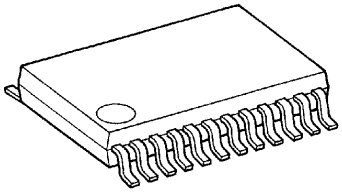
TOSHIBA BIPOLAR LINEAR INTEGRATED CIRCUIT SILICON MONOLITHIC

T A 3 1 1 3 7 F N G

IF DETECTOR IC FOR CORDLESS AND CELLULAR PHONES



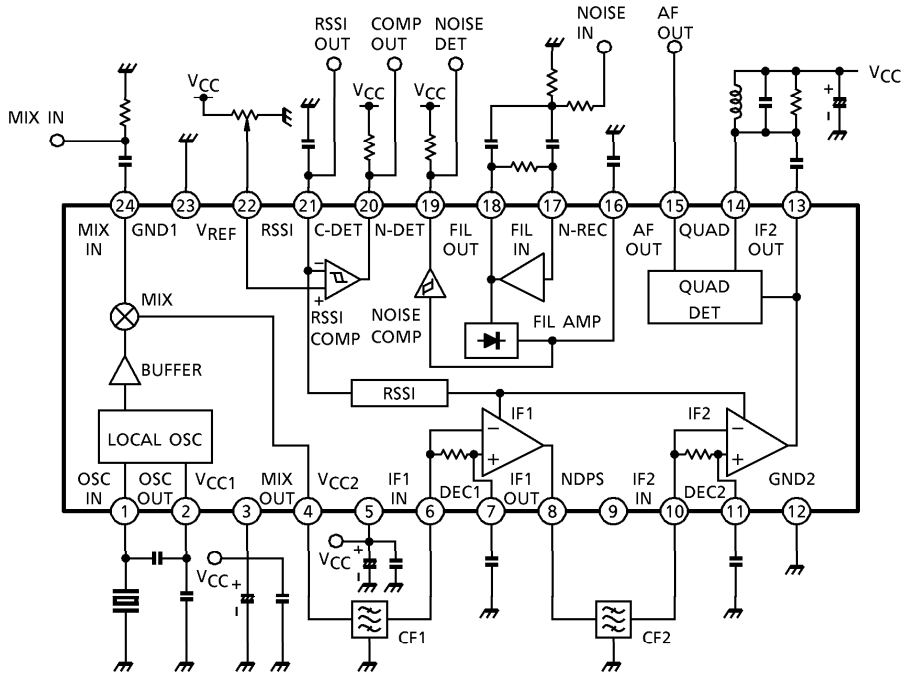
SSOP24-P-300-0.65A

Weight : 0.14g (Typ.)

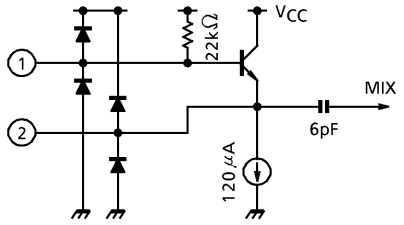
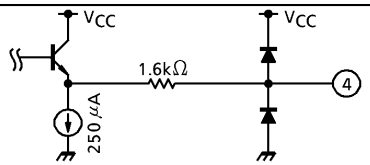
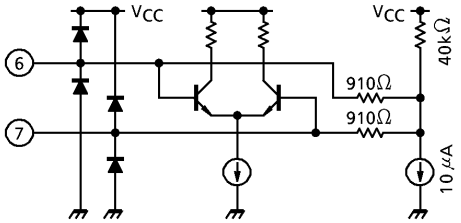
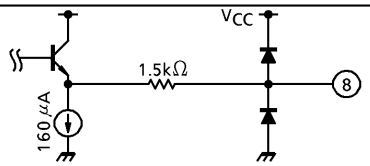
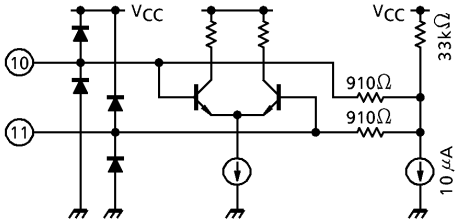
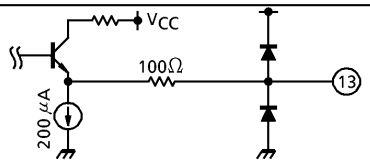
FEATURES

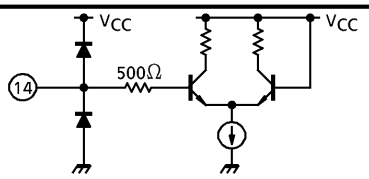
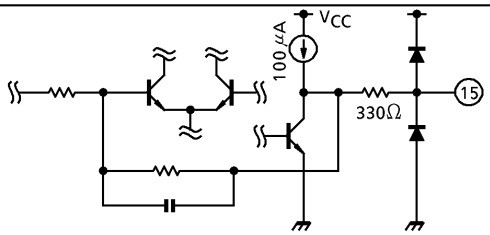
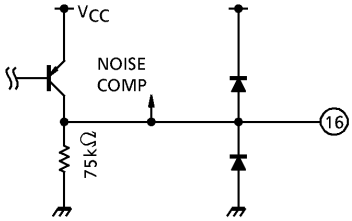
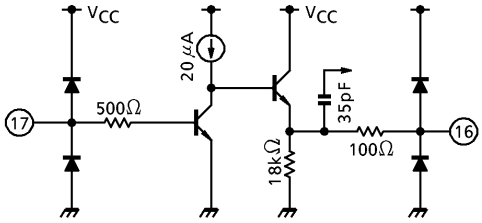
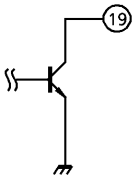
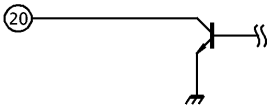
- Low operating voltage : V_{CC} = 1.8~6.0V
- Excellent temperature characteristic
- High selectivity can be designed by 2 IF amps
- High sensitivity
  12dB sensitivity : 8.5dBμV EMF (50Ω)
- Intercept point is very high : 107dBμV (0dBm)
- Built-in 2nd MIX
  Operating frequency : 10~150MHz
- Built-in noise detection circuit
- RSSI function
- RSSI COMPARATOR
- Small current consumption : I_{CC} = 3.8mA (Typ.)
- Small package : SSOP 24 pin (0.65mm pitch)

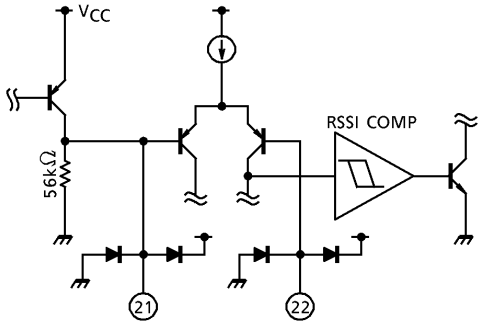
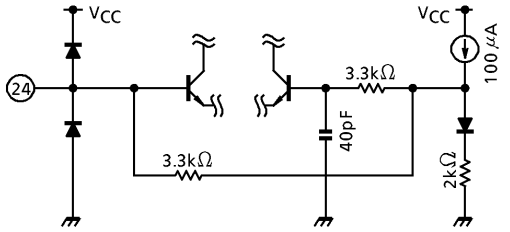
BLOCK DIAGRAM



PIN FUNCTION (The values of resistor and capacitor are typical.)

PIN No.	PIN NAME	FUNCTION	INTERNAL EQUIVALENT CIRCUIT
1	OSC IN	LOCAL OSC input and output terminals. Colpitts oscillator is formed by internal emitter follower and external X'tal. And external injection is possible from pin 2.	
2	OSC OUT		
3	V_{CC1}	Power supply 1	—
4	MIX OUT	MIX Output terminal. Output impedance is around 1.8kΩ.	
5	V_{CC2}	Power supply 2	—
6	IF1 IN	IF1 input and decoupling for bias. Input impedance is around 1.8kΩ.	
7	DEC1		
8	IF1 OUT	Output terminal of IF1 AMP.	
9	NDPS	Connect to V_{CC}	—
10	IF2 IN	IF2 input and decoupling for bias. Input impedance is around 1.8kΩ.	
11	DEC2		
12	GND2	GND terminal	—
13	IF2 OUT	Output terminal of IF2 AMP.	

PIN No.	PIN NAME	FUNCTION	INTERNAL EQUIVALENT CIRCUIT
14	QUAD	Phase input terminal of FM DETECTOR.	
15	AF OUT	Demodulate signal output terminal. Carrier leak is small as LPF is built-in. Output impedance is around 360Ω.	
16	N-REC	After output of inverter amp amplified around 20dB, noise signal is rectified by external capacitor.	
17	FIL IN	Inverter amp input and output terminal. BPF is composed of external capacitors and resistors. Connected internally to rectifier circuit by coupling capacitor.	
18	FIL OUT		
19	N-DET	The result of noise detection is output by comparing output voltage of N-REC terminal with internal reference. Hysteresis range is about 100mV and output is open collector.	
20	C-DET	Comparison output terminal of V_{REF} terminal input voltage and RSSI terminal output voltage. When V_{REF}<RSSI, C-DET output is "L" level.	

PIN No.	PIN NAME	FUNCTION	INTERNAL EQUIVALENT CIRCUIT
21	RSSI	This terminal outputs DC level according to input signal level to IF AMP. Dynamic range is around 70dB.	
22	V_{REF}	Reference voltage input terminal.	
23	GND1	GND terminal	—
24	MIX IN	1st IF signal input terminal.	

1. LOCAL OSC external injection method

Inject as shown in Fig. 1. Setting the injection level between 95dBμV and 100dBμV. A built-in buffer amp minimizes leakage from the MIX.
Input from pin 1 is possible as shown in Fig. 2. However, when the input frequency is high, the level at pin 2 may not be sufficient, causing a decrease in sensitivity. In such a case, add resistor R_{51} and set the input signal so that signal level at pin 2 is adequate. The input capacitance of pins 1 and 2 are respectively 2.4pF (Typ.) and 4.5pF (Typ.).

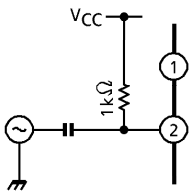


Fig. 1

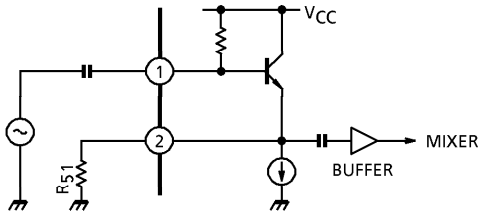


Fig. 2

2. Overtone oscillation

Fig. 3 shows the basic configuration of the local oscillation circuit using overtone oscillation. The C_{51} and L_1 tuning circuits prevent crystal fundamental oscillation. Therefore, set C_{51} and L_1 to inductive at the fundamental frequency and capacitive at the overtone frequency. Since the level at pin 2 may decrease and the sensitivity may fall at high frequency as with external injection, adjust the oscillation level using R_{51}.

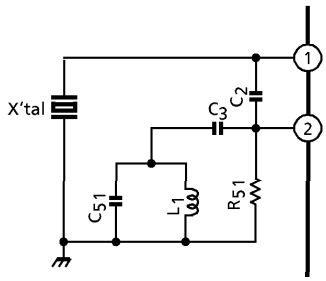


Fig. 3

3. Detection circuit

Demodulation output can be increased by raising damping resistance R_3. However, be careful because the temperature dependency of the modulation output also increases. The demodulation output depends largely on C_{101}. For C_{101}, use a capacitor with good temperature characteristics.

4. NDPS terminal

The NDPS terminal (pin 9) is used for the power source for the 16-19 pin block. When pins 16-19 are not in use, current consumption can be reduced by opening the NDPS terminal. (In this case, pins 16-19 can be open.)

5. C-DET terminal

The C-DET terminal (pin 20) is used for the comparator output of the V_{REF} terminal (pin 22) output voltage and the RSSI terminal (pin 21) output voltage.
When V_{REF} > RSSI, C-DET = "H"
When V_{REF} < RSSI, C-DET = "L"
* The hysteresis range is about 30V (Typ.).
When not in use, set pin 20 to open and connect pin 22 to V_{CC}.

6. Inverter amp usage

The inverter amp can be used to form a band pass filter as shown in Fig. 4.
Set constants as in equations (1) to (3). However, because a low pass filter and a high pass filter are built in, it is recommended that center frequency f_0 be about 30kHz.

(1) $f_0 = \dfrac{1}{2\pi\sqrt{R_4 (R_5 // R_6) C^2}}$

(2) $G_V = R_4 / 2 \times R_5$

(3) $Q^2 = \dfrac{R_4}{4 (R_5 // R_6)}$

at $R_5 \gg Rp$

Example: R_4 = 150kΩ, R_5 = 330kΩ
R_6 = 3.3kΩ, Rp = 20kΩ (VR)
When C = 220pF
$f_0 \simeq$ 31kHz, $G_V \simeq$ − 13dB
$Q^2 \simeq$ 12

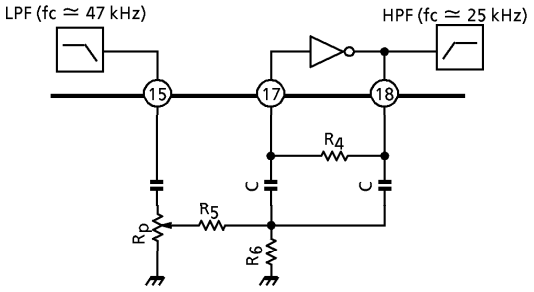


Fig. 4

7. Noise detection rise time

The rise time is a proportion of time constant 7.5ms of the smoothing capacitor C_9 = 0.1μF of the noise rectifier and internal resistor 75kΩ. Although decreasing the capacitance of C_9 can shorten the rise time, note that the noise detection output fluctuation may increase. This should be taken into account before use.

8. RSSI function

A DC voltage corresponding to the input level of IF input pins (pin 6 and pin 10) is output to the RSSI pin (pin 21). While the linear range is about 70dB when V_{CC} = 2V, the range can be expanded to 80dB as in Fig. 5.
However, in such a case, note that the temperature characteristics of the RSSI output may alter due to a disparity between the temperature coefficient of the external resistor and the internal resistance of the IC.

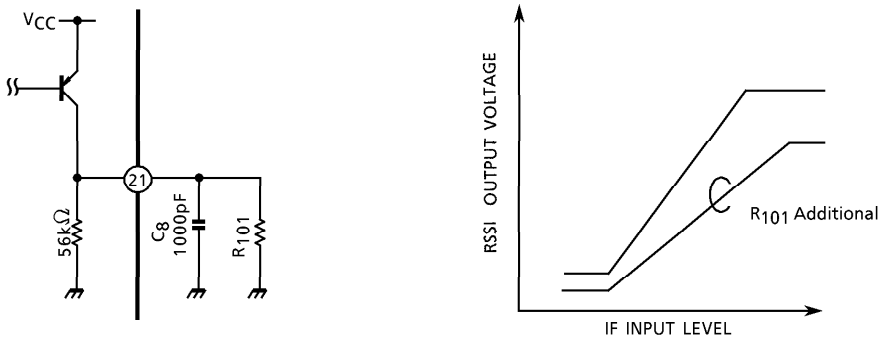


Fig. 5

9. DC voltages for pins (Typical values for reference)

V_{CC} = 3.0V

PIN No.	PIN NAME	VOLTAGE	PIN No.	PIN NAME	VOLTAGE
1	OCS IN	2.98	13	IF2 OUT	2.14
2	OSC OUT	2.28	14	QUAD	3.0
3	$V_{CC}1$	3.0	15	AF OUT	—
4	MIX OUT	1.76	16	N-REC	—
5	$V_{CC}2$	3.0	17	FIL IN	0.64
6	IF1 IN	2.58	18	FIL OUT	0.66
7	DEC 1	2.58	19	N-DET	—
8	IF1 OUT	2.0	20	C-DET	—
9	NDPS	3.0	21	RSSI	—
10	IF2 IN	2.65	22	V_{REF}	—
11	DEC 2	2.65	23	GND 1	0.0
12	GND 2	0.0	24	MIX IN	0.93

(Unit : V)

MAXIMUM RATINGS (Ta = 25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{CC}	7	V
Power Dissipation	P_D	780	mW
Operating Temperature	T_{opr}	−30~85	°C
Storage Temperature	T_{stg}	−50~150	°C

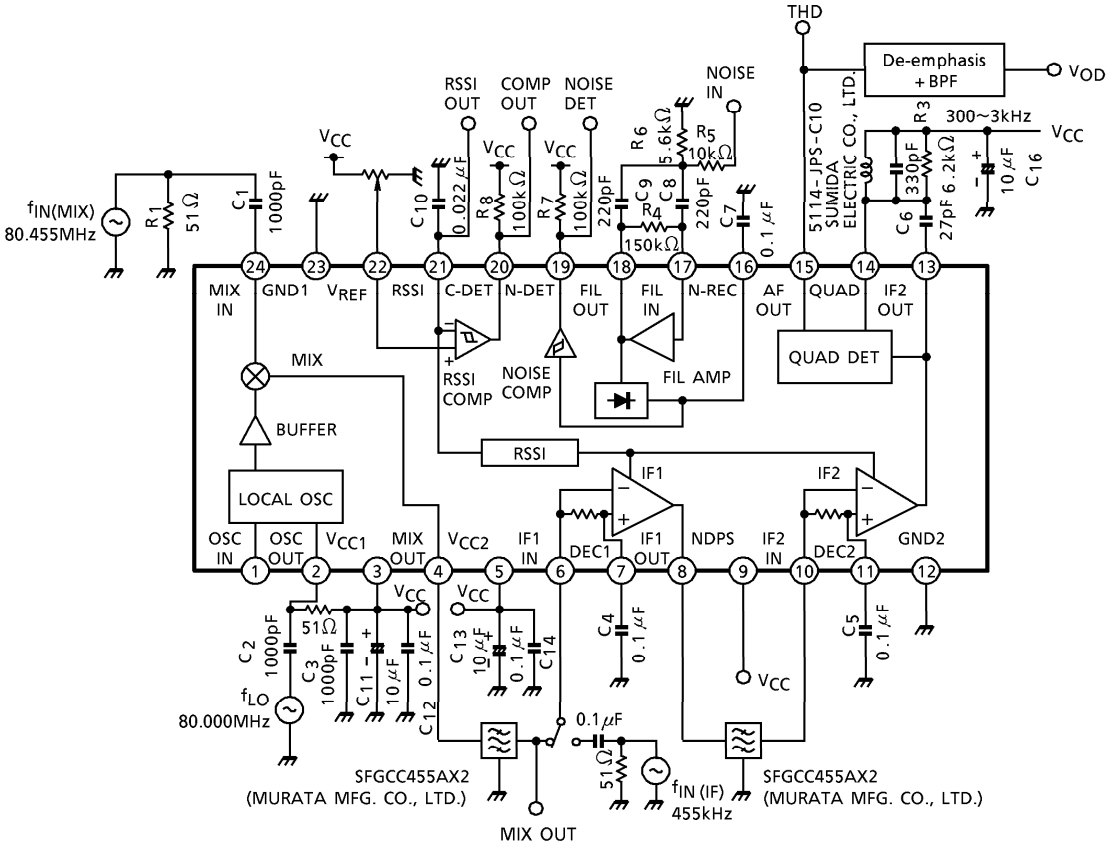
ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, V_{CC} = 3.0V, $f_{IN\ (MIX)}$ = 80.455MHz, Δf = ±8.0kHz, f_{MOD} = 1kHz, Ta = 25°C, f_{LO} = 80MHz, V_{LO} = 100dBμV, $f_{IN\ (IF)}$ = 455kHz, $V_{IN\ (IF)}$ = 60dBμV EMF)

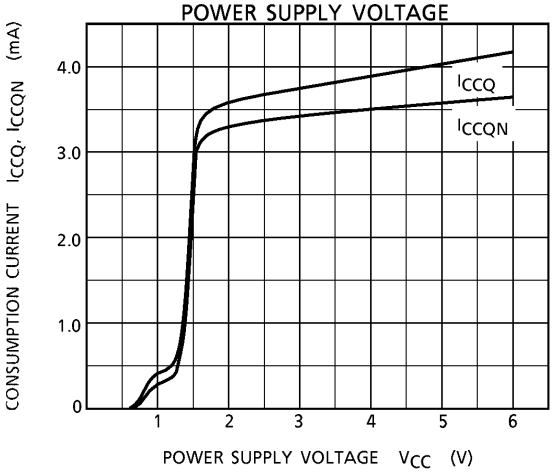
CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V_{CC}	—	—	1.8	3.0	6.0	V
Quiescent Current	I_{CCQ}	—	With NOISE CIRCUIT	—	4.1	5.6	mA
	I_{CCQN}	—	Without NOISE CIRCUIT	—	3.8	5.2	mA
MIX Conversion Gain	G_{VC}	—	Measurement after ceramic filter	12.5	15.5	18.5	dB
MIX Intercept Point	P_{IM}	—	—	—	107	—	dBμV
MIX Input Impedance	$R_{IN\ (MIX)}$	—	—	—	4.5	—	kΩ
	$C_{IN\ (MIX)}$	—	—	—	2.4	—	pF
MIX Output Resistance	$R_{OUT(MIX)}$	—	—	1.2	1.8	2.4	kΩ
12dB Sensitivity	12dB SN	—	50Ω Input	—	8.5	—	dBμV EMF
Demodulated Output	V_{OD}	—	$V_{IN\ (IF)}$ = 60dBμV EMF	160	210	280	mV_{rms}
SN Ratio	SN	—	$V_{IN\ (IF)}$ = 60dBμV EMF	50	65	—	dB
AM Rejection Ratio	AMR	—	$V_{IN\ (IF)}$ = 60dBμV EMF, AM = 30%	—	48	—	dB
IF1 Gain	G (IF1)	—	—	—	25	—	dB
IF2 Gain	G (IF2)	—	—	—	77	—	dB
IF1 Input Resistance	$R_{IN\ (IF1)}$	—	—	1.2	1.8	2.4	kΩ
IF1 Output Resistance	$R_{OUT\ (IF1)}$	—	—	1.2	1.8	2.4	kΩ
IF2 Input Resistance	$R_{IN\ (IF2)}$	—	—	1.2	1.8	2.4	kΩ
AF Output Impedance	Z_{AF}	—	—	—	360	—	Ω
RSSI Output Voltage	V_{RSSI-1}	—	V_{CC} = 3V, $V_{IN\ (IF)}$ = 20dBμV EMF	0.1	0.25	0.45	V
	V_{RSSI-2}	—	V_{CC} = 3V, $V_{IN\ (IF)}$ = 100dBμV EMF	1.8	2.2	2.6	V

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Noise Detection Output Voltage		V_{NDET}	—	I_{SINK} = 0.2mA	—	0.1	0.5	V
Noise Detection Out Leak Current		I_{LEAK}	—	V_{NREC} = 0.6V, V_{NDET} = 2V	—	0	5	μA
Noise Detection Level	"H"Level	V_{TH-H}	—	—	—	0.5	0.7	V
	"L"Level	V_{TH-L}	—	—	0.3	0.4	—	V
RSSI COMPARATOR Range Of Hysteresis		V_{HYS}	—	—	—	30	—	mV
RSSI COMPARATOR Input Range Of Reference		ΔV_{REF}	—	—	0.3	—	V_{CC} – 1	V

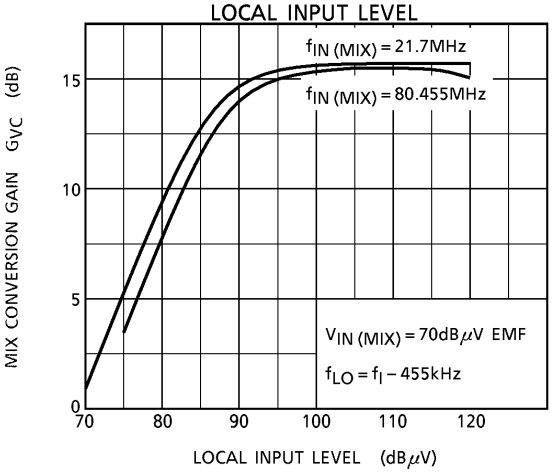
TEST CIRCUIT



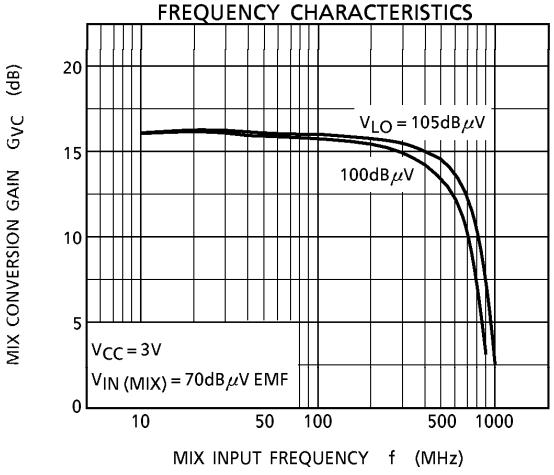
CONSUMPTION CURRENT – POWER SUPPLY VOLTAGE



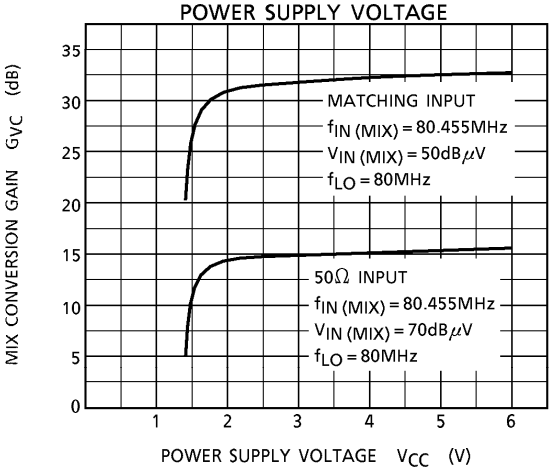
MIX CONVERSION GAIN – LOCAL INPUT LEVEL



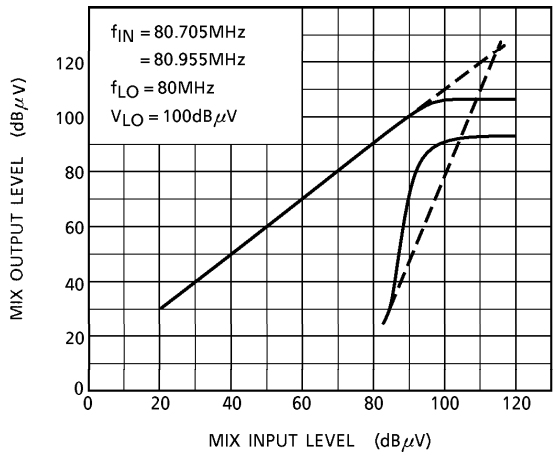
MIX CONVERSION GAIN FREQUENCY CHARACTERISTICS



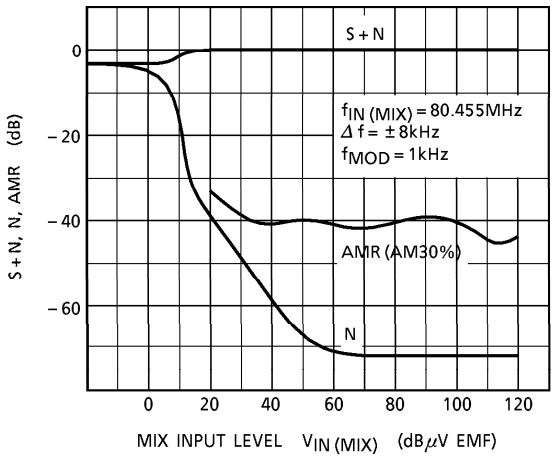
MIX CONVERSION GAIN – POWER SUPPLY VOLTAGE



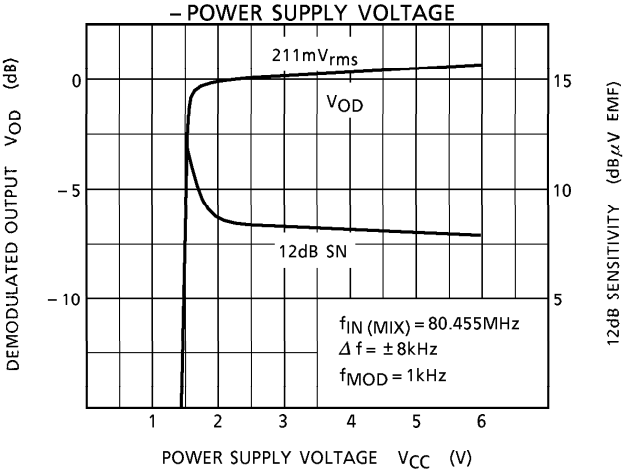
MIX INTERCEPT POINT CHARACTERISTICS



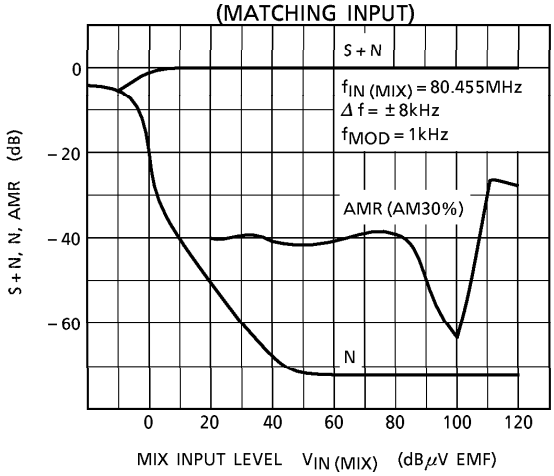
MIX + IF CHARACTERISTICS (50Ω INPUT)



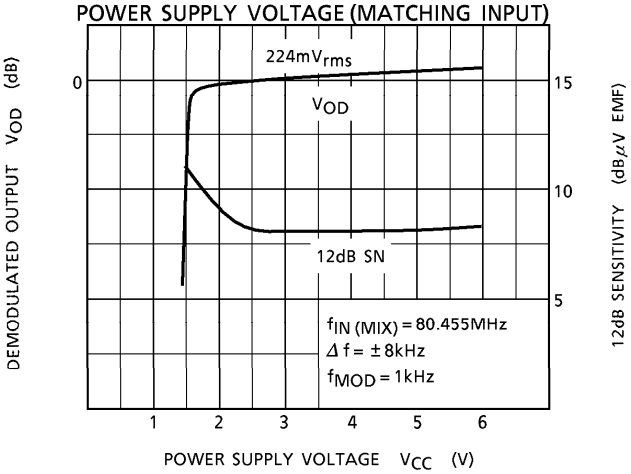
DEMODULATED OUTPUT 12dB SENSITIVITY – POWER SUPPLY VOLTAGE



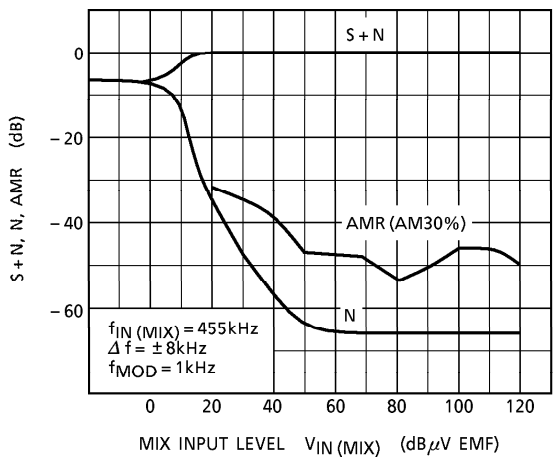
MIX + IF CHARACTERISTICS (MATCHING INPUT)



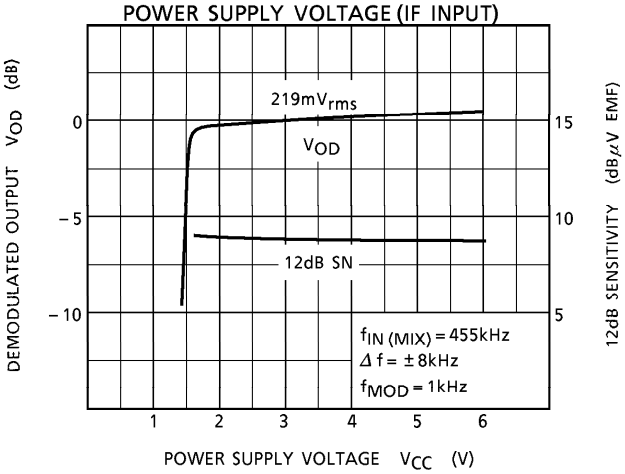
DEMODULATED OUTPUT 12dB SENSITIVITY – POWER SUPPLY VOLTAGE (MATCHING INPUT)



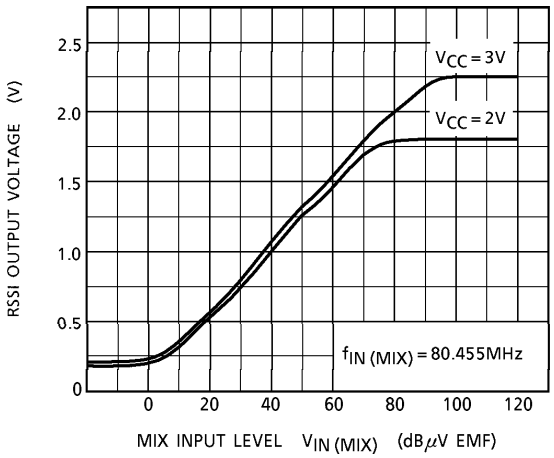
IF CHARACTERISTICS



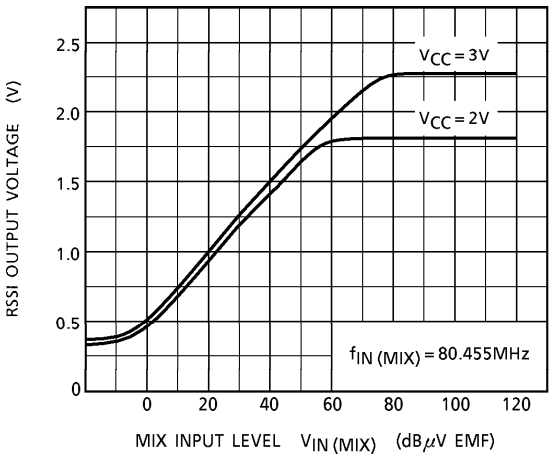
DEMODULATED OUTPUT12dB SENSITIVITY – POWER SUPPLY VOLTAGE (IF INPUT)



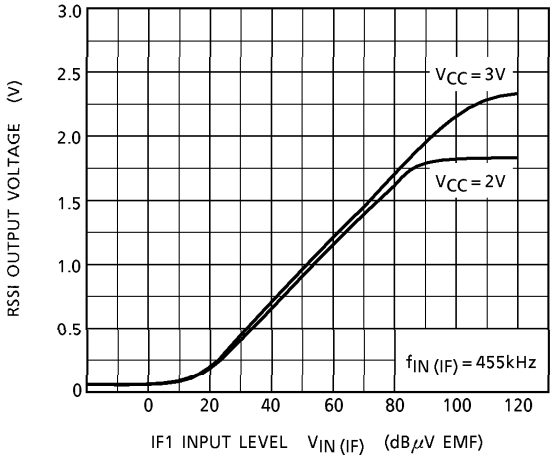
RSSI CHARACTERISTICS (50Ω INPUT)



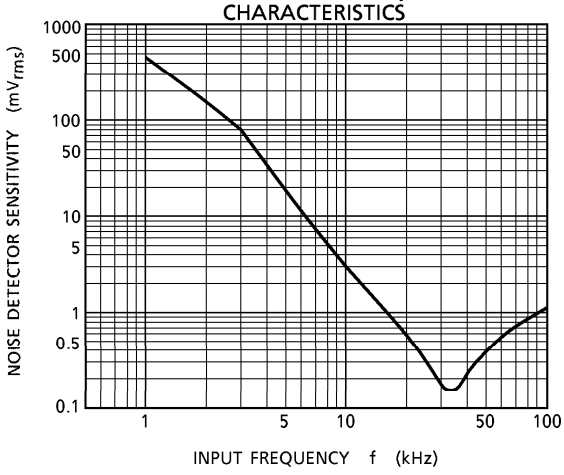
RSSI CHARACTERISTICS (MATCHING INPUT)



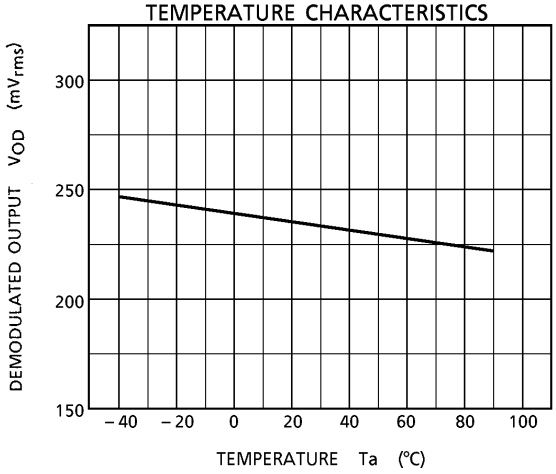
RSSI CHARACTERISTICS (IF1 INPUT)



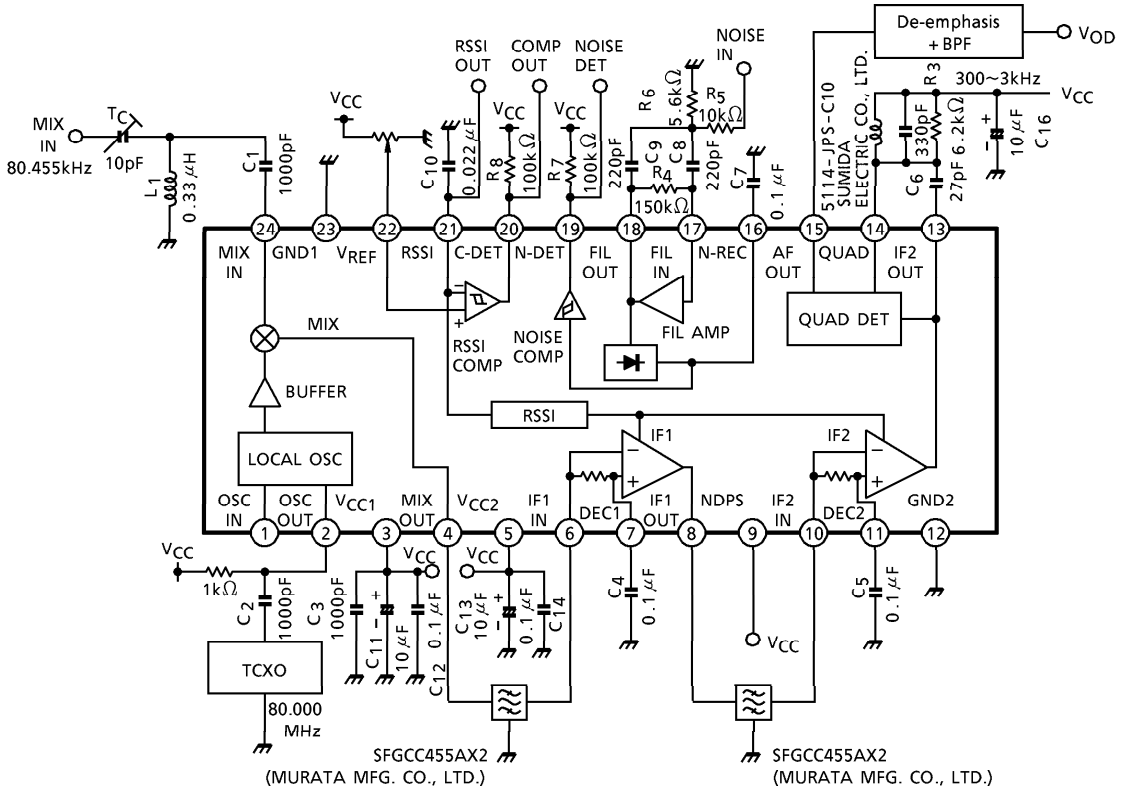
NOISE DETECTION FREQUENCY CHARACTERISTICS



DEMODULATED OUTPUT TEMPERATURE CHARACTERISTICS

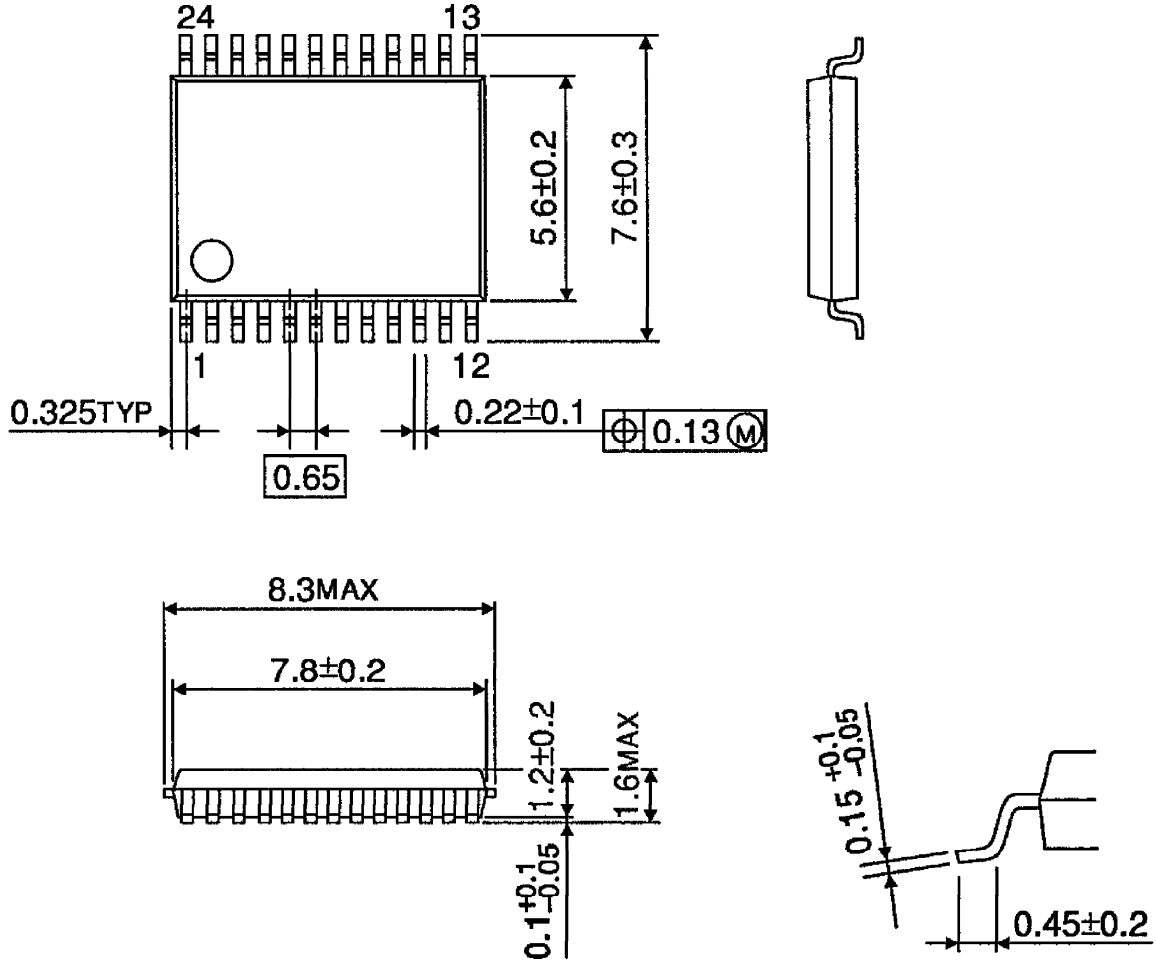


APPLICATION CIRCUIT



PACKAGE DIMENSIONS

SSOP24-P-300-0.65A Unit : mm



Weight : 0.14g (Typ.)

About solderability, following conditions were confirmed

- Solderability

  (1) Use of Sn-63Pb solder Bath
  - solder bath temperature = 230°C
  - dipping time = 5 seconds
  - the number of times = once
  - use of R-type flux

  (2) Use of Sn-3.0Ag-0.5Cu solder Bath
  - solder bath temperature = 245°C
  - dipping time = 5 seconds
  - the number of times = once
  - use of R-type flux

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