# 5580 Smart Vibration Signal Conditioner - SW5580 Smart Vibration Signal Conditioner and Configurable Switch

# 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 following two Metrix's devices:

- 5580 Smart Vibration Signal Conditioner;
- SW5580 Smart Vibration Signal Conditioner and Configurable Switch

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 is valid for the models indicated in paragraph 6.

When the Signal Conditioner 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 Signal Conditioner, 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 is 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 SW5580 Smart Signal Conditioner and Configurable Switch and 5580 Smart Signal Conditioner. As required by the IEC 61508-1 an appropriate level 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 based on 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, to transfer the process into a specified safe state, and where the frequency of demands is no greater than once per year.

- High Demand Mode: mode of operation where the SIF, is only performed on demand, to transfer the process into a specified safe state, and where the frequency of demands is greater than once 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.

**$\lambda$**

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

**$\lambda_D$**

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

**$\lambda_S$**

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

**$\lambda_{DU}$**

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

**$\lambda_{DD}$**

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

| | |
|---|---|
| **A/V** | Accelerometer/Velocity Sensor |
| **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 |
| **NC** | No Connection |
| **N.C.** | Normally Closed |
| **N.O.** | Normally Open |
| **MRT** | Mean Repair Time |
| **MTTR** | Mean Time to Restoration |
| **PC** | Proximity Common |
| **PFD** | Probability of Failure on Demand |
| **PLC** | Programmable Logic Controller |
| **PTC** | Proof Test Coverage |
| **PP** | Proximity Power |
| **PS** | Proximity Signal |
| **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 issuing:

| Doc ID | Project Document Name | Document Code | Version |
|---|---|---|---|
| [D7]. | Datasheet | Doc# 1899675 | Rev C, November 2021 |
| [D8]. | Installation Manual | Doc# 1874512 | Rev B, July 2021 |
| [D9]. | Software User Manual | Doc# 1916144 | Rev A, August 2021 |
| [D10]. | SIL Certificate | MTXI-W5580-ENS-E01 | - |
| [D11]. | Safety Assessment Report | 22-MTX-W5580-FSA-01 | - |

## 6. PRODUCTS INTRODUCTION

The 5580 is a new generation DIN rail mounted Smart Vibration Signal Conditioner. It has been designed to accept signals from machine casing mounted velocity sensors, accelerometers or shaft observing proximity probe systems and produce a 4-20 mA output proportional to the measured variable and an amplified raw signal. It provides the user with a programmable signal input type for one or two independent channels plus a configurable feature to scale output either to peak or RMS units. For each channel, a green LED indicates sensor and cable integrity. In the event of sensor failure, the LED changes to red and the output current is driven below 3.6 mA, thereby signaling a malfunction. A BNC connector gives access to the raw input signal for local analysis. A built-in 4-digit LCD display is used to display both dynamic input and 4-20 mA output signal. Isolation is provided between input, outputs and supply.
Designed for ease of use, the USB interface is fitted for quick and easy configuration. Connecting a standard USB cable between the 5580 and PC, the device can be configured in the field to meet application requirements, using the free configuration software. Use as a single or dual channel device.

The SW5580 Switch is a new generation DIN rail mounted Smart Vibration Signal Conditioner and Switch. It has been designed to accept signals from machine casing mounted velocity sensors, accelerometers or shaft observing proximity probe systems and produce a 4-20 mA output proportional to the measured variable and an amplified raw signal. It provides the user with a programmable signal input type for one or two independent channels plus a configurable feature to scale output either to peak or RMS units. For each channel, a green LED indicates sensor and cable integrity. In the event of sensor failure, the LED changes to red and the output current is driven below 3.6 mA, thereby signaling a malfunction. A BNC connector gives access to the raw input signal for local analysis. A built-in 4-digit LCD display is used to display both dynamic input and 4-20 mA output signal. Isolation is provided between input, outputs and supply. Each channel comes with two relays, either solid state or dry contacts, that can be configured for alarm level and time delay.

As for the 5580 version, the device is configured through USB connection with the free configuration software.


*Figure 1 – SW5580 & 5580 Signal Conditioners*

## 6.1. PRODUCTS FAMILY IDENTIFICATION

This Safety Manual is valid for SIL rated version listed in this paragraph.

**For a SIL rating version, the first digit in the H option shall be “S”.**

**5580 Smart Signal Conditioner**

Channel 1 | Channel 2

**5580-A-B-CCCC-D-E-FFFF-GG-H - B-CCCC-D-E-FFFF-GG**

**5580-□-□-□□□□-□-□-□□□□-□□-□ - □-□□□□-□-□-□□□□-□□**

**SW5580 Dual Channel Configurable Switch**

Channel 1 | Channel 2

**SW5580-A-B-CCCC-D-E-FFFF-GG-H-J - B-CCCC-D-E-FFFF-GG**

**SW5580-□-□-□□□□-□-□-□□□□-□□-□-□ - □-□□□□-□-□-□□□□-□□**

**Figure 2 - Part Numbers Covered by this safety manual**

| A | Channel Configuration |
|---|---|
| 1 | Channel 1 Only (1) |
| 2 | Channel 1 and Channel (2) |
| 3 | Enable Channel 2 On Site (3) |
| **B** | **Input Signal Type** |
| 1 | Velocity Sensor |
| 2 | Accelerometer |
| 3 | Proximity Probe System |
| **CCCC** | **Full Scale Range** |

| CCCC (If B=1) | | | | | | | | Sensor Input Type/ Mounting Style/ Range Code | |
|---|---|---|---|---|---|---|---|---|---|
| **Input Velocity Sensor Type** | | | | | | | | **Vibration Range (4-20 mA Output)** | **Output Measure** |
| **Electromechanical Velocity Sensor** | | | | **Piezoelectric Velocity Sensor** | | | | | |
| 1 | 0 | 2 | V | 5 | 0 | 2 | V | 0 - 1.0 ips, pk | Velocity/ English System |
| 1 | 3 | 2 | V | 5 | 3 | 2 | V | 0 - 1.0 ips, rms | |
| 1 | 0 | 3 | V | 5 | 0 | 3 | V | 0 - 2.0 ips, pk | |
| 1 | 3 | 3 | V | 5 | 3 | 3 | V | 0 - 2.0 ips, rms | |
| 1 | 0 | 5 | V | 5 | 0 | 5 | V | 0 - 10 mils, pk-pk | Integrated Displacement/ English System |
| 1 | 0 | 6 | V | 5 | 0 | 6 | V | 0 - 20 mils, pk-pk | |
| 3 | 0 | 2 | V | 7 | 0 | 2 | V | 0 - 20 mm/s, pk | Velocity/ Metric System |
| 3 | 3 | 2 | V | 7 | 3 | 2 | V | 0 - 20 mm/s, rms | |
| 3 | 0 | 3 | V | 7 | 0 | 3 | V | 0 - 50 mm/s, pk | |
| 3 | 3 | 3 | V | 7 | 3 | 3 | V | 0 - 50 mm/s, rms | |
| 3 | 0 | 5 | V | 7 | 0 | 5 | V | 0 - 200 um, pk-pk | Integrated Displacement/ Metric System |
| 3 | 0 | 6 | V | 7 | 0 | 6 | V | 0 - 500 um, pk-pk | |
| | | | | | | | | 1 mm/s = 0.03937 ips<br>1 ips = 25.4 mm/s<br>1 mil = 25.4 µm<br>1 µm = 0.03937 mil | |

| CCCC (If B=2) | | | | Sensor Input Type/ Mounting Style/ Range Code | |
|---|---|---|---|---|---|
| **Accel sensor (Input)** | | | | **Vibration Range (4-20 mA Output)** | **Output Measure/ Unit System** |
| DIN rail | | | | | |
| 1 | 0 | 2 | A | 0 - 10 g, pk | Acceleration/ English System |
| 1 | 3 | 2 | A | 0 - 10 g, rms | |
| 1 | 0 | 7 | A | 0 - 50 g, pk | |
| 1 | 3 | 7 | A | 0 - 35 g, rms | |
| 1 | 0 | 5 | A | 0 - 1.0 ips, pk | Integrated Velocity/ English System |
| 1 | 3 | 5 | A | 0 - 1.0 ips, rms | |
| 1 | 0 | 6 | A | 0 - 2.0 ips, pk | |
| 1 | 3 | 6 | A | 0 - 2.0 ips, rms | |
| 3 | 0 | 2 | A | 0 - 100 $m/s^2$, pk | Acceleration/ Metric System |
| 3 | 3 | 2 | A | 0 - 100 $m/s^2$, rms | |
| 3 | 0 | 7 | A | 0 - 500 $m/s^2$, pk | |
| 3 | 3 | 7 | A | 0 - 350 $m/s^2$, rms | |
| 3 | 0 | 5 | A | 0 - 20 mm/s, pk | Integrated Velocity/ Metric System |
| 3 | 3 | 5 | A | 0 - 20 mm/s, rms | |
| 3 | 0 | 6 | A | 0 - 50 mm/s, pk | |
| 3 | 3 | 6 | A | 0 - 50 mm/s, rms | |

| CCCC (IF B=3) | | | | Proximity Probe System Type |
|---|---|---|---|---|
| 0 | 0 | 2 | P | 4 mils, pk-pk (Vibration) |
| 0 | 0 | 3 | P | 5 mils, pk-pk (Vibration) |
| 0 | 0 | 4 | P | 6 mils, pk-pk (Vibration) |
| 0 | 0 | 5 | P | 10 mils, pk-pk (Vibration) |
| 0 | 0 | 6 | P | 15 mils, pk-pk (Vibration) |
| 0 | 0 | 7 | P | 20 mils, pk-pk (Vibration) |
| 0 | 0 | 8 | P | 30 mils, pk-pk (Vibration) |
| 0 | 0 | 9 | P | 40 mils, pk-pk (Vibration) |
| 0 | 2 | 1 | P | 100 µm, pk-pk (Vibration) |
| 0 | 2 | 2 | P | 150 µm, pk-pk (Vibration) |
| 0 | 2 | 3 | P | 200 µm, pk-pk (Vibration) |
| 0 | 2 | 4 | P | 250 µm, pk-pk (Vibration) |
| 0 | 2 | 5 | P | 300 µm, pk-pk (Vibration) |
| 0 | 2 | 6 | P | 400 µm, pk-pk (Vibration) |
| 0 | 2 | 7 | P | 500 µm, pk-pk (Vibration) |
| 0 | 2 | 8 | P | 750 µm, pk-pk (Vibration) |
| 0 | 2 | 9 | P | 1000 µm, pk-pk (Vibration) |
| 0 | 5 | 0 | P | 30-70 mils, avg gap (Position) |
| 0 | 5 | 1 | P | 20-80 mils, avg gap (Position) |
| 0 | 5 | 2 | P | 10-90 mils, avg gap (Position) |
| 0 | 5 | 3 | P | 10-50 mils, avg gap (Position) |
| 0 | 5 | 4 | P | 20-70 mils, avg gap (Position) |
| 0 | 5 | 5 | P | 10-60 mils, avg gap (Position) |
| 0 | 5 | 7 | P | 20-160 mils, avg gap (Position) |
| 0 | 5 | 8 | P | 20-180 mils, avg gap (Position) |
| 0 | 7 | 0 | P | 750-1750 µm, avg gap (Position) |

| | | | | | |
|---|---|---|---|---|---|
| 0 | 7 | 1 | P | 500-2000 µm, avg gap (Position) | |
| 0 | 7 | 2 | P | 250-2250 µm, avg gap (Position) | |
| 0 | 7 | 3 | P | 250-1250 µm, avg gap (Position) | |
| 0 | 7 | 4 | P | 500-1750 µm, avg gap (Position) | |
| 0 | 7 | 5 | P | 250-1500 µm, avg gap (Position) | |
| 0 | 7 | 7 | P | 500-4000 µm, avg gap (Position) | |
| 0 | 7 | 8 | P | 500-4500 µm, avg gap (Position) | |
| 5 | 0 | 1 | P | 500 RPM (Speed) | |
| 0 | 5 | 3 | P | 10-50 mils, avg gap (Position) | |
| 2 | 0 | 2 | P | 2000 RPM (Speed) | Events Per Rev. |
| 3 | 6 | 2 | P | 3600 RPM (Speed) | 1-99 (All) |
| 4 | 0 | 2 | P | 4000 RPM (Speed) | 1-95 |
| 5 | 0 | 2 | P | 5000 RPM (Speed) | 1-52 |
| 6 | 0 | 2 | P | 6000 RPM (Speed) | 1-47 |
| 7 | 5 | 2 | P | 7500 RPM (Speed) | 1-38 |
| 1 | 0 | 3 | P | 10000 RPM (Speed) | 1-31 |
| 1 | 5 | 3 | P | 15000 RPM (Speed) | 1-25 |
| 5 | 0 | 3 | P | 50000 RPM (Speed) | 1-19 |
| 6 | 0 | 3 | P | 60000 RPM (Speed) | 1-12 |
| 7 | 5 | 3 | P | 75000 RPM (Speed) | 1-3 |
| 1 | 0 | 4 | P | 100000 RPM (Speed) | 1-3 |
| **CCCC (IF B=2)** | | | | **Impact Measurement Type (4)** | |
| 0 | 0 | 1 | I | Low, <500 RPM and <500mV Baseline | |
| 0 | 0 | 2 | I | Medium, 500-1000 RPM and <500mV Baseline | |
| 0 | 0 | 3 | I | High, >1000 RPM or >500mV Baseline | |
| 0 | 0 | 1 | I | Low, <500 RPM and <500mV Baseline | |
| **D** | | | | **High-Pass Filter(5)** | |
| 0 | | | | No filter | |
| 1 | | | | N/A (Accel) or 5 Hz (Velocity or Proximity) | |
| 2 | | | | N/A (Accel) or 10 Hz (Velocity or Proximity) | |
| 3 | | | | N/A (Accel) or 20 Hz (Velocity or Proximity) | |
| 4 | | | | 50 Hz | |
| 5 | | | | 100 Hz | |
| 6 | | | | 200 Hz | |
| 7 | | | | 500 Hz | |
| 8 | | | | 1 kHz | |
| 9 | | | | 2 kHz | |
| **E** | | | | **Low-Pass Filter (5)** | |
| 0 | | | | No filter | |
| 1 | | | | 20 Hz | |
| 2 | | | | 50 Hz | |

| | | | | | |
|---|---|---|---|---|---|
| 3 | | | | 100 Hz | |
| 4 | | | | 200 Hz | |
| 5 | | | | 500 Hz | |
| 6 | | | | 1 kHz | |
| 7 | | | | 2 kHz | |
| 8 | | | | N/A (Vel) or 5 kHz (Acceleration or Proximity) | |
| 9 | | | | N/A (Velocity or Proximity) or 10 kHz (Accel) | |
| **FFFF (If B=1)** | | | | **Sensor Input in mV/ips (mV/mm/s)** | |
| 1 | 0 | 0 | V | 100 mV/ips (3.9 mV/mm/s) | SV6300A recommended |
| 1 | 0 | 5 | V | 105 mV/ips (4.1 mV/mm/s) | 5485C recommended |
| 1 | 4 | 5 | V | 145 mV/ips (5.7mV/mm/s) | |
| 1 | 5 | 0 | V | 150 mV/ips (5.9 mV/mm/s) | |
| 2 | 0 | 0 | V | 200 mV/ips (7.9 mV/mm/s) | |
| 5 | 0 | 0 | V | 500 mV/ips (19.7 mV/mm/s) | |
| **FFFF (If B=2)** | | | | **Sensor Input in mV/g (mV/mm/$s^2$)** | |
| 0 | 1 | 0 | A | 10 mV/g (1 mV/m/$s_2$) | |
| 0 | 2 | 5 | A | 25 mV/g (2.55 mV/m/$s_2$) | |
| 0 | 5 | 0 | A | 50 mV/g (5.10 mV/m/$s_2$) | |
| 1 | 0 | 0 | A | 100 mV/g (10.20 mV/m/$s_2$) | |
| **FFFF (If B=3)** | | | | **Driver Output in mV/mil (mV/µm)** | |
| 1 | 0 | 0 | P | 100mV/mil (3.937 mV/µm) | |
| 2 | 0 | 0 | P | 200mV/mil (7.87 mV/µm) | |
| **GG** | | | | **Pulses per Revolution** | |
| 0 | 0 | | | N/A (for vibration or position), Accelerometer or Velocity Input | |
| X | X | | | XX=Number of pulses per revolution (events per revolution), valid entries are two digit numbers from 01-99, with a maximum value of RPM x # of events ≤190,000. These two digits are relevant to proximity speed mode only | |
| **H** | | | | **Hazardous Area Certification** | |
| 0 | | | | Ordinary Location Approval (Non-Hazardous Area Approval) | |
| 5 | | | | Multiple Hazardous Area Approvals (6) (7) | |
| **J** | | | | **Relay Circuit Output (8)** | |
| 1 | | | | Solid-state switch (SPST, 100 mA, 120 VAC or 24 VDC) | |
| 2 | | | | Electromechanical relay (SPDT, 5A 240/120 VAC resistive load, or 5A 24 VDC resistive load) | |

(1) If only channel configuration “1” is entered in the order, channel 2 will be disabled by manufacturer, but can be enabled from the configuration software with additional fee.
(2) If channel configuration “2” is entered in the order, both channel 2 will be enabled by manufacturer.
(3) Channel configuration “3” cannot be ordered without channel configuration “1” having been ordered first. With an additional fee, Metrix will ship a passcode. User can enable channel 2 from the configuration software High- and Low-Pass filter corners for standard filters must be separated by at least one octave (low-pass frequency must be at least twice the high-pass frequency). All combinations are allowed except E = 6 and F = 4, 5, or 6. Custom filters with closer separation and/ or different roll-offs may be available in some instances. Consult the factory if custom filters are required.
(4) The Impact Measurement must have an 100mV/g Accelerometer input.
(5) Standard is E=0; Filters affect 4-20 mA output but have no effect on dynamic output. For the impact measurement type filters must be D=0 and E=0.

    **Ordering Example: 5580-1-2-102A-00-025A-0**

    Channel 1, Accelerometer input, DIN-rail with 0-10 g, pk range, no filter, 25 mV/g sensor input, no hazard area certification.

    **Ordering Example: SW5580-1-2-102A-00-025A-0-2**

    Channel 1, Accelerometer input, DIN-rail with 0-10 g, pk range, no filter, 25 mV/g sensor input, no hazard area certification, and electromechanical relays.
(6) When connected & wired w/approved Metrix sensor. Request Application Wiring Drawing 1874437 for details. If sensors are rated for Class I Div 1 or Zone 0 or 1 as long as the 5580/SW5580 remains in an approved area with barriers this is allowed.
(7) ETL, ATEX, IECEx, hazardous area approvals. See page 8 for details
(8) Relays are set at 25% and 50% of the full scale range

## 6.1. SOFTWARE FEATURES

The device also includes built-in firmware. This Safety Manual covers the following versions of firmware and FPGA code:

- Firmware Version Current Release: 2.5.58
- FPGA Code Current Release: 4.04

The device has parameters that may be configured differently from the factory settings. Refer to the Software User Manual [D9].
After any change in settings, the device must undergo validation to ensure proper functionality.

## 6.2. SPECIFICATIONS

| | |
|---|---|
| **INPUTS** | |
| **Supply voltage** | 100 to 500 mV/ips, 10 to 100 mV/g, 100-200 mV/mil |
| **Sensor Excitation Provided** | Required only for piezo-velocity sensor input types: 24 VDC, 4 mA constant current standard. |
| **Input Power** | 20 to 30 Vdc. Reverse polarity and electrical transient protection provided |
| **OUTPUTS** | |
| **Output Accuracy** | 4-20 mA dc (source) ± 5% |
| **Maximum Load Resistance** | 600 Ω |
| **Dynamic Signal Output** | Buffered input signal at BNC (5m or 16ft) and terminal block (300m or 1000ft) |
| **Solid State Switches** | 100 mA, SPST, 120 VAC or 24 VDC |
| **Electro Mechanical Relays** | SPDT<br>5A 240/120 VAC, resistive load<br>5A 24 VDC, resistive load |
| **SIGNAL PROCESSING** | |
| **Frequency Response** | 2 Hz to 2 kHz for velocity<br>2 Hz to 5 kHz for proximity<br>2 Hz to 10 kHz for acceleration |
| **Filters** | Optional low-pass and high-pass filters (36 db/octave). Filter section does not affect dynamic signal. See “Ordering Option E & F |
| **Vibration Range** | See “Ordering Option D” |
| **PHYSICAL** | |
| **Operating Temperature** | 5580: -40° C to +85° C (-40° F to +185° F)<br>SW5580: -40° C to +65° C (-40° F to +149° F) |
| **Hazardous Area Certification** | Available safety certification for CSA<br>& NRTL/C Class I (A, B, C & D) T4, Div. 2. ATEX/IECEx/UKCA<br>See “Ordering Option |

**IMPORTANT**

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

## 7. RELIABILITY AND SAFETY CHARACTERISTICS

| | |
|---|---|
| **Safety Functions** | (1) Vibration monitoring of rotating equipment in order to activate the EUC shutdown prior it reaches a potentially dangerous condition.<br>(2) Velocity monitoring of critical machine motion parts in order to activate the EUC shutdown prior it reaches a potentially dangerous condition.<br>(3) Thrust monitoring on each critical machine shaft-end in order to activate the EUC shutdown prior it reaches a potentially dangerous condition.<br>(4) Acceleration monitoring of critical machine motion parts in order to activate the EUC shutdown prior it reaches a potentially dangerous condition. |
| **Safe State** | **SW5580**<br>Expected safe state 1:<br>The transmitter output 4-20mA signal is read by the logic solver that, if necessary, takes the EUC to trip status.<br>Expected safe state 2:<br>The transmitter output contact open state is read by the logic solver that, if necessary, takes the EUC to trip status.<br>**5580**<br>The transmitter output contact open state is read by the logic solver that, if necessary, takes the EUC to trip status. |
| **Installation** | Refer to [D8] |
| **Lifetime** | When using in the prescribed manner indicated in [D8], the device can operate in safety applications up to 20 years. |
| **Interface** | Interfaces an accelerometer, velocity sensor, or proximity probe system to a PLC, DCS or other 4-20 mA input monitor |
| **MRT** | 4 hours. This is estimation considering skilled personnel for maintenance, availability of spare parts and adequate tools on site. |
| **Common Cause Failure** | $\beta = \beta_D$=5%. These values are valid for the 1oo2 architecture. The values for the other architecture shall be calculated according to IEC 61508 part 6, Table D.5 |

**WARNING!**

**Modification to the hardware are not permitted.**

**WARNING!**

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

**inspected by qualified personnel.**

**WARNING!**

**Explosion Hazard. Do not connect or disconnect when energized.**

## 7.1. RELIABILITY AND SAFETY

The reliability parameters have been obtained considering the Smart Vibration Conditioner as element of a safety-related system with the safety function(s):

(1) Vibration monitoring of rotating equipment in order to activate the EUC shutdown prior it reaches a potentially dangerous condition.
(2) Velocity monitoring of critical machine motion parts in order to activate the EUC shutdown prior it reaches a potentially dangerous condition.
(3) Thrust monitoring on each critical machine shaft-end in order to activate the EUC shutdown prior it reaches a potentially dangerous condition.
(4) Acceleration monitoring of critical machine motion parts in order to activate the EUC shutdown prior it reaches a potentially dangerous condition.

**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.**

The 5580 and SW5580 support most commercially available acceleration, velocity, and proximity sensors, including the provision of any necessary sensor power. A single +24Vdc connection powers the device, its 4-20mA output(s), and its connected sensor(s) –including the -24Vdc power required by proximity transducers and the constant current required by IEPE accelerometers and piezo-velocity sensors.

Two levels of setpoints are available in the SW5580: Alert (pre-shutdown) and Danger (shutdown). When the 5580 is used instead of the SW5580, the alarms are implemented in a PLC, DCS, or other control platform. Where alarm settings are available from the OEM, those levels should be implemented by default and then adjusted over time as process, operating conditions, and experience dictate. Although there can be numerous, vibration and position measurements associated with rotating and reciprocating machines, most industry standards suggest that only a small number be used for machinery protection (i.e., auto-shutdown) purposes with the rest being used for condition monitoring purposes.

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. For a detailed explanation of the parameters meaning, application and associated assumptions refer to paragraphs 7.2-7.4.

**Table 1 Reliability parameters for Signal Conditioners SW5580 & 5580 (all configurations).**

| **Configuration** | **$\lambda_S$** | **$\lambda_{DU}$** | **$\lambda_{DD}$** | **Type** |
|---|---|---|---|---|
| Input Channel (Accelerometer, Electro-Mechanical Velocity Sensor, Proximity Probe System) | 69,9 | 259,6 | 247,4 | A |
| Input Channel (Piezoelectric Velocity Sensor) | 70,4 | 260,1 | 317,5 | A |
| Common Part | 10,7 | 270,6 | 397,4 | B |
| Analog Output Channel | 0,0 | 4,3 | 38,2 | A |
| Digital Output (Electromechanical Relay) | 892,8 | 192,4 | 4,6 | A |
| Digital Output (SS Relay) | 33,3 | 5,0 | 4,6 | A |
| **Systematic Capability (SC)** | 2 (Route $1_S$) | | | |

**Notes:**

- Route 1H has been applied
- All failure fates are in FIT (Failure In Time 1 FIT = 1 failure / $10^9$ hours).
- For each safety functions indicated at para. 7, the device can be used up to SIL 1 with HFT=0. SIL 2 is achievable with HFT=1.
- Even if the output relays or input channels are used in redundancy (1oo2), the common part must always be considered with HFT=0 (1oo1).
- If the device is used with two input probes, they cannot be of the same type, otherwise the device cannot be used in SIL applications.

## 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 with 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 Smart Vibration Signal Conditioner SW5580/5580 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 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 faults that cause the failure of the safety function, as the Signal Conditioner output signal is no more reliable, and the machine is not tripped even if the dangerous vibration threshold is reached. The high vibration level is then not detected and the EUC could be seriously damaged. The two main phenomena leading to undetected failures are drift and non-linearity. The former causes the addition of unwanted signals to the current exit (white noise or communication interference) that modify the output signal while maintaining it in specs; this renders diagnostic methods ineffective. When linearity loss occurs, the 4-20 mA transmitter output is no more linearly related to the vibration level (in/s or mm/s), so the logic solver is unable to correctly convert the current signal to the corresponding vibration value, as the logic has been calibrated using a linear calibration curve.

The dangerous detected failure rate $\boldsymbol{\lambda_{DD}}$ value is due to Signal Conditioner faults (i.e. short circuit, open circuit and faults causing signal under-range and over-range) leading to the output current signal to exit the normal operating range 4-20mA. As the transmitters do not have internal diagnostics capabilities, the SIS logic solver shall be able to detect these Signal Conditioner faults through its current output signal.

**IMPORTANT**

**If the logic solver is not able to detect the output current signal over-range and under-range, $\lambda_{DU}$ 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 $\lambda_{RES}$ 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).

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.

The input and output channel of the Smart Vibration Signal Conditioner SW5580/5580 have been classified as **type A**– refer to para. 7 -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.

The Common Part (Logic Part) of the Smart Vibration Signal Conditioner SW5580/5580 have been classified as **type B** elements if used for the **common part** – refer to para. 7 -following 7.4.4.1.3. 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 mode of at least one constituent component is not well defined; or
b) the behavior of the element under fault conditions cannot be completely determined; or
c) there is insufficient dependable failure data to support claims for rates of failure for detected and undetected dangerous failures

# 8. REQUIREMENTS FOR IMPLEMENTATION INTO A SIS

Signal Conditioner shall be connected to a logic device that

- reads the sensor 4-20mA output signal and trip the machine if the vibration or acceleration or velocity or thrust dangerous threshold is reached. The Logic solver shall also be able to recognize the transmitter fault through its signal and shall be programmed to recognize and communicate signal under and over range and consequently to trip the machine.
- (just for SW5580) reads digital values and trip the machine if the dangerous configurable threshold is activated. The output relays, in order to be used for SIL application, shall be configured as open-to-trip and latched.

**WARNING!**

**Machine under control must be tripped if the transmitter output signal is out of the 4-20mA normal operating range.**

## 8.1. DEVICE CONNECTION

The signal conditioners are provided with a sensor malfunction detector. In the event of an open circuit, the output current will drop below 3.6 mA and the LED turns red. The signal conditioners also detect incorrect polarity or shorted cable conditions.
SENSOR (Signal Input): Connect the transducer or charge amp output cable leads to these terminals. If the transducer is a self-generating velocity pickup, polarity is arbitrary unless the signal polarity at the SIG OUT BNC connector is important for analysis purposes. If proximity sensor, accelerometer, piezoelectric velocity transducer or charge amp is used, correct polarity must be observed. 4-20 mA (Current Source Output): Wire the receiving device to these terminals, observing correct polarity. The total resistance of the receiver input and wiring must be between 25 and 600 ohms, up to 2000 meters (6500 ft). SIG OUT (Signal Output): This signal is identical to the input signal and is buffered for driving remote vibration analysis instruments. The terminal block terminals can send a signal up to 300 meters (1000 ft). The BNC can send the raw signal 5 meters (16 ft). 24 VDC (Power Input): For best results, the sum of the DC power voltage, plus or minus AC ripple and noise, should be within 20 to 30 volts. In Class I, Div 2, Groups A, B, C & D locations, the signal conditioner may be wired in accordance with page 4 or drawing 9031 for the 5580 Smart Signal Conditioner and page 5 or drawing for the SW5580 Dual Channel Configurable Switch. If the sensors going to the 5580/SW5580 are in a Class I, Div 1 or Zone 0 or 1 area then barriers will be required in accordance with the approved sensor drawings. The pin-out for the 5580 wiring diagram is shown in Table 2.

The SW5580 Dual Channel Configurable Switch comes with either Mechanical (Dry Contacts) Relays (4 SPDT 240/120 VAC resistive load, or 5A 24 VDC resistive load) or Solid State Relays (4 SPST, 100 mA, 120 VAC, or 24 VDC). The pin-out for the SW5580 wiring diagram is show in Table 2.

<table>
<tr><td>PIN</td><td colspan="2">Channel 1</td><td colspan="2">Channel 2</td></tr>
<tr><td>1</td><td colspan="2">4-20mA +</td><td colspan="2">4-20mA +</td></tr>
<tr><td>2</td><td colspan="2">4-20mA -</td><td colspan="2">4-20mA -</td></tr>
<tr><td>3</td><td colspan="2">Raw signal out +</td><td colspan="2">Raw signal out +</td></tr>
<tr><td>4</td><td colspan="2">Raw signal out -</td><td colspan="2">Raw signal out -</td></tr>
<tr><td>5</td><td>NC</td><td>PS</td><td>NC</td><td>PS</td></tr>
<tr><td>6</td><td>A/V +</td><td>PC</td><td>A/V +</td><td>PC</td></tr>
<tr><td>7</td><td>A/V -</td><td>PP</td><td>A/V -</td><td>PP</td></tr>
<tr><td>8</td><td>+</td><td rowspan="2">+24VDC</td><td colspan="2">NC</td></tr>
<tr><td>9</td><td>-</td><td colspan="2">NC</td></tr>
</table>

<table>
<tr><td>PIN</td><td colspan="2">Channel 1</td><td colspan="2">Channel 2</td></tr>
<tr><td>1</td><td colspan="2">4-20mA +</td><td colspan="2">4-20mA +</td></tr>
<tr><td>2</td><td colspan="2">4-20mA -</td><td colspan="2">4-20mA -</td></tr>
<tr><td>3</td><td colspan="2">Raw signal out +</td><td colspan="2">Raw signal out +</td></tr>
<tr><td>4</td><td colspan="2">Raw signal out -</td><td colspan="2">Raw signal out -</td></tr>
<tr><td>5</td><td>NC</td><td>PS</td><td>NC</td><td>PS</td></tr>
<tr><td>6</td><td>A/V +</td><td>PC</td><td>A/V +</td><td>PC</td></tr>
<tr><td>7</td><td>A/V -</td><td>PP</td><td>A/V -</td><td>PP</td></tr>
<tr><td>8</td><td>+</td><td rowspan="2">+24VDC</td><td>+</td><td rowspan="2">Reset</td></tr>
<tr><td>9</td><td>-</td><td>-</td></tr>
<tr><td></td><td>Dry Contacts</td><td>Solid State</td><td>Dry Contacts</td><td>Solid State</td></tr>
<tr><td>10</td><td>Alert N.O.</td><td>Alert +</td><td>Alert N.O.</td><td>Alert +</td></tr>
<tr><td>11</td><td>Alert N.C.</td><td>Not Used</td><td>Alert N.C.</td><td>Not Used</td></tr>
<tr><td>12</td><td>Alert Common</td><td>Alert -</td><td>Alert Common</td><td>Alert -</td></tr>
<tr><td>13</td><td>Danger N.O.</td><td>Danger +</td><td>Danger N.O.</td><td>Danger +</td></tr>
<tr><td>14</td><td>Danger N.C.</td><td>Not Used</td><td>Danger N.C.</td><td>Not Used</td></tr>
<tr><td>15</td><td>Danger Common</td><td>Danger -</td><td>Danger Common</td><td>Danger -</td></tr>
</table>

**Table 2 - Table 2 - 5580 & SW5580 Pinout**

**IMPORTANT**

**The dynamic signal is not suitable for SIL application**
**If the device is used with two input probes, they cannot be of the same type, otherwise the device cannot be used in SIL applications.**

## 9. PROOF TEST

The proof test interval shall not exceed 5 years. Signal Conditioners SW5580 & 5580 shall be tested verifying that the correct functioning has not been compromised by the continuous exposition to vibration.

**IMPORTANT**
**The proof test interval shall be chosen taking into consideration the main characteristics of each safety function where the Signal Conditioner is involved. This selection it's under the sole responsibility of who is in charge to implement the SW5580 & 5580 into the SIS and shall not exceed the 5 years.**

Description of the test

This test is executed in order to verify the device correct response.
The Signal Conditioner must be connected to the Input Simulator that shall simulate the relevant measurement: velocity, or acceleration or proximity signals.
For every amplitude value, the corresponding transmitter output current value shall be compared with the values reported in the table below. This test allows to verify if the signal current output belongs to the normal operating range 4-20mA, the linearity of said signal and the correct behaviors of the output relays (just for SW5580).

Test Instrument and equipment

- Power supply
- 3x Digital Multimeters
- Input Simulator (i.e. Signals Generator)

Test procedure

- Connect the Input Simulators to the Signal Conditioner.
- Connect the Analog Output to the Multimeter
- (SW5580) Connect the Digital Outputs to two different Multimeters.
- (SW5580) Set the alarm threshold (Relay 1) to 25% of full-scale range (open to trip-latched).
- (SW5580) Set the danger threshold (Relay 2) to 50% of full-scale range (open to trip-latched).
- Acquire the input signals changing the amplitude from 0 to 1 (% of the full-scale range)

| Amplitude | Output | (SW5580) Relay 1 (Alarm Threshold) | (SW5580) Relay 2 (Danger Threshold) |
|---|---|---|---|
| 0%FS | 4,0mA | Closed | Closed |
| 26%FS | 8,2mA | Open | Closed |
| 51%FS | 12,6mA | Open | Open |
| 80%FS | 16,8mA | Open | Open |
| 100% | 20,0mA | Open | Open |
| 20%FS | 7,2mA | Open (Latched) | Open (Latched) |

**Table 3 - Expected Outputs**

**NOTE**
1) When comparing the output values consider a 5% tolerance

Test results

The result of the test can be considered positive if the Signal Conditioner analog outputs for the different input amplitudes to the values reported in the table (consider a 5% tolerance).
For the SW5580 Signal Conditioner also the Outputs Relays behavior shall correspond to what indicated in the Table 3.
If there is no value correspondence the test is not passed, and the Signal Conditioner must be replaced with a correct functioning one.

Following the above procedure, the proof test coverage is 90%.

**WARNING!**

**Even if the proof test has been properly carried out, wrong or inappropriate maintenance may compromise the switch Follow the instruction listed in the user manual is mandatory to ensure the correct operability of this equipment and consiquently of the whole SIS.**