

R&S® TS-PI02 ANALOG AND DIGITAL I/O MODULE

For mixed-signal DUT testing



Product Brochure
Version 03.00

ROHDE & SCHWARZ

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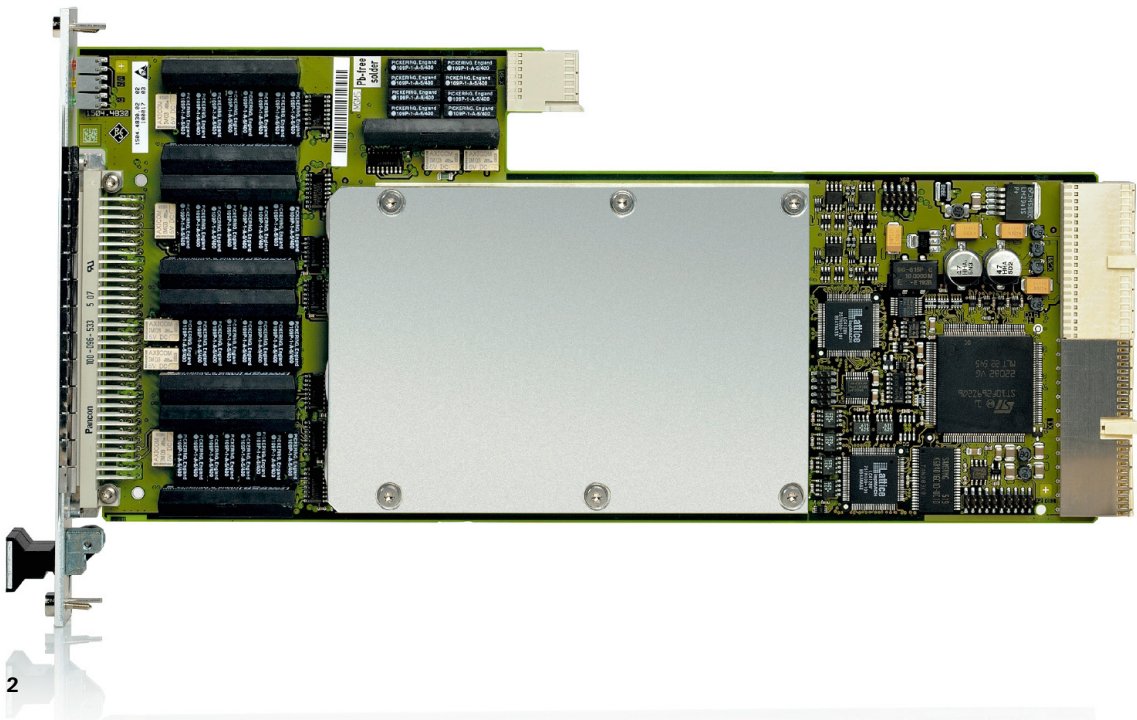


AT A GLANCE

The R&S®TS-PI02 analog and digital I/O module is a 16-channel stimulus and a 16-channel parametric measurement unit for versatile DUT testing. It is part of the R&S®TSVP modular test and measurement platform and makes full use of the common analog measurement bus and the standardized isolated frontend technology. The required floating R&S®TS-PDC rear I/O DC supply module is included in the R&S®TS-PI02.

Key facts

- ▶ 16-channel analog and digital signal acquisition
- ▶ High measurement resolution of 24 bit for level ranges up to ± 27 V
- ▶ Sampling rate of up to 5 ksample/s for inputs
- ▶ Arbitrary waveform and digital output pattern stored by two 5000 sample onboard memory sections
- ▶ Autocorrection feature for all input and output channels
- ▶ Analog measurement bus access to eight bus lines
- ▶ Trigger options via PXI trigger bus and trigger lines via front connector
- ▶ 16-channel analog and digital stimulus outputs, offering static and dynamic signal outputs
- ▶ 14 bit resolution and high output level of up to ± 27 V
- ▶ Update rate of up to 5 ksample/s for outputs
- ▶ Squarewave output and programmable duty cycle for digital stimulation
- ▶ 4 output channels providing up to 100 mA of applied current, including programmable limitation
- ▶ 12 output channels for driving up to 15 mA output currents
- ▶ Analog and digital input data stored by two 5000 sample onboard memory sections
- ▶ Versatile signal switching and DUT interconnection
- ▶ Stimulus and acquisition channels providing floating operation
- ▶ Self-test of all inputs, outputs and relays via analog measurement bus and R&S®TS-PSAM
- ▶ Soft front panel support for immediate deployment
- ▶ LabWindows/CVI device driver support
- ▶ Generic test software library (GTSL) in DLL format



PRODUCT INTRODUCTION

The R&S®TS-PIO2 is a CAN bus-controlled module, which takes up only one slot inside an R&S®TSVP chassis.

The module can be used as a flexible stimulus and parametric measurement unit for a wide range of applications in research and development of electronic circuitry.

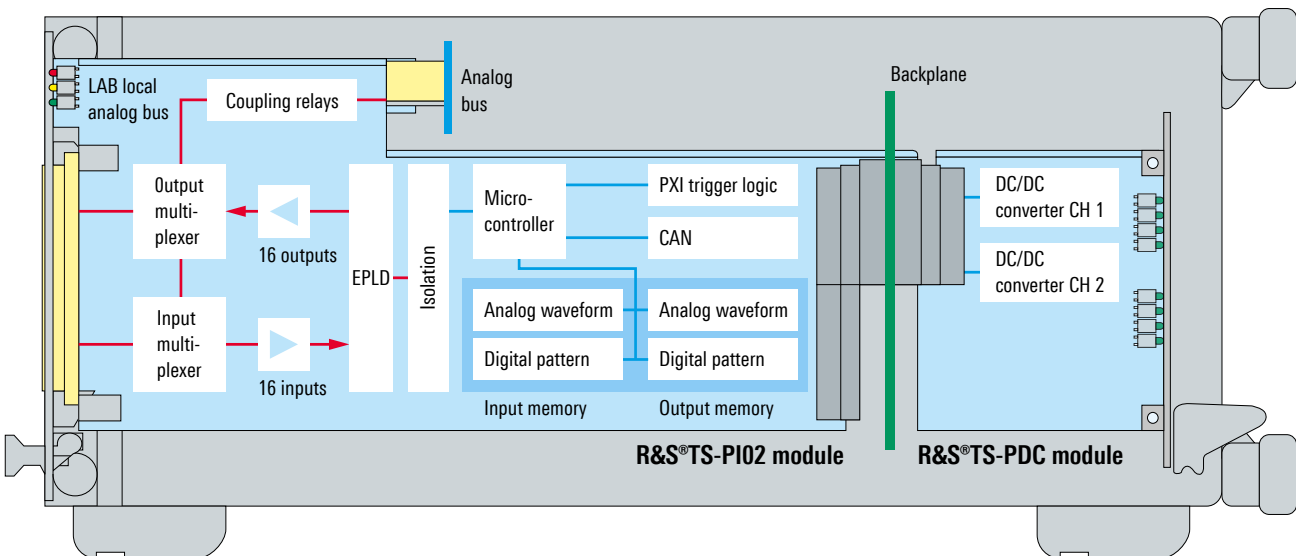
TYPICAL APPLICATIONS

Typical application scenarios are the testing of analog, digital and mixed signal assemblies in design and production, such as the following:

- ▶ Simultaneous analog input stimulus paradigms and parametric measurements
- ▶ Multiplexed measurements or single-channel dynamic data acquisition
- ▶ Measuring of load currents via onboard shunt resistors, or digital level comparisons on multiple channels using the module's extended channels
- ▶ Evaluation of current loop sensor outputs and control outputs or implementation of sensor simulation by providing programmable current values

The major benefit of the module's flexibility is that the user can deploy a single module to cover many measurement functionalities required for testing commercial and industrial electronic appliances.

R&S®TS-PIO2, including the R&S®TS-PDC DC supply module, in an R&S®TSVP chassis

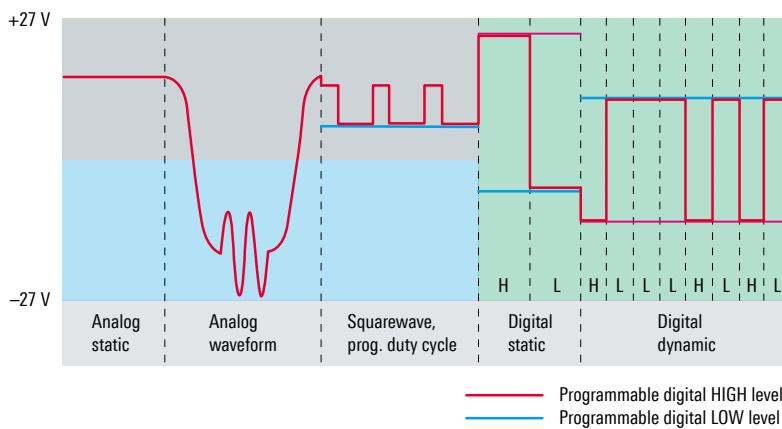


OUTPUT FUNCTIONALITY

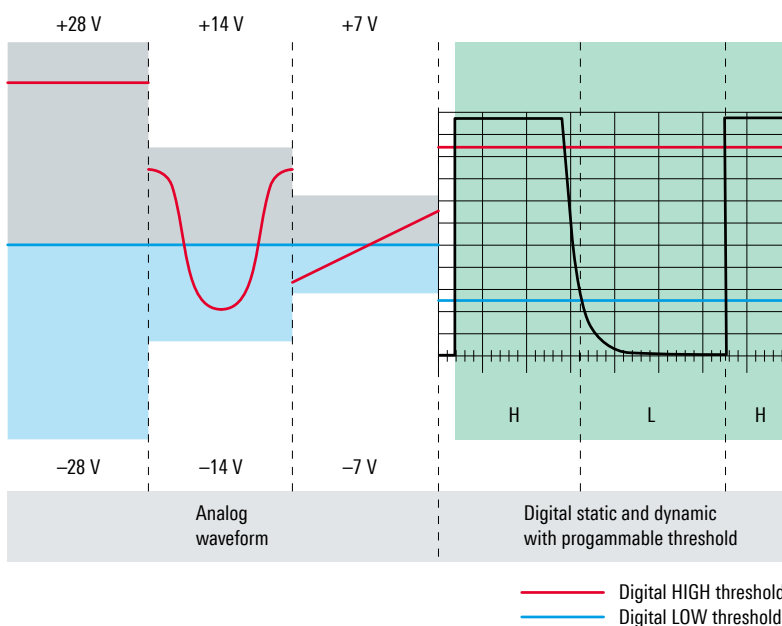
- ▶ The 16 output channels offer programmable voltages up to ± 27 V. The channels are organized in groups of four outputs. Each group provides three standard outputs with 15 mA sourcing and one extended output with programmable current limit up to 100 mA
- ▶ Output modes can be selected for each channel: analog, arbitrary waveform, digital static, digital dynamic and squarewave with variable duty cycle
- ▶ Dynamic signal stimulation can be performed with an update rate up to 5 ksample/s
- ▶ Easy programming of random sweep functions using up to 5000 sample stored in onboard memory

INPUT FUNCTIONALITY

- ▶ The digital logical HIGH level can be programmed individually for each output channel; the logical LOW level is set in groups of four channels
- ▶ The 16 input channels offer voltage measurements in three ranges (± 28 V, ± 14 V, ± 7 V) performed by an A/D converter with a nominal resolution of 24 bit
- ▶ In digital mode, each input is compared to two programmable thresholds to build a 16 bit digital input interface with programmable hysteresis and a data rate of maximum 5 ksample/s; thresholds can be programmed in four groups of four inputs
- ▶ Differential measurements are performed using a pair of inputs for true differential signal acquisition



Examples of output signal functionality for static and dynamic operation, using various voltage output levels



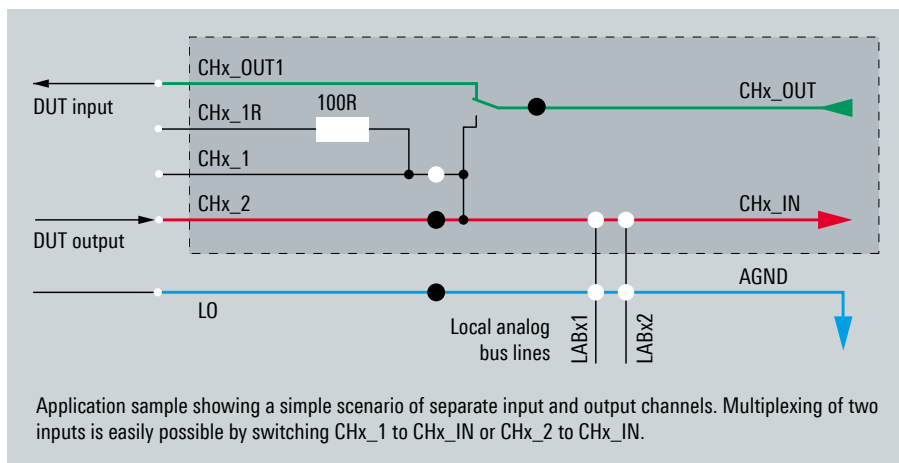
Examples of input signal acquisition functionality showing different input ranges for analog measurements and programmable digital threshold values

FLEXIBLE DUT ADAPTATION

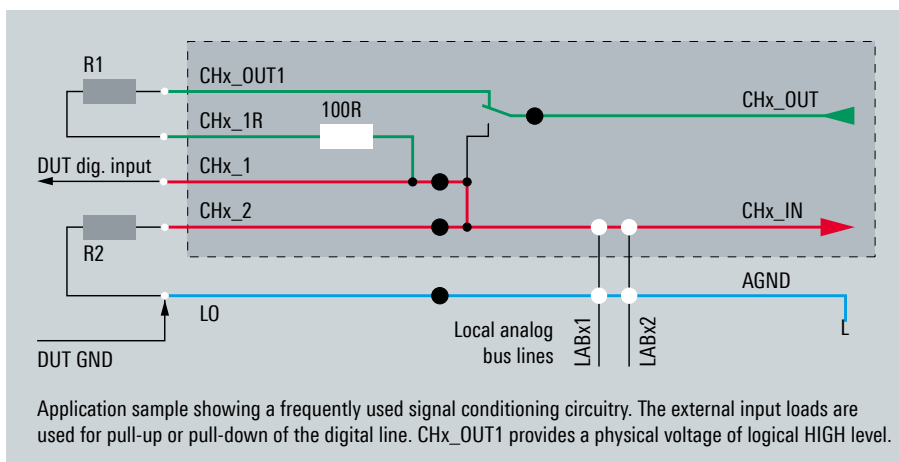
- ▶ Integrated 3:1 relay multiplexer for each set of input/output channels. All channels can be disconnected from the front connector. Each I/O channel has one precision load resistor, which can be used for current monitoring, for example
- ▶ Access of each set of input/output channels to the analog measurement bus of the R&S®TSVP platform
- ▶ Floating ground level with a maximum operating voltage of 120 V DC versus system ground or chassis ground
- ▶ Sampling of analog or digital data initiated by external triggering either by PXI trigger lines or by front connector inputs
- ▶ Onboard autocorrection of all input and output channels to compensate for measurement drift and to achieve high long-term accuracy

For many functional test applications, the user has to customize the test equipment to enhance signal routing flexibility. The programmable set of switches attached to each of the 16 sets of inputs and outputs of the R&S®TS-PIO2 module can handle most of these requirements.

Even scenarios including various signal conditioning extensions in the DUT adapter can be supported by the flexible DUT interfacing circuitry of the R&S®TS-PIO2 to implement very efficient mixed signal adaptations.



For simultaneous stimulus and measurement



For digital input channels of DUTs

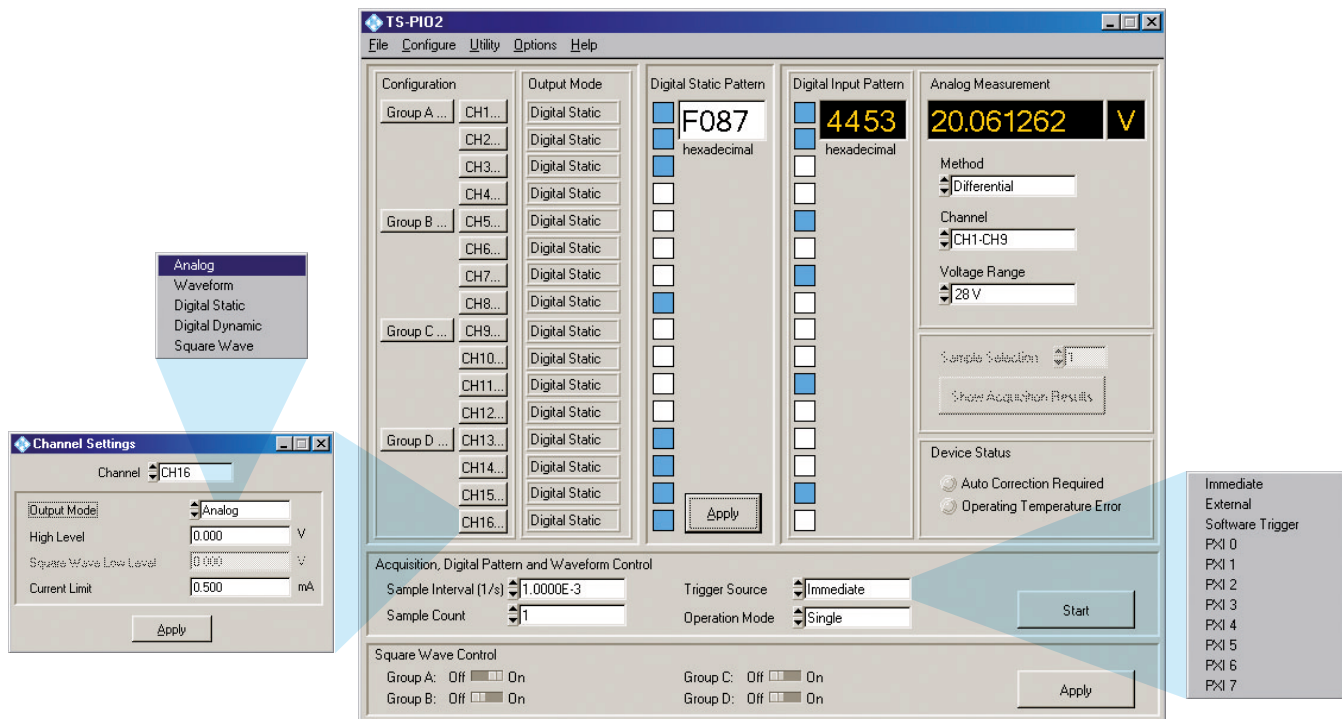
SOFTWARE SUPPORT

The R&S®TS-PIO2 module is supplied with an IVI-C compliant LabWindows/CVI driver, which offers function panels and online help as a common feature. Alternatively, all switching functions can be called via the GTSL switch manager.

Manual operation to evaluate test scenarios and verify DUT adaptation is provided by a sophisticated soft front panel offering access to the module's full scope of functionalities.

The R&S®TS-PIO2 features are completely described in the GTSL software framework and delivered to the user as a DLL file to support the use in various programming environments. The dynamic acquisition functions are controlled via the powerful onboard microprocessor and therefore do not compromise the efficient, no-polling execution to and from local waveform and pattern memory sections.

Soft front panel for interactive operation



SECURITY THROUGH SELF-TEST AND DIAGNOSTICS

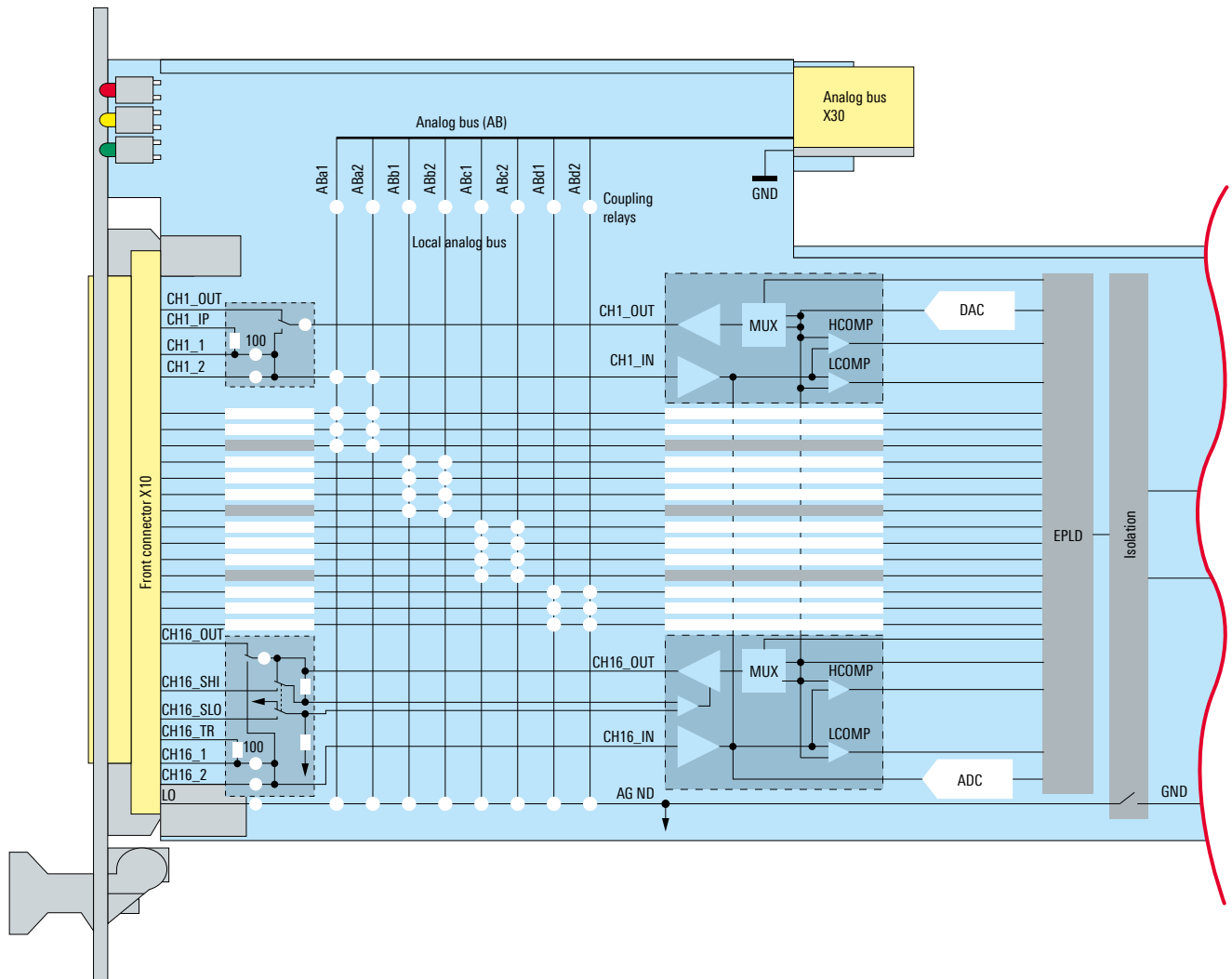
The built-in self-test capability of the module ranges from fast diagnostics to the complete, automated evaluation of output voltages and current limitation, measurement inputs, trigger and switching paths.

This extensive module self-test is provided via the instrument's analog measurement bus in conjunction with the R&S®TS-PSAM source and measurement module.

Diagnostic LEDs on the module front panel speed up system integration and indicate proper operation at a glance.

System designer's functional block diagram of the mixed signal frontend

The 16 combined I/O channels are shown as simplified box symbols or inflated circuits. An example of a standard channel is shown for CH1 as an inflated circuit with input and output signal routing. The four extended channels are CH4, CH8, CH12 and CH16. Therefore, the inflated circuit of CH16 shows the extensions of these channels, including sensing inputs (CHx_SHI and CHx_SLO).



SPECIFICATIONS

Specifications		
Application in R&S®TSVP platform	CAN bus controlled module	1 slot required, front and rear
Interface		
Control bus		CAN 2.0b (1 Mbit/s)
DUT connector (front)		DIN41612, 96 pins
Rear I/O connector		CompactPCI connector J2, 110 pins
Accuracy		
Uncertainties of specified values apply under the following conditions:		
Autocorrection	The module's firmware and driver software monitor temperature and time and request execution of the module's autocorrection feature after 24 h or a temperature drift > ±5°C.	
Condition of specified accuracy	The specified accuracy is applicable during a valid autocorrection period and in an ambient temperature range from +18°C to +28°C.	
Additional error due to temperature coefficient	±(0.1 × uncertainty)/°C for a valid autocorrection period and in ambient temperature ranges from +5°C to +18°C and +28°C to +40°C	
Warm-up time	1 h	
Output stage		
Output channels		16
Group	standard channels	extended channels
A	1, 2, 3	4
B	5, 6, 7	8
C	9, 10, 11	12
D	13, 14, 15	16
Output current per module		max. 300 mA, summation of all outputs
Standard output channels		12
	standard current	max. 15 mA, per channel
	voltage range	±27 V
	voltage resolution	14 bit
	voltage uncertainty (load > 100 kΩ)	±(0.1% + 27 mV), with autocorrection; ±(0.1% + 40 mV), with fast autocorrection; additional error of 150 µV per mA of current in common AGND path
	rise/fall time	typ. 4.5 µs, (5% to 95% of -27 V to +27 V transition)
Extended output channels		4
	extended output current	max. 100 mA per channel
	extended voltage range	±27 V
	voltage resolution	14 bit
	voltage uncertainty (external sensing)	±(0.05% + 13.5 mV) with autocorrection; ±(0.05% + 20 mV) with fast autocorrection
	current limit	0.5 mA to 100 mA, programmable
	current resolution	14 bit
	current uncertainty	±(0.3% + 300 µA + common mode error), common mode error = 20 µA/V of output voltage
	rise/fall time	typ. 36 µs (5% to 95% of -27 V to +27 V transition)

Specifications

Output modes¹⁾

Analog (static)	channels	up to 16 in parallel
Arbitrary waveform	channels	1 single channel of 16
	output update rate	max. 5 ksample/s
Digital (static, dynamic)	channels	up to 16 in parallel
	output update rate	max. 5 ksample/s
	logical HIGH level	programmable per channel
	logical LOW level	programmable for each group of 4 channels
Squarewave, one common setting for each group of 4 channels	uncertainty (load >100 kΩ)	±(0.2% + 54 mV) with autocorrection; ±(0.2% + 81 mV) with fast autocorrection
	stimulation	to be enabled for each channel
	duty cycle	1% to 99%
	duty cycle resolution	1%
Channels	frequency	resolution
Standard	10 Hz to 50 kHz	1 Hz
Extended	10 Hz to 7 kHz	1 Hz

Input stage

Channels		16
Protection		up to ±60 V
Input resistance		> 1 MΩ
Voltage	measurement method	single-ended or differential
	ranges	±28 V, ±14 V, ±7 V
	converter resolution	24 bit

Measurement uncertainty ±(% of value + absolute value)²⁾

Sampling interval	3 dB input bandwidth	Single sample, with fast autocorrection			Single sample, with autocorrection		
		7 V range	14 V range	28 V range	7 V range	14 V range	28 V range
10 ms ≤ t ≤ 1 s	50 Hz	0.01% + 1.5 mV	0.01% + 3.4 mV	0.01% + 6.8 mV	0.007% + 1.0 mV	0.01% + 2.4 mV	0.01% + 4.8 mV
1 ms ≤ t < 10 ms	550 Hz	0.01% + 3.4 mV	0.01% + 6.9 mV	0.01% + 13.8 mV	0.01% + 1.6 mV	0.01% + 3.2 mV	0.01% + 6.4 mV
200 μs ≤ t < 1 ms	7.1 kHz	0.05% + 16.1 mV	0.05% + 32.2 mV	0.05% + 64.4 mV	0.05% + 7.7 mV	0.05% + 15.4 mV	0.05% + 30.8 mV
Digital comparison		programmable hysteresis, 2 comparators per channel					
		threshold HIGH			one level for each group of 4 channels		
		threshold LOW			one level for each group of 4 channels		
		resolution			14 bit		
		uncertainty			±(0.4% + 100 mV) with autocorrection; ±(0.4% + 150 mV) with fast autocorrection		
Measurement capability		analog channels			1 single channel of 16		
		digital channels			up to 16 in parallel		
		max. sample rate			5 ksample/s		
Load resistor, 1 per channel, between CHx_1 and CHx_1R		value			100 Ω, 0.1%, TK25, 125 mW		

¹⁾ For applicable range of frequency and duty cycle setting, please consider rise and fall times of output channels.

²⁾ All uncertainties are valid for static operation without loads. Voltage drop on signal paths due to output currents can be compensated by differential measurements. For differential measurements, an additional error factor of (1.3 × measurement uncertainty for a single channel) has to be applied.

Specifications		
Miscellaneous		
Trigger lines		8 PXI, 1 XTI, 1 XTO
Autocorrection, with precision onboard reference, no disconnection of DUT required	execution time	typ. 2 s for fast autocorrection; typ. 53 s for autocorrection
Isolated DC/DC supply		R&S®TS-PDC, included in R&S®TS-PIO2 product package
Working voltage		max. 120 V DC referenced to ground potential
Analog measurement bus and relay multiplexer		
Coupling relays, 8, local analog bus (on module) to global analog bus (in instrument chassis), relay multiplexer	switching voltage	120 V DC, 50 V AC (RMS)
	switching current	1.0 A
	switching power	10 W/10 VA (RMS)
General data		
Power consumption		max. 7.0 A at 5 V, 1 A at 3.3 V including R&S®TS-PDC
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 60068-2-78
Altitude	operating	up to 2000 m
Mechanical resistance		
Vibration	sinusoidal	in line with EN 60068-2-6, frequency range: 5 Hz to 55 Hz, displacement: 0.3 mm (peak-to-peak) (1.8 g at 55 Hz), frequency range: 55 Hz to 150 Hz, acceleration: 0.5 g constant
	random	in line with EN 60068-2-64, 8 Hz to 500 Hz, acceleration 1.2 g (RMS); 5 min/axis
Shock		shock test in line with MIL-STD-810G, method 516.6, procedure I: shock response spectrum ramp 6 dB/octave up to 45 Hz, 45 Hz to 2000 Hz: max. 40 g
Product conformity		
Electromagnetic compatibility	EU: in line with EMC Directive 2014/30/EC	applied harmonized standards: ▶ EN 61326-1 (industrial environment) ▶ EN 61326-2-1 ▶ EN 55011 Group 1, Class A
Electrical safety	EU: in line with Low Voltage Directive 2014/35/EC	applied harmonized standard: EN 61010-1
	USA	applied standard: UL 61010
	Canada	applied standard: CSA-C22.2 No. 61010-1
RoHS	EU: in line with the restriction of the use of hazardous substances in electrical and electronic equipment 2011/65/EU	compliant; applied harmonized standard: EN IEC 63000
Dimensions (W × H × D)	R&S®TS-PIO2 main module	316 mm × 174 mm × 20 mm (12.44 in × 6.85 in × 0.79 in)
	R&S®TS-PDC isolated supply module	140 mm × 130 mm × 20 mm (5.5 in × 5.1 in × 0.79 in)
Weight	R&S®TS-PIO2 main module	0.5 kg (1.1 lb)
	R&S®TS-PIO2 main module including R&S®TS-PDC isolated supply module	0.64 kg (1.41 lb)
Calibration interval	recommended for highest accuracy	12 months

ORDERING INFORMATION

Designation	Type	Order No.
Analog/digital I/O module ¹⁾	R&S®TS-PIO2	1504.4801.02

¹⁾ Including R&S®TS-PDC isolated supply module.

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