Integrated, Quad RF Transceiver with Observation Path

Data Sheet

ADRV9029

FEATURES

4 differential transmitters
4 differential receivers
2 observation receivers with 2 inputs each
Center frequency: 75 MHz to 6000 MHz
Fully integrated DPD adaptation engine for power amplifier linearization
Crest factor reduction engine
Maximum receiver bandwidth: 200 MHz
Maximum transmitter large signal bandwidth: 200 MHz
Maximum transmitter synthesis bandwidth: 450 MHz
Maximum observation receiver bandwidth: 450 MHz
Fully integrated independent fractional-N radio frequency synthesizers
Fully integrated clock synthesizer
Multichip phase synchronization for all local oscillators and baseband clocks
Support for TDD and FDD applications
24.33 Gbps JESD204B/JESD204C digital interface

APPLICATIONS

3G/4G/5G TDD and FDD massive MIMO, macro and small cell base stations

GENERAL DESCRIPTION

The ADRV9029 is a highly integrated, radio frequency (RF) agile transceiver offering four independently controlled transmitters, dedicated observation receiver inputs for monitoring each transmitter channel, four independently controlled receivers, integrated synthesizers, and digital signal processing functions providing a complete transceiver solution. The device provides the performance demanded by cellular infrastructure applications, such as small cell base station radios, macro 3G/4G/5G systems, and massive multiple in/multiple out (MIMO) base stations.

The receiver subsystem consists of four independent, wide bandwidth, direct conversion receivers with wide dynamic range. The four independent transmitters use a direct conversion modulator resulting in low noise operation with low power consumption. The device also includes two wide bandwidth, time shared, observation path receivers with two inputs each for monitoring transmitter outputs.

The complete transceiver subsystem includes automatic and manual attenuation control, dc offset correction, quadrature error correction (QEC), and digital filtering, eliminating the need for these functions in the digital baseband. Other auxiliary functions such as analog-to-digital converters (ADCs), digital-to-analog converters (DACs), and general-purpose input/outputs (GPIOs) that provide an array of digital control options are also integrated.

To achieve a high level of RF performance, the transceiver includes five fully integrated phase-locked loops (PLLs). Two PLLs provide low noise and low power fractional-N RF synthesis for the transmitter and receiver signal paths. A third fully integrated PLL supports an independent local oscillator (LO) mode for the observation receiver. The fourth PLL generates the clocks needed for the converters and digital circuits, and a fifth PLL provides the clock for the serial data interface.

A multichip synchronization mechanism synchronizes the phase of all LOs and baseband clocks between multiple ADRV9029 chips. All voltage controlled oscillators (VCOs) and loop filter components are integrated and adjustable through the digital control interface.

This device contains a fully integrated, low power digital predistortion (DPD) adaptation engine for use in power amplifier linearization. DPD enables use of high efficiency power amplifiers, reducing the power consumption of base station radios while also reducing the number of SERDES lanes necessary to interface with baseband processors.

The low power crest factor reduction (CFR) engine of the ADRV9029 reduces the peak to average ratio (PAR) of the input signal, enabling higher efficiency transmit line ups while reducing the processing load on baseband processors.

The serial data interface consists of four serializer lanes and four deserializer lanes. The interface supports both the JESD204B and JESD204C standards, operating at data rates up to 24.33 Gbps. The interface also supports interleaved mode for lower bandwidths, thus reducing the number of high speed data interface lanes to one. Both fixed and floating-point data formats are supported. The floating-point format allows internal automatic gain control (AGC) to be invisible to the demodulator device.

The ADRV9029 is powered directly from 1.0 V, 1.3 V, and 1.8 V regulators and is controlled via a standard serial peripheral interface (SPI) serial port. Comprehensive power-down modes are included to minimize power consumption in normal use. The ADRV9029 is packaged in a 14 mm × 14 mm, 289-ball chip scale ball grid array (CSP_BGA).

Rev. 0 Document Feedback

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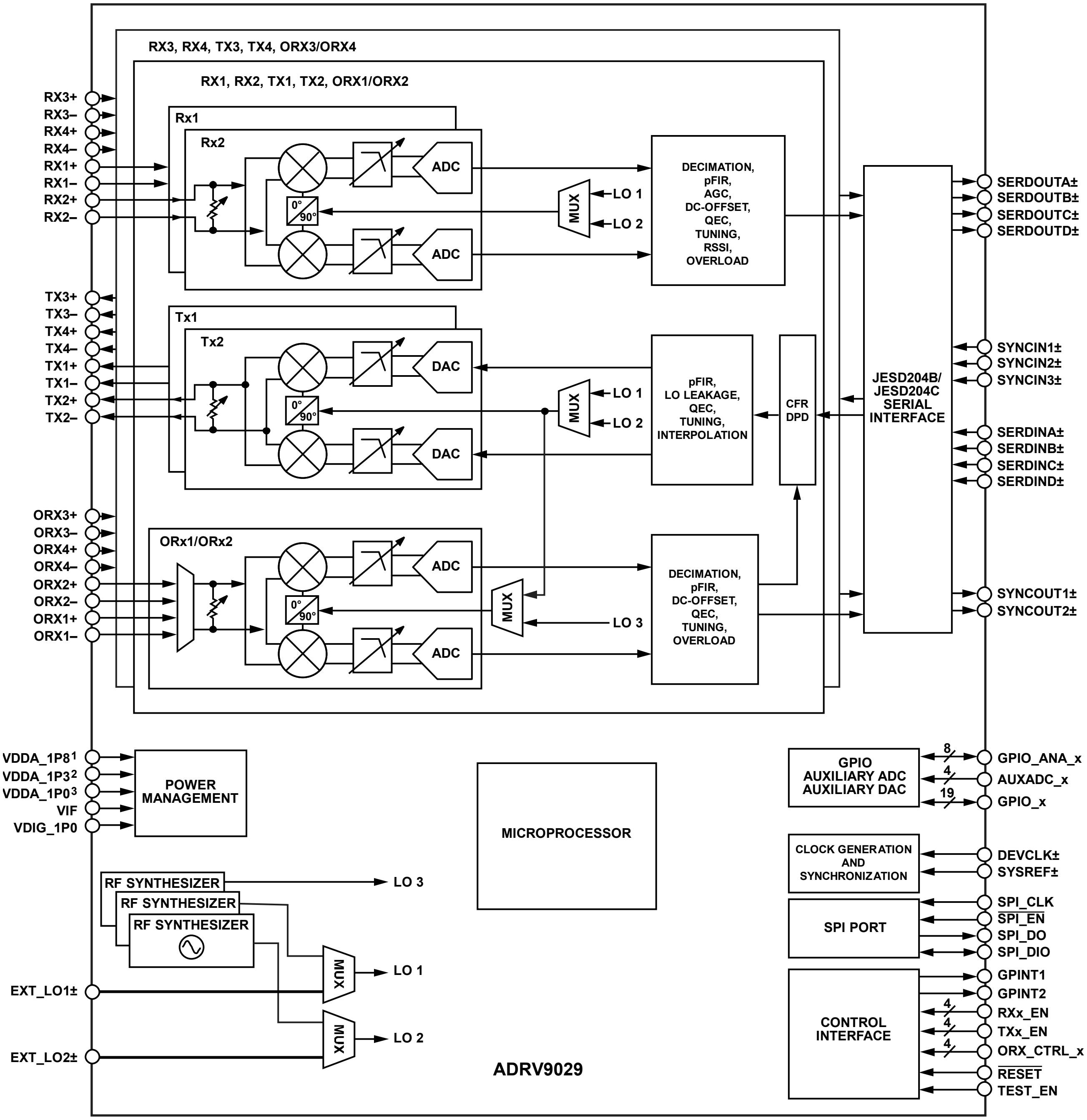
REVISION HISTORY

12/2020—Revision 0: Initial Version

FUNCTIONAL BLOCK DIAGRAM



[1]VDDA_1P8 REPRESENTS VCONV1_1P8, VCONV2_1P8, VANA1_1P8, VANA2_1P8, VANA3_1P8, VANA4_1P8, AND VJVCO_1P8.
[2]VDDA_1P3 REPRESENTS VANA1_1P3, VANA2_1P3, VCONV1_1P3, VCONV2_1P3, VRFVCO1_1P3, VRFVCO2_1P3, VAUXVCO_1P3, VCLKVCO_1P3, VRFSYN1_1P3, VRFSYN2_1P3, VCLKSYN_1P3, VAUXSYN_1P3, VRXLO_1P3, AND VTXLO_1P3.
[3]VDDA_1P0 REPRESENTS VJSYN_1P0, VDES_1P0, VTT_DES, AND VSER_1P0.

Figure 1.

SPECIFICATIONS

Electrical characteristics at ambient temperature range. Power supplies are as follows: VDDA_1P8 = 1.8 V, VIF = 1.8 V, VDDA_1P3 = 1.3 V, VDDA_1P0 = 1.0 V, and VDIG_1P0 = 1.0 V. VDDA_1P8 represents VCONV1_1P8, VCONV2_1P8, VANA1_1P8, VANA2_1P8, VANA3_1P8, VANA4_1P8, and VJVCO_1P8. VDDA_1P3 represents VANA1_1P3, VANA2_1P3, VCONV1_1P3, VCONV2_1P3, VRFVCO1_1P3, VRFVCO2_1P3, VAUXVCO_1P3, VCLKVCO_1P3, VRFSYN1_1P3, VRFSYN2_1P3, VCLKSYN_1P3, VAUXSYN_1P3, VRXLO_1P3, and VTXLO_1P3. VDDA_1P0 represents VJSYN_1P0, VDES_1P0, VTT_DES, and VSER_1P0. All RF specifications are based on measurements that include printed circuit board (PCB) and matching circuit losses, unless otherwise noted.

Device configuration profile: Receiver = 200 MHz bandwidth, I/Q rate = 245.76 MHz, transmitter = 200 MHz large signal bandwidth plus 450 MHz synthesis bandwidth, I/Q rate = 491.52 MHz, observation receiver (OR_X) = 450 MHz bandwidth, I/Q rate = 491.52 MHz, device clock = 245.76 MHz, unless otherwise noted. Characterization at 75 MHz followed this profile: Receiver = 62.5 MHz bandwidth, I/Q rate = 76.8 MHz, transmitter = 62.5 MHz large signal bandwidth plus 141 MHz synthesis bandwidth, I/Q rate = 153.6 MHz, observation receiver = 141 MHz bandwidth, I/Q rate = 153.6 MHz, device clock = 153.6 MHz.

Note: if signals are placed outside of the primary bandwidth, degradation in linearity, image rejection, and flatness may be observed.

TRANSMITTERS AND RECEIVERS

Table 1.

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions/Comments
TRANSMITTERS	Tx					
Center Frequency		75		6000	MHz	
Tx Synthesis Bandwidth				450	MHz	
Tx Large Signal Bandwidth				200	MHz	Zero intermediate frequency (IF) mode
Peak-to-Peak Gain Deviation			1.0		dB	450 MHz bandwidth, includes compensation by programmable finite impulse response (FIR) filter
			0.1		dB	Any 20 MHz bandwidth span, includes compensation by programmable FIR filter (pFIR)
Deviation from Linear Phase			1		Degrees	450 MHz bandwidth
Maximum Output Power						0 dBFS, 1 MHz signal input, 50 Ω load, 0 dB transmitter attenuation
75 MHz			7.0		dBm	
800 MHz			6.7		dBm	
1800 MHz			6.6		dBm	
2600 MHz			6.3		dBm	
3800 MHz			6.4		dBm	
4800 MHz			6.1		dBm	
5700 MHz			6.4		dBm	
Power Control Range			32		dB	
Power Control Resolution			0.05		dB	
Attenuation Accuracy						
Integral Nonlinearity (Gain)	INL		0.1		dB	Valid over full power control range for any 4 dB step
Differential Nonlinearity (Gain)	DNL		±0.04		dB	Monotonic
Output Power Temperature Slope			−4.5		mdB/°C	Valid over full power control range
LO Delay Temperature Slope			1.05		ps/°C	Valid over full power control range
Adjacent Channel Leakage Power Ratio (ACLR) Long Term Evolution (LTE)						20 MHz LTE at −12 dBFS
75 MHz			−64		dB	
800 MHz			−68		dB	
1800 MHz			−67		dB	
2600 MHz			−66		dB	
3800 MHz			−65		dB	
4800 MHz			−65		dB	
5700 MHz			−65		dB	

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions/Comments
In Band Noise Floor			−154.5		dBFS/Hz	0 dB attenuation; in band noise falls 1 dB for each decibel of attenuation for attenuation settings between 0 dB and 20 dB
Interpolation Images			−76		dBc	
Tx to Tx Isolation: All Tx Output Effects on All Other Tx Outputs						
800 MHz			78		dB	
1800MHz			77		dB	
2600 MHz			77		dB	
3800 MHz			71		dB	
4800 MHz			70		dB	
5700 MHz			65		dB	
Image Rejection						
Within 200 MHz Large Signal Bandwidth						QEC active up to 20 dB of attenuation, continuous wave tone swept across the large signal bandwidth
75 MHz			80		dB	
800 MHz			76		dB	
1800 MHz			75		dB	
2600 MHz			73		dB	
3800 MHz			65		dB	
4800 MHz			64		dB	
5700 MHz			61		dB	
Beyond Large Signal Bandwidth						Assumes that distortion power density is 25 dB below desired power density
800 MHz			40		dB	
1800 MHz			38		dB	
2600 MHz			34		dB	
3800 MHz			37		dB	
4800 MHz			37		dB	
5700 MHz			37		dB	
Output Impedance	Z_{OUT}		50		Ω	Differential—nominal
Maximum Output Load Voltage Standing Wave Ratio	VSWR			3		Maximum value to ensure adequate calibration
Output Return Loss			10		dB	
Output Third-Order Intercept Point	OIP3					0 dB transmitter attenuation
75 MHz			30		dBm	
800 MHz			29		dBm	
1800 MHz			29		dBm	
2600 MHz			28		dBm	
3800 MHz			26.5		dBm	
4800 MHz			29		dBm	
5700 MHz			27		dBm	
Carrier Leakage						With LO leakage correction active, 0 dB transmitter attenuation, scales decibel for decibel with attenuation
Carrier Offset from LO						
75 MHz LO			−84		dBFS/MHz	
800 MHz LO			−84		dBFS/MHz	
1800 MHz LO			−84		dBFS/MHz	
2600 MHz LO			−83		dBFS/MHz	
3800 MHz LO			−84		dBFS/MHz	
4800 MHz LO			−84		dBFS/MHz	
5700 MHz LO			−83		dBFS/MHz	

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions/Comments
Carrier on the LO			−71		dBFS/MHz	Measured using an LTE 20 MHz signal
Error Vector Magnitude	EVM					PLL optimized for narrow-band noise, measured using LTE 20 MHz signal
75 MHz LO			0.25		%	50 kHz PLL bandwidth
800 MHz LO			0.38		%	50 kHz PLL bandwidth
1800 MHz LO			0.60		%	50 kHz PLL bandwidth
2600 MHz LO			0.44		%	500 kHz PLL bandwidth
3800 MHz LO			0.53		%	200 kHz PLL bandwidth
4800 MHz LO			0.63		%	400 kHz PLL bandwidth
5700 MHz LO			0.84		%	500 kHz PLL bandwidth
Transmitter Time Division Duplex	TDD					
Time from $\overline{\text{SPI\_EN}}$ Going High to Change in Tx Attenuation	t_{SCH}		12		ns	
Time Between Consecutive Microattenuation Steps	t_{ACH}		20		ns	A large change in attenuation can be segmented into a series of smaller attenuation changes
Attenuation Overshoot During Transition			0.1		dB	
Change in Attenuation per Microstep			0.1		dB	
RECEIVERS	Rx					
Center Frequency		75		6000	MHz	
Gain Range			30		dB	
Attenuation Accuracy						
Analog Gain Step			0.5		dB	Attenuator steps from 0 dB to 6 dB
			1		dB	Attenuator steps from 6 dB to 30 dB
Residual Gain Step Error			0.1		dB	
Gain Temperature Slope			−6.4		mdB/°C	
Internal LO Delay Temperature Slope			1.0		ps/°C	
Frequency Response						
Peak-to-Peak Gain Deviation			1		dB	200 MHz bandwidth, includes compensation by programmable FIR filter
			0.2		dB	Any 20 MHz span, includes compensation by programmable FIR filter
Rx Bandwidth				200	MHz	Zero IF mode
Rx Alias Band Rejection		80			dB	Due to digital filters
Maximum Useable Input Level	P_{HIGH}					This continuous wave signal level corresponds to the input power that produces −2 dBFS at the digital output with 0 dB channel attenuation
75 MHz			−11.7		dBm	
800 MHz			−12.4		dBm	
1800 MHz			−12.7		dBm	
2600 MHz			−11.9		dBm	
3800 MHz			−11.0		dBm	
4800 MHz			−12.0		dBm	
5700 MHz			−11.1		dBm	
Maximum Source VSWR				3		
Input Impedance	Z_{IN}		100		Ω	Differential
Input Port/Return Loss			10		dB	Unmatched differential port return loss

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions/Comments
Noise Figure	NF					0 dB receiver attenuation, measured at single-ended input, matching circuit included
75 MHz			12		dB	
800 MHz			11		dB	
1800 MHz			11.5		dB	
2600 MHz			11.9		dB	
3800 MHz			12.8		dB	
4800 MHz			13.3		dB	
5700 MHz			14.5		dB	
Noise Figure Ripple			1.5		dB	At band edge
Second-Order Input Intermodulation Intercept Point	IIP2					0 dB attenuation, complex
75 MHz			70		dBm	
800 MHz			65		dBm	
1800 MHz			65		dBm	
2600 MHz			65		dBm	
3800 MHz			62		dBm	
4800 MHz			62		dBm	
5700 MHz			58		dBm	
Wideband Third-Order Input Intermodulation Intercept Point, Difference Product	$IIP3_{WB\_DIFF}$					Two tones near the band edge, test condition: P_{HIGH} − 9 dB/tone
75 MHz			14		dBm	
800 MHz			15		dBm	
1800 MHz			17		dBm	
2600 MHz			17		dBm	
3800 MHz			17		dBm	
4800 MHz			17		dBm	
5700 MHz			18		dBm	
Midband Third-Order Input Intermodulation Intercept Point, Difference Product	$IIP3_{MB\_DIFF}$					Two tones near the middle of the band; test condition: P_{HIGH} − 9 dB/tone
75 MHz			20		dBm	
800 MHz			18		dBm	
1800 MHz			22		dBm	
2600 MHz			21		dBm	
3800 MHz			22		dBm	
4800 MHz			22		dBm	
5700 MHz			20		dBm	
Wideband Third-Order Input Intermodulation Intercept Point, Sum Product	$IIP3_{WB\_SUM}$					Two tones approximately bandwidth ÷ 6 offset from the LO; test condition: P_{HIGH} − 9 dB/tone
75 MHz			15		dBm	
800 MHz			17		dBm	
1800 MHz			17		dBm	
2600 MHz			20		dBm	
3800 MHz			23		dBm	
4800 MHz			23		dBm	
5700 MHz			20		dBm	
Second-Order Harmonic Distortion						
Maximum Input	$HD2_{MAX}$		−72		dBc	P_{HIGH} continuous wave signal, harmonic distortion tones falling within 100 MHz of the LO
Recommended Input	HD2		−75		dBc	P_{HIGH} − 3 dB continuous wave signal, harmonic distortion tones falling within 100 MHz of the LO

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions/Comments
Third-Order Harmonic Distortion						
Maximum Input	$HD3_{MAX}$		−66		dBc	P_{HIGH} continuous wave signal, harmonic distortion tones falling within 100 MHz of the LO
Recommended Input	HD3		−72		dBc	P_{HIGH} − 3 dB continuous wave signal, harmonic distortion tones falling within 100 MHz of the LO
Fourth-Order Harmonic Distortion						
Maximum Input	$HD4_{MAX}$		−90		dBc	P_{HIGH} continuous wave signal, harmonic distortion tones falling within 100 MHz of the LO
Recommended Input	HD4		−90		dBc	P_{HIGH} − 3 dB continous wave signal, harmonic distortion tones falling within 100 MHz of the LO
Fifth-Order Harmonic Distortion						
Maximum Input	$HD5_{MAX}$		−87		dBc	P_{HIGH} continuous wave signal, harmonic distortion tones falling within 100 MHz of the LO
Recommended Input	HD5		−90		dBc	P_{HIGH} − 3 dB continuous wave signal, harmonic distortion tones falling within 100 MHz of the LO
Image Rejection			75		dB	QEC active, within 200 MHz receiver bandwidth
Rx to Rx Signal Isolation						
75 MHz			80		dB	
800 MHz			75		dB	
1800 MHz			70		dB	
2600 MHz			70		dB	
3800 MHz			65		dB	
4800 MHz			62		dB	
5700 MHz			60		dB	
Rx Band Spurs Referenced to RF Input at Maximum Gain			−95		dBm	No more than one spur at this level per 10 MHz of receiver bandwidth; excludes harmonics of the reference clock
Spurious-Free Dynamic Range	SFDR		81		dBc	P_{HIGH} continuous wave signal anywhere inside the band ±20 MHz, excludes harmonic distortion products
Rx Input LO Leakage at Maximum Gain						Leakage decreased decibel for decibel with attenuation for first 12 decibels
75 MHz			−68		dBm	
800 MHz			−68		dBm	
1800 MHz			−68		dBm	
2600 MHz			−65		dBm	
3800 MHz			−65		dBm	
4800 MHz			−58		dBm	
5700 MHz			−54		dBm	
Tx to Rx Signal Isolation: All Tx Output Effects on all Rx Inputs						
75 MHz			80		dB	
800 MHz			80		dB	
1800 MHz			75		dB	
2600 MHz			75		dB	
3800 MHz			65		dB	
4800 MHz			65		dB	
5700 MHz			65		dB	
OBSERVATION RECEIVERS	ORx					
Center Frequency		75		6000	MHz	
Gain Range			30		dB	
Attenuation Accuracy						
Analog Gain Step			0.5		dB	Attenuator steps from 0 dB to 6 dB
			1		dB	Attenuator steps from 6 dB to 30 dB

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions/Comments
Peak-to-Peak Gain Deviation			1		dB	450 MHz RF bandwidth, compensation by programmable FIR filter
			0.1		dB	Any 20 MHz bandwidth span, compensation by programmable FIR filter
Deviation from Linear Phase			1		Degrees	450 MHz RF bandwidth
ORx Bandwidth				450	MHz	
ORx Alias Band Rejection		60			dB	Due to digital filters
Maximum Useable Input Level	P_{HIGH}					This continuous wave signal level corresponds to the input power that produces −2 dBFS at the digital output with 0 dB channel attenuation
75 MHz			−11.4		dBm	
800 MHz			−12.7		dBm	
1800 MHz			−11.5		dBm	
2600 MHz			−10.6		dBm	
3800 MHz			−12.0		dBm	
4800 MHz			−11.3		dBm	
5700 MHz			−9.5		dBm	
Input Impedance	Z_{IN}		100		Ω	Differential
Input Source VSWR				3		
Input Port Return Loss			10		dB	Unmatched differential port return loss
Integrated Noise						
450 MHz Bandwidth			−58.5		dBFS	Sample rate at maximum value integrated from 500 kHz to 225 MHz, no input signal
491.52 MHz Bandwidth (Nyquist)			−57.5		dBFS	Sample rate at maximum value integrated from 500 kHz to 245.76 MHz, no input signal
Second-Order Input Intermodulation Intercept Point	IIP2					Maximum observation receiver gain; test condition: P_{HIGH} − 11 dB/tone
75 MHz			55		dBm	
800 MHz			55		dBm	
1800 MHz			53		dBm	
2600 MHz			55		dBm	
3800 MHz			48		dBm	
4800 MHz			45		dBm	
5700 MHz			55		dBm	
Third-Order Input Intermodulation Intercept Point	IIP3					Maximum observation receiver gain; test condition: P_{HIGH} − 11 dB/tone
Narrow Band	$IIP3_{NB}$					IM3 product < 130 MHz at baseband; test condition: P_{HIGH} − 11 dB/tone, 491.52 MSPS
75 MHz			11		dBm	
800 MHz			13.6		dBm	
1800 MHz			15		dBm	
2600 MHz			16.5		dBm	
3800 MHz			18		dBm	
4800 MHz			18		dBm	
5700 MHz			18		dBm	
Wide Band	$IIP3_{WB}$					IM3 products > 130 MHz at baseband; test condition: P_{HIGH} −11 dB/tone, 491.52 MSPS
800 MHz			7.8		dBm	
1800 MHz			13		dBm	
2600 MHz			11		dBm	
3800 MHz			13		dBm	
4800 MHz			13		dBm	
5700 MHz			14		dBm	

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions/Comments
Third-Order Intermodulation Product	IM3					
Narrow Band	$IM3_{NB}$					IM3 product < 130 MHz at baseband; test condition: two tones, each at P_{HIGH} − 11 dB, 491.52 MSPS
800 MHz			−74		dBc	
1800 MHz			−79		dBc	
2600 MHz			−78.6		dBc	
3800 MHz			−80.4		dBc	
4800 MHz			−79.8		dBc	
5700 MHz			−76		dBc	
Wide Band	$IM3_{WB}$					IM3 product > 130 MHz at baseband; test condition: two tones, each at P_{HIGH} − 11 dB, 491.52 MSPS
800 MHz			−62.4		dBc	
1800 MHz			−70		dBc	
2600 MHz			−67.6		dBc	
3800 MHz			−70.4		dBc	
4800 MHz			−69.8		dBc	
5700 MHz			−66		dBc	
Fifth-Order Intermodulation Product	IM5					
Narrow Band	$IM5_{NB}$					IM5 product < 130 MHz at baseband; test condition: two tones, each at P_{HIGH} − 11 dB, 491.52 MSPS
800 MHz			−83		dBc	
1800 MHz			−87		dBc	
2600 MHz			−84		dBc	
3800 MHz			−80		dBc	
4800 MHz			−78		dBc	
5700 MHz			−81		dBc	
Wide Band	$IM5_{WB}$					IM5 product > 130 MHz at baseband; test condition:two tones, each at P_{HIGH} − 11 dB, 491.52 MSPS
800 MHz			−83		dBc	
1800 MHz			−96		dBc	
2600 MHz			−85		dBc	
3800 MHz			−80		dBc	
4800 MHz			−77		dBc	
5700 MHz			−85		dBc	
Seventh-Order Intermodulation Product	IM7					
Narrow Band	$IM7_{NB}$					IM7 product < 130 MHz at baseband; test condition: two tones, each at P_{HIGH} − 11 dB, 491.52 MSPS
800 MHz			−74		dBc	
1800 MHz			−78		dBc	
2600 MHz			−75		dBc	
3800 MHz			−73		dBc	
4800 MHz			−78		dBc	
5700 MHz			−75		dBc	

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions/Comments
Wide Band	$IM7_{WB}$					IM7 product > 130 MHz at baseband; test condition: two tones, each at P_{HIGH} − 11 dB, 491.52 MSPS
800 MHz			−83		dBc	
1800 MHz			−82		dBc	
2600 MHz			−83		dBc	
3800 MHz			−83		dBc	
4800 MHz			−85		dBc	
5700 MHz			−81		dBc	
Spurious-Free Dynamic Range	SFDR		64		dB	Nonintermodulation related spurs; does not include harmonic distortion; input set at P_{HIGH} − 8 dB
Second-Order Harmonic Distortion	HD2					Input set at P_{HIGH} − 8 dB
In Band			−80		dBc	In-band harmonic distortion falls within ±100 MHz
Out of Band			−73		dBc	Out of band harmonic distortion falls within ±225 MHz
Third-Order Harmonic Distortion	HD3					Input set at P_{HIGH} − 8 dB
In Band			−70		dBc	Harmonic distortion falls within ±100 MHz
Out of Band			−65		dBc	Harmonic distortion falls within ±225 MHz
Image Rejection			75		dB	After online tone calibration, QEC active
Tx to ORx Signal Isolation: All Tx Output Effects on all ORx Inputs			75		dB	

SYNTHESIZERS, AUXILIARY CONVERTERS, AND CLOCK REFERENCES

Table 2.

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions/Comments
LO1 and LO2 SYNTHESIZER	LO1, LO2					
Frequency Step			7.3		Hz	1.6 GHz to 3.2 GHz, 245.76 MHz phase frequency detector (PFD) frequency
Spectral Purity			−80		dBc	
Integrated Phase Noise						Integrated from 1 kHz to 100 MHz
Narrow Bandwidth Optimized						PLL bandwidth optimized to minimize phase noise at offsets > 200 kHz
800 MHz			0.12		°rms	
1800 MHz			0.27		°rms	
2600 MHz			0.66		°rms	
3800 MHz			0.53		°rms	
4800 MHz			0.91		°rms	
5700 MHz			1.57		°rms	
Wide Bandwidth Optimized						PLL bandwidth optimized for integrated phase noise and phase noise at offsets > 1 MHz and phase noise at offsets > 1 MHz
800 MHz			0.07		°rms	
1800 MHz			0.11		°rms	
2600 MHz			0.17		°rms	
3800 MHz			0.26		°rms	
4800 MHz			0.30		°rms	
5700 MHz			0.42		°rms	
Spot Phase Noise: Narrow Band						PLL bandwidth optimized to minimize phase noise at offsets > 200 kHz
800 MHz LO1 and LO2						
100 kHz Offset			−115		dBc/Hz	
1 MHz Offset			−141		dBc/Hz	
10 MHz Offset			−162		dBc/Hz	

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions/Comments
1800 MHz LO1 and LO2						
100 kHz Offset			−107		dBc/Hz	
200 kHz Offset			−115		dBc/Hz	
400 kHz Offset			−123		dBc/Hz	
600 kHz Offset			−128		dBc/Hz	
800 kHz Offset			−131		dBc/Hz	
1.2 MHz Offset			−136		dBc/Hz	
1.8 MHz Offset			−140		dBc/Hz	
6 MHz Offset			−151		dBc/Hz	
10 MHz Offset			−156		dBc/Hz	
2600 MHz LO1 and LO2						
100 kHz Offset			−97		dBc/Hz	
1 MHz Offset			−124		dBc/Hz	
10 MHz Offset			−150		dBc/Hz	
3800 MHz LO1 and LO2						
100 kHz Offset			−100		dBc/Hz	
1 MHz Offset			−126		dBc/Hz	
10 MHz Offset			−149		dBc/Hz	
4800 MHz LO1 and LO2						
100 kHz Offset			−94		dBc/Hz	
1 MHz Offset			−120		dBc/Hz	
10 MHz Offset			−145		dBc/Hz	
5700 MHz LO1 and LO2						
100 kHz Offset			−89		dBc/Hz	
1 MHz Offset			−115		dBc/Hz	
10 MHz Offset			−141		dBc/Hz	
Spot Phase Noise: Wideband						PLL bandwidth optimized for integrated phase noise and phase noise at offsets > 1 MHz
800 MHz LO1 and LO2						
100 kHz Offset			−114		dBc/Hz	
1 MHz Offset			−141		dBc/Hz	
10 MHz Offset			−162		dBc/Hz	
1800 MHz LO1 and LO2						
100 kHz Offset			−112		dBc/Hz	
1 MHz Offset			−133		dBc/Hz	
10 MHz Offset			−156		dBc/Hz	
2600 MHz LO1 and LO2						
100 kHz Offset			−112		dBc/Hz	
1 MHz Offset			−120		dBc/Hz	
10 MHz Offset			−149		dBc/Hz	
3800 MHz LO						
100 kHz Offset			−104		dBc/Hz	
1 MHz Offset			−125		dBc/Hz	
10 MHz Offset			−149		dBc/Hz	
4800 MHz LO1 and LO2						
100 kHz Offset			−106		dBc/Hz	
1 MHz Offset			−117		dBc/Hz	
10 MHz Offset			−144		dBc/Hz	
5700 MHz LO1 and LO2						
100 kHz Offset			−104		dBc/Hz	
1 MHz Offset			−112		dBc/Hz	
10 MHz Offset			−140		dBc/Hz	

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions/Comments
AUXILIARY SYNTHESIZER	LO3					
Frequency Step			1.8		Hz	1.625 GHz to 3.25 GHz, 61.44 MHz PFD frequency
Spectral Purity			−65		dBc	$\lvert f_{RFLO} - f_{AUXLO} \rvert > 15$ MHz
Integrated Phase Noise						Integrated from 1 kHz to 100 MHz, PLL bandwidth optimized for integrated phase noise
800 MHz LO3			0.18		°rms	
1800 MHz LO3			0.22		°rms	
2600 MHz LO3			0.46		°rms	
3800 MHz LO3			0.43		°rms	
4800 MHz LO3			0.70		°rms	
5700 MHz LO3			1.12		°rms	
Spot Phase Noise						
800 MHz LO3						
100 kHz Offset			−112		dBc/Hz	
1 MHz Offset			−121		dBc/Hz	
10 MHz Offset			−141		dBc/Hz	
1800 MHz LO3						
100 kHz Offset			−110		dBc/Hz	
1 MHz Offset			−120		dBc/Hz	
10 MHz Offset			−134		dBc/Hz	
2600 MHz LO3						
100 kHz Offset			−103		dBc/Hz	
1 MHz Offset			−114		dBc/Hz	
10 MHz Offset			−132		dBc/Hz	
3800 MHz LO3						
100 kHz Offset			−104		dBc/Hz	
1 MHz Offset			−114		dBc/Hz	
10 MHz Offset			−128		dBc/Hz	
4800 MHz LO3						
100 kHz Offset			−100		dBc/Hz	
1 MHz Offset			−110		dBc/Hz	
10 MHz Offset			−127		dBc/Hz	
5700 MHz LO3						
100 kHz Offset			−95		dBc/Hz	
1 MHz Offset			−106		dBc/Hz	
10 MHz Offset			−126		dBc/Hz	
LO PHASE SYNCHRONIZATION						
Initial Phase Sync Accuracy			0.9		ps	
CLOCK SYNTHESIZER						
4915.2 MHz Sample Clock						
Integrated Phase Noise			0.69		°rms	1 kHz to 10 MHz, PLL bandwidth optimized for integrated phase noise
Spot Phase Noise						PLL bandwidth optimized for integrated phase noise
100 kHz Offset			−96		dBc/Hz	
1 MHz Offset			−113		dBc/Hz	
10 MHz Offset			−140		dBc/Hz	
3932.16 MHz Sample Clock						
Integrated Phase Noise			0.89		°rms	1 kHz to 10 MHz, PLL bandwidth optimized to minimize phase noise at offsets >200 kHz

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions/Comments
Spot Phase Noise						PLL bandwidth optimized to minimize phase noise at offsets >200 kHz
100 kHz Offset			−91		dBc/Hz	
1 MHz Offset			−120		dBc/Hz	
10 MHz Offset			−143		dBc/Hz	
REFERENCE CLOCK (DEV_CLK± INPUT SIGNAL)	DEV_CLK+, DEV_CLK−					
Frequency Range		15		1000	MHz	
Signal Level (Differential)		0.2		1.0	V p-p	AC-coupled, common-mode voltage internally supplied; for optimal spurious performance and to meet the specified PLL performance parameters, use a 1 V p-p input clock
SYSTEM REFERENCE INPUTS	SYSREF+, SYSREF−					
Logic Compliance			LVDS/LVPECL			
Differential Input Voltage		400	800	1800	mV p-p	External 100 Ω differential termination
Input Common-Mode Voltage			0.675	2.0	V	
Input Resistance (Differential)			18		kΩ	
Input Capacitance (Differential)			1		pF	
AUXILIARY CONVERTERS						
ADC						
Resolution			10		Bits	
Input Voltage						
Minimum			0.05		V	
Maximum			0.95		V	
AUXDAC_0						
Resolution			12		Bits	
Output Voltage						
Minimum			0.2		V	
Maximum			VDDA_1P8 − 0.25		V	
AUXDAC_1 To AUXDAC_7						
Resolution			12		Bits	
Output Voltage						
Minimum			0.1		V	
Maximum			VDDA_1P8 − 0.1		V	
Drive Capability			10		mA	

DIGITAL SPECIFICATIONS

Table 3.

Parameter	Min	Typ	Max	Unit	Test Conditions/Comments
DIGITAL SPECIFICATIONS—SINGLE-ENDED SIGNALS					Applies to the following pins: GPIO_x, GPINTx, TXx_EN, RXx_EN, ORX_CTRL_x, TEST_EN, RESET, SPI_EN, SPI_CLK, SPI_DO, and SPI_DIO
Logic Inputs					
Input Voltage					
High Level	VIF × 0.65		VIF + 0.18	V	
Low Level	−0.30		VIF × 0.35	V	

Parameter	Min	Typ	Max	Unit	Test Conditions/Comments
Input Current					
High Level	−10		+10	µA	
Low Level	−10		+10	µA	
Logic Outputs					
Output Voltage					
High Level	VIF − 0.45			V	
Low Level			0.45	V	
Drive Capability		10		mA	
DIGITAL SPECIFICATIONS—DIFFERENTIAL SIGNALS					Applies to the SYNCINx± pins and the SYNCOUTx± pins
Logic Inputs					
Input Voltage Range	825		1675	mV	Each differential input in the pair
Input Differential Voltage Threshold	−100		+100	mV	
Receiver Differential Input Impedance		100		Ω	Internal termination enabled
Logic Outputs					
Output Voltage					
High			1375	mV	
Low	1025			mV	
Differential		225		mV	
Offset		1200		mV	
DIGITAL SPECIFICATIONS—VDDA_1P8 REFERENCED SIGNALS					Applies to the GPIO_ANA_x pins
Logic Inputs					
Input Voltage					
High Level	VDDA_1P8 × 0.65		VDDA_1P8 + 0.18	V	
Low Level	−0.30		VDDA_1P8 × 0.35	V	
Input Current					
High Level	−10		+10	µA	
Low Level	−10		+10	µA	
Logic Outputs					
Output Voltage					
High Level	VDDA_1P8 − 0.45			V	
Low Level			0.45	V	
Drive Capability		10		mA	

POWER SUPPLY SPECIFICATIONS

Table 4. Power Supply Voltages

Parameter	Min	Typ	Max	Unit
SUPPLY CHARACTERISTICS				
VDDA_1P0 Supply	0.95	1.0	1.05	V
VDIG Supply	0.95	1.0	1.05	V
VDDA_1P3 Supply	1.235	1.3	1.365	V
VDDA_1P8 Supply	1.71	1.8	1.89	V
VIF Supply	1.71	1.8	1.89	V

CURRENT CONSUMPTION

In Table 5, Table 6, and Table 7, the first row contains the data for the UC13-NLS profile and subsequent rows provide UC13-NLS profile details. Note that all current measurements reported in Table 5, Table 6, and Table 7 are obtained at room temperature without a heat sink.

TDD Operation—Four Receiver Channels Enabled

Maximum gain and typical values.

Table 5.

Profile Conditions	Supply (A)			Total Average Power (W)	75% Tx, 25% Rx Average Power (W)
	1.0 V	1.3 V	1.8 V		
USE CASE UC13-NLS (16 BITS)	1.181	2.003	0.217	4.19	5.01
245.76 MSPS Tx/ORx Data Rate					
122.88 MSPS Rx Data Rate					
245.76 MHz Device Clock					

TDD Operation—Four Transmitter and One Observation Receiver Channels Enabled

Maximum gain, 0 dB attenuation, typical values.

Table 6.

Profile Conditions	Supply (A)			Total Average Power (W)	75% Tx, 25% Rx Average Power (W)
	1.0 V	1.3 V	1.8 V		
USE CASE UC13-NLS (16 BITS)	1.419	2.084	0.633	5.28	5.01
245.76 MSPS Tx/ORx Data Rate					
122.88 MSPS Rx Data Rate					
245.76 MHz Device Clock					

FDD Operation—LO1 and LO2, Four Receiver, Four Transmitter, and One Observation Receiver Channels Enabled

Maximum gain, 0 dB attenuation, typical values.

Table 7.

Profile Conditions	Supply (A)			Total Average Power (W)
	1.0 V	1.3 V	1.8 V	
USE CASE UC13-NLS (16 BITS)	1.664	2.929	0.762	6.86
245.76 MSPS Tx/ORx Data Rate				
122.88 MSPS Rx Data Rate				
245.76 MHz Device Clock				

DIGITAL INTERFACE AND TIMING SPECIFICATIONS

Table 8.

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions/Comments
SERIAL PERIPHERAL INTERFACE (SPI) TIMING						
SPI_CLK Period	t_{CP}	40			ns	
SPI_CLK Pulse Width	t_{MP}	10			ns	
$\overline{\text{SPI\_EN}}$ Setup to First SPI_CLK Rising Edge	t_{SC}	4			ns	
Last SPI_CLK Falling Edge to $\overline{\text{SPI\_EN}}$ Hold	t_{HC}	0			ns	
SPI_DIO Data Input Setup to SPI_CLK	t_S	4			ns	
SPI_DIO Data Input Hold to SPI_CLK	t_H	0			ns	
SPI_CLK Falling Edge to Output Data Delay	t_{CO}	10		8	ns	3- or 4-wire mode
Bus Turnaround Time After Baseband Processor Drives Last Address Bit	t_{HZM}	t_H		t_{CO}	ns	
Bus Turnaround Time After ADRV9029 Drives Last Address Bit	t_{HZS}	0		t_{CO}	ns	
DIGITAL TIMING						
TXx_EN Pulse Width		10			μs	
RXx_EN Pulse Width		10			μs	
ORX_CTRL_x Pulse Width		10			μs	
TXx_EN to Valid Data			2		μs	
RXx_EN to Valid Data			2		μs	
ORX_CTRL_x to Valid Data			3		μs	
JESD204B/JESD204C DATA OUTPUT TIMING						
Unit Interval	UI	41.1		333	ps	
Data Rate per Channel (No Return to Zero (NRZ))		3000		24330.24	Mbps	
Rise Time	t_R	17	20		ps	20% to 80% in 100 Ω load
Fall Time	t_F	17	20		ps	20% to 80% in 100 Ω load
Output Common-Mode Voltage	V_{CM}	0		1.8	V	AC-coupled
Differential Output Voltage	V_{DIFF}	475		1050	mV p-p	
Short-Circuit Current	I_{DSHORT}	−100		+100	mA	
Differential Termination Impedance	Z_{RDIFF}	80	100	120	Ω	
SYSREF± Input Signal Setup Time to DEV_CLK± Input Signal	t_S	200			ps	
SYSREF± Input Signal Hold Time to DEV_CLK± Input Signal	t_H	200			ps	
JESD204B/C DATA INPUT TIMING						
Unit Interval	UI	41.1		333	ps	
Data Rate per Channel (NRZ)		3000		24330.24	Mbps	
Input Common-Mode Voltage	V_{CM}	0.05		1.65	V	AC-coupled
Termination Voltage = 1.0 V	V_{TT}	720		1200	mV	DC-coupled (not recommended)
Differential Input Voltage	V_{DIFF}	110		1050	mV	
V_{TT} Source Impedance	Z_{TT}		7.5	30	Ω	
Differential Termination Impedance	Z_{RDIFF}	80	100	120	Ω	
V_{TT}						
AC-Coupled		0.95		1.05	V	
DC-Coupled		0.95		1.05	V	

ABSOLUTE MAXIMUM RATINGS

Table 9.

Parameter	Rating
VDDA_1P8 to VSSA	−0.3 V to +2.2 V
VDDA_1P3 to VSSA	−0.2 V to +1.5 V
VDDA_1P0, VDIG_1P0 to VSSD, VSSA	−0.2 V to +1.2 V
VIF Referenced Logic Inputs and Outputs to VSSD	−0.3 V to VIF + 0.3 V
JESD204B/JESD204C Logic Outputs to VSSA	−0.3 V to VSER_1P0
JESD204B/JESD204C Logic Inputs to VSSA	−0.3 V to VDES_1P0
Input Current to Any Pin Except Supplies	±10 mA
Maximum Input Power into RF Ports	See Table 11 for limits vs. survival time
Reflow Temperature	260°C
Junction Temperature Range[1]	−40°C to +110°C
Storage Temperature Range	−65°C to +150°C

[1] The maximum junction temperature for continuous operation is 110°C. See the Junction Temperature section for more details.

Stresses at or above those listed under Absolute Maximum Ratings may cause permanent damage to the product. This is a stress rating only; functional operation of the product at these or any other conditions above those indicated in the operational section of this specification is not implied. Operation beyond the maximum operating conditions for extended periods may affect product reliability.

JUNCTION TEMPERATURE

The maximum junction temperature for continuous operation is 110°C. Although operation up to 125°C is supported, specification compliance is only guaranteed up to 110°C. To avoid a reduction in operating lifetime by operating at temperatures greater than 110°C, the device must operate at a temperature less than 110°C for a period determined by the following equation:

$$t_{UNITS < 110} = (AF_{T > 110} - 1)/(1 - AF_{T < 110})$$

where:
AF is the acceleration factor.
$AF_{T > 110}$ and $AF_{T < 110}$ are acceleration factors obtained from Table 10.

For example, if the device operates at 125°C for 1 hour, expected device lifetime is maintained if the device operates at 100°C for 4.5 hours to offset the time operating above 110°C.

Table 10. Acceleration Factors for High Temperature Operation

Operating Junction Temperature (°C)	Acceleration Factor
125	3.75
120	2.44
115	1.57
110	1.00
105	0.63
100	0.39
95	0.24
90	0.14

Table 11. Maximum Input Power into RF Ports vs. Lifetime

RF Port Input Power, Continuous Wave Signal (dBm)	Lifetime	
	Gain = −30 dB	Gain = 0 dB
7	>10 years	>10 years
10	>10 years	20,000 hours
20	>10 years	14 hours
23	>10 years	110 minutes
25	>7 years	60 minutes

REFLOW PROFILE

The ADRV9029 reflow profile is in accordance with the JEDEC JESD20 criteria for lead-free (Pb-free) devices. The maximum reflow temperature is 260°C.

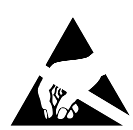
THERMAL RESISTANCE

Thermal resistance values specified in Table 12 are calculated based on JEDEC specifications and should be used in compliance with JESD51-2. Note that using enhanced heat removal techniques (PCB, heat sink, airflow, and so forth) improves thermal resistance.

Table 12. Thermal Resistance Values

Package Type	θ_{JA}	θ_{JCTOP}	θ_{JB}	ψ_{JC}	ψ_{JB}	Unit
BC-289-6	14.8	0.03	3.4	0.02	3.4	(°C/W)

ESD CAUTION



ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

ADRV9029
TOP VIEW
(Not to Scale)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
A	VSSA	VSSA	VSSA	TX3+	TX3–	VSSA	VTXLO_1P3	VSSA	VRXLO_1P3	VSSA	VSSA	VSSA	TX2+	TX2–	VSSA	VSSA	VSSA
B	RX3–	VSSA	VSSA	VANA3_1P8	VSSA	VSSA	VSSA	VSSA	VSSA	VSSA	VAUXVCO_1P0	VSSA	VSSA	VANA2_1P8	VSSA	VSSA	RX2+
C	RX3+	VSSA	NIC	GPIO_ANA_7	GPIO_ANA_6	VAUXSYN_1P3	VSSA	DEVCLK+	DEVCLK–	VSSA	VAUXVCO_1P3	GPIO_ANA_1	GPIO_ANA_0	VSSA	RBIAS	VSSA	RX2–
D	VSSA	VSSA	VANA2_1P3	VSSA	VSSA	VSSA	VSSA	SYSREF+	SYSREF–	VSSA	VSSA	VSSA	VSSA	VSSA	VANA1_1P3	VSSA	VSSA
E	AUXADC_3	EXT_LO2–	VSSA	ORX3+	ORX3–	VSSA	TX3_EN	GPIO_11	GPIO_9	GPIO_3	TX2_EN	VSSA	ORX1+	ORX1–	VSSA	EXT_LO1+	AUXADC_1
F	AUXADC_2	EXT_LO2+	VSSA	VSSA	VSSA	VSSA	ORX_CTRL_C	GPIO_12	GPIO_10	GPIO_4	ORX_CTRL_B	VSSA	VSSA	VSSA	VSSA	EXT_LO1–	AUXADC_0
G	VSSA	VSSA	VRFVCO2_1P3	VSSA	VRFVCO2_1P0	VSSA	RX3_EN	GPIO_13	VDIG_1P0	GPIO_5	RX2_EN	VSSA	VRFVCO1_1P0	VSSA	VRFVCO1_1P3	VSSA	VSSA
H	RX4–	VSSA	VCONV2_1P8	VSSA	VSSA	VSSA	GPIO_17	GPIO_14	VSSD	GPIO_6	GPIO_0	VSSA	VSSA	VSSA	VCONV1_1P8	VSSA	RX1+
J	RX4+	VSSA	VCONV2_1P3	VSSA	VRFSYN2_1P3	VSSA	RX4_EN	GPIO_15	VDIG_1P0	GPIO_7	RX1_EN	VSSA	VRFSYN1_1P3	VSSA	VCONV1_1P3	VSSA	RX1–
K	VSSA	VSSA	VCONV2_1P0	VSSA	VSSA	VSSA	GPIO_18	GPIO_16	VSSD	GPIO_8	GPIO_1	VSSA	VSSA	VSSA	VCONV1_1P0	VSSA	VSSA
L	GPIO_ANA_5	GPIO_ANA_4	VSSA	ORX4+	ORX4–	VSSA	ORX_CTRL_D	SPI_DIO	VDIG_1P0	SPI_EN	ORX_CTRL_A	VSSA	ORX2+	ORX2–	VSSA	GPIO_ANA_2	GPIO_ANA_3
M	VSSA	VSSA	VSSA	VSSA	VSSA	VSSA	TX4_EN	SPI_DO	VSSD	SPI_CLK	TX1_EN	VSSA	VSSA	VSSA	VSSA	VSSA	VSSA
N	TX4–	VANA4_1P8	VSSA	VSSA	VCLKVCO_1P3	SYNCIN3+	GPINT2	GPINT1	VIF	RESET	GPIO_2	SYNCIN1+	SYNCIN1–	SYNCOUT2+	SYNCOUT2–	VANA1_1P8	TX1+
P	TX4+	VSSA	VSSA	VSSA	VCLKVCO_1P0	SYNCIN3–	SYNCIN2+	SYNCIN2–	VSSA	TEST_EN	VJVCO_1P8	VDES_1P0	VDES_1P0	VTT_DES	SYNCOUT1+	VSSA	TX1–
R	VSSA	VSSA	VSER_1P0	VSER_1P0	VSSA	VSSA	VCLKSYN_1P3	VSSA	VJSYN_1P0	VSSA	NIC	VSSA	VSSA	VSSA	SYNCOUT1–	VSSA	VSSA
T	VSSA	VSSA	SERDOUTC+	SERDOUTC–	VSSA	VSSA	SERDOUTA+	SERDOUTA–	VSSA	SERDINA–	SERDINA+	VSSA	VSSA	SERDINC–	SERDINC+	VSSA	VSSA
U	SERDOUTD+	SERDOUTD–	VSSA	VSSA	SERDOUTB+	SERDOUTB–	VSSA	VSSA	VSSA	VSSA	VSSA	SERDINB+	SERDINB–	VSSA	VSSA	SERDIND+	SERDIND–

- ANALOG GROUND
- DIGITAL POWER
- AUXILIARY ADC INPUTS
- LVDS SERDES CONTROLS
- NOT INTERNALLY CONNECTED
- DIGITAL GROUND
- ANALOG INPUTS/OUTPUTS
- DIGITAL INPUTS/OUTPUTS
- SERDES INPUTS/OUTPUTS
- ANALOG POWER
- ANALOG GPIO
- SPI BUS
- DIFFERENTIAL SYSREF SIGNAL

NOTES
1. NIC = NOT INTERNALLY CONNECTED. THESE PINS MUST REMAIN DISCONNECTED.

25607-004

Figure 2. Pin Configuration

Table 13. Pin Function Descriptions

Pin No.	Mnemonic	Type[1]	Description
A1 to A3, A6, A8, A10 to A12, A15 to A17, B2, B3, B5 to B10, B12, B13, B15, B16, C2, C7, C10, C14, C16, D1, D2, D4 to D7, D10 to D14, D16, D17, E3, E6, E12, E15, F3 to F6, F12 to F15, G1, G2, G4, G6, G12, G14, G16, G17, H2, H4 to H6, H12 to H14, H16, J2, J4, J6, J12, J14, J16, K1, K2, K4 to K6, K12 to K14, K16, K17, L3, L6, L12, L15, M1 to M6, M12 to M17, N3, N4, P2 to P4, P9, P16, R1, R2, R5, R6, R8, R10, R12 to R14, R16, R17, T1, T2, T5, T6, T9, T12, T13, T16, T17, U3, U4, U7 to U11, U14, U15	VSSA	I	Analog Ground.
A4, A5	TX3+, TX3−	O	Differential Output for Transmitter Channel 3. If unused, do not connect these pins.
A7	VTXLO_1P3	I	1.3 V Supply Input.
A9	VRXLO_1P3	I	1.3 V Supply Input.
A13, A14	TX2+, TX2−	O	Differential Output for Transmitter Channel 2. When unused, do not connect.
B1, C1	RX3−, RX3+	I	Differential Input for Receiver Channel 3. If unused, connect these pins to VSSA.
B4	VANA3_1P8	I	1.8 V Supply Input.
B11	VAUXVCO_1P0	O	1.0 V Internal Supply Node. Bypass Pin B11 with a 4.7 µF capacitor.
B14	VANA2_1P8	I	1.8 V Supply Input.
B17, C17	RX2+, RX2−	I	Differential Input for Receiver Channel 2. If unused, connect these pins to VSSA.
C3, R11	NIC	N/A	Not Internally Connected. These pins must remain disconnected.
C4, C5, L1, L2, L17, L16, C12, C13	GPIO_ANA_7 to GPIO_ANA_0	I/O	General-Purpose Inputs and Outputs. The GPIO_ANA_7 to GPIO_ANA_0 pins are referenced to 1.8 V and can also function as auxiliary DAC outputs. If unused, these pins can be connected to VSSA with a 10 kΩ resistor or configured as outputs, driven low, and left disconnected.
C6	VAUXSYN_1P3	I	1.3 V Supply Input.
C8, C9	DEVCLK+, DEVCLK−	I	Device Clock Differential Input.
C11	VAUXVCO_1P3	I	1.3 V Supply Input.
C15	RBIAS	I	Bias Resistor Connection. Pin C15 generates an internal current based on an external 1% resistor. Connect a 4.99 kΩ resistor between Pin C15 and analog ground (VSSA).
D3	VANA2_1P3	I	1.3 V Supply Input.
D8, D9	SYSREF+, SYSREF−	I	LVDS System Reference Clock Inputs for the SERDES Interface. Connect a 100 Ω termination between these pins.
D15	VANA1_1P3	I	1.3 V Supply Input.
E1	AUXADC_3	I	Auxiliary ADC 3 Input. If Pin E1 is unused, do not connect.
E2, F2	EXT_LO2−, EXT_LO2+	I/O	Differential External LO Input/Output 2. If used for the external LO input, the input frequency must be 2× the desired carrier frequency. Do not connect if unused. External LO functionality not supported currently.
E4, E5	ORX3+, ORX3−	I	Differential Input for Observation Receiver Channel 3. Connect to VSSA if unused.
E7	TX3_EN	I	Enable Input for Transmitter Channel 3. Connect to VSSA if unused.

Pin No.	Mnemonic	Type[1]	Description
H11, K11, N11, E10, F10, G10, H10, J10, K10, E9, F9, E8, F8, G8, H8, J8, K8, H7, K7	GPIO_0 to GPIO_18	I/O	General-Purpose Digital Inputs and Outputs. See Figure 2 to match the ball location to the GPIO_x signal name. If unused, these pins can be connected to VSSA with a 10 kΩ resistor or configured as outputs, driven low, and left disconnected.
E11	TX2_EN	I	Enable Input for Transmitter Channel 2. Connect to VSSA if unused.
E13, E14	ORX1+, ORX1−	I	Differential Input for Observation Receiver Channel 1. Connect to VSSA if unused.
E16, F16	EXT_LO1+, EXT_LO1−	I/O	Differential External LO Input/Output 1. If used for the external LO input, the input frequency must be 2× the desired carrier frequency. Do not connect if unused. External LO functionality not currently supported.
E17	AUXADC_1	I	Auxiliary ADC 1 Input. Do not connect if unused.
F1	AUXADC_2	I	Auxiliary ADC 2 Input. Do not connect if unused.
F7, F11, L7, L11	ORX_CTRL_C, ORX_CTRL_B, ORX_CTRL_D, ORX_CTRL_A	I	Determine Active Observation Receiver Path. Connect to VSSA directly or with a pull-down resistor if unused.
F17	AUXADC_0	I	Auxiliary ADC 0 Input. Do not connect if unused.
G3	VRFVCO2_1P3	I	1.3 V Supply Input.
G5	VRFVCO2_1P0	O	1.0 V Internal Supply Node. Bypass this pin with a 4.7 μF capacitor.
G7	RX3_EN	I	Enable Input for Receiver Channel 3. Connect to VSSA if unused.
G9, J9, L9	VDIG_1P0	I	1.0 V Digital Supply Input.
G11	RX2_EN	I	Enable Input for Receiver Channel 2. Connect to VSSA if unused.
G13	VRFVCO1_1P0	O	1.0 V Internal Supply Node. Bypass this pin with a 4.7 μF capacitor.
G15	VRFVCO1_1P3	I	1.3 V Supply Input.
H1, J1	RX4−, RX4+	I	Differential Input for Receiver Channel 4. If unused, connect to VSSA.
H3	VCONV2_1P8	I	1.8 V Supply Input.
H9, K9, M9	VSSD	I	Digital Ground.
H15	VCONV1_1P8	I	1.8 V Supply Input.
H17, J17	RX1+, RX1−	I	Differential Input for Receiver Channel 1. If unused, connect to VSSA.
J3	VCONV2_1P3	I	1.3 V Supply Input.
J5	VRFSYN2_1P3	I	1.3 V Supply Input.
J7	RX4_EN	I	Enable Input for Receiver Channel 4. If unused, connect to VSSA.
J11	RX1_EN	I	Enable Input for Receiver Channel 1. If unused, connect to VSSA.
J13	VRFSYN1_1P3	I	1.3 V Supply Input.
J15	VCONV1_1P3	I	1.3 V Supply Input.
K3	VCONV2_1P0	O	1.0 V Internal Supply Node. Bypass this pin with a 4.7 μF capacitor.
K15	VCONV1_1P0	O	1.0 V Internal Supply Node. Bypass this pin with a 4.7 μF capacitor.
L4, L5	ORX4+, ORX4−	I	Differential Input for Observation Receiver Channel 4. If unused, connect to VSSA.

Pin No.	Mnemonic	Type[1]	Description
L8	SPI_DIO	I/O	Serial Data Input. SPI_DIO is the serial data input in 4-wire mode or input/output in 3-wire mode.
L10	$\overline{\text{SPI\_EN}}$	I	Serial Data Bus Chip Select. Active low.
L13, L14	ORX2+, ORX2−	I	Differential Input for Observation Receiver Channel 2. If unused, connect to VSSA.
M7	TX4_EN	I	Enable Input for Transmitter Channel 4. If unused, connect to VSSA.
M8	SPI_DO	O	Serial Data Output.
M10	SPI_CLK	I	Serial Data Bus Clock Input.
M11	TX1_EN	I	Enable Input for Transmitter Channel 1. If unused, connect to VSSA.
N1, P1	TX4−, TX4+	O	Differential Output for Transmitter Channel 4. If unused, do not connect.
N2	VANA4_1P8	I	1.8 V Supply Input.
N5	VCLKVCO_1P3	I	1.3 V Supply Input.
N6, P6	SYNCIN3+, SYNCIN3−	I	LVDS Sync Signal Input 3. If unused, connect to VSSA.
N7	GPINT2	O	General-Purpose Interrupt Output 2. If unused, do not connect.
N8	GPINT1	O	General-Purpose Interrupt Output 1. If unused, do not connect.
N9	VIF	I	1.8 V Interface Supply Input.
N10	$\overline{\text{RESET}}$	I	Active Low Chip Reset.
N12, N13	SYNCIN1+, SYNCIN1−	I	LVDS Sync Signal Input 1. If unused, connect to VSSA.
N14, N15	SYNCOUT2+, SYNCOUT2−	O	LVDS Sync Signal Output 2. If unused, do not connect.
N16	VANA1_1P8	I	1.8 V Supply Input.
N17, P17	TX1+, TX1−	O	Differential Output for Transmitter Channel 1. Do not connect if unused.
P5	VCLKVCO_1P0	O	1.0 V Internal Supply Node. Bypass this pin with a 4.7 μF capacitor.
P7, P8	SYNCIN2+, SYNCIN2−	I	LVDS Sync Signal Input 2. If unused, connect to VSSA.
P10	TEST_EN	I	Test Input for JTAG Boundary Scan. Pull high to enable boundary scan. If unused, tie to VSSA.
P11	VJVCO_1P8	I	1.8 V Supply Input.
P12, P13	VDES_1P0	I	1.0 V Analog Supply Input.
P14	VTT_DES	I	1.0 V Analog Supply Input.
P15, R15	SYNCOUT1+, SYNCOUT1−	O	LVDS Sync Signal Output 1. If unused, do not connect.
R3, R4	VSER_1P0	I	1.0 V Analog Supply Input.
R7	VCLKSYN_1P3	I	1.3 V Supply Input.
R9	VJSYN_1P0	I	1.0 V Analog Supply Input.
T3, T4	SERDOUTC+, SERDOUTC−	O	SERDES Differential Output C. If unused, do not connect.
T7, T8	SERDOUTA+, SERDOUTA−	O	SERDES Differential Output A. If unused, do not connect.
T10, T11	SERDINA−, SERDINA+	I	SERDES Differential Input A. If unused, do not connect.
T14, T15	SERDINC−, SERDINC+	I	SERDES Differential Input C. If unused, do not connect.
U1, U2	SERDOUTD+, SERDOUTD-	O	SERDES Differential Output D. If unused, do not connect.
U5, U6	SERDOUTB+, SERDOUTB−	O	SERDES Differential Output B. If unused, do not connect.

Pin No.	Mnemonic	Type[1]	Description
U12, U13	SERDINB+, SERDINB−	I	SERDES Differential Input B. If unused, do not connect.
U16, U17	SERDIND+, SERDIND−	I	SERDES Differential Input D. If unused, do not connect.

[1] I is input, O is output, I/O is input/output, and N/A is not applicable.

TYPICAL PERFORMANCE CHARACTERISTICS

Device configuration profile: receiver = 62.5 MHz bandwidth, I/Q rate = 76.8 MHz, transmitter = 62.5 MHz large signal bandwidth plus 141 MHz synthesis bandwidth, I/Q rate = 153.6 MHz, observation receiver (OR_X) = 141 MHz bandwidth, I/Q rate = 153.6 MHz, device clock = 153.6 MHz, unless otherwise noted.

75 MHZ BAND

The temperature settings refer to the die temperature. All LO frequencies set to 75 MHz, unless otherwise noted.

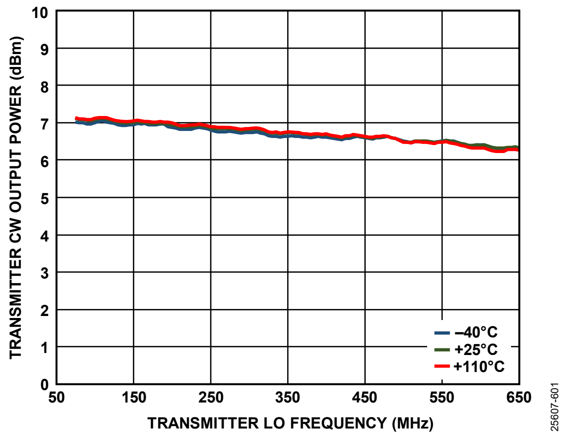


Figure 3. Transmitter Continuous Wave Output Power vs. Transmitter LO Frequency, 10 MHz Offset, 0 dB Attenuation

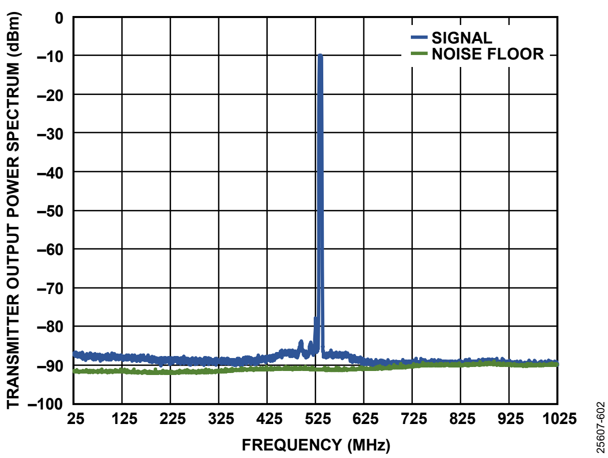


Figure 4. Transmitter Output Power Spectrum, Tx1, 5 MHz LTE, 10 MHz Offset, −10 dBFS RMS, 1 MHz Resolution Bandwidth, T_J = 25°C

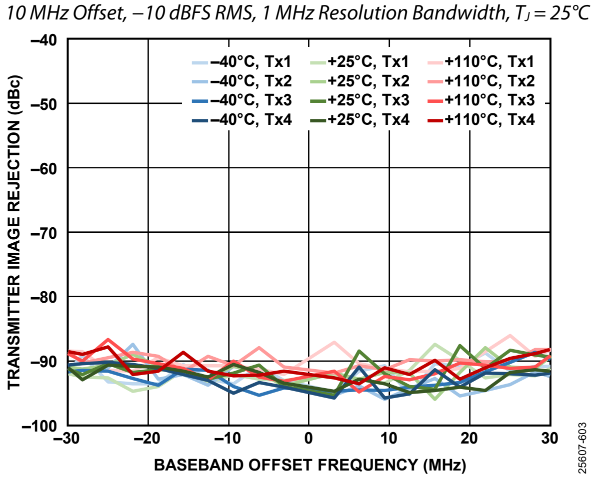


Figure 5. Transmitter Image Rejection Across Large Signal Bandwidth vs. Baseband Offset Frequency

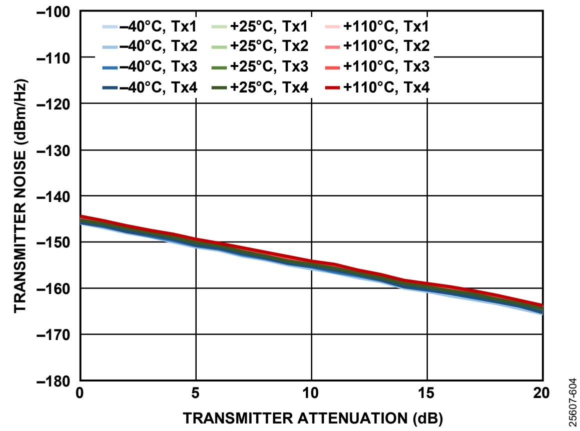


Figure 6. Transmitter Noise vs. Transmitter Attenuation, 10 MHz Offset

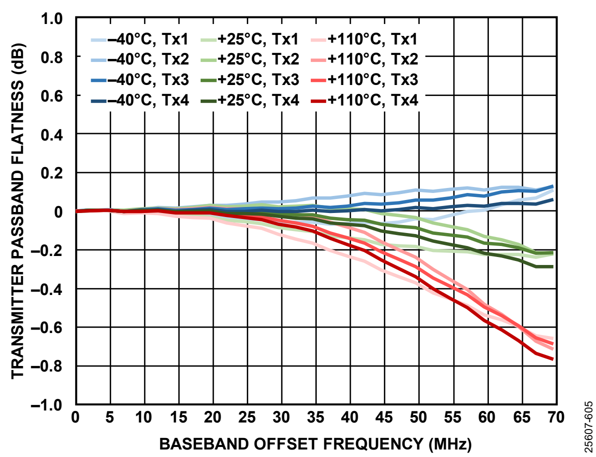


Figure 7. Transmitter Pass Band Flatness vs. Baseband Offset Frequency

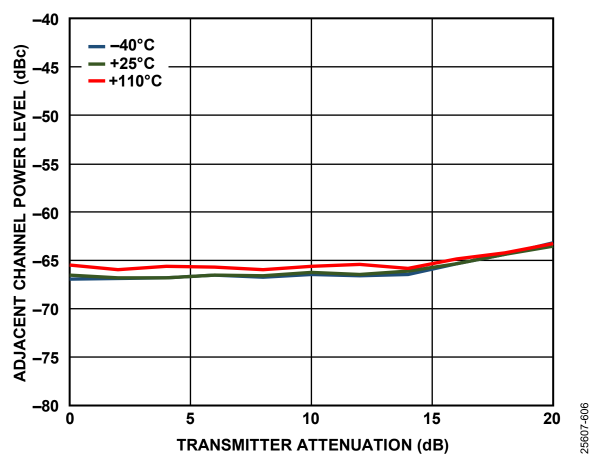


Figure 8. Adjacent Channel Power Level vs. Transmitter Attenuation, 21 MHz Baseband Offset, 5 MHz LTE, Peak to Average Ratio (PAR) = 12 dB

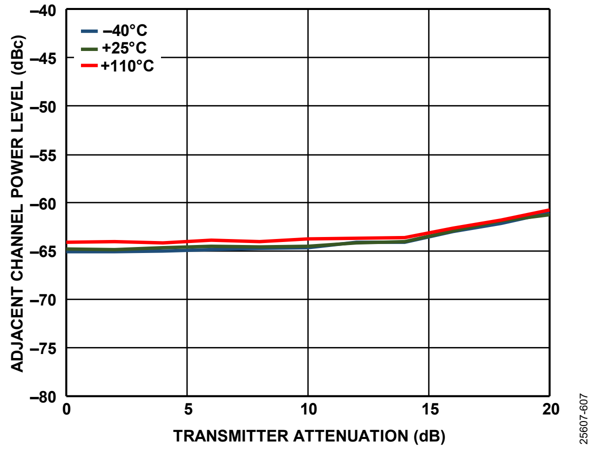


Figure 9. Adjacent Channel Power Level vs. Transmitter Attenuation, 44 MHz Baseband Offset, 5 MHz LTE, PAR = 12 dB

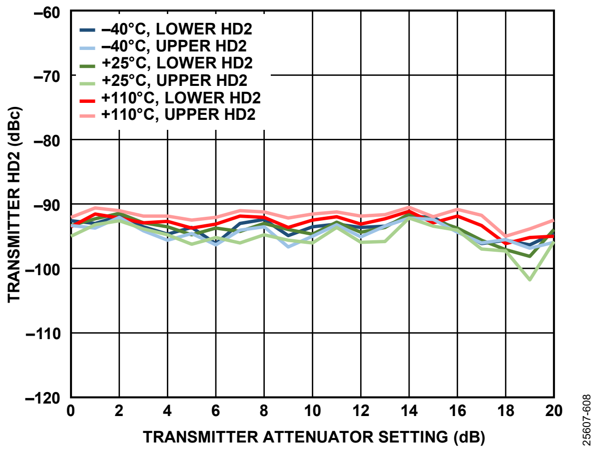


Figure 10. Transmitter Second-Order Harmonic Distortion (HD2) vs. Transmitter Attenuation, 10 MHz Offset

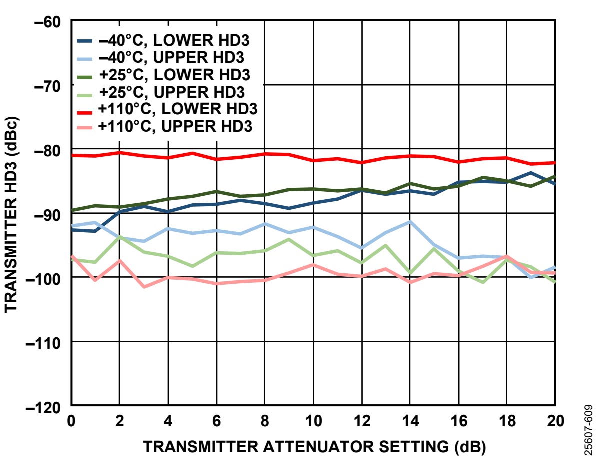


Figure 11. Transmitter Third-Order Harmonic Distortion (HD3) vs. Transmitter Attenuation, 10 MHz Offset

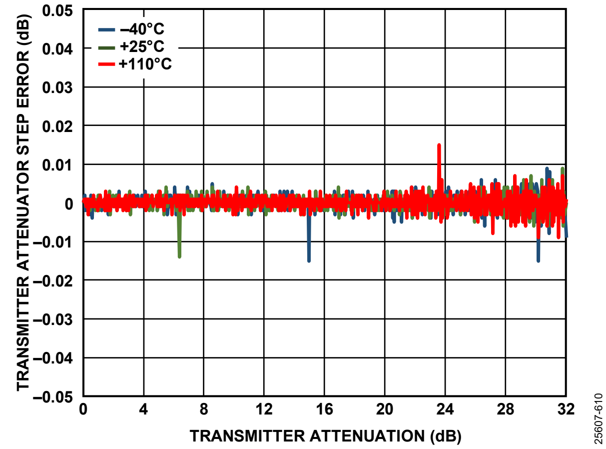


Figure 12. Transmitter Attenuator Step Error vs. Transmitter Attenuation, 10 MHz Offset

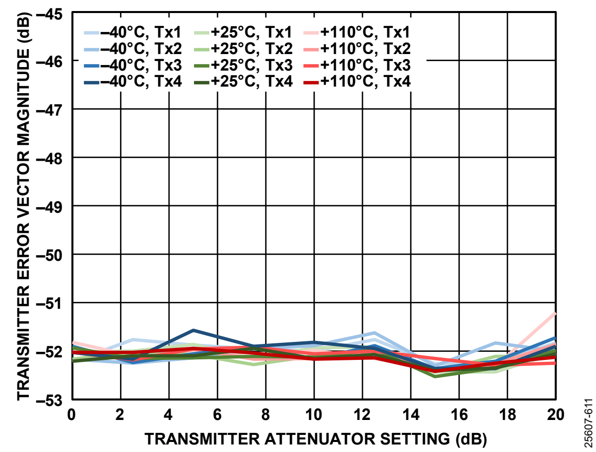


Figure 13. Transmitter Error Vector Magnitude vs. Transmitter Attenuation, 5 MHz LTE Signal Centered at LO Frequency, Sample Rate = 153.6 MSPS, Loop Filter Bandwidth = 50 kHz, Loop Filter Phase Margin = 40°

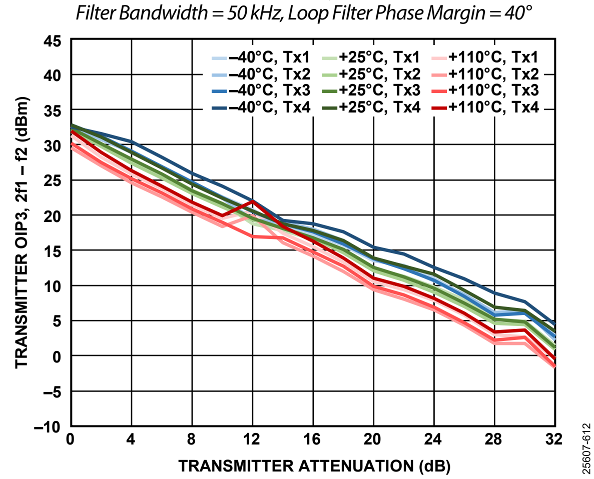


Figure 14. Transmitter OIP3, 2f1 − f2 vs. Transmitter Attenuation, 15 dB Digital Back Off per Tone, f1 = 45.5 MHz, f2 = 50.5 MHz

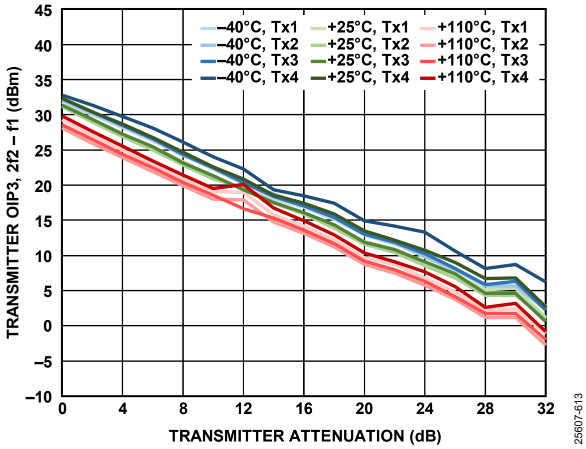


Figure 15. Transmitter OIP3, 2f2 – f1 vs. Transmitter Attenuation, 15 dB Digital Back Off per Tone, f1 = 45.5 MHz, f2 = 50.5 MHz

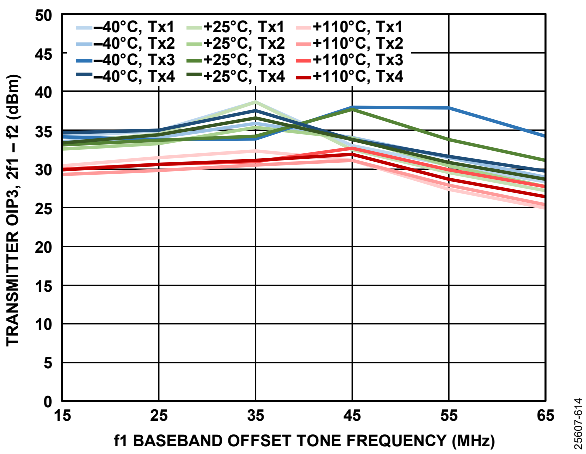


Figure 16. Transmitter OIP3, 2f1 – f2 vs. f1 Baseband Offset Tone Frequency, f2 = f1 + 5 MHz, 15 dB Digital Back Off per Tone

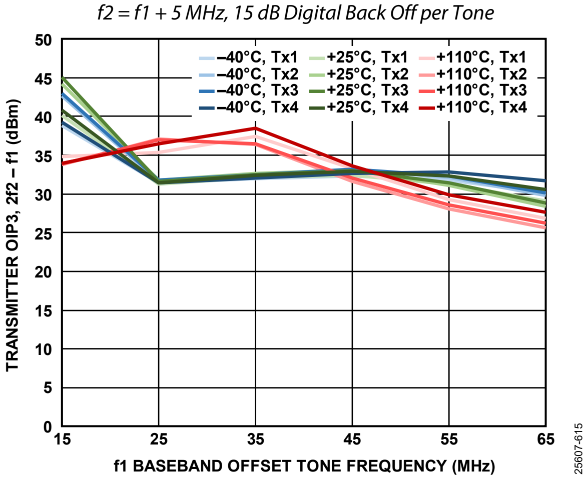


Figure 17. Transmitter OIP3, 2f2 – f1 vs. f1 Baseband Offset Tone Frequency, f2 = f1 + 5 MHz, 15 dB Digital Back Off per Tone

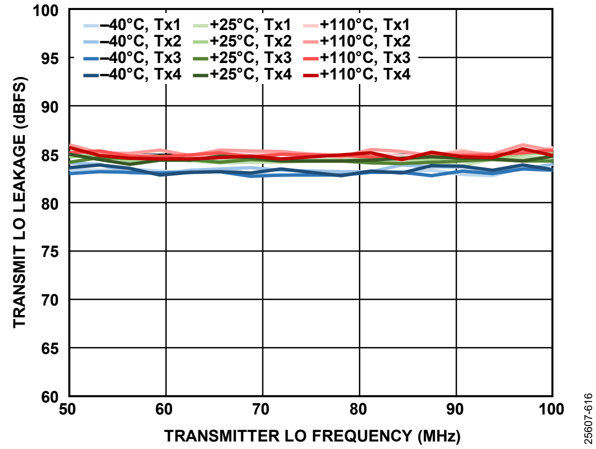


Figure 18. Transmitter LO Leakage vs. Transmitter LO Frequency

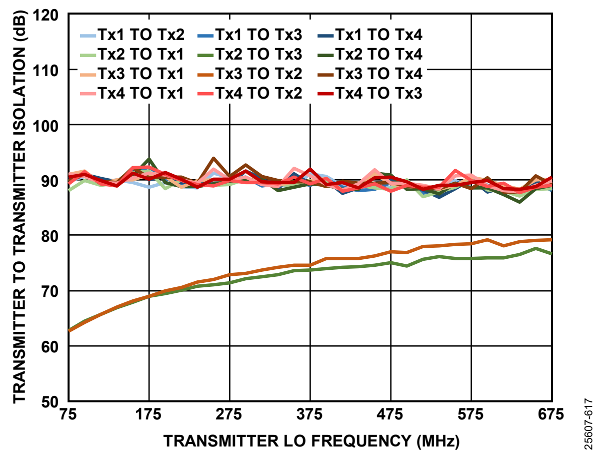


Figure 19. Transmitter to Transmitter Isolation vs. Transmitter LO Frequency

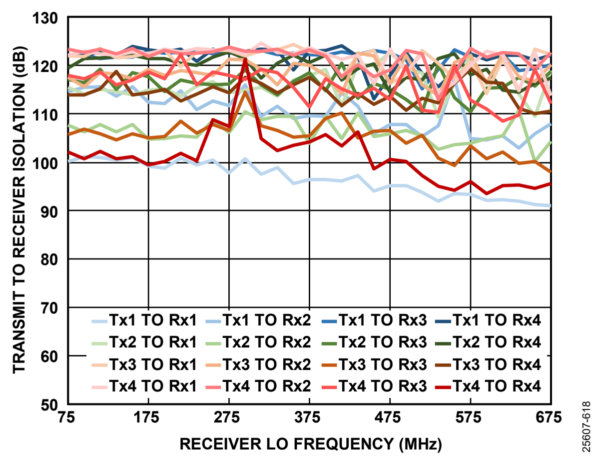


Figure 20. Transmitter to Receiver Isolation vs. Receiver LO Frequency

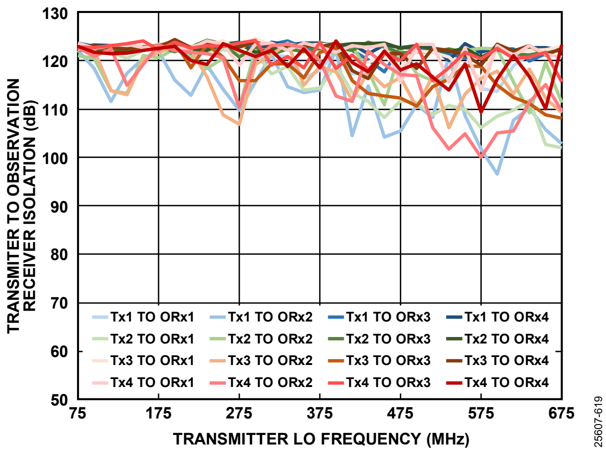


Figure 21. Transmitter to Observation Receiver Isolation vs. Transmitter LO Frequency

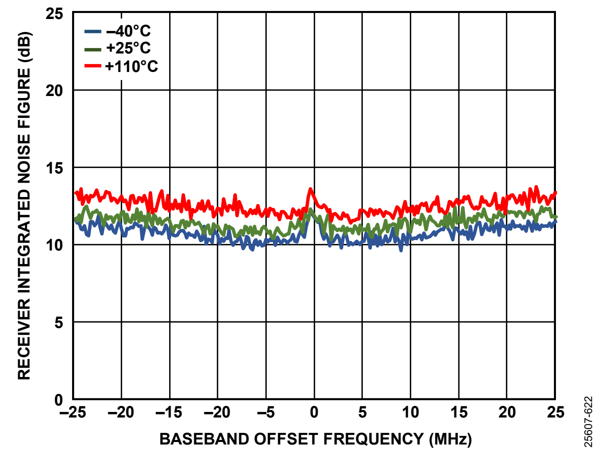


Figure 24. Receiver Integrated Noise Figure vs. Baseband Offset Frequency, 62.5 MHz Bandwidth, Sample Rate = 76.8 MSPS, Integrated in 200 kHz Steps

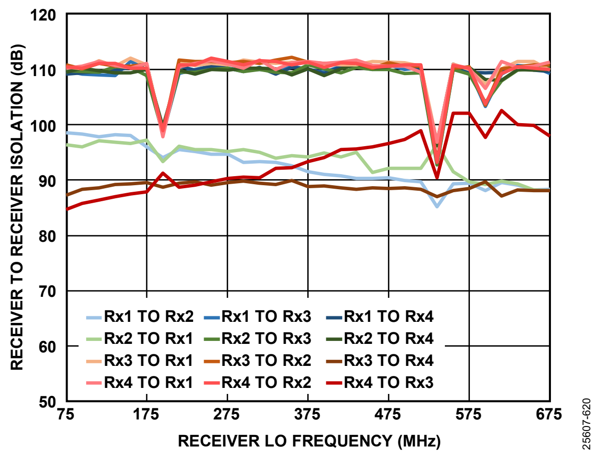


Figure 22. Receiver to Receiver Isolation vs. Receiver LO Frequency

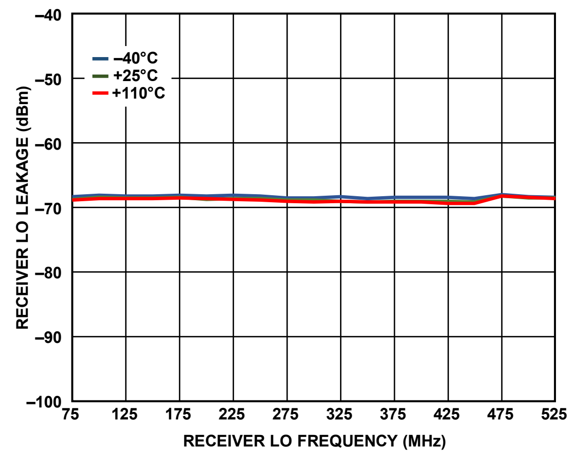


Figure 25. Receiver LO Leakage vs. Receiver LO Frequency, Attenuation = 0 dB, Sample Rate = 76.8 MSPS

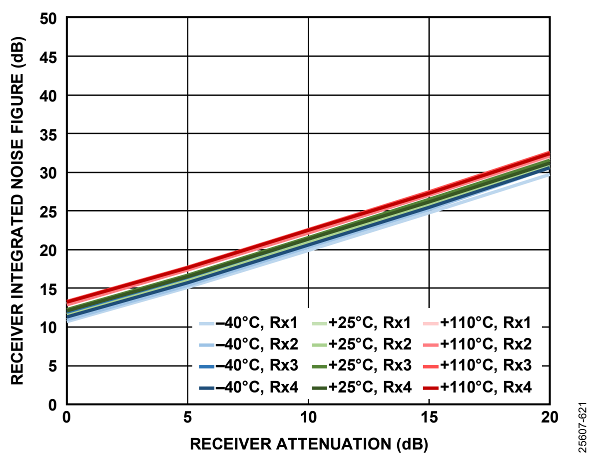


Figure 23. Receiver Integrated Noise Figure vs. Receiver Attenuation, 62.5 MHz Bandwidth, Sample Rate =76.8 MSPS, Integration Bandwidth = 500 kHz to 30 MHz

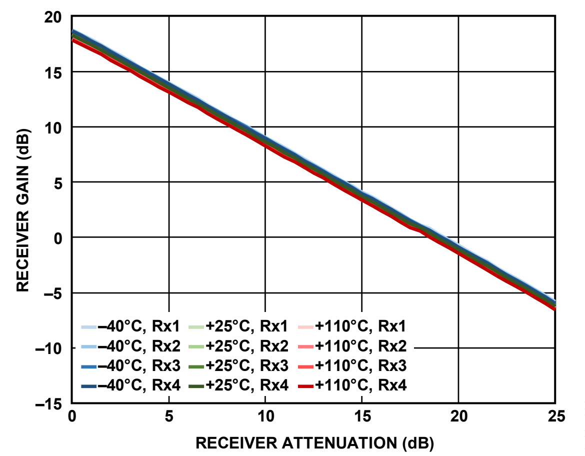


Figure 26. Receiver Gain vs. Receiver Attenuation, 20 MHz Offset, 62.5 MHz Bandwidth, Sample Rate = 76.8 MSPS

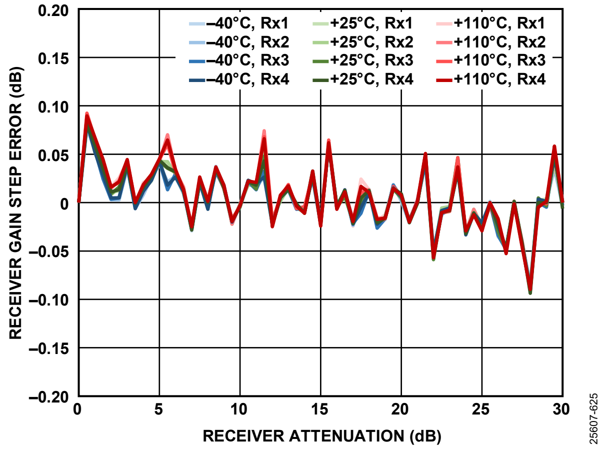


Figure 27. Receiver Gain Step Error vs. Receiver Attenuation, 10 MHz Offset, –5 dBFS Input Signal

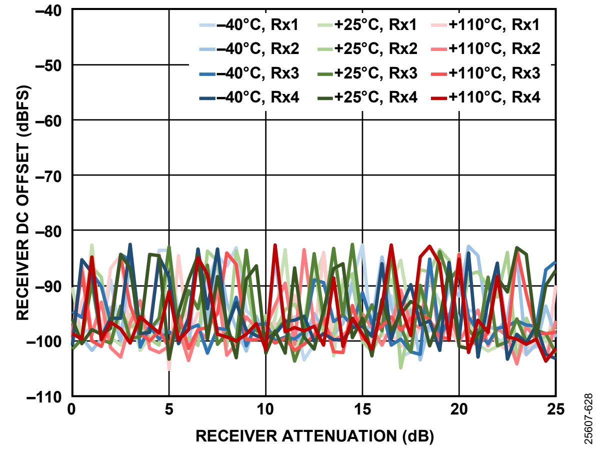


Figure 30. Receiver DC Offset vs. Receiver Attenuation, 10 MHz Offset, –5 dBFS Input Signal

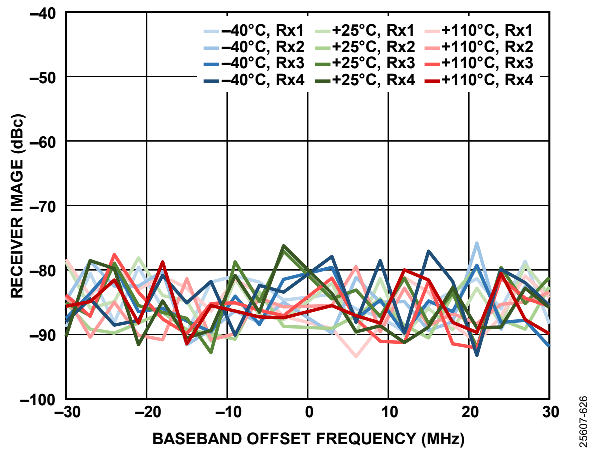


Figure 28. Receiver Image vs. Baseband Offset Frequency, Tracking Calibration Active, Sample Rate = 76.8 MSPS

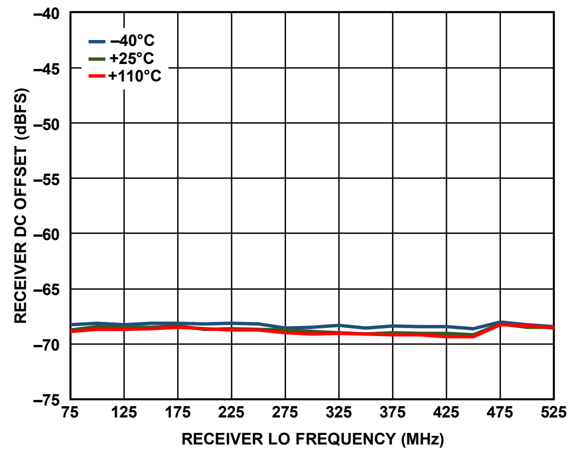


Figure 31. Receiver DC Offset vs. Receiver LO Frequency, 10 MHz Offset, –5 dBFS Input Signal

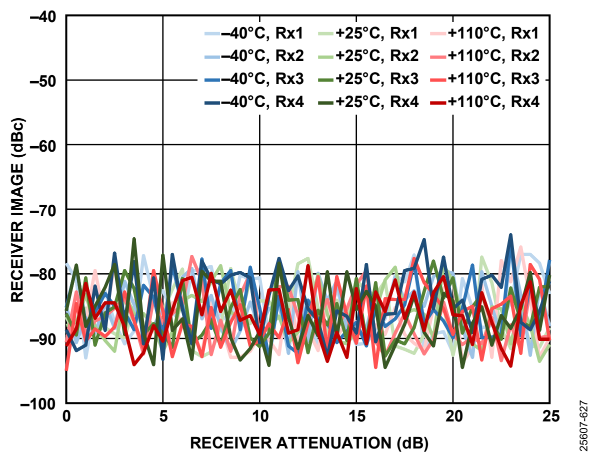


Figure 29. Receiver Image vs. Receiver Attenuation, 10 MHz Offset, Tracking Calibration Active, Sample Rate = 76.8 MSPS

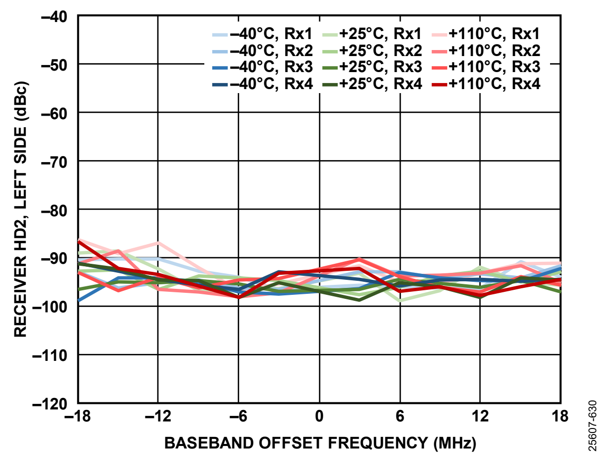


Figure 32. Receiver HD2, Left Side vs. Baseband Offset Frequency, –5 dBFS Input Signal, Distortion Tone Measured Left of 0 Hz (HD2 Canceller Enabled)

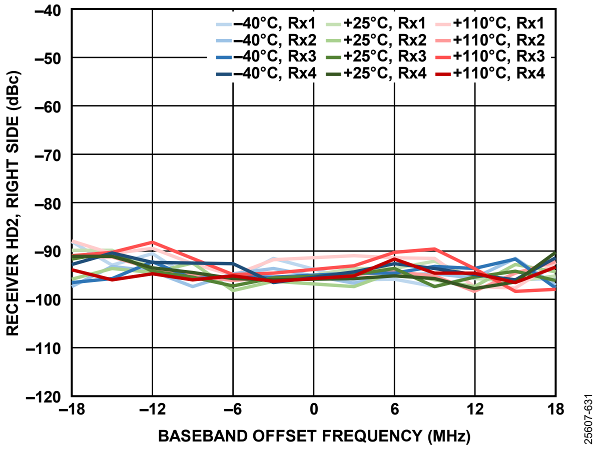


Figure 33. Receiver HD2, Right Side vs. Baseband Offset Frequency, −5 dBFS Input Signal, Distortion Tone Measured Right of 0 Hz (HD2 Canceller Enabled)

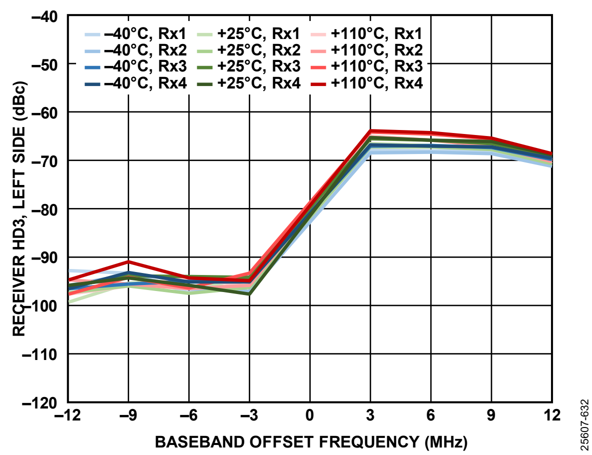


Figure 34. Receiver HD3, Left Side vs. Baseband Offset Frequency, −5 dBFS Input Signal, Distortion Tone Measured Left of 0 Hz

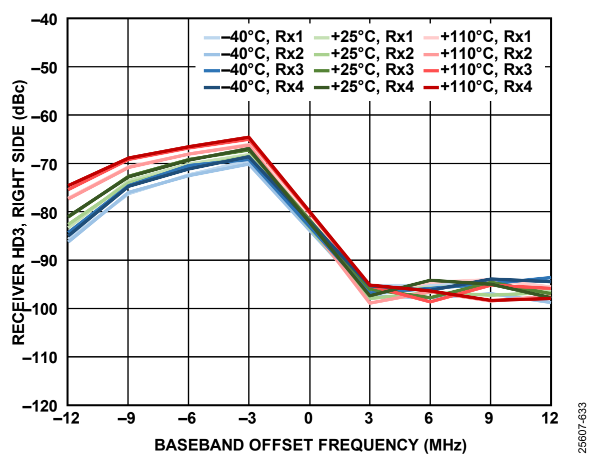


Figure 35. Receiver HD3, Right Side vs. Baseband Offset Frequency, −5 dBFS Input Signal, Distortion Tone Measured Right of 0 Hz

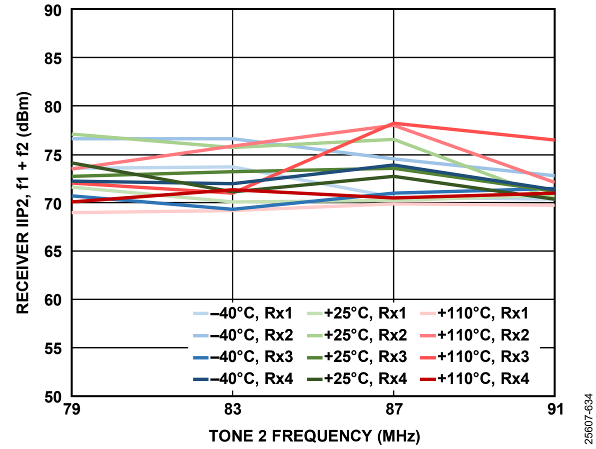


Figure 36. Receiver IIP2, f1 + f2 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

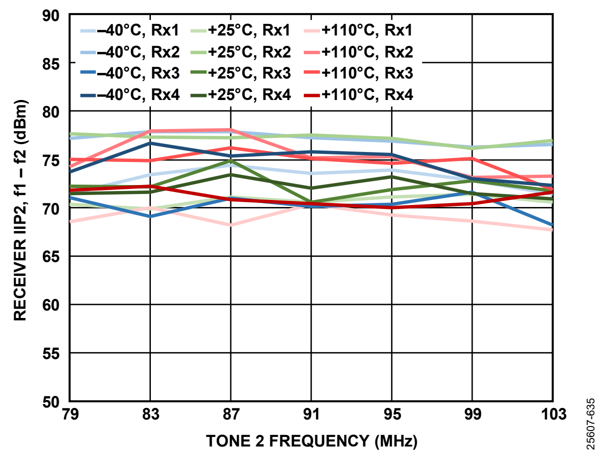


Figure 37. Receiver IIP2, f1 − f2 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

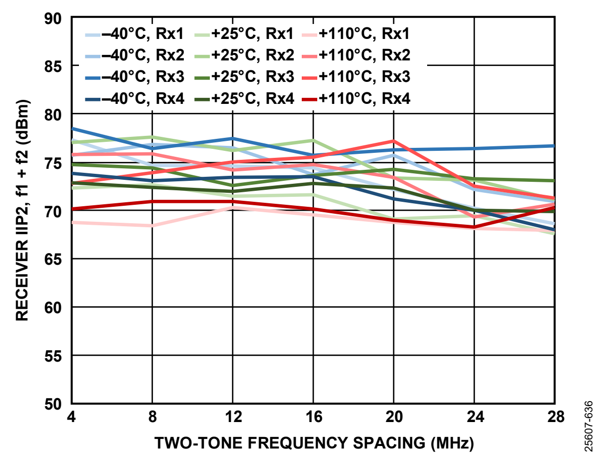


Figure 38. Receiver IIP2, f1 + f2 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

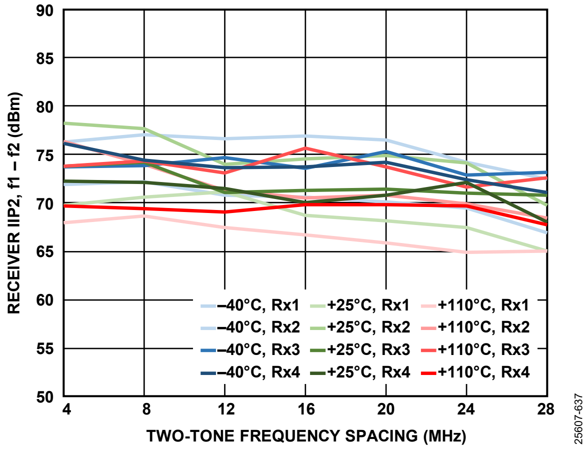


Figure 39. Receiver IIP2, f1 − f2 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

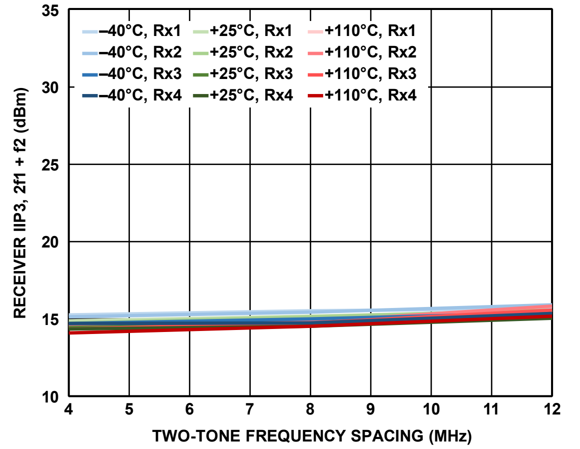


Figure 42. Receiver IIP3, 2f1 + f2 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

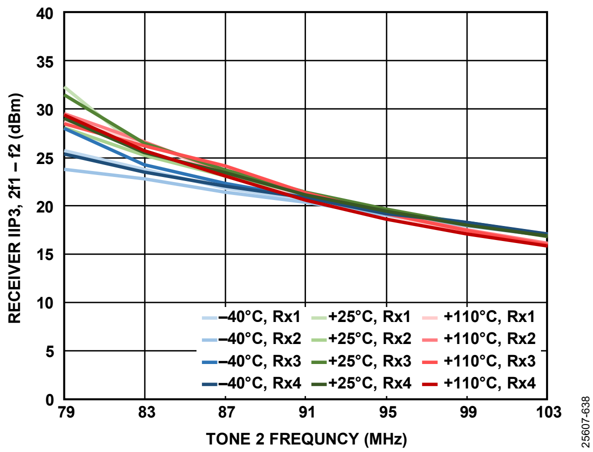


Figure 40. Receiver IIP3, 2f1 − f2 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

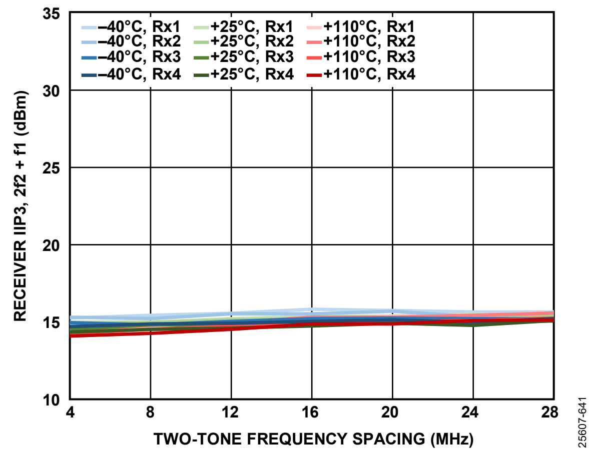


Figure 43. Receiver IIP3, 2f2 + f1 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

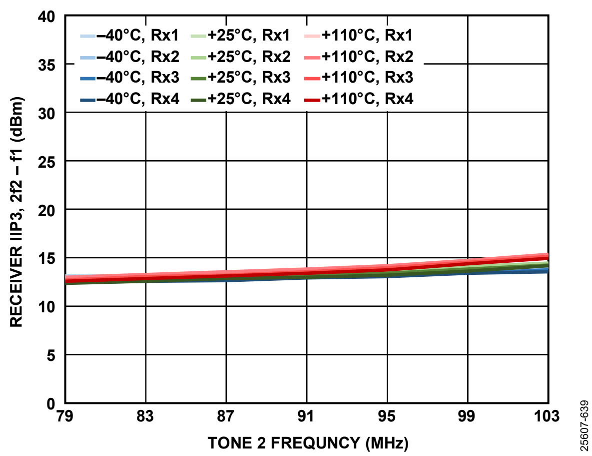


Figure 41. Receiver IIP3, 2f2 − f1 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

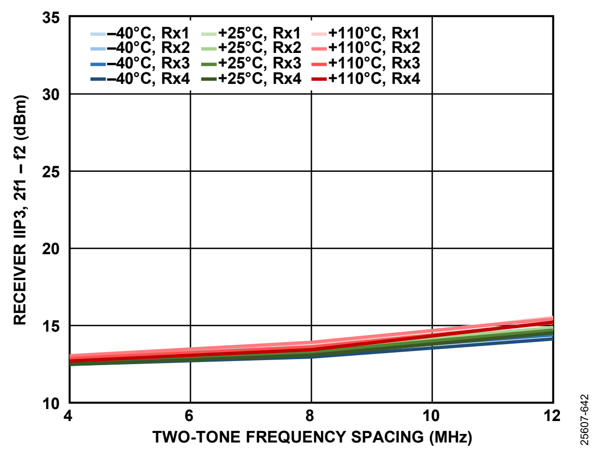


Figure 44. Receiver IIP3, 2f1 − f2 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

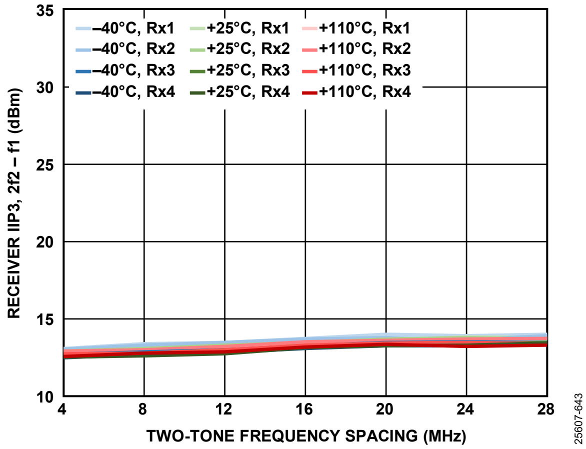


Figure 45. Receiver IIP3, 2f2 − f1 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

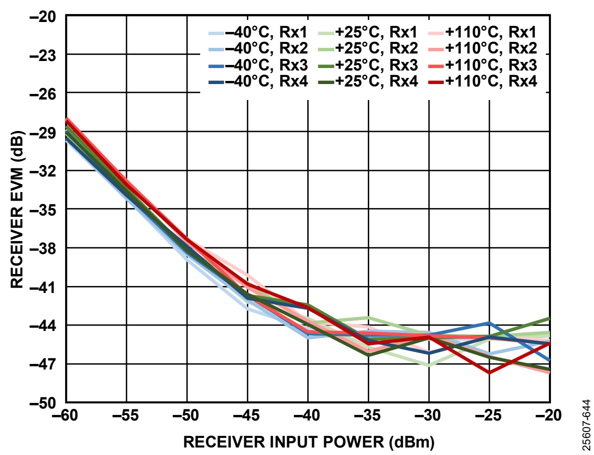


Figure 46. Receiver Error Vector Magnitude vs. Receiver Input Power, 20 MHz LTE Signal Centered at LO Frequency, Sample Rate = 153.6 MSPS, Loop Filter Bandwidth = 50 kHz, Loop Filter Phase Margin = 40°

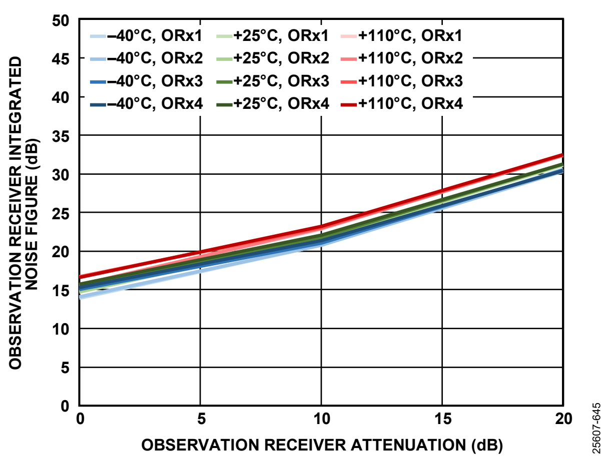


Figure 47. Observation Receiver (ORx) Integrated Noise Figure vs. Observation Receiver Attenuation, 141 MHz Bandwidth, Sample Rate = 153.6 MSPS, Integration Bandwidth = 500 kHz to 70.5 MHz

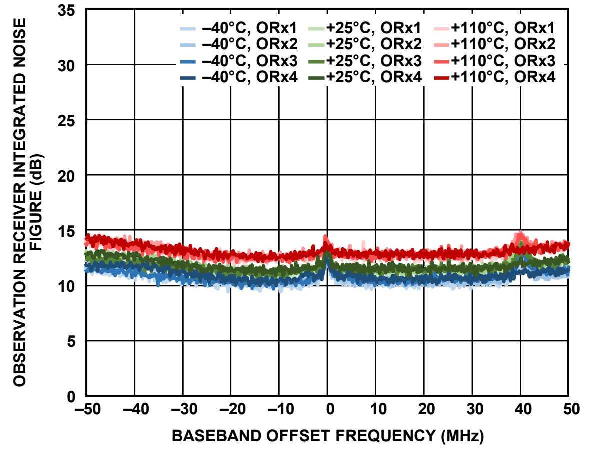


Figure 48. Observation Receiver Integrated Noise Figure vs. Baseband Offset Frequency, 141 MHz Bandwidth, Sample Rate =153.6 MSPS, Integrated in 200 kHz Steps

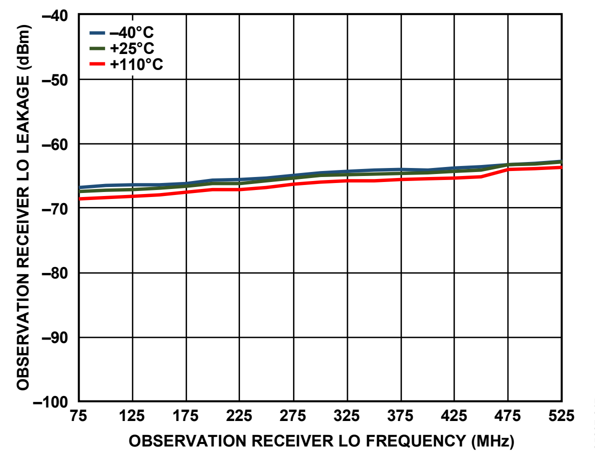


Figure 49. Observation Receiver LO Leakage vs. Observation Receiver LO Frequency, Attenuation = 0 dB, Sample Rate = 153.6 MSPS

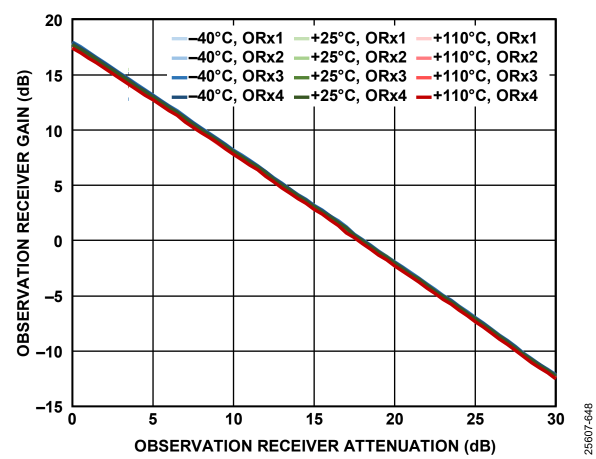


Figure 50. Observation Receiver Gain vs. Observation Receiver Attenuation, 14.1 MHz Offset, 141 MHz Bandwidth, Sample Rate = 153.6 MSPS

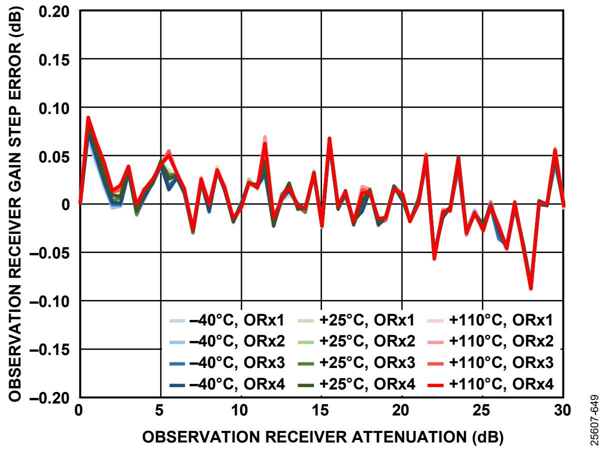


Figure 51. Observation Receiver Gain Step Error vs. Observation Receiver Attenuation, 14.1 MHz Offset, –10 dBFS Input Signal

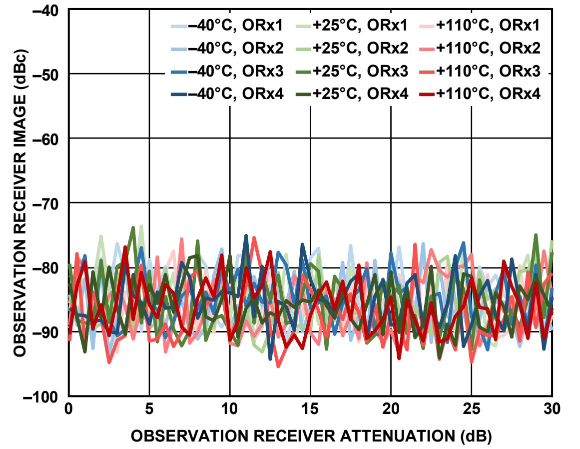


Figure 54. Observation Receiver Image vs. Observation Receiver Attenuation, 14.1 MHz Offset, Tracking Calibration Active, Sample Rate = 153.6 MSPS

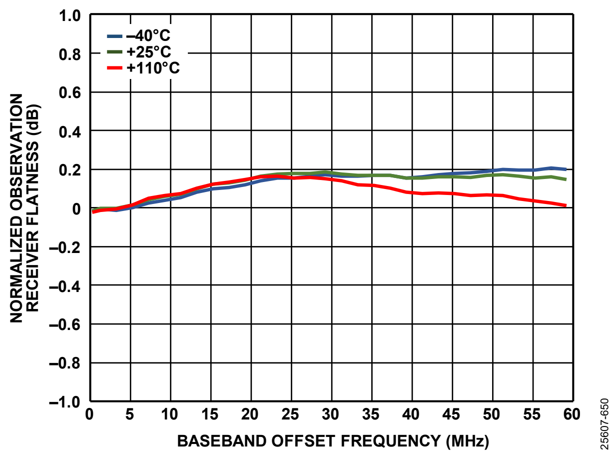


Figure 52. Normalized Observation Receiver Flatness vs. Baseband Offset Frequency, –10 dBFS Input Signal

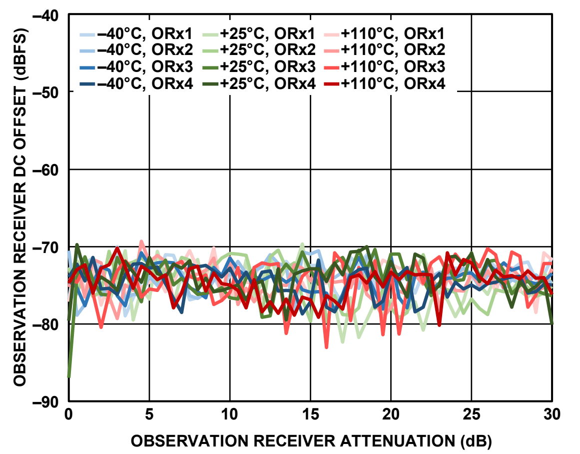


Figure 55. Observation Receiver DC Offset vs. Observation Receiver Attenuation, 14.1 MHz Offset, –10 dBFS Input Signal

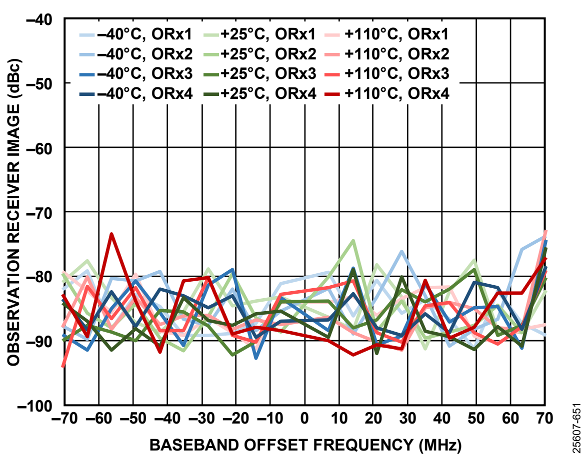


Figure 53. Observation Receiver Image vs. Baseband Offset Frequency, Tracking Calibration Active, Sample Rate = 153.6 MSPS

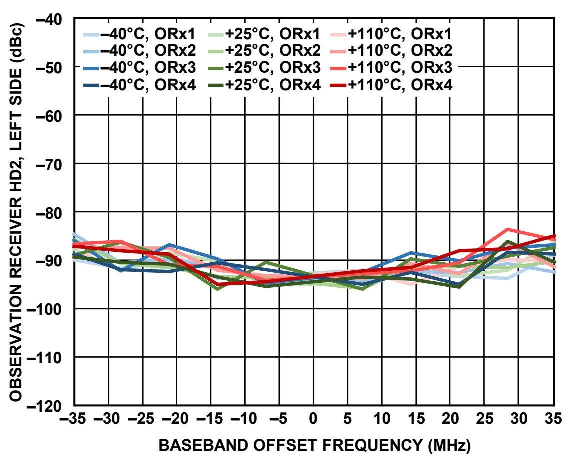


Figure 56. Observation Receiver HD2, Left Side vs. Baseband Offset Frequency, –10 dBFS Input Signal, Distortion Tone Measured Left of 0 Hz

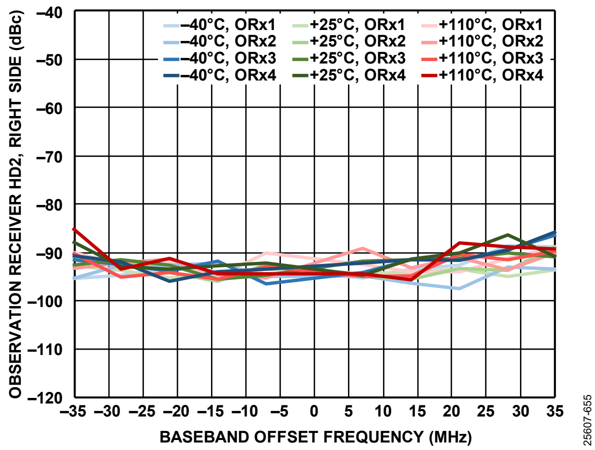


Figure 57. Observation Receiver HD2, Right Side vs. Baseband Offset Frequency, −10 dBFS Input Signal, Distortion Tone Measured Right of 0 Hz

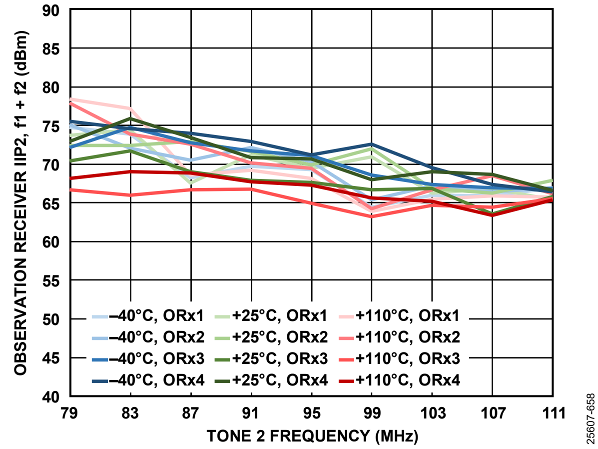


Figure 60. Observation Receiver IIP2, f1 + f2 vs. Tone 2 Frequency, Both Tones at −13 dBFS, f1 = f2 + 2 MHz

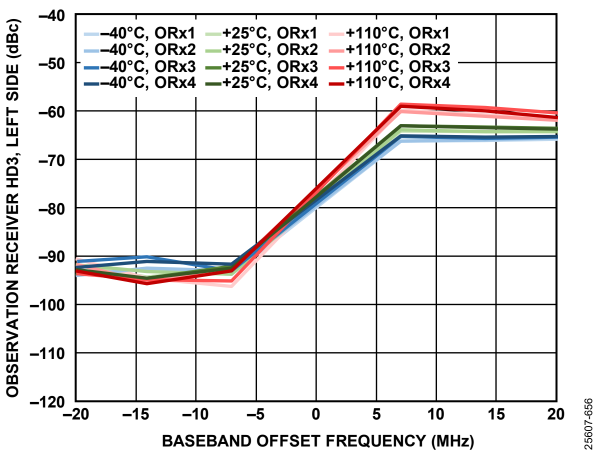


Figure 58. Observation Receiver HD3, Left Side vs. Baseband Offset Frequency, −10 dBFS Input Signal, Distortion Tone Measured Left of 0 Hz

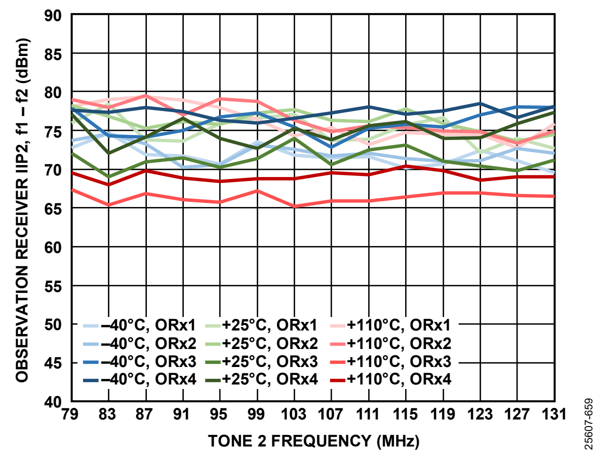


Figure 61. Observation Receiver IIP2, f1 − f2 vs. Tone 2 Frequency, Both Tones at −13 dBFS, f1 = f2 + 2 MHz

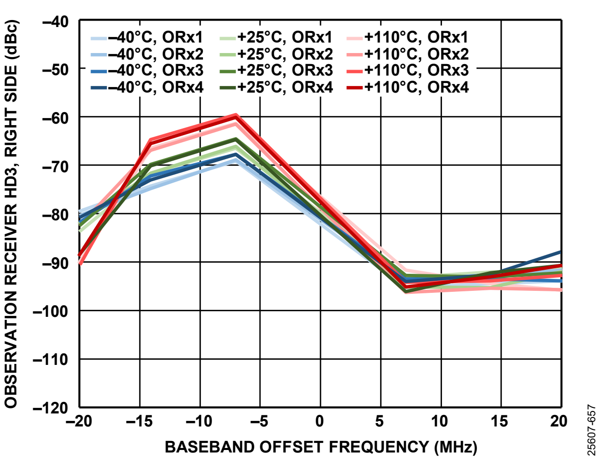


Figure 59. Observation Receiver HD3, Right Side vs. Baseband Offset Frequency, −10 dBFS Input Signal, Distortion Tone Measured Right of 0 Hz

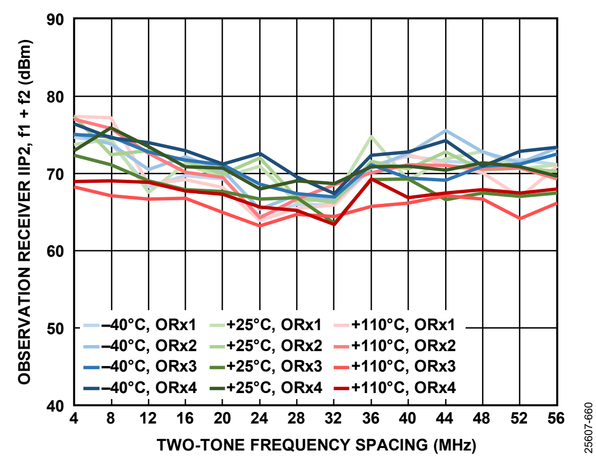


Figure 62. Observation Receiver IIP2, f1 + f2 vs. Two-Tone Frequency Spacing, Both Tones at −13 dBFS, f2 = 2 MHz

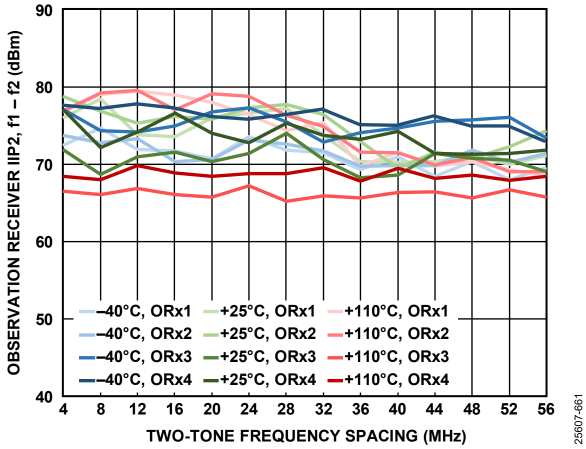


Figure 63. Observation Receiver IIP2, f1 – f2 vs. Two-Tone Frequency Spacing, Both Tones at –13 dBFS, f2 = 2 MHz

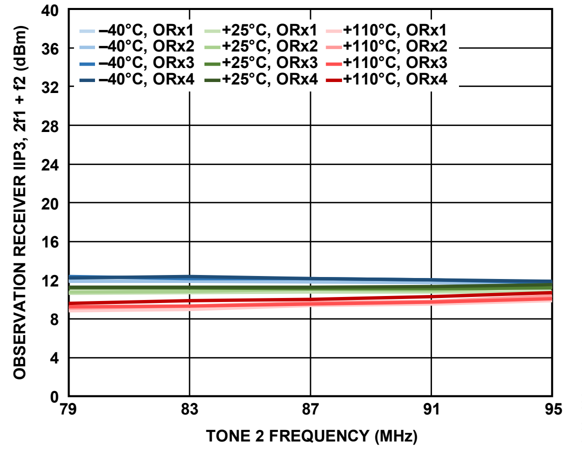


Figure 66. Observation Receiver IIP3, 2f1 + f2 vs. Tone 2 Frequency, Both Tones at –13 dBFS, f1 = f2 + 2 MHz

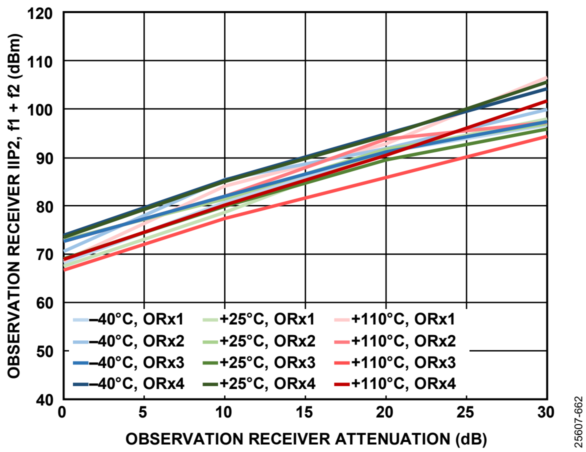


Figure 64. Observation Receiver IIP2, f1 + f2 vs. Observation Receiver Attenuation, Both Tones at –13 dBFS, f1 = 45 MHz, f2 = 2 MHz

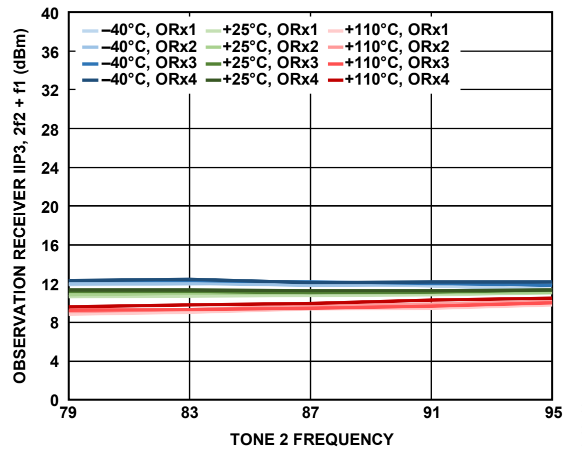


Figure 67. Observation Receiver IIP3, 2f2 + f1 vs. Tone 2 Frequency, Both Tones at –13 dBFS, f1 = f2 + 2 MHz

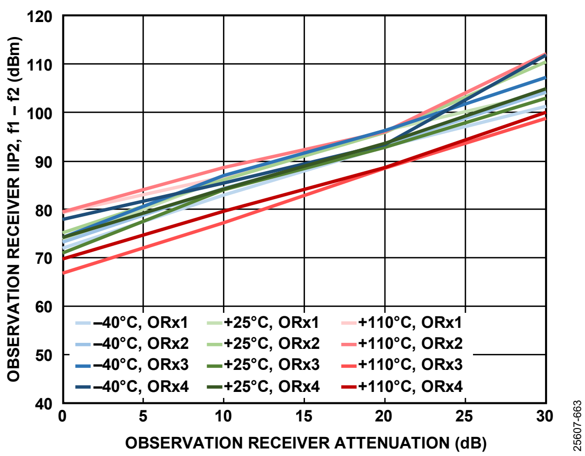


Figure 65. Observation Receiver IIP2, f1 – f2 vs. Observation Receiver Attenuation, Both Tones at –13 dBFS, f1 = 45 MHz, f2 = 2 MHz

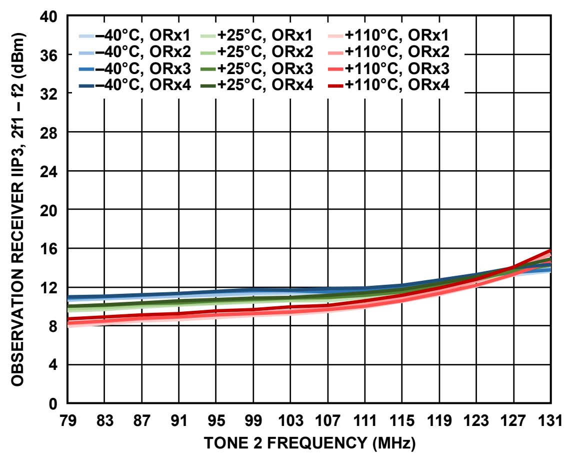


Figure 68. Observation Receiver IIP3, 2f1 – f2 vs. Tone 2 Frequency, Both Tones at –13 dBFS, f1 = f2 + 2 MHz

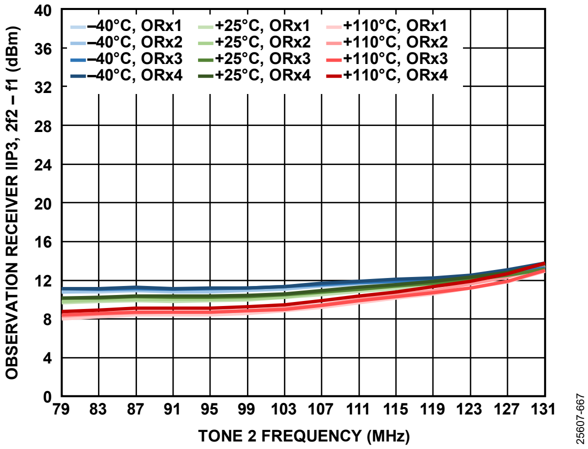


Figure 69. Observation Receiver IIP3, 2f2 – f1 vs. Tone 2 Frequency, Both Tones at –13 dBFS, f1 = f2 + 2 MHz

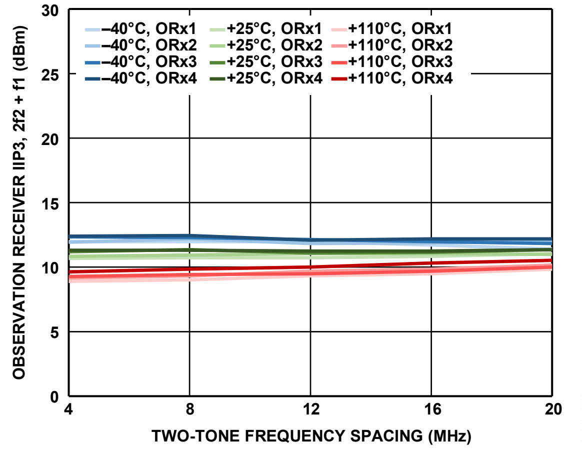


Figure 71. Observation Receiver IIP3, 2f2 + f1 vs. Two-Tone Frequency Spacing, Both Tones at –13 dBFS, f2 = 2 MHz

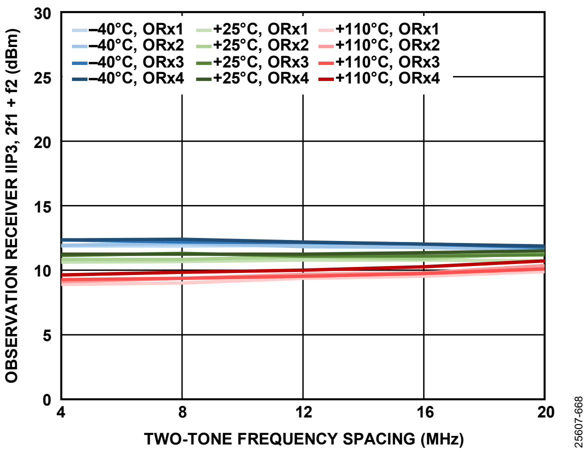


Figure 70. Observation Receiver IIP3, 2f1 + f2 vs. Two-Tone Frequency Spacing, Both Tones at –13 dBFS, f2 = 2 MHz

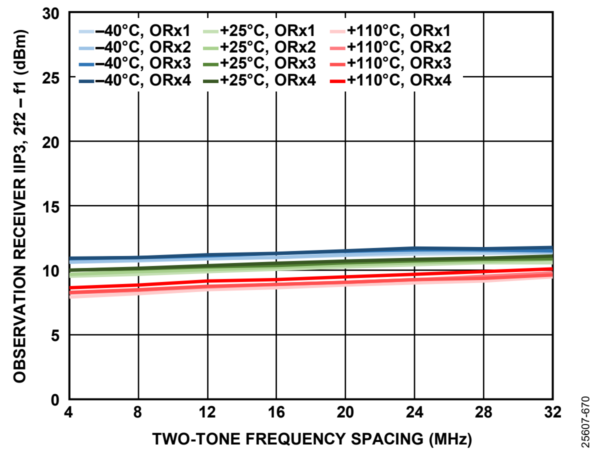


Figure 72. Observation Receiver IIP3, 2f1 – f2 vs. Two-Tone Frequency Spacing, Both Tones at –13 dBFS, f2 = 2 MHz

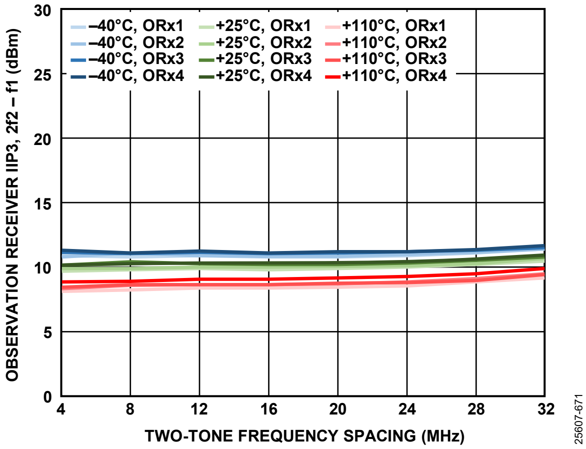


Figure 73. Observation Receiver IIP3, 2f2 − f1 vs. Two-Tone Frequency Spacing, Both Tones at −13 dBFS, f2 = 2 MHz

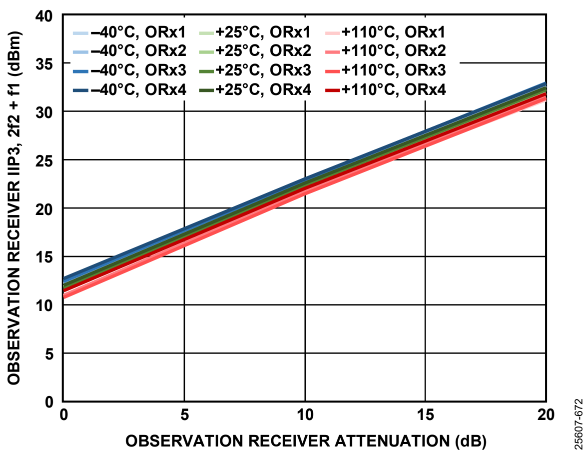


Figure 74. Observation Receiver IIP3, 2f2 + f1 vs. Observation Receiver Attenuation, Both Tones at −13 dBFS, f1 = 45 MHz, f2 = 2 MHz

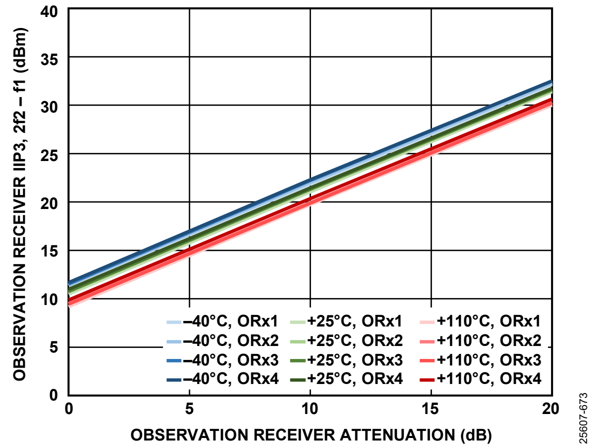


Figure 75. Observation Receiver IIP3, 2f2 − f1 vs. Observation Receiver Attenuation, Both Tones at −13 dBFS, f1 = 45 MHz, f2 = 2 MHz

800 MHz BAND

The temperature settings refer to the die temperature. All LO frequencies set to 800 MHz, unless otherwise noted.

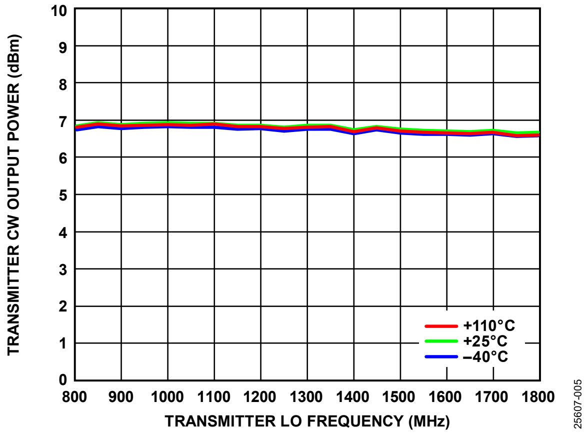


Figure 76. Transmitter Continuous Wave Output Power vs. Transmitter LO Frequency, 10 MHz Offset, 0 dB Attenuation

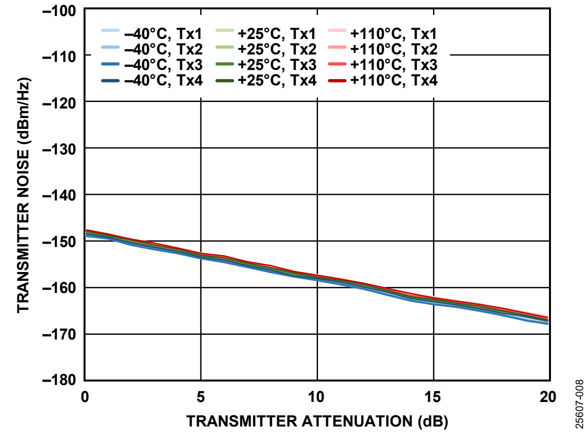


Figure 79. Transmitter Noise vs. Transmitter Attenuation, 10 MHz Offset

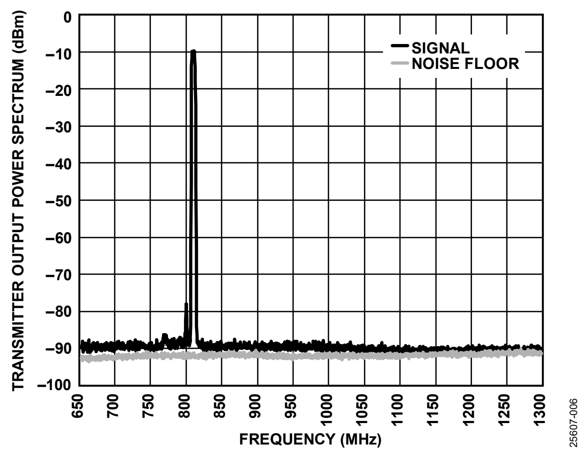


Figure 77. Transmitter Output Power Spectrum, Tx1, 5 MHz LTE, 10 MHz Offset, −10 dBFS RMS, 1 MHz Resolution Bandwidth, T_J = 25°C

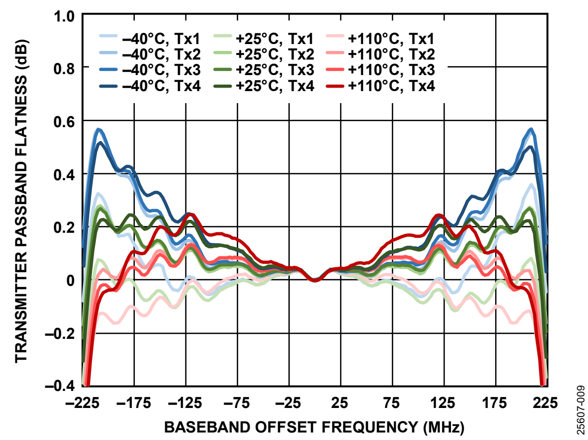


Figure 80. Transmitter Pass Band Flatness vs. Baseband Offset Frequency

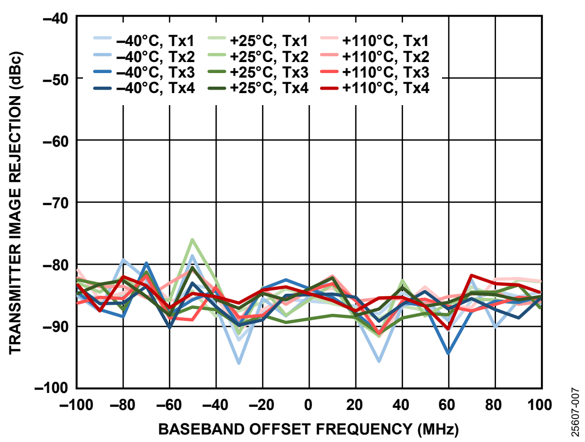


Figure 78. Transmitter Image Rejection Across Large Signal Bandwidth vs. Baseband Offset Frequency

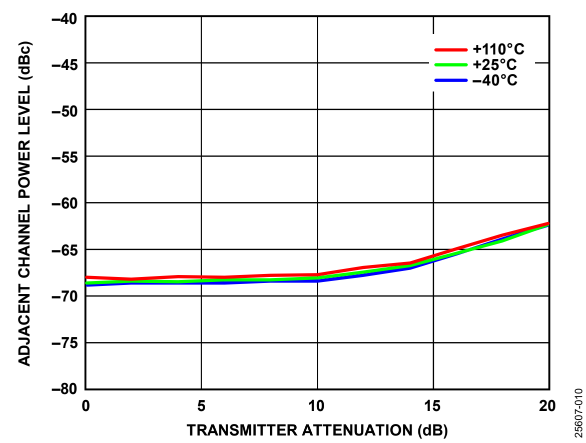


Figure 81. Adjacent Channel Power Level vs. Transmitter Attenuation, −10 MHz Baseband Offset, 20 MHz LTE, Peak to Average Ratio (PAR) = 12 dB

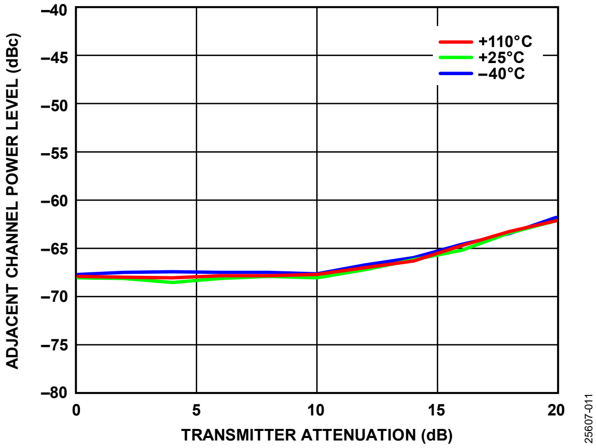


Figure 82. Adjacent Channel Power Level vs. Transmitter Attenuation, 90 MHz Baseband Offset, 20 MHz LTE, PAR = 12 dB

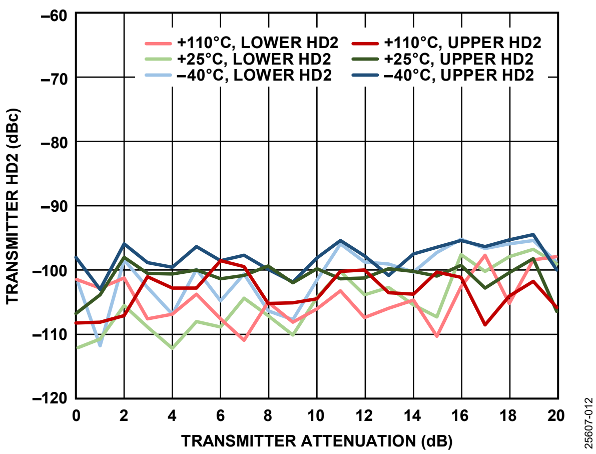


Figure 83. Transmitter Second-Order Harmonic Distortion (HD2) vs. Transmitter Attenuation, 10 MHz Offset

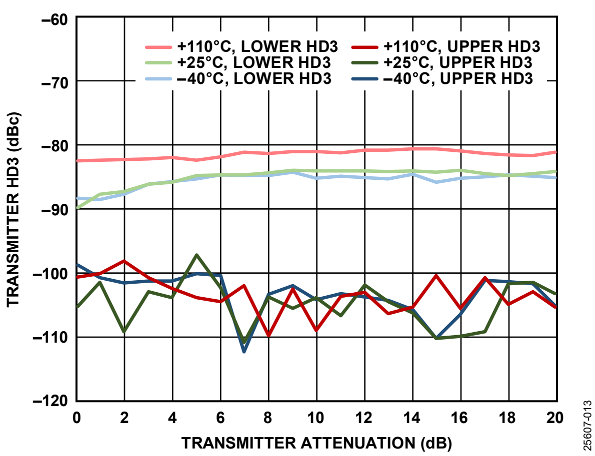


Figure 84. Transmitter Third-Order Harmonic Distortion (HD3) vs. Transmitter Attenuation, 10 MHz Offset

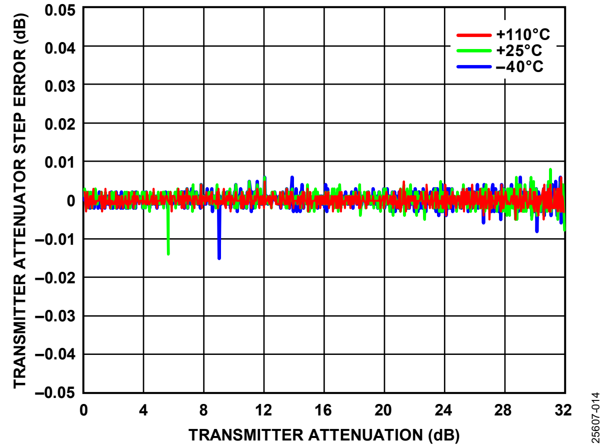


Figure 85. Transmitter Attenuator Step Error vs. Transmitter Attenuation, 10 MHz Offset

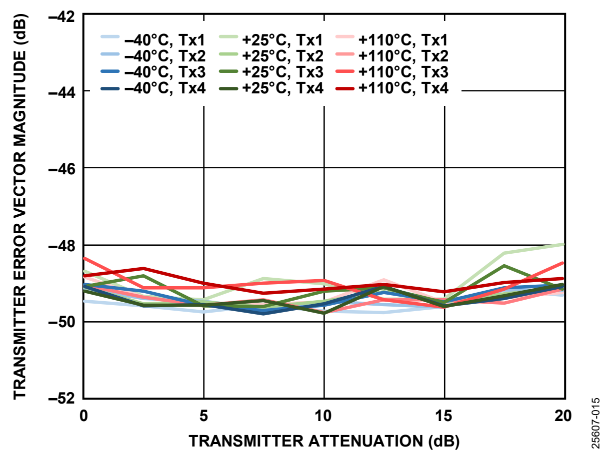


Figure 86. Transmitter Error Vector Magnitude vs. Transmitter Attenuation, 20 MHz LTE Signal Centered at LO Frequency, Sample Rate = 491.52 MSPS, Loop Filter Bandwidth = 50 kHz, Loop Filter Phase Margin = 85°

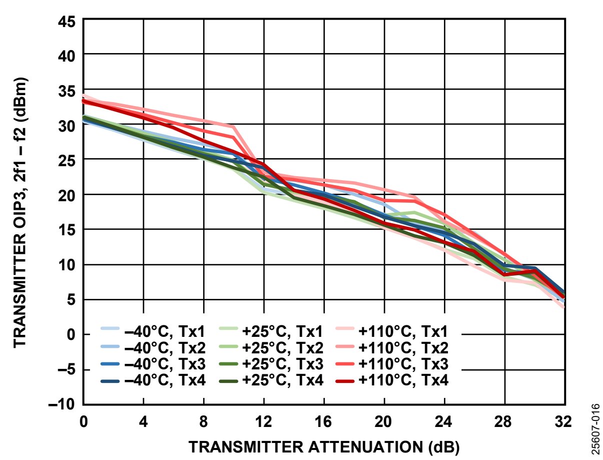


Figure 87. Transmitter OIP3, 2f1 – f2 vs. Transmitter Attenuation, 15 dB Digital Back Off per Tone, f1 = 50.5 MHz, f2 = 55.5 MHz

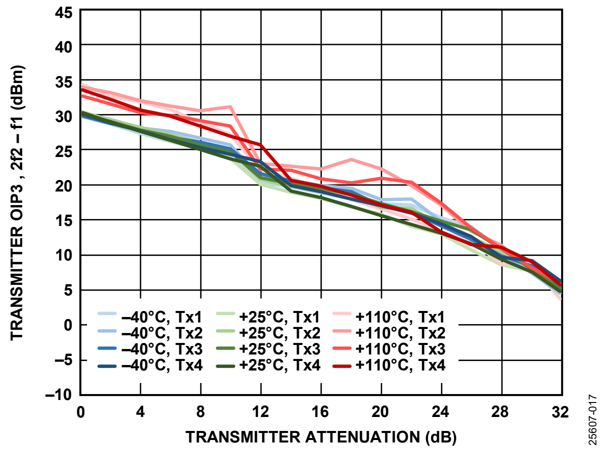


Figure 88. Transmitter OIP3, 2f2 – f1 vs. Transmitter Attenuation, 15 dB Digital Back Off per Tone, f1 = 50.5 MHz, f2 = 55.5 MHz

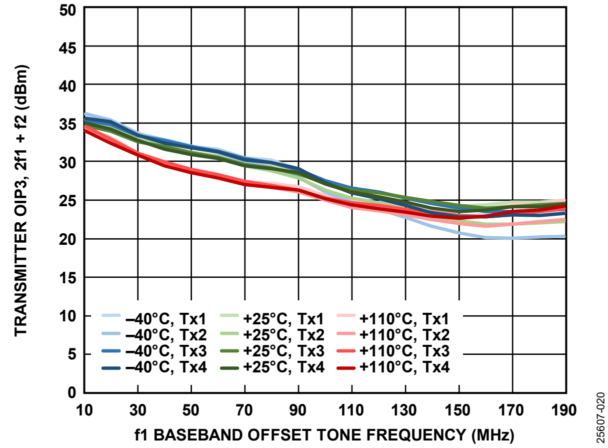


Figure 91. Transmitter OIP3, 2f1 + f2 vs. f1 Baseband Offset Tone Frequency, f2 = f1 + 5 MHz, 15 dB Digital Back Off per Tone

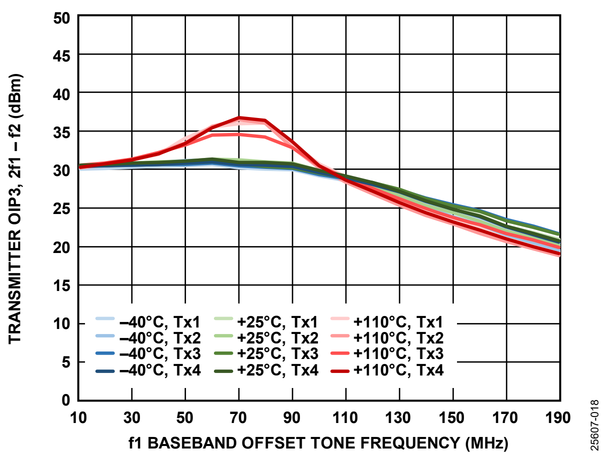


Figure 89. Transmitter OIP3, 2f1 – f2 vs. f1 Baseband Offset Tone Frequency, f2 = f1 + 5 MHz, 15 dB Digital Back Off per Tone

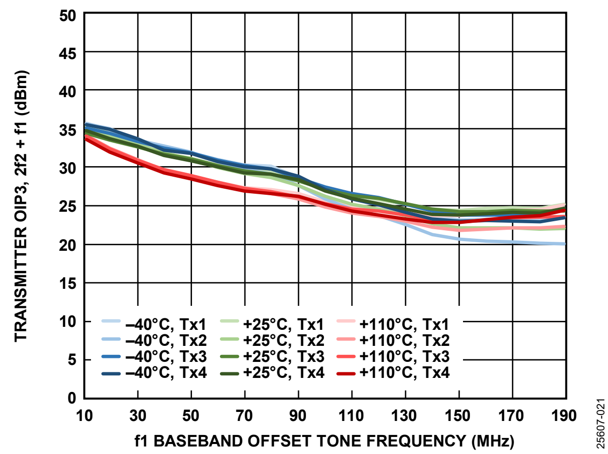


Figure 92. Transmitter OIP3, 2f2 + f1 vs. f1 Baseband Offset Tone Frequency, f2 = f1 + 5 MHz, 15 dB Digital Back Off per Tone

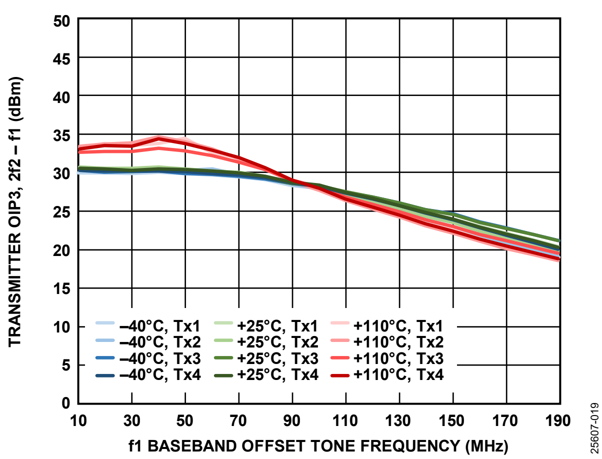


Figure 90. Transmitter OIP3, 2f2 – f1 vs. f1 Baseband Offset Tone Frequency, f2 = f1 + 5 MHz, 15 dB Digital Back Off per Tone

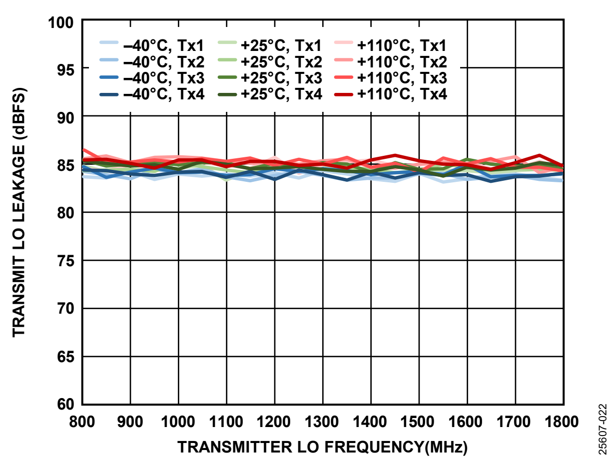


Figure 93. Transmitter LO Leakage vs. Transmitter LO Frequency

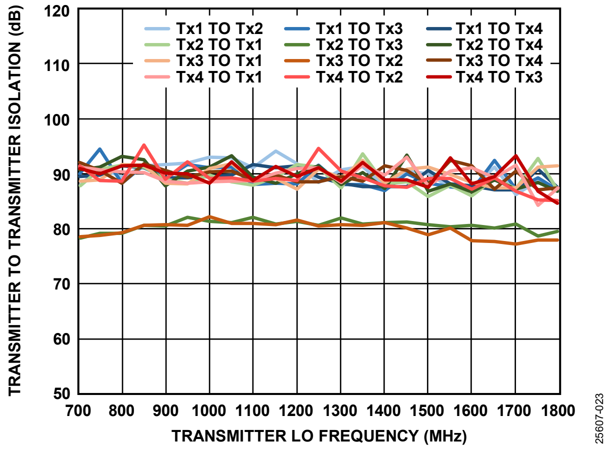


Figure 94. Transmitter to Transmitter Isolation vs. Transmitter LO Frequency

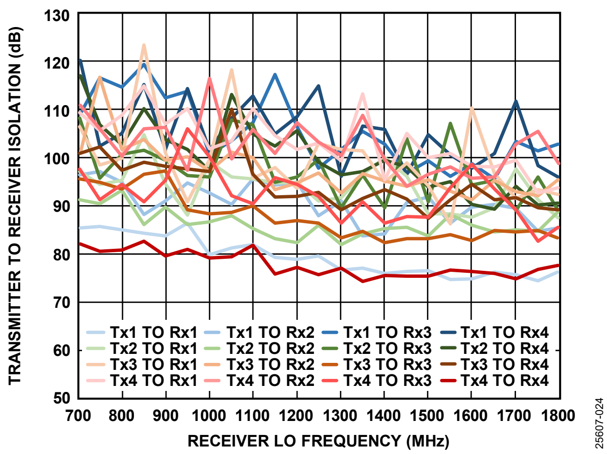


Figure 95. Transmitter to Receiver Isolation vs. Receiver LO Frequency

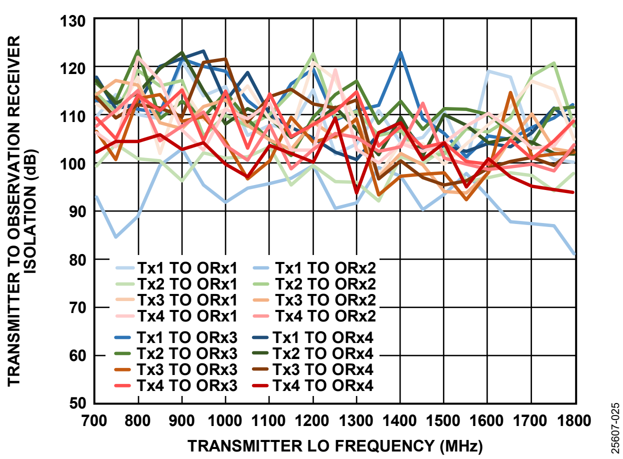


Figure 96. Transmitter to Observation Receiver Isolation vs. Transmitter LO Frequency

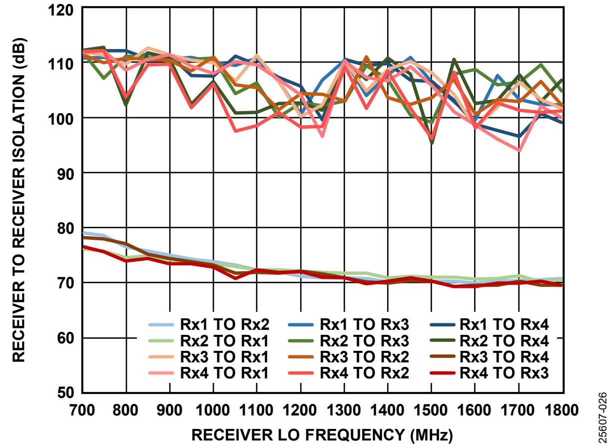


Figure 97. Receiver to Receiver Isolation vs. Receiver LO Frequency

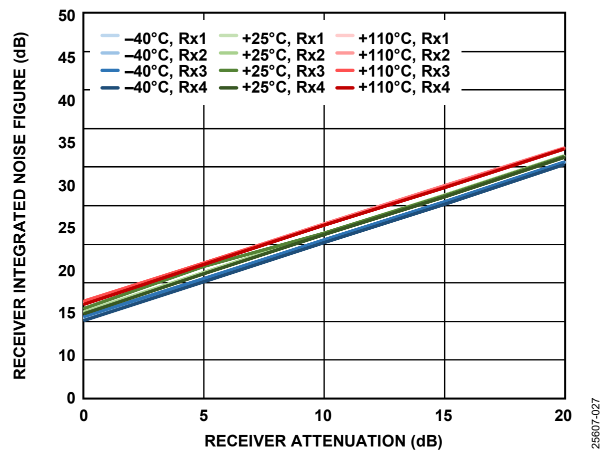


Figure 98. Receiver Integrated Noise Figure vs. Receiver Attenuation, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS, Integration Bandwidth = 500 kHz to 100 MHz

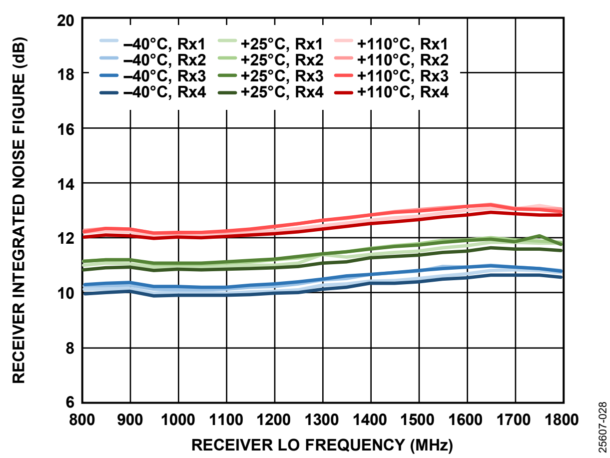


Figure 99. Receiver Integrated Noise Figure vs. Receiver LO Frequency, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS, Integration Bandwidth = 500 kHz to 100 MHz

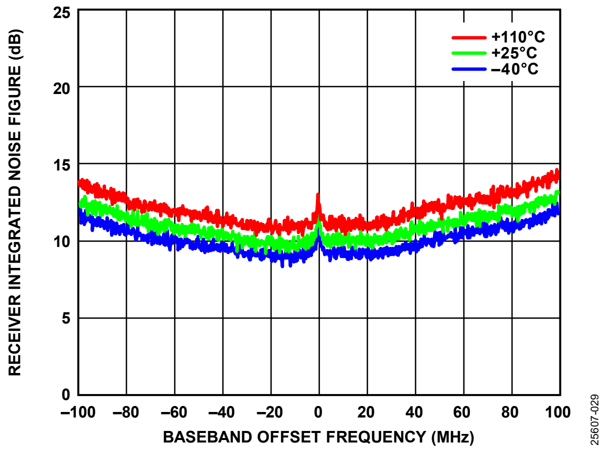


Figure 100. Receiver Integrated Noise Figure vs. Baseband Offset Frequency, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS, Integrated in 200 kHz Steps

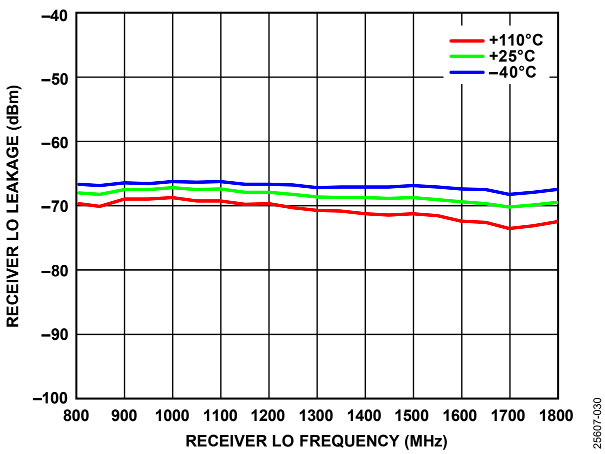


Figure 101. Receiver LO Leakage vs. Receiver LO Frequency, Attenuation = 0 dB, Sample Rate = 245.76 MSPS

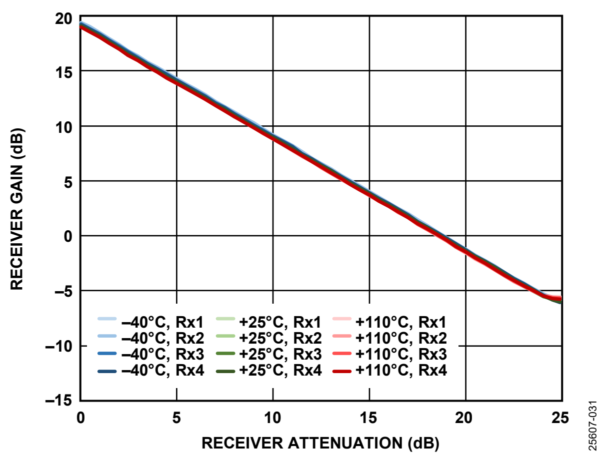


Figure 102. Receiver Gain vs. Receiver Attenuation, 20 MHz Offset, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS

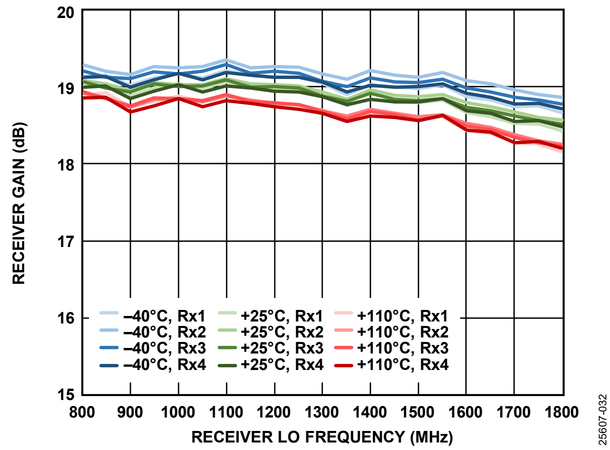


Figure 103. Receiver Gain vs. Receiver LO Frequency, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS

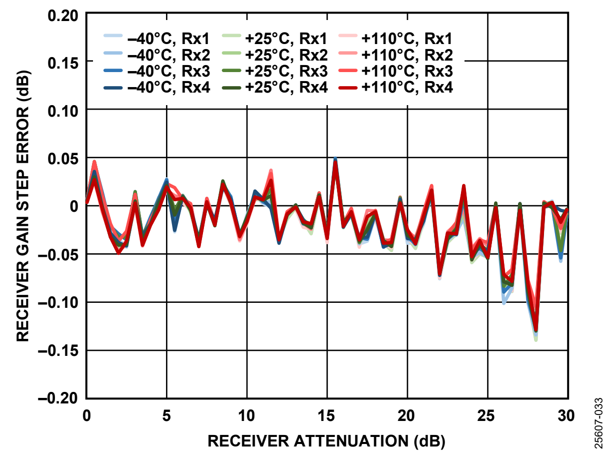


Figure 104. Receiver Gain Step Error vs. Receiver Attenuation, 20 MHz Offset, −5 dBFS Input Signal

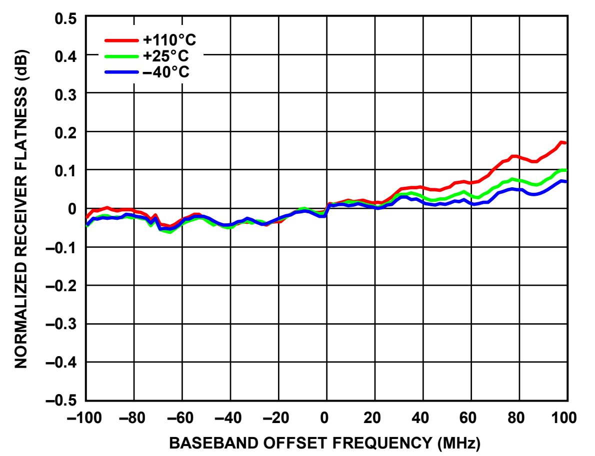


Figure 105. Normalized Receiver Flatness vs. Baseband Offset Frequency, −5 dBFS Input Signal

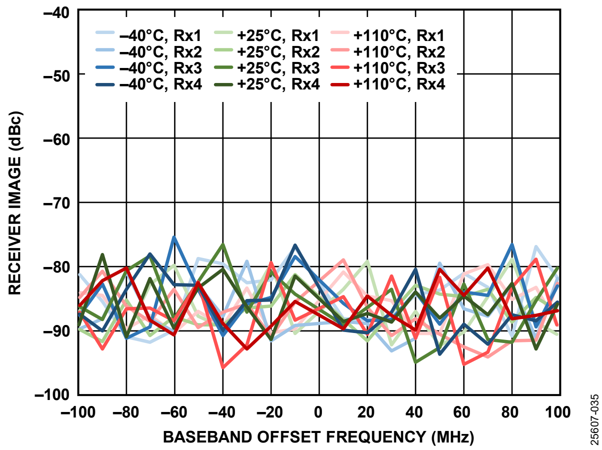


Figure 106. Receiver Image vs. Baseband Offset Frequency, Tracking Calibration Active, Sample Rate = 245.76 MSPS

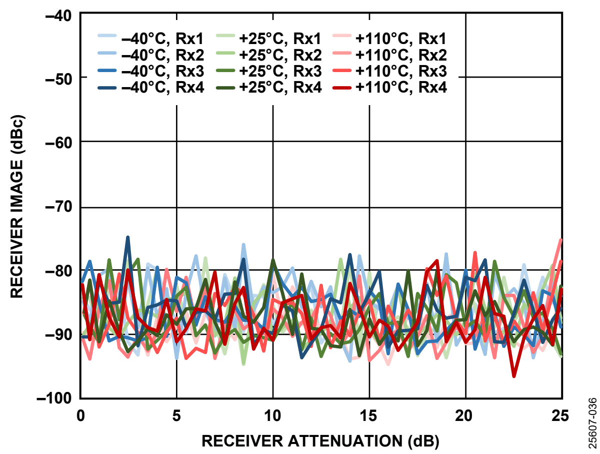


Figure 107. Receiver Image vs. Receiver Attenuation, 20 MHz Offset, Tracking Calibration Active, Sample Rate = 245.76 MSPS

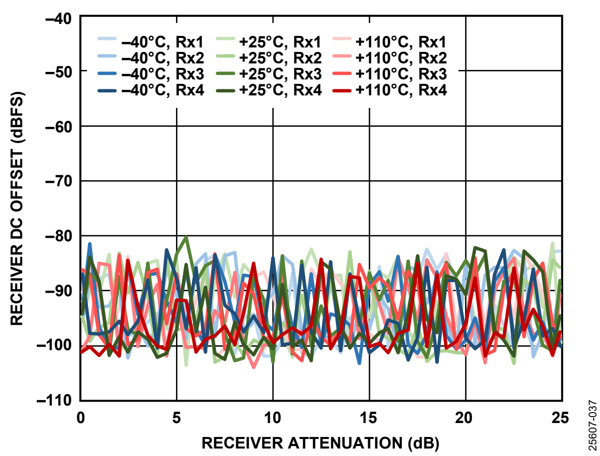


Figure 108. Receiver DC Offset vs. Receiver Attenuation, 20 MHz Offset, –5 dBFS Input Signal

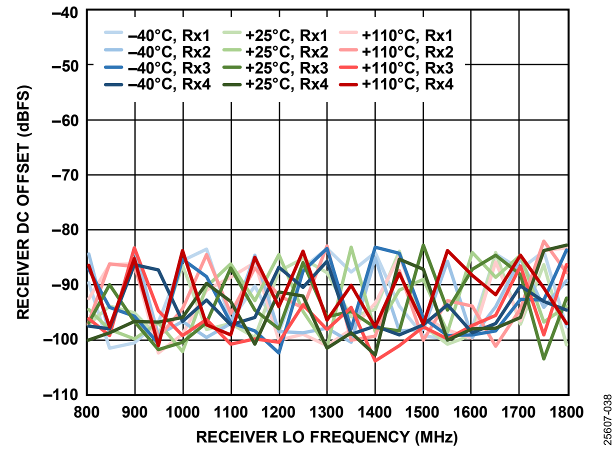


Figure 109. Receiver DC Offset vs. Receiver LO Frequency, 20 MHz Offset, –5 dBFS Input Signal

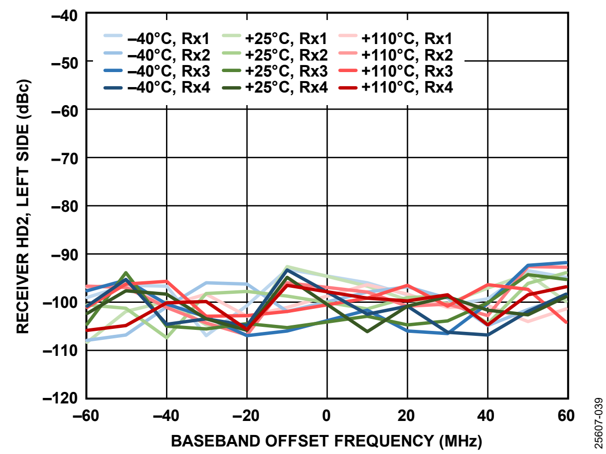


Figure 110. Receiver HD2, Left Side vs. Baseband Offset Frequency, –5 dBFS Input Signal, Distortion Tone Measured Left of 0 Hz (HD2 Canceller Enabled)

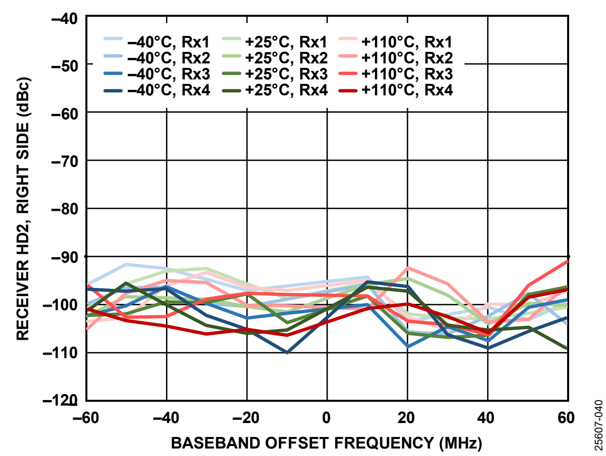


Figure 111. Receiver HD2, Right Side vs. Baseband Offset Frequency, –5 dBFS Input Signal, Distortion Tone Measured Right of 0 Hz (HD2 Canceller Enabled)

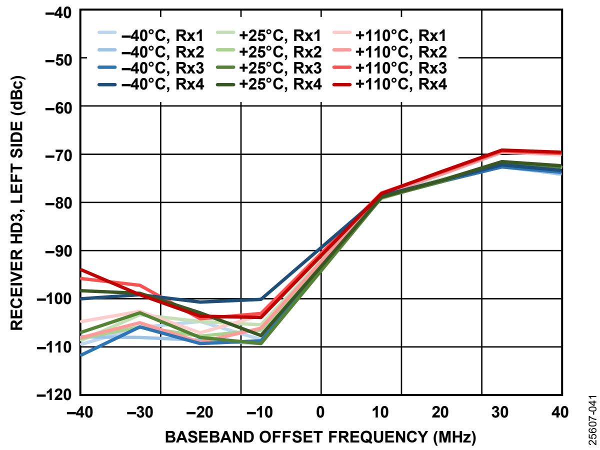


Figure 112. Receiver HD3, Left Side vs. Baseband Offset Frequency, −5 dBFS Input Signal, Distortion Tone Measured Left of 0 Hz

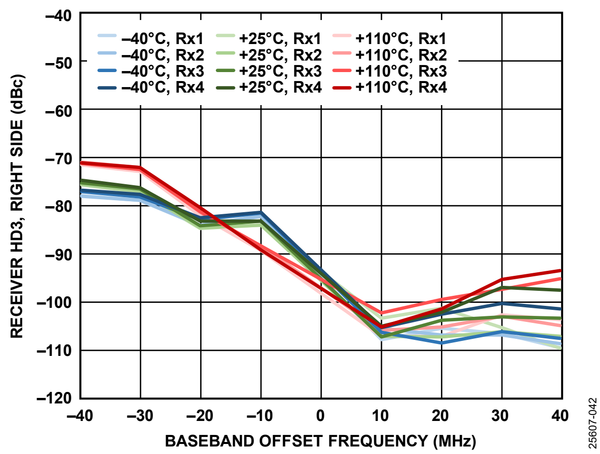


Figure 113. Receiver HD3, Right Side vs. Baseband Offset Frequency, −5 dBFS Input Signal, Distortion Tone Measured Right of 0 Hz

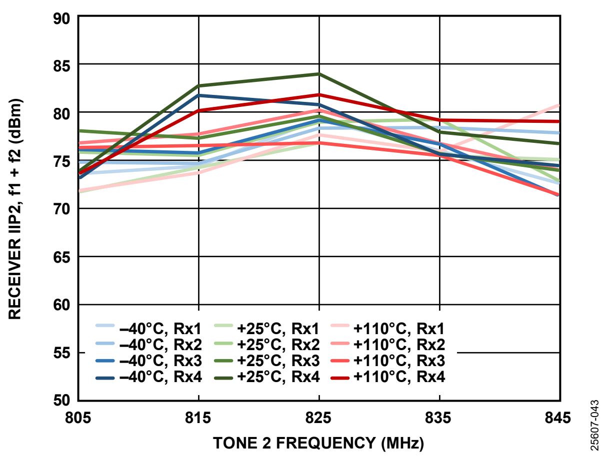


Figure 114. Receiver IIP2, f1 + f2 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

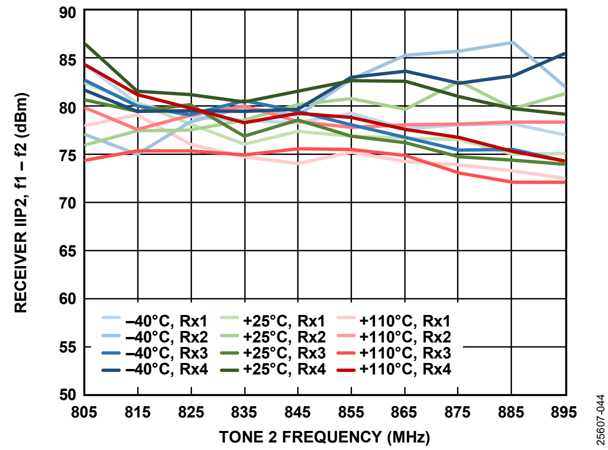


Figure 115. Receiver IIP2, f1 − f2 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

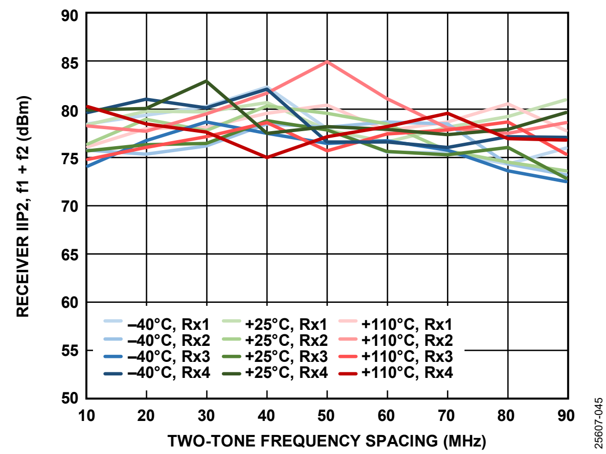


Figure 116. Receiver IIP2, f1 + f2 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

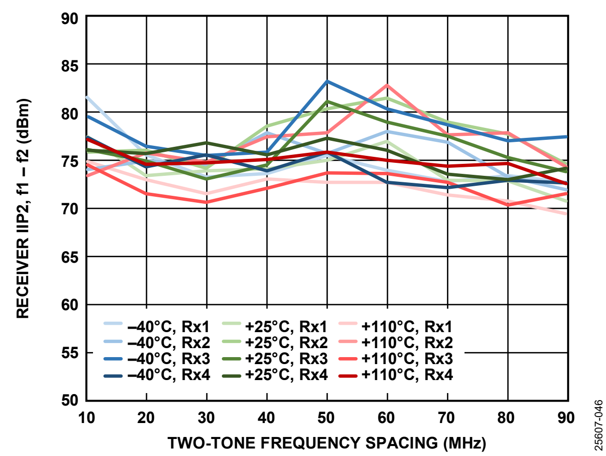


Figure 117. Receiver IIP2, f1 − f2 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

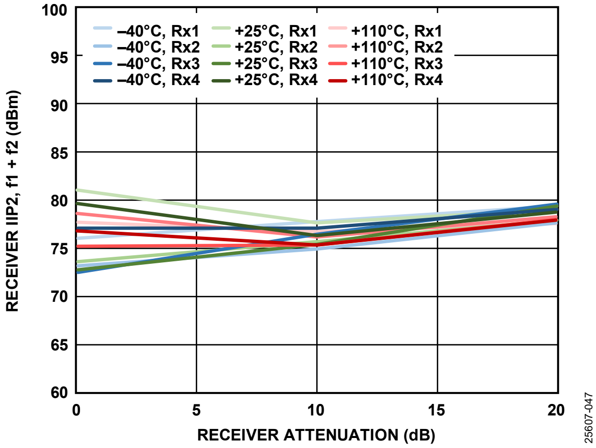


Figure 118. Receiver IIP2, f1 + f2 vs. Receiver Attenuation, Both Tones at −11 dBFS, f1 = 92 MHz, f2 = 2 MHz

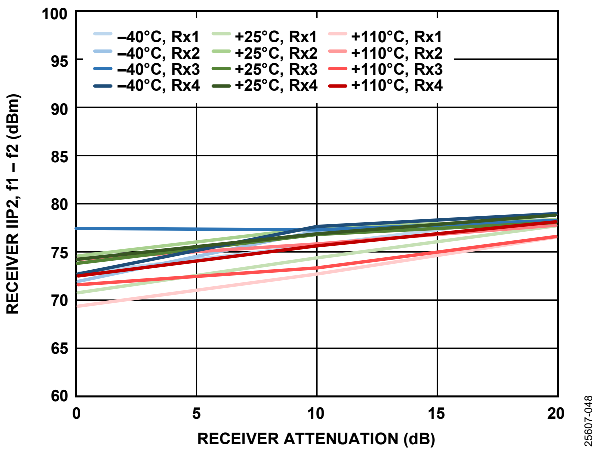


Figure 119. Receiver IIP2, f1 − f2 vs. Receiver Attenuation, Both Tones at −11 dBFS, f1 = 92 MHz, f2 = 2 MHz

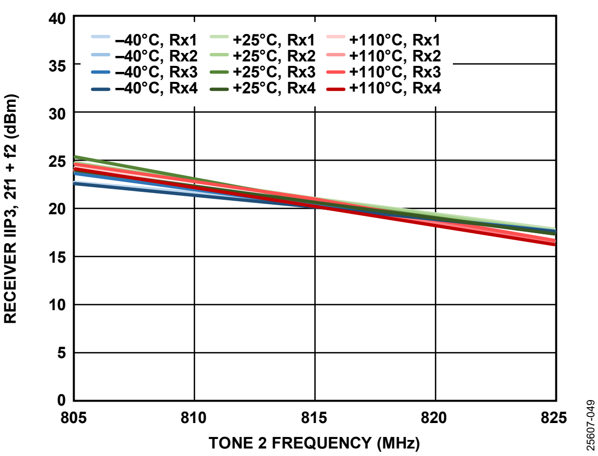


Figure 120. Receiver IIP3, 2f1 + f2 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

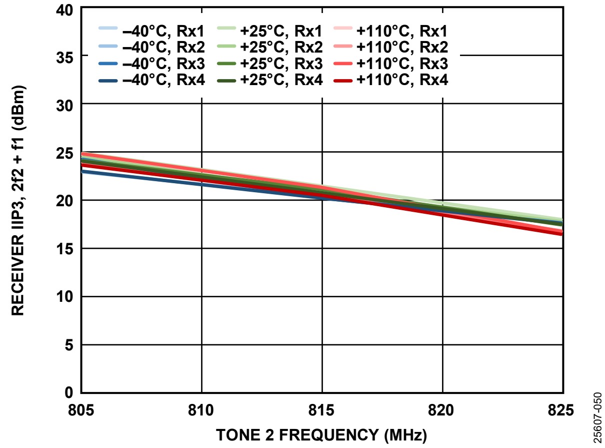


Figure 121. Receiver IIP3, 2f2 + f1 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

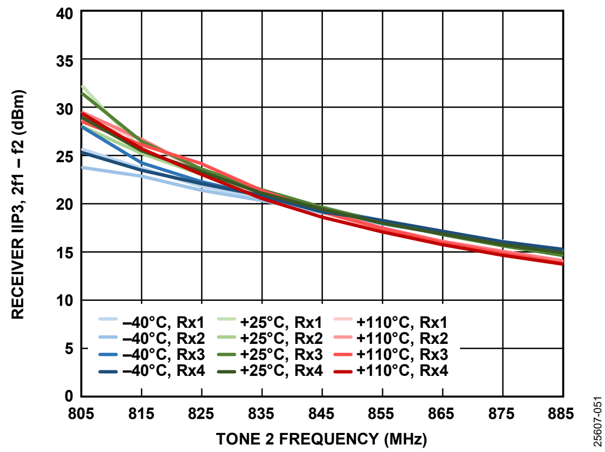


Figure 122. Receiver IIP3, 2f1 − f2 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

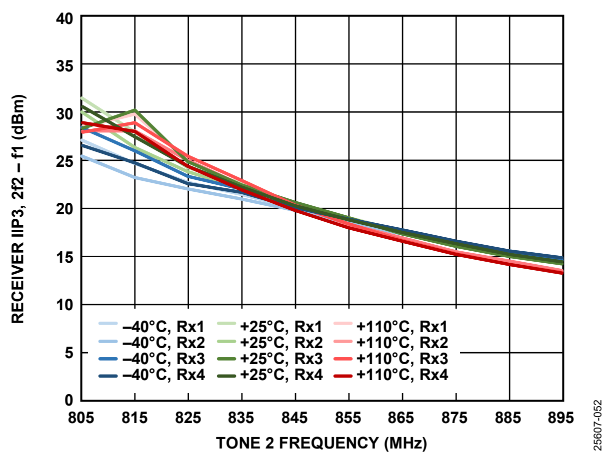


Figure 123. Receiver IIP3, 2f2 − f1 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

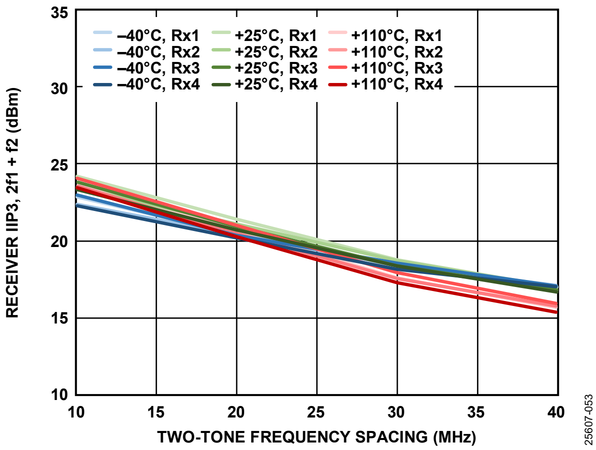


Figure 124. Receiver IIP3, 2f1 + f2 vs. Two-Tone Frequency Spacing, Both Tones at –11 dBFS, f2 = 2 MHz

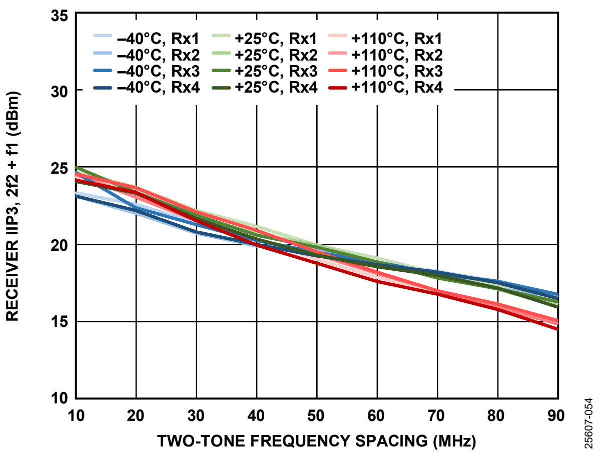


Figure 125. Receiver IIP3, 2f2 + f1 vs. Two-Tone Frequency Spacing, Both Tones at –11 dBFS, f2 = 2 MHz

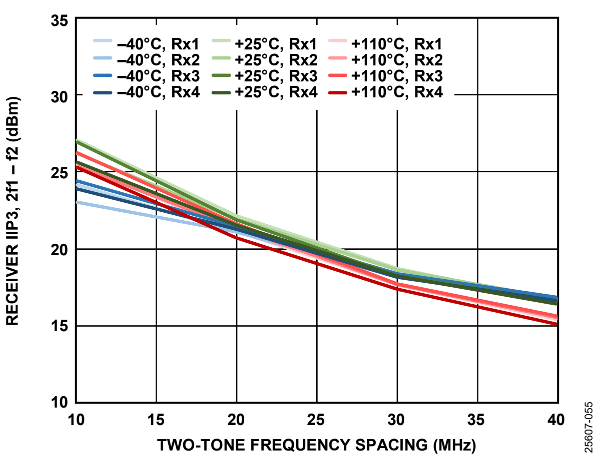


Figure 126. Receiver IIP3, 2f1 – f2 vs. Two-Tone Frequency Spacing, Both Tones at –11 dBFS, f2 = 2 MHz

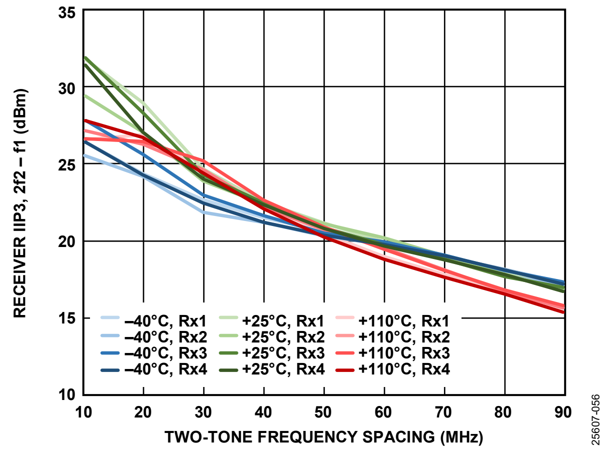


Figure 127. Receiver IIP3, 2f2 – f1 vs. Two-Tone Frequency Spacing, Both Tones at –11 dBFS, f2 = 2 MHz

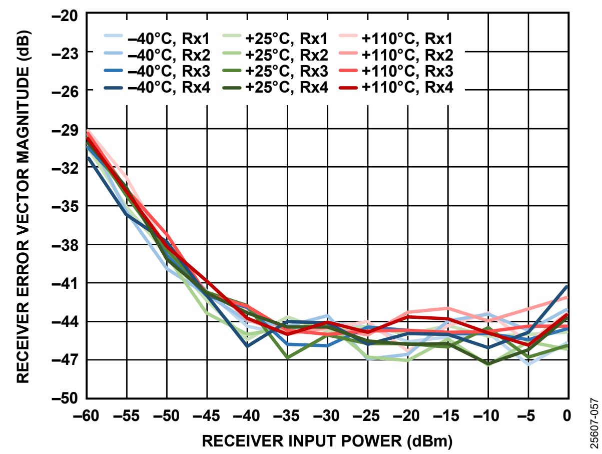


Figure 128. Receiver Error Vector Magnitude vs. Receiver Input Power, 20 MHz LTE Signal Centered at LO Frequency, Sample Rate = 245.76 MSPS, Loop Filter Bandwidth = 50 kHz, Loop Filter Phase Margin = 85°

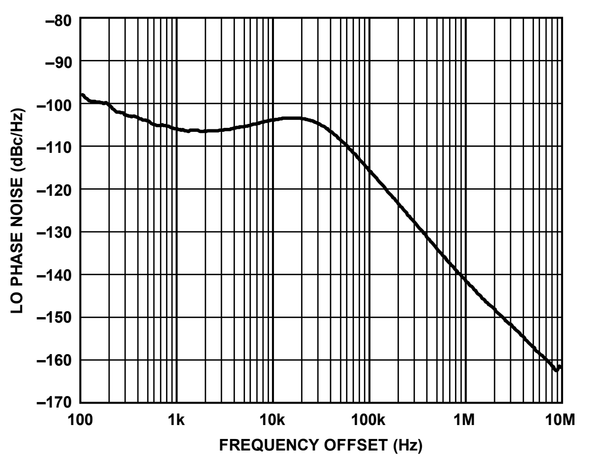


Figure 129. LO Phase Noise vs. Frequency Offset, Loop Bandwidth = 50 kHz, Phase Margin = 85°

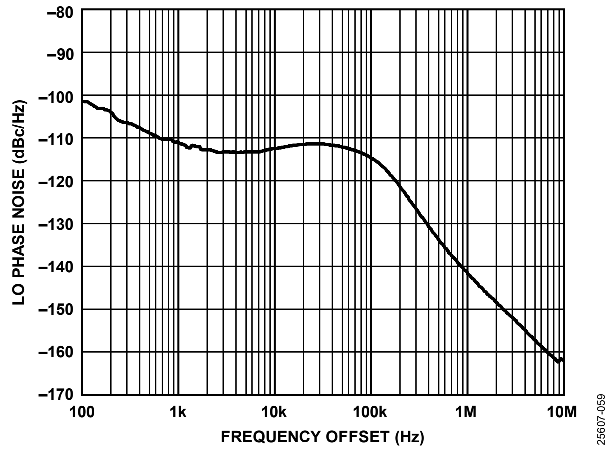


Figure 130. LO Phase Noise vs. Frequency Offset, Loop Bandwidth = 100 kHz, Phase Margin = 60°

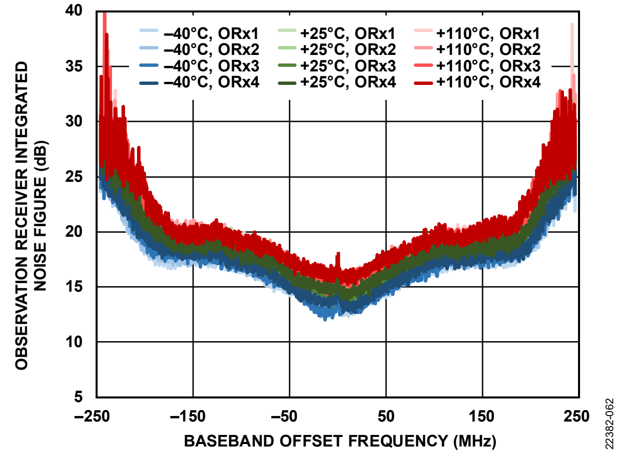


Figure 133. Observation Receiver Integrated Noise Figure vs. Baseband Offset Frequency, 450 MHz Bandwidth, Sample Rate = 491.52 MSPS, Integrated in 200 kHz Steps

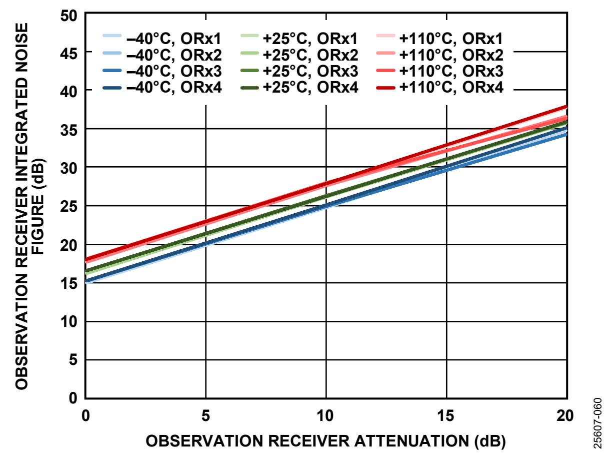


Figure 131. Observation Receiver (ORx) Integrated Noise Figure vs. Observation Receiver Attenuation, 450 MHz Bandwidth, Sample Rate = 491.52 MSPS, Integration Bandwidth = 500 kHz to 245.76 MHz

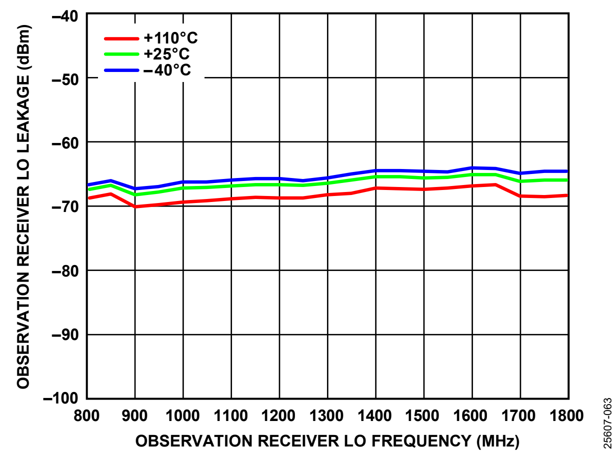


Figure 134. Observation Receiver LO Leakage vs. Observation Receiver LO Frequency, Attenuation = 0 dB, Sample Rate = 491.52 MSPS

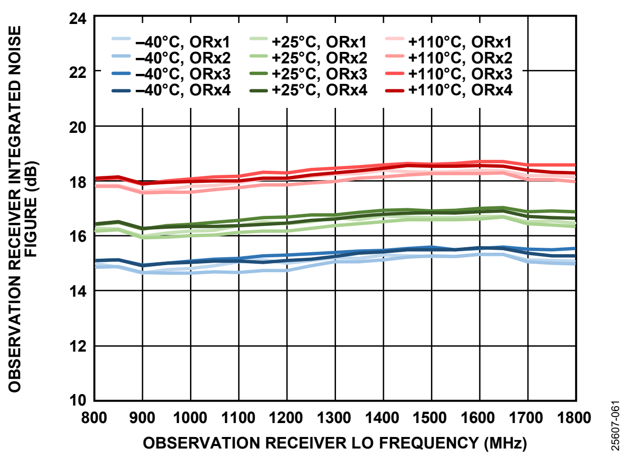


Figure 132. Observation Receiver Integrated Noise Figure vs. Observation Receiver LO Frequency, Attenuation = 0 dB, Sample Rate = 491.52 MSPS, Integration Bandwidth = 500 kHz to 245.76 MHz

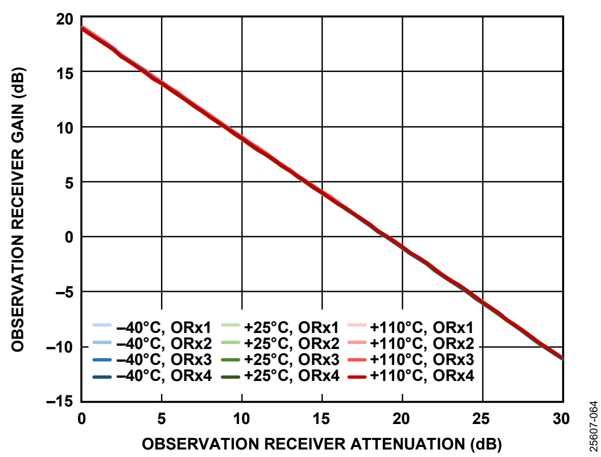


Figure 135. Observation Receiver Gain vs. Observation Receiver Attenuation, 45 MHz Offset, 450 MHz Bandwidth, Sample Rate = 491.52 MSPS

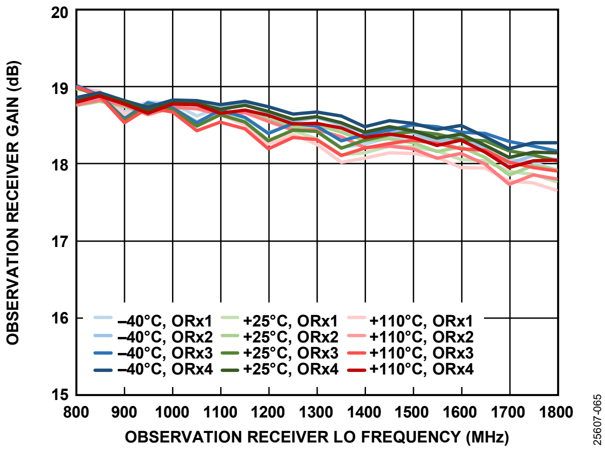


Figure 136. Observation Receiver Gain vs. Observation Receiver LO Frequency, 450 MHz Bandwidth, Sample Rate = 491.52 MSPS

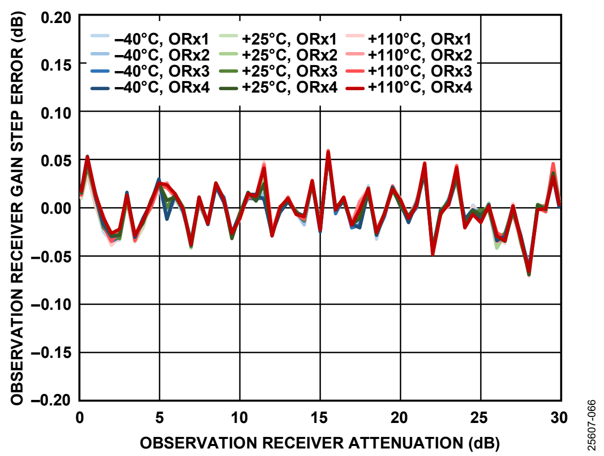


Figure 137. Observation Receiver Gain Step Error vs. Observation Receiver Attenuation, 45 MHz Offset, –10 dBFS Input Signal

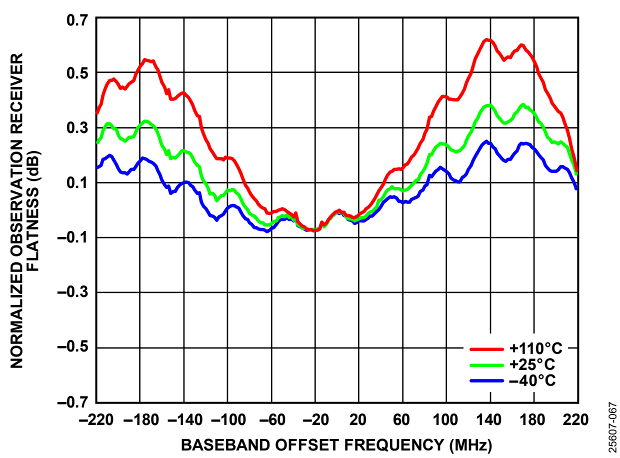


Figure 138. Normalized Observation Receiver Flatness vs. Baseband Offset Frequency, –10 dBFS Input Signal

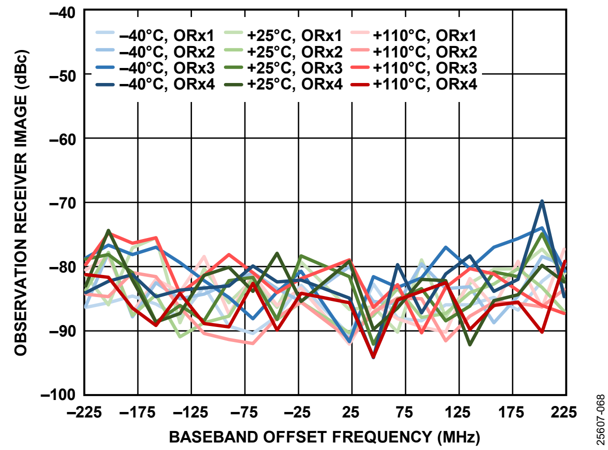


Figure 139. Observation Receiver Image vs. Baseband Offset Frequency, Tracking Calibration Active, Sample Rate = 491.52 MSPS

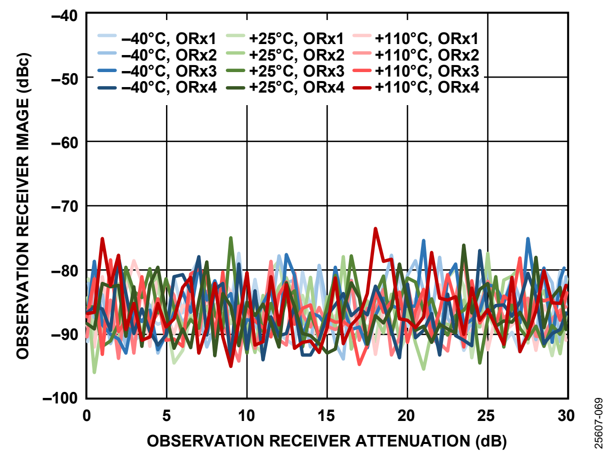


Figure 140. Observation Receiver Image vs. Observation Receiver Attenuation, 45 MHz Offset, Tracking Calibration Active, Sample Rate = 491.52 MSPS

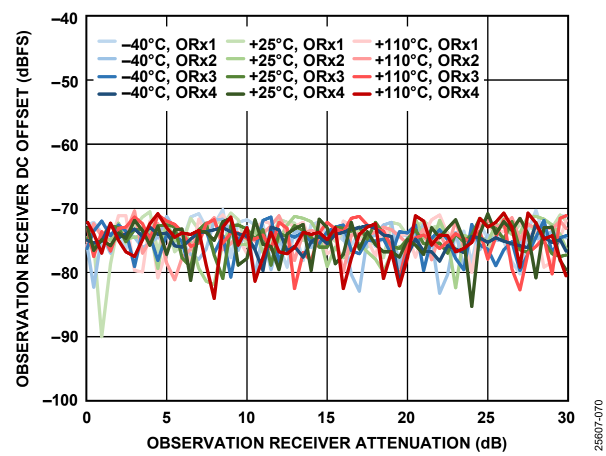


Figure 141. Observation Receiver DC Offset vs. Observation Receiver Attenuation, 45 MHz Offset, –10 dBFS Input Signal

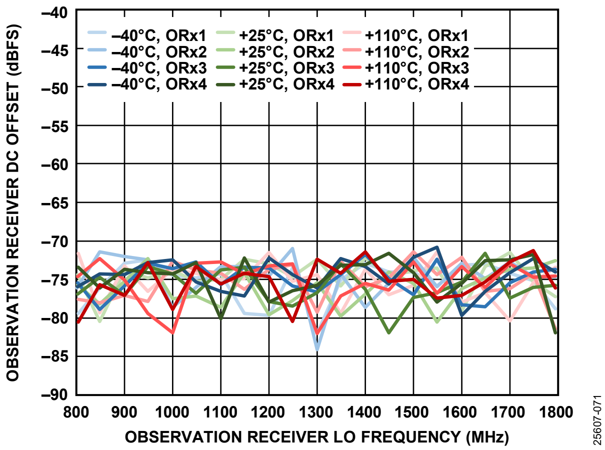


Figure 142. Observation Receiver DC Offset vs. Observation Receiver LO Frequency, Attenuation = 0 dB, Sample Rate = 491.52 MSPS

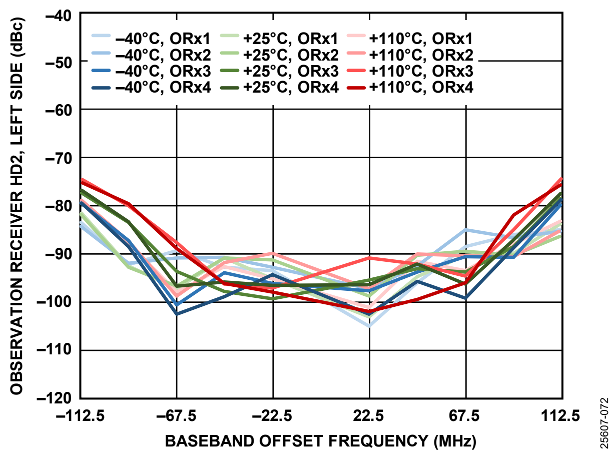


Figure 143. Observation Receiver HD2, Left Side vs. Baseband Offset Frequency, −10 dBFS Input Signal, Distortion Tone Measured Left of 0 Hz

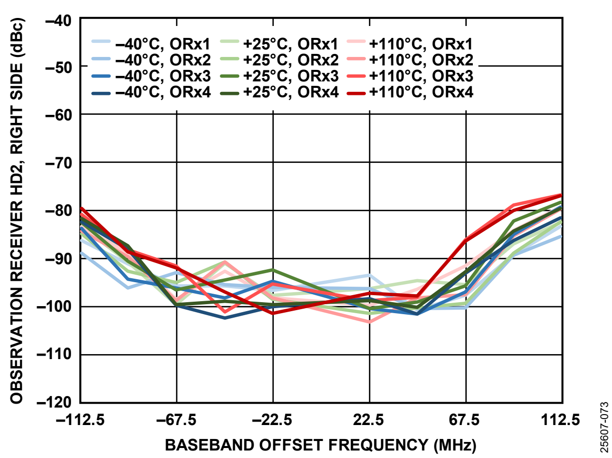


Figure 144. Observation Receiver HD2, Right Side vs. Baseband Offset Frequency, −10 dBFS Input Signal, Distortion Tone Measured Right of 0 Hz

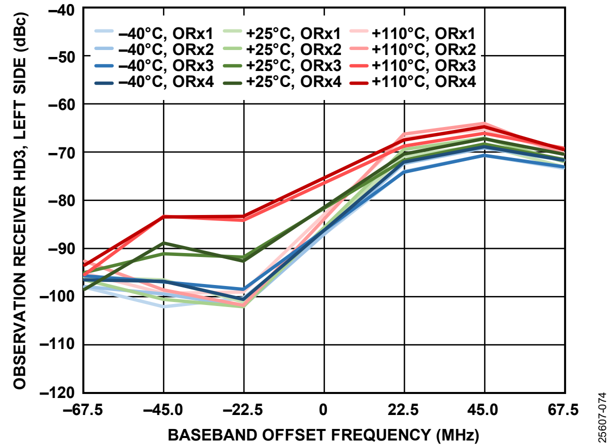


Figure 145. Observation Receiver HD3, Left Side vs. Baseband Offset Frequency, −10 dBFS Input Signal, Distortion Tone Measured Left of 0 Hz

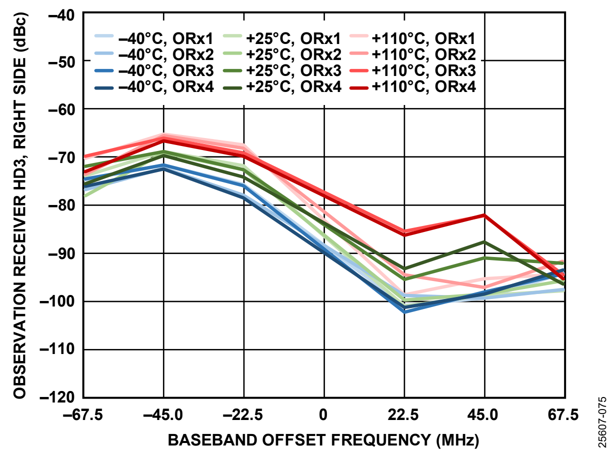


Figure 146. Observation Receiver HD3, Right Side vs. Baseband Offset Frequency, −10 dBFS Input Signal, Distortion Tone Measured Right of 0 Hz

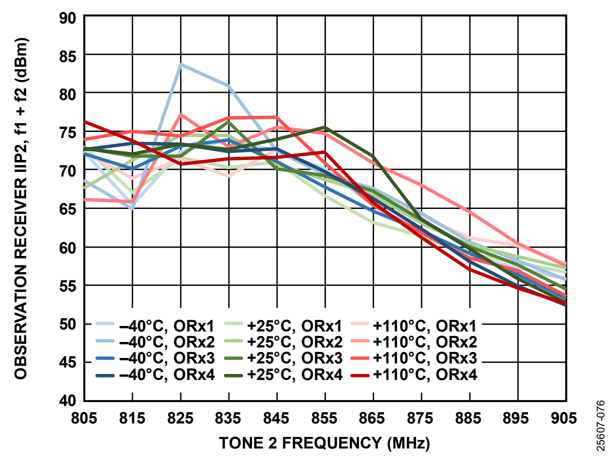


Figure 147. Observation Receiver IIP2, f1 + f2 vs. Tone 2 Frequency, Both Tones at −13 dBFS, f1 = f2 + 2 MHz

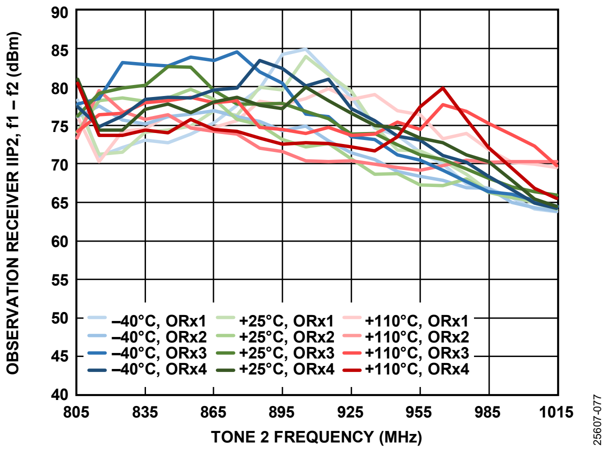


Figure 148. Observation Receiver IIP2, f1 – f2 vs. Tone 2 Frequency, Both Tones at –13 dBFS, f1 = f2 + 2 MHz

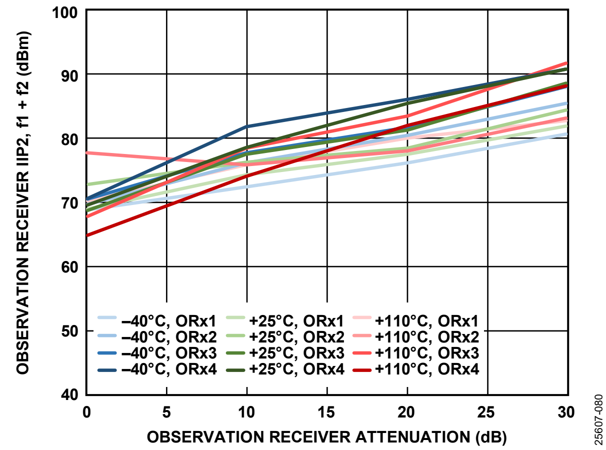


Figure 151. Observation Receiver IIP2, f1 + f2 vs. Observation Receiver Attenuation, Both Tones at –13 dBFS, f1 = 102 MHz, f2 = 2 MHz

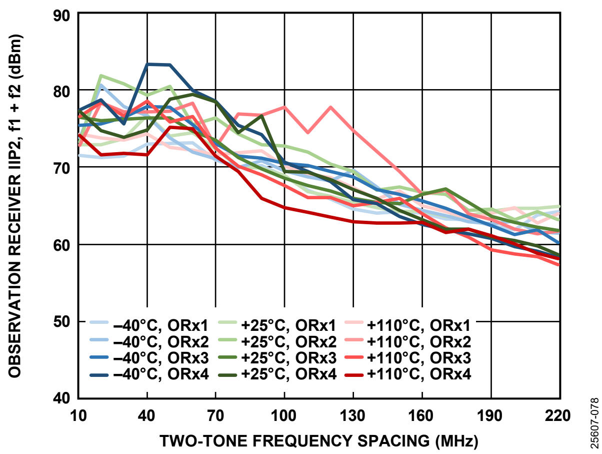


Figure 149. Observation Receiver IIP2, f1 + f2 vs. Two-Tone Frequency Spacing, Both Tones at –13 dBFS, f2 = 2 MHz

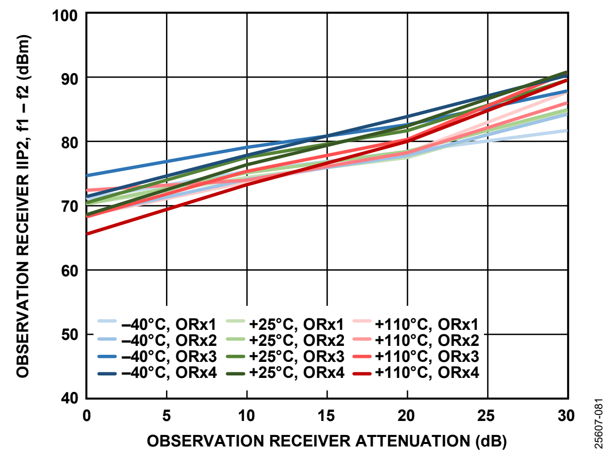


Figure 152. Observation Receiver IIP2, f1 – f2 vs. Observation Receiver Attenuation, Both Tones at –13 dBFS, f1 = 102 MHz, f2 = 2 MHz

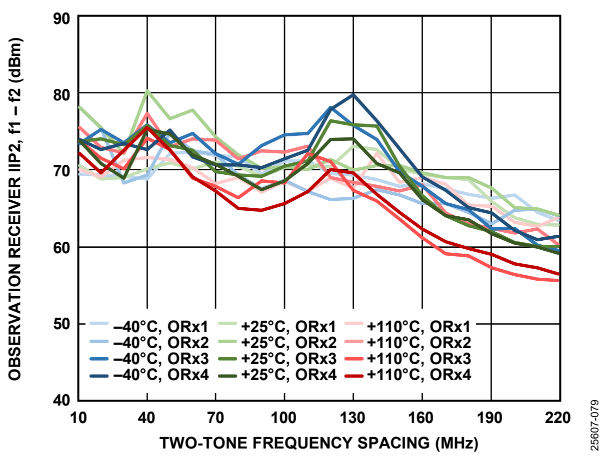


Figure 150. Observation Receiver IIP2, f1 – f2 vs. Two-Tone Frequency Spacing, Both Tones at –13 dBFS, f2 = 2 MHz

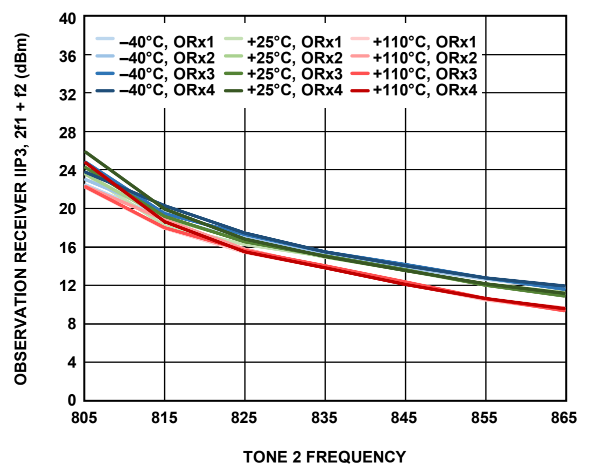


Figure 153. Observation Receiver IIP3, 2f1 + f2 vs. Tone 2 Frequency, Both Tones at –13 dBFS, f1 = f2 + 2 MHz

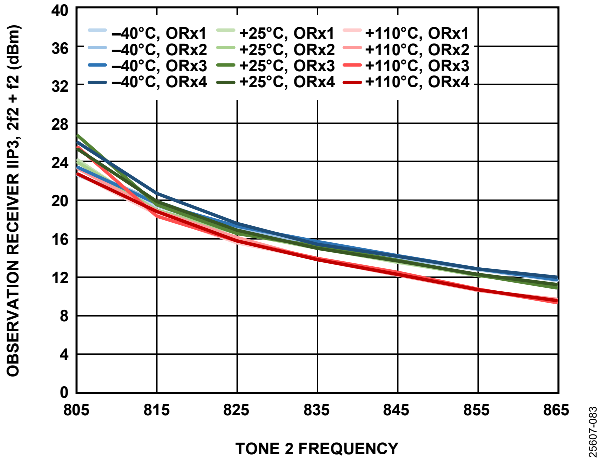


Figure 154. Observation Receiver IIP3, 2f2 + f2 vs. Tone 2 Frequency, Both Tones at −13 dBFS, f1 = f2 + 2 MHz

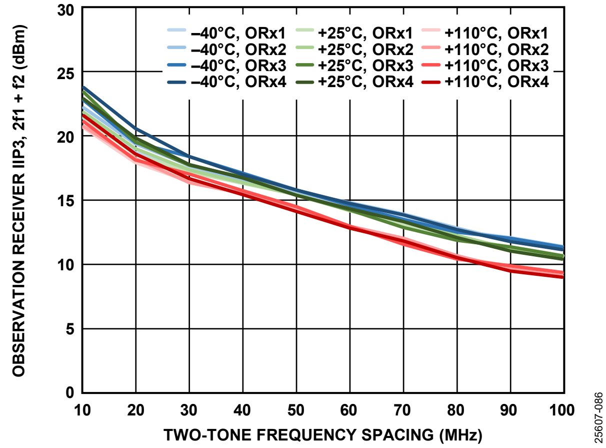


Figure 157. Observation Receiver IIP3, 2f1 + f2 vs. Two-Tone Frequency Spacing, Both Tones at −13 dBFS, f2 = 2 MHz

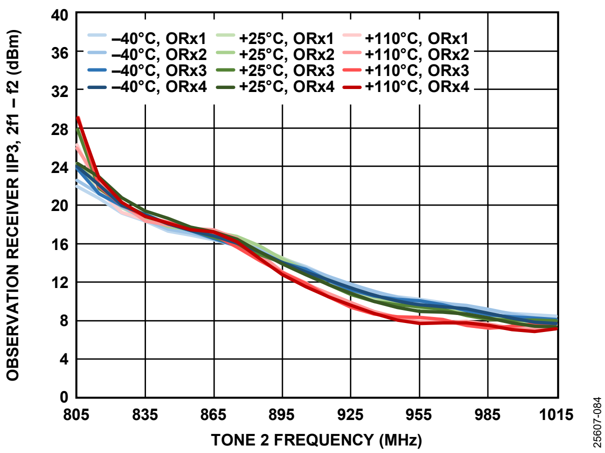


Figure 155. Observation Receiver IIP3, 2f1 − f2 vs. Tone 2 Frequency, Both Tones at −13 dBFS, f1 = f2 + 2 MHz

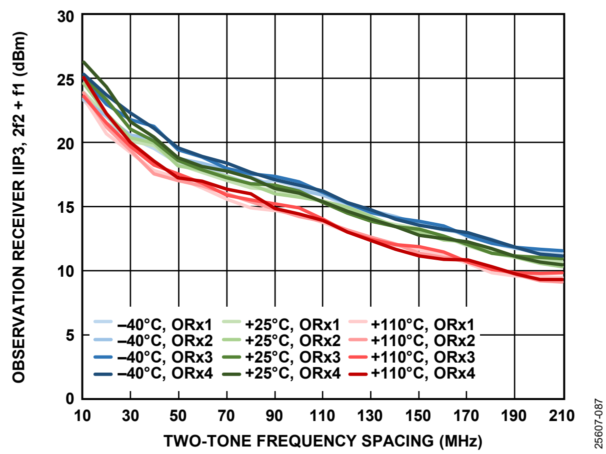


Figure 158. Observation Receiver IIP3, 2f2 + F1 vs. Two-Tone Frequency Spacing, Both Tones at −13 dBFS, f2 = 2 MHz

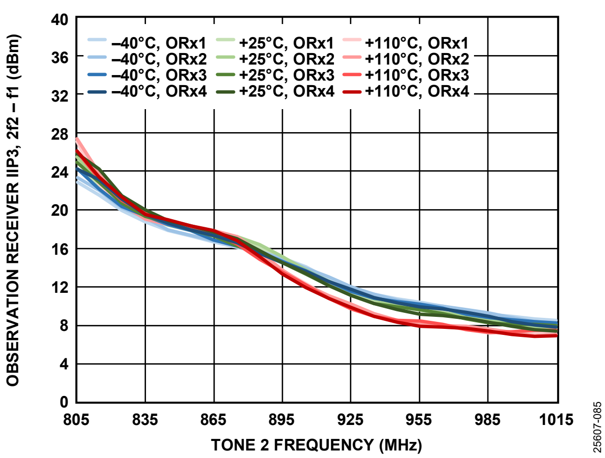


Figure 156. Observation Receiver IIP3, 2f2 − f1 vs. Tone 2 Frequency, Both Tones at −13 dBFS, f1 = f2 + 2 MHz

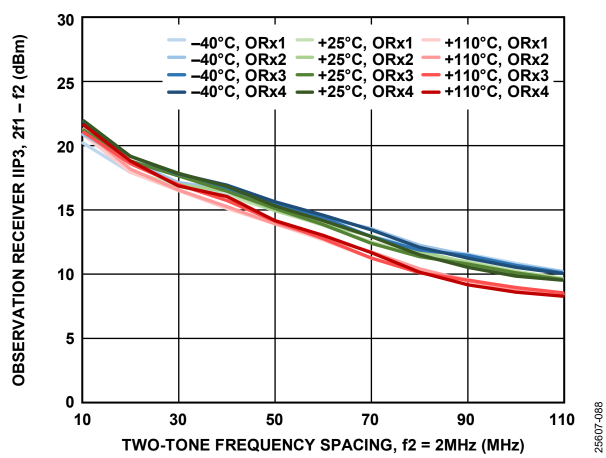


Figure 159. Observation Receiver IIP3, 2f1 − f2 vs. Two-Tone Frequency Spacing, Both Tones at −13 dBFS, f2 = 2 MHz

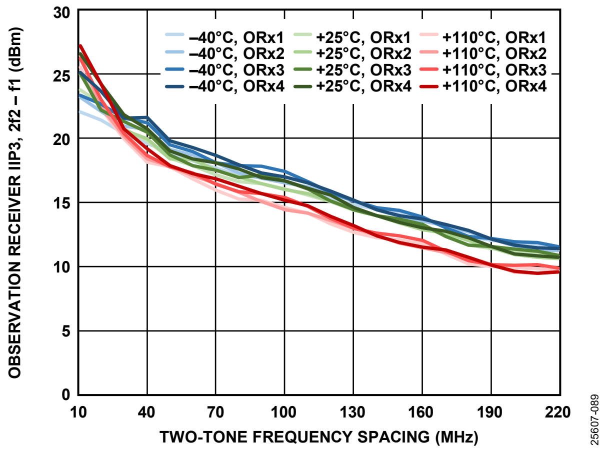


Figure 160. Observation Receiver IIP3, 2f2 – f1 vs. Two-Tone Frequency Spacing, Both Tones at –13 dBFS, f2 = 2 MHz

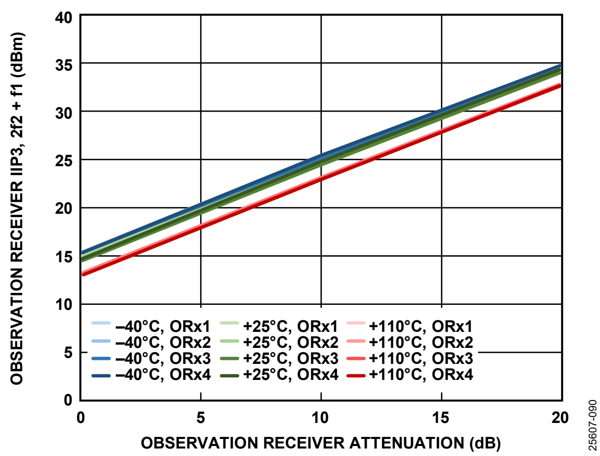


Figure 161. Observation Receiver IIP3, 2f2 + f1 vs. Observation Receiver Attenuation, Both Tones at –13 dBFS, f1 = 122 MHz, f2 = 2 MHz

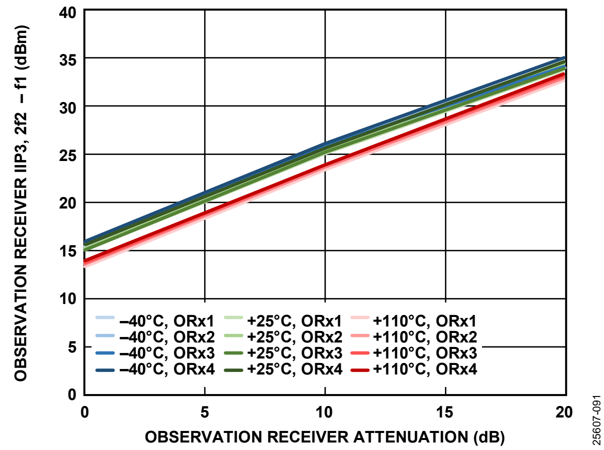


Figure 162. Observation Receiver IIP3, 2f2 – f1 vs. Observation Receiver Attenuation, Both Tones at –13 dBFS, f1 = 122 MHz, f2 = 2 MHz

1800 MHz BAND

The temperature settings refer to the die temperature. All LO frequencies set to 1800 MHz, unless otherwise noted.

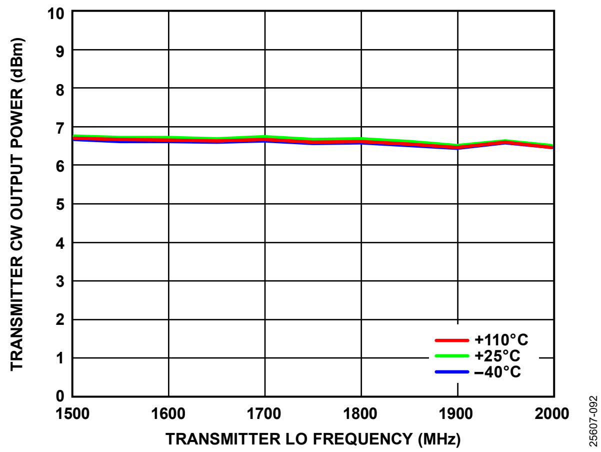


Figure 163. Transmitter Continuous Wave (CW) Output Power vs. Transmitter LO Frequency, 10 MHz Offset, 0 dB Attenuation

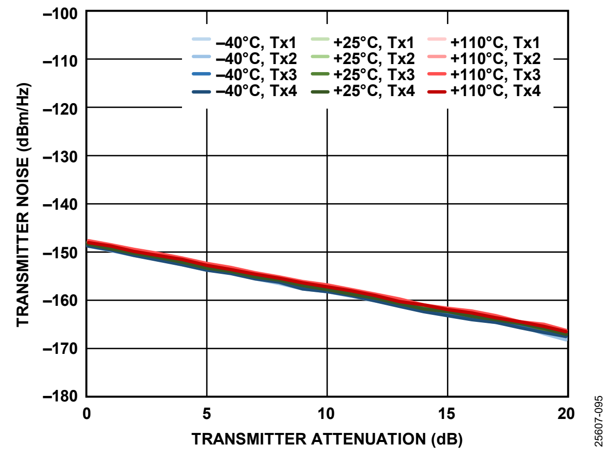


Figure 166. Transmitter Noise vs. Transmitter Attenuation, 10 MHz Offset

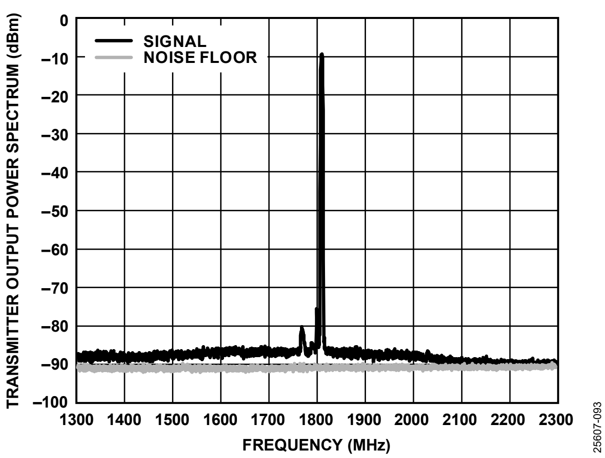


Figure 164. Transmitter Output Power Spectrum, TX1, 5 MHz LTE, 10 MHz Offset, −10 dBFS RMS, 1 MHz Resolution Bandwidth, T_J = 25°C

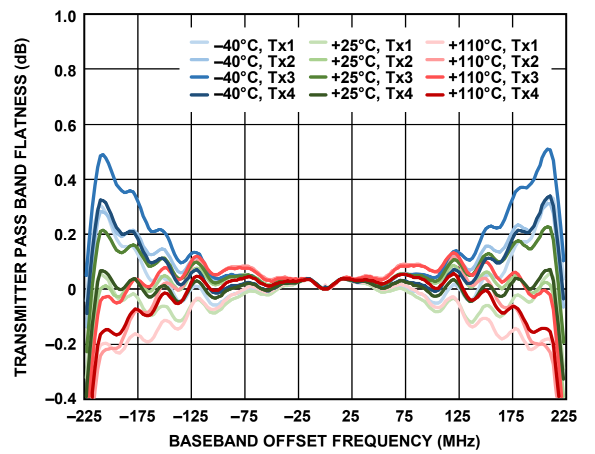


Figure 167. Transmitter Pass Band Flatness vs. Baseband Offset Frequency

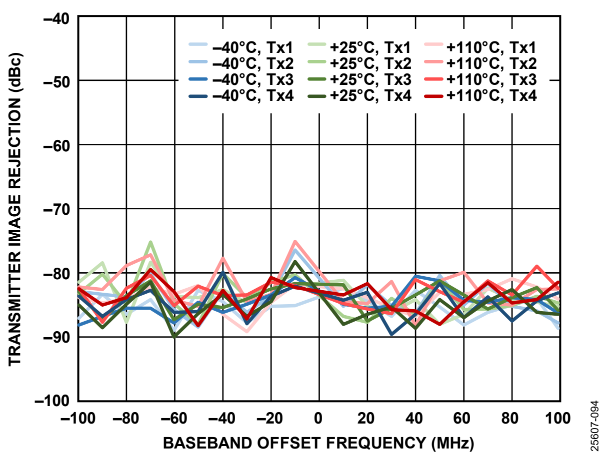


Figure 165. Transmitter Image Rejection Across Large Signal Bandwidth vs. Baseband Offset Frequency

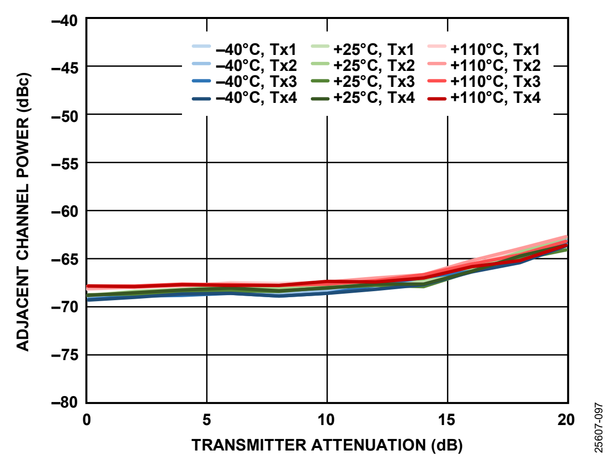


Figure 168. Adjacent Channel Power Level vs. Transmitter Attenuation, −10 MHz Baseband Offset, 20 MHz LTE, PAR = 12 dB

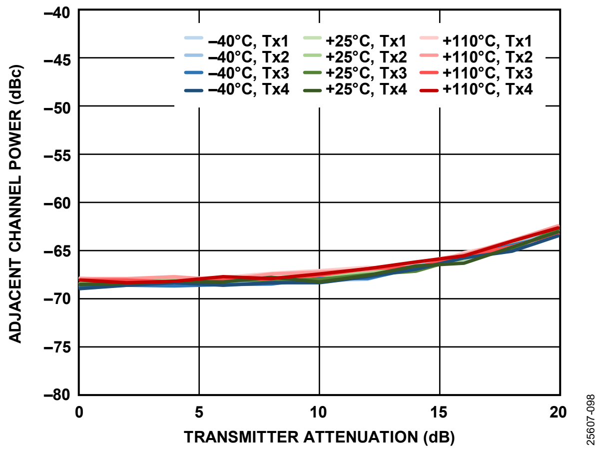


Figure 169. Adjacent Channel Power Level vs. Transmitter Attenuation, 90 MHz Baseband Offset, 20 MHz LTE, PAR = 12 dB

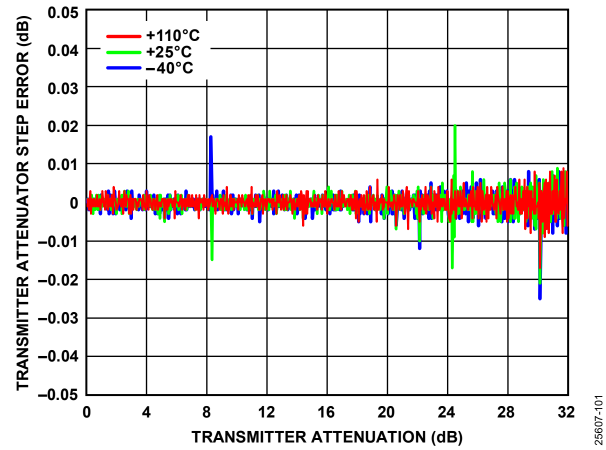


Figure 172. Transmitter Attenuator Step Error vs. Transmitter Attenuation, 10 MHz Offset

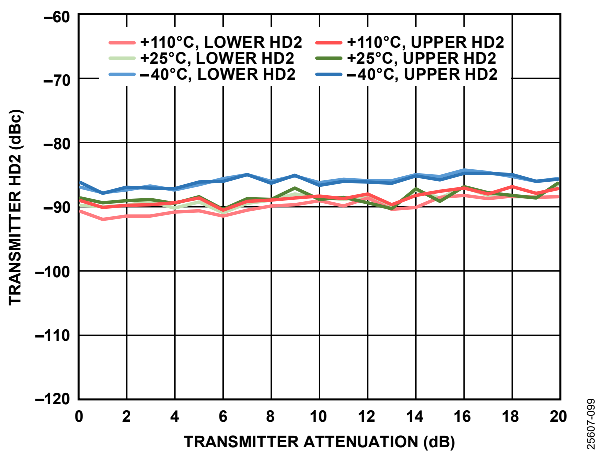


Figure 170. Transmitter Second Harmonic Distortion (HD2) vs. Transmitter Attenuation, 10 MHz Offset

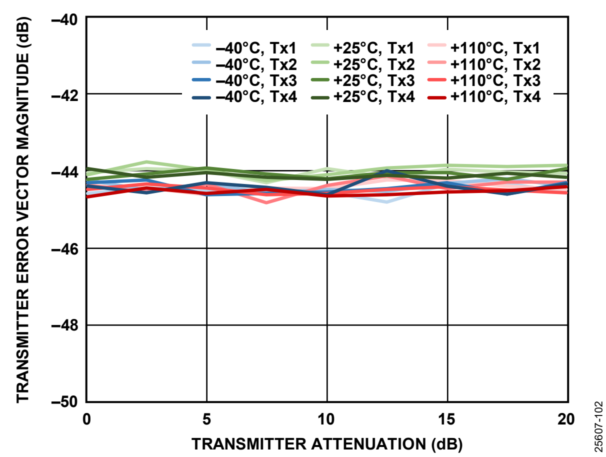


Figure 173. Transmitter Error Vector Magnitude vs. Transmitter Attenuation, 20 MHz LTE Signal Centered at LO Frequency, Sample Rate = 491.52 MSPS, Loop Filter Bandwidth = 500 kHz, Loop Filter Phase Margin = 60°

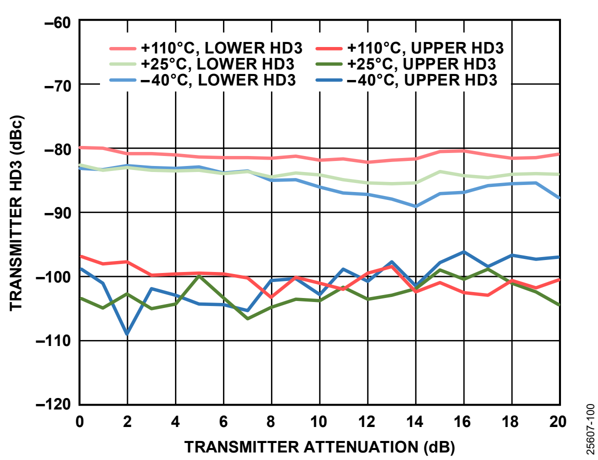


Figure 171. Transmitter Third Harmonic Distortion (HD3) vs. Transmitter Attenuation, 10 MHz Offset

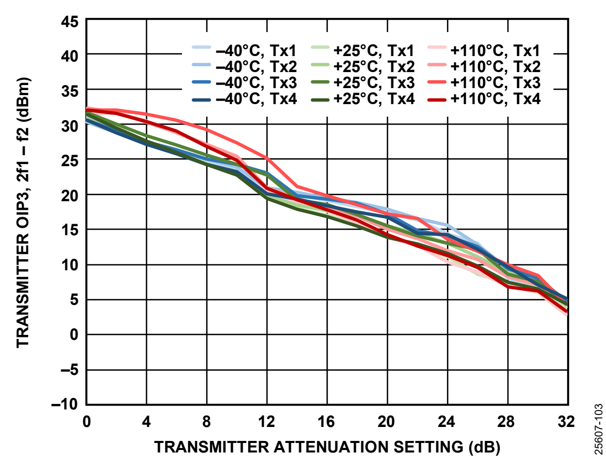


Figure 174. Transmitter OIP3, 2f1 − f2 vs. Transmitter Attenuation, 15 dB Digital Back Off per Tone, f1 = 50.5 MHz, f2 = 55.5 MHz

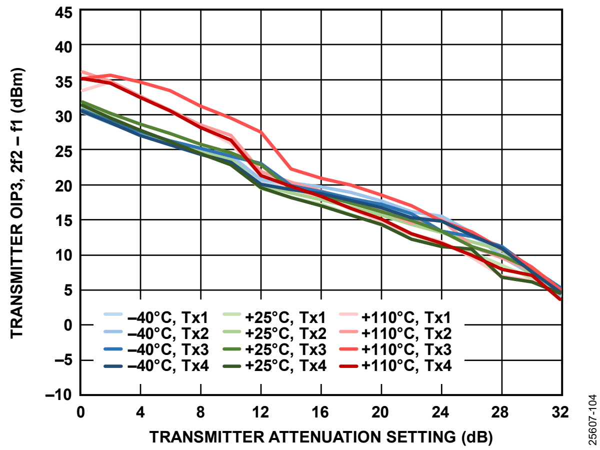


Figure 175. Transmitter OIP3, 2f2 – f1 vs. Transmitter Attenuation, 15 dB Digital Back Off per Tone, f1 = 50.5 MHz, f2 = 55.5 MHz

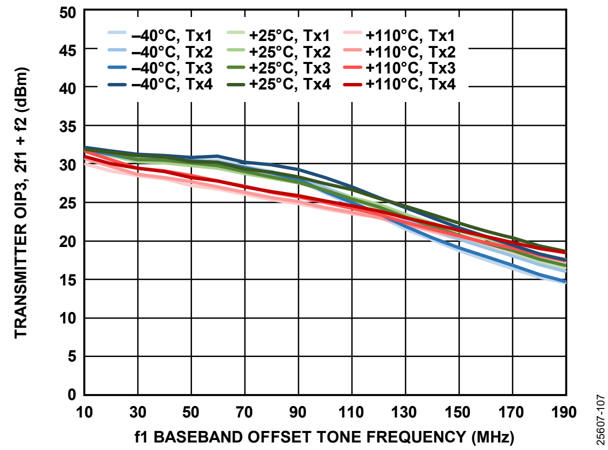


Figure 178. Transmitter OIP3, 2f1 + f2 vs. f1 Baseband Offset Tone Frequency, f2 = f1 + 5 MHz, 15 dB Digital Back Off per Tone

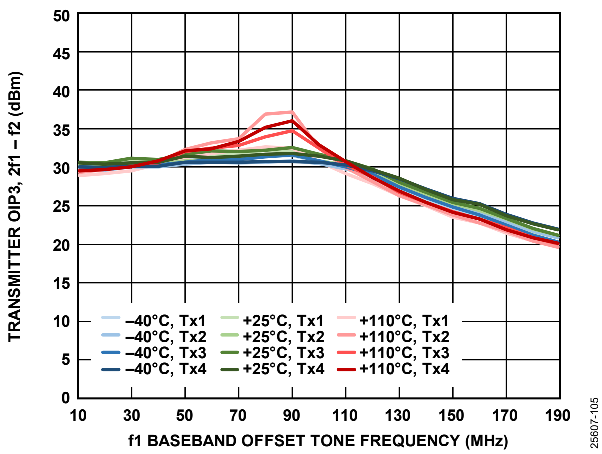


Figure 176. Transmitter OIP3, 2f1 – f2 vs. f1 Baseband Offset Tone Frequency, f2 = f1 + 5 MHz, 15 dB Digital Back Off per Tone

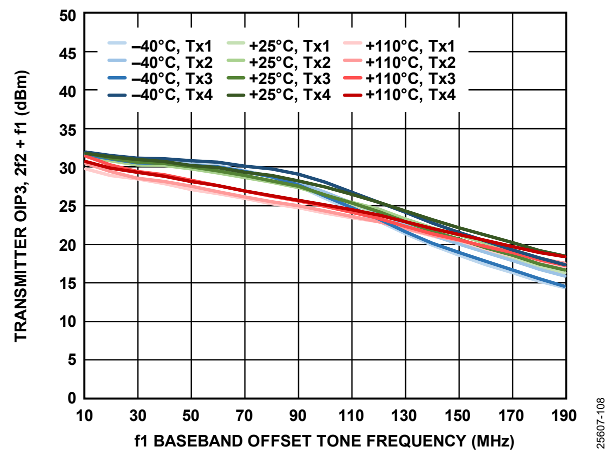


Figure 179. Transmitter OIP3, 2f2 + f1 vs. f1 Baseband Offset Tone Frequency, f2 = f1 + 5 MHz, 15 dB Digital Back Off per Tone

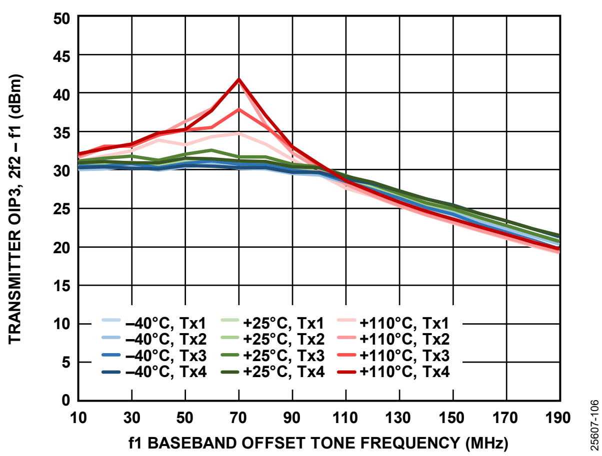


Figure 177. Transmitter OIP3, 2f2 – f1 vs. f1 Baseband Offset Tone Frequency, f2 = f1 + 5 MHz, 15 dB Digital Back Off per Tone

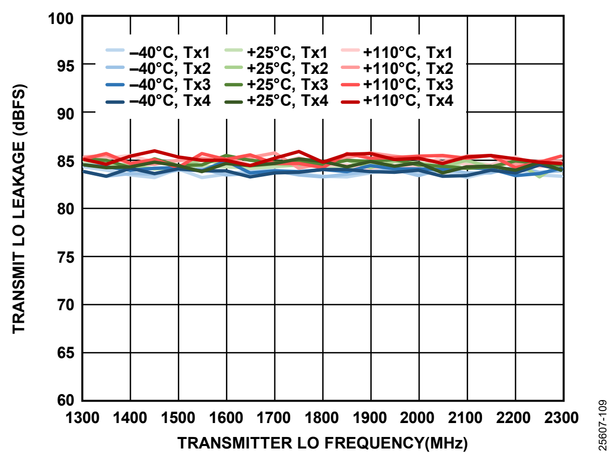


Figure 180. Transmitter LO Leakage vs. Transmitter LO Frequency

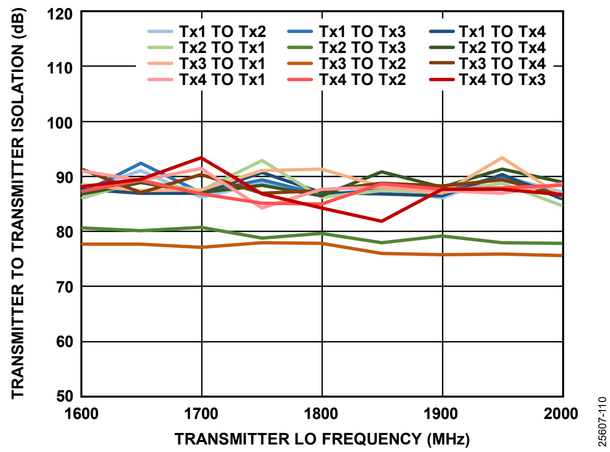


Figure 181. Transmitter to Transmitter Isolation vs. Transmitter LO Frequency

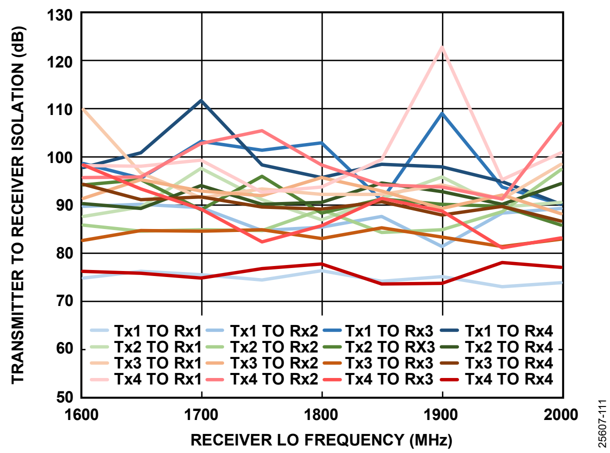


Figure 182. Transmitter to Receiver Isolation vs. Receiver LO Frequency

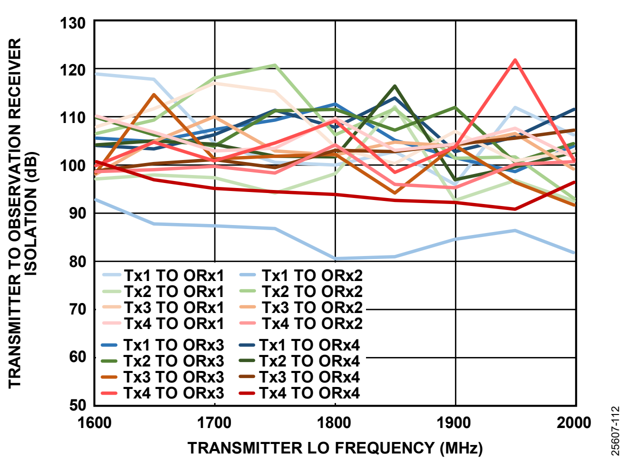


Figure 183. Transmitter to Observation Receiver Isolation vs. Transmitter LO Frequency

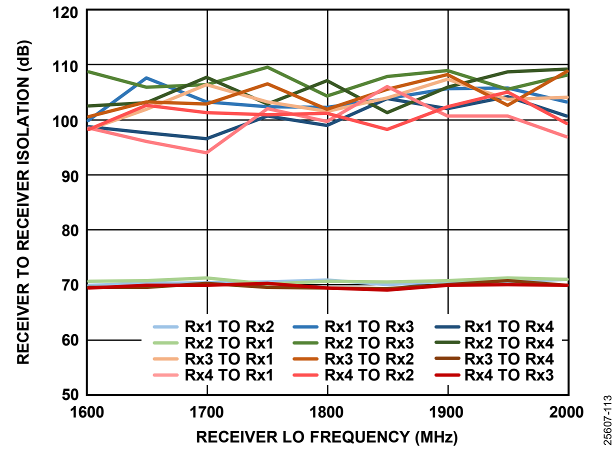


Figure 184. Receiver to Receiver Isolation vs. Receiver LO Frequency

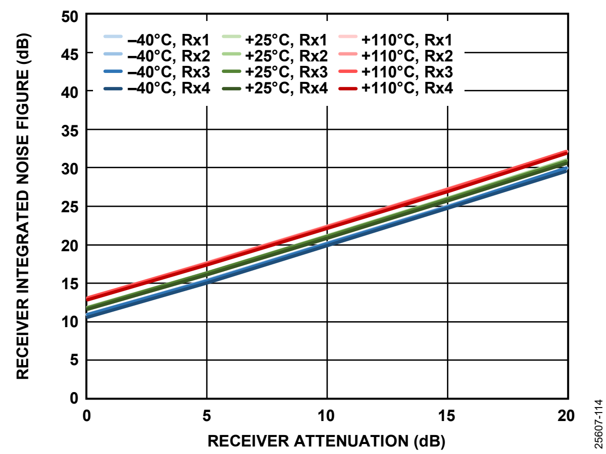


Figure 185. Receiver Integrated Noise Figure vs. Receiver Attenuation, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS, Integration Bandwidth = 500 kHz to 100 MHz

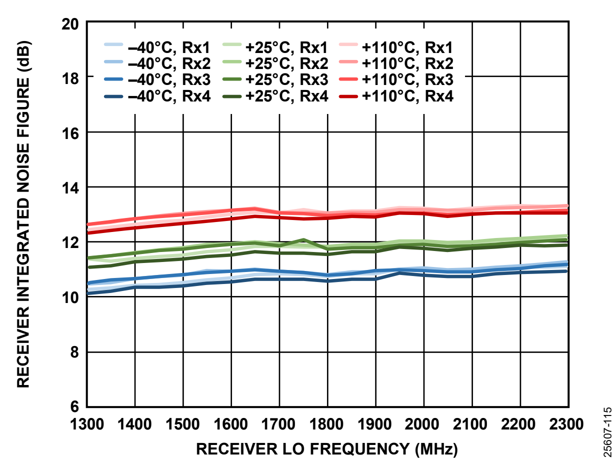


Figure 186. Receiver Integrated Noise Figure vs. Receiver LO Frequency, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS, Integration Bandwidth = 500 kHz to 100 MHz

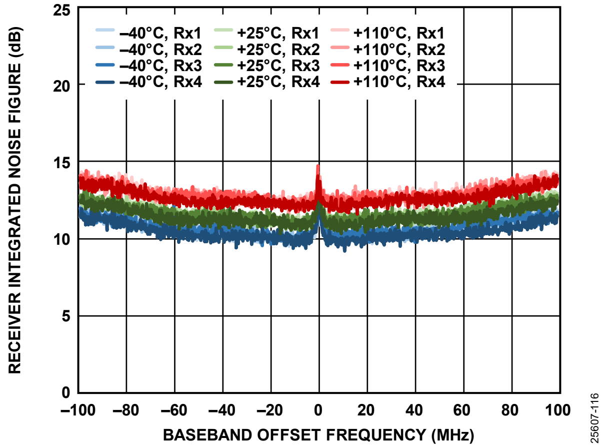


Figure 187. Receiver Integrated Noise Figure vs. Baseband Offset Frequency, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS, Integrated in 200 kHz Steps

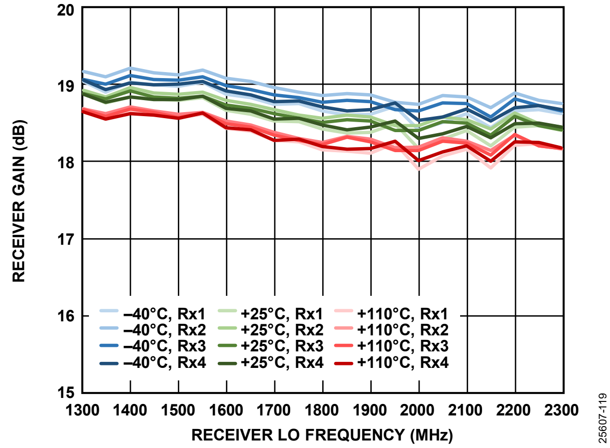


Figure 190. Receiver Gain vs. Receiver LO Frequency, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS

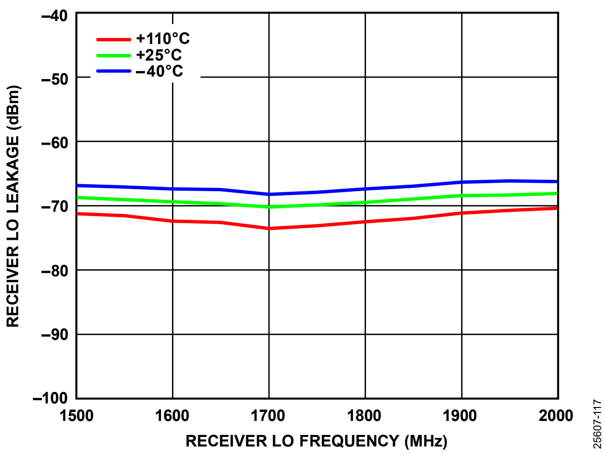


Figure 188. Receiver LO Leakage vs. Receiver LO Frequency, Attenuation = 0 dB, Sample Rate = 245.76 MSPS

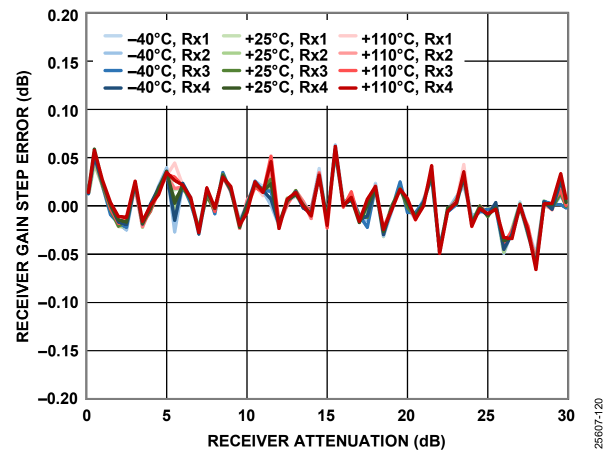


Figure 191. Receiver Gain Step Error vs. Receiver Attenuation, 20 MHz Offset, –5 dBFS Input Signal

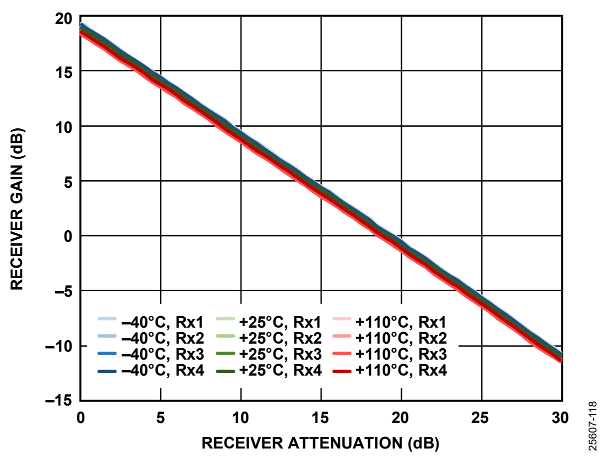


Figure 189. Receiver Gain vs. Receiver Attenuation, 20 MHz Offset, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS

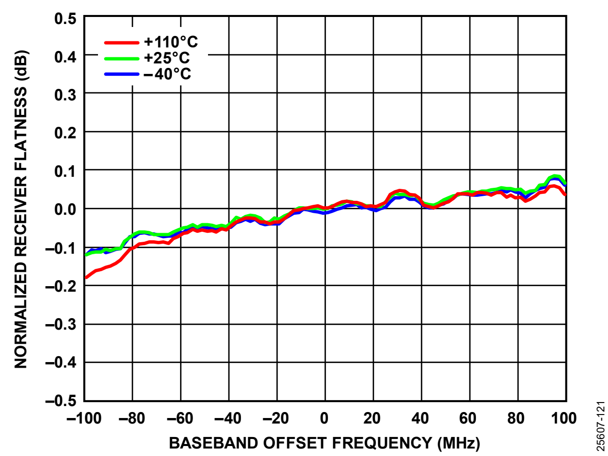


Figure 192. Normalized Receiver Flatness vs. Baseband Offset Frequency, –5 dBFS Input Signal

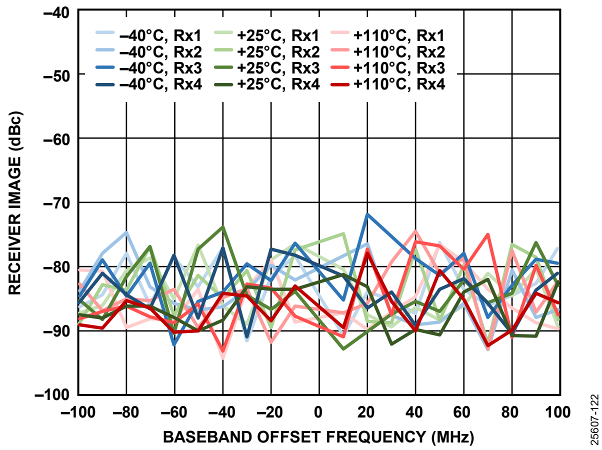


Figure 193. Receiver Image vs. Baseband Offset Frequency, Tracking Calibration Active, Sample Rate = 245.76 MSPS

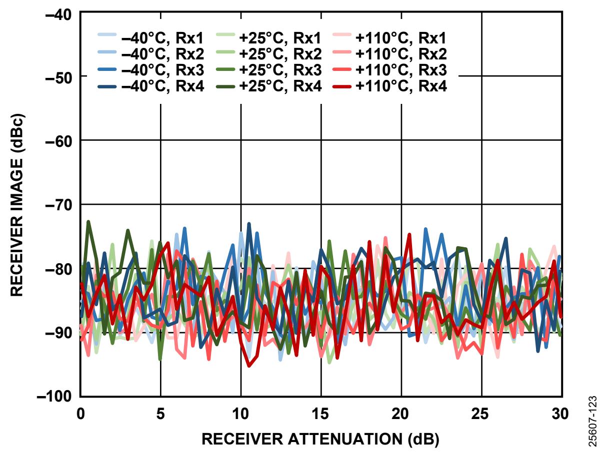


Figure 194. Receiver Image vs. Receiver Attenuation, 20 MHz Offset, Tracking Calibration Active, Sample Rate = 245.76 MSPS

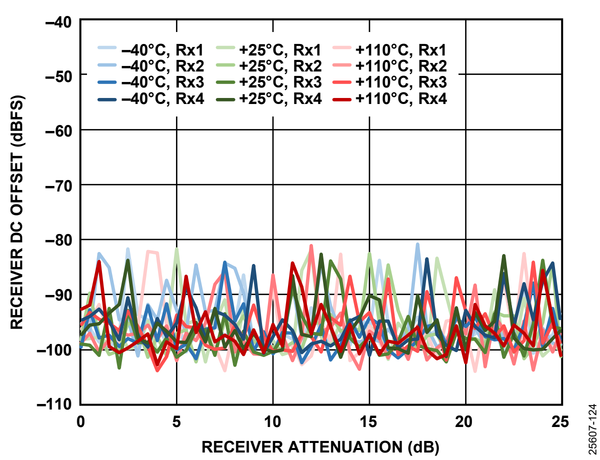


Figure 195. Receiver DC Offset vs. Receiver Attenuation, 20 MHz Offset, −5 dBFS Input Signal

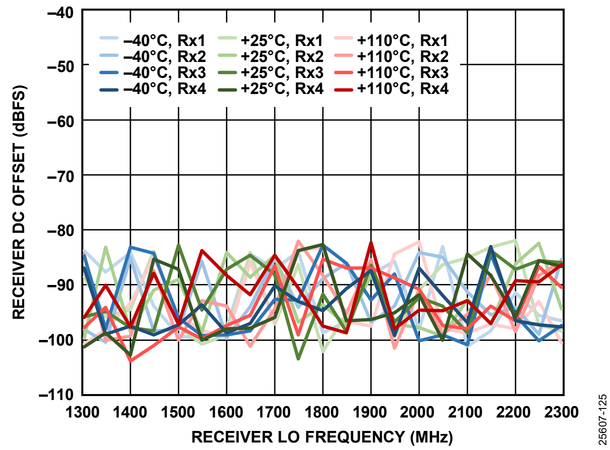


Figure 196. Receiver DC Offset vs. Receiver LO Frequency, 20 MHz Offset, −5 dBFS Input Signal

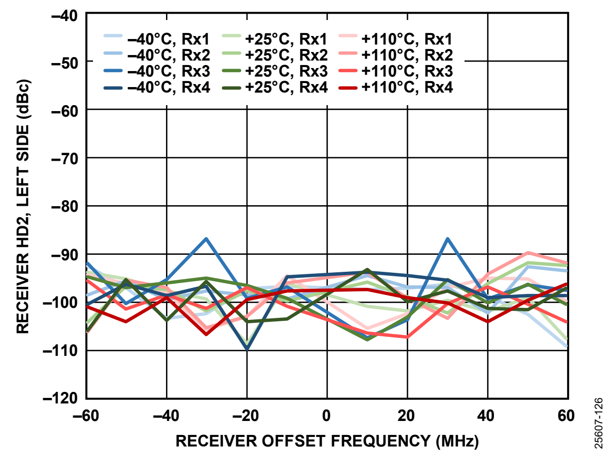


Figure 197. Receiver HD2, Left Side vs. Baseband Offset Frequency, −5 dBFS Input Signal, Distortion Tone Measured Left of 0 Hz (HD2 Canceller Not Enabled)

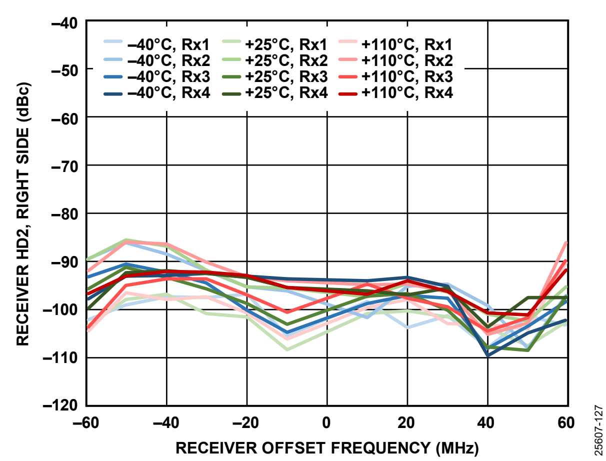


Figure 198. Receiver HD2, Right Side vs. Baseband Offset Frequency, −5 dBFS Input Signal, Distortion Tone Measured Right of 0 Hz (HD2 Canceller Not Enabled)

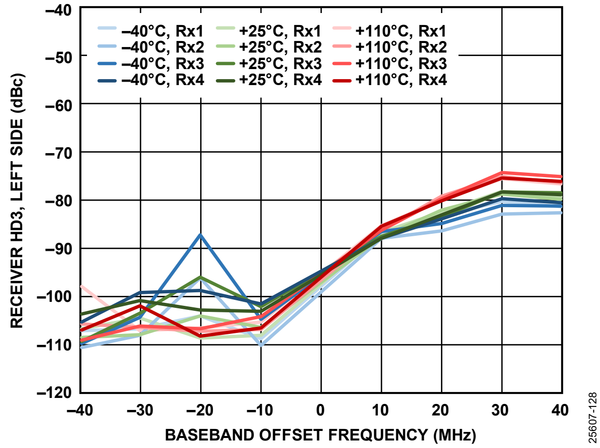


Figure 199. Receiver HD3, Left Side vs. Baseband Offset Frequency, –5 dBFS Input Signal, Distortion Tone Measured Left of 0 Hz

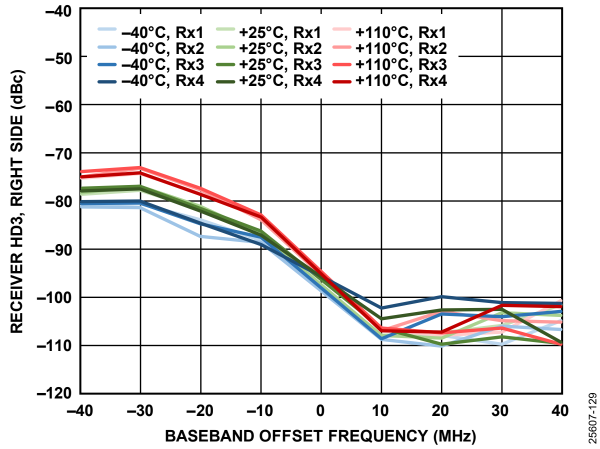


Figure 200. Receiver HD3, Right Side vs. Baseband Offset Frequency, –5 dBFS Input Signal, Distortion Tone Measured Right of 0 Hz

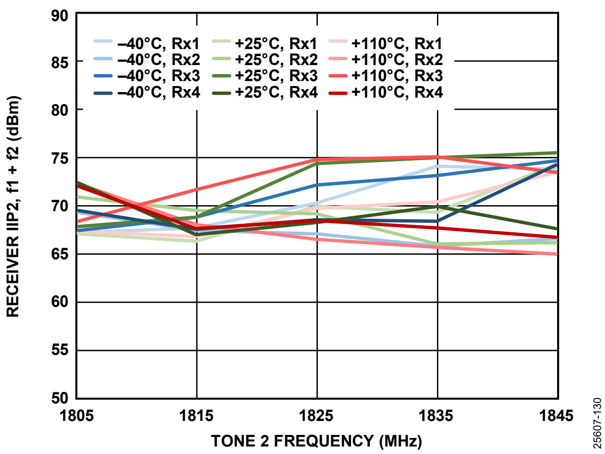


Figure 201. Receiver IIP2, f1 + f2 vs. Tone 2 Frequency, Both Tones at –11 dBFS, f1 = f2 + 2 MHz

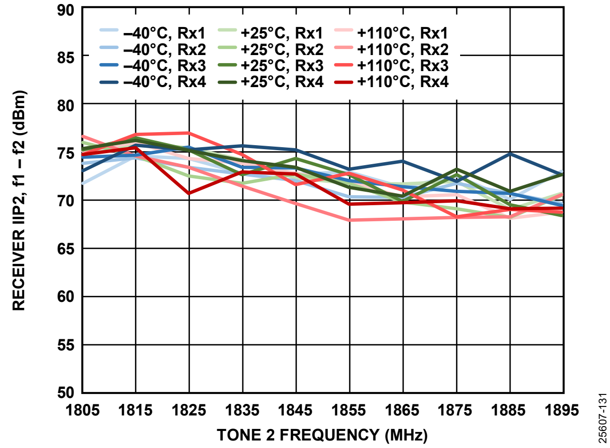


Figure 202. Receiver IIP2, f1 – f2 vs. Tone 2 Frequency, Both Tones at –11 dBFS, f1 = f2 + 2 MHz

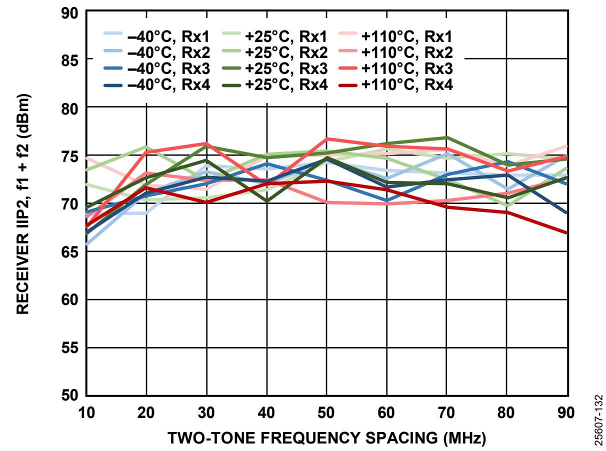


Figure 203. Receiver IIP2, f1 + f2 vs. Two-Tone Frequency Spacing, Both Tones at –11 dBFS, f2 = 2 MHz

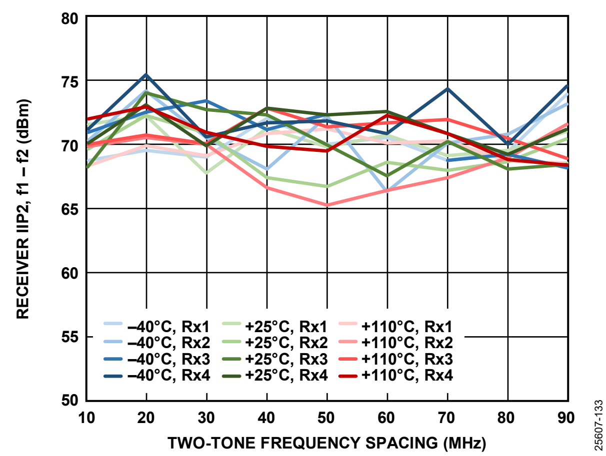


Figure 204. Receiver IIP2, f1 – f2 vs. Two-Tone Frequency Spacing, Both Tones at –11 dBFS, f2 = 2 MHz

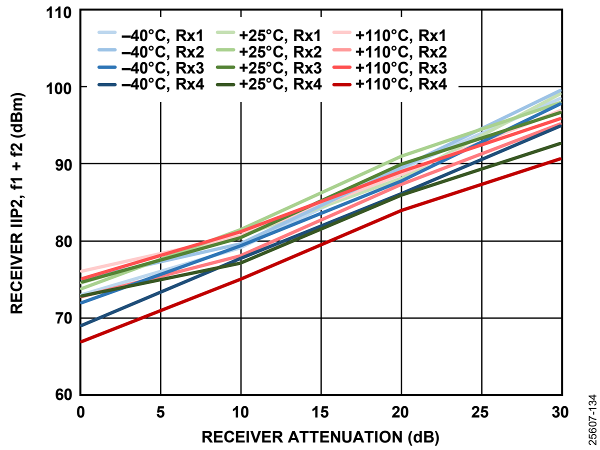


Figure 205. Receiver IIP2, f1 + f2 vs. Receiver Attenuation, Both Tones at −11 dBFS, f1 = 92 MHz, f2 = 2 MHz

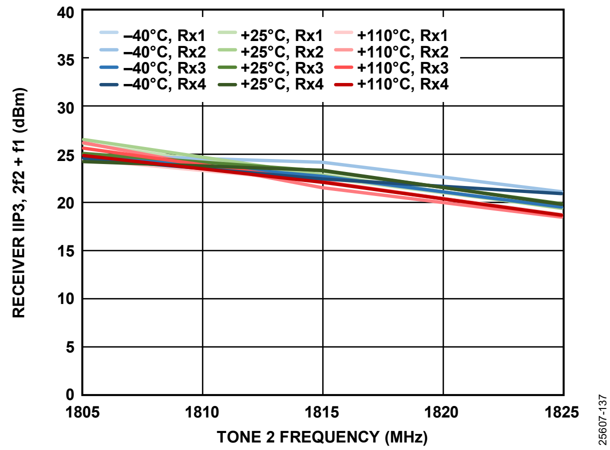


Figure 208. Receiver IIP3, 2f2 + f1 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

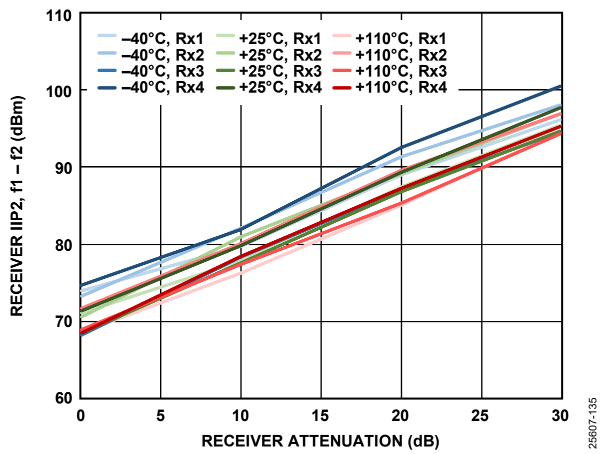


Figure 206. Receiver IIP2, f1 − f2 vs. Receiver Attenuation, Both Tones at −11 dBFS, f1 = 92 MHz, f2 = 2 MHz

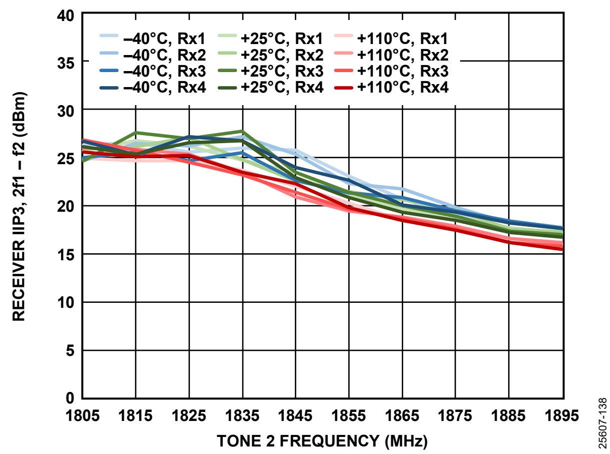


Figure 209. Receiver IIP3, 2f1 − f2 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

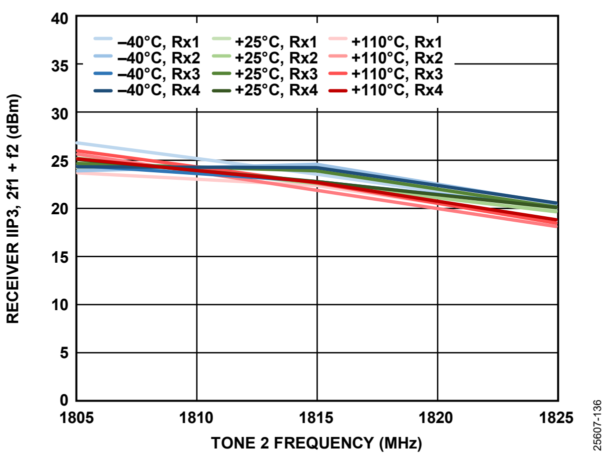


Figure 207. Receiver IIP3, 2f1 + f2 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

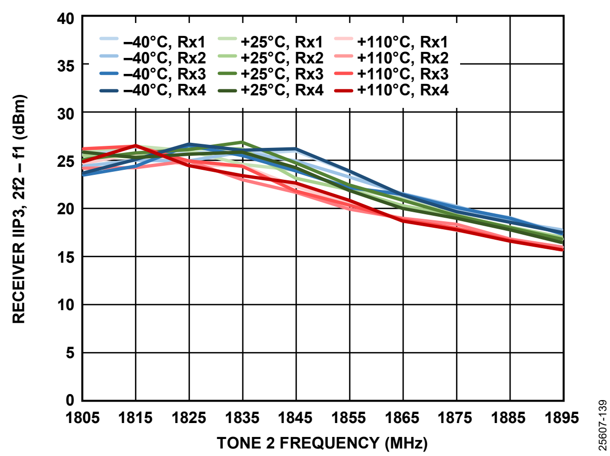


Figure 210. Receiver IIP3, 2f2 − f1 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

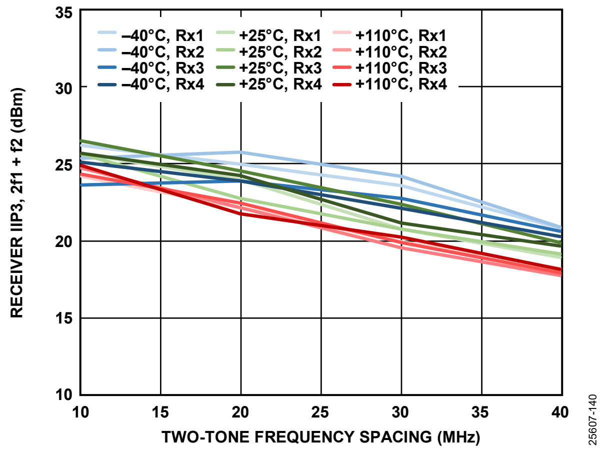


Figure 211. Receiver IIP3, 2f1 + f2 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

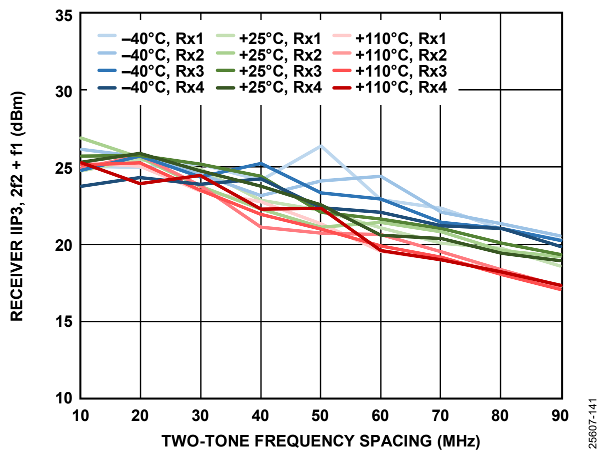


Figure 212. Receiver IIP3, 2f2 + f1 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

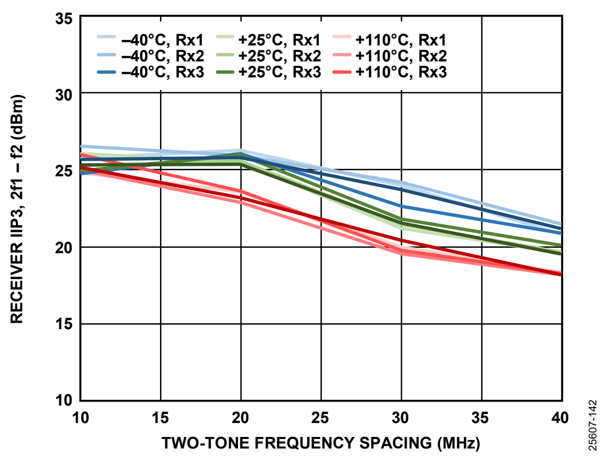


Figure 213. Receiver IIP3, 2f1 − f2 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

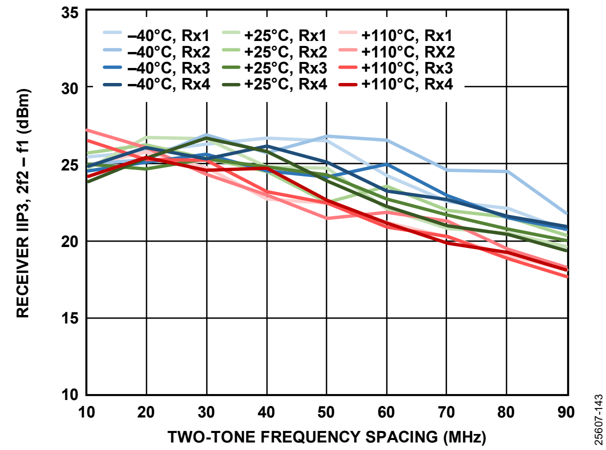


Figure 214. Receiver IIP3, 2f2 − f1 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

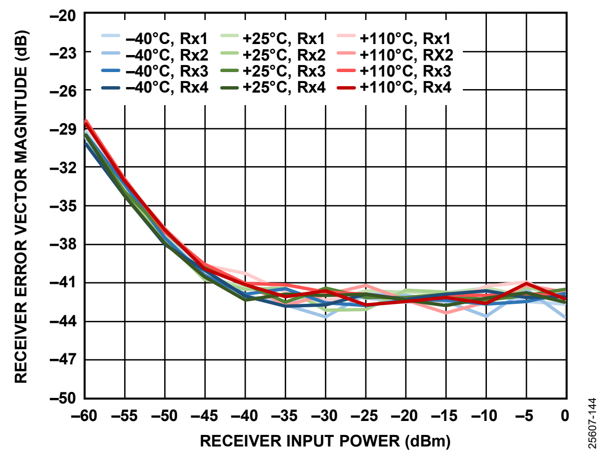


Figure 215. Receiver Error Vector Magnitude vs. Receiver Input Power, 20 MHz LTE Signal Centered at LO Frequency, Sample Rate = 245.76 MSPS, Loop Filter Bandwidth = 500 kHz, Loop Filter Phase Margin = 60°

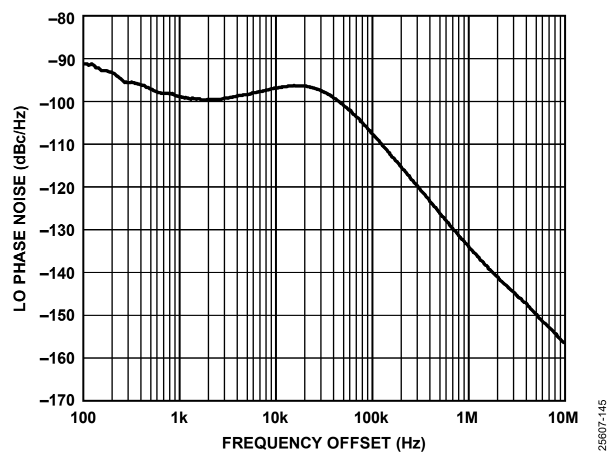


Figure 216. LO Phase Noise vs. Frequency Offset, Loop Bandwidth = 50 kHz, Phase Margin = 85°

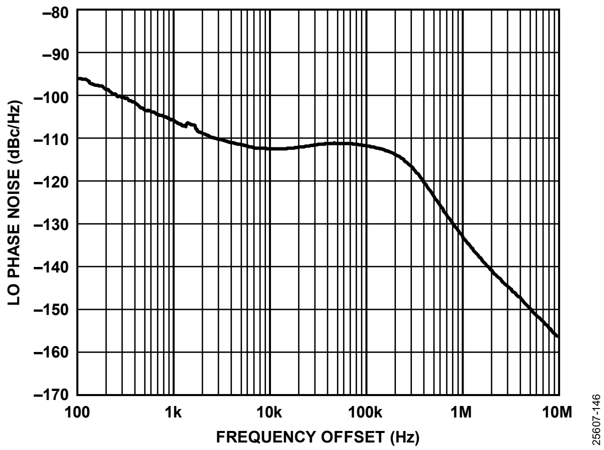


Figure 217. LO Phase Noise vs. Frequency Offset, Loop Bandwidth = 200 kHz, Phase Margin = 60°

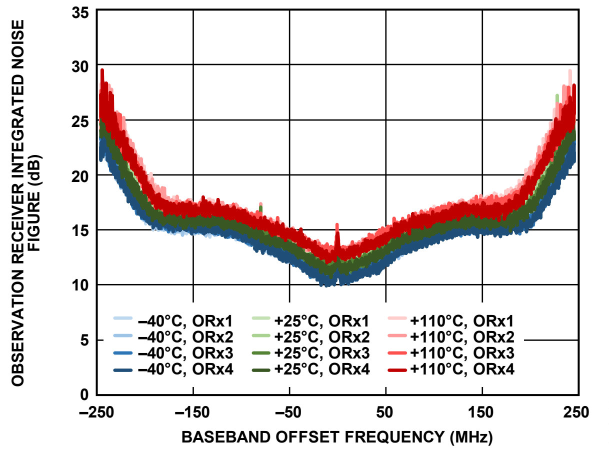


Figure 220. Observation Receiver Integrated Noise Figure vs. Baseband Offset Frequency, 450 MHz Bandwidth, Sample Rate = 491.52 MSPS, Integrated in 200 kHz Steps

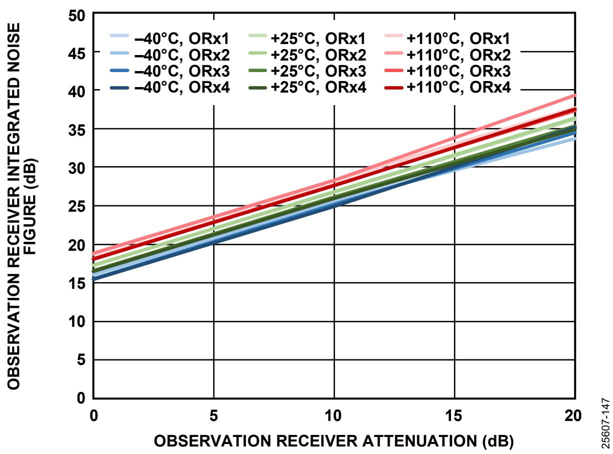


Figure 218. Observation Receiver Integrated Noise Figure vs. Observation Receiver Attenuation, 450 MHz Bandwidth, Sample Rate = 491.52 MSPS, Integration Bandwidth = 500 kHz to 245.76 MHz

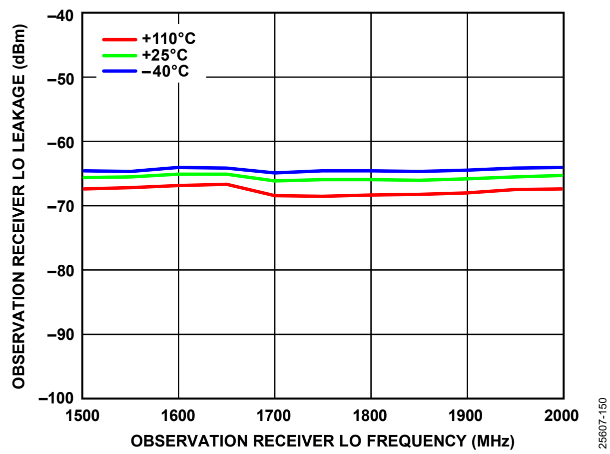


Figure 221. Observation Receiver LO Leakage vs. Observation Receiver LO Frequency, Attenuation = 0 dB, Sample Rate = 491.52 MSPS

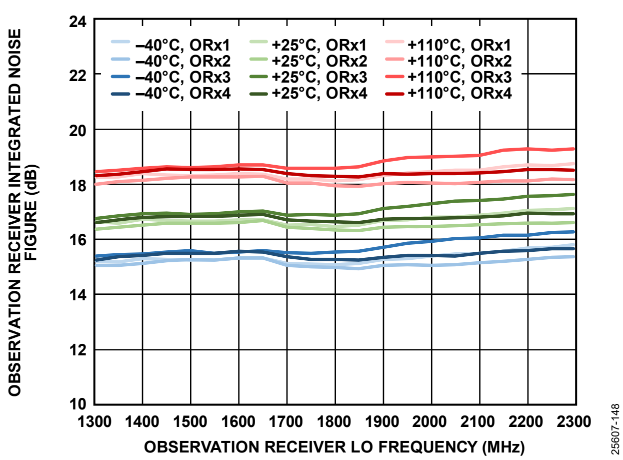


Figure 219. Observation Receiver Integrated Noise Figure vs. Observation Receiver LO Frequency, 450 MHz Bandwidth, Sample Rate = 491.52 MSPS, Integration Bandwidth = 500 kHz to 245.76 MHz

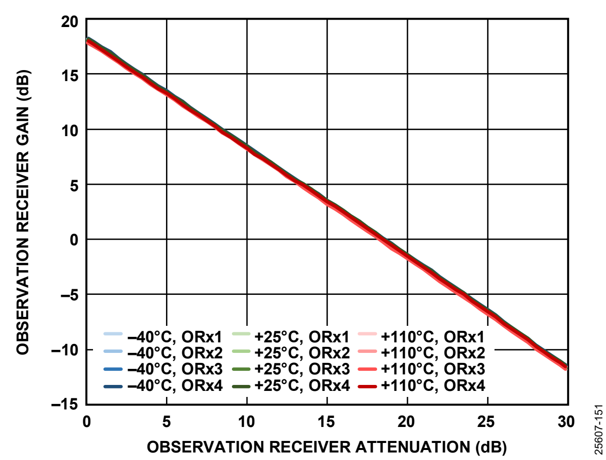


Figure 222. Observation Receiver Gain vs. Observation Receiver Attenuation, 45 MHz Offset, 450 MHz Bandwidth, Sample Rate = 491.52 MSPS

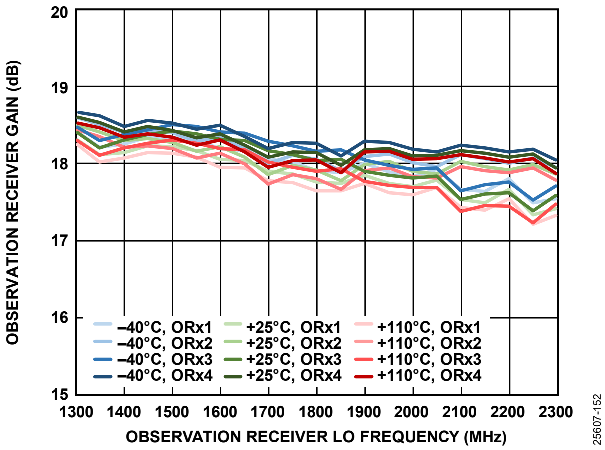


Figure 223. Observation Receiver Gain vs. Observation Receiver LO Frequency, 450 MHz Bandwidth, Sample Rate = 491.52 MSPS

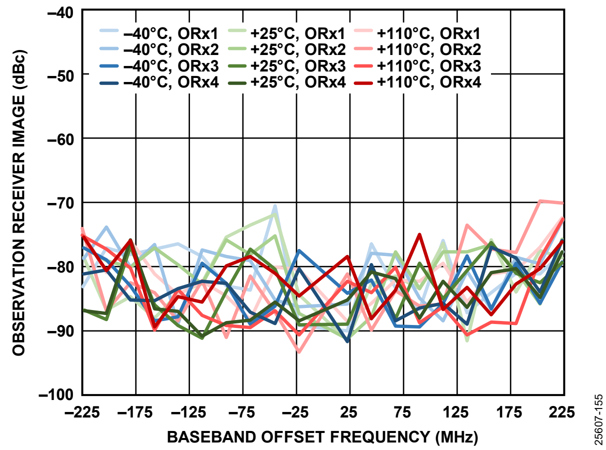


Figure 226. Observation Receiver Image vs. Baseband Offset Frequency, Tracking Calibration Active, Sample Rate = 491.52 MSPS

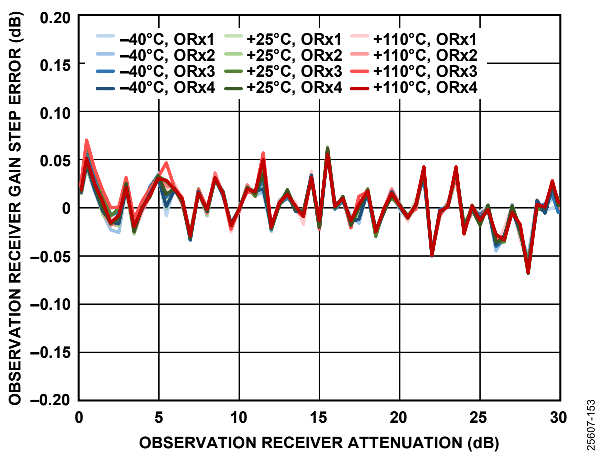


Figure 224. Observation Receiver Gain Step Error vs. Observation Receiver Attenuation, 45 MHz Offset, –10 dBFS Input Signal

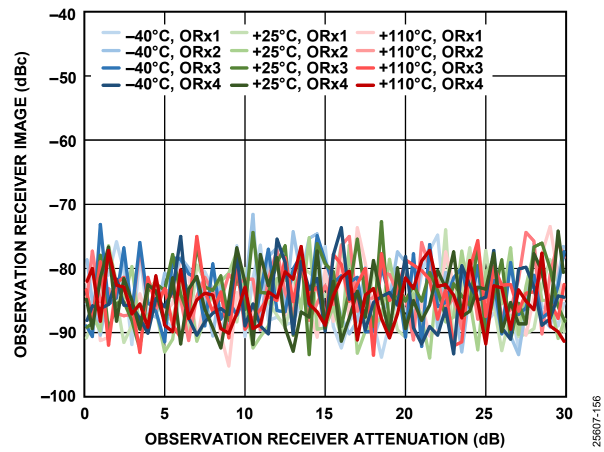


Figure 227. Observation Receiver Image vs. Observation Receiver Attenuation, 45 MHz Offset, Tracking Calibration Active, Sample Rate = 491.52 MSPS

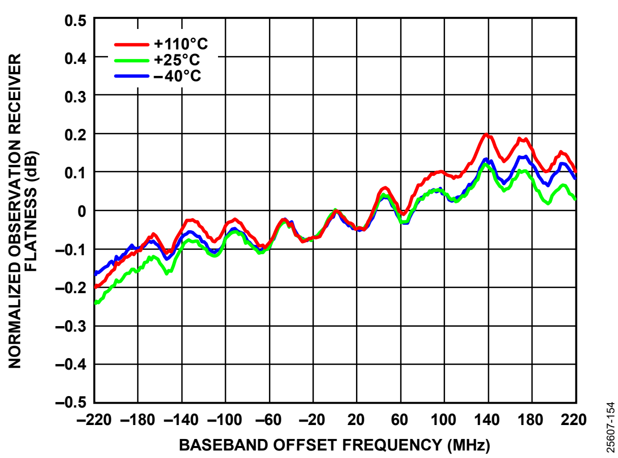


Figure 225. Normalized Observation Receiver Flatness vs. Baseband Offset Frequency, –10 dBFS Input Signal

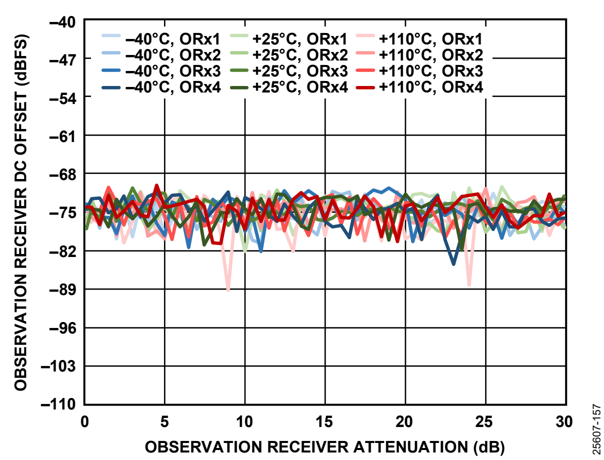


Figure 228. Observation Receiver DC Offset vs. Observation Receiver Attenuation, 45 MHz Offset, –10 dBFS Input Signal

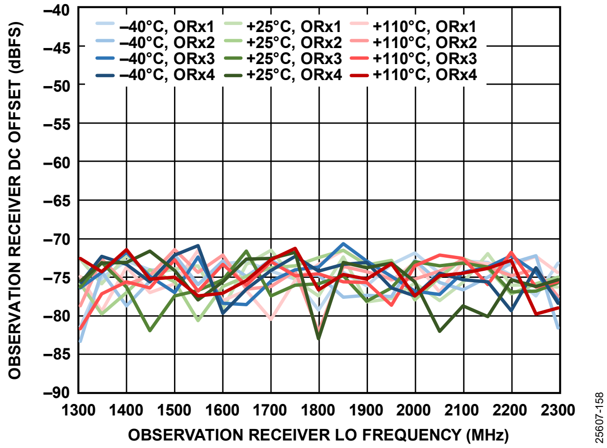


Figure 229. Observation Receiver DC Offset vs. Observation Receiver LO Frequency, Attenuation = 0 dB, Sample Rate = 491.52 MSPS

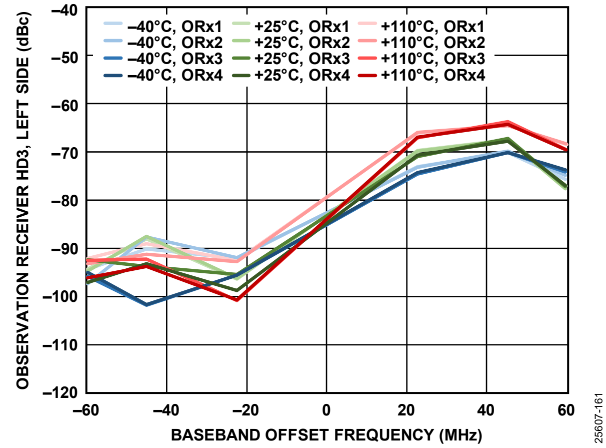


Figure 232. Observation Receiver HD3, Left Side vs. Baseband Offset Frequency, −10 dBFS Input Signal, Distortion Tone Measured Left of 0 Hz

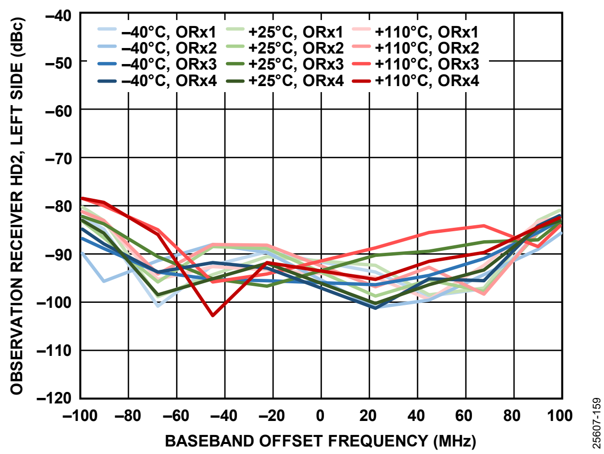


Figure 230. Observation Receiver HD2, Left Side vs. Baseband Offset Frequency, −10 dBFS Input Signal, Distortion Tone Measured Left of 0 Hz

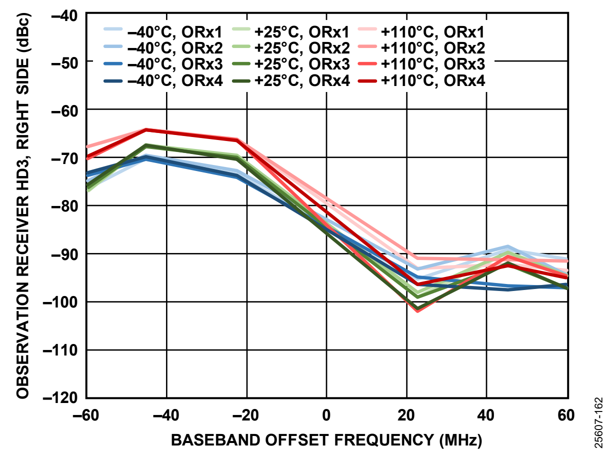


Figure 233. Observation Receiver HD3, Right Side vs. Baseband Offset Frequency, −10 dBFS Input Signal, Distortion Tone Measured Right of 0 Hz

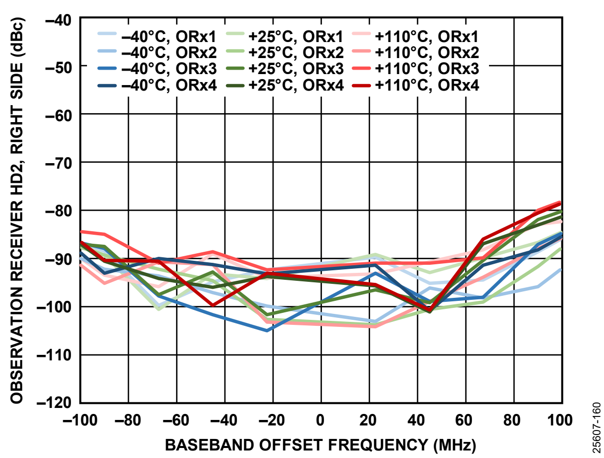


Figure 231. Observation Receiver HD2, Right Side vs. Baseband Offset Frequency, −10 dBFS Input Signal, Distortion Tone Measured Right of 0 Hz

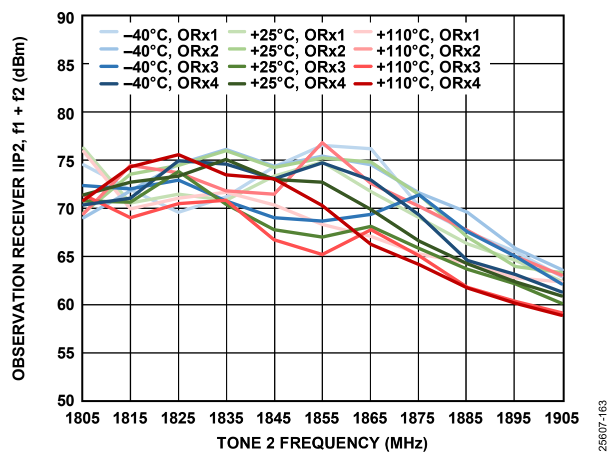


Figure 234. Observation Receiver IIP2, f1 + f2 vs. Tone 2 Frequency, Both Tones at −13 dBFS, f1 = f2 + 2 MHz

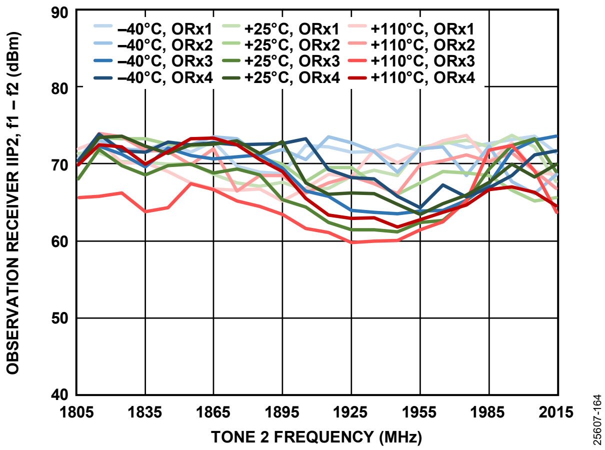


Figure 235. Observation Receiver IIP2, f1 – f2 vs. Tone 2 Frequency, Both Tones at –13 dBFS, f1 = f2 + 2 MHz

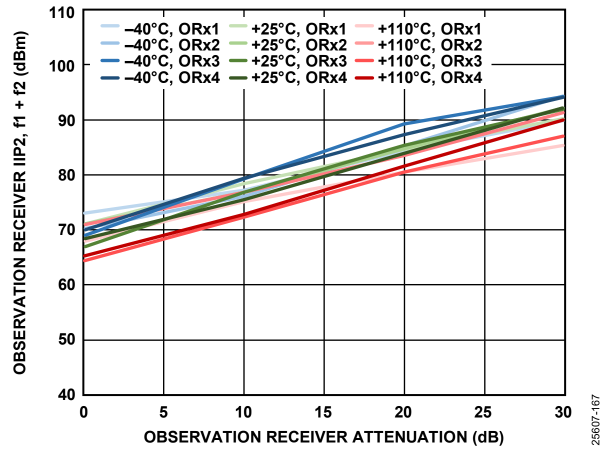


Figure 238. Observation Receiver IIP2, f1 + f2 vs. Observation Receiver Attenuation, Both Tones at –13 dBFS, f1 = 102 MHz, f2 = 2 MHz

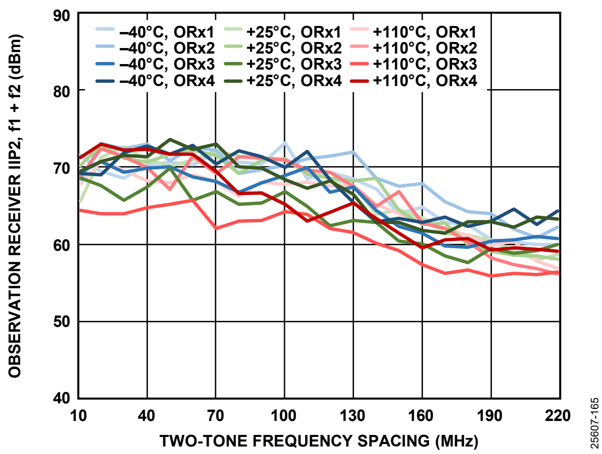


Figure 236. Observation Receiver IIP2, f1 + f2 vs. Two-Tone Frequency Spacing, Both Tones at –13 dBFS, f2 = 2 MHz

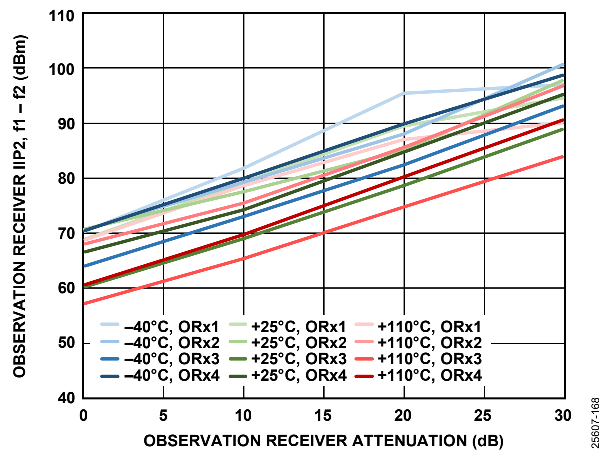


Figure 239. Observation Receiver IIP2, f1 – f2 vs. Observation Receiver Attenuation, Both Tones at –13 dBFS, f1 = 102 MHz, f2 = 2 MHz

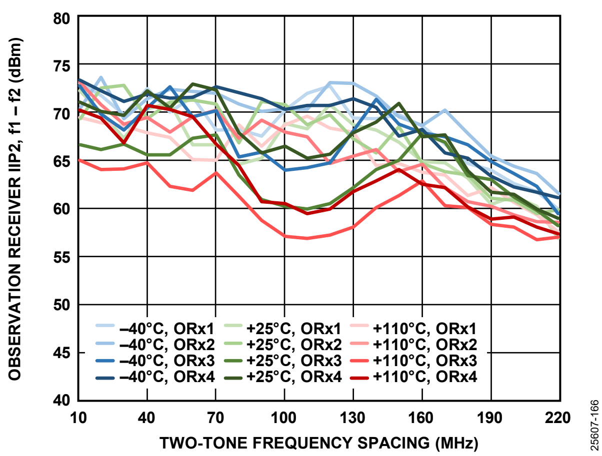


Figure 237. Observation Receiver IIP2, f1 – f2 vs. Two-Tone Frequency Spacing, Both Tones at –13 dBFS, f2 = 2 MHz

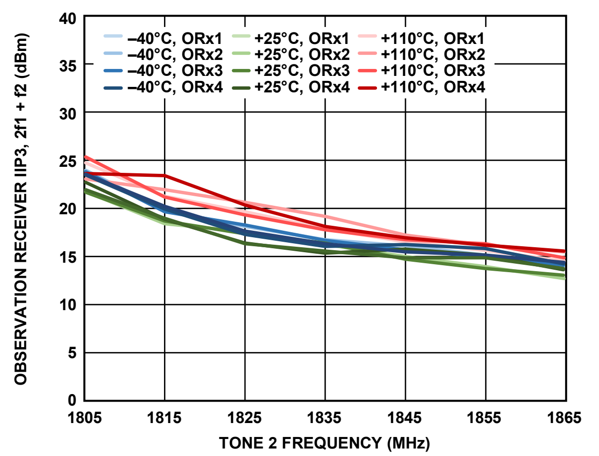


Figure 240. Observation Receiver IIP3, 2f1 + f2 vs. Tone 2 Frequency, Both Tones at –13 dBFS, f1 = f2 + 2 MHz

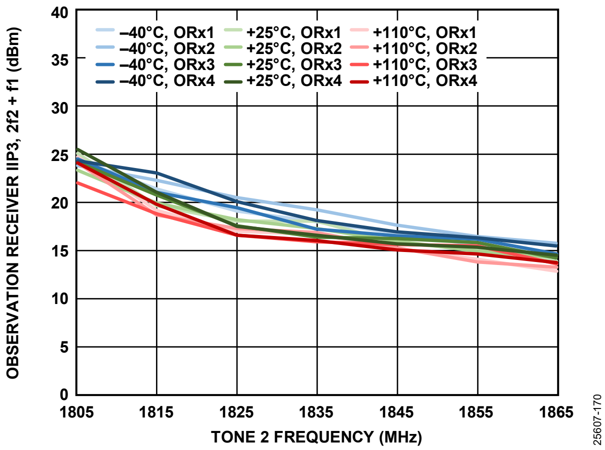


Figure 241. Observation Receiver IIP3, 2f2 + f1 vs. Tone 2 Frequency, Both Tones at −13 dBFS, f1 = f2 + 2 MHz

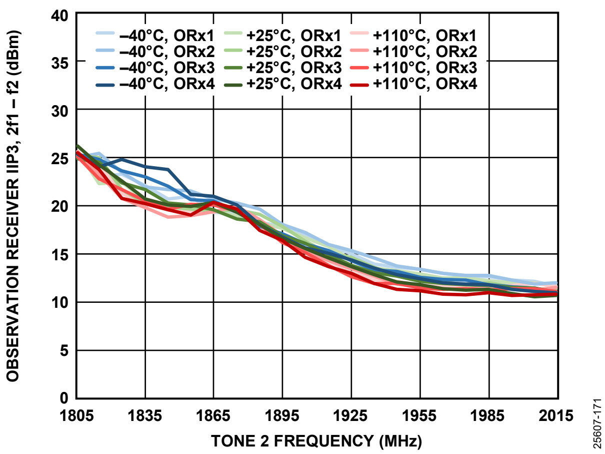


Figure 242. Observation Receiver IIP3, 2f1 − f2 vs. Tone 2 Frequency, Both Tones at −13 dBFS, f1 = f2 + 2 MHz

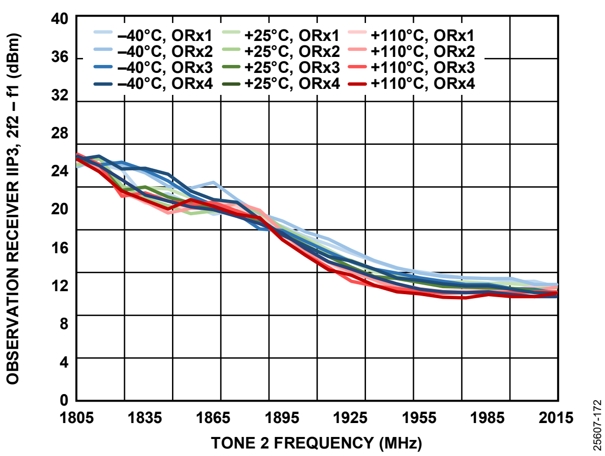


Figure 243. Observation Receiver IIP3, 2f2 − f1 vs. Tone 2 Frequency, Both Tones at −13 dBFS, f1 = f2 + 2 MHz

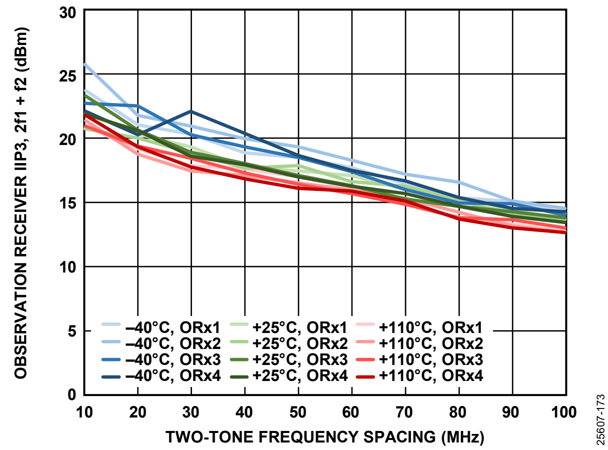


Figure 244. Observation Receiver IIP3, 2f1 + f2 vs. Two-Tone Frequency Spacing, Both Tones at −13 dBFS, f2 = 2 MHz

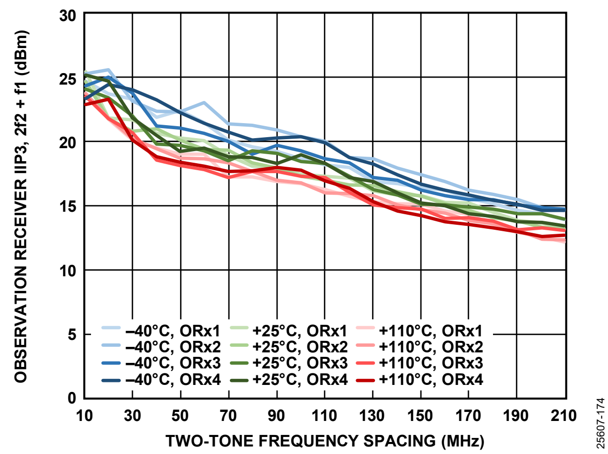


Figure 245. Observation Receiver IIP3, 2f2 + f1 vs. Two-Tone Frequency Spacing, Both Tones at −13 dBFS, f2 = 2 MHz

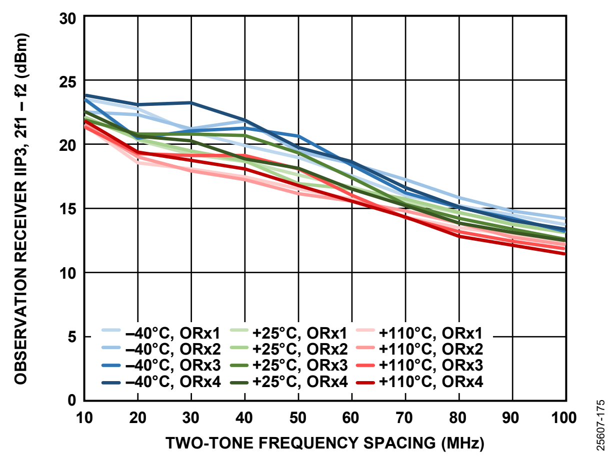


Figure 246. Observation Receiver IIP3, 2f1 − f2 vs. Two-Tone Frequency Spacing, Both Tones at −13 dBFS, f2 = 2 MHz

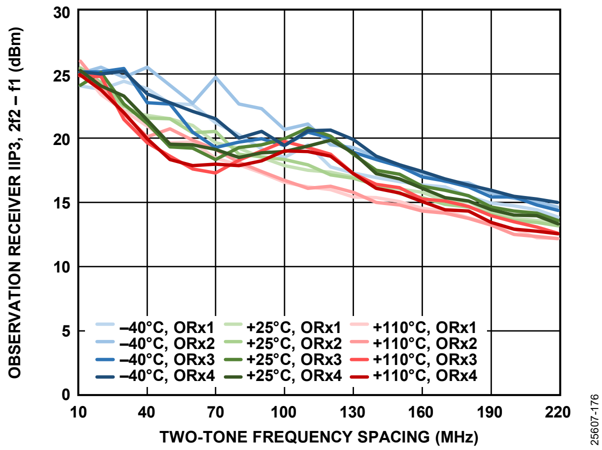


Figure 247. Observation Receiver IIP3, 2f2 – f1 vs. Two-Tone Frequency Spacing, Both Tones at –13 dBFS, f2 = 2 MHz

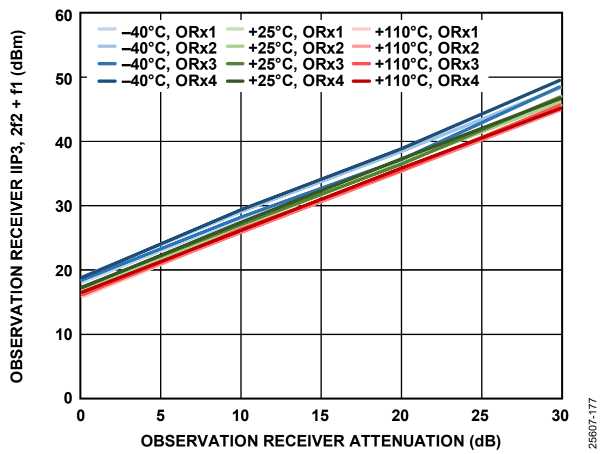


Figure 248. Observation Receiver IIP3, 2f2 + f1 vs. Observation Receiver Attenuation, Both Tones at –13 dBFS, f1 = 122 MHz, f2 = 2 MHz

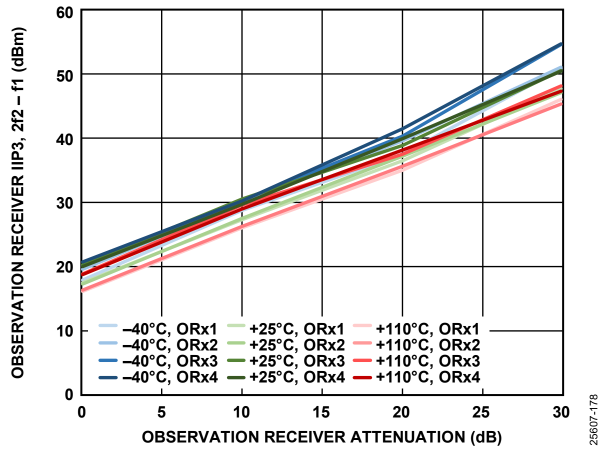


Figure 249. Observation Receiver IIP3, 2f2 – f1 vs. Observation Receiver Attenuation, Both Tones at –13 dBFS, f1 = 122 MHz, f2 = 2 MHz

2600 MHz BAND

The temperature settings refer to the die temperature. All LO frequencies set to 2600 MHz, unless otherwise noted.

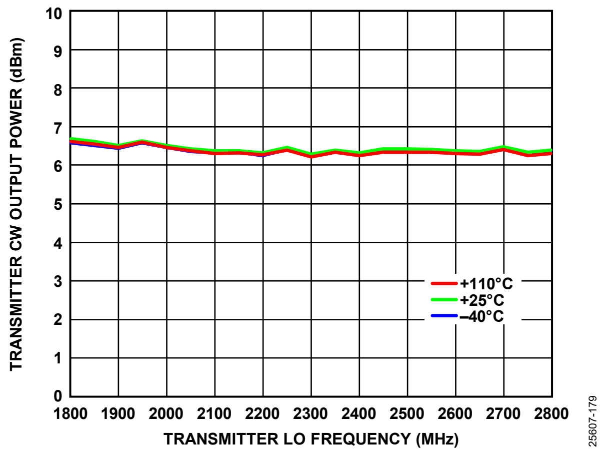


Figure 250. Transmitter Continuous Wave Output Power vs. Transmitter LO Frequency, 10 MHz Offset, 0 dB Attenuation

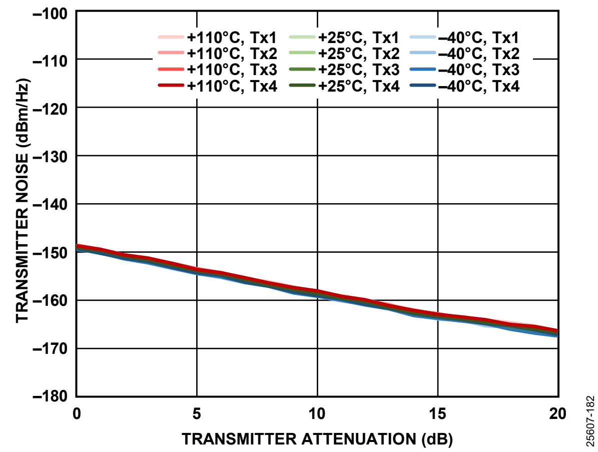


Figure 253. Transmitter Noise vs. Transmitter Attenuation, 10 MHz Offset

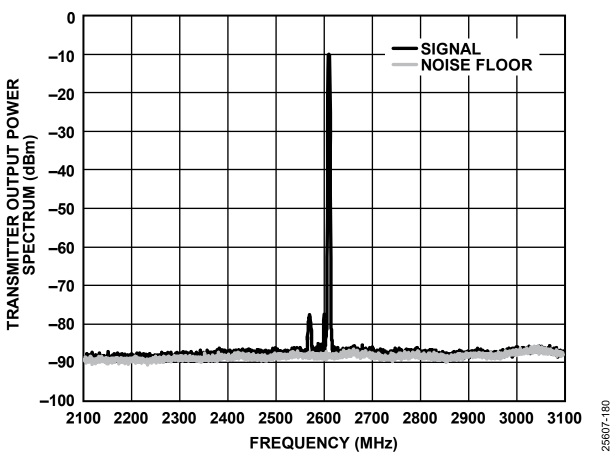


Figure 251. Transmitter Output Power Spectrum, Tx1, 5 MHz LTE, 10 MHz Offset, –10 dBFS RMS, 1 MHz Resolution Bandwidth, T_J = 25°C

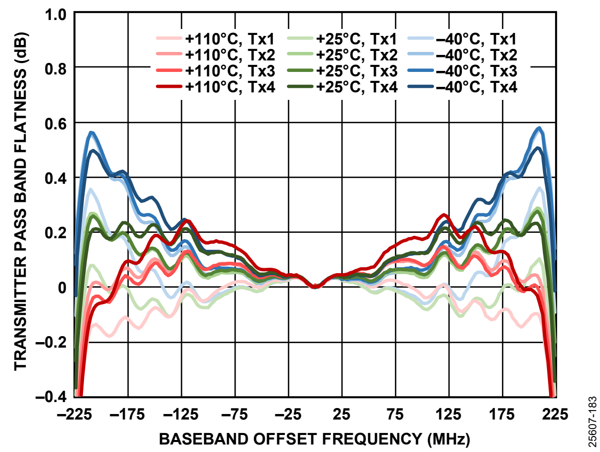


Figure 254. Transmitter Pass Band Flatness vs. Baseband Offset Frequency

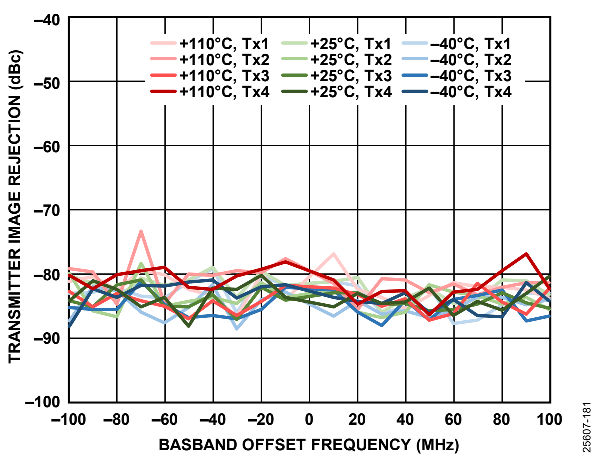


Figure 252. Transmitter Image Rejection Across Large Signal Bandwidth vs. Baseband Offset Frequency

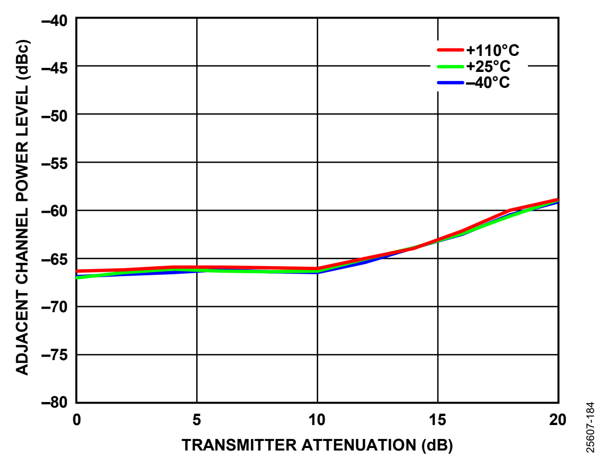


Figure 255. Adjacent Channel Power Level vs. Transmitter Attenuation, –10 MHz Baseband Offset, 20 MHz LTE, PAR = 12 dB

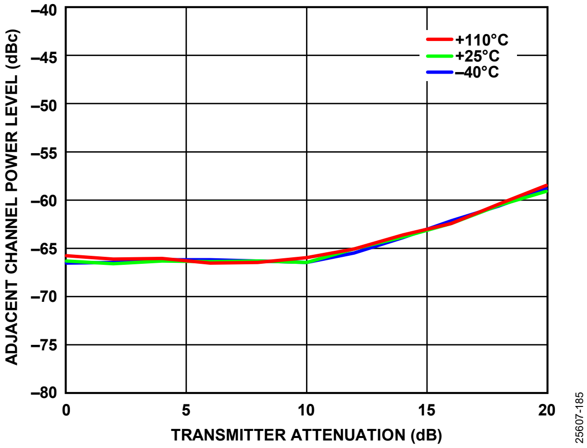


Figure 256. Adjacent Channel Power Level vs. Transmitter Attenuation, 90 MHz Baseband Offset, 20 MHz LTE, PAR = 12 dB

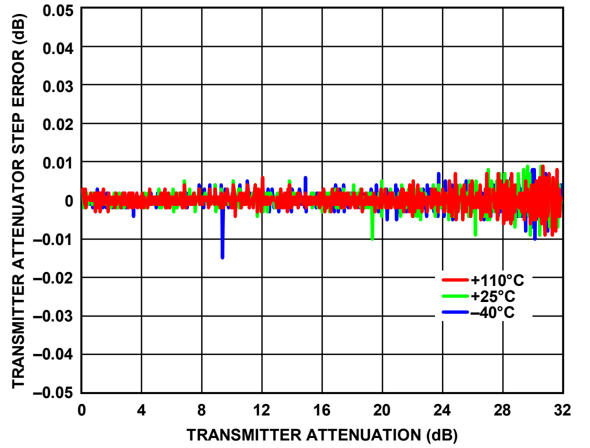


Figure 259. Transmitter Attenuator Step Error vs. Transmitter Attenuation, 10 MHz Offset

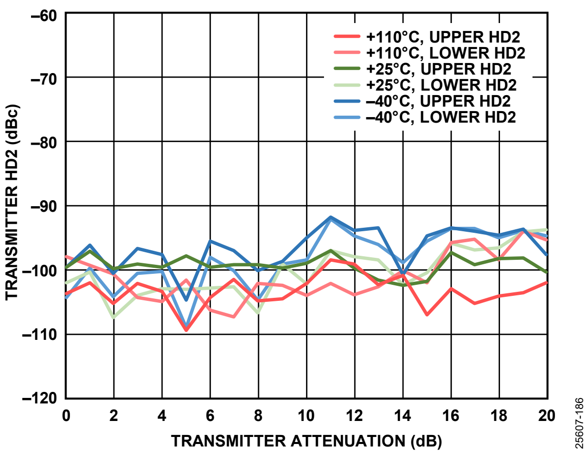


Figure 257. Transmitter Second Harmonic Distortion (HD2) vs. Transmitter Attenuation, 10 MHz Offset

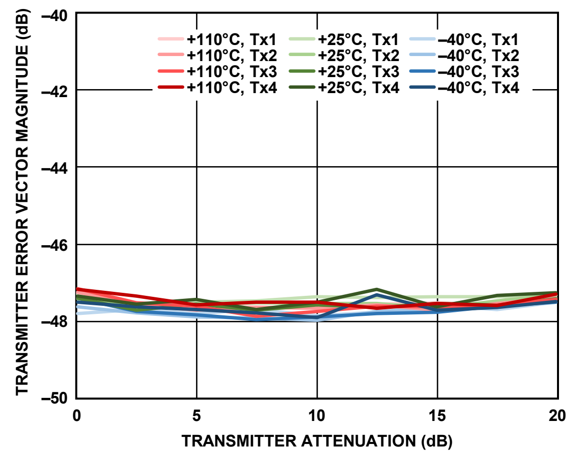


Figure 260. Transmitter Error Vector Magnitude vs. Transmitter Attenuation, 20 MHz LTE Signal Centered at LO Frequency, Sample Rate = 491.52 MSPS, Loop Filter Bandwidth = 500 kHz, Loop Filter Phase Margin = 60°

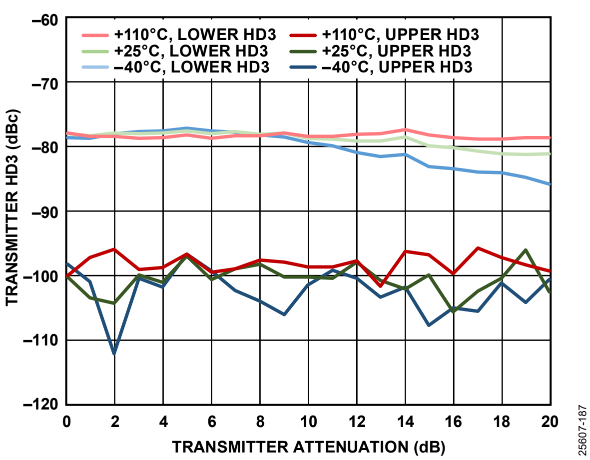


Figure 258. Transmitter Third Harmonic Distortion (HD3) vs. Transmitter Attenuation, 10 MHz Offset

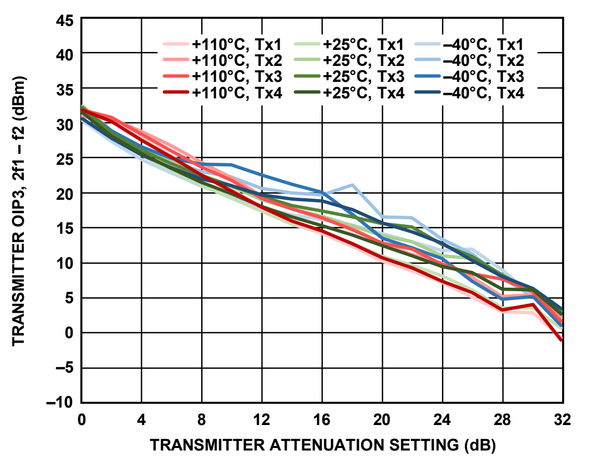


Figure 261. Transmitter OIP3, 2f1 – f2 vs. Transmitter Attenuation, 15 dB Digital Back Off per Tone, f1 = 50.5 MHz, f2 = 55.5 MHz

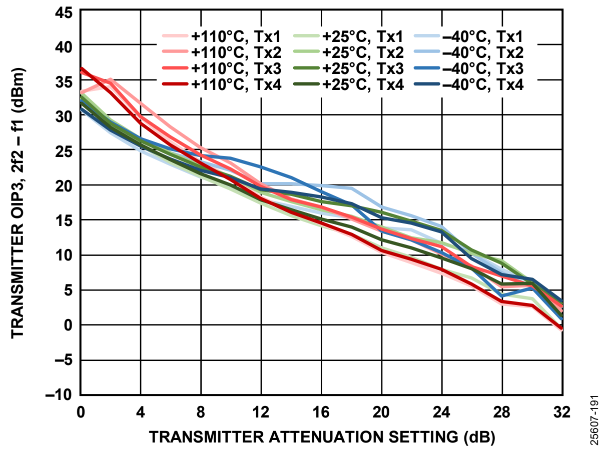


Figure 262. Transmitter OIP3, 2f2 – f1 vs. Transmitter Attenuation, 15 dB Digital Back Off per Tone, f1 = 50.5 MHz, f2 = 55.5 MHz

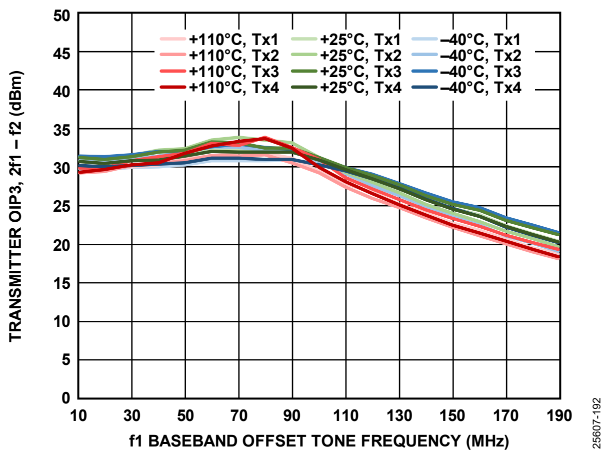


Figure 263. Transmitter OIP3, 2f1 – f2 vs. f1 Baseband Offset Tone Frequency, f2 = f1 + 5 MHz, 15 dB Digital Back Off per Tone

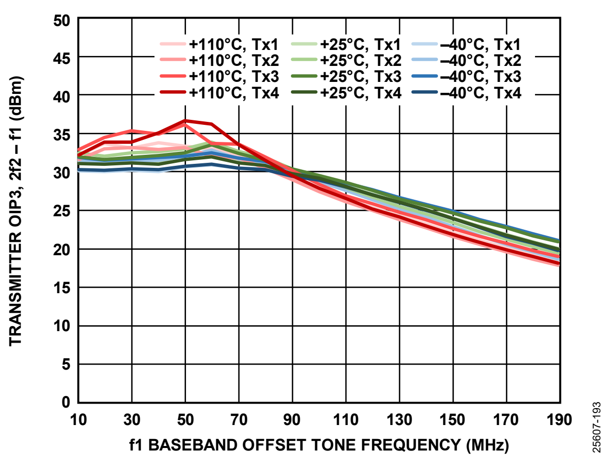


Figure 264. Transmitter OIP3, 2f2 – f1 vs. f1 Baseband Offset Tone Frequency, f2 = f1 + 5 MHz, 15 dB Digital Back Off per Tone

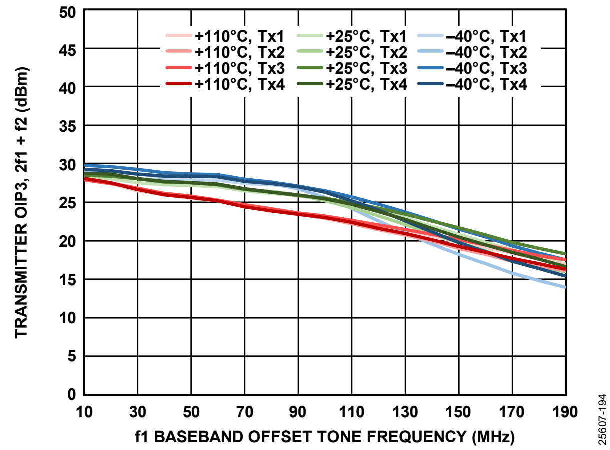


Figure 265. Transmitter OIP3, 2f1 + f2 vs. f1 Baseband Offset Tone Frequency, f2 = f1 + 5 MHz, 15 dB Digital Back Off per Tone

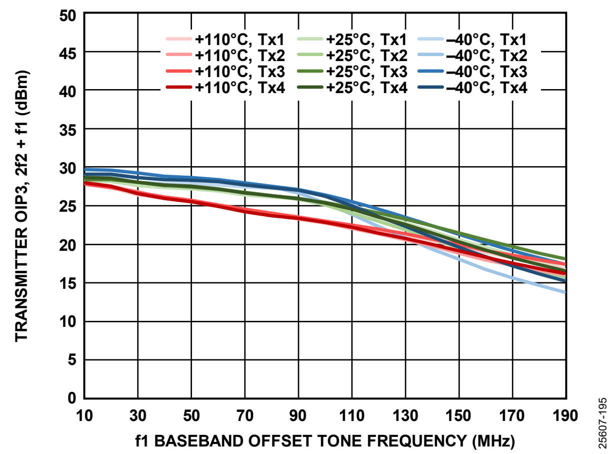


Figure 266. Transmitter OIP3, 2f2 + f1 vs. f1 Baseband Offset Tone Frequency, f2 = f1 + 5 MHz, 15 dB Digital Back Off per Tone

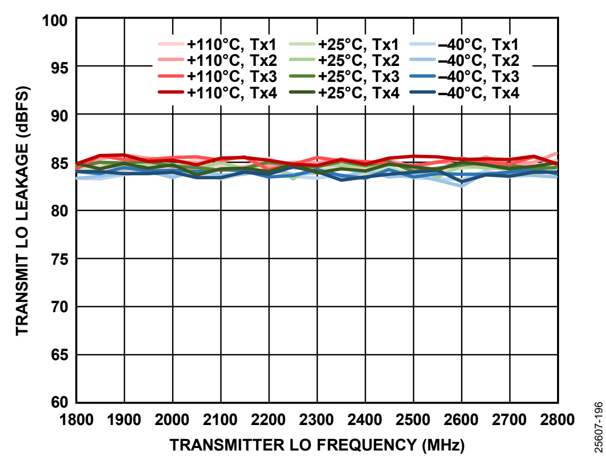


Figure 267. Transmitter LO Leakage vs. Transmitter LO Frequency

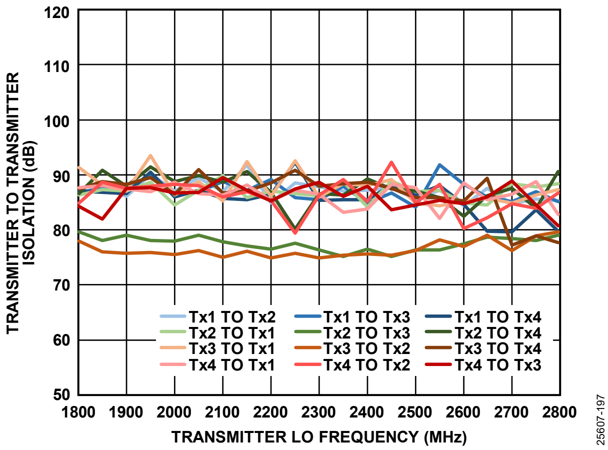


Figure 268. Transmitter to Transmitter Isolation vs. Transmitter LO Frequency

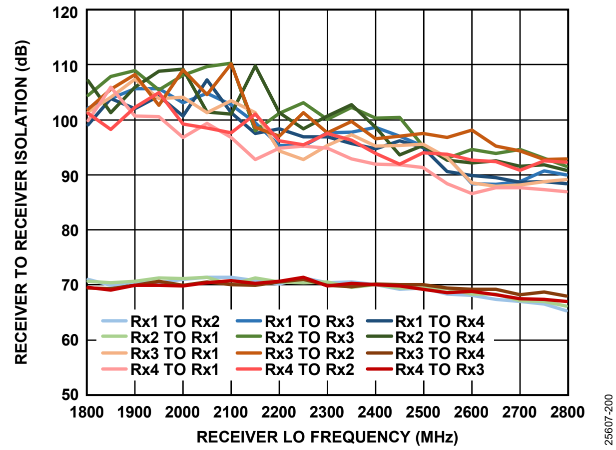


Figure 271. Receiver to Receiver Isolation vs. Receiver LO Frequency

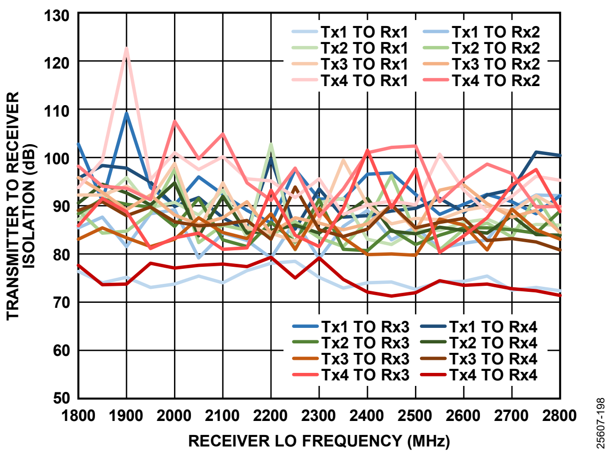


Figure 269. Transmitter to Receiver Isolation vs. Receiver LO Frequency

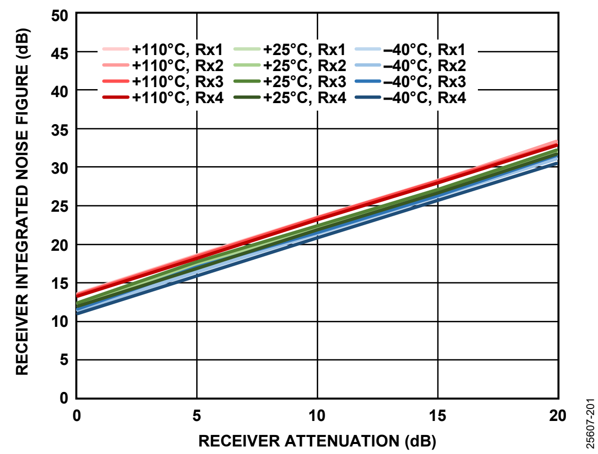


Figure 272. Receiver Integrated Noise Figure vs. Receiver Attenuation, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS, Integration Bandwidth = 500 kHz to 100 MHz

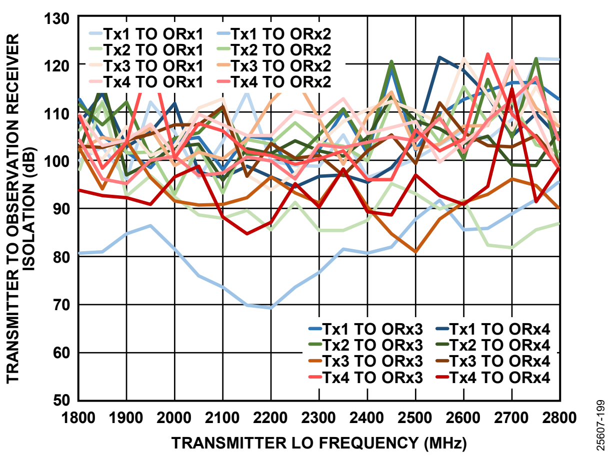


Figure 270. Transmitter to Observation Receiver Isolation vs. Transmitter LO Frequency

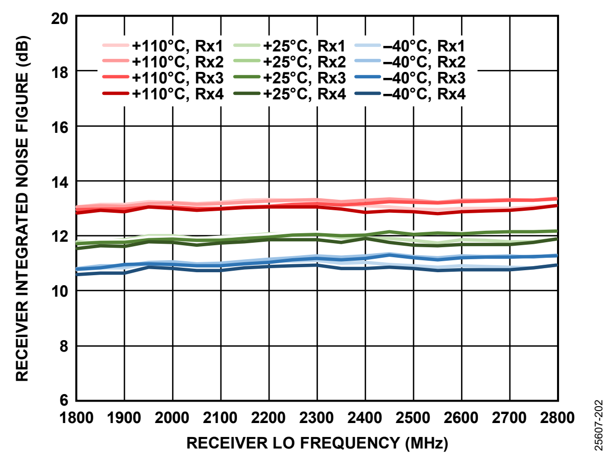


Figure 273. Receiver Integrated Noise Figure vs. Receiver LO Frequency, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS, Integration Bandwidth = 500 kHz to 100 MHz

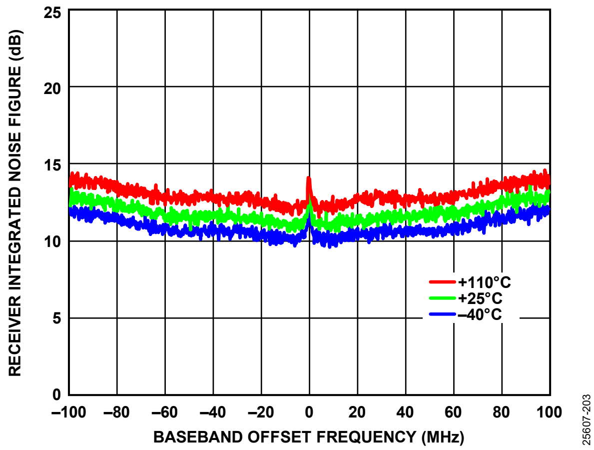


Figure 274. Receiver Integrated Noise Figure vs. Baseband Offset Frequency, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS, Integrated in 200 kHz Steps

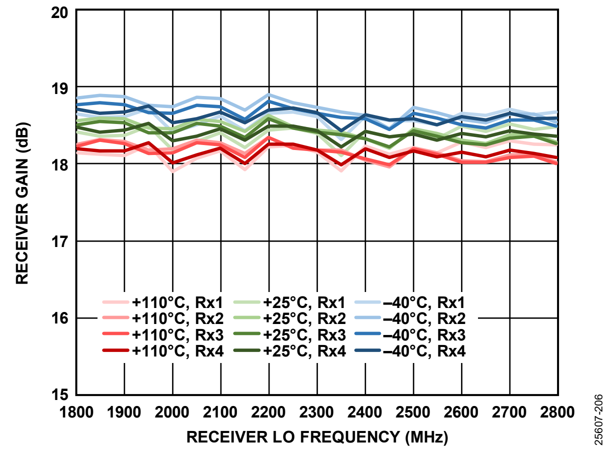


Figure 277. Receiver Gain vs. Receiver LO Frequency, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS

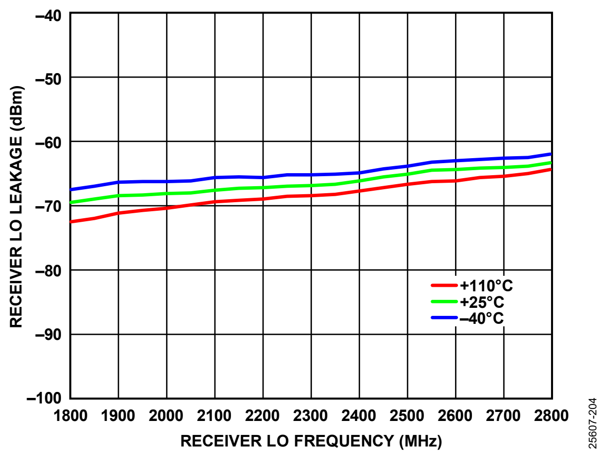


Figure 275. Receiver LO Leakage vs. Receiver LO Frequency, Attenuation = 0 dB, Sample Rate = 245.76 MSPS

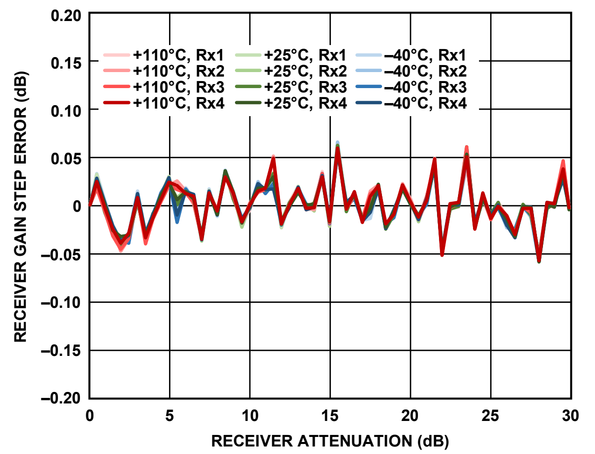


Figure 278. Receiver Gain Step Error vs. Receiver Attenuation, 20 MHz Offset, −5 dBFS Input Signal

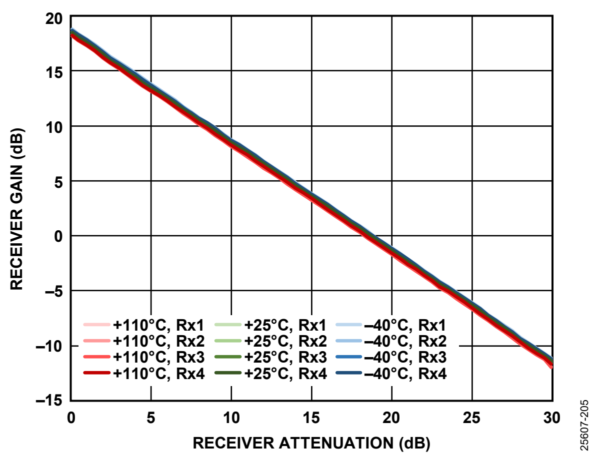


Figure 276. Receiver Gain vs. Receiver Attenuation, 20 MHz Offset, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS

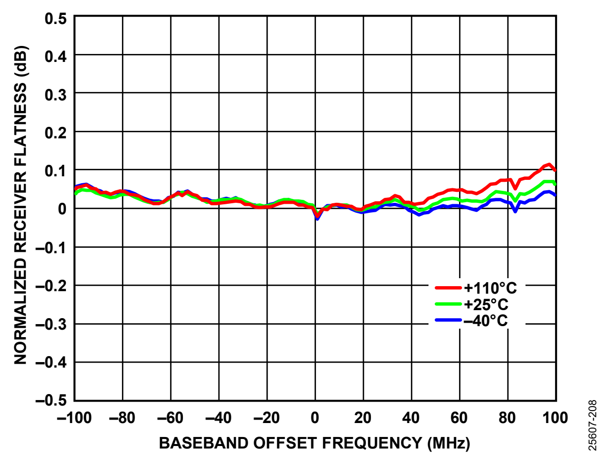


Figure 279. Normalized Receiver Flatness vs. Baseband Offset Frequency, −5 dBFS Input Signal

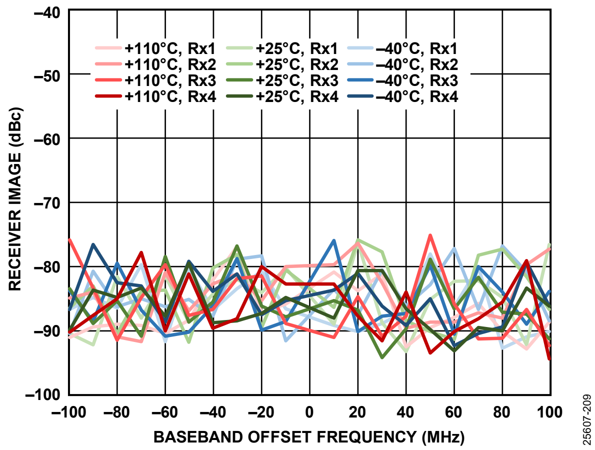


Figure 280. Receiver Image vs. Baseband Offset Frequency, Tracking Calibration Active, Sample Rate = 245.76 MSPS

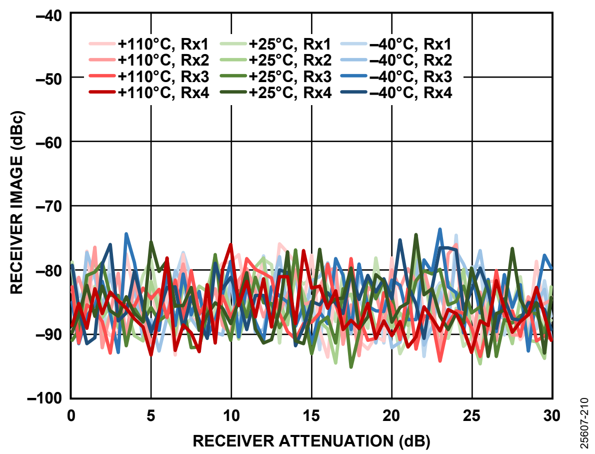


Figure 281. Receiver Image vs. Receiver Attenuation, 20 MHz Offset, Tracking Calibration Active, Sample Rate = 245.76 MSPS

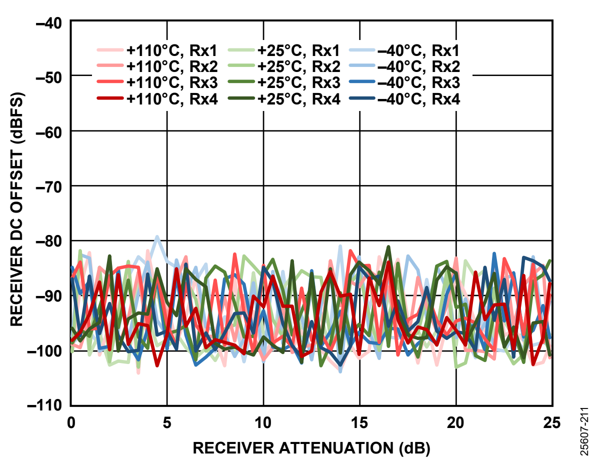


Figure 282. Receiver DC Offset vs. Receiver Attenuation, 20 MHz Offset, –5 dBFS Input Signal

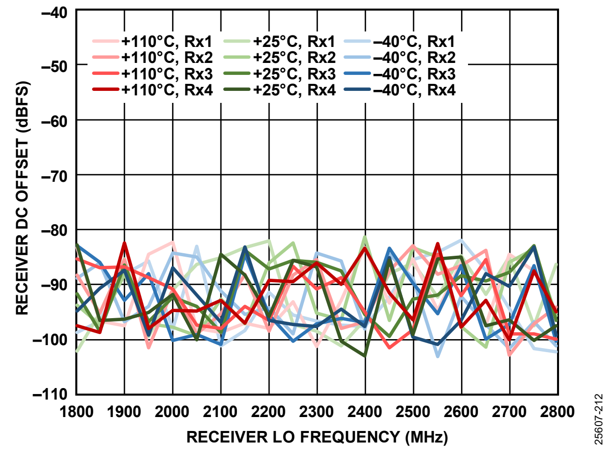


Figure 283. Receiver DC Offset vs. Receiver LO Frequency, 20 MHz Offset, –5 dBFS Input Signal

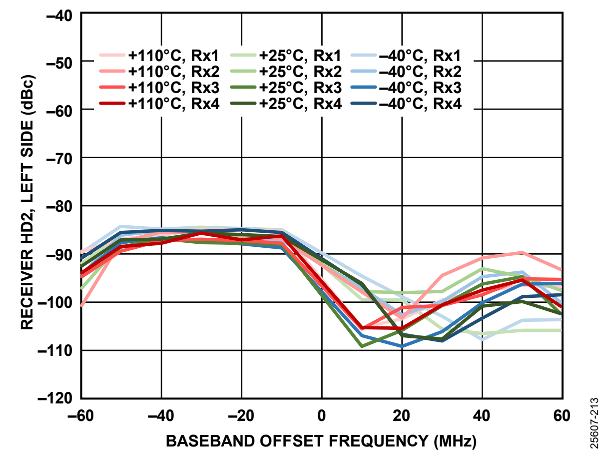


Figure 284. Receiver HD2, Left Side vs. Baseband Offset Frequency, –5 dBFS Input Signal, Distortion Tone Measured Left of 0 Hz (HD2 Canceller Not Enabled)

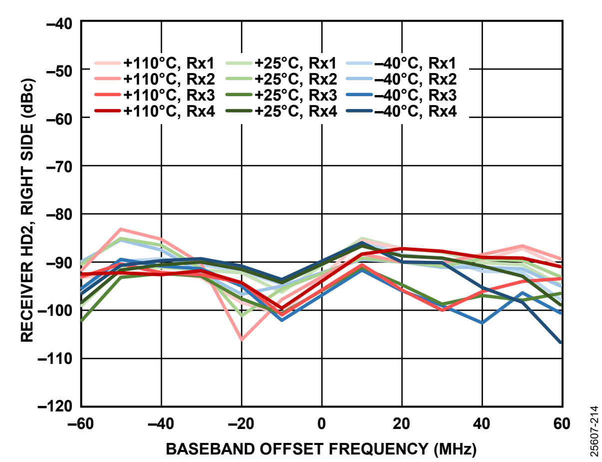


Figure 285. Receiver HD2, Right Side vs. Baseband Offset Frequency, –5 dBFS Input Signal, Distortion Tone Measured Right of 0 Hz (HD2 Canceller Not Enabled)

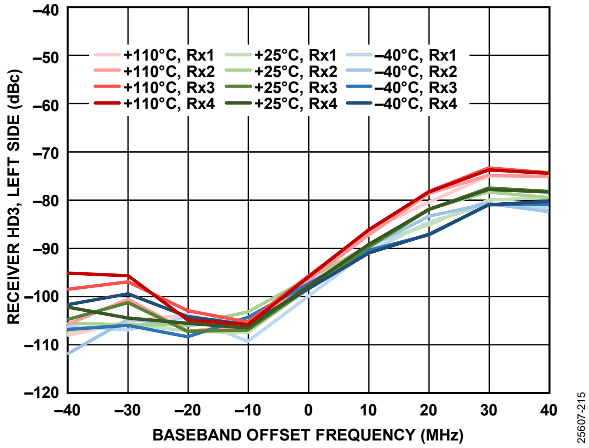


Figure 286. Receiver HD3, Left Side vs. Baseband Offset Frequency, –5 dBFS Input Signal, Distortion Tone Measured Left of 0 Hz

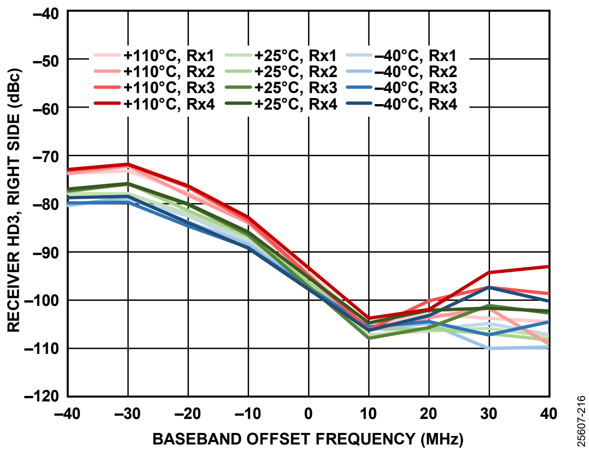


Figure 287. Receiver HD3, Right Side vs. Baseband Offset Frequency, –5 dBFS Input Signal, Distortion Tone Measured Right of 0 Hz

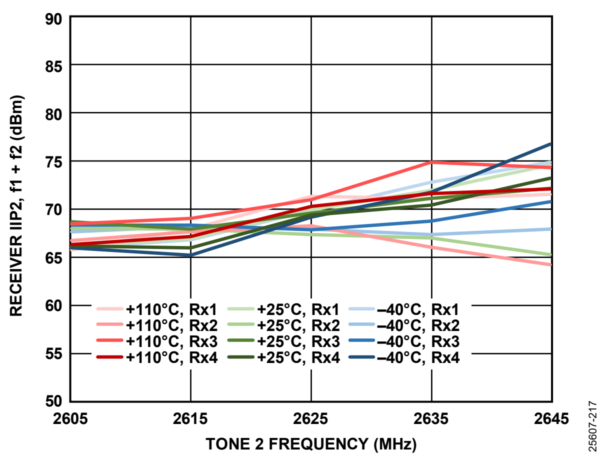


Figure 288. Receiver IIP2, f1 + f2 vs. Tone 2 Frequency, Both Tones at –11 dBFS, f1 = f2 + 2 MHz

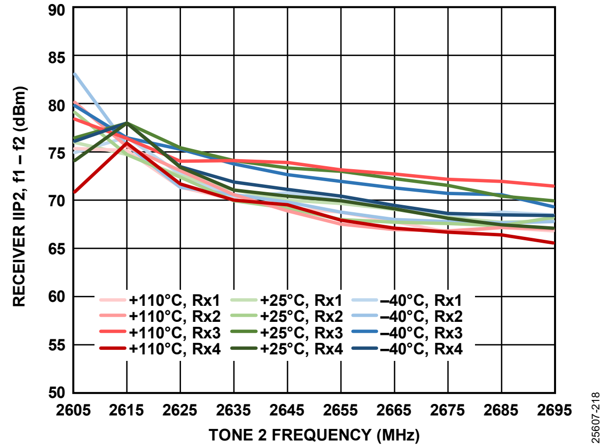


Figure 289. Receiver IIP2, f1 – f2 vs. Tone 2 Frequency, Both Tones at –11 dBFS, f1 = f2 + 2 MHz

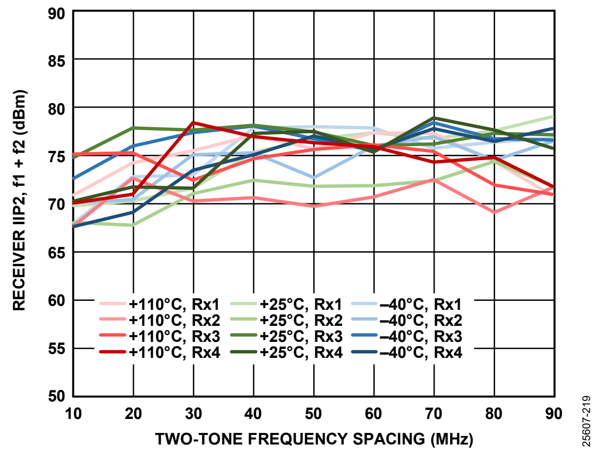


Figure 290. Receiver IIP2, f1 + f2 vs. Two-Tone Frequency Spacing, Both Tones at –11 dBFS, f2 = 2 MHz

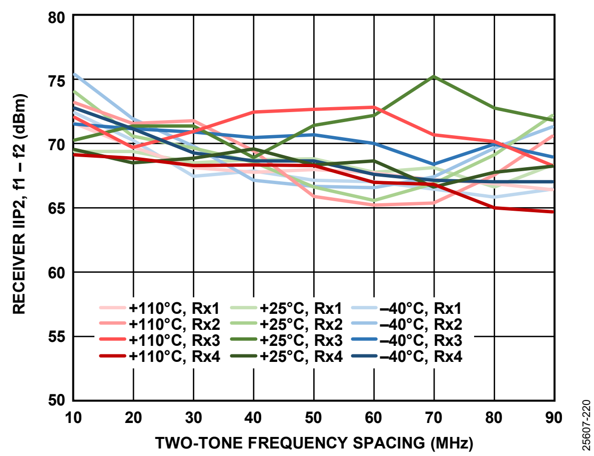


Figure 291. Receiver IIP2, f1 – f2 vs. Two-Tone Frequency Spacing, Both Tones at –11 dBFS, f2 = 2 MHz

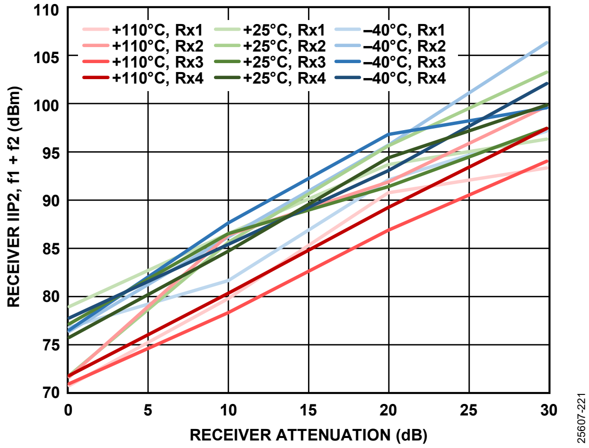


Figure 292. Receiver IIP2, f1 + f2 vs. Receiver Attenuation, Both Tones at −11 dBFS, f1 = 92 MHz, f2 = 2 MHz

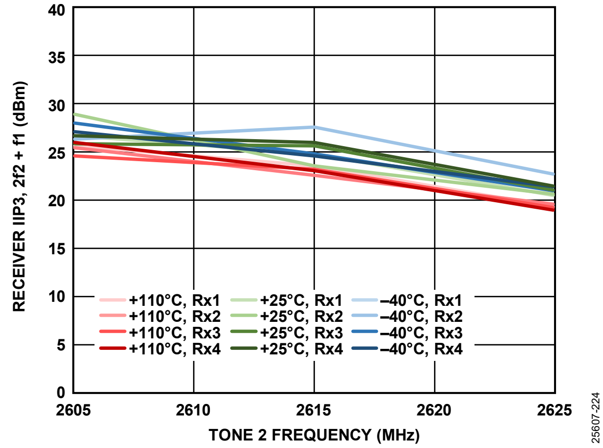


Figure 293. Receiver IIP2, f1 − f2 vs. Receiver Attenuation, Both Tones at −11 dBFS, f1 = 92 MHz, f2 = 2 MHz

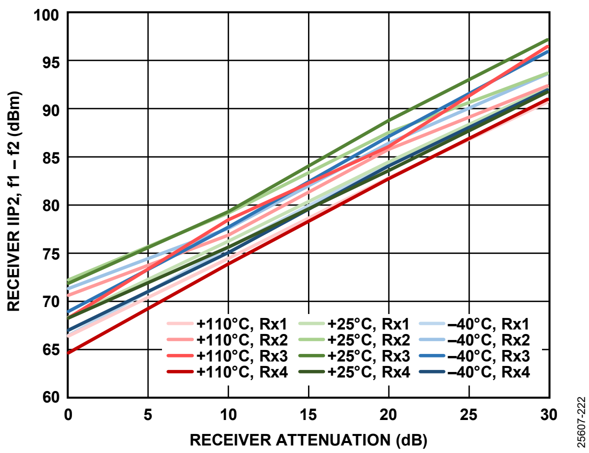


Figure 294. Receiver IIP3, 2f1 + f2 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

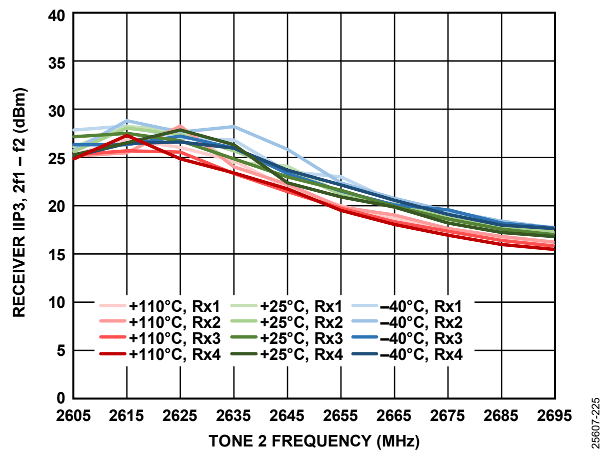


Figure 295. Receiver IIP3, 2f2 + f1 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

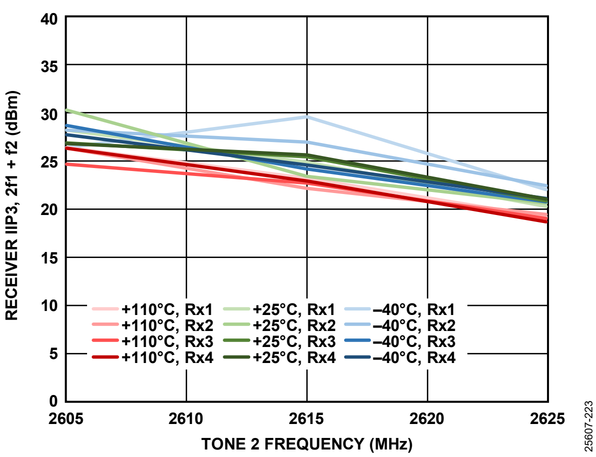


Figure 296. Receiver IIP3, 2f1 − f2 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

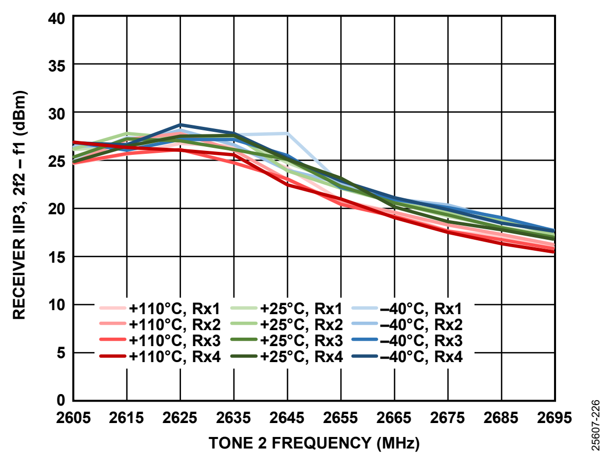


Figure 297. Receiver IIP3, 2f2 − f1 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

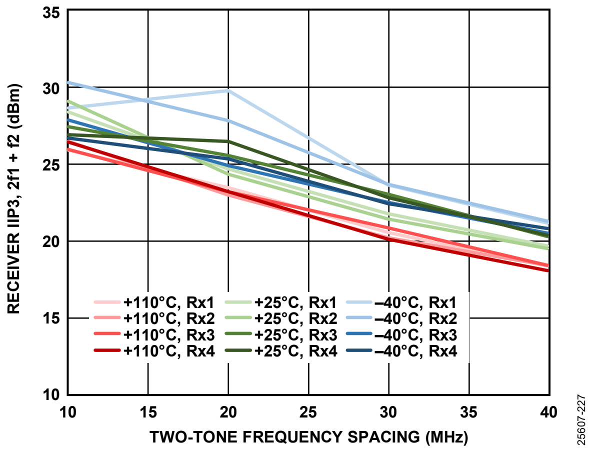


Figure 298. Receiver IIP3, 2f1 + f2 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

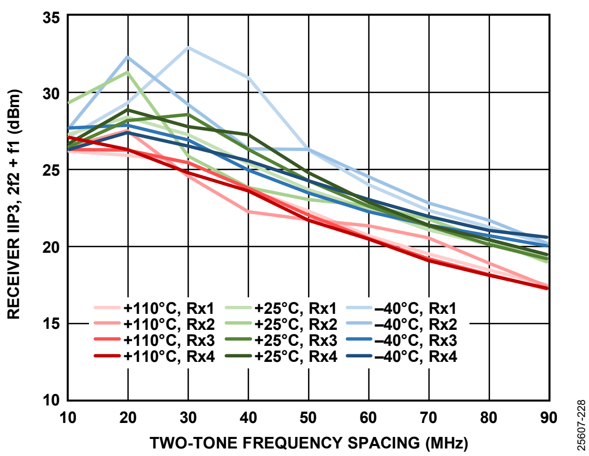


Figure 299. Receiver IIP3, 2f2 + f1 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

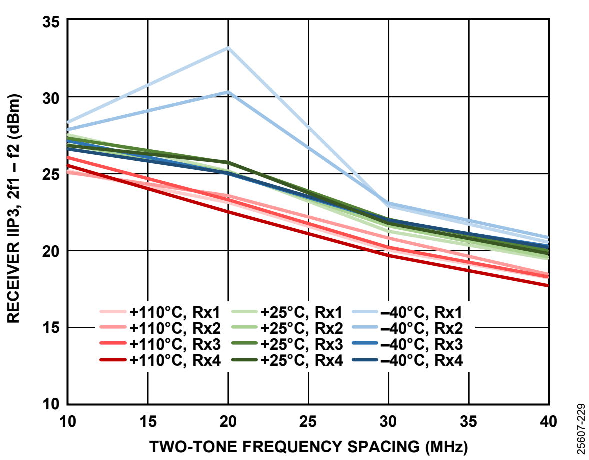


Figure 300. Receiver IIP3, 2f1 − f2 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

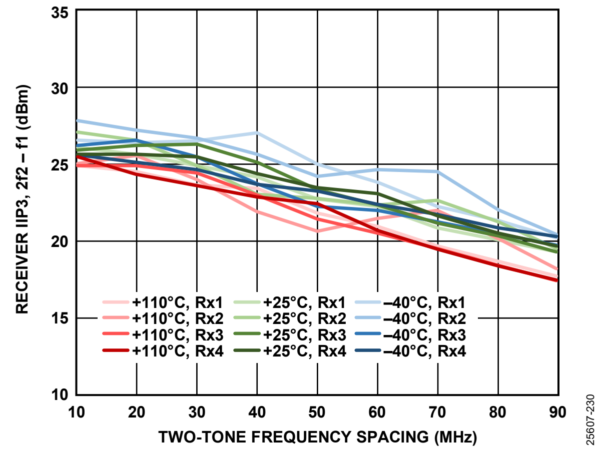


Figure 301. Receiver IIP3, 2f2 − f1 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

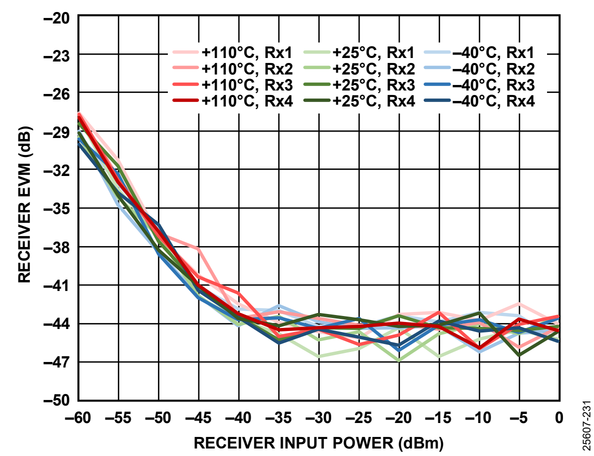


Figure 302. Receiver Error Vector Magnitude vs. Receiver Input Power, 20 MHz LTE Signal Centered at LO Frequency, Sample Rate = 245.76 MSPS, Loop Filter Bandwidth = 500 kHz, Loop Filter Phase Margin = 60°

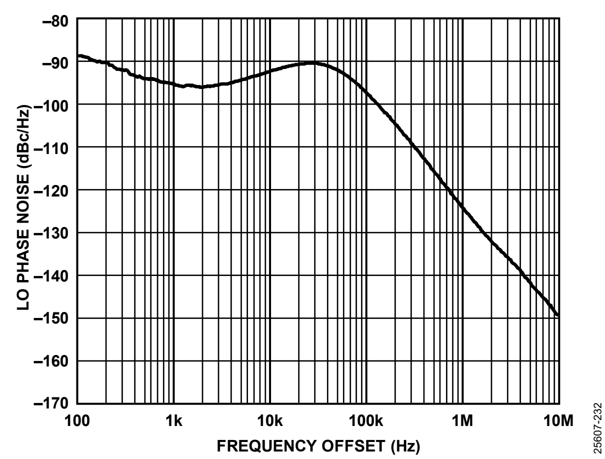


Figure 303. LO Phase Noise vs. Frequency Offset, Loop Bandwidth = 75 kHz, Phase Margin = 85°

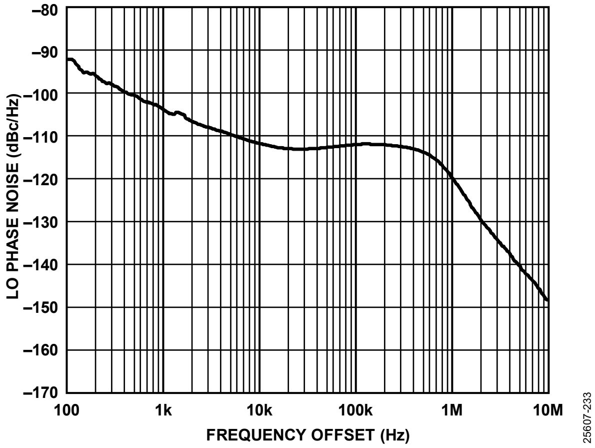


Figure 304. LO Phase Noise vs. Frequency Offset, Loop Bandwidth = 500 kHz, Phase Margin = 60°

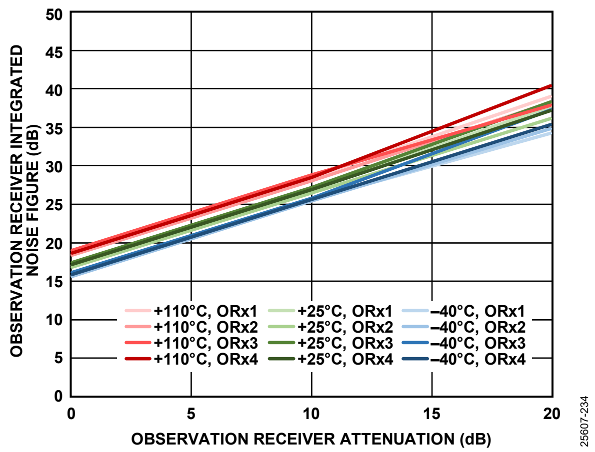


Figure 305. Observation Receiver Integrated Noise Figure vs. Observation Receiver Attenuation, 450 MHz Bandwidth, Sample Rate = 491.52 MSPS, Integration Bandwidth = 500 kHz to 245.76 MHz

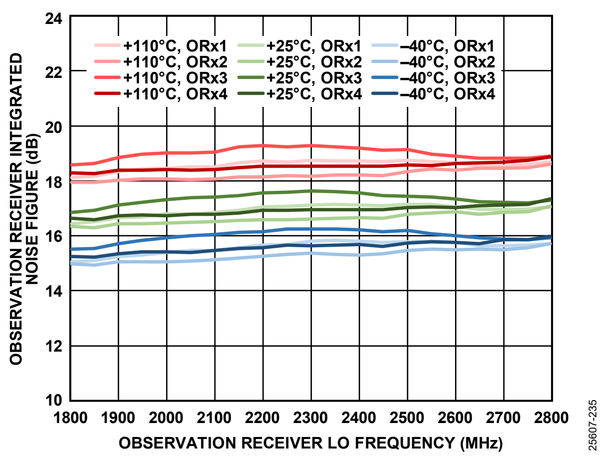


Figure 306. Observation Receiver Integrated Noise Figure vs. Observation Receiver LO Frequency, 450 MHz Bandwidth, Sample Rate = 491.52 MSPS, Integration Bandwidth = 500 kHz to 245.76 MHz

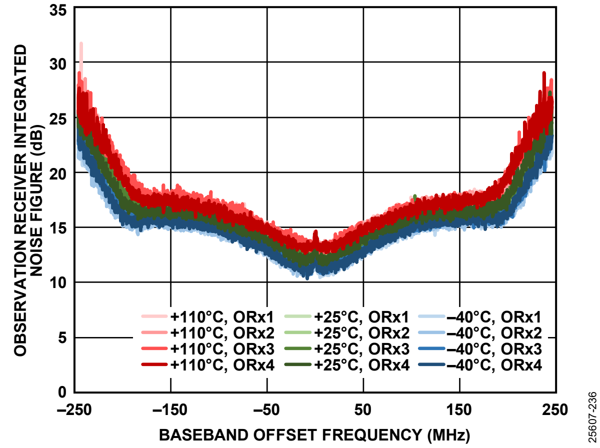


Figure 307. Observation Receiver Integrated Noise Figure vs. Baseband Offset Frequency, 450 MHz Bandwidth, Sample Rate = 491.52 MSPS, Integrated in 200 kHz Steps

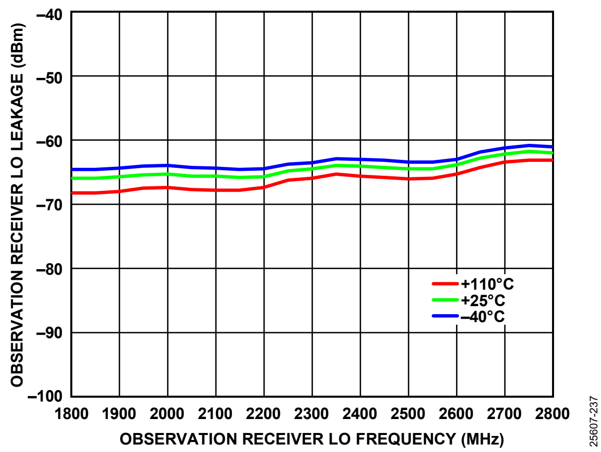


Figure 308. Observation Receiver LO Leakage vs. Observation Receiver LO Frequency, Attenuation = 0 dB, Sample Rate = 491.52 MSPS

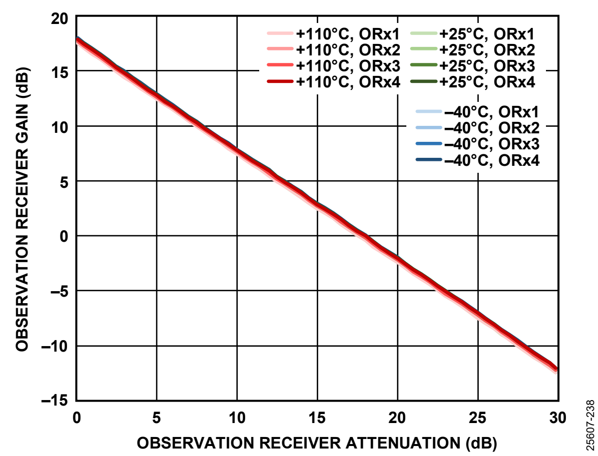


Figure 309. Observation Receiver Gain vs. Observation Receiver Attenuation, 45 MHz Offset, 450 MHz Bandwidth, Sample Rate = 491.52 MSPS

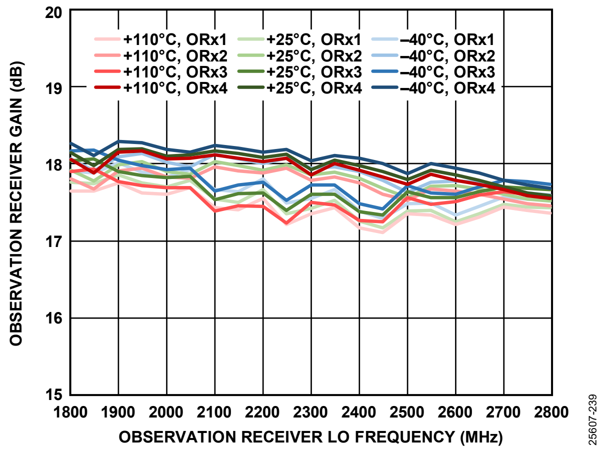


Figure 310. Observation Receiver Gain vs. Observation Receiver LO Frequency, 450 MHz Bandwidth, Sample Rate = 491.52 MSPS

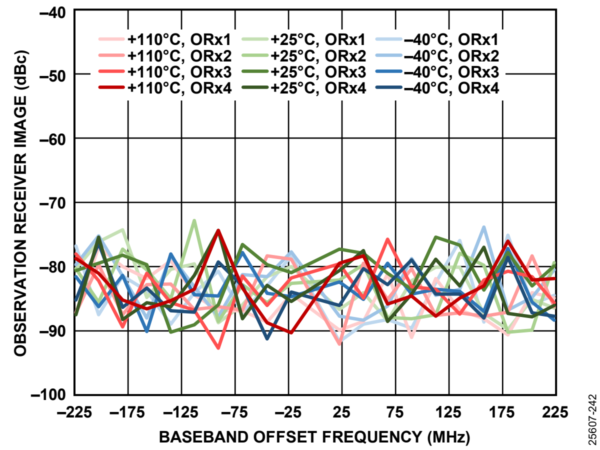


Figure 313. Observation Receiver Image vs. Baseband Offset Frequency, Tracking Calibration Active, Sample Rate = 491.52 MSPS

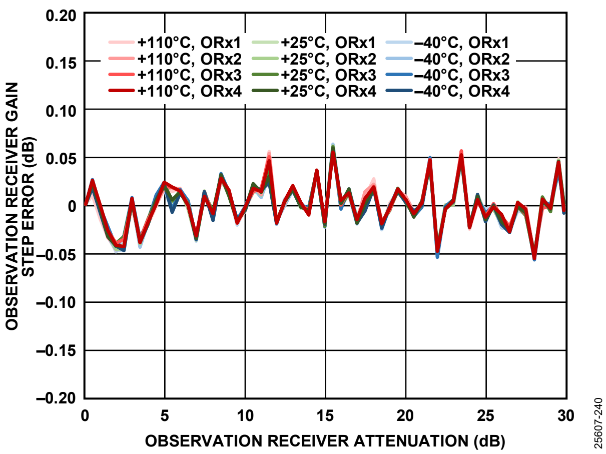


Figure 311. Observation Receiver Gain Step Error vs. Observation Receiver Attenuation, 45 MHz Offset, −10 dBFS Input Signal

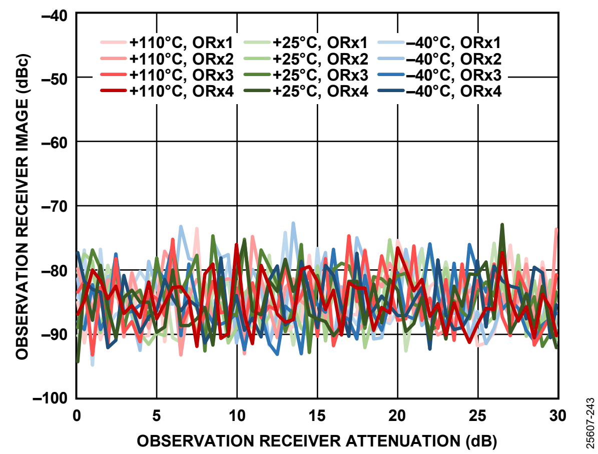


Figure 314. Observation Receiver Image vs. Observation Receiver Attenuation, 45 MHz Offset, Tracking Calibration Active, Sample Rate = 491.52 MSPS

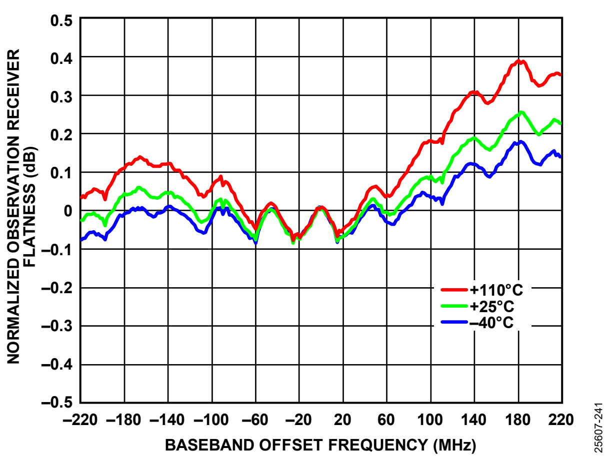


Figure 312. Normalized Observation Receiver Flatness vs. Baseband Offset Frequency, −10 dBFS Input Signal

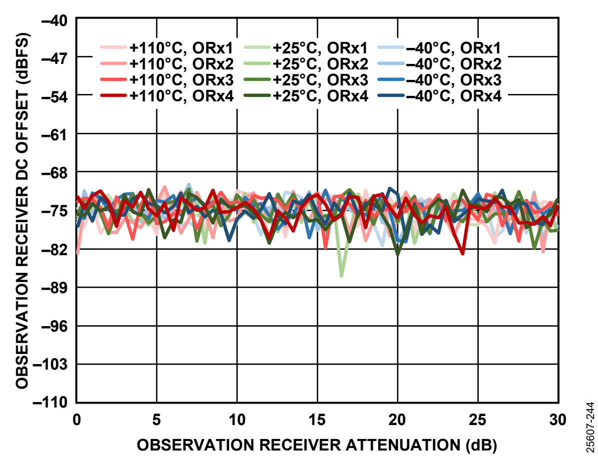


Figure 315. Observation Receiver DC Offset vs. Observation Receiver Attenuation, 45MHz Offset, −10 dBFS Input Signal

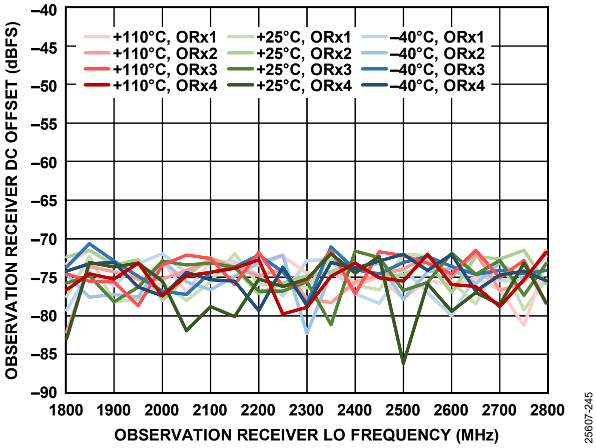


Figure 316. Observation Receiver DC Offset vs. Observation Receiver LO Frequency, Attenuation = 0 dB, Sample Rate = 491.52 MSPS

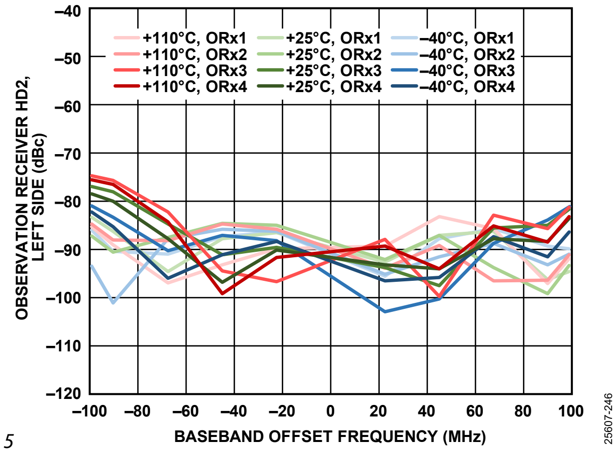


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Figure 317. Observation Receiver HD2, Left Side vs. Baseband Offset Frequency, –10 dBFS Input Signal, Distortion Tone Measured Left of 0 Hz

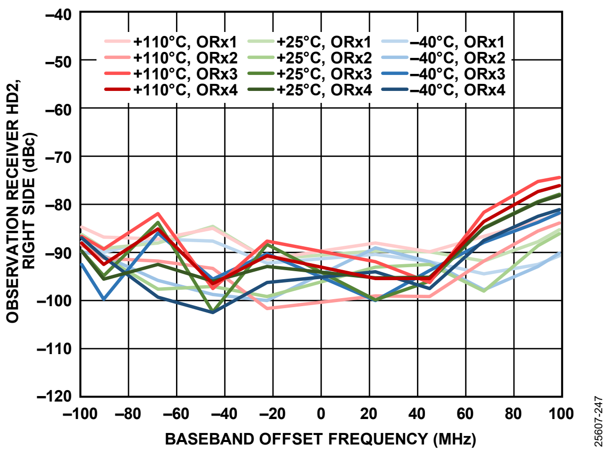

Figure 318. Observation Receiver HD2, Right Side vs. Baseband Offset Frequency, –10 dBFS Input Signal, Distortion Tone Measured Right of 0 Hz

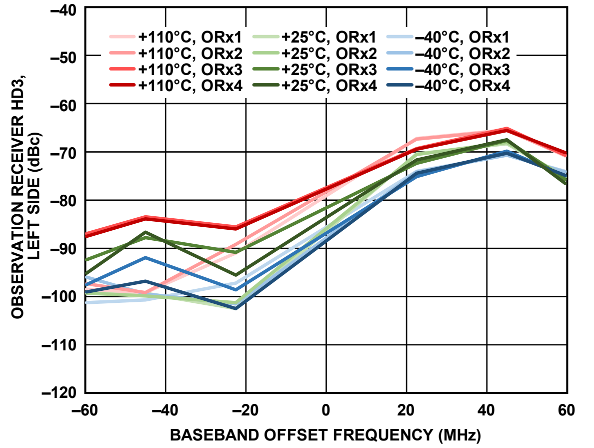

Figure 319. Observation Receiver HD3, Left Side vs. Baseband Offset Frequency, –10 dBFS Input Signal, Distortion Tone Measured Left of 0 Hz

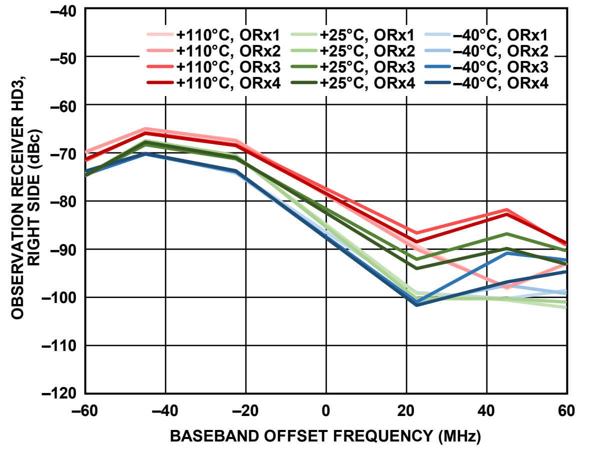

Figure 320. Observation Receiver HD3, Right Side vs. Baseband Offset Frequency, –10 dBFS Input Signal, Distortion Tone Measured Right of 0 Hz

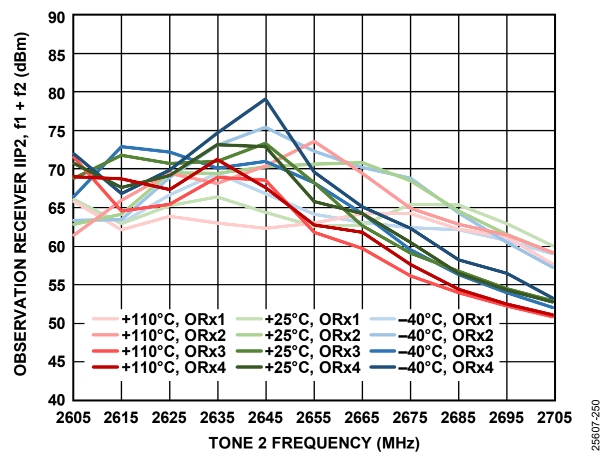

Figure 321. Observation Receiver IIP2, f1 + f2 vs. Tone 2 Frequency, Both Tones at –13 dBFS, f1 = f2 + 2 MHz

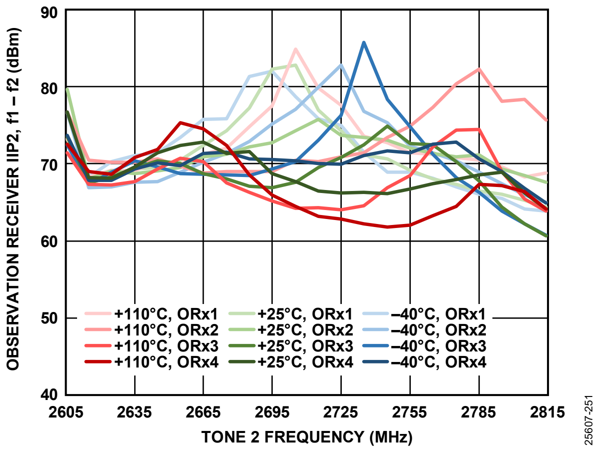

Figure 322. Observation Receiver IIP2, f1 – f2 vs. Tone 2 Frequency, Both Tones at –13 dBFS, f1 = f2 + 2 MHz

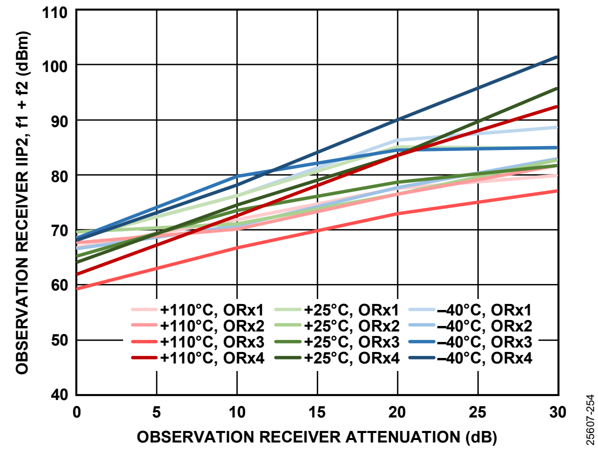

Figure 325. Observation Receiver IIP2, f1 + f2 vs. Observation Receiver Attenuation, Both Tones at –13 dBFS, f1 = 102 MHz, f2 = 2 MHz

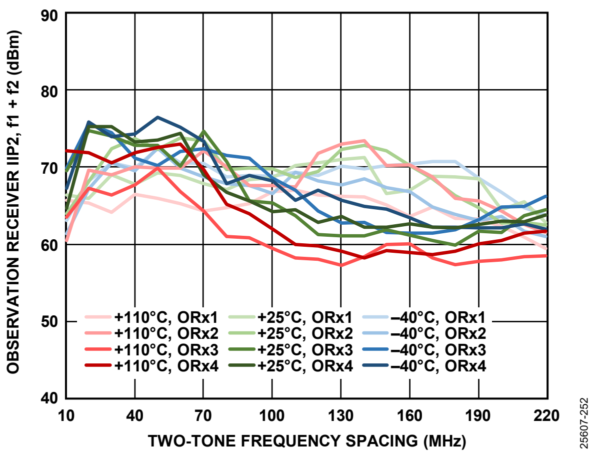

Figure 323. Observation Receiver IIP2, f1 + f2 vs. Two-Tone Frequency Spacing, Both Tones at –13 dBFS, f2 = 2 MHz

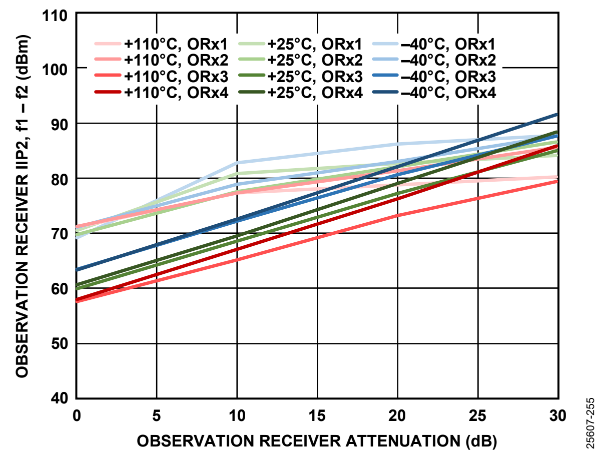

Figure 326. Observation Receiver IIP2, f1 – f2 vs. Observation Receiver Attenuation, Both Tones at –13 dBFS, f1 = 102 MHz, f2 = 2 MHz

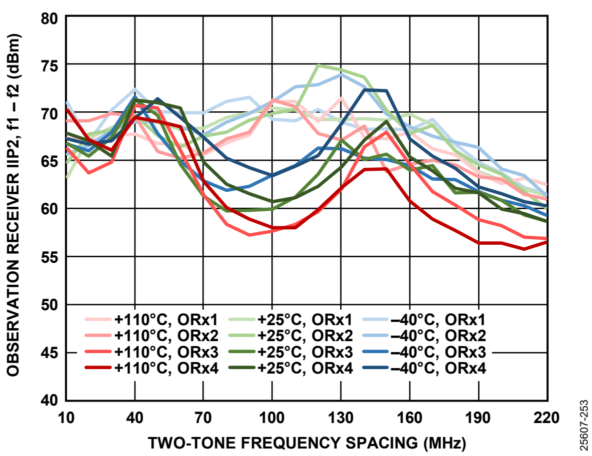

Figure 324. Observation Receiver IIP2, f1 – f2 vs. Two-Tone Frequency Spacing, Both Tones at –13 dBFS, f2 = 2 MHz

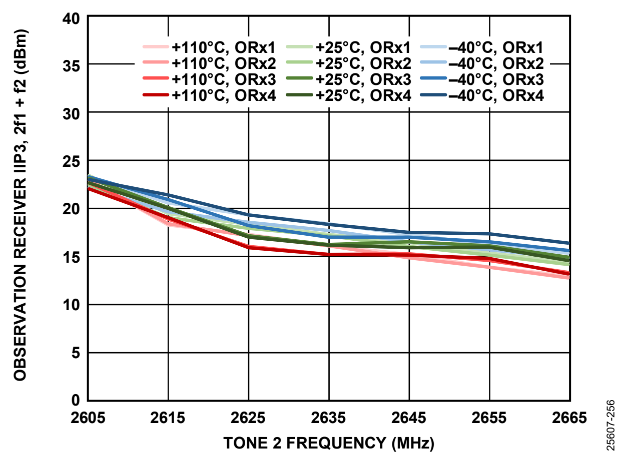

Figure 327. Observation Receiver IIP3, 2f1 + f2 vs. Tone 2 Frequency, Both Tones at –13 dBFS, f1 = f2 + 2 MHz

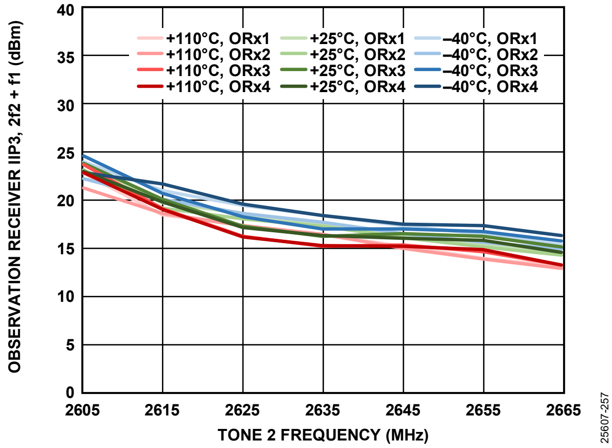

Figure 328. Observation Receiver IIP3, 2f2 + f1 vs. Tone 2 Frequency, Both Tones at −13 dBFS, f1 = f2 + 2 MHz

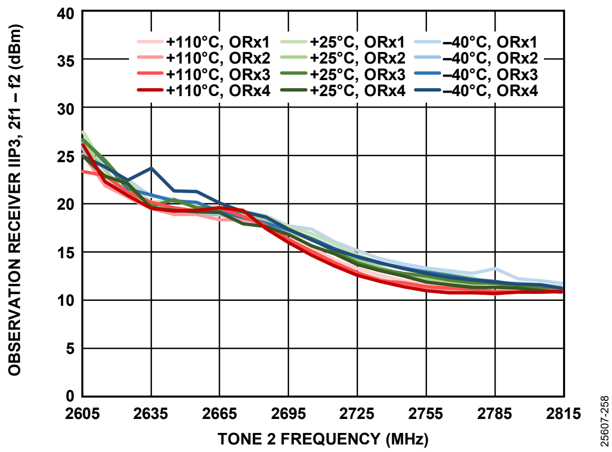

Figure 329. Observation Receiver IIP3, 2f1 − f2 vs. Tone 2 Frequency, Both Tones at −13 dBFS, f1 = f2 + 2 MHz

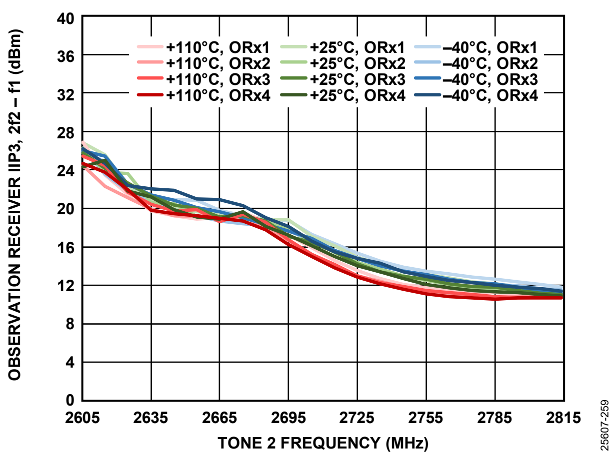

Figure 330. Observation Receiver IIP3, 2f2 − f1 vs. Tone 2 Frequency, Both Tones at −13 dBFS, f1 = f2 + 2 MHz

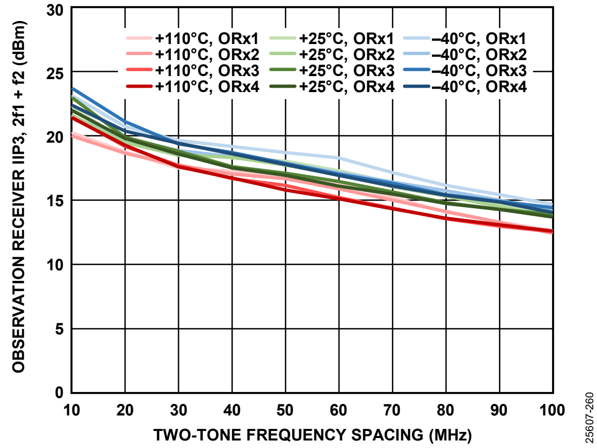

Figure 331. Observation Receiver IIP3, 2f1 + f2 vs. Two-Tone Frequency Spacing, Both Tones at −13 dBFS, f2 = 2 MHz

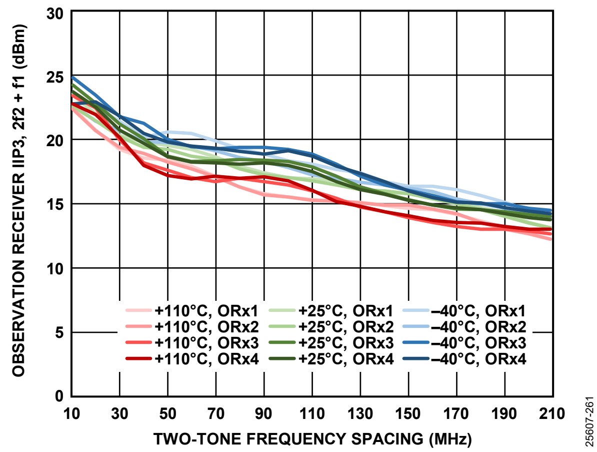

Figure 332. Observation Receiver IIP3, 2f2 + f1 vs. Two-Tone Frequency Spacing, Both Tones at −13 dBFS, f2 = 2 MHz

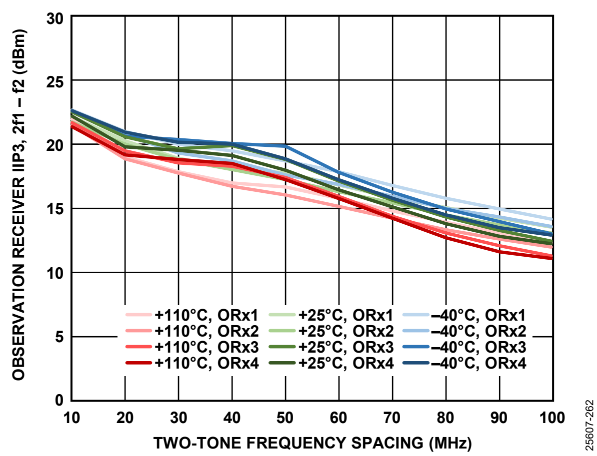

Figure 333. Observation Receiver IIP3, 2f1 − f2 vs. Two-Tone Frequency Spacing, Both Tones at −13 dBFS, f2 = 2 MHz

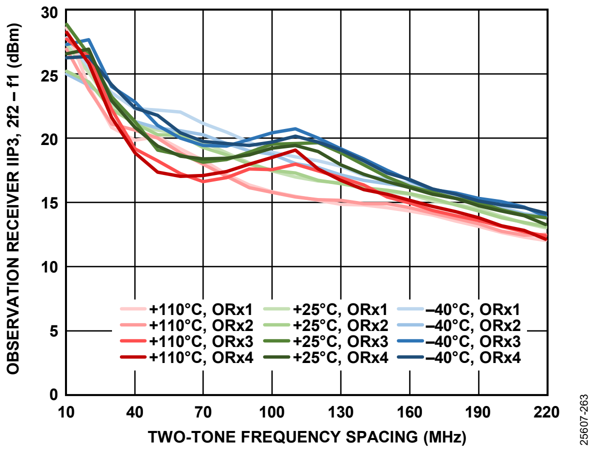

Figure 334. Observation Receiver IIP3, 2f2 – f1 vs. Two-Tone Frequency Spacing, Both Tones at –13 dBFS, f2 = 2 MHz

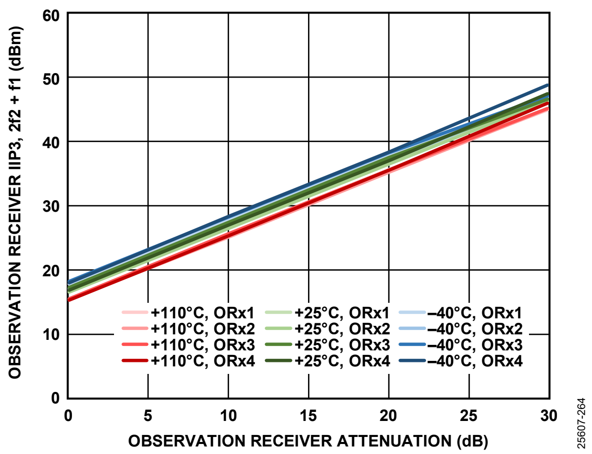

Figure 335. Observation Receiver IIP3, 2f2 + f1 vs. Observation Receiver Attenuation, Both Tones at –13 dBFS, f1 = 122 MHz, f2 = 2 MHz

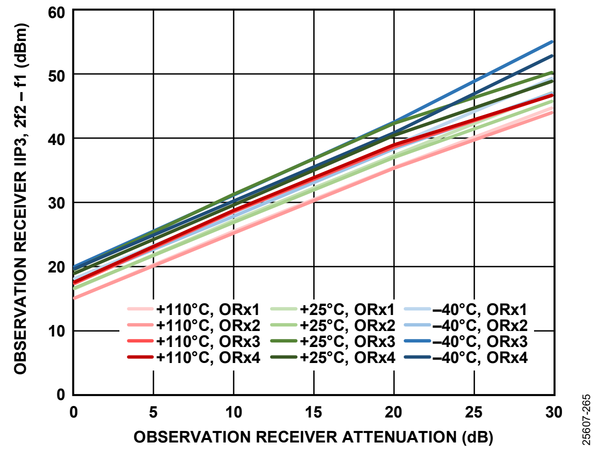

Figure 336. Observation Receiver IIP3, 2f2 – f1 vs. Observation Receiver Attenuation, Both Tones at –13 dBFS, f1 = 122 MHz, f2 = 2 MHz

3800 MHZ BAND

The temperature settings refer to the die temperature. All LO frequencies set to 3800 MHz, unless otherwise noted.

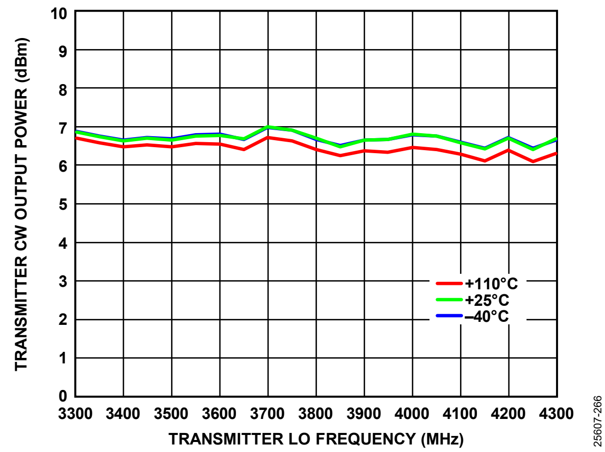

Figure 337. Transmitter Continuous Wave Output Power vs. Transmitter LO Frequency, 10 MHz Offset, 0 dB Attenuation

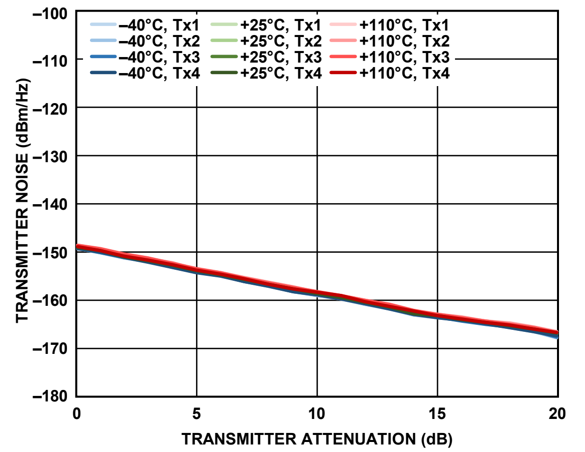

Figure 340. Transmitter Noise vs. Transmitter Attenuation, 10 MHz Offset Frequency

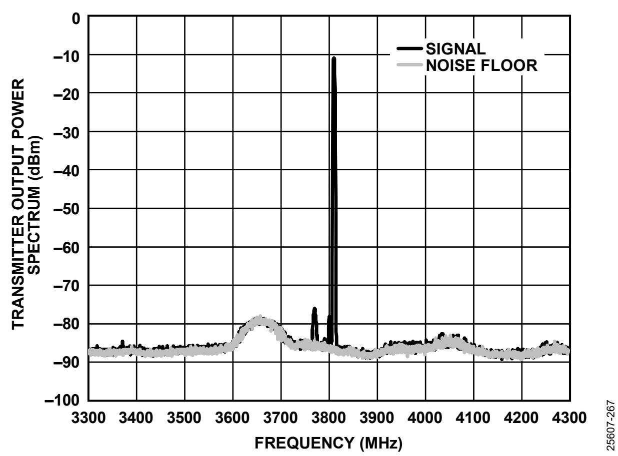

Figure 338. Transmitter Output Power Spectrum, Tx1, 5 MHz LTE, 10 MHz Offset, −10 dBFS RMS, 1 MHz Resolution Bandwidth, T_J = 25°C (Step at 3600 MHz Due to Spectrum Analyzer)

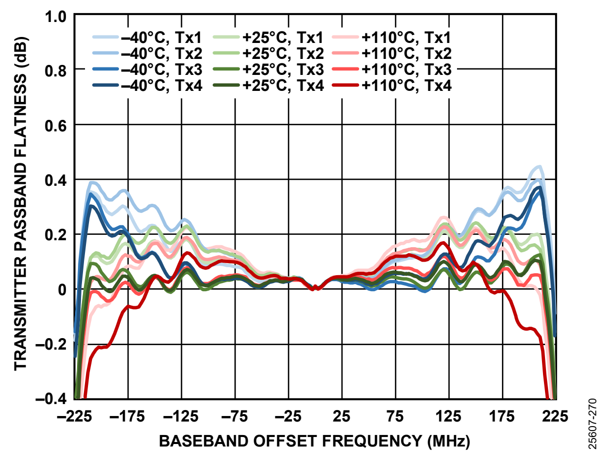

Figure 341. Transmitter Pass Band Flatness vs. Baseband Offset Frequency

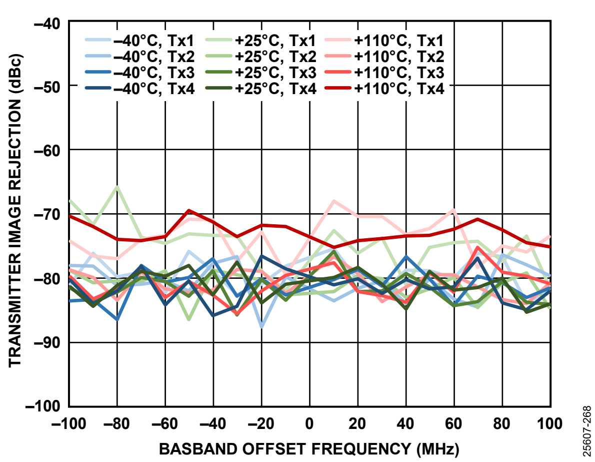

Figure 339. Transmitter Image Rejection Across Large Signal Bandwidth vs. Baseband Offset Frequency

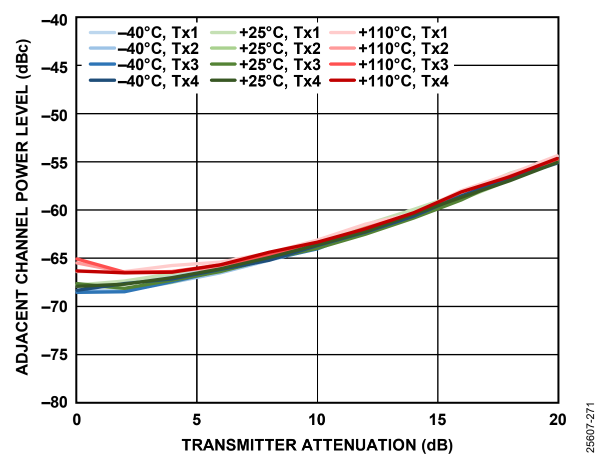

Figure 342. Adjacent Channel Power Level vs. Transmitter Attenuation, −10 MHz Baseband Offset, 20 MHz LTE, PAR = 12 dB

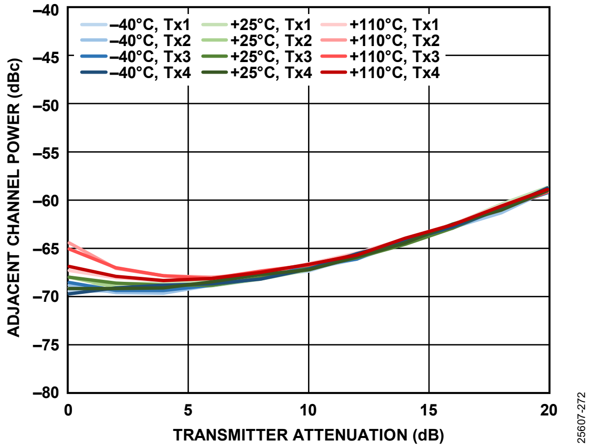

Figure 343. Adjacent Channel Power Level vs. Transmitter Attenuation, 90 MHz Baseband Offset, 20 MHz LTE, PAR = 12 dB

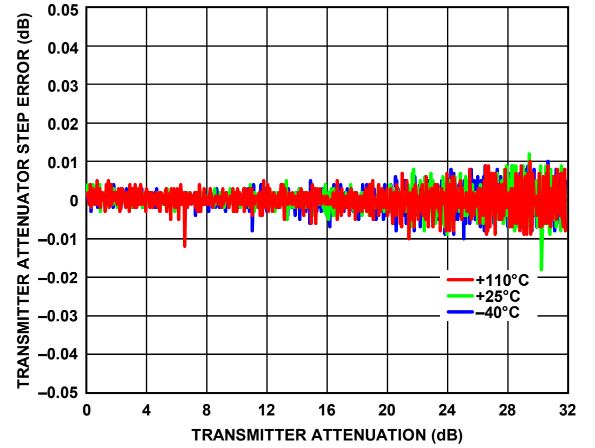

Figure 346. Transmitter Attenuator Step Error vs. Transmitter Attenuation, 10 MHz Offset

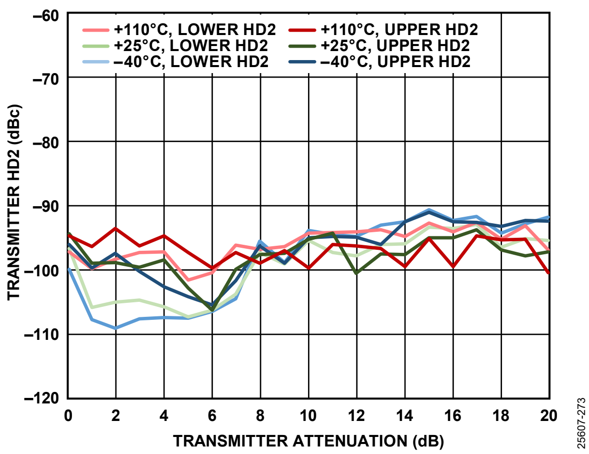

Figure 344. Transmitter Second Harmonic Distortion (HD2) vs. Transmitter Attenuation, 10 MHz Offset

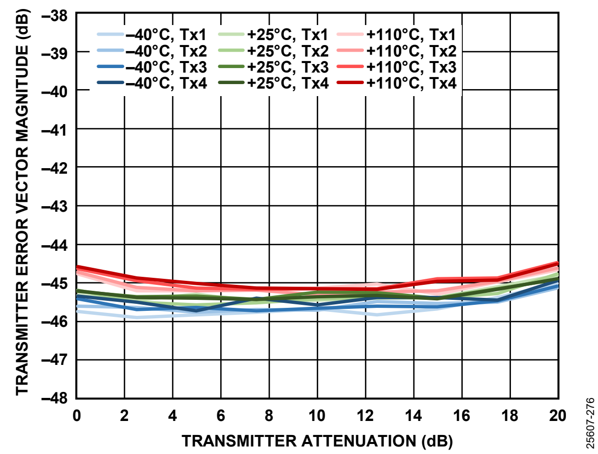

Figure 347. Transmitter Error Vector Magnitude vs. Transmitter Attenuation, 20 MHz LTE Signal Centered at LO Frequency, Sample Rate = 491.52 MSPS, Loop Filter Bandwidth = 200 kHz, Loop Filter Phase Margin = 60°

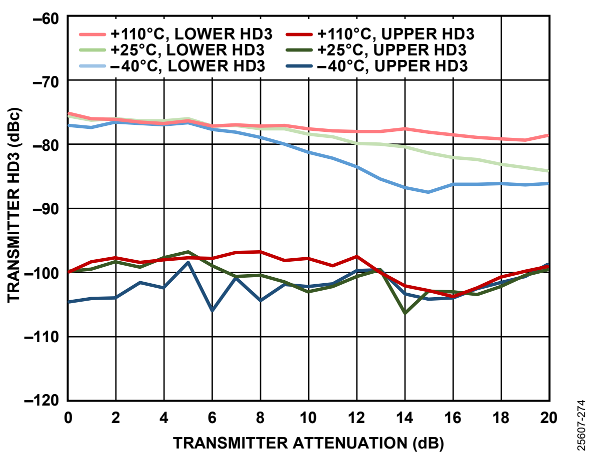

Figure 345. Transmitter Third Harmonic Distortion (HD3) vs. Transmitter Attenuation, 10 MHz Offset

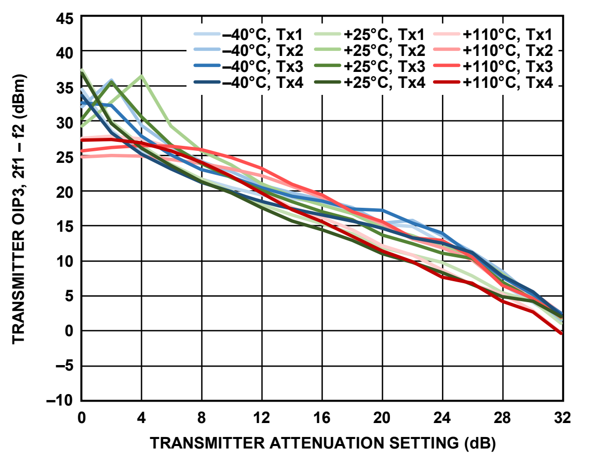

Figure 348. Transmitter OIP3, 2f1 – f2 vs. Transmitter Attenuation, 15 dB Digital Back Off per Tone, f1 = 50.5 MHz, f2 = 55.5 MHz

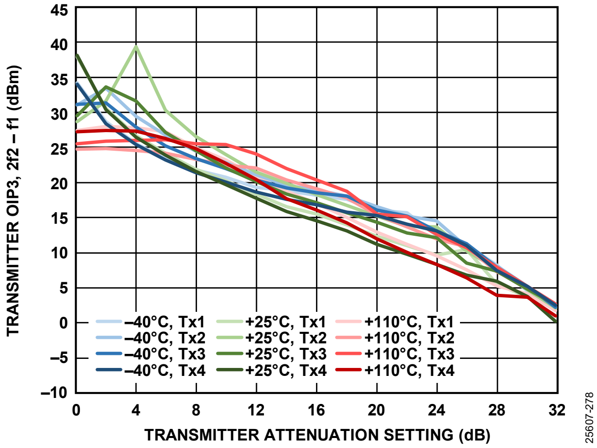

Figure 349. Transmitter OIP3, 2f2 – f1 vs. Transmitter Attenuation, 15 dB Digital Back Off per Tone, f1 = 50.5 MHz, f2 = 55.5 MHz

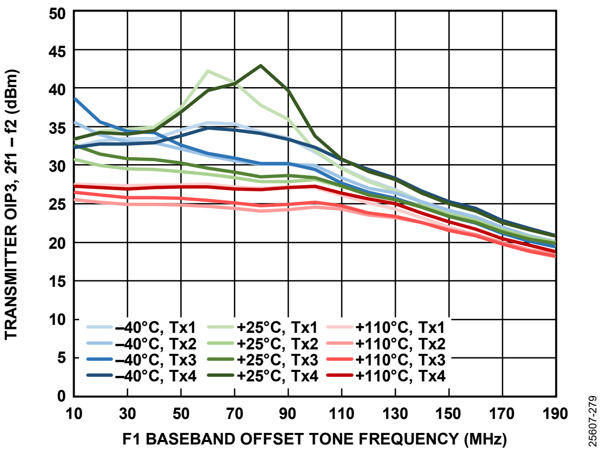

Figure 350. Transmitter OIP3, 2f1 – f2 vs. f1 Baseband Offset Tone Frequency, f2 = f1 + 5 MHz, 15 dB Digital Back Off per Tone

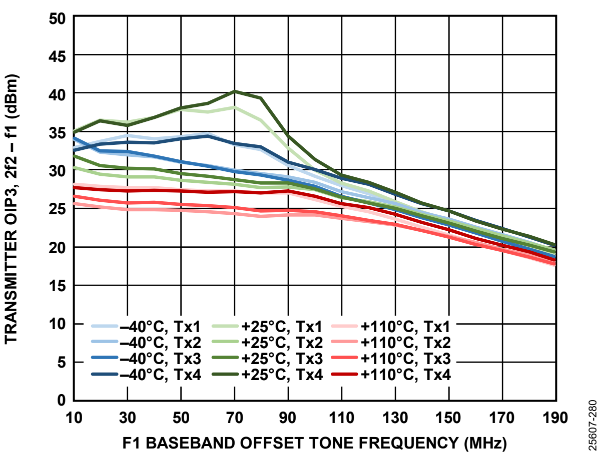

Figure 351. Transmitter OIP3, 2f2 – f1 vs. f1 Baseband Offset Tone Frequency, f2 = f1 + 5 MHz, 15 dB Digital Back Off per Tone

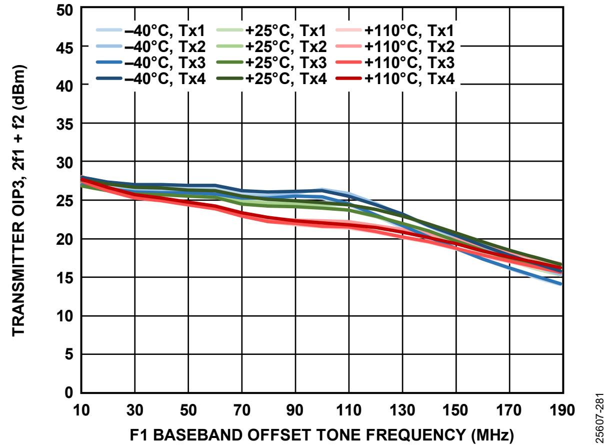

Figure 352. Transmitter OIP3, 2f1 + f2 vs. f1 Baseband Offset Tone Frequency, f2 = f1 + 5 MHz, 15 dB Digital Back Off per Tone

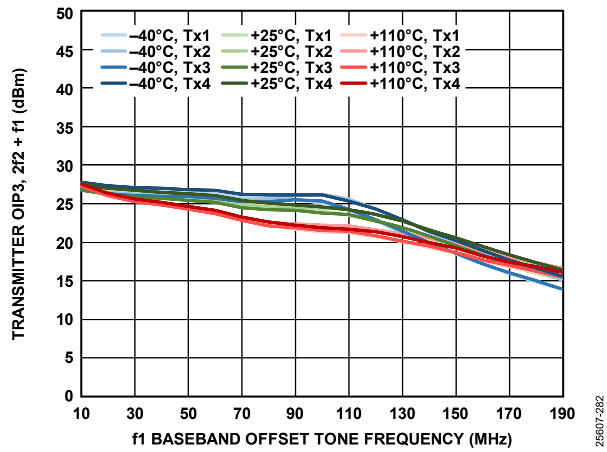

Figure 353. Transmitter OIP3, 2f2 + f1 vs. f1 Baseband Offset Tone Frequency, f2 = f1 + 5 MHz, 15 dB Digital Back Off per Tone

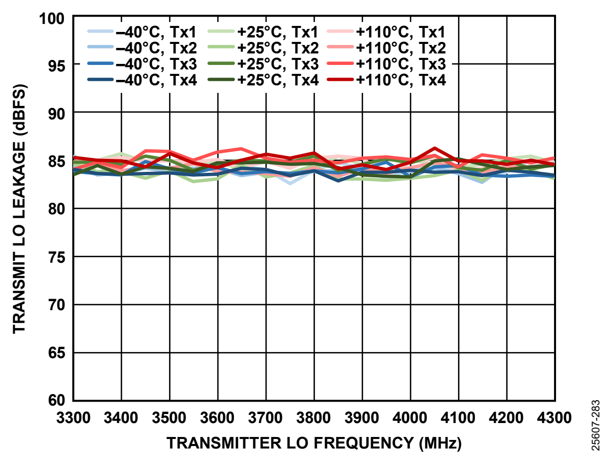

Figure 354. Transmitter LO Leakage vs. Transmitter LO Frequency

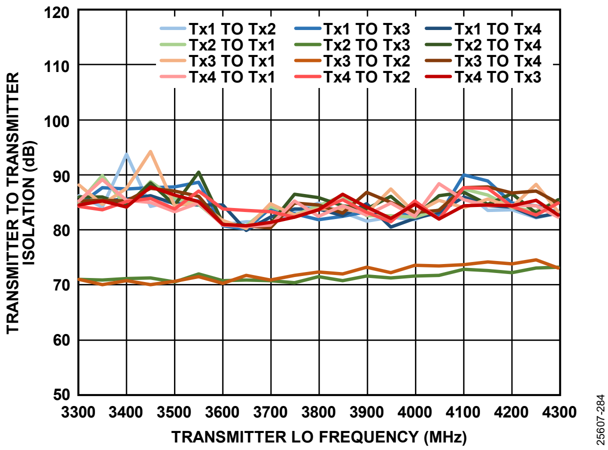

Figure 355. Transmitter to Transmitter Isolation vs. Transmitter LO Frequency

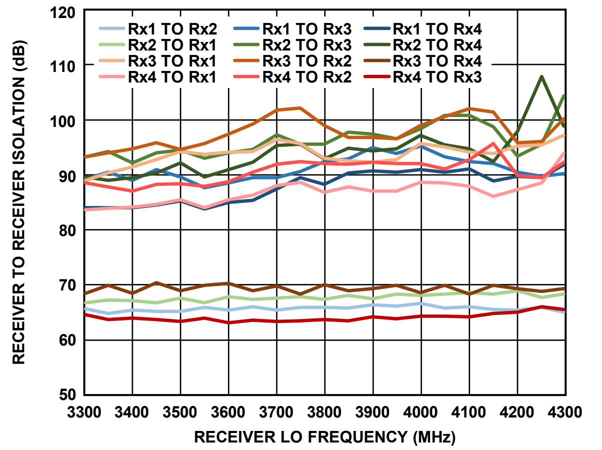

Figure 358. Receiver to Receiver Isolation vs. Receiver LO Frequency

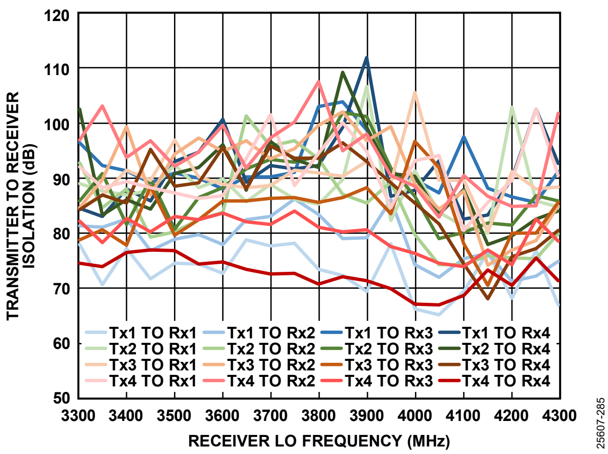

Figure 356. Transmitter to Receiver Isolation vs. Receiver LO Frequency

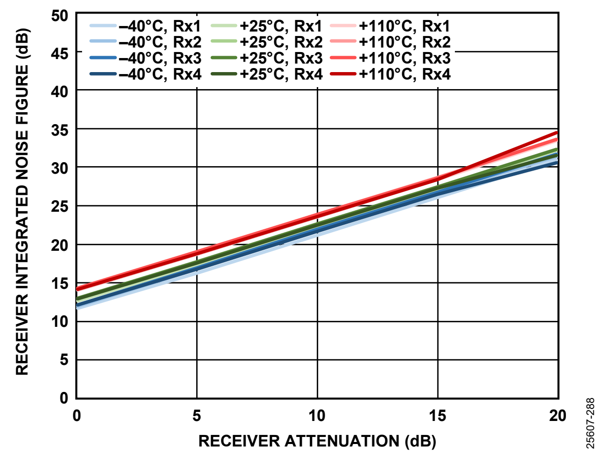

Figure 359. Receiver Integrated Noise Figure vs. Receiver Attenuation, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS, Integration Bandwidth = 500 kHz to 100 MHz

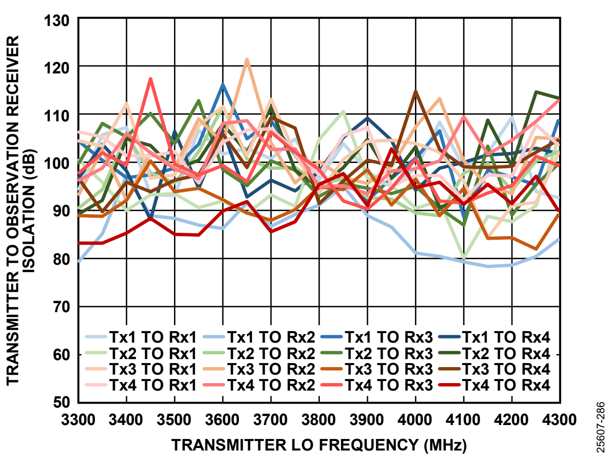

Figure 357. Transmitter to Observation Receiver Isolation vs. Transmitter LO Frequency

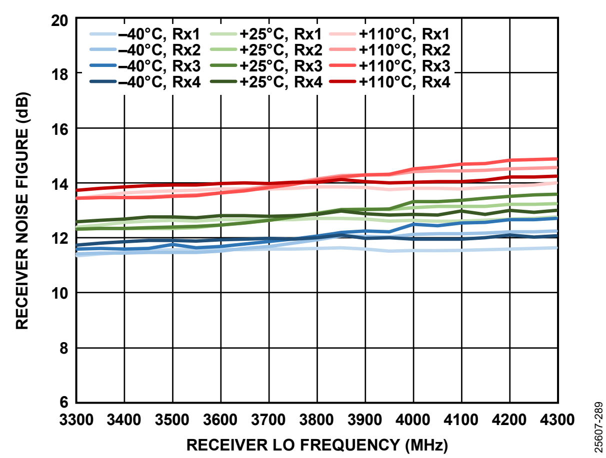

Figure 360. Receiver Integrated Noise Figure vs. Receiver LO Frequency, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS, Integration Bandwidth = 500 kHz to 100 MHz

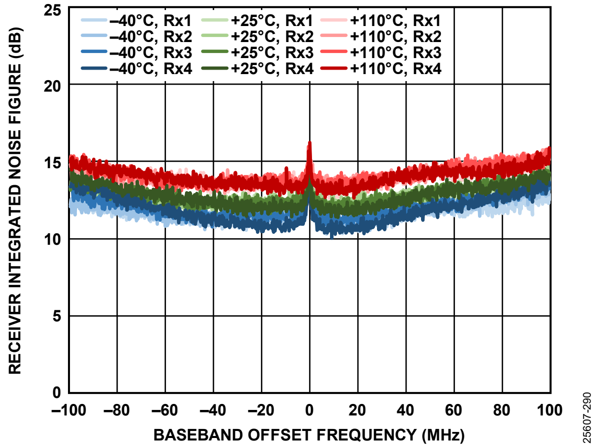

Figure 361. Receiver Integrated Noise Figure vs. Baseband Offset Frequency, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS, Integrated in 200 kHz Steps

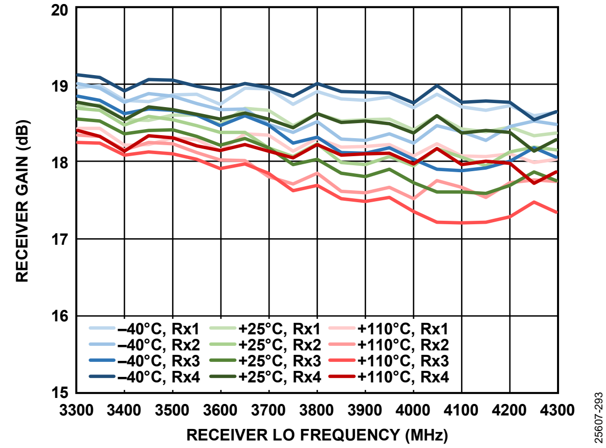

Figure 364. Receiver Gain vs. Receiver LO Frequency, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS

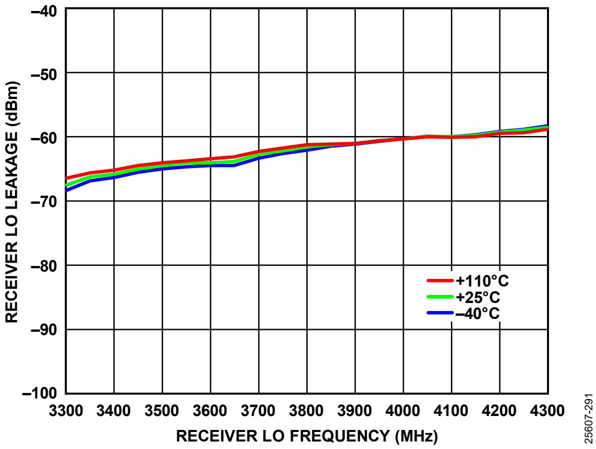

Figure 362. Receiver LO Leakage vs. Receiver LO Frequency, Attenuation = 0 dB, Sample Rate = 245.76 MSPS

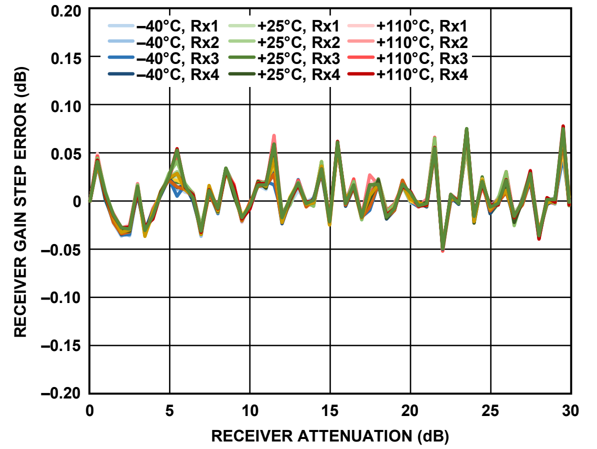

Figure 365. Receiver Gain Step Error vs. Receiver Attenuation, 20 MHz Offset, –5 dBFS Input Signal

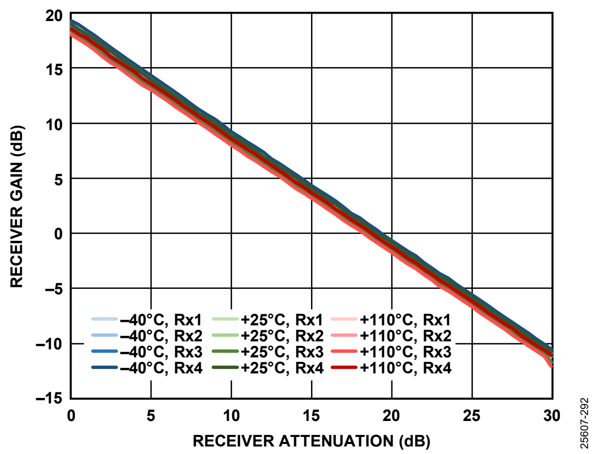

Figure 363. Receiver Gain vs. Receiver Attenuation, 20 MHz Offset, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS

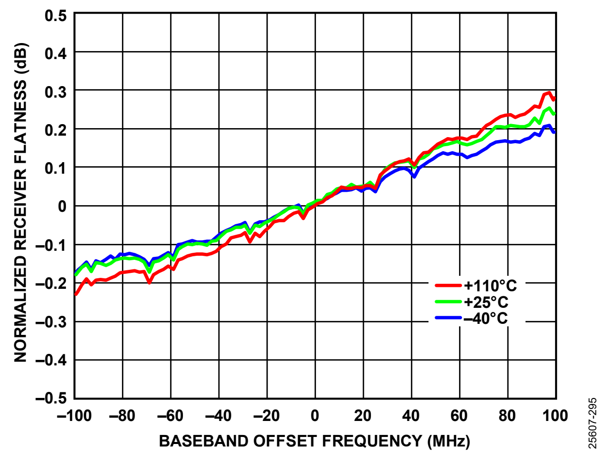

Figure 366. Normalized Receiver Flatness vs. Baseband Offset Frequency, –5 dBFS Input Signal

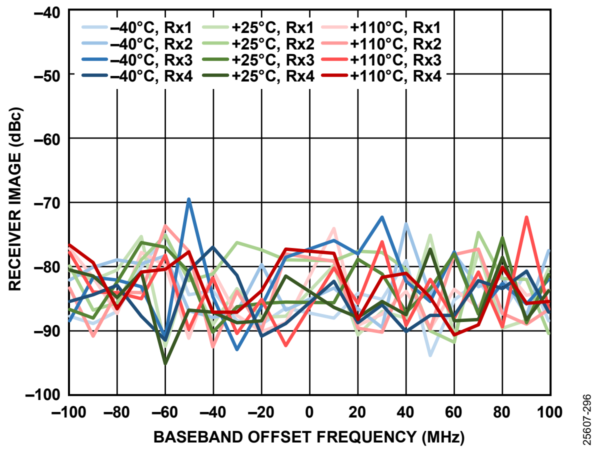

Figure 367. Receiver Image vs. Baseband Offset Frequency, Tracking Calibration Active, Sample Rate = 245.76 MSPS

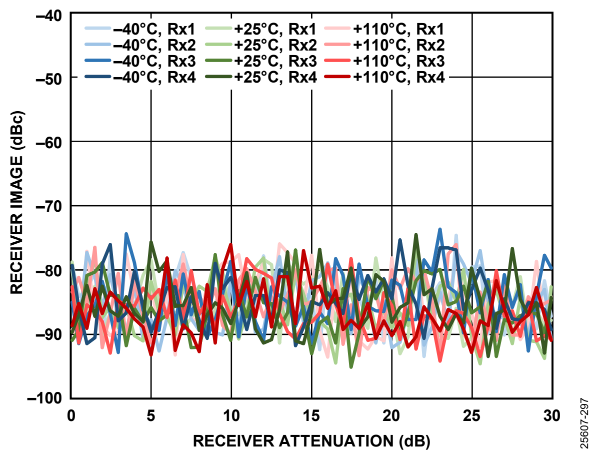

Figure 368. Receiver Image vs. Receiver Attenuation, 20 MHz Offset, Tracking Calibration Active, Sample Rate = 245.76 MSPS

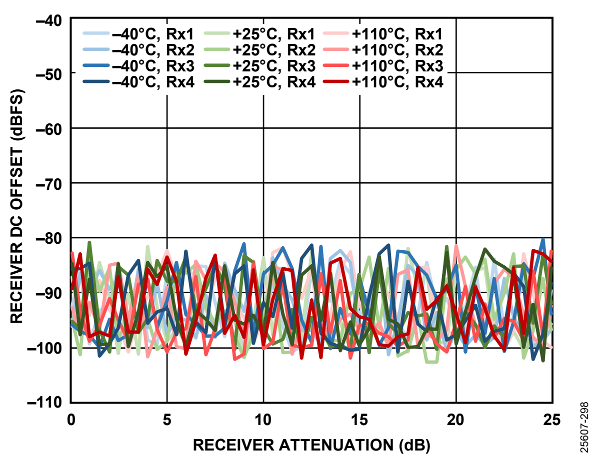

Figure 369. Receiver DC Offset vs. Receiver Attenuation, 20 MHz Offset, –5 dBFS Input Signal, Sample Rate = 245.76 MSPS

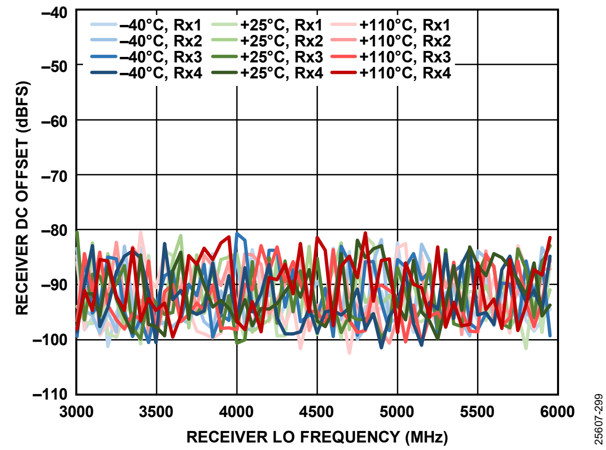

Figure 370. Receiver DC Offset vs. Receiver LO Frequency, Attenuation = 0 dB, Sample Rate = 245.76 MSPS

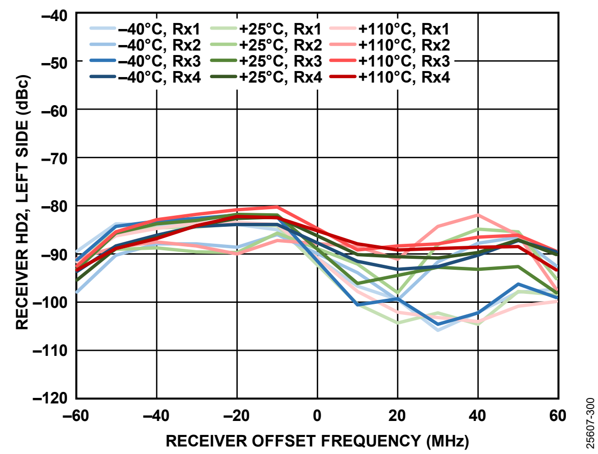

Figure 371. Receiver HD2, Left Side vs. Baseband Offset Frequency, –5 dBFS Input Signal, Distortion Tone Measured Left of 0 Hz (HD2 Canceller Not Enabled)

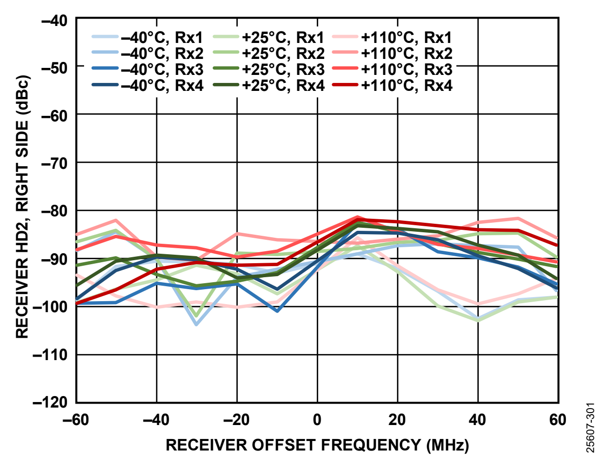

Figure 372. Receiver HD2, Right Side vs. Baseband Offset Frequency, –5 dBFS Input Signal, Distortion Tone Measured Right of 0 Hz (HD2 Canceller Not Enabled)

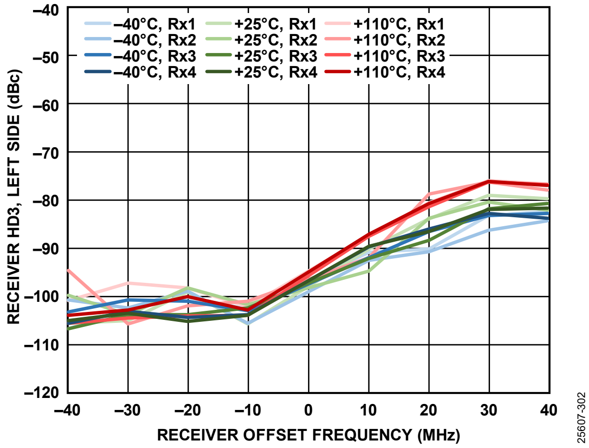

Figure 373. Receiver HD3, Left Side vs. Baseband Offset Frequency, −5 dBFS Input Signal, Distortion Tone Measured Left of 0 Hz

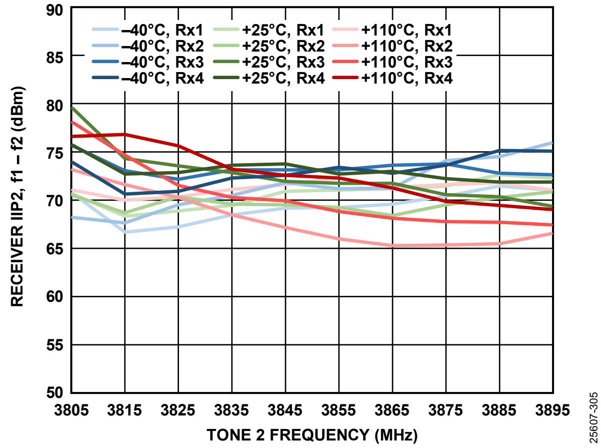

Figure 376. Receiver IIP2, f1 − f2 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

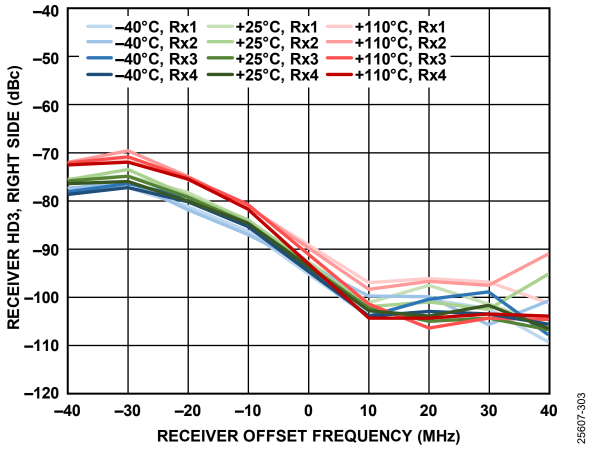

Figure 374. Receiver HD3, Right Side vs. Baseband Offset Frequency, −5 dBFS Input Signal, Distortion Tone Measured Right of 0 Hz

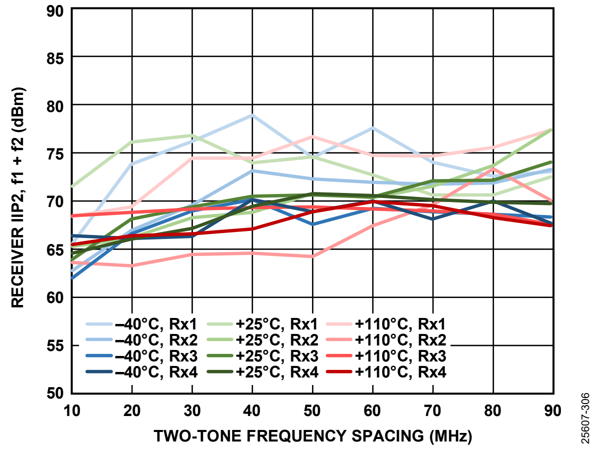

Figure 377. Receiver IIP2, f1 + f2 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

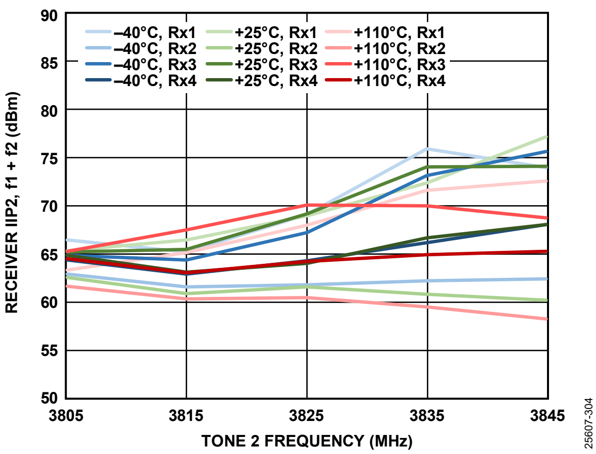

Figure 375. Receiver IIP2, f1 + f2 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

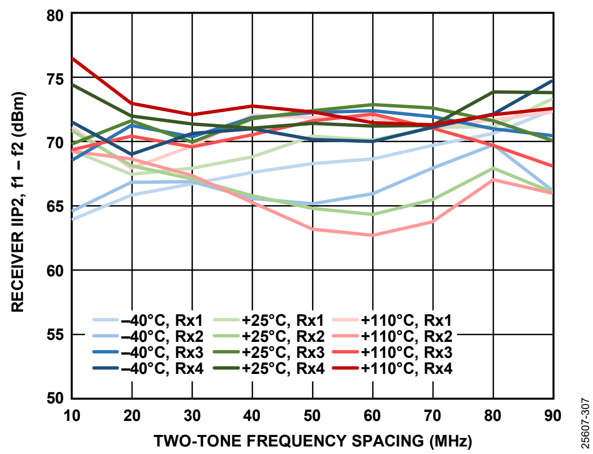

Figure 378. Receiver IIP2, f1 − f2 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

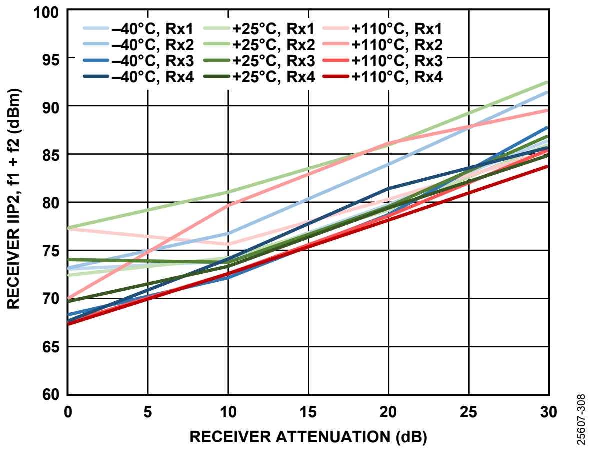

Figure 379. Receiver IIP2, f1 + f2 vs. Receiver Attenuation, Both Tones at −11 dBFS, f1 = 92 MHz, f2 = 2 MHz

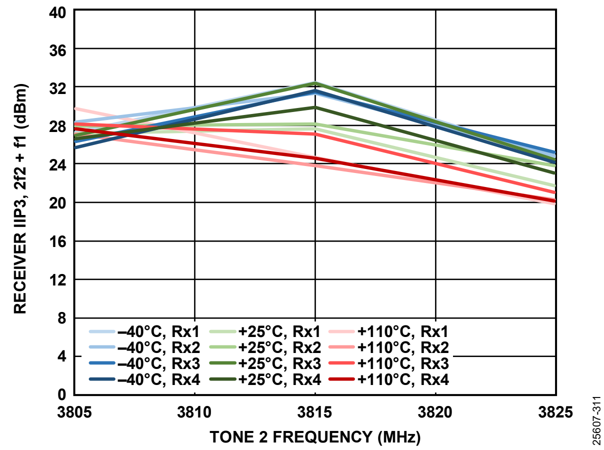

Figure 382. Receiver IIP3, 2f2 + f1 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

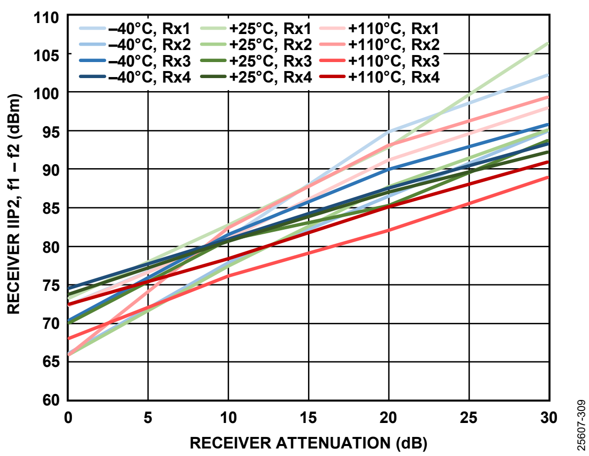

Figure 380. Receiver IIP2, f1 − f2 vs. Receiver Attenuation, Both Tones at −11 dBFS, f1 = 92 MHz, f2 = 2 MHz

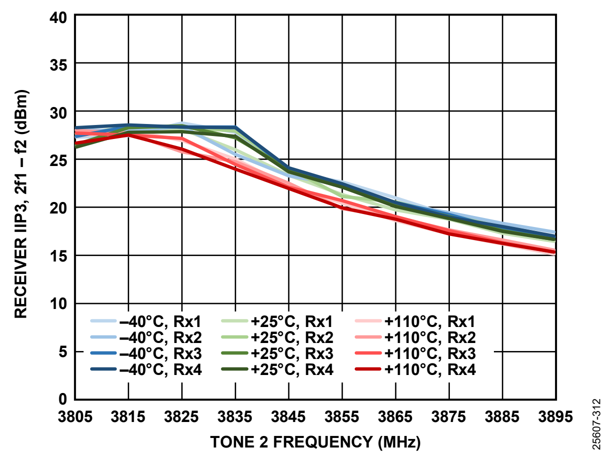

Figure 383. Receiver IIP3, 2f1 − f2 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

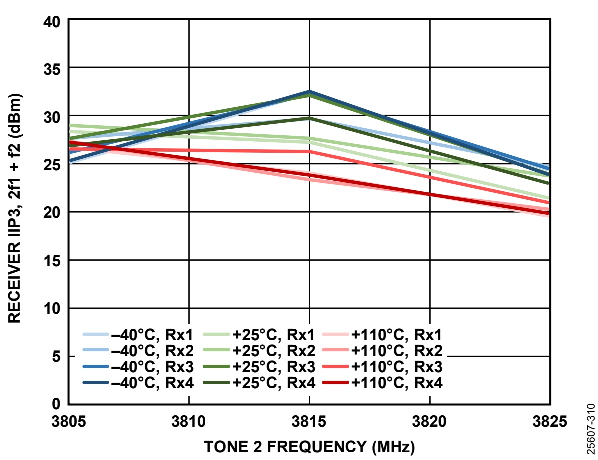

Figure 381. Receiver IIP3, 2f1 + f2 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

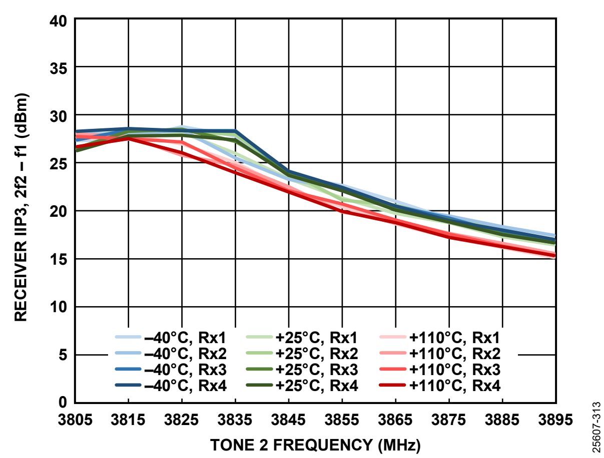

Figure 384. Receiver IIP3, 2f2 − f1 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

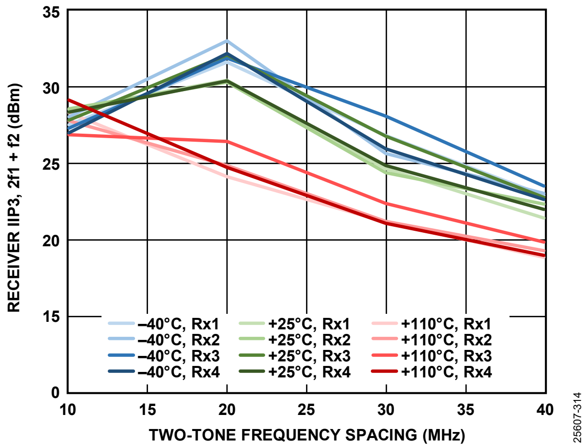

Figure 385. Receiver IIP3, 2f1 + f2 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

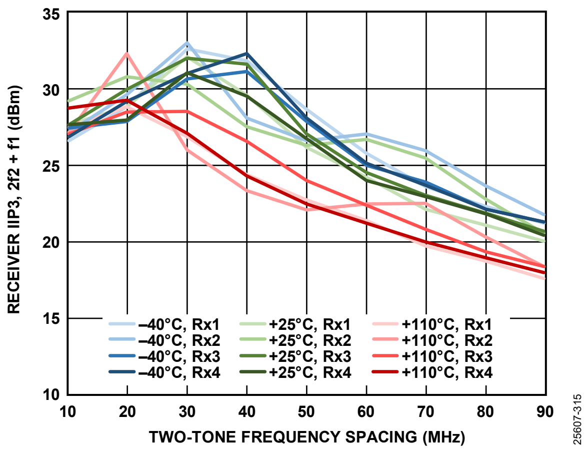

Figure 386. Receiver IIP3, 2f2 + f1 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

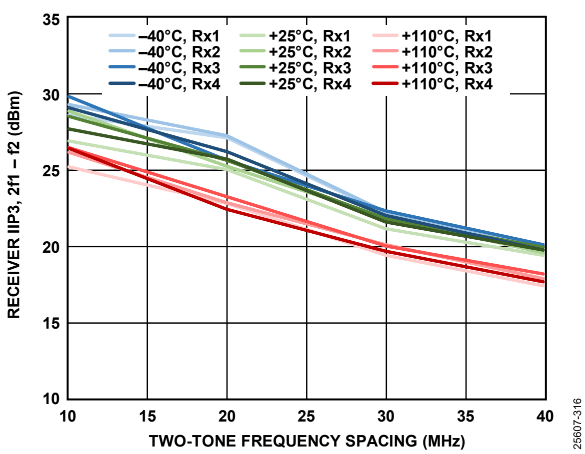

Figure 387. Receiver IIP3, 2f1 − f2 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

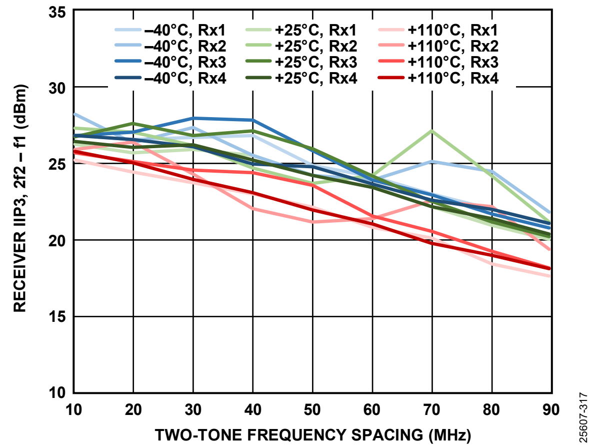

Figure 388. Receiver IIP3, 2f2 − f1 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

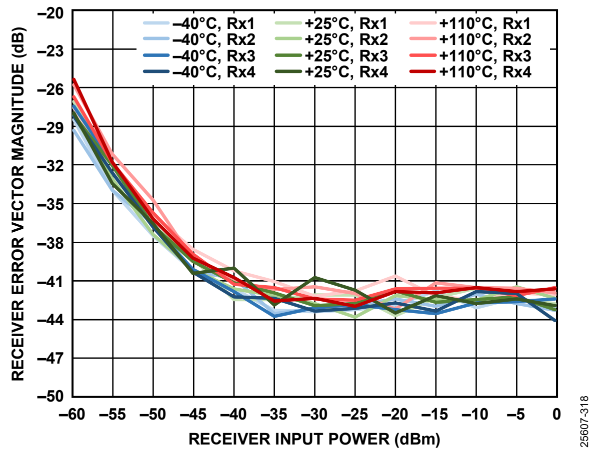

Figure 389. Receiver Error Vector Magnitude vs. Receiver Input Power, 20 MHz LTE Signal Centered at LO Frequency, Sample Rate = 245.76 MSPS, Loop Filter Bandwidth = 200 kHz, Loop Filter Phase Margin = 60°

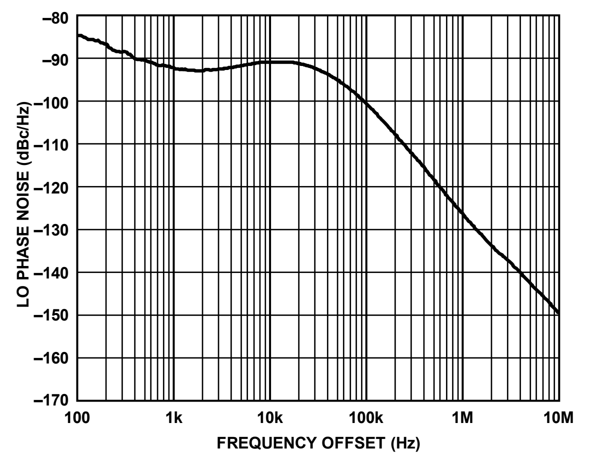

Figure 390. LO Phase Noise vs. Frequency Offset, Loop Bandwidth = 75 kHz, Phase Margin = 85°

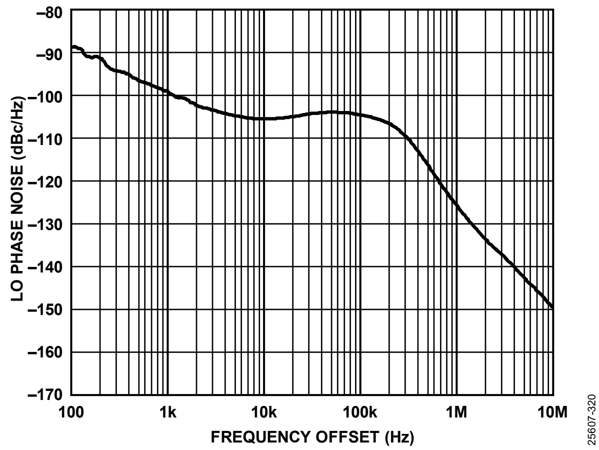

Figure 391. LO Phase Noise vs. Frequency Offset, Loop Bandwidth = 200 kHz, Phase Margin = 60°

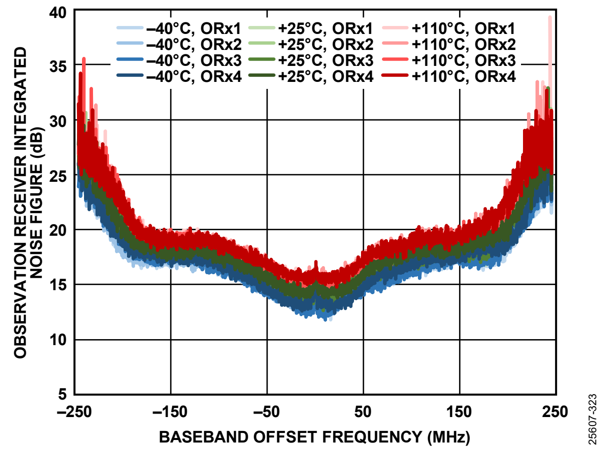

Figure 394. Observation Receiver Integrated Noise Figure vs. Baseband Offset Frequency, 450 MHz Bandwidth, Sample Rate = 491.52 MSPS, Integrated in 200 kHz Steps

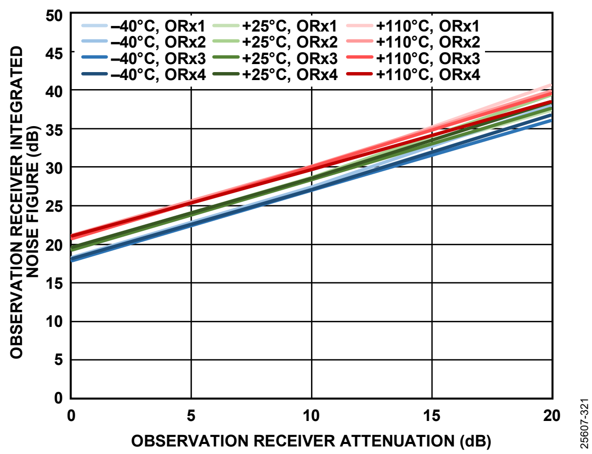

Figure 392. Observation Receiver Integrated Noise Figure vs. Observation Receiver Attenuation, 450 MHz Bandwidth, Sample Rate = 491.52 MSPS, Integration Bandwidth = 500 kHz to 245.76 MHz

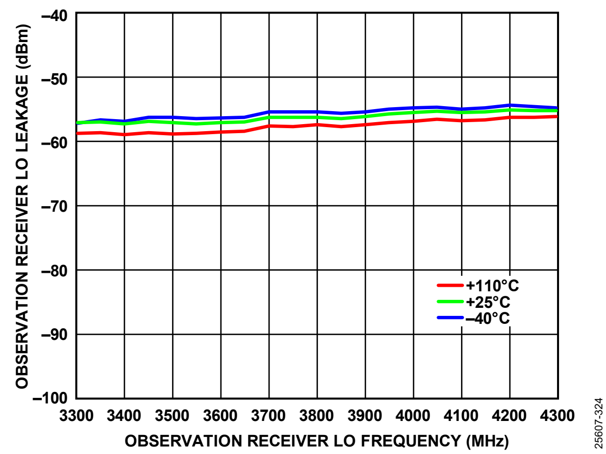

Figure 395. Observation Receiver LO Leakage vs. Observation Receiver LO Frequency, Attenuation = 0 dB, Sample Rate = 491.52 MSPS

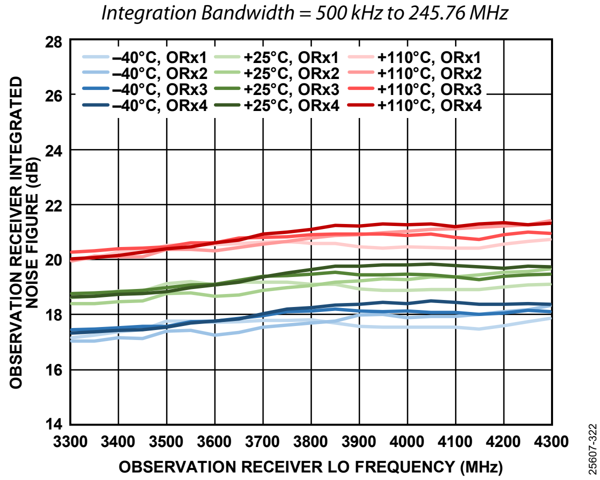

Figure 393. Observation Receiver Integrated Noise Figure vs. Observation Receiver LO Frequency, 450 MHz Bandwidth, Sample Rate = 491.52 MSPS, Integration Bandwidth = 500 kHz to 245.76 MHz

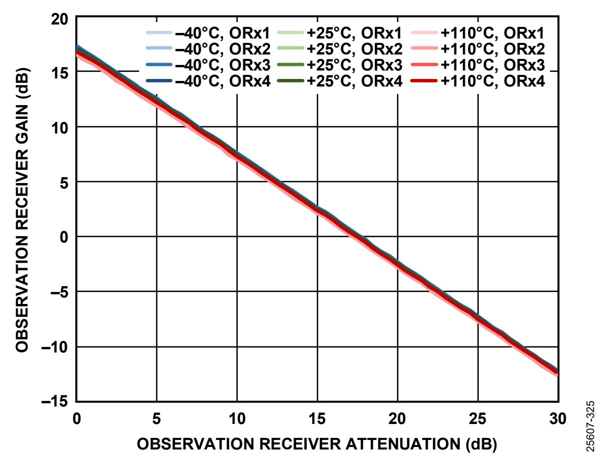

Figure 396. Observation Receiver Gain vs. Observation Receiver Attenuation, 45 MHz Offset, 450 MHz Bandwidth, Sample Rate = 491.52 MSPS

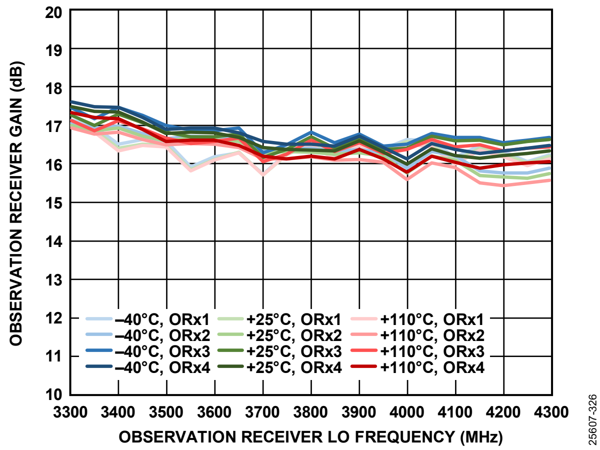

Figure 397. Observation Receiver Gain vs. Observation Receiver LO Frequency, 450 MHz Bandwidth, Sample Rate = 491.52 MSPS

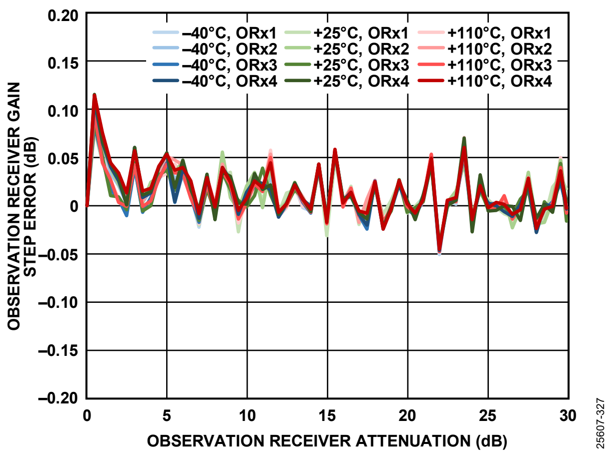

Figure 398. Observation Receiver Gain Step Error vs. Observation Receiver Attenuation, 45 MHz Offset, −10 dBFS Input Signal

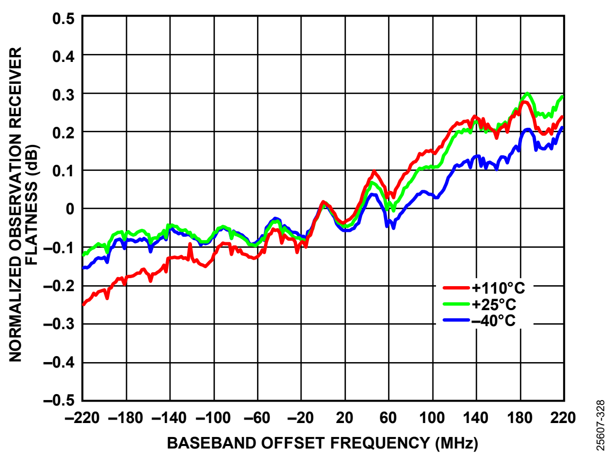

Figure 399. Normalized Observation Receiver Flatness vs. Baseband Offset Frequency, −10 dBFS Input Signal

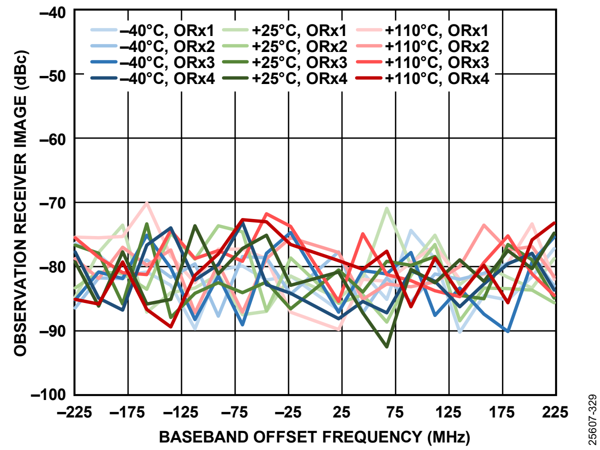

Figure 400. Observation Receiver Image vs. Baseband Offset Frequency, Tracking Calibration Active, Sample Rate = 491.52 MSPS

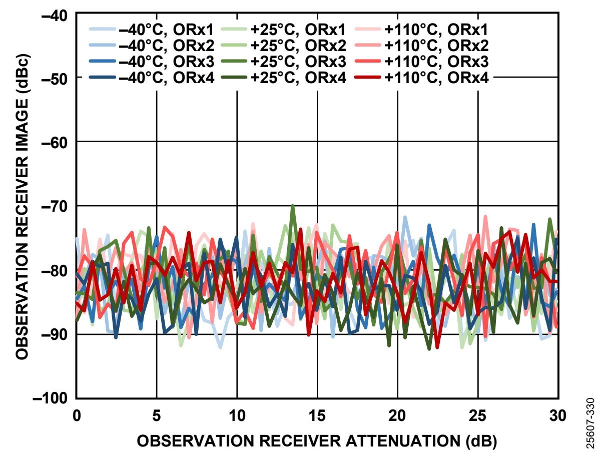

Figure 401. Observation Receiver Image vs. Observation Receiver Attenuation, 45 MHz Offset, Tracking Calibration Active, Sample Rate = 491.52 MSPS

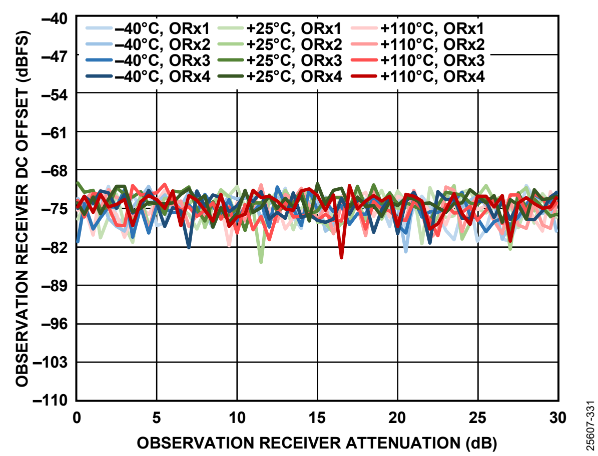

Figure 402. Observation Receiver DC Offset vs. Observation Receiver Attenuation, Sample Rate = 491.52 MSPS

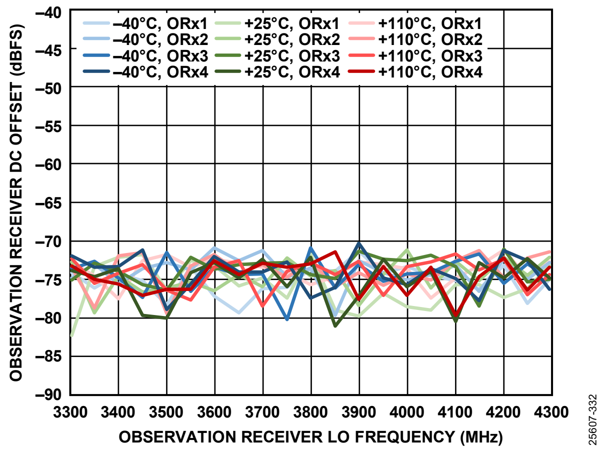

Figure 403. Observation Receiver DC Offset vs. Observation Receiver LO Frequency, Attenuation = 0 dB, Sample Rate = 491.52 MSPS

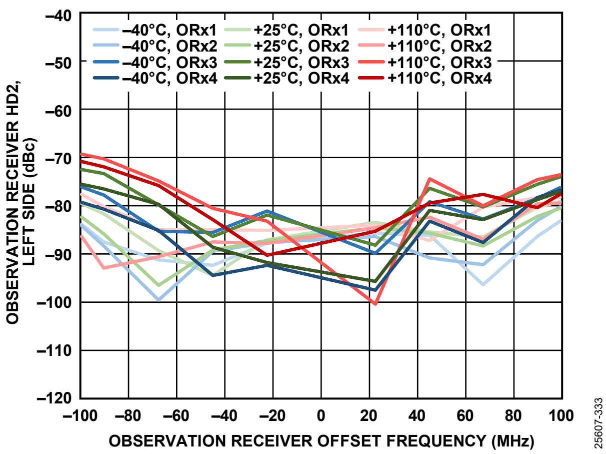

Figure 404. Observation Receiver HD2, Left Side vs. Baseband Offset Frequency, –10 dBFS Input Signal, Distortion Tone Measured Left of 0 Hz

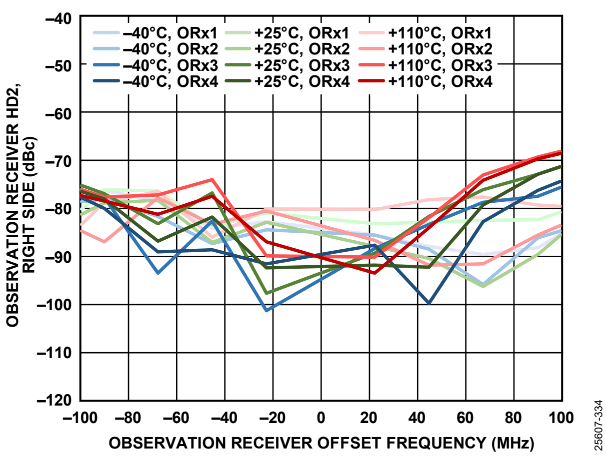

Figure 405. Observation Receiver HD2, Right Side vs. Baseband Offset Frequency, –10 dBFS Input Signal, Distortion Tone Measured Right of 0 Hz

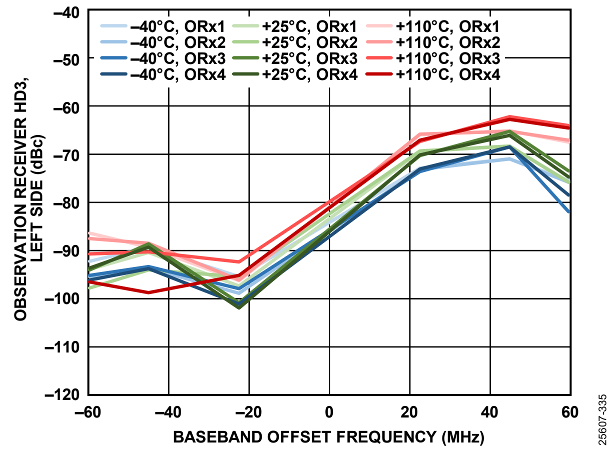

Figure 406. Observation Receiver HD3, Left Side vs. Baseband Offset Frequency, –10 dBFS Input Signal, Distortion Tone Measured Left of 0 Hz

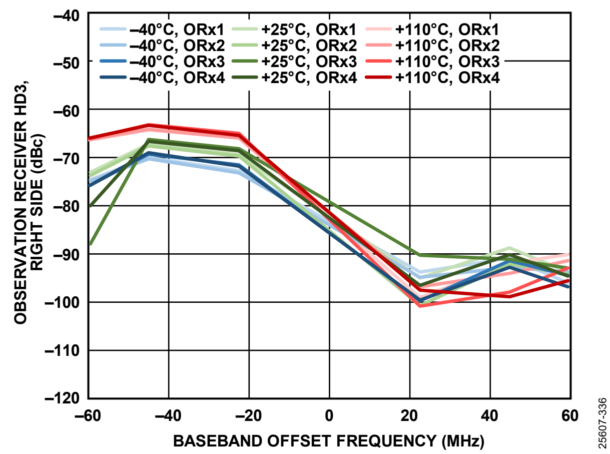

Figure 407. Observation Receiver HD3, Right Side vs. Baseband Offset Frequency, –10 dBFS Input Signal, Distortion Tone Measured Right of 0 Hz

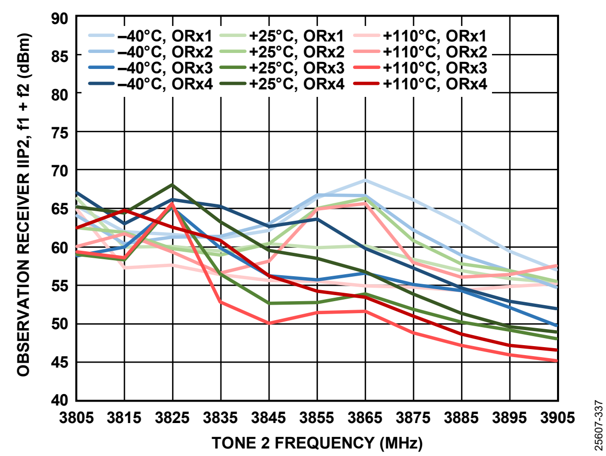

Figure 408. Observation Receiver IIP2, f1 + f2 vs. Tone 2 Frequency, Both Tones at –13 dBFS, f1 = f2 + 2 MHz

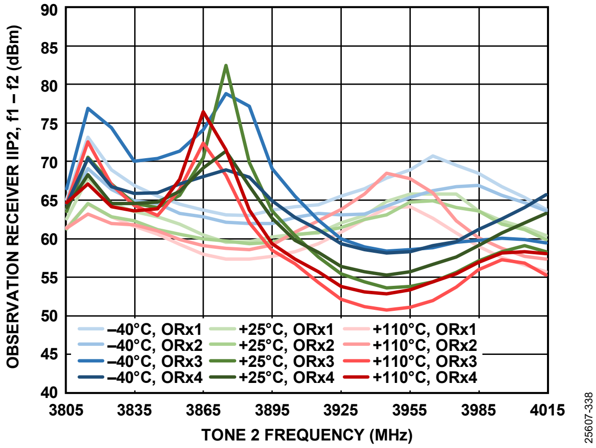

Figure 409. Observation Receiver IIP2, f1 – f2 vs. Tone 2 Frequency, Both Tones at –13 dBFS, f1 = f2 + 2 MHz

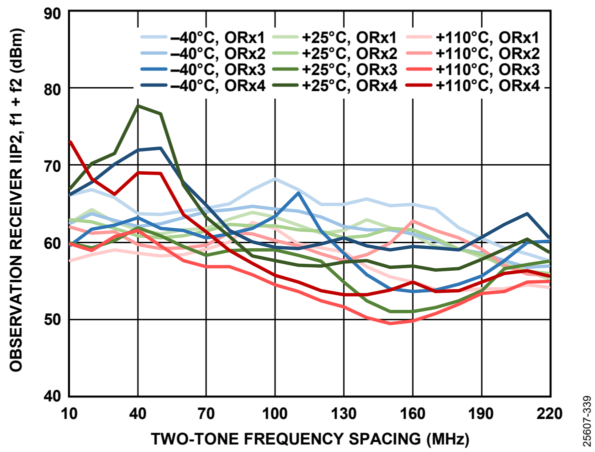

Figure 410. Observation Receiver IIP2, f1 + f2 vs. Two-Tone Frequency Spacing, Both Tones at –13 dBFS, f2 = 2 MHz

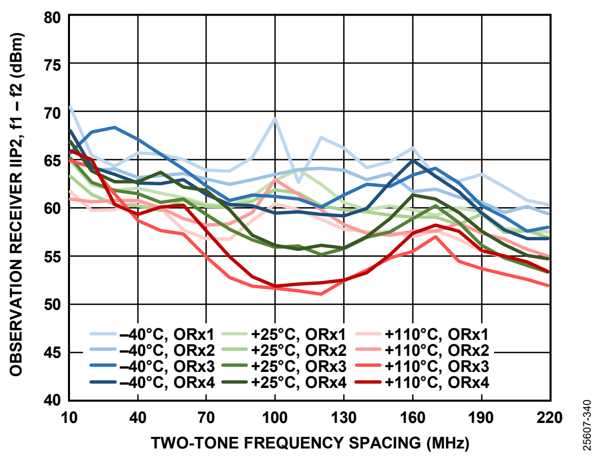

Figure 411. Observation Receiver IIP2, f1 – f2 vs. Two-Tone Frequency Spacing, Both Tones at –13 dBFS, f2 = 2 MHz

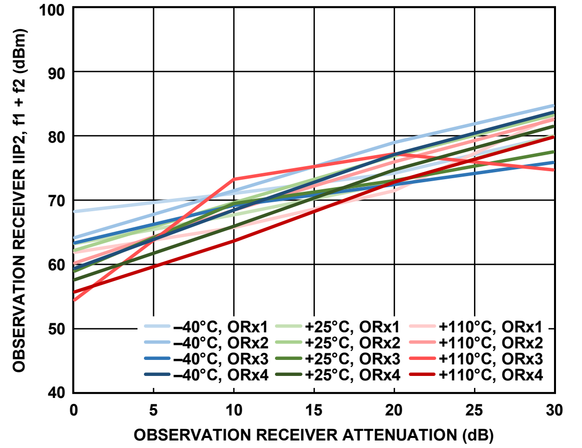

Figure 412. Observation Receiver IIP2, f1 + f2 vs. Observation Receiver Attenuation, Both Tones at –13 dBFS, f1 = 102 MHz, f2 = 2 MHz

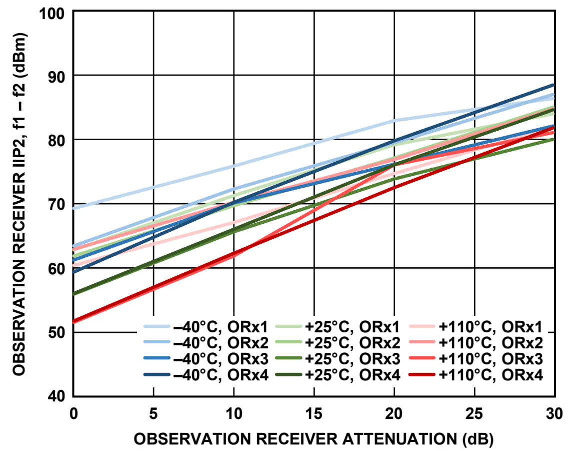

Figure 413. Observation Receiver IIP2, f1 – f2 vs. Observation Receiver Attenuation, Both Tones at –13 dBFS, f1 = 102 MHz, f2 = 2 MHz

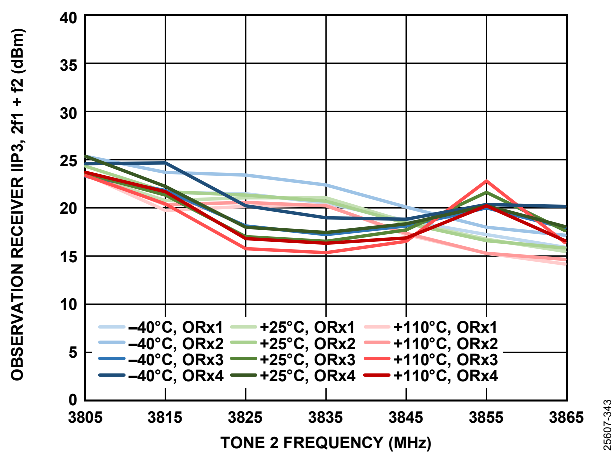

Figure 414. Observation Receiver IIP3, 2f1 + f2 vs. Tone 2 Frequency, Both Tones at –13 dBFS, f1 = f2 + 2 MHz

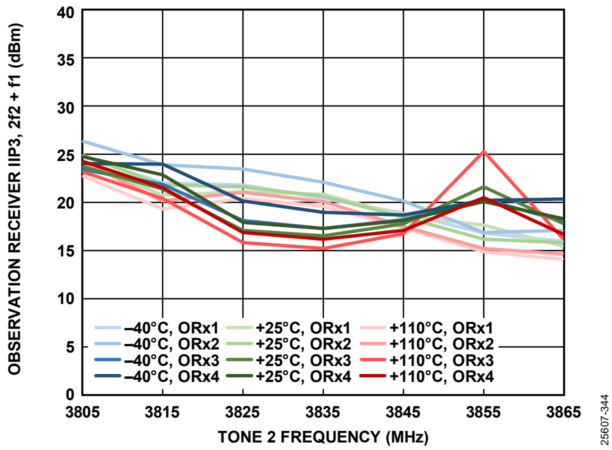

Figure 415. Observation Receiver IIP3, 2f2 + f1 vs. Tone 2 Frequency, Both Tones at −13 dBFS, f1 = f2 + 2 MHz

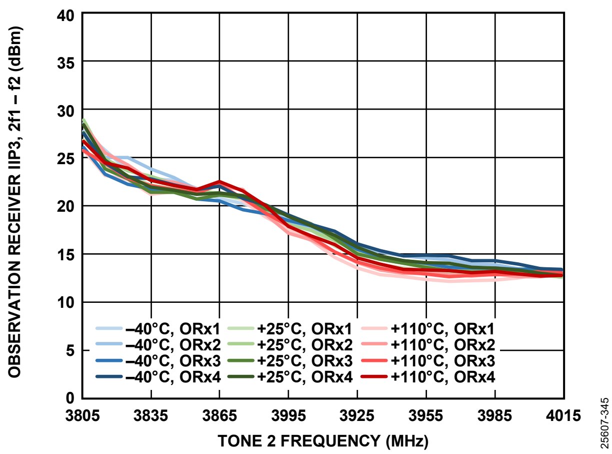

Figure 416. Observation Receiver IIP3, 2f1 − f2 vs. Tone 2 Frequency, Both Tones at −13 dBFS, f1 = f2 + 2 MHz

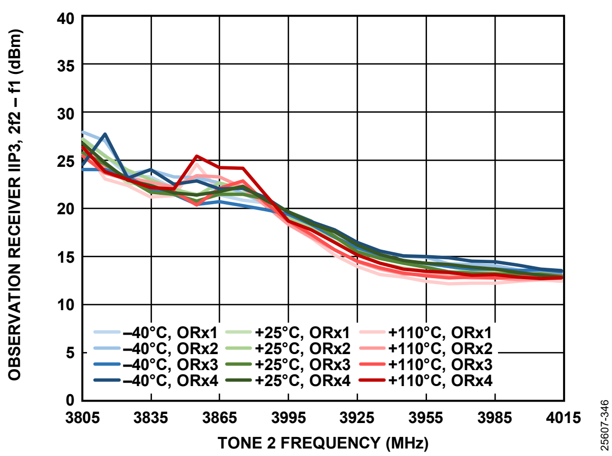

Figure 417. Observation Receiver IIP3, 2f2 − f1 vs. Tone 2 Frequency, Both Tones at −13 dBFS, f1 = f2 + 2 MHz

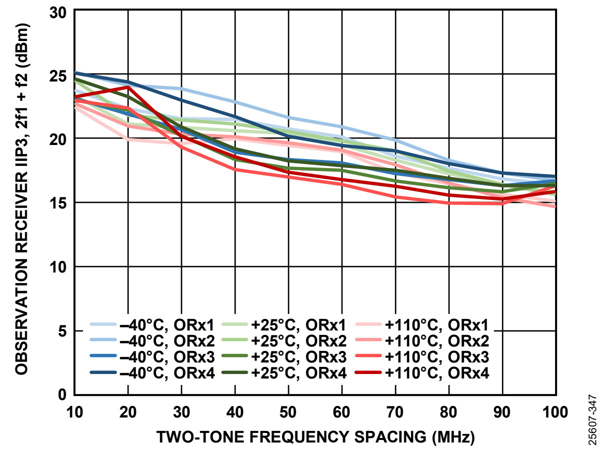

Figure 418. Observation Receiver IIP3, 2f1 + f2 vs. Two-Tone Frequency Spacing, Both Tones at −13 dBFS, f2 = 2 MHz

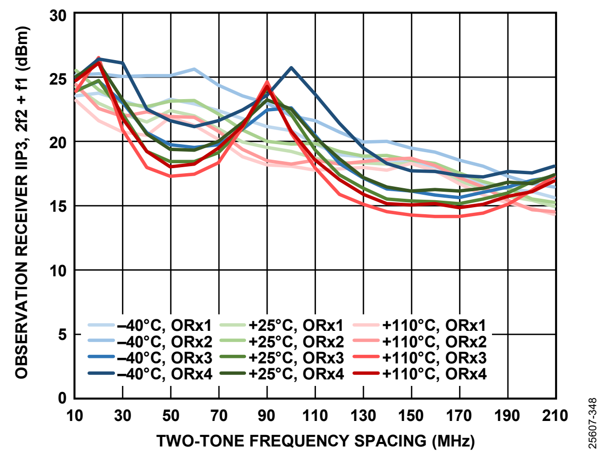

Figure 419. Observation Receiver IIP3, 2f2 + f1 vs. Two-Tone Frequency Spacing, Both Tones at −13 dBFS, f2 = 2 MHz

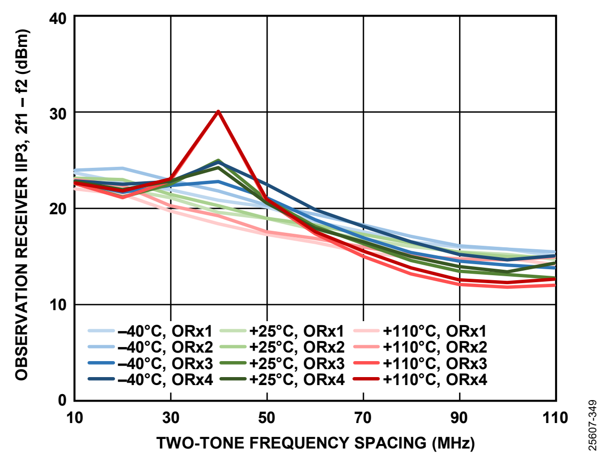

Figure 420. Observation Receiver IIP3, 2f1 − f2 vs. Two-Tone Frequency Spacing, Both Tones at −13 dBFS, f2 = 2 MHz

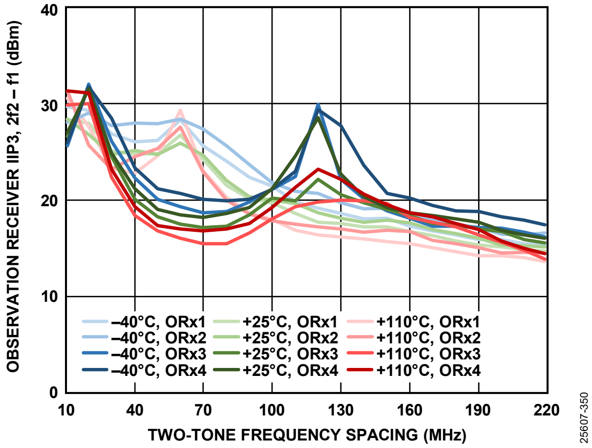

Figure 421. Observation Receiver IIP3, 2f2 – f1 vs. Two-Tone Frequency Spacing, Both Tones at –13 dBFS, f2 = 2 MHz

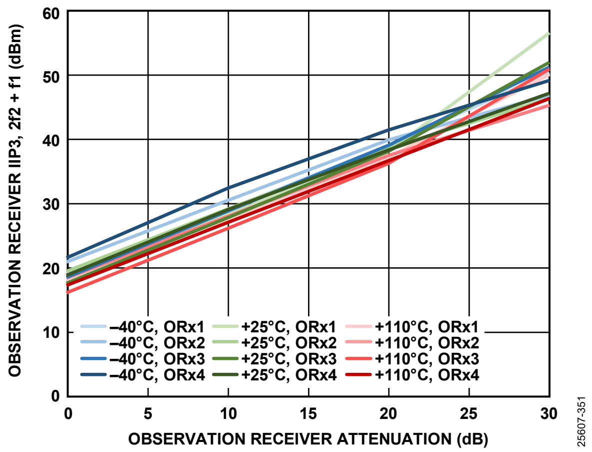

Figure 422. Observation Receiver IIP3, 2f2 + f1 vs. Observation Receiver Attenuation, Both Tones at –13 dBFS, f1 = 122 MHz, f2 = 2 MHz

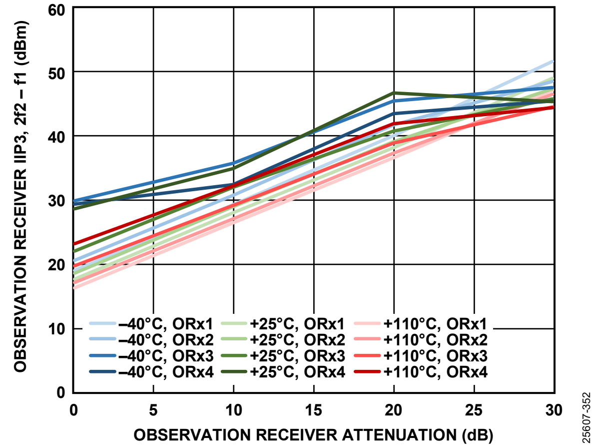

Figure 423. Observation Receiver IIP3, 2f2 – f1 vs. Observation Receiver Attenuation, Both Tones at –13 dBFS, f1 = 122 MHz, f2 = 2 MHz

4800 MHZ BAND

The temperature settings refer to the die temperature. All LO frequencies set to 4800 MHz, unless otherwise noted.

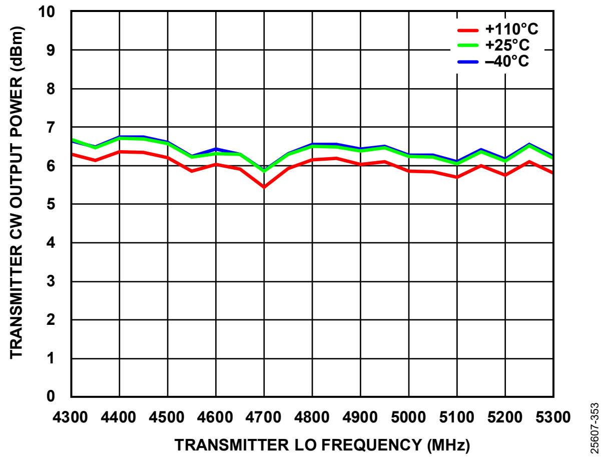

Figure 424. Transmitter CW Output Power vs. Transmitter LO Frequency, 10 MHz Offset, 0 dB Attenuation

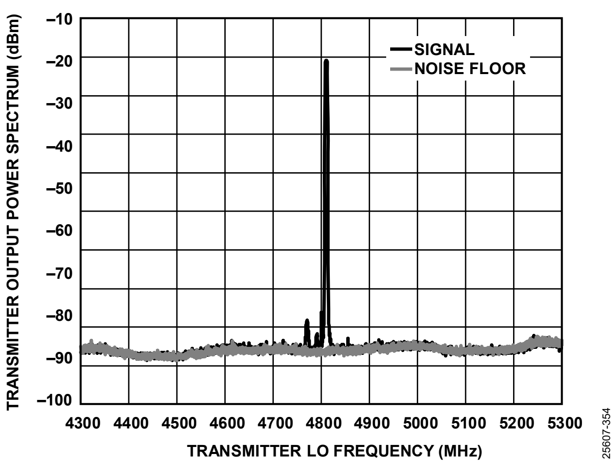

Figure 425. Transmitter Output Power Spectrum, Tx1, 5 MHz LTE, 10 MHz Offset, –10 dBFS RMS, 1 MHz Resolution Bandwidth, T_J = 25°C

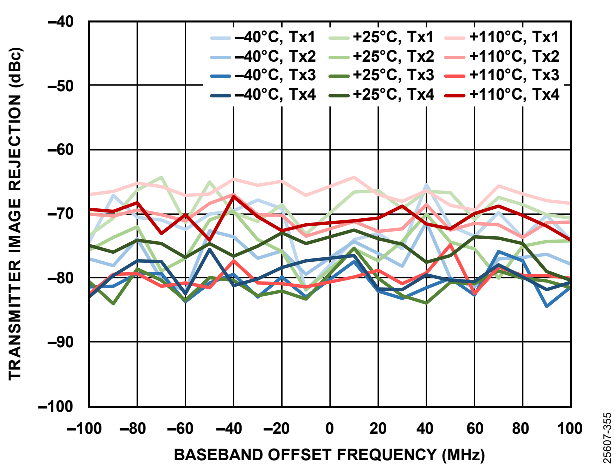

Figure 426. Transmitter Image Rejection Across Large Signal Bandwidth vs. Baseband Offset Frequency

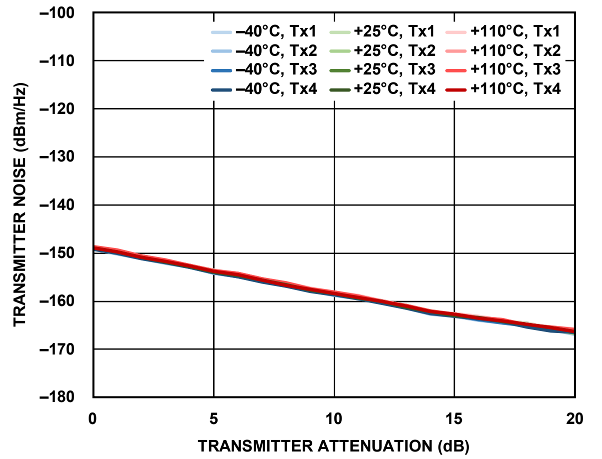

Figure 427. Transmitter Noise vs. Transmitter Attenuation, 10 MHz Offset Frequency

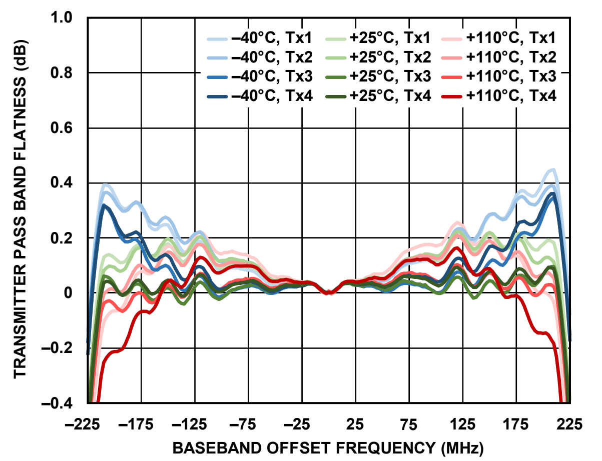

Figure 428. Transmitter Pass Band Flatness vs. Baseband Offset Frequency

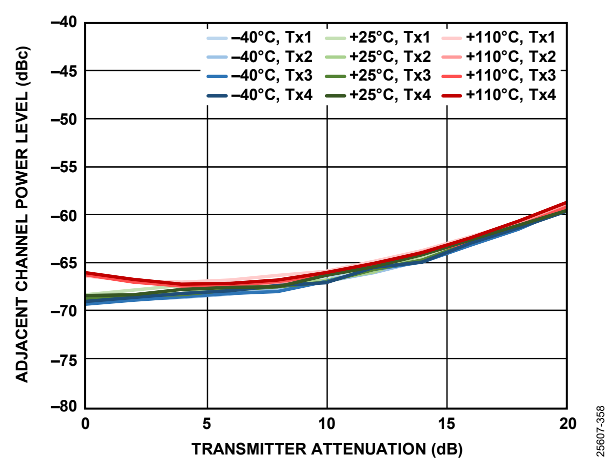

Figure 429. Adjacent Channel Power Level vs. Transmitter Attenuation, –10 MHz Baseband Offset, 20 MHz LTE, PAR = 12 dB

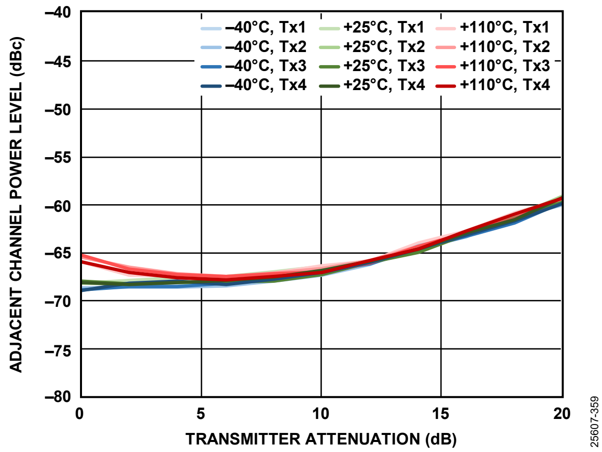

Figure 430. Adjacent Channel Power Level vs. Transmitter Attenuation, 90 MHz Baseband Offset, 20 MHz LTE, PAR = 12 dB

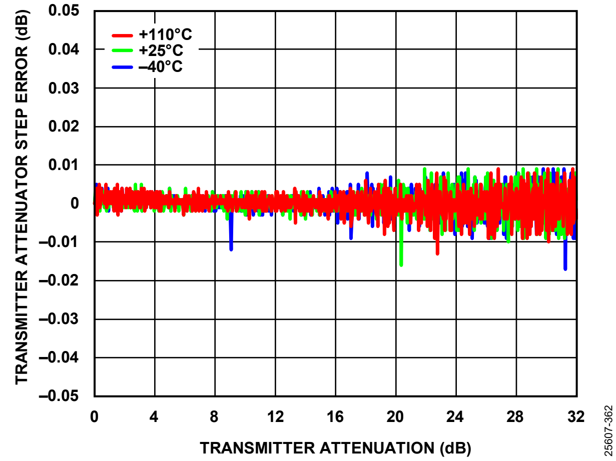

Figure 433. Transmitter Attenuator Step Error vs. Transmitter Attenuation, 10 MHz Offset

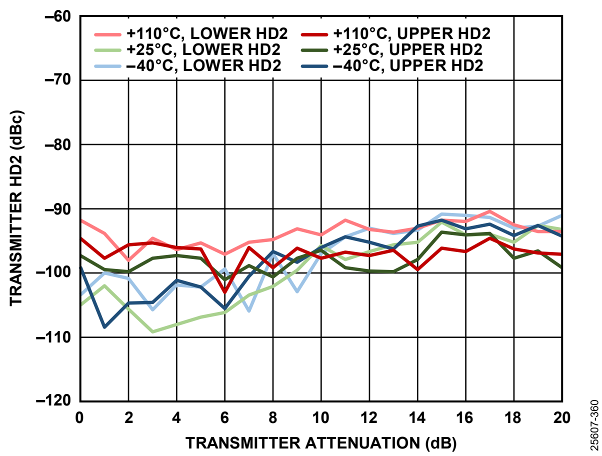

Figure 431. Transmitter Second Harmonic Distortion (HD2) vs. Transmitter Attenuation, 10 MHz Offset

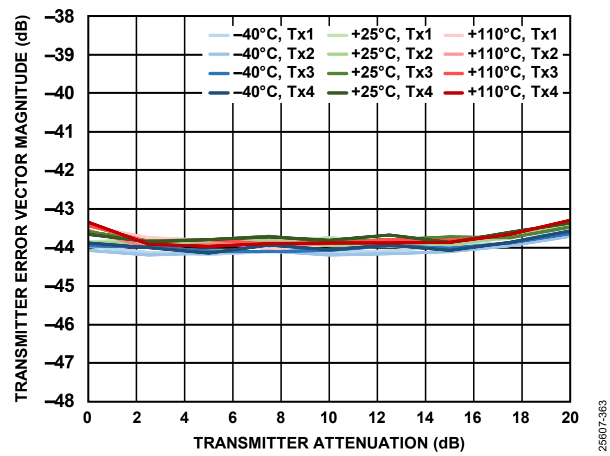

Figure 434. Transmitter Error Vector Magnitude vs. Transmitter Attenuation, 20 MHz LTE Signal Centered at LO Frequency, Sample Rate = 491.52 MSPS, Loop Filter Bandwidth = 400 kHz, Loop Filter Phase Margin = 60°

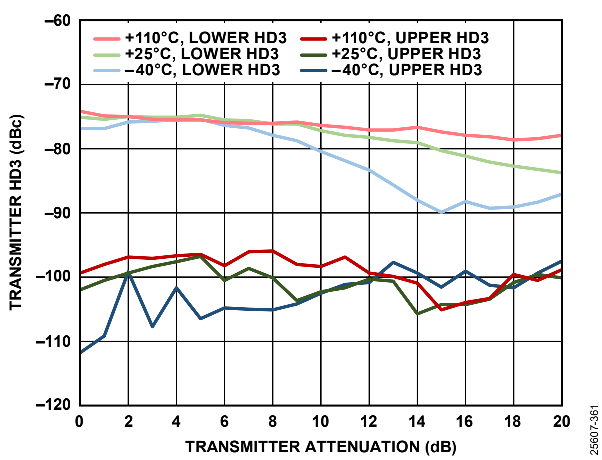

Figure 432. Transmitter Third Harmonic Distortion (HD3) vs. Transmitter Attenuation, 10 MHz Offset

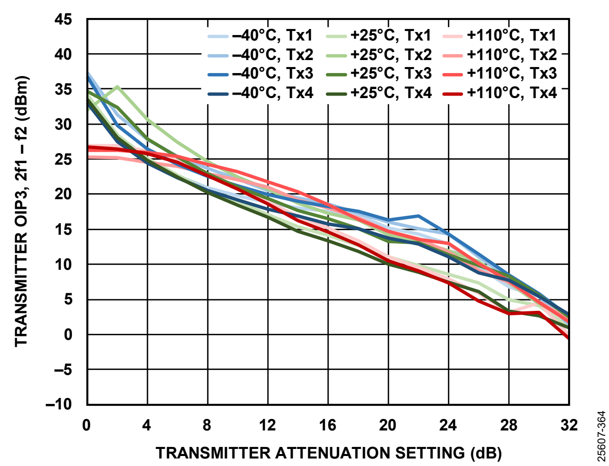

Figure 435. Transmitter OIP3, 2f1 – f2 vs. Transmitter Attenuation, 15 dB Digital Back Off per Tone, f1 = 50.5 MHz, f2 = 55.5 MHz

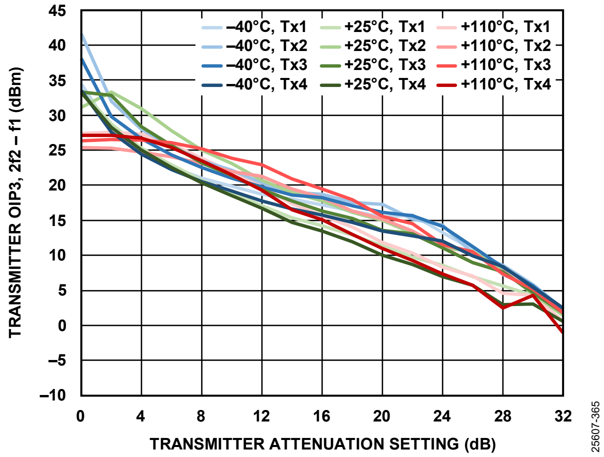

Figure 436. Transmitter OIP3, 2f2 – f1 vs. Transmitter Attenuation, 15 dB Digital Back Off per Tone, f1 = 50.5 MHz, f2 = 55.5 MHz

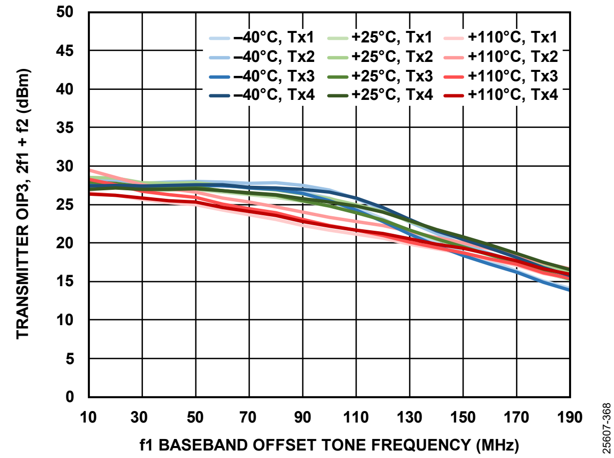

Figure 439. Transmitter OIP3, 2f1 + f2 vs. f1 Baseband Offset Tone Frequency, f2 = f1 + 5 MHz, 15 dB Digital Back Off per Tone

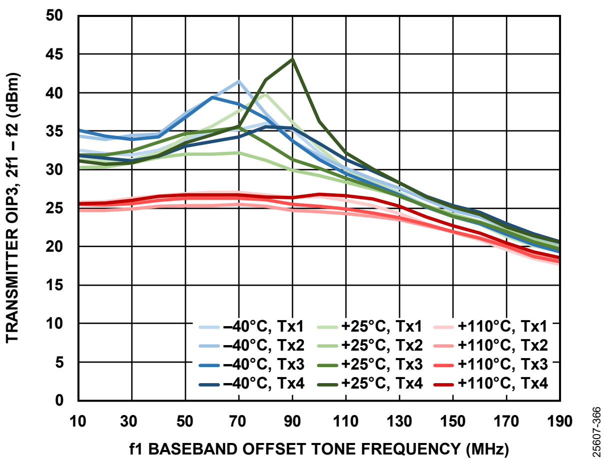

Figure 437. Transmitter OIP3, 2f1 – f2 vs. f1 Baseband Offset Tone Frequency, f2 = f1 + 5 MHz, 15 dB Digital Back Off per Tone

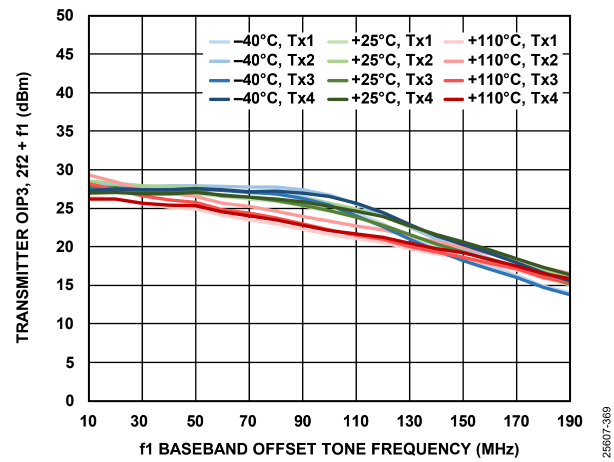

Figure 440. Transmitter OIP3, 2f2 + f1 vs. f1 Baseband Offset Tone Frequency, f2 = f1 + 5 MHz, 15 dB Digital Back Off per Tone

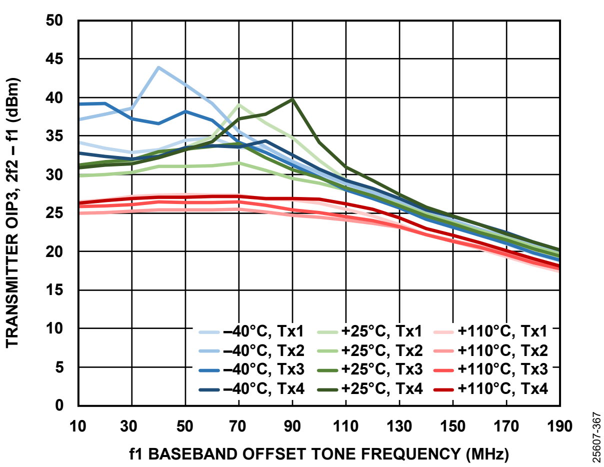

Figure 438. Transmitter OIP3, 2f2 – f1 vs. f1 Baseband Offset Tone Frequency, f2 = f1 + 5 MHz, 15 dB Digital Back Off per Tone

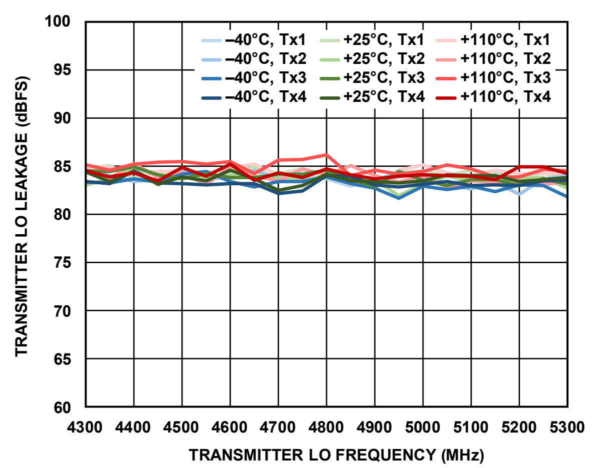

Figure 441. Transmitter LO Leakage vs. Transmitter LO Frequency

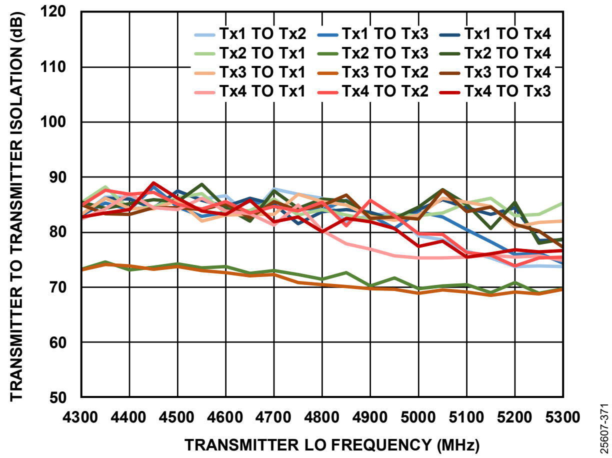

Figure 442. Transmitter to Transmitter Isolation vs. Transmitter LO Frequency

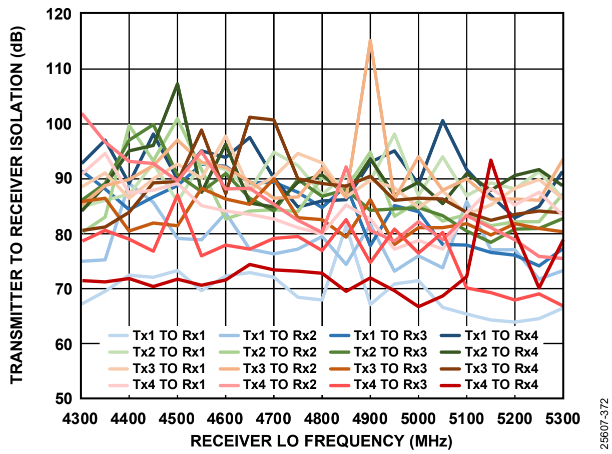

Figure 443. Transmitter to Receiver Isolation vs. Receiver LO Frequency

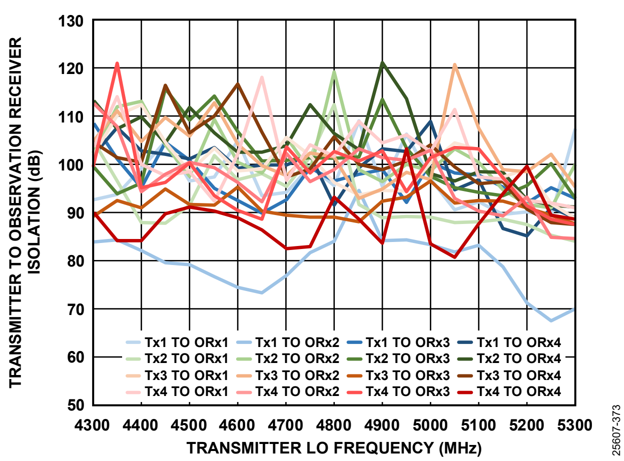

Figure 444. Transmitter to Observation Receiver Isolation vs. Transmitter LO Frequency

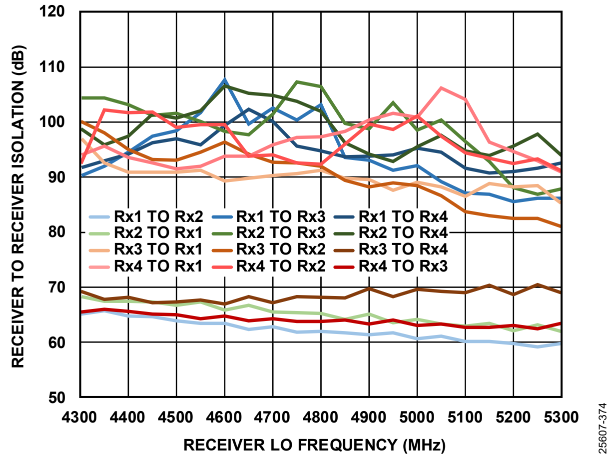

Figure 445. Receiver to Receiver Isolation vs. Receiver LO Frequency

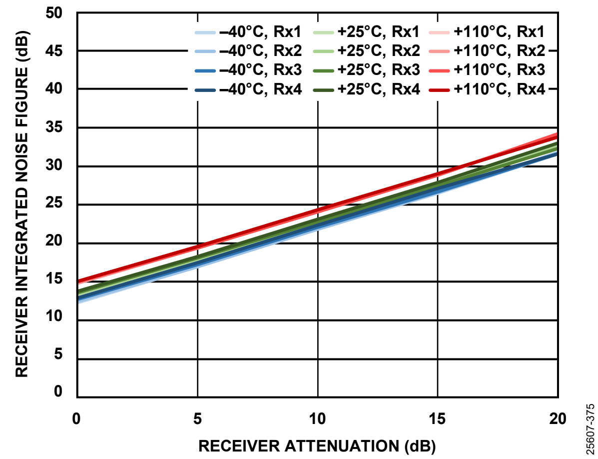

Figure 446. Receiver Integrated Noise Figure vs. Receiver Attenuation, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS, Integration Bandwidth = 500 kHz to 100 MHz

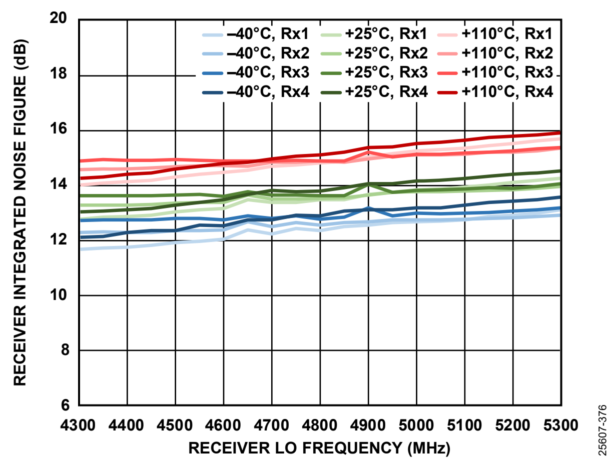

Figure 447. Receiver Integrated Noise Figure vs. Receiver LO Frequency, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS, Integration Bandwidth = 500 kHz to 100 MHz

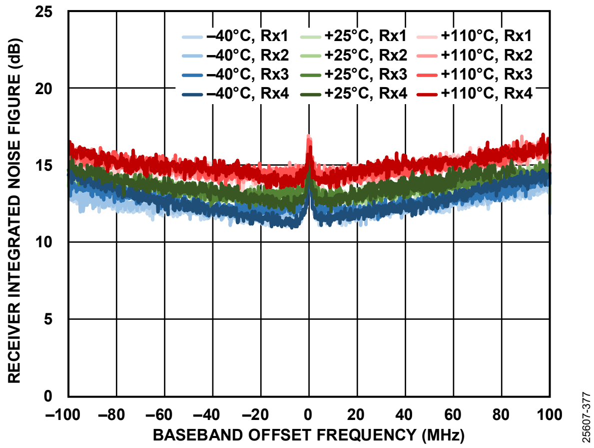

Figure 448. Receiver Integrated Noise Figure vs. Baseband Offset Frequency, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS, Integrated in 200 kHz Steps

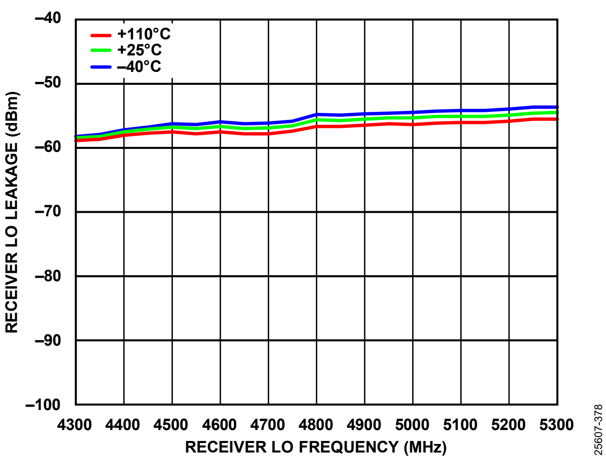

Figure 449. Receiver LO Leakage vs. Receiver LO Frequency, Attenuation = 0 dB, Sample Rate = 245.76 MSPS

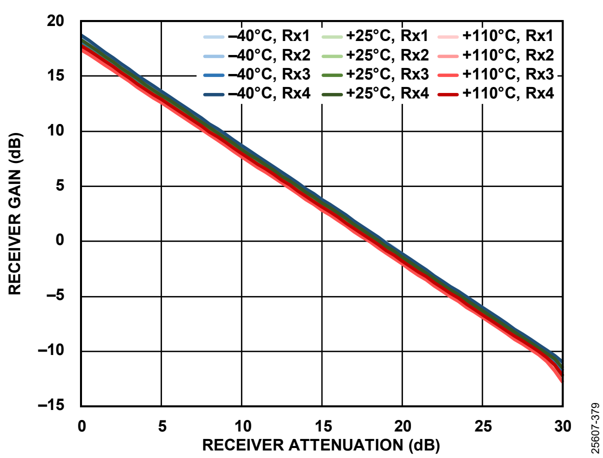

Figure 450. Receiver Gain vs. Receiver Attenuation, 20 MHz Offset, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS

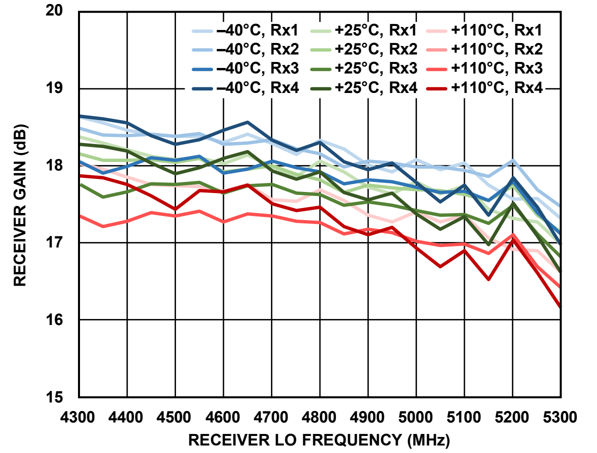

Figure 451. Receiver Gain vs. Receiver LO Frequency, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS

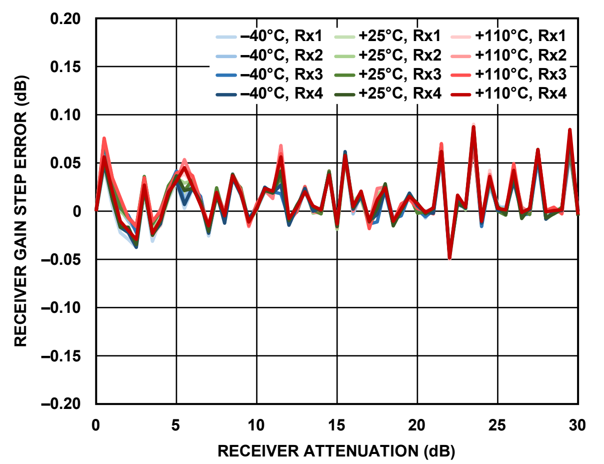

Figure 452. Receiver Gain Step Error vs. Receiver Attenuation, 20 MHz Offset, −5 dBFS Input Signal

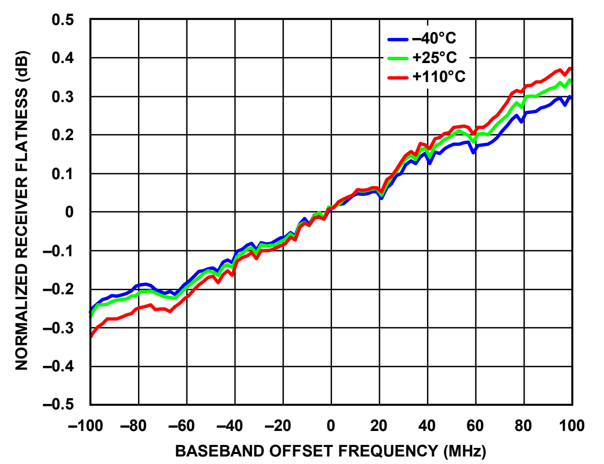

Figure 453. Normalized Receiver Flatness vs. Baseband Offset Frequency, −5 dBFS Input Signal

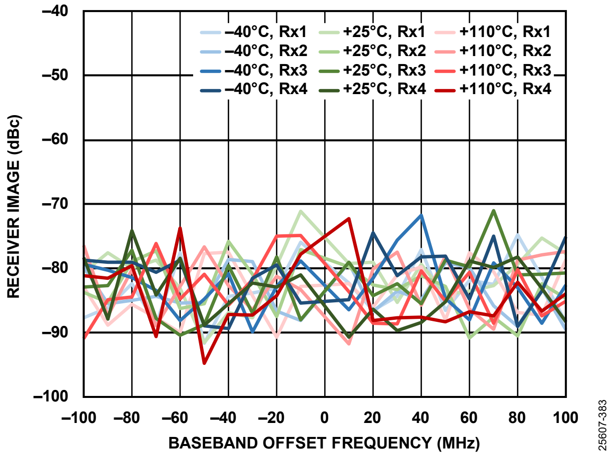

Figure 454. Receiver Image vs. Baseband Offset Frequency, Tracking Calibration Active, Sample Rate = 245.76 MSPS

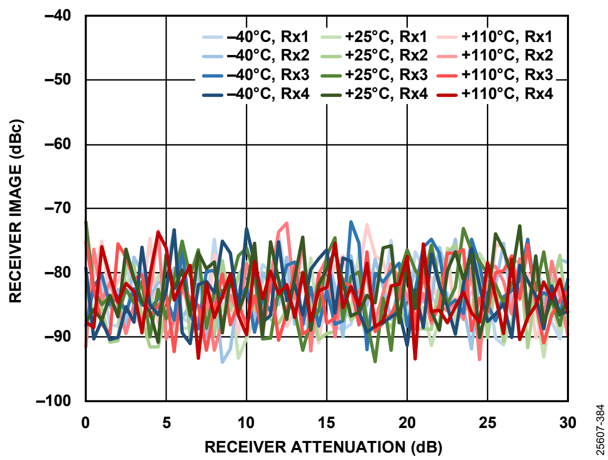

Figure 455. Receiver Image vs. Receiver Attenuation, 20 MHz Offset, Tracking Calibration Active, Sample Rate = 245.76 MSPS

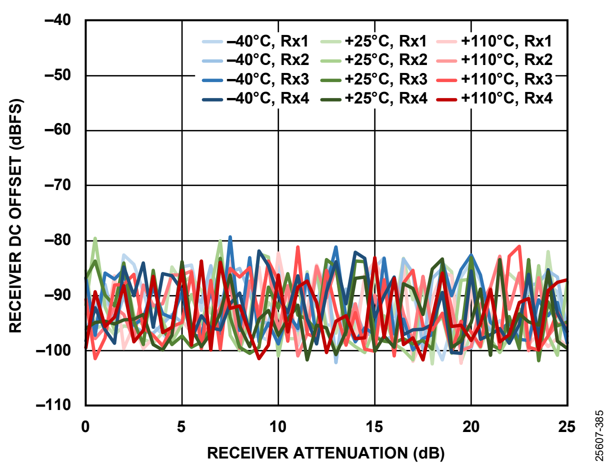

Figure 456. Receiver DC Offset vs. Receiver Attenuation, 20 MHz Offset, –5 dBFS Input Signal, Sample Rate = 245.76 MSPS

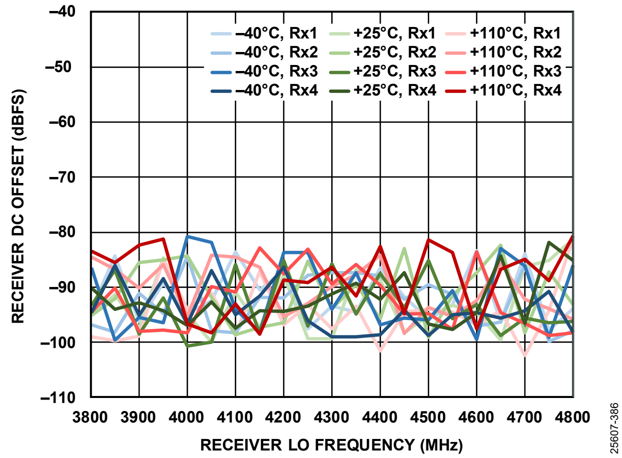

Figure 457. Receiver DC Offset vs. Receiver LO Frequency, Attenuation = 0 dB, Sample Rate = 245.76 MSPS

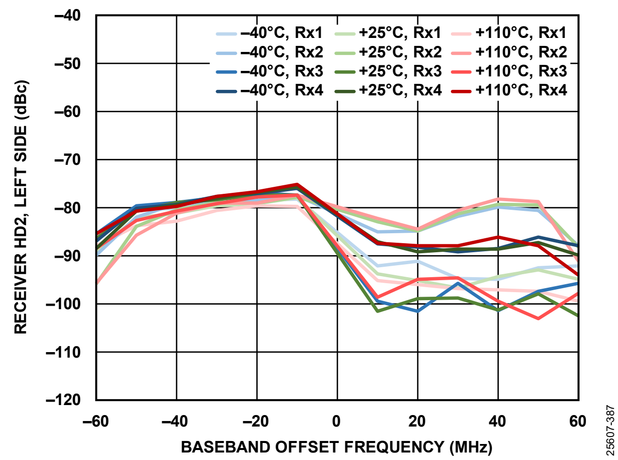

Figure 458. Receiver HD2, Left Side vs. Baseband Offset Frequency, –5 dBFS Input Signal, Distortion Tone Measured Left of 0 Hz (HD2 Canceller Not Enabled)

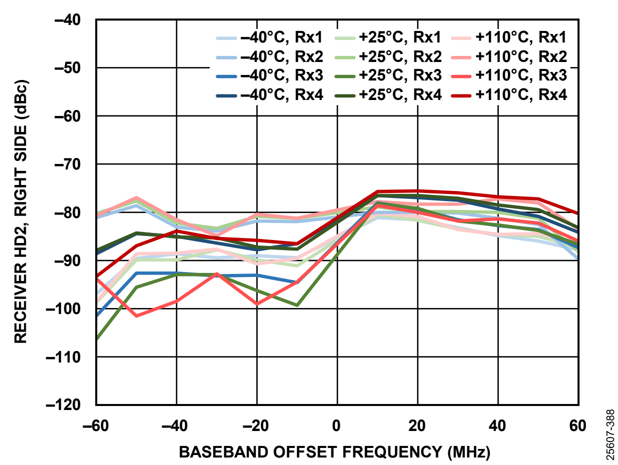

Figure 459. Receiver HD2, Right Side vs. Baseband Offset Frequency, –5 dBFS Input Signal, Distortion Tone Measured Right of 0 Hz (HD2 Canceller Not Enabled)

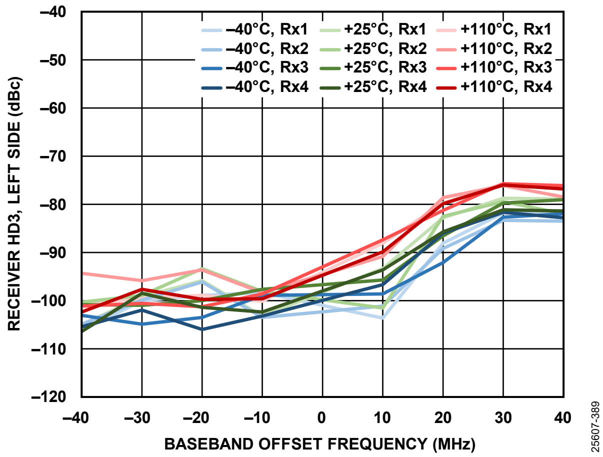

Figure 460. Receiver HD3, Left Side vs. Baseband Offset Frequency, −5 dBFS Input Signal, Distortion Tone Measured Left of 0 Hz

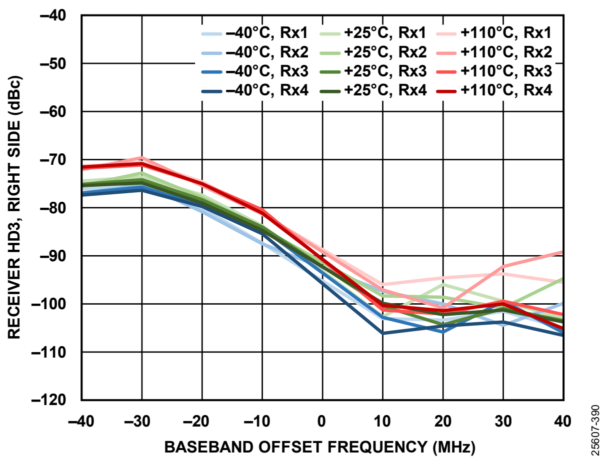

Figure 461. Receiver HD3, Right Side vs. Baseband Offset Frequency, −5 dBFS Input Signal, Distortion Tone Measured Right of 0 Hz

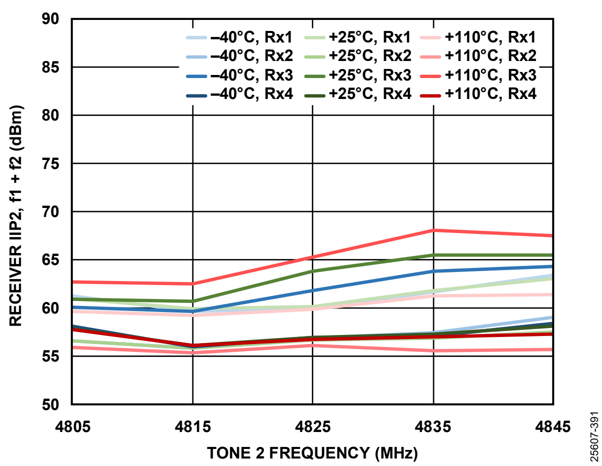

Figure 462. Receiver IIP2, f1 + f2 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

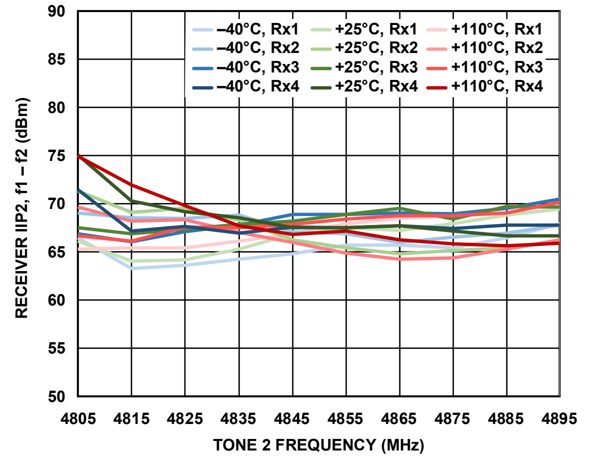

Figure 463. Receiver IIP2, f1 − f2 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

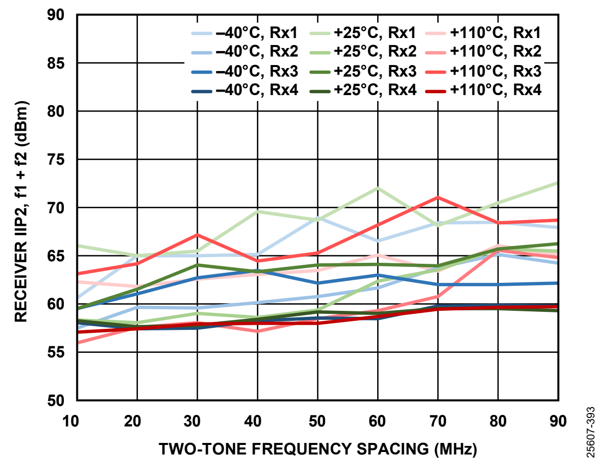

Figure 464. Receiver IIP2, f1 + f2 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

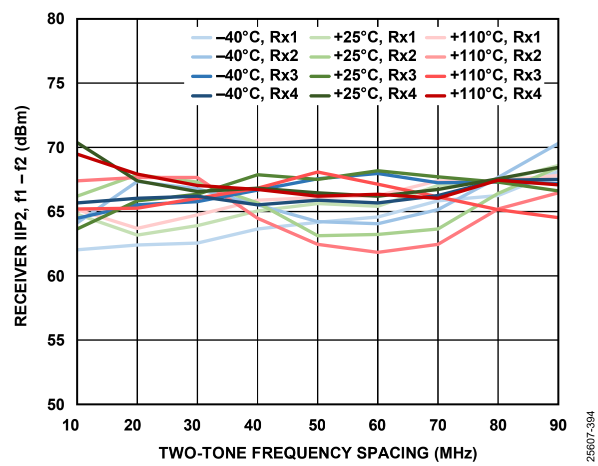

Figure 465. Receiver IIP2, f1 − f2 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

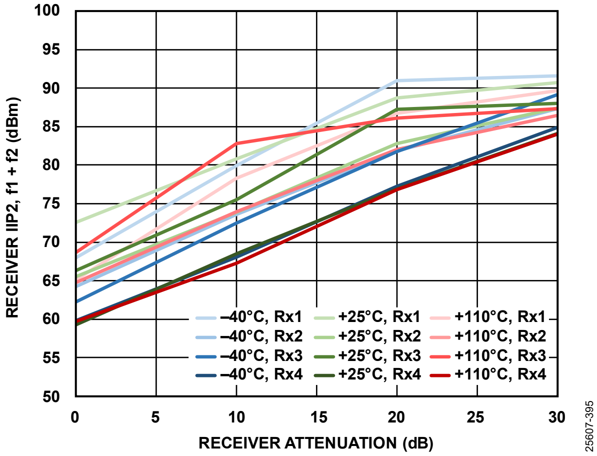

Figure 466. Receiver IIP2, f1 + f2 vs. Receiver Attenuation, Both Tones at –11 dBFS, f1 = 92 MHz, f2 = 2 MHz

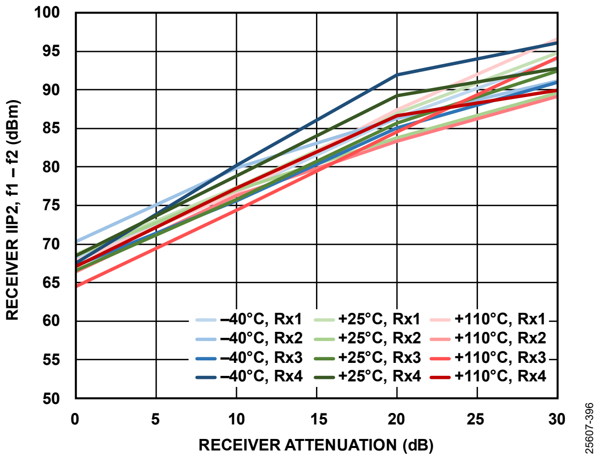

Figure 467. Receiver IIP2, f1 – f2 vs. Receiver Attenuation, Both Tones at –11 dBFS, f1 = 92 MHz, f2 = 2 MHz

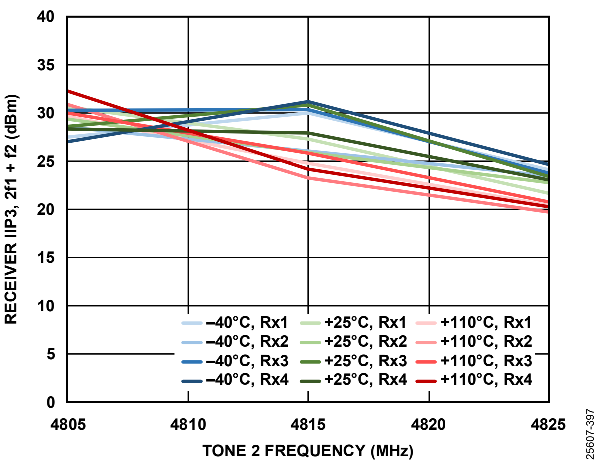

Figure 468. Receiver IIP3, 2f1 + f2 vs. Tone 2 Frequency, Both Tones at –11 dBFS, f1 = f2 + 2 MHz

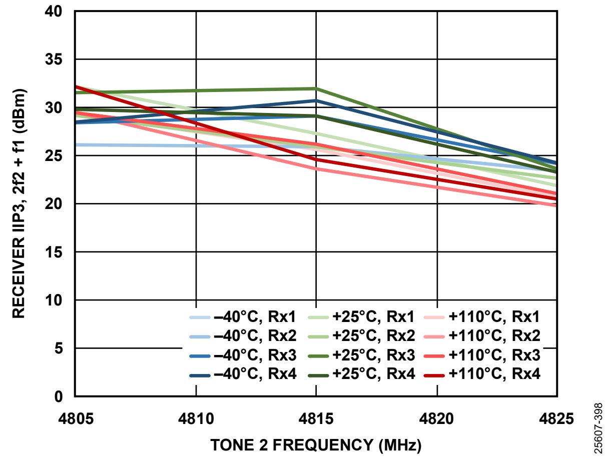

Figure 469. Receiver IIP3, 2f2 + f1 vs. Tone 2 Frequency, Both Tones at –11 dBFS, f1 = f2 + 2 MHz

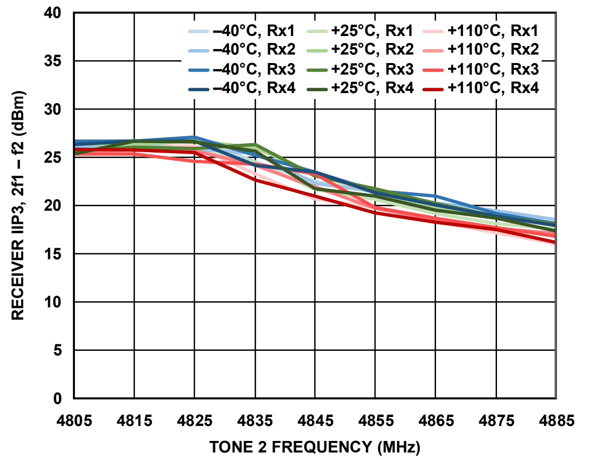

Figure 470. Receiver IIP3, 2f1 – f2 vs. Tone 2 Frequency, Both Tones at –11 dBFS, f1 = f2 + 2 MHz

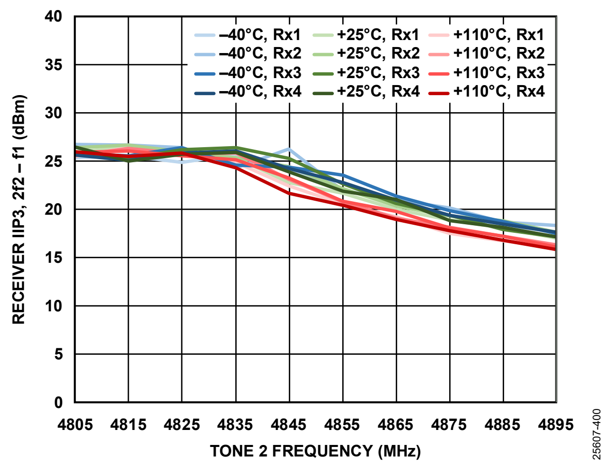

Figure 471. Receiver IIP3, 2f2 – f1 vs. Tone 2 Frequency, Both Tones at –11 dBFS, f1 = f2 + 2 MHz

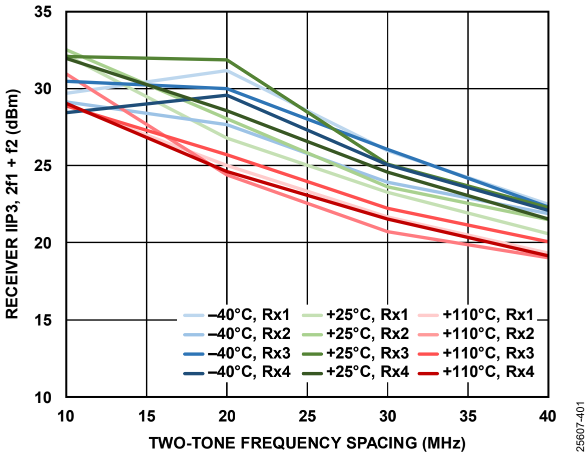

Figure 472. Receiver IIP3, 2f1 + f2 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

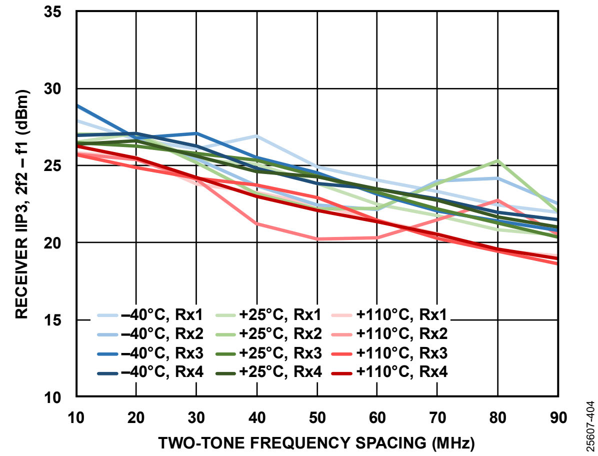

Figure 475. Receiver IIP3, 2f2 − f1 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

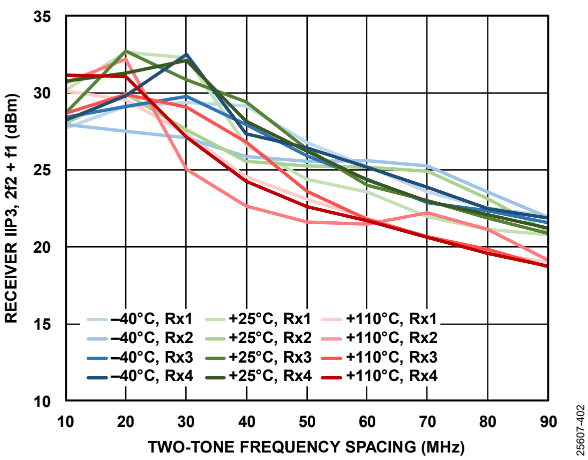

Figure 473. Receiver IIP3, 2f2 + f1 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

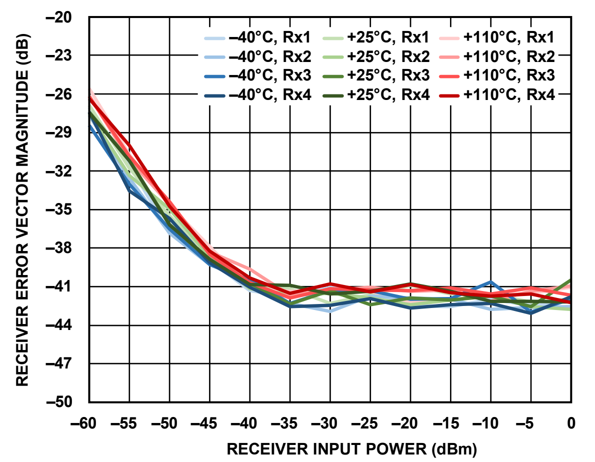

Figure 476. Receiver Error Vector Magnitude vs. Receiver Input Power, 20 MHz LTE Signal Centered at LO Frequency, Sample Rate = 245.76 MSPS, Loop Filter Bandwidth = 400 kHz, Loop Filter Phase Margin = 60°

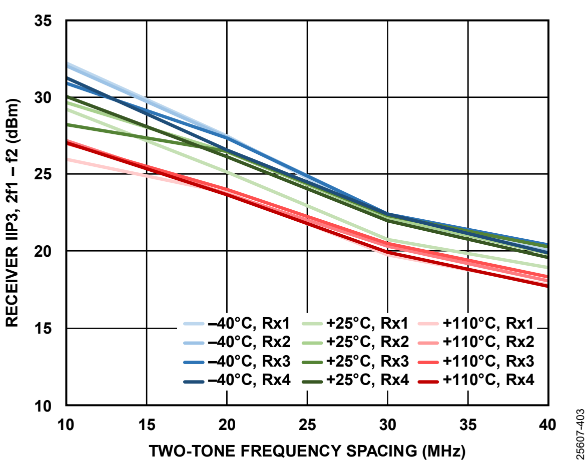

Figure 474. Receiver IIP3, 2f1 − f2 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

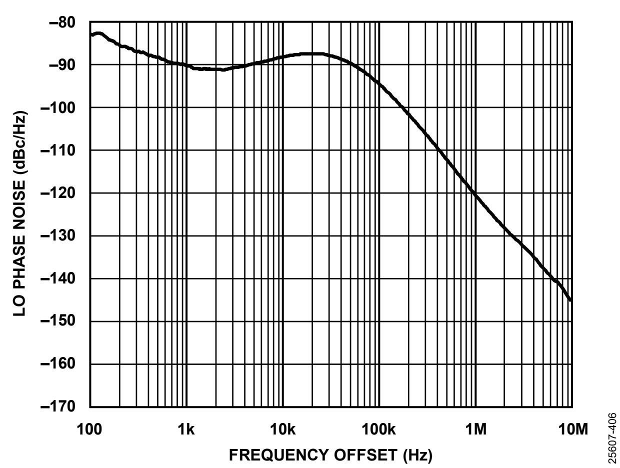

Figure 477. LO Phase Noise vs. Frequency Offset, Loop Bandwidth = 75 kHz, Phase Margin = 85°

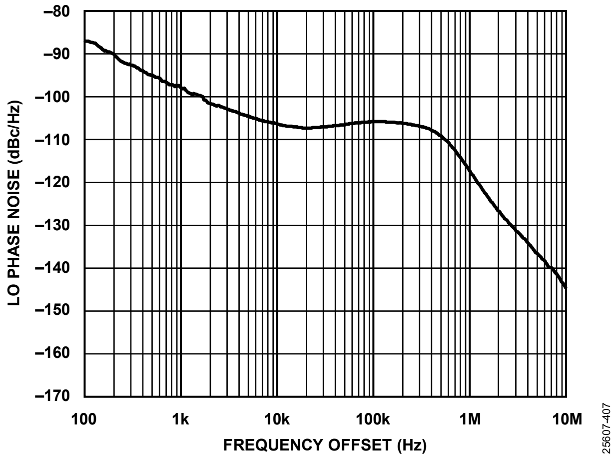

Figure 478. LO Phase Noise vs. Frequency Offset, Loop Bandwidth = 400 kHz, Phase Margin = 60°

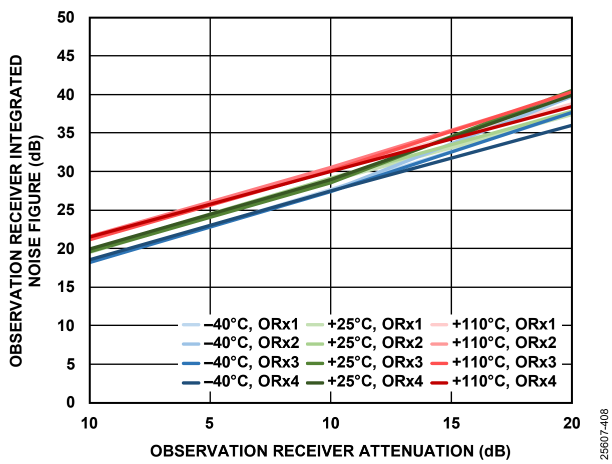

Figure 479. Observation Receiver Integrated Noise Figure vs. Observation Receiver Attenuation, 450 MHz Bandwidth, Sample Rate = 491.52 MSPS, Integration Bandwidth = 500 kHz to 245.76 MHz

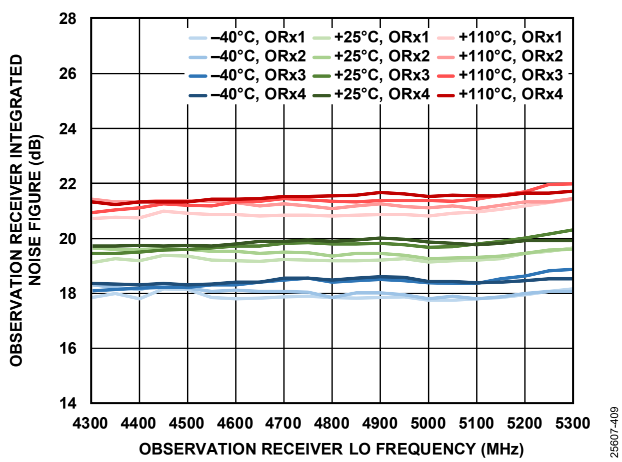

Figure 480. Observation Receiver Integrated Noise Figure vs. Observation Receiver LO Frequency, 450 MHz Bandwidth, Sample Rate = 491.52 MSPS, Integration Bandwidth = 500 kHz to 245.76 MHz

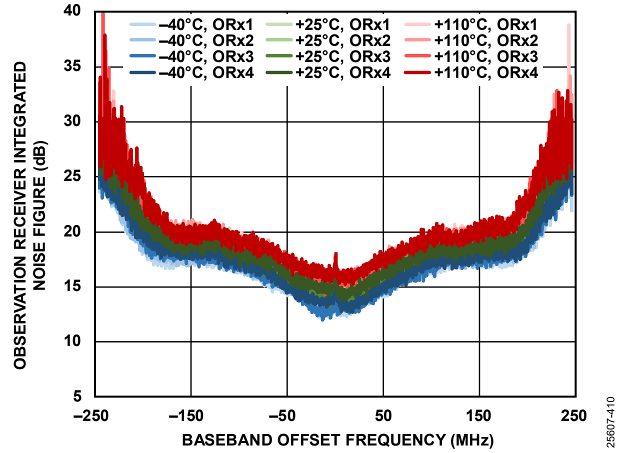

Figure 481. Observation Receiver Integrated Noise Figure vs. Baseband Offset Frequency, 450 MHz Bandwidth, Sample Rate = 491.52 MSPS, Integrated in 200 kHz Steps

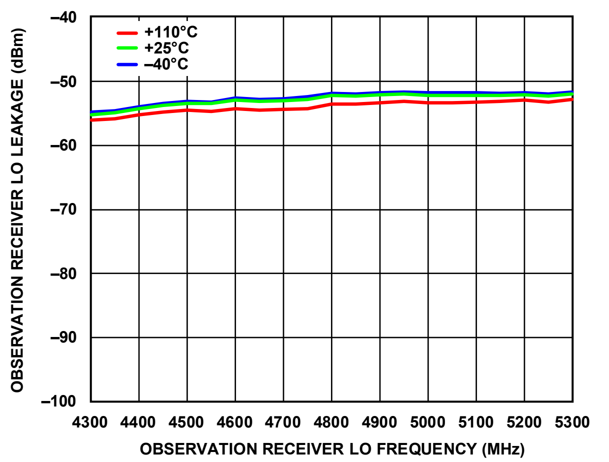

Figure 482. Observation Receiver LO Leakage vs. Observation Receiver LO Frequency, Attenuation = 0 dB, Sample Rate = 491.52 MSPS

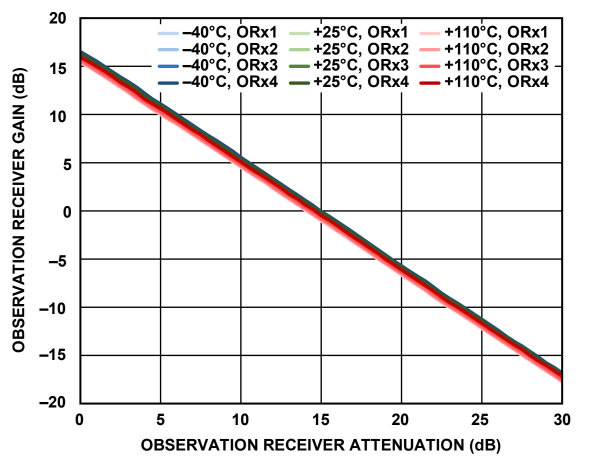

Figure 483. Observation Receiver Gain vs. Observation Receiver Attenuation, 45 MHz Offset, 450 MHz Bandwidth, Sample Rate = 491.52 MSPS

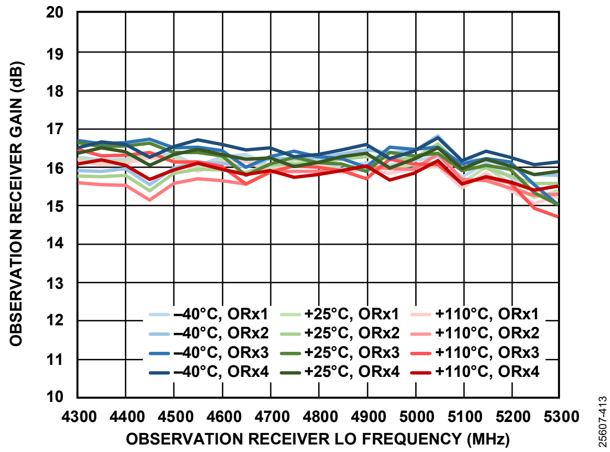

Figure 484. Observation Receiver Gain vs. Observation Receiver LO Frequency, 450 MHz Bandwidth, Sample Rate = 491.52 MSPS

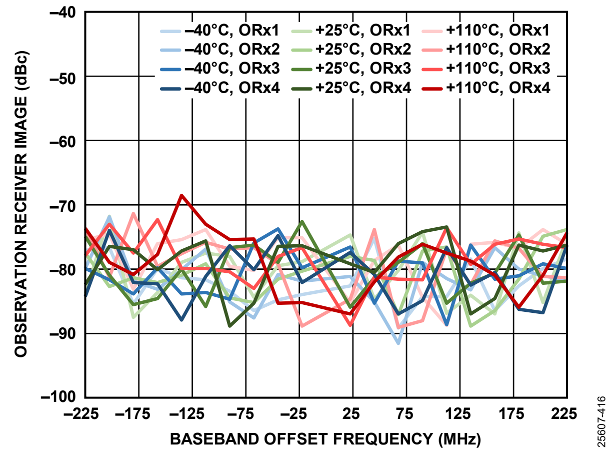

Figure 487. Observation Receiver Image vs. Baseband Offset Frequency, Tracking Calibration Active, Sample Rate = 491.52 MSPS

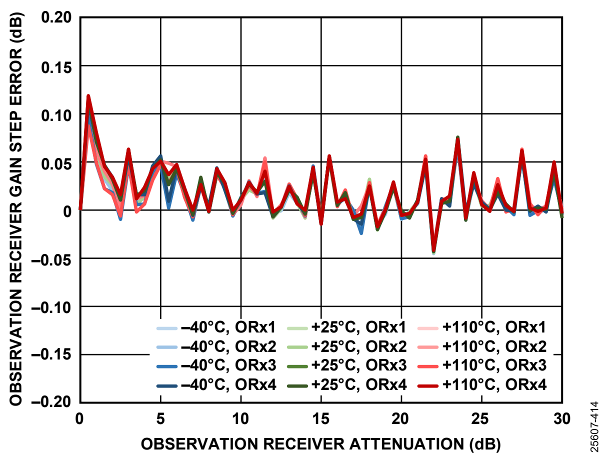

Figure 485. Observation Receiver Gain Step Error vs. Observation Receiver Attenuation, 45 MHz Offset, −10 dBFS Input Signal

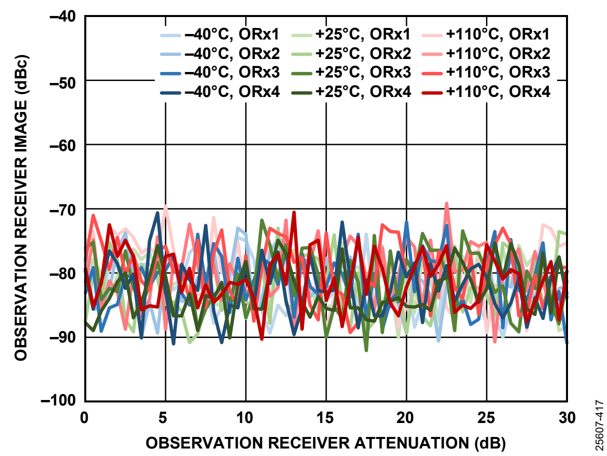

Figure 488. Observation Receiver Image vs. Observation Receiver Attenuation, 45 MHz Offset, Tracking Calibration Active, Sample Rate = 491.52 MSPS

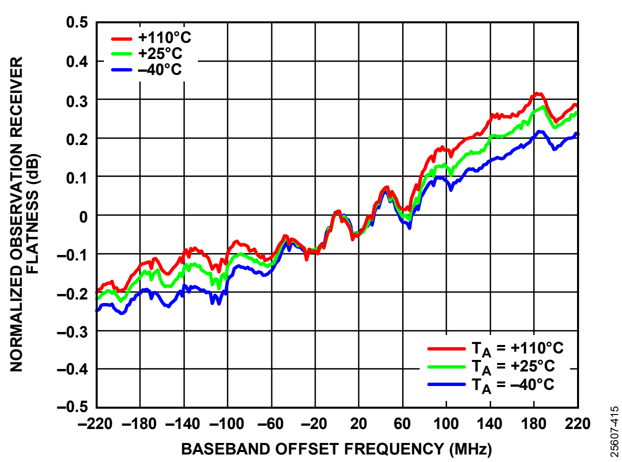

Figure 486. Normalized Observation Receiver Flatness vs. Baseband Offset Frequency, −10 dBFS Input Signal

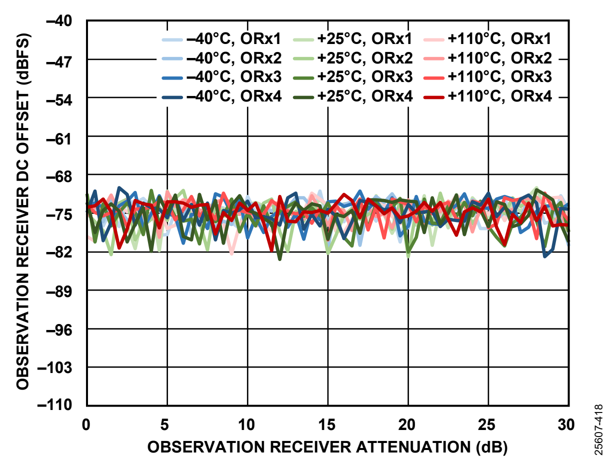

Figure 489. Observation Receiver DC Offset vs. Observation Receiver Attenuation, Sample Rate = 491.52 MSPS

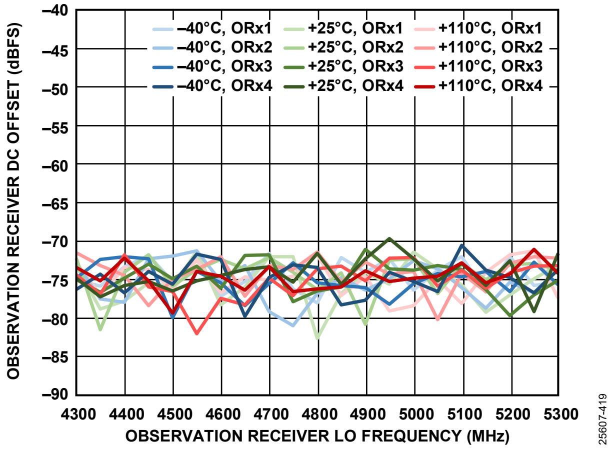

Figure 490. Observation Receiver DC Offset vs. Observation Receiver LO Frequency, Attenuation = 0 dB, Sample Rate = 491.52 MSPS

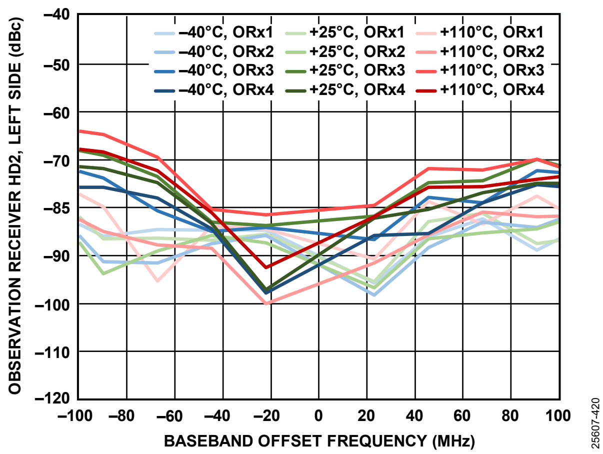

Figure 491. Observation Receiver HD2, Left Side vs. Baseband Offset Frequency, –10 dBFS Input Signal, Distortion Tone Measured Left of 0 Hz

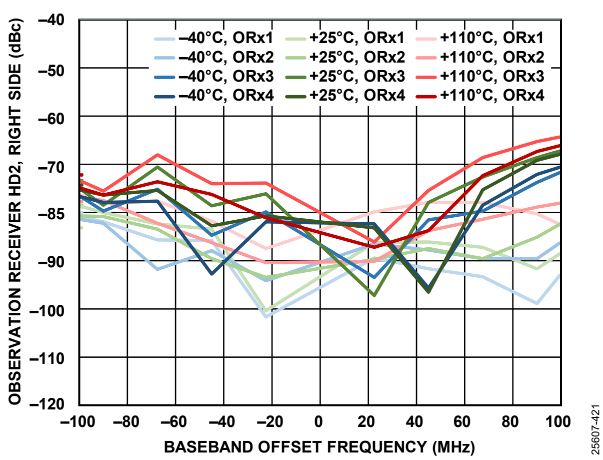

Figure 492. Observation Receiver HD2, Right Side vs. Baseband Offset Frequency, –10 dBFS Input Signal, Distortion Tone Measured Right of 0 Hz

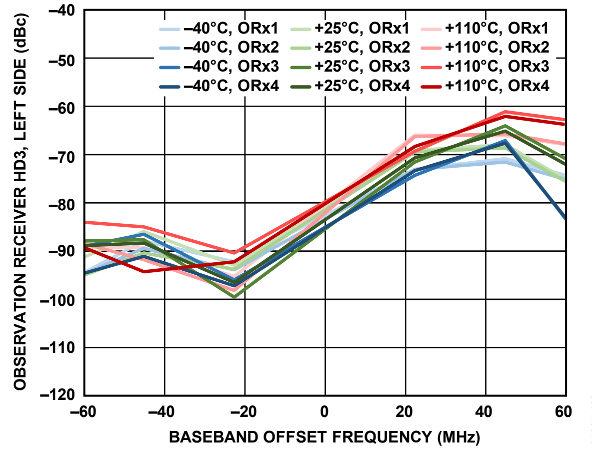

Figure 493. Observation Receiver HD3, Left Side vs. Baseband Offset Frequency, –10 dBFS Input Signal, Distortion Tone Measured Left of 0 Hz

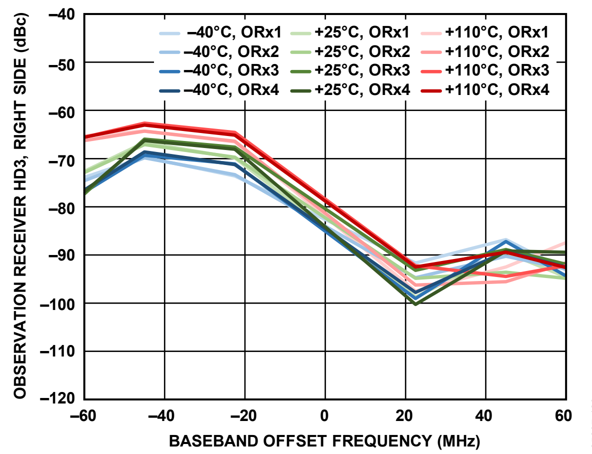

Figure 494. Observation Receiver HD3, Right Side vs. Baseband Offset Frequency, –10 dBFS Input Signal, Distortion Tone Measured Right of 0 Hz

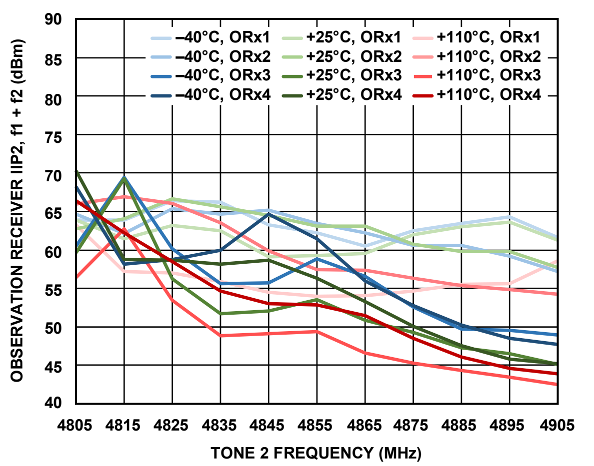

Figure 495. Observation Receiver IIP2, f1 + f2 vs. Tone 2 Frequency, Both Tones at –13 dBFS, f1 = f2 + 2 MHz

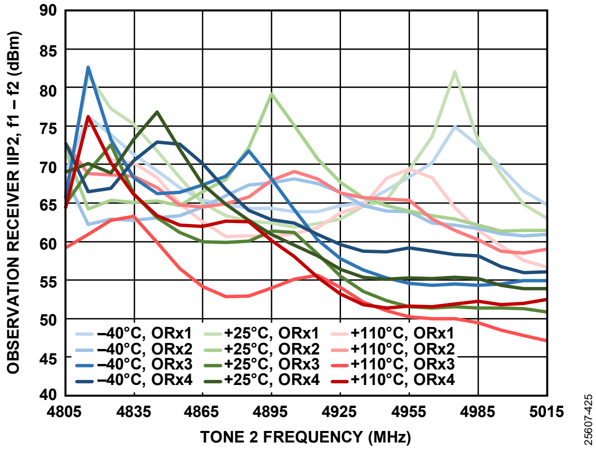

Figure 496. Observation Receiver IIP2, f1 – f2 vs. Tone 2 Frequency, Both Tones at –13 dBFS, f1 = f2 + 2 MHz

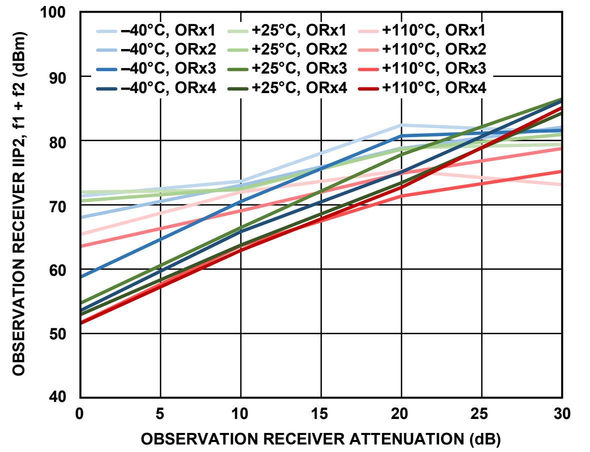

Figure 499. Observation Receiver IIP2, f1 + f2 vs. Observation Receiver Attenuation, Both Tones at –13 dBFS, f1 = 102 MHz, f2 = 2 MHz

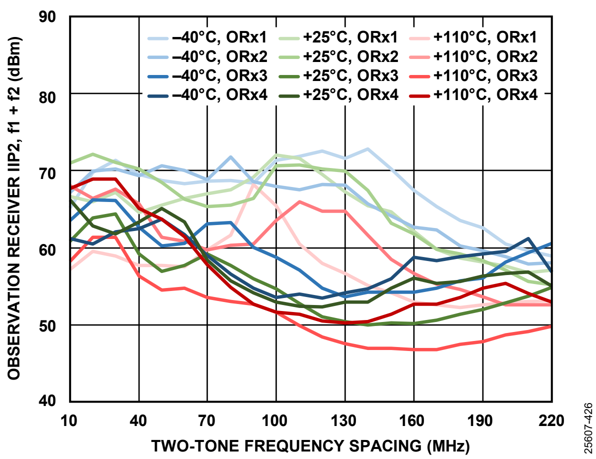

Figure 497. Observation Receiver IIP2, f1 + f2 vs. Two-Tone Frequency Spacing, Both Tones at –13 dBFS, f2 = 2 MHz

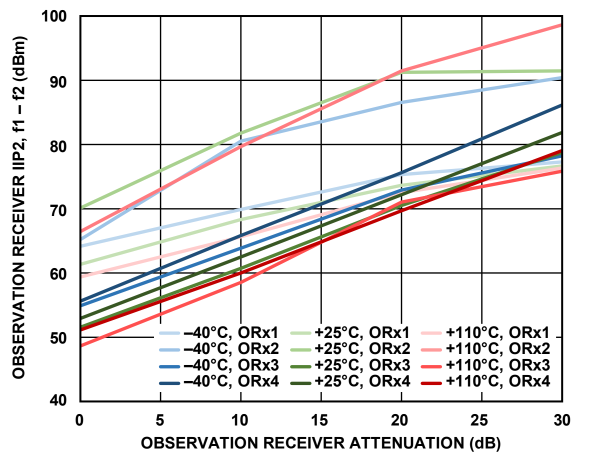

Figure 500. Observation Receiver IIP2, f1 – f2 vs. Observation Receiver Attenuation, Both Tones at –13 dBFS, f1 = 102 MHz, f2 = 2 MHz

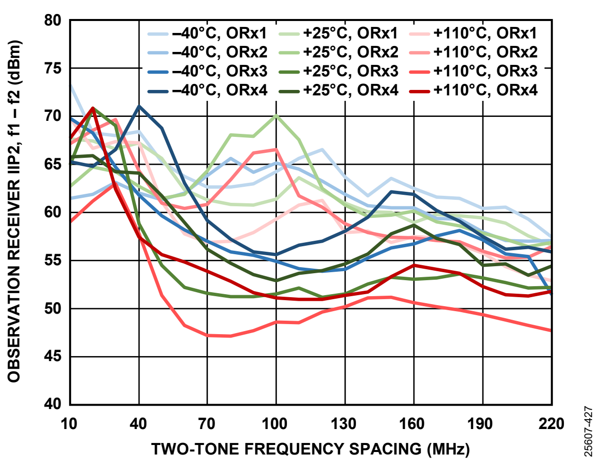

Figure 498. Observation Receiver IIP2, f1 – f2 vs. Two-Tone Frequency Spacing, Both Tones at –13 dBFS, f2 = 2 MHz

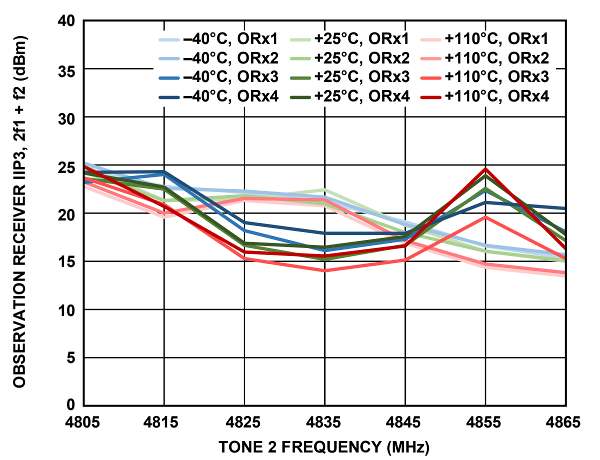

Figure 501. Observation Receiver IIP3, 2f1 + f2 vs. Tone 2 Frequency, Both Tones at –13 dBFS, f1 = f2 + 2 MHz

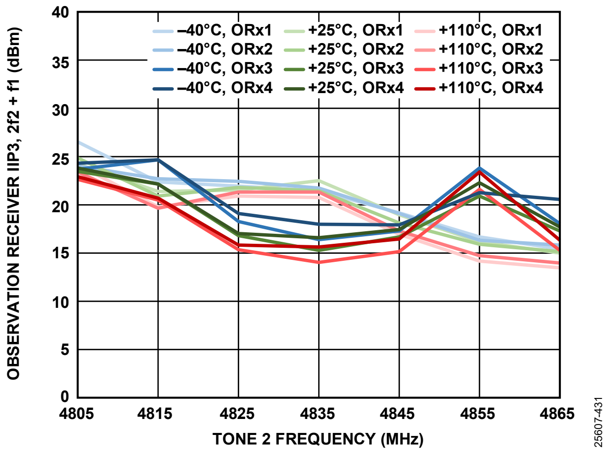

Figure 502. Observation Receiver IIP3, 2f2 + f1 vs. Tone 2 Frequency, Both Tones at −13 dBFS, f1 = f2 + 2 MHz

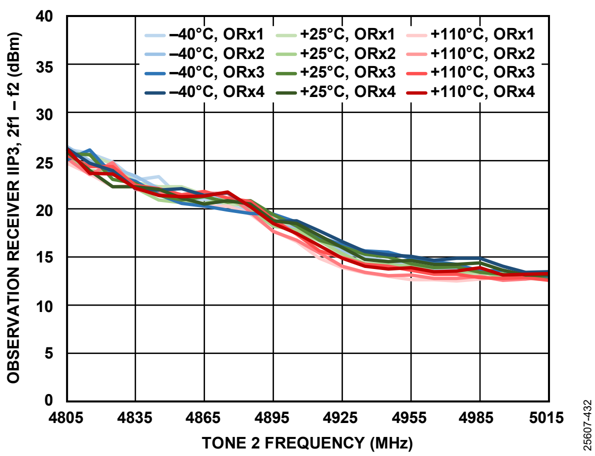

Figure 503. Observation Receiver IIP3, 2f1 − f2 vs. Tone 2 Frequency, Both Tones at −13 dBFS, f1 = f2 + 2 MHz

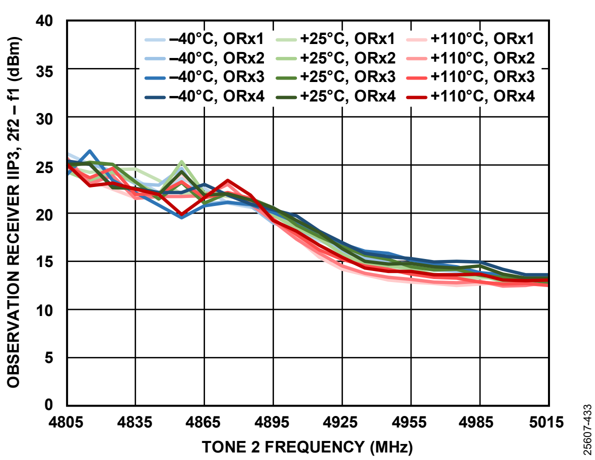

Figure 504. Observation Receiver IIP3, 2f2 − f1 vs. Tone 2 Frequency, Both Tones at −13 dBFS, f1 = f2 + 2 MHz

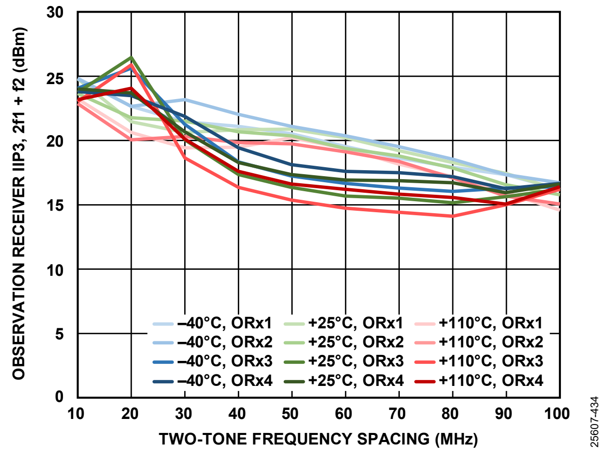

Figure 505. Observation Receiver IIP3, 2f1 + f2 vs. Two-Tone Frequency Spacing, Both Tones at −13 dBFS, f2 = 2 MHz

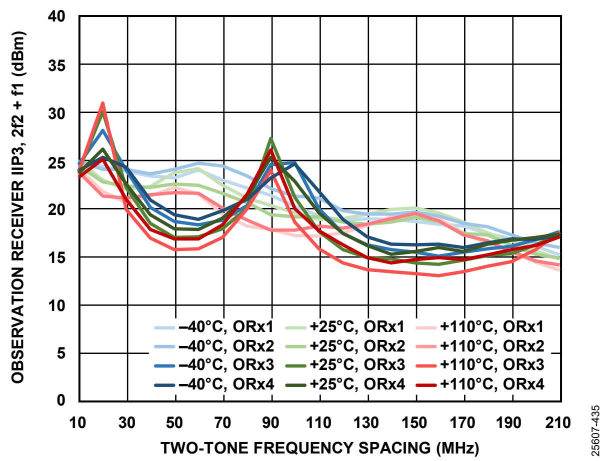

Figure 506. Observation Receiver IIP3, 2f2 + f1 vs. Two-Tone Frequency Spacing, Both Tones at −13 dBFS, f2 = 2 MHz

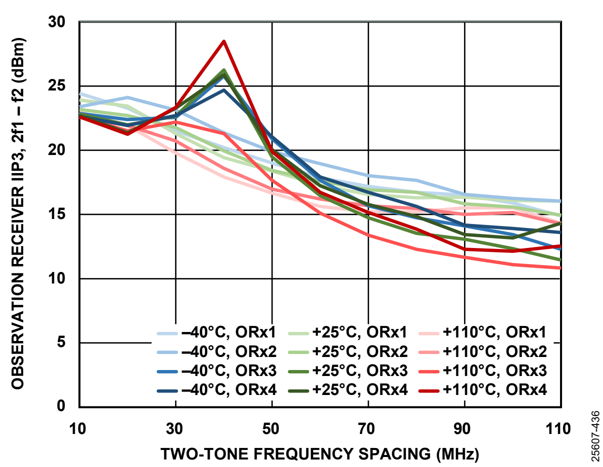

Figure 507. Observation Receiver IIP3, 2f1 − f2 vs. Two-Tone Frequency Spacing, Both Tones at −13 dBFS, f2 = 2 MHz

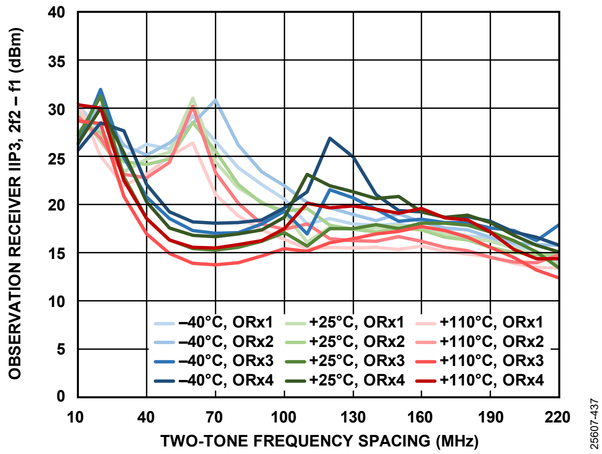

Figure 508. Observation Receiver IIP3, 2f2 − f1 vs. Two-Tone Frequency Spacing, Both Tones at −13 dBFS, f2 = 2 MHz

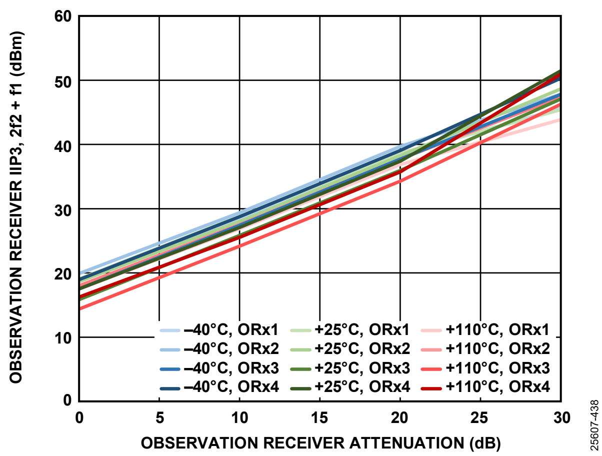

Figure 509. Observation Receiver IIP3, 2f2 + f1 vs. Observation Receiver Attenuation, Both Tones at −13 dBFS, f1 = 122 MHz, f2 = 2 MHz

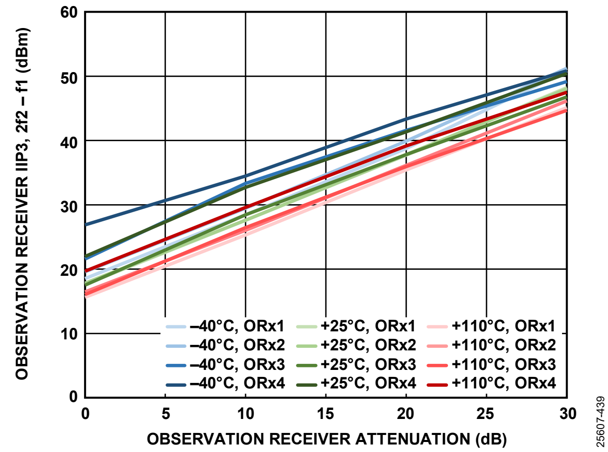

Figure 510. Observation Receiver IIP3, 2f2 − f1 vs. Observation Receiver Attenuation, Both Tones at −13 dBFS, f1 = 122 MHz, f2 = 2 MHz

5700 MHZ BAND

The temperature settings refer to the die temperature. All LO frequencies set to 5700 MHz, unless otherwise noted.

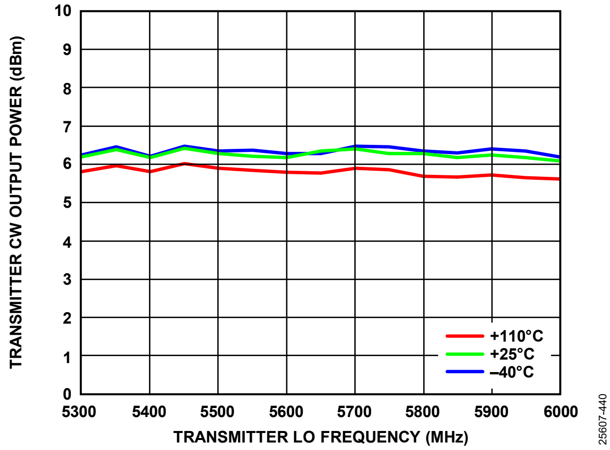

Figure 511. Transmitter Continuous Wave Output Power vs. Transmitter LO Frequency, 10 MHz Offset, 0 dB Attenuation

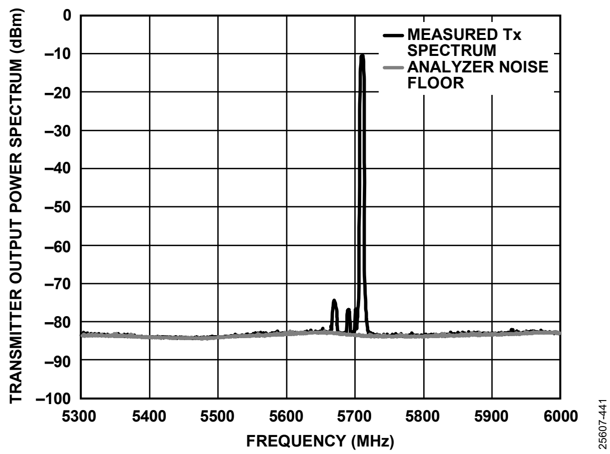

Figure 512. Transmitter Output Power Spectrum, Tx1, 5 MHz LTE, 10 MHz Offset, −10 dBFS RMS, 1 MHz Resolution Bandwidth, T_J = 25°C

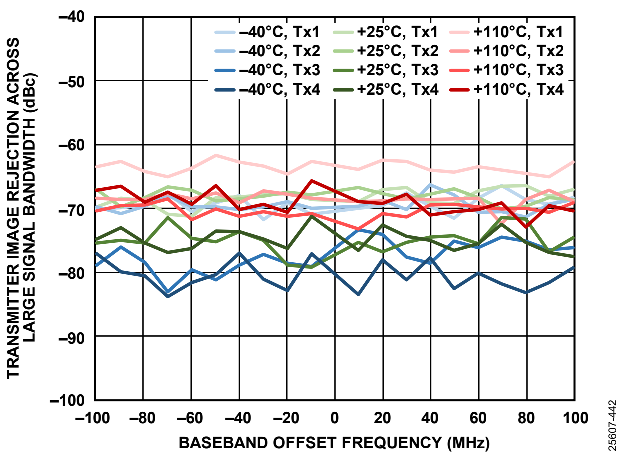

Figure 513. Transmitter Image Rejection Across Large Signal Bandwidth vs. Baseband Offset Frequency

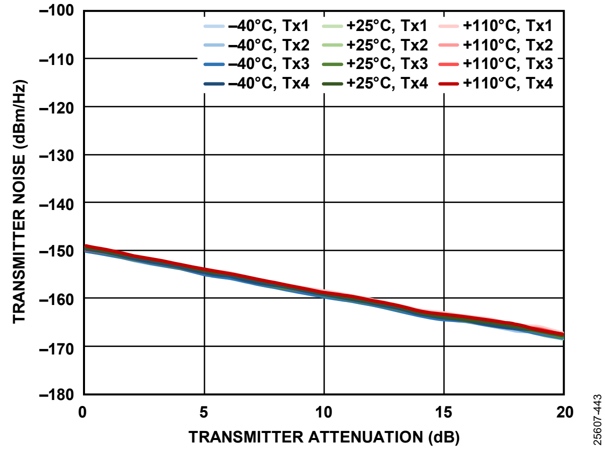

Figure 514. Transmitter Noise vs. Transmitter Attenuation, 10 MHz Offset Frequency

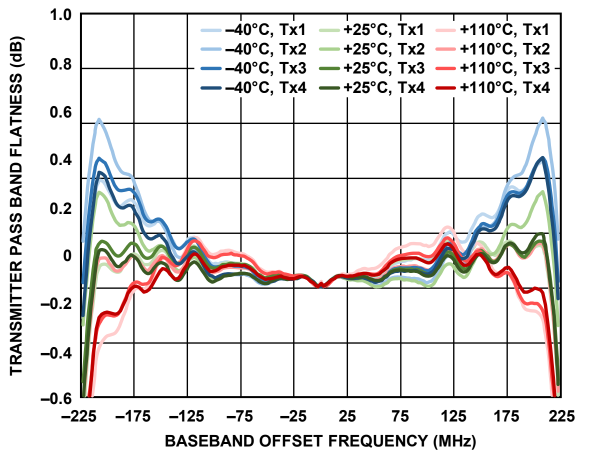

Figure 515. Transmitter Pass Band Flatness vs. Baseband Offset Frequency

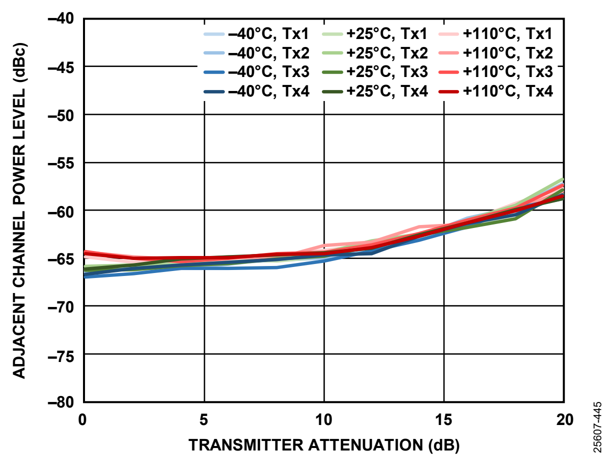

Figure 516. Adjacent Channel Power Level vs. Transmitter Attenuation, −10 MHz Baseband Offset, 20 MHz LTE, PAR = 12 dB

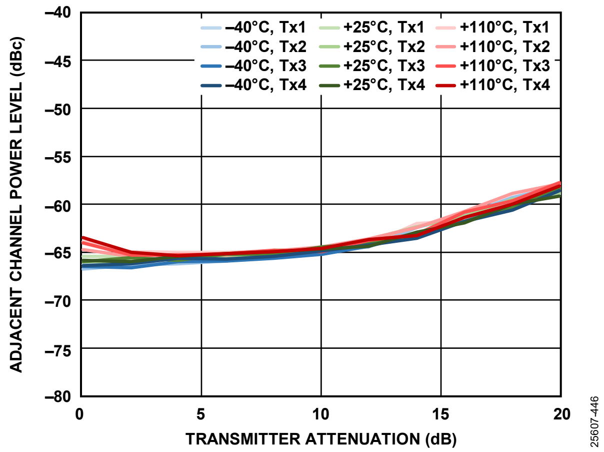

Figure 517. Adjacent Channel Power Level vs. Transmitter Attenuation, 90 MHz Baseband Offset, 20 MHz LTE, PAR = 12 dB

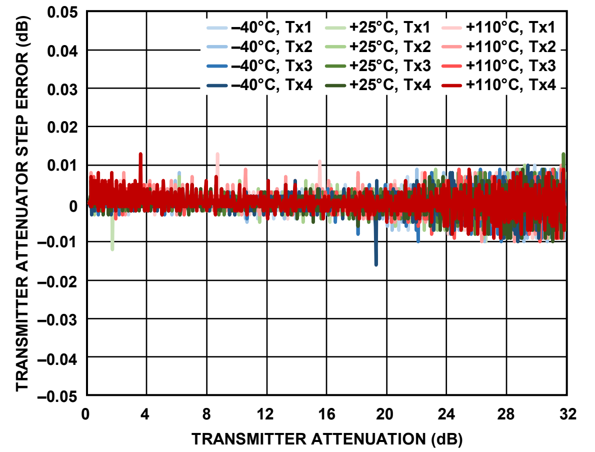

Figure 520. Transmitter Attenuator Step Error vs. Transmitter Attenuation, 10 MHz Offset

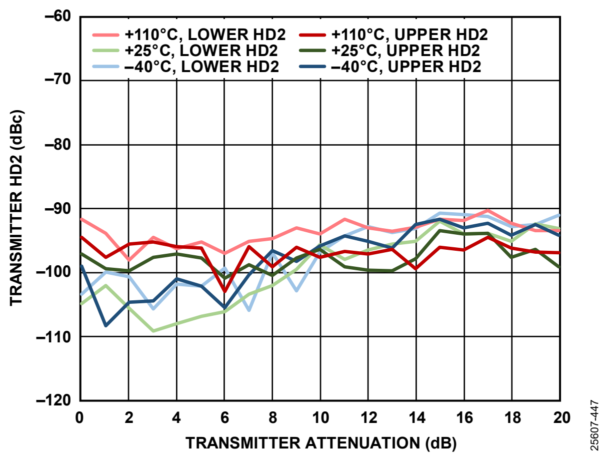

Figure 518. Transmitter Second Harmonic Distortion (HD2) vs. Transmitter Attenuation, 10 MHz Offset

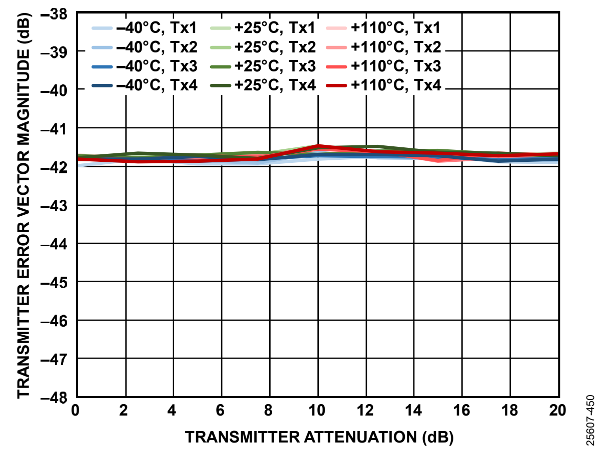

Figure 521. Transmitter Error Vector Magnitude vs. Transmitter Attenuation, 20 MHz LTE Signal Centered at LO Frequency, Sample Rate = 491.52 MSPS, Loop Filter Bandwidth = 400 kHz, Loop Filter Phase Margin = 60°

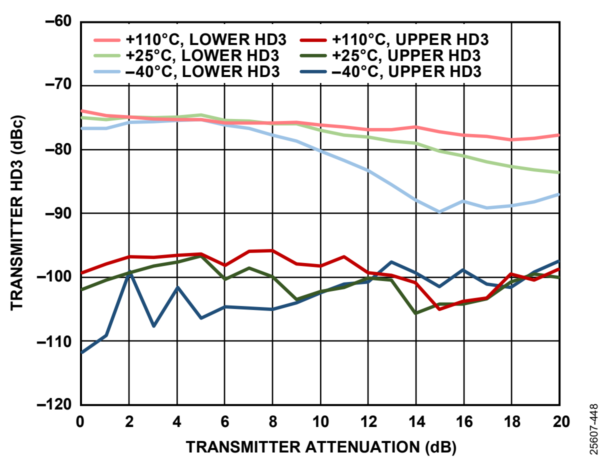

Figure 519. Transmitter Third Harmonic Distortion (HD3) vs. Transmitter Attenuation, 10 MHz Offset

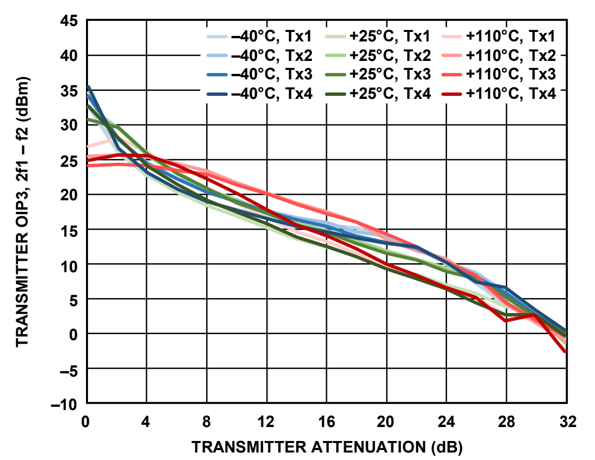

Figure 522. Transmitter OIP3, 2f1 − f2 vs. Transmitter Attenuation, 15 dB Digital Back Off per Tone, f1 = 50.5 MHz, f2 = 55.5 MHz

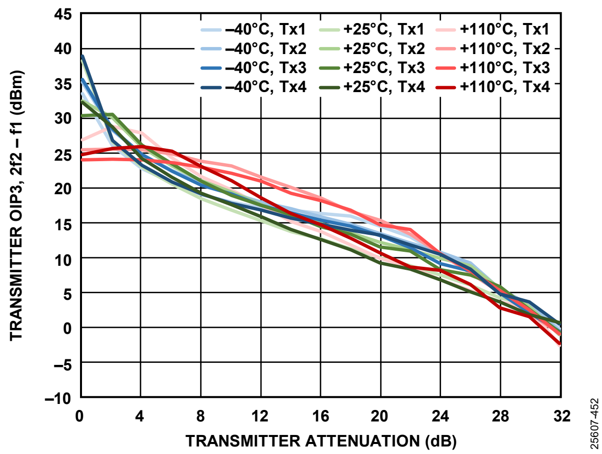

Figure 523. Transmitter OIP3, 2f2 – f1 vs. Transmitter Attenuation, 15 dB Digital Back Off per Tone, f1 = 50.5 MHz, f2 = 55.5 MHz

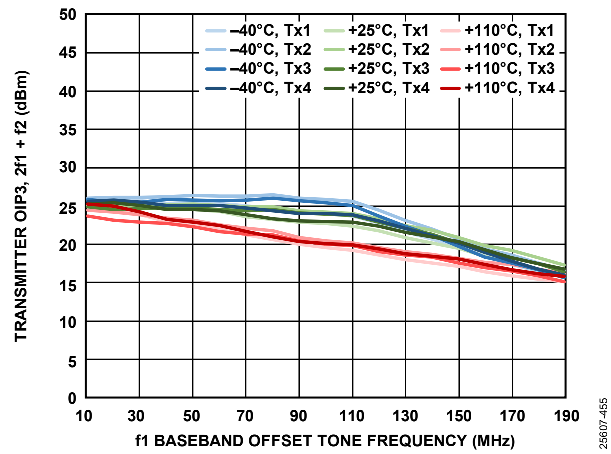

Figure 526. Transmitter OIP3, 2f1 + f2 vs. f1 Baseband Offset Tone Frequency, f2 = f1 + 5 MHz, 15 dB Digital Back Off per Tone

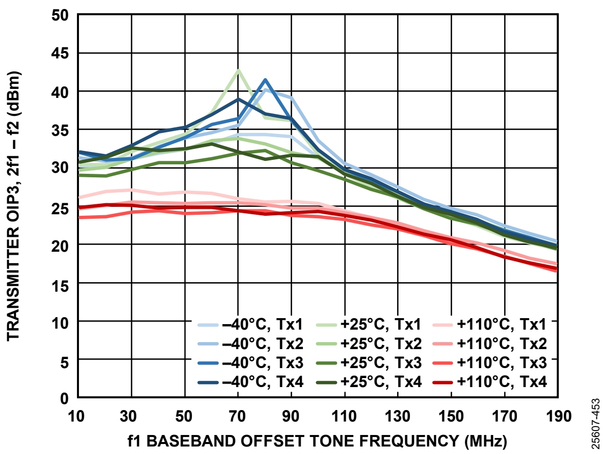

Figure 524. Transmitter OIP3, 2f1 – f2 vs. f1 Baseband Offset Tone Frequency, f2 = f1 + 5 MHz, 15 dB Digital Back Off per Tone

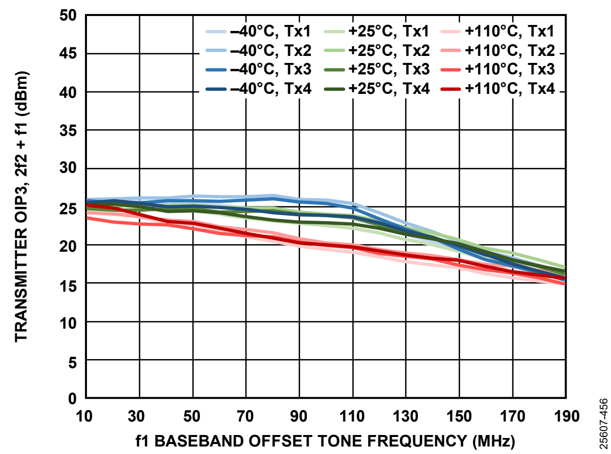

Figure 527. Transmitter OIP3, 2f2 + f1 vs. f1 Baseband Offset Tone Frequency, f2 = f1 + 5 MHz, 15 dB Digital Back Off per Tone

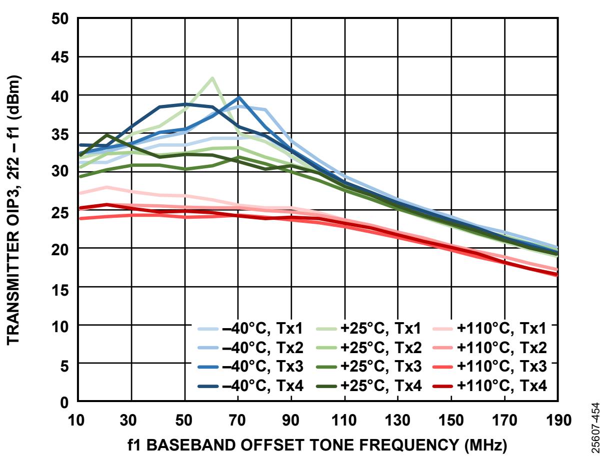

Figure 525. Transmitter OIP3, 2f2 – f1 vs. f1 Baseband Offset Tone Frequency, f2 = f1 + 5 MHz, 15 dB Digital Back Off per Tone

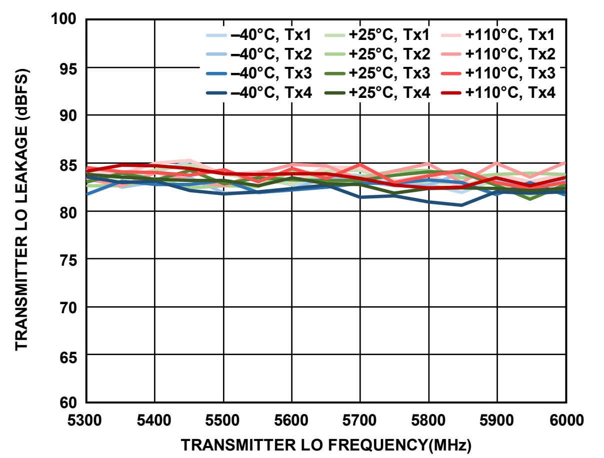

Figure 528. Transmitter LO Leakage vs. Transmitter LO Frequency

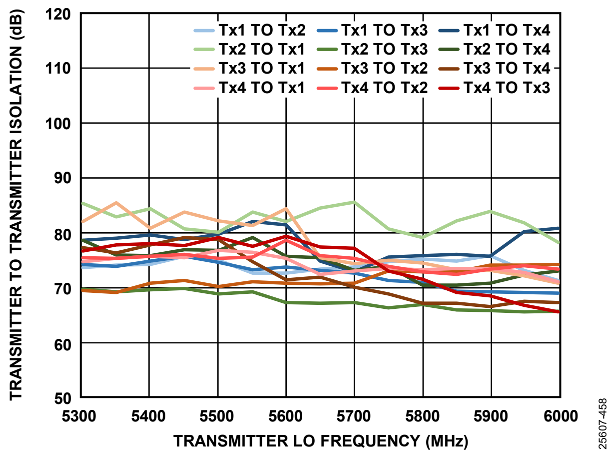

Figure 529. Transmitter to Transmitter Isolation vs. Transmitter LO Frequency

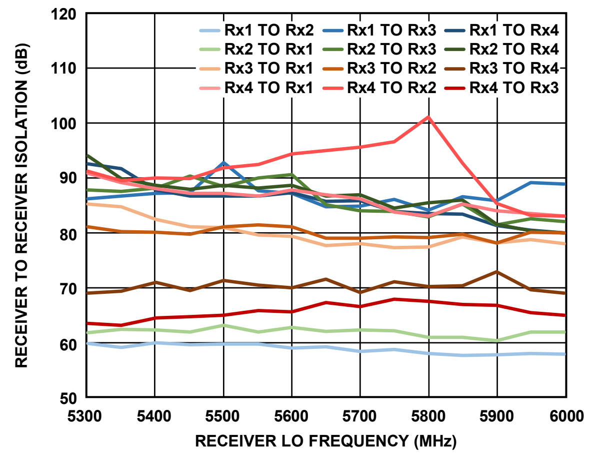

Figure 532. Receiver to Receiver Isolation vs. Receiver LO Frequency

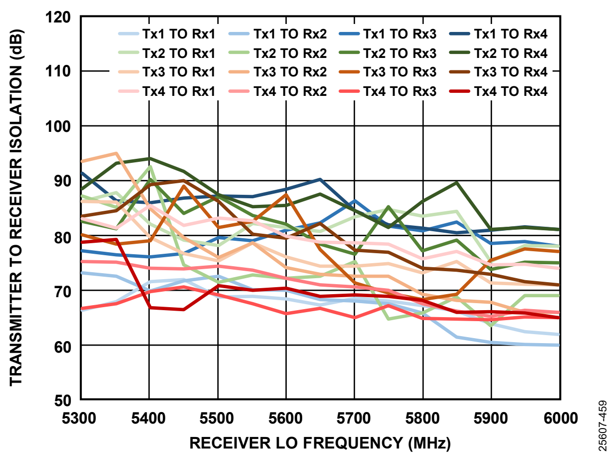

Figure 530. Transmitter to Receiver Isolation vs. Receiver LO Frequency

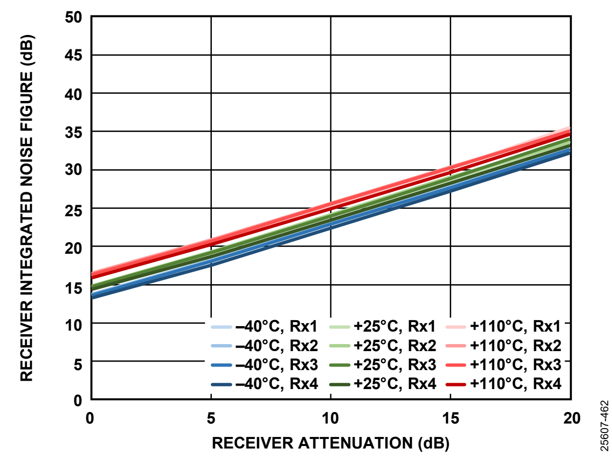

Figure 533. Receiver Integrated Noise Figure vs. Receiver Attenuation, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS, Integration Bandwidth = 500 kHz to 100 MHz

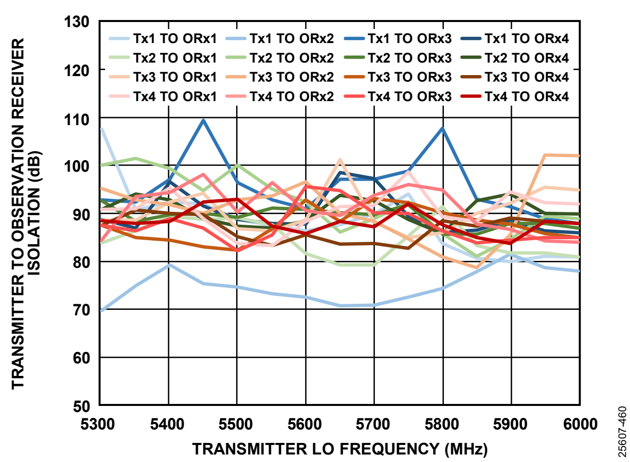

Figure 531. Transmitter to Observation Receiver Isolation vs. Transmitter LO Frequency

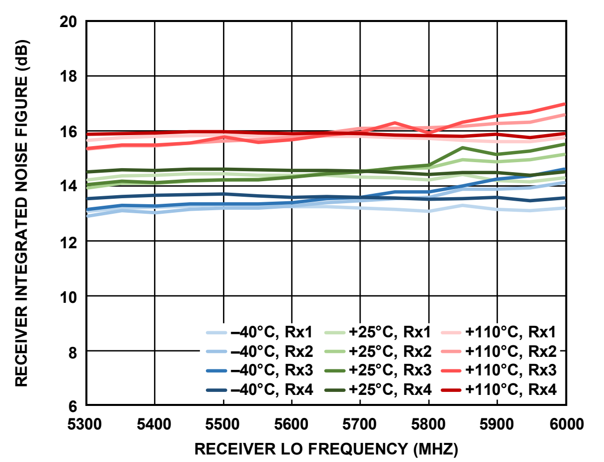

Figure 534. Receiver Integrated Noise Figure vs. Receiver LO Frequency, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS, Integration Bandwidth = 500 kHz to 100 MHz

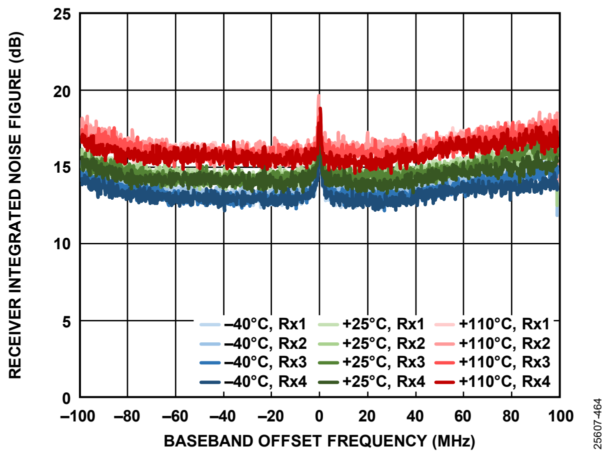

Figure 535. Receiver Integrated Noise Figure vs. Baseband Offset Frequency, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS, Integrated in 200 kHz Steps

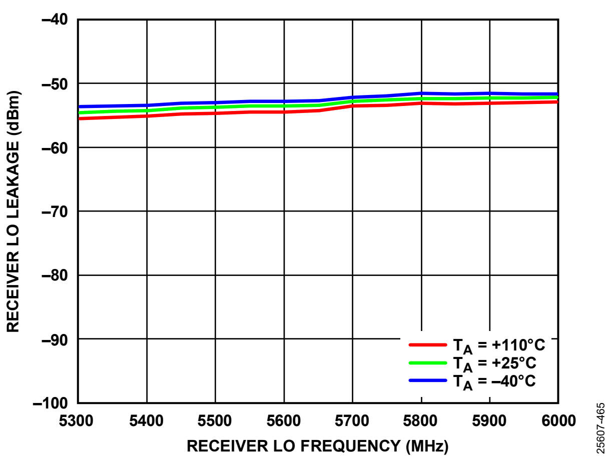

Figure 536. Receiver LO Leakage vs. Receiver LO Frequency, Attenuation = 0 dB, Sample Rate = 245.76 MSPS

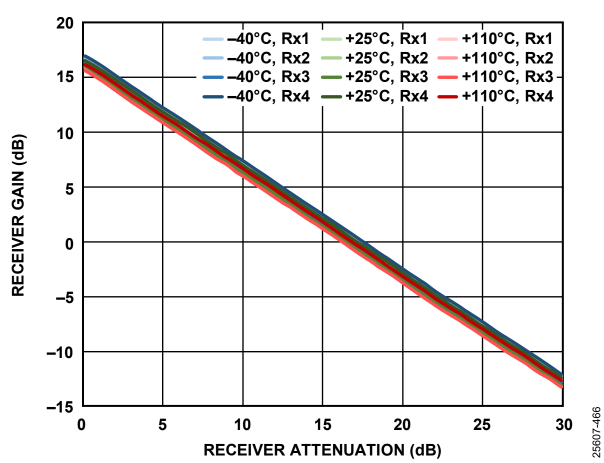

Figure 537. Receiver Gain vs. Receiver Attenuation, 20 MHz Offset, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS

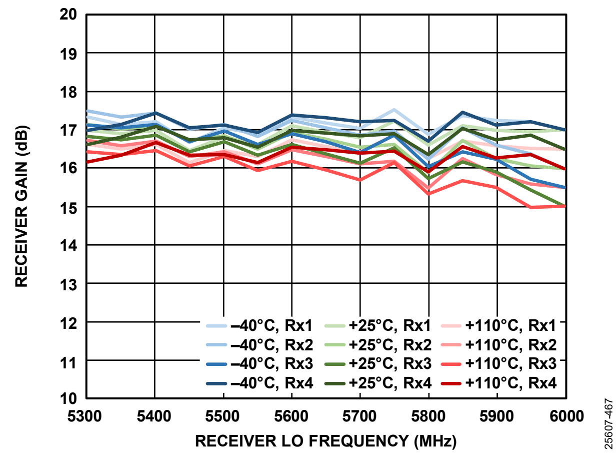

Figure 538. Receiver Gain vs. Receiver LO Frequency, 200 MHz Bandwidth, Sample Rate = 245.76 MSPS

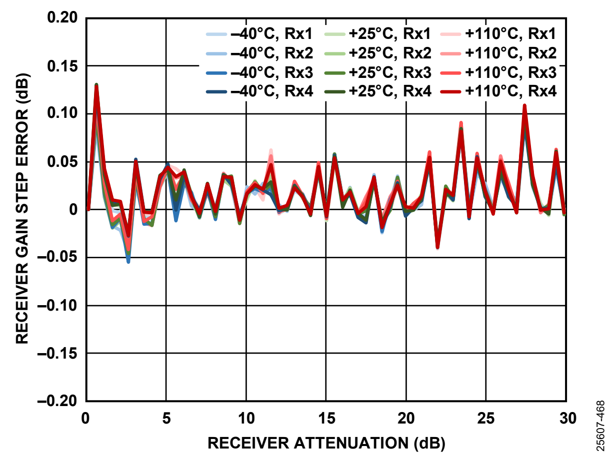

Figure 539. Receiver Gain Step Error vs. Receiver Attenuation, 20 MHz Offset, –5 dBFS Input Signal

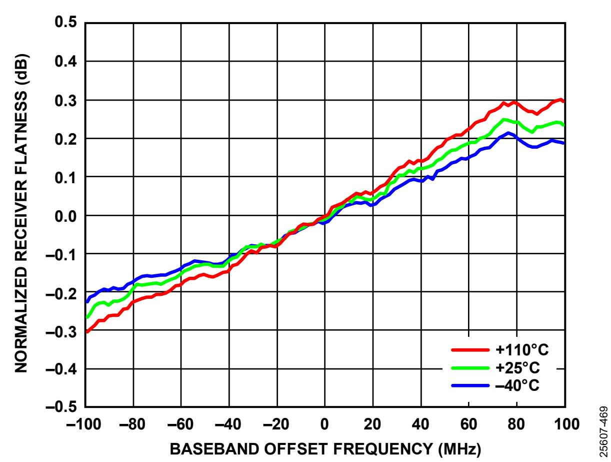

Figure 540. Normalized Receiver Flatness vs. Baseband Offset Frequency, –5 dBFS Input Signal

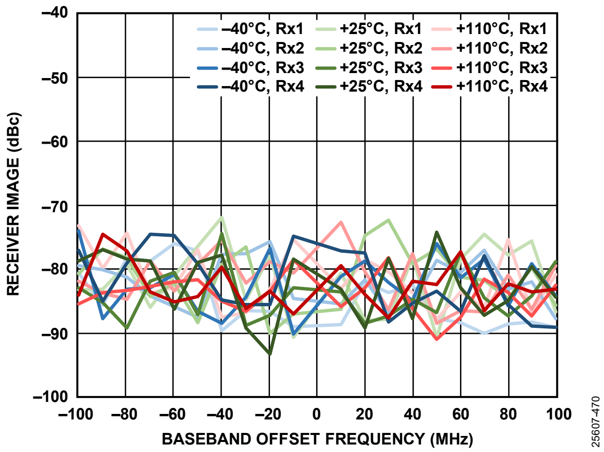

Figure 541. Receiver Image vs. Baseband Offset Frequency, Tracking Calibration Active, Sample Rate = 245.76 MSPS

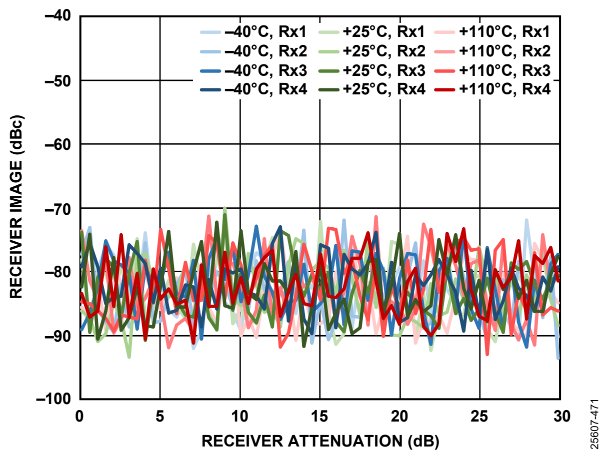

Figure 542. Receiver Image vs. Receiver Attenuation, 20 MHz Offset, Tracking Calibration Active, Sample Rate = 245.76 MSPS

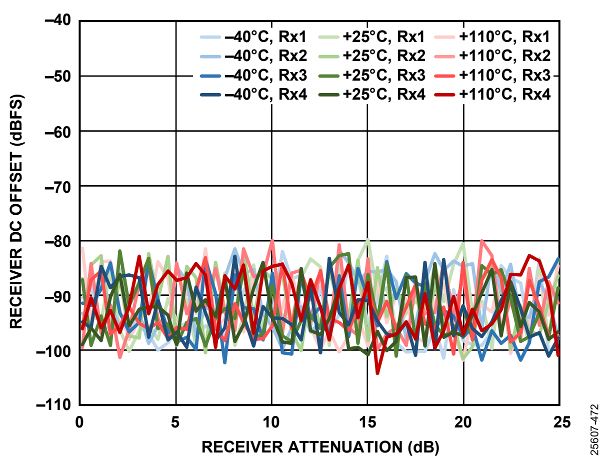

Figure 543. Receiver DC Offset vs. Receiver Attenuation, 20 MHz Offset, –5 dBFS Input Signal, Sample Rate = 245.76 MSPS

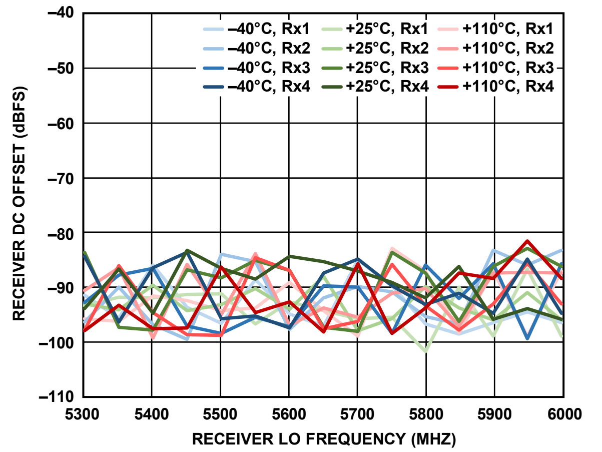

Figure 544. Receiver DC Offset vs. Receiver LO Frequency, Attenuation = 0 dB, Sample Rate = 245.76 MSPS

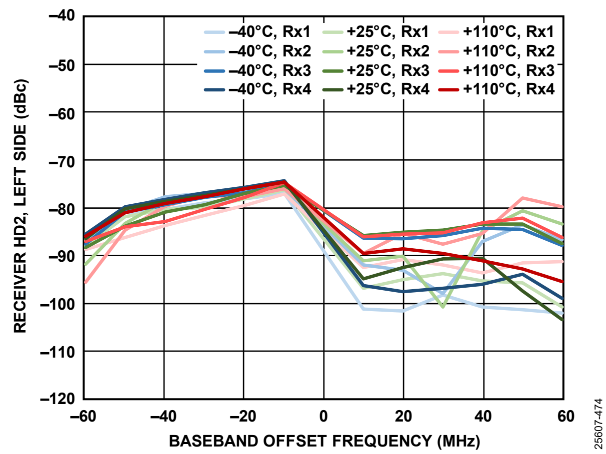

Figure 545. Receiver HD2, Left Side vs. Baseband Offset Frequency, –5 dBFS Input Signal, Distortion Tone Measured Left of 0 Hz (HD2 Canceller Not Enabled)

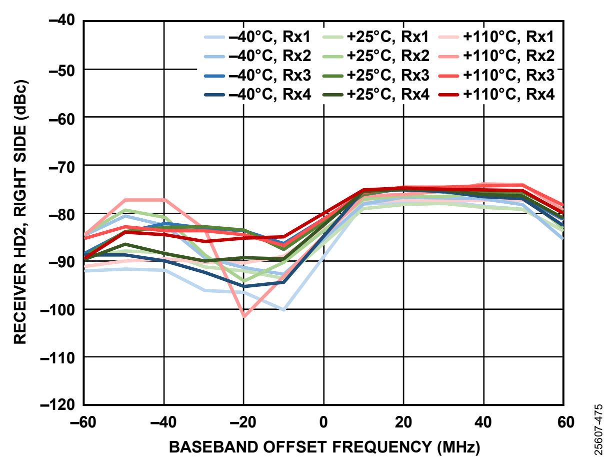

Figure 546. Receiver HD2, Right Side vs. Baseband Offset Frequency, –5 dBFS Input Signal, Distortion Tone Measured Right of 0 Hz (HD2 Canceller Not Enabled)

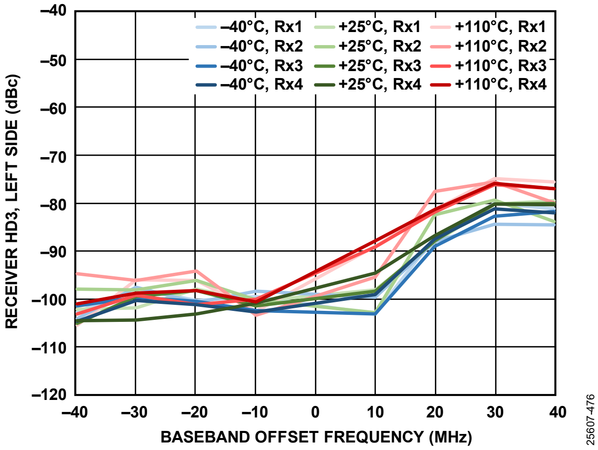

Figure 547. Receiver HD3, Left Side vs. Baseband Offset Frequency, −5 dBFS Input Signal, Distortion Tone Measured Left of 0 Hz

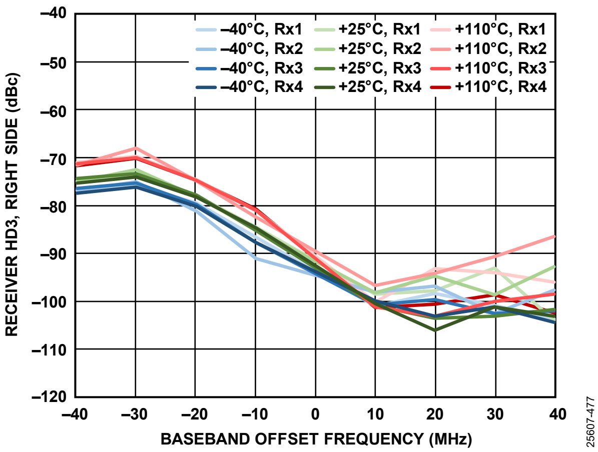

Figure 548. Receiver HD3, Right Side vs. Baseband Offset Frequency, −5 dBFS Input Signal, Distortion Tone Measured Right of 0 Hz

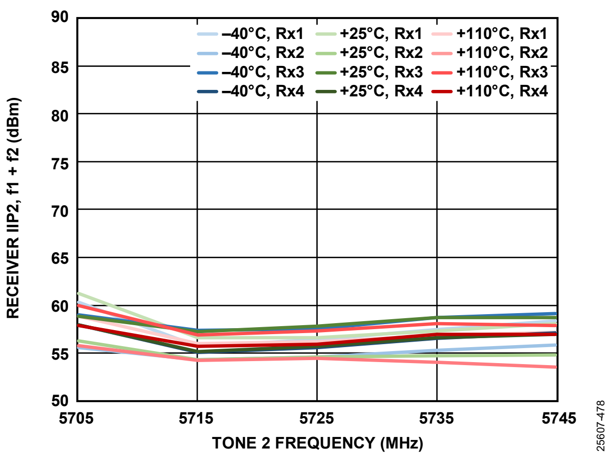

Figure 549. Receiver IIP2, f1 + f2 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

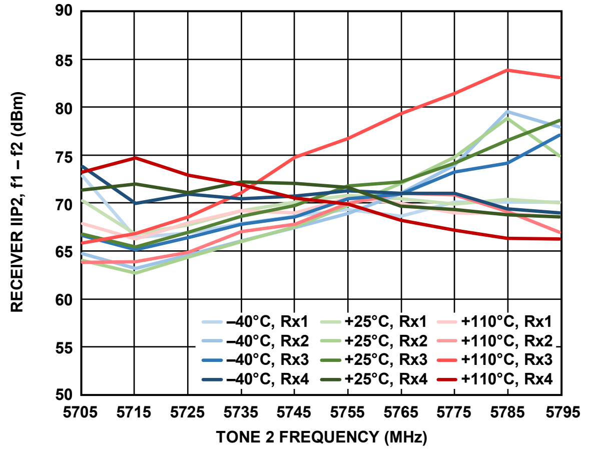

Figure 550. Receiver IIP2, f1 − f2 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

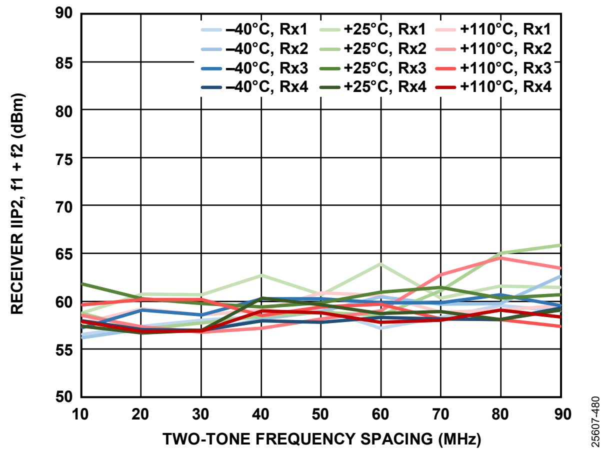

Figure 551. Receiver IIP2, f1 + f2 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

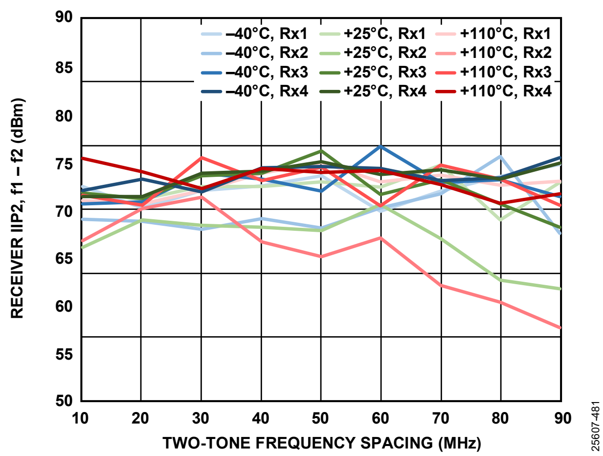

Figure 552. Receiver IIP2, f1 − f2 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

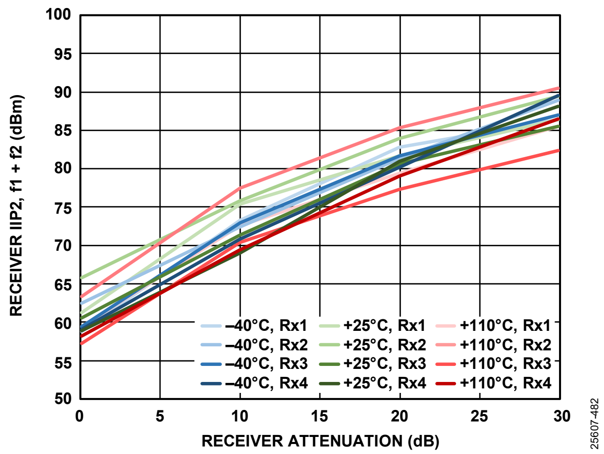

Figure 553. Receiver IIP2, f1 + f2 vs. Receiver Attenuation, Both Tones at −11 dBFS, f1 = 92 MHz, f2 = 2 MHz

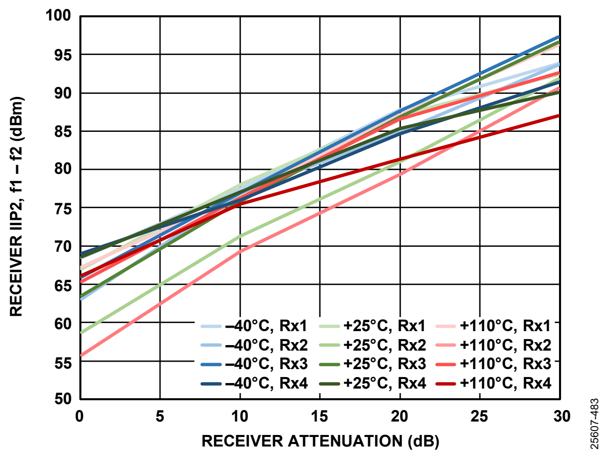

Figure 554. Receiver IIP2, f1 − f2 vs. Receiver Attenuation, Both Tones at −11 dBFS, f1 = 92 MHz, f2 = 2 MHz

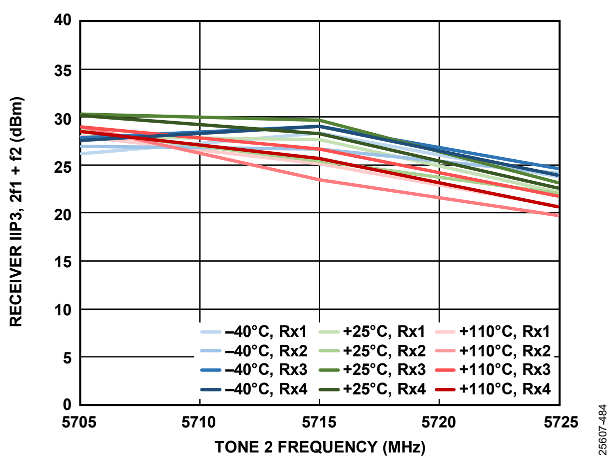

Figure 555. Receiver IIP3, 2f1 + f2 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

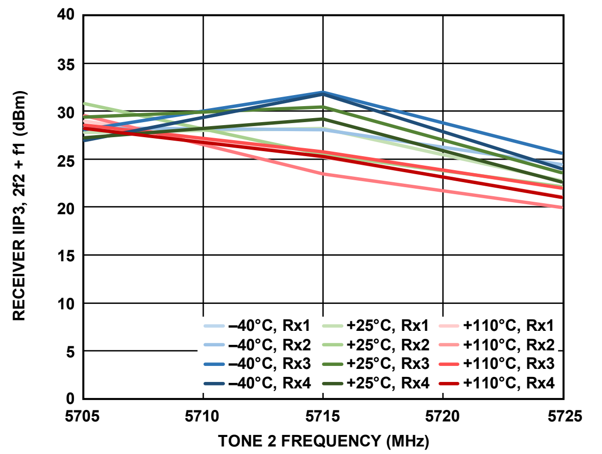

Figure 556. Receiver IIP3, 2f2 + f1 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

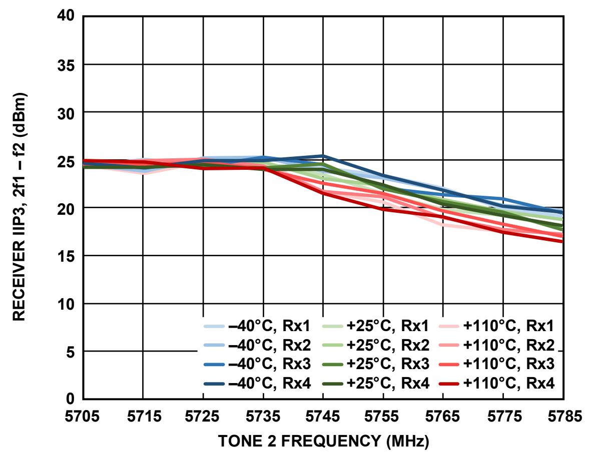

Figure 557. Receiver IIP3, 2f1 − f2 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

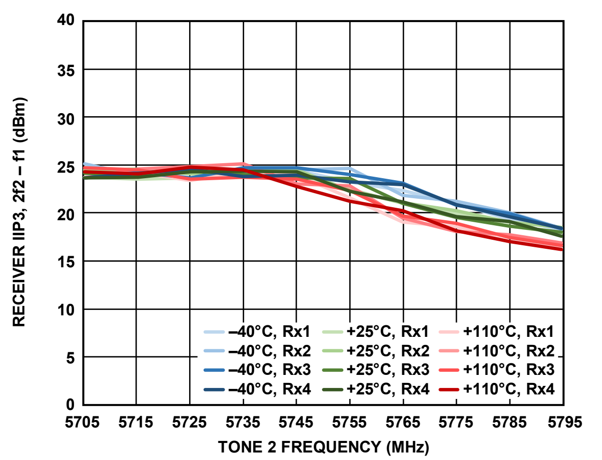

Figure 558. Receiver IIP3, 2f2 − f1 vs. Tone 2 Frequency, Both Tones at −11 dBFS, f1 = f2 + 2 MHz

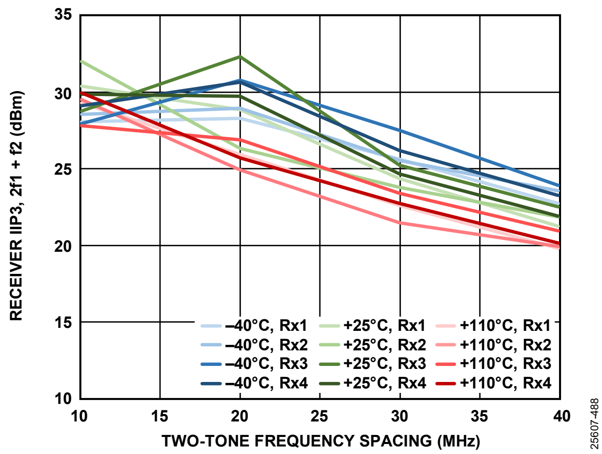

Figure 559. Receiver IIP3, 2f1 + f2 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

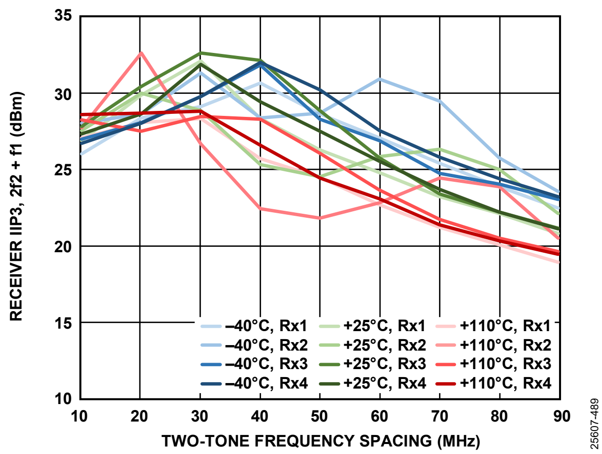

Figure 560. Receiver IIP3, 2f2 + f1 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

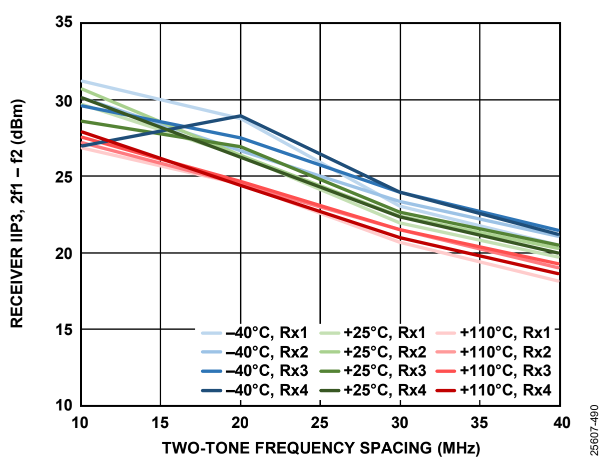

Figure 561. Receiver IIP3, 2f1 − f2 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

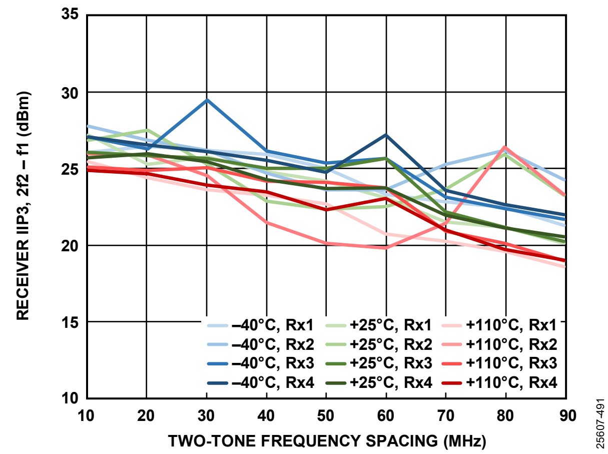

Figure 562. Receiver IIP3, 2f2 − f1 vs. Two-Tone Frequency Spacing, Both Tones at −11 dBFS, f2 = 2 MHz

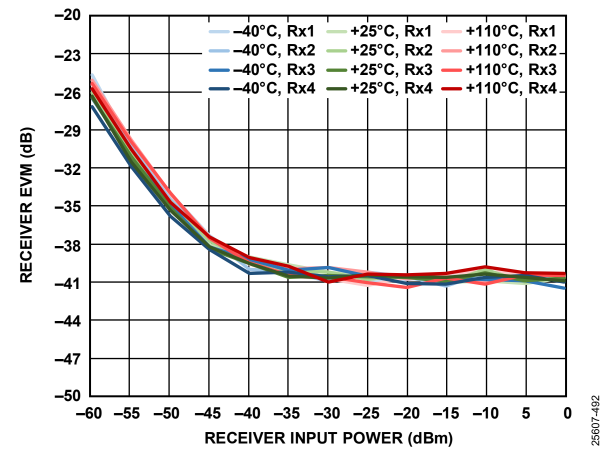

Figure 563. Receiver Error Vector Magnitude vs. Receiver Input Power, 20 MHz LTE Signal Centered at LO Frequency, Sample Rate = 245.76 MSPS, Loop Filter Bandwidth = 400 kHz, Loop Filter Phase Margin = 60°

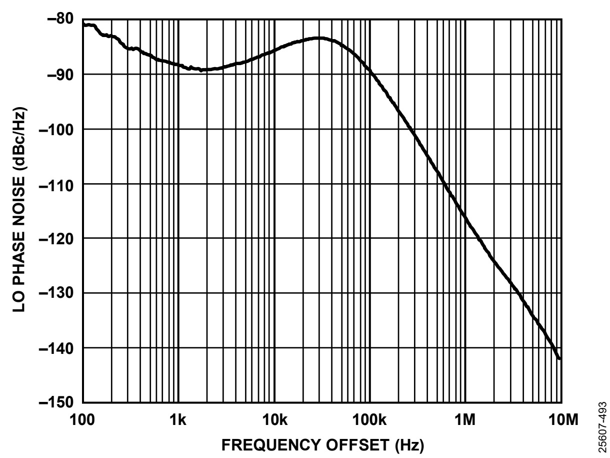

Figure 564. LO Phase Noise vs. Frequency Offset, Loop Bandwidth = 75 kHz, Phase Margin = 85°

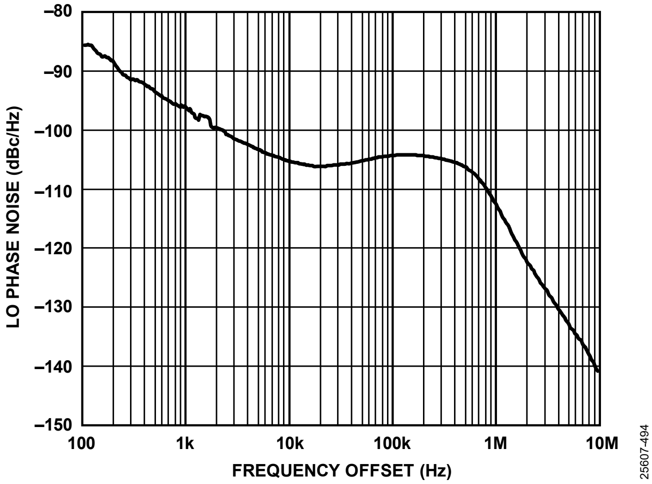

Figure 565. LO Phase Noise vs. Frequency Offset, Loop Bandwidth = 500 kHz, Phase Margin = 60°

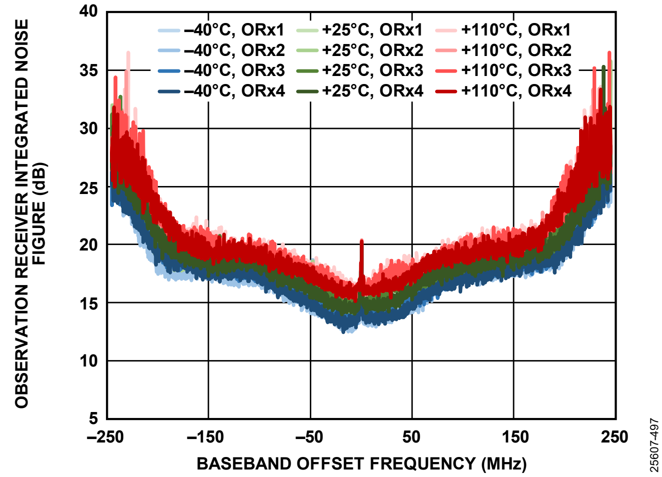

Figure 568. Observation Receiver Integrated Noise Figure vs. Baseband Offset Frequency, 450 MHz Bandwidth, Sample Rate = 491.52 MSPS, Integrated in 200 kHz Steps

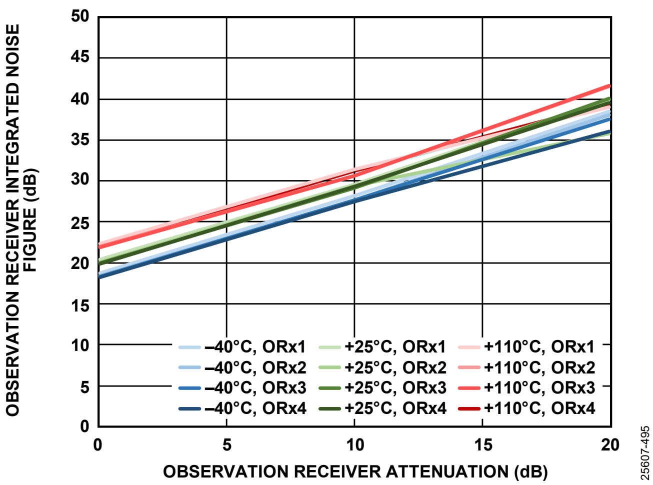

Figure 566. Observation Receiver Integrated Noise Figure vs. Observation Receiver Attenuation, 450 MHz Bandwidth, Sample Rate = 491.52 MSPS, Integration Bandwidth = 500 kHz to 245.76 MHz

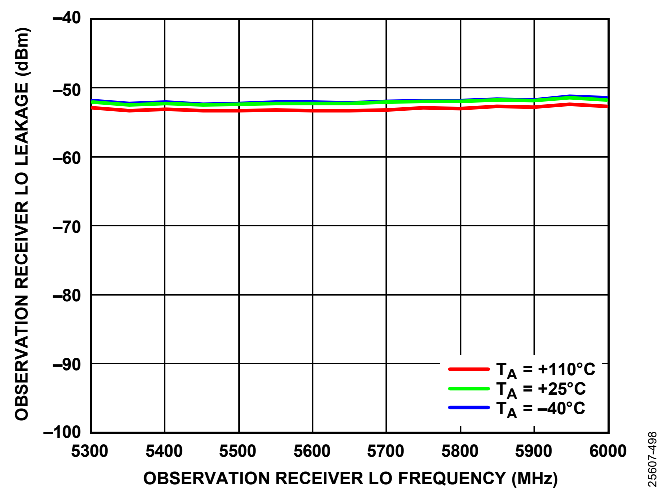

Figure 569. Observation Receiver LO Leakage vs. Observation Receiver LO Frequency, Attenuation = 0 dB, Sample Rate = 491.52 MSPS

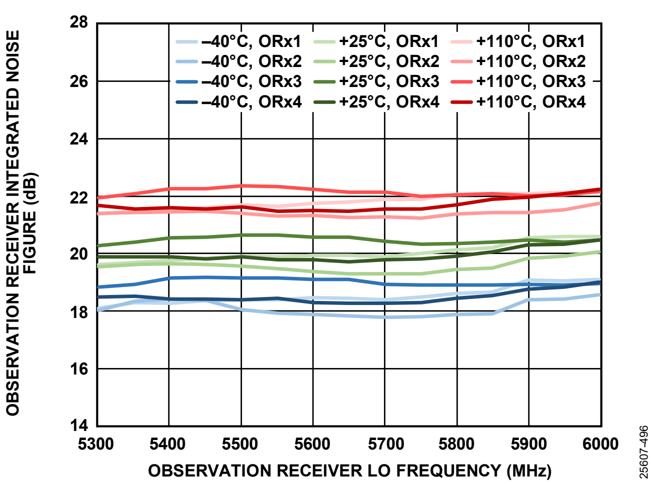

Figure 567. Observation Receiver Integrated Noise Figure vs. Observation Receiver LO Frequency, 450 MHz Bandwidth, Sample Rate = 491.52 MSPS, Integration Bandwidth = 500 kHz to 245.76 MHz

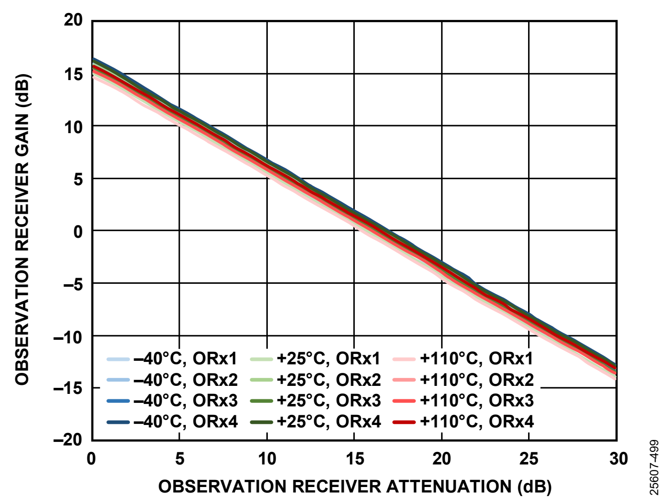

Figure 570. Observation Receiver Gain vs. Observation Receiver Attenuation, 45 MHz Offset, 450 MHz Bandwidth, Sample Rate = 491.52 MSPS

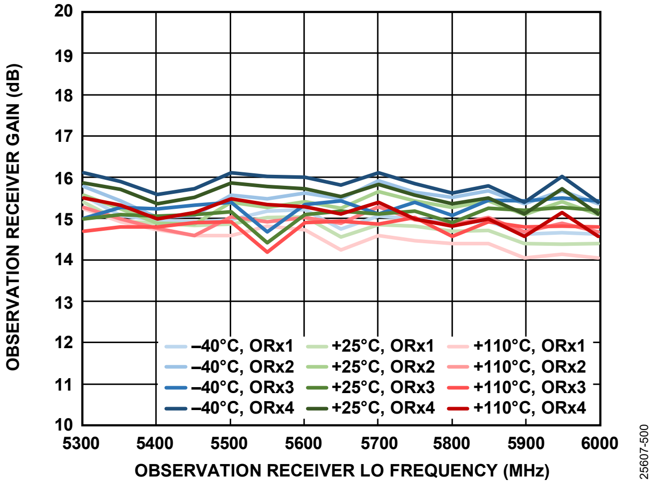

Figure 571. Observation Receiver Gain vs. Observation Receiver LO Frequency, 450 MHz Bandwidth, Sample Rate = 491.52 MSPS

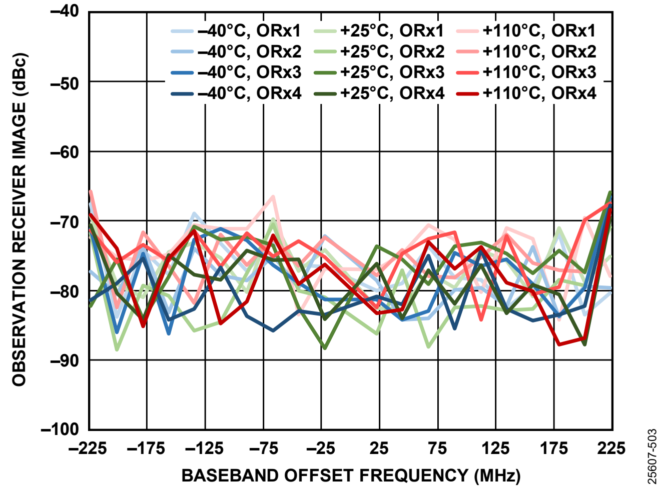

Figure 574. Observation Receiver Image vs. Baseband Offset Frequency, Tracking Calibration Active, Sample Rate = 491.52 MSPS

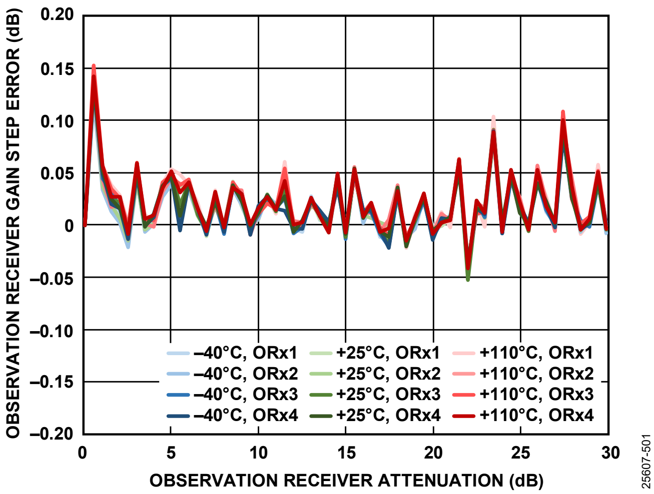

Figure 572. Observation Receiver Gain Step Error vs. Observation Receiver Attenuation, 45 MHz Offset, –10 dBFS Input Signal

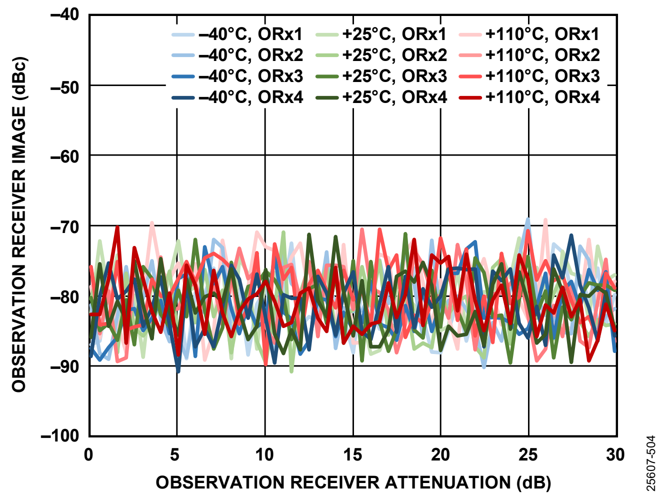

Figure 575. Observation Receiver Image vs. Observation Receiver Attenuation, 20 MHz Offset, Tracking Calibration Active, Sample Rate = 491.52 MSPS

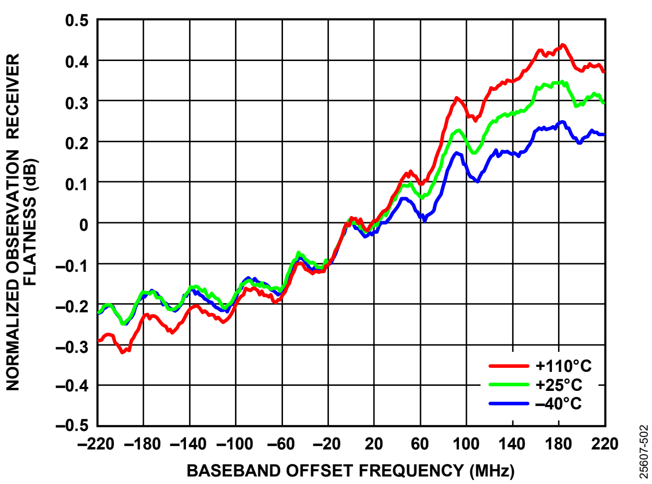

Figure 573. Normalized Observation Receiver Flatness vs. Baseband Offset Frequency, –10 dBFS Input Signal

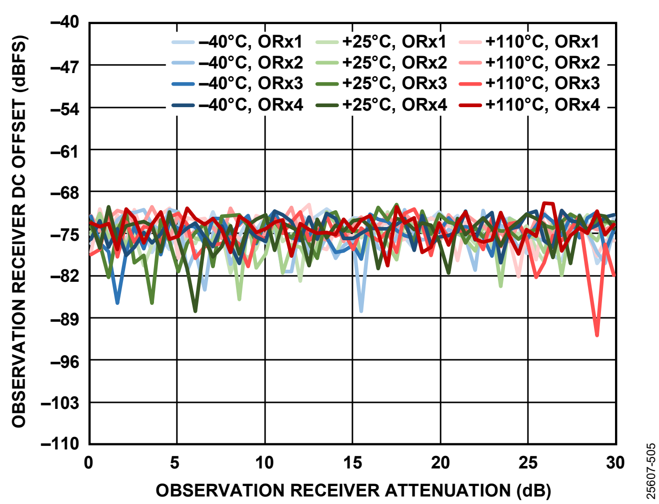

Figure 576. Observation Receiver DC Offset vs. Observation Receiver Attenuation, Sample Rate = 491.52 MSPS

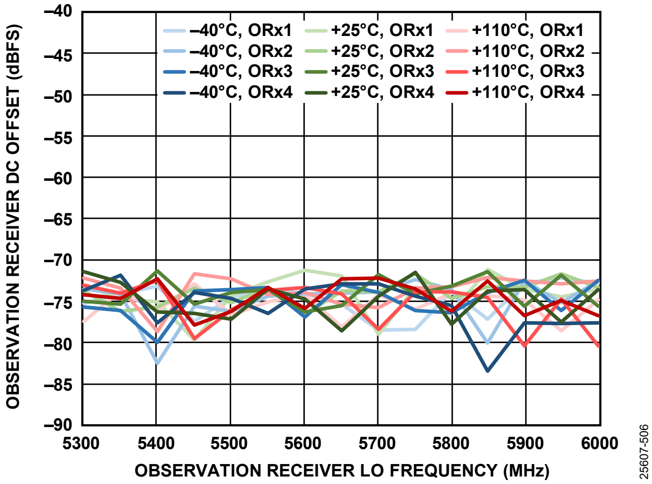

Figure 577. Observation Receiver DC Offset vs. Observation Receiver LO Frequency, Attenuation = 0 dB, Sample Rate = 491.52 MSPS

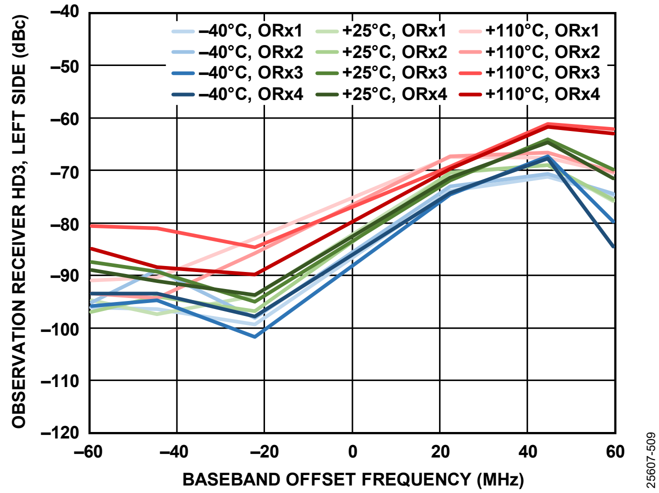

Figure 580. Observation Receiver HD3, Left Side vs. Baseband Offset Frequency, −10 dBFS Input Signal, Distortion Tone Measured Left of 0 Hz

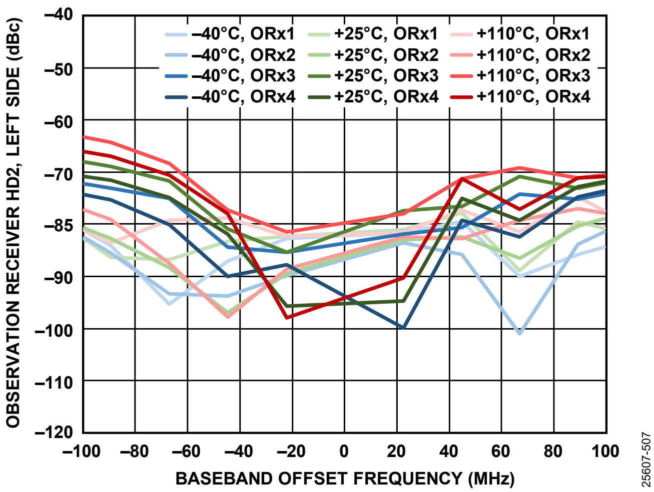

Figure 578. Observation Receiver HD2, Left Side vs. Baseband Offset Frequency, −10 dBFS Input Signal, Distortion Tone Measured Left of 0 Hz

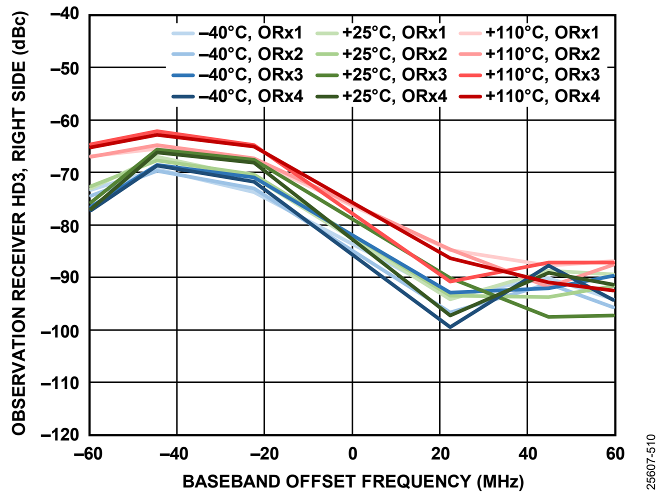

Figure 581. Observation Receiver HD3, Right Side vs. Baseband Offset Frequency, −10 dBFS Input Signal, Distortion Tone Measured Right of 0 Hz

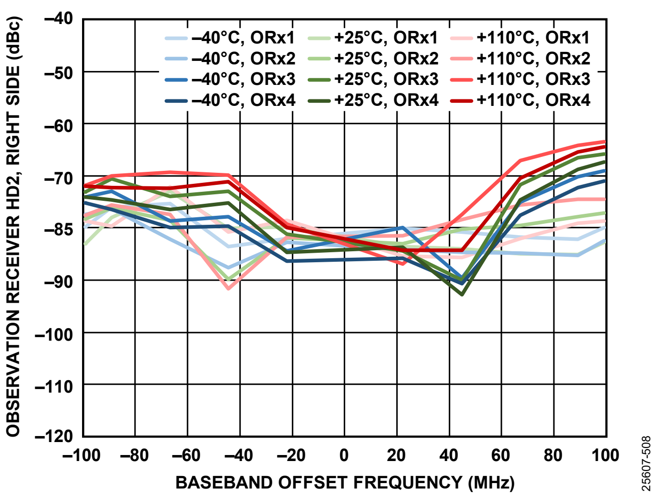

Figure 579. Observation Receiver HD2, Right Side vs. Baseband Offset Frequency, −10 dBFS Input Signal, Distortion Tone Measured Right of 0 Hz

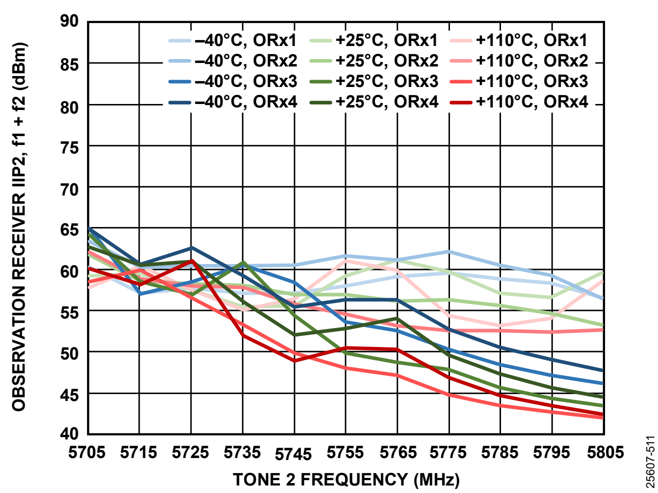

Figure 582. Observation Receiver IIP2, f1 + f2 vs. Tone 2 Frequency, Both Tones at −13 dBFS, f1 = f2 + 2 MHz

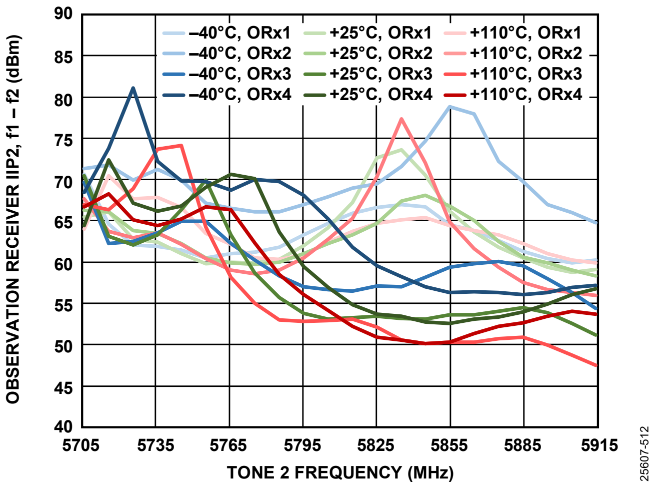

Figure 583. Observation Receiver IIP2, f1 – f2 vs. Tone 2 Frequency, Both Tones at –13 dBFS, f1 = f2 + 2 MHz

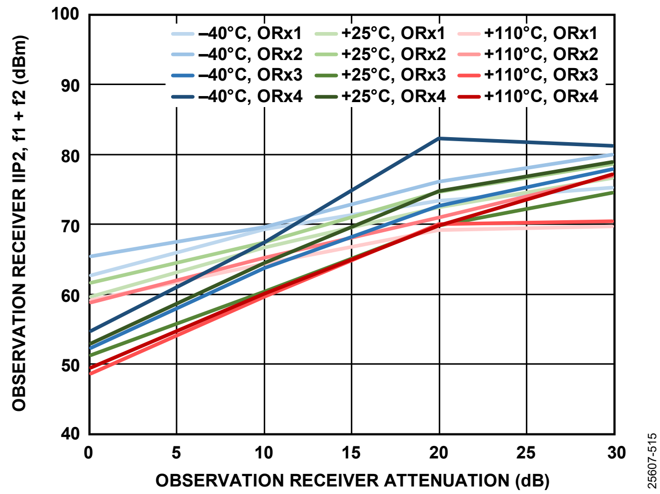

Figure 586. Observation Receiver IIP2, f1 + f2 vs. Observation Receiver Attenuation, Both Tones at –13 dBFS, f1 = 102 MHz, f2 = 2 MHz

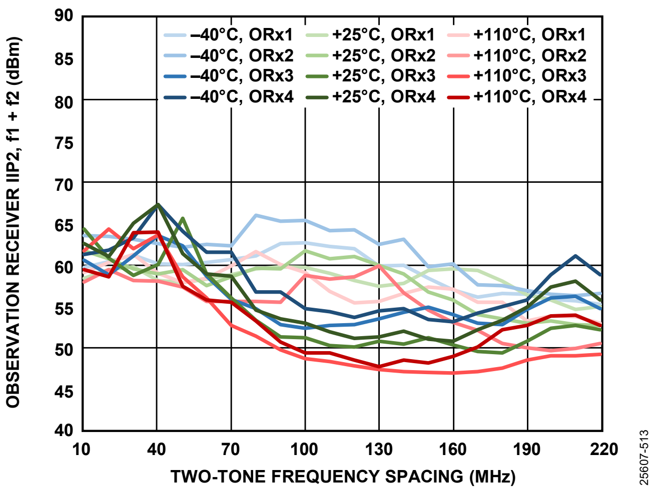

Figure 584. Observation Receiver IIP2, f1 + f2 vs. Two-Tone Frequency Spacing, Both Tones at –13 dBFS, f2 = 2 MHz

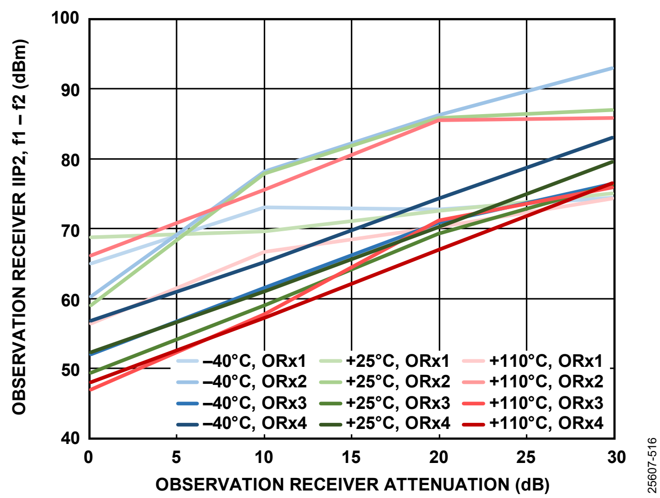

Figure 587. Observation Receiver IIP2, f1 – f2 vs. Observation Receiver Attenuation, Both Tones at –13 dBFS, f1 = 102 MHz, f2 = 2 MHz

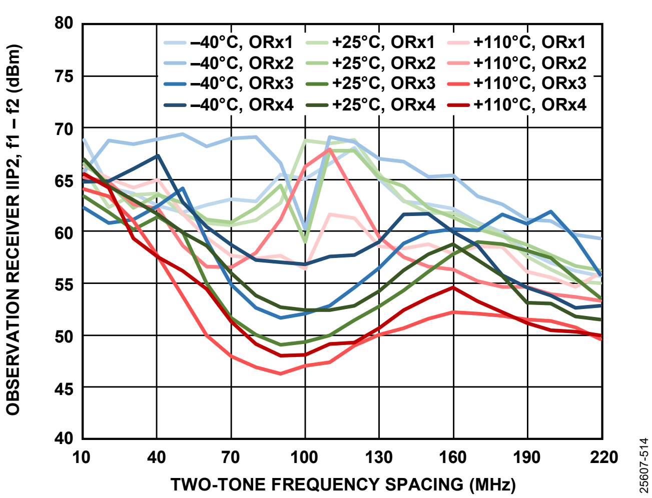

Figure 585. Observation Receiver IIP2, f1 – f2 vs. Two-Tone Frequency Spacing, Both Tones at –13 dBFS, f2 = 2 MHz

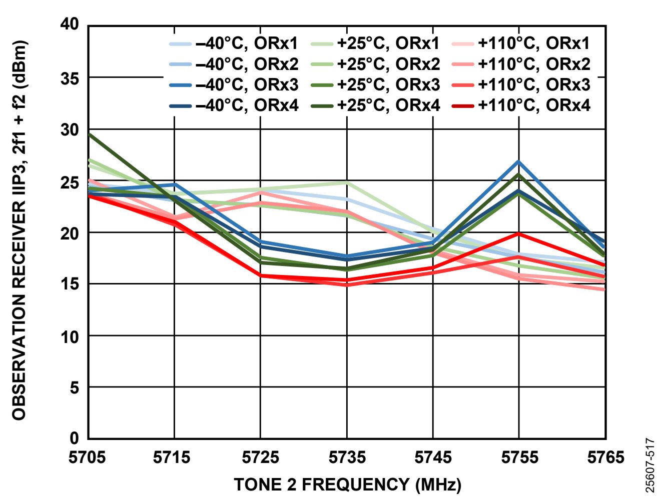

Figure 588. Observation Receiver IIP3, 2f1 + f2 vs. Tone 2 Frequency, Both Tones at –13 dBFS, f1 = f2 + 2 MHz

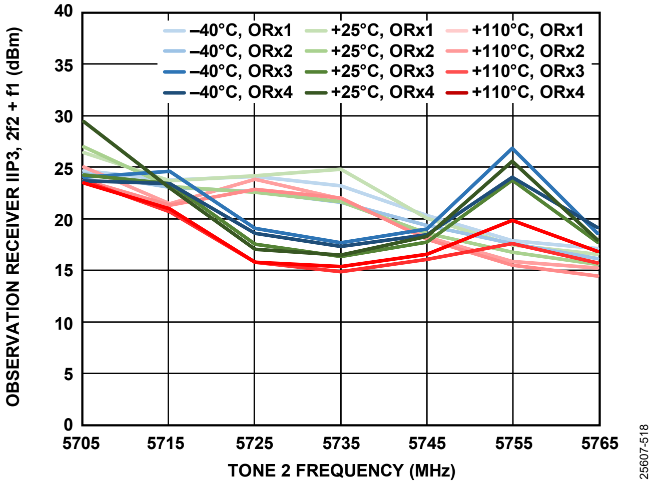

Figure 589. Observation Receiver IIP3, 2f2 + f1 vs. Tone 2 Frequency, Both Tones at −13 dBFS, f1 = f2 + 2 MHz

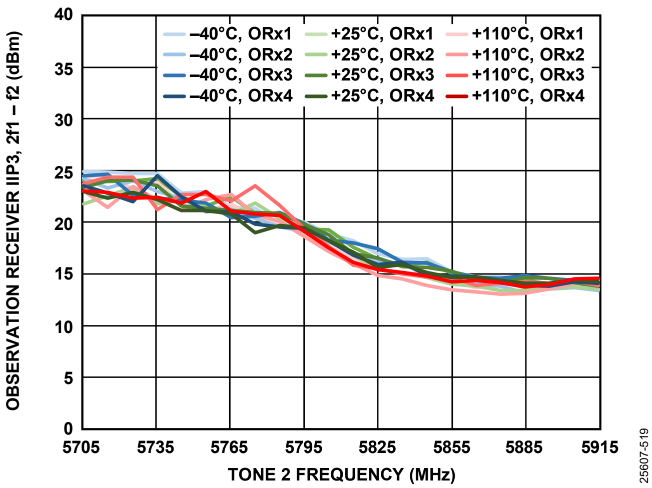

Figure 590. Observation Receiver IIP3, 2f1 − f2 vs. Tone 2 Frequency, Both Tones at −13 dBFS, f1 = f2 + 2 MHz

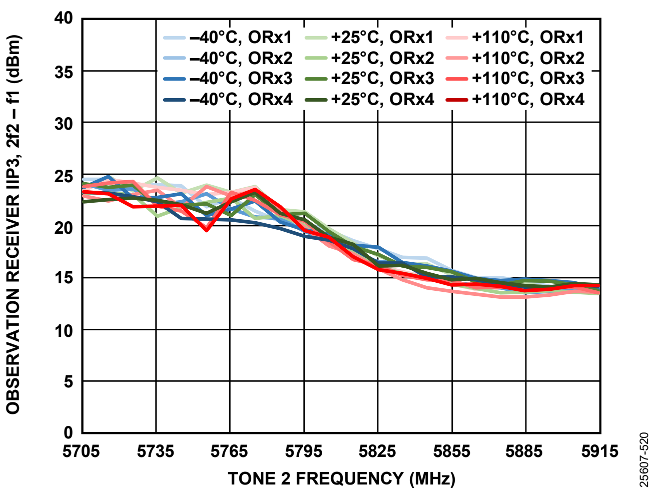

Figure 591. Observation Receiver IIP3, 2f2 − f1 vs. Tone 2 Frequency, Both Tones at −13 dBFS, f1 = f2 + 2 MHz

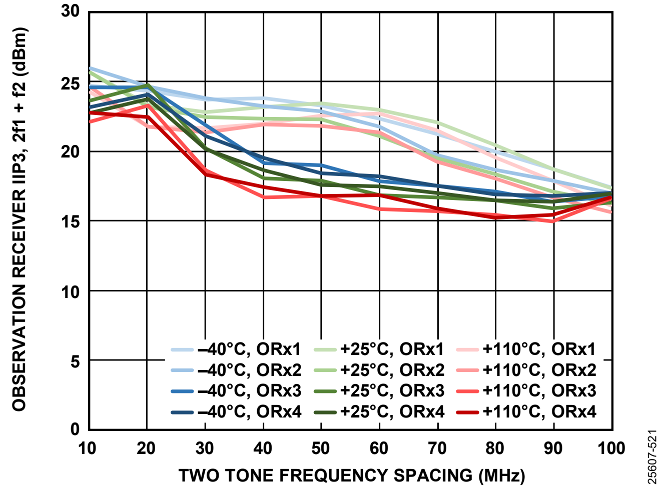

Figure 592. Observation Receiver IIP3, 2f1 + f2 vs. Two-Tone Frequency Spacing, Both Tones at −13 dBFS, f2 = 2 MHz

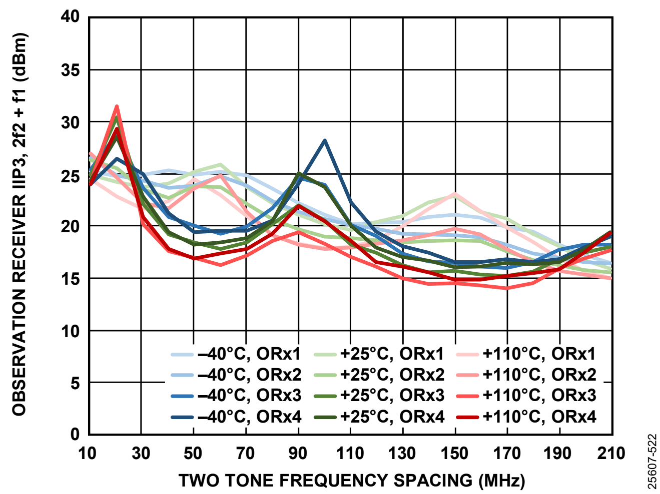

Figure 593. Observation Receiver IIP3, 2f2 + f1 vs. Two-Tone Frequency Spacing, Both Tones at −13 dBFS, f2 = 2 MHz

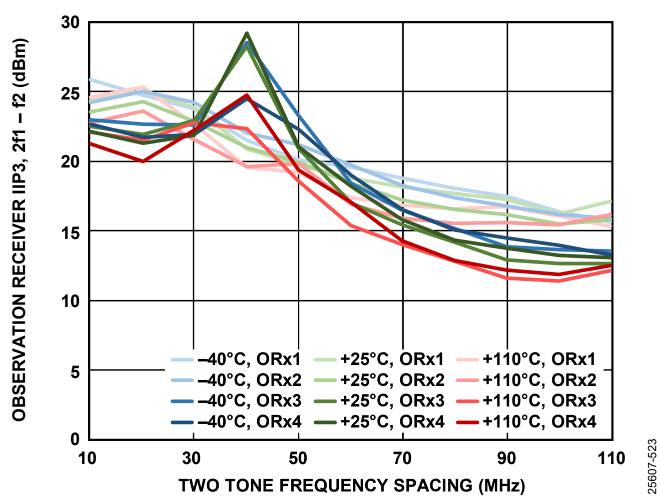

Figure 594. Observation Receiver IIP3, 2f1 − f2 vs. Two-Tone Frequency Spacing, Both Tones at −13 dBFS, f2 = 2 MHz

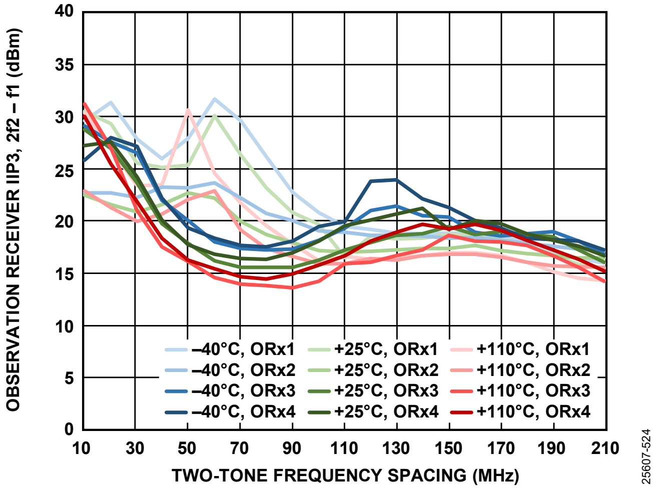

Figure 595. Observation Receiver IIP3, 2f2 – f1 vs. Two-Tone Frequency Spacing, Both Tones at –13 dBFS, f2 = 2 MHz

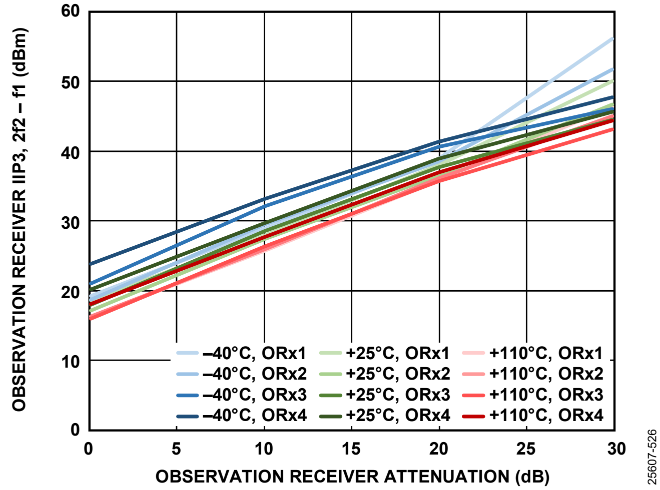

Figure 597. Observation Receiver IIP3, 2f2 – f1 vs. Observation Receiver Attenuation, Both Tones at –13 dBFS, f1 = 122 MHz, f2 = 2 MHz

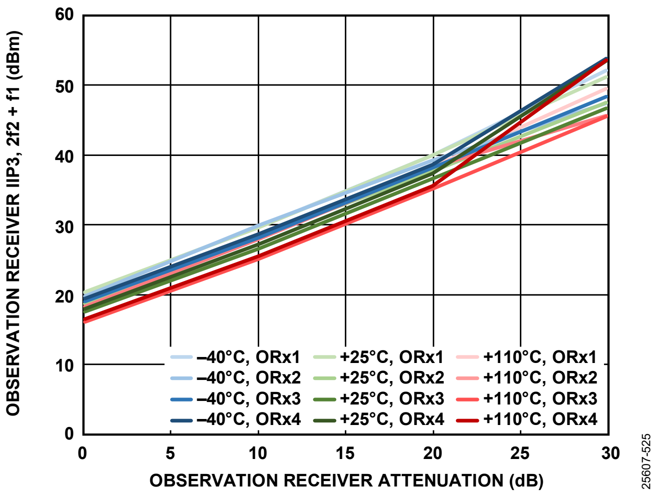

Figure 596. Observation Receiver IIP3, 2f2 + f1 vs. Observation Receiver Attenuation, Both Tones at –13 dBFS, f1 = 122 MHz, f2 = 2 MHz

THEORY OF OPERATION

GENERAL

The ADRV9029 is a highly integrated RF transceiver capable of configuration for a wide range of applications. The device integrates all the RF, mixed-signal, and digital blocks necessary to provide all transmitter, traffic receiver, and observation receiver functions in a single device. Programmability allows the device to be adapted for use in many 3G/4G/5G cellular standards in frequency division duplex (FDD) and time division duplex (TDD) modes.

Four observation receiver channels monitor the transmitter outputs and provide tracking correction of dc offset, quadrature error, and transmitter LO leakage to maintain a high performance level under varying temperatures and input signal conditions. Firmware supplied with the device implements all initialization and calibration with no user interaction. Additionally, the device includes test modes allowing system designers to debug designs during prototyping and to optimize radio configurations.

The ADRV9029 contains four high speed serial interface (SERDES) links for the transmit chain and four high speed links shared by the receiver and observation receiver chains (JESD204B Subclass 1 compliant and supports JESD204C).

TRANSMITTER

The ADRV9029 transmitter section consists of four identical and independently controlled channels that provide all the digital processing, mixed-signal, and RF blocks necessary to implement a direct conversion system while sharing a common frequency synthesizer. The digital data from the SERDES lanes pass through a digital processing block that includes a series of programmable half-band filters, interpolation stages, and FIR filters, including a programmable FIR filter with variable interpolation rates and up to 80 taps. The output of this digital chain is connected to the digital-to-analog converter (DAC). The DAC sample rate is adjustable up to 2.5 GHz. The in-phase (I) and quadrature (Q) channels are identical in each transmitter signal chain.

After conversion to baseband analog signals, the I and Q signals are filtered to remove sampling artifacts and fed to the upconversion mixers. Each transmit chain provides a wide attenuation adjustment range with fine granularity to help designers optimize signal-to-noise ratio (SNR).

RECEIVER

The ADRV9029 provides four independent receiver channels. Each channel contains all the blocks necessary to receive RF signals and convert these signals to digital data usable by a baseband processor. Each receiver can be configured as a direct conversion system that supports up to a bandwidth of 200 MHz. Each channel contains a programmable attenuator stage, followed by matched I and Q mixers that downconvert received signals to baseband for digitization.

Two gain control options are available, as follows:

- Users can implement their own gain control algorithms using their baseband processor to manage manual gain control mode
- Users can use the on-chip automatic gain control (AGC) system.

Performance is optimized by mapping each gain control setting to specific attenuation levels at each adjustable gain block in the receive signal path. Additionally, each channel contains independent receive signal strength indication (RSSI) measurement capability, dc offset tracking, and all the circuitry necessary for self calibration.

The receivers include analog-to-digital converters (ADCs) and adjustable sample rates that produce data streams from the received signals. The signals can be conditioned further by a series of decimation filters and a programmable FIR filter with additional decimation settings. The sample rate of each digital filter block is adjustable by changing decimation factors to produce the desired output data rate. All receiver outputs are connected to the SERDES block, where the data is formatted and serialized for transmission to the baseband processor.

OBSERVATION RECEIVER

The ADRV9029 provides four independent observation receiver inputs. These inputs are similar in implementation to the standard receiver channels in terms of the mixers, ADCs, and filtering blocks. The main difference is that these receivers operate with an observation bandwidth up to 450 MHz, allowing the receivers to receive all the transmitter channel information needed for implementing digital correction algorithms.

Each input is used as the feedback monitor channel for a corresponding transmitter channel. Table 14 shows the possible combinations of transmitter and observation channels.

Table 14. Possible Transmitter-Observation Channel Combinations

Transmitter Channel	Observation Channel
TX1±	ORX1± or ORX2±
TX2±	ORX1± or ORX2±
TX3±	ORX3± or ORX4±
TX4±	ORX3± or ORX4±

CLOCK INPUT

The ADRV9029 requires a differential clock connected to the DEVCLK± pins. The frequency of the clock input must be between 15 MHz and 1000 MHz and must have low phase noise because this signal generates the RF LO and internal sampling clocks.

SYNTHESIZERS

The ADRV9029 contains four fractional-N PLLs to generate the RF LO for the signal paths and all internal clock sources. This group of PLLs includes two RF PLLs for transmit and receive LO generation, an auxiliary PLL that can be used by the observation receivers, and a clock PLL. Each PLL is independently controlled with no need for external components to set frequencies.

RF Synthesizers

The two RF synthesizers use fractional-N PLLs to generate RF LOs for multiple receiver and transmitter channels. The fractional-N PLL incorporates a four-core internal voltage controlled oscillator (VCO) and loop filter, capable of generating low phase noise signals with no external components required. An internal LO multiplexer (mux) enables each PLL to supply LOs to any or all receivers and transmitters (for example, LO1 to all transmitters, LO2 to all receivers), resulting in maximum flexibility when configuring the device for TDD operation. The LOs on multiple devices can be phase synchronized to support active antenna systems and beam forming applications.

Auxiliary Synthesizer

The auxiliary synthesizer uses a single core VCO fractional-N PLL to generate the signals necessary to calibrate the device. The output of this block uses a separate mux system to route LOs for calibrating different functions during initialization. The auxiliary synthesizer can also be used to generate LO signals for the observation receivers or as an offset LO used in the receiver signal chains.

Clock Synthesizer

The ADRV9029 contains a single core VCO fractional-N PLL synthesizer that generates all baseband related clock signals and SERDES clocks. This fractional-N PLL is programmed based on the data rate and sample rate requirements of the system, which typically require the system to operate in integer mode.

For JESD204B configurations with Np = 12 and JESD204C configurations, a dedicated PLL included in the SERDES block generates the SERDES clocks.

SPI INTERFACE

The ADRV9029 uses a SPI to communicate with the baseband processor. This interface can be configured as a 4-wire interface with dedicated receive and transmit ports, or the interface can be configured as a 3-wire interface with a bidirectional data communications port. This bus allows the baseband processor to set all device control parameters using a simple address data serial bus protocol.

Write commands follow a 24-bit format. The first bit sets the bus direction of the bus transfer. The next 15 bits set the address where data is written. The final eight bits are the data being transferred to the specific register address.

Read commands follow a similar format with the exception that the first 16 bits are transferred on the SPI_DIO pin, and the final eight bits are read from the ADRV9029, either on the SPI_DO pin in 4-wire mode or on the SPI_DIO pin in 3-wire mode.

GPIO_X PINS

The ADRV9029 provides 19 general-purpose input/output signals (GPIOs) referenced to VIF that can be configured for numerous functions. When configured as outputs, certain pins can provide real-time signal information to the baseband processor, allowing the baseband processor to determine receiver performance. A pointer register selects what information is output to these pins.

Signals used for manual gain mode, calibration flags, state machine status, and various receiver parameters are among the outputs that can be monitored on the GPIO pins. Additionally, certain GPIO pins can be configured as inputs and used for various functions, such as setting the receiver gain in real time.

AUXILIARY CONVERTERS

GPIO_ANA_x/AUXDAC_x

The ADRV9029 contains eight analog GPIOs (the GPIO_ANA_x pins) that are multiplexed with eight identical auxiliary DACs (AUXDAC_x). The analog GPIO ports can be used to control other analog devices or receive control inputs referenced to the VDDA_1P8 supply. The auxiliary DACs are 12-bit converters capable of supplying up to 10 mA. These outputs are typically used to supply bias current or variable control voltages for other related components with analog control inputs.

AUXADC_x

The ADRV9029 contains two auxiliary ADCs with four total input pins (AUXADC_x). These auxiliary ADCs provide 10-bit monotonic outputs with an input voltage range of 0.05 V to 0.95 V. When enabled, each auxiliary ADC is free running. An application programming interface (API) command latches the ADC output value to a register. The ADRV9029 also contains an ADC that supports a built-in diode-based temperature sensor.

DIGITAL PREDISTORTION (DPD)

The ADRV9029 provides a fully integrated DPD system that linearizes the output of the transmitter power amplifier by altering the digital waveform to compensate for nonlinearities in the power amplifier response. Both the DPD actuator and coefficient calculation engine are integrated within the device. This system uses an ORx channel to monitor the output of the power amplifier and calculates the appropriate predistortion that must be inserted into the transmitter datapath to linearize the output. The integrated DPD capability allows the system to drive the power amplifier closer to saturation, enabling a higher efficiency power amplifier while maintaining linearity. The DPD is optimized for power amplifiers with rms output powers in the 250 mW to 10 W range. The DPD engine is highly configurable and can operate over a range of clock rates, which allows the DPD system to scale so this system can support different carrier configurations within the transmitter bandwidth. The additional power consumed by the DPD block when enabled ranges from 20 mW per channel (minimum bandwidth) to 325 mW per channel (maximum bandwidth).

DPD Improvement Example: 2600 MHz

DPD performance enhancement is shown in Figure 598 for a 20 MHz LTE signal and in Figure 599 for a 100 MHz 5G NR signal. A Band 41 Skyworks SKY66398-11 high efficiency power amplifier was used for both the 20 MHz LTE signal and the 100 MHz 5G NR signal to demonstrate the adjacent channel level reduction (ACLR) improvement for a particular device.

Table 15 and Table 16 show the details of the ACLR improvement achieved for these two scenarios when DPD is activated. Note that the magnitude of improvement in ACLR is heavily dependent on the power amplifier used and generally degrades as signal bandwidth increases.

DPD Improvement Example: 3500 MHz

Performance enhancement is shown in Figure 600 for a 20 MHz LTE signal, in Figure 601 for a 100 MHz 5G NR signal, and in Figure 602 for a 2×, 100 MHz 5G NR signal. An NXP AFSC5G35D37 high efficiency power amplifier was used for the 20 MHz LTE signal, the 100 MHz 5G NR signal, and the 2×, 100 MHz 5G NR signal to demonstrate the ACLR improvement for a particular device.

Table 15, Table 16, and Table 17 show the details of ACLR improvement achieved for these two scenarios when DPD is activated. Note that the magnitude of improvement in ACLR is heavily dependent on the power amplifier used and generally degrades as signal bandwidth increases.

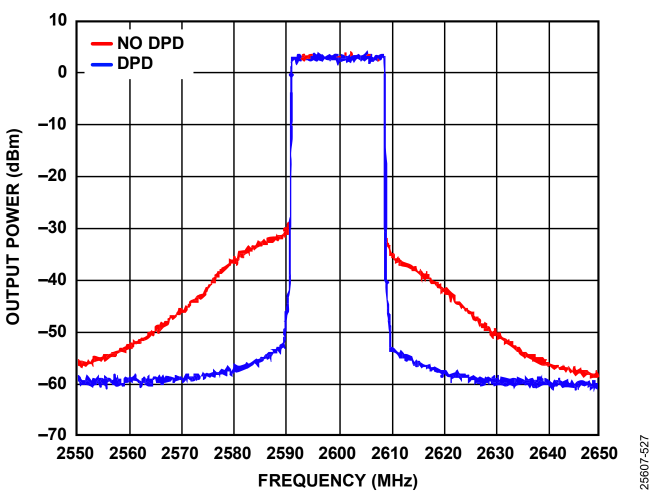

Figure 598. Transmitter Output Spectrum for Normal Operation (Red) and with DPD Activated (Blue) for a 20 MHz LTE Signal, 28 dBm, LO = 2600 MHz, and Resolution Bandwidth (R_{BW}) = 100 kHz

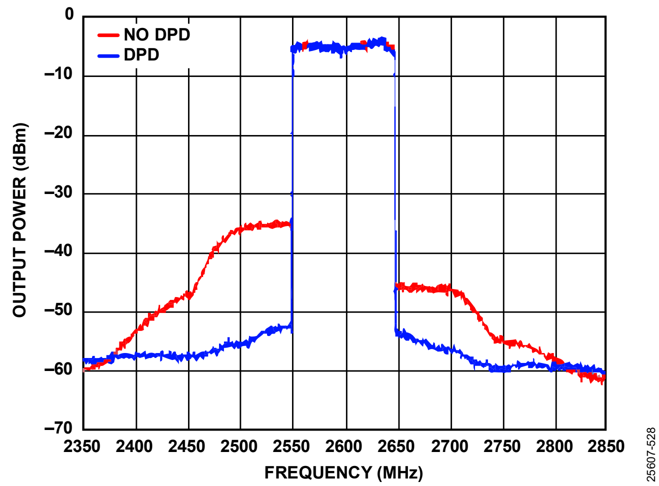

Figure 599. Transmitter Output Spectrum for Normal Operation (Red) and with DPD Activated (Blue) for a 100 MHz, 5G NR100 Waveform, 28 dBm, LO = 2600 MHz, and R_{BW} = 100 kHz

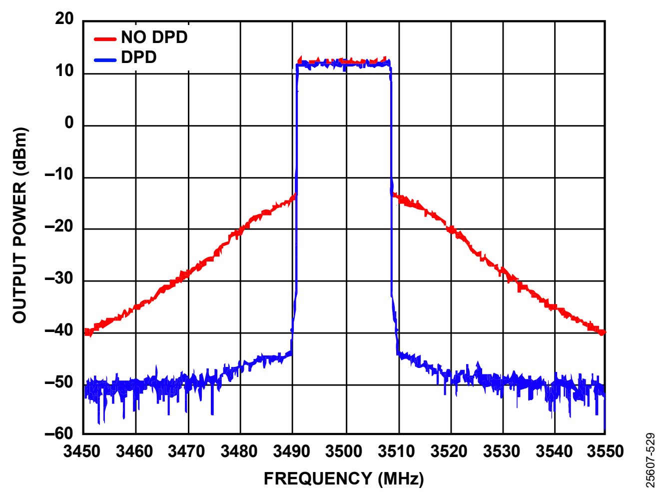

Figure 600. Transmitter Output Spectrum for Normal Operation (Red) and with DPD Activated (Blue) for a 20 MHz LTE Signal, 37 dBm, LO = 3500 MHz, and R_{BW} = 100 kHz

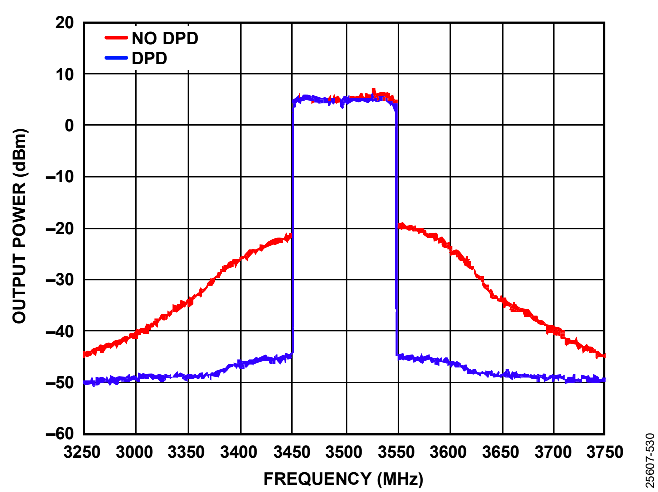

Figure 601. Transmitter Output Spectrum for Normal Operation (Red) and with DPD Activated (Blue) for a 100 MHz, 5G NR100 Waveform, 37 dBm, LO = 3500 MHz, and R_{BW} = 100 kHz

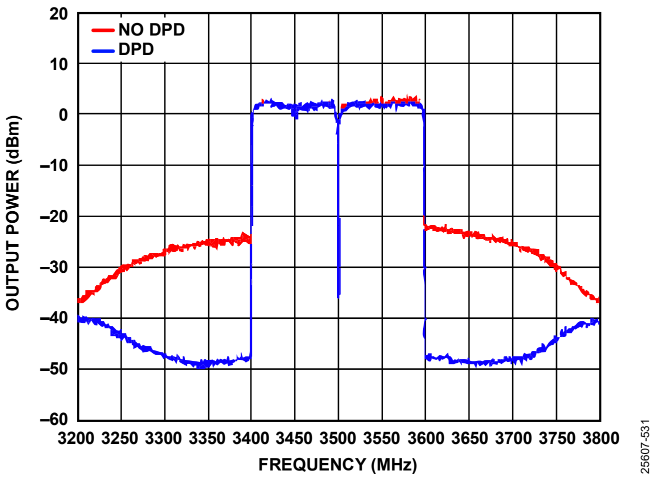

Figure 602. Transmitter Output Spectrum for Normal Operation (Red) and with DPD Activated (Blue) for a 2×, 100 MHz, 5G NR200 Waveform, 37 dBm, LO = 3500 MHz, and R_{BW} = 100 kHz

Table 15. 20 MHz LTE Waveform ACLR Comparison With and Without DPD

	20 MHz Offset (dBc)		40 MHz Offset (dBc)	
Mode[1]	**Lower**	**Upper**	**Lower**	**Upper**
2600 MHz				
Normal Operation	−38.6	−43.5	−54.4	−58.0
DPD Activated	−60.3	−60.5	−63.2	−64.3
3500 MHz				
Normal Operation	−31.9	−31.0	−45.9	−45.5
DPD Activated	−60.7	−59.8	−62.6	−62.0

[1] Waveform is LTE evolved universal terrestrial radio access (E-UTRA) Test Model 3.1 (E-TM 3.1) at 8 dB PAR, with CFR active, 18.015 MHz occupied bandwidth, 28 dBm output at LO = 2600 MHz, and 37 dBm output at LO = 3500 MHz.

Table 16. 100 MHz 5G NR Waveform ACLR Comparison With and Without DPD

	100 MHz Offset (dBc)		200 MHz Offset (dBc)	
Mode[1]	**Lower**	**Upper**	**Lower**	**Upper**
2600 MHz				
Normal Operation	−31.9	−42.0	−46.5	−52.8
DPD Activated	−49.5	−51.0	−52.4	−54.5
3500 MHz				
Normal Operation	−30.8	−28.3	−43.9	−43.5
DPD Activated	−50.9	−50.7	−52.8	−53.1

[1] Waveform is NR-FR1-TM3.1 64 QAM (mu = 1:30 kHz subcarrier spacing) at 8 dB PAR with CFR active, 98.28 MHz occupied bandwidth, 28 dBm output at LO = 2600 MHz, and 37 dBm output at LO = 3500 MHz.

Table 17. 2 × 100 MHz 5G NR Waveform ACLR Comparison With and Without DPD

	200 MHz Offset (dBc)	
Mode[1]	**Lower**	**Upper**
3500 MHz		
Normal Operation	−27.5	−25.3
DPD Activated	−49.0	−48.3

[1] Waveform is two adjacent NR-FR1-TM3.1 64 QAM (mu = 1:30 kHz subcarrier spacing) at 8 dB PAR with CFR active, 196.56 MHz occupied bandwidth, and 37 dBm output.

CREST FACTOR REDUCTION (CFR)

The ADRV9029 includes a low power CFR feature that enables power amplifiers to operate more efficiently. When nonconstant envelope modulation schemes are used, the signal can have a high PAR. The CFR algorithm reduces the PAR, enabling the power amplifier to operate more efficiently while minimizing the impact to signal quality parameters such as EVM and out of band emission levels. System designers can configure the CFR algorithm to ensure these performance parameters are within the system specification limits.

JTAG BOUNDARY SCAN

The ADRV9029 provides support for a JTAG boundary scan. There are five dual function pins associated with the JTAG interface. These pins, listed in Table 18, are used to access the on-chip test access port. To enable the JTAG functionality, set the GPIO_0 pin through the GPIO_2 pin according to Table 19, depending on how the desired JESD204B sync signals are configured in the software (differential or single-ended mode). Pull the TEST_EN pin high to the VIF supply to enable the JTAG mode.

Table 18. Dual Function Boundary Scan Test Pins

Mnemonic	JTAG Mnemonic	Description
GPIO_14	$\overline{\text{TRST}}$	Test access port reset
GPIO_15	TDO	Test data output
GPIO_16	TDI	Test data input
GPIO_17	TMS	Test access port mode select
GPIO_18	TCK	Test clock

Table 19. JTAG Modes

Test Pin Level	GPIO_2 to GPIO_0	Description
0	XXX[1]	Normal operation
1	000	JTAG mode with differential JESD204B sync signals
1	011	JTAG mode with single-ended JESD204B sync signals

[1] X means any combination.

APPLICATIONS INFORMATION

POWER SUPPLY SEQUENCE

The ADRV9029 requires a specific power-up sequence to avoid undesired power-up currents. In the optimal power-up sequence, the VDIG_1P0 supply is activated first. When VDIG_1P0 powers VDDA_1P0, then all 1.0 V supplies can be powered on at the same time.

If VDIG_1P0 is isolated, all VDDA_1P8, VDDA_1P3, and VDDA_1P0 supplies must be powered up after VDIG_1P0 is activated. The VIF supply can be powered up at any time.

It is also recommended prior to configuration to toggle the $\overline{\text{RESET}}$ signal after power has stabilized.

If a power-down sequence is followed, to avoid any back biasing of the digital control lines, remove the VDIG_1P0 supply last. If no sequencing is used, it is recommended to power down all supplies simultaneously.

DATA INTERFACE

The digital data interface for the ADRV9029 implements JEDEC Standard JESD204B Subclass 1 and JESD204C. The serial interface operates at speeds of up to 24,330.24 Mbps. Table 20, Table 21, and Table 22 list example parameters for various JESD interface settings. Other output rates, bandwidth, and number of lanes are also supported for each of the interface rates reported in Table 20, Table 21, and Table 22.

Table 20. Example Receiver Interface Rates with Four Channels Active (M = 8)

Bandwidth (MHz)	Output Rate (MSPS)	JESD Np Parameter	JESD204B F Parameter	JESD204B Lane Rate (Mbps)	JESD204B Number of Lanes	JESD204C F Parameter	JESD204C Lane Rate (Mbps)	JESD204C Number of Lanes
40	61.44	16	16	9830.4	1	16	8110.08	1
60	76.8	16	16	12288	1	16	10137.6	1
100	122.88	16	8	9830.4	2	8	8110.08	2
150	184.32	16	4	7372.8	4	8	12165.12	2
200	245.76	16	4	9830.4	4	4	8110.08	4
200	245.76	12	3	7372.8	4	6	12165.12	2
200	245.76	12	6	14745.6	2	12	24330.24	1

Table 21. Transmitter Interface Rates with Four Channels Active (M = 8)

Primary Signal Bandwidth (MHz)	Total Bandwidth (MHz)	Input Rate (MSPS)	JESD Np Parameter	JESD204B F Parameter	JESD204B Lane Rate (Mbps)	JESD204B Number of Lanes	JESD204C F Parameter	JESD204C Lane Rate (Mbps)	JESD204C Number of Lanes
50	113	122.88	16	8	9830.4	2	8	8110.08	2
75	150	184.32	16	4	7372.8	4	8	12165.12	2
100	225	245.76	16	4	9830.4	4	4	8110.08	4
100	225	245.76	12	3	7372.8	4	6	12165.12	2
200	450	491.52	12	3	14745.6	4	8	24330.24	2

Table 22. Observation Path Interface Rates with 1 Channel Active (M = 2)

Total Bandwidth (MHz)	Output Rate (MSPS)	JESD Np Parameter	JESD204B F Parameter	JESD204B Lane Rate (Mbps)	JESD204B Number of Lanes	JESD204C F Parameter	JESD204C Lane Rate (Mbps)	JESD204C Number of Lanes
150	184.32	16	4	7372.8	1	4	6082.56	1
225	245.76	16	4	9830.4	1	4	8110.08	1
225	245.76	12	3	7372.8	1	3	6082.56	1
250	307.2	16	4	12288	1	4	10137.6	1
300	368.64	16	2	7372.8	2	4	12165.12	1
450	491.52	16	2	9830.4	2	2	8110.08	2
450	491.52	12	3	14745.6	1	4	12165.12	1

OUTLINE DIMENSIONS

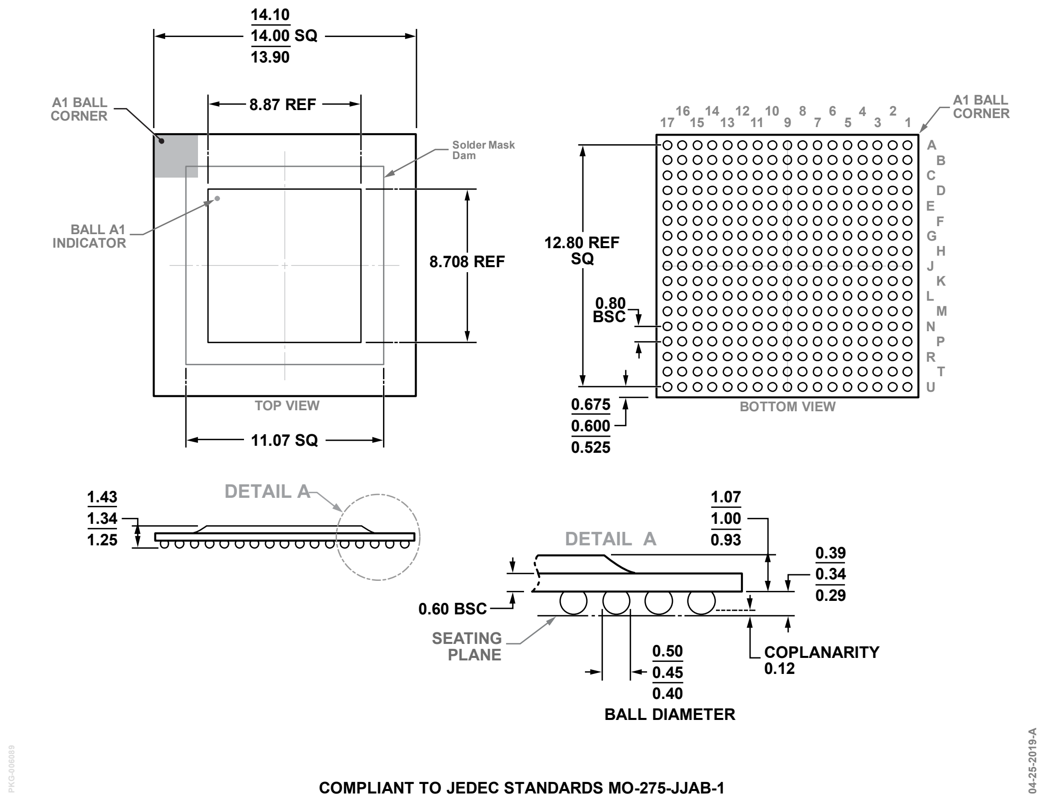

Figure 603. 289-Ball Chip Scale Package Ball Grid Array [CSP_BGA]
(BC-289-6)
Dimensions shown in millimeters

ORDERING GUIDE

Model[1, 2]	Temperature Range[3]	Package Description	Package Option
ADRV9029BBCZ	−40°C to +110°C	289-Ball Chip Scale Package Ball Grid Array [CSP_BGA]	BC-289-6
ADRV9029BBCZ-REEL	−40°C to +110°C	289-Ball Chip Scale Package Ball Grid Array [CSP_BGA]	BC-289-6
ADRV9029-HB/PCBZ		High Band Evaluation Board for 2.8 GHz to 6 GHz	
ADRV9029-MB/PCBZ		Mid Band Evaluation Board for 650 MHz to 2.8 GHz	
ADRV9029-LB/PCBZ		Low Band Evaluation Board for 50 MHz to 1.0 GHz	
ADS9-V2EBZ		ADS9-V2 Motherboard	

[1] Z = RoHS Compliant Part.
[2] The ADS9-V2EBZ motherboard (ordered separately) must be used with the ADRV9029-HB/PCBZ, ADRV9029-MB/PCBZ, or ADRV9020-LB/PCBZ evaluation board.
[3] See the Junction Temperature section.