

100MHz INPUT MIXER AND 450kHz IF GAIN CONTROL IC

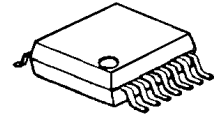
■ GENERAL DESCRIPTION

The **NJM2287** is an IF Gain Control IC with 450kHz (standard) IF input, which operates from 2.7V to 5.5V supply. It includes a local-buffer, mixer, IF gain control amplifier, and RSSI circuit.

The **NJM2287** is especially designed for digital transceivers with built-in an analog gain control amplifier and a subsequent analog to digital converter circuit.

The useful functions of the **NJM2287** are rail-to-rail output swing of 3Vpp @3.3V and wide gain control of over 80dB. These features help streamline the subsequent circuit design.

■ PACKAGE OUTLINE

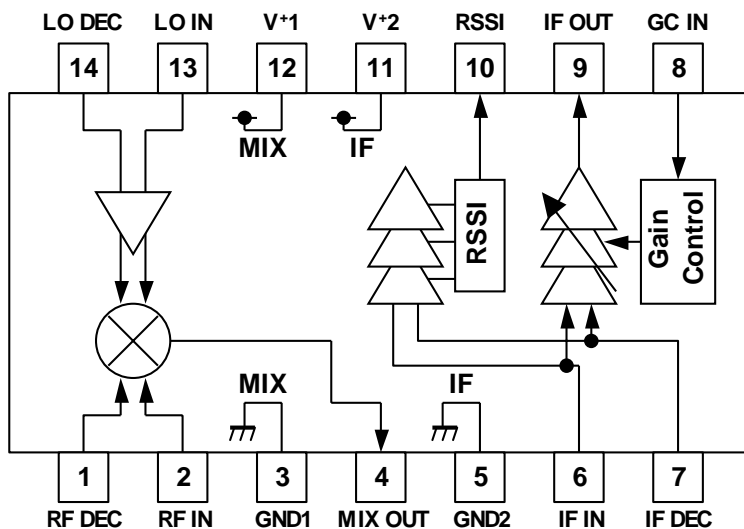


NJM2287V (SSOP14)

■ FEATURES

- Operating Voltage 2.7V to 5.5V
- Low Operating Current 4.7mA @V⁺ = 3.3V, no signal
- Maximum Mixer Input Frequency 100MHz (reference value)
- IF Frequency 450kHz (standard)
- Wide IF Gain Control Range over 80dB
- Rail - to - rail Output 3Vp-p @V⁺ = 3.3V
- Wide Range RSSI over 70dB (linear area)
- Bipolar Technology
- Package Outline SSOP14

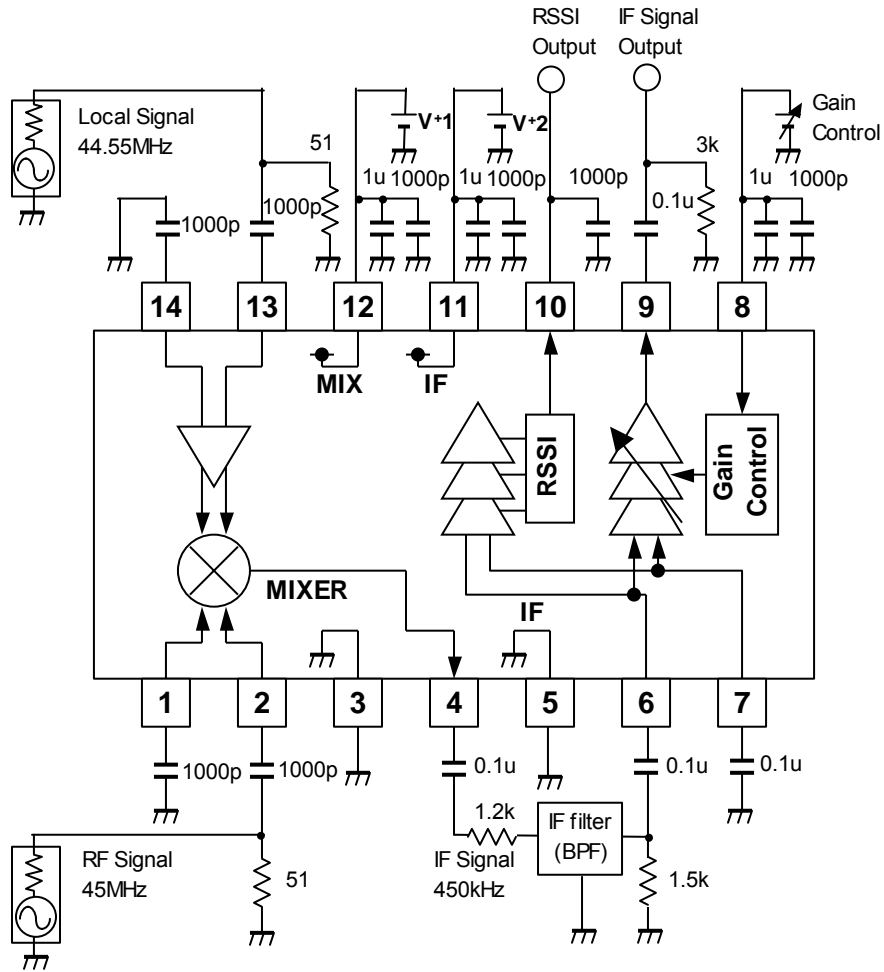
■ BLOCK DIAGRAM



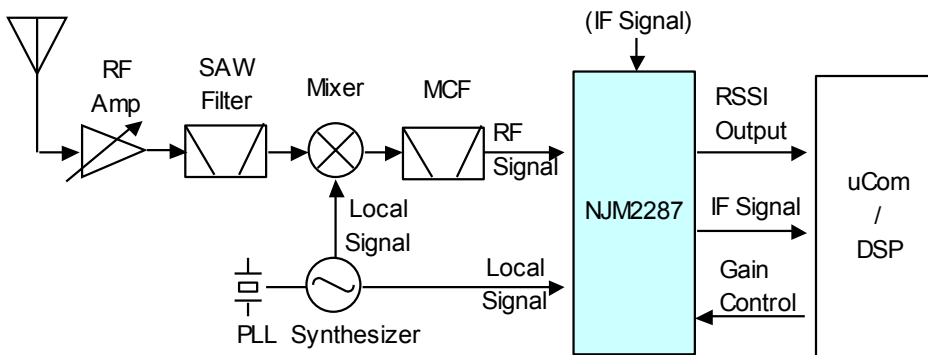
No.	Symbol	Description
1	RF DEC	Mixer Decoupling
2	RF IN	Mixer Input
3	GND1	Mixer Ground
4	MIX OUT	Mixer Output
5	GND2	IF Ground
6	IF IN	IF Limiter Amplifier Input
7	IF DEC	IF Decoupling
8	GC IN	Gain Control Voltage Input
9	IF OUT	FM IF Output
10	RSSI	RSSI Output
11	V ⁺ 2	Supply Voltage for IF
12	V ⁺ 1	Supply Voltage for Mixer
13	LO IN	Local Input
14	LO DEC	Local Decoupling

■ REFERENCE

- Representative Block Diagram



- Simplified Application Block Diagram



■ Symbols related to Electrical Characteristics

SYMBOL	DESCRIPTION
IccqMIX	Current consumption 1 The current passing through pin12 (V^{+1}) when V^{+1} is supplied to pin 12. No input signal.
IccqIF	Current consumption 2 The current passing through pin11 (V^{+2}) when V^{+2} is supplied to pin 11. No input signal.
Icont1	Supply current 1 at GC IN / GC IN supply current 1 The current passing through pin8 (GC IN) when the voltage at pin8 is 0V.
Icont2	Supply current 2 at GC IN / GC IN supply current 2 The current passing through pin8 (GC IN) when the voltage at pin8 is 2V.
FI MIX	Mixer input frequency at RF IN / RF IN input frequency The suitable frequency range of RF input signal at pin2 (RF IN). At this frequency range, the output signal at pin4 satisfies the gain flatness of within ± 3 dB.
CG	Mixer Conversion Gain The difference between the output signal level at pin4 and the input signal level at pin2
P1 MIX	Mixer input 1dB compression point The RF input signal level at 1dB compression point.
IIP3	Mixer 3rd order intercept point The RF signal level at 3 rd order interrupt point, where FIMIX1=45MHz, FIMIX2=FIMIX1-6.25kHz
NO MIX	Noise level at MIX OUT / MIX OUT noise level The noise level at pin4 (MIX OUT) within the frequency range from 450-3.125kHz to 450+3.125kHz Note: This range means the center frequency is 450kHz and the BW is 6.25kHz.
PI LO	Input level at LO IN / LO IN input level The suitable level of local input signal at pin13 (LO IN). At this frequency range, the output signal at pin4 (MIX OUT) satisfies the gain flatness of within ± 3 dB.
RIMIX	Input resistance at RF IN / RF IN input resistance The resistance between pin 1 (RF DEC) and pin2 (RF IN)
RILO	Input resistance at LO IN / LO IN input resistance The resistance between pin13 (LO IN) and pin14 (LO DEC)
ROMNIX	Output resistance at MIX OUT / MIX output resistance The AC resistance at pin 4(MIX OUT) within the range from 450-3.125kHz to 450+3.125kHz
FI IF	Input frequency at IF IN / IF IN input frequency The suitable frequency range of IF input signal at pin6 (IF IN). At this frequency range, the output signal level at pin9 (IF OUT) is satisfied with the gain flatness of within ± 3 dB.
G IF1 (to 4)	IF gain at each of the different GC IN voltage.
PI IF	IF Input 1dB Compression point The IF input signal level at 1dB compression point.
NO IF	Noise level at IF OUT / IF OUT noise level The noise level at pin9 (IF OUT) within the range from 450-3.125kHz to 450+3.125kHz
PO IF	Maximum output voltage at IF OUT / IF OUT maximum output voltage The maximum output level at pin9 (IF OUT) when input level at pin6 is 30dBuV.
RIF	Input resistance at IF IN / IF IN input resistance The resistance between pin 6 (IF IN) and pin9 (IF OUT).
VRSSI1(to3)	RSSI output The RSSI output level at different IF IN input level
GCR	Gain control range The range of IF gain change with GC IN voltage.
GCS	Gain scaling The ratio of IF gain change with GC IN voltage

■ ABSOLUTE MAXIMUM RATINGS (Ta=25°C)

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	V ⁺	7.0	V
Power Dissipation	P _d	300	mW
Gain Control Voltage	GC IN	- 0.3 to V ⁺	V
Operating Temperature	T _{opr}	- 40 to + 85	°C
Storage Temperature	T _{stg}	- 50 to + 125	°C

■ RECOMMENDED OPERATING CONDITION (Ta=25°C)

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V ⁺		2.7	3.3	5.5	V

■ ELECTRICAL CHARACTERISTICS

Ta = 25°C, V⁺1 = V⁺2 = 3.3V, RF IN input signal = 45MHz / 50dBuV, LO IN input signal = 44.55MHz / 100dBuV, IF = 450kHz, Test Circuit 1, unless otherwise noted.

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT
DC CHARACTERISTICS						
Current Consumption 1	I _{ccqMIX}	No signal, V ⁺ 1=3.3V	---	0.5	0.8	mA
Current Consumption 2	I _{ccqIF}	No signal, V ⁺ 2=3.3V GC IN = 2V	---	4.2	5.4	
Supply Current at GC IN	I _{cont1}	GC IN = 0V	-0.5	-0.2	0.1	uA
	I _{cont2}	GC IN = 2V	36.5	44.5	52	

MIXER CHARACTERISTICS

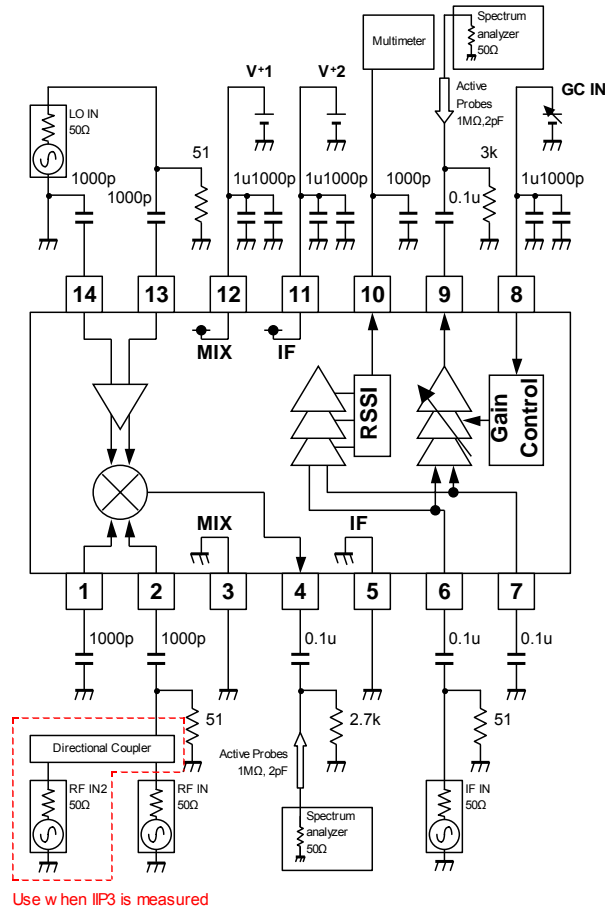
Mixer Input Frequency at RF IN	FI MIX	Gain flatness ±3dB at pin4	---	45	100	MHz
Conversion Gain	CG	Voltage gain between pin 4 and pin 2	3.5	6.5	9.5	dB
Mixer Input 1dB Compression point	P1 MIX	P1dB	93	96	---	dBuV
3rd Order Intercept Point	IIP3	FIMIX1=45MHz FIMIX2=FIMIX1-6.25kHz	101	104	---	
Noise Level at MIX OUT	NO MIX	Circuit 2 BW = 6.25kHz	---	9	14	
Input Level at LO IN	PI LO	Gain flatness ±3dB at pin 13	87	100	107	
Input Resistance at RF IN	RIMIX	Resistance between pin 1 and pin 2	8.2	10	11.8	kΩ
Input Resistance at LO IN	RILO	Resistance between pin 13 and pin 14	7.7	10	12.3	
Output Resistance at MIX OUT	ROMIX	Test Circuit3 AC resistance at pin 4	230	330	430	Ω

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT
IF AMP CHARACTERISTICS						
Input Frequency at IF IN	FI IF	Gain flatness of ± 3 dB at pin9 GC IN = 1V	200	450	1000	kHz
IF Gain	G IF1	GC IN = 0V	98	102	106	dB
	G IF2	GC IN = 1V	—	61	—	
	G IF3	GC IN = 2V	—	22	—	
	G IF4	GC IN = 2.5V	—	9	—	
IF Input 1dB Compression point	PI IF	P1dB GC IN = 2.5V	89	94	—	dBuV
Noise Level at IF OUT	NO IF	Test Circuit4 GC IN = 2V BW = 6.25kHz	—	38	43	
Maximum Output Voltage at IF OUT	PO IF	IF IN = 30dBuV GC IN = 0V	120	121	—	
Input Resistance at IF IN	RIF	Resistance between pin 6 and pin 7	34	40	46	k Ω
RSSI CHARACTERISTICS						
RSSI Output	VRSSI1	IF IN = 20dBuV	—	20	100	mV
	VRSSI2	IF IN = 60dBuV	0.95	1.1	1.25	V
	VRSSI3	IF IN = 100dBuV	1.95	2.15	2.35	
Gain Control CHARACTERISTICS						
Gain Control Range	GCR	GC IN = 0 to 2.5V	81	—	—	dB
Gain Scaling	GCS	GC IN = 1 to 2V	35	38	41	dB/V

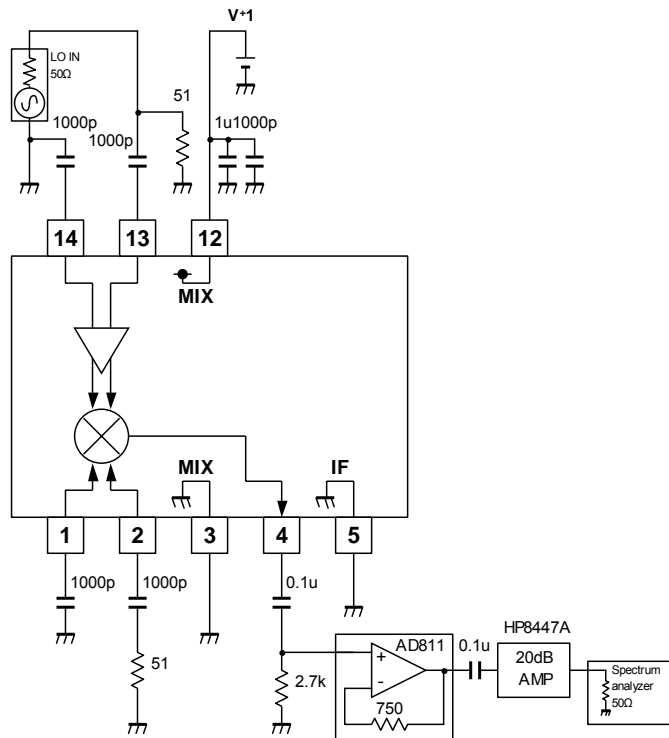
■ TEST CIRCUIT

This test circuit allows the measurement of all parameters described in "ELECTRICAL CHARACTERISTICS".

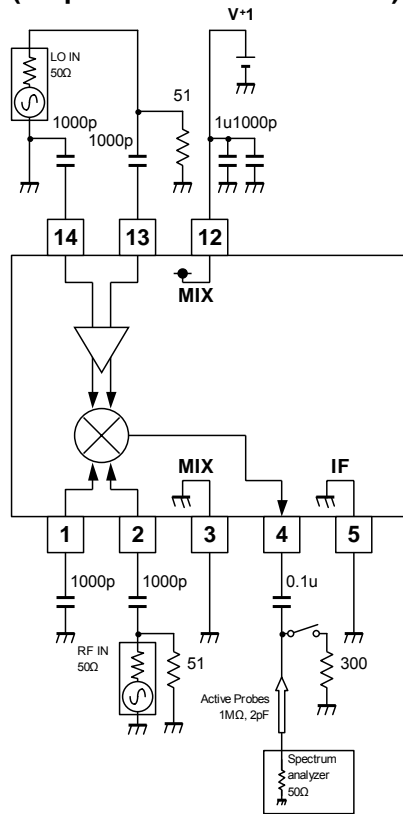
● Test Circuit 1



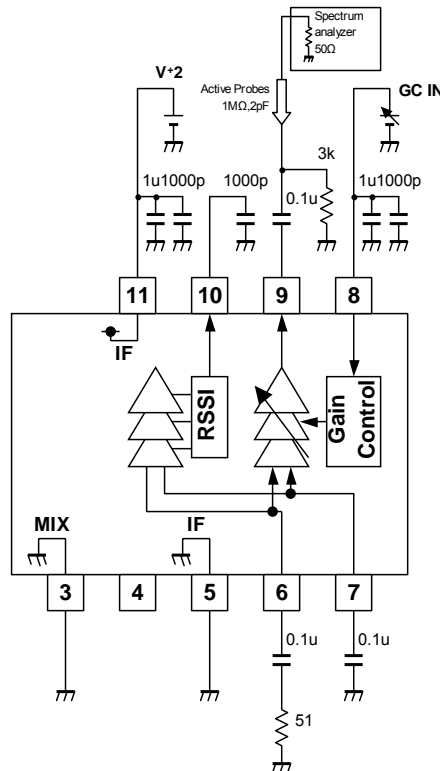
● Test Circuit 2 for NO MIX (Noise Level at MIX OUT)



● Test Circuit 3 for RO MIX (Output Resistance at MIX OUT)



● Test Circuit 4 for NO IF (Noise Level at IF OUT)



■ **TERMINAL FUNCTION (The voltages are measured at Ta=25°C, V⁺=3.3V, Test circuit 1, no signal)**

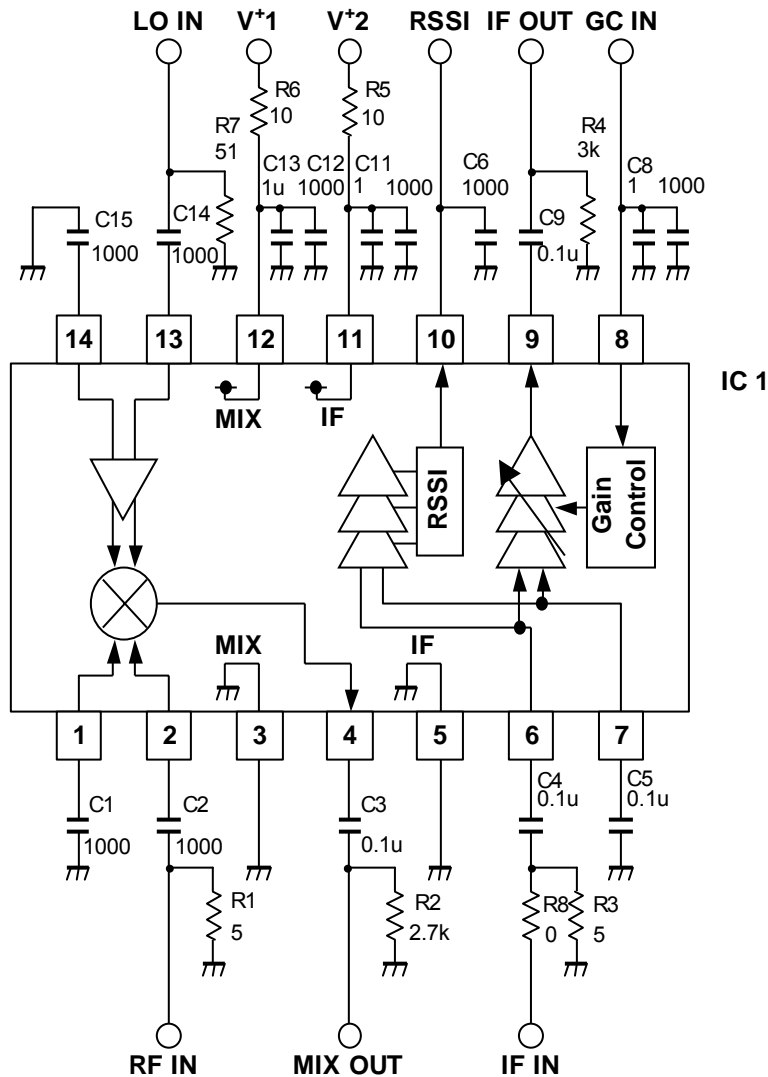
Pin No.	SYMBOL	EQUIVALENT CIRCUIT	VOLTAGE	FUNCTION
1	RF DEC		0.82V	Mixer Decoupling An external decoupling capacitor is connected to enhance stability
2	RF IN			Mixer Input The mixer is designed to work up to 100MHz with the typical input impedance of RinM = 10kΩ
3	GND 1			--
4	MIX OUT		1.76V	Mixer Output An external 450kHz ceramic filter is connected. The typical output impedance is 330Ω .
5	GND 2	--	--	IF Ground
6	IF IN		1.71V @GC IN = 0V 2.16V @GC IN = 2V	IF Limiter Amplifier Input This is an input to the IF amplifier after passing through external 450kHz ceramic filter. The typical input impedance is 40kΩ .
7	IF DEC			IF Decoupling An external decoupling capacitor is connected to enhance stability.
8	GC IN		--	Gain Control Voltage Input The IF gain is changed according to the level of voltage supplied to this pin. The IF gain is 102dB (typ.) @GC IN=0V, and 9dB (typ.) @GC IN=2.5V.

Pin No.	SYMBOL	EQUIVALENT CIRCUIT	VOLTAGE	FUNCTION
9	IF OUT		1.64V	<p>IF Output This is an output of IF signal passing through the internal IF gain control amplifier.</p>
10	RSSI		0.43V	<p>Received Signal Strength Indicator Output Pin 10 outputs DC level proportional to the log of input signal level to pin 6.</p>
11	V ⁺ 2		--	<p>Supply voltage for IF</p>
12	V ⁺ 1		--	<p>Supply voltage for Mixer</p>
13	LO IN		2.06V	<p>Local Input The mixer is designed to work up to 100MHz (reference value) with the typical input impedance of RinM = 10kΩ</p>
14	LO DEC			<p>Local Decoupling An external decoupling capacitor is connected to enhance stability.</p>

■ EVALUATION PC BOARD

The evaluation board is useful for your design and to have more understanding of the usage and performance of this device. This circuit is the same as TEST CIRCUIT. Note that this board is not prepared to show the recommendation of pattern and parts layout.

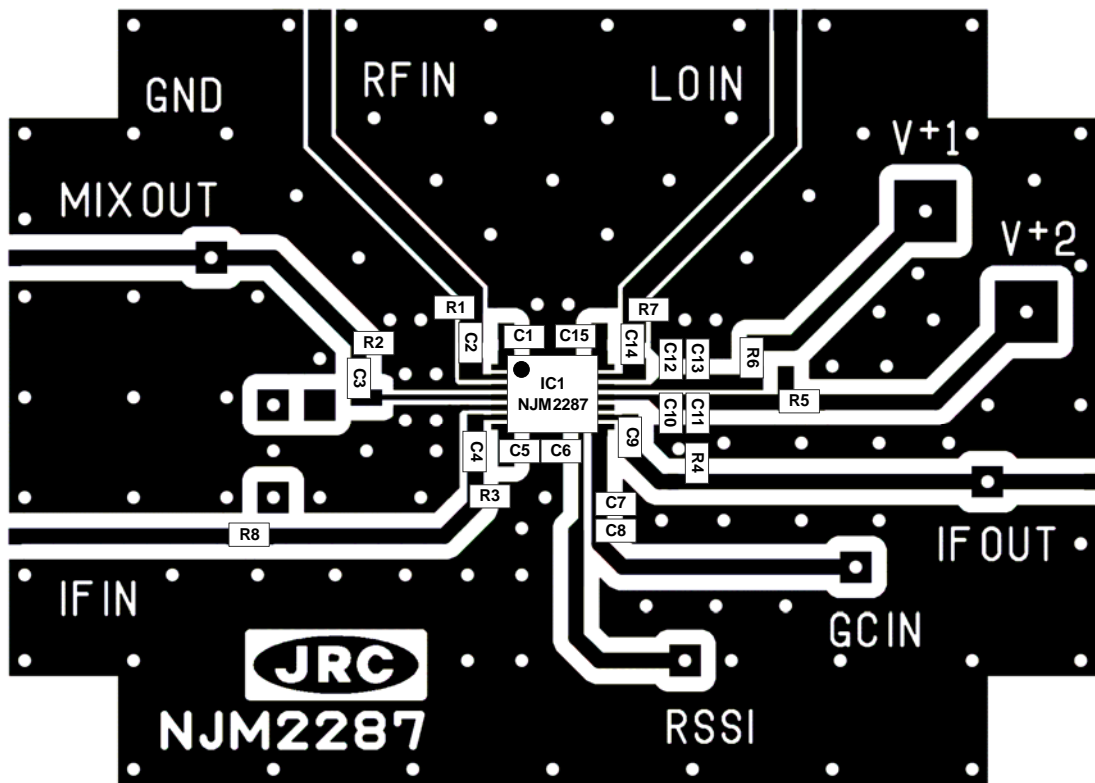
● Circuit Diagram



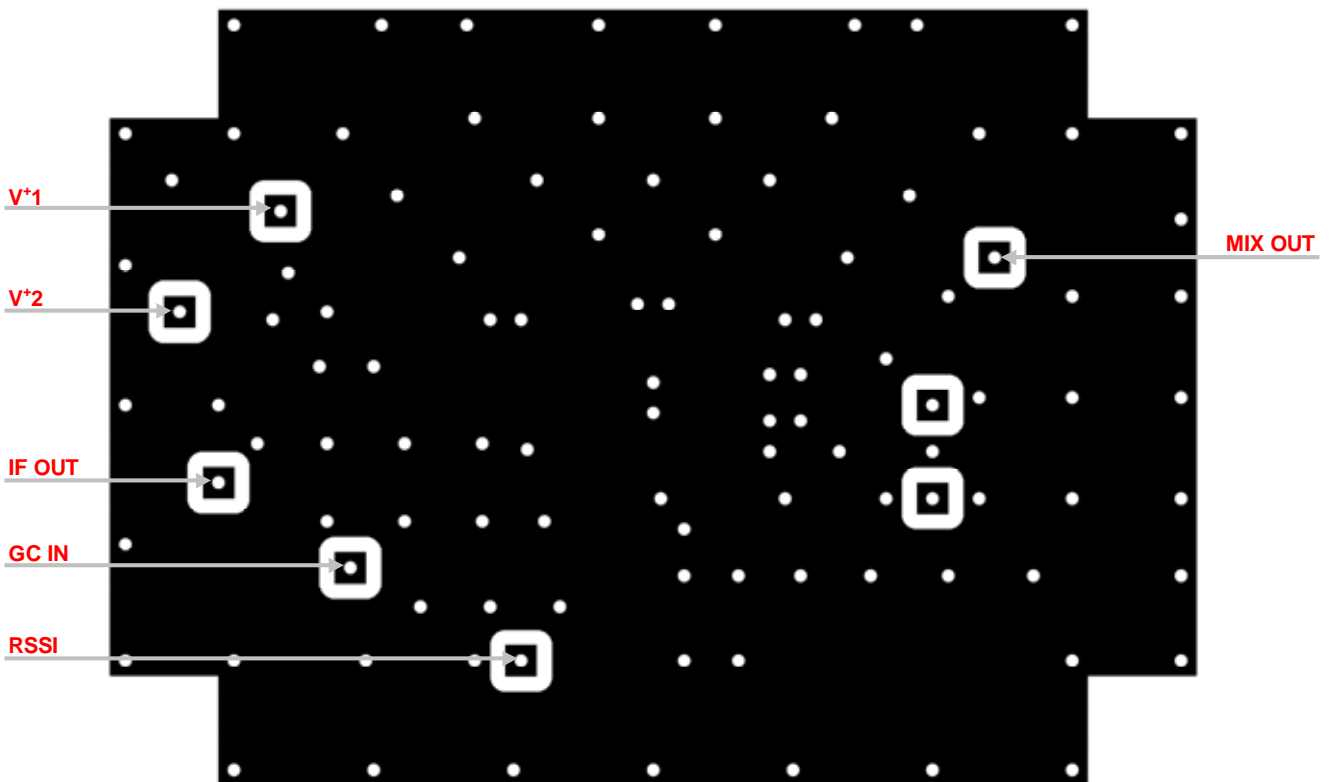
● List of Component

Items	Designation	Value	Items	Designation	Value	Items	Designation	Value
Capacitor	C1	1000pF	Capacitor	C11	1uF	Resistor	R1	51Ω
	C2	1000pF		C12	1000pF		R2	2.7kΩ
	C3	0.1uF		C13	1uF		R3	51Ω
	C4	0.1uF		C14	1000pF		R4	3kΩ
	C5	0.1uF		C15	1000pF		R5	10Ω
	C6	1000pF					R6	10Ω
	C7	1000pF					R7	51Ω
	C8	1uF					R8	0Ω
	C9	0.1uF		IC	IC1	NJM2287		
	C10	1000pF						

- PRINTED CIRCUIT BOARD
Circuit Side View



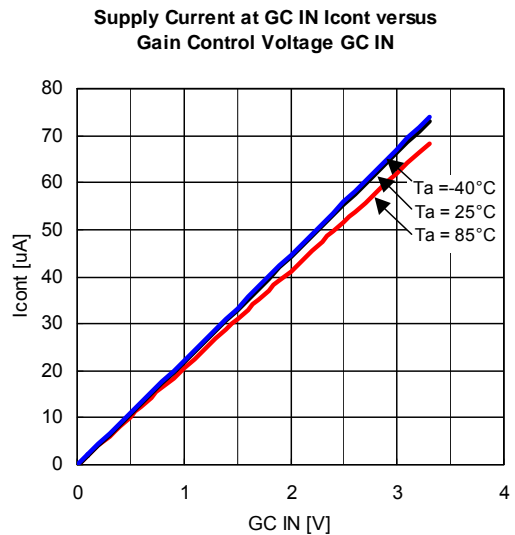
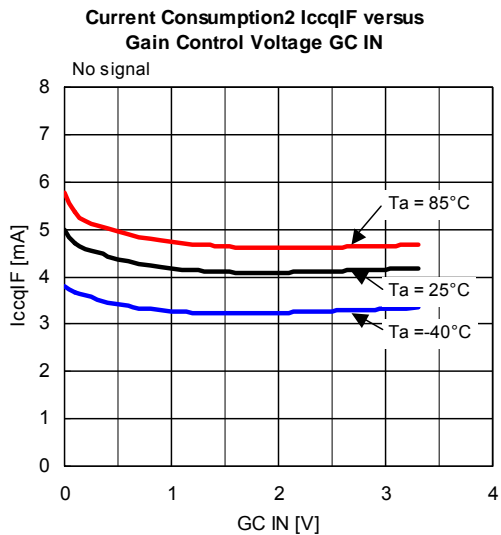
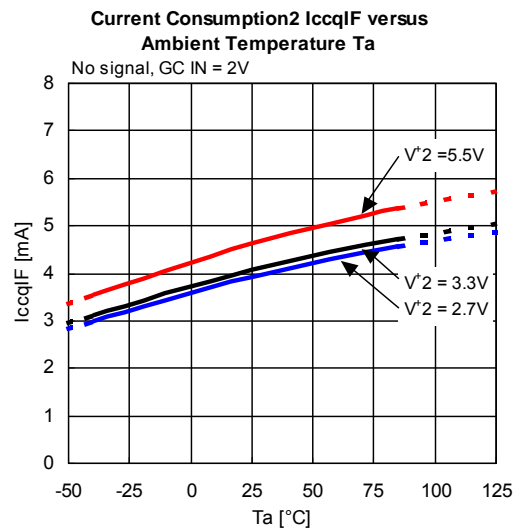
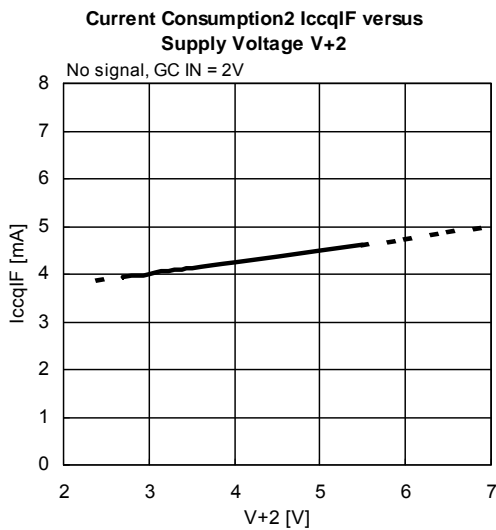
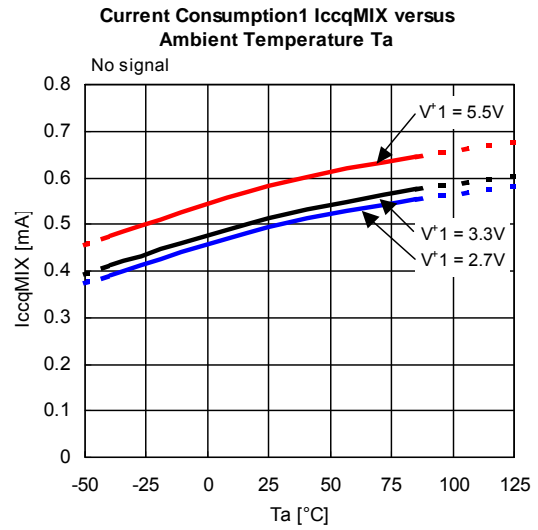
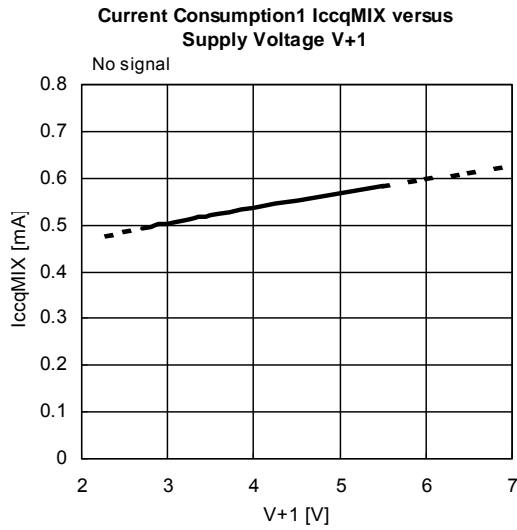
Ground Side View



■ TYPICAL CHARACTERISTICS

[DC Characteristics]

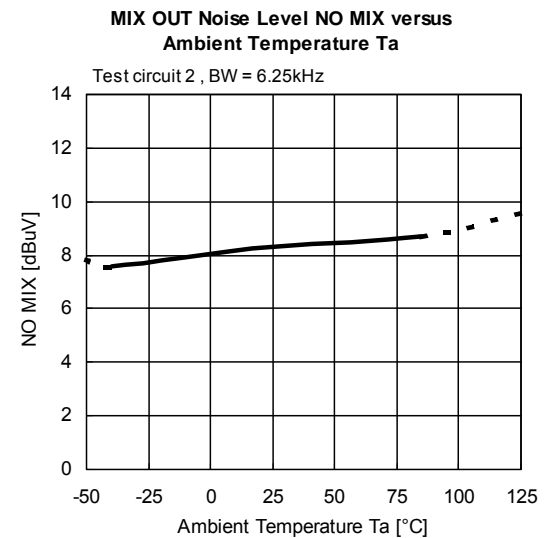
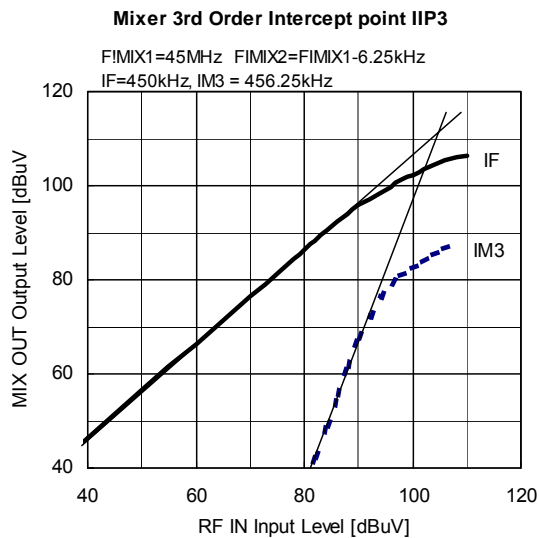
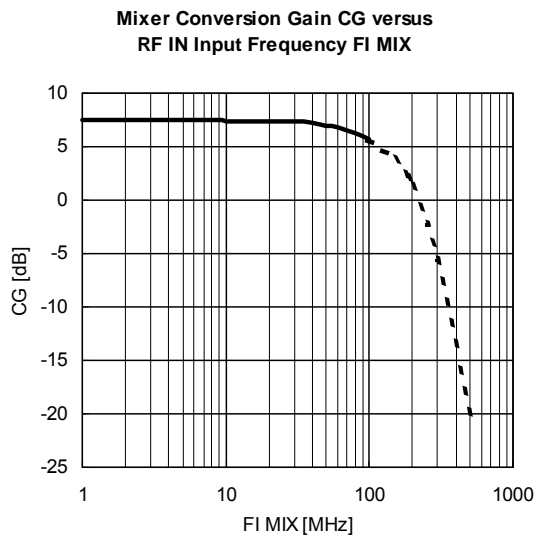
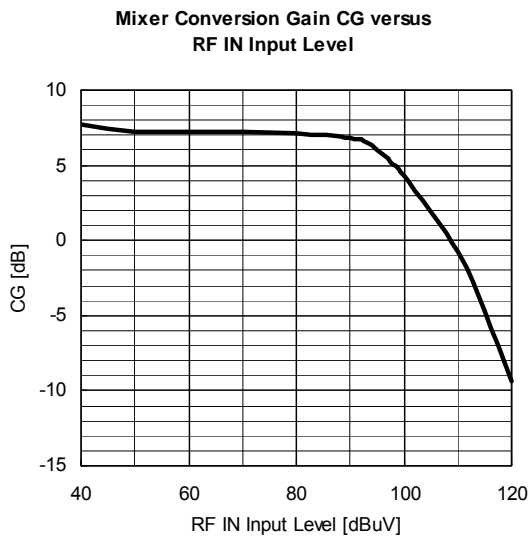
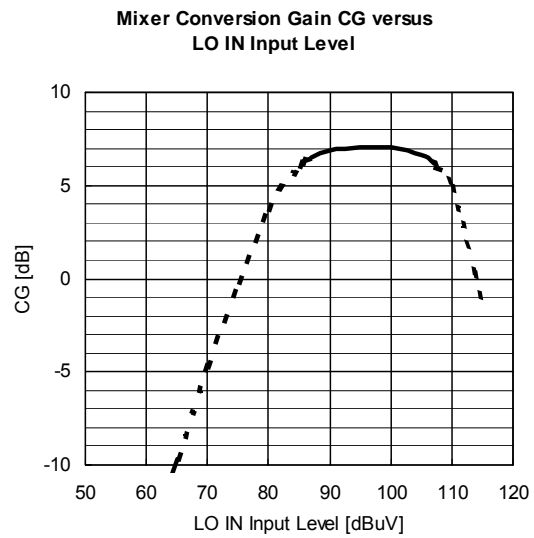
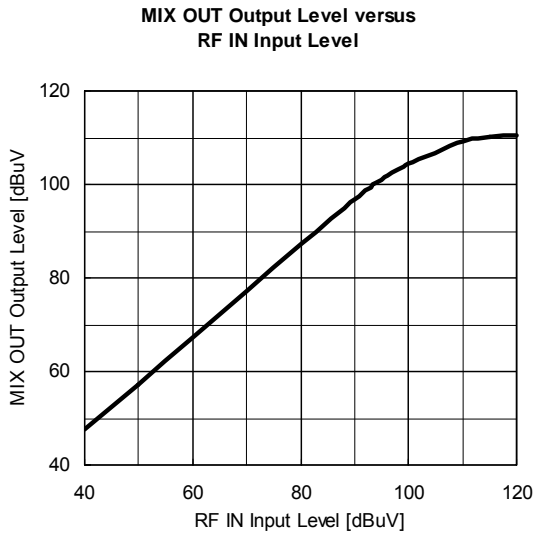
Ta = 25°C, Circuit1, V⁺¹ = V⁺² = 3.3V, unless otherwise noted.



[MIXER CHARACTERISTICS]

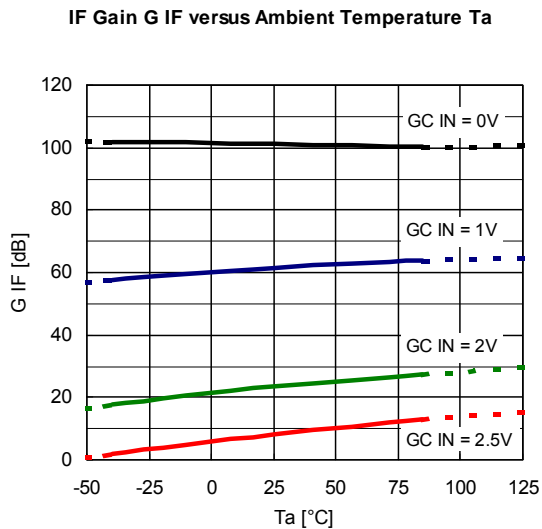
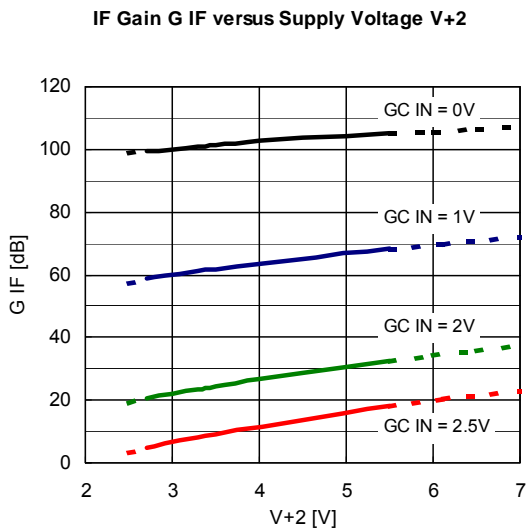
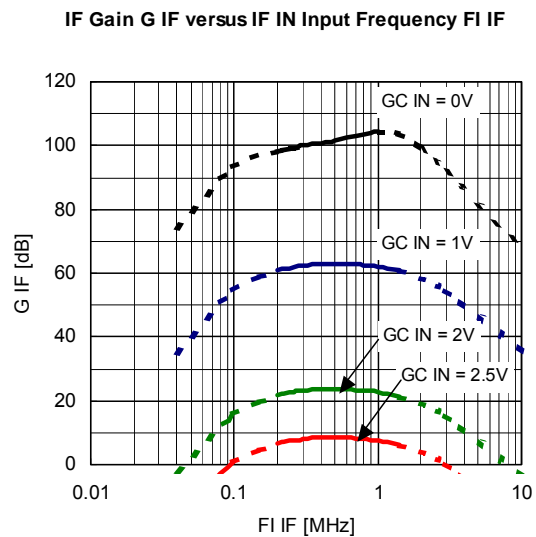
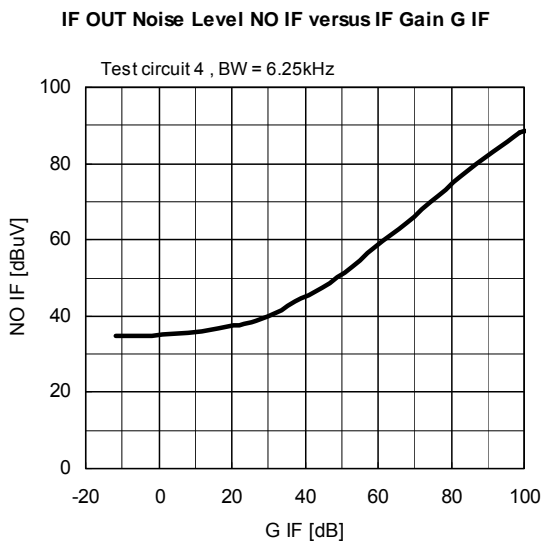
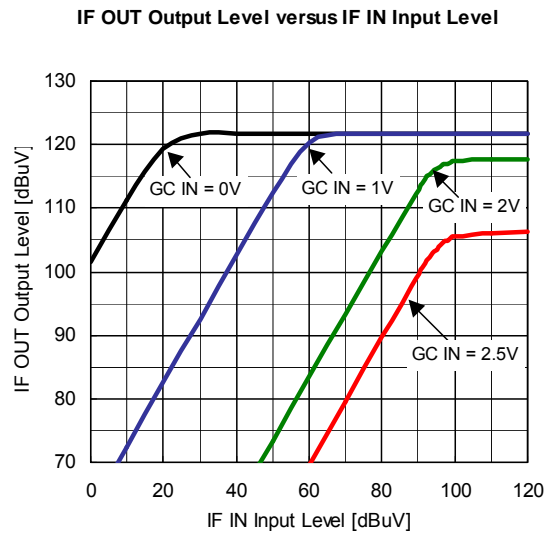
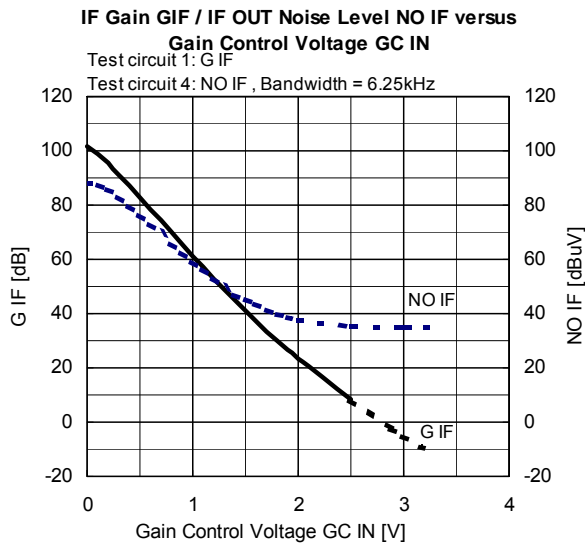
Ta = 25°C, Circuit1, V⁺1 = V⁺2 = 3.3V, RF IN = 45MHz / 50dBuV,

LO IN = 44.55MHz / 100dBuV, MIX OUT = 450kHz, unless otherwise noted.



[IF AMP CHARACTERISTICS]

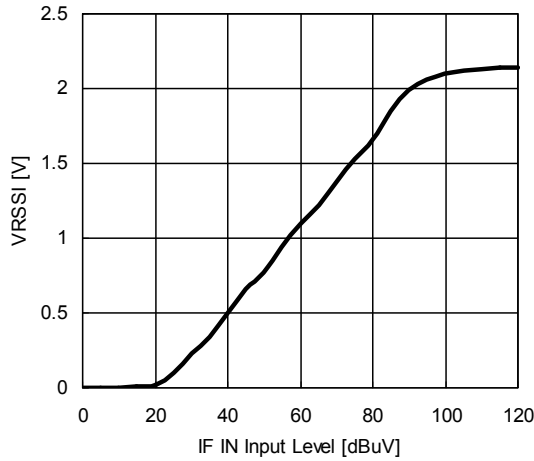
Ta = 25°C, Circuit1, V+1 = V+2 = 3.3V, IF IN = 450kHz, unless otherwise noted.



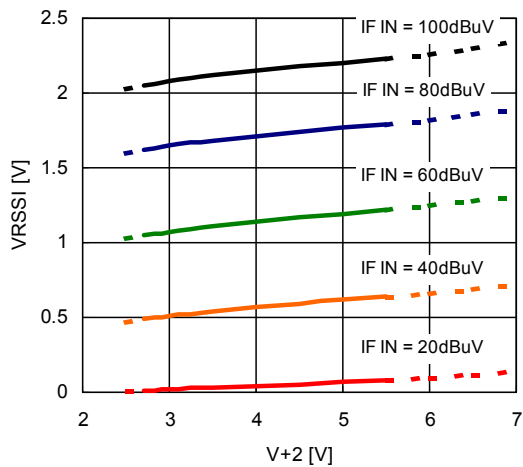
[RSSI CHARACTERISTICS]

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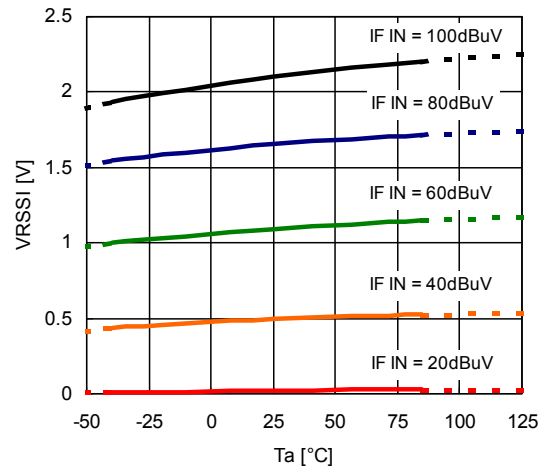
RSSI Output Volage VRSSI versus
IF IN Input Level



RSSI Output Voltage VRSSI versus
Supply Voltage V+2



RSSI Output Voltage VRSSI versus
Ambient Temperature Ta



[CAUTION]
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