EMI Test Receiver R&S®ESCI

For compliance tests to all civil standards from 9 kHz to 3 GHz

Excellent RF characteristics
- 1 dB compression +5 dBm
- Displayed average noise level (DANL) typ. −155 dBm
- 11 preselection filters
- Pulse-protected RF input
- Pulse weighting in full compliance with CISPR 16-1-1

Outstanding performance
- Total measurement uncertainty <1 dB
- Spectrum analyzer
- Fast ACP measurements
- Time domain analysis
- Recording time of more than two hours

Versatile use
- Battery or AC supply operation
- Remote control operation
- PC-compatible screenshots
- Windows printer support
- USB interface
- Storable instrument settings

ROHDE&SCHWARZ

Full-compliance tests for certification …

Excellent test receiver characteristics
◆ Pulse-protected RF input
◆ Total measurement uncertainty <1 dB
◆ EMI measurement bandwidths 200 Hz, 9 kHz, 120 kHz, 1 MHz
◆ Peak (max, min), quasi-peak, RMS, CISPR average and average detectors (max. three detectors simultaneously)
◆ Pulse weighting conforming to CISPR 16-1-1 with quasi-peak detector
◆ 11 preselection filters and built-in preamplifier
◆ For all civil EMI standards such as CISPR, EN, ETS, FCC, ANSI C63.4, VCCI and VDE
◆ Time domain analysis, e.g. for measuring click interference

Speed
◆ **Receiver mode**
– Measurement times from 100 μs (SCAN mode)
◆ **Spectrum analyzer mode**
– Sweep times from 2.5 ms to 16 000 s (span ≥10 Hz)
– Zero span (time domain) from 1 μs to 16 000 s, resolution 125 ns

Spectrum analyzer
◆ Switch-selected preamplifier and preselection
◆ Resolution bandwidths from 10 Hz to 3 MHz (in steps of 1/3/10)
◆ Digital filters from 1 Hz to 30 kHz
◆ Channel filters from 100 Hz to 5 MHz
◆ Fast ACP measurements in time domain

Performance
◆ 1 dB compression +5 dBm nominal (without preselection)
◆ Displayed average noise level (DANL) typ. −155 dBm (RBW = 10 Hz, preamplifier on)
◆ Phase noise (f = 500 MHz) typ. −113 dBc (1 Hz) (at 10 kHz from carrier)
◆ Programmable scan table with up to ten subranges
◆ Comprehensive test and analysis functions

◆ Limit lines to civil standards
◆ Frequency-dependent transducer factors and sets taken into account
◆ Power supply for accessories such as sensors, probes or antennas

Applications

The EMI Test Receiver R&S®ESCI is a new addition to the tried-and-tested family of top-class EMI test receivers from Rohde & Schwarz with

… enhanced by spectrum analyzer functionality for laboratory applications

a spectrum analyzer platform. The R&S®ESCI provides measurements in full compliance with CISPR 16-1-1. The instrument operates in the frequency range from 9 kHz to 3 GHz and is equipped with a 21 cm TFT colour display.

The EMI Test Receiver R&S®ESCI measures electromagnetic emissions in line with all civil standards and combines several types of instrument in one:

◆ Portable, manually controllable EMI test receiver with a weight of approx. 10 kg; suitable for mobile use independently of the AC supply with the R&S®FSP-B30 and R&S®FSP-B31 battery options fitted
◆ Automatic, standard-conforming test receiver that performs measurements for certifications as a stand alone unit
◆ System-compatible test receiver capable of remote control via the IEC/IEEE bus interface or the LAN interface using EMI software packages, e.g. R&S®EMC32

◆ Spectrum analyzer with excellent RF characteristics and comprehensive test functionality for laboratory measurements and also for measurements in compliance with mobile radio standards, featuring an RMS detector, selectable ACP standard and channel bandwidths up to 5 MHz
◆ Time domain analyzer for measuring click interference, capable of recording interference versus time for more than two hours

The measurements required in order to verify electromagnetic compatibility are laid down in international and national legislation and standards. The time that is spent measuring conducted and radiated EMI until approval and CE certification are obtained is substantial.

The R&S®ESCI is backed by decades of experience gained by Rohde & Schwarz in the development of test receivers and spectrum analyzers. The test receiver's optimized operating concept makes this know-how easily accessible to the user.

The instrument's built-in intelligence significantly reduces the required measurement effort. Specially designed for performing EMI measurements, the test receiver furnishes results at maximum speed and accuracy in accordance with the requirements published by CISPR, CENELEC, ETSI, FCC, VCCI and VDE.

Compact tester up to 3 GHz …

Outstanding features

◆ Unprecedented wealth of functions
◆ Maximum measurement speed
◆ Superior measurement accuracy

The R&S®ESCI sets new standards in terms of scope of functions, measurement speed and measurement accuracy in the range up to 3 GHz.

The use of innovative techniques such as an LSI frontend and largely digital signal processing, in conjunction with ASICs developed by Rohde & Schwarz, results in excellent specifications and high reliability.

The functionality of a conventional "compliance tester" for civil applications has been expanded by a wide range of spectrum analyzer functions.

EMI TEST RECEIVER

◆ Integrated preselection and 20 dB preamplifier
◆ Weighting with peak, quasi-peak, RMS, CISPR AV and AV detectors (max. three detectors simultaneously)
◆ CISPR-conforming EMI measurement bandwidths: 200 Hz, 9 kHz, 120 kHz, 1 MHz
◆ Pulse weighting conforming to CISPR 16-1-1, including single pulses
◆ For all civil EMI standards such as CISPR, EN, ETS, FCC, ANSI C63.4, VCCI and VDE

SPECTRUM ANALYZER

◆ Resolution bandwidths from 10 Hz to 3 MHz (in steps of 1/3/10)
◆ RMS detector for measurements on digitally modulated signals
◆ Channel filter bandwidths from 100 Hz to 5 MHz
◆ Test routines for determining TOI, ACPR, OBW

EMC performance features

◆ Total measurement uncertainty
  – Receiver mode <1 dB
  – Spectrum analyzer mode <0.5 dB (without preselection)
◆ Displayed average noise level (DANL) **–155 dBm** (10 Hz)
◆ Noise figure typ. 7 dB
◆ Overview measurements in spectrum analyzer mode
◆ User-programmable scan tables
◆ Display and comparison of results with limit lines
◆ Inclusion of correction values for cable loss, coupling networks and antennas in the form of transducer factors
◆ Data reduction and modification of frequency list for weighted final measurement
◆ Bargraph display for various detectors with Max Hold indication
◆ Overload indication
◆ Built-in AF demodulator
◆ Bright 21 cm TFT colour display

# ... for EMI full-compliance measurements

High measurement speed

The R&S®ESCI allows fast detection of critical frequencies by repetitive overview measurements
◆ in spectrum analyzer mode from 2.5 ms per sweep (for span >10 Hz)
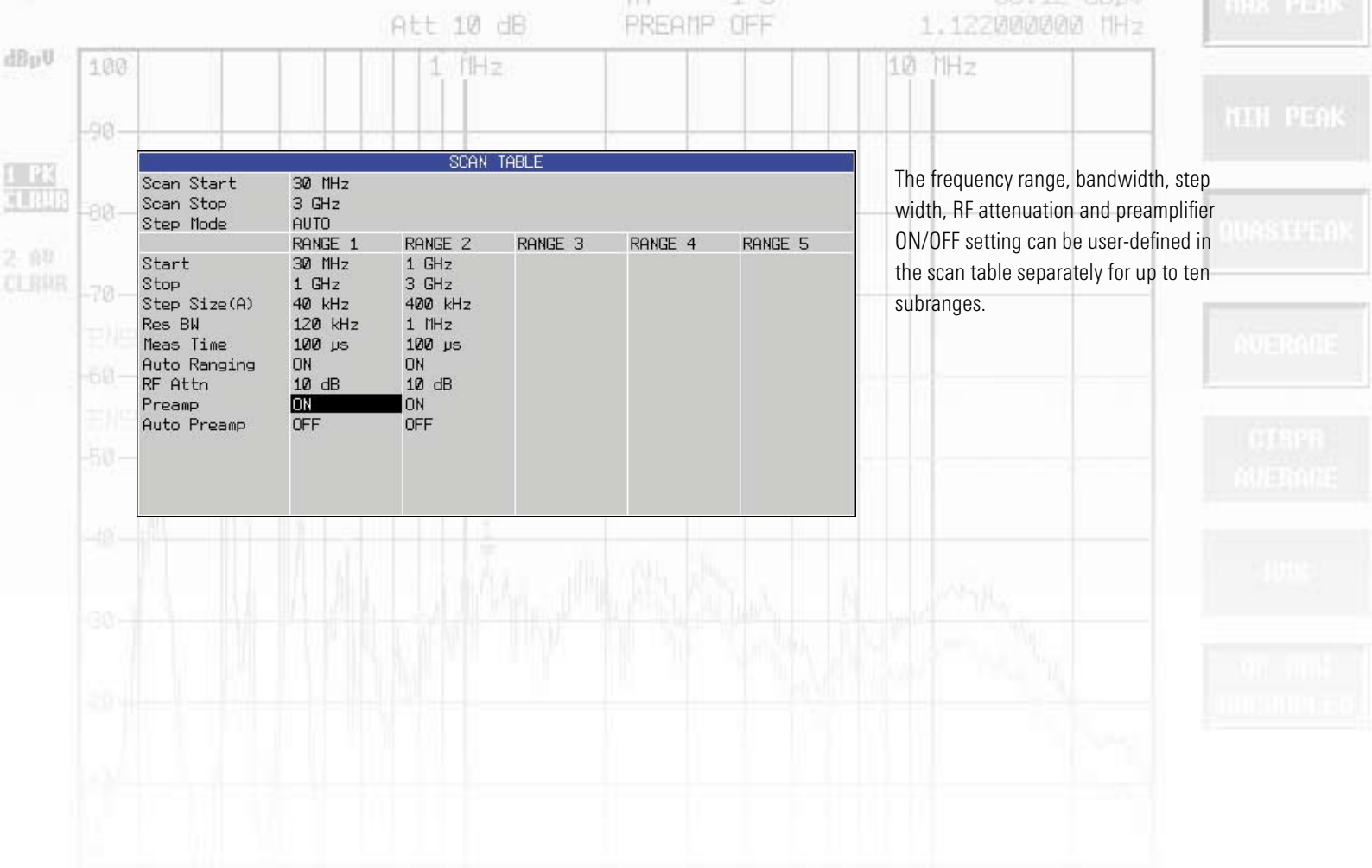
This is followed by exact frequency identification
◆ in receiver mode from 100 μs per frequency step

The prescan measurement is performed, for example, with the peak and the average detector operating simultaneously. Only a short measurement time per frequency is required since the final measurement involves performing standard-conforming weighting at fewer frequencies for an extended measurement time.
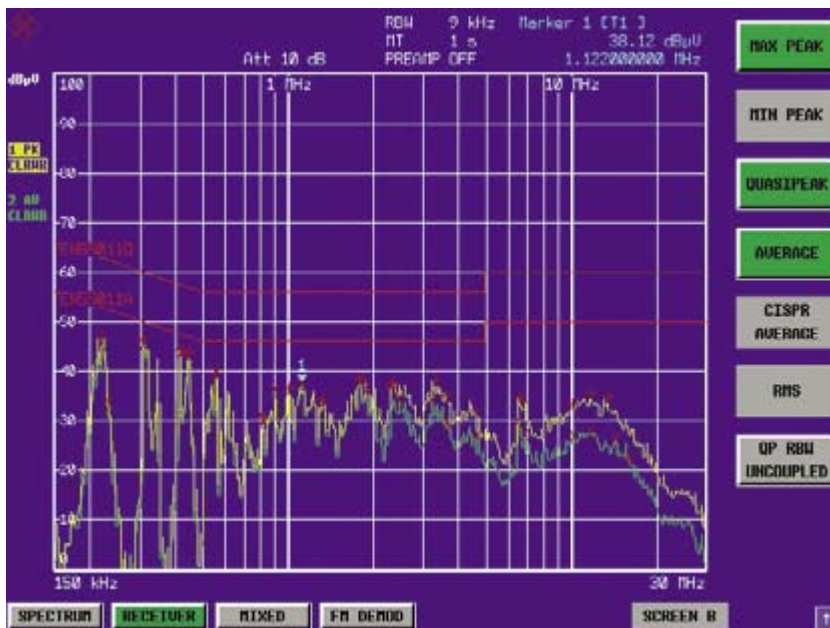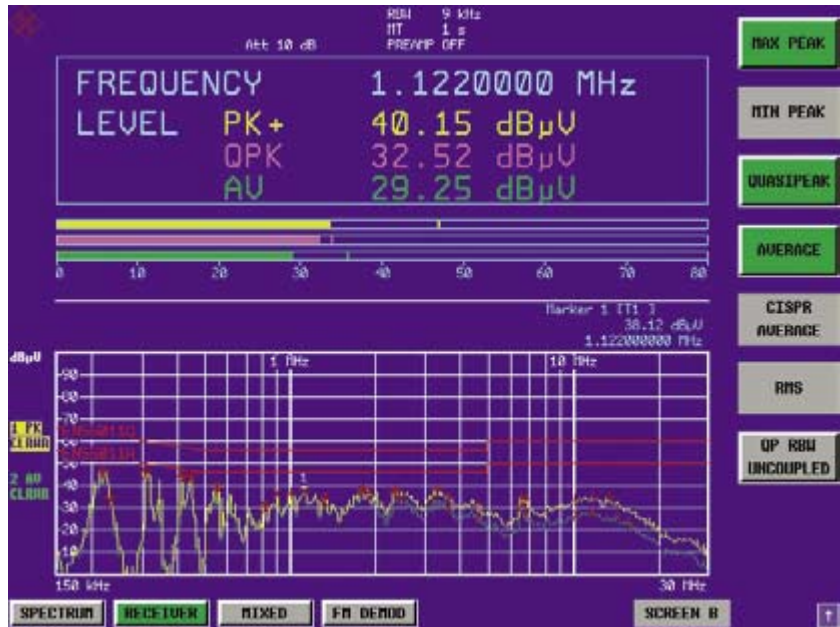
For single-frequency measurements, the marker is coupled with the quasi-peak detector (CISPR) and the receiver frequency. The marker is manually moved across the entire spectrum to critical frequencies.

The bright 21 cm colour display provides a quick view of measurements and results in full-screen and in split-screen mode. The user can select the colours for the various graphical components such as the background, traces, limit lines, markers, softkeys, etc.

The frequency range, bandwidth, step width, RF attenuation and preamplifier ON/OFF setting can be user-defined in the scan table separately for up to ten subranges.

| SCAN TABLE					
Scan Start	30 MHz				
Scan Stop	3 GHz				
Step Mode	AUTO				
	RANGE 1	RANGE 2	RANGE 3	RANGE 4	RANGE 5
Start	30 MHz	1 GHz			
Stop	1 GHz	3 GHz			
Step Size(A)	40 kHz	400 kHz			
Res BW	120 kHz	1 MHz			
Meas Time	100 µs	100 µs			
Auto Ranging	ON	ON			
RF Attn	10 dB	10 dB			
Preamp	ON	ON			
Auto Preamp	OFF	OFF			

The frequency list generated as a result of the prescan and subsequent data reduction can be edited for the final measurement by using the marker function (ADD to Peak List). It is also possible to delete frequencies from the list.
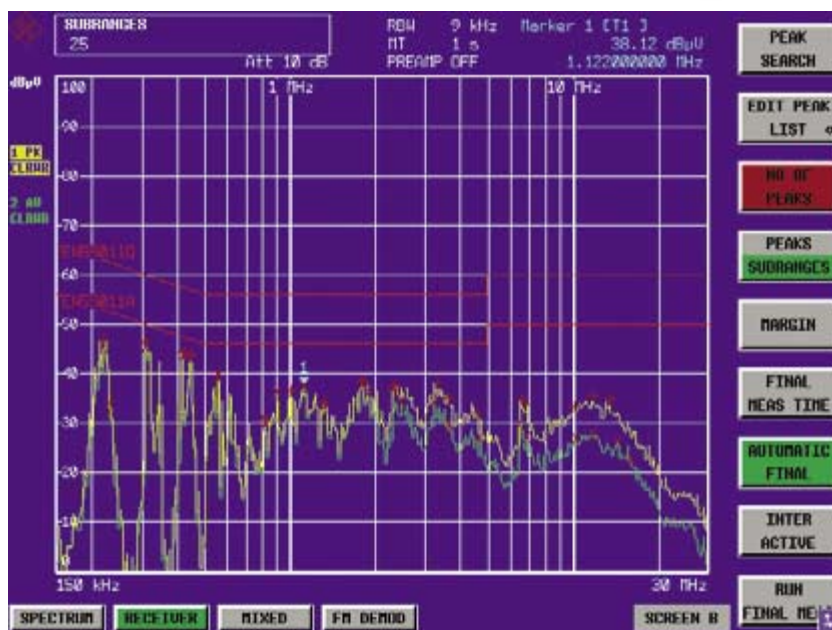
```
          EDIT PEAK LIST (Prescan Results)
Trace1:          EN55011Q
Trace2:          EN55011A
Trace3:          ---
      TRACE          FREQUENCY      LEVEL  dBµV      DELTA LIMIT dB
 1  Max Peak     206  kHz           43.82  L1 gnd      -19.54
 2  Average      206  kHz           42.64  L1 gnd      -10.72
 2  Average      230  kHz           26.82  L1 gnd      -25.62
 1  Max Peak     306  kHz           47.14  L1 gnd      -12.93
 2  Average      306  kHz           47.02  L1 gnd       -3.05
 1  Max Peak     398  kHz           31.56  L1 gnd      -26.33
 2  Average      398  kHz           29.85  L1 gnd      -18.03
 1  Max Peak     450  kHz           42.19  L1 gnd      -14.68
 2  Average      450  kHz           41.45  L1 gnd       -5.41
 1  Max Peak     654  kHz           38.78  L1 gnd      -17.21
 2  Average      654  kHz           38.45  L1 gnd       -7.54
 1  Max Peak     670  kHz           40.21  L1 gnd      -15.78
 2  Average      670  kHz           39.70  L1 gnd       -6.29
 1  Max Peak     894  kHz           32.06  L1 gnd      -23.93
 2  Average      902  kHz           31.66  L1 gnd      -14.33
 1  Max Peak     1.246 MHz          34.34  L1 gnd      -21.65
 2  Average      1.246 MHz          33.75  L1 gnd      -12.25
 1  Max Peak     1.418 MHz          38.30  L1 gnd      -17.69
 2  Average      1.418 MHz          38.11  L1 gnd       -7.89
 1  Max Peak     1.578 MHz          38.43  L1 gnd      -17.56
```

In addition to the graphical representation of results, a list of measured values is output including, for example, the selected phase and grounding condition. This is an important prerequisite for overall measurement reproducibility and the retrieval of critical frequencies.

When a line impedance stabilization network (LISN) from Rohde & Schwarz is used in the automatic final measurement (remote control via the USER PORT), switchover is made between all possible settings, and the maximum value together with the selected phase and grounding condition is returned and stored in the final result list.
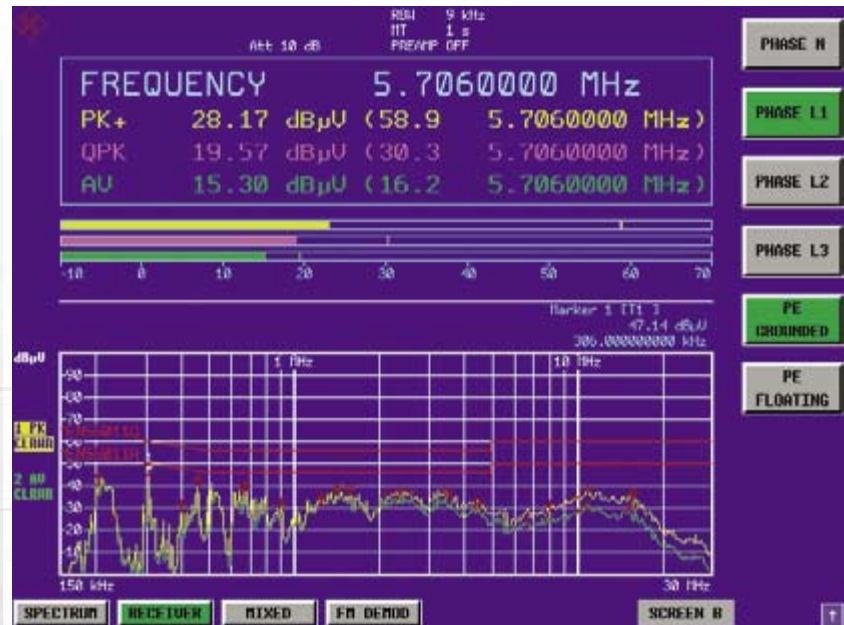
```
              SELECTED LIMIT LINE
Name:      EN55011A        x-Axis:      LOG
Domain:    FREQUENCY       x-Scaling:   ABSOLUTE
Unit:      dBuV            y-Scaling:   ABSOLUTE
Limit:     UPPER
Comment:   EN 55011 Voltage on Mains AV
```

```
                        LIMIT LINES
   NAME      COMPATIBLE  LIMIT CHECK  TRACE      MARGIN
×EN55011A        ×          off         2      0.000 dB
 EN55011F                   off         1      0.000 dB
×EN55011Q        ×          off         1      0.000 dB
 EN55014A                   off         1      0.000 dB
 EN55014Q                   off         1      0.000 dB
 EN55015A        ×          off         1      0.000 dB
 EN55015Q        ×          off         1      0.000 dB
 EN55022A        ×          off         1      0.000 dB
 EN55022F                   off         1      0.000 dB
 EN55022Q        ×          off         1      0.000 dB
 FCC15AF                    off         1      0.000 dB
 FCC15AVQ        ×          off         1      0.000 dB
 FCC15BF                    off         1      0.000 dB
 FCC15BVQ        ×          off         1      0.000 dB
 STRING          ×          off         1      0.000 dB
 THRTEST                    off         1      0.000 dB
 VDE0875L                   off         1      0.000 dB
```

An internal database provides a number of limit lines complying with current civil standards. New or user-specific limit lines can easily be generated and likewise stored in the database on the instrument's hard disk. The instrument automatically checks and indicates whether the unit of the limit line is compatible with the unit used in the current graphic display.

Powerful firmware functions

◆ Scan table with individually programmable parameters for subranges for automatic and interactive test routines
◆ Automatic level calibration
◆ Prescan measurement, data reduction and final measurement separate for each trace memory, i.e. up to three traces of 500 measured values each in tabular form
◆ Internal storage of complete instrument setups on disk or hard disk

The screen display on the right illustrates the R&S® ESCI's powerful firmware functions. A modulated or drifting signal is mapped onto the center frequency.

In the case of a drifting signal, the center frequency is thus updated with every sweep. The upper screen provides the current results obtained with three different detectors in receiver mode. The values in brackets indicate the absolute maximum in each case together with the frequency at which it occurred. This function can be used, for example, in conjunction with a limit line that ensures that only values exceeding a certain threshold are measured.
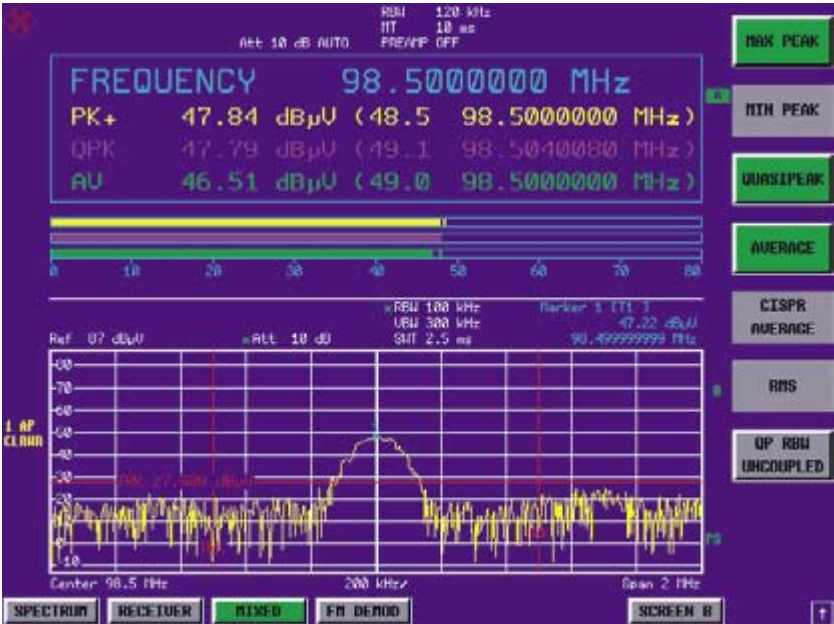
Fast EMI measurements and display in MIXED mode

EMI full-compliance test receivers are needed when certification in accordance with relevant standards is to be obtained. Featuring a pulse-resistant attenuator, preselection with a 20 dB preamplifier and a frontend withstanding high loads, the EMI Test Receiver R&S®ESCI meets the requirements of the CISPR, VDE, ANSI, FCC, EN and VCCI civil standards.

Typical EMC parameters such as the following can be measured both with the analyzer and the receiver:

◆ RFI voltage
◆ RFI power
◆ RFI field strength

The analyzer comes into its own where fast prescan sweeps have to be performed and evaluated with marker functions. The test receiver, on the other hand, offers the more sophisticated techniques for data reduction and standard-conforming final measurements, including storage of all measured values and exact frequency identification.

The two operating modes can be combined in MIXED mode, thus allowing the user to optimally benefit from the advantages of either mode.

A number of operating parameters can be coupled or decoupled for test receiver mode and spectrum analyzer mode. When the same center frequency is used in the two windows, for example, IF analysis will be displayed automatically. For a test sequence using the spectrum analyzer in the prescan measurement and the test receiver in the final measurement, it is useful to couple the resolution bandwidths.

MIXED mode bargraph and spectrum measurement. The standard-conforming bargraph measurement and the fast sweep are displayed simultaneously.
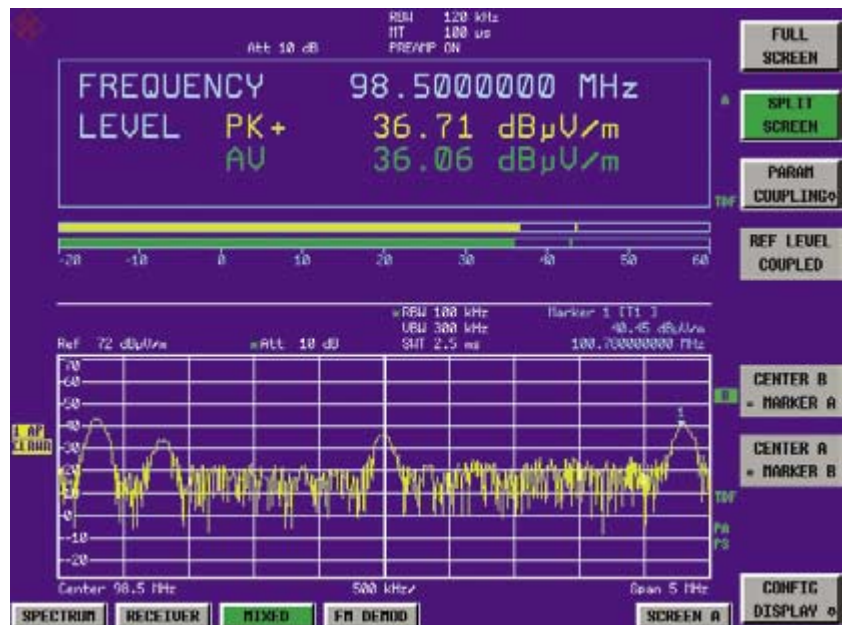
Time domain measurements

Devices with thermostatic or program control generate discontinuous interference. CISPR 14 and EN 55014 therefore specify limit values for RFI voltage with click rate weighting in the range 0.15 MHz to 30 MHz. A critical factor in measurements with conventional click rate analyzers is the occurrence of successive pulses. The individual pulse amplitudes cannot be exactly allocated due to the time constants used in quasi-peak weighting, which may result in limit values being exceeded.

The R&S®ESCI's time domain analysis function can determine the pulse amplitude and duration and can thus prove very useful in such cases. It satisfies the requirements of CISPR 16-1-1 in terms of accuracy of the pulse duration measurement when the pulse duration is 10 ms or longer.

The result memory can store 1.44 million measured values per trace in time domain analysis. The measured values are stored internally and can, for example, be analyzed subsequently by zooming in on them with the marker. Each individual click interferer can thus be evaluated in detail if necessary. At a measurement time of 5 ms per measured value, the memory depth is large enough to record the peak value and quasi-peak values continuously for two hours. Thus, DUTs such as washing machines can be evaluated for click interference.

Design and operation

◆ 21 cm (VGA) TFT colour monitor for displaying interference spectra, including limit lines
◆ Clear-cut digital level display with 0.01 dB resolution in a separate window
◆ Quasi-analog display of results in the form of bargraphs, allowing immediate comparison of results supplied by detectors
◆ Time domain analysis (oscilloscope mode) for measuring pulse widths and heights; results can be enlarged up to maximum resolution (storage of up to 1.44 million measured values)

The 21 cm TFT colour display informs the user of all important parameters at a glance. Vertical and horizontal softkey bars make it easier to perform complex measurement tasks. For some parameters such as frequency and amplitude, dedicated hardkeys and unit keys are available.

When switching between receiver mode and spectrum analyzer mode, basic measurement settings are often different. For some applications, it may be helpful to couple important parameters between the two modes, which is possible with the R&S®ESCI.

Wide dynamic range, low DANL

The R&S®ESCI features an extremely low displayed average noise level (DANL typ. −155 dBm at 10 Hz bandwidth with preamplifier switched on). This yields an improved S/N ratio that allows even very small signals to be measured accurately.
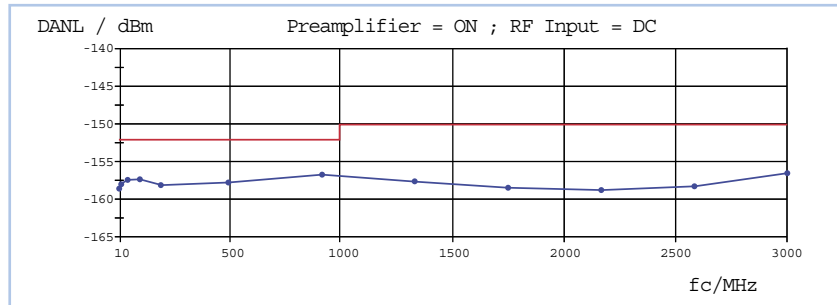
Example of DANL measurement (from acceptance test report).

To prevent overloading caused by high-energy pulsed signals and to ensure that signal weighting remains in the linear operating range of the instrument, a preselection/preamplifier module is integrated as standard. Preselection includes 11 filters with fixed and tuned bandwidths up to 3 GHz. In receiver mode, preselection is always switched on; in analyzer mode, it can be switched on or off. The preamplifier provides 20 dB gain and thus lowers the instrument's inherent noise figure. In conjunction with the high third-order intercept (TOI) point, this yields an intermodulation-free range of typ. 93 dB – an excellent value even for the upper compliance class.
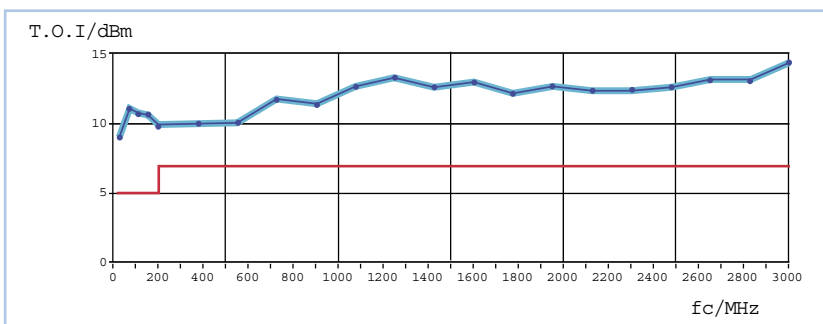
Example of TOI measurement (from acceptance test report).

Spectrum analyzer test routines

In analyzer mode, the R&S®ESCI offers fast test routines for a large number of typical laboratory measurements:

◆ Determination of TOI
◆ Occupied bandwidth (OBW)
◆ Burst power with peak, average and RMS indication
◆ Phase noise
◆ Bandwidth markers

The above routines can also be controlled via the fast GPIB interface.

ACPR measurements

Many mobile radio standards stipulate adjacent channel power ratio (ACPR) measurements for components and instruments. The R&S®ESCI carries out these measurements in analyzer mode using automatic test routines. All settings, measurements and filters required for a selected standard are activated at a keystroke.

In addition to offering a large number of preprogrammed standards, the R&S®ESCI allows the settings for the channel width and channel spacing to be user-defined.

With its excellent dynamic range, low phase noise and RMS detector, the R&S®ESCI offers outstanding performance also in this area.

The low phase noise of the R&S®ESCI makes it suitable for demanding measurement tasks both in the vicinity of the carrier (typ. −113 dBc (1 Hz) at 10 kHz) and far from the carrier (typ. −125 dBc (1 Hz) at 1 MHz). The R&S®ESCI is thus an ideal choice for performing spectral analysis and ACPR measurements both on narrowband systems such as IS-136 or PDC and broadband systems such as IS-95 or WCDMA.

Sturdy construction – for use under any conditions

For outdoor applications, the R&S®ESCI is also available with a rugged case (option R&S®FSP-B1) with shock-absorbing corners and a carrying handle. In vehicles, the test receiver can be operated from 12 V to 28 V DC from an optional DC power supply (R&S®FSP-B30). At outdoor test sites, the R&S®ESCI can perform measurements for several hours if equipped with the optional R&S®FSP-B31 battery pack. In extreme cases, the operating time can be extended by means of an additional battery pack. In the R&S®ESCI standard unit, data is stored on a hard disk. For use in vehicles, a flash disk can be used instead of the hard disk to withstand significant temperature fluctuations (0 °C to 55 °C) and higher levels of shock and vibration. The flash disk option (R&S®ESCI-B20) has been specially designed for use under adverse conditions.

R&S®ESCI with rugged case (option R&S®FSP-B1) including shock-absorbing corners and carrying handle.

Innovative solutions

Option: LAN interface

Using the optional LAN Interface R&S®FSP-B16, the R&S®ESCI can be configured as a network workstation:

◆ File logging on network drives
◆ Network printer
◆ Remote desktop function
◆ Remote control via LAN

These functions make the R&S®ESCI ideal for networking.

Option: scalar network analysis

The optional Internal Tracking Generator R&S®FSP-B9 and the optional External Generator Control R&S®FSP-B10 extend the R&S®ESCI to include scalar network analyzer functionality. Using a selective measurement method, the gain, frequency response, insertion loss and return loss are measured over a wide dynamic range without being influenced by harmonics or spurious from the generator. The Internal Tracking Generator R&S®FSP-B9 covers the frequency range from 9 kHz to 3 GHz. A frequency offset of ±150 MHz can be set for measurements on frequency-converting modules. The tracking generator can be broadband-modulated using an external I/Q baseband signal.

The R&S®FSP-B10 option uses commercial RF signal generators as its external tracking source that can be controlled via the IEC/IEEE bus or a TTL bus. This solution provides the functionality of the internal tracking generator:

◆ Normalization with interpolation also for reflection measurements with open and short
◆ Automatic bandwidth measurements with "n dB down" function
◆ Tolerance lines with PASS/FAIL evaluation

The R&S®FSP-B6 option makes the R&S®ESCI suitable for analog TV measurements. It provides a settable RF level trigger for measurements on pulsed RF signals that are used in TDMA transmission systems.

Option: FM measurement demodulator

The R&S®FS-K7 option adds universal digital FM demodulation capability to the R&S®ESCI. For example, synthesizer settling or frequency deviation measurements can be performed.

Results can be displayed as either of the following:

◆ Frequency modulation (FM) or carrier power versus time
◆ RF spectrum (FFT)

The FM and RF level trigger functions with wide dynamic range provide special trigger capabilities. They even allow signals to be measured for which no external trigger signal is available.

The demodulated data can be read via the IEC/IEEE bus, RS-232-C, or LAN interface and processed on an external PC.

R&S®ESCI rear view.

Environmental compatibility

◆ Fast and easy disassembly
◆ Small number of materials
◆ Compatibility of materials
◆ Easy identification of materials through appropriate marking (plastics)
◆ Recyclable housing

Ready for the PC world

◆ PC-compatible screenshots, no conversion software needed
◆ Windows printer support
◆ USB interface (keyboard, mouse)
◆ Drivers: LabView, LabWindows/CVI, VXI plug & play instrument driver for VEE, Visual Basic, Visual C++, Borland C++, etc
◆ SCPI-compatible

User support

◆ Customized training
◆ Solution-oriented consulting
◆ Application notes
◆ Recommended calibration cycle of one year

Certified Quality System
ISO 9001
DQS REG. NO 1954 QM

Certified Environmental System
ISO 14001
DQS REG. NO 1954 UM

For specifications see PD 0758.1558.22
and www.rohde-schwarz.com
(search term: ESCI)

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