S3Ex-U

ATEX

Intrinsically safe barrier with separation
TWO-WIRE VOLTAGE, CURRENT or THERMOCOUPLE CONVERTER
- **"group I" "category M1" and "group II" "category 1" accompanying device**
- **Intrinsically safe input circuit of level „ia" – ATEX compliance,**
- **EC-Type Examination Certificate: KDB 10ATEX129**
- **FEATURE I (M1) [Ex ia] I, II (1)G [Ex ia] IIC, II (1)D [Ex iaD] 20**

Protection level IP20   Operating temperature range -25..+70°C
Designation based on the ATEX conformity assessment procedure of module A:
II 3G Ex ec II T4, group "II" category "3" device

- Intrinsically safe input circuit can work with other intrinsically safe input circuit of "ia" or "ib" protection level that is in a device that is installed in hazardous zone (zones 0, 1, 2, 20, 21, 22) – including any type of thermocouple. Maximal input parameters: **Ui=30V**, **Ii=100mA**, **Pi=1W**.
- Output circuit can work with non-intrinsically safe circuits of devices working with voltage **Um=253V**, e.g. supplied from 230Vac network.
- Converter can be installed only in a safe room in terms of explosion or in explosion hazardous zone in enclosure of a device with explosion-proof construction (see page 3). The surroundings should be dry, dust-free and protected against access of people not trained in maintenance and operation of the separator.
- Converter as accompanying device can be installed in any explosion hazardous zone in enclosure with explosion-proof construction e.g. in flameproof housing or in zone 2 in other enclosure according to applicable rules. Basing on the marking Ex ec II T4 (device of category 3) separator can be installed in accordance with the rules given on page 3.

Application:

S3Ex-U converter is designed to convert the growth of voltages or currents to 4÷20mA current signal in two-wire current loop. typical application is a cooperation with thermocouple at which a characteristic's linearization system (table 1÷6) and cold contacts temperature compensation system can be used. Input, output and supply circuit of the converter are mutually galvanically separated.

Output can be connected between terminals „6, 5" or „6, 7". Connecting as shown on fig.3b allows to measure the output current with ammeter (R≤10Ω) without cables disconnection.

Galvanic separation allows to reduce the impact of object interferences on work in the central part.

Technical specification:

Input signal:	voltage	- $\Delta U_{min}=1mV÷30V$ (Ui=30V)
	current	- $\Delta I_{min}=1\mu A$, Imax=100mA
	thermocouple	- for example from tab. 1÷6

Input resistance
for voltage	- $\geq 100k\Omega$
for cathodic protection	$10M\Omega$
for current	- typically 50Ω ($0.1\,\Omega÷1\,k\Omega$)

Output signal - **4÷20mA**
load resistance - R=(Uz-10V)/20mA [kΩ]
power supply voltage Usup - 10V ÷ 27V

Note: In case of supply voltage >28V the protection barrier fuse blowing can occur – repair by the producer.

Class: -for voltage and current - 0.1 %
  -for thermocouple - 0.3%+nonlinearity error (tab. 1÷6)
Error due to supply voltage or
  load changes - ±0.02%
Error due to ambient temperature changes:
  -ΔU≤40mV, ΔI≤10µA - 0.025 % / °C
  -ΔU>40mV, ΔI>10µA - 0.01 % / °C
  - thermocouples with cold
    endings compensation - 0.04 % / °C
Cold endings compensation -20°C ÷ +70°C with error ±2°C
Nonlinearity:
  output signal = f(U, I) - ±0.1 %
  output signal = f(T) - for thermocouples from tab. 1÷6
Zero and span adjustment ±7.5 % by potentiometers
Galvanic circuit separation - **between input and output**
Isolation test voltage between - **2 kV, 50Hz** or equivalent
  input and output
Time constant - typically 0.2sec.
  0.001÷1s if requested

For small input signals to reduce the impact of interferences cable should be shielded.

Ordering code:

S3Ex-U- ---------------	Voltage converter with separation
1T ÷ 9T - ----	thermocouple according to table 1
1J ÷30J - -----	thermocouple according to table 2
1S ÷13S - -----	thermocouple according to table 3
1R ÷ 5R - -----	thermocouple according to table 4
1B ÷ 6B - -----	thermocouple according to table 5
1K÷46K - ----	thermocouple according to table 6
KW - -----	automatic cold endings compensation
or temp e.g. 20°C	or constant compensation temperature value
U - -----	voltage ranges ≤30V
I - -----	current ranges ≤100mA
L -	linearization
BL -	without linearization

Note:

1. In case of other ranges than in tables 1÷6, lower and upper range values should be given together with thermocouple marking.
2. If time constant is to be other than 0.2s, its value should be given.
3. For version with thermocouple input calibration should be done for 10% and 90% of the range (unless specified otherwise in module description).

Order example:

Converter for thermocouple type J (400º÷1000ºC), internal cold endings compensation, linearization:
type   S3Ex-U - (J, 400º÷1000ºC) - KW - L

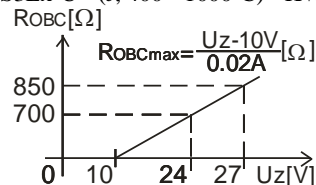$$R_{OBCmax}= \frac{Uz-10V}{0.02A}[\Omega]$$

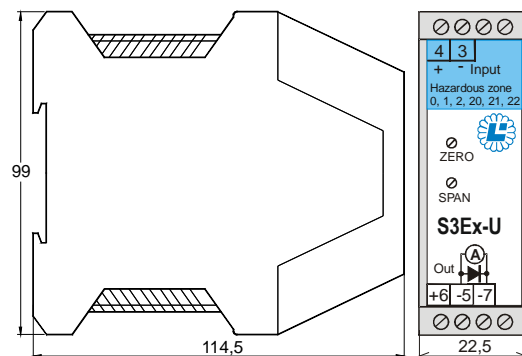Fig.1 How to calculate max load resistance (Robc)

Fig.2 Housing scheme

Safety parameters for S3Ex-U – input circuit with „ia" protection level:

    a) Intrinsically safe input circuit parameters: **„Input" – terminals „3, 4"**:

        U_i=30V, I_i=0,1A, P_i=1W, L_i= 0,1mH, $C_i \cong$ 11nF, U_o=5,4V, I_o=0,9mA, P_o=1,2mW

        Values of Lo, Co (also for clustered values) and L/R connection cable parameters should be adopted according to the table shown below:

Explosive group	Lo [mH]	Co [µF]	L/R [mH/Ω]
I and IIA	**200**	**30**	**244**
IIB	**200**	**30**	**122**
IIC	**200**	**30**	**30**
Characteristic of the circuit is linear.			

    b) Non-intrinsically safe output circuit parameters: **„Output" – terminals „5, 6, 7"**:   **U_m=253V**

Maximum capacitance and inductance values connected to the intrinsically safe terminals 3, 4 of the converter have to be chosen according to connected circuits rules (that means Co, Lo given in the terms of use of the device to which the input of the S3Ex-U converter is to be connected). However, they must not exceed the values given above.

Application conditions:

Intrinsically safe input measuring circuit of the converter type S3Ex-U (terminals 3-4) with "ia" protection level can work with other circuits with "ia" or "ib" protection levels of devices installed in zone 0, 1, 2 (with hazardous mixtures with air, that are in explosion groups IIA, IIB, IIC) and in zone 20, 21, 22 (dust explosion hazard, group III).

Converter can be mounted in hazardous zone in flameproof enclosure. Using in I explosive group does not require putting warning on the enclosure. After turning off the supply it can be taken out of the enclosure without delay. In case of using it in II and III explosive group, on outer part of the enclosure must be warning: "Do not open the enclosure within 10 minutes after turning off the power".

Output terminals 5-6 can work with non-intrinsically safe circuits of devices working with voltage **U_m=253V** , e.g. supplied from 230Vac network.

Separator's housing is made of self-extinguishing plastic (poliamid PA 6.6) and can be mounted on TS35 rail. The housing and terminals are IP20 made.

Outer connections should be connected using cables of $\varnothing \le 2.5$ mm wire diameter.

ATEX compliance: directive 2014/34/UE: PN-EN 60079-0:2013, PN-EN 60079-11:2012.

EMC requirements: directive 2004/108/UE: PN-EN 61326-1:2013.

For installation in zone 2:

1) The housing provides a minimum degree of protection IP20. The device can be installed inside a building provided it is protected against dirt, dust, especially conductive dust, extreme mechanical exposures (eg vibrations, impacts, shocks), and thermal stress.

2) Installation outside the building requires an additional enclosure with a higher degree of protection minimum IP54 or higher, eg IP65, in accordance with the surrounding environment in which the installation operates. It may be an enclosure **without an explosion-proof designation**, but:
    - with the warning label "Caution: risk of electrostatic discharge" (see point 6).
    - provided that it will be mounted with protection against falls and mechanical impacts.

3) It is safest to install the device in zone 2, both inside and outside of the building, in an explosion proof enclosure (eg with an "Ex e" protection level) providing a minimum IP54 protection degree or higher (eg IP65) in accordance with the surrounding environment in which the installation operates.

4) Regardless of the place of installation, the devices must be protected against dirt, dust, especially conductive dusts, extreme mechanical infections (eg vibrations, impacts, shocks) and thermal stress.

5) In order to prevent self-loosing of cables in non-intrinsically safe screw terminals numbers 5, 6, 7 one should place non-tinned cables in each of the clamp:
    - a single wire or cable with a twisted tip with a cross-section of $0.25 \div 2.5$ mm²,
    - two cables with the same cross-section of $0.5 \div 1.5$ mm² type wire with a twisted tip placed in a common tube sleeve with plastic crushed by a specialized tool.

Tighten the terminal firmly with a torque of 0.5 Nm (typically 2 kgf force on the handle of a screwdriver with a diameter of 2.5 cm) with a flat screwdriver 3.0...3.5 mm wide. Every 6 months, check the tightening of the terminals by tightening with a torque of 0.5 Nm using a screwdriver with a width of 3...3.5 mm.

6) If the housing needs cleaning, use a cloth lightly moistened with a mixture of detergent and water.
Electrostatic hazard: to avoid the risk of electrostatic discharge, the casing of the device and / or the enclosure in which the device is installed should be cleaned only with a damp or antistatic cloth (soaked in antistatic liquid).
Avoid any penetration of cleaning liquid into the interior to prevent damage to the device.

7) Non-intrinsically safe circuits (including 24Vdc power supply) must be connected to power suppliers and devices galvanically separated from the power grid (SELV or SELV-E circuits).

8) If an explosive atmosphere is present or can occur, non-intrinsically safe terminals numbers 5, 6, 7 must not be connected to live cables. When the device is powered, you can disconnect / connect disconnectable connector blocks but do not disconnect / connect non-intrinsically safe circuits. If an explosive atmosphere is present or can occur during service work, disconnect all non-intrinsically safe connector blocks or disconnect these circuits in the safe area. If there is no explosive atmosphere during service work, the above-mentioned principles from point 8 are not required.

Operation condition:
Note it is recommended:
1) Install the converters with a minimum distance of 5mm between the sidewalls of adjacent modules.
2) Measurement accuracy is ensured after 15 minutes from the moment of turning on the 24Vdc power supply.

Ambient temperature - for storage	-	-30 ÷ +70°C
Ambient temperature - operation	-	-30 ÷ +70ºC
Relative humidity	-	max 90%
Ambient atmosphere	-	no dust and aggressive gases
Working place	-	any

User can measure output current (without disconnecting the cables) when connecting ammeter as shown in Fig.3b
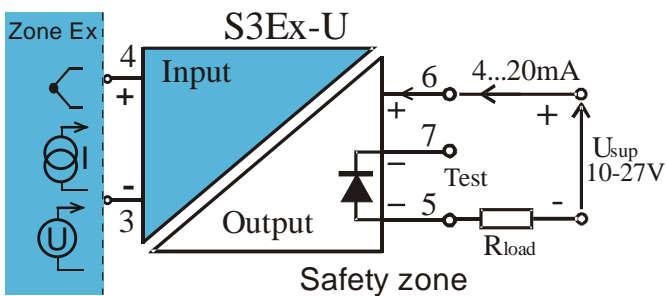

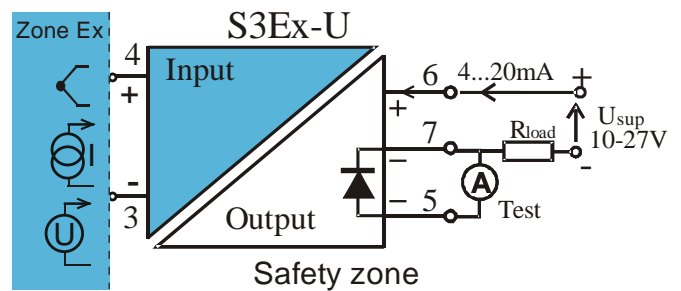Fig.3a Connection of the load without output current control.   Fig.3b Connection of the load without output current control.

Sample measurement ranges

Tab. 1   Fe-Ko   Type J

Range No	Range °C	Sensor nonlinearity [%]	Nonlinearity of the converter with linearization
1J	0....100	- 0.92	± 0.4 %
2J	0....150	- 1.1	± 0.4 %
3J	0....200	- 1.15	± 0.4 %
4J	0....250	- 1.15	± 0.4 %
5J	0....300	- 1.05	± 0.4 %
6J	0....400	- 0.90	± 0.4 %
7J	0....500	- 0.78	± 0.3 %
8J	0....600	- 0.8	± 0.3 %
9J	0....800	- 2.3	± 0.5 %
10J	0....900	- 2.8	± 0.5 %
11J	50....100	- 0.34	± 0.2 %
12J	50....200	- 0.6	± 0.25 %
13J	50....300	- 0.55	± 0.25 %
14J	100....200	- 0.27	± 0.2 %
15J	100....300	- 0.22	± 0.22 %
16J	100....400	- 0.15	- 0.15 %
17J	100....500	- 0.12	- 0.12 %
18J	100....600	- 0.52	± 0.25 %
19J	200....300	+ 0.04	+ 0.04 %
20J	200....350	+ 0.08	+ 0.08 %
21J	200....400	+ 0.12	+ 0.12 %
22J	200....500	+ 0.06	+ 0.06 %
23J	300....400	+ 0.06	+ 0.06 %
24J	300....500	- 0.13	- 0.13 %
25J	300....900	- 2.8	± 0.5 %
26J	400....500	- 0.10	- 0.1 %
27J	400....600	- 0.75	± 0.25 %
28J	400....800	- 2.5	± 0.5 %
29J	500....600	- 0.55	± 0.25 %
30J	680....900	- 0.42	± 0.2 %
Other range according to order			

Tab. 2   Cu-Ko   Type T

Range No	Range °C	Sensor nonlinearity [%]	Nonlinearity of the converter with linearization
1T	0..........50	- 1.3	± 0.3 %
2T	0........100	- 2.4	± 0.5 %
3T	0........150	- 3.25	± 0.5 %
4T	0........250	- 4.5	± 0.5 %
5T	0........400	- 5.5	± 0.5 %
6T	100....300	- 2.7	± 0.5 %
7T	100....400	- 3.4	± 0.5 %
8T	200....300	- 1.1	± 0.3 %
9T	200....400	- 1.5	± 0.3 %
Other range according to order			

Tab. 3   PtRh10-Pt   Type S

Range No	Range °C	Sensor nonlinearity [%]	Nonlinearity of the converter with linearization
1S	0.........1000	- 6	± 1 %
2S	0.........1200	- 6.3	± 1 %
3S	0.........1400	- 6.4	± 1 %
4S	0.........1600	- 6.4	± 1 %
5S	500.....1400	- 2.85	± 0.5 %
6S	600.....1400	- 2.4	± 0.5 %
7S	700.....1600	- 1.8	± 0.5 %
8S	800.....1200	- 1.3	± 0.3 %
9S	800.....1400	- 1.2	± 0.3 %
10S	900.....1500	- 1.0	± 0.3 %
11S	1000...1600	- 0.48	± 0.25 %
12S	1200...1600	+ 0.25	± 0.25 %
13S	1300...1600	+ 0.32	± 0.25 %
Other range according to order			

Tab. 4   PtRh13-Pt   Type R

Range No	Range °C	Sensor nonlinearity [%]	Nonlinearity of the converter with linearization
1R	0.........1750	- 7.8	....
2R	600.....1000	- 1.5	± 0.3 %
3R	800.....1400	- 1.82	± 0.4 %
4R	1000...1600	- 0.7	± 0.25 %
5R	1300...1750	- 0.78	± 0.3 %
Other range according to order			

Tab. 5   PtRh30-Pt   Type B

Range No	Range ° C	Sensor nonlinearity [%]	Nonlinearity of the converter with linearization
1B	0........1800	- 22	.....
2B	600.....1200	- 6.5	± 1 %
3B	800.....1400	- 4.75	± 1 %
4B	1000...1600	- 3.25	± 1 %
5B	1400...1750	- 0.43	± 0.25 %
6B	1500...1800	+ 0.15	± 0.15 %
Other range according to order			

Tab. 6   NiCr-NiAl   Type K

Range No	Range ° C	Sensor nonlinearity [%]	Nonlinearity of the converter with linearization
1K	0......100	- 0.65	± 0.25 %
2K	0......200	+ 0.45	± 0.2 %
3K	0......250	+ 0.45	± 0.2 %
4K	0......300	+ 0.3	+ 0.3 %
5K	0......350	- 0.4	± 0.2 %
6K	0......400	- 0.6	± 0.25 %
7K	0......600	- 0.95	± 0.3 %
8K	0......800	- 0.8	± 0.3 %
9K	0....1000	+ 0.6	± 0.25 %
10K	0....1100	- 1.0	± 0.3 %
11K	0....1200	+ 1.5	± 0.4 %
12K	0....1300	+ 2.0	± 0.4 %
13K	50......150	+ 0.40	± 0.2 %
14K	50......300	+ 0.45	± 0.25 %
15K	100....250	+ 0.4	± 0.2 %
16K	100....400	- 0.8	± 0.3 %
17K	100....500	- 0.95	± 0.3 %
18K	150....250	- 0.27	± 0.2 %
19K	150....400	- 0.9	± 0.3 %
20K	150....550	- 1.0	± 0.3 %
21K	200....300	- 0.5	± 0.25 %
22K	200....400	- 0.72	± 0.25 %
23K	200....600	- 0.78	± 0.25 %
24K	300....400	- 0.22	- 0.22 %
25K	300....500	- 0.33	± 0.2 %
26K	300....600	- 0.35	± 0.2 %
27K	300....900	+ 0.7	± 0.25 %
28K	300..1200	+ 2.0	± 0.3 %
29K	350....500	- 0.22	- 0.22 %
30K	350....600	- 0.23	- 0.23 5
31K	400....500	- 0.11	- 0.11 %
32K	400....600	+ 0.12	+ 0.12 %
33K	400....800	+ 0.45	± 0.25 %
34K	500....600	+ 0.02	+ 0.02 %
35K	500....650	+ 0.11	+ 0.11 %
36K	500....800	+ 0.5	± 0.25 %
37K	500..1000	+ 1.25	± 0.3 %
38K	600....750	+ 0.30	+ 0.3 %
39K	600..1000	+ 1.15	± 0.25 %
40K	600..1200	+ 1.9	± 0.3 %
41K	700....850	+ 0.45	± 0.25 %
42K	700....900	+ 0.6	± 0.25 %
43K	700..1300	+ 2.2	± 0.4 %
44K	800....950	+ 0.47	± 0.25 %
45K	800..1000	+ 0.65	± 0.25 %
46K	800..1200	+ 1.4	± 0.4 %
Other range according to order			