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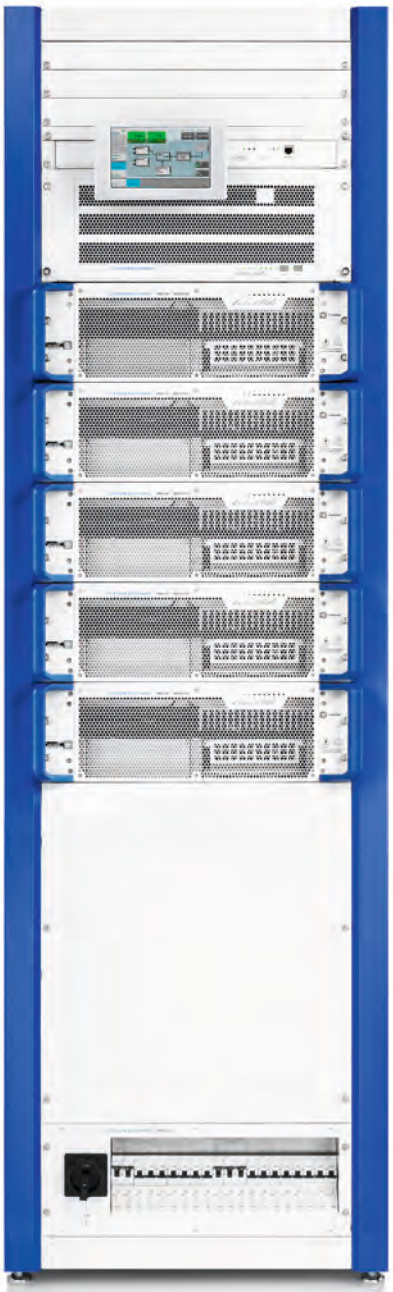
R&S®TMU9/ R&S®TMV9 Air-Cooled Transmitter Families

At a glance



The R&S®TMU9/R&S®TMV9 transmitter families offer unique flexibility by providing more than 50 different standard configurations. Featuring efficiency of up to 42 % for UHF and up to 50 % for VHF, they achieve the highest energy savings on the market. Plus, the simple system configuration allows quick startup. The high availability of the R&S®TMU9 ensures unsurpassed reliable operation. And its compact size saves space at the transmitter site.

The R&S®TMU9 air-cooled transmitters attain output powers in the UHF range from 300 W to 3.0 kW for digital standards and up to 4.75 kW for analog standards. In the VHF range, the R&S®TMV9 achieves up to 4.3 kW for digital audio broadcasting and digital TV, and up to 6.9 kW for analog TV. The transmitters are accommodated in only one rack, saving a lot of space at the transmitter site.

With efficiency values of up to 30 % for UHF and up to 41 % for VHF in normal mode, the transmitters save a great deal of energy and significantly reduce CO_2 emissions. The Doherty architecture for boosting efficiency even increases these figures to up to 42 % for UHF and up to 50 % for VHF. These figures are unparalleled on the market, making the R&S®TMU9/R&S®TMV9 transmitter families the global benchmark for broadcast transmitters with optimized operating costs.

The transmitters feature unique system variability. Innovative configurations, such as MultiTX or N+1 systems in a single rack, and built-in bandpass filters ensure short delivery times even for special transmitter configurations. Excellent efficiency and the integration of multiple transmitters into a single rack reduce the total cost of ownership (TCO) of a transmitter system by more than half over the system's lifetime.

Key facts

- Efficiency of up to 42 % for UHF and up to 50 % for VHF
- Unique flexibility
- Small footprint
- Quick startup, easy operation and high availability

Outstanding efficiency			
		UHF	VHF
COFDM	Doherty mode	38 %	46 %
	Normal mode	25 %	33 %
ATSC	Doherty mode	42 %	50 %
	Normal mode	30 %	41 %

R&S®TMU9/ R&S®TMV9 Air-Cooled Transmitter Families

Benefits and key features

Transmitters with exceptional efficiency

- Next level of efficiency thanks to Doherty technology
- Voltage regulation and crest factor reduction
- Adaptive digital equalization
- Efficient amplifier layout

▷ page 5

Unique variability

- Flexible system configuration
- R&S®TCE900 – a multitalent as transmitter control unit and/or exciter
- IP transport stream feed to reduce infrastructure costs
- Simple switchover from analog to digital TV
- Integrated satellite receiver for fewer components in the rack

▷ page 7

Small footprint

- Multiple transmitters in a single rack
- Compact coupler units integrate different functionalities
- Compact components with integrated cooling

▷ page 9

Easy handling and outstanding reliability

- Simple system configuration for quick startup and expansion
- Easy and efficient operation
- Innovative solutions for increasing availability

▷ page 10

E⁵ – efficiency to the power of five

The R&S®Tx9 transmitter generation scores with efficiency on five different levels:

- **Efficiency in energy**
  Economical: minimum power consumption for cost savings over system lifetime
- **Efficiency in space**
  Space-saving: several transmitters and additional components in one rack
- **Efficiency in operation**
  Smooth: installation, operation and maintenance
- **Efficiency in configuration**
  Customer-focused: modular solutions for flexible system configuration
- **Efficiency for a lifetime**
  Future-ready: can be expanded to accommodate new standards and technologies

Model overview

R&S®TMU9/R&S®TMV9 transmitter system							
Number of amplifiers	**1**	**1**	**2**	**3**	**4**	**5**	**6**
UHF							
Output power (AVG) for digital standards [1]							
470 MHz to 862 MHz	300 W	600 W	1200 W	1800 W	2400 W	3000 W	–
Output power (sync peak) for ATV [1]							
470 MHz to 862 MHz	500 W	1000 W	1900 W	2850 W	3800 W	4750 W	–
VHF							
Output power (AVG) for digital standards [1]							
170 MHz to 230 MHz	350 W	750 W	1450 W	2200 W	2900 W	3600 W	4300 W
230 MHz to 254 MHz	350 W	700 W	1350 W	2050 W	2700 W	3350 W	4000 W
Output power (sync peak) for ATV [1]							
170 MHz to 230 MHz	600 W	1200 W	2350 W	3500 W	4650 W	5800 W	6900 W
230 MHz to 254 MHz	600 W	1100 W	2150 W	3200 W	4250 W	5300 W	6350 W
Dimensions (H × W × D)	2000 mm × 600 mm × 800 mm (78.74 in × 23.62 in × 31.49 in)						
Height of integration kit for 19" third-party rack	310 mm (12.2 in) (7 HU)	310 mm (12.2 in) (7 HU)	490 mm (19.3 in) (11 HU)	–	–	–	–
Possible MultiTX configurations							
Number of transmitters per rack with MultiTX	up to 6	up to 6	up to 3	2	–	–	–
N+1 configuration per rack with MultiTX	4+1	4+1	2+1	1+1	–	–	–

[1] Before bandpass filter.

R&S®TMV9 transmitter with three amplifiers and an output power of 2.2 kW (DAB and DTV).

Transmitters with exceptional efficiency

Next level of efficiency thanks to Doherty technology

The R&S®TMU9/R&S®TMV9 broadcast transmitters even achieve excellent efficiency of up 30 % for UHF and 41 % for VHF in normal mode.

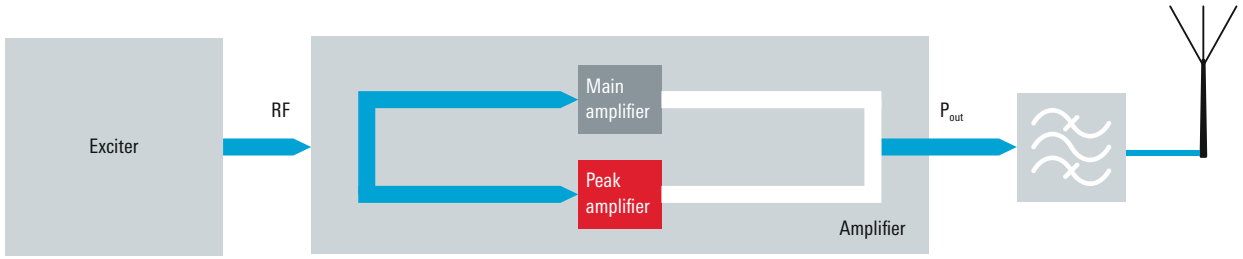
In Doherty mode, the R&S®TMU9/R&S®TMV9 attain the next level of efficiency. The transmitters set benchmarks, with up to 42 % for UHF and up to 50 % for VHF. The transmitters reduce energy costs by significantly more than 50 % compared with the average 20 % efficiency delivered by other transmitters on the market.

To attain these values, Doherty technology is the method of choice. This technology is based on an architecture invented in the 1930s by William H. Doherty. It has been used successfully in wireless communications for many years and helps to reduce energy costs.

The basic principle involves splitting signal amplification into two paths. In the main amplifier, only the average signal is amplified, and no power margins have to be reserved for peak signals in this path. The peak amplifier is only used when peaks occur in the signal. This architecture saves energy in both the main and the peak amplifier.

has revolutionized this technology with the R&S®TMU9/R&S®TMV9. For the first time, the ampli-fier has a broadband design while still making use of the basically narrowband Doherty architecture. Even in large transmitter networks that use many different frequencies, it is now possible to efficiently manage the spare parts inventory. Because no additional modules are required, the mean time between failure (MTBF) of the amplifiers remains unchanged when this technology is used.

Transmitter system with Doherty amplifier



The R&S®PMV901 amplifier features an output power of 750 W for DAB/DTV and 1200 W for ATV.

Voltage regulation and crest factor reduction To significantly increase efficiency, has incorporated two other innovative approaches into its mix of technologies, in addition to the optimized system design.

Voltage regulation considerably boosts efficiency. Only offers this. The control mechanism in the transmitter control unit allows transmitter efficiency to be optimized for all digital TV standards. The signal is decoupled by the directional coupler at the transmitter output, routed back to the R&S®TCE900 exciter and ana-lyzed. At the same time, the supply voltage for the power transistors is iteratively adjusted via the power supplies in the amplifiers. Voltage regulation considerably boosts ef-ficiency especially when a transmitter operates at reduced output power.

With the R&S®TCE900 exciter, is the first manufacturer to offer a reduction of the crest factor for all COFDM standards. The crest factor is reduced to 8 dB without any negative impact on MER, improving the total transmitter efficiency. For DVB-T2, the tone reservation method defined in the standard can alternatively be used to reduce the crest factor.

Adaptive digital equalization

All R&S®TMU9/R&S®TMV9 configurations feature adap-tive digital equalization (ADE) to equalize the transmitter system quickly, easily and at any time. ADE can be used either once when the system is put into operation or adaptively.

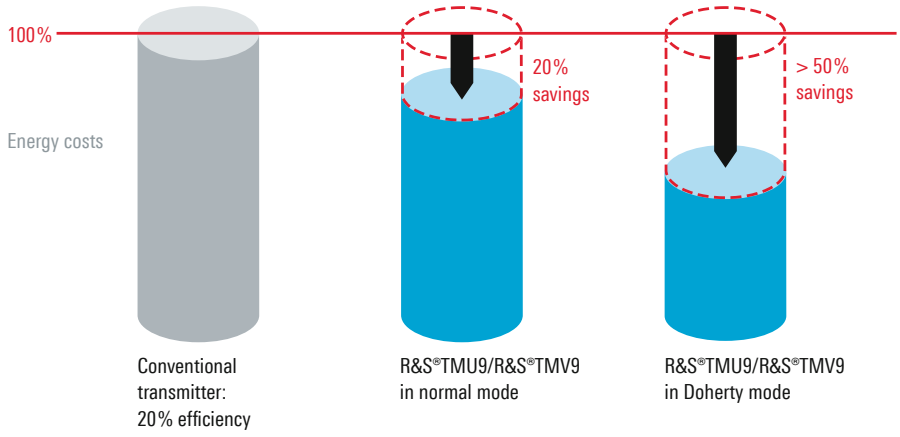
Efficient amplifier layout

Featuring output power of 600 W for UHF and 750 W for VHF, the amplifier achieves outstanding power density. The power transistors use sophisticated 50 V LDMOS technol-ogy. The close cooperation between and the semiconductor manufacturer and the optimal match-ing of the transistors result in excellent efficiency and proven long-term stability of the amplifier section.

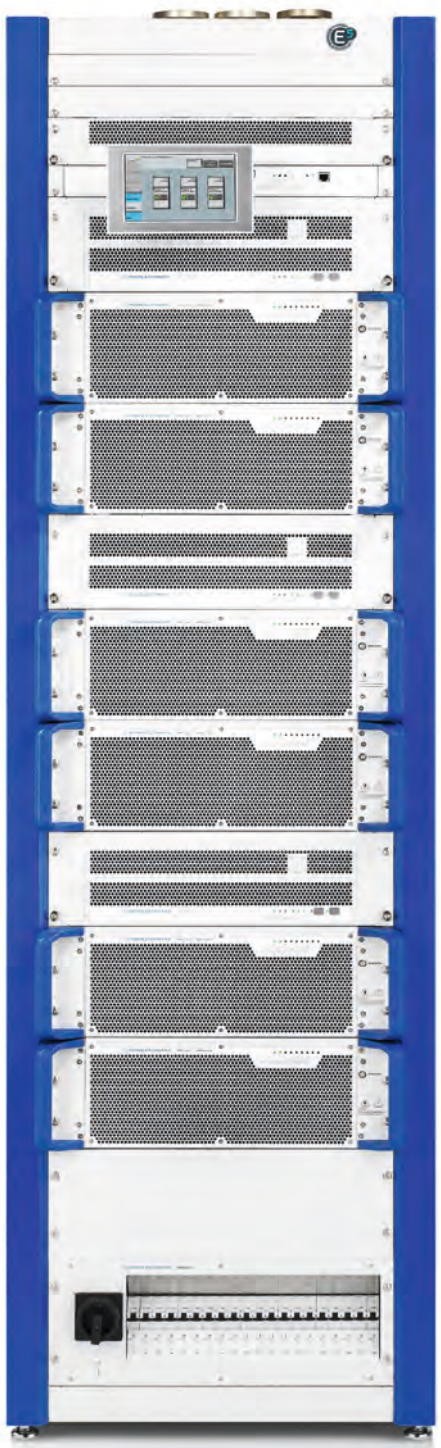
The same amplifier can be used both in normal mode and in Doherty mode.

A technology first, passively cooled power supplies are used in the new air-cooled amplifiers, contributing to sys-tem efficiency and increasing availability.

Energy savings with the R&S®TMU9



Unique variability



MultiTX system with three R&S®TMU9 1.2 kW transmitters in one rack.

Flexible system configuration

The R&S®TMU9/R&S®TMV9 broadcast transmitters offer unique flexibility. Because the system can be flexibly configured, more than 50 different standard system configurations are available, ensuring short delivery times even when special configuration requirements need to be met.

The new MultiTX concept makes it possible to install up to six transmitters in one rack. Even complete N+1 systems can be accommodated in a single rack.

Transmitters with up to two amplifiers can also be ordered without a rack, allowing installation in racks where space is still available or in a rack acquired on site. Bandpass filters, dummy antennas and other accessories can also be integrated into the transmitter rack, saving additional space.

Various air ducting configurations can be implemented, allowing the transmitter to operate both with and without ducted exhaust air. If the exhaust air is ducted, the system comes with a kit that has a pressure monitor and ensures constant cooling even if air intake fluctuates.

R&S®TCE900 – a multitalent as transmitter control unit and/or exciter

The R&S®TMU9/R&S®TMV9 transmitter families use the R&S®TCE900 platform introduced with the R&S®THU9 UHF TV transmitter family. This cross-family platform allows network operators who use multiple R&S®Tx9 transmitters to easily and economically manage their spare parts inventories. Thanks to the system's modularity, network operators with both DAB and TV networks can look forward to cost savings since they will require fewer spare parts.

By inserting supplementary specific plug-in boards, the base unit can be configured as a transmitter control unit or as an exciter, resulting in unprecedented flexibility for network operators. To reconfigure the R&S®TCE900 on site for another application, the user simply needs to exchange the modules. The platform also offers free option slots for expanding its functionality (e.g. by adding a satellite receiver).

When configured as a transmitter or system control unit, the R&S®TCE900 ensures smooth operation of the transmitter system. The R&S®TCE900 connects to the different system components via plug-in boards. Depending on the configuration, the cooling-system interface connects the exhaust air duct system, while the transmitter interface connects to the exciters. The control unit uses the connected exciters to communicate with the amplifiers, the directional coupler and other system modules via CAN bus.

In the exciter configuration, a coder board for baseband signal processing and an RF board for RF modulation are added to the R&S®TCE900 base unit. The exciter is extremely versatile. It can be used for the DVB-T, DVB-T2, DVB-H, ISDB-T/ISDB-T_B, DTMB, ATSC and ATSC Mobile DTV digital TV standards as well as for analog TV. Equipped with the appropriate coder board, the exciter is ideal for the DAB/DAB+ digital audio broadcast standards and T-DMB Mobile TV applications. All these transmission standards are available as software options for easy retrofitting. It is therefore no problem to install multiple standards in one exciter (e.g. DVB-T and DVB-T2). The exciter configuration also includes a GPS receiver that can be easily activated via option key.

In the R&S®TMU9/R&S®TMV9, the R&S®TCE900 can combine the functionalities of a transmitter control unit and an exciter, allowing a complete transmitter rack to operate with a single R&S®TCE900 as control unit and exciter. This saves space and increases the system's MTBF.

IP transport stream feed to reduce infrastructure costs

Due to its cost-effectiveness, IP technology is also gaining ground in broadcast networks. For all digital standards, the R&S®TCE900 exciter optionally offers feeding two transport streams redundantly via Gigabit Ethernet interfaces. This also applies to DAB. Transport streams can be fed in via IP at any time using the EDI standard, eliminating the need for external IP-to-ASI/ETI gateways. Because it is integrated in the transmitter control unit, this solution saves money and space, and simplifies feed monitoring.

Simple switchover from analog to digital TV

In the years to come, many operators will switch over from analog transmission to digital TV. The R&S®TMU9/R&S®TMV9 broadcast transmitters facilitate this transition. When the exciter is fed with both analog and digital input signals, switchover can take place locally (by pressing a key) or remotely.

Integrated satellite receiver for fewer components in the rack

A module with two satellite receivers makes it possible to receive up to two DVB-S/DVB-S2 satellite streams without additional external equipment. This saves space in the rack and eliminates investment costs for additional instruments. Encoded streams can be decoded via the two integrated common interface slots. Streams can also be processed outside the transmitter by feeding them to third-party instruments via the integrated IP output or ASI output and returning them via the IP and ASI inputs.

R&S®TMU9 with 1.2 kW DTV output power in dual drive in a MultiTX group.

Small footprint

Multiple transmitters in a single rack

The new MultiTX concept makes it possible to accommodate up to six transmitters in a 42 HU rack. Functioning as a system control unit, the R&S®TCE900 optionally monitors the transmitters and establishes a connection to the monitoring room via web interface or SNMP. If exhaust air is ducted, the R&S®TCE900 also monitors the exhaust air duct. If this is not desired, multiple autonomous transmitters can be integrated into a rack without shared monitoring.

Each transmitter in a multitransmitter group can be operated in dual drive configuration. A MultiTX system can also be quickly and easily expanded by installing an additional transmitter.

6-in-1 coupler unit for coupling two R&S®PMU901 amplifiers.

N+1 configurations can also be implemented in a single rack. For example, a 4+1 system with an output power of up to 600 W (UHF) and 750 W (VHF) can be configured in just one rack, making it possible to save up to three racks or more than 3 m^2 per transmitter system (compared with existing systems). As a result, an enormous amount of costs can be saved when leasing site surface.

Compact coupler units integrate different functionalities

The new 6-in-1 coupler unit includes the coupler unit, an input signal splitter, harmonics filter, lightning protection, power absorber and the measuring systems.

The harmonics filter is already integrated into the R&S®TMV9 amplifier. Coupler unit, power absorber and measuring systems are combined into one module. Each coupler unit has an optional connector for integrating a customer test point. The module is located directly behind the amplifiers, saving space and reducing the attenuation in the system. The compact design allows fast system startup and makes it possible to add a transmitter to the rack quickly and easily.

Compact components with integrated cooling

The compact R&S®PMU901/R&S®PMV901 amplifiers, only 3.5 height units in size, achieve an output power of up to 600 W for UHF and 750 W for VHF. This saves space in the rack for installing other components or additional transmitters. Two integrated fans in the amplifiers that can be exchanged during operation allow the transmitter system to operate without an exhaust air system. Ducted exhaust air can be optionally added to the configuration.

The R&S®TCE900 also significantly contributes to the system's compactness. The entire backup drive setup requires only three height units, saving more space. Integrated long-life fans allow reliable operation. They do not need to be replaced.

Easy handling and outstanding reliability

Simple system configuration for quick startup and expansion

The transmitters come fully cabled; only feed cables, power supply and system monitoring need to be added. Together with the self-engaging connection of the amplifier with the coupler, power supply and signal feed, the R&S®TMU9/R&S®TMV9 can be put into operation fast and easily.

The R&S®TCE900 is accessible from the front, allowing new plug-in boards to be added quickly and easily.

Easy and efficient operation

Each R&S®TMU9/R&S®TMV9 is equipped with a status display on the R&S®TCE900 rackmounts, where the transmitter status can be read off at any time. The buttons on the front panel make it quick and simple to switch from remote to local operation and to switch the transmitter on and off.

The optional R&S®TDU900 transmitter display unit allows fast, intuitive operation of the transmitter system via a 7" touchscreen. The retractable unit automatically slides out of the housing simply by giving it a slight push. It can be conveniently turned to the desired position, for fast, user-friendly operation.

An Ethernet connector, available with and without an R&S®TDU900, allows the transmitter to be operated locally via the web interface. The transmitter can also be operated remotely via web interface or integrated into a network management system via SNMP.

Innovative solutions for increasing availability

The R&S®TMU9/R&S®TMV9 transmitters offer an innovative backup drive redundancy concept comprising only two R&S®TCE900. The two units monitor and synchronize each other, making extra hardware for monitoring and controlling exciter switchover unnecessary. Doing away with a separate, governing control unit eliminates the risk of a single point of failure. The backup drive configuration offers the functionality and convenience of a classic exciter redundancy configuration and also increases transmitter availability.

All transmitter settings can be performed centrally via exciter A. As a result, a single IP address is sufficient for configuring and monitoring the system. Nevertheless, this concept also makes it possible to directly address the second exciter via its own IP address in the event of a failure of exciter A, allowing convenient remote diagnosis and eliminating unnecessary visits to the transmitter site.

Optional power supply redundancy for the amplifiers also helps to increase availability. Normally, each of the two power supplies delivers half of the necessary current. If one of the power supplies fails, the other delivers the full current. This ensures interruption-free transmission even if a power supply or a phase in the feed network fails. The power supplies can be easily replaced during operation.

Transmitter status display on the front panel via LEDs.

Specifications

Specifications		
Digital TV		
Standards		DVB-T, DVB-T2, DVB-H, ISDB-T, ISDB-T_B, ATSC, ATSC Mobile DTV, DTMB
Channel bandwidth	DVB-T, DVB-H	5/6/7/8 MHz
	DVB-T2	1.7/5/6/7/8 MHz
	ATSC	6 MHz
	ISDB-T/ISDB-T_B	6/8 MHz
	DTMB	8 MHz
Inputs	DVB-T, DVB-H, DVB-T2, DTMB	2 × ASI (HP/LP), 75 Ω BNC, 2 × RJ-45
	ATSC	2 × SMPTE310M or 2 × ASI, 75 Ω BNC, 2 × RJ-45
	ISDB-T/ISDB-T_B	2 × BTS, 75 Ω BNC, 2 × RJ-45
Digital radio/Mobil TV in the VHF band	standards	DAB, DAB+, T-DMB
Channel bandwidth		1.536 MHz
Inputs		2 × ETI, 75 Ω BNC/high impedance, 2 × EDI, RJ-45
Analog TV	standards	B/G, D/K, M[2], N[2], I, I1
Color transmission		PAL, NTSC, SECAM
Sound transmission		IRT dual-sound coding, FM single sound and NICAM728 (–13 dB/–20 dB) (optional), FM single sound (–10 dB)
Inputs		1 × video (75 Ω BNC), 2 × audio (XLR)
General data		
Frequency range	UHF bands IV/V	470 MHz to 862 MHz
	VHF band III	170 MHz to 254 MHz
Supply voltage		▮ 230 V; 2 wires + PE (L1/N/PE) ± 15% ▮ 400 V/230 V; 4 wires + PE (L1/L2/L3/N/PE) ± 15% ▮ 240 V; 2 wires + PE (L1/L2/PE) ± 10% ▮ 208 V; 4 wires + PE (L1/L2/L3/N/PE) ± 10%
Max. installation height		2000 m above sea level (> 2000 m on request)
Operating temperature range		+1 °C to +45 °C
Relative humidity (max.)		95 %, noncondensing
Immunity[1]	to fast transients and bursts in line with EC 61000-4-4	< 2 kV (AC supply), < 1 kV (signal inputs)
	to surges in line with EC 61000-4-5	symmetrical < 1 kV (e.g. L1-L2), asymmetrical < 2 kV (e.g. L1-N)
Synchronization		
Reference frequency		10 MHz, 0.1 V to 5 V (V_{pp}) or TTL, BNC
Reference pulse		1 Hz, TTL, BNC
Operation		
Display unit with touchscreen and LEDs	optional	local operation and display
Ethernet interface, RJ-45		local, remote, standard web browser
	optional	network management interface via SNMP
Parallel remote interface	optional	floating contacts for messages and commands

[1] With built-in AC overvoltage protection; more stringent requirements must be satisfied by implementing appropriate measures in the stations.
[2] Single sound.

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