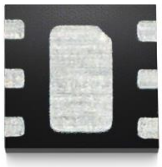
DATA SHEET

RELEASE Ø DATA SHEET



GRF7001

High-Linearity Single-Ended Mixer with Integrated LO Buffer

FEATURES

- RF/IF Range: 0.01 to 4 GHz
- LO Range: 0.1 to 4 GHz
- Integrated LO Buffer
- Flexible Bias Voltage
- Compact 1.5 x 1.5 mm DFN-6 Package
- Process: GaAs pHEMT

Reference: 3 V / 10 mA

- RF: 808 MHz
- LO: 965 MHz, 0 dBm
- IF: 157 MHz
- Conversion Loss: 6 dB
- IIP3: 25 dBm
- IP1dB: 19 dBm

APPLICATIONS

- Bi-directional Mixer for High-Linearity Transmit/Receive Chains
- Low-Power Applications

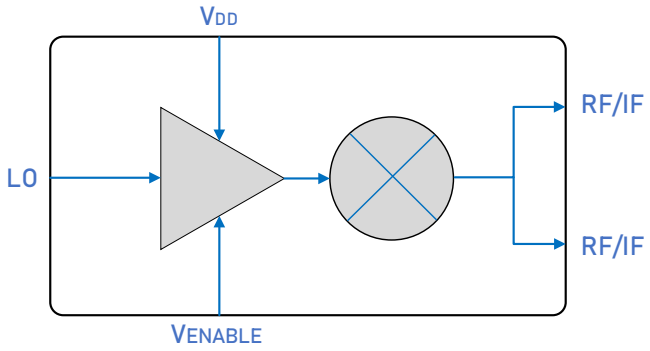
DESCRIPTION

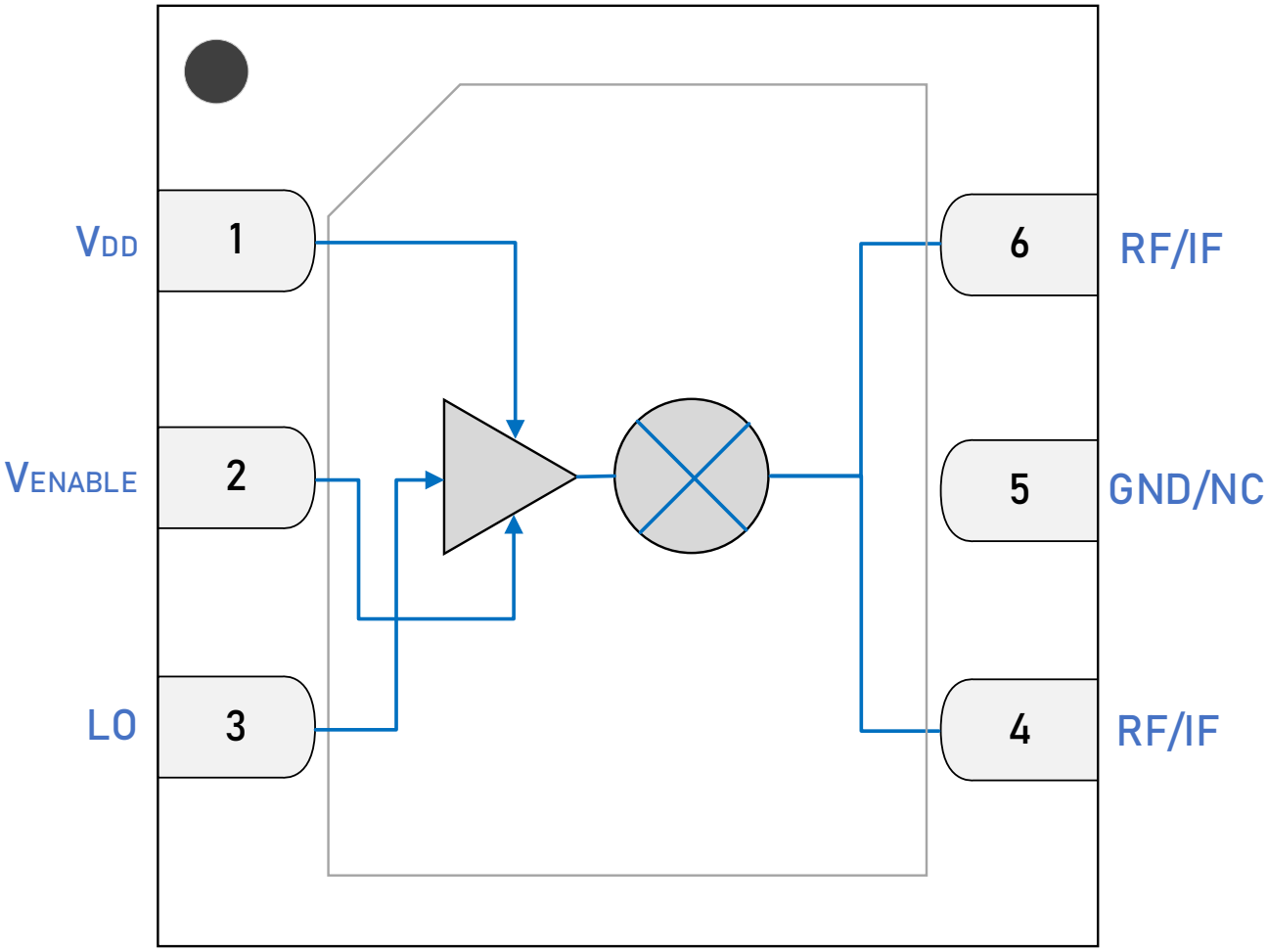
The GRF7001 is a broadband (0.01 to 4 GHz) high-linearity mixer with an integrated LO buffer that can be used as either an up or down converter. The device inputs and outputs are single-ended and easily matched to 50 Ω. Implementation requires an external image-reject filter on the RF port and a bandpass filter on the IF port. Pins 4 and 6 can be used for either RF or IF with appropriate filtering in place.

The integrated LO buffer operates from a single positive supply of 1.8 to 5 volts for both the V_{DD} and V_{ENABLE} inputs.

Please consult with the GRF applications engineering team for custom tuning/evaluation board data.

BLOCK DIAGRAM





1.5 x 1.5 mm DFN-6 Pin Out (Top View)

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Pin Assignments

Pin	Name	Description	Note
1	V_{DD}	LO Buffer Voltage	V_{DD}: 3 to 5 Volts.
2	V_{ENABLE}	LO Buffer Control Voltage	LO Buffer Enabled: 3 to 5 volts, $V_{ENABLE} \leq$ 0.2 volts disables the LO buffer. $V_{ENABLE} \leq V_{DD}$.
3	LO	LO Buffer Input Signal	Optimal LO input power: 0 dBm +/- 3 dB.
4, 6	RF/IF	RF/IF Input or Output Signal	External filter required.
5	GND/NC	Ground or No Connect	No internal connection to die. We recommend connecting this pin to ground.
PKG BASE	GND	Ground	Provides DC and RF ground for the Mixer, as well as thermal heat sink. Recommend multiple 8 mil vias beneath the package for optimal RF and thermal performance. Refer to evaluation board top layer graphic on schematic page.

Absolute Ratings

Parameter	Symbol	Min.	Max.	Unit
LO Buffer Supply Voltage	V_{DD}	0	6	V
LO Buffer Control Voltage	V_{ENABLE}	0	V_{DD}	V
RF/IF/LO Input Power: Load VSWR < 2:1, V_{DD} = 5 V	$P_{IN\ MAX}$		20	dBm
Operating Temperature (package base)	$T_{PKG\ BASE}$	-40	105	°C
Maximum Channel Temperature (MTTF >10^6 Hours)	T_{MAX}		170	°C
Maximum Dissipated Power	$P_{DISS\ MAX}$		200	mW

Electrostatic Discharge

Charged Device Model	CDM	1500		V
Human Body Model	HBM	250		V

Storage

Storage Temperature	T_{STG}	-65	150	°C
Moisture Sensitivity Level	MSL		1	--

Caution! ESD Sensitive Device.
Exceeding Absolute Maximum Rating conditions may cause permanent damage.

Note: For additional information, please refer to *Manufacturing Note MN-001 — Package and Manufacturing Information.*

All Guerrilla RF products are provided in RoHS compliant lead (Pb)-free packaging requiring no exemptions. Additional information for this topic can be found at this link - *Environmental and Restricted Substance Statement Library*

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Recommended Operating Conditions

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
LO Buffer Supply Voltage	V_{DD}	1.8	3	5	V	
LO Buffer Control Voltage	V_{ENABLE}		V_{DD}		V	Set equal to V_{DD}.
Operating Temperature (package base)	$T_{PKG\ BASE}$	-40		105	°C	
RF Frequency Range	F_{RF}	10	808	4000	MHz	
LO Frequency Range	F_{LO}	100	965	4000	MHz	
IF Frequency	F_{IF}	10	157	4000	MHz	
LO Buffer Input Power			0		dBm	

Nominal Operating Parameters – General

The following conditions apply unless noted otherwise: typical application schematic, V_{DD} = 3 V, V_{ENABLE} = 3 V, I_{DD} = 12.5 mA, F_{RF} = 808 MHz, F_{LO} = 965 MHz, F_{IF} = 157 MHz, LO = 0 dBm, $T_{PKG\ BASE}$ = 25 °C. Evaluation board losses are included within the specifications.

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Supply Voltage	V_{DD}	1.8	3	5	V	
Supply Current	I_{DD}		12.5		mA	

Thermal Data

Thermal Resistance: (Infrared Scan)	Θ_{JC}		91		°C/W	On standard evaluation board **(note 2).**
Channel Temperature at 85 °C. Reference Package Base	T_j		90		°C	V_{DD} =3 V, V_{ENABLE} = 3 V, I_{BUFFER} = 13 mA, RF OFF. P_{DISS} = ~40mW.

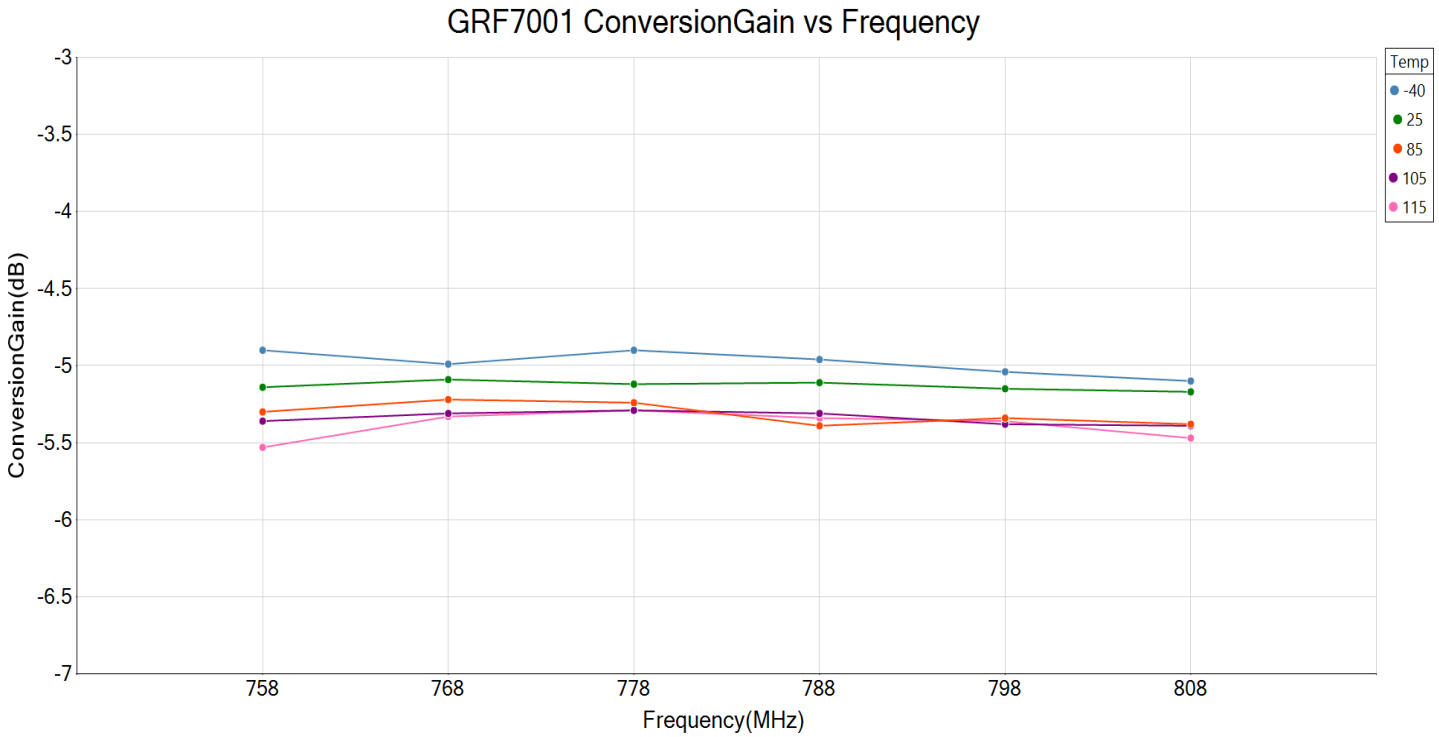
Note 2: MTTF >10^6 hours for $T_{CHANNEL}$ ≤ 170 °C.

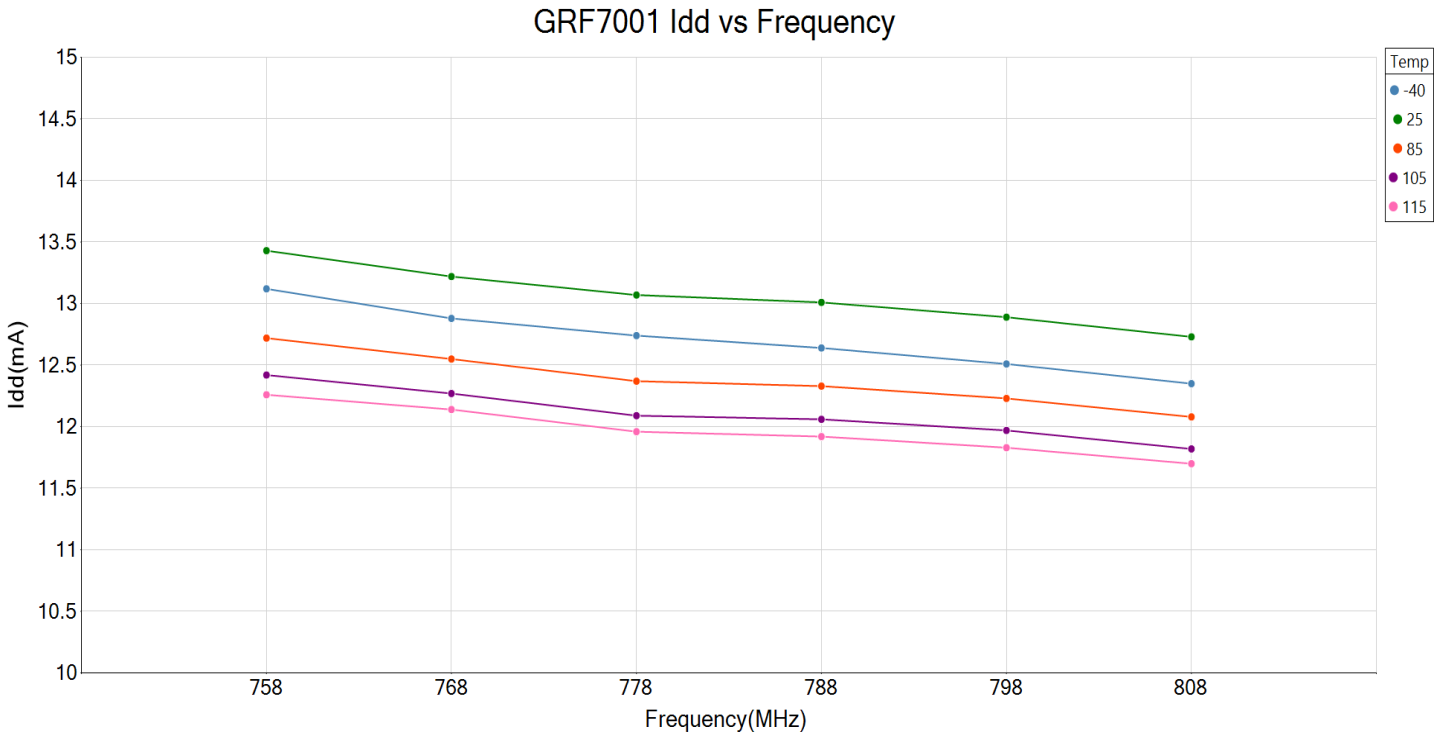
Nominal Operating Parameters – RF

The following conditions apply unless noted otherwise: typical application schematic, V_{DD} = 3 V, V_{ENABLE} = 3 V, I_{DD} = 12.5 mA, F_{RF} = 808 MHz, F_{LO} = 965 MHz, F_{IF} = 157 MHz, LO = 0 dBm, $T_{PKG\ BASE}$ = 25 °C. Evaluation board losses are included within the specifications.

Parameter	Symbol	Specification			Unit	Condition
		Min.	Typ.	Max.		
Conversion Gain	S21		-5.5		dB	
Input 3rd Order Intercept Point	IIP3		25		dBm	
Input P1dB Compression Power	IP1dB		19		dBm	
LO to IF Rejection	LO_IF		20		dB	Measured with LO = 0 dBm with band-specific matching.
LO to RF Rejection	LO_RF		10.5		dB	Measured with LO = 0 dBm with band-specific matching.
LO Buffer Current	I_{BUFFER}		10		mA	Measured with LO = 0 dBm with band-specific matching.
LO Buffer Enable Current	I_{ENABLE}		0.5		mA	

GRF7001 Typical Operating Curves:





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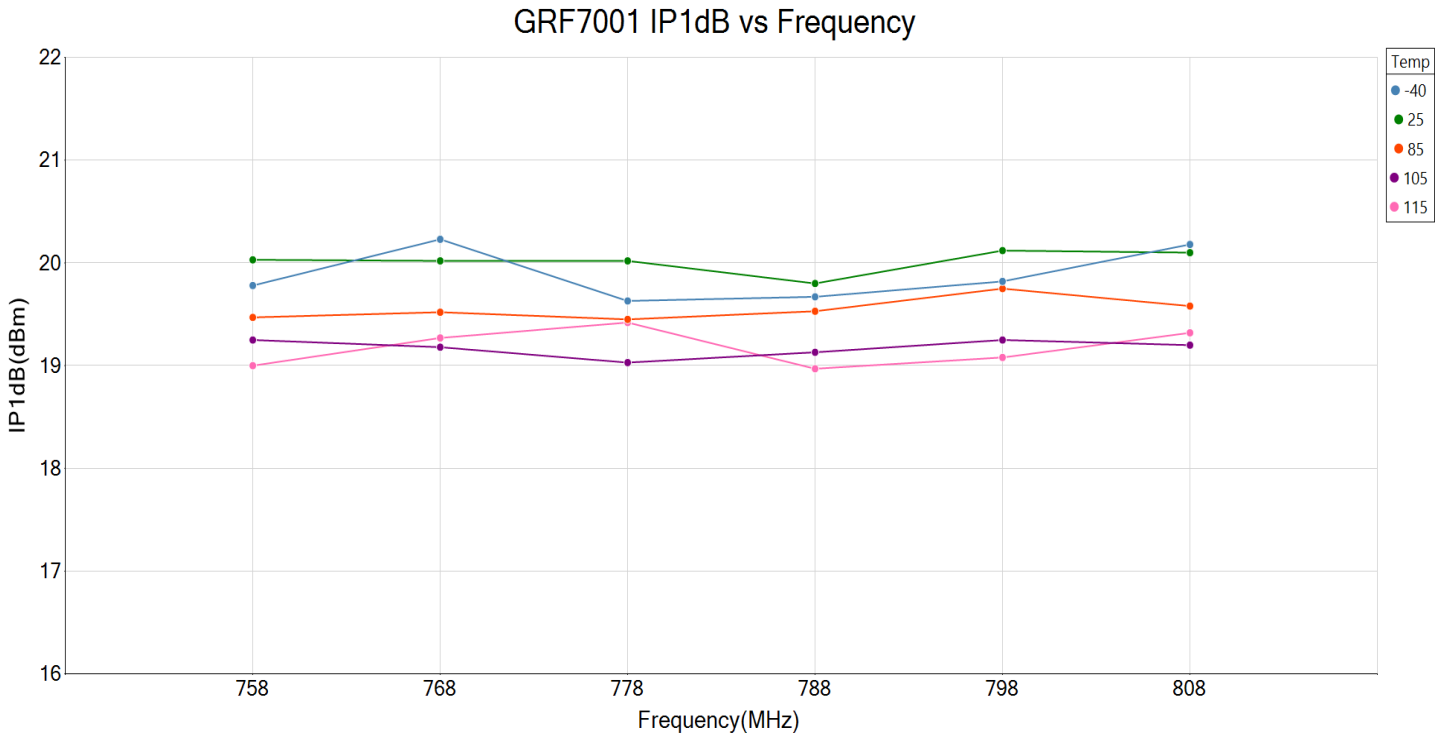
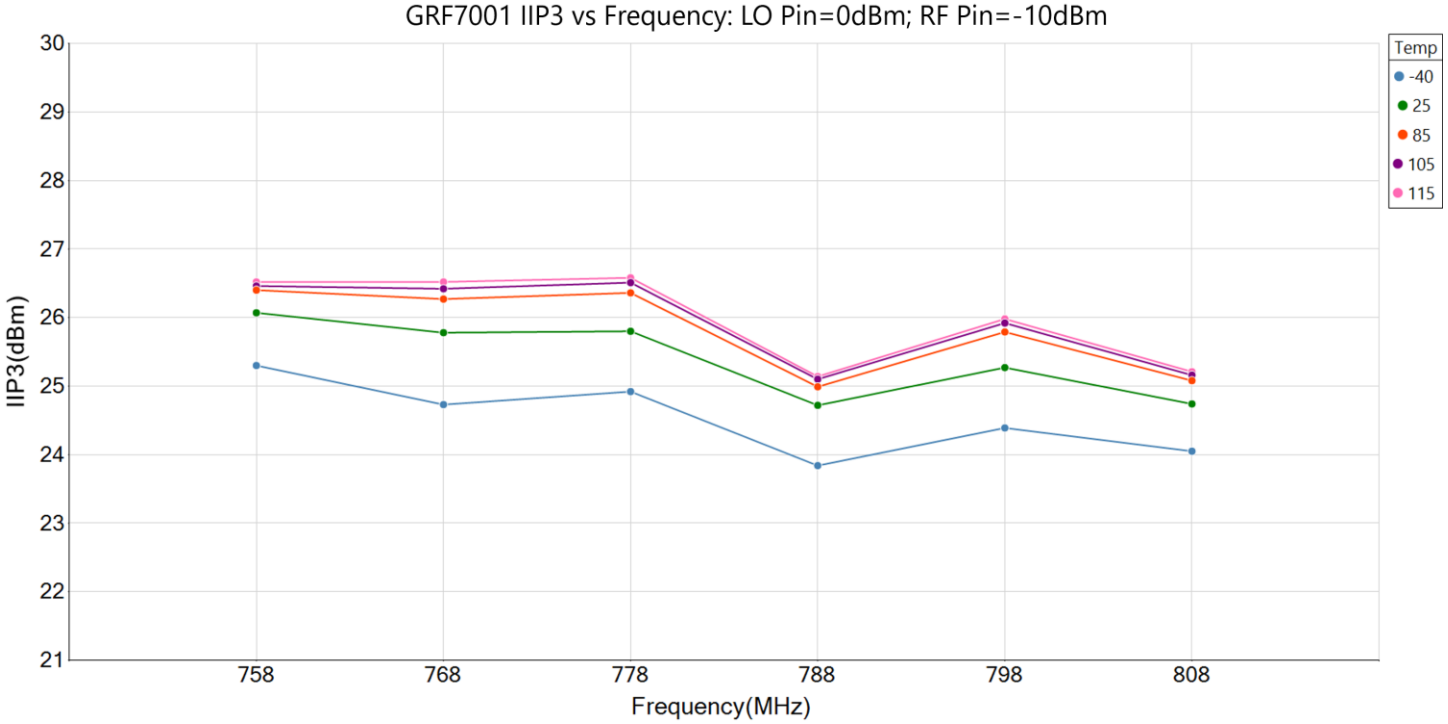
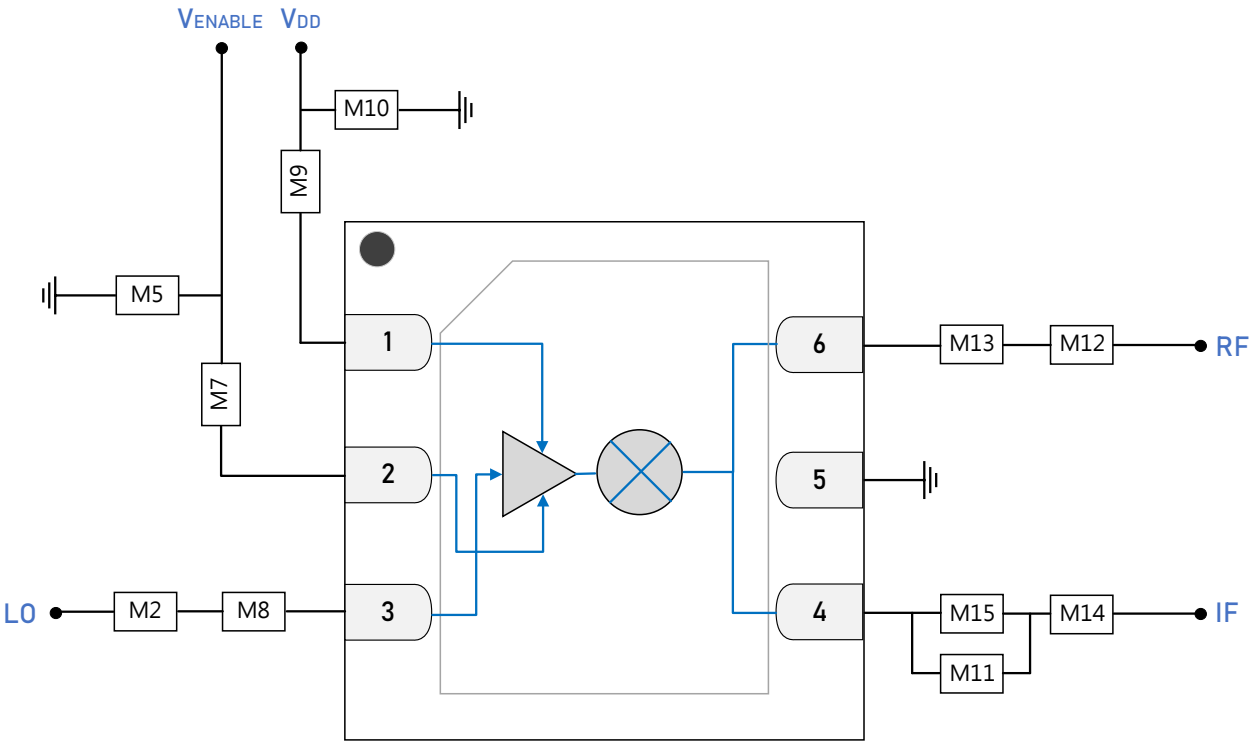
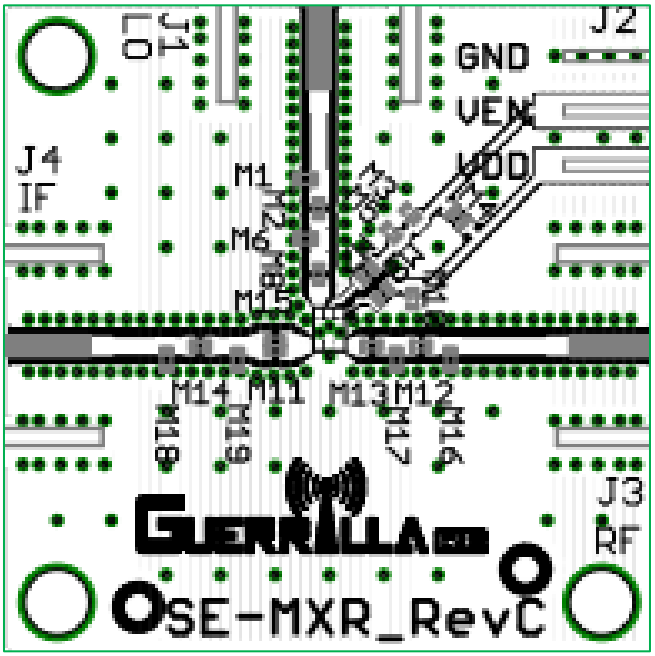
GRF7001 Typical Operating Curves:







GRF7001 Standard Evaluation Board Schematic



GRF7001 Evaluation Board Assembly Diagram

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GRF7001 Evaluation Board Assembly Diagram Reference:

RF frequency: 758 to 808 MHz, LO frequency: 915 to 1015 MHz, IF frequency: 157 MHz

Component	Type	Manufacturer	Family	Value	Package Size	Substitution
M2	Capacitor	Murata	GJM	33 pF	0402	ok
M5	Capacitor	Murata	GRM	0.1 µF	0402	ok
M7	Resistor	Various	5%	See table	0402	ok
M8	Inductor	Murata	LQG	5.6 nH	0402	ok
M9	Inductor	Murata	LQG	18 nH	0402	ok
M10	Capacitor	Murata	GRM	1000 pF	0402	ok
M11	Capacitor	Murata	GJM	3.9 pF	0402	ok
M12	Inductor	Murata	LQG	8.2 nH	0402	ok
M13	Capacitor	Murata	GRM	3.9 pF	0402	ok
M14	Capacitor	Murata	GRM	330 pF	0402	ok
M15	Inductor	Murata	LQG	8.2 nH	0402	ok
Evaluation Board	SE-MXR_RevC					

LO Buffer I_{DD} vs. V_{DD} vs. V_{ENABLE} Bias Resistor

$V_{DD} = V_{ENABLE}$ (V)	M7 (Ω)	I_{DD} (mA)
3	0	10
3.3	20 k	10
4	60 k	10
4.5	80 k	10
5	100 k	10

Note regarding evaluation board matching: The evaluation board accommodates simple LC matching/filtering to implement a chosen frequency scheme. It should be noted that the RF and IF ports of the mixer are connected to the same node on the mixer die. This means that the IF port must reject the RF signals and vice-versa.

For this reason, GRF applications engineering cannot effectively support tuned evaluation board requests in which the lowest RF frequency is not at least 3X the highest IF frequency. Applications such as these can be viable if high-performance SAW-type filters are used to achieve the necessary RF/IF frequency separation. The tables on the following page show suggested RF, LO and IF LC matching/filter values for a range of common frequency schemes.

GRF7001 Port Matching vs. Frequency:

RF					IF	
RF (MHz)	RF Port		IF Port		IF (MHz)	IF Port
	M12 (nH)	M13 (pF)	M11 (pF)	M15 (nH)		M14 (pF)
450	12	12	12	12	10	100,000
520	10	8.2	6.8	12	50	1000
750	8.2	6.8	6.8	8.2	100	470
850	8.2	3.9	3.9	8.2	150	330
950	8.2	3.6	3.6	8.2	200	220
1300	4.3	3.3	3.3	4.7	250	100
1500	3.9	3.3	3.3	3.0	300	100
1900	2.4	2.4	2.4	2.4	400	100
Note: The DC blocking capacitor value used for **M14** is somewhat flexible. The capacitor should be a reasonably good short for the frequency of interest.					500	100
					700	100
					900	100

LO			
LO (MHz)	LO Port		Choke
	M8 (nH)	M2 (pF)	M9 (nH)
400	22	100	68
500	9.1	68	68
650	7.5	56	33
750	6.8	47	33
800	6.8	47	33
950	5.6	33	18
1100	5.6	30	15
1600	5.6	15	6.2
1700	5.6	15	5.1

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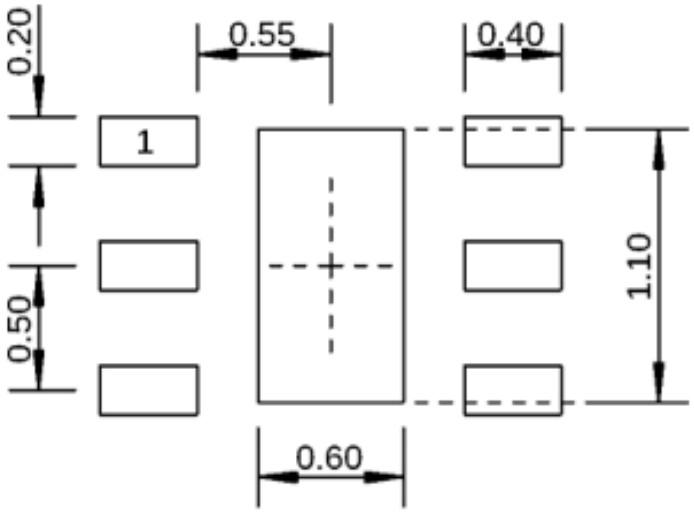
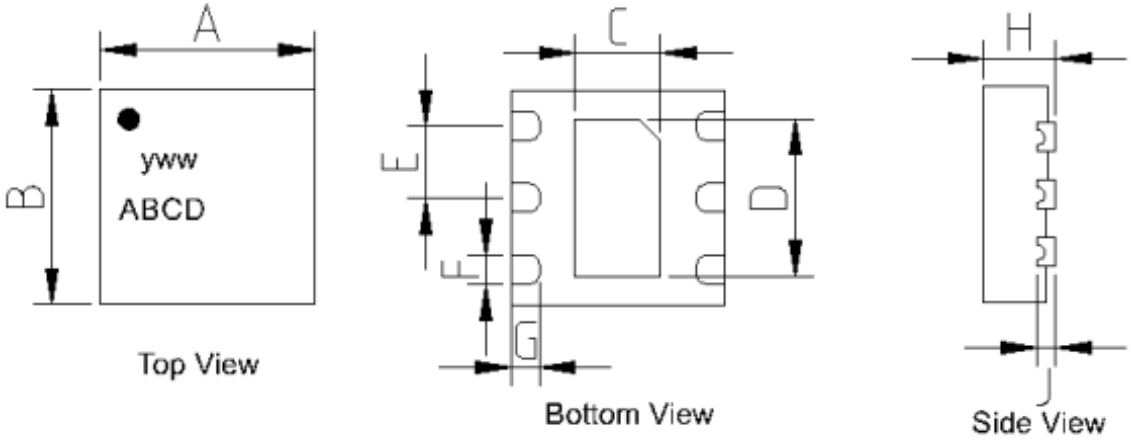


1.5 x 1.5 mm DFN-6 Suggested PCB Footprint (Top View)



Dimensions (mm)	
A	1.5 +/- 0.05
B	1.5 +/- 0.05
C	0.6 +/- 0.05
D	1.1 +/- 0.05
E	0.5 BSC
F	0.2 +/- 0.05
G	0.2 +/- 0.05
H	0.45 +/- 0.05
J	0.12 Ref.

Dimensions in millimeters

1.5 x 1.5 mm DFN-6 Package Dimensions

Package Marking Diagram

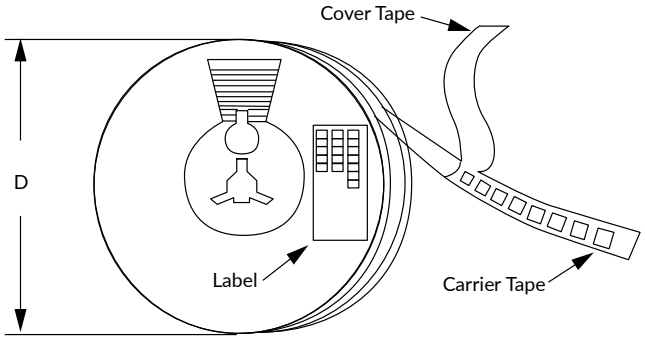
- Line 1: "Y" = YEAR (single digit). "WW" = WORK WEEK the device was assembled.
- Line 2: "XXXX" = Device PART NUMBER.

Tape and Reel Information

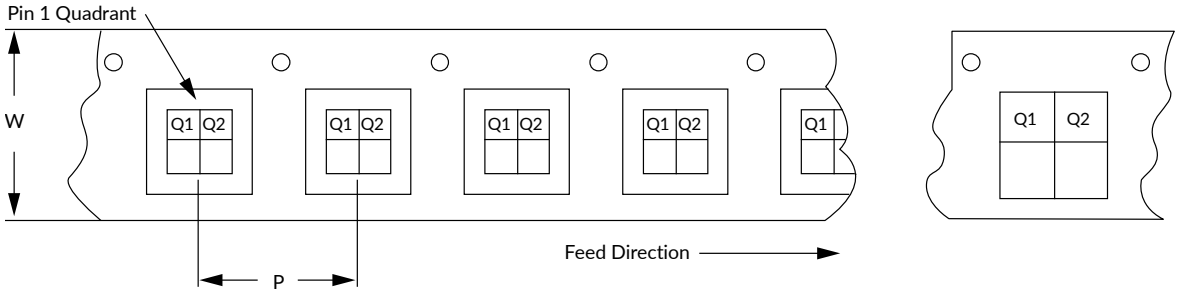
Guerrilla RF's tape and reel specification complies with Electronic Industries Alliance (EIA) standards for "Embossed Carrier Tape of Surface Mount Components for Automatic Handling" (reference EIA-481). See the following page for the Tape and Reel Specification and Device Package Information table, which includes units per reel.

Devices are loaded with pins down into the carrier pocket with protective cover tape and reeled onto a plastic reel. Each reel is packaged in a cardboard box. There are product labels on the reel, the protective ESD bag and the outside surface of the box.

For the Tape and Reel Reference Table, please refer to: Package Manufacturing Information | Guerrilla RF (guerrilla-rf.com)



Tape and Reel Packaging with Reel Diameter Noted (D)



Carrier Tape Width (W), Pitch (P), Feed Direction and Pin 1 Quadrant Information

Revision History

Revision Date	Description of Change
May 9, 2019	Preliminary Data Sheet.
December 20, 2024	Release Ø Data Sheet. Updated specifications and plots.

Data Sheet Classifications

Data Sheet Status	Notes
Advance	S-Parameter and NF data based on EM simulations for the fully packaged device using foundry-supplied transistor S-Parameters. Linearity estimates based on device size, bias condition and experience with related devices.
Preliminary	All data based on limited evaluation board measurements taken within the Guerrilla RF Applications Lab. All parametric values are subject to change pending the collection of additional data.
Release Ø	All data based on measurements taken with *production-released* material. TYP values are based on a combination of ATE and bench-level measurements, with MIN/MAX limits defined using *modelled estimates* that account for part-to-part variations and expected process spreads. Although unlikely, future refinements to the TYP/MIN/MAX values may be in order as multiple lots are processed through the factory.
Release A-Z	All data based on measurements taken with production-released material *derived from multiple lots which have been fabricated over an extended period of time*. MIN/MAX limits may be refined over previous releases as more statistically significant data is collected to account for process spreads.