Application Note

Measuring Harmonics Using the SC2250

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Revision History

Revision	Date	Author	Description
1.0	2019-Feb-7	L. McClennan	Initial Release
1.1	2019-May-30	L. McClennan	Content Update

1. Introduction

The SC2250 has been designed specifically to facilitate measurements of high frequency, low level harmonics in a cost-effective manner. Typically, these measurements would require an expensive, high-frequency analyzer and a complex assortment of filters, switches and cables. Using the SC2250, the harmonic signal of interest is converted to a low-frequency so that a lower frequency analyzer, such as National Instruments' Vector Signal Transceiver (VST), can perform the measurement.

Calibration complexity, inherent in these types of test benches, is simplified when incorporating the SC2250 into a harmonic measurement setup. The device includes internal calibration tables for all signal path combinations. These paths are characterized in the factory and accessible to the user.

2. Typical Harmonic Test Setup

The SC2250 provides various stages of internal filtering to ensure that only the harmonics of the Device Under Test (DUT) are presented to the analyzer. This feature greatly simplifies the test setup when measuring multiple harmonics of different frequencies. In a traditional measurement setup, additional equipment would be required to switch in the variety of filters and amplifiers required to perform these tasks.

Figure 1 presents a typical test setup for measuring the harmonics of a DUT, such as an amplifier, using the SC2250.

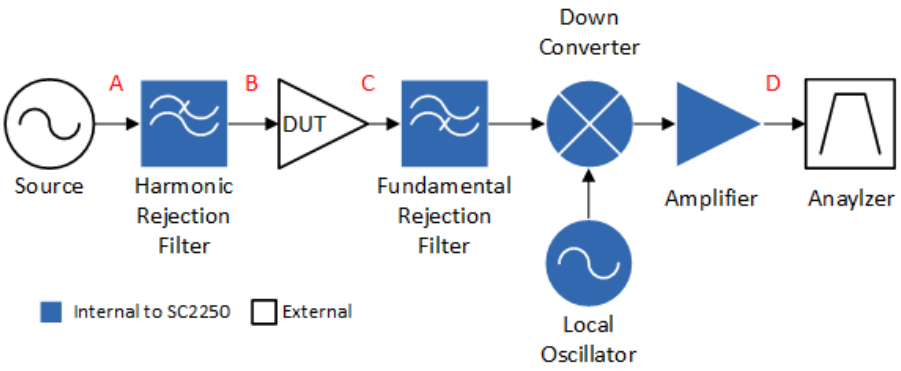

Figure 1 - Block Diagram of Harmonic Measurement Setup Using SC2250

To ensure the harmonics measured by the analyzer are in fact harmonics originating from the DUT, and not from the excitation source in the test system (Point A), the SC2250 includes a harmonic rejection filter bank. This filter bank significantly reduces the level of source harmonics at the input to the DUT (Point B). Figure 2 provides an example of the signal source harmonics which can be present within the measurement system.

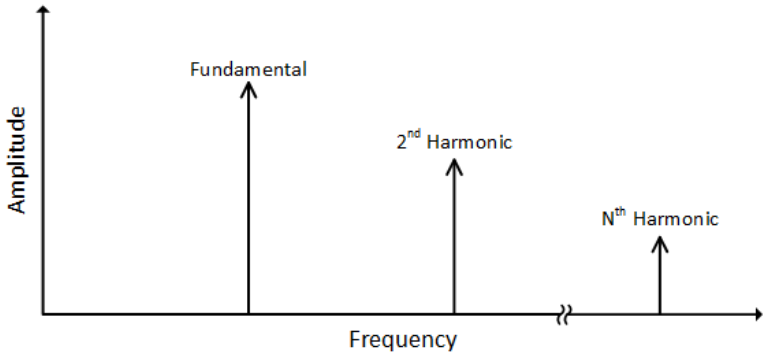

Figure 2 - Spectrum at Output of Source (A)

After passing through the harmonic rejection filter, the signal at the input to the DUT (Point A) has significantly lower harmonic levels as shown in Figure 3. Typical filter rejection of 30 to 40 dB is achievable.

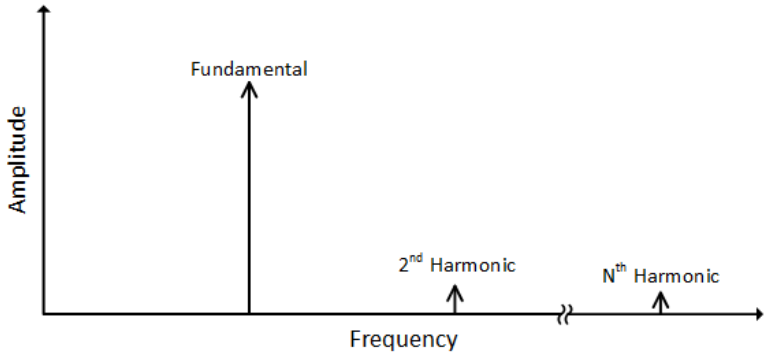

Figure 3- Input Signal to DUT After Passing Through SC2250 Harmonic Rejection Filter (Point B)

Ideally, the signals under test present at the input to the SC2250 are exclusively generated by the DUT. Figure 4 illustrates what the spectrum may look like at the input to the SC2250 (Point C).

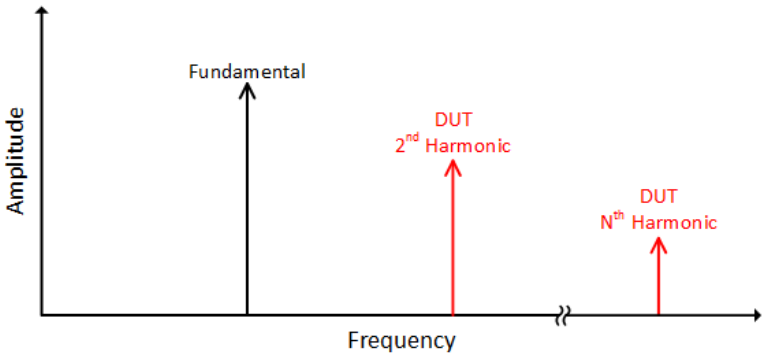

Figure 4 - Harmonic Content at the Output of the DUT (Point C)

The SC2250 subsequently down converts the harmonic to a lower frequency, as shown in Figure 5. This signal falls within the bandwidth of the external analyzer. Prior to conversion, a rejection filter will lower the level of the fundamental to maximize the dynamic range available in the analyzer.

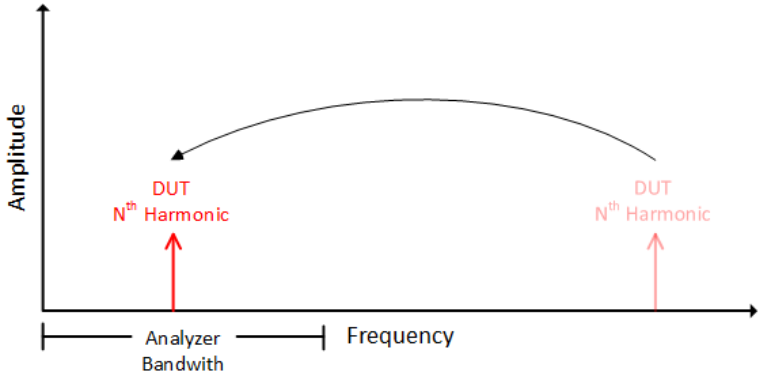

Figure 5 - Spectrum at the Input to the Analyzer (Point D)

The level of the harmonic can now be measured even though it was originally outside of the frequency range of the analyzer.

3. SC2250 Configuration for Harmonic Measurements

The following procedure describes how to setup and perform a harmonic measurement with the SC2250.[1]

3.1 Physical Connections

1. Connect the output of the external source/signal generator to the *TX IF IN* port of the SC2250
2. Connect the input of the DUT to the *TX RF OUT 0* port of the SC2250
3. Connect the output of the DUT to the *RX RF IN* port of the SC2250
4. Connect the input of the spectrum/signal analyzer to the *RX IF OUT* port of the SC2250

[1] Proper calibration of the test setup must be performed to ensure accuracy of the measurements.

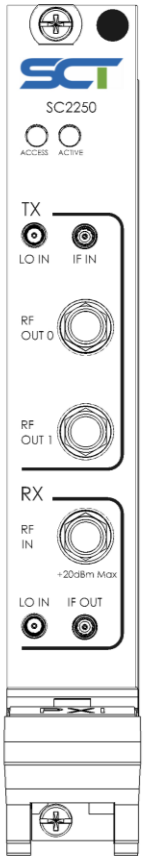

Figure 6 - From Panel of SC2250

3.2 Measurement Procedure

The italicized text below represents the function calls made to the SC2250.

1. Set the output power and fundamental frequency of the source/signal generator.
2. Initialize the SC2250 (*si2250_init*).
3. Set the TX output path of the SC2250 to *TX RF OUT 0* (*si2250_ConfigureTXOutputPath*).
4. Set the TX fundamental input frequency, which automatically selects the appropriate harmonic rejection filter of the SC2250 based on the frequency of the fundamental (*si2250_ConfigureTXINFrequency*).
5. Configure the down converter of the SC2250 by setting the fundamental input frequency and the harmonic index of interest. The SC2250 will calculate and report the optimum output frequency of the down converted harmonic that will be output via the RX IF OUT port (*si2250_ConfigureHarmonicConverter*).
6. Set the frequency of the spectrum/signal analyzer to the frequency of the down converted harmonic, as reported by *si2250_ConfigureHarmonicConverter*, and record the level.
7. Query the gain of the SC2250 *(si2250_GetRXGain*). This is the factory measured gain/loss of the SC2250 under the test operating conditions, as set in steps 3-6 above, that can be applied to the level of the harmonic as measured with the external spectrum/signal analyzer.

4. Summary

The SC2250 is an easy to use and cost-effective instrument for making accurate, high frequency harmonic measurements. Utilizing the internal harmonic rejection filters at the input to the DUT and down converting harmonics to within the frequency range of lower cost spectrum/signal analyzers simplifies the test setup and lowers the overall cost of the test system.