M54125L/P

EARTH LEAKAGE CURRENT DETECTOR

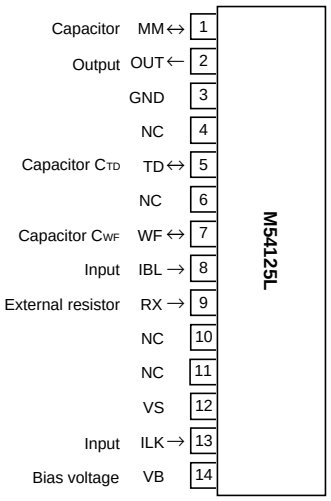
DESCRIPTION
The M54125 is a semiconductor integrated circuit consisting of an amplifier for high-speed earth leakage circuit breaker.

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 (Ta = -20 – +80°C)

APPLICATION
High-speed earth-leakage circuit breakers

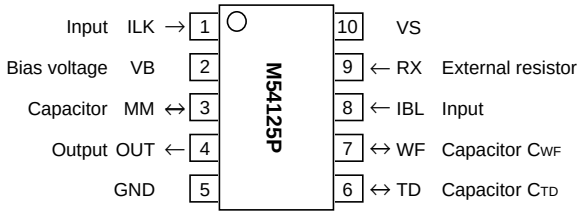
FUNCTION
The M54125 is a semiconductor integrated circuit for use in the amplifier section of earth-leakage circuit breakers. It consists of a differential amplifier, one-shot circuit, output circuit, current regulator, waveform regulator and delay circuit. The following description refers to the block diagram, application example, and operational waveforms.

PIN CONFIGURATION (TOP VIEW)



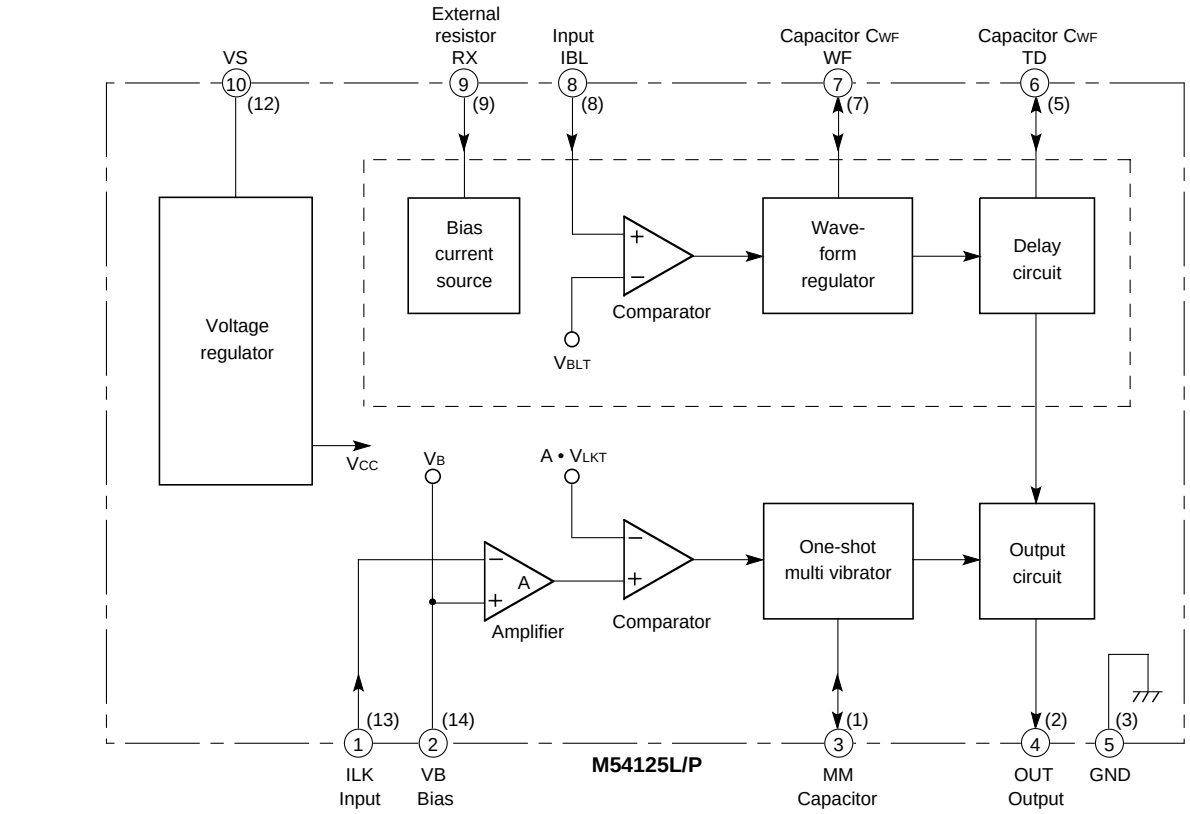
Outline 14P5A

N.C: no connection



Outline 10P2-C

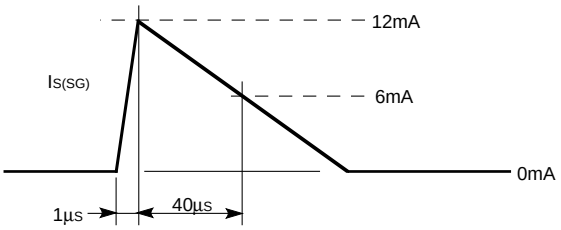
BLOCK DIAGRAM (Note: Pin No. in parentheses are of M54125L)



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

Symbol	Parameter	Conditions	Ratings	Unit
I_S	Supply voltage	Average supply current frequency per cycle	0 – 6	mA
$I_{S(SO)}$	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: $I_{S(SG)}$ 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.	
V_S	Supply voltage	When output OUT is OFF	12			V
I_S	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 R_X			27		kΩ

Handling of unused pins when the abnormal voltage detection function is not used
- Pin R_X 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 current Ig 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 VB 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

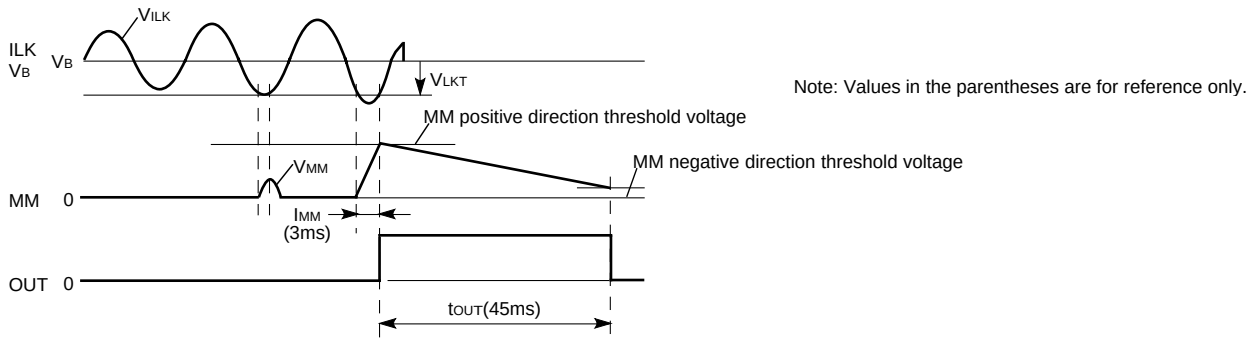
Normally V_{IBL}, fixed amplitude AC supply that has been rectified and divided by a resistor, is input to abnormal voltage input IBL. When a fault occurs in the neutral line N, successive peaks of V_{IBL} become alternately small and large, with the levels determined by the load on the AC power lines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

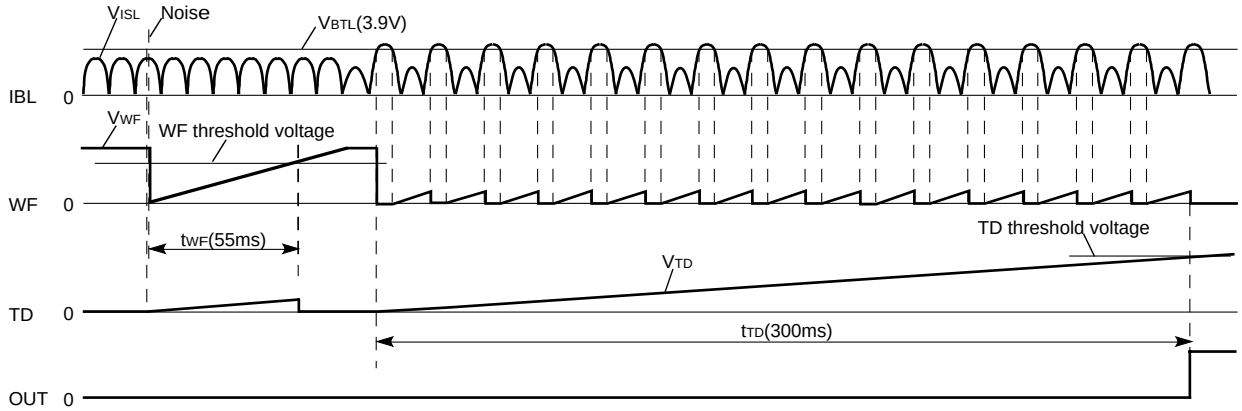
WAVEFORM DIAGRAM

1) Voltage waveform when earth leakage is detected.



Note: Values in the parentheses are for reference only.

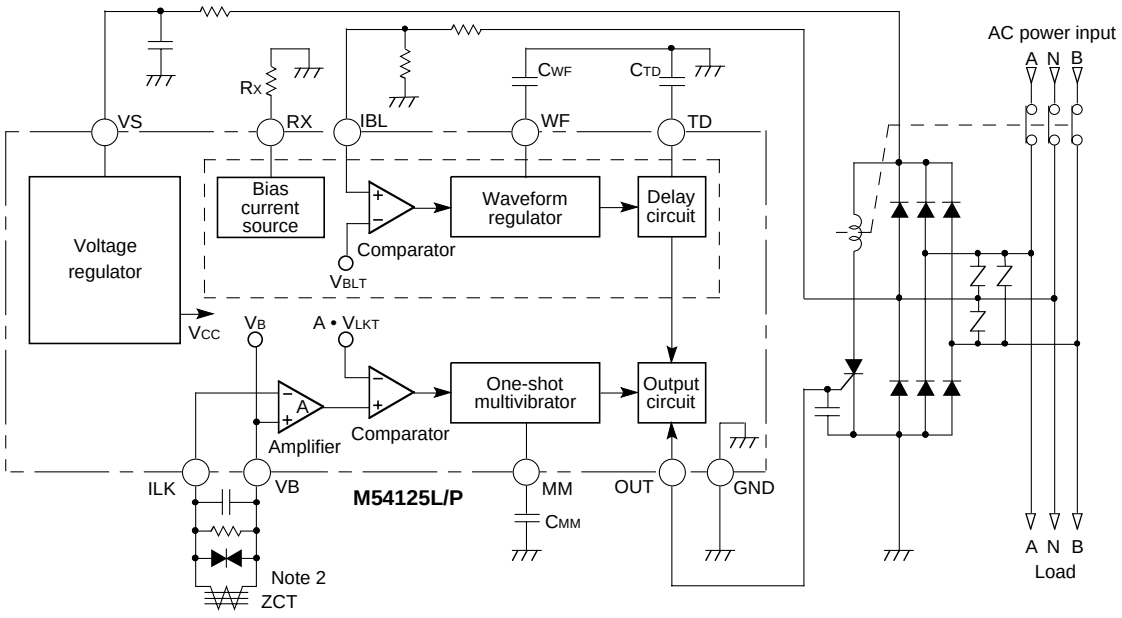
2) Voltage waveform when abnormal voltage is detected.



ELECTRICAL CHARACTERISTICS (V_{CC} = 5V and Ta = -20 – 80°C unless otherwise noted)

Symbol	Parameter		Test conditions	Limits			Unit	Test circuit
				Temperature	Min.	Max.		
I_{S1}	Supply current 1	Pin VS	V_S = 12V, ΔV_{ILK} = 0mV, Out : "OFF"			0.7	mA	1
I_{S2}	Supply current 2	Pin VS	V_S = 16V, ΔV_{ILK} = -15mV, Out : "ON"			1.2	mA	1
V_{LKT}	Trip voltage	Pin ILK and VB	V_S = 16V, V_{LKT} : 60Hz Test circuit 3		4	9	mVrms	
I_{MM+}	Sink current	Pin MM	V_S = 16V, ΔV_{ILK} = 0mV, V_{MM} = 0.8V	25	170	370	µA	4
I_{MM-}	Source current	Pin MM	V_S = 16V, ΔV_{ILK} = -15mV, V_{MM} = 0.8V	25	-110	-250	µA	4
t_{MM}	Detect inhibit time	Pin MM	V_S = 16V		1.7	4	ms	10
I_{OU+}	Sink current	Pin OUT	V_S = 16V, ΔV_{ILK} = 0mV, V_{OUT} = 0.2V		150		µA	5
I_{OU-}	Source current	Pin OUT	V_S = 16V, ΔV_{ILK} = -15mV V_{OUT} = 0.8V	-20	-200		µA	5
				25	-100			
				80	-70			
t_{OUT}	Output pulse width	Pin OUT	V_S = 16V		25	100	ms	10
V_{SM}	Maximum current voltage	Pin VS	I_S = 3.5mA	25	20	26	V	6
I_{S3}	Supply current 3	Pin VS	V_S = 12V, V_{ILK} : 0mV V_{IBL} = 0V, OUT : "OFF" Test circuit 2			1	mA	
I_{S4}	Supply current 4	Pin VS	V_S = 12V, V_{ILK} : -15mV V_{IBL} = 12V, OUT : "ON" Test circuit 2			1.4	mA	
V_{BLT}	Trip voltage	Pin IBL	V_S = 16V		3.6	4.1	V	7
I_{IBL}	Input current	Pin IBL	V_S = 16V, V_{IBL} = 4.5V Test circuit 7	25		0.8	µA	
I_{WF+}	Sink current	Pin WF	V_S = 16V, V_{IBL} = 4.5V, V_{WF} = 0.5V	25	1		mA	8
I_{WF-}	Source current	Pin WF	V_S = 16V, V_{IBL} = 0V, V_{WF} = 0.5V	25	-22	-30	µA	8
t_{WF}	Recovery time	Pin WF	V_S = 16V		35	70	ms	11
I_{TD+}	Sink current	Pin TD	V_S = 16V, V_{IBL} = 0V, V_{TD} = 0.5V	25	1		mA	9
I_{TD-}	Source current	Pin TD	V_S = 16V, V_{IBL} = 4.5V, V_{TD} = 0.5V	25	-22	-30	µA	9
t_{DT}	Delay time	Pin TD	V_S = 16V		200	420	ms	12

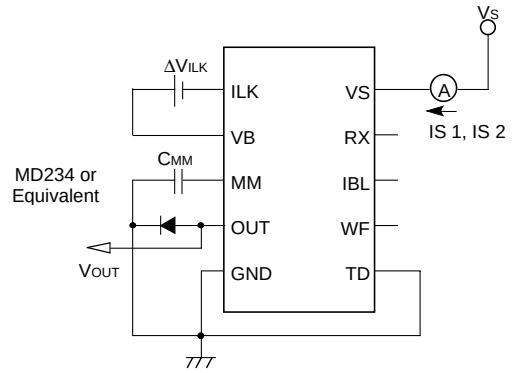
APPLICATION EXAMPLE



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

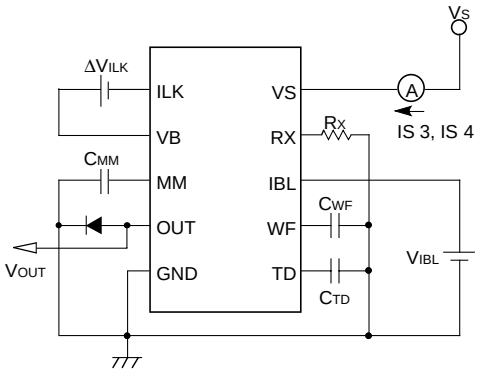
TEST CIRCUIT (C_{MM} = 0.22µF, C_{TD} = 6.8µF and R_X = 27kΩ unless otherwise noted)

1 IS 1 and IS 2 Measurement



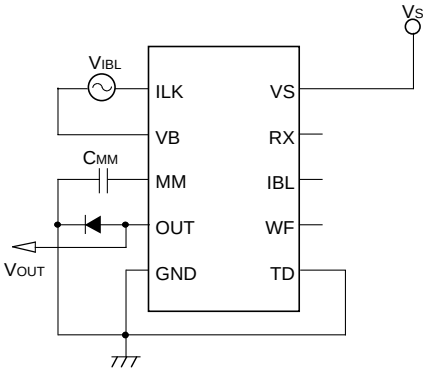
∗: IS 2 is the value after OUT turns on. (V_{out} > 0.5V)

2 IS 3 and IS 4 Measurement



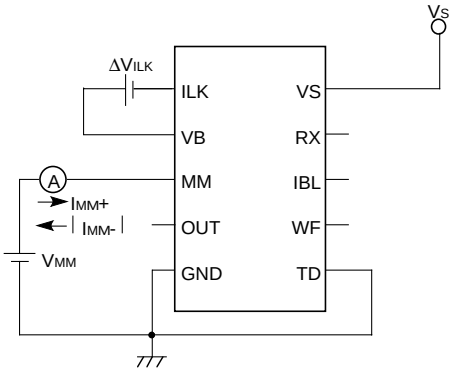
∗: IS 4 is the value after OUT turns on.

3 V_{LKT}

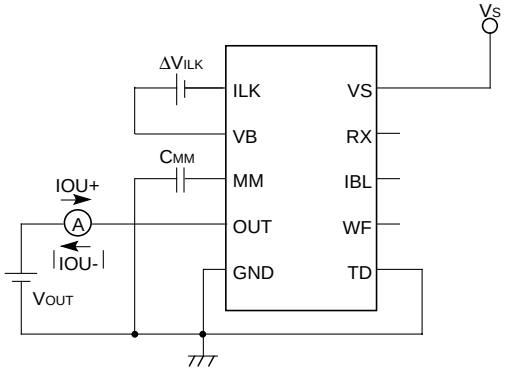


∗: V_{LKT} is the value of V_{IBL} when OUT turns on as V_{IBL} is gradually increased.

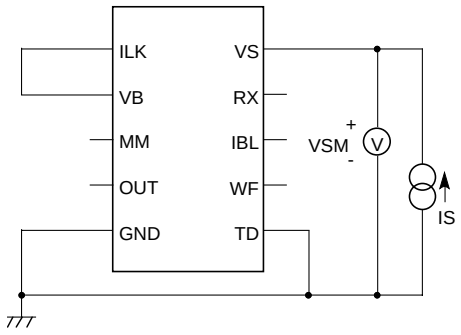
4 IMM+ and IMM- Measurement



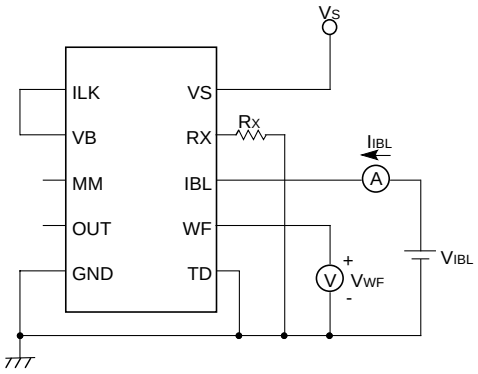
5 IOU+, IOU- Measurement



6 VSM Measurement

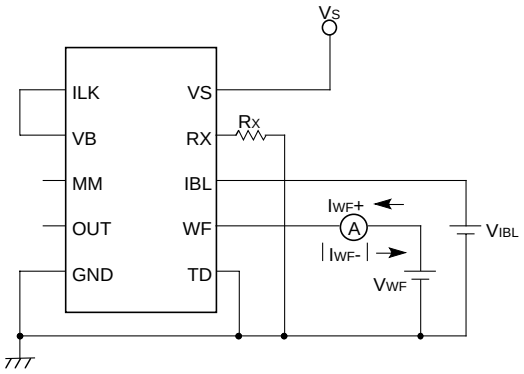


7 V_{BLT}, I_{IBL} Measurement

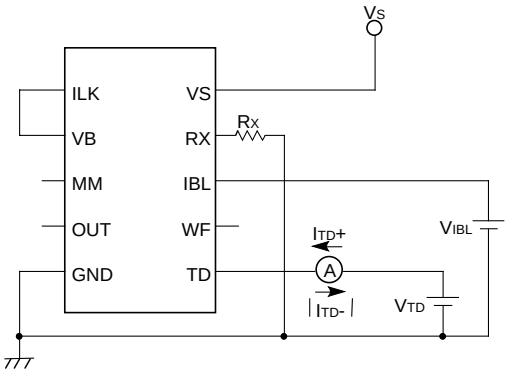


∗: V_{BLT} is the value of V_{IBL} when VF = 0.5V.

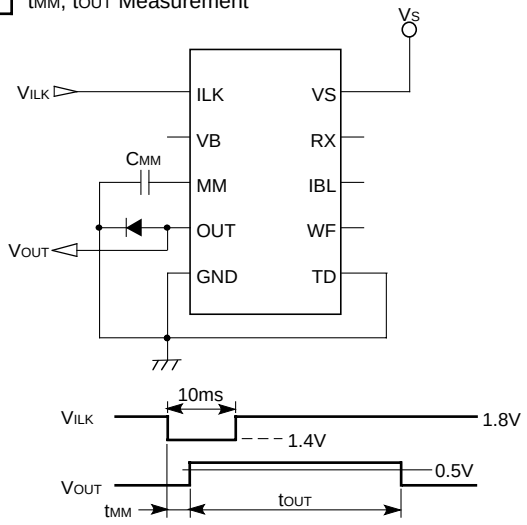
8 I_{WF+}, I_{WF-} Measurement



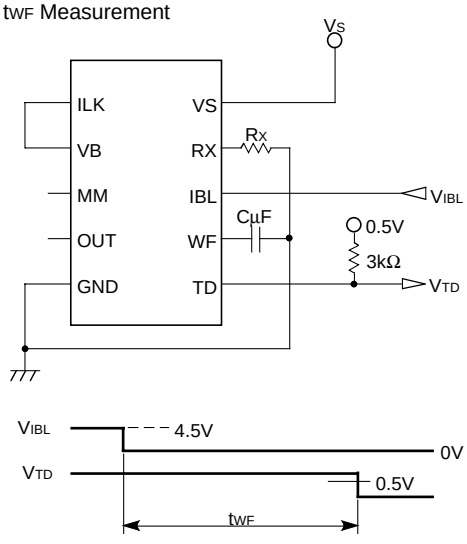
9 I_{TD+}, I_{TD-} Measurement



10 t_{MM}, t_{OUT} Measurement



11 t_{WF} Measurement



12 t_{TD} Measurement