Application Note

Electromagnetic Interference Testing Using the LDC3114

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Position Sensing

ABSTRACT

The BOOST-LDC3114EVM is used in CISPR25 testing to showcase the performance of the LDC3114. These test results are application-specific and do not ensure performance in another use case.

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1 Introduction

1.1 Inductive Sensing

The LDC3114 is an inductive sensing device that enables touch-button design for human machine interface (HMI) on a wide variety of materials by measuring small deflections of conductive targets using a coil that can be implemented on a small printed circuit board (PCB) located behind the panel. This technology can be used for precise linear position sensing of metal targets for automotive, consumer, and industrial applications by allowing access to the raw data representing the inductance value. Inductive sensing solution is insensitive to humidity or non-conductive contaminants such as oil and dirt.

This device works by utilizing an inductive coil with a parallel capacitor to implement an LC tank. The LC tank has a resonant operating frequency that changes as a metal target interacts with the magnetic field generated by the planar inductor coil. Because of this magnetic field operating at a resonant frequency designed for a specific application, the electromagnetic interference of the system needs to be tested to ensure it meets the required specifications of the application.

For more information on inductive sensing, visit ti.com/inductive.

1.2 EMI

When an electronic system or device resides in a harsh and noisy environment, electromagnetic interference (EMI) can occur, disrupting system level functions or causing a product to fail electromagnetic compatibility (EMC) testing. EMI is essentially any unwanted radiated or conducted electrical signals that negatively affect the performance of a system or device. Due to the increasing number of radiating wireless devices, it is vital to ensure EMC and adhere to its standards. Many applications require CISPR testing to be done on their systems to ensure that the product meets FCC standards for EMI and EMC. The level of CISPR testing required varies per application and should be tested on a system level. This application note covers an example test setup using the LDC3114 along with different coil designs to showcase the EMI performance of the device.

2 CISPR 25 Requirements

CISPR 25 is an automotive EMI standard that is required for many manufacturers. This testing is titled as "*Vehicles, boats and internal combustion engines – Radio disturbance characteristics – Limits and methods of measurement for the protection of on-board receivers*." The purpose of this standard is to limit the amount of emissions from the device under test (DUT) in different frequency bands to ensure that the DUT does not interfere with other systems that operate in those bands. The testing and limits are split into two separate types of emissions: conducted and radiated. Conducted emissions are coupled onto supply lines directly through conductors (such as traces or wires), and radiated emissions are emitted as EM waves and can be picked up by intentional and unintentional antennas on other systems.

The test procedures, relevant-frequency bands, and limits are different for both types of emissions, but the basics are similar: the device under test (DUT) is placed in an isolated room or chamber and set up in a well-defined, reproducible-electrical setup. All other possible emitters are removed from the chamber and the DUT is turned on and then allowed to operate normally. The DUT is powered through an artificial network (LISN) and loaded through its normal operation. A spectrum analyzer is used to measure the DUT emissions across different frequencies (through the LISN or from an antenna) and compares the emissions against the CISPR 25 limits. Both the peak and average values of the emissions are measured, and both must pass. Finally, the level of passing falls into several categories, or classes, that have different limits. OEMs define which class a specific subsystem must satisfy. For more information on the test procedure and limits, please see the official CISPR25 documentation.

2.1 Radiated EMI Testing

2.1.1 Test Setup

The BOOST-LDC3114EVM is the evaluation module available for the LDC3114. It has a two-board setup where the device is provided as a booster pack for the MCU board. Since the MCU is not the subject of this test, the booster pack is disconnected after the device is configured, leaving only the BOOST-LDC3114EVM board along with the power supply. Information on the board design and layout is found in the *BOOST-LDC3114 Evaluation Module* user's guide. During radiated EMI testing, multiple antenna types are used to determine the performance of the DUT over different frequency ranges. The four different antennae used in this setup are: active monopole (150 kHz–30 MHz), bi-conical (30 MHz–200 MHz), log-periodic (200 MHz–1 GHz), and horn (1 GHz–2.5 GHz).

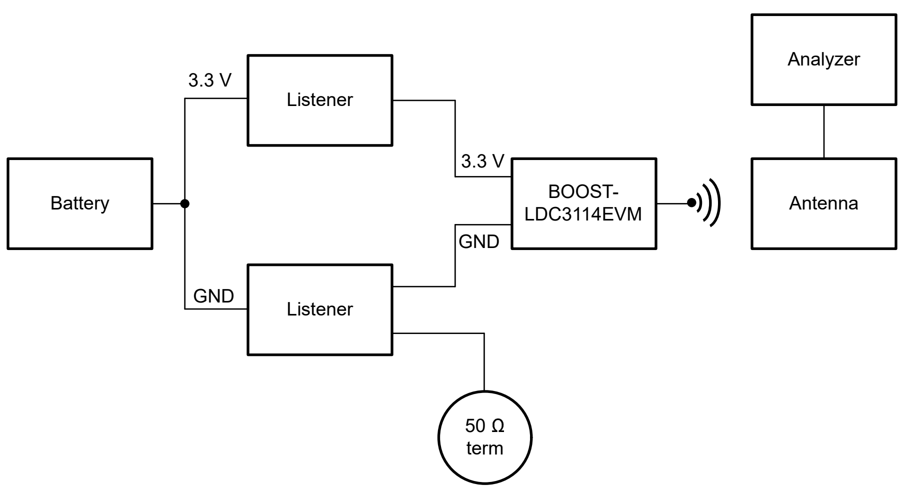

Figure 2-1. Radiated Test Block Diagram

2.1.2 Test Results

The active monopole antenna was the first test performed. Figure 2-2 and Figure 2-3 show the test results along with the room baseline.

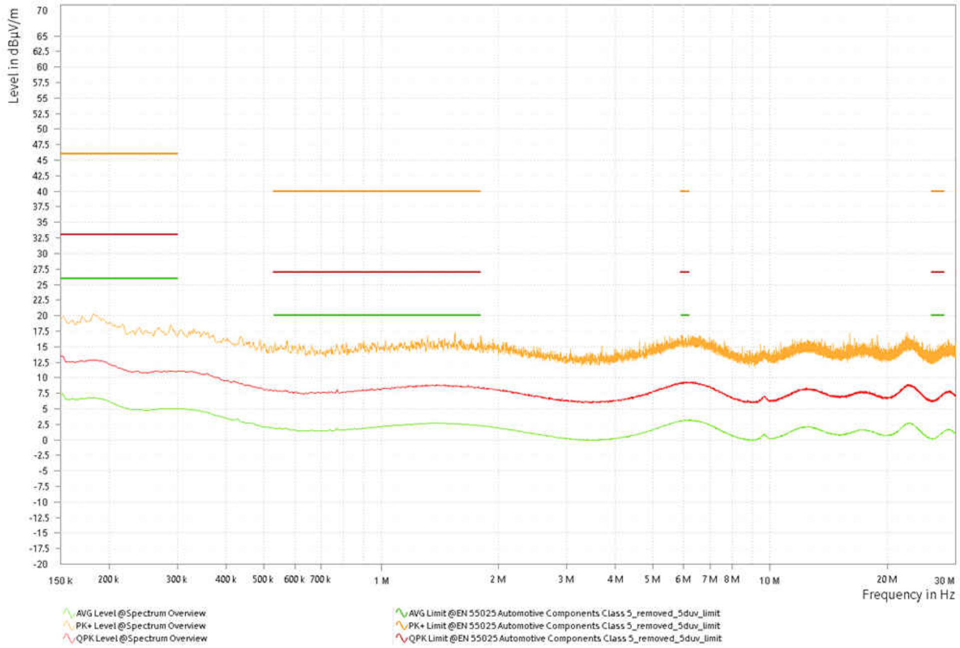

Figure 2-2. Active Monopole Antenna Baseline

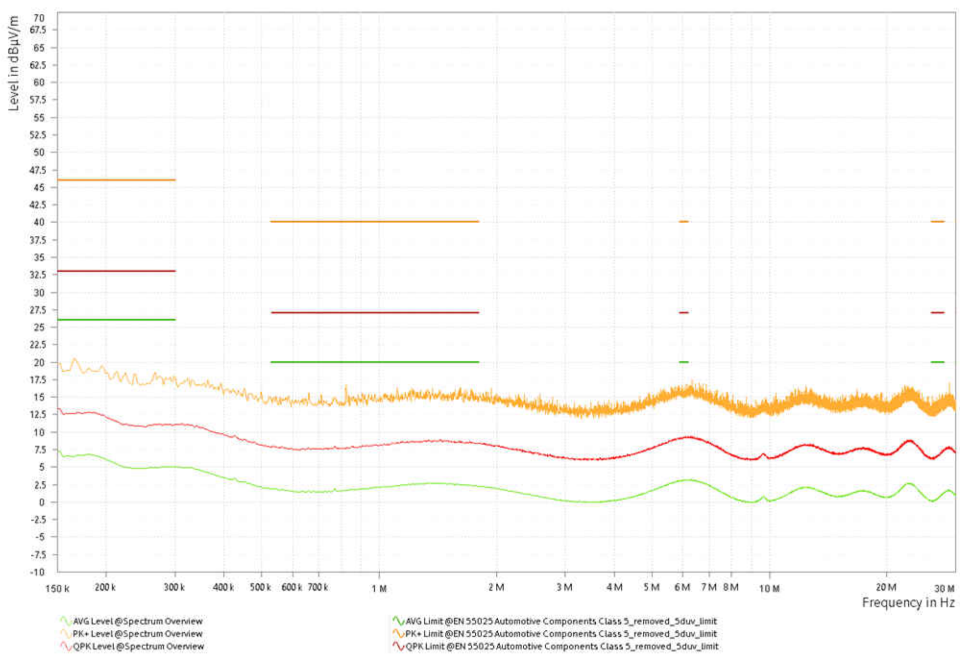

Figure 2-3. Active Monopole Antenna Results

The limits of the testing are shown on all graphs to create an easy visual for the device performance. The next test performed used the bi-conical antenna to measure the board.

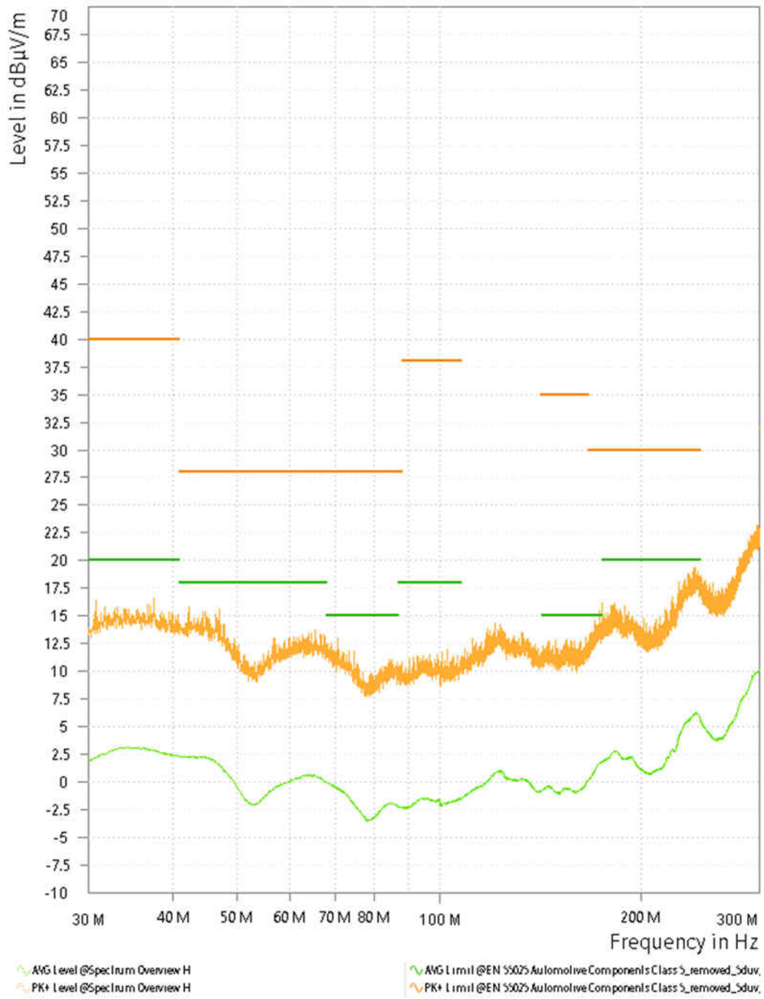

Figure 2-4. Bi-Conical Antenna Baseline

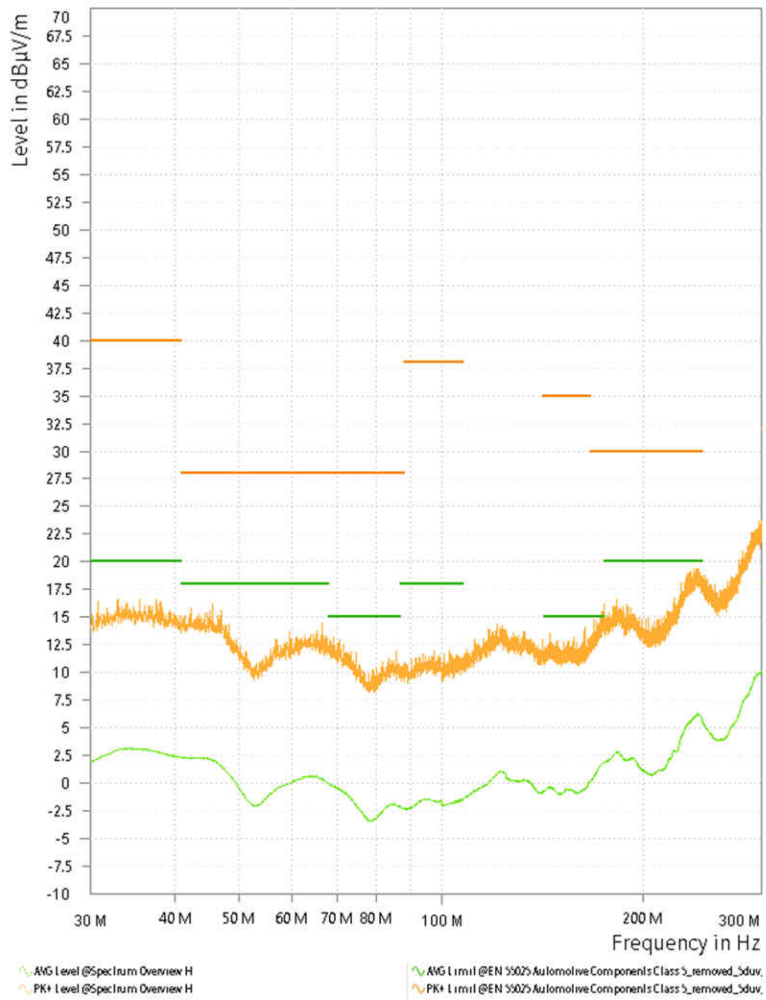

Figure 2-5. Bi-Conical Antenna Results

Next, the log-periodic antenna was used to perform the same test, see the results in Figure 2-6 and Figure 2-7.

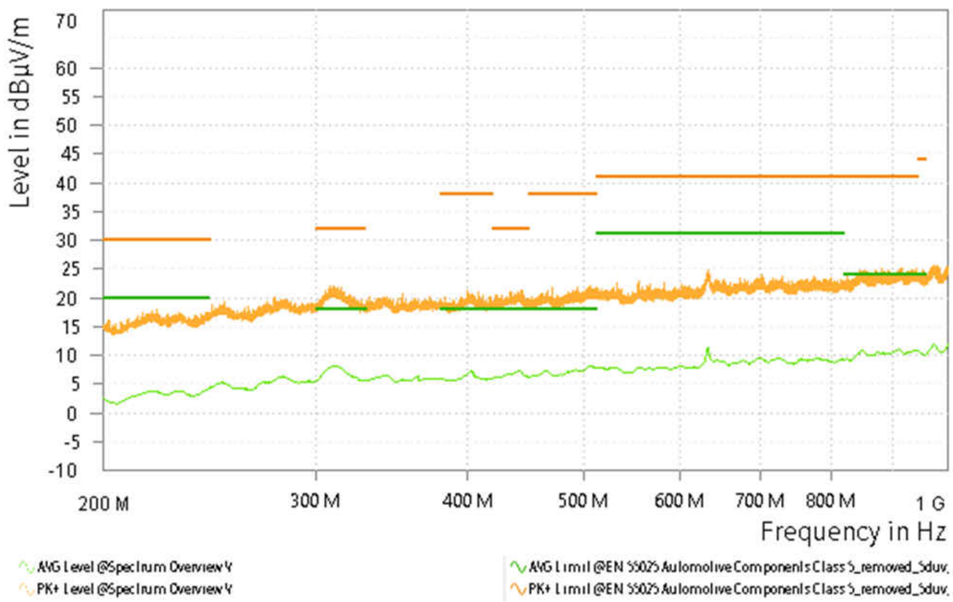

Figure 2-6. Log-Periodic Antenna Baseline

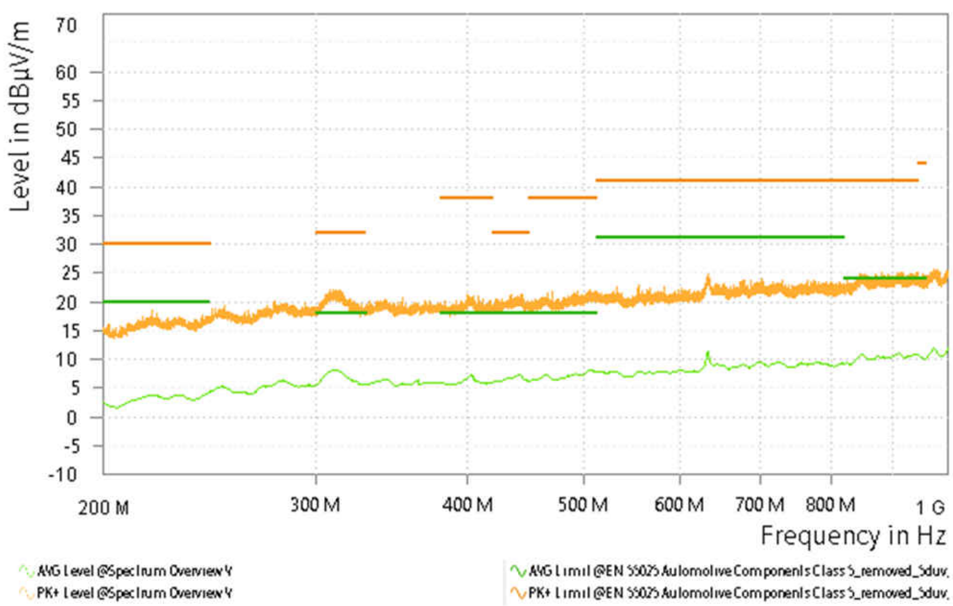

Figure 2-7. Log-Periodic Antenna Results

Lastly, the horn antenna is used to perform the test. Figure 2-8 shows the horn antenna baseline and Figure 2-9 shows the horn antenna results.

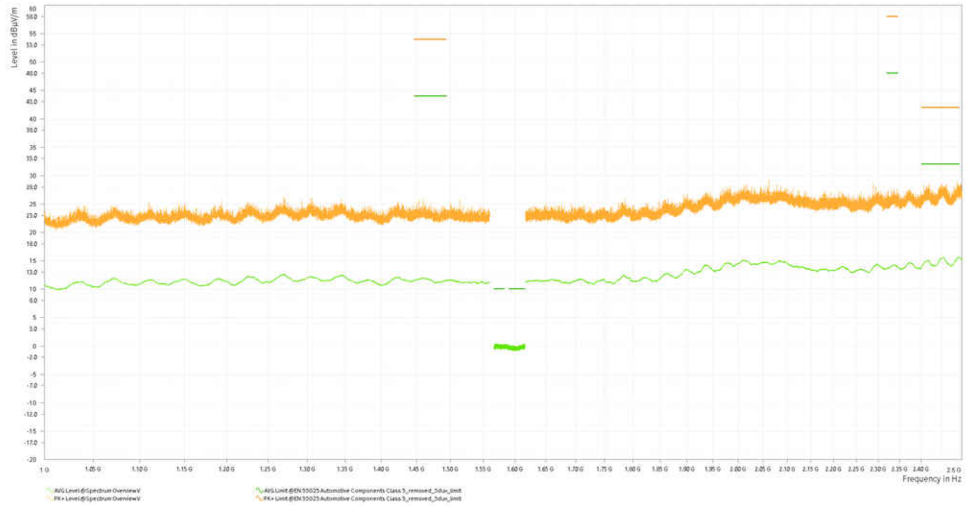

Figure 2-8. Horn Antenna Baseline

Figure 2-9. Horn Antenna Results

All of the radiated tests passed the CISPR25 requirements without concern or need for modification.

2.2 Conducted EMI Testing

2.2.1 Test Setup

The conducted testing setup (see Figure 2-10) is similar to the radiated case with the main difference being where the spectrum analyzer is connected and the lack of antenna in the system. These tests show the noise produced by the BOOST-LDC3114EVM that couples through the supply lines.

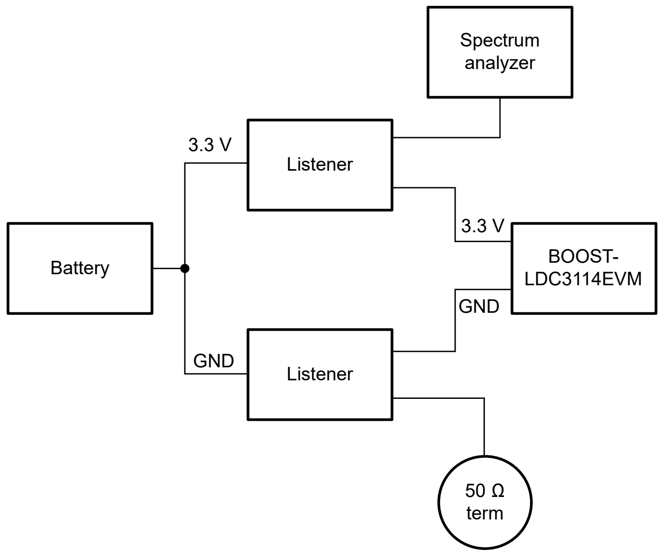

Figure 2-10. Conducted Test Block Diagram

The test was run using different sensor coils with the LDC3114. These sensors show the impact of using different sensor frequencies and how they impact the EMI performance of the device.

2.2.2 Test Results

The first test done is to get a baseline of the EVM without the sensor coil included. The baseline test shown in Figure 2-11 only has the EVM with the battery connected.

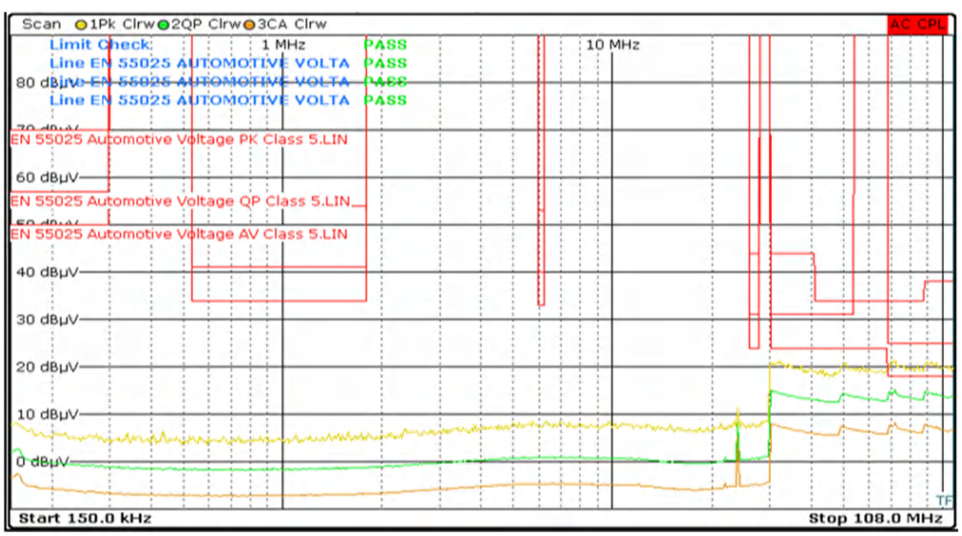

Figure 2-11. Conducted Test Baseline

Next, a 7-MHz sensor coil is attached to the EVM and the test is run again, see the results in Figure 2-12.

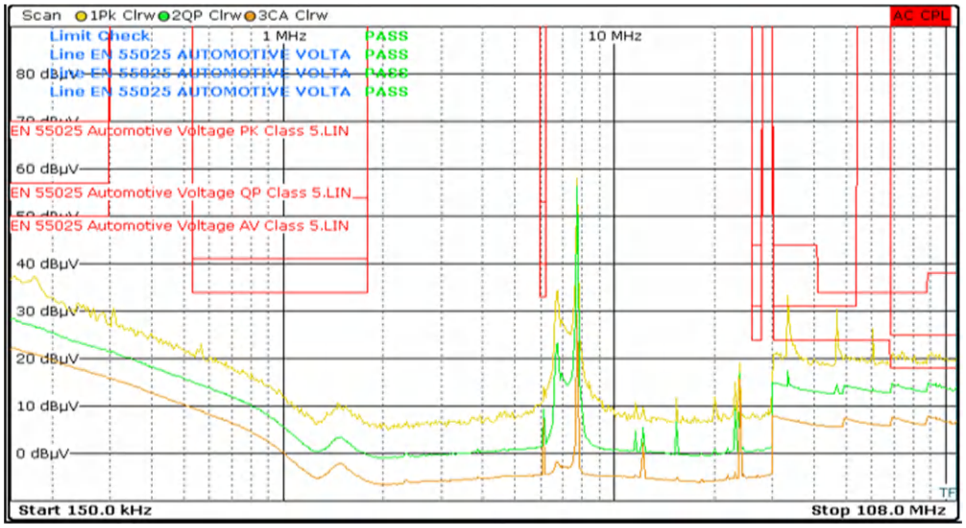

Figure 2-12. Conducted Test With 7-MHz Sensor Coil

The added sensor coil has a significant impact on the test performance but the test still passes. A similar result also occurs when the coil is replaced with a 12.6-MHz coil, see Figure 2-13.

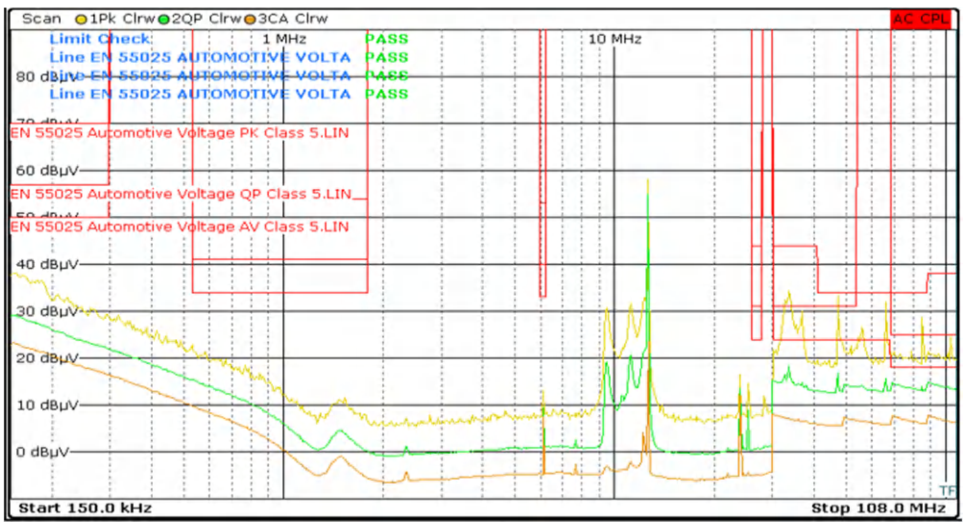

Figure 2-13. Conducted Test With 12.6-MHz Sensor Coil

The frequency of the spikes in the test data increased as the coil frequency increased. Because of this, the coil frequency is an important part of the design when considering other EMI noise sources or any keep-out-regions for the system requirements.

3 Summary

CISPR25 is an important test to perform for applications in the automotive space and is a system-dependent test. The results shown in this paper are a general performance of the LDC3114 but do not ensure results in any specific system. As seen from the radiated testing, the frequency of the sensor coil has a direct impact on the test performance and should be taken into consideration with the rest of the system design.

4 References

- Texas Instruments, *LDC3114-Q1, Automotive 4-channel inductance-to-digital converter for low-power proximity & touch-button sensing* product page
- Texas Instruments, *BOOST-LDC3114EVM LDC3114 evaluation module for inductive sensing* tools page
- CISPR 25, CISPR 25 - IEC page

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