EMC measurements up to 40 GHz with Microwave Signal Generator SMP

Apart from an RF signal of high spectral purity and precisely adjustable output power, signal generators for EMC measurements require top-quality AM and pulse modulation, spike-free frequency and level sweeps and last but not least a mature operating concept permitting automatic measurement sequences to be performed with or without an external controller. The microwave generators from the SMP family set the standards – as do all other signal generators from Rohde & Schwarz. Four models and a comprehensive range of options are available from which the user may choose the equipment he needs – tailored to his specific requirements – at an excellent and unrivalled price/performance ratio [1 to 3].

FIG 1 Signal Generator SMP and GTEM (gigahertz transverse electromagnetic) cell – an up-to-date combination for susceptibility measurements
Photo 42 574

The term **electromagnetic compatibility** (EMC) is very apt: if people are compatible they can work together easily and effectively without anyone disturbing anyone else, and the same applies to electrical devices. Certain ground rules must be observed in any partnership and this is why EMC standards and suitable measuring instruments were developed at a very early stage. However, the frequency range did not go beyond 1 GHz as this was all that was required for all the main activities of modern radiocommunication. The range beyond 1 GHz was generally reserved for military and scientific applications.

The need for EMC testing has always been appreciated by forward-looking manufacturers of top-quality electronic devices and systems. The end of the transition period for the CE mark at the beginning of this year would not have been a reason to implement any major changes as EMC awareness was already considered good practice. The **EMC test equipment** used today derives from equipment for military applications, where sensitive receivers, powerful transmitters and noisy engines have always had to operate in close proximity without interfering with one another. Compatibility principles were, therefore, defined and appropriate test equipment developed. Adapted to present-day requirements, these principles are now the basis of current national and international EMC regulations.

As said already, mature **standards and test specifications** are currently available for civil and military applications in the range up to 1 GHz. Military standards still apply to higher frequencies, although lately more and more civil applications are transferring to this range. Examples can be found in satellite communications as well as in automobile and aeronautical engineering. It can be assumed, therefore, that standards for EMC tests will be extended to 40 GHz in the near future. New top-class technology at an affordable price will obviously be required

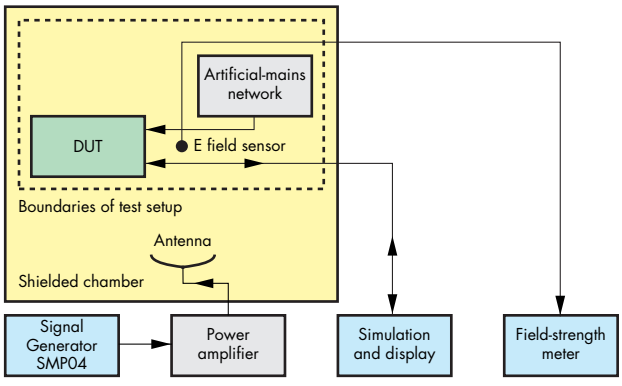


FIG 2 Measurement of immunity to radiated interference from 1 to 40 GHz using Signal Generator SMP (to MIL-STD-462D). Signal Generator SMP04 (10 MHz to 40 GHz) is used as stimulator, EMI Test Receiver ESMI with Harmonic Mixer FS-Z40 for display purposes and field-strength measurements.

Selection of currently valid military and civil EMC standards for the microwave range

Standard	Designation	Description	Microwave range	Application
MIL-STD-461D/462D RES103	Radiated Emissions, Antenna Spurious and Harmonic Outputs	Measurement of harmonics and spurious emissions from antennas	1 to 40 GHz	Military (USA)
MIL-STD-461D/462D RES103	Radiated Susceptibility, Electric Fields	Measurement of immunity to radiated RFI (electric field)	1 to 40 GHz	Military (USA)
DEF STAN 59-41 (PART 3), DRS03	Radiated Susceptibility	Measurement of immunity to radiated RFI	0.79 to 18 GHz	Military (UK)
VG 95 370/VG 95 373, Teil 13, Messverfahren SF 04 G	Messverfahren für Störsicherheits-abstände gegenüber systemeigenen Feldstärken	Measurement of immunity to radiated RFI	1 to 40 GHz	Military (Germany)
SAEJ1113 Part 21	Semi-anechoic Chamber	Measurement of immunity to radiated RFI	0.03 to 18 GHz	Vehicle test (USA)
ISO 11451-2/ ISO 11452-2	Road vehicles – Electrical disturbances by narrowband radiated electromagnetic energy – vehicle test methods – Part 2: Off-vehicle radiation sources	Measurement of immunity to radiated RFI	0.2 to 18 GHz	Vehicle test (international)
EN 50083-2	Cabled distribution systems for television and sound signals – Part 2: Electromagnetic compatibility for equipment	Measurement of radiated interference (substitution method)	1 to 25 GHz	Telecommunications, TV and sound broadcasting (Europe)

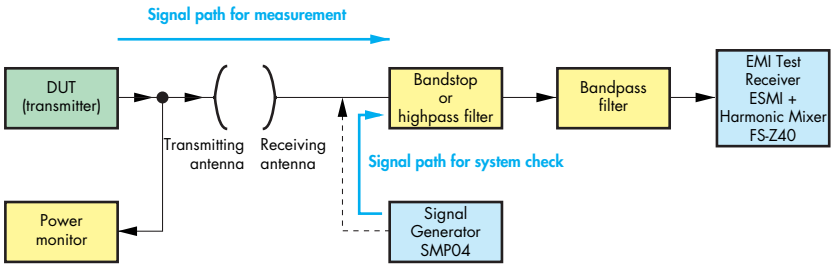
and is already available in the form of generator family SMP (FIG 1) from Rohde & Schwarz with models from 10 MHz/2 GHz to 20, 27 and 40 GHz. The table in the blue box gives a selection of current military and civil EMC standards covering 1 to 40 GHz.

A glance at the standards shows the main fields of application for microwave signal generators. First, there are **measurements of immunity to radiated interference** – also known as susceptibility measurements. In this case the signal generator usually drives a power amplifier with an appropriate bandwidth connected to an antenna emitting the signals for irradiating the DUT (FIG 2). Depending on the requirements, the DUT's functions should not be impaired at all or only within certain defined limits. In particular, there may be DUT resonances at the high-frequency end of the microwave band: small slits in the housing or short line structures in circuits or on PCBs may act as high-Q resonators and cause total failure in an extremely narrow frequency range. Thanks to SMP's digital sweep such resonance points can be rapidly and reliably detected, the smallest settable increment being 0.1 Hz. The excellent frequency stability also ensures that measurements can be reproduced. Any DUT malfunction can be found and demonstrated at a later date. Another important advantage of the SMP sweep is that there are no level spikes. Level spikes may destroy any power amplifier down-stream or even the DUT and will certainly cause measurement errors.

Another main application of microwave signal generators is the **calibration of test setups,** as shown in FIG 3. Prior to the actual measurement, the signal generator is used to calibrate the level display of the test receiver. Obviously, the accuracy and stability of the generator level have to meet stringent requirements. Thanks to an over-designed ALC system and careful instrument calibration in the factory, this is no problem for generators from the SMP family. The test receiver used in test setups like that shown in FIG 3 can also be calibrated by applying the generator signal to the receiver via an antenna and not via a cable [2]. This means that the transfer characteristics of the receiving antenna are also taken into account.

Normally, frequency drifts in RF cables, power amplifiers and the antenna of the test setup cause considerable level errors. This cannot be avoided in spite of the excellent level accuracy of SMP (typical error 0.1 dB). Fortunately, SMP does have a number of **functions for frequency response correction:**

FIG 3 Measurement of radiated harmonics and spurious from 1 to 40 GHz to MIL-STD-462D using Signal Generator SMP and EMI Test Receiver ESMI



- user correction for a user-defined RF frequency response,
- memory sequence, a programmable sequence of complete front-panel setups,
- list mode, a programmable sequence of up to 2003 frequency/level pairs,
- and, last but not least, external level control using an external power meter [4].

When SMP is operated manually, ie without an external controller, it is best to use the user correction function to correct the overall frequency response. If a Power Meter NRVS or NRVD is available, the required correction values can be determined automatically by means of a keystroke. Programmers of automatic test systems prefer direct frequency response correction via IEC/IEEE bus using the controller. In this case, level control is performed by SMP's ALC, giving resolution of 0.01 dB. The actual value is determined by means of a power meter with directional coupler at the antenna input or via a field-strength sensor near the DUT.

The above examples clearly show that SMP, a powerful, future-oriented and favourably priced instrument from a manufacturer with decades of experience in all fields of EMC measurements, is the right solution to any EMC measurement problem between 10 MHz and 40 GHz.

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