Automotive EMI/EMC Pre-compliance Tests

Tektronix RF Automotive Test Solution

APPLICATION NOTE

Tektronix®

Introduction

Electromagnetic interference (EMI) regulations are in place throughout the world to provide improved reliability and safety for users of electrical and electronic equipment. The automotive industry and individual automobile manufacturers are required to meet EMI standards specifically for automotive systems.

With the introduction of USB-based real-time spectrum analyzers, pre-compliance EMI testing has become significantly easier and more cost-effective for designers. This application note provides an overview of measurement regulations and EMI pre-compliance procedures. Test setups for both radiated and conducted emissions are shown using the Tektronix RSA306B with EMCVu software.

EMI Pre-compliance testing

Most engineers employ good design practices to minimize the potential for EMI problems. Still, to identify and address any potential EMI issues before formal compliance testing, it is considered best practice to perform in-house pre-compliance measurements during the design and prototyping stages. This reduces the risk that the product will fail final compliance tests at the test house.

Also, in the event of a failure during formal testing, the ability to test in your own lab gives you the time to methodically isolate problem areas and test different corrections.

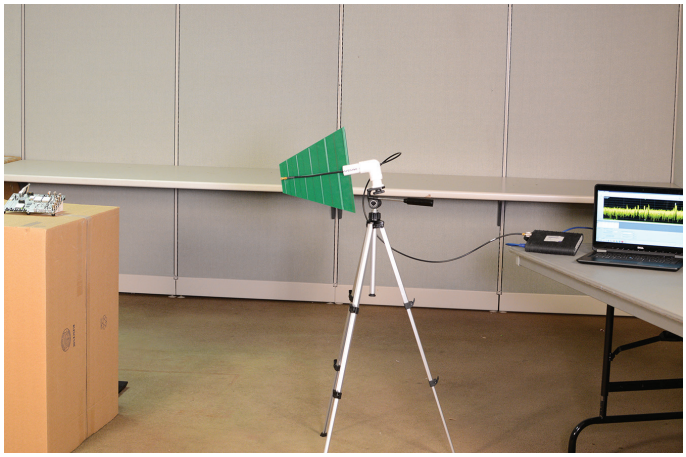

FIGURE 1. Affordable pre-compliance testing can easily be set up to uncover potential problems so that you can minimize test time in more expensive compliance test facilities.

AUTOMOTIVE ELECTROMAGNETIC COMPATIBILITY STANDARDS

CISPR 12 and CISPR 25 are international standards containing procedures and requirements for the measurement of radio disturbances to protect off-board receivers and on-board receivers of automotive, respectively.

CISPR 12 is a whole vehicle test rather than applying to subassemblies. The goal is to assure that receivers are not affected when the vehicle drives them. The test frequency range is usually from 30 MHz to 1 GHz. Only radiated tests are required.

CISPR 25 measures the RF interference that is generated by the vehicle and then picked up by vehicle mounted antennas (such as the AM/FM radio or GPS antenna). The test frequency bands are the operating bands of selected wireless standards (FM and TV broadcasting, cellular service, …).

In addition to CISPR 12 and CISPR 25, most manufacturers have their own set of standards to augment the CISPR guidelines. For example, Ford Motor Company has their own Electromagnetic Compatibility Specification for Electrical/ Electronic Components and Subsystems (FMC1278). Other OEMs have similar standards.

Tektronix EMCVu pre-compliance software supports EMC standards including CISPR, FCC and MIL-STD for many types of devices. To automate testing, EMCVu provides a built-in standards table allowing you to choose the applicable standard for your product and the region in which it will be sold.

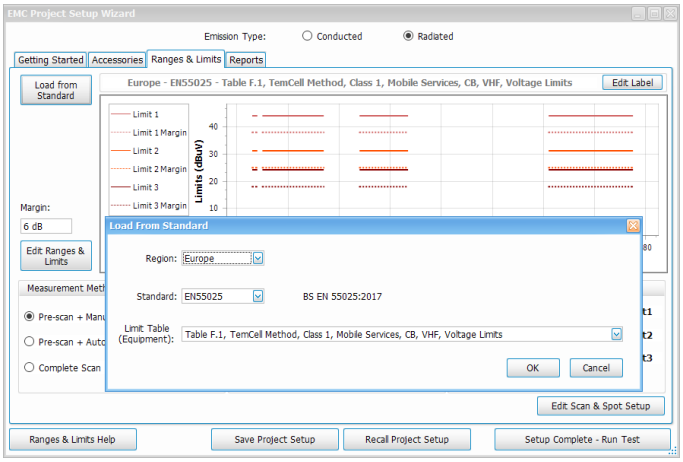

FIGURE 2. EMI standard presets.

SELECTING ACCESSIORES

Selecting accessories is one of the keys for EMI compliance tests. It is not unusual for the cost of accessories to exceed the cost of the spectrum analyzer itself. The required accessories depend on the type of emission testing being performed.

Emission type	Available Accessories selection
Conducted	LISN, Cable, Limiter, Amplifier, Attenuator, Filter and Others
Radiated	Antenna, Near field probe, Cable, Amplifier, Limiter, Attenuator, filter and others.

To help manage costs, there are low-cost accessories available. For example, the measurements shown Figure 1 are being made with a very low-cost PC board log periodic antenna. One or two of these, along with a biconical antenna can often cover the required frequency range. The biconical antenna is used for 20 to 200 MHz frequencies, since the longer wavelengths require a larger antenna. In this example the antennas were mounted on an inexpensive tripod. Antenna Factors (AF) and cable loss can be input into the spectrum analyzer software for field strength correction.

To achieve better measurement accuracy and avoid accessory mismatches, Tektronix offers fully-validated accessories including antennas, Line Impedance Stabilization Networks (LISN) and pre-amplifiers. You can purchase accessories individually, or in comprehensive accessory bundles for conducted and radiated tests. Characterization of accessories including gain and loss values are pre-loaded into EMCVu to provide simple set-up and greater measurement accuracy. Measurements are corrected by negating the combined impact of all the accessories gains and losses.

FIGURE 3. Tektronix accessories for EMI pre-compliance tests.

FIGURE 4. Tektronix near field probe set for trouble shooting.

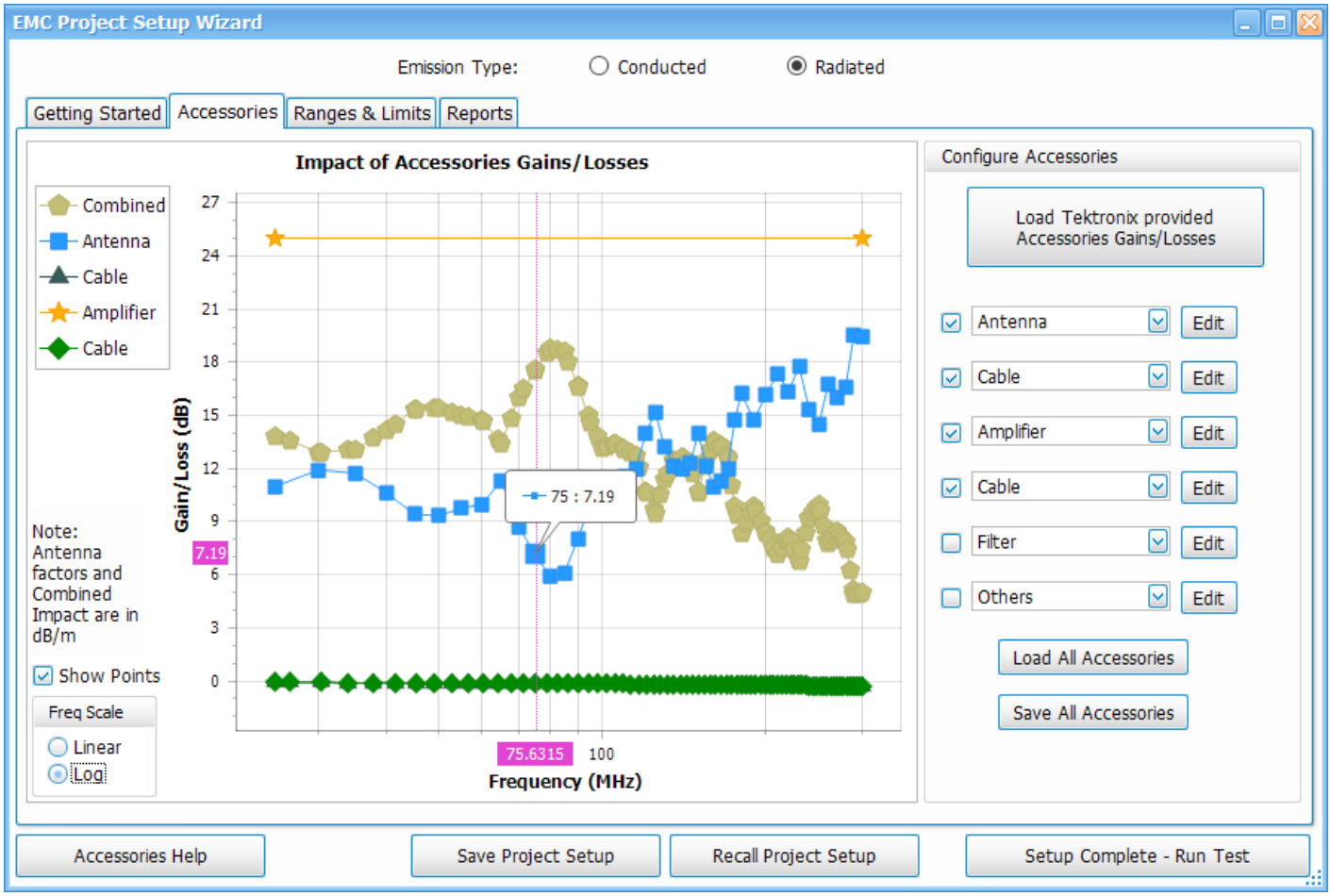

FIGURE 5. Accessory setup wizard in EMCVu.

BETTER UNDERSTAND THE TEST ENVIRONMENT WITH AN AMBIENT SCAN

Most designers do not have access to a dedicated anechoic chamber, and must adapt to using less ideal testing environments. A good testing location should be roomy, and free from powerful emitters such as Wi-Fi access points and noisy electrical equipment. Basements, unused commercial space, or parking garages may be good candidates.

However, without a professionally built anechoic chamber, background noise and over-the-air broadcast signals will find their way to the front end of the spectrum analyzer and risk impacting measurements.

This makes it critical to have a better understanding the RF environment and establish a baseline in order to achieve useful pre-compliance test results that approximate those expected from a test house.

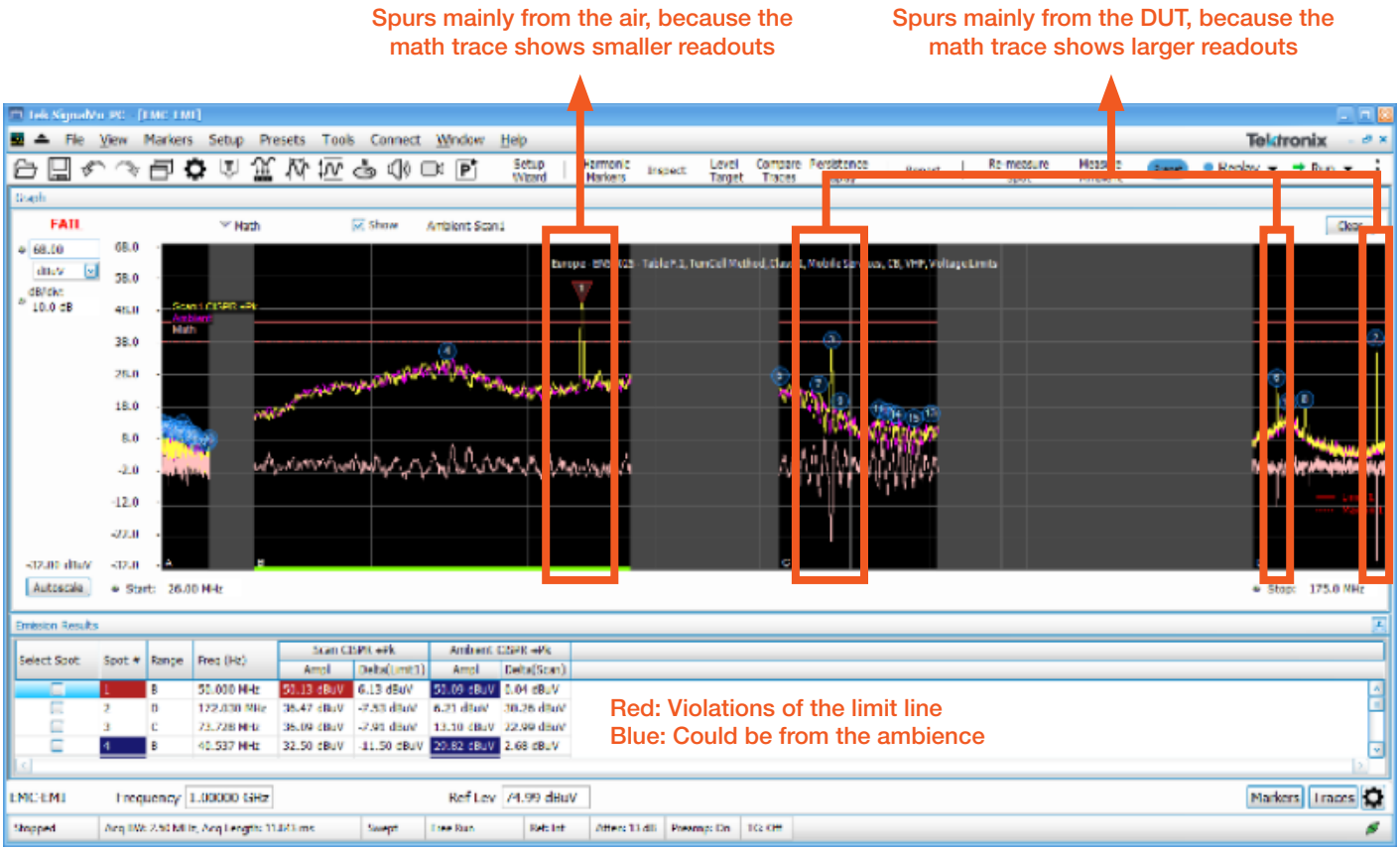

FIGURE 6. Using ambient scan and math trace (ambient minus peak scan) to separate the spurs from DUT and spurs from environment and spectrum analyzer.

An 'Ambient scan' tool in Tektronix EMCVu software helps establish an ambient EMI baseline by capturing emissions caused by environment or equipment. Before an ambient scan is done, the DUT (device under test) must be switched off, or completely removed from the setup. After performing an ambient scan with the DUT turned off, and then performing a scan with the DUT activated, a math trace can be used to observe the difference between the ambient signals and the spurs from the DUT.

CONDUCT A QUICK SCAN WITH PEAK DETECTORS

The quasi-peak detector specified in many EMI standards takes significant time to scan over wide frequency ranges. To save time, you can perform a quick scan using a peak detector, instead of a quasi-peak detector. The scan using the peak detector will give a set of "worst case" measurements, and you can perform quasi-peak measurements to dig deeper into out-of-limit conditions.

The example in Figure 6 shows a CISPR 25 radiated emission test. After the recalling the standard preset, EMCVu displays a peak scan with the trace with yellow color. The magenta trace is the ambient scan measured when the DUT is turned off. The pink trace is the math trace presents the difference between the ambient and peak scan. From the math trace, it is easy to tell the spur #1 is from the environment, because peak scan and ambient scan have almost the same value. The spur #2, #3, and #6 are likely from the DUT, because the math trace indicates the ambient scan is little compared to the peak scan. In the emission results table, the spots with ambient effects are flagged in blue.

RE–MEASURE OVERLIMIT SPOTS WITH CISPR QUASI–PEAK DETECTOR

Once you have identified potential trouble areas within the spectrum, you can apply long dwell time detectors, such as quasi-peak, to only those frequencies that have exceeded limits.

EMCVu offers three measurement methods for most standards

- Pre-scan + Manual Spot - A quick pre-scan followed by choosing spots from the results table and re-measuring them with detectors recommended by the standard (or those of your choice).
- Pre-scan + Auto Spot - A pre-scan followed by an automated re-measurement for a chosen number of spots fail the test criteria. The maximum number spots can be set for re-measurement. Complete Scan - A complete scan with detectors recommended by the standard – this could be time consuming if detectors such as CISPR Quasi Peak or CISPR Avg are chosen.

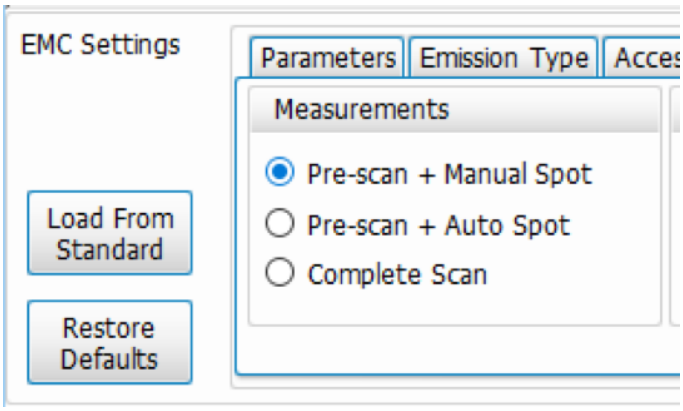

FIGURE 7. Three measurement methods in EMCVu.

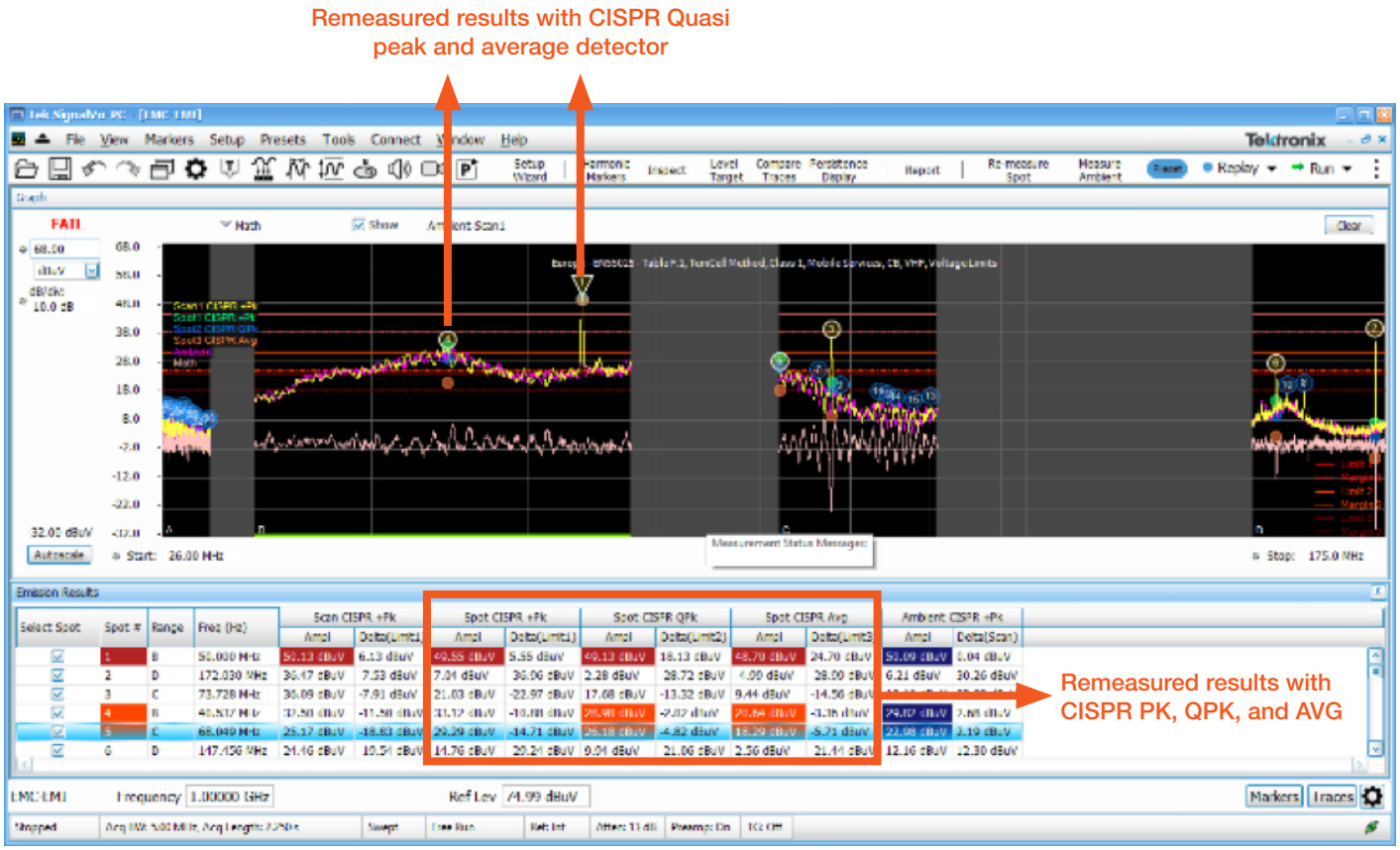

FIGURE 8. Re-measure the selected over limit spurs with CISPR quasi-peak and average detectors.

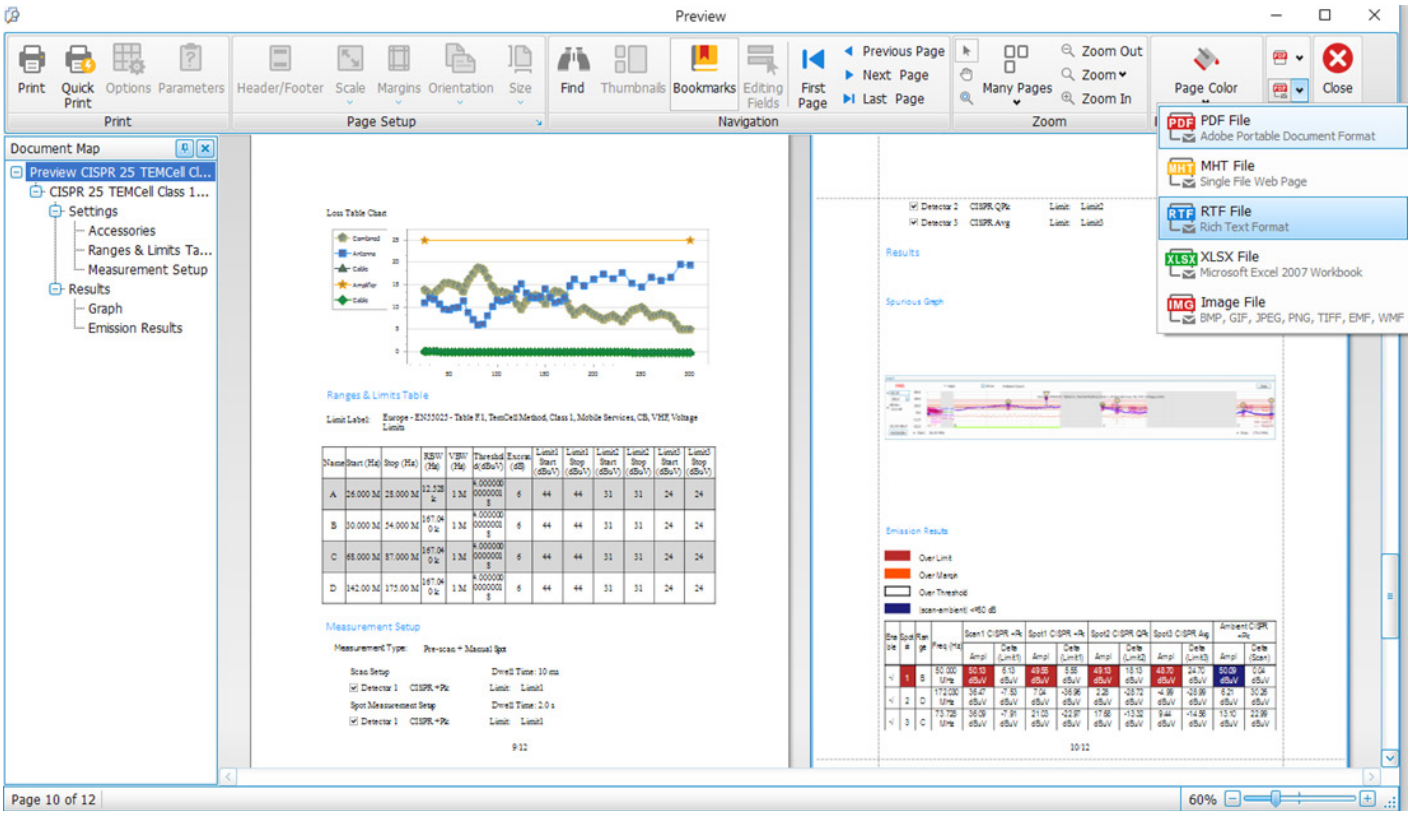

FIGURE 9. Complete report preview and generation.

GENERATING A TEST REPORT

After taking pre-compliance measurements, the results must be recorded and documented for future use. Creating a report similar to the certification lab report may help you discover potential issues and gain confidence before the formal certification tests.

Whereas making notes on a general-purpose spectrum analyzer may be challenging, PC-based test and analysis software simplifies the report generation process. A “report wizard” in EMCVu simplifies report generation by allowing you to specify the information to include in the report, and allowing you to merge multiple test results. Reports may be output in several formats, including PDF, MHT, XLSX and several image formats.

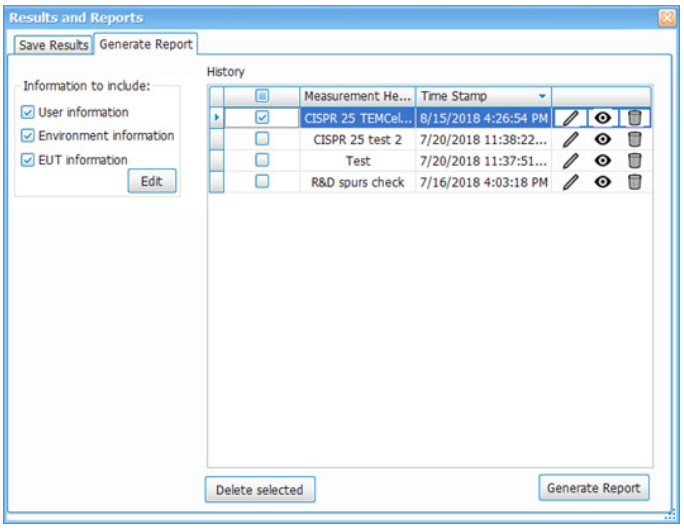

FIGURE 10. Report Generation wizard.

Troubleshooting and debugging with real–time spectrum analysis technology

Once issues have been found in pre-compliance tests, what's next? You need to troubleshoot the issues and locate the sources of RF emissions. The real-time DPX® technology in Tektronix spectrum analyzers can help you to discover the most difficult, hard-to-find problems. It enables you to see RF characteristics that are practically invisible to a conventional spectrum analyzer.

Figure 11 shows a near-field probe being used to locate emission sources in the near-field. Figure 12 shows both the DPX spectrum and the regular spectrum displays. The DPX spectrum indicates regularly occurring spurs, even though they are hidden below wideband noise.

FIGURE 11. The DPX real time spectrum analysis with a near filed probe helps you discover and locate the transient emission sources.

FIGURE 12. The DPX real time spectrum analysis vs regular swept spectrum analysis. DPX can detect transient signals, and helps users to gain insights of co-channel interference.

Summary

EMI compliance testing for automotive components and subsystems is an important part of the design process, and it usually occurs quite late. Pre-compliance testing can take help mitigate stress on your project and by taking the right steps, you can have higher confidence that your design will pass at the test house. New, relatively low-cost instruments and software are available to help you minimize testing expense and achieve schedule commitments while getting your products EMI certified.

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