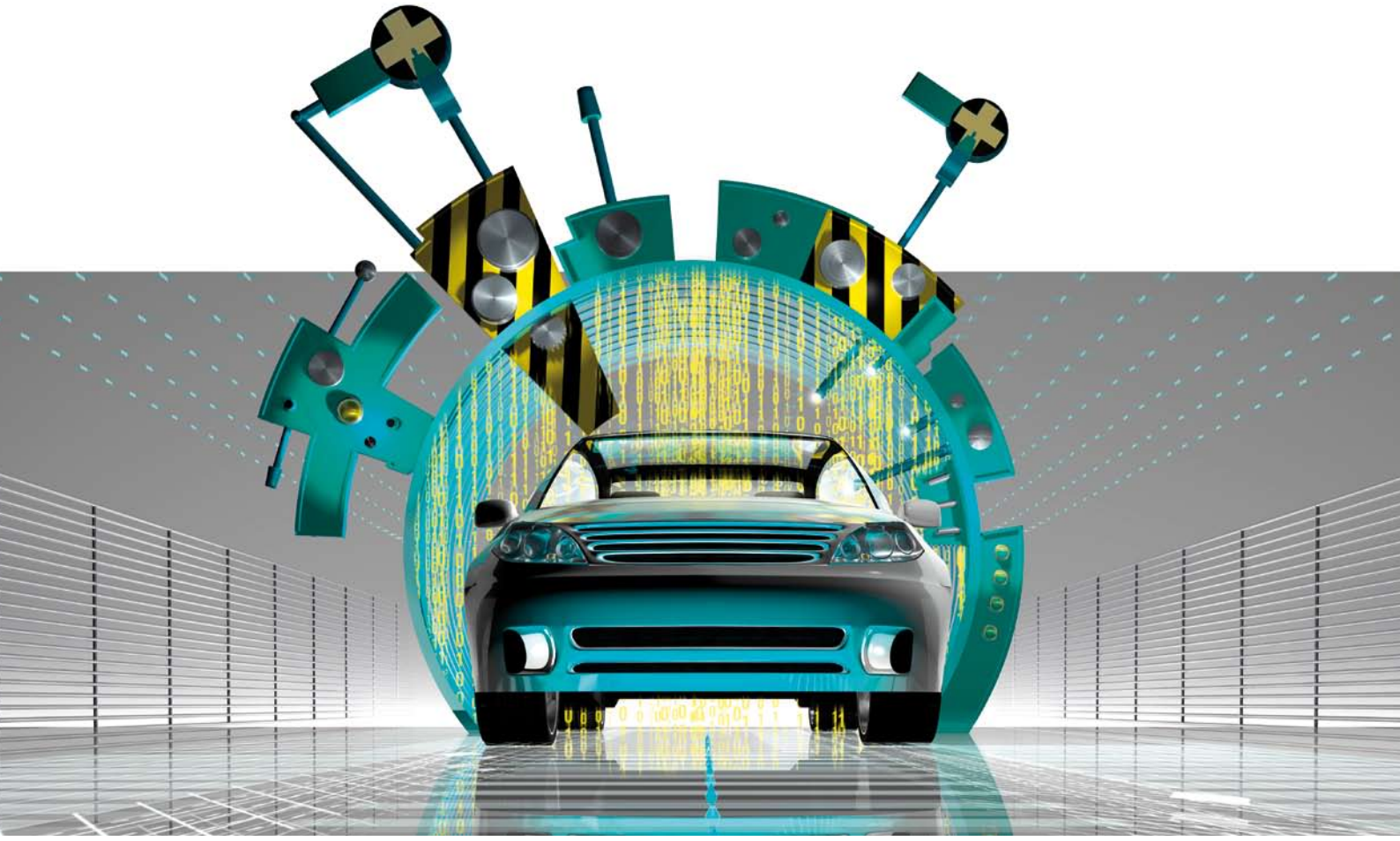


Test and Measurement Solutions for the Automotive Industry

ROHDE&SCHWARZ

A megatrend in the fast lane

One revolution is already behind us. Whatever technical signals could be digitized have been digitized. Information not capable of being expressed in a data format cannot be handled any longer. It can neither be stored nor compressed nor calculated nor automatically processed. Moreover, it cannot be transmitted via radio, which is a major disadvantage. This means that such information will be excluded from the successor revolution, which is currently keeping us on our toes – for the alliance of data and radio, of intelligent signal processing and radio-frequency technology is causing innovation rates to soar in many fields of technology, last but not least in the automobile industry. The megatrend of mobile communications is returning home, as it were, to its original domain of personal mobility where, having accumulated new features, it is developing at an even higher speed.

Since mobile communications came of age, Rohde&Schwarz has played a leading role in this market, which includes terminal equipment testing and the installation of radio and broadcast infrastructures for industrial and public projects. Based on this vast experience, we have in the past few years acquired comprehensive expertise in testing all types of communications equipment used in modern automobiles. Leading German car manufacturers, for example, use T&M technology from Rohde&Schwarz to test the complete infotainment systems of their vehicles during series production. We develop a test strategy in close cooperation with the automobile and supplier companies' design departments prior to the startup of series production and optimize the strategy at reference test centers at the production site.

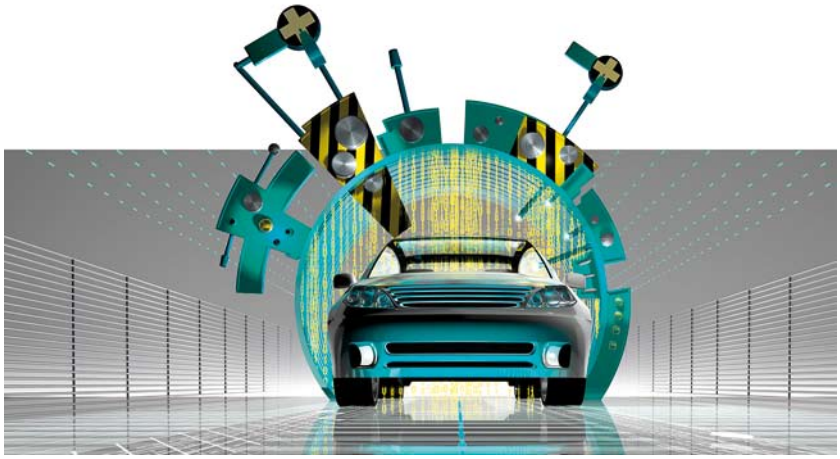
Applications of Rohde&Schwarz T&M technology are of course not limited to testing automobile communications equipment. Our products also help to increase the reliability of the individual components throughout the entire automotive electronics design and manufacturing process. This begins at the chip manufacturer. In cooperation with a manufacturer of tire pressure monitoring system (TPMS) chips, for example, we have developed new base technologies and T&M system components for future-oriented and efficient component tests both at the wafer and the component level.

Many tier 1 suppliers of automotive electronics rely on T&M equipment from Rohde&Schwarz in order to ensure that their products reach the zero defect rate required by car manufacturers (OEMs). The range of DUTs that are put through their paces using our T&M equipment (which also tests electromagnetic compatibility) prior to their release includes handsfree equipment and wireless garage door openers as well as engine control units for Formula One.

The percentage of electronic devices in cars has been growing at an annual rate of 15% for years. New applications are continuously being added. For example, mechanical components are being replaced by mechatronic or electronic components as in steer-by-wire systems, radar-based safety systems for collision avoidance are being developed, and new telematics systems allowing overall traffic flow control are being designed. This, however, means a corresponding increase in the demand for suitable technologies to ensure that this legion of helpful devices function properly. This is where we at Rohde&Schwarz see our task and our responsibility. T&M technology from Rohde&Schwarz is designed to make electronics in modern automobiles significantly more reliable. We invite you to put our performance to the test – anywhere, any time.

Udo Reil, Business Development Manager Automotive

The fact that automobiles are increasingly being equipped with modern infotainment and safety electronics calls for ever more innovative and complex test strategies in production. Rohde&Schwarz faces this challenge in close cooperation with renowned automobile manufacturers.

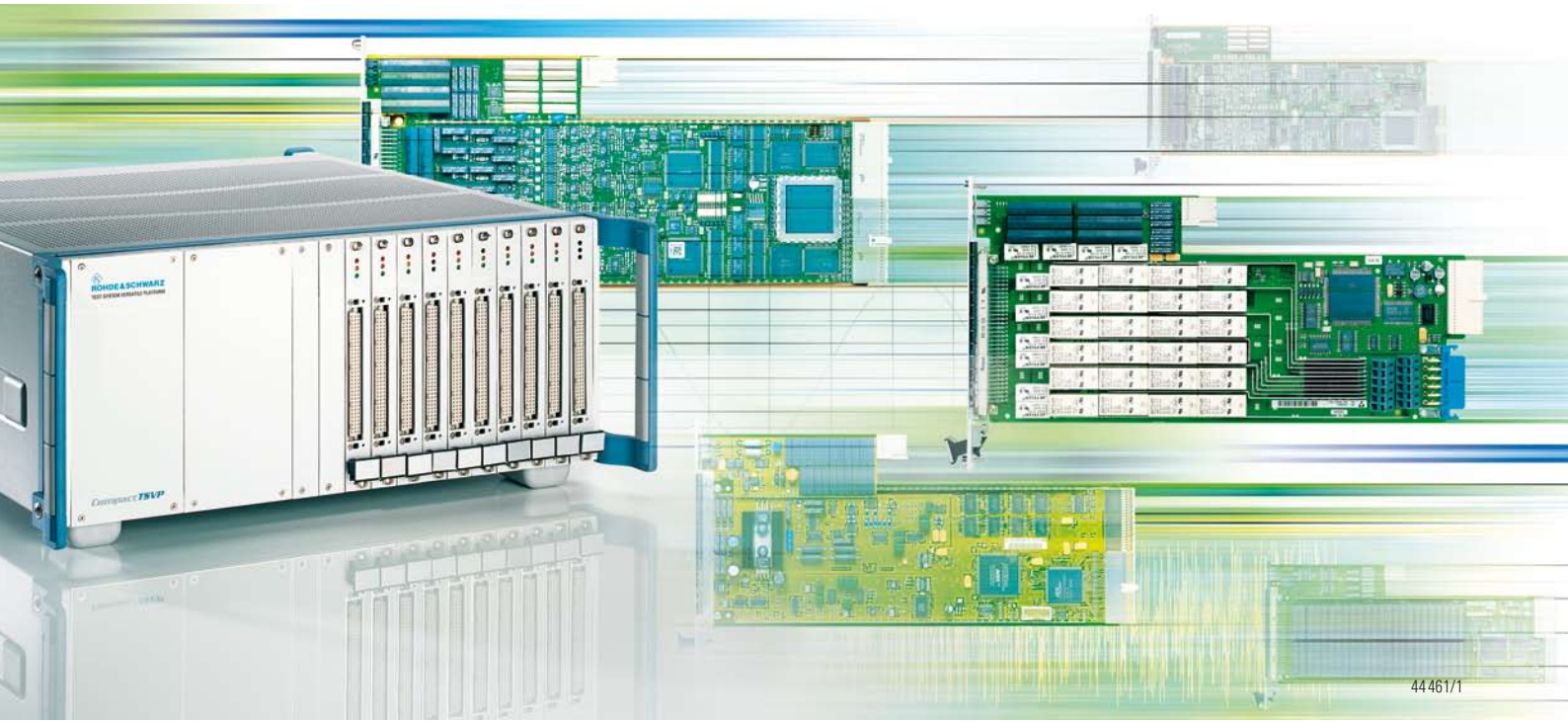


Module test

Infotainment

Safety/driver assistance

EMC



CompactPCI/PXI Test Platform R&S®CompactTSVP

Modular test equipment for tomorrow's automotive electronics

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

The trend: favorably priced and industry-compatible platforms

There is a heightened interest in test departments to configure the required functions in compact units as flexibly as possible so that future requirements can be met 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 into a multitude of applications.

Customer requirements, particularly in the automotive electronics sector, emphasize power density and modularity and thus clearly point to platform-based T&M equipment that is favorably priced and suitable for industry.

The 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 automotive electronics. It provides users with a basic modular concept of T&M functionalities and communications interfaces for hardware and software (FIG 1).

The 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 led to a commonly acceptable path for the technical community to implement measurement functionalities based on an already established standard at cost-efficient

You can find further articles on the R&S®CompactTSVP open test platform on pages 8 and 20.

pricing, featuring well performing modular system components. More than 600 measurement and interface products are currently available for the PXI standard.

Modular test equipment for development, production and service

The reason behind the development of the test platform was to provide users, especially those from the automobile industry, with an extremely wide portfolio of modern T&M methods. 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.

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 standard 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 for test programming or the test equipment itself.

The system concept chosen by Rohde&Schwarz with floating T&M equipment together with the integrated, analog measurement bus and CAN-controlled circuitry eliminates the above-mentioned adaptation problems, thus setting a new standard in the field of modular test instruments.

Module structure

The form factor of the R&S®CompactTSVP measurement and switching modules reflects the consistent product philosophy of meeting cross-section requirements in electronics production (FIG 2). 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 need 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 up to 125 V (V_{rms}). They pre-

FIG 1 Qualified to manage any task: Many modules make the Test Platform R&S®CompactTSVP fit for daily production.

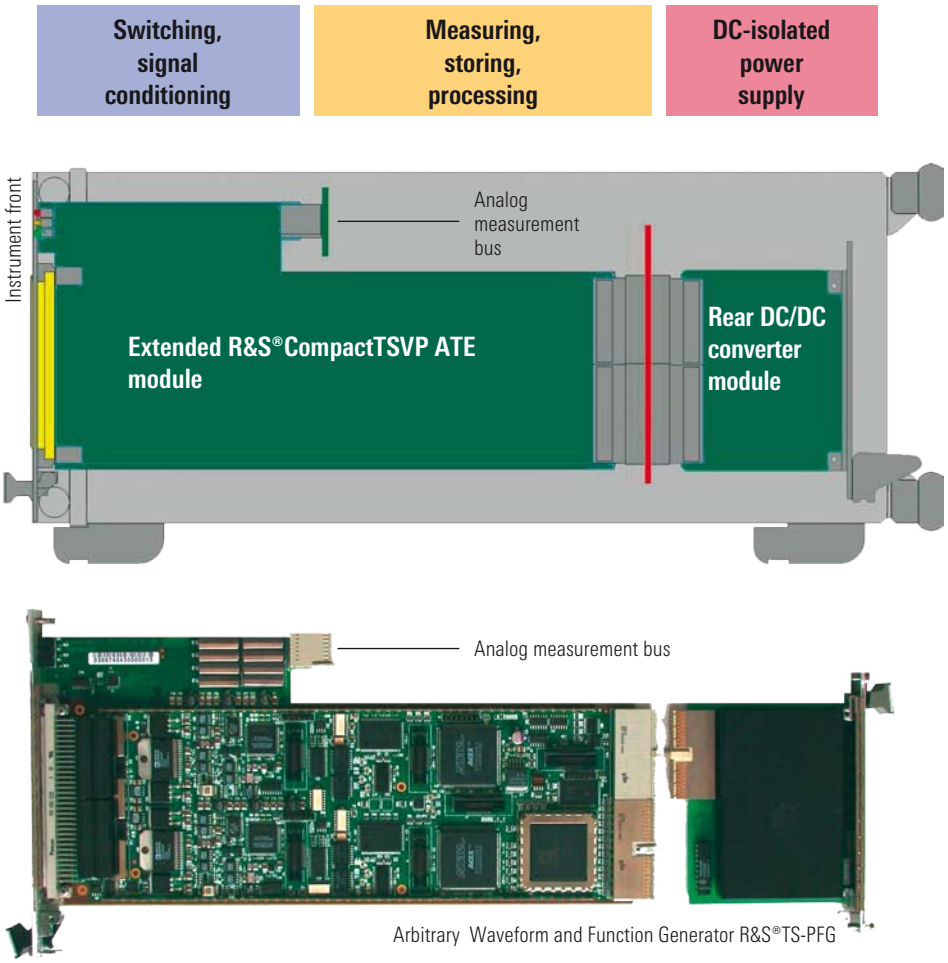
44461/2

vent the latent danger of hum pick-ups which are likely to occur with ground-referenced measurements, in particular with longer wiring arrangements. The isolation of the measurement signal and the signal conditioning – e.g. filtering – is performed directly on the modular measurement modules of the R&S®CompactTSVP. Additional, cost-intensive subsystems for signal conditioning are not required.

System diagnostics

The analog measurement bus has another important task: It forms the basis for an efficient selftest of the modules. For example, 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 is to be used as the 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.

FIG 2 Schematic of module format in the R&S®CompactTSVP and example of its implementation: Arbitrary Waveform and Function Generator R&S®TS-PFG.



The modules of the R&S®CompactTSVP product line

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

- **System Controller R&S®TS-PSC4** Embedded CompactPCI controller with inputs / outputs at the rear; Pentium M 1.6 GHz; USB, RS-232-C, Ethernet
- **PCI Interface Kit R&S®TS-PSC0** For using an external PC as the system controller. Transparent PCI-to-CPCI link, up to max. 10 m
- **Digital Multimeter R&S®TS-PSAM** Measurement of U / I / R, base functionality for analog in-circuit test. Discharge of capacitors. Max. sample rate 200 kHz
- **In-Circuit Test (ICT) Extension Module R&S®TS-PICT** Extended functionality for in-circuit tests (L / C / impedance) in conjunction with R&S®TS-PSAM
- **Arbitrary Waveform and Function Generator R&S®TS-PFG** Simulation of dynamic signals/sources. Two floating channels: ±20 V, 250 mA. Max. sample rate 25 MHz per channel
- **Analyzer Module R&S®TS-PAM** Recording / analysis of dynamic signals. Eight floating channels: ±125 V. Max. sample rate 2×20 MHz or 8×5 MHz
- **Digital Functional Test Module R&S®TS-PDFT** Realtime simulation of digital interfaces. Digital inputs / outputs up to 20 MHz, CAN, K-bus, I2C, SPI
- **Power Supply / Load Module R&S®TS-PSU** Simulation of voltage / current sources and loads; Two floating channels: ±50 V, 3 A, max. 50 W
- **Switching Matrix Module R&S®TS-PMB** Switching of measurement signals. 90 channels on 4 buses; full matrix: ±125 V, 1 A

- **Power Switching Module R&S®TS-PSM1** Switching sources and loads up to 16 A. Channels: 8×16 A with current shunt, 10×2 A
- **Multiplexer Switching Module R&S®TS-PSM2** Multiplexing of signals, switch simulation. 8×4:1 MUX DPST or 32 switches, max. 2 A
- **Analog/Digital Module R&S®TS-PIO2** Simulation/recording of analog/digital signals up to ±26 V, 5 kHz (currently being developed)

In addition to the modules from Rohde&Schwarz, the system can also accommodate any standard-conforming 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 (GTSL); it features ready-to-go and fully tested software modules for function 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 integrated modules. This library allows fast and reliable on-site configuration of test sequences in production and their adaptation to changing requirements. The uniform structure of the software modules quickly familiarizes the user with the product and ensures worldwide support from Rohde&Schwarz for a variety of applications. The availability of the measurement system is increased by providing selftest functionalities in GTSL. Currently, the Windows® 2000 and Windows® XP operating systems are supported.

Additional software tools 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. 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 takes less time.

Already used by renowned automobile manufacturers

FIG 3 shows a system used by an automotive supplier. It tests seven different DUTs in up to 18 versions in the field of power and comfort electronics. The capacity of the system is rated for testing 160000 modules per year. The heating and actuating system components in the seat, door and steering wheel as well as the corresponding display and control elements are subjected to comprehensive in-circuit and function tests:

- Flash download
- Power-on timing
- Watchdog function
- Standby current determination
- Testing digital and analog inputs/outputs
- LED test
- DUT communication via CAN and K-bus
- Simulation of loads

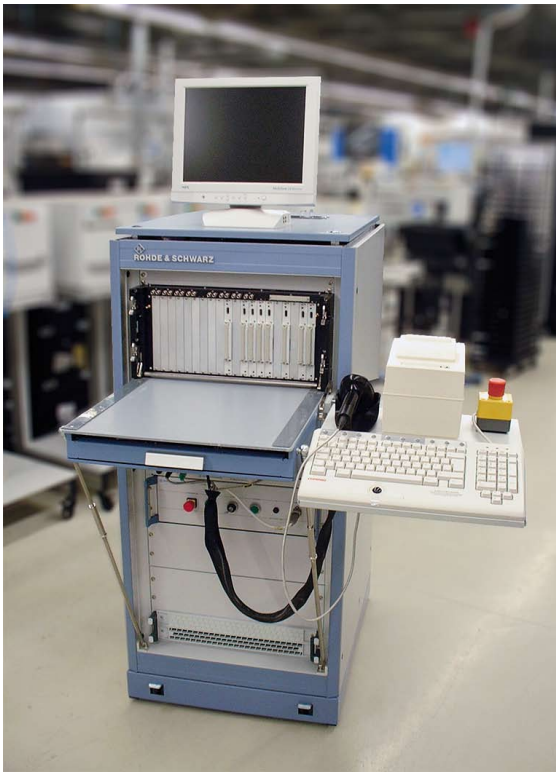


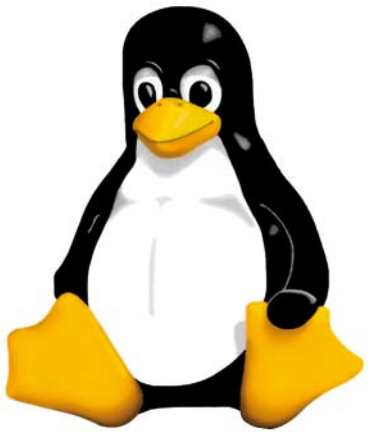
FIG 3 This system tests seven different DUTs in up to 18 versions in the field of power and comfort electronics.

The R&S®CompactTSVP test platform comes into its own at renowned manufacturers. The long-standing experience of Rohde&Schwarz in automated testing and a range of first-class products from our own development and production are ideal prerequisites for high-performance system solutions in the automobile industry.

Michael Grandauer

More information and data sheets at www.rohde-schwarz.com (search term: TSVP)

Since product development cycles are being continuously reduced, the automotive industry has to use standardized test platforms that not only provide fast and cost-efficient solutions for current testing tasks but also allow the industry to flexibly respond to future requirements. An open system platform with regard to the hardware and software components used is a key factor. The Linux support for the R&S®CompactTSVP test platform is an example of how to create an open hardware and software test system by using an open source operating system. The solution was showcased for the first time at Electronica in 2004.



CompactPCI/PXI Test Platform R&S®CompactTSVP

PXI-based test system under Linux as an alternative

Modern test systems face great challenges

With test tasks becoming more and more complex and cost pressure permanently growing, scalable standardized system solutions are called for that meet the following criteria:

- High performance
- Minimum costs
- Easy migration of existing application software
- Cost-efficient integration in existing infrastructure

The modular R&S®CompactTSVP open test platform (page 4) ideally fulfills these criteria because it is based on CompactPCI/PXI and can be flexibly and swiftly adapted to perform future measurement tasks.

Independent choice of operating system

The user's request for independent system architecture is of course not limited to hardware. Open software solutions are also in demand. As part of the system partnership between Rohde & Schwarz and SEKAS (box), SEKAS developed a software infrastructure that ensures the high performance of the R&S®CompactTSVP test platform also under the Linux operating system.

Linux's reputation as a cost-efficient and reliable operating system satisfies strategic aspects such as manufacturer independence and future-proofness; Linux is also increasingly used in automatic test systems. Since Linux is scalable, it can be adapted to the system's hardware performance. Moreover, Linux is very safe, robust and easy to maintain, for components that are no longer required can be removed from the operating system. If necessary, the open source concept of Linux even allows users to optimize software timing, without aid from the software manufacturer.

Economical migration of existing software

In the 1990s, many test systems were implemented by using the then unique VXI hardware platform and UNIX derivatives as operating systems. The service life of these systems will end within the foreseeable future. Devising comprehensive and complex test applications for these systems involved high investments, which users of course want to protect.

Migrating the operating system and application software from UNIX to Windows is very complex, since the two operating systems strongly differ in their system call structure for controlling T&M modules. Linux, on the other hand, is an economical and low-risk target platform because it has numerous characteristics in common with UNIX derivatives.

Provided that the existing software can be economically migrated at low risk, the R&S®CompactTSVP test platform with the Linux operating system is the ideal new target platform. It provides an excellent price/performance ratio and has a unique system architecture due to its compactness, floating measurement / stimuli methods and measurement bus concept.

Powerful also under Linux: R&S®CompactTSVP

The generic test system library (GTSL) standard software for the R&S®CompactTSVP test platform has been designed as an open software architecture under Microsoft Windows. It allows efficient configuration of the application software, irrespective of the test system hardware. Driver libraries are available for the modules of the R&S®CompactTSVP product line. The application programming interface (API) of these libraries is based on the standard issued by the Interchangeable Virtual Instruments (IVI) Consortium. If the hardware's software drivers comply with this standard, it can be integrated in the GTSL software environment without requiring any modifications.

A wizard makes it very easy to program the IVI drivers under LabWindows/CVI. However, an IVI engine is required for operation, which National Instruments offers exclusively for Windows. Special focus was therefore placed on migrating the software drivers for the R&S®CompactTSVP modules to Linux, keeping in mind their long-term and economical maintenance. The driver software was not redeveloped under Linux; rather, the software infrastructure required in accordance with the IVI standard was simulated under Linux, saving approximately 90 % of the costs compared with a completely new development.

Single source concept ensures high quality

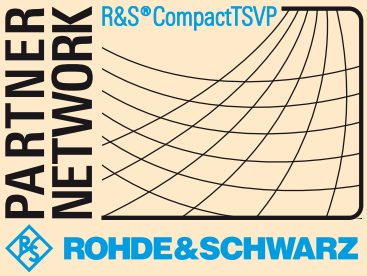
The single source concept was selected to port software to Linux, ensuring that – after migration has been completed – just one common driver source code for the R&S®CompactTSVP modules exists under Windows and Linux. Rohde & Schwarz continues to be responsible for servicing and developing the software on a functional level. SEKAS is fully involved in the software source modification cycle performed by Rohde & Schwarz and makes sure that all Linux users immediately benefit from software modifications, improvements and enhancements. Users of the R&S®CompactTSVP system platform can select their ideal operating system, since the Rohde & Schwarz quality standard is ensured in both versions.

Numerous tools under Linux

As a result of porting, the Rohde & Schwarz software is available under Linux as an ANSI-C library in an API with the same functions as with Microsoft Windows. The library includes managing and configuring the resources used, connecting DUTs, and also provides the applicable measurement functions of the hardware modules.

SEKAS additionally offers graphical user interfaces for manually measuring individual modules or putting them into operation. The system selftest of the R&S®CompactTSVP is also available under Linux. Quotis® from SEKAS is a product that provides Linux users with libraries for logging test results and transferring data to a quality management system, including paperless repair capability.

Hans Hopf (SEKAS);
Michael Grandauer



The Rohde & Schwarz partner network

The Rohde & Schwarz partner network is made up of various companies collaborating to develop and sell customized hardware and software solutions based on products from Rohde & Schwarz. This article gives an example of such a partnership: SEKAS developed the software infrastructure that ensures the high performance of the R&S®CompactTSVP test platform also under the Linux operating system. To find out more about the other companies of this network, visit **www.rohde-schwarz.com/www/dev_center.nsf/html/automotive_partners.**

Automatic RF Test Chambers R&S®TS712x

Interference-free and reproducible tests on automotive radio modules

Automobiles vehicles today include a host of modules and devices with radio interfaces. These modules and devices have to satisfy exacting demands in terms of reliability, which means, for example, that results in alignments and final tests must be reproducible. The new RF Test Chambers R&S®TS712x ideally meet this requirement. Featuring high shielding effectiveness and robust design, they enable interference-free tests on automotive modules equipped with radio interfaces of a variety of standards, including ISM, GSM, WCDMA, CDMA2000®, WLAN and Bluetooth®.

Communication in automobiles via radio interfaces

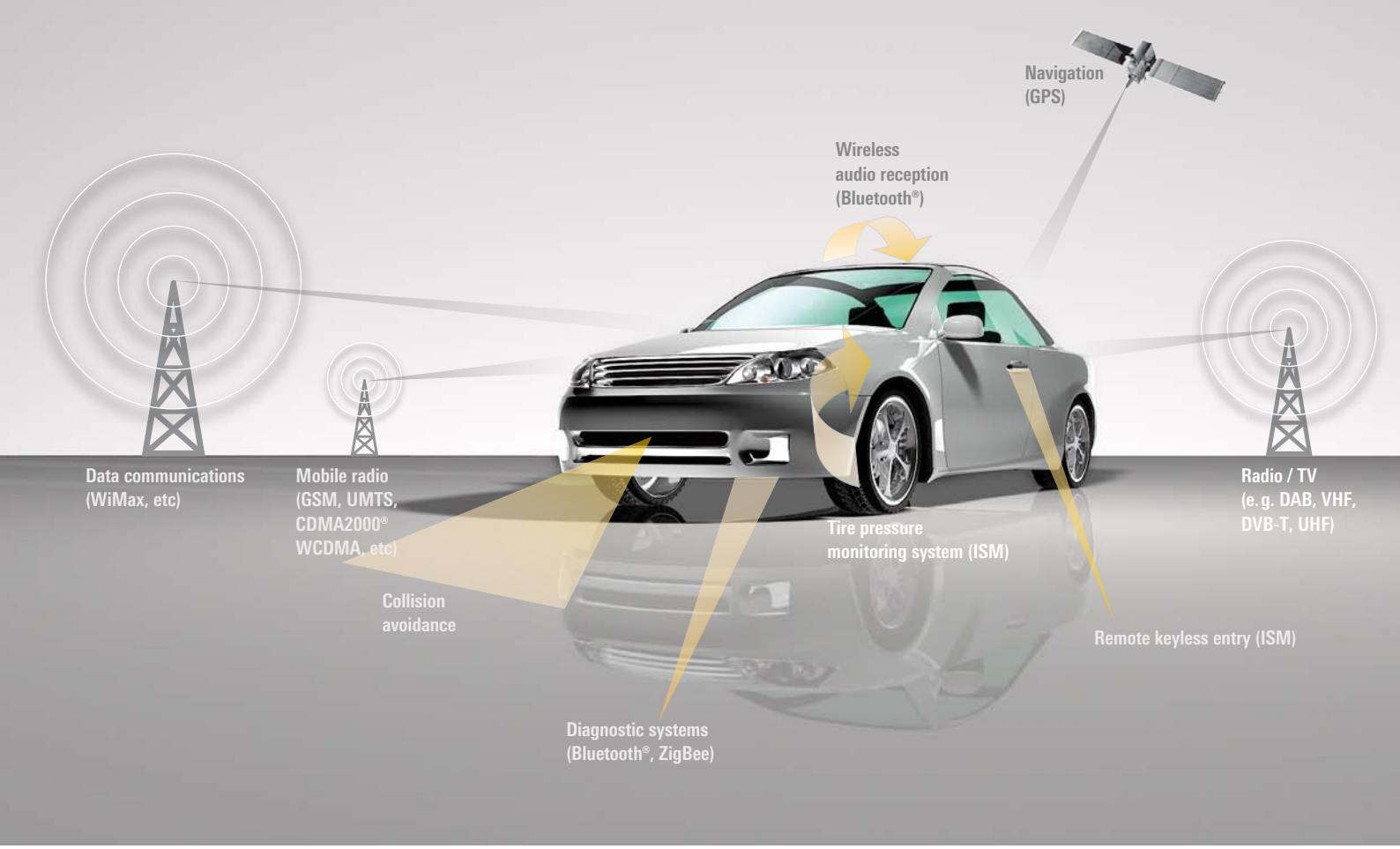
The number of modules with radio interfaces in automobiles is rapidly on the increase. Common applications include remote keyless entry for car doors with theft protection and transmitters for opening garage doors or for controlling auxiliary heating systems. Such applications as a rule use the ISM band, where no license is required. Another element employed by state-of-the-art vehicle communications are GPS-based navigation systems. GSM modules integrated into the car ensure optimal mobile communications by radio and, where necessary, Bluetooth® interfaces allow wireless audio communications in the car, e.g. for making phone calls or for audio reception for passengers.

Some newer applications include tire pressure monitoring systems and DVB-T receivers for dependable television reception. Diagnostic systems with radio interfaces for use by car repair centers and emergency helpers are being installed more and more often. Other applications include radio sensors for monitoring temperature, pressure and speed parameters in the engine compartment.

In the near future, we can expect to see radio interfaces based on WiMAX and other standards for mobile reception at high data rates. Radio systems for communications between vehicles that will help to prevent collisions are under development.

FIG 1 Use of the various radio standards in the automobile industry.

Standard/band	Application	Data rate	Status
ISM	◆ Remote keyless entry ◆ Tire pressure sensors ◆ Radio control of auxiliary heating systems and door openers ◆ Radio sensors	low	available
Bluetooth®	◆ Audio sets	medium	available
GSM, WCDMA, CDMA2000® etc	◆ Mobile radio sets including antenna and amplifier	medium	available
DVB-T	◆ Mobile digital TV	high	increasingly available
ZigBee	◆ Radio sensors	medium	in preparation
WiMAX	◆ Mobile data transmission from and to cars	high	planned



In all of the above examples, the modules involved include radio interfaces that, depending on the specific requirements, operate in different frequency bands and are optimized for the required data rates and safety standards (FIGs 1 and 2). For the new technologies described here, it is crucial that these modules function reliably. In the case of safety-related systems, this can mean the difference between life and death.

Modules with radio interfaces, therefore, have to be tested and often aligned already at the production stage to ensure compliance with radio standards as well as proper operation. The safety requirement mentioned above as well as the extreme environmental conditions encountered in cars, including major temperature fluctuations and strong vibrations, often necessitate extensive tests of the radio interface after final assembly. In order to obtain reproducible results when testing the radio interface, it must be ensured that external interference does not influence the test. Conversely, other systems and devices in the vicinity of the module under test must not be affected by the test. RF test chambers are ideal for performing these tests. Their high shielding effectiveness prevents the module under test and external systems and devices from affecting each other.

R&S®TS 712x product family: models that suit any application

As a solution for the above tasks, Rohde & Schwarz has extended its portfolio of RF test fixtures [*] by the new R&S®TS 712x family of RF test chambers. The R&S®TS 712x product family has been optimized for use in automatic production lines. It offers, for example, a long service life, rugged design and automatic opening and closing of the RF chamber. Featuring high shielding effectiveness between 300 MHz and 6 GHz, the RF test chambers perform tests on modules with radio interfaces of a variety of standards, including ISM, GSM, CDMA2000®, WCDMA, UMTS, WLAN, Bluetooth® and WiMAX.

The R&S®TS 712x product family includes two base models that differ mainly in width. Plus, an automatic and a manual version of each model is available.

The narrow R&S®TS 7121 models have a width of 155 mm and are particularly suitable for testing small modules, e.g. RFID modules, radio sensors and receivers, remote keyless entry and Bluetooth® modules. The R&S®TS 7123 models with a width of 330 mm enable tests on devices requiring up to double-height DIN radio slots, e.g. car radios and navigation and infotainment systems.

The wider R&S®TS 7123 RF chambers also provide room for integrating subsystems to generate special ambient conditions. An example are pressure chambers for testing pressure sensors as

used in tire pressure monitoring systems (FIGs 5 and 6). With such a subsystem integrated, you can test not only radio interfaces but also the functioning of tire pressure sensors under various pressure conditions as occur in car tires. For this application, Rohde&Schwarz offers the R&S®TS7810 RF test system with the R&S®TS7123A RF test chamber including software for final tests on tire pressure sensors (see page 22).

All R&S®TS712x RF test chambers are available as an automatic and a manual version, indicated by the letters A and M in the type designation (FIG 4). The automatic R&S®TS712xA RF test chambers are mainly used in production. The manual R&S®TS712xM versions are particularly suited for applications in service, quality control and R&D. The automatic and the manual RF test chambers have the same basic design, ensuring the same test functionality for both versions.

Extremely robust mechanical design

The RF test chambers were designed with high shielding effectiveness and sturdy construction in mind. To meet these requirements without diminishing manufacturing efficiency, the base structure of the RF chamber is milled from a single aluminum block. The shielded RF test chambers consist of the milled base, a slide-in unit and the cover of the RF chamber. The lower compartment of the base accommodates the guide rails and, in the case of the automatic versions, also the pneumatic system including the pressure regulators and valves. The valves are controlled via a 24 V connector or an optional USB control.

Summary

Using the Shielded RF Test Chambers R&S®TS7121 or R&S®TS7123 from Rohde&Schwarz, you can quickly implement a wide variety of applications in service, R&D and series production. Rohde&Schwarz manufactures the RF test chambers itself; customized models can, therefore, also be supplied at short notice if larger quantities are ordered. Rohde&Schwarz offers complete customized test solutions based on the RF test chambers described above as well as on other test equipment, for example for testing tire pressure sensors, mobile phones or ISM, Bluetooth® or WLAN modules.

Gert Heuer

FIG 3 Applications of the Shielded RF Test Chambers R&S®TS712x.

Application	R&S®TS7121	R&S®TS7123
Tire pressure monitoring systems	Transmitters, stimulators	Tire pressure sensors in additional pressure chamber
	Receiver modules	
Radio measurement sensors	Radio sensors and receivers	Diagnostic equipment
Radio remote control	Remote keyless entry, radio remote-control units	
	Receiver modules	
Navigation	GPS modules	Navigation systems
Multimedia	Wireless headphones DVB-T modules	Car radio and information systems, DVB-T receivers
Mobile radio	Antennas, mobile radio modules	
Collision avoidance (v2v – vehicle-to-vehicle communications)	GPS and GSM modules	
Internet, data communications	Transmitter and receiver modules	

More information and data sheet at
www.testsystems.rohde-schwarz.com
(search term: TS712x)
www.rf-chamber.rohde-schwarz.com

REFERENCES
[*] Automatic/manual RF Test Chambers R&S®TS7121: Reliable RF tests on small modules and devices. News from Rohde&Schwarz (2005) No. 187, pp 6–8

FIG 4 **Product range of the Shielded RF Test Chambers R&S®TS712x. All models are optionally available with an elevated cover.**

FIG 5 **R&S®TS7123A with integrated pressure chamber.**

FIG 6 **Rear view of the R&S®TS7123A with pressure regulator.**

Infotainment Test System R&S®ATSI

Fast, comprehensive tests in automobile production

The new R&S®ATSI infotainment test system is the follow-up to the Automotive Verification Test System R&S®AVTS, which has been tried and tested by many renowned automobile manufacturers. The R&S®ATSI performs automatic tests on broadcast receivers, sound systems, TV receivers, navigation systems and mobile phones. The architecture of the new system is based on application-specific modules, making it highly flexible in all stages of the production process. Due to the system's versatility, the test sequence can be optimized and costs for rework reduced. The R&S®ATSI is equipped with a large number of monitoring functions such as continuous self-test and monitoring of all radiated test signals.

43 833/2

FIG 1 Infotainment tests: Ever shorter innovation cycles and the increasing diversity of applications can only be mastered with fast and future-proof test systems.

Test system for production – versatile and future-proof

Comprehensive communications and infotainment components are already an integral part of today's automotive equipment in the volume sector. Original equipment manufacturers (OEM) thus face a challenging task, for they must fulfill high customer requirements for these components with respect to quality and reliability – despite ever shorter innovation cycles and increasing diversity of applications (FIG 1).

The employed test equipment must feature high flexibility and upward compatibility to meet the needs of this trend, for it must not only ensure that the components have been correctly installed but also verify the proper functioning of the entire communications and infotainment system – and for a wide range of configuration levels.

This is where Rohde&Schwarz facilitates production with its R&S®ATSI infotainment test system. The system offers special features and increases efficiency:

- It reduces production time and minimizes the frequency of errors by using automatic test sequences
- It minimizes the costs for rework by verifying the correct installation of the infotainment components already early on in production, i.e. before final assembly
- It ensures that a high level of quality is maintained in production at locations anywhere in the world
- It can be economically enhanced for future versions
- It requires no special know-how for on-site maintenance

The best solution for any application

Application-specific function modules ensure utmost operational flexibility and reduce the costs of installing, operating and maintaining the system (FIG 2). The R&S®ATSI supports a wide variety of test strategies in all stages of the production process:

- Conventional testing of the finished vehicle on the assembly line or in the test chamber
- Testing vehicle modules prior to installation (e.g. loudspeaker in the door module)
- Mobile testing with handheld measuring equipment via radio interfaces

The function modules for generating the test signals are equipped with a LAN interface. They can therefore be installed exactly where the individual test signals are needed – and still be remote-controlled and monitored from a central control PC. This largely avoids time-consuming laying of RF cables.

User-friendly configuration

User-friendly software packages support the modular system concept:

- All function modules are equipped as standard with software whose uniform graphical user interface allows them to be operated autonomously with fixed settings (FIG 3).
- The R&S®ATSI-K7 system configuration software provides a representation of the entire system installed in the production facility, including all distributed components such as active antennas, splitters, monitoring modules, etc. It centrally manages all configuration data for the different test scenarios and evaluates the self-test signals of the modules, allowing errors to be instantly located.
- The R&S®ATSI-K1 test sequencer makes it easy to program test sequences such as AM, FM and DAB radio tests on different frequencies.
- The R&S®ATSI-K2 interface software uses the interface to the master production computer in customer specific versions.

Test signals for all cases

- Analog sound broadcasting: AM, FM
- Digital sound broadcasting: DAB / DMB
- Analog TV: PAL / NTSC / SECAM
- Digital TV: DVB-T / -H, ATSC
- Mobile phone: GSM / CDMA / UMTS
- Navigation system: GPS
- Loudspeaker / sound system
- ISM (keyless entry, TPMS)

FIG 2 Function modules of the R&S®ATSI infotainment test system in the rack.

44490/4

Hot plug-in – installation and maintenance made easy

Sensor antennas continuously receive all radiated signals on the air interface and thus seamlessly monitor the integrity of the entire system. If an error occurs, the system configuration software analyzes the problem and outputs a message to the master production computer via the interface software. In the event of a defective module, all you need to do is replace the affected module, and the software takes care of the rest. Since the system does not have to be powered down in order to replace the module, the other test signals remain available. If backup modules are installed, the software automatically switches to a redundant module when an error occurs, allowing the system to continue operating virtually without interruption.

On request: single-source, all-in-one solutions

Rohde&Schwarz not only provides system components but also offers single-source, all-in-one solutions. On request, system specialists will advise you in advance with regard to designing the test concept and provide support in selecting suitable locations – e.g. by analyzing the EMC environment – while taking the specific production environment into account. After installing and configuring the system, they will parameterize it for the different types of vehicles and optimize the test sequence until the start of series production.

To ensure that the entire system functions flawlessly during the operation phase, all parameters should be verified and recalibrated regularly. For this purpose, the service team from Rohde&Schwarz has a comprehensive test equipment pool for on-site use.

Summary

The R&S®ATSI infotainment test system allows fast and comprehensive automatic testing of the installation and operability of infotainment and communications components in vehicles. Besides conventional final acceptance tests, it also tests subsystems before they are integrated into the vehicle, thus considerably reducing test times and ensuring competitive advantages. Handheld equipment is available for wireless interfaces such as WLAN, Bluetooth® or proprietary standards, which makes it possible to perform mobile tests as well.

The individual modules of the system are autonomous and can be operated independently of each other or combined into a system via LAN. Continuous monitoring of all components ensures maximum availability. The test system is rounded out by a large number of antennas that are specially designed for use in production. Customer-specific requirements are taken into account on an individual basis.

There are plenty of reasons for choosing the R&S®ATSI – renowned automobile manufacturers are already working with the test system.

Dietmar Weber

More information at www.rohde-schwarz.com (search terms: AVTS and ATSI)

FIG 3 A uniform user interface for all function modules simplifies parameterization (here, for example, the FM generator).

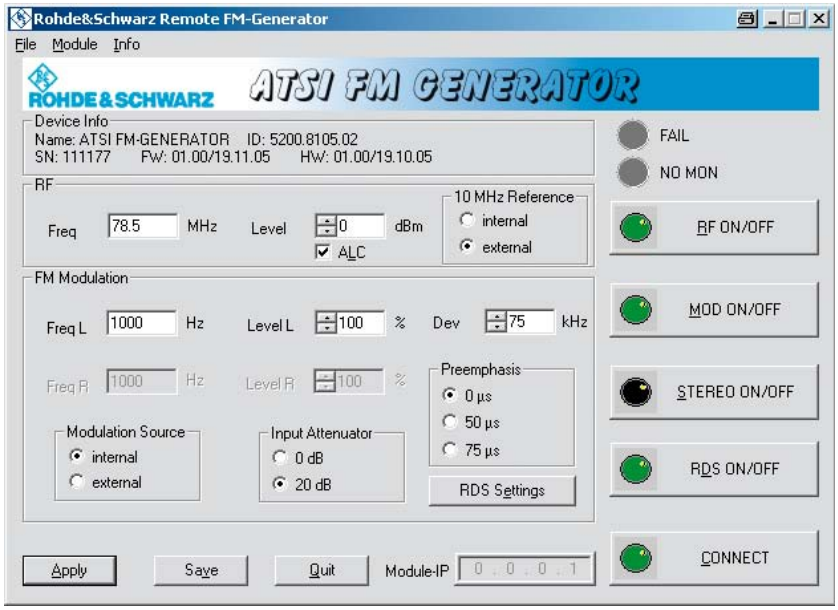


Fig. 1 The Audio Analyzer R&S®UPV (FIG) and the Signal Generator R&S®SML (FIG 2) with realtime stereo coder and built-in RDS signal generator make up a team that is superior to all test solutions currently on the market.

Audio Analyzer R&S®UPV / Signal Generator R&S®SML

Unrivaled duo for testing car radios

Conventional car radios have been superseded in modern vehicles by complex sound systems that feature a wide range of functions. But these systems will convince customers only if the radio modules provide flawless reception, which can be verified by means of first-rate T&M equipment.

Demanding tests ensure high quality

To ensure high-quality reception without interference, many parameters must comply with specified requirements. These parameters, such as S/N ratio, non-linear distortion, frequency response, AM suppression and crosstalk, are measured in accordance with the relevant standards. The most important standard is IEC 60315-4: Methods of measurement on radio receivers for various classes of emission – Part 4: Receivers for frequency-modulated sound broadcasting emissions (1997). To perform these measurements, a stereo-modulated signal generator for generating the RF test signal (FIG 3) and an audio analyzer for generating and measuring the audio test signals are required.

The R&S®SML signal generator [1] (or the R&S®SMV) with the R&S®SML-B5 stereo coder option and the R&S®UPV [2] audio analyzer from Rohde & Schwarz make up a first-rate duo that is used by leading car radio and HiFi equipment manufacturers all over the world (FIGs 1 and 2).

Maximum dynamic range and accuracy are crucial when receive sections are developed and their quality assured. In production, however, considerable test depth coupled with short measurement times is necessary. Combining the Signal Generator R&S®SML with the Audio Analyzer R&S®UPV is of considerable advantage in all these cases, since the generator, if equipped with the R&S®SML-B5 option, provides a realtime stereo coder. The test sequence is relatively simple: The audio analyzer generates all the required test signals, which are routed to the stereo coder in the signal generator. The generator provides a standard-modulated transmit signal that is applied at the antenna input of the DUT; the demodulated audio signals on the DUT output are fed to the audio analyzer for measurement (FIG 4).

Fig. 2 The Signal Generator R&S®SML with the stereo/RDS coder option generates standard stereo-modulated RF signals.

This test setup allows you to perform conventional measurements with sine-wave tones at maximum dynamic range as well as very fast and complex measurements with multitone signals (FIG 5). This combination of instruments can be used both in R&D and production – which is beneficial, since the production test methods can already be devised and tested in the development lab.

Convenient ARI and RDS testing

In addition to stereo signals, the Signal Generator R&S®SML can generate automotive radio information (ARI) and radio data system (RDS) test signals. ARI is hardly used anymore, since RDS provides ARI and other functions. Up to five RDS data sets can be stored in the stereo coder option and retrieved for function tests. The remote control via IEC/IEEE bus or RS-232-C interface allows you to operate all RDS functions – including RDS enhanced other network (EON) simulation.

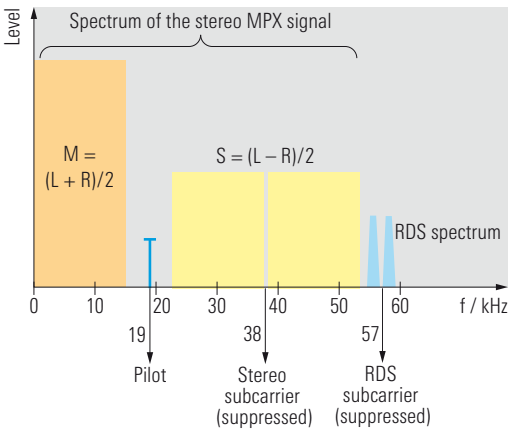
Rohde & Schwarz offers a program for menu-controlled generation of all RDS parameters via an external PC (FIG 6), thus providing a convenient test solution for developing RDS-capable car radios and ensuring their quality.

Summary

The Audio Analyzer R&S®UPV and the Signal Generator R&S®SML with real-time stereo coder and built-in RDS signal generator make up a team that is superior to all test solutions currently on the market. The outstanding specifications for S/N ratio, harmonic distortion, channel separation, frequency response and so forth ensure the high quality of the receivers tested by this duo. Using complex multitone signals makes for very short measurement times and maximum throughput in production.

Tilman Betz

FIG 3 The stereo spectrum.



More information and data sheets at www.rohde-schwarz.com (search term: UPV / SML)

REFERENCES
[1] Signal Generators R&S®SML / R&S®SMV 03: Stereo-modulated RF signals to standard with stereo/RDS coder. News from Rohde & Schwarz (2002) No. 175, pp 40–42
[2] Audio Analyzer R&S®UPV: The benchmark in audio analysis. News from Rohde & Schwarz (2004) No. 183, pp 16–20

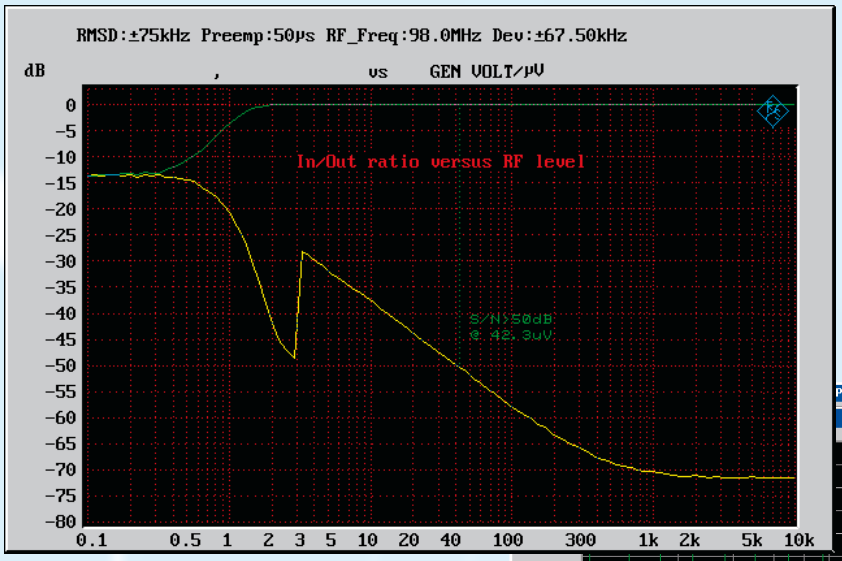


FIG 4
Measurement result after a modulated transmit signal was applied at the DUT. The audio analyzer examines the demodulated audio signals on the DUT output.

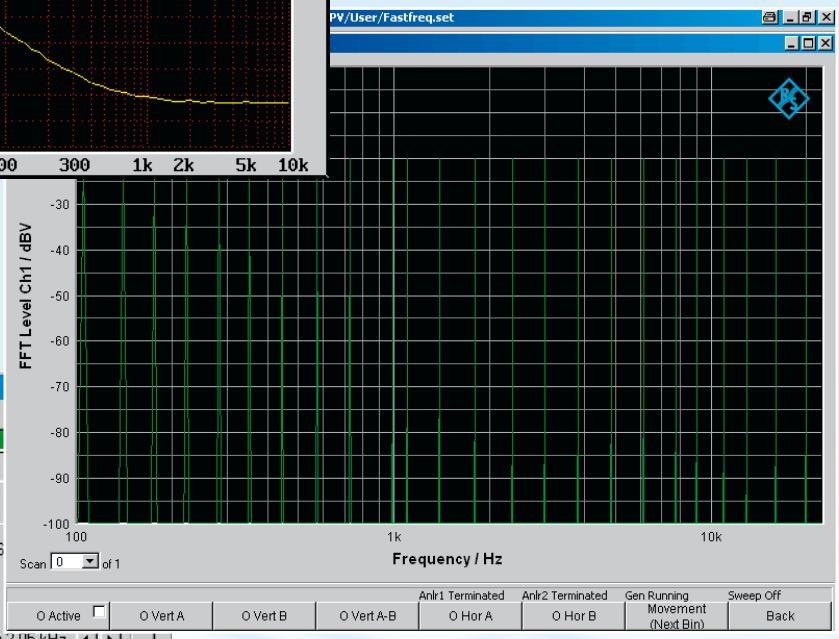
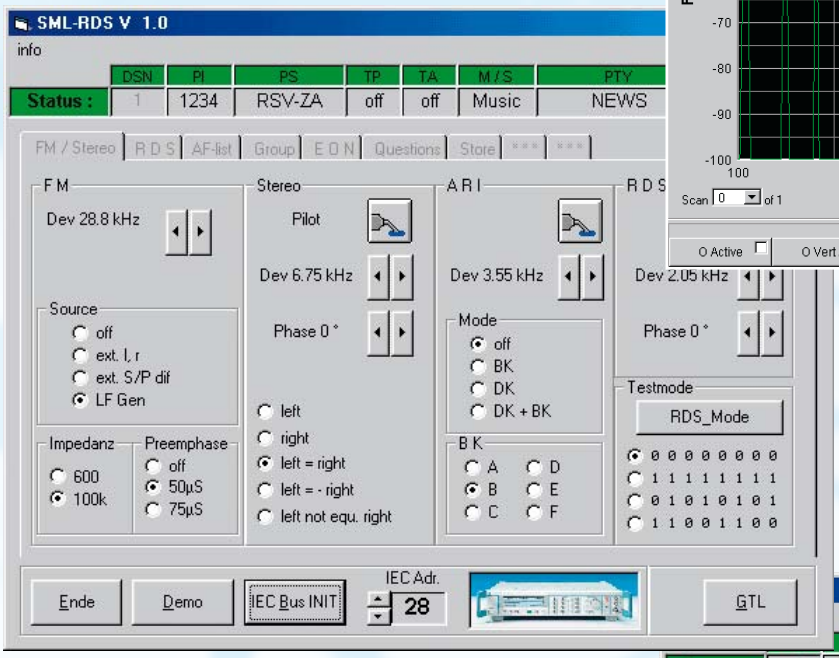


FIG 5
Using complex multitone signals makes for very short measurement times and maximum throughput in production.



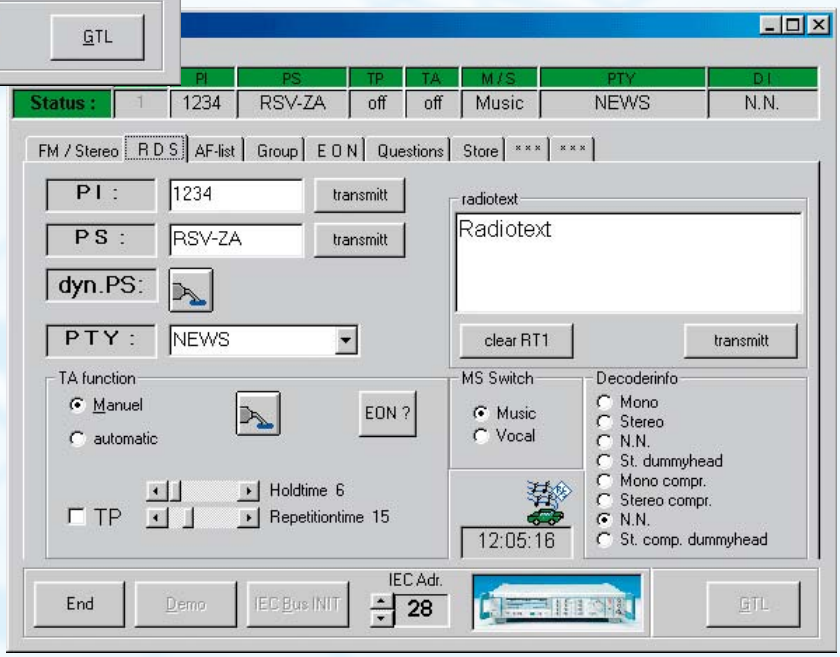


FIG 6
Rohde & Schwarz program for controlling all stereo, ARI and RDS data.

FIG 1 **Open Test Platform R&S®CompactTSVP with manual test fixture.**

CompactPCI/PXI Test Platform R&S®CompactTSVP

Tests of electronic brake control and safety modules

The versatile R&S®CompactTSVP from Rohde&Schwarz is the first CompactPCI/PXI-based system platform that uses floating stimulations and measurements for testing safety-related automotive control units.

For details on the R&S®CompactTSVP, see pages 4 and 8.

Intensive tests for maximum safety

An increasing number of motor vehicles are being equipped with the anti-lock braking system (ABS) and the anti-slip regulation (ASR) system. In conjunction with the electronic stability program (ESP), the ABS and ASR control modules provide an efficient driver assistance system that significantly cuts down on the number of accidents and the resulting damage.

To be able to ensure customers high quality and safety standards, the automobile industry requires subcontractors to subject their electronic control units (ECUs) to extensive tests and provide detailed test documentation before such control units are integrated into vehicles. For function tests on ABS/ASR ECUs, the test system must be able to simulate sensor signals in normal and critical driving situations and check the ECU's response at the actuators.

The R&S®CompactTSVP test platform (FIG 1) has been specially designed for testing state-of-the-art automotive electronics. Its compact design and versatile configuration options make it ideal for use in manual and fully automatic test stations.

High versatility safeguards your investment

For the above applications, the CompactPCI/PXI-based test system is equipped with an embedded controller, which controls the system and the test sequences. Alternatively, an external PC can be used. The test system includes various modules, which are described below.

The DUT is powered by the compact Power Supply and Load Module R&S®TS-PSU, which has two independent, floating channels with an integrated measurement unit and is based on four-quadrant operation (FIG 2). The Digital Functional Test Module R&S®TS-PDFT programs the DUT memory, simulates missing devices on the CAN bus and communicates with the DUT via the bus. The Arbitrary Waveform and Function Generator Module R&S®TS-PFG is used for the synchronized and floating simulation of sensor signals. Each R&S®TS-PFG module has two independent channels via which standard waveforms as well as arbitrary waveforms can be output. The sensor or control signals required for testing an ECU are generated prior to the test, loaded into the R&S®TS-PFG memory and output in synchronized form during the test.

The Analyzer and Data Acquisition Module R&S®TS-PAM records the analog control signals at the ECU outputs as well as the status of its digital trigger inputs. The R&S®TS-PAM performs floating and quasi-simultaneous sampling of up to eight signals at a rate of 5 Msample/s. The recording method and the sampling frequencies can be selected separately for groups of four channels each. Using pre- and post-triggering, a time analysis of measured data can be performed, based on digital reference signals.

ECUs put through their paces

Test programs can be conveniently developed by means of the powerful, hardware-independent Generic Test Software Library R&S®GTSL. This software package contains a tool that generates speed profiles for ABS and ASR test cycles (FIG 3). Alternatively, the R&S®Waveform Composer software supplied with the R&S®CompactTSVP can be used.

During the ABS test, the system first simulates a signal of constant frequency, corresponding to a constant driving speed. After a few test cycles, the signal frequency is abruptly reduced (frequency modulation) to simulate locking of the wheels. Then the frequency is increased up to the initial value. The test sequence for ASR is basically the same, the only difference being that the frequency is not reduced but abruptly increased, simulating slipping of the wheels. The ECU responds to the simulated sensor signals with selective changes at the control outputs for the actuators. These control signals are recorded by the analyzer module, and their waveforms and timing are analyzed by means of the hardware-independent R&S®GTSL library.

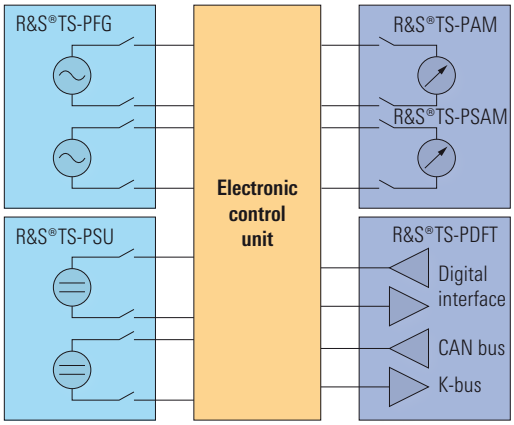


FIG 2 Connection of the R&S®CompactTSVP modules to the electronic control unit.

The test system presented here is a highly compact solution. Featuring modular architecture, the system can be easily adapted to handle further measurement tasks on safety-related automotive control units by choosing the required functionality from a wide variety of modules.

Christian Hof

FIG 3 Graphical configuration of speed profiles.

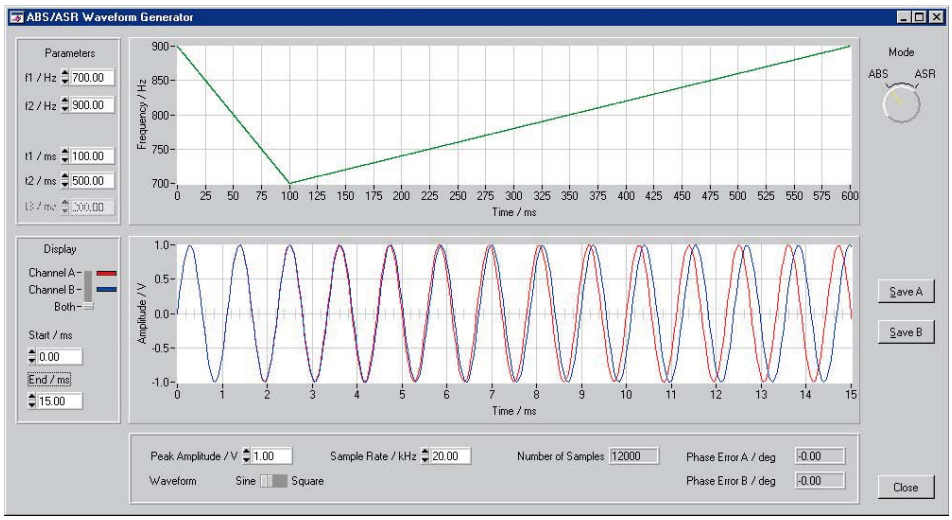


FIG 1 The compact R&S®TS7810 can be easily integrated into production lines (here with generator for optional receiver measurements). The Shielded RF Test Chamber R&S®TS7123 (right) is equipped with a pressure regulator.

The RF Test System R&S®TS7810 is designed especially for the fast growing market of tire pressure sensors. By using standard equipment such as the Spectrum Analyzer R&S®FSP3 or the Open Test Platform R&S®CompactTSVP, the R&S®TS7810 can be quickly adapted to meet project-specific requirements. For use in production, development and quality assurance, Rohde&Schwarz provides both the turnkey system and individual system components.

RF Test System R&S®TS7810

Testing tire pressure sensors in the automotive industry

Tire pressure sensors are becoming standard

In recent years, the safety of automobiles has continuously increased. Nevertheless, in 30% of the serious accidents that occur due to technical defects of the vehicle, the accident cause can be attributed to the tires. A number of tragic accidents in the USA, for example, happened as a result of a specific tire model having too low a pressure. In the coming years, in the USA all vehicles up to five tons must therefore be equipped with a tire pressure monitoring system (TPMS).

Primarily, two different methods are currently used for measuring tire pressure: An indirect measuring system that uses ABS sensors, and a direct measuring system that uses sensors with radio interface built into the tire. The indirect measuring system uses the information of the ABS sensors for calculation and calculates changes in tire pressure from the different tire speeds. This system can be implemented economically but has the disadvantage that tire speed cannot be measured when the vehicle stops or when the pressure of two tires drops simultaneously. Direct measuring systems with sensor technology are thus expected to gain the upper hand on the market.

In addition to tire pressure, tire temperature and acceleration are also transmitted to the central control unit in the vehicle. The tire pressure sensor is a pot-

ted, LSI module and basically contains a sensor chip with µ-controller and an ISM transmitter that generates the RF signal. It is powered by a lithium battery with a lifetime of up to 100 000 km. There are also ways to supply power by means of the tire vibration energy or by using an external magnetic field via a coil within the wheel housing. The European Union already supports this technology with research programs, and tire pressure sensors are expected to become standard equipment in all vehicles over the next ten years.

Versatile and compact

With the R&S®TS 7810, Rohde & Schwarz now provides an all-in-one test solution for the fast growing TPMS market (FIG 1). This test system includes the CompactPCI/PXI-based Open Test Platform R&S®CompactTSVP (page 4), the R&S®GTSL system software, the Spectrum Analyzer R&S®FSP 3, the Shielded RF Test Chamber R&S®TS 7123 (page 10) as well as customer-specific test sequence adaptations.

A pressure-proof chamber simulates tire pressure inside the R&S®TS 7123 RF test chamber. Different pressure values can be set by means of a programmable pressure control unit. Since the test chamber is RF-shielded, several test systems can be operated in parallel without affecting each other.

Which standard?

There are a number of license-free radio bands (ISM: industrial, scientific, medical) in the frequency range from 100 MHz to 3 GHz. They are used for transmitting short data packets. Europe transmits in the 433 MHz and 868 MHz bands while the USA and Japan use the 315 MHz and 915 MHz bands. The 2.4 GHz band is freely accessible worldwide.

The Spectrum Analyzers R&S®FSP 3 and R&S®FSL 3 cover this wide frequency range. By adding the optional FM Measurement Demodulator R&S®FS-K 7, the R&S®FSP 3 and R&S®FSL 3 also measure the different modulation modes such as on-off keying (OOK), amplitude shift keying (ASK) and frequency shift keying (FSK).

TPMS receiver modules can be easily tested simply by expanding the R&S®TS 7810 by a signal generator. The RF test system thus covers applications not only in the automotive industry but also in industrial and consumer electronics.

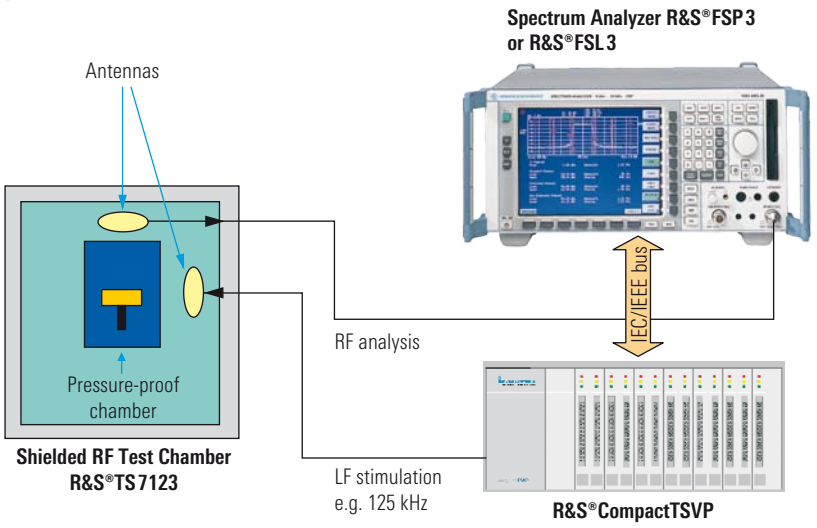
Comprehensive tests

The automotive industry requires its suppliers to perform extensive tests including documentation of the test results for each single part. Only an automatic test system such as the R&S®TS 7810 can meet this requirement.

The R&S®GTSL system software, which controls all test runs, issues the start command for a measurement. The software's open architecture makes it easy to integrate the R&S®TS 7810 into fully automatic production lines. The Open Test Platform R&S®CompactTSVP, which was specially designed for testing modern automotive electronics, then generates a 125 kHz LF data telegram that stimulates the tire pressure sensor in the test fixture (FIG 2). If necessary, you can expand the R&S®CompactTSVP with additional CompactPCI/PXI measurement and control cards for communicating with the production cell or for programming µ-controllers on printed boards, for example.

An antenna module with an amplifier in the R&S®TS 7123 transfers the transmitted data to the spectrum analyzers, which measure the most important RF parameters such as RF power, RF frequency offset and frequency deviation in one cycle and demodulate the data telegram (FIG 3). The spectrum analyzers

FIG 2 Stimulation and measurement of a tire pressure sensor.



then transfer the digitized data telegram content to the controller, where the system software analyzes the data telegram content together with the TestStand® sequencer from National Instruments. Contents such as pressure or temperature are displayed clearly and concisely.

If the vehicle is moving, each tire pressure sensor transmits three to five data packets per minute with a period of approx. 10 ms and makes variable pauses of about 100 ms between each packet (FIG 4). The individual data telegrams of the four tires can superimpose on each other and can no longer be properly decoded. The method used therefore ensures that the packets in the next transmission window are sent with a time delay and that each individual tire is clearly detected by the central receiver module.

Transparent data analysis

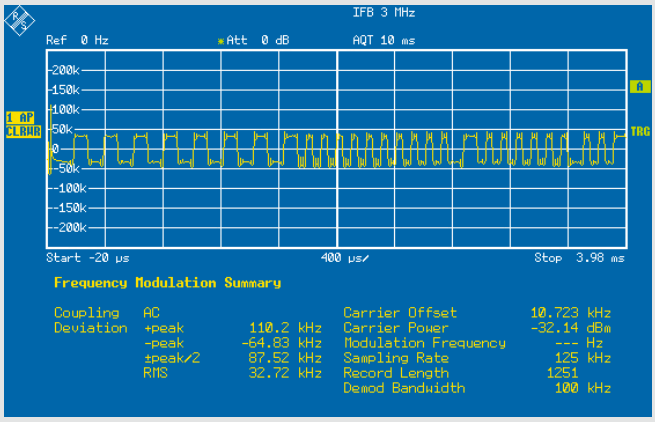
Software libraries in the standard programming language C let you change data telegram analysis without any special knowledge. An open source code allows quick adaptation to customer-specific requirements. Since all these functions interact optimally, test times are extremely short, making for high throughput in the production line.

Each tire pressure sensor transfers a unique ID number together with the pressure, temperature and acceleration data. The central receiver can thus clearly detect the respective tire, even after a tire change (FIG 5). A checksum at the end of the data telegram prevents erroneous analysis of the content.

Summary

With just 15 height units, the compact R&S®TS 7810 can be easily integrated into any production line. As an all-in-one turnkey solution, the system is also ideal for development, quality assurance and incoming goods inspection. If you want to integrate your own system components during a project, you can complement them with individual units and software modules of the R&S®TS 7810, for example to retain the software user interface you are familiar with.

Erwin Böhler



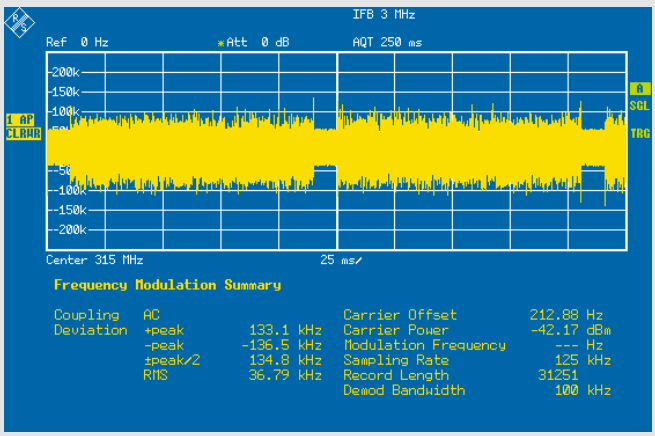


FIG 3
Demodulated data telegram with the FM Measurement Demodulator R&S®FS-K7.

FIG 4
Repetition of three consecutive data telegrams with variable pause.

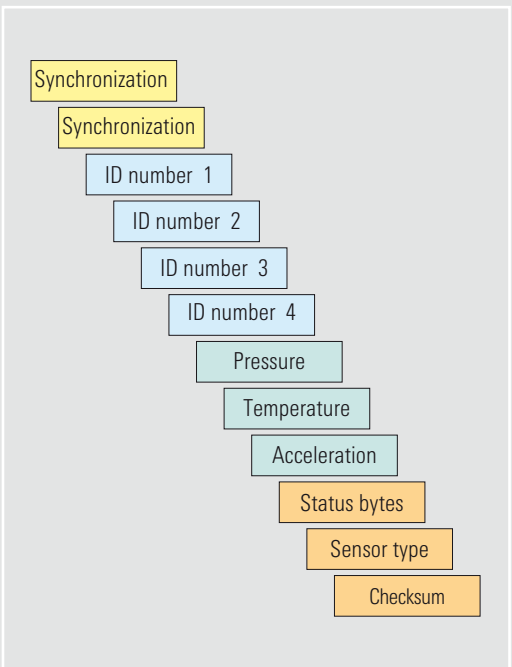


FIG 5
Typical structure of a data telegram (12 bytes).

More information at www.testsystems.rohde-schwarz.com (production test)

Changing times: EMC chambers for the automotive industry

Anechoic chambers are indispensable for EMC measurements on vehicles. They can measure both vehicle components and complete vehicles under realistic conditions. Rohde & Schwarz has implemented many turnkey EMC systems for vehicle manufacturers and component suppliers.

Anechoic chambers – indispensable for EMC measurements

In Europe, EMC measurements on vehicles and components are carried out in accordance with the European Directive 95/54/EC, which will soon be superseded by the European Directive 2004/104/EC. For vehicle tests, the directive stipulates anechoic chambers that are equipped with absorbers for attenuating the reflections on the metallic frame. You can test both vehicle components and complete vehicles in such anechoic chambers. Since modern vehicles contain a large number of modules that call for a variety of test scenarios, the equipment of the chambers has changed in the course of the last few years.

Vehicle testing

EMC chambers have been used for vehicle tests for more than 15 years. The measurements are frequently based on manufacturer-specific standards, which in most cases closely fol-

FIG 1 Modern anechoic chamber with E/H field generators above vehicle. Rohde & Schwarz supplied the complete EMC measurement equipment for this chamber.

Photo courtesy of Albatross Projects GmbH

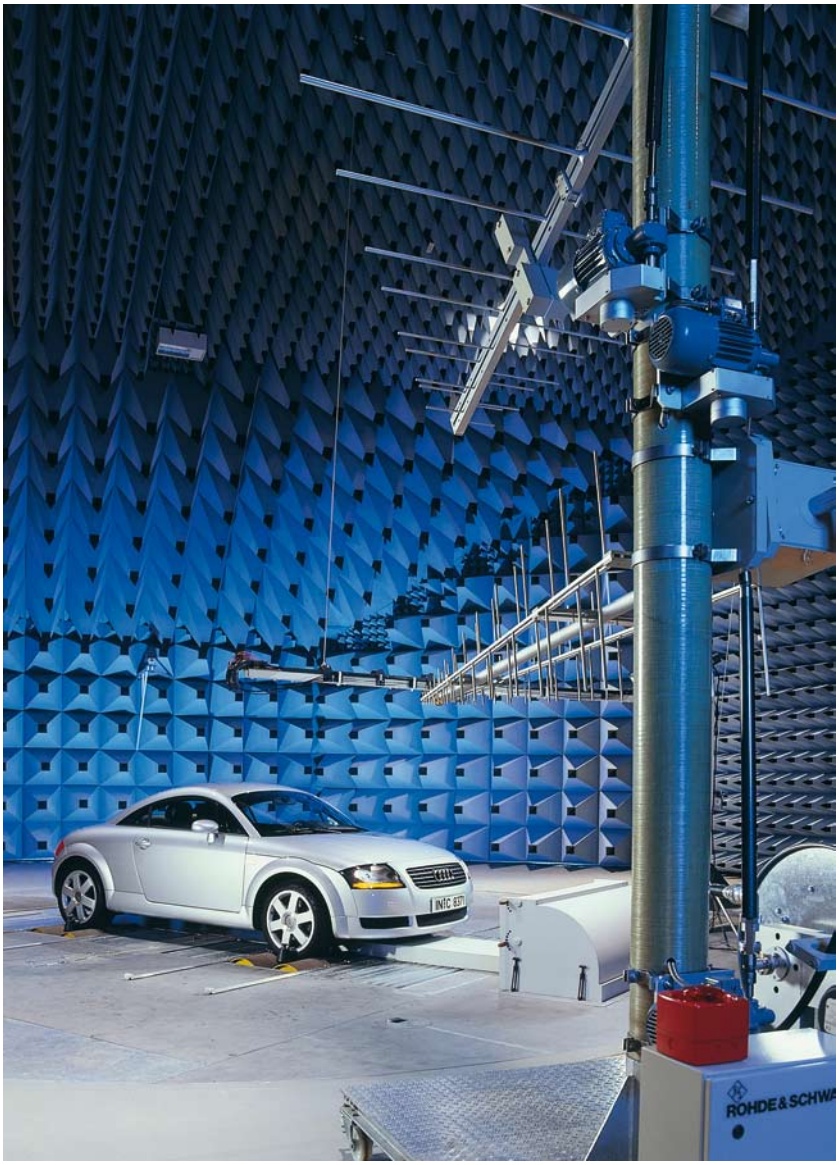
low the ISO 11451 and CISPR 25 standards. Apart from **electromagnetic interference (EMI) measurements** during which an antenna receives emissions from off-vehicle radiation sources, manufacturer standards are especially used for **electromagnetic susceptibility (EMS) measurements** between 10 kHz and 18 GHz at typical levels of 100 V/m or 200 V/m. The European Directive 95/54/EC (1995) and its revised version 2004/104/EC only specify field strengths of 30 V/m.

E/H field generators (FIG 1) are used in the frequency range up to 20 MHz. They consist of two conductors above the vehicle. Distance and height can be set. A transformer provides the correct matching. The two conductor groups are triggered in differential or in common mode which results in a vertical or horizontal polarization of the E field.

Log-periodic antennas are used particularly between 30 MHz and 1000 MHz (FIG 2). To increase the antenna gain, several individual antennas are usually installed one on top of the other above 220 MHz. And there are promising innovative methods that make use of broadband dipoles.

Above 1 GHz, horn antennas are used to create the wanted fields. Many manufacturer standards also require lightning stroke simulations using an E/H field generator. A special generator creates the LEMP pulse, which attains levels of up to 4 kV/m and has a rising edge of 1.2 µs and a fall time of 50 µs until half the level is attained.

FIG 2 Log-periodic antennas generate high field strengths.



43.350/3

The standard stipulates a distance of at least 2 m between the tip of the antenna and the reference point of the vehicle. Vehicle manufacturers prefer larger distances because they facilitate testing and enlarge illuminated areas. Amplifiers with powers up to 10 kW are usually used to attain the required high field strengths in the critical range up to 100 MHz. They call for extensive infrastructure work, e.g. a separate amplifier room in the vicinity of the antenna feed, a water-cooling or an adequately powerful air conditioning system. The line filters that supply such amplifiers must have sufficient dimensions.

Since the vehicles have to be measured from different directions and also be in the operating state, a turntable with an integrated chassis dynamometer is usually required to speed the vehicle up to 50 km/h. To manage special acceleration and braking cycles, the EMS software used must also be able to control the chassis dynamometer.

For vehicle tests, the absorbers on the walls must yield a sufficiently high return loss starting at 10 kHz. Since only absorbers of a certain length can fulfill this requirement, absorbers with

a length of approx. 2 m are used in such anechoic chambers. Although the ISO 11451-2 standard does not explicitly mention floor absorbers, they are definitely permitted for use.

Component testing

Before subjecting the complete vehicle to EMC tests, you first have to test the individual components. One of the tests, for example, is the susceptibility test, which is performed in chambers in accordance with ISO 11452-2. In this case, radiation is particularly applied to the cable harnesses of units with frequencies up to 1 GHz and also to the units themselves up to 18 GHz. The DUTs required for these tests are attached to a table with a metallic surface. The surface is bonded to the shielding with low DC resistance.

Neither the CISPR 25 nor the ISO 11452-2 standard specifically stipulate that the anechoic chamber has to be equipped with floor absorbers when testing components. In most cases, it is better not to use them since they obstruct the access to the test stand.

Increasing use of electronics in vehicles

In the early 90s, electronic modules in vehicles were first installed for the antilock braking system (ABS). In the meantime, the number of electronic components has drastically increased: They range from navigation systems and engine characteristic control to intelligent seat adjustment; from distance radar, steering and braking support to keyless entry. Networking of these numerous vehicle components ensures complex interaction yet provides excellent diagnostic options. In the past, a variety of analog sensors plus corresponding cabling had to be used to test vehicles. Today, bus systems such as CAN, MOST or FlexRay are used, which transfer data to the control modules and make monitoring considerably easier.

Some manufacturer-specific standards go far beyond ISO 11451 and ISO 11452 specifications. The GMW 3097 standard for component tests, for example, stipulates field strengths up to 600 V/m and the use of pulse modulation. Tests at such high field strengths are to prove the high reliability of components. Extremely powerful amplifiers are needed to generate such fields. The European Directive 95/54/EC (1995) stipulates only 30 V/m for components in anechoic chambers, the revised version of the Directive (2004/104/EC) only 25 V/m.

Driver assistance systems

Active safety facilities such as ABS and ESP have become more and more important in recent years. These facilities have to be subjected especially to thorough EMS tests. In addition to the chassis dynamometer, oncoming traffic also has to be simulated. Since a lot of space is needed for these tests, modern chambers are far larger than they used to be.

A chamber containing a turntable with a diameter of more than six meters represents a special challenge for generating the required field strengths. If the antenna in such a chamber is placed on the turntable to generate the required field strength from a favorable distance to the vehicle, you may have to move it aside prior to turning the table. If the antenna is not on the turntable, the field strength will be reduced due to the larger distance. Innovative designs get around these problems by having the antenna installed on a mobile and adjustable facility on the ceiling of the chamber.

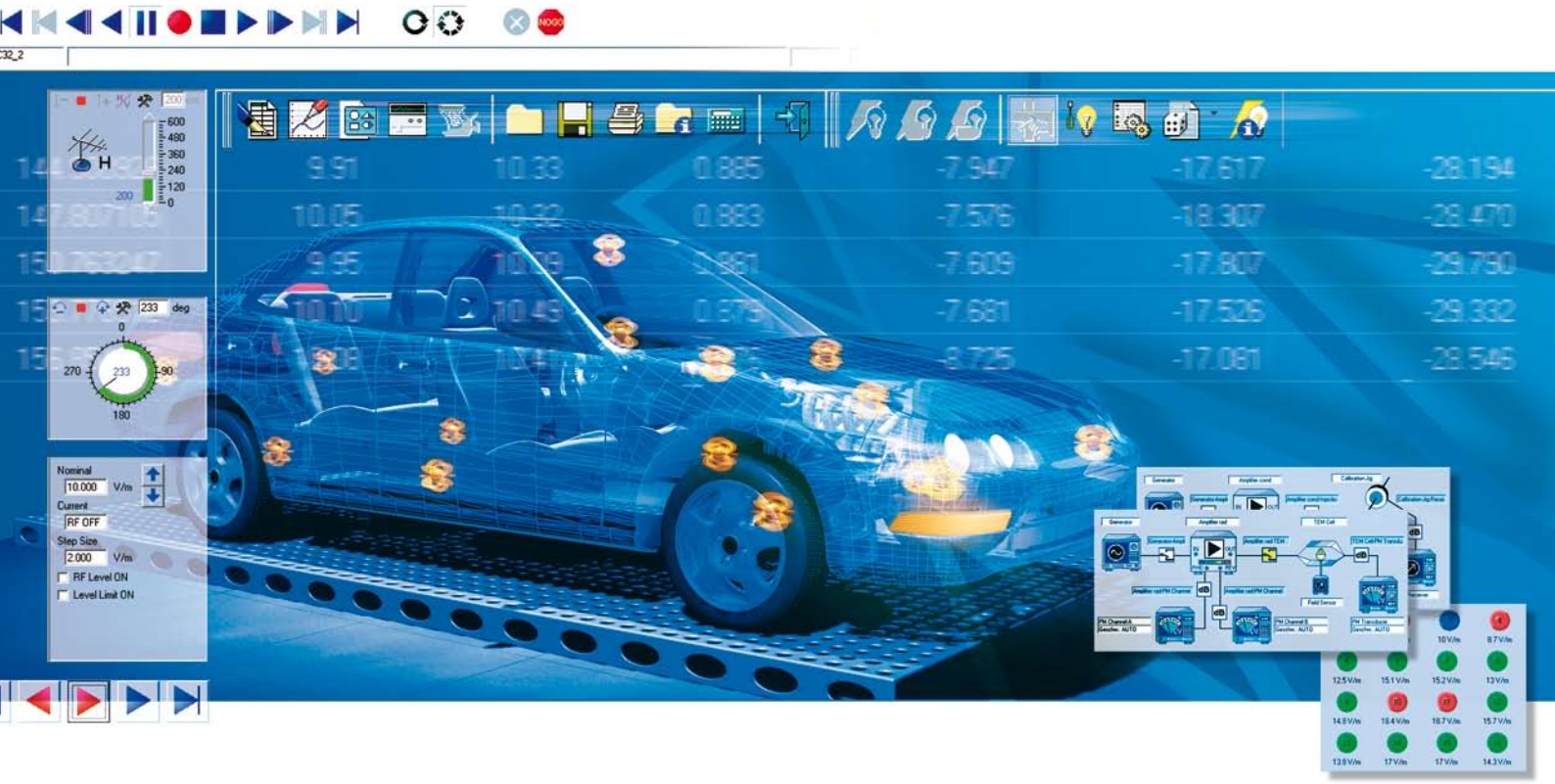
Reverberation chambers

Over the last few years, component tests have been made in reverberation chambers in accordance with American standards. Reverberation chambers are shielded rooms without absorbers. Electromagnetic waves in different modes are created by turning special stirrers. A transmit antenna radiates into a corner of the room while horizontal and vertical stirrers reverberate the created wave.

This method creates high field strengths at a relatively low amplifier power. However, you cannot predict which field strength is attained in a specific constellation of stirrers and frequencies at a particular spot in the room. Statistical evaluations and averaging over different stirrer positions thus have to be made to achieve conditions similar to an isotropic and homogeneous field.

The tried-and-tested Software R&S®EMC32 from Rohde & Schwarz supports EMS measurements in reverberation chambers including the required calibrations.

Dr Christoph von Gagern



EMC Measurement Software R&S®EMC32-S

Versatile EMS measurements for the automobile sector

EMC Measurement Software R&S®EMC32-S from Rohde&Schwarz together with its specific automotive extensions is a powerful tool that is specially tailored to measurements in the automobile sector in line with ISO 11451/2 standards and manufacturer-specific measurement procedures.

Communications and mobility are converging

With regard to technology, the 1990s featured a significant expansion of useful frequency ranges and the introduction of new modulation modes in wireless communications. At the same time, the percentage of electronic components used in the automobile sector rose steadily. In addition to fixtures such as airbags, ABS systems and traction control, which increase passive safety, it is hard to imagine automobiles without the auxiliary devices that make driving more convenient and enhance communications behind the wheel. In terms of electromagnetic compatibility, the merging of mobility and communications creates new challenges.

Mutual influence of electronic components in the vehicle must be excluded, and radiated disturbances from outside must not impair vehicle safety. For this reason, EMC measurements are performed when the vehicles and their electronic subassemblies (ESAs) are still in the development stage.

For this special field of applications in the automobile sector, Rohde&Schwarz has developed EMC Measurement Software R&S®EMC32-S as well as special automotive expansions. The new software, which is based on EMC Measurement Software R&S®EMC32 [*] launched in 2000, reflects Rohde&Schwarz's 20-plus years of experience in EMC measurements and the company's close cooperation with automobile manufacturers and suppliers.

Complete package for automobile EMS world

R&S®EMC32-S together with option R&S®EMC32-K1 (referred to as R&S®EMC32 in the following) supports measurements for determining the immunity to conducted and radiated signals of motor vehicles and ESAs. The intuitive, easy-to-operate user interface allows users to get a quick start (FIG 1).

The software's measurement philosophy is ideal for compliance and batch testing with a high EUT throughput as well as for measurements accompanying development. Consequently, the wide range of applications includes development and compliance testing as well as production and quality assurance.

For EMS measurements, the measurement procedures specified by the international standards ISO 11451 (for motor vehicles) and ISO 11452 (for components) are implemented in the software. The test setups for ISO 11451 / 2 preinstalled in R&S®EMC32 can be easily adapted to the instruments available in the laboratory interactively or by means of the integrated wizard and appropriate configuration files (FIGs 2 and 3). The online help provides step-by-step instructions from configuring the setup to performing the measurement.

Integrated control algorithms limit the susceptibility level during susceptibility tests, thus protecting the EUT and the test system against overloading.

Stimulating and monitoring EUTs

In addition to generating interference signals, the functions for monitoring and stimulating EUTs represent the second important task of EMS software. This task also forms the basis for automated measurements.

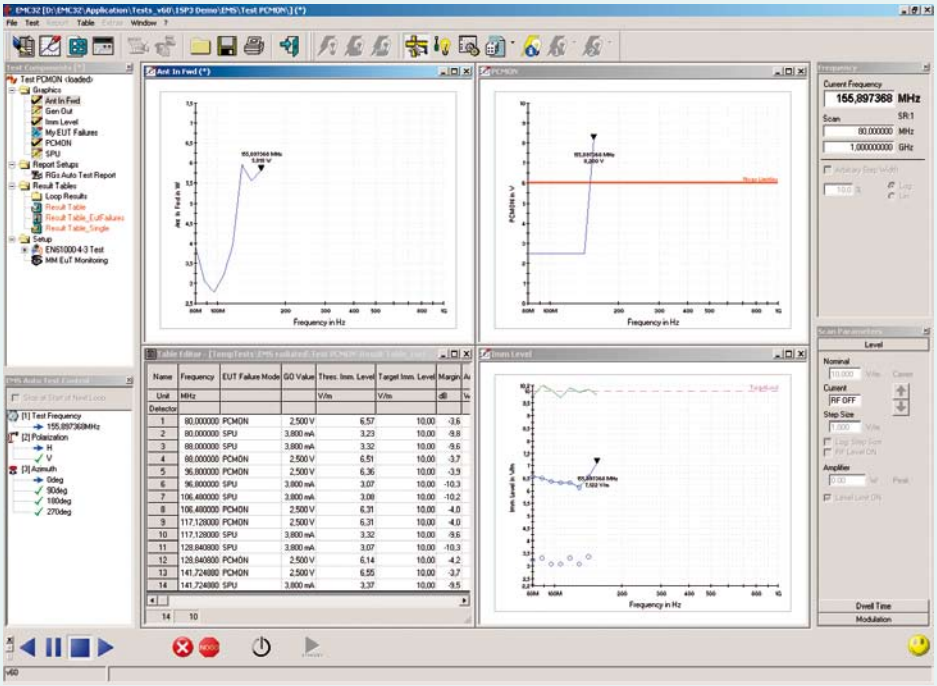


FIG 1 EMC Measurement Software R&S®EMC32 during a susceptibility test.

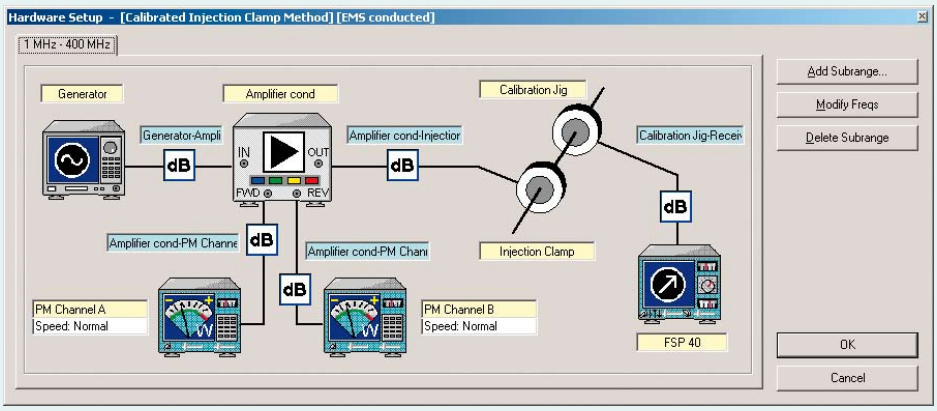


FIG 2 Device configuration for BCI measurements with a spectrum analyzer.

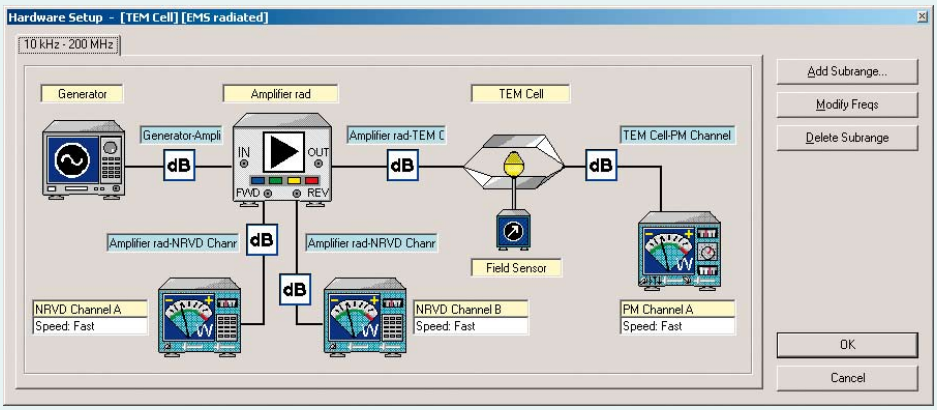


FIG 3 Device configuration for measurements in a TEM cell in accordance with ISO11452-3.

The following **integrated stimulation functions** in R&S®EMC32 allow the EUT to be controlled at defined times in the test sequence:

- Putting the EUT into a defined state (e.g. switching it on or off) when a measurement is started or stopped
- Triggering an action of the EUT at certain frequencies or at each test frequency and using the monitoring functions to check the EUT's response to the influence of the susceptibility parameter
- Resetting the EUT to a defined state after a malfunction has been detected

The software allows **fully automatic monitoring** of the EUT. For this purpose you can define monitoring channels that use defined threshold values or decision windows to provide a Go / NoGo statement as a function of test frequency and test level. The software displays the measurement results in tables and graphs. It also generates a table that only contains frequencies at which an error was detected.

FIG 4 shows the software's extensive interfaces and communications possibilities with the EUT. Communications can be on the basis of physical parameters (voltage, current, frequency, temperature) and by way of acoustic (sound level) or visual (camera) signals. A truly pioneering feature is the monitoring of the EUT via the vehicle's communications bus systems such as CAN, LIN, MOST or FlexRay.

Automatic determination of immunity thresholds

Even in the development phase, it is important to determine the characteristic of the maximum susceptibility as a function of frequency. This measurement can be automated using the extensive monitoring capabilities of R&S®EMC32.

The susceptibility measurement determines the immunity threshold both interactively via user entries and fully automatically based on the Go / NoGo information of EUT monitoring. If an EUT error occurs, the immunity threshold is reduced until the error disappears and is then increased again until the error reoccurs.

Simultaneous analysis of several parameters

Since the number of parameters to be tested in the automotive range is quite large, it is often desirable to analyze several error states at the same time. R&S®EMC32 determines the immunity threshold for up to ten different error states that are recorded manually. It also monitors all active monitoring channels in parallel and evaluates them separately. This means that the determined immunity threshold is recorded for each error mode. At the end of the measurement, R&S®EMC32 automatically creates a result graphic and a table that provide an overview of the immunity threshold of each subsystem (FIG 5). You can thus considerably reduce the test time, since the error can easily be assigned to the function or module level.

EMS Auto Test Sequencer R&S®EMC32-K4

To further automate testing to make the use of test chambers more cost-efficient, it is necessary to sequence the EUT test and have it run automatically via several parameters (loops), e.g.

- multiple modulation modes (CW, AM, FM, φM)
- multiple turntable positions
- multiple polarizations

In addition to the test results of the individual scans, a sum table of EUT errors will be created. An important aspect of automated test sequences is that the user is automatically informed of unexpected events, e.g. if an error occurs or if the test is terminated. R&S®EMC32 offers interfaces allowing you to send e-mails or SMS messages, depending on the local infrastructure.

Comprehensive driver package

A comprehensive driver package, which is standard with R&S®EMC32, is used for controlling the following equipment classes:

- Signal generators / analyzers
- Power meters
- Field-strength sensors
- Amplifier control units
- Switch units
- Mast and turntable control units

To ensure the use of existing systems or of instruments from other manufacturers, configuration files for the generic drivers supplied with R&S®EMC32 can be downloaded from the Rohde & Schwarz website for the following equipment classes:

- Signal generators
- Power meters
- Amplifier control units
- EUT monitoring

The website also provides an up-to-date overview of all drivers, sorted according to equipment classes, in table and graphic form.

Expansion through options R&S®EMC32-K2, -K3

There are new developments in the automobile sector as far as measurement requirements are concerned. The increasing use of wireless communications in vehicles (e.g. mobile phones, keyless entry as well as infotainment systems) calls for special EMC tests for these devices. The R&S®EMC32-K2

option supports the control of communications analyzers from Rohde & Schwarz, e.g. the R&S®CMU. Another test already required by some vehicle manufacturers in the USA is the EMS measurement in reverberation chambers, which is to be performed in accordance with their company standards. This method will become increasingly important in Europe and Asia, since vehicle manufacturers and suppliers operate globally. You can expand R&S®EMC32 by the R&S®EMC32-K3 module to perform this special test to meet innovative requirements.

Summary

EMC Measurement Software R&S®EMC32 is an outstanding all-in-one package for EMC measurements in the automobile sector. It features not only comprehensive functionality for stimulating and monitoring automotive components and motor vehicles but also standard-compliant generation of required immunity signals. With its modular structure, the software can be easily adapted to changes in standards or manufacturer-specific test procedures and allows new measurement instruments to be integrated. It is therefore a future-proof investment.

Robert M. Gratzl; Xaver Sutter

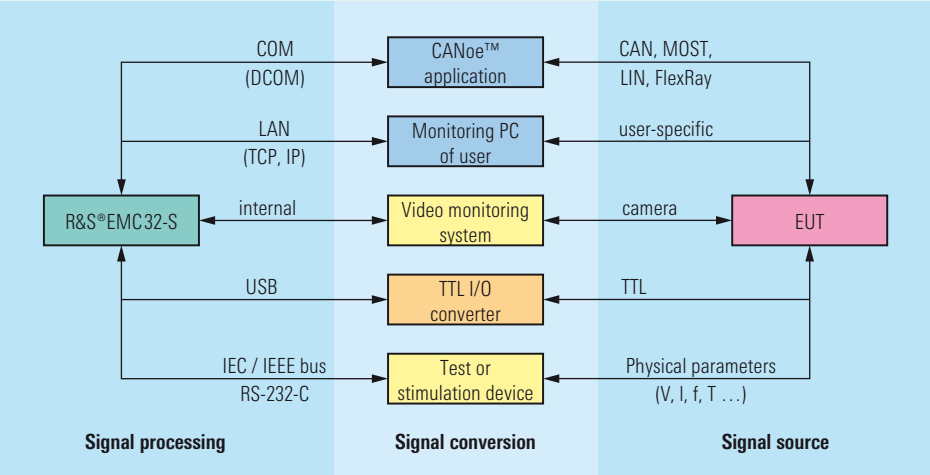
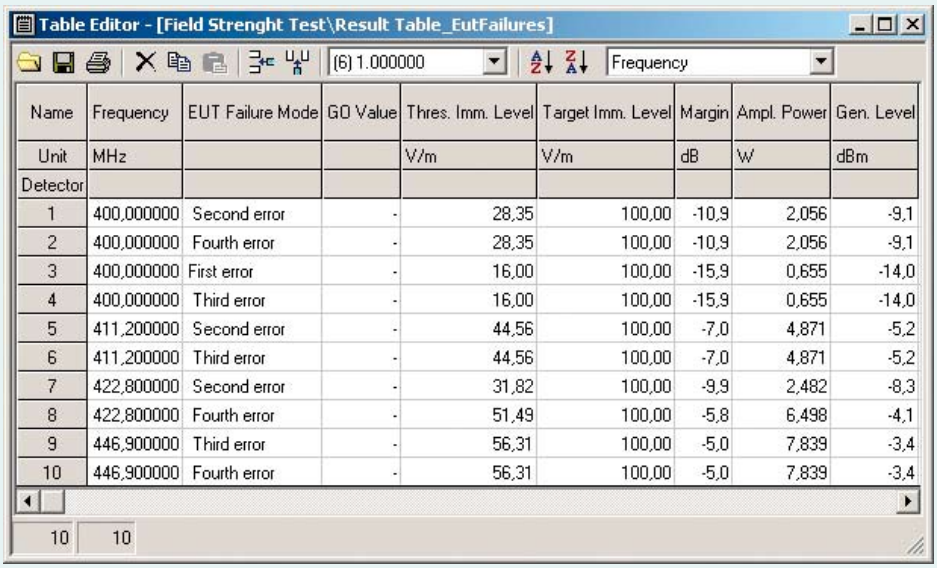


FIG 4 Overview of monitoring capabilities with EMC Measurement Software R&S®EMC32.



Name	Frequency	EUT Failure Mode	GO Value	Thres. Imm. Level	Target Imm. Level	Margin	Ampl. Power	Gen. Level
Unit	MHz			V/m	V/m	dB	W	dBm
Detector								
1	400,000000	Second error	-	28,35	100,00	-10,9	2,056	-9,1
2	400,000000	Fourth error	-	28,35	100,00	-10,9	2,056	-9,1
3	400,000000	First error	-	16,00	100,00	-15,9	0,655	-14,0
4	400,000000	Third error	-	16,00	100,00	-15,9	0,655	-14,0
5	411,200000	Second error	-	44,56	100,00	-7,0	4,871	-5,2
6	411,200000	Third error	-	44,56	100,00	-7,0	4,871	-5,2
7	422,800000	Second error	-	31,82	100,00	-9,9	2,482	-8,3
8	422,800000	Fourth error	-	51,49	100,00	-5,8	6,498	-4,1
9	446,900000	Third error	-	56,31	100,00	-5,0	7,839	-3,4
10	446,900000	Fourth error	-	56,31	100,00	-5,0	7,839	-3,4

10 10

FIG 5 Result of an automatic determination of immunity thresholds.

More information at www.rohde-schwarz.com (search term: EMC32)

REFERENCE

[*] EMC Measurement Software R&S®EMC32: Comprehensive EMI and EMS measurements at a keystroke. News from Rohde & Schwarz (2001) No. 172, pp 27–29

www.rohde-schwarz.com

Europe: customersupport@rohde-schwarz.com · **North America:** customer.support@rsa.rohde-schwarz.com · **Asia:** customersupport.asia@rohde-schwarz.com

Test and Measurement Solutions for the Automotive Industry · PD 5213.6935.62 Version 01.00