

## Low Power FM IF Amplifier

### Description

The CXA1293M/N are single-chip ICs FM radio such as CELLULAR mobile, etc.

### Features

- Low current consumption ( $I_{CC}=3.8\text{mA}$ , at  $V_{CC}=3.6\text{V}$ )
- It includes all the functions needed to the cellular mobile such as second mixer, FM detecting circuit, muting circuit, RSSI, etc...
- It has low and wide operating voltage (3.0 to 6.0V).
- It has wide RSSI range and excellent temperature characteristics.
- It is pin replaceable with CXA1003.

### Structure

Bipolar silicon monolithic IC

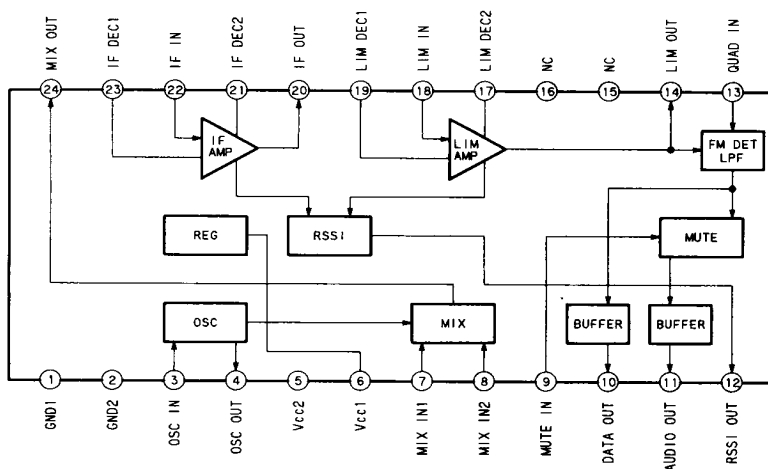
### Absolute Maximum Ratings ( $T_a=25^\circ\text{C}$ )

• Supply voltage	$V_{CC}$	12.0	V
• Operating temperature	$T_{opr}$	$-35$ to $+85$	$^\circ\text{C}$
• Storage temperature	$T_{stg}$	$-55$ to $+150$	$^\circ\text{C}$
• Allowable power dissipation	$P_D$	600	mW (CXA1293M)
		400	mW (CXA1293N)

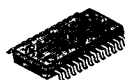
### Operating Condition

• Supply voltage	$V_{CC}$	3.0 to 6.0	V
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### Block Diagram and Pin Configuration (Top View)



CXA1293M 24pin SOP (Plastic) CXA1293N 24pin VSOP (Plastic)



### Functions

- Second mixer and oscillator
- IF amplifier and limiter
- RSSI
- FM detecting circuit
- Muting circuit

## Pin Description

Pin No.	Symbol	Voltage (Typ)	Equivalent circuit	Description
1 2	GND1 GND2	0V		Grounding pin
3 4	OSC IN OSC OUT	1.3V 0.6V		<p>Connect a crystal oscillator to compose a Colpitts type oscillation circuit.</p> <p>In case of using an external oscillator, input a signal to Pin 3 and connect Pin 4 to <math>V_{CC}</math>.</p>
5 6	$V_{CC} 1$ $V_{CC} 2$	3.6V		Power supply pin
7 8	MIX IN1 MIX IN2	1.3V 1.3V		<p>Input pin of mixer.</p> <p>In case of using a single input, connect Pin 8 to GND with capacitor.</p>
9	MUTE IN			<p>Control pin of Pin 11; audio output.</p> <p>A signal is output at L (<math>\leq 0.8V</math>), and is muted at H (<math>\geq 2.0V</math>).</p>
10	DATA OUT	1.3V		FM detected signal is output.
11	AUDIO OUT	1.3V		<p>FM detected signal is output.</p> <p>The output of Pin 11 can be muted by the input of Pin 9.</p>

Pin No.	Symbol	Voltage (Typ)	Equivalent circuit	Description
12	RSSI OUT	0.4V		Current corresponding to the input signal level to IF and LIM amplifiers is output.
13	QUAD IN	3.6V		Input pin of quadrature detecting circuit. Connect a resonance circuit between Pins 13 and 14.
14	LIM OUT	1.9V		Output pin of limiter.
17 18 19	LIM DEC2 LIM IN LIM DEC1	2.6V 2.6V 2.6V		Input and decoupling pins of limiter. Connect Pins 17 and 19 to GND with capacitor (0.01 to 0.047 $\mu$ F).
20	IF OUT	3.4V		Output pin of IF amp.

Pin No.	Symbol	Voltage (Typ)	Equivalent circuit	Description
21 22 23	IF DEC2 IF IN IF DEC1	2.6V 2.6V 2.6V		Input and decoupling pins of IF amp. Connect Pins 21 and 23 to GND with capacitor (0.01 to 0.047 $\mu$ F).
24	MIX OUT	2.5V		Output pin of mixer.

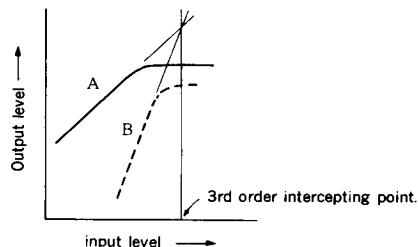
**Electrical Characteristics**(Ta=25°C, V<sub>CC</sub>=3.6V See the Electrical Characteristics Test circuit.)

0dBm=223.6mVrms.

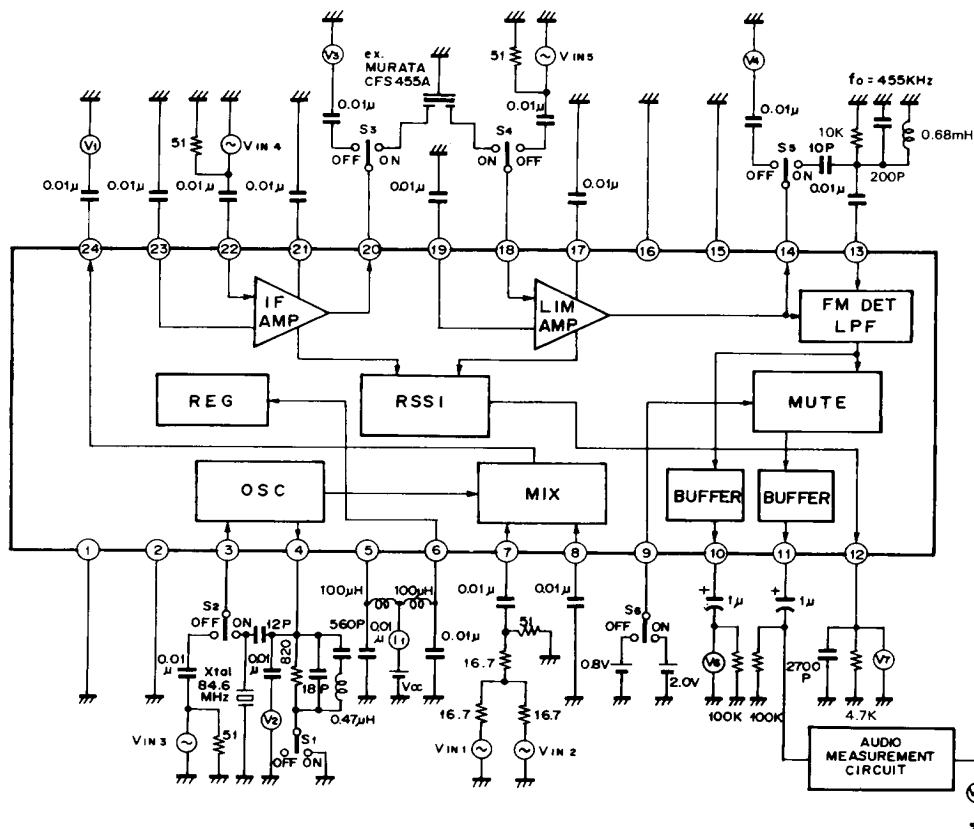
No.	Item	Symbol	Input signal	Remarks	Test point	Min.	Typ.	Max.	Unit
1	Current consumption	I <sub>CC</sub>			I1	2.9	3.8	5.0	mA
2	Mixer conversion gain	VG1	Vin 80MHz, -40dBm Vin 80.455MHz, 0dBm	f <sub>out</sub> =455kHz, the ratio of 455kHz component to input level	V1	10.0	12.0	14.0	dB
3	IF amp voltage gain	VG2	Vin 455kHz, -50dBm		V3	44	48	52	dB
4	Limiter voltage gain	VG3	Vin5 455kHz, -90dBm		V4	68	72	76	dB
5	Audio output voltage	VO4	Vin5 455kHz, -20dBm	f <sub>audio</sub> =1 kHz, Dev. = $\pm$ 8kHz FM	V5	155	195	225	mVrms
6	Audio output distortion	VD4	Vin5 455kHz, -20dBm	f <sub>audio</sub> =1 kHz, Dev. = $\pm$ 8kHz FM	V5	—	—	1.0	%
7	Audio output S/N	SN4	Vin5 455kHz, -20dBm		V5	40	—	—	dB
8	Audio output AMRR	AR4	Vin5 455kHz, -20dBm	f <sub>audio</sub> =1 kHz, Dev. = $\pm$ 80% FM	V5	30	—	—	dB
9	Crosstalk in muting	MX4	Vin5 455kHz, -20dBm	f <sub>audio</sub> =1 kHz, Dev. = $\pm$ 8kHz FM	V5			-65	dB
10	Data output voltage	VO5	Vin5 455kHz, -20dBm	f <sub>audio</sub> =1 kHz, Dev. = $\pm$ 8kHz FM	V6	155	195	225	mV
11	RSSI output VOL L	VO6	Vin4 455kHz, -100dBm		V7		0.50		V
12	RSSI output VOL H	VO7	Vin4 455kHz, -20dBm		V7		1.55		V

**Note)** Definition of the 3rd order intercepting point.

The 3rd order intercepting point is determined by the input level of Pin 7 at the tangent intersection of A and B. A and B is 455 kHz component in case of 1 and 2. In case 1,  $V_{IN1}$  is 80MHz,  $V_{IN2}$  is terminated by  $50\Omega$  and  $V_{IN3}$  is 10 dBm 80.455MHz. In case2,  $V_{IN1}$  is 80.06MHz,  $V_{IN2}$  is 80.12MHz and  $V_{IN3}$  is 10 dBm 80.455 MHz.



### Electrical Characteristics Test Circuit

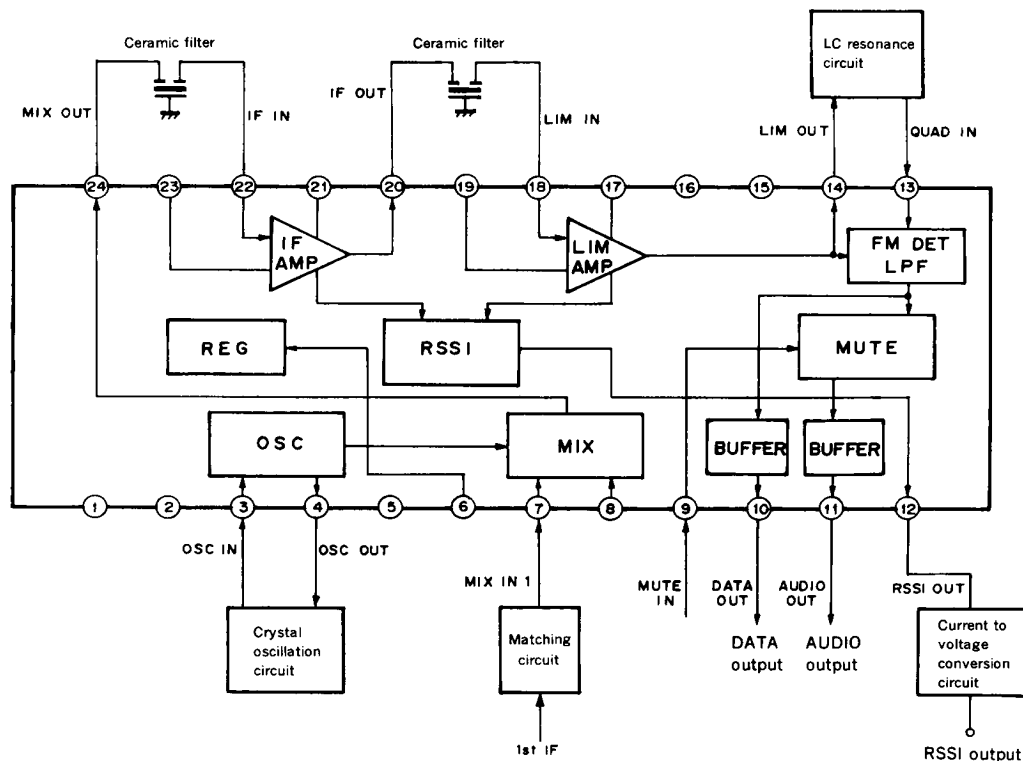


## Application Circuit



### Description of Operation

- The signals which have been input from Pins 7 and 8 are mixed with the local oscillation signals from the oscillator in the mixer, and the frequency converted signal is output from Pin 24. The oscillator is self-oscillated by composing Colpitts type crystal oscillation circuit between Pins 3 and 4. In addition, it is possible to apply a local oscillation signal to Pin 3 from the external circuit.
- After the bandwidth is limited by BPF, the mixer output is amplified by IF amplifier and output from Pin 20. The IF amplifier output is limited its bandwidth again, and amplitude limited by the limiter and output from Pin 14. The limiter amplifier output is phase-shifted by LC resonance circuit, etc., and audio signal is output from Pins 10 and 11 after being quadrature detected. The output from Pin 11 can be muted by control signal from Pin 9. The control signal is muting at "H" and through at "L" in TTL level.



- The RSSI output is the currents corresponding to the input levels at the IF amplifier and the limiter. It is possible to obtain RSSI voltage output by connecting a proper I-V conversion circuit to Pin 12.

### Notes on Operation

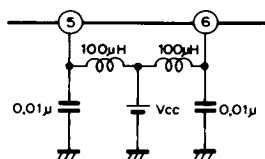
CXA1293M/N have very high voltage gains (IF amp: 48dB, limiter amp: 72dB) and deal with high frequency.

1. Decouple Pins 5 and 6 with L and C as near to the pins as possible.
2. Connect Pins 15 and 16 (NC) to GND.
3. Separate input line from the output line as far as possible, and make the wiring short.
4. Connect mixer (Pin 8), IF amp (Pins 23), limiter amp (Pins 17 and 19) to GND with decoupling capacitor as near to pins as possible.
5. The GND impedance should be as low as possible.
6. It is better to separate statically the input from the output of the limiter with shielding plate. (Use GND (Pins 1 and 2) and NC (Pins 15 and 16)).

### Application Note

#### 1) Power supply

The CXA1293M/N have a voltage regulator within the IC, so these have wide operating supply voltage range (+3.0 to +7.0V; Typ: 3.6). There is little change in characteristics in the operating range. Decouple Pins 5 and 6 with L and C. (See Fig. right)



Power supply decoupling

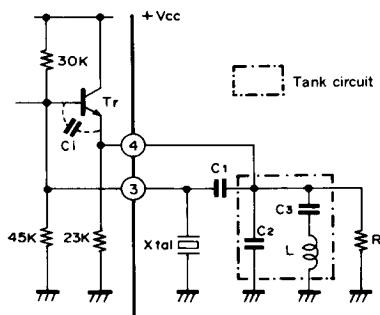
#### 2) Oscillator

The method to use oscillator of CXA1293M/N is the following:

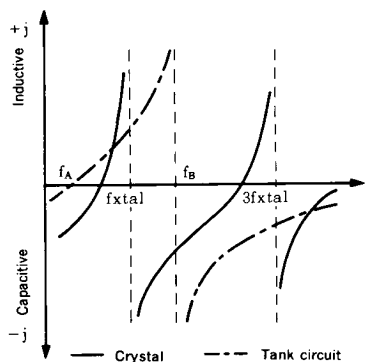
- (a) Method to input from Pin 3 with the self-exciting oscillation signal by composing a crystal oscillation circuit of the Colpitts type to Pins 3 and 4.
- (b) Method to input directly the local oscillation signal to Pin 3.

<Crystal oscillation circuit>

The 3rd overtone crystal oscillation circuit of the Colpitts type is shown Fig. below.



Colpitts type crystal oscillation circuit.



Reactance characteristics



The conditions of the 3rd overtone oscillation of this oscillation circuit are the following.

- The parallel resonance frequency ( $f_B$ ) of the tank circuit should be smaller than the 3rd oscillation frequency ( $3f_{xtal}$ ) and the serial resonance frequency ( $f_A$ ) should be smaller than the basic oscillation frequency ( $f_{xtal}$ ) ( $3f_{xtal} > f_B$ ,  $f_{xtal} > f_A$ ).
- The load capacitance ( $C_L$ ) of the crystal should be adequate.
- The  $f_t$  of the amplifier ( $T_r$ ) should be sufficiently larger than  $3f_{xtal}$ .

The constant is determined so as to satisfy these conditions.

The oscillation level is set at 280 to 890 mVrms (Typ: 500 mVrms) and adjust the level by changing the resistance value (R). The slight adjustments of the oscillation frequency and oscillation level are performed with  $C_2$  and L.

<In case of direct input>

In case of direct input, connect Pin 4 to  $V_{CC}$  and input local oscillation signal to Pin 3. Input level at this time is also 280 to 890 mVrms (Typ: 500mVrms).

### 3) Mixer

Mixer of the CXA1293M/N is a double balance type. Input ports are Pins 7 and 8, and in case of single input, input signal to Pin 7, and connect Pin 8 to GND with capacitor. It is possible to use differential input. The standard input level is  $-110$  to  $-30$  dBm ( $0.7\mu$  to 7.0 mVrms), and input through a proper matching circuit.

### 4) Filter

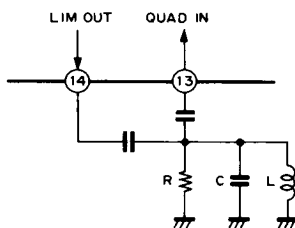
The band-pass filters which are connected between Pins 24 and 22 and between Pins 20 and 18 of the CXA1293M/N are desired to have the specifications as follows.

- Input/output impedance:  $1.5k\Omega \pm 10\%$
- Insertion loss (center frequency):  $< 6$  dB

Use each filter for other center frequency, 3dB band width and others.

### 5) Phase shifter

Input to Pin 13 to shift the phase of the limiter output (Pin 14)  $90^\circ$  by the RLC parallel resonance circuit or the discriminator, etc. in order to quadrature FM detection. The Fig. below shows the RLC phase shifter. In this case, determine the L and C values so that the 2nd IF signal frequency and the parallel resonance frequency are the same, and the audio output level is determined by R value.



RLC phase shifter

## 6) Audio output, data output and muting

The FM modulated audio data signal is demodulated in the prior stage and is output from Pins 11 (AUDIO OUT) and 10 (DATA OUT). Output from Pin 11 can be muted by control signal of TTL level from Pin 9 (MUTE IN). (See table below.)

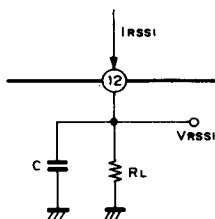
Control signal	Audio signal
H ( $\geq 2.0\text{V}$ )	Mute
L ( $\leq 0.8\text{V}$ )	Slew

Table of muting control

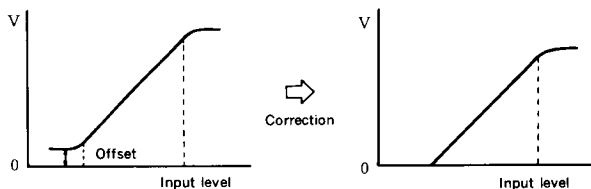
## 7) RSSI

The function of RSSI is to detect the input level, and output current increases equally within the range of IF input level  $-100$  to  $0$  dBm ( $2.24\mu$  to  $224$  mVrms). The supply voltage and temperature effect little on output current. However, the output current is distributed within the range of  $\pm 20\%$  due to the resistance within the IC. In case voltage output is required, it needs current to voltage conversion composing with resistance, etc. The resistance value is determined by the RSSI maximum output current and the allowable maximum voltage of Pin 12. The RSSI maximum output current is approximately  $1\text{mA}$  (Typ:  $700\mu\text{A}$ ) and the allowable maximum voltage (recommended maximum voltage) is  $V_{CC} - 0.3\text{V}$ , select the resistance according to the supply voltage and the required output voltage. In case the output voltage is required above  $V_{CC} - 0.3\text{V}$ , amplify a voltage using an operational amplifier, etc.

The AMPS defines that the RSSI output voltage increases equally from  $0\text{V}$ . The CXA1293M/N have an offset of approximately  $0.3$  to  $0.5\text{V}$  ( $V_{CC} = 5\text{V}$ ,  $R_L = 4.7\text{k}\Omega$ ), if it needs, utilize the offset correction circuit.

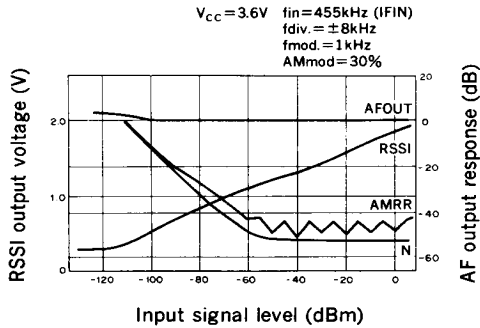


Current to voltage conversion with resistance of RSSI output

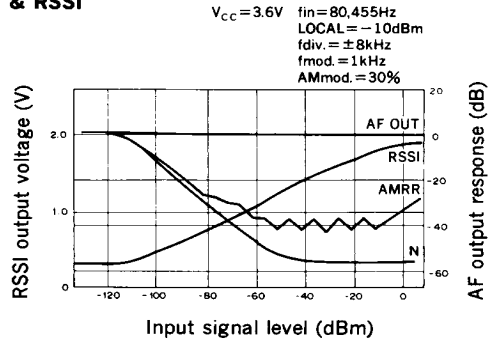


Offset correction of RSSI output voltage

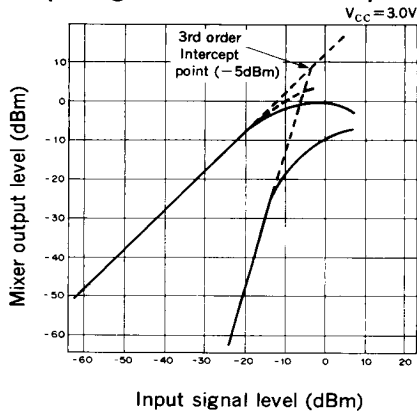
AF & RSSI



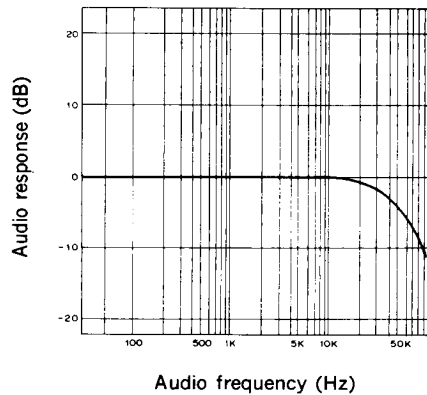
AF & RSSI



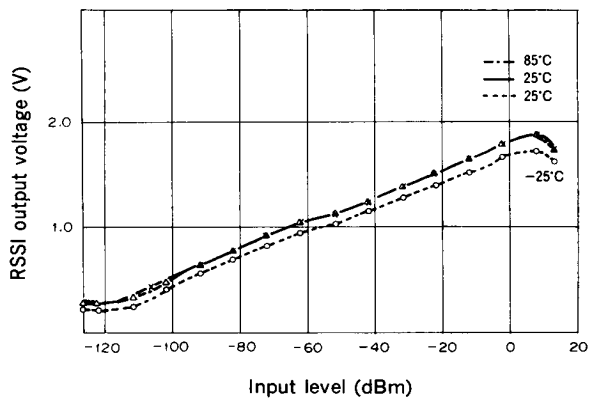
Input Signal Level vs. Mixer Output Level



Detected Audio Frequency Response



Input Level vs. RSSI Output Voltage

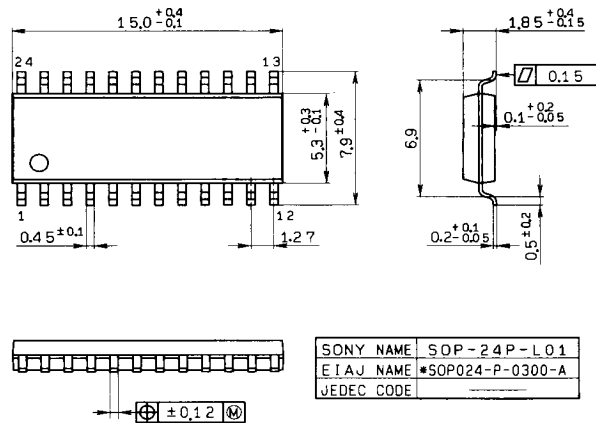


Package Outline

Unit: mm

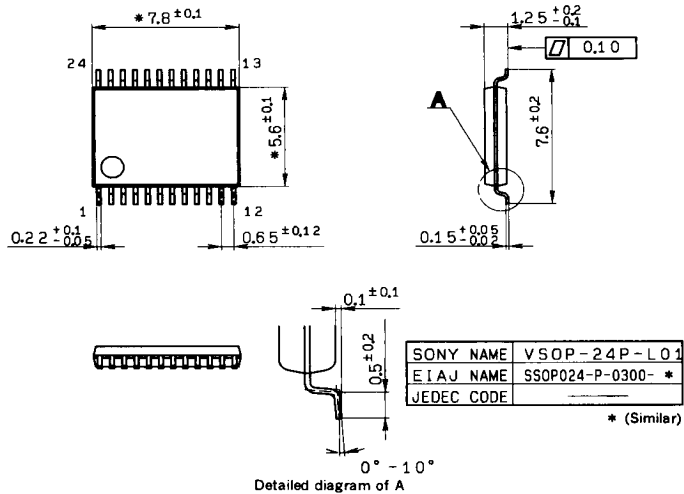
CXA1293M

24pin SOP (Plastic) 300mil 0.3g



CXA1293N

24pin VSOP (Plastic) 275mil



Note) Dimensions marked with \* do not include resin residue.