Safety Manual

Figure ESW small Transmitter Ex-i M 10-25_SIL

Electronic vibration monitoring unit

ESW®-small-Transmitter 10-**_SIL
ESW®-small-Transmitter M 10-**_SIL
ESW®-small-Transmitter Ex-d M 10-**_SIL
ESW®-small-Transmitter Ex-i M 10-**_SIL

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applicable documents:	user manual data sheet

technical changes reserved!
The company holthausen elektronik GmbH is certified according to DIN EN ISO 9001.

holthausen elektronik GmbH
Wevelinghoven 38
41334 Nettetal
Tel.: +49 (0) 21 53 - 40 08
Fax: +49 (0) 21 53 - 89 99 4
info@holthausen-elektronik.de
www.holthausen-elektronik.de

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These operation instructions are to be read through completely and carefully heeded before starting the device. Failure to heed or adhere can result in claims on manufacturer's liability becoming null and void for damages ensuing there from.

Manual action of any manner on the device – with the exception of proper procedures and those described in these operation instructions – lead to forfeit of guarantee and exclusion from liability.

The device is solely intended for the usage as described below. It is particularly not intended for the direct or indirect protection of persons.

holthausen elektronik GmbH assumes no liability whatsoever as regards suitability for some specific purpose.

If any question should remain open, please never hesitate to contact us.

holthausen elektronik GmbH
Wevelinghoven 38, 41334 Nettetal
Tel.: +49 (0) 21 53 - 40 08
Fax: +49 (0) 21 53 - 8 99 94
Mail: info@holthausen-elektronik.de

1. Functional saftey

1.1 General

Coverage

This safety manual applies to the electronic vibration monitoring unit:

- ESW®-small-Transmitter 10-**_SIL
- ESW®-small-Transmitter M 10-**_SIL
- ESW®-small-Transmitter Ex-d M 10-**_SIL
- ESW®-small-Transmitter Ex-i M 10-**_SIL

Device variants

M:	For maritime, area of application on ships.
10:	Version with current sink in 2-wire technology.
**:	consecutive numbering of version. The versions differs at the length of the connection cable, the measurand and the measuring range as well as the frequency range, which can be between 2Hz and 2kHz.
Ex-i:	use in hazardous area, ignition protection type intrinsically safe
Ex-d:	use in hazardous area, ignition protection type flameproof encapsulation
SIL:	The device is suitable for the usage in safety-related tasks.

for example: **ESW®-small-Transmitter Ex-i M-10-25_SIL**

In the full type designation, the asterisks are replaced by digits, to identify different device variants, which differ in the measuring range, frequency range and signal evaluation.
These variants don´t affect to any basic function.

<u>- General technical data of the device-series ESW-Transmitter</u>

Measurand:	Acceleration or velocity
Signal evaluation:	Average or Peak value
Measuring range:	1 to 10g respectively. 10mm/s to 50mm/s in measuring direction
Frequency range:	2Hz to 2kHz
Signal output:	Current sink
Accuracy:	+/- 10%
Temperature range	-40°C - +50°C for the Ex-i-version -40°C - +80°C for additional versions

Field of application

The electronic vibration monitoring unit can be deployed for monitoring vibrations and oscillations at machines with rotating components like centrifuges, pumps and ventilators, which meet the special requirements of the safety technologies.
In a single-channel architecture it´s possible up to SIL2.

Different versions	Depending on the design of the monitored machine, own appropriate values must be specified for measuring range and measurement frequency. The frequency range shall be chosen such that all relevant vibration components are captured and possible interference signals are hidden. Depending on the version of the device, different response-times can be result in. Before mounting of the device, it must be checked with the device name, if the used version of the device is actually correspond to the intended version.
Installation-place and - position	In order that the device work reliably and as expected, the installation-place and installation-position must be selected carefully. Please observe for this the instructions in the user manual. Ensure, that the device is only installed at the intended installation place and only in the intended installation position.

Use in safety-oriented applications up to SIL2

Conditions:	The operation mode of the device is usually the low demand mode. The analog values 0 to 3,8mA and above 22mA will be detected in the superior control as a fault, the process goes into the safe state. At the usage of the operating mode PFH(High Demand) up to SIL2,it will be strongly recommended, to monitor also the position of the 4mA. If the signal output remains at 4mA ,despite the machine is running, it must be assumed of a disturbance and the safe state have to be initiate. - A measurement deviation less than 10% of the measurand have no effects at the safety function. - The functioning of the device must be checked every 5 years by the prooftest. **For the diagnosis or evaluation of the 4-20mA signal, the customer respectively the user is responsible.**
SIL-conformity	The SIL-conformity will be occupied by the proof documents at the appendix.

Acronyms, terms

SIL	Safety Integrity Leevel
HFT	Hardware Fault Tolerance
SFF	Safe Failure Fraction
PFD	Probability of dangerous Failure on Demand
PFH	Probability of a dangerous Failure per Hour

FMEA	Failure Mode and Effects Analysis
λ_{SD}	Rate for safe detected failure
λ_{SU}	Rate for safe undetected failure
λ_{DD}	Rate for dangerous detected failure
λ_{DU}	Rate for dangerous undetected failure
DC	Diagnostic Coverage
FIT	Failure In Time (1 FIT = 1failure/10E9 h)
MTTF	Mean Time To Failure

Additional acronyms and terms are named in the IEC 61508-4

Relevant standards

IEC 61508	Functional safety securityrelated electrical/electronic/programmable electronic systems
IEC 61511-1	Functional safety Safety instrumented systems for industrial processes

One example for a safety-related system can be found at the appendix under point 5.2.2, safety-related system(SIS)

1.2 Project planning

Safety function

The safety function of this vibration monitoring consists in to grab the mechanical oscillation at the operation area, convert the vibration-level into a proportional electrical signal and transmit this signal to the following superior control for further processing.

Diagnosis

The following superior control monitors the signal.

At the usage of the operating mode PFD (Low Demand) up to SIL2, a current below 3.8mA and above 22mA must be detected as a fault. The control initiate the safe state.
(For example shut down)

At the usage of the operating mode PFH (High Demand) up to SIL2, it will be strongly recommened, to monitor also the position of the 4mA.
If the signal output remains at 4mA ,despite the machine is running, it must be assumed of a disturbance and the safe state have to be initiate.

Safe state

The safe state occurs, if the superior control can detected a fault and the system can be brought into the safe state.

PFD = Probability of a dangerous failure on demand
≈ PFH * 5years/2

PFH = mean frequency of a dangerous failure per hour
≈ 1/MTTF

Accuracy

If the device displays more than the real value, a failure is present at the safe direction. Should the device display less than 10%, it´s a failure in the dangerous direction.

Assembly and installation, commissioning

- Assembly, installation and commissioning are descriped in the user-manual.
- Additional information can be found in the data sheet.

Behavior in operation and in case of failure

- The behavior and in case of failure are descriped in the user-manual.

Retest (TProof)

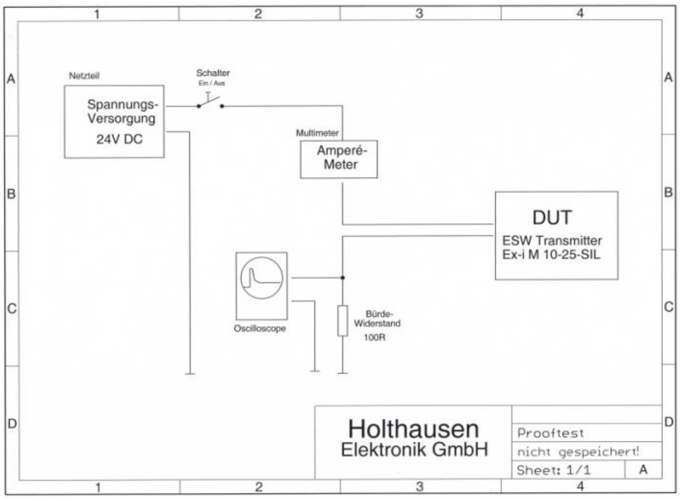
- According to IEC 61508-4, section 3.8.5, the recurrent test to cover concealed hazardous failures in a safety-related system.

- simple functional testing

For a simple functional testing, the device can dismantled and shaked in the measurement direction by hand. At rest, a current of 4mA must be flown, whereas shaking the device the current must increase. The degree of increase depends on the technical data of the device and the intensity of shaking.

- Functional check in assembled condition

If the device is firstly switched off and after this turned on, the inrush current must increase up to 10 to 15mA and then must have fallen down within 1 second to 4mA. If the transient response process is missing, the functionality must be doupted and the device must be checked.
The transient response can be measured with the oscilloscope, for example as a voltage drop at the load resistance.
At a load resistance of 100R, the voltage first increase up to 1V to 1.5V and then decrease within 1 second to 0.4V.
Also with a multimeter, the transient response can be detected unequivocal. However, the displayed maximum value depends on the switch on moment and the measurement rate of the multimeter.
If the transient response is absent, the current consumption immediatly jumps from 0mA to 4mA. This can be clearly distinguishing on the oscilloscope and multimeter.



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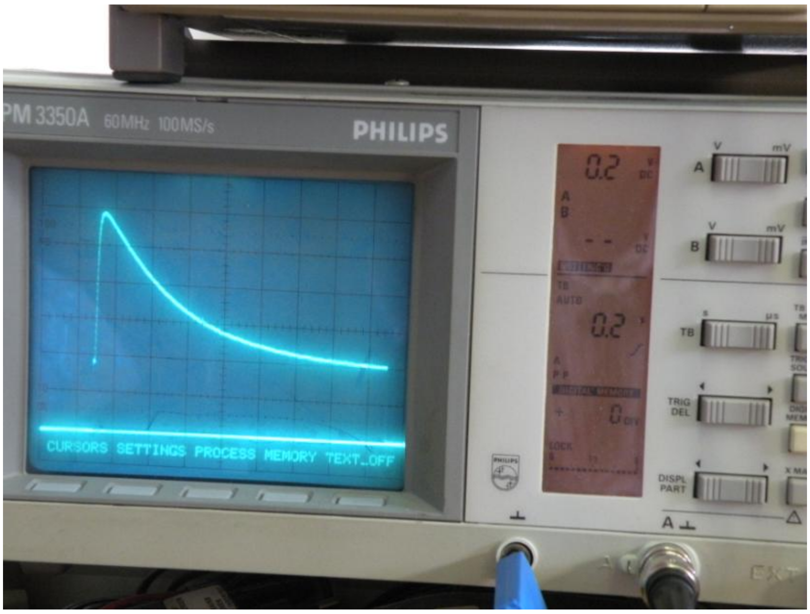

Figure oft he transient process

- Function control in operation

When the device display lower values in normal operation than usual or display no oscillations and remains at 4mA, the functionality must be doupted and the device must be checked.

- complete function test

For a complete function verifiying, the devices must be sent back for verifying to the company holthausen elektronik.

Repairs

Defect devices cannot be repaired. If the condition is questionable, the devices must be sent back for verifying to the company holthausen Elektronik.

Useful life

- The useful life is depending on the ambient temperature between 10 years, at medium ambient temperatures above 50°C and at 20 years, at temperatures below 50°C.
- The maximum useful life is limited at 20 years.

Maximum reaction time

- The maximum reaction time depends on the lower cut-off frequency of the choosen frequency range.
  At the lower cut-off frequency of 10Hz, there are to be expected with the maximum reaction time of 1s. At 1Hz, there are to be expected with a maximum of 10s.
  The valid values for your version can be found in the data sheet.

1.3. Safety performance indicators

Failure category	Failure rates (fit)
- Fail Safe Detected (λ_{SD})	18,45 FIT
- Fail Safe Undetected (λ_{SU})	66,3 FIT
- Fail Dangerous Detected (λ_{DD})	0 FIT
- Fail Dangerous Undetected (λ_{DU})	23,96 FIT
- Total failure rate	108,71 FIT
- SFF	78 %
- PFH = 1/ MTTF	≈ 1/4764 years
- PFD = PFH * $T_{(Proof)}/2$	≈ 1/1905
- MTTF	1052 years
- DC	no internal diagnosis The superior control must detect a disturbance at a current ≤3,8mA and ≥22mA. For SIL 2 High Demand the 4mA position should be monitored
- Category	______
- Performance Level	______
- $T_{(Proof)}$	5 years

Error descirption

- Fail Safe Detected (λSD)

= A Failure at the non dangerous direction, which will be detected.

A Fail Safe Detected (λSD) is available:

1. When the device receives a current less than 3.8mA due to a power failure or a defect, and this condition is recognized by the higher-level controller.
2. When the device receives a current more than 22mA due to a defect, and this condition is recognized by the higher-level controller.

- Fail Safe Undetected (λSU)

= A Failure at the non dangerous direction, which will not be detected.

A Fail Safe Undetected (λSD) is available:
When the device displays a stronger oscillation, which is in fact doesn´t exist.

- Fail Dangerous Detected (λDD)

= A Failure at the dangerous direction, which will be detected.

The case that a hazardous failure is detected, but does not lead to a reaction, does not occur.

- Fail Dangerous Undetected (λDU)

= A Failure at the dangerous direction, which will not be detected.

A Fail Dangerous Undetected (λDU) is available:

1. When the device outputs a signal for a weaker vibration ,as real existing vibration.
2. When the device receives a constant current from 3,8mA to 22mA due to a defect and real vibrations are not output.

2. Annex

2.1 SIL- declaration of conformity

Data sheet to the functional safety

2.2 Safety-related system (SIS)

A safety-related system usually consists of three subsystems input-subsystem(sensor), logic- subsystem and outputsubsystem.
The average probability of a failure PFD_{AVG} at a request is usually split as follows:

PFD_{AVG}: ≤ 35% ≤ 15% ≤ 50%

Average probability of a failure at a request (PFD_{AVG})
This list shows the achievable security integrity level(Sil) as a function of the average probability of a failure on request.

Safety integrity integrity level (SIL)	PFD_{AVG} with lower requirement rate (low demand mode)
4	$\geq 10^{-5}$ .. $< 10^{-4}$
3	$\geq 10^{-4}$ .. $< 10^{-3}$
2	$\geq 10^{-3}$ .. $< 10^{-2}$
1	$\geq 10^{-2}$ .. $< 10^{-1}$

Safety integrity of the hardware
for safety-related subsystems of type A (IEC 61508-2, 7.4.3)

proportion harmless fault (SFF)	fault tolerance of the hardware (HFT)		
SFF	HFT = 0	HFT = 1	HFT = 2
< 60%	SIL1	SIL2	SIL3
60% ... < 90%	SIL2	SIL3	(SIL4)
90% ... < 99%	SIL3	(SIL4)	(SIL4)
≥ 99%	SIL3	(SIL4)	(SIL4)