M51907P

8-STEP BAR TYPE LED LEVEL INDICATOR

DESCRIPTION

The M51907P is a semiconductor integrated circuit designed for LED level meters. It drives a bar-type input-level display for up to 8 LEDs. With its built-in advanced half-wave rectification operational amplifier, the M51907P accepts direct input of either AC or DC signals.

A logarithmic scale of 5, 2, 0, −2, −5, −8, −13, and −18dB display levels is provided, making the M51907P ideal for signal meter applications.

FEATURES

- Advanced half-wave rectification OP amp built in
  - Cut-off frequency ·························· 200kHz(typ.)
  - Offset voltage ······························ 2mV(typ.)
- Output current can be adjusted with a single resistor ······························ 2~25mA
- Wide supply voltage range ························ 4~15V
- LEDs are grouped in two's by cascade connection, so when all LEDs are driven in parallel, the current required is reduced by half
- Parallel shifting of the LED turn-on voltage is easy with the lower ref in pin
- Advanced half-wave OP amp gain is varied by external resistance
- Reference voltage terminal for full-scale coordination, making it easy to use the M51907P and the companion M51909P in cascade connection to drive more than 8 LEDs.

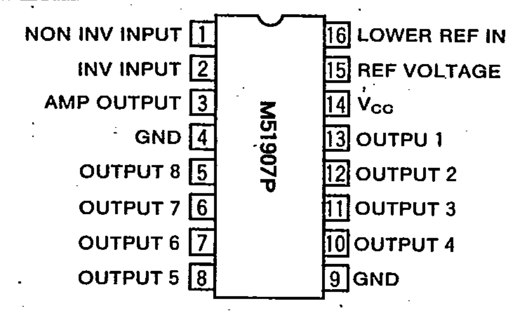
APPLICATION

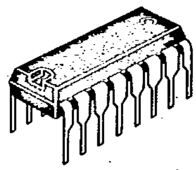
Signal meters, VU meters, and tuning meters.

RECOMMENDED OPERATING CONDITIONS

Supply voltage range ························ 4~15V
Rated power supply ·························· 9V±10%

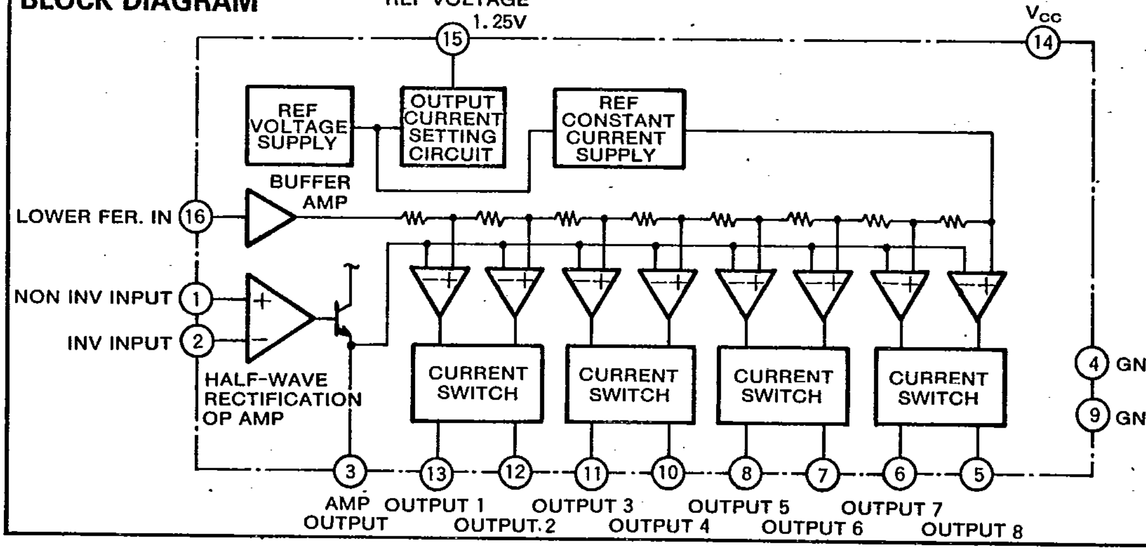
PIN CONFIGURATION (TOP VIEW)





16-pin molded plastic DIP

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (T_a=25℃, unless otherwise noted)

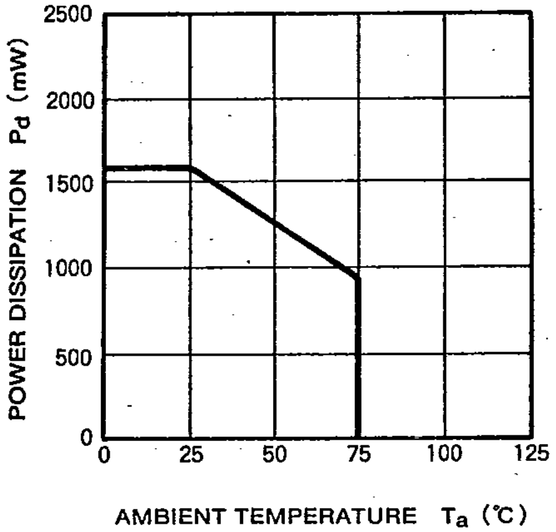
Symbol	Parameter	Conditions	Ratings	Unit
V_{CC}	Supply voltage		16	V
BV_O	Output voltage		16	V
I_O	Output current		25	mA
V_{IN}	Input voltage	Input pin to GND	$-3\sim V_{CC}$	V
$\|V_{①}-V_{②}\|$	Input differential voltage	Pin ① to pin ②	5	V
$V_{⑯}$	Pin ⑯ voltage	Pin ⑯ to GND	V_{CC}	V
$I_{⑮}$	Pin ⑮ input current		500	μA
$I_{③}$	Pin ③ output current	Static value	−1	mA
P_d	Power dissipation		1600	mW
K_θ	Thermal derating	$T_a \geqq 25$℃	12.8	mW/℃
T_{opr}	Operating temperature		−20~+75	℃
T_{stg}	Storage temperature		−40~+125	℃

ELECTRICAL CHARACTERISTICS (T_a=25℃, V_{CC}=9V, unless otherwise noted) R_{ad}: Pin ⑮ adjustable resistor

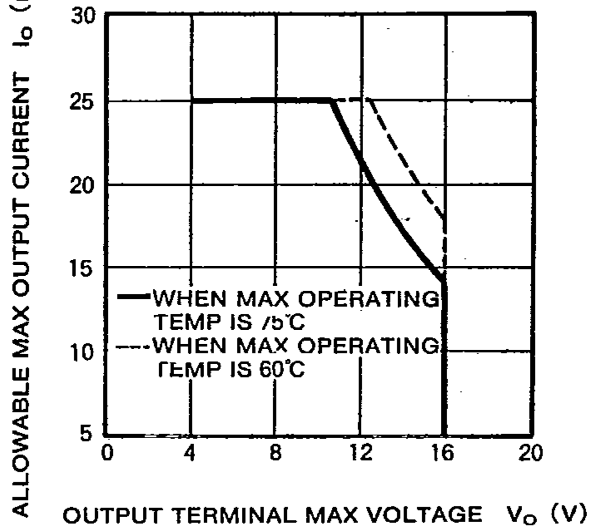
Symbol	Parameter	Test conditions	Limits			Unit
			Min	Typ	Max	
V_{CC}	Supply voltage		4.0		15.0	V
I_{CC1}	Circuit current	$V_{①}$=0V(when all LEDs are off) R_{ad}=2.8kΩ		5.0	8.0	mA
I_{CC2}	Circuit current	$V_{①}$=2V(when all LEDs are on) R_{ad}=2.8kΩ		7.0	11.2	mA
V_{IO}	Input offset voltage	Input voltage $V_{①}$=1V		2	10	mV
I_{IB}	Input bias current	Input voltage $V_{①}$=0V	−300	−50		nA
V_{IN}	Input voltage range		0		$V_{CC}-2$	V
V_{ref}	Reference voltage	R_{ad}=6.4kΩ	1.125	1.250	1.375	V
$V_{⑯}$	Pin ⑯ set voltage range		−0.2		$V_{CC}-3.5$	V
$I_{⑯}$	Pin ⑯ output current		−2000	−50		nA
V_{th1}	Output 1 threshold voltage	Amp gain=1 Pin ⑯ voltage is taken as reference	70	89	111	mV_{DC}
			−20	−18	−16	dB
V_{th2}	Output 2 threshold voltage		125	157	198	mV_{DC}
			−15	−13	−11	dB
V_{th3}	Output 3 threshold voltage		235	280	333	mV_{DC}
			−9.5	−8	−6.5	dB
V_{th4}	Output 4 threshold voltage		352	395	443	mV_{DC}
			−6	−5	−4	dB
V_{th5}	Output 5 threshold voltage		498	558	627	mV_{DC}
			−3	−2	−1	dB
V_{th6}	Output 6 threshold voltage		627	703	789	mV_{DC}
			−1	0	+1	dB
V_{th7}	Output 7 threshold voltage		789	885	993	mV_{DC}
			+1	+2	+3	dB
V_{th8}	Output 8 threshold voltage		1114	1250	1403	mV_{DC}
			+4	+5	+6	dB
I_{OL}	Output leak current				1	μA
I_O	Output current	R_{ad}=6.4kΩ	9.6	12	14.4	mA
I_O'	Output current	R_{ad}=2.8kΩ	20	25	30	mA
V_{SAT}	Output saturation voltage	R_{ad}=2.8kΩ I_O=12.5mA			500	mV

TYPICAL CHARACTERISTICS (T_a=25°C, unless otherwise noted)

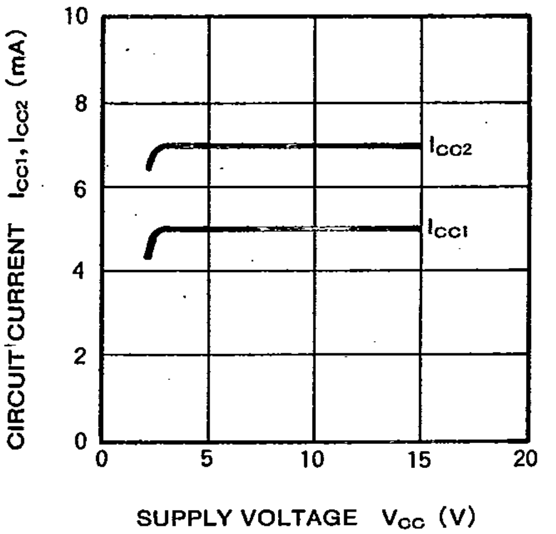
THERMAL DERATING (MAXIMUM RATING)



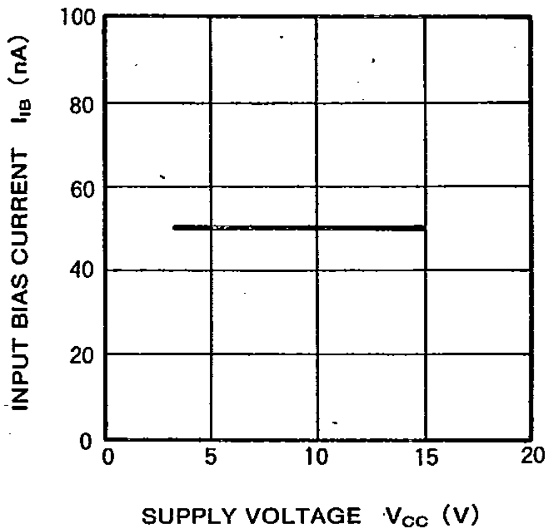
ALLOWABLE MAX OUTPUT CURRENT VS. OUTPUT TERMINAL MAX VOLTAGE



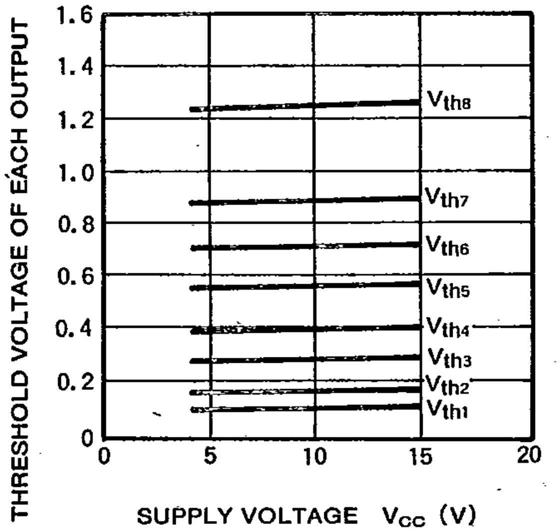
CIRCUIT CURRENT VS. SUPPLY VOLTAGE



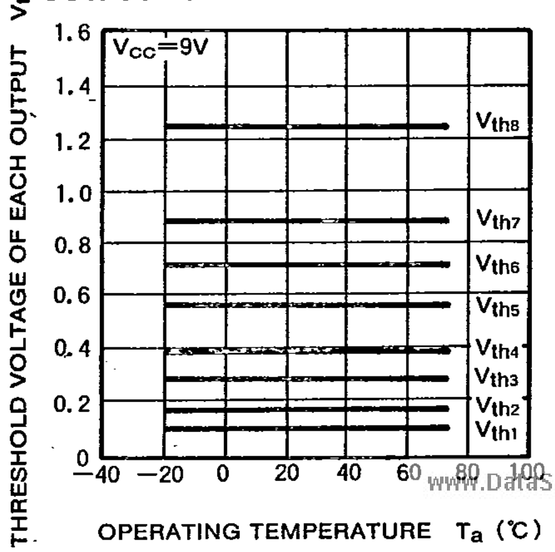
INPUT BIAS CURRENT VS. SUPPLY VOLTAGE



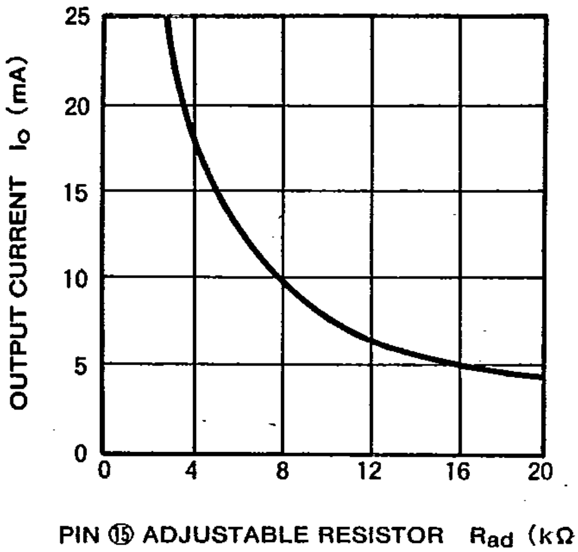
THRESHOLD VOLTAGE OF EACH OUTPUT VS. SUPPLY VOLTAGE



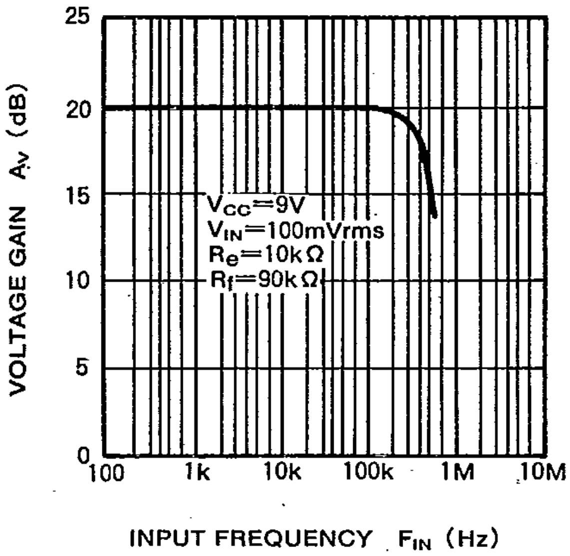
THRESHOLD VOLTAGE OF EACH OUTPUT VS. OPERATING TEMPERATURE



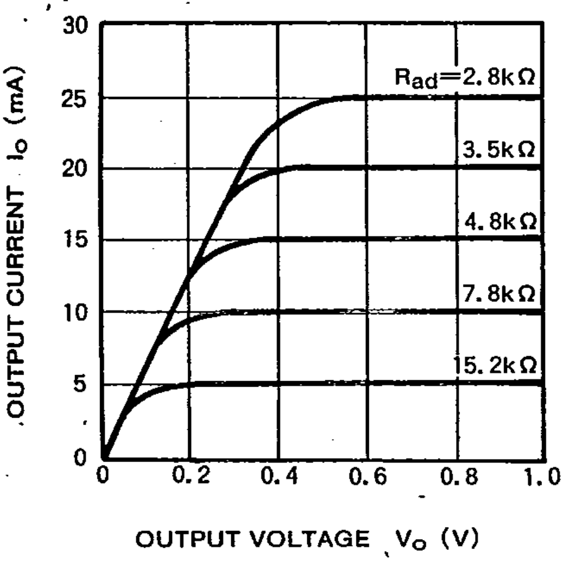
OUTPUT CURRENT VS. PIN ⑮ ADJUSTABLE RESISTOR



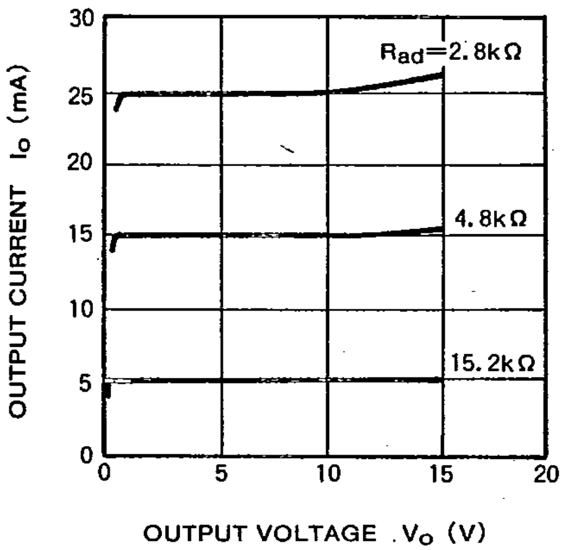
HALF-WAVE RECTIFIER OP AMP VOLTAGE GAIN VS. INPUT FREQUENCY



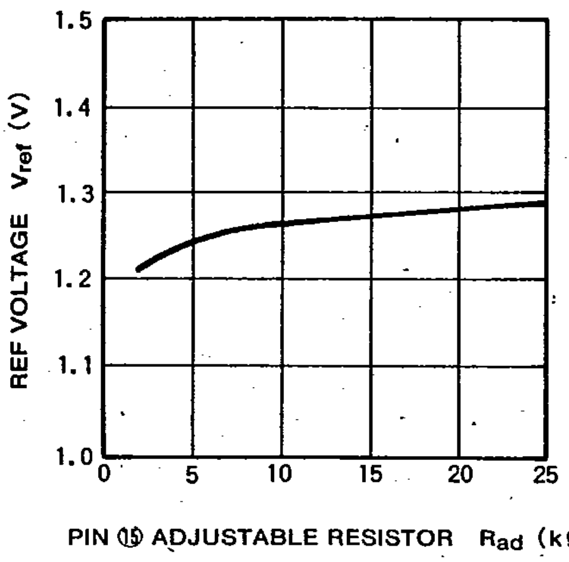
OUTPUT CURRENT VS. OUTPUT VOLTAGE (1)



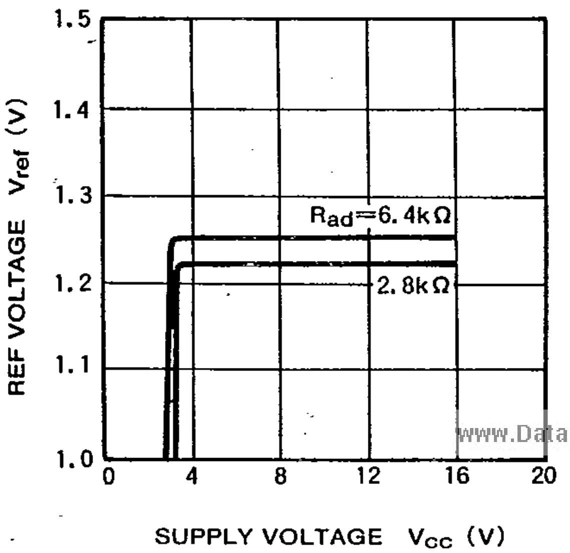
OUTPUT CURRENT VS. OUTPUT VOLTAGE (2)



REF VOLTAGE VS. PIN ⑮ ADJUSTABLE RESISTOR

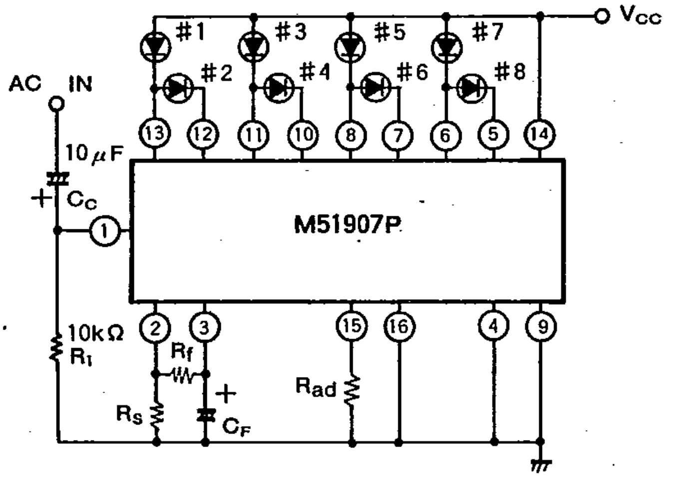


REF VOLTAGE VS. SUPPLY VOLTAGE

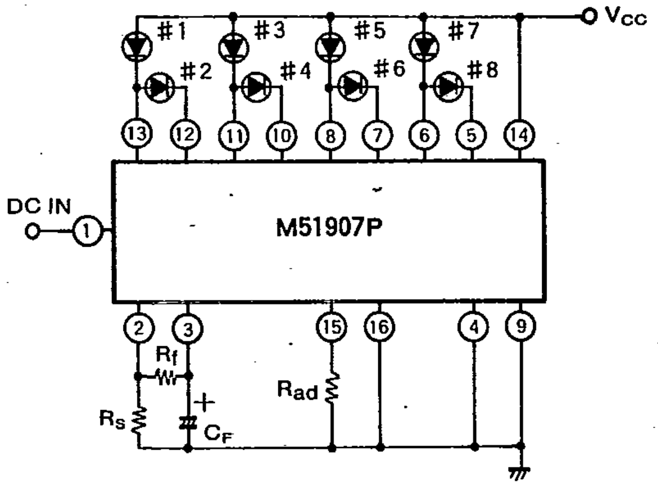


APPLICATION EXAMPLES

(1) AC INPUT



(2) DC INPUT



R_{ad}: Resistance determining LED current
(See OUTPUT CURRENT VS. PIN ⑮ ADJUSTABLE RESISTANCE graph)

OPERATION

The AC signal applied through the coupling capacitor C_C is rectified and amplified mainly by the GND voltage and output at Pin ③. The voltage at Pin ③ is compared with the reference voltage at Pin ⑯ (internal reference voltage 1.25V divided on a logarithmic scale), and the resultant comparator output drives the LEDs.

Note 1. Amp gain

$$\frac{R_S+R_f}{R_S}$$

The peak value is output at Pin ③, so when this is a sine wave, a DC voltage of approximately 1.4 times the rms value is output.

Note 2. Select the value of C_F according to the recovery time.

Recovery time: $C_F \times (R_S+R_f)$

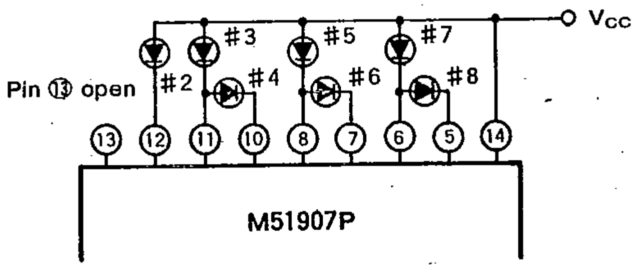
Attack time: $C_F \times 460\Omega$

Note 3. LED current

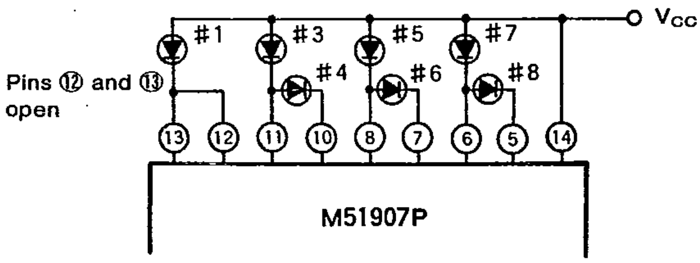
Pin ⑮ adjustable resistor determines the LED current. (See the OUTPUT CURRENT VS. PIN ⑮ ADJUSTABLE RESISTOR graph)

Note 4. When less than 8 LEDs are used, proceed as follows.

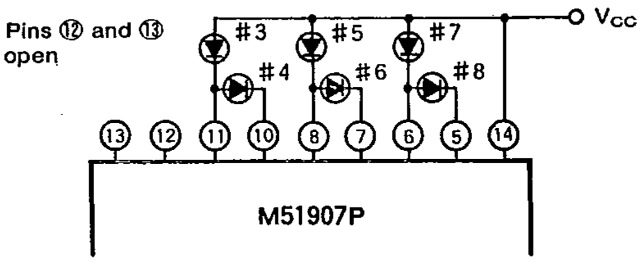
1. When #1 LED is not used:



2. When #2 LED is not used:

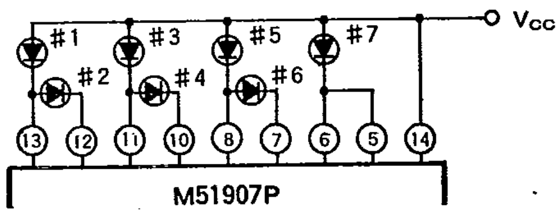


3. When #1 and #2 LEDs are not used:



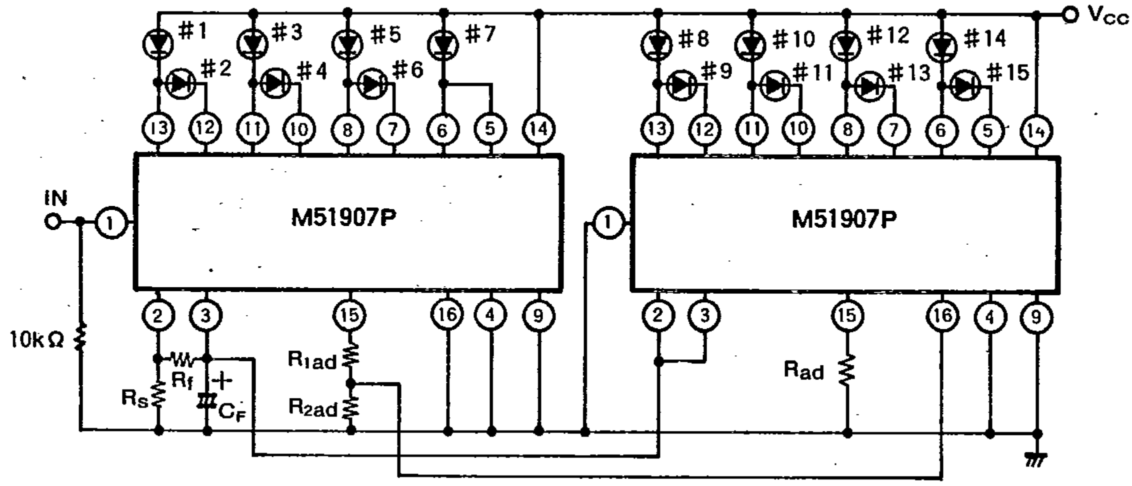
4. When any of LEDs #3 to #8 are not used:

When an even-numbered LED is not used, follow the procedure given for LED # 2, and when an odd-numbered LED is not used, follow that for LED #3.



(3) Cascade connection

It is easy to create a 16-step indicator by using two M51907Ps, but the drive threshold value (dB) is irregular, so there is a tendency to unnatural deviation is the drive threshold value at the connection. The following example illustrates how this problem is avoided. Fifteen LEDs can be driven using this configuration with the M51907P and the M51909P.

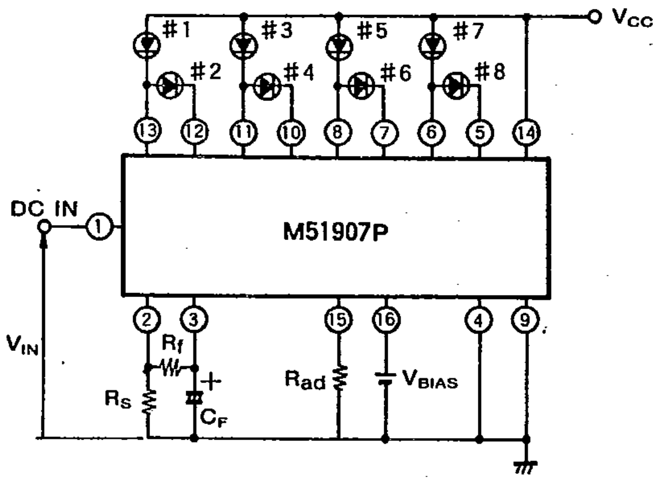


Note 1. To equalize the brightness levels of the M51907P and the M51909P, select R_{1ad} and R_{2ad} so that $R_{ad}=R_{1ad}+R_{2ad}$.

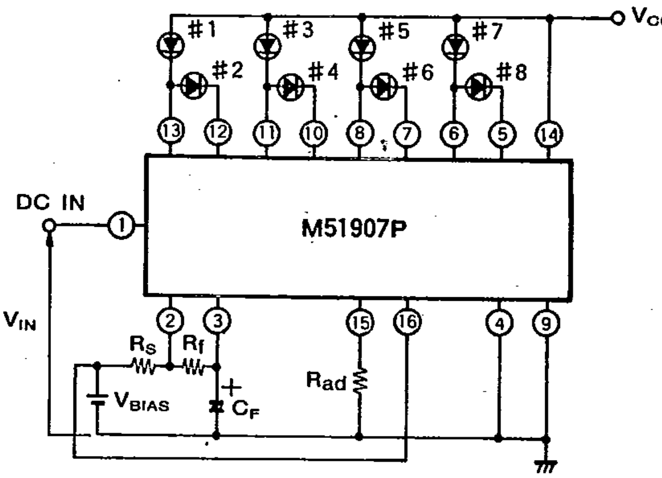
Note 2. When values for R_{1ad} and R_{2ad} are selected so that $R_{1ad}:R_{2ad}=1:2.53$, the threshold values are as follows.

#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15
−24.6dB	−19.7dB	−14.7dB	−11.7dB	−8.7dB	−6.7dB	−4.7dB	−3.2dB	−2.0dB	−0.9dB	0dB	0.86dB	1.63dB	2.34dB	3dB

(4) Fixed reference bias DC input



Display is given by the formula $V_{IN}\times\frac{R_S+R_f}{R_S}-V_{BIAS}$

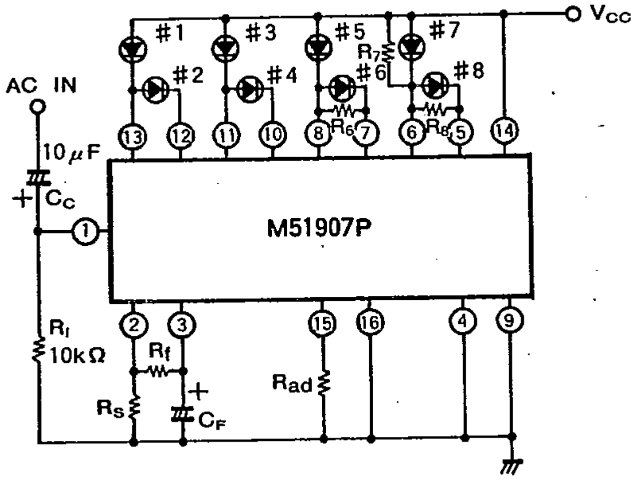


Display is given by the formula $(V_{IN}-V_{BIAS})\times\frac{R_S+R_f}{R_S}$

(5) Different color LEDs (when different drive currents are desired for the LEDs)

Select Pin ⑮ adjustable resistor for connection to the LED that requires the maximum drive current. Then connect resistors in parallel to the remaining LEDs with reduced current.

For example, to reduce the current for LEDs #6, #7, and #8, use the following arrangement.



The currents flowing through each of the LEDs in the above circuit configuration are given by the following formulas.

For LEDs #1~#5

$$I_{LEDA} \sim 60 \times \frac{V_{⑮}}{R_{ad}}$$

For LED #6

$$I_{LEDB} \sim 60 \times \frac{V_{⑮}}{R_{ad}} - \frac{V_{F6}}{R_6} = I_{LEDA} - \frac{V_{F6}}{R_6}$$

For LED #7

$$I_{LEDC} \sim 60 \times \frac{V_{⑮}}{R_{ad}} - \frac{V_{F7}}{R_7} = I_{LEDA} - \frac{V_{F7}}{R_7}$$

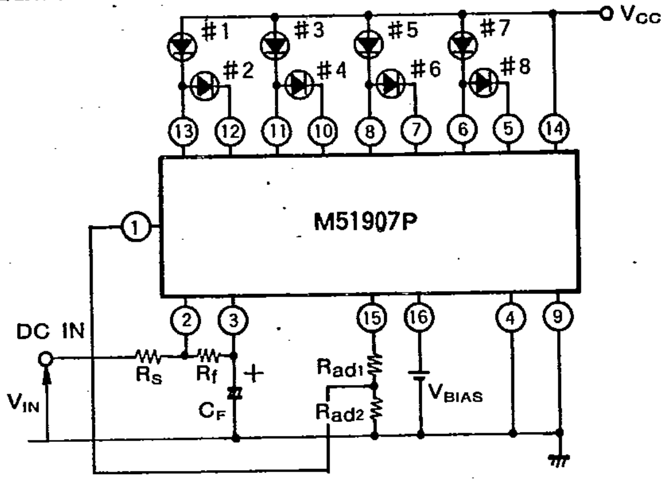
For LED #8

$$I_{LEDD} \sim 60 \times \frac{V_{⑮}}{R_{ad}} - \frac{V_{F8}}{R_8} = I_{LEDA} - \frac{V_{F8}}{R_8}$$

$V_{⑮}$, Pin ⑮ voltage, is 1.25V and V_{F6}, V_{F7}, and V_{F8} are the forward voltage drops for LEDs #6, #7, and #8 respectively.

The M51907P is designed so that the temperature-dependency of the voltage at Pin ⑮ is very low. The LED forward voltage drop, only −2 to −2.5mV/℃, also has a relatively low temperature dependence. These design features make it possible to accurately set the current flowing through each LED.

(6) All LEDs light at minimum-voltage input signal, and the LEDs are extinguished as the input voltage increases



Display follows the formula:

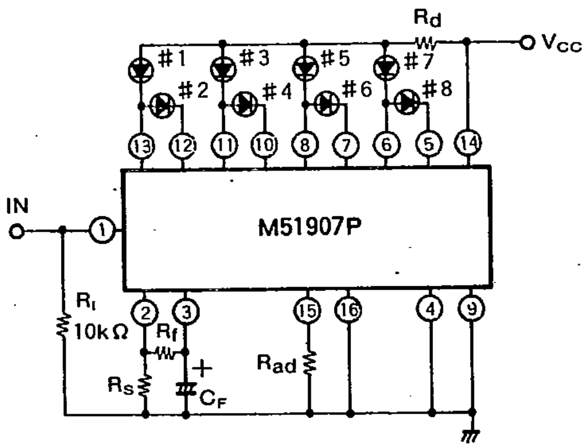
$$\frac{1.25(V) \times R_{ad2}}{R_{ad1} + R_{ad2}} \times \left(1 + \frac{R_f}{R_S}\right) - V_{IN} \times \frac{R_f}{R_S} - V_{BIAS}$$

Note: LED drive voltage is determined by $R_{ad1} + R_{ad2}$.

(7) High supply voltage produces high output currents

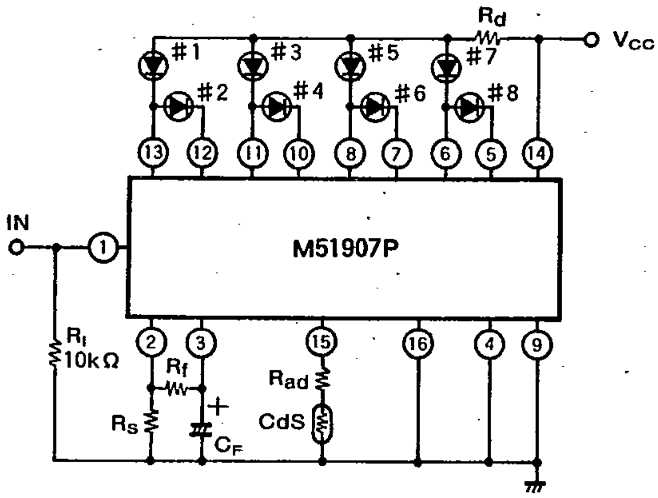
The relation between the allowable output current and the maximum voltage at the output terminal is determined by the thermal derating curve. (See the ALLOWABLE OUTPUT CURRENT VS. OUTPUT TERMINAL MAXIMUM VOLTAGE graph)

Therefore, if the user wants a high supply voltage to produce high output currents, the following circuit configuration can be used, but the output terminal voltage must be low.



A realistic design involves taking the required output current (LED current: I_{LED}) as the allowable maximum output current, and then determining the corresponding output terminal maximum voltage $V_{O\,max}$ from the ALLOWABLE OUTPUT CURRENT VS. OUTPUT TERMINAL MAX VOLTAGE graph. Then if the maximum value for the supply voltage is $V_{CC\,max}$, the value of R_d has to be determined to satisfy the relation $4 \cdot I_{LED} \cdot R_d > V_{CC\,max} - V_{O\,max}$.

(8) Adjusting LED brightness with respect to the surrounding light



The LED current is determined by $R_{ad} + R_{cds}$.