M54125L

Earth Leakage Current Detector

REJ03F0033-0100Z
Rev.1.0
Sep.16.2003

Description

The M54125L is a semiconductor integrated circuit having the functions of an amplifier for use with high-speed ground-fault breakers.

Features

- Satisfies JIS C 8371
- Good temperature characteristic of the input sense current (VLKT = 9 mV)
- Internal neutral line open-phase (N open) detection function
- Few external components
- Good stability with respect to noise, surges
- Broad operating temperature range (Ta = –20 to 80°C)

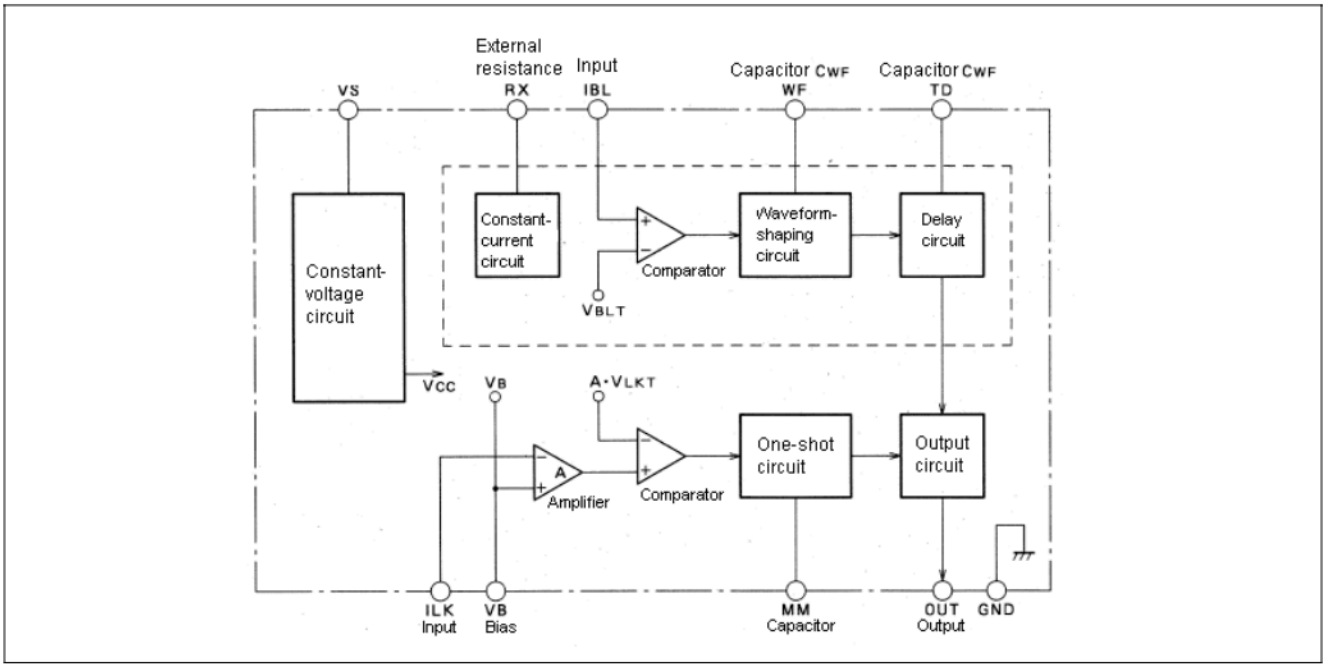
Applications

- High-speed ground-fault breakers

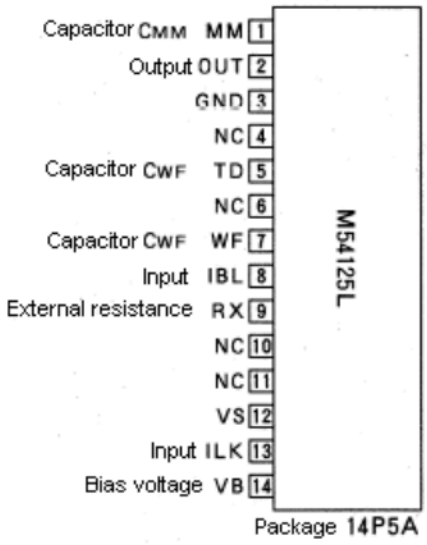
Summary of functions

The M54125L is an integrated circuit used in the amplification unit of a high-speed ground-fault breaker, and consists of a differential amplifier, one-shot circuit, output circuit, constant-current circuit, waveform-shaping circuit, and delay circuit. Operation is explained below, based on the block diagram, application example, and operating waveforms.

Block diagram



Pin Configuration (Top View)



Package 14P5A

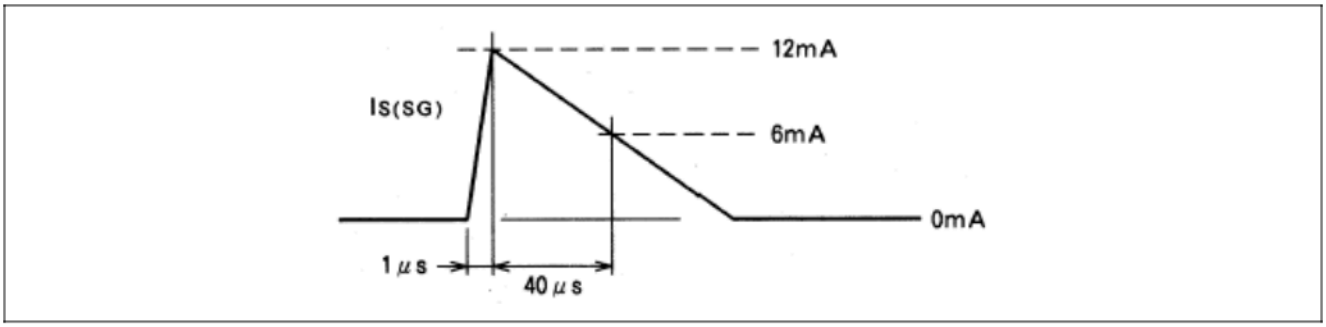
NC : Not connected

Absolute maximum ratings

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

Symbol	Quantity	Conditions	Rated value	Unit
Is	Power supply voltage	Mean current over one cycle of the power supply frequency	0 to 6	mA
Is (so)	Power supply surge current	(Note 1)	0 to 12	mA
ΔV_{ILK}	ILK input voltage	Taking pin VB to be ground potential	–1.8 to +1.8	V
V_{IBL}	IBL input voltage		–0.3 to 6	V
V_{OUT}	OUT applied voltage	With external voltage applied	–0.3 to 4	V
Pd	Power consumption		160	mW
Topr	Operating temperature		–20 to 80	°C
Tstg	Storage temperature		–55 to 125	°C

Note 1: The $I_{S(SG)}$ current waveform is as shown below; one surge or less in a given minute is assumed.



Recommended operating conditions

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

Symbol	Quantity		Rated value			Unit
			Min.	Typ.	Max.	
Vs	Power supply voltage	when OUT is off	12			V
Is	Power supply current	Mean current over one cycle of the power supply frequency			5.6	mA
C_{MM}	External capacitor MM			0.22		∝F
C_{WF}	External capacitor WF			1		∝F
C_{TD}	External capacitor TD			6.8		∝F
Rx	External resistor R_X			27		kΩ

Note: Handling of unused pins when the abnormal voltage detection function not used:
- Pin Rx is open
- Pin TD is shorted to GND
- Pin WF and pin IBL are open are shorted to GND

Leakage Detection Function

When a leakage current Ig occurs on the primary side of ZCT (a zero-phase current transformer), a leakage signal voltage V_{ILK} appears in the secondary-side output, and is input to the ILK input pin, with the bias pin VB as reference. During the half-cycle in which V_{ILK} is negative, in the interval in which the voltage is equal to or below the DC trip voltage V_{LKT}, the capacitor C_{MM} connected to the pin MM is charged.

In this case, if the pin MM voltage V_{MM} does not reache the MM positive-direction threshold voltage, when the charging interval ends the capacitor C_{MM} is discharged with a current larger than the charging current. If the pin voltage V_{MM} reaches the MM positive-direction threshold voltage, at this time the output OUT is "ON" (the state in which output current is flowing out), and at the same time a small current is discharged from the capacitor C_{MM}. When V_{MM} falls to the MM negative-direction threshold voltage, the output OUT is returned to "OFF" (the state in which output current flows in).

That is, the leakage current for which the dead time t_{MM} coincides with the interval during which the amplitude of the input voltage V_{ILK} is equal to or greater than the DC trip voltage V_{ILK} becomes the sense current of the ground-fault breaker.

The output OUT is "ON" for the length of time t_{OUT}, and the output current turns on the thyristor, effectively causing the breaker to operate.

Abnormal Voltage Detection Function

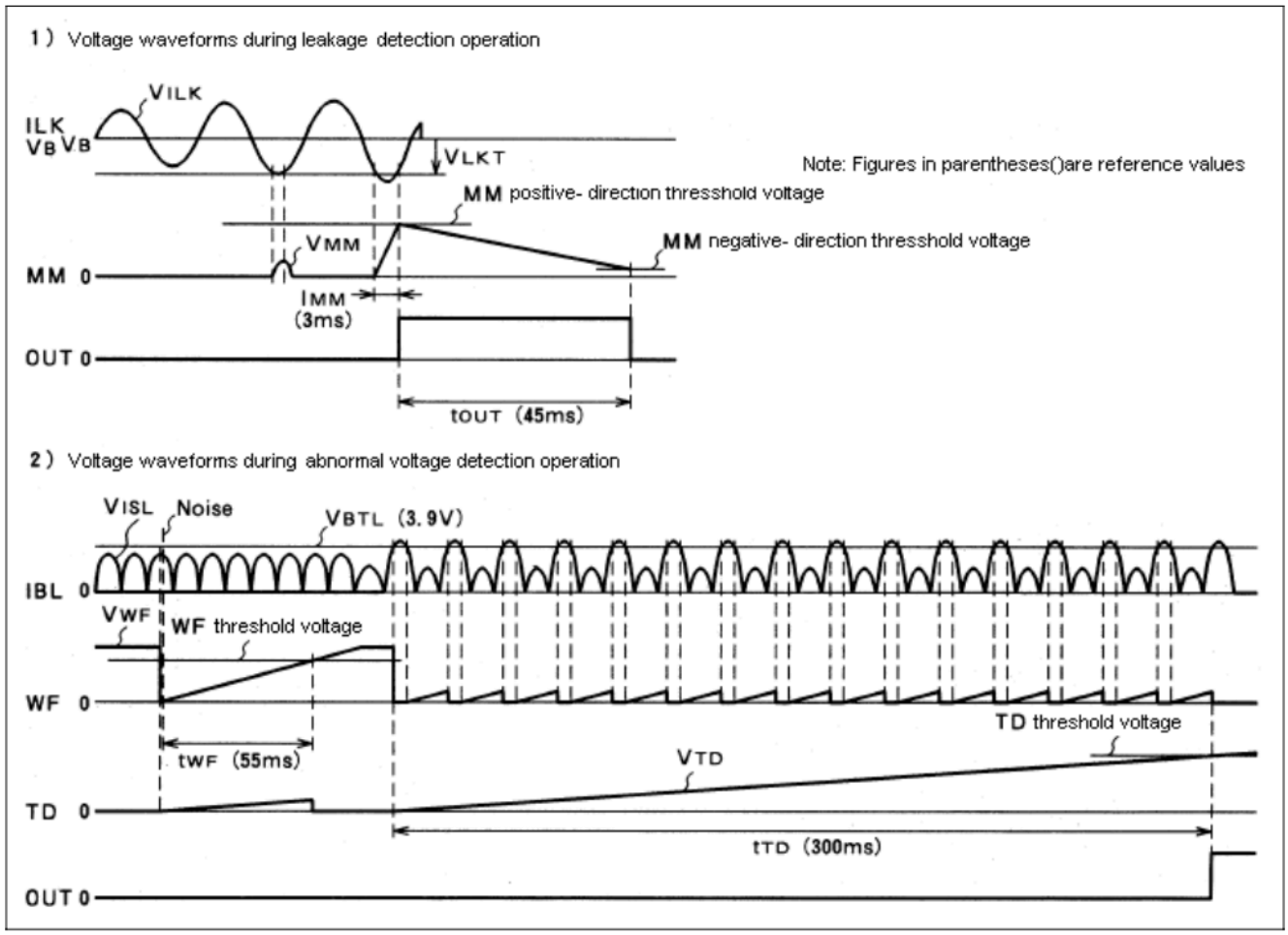
Normally, the rectified voltage of an AC power supply with uniform amplitude is voltage-divided and input to the abnormal voltage input pin IBL as the voltage V_{IBL}. In this case, if the neutral line N is interrupted, depending on the load states of the voltage lines A and B, the input voltage V_{IBL} may become a rectified voltage with amplitude alternating between high and low.

At this time, the capacitor C_{WF} connected to the pin WF discharges during the interval in which the amplitude of V_{IBL} is equal to or greater than the abnormal voltage trip voltage V_{BLT}. (When the discharge interval ends, the charging interval begins.) When the WF pin voltage V_{WF} falls below the WF threshold voltage, the capacitor C_{TD} of pin TD begins to charge, and after the delay time t_{TD} has elapsed, when the TD pin voltage V_{TD} reaches the TD threshold voltage, the output OUT is turned "ON", effectively causing the breaker to operate.

When single-shot noise is superposed on the input voltage V_{IBL} causing it to rise above V_{BLT}, the original state is restored after approximately time t_{WF}, thus preventing erroneous operation.

Current flows in this abnormal voltage detection unit to enable operation only when an external resistor R_X is connected to pin RX.

Operation Waveform Diagrams

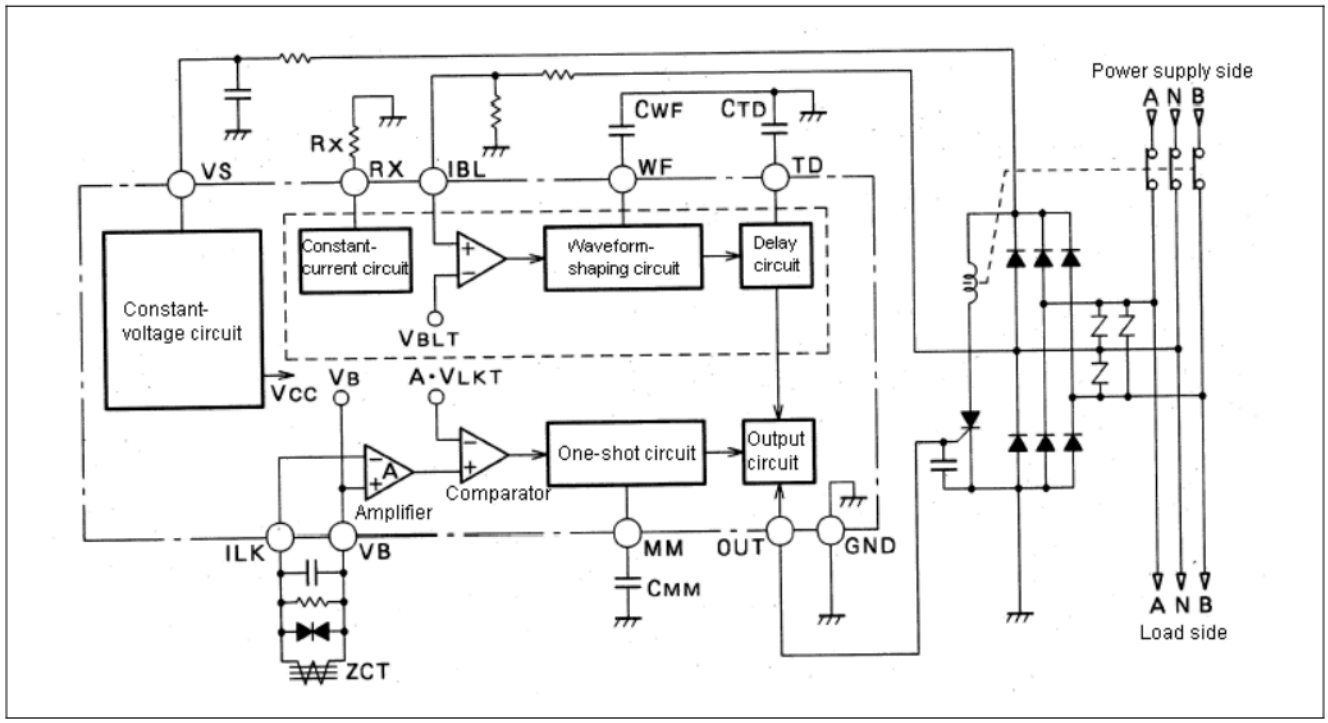


Electrical Characteristics

(unless otherwise noted, V_{CC} = 5 V, Ta=-20 to 80°C)

Symbol	Quantity		Measurement conditions	Rated value			Unit	Test circuit
				Temp-erature	Min.	Max.		
I_{S1}	Power supply current 1	VS	Vs = 12V, ΔILK = 0mV, Out : "OFF"			0.7	mA	1
I_{S2}	Power supply current 2	VS	Vs = 16V, ΔILK = –15mV, Out : "ON"			1.2	mA	1
V_{LKT}	Trip voltage	ILK and VB	Vs = 16V, ΔV_{ILK} = 60Hz		4	9	mVrms	3
I_{MM+}	Sink current	MM	Vs = 16V, ΔILK = 0mv V_{MN} = 0.8V	25	170	370	∝A	4
I_{MM-}	Source current	MM	Vs = 16V, ΔILK = –15mV V_{MN} = 0.8V	25	–110	–250	ms	4
t_{MM}	Dead time	MM	Vs = 16V		1.7	4	∝A	10
IOU+	Sink current	OUT	Vs = 16V, ΔILK = 0mv V_{MN} = 0.2V		150		∝A	5
IOU–	Source current	OUT	Vs = 16V, ΔILK = –15mv V_{MN} = 0.8V	–20	–200		∝A	5
				25	–100			
				80	–70			
I_{OUT}	Output pulse width	OUT	Vs = 16V		25	100	ms	10
V_{SM}	Voltage at max. current	VS	Is = 3.5mA,	25	20	26	V	6
I_{S3}	Power supply current 3	VS	Vs = 12V, V_{ILK} : 0mV V_{IBL} = 0V, OUT :"OFF"			1	mA	2
I_{S4}	Power supply current 4	VS	Vs = 12V, V_{ILK} : 0mV V_{IBL} = 0V, OUT :"ON"			1.4	mA	2
V_{BLT}	Trip voltage	IBL	Vs = 16V,		3.7	4.1	V	7
I_{IBL}	Input current	IBL	Vs = 16V,V_{IBL} = 4.5V	25		0.8	∝A	7
I_{WF+}	Sink current	WF	Vs = 16V,V_{IBL} = 4.5V, V_{WF} = 0.5V	25	1		mA	8
I_{WF-}	Source current	WF	Vs = 16V,V_{IBL} = 0V V_{WF} = 0.5V	25	–22	–30	∝A	8
t_{WF}	Return time	WF	Vs = 16V,		35	70	ms	11
I_{TD+}	Sink current	TD	Vs = 16V, V_{IBL} = 0V, V_{TD}= 0.5V	25	1		mA	9
I_{TD-}	Source current	TD	Vs = 16V, V_{IBL} = 4.5V, V_{TD}= 0.5V	25	–22	–30	∝A	9
t_{DT}	Delay time	TD	Vs = 16V,		200	420	ms	12

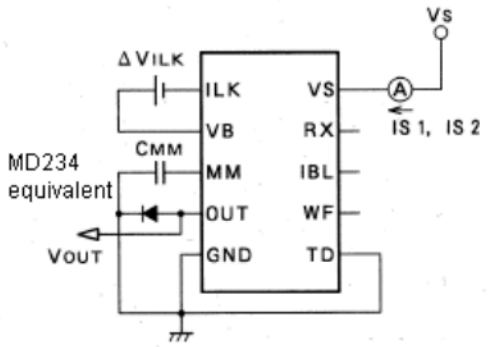
Application Circuit Example



Measurement Circuits

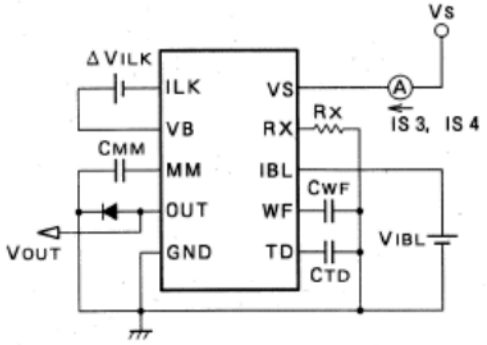
(unless otherwise specified, C_{MM} = 0.22 ∝F, C_{WF} = 1 ∝F, C_{TD}=6.8 ∝F, R_X = 27 kΩ)

1 Measurement of IS1, IS2



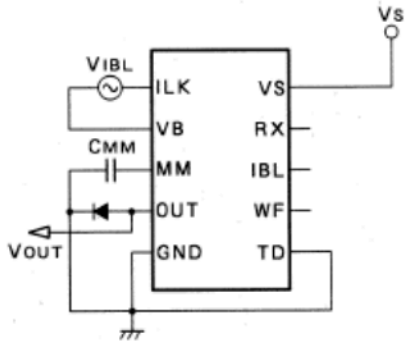
*IS2 is the value immediately after OUT turns on (Vout>0.5V)

2 Measurement of IS3, IS4



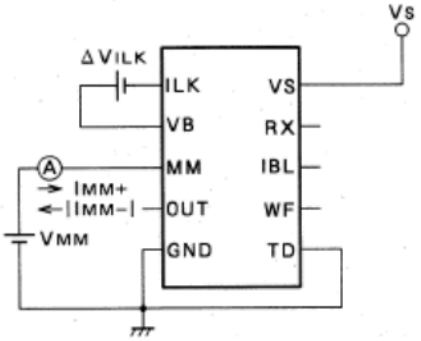
*IS4 is the value immediately after OUT turns on.

3 VLKT

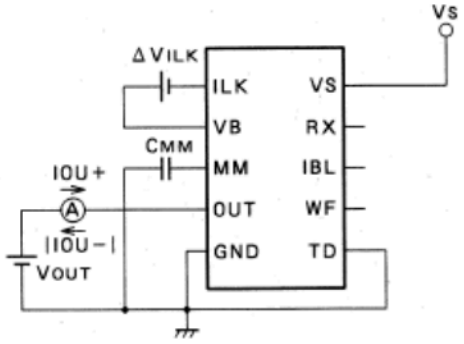


*VLKT is the value of VIBL when VIBL gradually increases and OUT turns on.

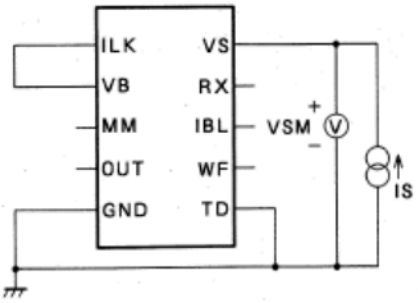
4 Measurement of IMM+, IMM−



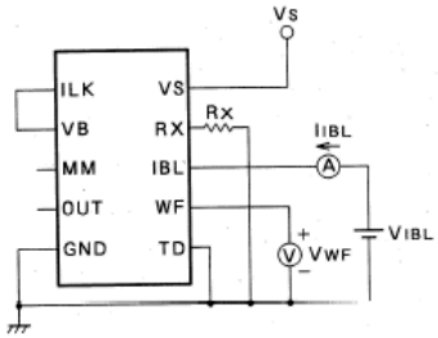
5 Measurement of IOU+, IOU-



6 Measurement of VSM

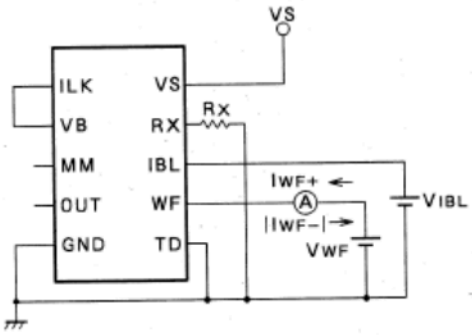


7 Measurement of V_{BLT}, I_{IBL}

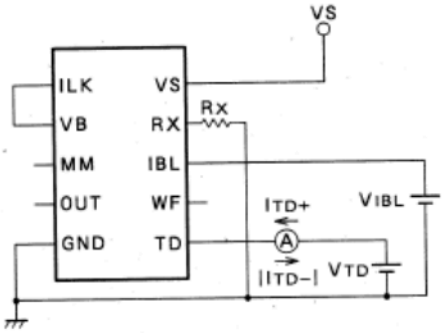


* : V_{BLT} is the value of V_{IBL} when VF=0.5 V.

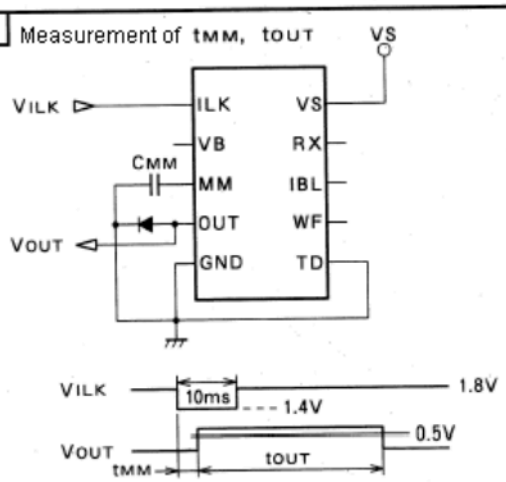
8 Measurement of I_{WF+}, I_{WF-}



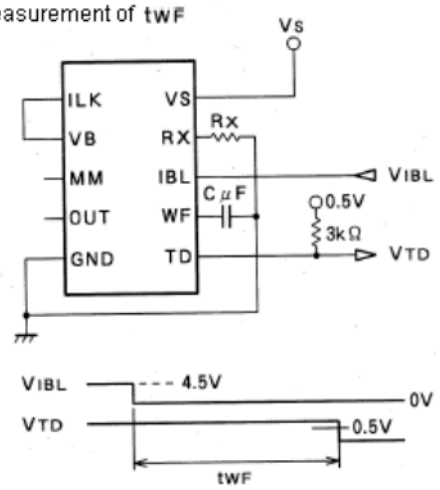
9 Measurement of I_{TD+}, I_{TD-}



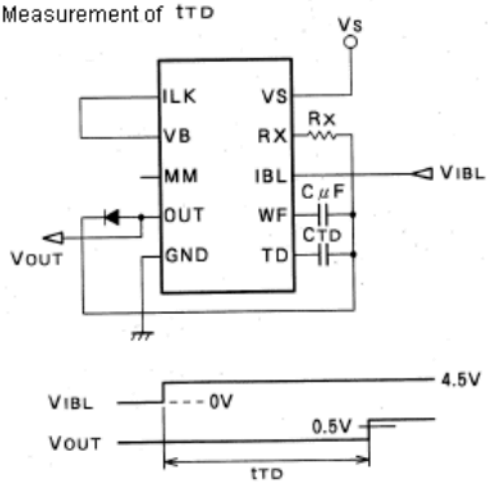
10 Measurement of t_{MM}, t_{OUT}



11 Measurement of t_{WF}



12 Measurement of t_{TD}



Package Dimensions

Plastic 10pin 300mil SOP

10P2-C

EIAJ Package Code	JEDEC Code	Weight(g)	Lead Material
SOP10-P-300-1.27	–	0.12	Alloy 42/Cu Alloy

Recommended Mount Pad

Symbol	Dimension in Millimeters		
	Min	Nom	Max
A	–	–	2.15
A_1	0.05	–	–
A_2	–	1.75	–
b	0.4	0.45	0.55
c	0.13	0.15	0.2
D	5.93	6.13	6.33
E	5.1	5.3	5.5
e	–	1.27	–
H_E	7.82	8.12	8.42
L	0.3	0.5	0.7
L_1	–	0.41	–
Z	–	0.525	–
Z_1	–	–	0.675
x	–	–	0.25
y	–	–	0.1
θ	0°	–	10°
b_2	–	0.76	–
e1	–	7.62	–
l_2	–	1.27	–

Renesas Technology Corp. Sales Strategic Planning Div. Nippon Bldg., 2-6-2, Ohte-machi, Chiyoda-ku, Tokyo 100-0004, Japan

RENESAS SALES OFFICES

http://www.renesas.com

Renesas Technology America, Inc.
450 Holger Way, San Jose, CA 95134-1368, U.S.A
Tel: <1> (408) 382-7500 Fax: <1> (408) 382-7501

Renesas Technology Europe Limited.
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, United Kingdom
Tel: <44> (1628) 585 100, Fax: <44> (1628) 585 900

Renesas Technology Europe GmbH
Dornacher Str. 3, D-85622 Feldkirchen, Germany
Tel: <49> (89) 380 70 0, Fax: <49> (89) 929 30 11

Renesas Technology Hong Kong Ltd.
7/F., North Tower, World Finance Centre, Harbour City, Canton Road, Hong Kong
Tel: <852> 2265-6688, Fax: <852> 2375-6836

Renesas Technology Taiwan Co., Ltd.
FL 10, #99, Fu-Hsing N. Rd., Taipei, Taiwan
Tel: <886> (2) 2715-2888, Fax: <886> (2) 2713-2999

Renesas Technology (Shanghai) Co., Ltd.
26/F., Ruijin Building, No.205 Maoming Road (S), Shanghai 200020, China
Tel: <86> (21) 6472-1001, Fax: <86> (21) 6415-2952

Renesas Technology Singapore Pte. Ltd.
1, Harbour Front Avenue, #06-10, Keppel Bay Tower, Singapore 098632
Tel: <65> 6213-0200, Fax: <65> 6278-8001

Colophon 1.0