

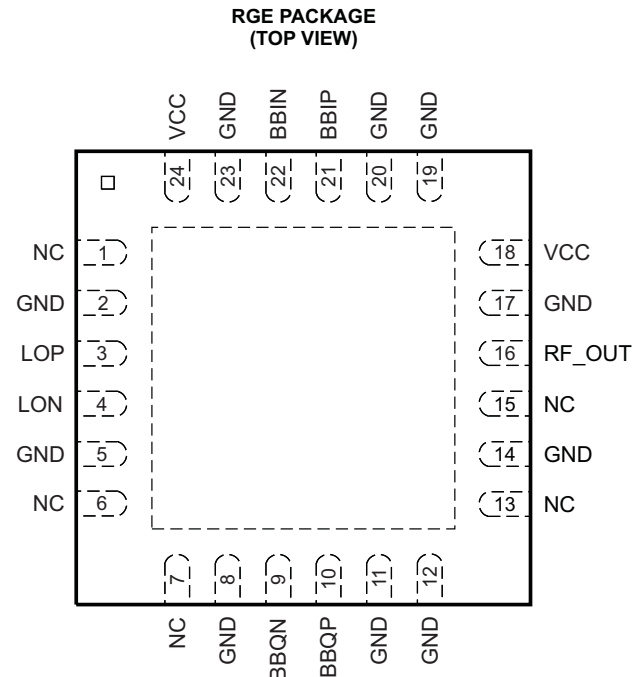
0.4-GHz TO 4-GHz QUADRATURE MODULATOR

FEATURES

- 75-dBc Single-Carrier WCDMA ACPR at –11-dBm Channel Power
- Very Low Noise Floor: –163 dBm/Hz
- OPI3 of 23 dBm
- P1dB of 9 dBm
- Unadjusted Carrier Feedthrough of –40 dBm
- Unadjusted Side-Band Suppression of –40 dBc
- Single Supply: 4.5 V–5.5 V Operation
- Silicon Germanium Technology
- TRF370333 With 3.3-V CM at I, Q Baseband Inputs
- TRF370315 With 1.5-V CM at I, Q Baseband Inputs

APPLICATIONS

- Cellular Base Transceiver Station Transmit Channel
- CDMA: IS95, UMTS, CDMA2000, TD-SCDMA
- TDMA: GSM, IS-136, EDGE/UWC-136
- Wireless Local Loop
- Wireless MAN Wideband Transceivers



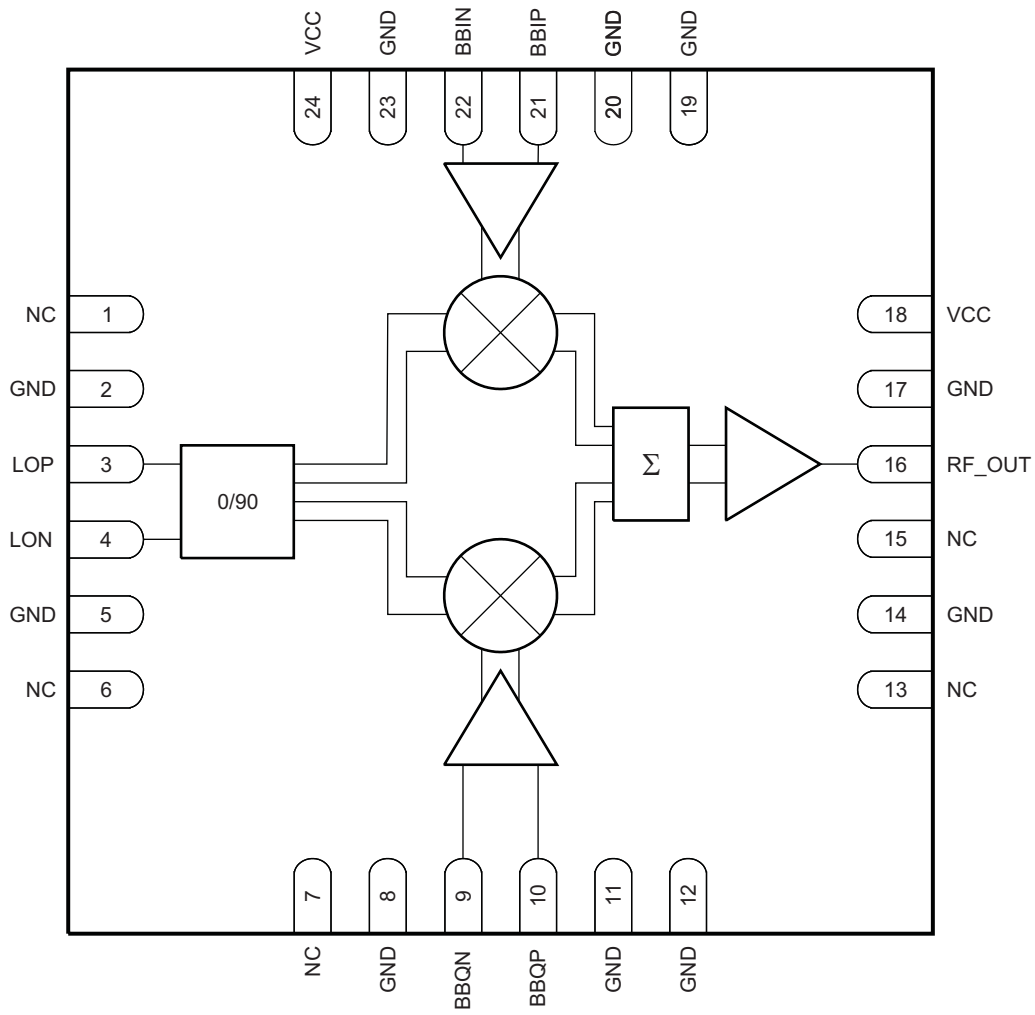
DESCRIPTION

The TRF3703 is a very low-noise direct quadrature modulator, capable of converting complex modulated signals from baseband or IF directly up to RF. The TRF3703 is ideal for high-performance direct RF modulation from 400 MHz up to 4 GHz. The modulator is implemented as a double-balanced mixer. The RF output block consists of a differential to single-ended converter and an RF amplifier capable of driving a single-ended 50-Ω load without any need of external components. The TRF3703 comes in two types, TRF370333 and TRF370315. The TRF370333 and TRF370315 devices have different common-mode voltage ratings at the I, Q baseband inputs. The TRF370333 requires a 3.3-V common-mode voltage, and the TRF370315 requires a 1.5-V common-mode voltage.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

Functional Block Diagram



NOTE: NC = No connection

B0175-01



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

DEVICE INFORMATION

TERMINAL FUNCTIONS

TERMINAL		I/O	DESCRIPTION
NAME	NO.		
BBIN	22	I	In-phase input
BBIP	21	I	In-phase input
BBQN	9	I	In-quadrature input
BBQP	10	I	In-quadrature input
GND	2, 5, 8, 11, 12, 14, 17, 19, 20, 23	–	Ground
LON	4	I	Local oscillator input
LOP	3	I	Local oscillator input
NC	1, 6, 7, 13, 15	–	No connect
RF_OUT	16	O	RF output
VCC	18, 24	–	Power supply

ABSOLUTE MAXIMUM RATINGS⁽¹⁾

over operating free-air temperature range (unless otherwise noted)

	VALUE ⁽²⁾	UNIT
Supply voltage range	–0.3 V to 6	V
Digital I/O voltage range	–0.3 V to $V_I + 0.3$	V
T_J Operating virtual junction temperature range	–40 to 150	°C
T_A Operating ambient temperature range	–40 to 85	°C
T_{stg} Storage temperature range	–65 to 150	°C

(1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

(2) All voltage values are with respect to network ground terminal.

RECOMMENDED OPERATING CONDITIONS

over operating free-air temperature range (unless otherwise noted)

	MIN	NOM	MAX	UNIT
V_{CC} Power-supply voltage	4.5	5	5.5	V

THERMAL CHARACTERISTICS

PARAMETER	TEST CONDITIONS	VALUE	UNIT
$R_{\theta JA}$ Thermal resistance, junction-to-ambient	High-K board, still air	64.33	°C/W
$R_{\theta JC}$ Thermal resistance, junction-to-case		49.3	°C/W

ELECTRICAL CHARACTERISTICS

over operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
DC Parameters						
I_{CC}	Total supply current (1.5 V CM)	$T_A = 25^\circ\text{C}$		195	205	mA
	Total supply current (3.3 V CM)	$T_A = 25^\circ\text{C}$		210	235	
LO Input (50-Ω, Single-Ended)						
f_{LO}	LO frequency range		0.4		4	GHz
	LO input power		-5	0	12	dBm
	LO port return loss			15		dB
Baseband Inputs						
V_{CM}	I and Q input dc common voltage	TRF370333		3.3		V
		TRF370315		1.5		
BW	1-dB input frequency bandwidth		350			MHz
$Z_{I(\text{single ended})}$	Input impedance, resistance	TRF370333		10		k Ω
	Input impedance, parallel capacitance			3		pF
	Input impedance, resistance	TRF370315		5		k Ω
	Input impedance, parallel capacitance			3		pF

ELECTRICAL CHARACTERISTICSover recommended operating conditions, power supply = 5 V, $T_A = 25^\circ\text{C}$, $f_{LO} = 400\text{ MHz}$ at 0 dBm (unless otherwise noted)

RF Output Parameters						
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
G	Voltage gain	Output rms voltage over input I (or Q) rms voltage		-2.3		dB
P1dB	Output compression point			9.4		dBm
IP3	Output IP3		20	23		dBm
IP2	Output IP2	Measured at $f_{LO} + 2 \times f_{BB}$		62		dBm
	Carrier feedthrough	Unadjusted		-37		dBm
	Sideband suppression	Unadjusted		-39		dBc

ELECTRICAL CHARACTERISTICS

over recommended operating conditions, power supply = 5 V, $T_A = 25^\circ\text{C}$, $f_{LO} = 900\text{ MHz}$ at 0 dBm (unless otherwise noted)

RF Output Parameters					
PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
G	Voltage gain	Output rms voltage over input I (or Q) rms voltage		-4.1	dB
P1dB	Output compression point			9	dBm
IP3	Output IP3	20	23		dBm
IP2	Output IP2	Measured at $f_{LO} + 2 \times f_{BB}$		63	dBm
	Carrier feedthrough	Unadjusted		-37	dBm
	Sideband suppression	Unadjusted		-42	dBc
	Output return loss			9	dB
	Output noise floor	DC only to BB inputs, 13 MHz offset from f_{LO}		-160.4	dBm/Hz
		1.8-MHz offset from f_{LO} ; 1 CW tone; $P_{out} = 0\text{ dBm}$		-156.6	
		6-MHz offset from f_{LO} ; 1 CW tone; $P_{out} = 0\text{ dBm}$		-158.5	
EVM	Error vector magnitude (rms)	1 EDGE signal, $P_{out} = -5\text{ dBm}$		0.59%	
		1 EDGE signal, $P_{out} = 0\text{ dBm}$		0.63%	
		1 EDGE signal, $P_{out} = 0\text{ dBm}$, 2nd harmonic of LO = -15 dBm, 3rd harmonic of LO = -33 dBm ⁽¹⁾		1%	

(1) The second- and third-harmonic tests were made independently at each frequency.

ELECTRICAL CHARACTERISTICS

over recommended operating conditions, power supply = 5 V, $T_A = 25^\circ\text{C}$, $f_{LO} = 1800\text{ MHz}$ at 0 dBm (unless otherwise noted)

RF Output Parameters					
PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
G	Voltage gain	Output rms voltage over input I (or Q) rms voltage		-4.4	dB
P1dB	Output compression point			9.5	dBm
IP3	Output IP3	20	23		dBm
IP2	Output IP2	Measured at $f_{LO} + 2 \times f_{BB}$		55	dBm
	Carrier feedthrough	Unadjusted		-40	dBm
	Sideband suppression	Unadjusted		-47	dBc
	Output return loss			8	dB
	Output noise floor	DC only to BB inputs, 13 MHz offset from f_{LO}		-162.6	dBm/Hz
		1.8-MHz offset from f_{LO} ; 1 CW tone; $P_{out} = 0\text{ dBm}$		-160	
		6-MHz offset from f_{LO} ; 1 CW tone; $P_{out} = 0\text{ dBm}$		-159.4	
EVM	Error vector magnitude (rms)	1 EDGE signal, $P_{out} = -5\text{ dBm}$		0.66%	
		1 EDGE signal, $P_{out} = 0\text{ dBm}$		0.74%	
		1 EDGE signal, $P_{out} = 0\text{ dBm}$, 2nd harmonic of LO = -15.5 dBm, 3rd harmonic of LO = -30 dBm ⁽¹⁾		1%	

(1) The second- and third-harmonic tests were made independently at each frequency.

ELECTRICAL CHARACTERISTICS

over recommended operating conditions, power supply = 5 V, $T_A = 25^\circ\text{C}$, $f_{LO} = 2140\text{ MHz}$ at 0 dBm (unless otherwise noted)

RF Output Parameters					
PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
G	Voltage gain	Output rms voltage over input I (or Q) rms voltage		-4.5	dB
P1dB	Output compression point			9.5	dBm
IP3	Output IP3	18	21		dBm
IP2	Output IP2	Measured at $f_{LO} + 2 \times f_{BB}$		58	dBm
	Carrier feedthrough	Unadjusted		-40	dBm
	Sideband suppression	Unadjusted		-47	dBc
	Output return loss			8.5	dB
	Output noise floor	20-MHz offset from f_{LO} ; dc only to BB inputs		-163	dBm/Hz
		20-MHz offset from f_{LO} ; 1 WCDMA signal; $P_{in} = -20.5\text{ dBVrms}$ (I and Q input)		-162	
ACPR	Adjacent-channel power ratio	1 WCDMA signal; $P_{out} = -13\text{ dBm}$		-75.8	dBc
		1 WCDMA signal; $P_{out} = -9\text{ dBm}$		-72	
		4 WCDMA signals; $P_{out} = -23\text{ dBm}$ per carrier		-68	
	Alternate-channel power ratio	1 WCDMA signal; $P_{out} = -13\text{ dBm}$		-79	dBc
		1 WCDMA signal; $P_{out} = -9\text{ dBm}$		-80.5	
		4 WCDMA signals; $P_{out} = -23\text{ dBm}$ per carrier		-69	

ELECTRICAL CHARACTERISTICS

over recommended operating conditions, power supply = 5 V, $T_A = 25^\circ\text{C}$, $f_{LO} = 2500\text{ MHz}$ at 0 dBm (unless otherwise noted)

RF Output Parameters					
PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
G	Voltage gain	Output rms voltage over input I (or Q) rms voltage		-4.4	dB
P1dB	Output compression point			9.5	dBm
IP3	Output IP3	18	21		dBm
IP2	Output IP2	Measured at $f_{LO} + 2 \times f_{BB}$		63	dBm
	Carrier feedthrough	Unadjusted		-38	dBm
	Sideband suppression	Unadjusted		-47	dBc

ELECTRICAL CHARACTERISTICS

over recommended operating conditions, power supply = 5 V, $T_A = 25^\circ\text{C}$, $f_{LO} = 3600\text{ MHz}$ at 0 dBm (unless otherwise noted)

RF Output Parameters					
PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
G	Voltage gain	Output rms voltage over input I (or Q) rms voltage		-3.5	dB
P1dB	Output compression point			9.5	dBm
IP3	Output IP3	20	23		dBm
IP2	Output IP2	Measured at $f_{LO} + 2 \times f_{BB}$		63	dBm
	Carrier feedthrough	Unadjusted		-41	dBm
	Sideband suppression	Unadjusted		-45	dBc

ELECTRICAL CHARACTERISTICS

over recommended operating conditions, power supply = 5 V, $T_A = 25^\circ\text{C}$, $f_{LO} = 4000 \text{ MHz}$ at 0 dBm (unless otherwise noted)

RF Output Parameters						
	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
G	Voltage gain	Output rms voltage over input I (or Q) rms voltage		-4.5		dB
P1dB	Output compression point			9		dBm
IP3	Output IP3		19	22		dBm
IP2	Output IP2	Measured at $f_{LO} + 2 \times f_{BB}$		50		dBm
	Carrier feedthrough	Unadjusted		-37		dBm
	Sideband suppression	Unadjusted		-40		dBc

TYPICAL CHARACTERISTICS

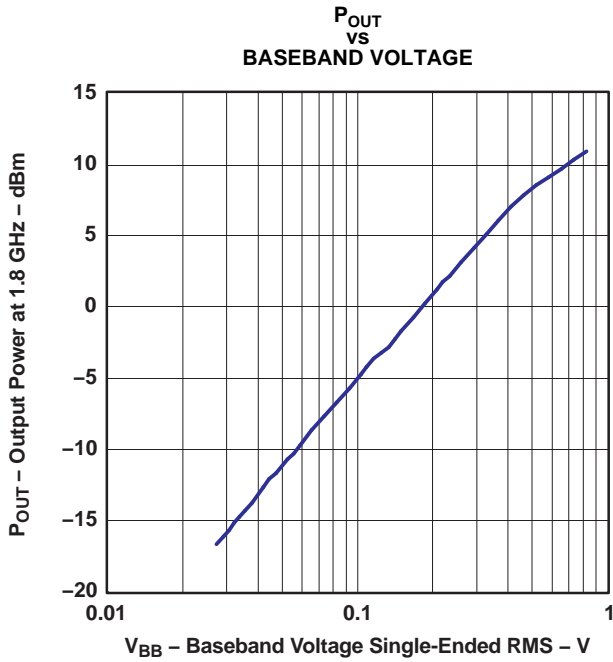


Figure 1.

G023

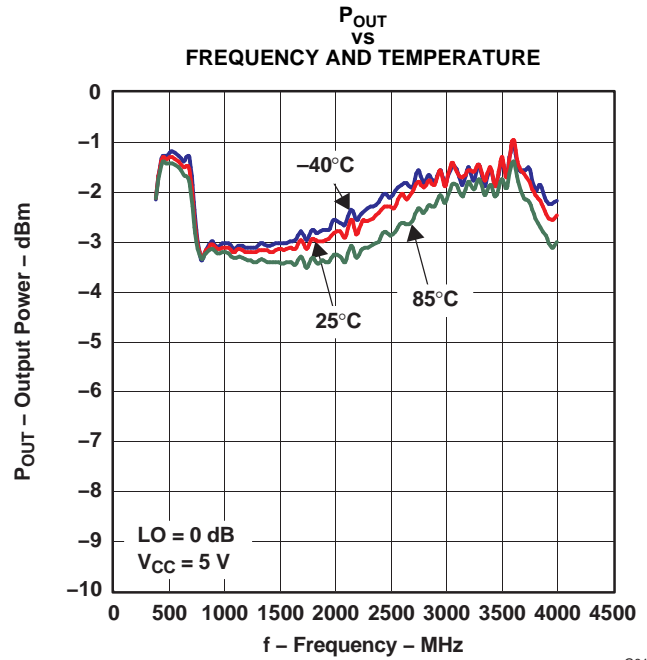


Figure 2.

G010

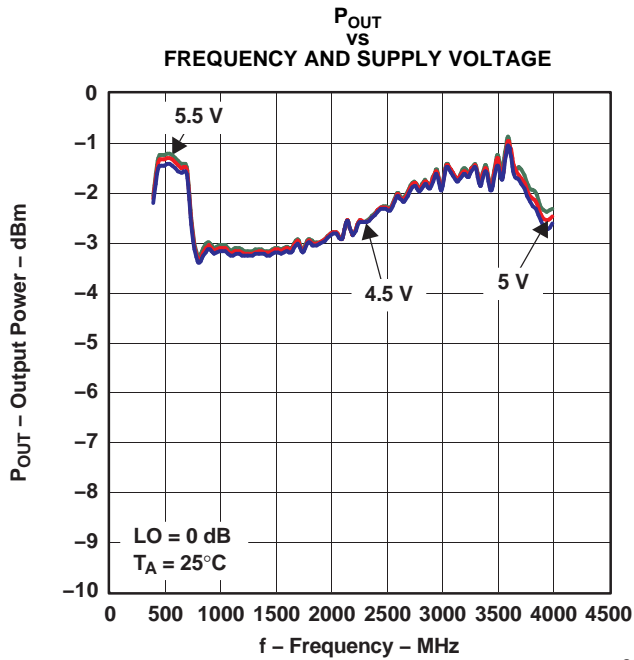


Figure 3.

G011

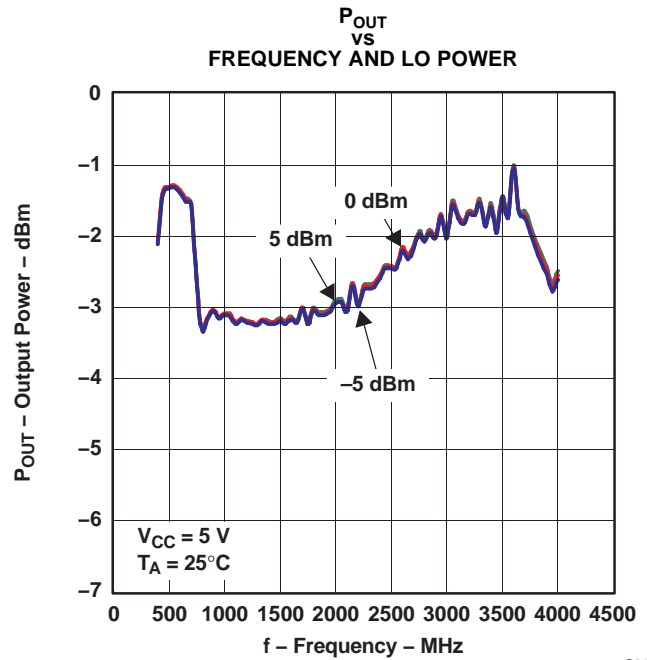
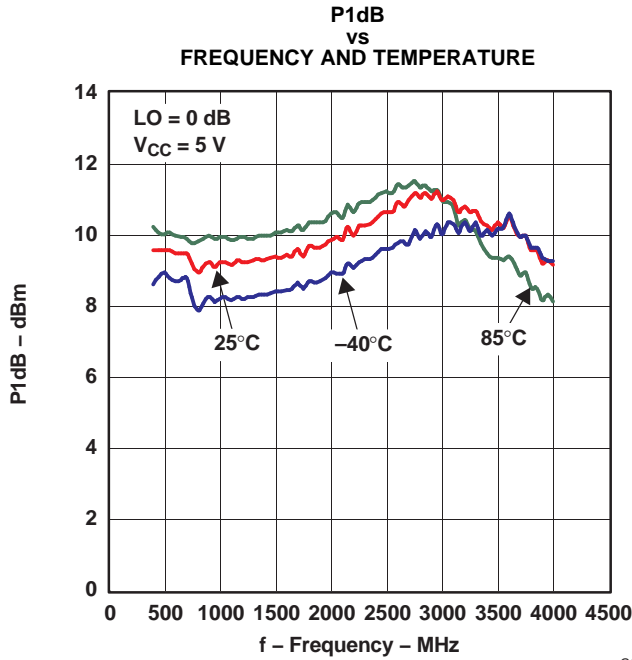


Figure 4.

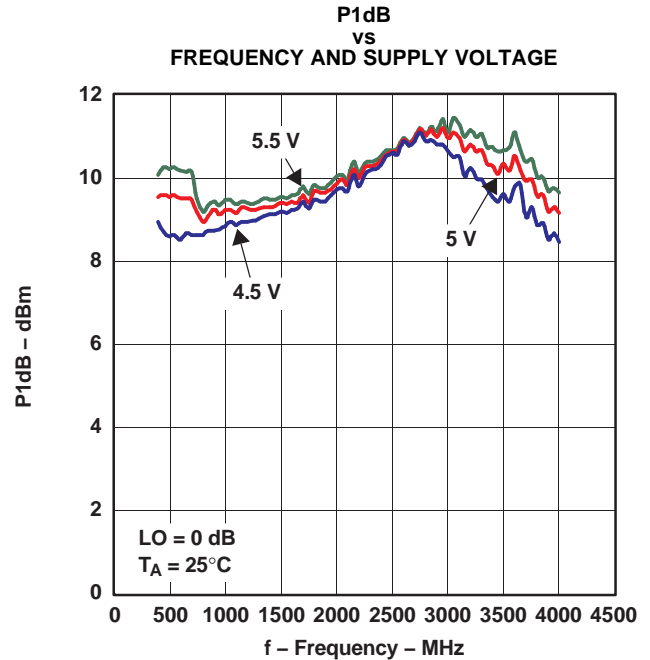
G012

TYPICAL CHARACTERISTICS (continued)



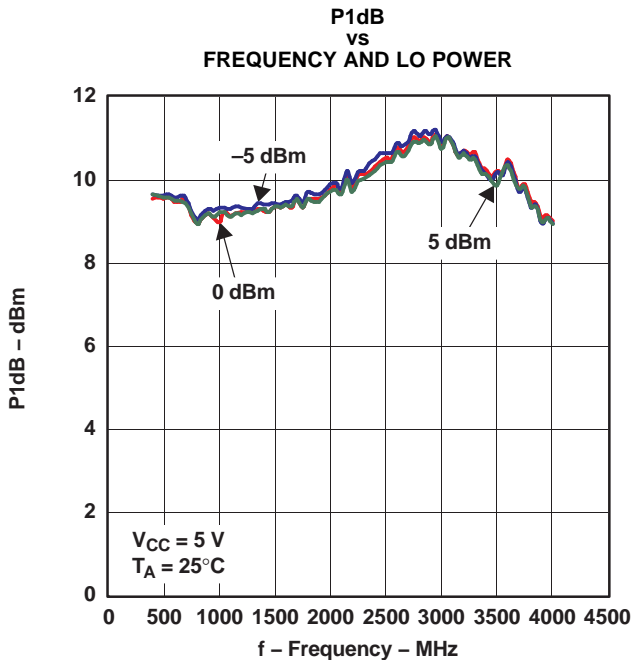
G001

Figure 5.



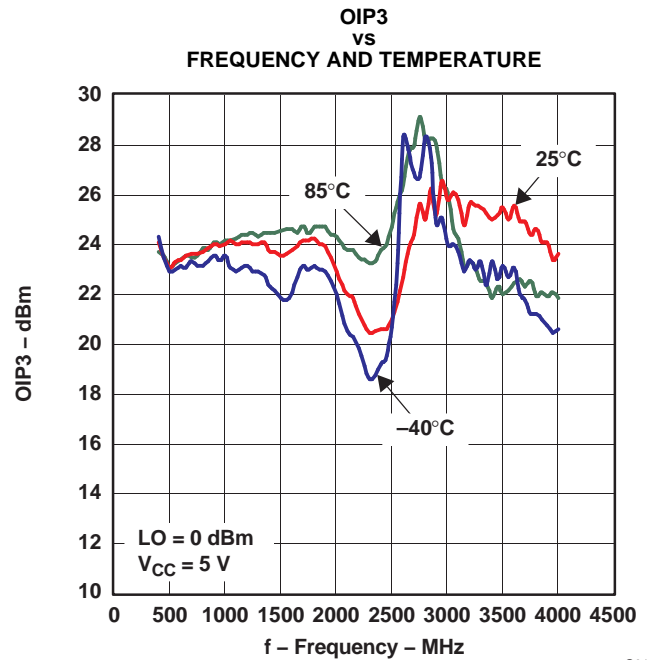
G002

Figure 6.



G003

Figure 7.



G014

Figure 8.

TYPICAL CHARACTERISTICS (continued)

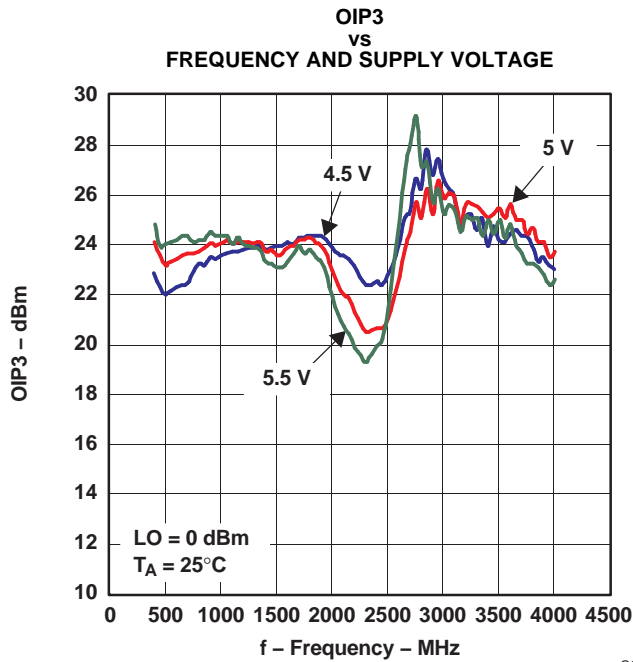


Figure 9.

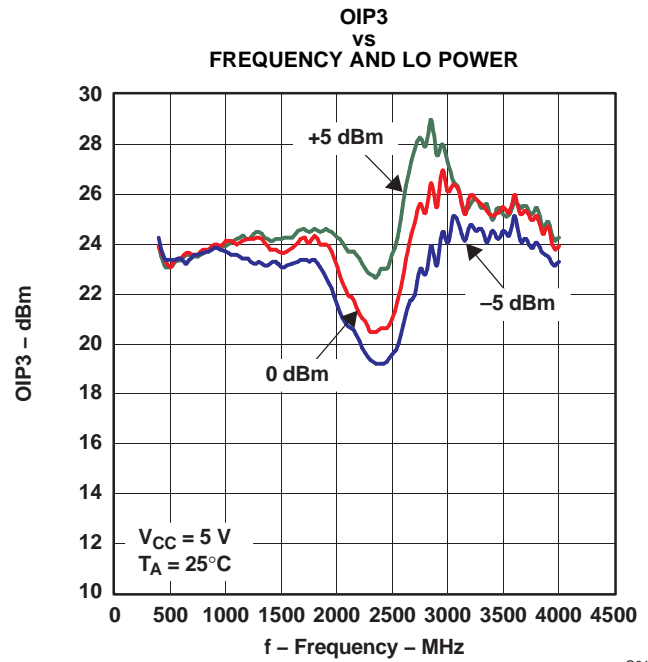


Figure 10.

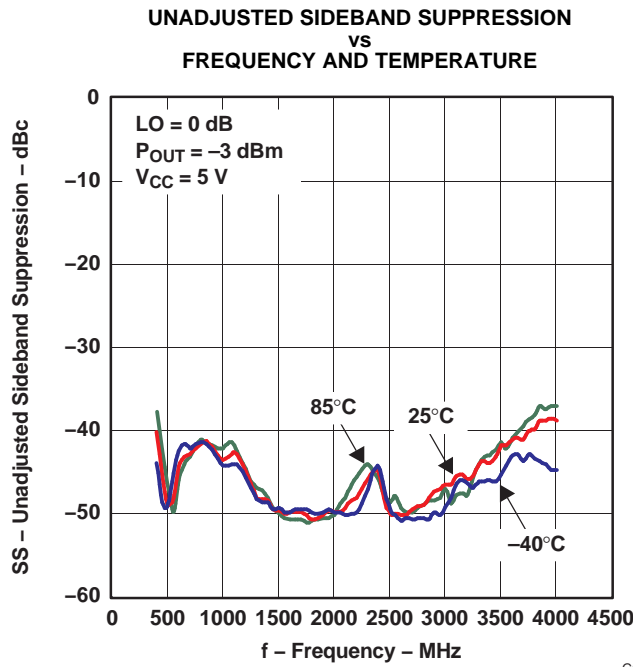


Figure 11.

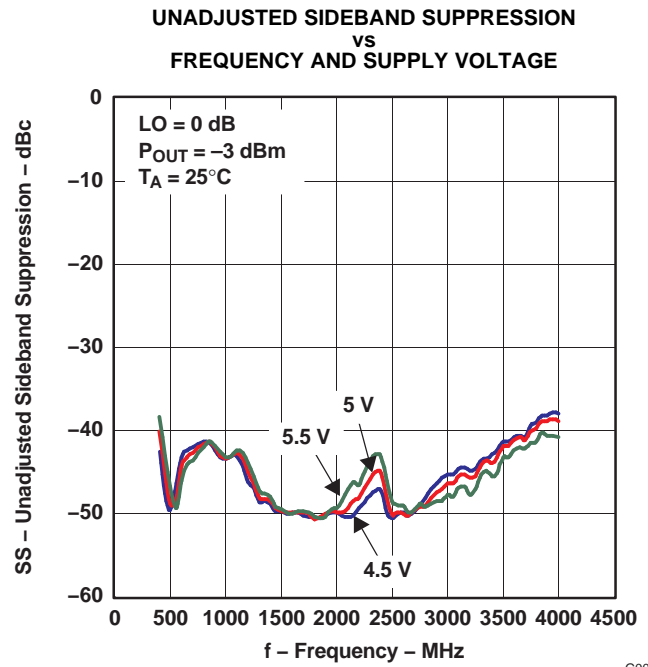


Figure 12.

TYPICAL CHARACTERISTICS (continued)

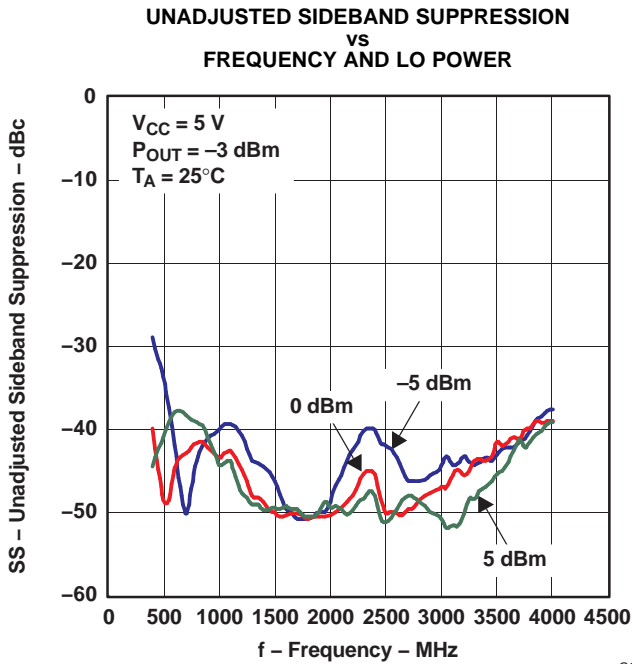


Figure 13.

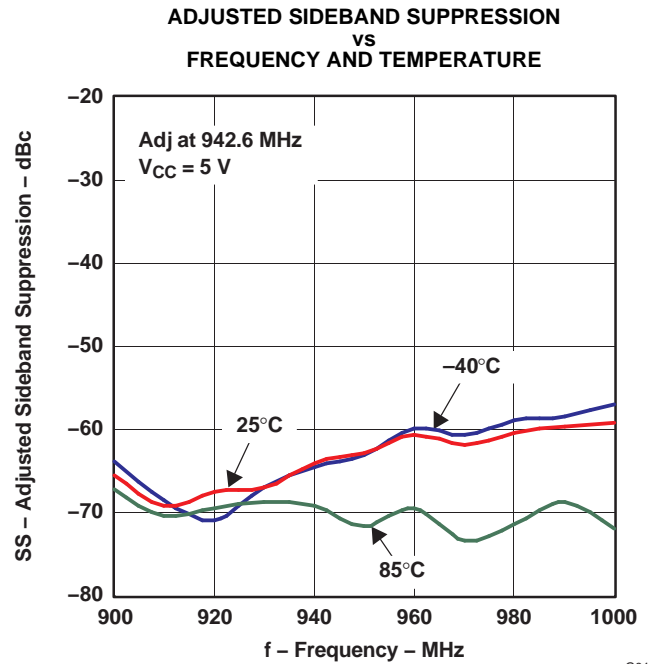


Figure 14.

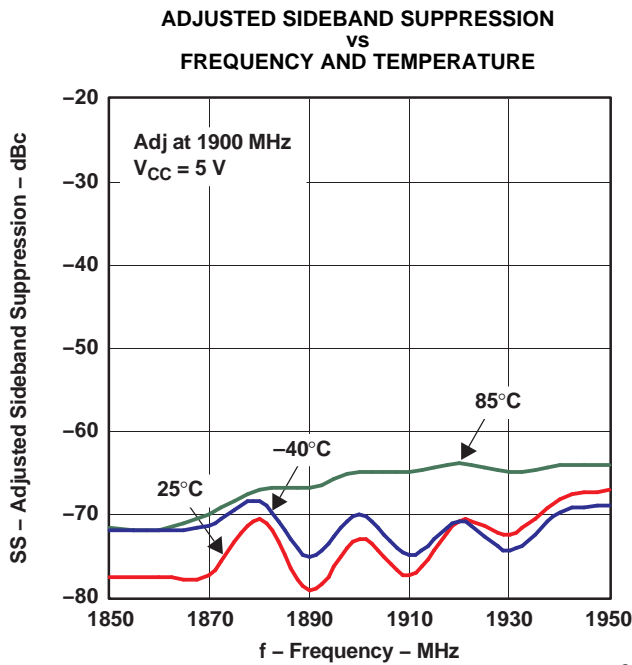


Figure 15.

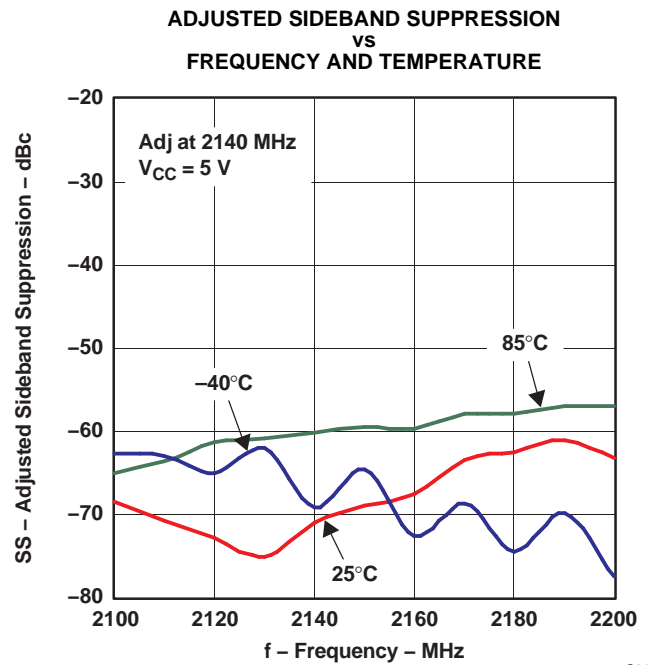


Figure 16.

TYPICAL CHARACTERISTICS (continued)

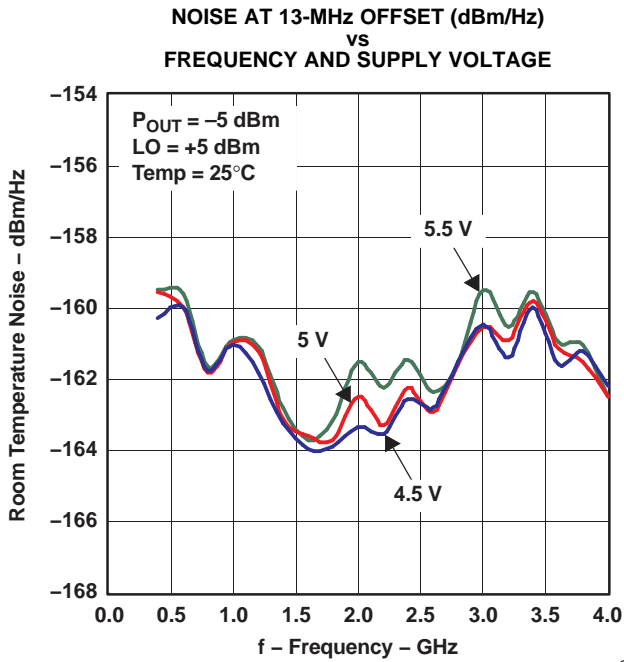


Figure 17.

G019

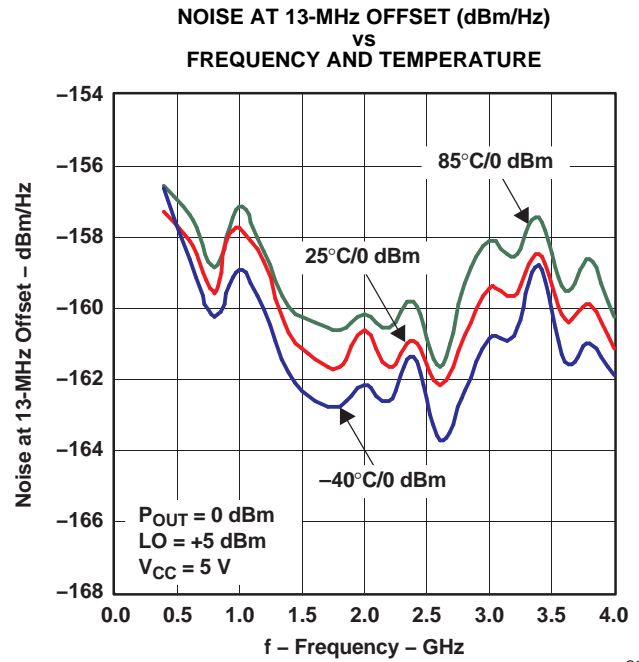


Figure 18.

G020

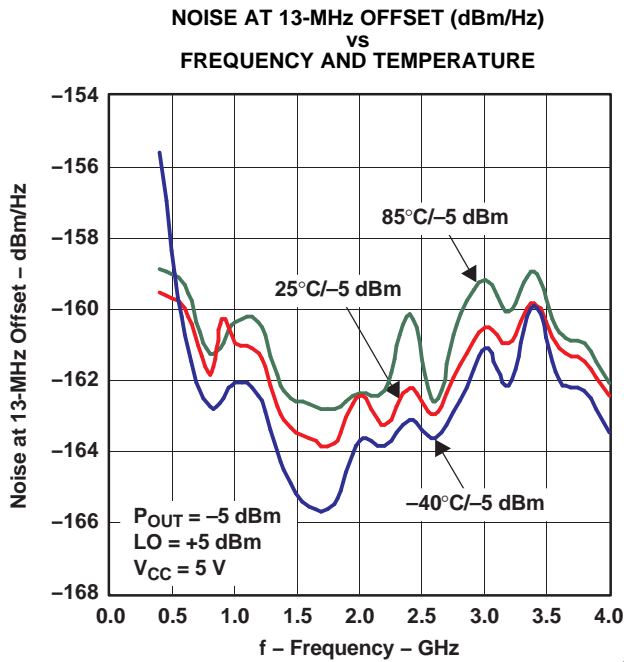


Figure 19.

G021

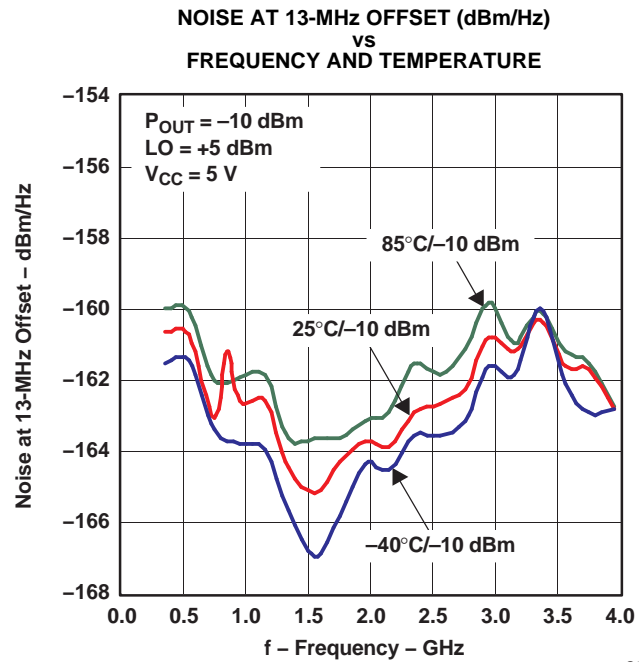


Figure 20.

G022

TYPICAL CHARACTERISTICS (continued)

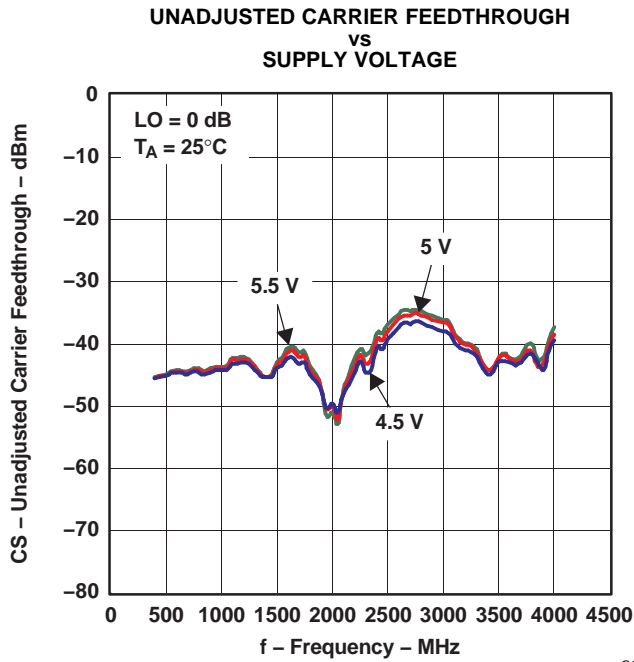


Figure 21.

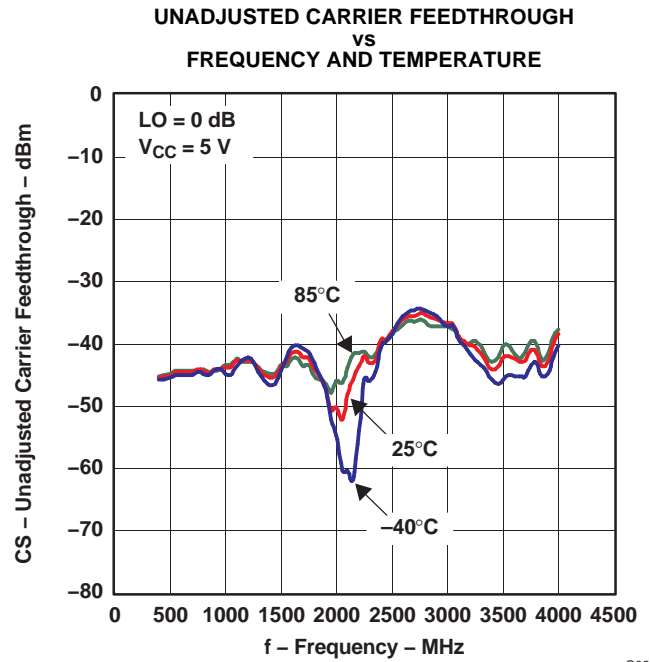
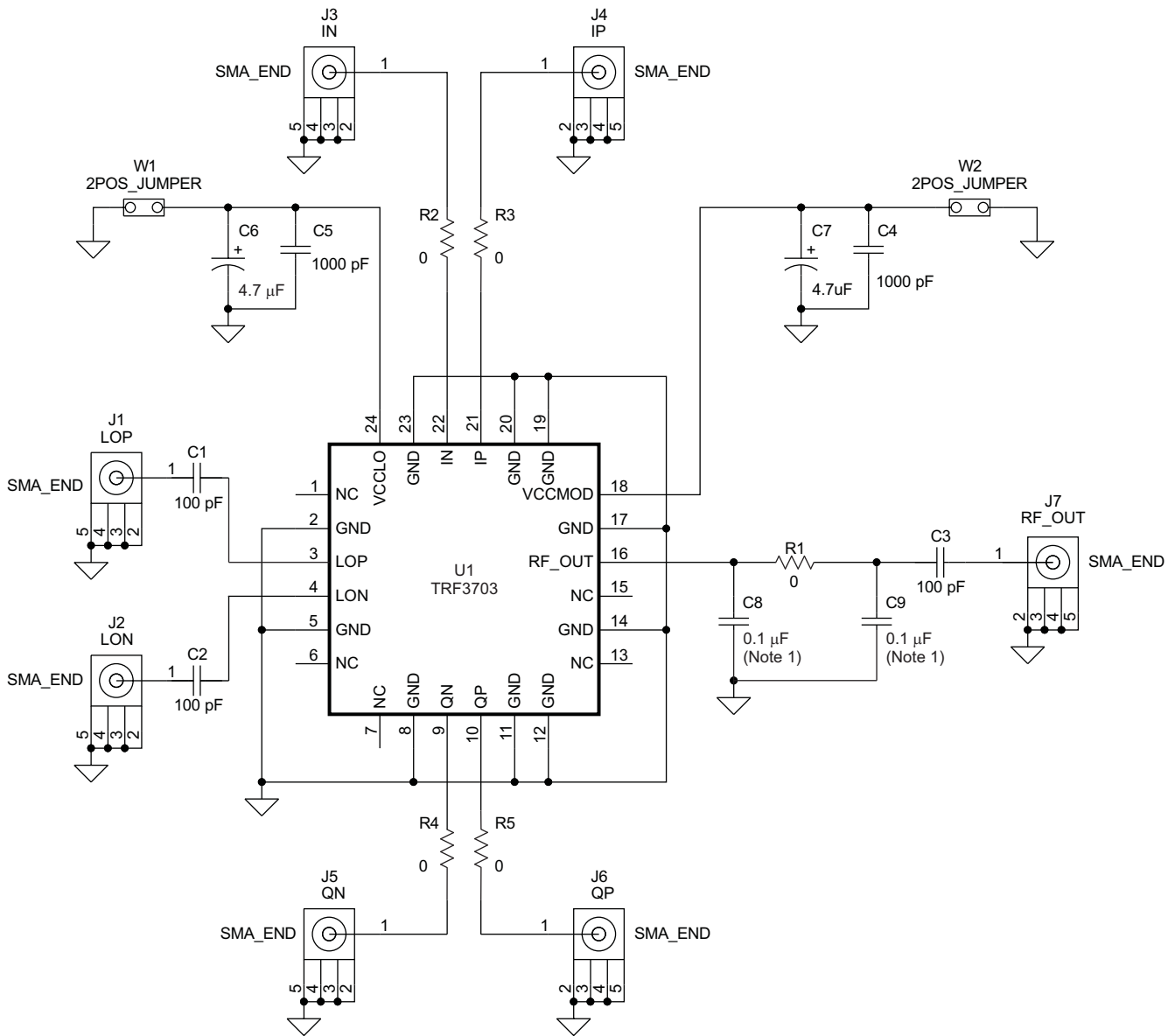


Figure 22.

APPLICATION INFORMATION AND EVALUATION BOARD**Basic Connections**

- See [Figure 23](#) for proper connection of the TRF3703 modulator.
- Connect a single power supply (4.5 V–5.5 V) to pins 18 and 24. These pins should be decoupled as shown on pins 4, 5, 6, and 7.
- Connect pins 2, 5, 8, 11, 12, 14, 17, 19, 20, and 23 to GND.
- Connect a single-ended LO source of desired frequency to LOP (amplitude between –5 dBm and 12 dBm). This should be ac-coupled through a 100-pF capacitor.
- Terminate the ac-coupled LON with 50 Ω to GND.
- Connect a baseband signal to pins 21 = I, 22 = \bar{I} , 10 = Q, and 9 = \bar{Q} .
- The differential baseband inputs should be set to the proper level, 3.3 V for the TRF370333 or 1.5 V for the TRF370315.
- RF_OUT, pin 16, can be fed to a spectrum analyzer set to the desired frequency, LO \pm baseband signal. This pin should also be ac-coupled through a 100-pF capacitor.
- All NC pins can be left floating.

APPLICATION INFORMATION AND EVALUATION BOARD (continued)



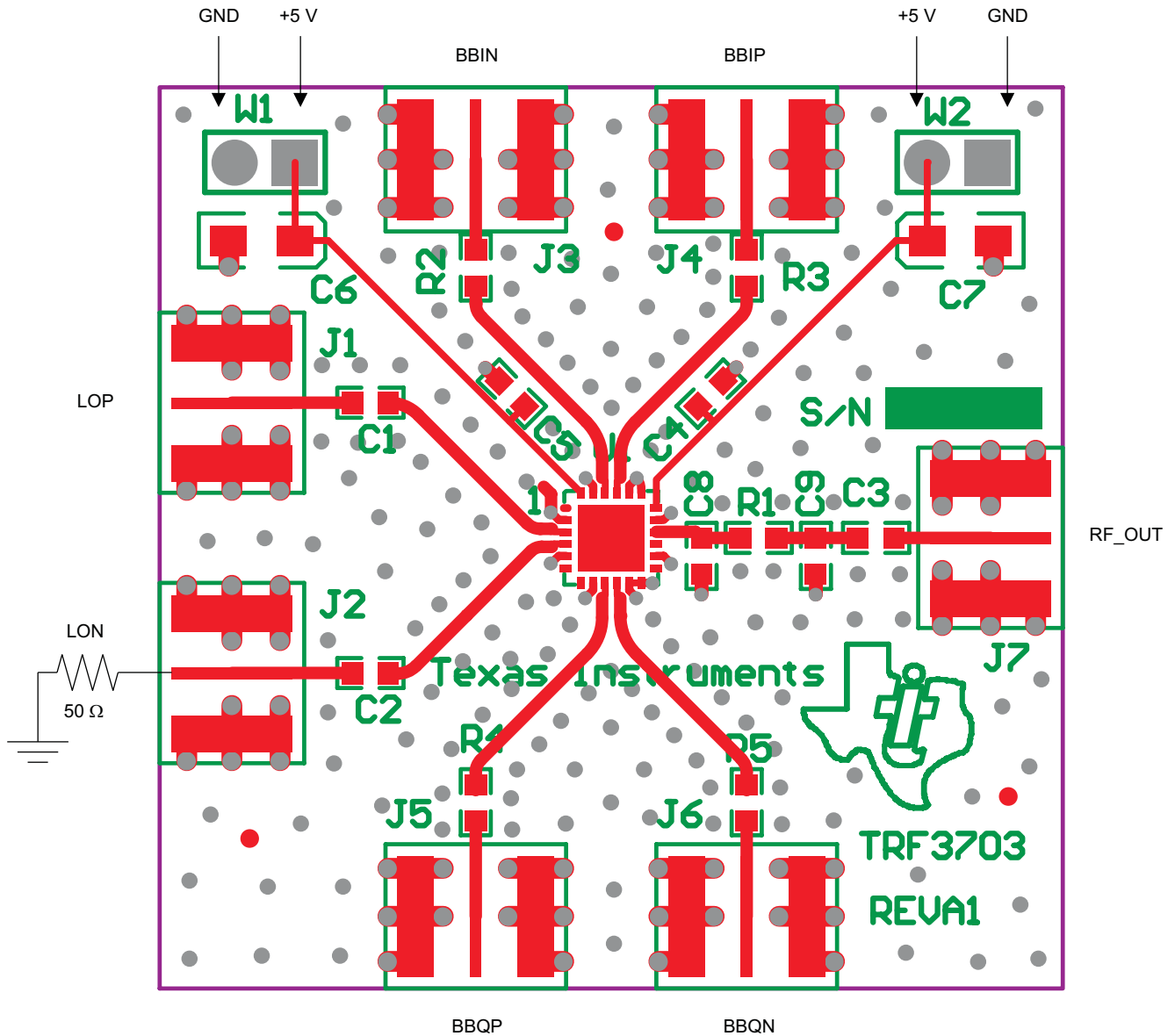
S0214-01

(1) Do not install.

Figure 23. TRF3703 EVM Schematic

APPLICATION INFORMATION AND EVALUATION BOARD (continued)

Figure 24 shows the top view of the TRF3703 EVM board.



K001

Figure 24. TRF3703 EVM Board Layout

Table 1. Bill of Materials for TRF3703 EVM

Value	Footprint	QTY	Part Number	Vendor	Digi-Key Number	REF DES	Not Installed
Tantalum 4.7- μ F, 10-V, 10% capacitor	3216	2	T491A475K010AS	KEMET	399-1561-1-ND	C6, C7	
1000-pF, 50-V, 5% capacitor	603	2	ECJ-1VC1H102J	Panasonic	PCC2151CT-ND	C4, C5	
100-pF, 50-V, 5% capacitor	603	3	ECJ-1VC1H101J	Panasonic	PCC101ACVCT-ND	C1, C2, C3	
Capacitor	603	0					C8, C9

APPLICATION INFORMATION AND EVALUATION BOARD (continued)

Table 1. Bill of Materials for TRF3703 EVM (continued)

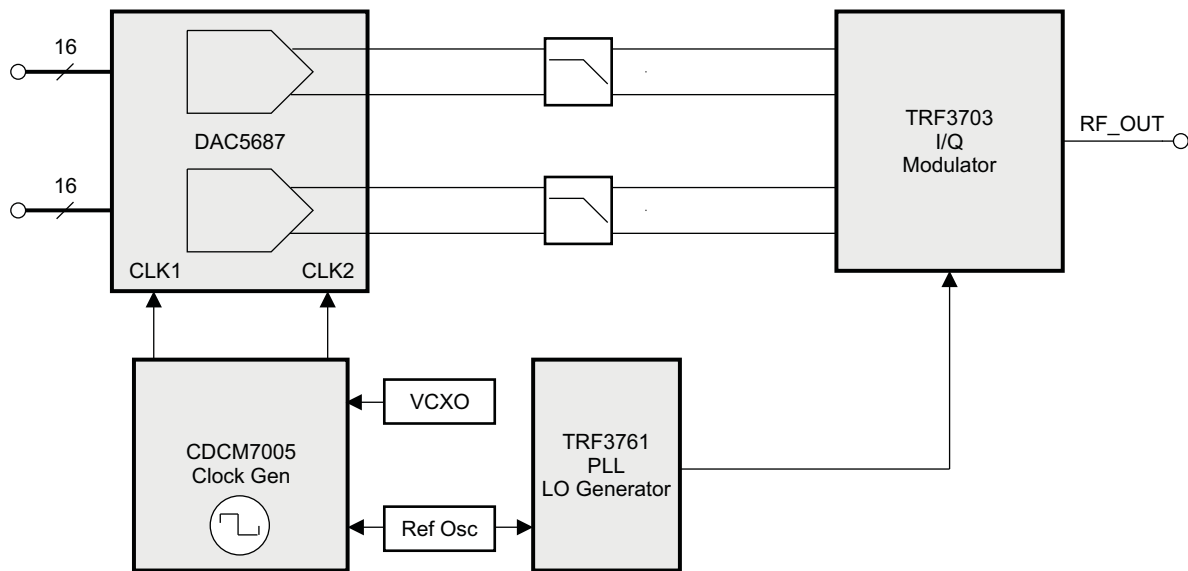
Value	Footprint	QTY	Part Number	Vendor	Digi-Key Number	REF DES	Not Installed
0-Ω resistor, 1/10-W, 5%	603	5	ERJ-3GEY0R00V	Panasonic	P0.0GCT-ND	R1, R2, R3, R4, R5	
TRF3703	24-QFN-PP-4X4MM	1		TI		U1	
SMA connectors	SMA_END_SMALL	6	16F3627	Newark	142-0711-821	J1, J2, J3, J4, J5, J6, J7	
2POS_HEADER	2POS_JUMP	2	HTSW-150-07-L-S	SAMTEC	N/A	W1, W2	

GSM Applications

The TRF3703 is suited for GSM applications because of its high linearity and low noise level over the entire recommended operating range. It also has excellent EVM performance, which makes it ideal for the stringent GSM/EDGE applications.

WCDMA Applications

The TRF3703 is also optimized for WCDMA applications where both adjacent-channel power ratio (ACPR) and noise density are critically important. Using Texas instruments' DAC568X series of high-performance digital-to-analog converters as depicted in [Figure 25](#), excellent ACPR levels were measured with one-, two-, and four-WCDMA carriers. See *Electrical Characteristics*, $f_{LO} = 2140$ MHz for exact ACPR values.



B0176-01

Figure 25. Typical Transmit Setup Block Diagram

DEFINITION OF SPECIFICATIONS

Unadjusted Carrier Feedthrough

This specification measures the amount by which the local oscillator component is attenuated in the output spectrum of the modulator relative to the carrier. This further assumes that the baseband inputs delivered to the pins of the TRF3703 are perfectly matched to have the same dc offset (VCM). This includes all four baseband inputs: I, \bar{I} , Q, and \bar{Q} . This is measured in dBm.

Adjusted (Optimized) Carrier Feedthrough

This differs from the unadjusted suppression number in that the baseband input dc offsets are iteratively adjusted around their theoretical value of VCM to yield the maximum suppression of the LO component in the output spectrum. This is measured in dBm.

Unadjusted Sideband Suppression

This specification measures the amount by which the unwanted sideband of the input signal is attenuated in the output of the modulator, relative to the wanted sideband. This further assumes that the baseband inputs delivered to the modulator input pins are perfectly matched in amplitude and are exactly 90° out of phase. This is measured in dBc.

Adjusted (Optimized) Sideband Suppression

This differs from the unadjusted sideband suppression in that the baseband inputs are iteratively adjusted around their theoretical values to maximize the amount of sideband suppression. This is measured in dBc.

Suppressions Over Temperature

This specification assumes that the user has gone through the optimization process for the suppression in question, and set the optimal settings for the I, Q inputs. This specification then measures the suppression when temperature conditions change after the initial calibration is done.

Figure 26 shows a simulated output and illustrates the respective definitions of various terms used in this data sheet. The graph assumes a baseband input of 50 kHz.

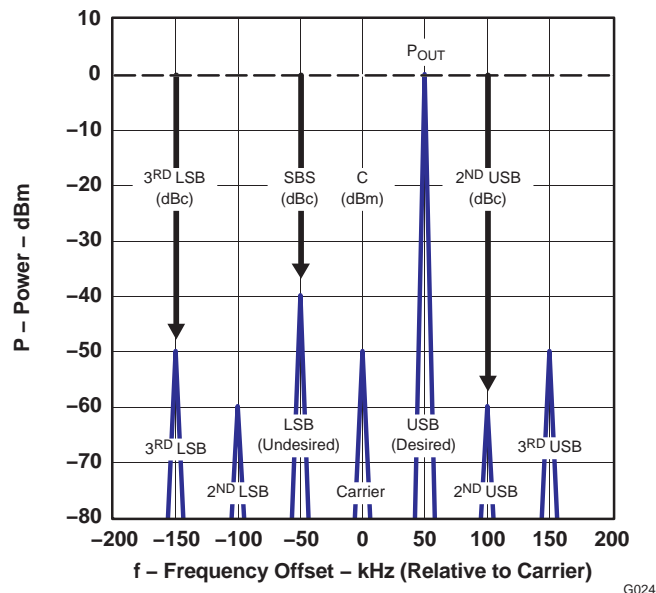


Figure 26. Graphical Illustration of Common Terms

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
TRF370315IRGER	ACTIVE	VQFN	RGE	24	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
TRF370315IRGET	ACTIVE	VQFN	RGE	24	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
TRF370333IRGER	ACTIVE	VQFN	RGE	24	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
TRF370333IRGERG4	ACTIVE	VQFN	RGE	24	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
TRF370333IRGET	ACTIVE	VQFN	RGE	24	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR
TRF370333IRGETG4	ACTIVE	VQFN	RGE	24	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

Important Information and Disclaimer:The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION



QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TRF370315IRGER	VQFN	RGE	24	3000	330.0	12.4	4.3	4.3	1.5	8.0	12.0	Q1
TRF370315IRGET	VQFN	RGE	24	250	330.0	12.4	4.3	4.3	1.5	8.0	12.0	Q1
TRF370333IRGER	VQFN	RGE	24	3000	330.0	12.4	4.3	4.3	1.5	8.0	12.0	Q2
TRF370333IRGET	VQFN	RGE	24	250	330.0	12.4	4.3	4.3	1.5	8.0	12.0	Q2

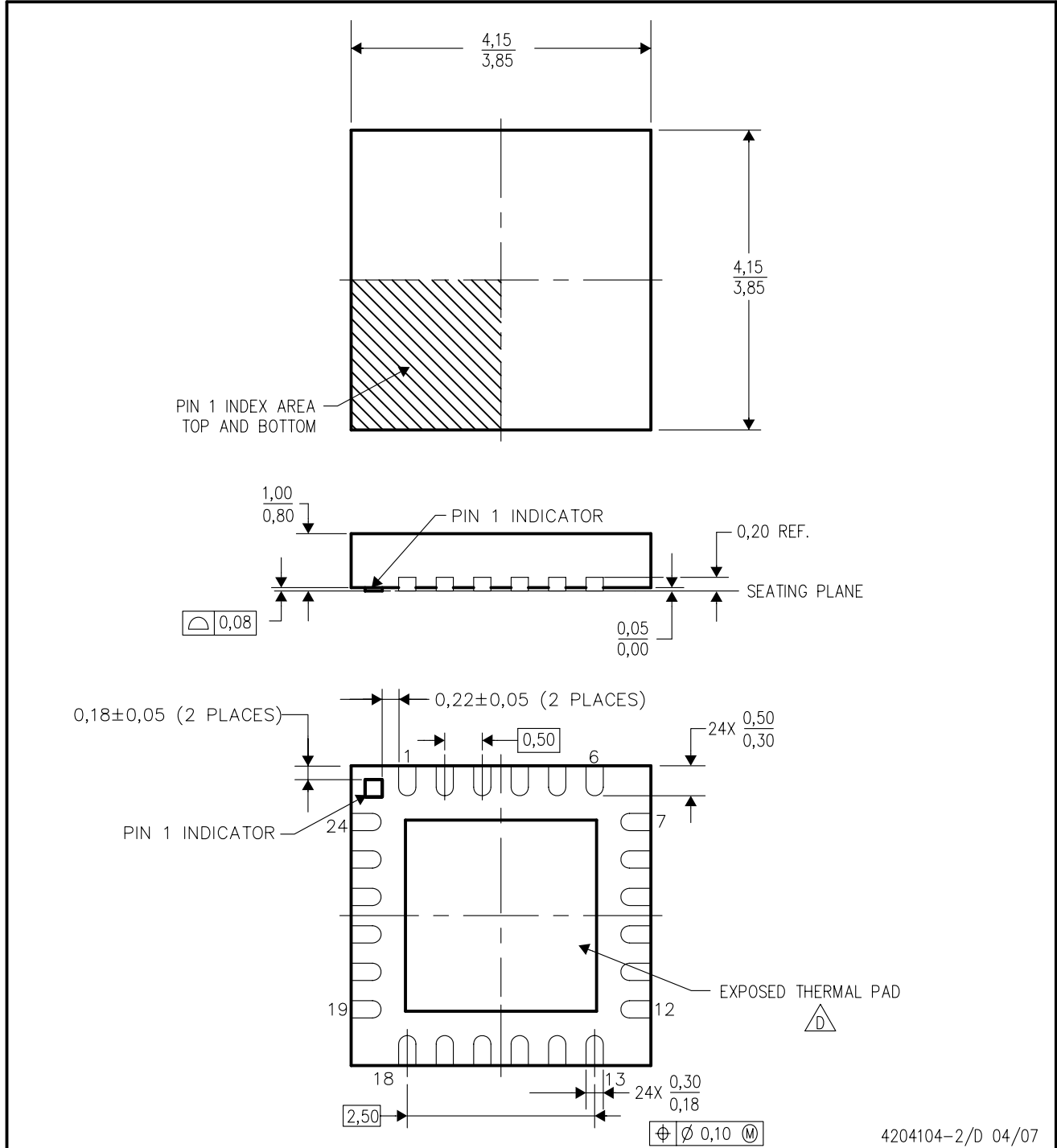
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TRF370315IRGER	VQFN	RGE	24	3000	340.5	333.0	20.6
TRF370315IRGET	VQFN	RGE	24	250	340.5	333.0	20.6
TRF370333IRGER	VQFN	RGE	24	3000	340.5	333.0	20.6
TRF370333IRGET	VQFN	RGE	24	250	340.5	333.0	20.6

RGE (S-PQFP-N24) PIN 1 BUMP OPTION PLASTIC QUAD FLATPACK



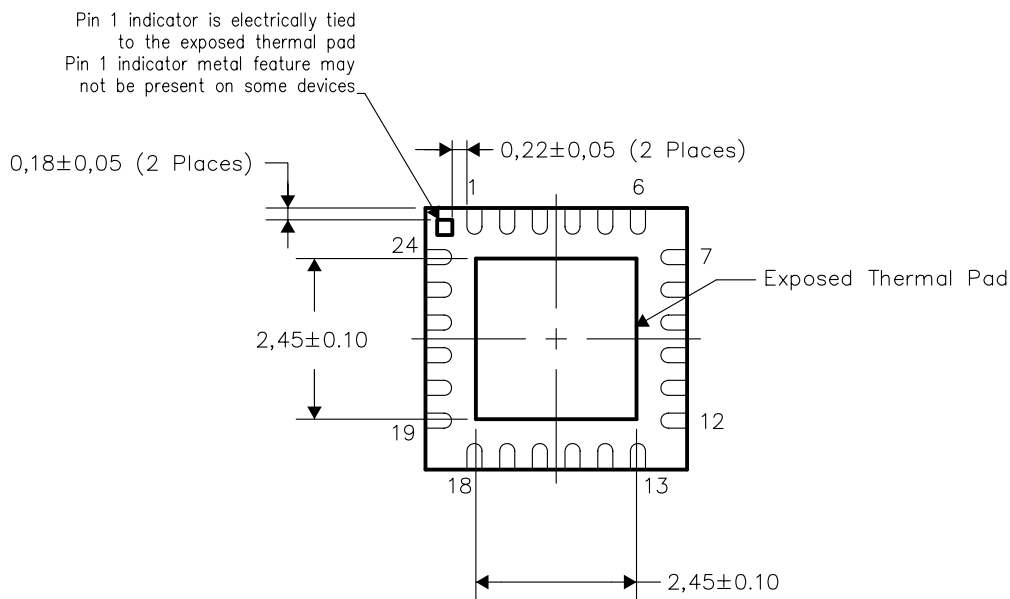
- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
 - B. This drawing is subject to change without notice.
 - C. Quad Flatpack, No-Leads (QFN) package configuration.
 - D. The package thermal pad must be soldered to the board for thermal and mechanical performance. See the Product Data Sheet for details regarding the exposed thermal pad dimensions.
 - E. Falls within JEDEC MO-220.

THERMAL INFORMATION

This package incorporates an exposed thermal pad that is designed to be attached directly to an external heatsink. The thermal pad must be soldered directly to the printed circuit board (PCB). After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For information on the Quad Flatpack No-Lead (QFN) package and its advantages, refer to Application Report, Quad Flatpack No-Lead Logic Packages, Texas Instruments Literature No. SCBA017. This document is available at www.ti.com.

The exposed thermal pad dimensions for this package are shown in the following illustration.

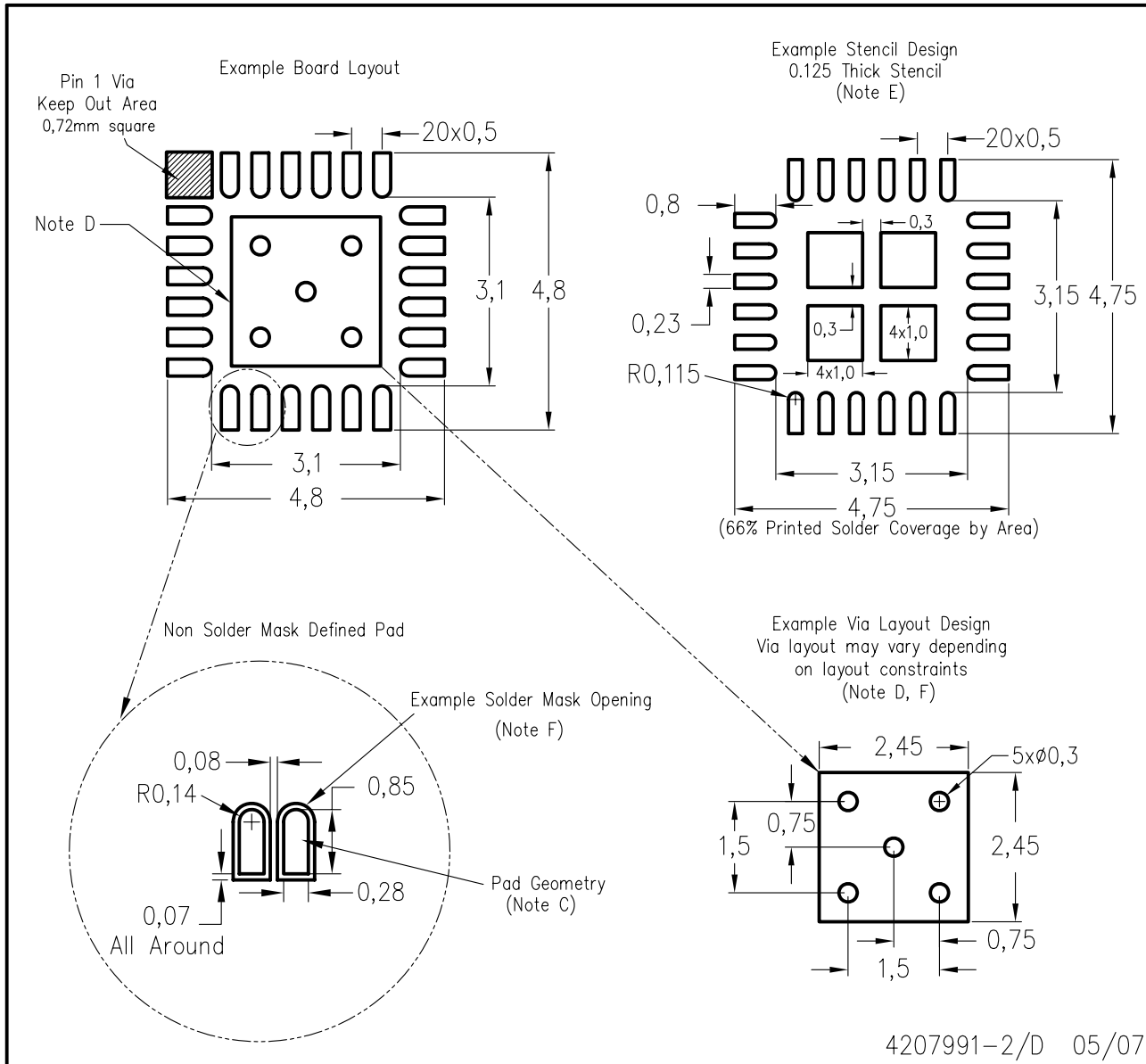


Bottom View

NOTE: All linear dimensions are in millimeters

Exposed Thermal Pad Dimensions

RGE (S-PQFP-N24)



- NOTES:
- All linear dimensions are in millimeters.
 - This drawing is subject to change without notice.
 - Publication IPC-7351 is recommended for alternate designs.
 - This package is designed to be soldered to a thermal pad on the board. Refer to Application Note, Quad Flat-Pack Packages, Texas Instruments Literature No. SCBA017, SLUA271, and also the Product Data Sheets for specific thermal information, via requirements, and recommended board layout. These documents are available at www.ti.com <<http://www.ti.com>>.
 - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC 7525 for stencil design considerations.
 - Customers should contact their board fabrication site for recommended solder mask tolerances and via tenting recommendations for vias placed in the thermal pad.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products

Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
RF/IF and ZigBee® Solutions	www.ti.com/lprf

Applications

Audio	www.ti.com/audio
Automotive	www.ti.com/automotive
Broadband	www.ti.com/broadband
Digital Control	www.ti.com/digitalcontrol
Medical	www.ti.com/medical
Military	www.ti.com/military
Optical Networking	www.ti.com/opticalnetwork
Security	www.ti.com/security
Telephony	www.ti.com/telephony
Video & Imaging	www.ti.com/video
Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2008, Texas Instruments Incorporated