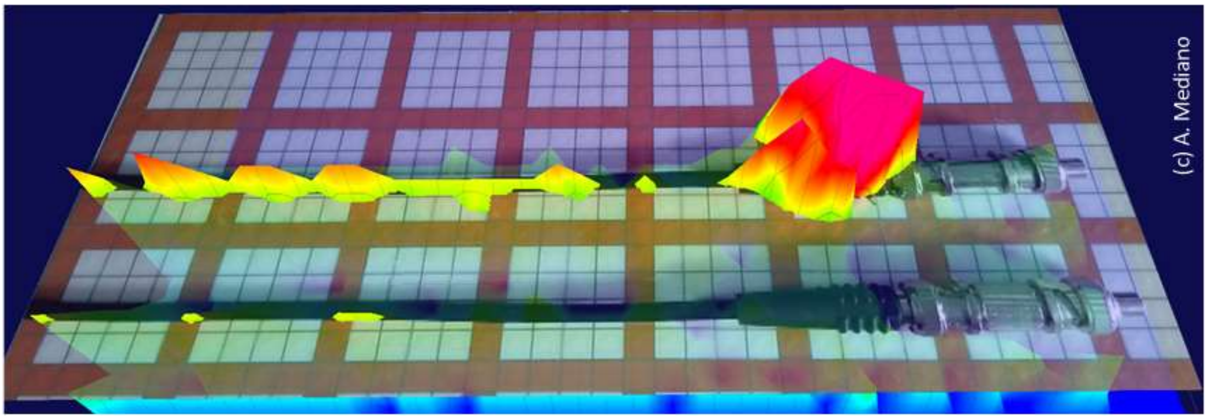
Y.I.C. Technologies

Comprehensive Application Note

Finding EMC leakage in cables and connectors



ABSTRACT

This Application Note examines, by way of example, the problem in an RG-58 coaxial cable terminated in 50 ohms and experiencing radiated emissions issues between 100MHz and 300MHz due to the clock signal it carries.

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Introduction

Near-field probes and scanners are powerful tools for analyzing leaks in cables and connectors. These techniques have numerous applications, with notable emphasis on the automotive industry, digital communications, and audio/video services.

In these systems, it is common to encounter failures in radiated emissions tests within the frequency range of 30MHz to 400MHz. This range is where the cables of the product often act as the main antennas of the system, given their dimensions relative to the wavelength of these frequencies.

So, how do you locate a leak in a cable or connector? How do you validate the quality of a specific cable and/or connector production process?

This application note examines, by way of example, the problem in an RG-58 coaxial cable terminated in 50 ohms and experiencing radiated emissions issues between 100MHz and 300MHz due to the clock signal it carries (see Fig. 1).

Fig. 1. Basic diagram of the analyzed system.

The signal source is a 24MHz clock with rise and fall times on the order of 2ns.

Initially, this is a perfectly shielded system, so emissions should be minimal. However, when different units of a certain cable type are used, the problem appears with some and not with others.

To evaluate the issue, two cables were tested: one exhibiting problems (cable A) and another allowing for compliance with radiated emissions (cable B). Both cables were "exactly the same."

For the test, the common-mode current in the cables was measured using an R&S EZ-17 current probe and a R&S RTO6 scope (see Fig. 2). The cable termination is 50 ohms with a 360-degree connection to the cable connector.

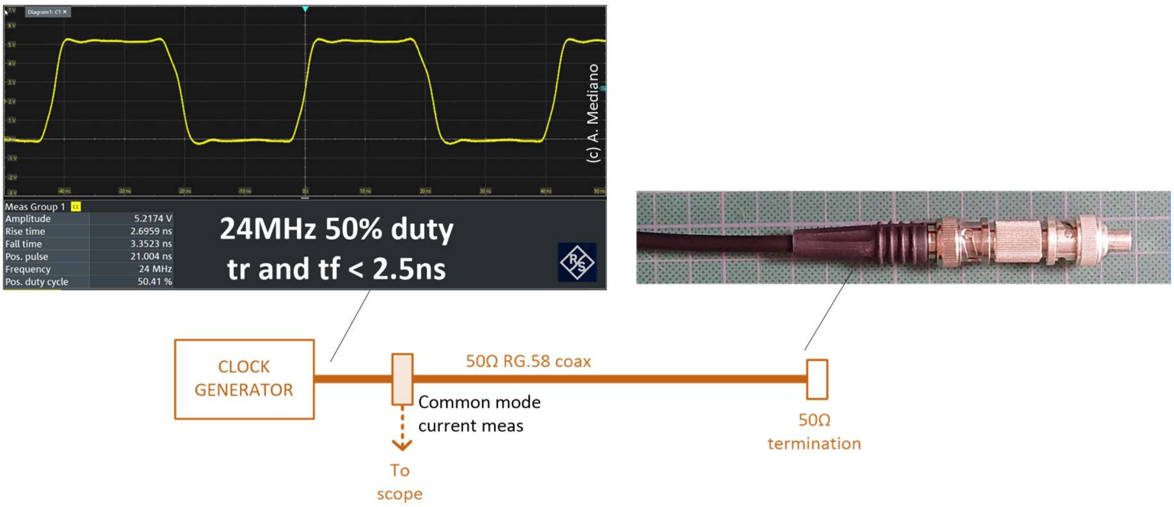

Fig. 2. Details of the setup.

The results obtained for the common-mode current are shown for both cables in Fig. 3:

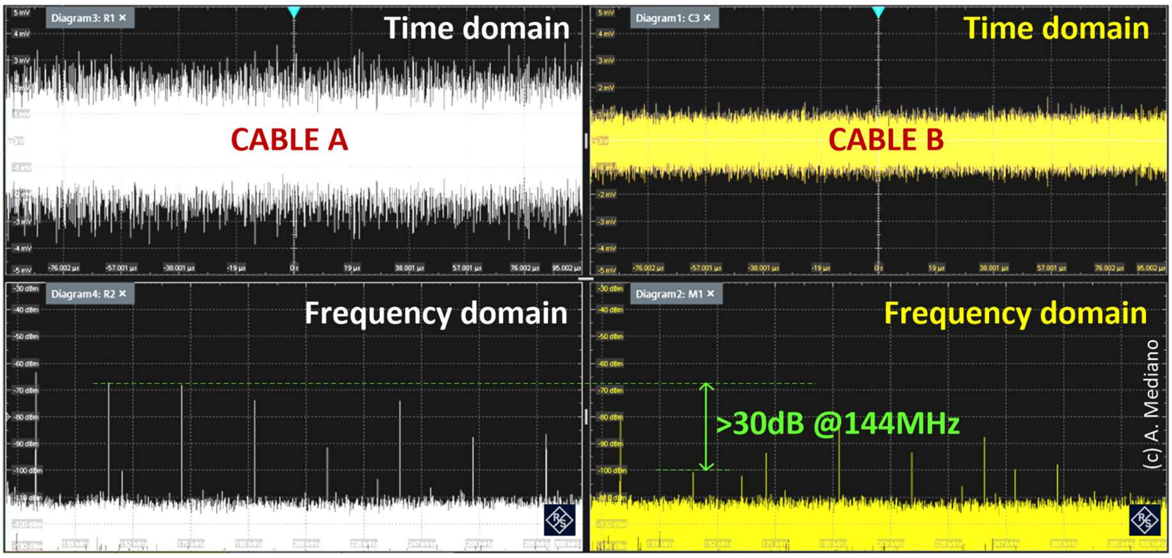

Fig. 3. Measurement of common-mode current in the cables (100-300MHz).

The results in the time domain clearly show a significant difference in the amplitude of the common-mode current flowing through both cables.

It is interesting to observe in the frequency domain that within the range of 100MHz to 300MHz, certain harmonics experience a reduction of more than 30dB (as exemplified by the case at 144MHz in the figure) when using either a good (cable B) or bad (cable A) cable. This reduction of 30-40dB is the primary reason why one cable passes the tests (cable B) while the other does not (cable A).

However, if the cables are "identical," where does this discrepancy originate?

To analyze the situation, both cables were tested using the same signal with the YIC Technologies EMScanner. As depicted in the figure, the results of the analysis were compared between two "identical" cables using the same clock signal.

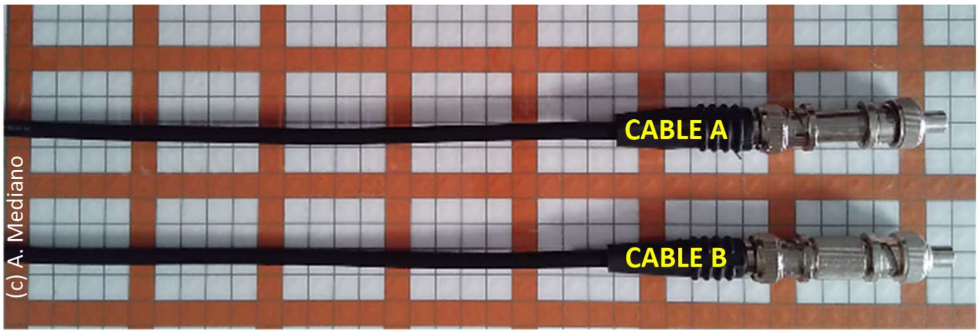

Fig. 4. The two tested cables on the EMScanner.

It is important to highlight that visually, both cables appear to be identical, so it is not possible to infer where the problem lies through visual inspection alone.

The first analysis conducted was a spectral analysis between 100MHz and 300MHz (Fig. 5).:

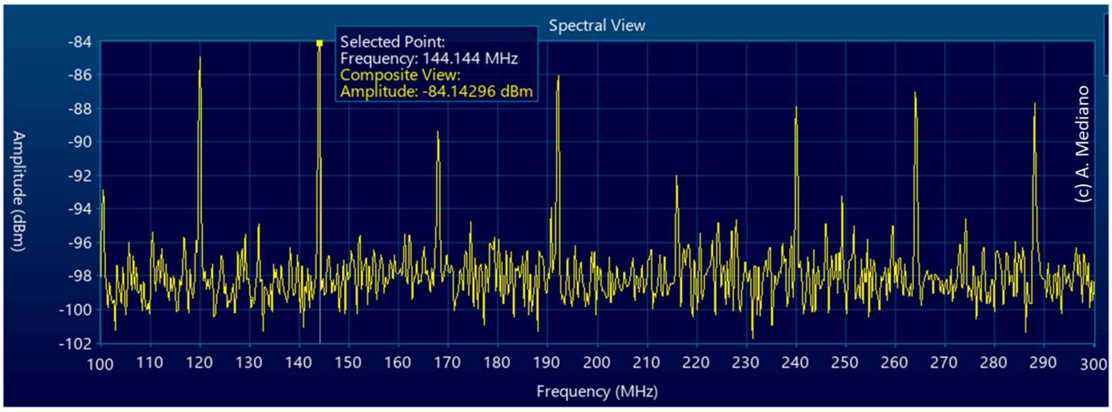

Fig. 5. Spectral scan from the two cables in Fig. 4.

The clock harmonics are clearly visible with a peak at the frequency of 144MHz in the spectral analysis.

For this frequency, a spatial analysis was conducted, and it was found that cable A exhibited an anomaly (leak) at the connection point to the BNC connector (Fig. 6).:

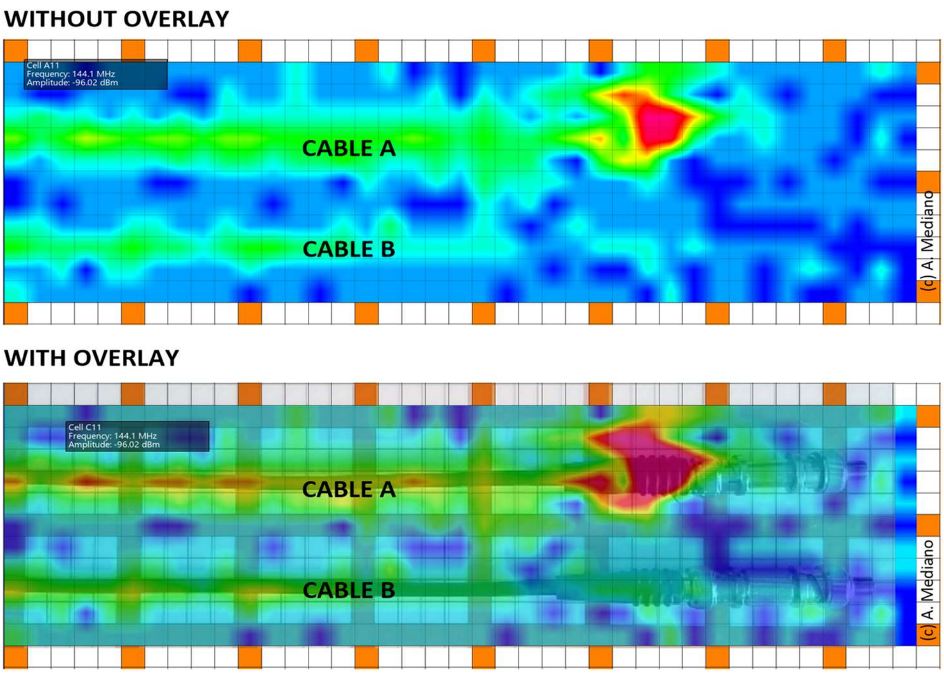

Fig. 6. Spatial scan at 144MHz (2D).

A 3D visualization provides a clearer view of the difference between both cases:

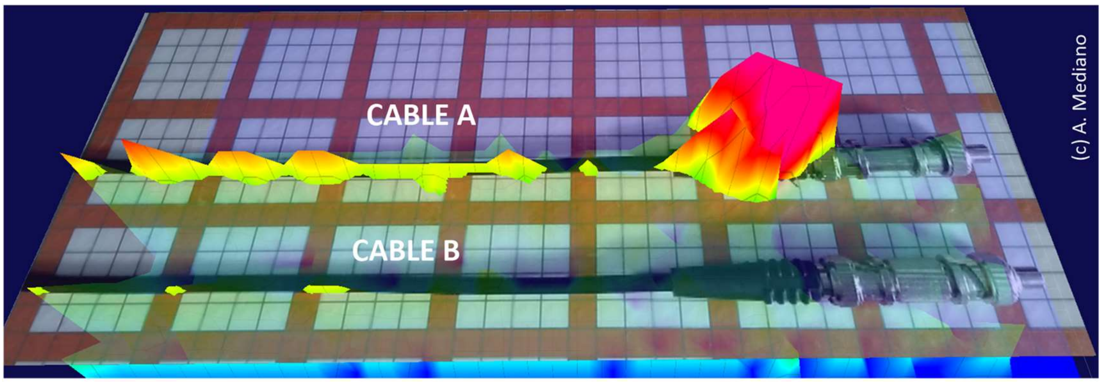

Fig. 7. Spatial scan at 144MHz (3D).

To understand the origin of this difference, the plastic covering was removed from both cables to check for any discrepancies. Indeed, in the case of cable A, the shield of the cable was connected to the connector via a few millimeters of copper wire (pigtail). In cable B, the connection was made (correctly) with a 360º connection around the connector (see Fig. 8):

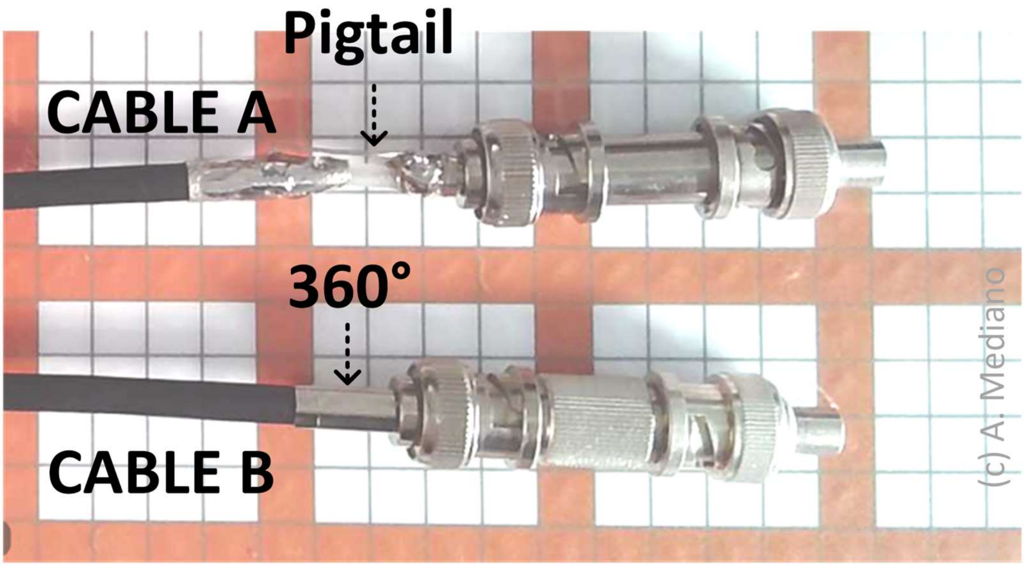

Fig. 8. Why cables A and B are different.

Conclusion

The quality of a cable and the detection of these kinds of leakages can be easily analyzed using near-field tools such as the EMScanner from Y.I.C. Technologies.

This issue is common when using low-cost shielded cables in applications like USB, HDMI, etc. A pigtail connection poses a significant risk (and is often invisible to the user).

Y.I.C. Technologies solutions offer a powerful way to look at your product design by offering desktop solutions with fast and reliable results.

For more information, please contact us:

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