

# M54124L

## Earth Leakage Current Detector

REJ03F0031-0100Z

Rev.1.0

Sep.16.2003

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### Description

The M54124L is a semiconductor integrated circuit having amplifier functions for high-speed earth leakage breakers.

### Features

- Satisfies JIS C 8371 standards
- Good temperature characteristic of input sense current
- High input sensitivity ( $V_T=6.5$  mV)
- Fewer external components, for greater economy
- Good stability with respect to noise, surges
- Can be used at both 100 V and 200 V with low power consumption ( $P_d=5$  mW)
- 8-pin SIP for high mounting density
- Broad operating temperature range ( $T_a=-20$  to  $80^\circ\text{C}$ )

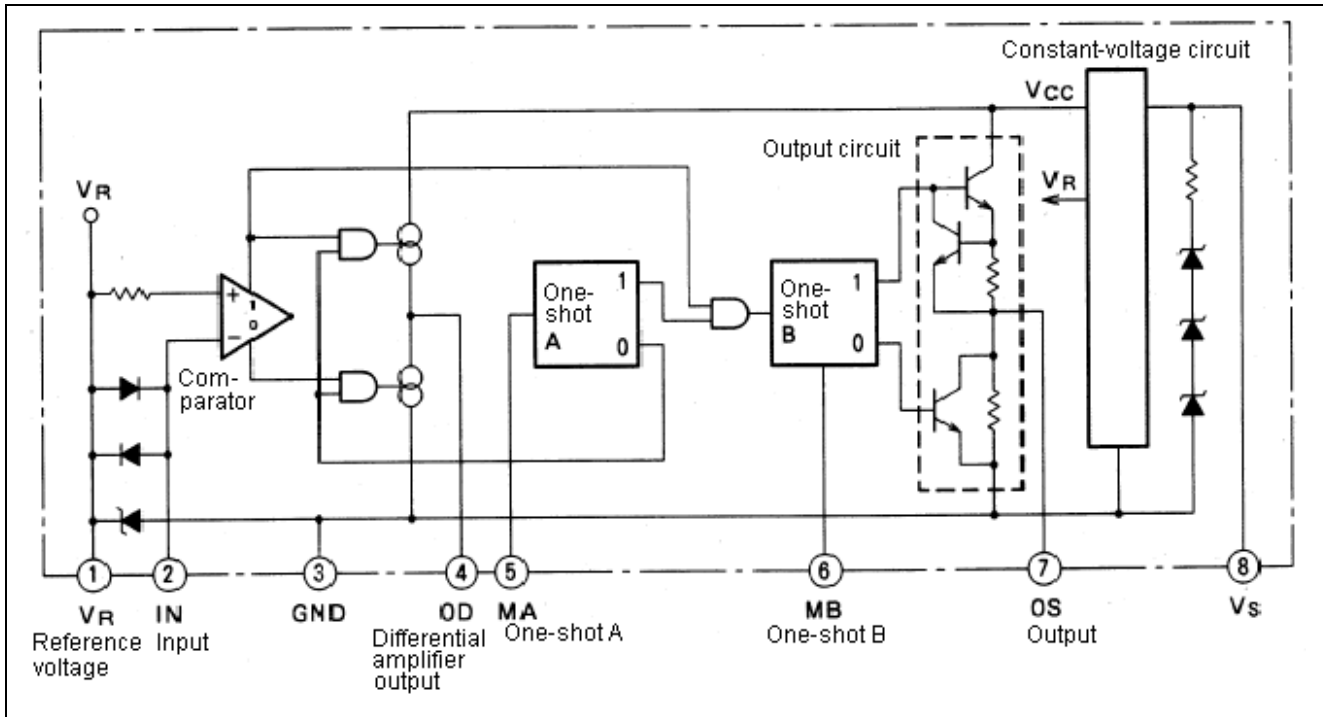
### Applications

- High-speed earth leakage breaker

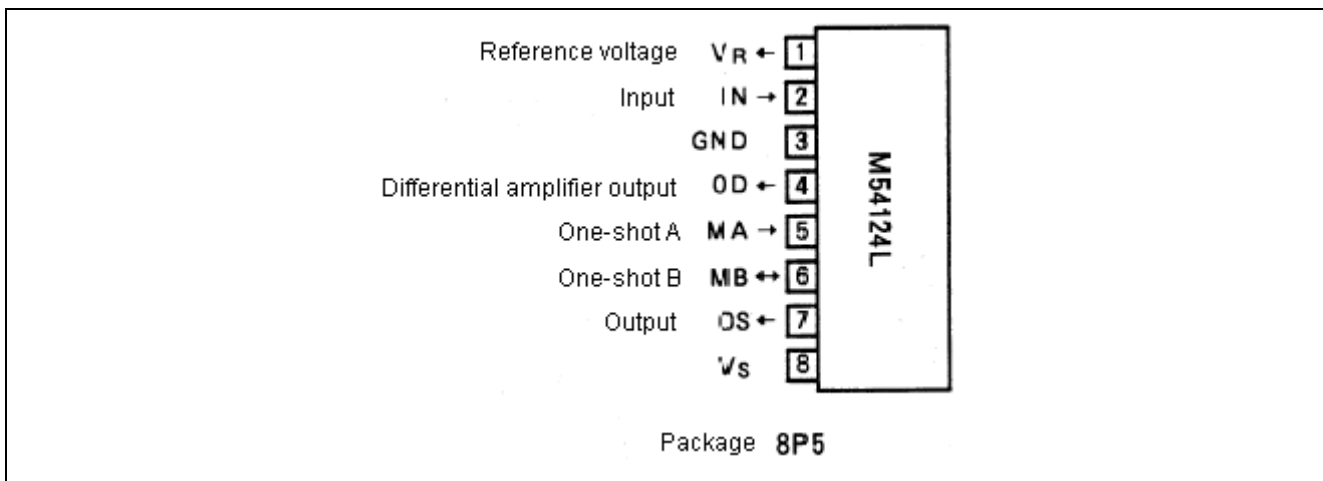
### Summary of Functions

This integrated circuit is used in the amplification unit of earth leakage breakers, and consists of a differential amplifier, one-shot circuit, output circuit, and constant-voltage circuit. The secondary side of a zero-phase current transformer (ZCT) which detects leakage currents is connected to both inputs of the differential amplifier. The signal amplified by the differential amplifier is integrated by an external capacitor, and after obtaining a time delay satisfying the characteristics of a high-speed earth leakage breaker as stipulated in JIS C 8371, is connected to the input of the one-shot circuit. The one-shot circuit holds its output at "L" level until the input voltage reaches a prescribed level, and when a leakage current above the prescribed level flows, generates an "H" one-shot pulse at the output, to drive a thyristor connected to the output.

Block Diagram



Pin Configuration (Top view)

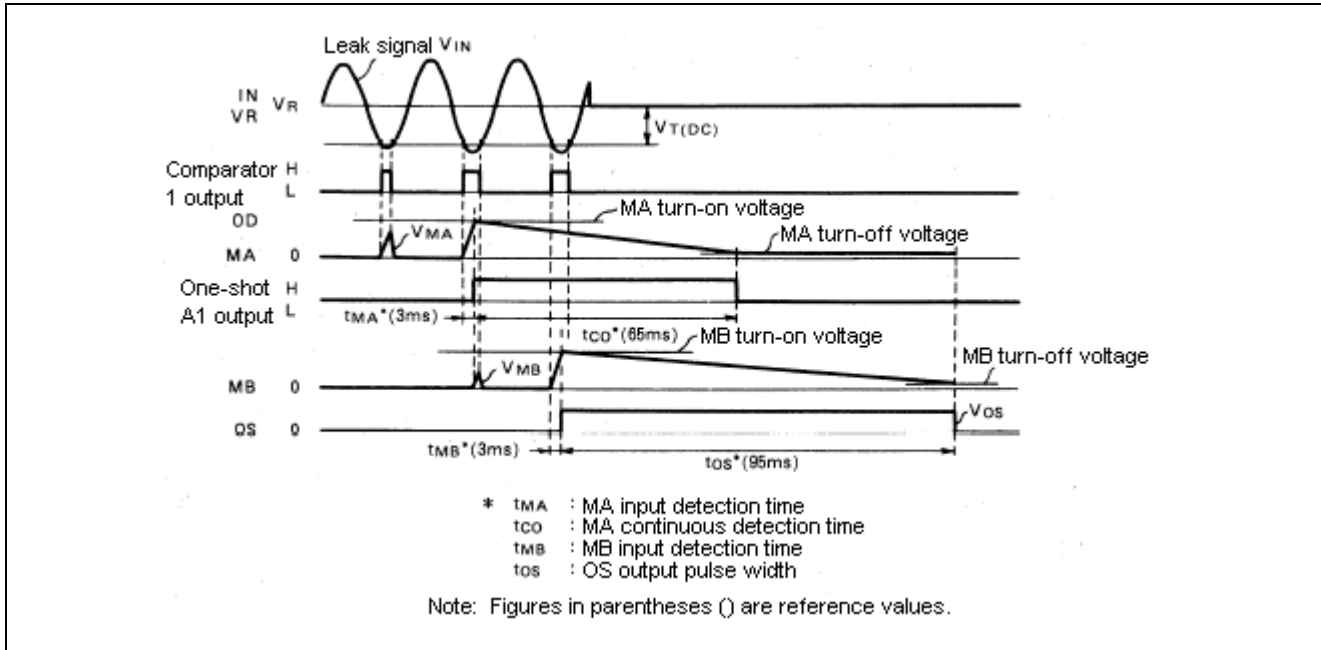


## Explanation of Operation

Operation is explained referring to the block diagram, an application example, and operation waveform diagrams.

- When a leakage current  $I_g$  occurs on the primary side of ZCT (the zero-phase current transformer), a leakage signal voltage  $V_{IN}$  appears in the secondary-side output, and is input to the input pin IN with the reference voltage pin VR as reference.
- During the half-cycle when  $V_{IN}$  is negative, in the interval in which  $V_{IN}$  is below the DC trip voltage  $V_T$  (DC), the capacitor CMA connected to pin MA is charged. In this case, if the pin voltage  $V_{MA}$  does not reach the MA turn-on voltage, when the charging interval ends the capacitor CMA is discharged with a current greater than the charging current. If the pin voltage  $V_{MA}$  reaches the MA turn-on voltage, from that moment until  $V_{MA}$  reaches the MA turn-off voltage, CMA is discharged with a small current, to obtain the time  $t_{CO}$ .
- During the interval of this time  $t_{CO}$ , a similar operation is performed for the capacitor CMB, as a result of which an output current with pulse width  $t_{OS}$  is output from the output pin OS.
- That is, the leakage current when the interval during which the amplitude of the input voltage  $V_{IN}$  is equal to or greater than the DC trip voltage  $V_T$  (DC) coincides with the input detection time  $t_{MA}$  ( $= t_{MB}$ ) is the sense current for the earth leakage breaker.
- Also, the output current turns on the thyristor, opening an external contact point to cause the breaker to operate.

## Operation Waveforms



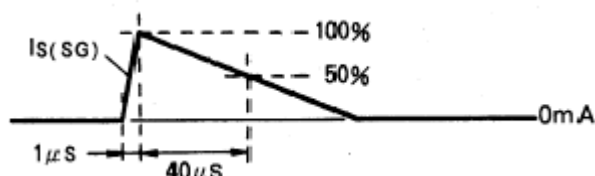
## Absolute Maximum Ratings

(Unless otherwise noted, Ta = -20 to 80°C)

Symbol	Quantity	Conditions	Rated value	Unit
I <sub>S</sub>	Power supply voltage		8	mA
I <sub>S(SG)</sub>	Power supply surge current	(Note 1)	12	mA
I <sub>IN</sub>	Input current	Across IN-VR (Note 2)	-250 to +250	mA
I <sub>IG</sub>	Input pin current	Across VR-GND, IN-GND	30	mA
V <sub>OD</sub>	OD applied voltage	When an external voltage is applied	6	V
I <sub>MA</sub>	MA input voltage	When an external voltage is applied	4	mA
V <sub>OS</sub>	OS applied voltage	When an external voltage is applied	6	V
P <sub>d</sub>	Power consumption		200	mW
T <sub>opr</sub>	Operating temperature		-20 to 80	°C
T <sub>stg</sub>	Storage temperature		-55 to 125	°C

Remarks: When not specified, voltages are expressed taking the circuit GND pin level to be 0 V, and currents are expressed taking the direction of flow into the circuit to be positive (no sign given), and the direction flowing out to be negative (prepending with "-"). Rated values, standard values, and other maximum and minimum values are given as absolute values.

Note 1: The I<sub>S(SG)</sub> current waveform is as indicated on the right; there is one shot or less in one minute.



## Recommended Operating Conditions

(unless otherwise noted, Ta = -20 to 80°C)

Symbol	Quantity	Rated value			Unit
		Min.	Typ.	Max.	
V <sub>S</sub>	Power supply voltage (when output is turned off)	12			V
C <sub>VS</sub>	VS-GND capacitance	1			μF
C <sub>OS</sub>	OS-GND capacitance			1	μF
C <sub>MA</sub>	MA-GND capacitance		0.1		μF
C <sub>MB</sub>	MB-GND capacitance		0.1		μF
R <sub>IN</sub>	IN external resistance		100		Ω

## Electrical Characteristics

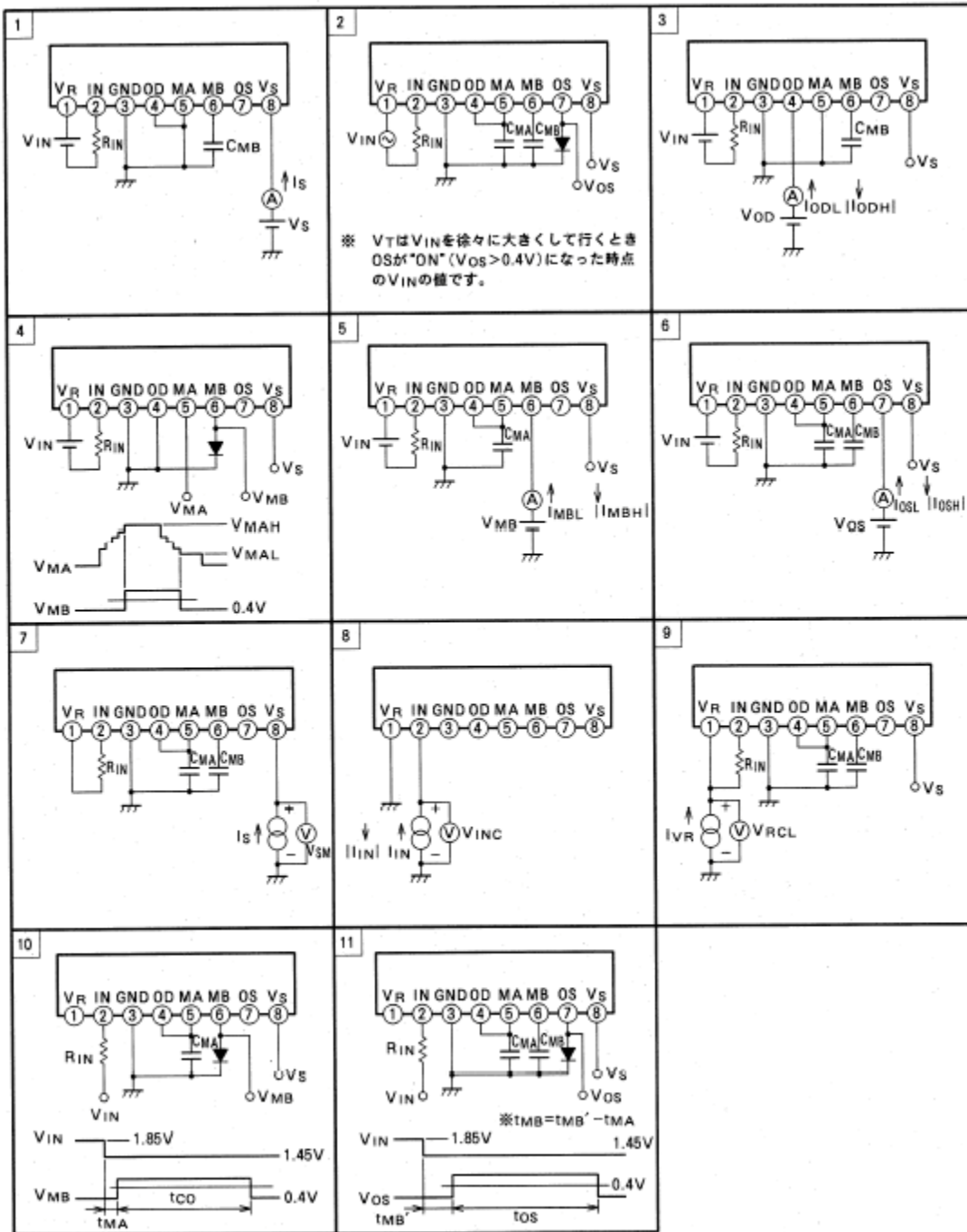
(unless otherwise noted, Ta = -20 to 80°C)

Symbol	Quantity	Measurement conditions	Rated value			Unit	
			Temperature	Measurement circuit	Min.		Typ.
I <sub>S</sub>	Power supply current	V <sub>S</sub> = 12 V, V <sub>IN</sub> = -15 mV		1		800	μA
V <sub>T</sub>	Trip voltage	V <sub>S</sub> = 16 V 60 Hz sine wave		2	4	9	mVrms
I <sub>ODL</sub>	OD sink current	V <sub>S</sub> = 16 V, V <sub>IN</sub> = 0 mV, V <sub>OD</sub> = 4 V	25	3	120	240	μA
I <sub>ODH</sub>	OD source current	V <sub>S</sub> = 16 V, V <sub>IN</sub> = -15 mV, V <sub>OD</sub> = 4 V	25	3	-75	-150	μA
V <sub>MAH</sub>	MA turn-on voltage	V <sub>S</sub> = 16 V, V <sub>IN</sub> = -15 mV	25	4	2.8	3.4	V
V <sub>MAL</sub>	MA turn-off voltage	V <sub>S</sub> = 16 V, V <sub>IN</sub> = -15 mV	25	4	0.8	1.2	V
I <sub>MBL</sub>	MB sink current	V <sub>S</sub> = 16 V, V <sub>IN</sub> = 0 mV, V <sub>MB</sub> = 1.6 V	25	5	120	240	μA
I <sub>MBH</sub>	MB source current	V <sub>S</sub> = 16 V, V <sub>IN</sub> = -15 mV, V <sub>MB</sub> = 1.6 V	25	5	-75	-150	μA
I <sub>OSL</sub>	OS sink current	V <sub>S</sub> = 16 V, V <sub>IN</sub> = 0 mV, V <sub>OS</sub> = 0.2 V		6	200		μA
I <sub>OSH</sub>	OS source current	V <sub>S</sub> = 12 V, V <sub>IN</sub> = -15 mV, V <sub>OS</sub> = 1.6 V	-20	6	-200		μA
			+25		-100		
			+80		-75		
V <sub>SM</sub>	VS voltage at maximum current	I <sub>S</sub> = 7 mA	25	7	20	30	V
V <sub>INC</sub>	IN, VR input clamping voltage	V <sub>S</sub> = Open, I <sub>IN</sub> = ±100 mA	25	9	±0.4	±0.2	V
V <sub>RCL</sub>	VR clamping voltage	V <sub>S</sub> = 16 V, I <sub>VR</sub> = 20 mA	25	9	4.4	6.6	V
t <sub>MA</sub>	MA input detection time	V <sub>S</sub> = 16 V		10	1.7	4.0	ms
t <sub>CO</sub>	MA continuous detection time	V <sub>S</sub> = 16 V		10	40	100	ms
t <sub>MB</sub>	MB input detection time	V <sub>S</sub> = 16 V		11	1.7	4.0	ms
t <sub>OS</sub>	OS input detection time	V <sub>S</sub> = 16 V		11	60	150	ms

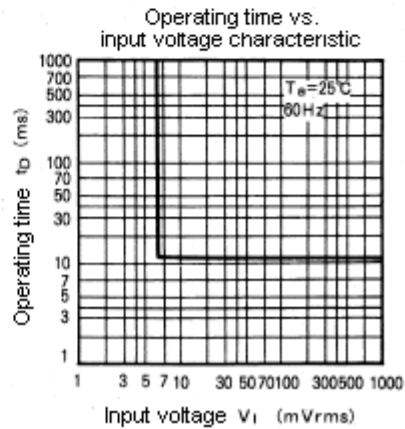
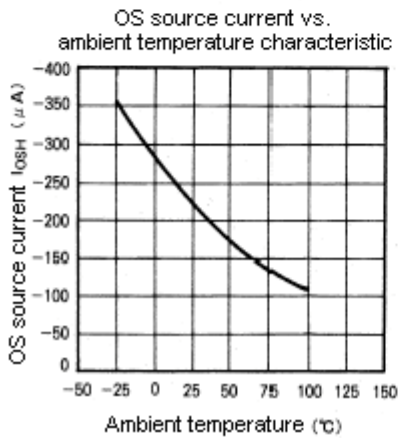
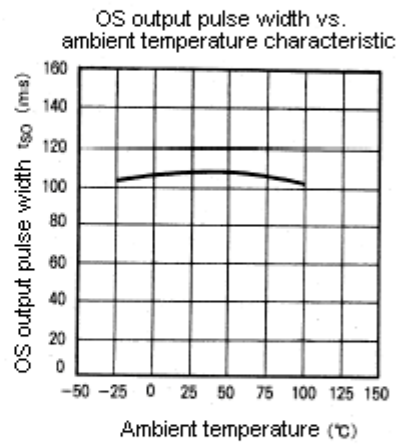
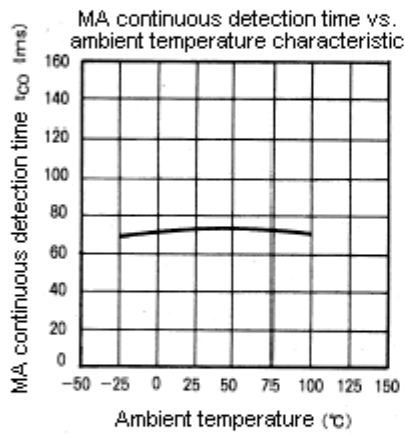
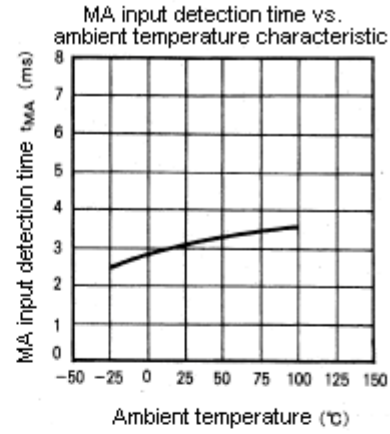
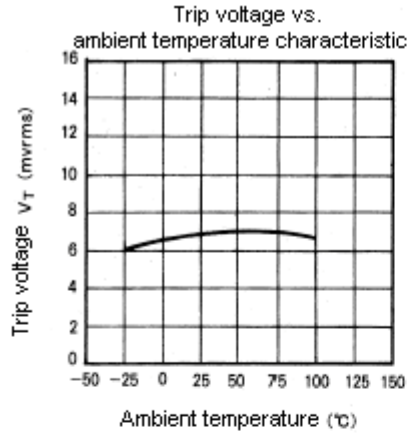
Note: V<sub>IN</sub> is the input voltage relative to V<sub>R</sub>, and is input to the input pin IN via the resistor R<sub>IN</sub>.

Measurement Circuits

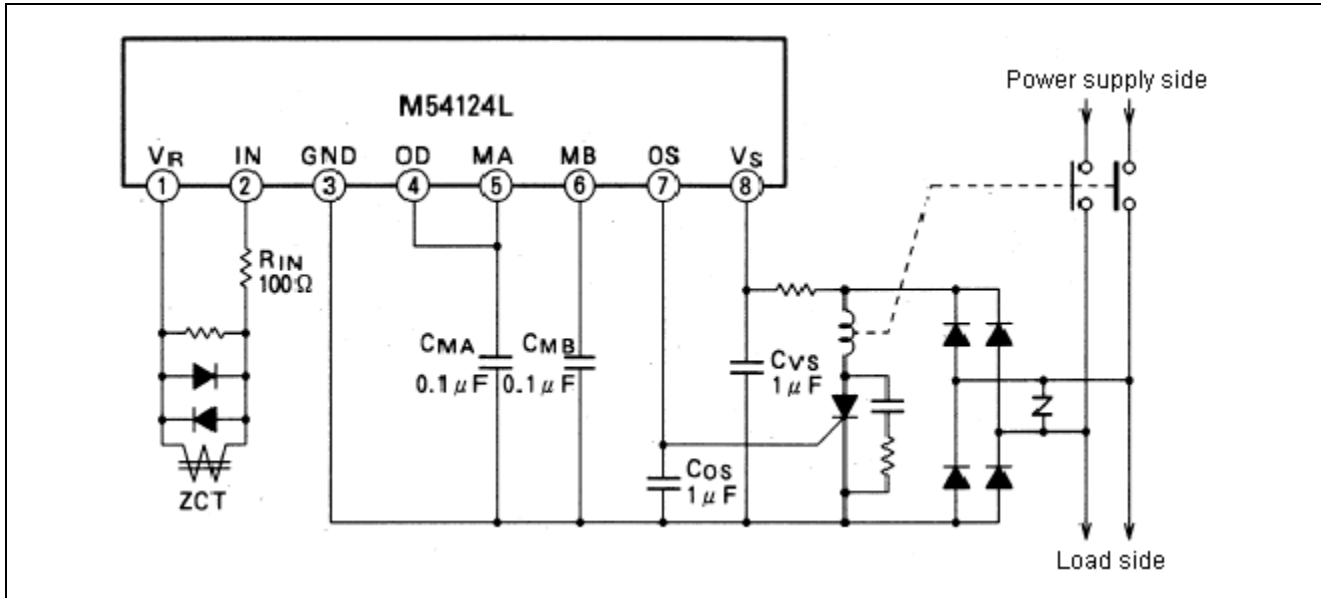
(unless otherwise noted,  $C_{MA} = 0.1 \mu\text{F}$ ,  $C_{MB} = 0.1 \mu\text{F}$ ,  $R_{IN} = 100 \Omega$ , and diodes are equivalent to MD234)



Characteristic Curves



## Application Circuit Example (High-speed earth leakage breaker using the M54124L)



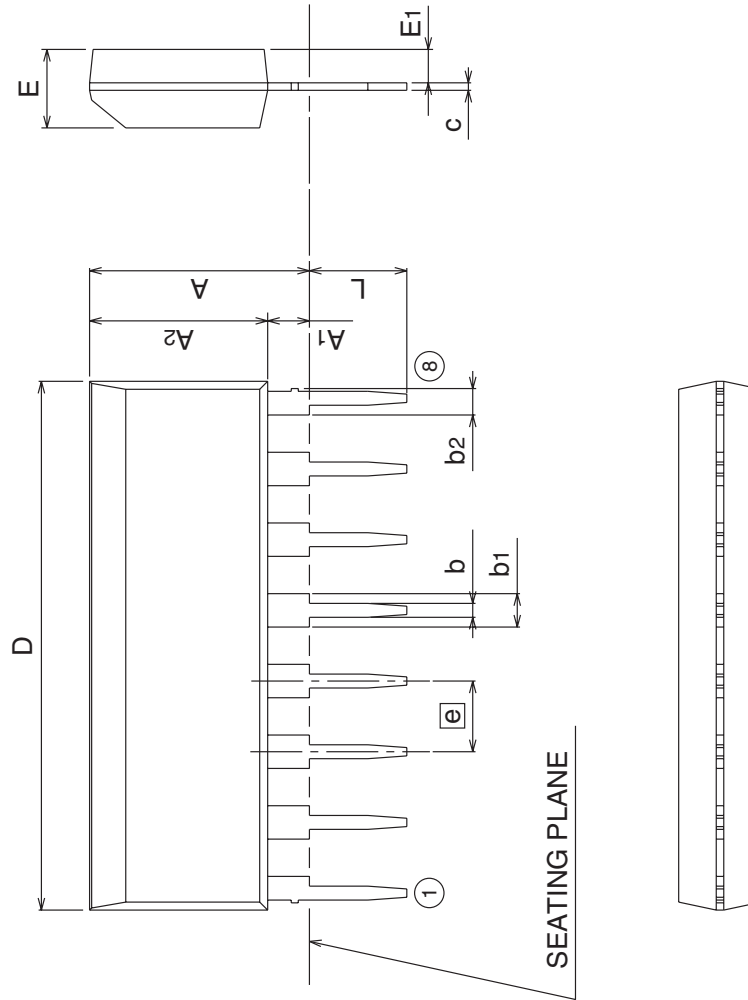


Package Dimensions

**8P5**

**Plastic 8pin 340mil SIP**

EIAJ Package Code SIP8-P-340-2.54	JEDEC Code —	Weight(g) 0.73	Lead Material Cu Alloy
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Symbol	Dimension in Millimeters		
	Min	Nom	Max
A	—	—	8.3
A1	1.2	—	—
A2	—	6.4	—
b	0.4	0.5	0.6
b1	1.1	1.2	1.5
b2	0.75	0.85	1.15
c	0.22	0.27	0.34
D	18.8	19.0	19.2
E	2.6	2.8	3.0
E1	1.1	1.2	1.3
e	—	2.54	—
L	3.0	—	—

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