

DESCRIPTION

This document describes the specifications for the F0502 600MHz to 1000MHz dual path Sampling IF (SIF) Receiver used in Multi-mode, Multi-carrier BaseStation Receivers. Refer to the Part Number# Matrix below describing the frequency coverage of the complete series. This series is offered with high side or low side LO injection options for all UTRA bands and offers significantly better Noise and Distortion performance than currently available solutions. IF frequencies from 60MHz to 275MHz are supported.

The F0502 SIF provides 28.2dB gain and offers 47dB gain adjustment in 1dB steps and is designed to operate with a single 5V supply. Nominally, the device offers +44dBm Output IP3 using 480mA of I_{CC}. Alternately one can configure the device in low current (LC) mode to reduce power consumption to less than 1.95 watts.

This device is packaged in a 10x10 68-pin TQFN with 50Ω single-ended RF input and 200Ω differential IF output impedances for ease of integration into the receiver lineup. The 200Ω differential IF output can easily be matched to 100Ω differential per the application drawing.

COMPETITIVE ADVANTAGE

Renesas' Zero-Distortion™ mixer in combination with interstage filtering and Renesas' proprietary FlatNoise™ DVGA improves system SNR to the point where the external SAW filter can be eliminated. Both IP_{3o} and NF are kept virtually flat while gain is backed off, enhancing SNR significantly under high level interferer conditions, and greatly benefiting 2G/3G/4G Multi-Carrier IF sampling receivers. In addition, total power consumption is reduced by 35% compared to conventional solutions.

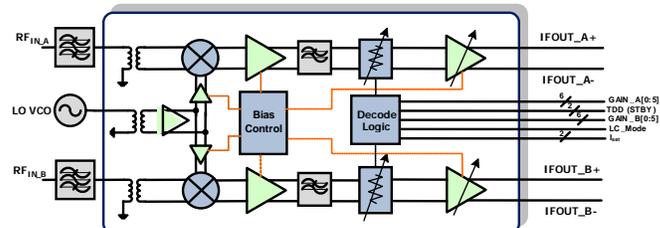
- ✓ No external SAW is needed
- ✓ Reduced Power Consumption by 35%
- ✓ NF and OIP3 virtually flat for first 13dB gain reduction

The fast-settling, parallel mode gain step of 1.0 dB coupled with the excellent differential non-linearity allow for SNR to be maximized further by targeting the minimum necessary gain in small, accurate increments. The matched output does not require a terminating resistor, thus the gain and distortion performance are preserved when driving Bandpass Anti-Alias filters.

FEATURES

- Dual Channel for Diversity / MIMO Systems
- Combines FlatNoise™ and Zero-Distortion™ technology
- 28.2dB Total Power Gain
- 47dB gain control range
- 1dB Gain Steps
- Ultra linear +44dBm IP_{3o}
- Low NF: 9.6dB at G_{MAX}
- 50Ω input impedance
- Matched 100Ω differential output impedance
- Ultra high +20.2dBm P1dB_o
- Independent path standby mode
- Constant LO impedance in STBY mode
- 6 bit parallel control
- 60MHz to 275MHz IF frequency range
- Excellent 2nd Harmonic Rejection
- I_{CC} = 480mA STD Mode, 390mA LC Mode
- 10 x 10 mm 68-pin VFQFPN package

DEVICE BLOCK DIAGRAM



PART NUMBER# MATRIX

| Part# | RF Freq Range (MHz) | UTRA bands | IF Freq Range (MHz) | Typ. Gain (dB) | Injection |
|-------|---------------------|--------------------------------------|---------------------|----------------|-----------------|
| F0502 | 600 - 1000 | 5,6,8,12,13,14,17,18,19,20 | 60 - 275 | 28.2 | Low & High Side |
| F0552 | 1710 - 2050 | 1,2,3,4,9,10,23,25,33,34,35,36,37,39 | 60 - 450 | 29 | Low & High Side |
| F0562 | 2300 - 2700 | 7,38,40,41 | 60 - 450 | 29 | Low & High Side |

Table of Contents

| | |
|--|----|
| Absolute Maximum Ratings | 3 |
| F0502 Recommended Operating Conditions | 5 |
| F0502 Specification..... | 6 |
| Typical Operating Conditions (184 MHz IF Center)..... | 9 |
| TOCs [Max Gain, STD Mode, IF = 184MHz +/- 40MHz] Gain, OIP3, OIP2 (-1-)..... | 10 |
| TOCs [Max Gain, STD Mode, IF = 184MHz +/- 40MHz] 2x2, L-I, DC Current (-2-)..... | 11 |
| TOCs [Swept Gain, STD Mode, IF = 184MHz, HS Injection] Gain, OIP3, IIP3 (-3-) | 12 |
| TOCs [Swept Gain, STD Mode, IF = 184MHz, HS Injection] OIP2, IIP2, 2x2 (-4-)..... | 13 |
| TOCs [Swept Gain, STD Mode, IF = 184MHz, HS Injection] 3x3, L-I, R-I (-5-)..... | 14 |
| TOCs [Swept Gain, <i>LC Mode</i> , RF=900MHz, IF = 184MHz, HS Injection] Gain, OIP3, IIP3 (-6-)..... | 15 |
| TOCs [Swept Gain, <i>LC Mode</i> , RF=900MHz, IF = 184MHz, HS Injection] OIP2, Chan Iso, 2x2 (-7-) | 16 |
| TOCs [Swept Gain, <i>LC Mode</i> , RF=900MHz, IF = 184MHz, HS Inj] 3x3, L-I, DC Current, R-I (-8-) | 17 |
| Typical Operating Conditions [276 MHz IF Center]..... | 18 |
| TOCs [Swept Gain, STD Mode, IF = 276MHz, HS Injection] Gain, OIP3, OIP2 (-9-) | 19 |
| TOCs [Swept Gain, STD Mode, IF = 276MHz, HS Injection] 2x2, 3x3, Current, R-I, ISO (-10-) | 20 |
| Typical Operating Conditions (80 MHz IF Center)..... | 21 |
| TOCs [Swept Gain, STD Mode, IF = 80MHz, HS Injection] Gain, OIP3, OIP2 (-11-) | 22 |
| TOCs [Swept Gain, STD Mode, IF = 80MHz, HS Injection] 2x2, 3x3, Current, R-I, ISO (-12-)..... | 23 |
| TOCs Return Loss [STD Mode] (-13-) | 24 |
| TOCs Noise Figure, Gain Accuracy, P1dB [STD Mode] (-14-) | 25 |
| TOCs M x N Spurs [LO = 1.08182 GHz, T _{CASE} = 25C, > -90 dBc] (-15-)..... | 26 |
| TOCs Histograms [N= 4584, T _{CASE} = 25C] (-16-) | 27 |
| Package Outline Drawings..... | 28 |
| Pin Diagram | 28 |
| Pin Description | 29 |
| Pin Description (continued) | 30 |
| Digital Pin Voltage and Resistance Values | 31 |
| EVKIT and Typical Application Schematic | 33 |
| EVkit Picture | 34 |
| | 34 |
| BOM 1 and 2..... | 35 |
| IF Bias and Output Matching Circuit and BOM for Various IFs..... | 36 |
| IF Network BOM for different frequencies | 37 |
| Top Marking..... | 37 |
| Ordering Information..... | 37 |
| Revision History..... | 37 |

ABSOLUTE MAXIMUM RATINGS

| Parameter / Condition | Symbol | Min | Max | Unit |
|--|---------------------|------|------------------------|------|
| Vcc to GND | V _{CC} | -0.3 | +5.5 | V |
| A[5:0], B[5:0], TDD_A, TDD_B, LCMode | V _{CNTL} | -0.3 | V _{CC} + 0.25 | V |
| MX_IFA+, MX_IFA-, MX_IFB+, MX_IFB- | V _{MX} | -0.3 | V _{CC} + 0.25 | V |
| IFOUT_A+, IFOUT_A-, IFOUT_B+, IFOUT_B- | V _{IF} | +1 | V _{CC} + 0.3 | V |
| LO1_ADJ | V _{LO1ADJ} | +1 | +3 | V |
| LO2_ADJ | V _{LO2ADJ} | +2.1 | +4 | V |
| MX_IF_BiasA, MX_IF_BiasB | V _{BIAS} | -0.3 | +0.3 | V |
| ISET_A, ISET_B to GND | V _{ISET} | -0.3 | +2.2 | V |
| LO_IN, RFIN_A, RFIN_B | V _{RF} | -0.3 | +0.3 | V |
| RF Input Power (RFIN_A, RFIN_B) | P _{RFMAX} | | +20 | dBm |
| LO Input Power (LO_IN) | P _{LOMAX} | | +20 | dBm |
| Continuous Power Dissipation | P _{DISS} | | 3 | W |
| Operating Case Temperature (T _c) | T _{OP} | -40 | +105 | °C |
| Maximum Junction Temperature | T _{Jmax} | | +150 | °C |
| Storage Temperature Range | T _{ST} | -65 | +150 | °C |
| Lead Temperature (soldering, 10s) | T _{LEAD} | | +260 | °C |
| ESD Voltage– HBM (Per JESD22-A114) | V _{ESDHBM} | | Class 1C (1000V) | |
| ESD Voltage – CDM (Per JESD22-C101) | V _{ESDCDM} | | Class III (500V) | |

Stresses above those listed above may cause permanent damage to the device. Functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

PACKAGE THERMAL AND MOISTURE CHARACTERISTICS

| | |
|---|--------|
| θ_{JA} (Junction – Ambient) | 25°C/W |
| θ_{JC} (Junction – Case) The Case is defined as the exposed paddle | 3°C /W |
| Moisture Sensitivity Rating (Per J-STD-020) | MSL 3 |

Truth Table – Channel A & B

| Gain Set Target | Gain CodeWord | Code Name | Gain Set Target | Gain CodeWord | Code Name | Gain Set Target | Gain CodeWord | Code Name |
|-----------------|---------------|-----------------|-----------------|---------------|------------------|-----------------|---------------|------------------|
| 27 | 000000 | G ₂₇ | 5 | 010110 | G ₅ | -17 | 101100 | G ₋₁₇ |
| 26 | 000001 | G ₂₆ | 4 | 010111 | G ₄ | -18 | 101101 | G ₋₁₈ |
| 25 | 000010 | G ₂₅ | 3 | 011000 | G ₃ | -19 | 101110 | G ₋₁₉ |
| 24 | 000011 | G ₂₄ | 2 | 011001 | G ₂ | -20 | 101111 | G ₋₂₀ |
| 23 | 000100 | G ₂₃ | 1 | 011010 | G ₁ | -20 | 110000 | G ₋₂₀ |
| 22 | 000101 | G ₂₂ | 0 | 011011 | G ₀ | -20 | 110001 | G ₋₂₀ |
| 21 | 000110 | G ₂₁ | -1 | 011100 | G ₋₁ | -20 | 110010 | G ₋₂₀ |
| 20 | 000111 | G ₂₀ | -2 | 011101 | G ₋₂ | -20 | 110011 | G ₋₂₀ |
| 19 | 001000 | G ₁₉ | -3 | 011110 | G ₋₃ | -20 | 110100 | G ₋₂₀ |
| 18 | 001001 | G ₁₈ | -4 | 011111 | G ₋₄ | -20 | 110101 | G ₋₂₀ |
| 17 | 001010 | G ₁₇ | -5 | 100000 | G ₋₅ | -20 | 110110 | G ₋₂₀ |
| 16 | 001011 | G ₁₆ | -6 | 100001 | G ₋₆ | -20 | 110111 | G ₋₂₀ |
| 15 | 001100 | G ₁₅ | -7 | 100010 | G ₋₇ | -20 | 111000 | G ₋₂₀ |
| 14 | 001101 | G ₁₄ | -8 | 100011 | G ₋₈ | -20 | 111001 | G ₋₂₀ |
| 13 | 001110 | G ₁₃ | -9 | 100100 | G ₋₉ | -20 | 111010 | G ₋₂₀ |
| 12 | 001111 | G ₁₂ | -10 | 100101 | G ₋₁₀ | -20 | 111011 | G ₋₂₀ |
| 11 | 010000 | G ₁₁ | -11 | 100110 | G ₋₁₁ | -20 | 111100 | G ₋₂₀ |
| 10 | 010001 | G ₁₀ | -12 | 100111 | G ₋₁₂ | -20 | 111101 | G ₋₂₀ |
| 9 | 010010 | G ₉ | -13 | 101000 | G ₋₁₃ | -20 | 111110 | G ₋₂₀ |
| 8 | 010011 | G ₈ | -14 | 101001 | G ₋₁₄ | -20 | 111111 | G ₋₂₀ |
| 7 | 010100 | G ₇ | -15 | 101010 | G ₋₁₅ | | | |
| 6 | 010101 | G ₆ | -16 | 101011 | G ₋₁₆ | | | |

F0502 RECOMMENDED OPERATING CONDITIONS

| Parameter | Symbol | Conditions | Min | Typ | Max | Units |
|-----------------------------|------------|-------------------|------|-----|------|-------|
| Supply Voltage | V_{CC} | All V_{CC} pins | 4.75 | | 5.25 | V |
| LO Power | P_{LO} | | -3 | | +3 | dBm |
| Operating Temperature Range | T_{CASE} | Case Temperature | -40 | | +105 | °C |
| RF Frequency Range | F_{RF} | | 600 | | 1000 | MHz |
| LO Frequency Range | F_{LO} | | 600 | | 1225 | |
| IF Frequency Range | F_{IF} | | 60 | | 275 | |

F0502 SPECIFICATION

F0502 Typical Application Circuit, when operated as a Sampling IF Receiver, $V_{CC} = +5.00V$, $T_C = +25^\circ C$, $F_{RF} = 850MHz$, $F_{IF} = 184MHz$, $F_{LO} = 1034MHz$, $P_{LO} = 0\text{ dBm}$, Max gain setting, IF output power = +3dBm per tone, $TDD_ = LOW$, STD Mode, unless otherwise stated. EVkit PCB, connector and IF transformer losses are de-embedded unless otherwise noted.

| Parameter | Symbol | Conditions | Min | Typ | Max | Units |
|---------------------------|------------------|---|-------------|-------|------------------------|---------|
| Logic Input High | V_{IH} | For all control pins | 1.07 | | | V |
| Logic Input Low | V_{IL} | For all control pins | | | 0.68 | V |
| Logic Current | I_{IH}, I_{IL} | For all control pins | -150 | | 10 | μA |
| Total Supply Current | I_{CC} | STD Mode | | 480 | 545¹ | mA |
| | | LC Mode | | 390 | 440 | |
| | | Standby Mode $STBY = V_{IH}$ | | 26 | 36 | |
| Conversion Power Gain | G | STD Mode | 26.2 | 28.2 | 30.2 | dB |
| | | LC Mode | 26.2 | 28.2 | 30.2 | |
| | | STD Mode Max attenuation | | -18.8 | | |
| Gain Control Range | G_{RANGE} | | | 47 | | dB |
| Step Size | G_{STEP} | | | 1 | | dB |
| Differential Gain Error | DNL | Between any two adjacent 1dB steps | | 0.1 | 0.2^2 | dB |
| Integral Gain Error | INL | Error vs. line (G_{27} Ref) | | 0.2 | 0.8 | dB |
| Phase Error | IPE | Maximum phase change between G_{MAX} and any state down to G_{-14} | | 2 | | deg |
| Noise Figure | NF | STD Mode | | 9.6 | 10.6 | dB |
| | | STD Mode at $G_{MAX} - 10dB$ | | 9.6 | 10.6 | |
| | | LC Mode | | 9.3 | 10.3 | |
| | | LC Mode at $G_{MAX} - 10dB$ | | 9.3 | 10.3 | |
| Noise Figure with Blocker | NF_{BLK} | Desired RF = 800MHz Blocker = 700MHz LO = 984MHz $P_{IN} = +4dBm$ Gain = -1dB | | 17.5 | 19 | dB |

F0502 SPECIFICATION (CONTINUED)

F0502 Typical Application Circuit, when operated as a Sampling IF Receiver, $V_{CC} = +5.00V$, $T_C = +25^\circ C$, $F_{RF} = 850MHz$, $F_{IF} = 184MHz$, $F_{LO} = 1034MHz$, $P_{LO} = 0\text{ dBm}$, Max gain setting, IF output power = +3dBm per tone, $TDD_ = LOW$, STD Mode, unless otherwise stated. EVkit PCB, connector and IF transformer losses are de-embedded unless otherwise noted.

| Parameter | Symbol | Conditions | Min | Typ | Max | Units |
|-------------------------------------|-------------|---|-----------------|------|------|---------|
| Turn-on time | T_{SETT1} | Gate STBY from V_{IH} to V_{IL} Time for IF Signal to settle to within 0.1 dB of final value | | 0.17 | 0.20 | μs |
| Attenuator Adjustment Settling Time | T_{1dB} | Any two Adjacent 1dB Steps +/-0.10 dB Pout settling | | 17.5 | 25 | ns |
| Output IP3 | OIP3 | STD Mode 800 KHz Tone Separation | 40 | 44 | | dBm |
| | | STD Mode Gain = $G_{MAX} - 10dB$, Pout = +1dBm per tone 800 KHz Tone Separation $-40C \leq T_{case} \leq +105C$ IF = 138MHz, LO = 988MHz IF = 184MHz, LO = 1034MHz IF = 276MHz, LO = 1126MHz | 40 | 44 | | |
| | | LC Mode 800 KHz Tone Separation | 40 | 44 | | |
| Input IP3 | IIP3 | STD Mode Gain = $G_{MAX} - 22dB$, Pin = -5dBm/tone 800 KHz Tone Separation | 21 | 25 | | dBm |
| | | LC Mode Gain = $G_{MAX} - 22dB$, Pin = -10dBm/tone 800 KHz Tone Separation | | 21 | | |
| 1 dB Output Compression | OP1dB | STD Mode | 17.5 | 20.2 | | dBm |
| | | LC Mode | 17.5 | 20.2 | | |
| 1 dB Input Compression | IP1dB | Gain = $G_{MAX} - 30dB$ | STD Mode | 7.7 | 8.7 | dBm |
| | | | LC Mode | 6.5 | 7 | |

F0502 SPECIFICATION (CONTINUED)

F0502 Typical Application Circuit, when operated as a Sampling IF Receiver, $V_{CC} = +5.00V$, $T_C = +25^\circ C$, $F_{RF} = 850MHz$, $F_{IF} = 184MHz$, $F_{LO} = 1034MHz$, $P_{LO} = 0\text{ dBm}$, Max gain setting, IF output power = +3dBm per tone, $TDD_ = LOW$, STD Mode, unless otherwise stated. EVkit PCB, connector and IF transformer losses are de-embedded unless otherwise noted.

| Parameter | Symbol | Conditions | Min | Typ | Max | Units | |
|---------------------|-------------------|--|-----------------|-----|-----|-------|-----|
| 2LO – 2RF Rejection | | STD Mode Frequency = $F_{RF} + \frac{1}{2} F_{IF}$ $P_{RF} = -27dBm$ | | -75 | -65 | dBc | |
| | | STD Mode , Gain = $G_{MAX} - 22dB$, Frequency = $F_{RF} + \frac{1}{2} F_{IF}$ $P_{RF} = -5dBm$ | | -69 | -60 | | |
| | | LC Mode Frequency = $F_{RF} + \frac{1}{2} F_{IF}$ $P_{RF} = -27dBm$ | | -73 | -60 | | |
| | | LC Mode , Gain = $G_{MAX} - 22dB$, Frequency = $F_{RF} + \frac{1}{2} F_{IF}$ $P_{RF} = -27dBm$ | | -69 | -60 | | |
| 2nd Harmonic | HD2 | $P_{RF} = -27\text{ dBm}$ | STD Mode | | -81 | -70 | dBc |
| | | | LC Mode | | -80 | -70 | |
| 3rd Harmonic | HD3 | $P_{RF} = -27\text{ dBm}$ | STD Mode | | -94 | -80 | dBc |
| | | | LC Mode | | -94 | -80 | |
| Channel Isolation | ISO _C | RFIN_A applied, IFOUT_A compared with IFOUT_B | STD Mode | 45 | 50 | | dB |
| | | | LC Mode | 45 | 50 | | |
| LO to IF Leakage | ISO _{LI} | | STD Mode | | -60 | -55 | dBm |
| | | | LC Mode | | -60 | -55 | |
| RF to IF leakage | ISO _{RI} | | STD Mode | | -80 | -70 | dBm |
| | | | LC Mode | | -80 | -70 | |
| LO to RF leakage | ISO _{LR} | | | -44 | | dBm | |
| RFIN Impedance | Z _{RFIN} | Single Ended | | 50 | | Ω | |
| LO Port Impedance | Z _{LO} | Single Ended | | 50 | | | |
| IF Output Impedance | Z _{IF} | Differential | | 200 | | | |

- 1 – Items in min/max columns in **bold italics** are Guaranteed by Test using BOM1 components supporting 4:1 output impedance transformation to 50Ω
- 2 – Items in min/max columns that are not bold/italics are Guaranteed by Design Characterization using BOM2 components supporting 2:1 output impedance transformation to 100Ω

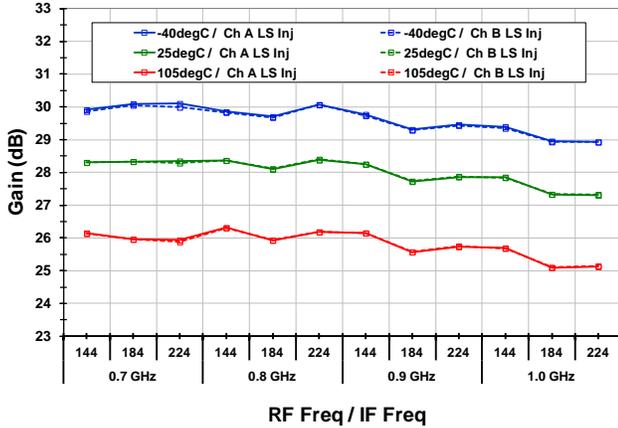
TYPICAL OPERATING CONDITIONS (184 MHz IF CENTER)

Unless otherwise noted, the following conditions apply:

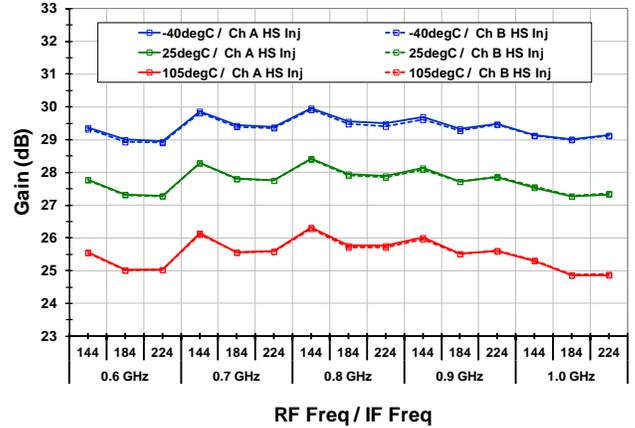
- Applications circuit for 100 Ω differential load with 184MHz +/- 40MHz BW into 2:1 transformer. See schematic in BOM section.
- Pout ~ +3dBm
- Measurement on Channel A
- P_{IN} from -27dBm to -5dBm per tone (Gain Setting Adjusted to yield Pout ~ +3dBm)
- Tone Spacing = 800KHz
- Device configured in Standard Mode with High Side Injection
- T_{CASE} = 25C, V_{CC} = 5.00V, LO Power = 0dBm
- RF Frequency: 915MHz
- IF Frequency: 184MHz
- IF Transformer losses are de-embedded
- Input RF trace and connector losses are de-embedded
- Listed Temperatures are Case Temperature (T_C = Case Temperature)
- Where noted, T_A or T_{AMB} = Ambient Temperature

TOCs [MAX GAIN, STD MODE, IF = 184MHz +/- 40MHz] GAIN, OIP3, OIP2 (-1-)

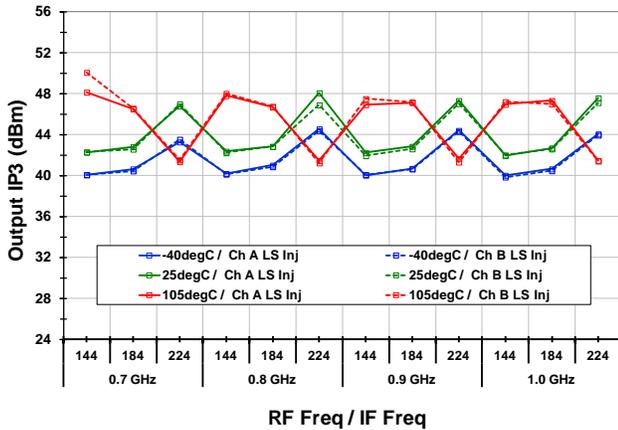
RF Gain vs. T_{CASE} [low side inj.]



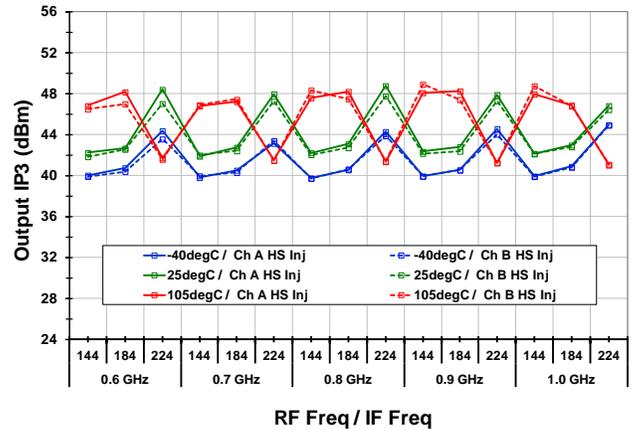
RF Gain vs. T_{CASE} [high side inj.]



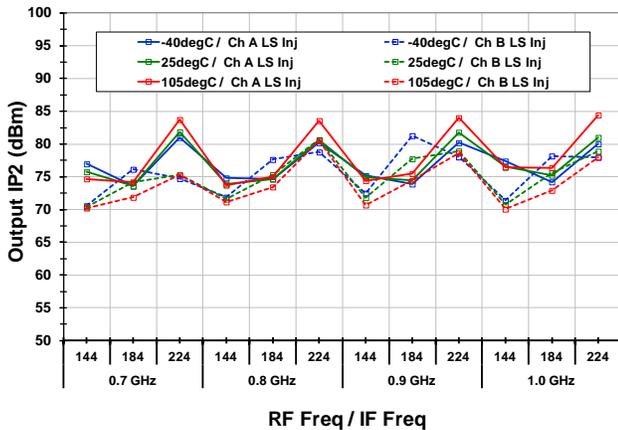
Output IP3 vs. T_{CASE} [low side inj.]



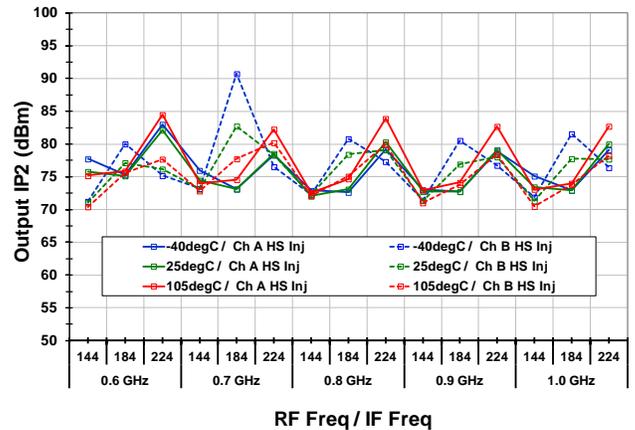
Output IP3 vs. T_{CASE} [high side inj.]



Output IP2 vs. T_{CASE} [low side inj.]

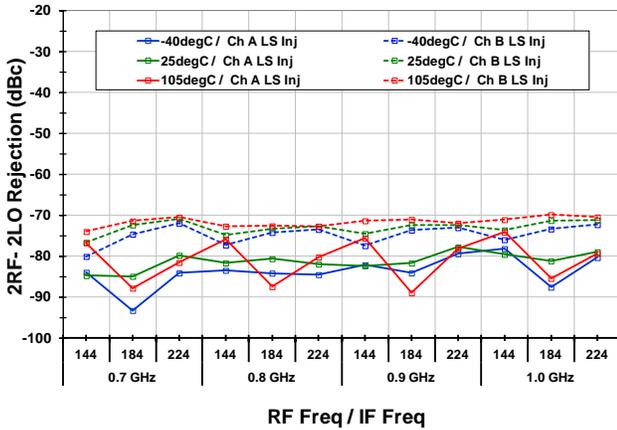


Output IP2 vs. T_{CASE} [high side inj.]

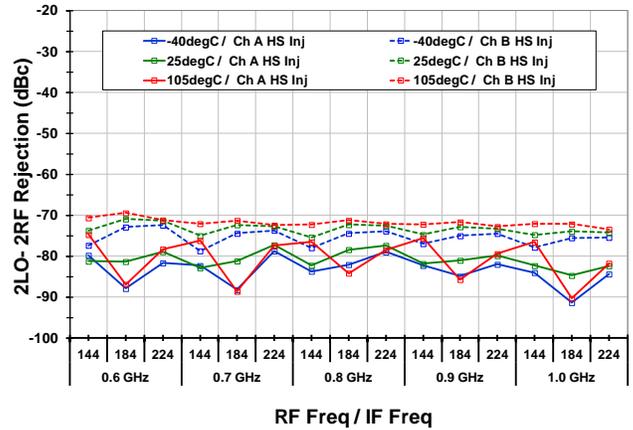


TOCs [MAX GAIN, STD MODE, IF = 184MHz +/- 40MHz] 2x2, L-I, DC CURRENT (-2-)

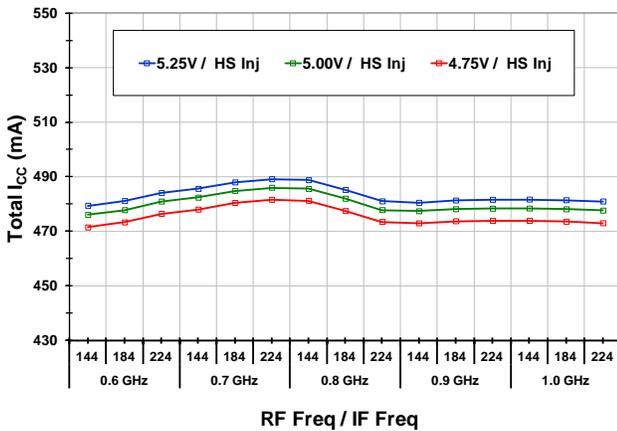
2RF-2LO vs. T_{CASE} [low side inj.]



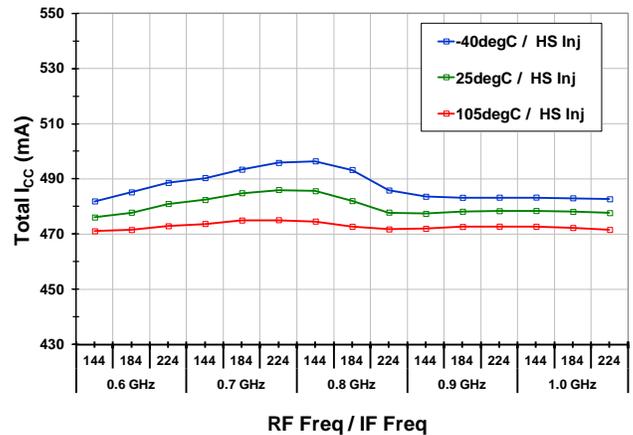
2LO-2RF vs. T_{CASE} [high side inj.]



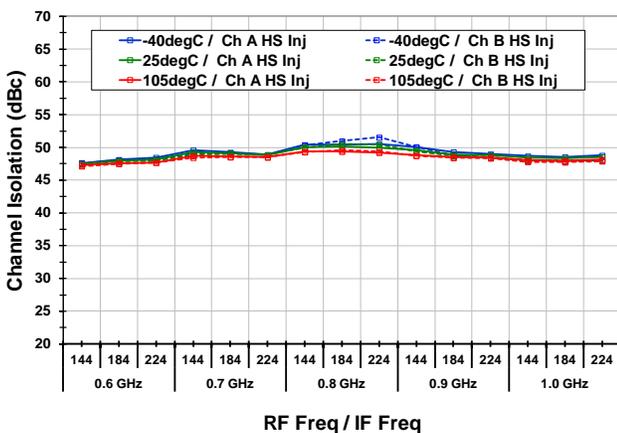
Total Current Drain [v V_{SUPPLY}, high side inj.]



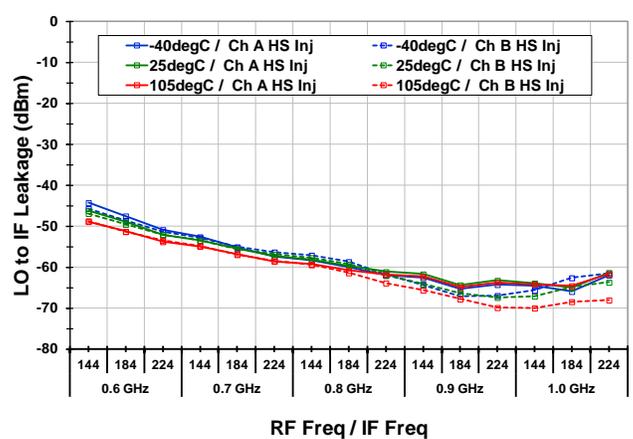
Total Current Drain [v Temp, high side inj.]



Channel Isolation [high side inj.]

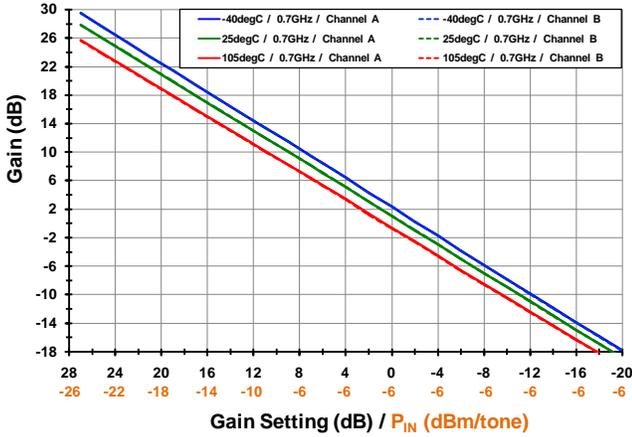


LO to IF Leakage [high side inj.]

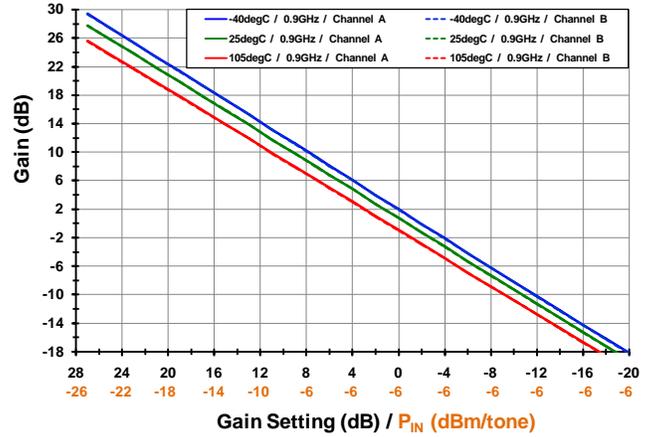


TOCs [SWEPT GAIN, STD MODE, IF = 184MHz, HS INJECTION] GAIN, OIP3, IIP3 (-3-)

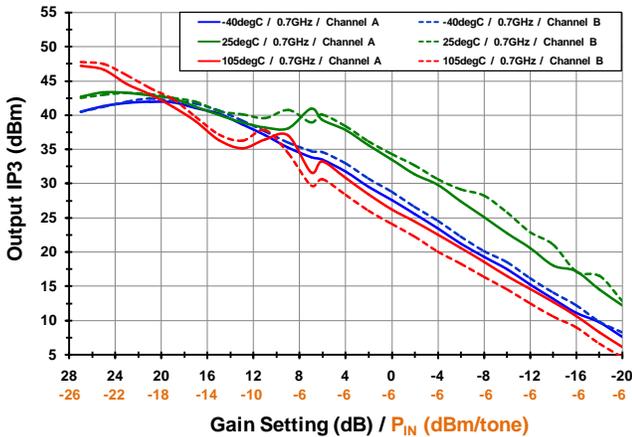
RF Gain [RF=0.7 GHz]



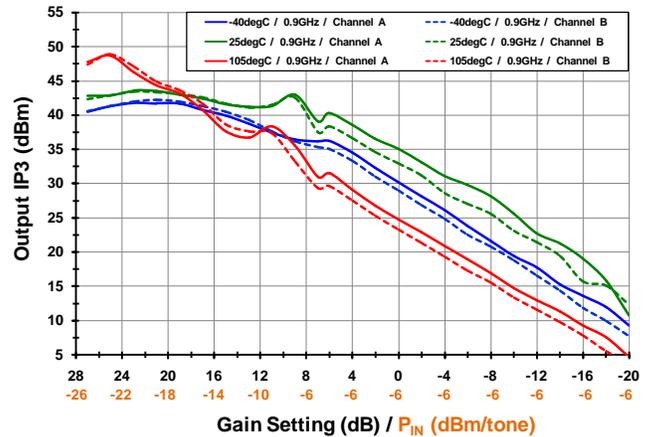
RF Gain [RF=0.9 GHz]



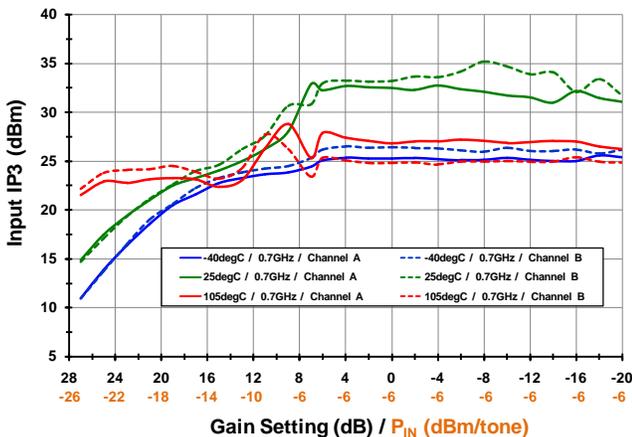
Output IP3 [RF=0.7 GHz]



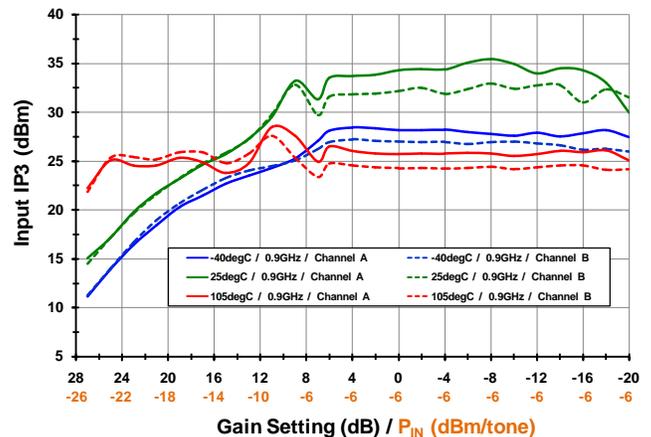
Output IP3 [RF=0.9 GHz]



Input IP3 [RF=0.7 GHz]

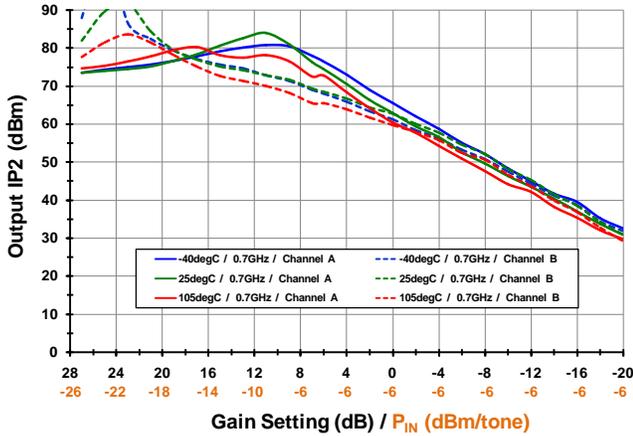


Input IP3 [RF=0.9 GHz]

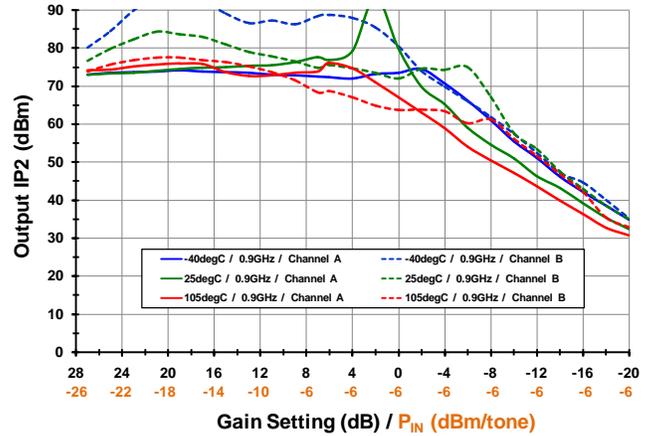


TOCs [SWEPT GAIN, STD MODE, IF = 184MHz, HS INJECTION] OIP2, IIP2, 2X2 (-4-)

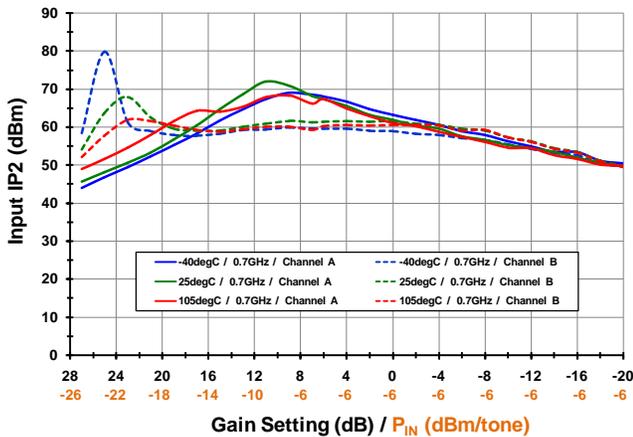
Output IP2 [RF=0.7 GHz]



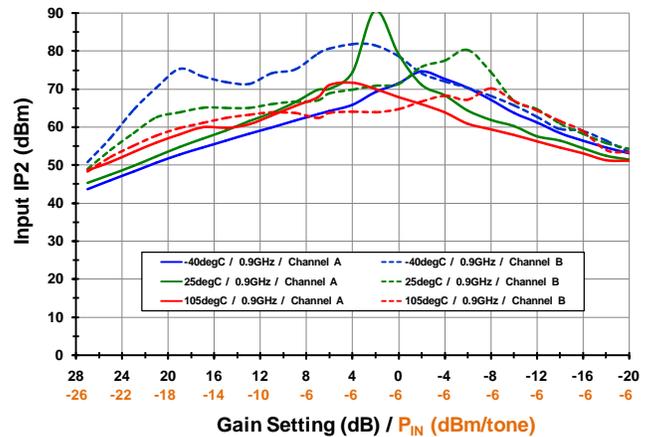
Output IP2 [RF=0.9 GHz]



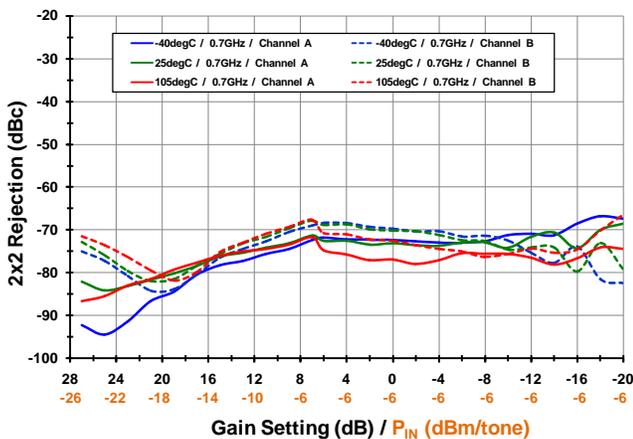
Input IP2 [RF=0.7 GHz]



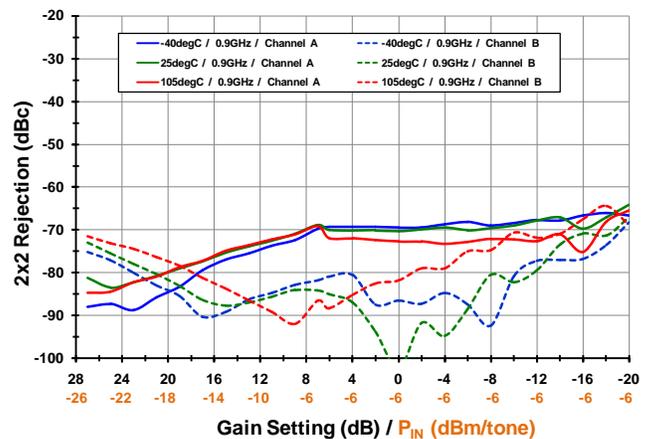
Input IP2 [RF=0.9 GHz]



2LO-2RF Rejection [RF=0.7 GHz]

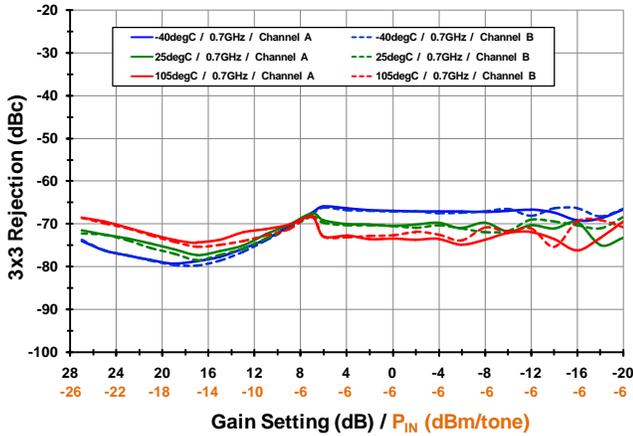


2LO-2RF Rejection [RF=0.9 GHz]

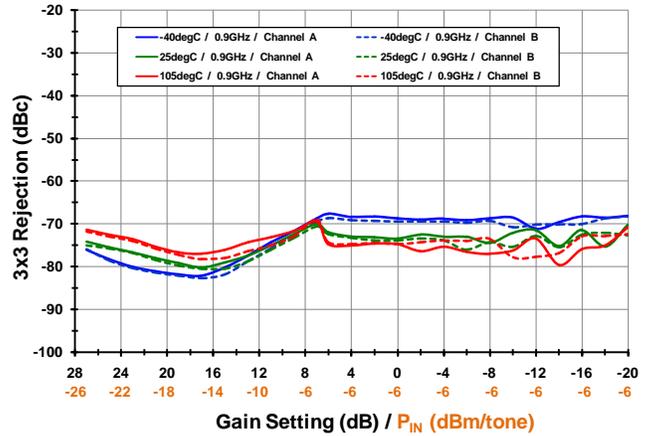


TOCs [SWEPT GAIN, STD MODE, IF = 184MHz, HS INJECTION] 3X3, L-I, R-I (-5-)

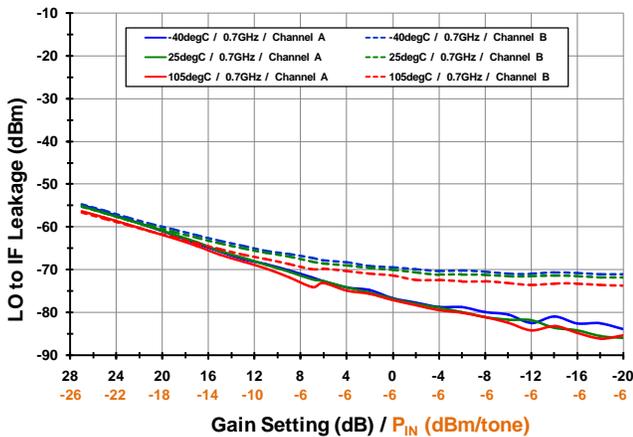
3LO-3RF Rejection [RF=0.7 GHz]



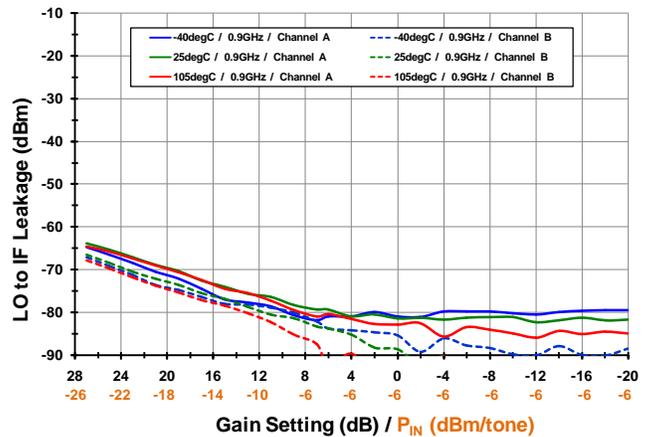
3LO-3RF Rejection [RF=0.9 GHz]



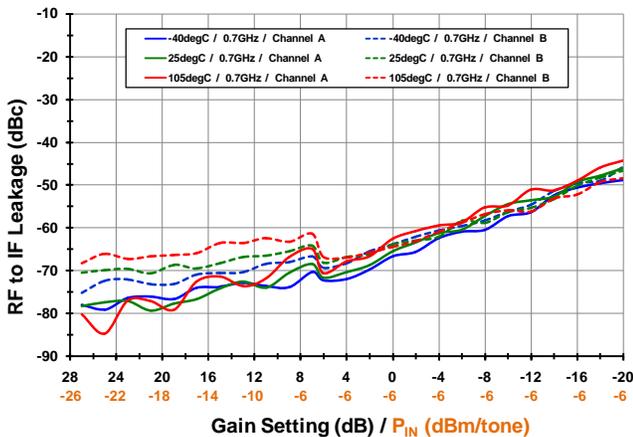
LO to IF Leakage [RF=0.7 GHz]



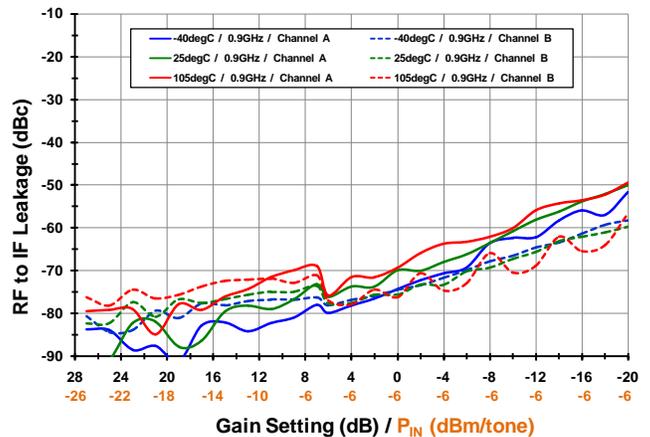
LO to IF Leakage [RF=0.9 GHz]



RF to IF Leakage [RF=0.7 GHz]

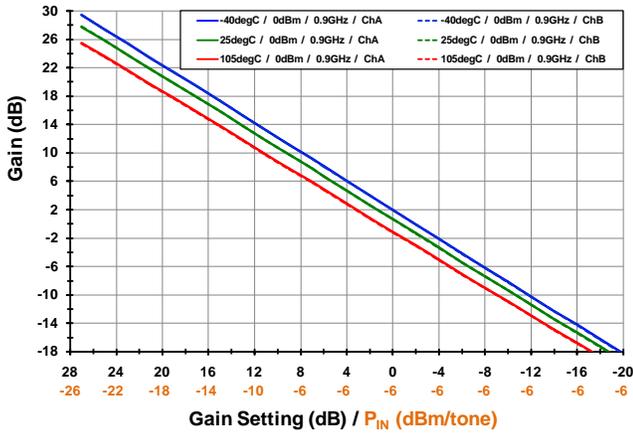


RF to IF Leakage [RF=0.9 GHz]

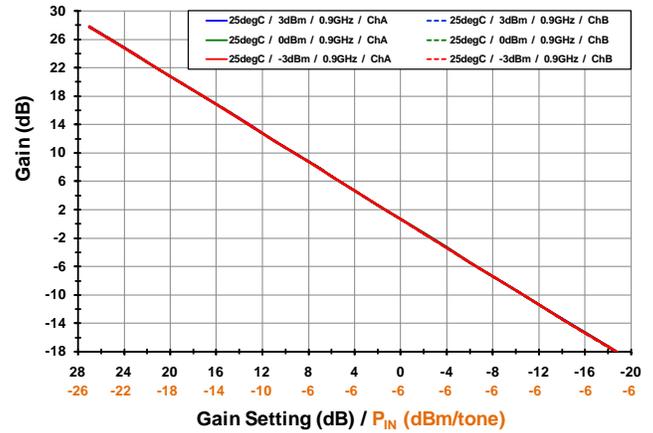


TOCs [SWEPT GAIN, *LC MODE*, RF=900MHz, IF = 184MHz, HS INJECTION] GAIN, OIP3, IIP3 (-6-)

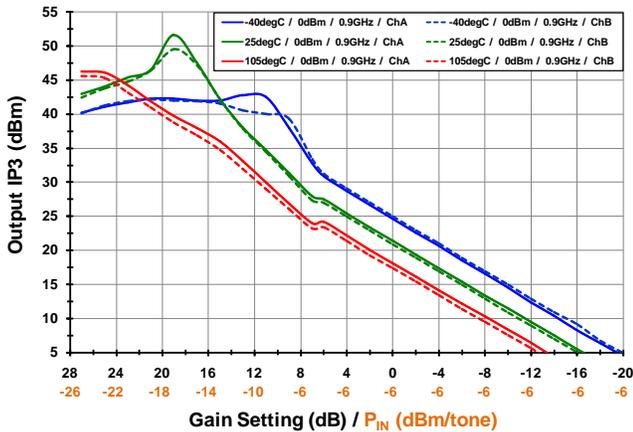
RF Gain [v Temp]



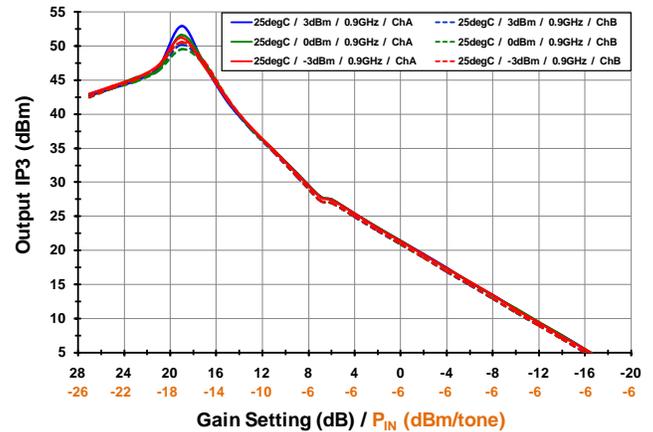
RF Gain [v LO Power]



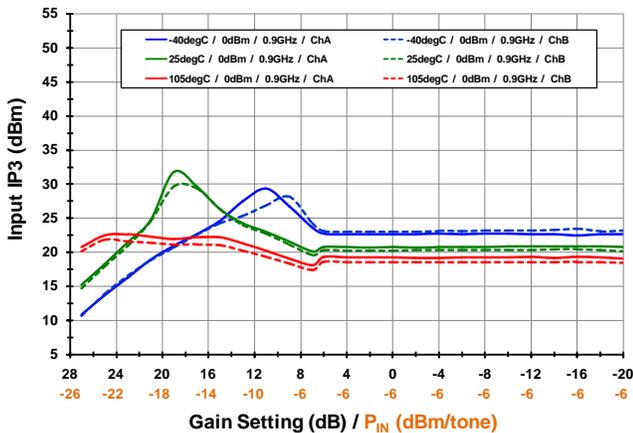
Output IP3 [v Temp]



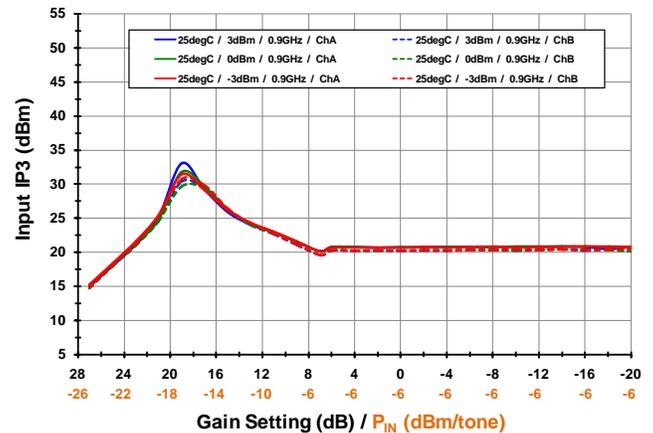
Output IP3 [v LO Power]



Input IP3 [v Temp]

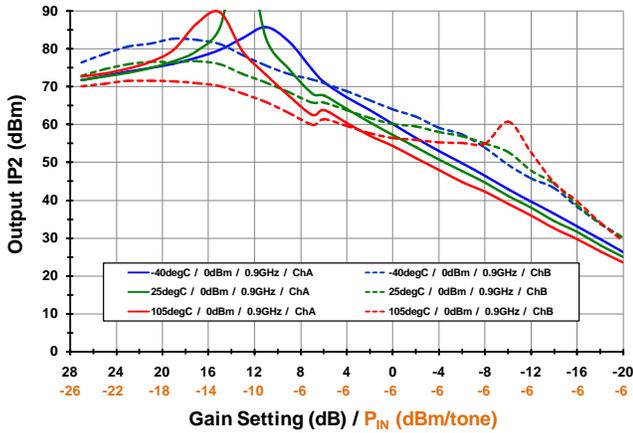


Input IP3 [v LO Power]

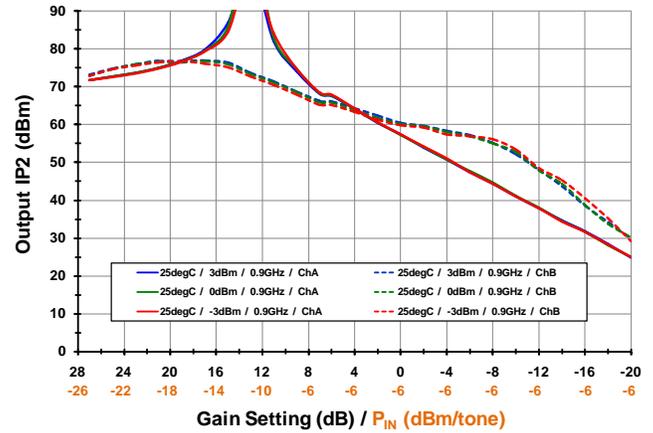


TOCs [SWEPT GAIN, *LC MODE*, RF=900MHz, IF = 184MHz, HS INJECTION] OIP2, CHAN ISO, 2X2 (-7-)

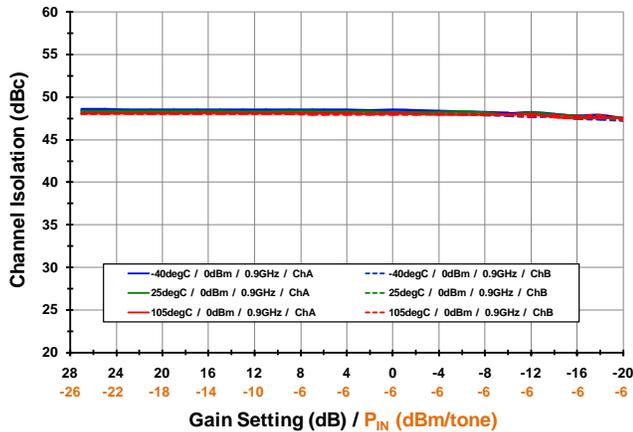
Output IP2 [v Temp]



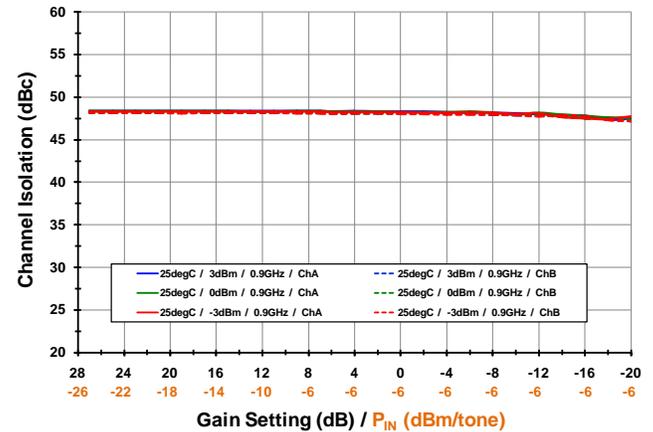
Output IP2 [v LO Power]



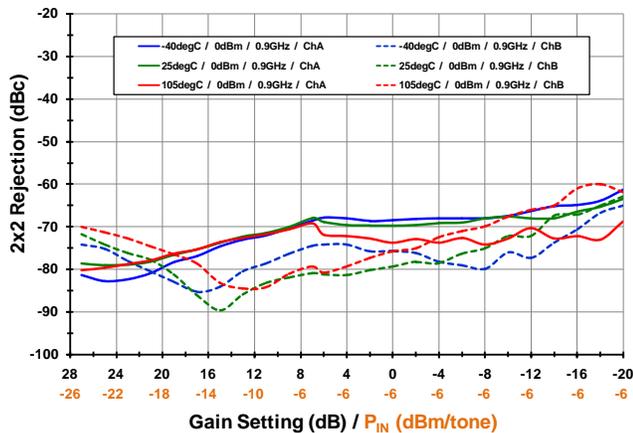
Channel Isolation [v Temp]



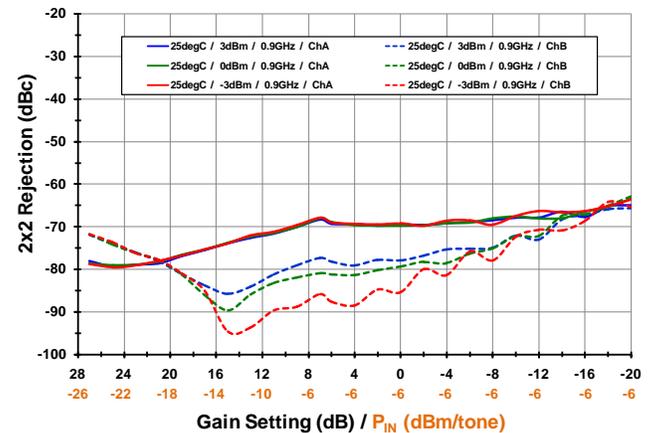
Channel Isolation [v LO Power]



2LO-2RF Rejection [v Temp]

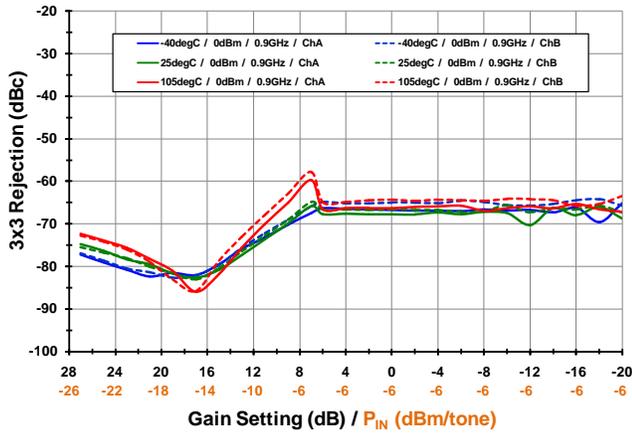


2LO-2RF Rejection [v LO Power]

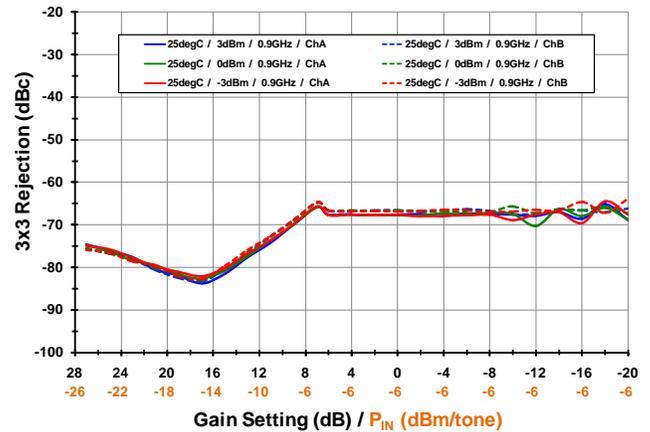


TOCs [SWEPT GAIN, *LC MODE*, RF=900MHz, IF = 184MHz, HS INJ] 3x3, L-I, DC CURRENT, R-I (-8-)

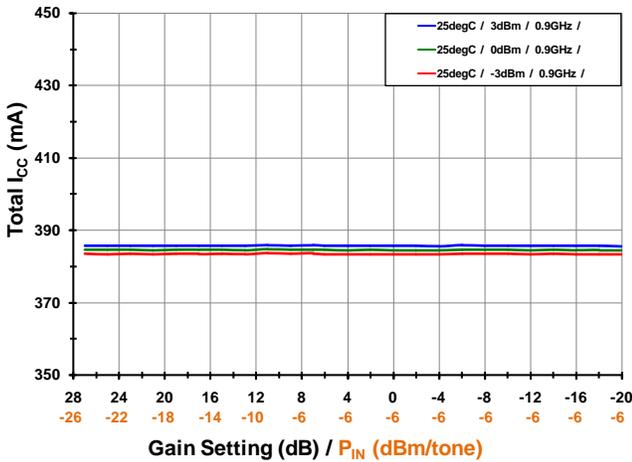
3LO-3RF Rejection [v Temp]



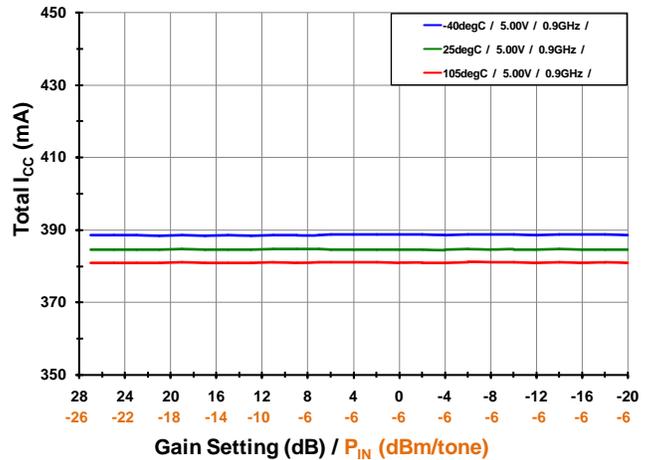
3LO-3RF Rejection [v LO Power]



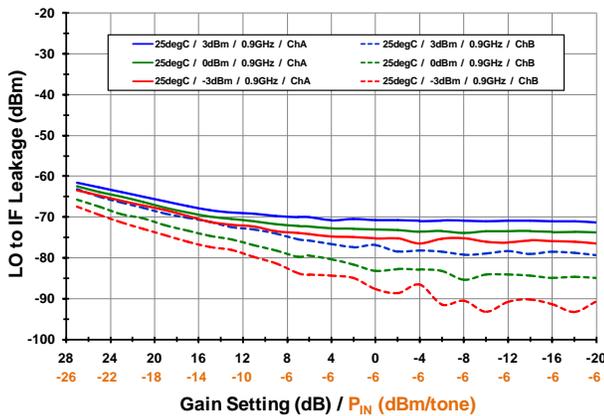
Total I_{CC} [v LO Power]



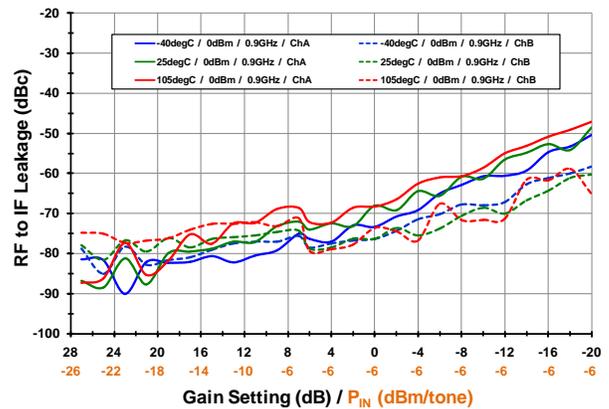
Total I_{CC} [v Temp]



LO to IF Leakage [v LO Power]



RF to IF Leakage [v Temp]



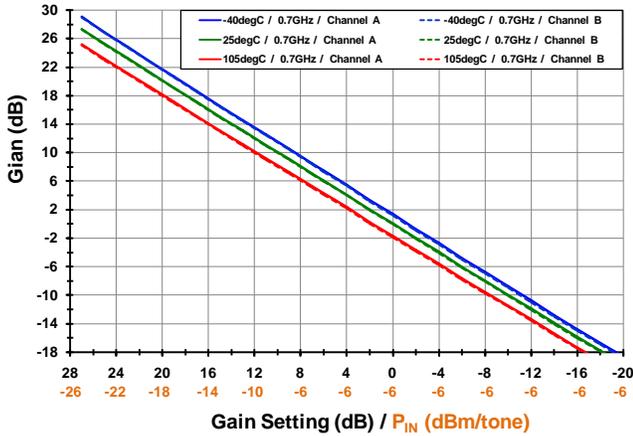
TYPICAL OPERATING CONDITIONS [276 MHz IF CENTER]

Unless otherwise noted, the following conditions apply:

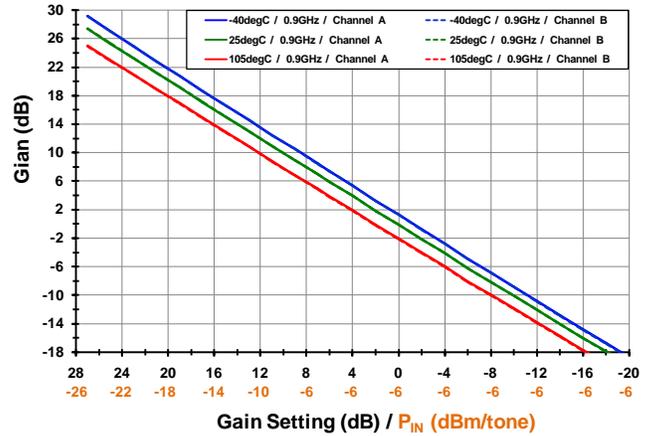
- Applications circuit for 100Ω differential load with 276MHz +/- 40MHz BW into 2:1 transformer. See schematic in BOM section.
- Pout ~ +3dBm
- Measurement on Channel A
- P_{IN} from -27dBm to -6dBm per tone (Gain Setting Adjusted to yield Pout ~ +3dBm)
- Tone Spacing = 800KHz
- Device configured in Standard Mode with High Side Injection
- T_{CASE} = 25C, V_{CC} = 5.00V, LO Power = 0dBm
- RF Frequency: 915MHz
- IF Frequency: 276MHz
- IF Transformer Losses are de-embedded
- Input RF trace and connector losses are de-embedded
- Listed Temperatures are Case Temperature (T_C = Case Temperature)
- Where noted, T_A or T_{AMB} = Ambient Temperature

TOCs [SWEPT GAIN, STD MODE, IF = 276MHz, HS INJECTION] GAIN, OIP3, OIP2 (-9-)

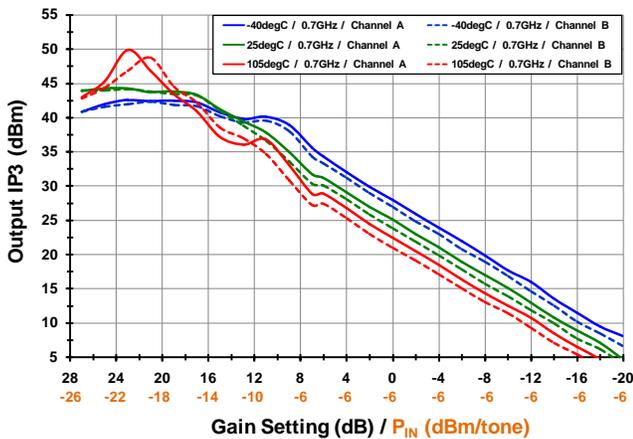
RF Gain [RF=0.7 GHz]



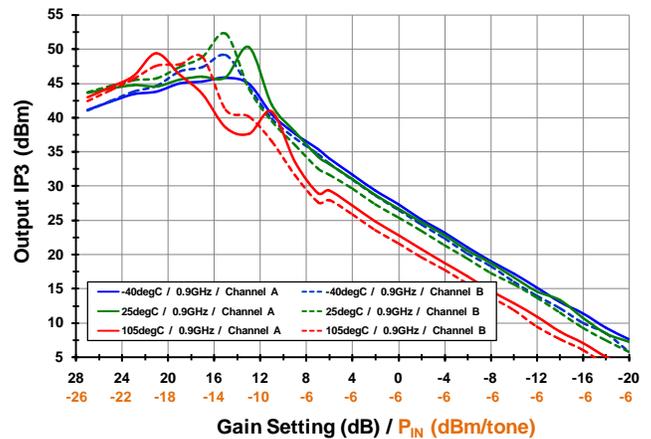
RF Gain [RF=0.9 GHz]



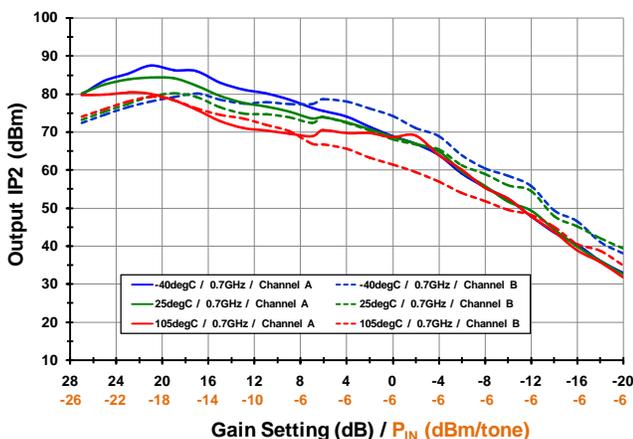
Output IP3 [RF=0.7 GHz]



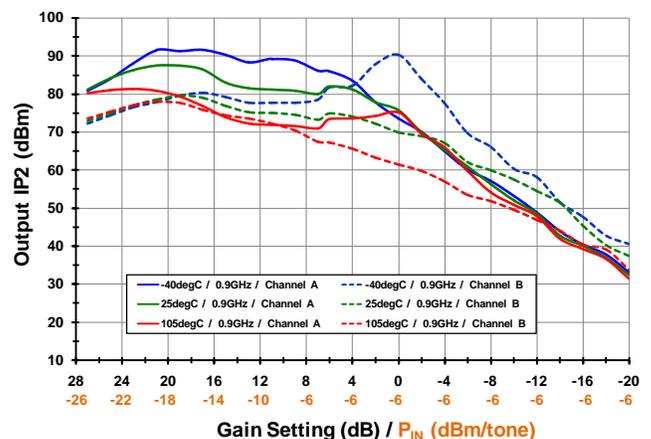
Output IP3 [RF=0.9 GHz]



Output IP2 [RF=0.7 GHz]

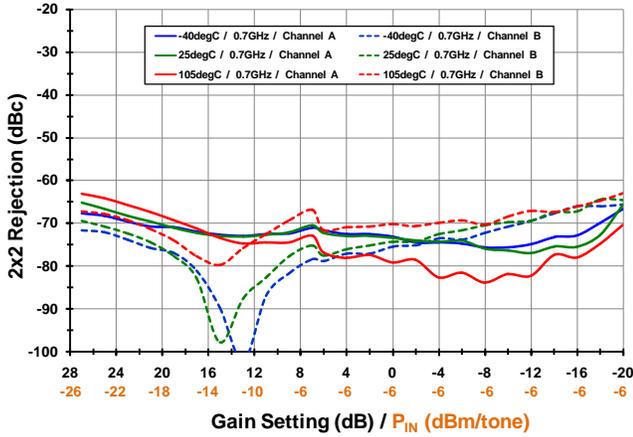


Output IP2 [RF=0.9 GHz]

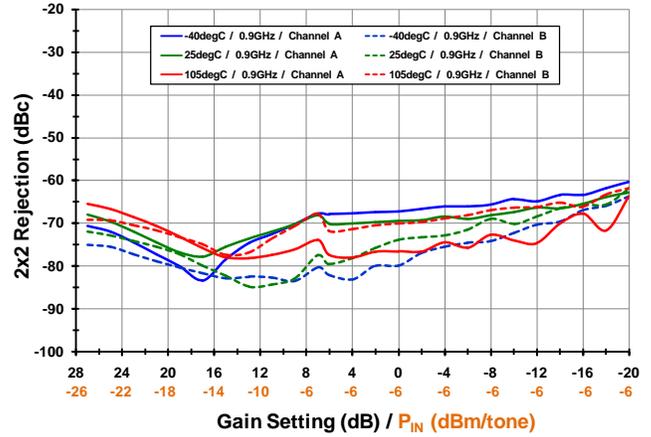


TOCs [SWEPT GAIN, STD MODE, IF = 276MHz, HS INJECTION] 2X2, 3X3, CURRENT, R-I, ISO (-10-)

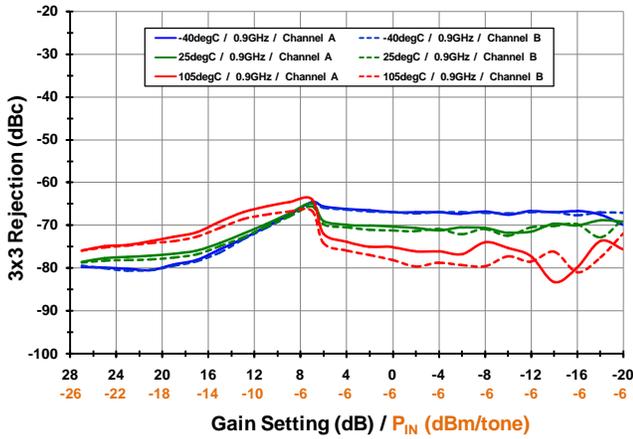
2x2 Rejection [RF=0.7 GHz]



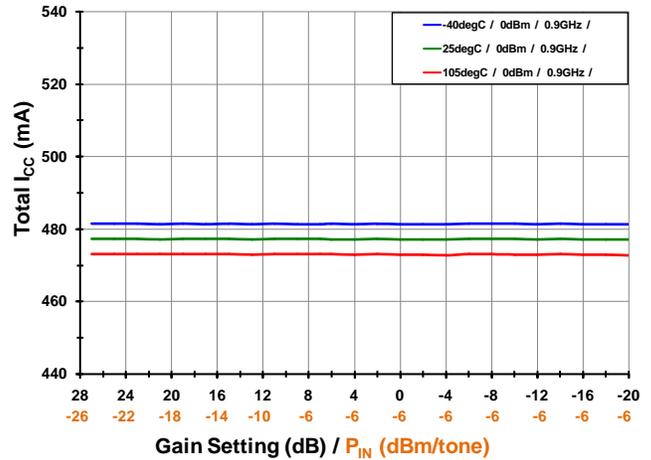
2x2 Rejection [RF=0.9 GHz]



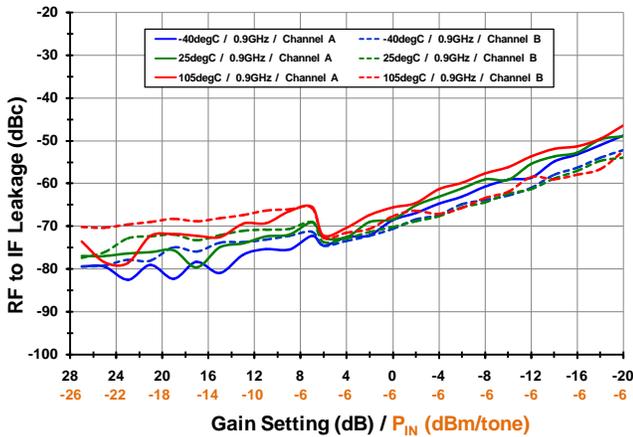
3x3 Rejection [RF=0.9 GHz]



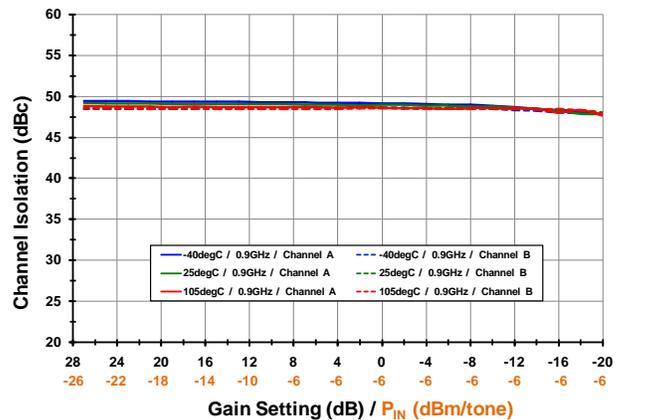
Total I_{CC} [RF=0.9 GHz]



RF to IF Leakage [RF=0.9 GHz]



Channel Isolation [RF=0.9 GHz]



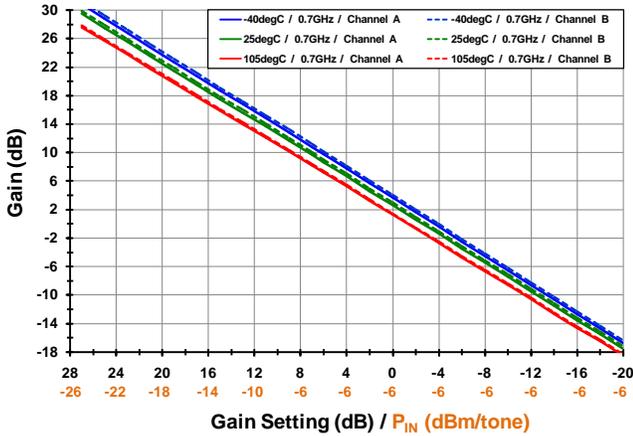
TYPICAL OPERATING CONDITIONS (80 MHz IF CENTER)

Unless otherwise noted, the following conditions apply:

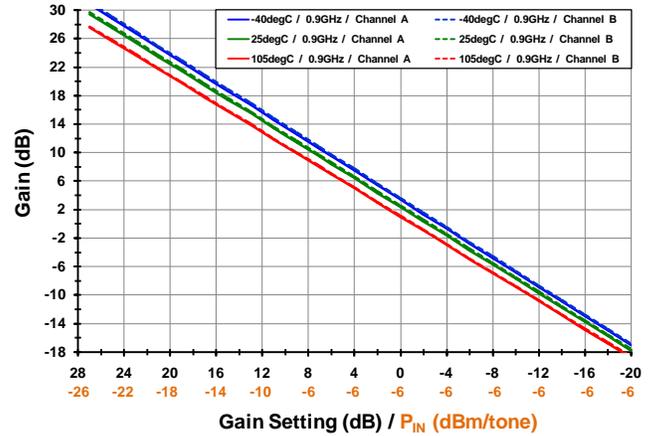
- Applications circuit for 100Ω differential load with 80MHz +/- 40MHz BW into 2:1 transformer. See schematic in BOM section.
- Pout ~ +3dBm
- Measurement on Channel A
- P_{IN} from -27dBm to -5dBm per tone (Gain Setting Adjusted to yield Pout ~ +3dBm)
- Tone Spacing = 800KHz
- Device configured in Standard Mode with High Side Injection
- T_{CASE} = 25C, V_{CC} = 5.00V, LO Power = 0dBm
- RF Frequency: 915MHz
- IF Frequency: 80MHz
- IF Transformer Losses are de-embedded
- Input RF trace and connectors losses are de-embedded
- Listed Temperatures are Case Temperature (T_C = Case Temperature)
- Where noted, T_A or T_{AMB} = Ambient Temperature

TOCs [SWEPT GAIN, STD MODE, IF = 80MHz, HS INJECTION] GAIN, OIP3, OIP2 (-11-)

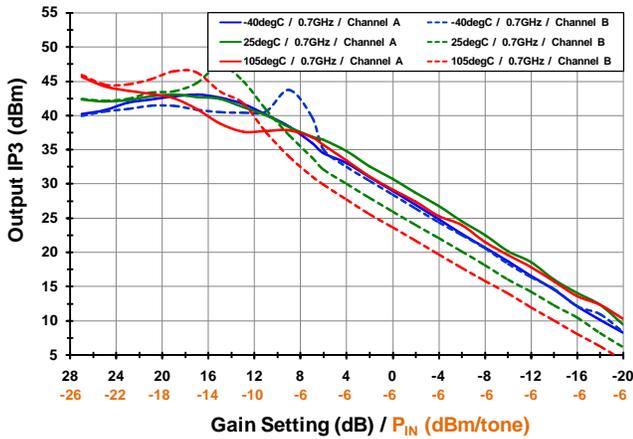
RF Gain [RF=0.7 GHz]



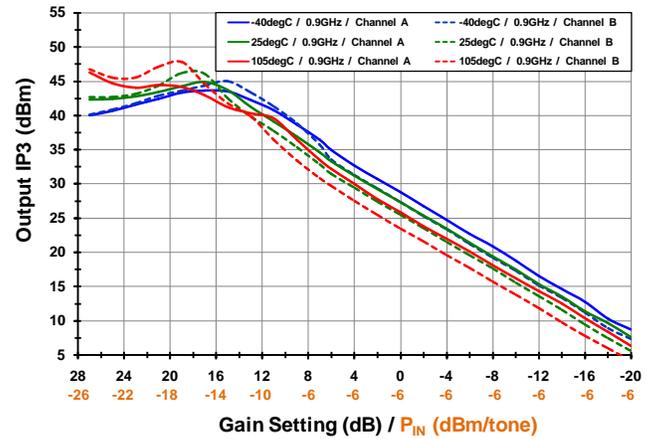
RF Gain [RF=0.9 GHz]



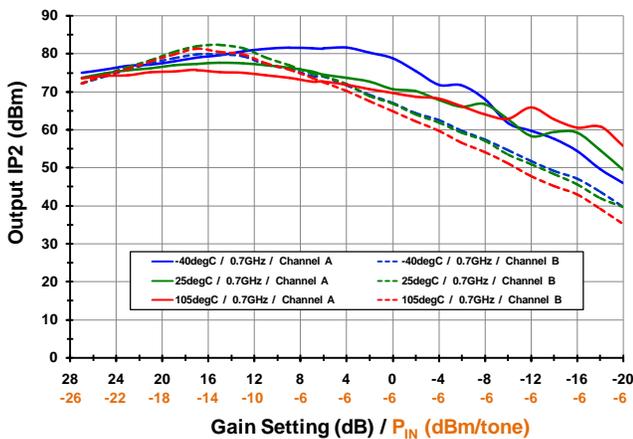
Output IP3 [RF=0.7 GHz]



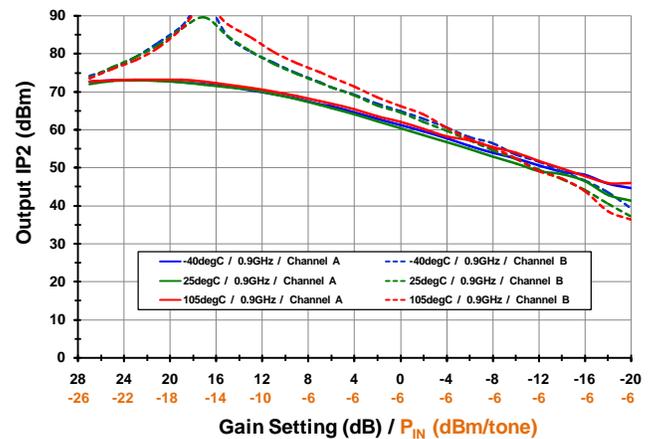
Output IP3 [RF=0.9 GHz]



Output IP2 [RF=0.7 GHz]

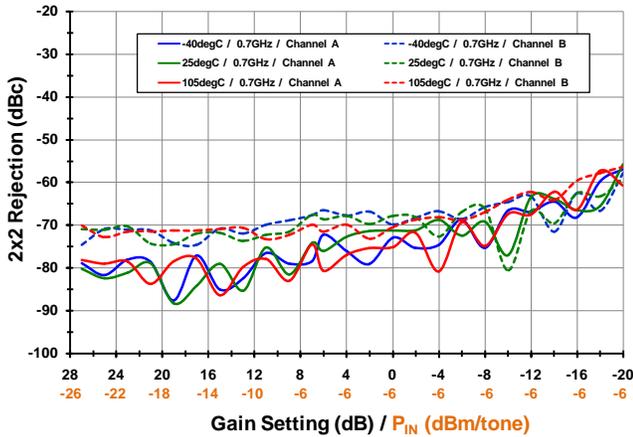


Output IP2 [RF=0.9 GHz]

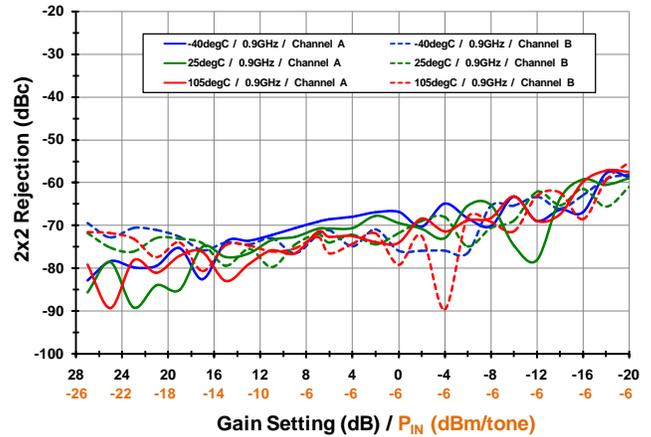


TOCs [SWEPT GAIN, STD MODE, IF = 80MHz, HS INJECTION] 2X2, 3X3, CURRENT, R-I, ISO (-12-)

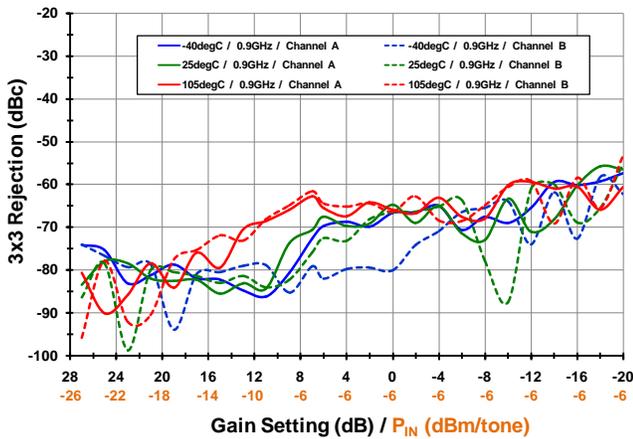
2LO-2RF Rejection [RF=0.7 GHz]



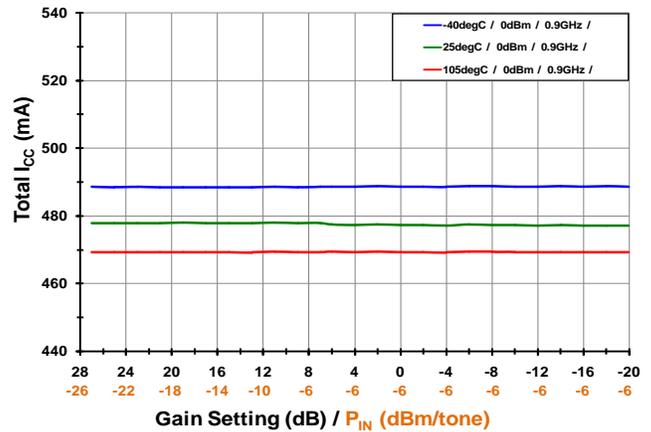
2LO-2RF Rejection [RF=0.9 GHz]



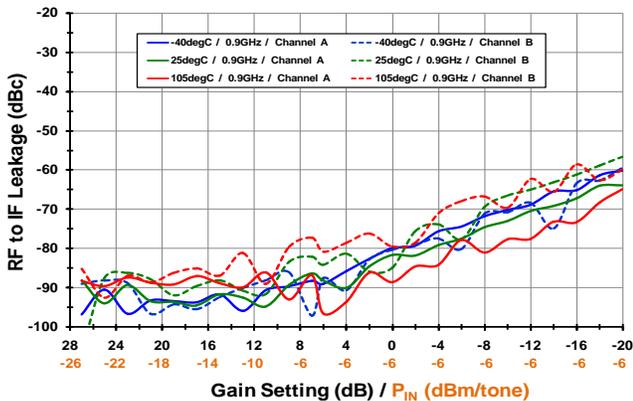
3LO-3RF Rejection [RF=0.9 GHz]



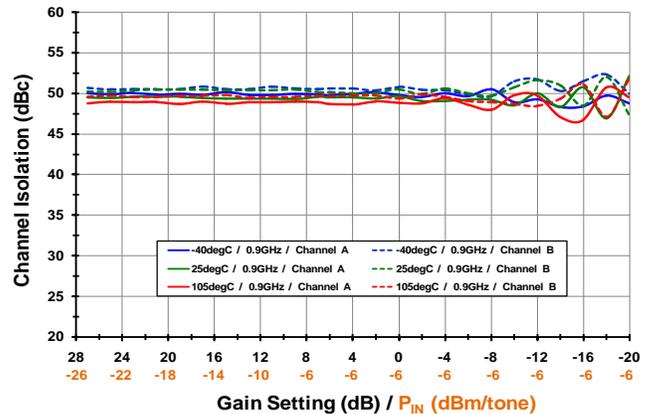
Total I_{CC} [RF=0.9 GHz]



RF to IF Leakage [RF=0.9 GHz]

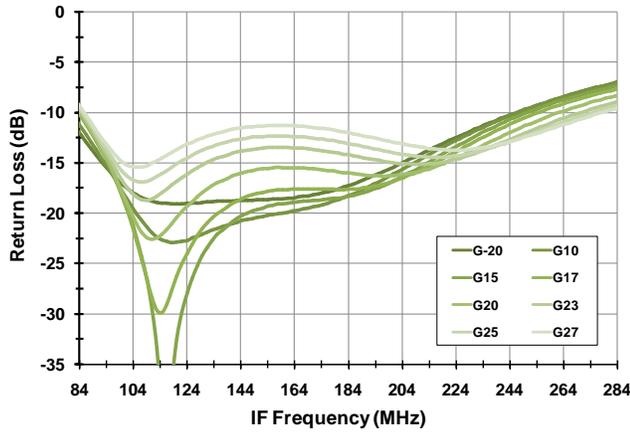


Channel Isolation [RF=0.9 GHz]

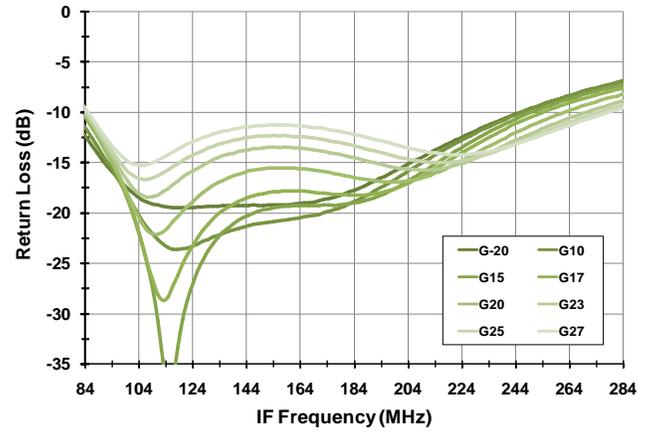


TOCs RETURN LOSS [STD MODE] (-13-)

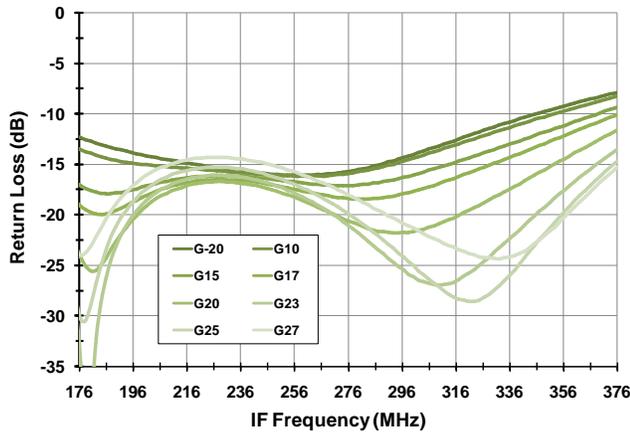
IF_A Output Return Loss 184MHz match



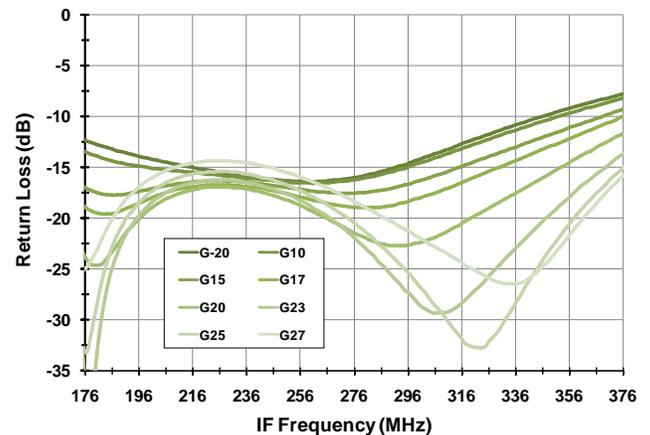
IF_B Output Return Loss 184MHz match



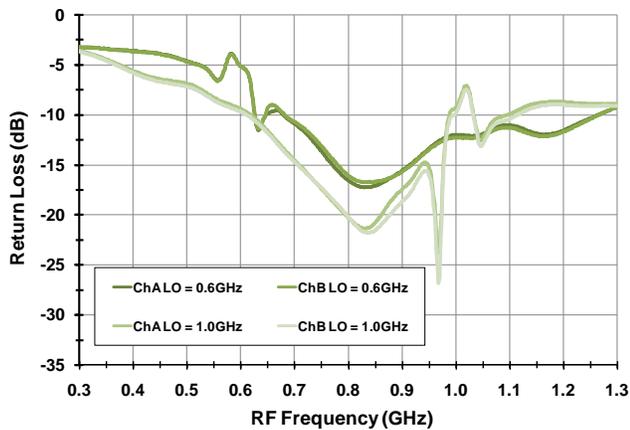
IF_A Output Return Loss 276MHz match



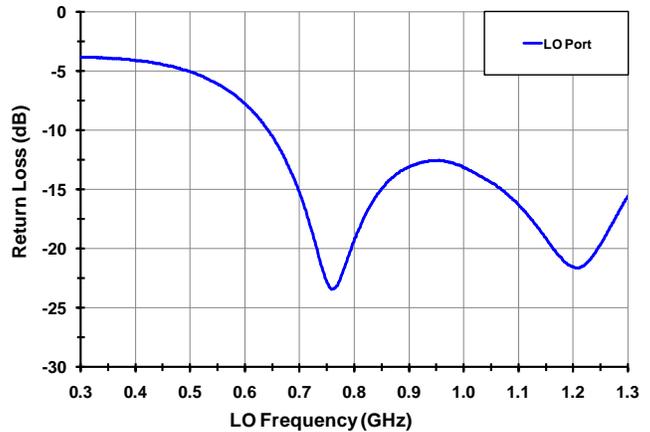
IF_B Output Return Loss 276MHz match



RF Port Return Loss

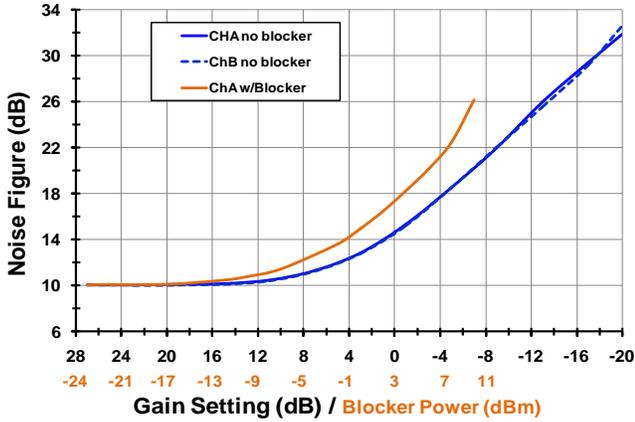


LO Port Return Loss

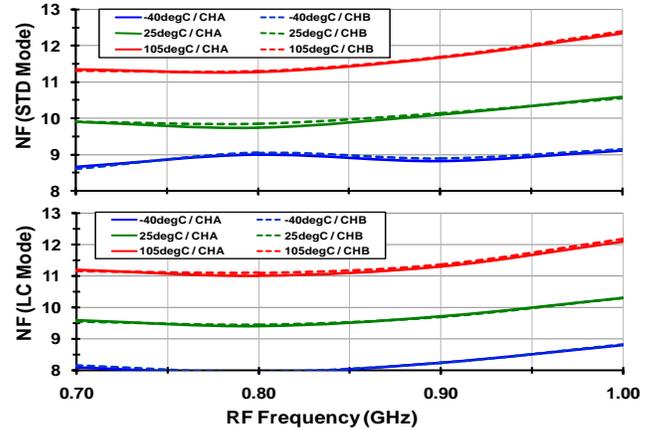


TOCS NOISE FIGURE, GAIN ACCURACY, P1dB [STD MODE] (-14-)

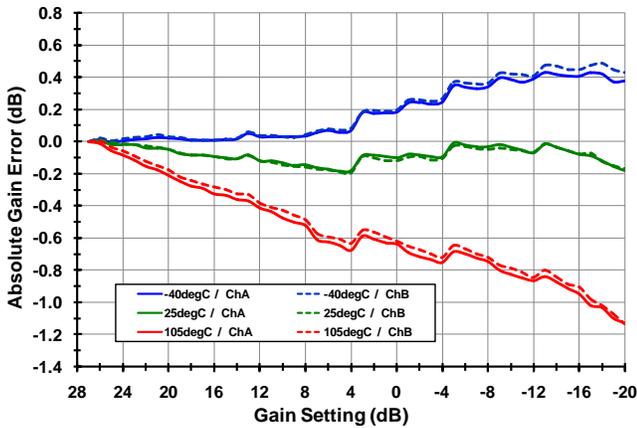
NF v Gain [RF=915M, IF=184M, HS Injection]



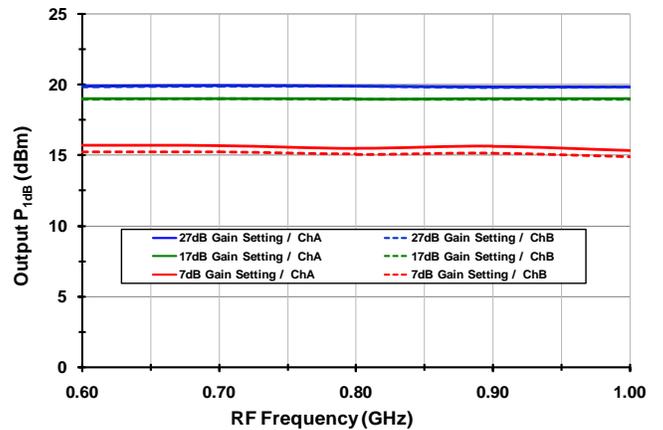
NF v Temp [RF=915M, IF=184M, HS Injection]



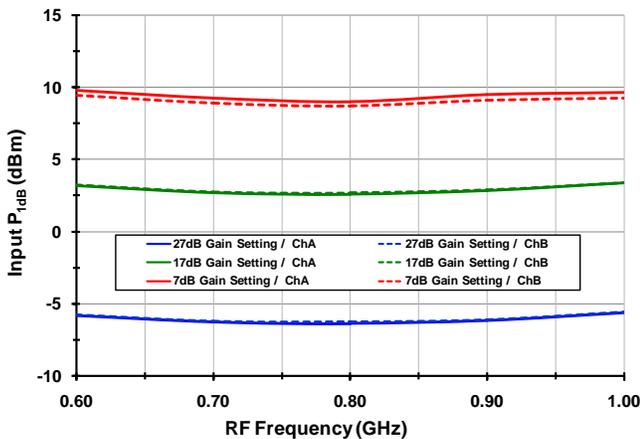
Gain Accuracy [RF = 915M, IF=184M, HS Injection]



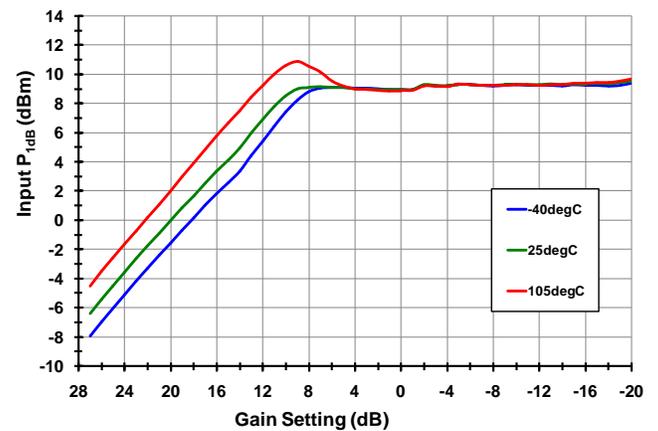
Output P1dB [IF = 184 MHz, High Side Injection]



Input P1dB [IF = 184 MHz, High Side Injection]

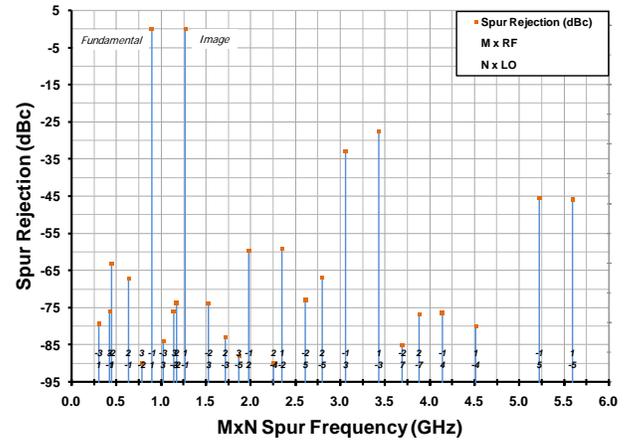
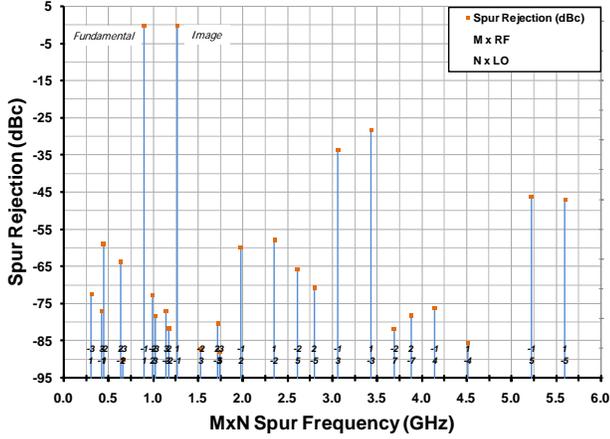


Input P1dB [RF = 915M, IF = 184M, High Side Inj.]

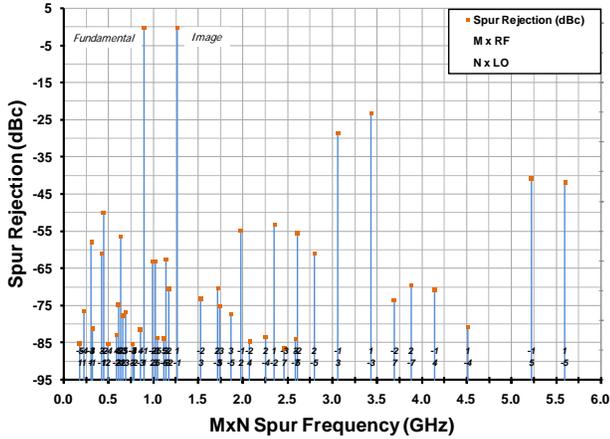


TOCs M x N SPURS [LO = 1.08182 GHz, T_{CASE} = 25C, > -90 dBc] (-15-)

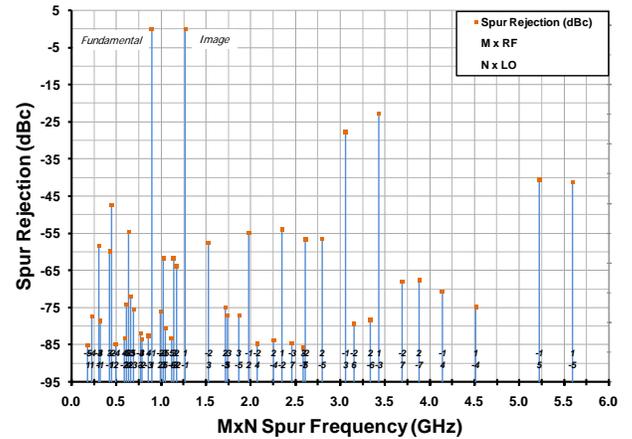
Spur Rejection [ChA, Spur P_{IN} = -5 dBm]



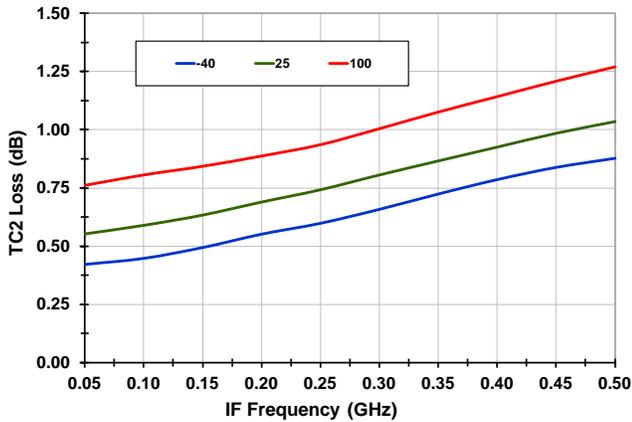
Spur Rejection [ChA, Spur P_{IN} = 0 dBm]



Spur Rejection [ChB, Spur P_{IN} = 0 dBm]

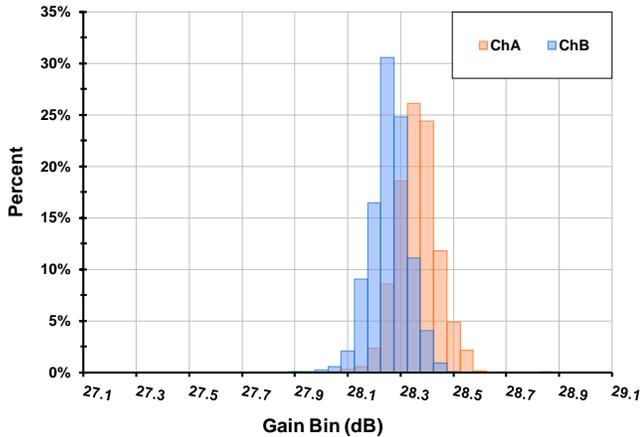


Transformer TC2-7T Loss vs. Temperature

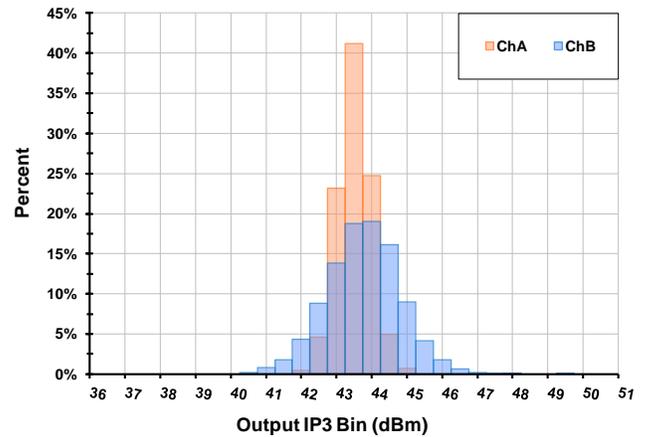


TOCS HISTOGRAMS [N= 4584, T_{CASE} = 25C] (-16-)

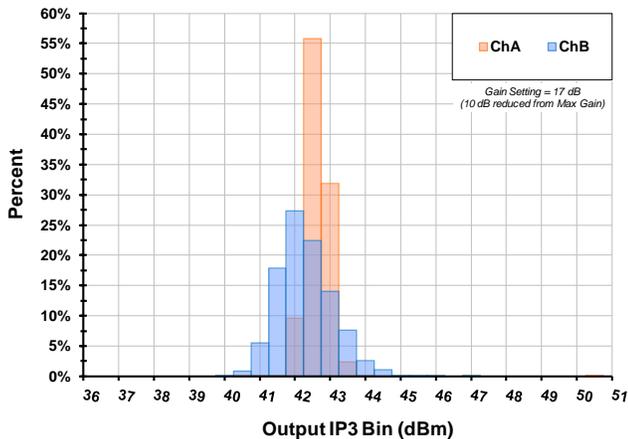
Gain [RF = 850MHz, G_{MAX}]



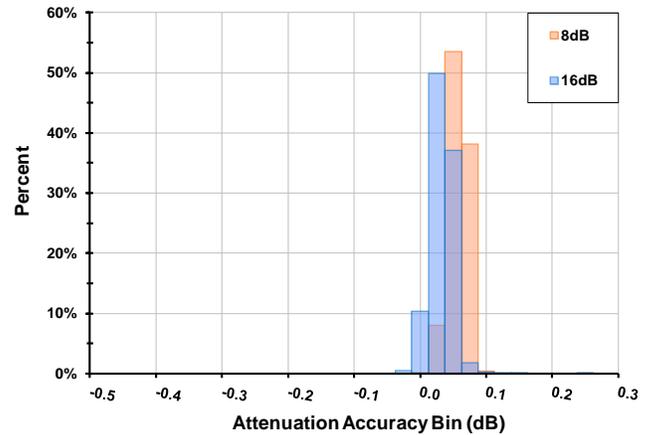
Output IP3 [RF = 850MHz, G_{MAX}]



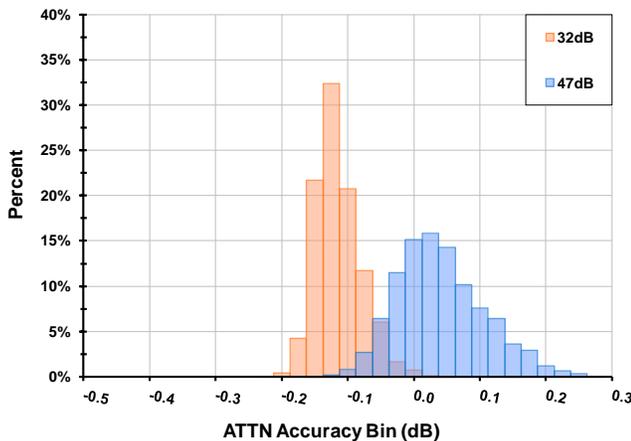
Output IP3 [RF = 850MHz, G₁₇]



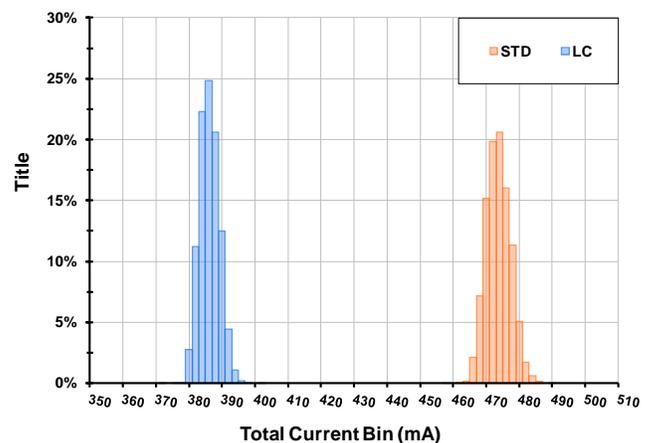
ATTN Accuracy1 [RF = 850MHz, ChB]



ATTN Accuracy2 [RF = 850MHz, ChB]



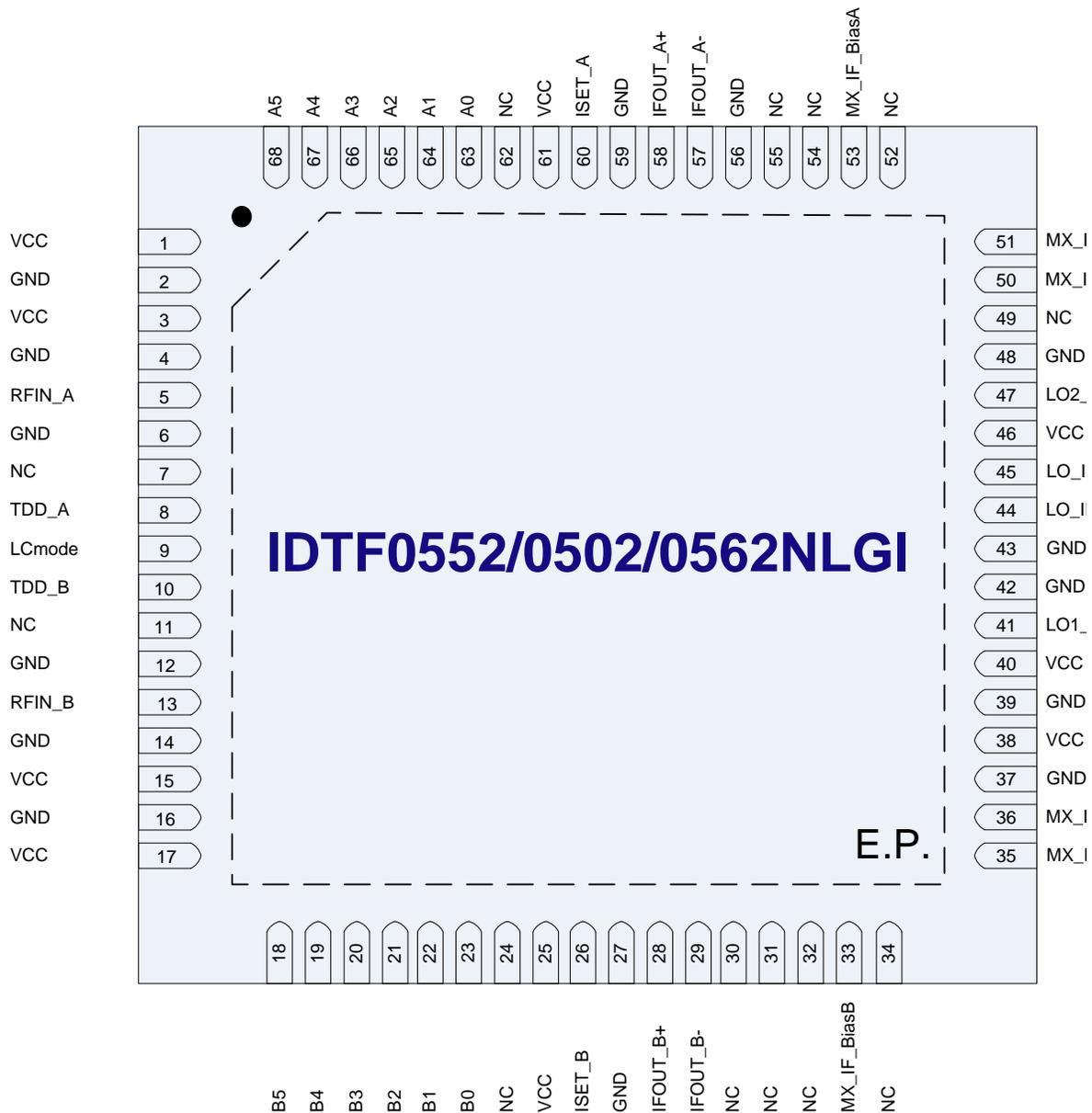
Total I_{CC} [LO = 1034MHz, V_{CC} = 5.00 V]



PACKAGE OUTLINE DRAWINGS

The package outline drawings are located at the end of this document and are accessible from the Renesas website (see Ordering Information for POD links). The package information is the most current data available and is subject to change without revision of this document.

PIN DIAGRAM



PIN DESCRIPTION

| Pin | Name | Function |
|--|-------------|--|
| 1, 3, 15, 17, 25, 38, 40, 46, 61 | VCC | Power Supply. Bypass to GND with capacitors shown in the Typical Application Circuit as close as possible to pin. |
| 2, 4, 6, 12, 14, 16, 27, 37, 39, 42, 43, 48, 56, 59 | GND | Ground these pins. These pins are internally tied to the exposed paddle. |
| 5 | RFIN_A | Main Channel RF Input. Internally matched to 50Ω. DO NOT apply DC to this pin, |
| 7, 11, 24, 30, 31, 32, 34, 49, 52, 54, 55, 62 | NC | No Connection. Not internally connected. OK to connect to VCC, or GND |
| 8 | TDD_A | Standby control for Channel A. Includes an internal pull-up resistor so leave as NC for Standby mode. Set this pin to low or GND for normal operation. |
| 9 | LCmode | Low_Current Mode. Includes an internal pull-up resistor so leave as NC for LC mode. Set this pin to low or GND for STD mode. |
| 10 | TDD_B | Standby control for Channel B. Includes an internal pull-up resistor so leave as NC for Standby mode. Set this pin to low or GND for normal operation. |
| 13 | RFIN_B | Diversity Channel RF Input. Internally matched to 50Ω. DO NOT apply DC to this pin, |
| 18 | B5 | Parallel Gain Control Input - MSB |
| 19 | B4 | Parallel Gain Control Input |
| 20 | B3 | Parallel Gain Control Input |
| 21 | B2 | Parallel Gain Control Input |
| 22 | B1 | Parallel Gain Control Input |
| 23 | B0 | Parallel Gain Control Input – LSB (1 dB step) |
| 26 | ISET_B | ChB VGA Icc set: Recommended resistor value = 3.48kΩ |
| 28 | IFOUT_B+ | Channel B Differential Output +. Pull up to Vcc through an inductor |
| 29 | IFOUT_B- | Channel B Differential Output -. Pull up to Vcc through an inductor |
| 33 | MX_IF_BiasB | Connect the specified resistor for either Standard mode (40.2Ω) or LC mode (62Ω) from this pin to ground to set the bias for the Diversity IF amplifier. This is NOT a current set resistor. |
| 35 | MX_IFB+ | Diversity Mixer Differential IF (+) Output. Connect a pullup inductor from this pin to VCC. |
| 36 | MX_IFB- | Diversity Mixer Differential IF (-) Output. Connect a pullup inductor from this pin to VCC. |

PIN DESCRIPTION (CONTINUED)

| | | |
|----|-------------|--|
| 41 | LO1_ADJ | Connect the specified resistor for either Standard mode (91Ω) or LC mode (180Ω) from this pin to ground to set the LO common buffer Icc. |
| 44 | LO_IN | Local Oscillator Input. Connect the LO to this port through the recommended coupling capacitor. |
| 45 | LO_IN_RTN | Transformer ground return. Ground this pin close to the device |
| 47 | LO2_ADJ | Connect the specified resistor for either Standard mode (1.21kΩ) or LC mode (1.91kΩ) from this pin to ground to set the LO drive buffers Icc. |
| 50 | MX_IFA- | Diversity Mixer Differential IF (-) Output. Connect a pullup inductor from this pin to VCC. |
| 51 | MX_IFA+ | Diversity Mixer Differential IF (+) Output. Connect a pullup inductor from this pin to VCC. |
| 53 | MX_IF_BiasA | Connect the specified resistor for either Standard mode (40.2Ω) or LC mode (62Ω) from this pin to ground to set the bias for the Diversity IF amplifier. This is NOT a current set resistor. |
| 57 | IFOUT_A- | Channel A Differential Output -. Pull up to Vcc through an inductor |
| 58 | IFOUT_A+ | Channel A Differential Output +. Pull up to Vcc through an inductor |
| 60 | ISET_A | ChA VGA Icc set: Recommended resistor value = 3.48kΩ |
| 63 | A0 | Parallel Gain Control Input – LSB (1dB step) |
| 64 | A1 | Parallel Gain Control Input |
| 65 | A2 | Parallel Gain Control Input |
| 66 | A3 | Parallel Gain Control Input |
| 67 | A4 | Parallel Gain Control Input |
| 68 | A5 | Parallel Gain Control Input - MSB |
| 69 | EP | Exposed Pad. Internally connected to GND. Solder this exposed pad to a PCB pad that uses multiple ground vias to provide heat transfer out of the device into the PCB ground planes. These multiple via grounds are also required to achieve the noted RF performance. |

DIGITAL PIN VOLTAGE AND RESISTANCE VALUES

The following table provides open-circuit DC voltage referenced to ground and resistance values for each of the control pins listed.

| Pin | Name | DC Voltage (volts) | Resistance (ohms) |
|---------|--------|--------------------|-------------------|
| 8 | TDD_A | 5V | 50kΩ to Vcc |
| 9 | LCmode | 5V | 50kΩ to Vcc |
| 10 | TDD_B | 5V | 50kΩ to Vcc |
| 18 – 23 | B5-B0 | 5V | 50kΩ to Vcc |
| 63 - 68 | A0-A5 | 5V | 50kΩ to Vcc |

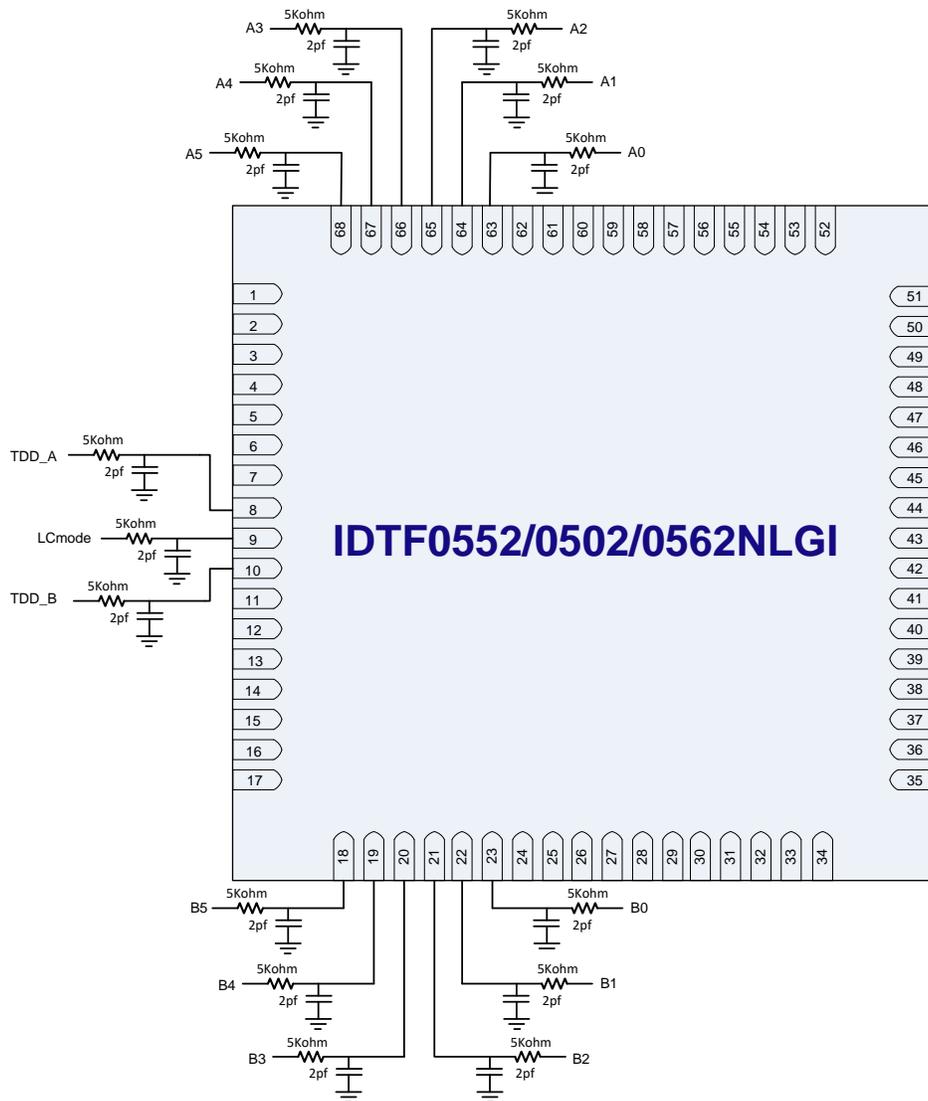
APPLICATIONS INFORMATION

Power Supplies

A common VCC power supply should be used for all pins requiring DC power. All supply pins should be bypassed with external capacitors to minimize noise and fast transients. Supply noise can degrade noise figure and fast transients can trigger ESD clamps and cause them to fail. Supply voltage change or transients should have a slew rate smaller than $1V/20\mu s$. In addition, all control pins should remain at 0V (+/-0.3V) while the supply voltage ramps or while it returns to zero.

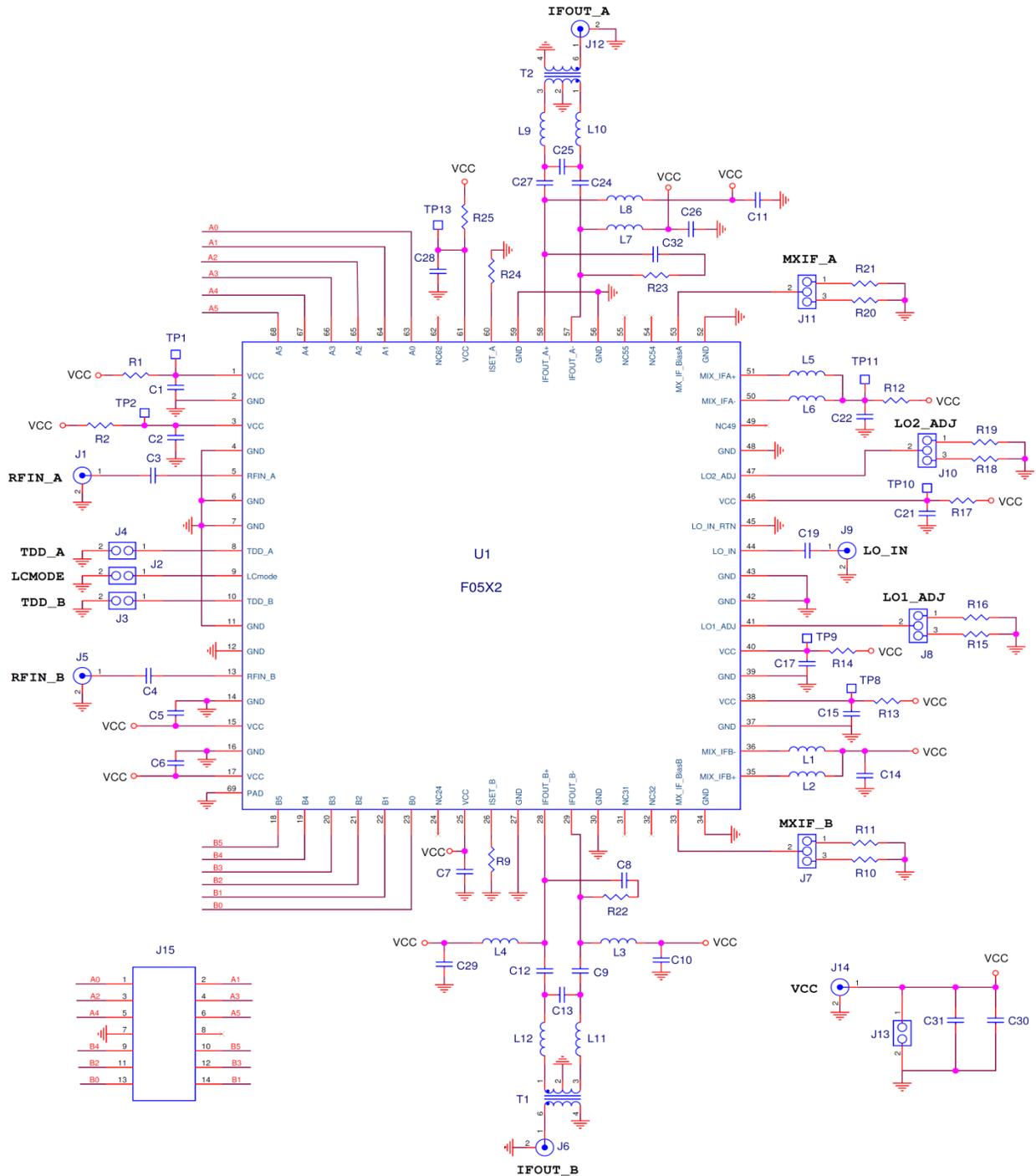
Control Pin Interface

If control signal integrity is a concern and clean signals cannot be guaranteed due to overshoot, undershoot, ringing, etc., provisions for an R-C circuit at the input of each control and data pin is recommended. This applies to pins 8, 9, 10, 18 - 23, and 63 - 68 as shown below.

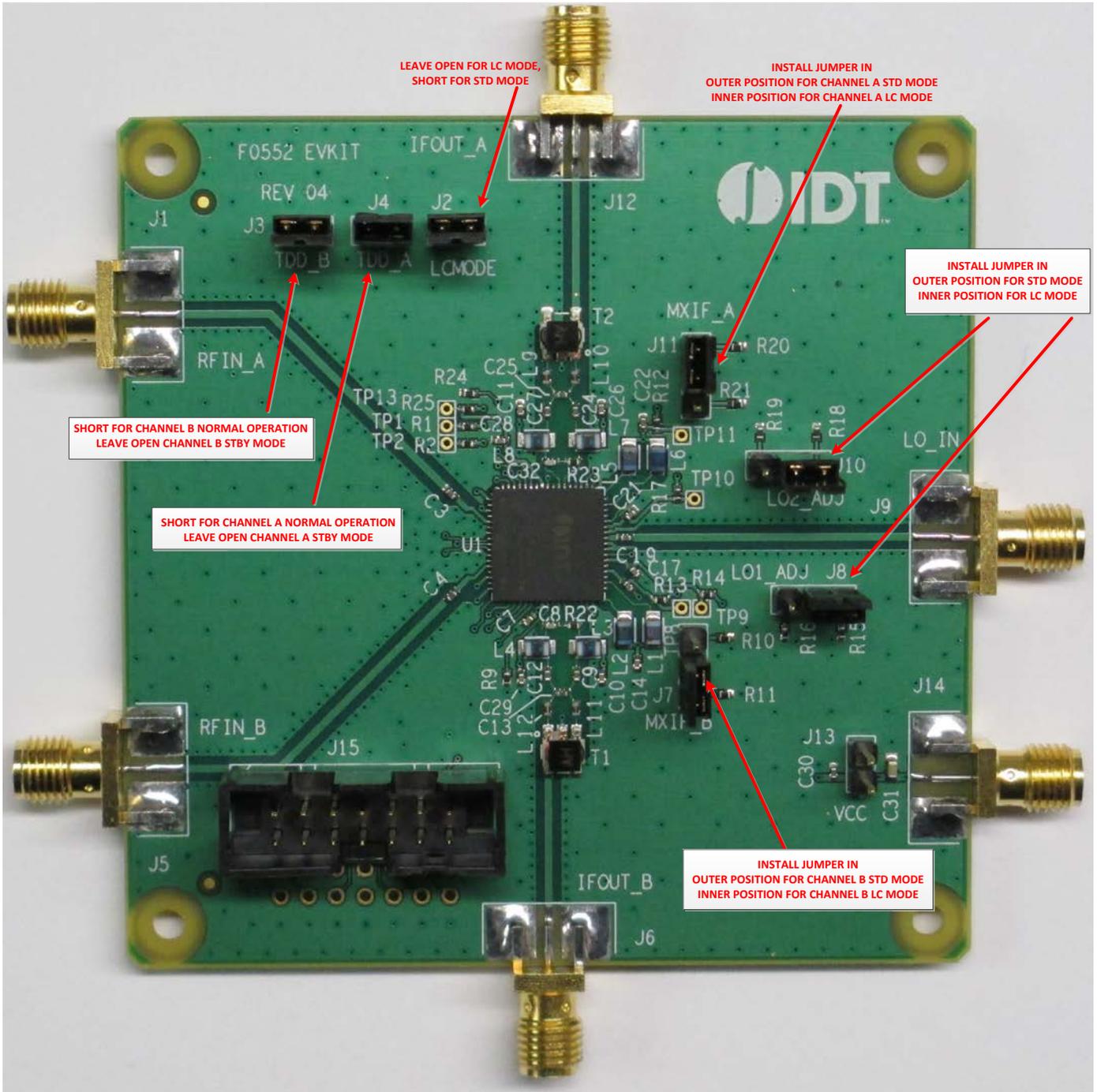


EVKIT AND TYPICAL APPLICATION SCHEMATIC

The following schematic describes the recommended EVkit and applications circuit.



EVKIT PICTURE



BOM 1 AND 2

Two BOMs are included: BOM1 supports the 4:1 output transformation from 200Ω to 50Ω used for production test and BOM2 supports the 2:1 output transformation from 200Ω to 100Ω used to generate the typical operating curve graphs.

- For Standard (STD) Mode, use resistor values in **RED** and short J2 LCMODE jumper (short pin to GND).
- For Low Current (LC) Mode, use resistor values in **BLUE** and open J2 LCMODE jumper (open pin).

BOM1 includes components for 4:1 output transformation supporting production test (IF center frequency 184MHz)

4:1 Transformer, IF = 184MHz 8/13/14

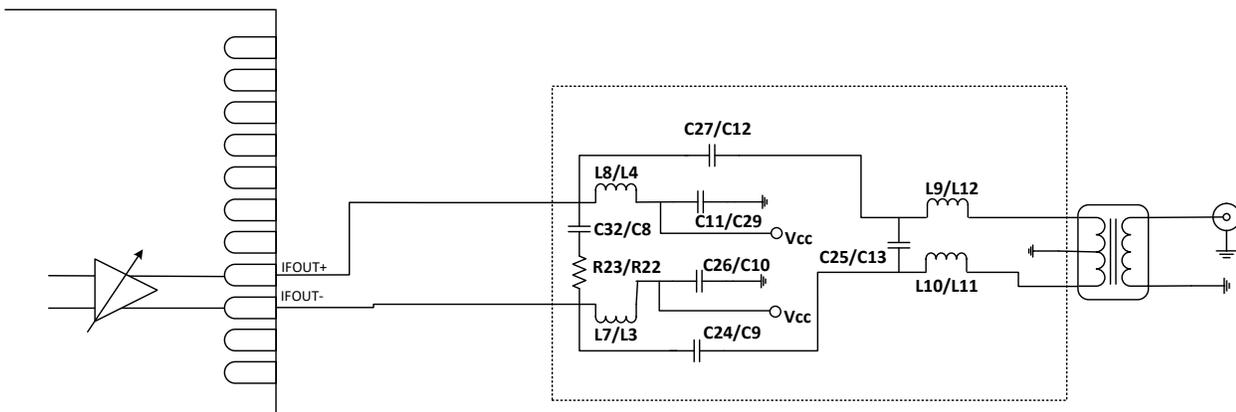
| Part Reference | QTY | DESCRIPTION | Mfr. Part # | Mfr. |
|--|-----|-------------------------------------|--------------------|-----------------|
| C3, 4, 19 | 3 | CAP CER 39PF ±5% 50V C0G (0402) | GRM1555C1H390JZ010 | Murata |
| C9, 12, 24, 27 | 4 | CAP CER 1000PF ±5% 50V C0G (0402) | GRM1555C1H102JA01D | Murata |
| C1, 2, 5, 6, 7, 10, 11, 14, 15, 17, 21, 22, 26, 28, 29, 30 | 16 | CAP CER 10NF ±10% 16V X7R (0402) | GRM155R71C103KA01D | Murata |
| C31 | 1 | CAP CER 10UF ±20% 6.3V X5R (0603) | GRM188R60J106ME47D | Murata |
| C8, 32 | 2 | CAP CER 0.6PF ±0.1PF 50V C0G (0402) | GRM1555C1HR60B | Murata |
| R15 | 1 | RES 91.0 OHM ±1% 1/10W (0402) | ERJ-2RKF91R0X | Panasonic |
| R16 | 1 | RES 180 OHM ±1% 1/10W (0402) | ERJ-2RKF1800X | Panasonic |
| R18 | 1 | RES 1.21K OHM ±1% 1/10W (0402) | ERJ-2RKF1211X | Panasonic |
| R19 | 1 | RES 1.91K OHM ±1% 1/10W (0402) | ERJ-2RKF1911X | Panasonic |
| R10, 21 | 2 | RES 62.0 OHM ±1% 1/10W (0402) | ERJ-2RKF62R0X | Panasonic |
| R9, 24 | 2 | RES 3.48K OHM ±1% 1/10W (0402) | ERJ-2RKF3481X | Panasonic |
| R11, 20 | 2 | RES 40.2 OHM ±1% 1/10W (0402) | ERJ-2RKF40R2X | Panasonic |
| R22, 23 | 2 | RES 100 OHM ±1% 1/10W (0402) | ERJ-2RKF1000X | Panasonic |
| R1, 2, 12, 13, 14, 17, 25, L9-L12 | 11 | RES 0.0 OHM 1/10W (0402) | ERJ-2GE0R00X | Panasonic |
| L1-8 | 8 | IND 390nH ±5% 0805CS (2012) | 0805CS-391XJLB | Coilcraft |
| J6, 12, 14 | 3 | SMA END LAUNCH (Big) | 142-0701-851 | Emerson Johnson |
| J1, 5, 9 | 3 | SMA END LAUNCH (small) | 142-0711-821 | Emerson Johnson |
| J15 | 1 | CONN HEADER VERT SGL 7 x 2 POS GOLD | N2514-6002-RB | 3M |
| J2, 3, 4, 13 | 4 | CONN HEADER VERT SGL 2 x 1 POS GOLD | 961102-6404-AR | 3M |
| J7, 8, 10, 11 | 4 | CONN HEADER VERT SGL 3 x 1 POS GOLD | 961103-6404-AR | 3M |
| T1, 2 | 2 | 4:1 Center Tap Balun (SM-22) | TC4-1WG2+ | Mini Circuits |
| U1 | 1 | Sampling IF receiver (TQFN-68) | F0502 | IDT |
| C13, 25 | | Not Installed CER CAP (0402) | | |
| | 1 | Printed Circuit Board | F0502 EVKit Rev 04 | |

BOM2 includes components for 2:1 output transformation used for TOCs (IF center frequency 184MHz +/- 40MHz)

2:1 Transformer, IF = 184MHz 8/13/14

| Part Reference | QTY | DESCRIPTION | Mfr. Part # | Mfr. |
|---|-----|-------------------------------------|--------------------|-----------------|
| C3, 4, 19 | 3 | CAP CER 150PF ±5% 50V C0G (0402) | GRM1555C1H151JA01D | Murata |
| C9,12, 24, 27 | 4 | CAP CER 20PF ±5% 50V C0G (0402) | GRM1555C1H200JZ01D | Murata |
| C1, 2, 5, 6, 7, 10, 11, 14,15, 17, 21, 22, 26, 28, 29, 30 | 16 | CAP CER 10NF ±10%16V X7R (0402) | GRM155R71C103KA01D | Murata |
| C31 | 1 | CAP CER 10UF ±20% 6.3V X5R (0603) | GRM188R60J106ME47D | Murata |
| C13, 25 | 2 | CAP CER 3PF ±0.25PF 50V C0G (0402) | GRM1555C1H3R0CZ01D | Murata |
| C8, 32 | 2 | CAP CER 0.6PF ±0.1pF 50V C0G (0402) | GRM1555C1HR60BB01D | Murata |
| R15 | 1 | RES 91.0 OHM ±1% 1/10W (0402) | ERJ-2RKF91R0X | Panasonic |
| R16 | 1 | RES 180 OHM ±1% 1/10W (0402) | ERJ-2RKF1800X | Panasonic |
| R18 | 1 | RES 1.21K OHM ±1% 1/10W (0402) | ERJ-2RKF1211X | Panasonic |
| R19 | 1 | RES 1.91K OHM ±1% 1/10W (0402) | ERJ-2RKF1911X | Panasonic |
| R10, 21 | 2 | RES 62.0 OHM ±1% 1/10W (0402) | ERJ-2RKF62R0X | Panasonic |
| R9, 24 | 2 | RES 3.48K OHM ±1% 1/10W (0402) | ERJ-2RKF3481X | Panasonic |
| R11, 20 | 2 | RES 40.2 OHM ±1% 1/10W (0402) | ERJ-2RKF40R2X | Panasonic |
| R22, 23 | 2 | RES 100 OHM ±1% 1/10W (0402) | ERJ-2RKF1000X | Panasonic |
| R1, 2, 12, 13, 14, 17, 25 | 7 | RES 0.0 OHM 1/10W (0402) | ERJ-2GE0R00X | Panasonic |
| L1, 2, 5, 6 | 4 | IND 390nH ±5% 0805CS (2012) | 0805CS-391XJLB | Coilcraft |
| L3, 4, 7, 8 | 4 | IND 150nH ±5% 0805CS (2012) | 0805CS-151XJLB | Coilcraft |
| L9-12 | 4 | IND 30nH ±5% 0402CS | 0402CS-30NXJLU | Coilcraft |
| J1, 5, 9 | 3 | SMA END LAUNCH (Big) | 142-0701-851 | Emerson Johnson |
| J6,12,14 | 3 | SMA END LAUNCH (small) | 142-0711-821 | Emerson Johnson |
| J15 | 1 | CONN HEADER VERT SGL 7 x 2 POS GOLD | N2514-6002-RB | 3M |
| J2, 3, 4, 13 | 4 | CONN HEADER VERT SGL 2 x 1 POS GOLD | 961102-6404-AR | 3M |
| J7, 8, 10, 11 | 4 | CONN HEADER VERT SGL 3 x 1 POS GOLD | 961103-6404-AR | 3M |
| T1, 2 | 2 | 2:1 Center Tap Balun (SM-22) | TC2-72T+ | Mini Circuits |
| U1 | 1 | Sampling IF receiver (TQFN -68) | F0502 | IDT |
| | 1 | Printed Circuit Board | F0502EV Kit Rev 04 | |

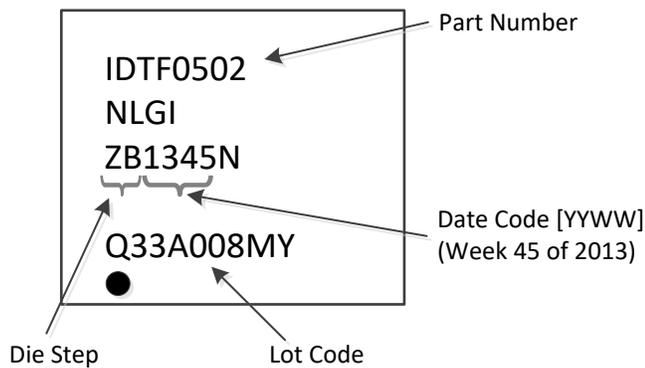
IF BIAS AND OUTPUT MATCHING CIRCUIT AND BOM FOR VARIOUS IFs



IF NETWORK BOM FOR DIFFERENT FREQUENCIES

| Item # | Part Reference | Value | | | | Unit |
|--------|----------------|--------------|-------------------|---------------|---------------|------|
| | | IF frequency | | | | |
| | | 80 (60-100) | 138, 184 (98-240) | 276 (190-316) | 330 (250-410) | MHz |
| 1 | C9, 12, 24, 27 | 75 | 20 | 8 | 6 | pF |
| 2 | C13,25 | 11 | 3 | 1.2 | 0.7 | pF |
| 3 | C8, C32 | 0.6 | 0.6 | 0.6 | 0.6 | pF |
| 4 | R22, R23 | 100 | 100 | 100 | 100 | ohm |
| 5 | L3, 4, 7, 8 | 220 | 150 | 82 | 56 | nH |
| 6 | L9-12 | 36 | 30 | 24 | 18 | nH |

TOP MARKING

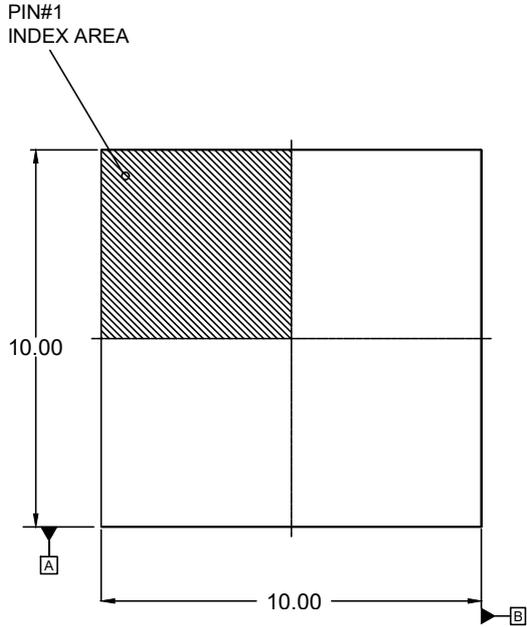


ORDERING INFORMATION

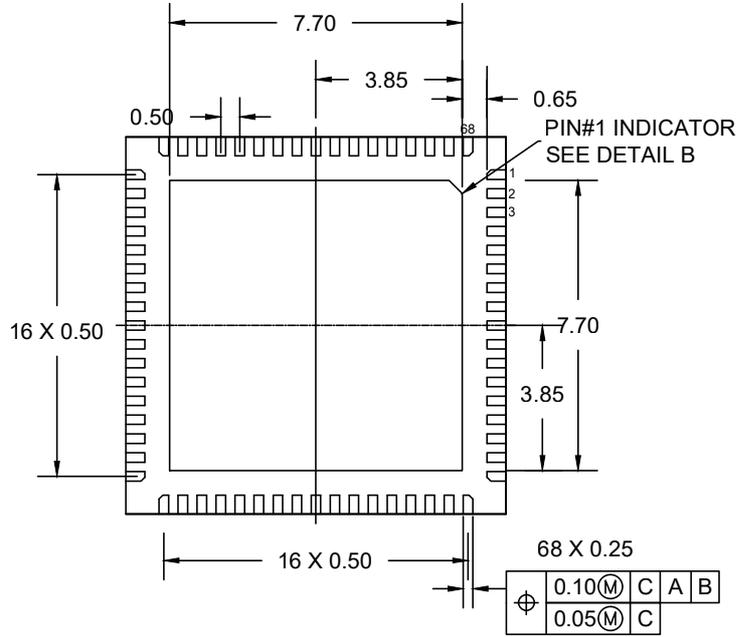
| Part Number | Package Description | Carrier Type | Temperature Range |
|-------------|--|---------------|-------------------|
| F0502NLGI | 68-VFQFPN , 10 × 10 mm | Tape and Reel | -40°C to +85°C |
| F0502NLGI8 | | Tray | |

REVISION HISTORY

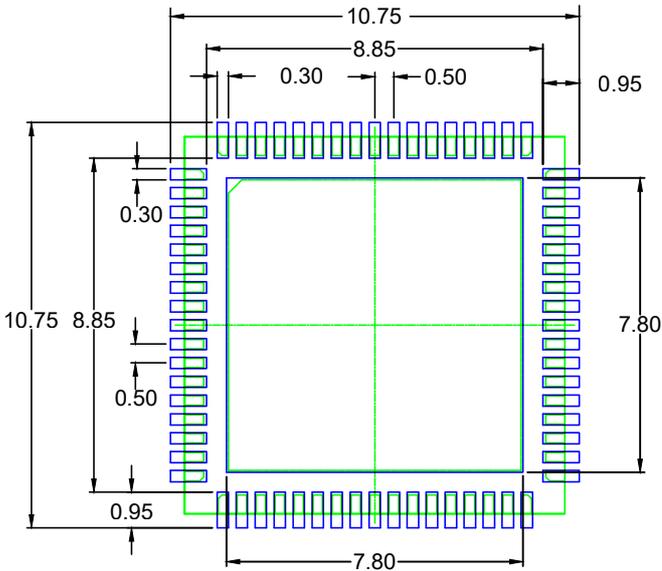
| Revision Date | Description |
|------------------|-----------------------|
| February 8, 2022 | Rebranded to Renesas. |
| July 20, 2016 | Initial release. |



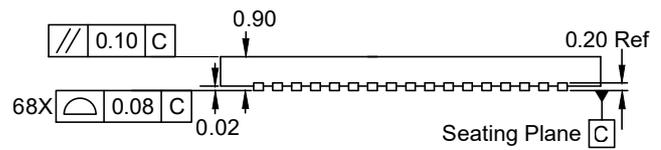
TOP VIEW



BOTTOM VIEW



RECOMMENDED LAND PATTERN DIMENSION



SIDE VIEW

NOTES:

1. All dimension are in mm, angles in degrees.
2. Top down view, as viewed on PC.
3. Land pattern in blue. NSMD land pattern assumed.
4. Land pattern recommendation as per IPC-7351B generic requirement for surface mount design and land pattern.