

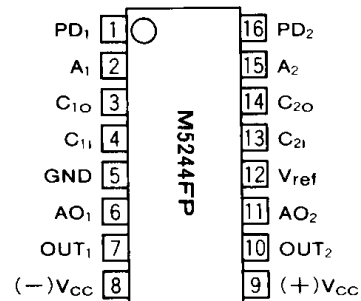
**M5244FP****LEVEL CONTROLLER FOR PHOTO DETECTION****DESCRIPTION**

M5244FP is a photo-reception amplifier which performs the impedance conversion for small signals received by a photo-reception diode, converts their absolute values into binary-code signals and outputs the results to a comparator.

The input stage performs the impedance conversion using a J-FET type high-sensitive operational amplifier. Amplifiers, DC servo circuits, and comparators in the later stages output H/L (binary-code) signals. Thus, this device provides high performance and functions and is best suitable for photo-reception devices such as faximiles, etc.

**FEATURES**

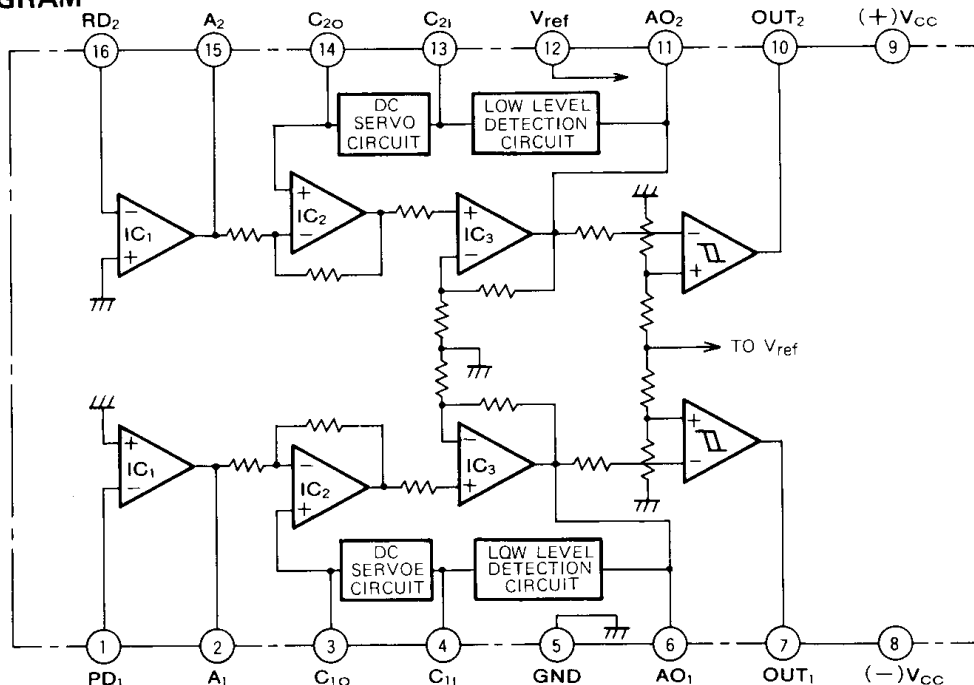
- SOP package is used to decrease the size and weight of application devices.
- Contains a Bi-FET operational amplifier (equivalent to that of M5238) with high-input impedance, allowing few nA of input signals to be processed.
- Contains 2-stage of low-noise operation circuits whose gain has been set internally. (Total gain = about 60dB)
- Can accept weak analog signals, amplify them, and use them as a monitor output pin. (Analog output pin)
- Contains very accurate zero compensation circuits.
  - DC servo circuit
  - Low level detection circuit
- Contains a highly sensitive comparator with hysteresis characteristics.
- Requires few external devices.
- You can easily design the photo-reception sections using 4, 6, or more devices because the device contains two circuits.

**PIN CONFIGURATION (TOP VIEW)****Outline 16P2S****APPLICATION**

OA equipments such as faximiles which use photo-reception units

**RECOMMENDED OPERATING CONDITIONS**

(+) V <sub>CC</sub> .....	+5V
(-) V <sub>CC</sub> .....	-12V
V <sub>ref</sub> .....	+2V

**BLOCK DIAGRAM**

**LEVEL CONTROLLER FOR PHOTO DETECTION****ABSOLUTE MAXIMUM RATINGS** ( $T_a = 25^\circ\text{C}$ , unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
$V_{CC}$	Supply voltage		$\pm 15(30)$	V
$P_d$	Power dissipation		550	mW
$K_\theta$	Thermal derating	$T_a \geq 25^\circ\text{C}$	5.5	mW/ $^\circ\text{C}$
$T_{opr}$	Operating temperature		$-20 \sim +75$	$^\circ\text{C}$
$T_{stg}$	Storage temperature		$-55 \sim +125$	$^\circ\text{C}$

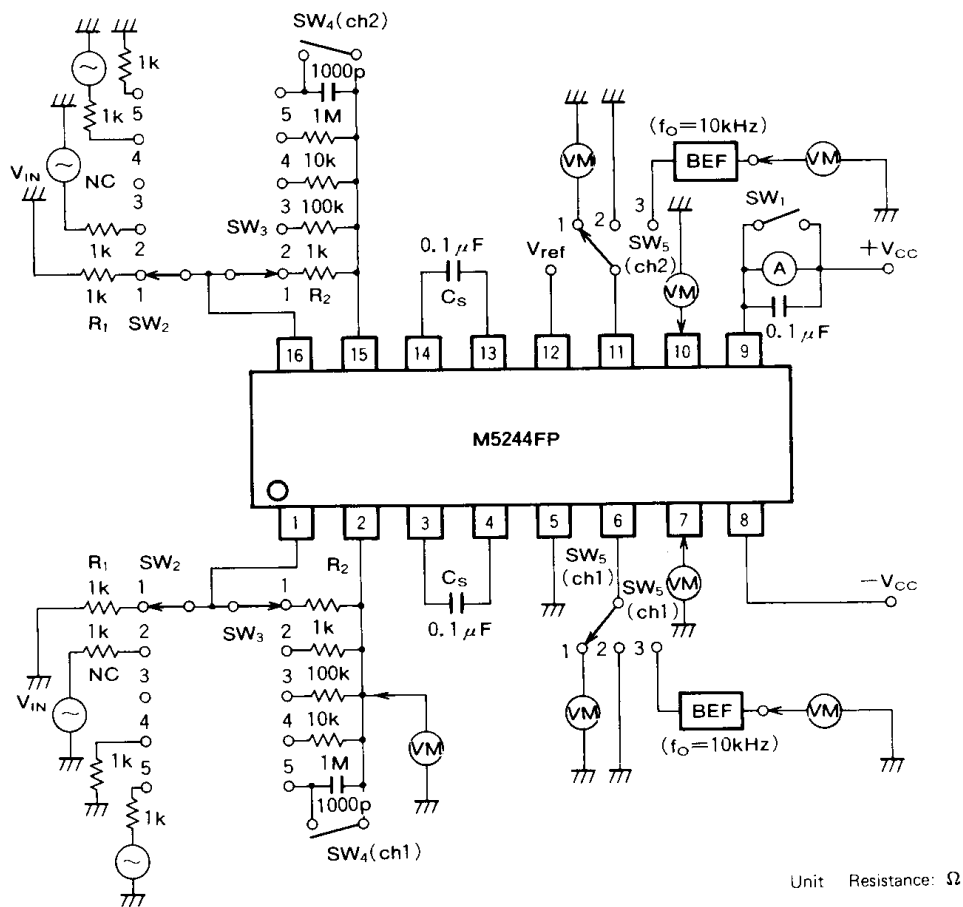
**ELECTRICAL CHARACTERISTICS** ( $T_a = 25^\circ\text{C}$ ,  $V_{CC} = 5\text{V}$ ,  $-V_{CC} = -12\text{V}$ ,  $V_{ref} = +2\text{V}$ ,  $C_s = 0.1\mu\text{F}$ , unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
$I_{CC}$	Circuit current while no signal is present	$V_i = 0$		12.4	18	mA
$V_{IO1}$	IC1 input offset voltage			3	15	mV
$G_V$	Voltage gain	$f = 10\text{kHz}$ , $V_i = -60\text{dBm}$ $R_1 = 1\text{k}\Omega$ , $R_2 = 1\text{k}\Omega$	57	60	63	dB
$V_O$	IC1 output voltage	$V_i = -20\text{dBm}$ , $f = 10\text{kHz}$ $R_1 = 1\text{k}\Omega$ , $R_2 = 10\text{k}\Omega$	-1.5	0	1.5	dBm
$V_{OH}$	Comparator output voltage	$V_{ref} = 200\text{mV}$	4.6	4.9		V
$V_{OL}$	Comparator output voltage	$V_{ref} = -200\text{mV}$		0.02	0.2	V
$V_{AOH}$	Analog output voltage	$f = 10\text{kHz}$ , $V_i = -60\text{dBm}$ $V_{ref} = 5\text{V}$ , $R_1 = R_2 = 1\text{k}\Omega$	4.6	4.9		V
$V_{AOL}$	Analog output voltage	$f = 10\text{kHz}$ , $V_i = -60\text{dBm}$ $V_{ref} = -400\text{mV}$ , $R_1 = R_2 = 1\text{k}\Omega$		0.02	0.2	V
$V_{NO}$	Analog output noise voltage	$R_1 = R_2 = 1\text{k}\Omega$		20	50	mVrms
$t_r$	Comparator output response			2		$\mu\text{s}$
$V_{NC}$	Comparator inversion noise	$f = 10\text{kHz}$ , $V_i = -60\text{dBm}$ , BEF ( $f_o = 10\text{kHz}$ )		40	100	mVrms
CS	Channel separation	$f = 10\text{kHz}$ , $V_i = -60\text{dBm}$		-31	-20	dB
$I_B$	IC1 input bias current			0.1	10	nA
$V_A$	Voltage at pin A1 and A2	$V_A = I_B \times R_f + V_{IO1}$ ( $R_f = 1\text{M}\Omega$ )		3.1	16	mV

# M5244FP

## LEVEL CONTROLLER FOR PHOTO DETECTION

### TEST CIRCUIT



Unit Resistance: Ω

	SW <sub>1</sub>	SW <sub>2</sub>	SW <sub>3</sub>	SW <sub>4</sub>	SW <sub>2</sub>	V <sub>IN</sub> Voltage	V <sub>ref</sub> Voltage	Test pin		
I <sub>CC</sub>	OFF	1	1	ON	—	—	+2V	⑨		
V <sub>I01</sub>	ON	1	2	ON	—	—	+2V	②, ⑮		
G <sub>V</sub>	ON	2	1	ON	1	-60dBm	+2V	⑥, ⑪	f = 10kHz	
V <sub>O</sub>	ON	2	3	ON	—	-20dBm	+2V	②, ⑮	f = 10kHz	
V <sub>OH</sub>	ON	3	1	ON	2	—	+200mV	⑦, ⑩		
V <sub>OL</sub>	ON	3	1	ON	2	—	+200mV	⑦, ⑩		
V <sub>A0H</sub>	ON	2	1	ON	1	-60dBm	+5V	⑦, ⑩	f = 10kHz	
V <sub>A0L</sub>	ON	2	1	ON	1	-60dBm	-400mV	⑦, ⑩	f = 10kHz	
V <sub>N0</sub>	ON	1	1	ON	1	—	+2V	⑥, ⑪		
V <sub>N0</sub>	ON	2	1	ON	3	-60dBm	+2V	⑥, ⑪	After passing the band-rejection filter	
V <sub>A</sub>	ON	3	4	ON	—	—	+2V	②, ⑮	V <sub>A</sub> = I <sub>B</sub> · R <sub>f</sub> + V <sub>I0</sub>	
I <sub>B</sub>	ON	3	5	ON → OFF	—	—	+2V	②, ⑮	I <sub>B</sub> = - $\frac{C}{I}$ · V <sub>O</sub>	
C <sub>S</sub>	ch1	ON	4	1	ON	1	-60dBm	+2V	⑥	ch1: OFF, ch2: ON
	ch2	ON	5	1	ON	1	-60dBm	+2V	⑪	ch1: ON, ch2: OFF

## LEVEL CONTROLLER FOR PHOTO DETECTION

## PRINCIPLE OF OPERATIONS

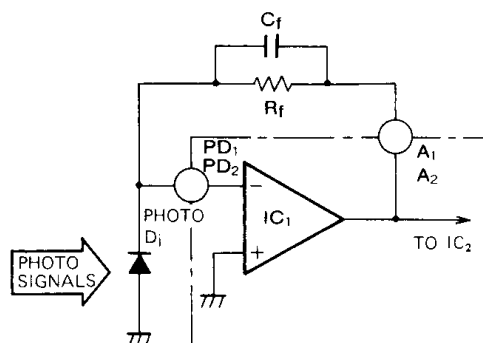
## First-stage amplifier

The input part of IC<sub>1</sub> has the FET configuration. The photo-reception element (i.e. photo D<sub>i</sub>) connected to PD<sub>1</sub> and PD<sub>2</sub> pins will receive photo signals as shown in the figure right. Then, the current change at the photo D<sub>i</sub> is converted into voltage and it is supplied to the input of the second-stage amplifier.

Feedback resistor R<sub>f</sub>, feedback capacitor C<sub>f</sub>, and photo-reception element should be connected externally. R<sub>f</sub> and C<sub>f</sub> should be set to the most proper values according to the input signal level, noise level of analog output signals, and the required rising speed.

(Note)

When the input signal is very weak (that is, when the current through the photo D<sub>i</sub> is few nA level and the R<sub>f</sub> value is about 1MΩ), provide enough shield around PD<sub>1</sub> and PD<sub>2</sub> pins.



## Second- and third-stage amplifiers

The total gain of second- and third-stage amplifiers is 60dB ± 3dB. The second-stage has a 30dB of inversion amplifier and the third-stage has a 30dB of non-inversion amplifier.

The output from the third-stage amplifier is connected to AO<sub>1</sub> and AO<sub>2</sub> pins (analog output pins) and are used as monitor output pins.

## Zero compensation circuit

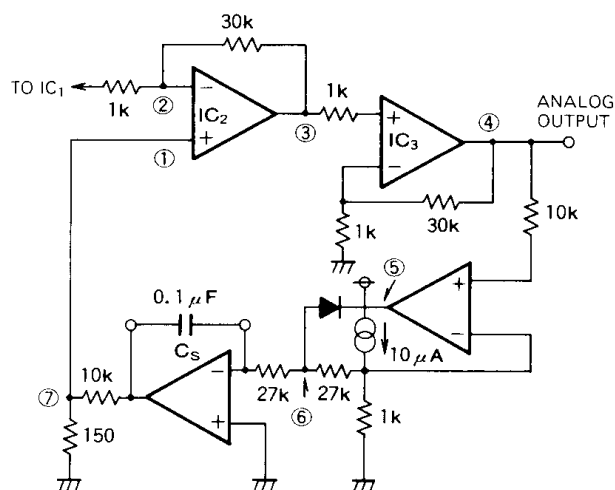
This device contains a zero compensation circuit consisting of a low level detection circuit and a DC servo circuit to cancel the DC potential such as the input offset voltage in the IC.

The feedback capacitor C<sub>s</sub> in the DC servo circuit is connected externally and its value should be around 0.1μF. The zero compensation voltage range is internally set to ±70mA (@V<sub>CC</sub> = ±5V).

The zero compensation circuit will set the analog output pin close to the GND potential level when the analog output pin has no input signal as shown in the following operational mechanism.

In the figure right if the potential difference between ① and ② of IC<sub>2</sub> is V<sub>IO</sub>, the potential at each point forms the following loops to perform the zero compensation:

- Potential at ① : 0 (V)
- Potential at ② : V<sub>IO</sub> (V)
- Potential at ③ : V<sub>IO</sub> × 30 (V)
- Potential at ④ : V<sub>IO</sub> × 900 (V)
- Potential at ⑤ : Turns to HIGH or LOW by comparing the potential at ④ with +10mA.
- Potential at ⑥ : Becomes +10mA or LOW level depending on the potential at ⑤.
- Potential at ⑦ : This potential is found by dividing the HIGH or LOW level by 10k to 150Ω and it changes the potential at ①. This draws a loop which cancels the voltage difference between ① and ②.



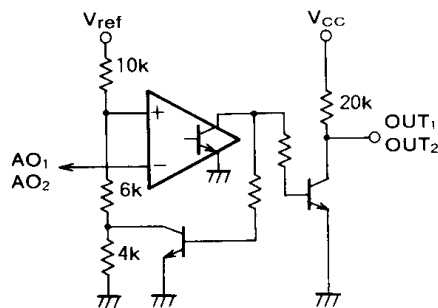
Unit Resistance: Ω

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## LEVEL CONTROLLER FOR PHOTO DETECTION

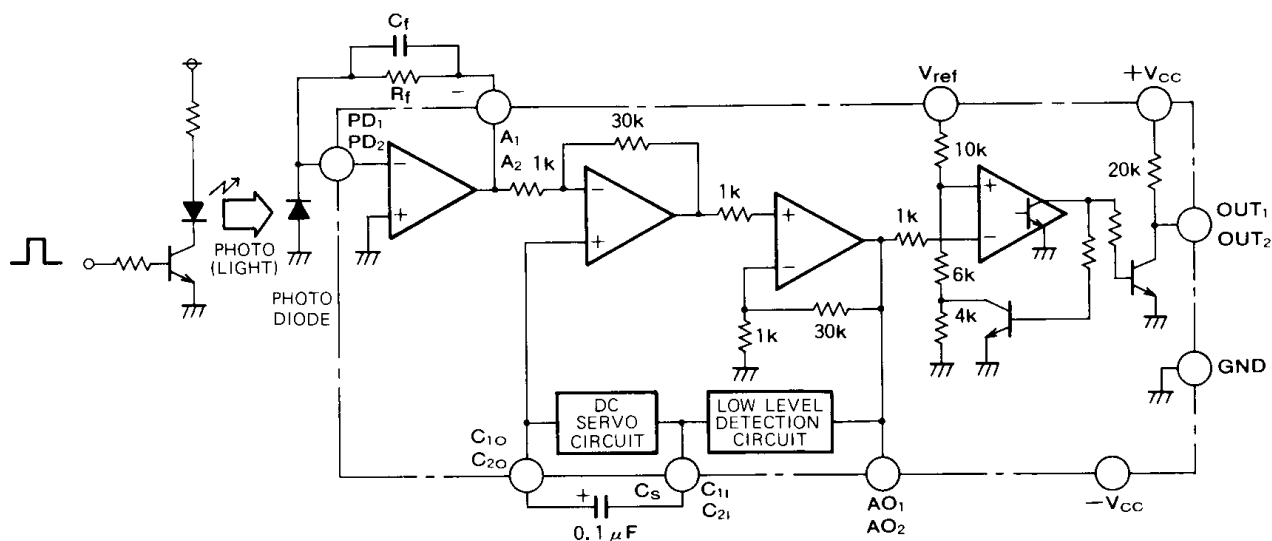
### Voltage Comparator

This separates analog output signals (from AO<sub>1</sub> and AO<sub>2</sub>) to HIGH or LOW. (The comparator output turns to HIGH at the GND level.) The voltage to be compared is sent externally and divided into 1/2 to be input. This has the hysteresis characteristics and its width is 250mV (@V<sub>ref</sub> = 2V).

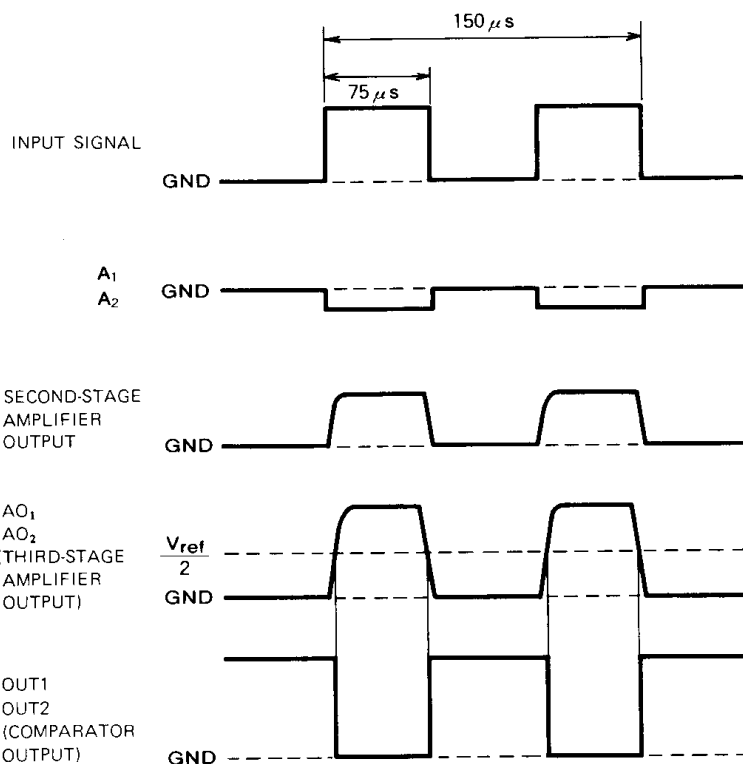


Unit Resistance: Ω

### SIGNAL TRANSMISSION PATH



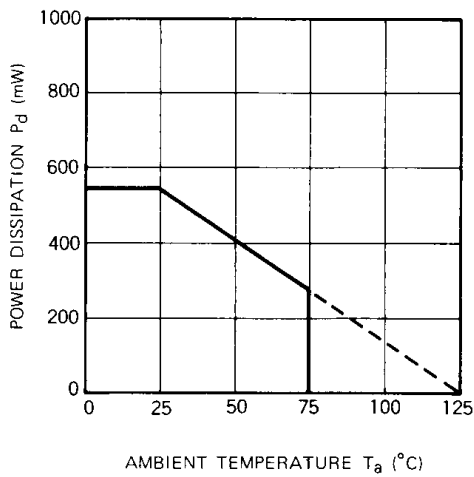
Unit Resistance: Ω



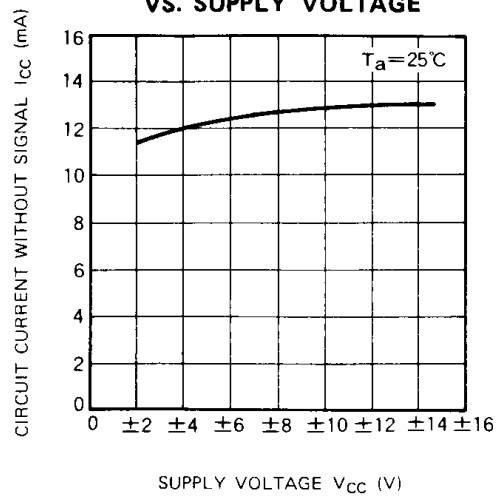
**LEVEL CONTROLLER FOR PHOTO DETECTION**

**TYPICAL CHARACTERISTICS**

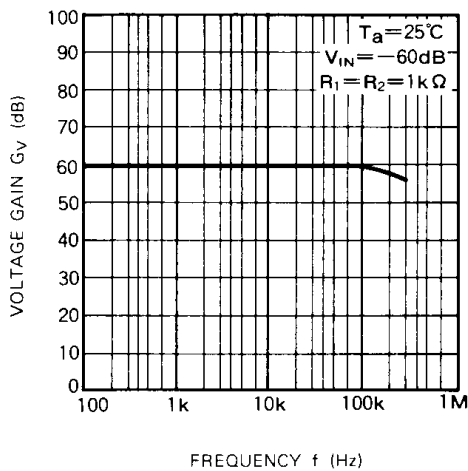
**THERMAL DERATING (MAXIMUM RATING)**



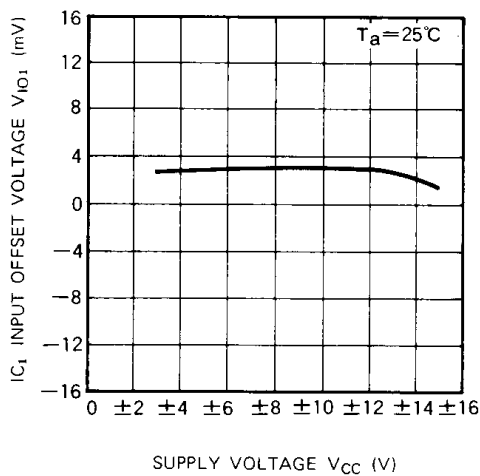
**CIRCUIT CURRENT WITHOUT SIGNAL VS. SUPPLY VOLTAGE**



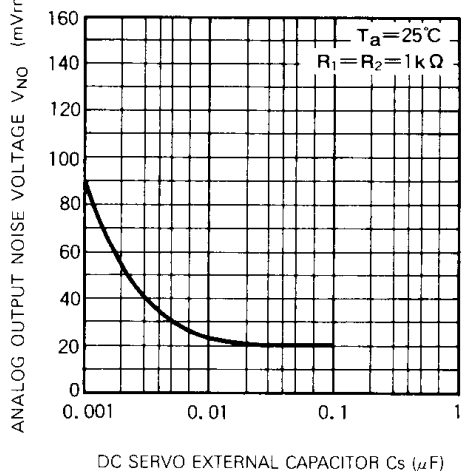
**VOLTAGE GAIN VS. FREQUENCY RESPONSE**



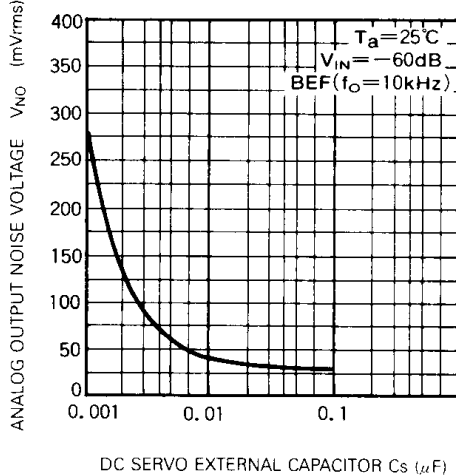
**IC1 INPUT OFFSET VOLTAGE VS. SUPPLY VOLTAGE**



**ANALOG OUTPUT NOISE VOLTAGE VS. DC SERVO EXTERNAL CAPACITOR**



**COMPARATOR INVERSION NOISE VS. DC SERVO EXTERNAL CAPACITOR**



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