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Test Procedure for Measuring Transmission and Reflection

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1. Introduction

1.1. Executive Summary

The measurement of RF reflection and transmission spans several generations of test equipment. The fundamental components of these measurements are a sweep generator, a coaxial switcher, a directional coupler bridge, switchable attenuators, an RF amplifier, an RF detector and a scalable display.

The fundamental transmission measurement process is to generate an RF signal that sweeps through a user defined frequency range. This CW signal is routed through two paths by means of a coaxial split relay at each end of the two paths. One path is a reference that conducts the generator output through a reference attenuator directly to the detector. The other path travels through the device under test. As the signal alternates, rapidly between the two paths, a differential image of the frequency response of the two paths is displayed. Measurements at each frequency are inferred by the difference between the two traces.

The same technique is applied to reflection measurements by inserting a directional coupler bridge in place of the device under test. The tap port of the bridge is connected to the device port to separate the incident from the reflected signals. The quality of the return loss measurement depends upon the directivity of the bridge.

This early method of measurement is scalar. This means that only the magnitude of the signal power is recovered on the display. Early network analyzers packaged these basic functions into one test instrument, and the use of internal microprocessors enabled a more accurate display of the difference between the reference and the device under test. Examples of early scalar network analyzers are Keysight Technologies 8711 and 8713. These analyzers are obsolete and no longer available. They have been replaced by the Keysight E5061B Electronic Network Analyzer (ENA).

However, the phase of the test signal is also important. The magnitude and phase define a complex data set at each test frequency that completely characterizes the behavior of a signal as it encounters an RF device. This requires an advanced layer of signal processing. A network analyzer capable of rendering the complex parameters of a waveform is called a vector network analyzer. Most of the early scalar network analyzers are now obsolete but the vector analyzer market has continued to evolve. These instruments have become widely accessible, and the complex output data is far more useful in applications from circuit and component design to manufacturing.

Therefore, while a scalar measurement approach to measuring return loss and insertion loss or gain is sufficient, a vector network analyzer is recommended for this generalized test procedure primarily because the results are far more applicable and the error correction capabilities enable greater measurement precision**.**

1.2. Scope

The purpose of this test procedure is to determine the reflection at any port, or the transmission between any two ports of a properly terminated device, as measured across a frequency range of interest. Depending on use of the data, return loss, insertion gain or loss, isolation, response variation or bandwidth can be derived. This specification is applicable to the testing of 75 Ω devices.

1.3. Benefits

Test Procedure for Measuring Transmission and Reflection, when executed per this procedure, will yield accurate and consistent RF parameters; reflections and transmission characteristics, for the device under test. Use of this test method provides user a means to verify manufacturer test