



International Society of Automation
Setting the Standard for Automation™

**TECHNICAL
REPORT**

ISA-TR18.2.3-2024

Basic Alarm Design

Approved: 2 OCTOBER 2024

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FOREWORD

In 2009, ANSI/ISA-18.2-2009, *Management of Alarm Systems for the Process Industries*, commonly referred to as ISA-18.2, was issued and was later updated in 2016. In that same year the ISA18 Committee established working groups to develop and maintain a series of technical reports with guidance on how to implement the practices outlined in ISA-18.2. The eight independent technical reports are described below:

- ISA-TR18.2.1, *Alarm Philosophy* [TR1], provides guidance on the alarm philosophy. TR1 is limited to the scope of Clause 6 in ISA-18.2. The alarm philosophy provides guidance for successful management of the alarm system. It covers the definitions, principles, and activities by providing overall guidance on methods for alarm identification, rationalization, classification, prioritization, monitoring, management of change, and audit.
- ISA-TR18.2.2, *Alarm Identification and Rationalization* [TR2], provides guidance on alarm identification and rationalization. TR2 is limited to the scope of Clauses 8 and 9 in ISA-18.2. Identification and rationalization cover the activities to determine the possible need for an alarm or a change to an alarm; systematically compare alarms to the alarm philosophy; and determine the alarm setpoint, consequence, operator action, priority, and class. Activities include, but are not limited to, identification, justification, prioritization, classification, and documentation.
- ISA-TR18.2.3, *Basic Alarm Design* [TR3], provides guidance on basic alarm design. TR3 focuses on the scope of Clause 10 of ISA-18.2 and may include other clauses as needed (e.g., Clause 14 on operations and Clause 15 on maintenance). Basic alarm design covers the selection of alarm attributes (e.g., types, deadbands, and delay times) and may be specific to each control system.
- ISA-TR18.2.4, *Enhanced and Advanced Alarm Methods* [TR4], provides guidance on enhanced and advanced alarm methods. TR4 focuses on the scope of Clause 12 of ISA-18.2. Enhanced alarm design covers guidance on additional logic, programming, or modeling used to modify alarm behavior. These methods may include dynamic alarming, state-based alarming, adaptive alarms, logic-based alarming, and predictive alarming, as well as most of the designed suppression methods.
- ISA-TR18.2.5, *Alarm Monitoring, Assessment, and Audit* [TR5], provides guidance on monitoring, assessment, and audit of alarms. TR5 focuses on the scope of Clauses 16 and 18 in ISA-18.2. Monitoring, assessment, and audit cover the continuous monitoring, periodic performance assessment, and recurring audit of the alarm system.
- ISA-TR18.2.6, *Alarm Systems for Batch and Discrete Processes* [TR6], provides guidance on the application of ANSI/ISA-18.02-2009 alarm lifecycle activities to batch and discrete processes, expanding on multiple clauses of ISA-18.2.
- ISA-TR18.2.7, *Alarm Management when Utilizing Packaged Systems* [TR7], provides guidance on the application of ANSI/ISA-18.2-2009 to plants utilizing packaged systems, expanding on multiple clauses of ANSI/ISA-18.02-2009.
- ISA-TR18.2.8, *Guidelines for Non-alarm Notifications* [TR8], provides a system of nomenclature for notifications other than alarms and guidance on managing notifications generated by automation systems.

The guidance as presented in this document is general in nature and should be applied to each system as appropriate by personnel knowledgeable in the manufacturing process and control systems to which it is being applied. This guidance will evolve with experience and technology advancements.

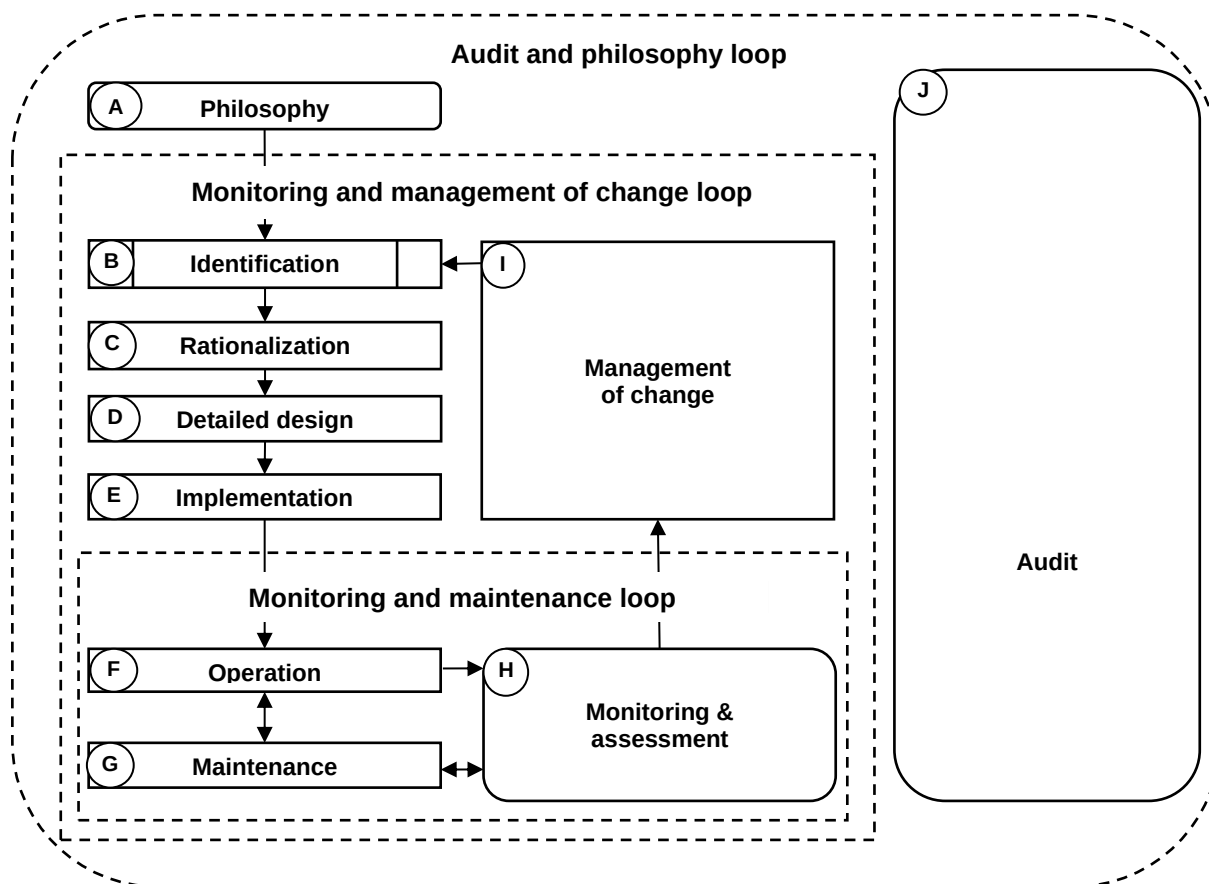
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Introduction

Alarm management lifecycle

ISA-18.2 defines requirements that address alarm systems for facilities in the process industries to improve safety, quality, and productivity. The general principles and processes in ISA-18.2 are intended for use in the lifecycle management of an alarm system based on programmable electronic controller- and computer-based human-machine interface (HMI) technology. These requirements are presented in the standard, using the alarm management lifecycle shown in Figure 1.

The lifecycle model is useful in organizing the requirements and responsibilities for implementing an alarm management system. The lifecycle is applicable for the installation of new alarm systems or managing an existing system.



NOTE 1 The box used for stage B represents a process defined outside of this document per 5.2.2.3.

NOTE 2 The independent stage J represents a process that connects to all other stages per 5.2.2.11

NOTE 3 The rounded shapes of stages A, H, and J represent entry points to the lifecycle per 5.2.3.

NOTE 4 The dotted lines represent the loops in the lifecycle per 5.2.5.

Figure 1 – Alarm management lifecycle (from ISA-18.2)

Basic alarm design

This technical report is designed to provide guidance, rationale, and examples of the basic alarm design process described in ISA-18.2 Clause 10. Basic alarm design, which is a step in the detailed design stage of the lifecycle, covers the selection of alarm attributes (e.g., types, deadbands, and delay times) and may be specific to each control system.

Following the recommended guidance in this technical report will not necessarily ensure that alarm management problems will be avoided. It will, however, help to identify and address alarm management vulnerabilities and help minimize the existence of nuisance alarms that could compromise and impair the operator's awareness, understanding, and response to abnormal situations.

Purpose of this technical report

This technical report provides details on the basic alarm design process described in ISA-18.2 Clause 10. Following the lifecycle model shown in Figure 1, this report assumes that alarms to be addressed in basic alarm design have completed rationalization where attributes such as alarm setpoint and priority have already been defined.

1 Scope

1.1 General applicability

This technical report addresses alarm systems for facilities in the process industries to improve safety, quality, and productivity.

In the design stage, the alarm attributes are specified and designed based on the requirements found in the alarm philosophy and determined by rationalization (e.g., alarm priority and setpoint). There are three areas of design: basic alarm design, HMI design, and design of advanced alarming techniques. This technical report addresses considerations for the basic alarm design. Note that HMI design detailed requirements and recommendations can be found in ISA-18.2 Clause 11 and ANSI/ISA-101.01-2015, *Human Machine Interfaces for Process Automation Systems*. Guidance on advanced alarming techniques is provided in TR4.

1.2 Basic alarm design versus advanced alarm

1.2.1 Basic alarm design (TR3) versus enhanced and advanced alarm (TR4)

This technical report, TR3, addresses basic alarm design, while TR4 focuses on advanced alarm design—enhanced and advanced alarm methods. The purpose of this subclause is to provide clarity as to what methods and techniques are treated as basic alarm design versus those that are treated as advanced alarm design.

1.2.2 Basic alarm design

Basic alarm design covers the design and specification of individual alarm attributes and the selection of appropriate alarm types. Attributes can include deadband, priority, and on/off delay.

Process variable (PV) calculations, analog and logical, are considered part of the control system and basic alarm design. PV calculations can be complex yet have basic alarming functionality. This includes such techniques as:

- a) common alarms, e.g., a common high-temperature alarm coming from multiple temperature transmitters on a tank or a common toxic-gas alarm coming from multiple gas detectors;
- b) numeric calculations within the control system used with basic alarming, such as rate calculations (producing rate-of-change alarms if not already present), statistical calculations (producing statistical alarms, such as alarming on standard deviations, etc.), and other complex calculations;
- c) simple to complex models used to estimate process values online, often referred to as virtual, soft, inferential sensors or equivalent terms; high-speed counters and accumulators, often needed in discrete manufacturing applications, which accumulate and aggregate within the control system before applying basic alarming;
- d) logic calculations within the control system to create an alarm only when it is a valid alarm (e.g., a calculation including a logical AND of low pressure and the associated pump run status to create a logical PV that is alarmed).

NOTE If the alarm is created by the control system, and logic is added to conditionally suppress it, this falls under the definition of advanced alarming and is discussed in TR4.

1.2.3 Enhanced and advanced alarm methods

The enhanced and advanced alarm methods in TR4 include ways to modify alarm attributes dynamically for one or more process variables. Different from basic alarm design, advanced alarm design often has a larger scope (applies to multiple variables at once) and ensures that alarm attributes track the process (are relevant for different operating states). Additional layers of logic, programming, modeling, or a combination of these beyond basic alarming methods, are used to modify alarm behavior to ensure alarms are relevant when presented to the operator. These additional layers may be used to improve operator guidance to better meet the performance objectives of an alarm system. The techniques outlined in TR4 include the following examples:

- a) advanced alarm methods provide ways to modify alarm behavior through such techniques as designed suppression and state-based alarming;
- b) enhanced alarm methods provide ways to augment alarms with better operator guidance, including identification of causes, and redirecting the alarm to the location of the desired responder.

NOTE TR6 is also a relevant reference regarding modifying alarm behavior as batch processes typically require such functionality.

2 References

ANSI/ISA-18.2-2016, *Management of Alarm Systems for the Process Industries*, also known as ISA-18.2

ANSI/ISA-61511-1-2018 / IEC 61511-1:2016, Parts 1-3: *Functional Safety – Safety Instrumented Systems for the Process Industry Sector*

IEC 62682:2022, *Management of Alarm Systems for the Process Industries*

ANSI/ISA-101.01-2015, *Human Machine Interfaces for Process Automation Systems*

3 Terms, definitions, and abbreviated terms

Defined terms are used in this technical report. Synonymous terms, which are not used in this technical report, are listed in parentheses.

3.1 Terms and definitions

For the purposes of this technical report, the terms given in ISA-18.2-2016 and the following apply. Terms taken directly from ISA-18.2-2016 are cited as such; other terms are defined by this TR.

3.1.1

absolute alarm

alarm generated when the setpoint is exceeded

EXAMPLE high-high, high, low, low-low

[SOURCE: ISA-18.2-2016]

3.1.2

active

alarm in a state in which the alarm condition is true

Note 1 to entry: Functions such as deadband, on or off delays, and latching can allow the alarm to be active when the alarm condition is false or the alarm to not be active when the alarm condition is true.

[SOURCE: ISA-18.2-2016]

3.1.3

adaptive alarm

alarm for which the setpoint is changed by an algorithm (e.g., calculated based on production rate)

[SOURCE: ISA-18.2-2016]

3.1.4

adjustable alarm

operator-set alarm

alarm for which the setpoint can be changed manually by the operator

[SOURCE: ISA-18.2-2016]

3.1.5

advanced alarming

collection of techniques that can help manage alarm rates in specific situations

EXAMPLE state-based alarming

[SOURCE: ISA-18.2-2016]

3.1.6

alarm

audible and/or visible means of indicating to the operator an equipment malfunction, process deviation, or abnormal condition requiring a timely response

[SOURCE: ISA-18.2-2016]

3.1.7

alarm attribute

setting for an alarm within the process control system

EXAMPLE alarm priority

[SOURCE: ISA-18.2-2016]

3.1.8

alarm deadband

change in signal from the alarm setpoint necessary for the alarm to return to normal

[SOURCE: ISA-18.2-2016]

3.1.9

alarm message

text string displayed with the alarm indication that provides additional information to the operator

EXAMPLE operator action

[SOURCE: ISA-18.2-2016]

3.1.10

alarm off-delay

debounce

time an alarm remains active after the process measurement has returned within the alarm setpoint

[SOURCE: ISA-18.2-2016]

3.1.11

alarm on-delay

time before an alarm becomes active after the process measurement has exceeded the alarm setpoint

[SOURCE: ISA-18.2-2016]

3.1.12

alarm philosophy

document that establishes the basic definitions, principles, and processes to design, implement, and maintain an alarm system

[SOURCE: ISA-18.2-2016]

3.1.13

alarm priority

relative importance assigned to an alarm within the alarm system to indicate the urgency of response (e.g., seriousness of consequences and allowable response time)

[SOURCE: ISA-18.2-2016]

3.1.14**alarm setpoint****alarm limit****alarm trip point**

threshold value of a process variable or discrete state that is used to determine if the alarm is active

[SOURCE: ISA-18.2-2016]

3.1.15**alarm summary****alarm list**

display that lists annunciated alarms with selected information (e.g., date, time, priority, and alarm type)

Note 1 to entry: Return-to-normal indications can also appear on the alarm summary.

[SOURCE: ISA-18.2-2016]

3.1.16**alarm type**

alarm attribute that gives a distinction of the alarm condition

EXAMPLE low process variable alarm, high process variable alarm, or discrepancy alarm

[SOURCE: ISA-18.2-2016]

3.1.17**allowable response time**

maximum time between the annunciation of the alarm and the time the operator must take corrective action to avoid the consequence

[SOURCE: ISA-18.2-2016]

3.1.18**annunciated alarm**

alarm that has been communicated to the operator

3.1.19**bad-measurement alarm**

alarm generated when the signal for a process measurement is outside the expected range (e.g., 3.8 ma for a 4–20 ma signal)

[SOURCE: ISA-18.2-2016]

3.1.20**bit-pattern alarm**

alarm that is generated when a pattern of digital signals matches a predetermined pattern

[SOURCE: ISA-18.2-2016]

3.1.21**calculated alarm**

alarm generated from a calculated value instead of a direct process measurement

[SOURCE: ISA-18.2-2016]

3.1.22**call-out alarm**

alarm that notifies and informs an operator by means other than, or in addition to, a console display (e.g., pager or telephone)

[SOURCE: ISA-18.2-2016]

3.1.23

chattering alarm

alarm that repeatedly transitions between the alarm state and not active state in a short period of time

[SOURCE: ISA-18.2-2016]

3.1.24

common alarm

single alarm with several related input sensors where one operator action is required to address any and all of the common alarm conditions

3.1.25

control system

system that responds to input signals from the equipment under control and/or from an operator and generates output signals that cause the equipment under control to operate in the desired manner

Note 1 to entry: The control system can include one or more basic process control systems (BPCS), safety instrumented systems (SISs), or packaged systems.

[SOURCE: ISA-18.2-2016]

3.1.26

controller-output alarm

alarm generated from the output signal of a control algorithm (e.g., PID controller) instead of a direct process measurement

[SOURCE: ISA-18.2-2016]

3.1.27

deviation alarm

alarm generated when the difference between two values exceeds an alarm set point (e.g., deviation between primary and redundant instruments or a deviation between process variable and setpoint)

[SOURCE: ISA-18.2-2016]

3.1.28

discrepancy alarm

mismatch alarm

alarm generated by the difference between the expected plant or device state to its actual state (e.g., when a motor fails to start after it is commanded to the on state)

[SOURCE: ISA-18.2-2016]

3.1.29

dynamic alarming

automatic modification of alarm attributes based on process state or conditions

[SOURCE: ISA-18.2-2016]

3.1.30

first-out alarm

first-up alarm

alarm determined (i.e., by first-out logic) to be the first in a multiple-alarm scenario

[SOURCE: ISA-18.2-2016]

3.1.31

fleeting alarm

alarm that transitions between an active alarm state and a not active state in a short period of time without rapidly repeating

[SOURCE: ISA-18.2-2016]