

PXI
CompactPCI
CAN
Industrial Platform
ICT
Functional Test

Version
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R&S®TS-PIO2 Analog and Digital I/O Module

16-channel stimulus and parametric measurement unit for mixed-signal DUT testing

- ◆ 16-channel analog and digital signal acquisition
- ◆ High measurement resolution of 24 bits for level ranges up to ± 27 V
- ◆ Sampling rate of up to 5 ksamples/s for inputs
- ◆ Arbitrary waveform and digital output pattern stored by two 5000-sample on-board memory sections
- ◆ Autocorrection feature for all input and output channels
- ◆ Analog measurement bus access to 8 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
- ◆ 16-bit resolution and high output level of up to ± 27 V
- ◆ Update rate of up to 5 ksamples/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 on-board memory sections
- ◆ Versatile signal switching and DUT interconnection
- ◆ Stimulus and acquisition channels providing floating operation
- ◆ Selftest 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



ROHDE & SCHWARZ



Product introduction

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 front-end technology. The required floating R&S®TS-PDC rear I/O DC supply module is included in the R&S®TS-PI02.

The unit can be used for the R&S®TS-PCA3 (R&S® CompactTSVP) as well as for the R&S®TS-PWA3 (R&S® PowerTSVP).

The R&S®TS-PI02 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.

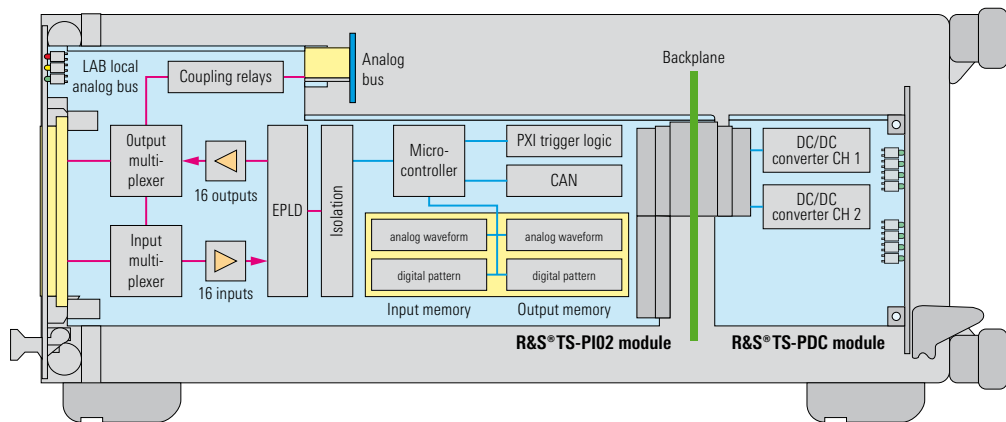
Typical application scenarios are the testing of analog, digital, and mixed signal assemblies in design and production, such as the following:

- ◆ Simultaneous analog input stimulus paradigms and parametric measurements
- ◆ Multiplexed measurements or single-channel dynamic data acquisition
- ◆ Applying of loads to digital outputs, measuring of load currents via on-board shunt resistors, or digital level

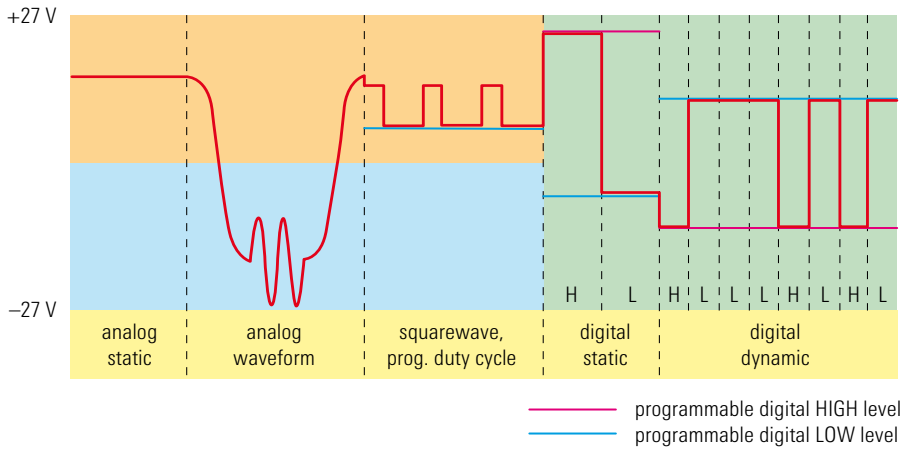
comparisons on multiple channels using the module's extended channels

- ◆ 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.



Functional block diagram of the R&S®TS-PI02, including the R&S®TS-PDC DC supply module, in an R&S® PowerTSVP chassis.



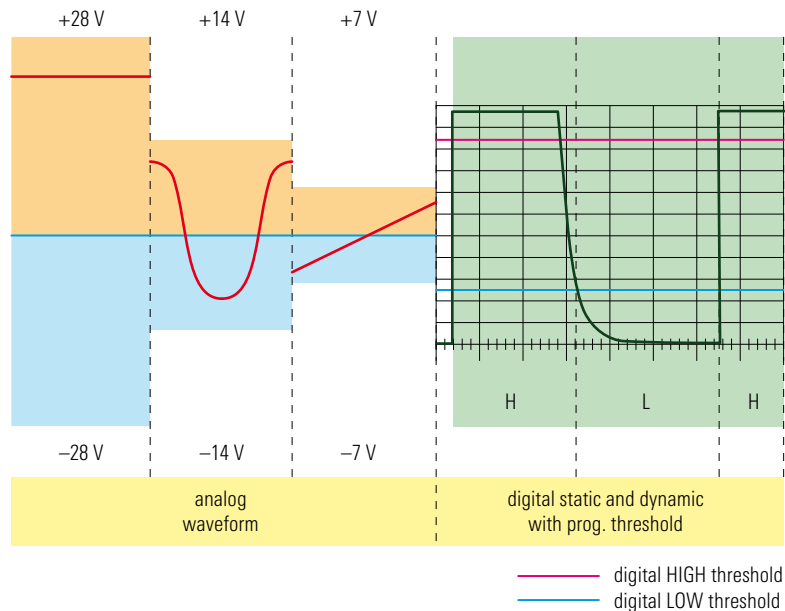
Examples of output signal functionality for static and dynamic operation, using various voltage output levels.

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 ksamples/s
- ◆ Easy programming of random sweep functions using up to 5000 samples stored in on-board memory
- ◆ The digital logical HIGH level can be programmed individually for each output channel; the logical LOW level is set in groups of four channels

Input functionality

- ◆ 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 bits
- ◆ In digital mode, each input is compared to two programmable thresholds to build a 16-bit digital input interface with programmable hysteresis



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

and a data rate of max. 5 ksamples/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
- ◆ 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 125 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
- ◆ On-board autocorrection of all input and output channels to compensate for measurement drift and to achieve high long-term accuracy

Flexible DUT adaptation

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

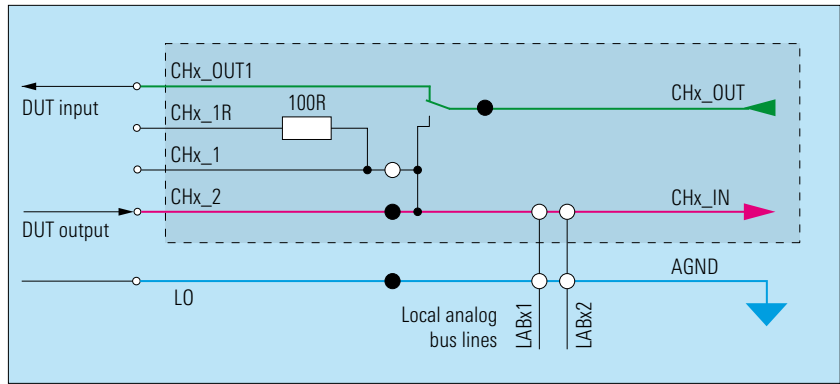
Even scenarios including various signal conditioning extensions in the DUT adapter can be supported by the flexible DUT interfacing circuitry of the R&S®TS-PIO2 to implement very efficient mixed signal adaptations.

Software support

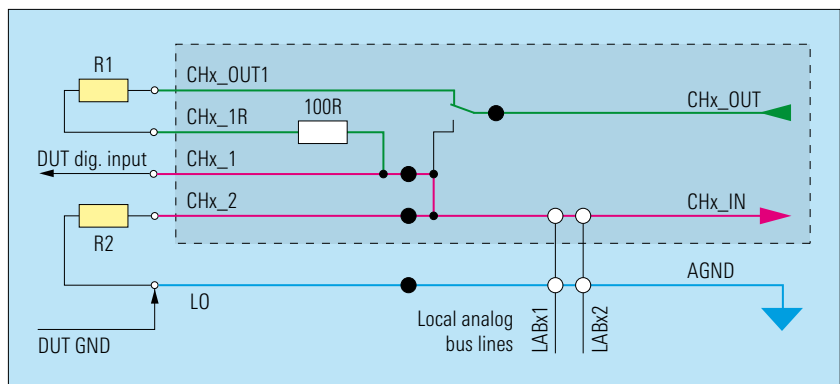
The R&S®TS-PIO2 module is supplied with an IVI-C compliant LabWindows/CVI driver, which offers function panels and online help as a common feature. Alternatively, all switching functions can be called via the GTSL switch manager (generic test software library).

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 on-board microprocessor and therefore do not compromise the efficient, no-polling execution to and from local waveform and pattern memory sections.



Application sample showing a simple scenario of separate input and output channels for simultaneous stimulus and measurement. Multiplexing of two inputs is easily possible by switching CHx_1 or CHx_2 to CHx_IN.



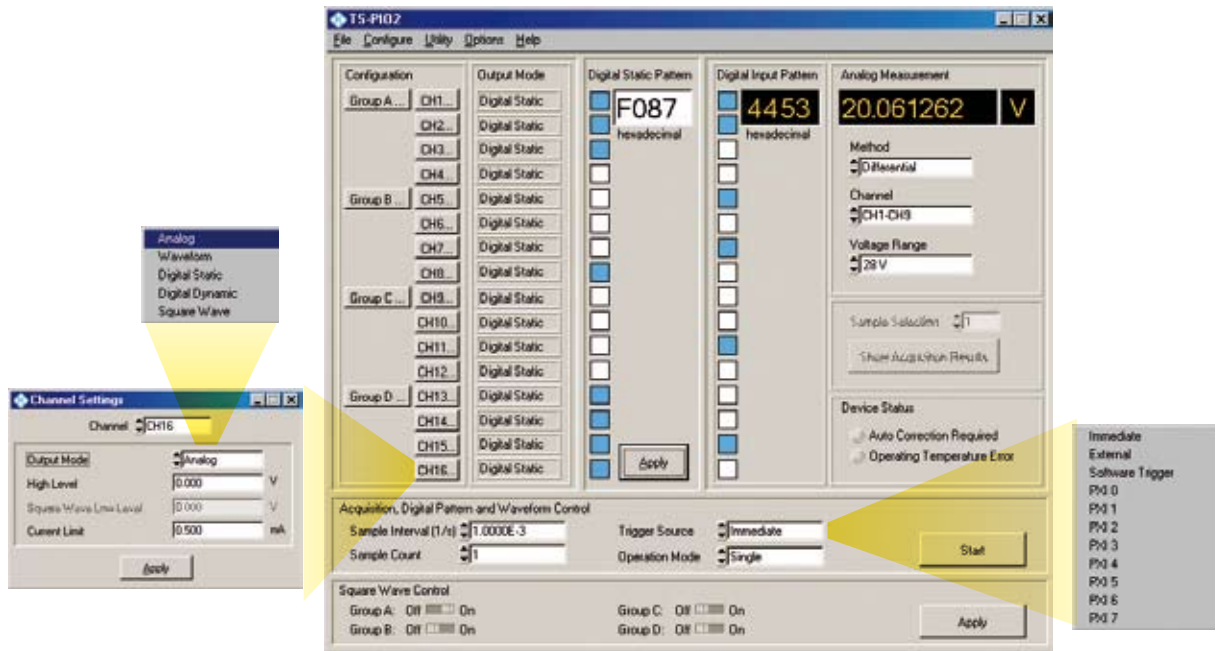
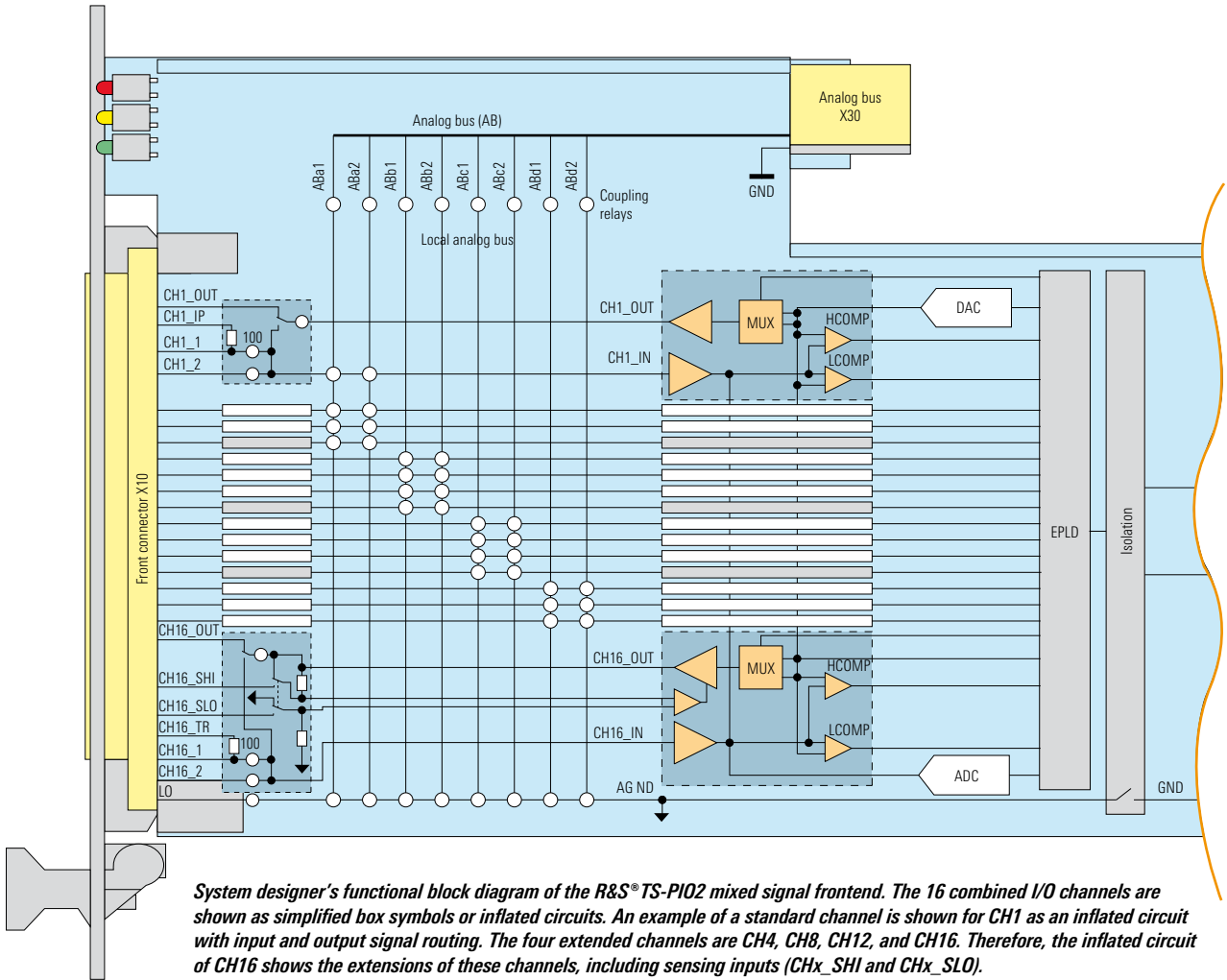
Application sample showing a frequently used signal conditioning circuitry for digital input channels of DUTs. The external input loads are used for pull-up or pull-down of the digital line. CHx_OUT1 provides a physical voltage of logical HIGH level.

Security through selftest and diagnostics

The built-in selftest 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 selftest 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.



Specifications

Application in R&S®TSVP platform		
R&S®CompactTSVP	1 slot required, front and rear	
R&S®PowerTSVP	1 slot required, front and rear	
Interface		
Control bus	CAN 2.0b (1 Mbit/s)	
DUT connector (front)	DIN 41612, 96 pins	
Rear I/O connector	CompactPCI connector J2, 110 pins	
Accuracy		
Uncertainties of specified values apply under the following conditions:		
Recommended calibration interval	1 year	
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 $> \pm 5\text{ }^{\circ}\text{C}$	
Condition of specified accuracy	The specified accuracy is applicable during a valid autocorrection period and in an ambient temperature range of $+18\text{ }^{\circ}\text{C}$ to $+28\text{ }^{\circ}\text{C}$	
Additional error due to temperature coefficient	$\pm(0.1 \times \text{uncertainty})/^{\circ}\text{C}$ for a valid autocorrection period and in ambient temperature ranges from $+5\text{ }^{\circ}\text{C}$ to $+18\text{ }^{\circ}\text{C}$ and $+28\text{ }^{\circ}\text{C}$ to $+40\text{ }^{\circ}\text{C}$	
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	$\pm 27\text{ V}$	
Voltage resolution	14 bits	
Voltage uncertainty (load $> 100\text{ k}\Omega$)	$\pm(0.1\% + 27\text{ mV})$, with autocorrection $\pm(0.1\% + 40\text{ mV})$, with fast autocorrection additional error of $150\text{ }\mu\text{V}$ per mA of current in common AGND path	
Rise time/fall time	typ. $4.5\text{ }\mu\text{s}$, (5% to 95% of -27 V to $+27\text{ V}$ transition)	

Extended output channels	4	
Extended output current	max. 100 mA per channel	
Extended voltage range	$\pm 27\text{ V}$	
Voltage resolution	14 bits	
Voltage uncertainty (ext. sensing)	$\pm(0.05\% + 13.5\text{ mV})$ with autocorrection $\pm(0.05\% + 20\text{ mV})$ with fast autocorrection	
Current limit	0.5 mA to 100 mA, programmable	
Current resolution	14 bits	
Current uncertainty	$\pm(0.3\% + 300\text{ }\mu\text{A} + \text{common mode error})$, common mode error = $20\text{ }\mu\text{A}$ per V of output voltage	
Rise time/fall time	typ. $36\text{ }\mu\text{s}$ (5% to 95% of -27 V to $+27\text{ V}$ transition)	
Output modes		
Analog (static)		
Channels	up to 16 in parallel	
Arbitrary waveform		
Channels	1 single channel of 16	
Output update rate	max. 5 ksamples/s	
Digital (static, dynamic)		
Channels	up to 16 in parallel	
Output update rate	max. 5 ksamples/s	
Logical HIGH level	programmable per channel	
Logical LOW level	programmable for each group of 4 channels	
Uncertainty (load $> 100\text{ k}\Omega$)	$\pm(0.2\% + 54\text{ mV})$ with autocorrection $\pm(0.2\% + 81\text{ mV})$ with fast autocorrection	
Squarewave		
one common setting for each group of 4 channels		
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
For applicable range of frequency and duty cycle setting, please consider rise and fall times of output channels.		
Input stage		
Channels	16	
Protection	up to $\pm 60\text{ V}$	
Input resistance	$> 1\text{ M}\Omega$	
Voltage		
Measurement method	single-ended or differential	
Ranges	$\pm 28\text{ V}$, $\pm 14\text{ V}$, $\pm 7\text{ V}$	
Converter resolution	24 bits	

Measurement uncertainty		±(% of value + absolute value)					
		Single sample, with fast autocorrection			Single sample, with autocorrection		
Sampling interval	3 dB input bandwidth	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

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.

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 bits
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 ksamples/s
Load resistor	1 per channel, between CHx_1 and CHx_1R
Value	100 Ω, 0.1 %, TK25, 125 mW
Miscellaneous	
Trigger lines	8 PXI, 1 XTI, 1 XTO
Autocorrection	with precision on-board 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. 125 V DC referenced to ground potential
Analog measurement bus and relay multiplexer	
R&S®CompactTSVP analog measurement bus	8 lines
Coupling relays	8, local analog bus (on module) to global analog bus (in instrument chassis)
Switching voltage DC / rms	125 V/90 V
Switching current	1.0 A
Switching power DC / rms	10 W/10 VA
Relay multiplexer	
Output	1:4-pin relay multiplexer
Input	3:1-pin relay multiplexer

General data

Power consumption	max. 7.0 A at 5 V, 1 A at 3.3 V including R&S®TS-PDC
EMC compliance	in line with EMC directive 89/336/EEC and EMC standard EN 61326
Safety	CE, EN 61010 Part 1
Mechanical loading	
Vibration test, sinusoidal	5 Hz to 55 Hz: 2 g, MIL-T-28800D, class 5 55 Hz to 150 Hz: 0.5 g, MIL-T-28800D, class 5
Vibration test, random	10 Hz to 300 Hz, 1.2 g
Shock test	40 g, MIL-STD-810, classes 3 and 5
Temperature loading	
Operating temperature range	+5 °C to +40 °C
Permissible temperature range	0 °C to +50 °C
Storage temperature range	-40 °C to +70 °C
Humidity	+40 °C, 95 % relative humidity
Dimensions	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	0.6 kg (0.9 kg including R&S®TS-PDC), 1.3 lbs (2.0 lbs including R&S®TS-PDC)

Ordering information

Designation	Type	Order No.	Remark
Analog/Digital I/O Module	R&S®TS-PIO2	1504.4801.02	including R&S®TS-PDC isolated supply module
R&S®CompactTSVP Open Test Platform	R&S®TS-PCA3	1152.2518.02	
R&S®PowerTSVP Switching Application Chassis	R&S®TS-PWA3	1157.8043.02	



More information at
www.rohde-schwarz.com
(search term: TS-PI02)



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