

# M54124L

## EARTH LEAKAGE CURRENT DETECTOR

### DESCRIPTION

The M54124L is a semiconductor integrated circuit consisting of an amplifier for a high-speed earth-leakage circuit breaker.

### FEATURES

- Satisfies JIS C 8371
- Temperature-stable input current threshold
- High-input sensitivity ( $V_T = 6.5\text{mV}$ )
- Low external component count
- Highly resistant to noise and power surges
- Low power dissipation ( $P_d = 5\text{mW typ}$ )
- Can be used at 100V and 200V
- High-density mounting eight-pin SIL package
- Wide operating temperature range ( $T_a = -20 - +80^\circ\text{C}$ )

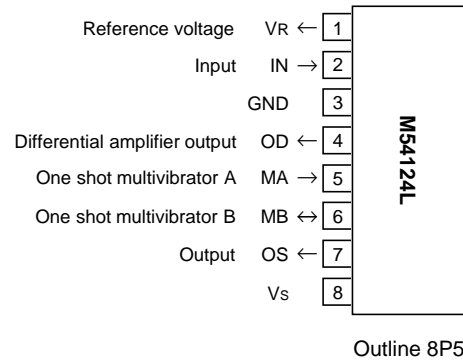
### APPLICATION

High-speed earth-leakage circuit breakers

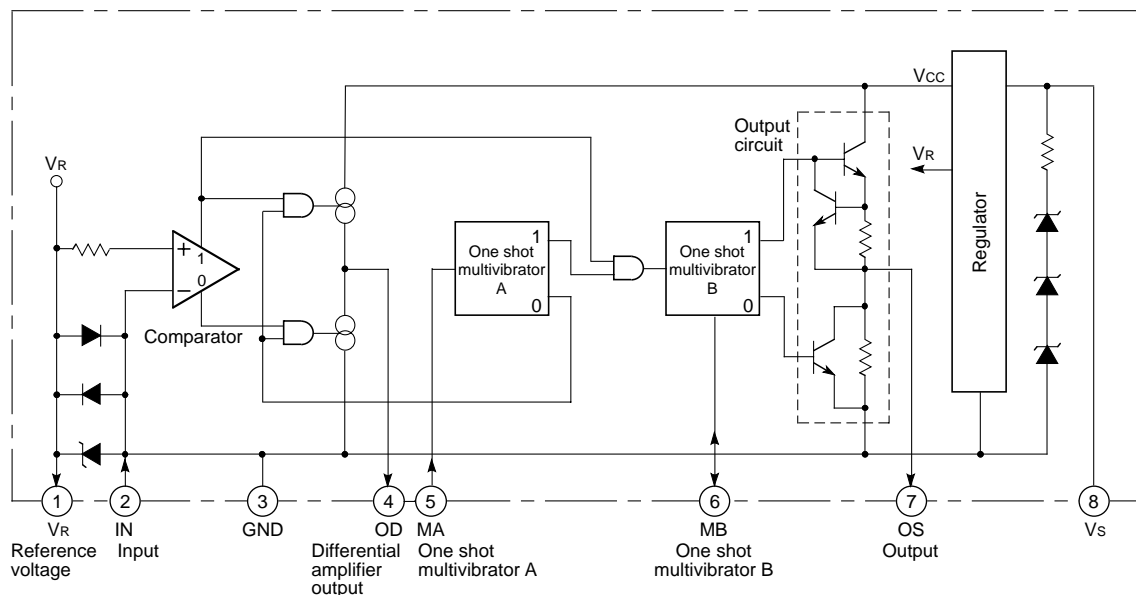
### FUNCTION

The M54124L is a semiconductor integrated circuit for use in the amplifier section of earth-leakage circuit breakers. It consists of a differential amplifier, one-shot circuit, output circuit and voltage regulator. It is connected to the secondary side of the zero-current transformer, ZCT, and detects leakage current in both inputs of the differential amplifier. Signals amplified by the differential amplifier are integrated by an external capacitor, and applied to the input pin of a one-shot multivibrator circuit having time-delay characteristics that are suitable for high-speed earth-leakage circuit breakers (such as specified in JIS C 8371). The one-shot multivibrator circuit normally maintains a low output. When the input current (earth-leakage) exceeds a specified level, a one-shot high pulse is output to turn on an externally connected thyristor.

### PIN CONFIGURATION (TOP VIEW)



### BLOCK DIAGRAM

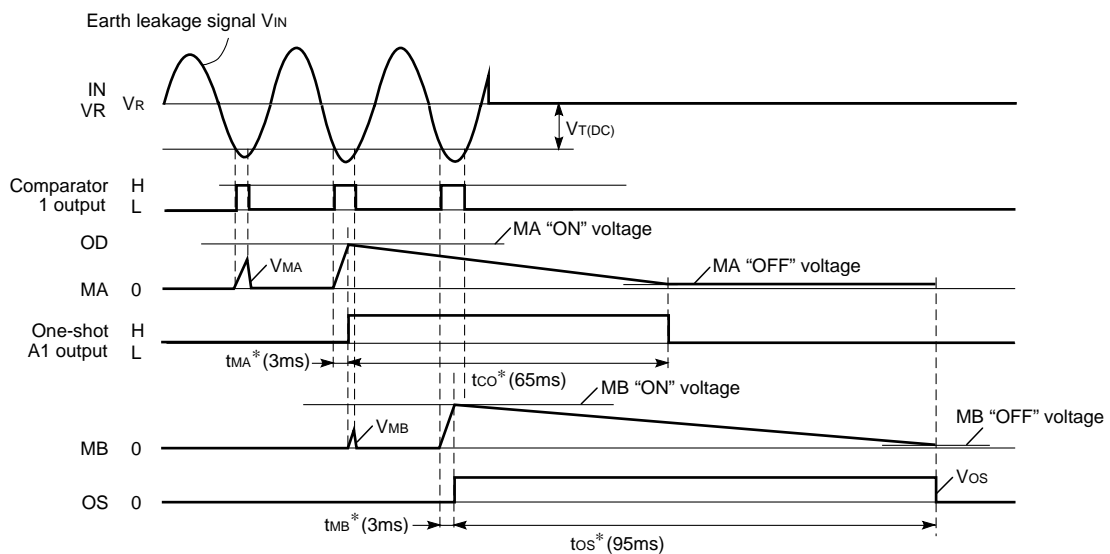


## OPERATION

Discussion refers to the block diagram, application example, and operational waveform diagram.

- When an earth leakage current appears on the primary side of zero-current transformer ZCT, leakage signal voltage  $V_{IN}$  appears on the secondary side and is input at IN with  $V_R$  as the reference.
- In the half cycle when  $V_{IN}$  is negative, capacitor  $C_{MA}$  connected to pin MA charges until  $V_{IN}$  reaches the trip voltage  $V_T$  (DC). If voltage  $V_{MA}$  at pin MA does not reach the MA threshold voltage, capacitor  $C_{MA}$  discharges immediately at a current greater than the charge current, when the charging current phase is completed. When  $V_{MA}$  reaches the MA threshold voltage, capacitor  $C_{MA}$  discharges at a small current for a period time  $t_{CO}$  during which the output of one-shot multivibrator A is high.
- During  $t_{CO}$ , the same operation takes place again at capacitor  $C_{MB}$ , causing one-shot multivibrator B to trigger current pulse of duration  $t_{OS}$  at output pin OS.
- Earth leakage currents are detected when the amplitude of input voltage  $V_{IN}$  exceeds the trip voltage  $V_T$  (DC) for longer than the input detection time  $t_{MA}$ .
- The output current is used to turn on the thyristor that opens the breaker contacts.

## OPERATING WAVEFORM DIAGRAM



\*  $t_{MA}$  : MA input detection time  
 $t_{CO}$  : MA detector on time  
 $t_{MB}$  : MB input detection time  
 $t_{OS}$  : OS output pulse width (MB detector on time)

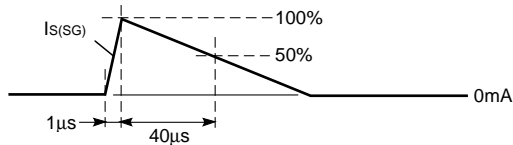
Note. The values in the parentheses are typical values for reference only.

**ABSOLUTE MAXIMUM RATINGS** (Ta = -20 – 80°C unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
Is	Supply voltage		8	mA
Is (SG)	Supply surge current	(Note 1)	12	mA
IIN	Input current	Between IN and VR (Note 2)	-250 – +250	mA
IIG	Input pin current	Between VR and GND, and between IN and GND	30	mA
VOD	OD applied voltage	When external voltage is applied	6	V
IMA	MA input current	When external voltage is applied	4	mA
VOS	OS applied voltage	When external voltage is applied	6	V
Pd	Power dissipation		200	mW
Topr	Operating temperature		-20 – 80	°C
Tstg	Storage temperature		-55 – 125	°C

Note 1: The surge waveform

The waveform of surge current Is(SG) is shown on the left. It is applied less than once per minute.

Note 2: Applies to currents between IN and VR with pulse widths less than 1ms and duty cycles less than 12%. If AC current is applied, the current limit is 100mA<sub>rms</sub> when the IC supply power is off.

Remark: Circuit voltage at GND pin is 0V. Current flowing into the circuit is positive (no sign) and the current flowing out from the circuit is negative (negative sign), unless otherwise noted. Maximum values of rated and specified values are shown in absolute values.

**RECOMMENDED OPERATING CONDITIONS** (Ta = -20 – 80°C unless otherwise noted)

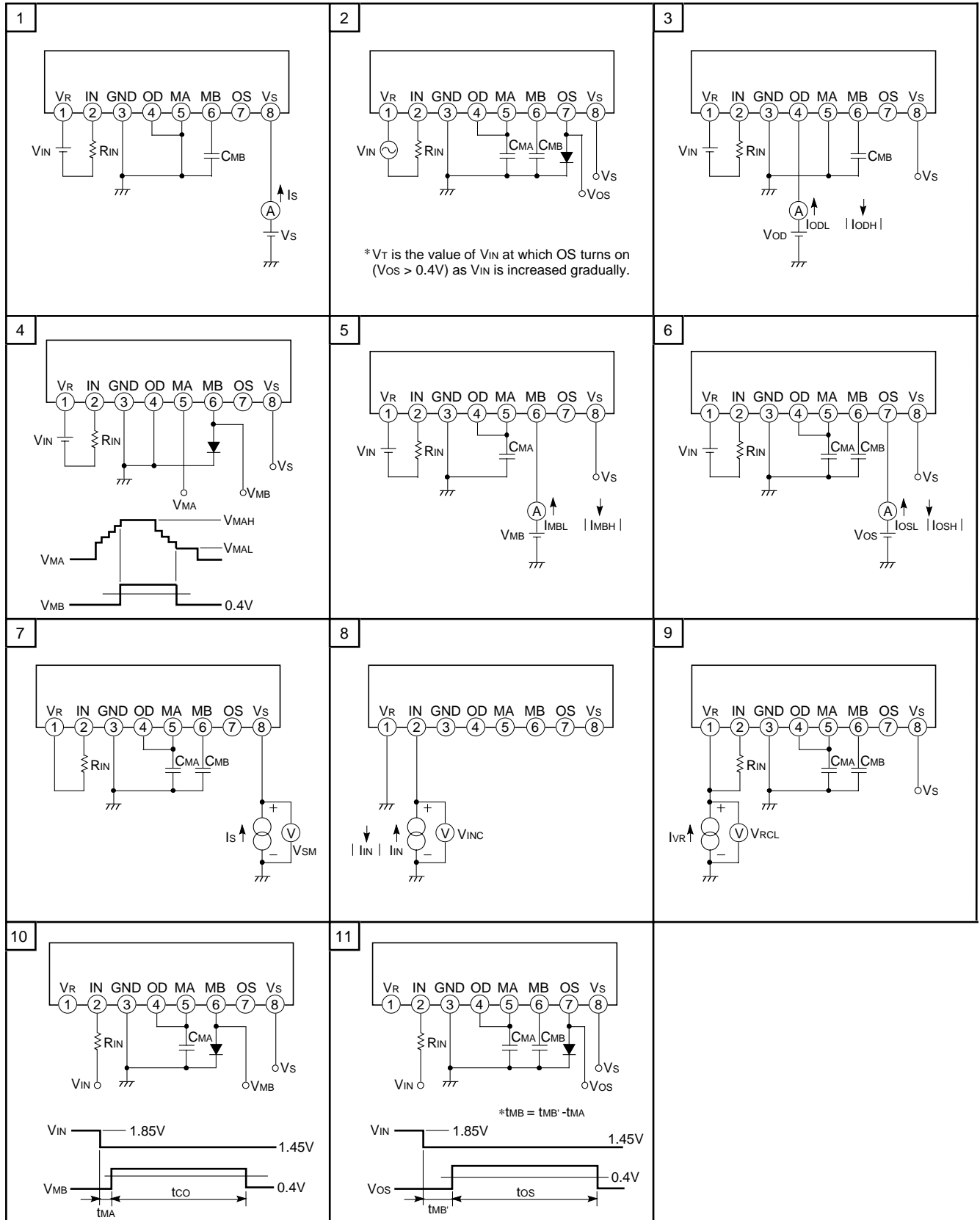
Symbol	Parameter	Limits			Unit
		Min.	Typ.	Max.	
Vs	Supply voltage when output is OFF	12			V
Cvs	Capacitance between VS and GND	1			μF
Cos	Capacitance between OS and GND			1	μF
CMA	Capacitance between MA and GND		0.1		μF
CMB	Capacitance between MB and GND		0.1		μF
RIN	External resistor at IN		100		Ω

**ELECTRICAL CHARACTERISTICS** (Ta = -20 – 80°C unless otherwise noted)

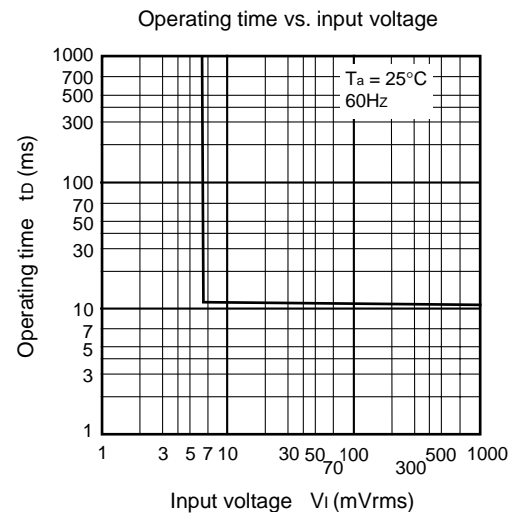
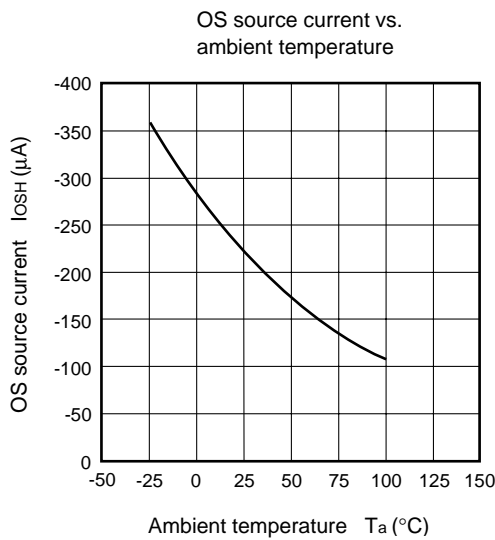
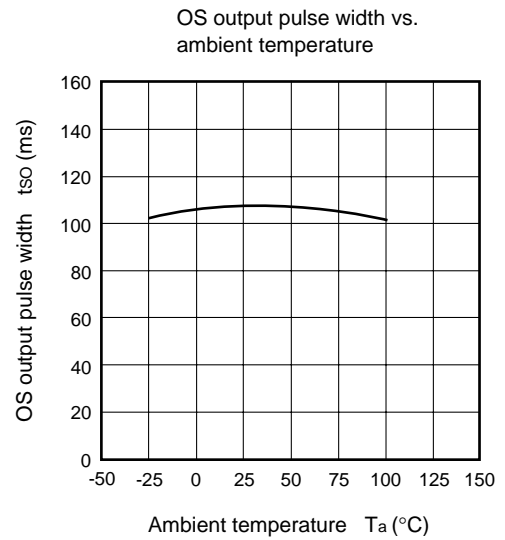
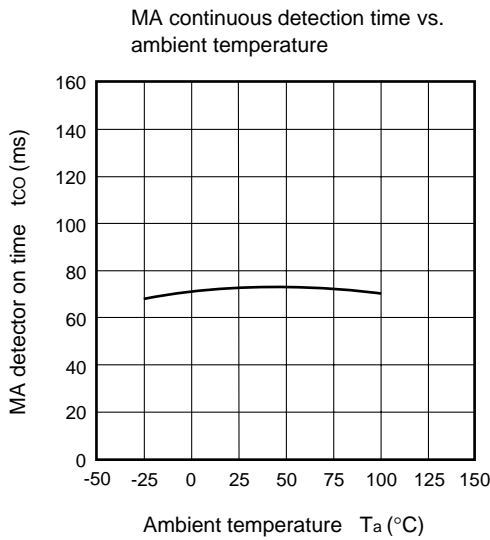
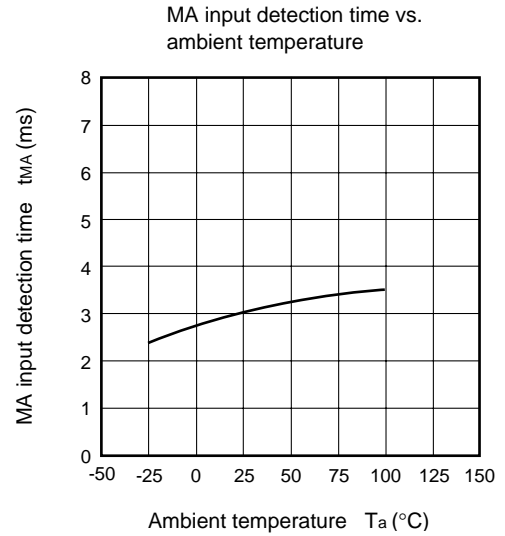
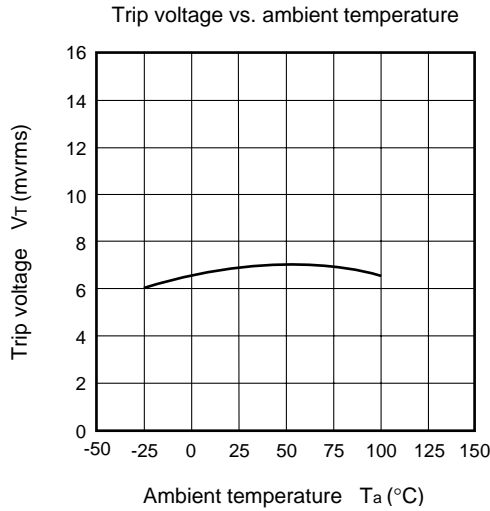
Symbol	Parameter	Test conditions	Temperature (°C)	Test circuit	Limits			Unit
					Min.	Typ.	Max.	
Is	Supply current	Vs = 12V, VIN = -15mV		1			800	μA
VT	Trip voltage	Vs = 16V, VIN: 60Hz sine wave		2	4		9	mVrms
I <sub>ODL</sub>	OD sink current	Vs = 16V, VIN = 0mV, VOD = 4V	25	3	120		240	μA
I <sub>ODH</sub>	OD source current	Vs = 16V, VIN = -15mV, VOD = 4V	25	3	-75		-150	μA
VMAH	MA "ON" voltage	Vs = 16V, VIN = -15mA	25	4	2.8		3.4	V
VMAL	MA "OFF" voltage	Vs = 16V, VIN = -15mA	25	4	0.8		1.2	V
IMBL	MB sink current	Vs = 16V, VIN = 0mA, VMB = 1.6V	25	5	120		240	μA
IMBH	MB source current	Vs = 16V, VIN = -15mA, VMB = 1.6V	25	5	-75		-150	μA
I <sub>OSL</sub>	OS sink current	Vs = 16V, VIN = 0mA, Vos = 0.2V		6	200			μA
I <sub>OSH</sub>	OS source current	Vs = 12V, VIN = -15mA, Vos = 1.6V	-20	6	-200			μA
			+25		-100			
			+80		-75			
VSM	VS maximum current voltage	Is = 7mA	25	7	20		30	V
VINC	IN, VR input clamp voltage	Vs : open, IIN = ±100mA	25	9	±0.4		±2.0	V
VRCL	VR clamp voltage	Vs = 16V, I <sub>VR</sub> = 20mA	25	9	4.4		6.6	V
tMA	MA input detection time	Vs = 16V		10	1.7		4.0	ms
tCO	MA detector on time	Vs = 16V		10	40		100	ms
tMB	MB input detection time	Vs = 16V		11	1.7		4.0	ms
tOS	OS input detection time	Vs = 16V		11	60		150	ms

Note: VIN is the input voltage with VR as reference. VIN is applied to IN through resistor RIN.

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

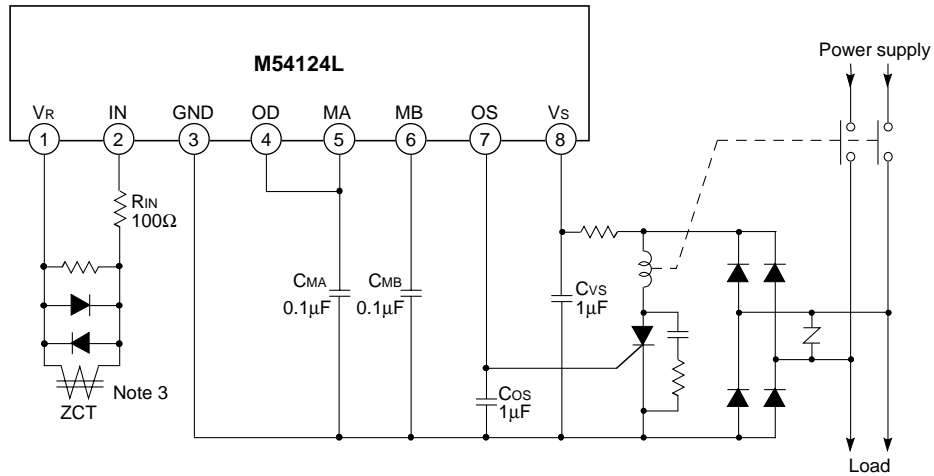


**TYPICAL CHARACTERISTICS**



**APPLICATION EXAMPLE**

- A high-speed earth-leakage circuit breaker using the M54124L



Note 3 : MZ Core Series by Soryo Denshi Kagaku Co., Ltd (Mitsubishi Subsidiary)  
Tel. +81-427-74-7813

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