Noise Figure Measurement of Narrow Bandwidth Subsystem Products

1. Introductions

It can be pretty tricky to accurately measure the noise figure of a narrow bandwidth subsystem product due to the sharp roll-off at the edges of the pass band and the ultra low noise figure of a LNA such as WanTcom's WLA19-3030A. The subsystem product can be a Filter/LNA or LNA/Filter for a wireless base station, repeater, or micro cell applications. The measured noise figure is substantially higher at close to the edges of the passband than that of the actual noise figure number. The measured noise figure of the entire pass band can be completely higher than that of the actual number when the bandwidth of the subsystem is less than 4 MHz.

A proper calibration is needed to accurately measure the noise figure of a subsystem which contains filter. For a Filter/LNA or LNA/Filter subsystem, an identical filter is needed in between the noise source and the input of the noise figure meter during the calibration and noise measurement. Without losing generality, the duplexer/LNA subsystem (WanTcom product model number: WULA21-0515A) for 3G wireless base station is used for the example. The HP8970B noise figure meter with option 020 and HP346A noise source are used for the measurement.

2. WULA21-0515A Duplexer/LNA Subsystem

Figure 1 shows the block diagram of WULA21-0515A Duplexer/LNA Subsystem.

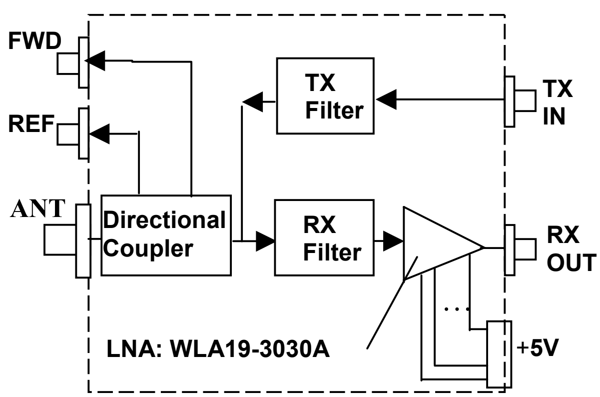

Fig. 1 The block diagram of WULA21-0515A Duplexer/LNA Subsystem.

A total of 30 W composite 4 - channels W-CDMA signal is injected into TX IN port. The passband of the TX filter is 2110 ~ 2170 MHz with the insertion loss of 0.50 dB. The Directional Coupler has 30 dB coupling factor in both monitoring ports and provides the forward transmitting power monitoring and antenna port VSWR monitoring. The RX Filter has insertion loss of 0.60 dB across the passband of 1920 ~1980 MHz with the rejection of 115 dB at the TX frequency band. The LNA (WLA19-3030A) presents gain of 31.0 dB with the noise figure of 0.70 dB. **Figure 2** shows the measured RX path from ANT to RX OUT performance at 25 ^{o}C.

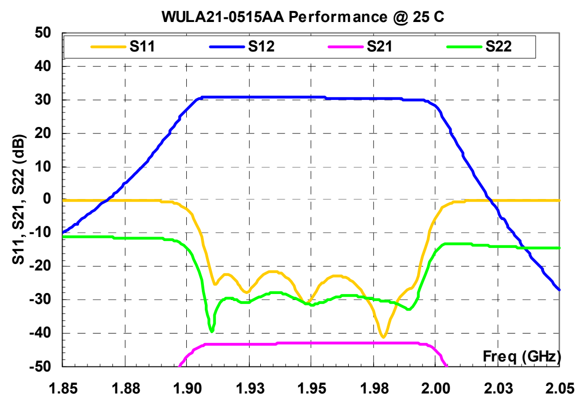

***Fig. 2** The measured RX path from ANT to RX OUT performance at 25 ^{o}C.*

3. Noise Figure Measurement of WULA21-0515A

Figure 3 illustrates the noise figure measurement setup. A filter, RX Filter1, which has the identical performance as the RX Filter in WULA21-0515A, is connected at the input of the noise figure meter.

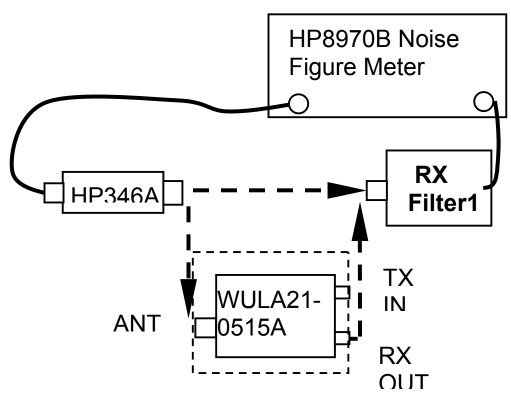

***Fig. 3** The noise figure measurement setup.*

The noise source is connected to the input of the RX Filter 1 during the calibration. Set the start, stop, and step frequencies of the noise figure meter at 1920 MHz, 1980 MHz, and 10 MHz and the Smooth index of the noise figure meter at 8. Start the calibration.

After the calibration, the device-under-test (DUT), which is WULA21-0515A, is inserted between the noise source and the input of the RX Filter 1. **Figure 4** shows the measured noise figures of WULA21-0515A with and without RX Filter 1 during the calibration and measurement.

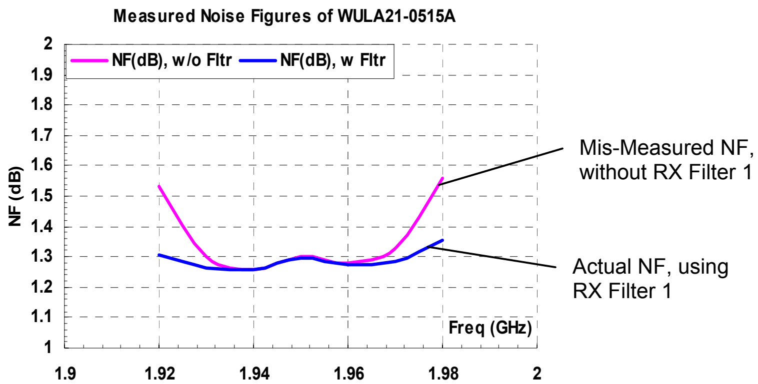

Fig. 4 *The measured noise figures of WULA21-0515A with and without RX Filter 1 during the calibration and measurement.*

The measured noise figure, NF(dB),w/o Fltr, is much higher at close to the edges of the passband without RX Filter1 during the noise figure calibration and measurement. The reason for the increased noise figure reading is the internal noise figure mis-calculation by the noise figure meter. The noise figure is calculated based on the signal-to-noise ratio within a certain bandwidth (about 4 MHz for HP8970B noise figure meter). At the edge of the pass band, partial signal energy will be attenuated due to the sharp roll-off of the pass band. However, the roll-off effect can be corrected by using an identical filter during the noise calibration and measurement as illustrated in this application note.

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