MX8030 – MX2030 – 10000*(7200)**

Proximity Probes

MX8031 – MX2031 – 7200**

Extension Cables

SAFETY MANUAL

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1. PURPOSE

The purpose of this safety manual is to document all the information specifically related to the safety aspect of the Metrix MX8030 – MX2030 – 10000*(2700)** Proximity Probes and its relative Extension Cables MX8031 – MX2031 – 7200**. These devices are certified for use as components in a functional safety system. This safety manual is then required in order to enable the integration of the devices into a safety related system with the objective to be in compliance with the requirements of the IEC 61508-2 Annex D.

The information contained in this Safety Manual are valid for the models indicated in paragraph 6.

When the Proximity Probe is included in a Safety Instrumented Function, the integrator shall evaluate the performance of the device into the SIF loop, in order to ensure its proper implementation.

The instructions and information contained in this manual are valid only for the Proximity Probe and Extension Cables, in case of integration in a Safety Instrumented System, the Logic Solver and Final Element information will be provided by the specifics safety manuals.

1.1. DISCLAIMER AND WARNING

By using this product, you hereby signify that you have read this disclaimer and warning carefully and that you understand and agree to abide by the terms and conditions herein. Integrating this device into a safety instrumented system, you agree that you are solely responsible for your own conduct while using this product, and for any consequences thereof. You agree to use this product only for purposes that are proper and in accordance with all applicable laws, rules, and regulations, and all terms, safety prescriptions and precautions, practices, policies and all additional revisions or guidelines that METRIX has made and may make available.

2. SYMBOLS USED IN THIS MANUAL

This manual contains some symbols that are used to focus the user's attention on safety-related aspects. The following symbols are used:

WARNING!

This symbol identifies instructions that must be respected in order to avoid damages to things or to the personnel involved during the use of the SIS.

CAUTION

This symbol identifies instructions that must be followed to avoid malfunctioning of the SIS.

IMPORTANT

This symbol identifies important information that are necessary to understand the meaning of an operation or an activity.

WARNING!

Read the safety manual to become familiar with the features of this product before operating. Failure to operate the product correctly can result in damage to the product, personal property, and cause serious injury. This is a sophisticated safety-related product. It must be operated with caution and common sense and requires some basic mechanical ability. Failure to operate this product in a safe and responsible manner could result in injury or damage to the product, compromise the overall safety of the equipment under control or other property. This product is not intended for use by not functional safety qualified and properly trained personnel. Do not use with incompatible components or alter this product in any way outside of the documents provided by METRIX Instruments Co.

3. REQUIRED SKILLS AND QUALIFICATIONS

This manual is addressed to qualified personnel authorized for installation, operation and maintenance of Metrix MX8030 – MX2030 – 10000*(2700)** Proximity Probes. As required by the IEC 61508-1 the appropriateness of competence shall be considered taking into account all relevant factors including safety engineering knowledge appropriate to the technology, knowledge of safety regulatory framework and previous experience.

IMPORTANT

In case of unqualified interventions, or if the advice of this manual is neglected, causing disturbances of safety functions, personal injuries, property or environmental damages may occur for which Metrix Instrument Co. cannot take liability.

4.   TERMS, DEFINITIONS AND ABBREVIATIONS

4.1. TERMS AND DEFINITIONS

Architecture

Arrangement of hardware and/or software elements in a system.

Architectural constraint

This reports the maximum SIL achievable based on the SIF's subsystems architecture alone. This is calculated solely on the basis of Type A or Type B device selection, redundancy (hardware fault tolerance), and the safe failure fraction (calculated or conservatively assumed if no data is provided). It does not pertain to Systematic Capability or certification. This is calculated as indicated, using respective IEC 61508 or IEC 61511 tables.

Architectural Type

-         Type A equipment or (sub)system: "Non –complex" (sub)system or equipment according 7.4.3.1.2 of IEC 61508-2;

-         Type B equipment or (sub)system: "Complex" (sub)system or equipment according 7.4.3.1.3 of IEC 61508-2.

Diagnostic Coverage

Fraction of dangerous failures rates detected by diagnostics. Diagnostics coverage does not include any faults detected by proof tests.

Mean Repair Time

Expected overall repair time

Mean Time to Restoration

Expected time to achieve restoration.

Mode of operation

Way in which a SIF operates which may be either low demand mode, high demand mode or continuous mode:

•   Low Demand Mode: mode of operation where the SIF is only performed on demand, in order to transfer the process into a specified safe state, and where the frequency of demands is no greater than one per year;

•   High Demand Mode: mode of operation where the SIF, is only performed on demand, in order to transfer the process into a specified safe state, and where the frequency of demands is greater than one per year;

•   Continuous Mode: where the mode of operation where the SIF retains the process in a safe state as part of normal operation.

MooN

SIS, or part thereof, made up of "N" independent channels, which are so connected, that "M" channels are sufficient to perform the SIF.

Hardware Fault Tolerance

A hardware Fault Tolerance of N means that N+1 is the minimum number of faults that could cause a loss of the safety function. In determining the hardware fault tolerance no account shall be taken of other measures that may control the effects of faults such as diagnostics.

Probability of dangerous Failure on demand PFD

Average probability of dangerous failure on demand.

Probability of dangerous Failure per Hour PFH

Average probability of dangerous failure within 1 h.

Proof Test

Periodic test performed to detect dangerous hidden faults in a SIS so that, if necessary, a repair can restore the system to an "as new" condition or a close as practical to this condition.

Safe Failure Fraction

Property of a safety related element that is defined by the ratio of the average failure rates of safe plus dangerous detected failures and safe plus dangerous failures.

Safety instrumented function (SIF)

Safety Function to be implemented by a safety instrumented system (SIS)

Safety instrumented system (SIS)

Instrument system used to implement one or more SIFs.

Safety Integrity

Ability of the SIS to perform the required SIF as and when required.

Safety Integrity Level (SIL)

Discrete level (one out of four) allocated to the SIF for specifying the safety integrity requirements to be achieved by the SIS.

Safe State

State of process when safety is achieved.

Systematic Capability

Measure (expressed on a scale of SC 1 to SC 4) of the confidence that the systematic safety integrity of a device meets the requirements of the specified SIL, in respect of the specified safety function, when the device is applied in accordance with the instructions specified in the device safety manual.

λ

Failure rate (per hour) of a channel in a subsystem.

λ_D

Dangerous failure rate (per hour) of a channel in a subsystem.

λ_S

Safety failure rate (per hour) of a channel in a subsystem.

λ_{DU}

Dangerous undetected failure rate (per hour) of a channel in a subsystem.

λ_{DD}

Dangerous detected failure rate (per hour) of a channel in a subsystem.

functional safety

part of the overall safety relating to the EUC and the EUC control system that depends on the correct functioning of the E/E/PE safety-related systems and other risk reduction measures

safe state

state of the EUC when safety is achieved

4.2. ACRONYMS AND ABBREVIATIONS

BPCS	Basic Process Control System
DC	Diagnostic Coverage
E/E/PE	Electrical / Electronic / Programmable Electronic
EUC	Equipment Under Control
FIT	Failure In Time
HFT	Hardware Fault Tolerance
IEC	International Electro-Technical Commission
MRT	Mean Repair Time
MTTR	Mean Time to Restoration
PFD	Probability of Failure on Demand
PLC	Programmable Logic Controller
PTC	Proof Test Coverage
SC	Systematic Capability
SFF	Safe Failure Fraction
SIL	Safety Integrity Level
SIS	Safety Instrumented System

5.   REFERENCE DOCUMENTS AND STANDARDS

The following table shows the Standards useful for the Safety Manual realization:

Doc ID	Standard Code	Standard title
[D1].	IEC 61508-1:2011-02	Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 1: General requirements
[D2].	IEC 61508-2:2011-02	Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems
[D3].	IEC 61508-4:2011-02	Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 4: Definitions and abbreviations
[D4].	IEC 61508-5:2011-02	Functional safety of electrical/electronic/programmable electronic safety related systems - Part 5: Examples of methods for the determination of safety integrity levels
[D5].	IEC 61508-6:2011-02	Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 6: Guidelines on the application of IEC 61508-2 and IEC 61508-3
[D6].	IEC 61508-7:2011-02	Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 7: Overview of techniques and measures

The following table shows the documents useful for the Safety Manual realization:

Doc ID	Project Document Name	Document Code	Version
[D7].	Datasheet	Doc# 1507096	November 2018-Rev E
[D8].	Datasheet	Doc# 1115343	August 2018-Rev D
[D9].	Datasheet	Doc# 1009553	October 2015-Rev F
[D10].	Datasheet	Doc# 1507097	Feb2017-Rev C
[D11].	Datasheet	Doc# 1475352	December 2015-Rev A
[D12].	Installation Manual	Doc# 100545	May 2016-Rev C
[D13].	SIL Certificate	MTXI-10000-ENS-E01	-
[D14].	Safety Assessment Report	22-MTX-10000-FSA-01	16 February 2022 – Rev 0

6. PRODUCTS INTRODUCTION

The Metrix MX8030 – MX2030 – 10000*(2700)** probe series consist of inductive proximity probes that can be used in conjunction with extension cables MX8031 – MX2031 – 7200** to measure the vibration levels, gap distances, or rotational speed of machinery shafts. Their operating principle is based on eddy currents: the AC current flowing through the coil induces an electromagnetic field that is altered by the presence of a metallic object (target) in the operating area. The output voltage signal is proportional to the Target distance and speed. Inductive Proximity Probes operate with high rates, provide a fast response and do not required physical contact with the object to be detected, thus avoiding wear.

The MX8030 probe series consist of 8mm tip diameter probes with VibeLock^{TM}* connectors and Triaxial Cables. The probes offer a full 80 mil (2mm) range and are fully interchangeable with Bently Nevada** (BN) 3300 and 3300 XL 8mm probes.

The Metrix* MX2030 probe series consist of 5mm and 8mm tip diameter probes. Both probes offer a full 80 mil (2mm) range and are fully interchangeable with Bently Nevada** (BN) 3300 and 3300 XL 5mm/8mm probes.

Metrix* 10000 Series probes are interchangeable with the probes in the Bently Nevada** 7200 series rack monitors. Although the 7200 series rack monitors are obsolete, the 7200 series proximity probe transducers are still on many machines in a variety of industries. Proximity probes, cables and drivers or transmitters are combined within a unique series and not mixed with other series. The lengths of the proximity probes and extension cables must combine for a system length of 5 or 9 meters.

The proximity probes can be used in conjunction with extension cables MX8031 – MX2031 – 7200**.

Metrix* MX8031 extension cables are available with and without protective armor and feature VibeLock^{TM}* and Triaxial Cables. They are compatible with all Metrix* MX8030 series 5mm & 8mm probe systems, and Bently Nevada** (BN) 3300 / 3300XL 5mm & 8mm probe systems. They can be used in refineries, petrochemical plants, natural gas transmission, natural gas processing, power generation plants or any oil & gas application.

Metrix* MX2031 extension cables are available with and without protective armor. They are compatible with all Metrix MX2030 series 5mm & 8mm probe systems, and Bently Nevada** (BN) 3300 / 3300XL 5mm & 8mm probe systems.

6.1. PRODUCTS FAMILY IDENTIFICATION

This Safety Manual is valid for each product listed in this paragraph.

6.1.1. PROBES

In the following table are listed the family models for the Proximity Probes MX8030.

MX8030-AA-BBB-CCC-DD-EE (5mm/8mm Proximity Probe with VibeLock™*)								
MX8030 - AA					BBB	CCC	DD	EE
AA	Armor	Mount	Tip Diameter	Case Threads	Unthreaded Length	Case Length	Total Length	Agency Approval
01	No	FWD	8mm	3/8"-24	BBB = BB.B" Order in increments of 0.1" Min: 000 = 00.0" Max: case length minus 0.8" Example: 024 = 2.4"	CCC = CC.C" Order in increments of 0.1" Min: 008 = 0.8" Max: 096 = 9.6" Example: 032 = 3.2"	05 = 0.5 m 10 = 1.0 m 15 = 1.5 m 20 = 2.0 m 50 = 5.0 m 90 = 9.0 m	00 = None 05 = CSA, ATEX, IECEx, EAC, KOSHA
02	Yes	FWD	8mm	3/8"-24				
03	No	FWD	8mm	M10x1	BBB = BBB mm Order in increments of 10mm Min: 000 = 00mm Max: case length minus 20mm Example: 070 = 70mm	CCC = CCC mm Order in increments of 10mm Min: 020 = 20mm Max: 250= 250mm Example: 090 = 90mm		
04	Yes	FWD	8mm	M10x1				
05	No	REV	8mm	3/8"-24	002 = 0.2" ONLY	012 = 1.2" ONLY		
06	No	REV	8mm	M10x1	005 = 5 mm ONLY	030 = 30 mm ONLY		

NOTE: All Metrix* MX8030 series probes and extension cables are part of the 10000 series part number designation for agency approvals. The 10000 series p/n will appear on the product's label along with the MX8030 p/n. e.g. MX8030-AA-BBB-CCC-DD-EE = 103AA-BBB-CCC-DD-EE.
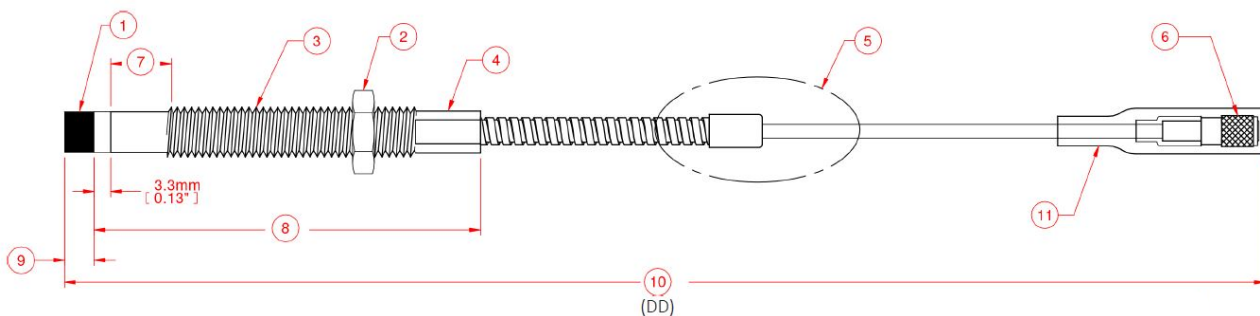

Figure 1: MX8030 Forward-Mount Probe

Notes:

1. Probe tip
2. Locknut
3. Case threads
4. Wrench flats
5. 750Ω triaxial cable with ETFE jacket
6. VibeLock™ coaxial connector
7. Unthreaded length
8. Case length
9. 6.0mm max
10. Total length
11. Fluorosilicone connector insulator boot.

Figure 2: MX8030 Reverse-Mount Probe

Notes:

1. Probe tip
2. 7/16" hexagonal
3. Case threads
4. 750Ω triaxial cable with ETFE jacket
5. VibeLock™ coaxial connector

6. Unthreaded length
7. Case length
8. 6.0mm max
9. Total length
10. Fluorosilicone connector insulator boot.

In the following table are listed the family models for the Proximity Probes MX2030.

MX2030-AA-BBB-CCC-DD-EE (5mm/8mm Proximity Probe)								
MX2030 - AA					BBB	CCC	DD	EE
AA	Armor	Mount	Tip Diameter	Case Threads	Unthreaded Length	Case Length	Total Length	Agency Approval
01	No	FWD	8mm	3/8"-24	BBB = BB.B" Order in increments of 0.1" Min: 000 = 00.0" Max: case length minus 0.8" Example: 024 = 2.4"	CCC = CC.C" Order in increments of 0.1" Min: 008 = 0.8" Max: 096 = 9.6" Example: 032 = 3.2"	05 = 0.5m 10 = 1.0m 15 = 1.5m 20 = 2.0m 50 = 5.0m 90 = 9.0m	00 = None 05 = CSA, ATEX, IECEx
02	Yes	FWD	8mm	3/8"-24				
71	No	FWD	5mm	1/4"-28				
72	Yes	FWD	5mm	1/4"-28				
03	No	FWD	8mm	M10x1	BBB = BBB mm Order in increments of 10mm Min: 000 = 00mm Max: case length minus 20mm Example: 070 = 70mm	CCC = CCC mm Order in increments of 10mm Min: 020 = 20mm Max: 250= 250mm Example: 090 = 90mm		
04	Yes	FWD	8mm	M10x1				
73	No	FWD	5mm	M8x1				
74	Yes	FWD	5mm	M8x1				
05	No	REV	8mm	3/8"-24	002 = 0.2" ONLY	012 = 1.2" ONLY		
06	No	REV	8mm	M10x1	005 = 5mm ONLY	030 = 30mm ONLY		

NOTE: All Metrix* MX2030 extension cables are part of the 10000 series part number designation for agency approvals. The 10000 series p/n will appear on the product's label along with the MX2030 p/n. e.g. MX2030-AA-BBB-CCC-DD-EE = 102AA-BBB-CCC-DD-EE
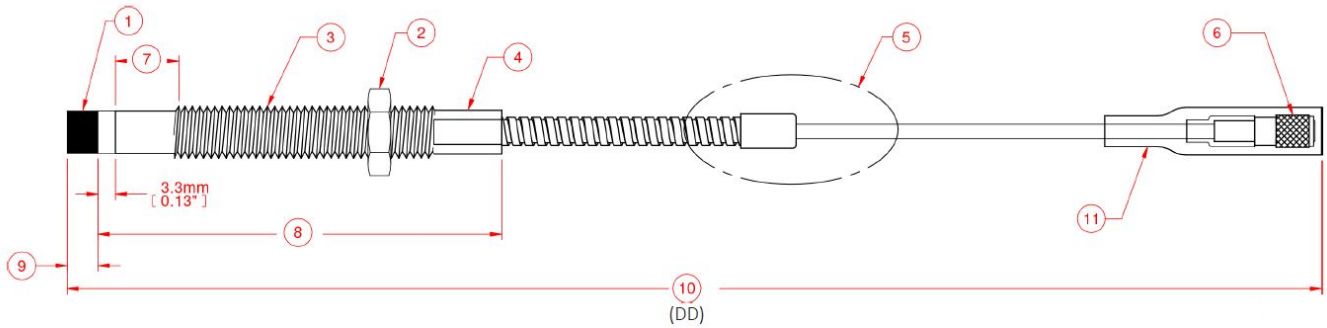
Figure 3: MX2030 Forward-Mount Probe

Notes:

1. Probe tip
2. Locknut
3. Case threads
4. Wrench flats
5. 750Ω triaxial cable with ETFE jacket
6. VibeLock™ coaxial connector
7. Unthreaded length
8. Case length
9. 6.0mm max
10. Total length
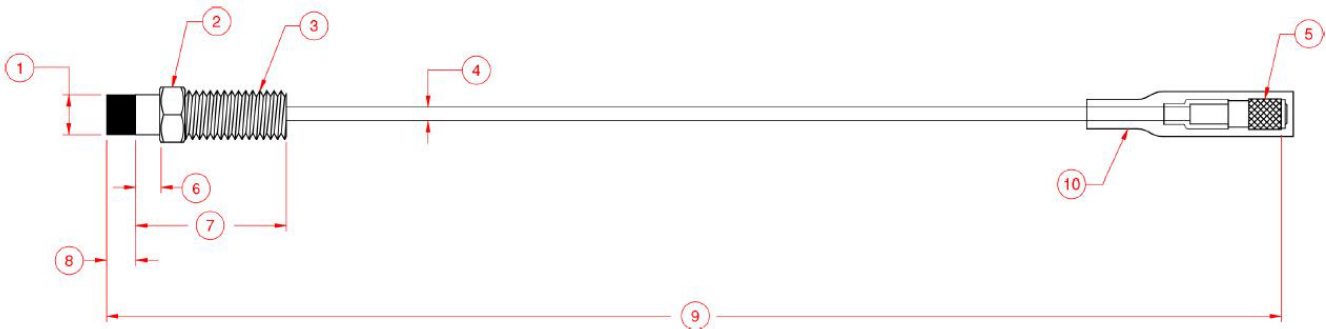11. Fluorosilicone connector insulator boot.

Figure 4: MX2030 Reverse-Mount Probe

Notes:

1. Probe tip
2. 7/16" hexagonal
3. Case threads
4. 750Ω triaxial cable with ETFE jacket
5. VibeLock™ coaxial connector
6. Unthreaded length
7. Case length
8. 6.0mm max
9. Total length
10. Fluorosilicone connector insulator boot.

In the following table are listed the family models for the Proximity Probes 10000*(2700)**

STANDARD PROXIMITY PROBE 100XX-AA-BB-CC-02						
Model No.	Tip Diameter	Case Threads	Unthreaded Length AA	Case Length BB	Probe Length CC	Armor
10001	5 mm	1/4"-28	Increments of 0.5 in. Maximum= case length minus 1 in.	10=1 in. (min) 05= 0.5 in. (delta) 30= 3 in. (standard) 95= 9.5 in. (max) Even increments only	05 = 0.5 m ± 0.05 m 10 = 1.0 m ± 0.1 m	No
10002						Yes
10005	8 mm	3/8"-24				No
10006						Yes
10003	5 mm	M8X1	Increments of 10 mm. Maximum= case length minus 20 mm.	02= 20mm. (min) 07= 70mm. (standard) 25= 250mm. (max)		No
10004						Yes
10007	8 mm	M10X1				No
10008						Yes
10026*	8 mm	3/8"-24	02= 0.2 in.	12= 1.2 in.		
10030*		M10X1	05= 5 mm.	30= 30 mm.		

| STANDARD PROXIMITY PROBE 100XX-AA-BB-CC-02						
Model No.	Tip Diameter	Case Threads	Unthreaded Length AA	Case Length BB	Probe Length CC	Armor
10037	11mm	1/2"-20	**Standard** **00**=0.0 in. **Increments** **05**=0.5 in. **Maximum**= Case Length minus 1.0 in.	Min: **10**=1.0 in Delta: **05**=.05 in Std: **30**=3.0 in Max: **95**=9.5 in	05 = 0.5 m ± 0.05 m 10 = 1.0 m ± 0.1 m	No
10038						Yes
10039		M14-1.5	**Standard** **00**=0 mm **Increments** **01**= 10 mm **Maximum**= Case Length minus 20 mm.	Min: **02**=20 mm Delta: **01**=10 mm Std: **07**=70 mm Max: **25**=250 mm		No
10040						Yes
10041*		3/8-24	02= 0.2 in.	12 = 1.2 in.		No
10042*		M10-1.0	05 = 0.5 mm.	30= 30 mm.		No

* Reverse Mount
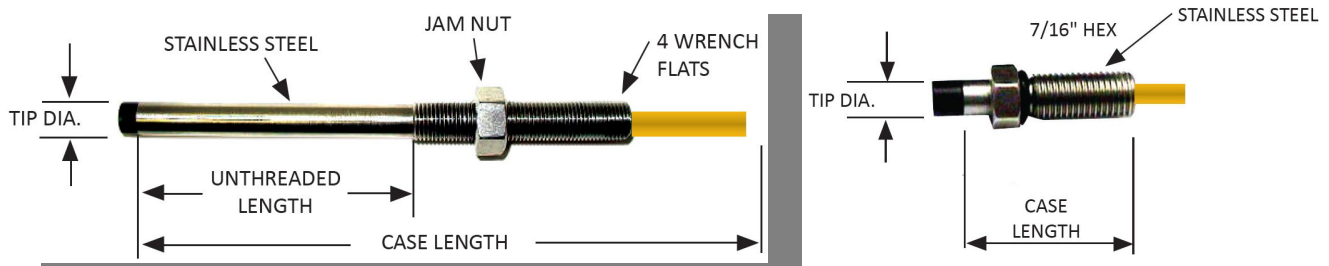
Figure 5: 10000 Forward and Reverse-Mount Probe

6.1.2. CABLES

In the following tables are listed the family models for the Extension Cables MX8031-MX2031

MX8031-AAA-BB-CC (5mm/8mm Extension Cable)

A	A	A	Cable Length		B	B	Cable Armor
0	3	0	3.0 meters		0	0	No Armor
0	3	5	3.5 meters		0	1	Armor
0	4	0	4.0 meters		C	C	Approvals
0	4	5	4.5 meters		0	0	None
0	7	0	7.0 meters		0	5	CSA, ATEX, IECEx
0	7	5	7.5 meters				
0	8	0	8.0 meters				
0	8	5	8.5 meters				

MX2031-AAA-BB-CC (5mm/8mm Extension Cable)

A	A	A	Cable Length		B	B	Cable Armor
0	3	0	3.0 meters		0	0	No Armor
0	3	5	3.5 meters		0	1	Armor
0	4	0	4.0 meters		C	C	Approvals
0	4	5	4.5 meters		0	0	None
0	7	0	7.0 meters		0	5	CSA, ATEX, IECEx
0	7	5	7.5 meters				
0	8	0	8.0 meters				
0	8	5	8.5 meters				
9	9	9	Other				

In the following table are listed the family models for the Extension Cables for 7200 series

EXTENSION CABLE FOR 7200 SERIES 9282-AAA-BB

Cable length AAA
040= 4.0 m
045= 4.5 m
080= 8.0 m
085= 8.5 m
Armor BB
00 = NO
01 = YES

6.2. SPECIFICATIONS

	10000*(7200)**	MX8030	MX2030
Probe Tip Material	Ryton	Polyphenylene Sulfide (PPS)	Polyphenylene Sulfide (PPS)
Probe Case Material	FWD-mount probe: Series 300 SS REV-mount probe: Series 300 SS	FWD-mount probe: AISI 304 stainless steel REV-mount probe: AISI 303 stainless steel	FWD-mount probe: AISI 304 stainless steel REV-mount probe: AISI 303 stainless steel
Probe/Extension Cable Specs	Coaxial cable with Tefzel insulation for maximum abrasion resistance	Coaxial cable with Tefzel insulation for maximum abrasion resistance	Coaxial cable with Tefzel insulation for maximum abrasion resistance
Cable Impedance	95 Ω	75Ω	75Ω
Connector to Connector Torque	Hex connector to hex connector- finger tight and 1/8 turn with wrenches. Hex connector to "click type" connector- finger tight plus 1/8 turn with wrench & pliers	Maximum: 0.565 N-m (5 in-lb) Recommended: finger tight	Maximum: 0.565 N-m (5 in-lb) Recommended: finger tight
Tensile Strength	Probe case to Probe lead: 334N (75 lb) Probe pigtail to Connector: 267N (60 lb) Cable to Connector: 267N (60 lb)	Probe body to probe cable: 245N (55 lb) Cable to Connector: 245N (55 lb)	Probe body to probe cable: 245N (55 lb) Cable to Connector: 245N (55 lb)
Probe / Cable Armor	Series 300 SS, flexible, connected to probe body with case internal thread	AISI 304 stainless steel (armor) AISI 303 stainless steel (armor ferrule)	AISI 304 stainless steel (armor) AISI 303 stainless steel (armor ferrule)
Minimum Bend Radius	Without Armor: 25.4 mm (1.0 in)	Without Armor: 25.4 mm (1.0 in) With Armor: 25.4 mm (1.0 in)	Without Armor: 25.4 mm (1.0 in) With Armor: 25.4 mm (1.0 in)
Target Material	4140 steel (standard)	-	-
Probe & Extension Cable Temperature Range	-40°C to +177°C (-40°F to +351°F)	-51°C to +177°C (-60°F to +350 °F)	-51°C to +177°C (-60°F to +350 °F)
Probe Pressure	Standard probe design includes seal between probe tip and case and is not pressure tested before shipment. If pressures are present, contact the factory for possible high-pressure probe designs	8mm Probe 68 bar (1000 psi)	5mm Probe 13.6 bar (200 psi) 8mm Probe 68 bar (1000 psi)
Relative Humidity	100% condensing but not submersible and with connectors properly protected	95%, non-condensing	95%, non-condensing
Connector Material	Gold-plated brass	Gold-plated brass	Gold-plated brass

IMPORTANT

The information listed in the above table are extracted by datasheet [D7]-[D11] and shall be considered for reference only. In case of mismatch, the datasheet have the priority on the present table.

7. RELIABILITY AND SAFETY CHARACTERISTICS

Safety Functions	Inductive proximity sensor for no contact motion measures of metallic object.
Installation	Refer to [D12].
Lifetime	When using in the prescribed manner indicated in the [D12], the device can operate in safety applications up to 20 years.
Diagnostic	No internal diagnostics are present. The diagnostic can be performed by the SIS logic solver, revealing easily the probe output voltage signal under-range and over-range.
Interface	The interface towards the SIS can be implemented with a Digital Proximity System and, if the device is installed in hazardous areas, an intrinsically safe barrier.

WARNING!

Interface devices such as proximitors and intrinsecally safe barriers could modify the SIS safety. The end-user shall take into account this possibility during calculation of the whole safety loop implementing the SIF.

WARNING!

Modification to the hardware are not permitted. Cables length are fixed, do not use other connectors than the ones provided with Probes and Extension cables.

WARNING!

To avoid potential hazards, use this product only as specified. Only qualified personnel should perform installation and uninstallation procedures. If you suspect there is damage to this product, have it inspected by qualified personnel.

CAUTION

During the installation, if possible, set the probe gap while the machine is shutdown, to avoid the danger of damaging the probe in the event that it touches the shaft.

CAUTION

During the installation make certain the cable is not kinked, scraped, nor bent beyond the minimum recommended radius.

7.1.   RELIABILITY DATA

The reliability parameters have been obtained considering the Proximity Probes as elements of a safety-related system with the safety function(s):

Inductive proximity sensor that generates an emf directly proportional to the magnetic field alteration caused by the metallic target presence in the probe operating area. Suitable for no-contact measures of radial vibration, thrust and speed of rotating machinery.

IMPORTANT

The design of each Safety Instrumented Function shall meet the requirements listed in the reference standards that shall be selected by taking into account the specific application.

Specific activities necessary to investigate and reach a judgment on the adequacy of the functional safety achieved by the E/E/PE safety-related system or compliant items (elements/subsystems) has been conducted by an independent assessor.
The following tables show the safety parameters of the devices listed in paragraph 6.1. The first table refers to Proximity Probes MX2030-MX8030-10000 while the second one reports the Extension Cables MX8031-MX2031-7200** reliability parameters. The probes were analyzed separately in respect to the extension cables to leave to the user more flexibility in the configuration of the system. For a detailed explanation of the parameters meaning, application and associated assumptions refer to paragraphs 7.2-7.4.

Table 1 Reliability parameters for Probes (a) and Extension cables (b)

Proximity Probe MX2030 – MX8030 – 10000*(7200)**				
λ_{SU} (FIT)	λ_{SD} (FIT)	λ_{DU} (FIT)	λ_{DD} (FIT)	λ_{RES} (FIT)
0	0	75	261	572
Systematic Capability [SC]:		2 (Route 1_S)		
Hardware Safety Integrity:		Type A	Route 1_H	

Extension Cable MX8031 – MX2031 – 7200**				
λ_{SU} (FIT)	λ_{SD} (FIT)	λ_{DU} (FIT)	λ_{DD} (FIT)	λ_{RES} (FIT)
0	0	24	199	147
Systematic Capability [SC]:		2 (Route 1_S)		
Hardware Safety Integrity:		Type A	Route 1_H	

7.2. SYSTEMATIC CAPABILITY

Techniques and measures to control and avoid systematic failures during the different phases of the lifecycle have been evaluated and found to be sufficient to meet the requirements of SIL 2 in accordance to IEC 61508, Parts 1 - 7:2010. The compliance with the requirements has been achieved following the compliance Route 1_S.

The systematic capability provides a quantitative estimation of the robustness of the device against systematic failures resulting from design, project management and documentation quality. An appropriate group of techniques and measures to prevent the introduction of faults during the design and development phases are in place.

To control systematic faults the maintenance and test requirements formalized at design stage must be followed.

In order to preserve the systematic capability, the Probes and Extension Cables must be used following the constraints reported in this manual in term of authorized personnel, installation, operating conditions and maintenance.

WARNING!

The declared systematic capability level is valid only if the requirements and limitations reported in this Safety Manual are fulfilled

7.3. RANDOM SAFETY INTEGRITY

The failure rates show in the previous tables are resulting from the FMEDA analysis, a FMEA extension that combines standard FMEA techniques with extension to identify online diagnostics techniques and the failure modes relevant to safety instrumented system design. The failure rates shall be used for the PFD_{AVG} estimation, taking into consideration all parameters such as redundancy, architectural constraints, diagnostic capability, also introduced by the whole system, including the considerations about the proof test and its effectiveness, mean time of restoration, up to the maintenance capability and its minimum characteristics.

The assumptions associated with these failure rates are as follows:

- Failure rates are constant, wear-out or infant mortality contributions are not included;

- The tabulated failure rates are in Failures in Time (FIT):

    1 FIT = $[10^{-9}\ h^{-1}]$

The device (probe or cable) total failure rate λ is given by $\lambda = \lambda_{SU} + \lambda_{SD} + \lambda_{DU} + \lambda_{DD} + \lambda_{RES}$.

The dangerous undetected failure rate $\boldsymbol{\lambda_{DU}}$ is due to the addition of unwanted signals to the probe voltage output. Phenomena as drift and/or noise (white noise or communication interference) could modify the probe output voltage signal while maintaining it into the probe correct operating range, rendering diagnostic methods ineffective (erroneous output in specs).

The dangerous detected failure rate $\boldsymbol{\lambda_{DD}}$ is due to probe faults (i.e. probe misplacement, open circuit) leading to the output voltage signal exiting the probe correct operating range for the particular application. As the Proximity Probes do not have internal diagnostic capabilities, the SIS logic solver shall be able to detect the probe fault through its voltage output signal, verifying the compliance with the correct operating output range.

IMPORTANT

If the logic solver is not able to detect the output voltage signal over-range and under-range, λ_{DU} value is given by $\lambda_{DU} + \lambda_{DD}$ as no diagnostic measure is implemented.

The safe failure rate $\lambda_S = \lambda_{SU} + \lambda_{SD}$ represents failure of elements or subsystems that play a part in implementing the safety function, as they result in the spurious operation of the safety function or in the increase of the probability of spurious operation of the safety function to put the EUC (or part thereof) into a safe state or maintain a safe state;

The residual failure rate λ_{RES} includes the NO PART and NO EFFECT failure rates that is failure of a component that plays no part in implementing the safety function (NO PART) and failure of an element that plays a part in implementing the safety function but has no direct effect on the safety function (NO EFFECT).
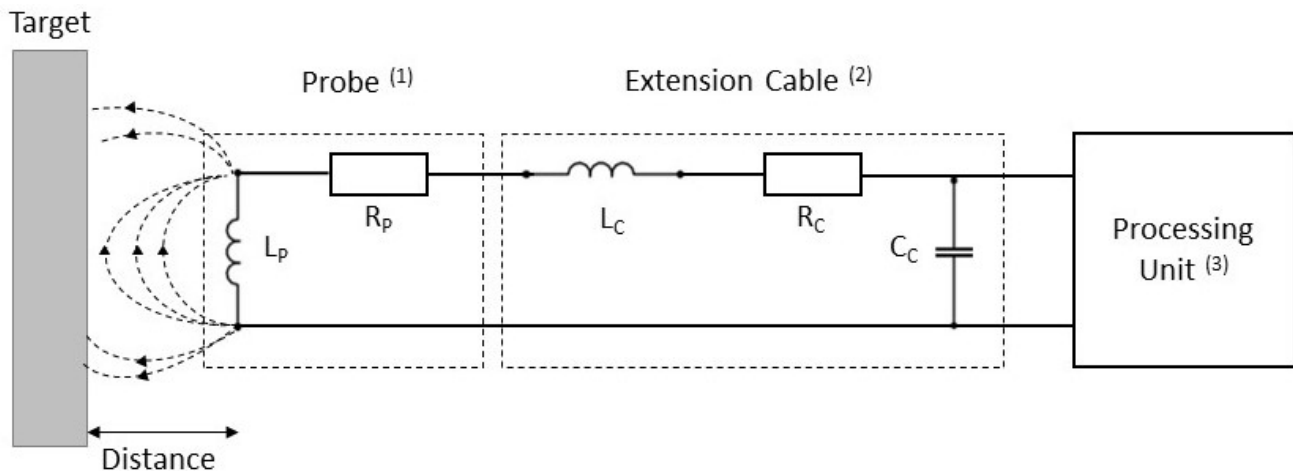
IMPORTANT

When the proximity probe is used in conjunction with its extension cable the failure rate values must be summed, obtaining the values reported in the following table.

CAUTION

The extension cables must be used only in conjunction with the relative probes.

(1) Reliability parameters are listed in table 1(a)
(2) Reliability parameters are listed in table 1(b)
(3) Processing unit is not provided by Metrix Instrument

Table 2 Conjured Probes and Cable failure rates

Proximity Probe + Extension cable				
λ_{SU} (FIT)	λ_{SD} (FIT)	λ_{DU} (FIT)	λ_{DD} (FIT)	λ_{RES} (FIT)
0	0	99	460	719

The integration in the SIS, the whole SIS validation, and the PFD_{avg} calculation of the whole safety loop implementing the SIF is under end-user responsibility, together with the verification of the compliance with the allocated target SIL.

7.4. HARDWARE SAFETY INTEGRITY

The constraints on hardware safety integrity have been verified in order to achieve a sufficiently robust architecture taking into account the level of element and subsystem complexity following the compliance route 1_H.

Route 1H is based on hardware fault tolerance and safe failure fraction concepts. According to Route 1H, in order to determine the maximum safety integrity level that can be claimed, the safe failure fraction shall be calculated for the item under analysis using the failure rate data.

The maximum allowable safety integrity level that can be claimed in terms of architectural constraints can be determined according to tables 2 and 3 (7.4.4.2 IEC 61508-2). Different tables are used if the element is classified as type A or B.

Proximity Probes and Extension Cables have been classified as **type A** elements, following 7.4.4.1.2. IEC 61508-2 explanation. An element can be regarded as type A if, for the components required to achieve the safety function:
   a) The failure modes of all constituent components are well defined; and
   b) The behavior of the component under fault conditions cannot be completely determined; or
   c) There is sufficient dependable failure data to show that the claimed rates of failure for detected and undetected dangerous failures are met.

8. REQUIREMENTS FOR IMPLEMENTATION INTO A SIS

The SIS logic solver shall be able to detect the probe fault through its signal. The most critical failure modes involve the voltage output to be under/over range.

In order to be able to recognize and report the probe fault through its voltage output, the SIS logic solver must be correctly programmed during installation and commissioning. As different metallic targets interfere differently with the probe magnetic field and thus induce diverse voltage outputs, the output reference range for the correct operation detection must be set basing on the particular application (i.e. target different metallic composition).

In order to maintain the safety capability of the probe, the logic solver shall activate a proper feedback when an under/over range signal is detected. This proper feedback shall be used as fault condition of the sensor. The fault condition shall be properly managed as per each specific safety function.

CAUTION

For RPM measurement ensure that the minimum keyway depth is 0.060" (1.5 mm) and the minimum keyway and key width is the diameter of the probe tip. These minimums will ensure that the transmitter or driver responds properly to the keyway at all RPMs.

WARNING!

Proximity probes must be correctly tested with a comparator before installation.

9.   PROOF TEST

 Due to the Proximity probes and extension cables construction features, reliability characteristics remains constant for the device entire lifetime, consequently proof test is not necessary. As the device has no moving mechanical parts, wear-out mechanisms are not to be considered. Therefore, if the device had been correctly tested and calibrated before installation, reliability is kept unchanged.

WARNING!

Maintenance may compromise the sensor. Follow the instruction listed into the user manual is mandatory to ensure the correct operability of SIS.

Note:
- *Registered trademark of Metrix Instrument Co.
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