NEC

BIPOLAR ANALOG INTEGRATED CIRCUIT
μPC8001

IF AMPLIFIER IC
WITH ON-CHIP MIXER FOR DIGITAL CELLULAR PHONES

The μPC8001 is a 3-volt IF amplifier IC with an on-chip mixer developed for digital cellular phones.

The μPC8001 consists of a high-sensitivity limiter amplifier with an input frequency of 455 kHz, a high-speed and high-precision linear RSSI (received signal strength indicator), and a second mixer with an input frequency of 80 to 150 MHz.

The μPC8001 features a low 3 mA (TYP.) and 2.2 μA (TYP.) current consumption at normal operation and power-OFF, respectively. Its high-speed charge/discharge circuit enables fast power-ON/OFF switching.

The μPC8001 boasts an extremely small size packaged in a 14-pin plastic shrink SOP, and low external capacitances of less than 0.01 μF, in addition to an on-chip RSSI output resistor, and is most suitable for high-density mounting.

FEATURES

- Low-voltage operation...3 V ±10%
- Low power consumption...(V_{CC} = 3 V)

	Mixer	IF amp. + RSSI
During operation	2.1 mA (TYP.)	0.95 mA (TYP.)
At power-OFF	0 μA (TYP.)	2.2 μA (TYP.)

- High limiting sensitivity...–91 dBm (TYP.)
- High-precision RSSI linearity...±0.5 dB (TYP.) ($V_{IF\ IN}$ = –86 to –6 dBm)
- High-speed RSSI response time

RSSI output rise time	77μs (TYP.)
RSSI output fall time	113 μs (TYP.)

- High-speed power-ON/OFF switching time

Rise time at power-ON	174 μs (TYP.)
Fall time at power-OFF	3 μs (TYP.)

- External capacitors of less than 0.01 μF
- On-chip RSSI output resistor (34 kΩ)
- Ultra-compact package...14-pin plastic shrink SOP

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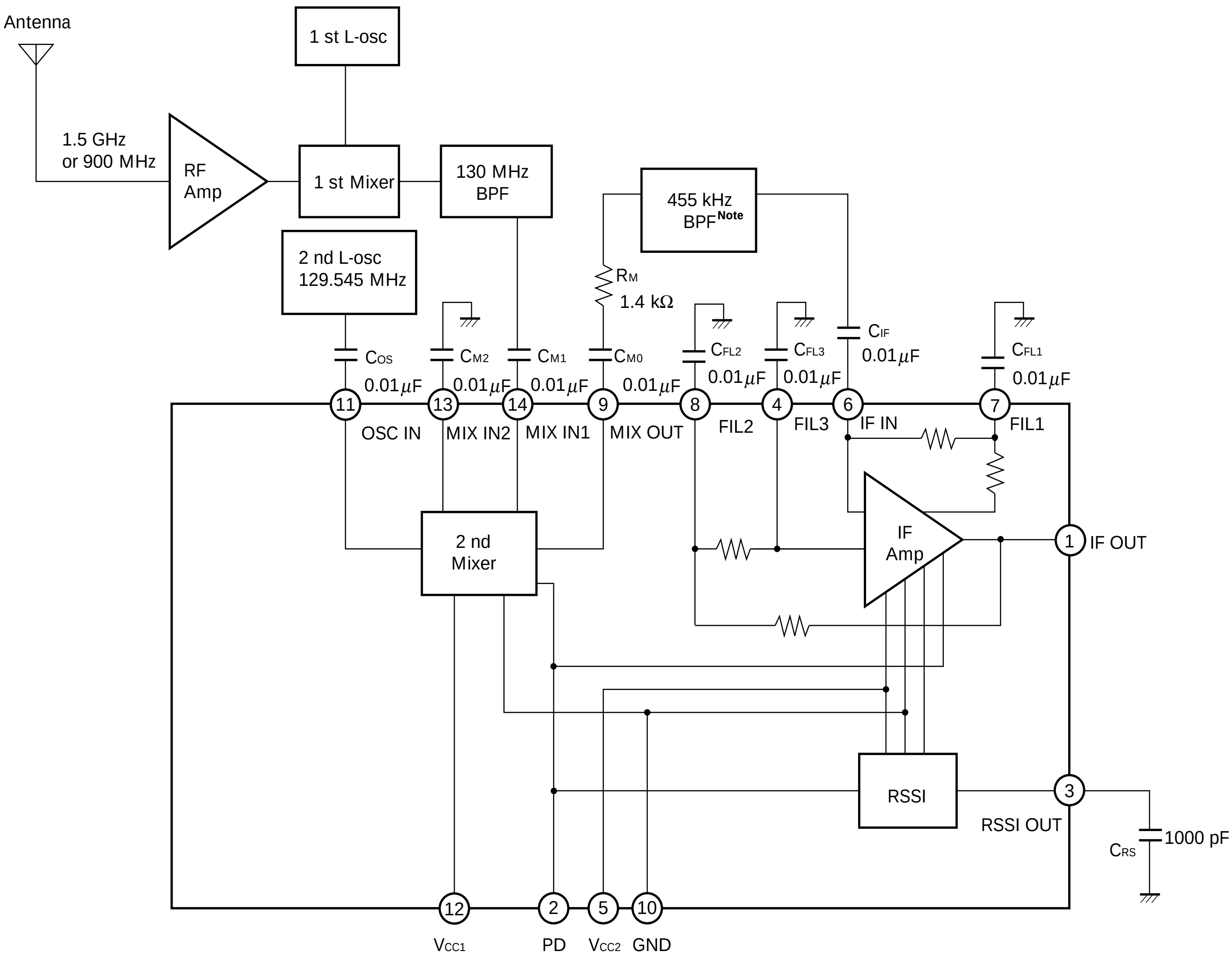
The mark ★ shows revised points.

ORDERING INFORMATION

Part number	Package
μPC8001GR	14-pin plastic shrink SOP (225 mil)
μPC8001GR-E1	14-pin plastic shrink SOP (225 mil) Embossed carrier taping (Pin 1 located toward tape unwind direction)
μPC8001GR-E2	14-pin plastic shrink SOP (225 mil) Embossed carrier taping (Pin 1 located toward tape wind direction)

BLOCK DIAGRAM



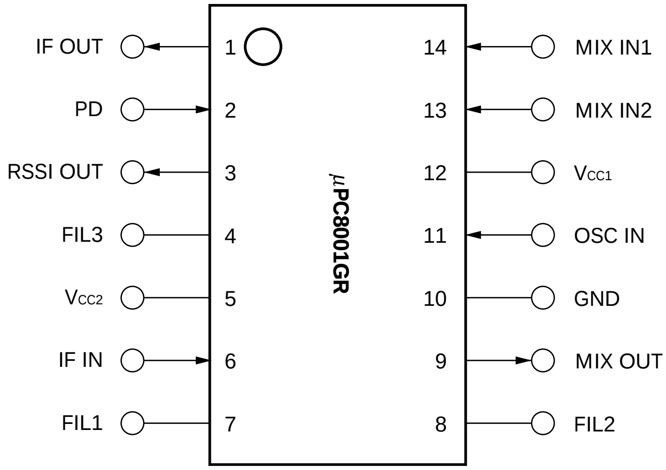
Note Input/output impedance of 455 kHz BPF: 1.5 k Ω

CONTENTS

1. PIN CONFIGURATION AND PIN FUNCTIONS

(1) PIN CONFIGURATION (Top View)

- **14-pin plastic shrink SOP (225 mil)**



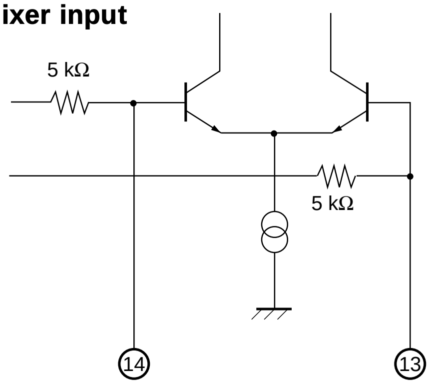
FIL1-FIL3	: Filter
GND	: Ground
IF IN	: Intermediate Frequency Input
IF OUT	: Intermediate Frequency Output
MIX IN1, MIX IN2	: Mixer Input
MIX OUT	: Mixer Output
OSC IN	: Oscillator Input
PD	: Power Down
RSSI OUT	: Received Signal Strength Indicator Output
V_{CC1}, V_{CC2}	: Power Supply

(2) PIN FUNCTIONS

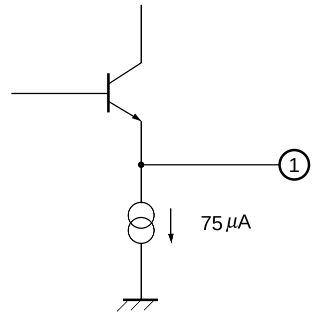
Number	Pin Name	I/O	Function
1	IF OUT	O	IF amplifier output
2	PD	I	Power-ON/OFF control signal input High level: Power-ON; Low level: Power-OFF
3	PSSI OUT	O	RSSI output
4	FIL3	—	Connect capacitor for filter.
5	V_{CC2}	—	IF amplifier and RSSI power pin
6	IF IN	I	IF amplifier input
7	FIL1	—	Connect capacitor for filter.
8	FIL2	—	Connect capacitor for filter.
9	MIX OUT	O	Mixer output
10	GND	—	Ground pin
11	OSC IN	I	Oscillator input
12	V_{CC1}	—	Mixer power pin
13	MIX IN2	I	Connect capacitor for filter.
14	MIX IN1	I	Mixer input

2. I/O EQUIVALENT CIRCUIT

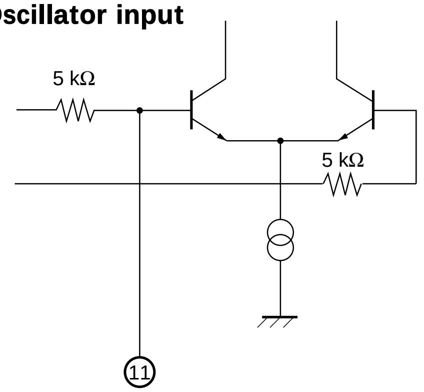
Mixer input



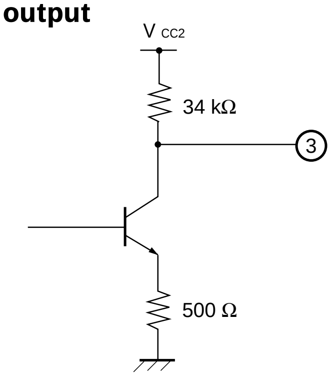
IF amplifier output



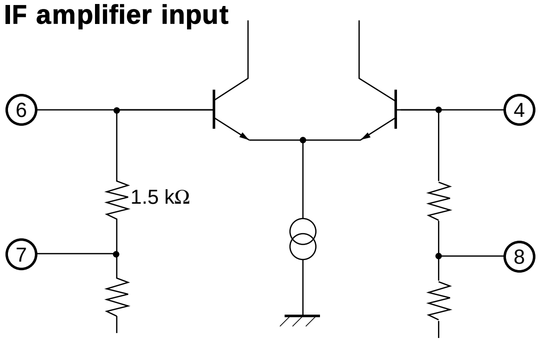
Oscillator input



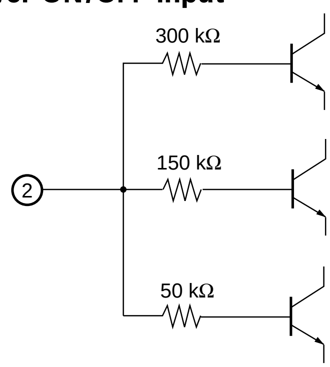
RSSI output



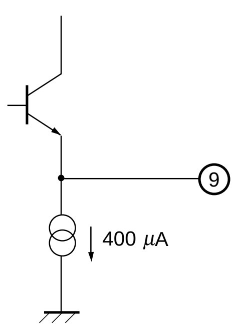
IF amplifier input



Power-ON/OFF input



Mixer output



3. ELECTRICAL SPECIFICATIONS

Absolute Maximum Ratings (T_A = 25°C)

Parameter	Symbol	Conditions	Rating	Unit
Supply voltage	V_{CC}		7	V
Total power dissipation	P_T		300	mW
Operating ambient temperature	T_A		–30 to +85	°C
Storage temperature	T_{stg}		–40 to +125	°C

Caution Exposure to Absolute Maximum Ratings for extended periods may affect device reliability; exceeding the ratings could cause permanent damage. The parameters apply independently. The device should be operated within the limits specified under DC and AC Characteristics.

Recommended Operating Conditions (T_A = 25°C)

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Supply voltage	V_{CC}			2.7	3.0	3.3	V
Mixer input level	$V_{MIX\ IN}$	See **Figure 3-1**.	50 Ω termination	–100		–20	dBm Note1
			LC matching	–113 Note2		–33 Note2	dBm Note1
IF amplifier input level	$V_{IF\ IN}$			–86		–6	dBm Note1
Oscillator input level	$V_{OSC\ IN}$			–30	–15	–5	dBm Note1
IF amplifier input frequency	$f_{IF\ IN}$			400	455	500	kHz
Mixer input frequency	$f_{MIX\ IN}$			80	130	150	MHz
Mixer output frequency	$f_{MIX\ OUT}$			400	455	500	kHz

Notes 1. Assuming a conversion value of 50 Ω, 0 dBm = 0.2236 V_{rms}.

2. Depends on board wiring pattern, use as reference value.

ELECTRICAL CHARACTERISTICS

(T_A = 25°C, V_{CC1} = V_{CC2} = 3 V, $f_{MIX\ IN}$ = 130 MHz, $f_{OSC\ IN}$ = 129.545 MHz, $f_{IF\ IN}$ = 455 kHz, C_{RS} = 1000pF, C_{OS} = C_{M1} = C_{M2} = C_{M0} = C_{IF} = C_{FL1} = C_{FL2} = C_{FL3} = 0.01μF, 0 dBm = 0.2236 V_{rms})

(1) Mixer

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Supply current	I_{CC1}	No signal			2.1	3.0	mA
Conversion gain	CG	$V_{MIN\ IN}$ = –50dBm $V_{OSC\ IN}$ = –15 dBm See **Figure 3-1**.	50Ω termination	15	20	23	dB
			LC matching		33 Note 1		dB
Third order intercept	IC_3	See **Figure 3-2**.		–13	–8		dBm
–1dB compression output level	V_{OMIX}	$V_{OSC\ IN}$=–15dBm See **Figure 3-3**.		–5	0		dBm
Cut-off frequency	f_C	–3 dB point		200	470		MHz
Noise figure	NF	See **Figure 3-6**.			10 Note 1		dB
Local isolation	IS_L			20	26		dB
Mixer input impedance	Z_{IM}				48-j383		Ω
Local input impedance	Z_{IL}				80-j425		Ω
Output resistance	R_{OM}			60	120	180	Ω
Power-ON rise time Note2	t_{ONM}	V_{ON} = 3 V Rise time of PD signal : 10 ns			33	600	μs
Power-OFF fall time Note3	t_{OFM}	V_{OF} = 0 V Fall time of PD signal : 10 ns			3	200	μs
Power-OFF supply current	I_{LM}	V_{OF} = 0 V			0	10	μA

Notes 1. Depends on board wiring pattern, use as reference value.

2. Time until DC voltage of mixer output reaches ±10% of power-ON value.

3. Time until supply current reaches 10% of power-ON value.

(2) Power-ON/OFF

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Power-ON input voltage	V_{ON}	Power-ON over V_{ON} and under V_{CC}		1.2	2.4	V
Power-OFF input voltage	V_{OF}	Power-OFF over GND and under V_{OF}	0.6	1.2		V
Power-ON input current	I_{ON}	V_{ON} = 3 V		48	75	μA

(3) IF Amplifier/RSSI

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Supply current	I_{CC2}	No signal		0.95	1.3	mA
IF amplifier output amplitude	V_O	$V_{IF\ IN}$ = –20 dBm	1.2	1.5	1.8	V_{p-p}
Limiting sensitivity	LS	–3dB point, see **Figure 4-5**.		–91	–86	dBm
IF amplifier input impedance	Z_{IN}		1.2	1.5	1.8	kΩ
IF amplifier phase variation	$\Delta\phi$	$V_{IF\ IN}$ =–86 to –6 dBm See **Figure 4-6** Note1.		11		deg
★ RSSI linearity	L_{RS}	$V_{IF\ IN}$ = –86 to –6 dBm Recursive calculation with $V_{IF\ IN}$ = –60 to –6 dBm		±0.5	±2	dB
RSSI slope	SL_{RS}	Recursive calculation with $V_{IF\ IN}$ = –60 to –6 dBm	22.3	24.4	30.1	mV/dB
★ RSSI intercept	IC_{RS}	Recursive calculation with $V_{IF\ IN}$ = –60 to –6 dBm See **Figure 3-4**.	–135	–118	–104	dBm
RSSI output voltage1	V_{R1}	$V_{IF\ IN}$ = –86 dBm	0.50	0.79	0.98	V
★ RSSI output voltage 2	V_{R2}	$V_{IF\ IN}$ = –46 dBm	1.60	1.79	1.90	V
RSSI output voltage 3	V_{R3}	$V_{IF\ IN}$ = –6 dBm	2.70	2.75	2.82	V
RSSI output temperature stability	S_T	$V_{IF\ IN}$ = –86 to –6 dBm, T_A = –30 to +85 °C		1		dB
★ RSSI rise time	t_{rRS}	$V_{IF\ IN}$ = –6 dBm See **Figure 3-5**.		77	300	μs
★ RSSI fall time	t_{fRS}	$V_{IF\ IN}$ = –6 dBm See **Figure 3-5**.		113	300	μs
★ RSSI output ripple	V_{RRS}	$V_{IF\ IN}$ = –6 dBm		3	12	mV_{p-p}
Power-OFF supply current	I_{LI}	V_{OF} = 0 V		2.2	10	μA
Power-ON rise time Note2	t_{ONI}	V_{ON} = 3 V, $V_{IF\ IN}$ = –86 dBm PD signal rise time: 10 ns		174	600	μs
Power-OFF fall time Note3	t_{OFI}	V_{OF} = 0 V PD signal fall time: 10 ns		3	200	μs
IF amplifier output slew rate	SR_O	$V_{IF\ IN}$ = –20 dBm, Rise Note4		3.4		V/μs
		$V_{IF\ IN}$ = –20 dBm, Fall Note5		3.8		V/μs
RSSI output resistance	R_{OR}		27	34	41	kΩ

★ **Notes 1.** Use the network analyzer at RBW = 3 Hz.

2. Time until RSSI output reaches ±10% of power-ON value.

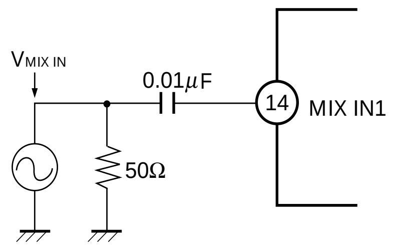
3. Time until supply current reaches 10% of power-ON value.

4. Rise: 10% to 90%

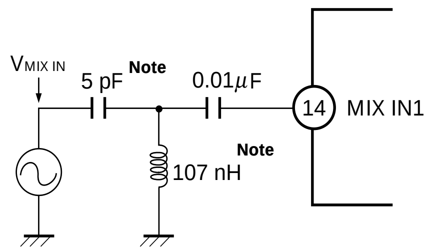
5. Fall: 90% to 10%

Figure 3-1. Mixer Input

(a) 50Ω Termination



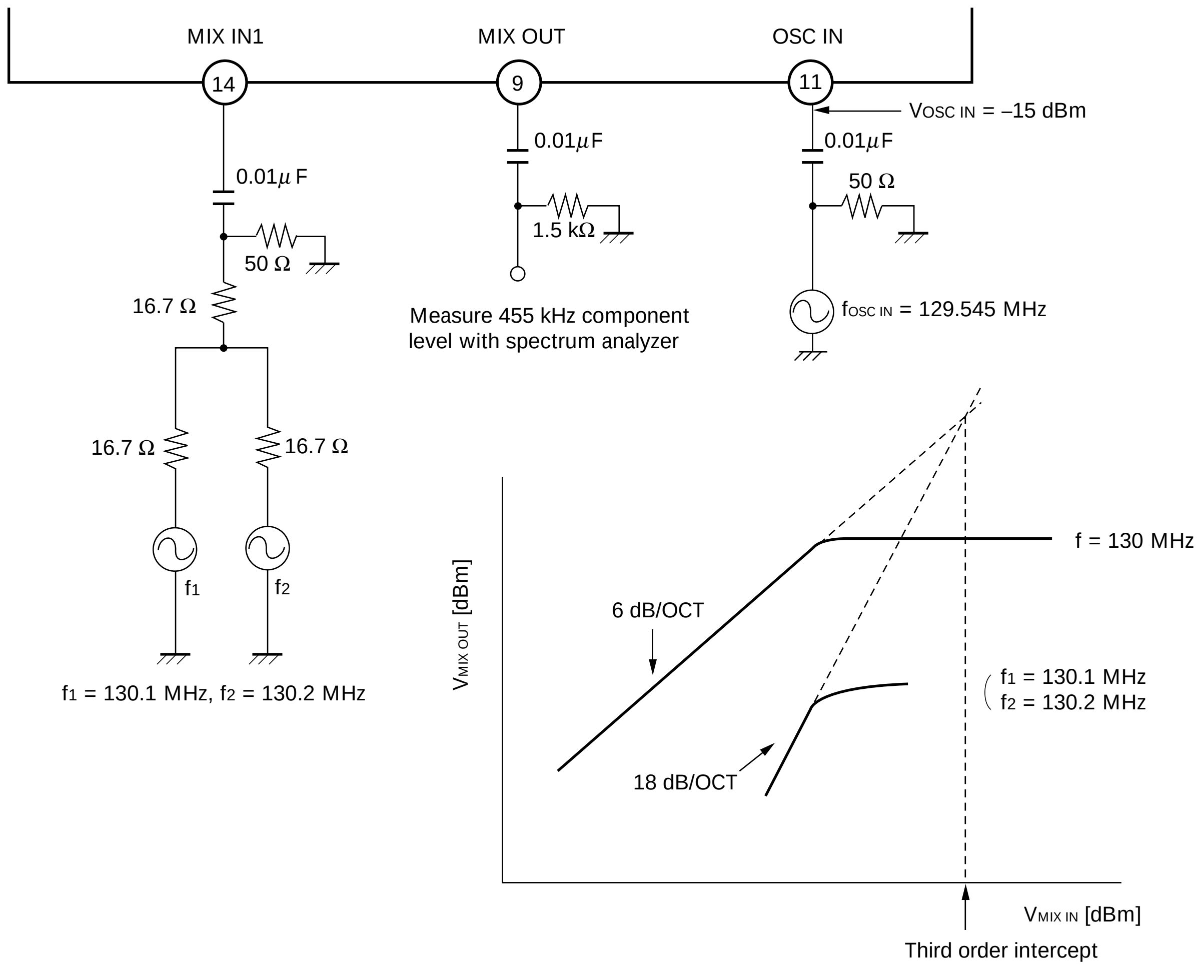
(b) LC Matching



Note The values L and C are affected by the parasitic capacitance and inductance of the board. Therefore, adjust L and C so that the impedance at the MIX IN pin from the signal source equals 50Ω.

Remark The signal source impedance is 50Ω.

Figure 3-2. Third Order Intercept



Remark Signal source impedance is 50Ω.

Figure 3-3. –1 dB Compression Output Level

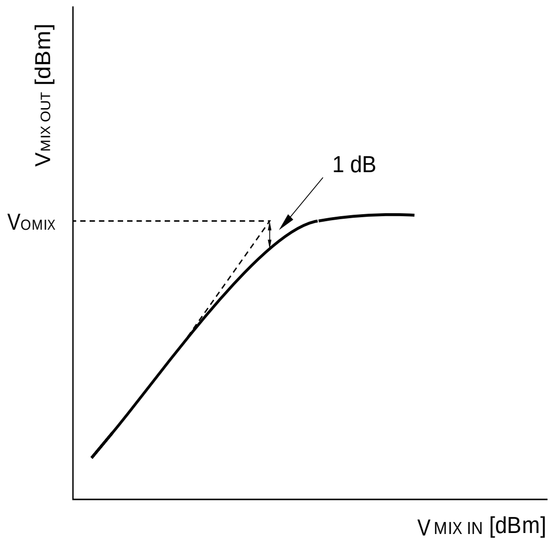


Figure 3-4. RSSI Intercept

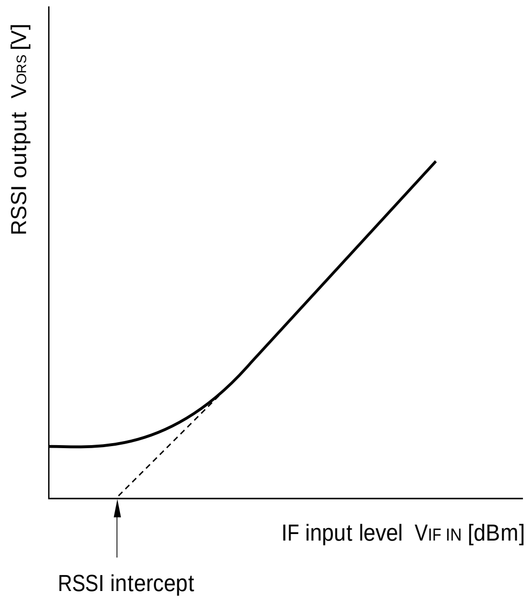


Figure 3-5. RSSI Response Time

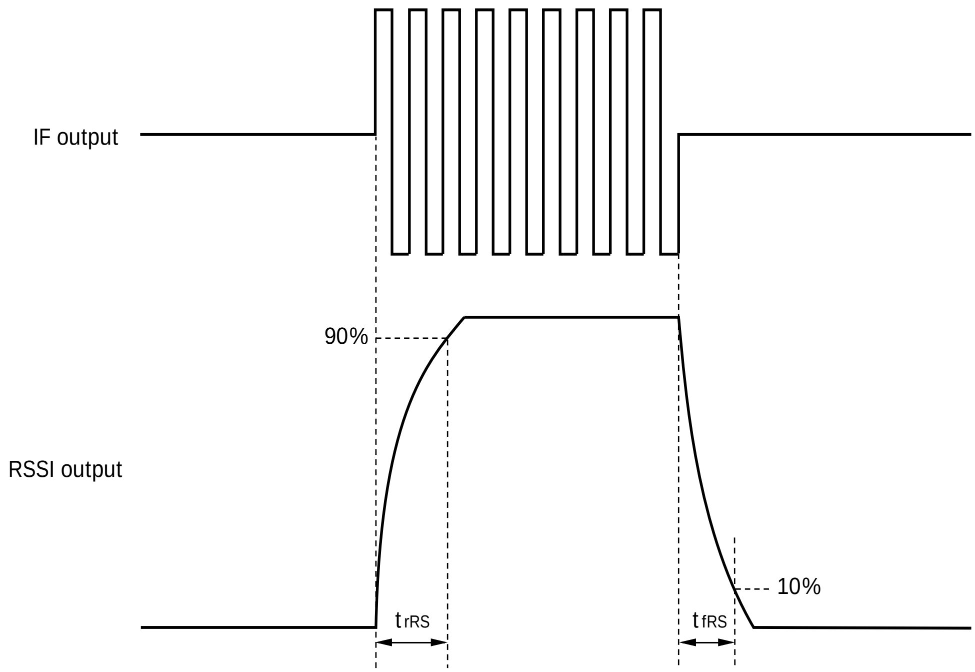
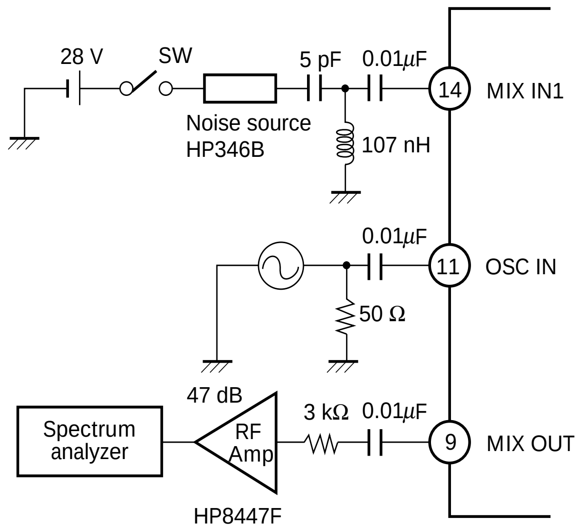


Figure 3-6. Noise Figure Measurement



The noise figure is calculated as follows:

$$\mathbf{NF = ENR - 10\ log\ (Y - 1)}$$

NF (dB): Noise figure
ENR (dB): ENR of noise source

Y: $Y = 10^{\frac{N_2 - N_1}{10}}$

N_1 (dBm): Spectrum analyzer indication value at SW OFF.
N_2 (dBm): Spectrum analyzer indication value at SW ON.

Remark This measurement measures DSB. To measure SSB, add 3 dB to NF above.

4. CHARACTERISTIC CURVES

Figure 4-1. Mixer Supply Current vs. Supply Voltage

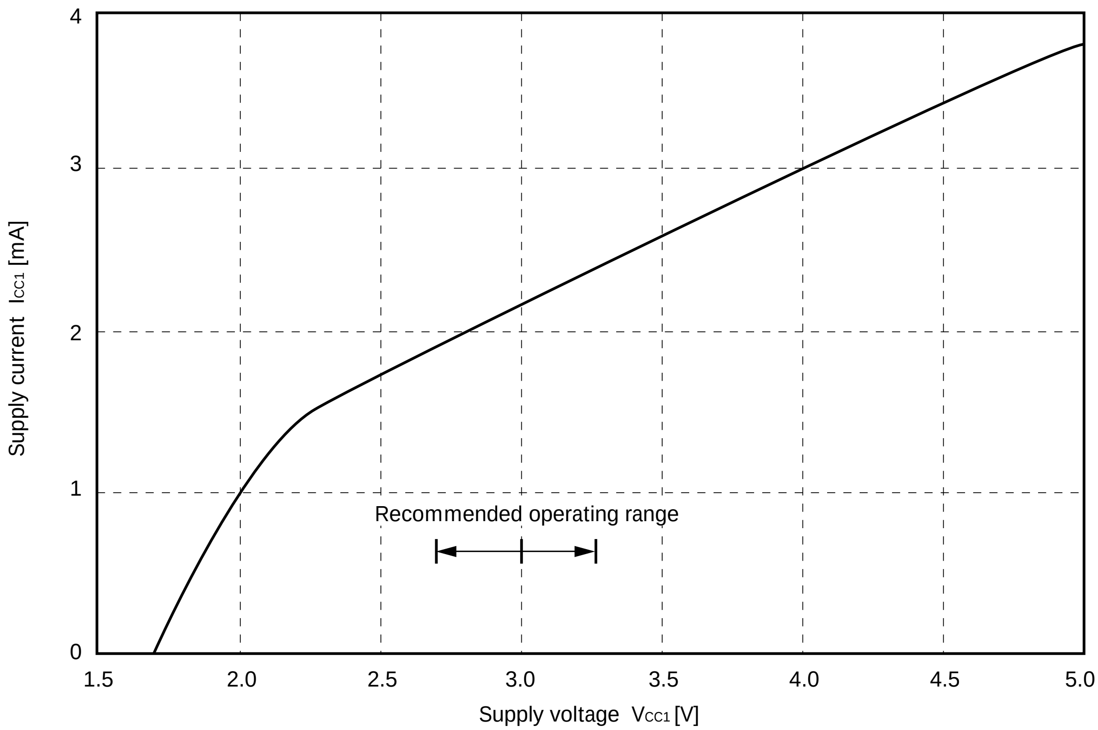


Figure 4-2. Mixer Output Level vs. Mixer Input Level
(fMIX IN= 130 MHz, fOSC IN = 129.545 MHz, fMIX OUT = 455 kHz, VOSC IN = –15 dBm)

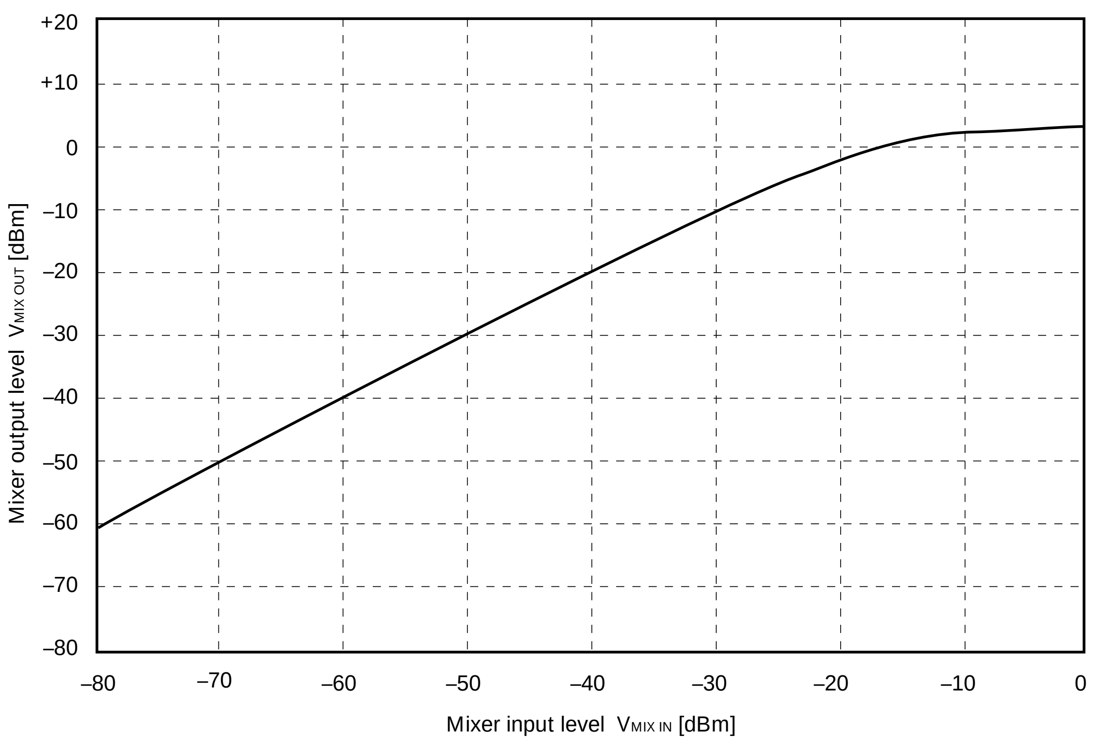


Figure 4-3. Mixer Conversion Gain vs. Mixer Input Frequency
($V_{MIX\ IN}$ = –30 dBm, $V_{OSC\ IN}$ = –15 dBm, $f_{OSC\ IN}$ = $f_{MIX\ IN}$ – $f_{MIX\ OUT}$, $f_{MIX\ OUT}$ = 455 kHz)

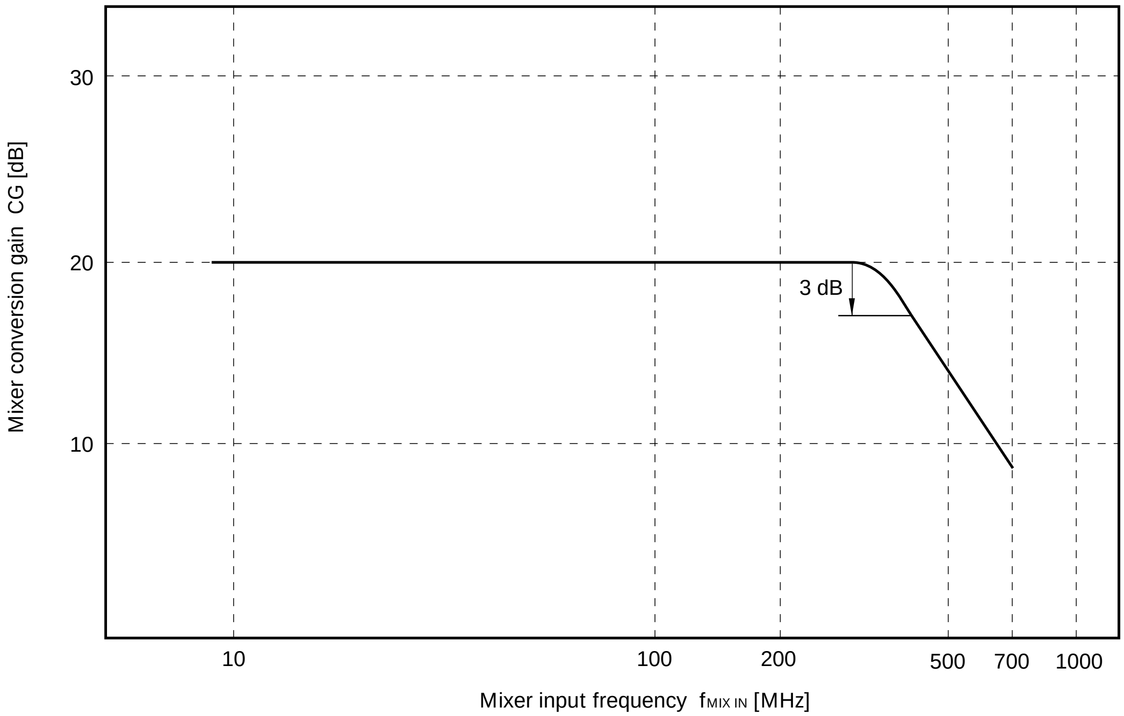


Figure 4-4. IF Amplifier/RSSI Supply Current vs. Supply Voltage

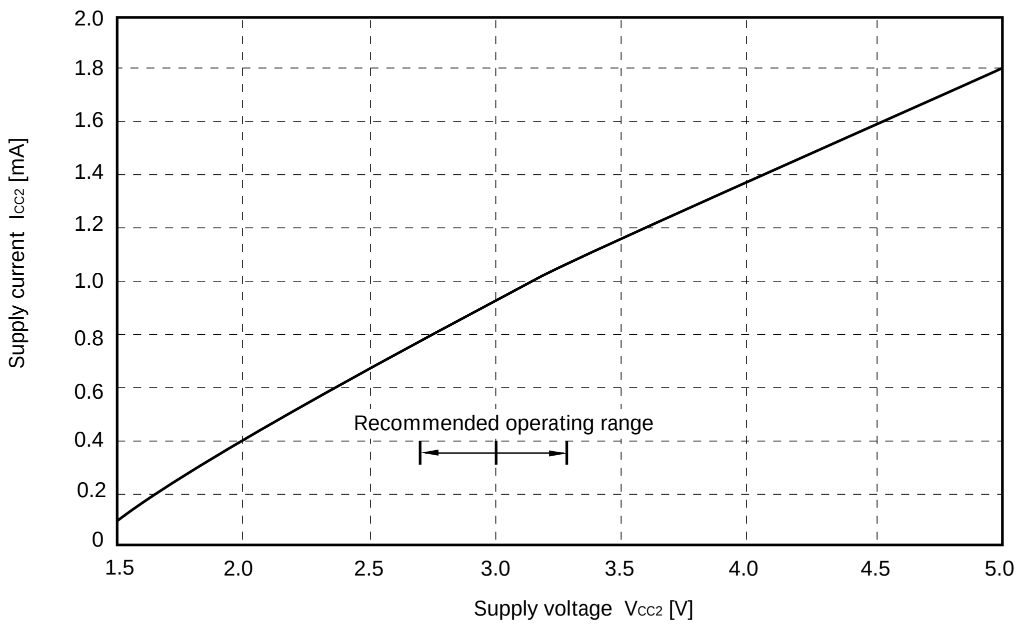


Figure 4-5. IF Amplifier Output Level vs. IF Amplifier Input Level

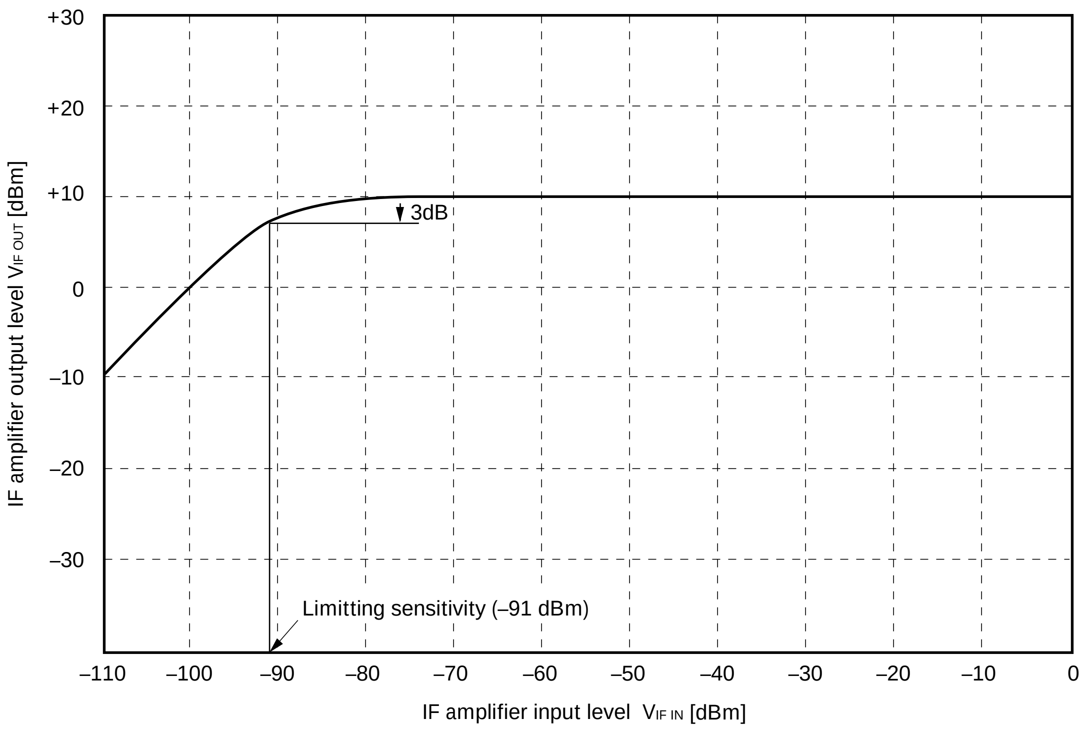


Figure 4-6. IF Amplifier Output Phase vs. IF Amplifier Input Level

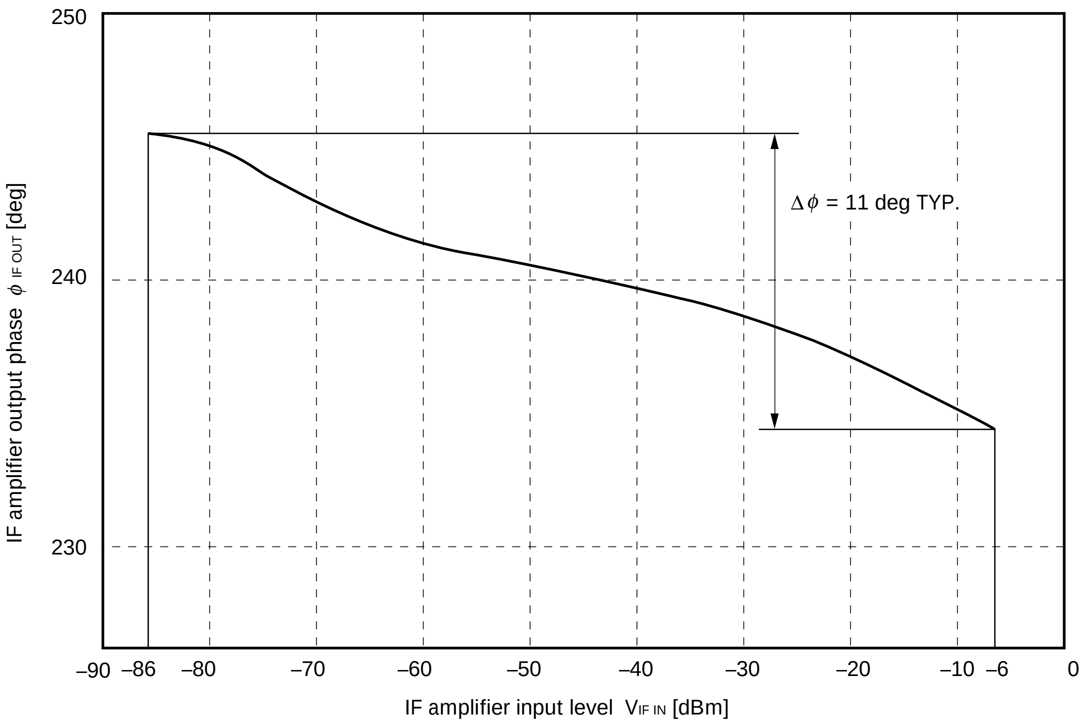
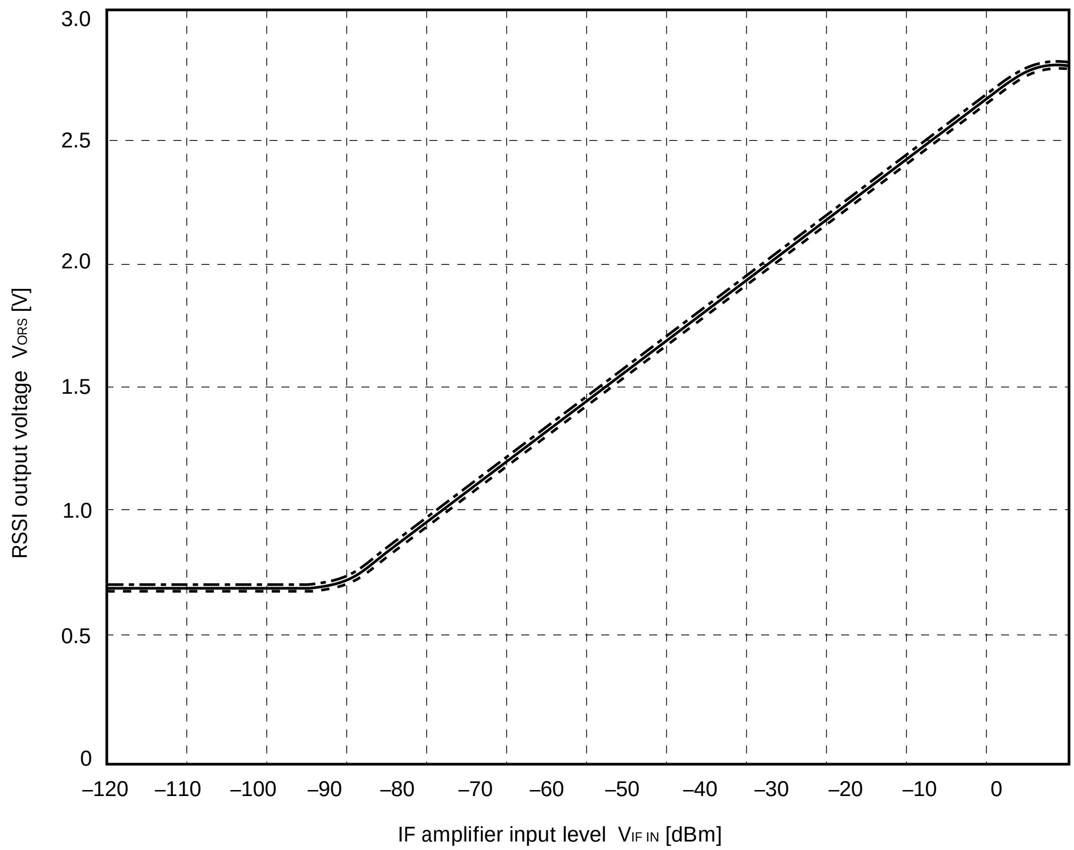


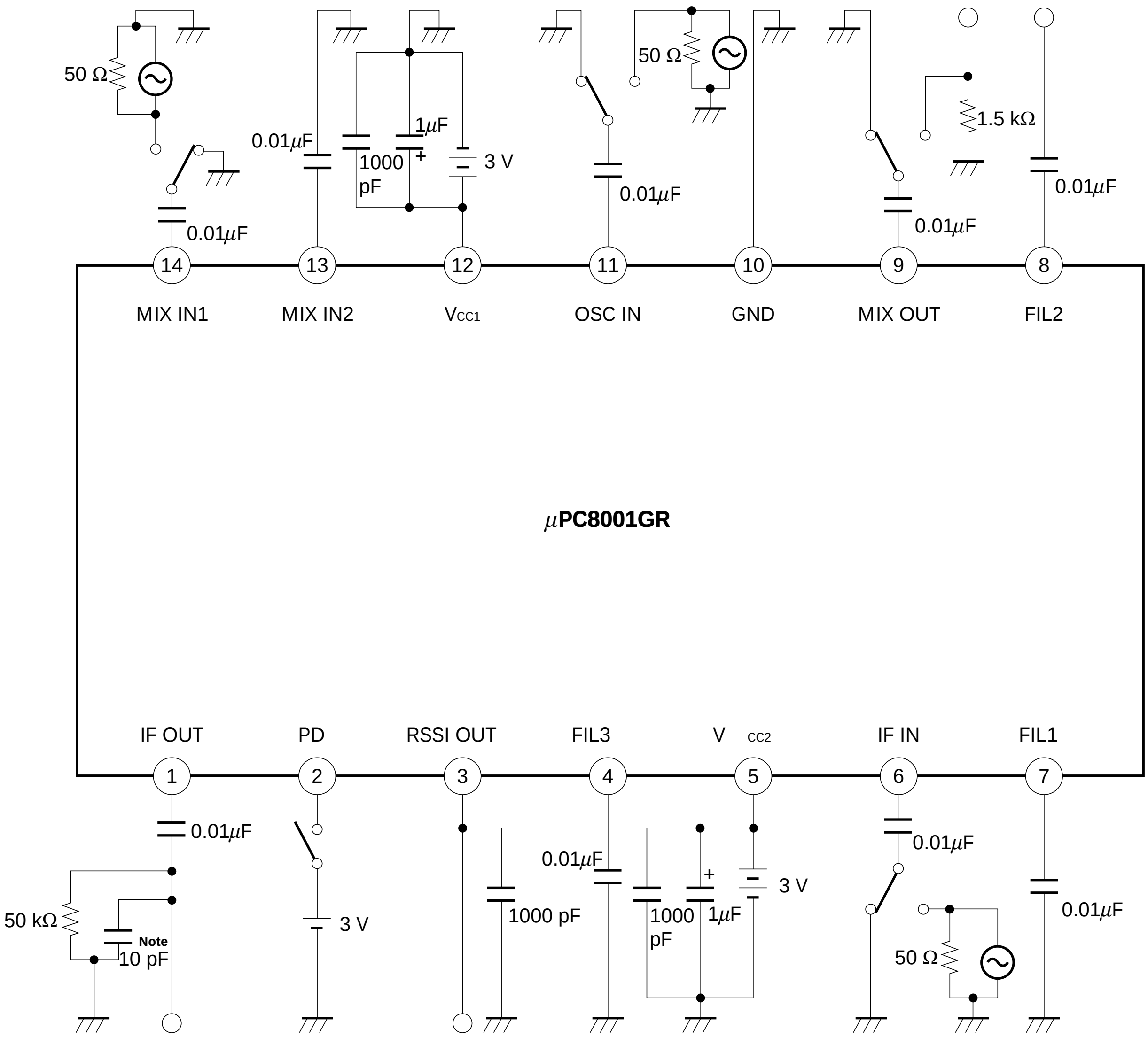
Figure 4-7. RSSI Output Voltage vs. IF Amplifier Input Level (The temperature characteristics curves) ★



Remarks 1. –·–·– T_A = –30 °C
——— T_A = +25 °C
- - - - - T_A = +85 °C

2. The three temperature characteristic curves are virtually identical.

★ 5. TEST CIRCUIT EXAMPLE

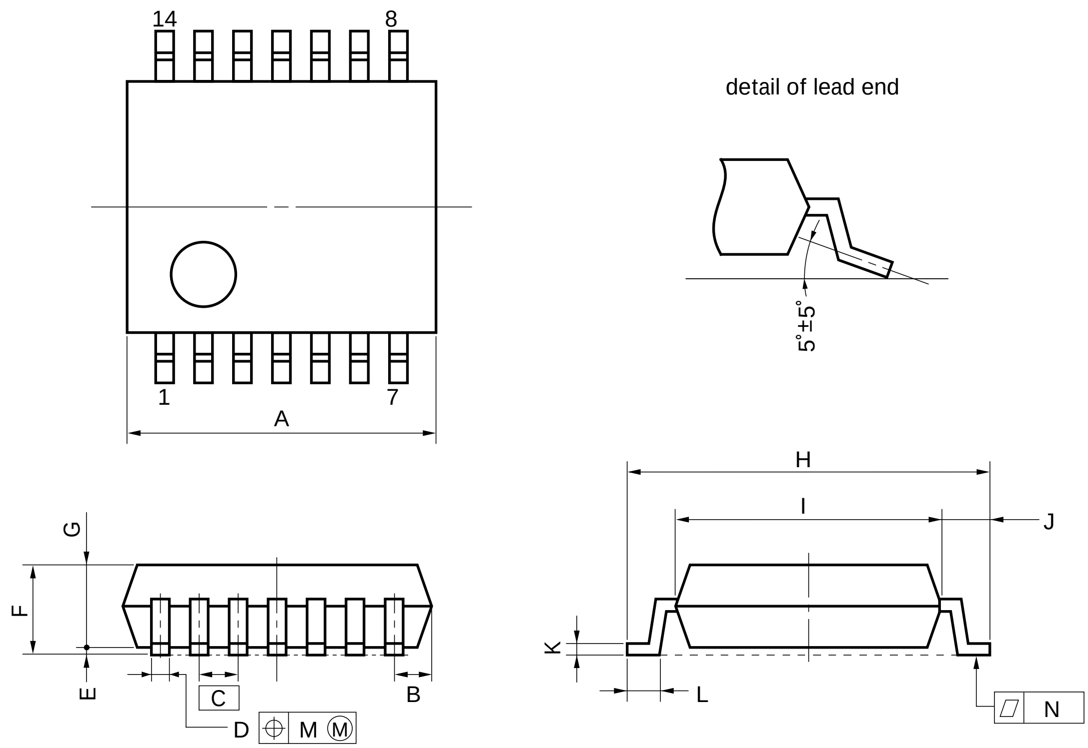


Note The value of the capacitance connected to the IF OUT pin (No. 1) includes the capacitances of PCB wiring patterns and the tester.

Remark In three cases of Mixer Input, Third Order Intercept and Noise Figure Measurement, refer to Figures 3-1, 3-2, and 3-6.

6. PACKAGE DRAWINGS

14 PIN PLASTIC SHRINK SOP (225 mil)



P14GM-65-225B-2

NOTE

Each lead centerline is located within 0.10 mm (0.004 inch) of its true position (T.P.) at maximum material condition.

ITEM	MILLIMETERS	INCHES
A	5.40 MAX.	0.213 MAX.
B	0.75 MAX.	0.030 MAX.
C	0.65 (T.P.)	0.026 (T.P.)
D	$0.30^{+0.10}_{-0.05}$	$0.012^{+0.004}_{-0.003}$
E	0.125±0.075	0.005±0.003
F	1.8 MAX.	0.071MAX.
G	1.44	0.057
H	6.2±0.3	0.244±0.012
I	4.4	0.173
J	0.9	0.035
K	$0.15^{+0.10}_{-0.05}$	$0.006^{+0.004}_{-0.002}$
L	0.5±0.2	$0.020^{+0.008}_{-0.009}$
M	0.10	0.004
N	0.10	0.004

7. RECOMMENDED SOLDERING CONDITIONS

The following conditions must be met for soldering conditions of the μPC8001. For more details, refer to our document “SEMICONDUCTOR DEVICE MOUNTING TECHNOLOGY MANUAL” (IEI-1207).

Please consolt with our sales offices in case other soldering process is used, or in case the soldering is done under different conditions.

Types of Surface Mount Device

μPC8001GR: 14-pin plastic shrink SOP (225 mil)

Soldedering process	Soldering conditions	Symbol
Infrared ray reflow	Peak temperature of package surface: 235 ˚C or below, Reflow time: 30 seconds or below (210 ˚C or higher), Number of reflow processes: MAX. 2 **[Remark]** (1) Please start the second reflow process after the temperature, raised by the first reflow process, returns to normal. (2) Please avoid removing the residual flux with water after the first reflow process.	IR35-107-2
Partial heating method	Terminal temperature: 300 ˚C or below, Time: 3 seconds or below (Per one side of the device).	———

Precautions Against Static Electricity

Caution **When handling the device, be careful to protect it from static electricity. exposure to a strong static electricity charge may destroy internal transistor junctions. During transportation and storage, place the device in the conductive tray or case originally provided by NEC for shipping, or conductive shock absorbing material, metal case, etc. During assembly, be sure to ground the device. Be careful not to place the device on a plastic board and do not touch the device's pins.**

[MEMO]