

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 ($T_a = -20 - +80^\circ\text{C}$)

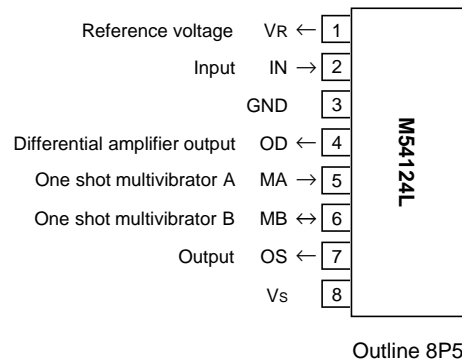
APPLICATION

High-speed earth-leakage circuit breakers

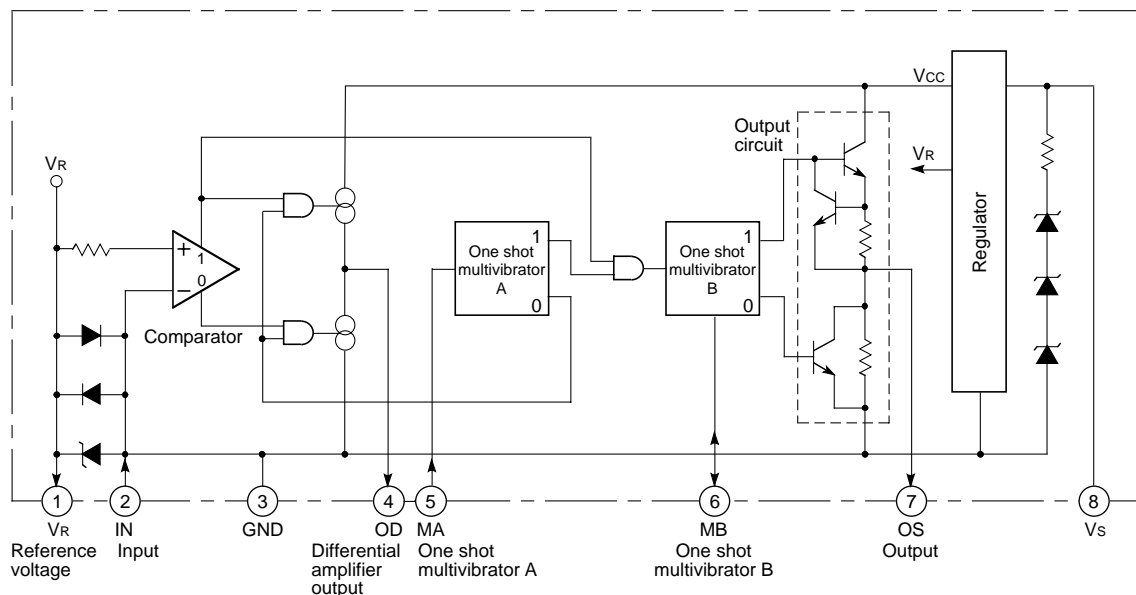
FUNCTION

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

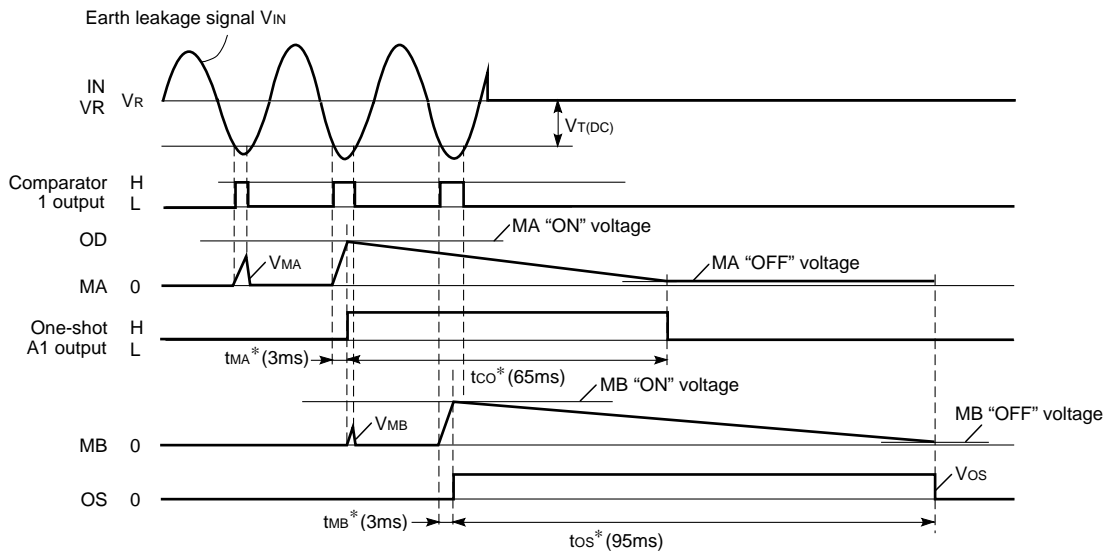


OPERATION

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



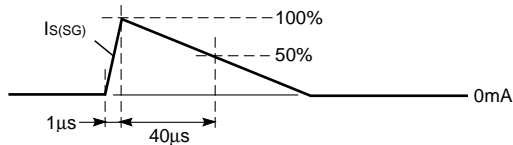
* t_{MA} : MA input detection time
 * t_{CO} : MA detector on time
 * t_{MB} : MB input detection time
 * t_{OS} : OS output pulse width (MB detector on time)

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 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)

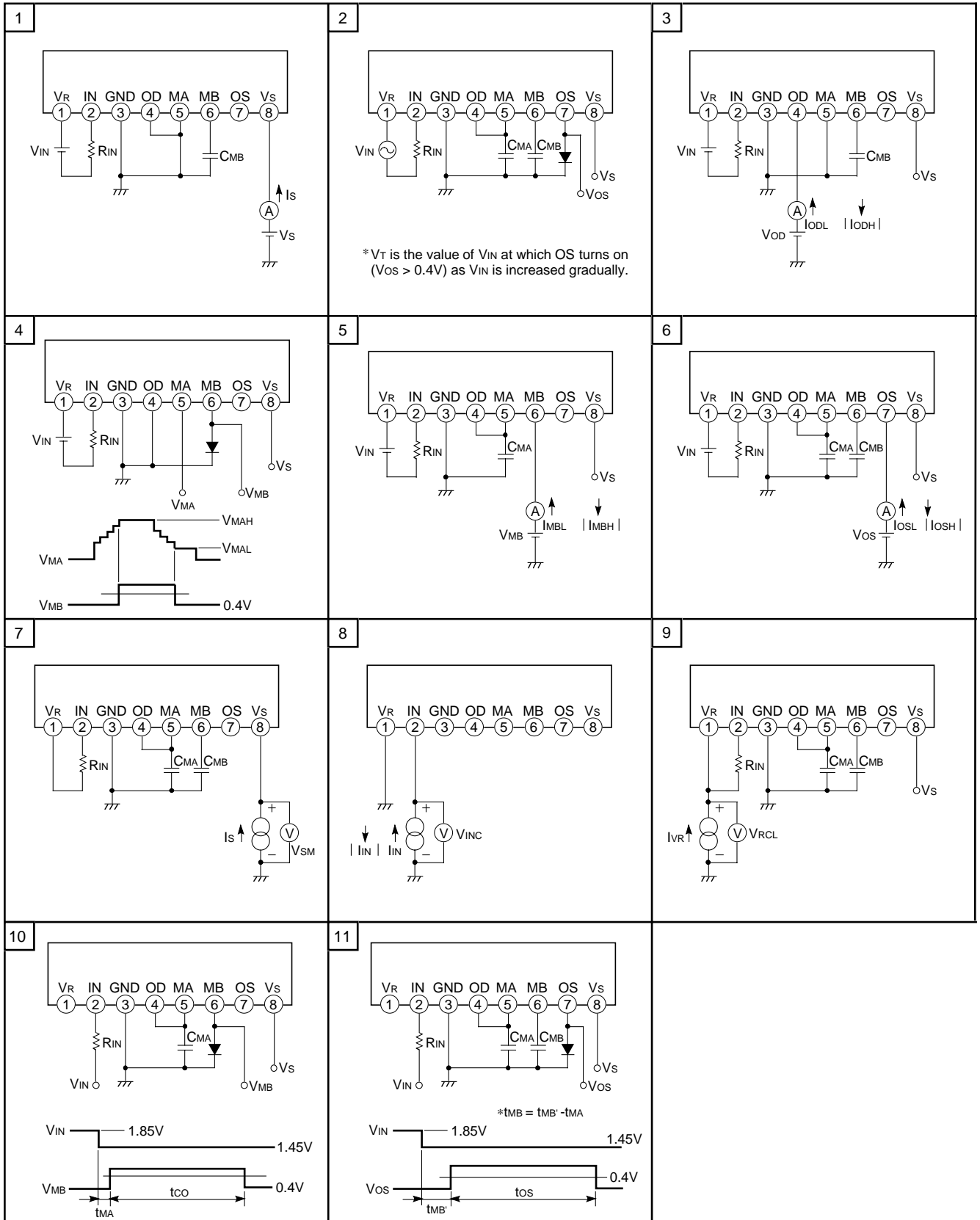
| Symbol | Parameter | Limits | | | Unit |
|--------|-----------------------------------|--------|------|------|------|
| | | Min. | Typ. | Max. | |
| Vs | Supply voltage when output is OFF | 12 | | | V |
| Cvs | Capacitance between VS and GND | 1 | | | µF |
| Cos | Capacitance between OS and GND | | | 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)

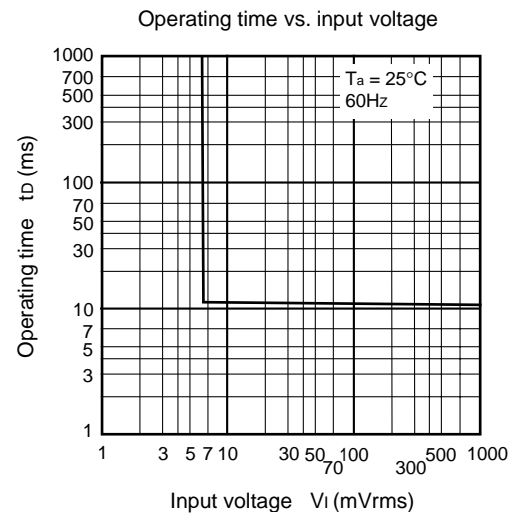
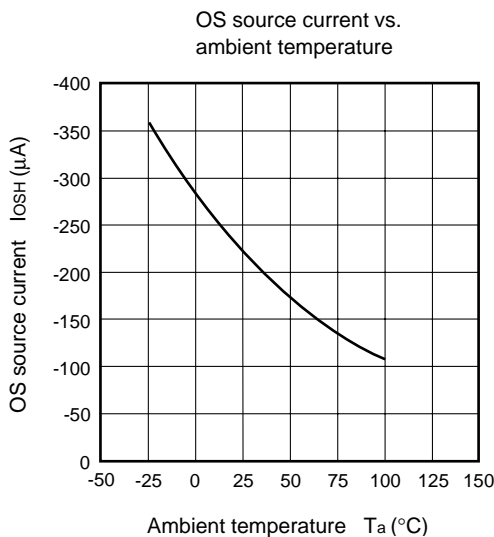
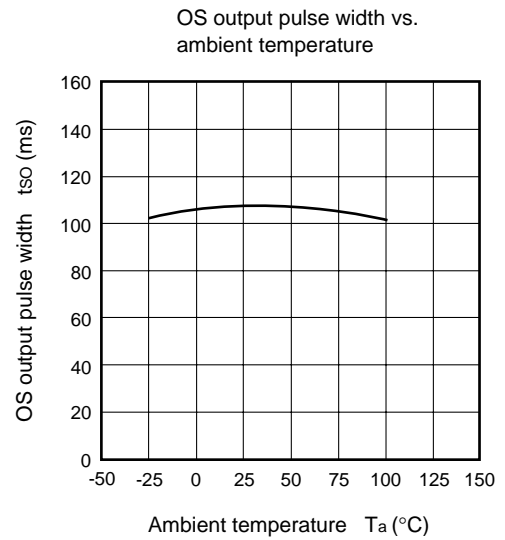
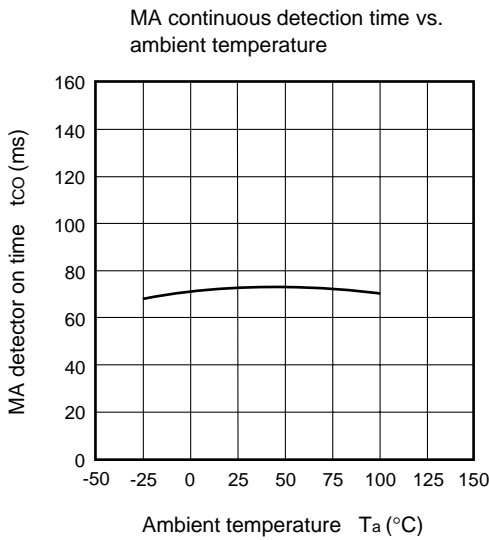
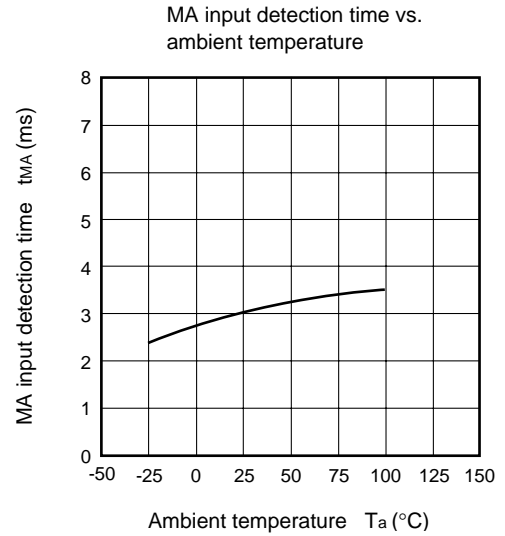
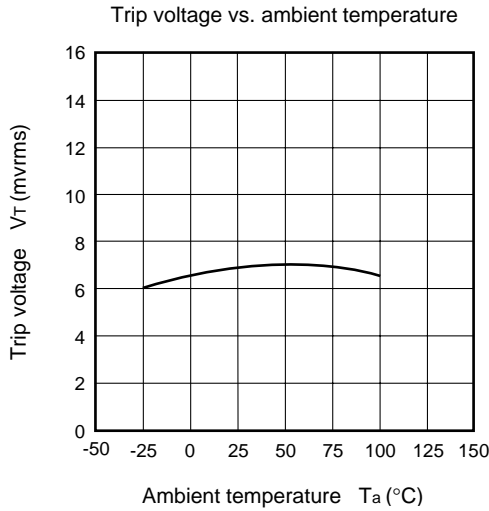
| Symbol | Parameter | Test conditions | Temperature (°C) | Test circuit | Limits | | | Unit |
|--------|----------------------------|-----------------------------------|------------------|--------------|--------|------|------|-------|
| | | | | | Min. | Typ. | Max. | |
| Is | Supply current | Vs = 12V, VIN = -15mV | | 1 | | | 800 | µA |
| Vt | Trip voltage | Vs = 16V, VIN: 60Hz sine wave | | 2 | 4 | | 9 | mVrms |
| IODL | OD sink current | Vs = 16V, VIN = 0mV, VOD = 4V | 25 | 3 | 120 | | 240 | µA |
| IODH | 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 |
| IOSL | OS sink current | Vs = 16V, VIN = 0mA, Vos = 0.2V | | 6 | 200 | | | µA |
| IOSH | 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, IVR = 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)

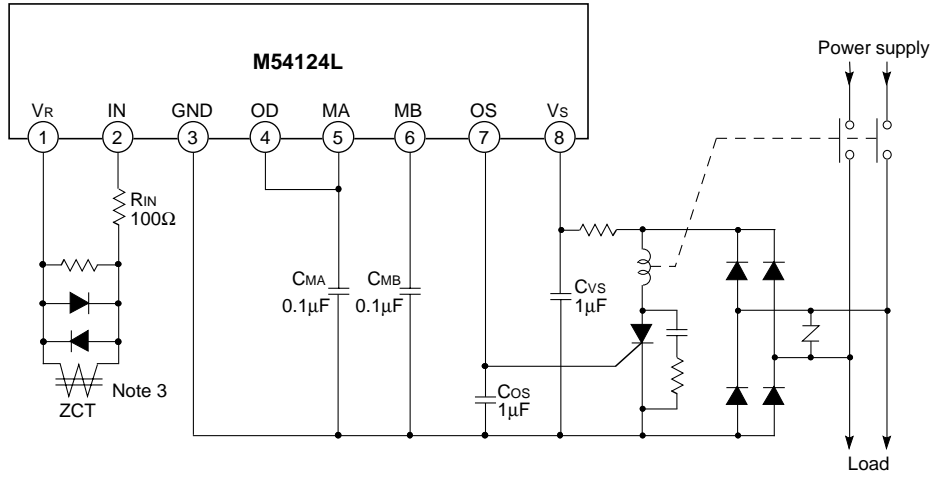


TYPICAL CHARACTERISTICS



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)
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