VSS Test Bench for Verizon 5G Technical Forum Downlink System

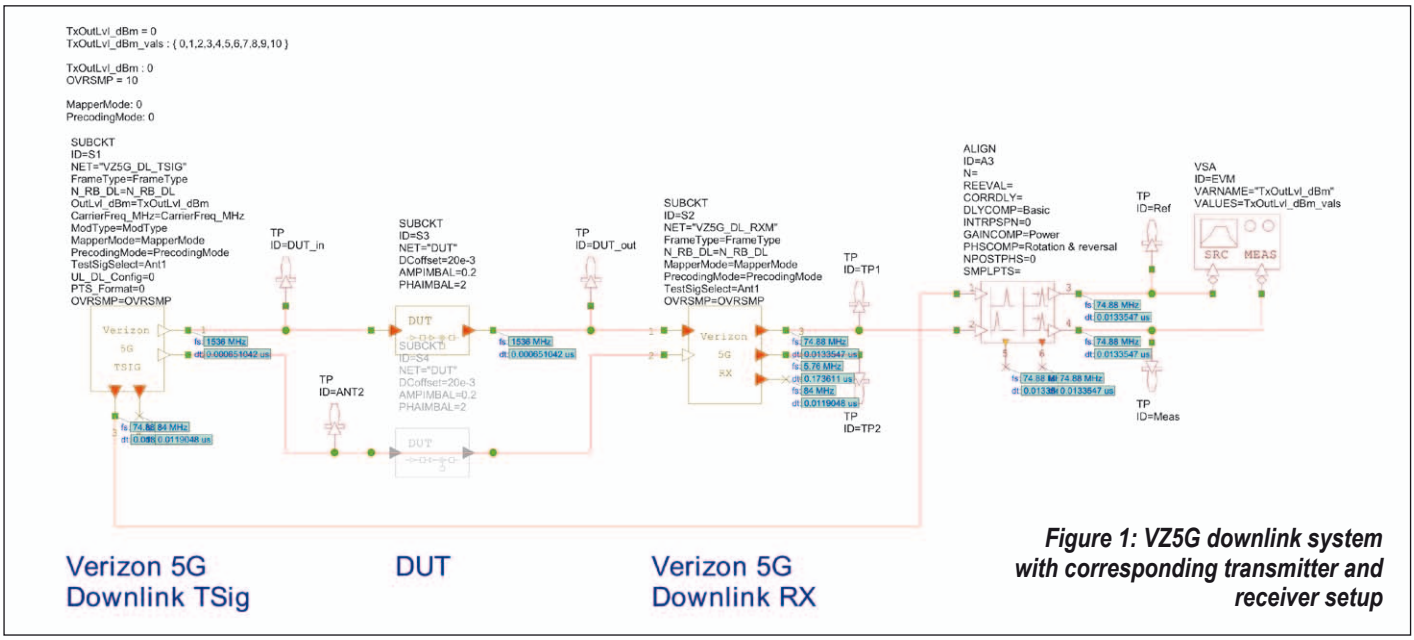

Figure 1: VZ5G downlink system with corresponding transmitter and receiver setup

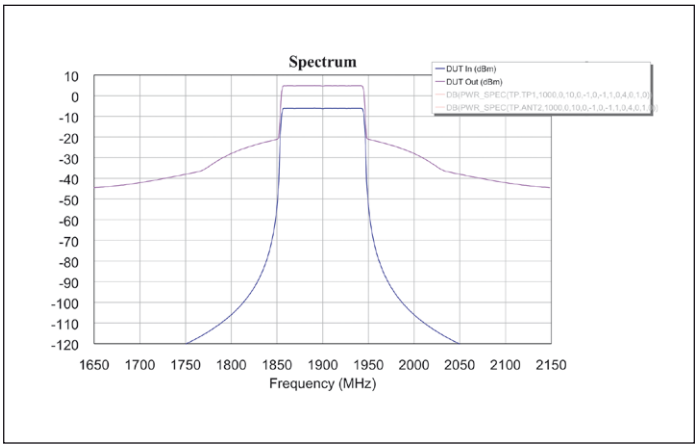

Figure 2: 100-MHz-wide signal before and after the DUT

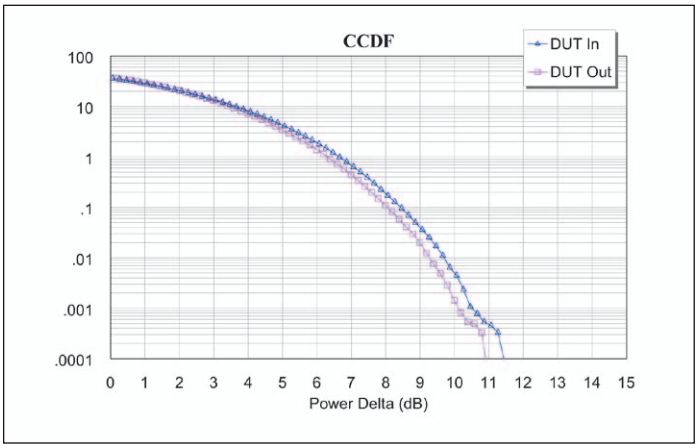

Figure 3: CCDF measurements with input and output to the DUT

Current 4G waveforms are not capable of supporting escalating demand for faster, more robust communication. What is needed is more spectrum, more and smaller cells, power efficiency, new modulation schemes, higher data rates, high-directivity antennas, and lower latency.

The ideal waveform for the 5G next generation of communications will be capable of supporting high data-rate and wide-bandwidth communications. It will enable energy-efficient operation, have low latency for long and short-burst transmis-

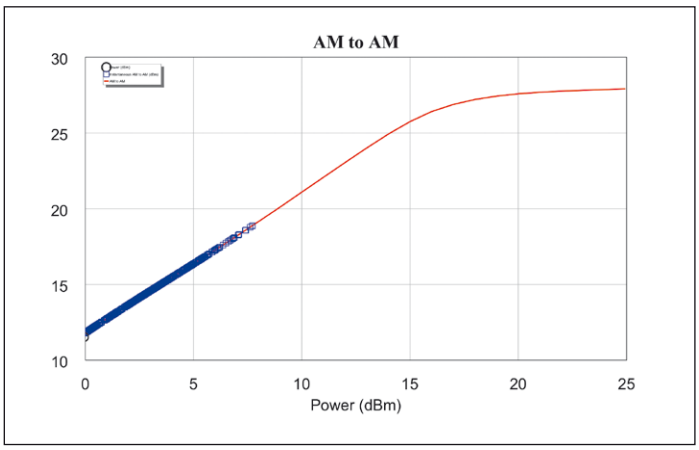

Figure 4: CCDF measurements with input and output to the DUT

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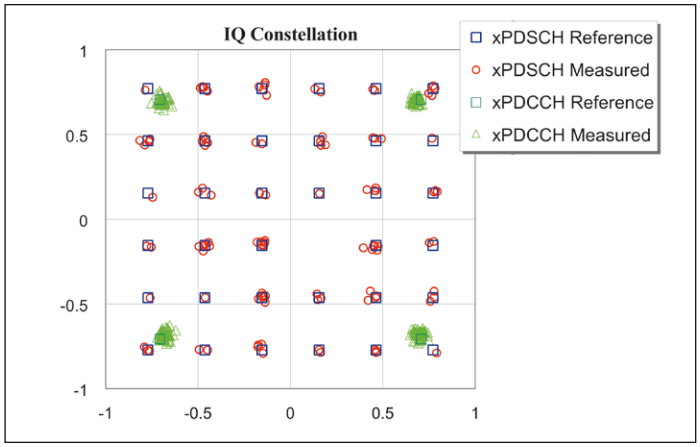

Figure 5: Plot of received demodulated IQ constellation for both xPDCCH and xPDSCH

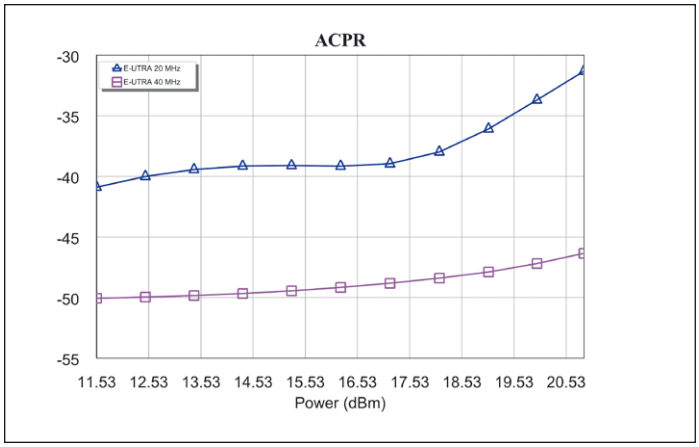

Figure 6: ACPR measurements that represent the channels for the VZ5G specification

sion modes, and will be capable of fast switching between the uplink and downlink.

From several proposals in May 2017, the 3GPP standards organization, as well as Ericsson, are now converging towards using cyclic-prefix orthagonal frequency division multiplexing (CP-OFDM) as the waveform of choice for 5G New Radio (NR). CP-OFDM is used by LTE and ranks best on the performance indicators that matter most: compatibility with multi-antenna technologies such as MIMO, high spectral efficiency, and low implementation complexity. It is less susceptible to phase noise and Doppler effects than other multicarrier systems and has a high peak-to-average power ratio (PAPR) like other OFDM signals. Verizon 5G (VZ5G) Technical Forum has also chosen CP-OFEM, a key difference being that Verizon's CP-OFDM has a variable 15-120 kHz carrier spacing.

In anticipation of the need for NI AWR Design Environment users to have the ability to simulate Verizon 5G signals, Visual System Simulator (VSS) system simulation software now offers a Verizon 5G test bench that

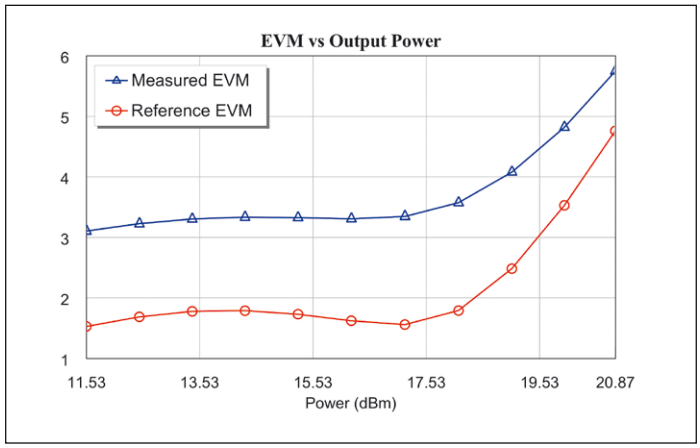

Figure 7: EVM versus output power sweep measurement showing EVM characteristics as a function of output power

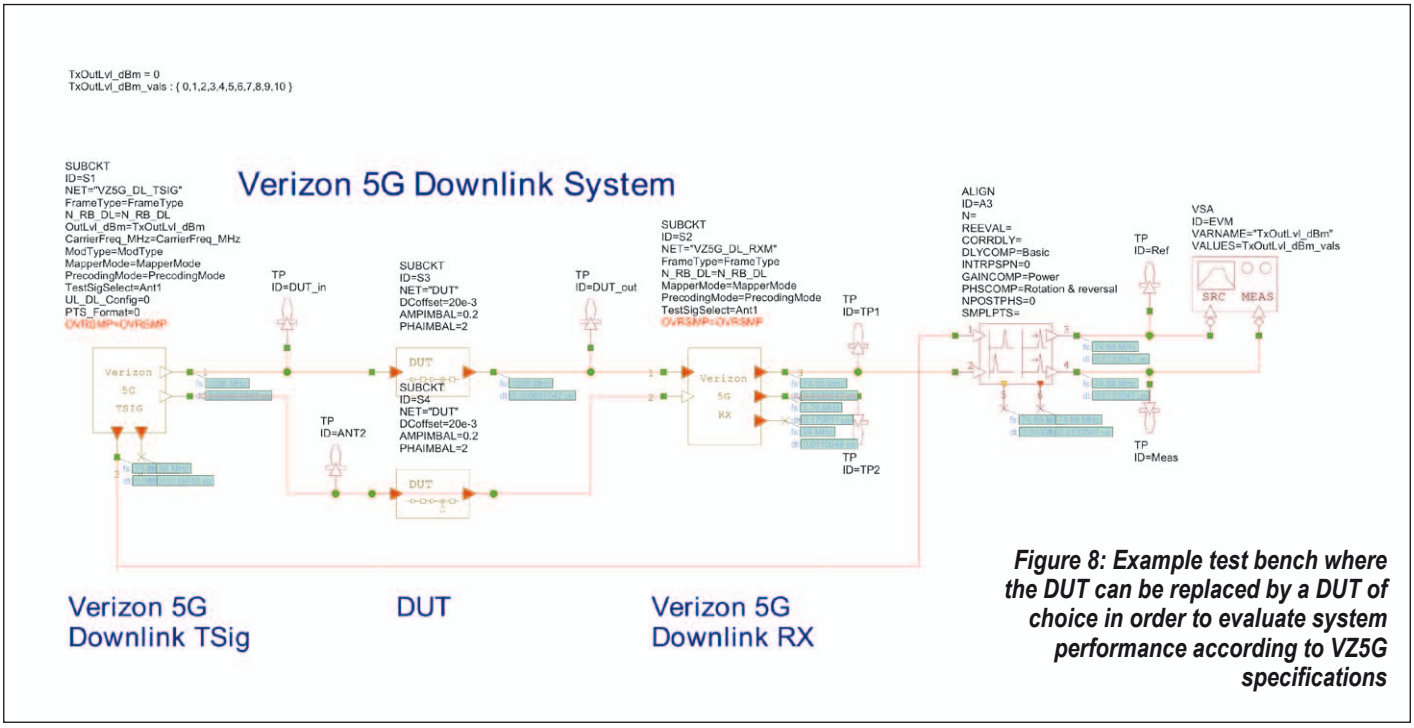

Figure 8: Example test bench where the DUT can be replaced by a DUT of choice in order to evaluate system performance according to VZ5G specifications

allows designers to simulate 5G device under test (DUTs) in the Verizon downlink system and, alternatively, perfom error vector magnitude (EVM) and adjacent channel power ratio (ACPR) measurements.

VSS VZ5G Downlink System Test Bench

This application example demonstrates the VZ5G downlink transmission, which includes the physical broadcast channel (PBCH), physical downlink control channel (PDCCH), and physical downlink shared channel for data (PDSCH). The corresponding transmitter and receiver have already been set up, along with a behavioral amplifier DUT in between, as shown in Figure 1. The example has been configured to enable the user to perform various measurements.

Figure 2 is a 100-MHz-wide signal before and after the DUT. Some spectral regrowth can be seen at the output of the spectrum. Some complementary cumulative distribution (CCDF) measurements have been set up in Figure 3, where the input and output to the DUT are shown.

There is also a parallel power sweep measurement being performed on the signal operating on the AM-to-AM curve. The IQ constellation plot in Figure 5 shows the received demodulated IQ constellation for both the xPDCCH and xPDSCH.

Figure 6 shows ACPR measurements at the 100 MHz and 200 MHz offset, which represent the channels for the VZ5G specification. The EVM versus input power and output power sweep measurement in Figure 7 shows the EVM characteristics as a function of output power.

By replacing the DUT element in the diagram with the user's DUT element of choice, this example can be quickly turned into a VZ5G-based test bench to evaluate system performance according to VZ5G specifications (Figure 8).

Conclusion

The VZ5G downlink system test bench within VSS enables designers to simulate 5G DUTs in the Verizon downlink system and also perform EVM and ACPR measurements. Because VZ5G specifications are in the early stages and therefore changing constantly, the current implementation in VSS will be updated according to developments.

The advantage of the VSS signal generator is that it is built from basic building blocks, so when specifications change, the parameters in the root blocks can be updated without having to change hard code. When final specifications are made, the current VSS signal channel model (SCM) in the 5G channel model will be updated to the final configuration defined in 3GPP. ◄