VARAN

REAL-TIME
ETHERNET

www.varan-bus.net

E

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VARAN
REAL-TIME ETHERNET

VARAN is the real-time Ethernet for industrial automation. Following the Industry 4.0 approach, the high-performance network connects systems, machines and components from the management level to the smallest sensor, in hard real-time. With its adaptable topology and guaranteed data security, the VARAN bus is utilized wherever the highest demands are made on flexibility and availability. Bus properties, such as the cycle time and isochronous start time, can be adapted for any requirement. Whereby, the real-time Ethernet is designed for small systems as well as for complex multi-manager structures.

SAFE

Each message is immediately acknowledged by the recipient. Unacknowledged messages are repeated within the same bus cycle. Consistent process data and the highest availability are guaranteed.

SIMPLE

The entire instruction set is reduced to a few commands. The VARAN bus implementation is therewith easy to implement.

INEXPENSIVE

Through the use of standard components, the VARAN connection is on the price level of a commercial field bus connection.

OPEN

The independent VARAN BUS USER ORGANIZATION holds the rights to the technology. Each member of the VNO can contribute to the further development.

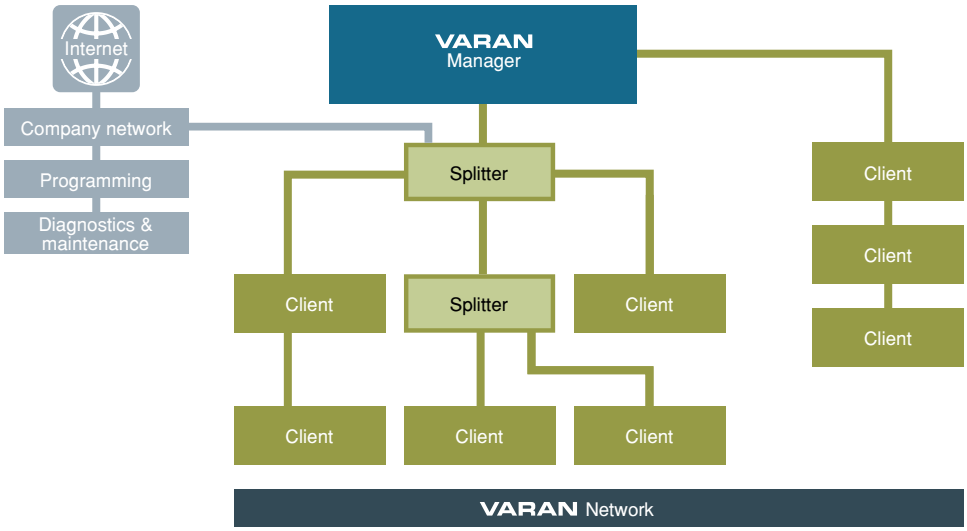
BASICS

THE **VARAN** TECHNOLOGY

The real-time bus system VARAN operates according to the manager/client principle, this means that in each network, there is a manager and one or more subordinate clients. Each data transfer in the bus system is initialized by the VARAN manager, whereby packet collisions are prevented from the beginning.
From the manager's view, the entire network appears as a large memory area that is managed with read and write instructions. Every bus participant is hereby assigned a virtual memory space, which is physically located on the client side. VARAN bus systems can be configured in tree, star and line structures as desired. Network splitters provide the option to connect the VARAN system with company networks or other Ethernet systems and exchange data accordingly.

HIGH PERFORMANCE

The update times are an essential aspect in real-time Ethernet networks. For writing to 16 I/Os (command length 2 bytes), the VARAN bus reaches an update time of 2 µs. Drives with 16 bytes of actual and preset values each can be processed in 5 µs using a single read/write command.



Bus cycle times	< 100 µs	
Jitter	< 100 ns	
Isochronous access time	1-byte r/w	2.18 µs
	16-byte r/w (1 Drive)	5.05 µs
Asynchronous direct access	128-byte r/w	< 25 µs

Portable to Gigabit Ethernet without protocol changes

INDUSTRIES

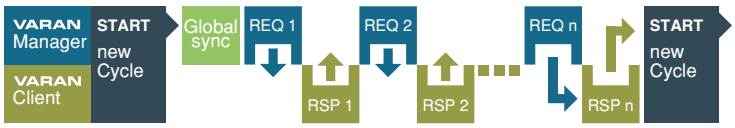
Different needs in the most varying sectors of today's industry require a universally implementable real-time Ethernet. VARAN proves its versatile usability through the establishment in various applications and branches of the industry.

FEATURES

SAFE DATA TRANSFER

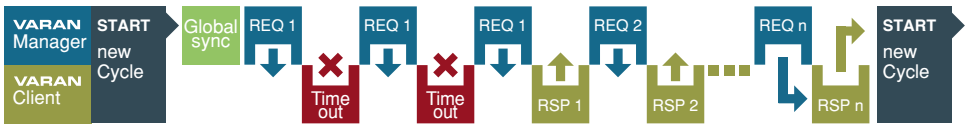
Applications in industrial environments require data security, as well as the highest availability. The VARAN bus was especially designed for these demands and provides unique data handling for consistent and Safe transmission.
At the start of each bus cycle, there is a global synchronization command. The data exchange between the manager and client is then performed in the Request (REQ) and Response (RSP) process. Each data packet sent from the VARAN manager is thereby immediately confirmed by the VARAN client. If confirmation is not received within the defined timeout period, the data packet is repeated in the same bus cycle until a valid answer is returned. This process guarantees that at the end of the bus cycle, all process data is consistent. The permanent testing of data validity – also with bus cycle times under 100 µs – is only possible with the use of the small VARAN data frames.

COMMUNICATION without error



MESSAGE REPEATED IN THE SAME BUS CYCLE

COMMUNICATION with error

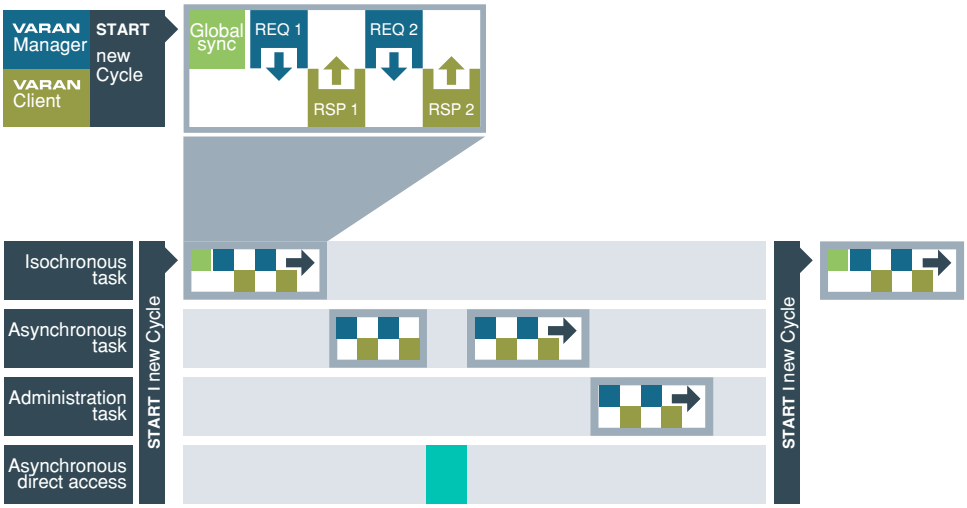


DISRUPTION RESISTANT

Especially in the area of motion, industrial networks are exposed to strong electromagnetic signals that can quickly lead to disruptions. Through their low payloads (1-128 bytes) and low data overhead, the VARAN data frames are essentially more resistant to disruptions than large standard Ethernet packets in common bus systems with lengths of 1,500 bytes. The probability of a disruption is significantly lower for small frames and in the event of an error, only a small data packet with a max. payload length of 128 bytes must be resent.

DATA HANDLING: ALL IN GOOD TIME

To prioritize tasks in the bus system, the VARAN bus protocol distinguishes between three different tasks, was well as asynchronous direct access. At the start of each cycle, the real-time process data is sent in the isochronous task (ISO) after the global synchronization command.
The asynchronous data objects (ASYN) then follow with a lower priority. Ethernet packets and service data are transferred during the administration task with the lowest priority. With asynchronous direct access (DA), the VARAN manager can interrupt active communication for up to 25 µs and send process data between the cycle times to the VARAN clients. The data can thereby be sent at the precalculated time point and does not have to wait for the next cycle.



Communication process over time: VARAN enables asynchronous **direct access** to bus participants

FEATURES

SIMPLE PROTOCOL STRUCTURE

Real-time systems with distributed clocks are often very complex and require clients that are dimensioned accordingly. Through the VARAN bus synchronization via phase-locked loop (PLL), distributed clocks according to IEEE 1588 are unnecessary. This results in a considerably more simple code structure for VARAN bus components. The protocol is based on simple read and write processes, which implement the data exchange between the manager and client.

From the manager's view, the entire network appears as a large memory area that is managed with read and write instructions. Every bus participant is assigned a virtual memory area, which is physically located on the client side. The information exchange is based on four operations:
Memory Read I Memory Write I Global Write I Foreign Package Request/Response

MEMORY READ

Reads data from the memory of a bus participant. The instruction contains the start address and the number of bytes to read.
The client answers with the requested data.

MEMORY WRITE

Writes data to the memory of a bus participant. The instruction contains the start address and the number of bytes to write. The client sends a confirmation.

GLOBAL WRITE

All bus participants are written to at the same time. This command is used for a global reset of the bus participants and to send the SYNC command.

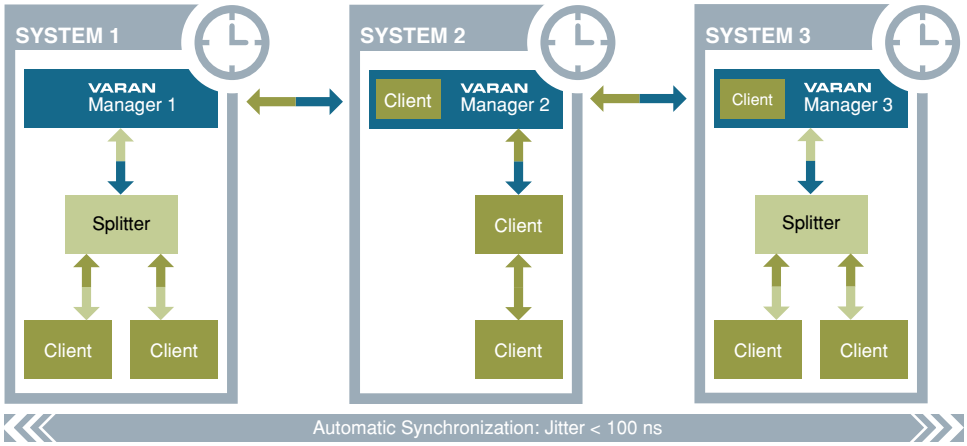
FOREIGN PACKAGE REQUEST/RESPONSE

Allows the transport of third-party data packets (TCP/IP, Safety or other protocols) through the VARAN bus system.

The low data overhead in the VARAN bus protocol can be further reduced through the targeted combination of read and write commands in a single memory read/write instruction.

SYNCHRONOUS MULTI-MANAGER STRUCTURE

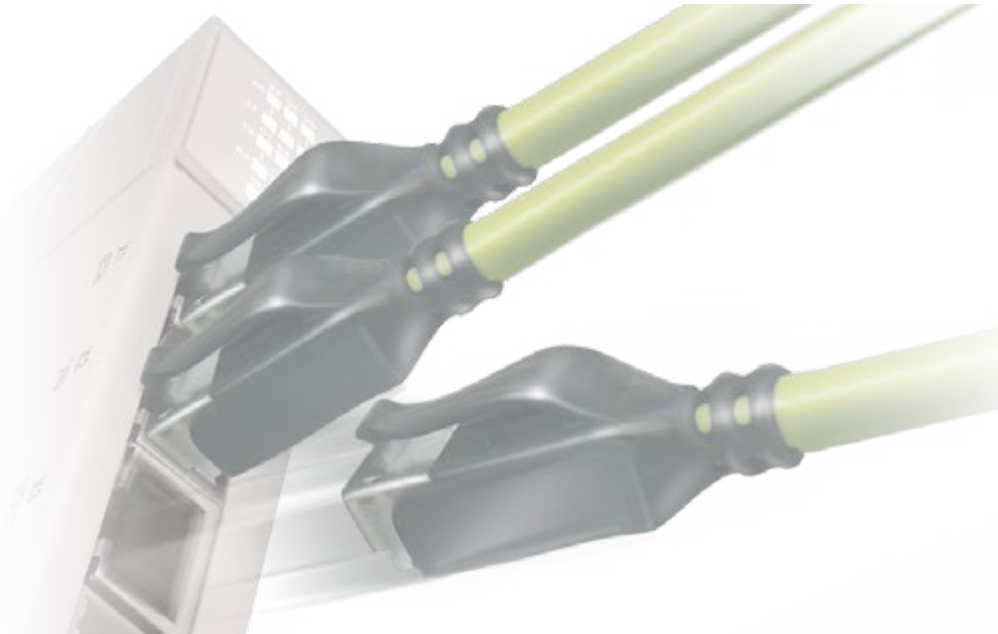
Several VARAN networks can be cascaded into a complete synchronous network through a higher-level VARAN manager. The multi-manager structure enables data exchange between multiple autonomous systems with its own VARAN manager in real-time. The jitter between the systems is thereby under 100 ns. Individual systems can be coupled and decoupled during active operation. This is especially valuable in production lines, which are often adapted for different processes under the Industry 4.0 concept.



Data exchange and synchronization between machines

HOT PLUG

Unlike in field bus systems that use a ring topology, the Hot Plug feature allows individual VARAN clients to be removed from the network and reconnected or exchanged during active operation. This is implemented via the automated address assignment of the VARAN manager.



AUTOMATIC DEVICE IDENTIFICATION

All devices with a VARAN connection receive an electronic type label, which contains the device-specific data:

- Vendor ID
- Device ID
- License number

Devices with an invalid type label or license are deactivated. The bus system is therewith protected against influences from unauthorized participants. Customer-specific files can be stored directly in the VARAN client. The device description can therefore be saved as a PDF file. This is accessed through the VARAN service tool or from the control application directly.

FEATURES

INEXPENSIVE

The VARAN bus is based on the physical layer of the Ethernet standard IEEE 802.3, whereby the least expensive standard components can be used for the implementation. The hardware costs are within the range a of conventional field bus connection.

NO ADDRESSING

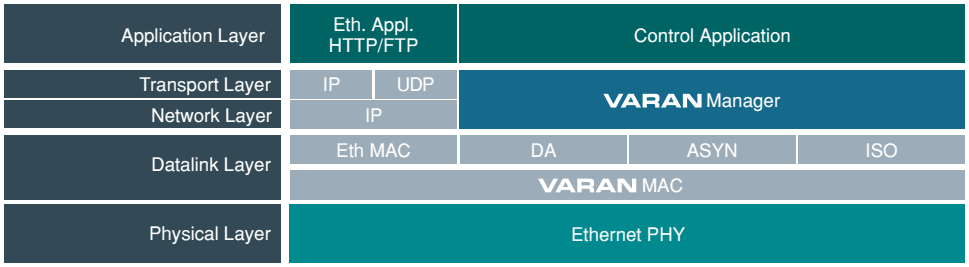
The automatic addressing of all bus participants by the VARAN manager minimizes the configuration work in the planning and initial start-up phase.

MINIMIZE OPERATING AND MAINTENANCE COSTS

The simple network analysis with the VARAN Service Tool saves operating and maintenance costs. VNO members can download the service tool free of charge.

The VARAN Datalink Layer, which provides the data packets with checksum and guarantees consistent transmission, is based on Ethernet physics. Data transfers are initialized by the VARAN manager and assigned different priorities. The VARAN manager sends third-party packets, such as standard Ethernet frames, to all clients in the bus system.

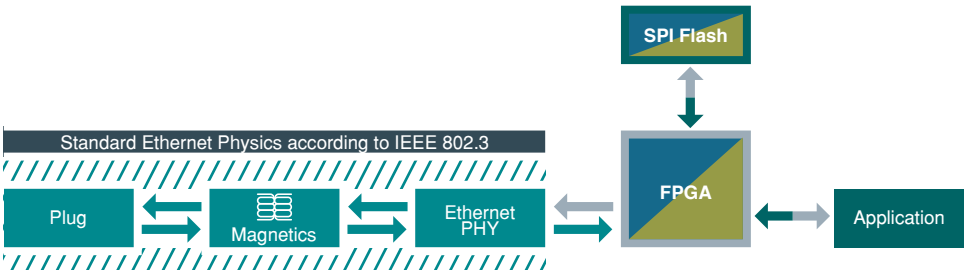
The VARAN MANAGER according to the Layer Concept of the OSI Model



100% HARDWARE

Unlike conventional Ethernet systems, the VARAN protocol is completely simulated in the hardware. In the form of an FPGA component, the VARAN bus needs neither its own processor nor computing power from the control system.

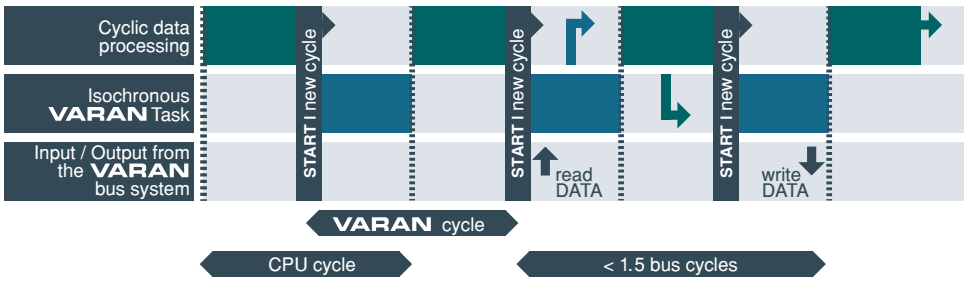
The VARAN manager organizes the data transfer in the entire VARAN network automatically. The VHDL codes from the manager, splitter and client are stored in the external Flash memory and run in the respective FPGA. The VHDL code is also the interface for application-specific hardware and can be adapted as required.



All components of a connection **VARAN**

MINIMUM LATENCY TIME

For a read, and subsequent write access operation with a bus participant, the latency time is a maximum of 1.5 bus cycles – including processing of the I/O data via the CPU.



CANopen

SIMPLE INTEGRATION IN COMPLIANCE WITH CIA STANDARDS

CANopen is a globally distributed application protocol and is represented and continuously developed by CiA (CAN in Automation). The data objects used in CANopen, PDO (Process Data Objects) and SDO (Service Data Objects) are simulated in the VARAN bus system via isochronous and asynchronous data objects. This simplifies the integration of various devices according to the CiA standard.

With the significantly higher bandwidth of VARAN, data lengths of 64 bytes are possible. Since in the VARAN bus, the station addressing as well as explicit confirmation of received data is implemented through the bus protocol receiver, labeling the objects with the usual CANopen identifier is not required. Existing CANopen devices can be therewith easily integrated into the high-performance real-time Ethernet system.

COMFORTABLE NETWORK ANALYSIS

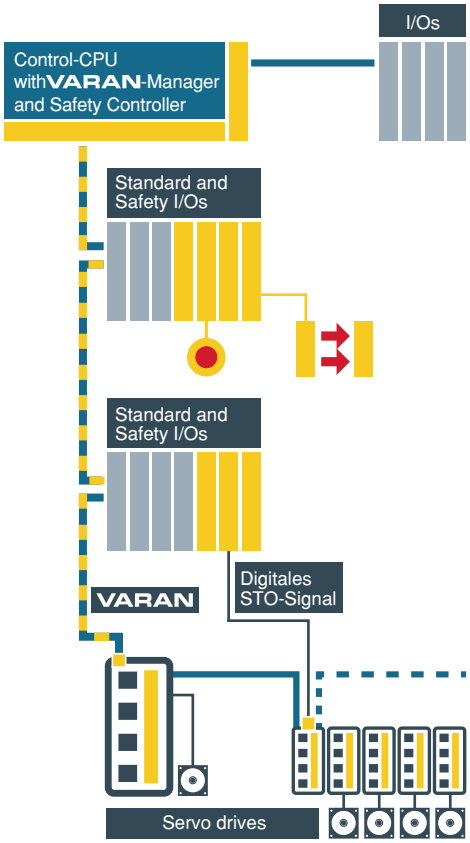
With the VARAN Service Tool and VARAN Analyzer, efficient tools for monitoring and analyzing the real-time Ethernet bus system are provided.

Helpful functions such as automatic scanning and subsequent graphic display of the network topology simplify service and maintenance of machines and systems. Reading the device information and software updates can be run with only a few mouse clicks.

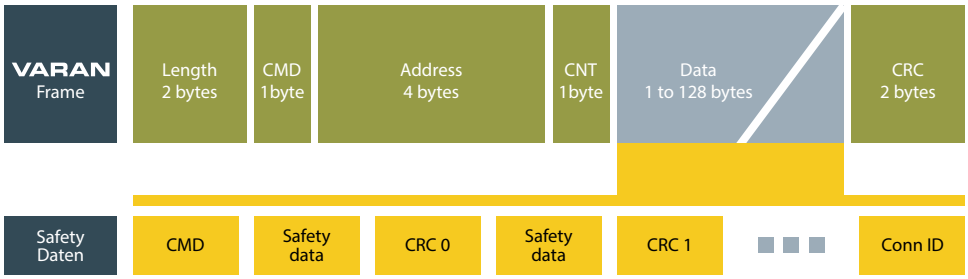
SAFETY OVER VARAN

In increasingly more sectors of the industry, modern safety solutions for the protection of humans and machines are indispensable. VARAN provides the possibility to transmit data using the Black Channel principle. The bus system is thereby excluded from the Safety assessment and allows Safety data to be forwarded over other transport media. For example, an STO signal can be integrated via the VARAN bus system or external backplane wiring. The user has therewith, complete security with maximum flexibility.

In systems with multi-manager networks, the Safety signals can be transmitted over multiple machines and are then available to the entire production line. This allows the simple and inexpensive implementation of central and decentralized Safety solutions up to SIL3 in accordance with IEC 62061 and PLe in accordance with EN ISO 13849-1/-2 with VARAN.



Modern
automation concept
with integrated SAFETY



Example of imbedding
a SAFETY telegram

VARAN
BUS USER ORGANIZATION

OPEN AND MANUFACTURER-INDEPENDENT

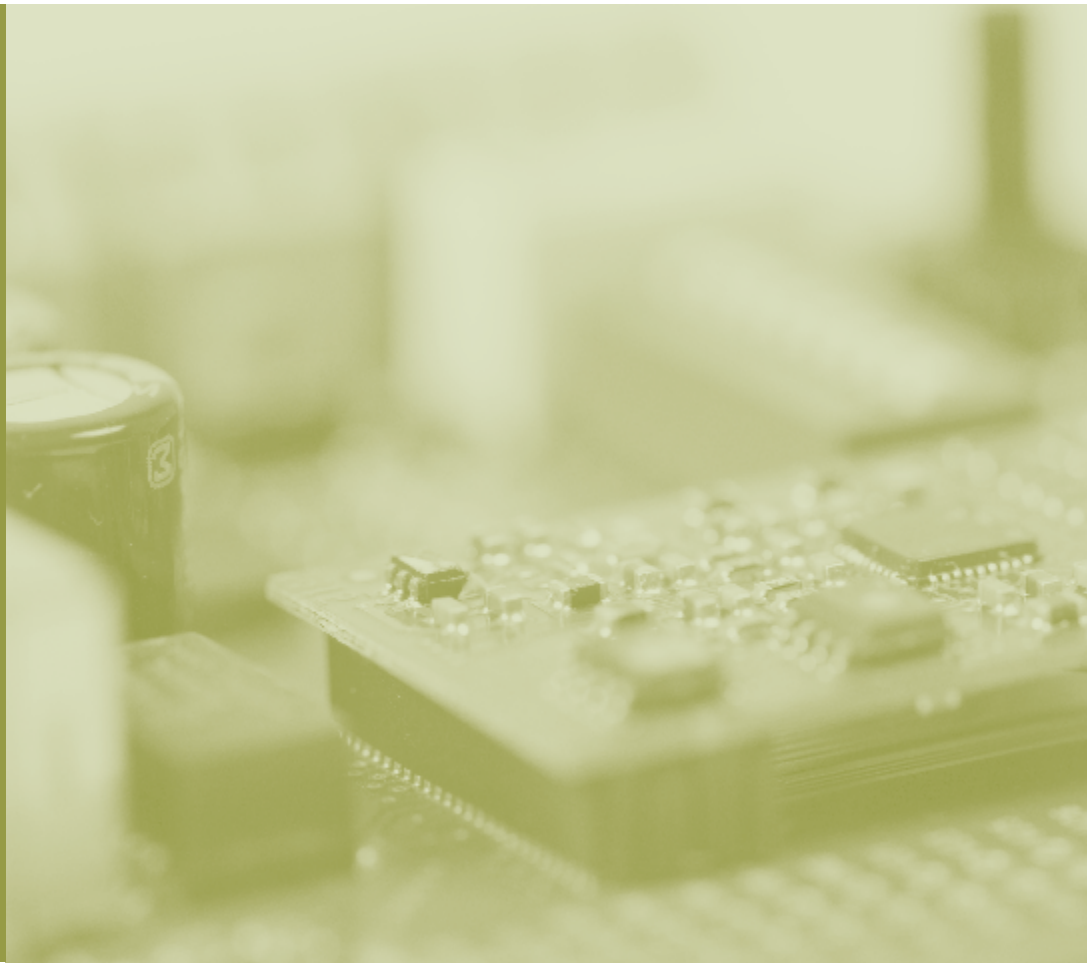
The VARAN BUS USERORGANIZATION was founded in 2006 and holds the exclusive rights to the VARAN bus. The independent organization is continuously researching, developing and implementing new technologies and supports its members in implementing VARAN.

The broad product palette offers the right VARAN components for any job: Various VARAN manager and expansion cards, as well as client components in the areas of motion, I/O, sensors and communication are available from various manufacturers. The spectrum of products is rounded out with infrastructure components, which reliably connect the VARAN bus participants with one another under industrial conditions.

For the application areas of IP20 and IP67, the VNO selected various connectors that are tested for industrial suitability. With the hybrid variant of connectors and cables, real-time data and supply voltage can be transported to the device over one connector plug. Costs are thereby saved and error sources minimized.

STARTER KITS

In the VNO starter kits, as well as various manager/client and evaluation boards, are available to choose from. Beginner and experienced developers can therewith easily become familiar with the function and performance of VARAN and implement their own client connections.



VARAN
BUS USER ORGANIZATION

SIMPLE **VARAN**-INTEGRATION

Members of the VNO receive access to the complete VARAN design specification, with which independent integration is already possible. For the simple implementation of a VARAN interface, manager/client boards or VHDL designs can be utilized. Depending on the application, the optimal method for implementation can be selected.

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