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E-Band VNA for Automotive Market: Bumper and Emblem Measurments

Introduction

The use of radars in the automotive industry has become increasingly critical over the past few years. Cars now have many features and options enabled by these radars, which provide the required information from the environment to make driving easier and safer. Most of these radars work in the 60 to 90 GHz frequency band, which is called the E-band.

For bumper manufacturers, it is critical to characterize the materials used in their production processes and their influence on the signals transmitted by these radars. Radars are usually placed somewhere behind a bumper and can be placed perpendicular or at a certain angle related to the bumper itself. Thickness of the bumper, material used, paint coatings, mounting angle, etc. can all affect radar transmissions and must be clearly characterized.

Several considerations must be taken into account prior to conducting material measurement tests. To simulate real-world conditions that would affect these transmissions, over-the-air (OTA) testing should be conducted. Considering the fact that test could be eventually conducted in production environments, the test system should be as easy as possible to configure and use, as well as ruggedized to withstand production conditions.

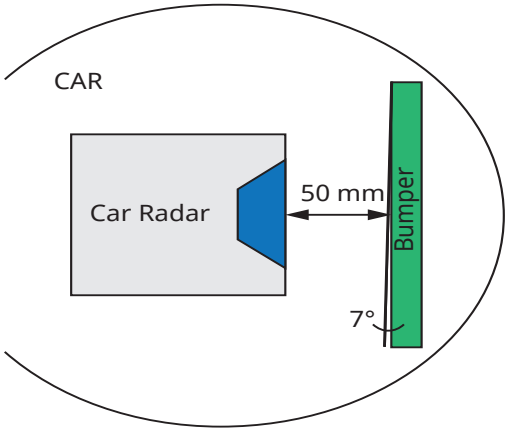

Figure 1. Radar positioning related to the bumper

The VNA and the Test Setup

The ShockLine™ MS46522B E-band solution (options 82 or 83) is ideal for these kinds of measurements. Its simplicity, robustness, and frequency range make this solution ideal for these setups. The ShockLine MS46522B E-band solution consists of small tethered source/receiver modules and a base chassis. The modules are permanently attached to the chassis via 1 or 5 meter cables, making this a compact, ready-to-use E-band VNA. The remote modules have a native WR-12 waveguide interface for convenient interfacing to typical waveguide devices like horn antennas or dielectric antennas to be used in OTA setups.

The ShockLine MS46522B E-band VNA can also be controlled remotely with programming and scripting that enables automated measurements. It has a TCP/IP interface and supports LabView, Matlab, Python, etc.

For the characterization of the material to be used in the bumper, only simple S-parameters (S11, S12, S21, and S22) measurements will be required. Instead of using a typical conducted environment, a radiated environment will be used and proper antennas will be needed.

For the antenna selection, a few parameters must be considered. First of all, the far field condition must be met to obtain coherent measurements. This is something easily achieved considering the working frequency range (at 75 GHz, far field condition is met with roughly 4 cm separation from the antenna). Besides the frequency, the antenna directivity should be high enough to avoid dispersion at the edge of the material. Antennas with a WR-12 waveguide interface like horn antennas or dielectric antennas with even a higher gain can be used in this type of application.

The Calibration

As with all uses of a VNA, the instrument must be configured and calibrated to get accurate results. The calibration method used for these OTA measurements is the Line, Reflect, and Match (LRM) algorithm, in which we will use a reflection plane for reflective calibration, a line for transmission calibration, and a perfect match. Aiming for simplicity, accuracy, and repeatability, the calibration kit will consist of a simple metallic plate in the middle of both ports, perpendicular for the reflection term, turned 45° for the match.

Figure 2. E-Band ShockLine VNA

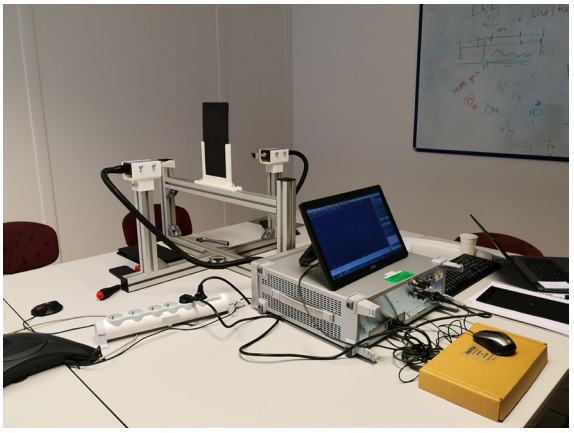

Figure 3. Setup for the E-band bumper measurements

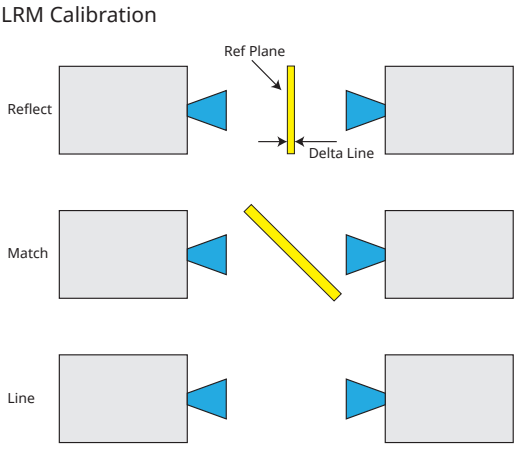

Figure 4. LRM setup with metal plate and antennas

Measurements

After calibration, S-parameters can be measured. The setup would be as simple as placing a material sample right in the middle of the two antennas so that both phase and amplitude of the S-parameters can be obtained. (See figure 5)

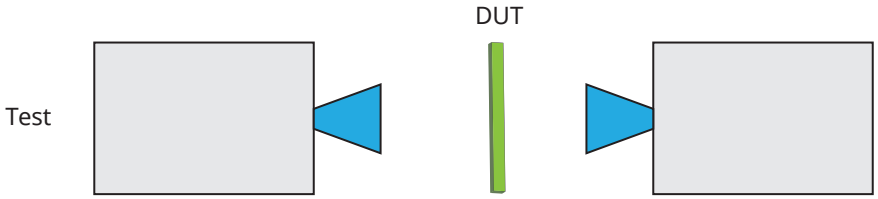

Figure 5. Measurement setup

S-parameters will give us information of how much energy is being reflected due to the bumper material and how much attenuation the radar signal is suffering (figure 6). Time gating can be applied to both to obtain more accurate results without the influence of external reflections.

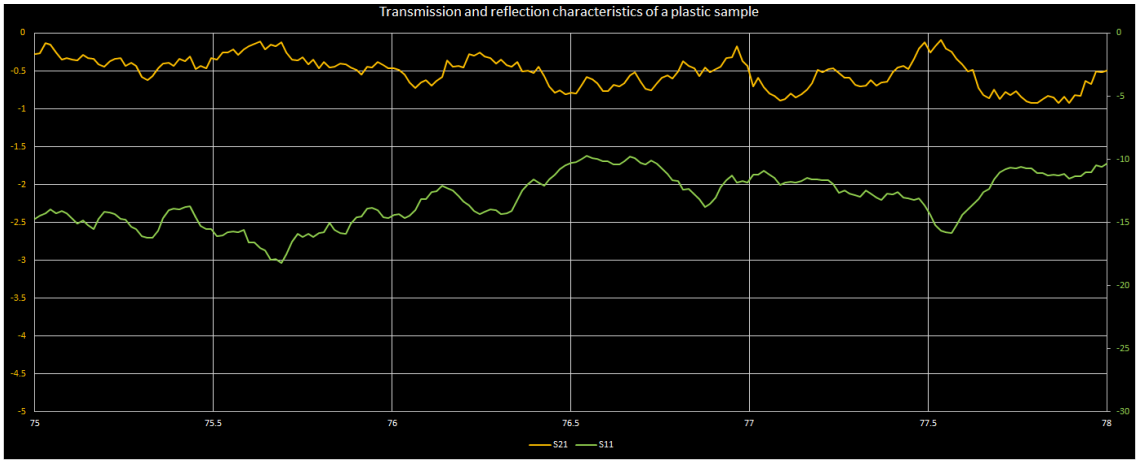

Figure 6. Energy measurement

Summary

The ShockLine MS46522B E-band model is a cost-effective solution that covers the extended E-band frequency range (55 to 92 GHz) with two unique tethered VNA configurations (options 82 and 83). Unlike competitive E-band VNAs that require some level of setup, the ShockLine MS46522B E-band VNAs are ready to use out of the box. Option 82 comes with 1 meter and Option 83 comes with 5 meter tethers that permanently attach E-band source/measurement modules to the base chassis. Each measure module features a WR-12 waveguide interface, making it very convenient to interface to most E-band DUTs. The 1 meter E-band VNA is aimed at production testing of E-band devices, while the 5 meter option is targeted at OTA chamber testing of antennas and similar DUTs.

The ShockLine MS46522B E-band setup with WR-12 dielectric antennas is the ideal setup to characterize the material behavior of plastics and painting coatings used in automotive environments. Its simple setup, ruggedized design, and advanced architecture help reduce the cost-of-test and speed time-to-market in numerous test applications up to 92 GHz.

The added flexibility of remotely controlling the instrument enables automated measurements to reduce setup errors and simplify the tests themselves. The ShockLine MS46522B with options 82 or 83 offers the best solution for the automotive industry to test the various materials used to hide or protect radars and determine how they affect radar signals.

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