

GENERAL SPECIFICATION

INSTRUMENTATION

GS EP INS 196

Input and Output Standard Functions
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1. Scope

The purpose of this document is to define a set of Standard Functions for most common inputs and outputs.

It includes the following functions with some options:

- Digital input
- Line monitored digital input
- Process Analogue input
- Safety analogue input
- Digital output
- Analogue output
- Redundant analogue inputs.

2. Reference documents

The reference documents listed below form an integral part of this General Specification.

External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the effective date of this document.

Reference	Title
Not applicable	

Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published in the applicable yearly collection.

Reference	Title
GS EP INS 150	Design method for system configuration - Standard functions
GS EP INS 198	Safety and Fire & Gas Standard Functions

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Chapter 1 Digital Input Standard Function - DI -

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1. Scope

The purpose of this document is to define the Standard Function for a digital input to the PCS, PSS, ESD and F&G system, with alarm detection in option.

Digital inputs may concern:

- Field switches processed by PCS or Safety systems (PSS, ESD and FGS)
- Hardwired signals between Safety logic solvers.

In order to assist in understanding, this document should be read in conjunction with **GS EP INS 150**, Design Methods for System Configuration Standard Functions.

This Standard Function is a fundamental building block. It may either be used standalone, e.g. for monitoring an equipment status, or associated to other Standard Functions (e.g. Safety Bar, Voting Logic).

2. General Description of Functions

2.1 List of main functions

- ON/OFF signal acquisition including signal filtering function
- Alarm detection (option DI_AL)
- Fault detection (Input card fault)
- Maintenance inhibit (PCS)
- Input enable/disable (option)

3. Description of Interfaces

INPUTS						OUTPUTS			
Field	HMI	Internal				Internal	HMI	Field	
			Digital input	DI Standard Function	Status			Alm	Opt.
	Opt.		Start-up inhibit (PSS)		Fault status			Alm	
		Opt	Automatic masking		Start-up inhibit status				
			Maintenance inhibit (PCS)		Maintenance inhibit status (PCS)				
	Opt		Input enable/disable						
		Opt	Master key-switch						
		Opt	Inhibit key-switch						
						Opt. = optional Alm = Alarm			

4. Detailed Description of Functions

There are two field wiring principles possible, each with its own associated software treatment:

DI-D = “De-energised to trip” principle:

Switch OFF (loop electrical status = “0”) → *ACTIVE* or *ALARM* status

Switch ON (loop electrical status = “1”) → *INACTIVE* or *NORMAL* status

DI-E = “Energised to trip” principle:

Switch ON (loop electrical status = “1”) → *ACTIVE* or *ALARM* status

Switch OFF (loop electrical status = “0”) → *INACTIVE* or *NORMAL* status

4.1 Maintenance Functions

This section defines maintenance inhibit and input enable/disable principles, this last command being used only when detectors are processed by voting logics.

In case of brown field development and potentially new development within the same asset, the existing maintenance inhibit procedure will be maintained, unless otherwise specified in the project documents (e.g. operating philosophy, instrumentation and control philosophy).

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4.1.1 Definitions

4.1.1.1 Maintenance inhibit

- **DI used in PCS**

One maintenance inhibit command is required for DIs processed by the PCS.

When the maintenance inhibit is active, yCH/L or yAH/L is forced to its healthy state and the alarm is masked. In addition the loop fault alarm is also masked. However, the status of the input is still available and displayed.

- **DI used in PSS, ESD and FGS**

Activation of maintenance inhibit command will prevent the input signal to be processed by the Safety Bar.

This maintenance inhibit function is fully detailed within the Safety Bar Standard Function.

4.1.1.2 Input enable/disable (option)

When included in voting logic, the enable/disable command will prevent the input signal to be processed by the voting logic.

The primary voting logic arrangement shall automatically be reconfigured in accordance with the downgraded voting logic arrangement defined in the Voting Logic Standard Function (Refer to the [GS EP INS 198](#)).

When the input enable/disable is active, the fault status (invalid status) will be forced.

4.1.2 Input enable/disable logic (option)

A first maintenance inhibit MASTER hard wired key-switch shall enable the input enable/disable function and provide security control against accidental input enable/disable operation. No input enable/disable can be initiated until this MASTER key-switch is set in the ENABLE position.

All active input enable/disable will be reset when this key-switch is switched to the DISABLE position.

Adequate authority level shall operate this MASTER key switch.

A second maintenance inhibit hard wired key-switch shall allow the transfer of the individual input enable/disable command to the ESD system and PSS during a limited time interval (by default 30 minutes). This inhibit key switch will be set in the maintenance inhibit while the above MASTER key-switch is in the ENABLE position. Generally, this inhibit key switch is operated by the control room operator in line with the relevant work permit requirements.

All individual input enable/disable commands will be set /reset using Operator Working Stations (OWS).

Use of maintenance working station (MWS) might also be considered as alternative, as per Project Instrumentation and control philosophy.

Access to maintenance inhibit commands shall be access restricted (e.g. maintenance mode).

The individual input enable/disable command will be latched in the safety system logic.

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It will stay set until one of the following conditions is met:

- The input enable/disable command is reset from either Operator Working Stations, or MWS.
- The maintenance inhibit MASTER key-switch is switched to the DISABLE position.

4.1.3 Hardware Implementation (option)

The inhibit MASTER key-switch and the second maintenance inhibit key-switch shall be common to maintenance inhibit related to PSS, ESD and FGS (i.e. doesn't apply to PCS) and input enable/disable functions.

Those key-switches will be hardwired to one ESD controller and then dispatched to all over safety controllers (ESD, PSS and FGS) through the safety network. Hardwired links between safety systems might be considered as alternative where the safety network is not available.

Both key-switches shall be line monitored and therefore processed by DI-LM Standard Function.

The inhibit MASTER key-switch will be of "stay put" type with key reset and protected by lift flap, unlike the inhibit key-switch of a spring return type.

MASTER key-switch: 0 = Enable position

1 = Disable position

Inhibit key-switch:  = On rising edge detection timer will be launched

ESD/PSS/FGS shall capture the input enable/disable command only during the timer countdown.

4.1.4 Input enable/disable logging (option)

The status of the above key-switches (i.e. MASTER key-switch and maintenance key-switch) shall be logged by the FGS / PSS / ESD system as event.

Input enable/disable status shall be classified as events, as well.

Their number and their duration shall be available through the Operator Working Station and recorded.

Report and dedicated display shall be generated periodically and upon operator request showing all current active input enable/disable.

4.2 Loop fault management

Generally, loop fault of a safety bar trip initiator will trip the concerned safety bar, except if specified differently in Project Safety concept.

Special consideration will be made to signals starting Deluge or Fire fighting systems.

4.3 Automatic masking

Each individual alarm can be masked by an external event (as per **GS EP INS 150**). During this automatic masking, the alarm is not generated and the fault status treatment is no longer active.

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4.4 Start-up inhibit

Each individual alarm can be masked by a corresponding active start-up inhibit on the Safety bar.

During this masking, the alarm is not generated, but the fault status treatment and trip condition monitoring are still active.

When the start-up inhibit is removed (inhibit timer elapsed), the corresponding threshold alarm is not re-alarmed again (klaxon and flashing) if the trip condition is still active (the Safety bar will tripped again). First fault detection will help to identify the trip condition.

5. Tuning parameters and variables

Parameter	Access level
Filtering pre-set value	Engineer
Inhibit Timer (typically 30 minutes)	Engineer

6. Representation and Animation (HMI)

Events to be recorded:

- Alarm (option DI_AL)
- Fault status
- Maintenance inhibit (PCS)
- Input enable/disable (where applicable)
- Master key-switch status
- Maintenance inhibit key-switch.

Master key-switch and maintenance inhibit key-switch are common to maintenance inhibit and input enable/disable functions, whatever the concerned safety system (ESD, FGS or PSS).

6.1 Alarm handling

Alarm Description	Priority
PCS input alarm	level 1
PSS/ESD/FGS input alarm	level 2
PCS Fault alarm	level 1
PSS / ESD /FGS Fault alarm	level 2

6.2 Control display

The events which drive these displays may not be mutually exclusive. Therefore, the precedence on the display, from most to least important, shall be: magenta, white, blue, yellow.

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Chapter 1

6.2.1 PCS digital input without alarm for process mimic

yCz xxxx: Tag name of signal (e.g. position switch)

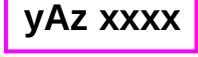
Internal data	Display	Text	Frame
Input status = <i>INACTIVE</i>		Hidden	NA
Input status = <i>ACTIVE</i>	yCz xxxx	Green	NA
Maintenance inhibit = <i>INHIBITED</i>	yCz xxxx	White	Yellow (external frame)
Fault status = <i>ACTIVE</i> Alarm unacknowledged	yCz xxxx xxxx	White	Flashing red (internal frame)
Fault status = <i>ACTIVE</i> Alarm acknowledged	yCz xxxx	White	Steady red (internal frame)
Communication fault = <i>ACTIVE</i>	yCz xxxx	White	Magenta (external frame)

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Chapter 1

6.2.2 PCS digital input with alarm (option DI_AL) for process mimic

yAz xxxx: Tag name of signal (e.g. digital alarm)

Internal data	Display	Text	Frame
Input status = <i>NORMAL</i>		Hidden (process displays)	NA
Input status = <i>ALARM</i> Alarm unacknowledged		Flashing colour (colour depends on alarm priority level)	NA
Input status = <i>ALARM</i> Alarm acknowledged	yAz xxxx	Colour steady (colour depends on alarm priority level)	NA
Maintenance inhibit = <i>INHIBITED</i>		If Input Status = <i>ALARM</i> then as above If Input status = <i>NORMAL</i> then white	Yellow (external frame)
Fault status = <i>ACTIVE</i> Alarm unacknowledged		Flashing colour or white	Flashing red (internal frame)
Fault status = <i>ACTIVE</i> Alarm acknowledged		White	Steady red (internal frame)
Communication fault = <i>ACTIVE</i>		White	Magenta (external frame)

6.2.3 PSS /ESD digital input with alarm (option DI_AL) for process mimic

ySzz xxxx: Tag name of signal

Internal data	Display	Text	Frame
Input status = <i>NORMAL</i>		Hidden (process displays)	NA
Input status = <i>ALARM</i> Alarm unacknowledged		Flashing colour (colour depends on alarm priority level)	NA
Input status = <i>ALARM</i> Alarm acknowledged		Colour steady (colour depends on alarm priority level)	NA
Corresponding bar input Maintenance inhibit active		as above	Yellow (external frame)
Corresponding bar input start-up inhibit active		Colour steady or white	Yellow (external frame)
Fault status = <i>ACTIVE</i> Alarm unacknowledged		Flashing colour or white	Flashing red (internal frame)
Fault status = <i>ACTIVE</i> Alarm acknowledged		White	Steady red (internal frame)
Communication fault = <i>ACTIVE</i>		White	Magenta (external frame)

6.2.4 PSS / ESD /FGS digital input with alarm (option DI_AL) for a safety mimic

ySzz xxxx: Tag name of signal (example for a Safety bar input)

Internal data	Display	Text	Frame
Input status = <i>NORMAL</i>	ySzz xxxx	Blue	NA
Input status = <i>ALARM</i> Alarm unacknowledged		Flashing red	NA
Input status = <i>ALARM</i> Alarm acknowledged	ySzz xxxx	Steady red	NA
Corresponding bar input Maintenance inhibit active		as above	Yellow (external frame)
Corresponding bar input Start-up inhibit active		as above	Yellow (external frame)
Fault status = <i>ACTIVE</i> Alarm unacknowledged		Flashing red or Blue	Flashing red (internal frame)
Fault status = <i>ACTIVE</i> Alarm acknowledged		Red or Blue	Steady red (internal frame)
Communication fault = <i>ACTIVE</i>		White	Magenta (external frame)

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Chapter 2 Line Monitored Digital Input Standard Function - DI_LM -

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1. Scope

The purpose of this document is to define the Standard Function for a Line monitored Digital Input.

This standard is used for linear heat sensing cables or loops based on “energise to trip” principle (e.g. local Manual Call Points, push buttons included in the F&G matrix and ESD panels, local ESD push buttons).

This Standard Function is a fundamental building block. It may either be used standalone, e.g. for monitoring an equipment status, or associated to other Standard Functions (e.g. Safety Bar, Voting Logic).

In order to assist in understanding, this document should be read in conjunction with **GS EP INS 150**, Design Methods for System Configuration Standard Functions.

2. General description of functions

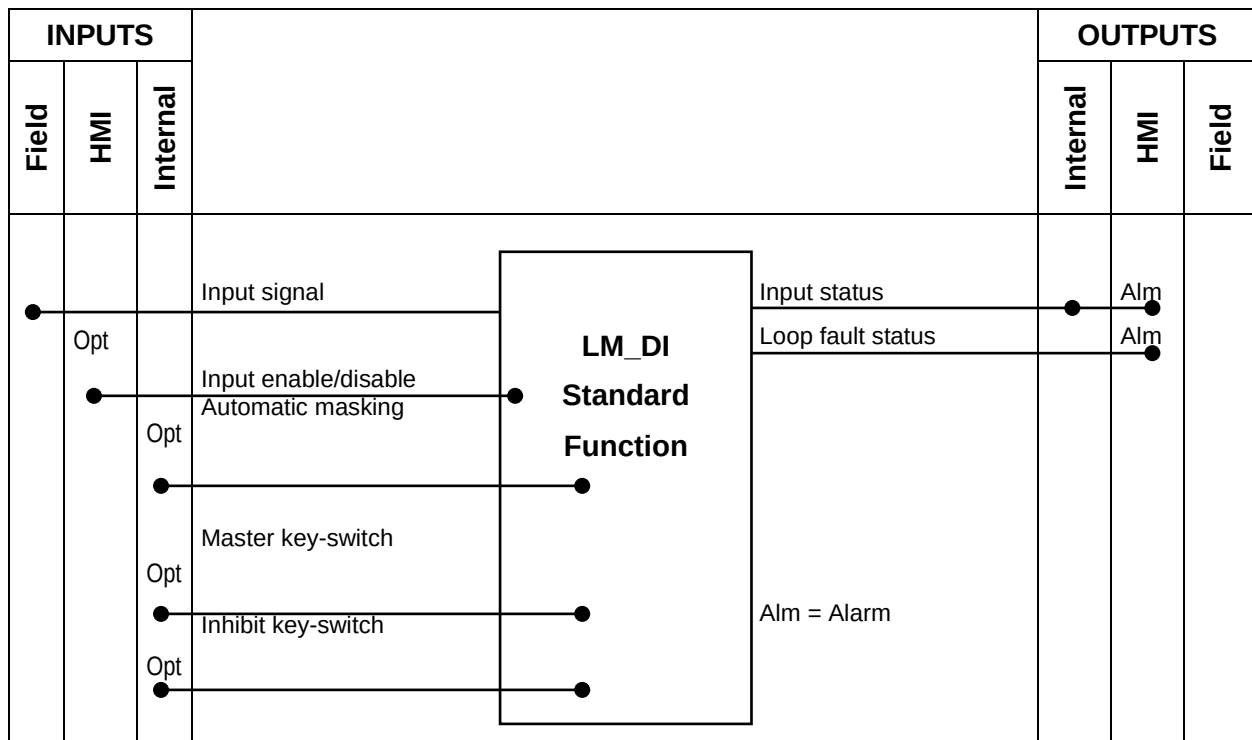
2.1 List of main functions

- ON/OFF signal acquisition including signal filtering function
- Alarm detection
- Loop Fault detection (open & short circuits)
- Input enable/disable (option).

Signal acquisition may be achieved through standard analogue inputs card. This analogue loop will include up to four individual contacts.

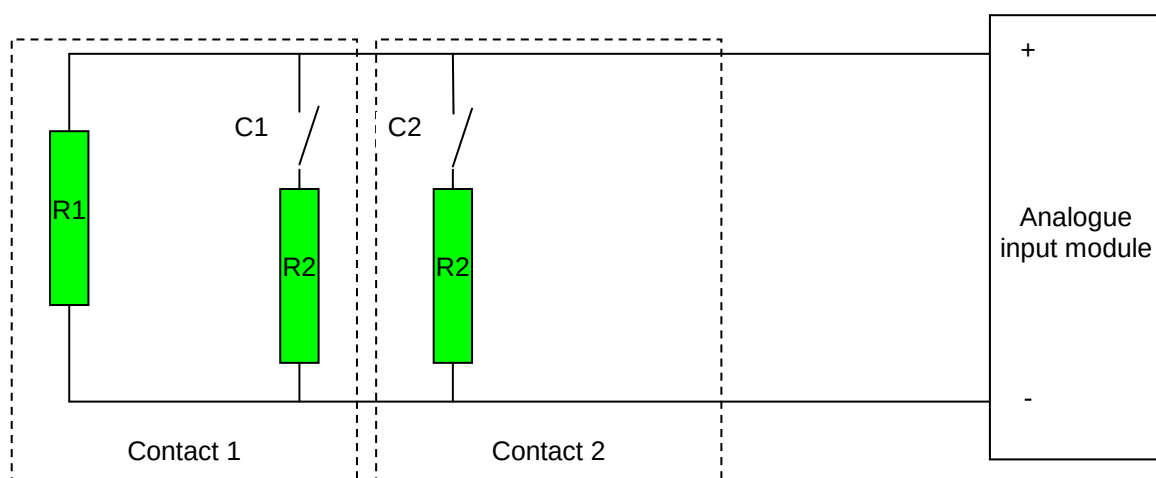
3. Interfaces description

3.1 General description



3.2 Field interface description

The field wiring principle for this type of ON/OFF data acquisition shall be designed as below (example showing two individual contacts):



R1 = 4.7 Kohm

R2 = 3.3 Kohm

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Chapter 2

The resistors R1 and R2 shall be calculated to ensure the signal levels suit the system capabilities.

Typical input signal characteristics:

- Signal ≤ 0.8 mA Loop status = INVALID (open circuit)
- Signal = 4 mA Loop status = NORMAL (loop healthy, no contacts activated)
- Signal ≥ 7 mA Loop status = ALARM (at least 1 contact activated)
- Signal ≥ 23.2 mA Loop status = INVALID (short circuit).

For linear heat detector, the above description doesn't apply since the principle is slightly different:

The wiring principle includes RTD converter as well as "beginning of line" and "end of line" resistors.

Calculation of resistors will depend on the RTD converter type, cable type and length.

Typical input signal characteristics:

- Signal ≤ 4 mA INVALID (open circuit)
- Signal = 6 mA ALARM (detected fire at the beginning of the cable)
- $9 \text{ mA} \leq \text{Signal} \leq 12 \text{ Ma}$ ALARM (detected fire at the end of the sensitive cable)
- Signal ≥ 18 mA NORMAL
- Signal ≥ 20 mA INVALID (short-circuit)

4. Detailed description of functions

4.1 Status definition

Internal data	Calculation rules	Status
Input status	$7 \text{ mA} < \text{signal (at least 1 contact activated)}$ $< 23.2 \text{ mA}$	ALARM
	Else	NORMAL
Loop fault	$\text{Signal} < 0.8 \text{ mA or } > 23.2 \text{ mA}$	ALARM
	Else	NORMAL

For linear heat detector:

Internal data	Calculation rules	Status
Input status	$6 \text{ mA} < \text{signal} < 12 \text{ mA}$	ALARM
	Else	NORMAL
Loop fault	$\text{Signal} < 4 \text{ mA or } > 20 \text{ mA}$	ALARM
	Else	NORMAL

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4.2 Functional standard behavior

In the case of a short or open circuit detection (loop fault activated), the Input status will be forced *NORMAL* and the loop fault signal will generate an alarm.

For loops based on “energize to trip” principle, loop fault will not trip any Safety Bar or initiate any safety-related action.

For the linear heat detectors, loop fault will be processed by associated voting logic.

4.3 Maintenance Functions

This section defines maintenance inhibit and input enable/disable principles, this last command being used only when detectors are processed by voting logics.

In case of brown field development and potentially new development within the same asset, the existing maintenance inhibit procedure will be maintained, unless otherwise specified in the project documents (e.g. operating philosophy, instrumentation and control philosophy).

4.3.1 Definitions

4.3.1.1 Maintenance inhibit

Activation of maintenance inhibit command will prevent the input signal to be processed by the Safety Bar.

This maintenance inhibit function is fully detailed within the Safety Bar Standard Function.

4.3.1.2 Input enable/disable (option)

When included in voting logic, the enable/disable command will prevent the input signal to be processed by the voting logic.

The primary voting logic arrangement shall automatically be reconfigured in accordance with the downgraded voting logic arrangement defined in the Voting Logic Standard Function (Refer to the **GS EP INS 198**).

When the input enable/disable is active, the fault status (invalid status) will be forced.

4.3.2 Input enable/disable logic (option)

A first maintenance inhibit MASTER hard wired key-switch shall enable the input enable/disable function and provide security control against accidental input enable/disable operation. No input enable/disable can be initiated until this MASTER key-switch is set in the ENABLE position.

All active input enable/disable will be reset when this key-switch is switched to the DISABLE position.

Adequate authority level shall operate this MASTER key switch.

A second maintenance inhibit hard wired key-switch shall allow the transfer of the individual input enable/disable command to the ESD system and PSS during a limited time interval (by default 30 minutes). This inhibit key switch will be set in the maintenance inhibit while the above MASTER key-switch is in the ENABLE position. Generally, this inhibit key switch is operated by the control room operator in line with the relevant work permit requirements.

All individual maintenance inhibit commands will be set /reset using the Operator Working Stations (OWS).

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Use of maintenance working station (MWS) might also be considered as alternative, as per Project Instrumentation and control philosophy.

Access to maintenance inhibit commands shall be access restricted (e.g. maintenance mode).

The individual maintenance inhibit command will be latched in the safety system logic.

It will stay set until one of the following conditions is met:

- The maintenance inhibit is reset from either OWS, or MWS
- The maintenance inhibit MASTER key-switch is switched to the DISABLE position.

4.3.3 Hardware Implementation (option)

The inhibit MASTER key-switch and the second maintenance inhibit key-switch shall be common to maintenance inhibit related to PSS, ESD and FGS (i.e. doesn't apply to PCS) and input enable/disable functions.

Those key-switches will be hardwired to one ESD controller and then dispatched to all over safety controllers (ESD, PSS and FGS) through the safety network. Hardwired links between safety systems might be considered as alternative where the safety network is not available.

Both key-switches shall be line monitored and therefore processed by DI-LM Standard Function.

The inhibit MASTER key-switch will be of "stay put" type with key reset and protected by lift flap, unlike the inhibit key-switch of a spring return type.

MASTER key-switch: 0 = Enable position

1 = Disable position

Inhibit key-switch:  = On rising edge detection timer will be launched

ESD/PSS/FGS shall capture the input enable/disable command only during the timer countdown.

4.3.4 Input enable/disable logging (option)

The status of the above key-switches (i.e. MASTER key-switch and maintenance key-switch) shall be logged by the FGS / PSS / ESD system as event.

Input enable/disable status shall be classified as events, as well.

Their number and their duration shall be available through the Operator Working Station and recorded.

Report and dedicated display shall be generated periodically and upon operator request showing all current active input enable/disable.

4.4 Automatic masking

Each individual alarm can be masked by an external event (as per [GS EP INS 150](#)). During this automatic masking, the alarm is not generated and the fault status treatment is no longer active.