

## Noise Reduction

## Description

The CX20099/CX20148 is a bipolar IC designed for the 8 mm VTR PCM audio noise reduction system.

Application in the PCM audio recording and playback system makes it possible to obtain about a 100 dB dynamic range.

## Features

- 5V single power supply operation
- Low power consumption (70 mW typical in operation)
- Logarithmic compress/expand compandor is provided. (Compress/Expand ratio: 2)
- REC/PB electronic switching (Compatible with TTL)
- Noise modulation reduction with the fixed preemphasis
- Improvement in low band distortion with the holding recovery characteristics
- Built-in two channels

## Structure

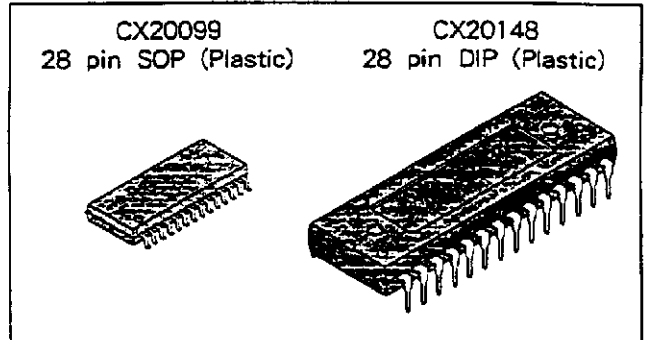
Bipolar silicon monolithic IC

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

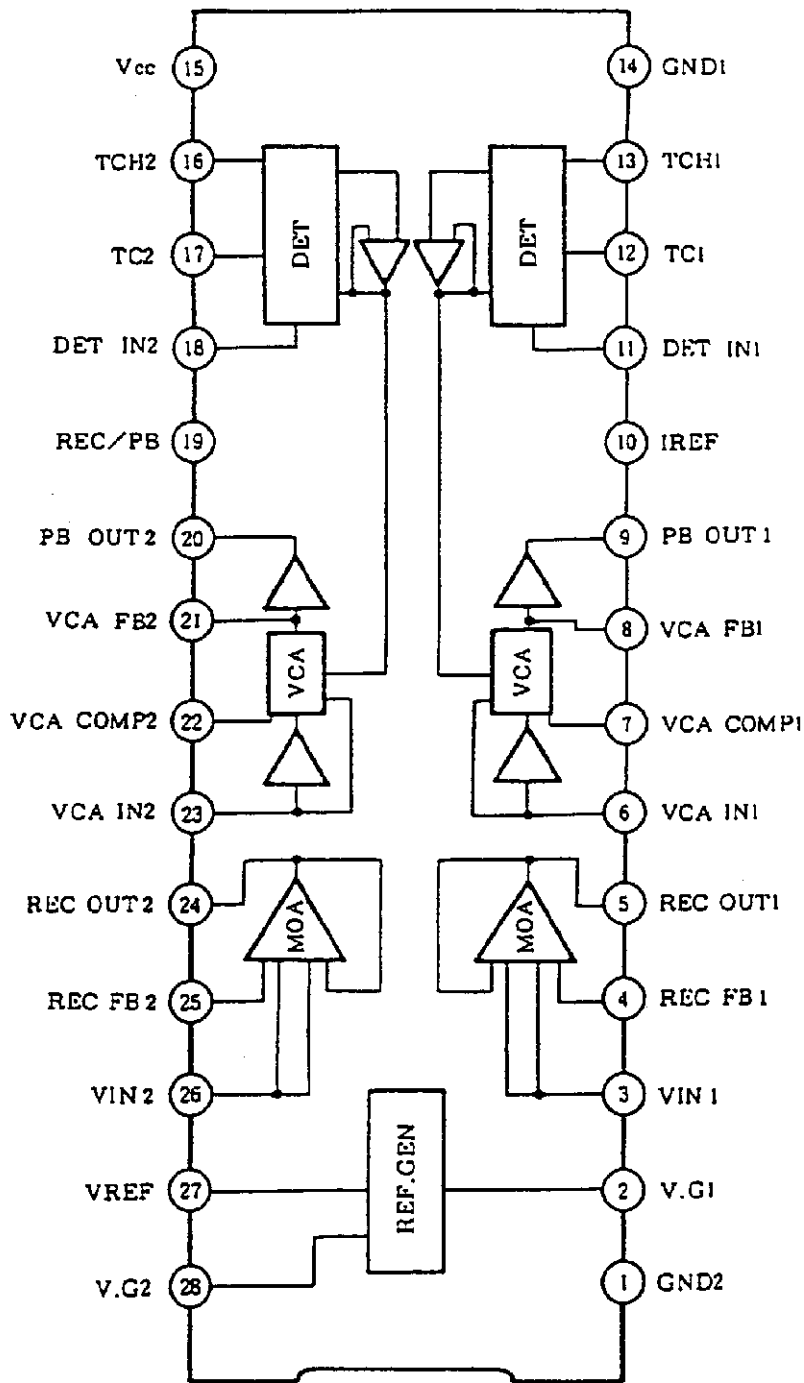
• Power supply voltage	V <sub>CC</sub>	10	V
• Operating temperature	T <sub>opr</sub>	-20 to +75	°C
• Storage temperature	T <sub>stg</sub>	-55 to +150	°C
• Allowable power dissipation	P <sub>D</sub>	CX20099 800 mW CX20148 1170 mW	

## Recommended Operating Condition

V <sub>CC</sub>	4.2 to 6.0	V (5.0V typical)
-----------------	------------	------------------



Block Diagram



## Pin Description

DC voltage ( $T_a = 25^\circ\text{C}$ ,  $V_{CC} = 5.0\text{V}$ , See Fig. 1.)

No.	Name	Function	DC voltage (V) (Typical)	Remark
1	GND2	Circuit GND for $V_{REF}$ -V.G (median point)	0.0	
2	V.G1	V.G signal reference for 1 ch	2.50	Maximum current $\approx \pm 200\mu\text{A}$ Output impedance $\approx 260\Omega$ typical
3	VIN1	REC/PB common input terminal for 1 ch	2.50	Bias current $\approx 150\text{nA}$
4	RECFB1	MOA inverter phase input terminal In REC, PB output for 1 ch is feedback	2.50	Bias current $\approx 150\text{nA}$
5	RECOUT1	REC output for 1 ch	2.50	Maximum output $\approx 2.8\text{V}_{\text{p-p}}$ ( $R_L = 7\text{k}\Omega$ ) (2.1dBm)
6	VCAIN1	VCA input terminal for 1 ch to input current with the same voltage as V.G.	2.50	Bias current $\approx 100\text{nA}$ Max. current $\approx 1.7\text{mA}_{\text{p-p}}$ ( $i_{\text{in}} + i_{\text{out}}$ ) (at $V_{CC} = 5.0\text{V}$ )
7	VCACOMP1	1 ch VCA phase compensation terminal	2.46	
8	VCAFB1	1 ch VCA output amp inverted phase input terminal to convert I to V	2.50	Bias current $\approx 150\text{nA}$
9	PBOUT1	1 ch PB output terminal	2.50	Max. output $\approx 3.0\text{V}_{\text{p-p}}$ ( $R_L = 5\text{k}\Omega$ ) (3.7dBm)
10	IREF	Reference current input terminal for both ch detectors	0.91	
11	DETIN1	1 ch detector input terminal to input current	1.36	
12	TC1	For smoothing the 1 ch detector full-wave rectified waveform. It also determines the attack and recovery time constants.	2.15	
13	TCH1	It determines the 1 ch detector hold time constant.	2.74	
14	GND1	Signal and control GND for both channels	0.0	
15	Vcc	Power supply terminal for both channels	5.0	
16	TCH2	It determines the 2 ch detector hold time constant.	2.74	
17	TC2	For smoothing the 2 ch detector full-wave rectified waveform. It also determines the attack and recovery time constants.	2.15	
18	DETIN2	2 ch detector input terminal to input current	1.36	

No.	Name	Function	DC voltage (V) (Typical)	Remark
19	REC/PB	REC/PB mode switching terminal	0.50	In REC, $0 \leq V_L \leq 0.5V$ $I_L \approx 50\mu A$ max. In PB, $2.5V \leq V_H \leq V_{CC}$ $I_H \approx 0$
20	PBOUT2	2ch PB output terminal	2.50	Max. output $\approx 3.0V_{p-p}$ ( $R_L = 5K\Omega$ ) (3.7dBm)
21	VCAFB2	2nd VCA output amp inverted phase input terminal to convert I to V.	2.50	Bias current $\approx 150nA$
22	VCACOMP2	2nd ch VCA phase compensation terminal	2.46	
23	VCAIN2	2ch VCA input terminal with the same voltage as V.G. to input current.	2.50	Bias current $\approx 100nA$ . Max. current $\approx 1.7mA_{p-p}$ (lin + lout) (at $V_{CC} = 5.0V$ )
24	RECOUT2	2ch REC output terminal	2.50	Max. output $\approx 2.8V_{p-p}$ ( $R_L = 7K\Omega$ ) (2.1dBm)
25	RECFB2	MOA inverter phase input terminal in REC, PB output for 1 ch is feedback	2.50	Bias current $\approx 150nA$
26	VIN2	REC/PB common input terminal for 2ch	2.50	Bias current $\approx 150nA$
27	VREF	Reference voltage for VCA gain	1.95	Max. current $\approx 4mA$ typical Output impedance $\approx 10\Omega$ typical
28	V.G2	V.G signal reference for 2 ch	2.50	Max. current $\approx \pm 200\mu A$ Output impedance $\approx 260\Omega$ typical

Electrical Characteristics

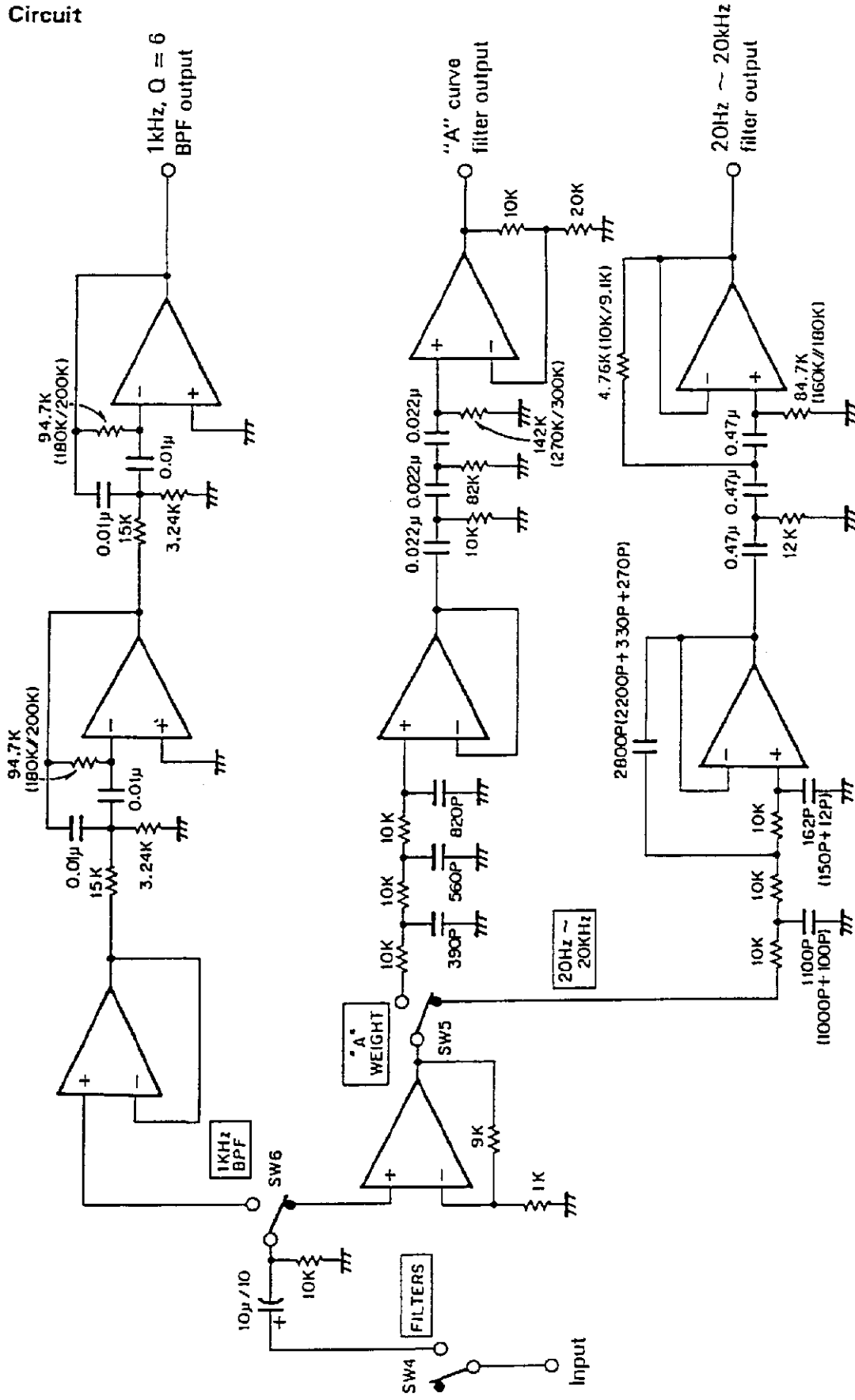
See the filter circuit of Electrical Characteristics Measuring Circuit  
(Ta = 25°C, Vcc = 5V)

Measuring No.	Item	Symbol	SW - condition						Input condition		Measuring point	Description of output waveform and measuring method	Standard			
			SW1	SW2	SW3	SW4	SW5	SW6	f VIN (kHz)	VIN (dBm)			Min.	Typ.	Max.	Unit
1	Circuit current	Icc	OFF	OFF	OFF	OFF	OFF	OFF	OFF	No signal	Vcc		10.0	14.0	18.0	mA
2	Decoder offset voltage (1)	V <sub>off</sub> (1)	ON	1ch						No signal	P/B OFFSET 1	Measure DC centering on 2.5 V	-330	0	330	mV
3	Decoder offset voltage (2)	V <sub>off</sub> (2)		2ch						No signal	P/B OFFSET 2		-330	0	330	mV
4	Reference level (1)	E - F - R(1)	OFF	OFF					0.4	-10	REC OUT 1		-11.5	-10.0	-8.5	dBm
5	Reference level (2)	E - F - R(2)									REC OUT 2		-11.5	-10.0	-8.5	dBm
6	Frequency response 1-(1)	E - F - 1(1)							0.4	-50	REC OUT 1		-21.5	-20.0	-18.5	dB
7	Frequency response 1-(2)	E - F - 1(2)									REC OUT 2		-21.5	-20.0	-18.5	dB
8	Frequency response 2-(1)	E - F - 2(1)							7.0	-50	REC OUT 1		-17.4	-15.9	-14.4	dB
9	Frequency response 2-(2)	E - F - 2(2)									REC OUT 2		-17.4	-15.9	-14.4	dB
10	Frequency response 3-(1)	E - F - 3(1)							0.4	-30	REC OUT 1	Measure the difference with the reference level.	-11.5	-10.0	-8.5	dB
11	Frequency response 3-(2)	E - F - 3(2)									REC OUT 2		-11.5	-10.0	-8.5	dB
12	Frequency response 4-(1)	E - F - 4(1)							7.0	-30	REC OUT 1		-7.4	-5.9	-4.4	dB
13	Frequency response 4-(2)	E - F - 4(2)									REC OUT 2		-7.4	-5.9	-4.4	dB
14	Frequency response 5-(1)	E - F - 5(1)							14.0	-30	REC OUT 1		-6.2	-4.7	-3.2	dB
15	Frequency response 5-(2)	E - F - 5(2)									REC OUT 2		-6.2	-4.7	-3.2	dB

Measuring No.	Item	Symbol	SW - condition						Input condition		Measuring point	Description of output waveform and measuring method	Standard				
			SW1	SW2	SW3	SW4	SW5	SW6	f/VIN (KHz)	VIN (dBm)			Min.	Typ.	Max.	Unit	
16	Frequency response 6-(1)	E - F - 6 (1)	OFF	OFF	OFF	OFF	OFF	OFF	OFF	7.0	-10	REC OUT 1	Measure the difference with the reference level.	2.6	4.1	5.6	dB
17	Frequency response 6-(2)	E - F - 6 (2)										REC OUT 2		2.6	4.1	5.6	dB
18	REC output distortion factor (1)	T H D - R (1)								0.4	-10	REC OUT 1	Measure the distortion factor.	-	0.13	0.40	%
19	REC output distortion factor (2)	T H D - R (2)										REC OUT 2		-	0.13	0.40	%
20	Signal handling (1)	S - H (1)	ON							1.0	-3.0	PB OUT 1	Measure the distortion factor.	-	0.2	1.1	%
21	Signal handling (2)	S - H (2)										PB OUT 2		-	0.2	1.1	%
22	REC output SN ratio (F)(1)	S N - R - F(1)	OFF			ON				No signal		Filter OUT	20 Hz to 20 kHz Use filter (20 dB) Rg = 600 Ω	-	-40.0	-34.0	dBm
23	REC output SN ratio (F)(2)	S N - R - F(2)			ON					No signal		Filter OUT		-	-40.0	-34.0	dBm
24	REC output SN ratio (A)(1)	S N - R - A(1)			OFF		ON			No signal		Filter OUT	"A" curve Use filter (20 dB) Rg = 600 Ω	-	-40.0	-34.0	dBm
25	REC output SN ratio (A)(2)	S N - R - A(2)			ON					No signal		Filter OUT		-	-40.0	-34.0	dBm
26	Crosstalk 1→2 (REC)	C T (1-2)					OFF	ON		1.0	-10	Filter OUT	Use 1 kHz (20 dB) BPF	-	-45.0	-39.0	dBm
27	Crosstalk 2→1 (REC)	C T (2-1)			OFF							Filter OUT	Vw2 input	-	-45.0	-39.0	dBm
28	Reference voltage	V <sub>REF</sub>				OFF				No signal		V <sub>REF</sub>		1.80	1.95	2.10	V
29	Median voltage 1	V <sub>G1</sub>								No signal		V <sub>G1</sub>		2.2	2.5	2.8	V
30	Median voltage 2	V <sub>G2</sub>								No signal		V <sub>G2</sub>		2.2	2.5	2.8	V

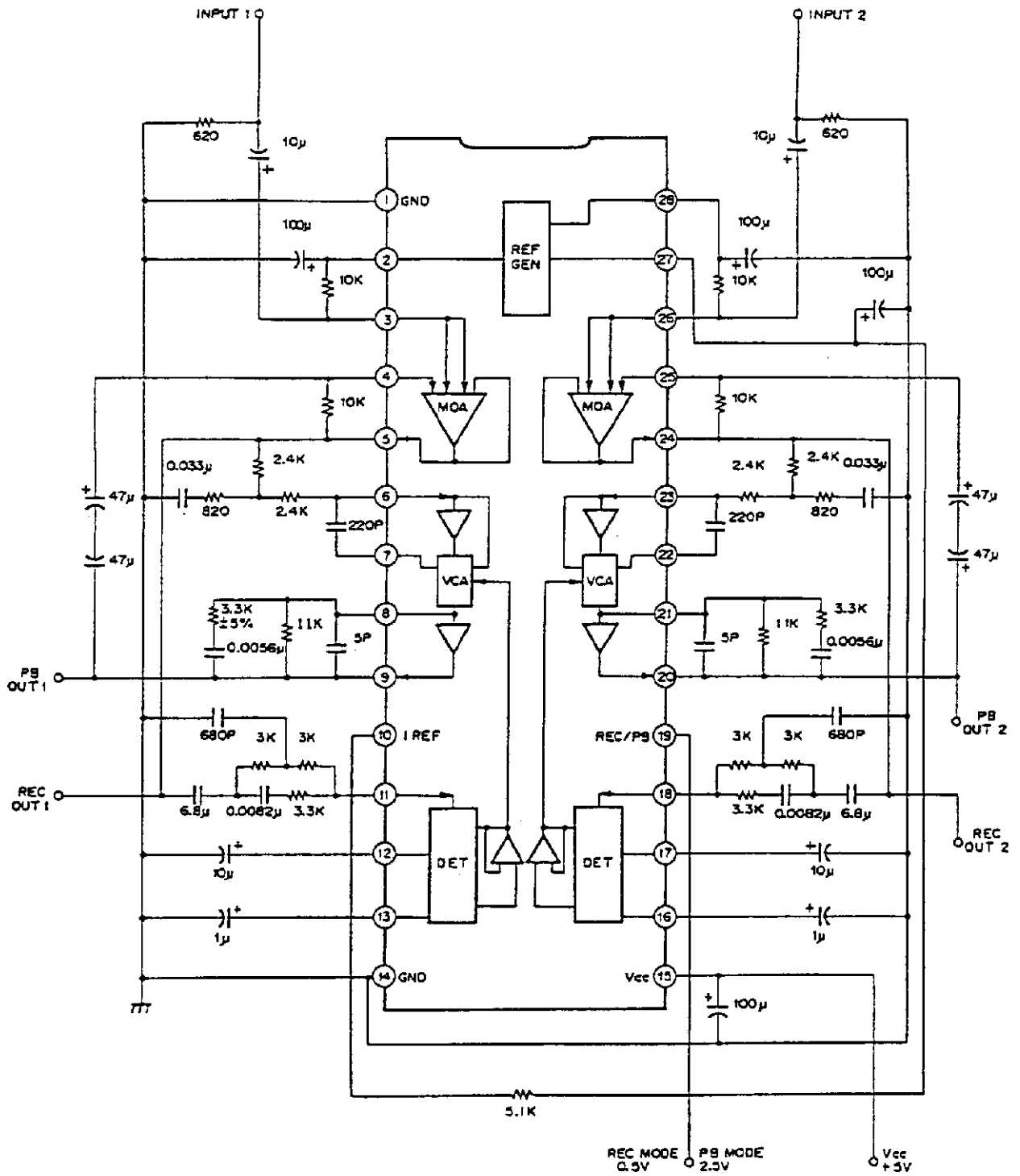


Filter Circuit





Example of Application Circuit



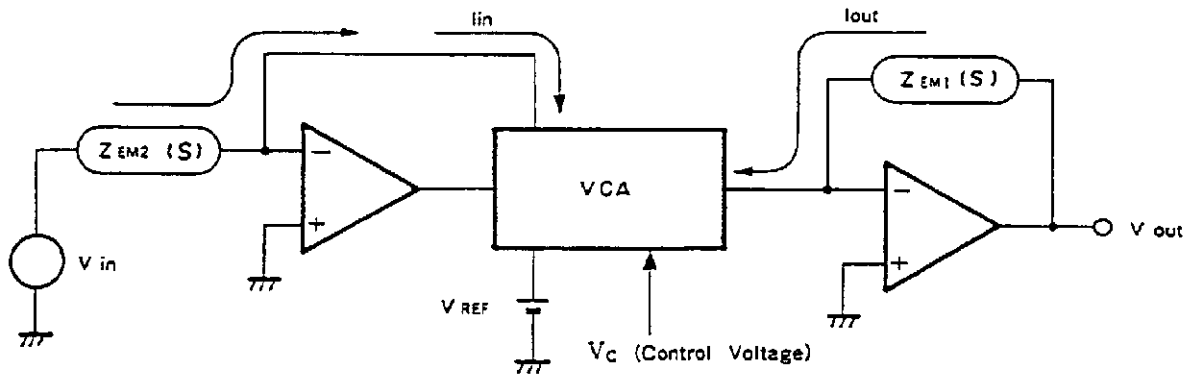
**Description of Functions**

**(1) MOA (Main Op Amp)**

With the internal switching, it operates as the voltage follower in PB and has the encoding characteristics in REC by inputting to the decoder circuit into the MOA feedback loop.

**(2) VCA (Voltage Controlled Amp)**

VCA is comprised of the current input and the power supply current divider. Before and after the VCA, the impedance elements (performing the emphasis as well) for the voltage — current and current — voltage conversions are connected.



The VCA control sensitivity is 0.33dB/mV and the VCA gain is determined based on the VREF reference. When  $(V_{REF} - V_c) = 30 \text{ mV}$ , the VCA gain becomes 10 dB; when the VCA gain is set as GVCA in the above diagram,

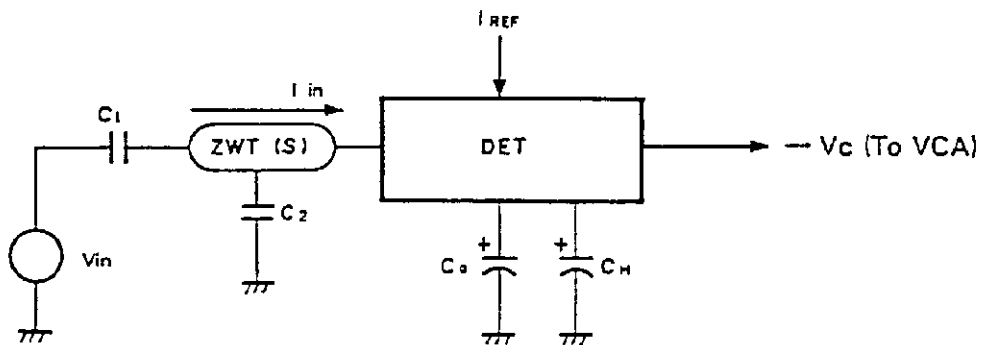
$$V_{OUT} = V_{in} \cdot GVCA \cdot Z_{EM1}(S)/Z_{EM2}(S).$$

In this VCA, the maximum I<sub>o</sub> value depends on the power supply voltage when  $I_o = I_{in} + I_{out}$ . That is, the maximum I<sub>o</sub> will be as follows:

- V<sub>cc</sub> = 5.0V — I<sub>o</sub> max. ≈ 1.7mA<sub>p-p</sub>.
- V<sub>cc</sub> = 4.2V — I<sub>o</sub> max. ≈ 1.4mA<sub>p-p</sub>.

**(3) DET (Detector)**

Current input is applied to the detector to cover a wide dynamic range with logarithm conversion.



The DC component in the detector input is eliminated by the capacitor (C1). Capacitor (C2) is also required to eliminate high frequency components as the ZWT(S) impedance is small.

In this case, the input current  $i_{in}$  will be,

$$i_{in} = V_{in}/Z_{WT(S)}.$$

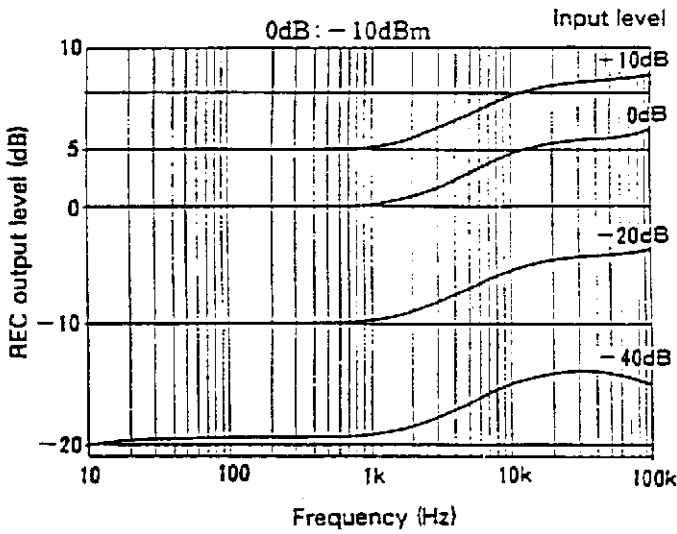
The VCA control voltage  $V_c$  will be a function of the ratio between  $i_{in}$  and  $I_{ref}$ . When  $I_{ref} = 100 \mu A$ ,  $i_{in}$  will be  $81.4 \mu A_{rms}$  and

$$V_c = V_{ref} \text{ (VCA gain = 0dB)}.$$

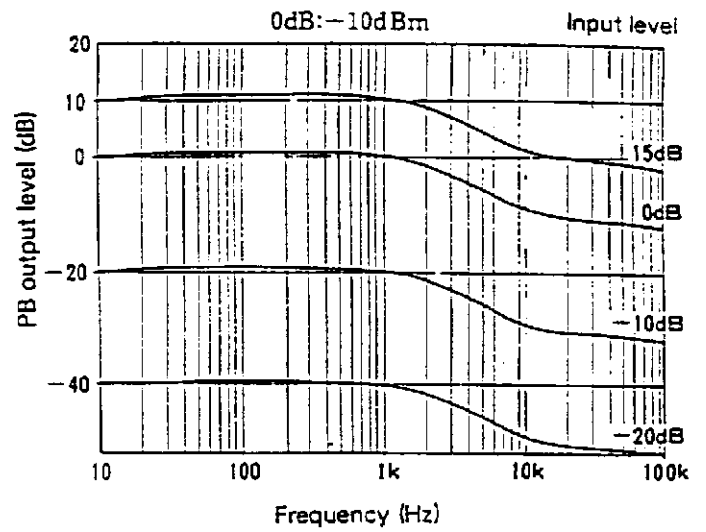
The recovery time constant is determined by  $C_o$ . As it is set to be comparatively short, the detector output ripple component will increase causing low band distortion due to modulation from mixing.

Therefore, the distortion factor is corrected using a short recovery time constant by holding the full-wave rectified waveform peaks with  $C_H$ .

Frequency Characteristics (Compression Mode)



Frequency Characteristics (Expansion Mode)



Output Level

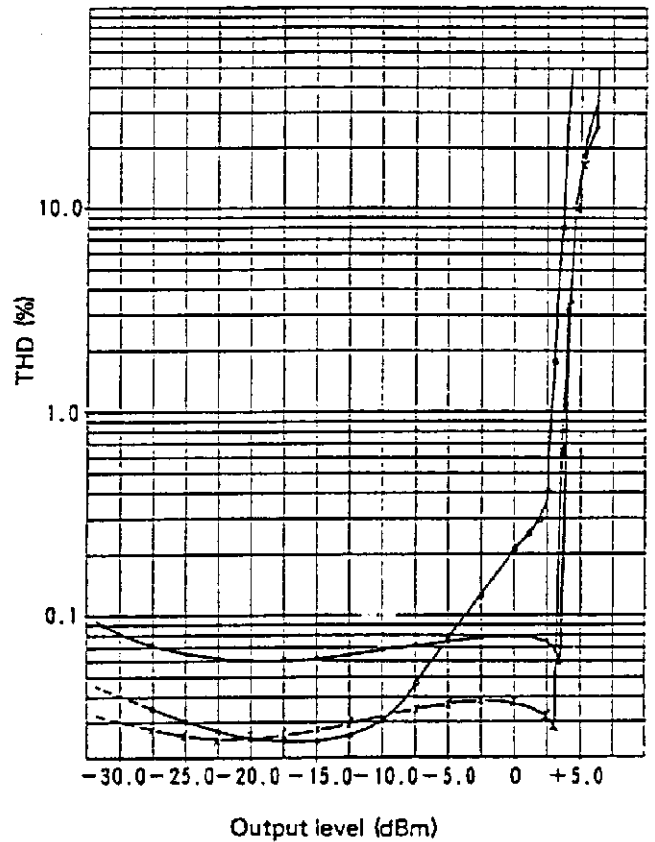
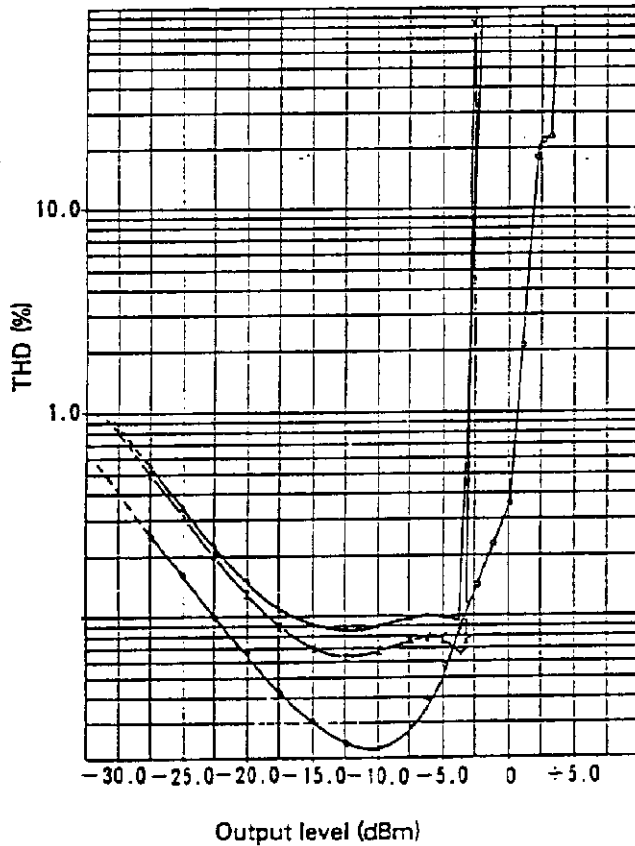
— THD Characteristics (Compression Mode)

- 400Hz(30kHz LPF)
- × 1kHz(400Hz HPF, 30kHz LPF)
- 10kHz(400Hz HPF, 30kHz LPF)

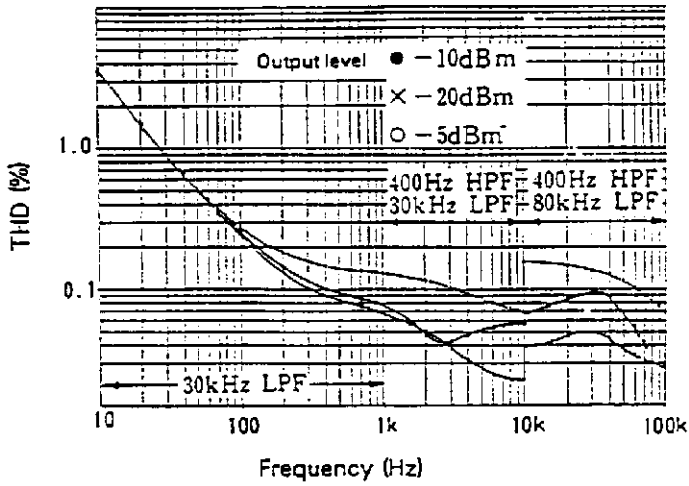
Output Level

— THD Characteristics (Expansion Mode)

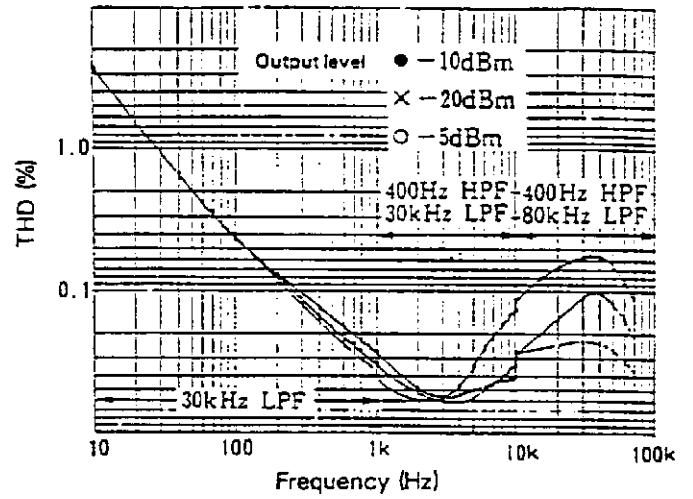
- 400Hz(30kHz LPF)
- × 1kHz(400Hz HPF, 30kHz LPF)
- 10kHz(400Hz HPF, 30kHz LPF)



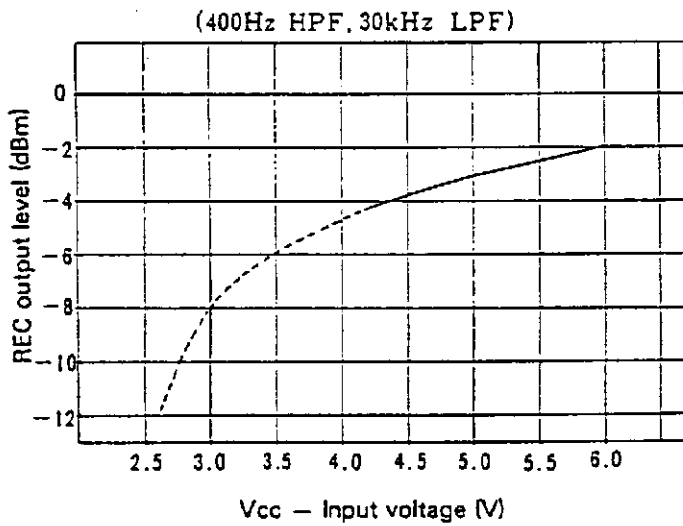
Frequency  
- THD Characteristics (Compression Mode)



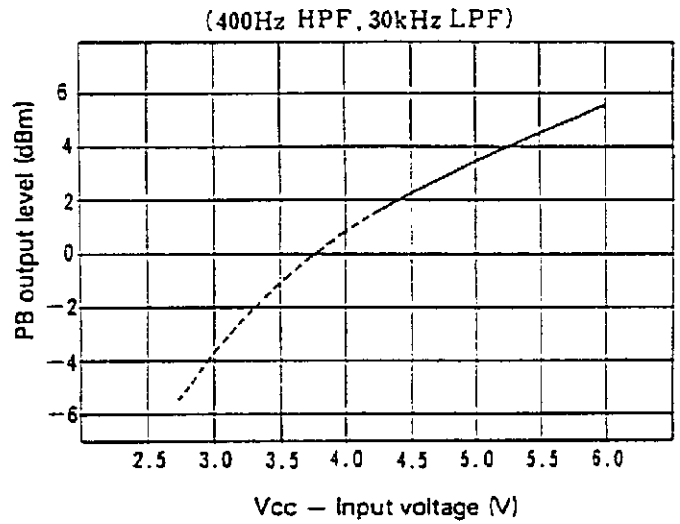
Frequency  
- THD Characteristics (Expansion Mode)



Signal Handling (Compression Mode)  
f = 1 kHz, 1% distortion

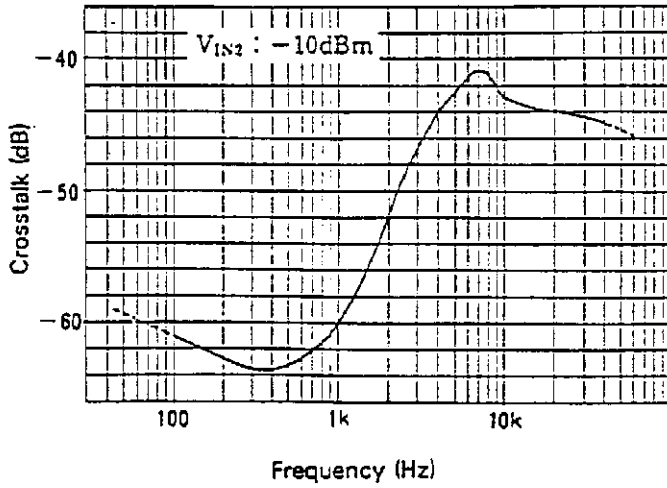


Signal Handling (Expansion Mode)  
f = 1 kHz, 1% distortion



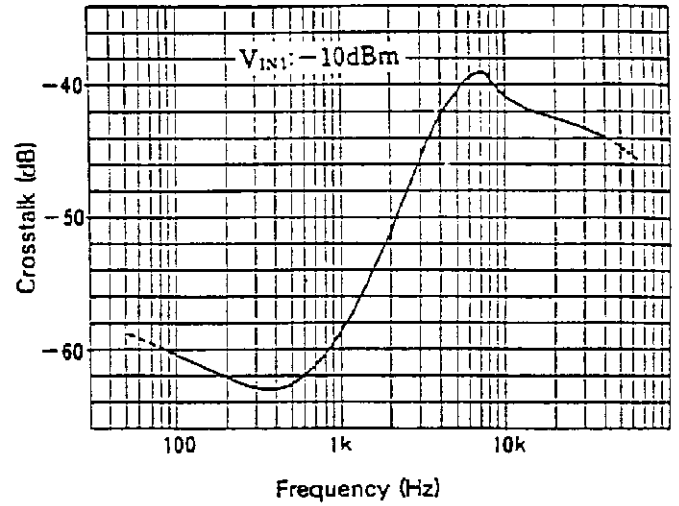
**Crosstalk (between Channels)**

2ch — 1ch (compression mode)  
 Crosstalk — Difference between input and REC output.



**Crosstalk (between Channels)**

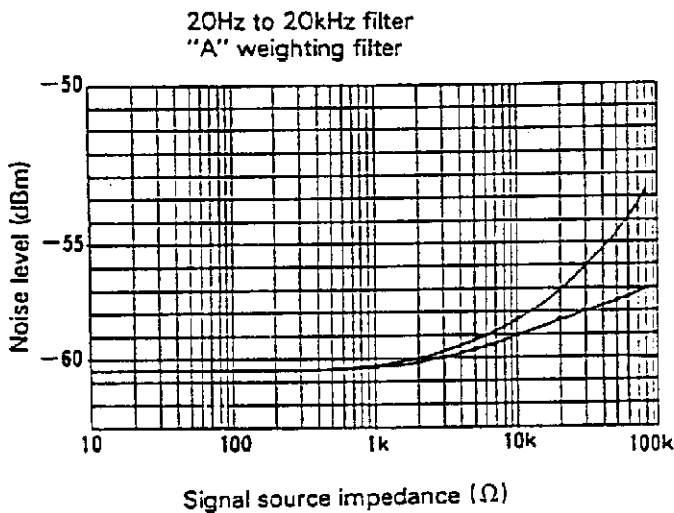
1ch — 2ch (compression mode)  
 Crosstalk — Difference between input and REC output.



**Signal Source Impedance**

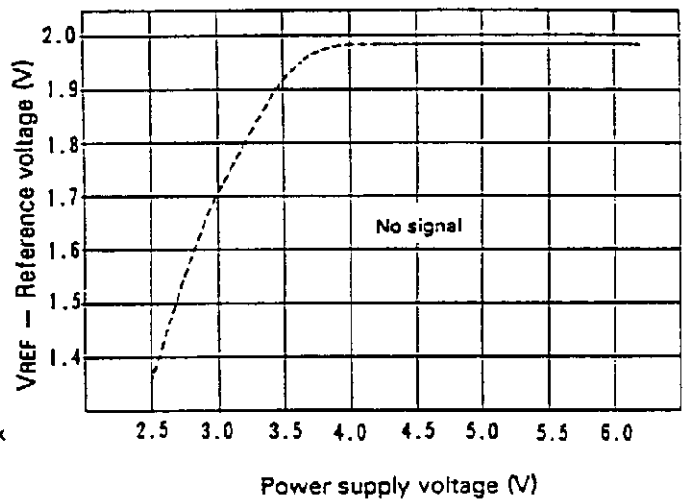
— Noise Level (S/N) Characteristics

Compression mode    No signal

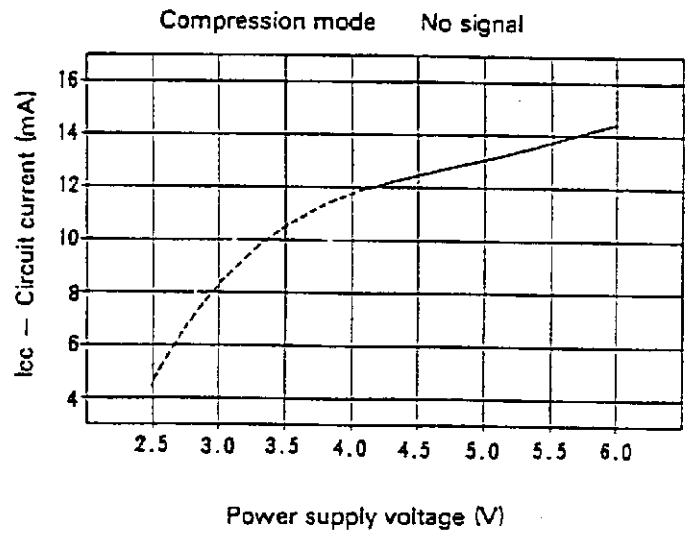


**Reference Voltage**

— Power Supply Voltage Characteristics

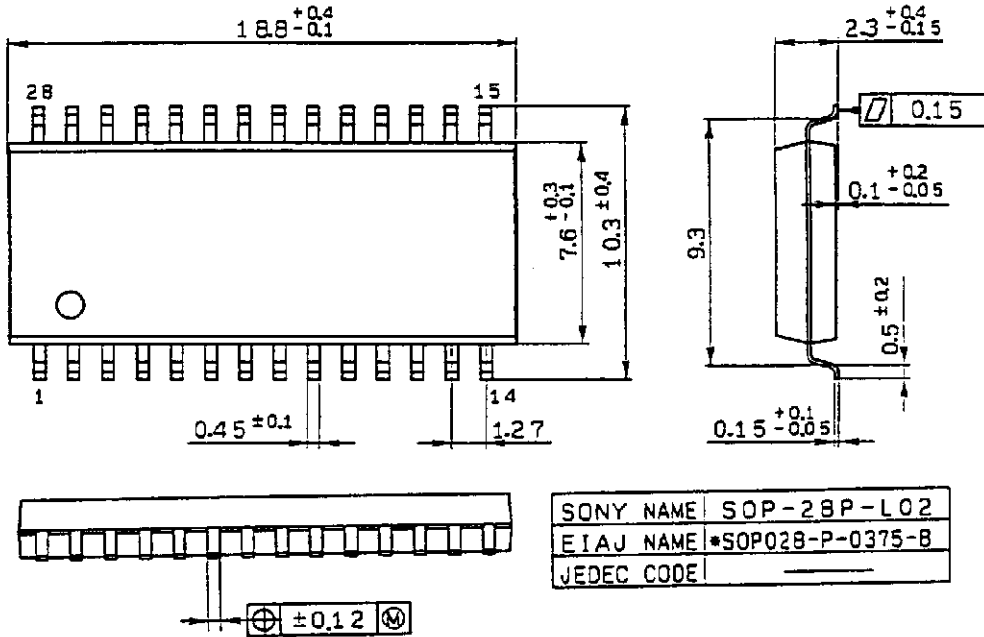


Circuit Current  
— Power Supply Voltage Characteristics



Package Outline Unit : mm

CX20099 28 pin SOP (Plastic)



CX20148 28 pin DIP (Plastic)

