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### Open Test Platform R&S®CompactTSVP

## Modular test equipment based on CompactPCI/PXI

The modular R&S®CompactTSVP open test platform provides special cost benefits for T&M applications in the development, production and servicing of telecommunications and automotive electronics.

The trend is towards economical platforms suitable for industry

There is a heightened interest in testing departments to configure the required functions in compact units as flexibly as possible so that future requirements can be covered without any need for large additional investments. Moreover, constantly reduced product development times call for powerful, easy-to-operate and standardized software components which can be integrated as reusable modules in a multitude of applications.

Customer requirements, particularly in the telecommunications and automotive electronics sector, emphasize power density and modularity, thus clearly pointing to platform-based T&M equip-

ment that is favourably priced and suitable for industry.

The new R&S®CompactTSVP open test platform from Rohde & Schwarz has been tailored to meet these requirements, offering special cost advantages for T&M applications in the development, production and servicing of telecommunications and automotive electronics. It provides users with a basic modular concept of T&M functionalities and communication interfaces for hardware and software.

The new product line is based on the CompactPCI / PXI and CAN standards already established on the market.

The introduction of the PXI (PCI eXtensions for Instrumentation) standard as

an extension of CompactPCI by the US company National Instruments led to a commonly acceptable path for the technical community to implement measurement functionalities based on an established standard at cost-efficient pricing, featuring well performing modular system components. More than 600 measurement and interface products are currently available for the PXI standard.

## Modular concept for development, production and servicing

The reason behind the development of the new test platform was to provide users with an extremely wide portfolio of T&M methods of modern test equipment. This was accomplished by consistently using open industrial standards such as CompactPCI/PXI and CAN. In addition to Rohde & Schwarz modules, other commercially available hardware components that support these standards can be integrated into the system without any modifications.

The measurement and switching modules are designed for flexible use in the function test of electronics modules. This test can be optionally expanded to a combination test by means of in-circuit testing of components. This is a unique capability based on the CompactPCI/PXI standard.

An enormous problem with conventional CompactPCI/PXI systems is the adaptation to the industrial environment and the DUTs. Even with functional tests, the number of signals to be measured and inputs requiring physical stimulation is constantly increasing. Voltages exceeding 100 V and currents up to 16 A often require DC-isolated measurement, stimulation or switching. The costs incurred for fixture cabling and signal conditioning are just as considerable as the test programming or test equipment itself.

The system concept chosen by Rohde & Schwarz eliminates the above-mentioned adaptation problems, thus setting a new standard in the field of modular test instruments.

## Test platform architecture

The R&S® CompactTSP base unit (product designation R&S®TS-PCA3) (FIG 1) includes a bus board with the industrial form of the PCI bus – the CompactPCI. The T&M expansions (trigger, synchronization clock) of the PXI standard are supported by 11 of the 14 available peripheral slots (FIG 2).

The CompactPCI standard 32-bit design with its rear transmission module (RTM) concept also makes it possible to route signals via the rear of the test platform without any additional cabling (slots 3 and 4). This is not possible with the PXI (64-bit) version because of the additional

address and data lines (slots 5 to 15). In practice, the rear cabling via RTMs proves to be of advantage whenever a 19" exchangeable fixture is projected on the front.

In the R&S® CompactTSP, the RTM concept is also used to install DC/DC converter modules that are required for DC-isolated T&M equipment. Since the T&M equipment and the power supply are spatially separated, the test components are not subjected to thermal influence, which in turn improves temperature stability. Moreover, the bit-serial CAN bus is available at slots 5 to 16. All relay-based switching modules are controlled via this internal communication bus.

When activating electromechanical relays, the extremely high data transmission rate of the PCI bus (up to 134 Mbyte/s) is less important when a small number of bits have to be trans-

**FIG 1** The new system platform includes the two base units, R&S®CompactTSP (FIG) and R&S®PowerTSP. Flexible configuration allows versatile applications in development, production and servicing.



mitted to control the switching path. The clear advantages of the CAN bus are the secured transmission protocol and the easy implementation of the interface on the switching modules. The lower transmission rate (1 Mbit/s) is compensated by means of local processors on the switching modules and command interface control. The measurement modules, on the other hand, use a register interface with the full performance of the bit-parallel PCI bus.

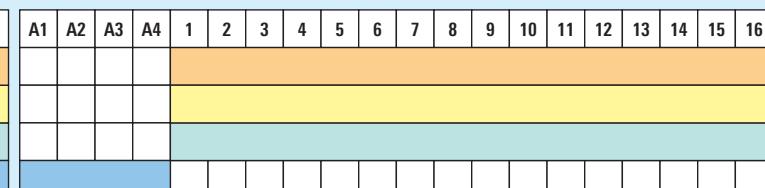
By means of the analog measurement bus (eight lines), signals with voltages of up to 125 V can be flexibly switched between the switching and measurement modules usually without signal conditioning, and rigid cabling can be avoided. It has been designed as a separate and spatially removed bus board and is available at all 16 slots. The special configuration ensures compatibility with standard CompactPCI/PXI modules and prevents interference from the control buses.

The power supply of the system is in accordance with the powerinterface standard (PICMG 2.11 Rev.1.0). In the base unit, a modular power supply unit is fitted at slots A3/A4. A second power supply can be connected in parallel (slots A1/A2) if the need for output current increases, or if a fail-safe switchover unit between redundant components is to be used. As an alternative, these slots can also accommodate a plug-in power supply for the DUT supply.

**FIG 2 Bus and slot overview of the R&S®CompactTSVP base unit (product designation: R&S®TS-PCA3).**



**FIG 3 Bus and slot overview of the R&S®PowerTSVP base unit (product designation: R&S®TS-PWA3).**



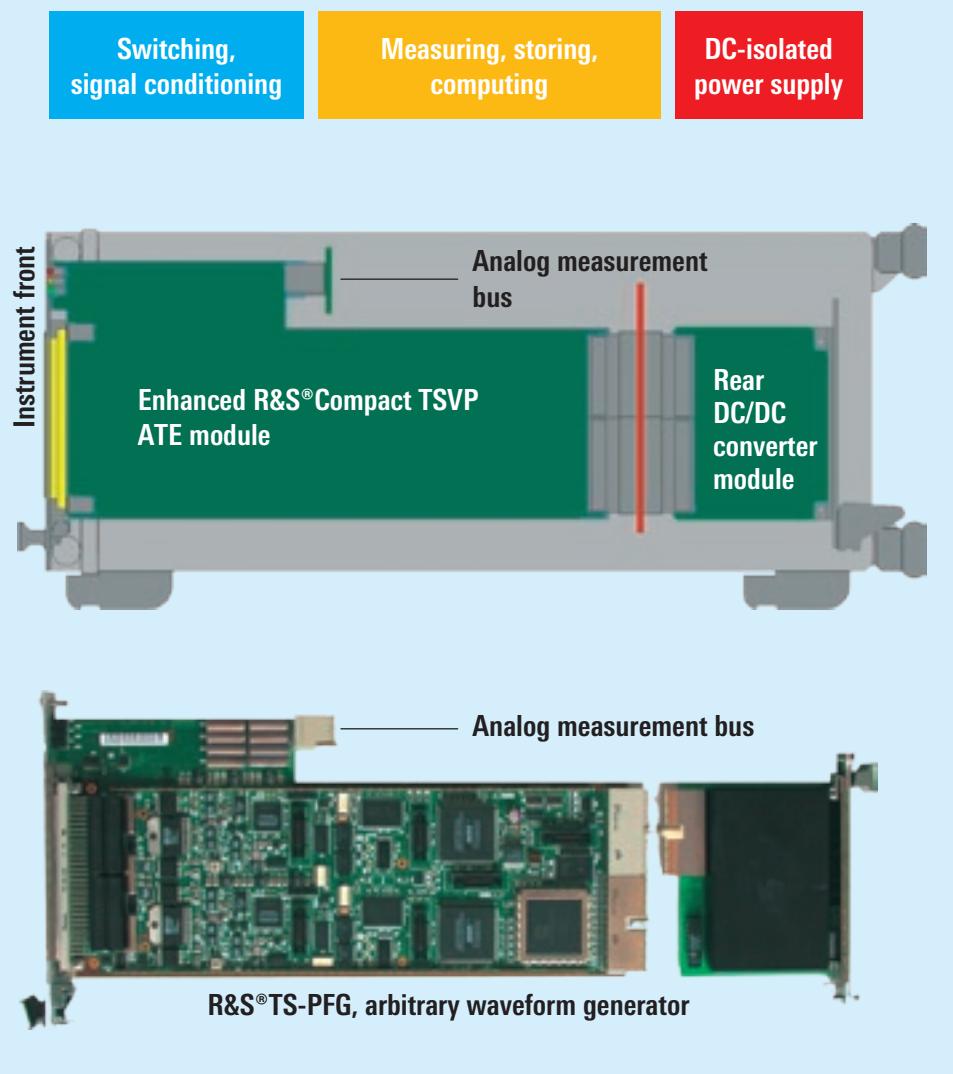
### The powerful R&S®PowerTSVP switching system

The R&S®PowerTSVP base unit (product designation R&S®TS-PWA3) is used to implement pure switching systems or enhance the number of test points that can be covered. T&M equipment and load circuitry can be separated if necessary because of high voltages or currents. Only CAN-based modules, preferably AF switching modules, are used. The implementation of RF switching systems is also planned as a follow-on development.

The switching system is either controlled via the internal CAN bus interface of the R&S®CompactTSVP or a desktop PC with an appropriate interface. With highly complex systems, a network of up to four R&S®PowerTSVP base units can be implemented simply by connecting the control bus and, if necessary, the analog measurement bus with each other.

As with the R&S®CompactTSVP, the simplified bus concept in the R&S®PowerTSVP is fitted with trigger lines based on PXI technology so that synchronous or event-triggered measurements can also be performed with different instruments (FIG 3).

**FIG 4** Schematic of the module format in the R&S®CompactTSPV plus an example of its use: the R&S®TS-PFG arbitrary waveform generator.



## Module design

The form factor of the R&S®CompactTSPV measurement and switching modules reflects the consistent product philosophy of meeting cross-section requirements in electronics production. Each measurement module allows the primary switching of incoming signals via the front connector plus free access to the internal analog measurement bus. If only a few signals need to be multiplexed for testing a DUT, the multiplexer on the measurement module is often sufficient. If, however, a large number

of channels needs to be handled, multiplexing is carried out via the analog measurement bus and matrix switching modules. As a result, module connection is flexible, which is highly valued in practice, and fixture cabling for these dedicated measurement tasks is simplified.

An important characteristic of the measurement modules is their capability for floating potential measurements or stimulation. They prevent the latent danger of hum pick-ups which are likely to occur with ground-referenced measurements, in particular with longer wiring arrange-

ments. Even measurements in electronic circuits are thus possible without any influence from the T&M equipment.

Isolation of the measurement signal and signal conditioning – e.g. filtering – is directly implemented on the measurement modules of the R&S®CompactTSPV so that most applications do not require any additional cost-intensive subsystems for signal conditioning.

To implement such a circuitry, the module format of PXI modules was elongated by 130 mm compared to the standard Eurocard format (160 mm × 100 mm) and the DC-isolated power supply of the measurement unit located there. A DC/DC converter module specifically developed for this purpose is inserted at the rear of the base unit (FIG 4).

As an extension for industrial use in typical automatic test equipment (ATE) environments, an additional backplane for the analog measurement bus has been integrated; it can be utilized for flexible test signal switching in the chassis between the modules without requiring any additional cables. The signal routing of partially high-impedance analog signals or signals with very low levels must be kept at a physical distance from the "digital highway", the PCI bus. The same applies to higher voltages. For this purpose, the format of the modules was expanded by an interface for the analog measurement bus. During the measurements the cross-connection of the signals from module to module is generated temporarily via coupling relays to the analog measurement bus.

The analog measurement bus has another important task: It is the basis for an efficient selftest of the modules. The relays of the switching matrix modules in a system can be fully tested by means of resistance measurements. The R&S®TS-PSAM multimeter module that

- is always provided in functional test systems intended as internal measuring equipment. It is also used to test measurement and stimulus modules. The comprehensive selftest report allows thorough system diagnostics and makes it easier to locate defective circuitry.

### Modules for the R&S® CompactTSPV

To implement test systems, the following modules from Rohde & Schwarz – in addition to the base units – are available (FIG 5):

- ◆ **R&S® TS-PSC3** System controller as CompactPCI plug-in, currently with 1.2 GHz Pentium III and 256 Mbyte RAM; standard interfaces include USB and Ethernet
- ◆ **R&S® TS-PSAM** Digital multimeter module with a maximum digitization rate of 200 ksamples/s
- ◆ **R&S® TS-PMB** Relay matrix module for signal switching of measurement signals with 90 input channels
- ◆ **R&S® TS-PSM1** Relay module for switching current up to 16 A with integrated current measurement capability via shunts and analog bus
- ◆ **R&S® TS-PDFT** Dynamic digital I/O module with a pattern rate up to 20 MHz, 32 level-programmable digital outputs, 32 digital inputs as well as serial communication interfaces
- ◆ **R&S® TS-PFG** Two-channel arbitrary waveform generator with a maximum pattern rate of 25 Msamples/s, 1 megaword signal memory per channel and a maximum output level of 40 V ( $V_{pp}$ )

The following modules are currently being developed:

- ◆ **R&S® TPICT** Complementary module for R&S® TS-PSAM. Combined, the modules allow complete analog in-circuit testing

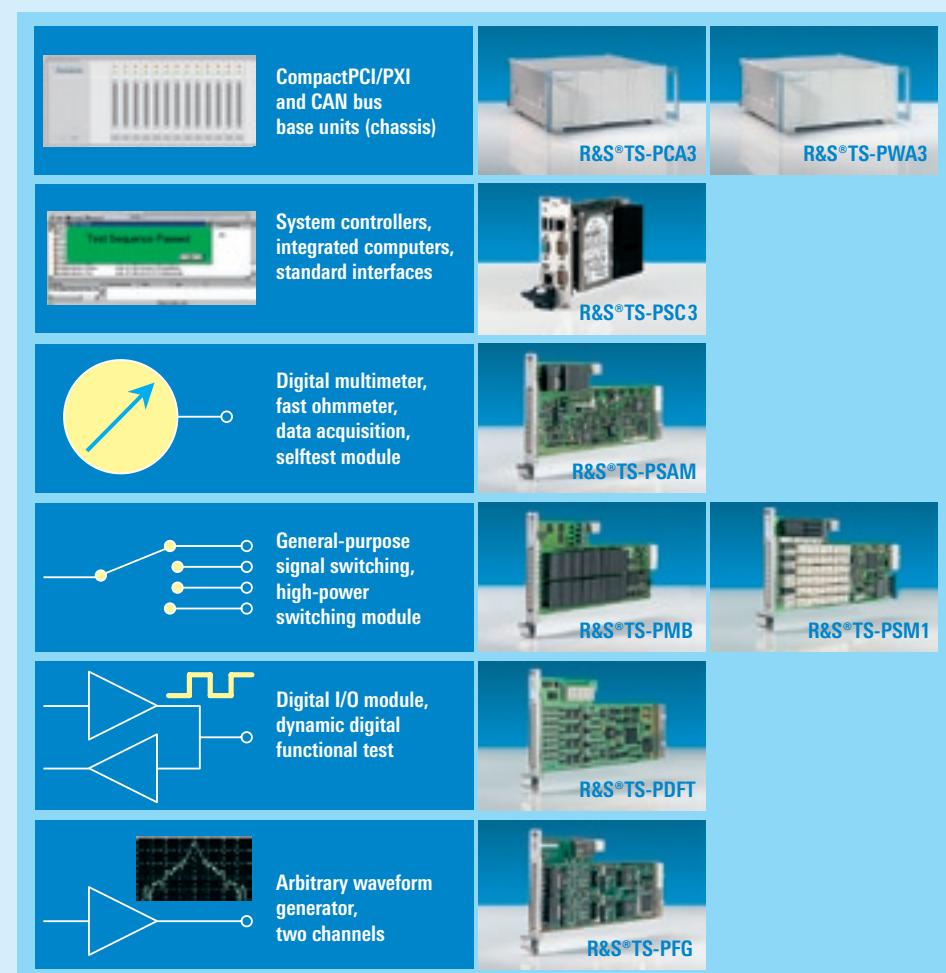
- ◆ **R&S® TS-PAM** Dynamic signal analysis module with two simultaneous sampling input channels for data acquisition of signals with sampling rates up to 20 Msamples/s

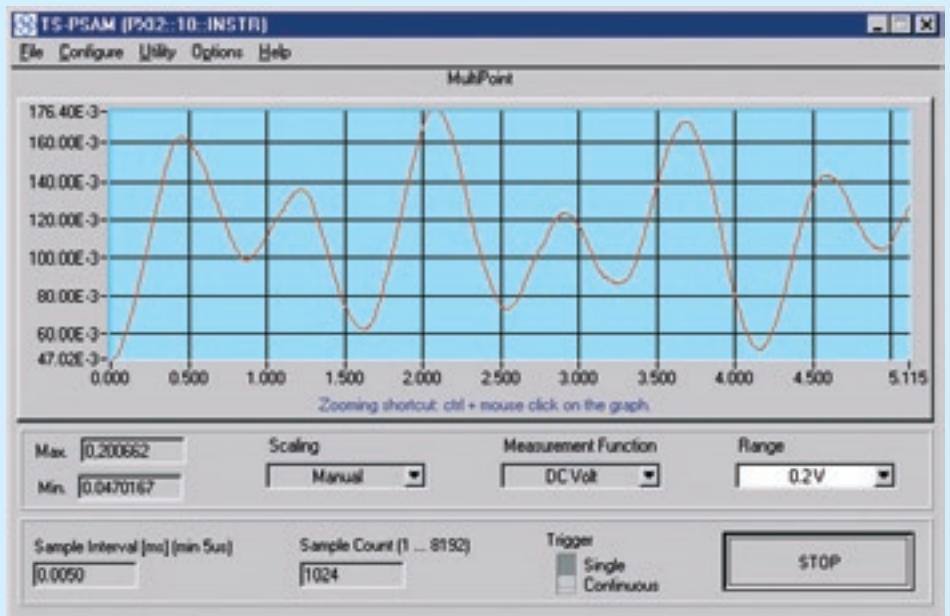
The dynamic measurement and generator modules are particularly outstanding for their floating characteristics and measurements up to 125 V ( $V_{pp}$ ). In addition to the modules from Rohde & Schwarz, the system can also accommodate any standard-conformant CompactPCI / PXI modules with three height units.

### Comprehensive software – ready to go

For convenient test program development, a comprehensive library is available, referred to as a generic test software library (GTSI); it features ready-to-go and fully tested software modules for functional tests, based on the Interchangeable Virtual Instruments (IVI) standard. It includes the entire resources management functionality and the configuration of the modules used in the system, DUT switching as well as all measurement functions of the inte-

**FIG 5** Overview of the available components of the R&S® CompactTSPV product line.





**FIG 6** User interface of the Analog Source and Measurement Module R&S®TS-PSAM , displaying an audio signal recorded with 200 ksamples/s.

grated modules. This library allows fast and reliable onsite configuration of test sequences in production and their adaptation to changing requirements.

Moreover, the use of GTSL in test programs significantly facilitates worldwide support for users and systems partners. Owing to the provision of selftest functionalities in GTSL, R&S® CompactTSPV system products can be efficiently verified onsite at any time. Currently, the Windows® NT4 and Windows® 2000 operating systems are supported.

Additional software modules come in handy alongside functional libraries and software drivers. Functional user interfaces (soft panels) are provided for putting a module into operation directly after automatic hardware detection and driver installation (FIG 6). They are used to configure switching paths, the setting of the signal conditioning of the switching and measuring instruments

and of course the measurements, and to instantly perform them. Thus, manual operation of the individual modules becomes possible without having to write a user software program, and putting a test setup into operation becomes considerably easier and takes less time.

### Using the test platform in functional tests

Since T&M basic functionalities and commercially available add-on modules can be combined – in particular for the production of electronics products of average complexity – it is possible to configure a powerful test platform in a single compact instrument. Coming up with a complete application solution usually only requires suitable power supply units for supplying the DUTs or, in the case of high-frequency products, the integration of RF T&M instruments into the system.

The system can be controlled by means of a modular embedded computer. The R&S®TS-PSC3 from Rohde & Schwarz is a system controller suitable for industry (currently 1.2 GHz Pentium III, 256 Mbyte RAM). Great emphasis was placed on standard interfaces such as Ethernet, USB and RS-232-C.

### Standardized fixture concept

A standardized fixture concept complements the modular design. The measurement and switching modules are to be fit with the easily accessible connectors according to DIN 41612 for cost-efficient signal transfer of a large number of test points. They can be easily wired (e.g. via wire-wrap with needle board fixtures) and are specified for higher voltages.

The counterparts are fitted at the fixture end by means of a robust connector carrier (FIG 7). At the tester end, a wear connector is also mounted by means of a connector carrier onto the fixture frame. The fixture frame is an optional part of the platform and available as a configurable standard component. Moreover, in addition to plug-in RF connections, compressed air or vacuum connections can be set up in the fixture.

### Summary

In everyday use, international development and production sites require T&M functionalities and testing resources that are product-related and thus available at all times to a varying extent and in different combinations. The R&S®CompactTSPV can provide an efficient basis for systems in diverse application scenarios.

In typical test systems such as engine test benches, conformance testers or production test systems, available components cover the common basic func-

tions with regard to test capacity and test depth. Additional functions and numerous interfaces can be seamlessly integrated by means of commercially available components from specialized manufacturers.

The module for analog in-circuit tests which will be available in the future makes it possible to test electronics products for production quality and functionality in one go and with one system.

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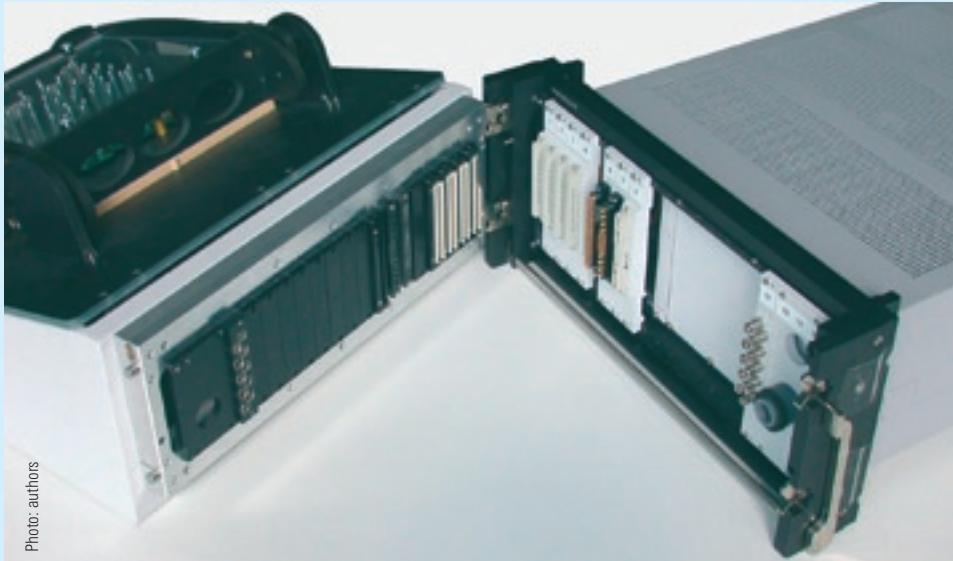


Photo: authors

#### FIG 7

Functional test fixture (left) and  
R&S®TS-PCA3 base unit with mounted  
R&S®TS-PAD3 fixture interface.

#### Abbreviations

<b>CAN</b>	Controller area network. Bit-serial bus originally developed by BOSCH for networking microprocessor-based control units in vehicles. Has become an automotive standard and, in automation systems, a field bus used all over the world.
<b>CompactPCI</b>	Standardized PCI-based bus system for industrial use.
<b>GTSL</b>	Generic test software library. Comprehensive library of software modules for R&S®CompactTSP-based test instruments. Includes functions for configuration, DUT connection and test data acquisition – also usable for direct calls from test sequences. Offers high software reusability and flexibility.
<b>IVI</b>	Interchangeable Virtual Instruments. An initiative to standardize driver software for T&M equipment. To allow software control of different manufacturers, the instruments are grouped according to functions, e.g. power supplies, and high-level driver functions are provided.
<b>PXI</b>	PCI-eXtension for Instrumentation. Extension of CompactPCI with T&M features, e.g. synchronization via reference clock 10 MHz, eight dedicated trigger lines.
<b>R&amp;S®TSP</b>	Test system versatile platform. Platform concept for PC-based T&M equipment with CompactPCI/PXI bus.

More information and brochure at  
[www.rohde-schwarz.com](http://www.rohde-schwarz.com)  
(search term: TSP)



The Open Test Platform R&S® CompactTSP brochure gives an overview of the R&S® CompactTSP modules including their major specifications and applications.