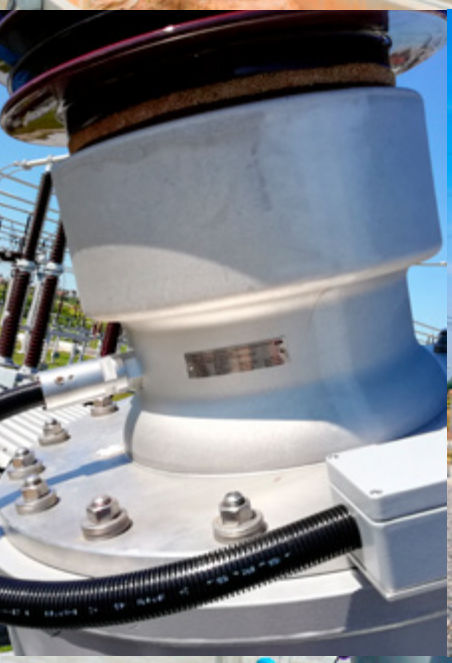
KONČAR

ELECTRICAL ENGINEERING INSTITUTE

KONČAR TMS

TRANSFORMER MONITORING SYSTEM



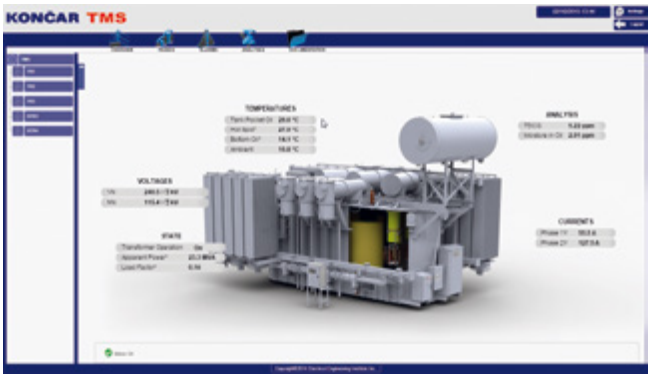


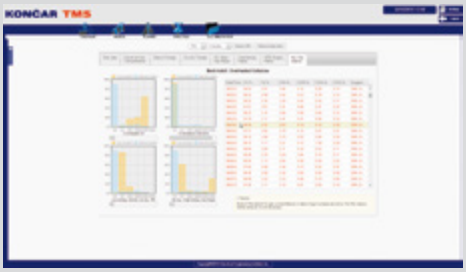


Overview

Transformers are one of the key and most valuable components in a power system. Equipping them with an on-line monitoring system is essential for information gathering, condition assessment, better management and decision making.

Decades of experience in transformer design, production and on-site diagnostics as well as a field-proven hardware platform are built into Končar TMS – a state of the art monitoring and diagnostic system.





Features

- Comprehensive on-line monitoring system for all types of power transformers and shunt reactors
- Modular and expandable system for a new or an existing transformer (retrofitting), open to any transformer manufacturer
- Provides monitoring and diagnostic for all vital transformer parts by integrating the available sensors and supporting various IED communication protocols
- Built-in models for transformer condition assessment (bushings, partial discharges, thermal model, insulation aging, cooling efficiency, OLTC)
- Advanced trending analysis tools
- Interpretation methods of fault gas analysis according to the relevant IEC and IEEE standards
- User-defined alarm limit and gradient setting
- Long term archival of data and event logging
- Periodic automatic report generation
- Various remote access options

Benefits

- Detects incipient faults and assists in preventing failures and unplanned outages
- Enables the condition-based maintenance
- Improves staff safety and environmental protection
- Provides valuable data for a root cause analysis and an investigation in case of a failure event
- Helps in optimizing transformer performance and enables better asset management (overloading, lifetime expectancy estimations, health and risk estimations)
- Makes your transformer ready for the 'Smart Grid'

Monitoring functions

Due to modularity any of the following functions may be included in the system:

Bushings

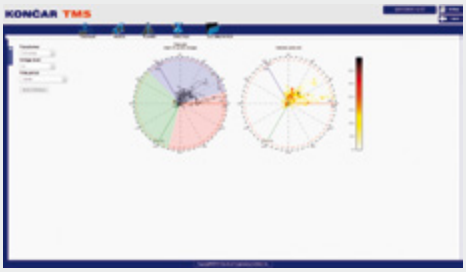
- Operating voltages
- Transients overvoltage recording
- Change of bushing capacitance
- Tan delta /power factor
- Loading current (single or three phase)

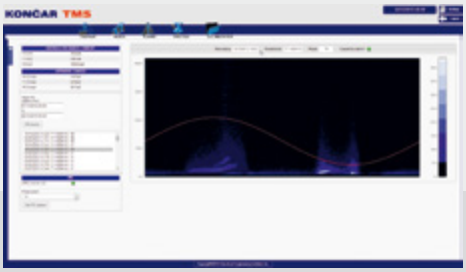
Active part

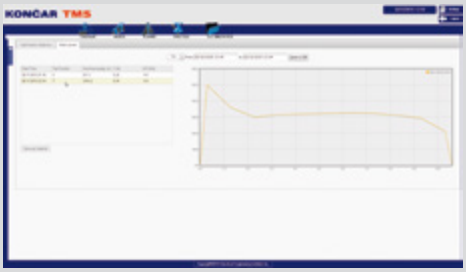
- Power (apparent, active, reactive)
- Losses
- Oil temperature (top, bottom)
- Ambient temperature
- Hot-spot temperature (calculation or fiber optic measurement)
- Gas in oil (single or multi gas sensors)
- Moisture in oil and paper
- Paper insulation ageing and lifetime

Partial discharges

- Electrical, acoustic and UHF methods available







On-Load Tap Changer

- Tap position
- Number of switching operations
- Switching time
- Power consumption of the OLTC motor drive
- OLTC oil temperature and differential
- Sum of switched current
- Contact wear

Cooling system

- Oil temperatures at the cooler inlets and outlets
- Cooling efficiency
- Running hours of pumps and fans
- Content of gas in the Buchholz relay
- Oil level in the conservator
- Intelligent cooling control
- Auxiliary equipment statuses and alarms (pressure relief device, OTI, WTI, Buchholz relay, etc.)

Tools

- Trend analysis
- Alarms and events logging
- Loading forecast
- Data export to text and Microsoft Excel
- Automatic report generation

System Architecture

Končar TMS is based on the KonFID processing platform which is primarily designed for usage in monitoring, control, and diagnostics of primary equipment in power generation, distribution and transmission. It comes with a vast variety of I/O modules and accessories which enables the platform to be used in any application including high-end partial discharge monitoring or transient voltage recorder. The main processing module utilizes a multi-core ARM processor with FPGA. It supports one USB 2.0 interface that can be Device type or Host type (contains both type A and type B connectors, only one can be used at a time), two 100 Mb Ethernet interfaces, one 1 Gb Ethernet interface and one SD card interface for storage. KonFID can easily be upgraded with voltage/current, RTD or digital input and output modules to form a complete monitoring and automation solution for every type of asset.

AVAILABLE I/O EXTENSIONS	
High Speed (100Ms/s) PD Inputs	Up to 8
High Speed (5Ms/s) Voltage Inputs	Up to 16
Low Speed (100s/s) 4-20mA Inputs	Up to 85
Low Speed (100s/s) Voltage Inputs	Up to 85
Pt-100 4wire Inputs	Up to 102

Digital Inputs	Up to 136
Analog U/I Outputs	Up to 136
Relay Outputs	Up to 136
Operating temperature range	-40°C to +70°C

Bushing Monitoring System

KONČAR TMS provides insight into the bushing insulation state while the transformer is online. Developing fault inside bushing can be detected at a very early stage so proper action can be taken to save substation equipment and personnel.

A powerful digital signal processor module enables precise measurement of bushing leakage current amplitude and phase angle. By measuring those parameters, relative dissipation factor change ($\Delta\tan\delta$) and relative capacitance change ($\Delta C/C_0$) can be estimated.

Key features

- Bushing capacitance and tanδ/power factor monitoring
- High-speed analog input channels
- Synchronous acquisition
- Digital signal processing
- Bushing adapters for various tap design
- Voltage RMS, Peak measurement
- Frequency and phase measurements
- User-configurable setpoints for alarms based on abnormal bushing condition

Measurement methods

Each method has its advantages and disadvantages. Method selection is based on measurement requirements, available conditions in substation and budget.

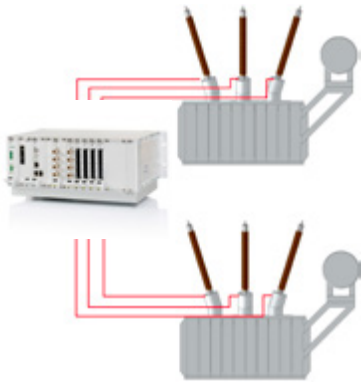
Sum-of-phasors

Advantages:

- Simple method
- Less cabling
- High sensitivity

Disadvantages:

- Network unbalance problems



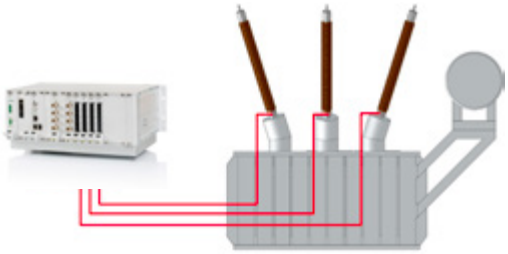
Voltage transformer reference

Advantages:

- Absolute measurement
- No network unbalance problems

Disadvantages:

- More cabling
- VTs are usually placed far away from the transformer and sometimes not available



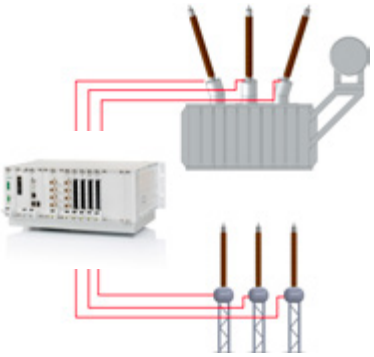
Bushing to Bushing comparison

Advantages:

- No network unbalance problems
- Monitors 6 bushings

Disadvantages:

- More cabling
- Available only if 2 transformers are operating concurrently on the same busbar



Bushing sensors

- Safe connection to the test tap
- Built-in overvoltage protection
- Hermetically sealed
- Available for various tap designs

Monitoring of overvoltages

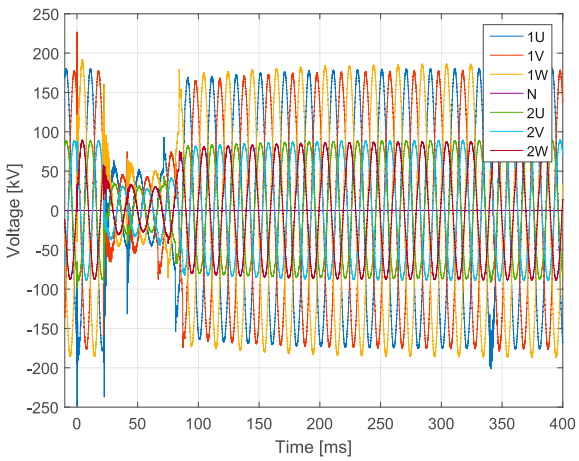
Today's power networks with high renewable shares and HVDC technology require advanced monitoring devices to meet the reliability requirements. In such networks power equipment is regularly exposed to transient voltages which can be caused by switching operations or lightning strikes. Exposure to such events leads to insulation degradation, depending on the number and severity of the overvoltages.

Continuous monitoring of transient overvoltages provides various information about the overvoltages: their number, amplitude, waveshape characteristics and the origin. In general, overvoltages in the power system significantly differ from the standard impulses, used to test the insulation of power equipment. With information on actual transient overvoltages, it is possible to:

- Estimate the impact on the insulation system of a power transformer
- Check the performance of overvoltage protection devices
- Analyze grid failures
- Detect severe events
- Make decisions related to system planning based on overvoltages (custom-made insulation depending on the characteristic overvoltage, adjustment or installation of additional surge arrestors, plan the level of insulation, etc.)

Overvoltage measurement method

The capacitive bushing can serve as a capacitive voltage divider for the measurement of voltage transients. A special bushing tap adapter and measuring impendence are designed to accurately transfer the overvoltage amplitude and shape to the low voltage side. These components are parts of the bushing sensor used for monitoring bushing capacitance and tanδ/power factor. Končar's system is tested and verified for all standard waveforms (switching, lightning and chopped lightning waveforms).

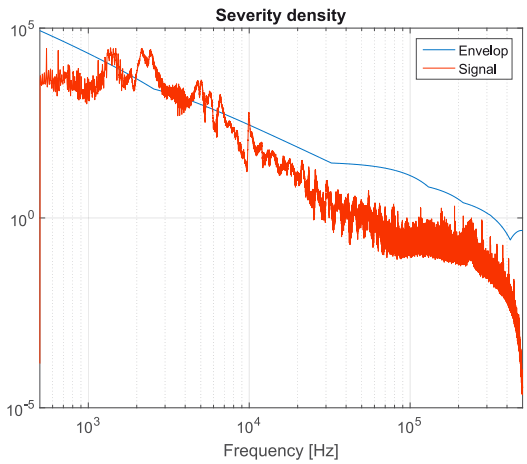


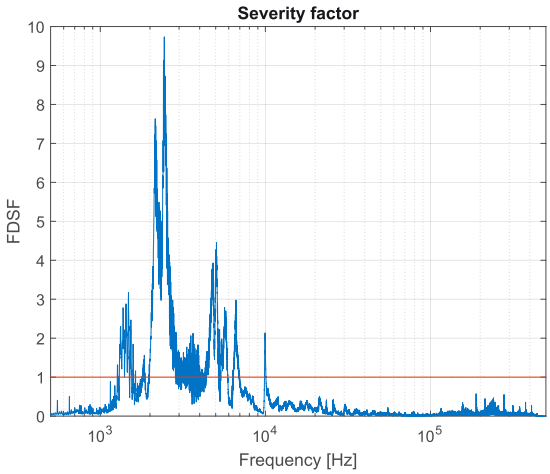
The low voltage output from the sensor is connected to a transient recorder module of Končar TMS. The system records waveforms on all channels synchronously with a sample rate of 4.5 MS/s and a duration of up to 7 seconds.

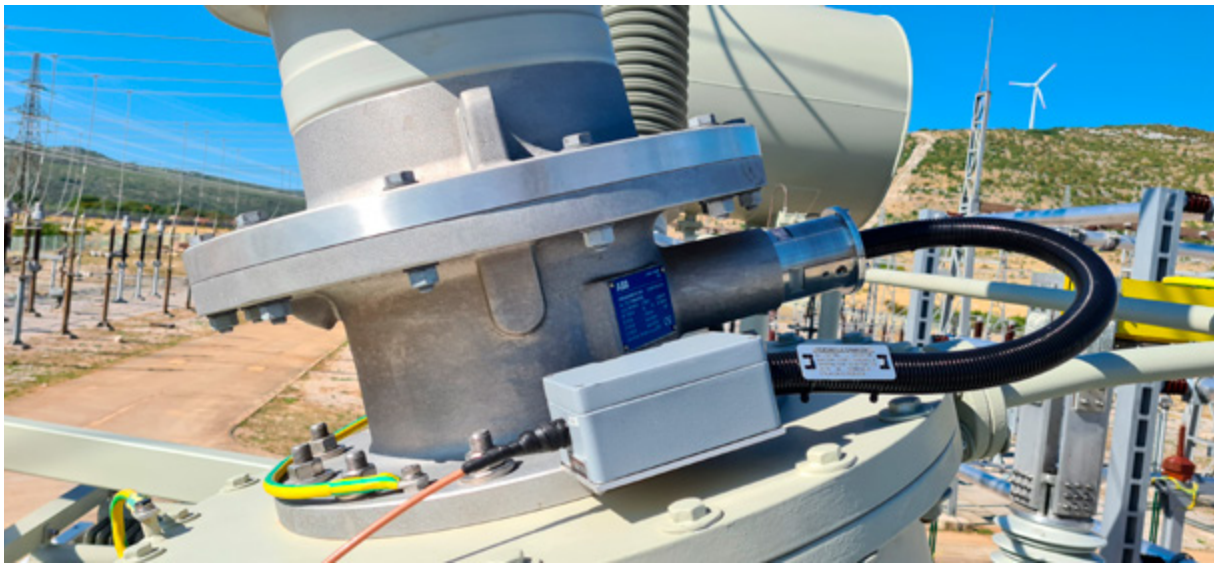
Overvoltage analyzes

Numerous data can be extracted from the database of the measured overvoltages. Using frequency domain severe factor (FDSF), detection of severe overvoltages is enabled. FDSF compares the frequency spectrum of the measured waveshape with the impulse test waveshape envelope. If the factor has a value higher than 1, it means that transformer is not tested for such waveshapes. It is important to note that even though the transformer has not been tested for the particular waveshape, it does not mean that it is not capable to withstand that waveshape.

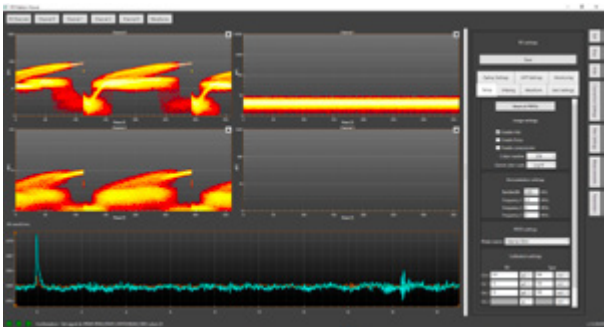
In addition to the FDSF, amplitude, rise time, tail time, and main oscillation frequency parameters are observed and statistically analyzed. In general, statistical analysis of the waveshapes of real overvoltages, that exist in the power network, can help in better understanding of overvoltage phenomena. Information about real overvoltages is useful for improving the transformer design and testing by specifying the transformer depending on the location of the unit installation.







Partial discharges monitoring

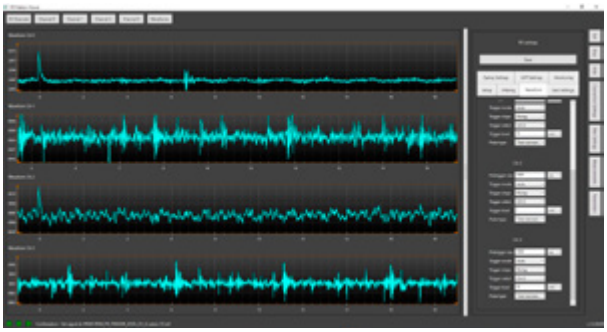


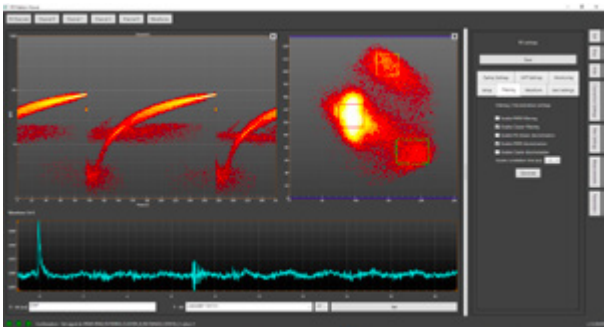
Partial discharge activity is the earliest sign of deterioration or defects in transformers. It is present well in advance of failure. By detecting or monitoring it, scheduled maintenance can be planned and catastrophic events avoided. Insulation plays a key role in every asset in power generation, transmission or distribution. In the majority of cases, the lifetime of an asset is defined by its insulation state. Failure of insulation is very often accompanied by fire or explosion which leads to heavy damage to the asset itself and nearby objects. This leads to great expenses due to the damage to assets and reduced availability. Every asset manager wants to minimize the risks of such events and keep maintenance expenses as low as possible.

Končar TMS provides insight into the insulation state by measuring partial discharges activity. It comes with a vast portfolio of accessories and sensors which enables measurement of every asset. Its state-of-the-art processing algorithms provide reliable measurement results and unparalleled real-time processing performance.

Features

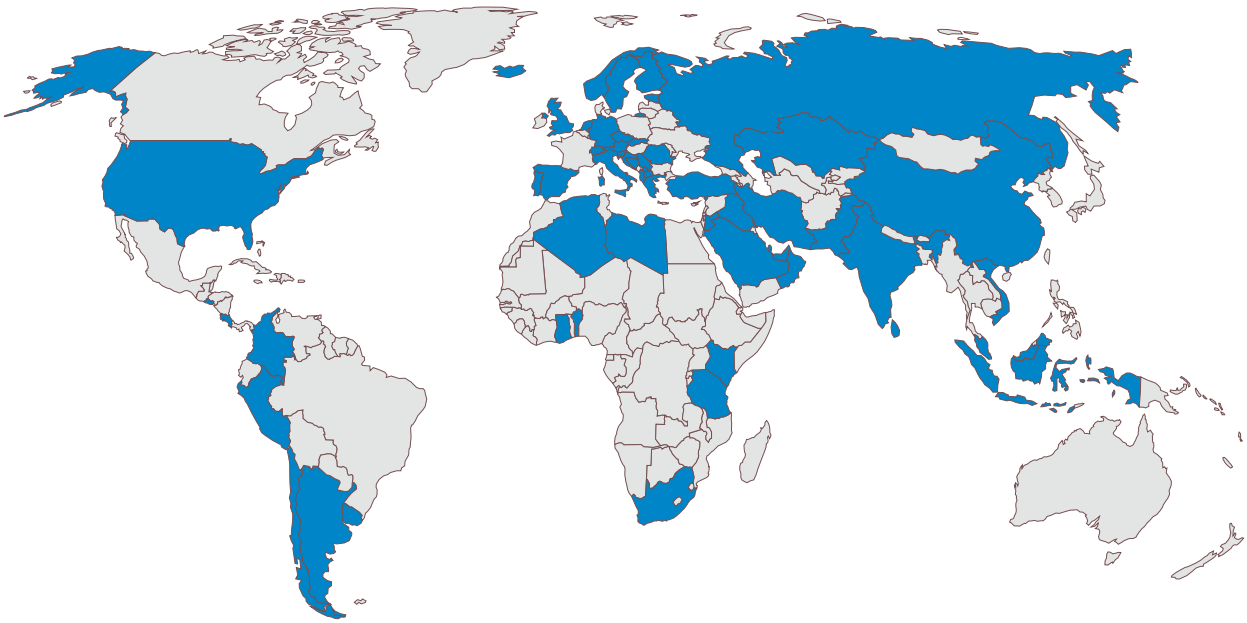
- Fully synchronous high-speed acquisition
- Wide Input range
- Wide bandwidth
- Adjustable digital filtering
- Smart self-adjustable gain control in 15 levels
- State of the art fully digital signal processing from telecom technologies
- Automatic noise suppression and source separation
- Automatic PD event classification
- Real-time processing with up to 2.000.000 pulses/second per channel
- Intuitive interface and configuration
- One solution for every asset
- Compliant with the latest IEC and IEEE standards





Services

- Tailor made systems as per customer specifications
- Consulting services on how to select the optimal condition monitoring system for a new or an old transformer
- Installation and commissioning
- Staff training
- Recommendation of limit values (alarms) settings
- Expertise in interpretation of the acquired monitoring results



Worldwide recognized and implemented solutions.

Transformer monitoring system Končar TMS is built with a clear goal - to help its users improve asset management and prevent critical equipment from unplanned shutdowns.

With the systems installed around the globe, Končar TMS set the standards in transformer monitoring.

Monitoring System Specification

Architecture	Data acquisition unit with the real-time controller installed on the transformer and Industrial PC installed in the control/telecom room	
Inputs and outputs	Bushing /Transient Recorder Analog Inputs: 0-300 mA, 0-100 V @ 5 MS/s Partial discharge Inputs: 10mVpp 160 Vpp @ 100 MS/s DC analog inputs: 4-20 mA; 0-10 V DC AC analog inputs (CT): 0-1/5 A RTD inputs: Pt-100	Digital inputs: dry contacts with 24V wetting Analog outputs: 4-20 mA Digital outputs: potential free contacts (SPDT relays) Quantity: as per requirement All channels protected from overvoltages and overcurrents
Data logging	SQL database used for long-term data, alarms and events archival	Event driven data acquisition results in a reduced database size
Data visualization	Web browser or client application for local and remote access Transient recorder Waveforms with up to 7 seconds record length	
Communication	Physical layer: RS-232, Ethernet 10/100/1000, Fiber optic	
Supported protocols	IEC 61850; IEC 60870-5-101 and 104; Modbus; OPC	
Power supply	Universal switching power supply	Voltage: 85 V AC - 264 V AC, single phase Frequency: 45 – 65 Hz
Cabinet	Material: Painted stainless steel (color selection per RAL scale)	Rating: IP66 (standard) IP68 (on request). Mounting: on a tank wall or a stand
Operating temperature	-40 to +60°C	
Standards compliance	EMC Directive 2014/30/EU and standards: EN IEC 61000-6-2:2019; EN IEC 61000-6-4:2019; EN IEC 61000-3-2:2019+A1:2021; EN IEC 61000-3-3:2013+A1:2019;	EN IEC 61326-1:2021 LVD Directive 2014/35/EU and standards EN 61010-1:2011; IEC 61180-1:1992 (Section 5); EN 62311:2008

All product, product specifications and data are subject to change without notice to improve reliability, function or design or otherwise



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