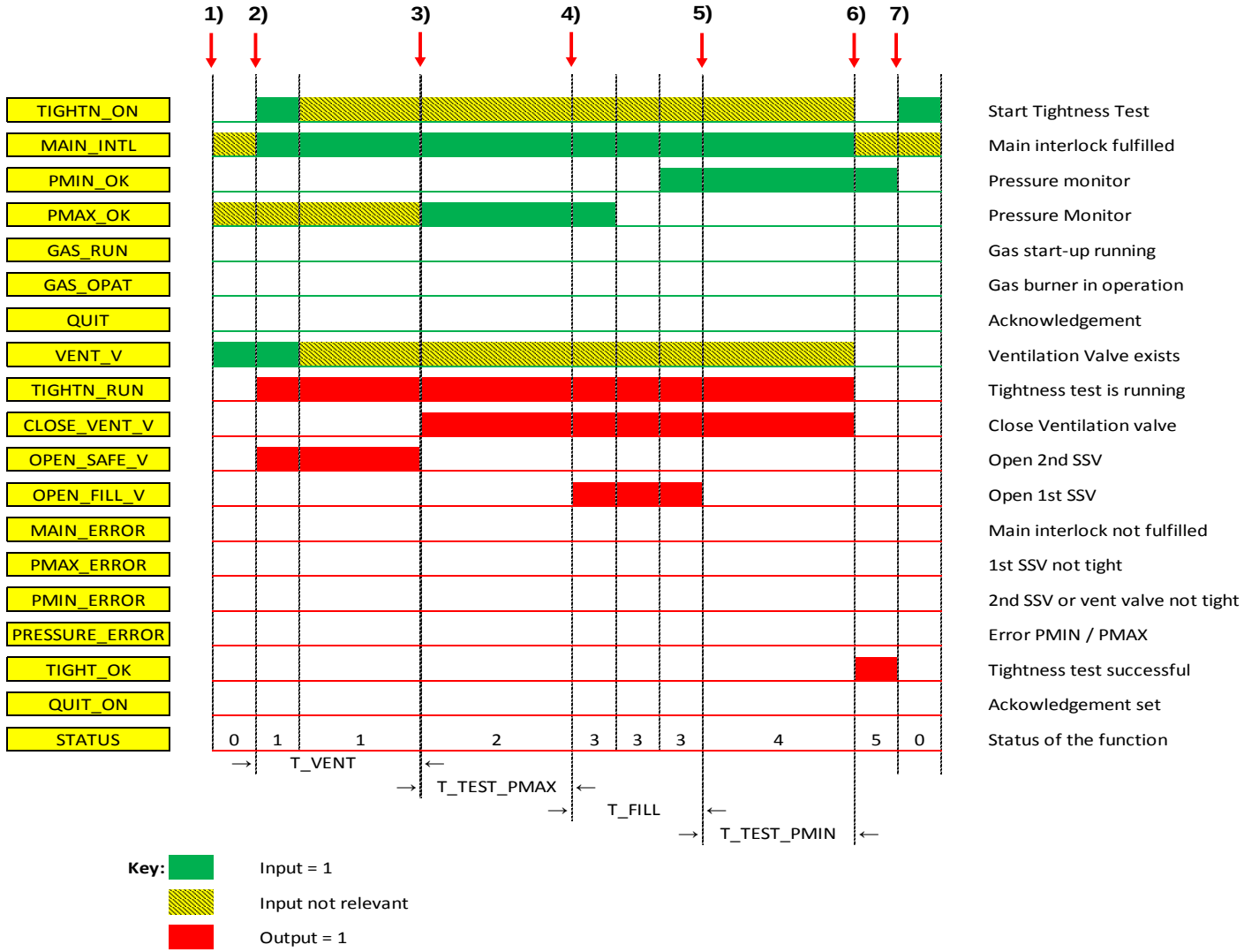
Figure 3-13 Time diagram of the function F_TIGHTN with vent valve



Description of the signal sequence with vent valve:

1. Prior to the test, the gas pressure in the space is equal to the air pressure (PMAX_OK = 1)
   VENT_V = 0 must be set (vent valve between the two SSV available)
2. The operating conditions are fulfilled (MAIN INTL = 1)
   The gas tightness test is started by means of a push button (rising edge at TIGHTN_ON)
   It is reported that the gas tightness test runs (TIGHTN_RUN = 1)
   The timer starts T_VENT
3. The vent valve is closed (CLOSE_VENT_V = 1)
   The timer starts T_TEST_PMAX
4. If within T_TEST PMAX no pressure increase is detected (PMAX_OK is still 1), the timer T_FILL is started
   Safety shut-off valve 1 is opened (OPEN_FILL_V = 1) and the space between the valves is filled with fuel
5. SSV 1 is closed after T_FILL has elapsed (OPEN_FILL_V = 0)
   The timer T_TEST_PMIN starts
6. If no pressure drop occurs within T_TEST_PMIN (PMIN_OK is still 1), the message: gas tightness test is successfully completed (TIGHT_OK = 1) is shown
   TIGHTN_RUN is reset
7. The 1-signal at TIGHT_OK is reset with a rising edge at input TIGHTN_ON
8. TIGHT_OK can also be reset with GAS_OPAT

Figure 3-14 Time diagram of the function F_TIGHTEN without vent valve

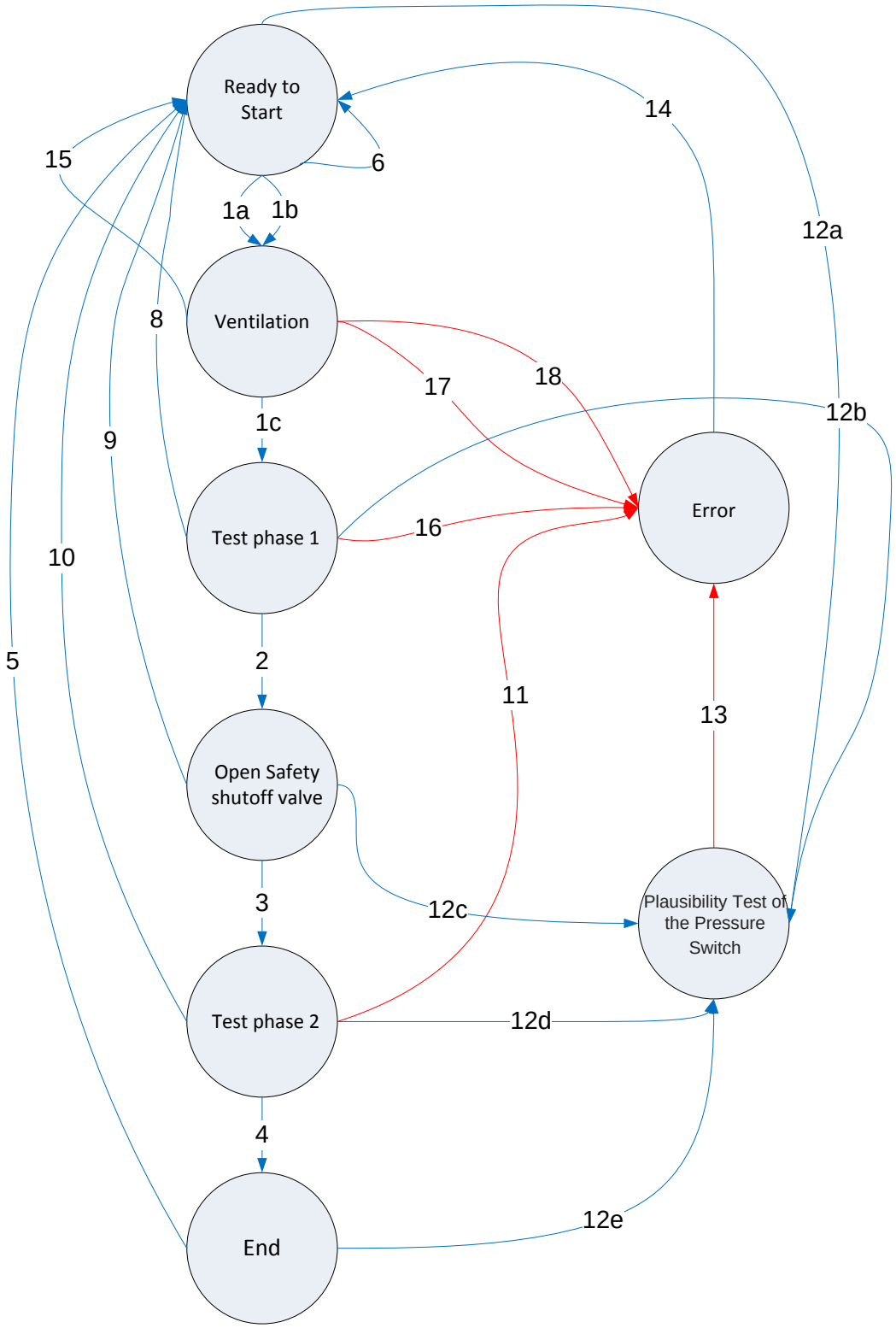


Description of the signal sequence without air vent:

1. Prior to the test, VENT_V must have 1-Signal (means no vent valve between the safety shut-off valves)
2. The operating conditions are fulfilled (MAIN INTL = 1)
   The gas tightness test is started by means of push a button (rising edge at TIGHTN_ON)
   It is reported that the gas tightness test runs (TIGHTN_RUN = 1)
   The second SSV2 is opened and the space is vented
   The timer T_VENT starts
3. The second SSV is closing
   The timer T_TEST_PMAX starts
4. If within T_TEST PMAX no pressure increase is detected (PMAX_OK is still 1), the timer T_FILL is started
   Safety shut-off valve 1 is opened (OPEN_FILL_V = 1) and the space between the valves is filled with fuel
5. SSV 1 is closed after T_FILL has elapsed (OPEN_FILL_V = 0)
   The timer T_TEST_PMIN starts
6. If no pressure drop occurs within T_TEST_PMIN (PMIN_OK is still 1), the message is shown: gas tightness test is successfully completed (TIGHT_OK = 1)
   TIGHTN_RUN is reset
7. The 1-signal at TIGHT_OK is reset with a rising edge at input TIGHTN_ON

3.4.6 Status graph

Figure 3-15 Status graph of the function F_TIGHTN



Explanation of the status graph

Table 3-7 Status graph of the function block F_TIGHTN transition

Transition	Condition for Transition
1a	TIGHTN_ON == rising edge **AND** GAS_RUN == 0 **AND** GAS_OPAT == 0 **AND** MAIN_INTL == 1 VENT_V == 0
1b	TIGHTN_ON == rising edge **AND** GAS_RUN == 0 **AND** GAS_OPAT == 0 **AND** MAIN_INTL == 1 **AND** VENT_V == 1
1c	Venting Time T_VENT elapsed **AND** PMAX_OK == 1
2	Safety Time T_TEST_PMAX elapsed
3	PMAX_OK == 0 **AND** PMIN_OK == 1 **AND** T_FILL elapsed
4	Safety Time T_TEST_PMIN elapsed
5	TIGHTN_ON == rising edge **OR** GAS_OPAT == 1
6	TIGHTN_ON == rising edge **AND** (GAS_RUN == 1 **OR** GAS_OPAT == 1)
8	GAS_RUN == 1 **OR** GAS_OPAT == 1
9	GAS_RUN == 1 **OR** GAS_OPAT == 1
10	GAS_RUN == 1 **OR** GAS_OPAT == 1
11	PMIN_OK == 0 **OR** MAIN_INTL == 0
12 a-e	PMAX_OK == TRUE **AND** PMIN_OK == TRUE
13	TIMER T_FAIL_P elapsed **OR** MAIN_INTL == 0
14	QUIT == 1 **AND** (PMAX_OK == 0 **OR** PMIN_OK == 0)
15	GAS_RUN == 1 **OR** GAS_OPAT == 1
16	PMAX_OK == 0 **OR** MAIN_INTL == 0
17	MAIN_INTL == 0
18	T_VENT elapsed **AND** PMAX_OK == 0

Table 3-8 Status graph of the function block F_TIGHTN Outputs

Status		Outputs, to be switched
Ready to Start		No outputs switched STATUS := “0”
Ventilation		Venting Time T_VENT is running TIGHTN_RUN := TRUE CLOSE_VENT_V := FALSE **For VENT_V == 1** OPEN_SAFE_V := TRUE **For VENT_V == 0** OPEN_SAFE_V := FALSE STATUS := “1”
Test Phase 1		CLOSE_VENT_V := TRUE TIGHT_RUN := TRUE OPEN_SAFE_V := FALSE Safety Time T_TEST_PMAX is running STATUS := „2“
Open Safety Shut-Off Valve		OPEN_FILL_V := TRUE Fill Time T_FILL is running STATUS := “3”
Test Phase 2		OPEN_FILL_V := FALSE Safety Time T_TEST_PMIN is running STATUS := „4“
End		TIGHT_OK := TRUE CLOSE_VENT_V := FALSE TIGHTN_RUN := FALSE STATUS := “5”
Error	from 16, 18	PMAX_ERROR := TRUE
	from 11	PMIN_ERROR := TRUE
	from 13	PRESSURE_ERROR := TRUE
	from 11, 13, 16, 17	MAIN_ERROR := TRUE TIGHTN_RUN := FALSE
	from all of the Transitions	STATUS := “7”
Plausibility Test of the Pressure Switch		Timer T_FAIL_P starts

3.5 Function for controlling a pilot burner (F_IGNTR)

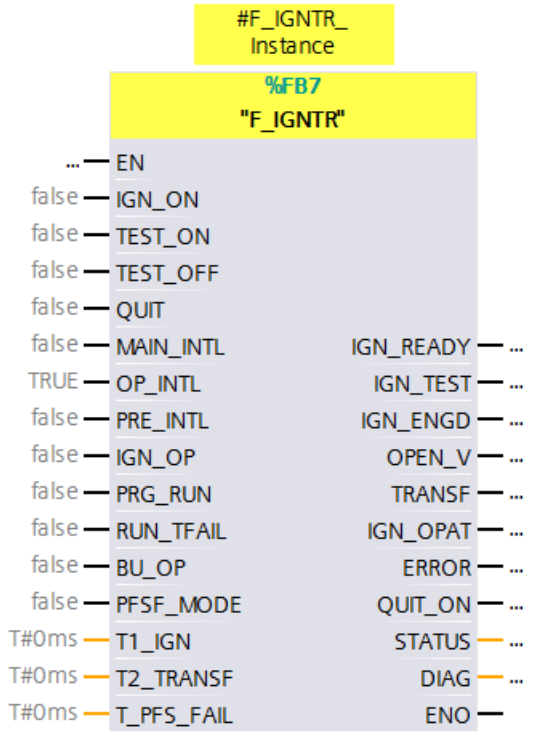
3.5.1 Introduction

Controlling a pilot burner is realized with the fail-safe function F_IGNTR.

If required, the function can also be used to control small direct ignited burners. For example: If the ignition does not have to be carried out at reduced power and the ignition position of the fuel valve and the air damper must not be monitored.

The function takes over the control of the valves to supply fuel to the pilot burner and control the ignition transformer. In case an error occurs during ignition, the components controlled by the function are brought into a safe state. If the main burner is not ignited, the function may be used to carry out an ignition test. The safety time and the pulse duration of the spark must be parameterized at the corresponding inputs.

Figure 3-16 function block F_IGNTR



NOTE When using this function, the function blocks F_TON (FB 185) F_TP (FB184) and F_BO_W (FC176) must exist in the system block folder.

3.5.2 Connections

The default value for all inputs of data type BOOL is 0-Signal
The default value for all inputs of data type TIME is T#0ms.

Table 3-9 Inputs/Outputs Parameter description of the function F_IGNTR

Name	Data type	Description
Inputs		
IGN_ON	BOOL	**Switch on Ignition** • The ignition is switched on with a 1-Signal at this Input if the main interlock is fulfilled • A possibly running ignition test is aborted
TEST_ON	BOOL	**Switch on Ignition Test** • The igniton test is activated with a rising edge at this input, if main interlock is fulfilled • TEST_OFF must be applied in this case, with 1-Signal
TEST_OFF	BOOL	**Switch off Ignition Test** • The ignition test is deactivated with a 0-Signal at TEST_OFF
QUIT	BOOL	**Error Acknowledgement** • Error messages are reset at this input • Acknowledgement requires a rising edge
MAIN_INTL	BOOL	**Main Interlock fulfilled** • The ignition is operational if there is a 1-Signal at this input • The Ignition is interrupted or not started if there is a 0-Signal at this input
OP_INTL	BOOL	**Operation Interlock** • Conditions which are relevant only from actual ignition time need to be connected to this input • The ignition can only be started if there is a 1-signal at this input • With 0-Signal the ignition is interrupted
PRE_INTL	BOOL	**Start Interlock** • Conditions that are prerequisites for the start or before the start of ignition must be connected to this input • The ignition can only be started if there is a 1-Signal at this input
IGN_OP	BOOL	**Pilot Flame detected** • Input from the Pilot flame detector • IGN_OP=0: Pilot flame **not** detected • IGN_OP=1: Pilot flame detected
PRG_RUN	BOOL	**Other Programs in progress** • As long as a 1-Signal is valid at this input, other functions are in operation which prevent to switch on the igniter (e.g. pre-purge is running)
RUN_TFAIL	BOOL	**Run Time Exceeded** • Input for Run Time Monitoring • A 1-Signal at this input prevents further ignition attempts of the burner

Name	Data type	Description
BU_OP	BOOL	**Burner in Operation** • As long as a 1-Signal is valid at this input, other burners are in operation which prevents to switch on the ignition test
PFSF-MODE	BOOL	**Stray Light Test / Pilot Flame Monitoring On / Off** • Plausibility check of the pilot flame: An error is detected If the pilot flame is reported (IGN_OP = 1) longer than the time T_PFS_FAIL, although the pilot burner is not in operation (IGN_OPAT = 0) • PFSF_MODE=0, Stray Light Test / Plausibility check is activated • PFSF_MODE=1, Stray Light Test / Plausibility check is de-activated • If only one flame detector is used for monitoring the pilot burner and main burner, the GAS_OPAT output of F_GAS_BU or OIL_OPAT output of F_OIL_BU must be interconnected with this input to avoid an unintentional error message (See chapter 4.3.3, Figure 4-5)
T1_IGN	TIME	**Safety Time Pilot Burner** • Within this safety time a pilot flame must be detected
T2_TRANSF	TIME	**Time for actuation pulse of the Ignition Transformer** • For this time the ignition transformer is activated
T_PFS_FAIL	TIME	**Monitoring Time for Stray Light Test / Pilot Flame Detector** • If a pilot flame is reported longer than the time T_PFS_FAIL (IGN_OP = 1), although ignition is not in operation (IGN_OPAT = 0), an error is detected
Ausgänge		
IGN_ READY	BOOL	**Ignition Operational** • 1-Signal = Main-Interlock and Start-Interlock fulfilled, no error stored and ignition attempts allowed • 0-Signal = Ignition not operational
IGN_TEST	BOOL	**Ignition Test in Progress** • Reports that the function is in test mode
IGN_ENGD	BOOL	**Control of the Pilot Burner** • Ignition is in operation • Main interlock and Operation interlock is fulfilled • Ignition or Ignition-Test were started
OPEN_V	BOOL	**Control of Ignition-Gas-Valve** • 1-Signal: Ignition-Gas-Valves will be opened • 0-Signal: Ignition-Gas-Valves will be closed
TRANSF	BOOL	**Control of Ignition-Transformer** • 1-Signal: Ignition-Transformer is activated • 0-Signal: Ignition-Transformer not activated
IGN_OPAT	BOOL	**Pilot-Burner in operation after T_IGN** • 1-Signal: the pilot burner was ignited within the safety time • 0-Signal: the pilot burner is not in operation If the ignition is switched off (IGN_ON or TEST_OFF = 0) and the flame is still detected (IGN_OP = 1), the output remains set. The output is reset if the flame is not detected anymore

Name	Data type	Description
ERROR	BOOL	**Ignition Error** • 1-Signal: one error ore more than one error detected • 0-Signal: no error in ignition process detected
QUIT_ON	BOOL	**Acknowledgement at the Input QUIT** • 1-Signal: 1-Signal at the input QUIT • 0-Signal: 0-Signal at the input QUIT
STATUS	INT	**Status** • The number at this output indicates the current status of the function block (See chapter 3.5.4) **This output is for information only and may not be used for fail-safe connection!**
DIAG	WORD	**Diagnostic-Word** • Information about the function status and errors are displayed at this output word (see chapter 3.5.5) **This output is for information only and may not be used for fail-safe connection!**

NOTE	**Please note that the parameterized safety times comply with the relevant standards**

3.5.3 Functionality

Basic Connections

IGN_ON must be connected with the corresponding output of F_GAS_BU or F_OIL_BU.

The input **IGN_OP** must be connected with the signal from the flame detector, (examples and options, see chapter 4.3.3).

If several ignition attempts are admissible for the application, a counter must be connected at the input **RUN_TFAIL** at which the number of ignition attempts is parameterized. If the maximum allowed number of ignition attempts is reached, the counter need to switch input RUN_TFAIL to TRUE. Further attempts are not possible.

PRG_RUN is to be connected with the corresponding outputs of functions for pre-purging (PRE_PURGE_RUN of F_PRE_PURGE) or carrying out the leak test (TIGHTN_RUN of F_TIGHTN). The input must not be connected to the output of the CL_RUN of F_OIL_CLEAN. Otherwise, it would not be possible to start the pilot burner to blow out the oil burner.

The closed state of the SSV, the confirmation of the successful completion of the gas tightness tests (TIGHT_OK of F_TIGHTN) and the pre-purge (PRE_PURGE_OK from F_PRE_PURGE) are either connected to **PRE_INTL** or at the PRE_INTL of F_GAS_BU or F_OIL_BU. If the function is used for direct control of the burner, the above mentioned enable signals need to be connected with the PRE_INTL of this function.

The output **IGN_READY** can be connected to the input PRE_INTL of the block F_GAS_BU or F_OIL_BU.

If a combination of main burner and pilot burner is used, the output **IGN_OPAT** must be connected to the input IGN_OP of F_GAS_BU or F_OIL_BU (See chapter 4.3.3).

The output **TRANSF** is used to control the ignition transformer.

Readiness of the function

The readiness of the function is indicated by IGN_READY = TRUE if:

- Main interlock is fulfilled (MAIN_INTL = TRUE)
- Start interlock is fulfilled (PRE_INTL = TRUE)
- A (further) ignition attempt is permitted (RUN_TFAIL = FALSE)
- Flame signal is not detected (IGN_OP = FALSE) or the Stray light test has been deactivated (PFSF_MODE = TRUE)
- No error has occurred (ERROR = FALSE)
- The igniter is not in operation (IGN_OPAT = FALSE)

The function can be started by a rising edge at IGN_ON or a 1-Signal at TEST_ON and TEST_OFF, if IGN_READY is set and no program is running (PRG_RUN = FALSE),

As long as the function is not yet started, a start attempt with the conditions not being fulfilled will lead to a diagnosis at DIAG (see chapter 3.5.5).

Start of the Test-Mode

The function can be started in test mode with a 1-Signal at TEST_ON and TEST_OFF. The conditions are: IGN_READY is set (see above), the burner is not in operation (BU_OP = FALSE) and no other program is running (PRG_RUN = FALSE).

If the test mode was started successful, then this is indicated by IGN_TEST = TRUE.

Start of the Igniter

The ignition is started with a 1-Signal at IGN_ON or TEST_ON and TEST_OFF. The successful start of the function is indicated at the IGN_ENGD (1-Signal), in test mode is in addition IGN_TEST set.

The operation interlocks need to be unlocked one cycle after the start of the igniter operation (OP_INTL = TRUE). The ignition operation is aborted if this condition is not fulfilled and an error is indicated (ERROR = TRUE).

The output OPEN_V delivers a 1-Signal and the ignition valve(s) open(s) if the operation interlocks are unlocked within one cycle after the start of the operation. In addition to that the ignition transformer is controlled for the parameterized time (T2_TRANSF) (TRANSF=TRUE).

The safety time T1_IGN starts as soon the valves open. If a flame is detected (IGN_OP = TRUE) after elapse of the safety time, IGN_OPAT delivers a 1-Signal which indicates the successful ignition (Pilot burner is in operation)

If no flame signal is detected within T1_IGN, (IGN_OP = FALSE) an error message is displayed (ERROR = TRUE), the ignition is aborted, the valves are closed (OPEN_V = FALSE) and the ignition transformer is switched off.

Change between Test-Mode and Normal-Operation

A Change form test mode (IGN_TEST = TRUE) to the normal operation is possible at any time by a 1 signal at IGN_ON. The test mode is ended and IGN_TEST reset.

Cancel the function of the pilot burner (Manual)

The function of the pilot burner can be stopped manually at any time with a 0-Signal at IGN_ON or TEST_OFF. The valves are closed (OPEN_V = FALSE), the ignition transformer switched off (TRANSF = FALSE) and the function is reset to its initial state (IGN_ENGD = FALSE).

Condition got lost

If the message, main burner in operation (BU_OP = TRUE) is displayed during the active test-mode, the test mode is canceled. No ERROR message is shown.

ERROR

An Error message is displayed if:

- No flame was detected (IGN_OP = FALSE) after the safety time (T1_IGN) has elapsed
- During the ignition process or in operation of the (pilot-) burner (IGN_OPAT = TRUE) the operational interlock or the main interlock is not anymore fulfilled (OP_INTL = FALSE or MAIN_INTL = FALSE).
- A Flame is detected after the time T_PFS_FAIL has elapsed and the burner is switched off (IGN_ENGD = FALSE and IGN_OPAT = FALSE) if the stray light test is active (PFSF_MODE = FALSE)

Stray light test is not monitored if PFSF_MODE has 1-Signal.

An error (ERROR_OP = TRUE) is displayed at the diagnosis word of the function F_IGNTR (see chapter 3.5.5).

If an error occurs during ignition, the ignition process will stopped (IGN_ENGD = FALSE), the ignition valves are closed (OPEN_V = FALSE) and the ignition transformer is switched off (TRANSF = FALSE).

Acknowledgment

If the system has detected an error, the error remains until it has been acknowledged. An error can be acknowledged by a rising edge at the input QUIT. The corresponding error messages are reset (PMAX_ERROR = FALSE, PMIN_ERROR=FALSE, PRESSURE_ERROR = FALSE, MAIN_ERROR = FALSE).

At the output QUIT_ON the current status of the input QUIT can be read.

Diagnostic messages can also be acknowledged by a rising edge at QUIT (see chapter 3.5.5).

3.5.4 Status

At the output STATUS the actual status of the function can be read. This output is used solely for information and may not be used for fail-safe interconnection.

Table 3-10 Status of the function F_IGNTR

Nr.	Status	Description
0	Initial State	The function is in the initial state. To start the (Pilot-) Burners, a 1-Signal at IGN_ON for the Normal-Operation or a 1-Signal at TEST_ON and TEST_OFF for the Test-Mode is required
1	Start-up Normal-Operation	The ignition (Pilot-) Burner is started (IGN_ENGD = 1). The safety shut-off valves will be opened and the ignition transformer will be controlled. The safety time (T1_IGN) runs down
2	Normal-Operation: Reset of the ignition transformer	The time to control the ignition transformer (T2_TRANS) has elapsed
3	Normal-Operation: Pilot Burner in operation	The safety time has elapsed and the burner was ignited successfully (IGN_OP = TRUE). The burner is in operation
4	Test-Mode: Start-up	The test mode was started (IGN_TEST = TRUE). The safety shut-off valves will be opened and the ignition transformer controlled. The safety time (T1_IGN) runs down.
5	Test-Mode: Reset the ignition transformer	The time to control the ignition transformer has elapsed (T2_TRANS)
6	Test-Mode: Igniter in operation	The safety time has elapsed and the burner was ignited successfully (IGN_OP = TRUE), the burner is in operation
7	Error	The function has detected an error. A detailed diagnosis is possible by evaluating the output DIAG (see chapter 3.5.5). The error can be reset with a rising edge at QUIT (if the error does not exist anymore).

3.5.5 Diagnose

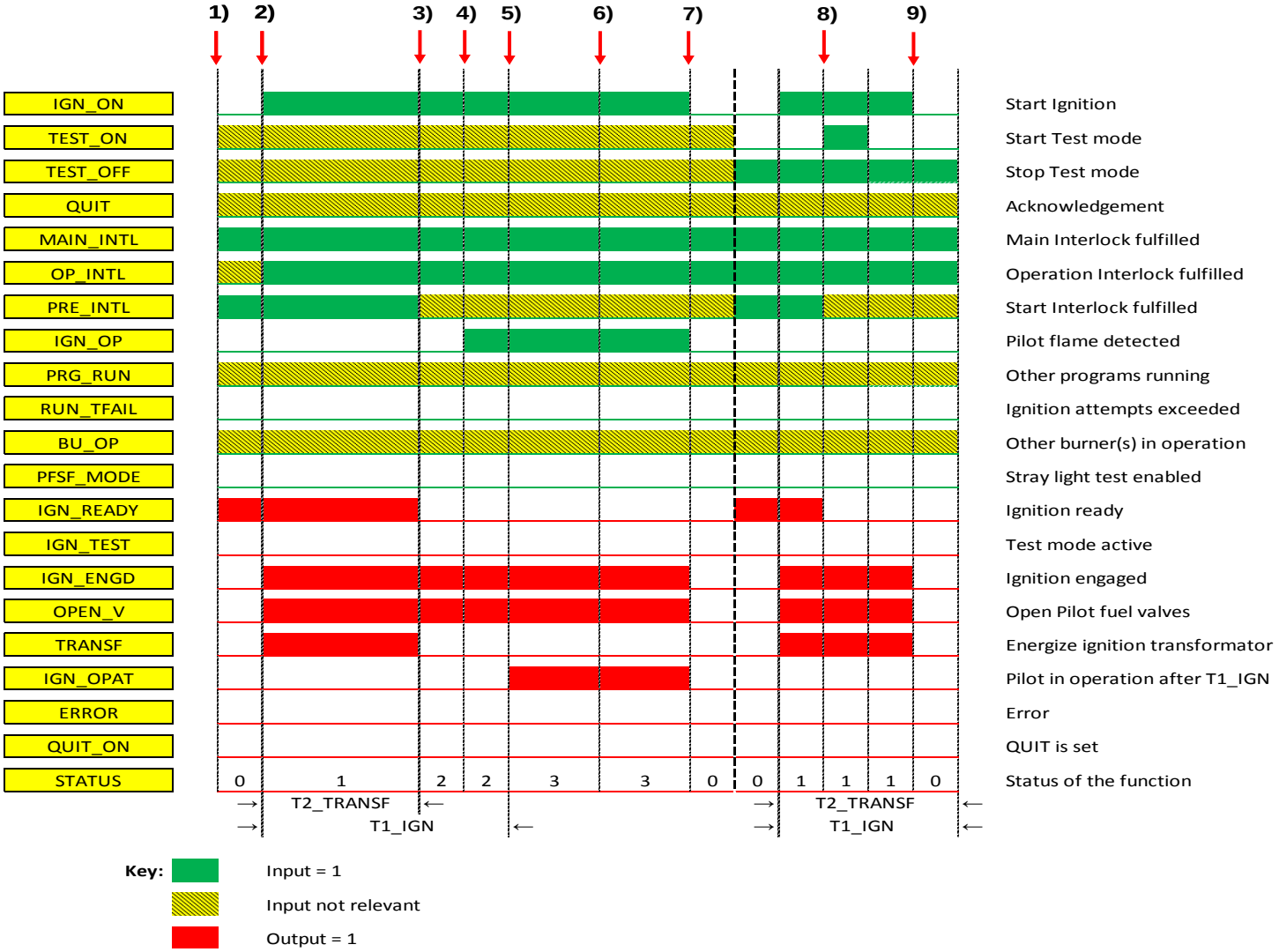
Table 3-11 Diagnose of the Function F_IGNTR

Bit Nr.	Description	Reset-Conditions
0	Start-Command or Test-Start-Command is activated, while main interlock is inactive (IGN_ON=1 or TEST_ON=1 and MAIN_INTL=0)	• MAIN_INTL=1 • Rising edge at QUIT
1	Start-Command or Test-Start-Command is set while no further attempt of ignition is permitted (IGN_ON=1 or TEST_ON=1 and RUN_TFAIL=1)	• RUN_TFAIL=0 • Rising edge at QUIT
2	Start-Command or Test-Start-Command is set while an unacknowledged error is still valid at the igniter (IGN_ON=1 or TEST_ON=1 and ERROR=1)	• Rising edge at QUIT
3	Reserve	
4	Operation interlock not fulfilled (OP_INTL=0)	• Rising edge at QUIT
5	Reserve	•
6	Signal from the Pilot-Flame-Detector is missing (IGN_OP=0), flame failed during operation (IGN_OPAT =1)	• Rising edge at QUIT
7	Reserve	
8	Test-Start-Command is set during other programs are running (TEST_ON=1 und PRG_RUN=1)	• PRG_RUN=0 • Rising edge at QUIT
9	Test-Start-Command is set, switch off Ignition-Test is not set (TEST_ON=1 and TEST_OFF=0)	• TEST_OFF=1 • Rising edge at QUIT
10	Test-Start-Command is set while a burner is in operation (TEST_ON=1 und BU_OP=1)	• BU_OP=0 • Rising edge at QUIT
11	Test-Start-Command is set while the pilot burner is activated (TEST_ON=1 and IGN_ON=1)	• IGN_ON=0 • Rising edge at QUIT
12	Reserve	
13	A flame is detected by the pilot flame detector although ignition is not in operation (IGN_OP=1 and IGN_ENGD=0)	• Rising edge at QUIT
14	The pilot burner could not be started within the safety time (T_IGN elapsed)	• Rising edge at QUIT
15	Reserve	

3.5.6 Time diagram

The following figures show the signal sequence of the F_IGNTR function, in normal operation and in test mode.

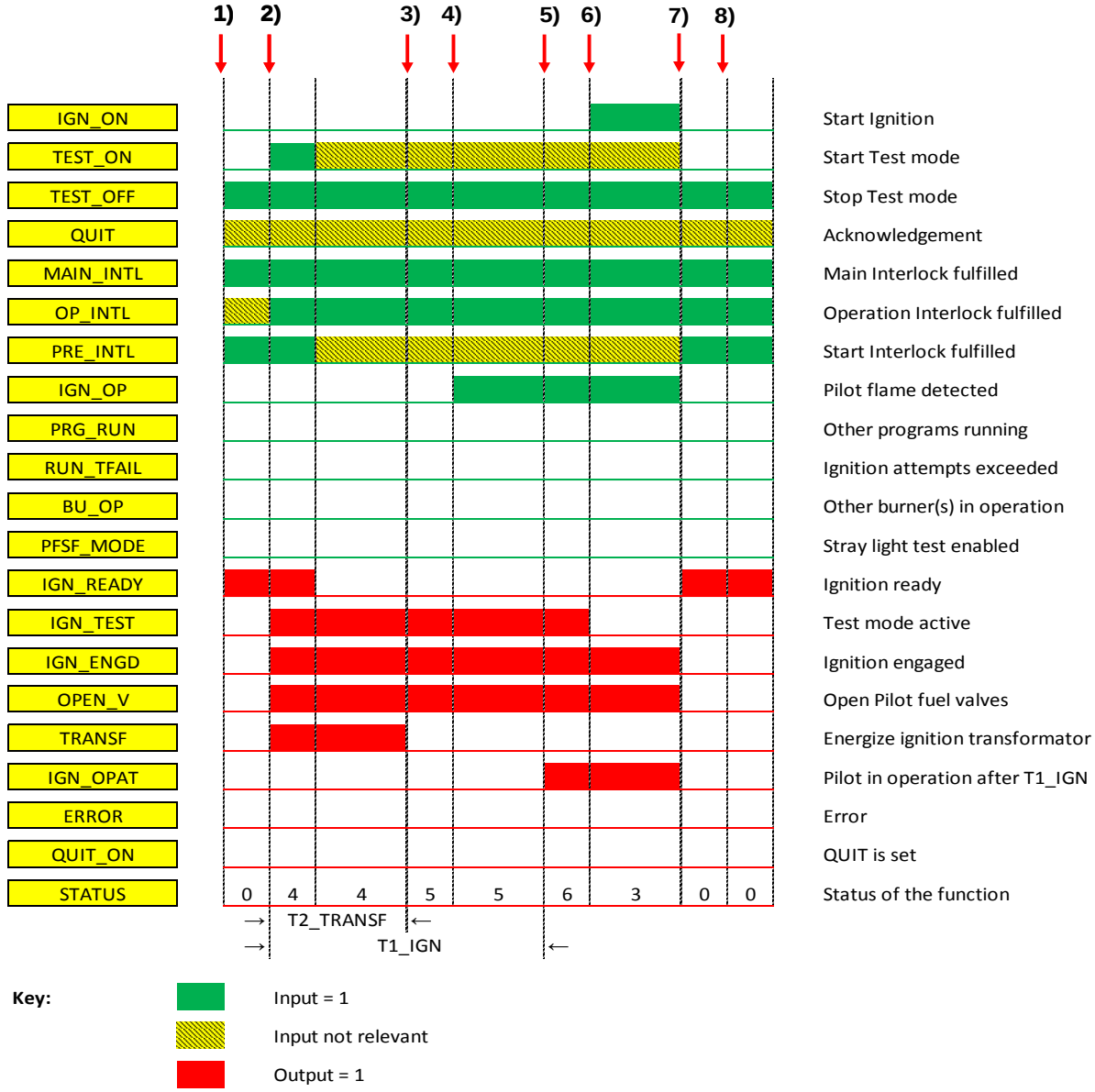
Figure 3-17 Time diagram of the function F_IGNTR in normal operation



Description of the signal sequence:

1. Main interlock fulfilled (MAIN_INTL=1)
   Start interlock fulfilled (PRE_INTL = 1)
   Ignition operational (IGN_READY=1)
2. Operational interlock fulfilled (OP_INTL=1)
   Start the ignition (IGN_ON=1)
   Message ignition is activated (IGN_ENGD=1)
   The ignition gas valves are opened (OPEN_V=1)
   The ignition transformer is activated (TRANSF=1)
   The timer T1_IGN for the ignition safety time starts
   The timer T2_TRANSF for the ignition transformer starts
3. The time T2_TRANSF has elapsed
   The ignition transformer is no longer activated (TRANSF = 0)
4. IGN_OP=1: the flame detector has a flame detected
5. If T1_IGN has elapsed and a flame is detected (IGN_OP = 1) the message is shown: pilot burner has been ignited successfully (IGN_OPAT = 1)
6. Switch off the ignition (IGN_ON=0)
   Ignition is not in operation anymore (IGN_ENGD = 0)
   The ignition valves are closed Die (OPEN_V = 0)
7. The ignition flame will be reset (IGN_OP = 0)
   The message IGN_OPAT will be reset
8. The ignition test is started if the ignition command is available
9. The ignition is aborted if the IGN_ON is reset prior to the ignition

Figure 3-18 Time diagram of the function F_IGNTR in Test-Mode

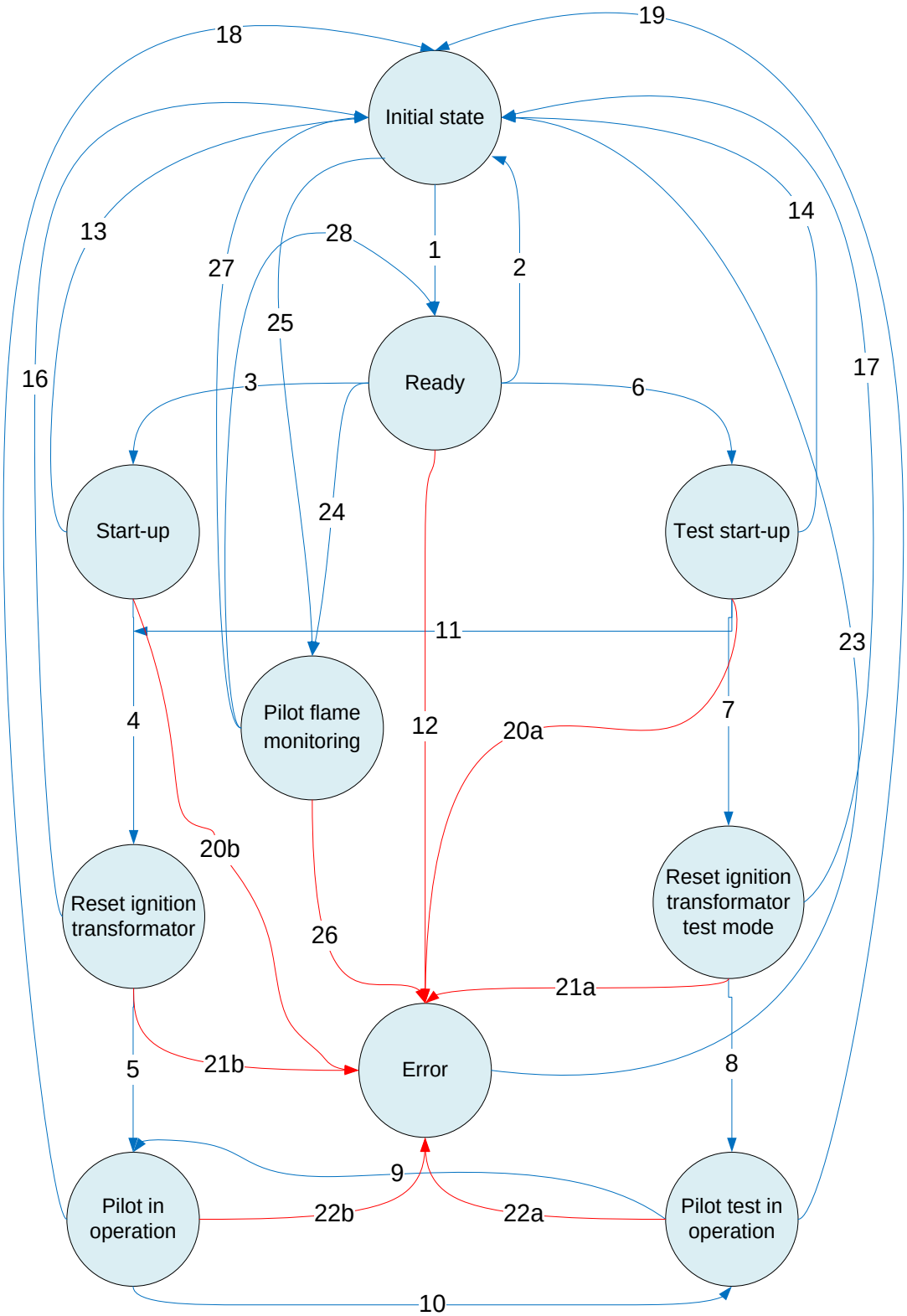


Description of the signal sequence in the Test-Mode:

1. The main interlocks and the start interlocks are fulfilled (MAIN_INTL=1, PRE_INTL=1)
   The ignition is ready for use (IGN_READY=1)
2. Interlocks for operation fulfilled (OP_INTL = 1)
   TEST_OFF and TEST_ON will be set
   Start of the ignition test with a positve edge at the input TEST_ON)
   Message that the pilot burner is activated (IGN_ENGD=1)
   The ignition gas valves are opened (OPEN_V=1)
   The ignition transformer is activated (TRANSF=1)
   The timer T1_IGN for the ignition safety time starts
   The timer T2_TRANSF for the ignition transformer starts
3. T2_TRANSF has elapsed, the ignition transformer is not activated anymore (TRANSF=0)
4. IGN_OP=1: the pilot flame is detected by the flame detector
5. If T1_IGN has elapsed and a flame is detected (IGN_OP = 1) the message is shown: pilot burner has been ignited successfully (IGN_OPAT = 1)
6. Change to the normal operation mode, IGN_ON = 1
   Ignition-Test-Mode is stopped (IGN_TEST = 0)
7. Switch off the ignition (IGN_ON=0)
   Ignition is not activated anymore (IGN_ENGD=0)
   The ignition gas valves will be closed (OPEN_V=0)
8. Pilot flame is extinguished (IGN_OP=0)
   Message at the output IGN_OPAT will be reset

3.5.7 Status graph

Figure 3-19 Status graph of the of the function F_IGNTR



Explanation of the Status graph

Table 3-12 Status graph of the function F_IGNTR Transition

Transition	Condition for Transition
1	MAIN_INTL == 1 **AND** PRE_INTL == 1 **AND** (IGN_OP == 0 **OR** PFSF_MODE == 1) **AND** RUN_TFAIL = 0
2	MAIN_INTL == 0 **OR** PRE_INTL == 0 **OR** RUN_TFAIL == 1
3	RUN_TFAIL == 0 **AND** ERROR == 0 **AND** OP_INTL == 1 **AND** IGN_ON == 1
4	T2_TRANSF elapsed
5	IGN_OP == 1 **AND** T1_IGN elapsed
6	PRG_RUN == 0 **AND** ERROR == 0 **AND** OP_INTL == 1 **AND** RUN_TFAIL == 0 **AND** TEST_ON == 1 **AND** TEST_OFF == 1 **AND** IGN_ON == 0
7	T2_TRANSF elapsed
8	IGN_OP == 1 **AND** T1_IGN elapsed
9, 11	IGN_ON == 1
10	IGN_ON == 0 **AND** TEST_ON == 1 **AND** TEST_OFF == 1 **AND** BU_OP == 0
12	OP_INTL == 0 **AND** (IGN_ON == 1 **OR** (TEST_ON == 1 **AND** TEST_OFF == 1))
13	IGN_ON == 0
14	TEST_OFF == 0 **OR** BU_OP == 1
16	IGN_ON == 0
17	BU_OP == 1 **OR** TEST_OFF == 0
18	IGN_ON == 0
19	BU_OP == 1 **OR** TEST_OFF == 0
20a, 20b	MAIN_INTL == 0 **OR** OP_INTL == 0
21a, 21b	MAIN_INTL == 0 **OR** OP_INTL == 0 **OR** T1_IGN elapsed
22a, 22b	MAIN_INTL == 0 **OR** OP_INTL == 0 **OR** IGN_OP == 0
23	QUIT == rising edge

Transition	Condition for Transition
24, 25	PFSF_MODE == 0 **AND** IGN_OP == 1 **and** (IGN_ON == 0 **OR** (TEST_ON == 0 **AND** TEST_OFF == 0))
26	T_PFS_FAIL elapsed
27	PFSF_MODE == 1 **OR** IGN_OP == 0 **AND** (MAIN_INTL == 0 **OR** PRE_INTL == 0 **OR** RUN_TFAIL == 1)
28	PFSF_MODE == 1 **OR** IGN_OP == 0 **AND** (MAIN_INTL == 1 **AND** PRE_INTL == 1 **AND** RUN_TFAIL == 0)

Table 3-13 Status graph of the function block F_IGNTR outputs

Status	Outputs, to be switched
Initial State	No outputs switched STATUS := “0”
Ready	IGN_READY := TRUE
Start-up	IGN_ENGD := TRUE OPEN_V := TRUE IGN_TEST := FALSE T1_IGN and T2_TRANSF start TRANSF := TRUE STATUS := “1”
Test Start-up	IGN_ENGD := TRUE OPEN_V := TRUE IGN_TEST := TRUE T1_IGN and T2_TRANSF start TRANSF := TRUE STATUS := “4”
Reset ignition transformer	TRANSF := FALSE IGN_TEST := FALSE STATUS := “2”
Reset ignition transformer Test mode	TRANSF := FALSE IGN_TEST := TRUE STATUS := “5”
Pilot in operation	T1_IGN elapsed IGN_OPAT := TRUE IGN_TEST := FALSE STATUS := “3”

Status	Outputs, to be switched
Pilot test in operation	T1_IGN elapsed IGN_OPAT := TRUE IGN_TEST := TRUE STATUS := “6”
Pilot flame monitoring	T_PFS_FAIL starts IGN_READY := FALSE
Error	ERROR := TRUE IGN_READY := FALSE IGN_ENGD := FALSE OPEN_V := FALSE TRANSF := FALSE IGN_TEST := FALSE STATUS := “7”

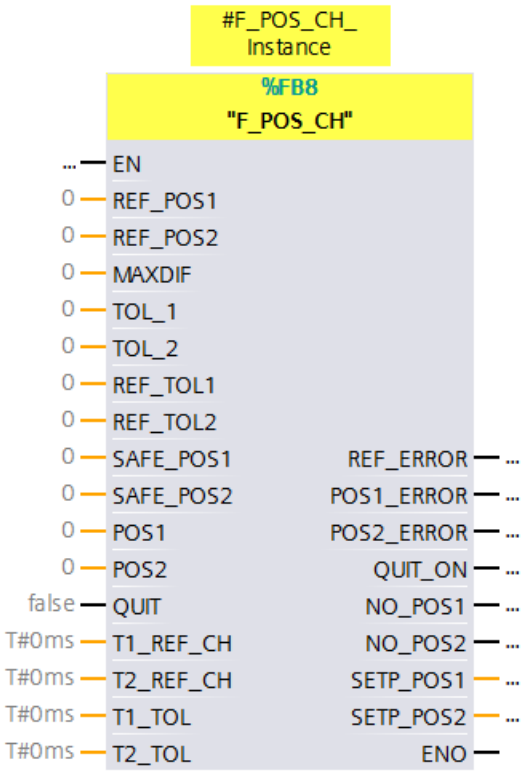
3.6 Function for position monitoring (F_POS_CH)

3.6.1 Introduction

The F_POS_CH function monitors the position of the actuators for air and fuel to maintain a predetermined reference position. In addition, the feature provides the ability to monitor the reference positions for fuel and air for the observance of excess air. If an error occurs, the block sets an error bit and the actuators brought into a predefined (parameterize able) safe position.

The reference positions can be either a fixed or controlled value.

Figure 3-20 function block F_POS_CH



Note When using this function, the function blocks F_TON (FB 185) and F_TP (FB184) must exist in the system block folder.

3.6.2 Connections

The default value for all inputs of data type BOOL is 0-Signal
The default value for all inputs of data type TIME is T#0ms.
The default value for all inputs of data type INT is 0.

Table 3-14 Inputs/Outputs Parameter description of the function F_POS_CH

Name	Data type	Description
Inputs		
REF_POS1	INT	**Reference position for actuator 1 / fuel actuator** • Value for REF_POS1 must be between 0 and 1000 (0.0% - 100.0%) • This input is provided for the fuel actuator • If the REF_POS1 is greater than REF_POS2 + MAXDIF the REF_ERROR is reported, a reverse comparison is not performed. **The module is designed for linear valve characteristics. If the actuator has a non-linear characteristic, then the value must be linearized to be used for this module.**
REF_POS2	INT	**Reference position for actuator 2 / air actuator** • Value for REF_POS2 must be between 0 and 1000 (0.0% - 100.0%) • This input is provided for the air actuator • REF_POS2 can be arbitrarily larger (within limits) than REF_POS1 **The module is designed for linear valve characteristics. If the actuator has a non-linear characteristic, then the value must be linearized, to be used with this module.**
MAXDIF	INT	**Maximum difference REF_POS1 - REF_POS2** • MAXDIF is the value the REF_POS1 can be greater than REF_POS2 • Limited between -1000 and 1000 (-100,0% and 100,0%). • Value "0" means that the actuator for fuel must not be greater than the actuator for air • An error is reported if the value is negative and the excess air is to low
TOL_1	INT	**Tolerance for actuator 1** • Maximum deviation (+/-) for actuator 1 • Limited between 0 and 1000.
TOL_2	INT	**Tolerance for actuator 2** • Maximum deviation (+/-) for actuator 2 • Limited between 0 and 1000.
REF_TOL1	INT	**Difference of the reference position of actuator 1 for which T1_REF_CH starts** • If upon a change of the value for the reference position of actuator 1 the here parameterized value is exceeded, the timer T1_REF_CH is started • Limited between 0 and 1000 (0,0% - 100,0%)

Name	Data type	Description
REF_TOL2	INT	**Difference of the reference position of actuator 2 for which T2_REF_CH starts** • If upon a change of the value for the reference position of actuator 2 the here parameterized value is exceeded, the timer T2_REF_CH is started • Limited between 0 and 1000 (0,0% - 100,0%)
SAFE_POS1	INT	**Safety position for actuator 1** • Position is written to output SETP_POS1 in case of an error • Limited between 0 and 1000 (0,0% - 100,0%)
SAFE_POS2	INT	**Safety position for actuator 2** • Position is written to output SETP_POS2 in case of an error • Limited between 0 and 1000 (0,0% - 100,0%)
POS1	INT	**Measured position actuator 1 (fuel)** • Actual position of the fuel actuator • The measured position of the actuator for fuel and the measured (and scaled) pressure or flow can be connected • Must be scaled between 0 and 1000 (0,0% - 100,0%)
POS2	INT	**Measured position actuator 2 (air)** • Actual position of the air actuator • The measured position of the actuator for air and the measured (and scaled) pressure or flow can be connected • Must be scaled between 0 and 1000 (0,0% - 100,0%)
QUIT	BOOL	**Error Acknowledgment** • Error messages are reset at this input parameter • Acknowledgement only at rising edge
T1_REF_CH	TIME	**Time for actuator 1 (reference position change)** • Time in which the SETP_POS1 output reference position must be read back to POS1
T2_REF_CH	TIME	**Time for actuator 2 (reference position change)** • Time in which the SETP_POS2 output reference position must be read back to POS2
T1_TOL	TIME	**Time for actuator 1 (actuator position change)** • Time in which at POS1 a valid position must be measured again, if the positon was left without a change in the reference position • Reference value: (0Sec < T1_TOL < 3Sec)
T2_TOL	TIME	**Time for actuator 2 (actuator position change)** • Time in which at POS2 a valid position must be measured again, if the positon was left without a change in the reference position • Reference value: (0Sek < T2_TOL < 3Sek)

Name	Data type	Description
Outputs		
REF_ERROR	BOOL	**Reference Error** • The value range 0-1000 has been exceeded • The tolerance was exceeded • The difference value between REF_POS1 and REF_POS2 is exceeded
POS1_ERROR	BOOL	**Position error actuator 1** • Actuator 1 is in a invalid position after the time of T1_REF_CH or T1_TOL has elapsed
POS2_ERROR	BOOL	**Position error actuator 2** • Actuator 2 is in a invalid position after the time of T2_REF_CH or T2_TOL has elapsed
QUIT_ON	BOOL	**Acknowledgment required** • 1-Signal: 1-Signal at the input QUIT • 0-Signal: 0-Signal at the input QUIT
NO_POS1	BOOL	**Actuator 1 in position** • 1-Signal: Actuator 1 is in an invalid position • 0-Signal: Actuator 1 is in a valid position
NO_POS2	BOOL	**Actuator 2 is not in position** • 1-Signal: Actuator 2 is in an invalid position • 0-Signal: Actuator 2 is in a valid position
SETP_POS1	INT	**Position for actuator 1 (fuel)** • Verified position for actuator 1 • Output-range: 0 - 1000 (0,0% - 100,0%)
SETP_POS2	INT	**Position for actuator 2 (air)** • Verified position for actuator 2 • Output-range: 0 - 1000 (0,0% - 100,0%)

NOTE	**Please note that the parameterized safety times comply with the relevant standards.**

3.6.3 Functionality

Basic Connections

The actuating value for fuel is connected to REF_POS1. The actuating value for air supply is connected to REF_POS2.

If the actuating values for air supply and fuel supply are not controlled values but statically fixed values, the value for REF_TOL1 and REF_TOL2 can stay on a 0 value (Note: the time needs to be parameterized anyway)

If the module receives the actuating values (REF_POS1 and REF_POS2) from a controller block, a larger setpoint jump is allowed (based on REF_TOL1 and REF_TOL2) without an error being reported.

The input **POS1** must be set to the actual position of the fuel actuator.

POS2 must be set to the actual position of the air actuator.

SETP_POS1 must be connected with the actuator for fuel.

SETP_POS2 controls the actuator for the air and must be connected with it.

Review of the Parameterization

The function verifies while the program is running whether the value range is fulfilled. If not, the value in question is limited.

The value for **REF_POS1** and **REF_POS2** need to be between the value range 0 and 1000.

An error will be reported if the value range is exceeded (REF_ERROR = TRUE) and REF_POS1 or REF_POS2 will be limited to the next valid value (0 or 1000)

The value for **TOL_1**, **TOL_2**, **REF_TOL1**, **REF_TOL2**, **SAFE_POS1** and **SAFE_POS2** must be between 0 and 1000. If this value range is exceeded the values will be limited to the next valid value (0 or 1000). No error message is reported.

The value range for **MAXDIF** must be between -1000 and 1000. If this value range is exceeded the value will be limited to the next valid value (-1000 or 1000). No error message is reported.

Control of the Actuators

The values at the inputs REF_POS1 and REF_POS2 will be transferred to the outputs SETP_POS1 and SETP_POS2 if no error exists. By reading the position values of the actuators (POS1 or POS2) back it is checked whether the controlled position is achieved or fulfilled.

For this purpose, it is continuously verified whether the measured positions of the actuators (POS1 and POS2) are within the parameterized tolerance range (SETP_POS1 or SETP_POS2). The tolerance range is determined by TOL1 or TOL2 (see Figure 3-21)

Monitoring of the Tolerance value TOL_1 and TOL_2

TOL_1 and TOL_2 are tolerance values. The measured position values POS1 and POS2 may not differ more than TOL_1 or TOL_2 from their actuating value. (SETP_POS1 and SETP_POS2).

As long as the values of REF_POS1 and REF_POS2 don`t change (or only within REF_TOL1 and REF_TOL2), only TOL_1 and TOL_2 are evaluated.

If the measured position values (POS1 or POS2) differ by more than the parameterized tolerance (TOL_1 or TOL_2) from the controlled positions

(SETP_POS1 or SETP_POS2) then the output NO_POS1 or NO_POS2 is set to report this discrepancy. If the position values return back into the tolerance range within the parameterized tolerance time (T1_TOL or T2_TOL), the timer is stopped and NO_POS1 or NO_POS2 reset.

If **NO_POS1** or **NO_POS2** is set longer than the tolerance time, an error is reported (POS1_ERROR = TRUE or POS2_ERROR = TRUE).

As long as there no error is displayed, **REF_POS1** is transferred to **SETP_POS1** and **REF_POS2** to **SETP_POS2.**

reaction on jumps at REF_POS1 and REF_POS2

REF_TOL1 and REF_TOL2 are used for the system at larger set point jumps at the inputs REF_POS1 or REF_POS2 larger time to reach the new position for which the normal tolerance time TOL_1 or TOL2 system specific would be not enough.

Therefore values should be parameterized on REF_TOL1 and REF_TOL2 were the regular tolerance time TOL_1 or TOL_2 is not enough to reach the position.

If the value at the inputs REF_POS1 or REF_POS2 changes by more than REF_TOL1 or REF_TOL2, instead of the tolerance timers (T1_TOL or T2_TOL) the timers T1_REF_CH and T2_REF_CH are started. While POS_1 or POS_2 are not within the tolerance range of SETP_POS1 and SETP_POS2, NO_POS1 and NO_POS2 remain TRUE (see Figure 5-1).

If the reference value time has elapsed the position values (POS1 or POS2) need to be within the tolerance range (TOL_1 or TOL_2) (NO_POS1 = FALSE or NO_POS2 = FALSE). Otherwise an error is reported (POS1_ERROR = TRUE or POS2_ERROR = TRUE).

Error

The verified (and limited) actuating values REF_POS1 and REF_POS2 are monitored for their position to each other. If the values differ by more than MAXDIF from each other (REF_POS1 - REF_POS2> MAXDIF) an error is reported (REF_ERROR = TRUE).

As soon as a measured position value PosX is not within the tolerance range of the output actuating value (SETP_POSx), NO_POSx is set. If NO_POSx remains set longer than the respective tolerance time (Tx_TOL), an error is reported (**POS1_ERROR** or **POS2_ERROR**).

If a value-jump happens at the input REF_POS1 or REF_POS2 which is greater than REF_TOL1 or REF_TOL2, then the monitoring of position values for the time T1_REF_CH or T2_REF_CH will be exposed. After the time has elapsed, the corresponding actuator must be within the tolerance range of the controlled value (NO_POS1 = FALSE or NO_POS2 = FALSE). Otherwise, an error is reported (POS1_ERROR = TRUE or POS2_ERROR = TRUE).).

If an error was detected, the safety actuator values (SAFE_POS1 and SAFE_POS2) are transferred to the output of the actuators (**SETP_POS1** and **SETP_POS2**).

Acknowledge

An error detected by the system, remains in effect until acknowledged. An error can be acknowledged by a rising edge at the input QUIT (REF_ERROR = FALSE = FALSE and POS1_ERROR POS2_ERROR = FALSE).

An acknowledgment of the respective error is possible only when the fault condition does not exist anymore.

If, for example, POS1_ERROR is set, then POS1 must be again within the tolerance range of SETP_POS1 to reset the fault when acknowledged.

Note that in case of an error, the safe position values (SAVE_POS1 and SAFE_POS2) are transferred to the actuators!

The actual status of the input QUIT can be read at the output QUIT_ON.

3.6.4 Time diagram

The following figures shows the signal sequence of the function F_POS_CH

Figure 3-21 Time diagram of the function F_POS_CH

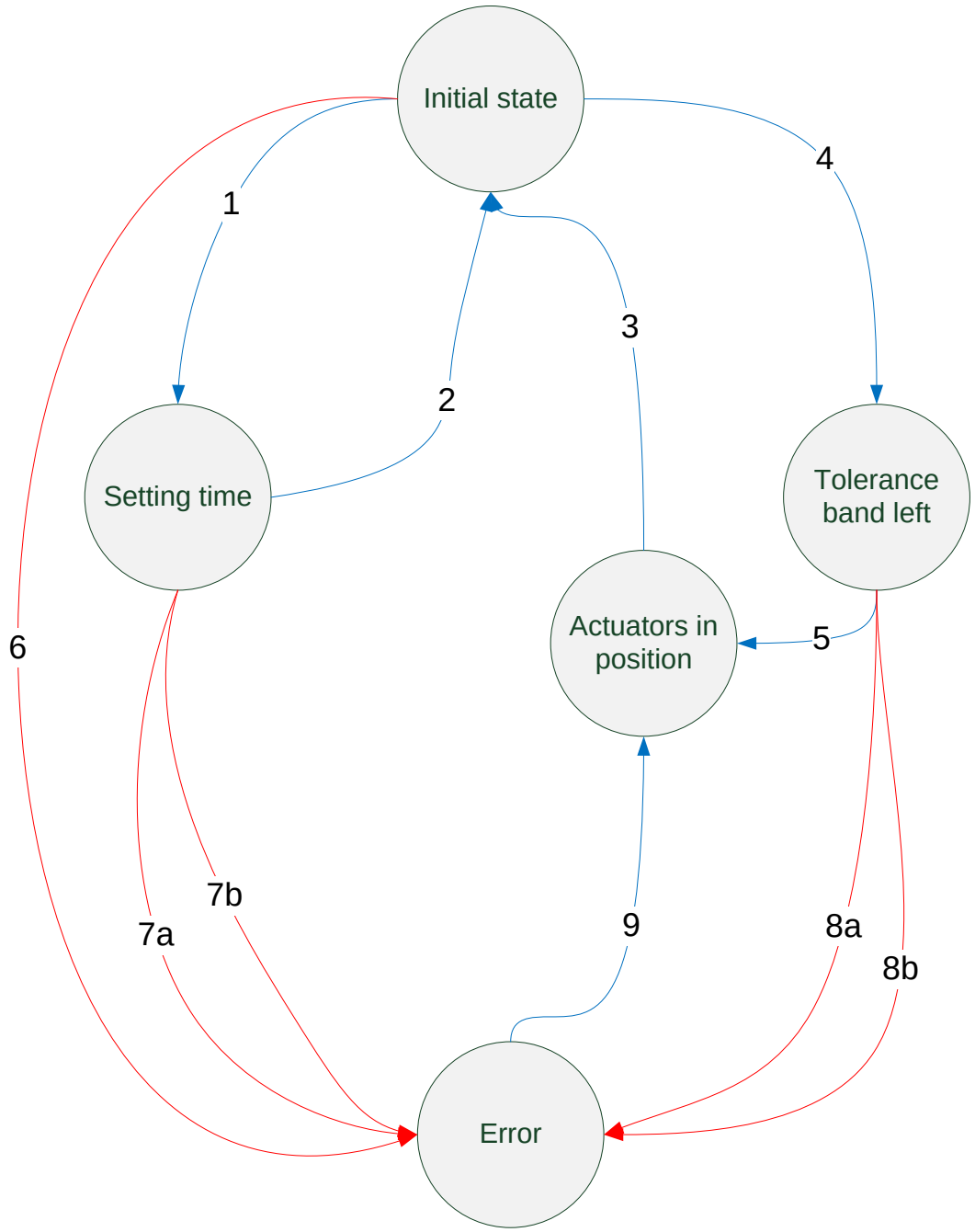
Description of the signal sequence:

1. Reference-Position 1 is changed from 75,0% to 50,0%
   Reference-Position 2 is changed form 65,0% to 40,0%
   MAXDIF is not exceeded
   The Reference-Positions are within the valid value range (0-1000)
   The Reference-Positions are transferred to the output SETP_POSx
   REF_TOLx is exceeded and the timer Tx_REF_CH is started
   The read back value in PosX changes and is beyond the tolerance
   NO_POSx is set
2. The actuators have reached the correct positions within Tx_REF_CH
   The actuators are within the tolerance and MAXDIF is exceeded
   NO_POSx is reset
3. Reference-Position 1 is changed from 50,0% to 42,0%
   The change does not exceed the value REF_TOL1. Timer T1_REF_CH is not started
   POS1 is beyond the tolerance of TOL_1
   NO_POS1 is set
   The timer T1_TOL is started
4. T1_TOL has elapsed
   POS1 is beyond the tolernance range (NO_POS1 = 1)
   POS1_ERROR is set
   The safety positions SAFE_POSx are transferred to the SETP_POSx

3.6.5 Status graph

The following status diagram is a simplified representation of the function block.

Figure 3-22 Status graph of the function F_POS_CH



Explanation of the Status graph

Table 3-15 Status graph of the function block F_POS_CH Transition

Transition	Condition for Transition
1	SETP_POS1 + REF_TOL1 < REF_POS1 **OR** SETP_POS1 – REF_TOL1 > REF_POS1 **OR** SETP_POS2 + REF_TOL2 < REF_POS2 **OR** SETP_POS2 – REF_TOL2 > REF_POS2
2	T1_REF_CH elapsed **AND** POS1 + TOL_1 > SETP_POS1 > POS1 – TOL_1 T2_REF_CH elapsed **AND** POS2 + TOL_2 > SETP_POS2 > POS2 – TOL_2
3	POS1 + TOL_1 > SETP_POS1 > POS1 – TOL_1 **AND** POS2 + TOL_2 > SETP_POS2 > POS2 – TOL_2
4	POS1 + TOL_1 < SETP_POS1 **OR** POS1 – TOL_1 > SETP_POS1 **OR** POS2 + TOL_2 < SETP_POS2 **OR** POS2 – TOL_2 > SETP_POS2
5	POS1 + TOL_1 > SETP_POS1 > POS1 – TOL_1 **AND** POS2 + TOL_2 > SETP_POS2 > POS2 – TOL_2
6	REF_POS1 – REF_POS2 > MAXDIF **OR** 1000 < REF_POS1 **OR** REF_POS1 < 0 **OR** 1000 < REF_POS2 **OR** REF_POS2 < 0
7a	T1_REF_CH elapsed **AND** (POS1 + TOL_1 < SETP_POS1 **OR** POS1 – TOL_1 > SETP_POS1)
7b	T2_REF_CH elapsed **AND** (POS2 + TOL_2 < SETP_POS2 **OR** POS2 – TOL_2 > SETP_POS2)
8a	T1_TOL elapsed **AND** (POS1 + TOL_1 < SETP_POS1 **OR** POS1 – TOL_1 > SETP_POS1)
8b	T2_TOL elapsed **AND** (POS2 + TOL_2 < SETP_POS2 **OR** POS2 – TOL_2 > SETP_POS2)
9	QUIT == 1 **AND** REF_POS1 – REF_POS2 <= MAXDIF **AND** 1000 > REF_POS1 > 0 **AND** 1000 > REF_POS2 > 0 **AND** POS1 + TOL_1 > SETP_POS1 > POS1 – TOL_1 **AND** POS2 + TOL_2 > SETP_POS2 > POS2 – TOL_2

Table 3-16 Status graph oft he function block F_POS_CH Outputs

Status		Outputs, switched
Initial state		SETP_POS1 := REF_POS1 SETP_POS2 := REF_POS2 POS_ERROR1 := FALSE POS_ERROR2 := FALSE REF_ERROR := FALSE
Setting time		NO_POS1 := TRUE Start T1_REF_CH NO_POS2 := TRUE Start T2_REF_CH
Tolerance band left		NO_POS1 := TRUE Start T1_TOL NO_POS2 := TRUE Start T2_TOL
Actuators in position		NO_POS1 := FALSE NO_POS2 := FALSE
Error	from 6	REF_ERROR := TRUE SETP_POS1 := SAFE_POS1 SETP_POS2 := SAFE_POS2
	Form 7a,8a	POS1_ERROR := TRUE SETP_POS1 := SAFE_POS1 SETP_POS2 := SAFE_POS2
	From 7b,8b	POS2_ERROR := TRUE SETP_POS1 := SAFE_POS1 SETP_POS2 := SAFE_POS2

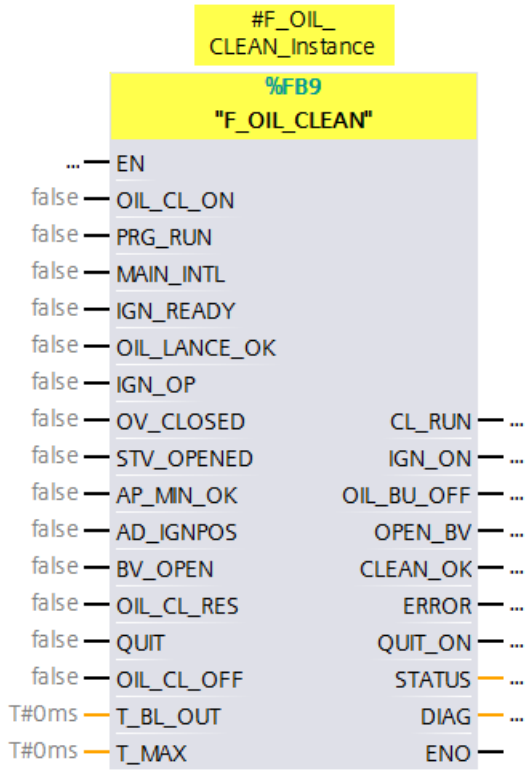
3.7 Function for cleaning the oil burner (F_OIL_CLEAN)

3.7.1 Introduction

The fail-safe function F_OIL_CLEAN initiates and monitors the cleaning program for the oil burner. The function controls the ignition function and the purge valve and monitors the time which is necessary to blow out the oil lance.

This function can be used for cleaning of an oil burner prior to the start-up or after operation. If the function is started during the operation of the burner, the function itself initiates a controlled shutdown of the main burner to ensure a seamless transition between the activation of the igniter/pilot burner and the shutdown of the main burner.

Figure 3-23 Function block F_OIL_CLEAN



NOTE When using this function, the function blocks F_TON (FB 185) and F_BO_W (FC176) must exist in the system block folder.

3.7.2 Connections

The default value for all inputs of data type BOOL is 0-Signal
The default value for all inputs of data type TIME is T#0ms.

Table 3-17 Inputs/Outputs Parameterdescription of F_OIL_CLEAN

Name	Data type	Descripton
Inputs		
OIL_CL_ON	BOOL	**Command cleaning program on** Cleaning is started with a rising edge
PRG_RUN	BOOL	**Other programs running** As long as a 1-signal exists, other functions are in operation to prevent the start of the cleaning
MAIN_INTL	BOOL	**Main Interlock for the cleaning program** • 1-Signal: Operation conditions fulfilled. • 0-Signal: Operation conditons not fulfilled
IGN_READY	BOOL	**Transition conditions** • 1-Signal: Ignition system operational • 0-Signal: Igniton system not operational
OIL_LANCE_ OK	BOOL	**Retract the oil lance** • 1-Signal: Oil lance is retracted • 0-Signal: Oil lance is not retracted
IGN_OP	BOOL	**Pilot burner in operation** • 1-Signal: Pilot burner in operation • 0-Signal: Pilot burner not in operation
OV_CLOSED	BOOL	**Safety shut-off valves closed** • 1-Signal: Safety shut-off valves closed • 0-Signal: Safety shut-off valves not closed
STV_OPENED	BOOL	**Atomizing valve open** • 1-Signal: Atomizing valve open • 0-Signal: Atomizing valve not open
AP_MIN_OK	BOOL	**Atomizing pressure > MIN** • 1-Signal: Atomizing pressure above the minimum limit • 0-Signal: Atomizing pressure not above the minimum limit
AD_IGNPOS	BOOL	**Air damaper in igniton position** • 1-Signal: Air damper in ignition position • 0-Signal: Air damper not in ignition position
BV_OPEN	BOOL	**Cleaning valve open** • 1-Signal: Cleaning valve open • 0-Signal: Cleaning vavle not open
OIL_CL_RES	BOOL	**Reset cleaning program** 1-Signal: Reset cleaning program
QUIT	BOOL	**Error acknowledgement** • Error messages are reset with a rising edge at this input
OIL_CL_OFF	BOOL	**Switch off cleaning program** The cleaning program is switched off with a rising edge at this input

Name	Data type	Descripton
T_BL_OUT	TIME	**Cleaning time** The time describes how long the cleaning valve should be open • Reference value : 0min < T_BL_OUT < 1min
T_MAX	TIME	**Runtime for the cleaning program** Maximum allowed run time for the cleaning program • Reference value : 0min < T_MAX < 3min
Outputs		
CL_RUN	BOOL	**Cleaning program is runnning** • 1-Signal: Cleaning program is running • 0-Signal: Cleaning program is not running
IGN_ON	BOOL	**Control of ignition** • 1-Signal: Switch on Ignition / pilot burner • 0-Signal: Switch off Igniton / pilot burner
OIL_BU_OFF	BOOL	**Switch off Oil-Burner** • 1-Signal: Switch off Oil burner • 0-Signal: Oil burner not switched off
OPEN_BV	BOOL	**Open cleaning valve** • 1-Signal: Open cleaning valve • 0-Signal: Close cleaning valve
CLEAN_OK	BOOL	**Cleaning program finished** • 1-Signal: Cleaning program finished • 0-Signal: Cleaning program not finished
ERROR	BOOL	**Error in cleaning program** • 1-Signal: one or more errors available • 0-Signal: no existing error
QUIT_ON	BOOL	**Acknowledgement is on** • 1-Signal: 1-Signal at the input QUIT • 0-Signal: 0-Signal at the input QUIT
STATUS	INT	**Status** The number at this output indicates the current status of the function block (see chapter 0) **This output is for information only and may not be used for fail-safe connection!**
DIAG	WORD	**Diagnostic-Word** • Information about the block status and errors are displayed at this output word (see chapter 0) **This output is for information only and may not be used for fail-safe connection!**

NOTE	**Please note that the parameterized safety times comply with the relevant standards**

3.7.3 Functionality

Basic Connections for burner operation

The inputs **IGN_READY** and **IGN_OP** must be connected with the respective outputs (IGN_READY and IGN_OPAT) of the block F_IGNTR.

The output **IGN_ON** must be connected to the corresponding input of the block F_IGNTR.

The input **AD_IGNPOS** can be linked to the output AD_IGNPOS_OK of the block F_AIRD.

The output **OIL_BU_OFF** must be connected to the input OIL_BU_OFF of the oil burner (F_OIL_BU). For the duration of cleaning F_OIL_CLEAN takes over the control of the pilot burner.

For starting and stopping the cleaning program the inputs OIL_CL_ON or OIL_CL_OFF must be connected with a corresponding control device. The input QUIT for the acknowledgment must be connected to a corresponding control device.

The operating conditions for the cleaning program can be collected and connected at the input **MAIN_INTL**.

The status of the oil-lance is connected at the input **OIL_LANCE_OK.** The status of the safety valves and the atomizer valve can be connected to the input signal **OV_CLOSED** or **STV_OPENED**. The related minimum pressure of the atomizer is connected to the input signal **AP_MIN_OK**. The position of the cleaning valve is connected to the input signal **BV_OPEN**.

The cleaning program can be reset at the input OIL_CL_RES by the user via a control device. This input must be connected to the output OPEN_V of function F_OIL_BU.

CLEAN_OK must be connected with the input CLEAN_OK of F_OIL_BU.

The outputs **CL_RUN, IGN_ON, OIL_BU_OFF, OPEN_BV** and **ERROR** are to be connected by the user with the appropriate blocks and actuators.

Start and operation of the cleaning program

The cleaning program F_OIL_CLEAN is started through a 1-Signal at the input OIL_CLEAN_ON. For this, the operation interlocks (MAIN_INTL = TRUE) must be fulfilled and no other program may be in operation (PRG_RUN = FALSE).

The start-up of the cleaning program will be displayed at the output “start-up program in operation” (CL_RUN = TRUE).

As soon as the start-up program is running (for single burner operation) the ignition must be ready (IGN_READY = TRUE) and the oil-lance must be retracted (OIL_LANCE_OK = TRUE). If the conditions are fulfilled the ignition is started with the command IGN_ON.

After the pilot burner has been successfully ignited (IGN_OP = 1) the oil burner, which may still be in operation, will be switched off by the command OIL_BU_OFF.

The cleaning valve is opened, if the safety shut-off valves are closed (OV_CLOSED = 1), the atomizer valve is opened (STV_OPENED = 1), the atomizing pressure is above the minimum limit (AP_MIN_OK = 1) and the air damper is in ignition position (AD_IGNPOS = TRUE).

The cleaning time T_BL_OUT starts with the feedback signal “cleaning valve opened” (BV_OPEN = 1)

After the cleaning time has elapsed the message “cleaning program finished” is displayed (CLEAN_OK = TRUE).

The timer T_MAX supervises the cleaning program. If the parameterized timer value is exceeded the program will be aborted and an error bit is set.

Manual Stop

The function can be stopped manually at any time by a 1-Signal at OIL_CL_OFF. All the valves will be closed (OPEN_BV = FALSE), the pilot burner is switched off (IGN_ON = FALSE) and the function is reset to the initial state.

Conditions are lost during start-up

As long as the function has not been started, a start attempt without the conditions being met will generate a diagnostic message (see chapter 0).

As long as the blow-out valve has not been activated (OPEN_BV = FALSE), the loss of a start-up conditions leads to a stop of the process and the generation of a diagnostic message but no error (ERROR = FALSE).

Error

An error message is displayed, if the monitoring time T_MAX has elapsed or one of the conditions for cleaning is lost while the blow out valve is activated (OPEN_BV= TRUE):

- Main interlock not fulfilled anymore (MAIN_INTL = FALSE)
- Oil-lance is not retraced (OIL_LANCE_OK = FALSE)
- Pilot burner not in operation yet (IGN_OP = FALSE)
- Safety shut-off valve(s) of the main burner (is)are not closed (OV_CLOSED = FALSE)
- Atomizer valve is not opened (STV_OPENED = FALSE)
- Minimum atomizing pressure not reached (AP_MIN_OK = FALSE)
- Air damper not in ignition position (AD_IGNPOS = FALSE)
- Blow-out valve is not open anymore (BV_OPEN = FALSE after it has already been reported open)

Acknowledge

An error detected by the system remains in effect until acknowledged. An error can be acknowledged with a rising edge at the input QUIT. The error message is reset (ERROR = FALSE)

The status of the input QUIT can be read out at the output QUIT_ON.

Diagnostic messages can be reset with a rising edge at the input QUIT (see chapter 3.5.7Status graph).

3.7.4 Status

At the output STATUS of the function the current status can be read. This output is used solely for information and may not be used for fail-safe interconnections.

Table 3-18 Status of the function F_OIL_CLEAN

No.	Status	Description
0	Initial Status	The function is in initial status. It can be started with a rising edge at the input OIL_CLEAN_ON The function is reset with a 1-Signal at the input OIL_CLEAN_OFF
1	Cleaning program started	Cleaning of the oil burner was initiated (OIL_CLEAN_RUN = TRUE) and T_MAX runs down. Before the igniter is activated, the oil-lance must be in positon (OIL_LANCE_OK = TRUE)
2	Activating the igniter	The igniter is activated (IGN_ON = TRUE). The function block awaits the feedback-signal (IGN_OP), that indicates that the igniter is in operation (IGN_OP = TRUE).
3	Switch off the main burner	The igniter is in operation. The main burner will be switched off (OIL_BU_OFF = TRUE). The function block awaits the following feedback-signals: The safety shut-off valves are closed (OV_CLOSED = TRUE) The atomizer valve is open (STV_OPENED = 1) The minimum atomizing pressure is fulfilled (AP_MIN_OK = TRUE) The air pressure is in igniter position (AD_IGNPOS = TRUE)
4	Open the cleaning valve	The cleaning valve is opened (OPEN_BV = TRUE). The function block awaits the feedback-signal (BV_OPEN), that indicates that the valve is open (BV_OPEN = TRUE).
5	Cleaning in operation	The oil burner is blown out. The cleaning time (T_BL_OUT) runs down.
6	Blow-out successful	The cleaning time has elapsed. Blown-out was successful (CLEAN_OK = TRUE). A rising edge at OIL_CLEAN_RES resets the function to the initial status.
7	Error	The function has detected an error. A detailed diagnosis is possible by evaluating the output DIAG (see chapter 0). A rising edge at QUIT resets to the initial status.

3.7.5 Diagnose

Table 3-19 Diagnose of the function F_OIL_CLEAN

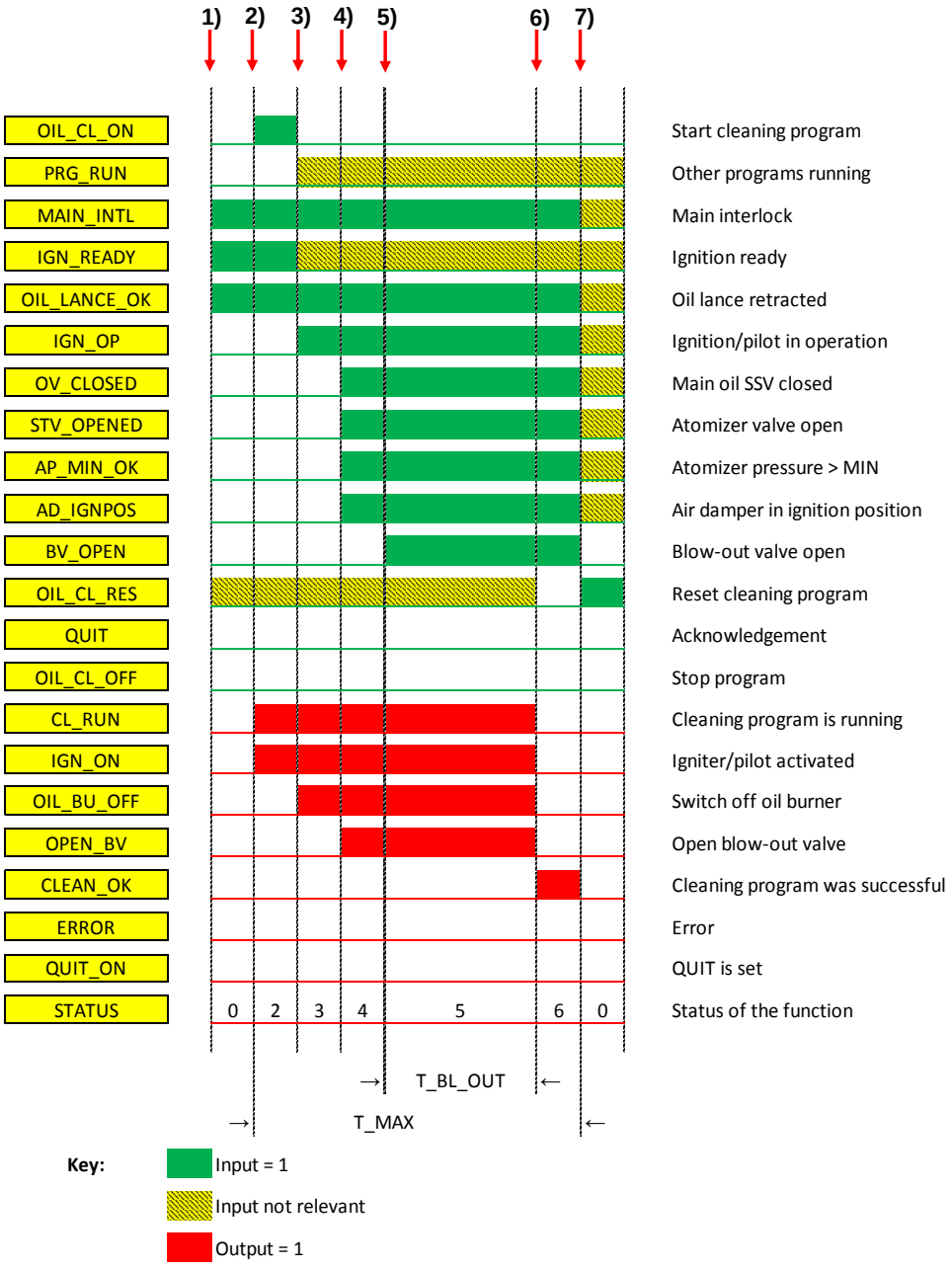
Bit No.	Description	Reset conditon
0	Start command is activated while other programs are running (OIL_CL_ON=1 and PRG_RUN=1)	• PRG_RUN=0 • Rising edge at QUIT
1	Main interlock not fulfilled at startup (MAIN_INTL = 0)	• Rising edge at QUIT • Neuer Startbefehl (OIL_CL_ON=1)
2	Start command is activated, while a stop command exists (OIL_CL_ON = 1 and OIL_CL_OFF = 1)	• OIL_CL_OFF=0 • Rising edge at QUIT
3	Start command is activated while a not acknowledged error exists (OIL_CL_ON = 1 and ERROR = 1)	• Rising edge at QUIT
4	The ignition function is not (yet) ready for operation (IGN_READY = 0)	• IGN_READY=1 • Rising edge at QUIT • Stop command (OIL_CL_OFF=1)
5	The air damper is not in ignition position (AD_IGNPOS = 0) If additionally DIAG 13 is set: AD_IGNPOS was lost during the cleaning process	• AD_IGNPOS=1 • Rising edge at QUIT • Stop command (OIL_CL_OFF=1)
6	Stray valve not opened yet (STV_OPENED = 0) If additionally DIAG 13 is set: STV_OPENED was lost during the cleaning process	• STV_OPENED=1 • Rising edge at QUIT • Stop command (OIL_CL_OFF=1)
7	Atomizing (air) pressure is less than the minimum pressure (AP_MIN_OK=0) If additionally DIAG 13 is set: AP_MIN_OK was lost during the cleaning process	• AP_MIN_OK=1 • Rising edge at QUIT • New Start command (OIL_CL_ON=1)
8	Oil-lance is not (yet) retracted (OIL_LANCE_OK=0) If additionally DIAG 13 is set: OIL_LANCE_OK was lost during the cleaning process	• OIL_LANCE_OK=1 • Rising edge at QUIT • Stop command (OIL_CL_OFF=1)
9	Cleaning valve is activated , but not yet opened (OPEN_BV=1 and BV_OPEN=0) If additionally DIAG 13 is set: BV_OPEN was lost during the cleaning process	• BV_OPEN=1 • Rising edge at QUIT • Stop command (OIL_CL_OFF=1)
10	Safety shut-off valves not (yet) closed (OV_CLOSED=0) If additionally DIAG 13 is set: OV_CLOSED was lost during the cleaning process	• OV_CLOSED=1 • Rising edge at QUIT • Stop command (OIL_CL_OFF=1)
11	Pilot burner is activated but not yet in operation (IGN_OP=0 und IGN_ON=1)	• IGN_OP=1 • Rising edge at QUIT • Stop command (OIL_CL_OFF=1)

Bit No.	Description	Reset conditon
12	Main interlocks during cleaning not fulfilled (MAIN_INTL=0)	• Rising edge at QUIT
13	An error was detected during cleaning (for accurate diagnose see Bits 5 to 10)	• Rising edge at QUIT
14	Monitoring time of the cleaning program has been exceeded (T_MAX elapsed)	• Rising edge at QUIT
15	Reserve	

3.7.6 Time diagram

The following figure shows the signal sequence of the function F_OIL_CLEAN

Figure 3-24 Time diagram of the function block F_OIL_CLEAN

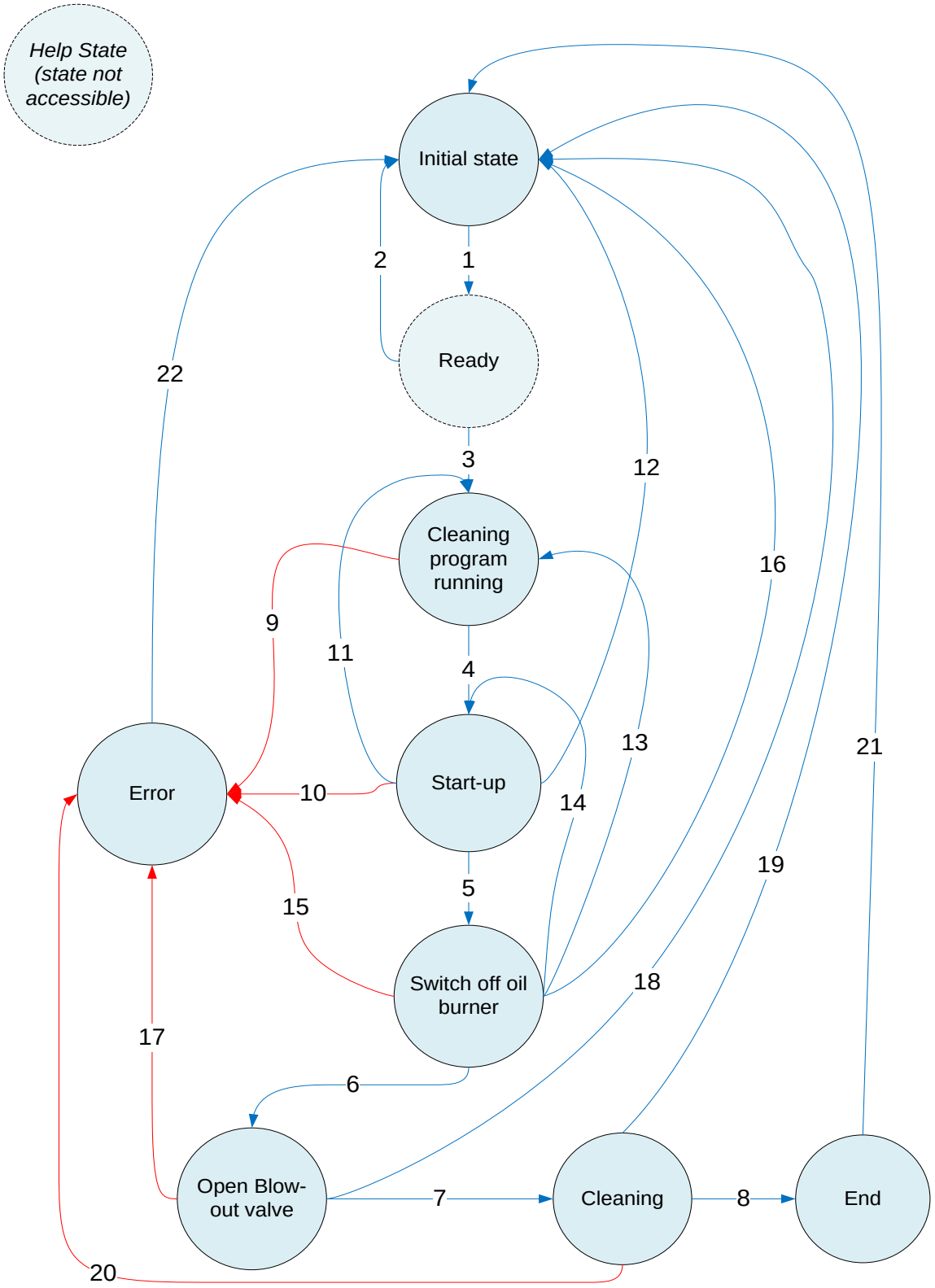


Description of the signal sequence:

1. Main interlocks fulfilled (MAIN_INTL=1)
   Pilot burner ready (IGN_READY=1)
   Oil-lance is retracted (OIL_LANCE_OK=1)
   No other programs active (PRG_RUN=0)
2. Start of the cleaning program with a rising edge at the input OIL_CL_ON
   Cleaning program active (Output CL_RUN=1)
   Ignition is activated (IGN_ON=1)
   Watchdog is started (T_MAX)
3. Pilot burner is in operation (IGN_OP=1)
   Oil burner is switched off (OIL_BU_OFF=1)
4. Safety shut-off valves closed (OV_CLOSED=1)
   Atomizer valve opened (STV_OPENED=1)
   Atomizing pressure > MIN (AP_MIN_OK=1)
   Air damper in ignition position (AD_IGNPOS=1)
   Cleaning valve is opened (OPEN_BV=1)
5. Cleaning valve is open (BV_OPEN=1)
   Cleaning time is started (T_BL_OUT)
6. Cleaning time has elapsed
   Cleaning program is finished (CLEAN_OK=1)
   Cleaning program is finished before T_MAX has elapsed
7. Reset with a rising edge at the input OIL_CL_RES

3.7.7 Status graph

Figure 3-25 Status graph of the function block F_OIL_CLEAN



Explanation of the status graph

Table 3-20 Status graph of the function block F_OIL_CLEAN Transition

Transition	Condition for Transition
1	MAIN_INTL == 1 **AND** CLEAN_OK == 0 **AND** OIL_CL_OFF == 0 **AND** ERROR == 0
2	MAIN_INTL == 0 **OR** OIL_CL_OFF == 1
3	Rising edge at OIL_CL_ON **AND** PRG_RUN == 0
4	IGN_READY == 1 **AND** OIL_LANCE_OK == 1
5	IGN_OP == 1
6	OV_CLOSED == 1 **AND** AP_MIN_OK == 1 **AND** STV_OPENED == 1 **AND** AD_IGNPOS == 1
7	BV_OPEN == 1
8	T_BL_OUT elapsed
9, 10	Monitoring time T_MAX elapsed **OR** MAIN_INTL == 0
11	OIL_LANCE_OK == 0
12	OIL_CL_OFF == 1
13	OIL_LANCE_OK == 0
14	IGN_OP == 0
15	Monitoring time T_MAX elapsed **OR** MAIN_INTL = 0
16	OIL_CL_OFF == 1
17	MAIN_INTL == 0 **OR** OIL_LANCE_OK == 0 **OR** IGN_OP == 0 **OR** OV_CLOSED == 0 **OR** STV_OPENED == 0 **OR** AP_MIN_OK == 0 **OR** AD_IGNPOS == 0 **OR** Monitoring time T_MAX elapsed
18	OIL_CL_OFF == 1
19	OIL_CL_OFF == 1
20	Within the cleaning time T_BL_OUT MAIN_INTL == 0 **OR** OIL_LANCE_OK == 0 **OR** IGN_OP == 0 **OR** OV_CLOSED == 0 **OR** STV_OPENED == 0 **OR** AP_MIN_OK == 0 **OR** AD_IGNPOS == 0 **OR** BV_OPEN == 0 **OR** Monitoring time T_MAX elapsed
21	Rising Edge at OIL_CL_RES
22	Rising Edge at QUIT

Table 3-21 State-Graph of the function F_OIL_CLEAN Outputs

Status	Outputs, switched
Initial State	Not any output switched STATUS := “0”
Ready	No output switched
Cleaning program running	CL_RUN := TRUE Start T_MAX STATUS := “1”
Start-up	IGN_ON := TRUE STATUS := “2”
Switch off Oil burner	OIL_BU_OFF := TRUE STATUS := “3”
Open blow-out valve	OPEN_BV := TRUE STATUS := “4”
Cleaning	Start of the cleaning program T_BL_OUT STATUS := „5“
End	CLEAN_OK := TRUE CL_RUN := FALSE IGN_ON := FALSE OIL_BU_OFF := FALSE OPEN_BV := FALSE STATUS := “6”
Error	ERROR := TRUE CL_RUN := FALSE IGN_ON := FALSE OIL_BU_OFF := FALSE OPEN_BV := FALSE STATUS := “7”

3.8 Function for controlling a Gas-Burner (F_GAS_BU)

3.8.1 Introduction

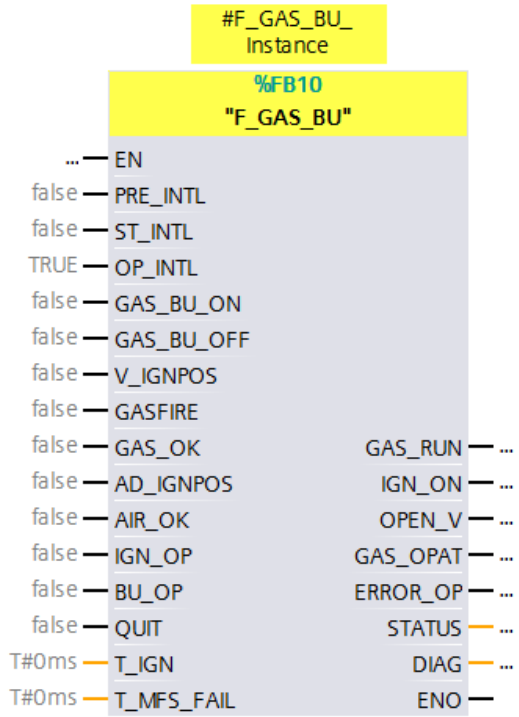
The fail-safe function F_GAS_BU initiates the start-up of a gas burner by controlling the ignition function. The function can be used for direct ignition with an ignition transformer, and for the indirect ignition based on a pilot burner (F_IGNTR). After successful ignition of the pilot burner and actuation of the ignition transformer the function opens the safety shut-off valve(s) of the burner and checks whether ignition has occurred within a defined time.

Single and multiple burner operation can be realized with this function. In multiple-burner operation, a combustion chamber monitoring can be realized (one flame detector for multiple burners). This is allowed if it is ensured that the unmonitored burners are ignited by the monitored "lead" burner within the safety time without adverse consequences.

With this function block, a switch over to the high temperature operation is also possible. For this, connections of the inputs must be adapted accordingly. An example is specified in chapter 4.3.5 .

The function itself does not move the air damper and the fuel valve in the ignition position.This is to be realized (if necessary) by the user (e.g. using the F_AIRD function, see chapter 3.3).

Figure 3-26 function block F_GAS_BU



Note When using this function, the function blocks F_TON (FB 185) and F_BO_W (FC176) must exist in the system block folder.

3.8.2 Connections

The default value for all inputs of data type BOOL (except OP_INTL) is 0-Signal.
The default value for all inputs of data type TIME is T#0ms.

Table 3-22 Inputs/Outputs Parameter description of function F_GAS_BU

Name	Data type	Description
Inputs		
PRE_INTL	BOOL	**Switch on interlock** • The gas burner function is ready for use if there is a 1-Signal at this input. • After the burner has been started on GAS_BU_ON, this input is no longer evaluated
ST_INTL	BOOL	**Start-up interlock** • The gas burner function can be started if there is a 1-Signal at this input. • This input is evaluated only during startup (starting with GAS_BU_ON = 1 to GAS_OPAT = 1)
OP_INTL	BOOL	**Operation interlock** • The gas burner function is operational if there is a 1-Signal at this input. • This input is evaluated after the function is put into operation (after the start-up phase) (GAS_OPAT = 1)
GAS_BU_ON	BOOL	**Command switch-on gas burner** • A rising edge starts the burner function
GAS_BU_OFF	BOOL	**Command Switch-off gas burner** • A 1-Signal terminates the operation of the burner. • The burner can only be started if a 0-Signal exists at GAS_BU_OFF
V_IGNPOS	BOOL	**Gas control valve in ignition position** • 1-Signal: the gas control valve is in ignition position • 0-Signal: the gas control valve is not in ignition position If the system is in high-temperature operation, or the “Lead” burner is active at a combustion chamber monitoring (BU_OP = 1) the fuel control valve does not have to be in ignition position upon start-up
GASFIRE	BOOL	**Flame detected** • 1-Signal: Flame detected / Temperature above the high temperature threshold • 0-Signal: No flame detected The signal of the flame detector must be connected at this input or the signal that the threshold for high-temperature operation has been exceeded (see chapter 4.3.5)
GAS_OK	BOOL	**Gas criteria are fulfilled** • 1-Signal: Gas criteria fulfilled • 0-Signal: Gas criteria not fulfilled Gas criteria are all conditions concerning the fuel supply (e.g. pressure), which are necessary for safe operation

Name	Data type	Description
AD_IGNPOS	BOOL	**Air damper in ignition positon** • 1-Signal: Air damper is in ignition position • 0-Signal: Air damper not in ignition position If the system is in high-temperature operation, or the “Lead” burner is active at a combustion chamber monitoring (BU_OP = 1) the air damper does not have to be in ignition position upon start-up.
AIR_OK	BOOL	**Common air-criteria fulfilled** • 1-Signal: Air criteria fulfilled • 0-Signal: Air criteria not fulfilled Air criteria are conditions in relation to the combustion air, which are necessary for safe operation
IGN_OP	BOOL	**Pilot burner in operation** • 1-Signal: Pilot burner ignited successfully • 0-Signal: Pilot burner not ignited
BU_OP	BOOL	**Burner in operation at combustion chamber monitoring and for high-temperature operation** • 1-Signal: Lead burner in operation / High-temperature operation active If this bit is set, a flame must be detected to start the burner(GAS FIRE = 1) • 0-Signal: Other burners are not in operation / high temperature operation not active A signal change from 0 to 1 of the flame detector is scanned (stray light test) The input must be set, if the “lead” burner is in combustion chamber monitoring operation (GAS_OPAT = 1) or the system switches to the high temperature operation. In both cases, the burner must detect a flame (GAS FIRE = 1) before start-up
QUIT	BOOL	**Error acknowledgement** • Error messages are reset at this input • Acknowledgement is only possible with rising edge
T_IGN	TIME	**Safety time of the burner** • The burner must have ignited successfully within this time • Reference value : 0sek < T_IGN < 10sek
T_MFS_FAIL	TIME	**Monitoring time for the flame detector (Ambient light test)** • An error is reported, if a flame is detected (GASFIRE = 1) longer than the time T_MFS_FAIL , even though the gas burner function is not operating (GAS_OPAT = 0) and the burner is not in the high-temperature operation, or a combustion chamber monitoring is in use (BU_OP = 1)

Name	Data type	Description
Outputs		
GAS_RUN	BOOL	**Gas start-up program is active** • 1-Signal: Gas start-up program in operation • 0-Signal: Gas start-up program has not been started or conditions for starting are not fulfilled The pilot burner is only activated until the main burner was successfully ignited and is in operation (GAS_OPAT = 1). If the pilot burner shall remain ignited after the successful ignition of the main burner, the input of the igniter (IGN_ON on F_IGNTR) must be logically linked by an “or” function with GAS_OPAT in addition (see chapter 4.3.3)
IGN_ON	BOOL	**Switch on ignition** • 1-Signal: Ignition is activated • 0-Signal: Ignition is not activated
OPEN_V	BOOL	**Control of safety shut-off valve(s)** • 1-Signal: Open Safety shut-off valve(s) • 0-Signal: Safety shut-off valve(s) will be closed or remain(s) closed
GAS_OPAT	BOOL	**Gas burner in operation after T_IGN** • 1-Signal: The burner was ignited within the safety time • 0-Signal: Burner not in operation
ERROR_OP	BOOL	**Operation cancelled** • 1-Signal: There is one or more errors that occurred during operation • 0-Signal: No errors exists
STATUS	INT	**Status of the function** • The number at this output indicates the current status of the function block (see chapter 3.8.4) **This output is for information only and must not be used for fail-safe interconnection!**
DIAG	WORD	**Diagnostic-Word** • Information about the block status and errors are displayed at this output word (see chapter 3.8.5) **This output is for information only and may not be used for fail-safe connection!**

NOTE	**Please note that the parameterized safety times comply with the relevant standards**

3.8.3 Functionality

Basic interconnections for the release of burner operation

The operating conditions for the gas supply of the burner are to be interconnected at the input **GAS_OK** (e.g. max. / min. pressure or max./min. temperature fulfilled).

The operating conditions for the air supply of the burner are to be interconnected at the input **AIR_OK** (e.g. maximum or minimum pressure fulfilled).

At **PRE_INTL** all conditions must be interconnected, which are necessary to start the gas start-up function (e.g. pre-purge or closed status of the safety shut-off valve(s)). After the successful start (**GAS_RUN** = TRUE) PRE_INTL must no longer be fulfilled.

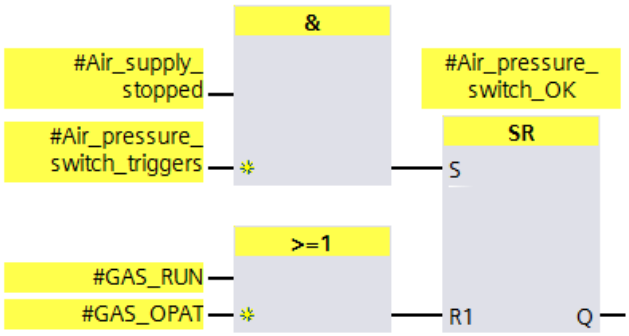
At **ST_INTL** all conditions are connected that must be fulfilled until the burner was ignited successfully and is operational (**GAS_OPAT** = TRUE). After that the input is no longer evaluated.

The conditions that are relevant only during operation of the burner (GAS_OPAT = TRUE), must be interconnected to **OP_INTL**. This is only evaluated after the ignition of the main burner. This includes, for example, monitoring the maximum temperature.

The output **IGN_ON** must be interconnected with the same input of the function for controlling the pilot burner (F_IGNTR). If no pilot burner is used, this output can be used also for direct control e.g. of an ignition transformer (see chapter 4.3.2).

Verification of the air monitoring

Figure 3-27 Example for interconnection to test the air pressure switch



The air monitoring equipment must be checked before start-up of the burner with a stationary flow. This can be realized, by checking with switched off or stopped air supply whether the air monitoring responds. An example for interconnecting is shown in Figure 3-27. „Air_supply_stopped" must be 0-Signal if the air supply was interrupted. If the air monitoring system detects the insufficient air supply the air pressure monitor is initiated (1-Signal).The signal "Air_pressure_switch_Ok" must be interconnected to the input **PRE_INTL**. If the burner is started (GAS_RUN = TRUE), the signal is reset.

Basic interconnections for the burner operation

The input signals **GAS_BU_ON** or **GAS_BU_OFF** are to be interconnected by the user to an appropriate control device for starting and stopping the burner. Similarly, the input signal for error QUIT must be interconnected by the user.

The condition for the ignition position of the gas control valve must be interconnected with the corresponding signal of the sensor at the input **V_IGNPOS**. (This does not apply when the system is in high-temperature operation, or the lead burner is active in a combustion chamber monitoring.

The input **AD_IGNPOS** for the ignition position of the air damper must be interconnected with the corresponding output-signal of the air damper **(**F_AIRD**).**

The Input **IGN_OP** is a feedback signal that the burner has successfully ignited and must be interconnected with F_IGNTR.

The outputs **GAS_RUN, OPEN_V** and **ERROR_OP** must be interconnected by the user with the appropriate blocks and actuators.

Additional interconnection using combustion chamber monitoring

If a combustion chamber monitoring is used, then the operating status of the “lead burner” (GAS_OPAT) must be interconnected with the input **BU_OP** of the burners without a flame detector. (Only a so-called “lead burner” has a flame detector and is monitored. The other burners are directly ignited by this ”lead burner” when the fuel valves are opened)

The signal of the flame detector of the “lead burner” must also be connected with the **GASFIRE** inputs of the burners without a separate flame detector (see chapter 4.3.6).

Additional interconnections for high-temperature operation

If the system is operated in high temperature mode (the temperature in the combustion chamber exceeds the the threshold defined in the standard(s)), flame monitoring is no longer necessary, as long as the temperature does not fall below this threshold. Accordingly, a query can be connected to the input **GASFIRE** whether this temperature threshold has been exceeded and will be linked logically by “or” with the flame detector (see chapter 4.3.5).

The same query, of the temperature exceeding the threshold, can be connected to the input **BU_OP** of all burners.

Start and Start-up in single burner operation/ normal temperature mode (BU_OP = FALSE)

With a rising edge at GAS_BU_ON the function is started, if the conditions are fulfilled:

- Switch on interlock fulfilled (PRE_INTL = TRUE)
- Start interlock fulfilled (ST_INTL = TRUE)
- Air damper in ignition position (AD_IGNPOS = TRUE)
- Fuel valve in ignition position (V_IGNPOS = TRUE)
- Flame not detected in the combustion chamber (GASFIRE = FALSE)
- Air criteria fulfilled (AIR_OK = TRUE)
- Fuel criteria fulfilled (GAS_OK = TRUE)
- No error exists (ERROR_OP = FALSE)

If the start of the function was successful it is indicated by a 1-Signal at GAS_RUN.

If any of the above mentioned conditions is not fulfilled anymore during start-up (GAS_RUN = TRUE and GAS_OPAT = FALSE), the start-up will be cancelled and a diagnostic message displayed at DIAG (see chapter. 3.8.5).

Start and Start-up in multiple burner operation/ high-temperature mode (BU_OP = TRUE)

With a rising edge at GAS_BU_ON the function is started, if the conditions are fulfilled:

- Switch on interlock fulfilled (PRE_INTL = TRUE)
- Start interlock fulfilled (ST_INTL = TRUE)
- Flame detected in the combustion chamber / Temperature in the combustion chamber above the threshold (GASFIRE = TRUE)
- Air criteria fulfilled (AIR_OK = TRUE)
- Fuel criteria fulfilled (GAS_OK = TRUE)
- No error exists (ERROR_OP = FALSE)

In this operation mode, it is not necessary that the ignition positions are approached. However, a flame must be detected.

If the start of the function was successful, it is indicated by a 1-Signal at GAS_RUN.

If any of the above mentioned conditions is not fulfilled anymore during start-up (GAS_RUN = TRUE and GAS_OPAT = FALSE), the start-up will be cancelled and a diagnostic message displayed at DIAG (see chapter 3.8.5).

Ignition and operation of the (main) burner

Once the feedback exist that the pilot burner has been successfully ignited (IGN_OP = TRUE), the safety shut-off valves are opened (OPEN_V = TRUE) and the safety time (T_IGN) starts to run.

Iignition of the burner was successful, if a flame is detected (GASFIRE = TRUE) after the T_IGN has elapsed and the operating conditions are fulfilled (OP_INTL = TRUE). It is indicated by a 1-Signal at GAS_OPAT that the burner is in operation and GAS_RUN is reset.

The ignition positions (V_IGNPOS and AD_IGNPOS), and the start conditions (ST_INTL) are no longer evaluated in the operation of the burner. If any condition

drops out while the burner is in operation an error message is shown instead of a diagnostic message.

Manual Stop

The burner can be stopped manually at any time by a 1-Signal at GAS_BU_OFF. All valves are closed (OPEN_V = FALSE) and the function is reset to its initial state (GAS_RUN = FALSE and GAS_OPAT = FALSE).

Conditions drop out during start-up

As long the function has not been started, a start attempt without the aforementioned conditions being fulfilled will generate a diagnostic message (see chapter 3.8.5).

If one of the start-up conditions (excluding PRE_INTL) is lost during start-up of the burner (GAS_RUN = TRUE) the start-up operation is cancelled and a diagnostic message is generated.

Behavior at error detection

An error message is issued if:

- No flame was detected after the safety time has elapsed (GASFIRE = FALSE after T_IGN)
- If one of the following conditions is **not** fulfilled anymore during operation of the burner (GAS_OPAT = TRUE):
  - Operation condition fulfilled (OP_INTL = TRUE)
  - Flame detected in the combustion chamber / Temperature in the combustion chamber above the threshold (GASFIRE = TRUE)
  - Air criteria fulfilled (AIR_OK = TRUE)
  - Fuel criteria fulfilled (GAS_OK = TRUE)
- A flame is detected (GASFIRE = TRUE) for longer than T_MFS_FAIL while the burner is switched off (GAS_RUN = FALSE and GAS_OPAT = FALSE) and in normal operation (BU_OP = FALSE)

If an error is detected, then this error is reported and issued in the diagnosis DIAG (see chapter 3.8.5).

Acknowledge

A detected error remains active until it has been acknowledged. An error can be acknowledged by a rising edge at the input QUIT. The error message is reset (ERROR_OP = FALSE) if the error is resolved. At the output QUIT_ON the current status of the input QUIT can be read.

Diagnostic messages can also be acknowledged by a rising edge at QUIT (see chapter 3.8.5).

3.8.4 Status

At the output STATUS the current status of the function can be read. This output is used purely for information and cannot be used for fail-safe connections.

Table 3-23 Status of the function F_GAS_BU

No.	Status	Description
0	Initial Status	The function is in the initial status. To start the function, a rising edge at the input GAS_BU_ON is required. The function is reset with a 1-Signal at the input GAS_BU_OFF.
1	Start-up gas burner	The start-up of the gas burner has been initiated (GAS_RUN = TRUE). The igniter is activated (IGN_ON = TRUE). The function block awaits the feedback-signal (IGN_OP), that indicates that the igniter is in operation (IGN_OP = TRUE)
2	Open the shut-off valve(s)	The safety shut-off valves opens (OPEN_V = TRUE). The safety time (T_IGN) runs down. After the safety time, a flame signal is expected (GASFIRE = TRUE)
3	Gas burner in operation	The burner was successfully ignited (GASFIRE = TRUE) and is in operation (GAS_OPAT = TRUE).
7	Error	The system has detected an error. A detailed diagnosis is possible by evaluating the output DIAG (see chapter 3.8.5). The initial status can be re-taken with a rising edge at input QUIT.

3.8.5 Diagnose

Table 3-24 Diagnose of the function block F_GAS_BU

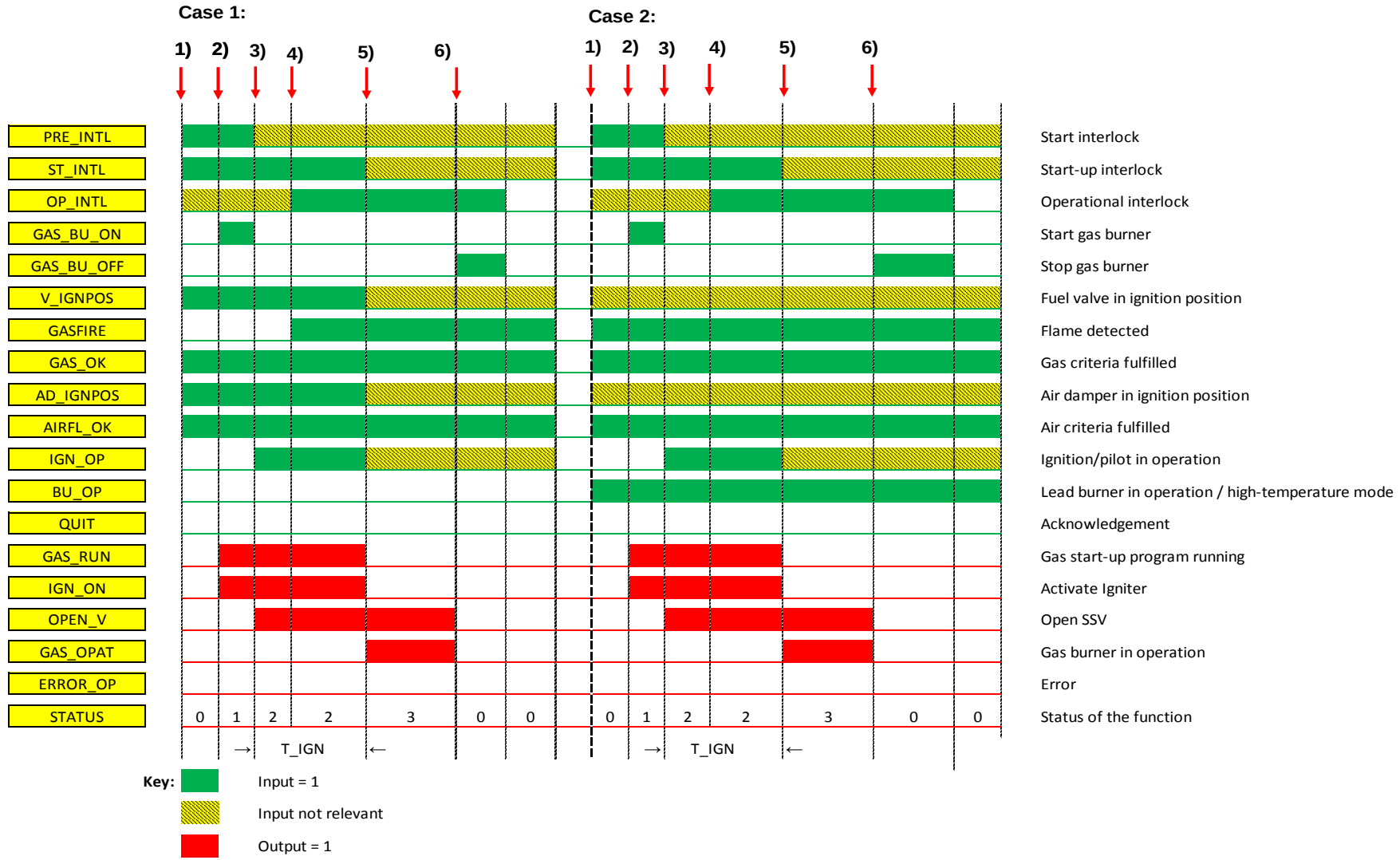
Bit No.	Description	Reset-conditions
0	Start command is activated, while pre-interlock is not set (GAS_BU_ON = 1 and PRE_INTL = 0)	• PRE_INTL=1 • rising edge at QUIT
1	Start command is activated, while Start-up interlock is not set (GAS_BU_ON = 1 and 0 = ST_INTL	• ST_INTL=1 • rising edge at QUIT
2	Start command is activated, while a stop command exists (GAS_BU_ON = 1 and GAS_BU_OFF = 1)	• BU_OFF=0 • rising edge at QUIT
3	Start command is activated, while an un-acknowledged error exists (GAS_BU_ON=1 und ERROR_OP=1	• rising edge at QUIT
4	The fuel control valve is not in ignition position, while the gas start-up program is running or program is started (GAS_BU_ON = 1 and V_IGNPOS = 0)	• Switch over to multiple burner operation (BU_OP=1 and GASFIRE=1)) • rising edge at QUIT • new start command (GAS_BU_ON=1)

Bit No.	Description	Reset-conditions
5	The air damper is not in ignition position while gas start-up program is running or is started (GAS_BU_ON=1 and V_IGNPOS=0)	• Switch over to multiple burner operation (BU_OP=1 und GASFIRE=1)) • rising edge at QUIT • new start command (GAS_BU_ON=1)
6	Flame detector does not detect a flame within the safety time (GASFIRE = 0 after T_IGN has elapsed)	• rising edge at QUIT • new start command (GAS_BU_ON=1
7	Air criteria not fulfilled during start-up / operation of the burner (GAS _RUN = 1 or GAS _OPAT = 1 and AIR_OK = 0)	• rising edge at QUIT • new start command (GAS_BU_ON=1)
8	Conditions of gas supply not fulfilled during start-up / operation of the burner (GAS_RUN = 1 or GAS _OPAT = 1 and GAS_OK = 0)	• rising edge at QUIT • new start command (GAS_BU_ON=1)
9	Reserve	•
10	Reserve	•
11	Pilot burner is activated, but not yet in operation (IGN_OP=0 und IGN_ON=1)	• IGN_OP=1 • rising edge at QUIT • new start command (GAS_BU_ON=1)
12	Operating interlocks have failed during the operation of the burner (GAS_OPAT = 1) (OP_INTL=0)	• rising edge at QUIT • new start command (GAS_BU_ON=1)
13	Flame detector reports a flame although no burner is in operation (GASFIRE=1 and BU_OP=0)	• rising edge at QUIT
14	Flame signal failed during operation of the burner (GAS_OPAT = 1 and GASFIRE = 0)	• rising edge at QUIT • new start command (GAS_BU_ON=1)
15	Reserve	

3.8.6 Time diagram

The following figure shows the signal sequence of the function block F_GAS_BU.

Figure 3-28 Time diagram of the function block F_GAS_BU



Case 1: Single operation

1. Pre-locks fulfilled (PRE_INTL=1)
   Stat-up locks fulfilled (ST_INTL=1)
   The fuel control valves are in ignition position (V_IGNPOS=1)
   Gas criteria are fulfilled (GAS_OK=1)
   The air damper in ignition position (AD_IGNPOS=1)
   Air criteria fulfilled (AIR_OK=1)
2. Start the burner by rising edge at input GAS_BU_ON
   The gas start-up program is running (GAS_RUN = 1)
   The pilot burner is activated (IGN_ON=1)
3. The pilot burner is in operation (IGN_OP=1)
   The safety shut-off valve opens (OPEN_V=1)
   The safety time T_IGN starts
4. The operating conditions are fulfilled within the safety time (OP_INTL=1)
   A flame is detected (GASFIRE=1)
5. The burner was successfully ignited (GAS_OPAT=1)
6. Cancellation by stop command at input GAS_BU_OFF

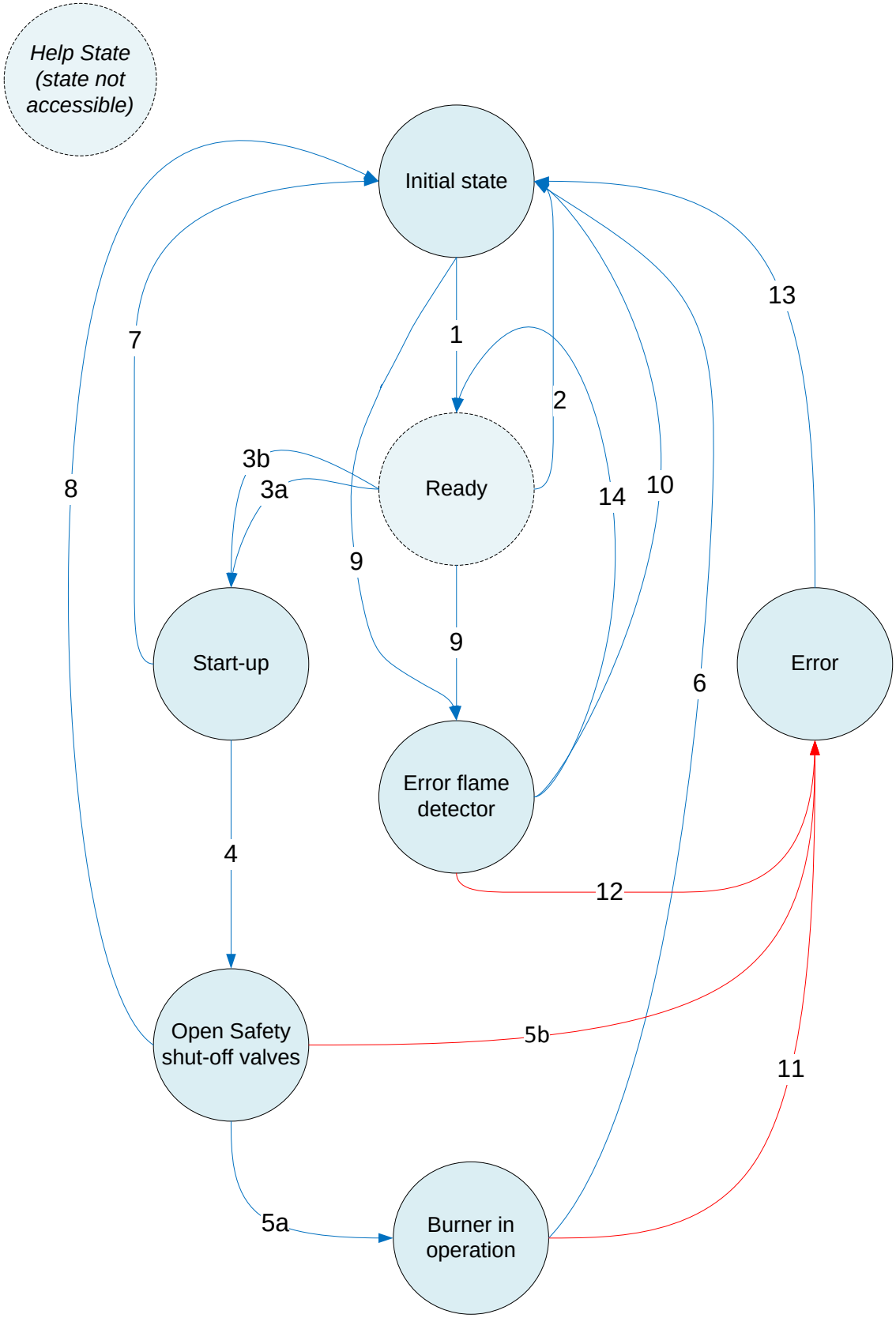
Case 2: multiple burner operation

Multiple burners are operated in a combustion chamber. The first burner is ignited by means of the previous time diagram. For all other burners the flame is already detected (GAS FIRE = 1). Therefore the signals V_IGNPOS and AD_IGNPOS of these burners are not relevant for ignition.

1. Pre-locks fulfilled (PRE_INTL=1)
   Stat-up locks fulfilled (ST_INTL=1)
   A flame is detected (GASFIRE=1)
   Gas criteria are fulfilled (GAS_OK=1)
   Air criteria fulfilled (AIR_OK=1)
   Others burners in operation (BU_OP=1)
2. Start the burner by rising edge at input GAS_BU_ON
   The gas start-up program is running (GAS_RUN = 1)
   The pilot burner is activated (IGN_ON=1)
3. The pilot burner is in operation (IGN_OP=1)
   The safety shut-off valve opens (OPEN_V=1)
   The safety time T_IGN starts
4. The operating conditions are fulfilled (OP_INTL=1)
   A flame is detected (GASFIRE=1) within the safety time
5. The burner was successfully ignited (GAS_OPAT=1)
6. Cancellation by stop command at input GAS_BU_OFF

3.8.7 Status graph

Figure 3-29 Status graph of the function block F_GAS_BU



Explanation of the Status graph

Table 3-25 Status graph of the function block F_GAS_BU Transition

Transition	Conditions for Transition
1	PRE_INTL == 1
2	PRE_INTL == 0
3a	**Single burner operation:** Rising edge at GAS_BU_ON **AND** ST_INTL == 1 **AND** GAS_BU_OFF == 0 **AND** GAS_OK ==1 **AND** AIR_OK == 1 **AND** V_IGNPOS == 1 **AND** AD_IGNPOS == 1
3b	**Multiple burner operation:** Rising edge at GAS_BU_ON **AND** ST_INTL == 1 **AND** GAS_BU_OFF == 0 **AND** GAS_OK ==1 **AND** AIR_OK == 1 **AND** GASFIRE ==1 **AND** BU_OP ==1
4	IGN_OP == 1
5a	T_IGN elapsed **AND** GASFIRE == 1
5b	T_IGN elapsed **AND** GASFIRE == 0
6	GAS_BU_OFF == 1
7	GAS_BU_OFF == 1 **OR** GAS_OK == 0 **OR** AIR_OK == 0 **OR** ST_INTL == 0 **OR** V_IGNPOS == 0 **OR** AD_IGNPOS == 0 **OR** (falling edge at BU_OP **OR** falling edge at GASFIRE)
8	GAS_OK == 0 **OR** AIR_OK == 0 **OR** ST_INTL == 0 **OR** GAS_BU_OFF == 1 **OR** IGN_OP == 0 **OR** V_IGNPOS == 0 **OR** AD_IGNPOS == 0 **OR** (falling edge at BU_OP **OR** falling edge at GASFIRE)
9	GASFIRE == 1 **AND** BU_OP == 0
10	GASFIRE == 0 **OR** BU_OP == 1
11	OP_INTL == 0 **OR** GASFIRE == 0 **OR** AIR_OK == 0 **OR** GAS_OK == 0
12	Monitoring time T_MFS_FAIL elapsed
13	QUIT == rising edge **AND** GASFIRE == 0
14	(GASFIRE == 0 **OR** BU_OP == 1) **AND** PRE_INTL == 1

Table 3-26 Status graph of the function block F_GAS_BU Outputs

Status	Outputs switched
Initial State	No switched outputs STATUS := “0”
Ready	No switched outputs
Start-up	GAS_RUN := TRUE IGN_ON := TRUE STATUS := “1”
Open Safety shut-off valve	OPEN_V := TRUE Safety time T_IGN starts STATUS := „2“
Burner in operation	Safety time elapsed and no error exist GAS_OPAT := TRUE OP_INTL := TRUE STATUS := “3”
Error	ERROR_OP := TRUE GAS_OPAT:= FALSE OPEN_V := FALSE STATUS := “7”
Error flame detector	Timer T_MFS_FAIL starts

3.9 Function for controlling an Oil-Burner (F_OIL_BU)

3.9.1 Introduction

The fail-safe function F_OIL_BU initiates the start-up of an oil burner by controlling the ignition function. The function can be used for direct ignition with an ignition transformer, and for indirect ignition based on a pilot burner (F_IGNTR). After successful ignition of the pilot burner and actuation of the ignition transformer the function opens the safety shut-off valve(s) of the burner and checks whether ignition has occurred within a defined time.

Single and multiple burner operation can be realized with this function. In multiple-burner operation, a combustion chamber monitoring can be realized (one flame detector for multiple burners). This is allowed if it is ensured that the unmonitored burners are ignited by the monitored "lead" burner within the safety time without adverse consequences.

With this module, a switch over to the high temperature operation is also possible. For this, connections of the inputs must be adapted accordingly. An example is specified in chapter 4.3.5

The function itself does not move the air damper and the fuel valve in the ignition position.This is to be realized (if necessary) by the user (e.g. using the F_AIRD function, see chapter 3.3).

Figure 3-30 function block F_OIL_BU

Note When using this function, the function blocks F_TON (FB 185) and F_BO_W (FC176) must exist in the system block folder.

3.9.2 Connections

The default value for all inputs of data type BOOL (except OP_INTL) is 0-Signal.
The default value for all inputs of data type TIME is T#0ms.

Table 3-27 Inputs/Outputs parameter description of the function block F_OIL_BU

Name	Datatype	Description
Inputs		
PRE_INTL	BOOL	**Switch on interlock** • The oil burner function is ready for use if there is a 1-Signal at this input. • After the burner has been started on OIL_BU_ON, the input is no longer evaluated
ST_INTL	BOOL	**Start-up interlock** • The oil burner function can be started if there is a 1-Signal at this input. • This input is evaluated only during startup (starting with OIL_BU_ON = 1 to OIL_OPAT = 1)
OP_INTL	BOOL	**Operation interlock** • The oil burner function is operational if there is a 1-Signal at this input. • This input is evaluated after the function is put into operation (OIL_OPAT = 1)
OIL_BU_ON	BOOL	**Command switch-on oil burner** • A rising edge starts the burner function
OIL_BU_OFF	BOOL	**Command Switch-off oil burner** • A 1-Signal terminates the operation of the burner. • The burner can only be started if a 0-Signal exists at OIL_BU_OFF
V_IGNPOS	BOOL	**Oil control valve in ignition position** • 1-Signal: the oil control valve is in ignition position • 0-Signal: the oil control valve is not in ignition position If the system is in high-temperature mode, or the “Lead” burner is active at a combustion chamber monitoring (BU_OP = 1) the fuel control valve does not have to be in ignition position upon start-up
OILFIRE	BOOL	**Flame detected** • 1-Signal: Flame detected / Temperature above the high-temperature threshold • 0-Signal: No flame detected The signal of the flame detector must be connected at this input or the signal that the threshold for high-temperature operation has been exceeded (see chapter 4.3.5)

Name	Datatype	Description
OIL_OK	BOOL	**Oil criteria are fulfilled** • 1-Signal: Oil criteria fulfilled • 0-Signal: Oil criteria not fulfilled Oil criteria are all conditions concerning the fuel supply (e.g. pressure), which are necessary for safe operation
AD_IGNPOS	BOOL	**Air damper in ignition positon** • 1-Signal: Air damper is in ignition position • 0-Signal: Air damper not in ignition position If the system is in high-temperature operation, or the “Lead” burner is active at a combustion chamber monitoring (BU_OP = 1) the air damper does not have to be in ignition position upon start-up
AIR_OK	BOOL	**Common air-criteria fulfilled** • 1-Signal: Air criteria fulfilled • 0-Signal: Air criteria not fulfilled Air criteria are conditions based on the combustion air, which are necessary for safe operation
IGN_OP	BOOL	**Pilot burner in operation** • 1-Signal: Pilot burner ignited successfully • 0-Signal: Pilot burner not ignited
BU_OP	BOOL	**Burner in operation at combustion chamber monitoring and for high-temperature operation** • 1-Signal: Lead burner in operation / High-temperature operation active If this bit is set, a flame must be detected to start the burner(OILFIRE = 1) • 0-Signal: Other burners are not in operation / high temperature operation not active A signal change from 0 to 1 of the flame detector is scanned (stray light test) The input must be set, if the “lead” burner is in combustion chamber monitoring operation (OIL_OPAT = 1) or the system switches to the high temperature operation. In both cases, the burner must detect a flame (OILFIRE = 1) before start-up
QUIT	BOOL	**Error acknowledgement** • Error messages are reset with a rising edge at this input
STV_OPEN	BOOL	**Atomizing valve open** • 1-Signal: Atomizing valve is open • 0-Signal: Atomizing valve is closed
BV_CLOSED	BOOL	**Cleaning valve is closed** • 1-Signal: Cleaning valve is closed • 0-Signal: Cleaning valve is open
CLEAN_OK	BOOL	**Cleaning program finished** • 1-Signal: The burner was cleaned before start-up • 0-Signal: No additional time is necessary to fill the oil lance
T_DRAIN	TIME	**Drainage of the atomizing steam** • Time in which the cleaned parts can be drained, before the ignition is started (T_DRAIN is the time between opening of the atomizing valve and activation of the ignition function) • Reference value: 0min < T_DRAIN < 2min

Name	Datatype	Description
T_IGN	TIME	**Safety time of the burner** • The burner must have ignited successfully within this time • Reference value: 0sek < **T_IGN** < 10sek
T_FILL_IGN	TIME	**Safety time and fill time of the burner** • The burner must have ignited successfully within this time • This time includes, besides the actual safety time also the time that is needed to fill the fuel line for oil after cleaning / purging • Reference value: 0sek < T_FILL_IGN < 15sek
T_MFS_FAIL	TIME	**Monitoring time for the flame detector (stray light test)** • If a pilot flame Is longer than the time T_MFS_FAIL reported (OILFIRE = 1) although the oil burner function is not in operation (OIL_OPAT = 0), an error is detected. Monitoring will take place only when the high temperature operation or “lead” burner is not active (BU_OP = 0)
Outputs		
OIL_RUN	BOOL	**Oil start-up program activated** • 1-Signal: Oil start-up program in operation • 0-Signal: Oil start-up program is not yet started or the conditions for start-up are not fulfilled
OPEN_STV	BOOL	**Open the atomizing valve** • 1-Signal: Oil atomizing valve will be activated • 0-Signal: Oil atomizing valve will be closed or remains closed
IGN_ON	BOOL	**Switch-on the pilot burner** • 1-Signal: Ignition function is activated • 0-Signal: Ignition function is not activated The pilot burner is only activated until the main burner was successfully ignited and is in operation (OIL_OPAT = 1). If the pilot burner shall remain ignited after the successful ignition of the main burner, the input of the igniter (IGN_ON on F_IGNTR) must be logically linked by an “or” function with OIL_OPAT in addition (see chapter 4.3.3).
OPEN_V	BOOL	**Control of the safety shut-off valves** • 1-Signal: Open Safety shut-off valve(s) • 0-Signal: Safety shut-off valve(s) will be closed or remain(s) closed
OIL_OPAT	BOOL	**Oil burner in operation after T_IGN** • 1-Signal: the oil burner was ignited within the safety time • 0-Signal: the oil burner is not in operation
FILL_REQ	BOOL	**Oil lance blown out** • 1-Signal: Oil lance has been cleaned / blown out • 0-Signal: Oil lance has not been cleaned The signal is available when the oil burner has been cleaned (CLEAN_OK = 1). As long as the output has 1-Signal, T_FILL_IGN is used as safety time. The output is reset when a start-up with T_FILL_IGN has occurred
ERROR_OP	BOOL	**Operation cancelled / error during operation** • 1-Signal: There is one or more errors that occurred during operation • 0-Signal: there are no errors

Name	Datatype	Description
STATUS	INT	**Status of the function** • The number at this output indicates the current status of the function block (see chapter 3.9.4) **This output is for information only and may not be used for fail-safe connections!**
DIAG	WORD	**Diagnostic-Word** • Information about the block status and errors are displayed at this output word (see chapter 3.9.5) **This output is for information only and may not be used for fail-safe connections!**

NOTE	**Please note that the parameterized safety times comply with the relevant standards**

3.9.3 Functionality

Basic interconnections for the release of burner operation

The operating conditions of the burner for oil supply are to be interconnected at the input **OIL_OK** (e.g. max. / min. pressure or max. / min. temperature fulfilled and oil lance is in position).

The operating conditions for the air supply of the burner are to be interconnected at the input **AIR_OK** (e.g. maximum or minimum pressure fulfilled).

At **PRE_INTL** all conditions must be interconnected, which are necessary to start the oil start-up function (e.g. pre-purge finished or closed status of the safety shut-off valve(s)). After the successful start (**OIL_RUN** = TRUE), PRE_INTL must no longer be fulfilled.

At **ST_INTL** all conditions are connected that must be fulfilled until the burner was ignited successfully and is operational (**OIL_OPAT** = TRUE). After that the input is no longer evaluated.

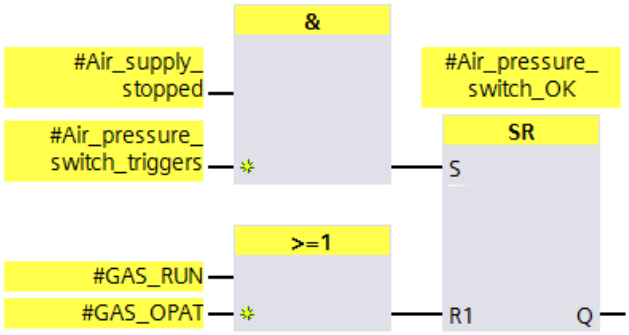
The conditions, that are relevant only during operation of the burner (OIL_OPAT = TRUE), must be interconnected to **OP_INTL**. This is only evaluated after the ignition of the main burner. This includes e.g. monitoring the maximum temperature.

The input **CLEAN_OK** must be interconnected with the corresponding enable signal of the oil-cleaning function F_OIL_CLEAN

The output **IGN_ON** must be interconnected with the same input of the function for controlling the pilot burner (F_IGNTR). If no pilot burner is used, then this output can be used also for direct control e.g. of an ignition transformer (see chapter 4.3.2).

Verification of the air monitoring

Figure 3-31 Example for interconnection to test the air pressure switch



The air monitoring equipment must be checked before start-up of the burner with a stationary flow. This can be realized, by checking with switched off or stopped air supply whether the air monitoring responds. An example for interconnecting is shown in Figure 3-31. „Air_supply_stopped" must be 1-Signal if the air supply was interrupted. If the air monitoring system detects the insufficient air supply the air pressure monitor is initiated (1-Signal).The signal "Air_pressure_switch_Ok" must be interconnected to the input **PRE_INTL**. If the burner is started (OIL_RUN = TRUE), the signal is reset.

Basic interconnections for the burner operation

The input signals **OIL_BU_ON** or **OIL_BU_OFF** are to be interconnected by the user to an appropriate control device for starting and stopping the burner. Similarly, the input signal for error QUIT must be interconnected by the user.

The condition for the ignition position of the oil control valve must be interconnected with the corresponding signal of the sensor at the input **V_IGNPOS**. (This does not apply when the system is in high-temperature operation, or the "lead" burner is active at a combustion chamber monitoring.

The input **AD_IGNPOS** for the ignition position of the air damper must be interconnected with the corresponding output-signal of the air damper **(**F_AIRD).

The Input **IGN_OP** is a feedback signal that the burner has successfully ignited and must be interconnected with F_IGNTR.

The outputs **OIL_RUN, OPEN_V** and **ERROR_OP** must be interconnected by the user with the appropriate blocks and actuators.

Additional interconnection using a combustion chamber monitoring

If a combustion chamber monitoring is used, then the operating status of the "lead burner" (OIL_OPAT) must be interconnected with the input **BU_OP** of the burners without a flame detector. (Only a so-called "lead burner" has a flame detector and is monitored. The other burners are directly ignited by this "lead burner" when the fuel valves are opened).

The signal of the flame detector of the "lead burner" must also be connected with the **OILFIRE** inputs of the burners without a separate flame detector

Additional interconnections for high-temperature operation

If the system is operated in high-temperature mode (the temperature in the combustion chamber exceeds the threshold defined in the standard(s)), flame monitoring is no longer necessary, as long as the temperature does not fall below this threshold. Accordingly, a query can be connected to the input **OILFIRE**

whether this temperature threshold has been exceeded and will be linked logically by “or” with the flame detector (see chapter 4.3.5).

The same query, of the temperature exceeding the threshold, can be connected to the input **BU_OP** of all burners.

Start and Start-up in single burner operation/ normal temperature mode (BU_OP = FALSE)

With a rising edge at OIL_BU_ON the function is started, if the conditions are fulfilled:

- Switch on interlock fulfilled (PRE_INTL = TRUE)
- Start interlock fulfilled (ST_INTL = TRUE)
- Air damper in ignition position (AD_IGNPOS = TRUE)
- Fuel valve in ignition position (V_IGNPOS = TRUE)
- Flame not detected in the combustion chamber (GASFIRE = FALSE)
- Air criteria fulfilled (AIR_OK = TRUE)
- Fuel criteria fulfilled (GAS_OK = TRUE)
- No error exists (ERROR_OP = FALSE)

If the start of the function was successful it is indicated by a 1-Signal at OIL_RUN and the atomizing valve opens (OPEN_STV = TRUE).

Once the atomizing valve is reported as open (STV_OPEN = TRUE), the drainage starts and the timer T_DRAIN runs down.

After T_DRAIN has elapsed (IGN_ON = TRUE), the pilot burner is activated (IGN_ON = TRUE).

If any of the above mentioned conditions is not fulfilled anymore during start-up (OIL_RUN = TRUE and OIL_OPAT = FALSE), the start-up will be cancelled and a diagnostic message displayed at DIAG (see chapter 3.9.5).

Start and Start-up in multiple burner operation/ high-temperature mode (BU_OP = TRUE)

With a rising edge at OIL_BU_ON the function is started, if the conditions are fulfilled:

- Switch on interlock fulfilled (PRE_INTL = TRUE)
- Start interlock fulfilled (ST_INTL = TRUE)
- Flame detected in the combustion chamber / Temperature in the combustion chamber above the threshold (OILFIRE = TRUE)
- Air criteria fulfilled (AIR_OK = TRUE)
- Fuel criteria fulfilled (OIL_OK = TRUE)
- No error exists (ERROR_OP = FALSE)

In this operation mode, it is not necessary that the ignition positions are approached. However, a flame must be detected.

If the start of the function was successful, it is indicated by a 1-Signal at OIL_RUN and the atomizing valve open (OPEN_STV = TRUE).

Once the atomizing valve is reported as open (STV_OPEN = TRUE), the drainage starts and the timer T_DRAIN runs down.

After T_DRAIN has elapsed (IGN_ON = TRUE), the pilot burner is activated (IGN_ON = TRUE).

If any of the above mentioned conditions is not fulfilled anymore during start-up (OIL_RUN = TRUE and OIL_OPAT = FALSE), or STV_OPEN = TRUE signal

drops out the start-up will be cancelled and a diagnostic message displayed at DIAG (see chapter 3.9.5).

Ignition and operation of the (main) burner

Once the feedback signal exists that the pilot burner has been successfully ignited (IGN_OP = TRUE), the safety shut-off valves are opened (OPEN_V = TRUE) and the safety time starts to run:

- T_IGN, if CLEAN_OK was not set before the start and the lance therefore does not need to be filled (FILL_REQ = FALSE)
- T_FILL_IGN, if the oil burner was cleaned prior, the lance therefore must be filled (FILL_REQ = FALSE) and a longer safety time is permitted

The ignition of the burner was successful, if a flame is detected after the time of T_IGN or T_FILL_IGN has elapsed (OILFIRE = TRUE) and the operating conditions are fulfilled (OP_INTL = TRUE). It is reported by a 1-signal at OIL_OPAT that the burner is in operation and OIL_RUN reset.

The ignition positions (V_IGNPOS and AD_IGNPOS), and the start conditions (ST_INTL) are no longer evaluated in the operation of the burner. If any condition drops out while the burner is in operation an error message is shown instead of a diagnostic message.

Manual Stop

The burner can be stopped manually at any time by a 1-Signal at OIL_BU_OFF. All valves will be closed (OPEN_V = FALSE and OPEN_STV = FALSE) and the function is reset to its initial status (OIL_RUN = FALSE and OIL_OPAT = FALSE).

Conditions drop out during start-up

As long the function has not been started, a start attempt without the aforementioned conditions being fulfilled will generate a diagnostic message (see chapter 3.9.5).

If one of the start-up condition (excluding PRE_INTL) drops out during startup of the burner (OIL_RUN = TRUE) the start-up operation is cancelled and a diagnostic message is generated.

Behavior at error detection

An error message is issued if:

- No flame was detected after the safety time has elapsed (OILFIRE = FALSE after T_IGN or T_FILL_IGN)
- If one of the following conditions is **not** fulfilled anymore during operation of the burner (OIL_OPAT = TRUE):
  - Operation condition fulfilled (OP_INTL = TRUE)
  - Flame detected in the combustion chamber / Temperature in the combustion chamber above the threshold (OILFIRE = TRUE)
  - Air criteria fulfilled (AIR_OK = TRUE)
  - Fuel criteria fulfilled (OIL_OK = TRUE)
  - Cleaning valve is closed (BV_CLOSED = TRUE)
- A flame (OILFIRE = TRUE) is detected for longer than T_MFS_FAIL while the burner is switched off (OIL_RUN = FALSE and OIL_OPAT = FALSE) and in normal operation (BU_OP = FALSE)

If an error is detected, then this error is reported (ERROR_OP = TRUE) and issued in the diagnosis DIAG (see chapter 3.9.5).
Acknowledge

A detected error remains unchanged until it has been acknowledged. An error can be acknowledged by a rising edge at the input QUIT. The error message is reset (ERROR_OP = FALSE) if the error is resolved. At the output QUIT_ON the current status of the input QUIT can be read.
Diagnostic messages can also be acknowledged by a rising edge at QUIT (see chapter 3.9.5).

3.9.4 Status

At the output STATUS the current status of the function can be read. This output is used purely for information and cannot be used for fail-safe connections.

Table 3-28 Status of the function block F_OIL_BU

No.	Status	Description
0	Initial Status	The function is in the initial status. To start the function, a rising edge on input OIL_BU_ON is required. The function is reset with a 1-Signal at the input OIL_BU_OFF to its initial status.
1	Start-up oil burner	The start-up of the oil burner has been initiated (OIL_RUN = TRUE). Opening of the atomizing valve is initialized (OPEN_STV = TRUE). The function block awaits the feedback-signal (STV_OPEN), that indicates that the atomizing valve is open (STV_OPEN = TRUE)
2	Drainage	The atomizing valve is open. The drainage is carried out for the time T_DRAIN. If T_DRAIN = 0S then it is directly passed over to the status No. “3”
3	Activate the Igniter/pilot burner	The igniter/pilot burner is activated (IGN_ON = TRUE). The function is waiting for the confirmation that the igniter/pilot burner is in operation (IGN_OP = TRUE)
4	Open the shut-off valve(s)	The igniter is in operation and the safety shut-off valves are opened (OPEN_V = TRUE). The safety time (T_IGN or T_FILL_IGN) runs down. After the safety time has elapsed, a flame signal is expected (OILFIRE = TRUE)
5	Oil burner in operation	The burner was successfully ignited (OILFIRE = TRUE) and is in operation (OIL_OPAT = TRUE).
7	Error	The system has detected an error. A detailed diagnosis is possible by evaluating the output DIAG (see chapter 3.9.5). The initial status can be re-taken with a rising edge at input QUIT.

3.9.5 Diagnose

Table 3-29 Diagnose of the function block F_OIL_BU

Bit No.	Description	Reset conditions
0	Start command is activated, while pre-interlock is not set (OIL_BU_ON=1 und PRE_INTL=0)	• PRE_INTL=1 • Rising edge at QUIT
1	Starting command is activated, while the Start-up interlock is not set (OIL_BU_ON=1 und ST_INTL=0)	• ST_INTL = 1 • Rising edge at QUIT
2	Start command is activated, while a stop command exists (OIL_BU_ON=1 and OIL_BU_OFF = 1)	• OIL_BU_OFF = 0 • Rising edge at QUIT
3	Start command is initiated while an unacknowledged error exists (OIL_BU_ON=1 und ERROR_OP=1)	• Rising edge at QUIT
4	The fuel control valve is not in ignition position, while the oil start-up program is running or is started (OIL_BU_ON=1 and V_IGNPOS=0)	• Switch over to multiple burner operation (BU_OP=1) • Rising edge at QUIT • New start command (OIL_BU_ON=1)
5	The air damper is not in ignition position, while the oil start-up program is running or is started (OIL_BU_ON=1 und AD_IGNPOS = 0)	• Switch over to multiple burner operation (BU_OP=1) • Rising edge at QUIT • New start command (OIL_BU_ON=1)
6	Flame detector does not detect a flame within the safety time (OILFIRE = 0 after T_IGN or T_FILL_IGN has elapsed)	• Rising edge at QUIT • New start command (OIL_BU_ON=1)
7	Air criteria not fulfilled during start-up / operation of the burner (OIL_RUN = 1 or OIL _OPAT = 1 and AIR_OK = 0)	• Rising edge at QUIT • New start command (OIL_BU_ON=1)
8	Conditions of oil supply not fulfilled during start-up / operation of the burner (OIL_RUN = 1 or OIL _OPAT = 1 and OIL_OK = 0)	• Rising edge at QUIT • New start command (OIL_BU_ON=1)
9	Atomizing valve is activated but not yet open (OPEN_STV = 1 and STV_OPEN = 0)	• STV_OPEN=1 • Rising edge at QUIT • Stop command (OIL_BU_OFF=1)
10	Cleaning valve is open during ignition of the burner (IGN_ON = 1 and IGN_OP = 1 and BV_CLOSED = 0)	• Rising edge at QUIT • New start command (OIL_BU_ON=1)
11	Pilot burner is controlled, but is not yet in operation (IGN_OP = 0 and IGN_ON = 1)	• IGN_OP=1 • Rising edge at QUIT • Stop command (OIL_BU_OFF=1)
12	Operating interlocks failed during the operation of the burner (OIL_OPAT = 1) (OP_INTL = 0)	• Rising edge at QUIT • New start command (OIL_BU_ON=1)
13	Flame detector reports flame although no burner is in operation (OILFIRE = 1, BU_OP = 0, OIL_RUN = 0 and OIL_OPAT = 0)	• Rising edge at QUIT

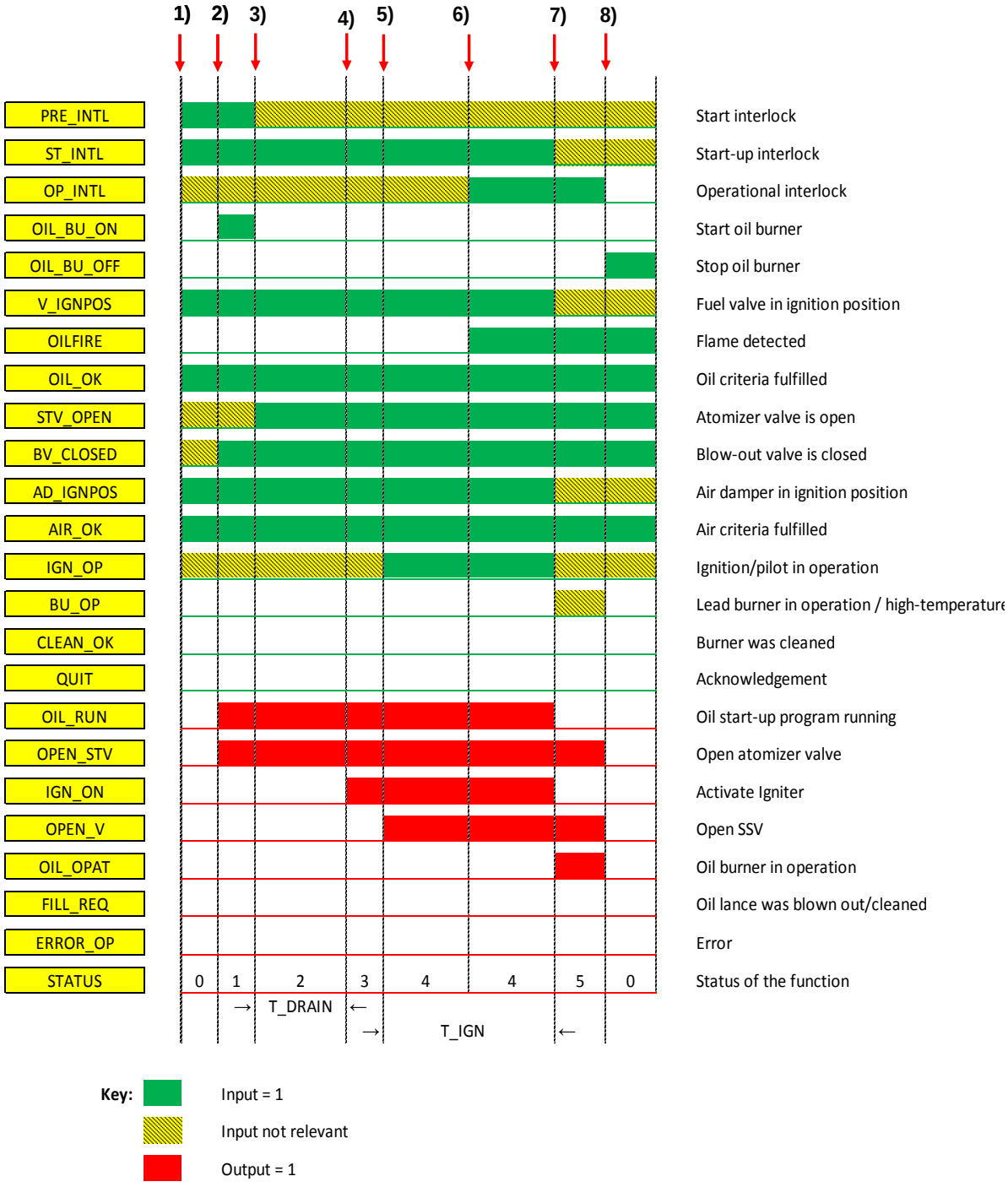
Bit No.	Description	Reset conditions
14	Flame failure during operation of the burner (OIL_OPAT = 0 and OILFIRE = 0)	• Rising edge at QUIT
15	Atomizing valve is no longer open during startup or operation of the burner (OIL_RUN = 1 or OIL_OPAT = 1 and STV_OPEN = 0)	• Rising edge at QUIT • New start command (OIL_BU_ON=1)

3.9.6 Time diagram

Signal sequence of single mode in normal operation

The figure below shows the signal sequence of the function F_OIL_BU in normal operation (no combustion chamber monitoring and no high-temperature operation).

Figure 3-32 Time diagram of the function block F_OIL_BU in normal operation without having been cleaned

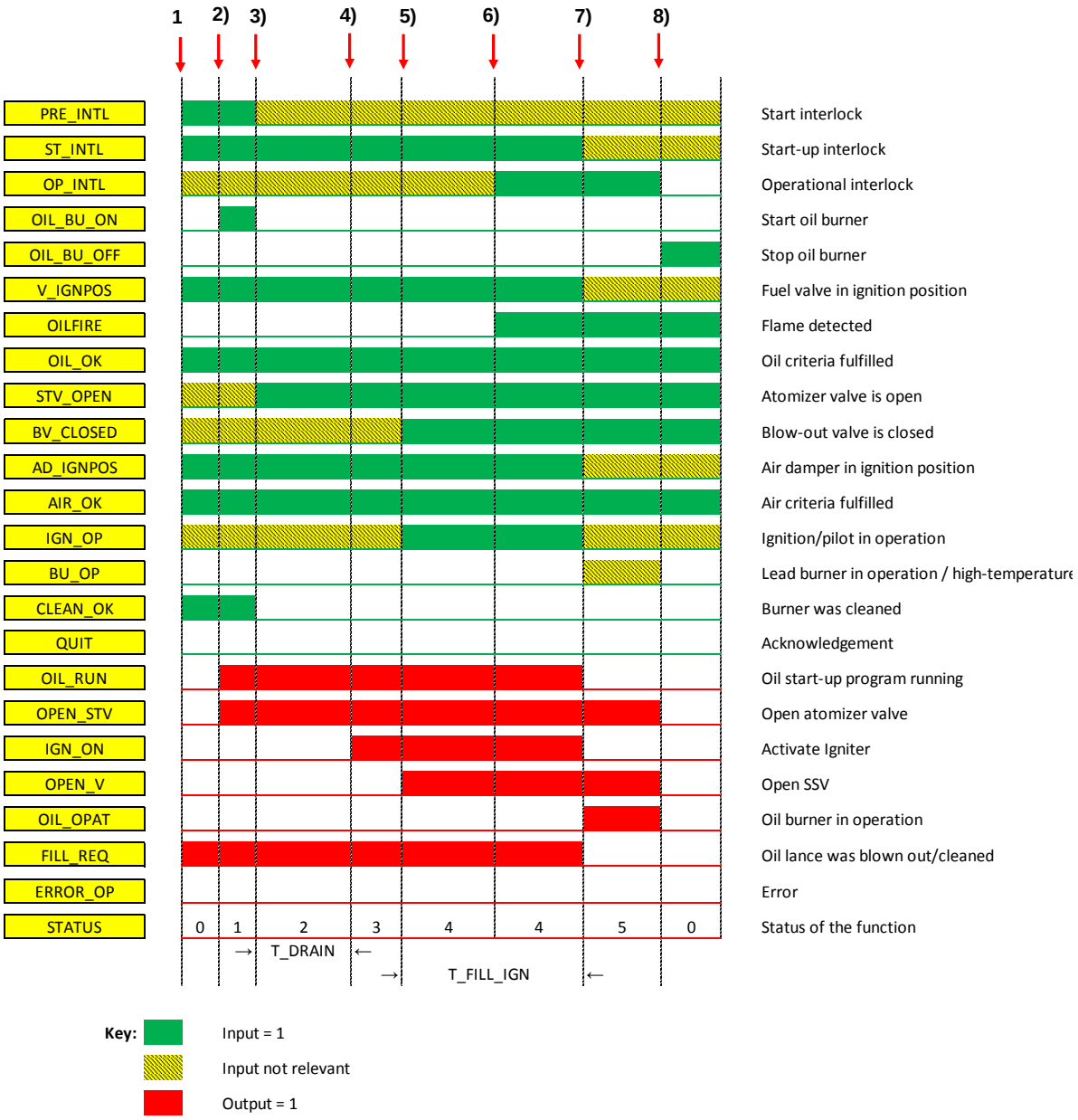


Description of the signal sequence:

Case 1: There is no fill time required for the oil lance (FILL_REQ = FALSE)

1. Pre-interlock fulfilled (PRE_INTL=1)
   Stat-up interlock fulfilled (ST_INTL=1)
   The fuel control valve is in ignition position (V_IGNPOS=1)
   Air damper in ignition position (AD_IGNPOS=1)
   Oil criteria are fulfilled (OIL_OK=1)
   Air criteria fulfilled (AIR_OK=1)
   No flame is detected (OILFIRE = 0)
2. Start the burner by a rising edge at input OIL_BU_ON
   The cleaning valve is closed (BV_CLOSED=1)
   The oil start-up program is running (OIL_RUN = 1)
   The atomizing valve opens (OPEN_STV = 1)
3. The atomizing valve is open (STV_OPEN=1)
   The timer T_DRAIN starts for the drainage
4. When the timer has elapsed, the pilot burner is activated (IGN_ON=1)
5. The pilot burner is in operation (IGN_OP=1)
   The safety shut-off valve(s) open(s) (OPEN_V=1)
   The safety time T_IGN starts
6. Within the safety time, the operating conditions are fulfilled (OP_INTL=1)
   A flame is detected (OILFIRE = 1)
7. The burner was successfully ignited (OIL_OPAT = 1)
8. Cancel the function by stop command at input OIL_BU_OFF

Figure 3-33 Time diagram of the function block F_OIL_BU in normal operation after having been cleaned



Case 2: The oil lance must be filled (FILL_REQ = TRUE)

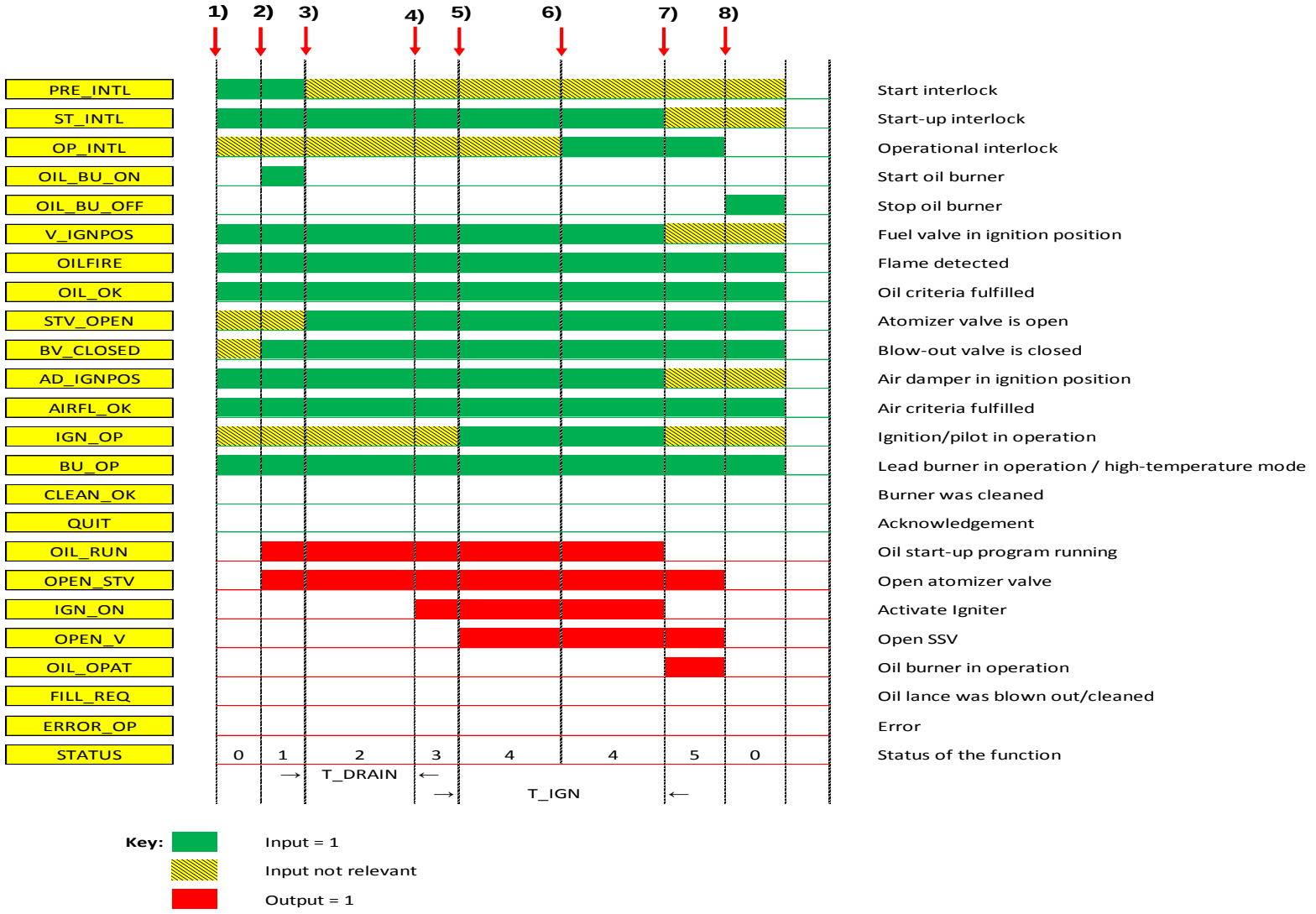
1. Pre-interlock fulfilled (PRE_INTL=1)
   Stat-up interlock fulfilled (ST_INTL=1)
   The fuel control valve is in ignition position (V_IGNPOS=1)
   Air damper in ignition position (AD_IGNPOS=1)
   Oil criteria are fulfilled (OIL_OK=1)
   Air criteria fulfilled (AIR_OK=1)
   No flame is detected (OILFIRE = 0)
   Burner was cleaned before start-up (CLEAN_OK = 1)

2. Start the burner by a rising edge at input OIL_BU_ON
   The cleaning valve is closed (BV_CLOSED=1)
   The oil start-up program is running (OIL_RUN = 1)
   The atomizing valve opens (OPEN_STV = 1)
3. The atomizing valve is open (STV_OPEN=1)
   The timer T_DRAIN starts for the drainage
4. When the timer has elapsed, the pilot burner is activated (IGN_ON=1)
5. The pilot burner is in operation (IGN_OP=1)
   The safety shut-off valve opens (OPEN_V=1)
   The safety time T_FILL_IGN starts
6. Within the safety time, the operating conditions are fulfilled (OP_INTL=1)
   A flame is detected (OILFIRE = 1)
7. The burner was successfully ignited (OIL_OPAT=1)
   FILL_REQ is reset
8. Cancel the function by stop command at input OIL_BU_OFF

Signal sequence of combustion chamber monitoring / high-temperature operation

The following signal sequence shows the F_OIL_BU when the system is in high-temperature operation, or the “lead” burner is already in operation at a combustion chamber monitoring (BU_OP = 1).

Figure 3-34 Time diagram of the function F_OIL_BU in high-temperature operation / active “Lead” burner

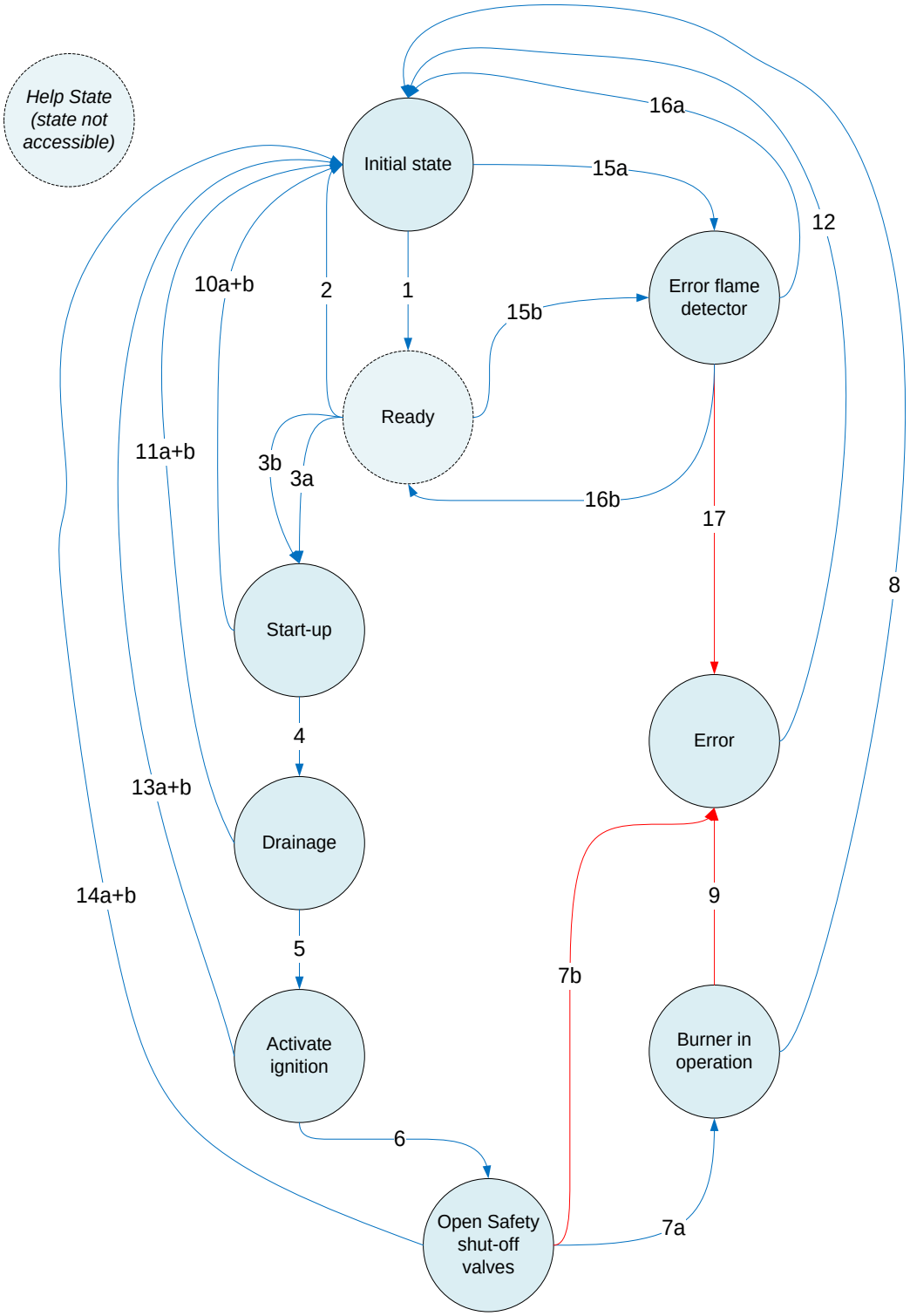


Description of the signal sequence with combustion chamber monitoring / high-temperature operation:

1. Start Interlock fulfilled (PRE_INTL=1)
   Start-up interlock fulfilled (ST_INTL=1))
   Oil criteria are fulfilled (OIL_OK=1)
   Air criteria fulfilled (AIR_OK=1)
   Lead burner is in operation (BU_OP=1)
   A flame has been detected (OILFIRE=1)
2. Start the burner by rising edge at input OIL_BU_ON
   The oil start-up program runs (OIL_RUN = 1)
   The atomizing valve opens (OPEN_STV = 1)
3. The atomizing valve is open (STV_OPEN=1)
   The timer T_DRAIN starts for the drainage
4. The pilot burner is activated (IGN_ON=1) when the timer T_DRAIN has elapsed
5. The pilot burner is in operation (IGN_OP=1)
   The cleaning valve is closed (BV_CLOSED=1)
   The safety shut-off valve(s) open(s) (OPEN_V=1)
   The safety time T_IGN starts
6. Within the safety time, the operating conditions are fulfilled (OP_INTL=1)
   A flame is detected (OILFIRE=1)
7. The burner was ignited successfully (OIL_OPAT=1)
8. Cancelling of the function by stop command at input OIL_BU_OFF

3.9.7 Status graph

Figure 3-35 Status graph of the function block F_OIL_BU



Explanation of the status graph

Table 3-30 Status graph of the function block F_OIL_BU Transition

Transition	Condition for Transition
1	PRE_INTL == 1
2	PRE_INTL == 0
3a	Single burner operation: (CLEAN_OK == 1 (see Table 3-32) **OR** CLEAN_OK == 0 (see Table 3-31)) **AND** Rising edge at OIL_BU_ON **AND** ST_INTL == 1 **AND** OIL_BU_OFF == 0 **AND** ERROR_OP == 0 **AND** OIL_OK ==1 **AND** AIR_OK == 1 **AND** V_IGNPOS == 1 **AND** AD_IGNPOS == 1 **AND** BV_CLOSED == 1 **AND** OILFIRE == 0 **AND** BU_OP == 0
3b	Multiple burner operation: (CLEAN_OK == 1 (siehe Table 3-32) **OR** CLEAN_OK == 0 (siehe Table 3-31) **AND** Rising edge at OIL_BU_ON **AND** ST_INTL == 1 **AND** OIL_BU_OFF == 0 **AND** ERROR_OP == 0 **AND** OIL_OK ==1 **AND** AIR_OK == 1 **AND** OILFIRE ==1 **AND** BU_OP ==1 **AND** BV_CLOSED == 1
4	STV_OPEN == 1
5	Timer T_DRAIN elapsed
6	IGN_OP == 1
7a	(OILFIRE == 1 **AND** OP_INTL == 1 within the safety time T_IGN) **OR** FILL_REQ == 1 (see Table 3-32 **AND** T_FILL_IGN elapsed **AND** OILFIRE == 1
7b	T_IGN elapsed **AND** OILFIRE == 1 **OR** FILL_REQ == 1 (see Table 3-32) **AND** T_FILL_IGN elapsed **AND** OILFIRE == 0

Transition	Condition for Transition
8	OIL_BU_OFF == 1
9	OIL_OK == 0 **OR** AIR_OK == 0 **OR** OILFIRE == 0 **OR** OP_INTL == 0
10a	Single burner operation: OIL_BU_OFF == 1 **OR** OIL_OK == 0 **OR** AIR_OK == 0 **OR** ST_INTL == 0 **OR** V_IGNPOS == 0 **OR** AD_IGNPOS == 0 **OR** BV_CLOSED == 0
11a, 13a	Single burner operation: OIL_BU_OFF == 1 **OR** OIL_OK == 0 **OR** AIR_OK == 0 **OR** ST_INTL == 0 **OR** V_IGNPOS == 0 **OR** AD_IGNPOS == 0 **OR** BV_CLOSED == 0 **OR** STV_OPEN == 0
10b	Multiple burner operation: OIL_BU_OFF == 1 **OR** OIL_OK == 0 **OR** AIR_OK == 0 **OR** ST_INTL == 0 **OR** (OILFIRE ==0 **AND** BU_OP ==1) **OR** (OILFIRE ==1 **AND** BU_OP ==0) **OR** BV_CLOSED == 0
11b, 13b	Multiple burner operation: OIL_BU_OFF == 1 **OR** OIL_OK == 0 **OR** AIR_OK == 0 **OR** ST_INTL == 0 **OR** (OILFIRE ==0 **AND** BU_OP ==1) **OR** (OILFIRE ==1 **AND** BU_OP ==0) **OR** BV_CLOSED == 0 **OR** STV_OPEN == 0
12	Rising edge at QUIT
14a	Single burner operation: OIL_BU_OFF == 1 **OR** OIL_OK == 0 **OR** AIR_OK == 0 **OR** ST_INTL == 0 **OR** STV_OPEN == 0 **OR** BV_CLOSED == 0 **OR** IGN_OP == 0 **OR** V_IGNPOS == 0 **OR** AD_IGNPOS == 0

Transition	Condition for Transition
14b	Multiple burner operation: OIL_BU_OFF == 1 **OR** OIL_OK == 0 **OR** AIR_OK == 0 **OR** ST_INTL == 0 **OR** STV_OPEN == 0 **OR** BV_CLOSED == 0 **OR** IGN_OP == 0 **OR** (OILFIRE ==0 **AND** BU_OP ==1) **OR** (OILFIRE ==1 **AND** BU_OP ==0)
15a, 15b	BU_OP := FALSE **AND** OILFRE := TRUE **AND**
16a	OILFIRE == 0 **OR** BU_OP == 1
16b	(OILFIRE == 0 **OR** BU_OP == 1) **AND** PRE_INTL == 1
17	Monitoring time elapsed T_MFS_FAIL

Table 3-31 Status graph of the function block F_OIL_BU outputs (for CLEAN_OK == 0)

Status	Outputs switched
Initial State	No outputs switched STATUS := “0”
Ready	No switched outputs
Start-up	OIL_RUN := TRUE OPEN_STV := TRUE STATUS := “1”
Drainage	Timer T_DRAIN started *STATUS := “2”*
Activate ignition	IGN_ON := TRUE STATUS := “3”
Open Safety shut-off valve	OPEN_V := TRUE Safety time T_IGN or starts STATUS := “4”
Burner in operation	OIL_OPAT := TRUE OIL_RUN := FALSE IGN_ON := FALSE STATUS := “5”
Error flame detector	Timer T_MFS_FAIL starts
Error	ERROR_OP := TRUE OPEN_V := FALSE OIL_OPAT := FALSE STATUS := “7”

Table 3-32 Status graph of the function F_OIL_BU Outputs (for CLEAN_OK = 1)

Status	Output switched
Initial Status	No switched outputs STATUS := “0”
Ready	No switched outputs
Start-up	OIL_RUN := TRUE OPEN_STV := TRUE FILL_REQ := TRUE STATUS := “1”
Drainage	Timer T_DRAIN started STATUS := “2”
Activate ignition	IGN_ON := TRUE STATUS := “3”
Open Safety shut-off valves	OPEN_V := TRUE Safety time T_FILL_IGN starts STATUS := “4”
Burner in operation	OIL_OPAT := TRUE OIL_RUN := FALSE IGN_ON := FALSE FILL_REQ := FALSE STATUS := “5”
Error flame detector	Timer T_MFS_FAIL starts
Error	ERROR_OP := TRUE OPEN_V := FALSE OIL_OPAT := FALSE STATUS := “7”

3.10 Function to control the pre-purging / pre-ventilation (F_PRE_PURGE)

3.10.1 Introduction

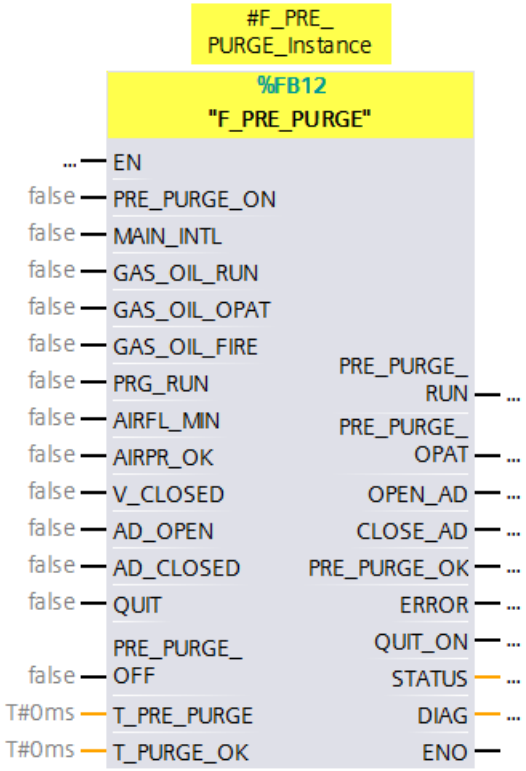
The module F_PRE_PURGE controls and monitors the pre-purging / pre-ventilation process for the plant. Before the burner is started or after a safety shut down of the burner, a purge must be carried out. A rising edge at the input PRE_PURGE_ON starts the process, if the conditions are fulfilled. The conditions are: The fuel supply valves are closed, pilot burner and main burner not in operation and don`t report a flame signal, and the air supply is continuously above the parameterized minimum flow rate. The duration of the PRE_PURGE operation must be defined by the user and depends on the application. Before the PRE_PURGE operation was not passed successfully, the burner may not be started again. The message about the successful completion of PRE_PURGE remains until the burner has been ignited, or the function is restarted (whichever occurs first).

The function must take place after the gas tightness test, or oil burner cleaning and prior to the ignition of the burner. In exceptional cases (specified in the standard), the gas tightness test and pre-purge / pre-ventilation may take place simultaneously, as long as it is assured that no gas enters the combustion chamber (e.g. by monitoring the closed status of the 2nd SSV).

After a failed attempt of ignition a pre-purge is to be carried out before re-ignition (unless otherwise approved by the standards).

The function provides signals for controlling the air damper, which can be interconnected with the F_AIRD function (see chapter 3.3). Monitoring of the air damper (e.g. damper run time) is carried out by the F_AIRD function.

Figure 3-36 function block F_PRE_PURGE



Note When using this function, the function blocks F_TON (FB 185) and F_BO_W (FC176) must exist in the system block folder.

3.10.2 Connections

The default value for all inputs of data type BOOL is 0-Signal, for all inputs of data type TIME is T#0ms and for all inputs of data type INT is 0.

Table 3-33 Inputs/Outputs Parameter description of the function block F_PRE_PURGE

Name	Data type	Description
Inputs		
PRE_PURGE_ON	BOOL	**Start command pre-ventilation** • A rising edge at this input starts pre-purging • Pre-purge does not start if a burner is in operation (GAS_OIL_RUN = 1)
MAIN_INTL	BOOL	**Main interlock fulfilled** • 1-Signal: Pre-purge function is operational • 0-Signal: Pre-purge is interrupted or not started

Name	Data type	Description
GAS_OIL_RUN	BOOL	**Operating status of the gas / oil burner** • The flushing process cannot be started with a 1-Signal at this input. • This input is queried if the burner is being started and the pre-purging may not take place • A 1-Signal at this input also resets PRE_PURGE_OK
GAS_OIL_OPAT	BOOL	**Gas-/ Oil-burner in Operation** • Once the gas / oil burner is in operation, the output parameter (PRE_PURGE_OK = 1) is set to zero • As long as the burner is in operation, the pre-purge must not be started • A 1-Signal at this input also resets PRE_PURGE_OK
GAS_OIL_FIRE	BOOL	**Flame detected** • 1-Signal: Flame detected • 0-Signal: Flame not detected • If a flame is detected, pre-purge must not be started or carried out
PRG_RUN	BOOL	**Other programs running** • As long as a 1-Signal exists at this input, other functions are in operation to prevent the start of the pre-purge
AIRFL_MIN	BOOL	**Minimum air flow rate available** • 1-Signal: Minimum air flow rate achieved • 0-Signal: Minimum air flow rate not achieved • If the minimum air flow rate is not reached, the pre-purge operation is cancelled
AIRPR_OK	BOOL	**Air pressure criteria fulfilled** • 1-Signal: Air pressure criteria fulfilled • 0-Signal: Air pressure criteria not fulfilled • If the air pressure is outside the permitted limits (maximum and minimum values), this input must be zero
V_CLOSED	BOOL	**Safety shut-off valves closed** • 1-Signal: Safety shut-off valves closed • 0-Signal: Safety shut-off valves open • Pre-purge can only be started and carried out if the safety shut-off valves are closed
AD_OPEN	BOOL	**Air damper open / fan in operation** • 1-Signal: Air damper is completely open (position for pre-purge) or the fan is in operation • 0-Signal: Air damper is not completely open
AD_CLOSED	BOOL	**Air damper closed / fan is switched off** • 1-Signal: Air damper is completely closed / fan is switched off • 0-Signal: Air damper is not completely closed

Name	Data type	Description
QUIT	BOOL	**Error acknowledge** • Error messages are reset at this input • Acknowledgement is only possible with rising edge
PRE_PURGE_OFF	BOOL	**Switch-off pre-purge** • A 1-Signal terminates the operation of pre-purge
T_PRE_PURGE	TIME	**Time for pre-purge** • The time indicates how long the pre-purge operation is performed • Within this time, the combustion chamber and the exhaust paths with the minimum flow rate (AIRFL_MIN) must have been sufficiently purged
T_PURGE_OK	TIME	**Period of time after it must be ignited** • After successful purging, ignition must have been carried out within this time • After the parameterized time T_PURGE_OK has elapsed, PRE_PURGE_OK is reset and it must be pre-ventilated again before ignition can occur • PRE_PURGE_OK is not reset if the value T # 0S is parameterized • Reference value: 0min oder 10min **For certain applications (e.g. steam boilers and water tube boilers) the burner has to be ignited within a certain time (given by the standard: 10min), after successful purging, If there is no ignition within this time, pre-purge has to be carried out again before the burner can be ignited/started.**
Outputs		
PRE_PURGE_RUN	BOOL	**Pre-purge program is running** • 1-Signal: Pre-purge program is running • 0-Signal: Pre-purge program is not running
PRE_PURGE_OPAT	BOOL	**Pre-purge active / Pre-purge time is running** • 1-Signal: Pre-purge process is running • 0-Signal: Pre-purge process is not running • If the pre-purge time is running the output is set. The output can be used to control an electric ignition device if necessary
OPEN_AD	BOOL	**Command: open air damper** • 1-Signal: Open Air damper • 0-Signal: Don`t open air damper
CLOSE_AD	BOOL	**Command: close air damper** • 1-Signal: Close air damper • 0-Signal: Don`t close air damper
PRE_PURGE_OK	BOOL	**Pre-purge succesfully performed** • Indicates that the pre-purge has been performed successfully • PRE_PURGE_OK is reset by the inputs GAS_OIL_RUN, GAS_OIL_OPAT, or a rising edge at PRE_PURGE_ON or T_PURGE_OK has elapsed
ERROR	BOOL	**Error in pre-purge** • 1-Signal: During pre-purge an error has occurred • 0-Signal: No error detected

Name	Data type	Description
QUIT_ON	BOOL	**Acknowledgment activated** • 1-Signal: Am Eingang QUIT steht ein 1-Signal an • 0-Singal: Am Eingang QUIT steht ein 0-Signal an
STATUS	INT	**Status of the function** • The number at this output indicates the current status of the function block (see chapter 0) **This output is for information only and may not be used for fail-safe connections!**
DIAG	WORD	**Diagnostic-Word** • Information about the function status and errors are displayed at this output (see chapter 3.10.5) **This output is for information only and may not be used for fail-safe connections!**

NOTE	**Please note that the parameterized safety times and threshold values comply with the relevant standards.**

3.10.3 Functionality

Interconnections with the main functional block(s) (F_GAS_BU or F_OIL_BU)

GAS_OIL_RUN is to be interconnected with the output of GAS_RUN F_GAS_BU or OIL_RUN of F_OIL_BU.

GAS_OIL_OPAT must be connected to the output of GAS_OPAT F_GAS_BU or OIL_OPAT of F_OIL_BU.

At **GAS_OIL_FIRE** the same signal as at GASFIRE of F_GAS_BU or OILFIRE of F_OIL_BU must be available.

PRE_PURGE_OK is linked to the input of PRE_INTL F_GAS_BU or F_OIL_BU.

If only one instance of the function F_PRE_PURGE I used, then all instances of F_GAS_BU or F_OIL_BU in accordance with the above requirements must be interconnected (by a logically OR) with an instance of F_PRE_PURGE.

Basic interconnections for the burner operation

At **MAIN_INTL** all operating conditions for the pre-purge can be interconnected.

If other programs are still running, and turning on the ignition test is to prevent, then the associated conditions are to be interconnected with the input signal **PRG_RUN**.

The parameters for monitoring the minimum air flow are to be interconnected.to the input **AIRFL_MIN.**

With the input signal **AIRPR_OK** is checked whether the air pressure criteria are fulfilled.

The verification of the position of the safety shut-off valve is interconnected with the input signal **V_CLOSED**.

An error can be acknowledged by the user at the input **QUIT**. The signal can be connected with a corresponding control device.

The pre-purge process can be switched off by using the input signal **PRE_PURGE_OFF** with an interconnection of a corresponding control device.

The output signals **PRE_PURGE_RUN, PRE_PURGE_OPAT** and **ERROR** are to be interconnected by the user with the appropriate modules and actuators.

Interconnection using an air damper (F_AIRD)

If an air damper is used, then these can be controlled for the pre-purge process directly from this function.

The outputs **OPEN_AD** and **CLOSE_AD** are to be interconnected directly with the inputs of the same name of the function F_AIRD.

The input **AD_OPEN** can be connected with the same signal AD_OPENED of F_AIRD and the input **AD_CLOSED** can be connected with the same signal AD_CLOSED from the same input of F_AIRD.

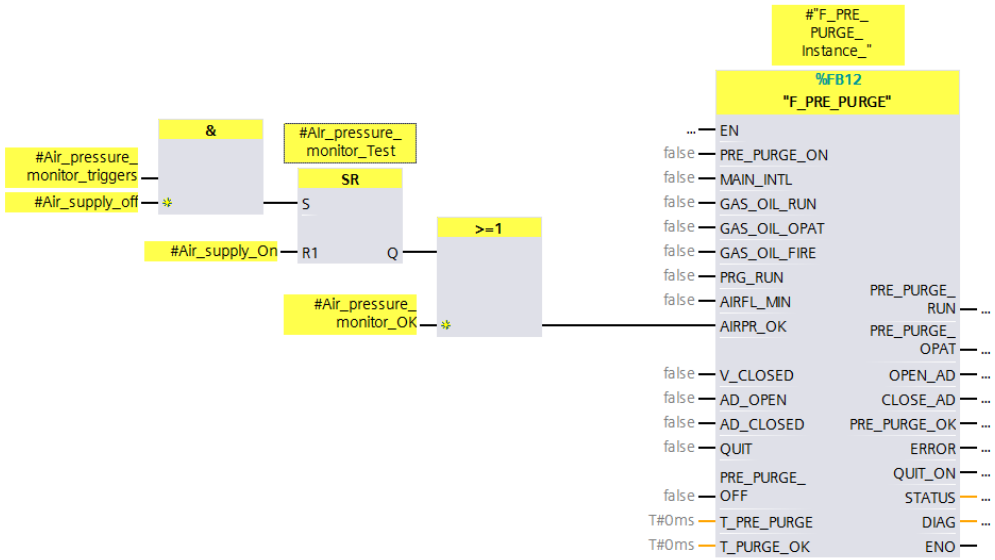
Interconnection if no air damper is used

If no air damper is used, the output **CLOSE_AD** must be either directly connected to the input **AD_CLOSED,** or the fan can be controlled on the basis of **OPEN_AD** and **CLOSE_AD** (**OPEN_AD** for starting and stopping **CLOSE_AD**).

In this case **AD_OPEN** must be connected in such way that a 1-Signal is available when the fan is running and **AD_CLOSED** has 1-Signal when the fan was stopped.

Since **AIRPR_OK** must already be set when starting the function, but the minimum air pressure will be established after the fan is switched on, the connection can be made as shown in Figure 3-37. The (successful) pressure switch test is interconnected with the input AIRPR_OK.

Figure 3-37 Example for connecting AIRPR_OK when using a fan



Operation

The function is started with a rising edge at PRE_PURGE_ON when the following conditions are fulfilled:

- Main interlock fulfilled (MAIN_INTL = TRUE)
- Safety shut-off valves closed (V_CLOSED = TRUE)
- No flame detected in the combustion chamber (GAS_OIL_FIRE = FALSE)
- Burner not in operation (GAS_OIL_OPAT = FALSE)
- Burner is not in start-up process (GAS_OIL_RUN = FALSE)
- Air criteria fulfilled (AIRPR_OK = TRUE)
- No error exists (ERROR = FALSE)

A successful start of the function is indicated by a 1-Signal at PRE_PURGE_RUN and the air damper opens (OPEN_AD = TRUE).

If not, a diagnostic message will be generated and displayed at DIAG (see chapter 3.10.5).

Once the damper is reported as open (AD_OPEN = TRUE) and the minimum flow rate was achieved (AIRFL_MIN = TRUE), the pre-purge time starts (T_PRE_PURGE).

The successful completion of the function is reported (PRE_PURGE_OK = TRUE), if the time (T_PRE_PURGE) has elapsed, and no error was detected or pre-purge has not been interrupted manually (PRE_PURGE_OFF = TRUE).

The air damper is not closed at the successful completion of pre-purge (CLOSE_AD = FALSE).

Manual cancellation of pre-purge

If necessary, the function can be cancelled with a 1-Signal at PRE_PURGE_OFF. The pre-purge is stopped, the function is reset to its original status and the command is given to close the damper (CLOSE_AD = TRUE). This remains unchanged until it is reported as closed (AD_CLOSED = TRUE) or PRE_PURGE_ON receives a rising edge.

Error

If one of the operating conditions drops out during active pre-purging (PRE_PURGE_OPAT = TRUE), an error is reported (ERROR = TRUE) and pre-purge will be cancelled. In addition to that, if the flow rate is below the minimum (AIRFL_MIN = FALSE) during the pre-purge, an error message is generated and the function will be aborted.

If the air damper is reported as open and closed simultaneously (AD_OPEN = TRUE and AD_CLOSED = TRUE) an error message will be generated, if the function was in operation (PRE_PURGE_RUN = TRUE).

If an error is detected, the function is aborted (PRE_PURGE_RUN = FALSE and PRE_PURGE_OPAT = FALSE) and the air damper is given the command for closing (CLOSE_AD = TRUE). This remains unchanged until it is reported as closed (AD_CLOSED = TRUE), or PRE_PURGE_ON receives a rising edge.

Each error message generates a diagnostic message which will be displayed at the output DIAG (see chapter 3.10.5).

Acknowledge

A detected error remains unchanged until it has been acknowledged. An error can be acknowledged by a rising edge at the input QUIT. The error message is reset (ERROR = FALSE) if the error is resolved.

Diagnostic messages can also be acknowledged by a rising edge at QUIT (see chapter 3.10.5)

3.10.4 Status

At the output STATUS the current status of the function can be read. This output is used purely for information and cannot be used for fail-safe connections.

Table 3-34 Status of the function block F_PRE_PURGE

No.	Status	Description
0	Initial Status	The function is in the initial status To start the function, a rising edge on input PRE_PURGE_ON is required if the following conditions are fulfilled: • Burner is not in start-up mode (GAS_OIL_RUN = 0) • Burner is not in operation (GAS_OIL_OPAT = 0) • Safety shut-off valves closed (OV_CLOSED = 1) • Main interlock fulfilled (MAIN_INTL = 1) • No flame detected (GAS_OIL_FIRE = 0) A 1-Signal at PRE_PURGE_OFF resets the function back to the initial status
1	Start-up pre-purge	The start-up of the function was initiated (PRE_PURGE_RUN = TRUE). The air damper opens (OPEN_AD = TRUE). The function block awaits the feedback-signals that indicate that the air damper is open (AD_OPEN = TRUE) and the minimum airflow was reached (AIRFL_MIN = TRUE)
2	Pre-purge in operation	The minimum flow rate was achieved. The pre-purging is in operation and the purging time runs down (T_PRE_PURGE).
3	Pre-purge successful	Purging time has elapsed. Purging was successful. (PRE_PURGE_OK = TRUE). If T_PURGE_OK differs from T # 0s, the timer starts to run down. The function takes the initial status ("0"), if 1-Signal at GAS_OIL_RUN exists, or T PURGE_OK has elapsed,
4	Cancel	Pre-purge was manually stopped by a 1-signal at PRE_PURGE_OFF. The air damper will be closed (CLOSE_AD = TRUE) and the function is waiting for the feedback-signal that the air damper is closed(AD_CLOSED = TRUE)
7	Error	The system has detected an error. A detailed diagnosis is possible by evaluating the output DIAG (see chapter 3.10.5). The initial status can be re-taken with a rising edge at input QUIT as soon as the air damper is closed (AD_CLOSED = TRUE)

3.10.5 Diagnose

Table 3-35 Diagnose of the function block F_PRE_PURGE

Bit No.	Description	Reset conditions
0	Start command is activated, while other programs are running (PRE_PURGE_ON = 1 and PRG_RUN = 1)	• PRG_RUN=0 • Rising edge at QUIT
1	Start command is activated, while a stop command is available (PRE_PURGE_ON=1 and PRE_PURGE_OFF_OFF=1)	• PRE_PURGE_OFF=0 • Rising edge at QUIT
2	A flame is (still) detected (PRE_PURGE_ON=1 and GAS_OIL_FIRE=1)	• Rising edge at QUIT • New start command (PRE_PURGE_ON=1)
3	Start command is initiated while an unacknowledged error exists (PRE_PURGE_ON=1 und ERROR=1)	• Rising edge at QUIT
4	Start command is initiated while the burner is in operation or the burner starts up (PRE_PURGE_ON=1 and GAS_OIL_OPAT=1 or GAS_OIL_RUN=1)	• Rising edge at QUIT • New start command (PRE_PURGE_ON=1)
5	Air criteria not (anymore) fulfilled (AIRPR_OK = 0)	• AIRPR_OK=1 • Rising edge at QUIT • New start command (PRE_PURGE_ON=1)
6	The command open Air damper is initiated, but the air damper is not yet open completely (OPEN_AD=1 und AD_OPEN=0)	• AD_OPEN=1 • Rising edge at QUIT • Stop command (PRE_PURGE OFF =1)
7	The pre-purge function is started, but the minimum flow rate has not yet been reached (PRE_PURGE_RUN=1, PRE_PURGE_OPAT=0 und AIRFL_MIN_OK=0)	• AIRFL_MIN=1 • Rising edge at QUIT • Stop command (PRE_PURGE OFF =1)
8	The minimum flow rate is not reached during active pre-purge (PRE_PURGE_OPAT=1 und AIRFL_MIN=0)	• Rising edge at QUIT
9	The command for closing the air damper is activated, but the damper not yet closed (CLOSE_AD=1 and AD_CLOSED=0)	• AD_CLOSED=1 • Rising edge at QUIT • New start command (PRE_PURGE_ON=1)
10	Start command is activated, while the safety shut-off valves are not yet closed (V_CLOSED = 0) If an ERROR is set simultaneously, then V_CLOSED is during operation of the function (PRE_PURGE_OPAT = 1) de-energized	• V_CLOSED=1 • Rising edge at QUIT • New start command (OIL_CL_ON=1)
11	The open and closed status of the	• Rising edge at QUIT

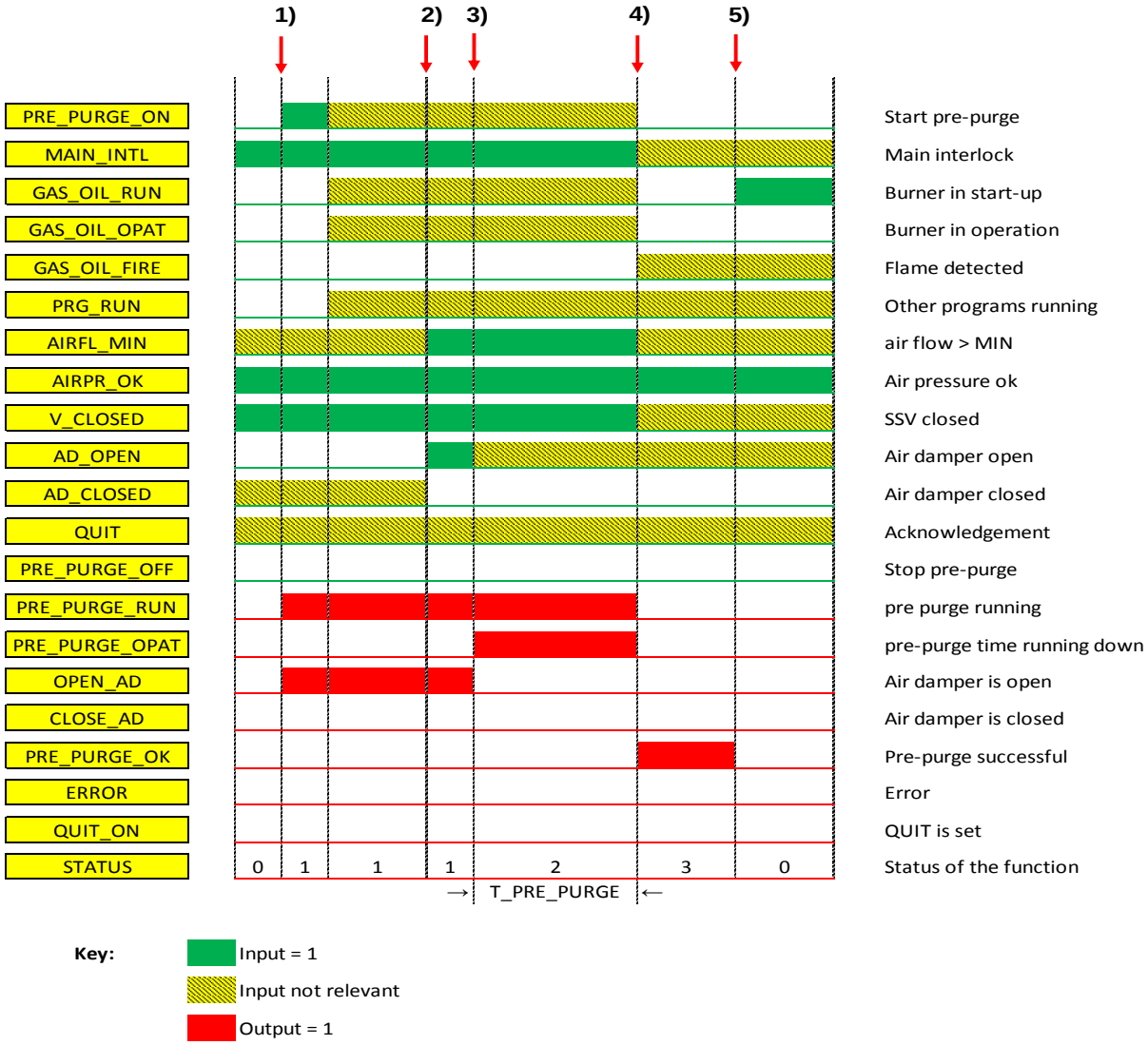
Bit No.	Description	Reset conditions
	damper is simultaneously reported (AD_OPEN=1 and AD_CLOSED=1)	
12	Main interlock not fulfilled (MAIN_INTL=0)	• Rising edge at QUIT • New start command (PRE_PURGE_ON=1)
13	The air damper is no longer reported as open during active pre-purge (PRE_PURGE_OPAT = 1 and AD_OPEN = 0)	• Rising edge at QUIT
14	PRE_PURGE_OK was reset due to T_PURGE_OK having elapsed	• Rising edge at QUIT • New start command (PRE_PURGE_ON=1)
15	Reserve	

3.10.6 Time diagram

Signal sequence of pre-purge without error

The figure below shows the signal sequence of the function F_PRE_PURGE.

Figure 3-38 Time diagram of the function block F_PRE_PURGE



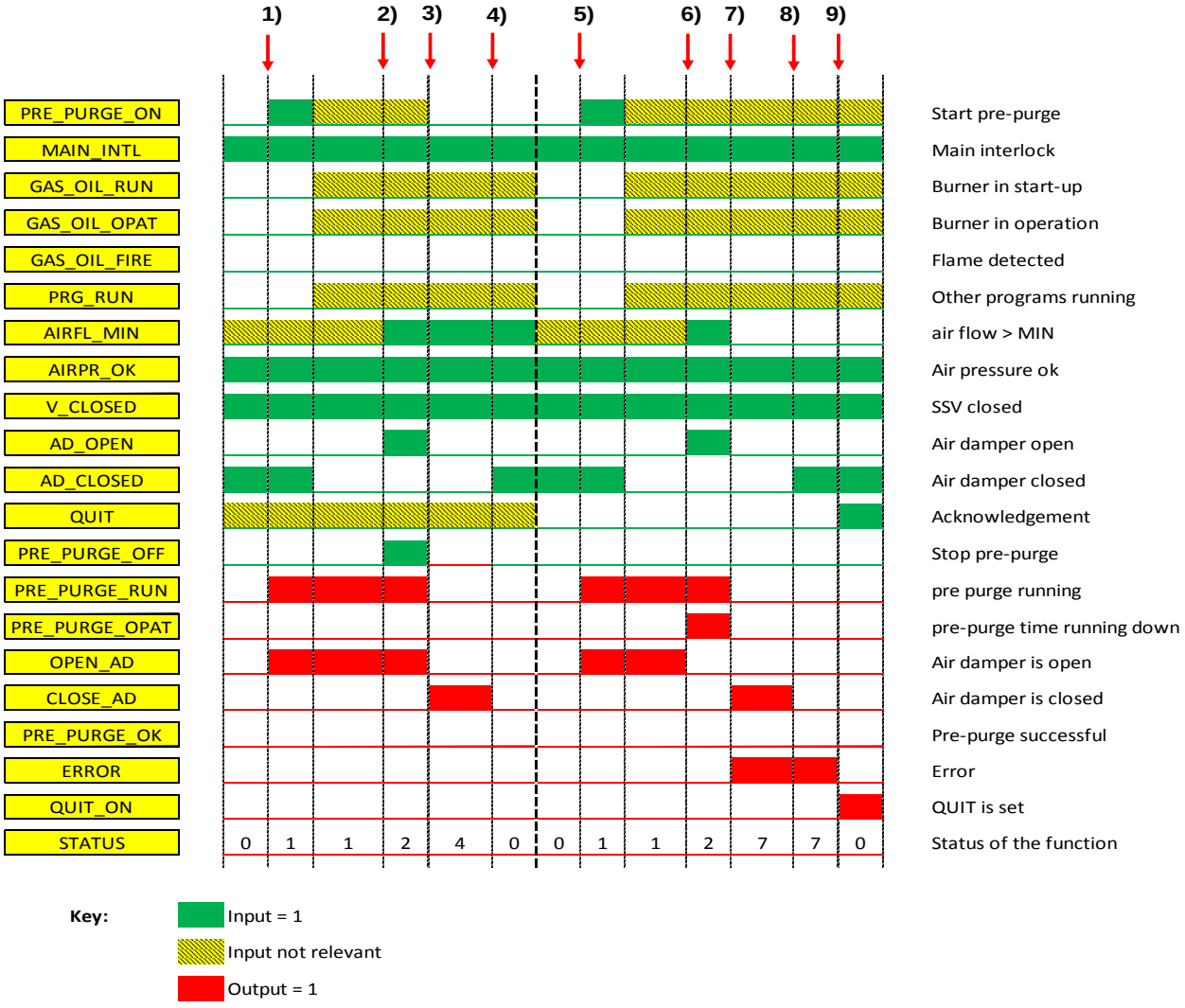
Description of the signal sequence:

1. Main interlock and air criteria fulfilled (MAIN_INTL=1, AIRPR=1)
   The safety shut-off valves are closed (V_CLOSED = 1)
   No burner in operation (GAS_OIL_RUN = 0 und GAS_OIL_OPAT = 0) and no flame is detected (GAS_OIL_FIRE = 0)
   No other program is currently running (PRG_RUN = 0)
   The pre-purge function is started with a rising edge at PRE_PURGE_ON (PRE_PURGE_RUN = 1)
   The air damper is opened (OPEN_AD = 1)
2. The minimum air flow rate is achieved (AIRFL_MIN = 1)
   The air damper is reported as open (AD_OPEN = 1)
3. The command to open the air damper is reset (OPEN_AD = 0)
   T_PRE_PURGE starts and PRE_PURGE_OPAT is set
4. T_PRE_PURGE has elapsed without error
   The successful completion of pre-purge is reported (PRE_PURGE_OK=1)
   The pre-purge process is finished (PRE_PURGE_RUN = 0 and PRE_PURGE_OPAT = 0)
5. The burner is started after pre-purge was successful (GAS_OIL_RUN=1)
   The signal “pre-purge successfully finished” is reset (PRE_PURGE_OK = 0)

Signal sequence with detected error and cancellation of pre-purge

The figure below shows the signal sequence of the function F_PRE_PURGE with detected error and cancellation of the function pre-purge

Figure 3-39 Time diagram of the function block F_PRE_PURGE in case of an error

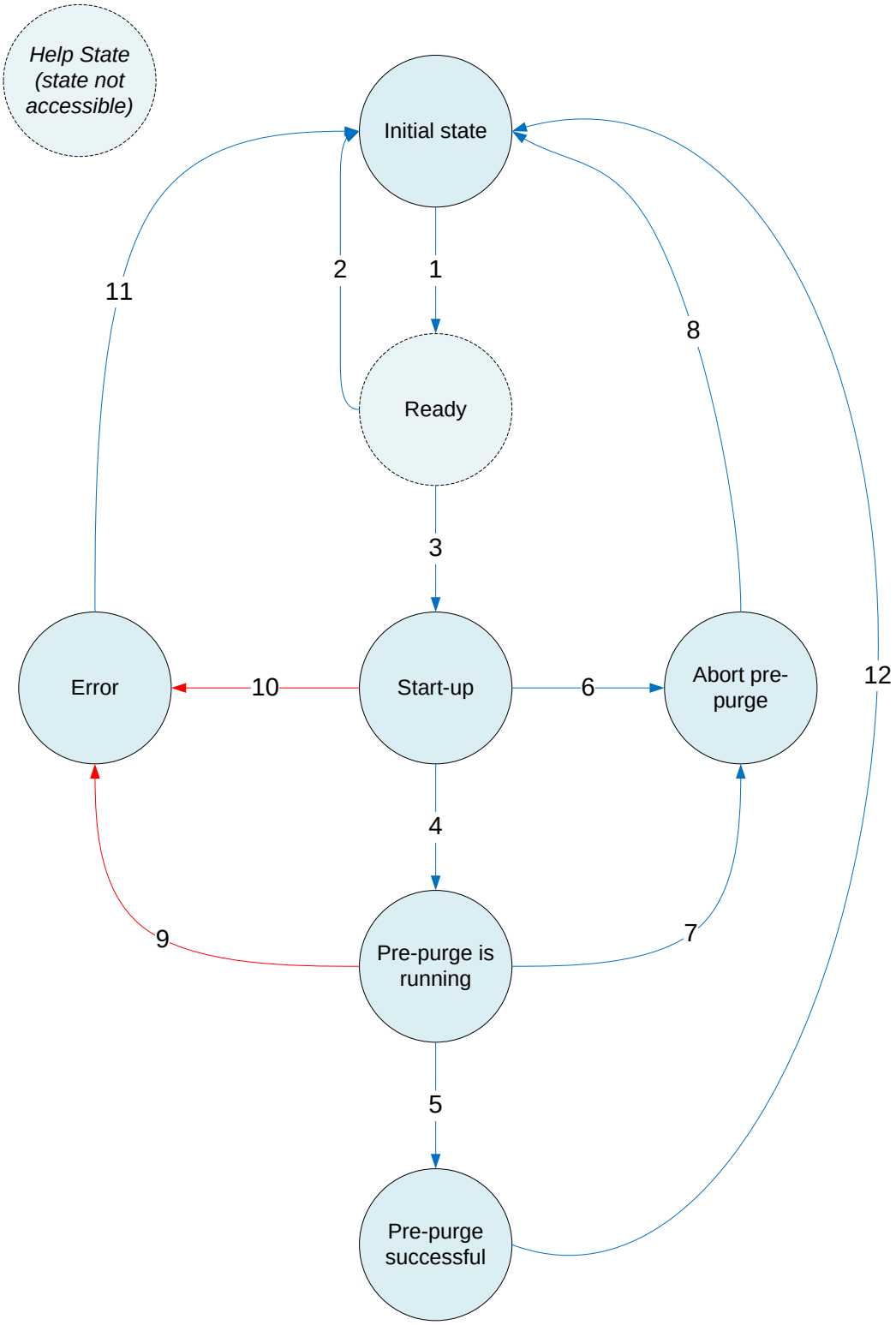


Description of the signal sequence:

1. Main interlock and air criteria fulfilled (MAIN_INTL=1, AIRPR=1)
   The safety shut-off valves are closed (V_CLOSED = 1)
   No burner in operation (GAS_OIL_RUN = 0 and GAS_OIL_OPAT = 0) and no flame detected (GAS_OIL_FIRE = 0)
   No other program currently running (PRG_RUN = 0)
   The pre-purge function is started with a rising edge at PRE_PURGE_ON (PRE_PURGE_RUN = 1)
   The air damper will open (OPEN_AD = 1)
2. The minimum air flow rate is achieved (AIRFL_MIN = 1)
   The air damper is reported as open (AD_OPEN = 1)
   Pre-purge is canceled manually (rising edge at PRE_PURGE_OFF)
3. The pre-purge process will be cancelled (PRE_PURGE_RUN = 0)
   The air damper will be closed (CLOSE_AD = 1)
4. The air damper is closed (AD_CLOSED = 1) and the command closing the air damper will be reset (CLOSE_AD = 0)
5. Main interlock and air criteria fulfilled (MAIN_INTL=1, AIRPR=1)
   The safety shut off valves are closed (V_CLOSED = 1)
   No burner is in operation (GAS_OIL_RUN = 0 und GAS_OIL_OPAT = 0) and no flame is detected (GAS_OIL_FIRE = 0)
   No other program is running currently (PRG_RUN = 0)
   The pre-purge function is started with a rising edge at PRE_PURGE_ON (RE_PURGE_RUN = 1)
   The air damper will be open (OPEN_AD = 1)
6. The minimum air flow rate is achieved (AIRFL = 1)
   The air damper is reported as open (AD_OPEN = 1)
   The command to open the air damper is taken back (OPEN_AD = 0)
   T_PRE_PURGE starts and PRE_PURGE_OPAT is set
7. The minimum air flow rate is not achieved (AIRFL_MIN = 0)
   The pre-purge process will be cancelled (PRE_PURGE_RUN = 0 and PRE_PURGE_OPAT = 0)
   An error is reported (ERROR = 1) and the air damper will be closed die (CLOSE_AD = 1)
8. The air damper is closed (AD_CLOSED = 1)
   The command to close the air damper will be reset (CLOSE_AD = 0)
9. An error will be acknowledged with a rising edge at the input QUIT (ERROR = 0)

3.10.7 Status graph

Figure 3-40 Status graph of the function block F_PRE_PURGE



Explanation of the Status-Graph

Table 3-36 Status-Graph of the function block F_PRE-PURGE Transition

Transition	Condition for Transition
1	MAIN_INTL == 1 **AND** AIRPR_OK == 1 **AND** GAS_OIL_RUN == 0 **AND** GAS_OIL_OPAT == 0 **AND** GAS_OIL_FIRE == 0 **AND** V_CLOSED == 1
2	MAIN_INTL == 0 **OR** AIRPR_OK == 0 **OR** GAS_OIL_RUN == 1 **OR** GAS_OIL_OPAT == 1 **OR** GAS_OIL_FIRE == 1 **OR** V_CLOSED == 0
3	Rising Edge at PRE_PURGE_ON
4	AD_OPEN == 1 **AND** AIRFL_MIN == 1 **AND** AD_CLOSED == 0
5	Time T_PRE_PURGE elapsed
6, 7	Rising Edge at PRE_PURGE_OFF
8	AD_CLOSED == 1
9, 10	MAIN_INTL == 0 **OR** AIRFL_MIN == 0 **OR** AIRPR_OK == 0 **OR** V_CLOSED == 0 **OR** GAS_OIL_FIRE == 1 **OR** (AD_OPENED == 1 **AND** AD_CLOSED == 1)
11	AD_CLOSED == 1 **AND** Rising Edge at QUIT
12	Rising Edge at PRE_PURGE_ON **OR** GAS_OIL_RUN == 1 **OR** T_PURGE_OK elapsed (if T_PURGE_OK <> 0)

Table 3-37 Status graph of the function block F_PRE-PURGE outputs

Status	Outputs switched
Initial State	CLOSE_AD := 0 ERROR := 0 STATUS := “0”
Ready	No switched outputs
Start-up	PRE_PURGE_RUN := 1 OPEN_AD := 1 STATUS := “1”
Pre-purge is running	Timer T_PRE_PURGE starts PRE_PURGE_OPAT := 1 OPEN_AD:= 0 STATUS := “2”
Pre-purge successful	PRE_PURGE_OK := 1 PRE_PURGE_RUN := 0 PRE_PURGE_OPAT := 0 **if T_PURGE_OK <> T#0ms** Time T_PURGE_OK starts STATUS := “3”
Abort pre-purge	PRE_PURGE_RUN := 0 PRE_PURGE_OPAT := 0 CLOSE_AD := 1 STATUS := “4”
Error	ERROR := 1 PRE_PURGE_RUN := 0 PRE_PURGE_OPAT := 0 CLOSE_AD := 1 OPEN_AD:= 0 STATUS := “7”

4 Interaction of the Blocks

4.1 Overview

This chapter provides an interconnection example of an oil and gas burner application. The type of connection depends on the requirements of the application and cannot be universally specified. If your application requires other parameters and / or other connections, it must be adapted according to the users own estimation.
The aim of this interconnection example is the demonstration of signal flows between the individual components and their interaction.

Using the interconnection examples shown in this chapter does not automatically lead to compliance with legal regulations.

4.2 Error Handling

If an error occurs in the function block parameterization or by an invalid input assignment through the process for a block, then this is reported by each function block by setting a corresponding error bit. If the error outputs are not sufficient for an adequate diagnosis, the modules have a DIAG output which permits a more accurate diagnosis through the displayed error code. The exact specification of the respective error code is specified in the chapters "Diagnose".

Because of the startup behavior of failsafe programs, this diagnostic data is not retentive. In order to ensure that the diagnostic data is not overwritten with new data in case of a fault, it is recommended to save the diagnostic data in retentive data blocks.

4.3 Block interconnections

This chapter provides examples of how the blocks can be interconnected with each another. Hereby the signal flows should be made clear that take place between the individual components. The applications shown are examples and can be connected differently if necessary.

4.3.1 Interconnection of (Safety shut-off) valves

The following examples show the connections of the FDBACK with F_GAS_BU for triggering the safety shut-off valves. The interconnection of the functions F_OIL_BU and F_IGNTR must be carried out in the same way (see Figure 4-1). If a gas tightness test is part of the application, then each valve can also be controlled with its own FDBACK module to control the safety shut-off valves independently from each other (see Figure 4-2). In principle, any activated valve (e.g. atomizer and cleaning valve) can be controlled and monitored with the FDBACK block.

Figure 4-1 Control of safety shut-off valves with FDBACK and F_GAS_BU

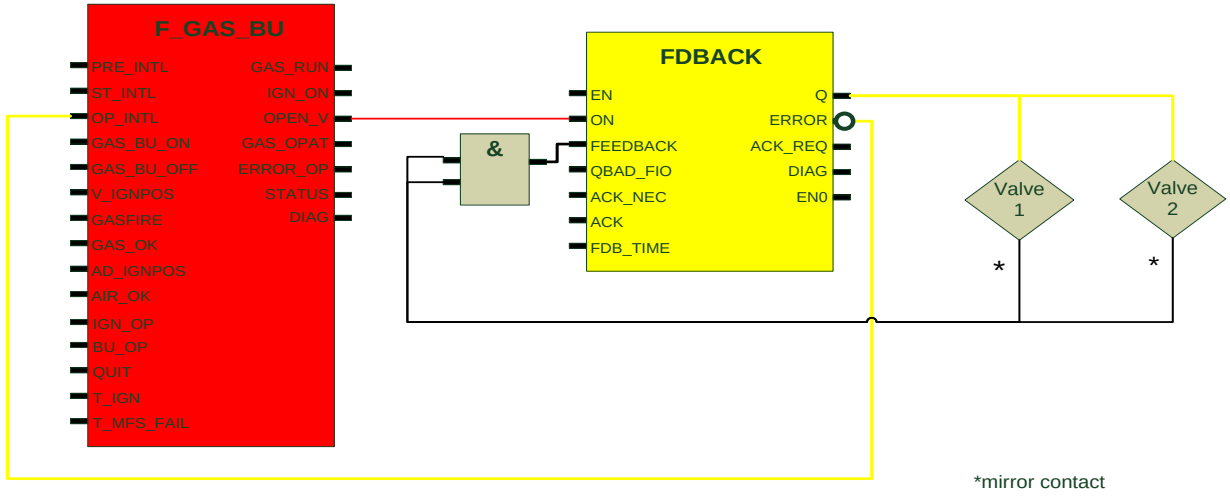
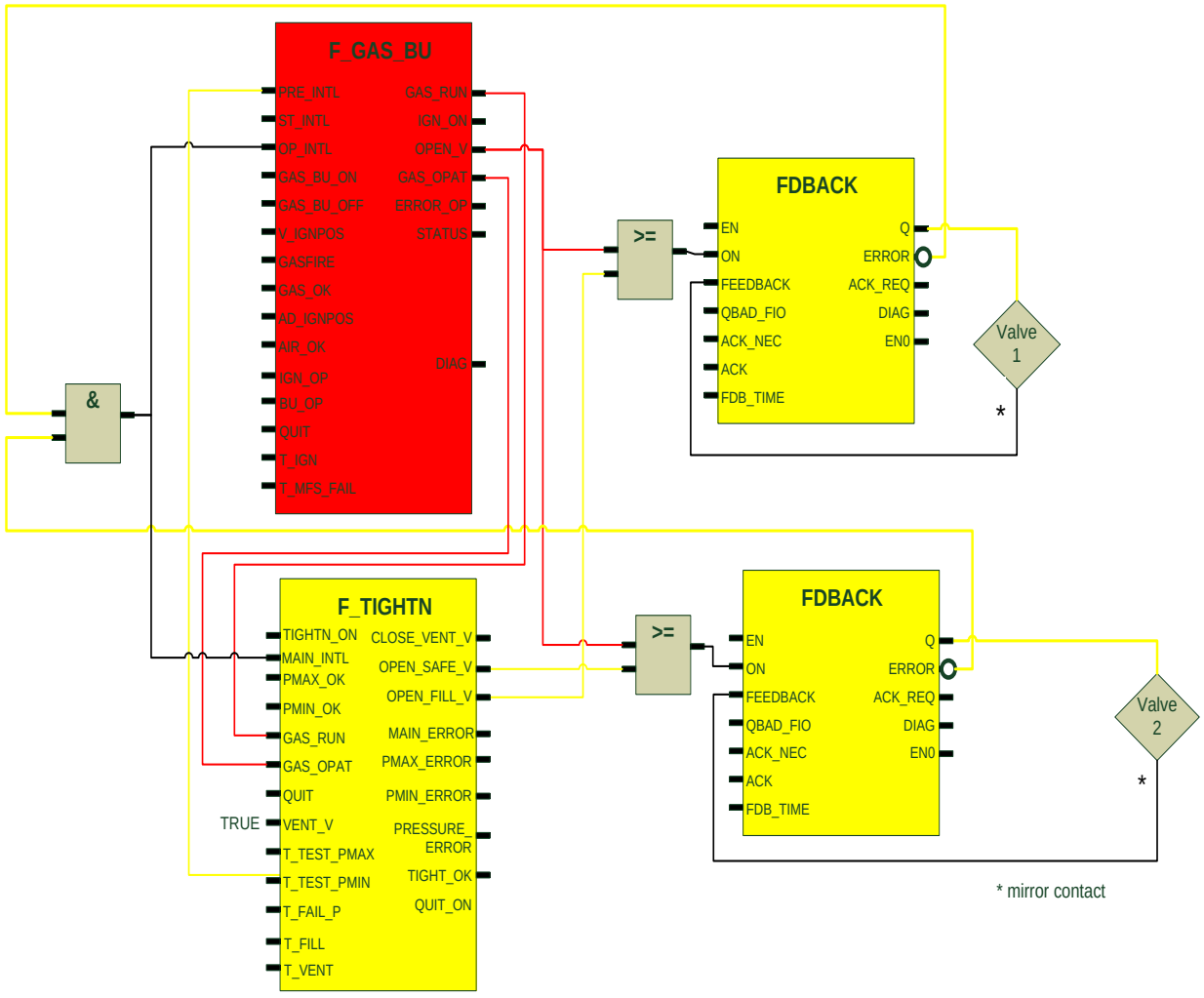


Figure 4-2 Control of safety shut-off valves with FDBACK to realize the gas tightness test

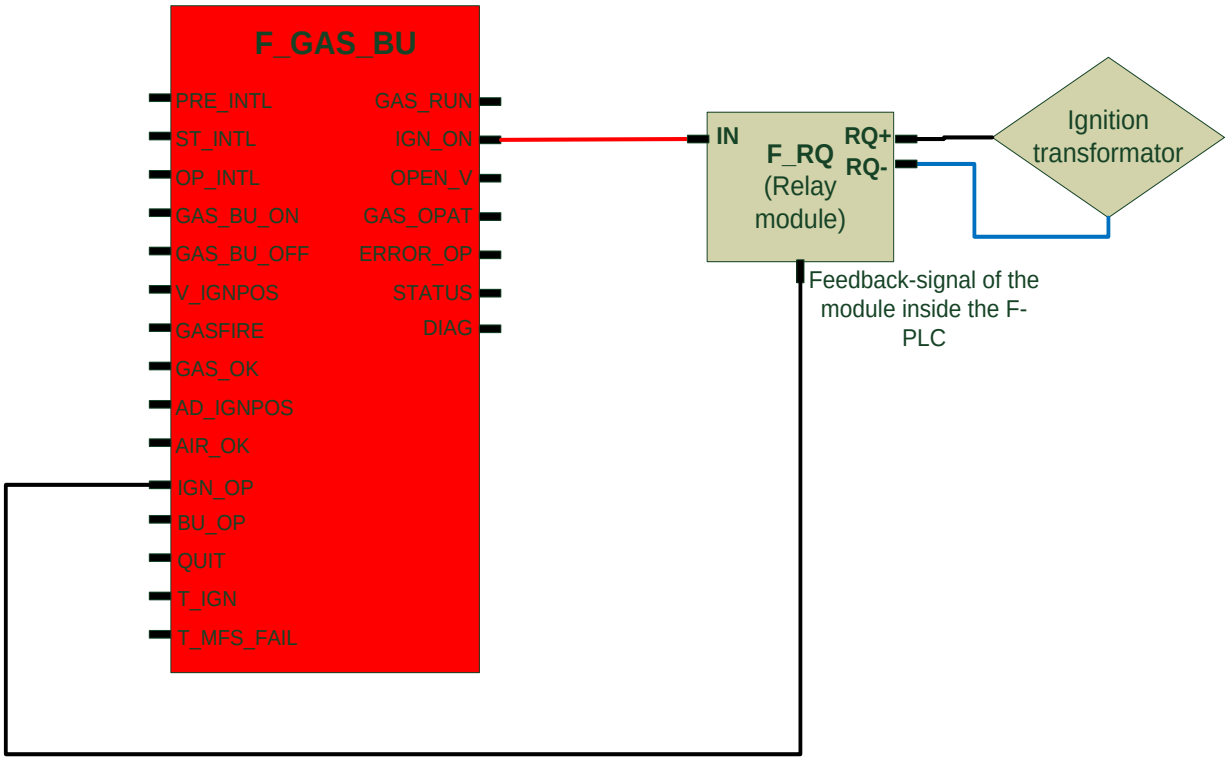


4.3.2 Ignition without pilot burner

If there is no pilot burner used and the main burner will be ignited directly, then there are two ways to make the connection:

1. IGN_ON of the main burner block (F_GAS_BU or F_OIL_BU) is used to directly control the ignition transformer, instead of F_IGNTR. The successful activation of the ignition transformer must be reported at IGN_OP of the block, on which the safety shut-off valves opens (Example: see Figure 4-3)
2. The module F_IGNTR can be used to control and monitor small directly ignited burners (e.g. if not ignited at reduced power and the ignition of the fuel valve and the air damper must not be monitored). The air and gas criteria (e.g. pressure within the limits) are to be interconnected at MAIN_INTL.

Figure 4-3 Ignition of the burner without pilot burner with the F_GAS_BU



4.3.3 Interconnection options with pilot burner

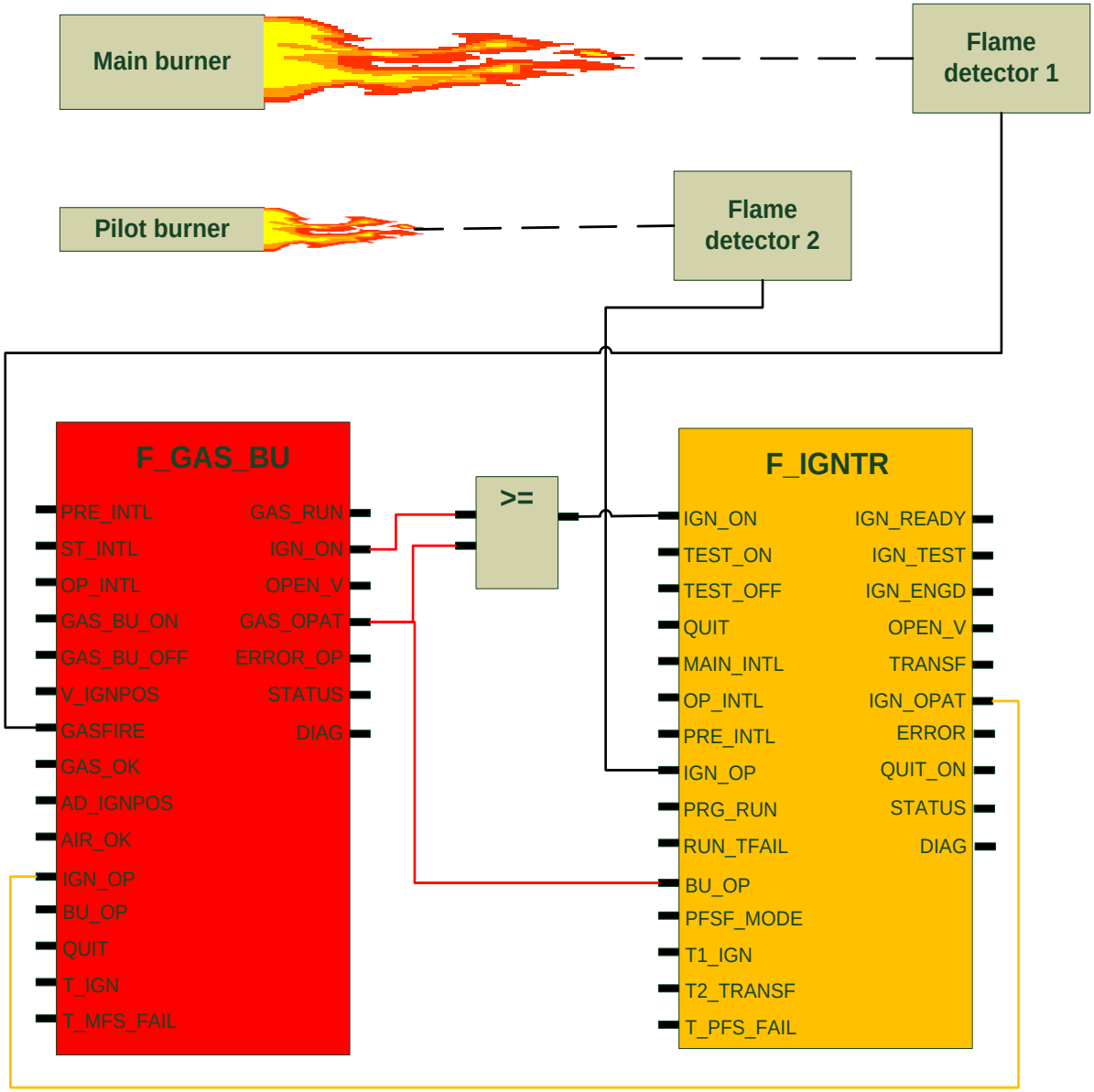
If the main burner is ignited by a pilot burner, then there are different options to do the flame monitoring:

1. Separate flame monitors for pilot and main burner (Option 1)
2. A flame detector, which monitors both the ignition and main flame (Option 2)
3. A flame sensor that monitors only the pilot flame (Option 3)

Option 1: Separate flame monitors for pilot and main burner

If the pilot burner is also activated during operation of the main burner, then both ignition and main flame should be monitored with a separate flame detector. The flame detector of the main flame may not be able to see the pilot flame.

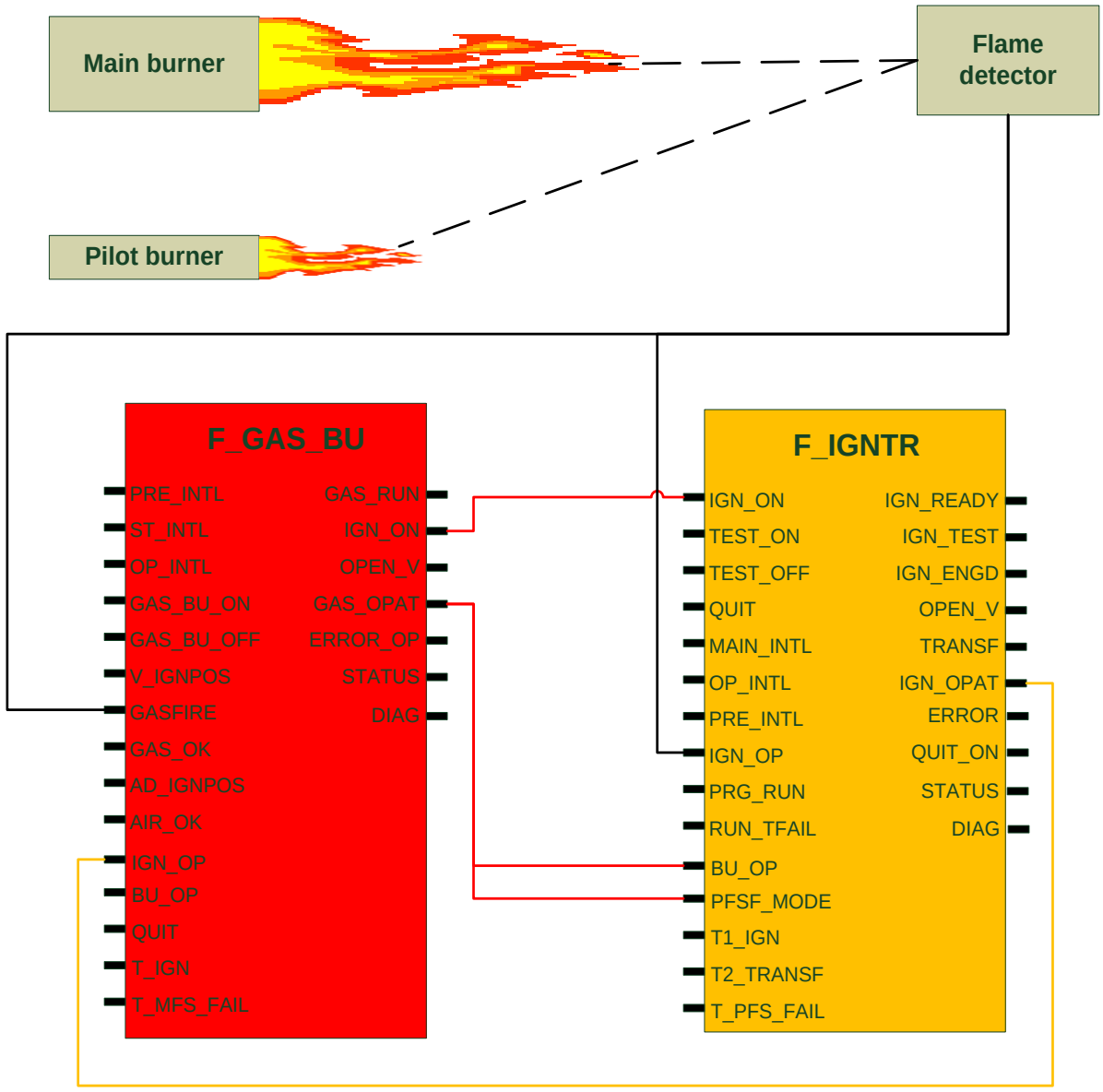
Figure 4-4 Option 1: Connection example for separate flame detectors for pilot and main burner



Option 2: One flame detector for pilot and main flame

If the pilot flame is turned off during operation of the main burner, then one flame detector for pilot and main flame is sufficient.

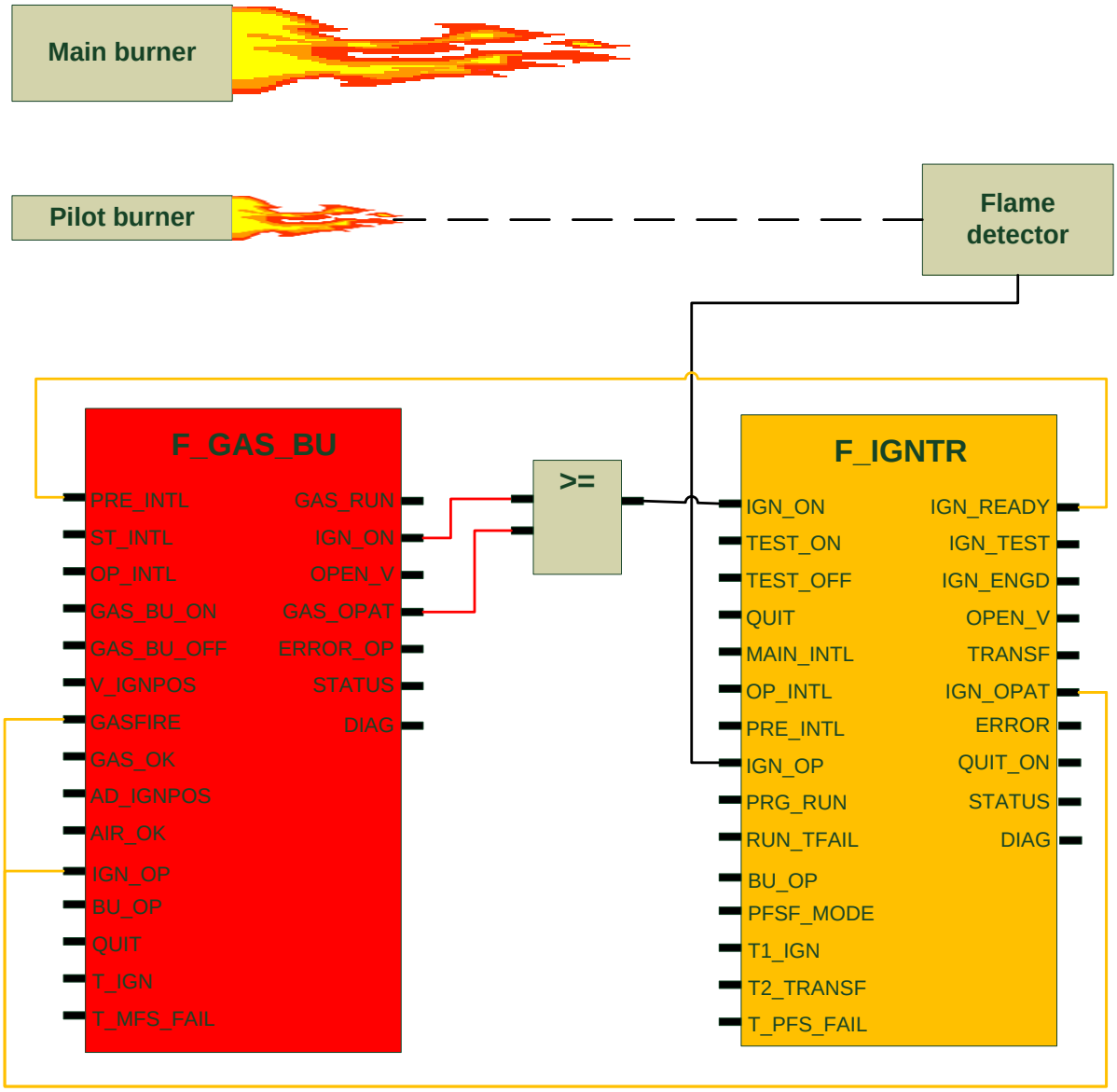
Figure 4-5 Option 2: Interconnection example for monitoring the pilot and main burner with only one flame detector



Option 3: One flame detector that monitors only the pilot flame

In the case that the pilot burner ignites the main burner under all circumstances, it is permissible to only monitor the pilot flame. The prerequisite for this is that the flow rate is checked accordingly (e.g. minimum gas pressure monitor).

Figure 4-6 Option 3: Connection example when only the pilot burner is monitored

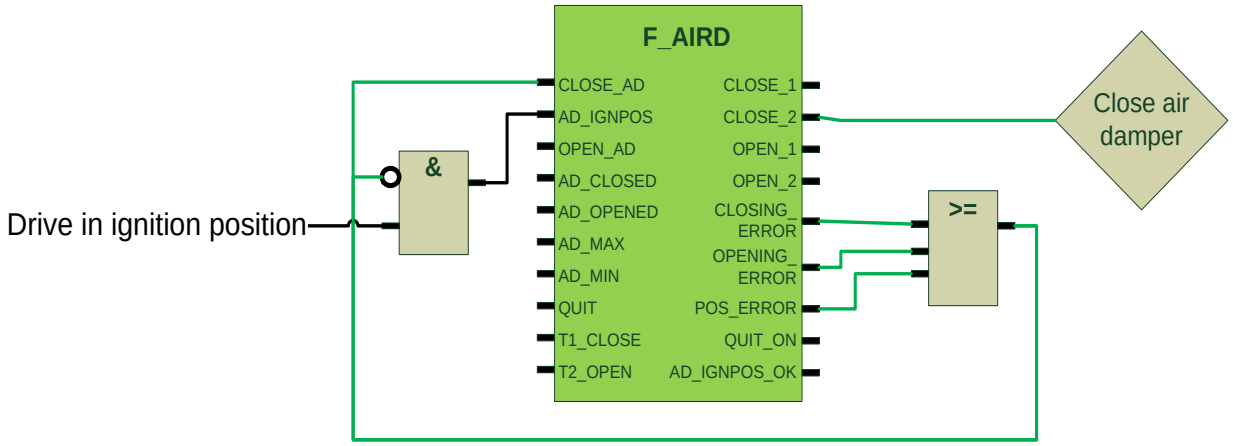


4.3.4 Safe position of the air damper (F_AIRD)

Depending on the application, closing the air damper may be the safe state of the burner in case of an error. If this is the case, the error outputs must be logically linked by an “or” function and applied to the input "CLOSE_AD" and applied negated to the input "AD_IGNPOS"; (see Figure 4-7).

If the safe state is to open the air damper, then the input OPEN_AD is interconnected instead of CLOSE_AD.

Figure 4-7 Interconnection of F_AIRD for safe closing of the air damper in case of an error



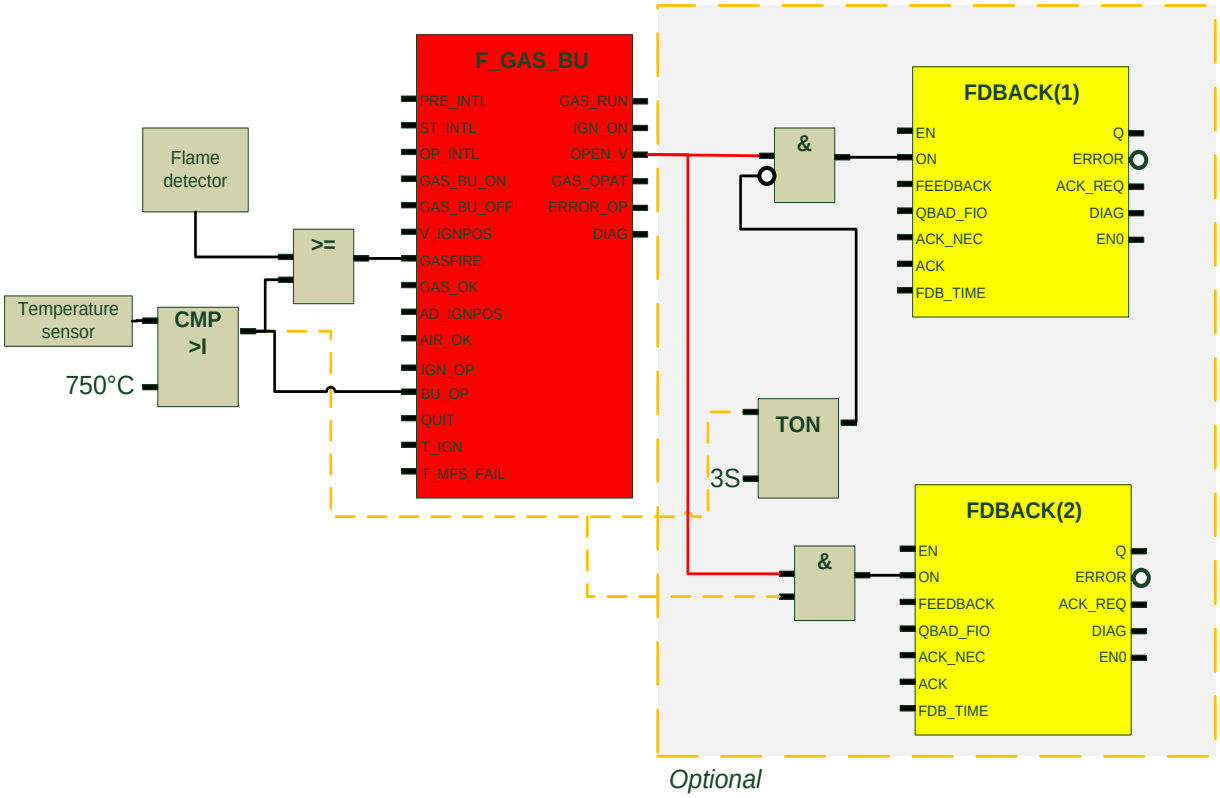
4.3.5 Interconnection for high-temperature operation

In high-temperature operation (when the temperature exceeds a certain standard-specified threshold - usually 750 ° C) a flame monitoring is no longer required because it is assumed that any fuel which reaches the combustion chamber at this temperature is immediately inflamed. This means that at this temperature, a temperature monitoring is sufficient and flame monitoring no longer required. How this can be implemented with the existing block, is shown in Figure 4-8.

The safe read-in temperature and the signal of the flame detector at the input GASFIRE of the block F_GAS_BU must be logically linked by an “or” function.

Optional is an example shown for high temperature operation for the case that an alternative gas valve would be opened for more power.

Figure 4-8 Interconnection example for high-temperature operation with F_GAS_BU



Description of the example:

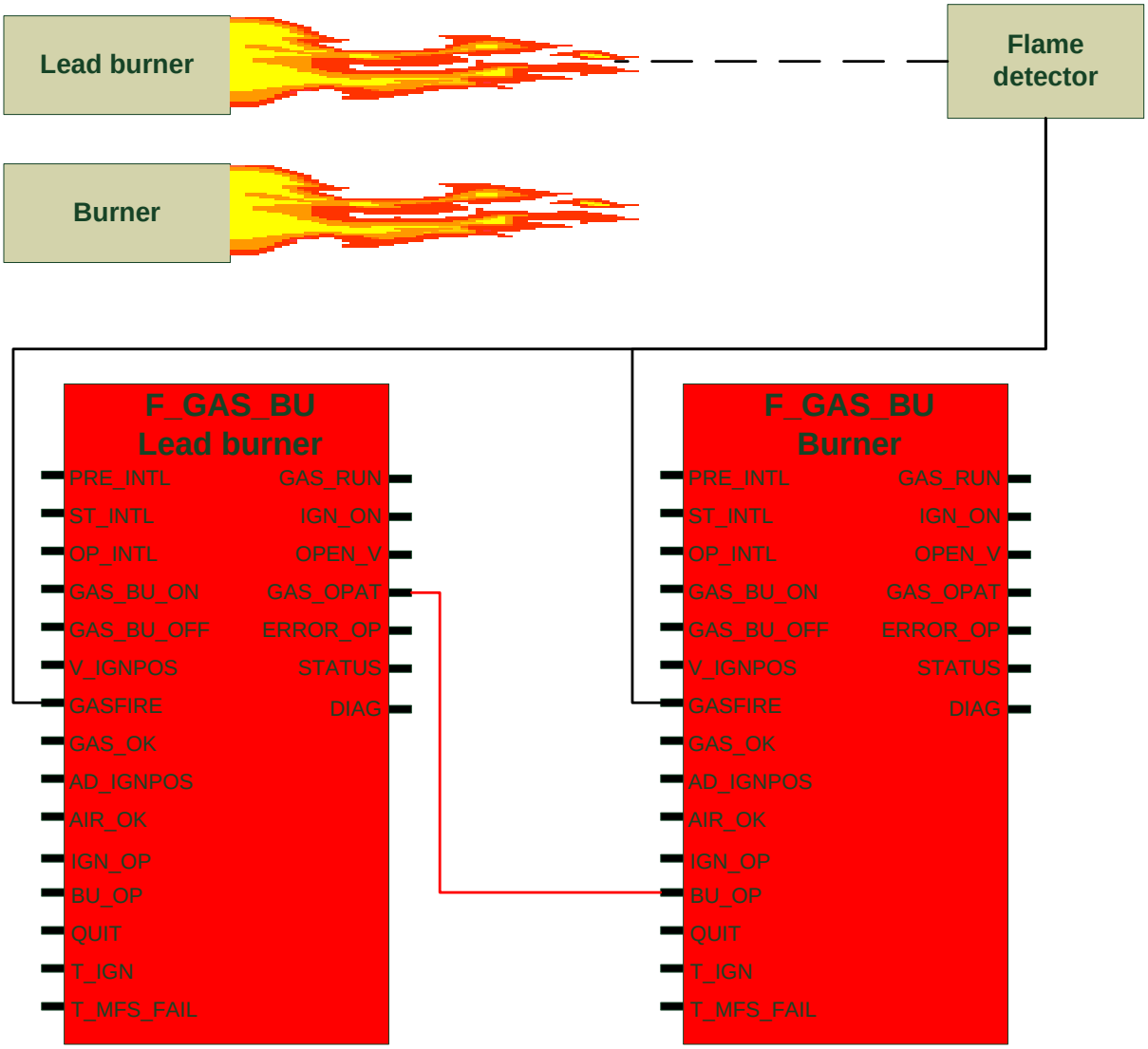
Upon reaching a combustion chamber temperature of over 750 ° C it is automatically changed to the high-temperature operation and another valve on FDBACK (2) will be opened. In high-temperature operation, the primary gas supply (controlled via FDBACK (1)) is no longer needed and can be closed. The primary valve is closed with a short time delay (3 seconds), to ensure that no flame loss occurs when changing the supply.

If the high-temperature operation should be implemented for F_OIL_BU, the interconnection would have to be carried out in the same way as for F_GAS_BU.

4.3.6 Interconnection example for a combustion chamber monitoring

By usage of the functions a combustion chamber monitoring can be realized (one flame detector for multiple burners). This is allowed if it is ensured that the unmonitored burners are ignited by the monitored "lead" burner within the safety time without negative consequences. The GAS_OPAT or OIL_OPAT of the “lead” burner module must be linked to the BU_OP input of the adjacent burners (see Figure 4-9).

Figure 4-9 Interconnection example for a combustion chamber monitoring



4.3.7 Sequence example of a gas burner

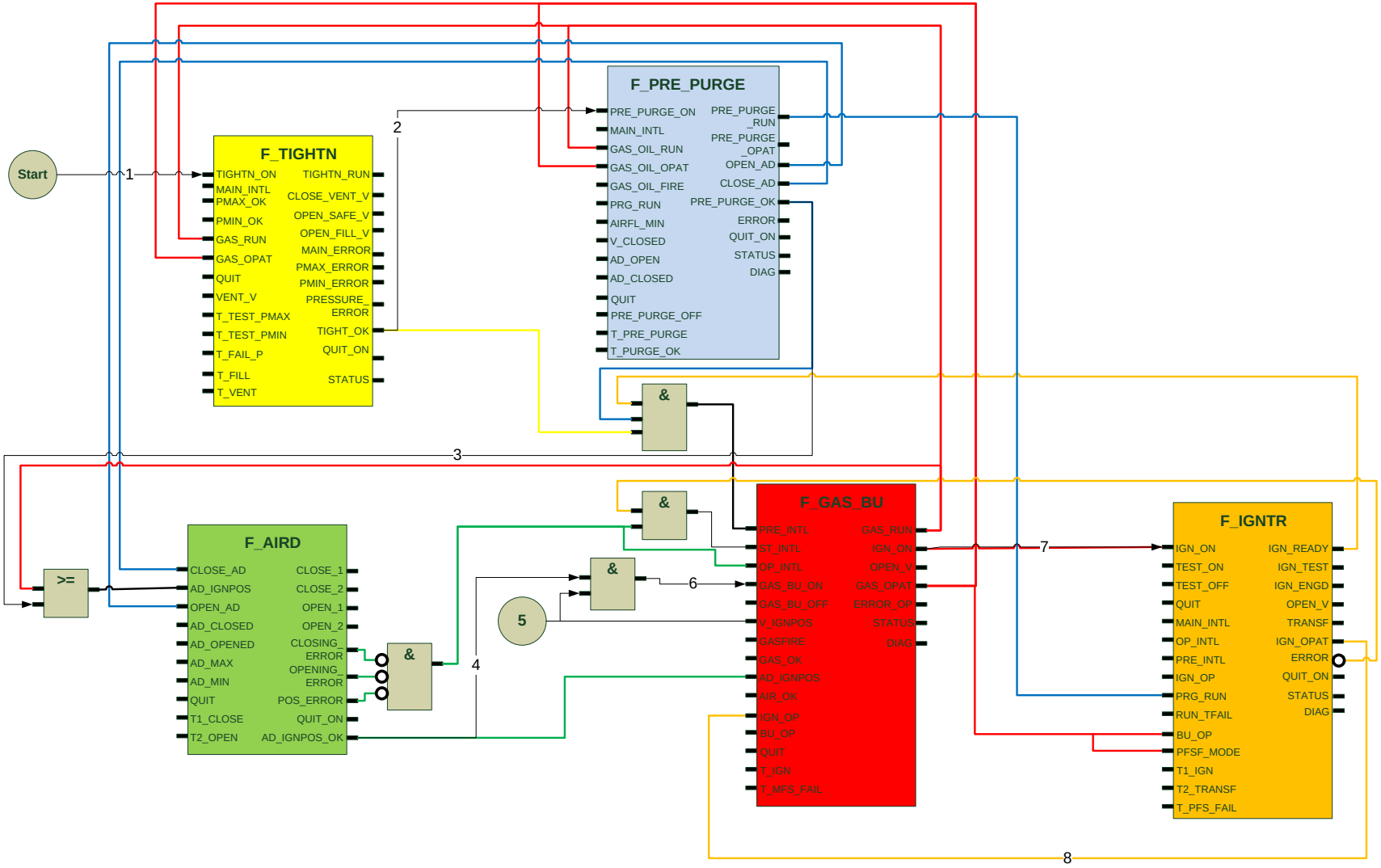
In the following is an example of a program sequence shown for starting a single, indirectly (with pilot burner) ignited gas burner. It is assumed that pilot burner and main burner together have one flame detector and the pilot burner is switched-off after the ignition.

In the example (see Figure 4-10) the function blocks are connected to each other in such a way that the burner automatically starts with a rising edge on "Start" and performs all the steps required for ignition such as: (tightness test of valves, pre-purging, drive valves in ignition position etc.). It is assumed that the gas and air criteria are fulfilled.

To control the amount of air just one air damper is used as an example. Point "5" in the example shows the position feedback of an analog actuator for the fuel that is being queried on reaching the ignition position. (If analog actuators are used for air and fuel supply then instead of F_AIRD also F_POS_CH can be used. An example of this is shown in chapter 4.3.8).

For a better overview, the activation of the peripheral (ignition transformer, valves, etc.) and the sensor signals and monitoring were not included in the drawing (Figure 4-10).

Figure 4-10 Signal flows: Example for gas burner



Explanation of the sequence example for gas burners

1. Before starting the burner, the valves are checked for tightness. A rising edge at input TIGHTN_ON of the F_TIGHTN starts the tightness test.
2. If the tightness test runs successfully (TIGHT_OK = 1), this signal can be connected directly to the input PRE_PURGE_ON of F_PRE_PURGE. The Pre-purge is carried out immediately afterwards. The activation of the air damper is hereby adopted by F_AIRD.
3. If pre-purge was carried out (PRE_PURGE_OK = 1), then this signal can be used to control the input AD_IGNPOS of F_AIRD, in order to drive the air damper (and also the fuel valve if necessary with another instance of the F_AIRD function) in ignition position. Because it`s logically linked by “or” with the output GAS_RUN of F_GAS_BU it is ensured that AD_IGNPOS_OK remains TRUE until the burner is in operation.
4. The ignition position has been reached (AD_IGNPOS_OK = 1).
5. If the fuel valve is also in ignition position (can also be brought about by the F_AIRD) the burner can be started.
6. The feedback signals that the air damper and the fuel valve are in ignition position will be logically linked by “and” to the input GAS_BU_ON of the function F_GAS_BU. A rising edge of this input, starts ignition of the burner (GAS_RUN = 1). This resets the enable signal of pre-purge (PRE_PURGE_OK = 0).
7. The F_GAS_BU function initiates the activation of the pilot burner.
8. If the pilot burner was successfully ignited (IGN_OPAT = 1) then this is reported to the input IGN_OP of F_GAS_BU which opens the fuel valves (OPEN_V = 1). If a flame is detected (GASFIRE = 1) after the safety time has elapsed, then the function indicates that the burner is in operation (GAS_OPAT = 1). This also resets the enable signal of the tightness test of the valves (TIGHT_OK = 0).

4.3.8 Sequence example of an oil burner

In the following is an example of a program sequence shown for starting a single, indirectly (with pilot burner) ignited oil burner. It is assumed that pilot burner and main burner together have one flame detector and the pilot burner is switched-off after the ignition.

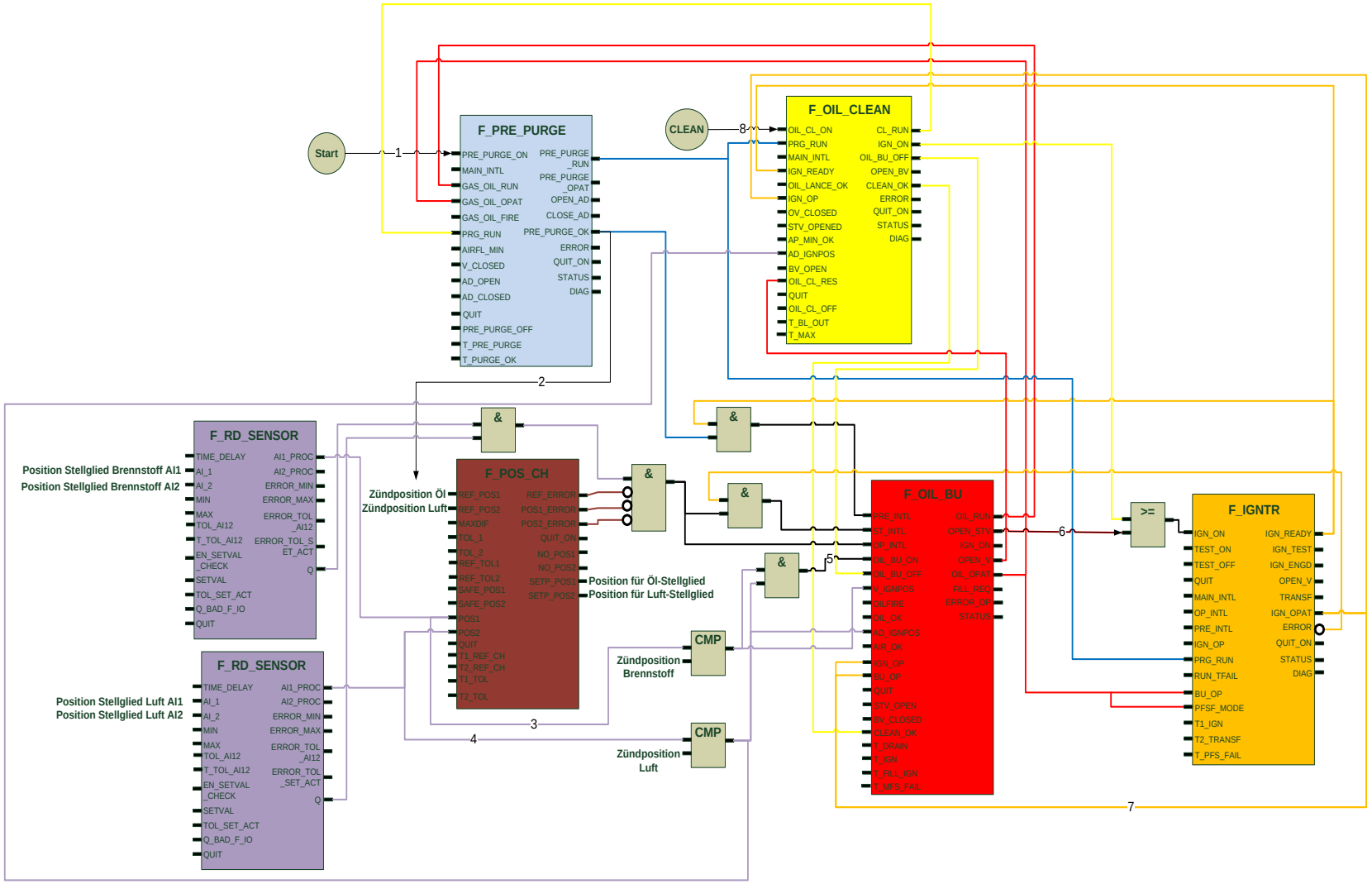
In the example (see Figure 4-11) the modules are connected to each other in such a way that the burner automatically starts with a rising edge on "Start" and performs all the steps required for ignition such as: (tightness test of valves, pre-purging, drive valves in ignition position etc.). It is assumed that the gas and air criteria are fulfilled. For controlling and monitoring the actuators for the oil and air supply the F_POS_CH is used.

The positioning of the actuators to the positions for ignition is realized by setting analogue outputs at the Input REF_POSx of the function F_POS_CH. The program checks, if the target position is reached by reading the analogue value.

If the burner is in operation, a controlled shutdown, with a preceding blowout of the oil lance, can be performed by a rising edge at "CLEAN". The function blocks are connected in such a way that the function F_OIL_CLEAN starts the pilot burner, switches off the main burner and then performs the cleaning.

For a better overview, the activation of the peripheral (ignition transformer, valves, etc.) and the sensor signals and monitoring were not included in the drawing (Figure 4-11).

Figure 4-11 Signal flows: Example for oil burner



Explanation of the sequence example for oil burners

1. Before starting the burner, a pre-purge is carried out. A rising edge at input PRE_PURGE_ON the function F_PRE_PURGE starts the pre-purge. The activation of the air damper is hereby adopted by F_AIRD.
2. If pre-purge was carried out (PRE_PURGE_OK = 1), the actuators for fuel and air are driven to ignition.
3. The ignition position for air is achieved (determined by a CMP instruction of the read-in analog position value of the actuator).
4. If the fuel valve is also in the ignition position the burner can be started.
5. The feedback signals that the actuators for air and fuel are in ignition position will be logically linked by “and” to the input OIL_BU_ON of the function F_OIL_BU. A rising edge starts ignition of the burner (OIL_RUN = 1). This resets the enable signal of the pre-purge function (PRE_PURGE_OK = 0).
6. The function F_OIL_BU initiates the activation of the pilot burner.
7. If the ignition was successfully (IGN_OPAT = 1) then this is transferred to the input of IGN_OP of F_OIL_BU and the fuel valves open (OPEN_V = 1). If a flame is detected after the safety time (OILFIRE = 1) has elapsed the function indicates that the burner is in operation (OIL_OPAT = 1).
   (The signal is applied in addition to BU_OP to trigger no mistake in the subsequent cleaning of the burner: F_OIL_CLEAN initiates the start-up of the pilot burner and turns off the main burner. Because of pilot and main burners share one flame detector, a stray light test would be reported without this interconnection of F_OIL_BU during blowout).
8. It will now take place, blowing out of the burner in the controlled shutdown. For this, a rising edge on input OIL_CL_ON of the function F_OIL_CLEAN is applieed. This initiates the start-up of the pilot burner (IGN_ON = 1). If the output CL_RUN is also interconnected with the input of IGNPOS F_AIRD then the function drives the air damper in ignition position. Once the pilot burner is in operation (IGN_OP = 1) the main burner is turned off (OIL_BU_OFF) and waits for the confirmation that the SSV of the main burner are closed (OV_CLOSED = 1). Once this is the case, the cleaning valve opens (OPEN_BV = 1) and blowing out is started. If blowing out was successfully (CLEAN_OK = 1) then the longer safety time (T_FILL_IGN) is valid for the next start-up of the main burner.
9. If the burner is started again (see steps 1-7) then CLEAN_OK of the cleaning function F_OIL_CLEAN must be reset as soon as the safety shut-off valves were opened. For this , the output of OPEN_V of F_OIL_BU is additionally interconnected to the input of OIL_CL_RES of F_OIL_CLEAN.

5 Appendix

5.1 Signature

Table 5-1 Signature

Module Name	Module Signature S7-1500F/1200F	Module Signature S7-300F	Default Value Signature S7-300F
F_AIRD	99133326	D8B5	A4C9
F_TIGHTN	407C8B22	6CFD	DC07
F_IGNTR	E03BC6DA	0CBA	5037
F_POS_CH	6B9E0BF3	8243	3FD5
F_OIL_CLEAN	831F35C3	10E5	A05C
F_GAS_BU	077C7CCB	0078	079C
F_OIL_BU	7D8B8E4A	90D6	4AD2
F_PRE_PURGE	F2B3360B	95E2	A05C

5.2 Standards

Unless otherwise specified, the referenced standards relate to the following revision:

- EN 746-2:2010
- EN 267:2011
- EN 676:2008
- EN 298:2012
- EN 1643:1014
- EN 12952-8:2002
- EN 12953-7:2002
- ISO13577-2:2014
- ISO 13577-4:2014
- NFPA 85:2011
- NFPA 86:2015
- IEC 61508:2011

5.3 List of Figures

5.4 List of Tables

5.5 Service and Support

Industry Online Support

Do you have any questions or need assistance?

Siemens Industry Online Support offers round the clock access to our entire service and support know-how and portfolio.

The Industry Online Support is the central address for information about our products, solutions and services.

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Service offer

Our range of services includes, inter alia, the following:

- Product trainings
- Plant data services
- Spare parts services
- Repair services
- On-site and maintenance services
- Retrofitting and modernization services
- Service programs and contracts

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https://support.industry.siemens.com/cs/sc

Industry Online Support app

You will receive optimum support wherever you are with the "Siemens Industry Online Support" app. The app is available for Apple iOS, Android and Windows Phone:
https://support.industry.siemens.com/cs/ww/en/sc/2067

5.6 Links and Literature

Table 5-2

No.	Topic
\1\	Siemens Industry Online Support https://support.industry.siemens.com
\2\	Link to this entry page of this application example https://support.industry.siemens.com/cs/ww/en/view/109477036
\3\	Safety Evaluation Tool http://www.industry.siemens.com/topics/global/en/safety-integrated/machine-safety/safety-evaluation-tool/Pages/default.aspx

5.7 History

Table 5-3 History of Released Versions

Version	Date	Change
V1.0	05/2015	First Release
V1.0.1	07/2015	Small formal corrections
V1.0.2	08/2015	Correction of the description of PMIN_OK and PMAX_OK in Table 3-5
V1.1	03/2017	Update to TIA Portal V14 • New note in 2.2 Standard Specification • Update of Table 2-1 Required RAM for the function blocks • FB „F_RD_SENSOR“ removed • New note in 4.2 Error Handling • Adjustments in 4.3.8 Sequence example of an oil burner • Several small formal corrections

Figure 5-1 Exemplary diagram of the function F_POS_CH of an actuator