LABOR – ASTER
INDUSTRIAL AUTOMATION

GIG System Zarządzania Jakością Quality Management System PN-EN ISO 9001 Certyfikat nr QS/14/07

GWARANCJA PRODUCENTA 3 LATA

CE

PCA POLSKIE CENTRUM AKREDYTACJI CERTYFIKACJA SYSTEMÓW ZARZĄDZANIA AC 083 QMS

Intrinsically safe barrier with separation, version with only RS485 on Ex side
TRANSMISSION LINES CONVERTER-SEPARATOR
type S2Ex-RS-[ic] v.Ex485
only Rs485 on Ex side: RS232/RS485, RS422/RS485, RS485/RS485

ATEX

- "group II and III", "category (3)" accompanying device
- intrinsically safe circuit of "ic" protection level – ATEX compliance
Explosion-proof construction marking:
II (3) G [Ex ic Gc] IIC, II (3) D [Ex ic Dc] IIIC, II 3G Ex nA II T4
Protection level   IP20   **Operating temperature range -30..+70°C**

- Intrinsically safe circuit can operate with transmission line led to explosion hazardous zone "2, 22" of any explosive mixtures.
- The second separated transmission side and supply circuit can work with non-intrinsically safe circuits of devices with voltage Um=253V e.g. supplied from 230Vac network.
- The separator can be installed in explosion safe zone or in explosion hazardous zone in explosion-proof designed enclosure (see page 3). Atmosphere should be dry, dust free and protected against access of people not trained in maintenance and operation of the separator.
- The separator as accompanying device can be installed in any explosion hazardous zone in explosion-proof designed enclosure e.g. flameproof enclosure or in zone 2 in other enclosure in accordance with rules in force. Basing on marking Ex nA II T4 (category 3 device) it can be installed in accordance with rules give on page 3.

● **Separation and translation of the following transmissions:**

Safe zone	Explosion hazardous zone
RS 232 RS 485 RS 422	RS485

• **The separator is designed between others for MODBUS RTU/ASCII, PROFIBUS DP and operates correctly with any half-duplex protocol.**
• **Jumpers-selected transmission speed: 9600, 14400, 19200, 38400, 57600, 115200 bd.**
• **Automatic transmission speed measurement: 300, 600, 1200, 2400, 4800, 9600, 14400, 19200, 33600, 38400, 57600 bd.**
• **Supported transmission parameters: 7N2, 7O1, 7O2, 7E1, 7E2, 8N1, 8N2, 8O1, 8O2, 8E1, 8E2[1].**
• **Smart control of flow direction.**
• **All circuits fully galvanically separated.**
• **Internal lines terminators.**
• **Led indication of supply, transmission and line damage.**

PURPOSE :
The separator is designed to galvanically separate and translate transmission standards RS232, RS485, RS422 in safe zone to standard RS485 in intrinsically safe circuit leading to hazardous zone.

For transmission RS485 and RS422 the separator allows to operate with the transmission line up to 1200 meters (up to 1000m for 57600bd, 600m for 115200bd) and many devices to operate with each other. Separation eliminates interferences and the differences of potentials. It also protects connected devices from power surges.

On the intrinsically safe side is only RS485 interface - communication in both direction on two-wire line. On the safe side user can use RS232, RS485 or RS422. Switching requires opening of the housing and switching the jumpers. Switching description is given later in this document.

BASIC TECHNICAL PARAMETERS:

Non-intrinsically safe side RS232 according to RS232C standard
Receiver parameters:

- low level	-	-9 V ÷ -3 V
- high level	-	+3 V ÷ +9 V
Connection line length	-	max 15m for 19200bd (capacity sum C<2500pF), max 5m (115200 C<100pF)

Transmitter parameters:

- output voltage	-	minimum ±5V on load R≥3kΩ

RS485 and RS422

|		
- receiver sensitivity	-	± 0.2 V
- signal from transmitter	-	min ±2V on load R≥100Ω
Connection line length	-	max 1200m for <57600bd max 1000m for 57600bd max 600m for 115200bd
Baudrate	-	300, 600, 1200, 2400, 4800, 9600, 14400, 19200, 33600, 38400, 57600, 115200
Minimal interval between switching	-	3 bods or[2] 15-20 bods
Direction of line switching time	-	<150 ns
Distortion of the bit	-	<100 ns
Phase shift of the bit	-	<100 ns
Number of devices in the line	-	max 32
Supply indication	-	PWR LED on
Transmission indication	-	RS LED blinking
Supply	-	20...28Vdc/60mA
Rail housing IP20	-	on TS35 rail cable terminals 2.5mm²
Galvanic separation	-	circuits of both sides of transmission and supply circuit mutually separated
- isolation test voltage	-	2kV 50Hz
Rail housing IP20		with rail 114.5 x 99 x 22.5mm
EMC requirements	-	PN-EN 61326-01:2013
Safety requirements	-	PN-EN 61010-1:2002

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[1] 7,8 – bits number, N -no parity bit, O – odd parity, E – even parity, 1 – 1 stop bit, 2 – 2 stop bits

[2] Depending on the position of jumper SV5A 6-7 and lack of transmission control
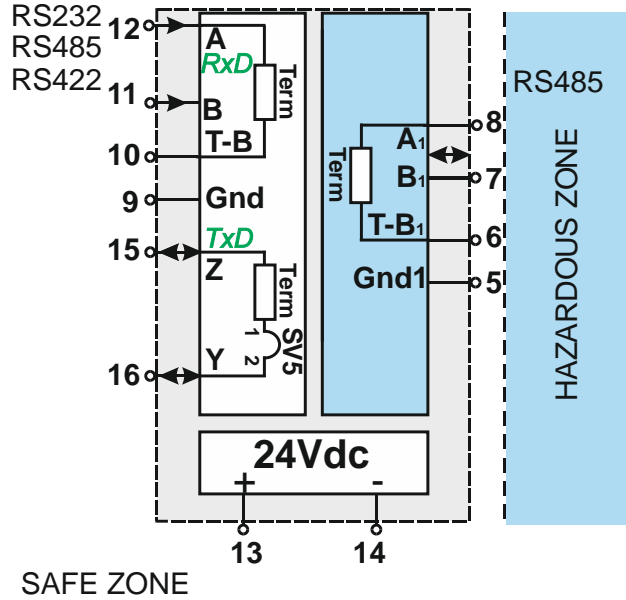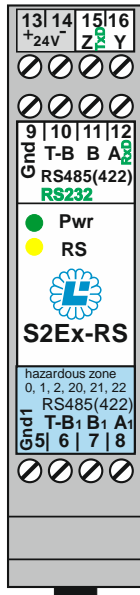
Housing dimensions: thickness 22.5 mm; width 99 mm, height 114.5 mm.
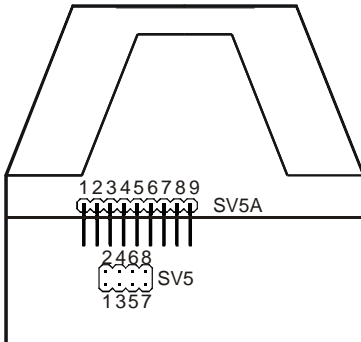
NOTE: Terminal GND1 in intrinsically safe circuit allows connecting shield of the transmission cable which goes to explosion hazardous zone. Braid of the shielded cable cannot be grounded from both sides (in safe zone and hazardous zone). Braid does not have to but can be connected to the ground but only from one side. If GND1 terminal together with cable shield is grounded in safe zone then braid of the cable in explosion hazardous zone must be distanced minimum 5cm from terminals of the core of this cable.

View of the jumpers comb to switch.
Description of the jumpers configuration is in the table on page 5.

<u>**THE SAFETY PARAMETERS:**</u> directive ATEX - PN-EN 60079-0:2013 + A11:2014-03 PN-EN 60079-11:2012

a) Intrinsically safe circuit: terminals T-B1, A1, B1, T-Z1, Z1, Y1, GND1 with "ic" protection level:

Distributed values of Co, Lo, L/R of the connection cable should be adopted according to the table shown below.

Version	Uo [V]	Io [mA]	Po [mW]	L/R [mH/Ω]			Lo [mH]			Co [µF]		
				I and IIA	IIB and III	IIC	I and IIA	IIB and III	IIC	I and IIA	IIB and III	IIC
S2Ex-RS-[ic]	4,2	70,7	74,3	3,83	1,91	0,47	70	30	9	800	800	80

Characteristic of the circuits is linear. For clustered values should be taken half of the values of Co, Lo given in this table remembering that Co cannot exceed 1µF for group I, IIA, IIB and 0,6µF for IIC.

b) Intrinsically safe circuit parameters: terminals T-B1, A1, B1, T-Z1, Z1, Y1, GND1

with "ic" protection level: $Li \cong 0,\ Ci \cong 0.$

Version	Ui [V]	Ii [mA]	Pi [mW]
S2Ex-RS-[ic]	30	79,7	does not require determination

c) Non-intrinsically safe circuits parameters:
   terminals "A, B, T-B, Y, Z" and "supply 24V": terminals "ZAS+, ZAS-":   Um=253V

Safety parameters for group III (dusts) are the same as for group IIB (gas).

After agreement there is possibility to adjust safety parameters Uo, Io to parameters Ui, Ii of a cooperating device installed in hazardous zone 2, 22.

In installations in which parameters Ci and Li of device cooperating with intrinsically safe circuit (connection cable excluded) exceeds 1% of the value of parameters Co and Lo given in the table above you should:
   - from 50% of the value of Co, Lo subtract Ci, Li of cooperating device,
   - these values remains for parameters of connection cable,
   - if cable parameters are unknown you can take 100pF/m, 0,7µH/m for calculation.

Conditions of use:

Typical application for the separator is to be installed in safe zone.

The separator can be installed in explosion hazardous zone in flameproof enclosure (or other in accordance with the rules in force). Application in first (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".

In general cables and wires of intrinsically safe circuits should be led separately regarding to non-intrinsically safe cables and wires. If intrinsically safe cable is shielded and is blue it can be in cable trays together with other non-intrinsically safe cables. Shield of the cable should be connected to the ground PE only from one side e.g. only in safe zone with a wire of 2,5mm2 diameter. Maintain a distance of 50mm from the end of the shield braid to the stripped ends of the cable cores in both the hazardous and safe zones. Put the crimping sleeves on the stripped ends of the cable cores. If in a multicore intrinsically safe cable are several intrinsically safe circuits the cables must be of A or B type with insulation test of 500V and the insulation cannot be thinner than 0.2mm. Cables and wires must be permanently fixed and protected against the possibility of mechanical damage. It is recommended to use blue cables. Compare the parameters U_o, I_o, P_o, C_o, L_o, U_i, I_i, P_i, C_i, L_i (L, C of the cable and L_i, C_i of the device installed in the hazardous area).

If the L, C clustered parameters in the connected circuit (and this is how the L_i, C_i parameters of the connected device should be treated) exceed 1% of the L_o, C_o value, for the calculation should be taken of the L_o, C_o parameters given in the certificate for the clustered values. If such parameters are not provided, then half of the C_o, L_o value from the certificate should be taken for calculations with the assumption that the C_o value cannot exceed 1 µF for groups I, IIA, IIB and III and 0.6 µF for IIC.

If a "simple device" made of plastic is installed in the hazardous area, the risk of electrostatics should be assessed. In the case of cable routes with high energy (power grid) or interferences, cables with measurement signals susceptible to the impact of interferences, apart from the use of shielded twisted-pair cables, should be led at a distance, e.g. in a separate tray, and the routes crossing each other should be at right angles.

For installation in zone 2: The separator can be installed in explosion-proof design enclosure e.g. with protection level Ex n or Ex e, Ex c, ensuring at least IP54. The enclosure should have cable inputs and blanking elements meeting the same requirements of protection level Ex n or Ex e, Ex c. To prevent self-loosing of cables in non-intrinsically safe screw terminals number 9, 10, 11, 12, 13, 14, 15, 16 should be used not-tinned cables:

- single wire or braid wire with twisted ending with diameter of 0.25÷2.5 mm²,
- 2 braid wires with the same diameter of 0.5÷1.5 mm² with twisted ending put together to common tubular sleeve kniked with special tool.

Terminals should be tighten with a torque of 0.5 Nm with a flathead screwdriver having a width of 3.0...3.5 mm. Every 6 months terminals should be checked and tighten with a torque of 0.5 Nm with a flathead screwdriver having a width of 3.0...3.5 mm.

Note: When there is or may be explosion atmosphere, it is not allowed to connect voltage cables to non-intrinsically safe terminals number 9, 10, 11, 12, 13, 14, 15, 16. When the device is powered, it is not allowed to connect or disconnect cables in non-intrinsically safe circuits. When there is or may be explosion atmosphere during service operations power supply should be disconnected in safe zone. Before starting service operations non-explosion atmosphere should be ensured when the separation is installed in zone 2.

FUNCTIONAL DESTRIPTION

The device on the hazardous side has only RS485 interface. The consequence of this is operation only in half-duplex mode (alternate communication in both directions on a two-wire line).

The device has 3 operating modes.

In the first mode the baudrate is set using jumpers. The device reads individual bytes. If there is no continuation in the frame after the last byte, then after the end of the transmission the line is released after 3 bauds from the last stop bit. If a frame error is detected, then the device releases the line after approximately 15 to 20 bauds from the last recorded edge. This mode is recommended with a known fixed baudrate which is within the capabilities of the device. It is strongly recommended when high interference can be present.

In the second mode the baudrate jumpers are set to automatic transmission speed measurement. In this case, the device first measures the baudrate. The first frame and possibly the second may not be transmitted correctly. This manifests itself in a delay in the release time of the transmission line in the same way as in the case of an incorrect frame. After measuring the baudrate, the device reads individual bytes. If there I no continuation in the frame after the last byte, then after the end of the transmission the line is released after 3 bauds from the last stop bit. If a frame error is detected, then the device releases the line after approximately 15 to 20 bauds from the last recorded edge and goes into

the baudrate measurement mode. <u>Setting this mode is recommended in the lack of information about the baudrate or the baudrate is not specified in the set of baudrates that can be set with jumpers.</u>

In the third mode the baudrate selecting jumpers are set to disable the automatic measurement and transmission speed analysis. In this case the device measures the duration of the levels (bauds). The transmission line is released after a time of 12 to 15 bauds. In this case it is possible to increase the line release time by an additional 12 bauds depending on the setting of the SV5A 6-7 jumper. The device treats each frame separately. In order for the device to work properly, it must be ensured that in each transmission frame there is at least one baud corresponding to the baudrate. This requirement is automatically met in the presence of strong polynominal-based checksums (e.g. CRC16 for MODBUS RTU, PROFIBUS DP etc.). <u>This mode is recommended in the case of transmission separation in which each pair (query → response) has a different transmission speed or transmission packets have gaps.</u>

Transmission control is indicated by LEDs.

- ➢ LED PWR   - Steady light after power is on means correct operation and no defined baudrate.
- ➢ LED PWR   - Blinking with fast pulses after power is on means correct operation and baudrate set with jumpers. After few seconds it goes to steady light.
- ➢ LED PWR   - Flashing with slow pulses means connection line is damaged. The program detects a situation when there is no data bit after the start bit. The pulse is too long. The flashing is just a feedback, the device does not stop working. To eliminate this error change polarity of the connecting wires.
- ➢ LED RS   - Flashing during transmission in any direction.

Configuration of the device.

The separator is equipped with optional attached internal 300Ω terminators matching the wave resistance of the line. After opening the housing can be set:

SV5A	Description of the jumpers configuration.
1-2	Shorting – echo block (for RS232 on safe side) Opening – echo block circuit is switched off
2-3	Shorting – enables transmission direction control on the side of the safe zone. Opening – disables transmission control. Transmitter is permanently switched on. Opening for RS232 on safe side.
4-5	Shorting – standard on safe zone is RS232. Opening – standard on safe zone is RS485 or RS422.
6-7 [3]	Shorting – additional parity bit is transmitted. For 8O1, 8O2, 8E1, 8E2 [4]. Opening – for 7N2, 7O1, 7O2, 7E1, 7E2, 8N1, 8N2.
6-7 [5]	Shorting – additional elongation of line releasing by 15 bauds. Opening – no elongation.
8-9	Shorting – in RS485 transmission on safe side only terminals 15 and 16 are used. Opening – typical RS422 connection. In case of RS485 on safe side additional terminals (11-15 and 12-16) shorting is needed.

SV5	Description of the jumpers configuration.
1-2	Shorting – connects the internal terminator to Y/Z line. Opening – disconnects the terminator of Y/Z line.
3-4 5-6 7-8	Configuration jumpers storage.

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[3] Jumper operates in this mode if transmission analysis is turned ON.
[4] 7,8 – bits number, N – no parity bit, O – odd parity, E – even parity, 1 – 1 stop bit, 2 – 2 stop bits
[5] Jumper operates in this mode if transmission analysis is turned OFF.

SV7A				Setting baudrate and transmission analysis
1-2	3-4	5-6	Jumpers view	
opened	opened	opened	1 2 3 4 5 6	9600 bd
opened	opened	shorted	1 2 3 4 5 6	14400 bd
opened	shorted	opened	1 2 3 4 5 6	19200 bd
opened	shorted	shorted	1 2 3 4 5 6	38400 bd
shorted	opened	opened	1 2 3 4 5 6	57600 bd
shorted	opened	shorted	1 2 3 4 5 6	15200 bd
shorted	shorted	opened	1 2 3 4 5 6	Automatic baudrate measuring
shorted	shorted	shorted	1 2 3 4 5 6	Transmission analysis turned off

Safe side	Device connecting description	External connecting description
RS232	SV5A 6-7 short. SV5A 4-5 open. SV5A 3-4 short	DB9 – Female (example) TxD – DB9-2 RxD – DB9-3 GND – DB9-5
RS485	SV5A 6-7 open SV5A 4-5 short	A short with Y $\Rightarrow$ bidirectional signal A of RS485 line B short with Z $\Rightarrow$ bidirectional signal B of RS485 line (optionally T-B connected to B – internal terminator)
RS422	SV5A 6-7 open SV5A 4-5 short (open option) SV5 1-2 (short option for terminator)	A $\Rightarrow$ signal A , B $\Rightarrow$ signal B (optionally T-B connected to B – internal terminator) Y $\Rightarrow$ signal Y, Z $\Rightarrow$ signal Z

Hazardous side	Device connecting description	External connecting description
RS485	SV5A 1-2 short	A1 $\Rightarrow$ signal A of RS485 line B1 $\Rightarrow$ signal B of RS485 line (optionally T-B1 connected to B1 – internal terminator)

Example of use of terminators

Connecting without noise filter
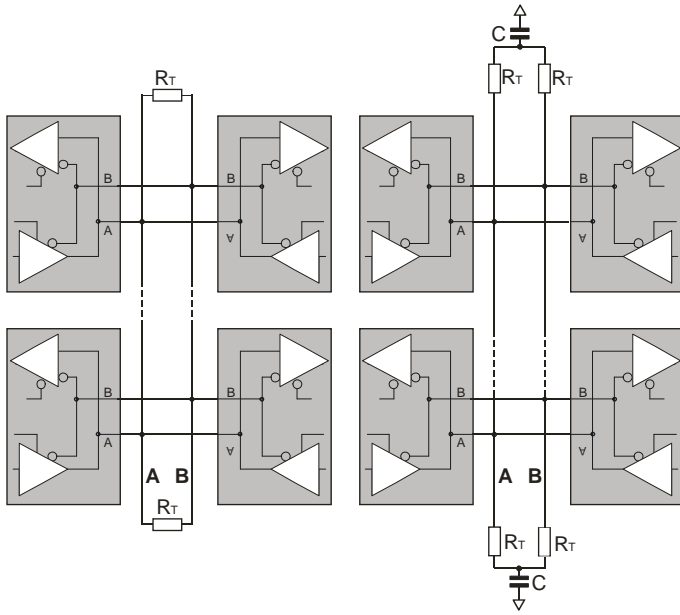
Connecting with noise filter. Only on the safe zone. Use in case of interference generators nearby e.g. high power electric engines, turbine, induction furnace. It can be ordered from LABOR-ASTER after consultancy.

$$C = \frac{1}{2 * \pi * BaudRate * R_T}$$

BaudRate – transmission speed in bods.

ORDERING CODE: Converter-separator type S2Ex-RS-[ic]-Y v.Ex485

Y=(A,B,C,CH,E) according to the table below
Y parameter in ordering code is optional because it can be changed by user with jumpers

	Safe zone - Y
RS232 without echo	A
RS232 echo	B
RS485	C
RS485 2-wires	CH
RS422 half-duplex with terminator	E

ORDER EXAMPLE: Transmission separator with RS485 on hazardous side and RS422 on safe side:
type: S2Ex-RS-[ic]-E v.Ex485

Detailed description of connection and configuration of each version.

Below description concerns ordered version and its connection. User can change his device version basing on below drawings (after demounting it and opening the housing). Most popular versions are marked on green. During inactive state of transmission lines A Y A1 Y1 have positive voltage in relation to their equivalent B Z B1 Z1 while voltmeter is between transmission terminals (couples: A B, A1 B1, Y Z, Y1 Z1). Producers have different interpretation of A and B lines. In case of troubles with transmission it is worth to try to swap these lines.

Connection between S2Ex-RS and master computer in version with RS-232 interface for two types of connectors. Other connection are shown in the end of this document.
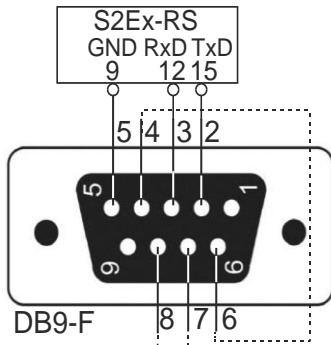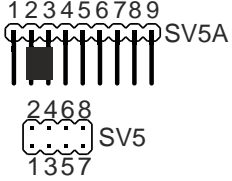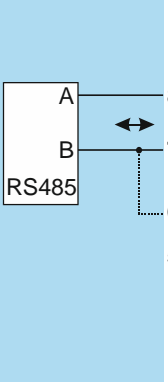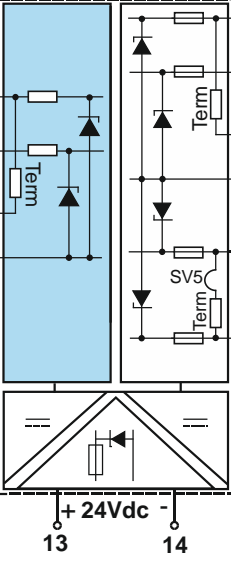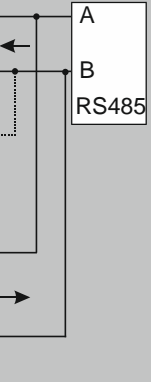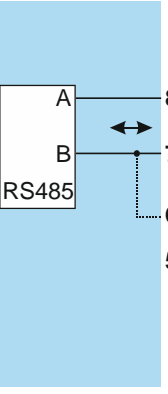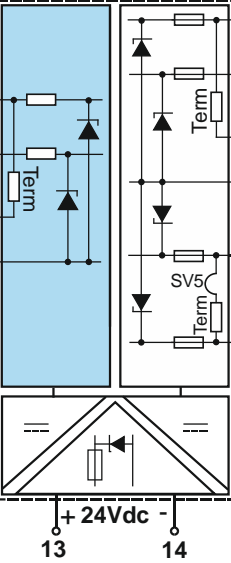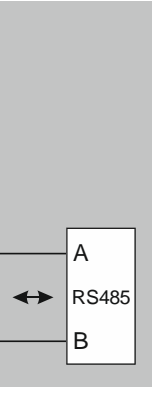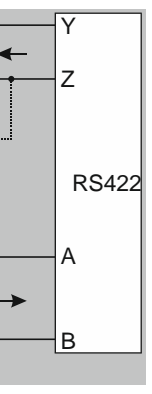

Dotted line is for optional connections.
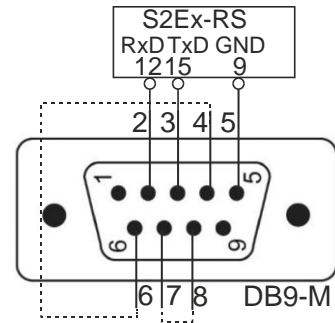
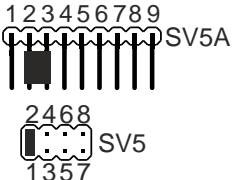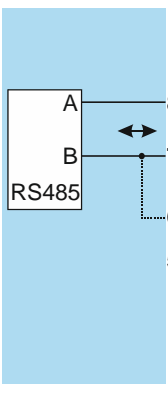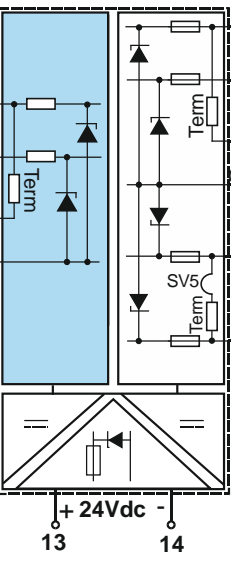| Code	Description	Jumpers description[6]	Hazardous zone　Connection drawing　Safe zone
S2Ex-RS-[ic]-A v.Ex485	**RS232⇔RS485** Transmission with echo suppression. Half-duplex transmission.	SV5A 1-2 shorted SV5A 4-5 shorted	
S2Ex-RS-[ic]-B v.Ex485	**RS232⇔RS485** Transmission with listening (echo) A1 B1 line. Half-duplex transmission. Wrong echo indicates a conflict in the RS485 line.	SV5A 4-5 shorted	

[6] Jumper SV5A 8-9 should be used in case of discontinuous transmission. This jumper does not affect function of the device described in the table.

Code	Description	Jumpers description	Hazardous zone	Connection drawing	Safe zone
S2Ex-RS-[ic]-C v.Ex485	**RS485⇔RS485** Transmission half-duplex with all direction control. Two available terminators, one by shorting terminals 10-11, second by putting on jumper SV5 1-2.	SV5A 2-3 shorted 1 2 3 4 5 6 7 8 9 SV5A 2 4 6 8 SV5 1 3 5 7			
S2Ex-RS-[ic]-CH v.Ex485	**RS485⇔RS485** Transmission half-duplex with all direction control. RS485 on safe zone in 2-wire version. With internal terminator on safe side (jumper SV5 1-2). Recommended configuration because it does not require additional shorting of terminals 11-15, 12-16.	SV5A 2-3 shorted SV5A 8-9 shorted SV5 1-2 shorted 1 2 3 4 5 6 7 8 9 SV5A 2 4 6 8 SV5 1 3 5 7			
Ex-RS-[ic]-E v.Ex485	**RS422⇔RS485** A, B receiving, Y Z transmitting. Transmission half-duplex with all transmission direction control. Terminators on safe side.	SV5A 2-3 shorted SV5 1-2 shorted 1 2 3 4 5 6 7 8 9 SV5A 2 4 6 8 SV5 1 3 5 7			

Below is a detailed table of RS232C interface connections from the device to the standards of the different companies. In order to ensure correct operation of the transmission control signals should be shorted. The table is for reference only. In order to determine the final connection, the following connections should be compared to the catalog data of the connected device.

Signal name	Sym	Direction	LABOR-ASTER S2Ex-RS	DB-25M	DB-25F	DB-9M	DB-9F	8P8C (RJ45)						10P10C (RJ50)		
								TIA-561	Yost	MMJ	Cisco	Hirschmann	Cyclades	National Instruments	Cyclades	Digi
Common Ground	G		GND	7	7	5	5	4	4-5	3-4	4-5	4	4	6	5	7
Transmitted Data	TxD	→	TxD	2	3	3	2	6	3	2	3	3	3	8	4	5
Received Data	RxD	←	RxD	3	2	2	3	5	6	5	6	5	6	9	7	6
Data Terminal Ready	DTR	→	Shorted	20	6	4	6	3	2	1	2	-	2	7	3	9
Data Set Ready	DSR	←	Shorted	6	20	6	4	1	7	6	7	-	8	5	9	2-10
Carrier Detect	DCD	←	Shorted	8	-	1	-	2	7	-	-	-	7	10	8	10-2
Request To Send or Ready to Receive	RTS RTR	→	Shorted	4	5	7	8	8	1	-	-	-	1	4	2	3
Clear To Send	CTS	←	Shorted	5	4	8	7	7	8	-	-	-	5	3	6	8
Ring Indicator	RI	←		22	(NC)	9	-	1	-	-	-	-	-	2	10	1

Note.   No Connect (NC) – leave unconnected. Empty fields (-) in the table mean signal is not used.

Separator is placed in a housing made of self-extinguishing plastic (polyamide PA 6.6) intended for mounting on TS35 rail. The enclosure and terminal protection degree is IP20.

Operational conditions:
Ambient temperature – storage   -30 ÷ +70°C
Ambient temperature - operation   -30 ÷ +70ºC
Relative humidity   max 90% no condensation
Ambient atmosphere   no aggressive dusts and gases
Operation position   any