SONY

CXA3176N

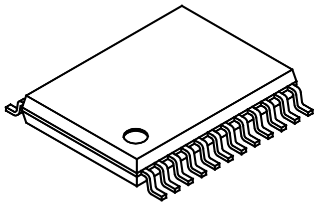
IF Amplifier for FM Receiver (AFC Supported)

For the availability of this product, please contact the sales office.

Description

The CXA3176N is a low current consumption FM IF amplifier which employs the newest bipolar process. It is suitable for FM receiver using AFC.

24 pin SSOP (Plastic)



Features

- Low current consumption :
  0.95 mA (typ. at $V_{CC}1$=1.4 V)
  0.15 mA (typ. at $V_{CC}2$=3.0 V)
- Small package 24-pin SSOP
- Second mixer and oscillator
- Needless of IF decoupling capacitor
- Reference power supply for operational amplifier
- RSSI function (dynamic range of 70 dB)
- IF input, V_{CC} standard
- AFC function
- Maximum input frequency : 30 MHz

Applications

- FM receiver supporting AFC
- Double conversion FM receiver

Structure

Bipolar silicon monolithic IC

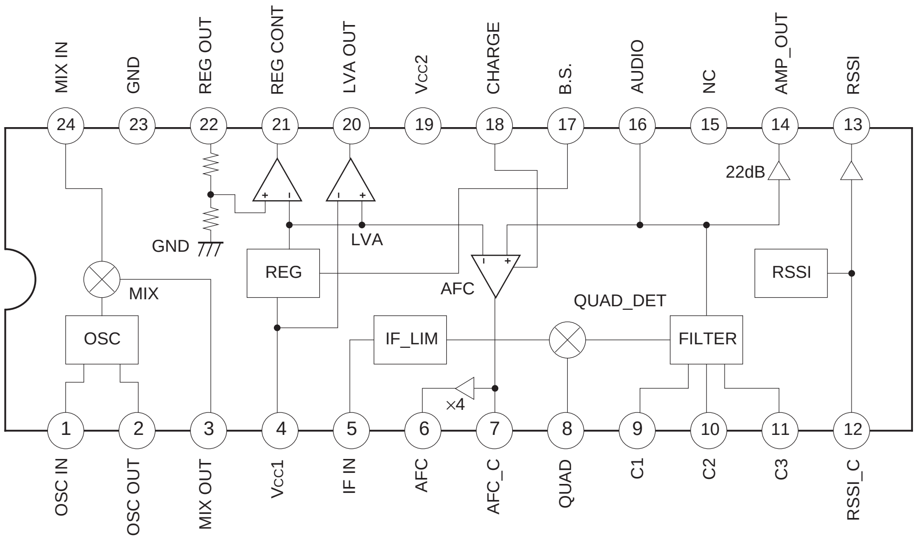
Absolute Maximum Ratings

• Supply voltage	V_{CC}	7.0	V
• Operating temperature	Topr	–20 to +75	°C
• Storage temperature	Tstg	–65 to +150	°C
• Allowable power dissipation			
	P_D	417	mW

Operating Condition

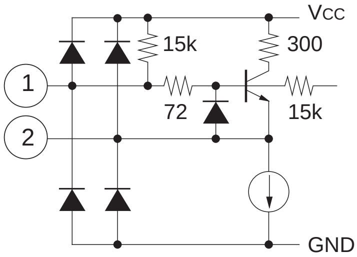
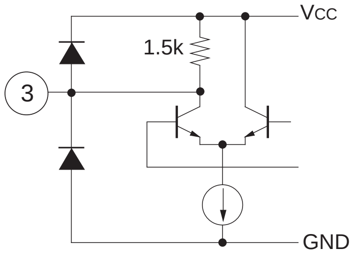
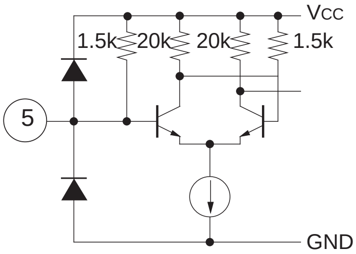
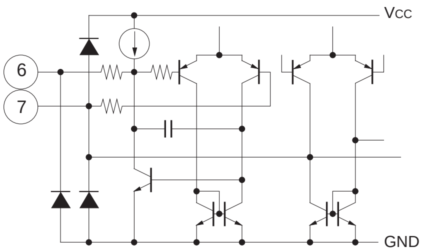
Supply voltage	$V_{CC}1$	1.1 to 4.0	V
	$V_{CC}2$	2.5 to 4.0	V

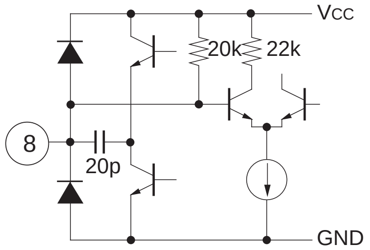
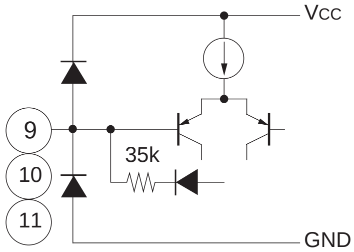
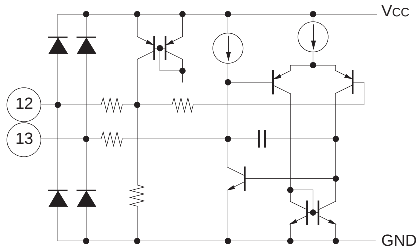
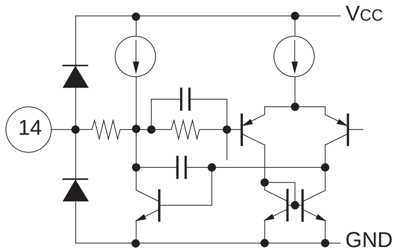
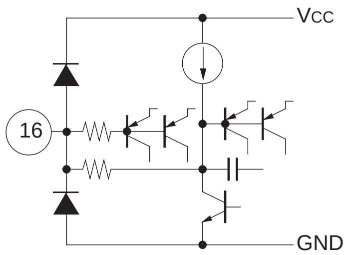
Block Diagram and Pin Configuration

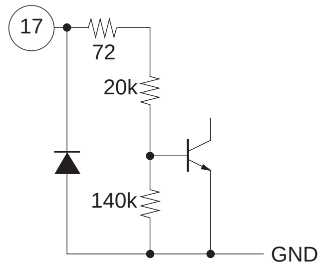
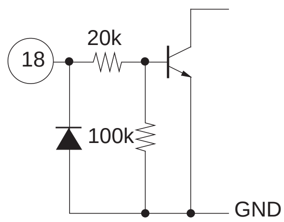
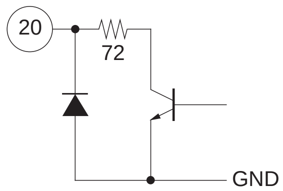
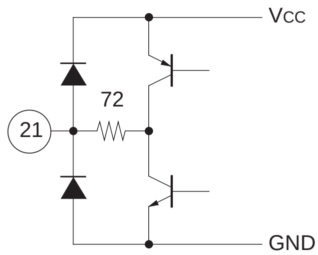
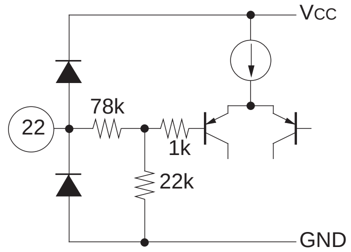
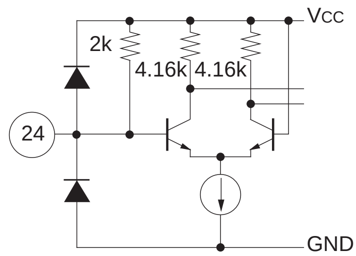


E96X14A8Z

Pin Description

Pin No.	Symbol	Pin voltage	Equivalent circuit	Description
1	OSC IN	1.4 V		Connects the external parts of crystal oscillator circuit. A capacitor and crystal oscillator are connected to these pins and Vcc.
2	OSC OUT	0.7 V		
3	MIX OUT	1.3 V		Mixer output. Connect a 450 kHz ceramic filter between this pin and IF IN.
4	Vcc1			Power supply 1.
5	IF IN	1.4 V		IF limiter amplifier input.
6	AFC	—		AFC output.
7	AFC_C	—		Connects the capacitor that becomes the AFC time constant.

Pin No.	Symbol	Pin voltage	Equivalent circuit	Description
8	QUAD	1.4 V		Connects the phase shifter of FM detector circuit.
9 10 11	C1 C2 C3	0.2 V		Connects the capacitor that determines the LPF cut-off.
12	RSSI_C	0.1 V		Connects the capacitor that determines the RSSI rising characteristics.
13	RSSI	0.1 V		RSSI circuit output.
14	AMP OUT	Vcc2/2		Output for the detector output amplification circuit.
15	NC	—		Not connected.
16	AUDIO	0.2 V		Input for the detector output amplification circuit and AFC circuit. The filter circuit output is connected.

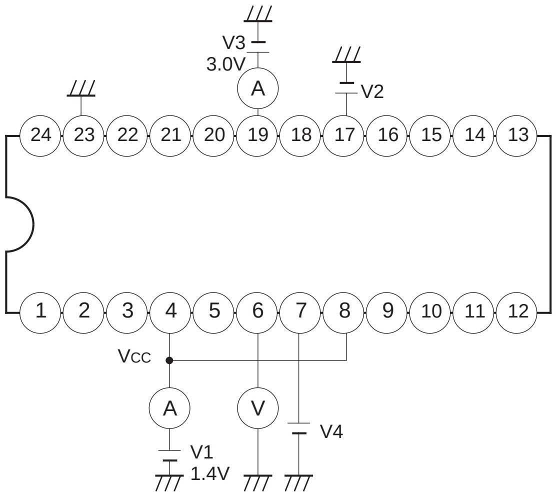
Pin No.	Symbol	Pin voltage	Equivalent circuit	Description
17	B.S.	—		Controls the battery saving. Setting this pin low suspends the operation of IC. (Applied voltage range : –0.5 V to +7.0 V)
18	CHARGE	—		Controls the time constant of the AFC circuit. Set this pin high to make the short time constant. (Applied voltage range: –0.5 V to +7.0 V)
19	Vcc2	—		Power supply 2.
20	LVA OUT	—		LVA comparator output. It is open collectors. (Applied voltage range: –0.5 V to +7.0 V)
21	REG CONT	—		Output for internal constant-voltage source amplifier. Connect the base of PNP transistor. (Current capacity : 100 µA)
22	REG OUT	1.0 V		Constant-voltage source output. Controlled to maintain 1.0 V.
23	GND	—		Ground
24	MIX IN	1.4 V		Mixer input.

Electrical Characteristics

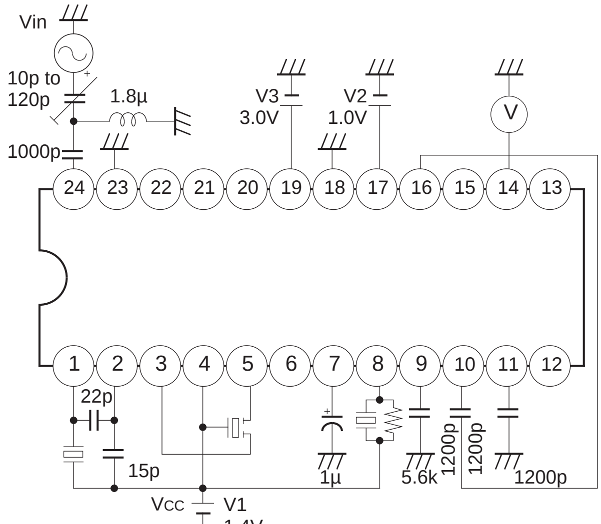
($V_{CC}1$=1.4 V, $V_{CC}2$=3 V, Ta=25 °C, F_S=21.7 MHz, F_{MOD}=4 kHz, F_{DEV}=4.5 kHz, AM_{MOD}=30 %)

Item	Symbol	Conditions	Min.	Typ.	Max	Unit
Current consumption1	$I_{CC}1$	Measurement circuit 1, V2=1.0 V	0.5	0.95	1.35	mA
Current consumption2	$I_{CC}2$	Measurement circuit 1, V2=1.0 V	—	0.15	0.25	mA
Current consumption	I_{CCS}	Measurement circuit 1, V2=0 V	—	6	10	µA
AM rejection ratio	AMRR	Measurement circuit 2, 30 k LPF	25	—	—	dB
VB output current	I_{OUT}	Measurement circuit 3	100	—	—	µA
VB output saturation voltage	V_{SATVB}	Measurement circuit 3	—	—	0.4	V
REG OUT voltage	V_{REG}	Output current 0 µA	0.92	0.97	1.02	V
LVA operating voltage	V_{LVA}	Measurement circuit 4, V1=1.4 to 1.0 V	1.00	1.05	1.10	V
LVA output leak current	I_{LLVA}	Measurement circuit 4, V1=1.0 V	—	—	2.0	µA
LVA output saturation voltage	V_{SATLVA}	Measurement circuit 5	—	—	0.4	V
Logic input voltage high level	V_{THBSV}	—	0.9	—	—	V
Logic input voltage low level	V_{TLBSV}	—	—	—	0.35	V
Limiting sensitivity	$V_{IN\ (LIM)}$	Measurement circuit 2, Data filter fc=6.2 kHz	—	–108	—	dBm
RSSI output offset	V_{ORSSI}	Measurement circuit 6	—	150	300	mV
Mixer input resistance	R_{INLIM}	—	1.6	2.0	2.4	kΩ
Mixer output resistance	R_{OUTMIX}	—	1.2	1.5	1.8	kΩ
IF limiter input resistance	R_{INLIM}	—	1.2	1.5	1.8	kΩ
AMP OUT	V_{AMP}	Measurement circuit 2	500	630	800	mVrms

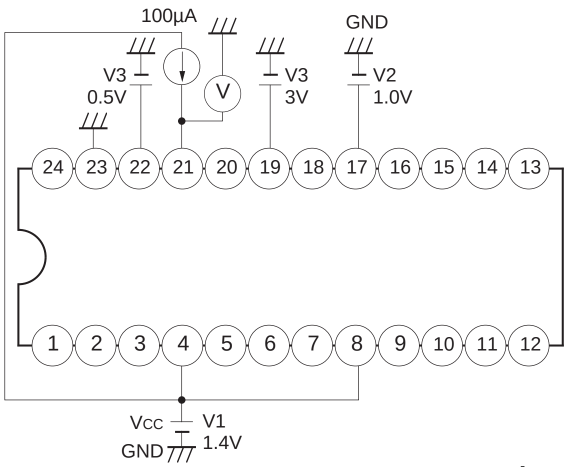
Electrical Characteristics Measurement Circuit



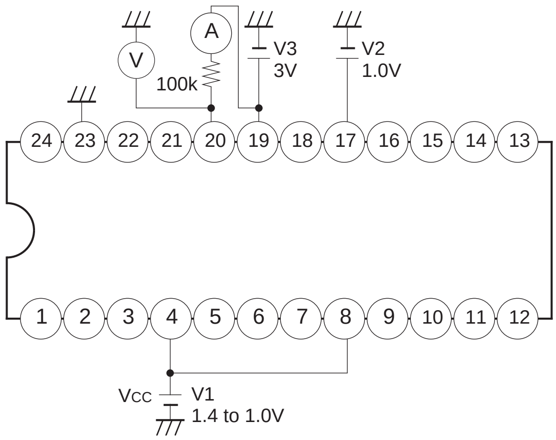
Measurement circuit 1



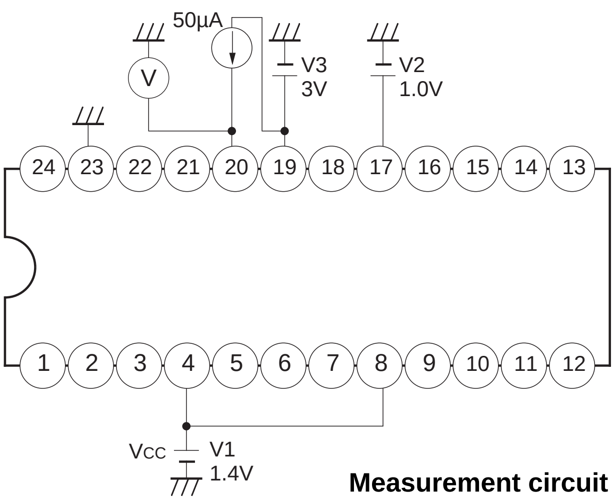
Measurement circuit 2



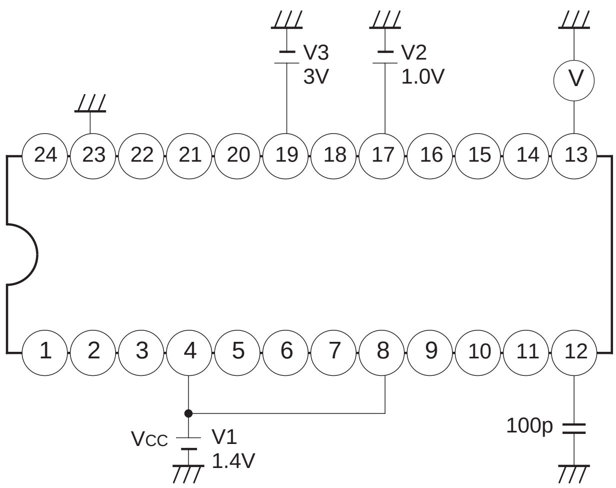
Measurement circuit 3



Measurement circuit 4

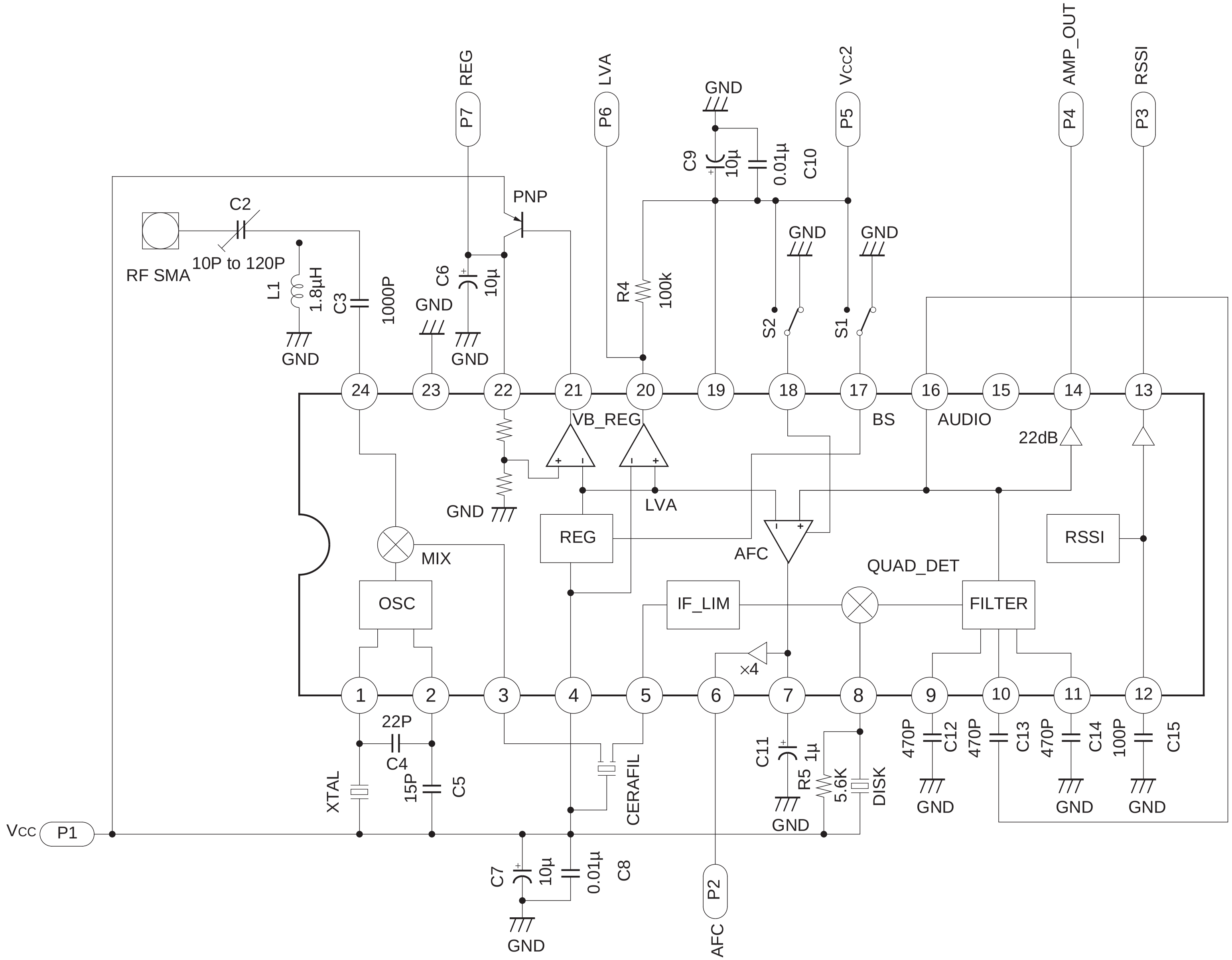


Measurement circuit 5



Measurement circuit 6

Application Circuit



Application circuits shown are typical examples illustrating the operation of the devices. Sony cannot assume responsibility for any problems arising out of the use of these circuits or for any infringement of third party patent and other right due to same.

Application Notes

1) Power Supply

The CXA3176N, with built-in regulator, is designed to permit stable operation at a wide range of supply voltage of $V_{CC}1$=1.1 to 4.0 V and $V_{CC}2$=2.5 to 4.0 V. Decouple the wiring to V_{CC} (Pins 4 and 19) as close to the pin as possible.

2) Oscillator Input

Oscillator input method

a) Using Pins 1 and 2, input a self-excited oscillation signal through the composition of a Colpitts type crystal oscillator circuit.

b) Directly input a local oscillation signal to Pin 1.

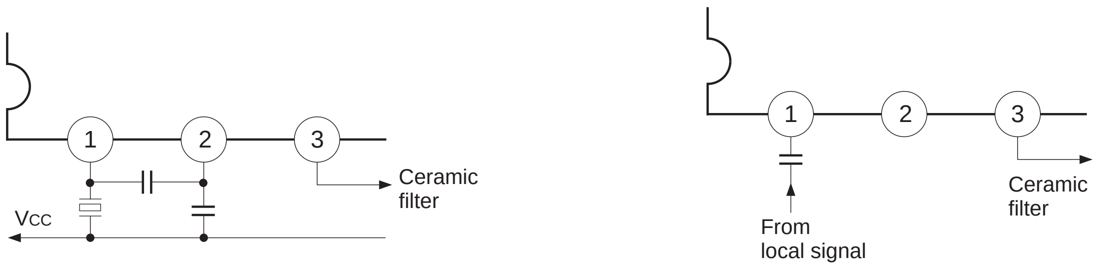


Fig. 1

3) Mixer

The mixer is of double-balance type. Pin 24 is the input pin. Input though a suitable matching circuit. The input impedance is 2.0 kΩ.

Pin 3 serves as the output pin for the mixer, and a load resistance of 1.5 kΩ is incorporated.

4) IF Filter

The filter to be connected between this mixer output and the IF limiter amplifier input should have the following specifications.

I/O impedance	: 1.5 kΩ ±10 %
Band width	: Changes according to applications.

5) IF Limiter Amplifier

The gain of this IF limiter amplifier is approximately 100 dB. Take notice of the following points in making connection to the IF limiter amplifier input pin (Pin 5).

a) Wiring to the IF limiter amplifier input (Pin 5) should be as short as possible.

b) As the IF limiter amplifier output appears at QUAD (Pin 8), wiring to the ceramic discriminator connected to QUAD should be as short as possible to reduce the interference with the mixer output and IF limiter amplifier input.

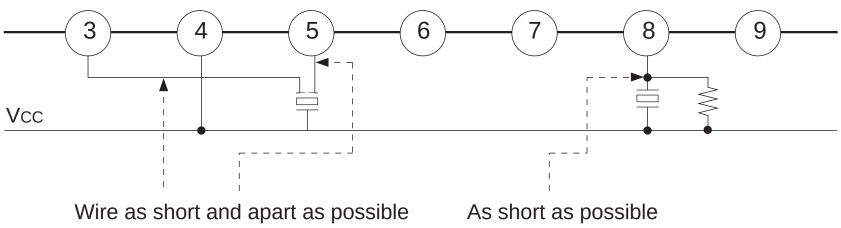


Fig. 2

6) Quick Charge

In order to hasten the rise time of Pin 7 from when power is turned on, the CXA3176N features a quick charge circuit. The capacitance value connected to Pin 7 should be chosen such that the voltage does not vary much due to discharge during battery saving.

Connect a signal for controlling the quick charge circuit to Pin 18. Setting this pin high enables the quick charge mode, and setting this pin low enables the steady-state reception mode. Quick charge is used when the power supply is turned on. The battery saving must be set high at the time.

Connect Pin 18 to GND when quick charge is not being used.

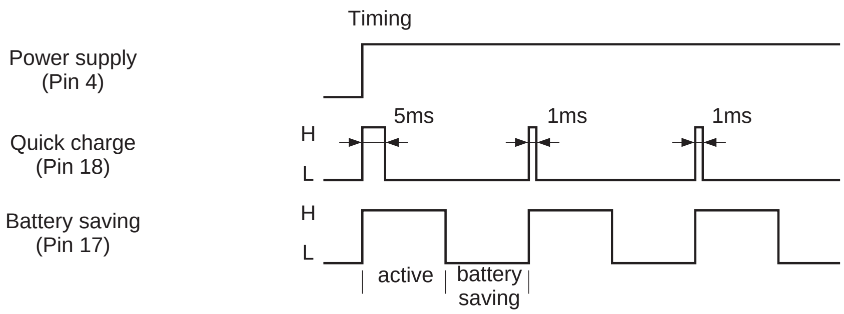


Fig. 3

7) Detector

The detector is of quadrature type. To perform phase shift, connect a ceramic discriminator to Pin 8.

The phase shifting capacitor for the quadrature detector is incorporated. The FM signal demodulated with the detector will be output to AMP_OUT (Pin 14) through the internal LPF.

The CDBC450CX50 (MURATA MFG. CO., LTD.) ceramic discriminator is recommended for the CXA3176N.

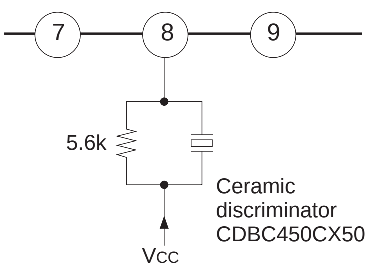


Fig. 4

8) REG CONT

Controls the base bias of the external transistors.

9) LVA OUT

This pin goes high (open) when the supply voltage becomes lower. Since the output is an open collector, it can be used to directly drive the CMOS device. The setting voltage of the LVA is 1.05 V (typ.), and it possesses a hysteresis with respect to the supply voltage. The hysteresis width is 50 mV (typ.).

10) B.S.

Operation of the CXA3176N can be halted by setting this pin low. This pin can be connected directly to the CMOS device. The current consumption for battery saving is 10 μA or less (at 1.4 V).

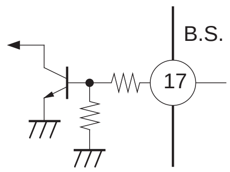


Fig. 5

11) Control Pins

The function controls are as shown below.

Pin No.	17	18
Symbol	B.S.	CHARGE
Function	Battery saving mode control	Pin 7 charge speed control
Input high	IC operation*	Quick charge
Input low	Sleep	Slow charge*

Note) When each function is not controlled externally, set it to the state with an asterisk (*).

12) LPF Constant

The composition of the data filter is ternary.
The first-stage cut-off f_{C1} is

$$f_{C1} = \frac{1}{2\pi C_{12} R}$$

The second-stage cut-off f_{C2} is

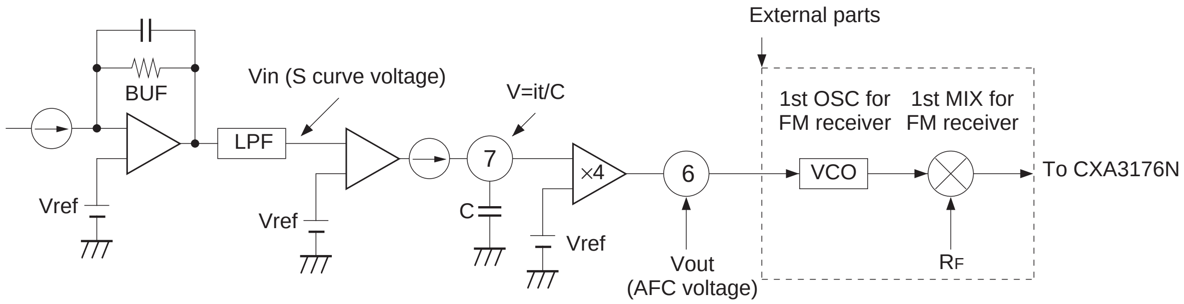
$$f_{C2} = \frac{1}{2\pi R\sqrt{C_{13}\,C_{14}}} \quad , \quad Q = \sqrt{\frac{C_{13}}{C_{14}}}$$

C_{12}, C_{13}, C_{14} : External capacitance shown in the Application Circuit
R : IC internal resistance

The Butterworse characteristic is for $C_{12}=C_{13}=C_{14}$.
R is approximately 55 kΩ ±20 %.

13) AFC

The AFC is of the current output type which outputs the frequency deviation in the form of the current and converts it to the voltage. The output current range is approximately ±0.4 µA for the slow mode and ±70 µA for the fast mode.

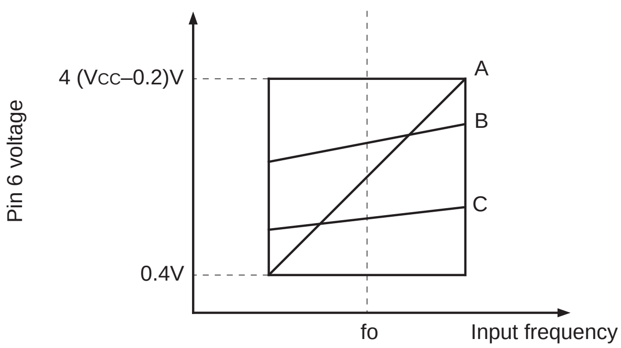


CXA3176N AFC Principle Diagram

The Pin 7 voltage V continues to change till the Vin value reaches the Vref value. When these values are equal, the Pin 7 output current becomes "0" and the voltage is determined by the charge and time.
The Pin 7 voltage V is output to Pin 6 through the amplifier.

$$V_{out}=V_{ref}+4\,(V-V_{ref})$$

The Vout operating range is 0.4 V to 4 (V_{CC}–0.2) V so that AFC should be set within this range.
Also, the voltage for Pin 7 is undefined with the IC itself.
The AFC voltage varies, for example, as shown below by the VCO characteristics. The AFC voltage follows the VCO characteristics because this voltage is independent of the slope of the S curve. In other words, the CXA3176N operates according to the VCO characteristics when the VCO characteristics have the linearity with respect to the voltage and the VCO characteristics can be controlled within the range shown in the graph below.



14) Sensitivity Adjustment Method

The constants shown in the Application Circuit are for the standard external parts. However, adjustment may be necessary depending on the conditions of use, characteristics of external parts, and the RF system circuit and decoder connected to the IF IC, etc. Adjust the sensitivity according to the following procedures.

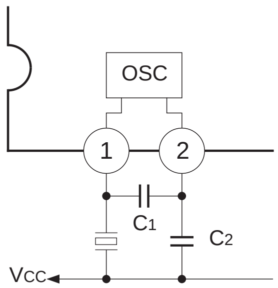
a) MIX IN matching

When using a matching circuit between the RF system circuit and MIX IN of the CXA3176N, adjust the trimmer to obtain the optimal sensitivity while monitoring the AUDIO output.

b) Local input level

The mixer circuit gain is dependent on the local signal input level to OSC IN. The input level to OSC IN should be set as high as possible within the range of –6 to +2 dBm as shown in the graph of "Local input level vs. Mixer gain characteristics". However, care should be taken as raising the input level above +2 dBm will cause the sensitivity to drop.

When creating the local signal using the internal oscillator circuit, the oscillation level varies according to the external capacitances attached to Pins 1 and 2 and the characteristics of the used crystal. Therefore, be sure to adjust the external capacitance values attached to Pins 1 and 2 according to the crystal characteristics.



C_1 and C_2 have the following range in the figure above.

$C_1 \geq C_2$

$C_1 = C_2$ to $C_1 = 5C_2$

As for the ratio of C_1 to C_2, the oscillation stabilizes as C_1 approaches equality with C_2.

The oscillation level decreases as the C_1 and C_2 values become larger, and increases as the C_1 and C_2 values become smaller.

Use a FET probe to confirm the local input level.

c) LPF constant (when the CXA3176N is used for the pager)

The data filter cut-off may need to be changed depending on the characteristics of the connected decoder. Adjust the capacitance values of Pins 9 to 12 while checking the incoming sensitivity including the decoder. If the capacitance values are too large, the detector output waveform will deviate at high data rates, causing the sensitivity to drop. Conversely, if the capacitance values are too small, the LPF will be easily affected by noise, causing the sensitivity to drop.

Adjust capacitance values of Pins 9 to 12 so that the capacitance value described in "12) LPF Constant" becomes smaller.

d) AFC

The CXA3176N uses the AFC to correct the IF frequency deviation. WHen the IF frequency deviation amount is large, correction takes time and may lower the sensitivity. Adjust the oscillator frequency of the local oscillator so that the center frequency of the signal input to Pin 5 (IF IN) is as close to 450 kHz as possible.

15) CXA3176N Standard Board Description

- Outline

  This board contains the external parts shown in the Application Circuit in order to evaluate the CXA3176N operation

- Features

  The following CXA3176N basic operations can be checked.

  1) Battery saving and other mode switching
  2) AFC pin
  3) The RSSI pin output is the low impedance because it is output via the buffer.

- Method of use

  1) Input the CXA3176N supply voltage $V_{CC}1=1.4$ V and $V_{CC}2=3$ V.
     This IC operates with a single power supply.
  2) The CXA3176N uses a 21.245 MHz crystal. Input the RF signal from the RF pin and use this IC in the condition where IF=450 kHz.
  3) The AFC pin voltage is undefined with the IC itself because the current output circuit is employed for the AFC. For the evaluation, be sure to apply the bias externally to the AFC pin or to make the AFC loop.
  4) Set the mode switches.

- Mode switch setting

  Mode switches S1 and S2 are provided in two locations in the board. Each basic operation can be confirmed by switching these mode switches while referring to the board layout. See the table in “11) Control Pins” for the mode switching.

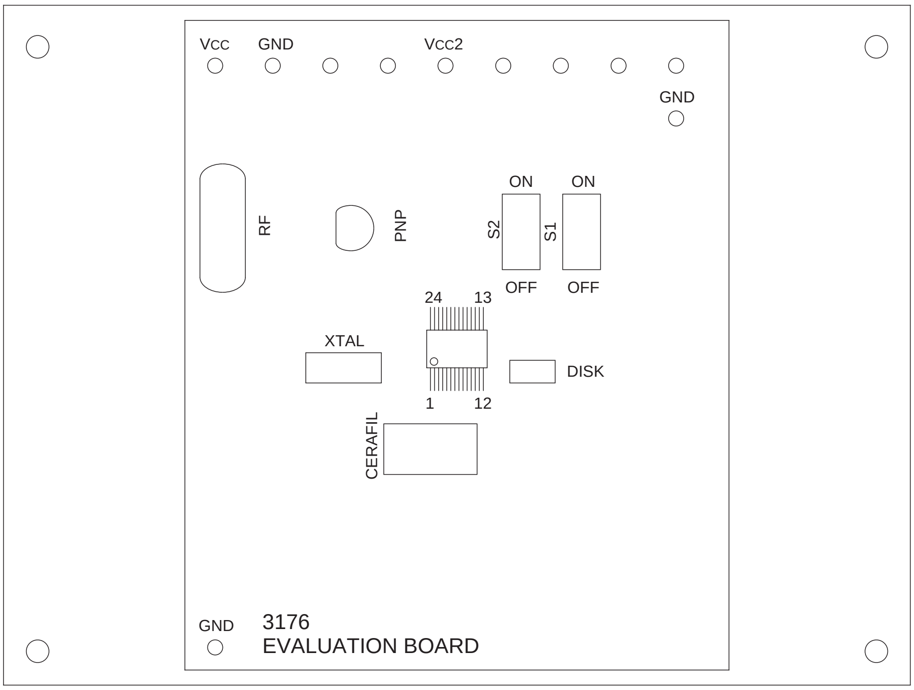
- Device specification

  See these specifications for the IC specifications. The ICs for this evaluation board are ES specification.

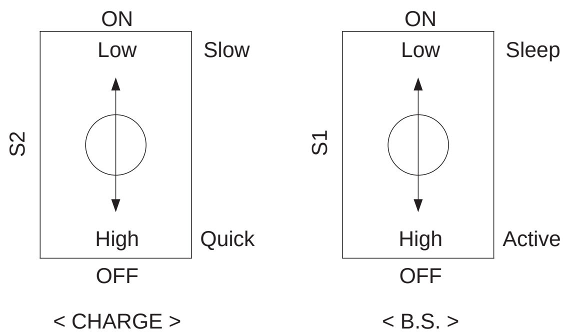
- Circuit diagram

  The circuit diagram is the same as the Application Circuit in these Specifications.

15) -1. [Board Layout]



15) -2. [Mode Switch Pattern]



15) -3. List of Standard Board Parts

Value	Part #	Remarks (Manufacture)	Note

Resistor

5.6 k	R5	(RIVER)	E12 series 1/8W
100 k	R4		

Capacitor

6.8 P to 45 P	C2	TZ03P450FR169 (MURATA PRODUCTS)	TRIMMER CAPACITOR
15 P	C5	DD100 series temperature characteristics type B (MURATA PRODUCTS)	CERAMIC CAPACITOR E12 series (high dielectric constant type)
22 P	C4		
100 P	C15		
470 P	C12 C13 C14		
1000 P	C3		
0.01 µ	C8 C10	RPE131F103Z50 (MURATA PRODUCTS)	MONOLITHIC CERAMIC CAPACITOR RPE series
1 µ	C11	25 V 1 µ (SHIN-EI TUSHIN KOGYO CO., LTD.)	ELECTROLYTIC CAPACITOR E6 series
10 µ	C6 C7 C9	25 V 10 µ (SHIN-EI TUSHIN KOGYO CO., LTD.)	

Inductor

1.8 µH	L1	EL0405 (TDK Products)	E12 series 2.5 mm pitch (Lead Pitch)

Active Component

	PNP	2SA1015 (TOSHIBA CORPORATION)	Vceo	Ic	Pc	Hfe	fc
			–50 V	–150 m	400 m	70 to 400	80 M

Crystal

21.245 MHz	XTAL	NR-18BN (NIHON DEMPA KOGYO CO., LTD.)	

Ceramic Filter

	CERAFIL	CFWS450D (MURATA PRODUCTS)	450 kHz 1.5 kΩ

Ceramic Discriminator

	DISC	CDBC450~~CX150~~ (MURATA PRODUCTS)	450 kHz

Switch

	S1 S2	ATE1D-2M3-10 (FUJISOKU CORPORATION)	ON-ON (1 poles) AC/DC 48 V 50 mA Max. AC/DC 20 mA 1 µA Min.

Connector

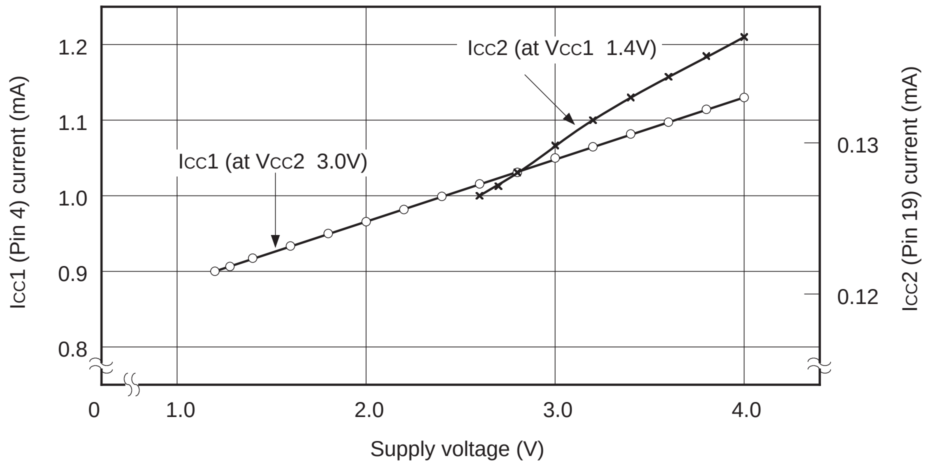
	RF	HRM300-25 (HIROSE ELECTRIC CO., LTD.)	SMA CONNECTOR

Pin

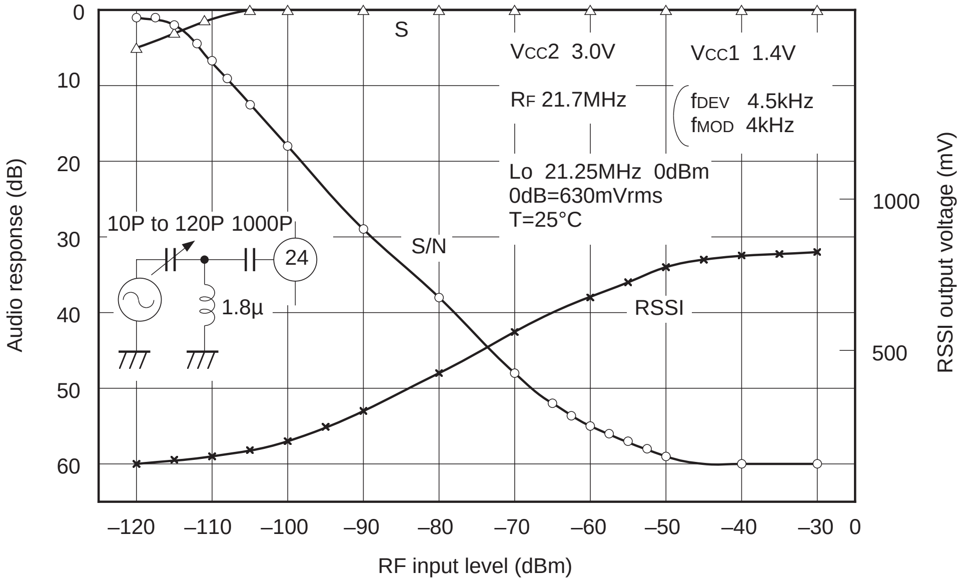
	× 5	Mac 8 test pin ST-1-3 (Mac eight)	L=10 mm 0.8 ϕ
	× 6	Mac 8 test pin LC-2-G (Mac eight)	

Example of Representative Characteristics

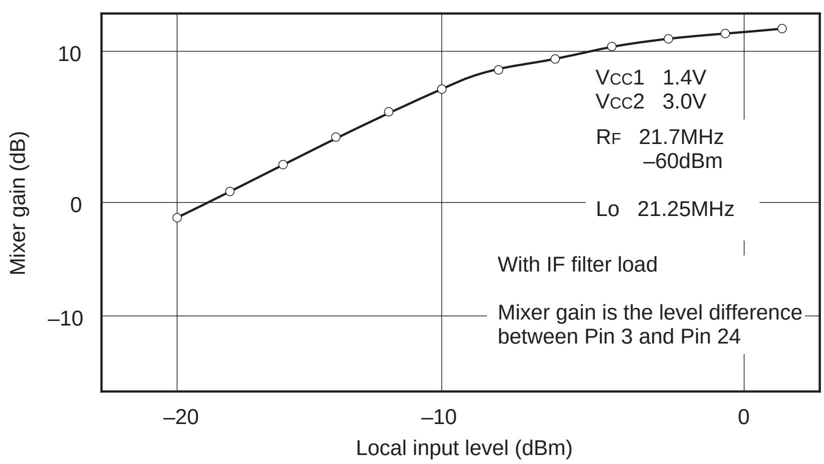
Current consumption characteristics



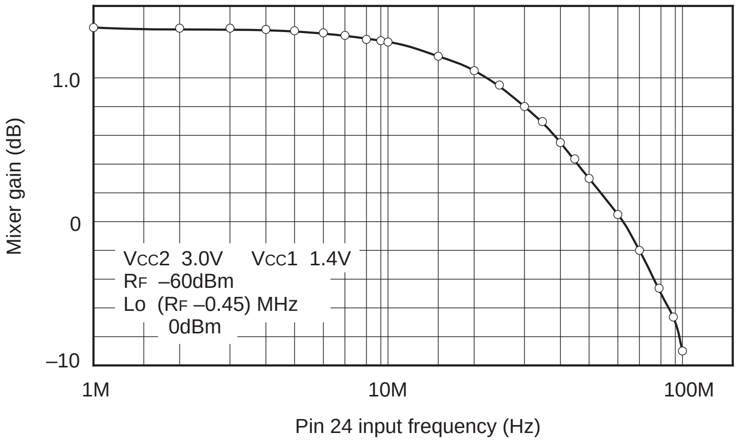
Mixer input audio response and RSSI characteristics



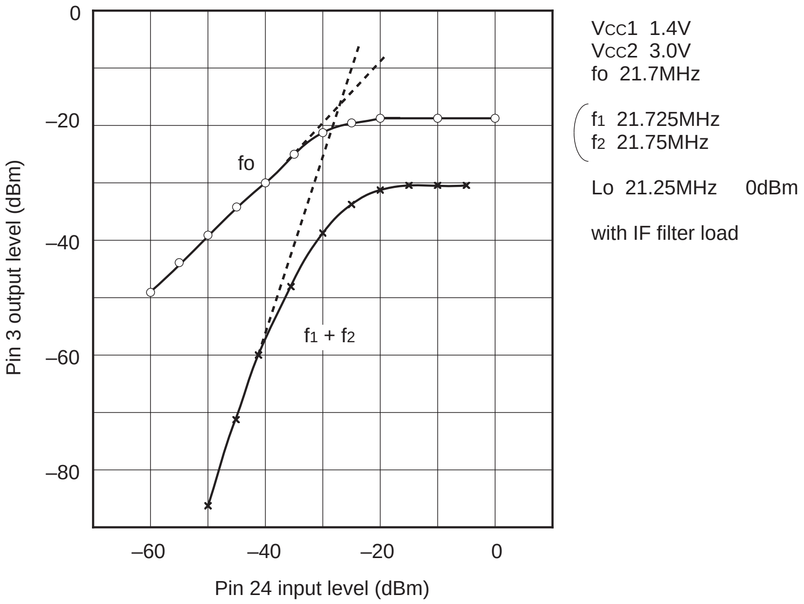
Local input level vs. Mixer gain characteristics



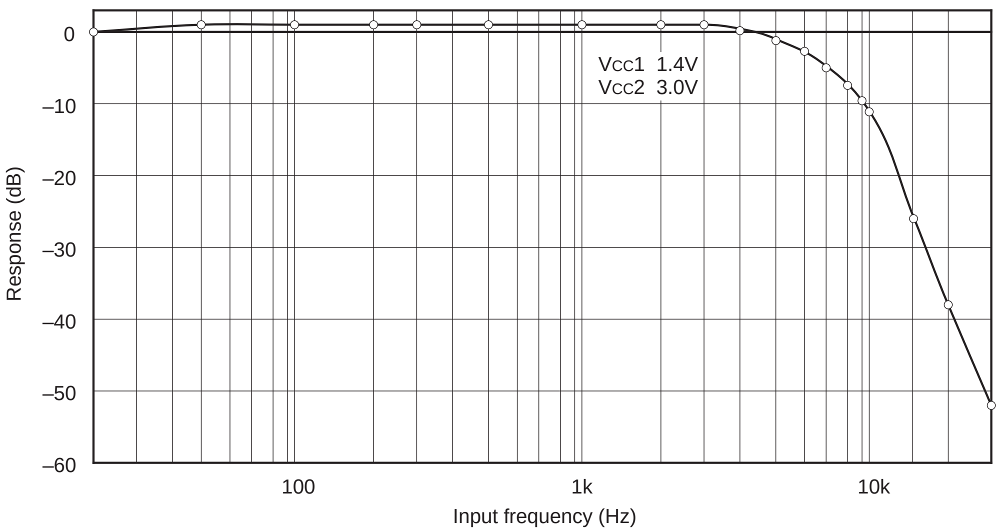
Mixer input frequency vs. Gain characteristics



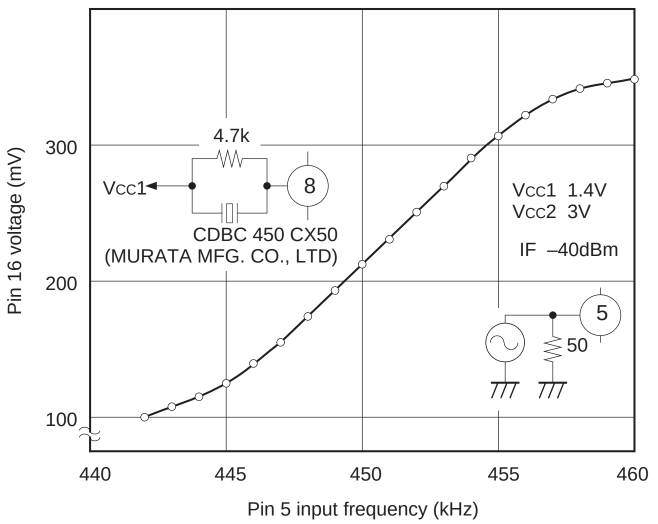
Mixer I/O characteristics and 3rd-order intercept point



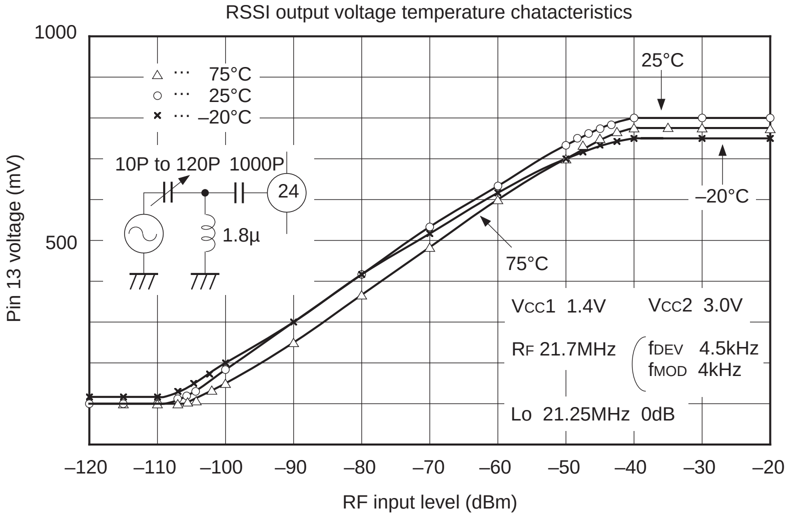
Cut-off characteristics of audio filter



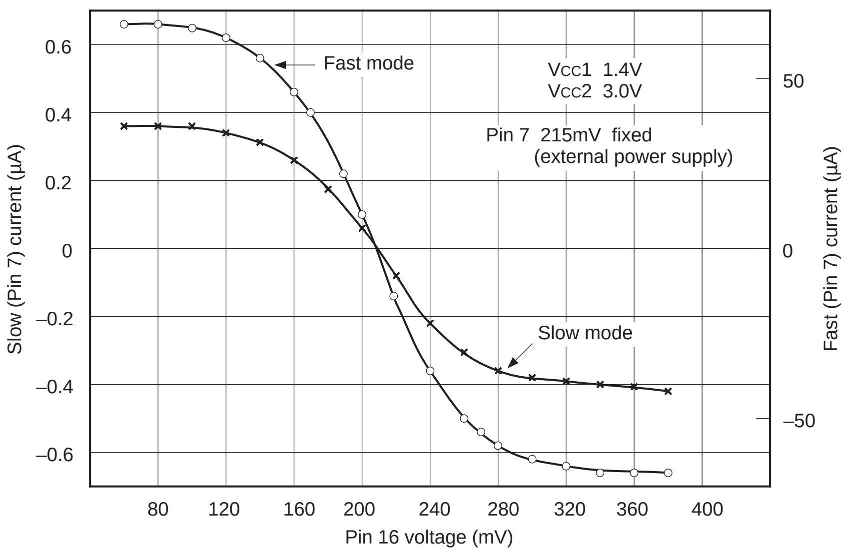
S curve characteristics



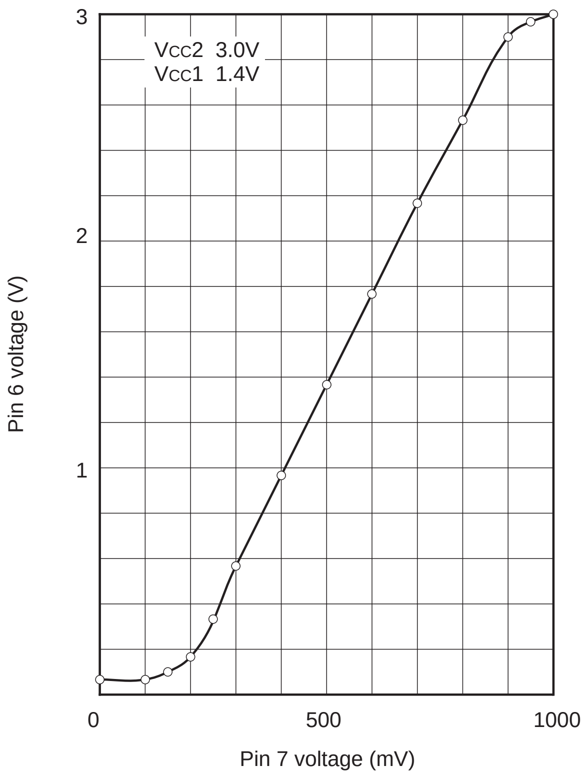
RSSI output voltage temperature chatacteristics



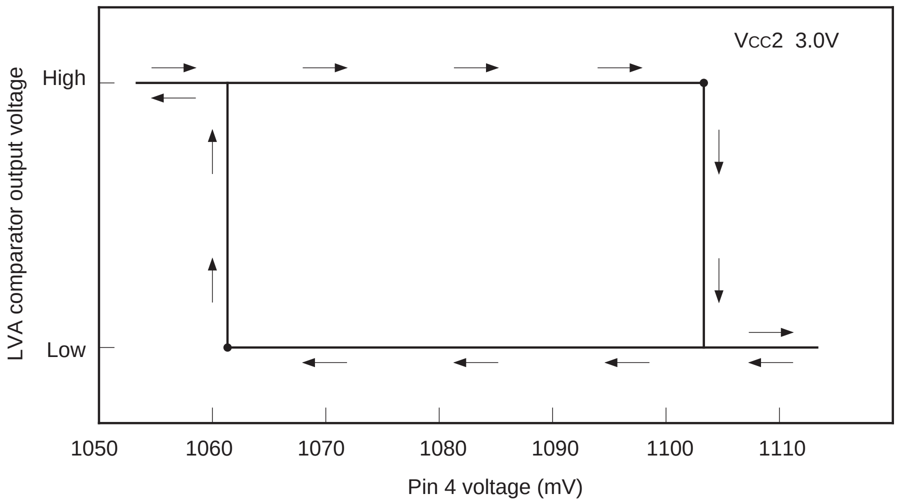
AFC output current characteristics



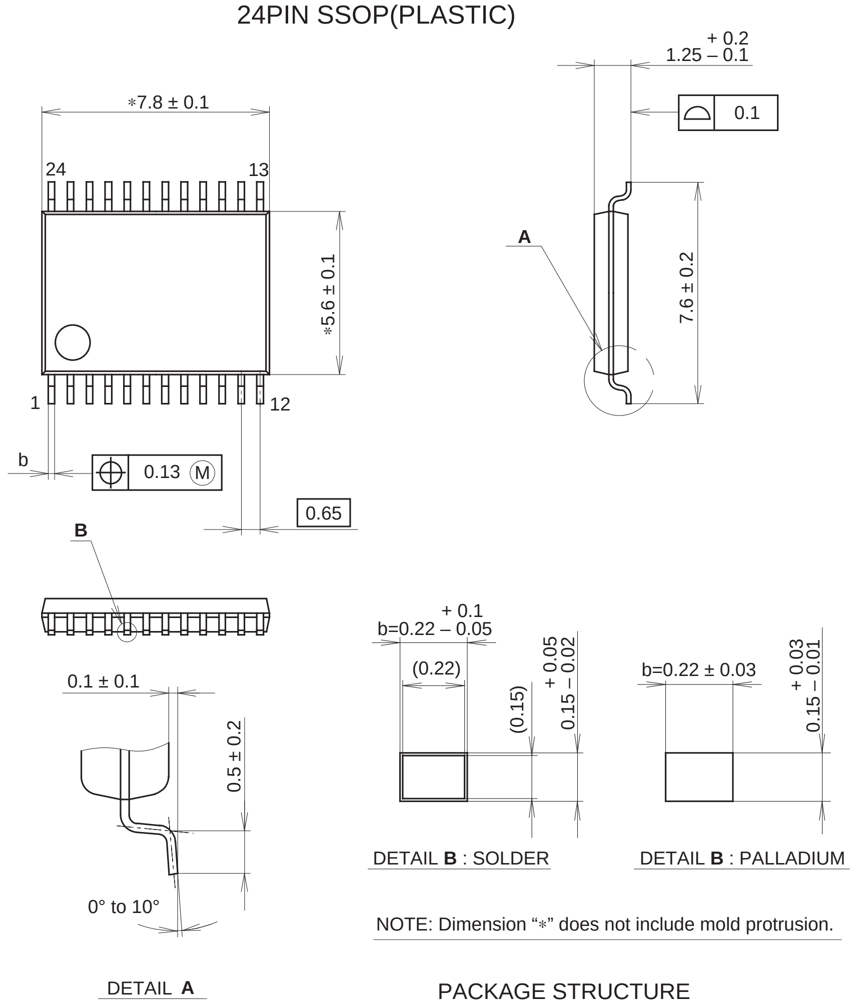
AFC amplifier characteristics



LVA characteristics



Package Outline Unit : mm



SONY CODE	SSOP-24P-L01
EIAJ CODE	SSOP024-P-0056
JEDEC CODE	————

PACKAGE STRUCTURE

PACKAGE MATERIAL	EPOXY RESIN
LEAD TREATMENT	SOLDER/PALLADIUM PLATING
LEAD MATERIAL	42/COPPER ALLOY
PACKAGE MASS	0.1g

NOTE : PALLADIUM PLATING
This product uses S-PdPPF (Sony Spec.-Palladium Pre-Plated Lead Frame).