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 = 8dBμVEMF (50 Ω)
5) High intercept point. (–11dBm)
6) Small package used. (0.65mm pitch)

●Absolute maximum ratings (Ta = 25°C)

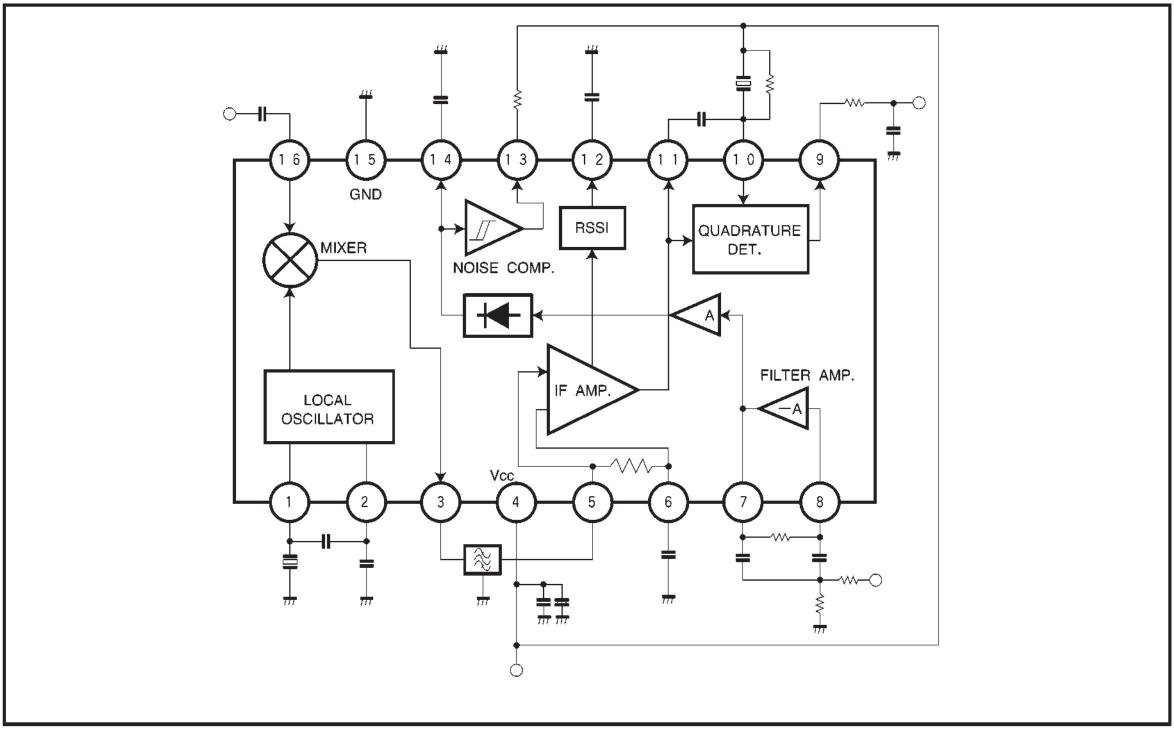
Parameter	Symbol	Limits	Unit
Power supply voltage	V_{CC}	7.0	V
Power dissipation	Pd	350*	mW
Operating temperature	Topr	−30～+85	℃
Storage temperature	Tstg	−55～+125	℃

* Reduced by 3.5mW for each increase in Ta of 1℃ over 25℃.

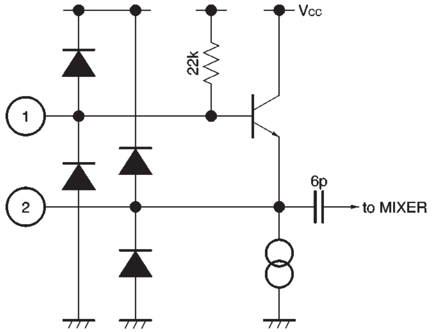
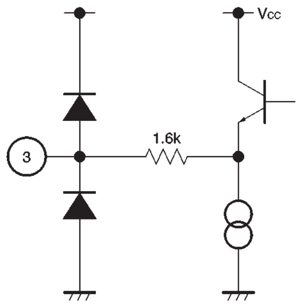
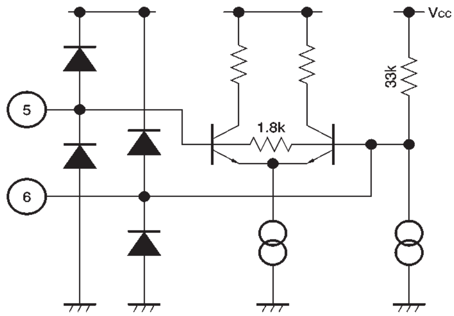
●Recommended operating conditions (Ta = 25°C)

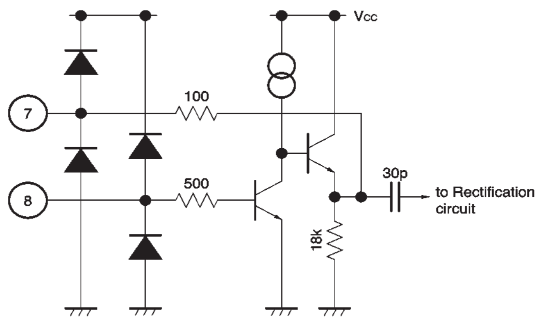
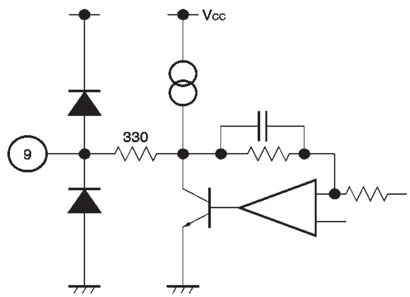
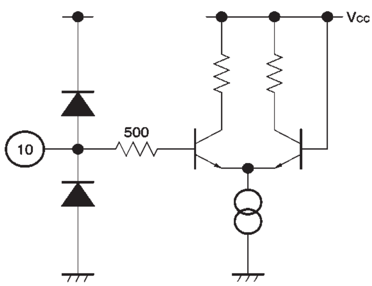
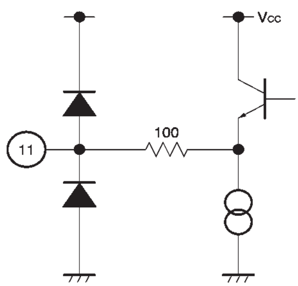
Parameter	Symbol	Min.	Typ.	Max.	Unit
Power supply voltage	V_{CC}	1.8	2.0	5.5	V

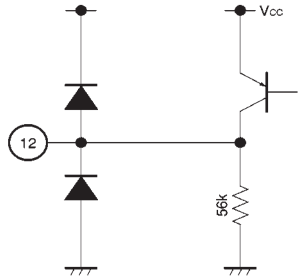
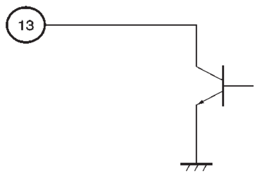
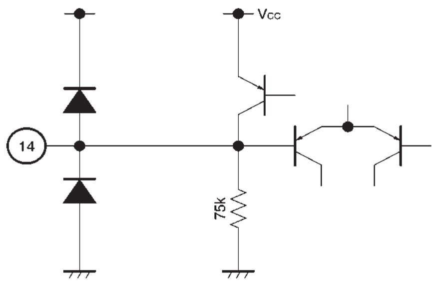
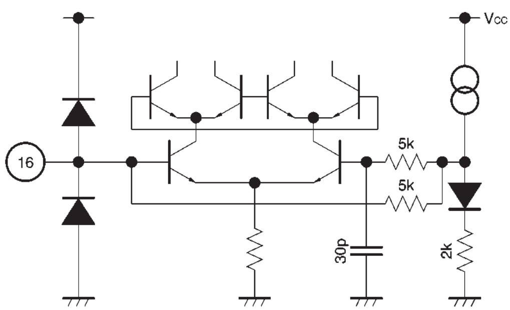
●Block diagram



●Pin descriptions

<table>
<tr><th>Pin No.</th><th>Function</th><th>Internal peripheral circuit</th><th>Pin voltage with no signal (V)</th></tr>
<tr><td>1</td><td>Local oscillator pin (base)
Connect crystal resonator and capacitor</td><td rowspan="2">
</td><td>Vcc</td></tr>
<tr><td>2</td><td>Local oscillator pin (emitter)
Connect capacitor or input local signal from external oscillator</td><td>Vcc−0.75</td></tr>
<tr><td>3</td><td>Mixer output pin
Connect ceramic filter; output impedance is 1.8 kΩ</td><td>
</td><td>Vcc−1.33</td></tr>
<tr><td>4</td><td>Vcc pin</td><td>—</td><td>Vcc</td></tr>
<tr><td>5</td><td>IF amplifier input pin
Connect ceramic filter; input impedance is 1.8 kΩ</td><td rowspan="2">
</td><td>Vcc−0.33</td></tr>
<tr><td>6</td><td>IF amplifier bypass pin
Connect capacitor</td><td>Vcc−0.33</td></tr>
</table>

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		Vcc
11	IF amplifier output pin Connect to phase-shifting capacitor		Vcc−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 resister		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, Ta = 25°C, V_{CC} = 2.0V, $f_{IN\ (Mix)}$ = 21.7MHz, $f_{IN\ (IF)}$ = 450kHz, Δf = ±1.5kHzdev, fm = 1kHz, 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	–	kΩ			–
	C_{IN}	–	4.6	–	pF			–
Output impedance	R_O	1.2	1.8	2.4	kΩ			–
12 dB SINAD sensitivity	S	–	8	–	dBμV			–
〈IF,FM detector section〉								
FM detector output	V_O	79	100	126	mVrms	$V_{IN\ (IF)}$ =80dBμV		Fig.1
Signal-to-noise ratio	S/N	43	63	–	dB	$V_{IN\ (IF)}$ =80dBμV		Fig.1
AM rejection ratio	AMR	–	40	–	dB	$V_{IN\ (IF)}$ =80dBμV, AM=30%		Fig.1
Input resistance	R_{IN}	1.2	1.8	2.4	kΩ			–
RSSI output voltage	V_{RSSI1}	0.7	1.0	1.45	V	V_{CC}=3V	$V_{IN\ (IF)}$ =50dBμV	Fig.1
	V_{RSSI2}	1.6	2.3	2.9	V		$V_{IN\ (IF)}$ =100dBμV	Fig.1
〈Noise detector section〉								
Output voltage	V_{NDET}	–	0.1	0.5	V	V_{NREC}=0.2V, I_{SINK}=0.2mA		Fig.1
Output leakage current	I_{LEAK}	–	0	5	μA	V_{NREC}=0.7V, V_{NDET}=2V		Fig.1
Noise detection high level	V_{TH-H}	0.5	0.6	0.7	V	Pin 14 voltage so that V_{NDET} ≦ 0.5 V		Fig.1
Noise detection low level	V_{TH-L}	0.3	0.4	0.5	V	Pin 14 voltage so that I_{SINK} ≦ 5 μA		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

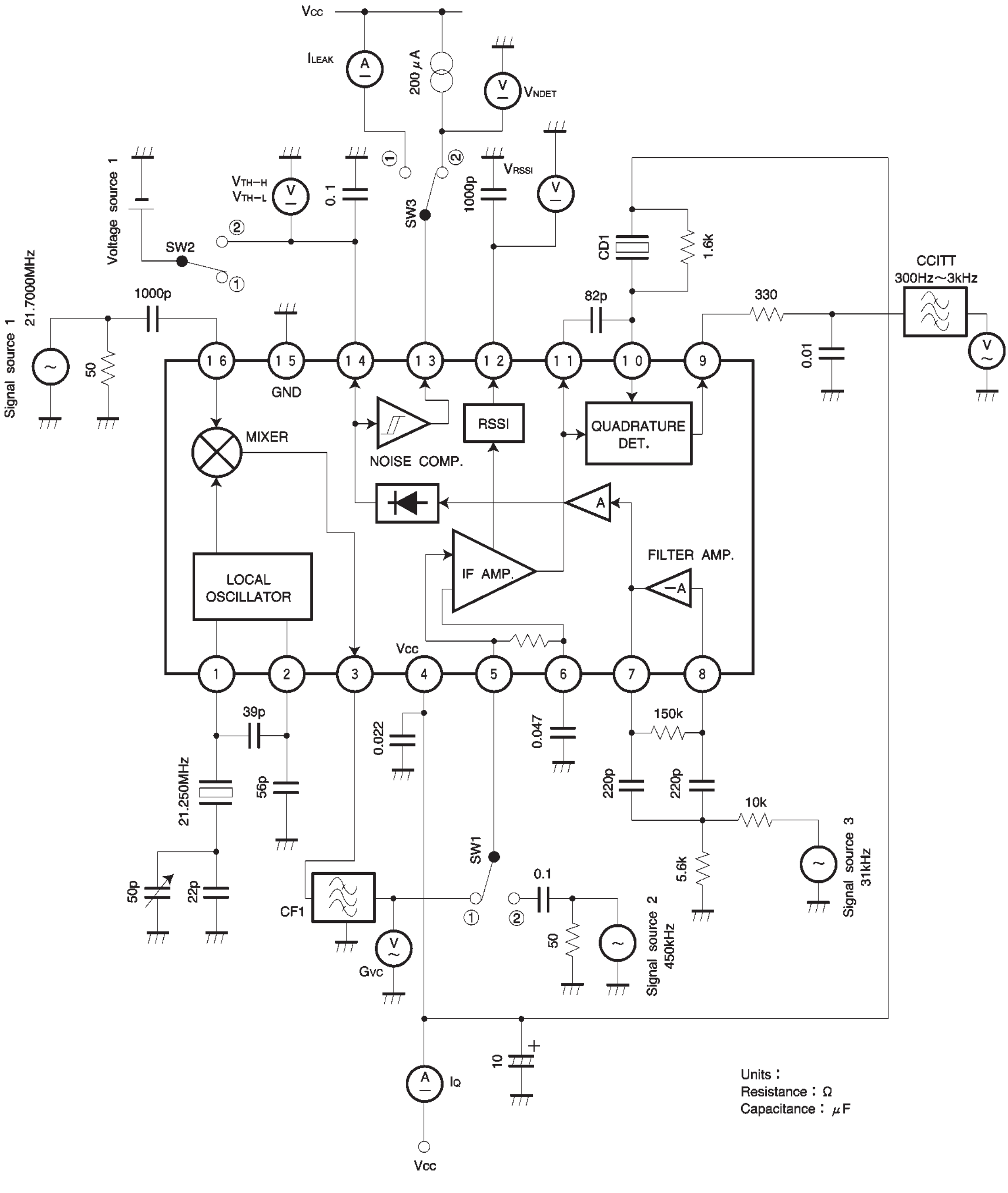


Fig. 1

●Application example

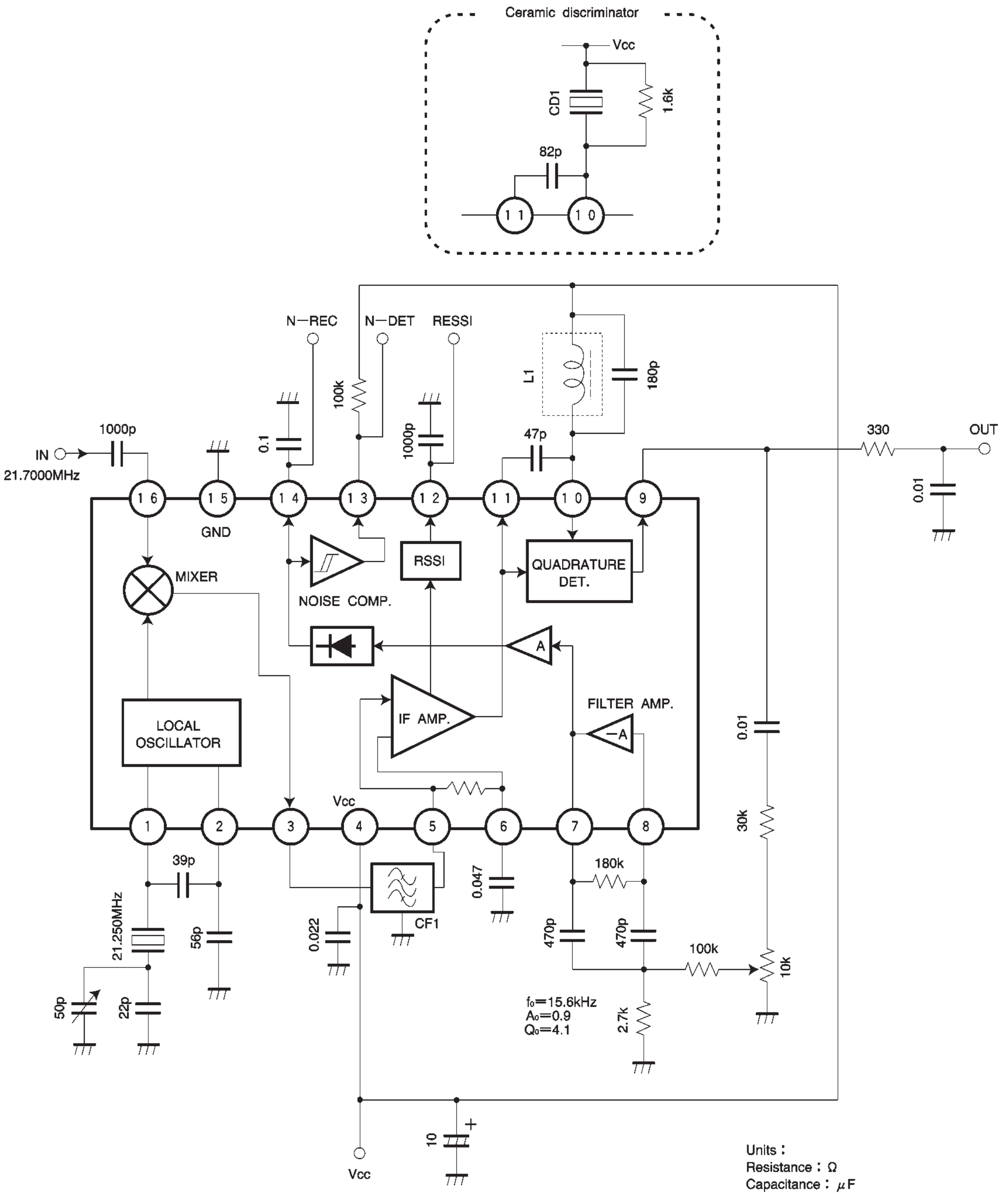
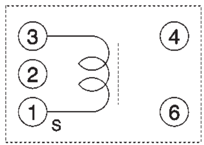


Fig. 2

●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	 1–3 190T Wire type: 0.045ø, 3UEW L variable range= ±4 % Q at no load = 20 min.

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

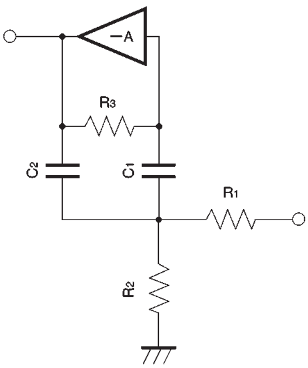


Fig. 3

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

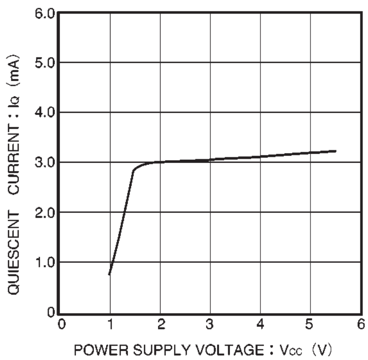


Fig. 4 Quiescent current vs. power supply voltage

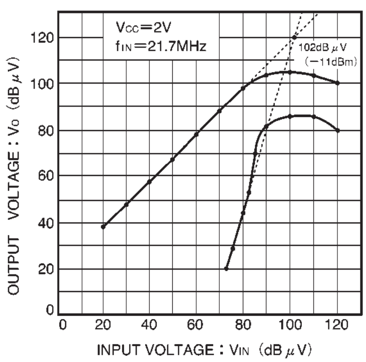


Fig. 5 Mixer output voltage vs. input voltage

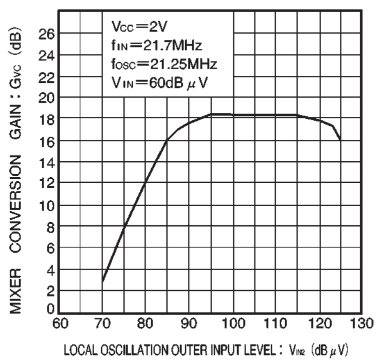


Fig. 6 Mixer conversion gain vs. Pin 2 OSC injection level

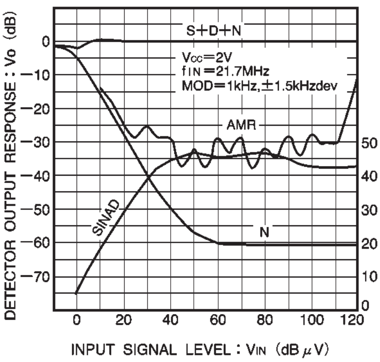


Fig. 7 Detector output response, AMR, SINAD vs. input signal leve

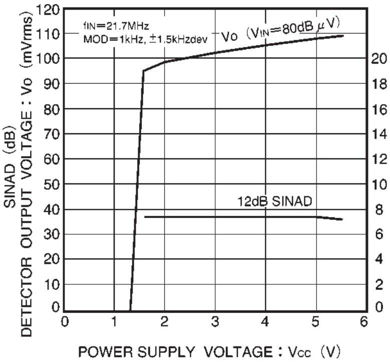


Fig. 8 Detector output voltage, 12 dB SINAD sensitivity vs. power supply voltage

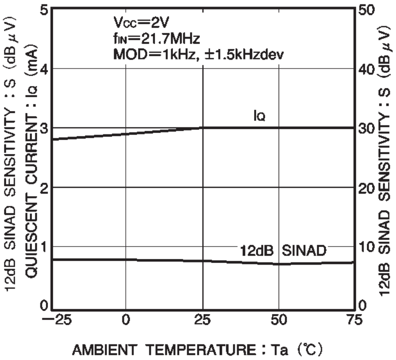


Fig. 9 Quiescent current, 12 dB SINAD sensitivity vs. ambient temperature

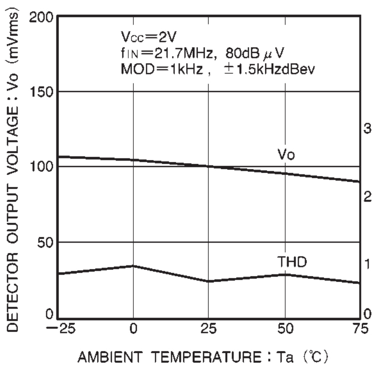


Fig. 10 Detector output level, THD vs. ambient temperature

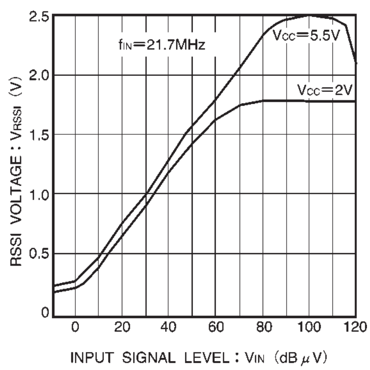


Fig. 11 RSSI voltage vs. input signal level

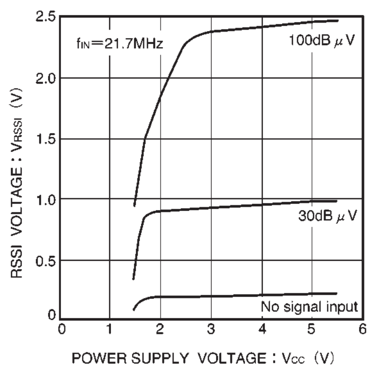


Fig. 12 RSSI voltage vs. power supply voltage

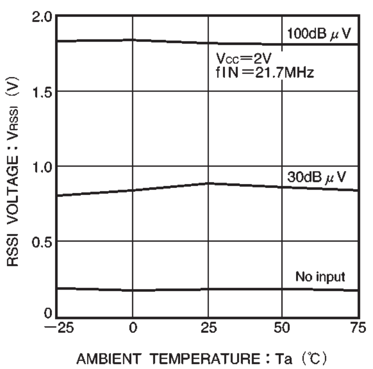


Fig. 13 RSSI voltage vs. ambient temperature

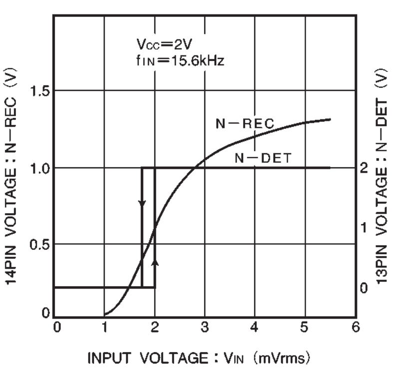


Fig. 14 Pin 13 voltage, Pin 14 voltage vs. noise amplifier input voltage

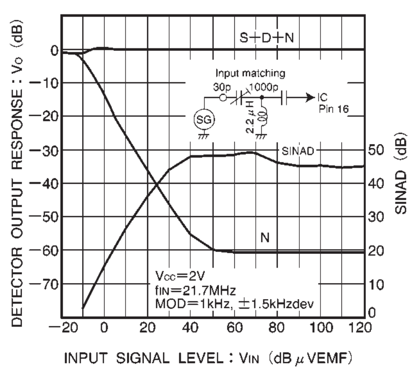
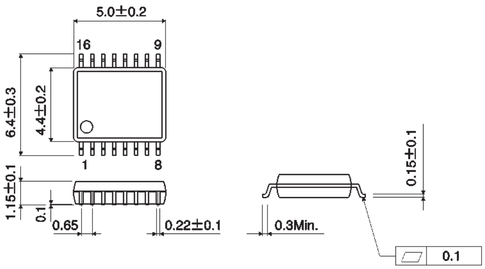


Fig. 15 Detector output response, SINAD vs. input signal level

●External dimensions (Units: mm)



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