Sideband Rejection and Feedback Isolation Impacts on DPD Performance

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ABSTRACT

Texas Instruments has DPD (Digital Pre-Distortion) chipsets for BTS (Basestation Transceiver System) and Repeater applications to improve overall system efficiency and meet various standard specifications. The GC5330 is an ultra-wideband transmit and receive signal processor that includes digital up/down-converters. The transmit path includes Crest Factor Reduction (CFR), Digital Pre-Distortion (DPD) and associated feedback path, complex equalization, bulk up-conversion, complex equalization, and I/Q imbalance correction. This document describes what levels of sideband image rejection and feedback path isolation are required to achieve optimum DPD performance in Complex-IF Transmitter and Real-IF Feedback architecture.

Contents

1 Introduction

In a Quadrature system, the amplitude and phase imbalance between In-phase (I) and Quadrature-phase (Q) paths in the analog domain generate a sideband image component over the transmitted signal. Complex IF is chosen as a transmit arthitecture of GC5330SEK, which a complex IQ baseband signal is directly upconverted to Intermediate Frequency (IF) using coarse mixer block of DAC. This coarse mixing is simply done by complex-multiplying the mixing functions of 1/0/-1/0 for the cosine waveform and 0/1/0/-1 for the sine waveform to the baseband I and Q rail respectively. Hence, sideband image is mirrored from local leakage and its diatance from carrier is twice of IF. Without appropriate filtering of the sideband on the transmission path, this image is fed into the input stage of the Power Amplifier (PA). Thus, the PA modeling is insufficiently accurate to adapt the transmitting signal well, as long as the sideband image is within the DPD processing bandwidth. Also, image interference aliased into the desired frequency band degrades the receiver performance.

Assuming inadequate feedback isolation, DPD performance is critical in the transceiver system because the feedback signal from the PA holds the leakage components in-band or very close to the in-band signal. This has a direct negative impact on the precise PA-model characterization, and eventually degrades the DPD correction performance.

Regarding feedback isolation test, the same LTE 1x10 MHz as main upper carrier is used as a leakage signal to feedback path and the location of carrier leakage is adjacent to the main carrier. The center frequency of feedback signal, 2x10 MHz of LTE, to GC5330SEK is 2.14 GHz and the leakage signal, 1x10 MHz of LTE, is located on 2.155 GHz as shown in Figure 35. Meanwhile, the same LTE 2x10 MHz as main carriers is used as correlated leakage signals to feedback path and the location of correlated leakage signal is the same as main carrier as 2.14 GHz as shown in Figure 49.

The quadrature modulation correction (QMC) block of the digital-to-analog converter (DAC) was used for each different level of sideband image by manually tuning gain and phase. A power combiner with an external signal generator was used to generate the leakage signal input to feedback path in DPD architecture. The details of the test setup environments are addressed in Section 2.2, Section 3.1.1, and Section 4.1.1.

2 DPD Performance versus Sideband Image Level

2.1 Test Setup Environment

The DPD performances were measured at 25, 30, and 35 dBm of P_{out}, depending on the various sideband image levels. The specifications of the setup are:

- Test signal and its peak-to-average ratio (PAR): LTE FDD 2 x 10 MHz, 6.7 dB at 0.01%
- Target board: TSW3100/GC5330SEK
- RF center: 2140 MHz
- IF: 153.6 MHz
- LO: 1861.4 MHz
- ADC sampling frequency: 204.8 MHz
- DAC sampling frequency: 614.4 MHz after x4 interpolation in DAC
- DPD BW: 153.6 MHz

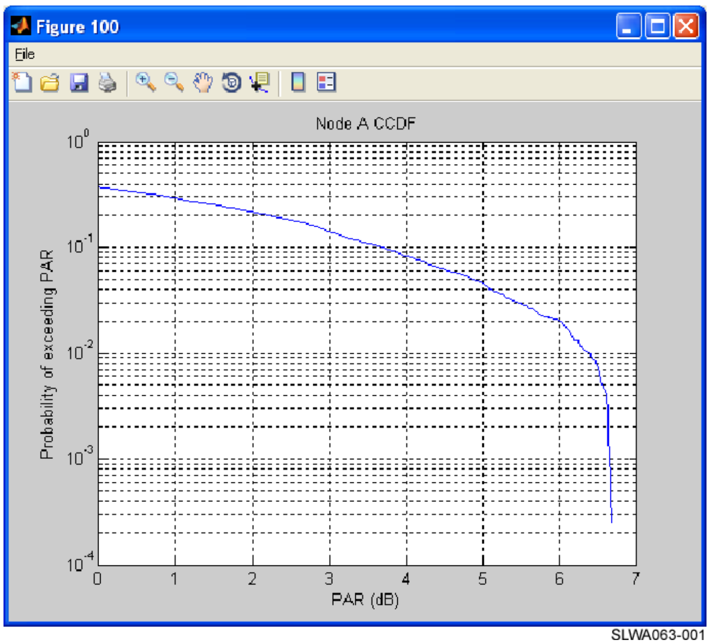


Figure 1. CCDF Curve for Sideband Image versus DPD Performance

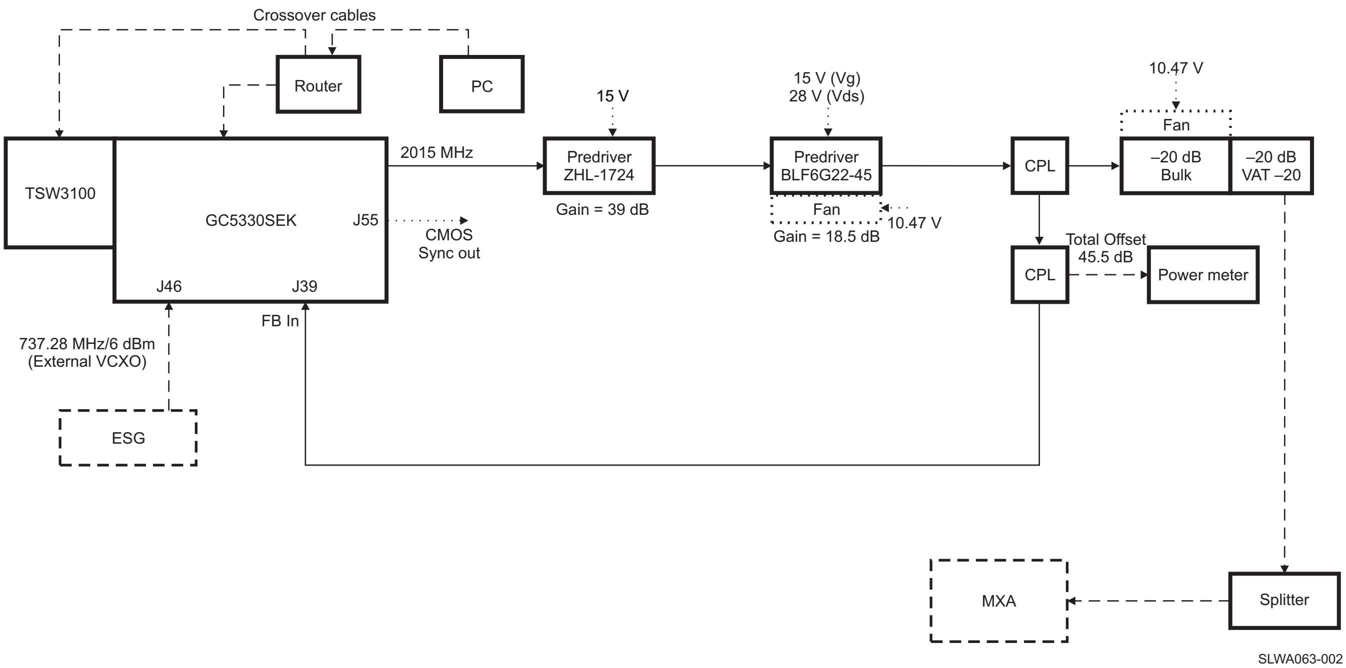


Figure 2. Test Setup for Sideband Image versus DPD Performance

2.2 *Quadrature Modulation Correction for Different Level of the Sideband Image*

The GC5330SEK includes the DAC3283 which is a dual-channel 16-bit, 800-Msps DAC. The QMC block provides a means for adjusting the gain and phase of the complex signal. At a quadrature modulator output, gain and phase imbalances result in an undesired sideband signal.

The QMC block contains three programmable parameters: Offset, Gain A, and Gain B. Offset controls the phase imbalance between I and Q with 10-bit resolution and covers the range from –3.75 to +3.75 degrees in 1024 steps. Gain A and Gain B consist of 11-bit resolution and control the gain of the I and Q paths. By manually adjusting Offset, Gain A, or Gain B, the sideband image level can be controlled and reduced to the desired level.

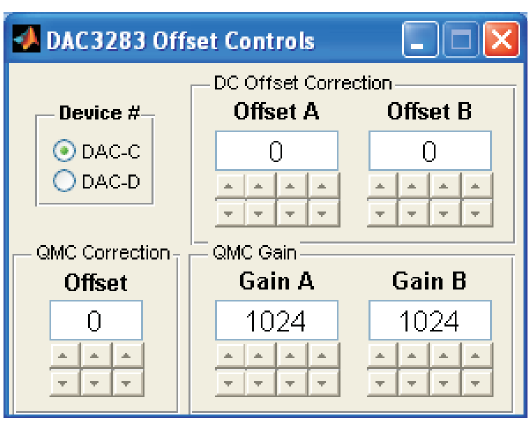


Figure 3. QMC Window from GC5330 GUI

2.3 Test Results

2.3.1 35 dBm of PA Output Power

The average output power of the BLF6G22-45 is 2.5 W (34 dBm) with 7.5 dB of PAR at 0.01%. For this test, the test signal has 6.7 dB of PAR at 0.01% and therefore the output power of the PA is set to 35 dBm.

Other parameters of the BLF6G22-45 are:

- Frequency range: 2110–2170 MHz
- V_{DS}: 28 V
- Gain: 18.5 dB
- Efficiency (D): 13%
- ACPR: –49 dBc (Test signal: 3GPP 64 DPCH with 7.5 dB of PAR at 0.01%, carrier spacing 5 MHz)

2.3.1.1 DPD Performance with –55 dBc of Sideband Image

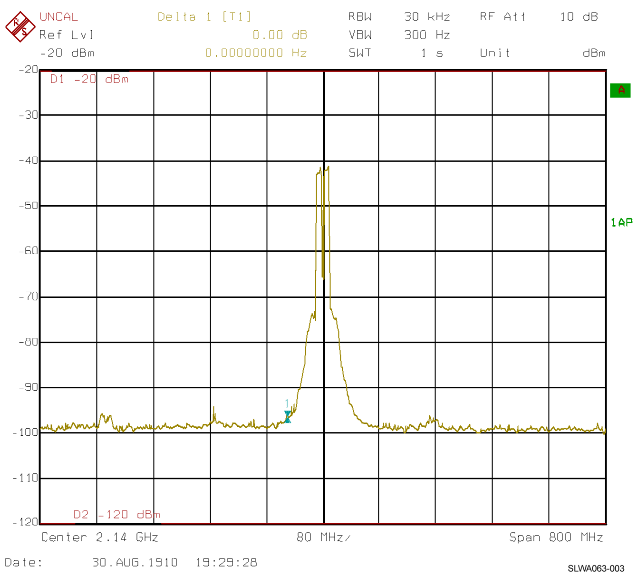


Figure 4. –55 dBc of Image Level at 35 dBm of P_{out}

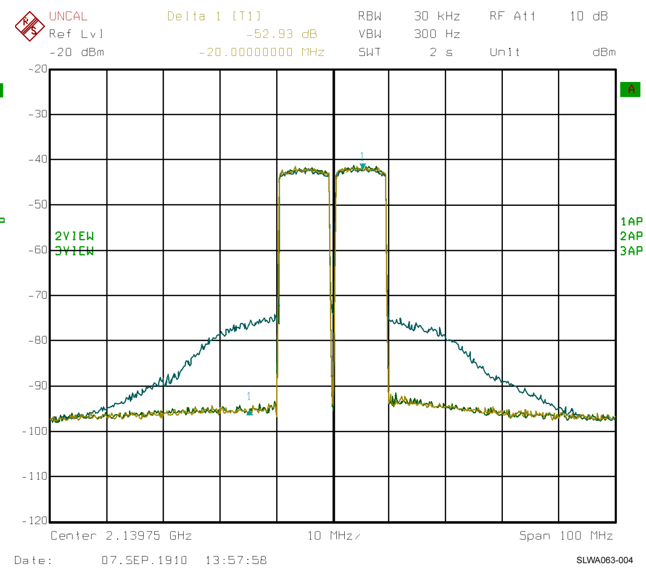


Figure 5. Pre/Post DPD with –55 dBc of Image at 35 dBm of P_{out}

Before enabling DPD, the sideband image is suppressed down to the noise floor by adjusting the QMC of the DAC, which is approximately –55 dBc from the main signal. This level does not impact DPD performance.

2.3.1.2 DPD Performance with –45 dBc of Sideband Image

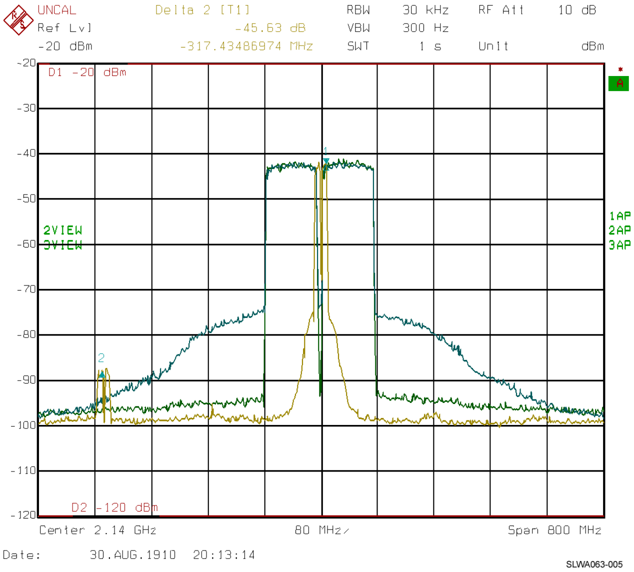


Figure 6. –45 dBc of Image Level at 35 dBm of P_{out}

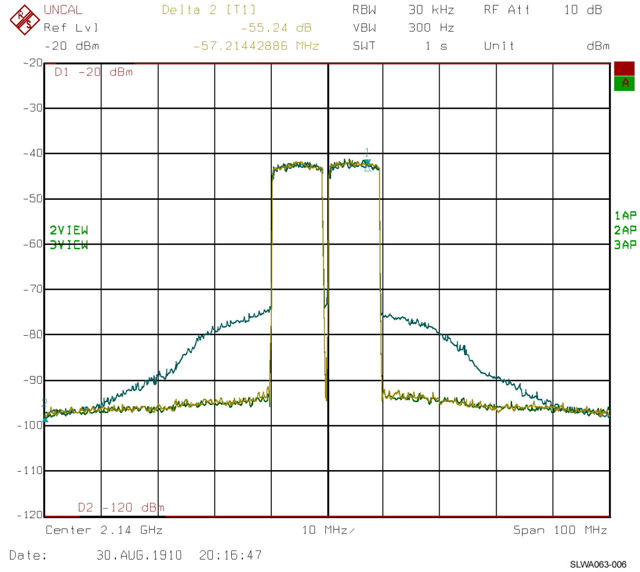


Figure 7. Pre/Post DPD with –45 dBc of Image at 35 dBm of P_{out}

Figure 6 describes the level of sideband image at 800 MHz of span from the spectrum analyzer. To illustrate the impact of different sideband levels on DPD performance, the pre/post DPD was kept for an exact comparison of the DPD performance.

The sideband image is adjusted to –45 dBc, as shown in Figure 6. The DPD performance with this level of image is the same as the DPD performance with –55 dBc of sideband level, as shown in Figure 7.

2.3.1.3 DPD Performance with –40 dBc of Sideband Image

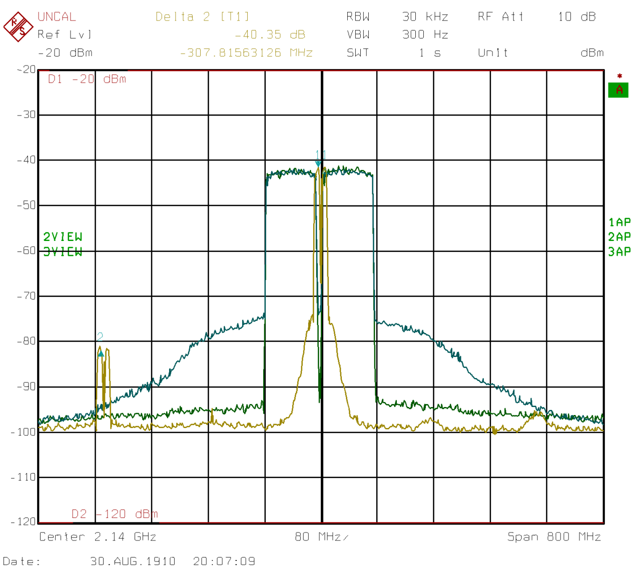


Figure 8. –40 dBc of Image Level at 35 dBm of P_{out}

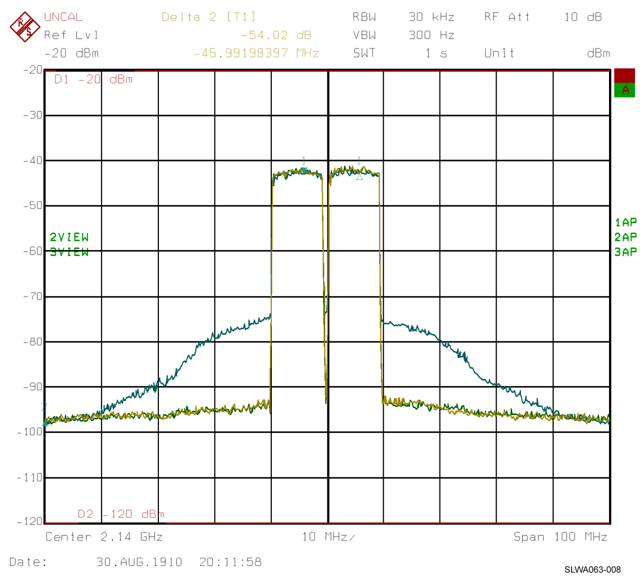


Figure 9. Pre/Post DPD with –40 dBc of Image at 35 dBm of P_{out}

The sideband image is adjusted to –40 dBc, as shown in Figure 8 . DPD performance with this level of image is the same as DPD performance with –55 dBc of the sideband level, as shown in Figure 9.

2.3.1.4 DPD Performance with –39 dBc of Sideband Image

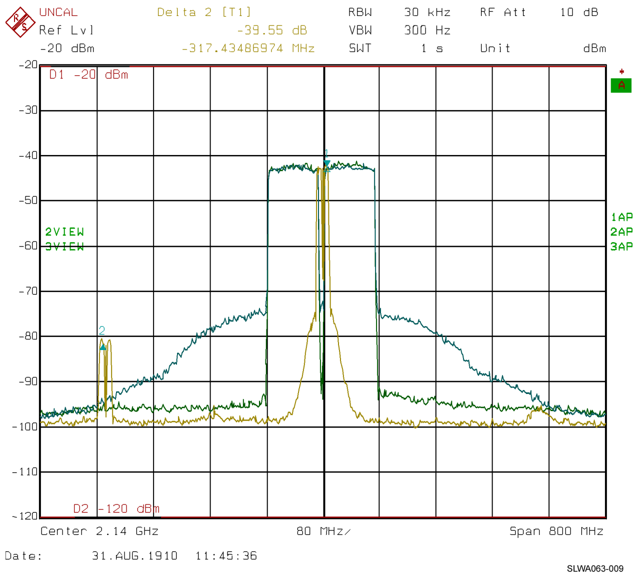


Figure 10. –39 dBc of Image Level at 35 dBm of P_{out}

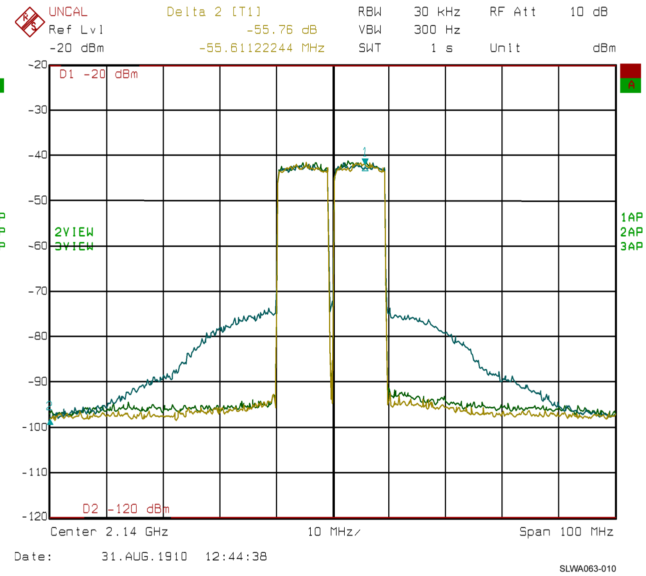


Figure 11. Pre/Post DPD with –39 dBc of Image at 35 dBm of P_{out}

The sideband image is adjusted to –39 dBc, as shown in Figure 10. This level of sideband image starts to slightly degrade DPD performance, shown in Figure 11.

2.3.1.5 DPD Performance with –38 dBc of Sideband Image

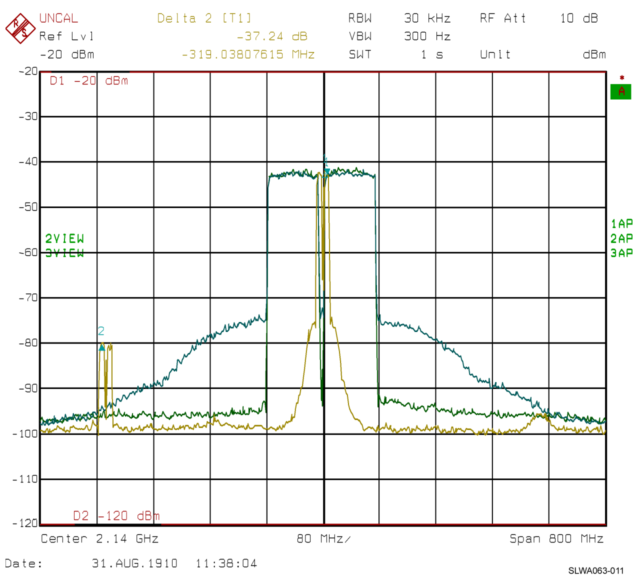


Figure 12. –38 dBc of Image Level at 35 dBm of P_{out}

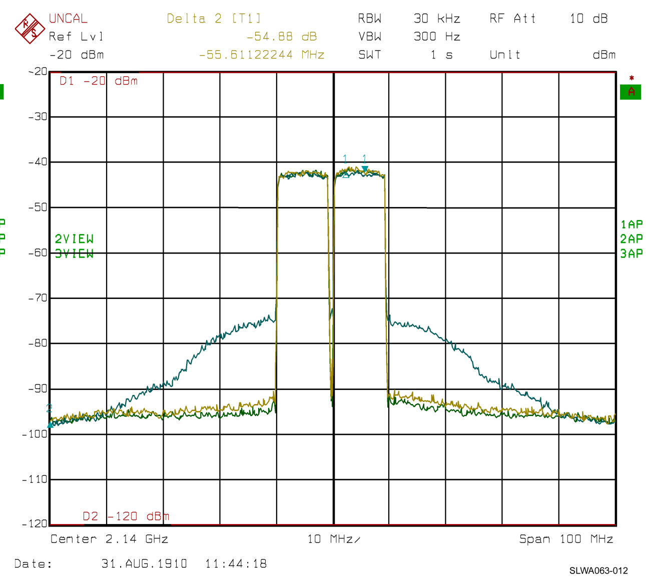


Figure 13. Pre/Post DPD with –38 dBc of Image at 35 dBm of P_{out}

The sideband image is adjusted to –38 dBc, as shown in Figure 12. This level of sideband image degrades DPD performance by 1–2 dB as compared to DPD performance with –55 dBc of sideband level, shown in Figure 13.

2.3.1.6 DPD Performance with –37 dBc of Sideband Image

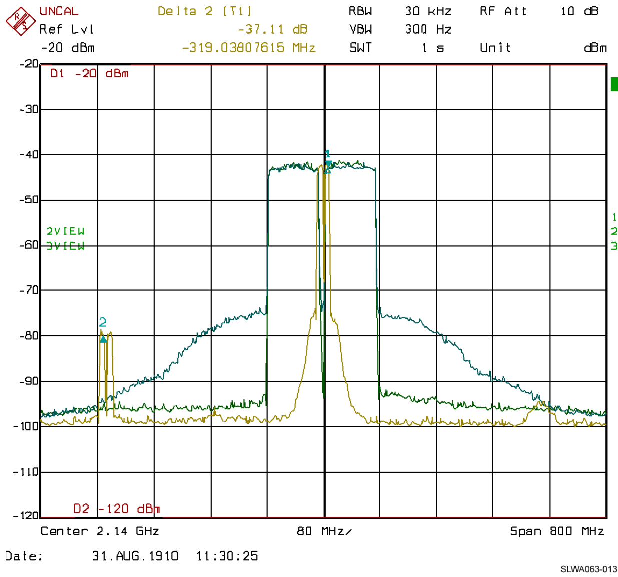


Figure 14. –37 dBc of Image Level at 35 dBm of P_{out}

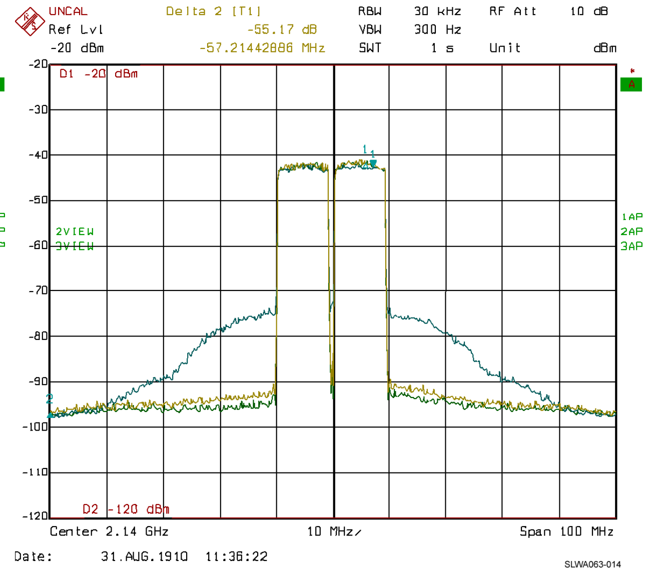


Figure 15. Pre/Post DPD with –37 dBc of Image at 35 dBm of P_{out}

The sideband image is adjusted to –37 dBc, as shown in Figure 14. The level of sideband image degrades DPD performance by 1–2 dB as compared to DPD performance of –55 dBc of sideband level, as shown in Figure 15.

2.3.1.7 DPD Performance with –36 dBc of Sideband Image

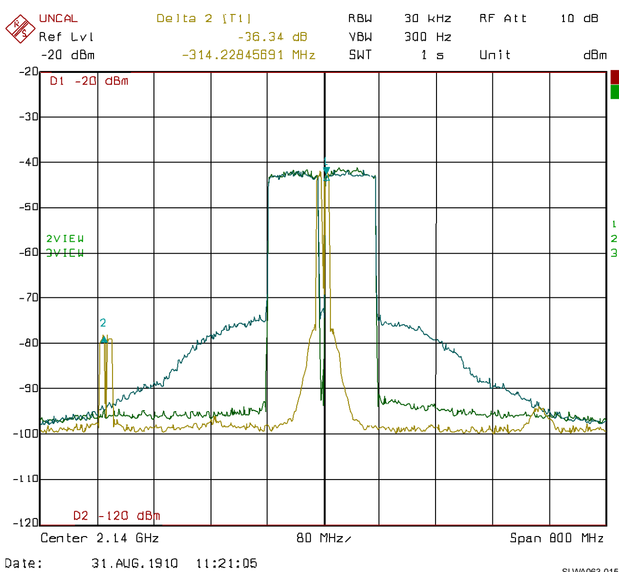


Figure 16. –36 dBc of Image Level at 35 dBm of P_{out}

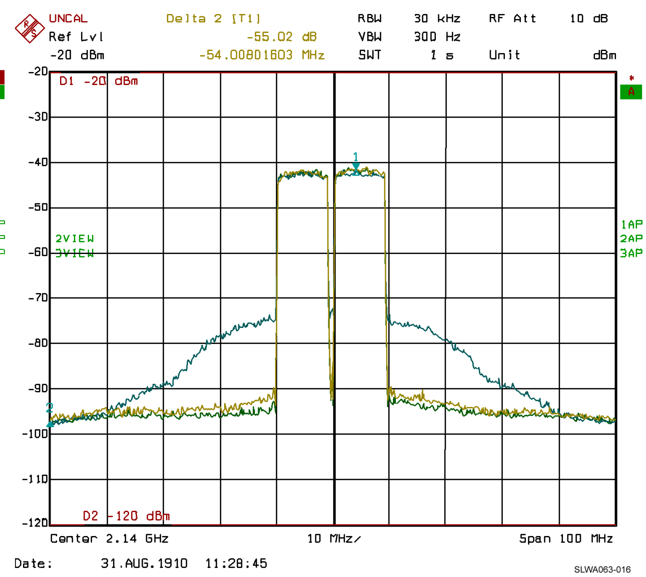


Figure 17. Pre/Post DPD with –36 dBc of Image at 35 dBm of P_{out}

The sideband image is adjusted to –36 dBc, as shown in Figure 16. This level of sideband image degrades DPD performance by 1–2 dB as compared to DPD performance of –55 dBc of sideband level, as shown in Figure 17.

2.3.1.8 DPD Performance with –35 dBc of Sideband Image

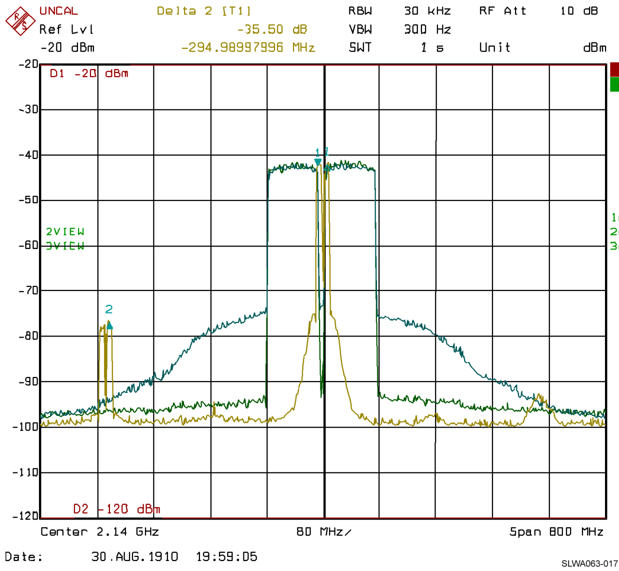


Figure 18. –35 dBc of Image Level at 35 dBm of P_{out}

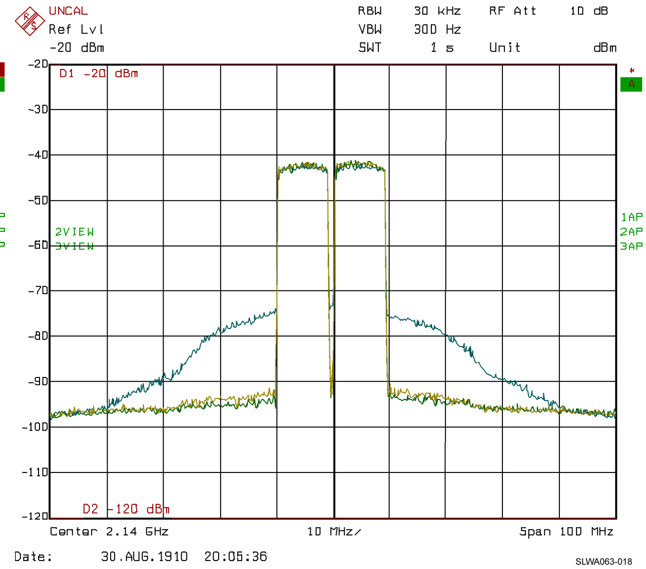


Figure 19. Pre/Post DPD with –35 dBc of Image at 35 dBm of P_{out}

The sideband image is adjusted to –35 dBc, as shown in Figure 18. This level of sideband image degrades DPD performance by 1–2 dB, as compared to to DPD performance of –55 dBc of sideband level, as shown in Figure 19.

2.3.1.9 DPD Performance with –30 dBc of Sideband Image

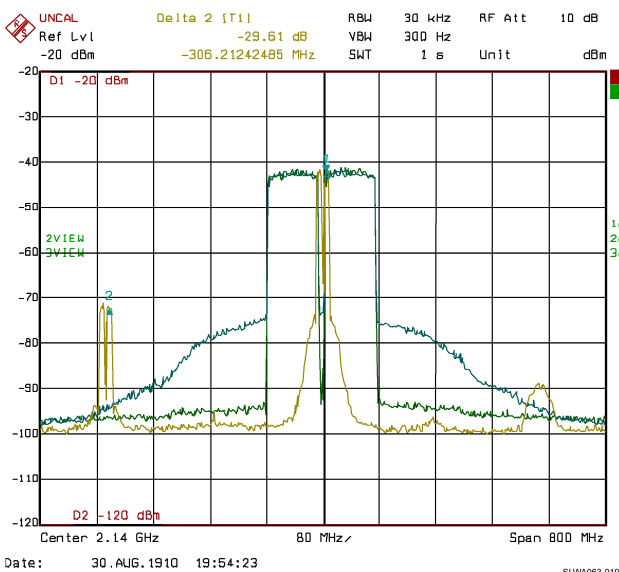


Figure 20. –30 dBc of Image Level at 35 dBm of P_{out}

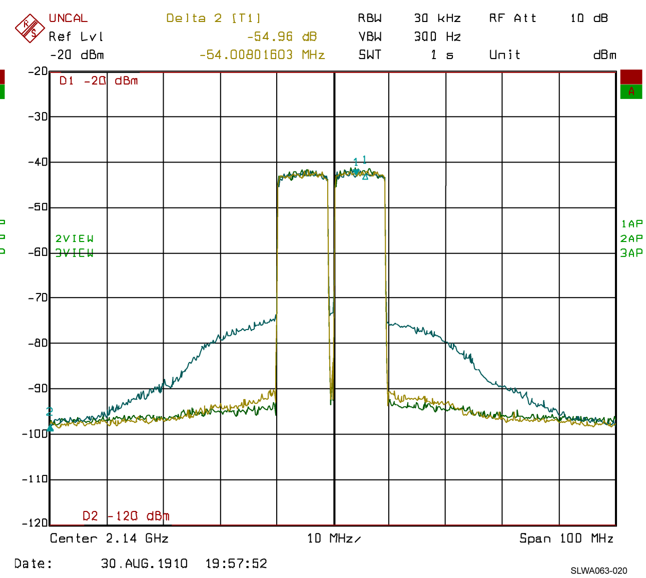


Figure 21. Pre/Post DPD with –30 dBc of Image at 35 dBm of P_{out}

The sideband image is adjusted to –30 dBc, as shown in Figure 20. This level of sideband image degrades DPD performance by 2–3 dB as compared to DPD performance of –55 dBc of sideband level, as shown in Figure 21.

2.3.1.10 DPD Performance with –25 dBc of Sideband Image

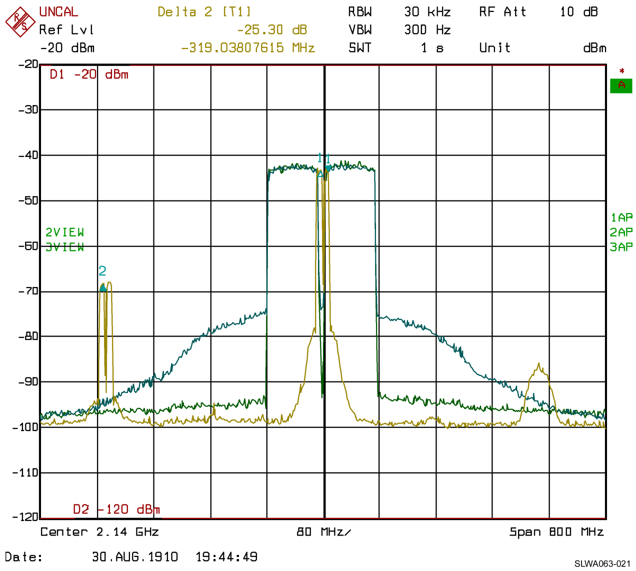


Figure 22. –25 dBc of Image Level at 35 dBm of P_{out}

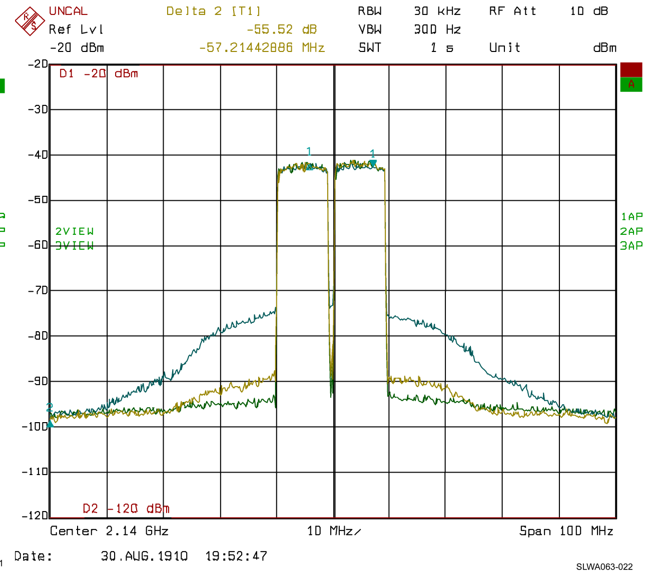


Figure 23. Pre/Post DPD with –25 dBc of Image at 35 dBm of P_{out}

The sideband image is adjusted to –25 dBc, as shown in Figure 22. This level of sideband image degrades DPD performance by 5–6 dB as compared to DPD performance of –55 dBc of sideband level, as shown in Figure 23.

2.3.2 30 dBm of PA Output Power

The output power of the target PA was reduced by 5 dB of the maximum output power to check how much sideband image impacts the DPD performance at lower levels.

2.3.2.1 *DPD Performance with –50 dBc of Sideband Image*

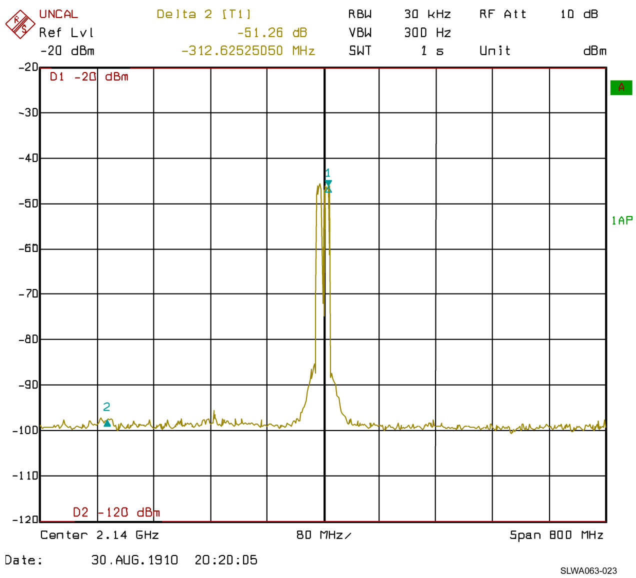


Figure 24. –50 dBc of Image Level at 30 dBm of P_{out}

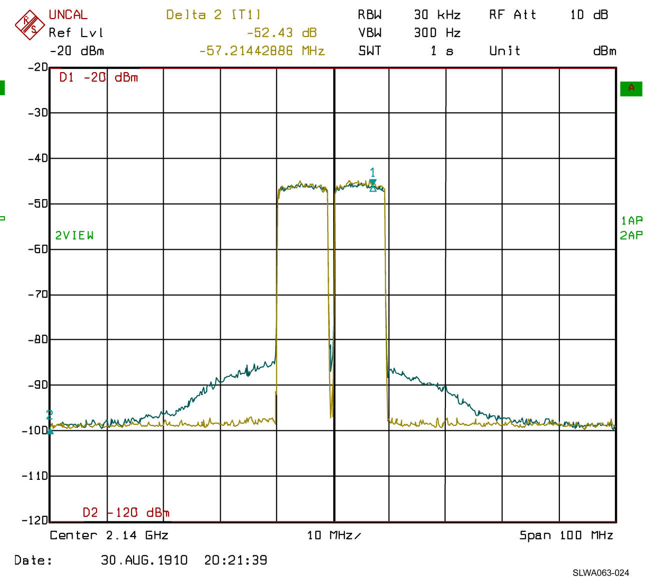


Figure 25. Pre/Post DPD Correction with –50 dBc of Image at 30 dBm of P_{out}

The sideband image is adjusted to –50 dBc, as shown in Figure 24. DPD performance with this level of sideband image does not degrade the DPD performance, as shown in Figure 25.

2.3.2.2 *DPD Performance with –30 dBc of Sideband Image*

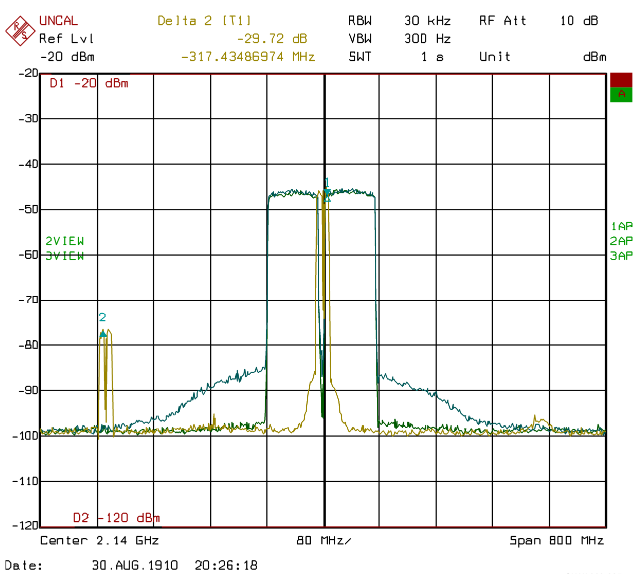


Figure 26. –30 dBc of Image Level at 30 dBm of P_{out}

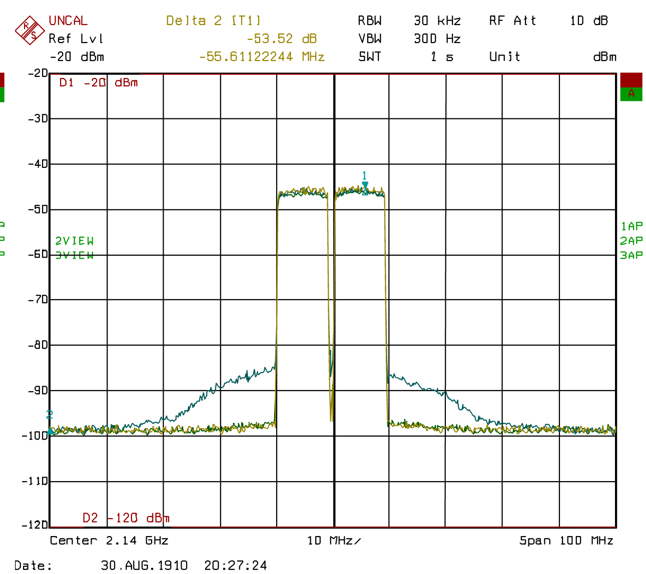


Figure 27. Pre/Post DPD Correction with –30 dBc of Image at 30 dBm of P_{out}

The sideband image is adjusted to –30 dBc, as shown in Figure 26. DPD performance with this level of sideband image does not degrade the DPD performance, as shown in Figure 27.

2.3.2.3 DPD Performance with –25 dBc of Sideband Image

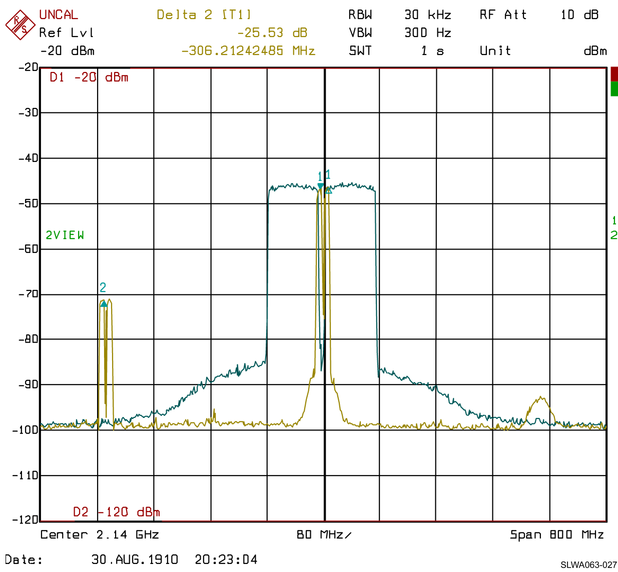


Figure 28. –25 dBc of Image Level at 30 dBm of P_{out}

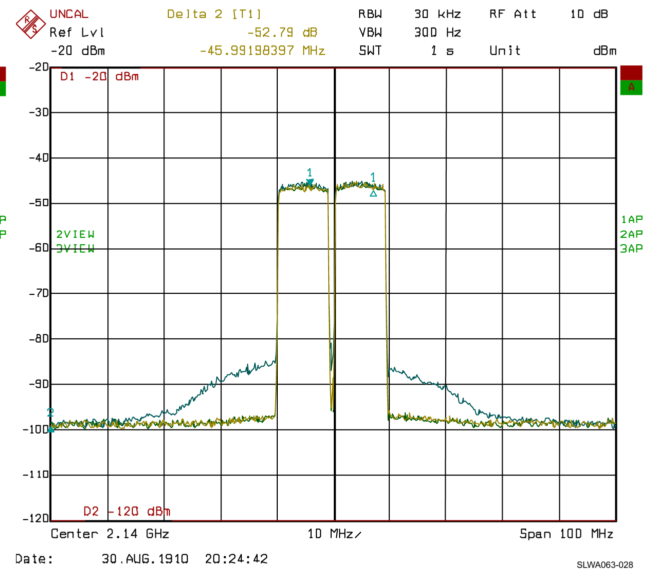


Figure 29. Pre/Post DPD Correction with –25 dBc of Image at 30 dBm of P_{out}

The sideband image is adjusted to –25 dBc, as shown in Figure 28. DPD performance with this level of sideband image does not degrade the DPD performance, as shown in Figure 29.

2.3.3 25 dBm of PA Output Power

The output power of the target PA was reduced by 10 dB from the maximum output power to check how much sideband image impacts the DPD performance at lower levels.

2.3.3.1 DPD Performance with –50 dBc of Sideband Image

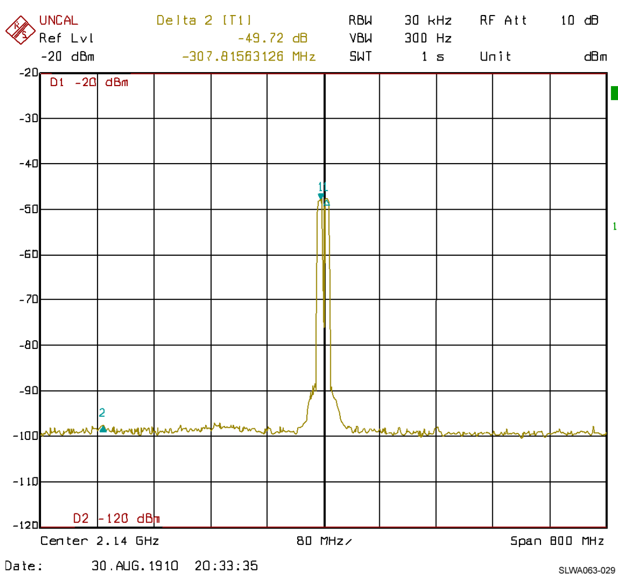


Figure 30. –50 dBc of Image Level at 25 dBm of P_{out}

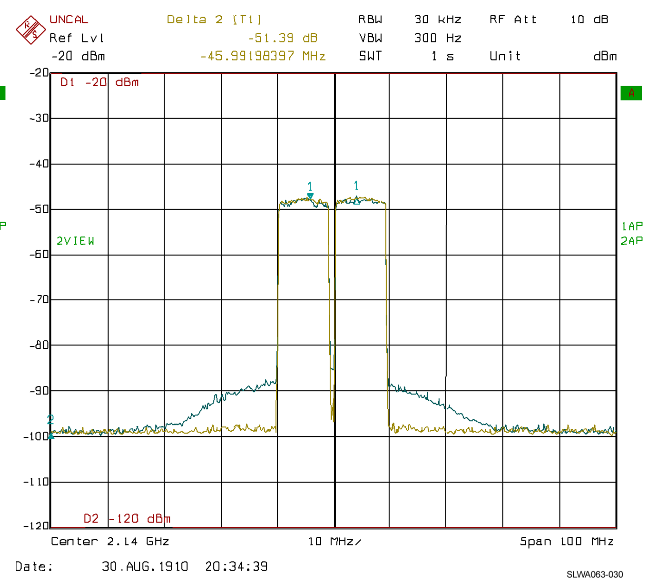


Figure 31. Pre/Post DPD Correction with –50 dBc of Image at 30 dBm of P_{out}

The sideband image is adjusted to –50 dBc, as shown in Figure 30. DPD performance with this level of sideband image does not degrade the DPD performance at 25 dBm of PA output power, as shown in Figure 31.

2.3.3.2 DPD Performance with –25 dBc of Sideband Image

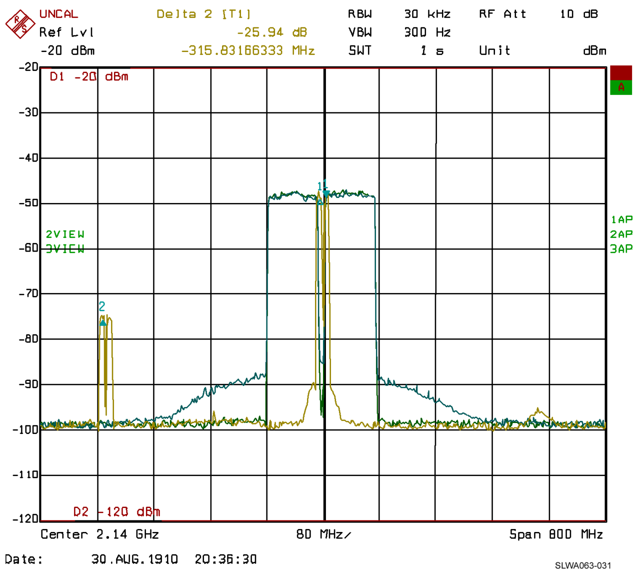


Figure 32. –25 dBc of Image Level at 30 dBm of P_{out}

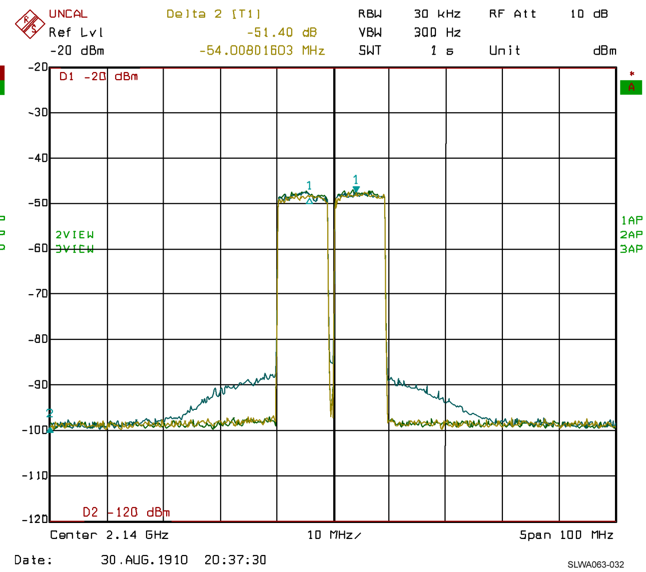


Figure 33. Pre/Post DPD Correction with –25 dBc of Image at 30 dBm of P_{out}

The sideband image is adjusted to –25 dBc, as shown in Figure 32. DPD performance with this level of sideband image does not degrade the DPD performance at 25 dBm of PA output power, as shown in Figure 33, even though the sideband image level is –25 dBc to the carrier.

2.4 Summary

DPD performance starts degrading at –39 dBc of sideband image level at the maximum output power of the PA from this test. This means at least –40 dBc of sideband-image rejection is required to avoid degradation of DPD performance. At 5 and 10 dB of reduction from the maximum PA output power, 30 and 25 dBm, respectively, the sideband image does not degrade DPD performance at all.

Table 1. Sideband Image Level versus DPD Performance

Sideband Image Level	–25 dBc	–30 dBc	–35 dBc	–39 dBc	–40 dBc	–45 dBc
DPD performance [(1)(2)(3)]	X	X	Δ	Δ	O	O

(1) X: More than 2–3 dB degraded DPD performance from sideband image

(2) Δ: Less than 1–2 dB degraded DPD performance from sideband image

(3) O: No degradation from the standard DPD performance

3 DPD Performance versus Isolation of Feedback Path with Adjacent Leakage Level

3.1 Test Setup Environment

DPD performances were measured at 36 dBm of maximum P_{out} depending on adjacent leakage level through the feedback switch from other channels. The specifications of setup are:

- Test signal and its PAR: LTE FDD 2 x 10 MHz, 6.7 dB at 0.01%
- Target board: TSW3100/GC5330SEK
- RF center: 2140 MHz
- IF: 153.6 MHz
- LO: 1861.4 MHz
- ADC sampling frequency: 204.8 MHz
- DAC sampling frequency: 614.4 MHz after x4 interpolation in DAC
- DPD BW: 153.6 MHz
- FB input: 3 dBm
- P_{out}: 36 dBm (The maximum P_{out} of BLFG6G22 is 34 dBm with 7.5 dB of PAR at 0.01%.) → 1 dB higher than specified P_{out}

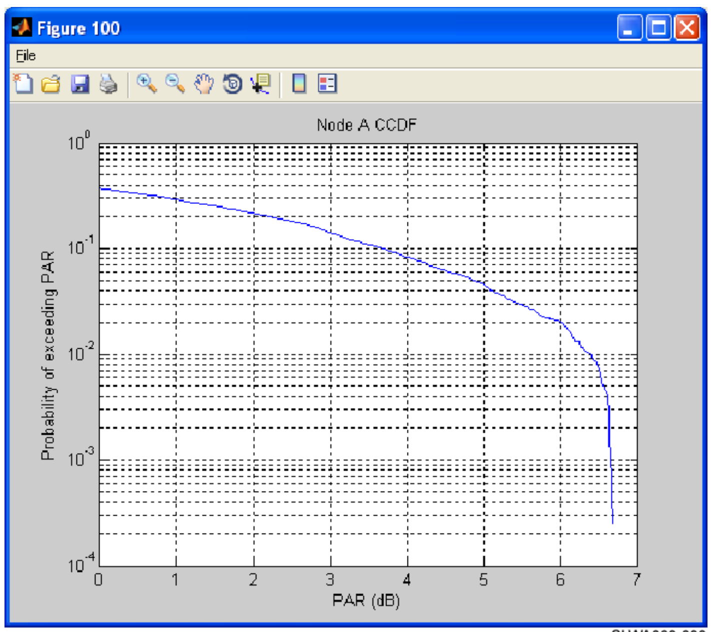


Figure 34. CCDF Curve for DPD Performance versus Adjacent Leakage of Feedback Switch

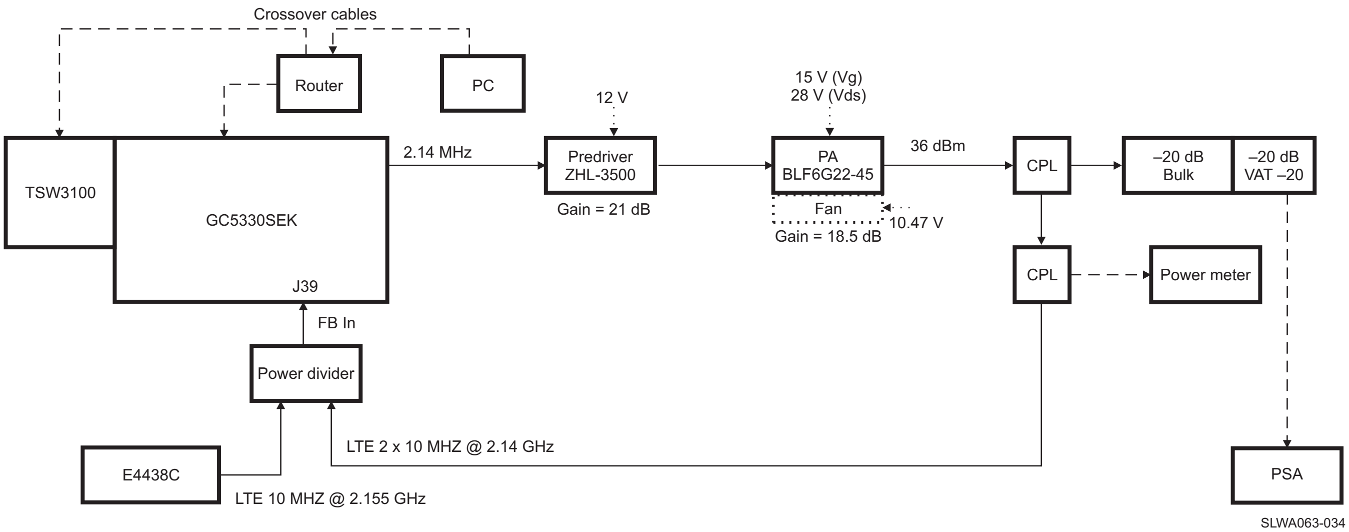


Figure 35. Test Setup for DPD Performance versus Adjacent Leakage of Feedback Switch

3.1.1 Adjacent Leakage Level

The adjacent carrier baseband signal can be downloaded to the E4438C and the level of adjacent leakage level can be controlled by adjusting the level of the amplitude from the signal generator.

3.2 Test Results

3.2.1 DPD Performance without Adjacent Leakage

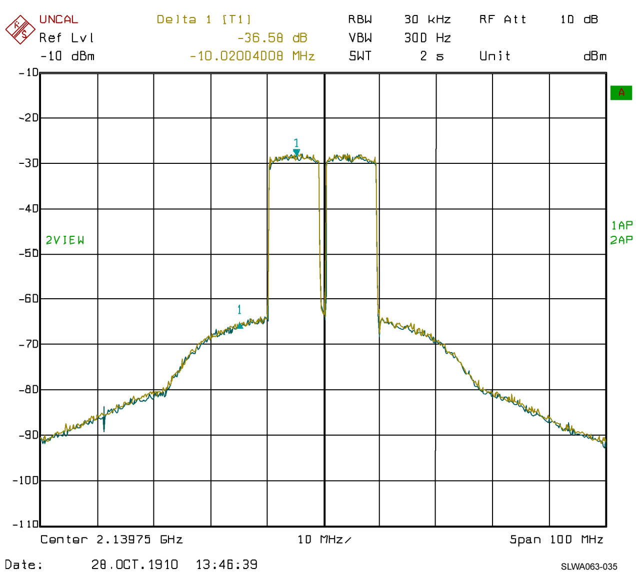


Figure 36. No Adjacent Leakage Into Feedback

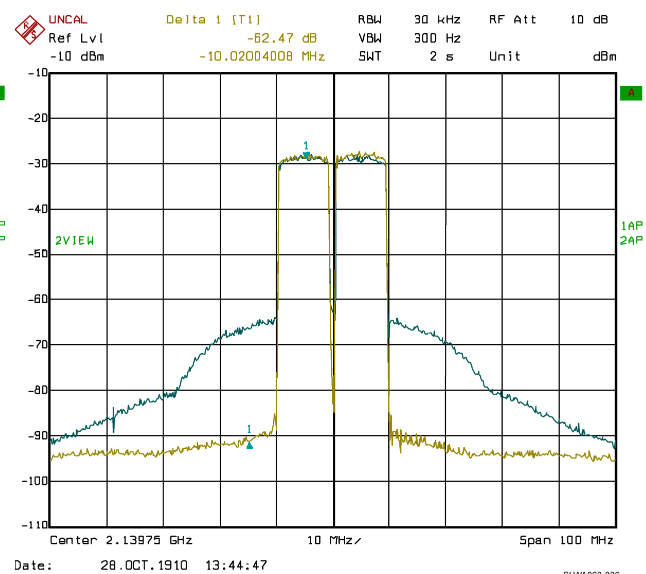


Figure 37. Pre/Post DPD Correction without Leakage

3.2.2 DPD Performance with –20 dBc of Adjacent Leakage Level

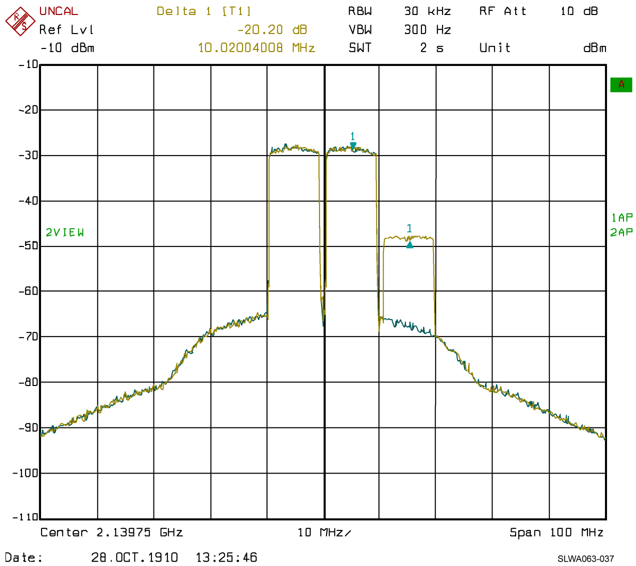


Figure 38. –20 dBc of Adjacent Leakage Into Feedback

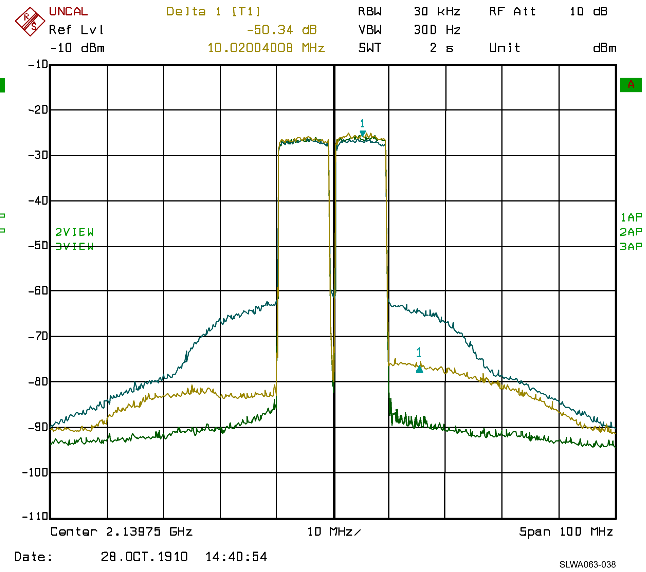


Figure 39. Pre/Post DPD Correction with –20 dBc of Leakage

The DPD performance is severely degraded by –20 dBc of adjacent leakage from the feedback path, as shown in Figure 38. More than 10 dB of correction is degraded by bad feedback isolation, as shown in Figure 39.

3.2.3 DPD Performance with –30 dBc of Adjacent Leakage Level

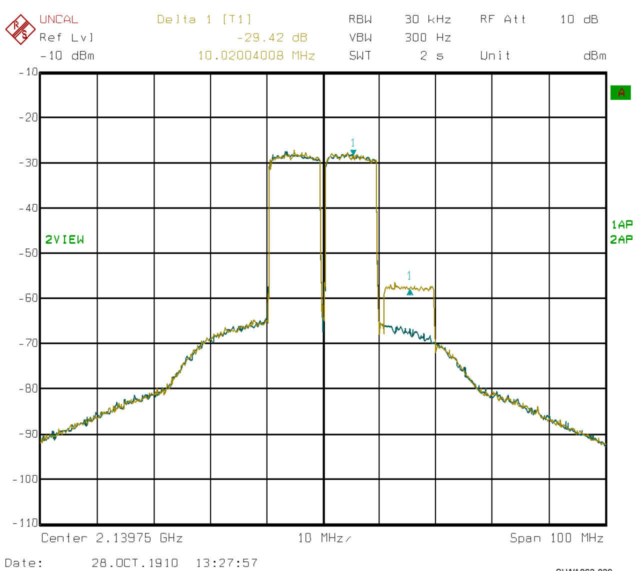


Figure 40. –30 dBc of Adjacent Leakage Into Feedback

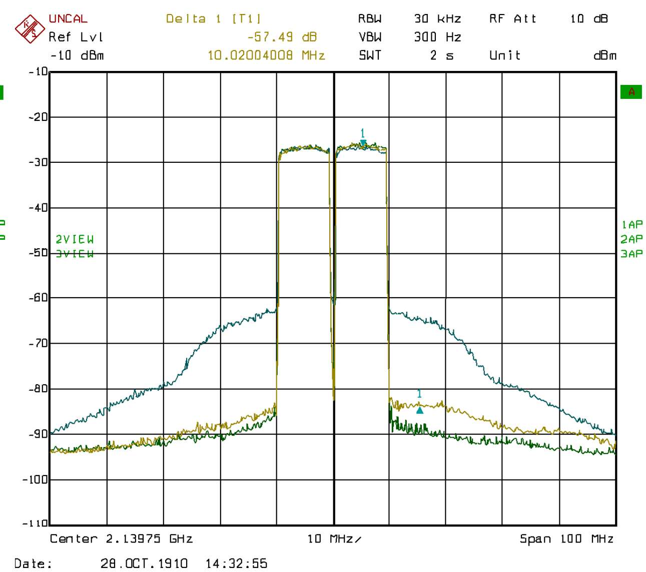
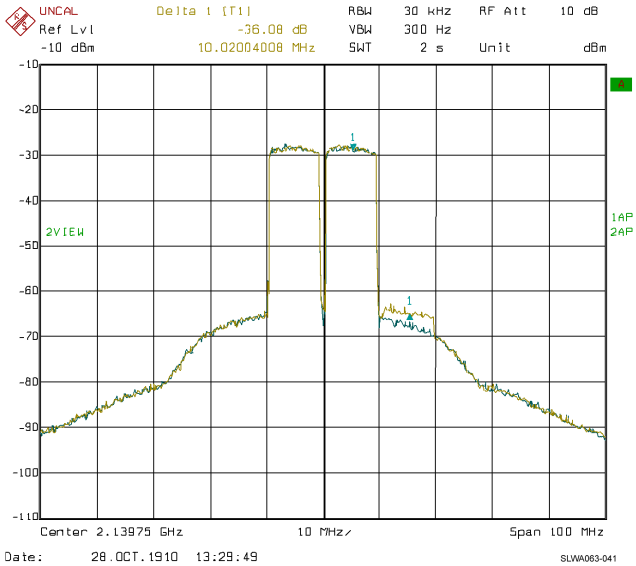


Figure 41. Pre/Post DPD Correction with –30 dBc of Leakage

The DPD performance is degraded by –30 dBc of adjacent leakage from the feedback path, as shown in Figure 40. Several dB of correction is degraded by bad feedback isolation, as shown in Figure 41.

3.2.4 DPD Performance with –40 dBc of Adjacent Leakage Level



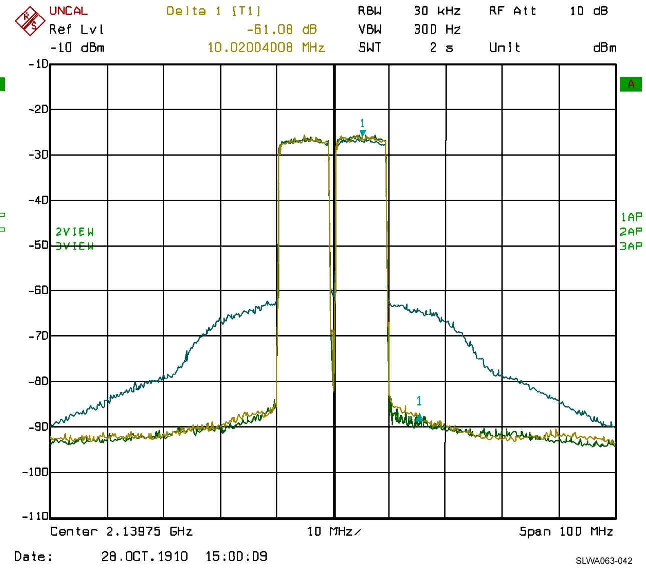
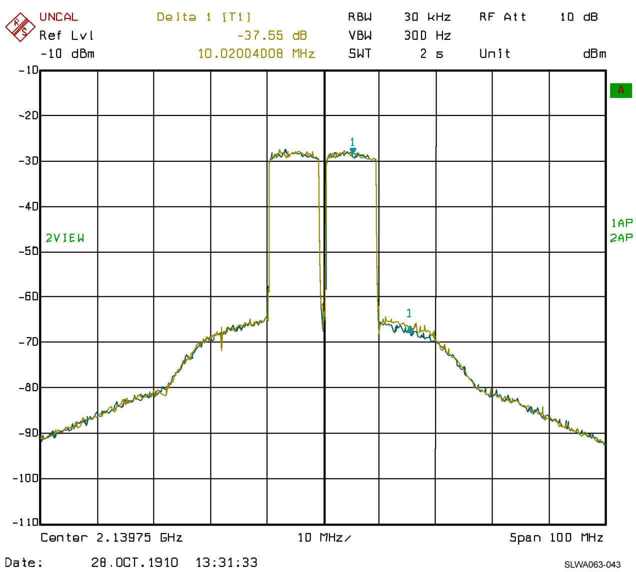


Figure 42. –40 dBc of Adjacent Leakage Into Feedback

Figure 43. Pre/Post DPD Correction with –40 dBc of Leakage

The DPD performance is degraded by –40 dBc of adjacent leakage from the feedback path, as shown in Figure 42. A small amount of correction is degraded by bad feedback isolation, as shown in Figure 43. Some fluctuation is observed at this level.

3.2.5 DPD Performance with –45 dBc of Adjacent Leakage Level



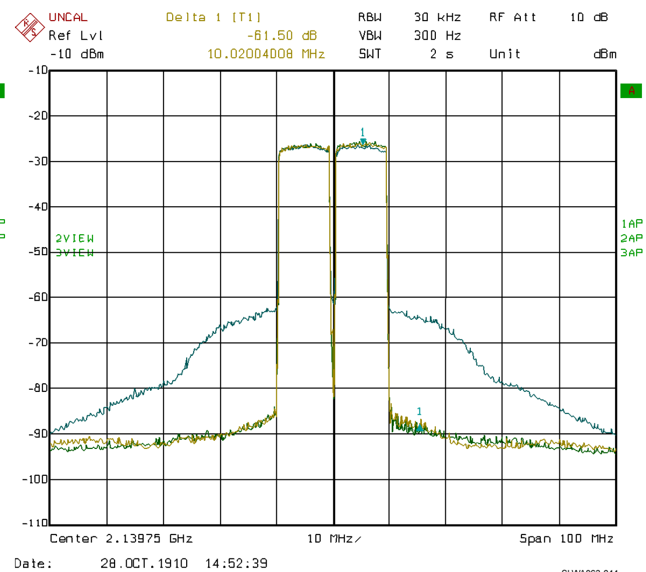


Figure 44. –45 dBc of Adjacent Leakage Into Feedback

Figure 45. Pre/Post DPD Correction with –45 dBc of Leakage

The DPD performance is the same as nonadjacent leakage from the feedback switch.

3.2.6 DPD Performance with –50 dBc of Adjacent Leakage Level

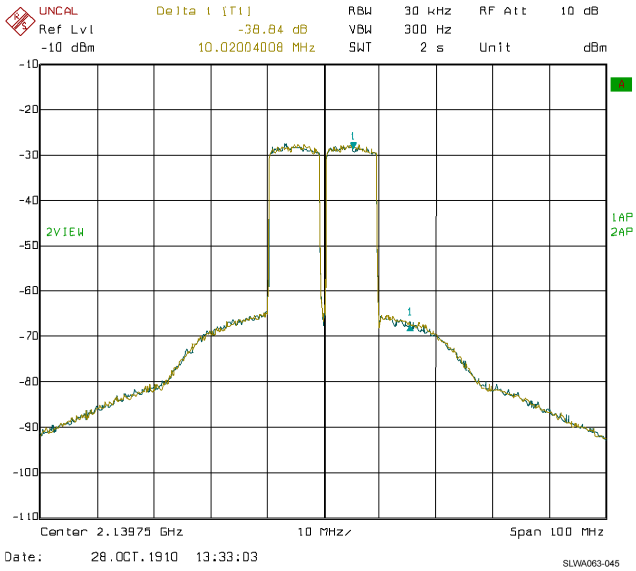


Figure 46. –50 dBc of Adjacent Leakage Into Feedback

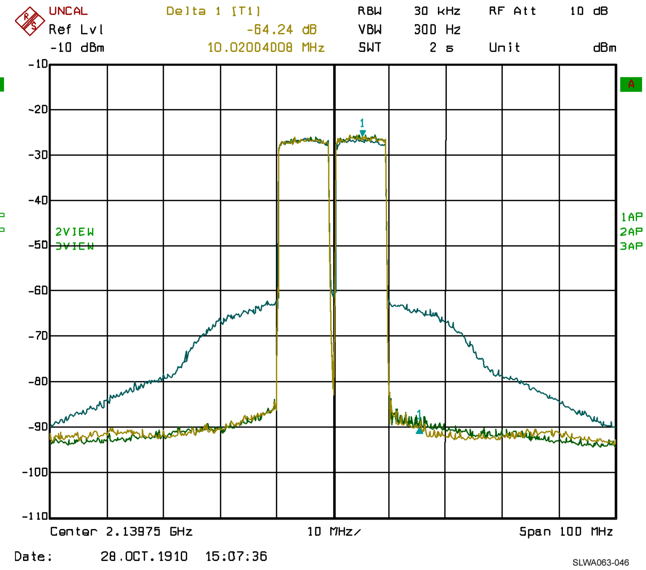


Figure 47. Pre/Post DPD Correction with –50 dBc of Leakage

The DPD performance is the same as nonadjacent leakage from the feedback switch.

3.3 Summary

DPD performance starts degrading at –40 dBc of adjacent leakage carrier from the feedback switch at the maximum output power of the PA. A small amount of fluctuation is observed at the location of adjacent leakage during adaptation. A minimum of –45 dBc of feedback isolation is required to avoid degradation of the DPD performance. For this test, BPF (Fc = 2.14 GHz with 150 MHz of BW) is used to exclude the impact of the sideband image and DC offset over DPD performance.

Table 2. Adjacent Leakge Level versus DPD Performance

Adjacent Leakage Level	–20 dBc	–30 dBc	–40 dBc	–45 dBc
DPD performance [(1)][(2)][(3)]	X	X	Δ	O

(1) X: More than 2–3 dB degraded DPD performance from adjacent leakage
(2) Δ: Less than 1–2 dB degraded DPD performance from adjacent leakage
(3) O: No degradation from the standard DPD performance

4 DPD Performance versus Isolation of Feedback Switch with Correlated Leakage Level

4.1 Test Setup Environment

DPD performances were measured at 36 dBm of maximum P_{out} depending on on the in-band leakage level through the feedback switch from other channels. The specifications of the setup are:

- Test signal and its PAR: LTE FDD 2 x 10 MHz, 6.7 dB at 0.01%
- Target board: TSW3100/GC5330SEK
- RF center: 2140 MHz
- IF: 153.6 MHz
- LO: 1861.4 MHz
- ADC sampling frequency: 204.8 MHz
- DAC sampling frequency: 614.4 MHz after x4 interpolation in DAC
- DPD BW: 153.6 MHz
- FB input: 3 dBm
- P_{out}: 36 dBm (The maximum P_{out} of BLFG6G22 is 34 dBm with 7.5 dB of PAR at 0.01%.) → 1 dB higher than specified P_{out}
- DPD performance was measured at 36 dBm of the maximum P_{out} depending on the level and phase of the leakage input through the feedback switch from other channels

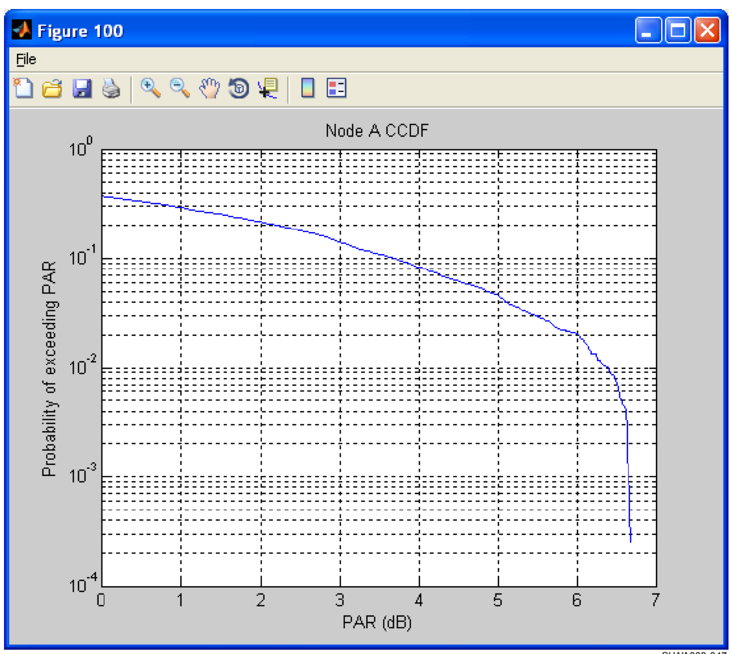


Figure 48. CCDF Curve for DPD Performance versus In-Band Leakage of Feedback Switch

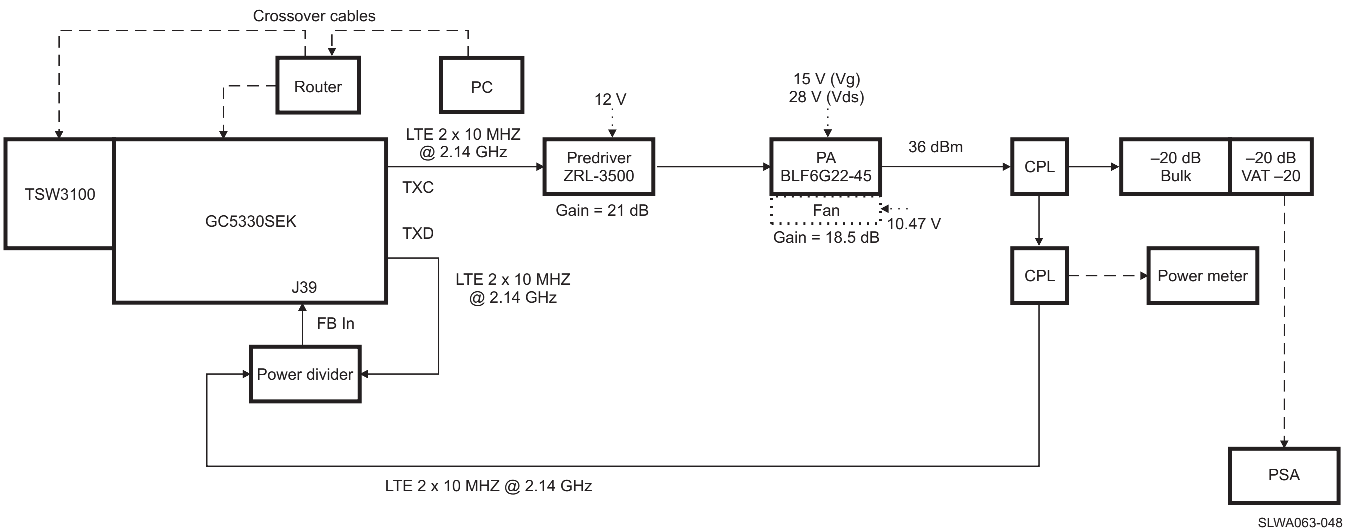


Figure 49. Test Setup for DPD Performance versus In-Band Leakage of Feedback Switch

4.1.1 In-Band Leakage Level

In-band leakage is generated from another channel of GC5330SEK called TXD. The in-band leakage signal can be the same signal of the transmit channel as TXC and its level can be controlled by adjusting an on-board attenuator through the GC5330 GUI. This in-band leakage signal is fed into a power divider and is merged with the feedback signal at the same frequency.

4.2 Test Results

4.2.1 DPD Performance without Leakage and Phase Offset

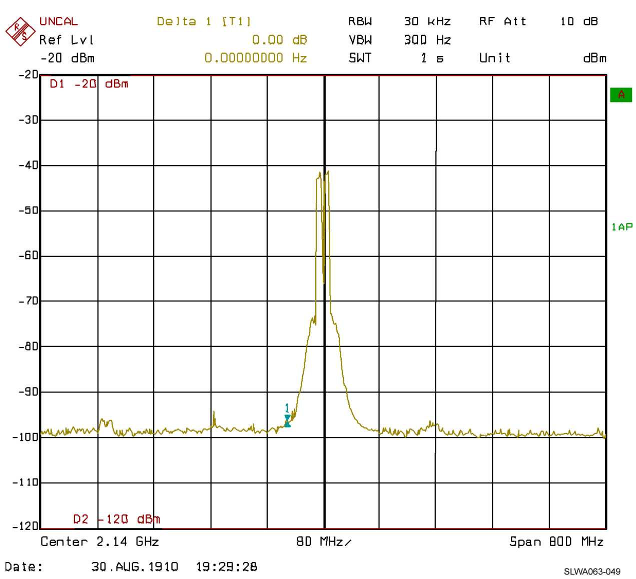


Figure 50. No In-Band Leakage From Feedback

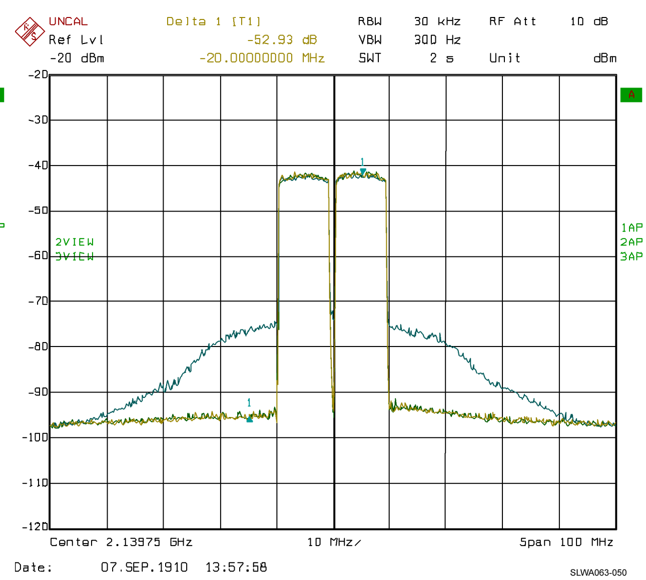


Figure 51. Pre/Post DPD Correction without In-Band Leakage

To avoid the impact of the sideband image for in-band leakage testing, the sideband image was corrected down to the noise floor, as shown in Figure 50. Figure 51 shows the pre/post DPD without in-band leakage.

4.2.2 No Phase Offset From In-Band Leakage

4.2.2.1 DPD Performance with –20 dBc of In-Band Leakage From Feedback Switch

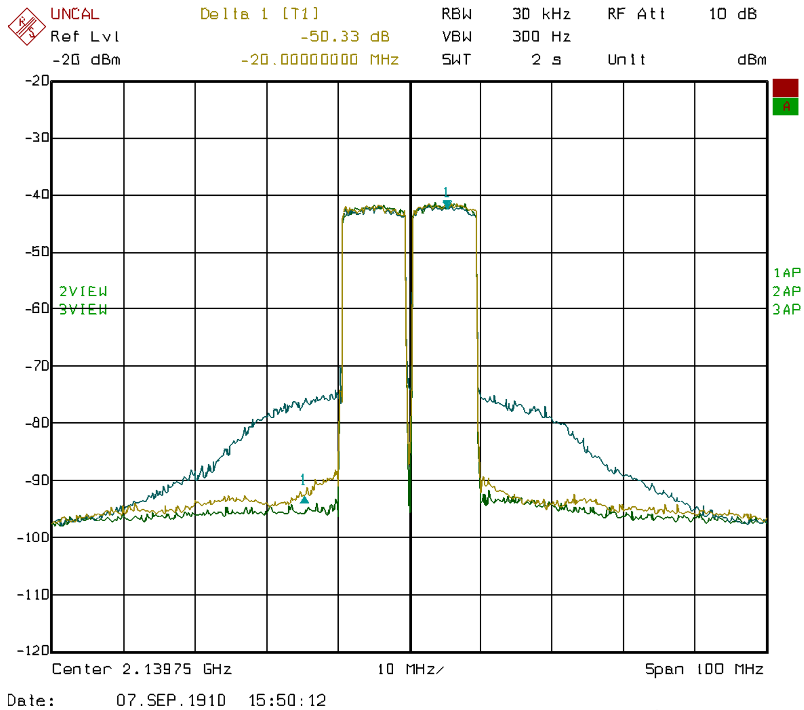


Figure 52. DPD Performance with –20 dBc of In-Band Leakage

The DPD performance is degraded by several dB due to bad isolation of the feedback switch, but it is better compared to the adjacent leakage. The in-band leakage is hidden in the in-band carrier, so it can not be observed.

4.2.2.2 DPD Performance with –30 dBc of Feedback Leakage

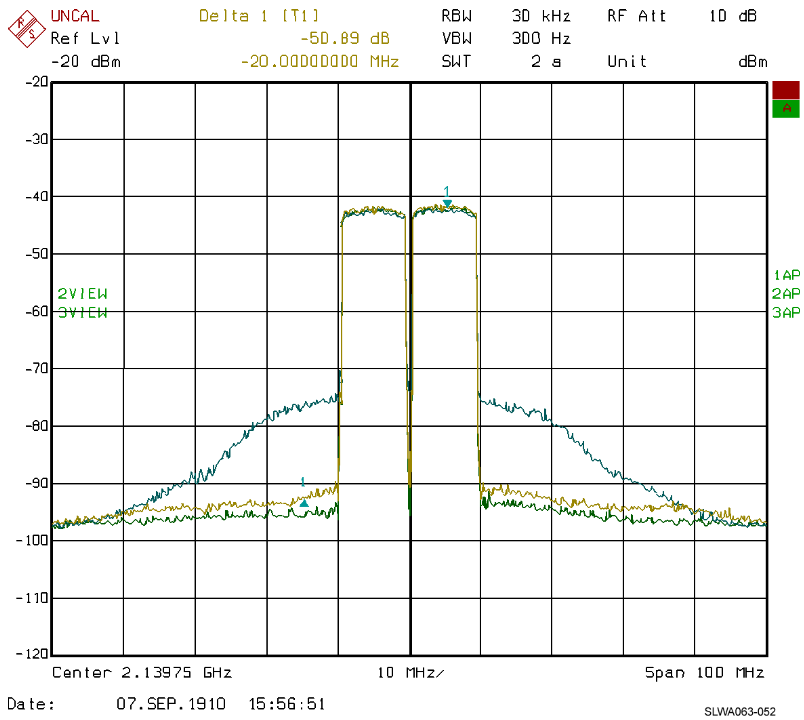


Figure 53. DPD Performance with –30 dBc of In-Band Leakage

The DPD performance is degraded by a couple of dB due to bad isolation of the feedback switch. But it is better compared to the adjacent leakage.

4.2.2.3 DPD Performance with –40 dBc of Feedback Leakage

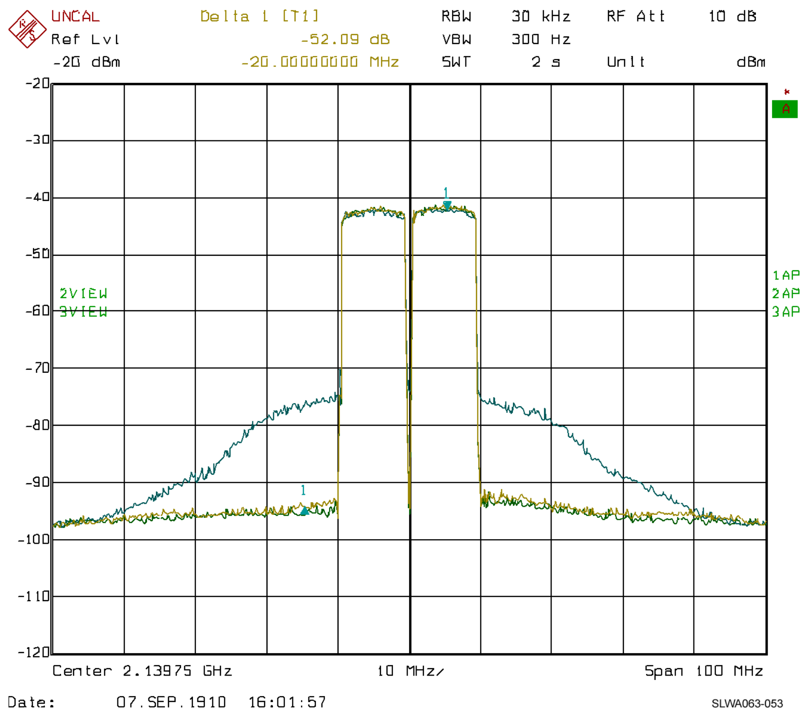


Figure 54. DPD Performance with –40 dBc of In-Band Leakage

The DPD performance shows a small amount of degradation at –40 dBc of in-band leakage compared to the performance without in-band leakage.

4.2.2.4 DPD Performance with –43 dBc of Feedback Leakage

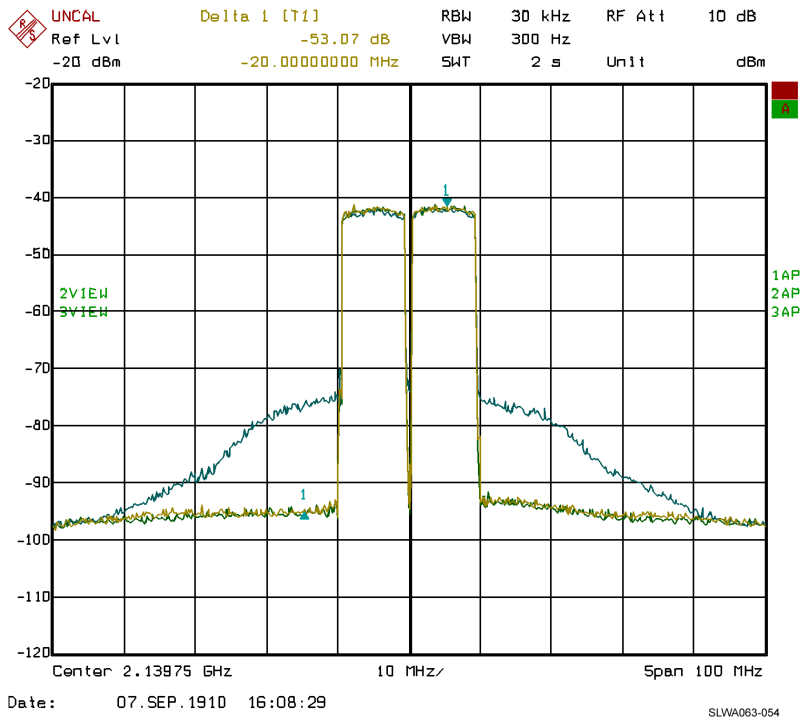


Figure 55. DPD Performance with –43 dBc of In-Band Leakage

The DPD performance does not show any difference compared to the performance without in-band leakage.

4.2.3 90-Degree Phase Offset From In-Band Leakage Carrier

The phase of the in-band leakage was set by 90 degrees of phase deviation from the main carrier to see any impact of phase offset on DPD performance

4.2.3.1 DPD Performance with –20 dBc of Feedback Leakage

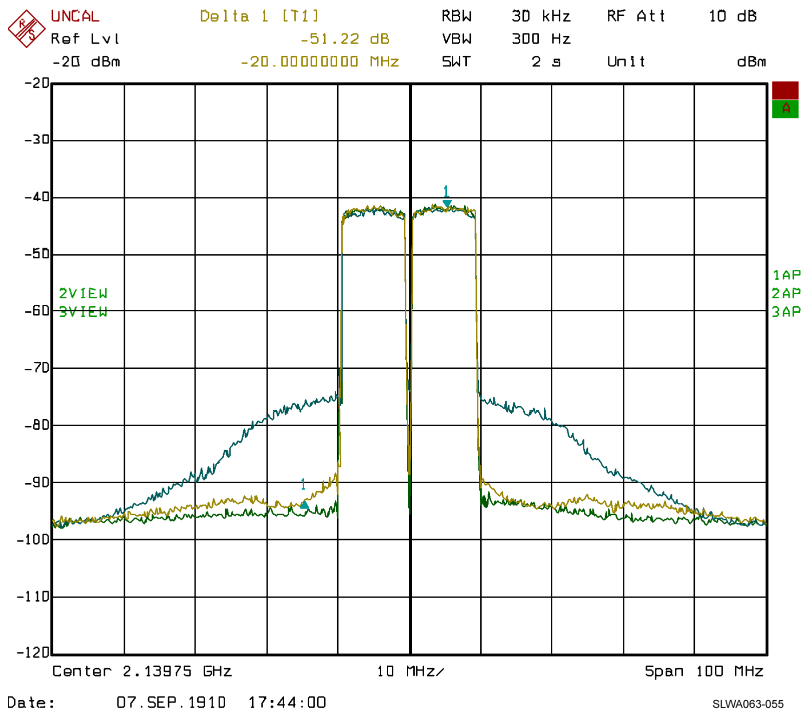


Figure 56. DPD Performance with –20 dBc of In-Band Leakage (90 Degrees of Phase Offset)

The DPD performance is degraded by several dB due to bad isolation of the feedback switch. The performance looks very similar to the nonphase offset test at the same leakage level. The in-band leakage is also hidden in the in-band carrier, so it cannot be observed.

4.2.3.2 DPD Performance with –30 dBc of Feedback Leakage

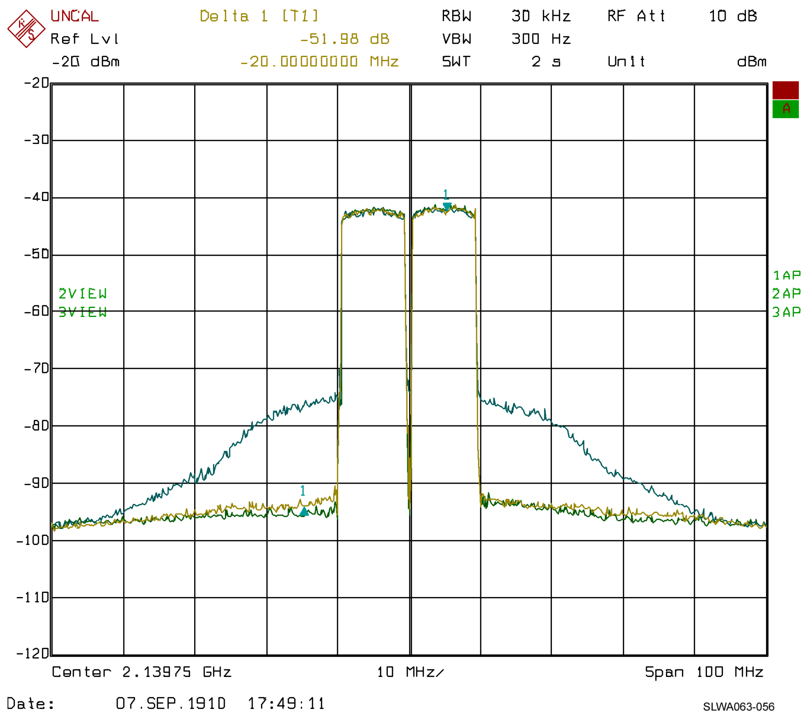


Figure 57. DPD Performance with –30 dBc of In-Band Leakage (90 Degrees of Phase Offset)

The DPD performance is degraded by 1–2 dB due to bad isolation of the feedback switch. The performance looks very similar to the nonphase offset test at the same leakage level.

4.2.3.3 DPD Performance with –40 dBc of Feedback Leakage

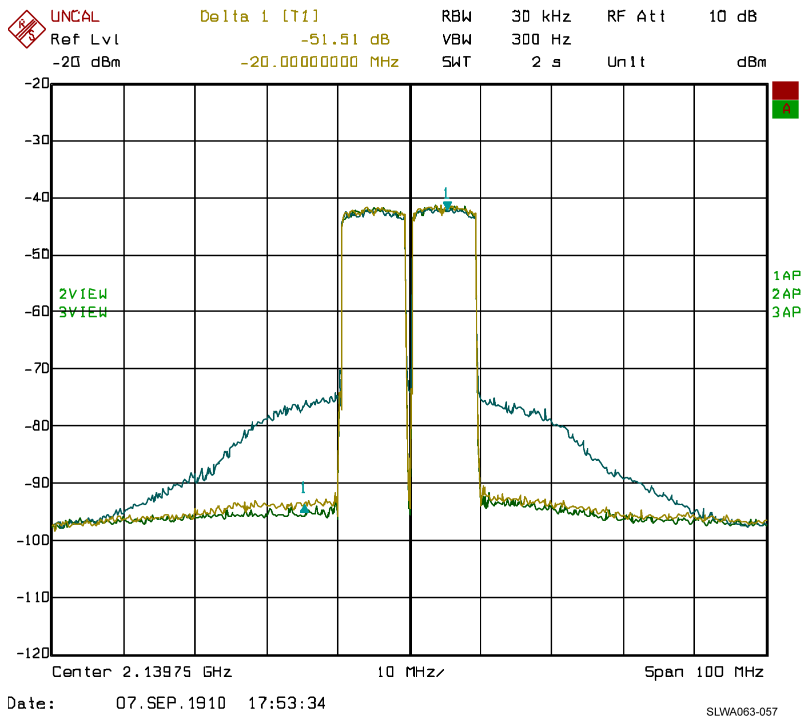


Figure 58. DPD Performance with –40 dBc of In-Band Leakage (90 Degrees of Phase Offset)

The DPD performance shows a small amount of degradation at –40 dBc of in-band leakage compared to the performance without in-band leakage.

4.2.3.4 DPD Performance with –43 dBc of Feedback Leakage

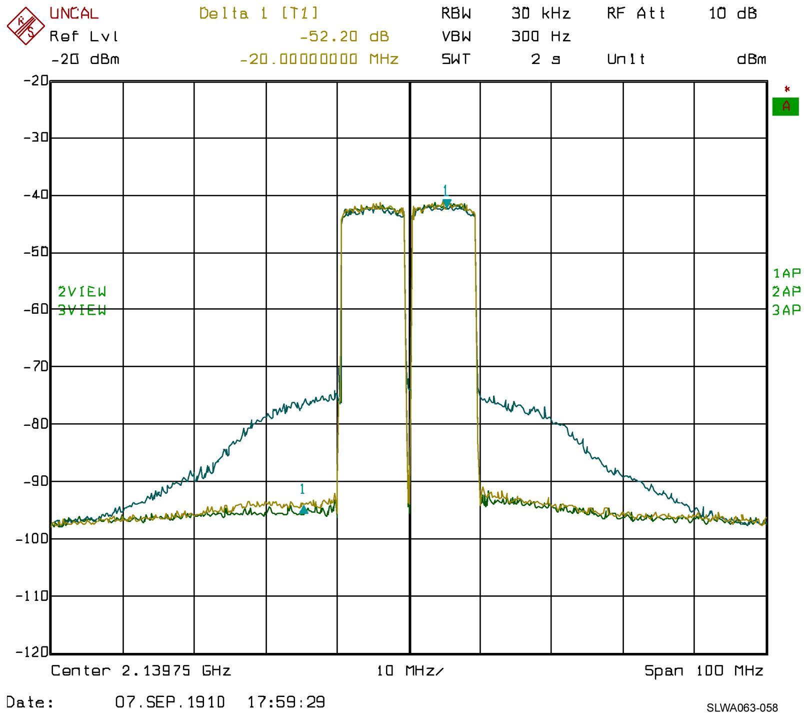


Figure 59. DPD Performance with –43 dBc of In-Band Leakage (90 Degrees of Phase Offset)

The DPD performance does not show any difference compared to the performance without in-band leakage.

4.3 Summary

DPD performance starts degrading at –40 dBc of in-band leakage from the feedback switch at the maximum output power of the PA. Approximately –43 dBc of feedback isolation is required to avoid degrading the DPD performance. A phase offset of in-band leakage signal shows no difference from the leakage signal without phase offset. The sideband image and DC offset was corrected by adjusting the QMC block of the DAC manually to avoid the effect of sideband image and DC offset.

Table 3. Correlated Leakge Level versus DPD Performance

Correlated Leakage Level	–20 dBc	–30 dBc	–40 dBc	–43 dBc
DPD performance (1)(2)(3)	X	X	Δ	O

(1) X: More than 2–3 dB degraded DPD performance from correlated leakage
(2) Δ: Less than 1–2 dB degraded DPD performance from correlated leakage
(3) O: No degradation from the standard DPD performance

5 Summary

DPD performance shows difference under various test conditions such as sideband image level and adjacent and correlated leakage level into feedback path from GC5330SEK. Without a properly designed analog filter, –40 dBc of sideband suppression from the main carrier should be achieved to get the optimum result of DPD correction at the maximum output power of power amplifier. Otherwise, the DPD performance starts degrading from –39 dBc by 1–2 dB of correction and gets worse as the sideband image level increases. Regarding adjacent and correlated leakage into feedback path, the isolation between the transmit and feedback paths should be at least –45 dBc and –43 dBc, respectively, to get the optimum DPD performances. Otherwise, DPD performance degrades as leakage level increases.

Table 4. Sideband and Leakge Level versus DPD Performance

Sideband and Leakage Level[(1)(2)(3)]	–20 dBc	–25 dBc	–30 dBc	–35 dBc	–39 dBc	–40 dBc	–43 dBc	–45 dBc
DPD performance vs Sideband Image	X	X	X	Δ	Δ	O	O	O
DPD performance vs Adjacent Leakage	X	X	X	X	X	Δ	Δ	O
DPD performance vs Correlated Leakage	X	X	X	X	X	Δ	O	O

(1) X: More than 2–3 dB degraded DPD performance from correlated leakage
(2) Δ: Less than 1–2 dB degraded DPD performance from correlated leakage
(3) O: No degradation from the standard DPD performance