ABB MEASUREMENT & ANALYTICS | SAFETY MANUAL

266CRx, 266CSx, 266JRx, 266JSx

Multivariable pressure transmitters

Engineered solutions for all applications

Measurement made easy

—

266 multivariable

Introduction

The 2600T family provides comprehensive range of top quality pressure measurement products, specifically designed to meet the widest range of applications ranging from arduous conditions in offshore oil and gas to the laboratory environment of the pharmaceutical industry.

This document has to be read in conjuction with 266Cxx/266Jxx operating manuals.
It provides additional instructions for IEC61508 certified device (ONLY for instruments having digits 8 or T under “output” option within the main product code).
This document replaces the existing Safety Manual chapter into ABB Pressure Transmitter documentation.

For more information

Further publications for 2600T series pressure products are available for free download from www.abb.com/pressure

Contents

1 Acronyms and abbreviations

Abbreviation	Designation	Description
HFT	Hardware Fault Tolerance	Hardware fault tolerance of the unit. Ability of a functional unit (hardware) to continue to perform a required function when faults or errors are prevailing.
MTBF	Mean Time Between Two Failures	Expected time between two failures for a reparable system. It is a reliability parameter.
MTTR	Mean Time To Repair	Mean time between the occurrence of an error in a unit or in a system and its repair.
PFD	Probability of Dangerous Failure on Demand	Probability of hazardous failures for a safety function on demand.
PFD_{AV}	Average Probability of Dangerous Failure on Demand	Average probability of hazardous failures for a safety function on demand.
PFH	Average Frequency of a Dangerous Failure per Hour	Average frequency of a dangerous failure of an E/E/PE safety related system to perform the specified safety function over a given period of time. The term “Probability of Dangerous failure per hour” is not used in the standard IEC 61508 but the acronym PFH has been retained but when it is used it means “average frequency of dangerous failure per hour”.
SIL	Safety Integrity Level	The international standard IEC 61508 defines four discrete Safety Integrity Levels (SIL 1 to SIL 4). Each level corresponds to a range of probability for the failure of a safety function. The higher the Safety Integrity Level of the safety-related systems, the lower the probability that they will not perform the required safety function. For a single component, it is not correct to define a SIL level. The term SIL refers to the complete safety loop, therefore the single device shall be designed in order to achieve the desired SIL level in the entire Safety Loop.
SFF	Safe Failure Fraction	The fraction of non-hazardous failures, i.e. the fraction of failures without the potential to set the safety-related system to a dangerous or impermissible state.
PTC	Proof Test Coverage	Indication of how many undetected dangerous failures are detected by the proof test. It is a value in percentage.
PTI	Proof Test Interval	The proof test interval represents the time after which a subsystem must be either totally checked or replaced to ensure that it is in an “as new” condition. Therefore, the proof test interval is usually the same as lifetime. It is performed off line.
XooY	“X out of Y” voting (e.g. 2oo3)	Classification and description of the safety-related system regarding redundancy and selection procedure used. “Y” specifies how often the safety function is performed (redundancy). “X” determines how many channels have to work properly. Example based on pressure measurement 1oo2 architecture: A safety-related system decides that a predefined pressure limit is exceeded when one of the two pressure sensors reaches this limit. If a 1oo1 architecture is used, there is only one pressure sensor available.

2 Relevant standards

2.1 Standard IEC 61508 (2010) (Edition 2), Part 1 to 7

Functional safety of electrical / electronic / programmable electronic safety-related systems (Target group: Manufacturers and Suppliers of Devices).

3 Terms

3.1 Dangerous failure

Failure of an element and / or subsystem and / or system that plays a part in implementing the safety function that:

a) prevents a safety function from operating when required (demand mode) or causes a safety function to fail (continuous mode) such that the EUC is put into a hazardous or potentially hazardous state; or
b) decreases the probability that the safety function operates correctly when required.

3.2 Safe failure

Failure of an element and / or subsystem and / or system that plays a part in implementing the safety function that:

a) results in the spurious operation of the safety function to put the EUC (or part thereof) into a safe state or maintain a safe state; or
b) increases the probability of the spurious operation of the safety function to put the EUC (or part thereof) into a safe state or maintain a safe state.

3.3 Systematic failure

Failure related in a deterministic way to a certain cause, which can only be eliminated by a modification of the design or of the manufacturing process, operational procedures, documentation or other relevant factors.

3.4 Safety-related system

A safety-related system performs the safety functions that are required to achieve or maintain a safe condition, e.g., in a plant.
Example: pressure meter, logics unit (e.g., limit signal generator) and valve form a safety-related system.

3.5 Safety function

A specified function that is performed by a safety-related system with the goal, under consideration of a defined hazardous incident, of achieving or maintaining a safe condition for the plant.
Example: limit pressure monitoring
About the safety function of 266Cxx / 266Jxx please refer to Chapter “Safety Function”.

3.6 Multivariable (abbreviation MV)

Multivariable is an instrument that measures the following process variables: differential pressure, static pressure and temperature in the “same” time and evaluates the flow value of the process on the output variable.

3.7 Multisensor (abbreviation MS)

Multisensor is an instrument that could measure one of the following process variable values: differential pressure, static pressure, temperature. User can choose what input variable set on 4 ... 20 mA as primary output variable.

3.8 Process safety time (PST)

The period between a failure occurring in the transmitter and the occurrence of the hazardous event if the safety function is not performed.

4 Other relevant documents

The following document includes details about functional specifications of the analog output and how to operate and configure the device.

Document name	Document type
OI/266CXX/266JXX/HART-EN	Operating Instruction

5 Scope and purpose of the safety manual

The present safety manual contains information to design, install, verify and maintain a Safety Instrumented Function (SIF) using 266Cxx / Jxx, Multivariable / Multisensor Transmitters certified according to IEC 61508. This document will set out all assumptions that must be made by the customers to ensure that the application of the instrument meets the SIL capability declared for the product. If these requirements are not respected, SIL capability cannot be achieved.
This manual shall be read in conjunction with the operative instruction OI/266CXX/266JXX/HART-EN downloadable from the ABB site.

6 Application area

The 266Cxx / Jxx transmitters certified according to IEC 61508 are intended to be applied for safety relevant application in the process industry. They are suitable to be used in SIL2 applications when applied as single channel and in SIL3 applications when applied with a double channel with architecture 1oo2. Special attention should be given to the separation of safety and non-safety relevant use.

The code 266Cxx indicates the Multivariable transmitter, the main measure is the mass flow or level of the process, while the code 266Jxx indicates the multisensor transmitter where the main process variable of the measure could be one of differential pressure, static pressure or temperature. The process variable value is converted in 4 ... 20 mA current signal.
The 266Cxx measures the mass flow of gases, vapors and liquids in the process industry. For information on measuring ranges refer to the operative instruction OI/266CXX/266JXX/HART-EN.

Using these products as intended includes compliance with the following points:
— Read and follow the instructions shown on operative instruction documents: OI/266CXX/266JXX/HART-EN.
— Read and follow the instructions in this operative instruction.
— The technical limit values must be complied with (refer to operative instruction document OI/266CXX/266JXX/HART-EN section “Technical data”)

The measuring equipment is in compliance with the following requirement:
— Functional safety according to IEC 61508:2010
— Explosion protection (depending on version)
— Electromagnetic compatibility according to EN 61326-1, with specific terminal block in according also to NAMUR recommendation NE21:2004

For special applications that are not considered in this manual and in the operative instruction, we recommend that you first familiarize yourself with the mode of operation of the MV / MS based on this manual and check that the safety function of the instrument will work still properly.

7 Safety philosophy

You must read this manual and operative instruction carefully prior to installing and commissioning the device. These instructions are an important part of the product and must be kept for future reference.

For additional information or if specific problems occur that are not discussed in these instructions, contact the manufacturer.

These products are field devices composed from components designed according to the requirements of the standard IEC 61508 for the safety related system. Standard currently used gives focus on individual parts of all the safe instrumentation used to implement a safety function. The IEC 61508 defines requirements related to all the system that normally comprises sensor devices, logic solver and final elements. It also introduces the concept of Safety lifecycle defining the sequence of activities involved in the implementation of the safety-instrumented system from conception through decommissioning. The term SIL (Safety Integrity Level) refers to the complete safety loop, therefore the single device shall be designed in order to be suitable to achieve the desired SIL level in the entire Safety Loop.

7.1 Safety function

The instrument can be used in safety-critical applications to measure the process variable (flow or level for the multivariable instrument 266Cxx output code 8 or T, or in case of the multisensor instrument 266Jxx output code 8 or T a single variable between differential pressure or static pressure or temperature) and drives the 4 ... 20 mA output current according to the measured values.
If the process value is invalid due to an internal failure of the instrument, the system is to go into safe / alarm state (in compliance with NAMUR NE43) and the malfunction is shown as warning message on the LCD (if any) as well as a variation in the output.
The definition of the safety function for the MV is to drive the 4 ... 20 mA output according to measured process values and the calculated flow value or the level value.
An internal malfunction the instrument drives the output current to alarm level in according NAMUR 43.

The instrument monitors and evaluates the generation of the 4 … 20 mA output current. In case of a detected deviation of 2 % between the output current generated and current read back ,the transmitter generates an analog alarm signal.
It is important that the transmitter is user-configured correctly and in accordance to the specific measuring application.

In addition to the safety function the multivariable instrument supports flow measurement applications with a diagnosis functionality that evaluates the user-configured flow value .The instrument evaluates the 100 % flow value (user-configuration) against the calculated 100 % flow value .
A detection of a deviation that exceeds the threshold value of ± 5 % (of 100 % flow) will lead the transmitter to generate a warning signal in the LCD.
This warning is not a safety function and has no effect on the output current signal.

7.2 Physical environment

The 2600T series models 266 are designed for use in industrial field environments and must be operated within the specified environmental limits as indicated in the datasheet or in the operative instruction:

All models	Ambient temperature limits
Silicone oil	-40 and 85 °C (-40 and 185 °F)
Fluorocarbon (Galden)	-40 and 85 °C (-40 and 185 °F)

All models	Ambient temperature limits
Integral LCD display[1)]	-40 and 85 °C (-40 and 185 °F)
Viton gasket	-20 and 85 °C (-4 and 185 °F)
PTFE gasket	-20 and 85 °C (-4 and 185 °F)

1) It may no longer be possible to read the LCD display clearly below -20 °C (-4 °F) and above 70 °C (158 °F).

NOTICE

For applications in potentially explosive environments, the temperature range specified in the certificate / approval which depends upon the type of protection sought shall apply.

7.2.1 Process

All models	Process temperature limits
Silicone oil	-40 and 121 °C (-40 and 250 °F)[1)]
Fluorocarbon (Galden)	-40 and 121 °C (-40 and 250 °F)[2)]
Viton gasket	-20 and 121 °C (-4 and 250 °F)
PTFE gasket	-20 and 85 °C (-4 and 185 °F)

1) 85 °C (185 °F) for applications under 10 kPa, 100 mbar abs., 1.45 psia up to 3.5 kPa abs., 35 mbar abs., 0.5 psia
2) 85 °C (185 °F) for applications below atmospheric pressure up to 17.5 kPa abs., 175 mbar abs., 2.5 psia

For diaphragm seals filling fluids when in transmitter with (a) diaphragm seal(s) please read the operative instruction paragraph “Temperature limits °C (°F)”.

7.2.2 Humidity

Relative humidity: up to 100 %.
Condensation, icing: permitted.

7.2.3 Test pressure

The transmitters can withstand a pressure test with the following line pressure without leaking up to 1.5 x nominal pressure (static pressure limit) simultaneously on both sides in according to hydrostatic test requirements of ANSI / ISA-S 82.03.

7.2.4 Electromagnetic compatibility

Meets requirements with EN 61326-1 and EN 61326-3-1.
Surge immunity: in according to IEC 60770 with terminal board MV/MS surge protection: 4 KV

NOTICE

In according to IEC 60770 with terminal board MV / MS standard, Ext EMC: 1KV
In according to the IEC 61326-3-1 in case of surge noise or burst, without terminal block surge, with intensity more than 1 KV, the acceptability criteria is FS, this means that the instrument could be damaged but the current output is more than 22 mA (safe condition).
For this reason, in case of environment with surge noise, burst noise above 1 KV, it is necessary and suggested the use of the terminal block with surge protector.

7.2.5 Maximum operating static pressure

0,6 MPa, 2 MPa, 10 MPa or 41 MPa (depending on selected static pressure sensor).

7.2.6 Maximum operating pressure

Depends on sensor range (please see the datasheet).

7.2.7 Power supply

— 10.5 V … 42 V with terminal block standard MV
— 12 V … 42 V with terminal block extended EMC NE21:2004 MV (cd. YE)
— 12.3 V … 42 V with terminal block surge MV (cd. S2)

NOTICE

For the hazardous area, the maximum power supply is 30 V.

7.2.8 Type of PT100 (RTD)

Two-wire, three-wire, four-wire circuits

NOTICE

A three-wire sensor or two-wire sensor may be used with degraded performance. If connecting a three-wire sensor may be used with degraded performance. Connect the three- or two-wire sensor in a manner to not interrupt the current path inside the circuit and use all connector on the terminal block.

7.2.9 Intended use

Using these products as intended includes compliance with the following points:

— Read and follow the instructions in this manual
— The technical limit values must be complied with (refer to the section “Technical data” in the operation instruction).

7.2.10 Improper use

The following are considered to be instances of improper use of the device:

— For use as a climbing aid, e.g. for mounting purposes
— For use as a support for external loads, e.g. as a support for piping, etc.
— Material application, e.g. by painting over the housing, name plate or welding/soldering on parts.
— Material removal, e.g. by spot drilling the housing.

Using the device in a manner that does not fall within the scope of its intended use, disregarding this manual, using underqualified personnel, or making unauthorized alterations releases the manufacturer from liability for any resulting damage. This renders the manufacturer’s warranty null and void.

8 Identification of 266 Multivariable / Multisensor transmitter IEC 61508 certified

Only IEC 61508-certified transmitter can be used in safety loops.

The 266-transmitter family includes a wide range of different instruments. To identify the safety ones, there are some important details to consider starting from the product code laser printed on the nameplate:

— The “Output” characteristic as per product datasheet is to be codified with digits 8 or T. To identify IEC 61508:2010 certified instruments by reading the nameplate, check if the main product code (mandatory characteristic) ends with 8 or T. Mandatory characteristics to be selected by the user are always composed by one single digit. If a product code ends with T, no additional options are required, whereas if the code ends with digit 8, the user selected some additional options, which are differentiated by being composed of two digits and being preceded by a blank space.

Below are two examples of nameplates with code 8 or T:

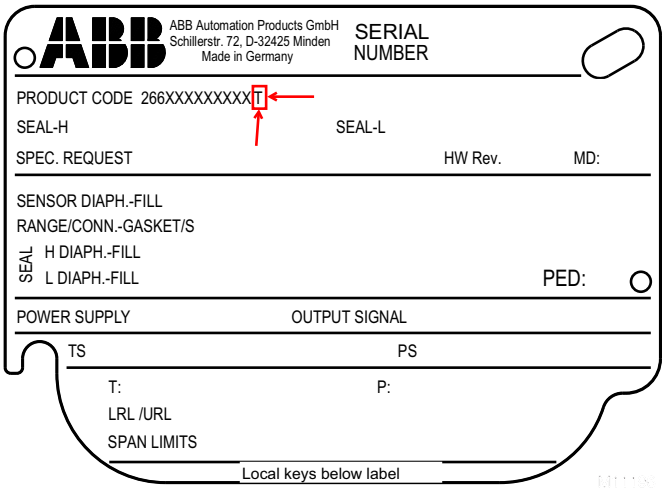

Fig. 1: Product Code with digit “T” (no additional options)

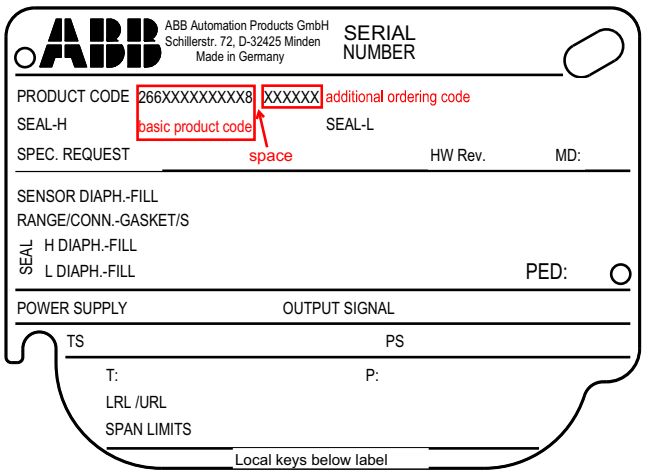

Fig. 2: Product Code with digit “8” (additional options required)

The user shall check 266Cxx / 266Jxx transmitter’s compliance for use in safety applications by reading the nameplate (product code).

NOTICE

266 pressure transmitters certified according to IEC 61508 have mounted on the neck an additional label with indicating the TUV mark, this permit to have a tag for SIL instrument. The additional label does not guarantee that the instrument is SIL, the only guarantee is the code printed on the name plate that must have the fixed part that ends with 8 or T. The user must check the correct product code before the installation of the instrument on the plant.

Fig. 3: TUV mark plate (the xxxxx is the number of the last IEC61508 certificate)

9 Determine the Safety Integrity Level (SIL)

The achievable Safety Integrity Level is determined by the following safety-related parameters:

— Average probability of hazardous failures for a safety function on demand (PFD_{AV})
— Hardware Fault Tolerance (HFT)
— Fraction of failures that do not have the potential to put the safety-related system in a hazardous or fail-to-function state (SFF)

The specific safety-related parameters for the transmitter, as part of a safety function, are listed in section 19 “Safety engineering parameters”.

The following table shows the dependence of the Safety Integrity Level (SIL) on the Average Probability of Failure on Demand (PFD_{AV}). The table applies the “low demand mode”, i. e. the rate of requests for the demanded safety function is maximum once a year.

Safety Integrity Level (SIL)		(low demand mode)
4	PFD_{AV}	≥ 10^{-5} ... < 10^{-4}
3		≥ 10^{-4} ... < 10^{-3}
2		≥ 10^{-3} ... < 10^{-2}
1		≥ 10^{-2} ... < 10^{-1}

Sensor, logics unit and actuator form a safety-related system that performs a safety function.

The Average Probability of Failure on Demand (PFD_{AV}) is usually divided between the sensor, logics unit and actuator sub-systems.

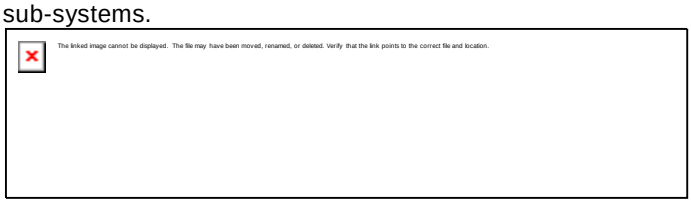

Abb. 4: Typical division of the Average Probability of Failure on Demand (PFDav) into subsystems

NOTICE

The 266Cxx / Jxx transmitter is considered a component of a safety function in this document. The following table displays the achievable Safety Integrity Level (SIL) for the entire safety-related system for type B systems depending on the Safe Failure Fraction (SFF) and the Hardware Fault Tolerance (HFT). Type B systems are, for example, sensors with complex components such as microprocessors and microcontroller (see also IEC 61508, Part 2).

Safe Failure Fraction (SFF)	Hardware Fault Tolerance (HFT)		
	0	1	2
< 60 %	Not permitted	SIL 1	SIL 2
60 ... < 90 %	SIL 1	SIL 2	SIL 3
90 ... < 99 %	SIL 2	SIL 3	SIL 4
≥ 90%	SIL 3	SIL 4	SIL 4

The 266Cxx generates an analog signal (4 ... 20 mA) proportional to the flow, this is the unique safety function for code Cxx, while the 266Jxx generates an analog signal (4 ... 20 mA) proportional to pressure or differential pressure or temperature and represent the safety function for the code Jxx.
The analog signal is fed to a downstream logics unit such as PLC or a limit signal generator, and is monitored to determine with it exceeds a maximum value. To monitor errors, the logics units must be able to detect both HI alarms (configurable between 21 ... 23 mA) and LO alarms (≤ 3.6 mA).

NOTICE

The mandatory settings and data for the safety functions are listed in the sections “Configuration“, “Commissioning” and “Safety engineering parameters”.

NOTICE

It is assumed an 8 h as mean time to restoration (MTTR) for each failure once it has been revealed as default. The MTTR=MRT=8 h is based on the assumption that the time to detect a dangerous failure, based on automatic detection, is <<MRT.
A safety-related system without a self-locking function must be monitored or set to an otherwise safe condition after performing the safety function within MTTR.

The 266Cxx / 266Jxx can be used in SIL2 loop used as a single channel (1oo1) or in SIL3 loop only in redundant operation (1oo2) within a safety function.

The 266Cxx / 266Jxx meet the following requirements:

— Hardware failure calculation according to IEC / EN 61508:2010 parts 1&2
— European directives: 2014/30/EU (EMC directive)
— Specifically: EN 61326-1:2006, EN 55011:2007 + A2:2007, EN 55016-2-3:2006, EN61000-4-2:2009, EN61000-4-3:2006+A1:2008+IS1:2009, EN61000-4-4:2004, EN 61000-4-5:2006, EN61000-4-6:1996+A1:2001+IS1:2004, EN61000-4-8:2010
— 2014/34/EU (ATEX directive)

Firmware according to IEC61508 part 3

10 Management of functional safety

For each application, the installer or the owner of a safety system must prepare a Safety Planning that must be updated throughout the Safety Life cycle and safety manual of the Safety Instrumented System.
The Safety planning shall include the safety instrumentation management. The requirements for the management of functional safety shall run in parallel with the overall safety lifecycle phases.

The safety planning shall consider:
— Policies and strategies for achieving safety;
— Safety life-cycle activities to be applied, including names of responsible persons and departments;
— Procedure relevant to the various life-cycle phases;
— Audits and procedures for follow up

11 Information requirements (to be available by the plant owner)

The information given to the plant owner shall comprehensively describe the system installation and its use in order that all phases of the overall safety lifecycles, the management of functional safety, verification and the functional assessment can be effectively performed.
The overall safety lifecycle shall be used as basis for claiming conformance to the standard IEC 61508. The lifecycle phases consider all the activities related to the safety-instrumented system (SIS) from the initial concept through design, implementation, operation and maintenance to decommissioning.
All applicable general laws and standards related to the allowed operations of the equipment, as UE - Directives shall be collected. The plant owner shall produce a regulatory requirements list document.

11.1 System Safety Requirement Assignment I/O system response time

The total response time is determined by the following elements:
— Sensor detection time;
— Logic solver time;
— Actuator response time
The total system response time must be less than the process safety time. The response time of the safety function (diagnostic test interval plus reaction time) must be less than the process safety time.

The response time of the system must include the time taken for input and output devices to respond and must be taken the worst-case assumptions for any cyclical (or non-deterministic) process.
To ensure a safe operation of the system, the scan rate of each section of the logic solver multiplied by the number of channels shall be taken into account together with the safety time of actuator and sensor response time.
In high demand applications, the process safety time must also be longer than the diagnostic test interval (time taken to detect internal faults max for 266Cxx / 266Jxx: 8 h) and fault reaction time (time taken to respond once a fault detected max for 266Cxx / 266Jxx: 5 min), without the hardware fault tolerance (HFT=0).
The Mean Time to Repair (for 266Cxx / 266Jxx is 8 h) the system must be taken into account for applications that will continue to operate before the safety function is repaired.
The safety-related system without a self-locking function must be monitored or set to an otherwise safe condition after performing the safety function within MTTR.
System configuration drawings shall be available to describe the equipment and the interfaces required for a complete operational system. The system must be fully operational before the start-up.
Each safety function, with its associated safety integrity requirement, shall be allocated to the designated safety related systems taking into account the risk reduction achieved by the other technology safety-related systems and external risk reduction facilities, so the necessary risk reduction for that safety function is achieved. The allocation indicated shall be done in such a way that all safety functions are allocated and the safety integrity requirements are met for each safety function.
Safety additional requirements may be defined to ensure the correct functionality of sequences in the safety instrumented system.
Considering that some errors drives the current output to low alarm 3.6 mA (or < 3.6 mA in case of reset) also if the alarm is selected to high, the downstream logics unit such as a PLC must be able to detect both HI alarms (configurable between 21 mA ... 23 mA) and LO alarms (3.6 mA).

12 Design verification

The inspection report for 266Cxx / 266Jxx multivariable / multisensor instrument in compliance with the IEC 61508:2010 is inside the 266 pressure transmitter because the multivariable is formed by different 266 pressure transmitter components. The inspection report and the certificate issued by the certification body can be downloadable by the ABB site Download Center: http://www.abb.com/abblibrary/downloadcenter/ inserting multivariable on the textbox. In case of problem with connection to the site, these documents may be requested to local ABB references that will get in touch with ABB marketing department at the factory.

A detailed Failure Modes, Effects and Diagnostic Analysis (FMEDA) document, developed using the Exida SILCAL tool and considering the SN29500 failure database is available only at ABB R&D department, only with manager's authorization due to its confidentiality. To request the authorization please contact the local ABB references.

By referring to the safety parameters listed inside this safety manual, the safety instrumented function designer (hereinafter referred to as "SIF" designer) shall verify the safety integrity level (SIL) achieved using the PFD_{avg} considering the architecture, the proof test interval, the proof test coverage, the automatic internal diagnostic, the repair time and failure rates of the entire equipment included in the SIF.

The hardware fault tolerance (HFT) must be checked and taken into consideration by the SIF designer to ensure that each subsystem within the SIF is in compliance with the minimum HFT requirements.

i NOTICE

The mandatory settings and data for safety functions are listed in the sections "Configuration" and "Safety-related parameters".

13 Installation

13.1 Environmental limits

As reported in chapter "Physical environment" the 266Cxx / 266Jxx transmitter have been designed to operate in a wide range of environmental conditions typical of an industrial field and in hazardous environments. The environment conditions under which the measuring equipment is designed to operate within its specified accuracy limits and without impairment of its operating characteristic are specified in chapter "Physical environment".

The accuracy values admitted are:

- % Error on the differential pressure 4 ... 20 mA reading value → allowed values within ± 0.075 % (± 0.04 %) calibrated span this depends on the sensor range selected
- Δ temperature in °C → allowed values within ± 0.3 °C
- % Error on the static reading value → allowed values within ± 0.1 % max. value this depend on the sensor range selected
- Safety accuracy for flow when this is safety function → 4 %
- Accuracy for flow / level → from 0,7 % to 0,9 % of the whole range

SIF designer must check that 266Cxx / 266Jxx certified according to IEC 61508:2010 are used within the expected environmental limits as in datasheet (chapter "Operating limits", chapter "Temperature limits"), operating instruction (chapter "Specifications") and also inside this manual (chapter "Physical environment").
To assure operator and plant safety, it is necessary to read "Installation" chapter of the present manual and operative instruction carefully.

13.2 Application limits

It is very important that SIF designer checks whether the model meets the measurement and safety requirements of the measuring point regarding materials, pressure rating, flow rating, temperature, explosion protection, operating voltage.
The transmitter should not be installed where it may be subjected to mechanical and thermal stresses or where existing or foreseeable aggressive substances may attach it. ABB cannot guarantee that construction materials are suited to a particular measuring medium under all possible process conditions.
The SIF designer must check for material compatibility by considering the process flow and the on-site chemical contaminants. Fill fluid and wet parts materials selections is under SIF's designer full responsibility. If 266Cxx / Jxx transmitters certified according to IEC 61508:2010, are used outside their application limits, environmental limits or with incompatible materials, the reliability data and the safety parameters predicted for SIL capability become invalid.

The materials for this instrument are specified in the ordering information, inside product data sheet for each transmitter.

13.3 Mounting

Before installing the transmitter, check whether the device design meets the requirements of the measuring point from a measurement technology and safety specifications point of view. This applies in respect of the:

— Measuring range
— Gauge pressure stability
— Temperature
— Explosion protection
— Operating voltage

The suitability of the materials must be checked as regards their resistance to the process flow and environment. This applies in respect of the:

— Gasket
— Process connection, separating diaphragm, etc.

In addition, the relevant directives, regulations, standards, and accident prevention regulations must be observed. Measurement accuracy is largely dependent on correct installation of the transmitter and, if applicable, the associated impulse line(s).

As far as possible, the measuring setup should be free from critical ambient conditions such as large variations in temperature, vibrations, or shocks.

i NOTICE

If unfavorable ambient conditions cannot be avoided for reasons relating to the building structure, measurement technology, or other issues, the measurement quality may be affected.
(See the operating instruction for more details).

If a remote seal with capillary piping is installed on the transmitter, the additional operating instructions for remote seals and the related data sheets must be observed.

13.3.1 Mounting position

The transmitter can be attached directly to a valve manifold provided for flange installation.
In according to IEC 61508, the manifold is not considered in the evaluation of the safety parameters, the SIF designer shall consider separately it according to IEC 61511. A failure on the manifold shall be considered danger undetected if the DCS cannot detect externally it.
For models 266CRx and 266JRx, version with remote seals, mounting brackets must always be used. This is available as accessory.
Ideally, the transmitter must be mounted in such a manner that the separating diaphragms are standing vertical, to avoid later zero point offsets.

i NOTICE

If the transmitters are mounted with an inclination that is not vertical, the filling fluid exerts hydrostatic pressure on the pressure sensor, which causes a zero point offset. In this case, the zero point can be adjusted via the zero point button (arranged under the nameplate).
The Hart communication is not safety related, the Hart protocol is not safety related. Communication via Hart protocol is used only to configure and calibrate the device during maintenance / commissioning phase with the plant put safety. During the configuration, the safety function could not work properly because the write protection is not activated (see chapter "Configuration"). This protocol is also used for diagnostic functions but not for safety-related critical operations. After each configuration made via HART please check that the parameters are well stored in the instrument with the rereading of the parameters modified.

For more information about the mounting dimensions please read the chapter "Mounting" in the operative instruction.

13.4 Connecting impulse lines

In order for the impulse lines to be laid correctly, the following points must be observed:

- The impulse lines must be as short as possible and have no sharp bends
- Lay the impulse lines so that no deposits can accumulate in them. Gradients should not be less than approx. 8 % (ascending or descending)
- The impulse lines should be blown through with compressed air or, better still, flushed through with the medium prior to connection
- With wet legs, the liquid in both lines must be at the same level
- With vaporous measuring media, measures must be taken to prevent steam entering the measuring chambers of the measuring cell and causing overheating
- It may be necessary to use condensate vessels or similar with small measuring spans and vaporous media
- If you are using condensate vessels (steam measurement), you should ensure that the vessels are at the same elevation in the differential pressure piping
- As far as possible, keep both impulse lines at the same temperature
- Completely depressurize the impulse lines if the medium is a liquid
- Lay the impulse lines so that gas bubbles (when measuring liquids) or condensate (when measuring gases) can flow back into the process line
- Ensure that the impulse lines are connected correctly (connection of high-pressure and low-pressure sides to the measuring cell, gaskets, etc.)
- All connections must be secure and tight
- Lay the impulse lines so that the medium cannot be blown out over the measuring cell

For more details please read the operating instruction section “Mounting”.

⚠ WARNING

Bodily injury!

Leaks in the process lines can result in death or severe injuries.

- Install and seal process connections and all accessory elements (including valve blocks) before the charging the device with pressure.
- For applications with toxic or hazardous substances prior to venting or draining, take all precautionary measures that are recommended in the respective safety data sheet.
- Only tighten the screws of the fastening accessories with a size 12 mm (15/32”) inch hexagon socket wrench.

i NOTICE

Impulse lines on the loop are not considered in the safety parameters reported in this document but shall be considered by SIF designer during his analysis in according to IEC 61511.

13.5 Process connections

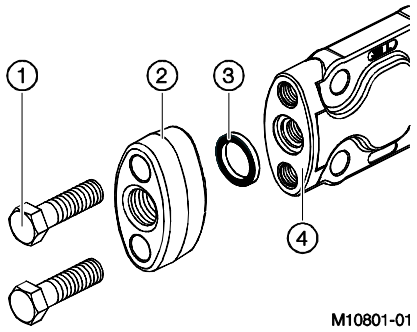

Fig. 5: Process connection
1 Screws 2 Flange adapter 3 O-ring 4 Transmitter connection flange

On the flange of the 266 multivariable transmitter there are 1/4 ... 18 NPT process connections with middle point spacings of 54 mm (2.13 inch). The process connections on the flange enable direct attachment of 3 elements or 5 element valve manifolds.
Optionally flange adapters with 1/2 ... 14 NPT connections are available. By turning one or both adapters, middle point spacing of 51 mm (2.01 inch), 54 mm (2.13 inch) or 57 mm (2.24 inch) is possible.

Mount the adapters as follows:

1. Correctly position the adapters with inserted O-ring.
2. Screw the adapters on the transmitter connection flange with the provided screws.
   Tighten the screws as follows: Preliminary tightening hand tight, preliminary tightening with 10 Nm, final tightening with 50 Nm.

⚠ WARNING

Bodily injury!

Flanges, flanges adapters, manifolds mounted on the instrument are not considered in the safety parameters reported in this document but shall be consider by SIF designer during his analysis in according to IEC 61511. A failure on the flanges or on the flanges adapter shall be considered danger undetected if the DCS cannot detect externally it.

13.6 Orifices and nozzles handled by flow calculation

The following orifices and nozzles are handled by flow calculation:

No	Primary element
1	Nozzle ISA 1932 ISO
2	Nozzle ISA 1932 ASME
3	Orifice Corner Taps ISO
4	Orifice Flange Taps ISO
5	Orifice D&D/2 Taps ISO
6	Orifice Corner Taps ASME
7	Orifice Flange Taps ASME
8	Orifice D&D/2 Taps ASME
9	Orifice Flange Taps AGA3
10	Orifice Corner Taps AGA3
11	Small Bore Orifice, ASME, Flange Taps
12	Small Bore Orifice, ASME, Corner Taps
13	Orifice 2.5D&8D Taps
14	Integral Orifice Assembly
15	Nozzle, Long Radius, High Beta, ISO
16	Nozzle, Long Radius, Low Beta, ISO
17	Nozzle, Long Radius, High Beta, ASME
18	Nozzle, Long Radius, Low Beta, ASME
19	Venturi, Rough Cast Inlet, ISO
20	Venturi, Machined Inlet, ISO
21	Venturi, Welded Inlet, ISO
22	Venturi Nozzle, ISO
23	Venturi, Rough Cast Inlet, ASME
24	Venturi, Machined Inlet, ASME
25	Venturi, Welded Inlet, ASME
26	Venturi Nozzle, ASME
27	Pitot Tube ISO 3966
28	Area Averaging Meter
29	V Cone
30	Wedge Meter
31	Standard Flow Measurement
32	Gilflow

13.7 Temperature measurement

The temperature measurement is made external resistance thermometer by PT100 in the four-wire circuit. Mount the temperature sensor in the downstream pipe of the primary element. Consider the downstream straight pipe requirements. If there is a significant difference between the temperature of the measuring medium and the ambient temperature, the measuring error caused by heat conduction must be minimized by insulating the installation location accordingly. Use the class “A “sensors to maximize accuracy. The lengths of the protective tubes should be 15 ... 20 times the diameter of the protective tube for gas measurement and 5 ... 10 times the diameter of the protective tube for liquid measurement.
The PT100 failure rate is not considered in the safety parameters reported in this document but shall be considered by SIF designer during his analysis.

For PT100 the following failures have been considered, simulating the PT100 with the resistor, during the fault insertion test:

— Break of current path on PT100
— Short circuit PT100
— Break of PT100 or connection lines of the PT100
— Overcoming the physical limits of the PT100, -200 ... 850 °C (-328 ... 1562 °F)

i NOTICE

For simulation purpose, a 178 Ω resistor (206 °C / 402.8 °F) with two jumpers has been installed between the terminals for PT100 connection. This resistor (including the jumpers in case of four-wire connections) must be removed before connecting the PT100. If Pt100 is not connected, the resistor must not be moved.
In the multisensor, when the primary variable is not temperature, the resistor must be left connected to Terminal board, if the PT100 is not available.

13.8 System wiring

The procedures safely to make the device electrical connections are described in the section “electrical connections” and “wiring” inside the operative instruction. For installation in hazardous areas, compliance with the safety information on the safety marking plate shall be ensured. Because the transmitter cannot be switched off, surge protection devices, lightning protection, or grid disconnect possibilities must be provided on the plant side (surge protection, lightning protection optional).
For dimensions and connection of the wires please read chapter 9 of the operating instruction.

SIF designer must check that wiring and electrical connections of 266Cxx / 266Jxx meet the requirements declared on the operative instruction.

i NOTICE

Material damage due to electrostatic discharge!
An open cover does not provide contact protection. Touching conductive parts can damage electronic components (in some cases beyond repair) due to electrostatic discharge. Therefore, do not touch conductive components. The handling of such parts must be done by technical trained staff with ESD protection to permit the discharge of the charges before open the cover. Make sure that the static electricity in your body is discharged when touching electronic components.

13.9 External indicator ABB

The use of the external indicator does not influence the safety function. The external indicator is not part of the safety function and is not evaluated inside the safety parameters reported in table “Error states and alarms” on page 24. In case of the use of the external meter, the metallic link between PWR – and Ext Meter shall be removed and the SIF parameters evaluation shall be re-made.

SIF designer must check that the metallic link is present and connected to “PWR/COMM-“ and “Ext Meter+” if the external meter is not connected.

In case that SIL2 indicator is used the SIF designer must consider it in the safety parameters of the loop.

13.10 Digital output (pulse / limit output)

The 266Cxx / 266Jxx has a digital output circuit integrated into the second front end board. The terminals for this are on the terminal block and are referred to as “DIGITAL OUTPUT +” and “DIGITAL OUTPUT -“.
The digital output can be set as a pulse or limit output switch (transistor output) using the software via Hart protocol.

Parameters for digital output are:

Contact switching capacity	10 … 30 V, maximum 120 mA DC
Low-level output voltage	0 … 2 V
High-level output voltage	Maximum 30 V
Quiescent current	500 µA

The digital output is not safety related part so all components that provide to it are considered as no interfering / no part. SIF designer must not consider it for safety function in the SIF project.

14 Commissioning

14.1 Overall System Functionality

The activities to validate the required safety functionality of the system together with multivariable or multisensor transmitter according to the Safety Requirement Specification are the following:

1. Put the Write protect Mode switch in operative position (write protection activated)
2. Power on the transmitter so that the transmitter performs automatically a self-test that consists of the operations below:

— ROM TEST
— RAM TEST
— Test of the analog output stage and of the feedback A/D converter
— Test of power supply voltage
— Nonvolatile memory test

Prior to switching on the operating voltage check:
— Product identification label to check that code 8 or T is present
— Process connections
— Electrical connection
— Complete filling of the impulse line and measuring chamber of the measuring cell with the measuring medium
— Check that the alarm current is achievable by the instrument
— Check the hardware revision and software revision are declared in this safety manual as “IEC 61508 certified”. Disconnect one line of PT100 and check that the instrument goes into alarm (output current in alarm state)

14.2 Output signal values

In case of multivariable instrument if the applied flow is inside the range defined by order, the output current ranges are between 4 and 20 mA.
In case of multisensor instrument if the applied DP/SP/T is within the values indicated on the rating plate, the output current ranges are between 4 and 20 mA.
The output current limits are in according to the NAMUR 43 (NE43), the overload condition in case that the primary variable selected (flow, differential pressure DP, static pressure SP, temperature T) measures a value out of the range are:
— Lower limit: 3.8 mA (configurable from 3.8 ... 4 mA)
— Upper limit: 20.5 mA (configurable from 20 ... 21 mA)

When the primary variable is out of the limit, a warning message “process” appears on display or it is communicated via Hart to advise the customer.
In case that an internal failure has been detected by diagnostic, the alarm current is set to the following values:
— Lower limit: 3.6 mA (configurable from 3.6 ... 4 mA)
— Upper limit: 21 mA (configurable from 20 ... 23 mA)

A message appears on the display to indicate the type of failure or it is communicated via Hart.
If the customer decides to configure the levels of the saturation or alarm the following limitations are to consider:
— Low alarm level must be less than the low saturation level
— High alarm level must be higher than the high saturation level
— Alarm and saturation levels must be separated by least 0.1 mA

Customer shall verify the saturation / alarm level if the alarm and saturation levels are changed.

NOTICE

After entering all the parameters, check the safety function. The transmitter allows users to simulate a signal current, independent of measured pressure, via the simulation and set simulation current options. These options can be used via asset vision software (with PC) or with the HART handheld terminal.

The SIFs designer must select a SIS logic solver where trip levels must be compatible with the levels declared above or set with the customer level declared.
The safety PLC must be designed to clearly detect errors that result in HI alarms as well as those that result in LO alarm.
The minimum downtime to be considered for SIL logic solver is 200 ms equal to the update time of the current.
The maximum detection time is 5 min (exclude checking on ROM) as declared in the safety specification.

NOTICE

The maximum time to have an error is when the last block of ROM is damaged, the internal diagnostic shall check the whole blocks in the ROM and after 8 h 40 min the failure is detected, and the alarm is in output.

NOTICE

A brief interruption in the power supply results in initialization of the electronics (program restarts).

NOTICE

Please check the safety function and the alarm level to ensures that the power supply of the instrument is appropriate to permit the alarm current for all temperature.

14.3 Zero point correction following installation

Once the transmitter has been installed, it is advisable to check the zero point and correct it if necessary.
The 266Jxx and 266Cxx transmitters only support the correction of the zero point, if the level/flow calculation function has been disabled.

NOTICE

During this operation, the DIP switch SW3 must be switched to position 0.

For more information and procedure about the zero point increase / suppression on pre-calibrated devices please read the operative instruction.
The write protect button must be deactivated (write enable) to permit the zero point correction and after the operation must be re-activated before to put the instrument on line on the safety loop.

NOTICE

The SIF designer must check that the push button below the nameplate on the top of the instrument is in write protect position (write protect enabled) and the icon of the write protection appear on the display if it is present.

15 Configuration

15.1 Factory settings

The transmitter is delivered preconfigured according to the information provided when placing the order.
The calibrated measuring range and the measuring point tag are specified on an additional labeling plate.
If nothing is specified by the customer in this regard, the transmitter will be delivered with a standard configuration, that contains the following parameters (among others).

Parameter	Factory setting
Measuring range start (LRV) (4 mA)	Zero
Measuring range end (URV) (20 mA)	Upper measuring range limit (URL)
Transmission function for the output	Mass flow for 266Cxx Linear for 266Jxx
Damping	0.125 seconds
Safety mode at transmitter failure (alarm)	High alarm (21.8 mA)
Push button write protection	Activated (mandatory for SIL instrument)
Presentation of the optional LCD display	Process value PV (1-place) and bar diagram of the output signal
SIL controls	Enabled (not possible to deactivate from user)
DIP Switch on Communication board	DIP Switch1: 0 DIP Switch2: 0 DIP Switch3: 1 (mandatory for MV) DIP Switch4: 1 DIP Switch5: 0 DIP Switch6: 0 (not used)

Each of the parameters listed here can be easily set via the optional LCD display with the operating menu.

If customer changes parameters above, it is responsibility of the SIF designer to verify that the safety function is still valid for the process.
After configuration change, the new calculation coefficients are provided within 10 s. During this time, no flow calculation is possible.
The default data for Multivariable instrument are defined in ANNEX A.

15.2 Write protection

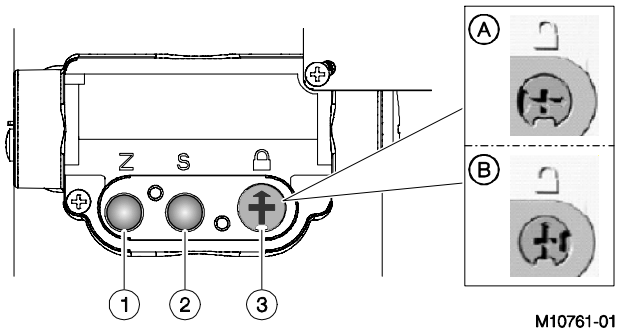

Fig. 6: Operating buttons, write protection turn switch
A Write protection deactivated B Write protection activated
1 Zero 2 Span 3 Write protection switch

The write protection prevents unauthorized users from overwriting the configuration data.

— With activated write protection the operating buttons "0% (Z)" and "100 % (S)" have no function.
— A change of parameters with the integral LCD indicator, via a handheld terminal, or the user interface (DTM) are not possible either.

i NOTICE

The use of handheld terminal or user interface (DTM) is not admitted in the instrument IEC61508 certified. It is admitted only during maintenance or repair operation made from ABB qualified authorized personnel when the safety function is disabled. It is the responsibility of the SIF designer verify that the safety function is still valid after the operation.

However, the configuration data can be read out via the graphic user interface (DTM) or another, similar communication tool certified.
If needed the operating device can also be sealed with a lead seal.
In the certificates instruments, 266Cxx / 266Jxx, the write protection function is activated by an external non-intrusive push button allocated behind the nameplate on the top of the instrument.
The activation of the write protection function can be performed as follows:

1. Remove the nameplate by releasing the holding screw lying on the bottom left corner
2. Use a suitable screwdriver to press the switch all the way down.
3. Turn the switch 90° clockwise.

The transmitter is considered in safety condition (normal operating mode) when the write protect switch placed outside the transmitter housing below the metallic nameplates is in write protect. In that condition, all kind of configurations of the device are disabled and all safety measures are activated.
The SIF designer must check that the write protection on the instrument is always activated before the implementation of the SIF loop.

⚠ WARNING

Noise can disturb the settings.
After any configuration operation, the transmitter must be put in write protect mode. Put the write protection as protect mode ensure that the safety parameter and measured parameters don't change during the operative time.

It is possible to change the write protection mode also via Hart command but in each case, the switch position has the priority on the software command.

15.3 DIP Switch inside CB

If a LCD display is not present to permit the setting of the CB, on the communication board there are 6 DIP switches. The DIP switches 1 and 2 activate the REPLACE MODE for sensor and the secondary electronics (NEW SENSOR 1-1 / NEW ELECTRONIC 1-0). The DIP switch 3 specifies the functions of the external push buttons ("Z" / "S"), zero corrections / span corrections or PV offset (bias) / PV offset (bias) reset. For the 266Cxx transmitters, we recommend leaving DIP switch 3 in position 1 at all times.
DIP switches 4 and 5 are used to select the alarm current (high / low). We recommend leaving the DIP switches 4 and 5 in 0 position (alarm: high current) as factory set parameters.
If the Users wish to modify the alarm current factory-set parameters, must set DIP Switch 4 to position 1.
Consequently, users must select whether the output is to change to the minimum (LO DIP Switch 1) or maximum output current (HI DIP Switch 0). If the DIP Switch 4 is disabled (0 position) the alarm could be set with the HMI or via software, the default value stored is HI alarm.

16 Operation

16.1 Principle of operation

The instrument consists in four main functional units:

— Primary unit (called frontend board)
— Secondary unit (called communication board)
— Temperature unit / DO (called second frontend board)
— Terminal block unit (could be standard, with surge protection: code S2, extended EMC NE21:2004 code:YE)

The pressure transducer connected to the multivariable / multisensor instrument is a piezo resistor sensor technology. This includes the sensor and the frontend electronic.

The secondary unit includes communication board, with the second front end connected to PT100 measure and the terminal board connectors to PT100 connections and power supply connection, and housing with feedthrough capacitors for EMC protection.

The two units are mechanically coupled by a threaded joint and electrically by a flat connection cable. The communication block is coupled with the terminal board through the feedthrough capacitors mounted on the housing.

In the primary unit, the measuring medium (liquid, gas or vapor) exerts pressure on to the sensor via flexible corrosion-resistant isolating diaphragms and capillary tubing containing the fill fluid.

As the sensor detects the pressure changes, it simultaneously produces variations of the primary physical value depending on the piezo resistive technology.

The signal is then converted in the frontend electronics in a digital form and the raw values are computed by a microcontroller to a precise primary output linearization, compensating for the combined effects of sensor non-linearity of static pressure and temperature changes on the basis of “mapped” parameters calculate in the manufacturing process and stored in the memory of the frontend electronic.

Calculations follow independent flows and they are compared in the microcontroller in order to validate the pressure signal. If a difference between the two measurements is detected, the current analog output is driven to a safety condition.

The measured values and the sensor parameters are transferred via a standard digital communication to the secondary unit where the communication board is fitted. The static pressure follows the same flow.

The temperature value is converted by second frontend and the value is given to microcontroller on the communication board, for the mass flow, or level computation in case of multivariable instrument, or to validate the output variable in case of the multisensor instrument.

The values of DP, SP, T, with the values stored in the memory of the communication board that depends on customer setting (viscosity of the flow, type of orifice and so on) are used to mass flow evaluation or level evaluation (multivariable instrument).

The output data value, flow / level for MV and primary variable for MS, is converted into a pulse-width signal (PWM) that is filtered and that activates the 4 ... 20 mA current generation. The bidirectional digital communication using the standard “Hart” protocol is implemented as part of this unit.
Internal diagnostics algorithms are implemented to check correctness and validity of all processing variables and the correct working of the memories.

The output stage is also checked, by reading back the analog output signal the feedback loop is obtained by additional A/D-converter put at the end of the output stage, which translates the 4 ... 20 mA signal into a digital form suitable to be compared by the microcontroller. In case of failure, the output is driven to alarm current and message appears on the LCD or communication via Hart.

The terminal block shall be chosen based on the electromagnetic (EM) environment where the instrument could be inserted, please follow the below suggestion to evaluate the correct terminal block to use:

1. If the EM environment has surge noise the use of the terminal block with surge is mandatory (code: S2)
2. If the EM environment has conducted disturbance from 10 Hz to 150 kHz the terminal block extended EMC (code: YE) is mandatory. The error in this range is 1 % of the URL.

16.2 System Operating Discipline

A plant policy guideline document, containing the specified plant policy guideline for the daily safe operation must be produced and periodically reviewed by representative of the Process control service. It is responsibility of user create the plant policy guideline.

16.3 Preventive and Routine Maintenance

Preventive and routine maintenance activities are defined in the maintenance section of the present manual (chapter “Decommissioning – Maintenance and Repair”) and in the operative instruction.
The routine activities, like the proof tests, are carried out to detect unrevealed faults.

16.4 Function-unit replacement

In case of hardware failure, corrective actions may be carried out by ABB authorized personnel. In case of transmitter replacement, all the operations described in the operating instruction “electrical connections“, “configuration” and “commissioning” and also in this manual shall be conducted.
All maintenance activities shall be documented in the system documentation.
The user, using his incident report document and process, shall report possible safety critical failures.

16.5 Modification Request

Request for modification due to possible safety critical failures and performance deviation shall be reported to the factory and analyzed by a specialist. Modifications shall follow the company modification’s procedures.

16.6 Change Management

All process changes or SIL category shall follow the procedures defined in the safety lifecycle of the system and shall be reviewed and validated by the external competent body for a new functional safety assessment.

16.7 Change Management for process components and roles

Each process component needs to be defined in details according to the requirements and the relevant documentation. Each process components change shall follow the activities defined in the overall safety lifecycle.

16.8 Change management for documentation and training requirements

The change management process shall follow documentation and training requirements defined in the system implementation.

17 Error messages

The error / failure messages are available if the instrument has connected the optional display HMI or if it is used a handheld terminal.
The integral display LCD HMI, connected to 266-communication board, can be used to visualize the process-measured variables as well as to configure the display and transmitter.

NOTICE

In 266Cxx / 266Jxx, IEC 61508 certified the configuration of the instrument via HMI and via handheld terminal is not possible, to avoid this the write protection key is activated.

The diagnostic information is provided to HMI, for more detail about the functionality and use of the keys 1-2-3-4 represented in the Fig. 7 “Display keypad” please read the operating instruction.

Fig. 7: Display keypad

The LCD HMI in case of transmitter errors or malfunctioning can display specific error / fault messages to help the user in identifying the problem and resolve it. In case of alarm, a message consisting of an icon and text appears at the bottom of the process display.

Just after you have unblocked the display with the key sequence (read the operative instruction for this) use the (1) key to call up the information level. Use “Diagnostics” menu to call up the error description. In the error description, the error number is displayed in the second line (Mxxx.xxx). The device status is divided into four groups in accordance with the NAMUR classification scheme. The message text beside this icon in the display provides information about where to look for the error. There are the following areas: Electronics, Sensor, Configuration, Operating and Process.

Symbol	Description
	Error / failure
	Function check
	Outside of the specification
	Maintenance required

The error messages are also divided into the following areas:

Area	Description
Process	Diagnostic messages that refer to the process and display impairments or states.
Sensor	Alarms that indicate problems with the measuring cell.
Electronics	Errors in the device electronics are displayed.
Configuration	Missing or faulty configuration of the transmitter is detected.

17.1 Error states and alarms

Error code	Displayed message	Possible cause	Recommended measure	Transmitter reaction
C042.046	Default Value as Process Value	Substitute value for differential pressure active.	The calculation will be executed with the substitute value for differential pressure.	None
		The last valid value for differential pressure active.	The calculation will be executed with the last valid value for differential pressure.	
		The calculation will be executed with the substitute value for absolute pressure.	The calculation will be executed with the substitute value for absolute pressure.	
		Last valid value for absolute pressure active.	The calculation will be executed with the last valid value for absolute pressure.	
		The calculation will be executed with the substitute value for process temperature.	The calculation will be executed with the substitute value for process temperature.	
		Last valid value for process temperature active.	The calculation will be executed with the last valid value for process temperature.	
		Substitute value for line temperature active.	The calculation will be executed with the substitute value for line temperature.	
		Last valid value for line temperature active.	The calculation will be executed with the last valid value for line temperature.	
C056.047	Wrong Process Condition for Flow	Wrong direction for root calculation.	Check process connections for the flow measurement in one direction.	None
		Wrong aggregate status of the measuring medium.	Check the aggregate status of the measuring medium.	
C088.030	Input Simulation Active	The P-dP-value generated on the output is derived from the value simulated on the input.	Use HART configurator (DTM – handheld terminal) to switch the device back into the normal mode (end input simulation).	None
		The static pressure value generated on the output is derived from the value simulated on the input.		
		The sensor temperature value generated on the output is derived from the value simulated on the input.		
C090.033	Loop Test	The analog outputs and digital /analog outputs for the primary variable are held at the desired value. The device is in fixed current mode (loop test).	Use HART configurator (DTM – handheld terminal) to switch the device back into the normal mode (loop test - end fixed output mode).	None

Error code	Displayed message	Possible cause	Recommended measure	Transmitter reaction
F098.034	Analog Output Saturated	The analog output for the primary variable is on the other side of upper measuring limit and no longer presents the process value. The analog output (4 ... 20 mA) corresponds to the configured upper current limit.	Set current limit, or if possible, work range.	None
		The analog output for the primary variable is on the other side of the lower current limit and no longer represents the process value. The analog value (4 ... 20 mA) corresponds to the lower current limit.		
F099.007	Process Temperature out of Limits	Wrong PT100 connection, line break or deviating process conditions.	Check the Pt100 connections and process conditions.	None
F100.005	Static Pressure Out of Limits	The static pressure of the process exceeds the limits of the measuring cell. An overshoot of the static pressure can reduce accuracy, mechanically damage the membrane, and make a calibration or replacement necessary. A wrong transmitter model may have been selected.	You must check whether the pressure transmitter is suitable for the process conditions. It is likely that a different transmitter type is required.	None
F102.004	P-dP Out Of Limits	The measuring range has not been calculated correctly or the wrong transmitter model has been selected.	You must check whether the pressure transmitter is suitable for the process conditions. It is likely that a different transmitter type is required.	None
F104.032	Pressure Overrange	This effect may have been induced by other devices in the process (valves, etc.). A pressure range overshoot can result in reduced accuracy or mechanical damage of the diaphragm material and can make calibration or replacement necessary.	You must check whether the pressure transmitter is suitable for the process conditions. It is possible that a different transmitter type is required.	None
F106.035	Unreliable Output Current	The D/A converter is not correctly calibrated.	Calibrate the output; if the error persists the electronics module must be replaced.	Analog alarm signal
		Device is not correctly calibrated.	Check device configuration.	
F108.040	Output ReadBack Failure	The output circuit may have been interrupted or not calibrated correctly.	Execute a calibration of the D/A converter. If the error persists, replace the electronics module.	Analog alarm signal

Error code	Displayed message	Possible cause	Recommended measure	Transmitter reaction
F109.003	Process Temperature Sensor Fail	A/D converter error of the temperature sensor.	Check the connection of the temperature electronics. Temperature electronics must be replaced if the problem persists.	Alarm current
		Wire break of wrong Pt100 connection.	Check the Pt100 connections and process conditions.	
		The reference voltage for the temperature measurement is not correct.	The PCB for the temperature measurement should be replaced.	
		The difference between the main channel and the reference measurement is outside of tolerance.		
F110.002	Sensor Temperature Fail	Error in the current circuit for scanning the temperature.	The measuring cell must be replaced.	Analog alarm signal
F112.001	Static Pressure Sensor Fail	Error in the current circuit for scanning the static pressure.	The measuring cell must be replaced.	Analog alarm signal
F114.000	P-dP Sensor Fail	Mechanical damage on the measuring cell. Measuring cell loses filling fluid, diaphragm is torn, sensor damaged.	The measuring cell must be replaced.	Analog alarm signal
F116.023	Electronic Memory Failure	Electronic memory is damaged.	The electronics must be replaced.	Analog alarm signal
F118.017	Sensor Memory Fail	Measuring cell memory damaged.	The measuring cell must be replaced.	Alarm current
F120.016	Sensor Invalid	The measuring cell signal is not updated correctly due to an electronics error, a measuring cell error or a poorly connected measuring cell cable.	Check the cable connection and replace measuring cell if the problem persists.	Analog alarm signal
		The model / the version of the measuring cell is no longer compatible with the connected version of the electronics.	The measuring cell must be replaced.	
M014.037	Configuration Error	See the operating manual for possible cause of the error.	Use HART configurator (DTM – handheld terminal) to correct the configuration.	None
M016.039	PILD-Changed Op. Conditions	The process conditions have changed to such an extent that new settings are required for the PILD algorithm.	New training is required for this new process condition.	None

Error code	Displayed message	Possible cause	Recommended measure	Transmitter reaction
M018.038	PILD Output	Both impulse lines between the measuring cell and the process are either clogged or closed by valves.	Check valves and impulse line. If required, clean the impulse lines and start PILD training.	None
		The impulse line between the pressure measuring cell and the process is either clogged on the high pressure side or closed by valves.		
		The impulse line between the pressure measuring cell and the process is either clogged on the low pressure side or closed by valves.		
		One of the impulse lines between the pressure measuring cell and the process is either clogged or closed by valves.		
M020.042	Replace Info	The electronics or the measuring cell have been replaced, but replacement mode has not been executed.	Execute replacement mode: Place switch SW 1 of the electronics in position 1 = activate replacement mode. With switch SW 2 select whether measuring cell or the electronics have been replaced. Switch device off and on. Return switch SW 1 of the electronics to position 0.	None
		The electronics or the measuring cell has been replaced and replacement mode for a new measuring cell must be executed.	Execute replacement mode: Only the data of the electronics can be copied into the measuring cell. Place switch SW 1 on (1) to activate replacement mode 1 - with switch SW2 select new measuring cell (1). Switch device off and on. Place switch SW 1 on (0) to deactivate replacement mode.	
		The electronics or the measuring cell has been replaced, replacement mode has been activated, but in the wrong direction (SW 2 = 0).	Change replacement direction (if possible). Switch SW 1 is already in position (1), replacement mode is activated. Switch SW 2 to position (1) for “new measuring cell”. Switch device off and on. Place switch SW 1 is position (0) to deactivate replacement mode.	

Error code	Displayed message	Possible cause	Recommended measure	Transmitter reaction
M022.041	Electronic Temperature Out of Limits	The electronics temperature underranges the permissible lower limit value. Error in the current circuit for scanning the temperature.	The electronics should be replaced as soon as possible.	None
		The temperature of the electronics exceeds its upper limit value. Error in the current circuit for scanning the temperature.		
M024.036	Power Supply Warning	The energy supply of the device is close to the lower permissible limit.	Check the voltage on the connection terminal block and for values outside of the valid range check the external energy supply.	None
		The energy supply of the device is close to the permissible high limit.		
M026.024	NV Electronic Memory Burn Error	Writing to non-volatile memory was not successful.	The electronics module should be replaced as soon as possible.	None
M028.018	NV Sensor Memory Burn Error	Writing to non-volatile memory of the measuring cell was not successful.	The measuring cell should be replaced as soon as possible.	None
M030.020	Electronic Interface Error	Data exchange between measuring cell and electronics is faulty.	Switch transmitter off and back on again. Check whether error persists. If yes, replace electronics module as soon as possible.	None
S038.044	Binary Output max Frequency reached	The process works outside of the range.	The setting of the binary output must be compared with the process conditions.	None
S040.045	MV Input Value out of Range	Differential pressure input value outside of the range.	Check the value of the differential pressure.	None
		Static pressure input value outside of the range.	Check the value of the static pressure.	
		Temperature range outside of the range.	Check the value of the temperature.	
S044.043	MV Calculation out of Range	Flow is outside of the range.	Compare the settings of the multivariable configuration with the process conditions.	None
		The volume flow is outside of the range.		
		The heat flow is outside of the range.		
		The calculated fill height is outside of the range.		
		The volume is outside of the range.		
		The mass is outside of the range.		

Error code	Displayed message	Possible cause	Recommended measure	Transmitter reaction
S052.031	Max operating pressure Exceeded	The static pressure of the process increases the maximum permissible operating pressure for the transmitter. Exceeding the maximum operating pressure can entail mechanical damage on the process connections (flanges, pipes, etc.) or cause dangerous situations.	You must check whether the pressure transmitter is suitable for the process conditions.	None
S054.006	Sensor Temperature Out of Limits	The temperature of the process environment influences the pressure transmitter. Excess temperatures can reduce accuracy, impair device components, and make a calibration or replacement necessary.	You must check whether the pressure transmitter is suitable for the process conditions. A different type of installation could be necessary, e.g. use of diaphragm seals.	None

18 Alarm current

As declared in the chapter 14.2 “Output signal values” the alarm current value could be high (HI) or low (LO) in accord to NAMUR 43:

— HIGH alarm: ≥ 21 mA
— LOW alarm: ≤ 3.6 mA

The alarm levels of the transmitter (down-scale or up-scale) can be selected by the user.
During the initialization phase, the current is fixed to 3.5 mA.

i NOTICE

As default, all 266 devices are configured with up-scale alarm. For some faults (e.g. crystal breakdown etc..) the output will latch at 3.6 mA ... 3.5 mA even if the up-scale alarm is selected.

The faults that put the power supply in short circuit drive the current loop at the maximum of current available by the loop. DCS shall support this values and manage the possible change of alarm value from HI to LO.

An oscillation of the alarm is possible if the power supply is not sufficient to ensure the high alarm, in this case to avoid this it is necessary to increase the power supply to the instrument or set the low level (3.6 mA) as alarm.

19 Safety engineering parameters

The 266Cxx / 266Jxx certified IEC 61508 meet SIL2 requirements according to IEC 61508:2010 in low as well as high demand mode of operation. The total PFD in low demand mode for 10 years' proof test interval in the worst case is less than 35 % of the SIL2 range defined in IEC 61508-1.

The values depend on the type of the terminal block connected to the instrument, the different terminal blocks that are represented in the table Tab.1 are:

— Terminal block Hart standard MV
— Terminal block Hart surge MV identify with the digit S2 on the product code
— Terminal block Hart Extended EMC NE21:2004 identify with the digit YE on the product code

The relevant numbers are stated in the table below:

	266Cxx, 266Jxx			266Jxx (range R)		
	TB Hart MV	TB Surge MV (code S2)	TB Ext EMC NE21:2004 MV (code YE)	TB Hart MV	TB Surge MV (code S2)	TB Ext EMC NE21:2004 MV (code YE)
λdd [h-1]	9,58E-07	9,58E-07	9,68E-07	9,65E-07	9,65E-07	9,75E-07
λdu [h-1]	7,77E-08	7,77E-08	7,78E-08	7,86E-08	7,86E-08	7,87E-08
λsd [h-1]	2,30E-07	2,29E-07	2,37E-07	2,30E-07	2,29E-07	2,38E-07
λsu [h-1]	1,36E-07	1,33E-07	1,39E-07	1,36E-07	1,33E-07	1,39E-07
HFT	0	0	0	0	0	0
Architecture	1oo1	1oo1	1oo1	1oo1	1oo1	1oo1
Tmission [years]	10	10	10	10	10	10
PTC [%]	90,00	90,00	90,00	90,00	90,00	90,00
SFF [%]	94,46	94,44	94,53	94,42	94,41	94,50
λtot safety [FIT]	1402	1397	1422	1410	1405	1430
MTBF [year]	81	82	80	81	81	80
MTTR [h]	8	8	8	8	8	8
DC_D [%]	92,50	92,50	92,56	92,47	92,47	92,53
DC_S [%]	62,85	63,26	63,06	62,87	63,27	63,07
PFDavg (PTI=1year)	6,54E-04	6,54E-04	6,55E-04	6,62E-04	6,62E-04	6,63E-04
PFDavg (PTI=10 year)	3,41E-03	3,41E-03	3,41E-03	3,45E-03	3,45E-03	3,46E-03
PFH	7,77E-08	7,77E-08	7,78E-08	7,86E-08	7,86E-08	7,87E-08
Testing time max [s]	60	60	60	60	60	60
ROM check time	8 h 40 m (512 K*60 s, it is checked 1 KB each 60 s)			8 h 40 m (512 K*60 s, it is checked 1 KB each 60 s)		

NOTICE

The safety- related parameters above not consider the failure rate of the PT100, this means that the SIF designer must add the PT100 failure rate to the final evaluation safety parameters of the loop.

The failure rate is valid only for useful lifetime of the instrument. Failure rate increases after expected lifetime has expired. To perform PFD_{avg} calculation, 10-year mission time has been considered. Mission time exceeding instrument lifetime cannot be used for this calculation since the result could be too optimistic.
All safety related parameters are calculated using SN 29500 failure database and considering an average environmental temperature of 40 °C without major temperature cycles. Parameters change if considering a temperature difference of 40 °C. In this case, re-calculation is necessary.

NOTICE

It is possible to connect remote seals to instrument if it is necessary, in this case, the failure rate of the diaphragm seal shall be added to the value reported above. The values represent the worst case and may be slightly different (nearly negligible) depending on the type of diaphragm seal. As a reference, only for ABB remote seals, you may want to consider the below value.

	One diaphragm seal configuration	Two diaphragm seal configuration
λdd [h-1]	0.46E-08	0.92E-08
λdu [h-1]	1.38E-08	2.75E-08
λs [h-1]	0	0

The table above has been evaluated in base of the return of field of the remote seals.

NOTICE

The SIF designer must add the above failures rates to the transmitter ones in case is has been selected a transmitter equipped with one or two diaphragm seals. The above table shows the dangerous failures only because the diaphragm seals system does not generate any safe failure.

It is impossible to detect leaks of the remote seals, therefore all leaks are dangerous undetected failures unless the variables are out of limit imposed on users in order phase.

In order to calculate the Safety Failure Fraction (SFF) and Diagnostic Coverage (DC) of a diaphragm-seal - equipped multivariable or multisensory system please use the following formulas:

$$SFF = \frac{\lambda s + \lambda dd}{\lambda d + \lambda s} \qquad DC = \frac{\lambda dd}{\lambda dd + \lambda du}$$

NOTICE

Values and instructions listed here are valid ONLY for HART digital communication and 4 ... 20 mA IEC 61508 SIL2 certified multivariable / multisensor transmitters (digit “T” or “8” under the “Output” option within product code). Therefore, safety instructions cannot be considered as valid in case the transmitter features PROFIBUS PA (digits P,2), FOUNDATION Fieldbus (digit F, 3), Modbus (code 6, N) communication protocols.
Manifolds and flanges are not considered in the safety evaluation as reported in the chapter 13.3 “Mounting”.

20 Proof Test

The operability of the measuring device must be tested at appropriate time interval, e.g. calibration check (see relevant operating instruction, sections on operation, calibration, maintenance / repair). We recommend that you perform the test at least once a year. The PFD_{avg} parameters are evaluated considering Proof Test Interval (PTI) equal to 1 year and 10 years with a Proof test coverage (PTC) equal to 90 % of the possible DU failures. Users are responsible for selecting the type of check and the intervals within the specified period.

Safe undetected faults could occur during the operation of the transmitters. These failures do not affect the transmitter operations. To maintain the claimed safety integrity level (SIL2) a proof test procedure is requested at max every 10 years.
The proof test for MV / MS can consist of the following operations:

1. Bypass the safety function and take appropriate action to avoid a false trip
2. Switch off the device
3. Assure that the write protection mode switch is in write protection condition
4. Power-on the transmitter so the transmitter can perform automatically a self-test that consist of the operations below:
   - ROM test
   - RAM test
   - Test of the analog output stage and of the feedback A/D converter
   - Test of the power supply voltage
   - Nonvolatile memory test
5. For multivariable instrument code 266Cxx, apply flow value on process for at 3 points of calibration 0 %-50 %-100 % of calibrated range and check the output value. It shall be within the stated accuracy (Typically 0,7 ... 0,9 %). The flow value must be within the accuracy of 4 % of the configured flow range. In case that is not possible to test, it is possible to test the single variables. Disabled the flow calculation through display or via HART with the configurator, set the primary variable (DP, SP, T) with the configurator via HART. Apply pressure for 3 points of calibration points 0 %-50 %-100 % of the calibrated range for DP and also for SP and check the output value. It shall be within the stated accuracy defined for the type of sensor, and if applicable check the calibration of the process temperature reading in the least two points. The value shall be within the stated accuracy ± 0.3 °C.
   Check that the generation of 4 ... 20 mA connected to primary variable is inside the safety accuracy of 4 % of the calibrated range.

   For multisensor instrument code 266Jxx. If the primary variable is set as pressure DP or SP apply pressure for 3 points of calibration points 0 %-50 %-100 % of the calibrated range and check the output value. It shall be within the stated accuracy defined for the type of sensor. If the primary variable is the process temperature, check the calibration of the process temperature reading in the least two points. The value shall be within the stated accuracy ± 0.3 °C.
   Check that the generation of 4 ... 20 mA connected to primary variable is inside the safety accuracy of 2 % of the calibrated range.
6. Send HART command to the transmitter to go to the high alarm current output and verify that the analog current reaches that value, this to detect the eventual voltage problems such as low loop power supply voltage or increasing wiring resistance. Check that the output current is inside the safety accuracy.
7. Send HART command to the transmitter to go to the low alarm current output and verify that the analog current reaches that value. This to detect the eventually quiescent current related failures. Check that the output current is inside the safety accuracy
8. Send HART command to the transmitter to go to 12 mA current output and verify that the analog current reaches that value.
   In case a test would fail, the transmitter will drive the output to the alarm values. In this case, a correction action consists in re-calibration of the AD converter. If a re-calibration is necessary, please disable the write protect mode before this.
   In case the normal functionality will be not re-established, the transmitter shall be considered failed and not possible to use. When you send a defective transmitter or module to the repair department, include information describing the error and explicit that is an instrument certified IEC61508, if it is possible to describe also the cause of failure.
   For more details please read chapter “Decommissioning – Maintenance and Repair”.

21 Decommissioning – Maintenance and Repair

⚠ WARNING

Bodily injury!
The device can be operated at high pressure and with aggressive media. Any medium that squirts out can cause severe injuries.
Depressurize the pipeline/tank before opening the transmitter connection.

NOTICE

Potential damage to parts
The electronic components of the printed circuit board can be damaged by static electricity (observe ESD guidelines).
Make sure that the static electricity in your body is discharged before touching electronic components.

If pressure transmitters are used as intended under normal operating conditions, no maintenance is required.
It suffices if the measuring range start and / or the stop are checked at specific intervals – depending on the operating conditions. If deposits are expected to accumulate in the measuring cell, the measuring cell should be cleaned on a regular basis, in accordance with the operating conditions. Preferably the measuring cell should be cleaned in a workshop.

After repair or substitution of spare parts or instrument please re-check that the safety function works correctly at the correct time.
Repair and maintenance tasks must only be executed by employees of an ABB authorized customer service organization with knowledge about IEC 61508 standard. For replacement and repair of individual components uses original parts for instrument certified IEC 61508.
When ordering spare parts or replacement devices, please always provide the serial number (S / N) as well as the year of manufacture for original device and indicate that it is instrument certified IEC 61508 on the form.

Please contact Customer Center Service acc. to page 2 for nearest service location.

Please check in detail chapter “Maintenance / Repair” in the operating instruction before dismounting the instrument to be sure that the operation will be made in safe conditions.
In case of decommissioning of the instrument, please keep attention that all operations will be made in safe conditions and that the plant will continue to remain in the safe condition when the instrument will be removed.

22 Systematic capability integrity

266Cxx / 266Jxx transmitter firmware has met the requirement for systematic capability equal 3, SC=3.This allows the usage of the instrument in the SIL3 safety loops only in redundant configuration (architecture 1002).
Considering the two instruments 266 MV or 266 MS connected in parallel in redundant mode and considering that it is not possible knowing the design of the SIF on the plant, the common cause factor could be at least ß=5 % and a common cause detected by diagnostic test factor could be at least $ß_D$=2,5 % should be considered in the safety integrity calculation.
It is the responsibility of the Safety Instrumented Function designer to do calculation for the entire SIF.

23 Random integrity

266Cxx / 266Jxx transmitter with IEC 61508:2010 certification is classified as a type B device in according to IEC 61508-2, as reported in the safety parameter tables the hardware fault tolerance (HFT) is 0.
The random integrity for type B device is SIL2 @HFT=0.

24 Rom check time

The most critical component about ROM check time is the ROM inside the microcontroller mounted on the communication board. The ROM memory is checked during startup within 30 s. A block of 1 Kbyte is checked periodically in the worst case every 60 s, so the whole ROM in the worst case is checked in 8 h 40 min.

25 Useful lifetime / Mission time

Based on the reliability data given by the manufacturer of the components that compose the instrument, on the worst data retention time of the microcontroller FLASH, as well as on the in-field experience as stated by section 7.4.9.5 of the IEC61508-2 standard, the useful lifetime to be considered should be 11 years at 40 °C environment temperature.
Useful lifetime decreases of two years for every 10 °C temperature increase. Lifetime is extended by two years for each 10 °C decrease environmental temperature.
If the plant experience indicates a shorter useful lifetime than 11 years, the number based on plant experience shall be used.

Although a constant failure rate (linear part of the bath-tube curve) is assumed by the probabilistic estimation method (see FMEDA results), this rate is applicable only if the useful lifetime of component is not exceeded. Beyond their useful lifetime, the result of the probabilistic calculation method is therefore meaningless as the probability of failure significantly increase with time. The useful lifetime is highly dependent on the components that form the instrument itself and its operating conditions (for example temperature, humidity etc.).
It is responsibility of the end user maintain and operate the 266Cxx or 266Jxx according to manufacturer instructions, therefore periodic inspection should demonstrate that all parts of the instrument are free from damage.
The instrument shall not be operated beyond the useful lifetime declared without undergoing overhaul or replacement or complete checking.
The mission time has been considered equal to 10 years equal to proof test time.

26 Connection to SIS logic solver

The 266Cxx or 266Jxx shall be connected to a logic solver where trip levels must be compatible with the sensor alarm level given in the paragraph “Alarm current” of this manual.
The logic solver shall be programmed to detect the over-scale current and the under-scale currents.
The minimum downtime to be considered is 200 ms equal to the update of the current.
The update cycle of flow / level is ≤ 100 ms and for heat transfer rate ≤ 500 ms.
Considering the single variables, the updated the differential pressure is calculated every max 100 ms, the static pressure is calculated every max 200 ms, the temperature is calculated every max 1000 ms.
The maximum detection time is 5 min (excluded ROM parts) as declared in the safety specifications.

i NOTICE

The maximum (worst case) detection time including FLASH ROM failures is 8 h 40 min.

27 Release history of 266 hardware and software

27.1 266Cxx / 266Jxx (excluded range R) software revision history

27.1.1 Communication board

Revision		Description	Release date
From	To		
	142.1.1	First revision for MV instrument	02/2012
142.1.1	142.1.3	Bug fixing: — Totalizer task delay modification. New features: — Change in process temperature diagnosis handling, for commissioning or maintenance purpose in case that PT100 is disconnected and there is flow as primary variable the current output alarm is not set but Namur icon “Device Malfunction” appears on the LCD and via HART.	03/2015
03142.1.3	142.1.4	Bug fixing: — Change in Reynolds number Calculation to avoid in some particular condition that output freeze to zero.	04/2015
142.1.4	142.1.4 (5)	Bug fixing: — Validation of “MV Easy Setup” menu on the HMI in case of review by user. — Damping entry enabled into standard “Easy Setup” menu on the HMI.	02/2016
142.1.4 (5)	142.1.5*	Bug fixing: — Process temperature diagnosis handling, in case of failure on the PT100 or disconnection of this the current is driven in alarm state and the Namur icon “Device Malfunction” still appears.	06/2016 Certified from: 05/2017

* IEC 61508 certified release from 05/2017

27.1.2 Front-end board

The software history is same of the software history for 266-pressure transmitter Mxx, Rxx, but the software release is not certified for MV instrument.

Revision		Description	Release date
From	To		
	1.1.0	First revision on MV instrument	12/2011
1.1.0	1.2.2*	— Start-up sequence modifications — Improvements functional performance	10/2013
1.2.2*	1.2.3*	— Improvement start-up sequence modification	Certified for MV from 05/2017

* IEC 61508 certified release from 05/2017

27.2 266Cxx / 266Jxx hardware revision (excluded range R) history

27.2.1 Communication board

Revision		Description	Release date
From	To		
	1.0.0	First revision on MV	12/2011
1.0.0	1.0.1*	— Change the SFE board	02/2013 Certified from 05/2017

* IEC 61508 certified release from 05/2017

27.2.2 Front-end board

The hardware history is same of the hardware history for 266-pressure transmitter Mxx, Rxx, but the hardware release was not certified for MV instrument.

Revision		Description	Release date
From	To		
	1.0.7	Initial release	12/2011
1.0.7	1.0.8	— Improvement for start-up circuit with low temperature (-50 °C)	04/2014
1.0.8	1.0.9*	— Improvement for start-up with low temperature (-50 °C)	03/2014 Certified from 05/2017

* IEC 61508 certified release from 05/2017

27.3 266Jxx (range R) software revision history

27.3.1 Communication board

Revision		Description	Release date
From	To		
	142.1.1	First revision	02/2012
142.1.1	142.1.3	Bug fixing: — Totalizer task delay modification. New features: — Change in process temperature diagnosis handling, for commissioning or maintenance purpose in case that PT100 is disconnected and there is flow as primary variable the current output alarm is not set but Namur icon “Device Malfunction” appears on the LCD and via HART.	03/2015
03142.1.3	142.1.4	Bug fixing: — Change in Reynolds number Calculation to avoid in some particular condition that output freeze to zero.	04/2015
142.1.4	142.1.4 (5)	Bug fixing: — Validation of “MV Easy Setup” menu on the HMI in case of review by user. — Damping entry enabled into standard “Easy Setup” menu on the HMI.	02/2016
142.1.4 (5)	142.1.5*	Bug fixing: — Process temperature diagnosis handling, in case of failure of the PT100 or disconnection of this the current is driven in alarm state and the Namur icon “Device Malfunction” still appears.	06/2016 Certified from: 05/2017

* IEC 61508 certified release from 05/2017

27.3.2 Front-end board

The software history is same of the software history for 266-pressure transmitter Mxx, Rxx, but the software release is not certified for MV instrument.

Revision		Description	Release date
From	To		
	1.1.0	First revision for MV	12/2011
1.1.0	1.2.2*	— Start-up sequence modifications — Improvements functional performance	10/2013
1.2.2*	1.2.3*	— Improvement start-up sequence modification	Certified for MV from 05/2017

* IEC 61508 certified release from 05/2017

27.4 266Jxx (range R) hardware revision history

27.4.1 Communication board

Revision		Description	Release date
From	To		
	1.0.0	First revision on MV	12/2011
1.0.0	1.0.1*	— Change the SFE board	02/2013 Certified from 05/2017

* IEC 61508 certified release from 05/2017

27.4.2 Front-end board

The hardware history is the same of the hardware history for 266-pressure transmitter Mxx, Rxx, but the hardware release was not certified for MV instrument.

Revision		Description	Release date
From	To		
	1.0.6	Initial release	12/2011
1.0.6	1.0.7	— Improvement for start-up circuit with low temperature (-50 °C)	04/2014
1.0.7	1.0.8*	— Improvement for start-up with low temperature (-50 °C)	03/2015 Certified from 05/2017

* IEC 61508 certified release from 05/2017

28 Revision history

Revision	Changes	Release data
0	First release	05/2017

29 Appendix

The default configuration data stored inside the multivariable/multisensor instrument are:

29.1 Global process data

Data	Unit	Default	Description
typeSel	-	Calculation disabled	Selection of “Calculation disabled” or “Calculation enabled”. It’s a factory parameter.
calcMode	-	No calculation	Mode select: “No calculation”, “Flow” or “Level”.
medium	-	Water	Type of Medium
viscosity	-	Disabled	Enable / Disable viscosity calculation
dpr	Pressure	100.0 mbar	Differential pressure at base conditions
Pr	Pressure	1.0 bar	Static pressure at upstream pressure tap at base conditions
tr	Temperature	1.0 °C	Temperature at base conditions
qmr	Mass flow or Volume flow	1.0 kg/s	Mass flow (Standard volume flow at medium “Gas”), 100 % value at base conditions
KQCL	%	100.0	Percent of the maximum flow at base condition
ΔpMin	Pressure	0.0 mbar	Minimum difference pressure of the media
ΔpMax	Pressure	100.0 mbar	Maximum difference pressure of the media
pMin	Pressure	0.0 bar	Minimum static pressure of the media
pMax	Pressure	1.0 bar	Maximum static pressure of the media
tMax	Temperature	1.0 °C	Maximum temperature of the media
tMin	Temperature	0.0 °C	Minimum temperature of the media
qmMax	Mass flow or Volume flow	1.0 kg/s	Maximum mass flow (Standard volume flow at medium “Gas”)
qmMin	Mass flow or Volume flow	0.0 kg/s	Minimum mass flow (Standard volume flow at medium “Gas”)
qvMax	Volume flow	1.0 m^3/s	Maximum volume flow
qvMin	Volume flow	0.0 m^3/s	Minimum volume flow
ΔpSubst	Pressure	0.0 mbar	Differential pressure substitute value
pSubst	Pressure	0.0 bar	Static pressure substitute value
tSubst	Temperature	0.0 °C	Temperature substitute value
ΔpSubstSel	-	use last useful value	Differential pressure substitute value selection (use always, use if difference pressure invalid, use last useful value).
pSubstSel	-	use last useful value	Static pressure substitute value selection (use always, use if static pressure invalid, use last useful value).
tSubstSel	-	use last useful value	Temperature substitute value selection (use always, use if temperature invalid, use last useful value).
tSel	-	External temperature	Temperature value selection (sensor temperature, external temperature)
qmSel	-	Mass flow	Mass flow / Standard volume flow selection (only if medium = “Gas”)
kapa	-	1.0	Isentropic exponent at base conditions (input for medium “Gas”, output for media “Saturated Steam” and “Heated Steam”)
rhoR	Density	1.0 kg/m^3	Density of the flowing fluid at base conditions
selLinTable	-	Disabled	Enable / Disable linearization table
linTableX(0 to 21)	%	0.0 ... 100.0	Linearization table % input values
linTableY(0 to 21)	%	0.0 ... 100.0	Linearization table % output values

29.2 Primary element / Tube data

Data	Unit	Default	Description
primaryElement	-	Standard Flow Measurement	Type of primary element
primaryElementMaterial	-	Code 0	Primary element material
$D_{PrimElement}$	Length	1.0 mm	Primary element diameter at 20 °C = beta * D_{Tube}
tubeMaterial	-	Code 0	Tube material
D_{Tube}	Length	1.0 mm	Tube diameter at 20 °C
beta	-	1.0	Diameter ratio,
ReDr	-	10000	Tube Reynolds number at base condition
K_{ExpAvM}	-	0.0	K for expansion factor at area averaging meter
$K_{IntgrOrif}$	-	1.0	Flow coefficient for Integral Orifice Assembly, Pitot Tube, Area Averaging Meter (always 1.0 !!!)
Cf	-	1.0	Discharge coefficient V-Cone (always 1.0 !!!)
$a_{ThermExp}$, $b_{ThermExp}$	1/°C, $1/°C^2$	0.0	Customer material thermal expansion coefficients.

29.3 Input data for medium “Liquid”

Data	Unit	Default	Description
liquidSel	-	User configured	Fluid selection from liquid data sets (User configured, ...)
liquid(0 to 31)	-	Spaces	Name of the liquid.
t_{RhoLiq}(0 to 5)	Temperature	0.0 ... 1.0 °C	Temperature values of liquid density table
rhoLiq(0 to 5)	Density	1.0 kg/m3	Density values of liquid density table
selLiqVisCalc	-	Tamman	Selection of liquid viscosity calculation (Tamman-Vogel- Fulcher or AiChE or Table)
viscLiq(0 to 4)	-	1.0 Pa * s	Constants of viscosity calculation (Tamman-Vogel- Fulcher or AiChE)

29.4 Input data for medium “Gas”

Data	Unit	Default	Description
gasSel	-	User configured	Gas selection from gas data sets (User configured, …)
gasName(0 to 31)	-	Spaces	Name of the gas
selGasVisCalc	-	Natural Gas	Selection of gas viscosity calculation (Natural Gas, AiChe, Table)
t_{GasVis}(0 to 2)	Temperature	0.0 ... 1.0 °C	Temperature values of gas / liquid viscosity table
viscGas(0 to 2)	Viscosity	1.0 Pa * s	Viscosity values of viscosity table
viscGasAiChE(0 to 3)	-	1.0	Constants of viscosity calculation AiChE
A_{kapa}, B_{kapa}, C_{kapa}, D_{kapa}, E_{kapa}		1.0	Gas isentropic exponent constants from AIChE/DIPPR 801 Physical Property Database
rhoNorm	-	1.0 kg/m^3	Gas density at standard condition
selGasDensCalc	Density	None compression factor	Selection of gas density calc. (3x3 Matrix, 4x3 Matrix, 9x7 Matrix, AGA8-92DC, GERG88, None compressibility factor)
pGas(0 to 8)	-	0.0 ... 1.0 bar	Pressure values of gas table
tGas(0 to 6)	Pressure	0.0 ... 1.0 °C	Temperature values of gas table
zGas(0 to 62)	Temperature	1.0	Compressibility factors of gas table
H_s	Density	20 MJ/m^3	Calorific value for GERG88 calc.
d_{rel}	Calorific value	0.55	Relative density for GERG88 calc.
$t1t2_{GERG}$	-	0.0 °C	Reference temperatures for GERG88 calculation (t1 = 25 °C, t2 = 0 °C; t1 = t2 = 0 °C; t1 = t2 = 15 °C; t1 = t2 = 60 °F)
$x_1 – x_{21}$	-	x_1 = 100.0, x_n = 0.0	Component mole fractions x_i for AGA8-92DC calculation I = 1 Methane I = 2 Nitrogen I = 3 Carbon dioxide (also for GERG88 = XCO2) I = 4 Ethane I = 5 Propane I = 6 Water I = 7 Hydrogen sulfide I = 8 Hydrogen (also for GERG88 = XH2) I = 9 Carbon monoxide I = 10 Oxygen I = 11 Isobutane I = 12 *n*-Butane I = 13 Isopentane I = 14 *n*-Pentane I = 15 *n*-Hexane I = 16 *n*-Heptane I = 17 *n*-Octane I = 18 *n*-Nonane I = 19 *n*-Decane I = 20 Helium I = 21 Argone

29.5 Input data for heat transfer rate calculation

Data	Unit	Default	Description
tC (0 to 4)	Temperature	0.0 ... 1.0 °C	Temperature values of specific heat capacity table
C (0 to 4)	Specific heat capacity	1.0 KJ/ (Kg * K)	Heat transfer rate values of specific heat capacity table
enableHeatTrfer	-	Disable	Enable of heat transfer rate calculation

29.6 Input data for Level / Volume / mass calculation

Data	Unit	Default	Description
selTransmConn	-	Open Tank	Selection of level calculation (Open tank, Closed tank or Steam drum level)
topTankMedium	-	None	Type of medium above the tank fluid (None, Water, Saturated Steam, Heated Steam, Gas)
prTopTank	Pressure	1.0 bar	(medium for tank fluid, see chapter “Global process data”)
trTopTank	Temperature	1.0 °C	Static pressure at top of tank at base conditions (only needed for GAS)
rhoRTopTank	Density	1.0 kg/m^3	Temperature at top of tank at base conditions (only needed for GAS)
legTempSubst	Temperature	0.0 °C	Density of top tank medium at base conditions (only needed for GAS)
legTempSubstSel	-	use last useful value	Dry / Wet leg temperature substitute value (tSubst for tank temperature, see chapter “Global process data”)
selLegTemp	-	Sensor-temperature	Dry / Wet leg temperature substitute value selection (use always, use if temperature invalid, use last useful value) (tSubstSel for tank temperature, see chapter “Global process data”)
levelOffset	Level	0.0	Dry / Wet leg temperature value selection (Sensor temperature, External temperature), (tSel for tank temperature, see chapter “Global process data”)
topLegH	Level	0.0	Offset value of level (Correction of transmitter mounting)
mountingPos	Level	0.0	Height from lower tank connection to top tank connection
volumeTransFunc	-	linear	Height from transmitter mounting position to lower tank connection.
levelEntry (0 to 21)	Level	0.0	Transfer function selection from level to volume (linear, Tank volume table, Cylindrical table, Spherical table)
volume (0 to 21)	Volume	0.0	Level values of tank volume table
levelMin	Level	0.0	Volume values of tank volume table
levelMax	Level	1.0	Minimum level of the fluid
volumeMin	Volume	0.0	Maximum level of the fluid
volumeMax	Volume	1.0	Minimum volume of the fluid
massMin	Mass	0.0	Maximum volume of the fluid
massMax	Mass	1.0	Minimum mass of the fluid

Notes

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