SBEx-4S BINARY SEPARATOR with examples of applications

1 OR 2 CHANNELS IN RAIL HOUSING (TS35, width 22,5mm)

ATEX

- accompanying device of group I of category (M1), group II i III category (1),
- level "ia" intrinsically safe input circuits – compliance with ATEX,
- EC-Type Examination Certificate: KDB 04ATEX061

FEATURE: I (M1) [Ex ia] I;   II (1) G [Ex ia] IIC;   III (1) D [Ex ia] IIIC
Protection Level   IP20   Operating temperature range -25..+70°C

- *Inputs: resistance comparator, reflective level sensor, proximity sensors, opto-relay, contacts, transistor switches, two-wire pressure switches, etc.*
- *Signaling short / open of the connection line – ALARM signal.*
- *ALARM signal is the logical sum of the individual channel alarms. Activation of the alarm detection in channels is made by switches which are accessible after opening the housing.*
- *Relay or opto-relay output..*
- *Activation phase is adjustable with switches which are accessible after opening the housing.*
- *Inputs, outputs and power supply mutually galvanically separated.*

- Intrinsically safe input circuit can work with any device, with intrinsically safe circuit of protection level **ia** or **ib**, that is installed in hazardous area of group I and areas „0, 1, 2, 20, 21, 22" of group II endangered with explosion of any mixture, including proximity sensor, turbine flow sensor, connection or OC etc.
- Output circuits, ALARM signaling circuit and supply circuit can work with any non-intrinsically safe devices circuits of voltage **Um=253V** e.g. supplied from the 230Vac network.
- Separator can be installed in a room that is safe in terms of explosion and protected against access of persons not trained in maintenance and operating the transducer.
- Separator installed in a hazardous area can have a flameproof housing. Separator can be removed from the housing shortly after power in group I is turned off, because it does not contain any energy storage elements and do not become too hot. A 10 minutes delay is necessary in group II and III.
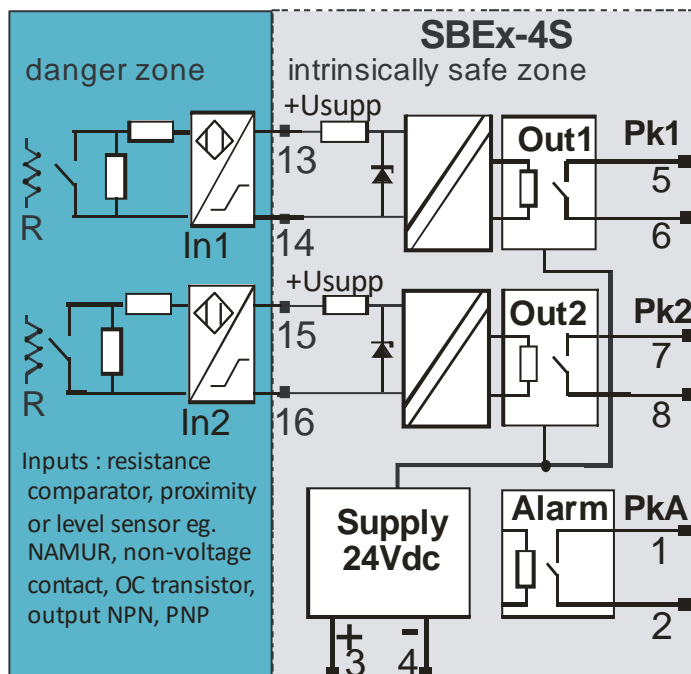
Purpose:

Separator can be used to compare resistance, to work with reflective level sensor, proximity sensor or two-wire pressure. It can transfer state of contacts or "open-collector" transistor to galvanically separated side.

There is a possibility to adjust input switching current level and hysteresis width. These parameters should be given descriptively.

Ordering code:

SBEx-4S-	binary separator, 1 or 2 channels
SBEx-4S-1-	one channel
SBEx-4S-2-	two channels
- Pk	PK1, PK2
	relay outputs
	opto-relay outputs:
- OPTO-A	OPA1, OPA2 opto-relay outputs
- OPTO-B	OPB1, OPB2 opto-relay outputs
SBEx-4S/G42-	details according to agreement
SBEx-4S/G500-	details according to agreement

Please describe type of sensor or circuit parameters connected to the separator's inputs. Conditions for switching threshold and hysteresis width should be descriptively specified.

Order example:

Binary separator, two channels, opto-relay OPTO-A outputs, 80Ω resistance comparison with hysteresis ±10Ω:
type   SBEx-4S-2-(OPA1)-(OPA2)

Note: While the power is turned off output relay's contacts „Pk1 (5-6)", „Pk2 (7-8) and alarm contacts „PkA (1-2)" are opened.

There is 15V on the input terminals. When using "open-collector" transistor as the separator driver terminals "In1+ 13" and "In2+ 15" should be connected to collector.

For not typical applications resistance or current switching thresholds as well as hysteresis should be specify in order.

SW1 and SW2 switches (accessible after opening the housing) are used to inverse operation of output contacts. ON position means inverse working of output contact in this channel.

If SW3 and SW4 switches (accessible after opening the housing) are set to ON, it activates input connection lines failure detection. OFF position means blocking alarm in the channel.

For SW1, SW2 $\Rightarrow$ OFF and for SW3, SW4 $\Rightarrow$ ON output contacts and LED indicator work as follows:

- input signal increase above
  switching level $+ 0,5 \bullet$ hysteresis

will cause shorting output relay contact (terminals „Pk1 5-6", „Pk2 7-8") and lighting of the green LED („Pk1", „Pk2"). Lighting up red ALARM LED and shorting of „PkA; Pk" contact means a break in the connection line (I<0,2mA). Lighting up orange ALARM LED and shorting „PkA; Pk" contact means a short in the connection line (I>5,5mA). „PkA; Pk" alarm contacts are shared indication for all channels – user should check which channel is related to the fault by looking at LED signaling.

Note: to let short / open in sensor channel indication on input work properly (when working with contact or transistor) join parallel resistor 20÷27kΩ and serial resistor 1.5÷2.4kΩ to the terminals of the sensor (in Ex area). Check figure on page 1.
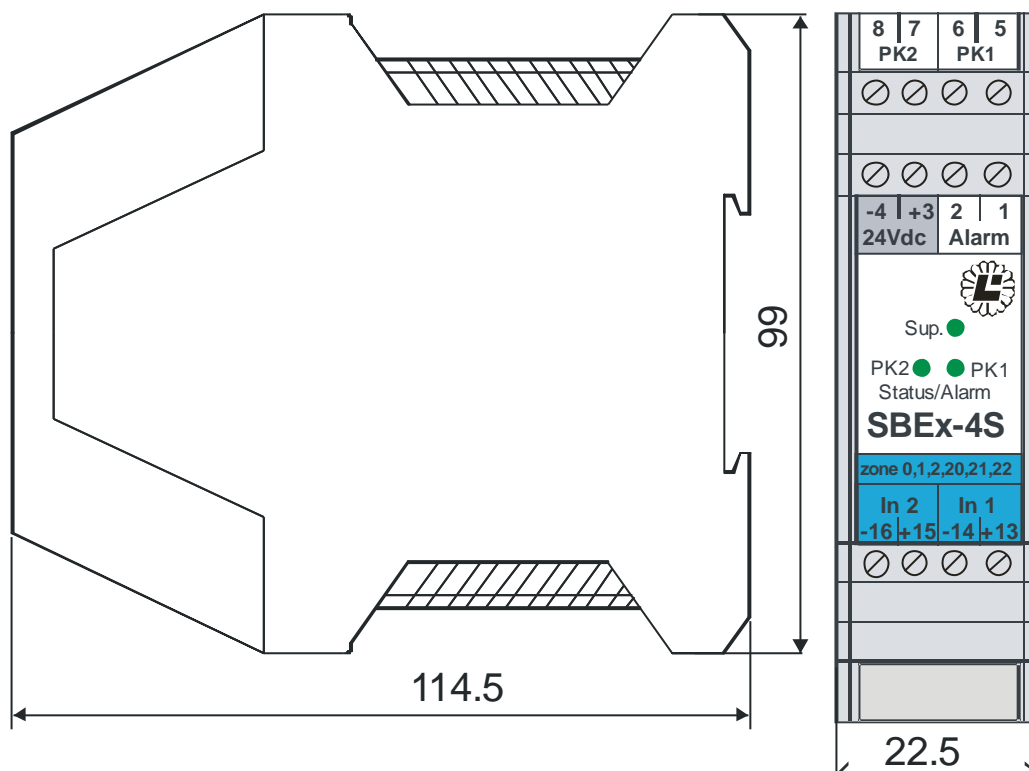
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Technical specification:

One or two channels with the following parameters.

Input signal type	- resistance, level sensor, proximity sensor, contact, transistor switch, pressure switch
default switching thresholds	- 1.4 / 1.9mA or according to order
supply voltage in input circuit	- 15V
Open signalization threshold in connection line	- opened I < 0.3mA not opened I > 0.35mA
Short signalization threshold in connection line or as agreed	- shorted I > 6,5mA not shorted I < 6mA
Output – potential-free contact of relay PK1, PK2	
- switching time	- 20 ms max
- switching frequency	- 50 Hz max
- mechanical durability	- 10^7 (for 1Hz $\Rightarrow$ 4 months)
- switched power	- max 5A / 250Vac or 30Vdc
Output optorelay:	
after agreement – OPTO-A	- 350V, 0,1A, 200 Hz, r=30Ω
after agreement – OPTO-B	- 30V, 1A, 200 Hz
ALARM output – PkA- optorelay	- 350V, 0,1A, 200 Hz, r=30Ω
Separator supply voltage	- 20 ÷ 30V DC 65mA for two channels 55mA for one channel

Note: If supply voltage exceeds 30V the fuse of the protection barrier may be burnt – repair only by the manufacturer.

Electrical isolation:	Isolation test voltage
inputs from each other	- 500 V
inputs/outputs/supply	- 2 kV
Connections	- 0,5 ÷ 2,5 mm^2 wires
Housing for TS35 rail	- housing and terminals IP20
housing material	- self-extinguishing poliamid
compliance with directive EMC 2004/108/W	- PN-EN 61000-6-4, PN-EN 61000-6-2

8	7	6	5
PK2		PK1	

-4	+3	2	1
24Vdc		Alarm	

Sup. ●

PK2 ● ● PK1
Status/Alarm

SBEx-4S

zone 0,1,2,20,21,22

| In 2		In 1	
-16	+15	-14	+13

99

114.5

22.5

Configuration:

Table describes logic operation of output contacts and corresponding LEDs on example of one of the channel.

Relays and LEDs state ╲ current(relay state on input)	output contact state in channel 1, 2 for SW1, SW2 in OFF state	output contact state in channel 1, 2 for SW1, SW2 in ON state	Led in channel with active alarm SW3 or SW4 in ON state	Led in channel with active alarm SW3 or SW4 in OFF state	contact state „PkA; Pk" ALARM with active alarm in channel SW3 or SW4 in ON state	contact state „PkA; Pk" ALARM with active alarm in channel SW3 or SW4 in OFF state
I > 6,5 mA ALARM (short line $R_L < 300\Omega$)	shorting	opening	orange	green	short	opening if no alarm on other channels
I > 1,9 mA (short contact)	shorting	opening	green	green	opening if no alarm on other channels	opening if no alarm on other channels
I < 1,4 mA (open contact)	opening	shorting	is off	is off	opening if no alarm on other channels	opening if no alarm on other channels
I < 0,3 mA ALARM open line $R_L > 40k\Omega$)	opening	shorting	red	is off	short	opening if no alarm on other channels
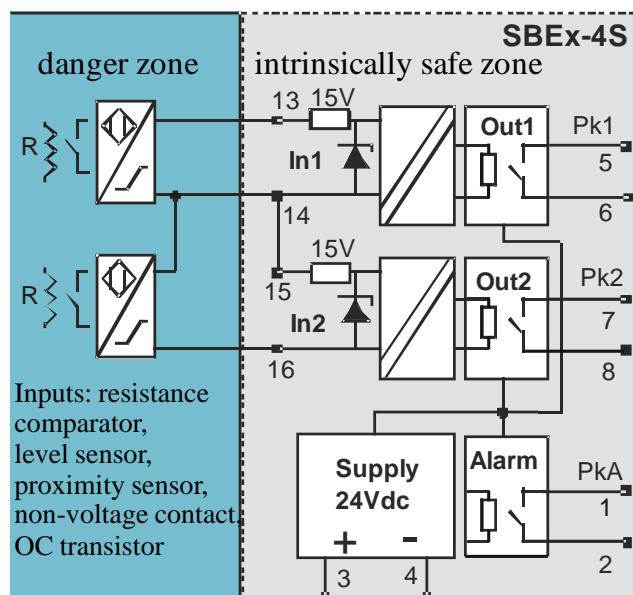
For this application version after order agreement manufacturer will give distributed parameters Lo, Co for connection wires. They will be placed on the nameplate.
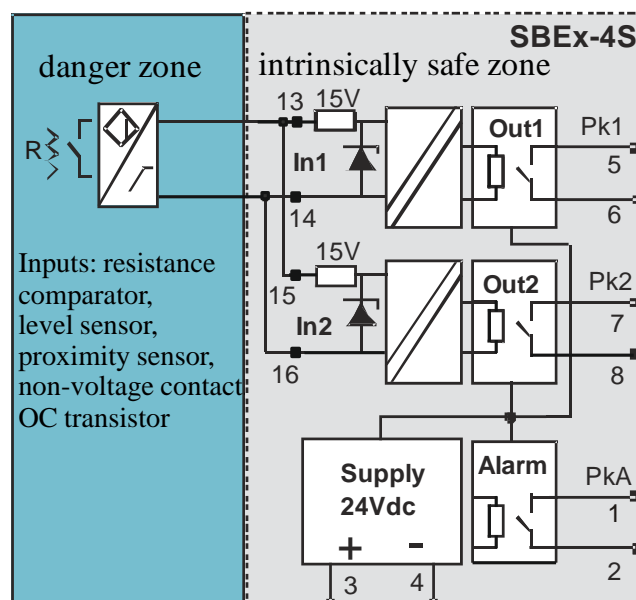
Lo, Co parameters should be taken from the table for parallel connected circuits.

Application examples of the SBEx-4S separator in intrinsically-safe circuits galvanically connected version.
For example, switching contact or two inductive proximity sensors in hazardous area can be connected to the separator with three wires. Shared terminal of both contacts is connected with one wire.

Intrinsically safe parameters for SBEx-4S, SBEx-4S/G500, SBEx-4S/G42 – input circuits with "ia" protection level:

I. SBEx-4S

"In1" "In2" terminals for SBEx-4S are separate intrinsically safe circuits with galvanically separation. One multi-wire type A or B IEC 60079-14 cable or separate cables may be used to connect these circuits simultaneously.

a) Intrinsically safe input circuits: "In1"- terminals 13-14, "In2"- terminals 15-16 with "ia" protection level:

Clustered parameters Lo, Co.

Clustered values Co, Lo and connection cable parameters L/R should be taken according to the table below. Data refer to clustered values can also be applied to cables.

Realization	Uo [V]	Io [mA]	Po [mW]	L/R [mH/Ω]			Lo [H]			Co [μF]		
				I and IIA	IIB	IIC	I and IIA	IIB	IIC	I and IIA	IIB	IIC
SBEx-4S	0÷16,4	67	273	1,04	0,52	0,13	0,06	0,039	0,0086	0,8	0,61	0,15
							0,02	0,02	0,005	1,4	0,92	0,22
							0,01	0,01	0,002	1,8	1,2	0,33
Characteristic of circuits is linear.												

Distributed parameters Lo, Co.

Distributed values Co, Lo for connection cable should be taken according to the table on the right. L/R connection cable parameters should be taken according to the table above.

realization	Lo [mH]			Co [μF]		
	I and IIA	IIB	IIC	I and IIA	IIB	IIC
SBEx-4S	60	39	8,6	10	2,5	0,413
Characteristic of circuits is linear.						

Safety parameters when both mutually separated intrinsically safe input circuits are serially galvanically connected .

Terminals "In1" "In2" connected serially can be connected with one multi-wire.

Clustered parameters Lo, Co.

Clustered values Co, Lo and connection cable parameters L/R should be taken according to the table below. Data refer to clustered values can also be applied to cables.

realization	Uo [V]	Io [mA]	Po [mW]	L/R [mH/Ω]			Lo [mH]			Co [μF]		
				I and IIA	IIB	IIC	I and IIA	IIB	IIC	I and IIA	IIB	IIC
SBEx-4S	0÷32,8	67	546	0,5	0,26	0,06	20	10	1,8	0,27	0,15	0,025
							2	2	1	0,32	0,22	0,035
							0,5	0,5	0,2	0,47	0,34	0,041
Characteristic of circuits is linear.												

Distributed parameters Lo, Co.

Distributed values Co, Lo for connection cable should be taken according to the table on the right. L/R connection cable parameters should be taken according to the table above.

realization	Lo [mH]			Co [μF]		
	I and IIA	IIB	IIC	I and IIA	IIB	IIC
SBEx-4S	47	26	1,8	1,47	0,433	0,041
Characteristic of circuits is linear.						

Safety parameters when both mutually separated intrinsically safe input circuits are parallelly galvanically connected.

Terminals "In1" "In2" connected parallelly can be connected with one multi-wire.

Clustered parameters Lo, Co.

Clustered values Co, Lo and connection cable parameters L/R should be taken according to the table below. Data refer to clustered values can also be applied to cables.

realization	Uo [V]	Io [mA]	Po [mW]	L/R [mH/Ω]			Lo [H]			Co [μF]		
				I and IIA	IIB	IIC	I and IIA	IIB	IIC	I and IIA	IIB	IIC
SBEx-4S	0÷16,4	134	546	0,5	0,26	0,06	15	9,5	2	1	0,77	0,2
							5	5	1	1,5	1	0,26
							1	1	0,1	2,4	1,7	0,33
Characteristic of circuits is linear.												

Distributed parameters Lo, Co.

Distributed values Co, Lo for connection cable should be taken according to the table on the right. L/R connection cable parameters should be taken according to the table above.	realization	Lo [mH]			Co [µF]		
		I and IIA	IIB	IIC	I and IIA	IIB	IIC
	SBEx-4S	15	9,5	2	10	2,5	0,413
	Characteristic of circuits is linear.						

b) Non-intrinsically safe circuits parameters:

realization	terminals	Um
SBEx-4S	„Pk1" – terminals „5-6", „Pk2" – terminals „7-8", „PkA" – terminals „1-2" and „24V supply" - terminals „3-4"	253V

II. SBEx-4S/G42

SBEx-4S/G42 can work as leakage security for not grounded electrical networks of 24Vdc, 24Vac or 42Vac (U≤24Vdc; U≤42Vac) and 50÷60Hz frequency. When network is off it acts as a security lock and after it switches as a central security function. It is made in specific version after agreement with the customer.

The separator operates correctly as central security for circuits with voltage U≤24Vdc when capacities of the line with regard to the ground do not exceed 1µF. In case of central security measuring circuit does not have to be intrinsically safe and in this case we suggest to use separator type SB-4S/G42. It can handle circuits with **U≤42Vdc, U≤42Vac**. Type SB-4S/G42 more accurately identifies leakage resistance even at capacities to the ground C≤3µF.
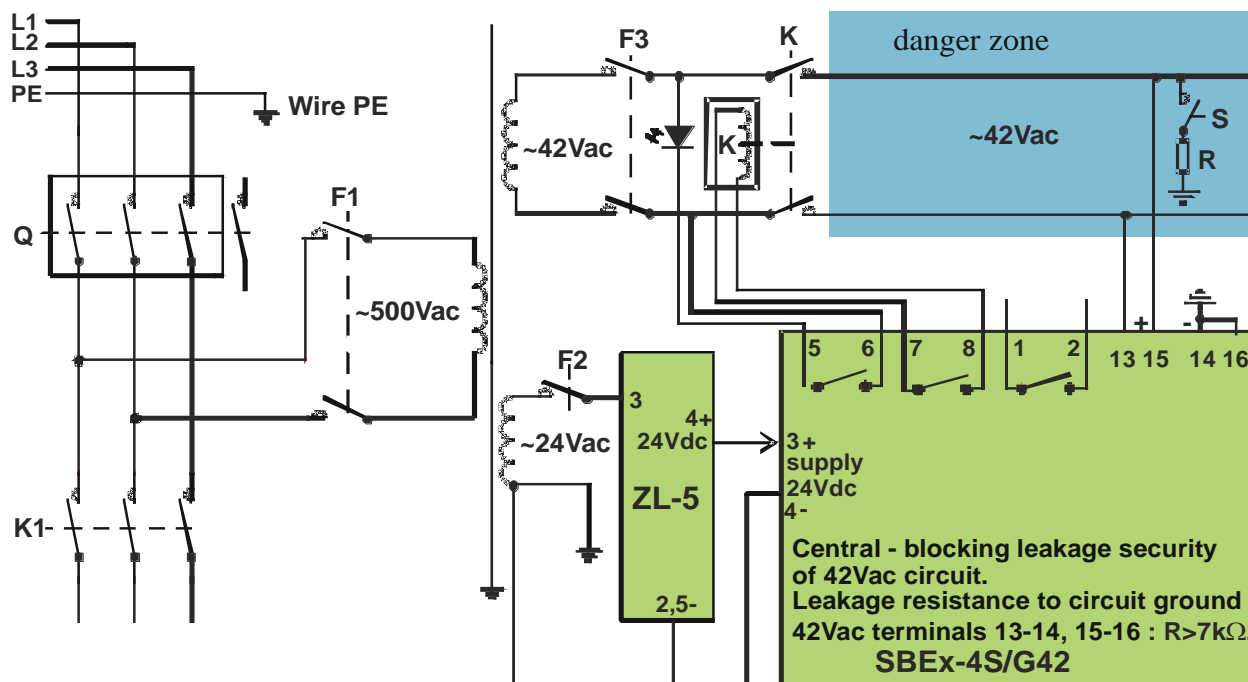
System blocks activation when there is resistance drop in controlled circuit below 7kΩ.
System has three contacts on non-intrinsically safe side confirming that the leakage is below 7kΩ.
Intrinsically safe circuits (terminals 13-14, 15-16) measure leakage in both supply lines 42Vac.
There are three non-intrinsically safe output contacts. Contact 7-8 is connected to control circuit K.
Contact 5-6 controls signaling circuit.

State of relays and LED diodes / Line resistance	output contact state in channel 1, 2 for SW1, SW2 in OFF state	output contact state in channel 1, 2 for SW1, SW2 in ON state	LED in channel 1 and 2 depending on line resistance	contact state „PkA; Pk" ALARM depenging on line resistance of channel 1 OR channel 2
$R < R_x$	shorting	opening	red	opening
$R > R_x$	opening	shorting	green	shorting

Example of blocking resistance: $R_x = 7k\Omega$

	version 24Vdc / 7 kΩ
Blocking resistance	7kΩ ± 20%
Unblocking resistance	≥ 10 kΩ
Reaction time	resistance change 7↔10kΩ t<1sec
Ready for operation after switching on the power supply	3 sec

Terminals „In1" „In2" are separate, galvanically isolated, intrinsically safe circuits. One multi-wire type A or B IEC 60079-14 cable or separate cables may be used to connect these circuits simultaneously.

a) **Intrinsically safe input circuits: „In1"- terminals 13-14, „In2"- terminals 15-16 for SBEx-4S/G42 with "ia" protection level:**

Distributed values Co, Lo and connection cable parameters L/R should be taken according to the table below.

realization	Uo [V]	Io [mA]	Po [mW]	L/R [mH/Ω]			Lo [H]			Co [µF]		
				I and IIA	IIB	IIC	I and IIA	IIB	IIC	I and IIA	IIB	IIC
SBEx-4S/G42	0÷16,4	3,2	13	21	10,5	2,6	1	0,5	0,12	10	2,5	0,413
Characteristic of circuits is linear.												

Safety parameters for SBEx-4S/G42 when both mutually separated intrinsically safe input circuits are serially galvanically connected..

Terminals „In1" „In2" connected serially can be connected with one multi-wire.

Distributed values Co, Lo and connection cable parameters L/R should be taken according to the table below:

realization	Uo [V]	Io [mA]	Po [mW]	L/R [mH/Ω]			Lo [H]			Co [µF]		
				I and IIA	IIB	IIC	I and IIA	IIB	IIC	I and IIA	IIB	IIC
SBEx-4S/G42	0÷32,8	3,2	26	10,5	5,2	2,6	1	0,5	0,12	1,47	0,433	0,041
Characteristic of circuits is linear.												

b) **Intrinsically safe input parameters: „In1" - terminals „13-14" and „In2" - terminals „15-16" with "ia" protection level: Ui=60V, Ii=any, Pi=any, Li ≅ 0, Ci ≅ 11nF.**

c) **In case of using input circuits "IN1" and "IN2" to operate with non-intrinsically safe circuits: Um=60V**

d) **Non-intrinsically safe circuits parameters:**
   „Pk1" – terminals „5-6", „Pk2" – terminals „7-8", „PkA" – terminals „1-2" and „24V supply" - terminals „3-4": Um=253V.

III. SBEx-4S/G500

The separator has "ia" protection level. This allows measuring circuit to remain powered with voltage (not greater than Ui=60V) even after exceeding the concentration of methane over 2%. The separator's power supply does not need to be switched off. Separator SBEx-4S/G500 is used to control condition of the isolation in isolated electrical networks.

Isolated networks marked with the IT symbol are characterized by isolating all active elements of the network from the ground potential. They ensure greater security from electric shocks because the current destruction is limited by very large network capacitive impedance to the ground. IT networks can have very large allowable grounding resistance.

Separator SBEx-4S/G500 can be used as:
   a) a leakage-blocking security designed to control grounding isolation resistance in a voltageless state in intrinsically safe and non-intrinsically safe circuits,
   b) central-blocking leakage security or central leakage security for circuits in which voltage does not exceed 238V after switching on. These circuits after switching on the power are no longer intrinsically safe (Um>60V),
   c) central-blocking leakage security or central leakage security for circuits in which voltage does not exceed 60V. These circuits after switching on the power can still be intrinsically safe if Um≤60V.

The SBEx-4S/G500 separator can operate as leakage-blocking protection designed to control grounding isolation resistance in a voltageless state in single-phase networks with isolated zero point with nominal voltage to the ground U≤238V.

The protective effect of security is based on the principle of blocking switching on the voltage on the damaged section of the network.

On the drawing supplier ZL5 converts supply 24Vac to supply 24Vdc which supplies the SBEx-4S/G500 separator.

The separator checks the network in voltageless state. It blocks switching on the power supply when the resistance of the controlled circuit drops below 15kΩ.

The separator has three separated from each other contacts on the nonintrinsically safe side.

Closing of the first contact (terminals 5-6) is given on control circuits and closing of the second contact (terminals 7-8) is given on signalization circuits.

It is possible to implement second measurement channel in the same housing but with only one output contact given on control circuits (terminals 1-2).

Contact with terminals 1-2 can be used as redundant control or indication which can improve reliability of the whole system.
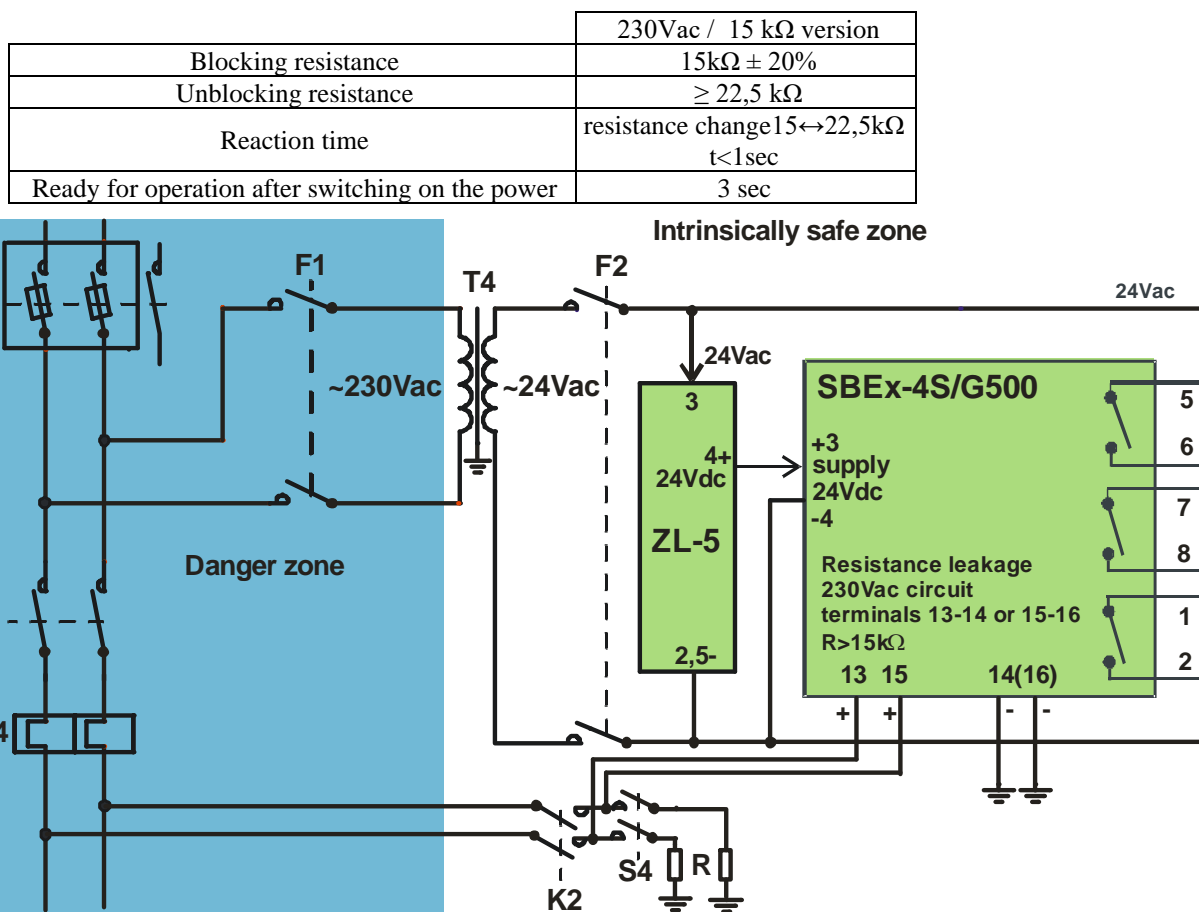
Sets of terminals "IN1" "IN2" are individual intrinsically safe circuits which are galvanically separated. For simultaneous connection of these circuits can be used a single multi-wire cable of type A or B in accordance with IEC 60079-14 or separate cables.

To sum up:

The separator SBEx-4S/G500 in version for voltages 230Vac can operate as blocking, central or central-blocking leakage protection designed to control grounding isolation resistance in single-phase networks which are isolate with nominal voltage U=230Vac – check the drawing.

For voltages U>60V the measurement circuit stops being intrinsically safe.

The protective effect of security is based on the principle of blocking switching on the voltage on the damaged section of the network or disconnecting the voltage when leakage resistance drops below 15kΩ.

	230Vac / 15 kΩ version
Blocking resistance	15kΩ ± 20%
Unblocking resistance	≥ 22,5 kΩ
Reaction time	resistance change 15↔22,5kΩ t<1sec
Ready for operation after switching on the power	3 sec

Power supply ZL5 supplier converts 24Vac to 24Vdc which supplies SBEx-4S/G500 separator.

a) **Intrinsically safe input circuits: „In1"- terminals 13-14, „In2"- terminals 15-16 for SBEx-4S/G500 with "ia" protection level:**
Distributed values Co, Lo and connection cable parameters L/R should be taken according to the table below:

realization	Uo [V]	Io [mA]	Po [mW]	L/R [mH/Ω]			Lo [H]				Co [µF]		
				I and IIA	IIB	IIC	I	IIA	IIB	IIC	I and IIA	IIB	IIC
SBEx-4S/G500	0÷16,4	0,288	1,18	240	120	30	5626	3430	1710	429	10	2,5	0,413
Characteristic of circuits is linear.													

Safety parameters when both mutually separated intrinsically safe input circuits are serially galvanically connected for SBEx-4S/G500.

Terminals „In1" „In2" connected serially can be connected with one multi-wire.

Distributed values Co, Lo and connection cable parameters L/R should be taken according to the table below:

realization	U_o [V]	I_o [mA]	P_o [mW]	L/R [mH/Ω]			Lo [H]				Co [μF]		
				I and IIA	IIB	IIC	I	IIA	IIB	IIC	I and IIA	IIB	IIC
SBEx-4S/G500	0÷32,8	0,288	2,36	120	60	15	5626	3430	1710	429	1,47	0,433	0,041
Characteristic of circuits is linear.													

b) Intrinsically safe input parameters: „In1" - terminals „13-14" and „In2" - terminals „15-16"
   with "ia" protection level: $U_i=60V$, $I_i=$ any, $P_i=$ any, $L_i \cong 0$, $C_i \cong 11nF$.

c) In case of using input circuits "IN1" and "IN2" to operate with non-intrinsically safe circuits:
   $U_m=238V$

d) Non-intrinsically safe circuits parameters:
   „Pk1" – terminals „5-6", „Pk2" – terminals „7-8", „PkA" – terminals „1-2" and
   „24V supply" - terminals „3-4": $U_m=253V$.

Application condition:

Due to danger of electrostatic discharge separator housing can only be cleaner with moist or antistatic cloth.

Maximal value of capacitance and inductance joined to intrinsically safe terminals **„In1", „In2"** should be selected based on joining circuits safety parameters (given in conditions of use of devices which will be connected to separator's input), but cannot exceed the values given in the tables above.

ATEX compliance - directive 94/9/WE: PN-EN 60079-0:2009, PN-EN 60079-11:2012, PN-EN 50303:2004,

Operation condition :

Ambient temperature - for storage	-	-30 ÷ +70°C
Ambient temperature - operation	-	-25 ÷ +70ºC
Relative humidity	-	max 90%
Ambient atmosphere	-	no dust and aggressive gases
Working position	-	any

Configuration – additional information:

Phase activation selection (does not concern alarm relay) is made by SW1, SW2 switches which are accessible after opening the housing.

Table 1.

input \ output	Channel 1 „Pk1; Pk" output contact	Channel 2 „Pk2; Pk" output contact
input **disconnected** I < 1,4 mA	contact **opened** when jumper SW1 **OFF**	contact **opened** when jumper SW2 **OFF**
input **disconnected** I < 1,4 mA	contact **shorted** when jumper SW1 **ON**	contact **shorted** when jumper SW2 **ON**
input **connected** I > 1,9 mA	contact **shorted** when jumper SW1 **OFF**	contact **shorted** when jumper SW2 **OFF**
input **connected** I > 1,9 mA	contact **opened** when jumper SW1 **ON**	contact **opened** when jumper SW2 **ON**

Channel selection (from which connection line breaking detection result is summed to detection results from other channels) is made by SW3, SW4 switches which are accessible after opening the housing.

Table 2.

Connection line breaking detection \ Channel	1	2
alarm off	when jumper SW3 **OFF**	when jumper SW4 **OFF**
alarm on	when jumper SW3 **ON**	when jumper SW4 **ON**

Table 3 describes function of switches which are used to set work with or without phase reversing.

Without phase reversing: Iin>I top level

input contact shorted $\Rightarrow$ output contact shorted

With phase reversing: Iin>I top level

input contact shorted $\Rightarrow$ output contact opened.

SW1, SW2 switches respectively refer to phase reversing acting of PK1, PK2 relays.

Table 3.

relays state / relays	SW1, SW2	
	ON	OFF
PK1 channel 1 relay PK2 channel 2 relay	with phase reversing	without phase reversing

Table 4 describes function of switches which are used to activate or to lock "ALARM" function for each channel. There is one shared output contact "PkA; Pk" of "ALARM" function. It works as logical sum – one alarm in one alarm activated channel is enough.

SW3, SW4 switches respectively refer to alarm state detection activation I<0,3mA or I>6,5mA in channels 1, 2. „PkA; Pk" contacts will connect when I<0,3mA or I>6,5mA in at least one channel which was alarm activated.

Table 4.

relays state / LED „state/alarm" and ALARM relay	SW3, SW4	
	ON	OFF
„Pk1", „Pk2" LED	- red $\quad$ I < 0,3 mA - orange $\quad$ I > 6,5 mA	- does not light $\quad$ I < 0,3 mA - green $\quad$ I > 6,5 mA
„PkA; Pk" contacts of ALARM relay	- shorted when on one of alarm activated channel I<0,3mA or I>6,5mA	- opened SW3=SW4= OFF or when on all of alarm activated channel 0,35<I<6mA