R&S®TS6710 TRM
Radar Test System
The all-in-one solution
for efficient
RF characterization
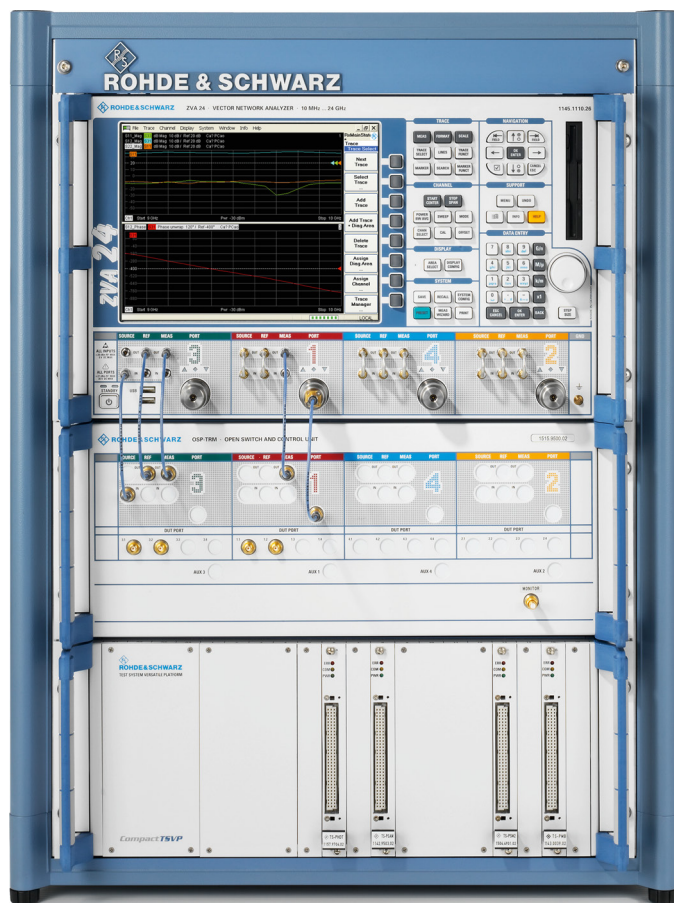

ROHDE & SCHWARZ

R&S®TS6710 TRM Radar Test System
At a glance

The R&S®TS6710 test system allows manufacturers of state-of-the-art AESA radar equipment to perform fast, automatic RF measurements on transmit-receive modules (TRM) in development and production. The test cases supplied with the system are adapted to customer requirements, e.g. to allow automatic control of the module.

State-of-the-art AESA radars contain several thousand TRMs each, and each TRM must be tested separately during development and production. To handle the large number of different measurements and measurement values involved, testing requires a high degree of automation.

The R&S®TS6710 is an all-in-one solution that offers extremely short test times for ensuring the high throughput required in production. In addition, it allows measurements to be flexibly configured for development. These capabilities help the manufacturer develop modules, reduce production cycles and make production more efficient.

Optimum test performance is achieved by specifically adapting the test cases on the basis of the supplied source code, either by Rohde & Schwarz or by experts of the customer. Since the test details can be adapted by the customer, it is easy for customers to protect their intellectual property rights. Because of the wide parameter ranges, the R&S®TS6710 supports the measurement of TRMs for diverse applications, e.g. due to its wide frequency range for future broadband radar equipment.

Key facts
▮ Frequency range from 1 GHz to 24 GHz
▮ Very short test times, e.g. typ. 15 s per module in production
▮ Optional extension to eight DUTs per test system
▮ Test sequencer for user-configurable test runs
▮ Standard test cases with complete source code
▮ Custom optimization of tests
▮ Turnkey solution from a single source
▮ Based on Rohde & Schwarz standard components
  ‣ R&S®ZVA high-end network analyzer for RF measurements
  ‣ R&S®CompactTSVP for fast communications with the TRM
  ‣ R&S®OSP-TRM for RF signal conditioning and DUT multiplexing

The R&S®TS6710 (low rack height). For systems with full rack height, see photo on front page.

R&S®TS6710 TRM Radar Test System
Benefits and key features

Future-ready system concept
ı Turnkey solution from Rohde & Schwarz ensures quality and long-term support
ı System design based on standard equipment reduces cost of ownership
ı Protection of intellectual property rights of TRM and radar
ı On-site test optimization through adaptation of supplied source code
▷ page 4

Efficient testing
ı High measurement speed
ı Optional extension to eight DUTs per test system
ı Integrated test report generator for easy evaluation of results
ı Export of measurement results in standard formats for easy processing
▷ page 6

Flexible use
ı For development and production
ı Fast adaptation to measurement task through parameterized test sequence
ı Ready-made test cases
ı Custom adaptation, e.g. of transmit power and frequency range
▷ page 8

What is an AESA?
AESA stands for active electronically scanned array and refers to radar equipment with active electronic beam steering. An AESA consists of a multitude of transmit-receive modules (TRMs) and the associated antenna elements. The radar beam is oriented and focused by phase shifting between the individual modules on the antenna surface. The advantages of AESA are fast beam steering, the detection of multiple targets and the absence of moving parts. In addition, an AESA provides high redundancy if individual modules fail.

What is a TRM?
The transmit-receive module (TRM) contains the main elements of the radar frontend: controllable attenuator and phase shifter for orienting and focusing the radar beam, power amplifier for transmission and low-noise amplifier for reception. It also includes additional components for switching between transmission and reception, for controlling and for limiting, for example. The radar antenna consists of thousands of TRMs and the associated antenna elements.
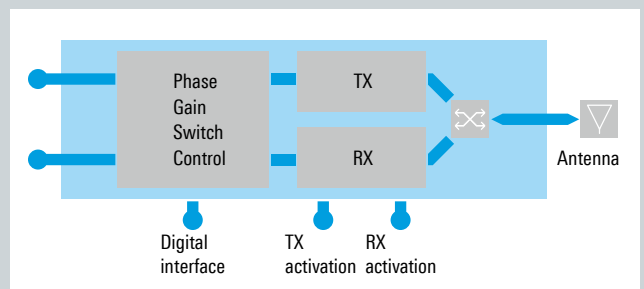
Block diagram of a TRM.

Future-ready system concept

Turnkey solution from Rohde & Schwarz ensures quality and long-term support

Rohde & Schwarz has been a partner of the aerospace and defense (A & D) industry for many years and supplies not only test and measurement equipment but also complete turnkey test systems. Consequently, the company has ample experience regarding the documentation and quality requirements of A & D customers for these types of projects. As a system and instrument supplier, Rohde & Schwarz can also ensure the long-term availability and compatibility of the system and its components, especially because the equipment used is already being deployed in production at many companies.
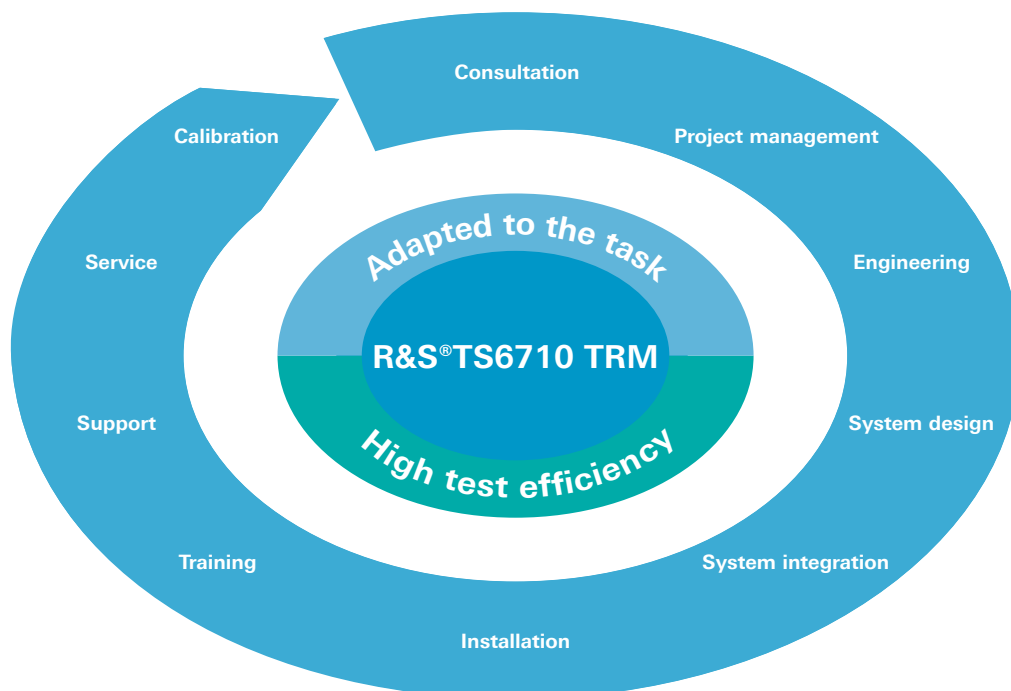
System design based on standard equipment reduces cost of ownership

State-of-the-art measuring equipment was used to reduce the system to just three standard hardware components. These components cover all tests, including module control and module power supply. This simplifies servicing and calibration. Performing service and calibration work in local Rohde & Schwarz centers saves time and money and increases availability.

Protection of intellectual property rights of TRM and radar

Typically, the R&S®TS6710 must be individually adapted to the customer test specification, at least regarding module control.

Turnkey solution from a single source

Diagram showing concentric rings around central "R&S®TS6710 TRM" labeled "Adapted to the task" and "High test efficiency". Outer ring labels: Consultation, Project management, Engineering, System design, System integration, Installation, Training, Support, Service, Calibration.
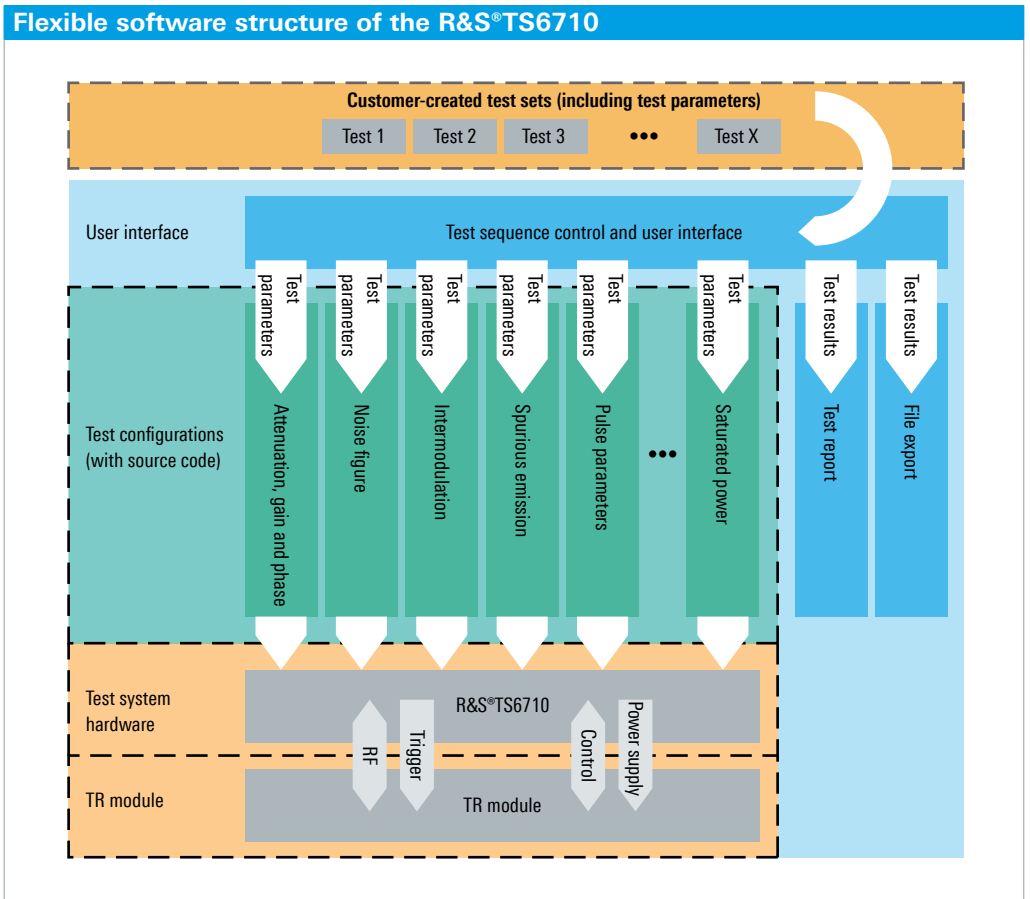
The protection of the technical data of the module and of the entire radar system is of high significance throughout such a project.

There are different alternatives for optimally adapting the R&S®TS6710 to a TR module:
▮ Complete integration at Rohde & Schwarz, including test case and time optimization under agreed confidentiality measures
▮ Integration and test of digital module control at Rohde & Schwarz based on an interface simulator; optimization with TRM at customer site either by Rohde & Schwarz or by the customer
▮ Software implementation of digital module control at Rohde & Schwarz. All TRM tests including optimization are carried out on-site

On-site test optimization through adaptation of supplied source code

The experience of the customer's software and test experts plus the expertise and test cases from Rohde & Schwarz make it possible to optimally structure the tests. This is why the C# source code comes with the test cases. The source code enables the customer or Rohde & Schwarz to flexibly adapt the test sequences and to optimize them on-site.

Flexible software structure of the R&S®TS6710

Customer-created test sets (including test parameters)

Test 1   Test 2   Test 3   •••   Test X

User interface — Test sequence control and user interface

Test configurations (with source code)

Test parameters: Attenuation, gain and phase | Noise figure | Intermodulation | Spurious emission | Pulse parameters | ••• | Saturated power

Test results: Test report | File export

Test system hardware — R&S®TS6710

RF | Trigger | Control | Power supply

TR module — TR module

Efficient testing

High measurement speed

With several thousand TRMs per radar system and typically 25 000 individual measurement values for the complete characterization of a TRM, test speed is a critical and crucial parameter.

High-speed measuring equipment such as the R&S®ZVA and the R&S®CompactTSVP alone is not enough. It is the test routines that make the difference. They use the speed advantage provided by the Rohde & Schwarz equipment and are combined into a consistently optimized test sequence. This results in the extremely short test times of the R&S®TS6710 without compromising measurement accuracy.

The exact time for testing a module depends on various parameters and will therefore be specified in detail in the project.

Optional extension to eight DUTs per test system

This extension can be achieved in two different ways:
▮ Simultaneous testing of two TRMs[1], which practically halves the test time per module
▮ Multiplexing between four test fixtures each

Multiplexing means that more DUTs can be inserted into other test fixtures during a measurement to ensure continuous testing. This optimizes system utilization in production. In addition, this facilitates comparison testing on DUTs where multiple TRMs are combined to form a functional unit.

The R&S®OSP-TRM and the R&S®CompactTSVP are already prepared for this type of testing so that the base test platform can be maintained and future retrofitting is easy.

[1] Parallel testing comprises all tests except intermodulation measurements. Intermodulation is measured sequentially because the two internal signal sources of the R&S®ZVA are used for each module.

Typical test times

Mode	Test	Parameter	Number of test points	Typical test time
RX + TX	complete characterization		25 000 measurement values	4 min
RX + TX	measurement of main parameters	typical test in production	2500 measurement values	15 s

## Extension for eight TRMs with parallel testing of two modules
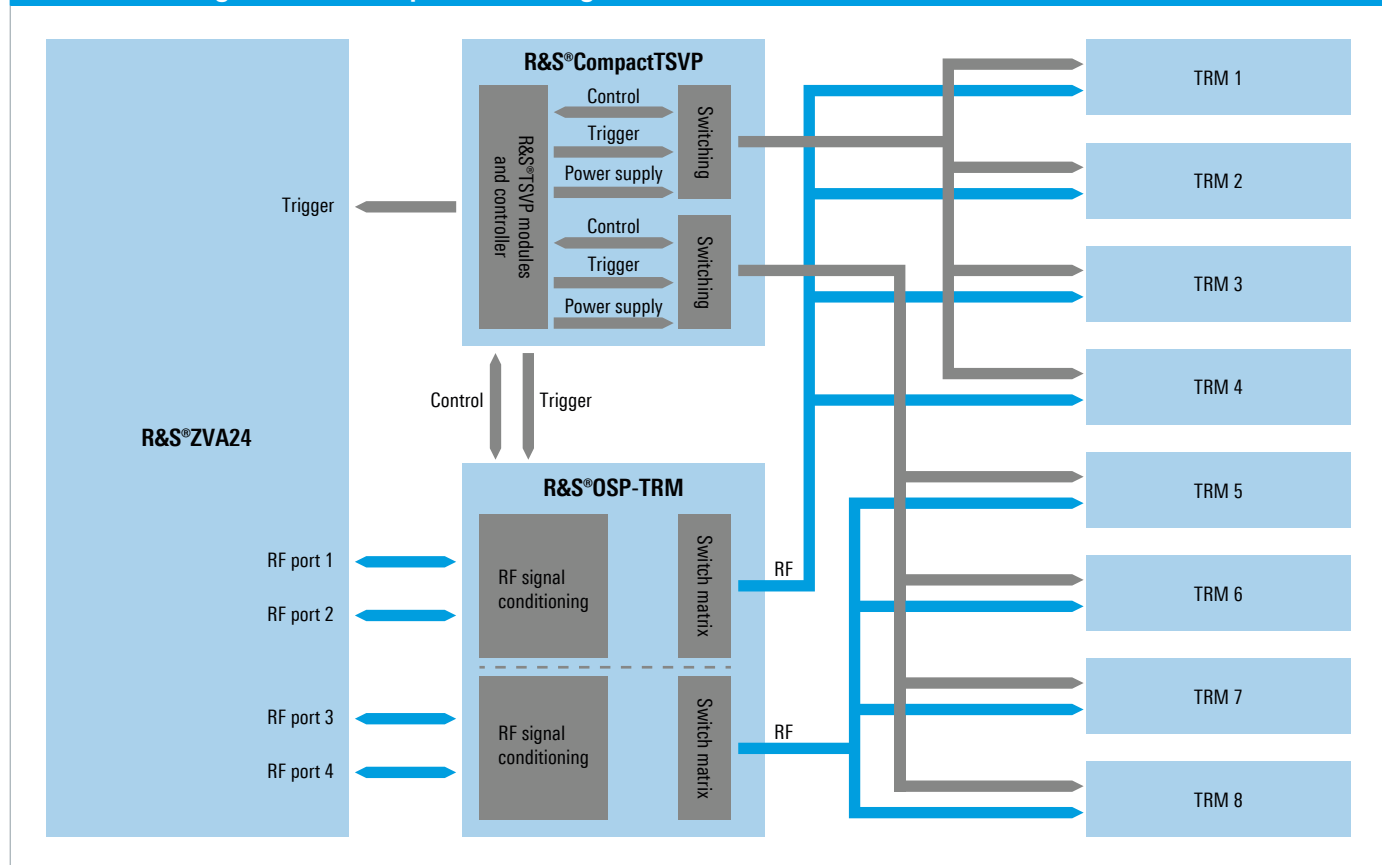
Integrated test report generator for easy evaluation of results

The report generator that is integrated into the test sequencer not only generates test documentation, but it also provides a color-coded pass/fail representation for fast visual evaluation and displays the results in clearly structured tables and graphics.

Export of measurement results in standard formats for easy processing

For documentation and subsequent analysis, the measurement results are stored in database systems. The data is available as PDF or XML and CSV files, which can be opened and processed with a wide variety of applications.

The R&S®TS6710 TRM report generator with tabular display.
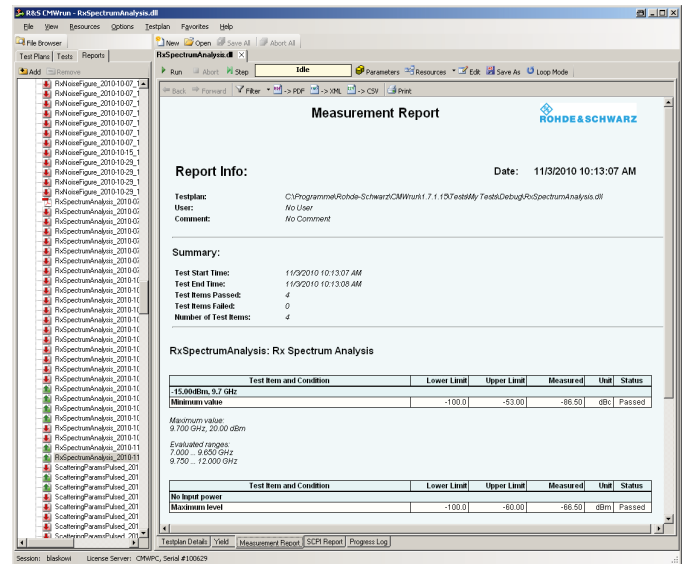
Graphical representation of results.
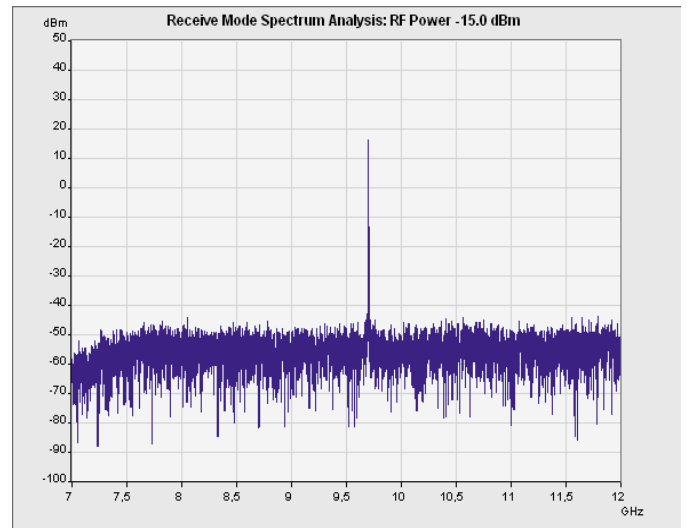
Flexible use ...

For development and production

By combining and parameterizing the tests in the test sequencer, the R&S®TS6710 easily and quickly covers the measurement task at hand: from the complete testing of a module and the repeated measurement of some parameters during module optimization to fast measurements in production. This consistent test concept also ensures that test results from development and production can be compared with each other.

Fast adaption to measurement task through parameterized test sequence

In the test sequencer, the individual tests can be combined into test sequences and the configurations can be stored. It is also possible to select and deselect individual lower-level tests by a mouse click and to configure the detailed test parameters. This allows the tests to be adapted quickly and flexibly to the specific measurement task.

In this way, the test can be reduced to a few parameters when a component has to be optimized in development and can be expanded again in order to determine the influence on the overall performance.

The customer can specify which parameters must be available for which test.

Detailed test settings.
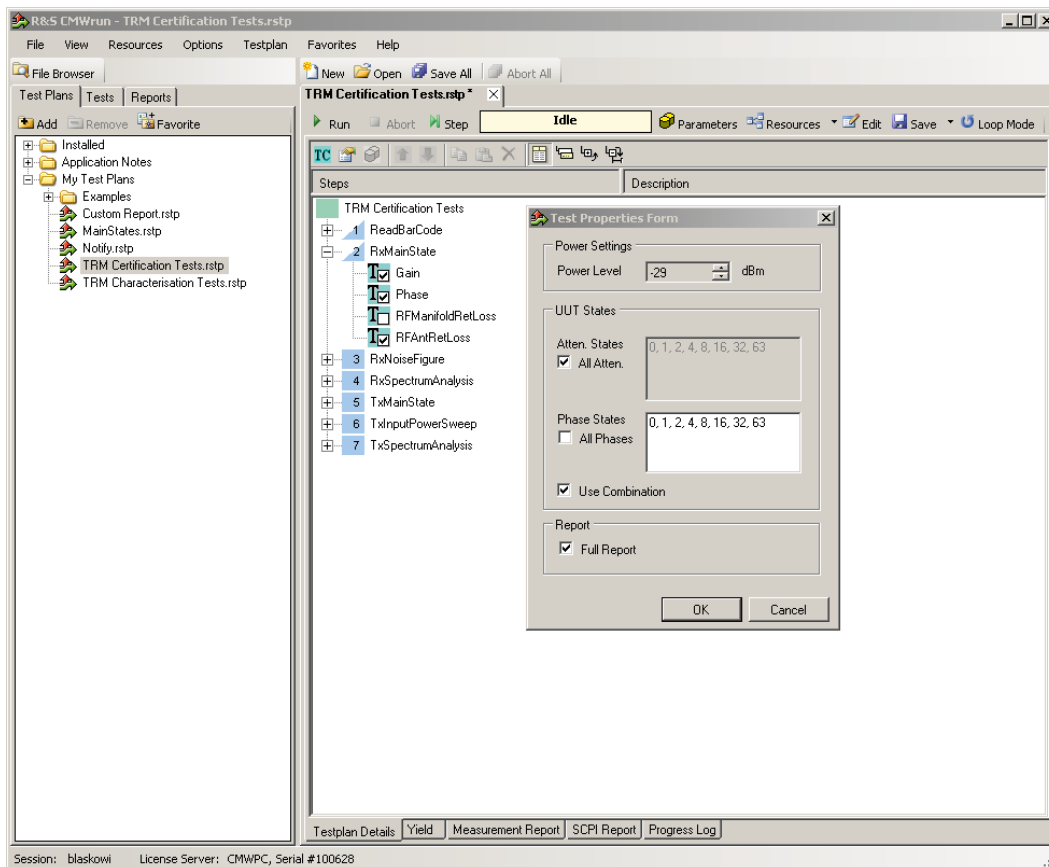
Ready-made test cases

The R&S®TS6710 includes ready-made test cases for common TRM tests. These preconfigured tests are designed for high measurement speed and accuracy.

The customer's experienced developers, for example, can adapt them to the specific requirements of the module under test, e.g. control and timing, and optimize their performance.

Some of the tests supplied with the system include:

RX mode	TX mode
▮ S-parameters for attenuation and phase combinations	▮ S-parameters for attenuation and phase combinations
▮ Noise figure	▮ Output power and saturated power
▮ Intermodulation	▮ Spurious emissions

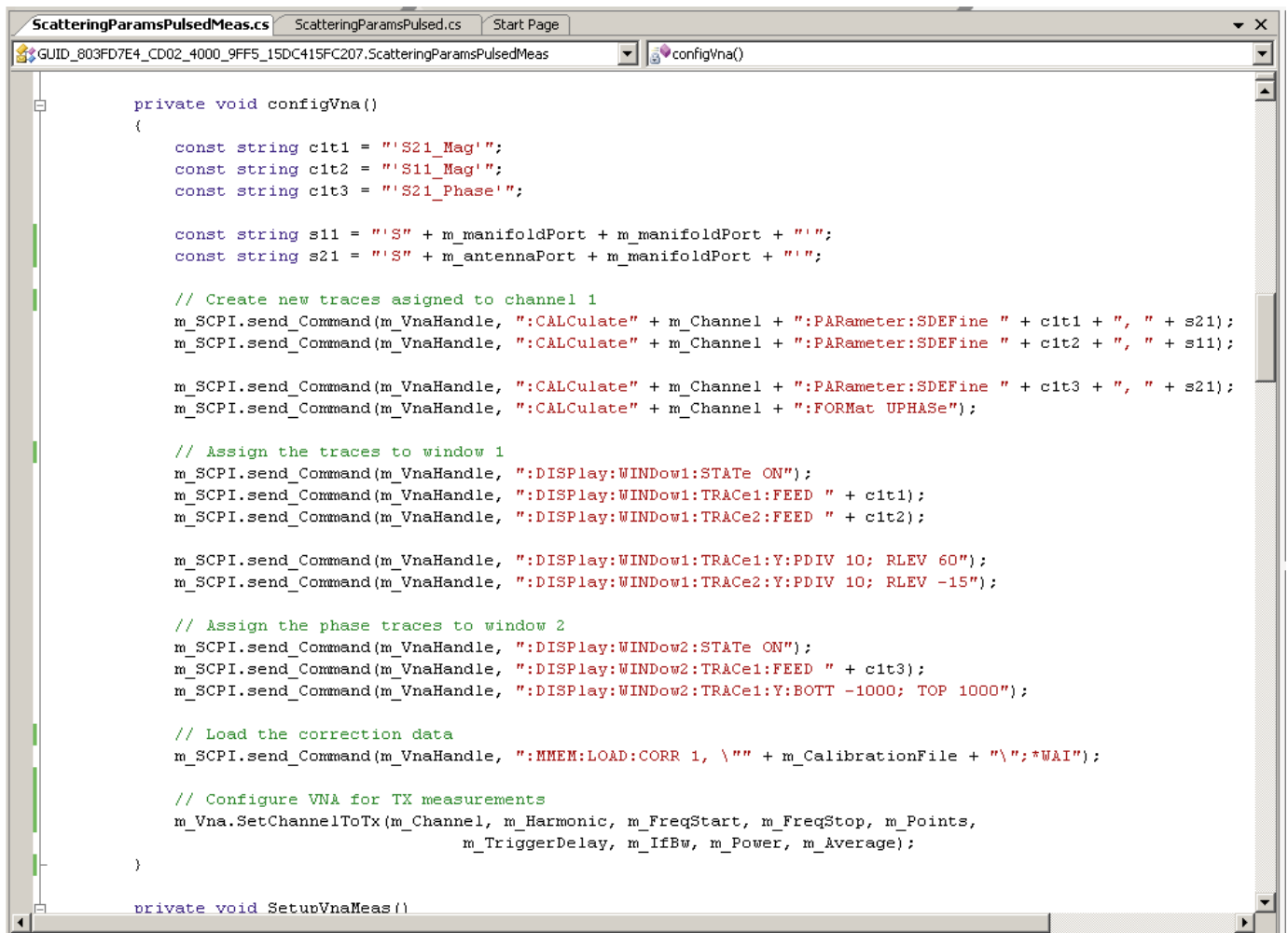## Custom adaptation, e.g. of transmit power and frequency range

Due to the application versatility of AESA radars, i.e. from satellite-based SAR radar and long-range radar to battlefield radar, the demands placed on the modules differ depending on the application.

That is why the customer, together with Rohde & Schwarz, can use the state-of-the-art R&S®TS6710 platform to perform specific measurement tasks as well as standard tests. This includes the setup for special frequency ranges or tests requiring additional hardware and software.

Examples are:
▮ Higher transmit power of the TRM
▮ Measurement of spurious emissions > 24 GHz
▮ Recovery tests

C# programmed test cases with source code.


```
ScatteringParamsPulsedMeas.cs    ScatteringParamsPulsed.cs    Start Page

GUID_803FD7E4_CD02_4000_9FF5_15DC415FC207.ScatteringParamsPulsedMeas          configVna()

            private void configVna()
            {
                const string c1t1 = "'S21_Mag'";
                const string c1t2 = "'S11_Mag'";
                const string c1t3 = "'S21_Phase'";

                const string s11 = "'S" + m_manifoldPort + m_manifoldPort + "'";
                const string s21 = "'S" + m_antennaPort + m_manifoldPort + "'";

                // Create new traces asigned to channel 1
                m_SCPI.send_Command(m_VnaHandle, ":CALCulate" + m_Channel + ":PARameter:SDEFine " + c1t1 + ", " + s21);
                m_SCPI.send_Command(m_VnaHandle, ":CALCulate" + m_Channel + ":PARameter:SDEFine " + c1t2 + ", " + s11);

                m_SCPI.send_Command(m_VnaHandle, ":CALCulate" + m_Channel + ":PARameter:SDEFine " + c1t3 + ", " + s21);
                m_SCPI.send_Command(m_VnaHandle, ":CALCulate" + m_Channel + ":FORMat UPHASe");

                // Assign the traces to window 1
                m_SCPI.send_Command(m_VnaHandle, ":DISPlay:WINDow1:STATe ON");
                m_SCPI.send_Command(m_VnaHandle, ":DISPlay:WINDow1:TRACe1:FEED " + c1t1);
                m_SCPI.send_Command(m_VnaHandle, ":DISPlay:WINDow1:TRACe2:FEED " + c1t2);

                m_SCPI.send_Command(m_VnaHandle, ":DISPlay:WINDow1:TRACe1:Y:PDIV 10; RLEV 60");
                m_SCPI.send_Command(m_VnaHandle, ":DISPlay:WINDow1:TRACe2:Y:PDIV 10; RLEV -15");

                // Assign the phase traces to window 2
                m_SCPI.send_Command(m_VnaHandle, ":DISPlay:WINDow2:STATe ON");
                m_SCPI.send_Command(m_VnaHandle, ":DISPlay:WINDow2:TRACe1:FEED " + c1t3);
                m_SCPI.send_Command(m_VnaHandle, ":DISPlay:WINDow2:TRACe1:Y:BOTT -1000; TOP 1000");

                // Load the correction data
                m_SCPI.send_Command(m_VnaHandle, ":MMEM:LOAD:CORR 1, \"" + m_CalibrationFile + "\";*WAI");

                // Configure VNA for TX measurements
                m_Vna.SetChannelToTx(m_Channel, m_Harmonic, m_FreqStart, m_FreqStop, m_Points,
                                     m_TriggerDelay, m_IfBw, m_Power, m_Average);
            }

            private void SetupVnaMeas()
```
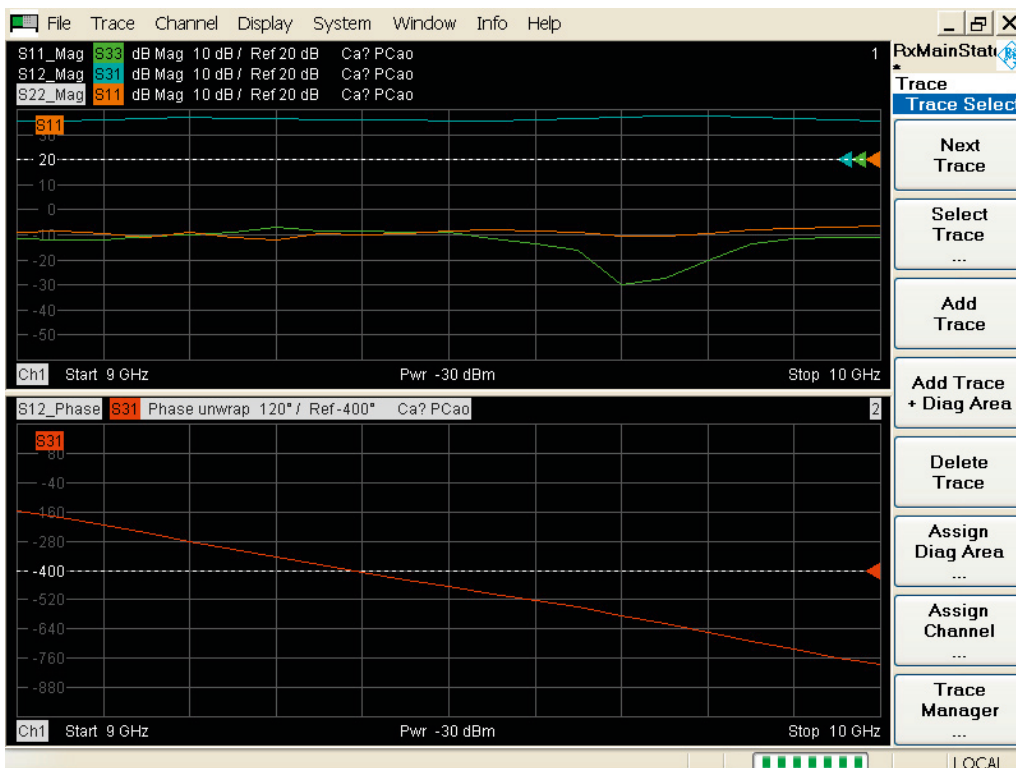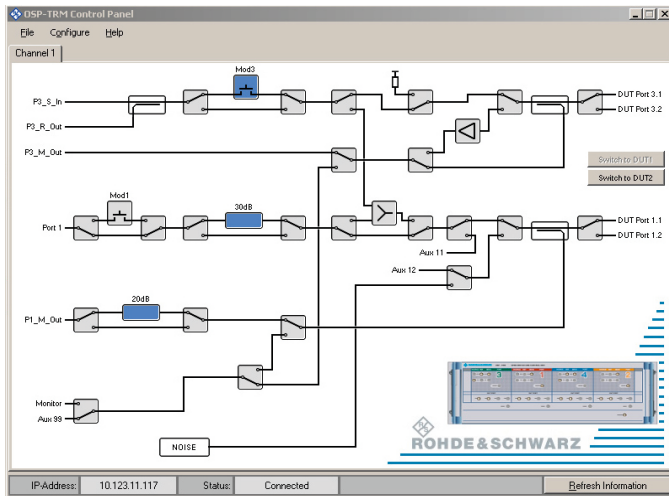
... including manual measurement

For non-standard measurement tasks such as interactive optimization of modules or measurement of special component parameters, the measurement can be carried out completely manually – without any automation.

The R&S®ZVA network analyzer and a mouse are used to manually operate the R&S®OSP-TRM for switching the signal paths. A separate graphical user interface is available for this purpose. It is possible to select individual relays and to save and recall complete signal paths. The module is controlled via a separate test case in which the relevant module parameters are selected individually and manually.

As a result, the system can easily carry out special measurements beyond the test cases. In addition, the parameters for new measurements can first be optimized manually before the customer generates a new test case.

R&S®OSP-TRM control.

For manual measurements, all R&S®ZVA and R&S®OSP-TRM system components and module control via the R&S®CompactTSVP can be operated separately.

Specifications

Specifications in brief		
RF specifications		
Frequency range		1 GHz to 24 GHz
Max. output power of TRM	5 µs pulse width, max. 2.5% duty cycle	50 W
Max. output power of test system		–2 dBm
Dynamic range of spurious-emission measurement		≤ –60 dBc
Resolution	measurement of pulse shape	30 ns
Typical test times	complete characterization (25 000 measurement values)	< 4 min
	measurement of key parameters (2500 measurement values, typ. for production)	< 15 s
TRM control		
Digital control of TRM		▪ 40 MHz clock rate ▪ programmable level ▪ on-board storage of digital commands up to 64M pattern ▪ realtime evaluation of response
DUT power supply	multichannel with current measurement	≤ 50 V/50 W
General data		
Operating temperature range		+5 °C to +40 °C
Power supply		max. 800 W
Dimensions (W × H × D)	other rack heights also available	600 mm × 1970 mm × 800 mm (23.62 in × 77.56 in × 31.50 in)
Weight		250 kg (551.16 lb)

Ordering information

Designation	Type	Order No.
TRM Radar Test System	R&S®TS6710	1516.4001.02

Your local Rohde & Schwarz expert will help you determine the optimum solution for your requirements.

To find your nearest Rohde & Schwarz representative, visit
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About Rohde & Schwarz

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

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

Certified Quality System
ISO 9001

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