VBC 121-K

VARAN Bus Coupler Module

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VARAN Bus Coupler Module VBC 121-K

for connecting VARAN and EtherCat bus systems

VARAN: **1x VARAN In**
3x VARAN Out
Of which are optional
1x ETHERNET Port (VtE)

EtherCat: **1x EtherCat In**
1x EtherCAT Out

This bus coupler module is used to connect a VARAN and EtherCAT bus system.

For synchronous data exchange, a triple buffer is provided. For asynchronous data exchange, CoE (CanOpen over EtherCat) and VoE (Vendor over EtherCat) is available.

The VARAN Out ports have automatic Ethernet recognition. If one of the ports is connected to an Ethernet participant, it automatically becomes an Ethernet port.

Incoming Ethernet packets to Ethernet ports are, similar to using a HUB, distributed to all other Ethernet ports in the VARAN bus system and the VARAN Manager (and therewith the CPU as well) with VtE (VARAN transmits Ethernet).

Contents

1 Technical Data

1.1 Performance Data

Interfaces	**VARAN:** 1x VARAN In (RJ45) (maximum cable length:100 m) 3x VARAN Out (RJ45) (maximum cable length:100 m) (of which 1 x ETHERNET Port VtE (RJ45) 10/100Mbit is optional) **EtherCAT** 1x EtherCat In (RJ45) 1x EtherCat Out (RJ45) (maximum cable length: 100 m)
Internal data memory (SPI-Flash)	64-Mbit

1.2 Electrical Requirements

Supply voltage	18 V-30 V DC	
Current consumption	typically 150 mA	maximum 200 mA

1.3 Miscellaneous

Article number	16-054-121-K
Hardware version	1.x
Standard	CE, UL in preparation

1.4 EtherCAT

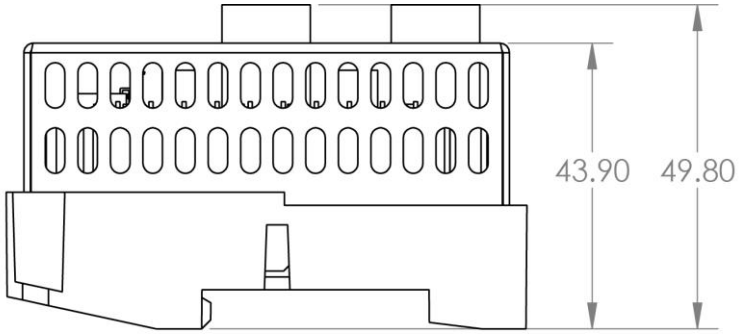
Real-time data exchange		in 8-byte stages write 0-512 bytes read 0-512 bytes (+1-byte status) Defined by process data profile	
Asynchronous data exchange	Protocol	Supported functions	Description
	CoE:	Complete Access Support SDO Info Support PDO Assign	Status information and data exchange with VARAN side
	VoE:	supported	Data exchange with VARAN side (not supported by TwinCAT)
	FoE:	supported	Update function
EtherCAT slave EEprom		ESC-EEPROM with 2048 byte available	
Supported EtherCAT addressing		Explicit Device Identification Second Slave Address (SSA) Configured Station Alias	

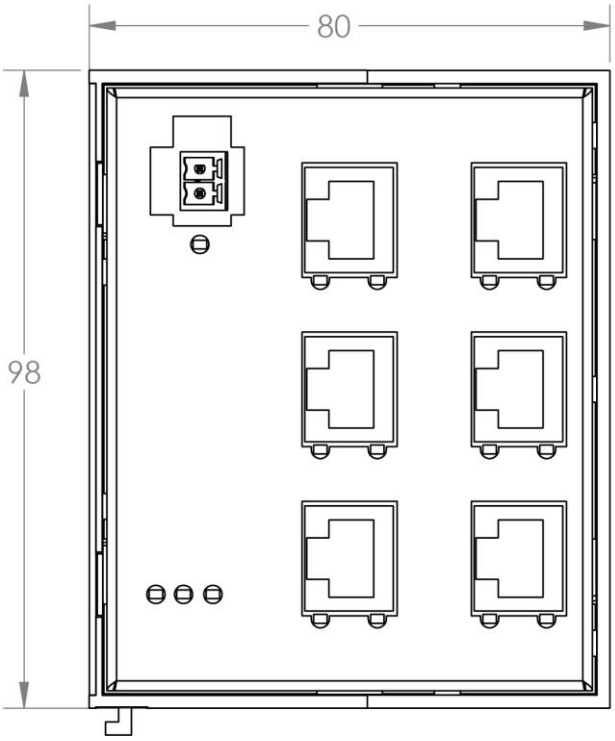
1.5 Environmental Conditions

Storage temperature	-20 ... +85 °C	
Operating temperature	0 ... +60 °C	
Humidity	0-95 %, non-condensing	
EMC resistance *)	in accordance with EN 61000-6-2 (industrial area)	
EMC - noise generation	in accordance with EN 61000-6-4 (industrial area)	
Vibration resistance	EN 60068-2-6	3.5 mm from 5 Hz-8.4 Hz 1g from 8.4 Hz-150 Hz
Shock resistance	EN 60068-2-27	15 g
Protection type	EN 60529	IP20

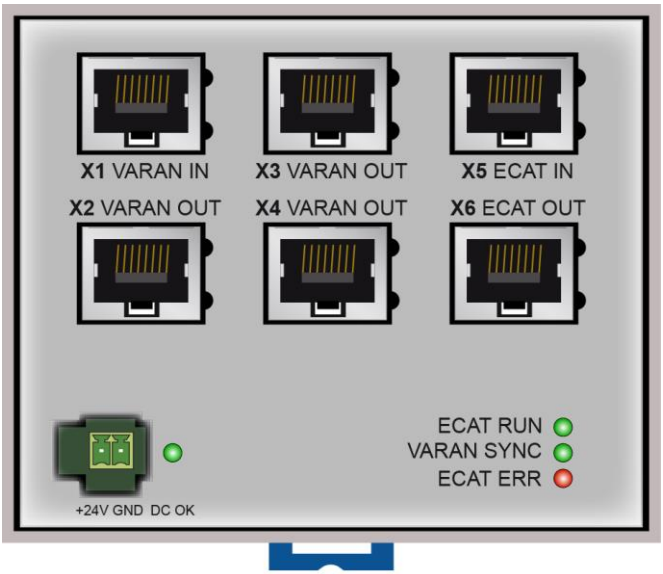
*) Control box mounting required

2 Mechanical Dimensions

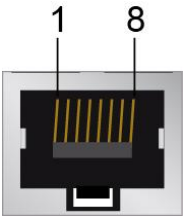




3 Connector Layout



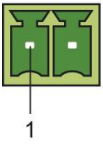
X1 – X6: VARAN, ECAT (8-pin RJ45)



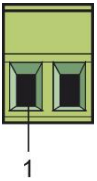
Pin	Function
1	TX/RX +
2	TX/RX -
3	RX/TX +
4-5	n.c.
6	RX/TX -
7-8	n.c.

n.c. = do not use

X7: +24 V Supply (2-pin Phoenix Contact 1.5/2-ST-3.81)



Pin	Function
1	+24 V supply
2	GND



3.1 Status LEDs

DC OK	green	Lights when the module is supplied with +24V.
VARAN Sync	green	Lights when the module is synchronized with the VARAN manager.
ECAT RUN	green	Lights when EtherCAT communication is active.
ECAT ERR	red	Lights when an EtherCAT communication error occurs.

3.2 Applicable Connectors

Connectors:
X1 – X6: 8-pin RJ45 (not included in delivery)

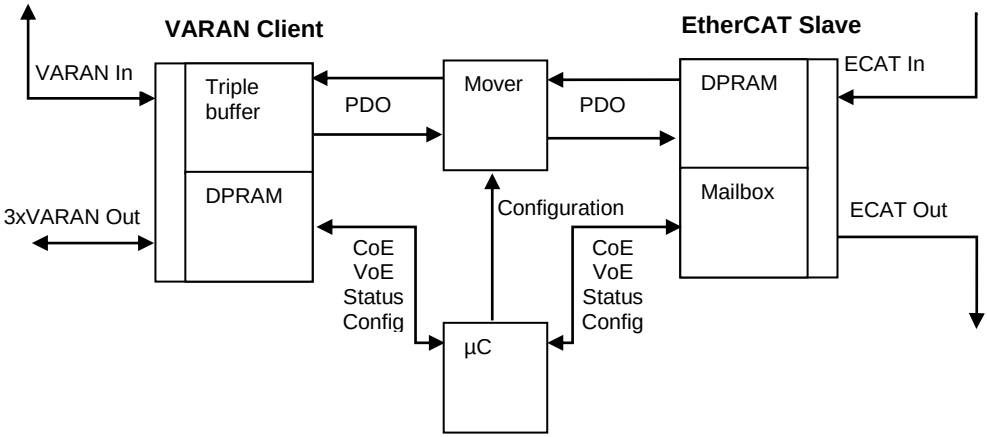
Connector with screw terminals:
X7: Phoenix Contact: MC 1.5/2-ST-3.81

4 Function

4.1 General

The VBC 121-K is used to connect VARAN and EtherCAT bus systems.

Block Diagram



4.2 VARAN Side

4.2.1 Overview of Address Assignments:

Address (hex)	Size (bytes)	Device ID (hex)	Description
memory			
1000	2k	0E62	Mover RAM for SDO exchange
2000	2k	0724	Triple buffer for PDO
3000	4k	0722	DPRAM for status and handshake

4.2.2 Mover

The mover copies the real-time data (PDOs) from the DPRAM of the EtherCAT slave into the triple buffer of the VARAN client and reverse. The µc assumes configuration of the mover using the settings for the PDO size.

4.2.3 Synchronous Triple Buffer

The synchronous triple buffer (1 kbyte per direction) ensures that data exchange between the two bus systems is possible through the synchronous bus cycle without the danger of inconsistent data.

Address (hex)	Size (bytes)	Description
Memory / Triple Buffer for PDO		
2000	2	Buffer size for reading (0 = not available)
2002	2	Buffer size for writing (0 = not available)
2004	2	Offset (from the beginning of the triple buffer components) from which must be read in order to switch the buffer to the last valid consistent page (should be set to the start of the read buffer).
2006	2	Offset (from the beginning of the Triple buffer component) to which must be written in order to mark the current page of the write buffer as the last consistent page (should be set to the offset of the last byte in the write buffer: write buffer offset + length - 1).
2008	x	Current valid consistent read buffer
2008	x	Current write buffer

4.2.4 µC

The µC operates the Ethercat client. In addition, it also configures the mover for copying the PDO data to and from the VARAN client triple buffer. With incoming PDO data via EtherCAT, the copy process of the mover starts. The copy process is started by the incoming PDO data in the EtherCAT slave.
The µC forwards incoming mailbox queries (Coe, VoE) to the VARAN client via the DPRAM. The µC answers CoE queries that only affect the EtherCAT itself.

4.2.5 Asynchronous Buffer (DPRAM)

Through the asynchronous buffer DPRAM (4 kbytes), service data objects (SDOs) can be exchanged between the bus systems. Both CoE and VoE data can also be transferred as SDOs. Data is exchanged using a mailbox protocol (see ETG1000.5 and ETG1000.6). The hardware class of the VBC 121-K operates this mailbox protocol and provides the SDO data to send.

4.2.6 DPRAM Structure

Address (hex)	Size (bytes)	Description
Memory / DPRAM for status and handshake		
3000	4	DPRAMInfoVersion
3004	4	Firmware version
3008	20	DateText
301C	4	Reserviert0
3020	1	status Bit 0: Setup complete Bit 1 PDO Bit 2 SDO Bit 3.. VoE
3021	1	Operation mode EtherCAT (mirrored)
3022	2	Reserved1
3024	2	Address of the PDO data from EtherCAT to VARAN
3026	2	Size of the PDO data from EtherCAT to VARAN
3028	2	Address of the PDO data from VARAN to EtherCAT
302A	2	Size of the PDO data from VARAN to EtherCAT
302C	2	Address of the SDO data from EtherCAT to VARAN
302E	2	Size of the SDO data from EtherCAT to VARAN
3030	2	Address of the SDO data from VARAN to EtherCAT
3032	2	Size of the SDO data from VARAN to EtherCAT
3034	2	Address of the VoE data from EtherCAT to VARAN
3036	2	Size of the VoE data from EtherCAT to VARAN
3038	2	Address of the VoE data from VARAN to EtherCAT
303A	2	Size of the VoE data from VARAN to EtherCAT

4.2.7 VARAN transmits ETHERNET (VtE)

The VARAN bus offers the possibility to transmit Ethernet packets. Some VARAN Clients have an Ethernet port. Incoming Ethernet packets to this port are, similar to using a HUB, distributed to all other Ethernet ports in the VARAN bus system and the VARAN manager (and therewith the CPU) with VtE.
Exchanging Ethernet packets with EtherCAT (EoE) in **not** possible.

4.3 EtherCAT

4.3.1 PDOs and Process Data Mapping

The process data are defined on the EtherCAT side using PDO assignment (PDO mapping).

4.3.1.1 Outputs:

For the EtherCAT to VARAN (outputs), the SDOs 0x1600 to 0x163F are used to define the size of the PDOs. The PDO assignment 0x1600 defines 8-byte PDO data. The PDO allocation 0x1601 defines 16 bytes (2x8 bytes). The PDO allocation 0x1602 defines 24 bytes (3x8 bytes). Up to PDO allocation 0x163F, 512 bytes (64x8 bytes) are defined. The respective PDO allocations can only be activated exclusively. With TwinCat, an 8-byte PDO variable is assigned for each 8-byte step.

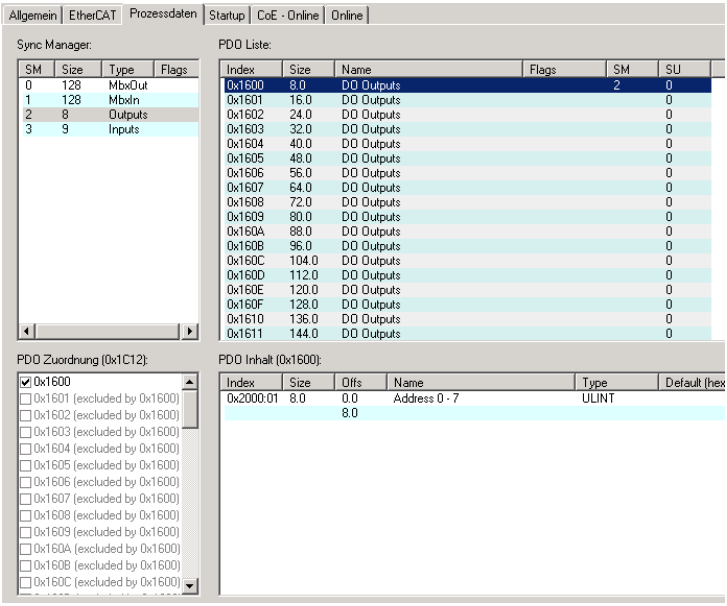
4.3.1.2 Inputs

For the direction VARAN to EtherCAT (inputs), the SDOs 0x1A00 to 0x1A3F are used to define the size of the PDOs. The respective sizes are defined exactly the same for the output direction, with the exception that a status byte for the VARAN hardware class is also sent.

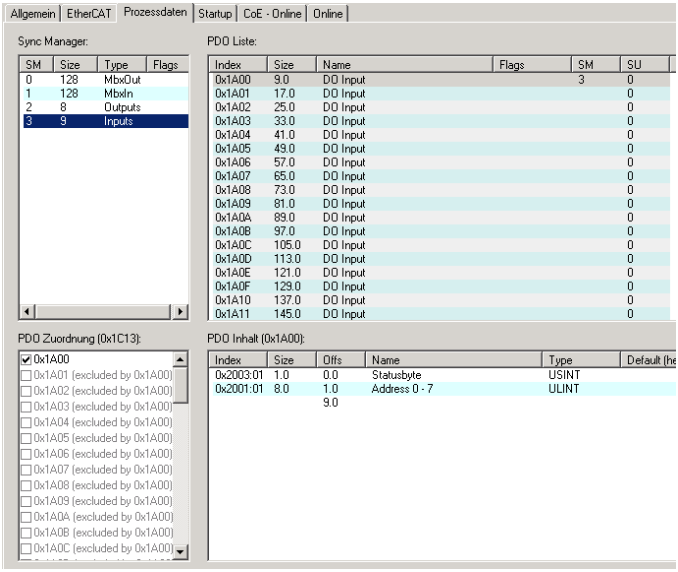
Size (bytes)	Description
Status byte structure	
1	Status byte of the VARAN hardware class Bit 0..3: heartbeat signal (count up = OK) Bit 4..6: reserved Bit 7: PDO size mismatch (1 = error)

4.3.1.3 TwinCAT Example 2

Outputs ECAT => VARAN



Inputs VARAN => ECAT



4.3.2 CanOpen over EtherCAT (CoE)

Index(hex)	Subindex(hex)	Size (bytes)	Description
SDOs to VARAN slave			
2003	-	1	VARAN status Bit 0: VARAN Uplink connected Bit 1: VARAN PLL locked Bit 2: VARAN PLL unlocked Bit 3..7 reserved
200D	1	1	FW Status Bit 0: Setup Finished Bit 1: PDO available Bit 2: CoE SDO available Bit 3: VoE SDO available
	2	1	Current EtherCAT slave OP mode
	3	2	Address of the PDO data from EtherCAT to VARAN
	4	2	Size of the PDO data from EtherCAT to VARAN
	5	2	Address of the PDO data from VARAN to EtherCAT
	6	2	Size of the PDO data from VARAN to EtherCAT
	7	2	Address of the CoE data from EtherCAT to VARAN
	8	2	Size of the CoE data from EtherCAT to VARAN
	9	2	Address of the CoE data from VARAN to EtherCAT
	A	2	Size of the CoE data from VARAN to EtherCAT
	B	2	Address of the VoE data from EtherCAT to VARAN
	C	2	Size of the VoE data from EtherCAT to VARAN
	D	2	Address of the VoE data from VARAN to EtherCAT
	E	2	Size of the VoE data from VARAN to EtherCAT
	F	2	Control byte address DPRAM info
	10	2	Control byte address DPRAM CoE read
	11	2	Control byte address DPRAM CoE write
	12	2	Control byte address DPRAM VoE read

Index(hex)	Subindex(hex)	Size (bytes)	Description
200D	13	2	Control byte address DPRAM VoE write
	14	4	DPRAM update counter
	15	4	DPRAM last update time
	16	1	Current control byte
200E(1	1	96	CoE data packet EtherCAT to VARAN
	2	96	CoE data packet VARAN to EtherCAT

(1 Using CoE, up to 96 bytes can be transferred in both directions. For data exchange with the VARAN side, the SDO with the index 0x200E is used. From EtherCAT to VARAN, the sub index 1 must be used and from VARAN to EtherCAT, sub index 2 is required.

All CoE-SDO indexes not listed above are EtherCAT-specific and are processed by the µC directly.

4.3.3 Vendor over EtherCAT (VoE)

Using VoE, up to 128 bytes can be transferred in both directions.

4.3.4 EtherCAT Addressing

The VBC 121-K supports use of the SecondSlaveAdress (SSA).

The station address is thereby permanently stored in the EEPROM of the VBC-K. During start-up, the EtherCAT slave loads this address in its 0x0012 register where it can be read by the EtherCAT master.

The user can write this address via the EtherCAT Master/TwinCAT system manager by system installation.

In nearly all cases, the application is not as a flexible station, but used to uniquely identify a device.
When exchanged, the current address must be newly stored in the replacement device.
A changed SSA is normally enabled by the ESC after a power restart.
The user can check the SSA by reading the 0x0012 register.

5 Recommended Shielding for EtherCat

Wiring the EtherCat cables according to ETG.

6 Recommended Shielding for VARAN

The VARAN real-time Ethernet bus system exhibits a very robust quality in harsh industrial environments. Through the use of IEEE 802.3 standard Ethernet physics, the potentials between an Ethernet line and sending/receiving components are separated. In the event of an error, the VARAN Manager resends messages to a bus participant immediately. The shielding described below is mainly recommended.

For applications in which the bus is operated outside the control cabinet, the correct shielding is required. This is especially important, if due to physical requirements, the bus cables must be placed next to sources of strong electromagnetic noise. It is recommended to avoid placing VARAN bus lines parallel to power cables whenever possible.

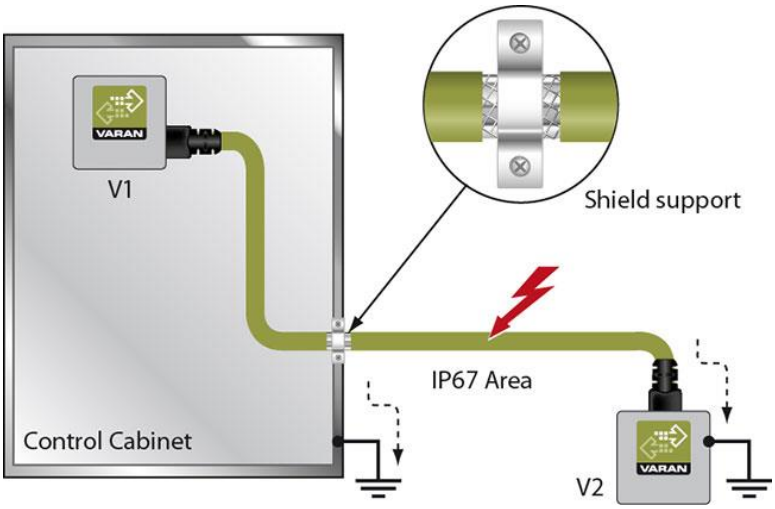
SIGMATEK recommends the use of CAT5e industrial Ethernet bus cables.

An S-FTP cable should be used for the shielding. An S-FTP bus is a symmetric, multi-wire cable with unshielded pairs. For the entire shielding, a combination of foil and braiding is used. A non-laminated variant is recommended.

The VARAN cable must be secured at a distance of 20 cm from the connector for protection against vibration!

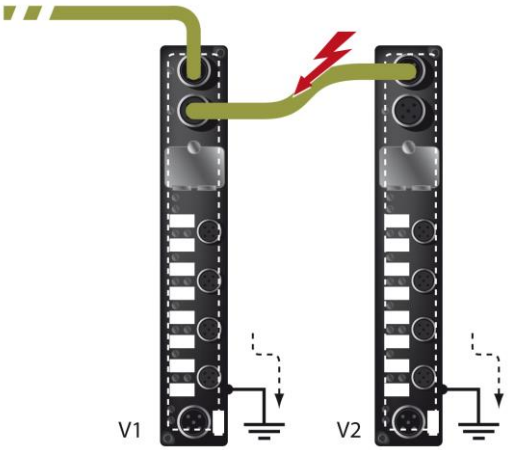
6.1 Wiring from the Control Cabinet to an External VARAN component

If the Ethernet lines are connected from a VARAN component to a VARAN node located outside the control cabinet, the shielding should be placed at the entry point of the control cabinet housing. All noise can then be deflected from the electronic components before reaching the module.



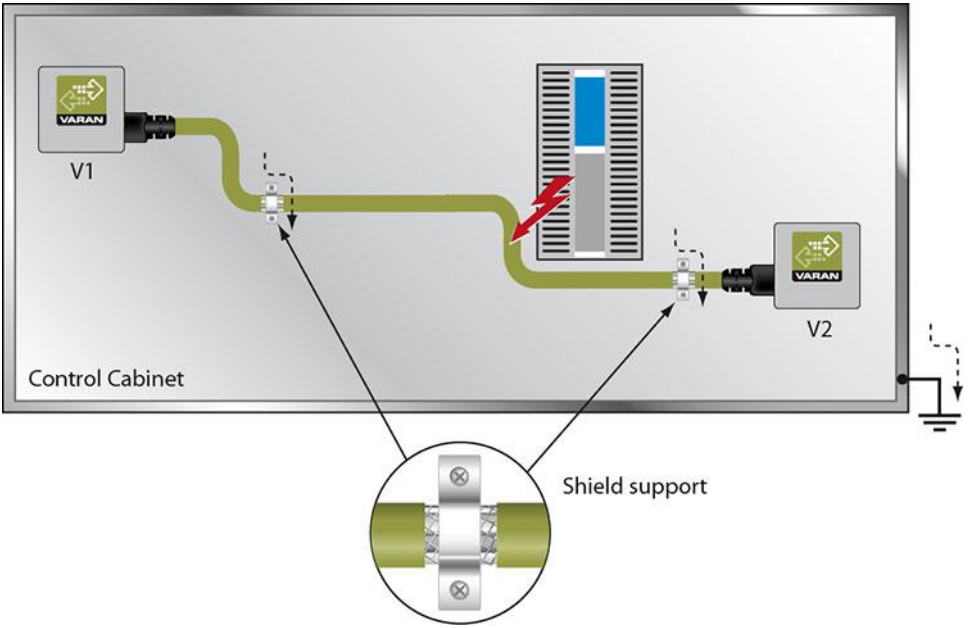
6.2 Wiring Outside of the Control Cabinet

If a VARAN bus line must be connected outside of the control cabinet only, no additional shield support is required. A requirement therefore, is that only IP67 modules and connectors can be used outside the control cabinet. These components are very robust and noise resistant. The shielding for all sockets in IP67 modules are electrically connected internally or over the housing, whereby voltage spikes are not dissipated through the electronics.



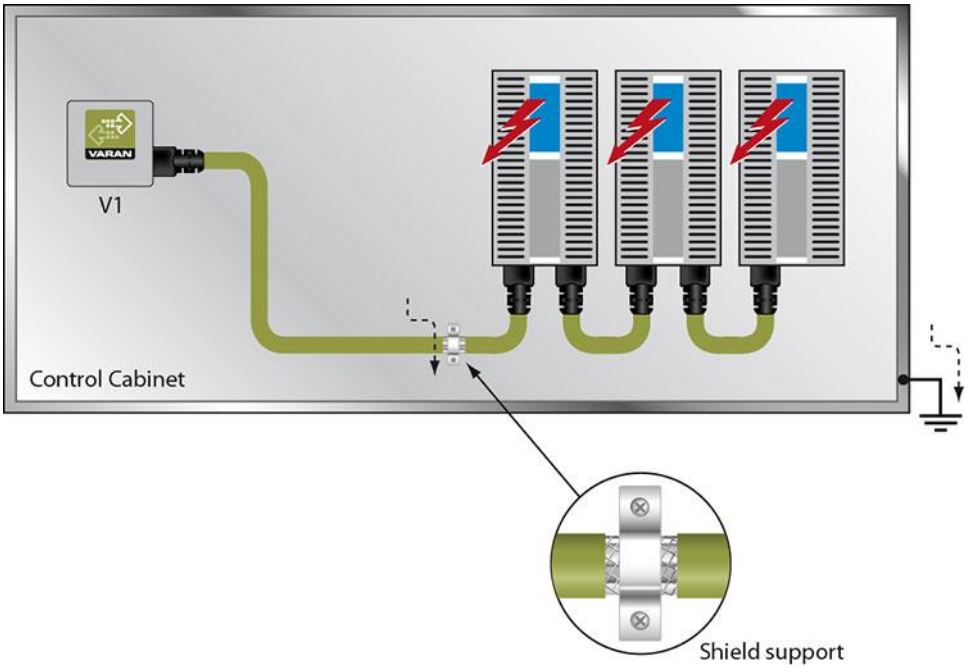
6.3 Shielding for Wiring Within the Control Cabinet

Sources of strong electromagnetic noise located within the control cabinet (drives, Transformers, etc.) can induce interference in a VARAN bus line. Spike voltages are dissipated over the metallic housing of a RJ45 connector. Noise is conducted through the control cabinet housing without further action from the electronic components. To eliminate sources of noise during data exchange, it is recommended that the shielding for all electronic components be connected within the control cabinet.



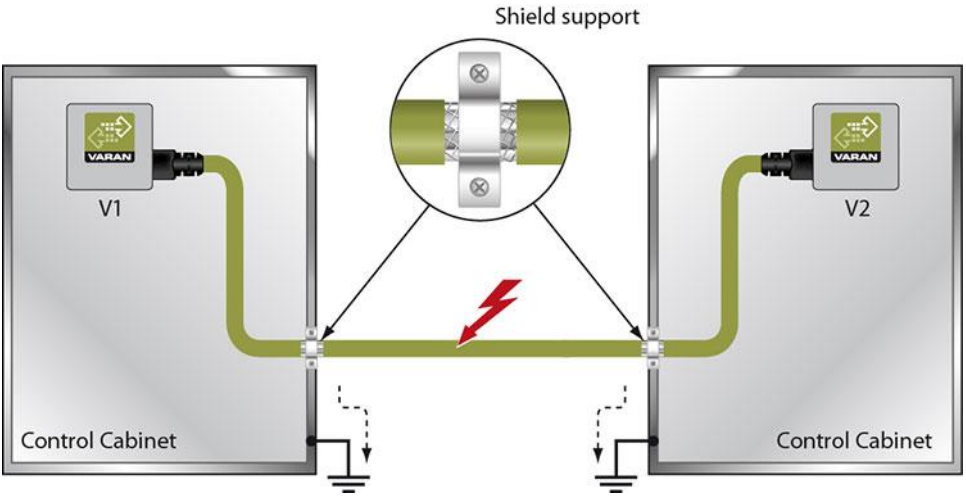
6.4 Connecting Noise Generating Components

With the connection of power components, which generate strong electromagnetic interference, it is also critical to ensure correct shielding. The shielding should be placed before a power element (or group of power elements).



6.5 Shielding Between Two Control Cabinets

If two control cabinets must be connected over a VARAN bus, it is recommended that the shielding be located at the entry points of both cabinets. Noise can be thereby prevented from reaching the electronics within the control cabinet.



Documentation Changes

Change date	Affected page(s)	Chapter	Note
13.01.2014	7	3. Connector Layout	Connectors changed to Phoenix Contact
10.12.2014	9	4.2	Sentence corrected
	10	4.4 CanOpen over EtherCAT (CoE)	Sentence corrected, "with the VARAN side" added
	12	4.8 EtherCat addressing	Entire text inserted form point 4.8
11.12.2014	5	1.4 EtherCAT	EtherCAT table newly added
05.05.2015		4	Chapter added