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APPLICATION NOTE

Low Frequency RFID Tag Characterization

Using the N9321/22C Basic Spectrum Analyzer (BSA)

Abstract

The resonance frequency of a radio frequency identification (RFID) tag is a key factor that determines the effective radio communication distance between the tag and the reader. Measuring the resonance frequency of an RFID tag is easy using the Keysight Technologies, Inc. N9321/22C basic spectrum analyzer (BSA).

About RFID Tags

Radio frequency ID (RFID) systems rely on RFID tags, which are small transponders (a combined radio receiver and transmitter) that transmit identity information over a short distance when asked. Generally, an RFID tag contains two parts. One is an integrated circuit for storing and processing information, and modulating and de-modulating an RF signal. Another part is an antenna for receiving and transmitting signals to the reader (see Figure 1).

The resonance frequency of the RFID tag is one of the key factors that impact the effective communication distance between the reader and RFID tags. When RFID tags are packaged, a non-contact coupling method can be used to measure their resonance frequencies, which corresponds to the negative peak of its return loss characteristic curve.

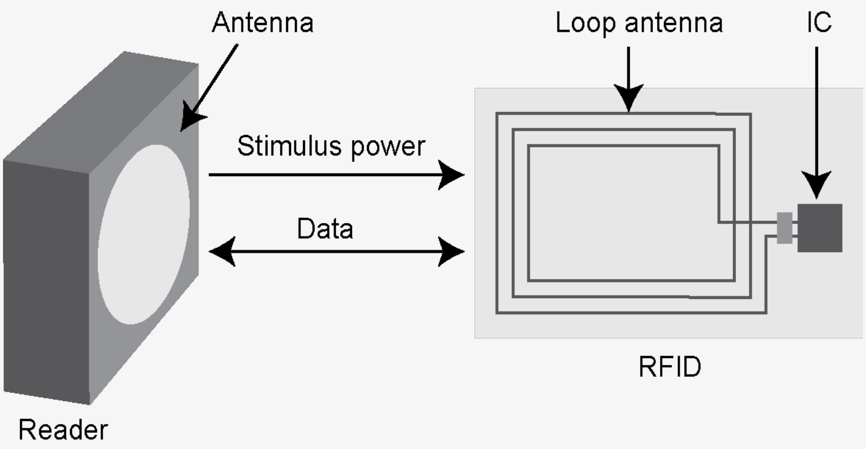


Figure 1. An overview of an RFID system

Measuring a 13.56 MHz Passive RFID Tag with the N9321/22C Basic Spectrum Analyzer (BSA)

The N9321C (9 kHz to 4 GHz) and N9322C (9 kHz to 7 GHz) are multi use RF analyzer that span to spectrum analysis, transmission measurement, and reflection measurement. By simply adding the tracking generator (Option N9321C-TG4 or N9322C-TG7) and the reflection measurement application (Option N9321C-RM4 or N9322C-RM7), the N9321/22C BSA is capable of measuring the return loss of RFID tags:

- The tracking generator contains a built-in VSWR bridge, which makes the reflection measurement more convenient to perform using the N9321/22C BSA versus using other analyzers that require an external bridge.
- In addition, the N9321/22C's refection measurement mode uses a high precision open-short-load (OSL) calibration procedure, which greatly reduces system errors.

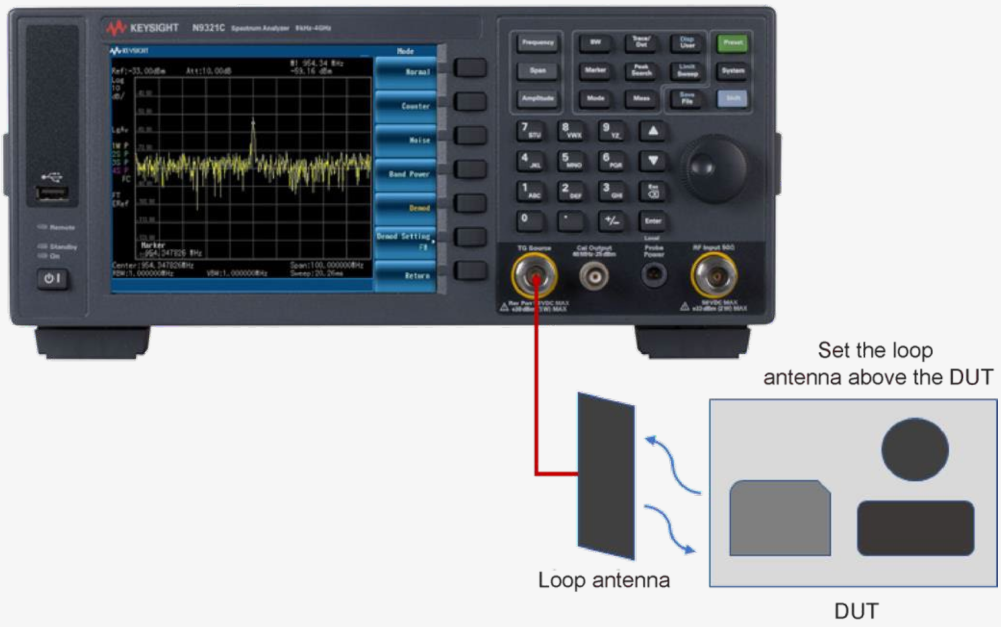


Figure 2. Simple test setup for reflection measurements

Demonstration: Measuring an RFID Tag with the N9321/22C BSA

- In this demonstration, we utilized a 13.56 MHz RFID tag, which follows the ISO/IEC 14443 type A standard.
- In the following demonstration procedure, text in [ ] refers to a hardkey and { } refers to a softkey on the N9321/22C spectrum analyzer.
- Instrument and accessories used in this demonstration include:
    - N9321/22C basic spectrum analyzer (BSA), with Options TG4/TG7 and RM4/RM7 enabled
    - N9311X-201 precision mechanical open-short-load (OSL) calibrator
    - Near field probe (used for radiating RF power from the tracking generator to activate the RFID tag)
    - A sample RFID tag (13.56 MHz)
    - E5071C ENA network analyzer (used to compare the measurement result to that obtained using the N9321/22C)

Step 1. Set up the measurement parameters

- Press [Mode] > {Reflection measurement}
- Press [Frequency] > {Start Freq} > [12] > {MHz} to set the start frequency to 12 MHz
- Press [Frequency] > {Stop Freq} > [15] > {MHz} to set the stop frequency to 15 MHz
- Toggle the {Cal. Type} to {Selected} in order to achieve the highest calibration accuracy within the frequency range of interest

Step 2. Calibrate the N9321/22C BSA

- Press {Calibrate} and follow the instructions on the BSA to calibrate with the OSL calibrator (product number: N9311X-201)
- When finished, a “Calibrated” mark displays in the left upper corner of the screen
- Press [Amplitude] > {Scale/DIV} > [2] > {dB} to display the amplitude scale for easier observation

Connect the OPEN and TG SOURCE as shown.
Once connected, press [ENTER] to continue, or [ESC] to abort.

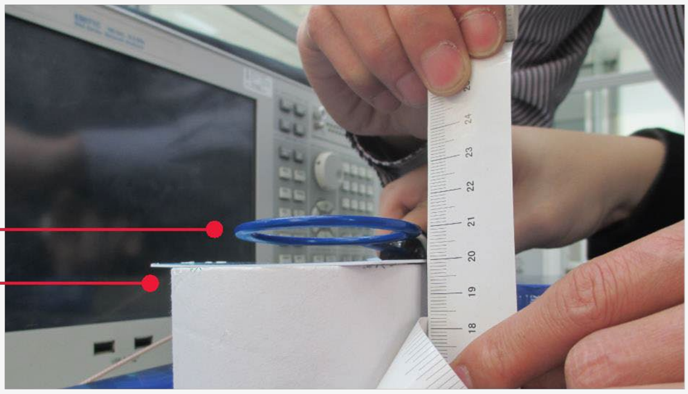
Figure 3. Performing OSL calibration on the N9321/22C BSA

Step 3. Start measurement using a near field probe

- Connect the near field probe to the TG Output port of the N9321/22C BSA, and place the probe about 1 cm (0.4 in) above the sample RFID tag (see Figure 4)
- Use the Marker on the N9321/22C BSA to read the negative peak of the trace. You can also verify the measurement result using an E5071C ENA (see Figures 5 and 6)

Near-field probe

Sample RFID tag



Connect the OPEN and TG SOURCE as shown.
Once connected, press [ENTER] to continue, or [ESC] to abort.

Figure 4. Use a close-field probe as the power radiator and collector

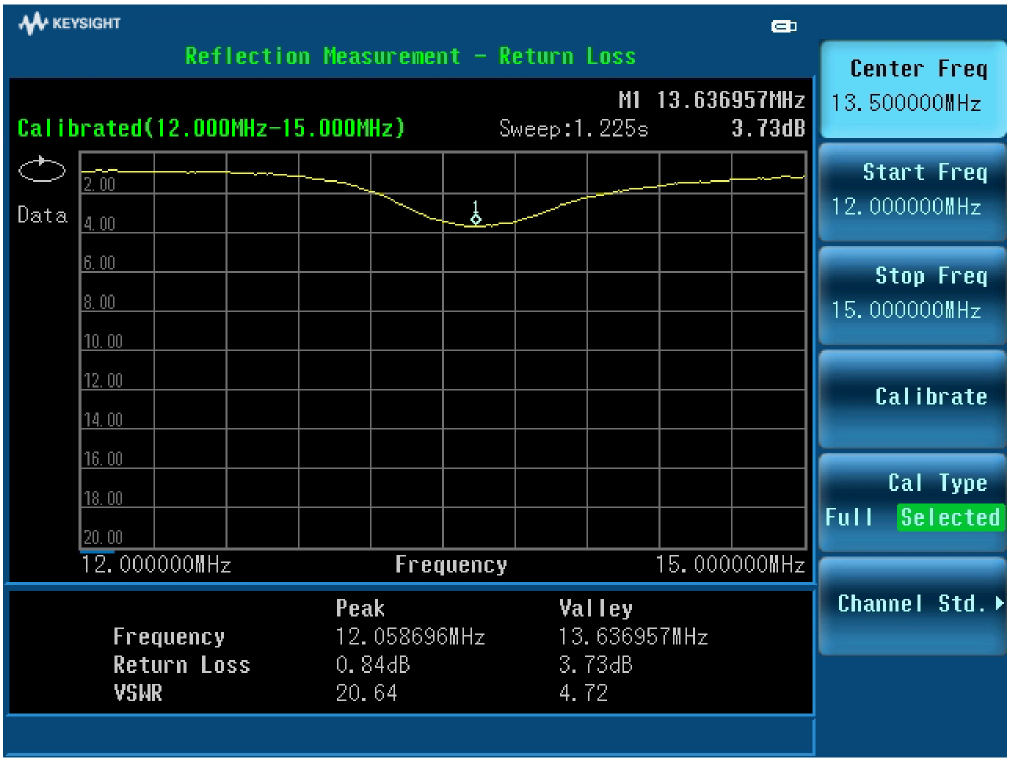


Figure 5. Return loss result measured with the N9321/22C BSA

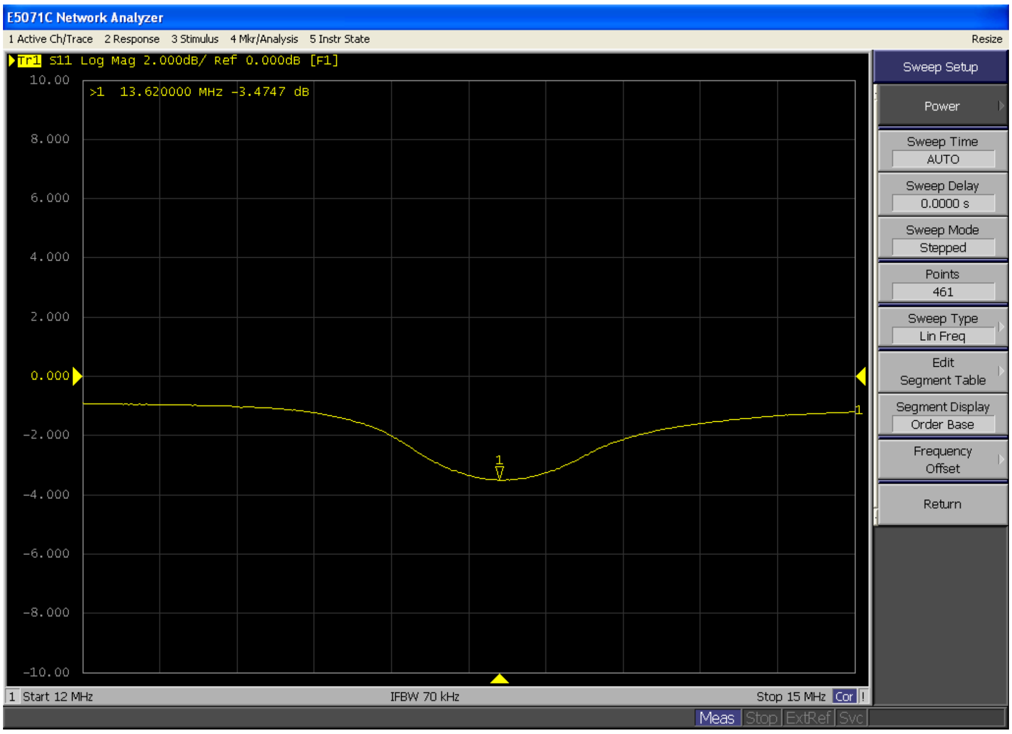


Figure 6. Return loss result measured with E5071C ENA

In order to get consistent measurement results between the N9321/22C BSA and E5071C ENA it is important the following items are set identically on both instruments:

- Output power level
- Number of trace points and amplitude scale
- Calibrator to implement the OSL calibration

Summary

The N9321/22C basic spectrum analyzer (BSA) is a cost-effective and multi-use RF analyzer.

It offers general purpose spectrum analysis, and also expands to one-port vector network analysis with the optional tracking generator and its built-in VSWR bridge.

In the RFID design process, you can easily measure the frequency and power output from the reader with the N9321/22C BSA. Using the tracking generator (Option TG4/TG7) and reflection measurement application (Option RM4/RM7), you can also address the return loss test needs of the tags.

Ordering Information

Product number	Description
N9321C	Basic spectrum analyzer, 9 kHz to 4 GHz
N9321C-TG4	Tracking generator, 5 MHz to 4 GHz
N9321C-RM4	Reflection measurement
N9322C	Basic spectrum analyzer, 9 kHz to 7 GHz
N9322C-TG7	Tracking generator, 5 MHz to 7 GHz
N9322C-RM7	Reflection measurement
N9311X-201	3-in-1 precision mechanic calibrator