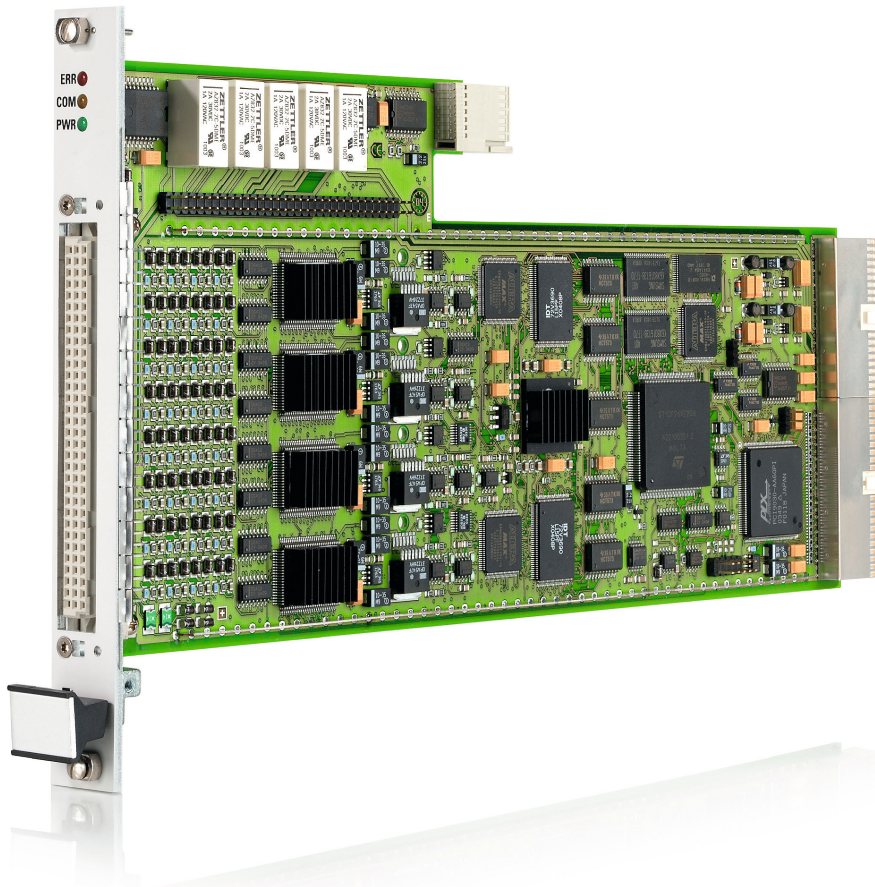# R&S®TS-PDFT Digital Functional Test Module

High-speed 32-bit digital pattern I/O and serial communications interfaces

## ROHDE & SCHWARZ

R&S®TS-PDFT Digital Functional Test Module At a glance

The R&S®TS-PDFT digital functional test module is a CompactPCI/PXI module which takes up only one slot in the R&S®CompactTSVP test system versatile platform.

Key facts

▪ 32 digital output channels in four groups
▪ 20 MHz pattern rate
▪ One programmable output level per group
▪ High output current
▪ Short-circuit protection
▪ Stimulation of digital realtime data, streams with variable bus width
▪ Four high-power open drain channels, fully protected, capable of pulse width modulation
▪ Five SPST relay channels
▪ 32 digital input channels in four groups
▪ Two programmable input threshold levels per group for hysteresis or level monitoring
▪ Acquisition of digital realtime data streams with variable bus width
▪ Overvoltage protection
▪ Serial communications interfaces
  · High-speed CAN 2.0b
  · Low-speed CAN 2.0b, fault-tolerant
  · RS-232/K bus
  · SPI bus emulation (master)
  · I²C bus emulation (master)
▪ Local microprocessor
▪ For time-critical tasks independent of the operating system used
▪ Synchronization via PXI trigger bus
▪ Software front panels for immediate use
▪ Selftest software
▪ LabWindows/CVI device driver support
▪ Test software library GTSL in DLL format

Functional block diagram of the R&S®TS-PDFT
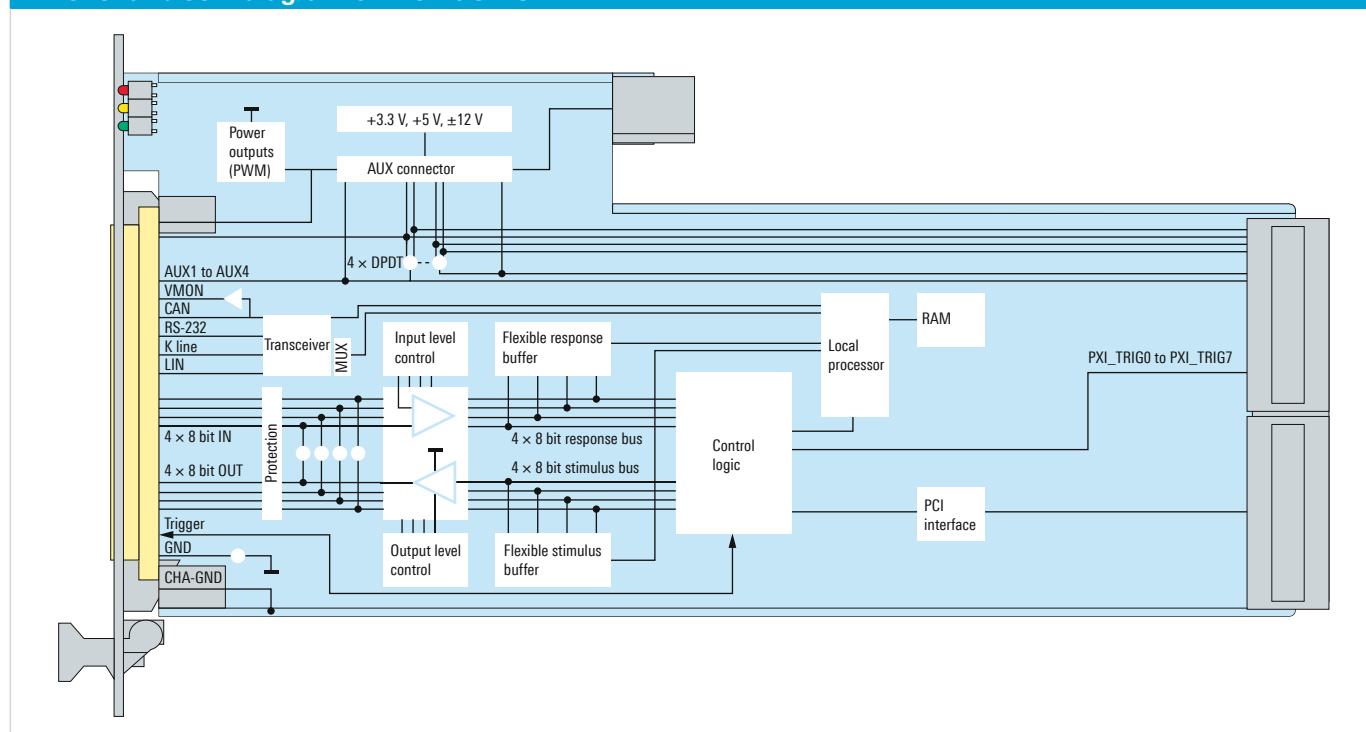
Product introduction

The R&S®TS-PDFT digital functional test module contains very flexibly programmable 32-bit digital inputs and 32-bit digital outputs which are able to acquire and stimulate static or dynamic digital patterns. The characteristics of the digital lines can be configured in 8-bit ports. In addition, the programmable levels of the output ports can be adjusted to the application requirements, and the input ports have a programmable threshold and hysteresis to match the specifications of common digital logic families.

Synchronization to digital communications, handshake signals and analog measurement tasks is provided via trigger lines accessible at the front connector or via the PXI trigger lines. Additionally, the module can generate trigger pulses derived from digital pattern comparisons and perform change detection at the input ports.

The digital I/O capabilities of the R&S®TS-PDFT are supported by the on-board microprocessor which can provide various communications interfaces especially suited for automotive applications.

Simulation of the DUT's environment is simplified by providing floating relays to switch supply voltages or loads to the DUT. With four additional power-output channels that can be pulse-width-modulated, digital control signals with up to 1 A can be applied to the test setup via open drain switching outputs.

The digital channels are equipped with protection circuits and signal conditioning features making the R&S®TS-PDFT digital functional test module a robust device for various in automatic test equipment (ATE) tasks, effectively covering a wide scope of measurement and control objectives.

Configuration of input ports.

Typical applications

The R&S®TS-PDFT digital functional test module can be used in all test and measurement scenarios where simple or complex digital circuits have to be tested using static or dynamic digital patterns. The feature of DUT programming in production provides a very efficient one-step approach to testing and uploading firmware to the DUTs in the test process.

For many applications, realistic simulation of the DUT's environment during testing is most important.

The R&S®TS-PDFT therefore offers deterministic generation and simultaneous acquisition of digital patterns at high data rates. This includes both tristate control and the implementation of bidirectional buses by configuring portwise connections of input and output lines by software. These test setups can be even operated in correlation with a realtime communications path based on standardized interfaces.

For automotive ATE, the most common interfaces are SPI, I²C, CAN, K bus or RS-232 which are supported by the R&S®TS-PDFT.

Further applications are related to various programming tasks that have to be performed by state-of-the-art board test systems. The R&S®TS-PDFT can handle most common programming procedures for downloading to flash memories and transferring data streams to on-board memory.

The on-board computing power provides firmware-implemented communications protocols and supports communications tasks that are time-critical or that need realtime response independently of the operating system that is running on the R&S®CompactTSVP system platform.

A sophisticated set of trigger setups provides flexible synchronization to DUT signals or synchronizes to multiple R&S®TS-PDFT modules, Rohde & Schwarz measurement modules or commercially available PXI modules via the standardized PXI trigger bus.
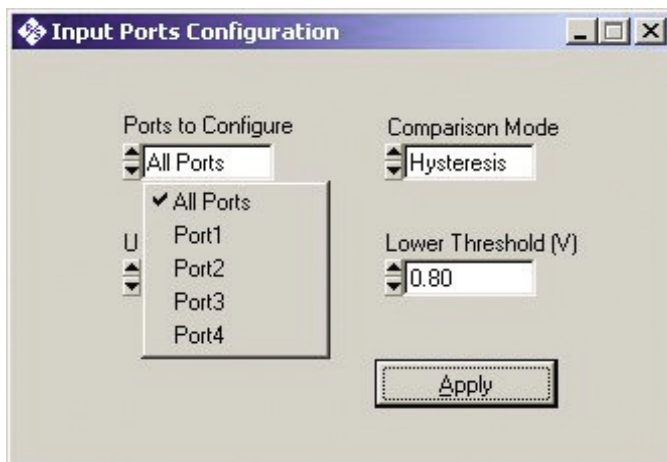
Typical applications include:
▮ Digital functional test
▮ Interfacing to digital communications
▮ Downloading to flash memories
▮ Deterministic stimulation and acquisition of digital data streams
▮ Digital I/O control
▮ Simulation of digital bus lines

Flexibility

The design of the module offers expanded flexibility for various application scenarios and high-speed pattern I/O. The programmability of the digital I/O interfaces enables the module to meet a wide range of requirements regarding data transfer, communications and trigger settings. The features are contained in the free software front panels and are available for immediate use.

The programmable output levels and input threshold levels of the configurable ports ensure compatibility with future generations of digital components. To improve noise immunity in test environments, the hysteresis of the input channels can be configured groupwise.

If a higher number of digital I/O lines is required, multiple R&S®TS-PDFT modules can be synchronized within the system or synchronized with other types of measurements via the PXI trigger bus.

To simplify update procedures, the firmware for the microcontroller and the on-board FPGA design can be easily downloaded. This allows the R&S®TS-PDFT firmware to be upgraded with new functionalities or enhancements.

Configuration of output ports.
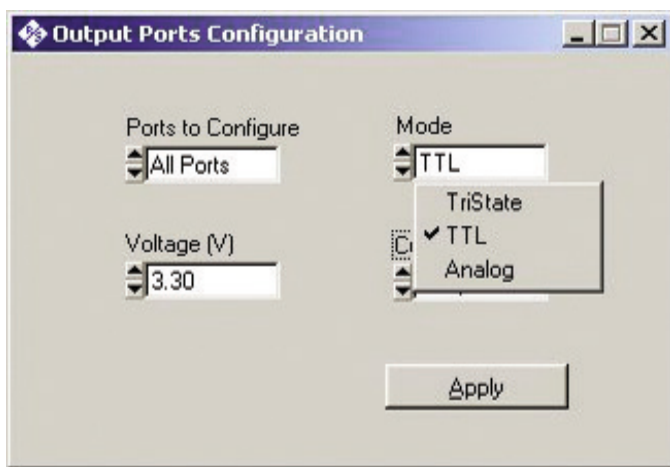
I²C bus test panel.
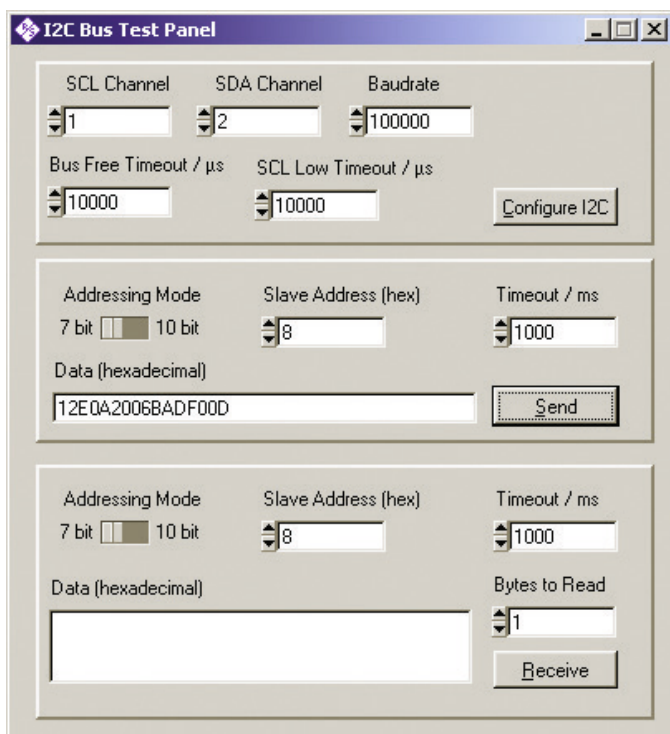
Software support

A LabWindows/CVI driver for standardized device operation is available for the R&S®TS-PDFT. Function panels and online help are available as common features for the LabWindows/CVI driver.

The definition and evaluation of complex digital test scenarios are supported by the Rohde & Schwarz generic test software library (GTSL) software including the DIO manager.

A set of software front panels makes it easy for users to learn the module's various functions. The software front panels also include features for evaluating serial communications protocols. This allows users to evaluate test setups by simply using test panels rather than by means of programming.

Waveform data can be loaded into and retrieved from the module's on-board memory using the driver functions provided by the DIO manager library, which is part of the Rohde & Schwarz GTSL software package. The driver functionality also includes the synchronization of multiple modules and pattern sets.

Selftest and diagnostics for reliable oparation

The built-in selftest capability of the module and the related selftest application ranges from fast diagnostics to the complete, automated evaluation of output levels, trigger lines and all switching paths.

Diagnostic LEDs on the module front panel speed up system integration and allow proper operation to be determined at a glance.

Static digital I/O loopback.
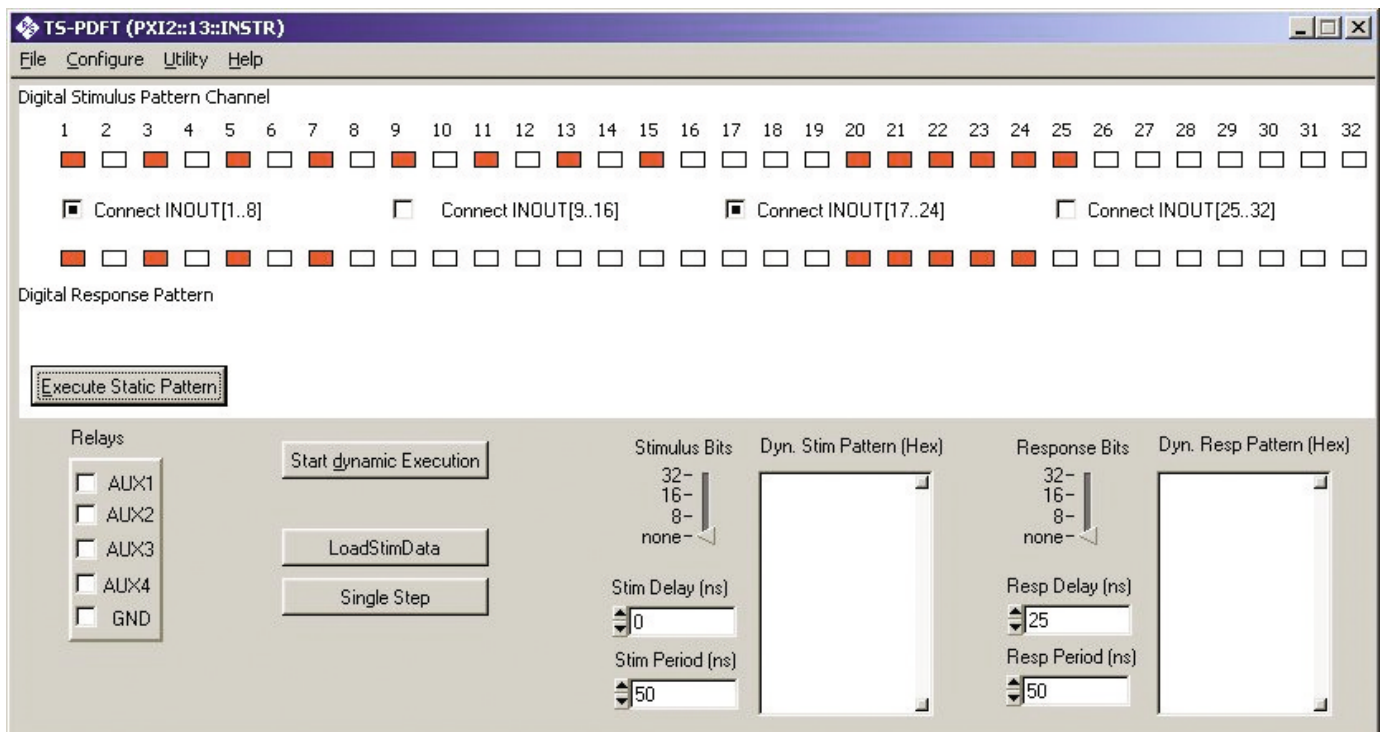
Specifications

Specifications		
Application in R&S®TSVP platform	R&S®CompactTSVP	1 slot required
Interface		
Control bus		CompactPCI/PXI
DUT connector (front)		DIN 41612, 96 pins
Rear I/O connector		CompactPCI, 110 pins
Data input channels		
Channels		32, in 4 groups of 8 bit
Input modes [1]		hysteresis, comparator
Input level	clamping if outside range	–5 V to +12 V
Input thresholds [1]	two programmable thresholds	0 V to +9.5 V at 12-bits resolution
Input resistance		1 MΩ
Realtime acquisition	sample rate	0.01 Hz to 20 MHz with 25 ns resolution
	trigger delay	0 s to 100 s with 25 ns resolution
	data buffer depth/width (programmable)	131071 sample at 8 bits (IN 1 to 8)
		65535 sample at 16 bits (IN 1 to 16)
		32768 sample at 32 bits (IN 1 to 32)
Protection	overvoltage protection	±42 V (max. 60 V < 30)
Data output channels		
Channels		32, in 4 groups of 8 bits
Output modes		TTL, analog, tristate
TTL output mode [1]	output voltage	V_{OH} = +3.3 V (max.)
		V_{OH} = +2.5 V at 20 mA (typ.)
		V_{OL} = +0.8 V at 20 mA (typ.)
	output current	80 mA (max.)
Analog output mode [1]	output voltage	–3 V to 10 V
	output current	150 mA per channel (max.), 10 mA to 700 mA per group [1]
	output resolution	12-bit
Tristate control output mode	output voltage	none
Output resistance		39 Ω (typ.)
Realtime stimulation [1]	sample rate	0.01 Hz to 20 MHz at 25 ns resolution
	trigger delay	100 ns to 100 s at 25 ns resolution
	data buffer depth/width (programmable)	131071 sample at 8 bits (OUT 1 to 8)
		65535 sample at 16 bits (OUT 1 to 16)
		32768 sample at 32 bits (OUT 1 to 32)
	tristate control	programmable, per sample
Implementation of bidirectional data buses		portwise connection of data output with data input channels via on-board analog switches
Protection	short-circuit	reverse voltage up to ±42 V at 150 mA
Power output channels		
Channels		4, open drain
Maximum switching voltage		+45 V
Maximum switching current		1 A per channel
Pulse width modulation (PWM)		1 Hz to 40 kHz at 0% to 100% duty cycle
Protection		short-circuit, overvoltage, overtemperature
Relay channels		
Channels		4, SPST, floating
		1, SPST, to ground
Maximum switching voltage	DC/AC	60 V/42 V (RMS)
Maximum switching current	DC/AC	1.5 A/1.5 A (RMS)
Maximum switching power	DC/AC	100 W/100 VA

Specifications

Communications interfaces

CAN interface	channels	1 (microprocessor, full CAN) CAN 2.0B active, 11/29-bit identifier
	modes	low-speed, fault-tolerant (ISO 11519-2) up to 125 kBd, transceiver TJA1054 high-speed (ISO 11898) up to 1 MBd, transceiver PCA82C251
	termination	programmable
	TX objects	4, software-FIFO-buffered
	RX objects	11, programmable filters, software-FIFO-buffered
	cyclic TX messages	2, independent frame bursts, software-FIFO-buffered, programmable cycle time
Asynchronous serial interface	channels	1 (microprocessor, UART)
	modes	RS-232, K bus, TTL (uses XTI and XTO)
	transfer rates	110 bit/s to 115 bit/s
	data formats	1 start bits
		7 data bits with even/odd parity
		8 data bits with/without even/odd parity
		9 data bits
		1 or 2 stop bits
SPI interface	channels	emulation of bus master via data channels
		used outputs: 3 (CLK, MOSI, CS)
		used inputs: 1 (MISO)
	modes	4
	transfer rate	100 bit/s to 300 kbit/s
	data formats	1 bit to 32 bit
I²C interface	channels	emulation of bus master via data channels [2]
	modes	outputs used: 2 (I²C_SCL, I²C_SDA)
		inputs used: 2 (I²C_SCL, I²C_SDA)
		7-bit and 10-bit addressing
	transfer rate	50 bit/s to 300 kbit/s

Pattern comparator

Comparison		32-bit data input channels with 32-bit reference pattern
		32-bit comparison enable mask
Application		
Frequency measurement [3]	maximum input frequency	12.5 MHz at 50 % duty cycle
	minimum pulse width	40 ns
	frequency resolution	25 ns
	measurement time	100 s to 160 ns gate time or up to 65 534 comparator matches
	trigger	software trigger
Application		
Event counting [3]	minimum pattern duration	40 ns
	gate time	100 s to 160 ns
	event counts	up to 65 534
Application trigger generator	output to PXI trigger	XTO input to trigger units

Realtime control unit

Local microprocessor		ST10F269
		16-bit
		40 MHz
		2 Mbyte RAM

Synchronization

Trigger units		2, fully independent hardware trigger logic
	applications	programmable trigger generator
		generation of realtime stimulation clock
		generation of realtime acquisition clock
		frequency measurement

Specifications

Synchronization

Trigger unit characteristics [4]		2, fully independent hardware trigger logic
	input signals	1, local TTL trigger (XTI)
		8, PXI trigger bus
		1, pattern comparator
	reference pattern	10-bit, 3 states: high, low, don't care
	slope	positive / negative
	delay	40 ns to 100 s
	output signals	trigger received signal (25 ns pulse)
		trigger active signal (start of trigger until burst end)
		sample pulse (25 ns pulse for each sample)
Synchronization outputs	channels	1, local TTL trigger (XTO)
		8, PXI trigger bus
	signals [5]	output trigger unit 1 (IT1)
		output trigger unit 2 (IT2)
		output pattern comparator
		input signal (XTI)

General data

Power consumption		+3.3 V/0.5 A, +5 V/1.6 A, +12 V/0.4 to 2.4 A, –12 V/0.1 A
Environmental conditions		
Temperature	operating temperature range	+5 °C to +40 °C
	storage temperature range	–10 °C to +60 °C
Damp heat		+40 °C, 80 % rel. humidity, steady state, in line with EN 60068-2-30
Mechanical resistance		
Vibration	sinusoidal	5 Hz to 55 Hz, 0.15 mm amplitude const., 55 Hz to 150 Hz, 0.5 g const., in line with EN 60068-2-6
	random	10 Hz to 300 Hz, acceleration 1.2 g (RMS), in line with EN 60068-2-64
Shock		40 g shock spectrum, in line with MIL-STD-810E, method 516.4, procedure I
Product conformity		
Electromagnetic compatibility	EU: in line with EMC Directive 2004/108/EC	applied harmonized standards: EN 61326-1 (industrial environment), EN 61326-2-1, EN 55011 (class A), EN 61000-3-2, EN 61000-3-3
Electrical safety	EU: in line with Low Voltage Directive 2006/95/EC	applied harmonized standard: EN 61010-1
Dimensions	W × H × D	316 mm × 174 mm × 20 mm (12.4 in × 6.8 in × 0.8 in)
Weight	R&S®TS-PSU power module	0.8 kg (1.76 lb)
	R&S®TS-PSU RIO module	0.12 kg (0.27 lb)
	R&S®TS-PSU AC/DC converter	1.2 kg (2.65 lb)

[1] Programmable per group.
[2] External diodes and pull-up resistors required.
[3] Uses one trigger unit.
[4] Programmable per trigger unit.
[5] Selectable per synchronization channel.

Ordering information

Designation	Type	Order No.
Digital Functional Test Module	R&S®TS-PDFT	1143.0080.02
R&S®CompactTSVP Test and Measurement Chassis	R&S®TS-PCA3	1152.2518.02

Service that adds value

- Worldwide
- Local and personalized
- Customized and flexible
- Uncompromising quality
- Long-term dependability

About Rohde & Schwarz

Rohde & Schwarz is an independent group of companies specializing in electronics. It is a leading supplier of solutions in the fields of test and measurement, broadcasting, radiomonitoring and radiolocation, as well as secure communications. Established more than 75 years ago, Rohde & Schwarz has a global presence and a dedicated service network in over 70 countries. Company headquarters are in Munich, Germany.

Environmental commitment

- Energy-efficient products
- Continuous improvement in environmental sustainability
- ISO 14001-certified environmental management system

Certified Quality System
ISO 9001

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