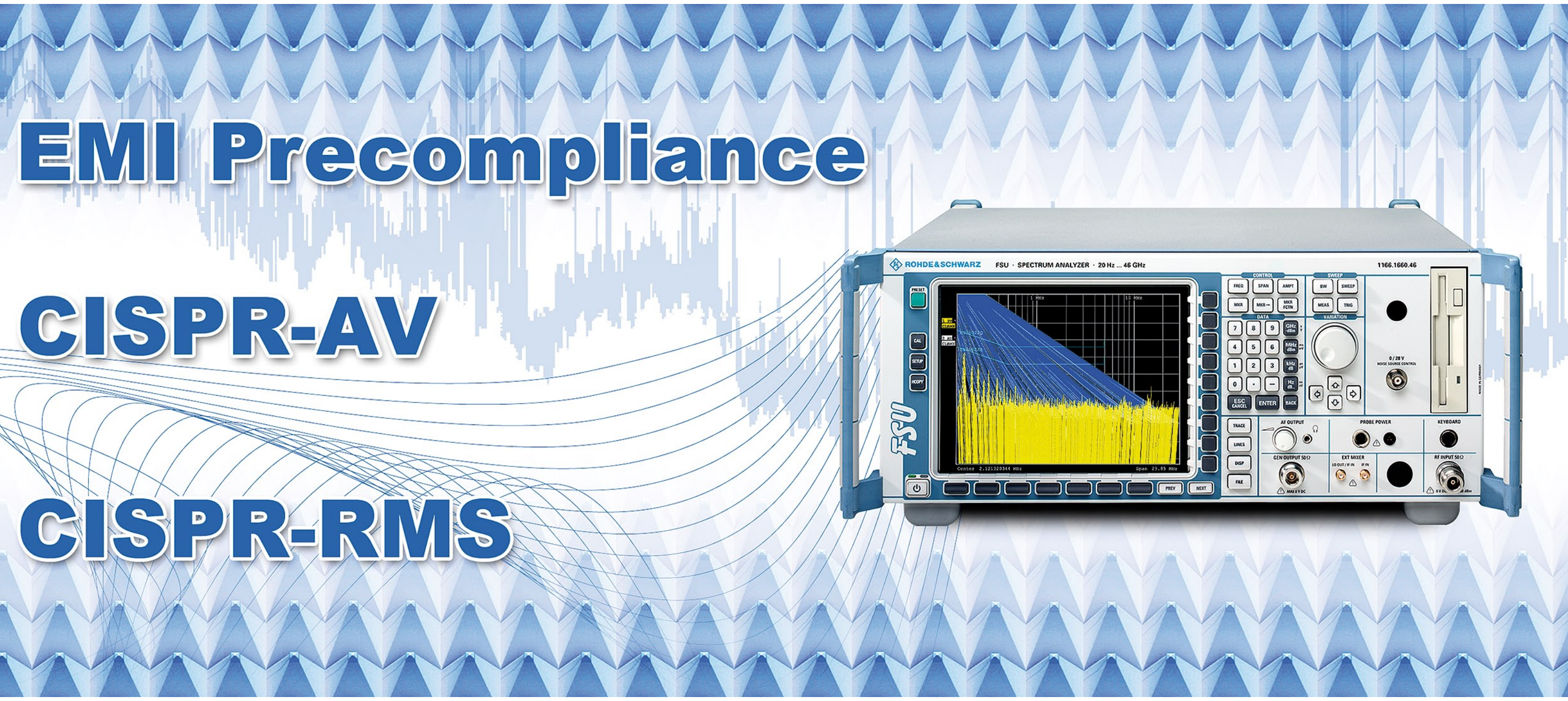


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**FIG 1 The Spectrum Analyzer R&S®FSU now also performs reproducible, reliable and fast EMI precompliance measurements.**

Spectrum Analyzer R&S®FSU

# Scope of functions expanded for EMI precompliance measurements

**You can now use the R&S®FSU family of spectrum analyzers (FIG 1) also for EMI precompliance measurement tasks: It offers EMI bandwidths, state-of-the-art EMI detectors, increased sweep resolution and logarithmic frequency axes.**

## Reducing development time

State-of-the-art products feature impressive innovative characteristics yet are developed and ready for market within a very short time. And on top of that, extensive measurements are required to ensure their electromagnetic compatibility. It is thus quite natural to want to use spectrum analyzers applied in the laboratory for EMI tasks as well.

The R&S®FSU high-end spectrum analyzers [1] are just one example: Owing to their high measurement speed, accuracy and high dynamic range, they are indispensable in development and production. Since their scope of functions now includes EMI bandwidths, state-of-the-art detectors, increased sweep resolution and logarithmic frequency axes, they can be used for EMI tasks – and thus save valuable development time.

## Innovations in detail

All the analyzers of the R&S®FSU family running on Windows XP and firmware version 3.91 or later include these new features. Five models with different frequency ranges (FIG 2) are thus available for performing EMI precompliance measurements between 20 Hz and 50 GHz.

**CISPR bandwidths (6 dB) for correct pulse weighting**

If you want to perform EMC measurements during development, e.g. localizing interference sources by probes or near-field probes, you often get by with a qualitative assessment of average accuracy. If the RFI voltage, RFI power and RFI field strength have to be measured on an EUT together with test setups and coupling devices, however, and if results have to be compared with emission limits, you definitely need precise, reproducible, quantitative weighting. For predefined CISPR bandwidths, this is done using quasi-peak or average detectors appropriate for the frequency bands. For bands A to D, measurement bandwidths are specified as 6 dB bandwidths and as impulse bandwidth for band E:

**CISPR band A** (9 kHz to 150 kHz):
$B_{res}$ = 200 Hz
**CISPR band B** (150 kHz to 30 MHz):
$B_{res}$ = 9 kHz
**CISPR band C** (30 MHz to 300 MHz):
$B_{res}$ = 120 kHz
**CISPR band D** (300 MHz to 1 GHz):
$B_{res}$ = 120 kHz
**CISPR band E** (1 GHz to 18 GHz):
$B_{res}$ = 1 MHz

Most of the spectrum analyzers use filters with several stages and define 3 dB bandwidths. Filters to be used for EMC tasks in interference measurements must adhere to the 6 dB bandwidth, however. The R&S®FSU thus includes the FILTER TYPE function, which offers a wide variety of options: resolution bandwidths from 10 Hz to 50 MHz (3 dB bandwidth), FFT filters, channel filters, RRC filters and also CISPR filters with 6 dB bandwidth from 200 Hz to 1 MHz for commercial EMC standards (e.g. EN standards).

## Innovations at a glance:

- **6 dB bandwidths or bandwidths in line with CISPR 16-1-1**
  200 Hz, 9 kHz, 120 kHz, 1 MHz
- **EMI measurement detectors**
  Pk, QP, RMS, AV as well as CISPR-AV and CISPR-RMS
- **Resolution during sweep**
  30001 test points, logarithmic frequency axis

**New EMI measurement detector CISPR-AV (CAV)**

To compare the amplitudes of noise signal spectra with emission limits laid down in product family standards (EN 55011 to EN 55025), CISPR measurement bandwidths and measurement detectors must be used. Since detectors with CISPR time constants are slower – which is due to the stipulated transient response – they are not suitable for fast preview measurements.

To perform fast preview measurements, select a short measurement time and use peak and average detectors to determine high interference levels and their frequencies. The R&S®FSU offers a fast sweep and simultaneously displays up to three curves of different detectors (e.g. Pk+ and AV).

Critical frequencies with high signal levels that exceed or are close to the limit, on the other hand, are best determined by final tests, which make use of detectors with CISPR time constants. The measurement time required for the final test is approx. one second so that single pulses or low pulse repetition frequencies can be weighted correctly. So far, these measurements have been made with the quasi-peak detector for broadband interference and with the average detector for narrowband interferers. The latest version of the basic CISPR 16-1-1 (2006-03) standard also assigns time constants to the linear average detector. Rohde&Schwarz calls this linear average detector CISPR average detector (CAV) – to distinguish it from the linear average detector (Average), which does not take time constants into account. In contrast to simple average weighting, the level increases at low pulse repetition frequencies when corrected by instrument time constants (depending on the CISPR band). A signal with $f_P$ = 1 Hz will then be weighted 7.4 dB higher in the CISPR band A / B. In CISPR bands C / D / E, the increase will be 11.3 dB (FIG 3). The latest version of the CISPR 16-1-1 standard thus includes more stringent weighting. The CISPR-AV detector will – after a transition period and by referencing to CISPR 16-1-1 (2005) – also be included in the product family standard.

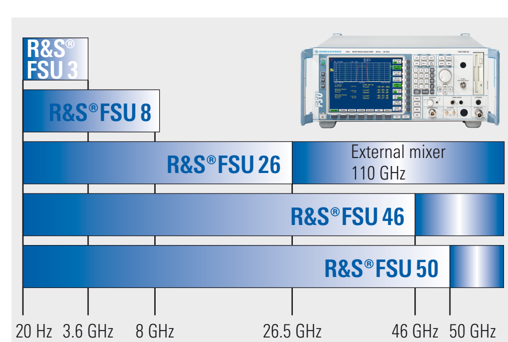


**FIG 2**
**The R&S®FSU family of high-end spectrum analyzers with five models between 20 Hz and 50 GHz is highly valued in development and production owing to its excellent RF characteristics.**

## New EMI measurement detector CISPR-RMS (CRMS)

Technology has undergone significant changes since the QP detector for weighting the interference of AM signals up to 30 MHz was launched more than 60 years ago. Today, mobile radio networks, digital broadcasting and TV as well as multimedia equipment are state-of-the-art technology. They all use digitally modulated signals. So far, we have lived without a reliable, standardized circuit for weighting such signals and their noise spectra. The Pk, QP and AV detectors used up to now indicate an over- or underweighting of pulse interference which, depending on the relevant mobile radio standard, may lead to different disturbing effects. To improve the reproducibility of measurements, measurement sequences have been used and comparisons have been made for quite some time with a circuit for weighting such signals. This circuit is based on a combination of RMS detector followed by an average detector circuit (including the instrument time constant). The results were discussed at various symposia throughout the world and finally taken into account in the form of corresponding correction curves in the CISPR-RMS detector (CRMS) (FIG 4). The new detector for weighting disturbance for its effects on digitally modulated signals has been included in a Committee Draft for Vote (CDV) and submitted to national committees.

In addition to all common EMI measurement detectors such as Pk, QP, RMS, AV, the R&S®FSU family of spectrum analyzers now also includes the new CISPR-AV and CISPR-RMS detectors

## EMI limit lines, transducer tables

To perform EMI precompliance measurements, the R&S®FSU spectrum analyzers offer limit lines for product standards. These limit lines can be activated quite easily, and potential out-of-limit conditions can already be displayed during the measurement (LIMIT CHECK). Other limits, e.g. for in-house standards of the automotive industry, can be quickly inserted as limit line points into a new table for limit lines which are stored under an individual file name on the hard disk. The table can be selected and activated in the default menu.

If additional attenuator pads and pulse limiters are used or if cable attenuation, the frequency response of an external preamplifier or antenna factors have

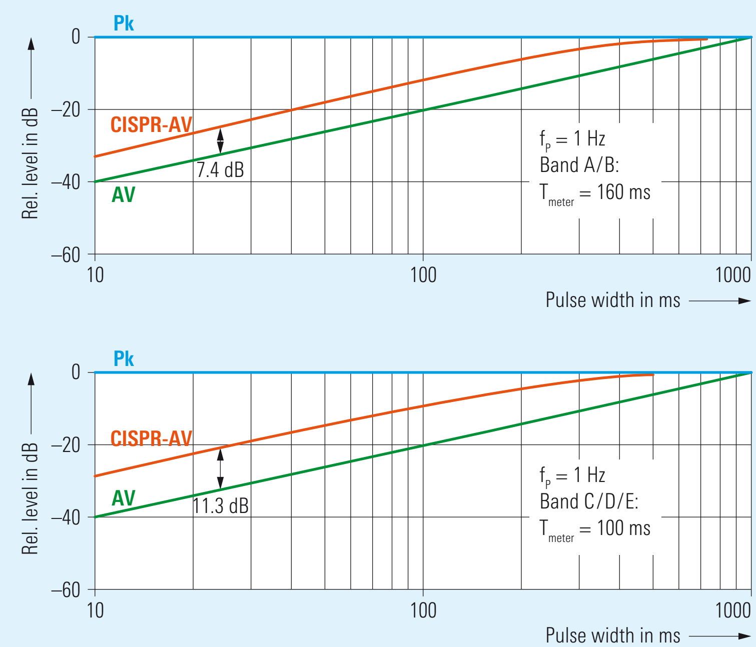


**FIG 3** In contrast to the linear average detector, the CISPR average detector (CAV) includes an instrument time constant with a subsequent Max Hold function. Low pulse repetition frequency weighting is thus higher, i.e. weighting is more stringent.

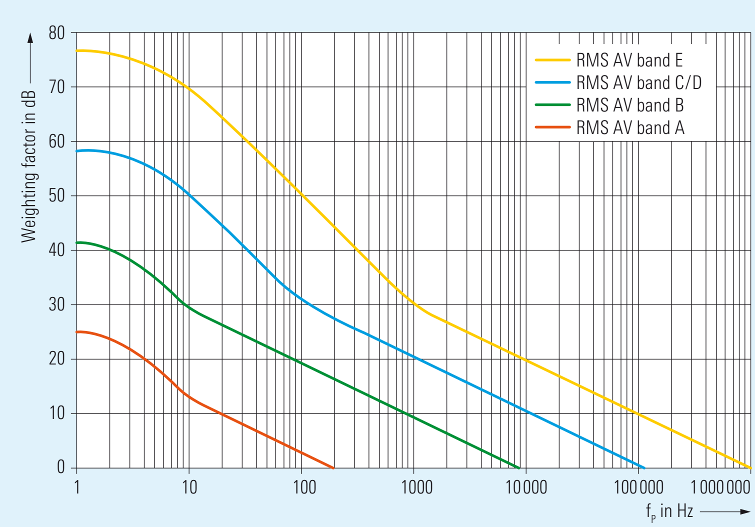


**FIG 4** The CISPR-RMS detector (CRMS) is a standard proposal for weighting pulse-shaped signals. The correction curves for weighting different pulse frequencies differ depending on CISPR band A to E.

to be taken into account, correction values are entered in transducer tables. Depending on their application and activation, the analyzer considers these correction values when calculating the current results – without affecting the measurement speed. This increases the measurement accuracy and the reproducibility of measurement results.

### Sweep with up to 30001 test points

The number of test points defined prior to the sweep was increased. The analyzer permits up to 30001 test points per trace – standard T&M equipment only offers 501 or 625 test points. The high resolution of the R&S®FSU makes it easier for you to pinpoint critical interfering frequencies that are required for final tests.

EMC measurement results are usually displayed with logarithmic scaling versus frequency. With the SWEEP LOG function, the R&S®FSU displays the test points on a logarithmically scaled frequency axis and thus facilitates the direct comparison with graphics obtained, for example, with full compliance test receivers (FIGs 5 and 6).

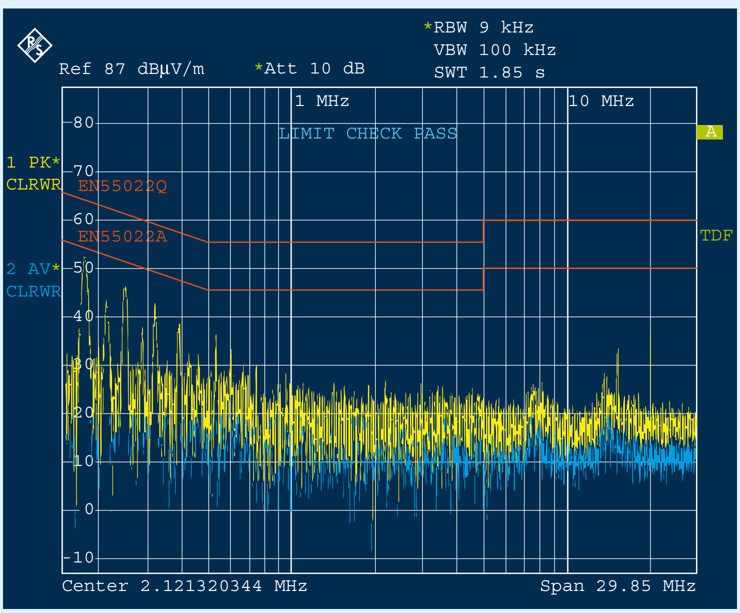


**FIG 5 Measurement of conducted EMI in the 150 kHz to 30 MHz range. The R&S®FSU displays limit lines with the LIMIT CHECK function, logarithmic scaling with 8001 test points and the use of 9 kHz (6 dB) bandwidth.**

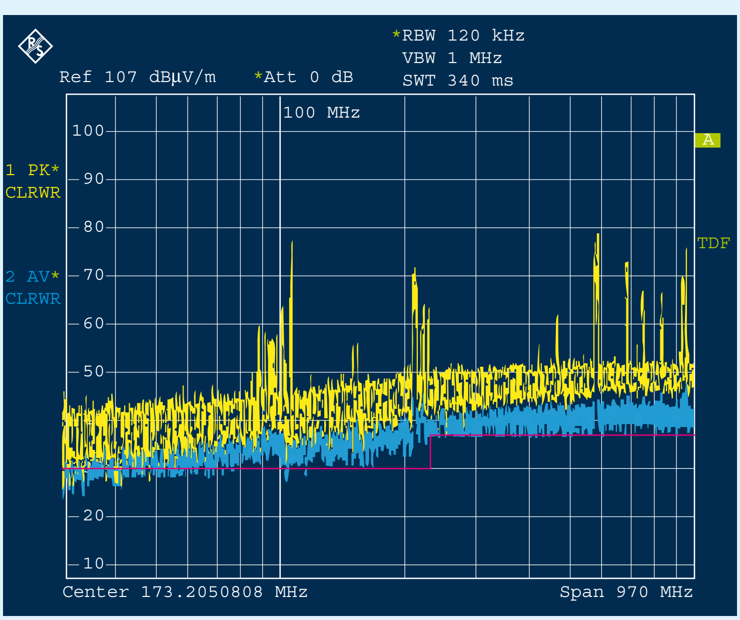


**FIG 6 Measurement of radiated EMI in the 30 MHz to 1000 MHz range. The R&S®FSU displays logarithmic scaling with 8001 test points, 120 kHz (6 dB) resolution bandwidth and the use of a transducer TDF (antenna correction table).**

## Summary

The R&S®FSU can now also perform reproducible, reliable and fast EMC precompliance measurements due to its new EMC functions such as CISPR bandwidths, state-of-the-art CISPR detectors, limit lines, consideration of correction value tables and logarithmic sweep display with up to 30001 test points. These functions and the powerful hardware of the spectrum analyzer are not only very useful when performing measurements during development and EMC precompliance measurements but also help to solve difficult EMI measurement problems in the preliminary product development stages.

Volker Janssen

**More information and data sheet at www.rohde-schwarz.com (search term: FSU)**

REFERENCES

[1] Spectrum Analyzer R&S®FSU – Best RF performance – third generation of high-end analyzers. News from Rohde&Schwarz (2001) No. 171, pp 20–25
– CISPR 16: 2003-11: Specification for radio disturbance and immunity measuring apparatus and methods.