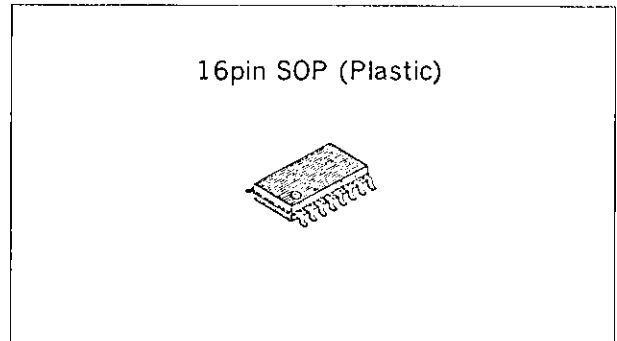


HDD Equalizer (Pulse Slimming) IC

Description

The CXA1445M is an IC for HDD read data equalizers (cosine equalization).

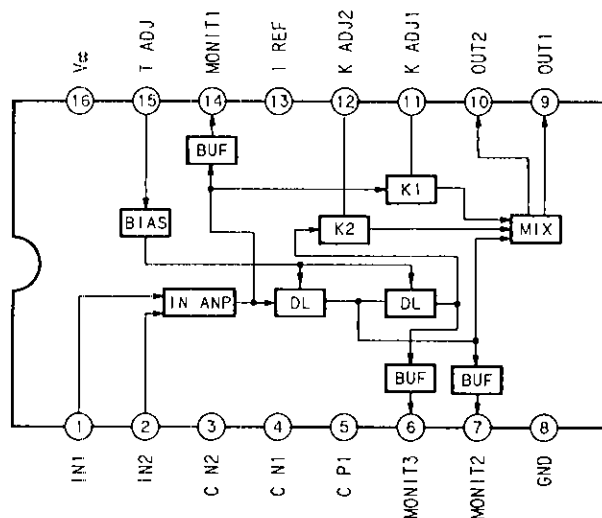
The delay circuit realized through the adoption of an active filter circuit dispenses from the expensive delay line so far in use. Delay time may be changed at will by altering the resistance value.



Features

- The delay circuit obtained through an active filter circuit dispenses from external delay lines. Delay time adjustment is possible by changing the external resistance value.
- Mix ratio adjustment of K1 and K2 is possible by changing the external resistance value.
- 5V single power supply

Block Diagram and Pin Configuration



**Absolute Maximum Ratings (Ta=25°C)**

- Supply voltage  $V_{CC}$  7 V
- Storage temperature  $T_{stg}$  -55 to +150 °C

**Operating Conditions**

- Supply voltage  $V_{CC}$  4.5 to 5.5 V
- Operating temperature  $T_{opr}$  -20 to +75 °C

**Pin Description**

No.	Symbol	Voltage	Equivalent circuit	Description
1	IN1	2.0V		Inputs data signals from read amplifier as differential signals through a capacitor. Internal impedance is approx. 16kΩ.
2	IN2			
3	CN2	1.7V		Connects capacitor (0.01μF) between this pin and GND to control noise in the circuit.
4	CN1			
5	CP1	3.5V		Connects capacitor (0.01μF) between this pin and V <sub>CC</sub> to control noise in the circuit.
6	MONIT3	2.4V		Monitor pin output through buffer after input signal passing two delay lines.
7	MONIT2	2.4V		Monitor pin output through buffer after input signal passing the first delay line.

No.	Symbol	Voltage	Equivalent circuit	Description
8	GND	0V		GND pin for all circuits
9	OUT1	3.8V		Signal output pin. Equalized signal is output to pulse detector.
10	OUT2			
11	K ADJ1	1.2V		A resistor is connected to set $K_1$ . $K_1$ = approx. 0.25 at 12k $\Omega$ (Typ.) Varying the resistance value from $\infty$ to 4k $\Omega$ varies $K_1$ from 0 to 0.3.
12	K ADJ2	1.2V		A resistor is connected to set $K_2$ . $K_2$ = approx. 0.25 at 12k $\Omega$ (Typ.) Varying the resistance value from $\infty$ to 4k $\Omega$ varies $K_2$ from 0 to 0.3.
13	I REF	1.2V		12k $\Omega$ resistor is connected to obtain internal reference current
14	MONIT1	2.4V		Output monitor pin of IN AMP
15	T ADJ	4.0		A resistor is connected to set delay time. Set to 58ns at 10k $\Omega$ (Typ.). Varying from 5 to 25k $\Omega$ produces a change from 40 to 150ns.
16	V <sub>CC</sub>	5V		Connects 5V power supply.

**Electrical Characteristics**

S3 and S4 taken as "a" side unless specified especially.

(Ta=25°C, Vcc=5V)

Item	Symbol	Conditions	Test point	Min.	Typ.	Max.	Unit
Current consumption	I <sub>CC</sub>	S1=ON, S2=ON	1M1	8	11	14	mA
Mix ratio accuracy *	K <sub>1</sub>	f=200kHz V <sub>IN</sub> =100mVp-p S1=ON, S2=OFF	VM1	-10	0	+10	%
	K <sub>2</sub>	f=200kHz V <sub>IN</sub> =100mVp-p S1=OFF, S2=ON	VM1	-10	0	+10	%
Delay time accuracy *	T <sub>L</sub>	f=6MHz V <sub>IN</sub> =100mVp-p	VM1	-13	0	+13	%
	T <sub>H</sub>	f=10MHz V <sub>IN</sub> =100mVp-p	VM1	-22	0	+22	%
Frequency characteristics	FC	-3dB V <sub>IN</sub> =25mVp-p S1=OFF, S2=OFF	VM1	15			MHz
Gain	GAIN	f=200kHz S1=OFF, S2=OFF	VM1	7.5	9	10.5	dB
Maximum input voltage range	V <sub>INMAX</sub>	f=3MHz THD≤5% S1=OFF, S2=OFF	VM1	300			mVp-p
Output noise voltage	V <sub>NOISE</sub>	S1=OFF, S2=OFF S3=b, S4=b	VM2			630	μV <sub>rms</sub>

\* With the center value of mix ratio and delay time taken as K<sub>1,2</sub>=0.255 and T=58ns.

The testing methods of mix ratio and delay time can be defined as follows: Equalizer frequency characteristics taken as H (W). To find K<sub>1</sub>, suppose K<sub>2</sub>=0 (S2=OFF), then,

$$| H(W) |^2 = 1 + K_1^2 - 2K_1 \cos \omega \tau$$

Here K<sub>1</sub>=0 (S1=OFF), 200kHz gain is taken as G<sub>0</sub> (dB). When a certain K<sub>1</sub> is set, 200kHz gain is taken as G<sub>1</sub> (dB). K<sub>1</sub> is calculated through the following formula:

$$K_1 = 1 - 10^{\frac{G_1 - G_0}{20}}$$

K<sub>2</sub> is solved in a similar way by supposing K<sub>1</sub>=0 (S1=OFF)

Delay time T<sub>L</sub> is calculated through the following formula:

S1 and S2 are OFF (where K<sub>1</sub> and K<sub>2</sub> are set to 0), 200kHz and 6MHz gain are taken as G<sub>0</sub>, G<sub>2</sub> (dB). When a certain K<sub>1</sub> and K<sub>2</sub> (S1 and S2=ON, K<sub>1</sub>=K<sub>2</sub>) are set, 200kHz and 6MHz gain are taken as G<sub>1</sub>', G<sub>3</sub>' (dB). T<sub>L</sub> is calculated through the following formula:

$$T_L = \frac{1}{\omega} \cos^{-1} \left( \frac{1 - 10^{\frac{G_1' - G_0}{20}}}{2K} \right)$$

K is calculated through the following formula:

$$K = \frac{1 - 10^{\frac{G_1' - G_0}{20}}}{2}$$

As the equalizer frequency characteristics have exceeded the gain peak at  $f=10\text{MHz}$ , delay time  $T_{11}$  when 10MHz gain are taken as  $G_3'$ ,  $G_2$  (dB) is expressed by the following formula :

$$T_{11} = \frac{1}{\omega} \left\{ 2\pi - \cos^{-1} \left[ \frac{1 - 10^{\frac{G_3' - G_2}{20}}}{2K} \right] \right\}$$

The calculating method for this delay time is applied when it is set around 60ns. For setting to any other delay time, the frequency used to test the gain should be changed.

### Calculation of delay time

T ADJ1 pin current is taken as I, while delay time is obtained approximately through the following formula :

$$\Delta t = \frac{5.4 \times 10^{-12}}{I}$$

As T ADJ pin voltage is 4.0V, the resistance to be connected to T ADJ pin is taken as R. We have

$$I = \frac{1.0}{R}$$

T ADJ pin voltage changes slightly according to the connected resistance value. However, ignoring this fluctuation, the relation between the delay time and R is given through the following formula:

$$\begin{aligned} \Delta t &= \frac{5.4 \times 10^{-12}}{1.0} \times R \\ &= 5.4 \times 10^{-12} \times R \end{aligned}$$

When  $R=10\text{k}\Omega$ , we have

$$\Delta t = 5.4 \times 10^{-12} \times 10 \times 10^3 = 54\text{ns}$$

Calculation of mix ratio  $K_1$ ,  $K_2$

Mix ratio calculation  $K_1$  generally follows the following formula :

$$2K_1 = \frac{I_1}{I_1 + I_2} \quad \begin{array}{l} I_1 : 11 \text{ pin (K ADJ1) current} \\ I_2 : 13 \text{ pin (I REF) current} \end{array}$$

K ADJ1 pin, I REF pin voltage is approx. 1.2V As a  $12\text{k}\Omega$  is connected to I REF pin.  $I_2=100\mu\text{A}$ . K ADJ1 pin voltage changes slightly according to the connected resistance value. However, ignoring this fluctuation, the relation between the mix ratio and R is given through the following formula :

$$I_1 = \frac{1.2}{R}$$

Therefore, the relation between  $K_1$  and R is as follows :

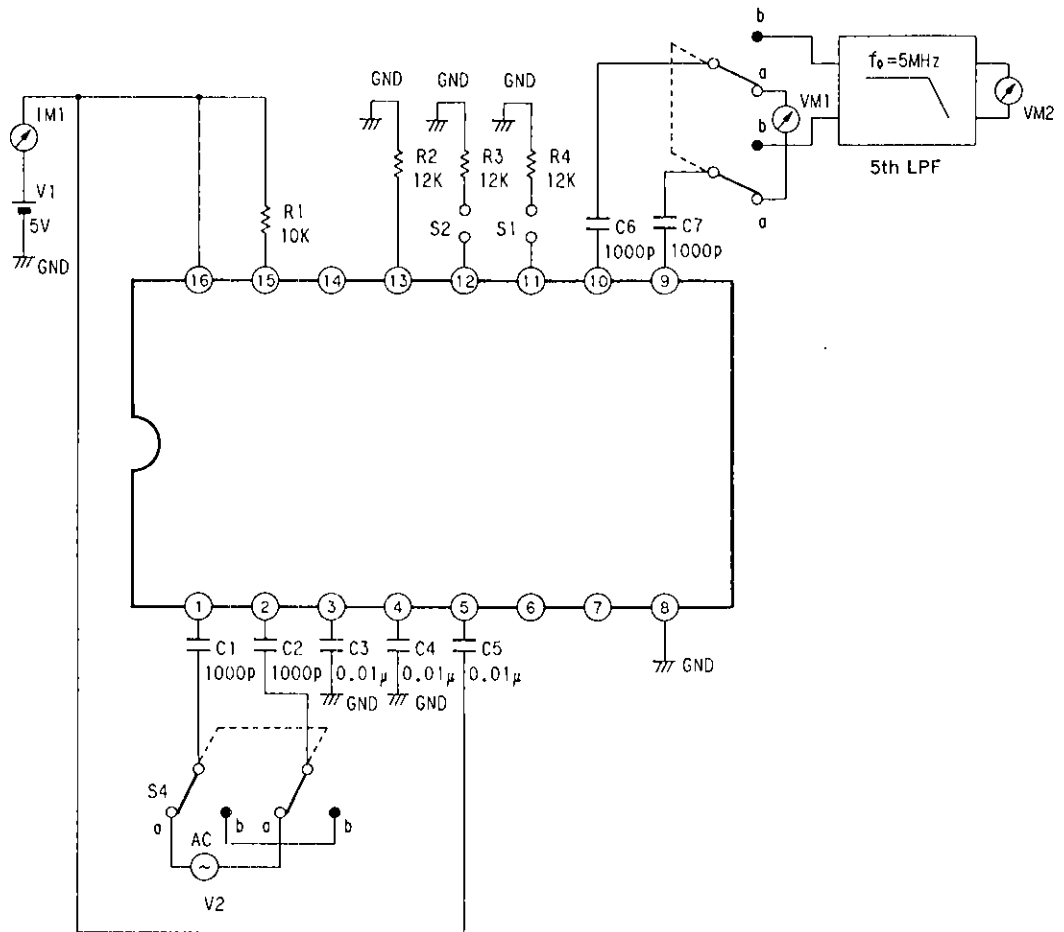
$$K_1 = \frac{0.6}{1.2 + 100 \times 10^{-6} \times R}$$

For example, when  $R=12\text{k}\Omega$ , we have

$$K_1 = \frac{0.6}{1.2 + 100 \times 10^{-6} \times 12 \times 10^3} = 0.25$$

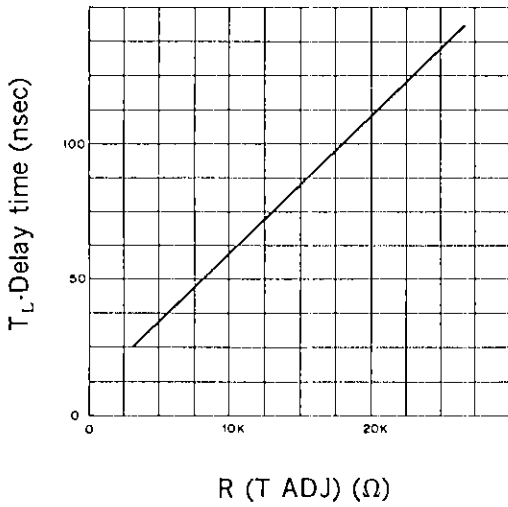
$K_2$  is solved in a similar way as being 12 pin K ADJ2 current.

Electrical Characteristics Test Circuit

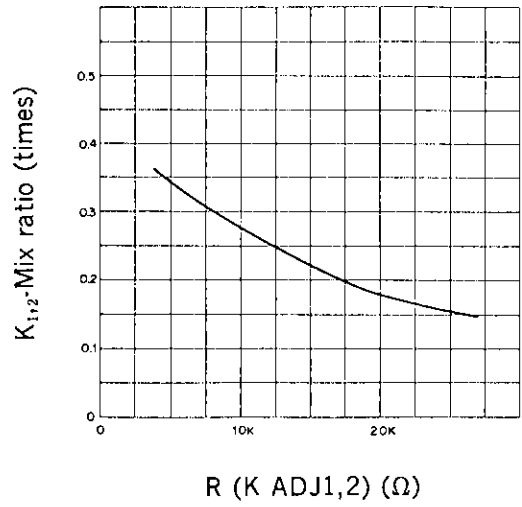


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Delay time vs. Setting resistance

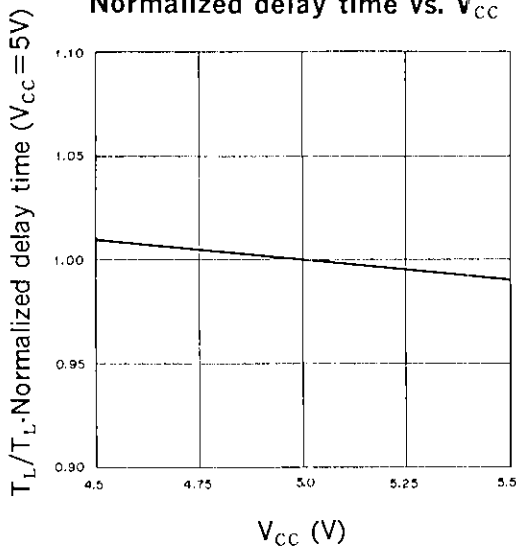


Mix ratio vs. Setting resistance

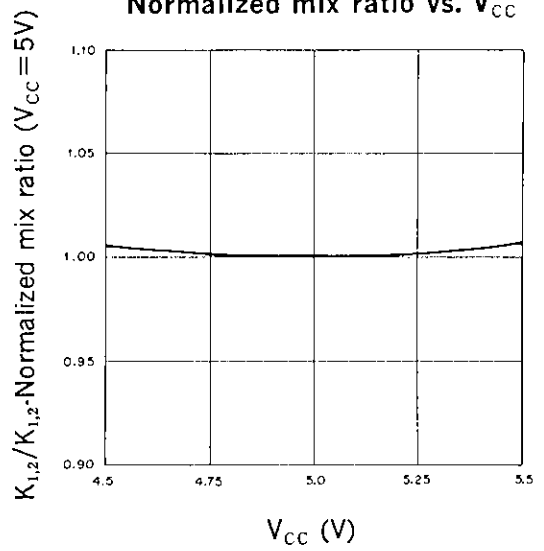


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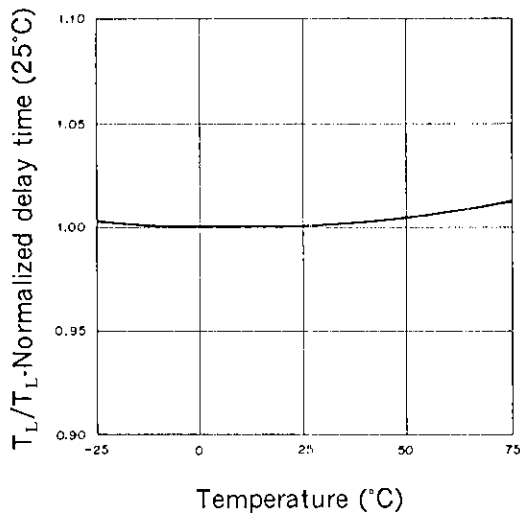
Normalized delay time vs. V<sub>CC</sub>



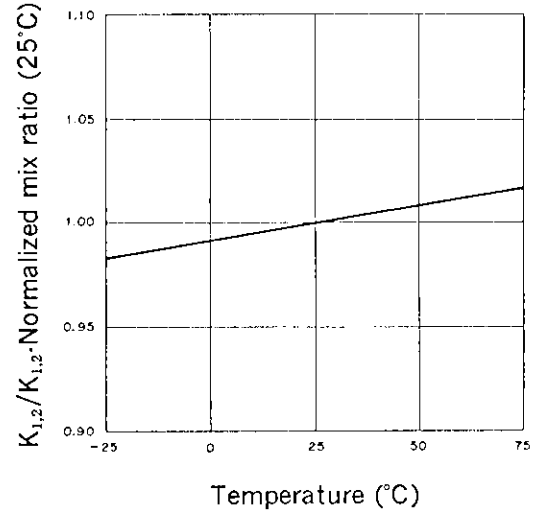
Normalized mix ratio vs. V<sub>CC</sub>



Normalized delay time vs. Temperature

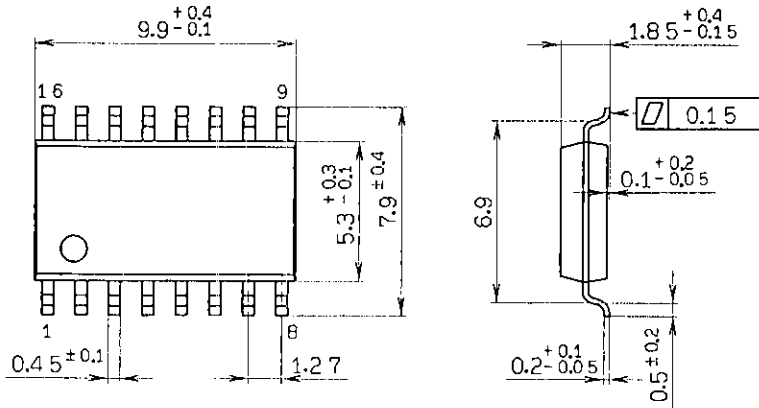


Normalized mix ratio vs. Temperature

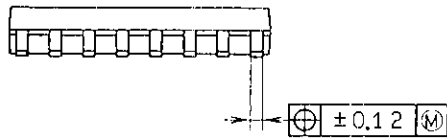


Package Outline Unit: mm

16pin SOP (Plastic) 300mil 0.2g



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SONY NAME	SOP-16P-L01
EIAJ NAME	*SOP016-P-0300-A
JEDEC CODE	_____