

# FM IF detector for cordless phones

## BA4116FV

The BA4116FV is an IC with mixing circuit, IF circuit, FM detector circuit, RSSI circuit, and noise detector circuit. As it can operate at low voltages, it is ideal for use in cordless phones.

### ●Applications

Cordless phones, amateur short wave radios, and other portable wireless equipment

### ●Features

- 1) Input frequencies of 10MHz to 150MHz can be accommodated.
- 2) Low-voltage operation. (1.8 to 5.5V)
- 3) Excellent temperature characteristic.
- 4) High sensitivity; 12dB SINAD sensitivity = 8dB $\mu$ VEMF (50  $\Omega$ )
- 5) High intercept point. (-11dBm)
- 6) Small package used. (0.65mm pitch)

### ●Absolute maximum ratings (Ta = 25°C)

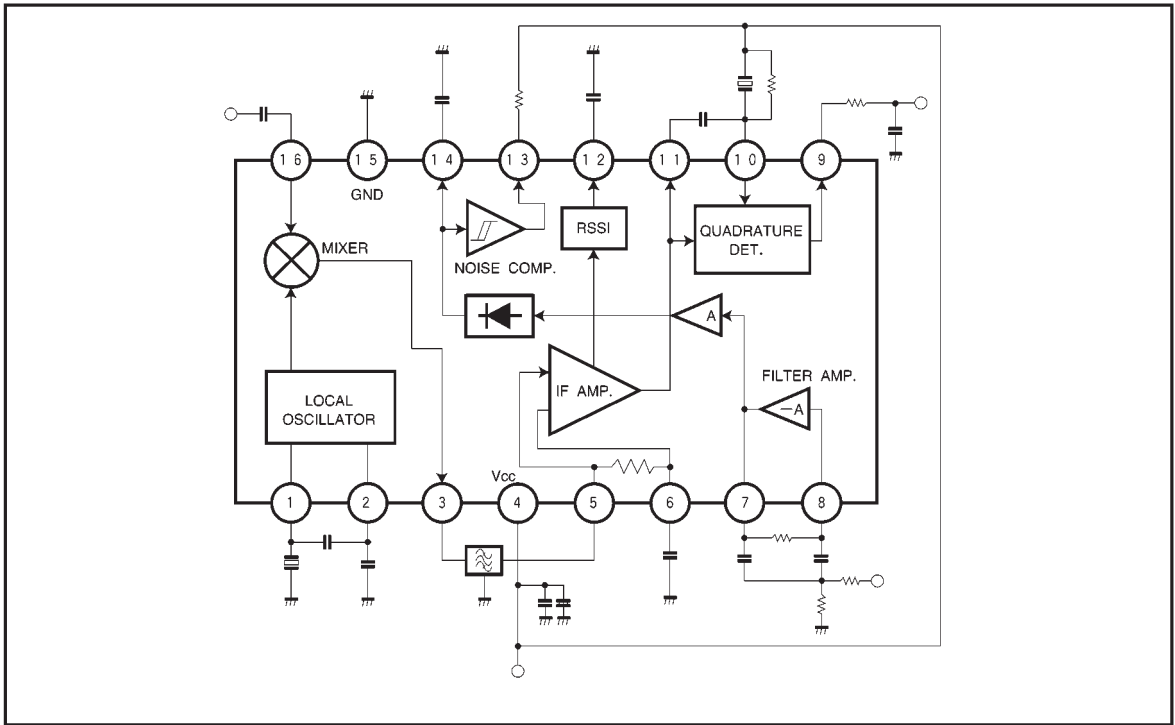
Parameter	Symbol	Limits	Unit
Power supply voltage	V <sub>CC</sub>	7.0	V
Power dissipation	P <sub>d</sub>	350*	mW
Operating temperature	T <sub>opr</sub>	-30~+85	°C
Storage temperature	T <sub>stg</sub>	-55~+125	°C

\* Reduced by 3.5mW for each increase in Ta of 1°C over 25°C.

### ●Recommended operating conditions (Ta = 25°C)

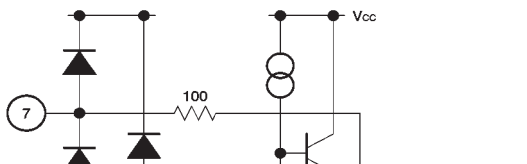
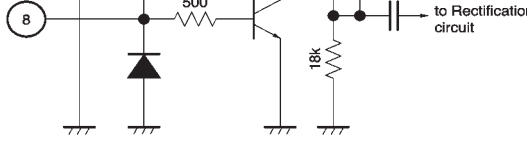
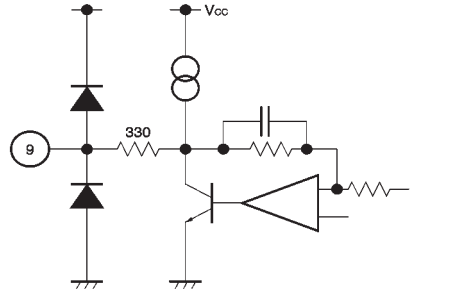
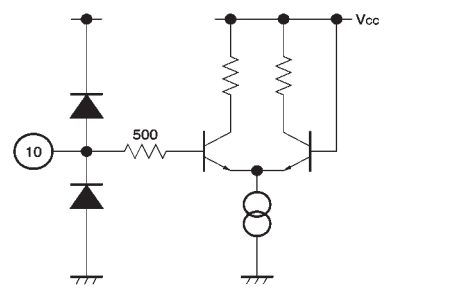
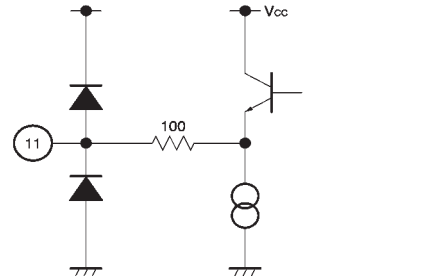
Parameter	Symbol	Min.	Typ.	Max.	Unit
Power supply voltage	V <sub>CC</sub>	1.8	2.0	5.5	V

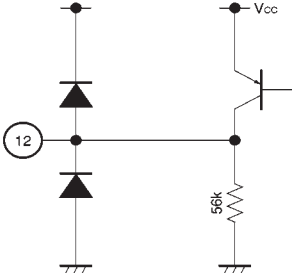
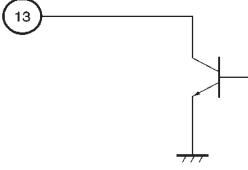
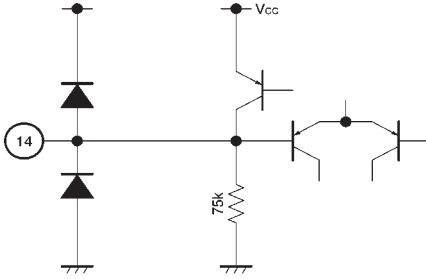

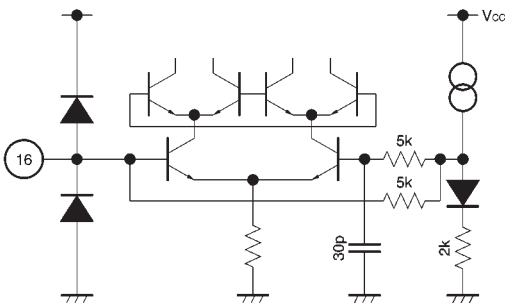
● Block diagram



● Pin descriptions

Pin No.	Function	Internal peripheral circuit	Pin voltage with no signal (V)
1	Local oscillator pin (base) Connect crystal resonator and capacitor		$V_{CC}$
2	Local oscillator pin (emitter) Connect capacitor or input local signal from external oscillator		$V_{CC}-0.75$
3	Mixer output pin Connect ceramic filter; output impedance is 1.8 k $\Omega$		$V_{CC}-1.33$
4	$V_{CC}$ pin	—	$V_{CC}$
5	IF amplifier input pin Connect ceramic filter; input impedance is 1.8 k $\Omega$		$V_{CC}-0.33$
6	IF amplifier bypass pin Connect capacitor		$V_{CC}-0.33$

Pin No.	Function	Internal peripheral circuit	Pin voltage with no signal (V)
7	Filter amplifier output pin Connect CR network		0.70
8	Filter amplifier input pin Connect CR network		0.70
9	Demodulated signal Connect to noise amplifier or similar device; output impedance is 360 Ω		0.86
10	Discriminator pin Connect phase-shifting coil or ceramic discriminator		V <sub>cc</sub>
11	IF amplifier output pin Connect to phase-shifting capacitor		V <sub>cc</sub> -0.95

Pin No.	Function	Internal peripheral circuit	Pin voltage with no signal (V)
12	RSSI output pin Connect to capacitor		0.4
13	Noise comparator output pin Connect to load resistor		0
14	Noise detector output pin Connect to capacitor		0
15	GND pin		0
16	Mixer input pin Connect 1st IF signal from DC cut; input impedance is 5 kΩ		0.95

- Electrical characteristics (unless otherwise noted,  $T_a = 25^\circ\text{C}$ ,  $V_{CC} = 2.0\text{V}$ ,  $f_{IN(MIX)} = 21.7\text{MHz}$ ,  $f_{IN(IF)} = 450\text{kHz}$ ,  $\Delta f = \pm 1.5\text{kHzdev}$ ,  $f_m = 1\text{kHz}$ , all AC levels open (EMF) display)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement circuit	
Quiescent current	$I_Q$	2.1	3.0	4.2	mA	No input	Fig.1	
〈Mixer section〉								
Conversion gain	$G_{VC}$	15	18	21	dB	Tested after ceramic filter(−3 dB loss)	Fig.1	
Intercept point	$I_P$	—	−11	—	dBm		—	
Input impedance	$R_{IN}$	—	5.5	—	k $\Omega$		—	
	$C_{IN}$	—	4.6	—	pF		—	
Output impedance	$R_O$	1.2	1.8	2.4	k $\Omega$		—	
12 dB SINAD sensitivity	$S$	—	8	—	dB $\mu\text{V}$		—	
〈IF,FM detector section〉								
FM detector output	$V_O$	79	100	126	mVrms	$V_{IN(IF)} = 80\text{dB } \mu\text{V}$	Fig.1	
Signal-to-noise ratio	S/N	43	63	—	dB	$V_{IN(IF)} = 80\text{dB } \mu\text{V}$	Fig.1	
AM rejection ratio	AMR	—	40	—	dB	$V_{IN(IF)} = 80\text{dB } \mu\text{V}$ , AM=30%	Fig.1	
Input resistance	$R_{IN}$	1.2	1.8	2.4	k $\Omega$		—	
RSSI output voltage	$V_{RSSI1}$	0.7	1.0	1.45	V	$V_{CC}=3\text{V}$	$V_{IN(IF)} = 50\text{dB } \mu\text{V}$	Fig.1
	$V_{RSSI2}$	1.6	2.3	2.9	V		$V_{IN(IF)} = 100\text{dB } \mu\text{V}$	Fig.1
〈Noise detector section〉								
Output voltage	$V_{NDET}$	—	0.1	0.5	V	$V_{NREC}=0.2\text{V}$ , $I_{SINK}=0.2\text{mA}$	Fig.1	
Output leakage current	$I_{LEAK}$	—	0	5	$\mu\text{A}$	$V_{NREC}=0.7\text{V}$ , $V_{NDET}=2\text{V}$	Fig.1	
Noise detection high level	$V_{TH-H}$	0.5	0.6	0.7	V	Pin 14 voltage so that $V_{NDET} \leq 0.5\text{V}$	Fig.1	
Noise detection low level	$V_{TH-L}$	0.3	0.4	0.5	V	Pin 14 voltage so that $I_{SINK} \leq 5\mu\text{A}$	Fig.1	
Noise detection hysteresis width	Hys	2.0	3.5	5.0	dB	Hysteresis width between $V_{TH-H}$ and $V_{TH-L}$ above	Fig.1	

● Measurement circuit

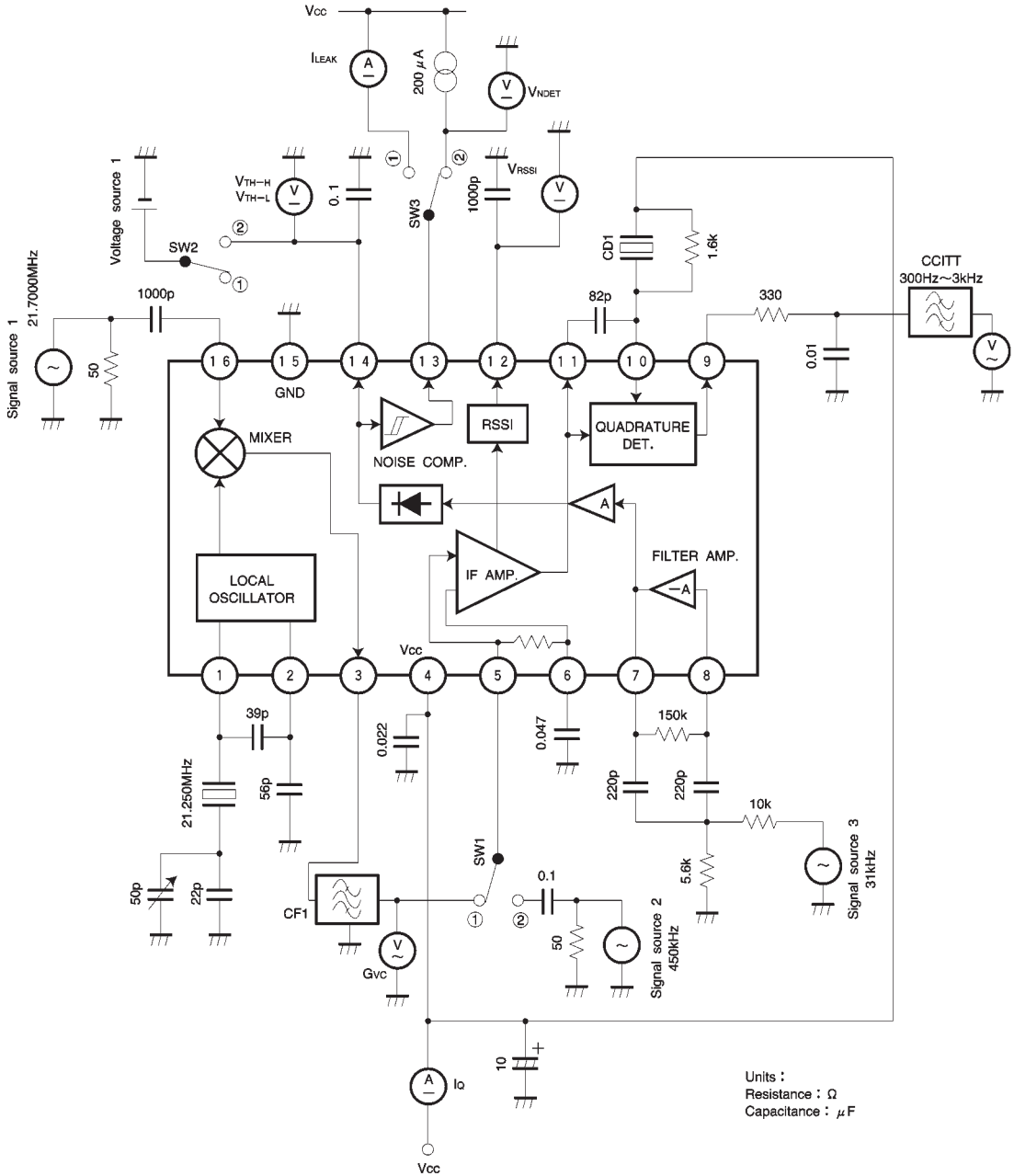


Fig. 1

● Application example

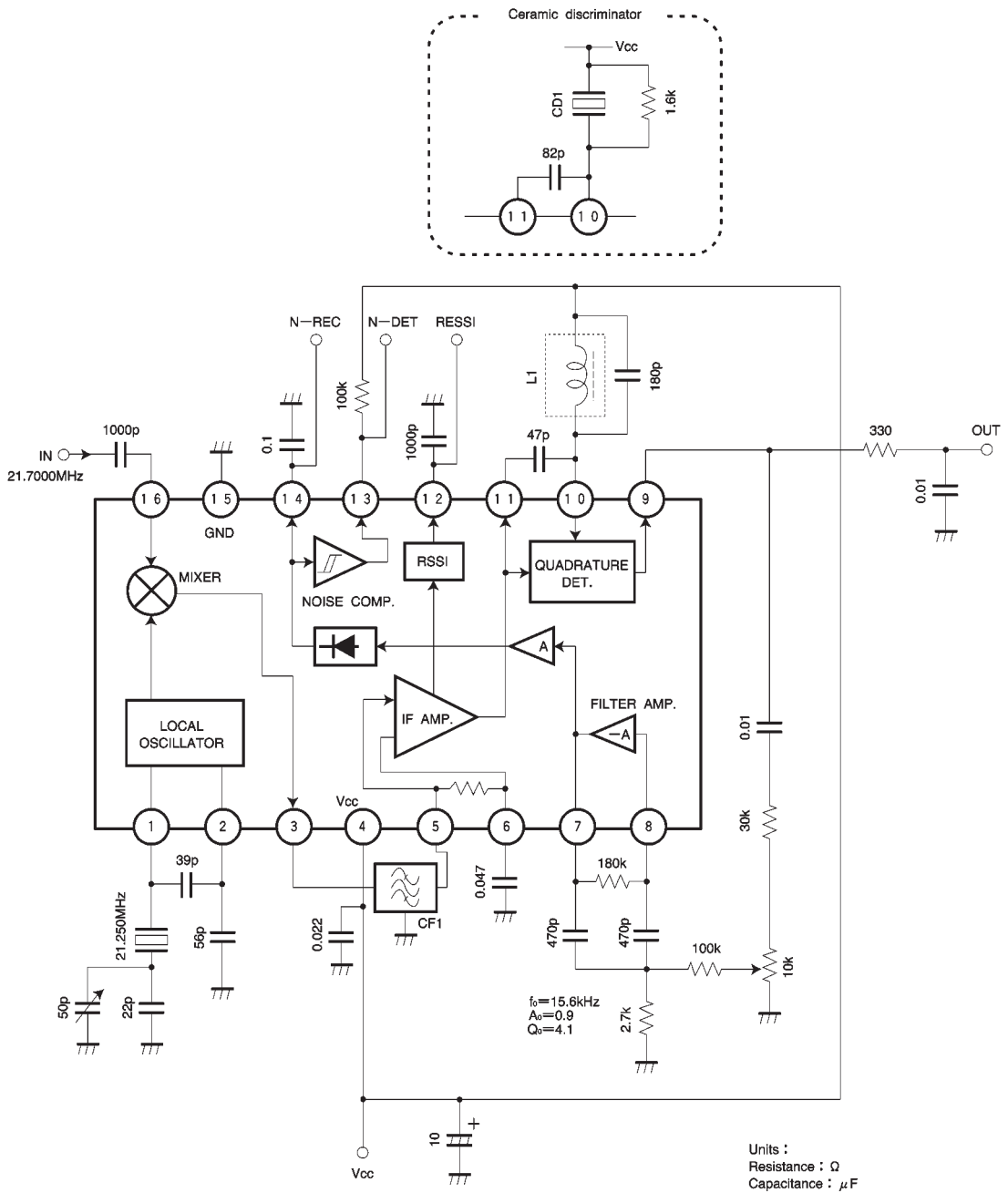
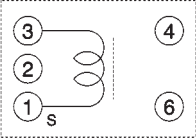


Fig. 2



●Attached components

Part No.	Part name	Prod. No./Mfg.	Notes
CF1	Ceramic filter	Murata: CFWM450G	6 dB band width = ±4.5 kHz min. Attenuation band width = ± 10 kHz max. Guaranteed attenuation= 35 dB min. Input loss = 6 dB max.
CD1	Ceramic discriminator	Murata: CDB450C24	
L1	Wave detection coil	Toko: 5PNR-2876Z	 <p>1-3 190T Wire type: 0.045ø, 3UEW</p> <p>L variable range= ±4 % Q at no load = 20 min.</p>

●Determining the filter amplifier constant (multi-layer recovery band pass filter)

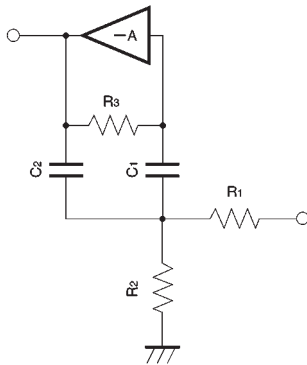


Fig. 3

$f_0$ : Center frequency

$Q$ : Center frequency  $f_0$ /band width BW

$A_0$ : I/O gain

The reference resistance  $R_0$  is determined as  $C_1 = C_2 = C_0$ .

$$R_0 = 1/2\pi f_0 \cdot C_0$$

$$R_1 = R_0 \cdot Q/A_0$$

$$R_2 = R_0/[2Q - (A_0/Q)]$$

$$R_3 = 2R_0 \cdot Q$$

The Filter gain can be adjusted by varying  $R_1$ , but with the  $A_0 > 1$  design, please be aware that influence from the open loop characteristic of the amplifier causes offset in the center frequency  $f_0$ .

●Electrical characteristic curves

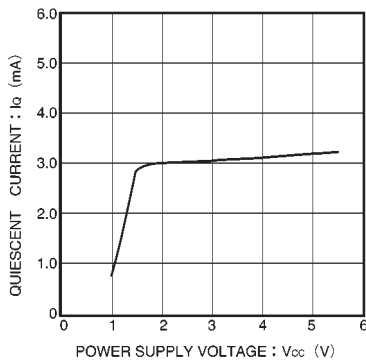


Fig. 4 Quiescent current vs. power supply voltage

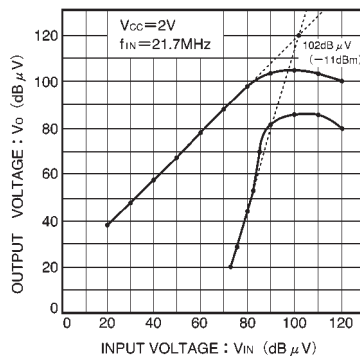


Fig. 5 Mixer output voltage vs. input voltage

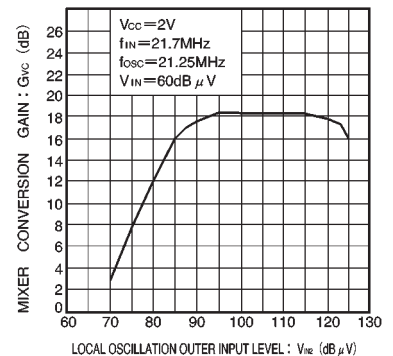


Fig. 6 Mixer conversion gain vs. Pin 2 OSC injection level

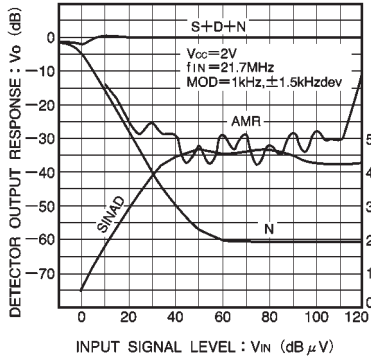


Fig. 7 Detector output response, AMR, SINAD vs. input signal level

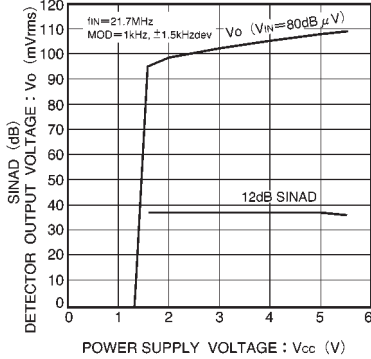


Fig. 8 Detector output voltage, 12 dB SINAD sensitivity vs. power supply voltage

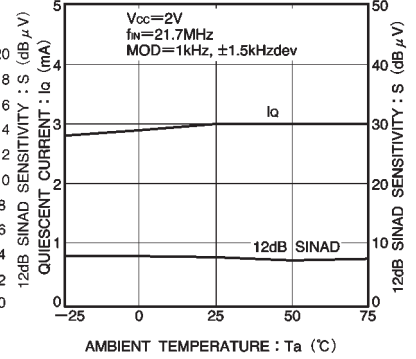


Fig. 9 Quiescent current, 12 dB SINAD sensitivity vs. ambient temperature

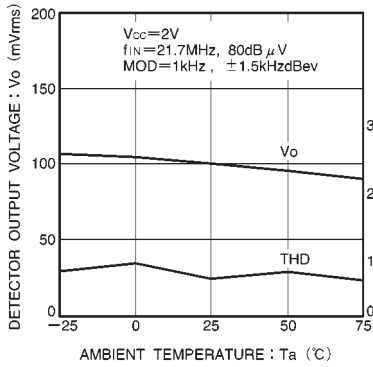


Fig. 10 Detector output level, THD vs. ambient temperature

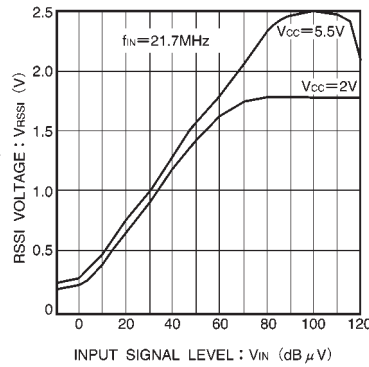


Fig. 11 RSSI voltage vs. input signal level

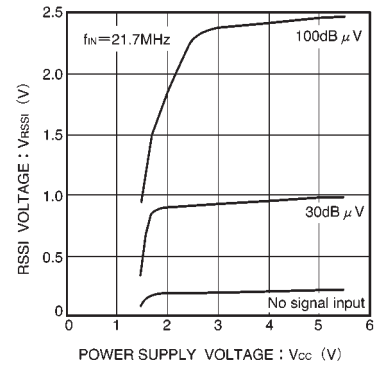


Fig. 12 RSSI voltage vs. power supply voltage

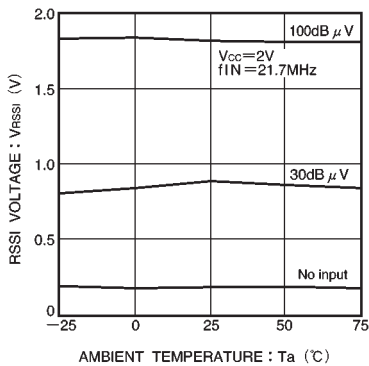


Fig. 13 RSSI voltage vs. ambient temperature

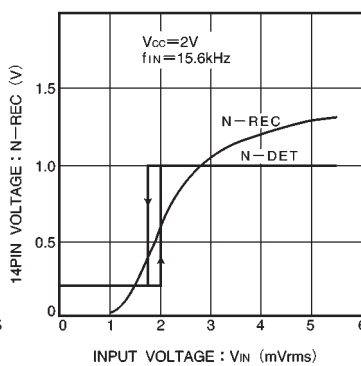


Fig. 14 Pin 13 voltage, Pin 14 voltage vs. noise amplifier input voltage

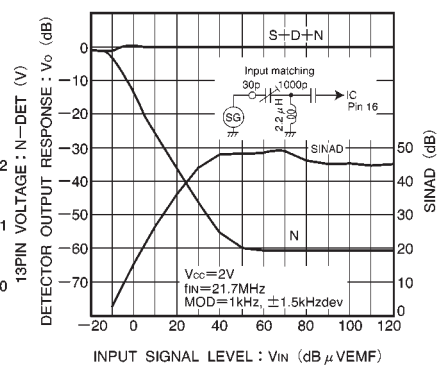
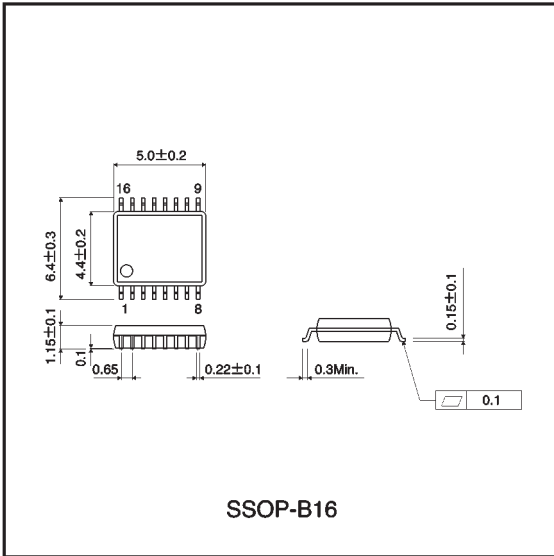


Fig. 15 Detector output response, SINAD vs. input signal level

● External dimensions (Units: mm)



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