M54124L

Earth Leakage Current Detector

REJ03F0031-0100Z
Rev.1.0
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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 (Ta=-20 to 80°C)

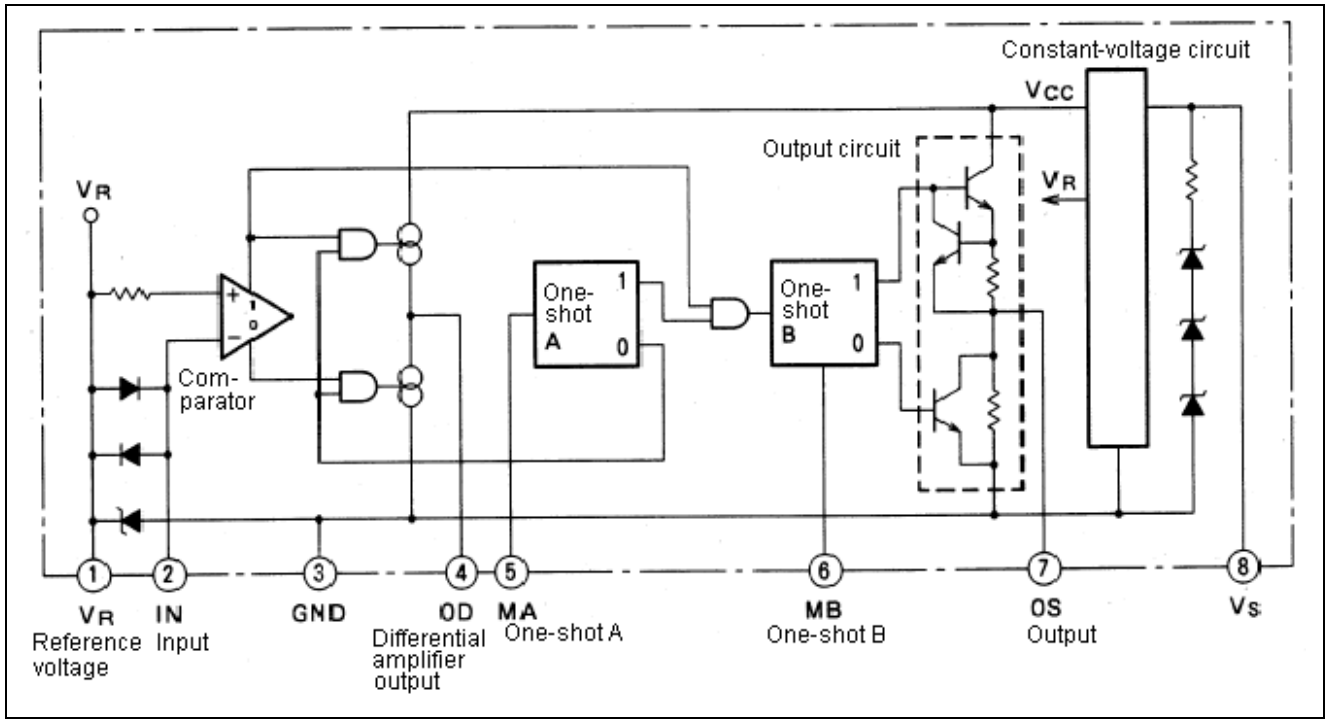
Applications

- High-speed earth leakage breaker

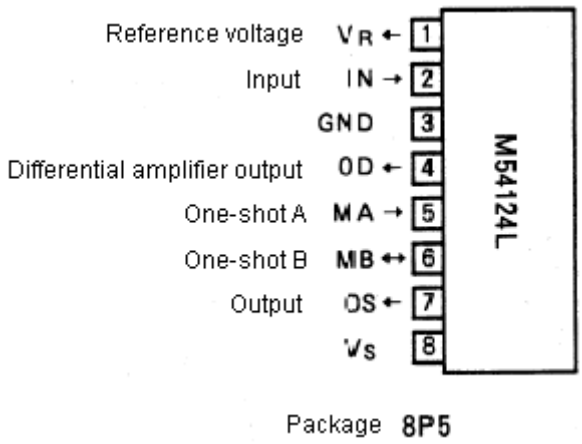
Summary of Functions

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)



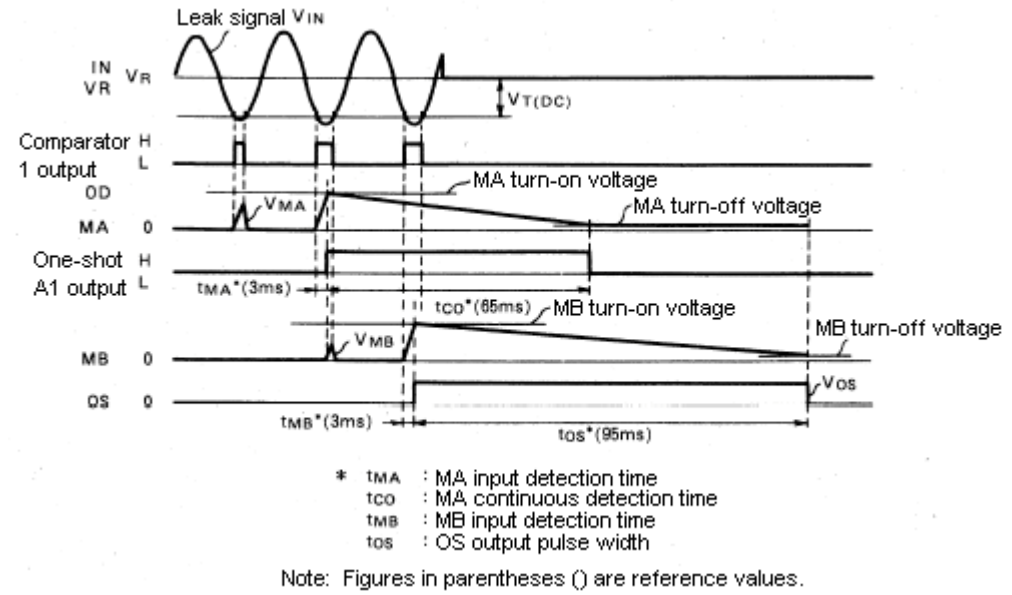
Package 8P5

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, C_{MA} 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 C_{MB}, 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



Note: Figures in parentheses () are reference values.

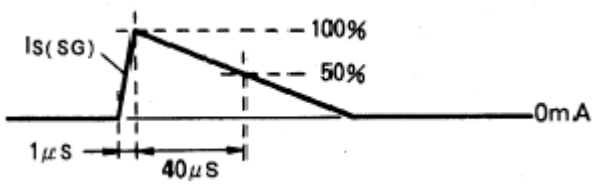
Absolute Maximum Ratings

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

Symbol	Quantity	Conditions	Rated value	Unit
Is	Power supply voltage		8	mA
$I_{S(SG)}$	Power supply surge current	(Note 1)	12	mA
I_{IN}	Input current	Across IN-VR (Note 2)	–250 to +250	mA
I_{IG}	Input pin current	Across VR-GND, IN-GND	30	mA
V_{OD}	OD applied voltage	When an external voltage is applied	6	V
I_{MA}	MA input voltage	When an external voltage is applied	4	mA
V_{OS}	OS applied voltage	When an external voltage is applied	6	V
Pd	Power consumption		200	mW
Topr	Operating temperature		–20 to 80	°C
Tstg	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 (prepended with "-"). Rated values, standard values, and other maximum and minimum values are given as absolute values.

Note 1: The $I_{S(SG)}$ 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.	
Vs	Power supply voltage (when output is turned off)	12			V
C_{VS}	VS-GND capacitance	1			μF
C_{OS}	OS-GND capacitance			1	μF
C_{MA}	MA-GND capacitance		0.1		μF
C_{MB}	MB-GND capacitance		0.1		μF
R_{IN}	IN external resistance		100		Ω

Electrical Characteristics

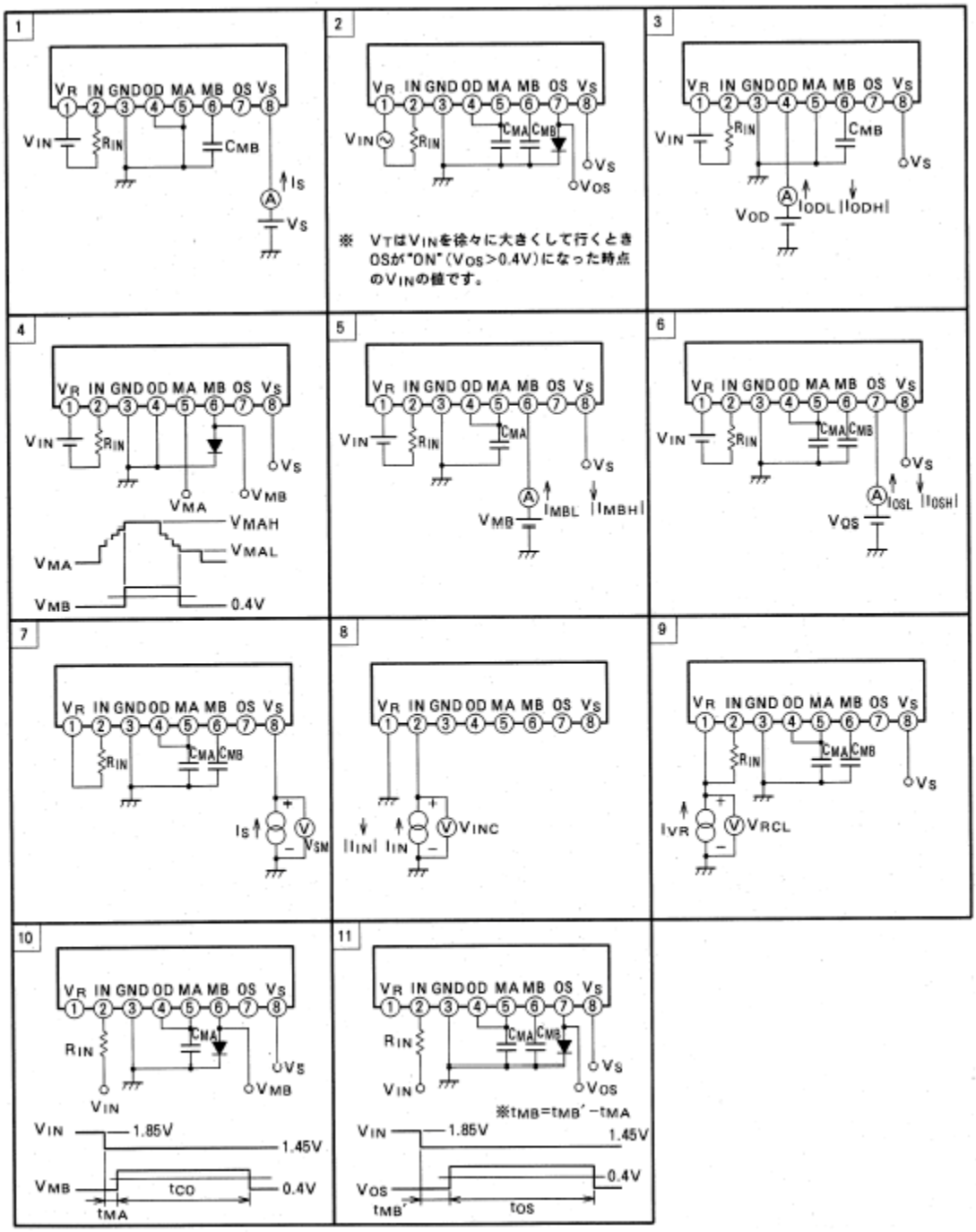
(unless otherwise noted, Ta = -20 to 80°C)

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

Note: V_{IN} is the input voltage relative to V_R, and is input to the input pin IN via the resistor R_{IN}.

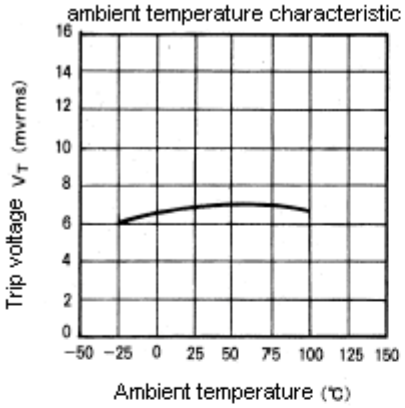
Measurement Circuits

(unless otherwise noted, C_{MA} = 0.1 µF, C_{MB} = 0.1 µF, R_{IN} = 100 Ω, and diodes are equivalent to MD234)

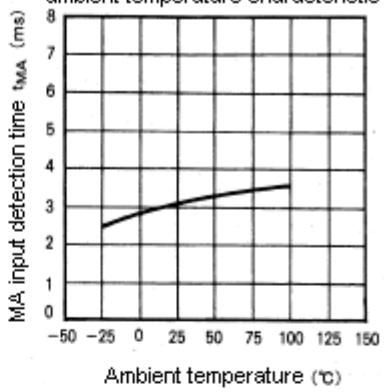


Characteristic Curves

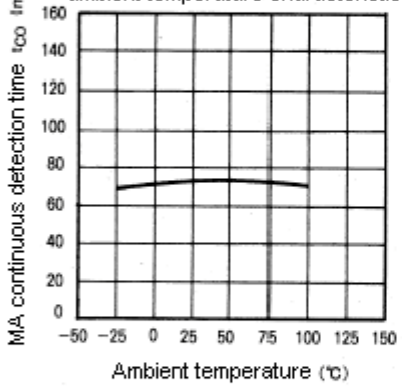
Trip voltage vs. ambient temperature characteristic



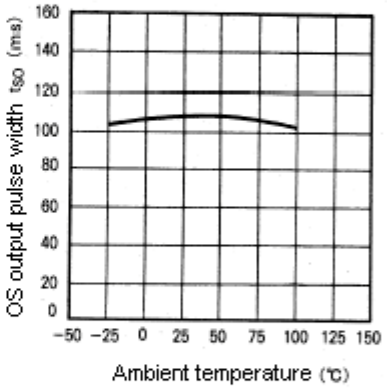
MA input detection time vs. ambient temperature characteristic



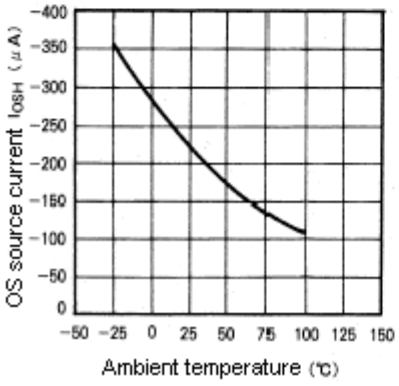
MA continuous detection time vs. ambient temperature characteristic



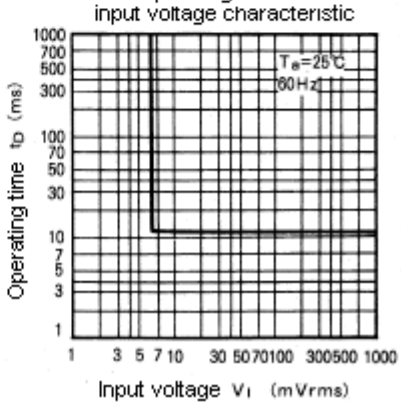
OS output pulse width vs. ambient temperature characteristic



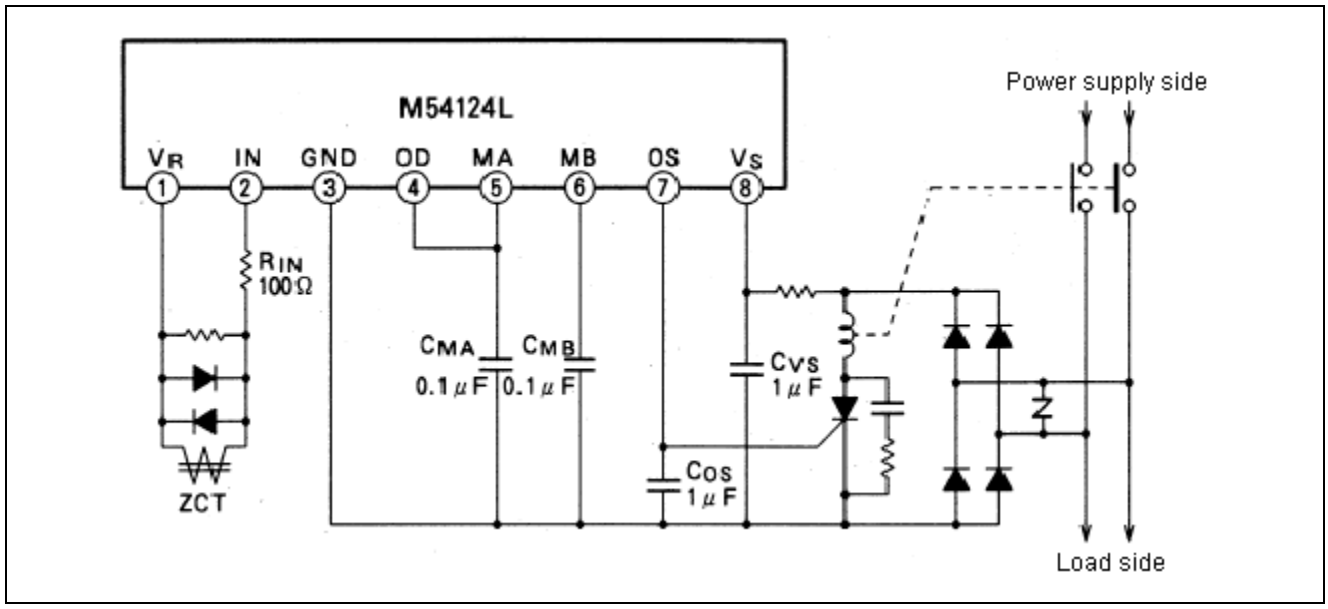
OS source current vs. ambient temperature characteristic



Operating time vs. input voltage characteristic

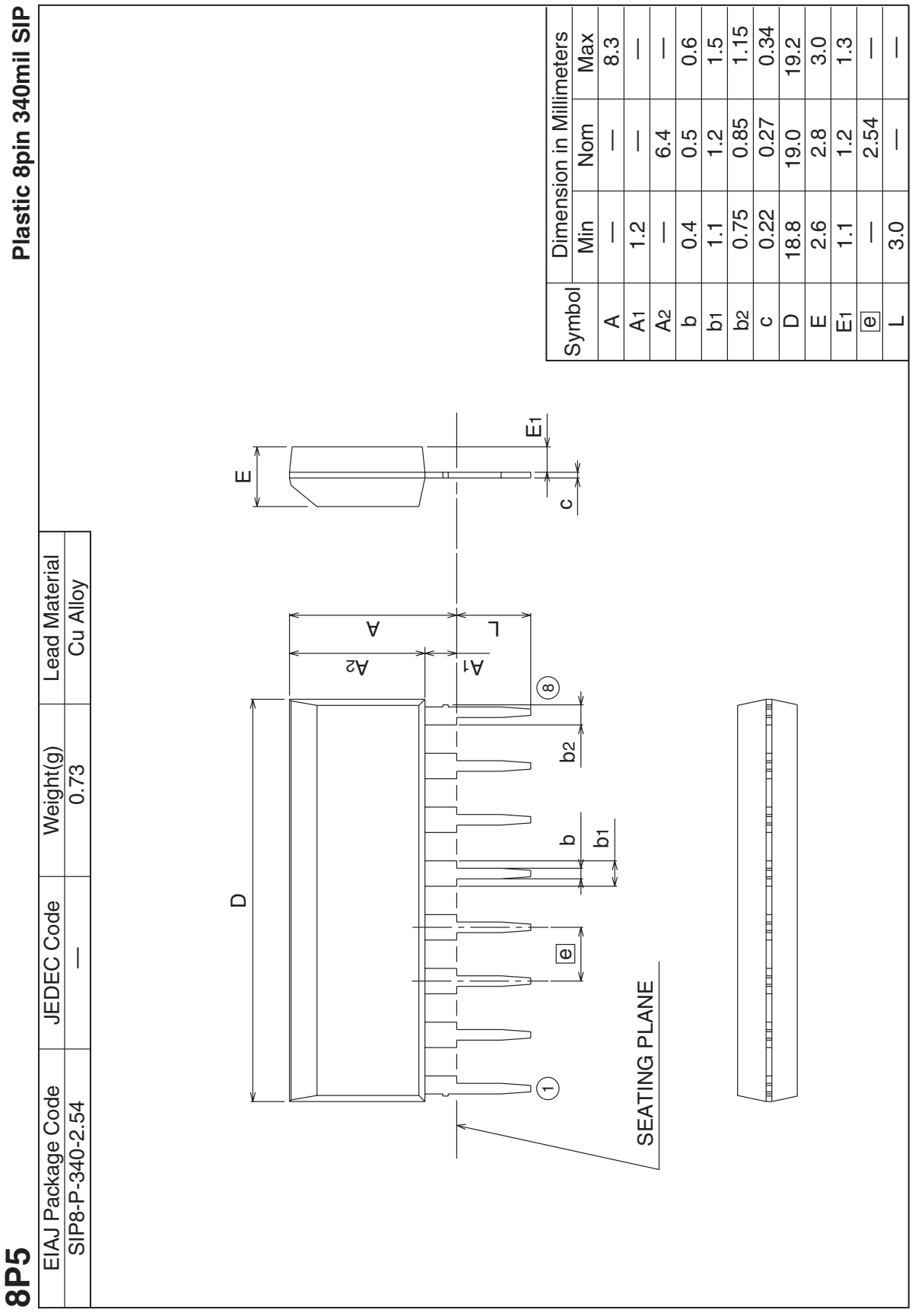


Application Circuit Example (High-speed earth leakage breaker using the M54124L)



Package Dimensions

Plastic 8pin 340mil SIP



Symbol	Dimension in Millimeters		
	Min	Nom	Max
A	—	—	8.3
A_1	1.2	—	—
A_2	—	6.4	—
b	0.4	0.5	0.6
b_1	1.1	1.2	1.5
b_2	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
E_1	1.1	1.2	1.3
e	—	2.54	—
L	3.0	—	—

8P5	EIAJ Package Code	JEDEC Code	Weight(g)	Lead Material
	SIP8-P-340-2.54	—	0.73	Cu Alloy

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