

M54125L/P

EARTH LEAKAGE CURRENT DETECTOR

DESCRIPTION

The M54125 is a semiconductor integrated circuit consisting of an amplifier for high-speed earth leakage circuit breaker.

FEATURES

- Satisfies JIS C 8371
- Temperature-stable input current trigger threshold ($V_{LKT} = 9mV$)
- Capable of detecting a lost phase on the neutral line
- Economical, low external component count
- Highly resistant to noise and power surges
- Wide operating temperature range ($T_a = -20 - +80^{\circ}C$)

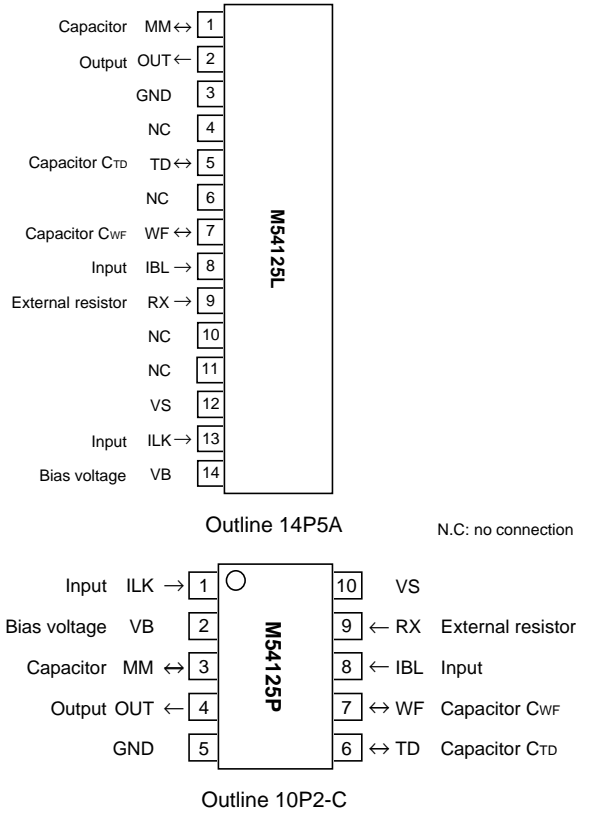
APPLICATION

High-speed earth-leakage circuit breakers

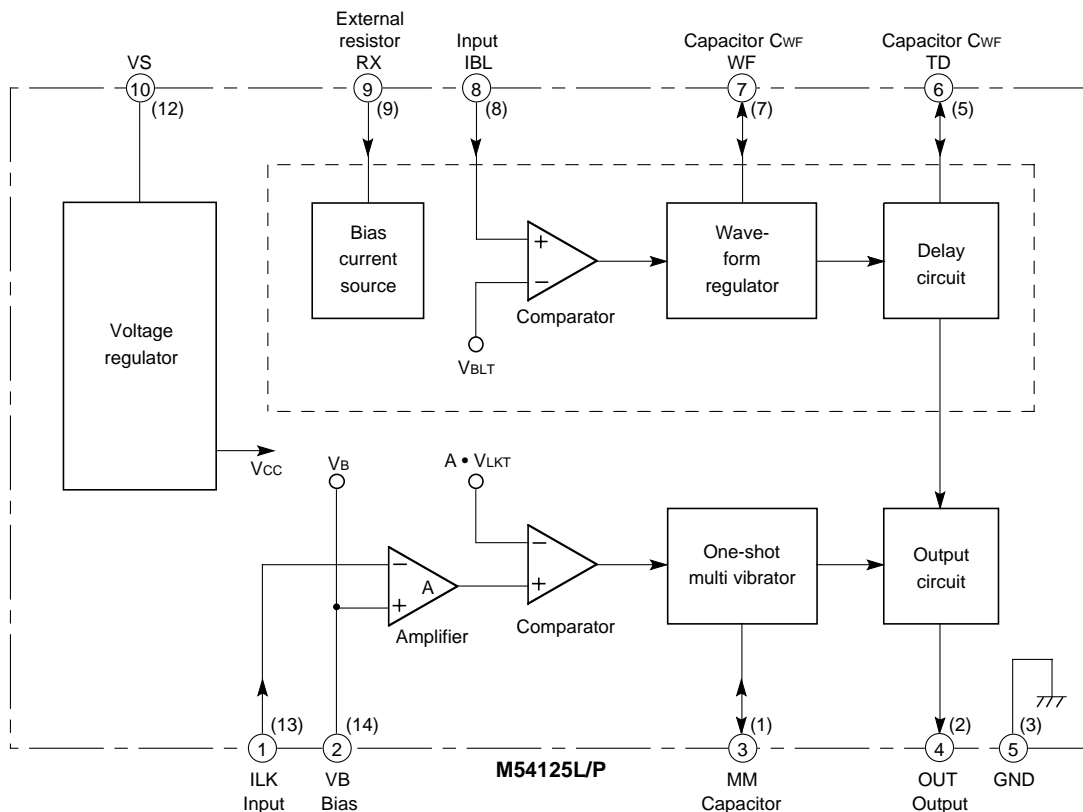
FUNCTION

The M54125 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, current regulator, waveform regulator and delay circuit. The following description refers to the block diagram, application example, and operational waveforms.

PIN CONFIGURATION (TOP VIEW)



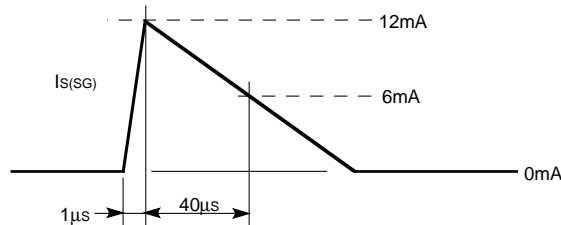
BLOCK DIAGRAM (Note: Pin No. in parentheses are of M54125L)



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

| Symbol | Parameter | Conditions | Ratings | Unit |
|------------------|-----------------------|--|-------------|------|
| Is | Supply voltage | Average supply current frequency per cycle | 0 – 6 | mA |
| Is(SO) | Supply surge current | (Note 1) | 0 – 12 | mA |
| ΔV_{ILK} | ILK input voltage | Pin VB serves as the voltage reference | -1.8 – +1.8 | V |
| V _{IBL} | IBL input voltage | | -0.3 – 6 | V |
| V _{OUT} | OUT applied voltage | When external voltage is applied | -0.3 – 4 | V |
| P _d | Power dissipation | | 160 | mW |
| T _{opr} | Operating temperature | | -20 – 80 | °C |
| T _{stg} | Storage temperature | | -55 – 125 | °C |

Note 1: Is(SG) current waveform, which is given in the following diagram, shall be one shot or less per minute.



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

| Symbol | Parameter | | Limits | | | Unit |
|-----------------|-----------------------|--|--------|------|------|------|
| | | | Min. | Typ. | Max. | |
| Vs | Supply voltage | When output OUT is OFF | 12 | | | V |
| Is | Supply current | Average power supply current per cycle | | | 5.6 | mA |
| C _{MM} | External capacitor MM | | | 0.22 | | µF |
| C _{WF} | External capacitor WF | | | 1 | | µF |
| C _{TD} | External capacitor TD | | | 6.8 | | µF |
| R _X | External resistor Rx | | | 27 | | kΩ |

Handling of unused pins when the abnormal voltage detection function is not used

- Pin Rx must be left open
- Pin TD must be shorted to GND
- Pin WF and pin IBL may be left open or shorted to GND

LEAKAGE DETECTION FUNCTION

When leakage current I_g appears on the primary side of zero-current transformer, ZCT, leakage signal voltage V_{ILK} appears on the secondary side and is input at ILK with bias V_B as the reference. In the half cycle when V_{ILK} is negative, capacitor C_{MM} connected to MM charges until V_{ILK} reaches the DC trip voltage.

If the voltage at MM does not reach the MM positive threshold voltage, when the charging phase is completed, capacitor C_{MM} discharges at a small current. The output OUT is reset to the off state (in which output current flows in) when V_{MM} descends to the MM negative threshold voltage.

Earth-leakage currents are detected when the amplitude of input voltage V_{ILK} exceeds the DC trip voltage V_{LKT} for longer than the detection time t_{MM} . The output OUT turns on for time t_{OUT} . The output current is used to turn on the thyristor that opens the breaker contacts.

ABNORMAL VOLTAGE DETECTION FUNCTION

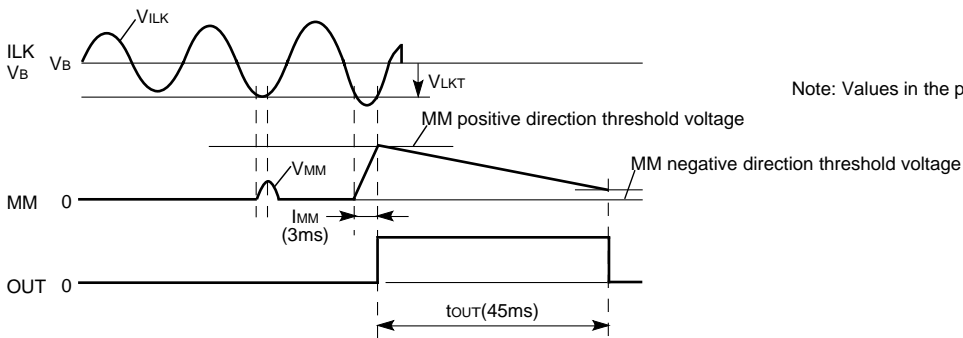
Normally V_{IBL} , fixed amplitude AC supply that has been rectified and divided by a resistor, is input to abnormal voltage input IBL. When a fault occurs in the neutral line N, successive peaks of V_{IBL} become alternately small and large, with the levels determined by the load on the AC power lines A and B.

When the amplitude of V_{IBL} exceeds the abnormal voltage trip voltage V_{BLT} , capacitor C_{WF} connected to pin WF discharges. After the discharge phase is completed, charging begins again.) When voltage V_{WF} at WF drops below the WF threshold voltage, capacitor C_{TD} at TD charges, and after delay time t_{TD} , when voltage V_{TD} at TD reaches the TD threshold voltage, output OUT turns on, activating the circuit breaker. To avoid misoperation due to the effect of repeated one-shot noise that brings V_{IBL} above V_{BLT} , the voltage drops to the initial value only after time t_{WF} .

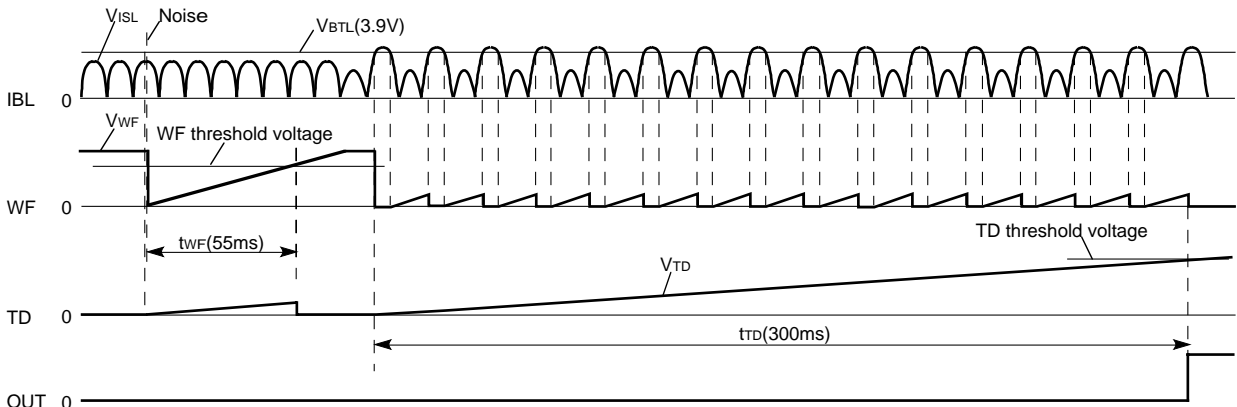
This abnormal voltage detection circuit is enabled only when an external resistor R_x is connected to pin Rx to enable the current flow.

WAVEFORM DIAGRAM

1) Voltage waveform when earth leakage is detected.



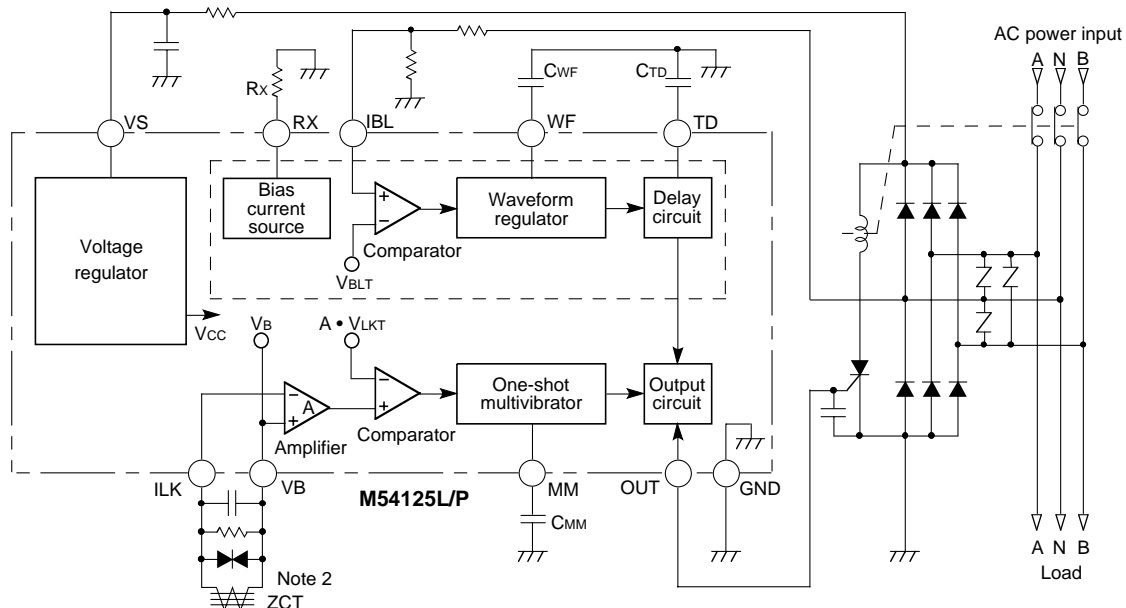
2) Voltage waveform when abnormal voltage is detected.



ELECTRICAL CHARACTERISTICS (Vcc = 5V and Ta = -20 – 80°C unless otherwise noted)

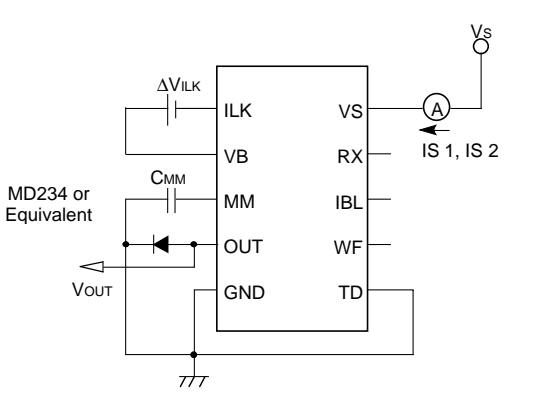
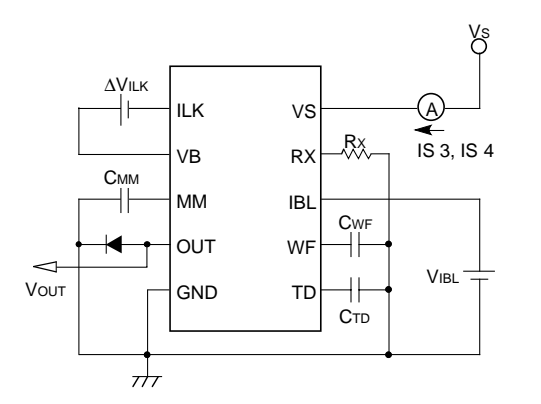
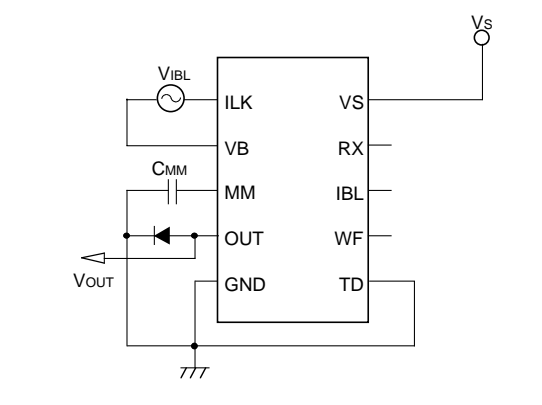
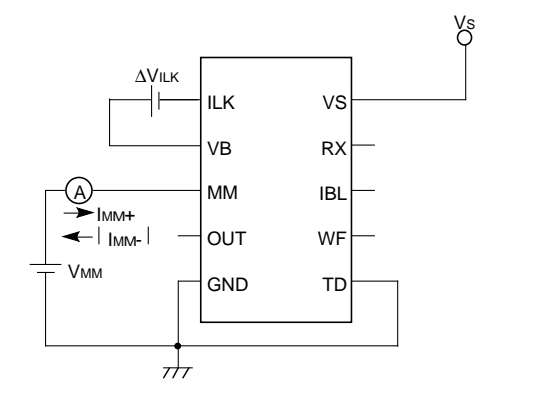
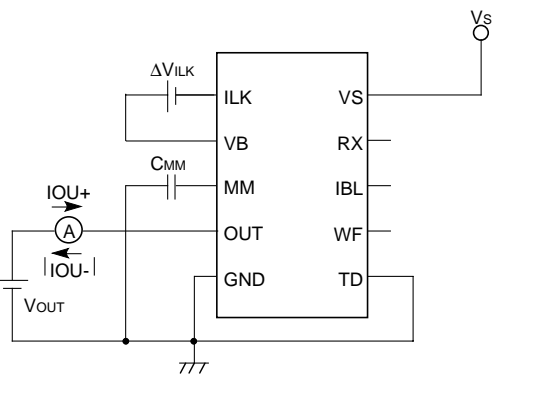
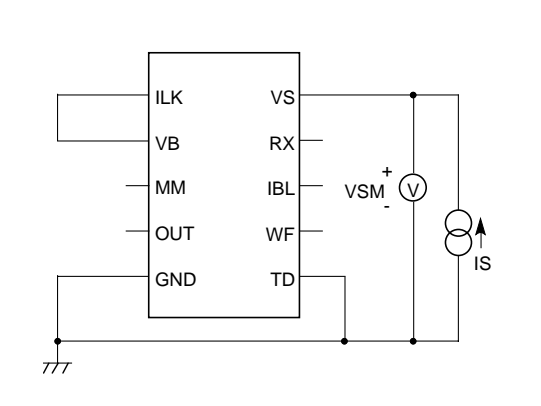
| Symbol | Parameter | Test conditions | Temperature | Limits | | Unit | Test circuit | |
|--------|-------------------------|-----------------|--|--------|------|------|--------------|----|
| | | | | Min. | Max. | | | |
| Is1 | Supply current 1 | Pin VS | Vs = 12V, ΔVILK = 0mV, Out : "OFF" | | 0.7 | mA | 1 | |
| Is2 | Supply current 2 | Pin VS | Vs = 16V, ΔVILK = -15mV, Out : "ON" | | 1.2 | mA | 1 | |
| VLKT | Trip voltage | Pin ILK and VB | Vs = 16V, VLKT : 60Hz Test circuit 3 | | 4 | 9 | mVrms | |
| IMM+ | Sink current | Pin MM | Vs = 16V, ΔVILK = 0mV, VMM = 0.8V | 25 | 170 | 370 | μA | 4 |
| IMM- | Source current | Pin MM | Vs = 16V, ΔVILK = -15mV, VMM = 0.8V | 25 | -110 | -250 | μA | 4 |
| tMM | Detect inhibit time | Pin MM | Vs = 16V | | 1.7 | 4 | ms | 10 |
| Iou+ | Sink current | Pin OUT | Vs = 16V, ΔVILK = 0mV, VOUT = 0.2V | | 150 | | μA | 5 |
| Iou- | Source current | Pin OUT | Vs = 16V, ΔVILK = -15mV VOUT = 0.8V | -20 | -200 | | μA | 5 |
| | | | | 25 | -100 | | | |
| | | | | 80 | -70 | | | |
| tOUT | Output pulse width | Pin OUT | Vs = 16V | | 25 | 100 | ms | 10 |
| VSM | Maximum current voltage | Pin VS | Is = 3.5mA | 25 | 20 | 26 | V | 6 |
| Is3 | Supply current 3 | Pin VS | Vs = 12V, VILK : 0mV VIBL = 0V, OUT : "OFF" Test circuit 2 | | | 1 | mA | |
| Is4 | Supply current 4 | Pin VS | Vs = 12V, VILK : -15mV VIBL = 12V, OUT : "ON" Test circuit 2 | | | 1.4 | mA | |
| VBLT | Trip voltage | Pin IBL | Vs = 16V | | 3.6 | 4.1 | V | 7 |
| IIBL | Input current | Pin IBL | Vs = 16V, VIBL = 4.5V Test circuit 7 | 25 | | 0.8 | μA | |
| IWF+ | Sink current | Pin WF | Vs = 16V, VIBL = 4.5V, VWF = 0.5V | 25 | 1 | | mA | 8 |
| IWF- | Source current | Pin WF | Vs = 16V, VIBL = 0V, VWF = 0.5V | 25 | -22 | -30 | μA | 8 |
| tWF | Recovery time | Pin WF | Vs = 16V | | 35 | 70 | ms | 11 |
| ITD+ | Sink current | Pin TD | Vs = 16V, VIBL = 0V, VTD = 0.5V | 25 | 1 | | mA | 9 |
| ITD- | Source current | Pin TD | Vs = 16V, VIBL = 4.5V, VTD = 0.5V | 25 | -22 | -30 | μA | 9 |
| tDT | Delay time | Pin TD | Vs = 16V | | 200 | 420 | ms | 12 |

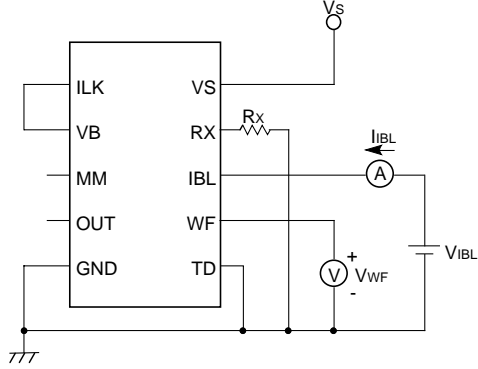
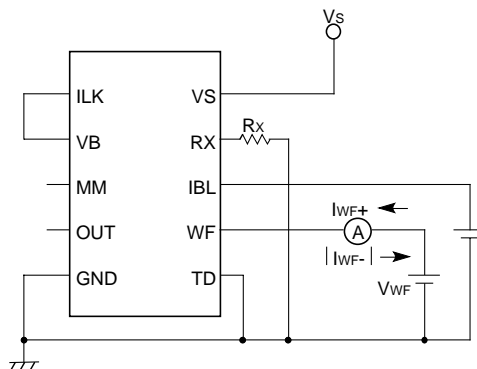
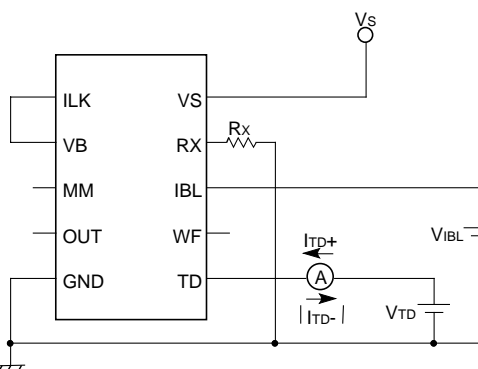
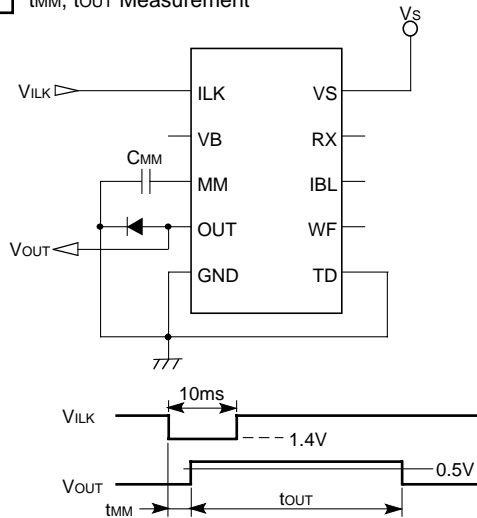
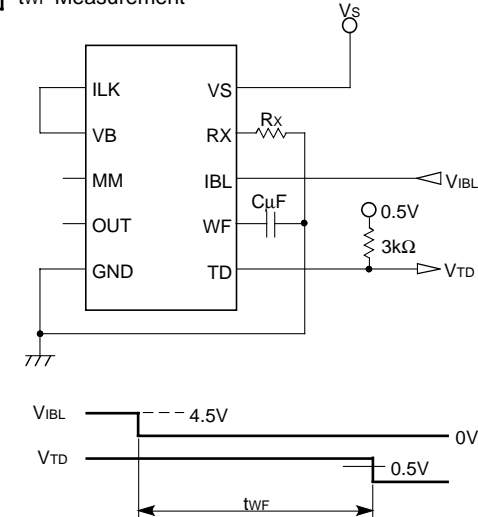
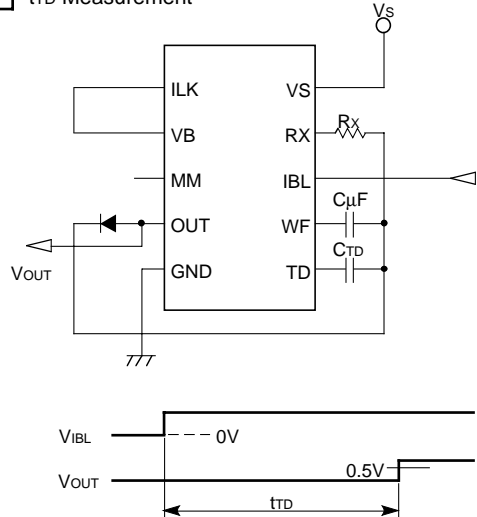
APPLICATION EXAMPLE



Note 2 : MZ Core Series by Soryo Denshi Kagaku Co., Ltd (Mitsubishi Subsidiary)
Tel. +81-427-74-7813

TEST CIRCUIT (CMM = 0.22 μ F, CTD = 6.8 μ F and RX = 27k Ω unless otherwise noted)

| | |
|--|---|
| <p>1 IS 1 and IS 2 Measurement</p>  <p>MD234 or Equivalent</p> <p>VS</p> <p>IS 1, IS 2</p> <p>ΔVILK</p> <p>ILK</p> <p>VS</p> <p>VB</p> <p>RX</p> <p>CMM</p> <p>MM</p> <p>IBL</p> <p>OUT</p> <p>WF</p> <p>GND</p> <p>TD</p> <p>VOUT</p> <p>777</p> <p>※: IS 2 is the value after OUT turns on. (Vout > 0.5V)</p> | <p>2 IS 3 and IS 4 Measurement</p>  <p>VS</p> <p>IS 3, IS 4</p> <p>ΔVILK</p> <p>ILK</p> <p>VS</p> <p>VB</p> <p>RX</p> <p>CMM</p> <p>MM</p> <p>IBL</p> <p>OUT</p> <p>WF</p> <p>GND</p> <p>TD</p> <p>VOUT</p> <p>CWF</p> <p>VIBL</p> <p>CTD</p> <p>777</p> <p>※: IS 4 is the value after OUT turns on.</p> |
| <p>3 VLKT</p>  <p>VS</p> <p>VIBL</p> <p>ILK</p> <p>VS</p> <p>VB</p> <p>RX</p> <p>CMM</p> <p>MM</p> <p>IBL</p> <p>OUT</p> <p>WF</p> <p>GND</p> <p>TD</p> <p>VOUT</p> <p>777</p> <p>※: VLKT is the value of VIBL when OUT turns on as VIBL is gradually increased.</p> | <p>4 IMM+ and IMM- Measurement</p>  <p>VS</p> <p>ΔVILK</p> <p>ILK</p> <p>VS</p> <p>VB</p> <p>RX</p> <p>MM</p> <p>IBL</p> <p>OUT</p> <p>WF</p> <p>GND</p> <p>TD</p> <p>IMM+</p> <p>IMM-</p> <p>VMM</p> <p>777</p> |
| <p>5 IOU+, IOU- Measurement</p>  <p>VS</p> <p>ΔVILK</p> <p>ILK</p> <p>VS</p> <p>VB</p> <p>RX</p> <p>CMM</p> <p>MM</p> <p>IBL</p> <p>OUT</p> <p>WF</p> <p>GND</p> <p>TD</p> <p>IOU+</p> <p>IOU-</p> <p>VOUT</p> <p>777</p> | <p>6 VSM Measurement</p>  <p>VS</p> <p>VSM</p> <p>ILK</p> <p>VS</p> <p>VB</p> <p>RX</p> <p>MM</p> <p>IBL</p> <p>OUT</p> <p>WF</p> <p>GND</p> <p>TD</p> <p>IS</p> <p>777</p> |

| | |
|---|--|
| <p>7 VBLT, IBL Measurement</p>  <p>*: VBLT is the value of VIBL when VF = 0.5V.</p> | <p>8 IWF+, IWF- Measurement</p>  |
| <p>9 ITD+, ITD- Measurement</p>  | <p>10 tMM, tOUT Measurement</p>  |
| <p>11 twF Measurement</p>  | <p>12 tTD Measurement</p>  |