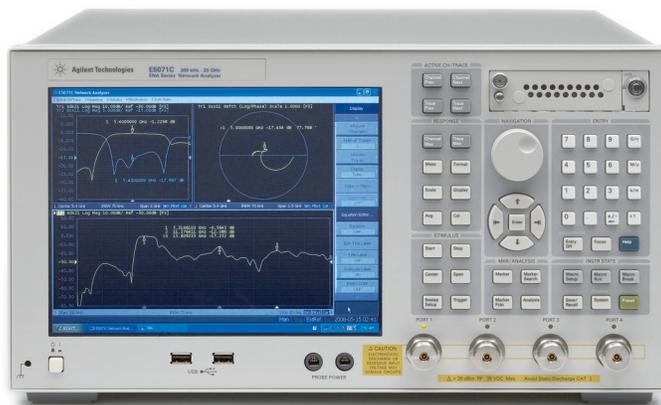


# UWB Antenna Measurements with the 20 GHz E5071C ENA Network Analyzer

## Application Note



- Minimize cost of test with the 20 GHz ENA's high performance and fast measurement speed
- Quickly leverage your current ENA programs
- Obtain consistent return loss measurements using the ENA's gating feature



**Agilent Technologies**

## Introduction

Ultra-wideband (UWB) is a rapidly growing technology that is used to transmit information spread over a large bandwidth (> 500 MHz) for short-range and wide-bandwidth communications. Using the extremely low emission levels currently allowed by regulatory agencies, UWB technology is attracting attention as the core technology for personal-area network (PAN) connectivity such as Wireless USB.

Currently, commercial devices for PAN applications are being introduced in the frequency range below 10.6 GHz. For commercialized antennas such as WLAN or those used in cellular systems, RF models of vector network analyzers (VNAs) such as the E5071C ENA (4.5 GHz/8.5 GHz) and E5061/62A ENA-L (1.5 GHz /3 GHz) network analyzers are widely used in the design process and on the production line to measure the return loss or VSWR. However, since UWB systems use a wider frequency range, UWB antenna measurements require higher frequency VNAs on the production line.

This document discusses the benefits of using 20 GHz ENA network analyzers for UWB antenna measurements, and present a measurement example using the ENA's gating function.

## The 20 GHz ENA minimizes cost of test

In August 2008, an ENA which covers frequencies up to 20 GHz was introduced. Carrying on the Series' tradition, the 20 GHz ENA boasts superior performance and measurement speed in its class to minimize the cost of test. For example, the ENA has 10 times lower trace noise across all frequency ranges and 10 times faster measurement speed than legacy VNAs such as 8719 or 8720 (10 MHz to 20 GHz, 51 pts, IFBW 1 kHz).

## Quickly leverage your current ENA programs

The 20 GHz ENA protects your software investment by providing the same user interface and programming commands as current ENAs (4.5 GHz/8.5 GHz options). Your software programs for existing measurement applications can be easily leveraged. For example, if the ENA is already installed on the production line, you can simply "drop" the 20 GHz ENA into the existing production environment. Also, upgrade capability is available across all options of E5071C ENA network analyzer. For example, the 8.5 GHz E5071C can be upgraded to 20 GHz option.<sup>1</sup> This allows for flexible investment plan of the VNA on the production line.

## Obtain consistent return loss measurements using the ENA's gating feature

Consistent measurements are always desirable on production lines. Because antennas are sensitive to the environment around the test system, it is difficult to obtain consistent and repeatable return loss measurements.

The ENA has a gating feature that eliminates undesired responses from measurement results using software simulation. (Option 010 Time-domain is required.) This feature reduces interference from the measurement environment, enabling you to obtain consistent and repeatable measurements. As a result, high yields with small guardbands can be achieved on the production line.

As an example, a measurement of a UWB antenna under test (AUT) is presented here. Figure 1 shows the measurement setup. The AUT, is a plate dipole antenna designed to have a 10 dB return loss, and a frequency range from 3 GHz to 10.6 GHz.

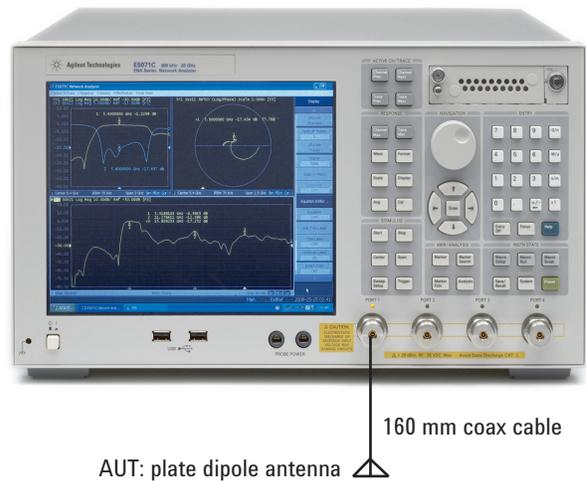


Figure 1. Antenna measurement setup

1. For more information on upgrading your ENA, go to:  
[www.agilent.com/find/ena\\_upgrades](http://www.agilent.com/find/ena_upgrades)

## Steps for consistent return loss measurements

The following steps will guide you through the measurement setup and analysis.

### ► Step 1: Set measurement conditions, perform calibration and measure S11

Set the measurement conditions, perform a full 1-port calibration on port 1, and then, connect the antenna under test (AUT) to port 1. In this example, a frequency range from 3 GHz to 12 GHz is set.

### ► Step 2: Set up the time domain conversion

The time domain feature transforms frequency domain measurement data into time domain data. In this example, a “Low pass impulse” conversion is used to see the time domain response. In order to perform proper time domain conversion, the Set Freq Low Pass function needs to be executed to change the lower frequency of the actual measurement. To set this function select:

- [Analysis] > Transform: On
- [Analysis] > Transform > Type: Lowpass Imp
- [Analysis] > Transform: Set Freq Low Pass

Figure 2 shows a measurement result of the time domain conversion. A large reflection of around 1.7 nsec point, which is a reflection from the AUT, is observed.

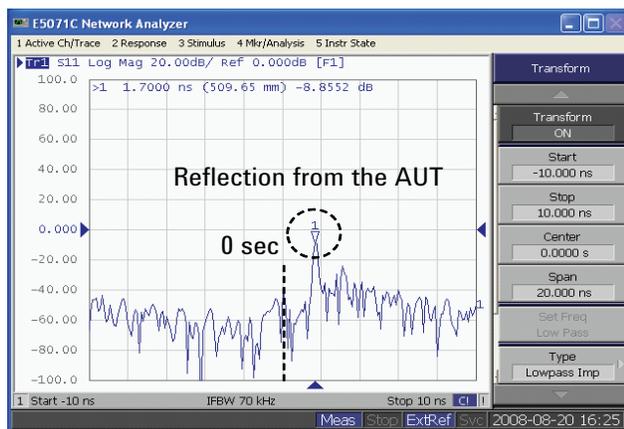


Figure 2. Time domain measurement result

### ► Step 3: Set up the gating parameters

The gating feature is a form of error correction which eliminates undesired responses from the measurement data. Defining a bandpass gate on the time domain trace, limits the measurement result to the “near field” response of the AUT and removes undesired responses such as reflection signals from the structure around AUT. In this example, the center of the gating is set to 1.7 nsec and the span is set to 1 nsec. This means that the measurement result only includes the response signal within 150 mm of the AUT. To set this function select:

- [Analysis] > Gating: On
- [Analysis] > Gating > Type: Bandpass
- [Analysis] > Gating > Center: 1.7 nsec
- [Analysis] > Gating > Span: 1 nsec

Figure 3 shows a time domain measurement result with gating on. As you can see, the undesired response has been removed.

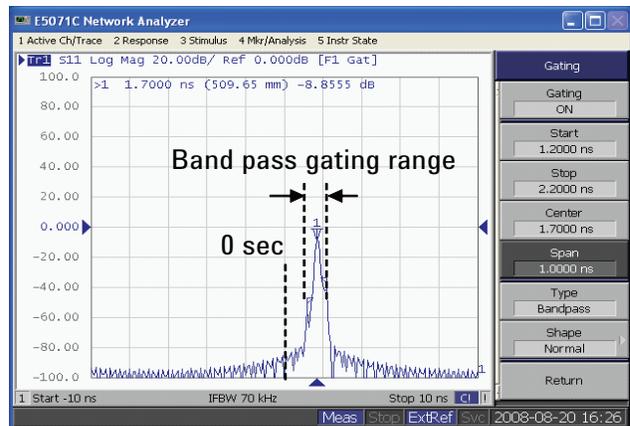


Figure 3. Time domain measurement result with gating on

► **Step 4: Return to the frequency domain measurement**  
 Now you will return to the frequency domain measurement by turning off the time domain mode. The gating setup still remains in frequency domain measurement. In this example, another trace is added in order to see the effect of the gating. To make another trace, select:

**[Analysis] > Transform: Off**  
**[Display] > Num of Trace: 2**

Note that the lowest frequency is changed from 3 GHz to 59 MHz, by executing the Set Freq Low Pass function in time domain analysis mode. Since the lowest frequency has changed, calibration needs to be performed again to obtain an accurate measurement.

Figure 4 compares the frequency measurement result with gating (trace 1 in blue) and without gating (trace 2 in red). Ripples on trace 2, caused from the reflection signal of the structure around the AUT, are removed by the gating feature on trace 1.



**Figure 4. Frequency domain with/without gating**

Ripples on trace 2, caused by changing the environment around the AUT such as the operator's hand, can easily change the trace shape. Trace 1, however, maintains a stable measurement result. This enables consistent and repeatable measurement results.

In addition, a 2 ~ 3 dB peak margin can be obtained by removing ripples. This is another benefit of the gating function, to have smaller guard band in the measurement results.

## Summary

This document discussed the benefits using the E5071C ENA for UWB antenna measurements, and gave a measurement example of the E5071C ENA using the gating feature.

UWB is a growing technology for a wide range of commercial devices. The E5071C ENA network analyzer provides a cost-effective, reliable solution for UWB antenna evaluation by providing consistent and repeatable measurement results on production lines.

## References

ENA Product Overview:  
[www.agilent.com/find/ena](http://www.agilent.com/find/ena)

ENA upgrades:  
[www.agilent.com/find/ena\\_upgrades](http://www.agilent.com/find/ena_upgrades)

ENA web help:  
[www.agilent.com/find/enahelp](http://www.agilent.com/find/enahelp)

Product Brochure:  
 Agilent E5071C ENA Network Analyzer – [5989-5478EN](#)

Application Note:  
 Agilent Time Domain Analysis Using a Network Analyzer – [5989-5723EN](#)

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