



Functional Safety IEC 61508 SIL 2

Level Electrode NRG 16-40, NRG 17-40, NRG 19-40, NRG 111-40

Level Electrode NRG 16-41, NRG 17-41, NRG 19-41, NRG 111-41

Level Electrode NRG 16-41.1, NRG 17-41.1, NRG 19-41.1, NRG 111-41.1

Level Switch NRS 1-40

Level Switch NRS 1-41

Level Switch NRS 1-40.1

Level Switch NRS 1-40.2

Temperature Transmitter TRV 5-40 with

Temperature Sensor TRG 5-63, TRG 5-64, TRG 5-65, TRG 5-66,

TRG 5-67 or TRG 5-68

SPECTOR*bus* CANopen

EN
English

Original Installation Instructions
819259-00

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Important notes

Description NRG 1..-40, NRG 1..-41, NRS 1-40, NRS 1-41

The control device NRS 1-40 has two limiting functions for monitoring low water levels in steam boiler and (pressurized) hot water installations to TRD and EN 12952 and EN 12953.

The control device NRS 1-41 has one limiting function for monitoring the high water level.

The level electrodes type NRG 1..-40 and NRG 1..-41 detect the current water level and their readings are sent as a data telegram to the CAN bus.

The CANopen protocol is used for the data transfer via CAN bus.

Note that only one control device NRS 1-40 and NRS 1-41 may be used per CAN bus network.

By using the control units NRS 1-40 or NRS 1-41 you can switch off different circuits, e. g. the safety circuit for heating and the control circuit for the feedwater pumps or circulating pumps.

Description NRG 1..-40, NRG 1..-41, NRG 1..-41.1, TRV 5-40, NRS 1-40.1, NRS 1-40.2,

The control units NRS 1-40.1 / NRS 1-40.2 have four limiting functions for monitoring the MIN/MAX water levels (low/high level alarms) and MAX temperature in steam boiler and (pressurised) hot water plants in accordance with TRD and EN 12952 and EN 12953.

The level electrodes NRG 1..-40, NRG 1..-41, NRG 1..-41.1 and the temperature transmitter type TRV 5-40 detect the current water level and temperature and their readings are sent as a data telegram to the CAN bus.

The CANopen protocol is used for the data transfer via CAN bus.

Note that only one control device NRS 1-40.1 and NRS 1-40.2 may be used per CAN bus network.

By using the control units NRS 1-40.1 or NRS 1-40.2 you can switch off different circuits, e. g. the safety circuit for heating and the control circuit for the feedwater pumps or circulating pumps.

Functional Safety acc. to EN 61508

Safety characteristics of the subsystems

The listed equipment combinations are approved and meet the technical requirements of IEC 61508 for safety functions up to Safety Integrity Level **SIL 2**.

The safety parameters indicated in the following tables **Fig. 1** and **3** are based on an assumed proof test interval of 20 years and provided that the make contacts of the output relays of the control unit(s) are connected in series.

The equipment combinations correspond to a subsystem type B, which means that the behaviour under fault conditions of the used components cannot be completely determined. The functional safety of the equipment combination refers to the detection and evaluation of the water level or temperature and, as a consequence, the contact position of the output relays.

The configuration of the equipment combinations corresponds to the architecture 1oo2. This architecture consists of two channels that detect and diagnose faults in each other. If a fault is detected, the equipment combination will go to the safe state, which means that the contacts of both output relays will open the safety circuit.

Safety characteristics of the subsystems NRG 1..-40, NRG 1..-41, NRS 1-40, NRS 1-41

Safety characteristics	SIL	Architecture	Lifetime (a)	Proof Test Interval (a)
General	2	1oo2	20	20
Equipment combination			PFH_D	SFF
1 Level electrode NRG 1..-40 + 1 control unit NRS 1-40 (LW)			1.01x10 ⁻⁷ 1/h (101 fit)	97 %
2 Level electrodes NRG 1..-40 + 1 control unit NRS 1-40 (LW)			8.12x10 ⁻⁸ 1/h (81 fit)	97 %
1 Level electrode NRG 1..-40 + 1 control unit NRS 1-40 (LW) 1 Level electrode NRG 1..-41 + 1 control unit NRS 1-41 (HW)			2.02x10 ⁻⁷ 1/h (202 fit)	96 %
2 Level electrodes NRG 1..-40 + 1 control unit NRS 1-40 (LW) 1 Level electrode NRG 1..-41 + 1 control unit NRS 1-41 (HW)			1.82x10 ⁻⁷ 1/h (182 fit)	96 %

Fig. 1

Terms and abbreviations

Terms Abbreviations	Description
Safety Integrity Level SIL	Classification of the Safety Integrity Level acc. to IEC 61508
Proof Test Intervall (a)	Proof test interval (a) in years
Safe Failure Fraction SFF	Percentage of failures without the potential to put the safety-related system into a dangerous state
Probability Failure per Hour PFH _D	Probability of a dangerous failure

Fig. 2

Safety characteristics of the subsystems
NRG 1..-40, NRG 1..-41, NRG 1..-41.1, NRS 1-40.1, NRS 1-40.2, TRG 5-6., TRV 5-40

Safety characteristics	SIL	Architecture	Lifetime (a)	Proof Test Interval (a)
General	2	1oo2	20	20
Equipment combination			PFH_D	SFF
1 Level electrode NRG 1..-40 + 1 control unit NRS 1-40.1 (LW)			1.01x10 ⁻⁷ 1/h (101 fit)	97 %
2 Level electrodes NRG 1..-40 + 1 control unit NRS 1-40.1 (LW)			8.12x10 ⁻⁸ 1/h (81 fit)	97 %
2 Level electrodes NRG 1..-40 + 1 level electrode NRG 1..-41.1 + 1 control unit NRS 1-40.1 (LW/HW)			1.49x10 ⁻⁷ 1/h (149 fit)	97 %
2 Level electrodes NRG 1..-40 + 1 level electrode NRG 1..-41.1 + 1 temperature transmitter TRV 5-40 with temperature sensor TRG 5-6.. + 1 control unit NRS 1-40.1 (LW/HW/STM/STL)			2.19x10 ⁻⁷ 1/h (219 fit)	97 %
1 Level electrode NRG 1..-40 + 2 temperature transmitters TRV 5-40 with temperature sensor TRG 5-6.. + 1 control unit NRS 1-40.1 (LW/STM/STL)			1.60x10 ⁻⁷ 1/h (160 fit)	97 %
2 Level electrodes NRG 1..-40 + 1 temperature transmitter TRV 5-40 with temperature sensor TRG 5-6.. + 1 control unit NRS 1-40.1 (LW/STM/STL)			1.52x10 ⁻⁷ 1/h (152 fit)	97 %
2 Level electrodes NRG 1..-40 + 2 temperature transmitters TRV 5-40 with temperature sensor TRG 5-6.. + 1 control unit NRS 1-40.1 (LW/STM/STL)			1.39x10 ⁻⁷ 1/h (139 fit)	98 %
1 Temperature transmitter TRV 5-40 with temperature sensor TRG 5-6.. + 1 control unit NRS 1-40.1 (STM/STL)			1.05x10 ⁻⁷ 1/h (105 fit)	96 %
2 Temperature transmitters TRV 5-40 with temperature sensor TRG 5-6.. + 1 control unit NRS 1-40.1 (STM/STL)			9.23x10 ⁻⁸ 1/h (92 fit)	97 %
1 Level electrode NRG 1..-41 + 1 control unit NRS 1-40.2 (HW)			1.01x10 ⁻⁷ 1/h (101 fit)	97 %
1 Level electrode NRG 1..-41 + 1 temperature transmitter TRV 5-40 with temperature sensor TRG 5-6.. + 1 control unit NRS 1-40.2 (HW/STM/STL)			1.72x10 ⁻⁷ 1/h (172 fit)	96 %
1 Level electrode NRG 1..-41 + 2 temperature transmitters TRV 5-40 with temperature sensor TRG 5-6.. + 1 control unit NRS 1-40.2 (HW/STM/STL)			1.60x10 ⁻⁷ 1/h (160 fit)	97 %
1 Temperature transmitter TRV 5-40 with temperature sensor TRG 5-6.. + 1 control unit NRS 1-40.2 (HW/STM/STL)			1.05x10 ⁻⁷ 1/h (105 fit)	96 %
2 Temperature transmitters TRV 5-40 with temperature sensor TRG 5-6.. + 1 control unit NRS 1-40.2 (HW/STM/STL)			9.23x10 ⁻⁸ 1/h (92 fit)	97 %

LW = Low Water HW = High Water STM = Safety Temperature Monitor STL = Safety Temperature Limiter

Fig. 3

Determination of the Safety Integrity Level (SIL) for safety-related systems

Level electrodes, temperature transmitters, control units and actuators (auxiliary contactors in safety circuit) are subsystems and together constitute a safety-related system that executes a safety function. The specification of the safety-related characteristics **Fig. 1** and **3** refers to the level electrode or temperature transmitter and the level switch including the output contacts. The actuator (e. g. an auxiliary contactor in the safety circuit) is installation specific and, according to EN 61508, must be considered separately for the whole safety-related system.

Table **Fig. 4** shows the dependence of the Safety Integrity Level (SIL) on the average probability of failure on demand of a safety function for the **whole** safety-related system (PFD_{sys}). The "Low demand mode" is here considered for a water level limiter, which means that the frequency of demands for operation of the safety-related system is no greater than one per year.

Low demand mode PFD_{sys}	Safety Integrity Level (SIL)
$\geq 10^{-5} \dots < 10^{-4}$	4
$\geq 10^{-4} \dots < 10^{-3}$	3
$\geq 10^{-3} \dots < 10^{-2}$	2
$\geq 10^{-2} \dots < 10^{-1}$	1

Fig. 4

The table in **Fig. 5** indicates the attainable Safety Integrity Level (SIL) as a function of the Safe Failure Fraction (SFF) and the Hardware Fault Tolerance (HFT) for safety-related systems.

Hardware Fault Tolerance (HFT) for type B			Safe Failure Fraction (SFF)
0	1	2	
	SIL 1	SIL 2	< 60 %
SIL 1	SIL 2	SIL 3	60 % - < 90 %
SIL 2	SIL 3	SIL 4	90 % - < 99 %
SIL 3	SIL 4	SIL 4	≥ 99 %

Fig. 5

Directives and standards

EC Pressure Equipment Directive 97/23/EC

Water level limiters and safety temperature limiters/monitors are safety accessories as defined in the Pressure Equipment Directive (PED). The listed equipment combinations are EC type approved according to EN 12952/EN 12953. These Directives state, among other things, the requirements made on limiting systems and equipment for steam boiler plants and (pressurised) hot-water installations.

Functional Safety acc. to EN 61508

The equipment combinations are certified according to EN 61508. This standard describes the functional safety of safety-related electrical/electronic/programmable electronic systems.

The equipment combinations correspond to a subsystem type B with Safety Integrity Level (SIL) 2.

VdTÜV Bulletin "Wasserstand 100" (= Water Level 100)

The equipment combinations are type approved according to VdTÜV Bulletin "Wasserstand (= Water Level) 100. The VdTÜV Bulletin "Wasserstand (=Water Level) 100" specifies the requirements made on water level control and limiting equipment for boilers.

DIN EN 14597

The equipment combinations are type approved according to DIN EN 14597. DIN EN 14597 describes and specifies the requirements made on safety temperature limiters/monitors.

LV (Low Voltage) Directive and EMC (Electromagnetic Compatibility)

The equipment combinations meet the requirements of the Low Voltage Directive 2006/95/EC and the EMC Directive 2004/108/EC.

ATEX (Atmosphère Explosible)

According to the European Directive 94/9/EC the equipment must **not** be used in potentially explosive areas.

Note on the Declaration of Conformity / Declaration by the Manufacturer C€

For details on the conformity of the equipment combinations according to the European Directives see our Declaration of Conformity or our Declaration of Manufacturer.

The current Declaration of Conformity and Declaration of Manufacturer are available in the Internet under www.gestra.com/documents or can be requested from us.



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