N321

Contents

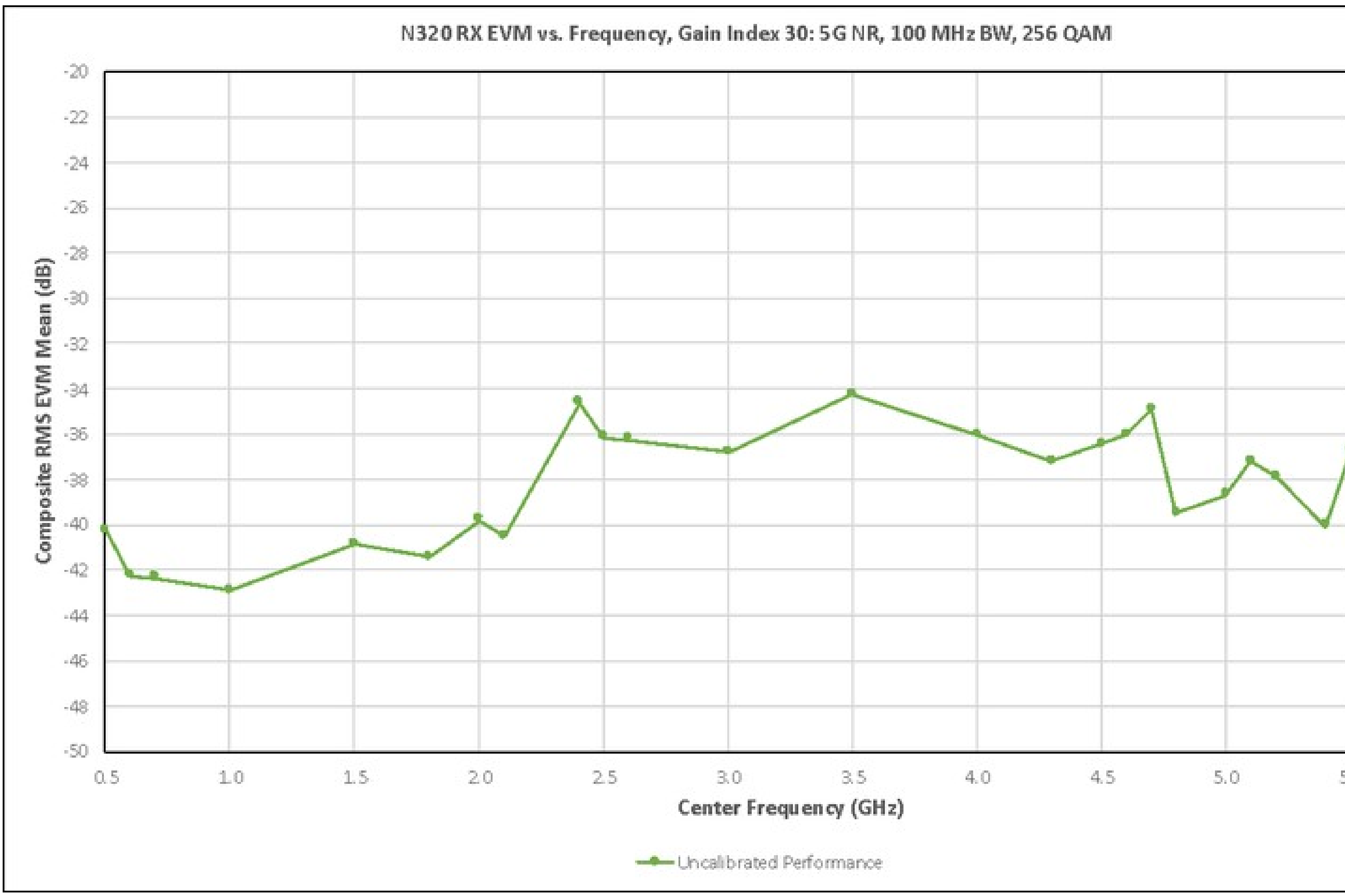
AN-452

Date	Author	Details
2019-04-17	Drew Fischer	Initial creation

Example EVM measurements are shown using the USRP N320/N321 receiver and the 5G New Radio (5G NR) modulation standard. The use of I/Q image calibration and spur-dodging are demonstrated as methods to improve EVM performance.

The NI-RFmx NR software [http://sine.ni.com/nips/cds/view/p/lang/en/nid/217188] and the PXIe-5840 Vector Signal Transceiver [http://www.ni.com/en-us/support/model.pxie-5840.html] were used to continuously generate a waveform using the 5G NR modulation standard. The waveform was configured for 100-MHz bandwidth, 256 QAM, and DFTS OFDM. The modulated signal generated by the Vector Signal Transceiver was connected to the RX2 input of the USRP N320/N321. Additional test code was written to acquire and post-process the received waveform in order to calculate EVM.

The gain index of the USRP N320/N321 receiver was fixed at 30 dB and the carrier frequency was swept from 500 MHz to 6 GHz. The modulated waveform was acquired and analyzed to compute the EVM. The corresponding results are shown in the following plot:



One key contributor to EVM performance is the image level. Images are generated by the I/Q demodulator in the signal chain and are an artifact of this receiver architecture. The image level can be measured and accounted for using the I/Q image calibration utility available in UHD, as shown in the example below.

From directory:

```
~/src/uhddev/host/build/utils
```

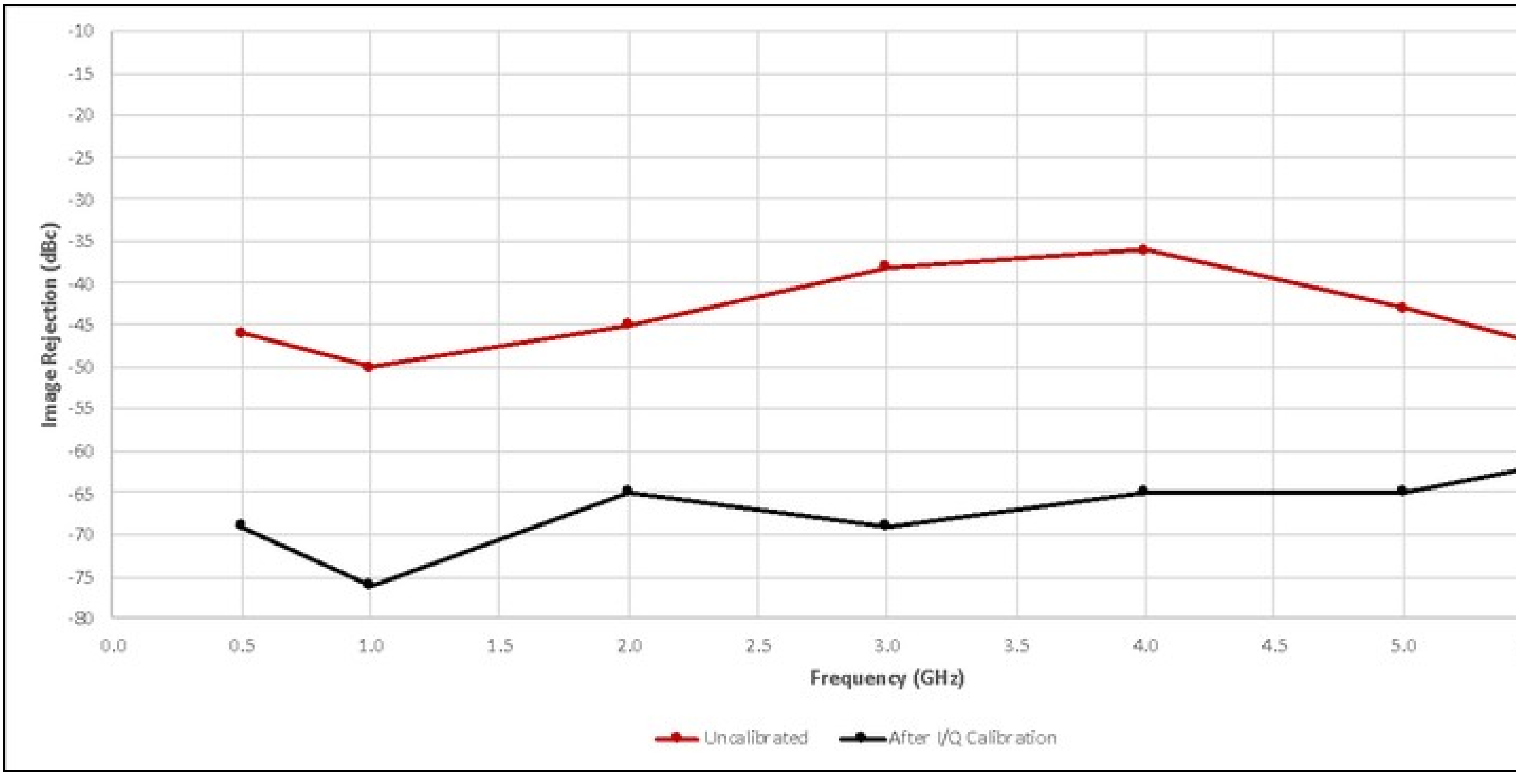
For CH0, run:

```
sudo ./uhd_cal_rx_iq_balance --subdev A:0 --freq_start 0.5e9 --freq_stop 6e9 --freq_step 0.1e9 --verbose
```

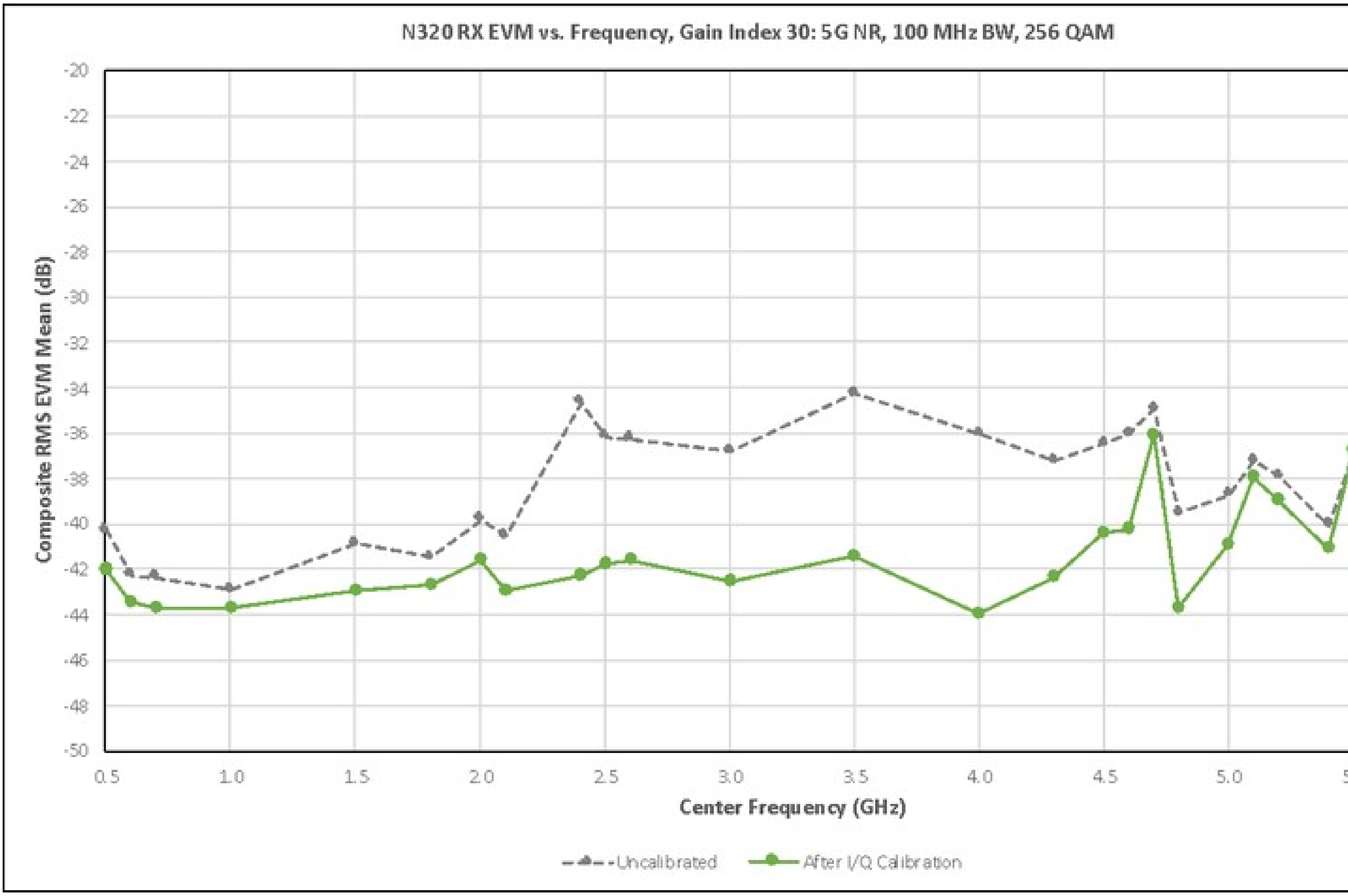
For CH1, run:

```
sudo ./uhd_cal_rx_iq_balance --subdev B:0 --freq_start 0.5e9 --freq_stop 6e9 --freq_step 0.1e9 --verbose
```

The image level was measured using external equipment before and after calibration to show the improvement, as shown in the plot below:



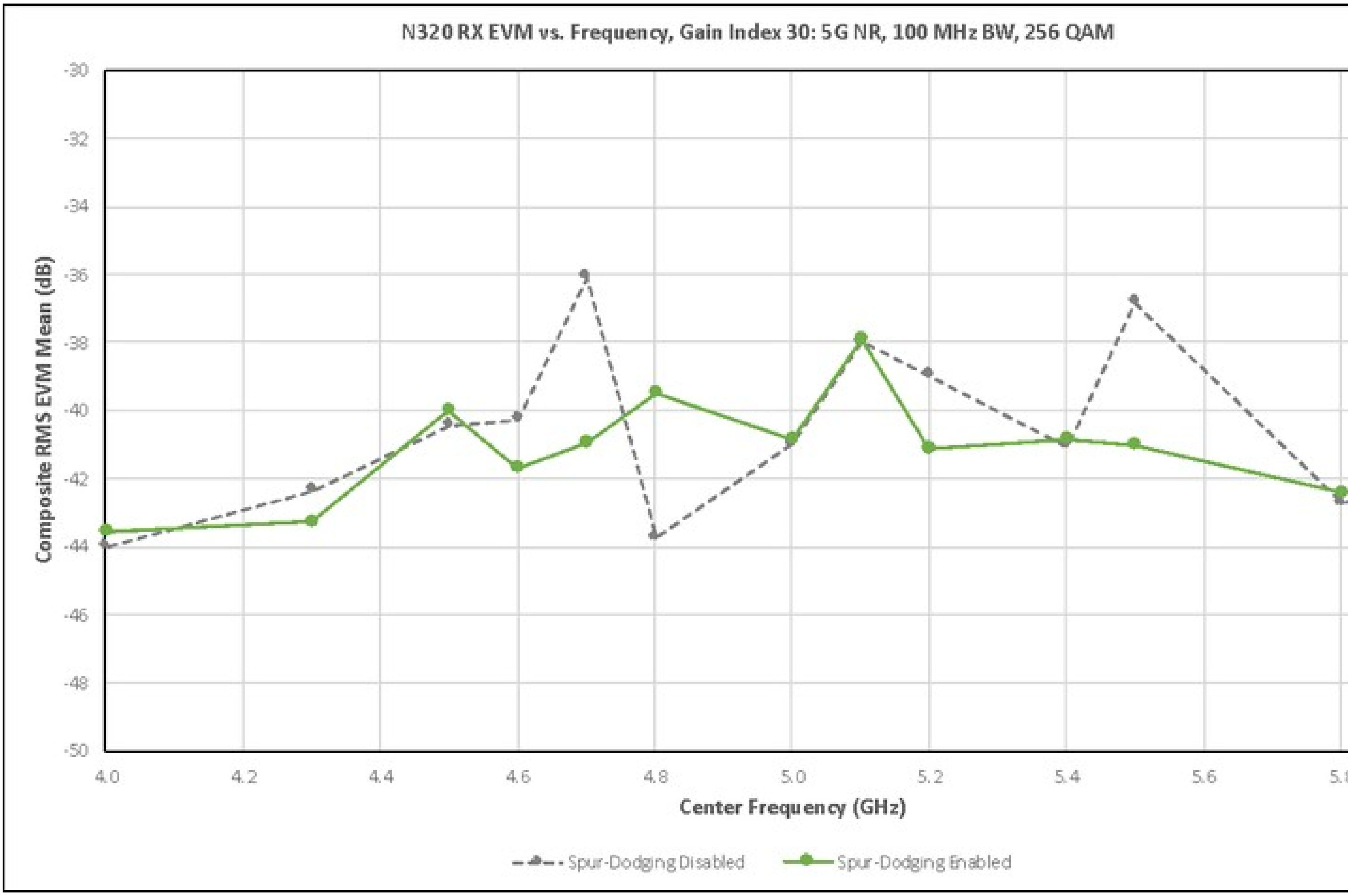
The EVM versus frequency was measured once again after applying the RX I/Q calibration. Significant improvements can be observed as demonstrated in the following comparison plot:



At some frequencies, synthesis spurs can be higher than desired and can result in EVM degradation. A spur-dodging algorithm was implemented for the USRP N320/N321 to improve the spurious performance when desired. By default, the spur-dodging algorithm is disabled, but can be enabled by adding the following device argument:

```
--args ?spur_dodging=enabled?
```

During the original measurement above, a few frequencies exhibited spur levels high enough to degrade the EVM performance. These frequencies were remeasured after enabling the spur-dodging algorithm. The corresponding EVM performance improved at these frequencies as highlighted in the following plot:



The USRP N320/N321 receiver with the 5G NR modulation standard exhibits excellent EVM performance. This performance can be further improved by taking advantage of the RX I/Q calibration utility available in UHD as well as the spur-dodging algorithm unique to the USRP N320/N321.

Footnotes The EVM performance presented here was measured on a single unit at room temperature during product development. The performance demonstrated here is for informational purposes only and is not covered by warranty.