# SAFETY MANUAL

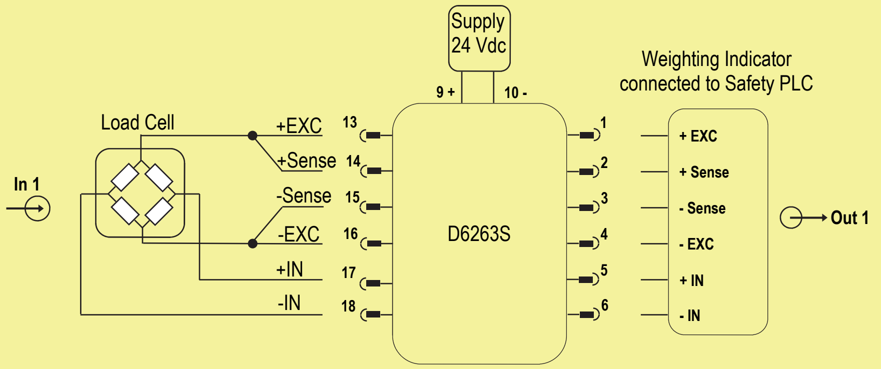
## SIL 2 Load Cell/Strain Gauge Bridge Isolating Repeater DIN-Rail and Power Bus Model D6263S

**Approval:** TÜV Certificate No. C-IS-722160171, SIL 2 conforms to IEC61508:2010 Ed.2 .
SIL 3 Functional Safety TÜV Certificate conforms to IEC61508:2010 Ed.2, for Management of Functional Safety.

Reference must be made to the relevant sections within the instruction manual ISM0473 and ISM0154 (for SWC5090 Configuration Software instruction manual), which contain basic guides for the installation and configuration of the equipment.

gm technology for safety

## Application for D6263S - with output connected to a weighting indicator read by Safety PLC



**Description:**

The module is powered by connecting 24 Vdc power supply to Pins 9 (+ positive) - 10 (- negative). The green LED is lit in presence of supply power.
Connect load cell or strain gauge bridge voltage supply at terminal “13” positive and terminal “16” negative.
Connect load cell or strain gauge bridge voltage sensing supply at terminal “14” positive and terminal “15” negative.
If load cell or strain gauge bridge has no internal voltage sensing capability always connect terminal "14" to terminal "13" and terminal "15" to terminal "16"; for better performance connect the wire at the end of the line near the load cells.
Connect load cell or strain gauge bridge output signal at terminal “17” positive and terminal “18” negative.
About output, connect weighting indicator: voltage supply at terminal “1” positive and terminal “14” negative; voltage sensing supply at terminal “2” positive and terminal “3” negative; output signal at terminal “5” positive and terminal “6” negative. The weighting indicator must be read by a Safety logic solver or Safety PLC.

**Safety Function and Failure behavior:**

D6263S is considered to be operating in Low Demand mode, as a Type B module, having Hardware Fault Tolerance (HFT) = 0.
The failure behavior of D6263S module is described by the following definitions:

□ fail-Safe State: it is defined as absence of output voltage signal due to module shutdown;
□ fail Safe: failure mode that causes the module / (sub)system to go to the defined Fail-Safe state without a demand from the process;
□ fail Dangerous: failure mode that does not respond to a demand from the process or deviates the output voltage signal by more than 5% (± 1 mV) of the full scale;
□ fail High: failure mode that causes the output voltage signal to go above the maximum value (> 20 mV).
Assuming that the application program in the Safety logic solver is configured to detect over-range High failures, they have been classified as Dangerous Detected (DD) failures.
□ fail Low: failure mode that causes the output voltage signal to go to minimum value (≤ 0 mV) and supposing that the Safety logic solver is able to consider an under-range value as ≤ 0 mV. Assuming that application program in the Safety logic is configured to detect under-range Low failures, they have been classified as Dangerous Detected (DD) failures.
□ fail Dangerous Detected: a dangerous failure which has been detected from module internal diagnostic so that output voltage signal is forced to the minimum value ≤ 0 mV (as Fail Low) or above the maximum value > 20 mV (as Fail High).
□ fail “No effect”: failure mode of a component that plays a part in implementing the safety function but is neither a safe failure nor a dangerous failure.
When calculating the SFF this failure mode is not taken into account.
□ fail “Not part”: failure mode of a component which is not part of the safety function but part of the circuit diagram and is listed for completeness.
When calculating the SFF this failure mode is not taken into account.

As the module has been evaluated in accordance with Route 2H (proven-in-use) of the IEC 61508:2010, Diagnostic Coverage DC ≥ 60% is required for Type B elements.
Being HFT = 0, in Low Demand mode the maximum achievable functional safety level is SIL 2.
Failure rate data: taken from Siemens Standard SN29500.

**Failure rate table:**

| **Failure category** | **Failure rates (FIT)** |
|---|---|
| $\lambda_{dd}$ = Total Dangerous Detected failures | 185.89 |
| $\lambda_{du}$ = Total Dangerous Undetected failures | 40.61 |
| $\lambda_{sd}$ = Total Safe Detected failures | 0.00 |
| $\lambda_{su}$ = Total Safe Undetected failures | 97.08 |
| **$\lambda_{tot\ safe}$ = Total Failure Rate (Safety Function) = $\lambda_{dd} + \lambda_{du} + \lambda_{sd} + \lambda_{su}$** | **323.58** |
| **MTBF (safety function, single channel) = (1 / $\lambda_{tot\ safe}$) + MTTR (8 hours)** | **353 years** |
| $\lambda_{no\ effect}$ = “No effect” failures | 242.72 |
| $\lambda_{not\ part}$ = “Not Part” failures | 11.30 |
| **$\lambda_{tot\ device}$ = Total Failure Rate (Device) = $\lambda_{tot\ safe} + \lambda_{no\ effect} + \lambda_{not\ part}$** | **577.60** |
| **MTBF (device) = (1 / $\lambda_{tot\ device}$) + MTTR (8 hours)** | **198 years** |

**Failure rates table according to IEC 61508:2010 Ed.2:**

| $\lambda_{sd}$ | $\lambda_{su}$ | $\lambda_{dd}$ | $\lambda_{du}$ | DC | SFF |
|---|---|---|---|---|---|
| 0.00 FIT | 97.08 FIT | 185.89 FIT | 40.61 FIT | 82.07% | 87.45% |

where DC means the diagnostic coverage for the input sensor by module internal diagnostic circuits and by Safety logic solver. This type “B” system, operating in Low Demand mode with HFT = 0, has got DC = 82.07 % ≥ 60 % as required by Route 2H evaluation (proven-in-use) of the IEC 61508:2010.

**PFDavg vs T[Proof] table** (assuming Proof Test coverage of 99%), with determination of SIL supposing module contributes ≤10% of total SIF dangerous failures:

| T[Proof] = 1 year | T[Proof] = 5 years |
|---|---|
| PFDavg = 1.80 E-04 Valid for **SIL 2** | PFDavg = 9.00 E-04 Valid for **SIL 2** |

**PFDavg vs T[Proof] table** (assuming Proof Test coverage of 99%), with determination of SIL supposing module contributes >10% of total SIF dangerous failures:

| T[Proof] = 20 years |
|---|
| PFDavg = 3.60 E-03 - Valid for **SIL 2** |

**SC 3: Systematic capability SIL 3.**

## Testing procedure at T-proof

The proof test shall be performed to reveal dangerous faults which are undetected by diagnostic.
This means that it is necessary to specify how dangerous undetected faults, which have been noted during the FMEDA, can be revealed during the proof test.

**Proof test 1** (to reveal approximately 50 % of possible Dangerous Undetected failures in the repeater)

| Steps | Action |
|---|---|
| 1 | Bypass the Safety PLC or take any other appropriate action to avoid a false trip. |
| 2 | Set the input load cell to the High (see Safety Function definition) voltage signal and verify that the related analog output voltage reaches the corresponding value.<br>This test is for voltage compliance problems, such as a low power supply voltage or an increased wiring resistance, and for other possible failures. |
| 3 | Set the input load cell to the Low (see Safety Function definition) voltage signal and verify that the related analog output voltage reaches the corresponding value.<br>This tests is for possible quiescent current related failures. |
| 4 | Restore the loop to full operation. |
| 5 | Remove the bypass from the Safety PLC or otherwise restore normal operation. |

**Proof test 2** (to reveal approximately 99 % of possible Dangerous Undetected failures in the repeater)

| Steps | Action |
|---|---|
| 1 | Bypass the Safety PLC or take any other appropriate action to avoid a false trip. |
| 2 | Perform steps 2 and 3 of **Proof Test 1**. |
| 3 | Perform a two-point calibration (i.e. down and full scale) of the connected load cell and verify that, forcing some values of the input range, the output voltage related values are within the specified accuracy (5 % (± 1 mV) of full scale) as defined in the Safety Function.<br>This requires that the input load cell has already been tested without the repeater and it does not contain any dangerous undetected failures. |
| 4 | Restore the loop to full operation. |
| 5 | Remove the bypass from the Safety PLC or otherwise restore normal operation. |