VIPA Networking Solutions

PBS | 921-1EB50 | Manual

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PROFIBUS MultiSwitch - PBMS-X5

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921-1EB50_000_PBMS-X5,2,GB -

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1 General

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1.2 About this manual

Objective and contents

This manual describes the PROFIBUS MultiSwitch X5 921-1EB50 from VIPA. It contains a description of the construction, project implementation and usage.

Product	Order number	as of state: HW
PBMS-X5	921-1EB50	01

Target audience

The manual is targeted at users who have a background in automation technology.

1.3 Safety information

Applications conforming with specifications

The system is constructed and produced for:

- communication and process control
- industrial applications
- operation within the environmental conditions specified in the technical data
- installation into a cubicle

DANGER!
This device is not certified for applications in

– in explosive environments (EX-zone)

Documentation

The manual must be available to all personnel in the

- project design department
- installation department
- commissioning
- operation

CAUTION!
The following conditions must be met before using or commissioning the components described in this manual:

– Hardware modifications to the process control system should only be carried out when the system has been disconnected from power!
– Installation and hardware modifications only by properly trained personnel.
– The national rules and regulations of the respective country must be satisfied (installation, safety, EMC ...)

Disposal

National rules and regulations apply to the disposal of the unit!

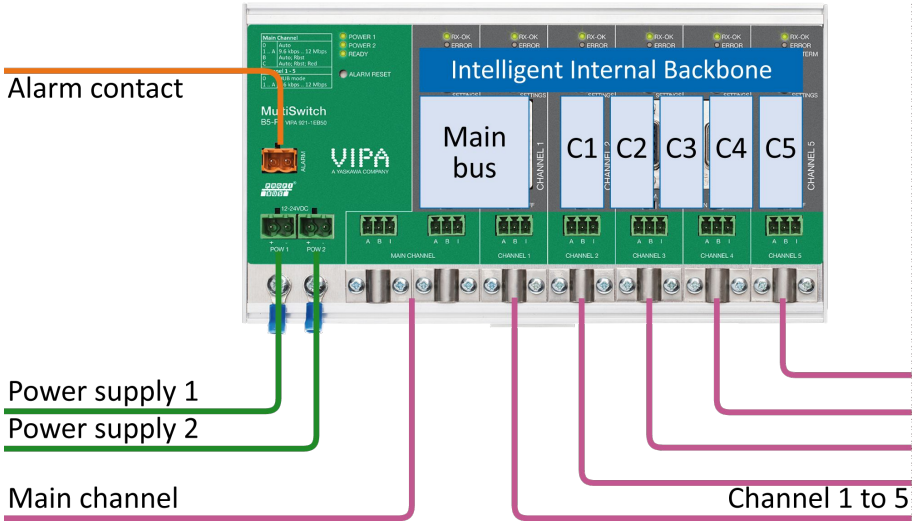
2 Product Description

2.1 General

The MultiSwitch X5 modernizes PROFIBUS network architecture for the next generation. The transparent repeater hub has the ability to create baudrate customization per channel. A simple rotary switch opens doors to a new landscape with reliable and money saving applications.

The X5 eliminates traditional PROFIBUS network baudrate constraints associated with spur lines, additional resistance, single master systems, poor cable segments and cable length limitations. Design limitations associated with legacy systems or new built systems are eliminated, creating the capability for unprecedented customizable network designs. One main PLC can now act as a workhorse with the ability to extend the network further, spur line hot swap, reduction of repeater installation, all without limiting speed performance. With limitless applications, the MultiSwitch X5 will become your go to device for creating networks without traditional limitations.

2.2 Product features



- Faster cycle time
- Legacy host systems

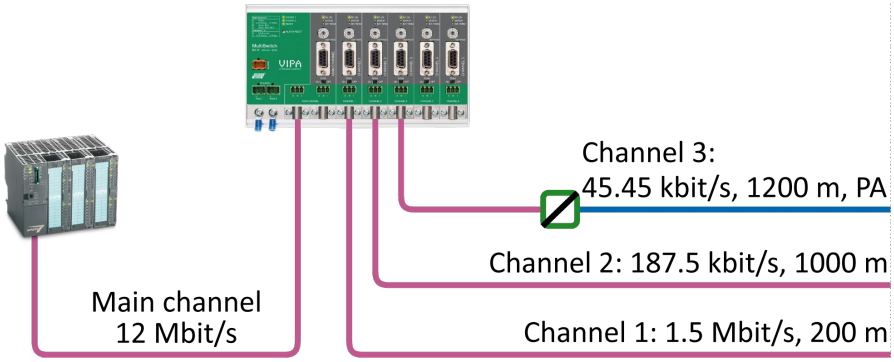
- 9.6 kbps - 12 Mbps
- 5 isolated repeater channels
- Transparent for all PROFIBUS DP - protocols (DPV0 & DPV1 class 2)
- 31 devices per channel
- Integrated termination facilities
- Redundant power supply
- Switch contact for errors
- Configurable grounding system

2.3 Application areas

- Extend Network length, without sacrificing baudrate speed.
- Adding to Legacy Systems with Fixed baudrate limitations
- Media Coupling within 1 network with PA and wireless devices
- Bad Segment Isolation
- EMC interference reduction
- Reduce Resistance effects, i.e. lightning arrestors
- Limited speed PROFIBUS devices, operating on high speed networks

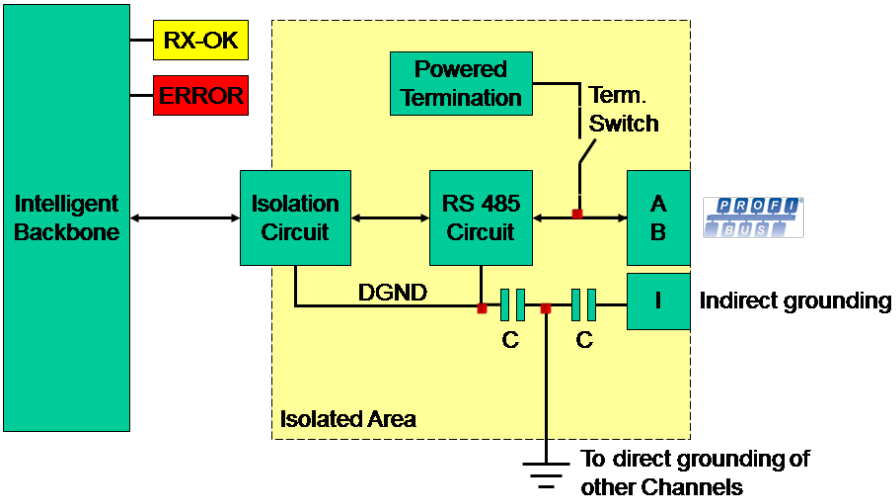
2.4 Additional Benefits

- Cable length limitation removed
- One master for different network types
- No more design limits
- Cost saving
- Coupler to any PB device
- Suitable for all DP cables
- Short circuit protection on each channel
- Insertion and removal of slaves is possible during operation
- Faster update times
- Less repeaters



2.5 Channel Structure

Each channel is electrically isolated and internally connected to the transparent intelligent backbone. The termination is switchable and powered by the MultiSwitch. The shielding of the PROFIBUS cable can be directly grounded or indirectly grounded.



2.6 Grounding System

The PROFIBUS MultiSwitch can be grounded by 3 methods:

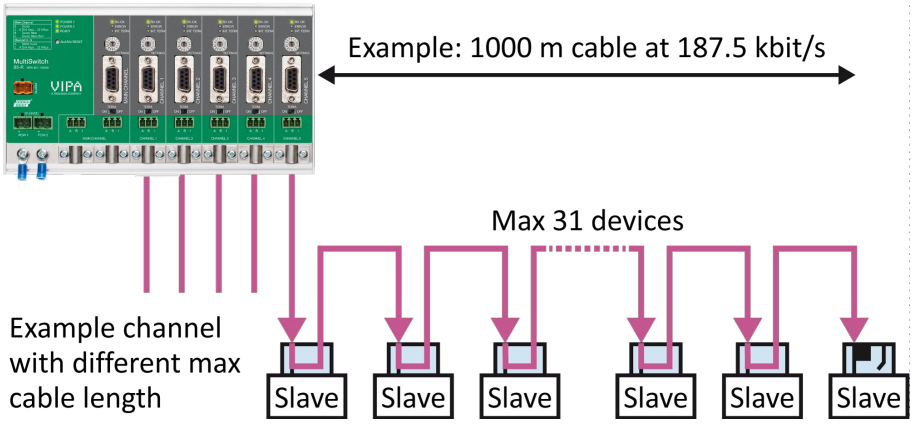
- Direct grounding on the Ground Rail
- Indirect grounding (through a capacitor)
- Combination of direct and indirect

The power supply must be grounded directly on the Ground Rail. The shielding of the PROFIBUS cables can be directly or indirectly grounded. If you do not want to ground all or some cables to the common ground, i.e. compensating current, the cable shielding must be connected to pin "I" which stands for Indirect grounding. A capacitor with a parallel high value resistor will separate the 2 potentials, ensuring protection of the signal against non-DC disturbances. If by accident on 1 channel the Direct Grounding is connected with the Indirect Grounding, the connection to the Direct Grounding bypasses the capacitor in the Indirect Ground connection. The current on the shield will flow to Direct Ground.

2.7 Cable lengths for PROFIBUS DP

The cables on all Channels must comply with the PROFIBUS DP cable specifications for RS485. Each channel may have its own baudrate and corresponding length.

Baudrate (kbit/s)	9.6	19.2	45.45	93.75	187.5	500	1500	3000	6000	12000
Segment length (m)	1200	1200	1200	1200	1000	400	200	100	100	100
Segment length (feet)	3940	3940	3940	3940	3280	1310	656	328	328	328

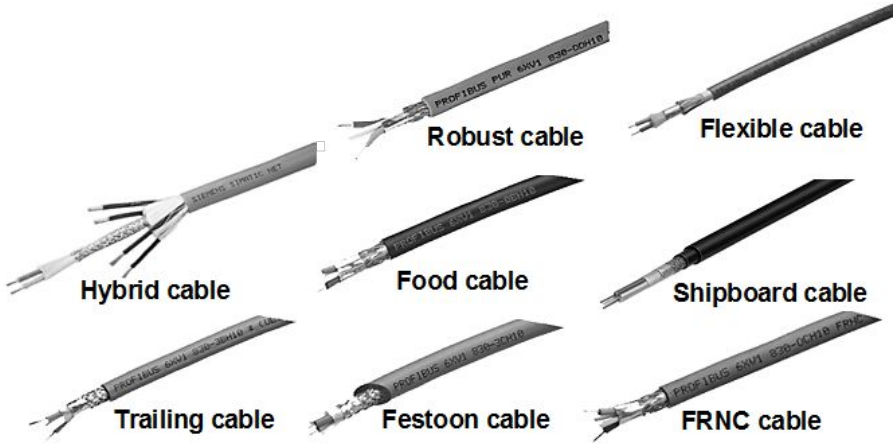


2.8 Cable types for PROFIBUS DP

The cable type must comply with the PROFIBUS DP cable specifications for RS485.

Parameter	Value
Wires	2 (twisted)
Impedance	135 ... 165 Ohm (3 to 20 MHz)
Capacity	< 30 pF/m
Loop resistance	< 110 Ohm/km
Wire diameter	> 0.64 mm
Wire area	> 0.32 mm^2

The PROFIBUS MultiSwitch can handle cables based on multiple protection sheaths with an overall cable diameter between 6 to 12 mm.



2.9 Status display

The Status LEDs on the PROFIBUS MultiSwitch 921-1EB50 are very useful for diagnostics.

	OFF	Blinking	ON
POWER 1 / 2	Power is not switched on or an internal failure	Power supply not stable, redundant power supply interrupted or an internal failure	Power supply OK
READY	Power is not switched on or an internal failure	Trying to detect the transmission speed, but has not locked it yet	The transmission speed has been detected
Main RX-OK	No communication detected on the Main Channel	1 or more devices communicating on the Main Channel	1 or more devices communicating on the Main Channel
Main ERROR	No problem has been detected	Problem in the cabling has been detected (Main Channel)	Problem in the cabling has been detected (Main Channel)
Channel RX-OK	There is no communication detected (on this Channel)	1 or more devices communicating (on this Channel)	1 or more devices communicating (on this Channel)
Channel ERROR	No problem has been detected	Problem in the cabling has been detected (on this Channel)	Problem in the cabling has been detected (on this Channel)
INT. TERM	Termination for this channel is OFF	Internal failure	Termination for this channel is ON

3 Installation Instructions

3.1 Location

The PROFIBUS MultiSwitch X5 can be installed everywhere in a non-hazardous area that complies with IP 20 (DIN 40 050) and the specified temperature range of -25 ... +70° C or -13 ... +158° Fahrenheit.

3.2 Position

Der PROFIBUS MultiSwitch X5 can be installed in every position, but it is recommended to install it with the cables pointing down. In this position it is also easier to read the status LEDs.

3.3 Mounting

The PROFIBUS MultiSwitch X5 can be mounted on 35 mm DIN rail with a minimum width of 203 mm.

The supplied rubber studs need to be placed on the back of the housing of the Switch for extra fixation. This is to prevent the product to potentially slide off the DIN rail.

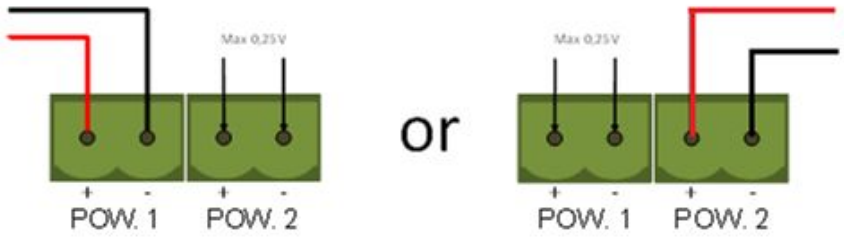
3.4 Power Supply

The two 2-pin screw type power connectors are located on the left of the PROFIBUS MultiSwitch X5.

- 1 = **+** (left)
- 2 = **-** (right)

1 Power LEDs
2 Alarm contact
3 Power connector
4 Grounding points
5 Grounding points

Both power connectors are linked 1-on-1 to the internal power supply of the MultiSwitch. If one power supply fails, the other takes over without delay time. When redundancy is not required, it is sufficient to use one power connector. Please note that when using only one power supply, a voltage of max. 0.25 V will exist on the other unconnected power connector.



If only one power supply is used, the alarm contact is closed. If two power sources are connected, the contact is open. As soon as one of the power supplies fails, the contact will close and the Power Indicator LED will blink.

The power supply must comply with the following specifications:

- Limited Power Source (LPS) or NEC Class 2 or CEC Class 2
- Voltage: 12 - 24 V DC
- Current: min. 275 mA
- Wire diameter: < 2.5 mm^2

Procedure

To connect the 24V supply to the 2-pin screw-type terminal, proceed as follows:

1. Strip the insulation from the cable or the conductors for the 24V power supply.
2. Add cable crimp terminals/wire ferrules to the conductors.
3. Secure the crimp terminals in the screw-type terminal.

To connect the power supply, you need a 3 mm screwdriver.

Testing

If the power is switched on it can be diagnosed by the following indicators:

- LEDs should be blinking in a circular animation for a short time.
- The "POWER" LED of the respective power connector (1, 2 or both) is ON.
- The "READY" LED is ON or blinking, depending on baud rate lock.

3.5 Grounding of the power

It is recommended to use a power supply with a ground lead (3-wire).

1. Connect the ground lead of the power lead to the Ground Rail of the PROFIBUS MultiSwitch.
2. Connect the Ground Rail to the common ground with a separate ground lead.

3.6 Alarm contact

The PROFIBUS MultiSwitch X5 features a potential-free relay contact. This alarm contact can be used to monitor the power supplies. Example applications are: Connect a LED tower, alarm buzzer, SMS server or use it as a digital signal for the PLC.

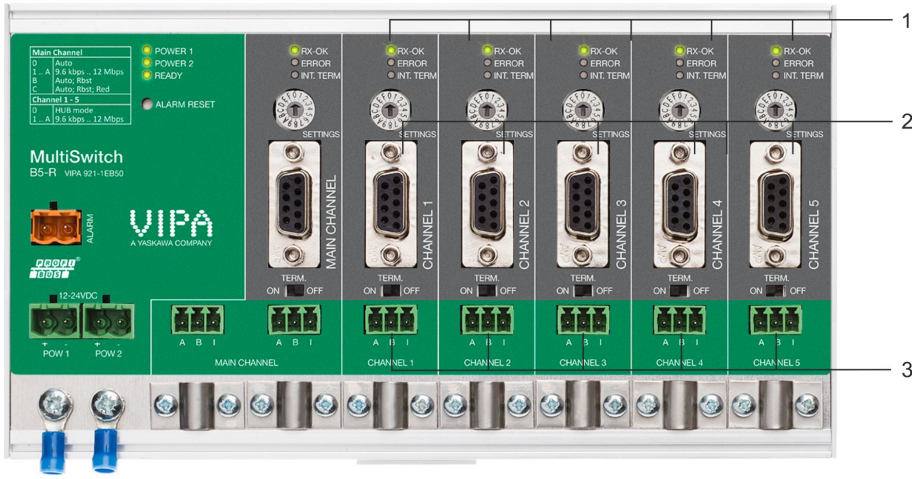
- If only one power supply is used, the alarm contact is closed. If two power sources are connected, the contact is open. As soon as one of the power supplies fails, the contact will close and the Power Indicator LED will blink.
- In the case of an interrupted power supply you can reset the contact by pressing the *[Reset]* button. The contact will open and the LEDs will stop blinking.
- The maximum power to be connected to the alarm contact is 24 V DC. The maximum switching current is 500 mA.

3.7 Main Channel

The PLC must be connected to the main channel. The rotary switch of this channel must be set to the same baud rate as the master, or you can set it to "Auto-Detect" (position 0). The options "Robust" or "Redundant" are also available (rotary setting B or C). You can connect up to 31 PROFIBUS nodes to the main channel.

3.8 Channel 1 - 5

→ Connect the spur segments to the connectors of channel 1 to 5. The second method is to place a PROFIBUS standardized plug on the DB9 connector of the specific Channel.



1 Communications status LEDs
2 Channel connectors
3 Channel connectors

Pin layout of the screw terminals

Pin	Wiring
A	Green wire
B	Red wire
I	Indirect cable shielding, for reducing EMC and noise in demanding areas

Connecting the indirect cable shielding is not required when the ground clips are used.

Testing

If a channel recognizes valid PROFIBUS messages from one or more connected devices, the "RX-OK" LED of the channel should be blinking.

Masters and slaves on Channel 1 - 5

The PLC must be connected to the main channel. If a channel 1 - 5 is in Hub mode, this channel will be fully transparent for other masters as well. If a Channel is on a different baudrate than the main channel, you can connect a master to that channel, but your master will only be able to communicate on that channel only. The use of address 1 for masters and/or slaves is not possible for channels 1 to 5. You can connect up to 31 PROFIBUS nodes to a Channel.

Bus parameters

The MultiSwitch uses a set of bus parameters for each Channel 1 to 5. The bus parameters depend on the selected baudrate.

	9.6 kbps	19.2 kbps	45.45 kbps	93.75 kbps	187.5 kbps	500 kbps	1.5 Mbps	3 Mbps	6 Mbps	12 Mbps
Retries	5	5	5	5	5	5	5	5	5	5
Tslot	100	100	640	2500	100	200	300	400	600	1000
MinTSDR	11	11	11	11	11	11	11	11	11	11
Ttr	800000	800000	800000	800000	800000	800000	800000	800000	800000	800000
Tquiet	1	1	1	1	1	1	1	1	6	9
Tid1	37	37	225	225	37	37	37	46	57	76
Tid2	60	60	400	1000	60	100	150	250	450	800
Tto	0	0	0	0	0	0	0	0	0	0
GAP	1	1	1	1	1	1	1	1	1	1
HSA	126	126	126	126	126	126	126	126	126	126

Watchdog

The Watchdog that is set in the master by the user, is automatically read by the MultiSwitch. It uses the Watchdog parameter to calculate a new Watchdog for a channel that is not in Hub mode.

The calculation is as follows:

$$\mathbf{WD_{channel} = WD_{main} \times (Baudrate_{main} / Baudrate_{channel})}$$

Example situation:

- Watchdog in the PLC or DCS is set to 200 ms
- Baudrate in the PLC or DCS is set to 1.5 Mbps
- Baudrate on channel 1 is set to 93.75 kbps
- Baudrate on channel 2 is set to 500 kbps

Then the Watchdog on channel 1 is 200 x (1500 / 93.75) = 3200 ms

and the Watchdog on channel 2 is 200 x (1500 / 500) = 600 ms

If the baudrate on the main channel is much lower than on Channel 1 - 5, it might be possible that slaves do not enter Data Exchange due to a low Watchdog. In that case, increase the Watchdog in the PLC.

Timing

The MultiSwitch X5 is not a fully transparent device; it uses a buffer between channels if these channels are not in Hub mode. This buffer can cause a delay in sending a telegram from one channel to the other. Channels 1 to 5 each have a master polling the slaves connected to that respective channel. If a telegram from a PLC to slave x is sent to the master of a specific channel, and the cycle of that master has just polled slave x, it will take a full cycle of that master before the telegram is sent to slave x. This makes the network less deterministic.

3.9 Baudrate switch

The PROFIBUS MultiSwitch X5 recognizes the transmission speed by default. The Main channel and Channels 1 to 5 can be locked to an individual transmission speed. The baudrate rotary switch of the Main channel will be detected automatically if the rotary switch is set to 0, B or C.

If the rotary switch of the individual channels is set to 0, that channel will work fully transparent in Hub mode. This is identical to a channel of a MultiRepeater. For all other baudrates you can choose a different position of the rotary switch according to the table in the Technical Data chapter.

Using a baudrate on Channel 1 - 5 which is higher than the Main Channel is not recommended. The I/O of the slaves will not be faster than the original PLC program. Setting the speed higher can only increase the chance of errors.

1 Baudrate switches
2 Alarm reset button

To set the rotary switch, use a 3 mm screwdriver.

Switch values

0 = Auto baudrate detect, Normal repeating (default)

1 = 9.6 kbps

2 = 19.2 kbps

3 = 45.45 kbps

4 = 93.75 kbps

5 = 187.5 kbps

6 = 500 kbps

7 = 1500 kbps

8 = 3000 kbps

9 = 6000 kbps

A = 12000 kbps

B = Auto baudrate detect, Robust repeating

C = Auto baudrate detect, Robust repeating, redundancy on channel 4 and 5

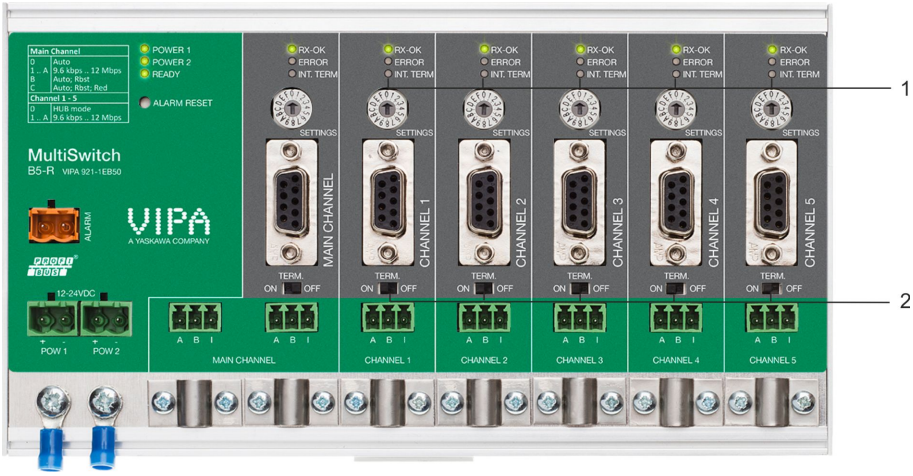
D ... F = Same as 0

Please note that the position of the rotary switch of the main channel is only sampled during start-up. Changing the position of the switch will not have effect during operation. However, the rotary switches of channels 1-5 are sampled continuously. Changing the position will immediately change the baud rate.

The auto baudrate detect feature will search for the correct baudrate within 10 seconds of receiving the first telegram. This baud rate lock will be lost after 50 seconds of incorrect or no message reception.

3.10 Termination

The termination of the channels have been set to ON by default, because it is assumed that the new segment is started at the Multi-Switch.



1 Termination LEDs
2 Termination of the channels (default ON)

The termination LED of the corresponding channel is activated when the termination switch is set to ON.

When the DB9 connector is used and the cable starts at the MultiSwitch, it is recommended to use the termination on the DB9 plug and NOT the MultiRepeater. This way, the connector can be removed while maintaining termination on the bus.

3.11 Robust Repeating mode

The PROFIBUS MultiSwitch X5 has two repeating modes: "normal" (default) and "robust" Repeating. In normal mode the bits are transferred directly on the other channel with a minimal delay (see delay times in the Technical data). In Robust mode (rotary setting B or C) the first byte is checked to verify if the following bits are a real PROFIBUS message. If the byte is illegal/corrupt, the message will not be transferred to the other channel. This helps network stability in EMC sensitive environments.

3.12 Channel Redundancy

To use the Redundancy option of the MultiSwitch X5, set the rotary switch of the main channel to the "C" position. This enables the two last channels (4 and 5) to be one redundant path to another Multi-Switch X5, a B5 or to any other supporting product.

When one redundant cable breaks, the other cable ensures safe delivery of the telegram. In this event the built-in alarm contact will close. The red "ERROR" LED will blink with an interval of 100ms. When the redundant path is fixed, press the *[ALARM RESET]* push-button to reset the alarm.

CAUTION!
For Redundancy to work properly, channel 4 and 5 are automatically set to "Hub mode". The rotary switch setting is bypassed. This means that channels 4 and 5 have the same baudrate as the main channel, and that they are completely transparent.

4 Technical data

Order no.	921-1EB50
Dimensions and weight	
Dimensions L x H x D (mm) with screws	203 x 111 x 31 mm
Weight	600 g
Ambient conditions	
Operating temperature	-25 ... +70 °C
	-13 ... +158 °Fahrenheit
Isolation class	IP 20 (DIN 40 050)
Protocol specifications	
Supported Protocols	DP-V0, DP- V1, DP-V2, FDL, MPI, FMS, PROFIdrive and any other FDL based protocol. ProfiSafe is not supported.
Transmission speed	9.6 kbps to 12 Mbps
Transmission speed detection	Auto detect (default) or selectable with rotary switch
Transmission speed switch main channel	0 = Auto baudrate detect, Normal repeating (default) 1 = 9.6 kbps 2 = 19.2 kbps 3 = 45.45 kbps 4 = 93.75 kbps 5 = 187.5 kbps 6 = 500 kbps 7 = 1500 kbps 8 = 3000 kbps 9 = 6000 kbps A = 12000 kbps B = Auto baudrate detect, Robust repeating C = Auto baudrate detect, Robust repeating, redundancy on channel 4 and 5 D = Normal repeating (auto baudrate detect) E ... F = Same as 0

Order no.	921-1EB50		
Transmission speed switch channels 1-5	0 = Hub mode (channel takes baudrate from main channel) 1 = 9.6 kbps 2 = 19.2 kbps 3 = 45.45 kbps 4 = 93.75 kbps 5 = 187.5 kbps 6 = 500 kbps 7 = 1500 kbps 8 = 3000 kbps 9 = 6000 kbps A = 12000 kbps B ... F = Not supported		
Transmission speed detection time	< 10 s (if it is set to auto detect)		
Data delay time	At baudrate:	Normal mode:	Robust mode:
	9.6 - 93.75 kbps	≤1.7 Tbit	≤13.25 Tbit
	187.5 - 500 kbps	≤1.8 Tbit	≤13.30 Tbit
	1.5 Mbps	≤1.9 Tbit	≤13.40 Tbit
	3 Mbps	≤2.2 Tbit	≤13.60 Tbit
	6 Mbps	≤3.0 Tbit	≤14.00 Tbit
	12 Mbps	≤4.0 Tbit	≤15.00 Tbit
Delay time jitter	Max. ¼ bit time		
Cascading depth	No limits		
PROFIBUS cable specifications			
Cable lengths	1200 m at 9.6 kbps to 93.75 kbps		
	1000 m at 187.5 kbps		
	400 m at 500 kbps		
	200 m at 1.5 Mbps		
	100 m at 3 Mbps to 12 Mbps		
Cable thickness	10 mm (when the ground rail is used)		
Wire diameter	< 2.5 mm^2		
Wire type	Stranded or Solid core		
Number of devices	Maximum 31 per Channel (including MultiRepeaters, OLMs, etc)		
Termination	Integrated and switchable. Powered according to IEC 61158 (390/220/390 Ohm) ■ All Channels (default: ON)		
Redundancy	Optional (Channel 4 and 5)		

Order no.	921-1EB50
Power supply specifications	
Power source	For UL: Limited Power Source (LPS) or NEC Class 2 or CEC Class 2, according to UL-60950-1 regulations
Nominal supply voltage	12 to 24 V DC
Redundant power supply	Yes
Current consumption	Min 275 mA at 12 V power supply (all Channels fully loaded)
Reverse polarity protection	Yes
Cable thickness	10 mm (when the ground rail is used)
Wire diameter	< 2.5 mm^2
Alarm contact	
Voltage	Max. 24 V DC
Current	0.5 A
Others	
MTBF	T.b.d.

5 Glossary

Address	Unique number of a device connected to the network. With PROFIBUS this can be 0 to 126. 127 is a broadcast address.
Analyzer	Software tool to observe the protocol traffic. Combi-Analyzers can also inspect the signal quality. Other term: Bus Monitor
Backbone	The primary bus cable. Most of the time only the control systems, MultiRepeaters and fiber optic couplers are connected to this cable. The field devices are connected behind the MultiRepeaters and fiber optic couplers.
Bit Time (Tbit)	The bit time Tbit is the time, which elapses during the transmission of one bit. It depends on the baudrate and is calculated as follows Tbit = 1 (bit) / baudrate (bps). Examples: 12 Mbps → Tbit = 83 ns 1,5 Mbps → Tbit = 667 ns
Busparameters	Settings that define the timing behaviour on the bus. They are defined in the master. Examples: Tslot, MaxTSDR.
C	Capacitance
DGND	Digital Ground
DIN	German Institute for Standardization (www.din.de)
DP-V0	DP-V0 is the basic stage of the PROFIBUS DP communication protocol. DP-V0 devices (master and slaves) perform the following basic functionalities: ■ Cyclic exchange of I/O data between controlling and slave devices ■ Device, Identifier (module) and Channel related Diagnosis ■ Parameterization of DP-slaves ■ Configuration of DP-slaves
DP-V1	DP-V1 is the first stage of extension of PROFIBUS DP after DP-V0. DP-V1 devices shall comply with the following features: ■ Device related diagnosis is replaced by status and alarms. ■ The first three octets of the user parameterization data are now standardized ■ Optionally these devices may support: – Acyclic communication (MS1, MS2) – If alarms are used, MS1 shall be supported
DP-V2	DP-V2 is the second stage of extension of PROFIBUS DP after DP-V1. DP-V2 devices shall comply with the following features: ■ Data Exchange Broadcast (DxB) for slave to slave communication (publisher/subscriber principle). ■ Isochronous Mode (time tick synchronized operating slaves, e.g. drives) ■ Up- and/or download of Load Region Data (domains) ■ Clock Control (synchronization within slaves) and Time Stamping ■ Redundancy
EMC (Electromagnetic Compatibility)	The extent to which an electric or electronic device will tolerate electrical interference from other equipment (immunity), and will interfere with other equipment. Within the European Community as well as in other countries it is regulated by law that electric and electronic components and equipment comply with basic standards such as IEC 61000-6-2 or IEC 61326 or corresponding individual product standards.

Hub	A Hub refreshes a signal and passes the information on to all nodes which are connected to the Hub. Data frames which were received on one port are transferred to all the other ports (chicken foot topology).
MPI	Multiple Protocol Interface. Protocol defined by Siemens which uses the layer 1 and 2 of PROFIBUS (FDL).
PCB	Printed Circuit Board
PROFIBUS DP	Acronym for "PROFIBUS for Decentralized Peripherals". Specification of an open fieldbus system with the following characteristics: ■ Polling master-slave-system (cyclic communications, MS0) ■ Flying masters with robin round token passing coordination (MM) ■ Connection based (MS1) and connectionless (MS2, MS3) acyclic communication between masters and slaves Options (e.g.): – Data exchange broadcast (DXB), i.e. slave to slaves communication – Isochronous mode of slaves – Clock synchronization – Redundancy PROFIBUS DP is standardized within IEC 61158 and IEC 61784, communication profile families 3/1 and 3/2 The term "PROFIBUS DP" also is a synonym for the RS485 based deployments within factory automation.
Repeater	Active physical layer device that receives and retransmits all signals over a different port to increase the distance and number of devices for which signals can be correctly transferred for a given medium.
Spur line	A cable attached to a bus segment with a T-connection . Spurs are not recommended with PROFIBUS DP. They are prohibited with 12 Mbps and PROFIsafe operations.
Stub line	See Spur line
Termination	A (powered) resistor network at both ends of a segment to prevent reflections (with PROFIBUS DP the termination must be powered).
Topology	In a communications network, the pattern of interconnection between network nodes; e.g. bus, ring, star configuration.
PI	PROFIBUS International. The International PROFIBUS Organization based in Karlsruhe.
PNO	PROFIBUS user Organization. The German PROFIBUS Organization based in Karlsruhe.
Drop Cable	See Spur line
Reflection	Part of the original signal that is transmitted back along the cable. It corrupts the original signal.