RIKEN KEIKI

Smart transmitter/Gas Detector Head

SD-3

Safety Manual

Document Number: PT2-306

[NOTE] The SD-3 is certified for functional safety (IEC 61508:2010 Part 2 and Part 3).
To ensure certified functionality, maintain the product as described in this document.

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Contents

Safety Manual

1 Purpose

This Safety Manual can be used at SIL2 in HFT 0 and SIL 3 in HFT 1. (SIL 3 Capable)
This document discusses topics for which the user is responsible if the SD-3 (this product), a certified device, functions as or is part of a configuration functioning as a safety instrument. These topics include proof testing, repairs and replacement, reliability data, product service life, environmental limitations, operational limitations, and various parameters. To ensure product safety, carefully read this document and all related documents.

This product monitors combustible gases, toxic gases, and oxygen concentrations at sampling points.

This safety device is designed to prevent gas-related accidents and injury by outputting a current (4 - 20 mA) to indicate the gas concentrations detected.

Classified as a sensor (subsystem) for safety devices, this product outputs 4 - 20 mA current according to the gas concentrations detected, or HART protocol signals when requested by the upstream system, to a logic section of the upstream system.

This product was developed for use as a single sensor in a SIL2 loop (IEC 61508).

1-1 Ambient conditions

Operating temperature range: -40 to +70 °C (no sudden changes)
Operating humidity range: 10 to 90 %RH (no condensation)
Storage temperature range: -10 to +40 °C (no sudden changes)
Storage humidity range: 10 to 90 %RH (no condensation)

1-2 Regulations and applicable standards (functional safety)

IEC 61508:2010 Parts 1 to 7
Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems

1-3 Applicable standards (other than functional safety standards)

Japanese explosion-proof	General provisions in 2015 technological standards Flameproof enclosures in technological standard 2018
EMC Directive	EN 50270:2015 (Type 2)
IECEx standards	IEC 60079-0:2017 IEC 60079-1:2014
ATEX Directive	EN 60079-0:2018 EN 60079-1:2014
Performance related	IEC/EN 60079-29-1 EN 45544-3 EN 50104
HART	HART7

1-4 Magnetic field threshold limit values (immunity level)

EN 50270:2015 request level

Table 1 Immunity test requirements: EN 50270:2015 (Type 2)

Item	Test Procedure	Specification	Criteria
Electrostatic discharges	EN 61000-4-2:2009	±6 kV (CD: contact discharge) ±8 kV (AD: air discharge)	A
Radio-frequency electromagnetic field	EN 61000-4-3:2006 +A1:2008 +A2:2010	10 V/m: 80 – 1,000 MHz 10 V/m: 1.4 - 2 GHz 3 V/m: 2 - 2.7 GHz 80 %AM, 1 kHz (unmodulated, rms)	A
Electrical fast transient/burst (DC power) (Earth line) (I/O signal)	EN 61000-4-4:2004 +A1:2010	(DC power, earth line) ±2 kV (5/50 ns, 5 kHz) (I/O Signal) ±1 kV (5/50 ns, 5 kHz)	A
Surges (DC power) (I/O signal)	EN 61000-4-5:2006	(DC power) ±2 kV (line to ground) ±1 kV (line to line) (1.2/50 (8/20) μs) (I/O signal) ±1 kV (line to ground) (1.2/50 (8/20) μs)	B
Radio-frequency common mode (I/O signal)	EN 61000-4-6:2009	0.15 - 80 MHz, 10 V (unmodulated, rms) 80 %AM, 1 kHz	A
Power frequency magnetic field	EN 61000-4-8:2010	50/60 Hz, 30 A/m (rms)	A
Voltage dips	EN61000-4-29	0 % residual voltage / 1,000 ms duration 40 % residual voltage / 1,000 ms duration	C
Short interruptions	EN61000-4-29	0 % residual voltage / 20 ms duration	C

2 Usage Instructions

2-1 Safety Functions

The following items are the safety functions of this product.

• Monitors combustible gases, toxic gases, and oxygen concentrations at sampling points.

• Safe status means the current is output to the upstream system according to the concentrations of the combustible gases, toxic gases, or oxygen being monitored. The product outputs 4 - 20 mA signals and HART protocol signals (*).

• 4 - 20 mA output

The relationship between the measured gas concentrations and 4 - 20 mA output is proportional. The output is 4 mA at F.S ×0 %, and when concentration is full scale, the output is 20mA at F.S×100 %.

* HART output is not included in the safety functions.

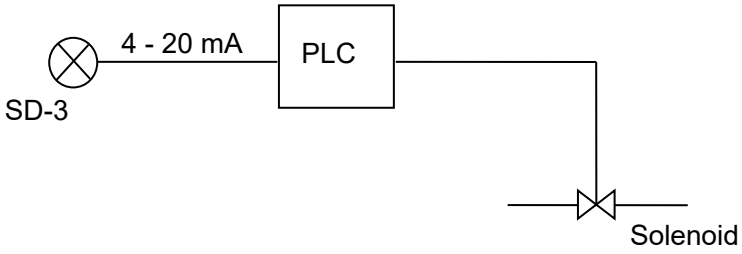
2-2 Non-functional safety features

The following features are not functional safety features:

- HART output
- Contact output (optional)
- RS485 output (optional)

System example

An example of a system that controls a solenoid valve via PLCs to create a shut off.



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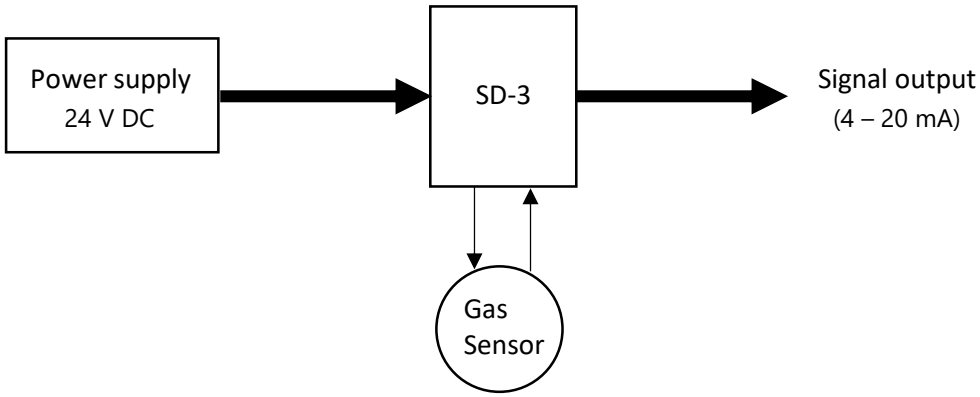

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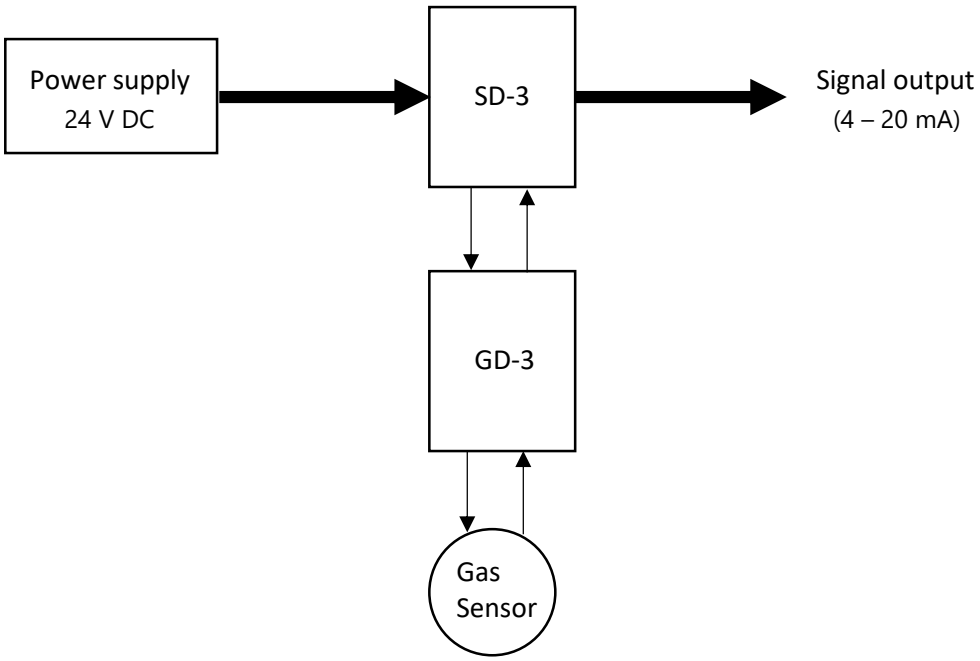

2-3 Safety accuracy

Safety accuracy: 20 %

*The FMEDA failure rate includes failures of internal parts causing deviations exceeding this accuracy.

Applicable sensors:	NCF series
Gas response:	50 % of response time is within 20 seconds
	90 % of response time is within 60 seconds

Applicable sensors:	IRF series
Gas response:	50 % of response time is within 20 seconds
	90 % of response time is within 60 seconds

2-4 Diagnosis response

ROM/RAM check self-diagnostic: 24 hours

Maximum response time for self-diagnostic results other than the above: 15 seconds

*This indicates that notification is output within this time with regard to part failures detected by the self-diagnostic.s. Note that this is the combined total time for the self-diagnostic test interval and failure response time.

2-5 Setup

Refer to the separate Operating Manual. Also test the parameters already set.

2-6 Proof test

The recommended intervals for running proof tests are 1 year for IRF and 6 months for NCF.

Proof test details:	Calibration, adjustment of 4 - 20 mA output values, sensor replacement, etc. (Refer to ‘Replacement of periodic replacement parts’ in the operating manual for the frequency for replacing sensors.)
Proof test standards:	Must allow/perform calibration. Alarm delay times and gas response times must meet performance expectations.
MTTR:	24 hours
Tools used:	Refer below

Tools used	Specifications	Maintenance
Calibration gas	Depends on gas type.	Must be traceable.
Calibration adapter	Dedicated calibration adapter for IRF sensors (4283 9011 00) Dedicated calibration adapter for combustible F sensors (4283 9012 70)	Undamaged
Pump	One with flow rate of 0.5 L/min or more One meeting explosion-proof specifications	Maintenance by the manufacturer
Flowmeter	One capable of measuring to 0.1 L tolerances One with markings allowing identification of flow rate settings and tolerances It is also possible to adjust the flow rate with a pump equipped with a flowmeter	Maintenance by the manufacturer
Piping	For general combustible gases – Material: Polyurethane Internal diameter: 4 mm Pipe length: Within 1 m For organic solvent gases – Material: Teflon Internal diameter: 4 mm Pipe length: Within 1 m For strongly adsorptive gases – Material: Teflon Internal diameter: 4 mm Pipe length: Within 10 cm	Undamaged

*Functionality anticipates disabling of product functions when performing the proof test.
*We recommend maintaining records of proof test results.
(Refer to the operating manual for more information.)
Proof test procedure
1) Make sure the safety functions are bypassed.
2) Confirm that the gas concentration reading on this product is zero.
3) Introduce the gas for gas calibration.
4) Perform checks of gas response time and 4 - 20 mA output values.
5) Restore the bypassed safety functions to finish the test.

*This product may malfunction if the proof test is not performed correctly. The proof test must be performed by trained service personnel.

2-7 Maintenance

For maintenance items other than the proof test, refer to ‘7. Maintenance’ in the operating manual.

2-8 Repairs and replacements

Refer to ‘7-7 Parts replacement’ in the operating manual.

2-9 Storage, Relocation, and Disposal

Refer to ‘8. Storage, Relocation, and Disposal’ in the operating manual.

2-10 Startup time (initialization time)

Initialization time is the time shown below from when the power for the product was turned on.

Proper gas detection is not possible during this time.

Model	Not compatible with EN	Compatible with EN
IRF	25 sec	60 sec
NCF	25 sec	60 sec

We plan to insert a reference to the operating manual. (The current description in the operating manual is inadequate.)

2-11 Updating firmware

You must return the product to a RIKEN KEIKI factory to update the firmware.

2-12 Reliability data

Failure rates, failure modes, and other information are recorded in the following FMEDA report.

Model	FMEDA report Report No.:
SD-3RI	RK 19/01-130 R001
SD-3NC	RK 20/05-036 R002

Refer to the separate ‘FMEDA Report’.

To satisfy SIL2, use at 1oo1 (HFT = 0). To satisfy SIL3, use at 1oo2 (HFT = 1).

2-13 Operation request frequency

Once annually or less

2-14 Operation mode

Low frequency operation request mode (frequency of operation requests is once annually or less)

2-15 Availability rate

Availability rate: Constantly available

2-16 Power source

Rating: 24 V DC

Allowable range: 18.0 to 30.0 V DC

2-17 Product service life

Product service life: 10 years from date of manufacture

The reliability data in the FMEDA report is valid only during this period.

2-18 Requested parameter settings

• The 4 - 20 mA output value in the event of a use involving burnout (failure) is 3.6 mA or less or 21 mA or greater.

• From a security perspective, use a write protect function that prevents changes in settings via HART protocol signals.

• The above requirements must be met for applications involving functional safety.

2-19 Limitations on installation and operating environments
Installation: Refer to ‘4. Installation’ in the operating manual.
Operating environment: Refer to ‘10. Product Specifications’ in the operating manual.

2-20 Application limitations
Refer to the separate Operating Manual for application limitations.

2-21 Identification of hardware/software configurations

SD-3NC

Software Version	Ver 1.1
Hardware Version	Ver 1.0

SD-3RI

Software Version	Ver 1.0
Hardware Version	Ver 1.0

2-22 Product Specifications
Refer to ‘10. Product Specifications’ in the operating manual.

2-23 Error codes and message
Corrective action and procedures when faults or errors occur
Refer to ‘Troubleshooting’ in the operating manual.

2-24 Operator interfaces
Refer to ‘Usage Instructions’ in the operating manual.

2-25 Prohibited items
Modification of this product is prohibited.

2-26 Terminology and abbreviations

Term

Safety	Freedom from unacceptable risk of harm.
Functional Safety	The ability of a system to carry out the actions necessary to achieve or to maintain a defined safe state for the equipment under control of system
Basic Safety	The equipment must be designed and manufactured such that it protects against resulting fire and explosion under explosive atmosphere
Safety Assessment	The investigation to arrive at a judgment - based on evidence - of the safety achieved by safety-related systems
Fail-Safe State	State that the defined fail-safe
Fail Safe	Failure that go to the defined fail-safe state without a demand from the process
Fail Dangerous	Failure that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state). Failure that deviates the process signal or the actual output by more than 15% of span, drifts away from the user defined threshold (Trip Point) and that leaves the output within active scale.
Fail Dangerous Undetected	Failure that is dangerous and that is not being diagnosed by automatic stroke testing.
Fail Dangerous Detected	Failure that is dangerous but is detected by automatic stroke testing.
Fail Annunciation Undetected	Failure that does not cause a false trip or prevent the safety function but does cause loss of an automatic diagnostic and is not detected by another diagnostic.
Fail Annunciation Detected	Failure that does not cause a false trip or prevent the safety function but does cause loss of an automatic diagnostic or false diagnostic indication.
Fail No Effect	Failure of a component that is part of the safety function but that has no effect on the safety function.
Low demand mode	Mode, where the frequency of demands for operation made on a safety-related system is no greater than twice the proof test frequency.

Abbreviations

FMEDA	Failure Modes, Effects and Diagnostic Analysis
HFT	Hardware Fault Tolerance Tolerance that to keep executing the function requested under the hardware fault and error condition
MOC	Management of Change Management of change the hardware or software elements, and keep traceability
PFDavg	Average Probability of Failure on Demand
SFF	Safe Failure Fraction The fraction of the overall failure rate of a device that results in either a safe fault or a diagnosed unsafe fault.
SIF	Safety Instrumented Function A set of equipment intended to reduce the risk due to a specific hazard.
SIL	Safety Integrity Level Discrete level (one out of a possible four) for specifying the safety integrity requirements of the safety functions to be allocated to the E/E/PE safety-related systems where Safety Integrity Level 4 has the highest level of safety integrity and Safety Integrity Level 1 has the lowest.
SIS	Safety Instrumented System Implementation of one or more Safety Instrumented Functions. A SIS is composed of any combination of sensor(s), logic solver(s), and final element(s).