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Tanks for transport of dangerous goods — Service equipment for tanks — Overfill prevention systems for liquid fuels

National foreword

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Foreword

This document (EN 13922:2011) has been prepared by Technical Committee CEN/TC 296 “Tanks for transport of dangerous goods”, the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2012, and conflicting national standards shall be withdrawn at the latest by March 2012.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 13922:2003.

Significant changes have been made to the following sections since the last edition:

— requirement concerning bonding of the tank shell to the vehicle's chassis added in 4.2;

— marking for equipment in hazardous areas updated and a note added in 6.3.7;

— referred standards updated.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

The overfill prevention system prevents the maximum filling level of a compartment of a tank vehicle from being exceeded by interrupting the filling operation on the loading site.

It is not the function of an overfill prevention system to prevent volume or weight overloading. The function of the overfill prevention system is the final means of containing loaded product within a compartment and preventing a dangerous condition. It is therefore of critical importance that all components have a high degree of reliability and that all European gantries provide a compatible system with the tank trucks.

Not all the components of an overfill prevention system are necessarily supplied by one manufacturer but may include cross-compatibility parts supplied by different manufacturers/suppliers.

1 Scope

This European Standard specifies the following points regarding the minimum requirements for an overfill prevention system:

— functions;

— major components;

— characteristics;

— test methods.

This European Standard is applicable to overfill prevention systems for liquid fuels having a flash point up to but not exceeding 100 °C, excluding liquefied petroleum gas (LPG). The requirements apply to overfill prevention systems suitable for use at ambient temperatures in the range from - 20 °C to + 50 °C, subjected to normal operational pressure variations.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 590, *Automotive fuels — Diesel — Requirements and test methods*

EN 60079-0:2009, *Explosive atmospheres — Part 0: Equipment — General requirements (IEC 60079-0:2007 + corrigendum Dec. 2010)*

EN 60079-11:2007, *Explosive atmospheres — Part 11: Equipment protection by intrinsic safety "i" (IEC 60079-11:2006 + corrigendum Dec. 2006)*

EN 61000-6-2, *Electromagnetic compatibility (EMC) — Part 6-2: Generic standards — Immunity for industrial environments (IEC 61000-6-2:2005)*

EN 61000-6-4, *Electromagnetic compatibility (EMC) — Part 6-4: Generic standards — Emission standard for industrial environments (IEC 61000-6-4:2006)*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
overfill prevention system
sensors or sensor circuits, interface plug/socket, overfill prevention controller and all connecting wiring and cables

3.2
cross-compatibility
ability of one part of the overfill prevention system to be able to work safely and satisfactorily with another part of the overfill prevention system although the parts are supplied by different manufacturers

3.3
diesel
according to EN 590

3.4
dry sensor
state of the sensor when not immersed in liquid

3.5
effective cycle time
time period taken for the overfill prevention system to identify a fault condition and switch to a non-permissive

3.6
fail-safe
switching to a non-permissive if any single component failure in the overfill prevention system renders the overfill prevention system unable to detect an overfill or loss of earth bond

3.7
five-wire system
uses five wire interface signals for liquid level detection

3.8
gantry control system
controls the loading of product into the transporting vehicle

3.9
gantry control system reaction time
time period commencing when the overfill prevention controller's output changes to non-permissive and ending with the cessation of all product flow after the closure of the gantry control valve

3.10
interface
ten-pin socket connection between the transporting vehicle and the gantry

3.11
inter-operable
ability of different parts of the overfill prevention system to operate together; the functional aspect of cross-compatibility

3.12
warm-up time
period to switch to a permissive state after plug connection is made to a vehicle socket with no sensor immersed in liquid

3.13
non-permissive
output state of the overfill prevention controller which disables liquid delivery

3.14
overfill prevention controller
device mounted at the gantry which connects to the transporting vehicle and which provides a permissive or non-permissive to the gantry control system

3.15
overfill prevention system response time
period commencing when a sensor becomes wet and ending when the controller output switches to non-permissive

3.16
permissive
output state of the overfill prevention controller which enables liquid delivery

3.17
self-checking
automatic and continuous checking of the integrity of an overfill prevention system's components to verify its ability to perform its minimum functions

3.18
sensor
device and any associated circuit mounted on or in a transporting vehicle's compartment and connected to interface socket which provides the wet or dry signal to the overfill prevention controller

3.19
sensor circuit
sensor not directly wired to the interface socket but using intermediate components/electronics to transfer the sensor output to the interface socket

3.20
signal specification
electronic wave form of the signal emitted by the controller

NOTE See Figure A.1.

3.21
two-wire system
uses two-wire interface signals for liquid level detection

3.22
wet sensor
state of a sensor just sufficiently submerged in liquid to initiate a change in output from permissive to non-permissive

4 Functions

4.1 To prevent overfilling of the transporting vehicle's compartment by providing a fail-safe output to a gantry control system.

4.2 To provide a fail safe monitored earth static bonding connection from the gantry to the transporting vehicle's shell via a bonding connection to the transporting vehicle's chassis.

4.3 To provide visual indication of the status of the overfill prevention system.

5 Major components

5.1 Vehicle mounted equipment

The following equipment shall be installed on the vehicle as a minimum:

- one sensor or sensor circuit per compartment;
- vapour recovery hose interlock switch;
- one 10 pin socket;
- wiring to the sensors;
- static earth bonding provision.

5.2 Equipment fitted at the gantry

The following equipment shall be installed at the loading gantry as a minimum:

— overfill prevention controller;

— one 10 pin plug and cable for connection to vehicle socket.

6 Characteristics

6.1 Overfill prevention system working characteristics

6.1.1 Overfill

The overfill prevention system shall be an electronic system, gantry based and gantry operated. The interface wiring shall be suitable for a two-wire or a five-wire overfill prevention system and the gantry based controller shall automatically detect the difference between either overfill prevention system through a standardized 10 pin plug and socket — see Figures A.2 and A.3 — and perform its functions.

Electrical specifications for the interface are included in Annex A.

If no wet sensor or system fault is detected, the controller shall give a permissive to permit loading to begin. Upon an overfill condition or the detection of any overfill prevention system or controller fault, the controller shall switch to non-permissive.

The overfill prevention system shall be fail safe and shall be self-checking. The effective cycle time between self-checks shall be less than the overfill response time.

The overfill prevention response time shall not exceed 700 ms.

The overfill prevention system shall be capable of handling up to and including the following number of compartments for each type of installation:

— two-wire system 8 compartments;

— five-wire system 12 compartments.

6.1.2 Bonding

The overfill prevention system shall provide an earth static bonding connection from the gantry to the vehicle chassis via the cable and connection plug and socket and shall continuously verify this connection throughout the loading operation.

Should any fault be detected or the electrical resistance of the connection exceed a maximum of 10 kΩ, the gantry controller shall switch to non-permissive.

6.1.3 Severe environmental condition

Where the overfill prevention system is subjected to temperatures outside the specified temperature range all applicable temperature values shall be extended. All other requirements shall remain unchanged.

6.2 Sensors

6.2.1 General

Any of the following types of sensors may be used:

- NTC thermistor, two-wire optic or other compatible device;
- five-wire optic or other compatible device;
- sensor circuit.

6.2.2 NTC thermistor, two-wire optic or other compatible sensor

Thermistor sensors shall have a negative temperature coefficient (NTC) and shall work at any temperature in the range from – 20 °C to + 50 °C.

Thermistor sensors have a warm-up time which shall not exceed 75 s with the thermistor sensor at an ambient temperature of – 20 °C.

NOTE Optic sensors have a negligible warm-up time.

Two-wire sensors can be used on vehicles with no more than 8 compartments. The overfill prevention controller shall always monitor 8 sensors and stop all loading if any sensor detects an overfill. Vehicles equipped with two-wire sensors with less than 8 compartments shall employ an electronic dummy sensor for the unused channels of the controller.

The electronic dummy sensor shall generate a permissive signal when it is connected to a controller. The signal shall correspond to a wave form as shown in Figure A.1 with the values according to Table A.4.

A two-wire optic or other compatible sensors shall work at any temperature in the range from –20 °C to +50 °C. When connected to a gantry controller, a dry sensor shall generate a permissive signal, which shall correspond to a wave form as shown in Figure A.1 with the values according to Table A.4.

6.2.3 A five-wire optic or compatible sensor

A five-wire optic sensor or other compatible sensors shall work at any temperature in the range from - 20 °C to + 50 °C. When connected to a gantry controller, a dry sensor shall generate a permissive signal, which shall correspond to a wave form as shown in Figure A.1 with the values according to Table A.1.

6.2.4 Sensor circuit

A sensor circuit shall comply with the requirements according to 6.2.2 and 6.2.3 as applicable.

6.2.5 Response time

The reaction time from sensor going wet to the change of state of the signal at the interface socket shall not exceed 250 ms.

6.2.6 Materials of construction

The manufacturer shall provide with the equipment a full material specification for those parts that may come into contact with the liquid.

6.2.7 Electrical requirements

At the interface each sensor or sensor circuit shall be suited for controller's intrinsically safe parameters. The electrical connections of the 10-pin-socket shall comply with Figure A.4 for a two-wire-system and Figure A.5 for a five-wire-system. The socket shall comply with Figure A.2.

6.3 Overfill prevention controller characteristics

6.3.1 Interface

The controller shall be fitted with the 10 pin plug (Figure A.3) and cable.

The controller shall be able to be connected to and communicate with both two-wire or five-wire circuits. The controller shall generate the specified wave forms (Annex A, Figure A.1, Table A.2 and A.5) as applicable to the type of circuit to which it is connected.

6.3.2 Outputs

The normal output condition shall be non-permissive. The output(s) shall switch to permissive only when all correct input conditions (earth static bond-made, all sensors dry and no overfill prevention system malfunction) are satisfied.

At least one "volt-free" normally open output contact shall be provided. Other types of outputs may be provided.

6.3.3 Response time

The response delay time from the change of state of the signal at the interface to the overfill prevention controller's output going non-permissive shall not exceed 450 ms.

6.3.4 Status indicators

The controller shall provide, as a minimum, separate visual status indicators:

— output non-permissive, colour RED;

— output permissive, colour GREEN;

— earth static bond status;

— wet sensor identification.

6.3.5 Materials of construction

The materials of the controller shall be suitable for the installed location.

6.3.6 Temperature range

The design operating temperature of the controller shall be – 20 °C to + 50 °C.

6.3.7 Electrical requirements

The overfill prevention controller's intrinsically safe parameters per output at the interface shall not exceed:

— U_{max} :13 V maximum external capacitance :10 µF;

— I_{max} : 250 mA maximum external inductance : 80 µH;

— $P_{max:}$: 0,7 W.

Minimum requirements for explosion protection per output at the interface shall be:

Ex ia IIA according to EN 60079-0:2009 and EN 60079-11:2007.

NOTE When connecting a five-wire sensor the above mentioned values for explosion protection can occur at 4 outputs (connection 4, 5, 6 and 8 according to Figure A.5).

6.4 Cable and plug interface characteristics

6.4.1 Plug

The dimension of the plug shall be in accordance with Figure A.3. To provide easy identification the plug colour shall be black. The electrical specification of the plug connection shall be in accordance with Table A.10.

6.4.2 Cable

6.4.2.1 Controller cable

The cable from the monitor to the plug shall meet the specifications of Table A.8. Flexible interconnection cable shall be made up of 10 individually screened cores.

The minimum cross-section area of each core shall be 1 mm². The core screens shall be connected together and taken to a common zero volt (Intrinsically Safe Earth) terminal at the controller. Core colours and pin assignments shall be according to Table A.16. The colour of the cable's outer sheath shall be blue.

6.4.2.2 Sensor cable

The cable on the vehicle from the sensor(s) to the socket shall meet the specifications of Table A.9.

6.4.3 Temperature range

The design operating temperature of the cable shall be – 20 °C to + 50 °C. The cable shall remain flexible throughout this temperature range.

7 Testing

7.1 General

Two different forms of tests shall be performed on overfill prevention systems. The type tests which are carried out on two sample production units, and the production tests which shall be performed upon all production items by the manufacturer. To ensure cross-compatibility, each part of a overfill prevention system shall be tested. When testing sensor/sensor circuits, the test shall be performed with the specified maximum number of sensing devices connected.

Calibrated standard test devices shall be used to provide the specified interface signals. Type tests shall additionally prove the operation of the overfill prevention system at the specified tolerance limits. Test liquid shall be diesel according to EN 590.

7.2 Type tests

7.2.1 General

Type tests shall include:

— performance testing;

— electromagnetic compatibility (EMC) tests;

— fail safe testing.

7.2.2 Performance tests

Performance tests shall be conducted as outlined in Annex A (Tables A.11 to A.15).

7.2.3 Electromagnetic compatibility (EMC) test

According to EN 61000-6-4 and EN 61000-6-2.

7.2.4 Fail safe testing

The fail safe operation of the overfill prevention system shall be verified as follows:

- failure of any single component, in short circuit or open circuit state, in the controller or in the sensor shall result in non-permissive or correct operation of the overfill prevention system; this may be verified by conducting a test or by conducting a circuit analysis;
- any opens or shorts in wiring to the sensors shall result in non-permissive or correct operation;
- power supply failure shall result in a non-permissive;
- failure of any functional component of a compatible sensor shall result in non-permissive or correct operation of the system; this may be verified by conducting a test or conducting a design analysis.

7.3 Production tests

Production tests shall be carried out by the manufacturer.

The tests shall cover, as a minimum:

a) on vehicle equipment:

   1) sensor test: each sensor or sensor circuit shall be tested for its wet and dry states;

   2) functional electrical test: ensure equipment meets manufacturer limiting values according to Figure A.1 and the appropriate Tables of Annex A.

b) gantry overfill prevention controller:

   1) functional electrical test to ensure proper operation of the permissive/non-permissive.

8 Marking

The separate parts of an overfill prevention system shall have identification plates or engraved or stamped markings which shall in addition to legal requirements include a reference to EN 13922.

9 Installation, operation and maintenance instructions

The equipment shall be provided with installation, operation and maintenance instructions.

The sensor switching point shall either be marked on the sensor or shall be clearly identified on the installation drawing.

Annex A
(normative)

Electrical specifications

A.1 Electrical specifications

Table A.1 — Electrical specifications for five-wire permissive signal (see Figure A.1)

Parameter	Min	Max	Units
Upper voltage (U_2)	5,3	—	V
Lower voltage (U_1)	—	0,8	V
Period (T_2)	30	100	ms
High pulse width (T_1)	0,8	2,5	ms

Table A.2 — Electrical specifications for controller in five-wire mode (see Figure A.1 and A.8)

Parameter	Min	Max	Units
Controller output voltage U_s	9,2	12	V
Supply voltage loaded at $I_s = 13 + 0{,}6\ (1/T_2 - 10)$ [mA][a]	8,2	—	V
Output pulse width (T_1)	0,2	2,5	ms
Output pulse period (T_2)	30	100	ms
Controller output U_2 at 4 mA	3,8	—	V
Controller output U_1	—	0,7	V
Controller output rise time	—	50	µs
Controller input resistance	30	—	kΩ
Controller reaction time from permissive to non-permissive	—	450	ms
[a] T_2 in seconds, dimensional equation determined empirically.			

Table A.3 — Electrical specification for five-wire sensor (see Figures A.1 and A.8)

Parameter	Min	Max	Units
Sensor current (I_{IN}), per sensor, with no input signal	—	1	mA
Sensor output U_2 at: U_s = 9,2 V, R_s = 923 Ω T_1 = 2,5 ms, T_2 = 100 ms	5,3	—	V
Sensor output U_2 at: U_s = 9,2 V, R_s = 444 Ω T_1 = 2,5 ms, T_2 = 30 ms	5,3	—	V
High pulse width (T_1)	0,8	2,5	ms
Output delay	—	100	µs
Output rise and fall time	—	50	µs
Sensor output impedance	—	1	kΩ
Effective signal input resistance at U_2 = 3,8 V	7	—	kΩ
Wet sensor response time	—	250	ms
Diagnostic output Resistance switched to ground Permissive condition (0,5 – 2 mA) Wet condition	 4,70 2	 4,80 —	 kΩ MΩ

Table A.4 — Electrical specification for two-wire interface (see Figure A.1)

Parameter	Min	Max	Units
Upper voltage (U_2)	5	—	V
Lower voltage (U_1)	—	3,6	V
Period (T_2)	8	50	ms
Duty cycle [(T_1/T_2) × 100 %]	20	80	%
High pulse width (T_1)	2	—	ms
Low pulse width (T_2 – T_1)	3	—	ms

Table A.5 — Electrical specification for controller in two-wire mode (see Figure A.1 and A.7)

Parameter	Min	Max	Units
Open output voltage (U_s)	9	12	V
Output current at thermistor switching threshold voltage	50	95	mA
Period (T_2)	8	50	ms
Duty cycle [$(T_1/T_2) \times 100$ %]	20	80	%
Controller reaction time from permissive to non-permissive	—	450	ms

Table A.6 — Electrical specification for two-wire optic sensor (see also Figure A.1 and A.9)

Parameter	Min	Max	Units
Supply current, high state (I_1)	—	20	mA
Low output voltage U_1 at I_2 = 95 mA	—	2,85	V
Period (T_2)	8	50	ms
Duty cycle [$(T_1/T_2) \times 100$ %]	20	80	%
Wet sensor response time	—	250	ms

Table A.7 — Electrical specification for two-wire thermistor sensors (see Figure A.10)

Parameter	Min	Max	Units
Period (T_2)	8	50	ms
Duty cycle [$(T_1/T_2) \times 100$ %]	20	80	%
Response time	—	250	ms
High pulse width (T_1)	2	—	ms
Low pulse width ($T_2 - T_1$)	3	—	ms

Table A.8 — Controller cable electrical specification

Parameter	Max	Units
Resistance of each wire	0,2	Ω
Total cable capacitance (each wire measured against shield)	8	nF

Table A.9 — Sensor cable electrical specification

Parameter	Max	Units
Resistance of each wire for 2-wire system	0,3	Ω
Resistance of each wire for 5-wire system	5	Ω
Total cable capacitance	12	nF

Table A.10 — Plug and socket electrical specification

Parameter	Max	Units
Resistance of each connection	0,5	Ω

A.2 Functional tests

Table A.11 — Functional test sequence of controller for five-wire interface arrangements according to Figure A.6

Step No.	Description of test step	Controller output	Remarks
1	Remove current meter. Adjust pulse generator output for U_2 = 7 V, U_1 = 0,8 V, T_1 = 1,5 ms and delay[a] = minimal.	permissive	Record U_s, U_1, U_2, T_2 and rise time of pulse output and verify against values in Table A.2. Verify T_1 presence at output of comparator and value within Table A.2.
2	Install current meter. Adjust potentiometer (P_1) for load current per formula in Table A.2 for value of T_2 measured in Step 1.	permissive	Read voltmeter and verify this value against U_s, under load in Table A.2.
3	Install pulse generator. Adjust pulse generator output for U_2 =5,3 V, U_1 = 0,8 V, T_1 = 0,8 ms and delay[a] = minimal.	permissive	—
4	Adjust generator output for T_1 = 2,5 ms.	permissive	—
5	Adjust generator delay = 1,2 ms. Repeat Steps 3 and 4.	permissive	—
6	Adjust generator output for steady DC voltage = 3,2 V.	non-permissive	—
7	Repeat Step 3.	permissive	—
8	Adjust generator for steady DC voltage = 5,3 V.	non-permissive	—
9	Repeat Step 3.	permissive	—
10	Adjust generator output to provide a 0,5 V pp (50/60 Hz) ripple on DC voltage. Vary DC voltage from 2 V to 6 V with this ripple.	non-permissive	—
11	Repeat Step 3.	permissive	—
12	Set generator output to 0 V.	non-permissive	Measure controller reaction time to non-permissive and verify it to be within the value in Table A.2.
13	Adjust pulse generator output for U_1 = 0,8 V, U_2 = 5,3 V, T_1 = 2,5 ms, delay = minimal. Repeat Step 12.	non-permissive	—
14	Remove circuit connections from pulse output and pulse input terminals.	non-permissive	—
15	Connect a wire between pulse output and pulse input terminals.	non-permissive	—

Table A.11 *(continued)*°

16	Repeat the tests above at the maximum and minimum ambient temperature.	—	—
[a] Delay is time difference between in and output pulse.			

Table A.12 — Functional test sequence of controller for two-wire optic interface arrangements according to Figure A.7

Step No.	Description of test step	Controller output	Remarks
1	Connect the circuit as in Figure A.7.	permissive	
2	Adjust generator for T_2 = 30 ms and T_1 = 15 ms.	permissive	Verify U_1 and U_2 in Table A.4.
3	Adjust generator for T_2 = 8 ms and T_1 = 2 ms.	permissive	As in Step 2.
4	Adjust generator for T_2 = 8 ms and T_1 = 5 ms.	permissive	As in Step 2.
5	Adjust generator for T_2 = 50 ms and T_1 = 10 ms.	permissive	As in Step 2.
6	Adjust generator for T_2 = 50 ms and T_1 = 40 ms.	permissive	As in Step 2.
7	Adjust generator for T_2 = 500 ms and T_1 = 40 ms.	non-permissive	Measure time non-permissive and verify in Table A.5.
8	Repeat Step 2.	permissive	—
9	Remove the sensor simulator circuit from channel 1.	non-permissive	Measure U_s, verify value in Table A.5.
10	Attach sensor simulator circuit to channel 1.	permissive	—
11	Repeat Steps 9-11 for the other channels.	—	—
12	Repeat Step 2.	permissive	—
13	Remove the sensor simulator circuit from sensor 1. Attach the static load circuit to channel 1 with the potentiometer at maximum resistance.	non-permissive	—
14	Slowly reduce the potentiometer's resistance. Watch for sudden drop in current I_s and stop.	non-permissive	Record peak current (I_s) prior to transition and verify values in Table A.5.
15	Repeat Steps 13 and 14 for all channels.	—	—
16	Repeat Steps 1 and 2.	permissive	—
17	Remove the sensor simulation circuit from channel 1.	non-permissive	—

Table A.12 (*continued)*

Step No.	Description of test step	Controller output	Remarks
18	Apply a DC voltage equal to Us from channel 1 to ground, slowly reduce voltage to 5 V.	non-permissive	—
19	Reduce the DC voltage to 0 V, slowly increase voltage to 3,6 V.	non-permissive	—
20	Repeat Steps 17-19 for all channels.	non-permissive	Voltage generator shall be capable of sourcing and sinking at least 200 mA.
21	Repeat the tests above at the maximum and minimum ambient temperatures.	—	—

Table A.13 — Functional test sequence for five-wire sensor according to Figure A.8

Step No.	Description of test step	Test performed	Remarks
1	Adjust pulse generator for DC output. Select R_s = 923 Ω. Slowly vary the generator output from 0 V to 0,7 V.	Measure current. Measure sensor output.	Verify current in Table A.3. Verify that no pulses are generated and steady voltage is below U_1 value in Table A.1.
2	Adjust generator output to supply 0 to 0,7 V pulses per T_1 and T_2 of Table A.1.	Measure sensor output.	Verify that no pulses are generated and steady voltage is below U_1 value in Table A.1.
3	Adjust pulse generator U_2 = 3,8 V, U_1 = 0,8 V, T_1 = 0,8 ms, T_2 = 100 ms. Select R_s = 923 Ω.	Measure sensor output wave form.	Verify delay (delay is time difference between in- and output pulse), rise and fall time, U_2 and T_1 with values in Table A.3.
4	Wet the sensor.	Measure output.	Steady DC voltage below U_1 value in Table A.1.
5	Adjust pulse generator for T_1 = 2,5 ms, T_2 = 100 ms. Select R_s = 923 Ω.	As in Step 3.	As in Step 3.
6	Repeat Step 4.	As in Step 4.	As in Step 4.
7	Adjust pulse generator for T_1 = 0,8 ms, T_2 = 30 ms. Select R_s = 444 Ω.	As in Step 3.	As in Step 3.
8	Repeat Step 4.	As in Step 4.	As in Step 4.
9	Adjust pulse generator T_1 = 2,5 ms, T_2 =30 ms.	As in Step 3.	As in Step 3.
10	Wet the sensor.	Check output response time.	Verify response time to be within 250 ms.
11	Repeat the tests above at the maximum and minimum ambient temperature.	—	—

Table A.14 — Functional test sequence for two-wire optic sensor according to Figure A.9

Step No.	Description of test step	Test performed	Remarks
1	Set the switch to position 1.	Check the wave form against Figure A.1.	Verify U_1, U_2, T_1 and T_2 of Table A.4.
2	Set the switch to position 2.	As in step 1.	As in Step 1.
3	Set the switch to position 3.	Measure U_1.	Verify in Table A.6.
4	Set the switch to position 4.	Supply current in high state.	Verify U_2 in Table A.4.
5	Set the switch to position 1.	—	—
6	Wet the sensor.	Check output response time.	Verify response time to be within 250 ms.
7	Same as above.	Measure output waveform.	Steady DC voltage either high or low signal.
8	Repeat the tests above at the maximum and minimum ambient temperature.	—	—

Table A.15 — Functional test sequence for thermistor sensor according to Figure A.10

Step No.	Description of test step	Test performed	Remarks
1	Connect sensor as per test set up and apply power.	Measure sensor output wave form against time.	Verify that it meets the parameters in Table A.4 and warm-up time less than 75 s.
2	Wet the sensor.	Measure output wave form.	Steady DC voltage either high or low.
3	Dry the sensor.	Measure output wave form.	Allow circuitry to resume permissive status.
4	Wet the sensor.	Check output response time.	Verify response time to be within 250 ms.
5	Repeat the tests above at the maximum and minimum ambient temperature.	—	—

Table A.16 — Pin assignment

Pin No.	Colour (optional) [a]	Five-wire / two-wire system	
		Five-wire pin usage	Two-wire pin usage
1	Brown	Unused	Plus (+) Power
2	Red	Unused	Plus (+) Power
3	Orange	Unused	Plus (+) Power
4	Yellow	Pulse to sensors	Plus (+) Power
5	Green	Diagnostics	Plus (+) Power
6	Blue	Return pulse	Plus (+) Power
7	Violet	Unused	Plus (+) Power
8	Grey	Plus (+) Power	Plus (+) Power
9	Black	Auxiliary bond	Auxiliary bond
10	White	Common sensor return/bond	Common sensor return/bond

[a] Wire identification by colour or number shall correspond to pin number.

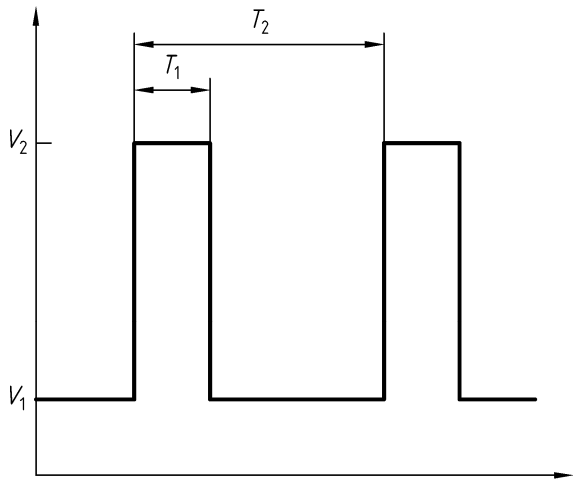
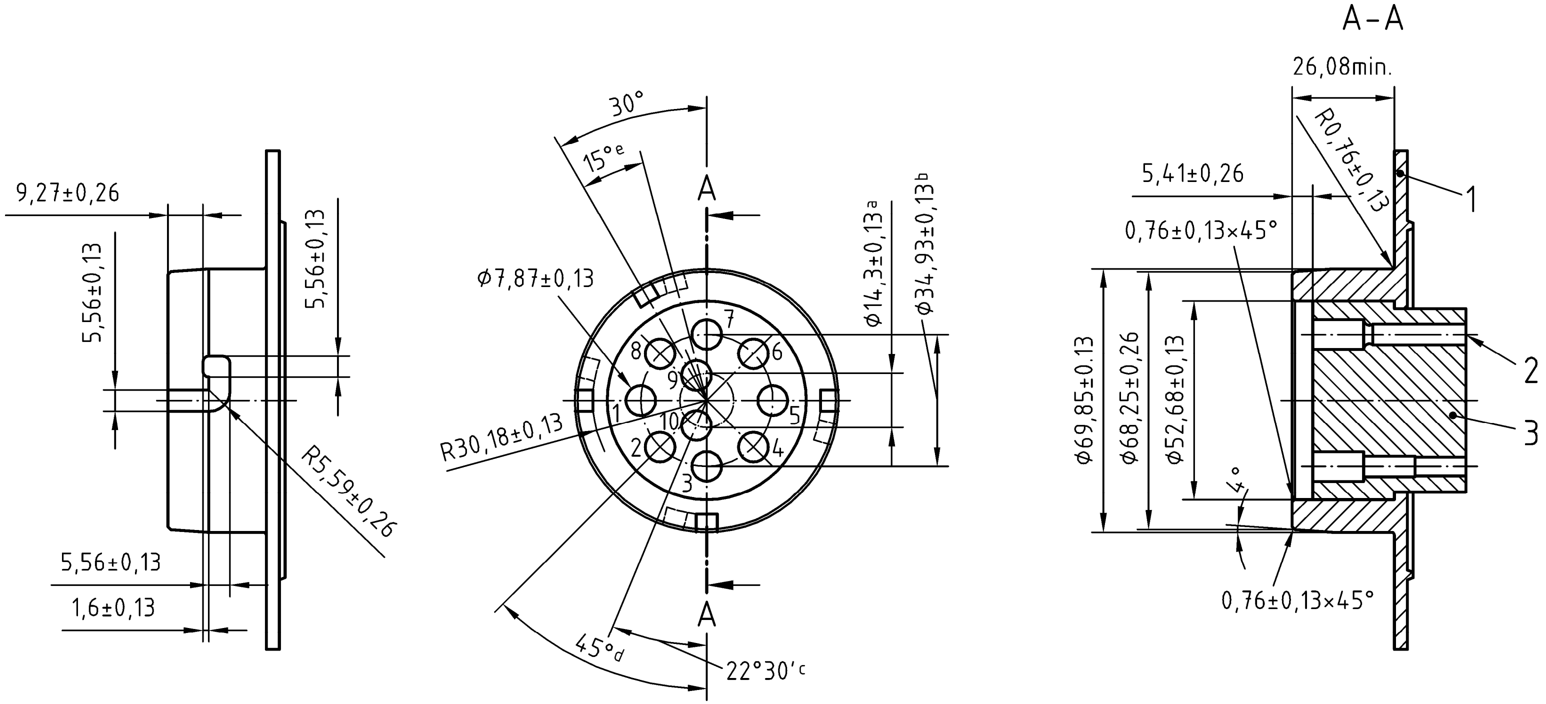


Figure A.1 — Signal waveform

Dimensions in millimetres

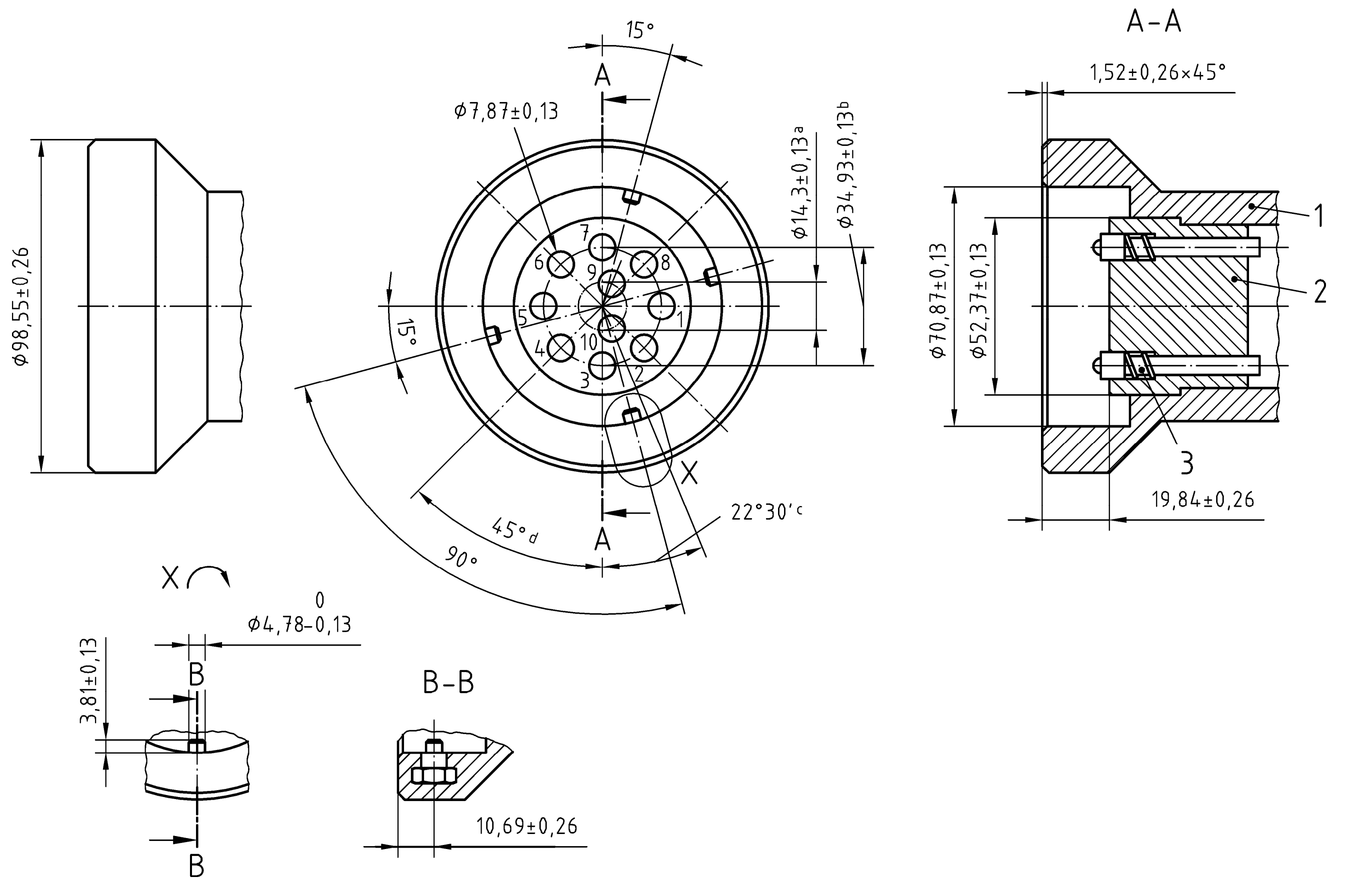


Key

1 Socket
2 Socket pin
3 Socket insert

Figure A.2 — 10 Pin socket

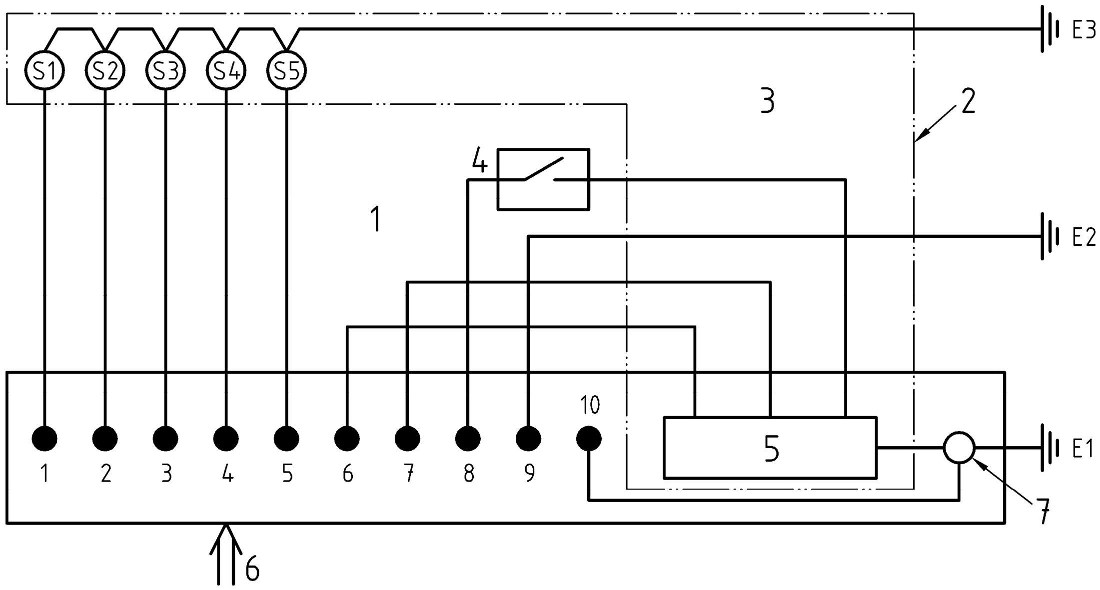
Dimensions in millimetres



Key

1 Plug
2 Plug insert
3 Spring loaded plug pin

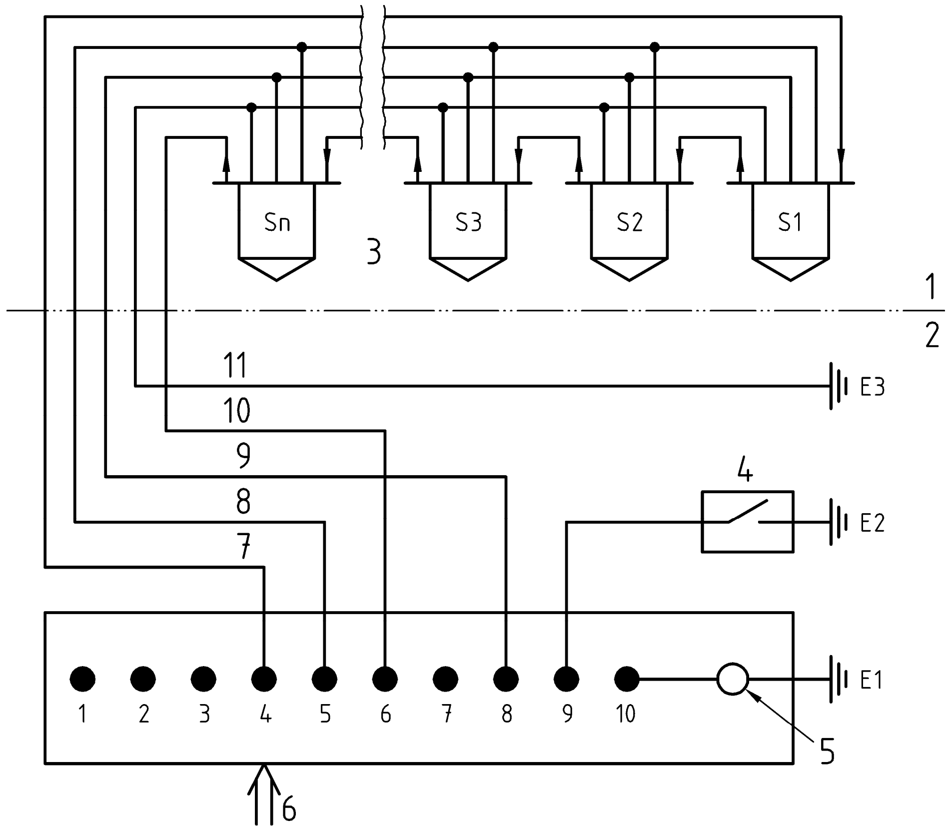
Figure A.3 — 10 Pin plug



Key

1 Normative
2 Informative
3 Arrangement with 2-wire-sensors at 5-compartment truck
4 Vapour recovery hose interlock switch; shall be in series with the sensor or dummy of compartment 8
5 Electronic dummy
6 Plug from controller
7 Earth connection inside socket's metallic enclosure
S Sensors (up to a max. of 8); number of working sensors shall equal number of tanker compartments; dummies shall be used to occupy the remaining channels
E1 Connection from pin 10 to truck chassis (via earth connection inside sockets metallic enclosure) extended by hardwiring to truck chassis
E2 Connection from pin 9 to truck chassis via mounting bolt of socket
E3 Connection to truck chassis at least 100 mm away from E1 and E2

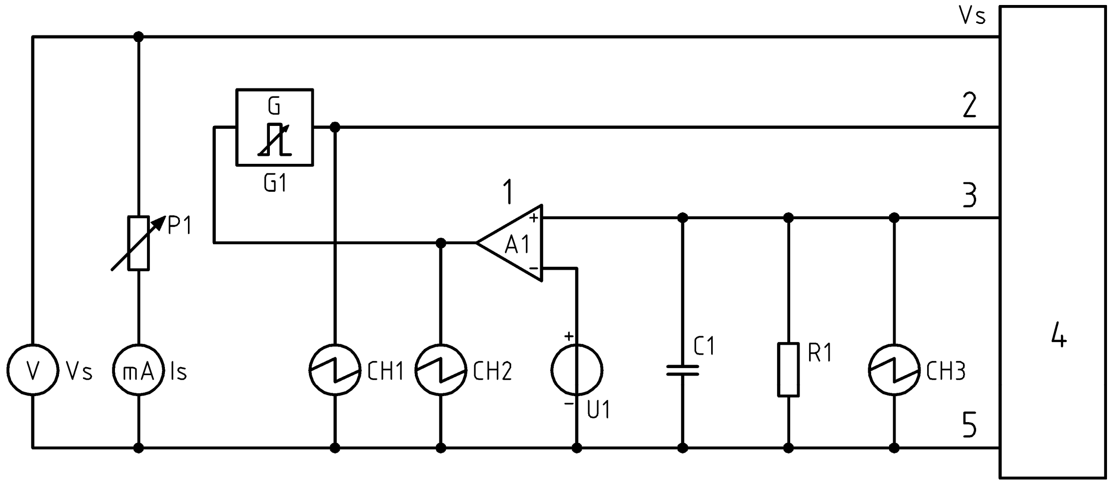
Figure A.4 — Road tanker socket connections – Arrangement for 2-wire system



Key

1 Informative
2 Normative
3 Arrangement with 5-wire sensors
4 Vapour recovery hose interlock switch
5 Earth connection inside socket's metallic enclosure
6 Plug from controller
7 Pulse to sensors
8 Diagnostics
9 Power
10 Return pulse
11 Power
E1 Connection from pin 10 to truck chassis (via earth connection inside sockets metallic enclosure) extended by hardwiring to truck chassis
E2 Connection from pin 9 to truck chassis via mounting bolt of socket
E3 Connection to truck chassis at least 100 mm away from E1 and E2

Figure A.5 — Road tanker socket connections - Arrangement for 5-wire system



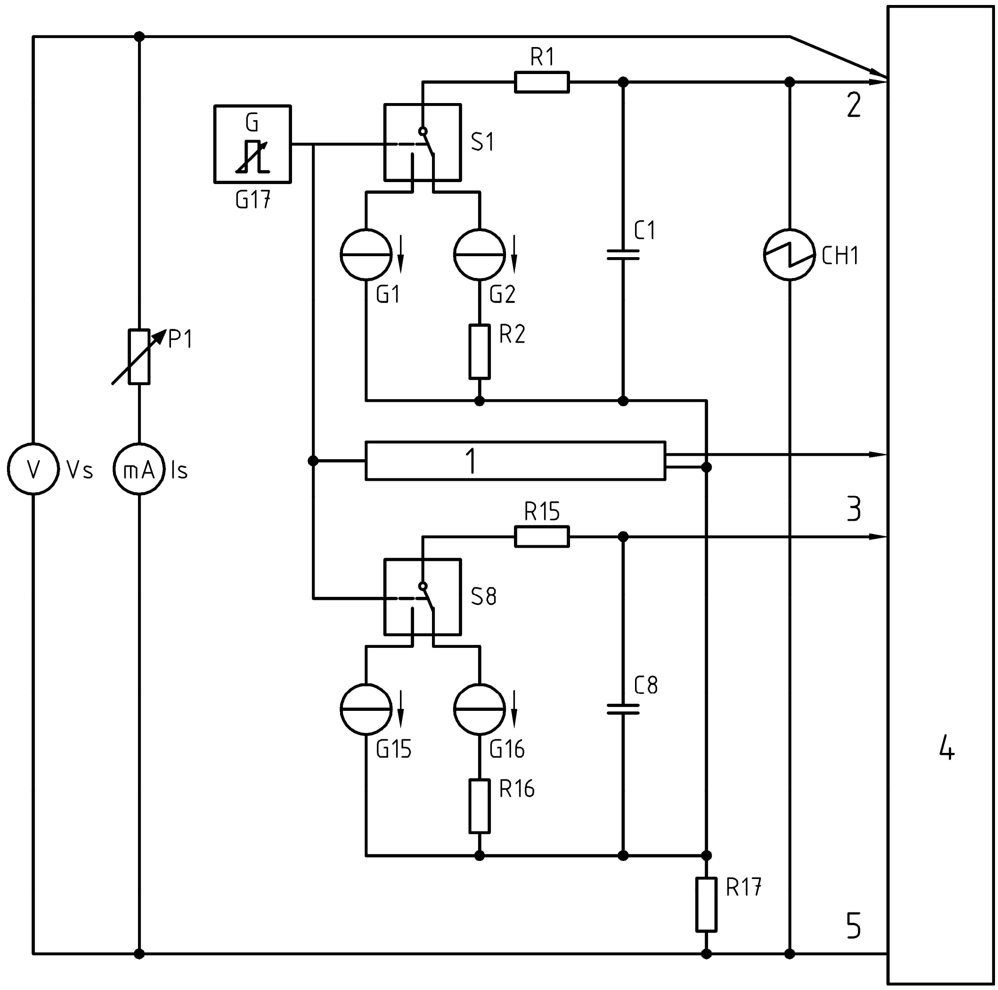
Key

1 Comparator
2 Pulse input
3 Pulse output
4 D.U.T. = Controller
5 Common GND

Components

C1	20 nF
G1	square wave generator
Is	supply current
P1	1 kΩ
R1	950 Ω
U1	3,8 V (reference voltage)
Vs	supply voltage

Figure A.6 — Five-wire mode controller test circuit



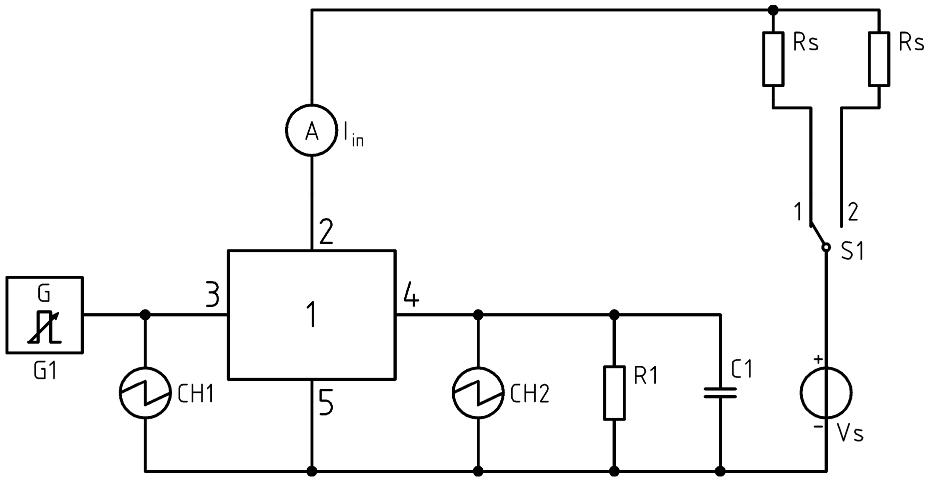
Key

1 Six additional identical sensor simulator circuits
2 Channel 1
3 Channel 8
4 D.U.T. = Controller
5 Common GND

Components

C1, C8	20 nF
G1, G15	current limiter 20 mA
G2, G16	current limiter 95 mA
G17	square wave generator
Is	supply current
P1	100 Ω
R1, R15	1 Ω
R2, R16	28 Ω
R17	1 Ω
S1, S8	electronic switch
Vs	supply voltage

Figure A.7 — Two-wire mode controller test circuit



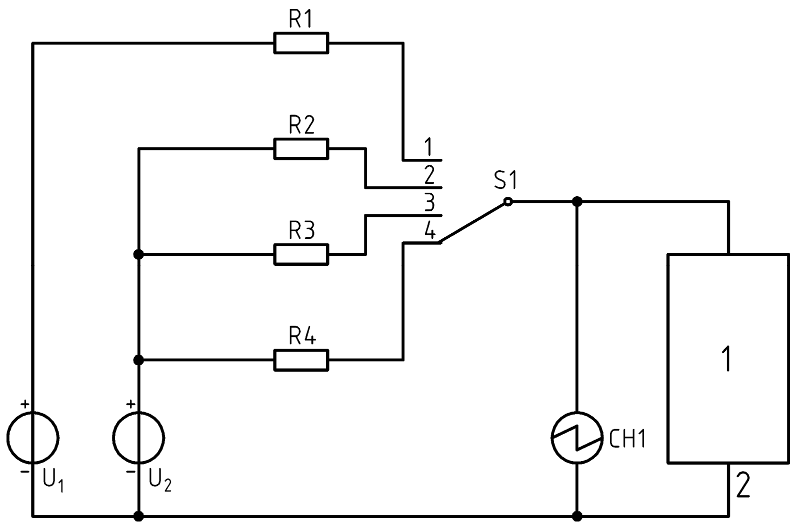
Key

1 D.U.T. = Sensor
2 Power
3 In
4 Out
5 GND

Components

C1	20 nF
G1	square wave generator
I_{in}	input current
R1	30 kΩ
Rs_{923}	923 Ω
Rs_{444}	444 Ω
S1	switch
Vs	9,2 V supply voltage

Figure A.8 — Five-wire sensor test circuit



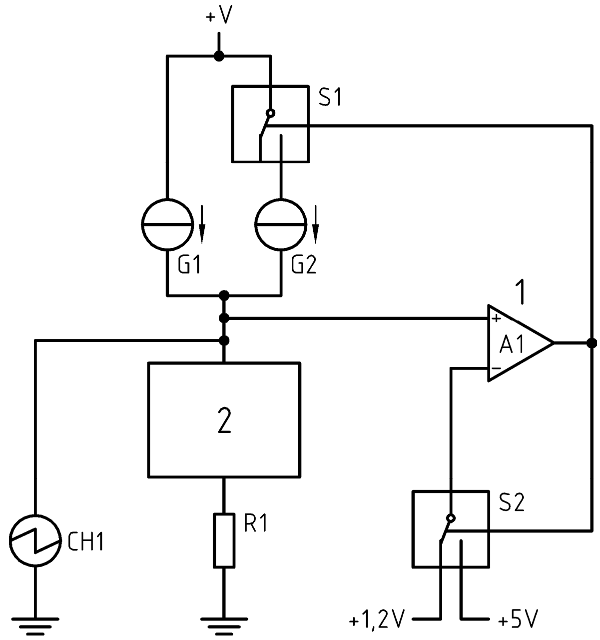
Key

1 D.U.T. = Sensor
2 Circuit return

Components

R1	61 Ω
R2	96 Ω
R3	86 Ω
R4	350 Ω
S1	switch
U1	9 V supply voltage
U2	12 V supply voltage

Figure A.9 — Two-wire optic sensor test circuit



Key

1 Comparator
2 D.U.T. = Sensor

Components

G1	current limiter 20 mA
G2	current limiter 75 mA
R1	3,5 Ω
S1	electronic switch
S2	electronic switch

Figure A.10 — Two-wire thermistor sensor test circuit

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[1] EN 60079-1, *Explosive atmospheres — Part 1: Equipment protection by flameproof enclosures "d" (IEC 60079-1:2007)*

[2] EN 60079-2, *Explosive atmospheres — Part 2: Equipment protection by pressurized enclosure "p" (IEC 60079-2:2007)*

[3] EN 60079-5, *Explosive atmospheres — Part 5: Equipment protection by powder filling "q" (IEC 60079-5:2007)*

[4] EN 60079-6, *Explosive atmospheres — Part 6: Equipment protection by oil immersion "o" (IEC 60079-6:2007)*

[5] EN 60079-7, *Explosive atmospheres -- Part 7: Equipment protection by increased safety "e" (IEC 60079-7:2006)*

[6] EN 60079-15, *Explosive atmospheres — Part 15: Equipment protection by type of protection "n" (IEC 60079-15:2010)*

[7] EN 60079-26, *Explosive atmospheres — Part 26: Equipment with equipment protection level (EPL) Ga (IEC 60079-26:2006)*

[8] *Directive 94/63/EC on the control of volatile organic compound (VOC) emissions resulting from the storage of petrol and its distribution from terminals to service stations*

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