Application Note

Evaluating Fluorescent Lighting Interference on Passive UHF RFID Systems

Using N934xC/B Handheld Spectrum Analyzers

Agilent Technologies

Overview

In passive radio frequency identification (RFID) systems an RFID reader transmits an RF signal to the RFID tag, which consists of an antenna and an integrated circuit chip. The chip is powered by converting the transmitted RF signal into DC power and communication from the tag to reader occurs in the form of RF backscatter. In this case, the chip responds by varying the load impedance of the tag antenna at the data rate of the system. Changes in the load result in changes in the reflection properties from this antenna. The reader then recognizes these small changes as tag data and recovers the tag ID.

However, as the reader is transmitting a continuous wave (CW) signal during the backscatter operation, other changes in the surrounding environment could potentially modulate the carrier. Electronic ballast-driven fluorescent lamps (EBFL) may unintentionally modulate the RF signal and affect the reception of backscatter signal from the UHF RFID tag.

As this application note illustrates, an effective way to determine if the affects of fluorescent lighting is impacting the RFID system, is through the use of a handheld spectrum analyzer (HSA). This is done by measuring the frequency spectrum under two conditions: first with the lighting switched off, and then with the lights switched on.

Test Configuration

As Figure 1 illustrates, an RF signal generator is configured to transmit an un-modulated carrier and a spectrum analyzer is used to compare the measured frequency spectrum with the florescent lighting turn off and again with the lights on.

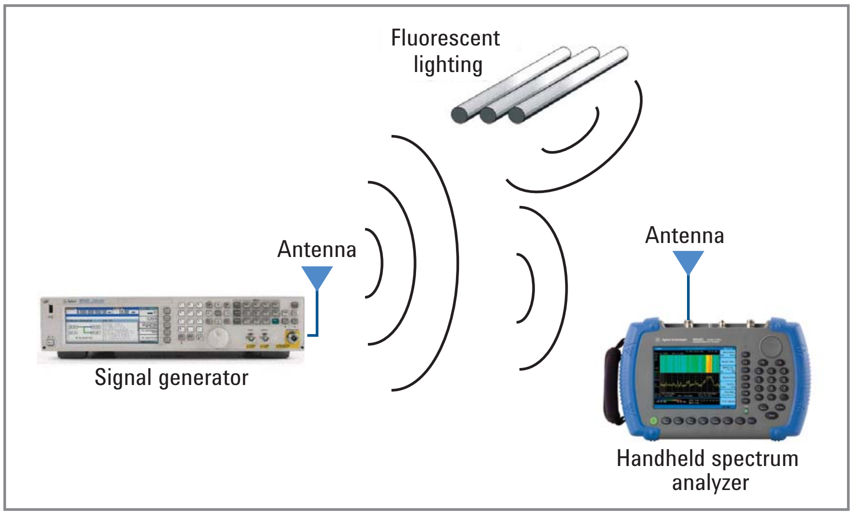

Figure 1. Test configuration for evaluating the affects of fluorescent lighting on a UHF RFID system

Table 1 briefly summarizes the equipment's role in the test configuration and suggests suitable Agilent products.

Device	Purpose	Agilent solution
Handheld spectrum analyzer	Measures the over-the-air spectrum	N9342C, N9343C, N9344C, or N9340B handheld spectrum analyzer
Signal generator	Generates the RF test signal	N5182A MXG vector signal generator
Flexible whip antenna (quantity 2)	Transmits and receives the RF signal from the surrounding area	N9311X-501 omni-directional antenna

Table 1. The role of equipment in an automated test system

Performance Results

Lights off

The Agilent Technologies N5182A MXG vector signal generator, with an attached omni-directional rubber ducky-type antenna such as the N9311-501, connected to the RF output connector, was configured to output an un-modulated 915 MHz signal with -10 dBm amplitude. The passive RFID backscatter signal is centered at 915 MHz so an Agilent Technologies N9342C handheld spectrum analyzer (HSA), was configured to measure the spectrum around a center frequency of 915 MHz. Another antenna was attached directly to the Agilent HSA input.

It's worth noting that under these conditions, the N9342C HSA has a convenient backlit keypad for instrument control and the instrument screen self-adjusts to a variety of lighting conditions from total darkness to full sunlight (see Figure 2).

Figure 2. The N934C/B HSAs have backlit features for ease of use in dark environments

Performance Results (continued)

Figure 3 shows the measurement display from the N9342C spectrum analyzer when the office lights were turned off. The analyzer center frequency was set to "915MHz" using the [FREQ] button and the displayed frequency span was set to "500kHz" using the [SPAN] button. The top line of the graph is the reference level and is adjustable using the [AMPTD] button.

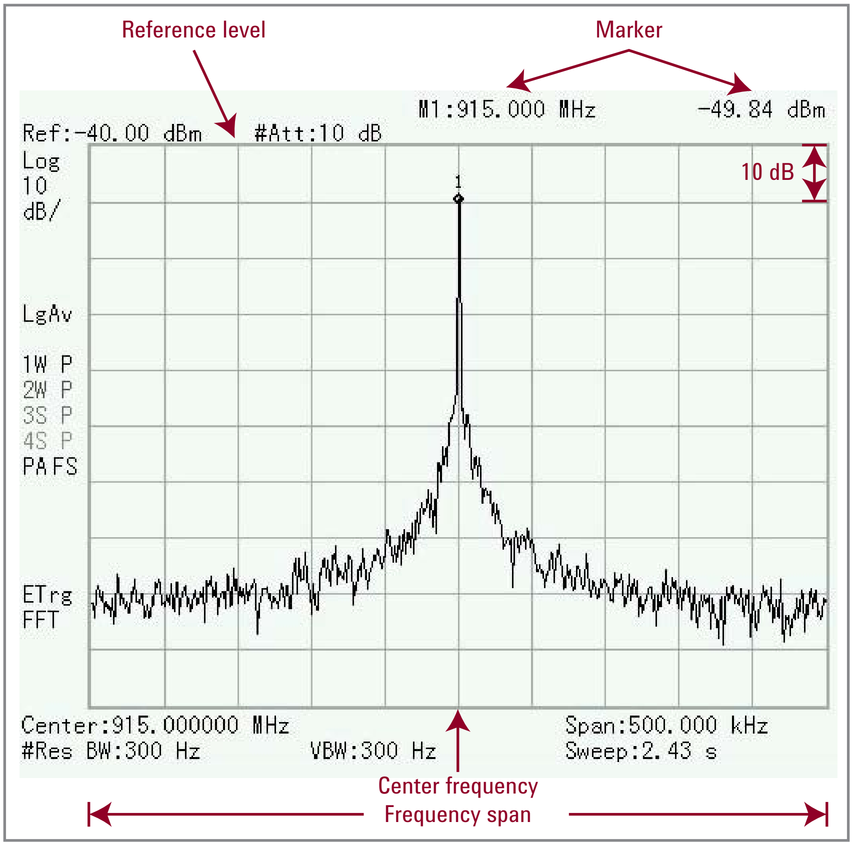

Figure 3. Over-the-air measurement of a 915MHz RF signal in an office environment with the lighting turned off

The reference level is adjusted to optimize the measurement display; in this case, the reference level was set to "-40dBm". Using the default scaling, each vertical box represents an amplitude difference of 10 dB, shown as "10dB/" on the screen, therefore with a total of 10 boxes the bottom line on the graph represents "-140dBm". It is important to properly adjust the reference level so that the signal does not appear to be clipped off the top of the graph.

The measured trace in Figure 3 shows a single RF carrier without modulation. The maximum amplitude level and frequency of the signal was measured using a marker placed at the peak of the signal. The marker functions, including "peak search", are found under the [MARKER] menu on the Agilent HSA but similar functions are available on most commercially-available spectrum analyzers. Using the marker, the peak amplitude is measured to be -49.84 dBm at the expected frequency of 915 MHz.

For this measurement, without the fluorescent lights, the spectrum appears relatively clean of any spurious or sideband modulation.

Lights on

Next the lights were switched on and the spectrum was measured for a second time. Figure 4 shows the measured spectrum with the fluorescent lighting and now the spectrum includes undesired sidebands modulated onto the RF carrier.

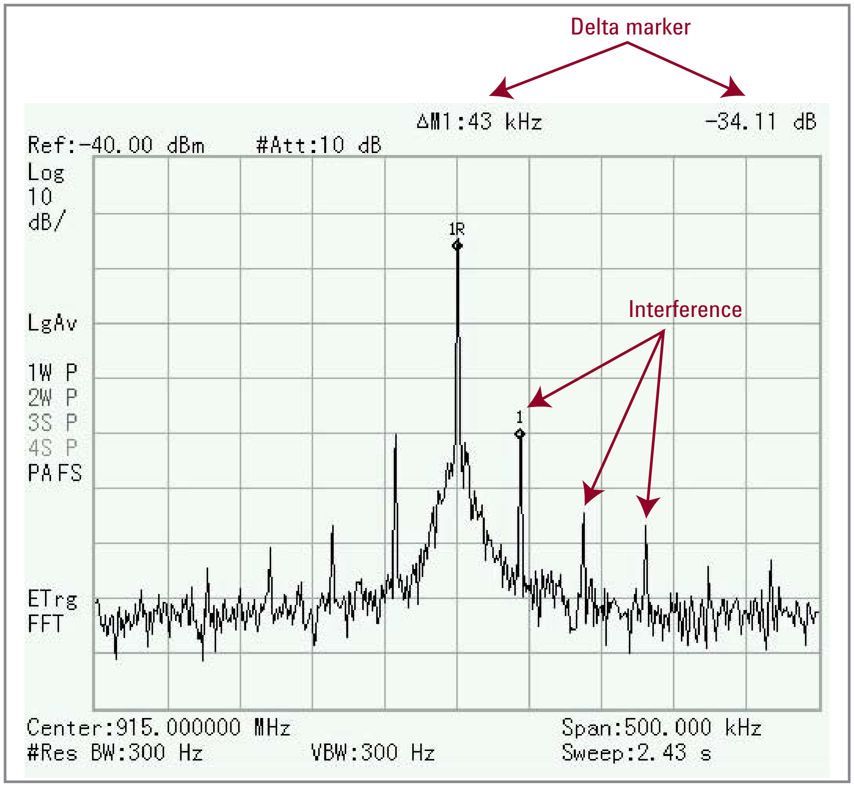

Figure 4. Over-the-air measurement of a 915 MHz RF signal in an office environment with the fluorescent lighting turned on. Shown are the modulation sidebands of the 43 kHz operating frequency of the electronic lighting ballast

This interference has been introduced into the RF signal by the electronic ballast of the fluorescent light fixtures. Another marker function was used to measure the difference between the peak signal level and the largest interference sideband. The "delta marker" function, also found under the [MARKER] menu reports a -34.11 dB difference between the peak signal and the largest interference just right of the signal peak. The frequency difference is 43 kHz which is the operating frequency of the fluorescent lighting ballast. The other interference sidebands are the harmonics of this 43 kHz frequency.

Recommendation

It is important to measure the EBFL effects in the environment surrounding an RFID reader installation. As the RFID tag backscatter may have modulation sidebands near the sidebands introduced by the EBFL, the EBFL may interfere with the RFID reader's ability to measure signals from the tag. If it is found that the EBFL creates high levels of interference, then proper reader antenna placement may improve system performance. For example, as passive UHF RFID reader antennas often use directional antennas with high gain (6 dBi), it may be possible to point the reader antenna(s) direction away from the EBFL fixtures such horizontally or better yet positioned high and pointed down.

EBFL are specified to operate over an operating range of 20 to 60 kHz. Often to avoid interference with certain infrared systems, the 30 to 42 kHz range is avoided by some manufacturers. It may be possible to select an EBFL operating frequency that will reduce interference with the UHF RFID system but this may be a trial and error investigation for optimal performance.

Conclusion

The use of RFID systems is expanding in environments lit by fluorescent fixtures. Given the known propensity for EBFL's to interfere with the reverse link and affect the reception of modulated backscattered UHF RFID tag signals, it is prudent to evaluate the installation environment for this source of interference prior to system installation using an HSA such as the Agilent N9344C, N9343C, N9342C, and N9340B. It's also recommended that the spectrum analysis cover a period of at least 24 hours to ensure cyclical events in the installation area does not introduce additional interference.

For More Information

Visit any of the following handheld spectrum analyzer product pages and click on the “Document Library” tab to access additional application notes:

- www.agilent.com/find/n9344c
- www.agilent.com/find/n9343c
- www.agilent.com/find/n9342c
- www.agilent.com/find/n9340b

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