To our customers,

Old Company Name in Catalogs and Other Documents

On April 1st, 2010, NEC Electronics Corporation merged with Renesas Technology Corporation, and Renesas Electronics Corporation took over all the business of both companies. Therefore, although the old company name remains in this document, it is a valid Renesas Electronics document. We appreciate your understanding.

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April 1st, 2010
Renesas Electronics Corporation

Issued by: Renesas Electronics Corporation (http://www.renesas.com)

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RENESAS

M54128L/FP

EARTH LEAKAGE CURRENT DETECTOR

REJ03F0027-0100Z
Rev.1.0
Sep.16.2003

Description

The M54128L/FP is a semiconductor integrated circuit having leakage detection and abnormal voltage detection functions for high-speed earth leakage interruption, and was developed for use in earth leakage breakers.

Features

- Lightning surge protection
  Two-count method adopted
  Improved dead-time performance for lightning impulses
- IEC support: 1.5 count method switching
- High input impedance
  Filter circuit can be configured using external capacitor, resistor
  Improved high-frequency, high harmonic superposition performance
- High input sensitivity: V_T=6.5 Vrms
- Abnormal voltage detection (N open) function
  Neutral line open-phase protection in single-phase three-wire designs
  Function halt control (circuit current reduction)
- Low-voltage operation 7 to 12 V (versus 12 to 20 V in previous series)
  Standby: 820 µA standard (V_S = 9 V, Ta = 25°C)
  SCR on: 740 µA standard (V_S = 9 V, Ta = 25°C)
- Highly stable design
  Circuit designed for minimum characteristic fluctuation with changes in power supply voltage, ambient temperature

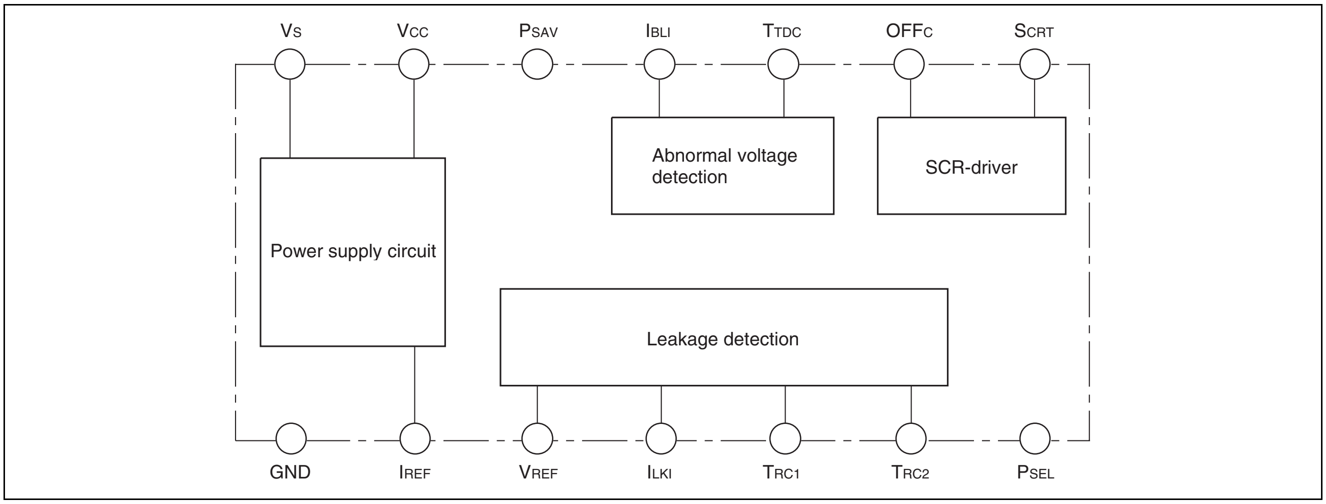
Applications

- Earth leakage breaker

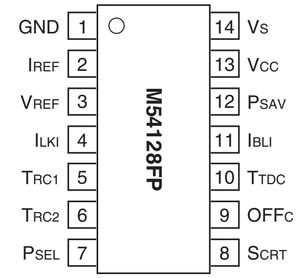
Recommended Operating Conditions

- Power supply operating conditions: 7 to 12V
- operating temperature: –20 to85°C

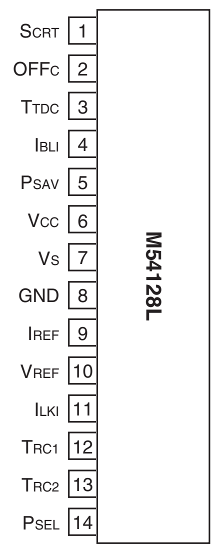
Block Diagram



Pin Configuration (TOP VIEW)



Outline 14P2N-A

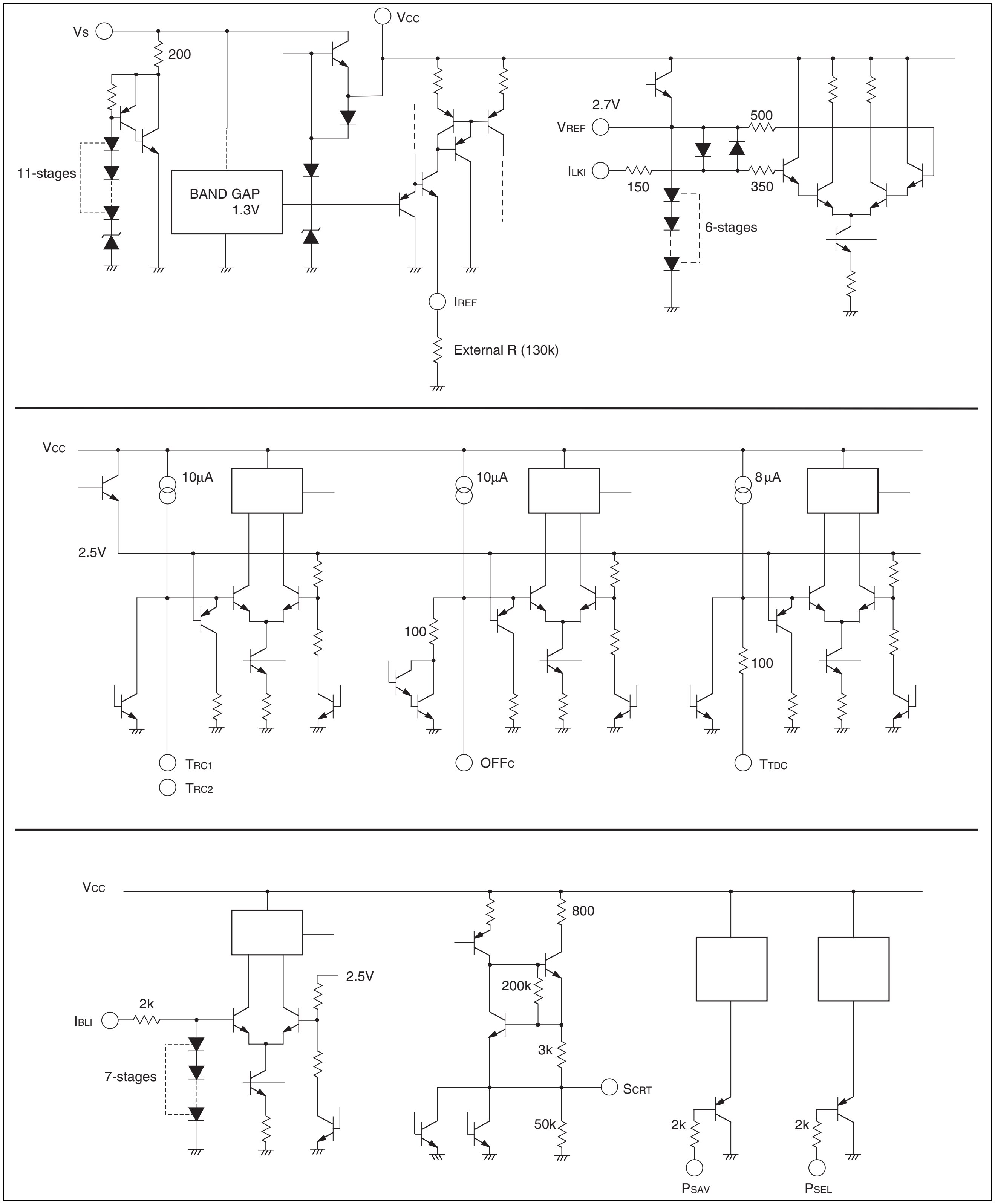


Outline 14P5A

Pin Functions

Pin no. L	Pin no. FP	Pin name	Function
Common			
7	14	Vs	Power supply
6	13	Vcc	Output pin for internal constant-voltage circuit; connect to a decoupling capacitor
9	2	IREF	Connect a resistor to set the constant current of the internal circuits; approx. 1.3 V
8	1	GND	Ground
5	12	P_{SAV}	During normal use, connected to V_{CC} pin [13]. When not using the abnormal voltage detection function, should be grounded, so that circuit currents can be reduced. Pin I_{BLI} [11] and pin T_{TDC} [10] should also be grounded.
Leakage detection, abnormal voltage detection, SCR driving circuits			
10	3	V_{REF}	Input standard level pin for leakage detection circuit; approx. 2.7 V
11	4	I_{LKI}	Another input pin for leakage detection circuit
12	5	T_{RC1}	Pin for connection to a capacitor to integrate the level discriminator output signal of the leakage input signal
13	6	T_{RC2}	Pin to connect a capacitor for noise elimination
14	7	P_{SEL}	Logic function switching pin for leakage detection •When grounded: negative input → positive input → negative input •When connected to V_{CC} pin [13]: negative input → positive input S_{CRT} operates with the above logic.
2	9	OFFc	•When leakage input signal is not continued •When abnormal voltage input signal is not continued •When a leakage or abnormal voltage is detected and SCR is turned on After a prescribed amount of time, this IC is returned to the initial state. A capacitor to set the time for this function is connected.
4	11	I_{BLI}	Abnormal voltage detection circuit input pin
3	10	T_{TDC}	Pin to connect a capacitor to set the time for the abnormal voltage detection circuit
1	8	S_{CRT}	Thyristor driving output pin

Input / Output Equivalent Circuits

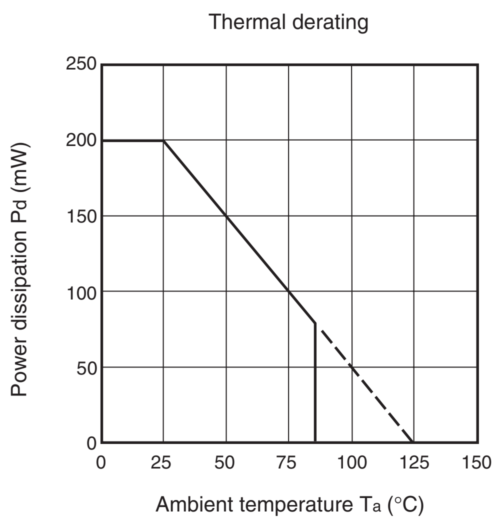


Absolute Maximum Ratings

(unless otherwise noted, Ta = 25°C)

Symbol	Quantity	Conditions	Rated value	Unit
Is	Power supply current		4	mA
VsMAX	Maximum power supply voltage		15	V
ΔVIL	Input voltage	across I_{LKI} and V_{REF}	–1.4 to +1.4	V
IIL	Input current	across I_{LKI} and V_{REF}	–5 to +5	mA
IIG	Input current	V_{REF}–GND	10	mA
VIBL	Input voltage	across I_{BLI} and GND	–0.3 to +4.0	V
IIBL	Input current	across I_{BLI} and GND	4	mA
Pd	Power consumption		200	mW
Topr	Operating temperature range		–20 to 85	°C
Tstg	Storage temperature		–55 to 125	°C

Characteristic Curve



Electrical Characteristics

(unless otherwise noted, Ta = 25°C)

Symbol	Quantity		Measurement conditions	Ratings			Unit
		Vs		Min.	Typ.	Max.	
Power supply circuit							
Is0	Power supply current, during standby	9V	Psav = Vcc	570	820	950	µA
Is1	Power supply current, during leakage detection			570	840	950	µA
Is2	Power supply current, during abnormal voltage detection			570	810	950	µA
Is3	Power supply current, immediately after SCR driving			520	740	870	µA
Is0’	Power supply current, during standby	9V	Psav = GND	520	740	870	µA
Is1’	Power supply current, during leakage detection			520	760	870	µA
Is3’	Power supply current, immediately after SCR driving			520	740	870	µA
–	I_{SO} ambient temperature dependence	9V	Ta = –20 to 85°C	—	–0.07	—	% / °C
Vs max	Voltage at maximum current	—	Is = 4mA	—	13.9	15	V
Leakage detection circuit 1							
Vion	Leakage detection DC input voltage	9V	vs. V_{REF}	—	±7.5	—	mVdc
I_{IH}	I_{LK1} pin input bias current		V_{IN} = V_{REF}	—	2	15	nA
Vo	V_{REF} pin output voltage			—	2.7	—	V
V_{ILKI}	I_{LKI}-V_{REF} input clamping voltage		I_{ILKI} = ±3mA	—	±1.2	—	V
V_{RCL}	V_{REF}-GND clamping voltage		I_{RCL} = 5mA	—	4.6	—	V
2 ms circuit							
EI_{OH}	T_{RC1} pin "H" output current precision	9V	o = 0V : I_{OH} = –10.4µA	–20	—	20	%
V_{TH}	T_{RC1} pin threshold voltage			—	2.4	—	V
ET_{w1}	T_{W1} pulse width precision		C = 0.01µF : T_{w1} = 2.3ms	–15	—	15	%
–	T_{W1} ambient temperature dependence		Ta = –20 to 85°C	—	–0.06	—	%/°C
1 ms circuit							
EI_{oH}	T_{RC2} pin "H" output current precision	9V	Vo = 0V : I_{OH} = –10µA	–20	–	—	%
V_{TH}	T_{RC2} pin threshold voltage			–	2.4	—	V
ET_{w2}	T_{W2} pulse width precision		C = 0.0047µF : T_{W2} = 1.1ms	15	—	15	%
–	T_{W2} ambient temperature dependence		Ta = –20 to 85°C	—	–0.06	20	%/°C
V_T	Total leakage detection AC voltage	9V	60Hz	—	6.5	—	mVrms
–	V_T ambient temperature dependence	9V	Ta =25 →85°C	—	–4.0	—	%
			Ta = 25 → –20°C	—	–4.0	—	%

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Electrical Characteristics (cont.)

(unless otherwise noted, Ta = 25°C)

Symbol	Quantity	Vs	Measurement conditions	Ratings Min.	Typ.	Max.	Unit
Abnormal voltage detection circuit							
V_{BLT}	Abnormal voltage detection voltage	9V		2.2	2.4	2.6	V
–	V_{BLT} power supply voltage dependence	—		—	0.01	—	%/V
–	V_{BLT} ambient temperature dependence	9V	Ta = –20 to 85°C	—	0.06	—	%/°C
I_{IBLT}	I_{BLI} pin input bias current		$V_{IN} = V_{REF}$	—	120	300	nA
V_{IBLC}	I_{BLI}-GND clamping voltage		I_{IN} = 1mA	—	7.2	—	V
V_{TH}	T_{TDC} pin "H" output current precision	9V	Vo = 0V : I_{OH} = –8μA	–20	—	20	%
E_{IOH}	T_{TDC} threshold voltage		1.0μF: T_{w4} = 300ms	—	2.4	—	V
ET_{w4}	Delay time pulse width precision		C = 0.33μF T_{w4} = 300ms	–30	—	30	%
Reset circuit							
E_{IOH}	OFF_C pin "H" output current precision	9V	Vo = 0V : I_{OH} = –10μA	–20	—	20	%
V_{TH}	OFF_C threshold voltage			—	2.4	—	V
ET_{w3}	Reset timer pulse width precision	9V	C = 0.33 μF : T_{W3} =55 ms	–30	—	30	%
SCR driver							
V_{oL8}	SCRT pin "L" output voltage	9V	I_{OL} = 200 μA	—	0.1	0.2	V
I_{OHc}	SCRT pin "H" output current	9V	Vo = 0.8V, Ta = –20°C	–200	–260	—	μA
I_{OHn}			Ta = 25°C	–100	–220	—	μA
I_{OHh}			Ta = 85°C	–70	–180	—	μA
V_{SOff}	IOH hold power supply voltage	—		—	3.0	4.5	V

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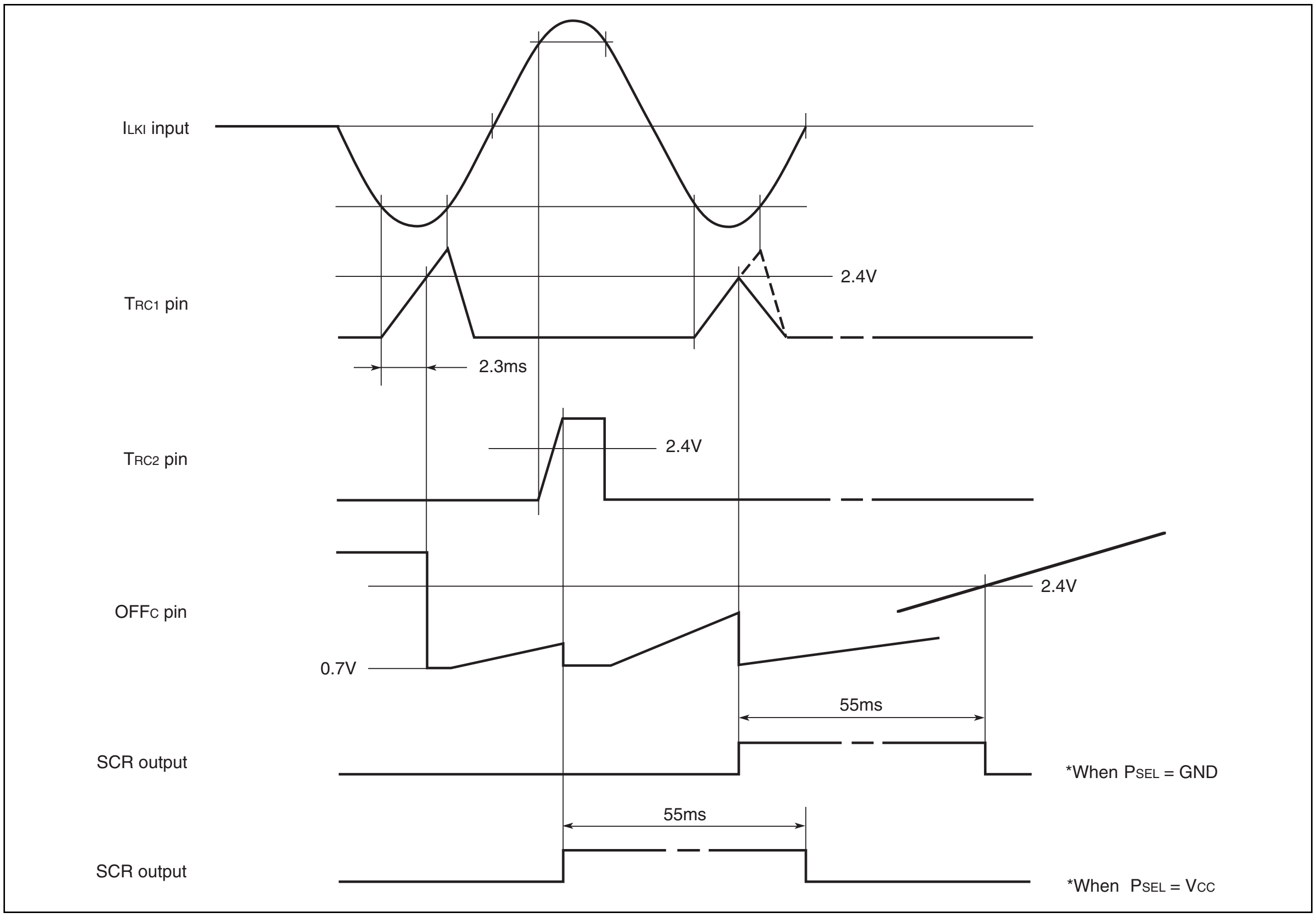
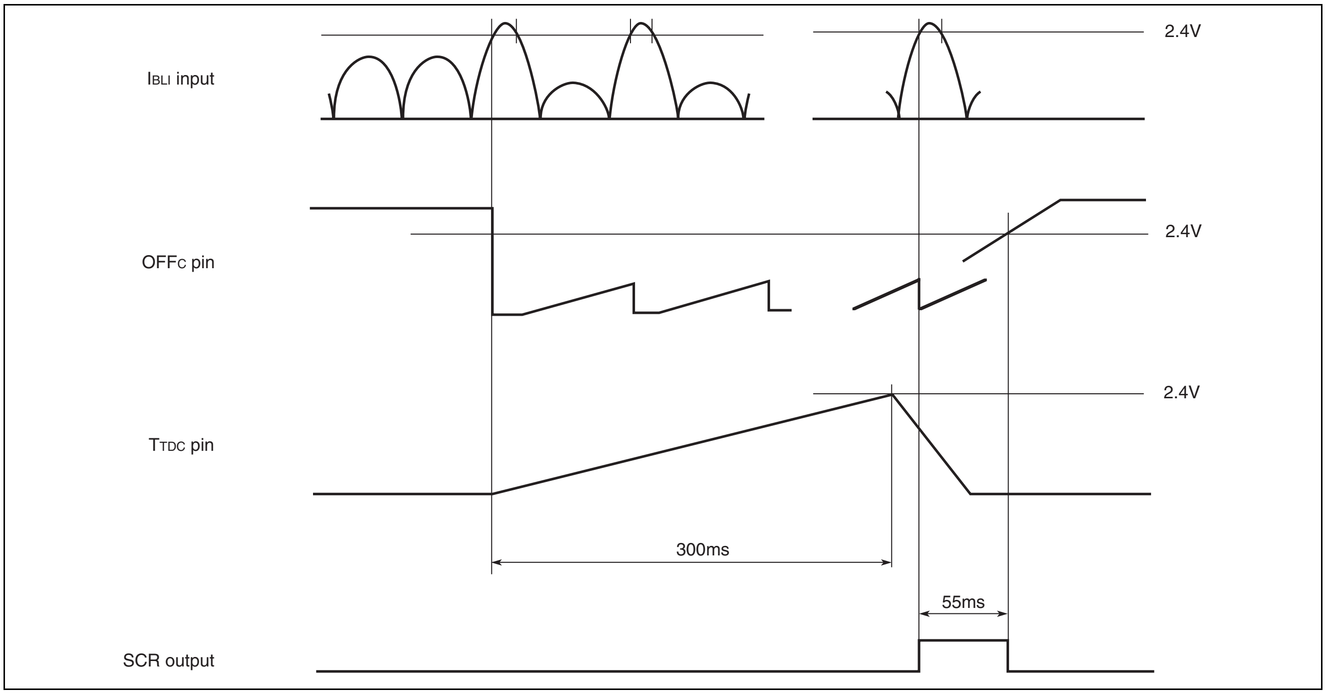
Earth Leakage Detection



Abnormal Voltage Detection

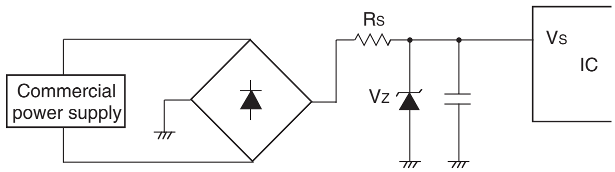


Precaution for Use

Important information on use of the M54128L/FP is given below. Examples of improvements are no more than single examples; improvement should be given adequate study.

1. Regarding the V_S applied voltage

(1) The Is circuit current (clamping circuit characteristics of equivalent circuit) is as shown by the characteristic diagram 1 on page 13. Sufficient care should be exercised when designing a power supply circuit.
Commercial power supply



(2) When rectifying a commercial power supply for use

a) As Vz, a 12 V or lower Zener diode should always be used (the absolute maximum rating should not exceed 15 V).
b) At high temperatures, the clamping voltage is reduced and IS increases, but this is limited by RS.

(3) When using an ordinary DC power supply, VS should be from 7 to 12 V.

2. Regarding the I_{REF} pin resistance (R = 130 kΩ)

This is the IC reference constant-current source. (Fluctuations in the power supply voltage and ambient temperature characteristics are suppressed.)

This resistance determines the characteristics for various circuits, and so it is recommended that a high-precision resistance (±2%) be used.

3. Regarding the printed circuit board layout

Due to the effect of external noise (or noise simulator etc.), erroneous operation is conceivable.

In order to improve noise resistance, the board layout should be such that wiring to external capacitors and resistors is as short as possible.

Particular care should be taken in wiring to connect capacitors to the V_S pin, the V_{CC} pin, and the S_{CRT} pin.

4. Care should be taken to ensure that the S_{CRT} output pin does not fall to a voltage more negative than ground level.

5. Regarding changes in sensitivity due to insulation degradation

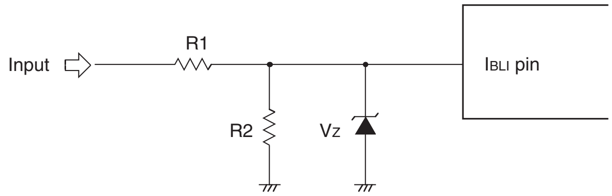
When degradation of the insulation between the ZCT input pin and the high-voltage unit is imagined, by connecting a resistance R = 100 kΩ or so between the V_{REF} pin and ground, there may be improvement; this possibility should be studied carefully.

However, the circuit current increases as $I \approx 2.7V/R$, so caution should be exercised.

6. Regarding the I_{BLI} input pin clamping diode

As indicated in the equivalent circuit, seven stages of a series resistance of approx. 2 kΩ and a forward-direction diode are employed.

(1) The drop in the diode V_F at high temperatures may cause the input pin clamping voltage to drop, to approach the comparator reference potential (2.4 V), so that on the occurrence of a leakage current, the over voltage detection level may fluctuate somewhat. The detection circuit should be configured as shown below. Also, it is recommended that R1, R2 and V_Z be set as indicated below.



• $R_1 + R_2 > 200k\Omega$

• $\frac{R_1 \times R_2}{R_1 + R_2} < 7k\Omega$

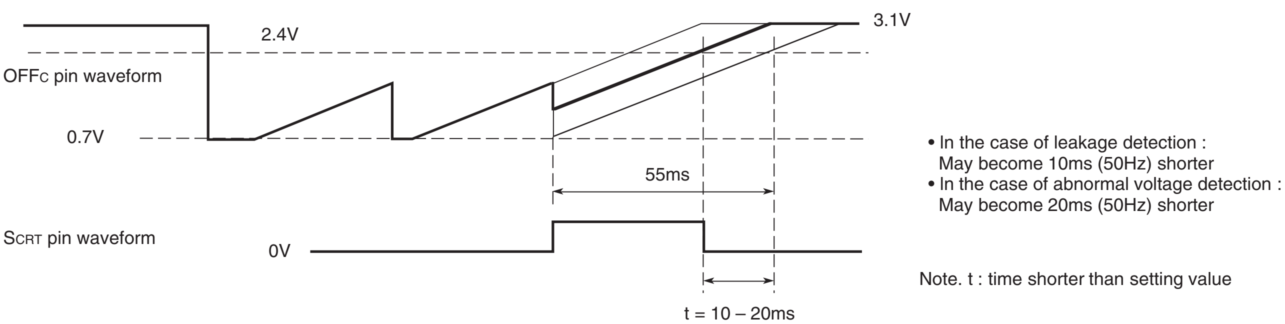
(2) During excessive input, as indicated above, settings should ensure that the input pin voltage is 4.3 V or lower (to prevent saturation operation of the comparator circuit).

$V_Z \approx 4.0$ V

7. Regarding the reset time in the reset timer circuit

This circuit is a timer circuit designed for V_L = 0.7 V, V_H = 2.5 V, and I_O = 10 µA; when SCR is turned on, the power supply to the leakage detection circuit and abnormal voltage detection circuit is interrupted, and V_L may not fall to 0.7 V, as shown in the diagram below, so that the reset time is shortened. The reset time should be set to a longer time in advance.

$$T = \frac{C \times (V_H - V_L)}{I} = \frac{0.33\mu F \times (2.4 - 0.7)}{10\mu A} \fallingdotseq 55ms$$



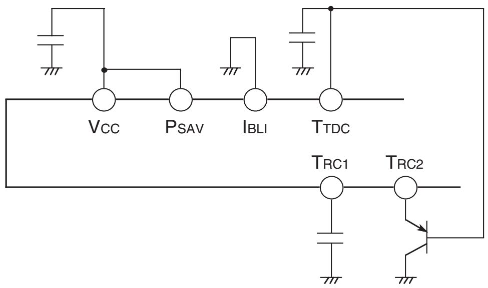
•For leakage detection: times may be shorter by 10 ms (50 Hz)

•For abnormal voltage detection: times may be shorter by 20 ms (50 Hz)

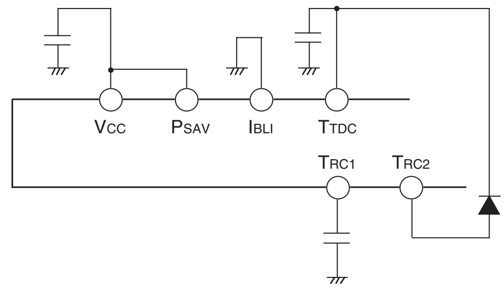
Note: t is the time shorter than the set time

8. Application of the leakage detection function to a time delay function

As shown below, by employing the N open function, the leakage detection function can be provided with a time delay function (several hundred ms). However, the N open function cannot be used.



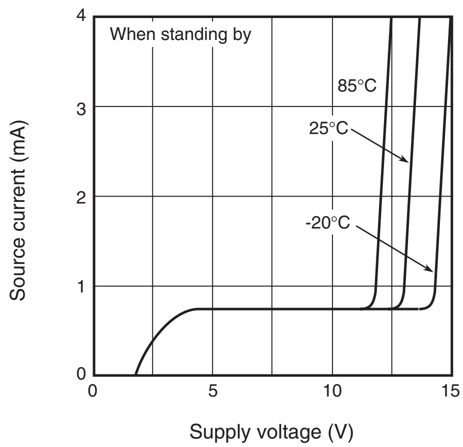
(Example 1)



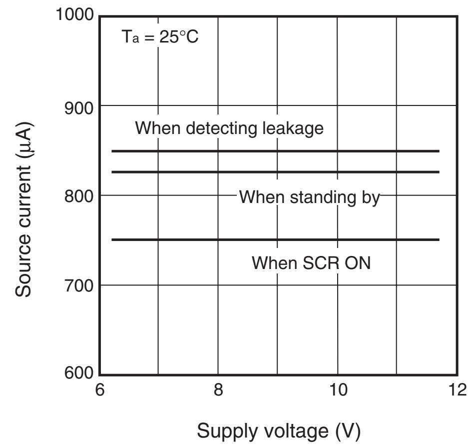
(Example 2)

Characteristic Curves

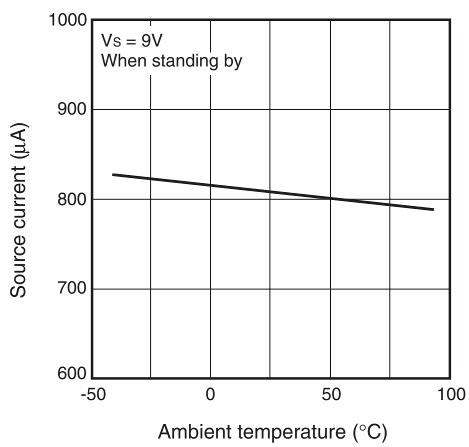
Source Current vs. Supply Voltage



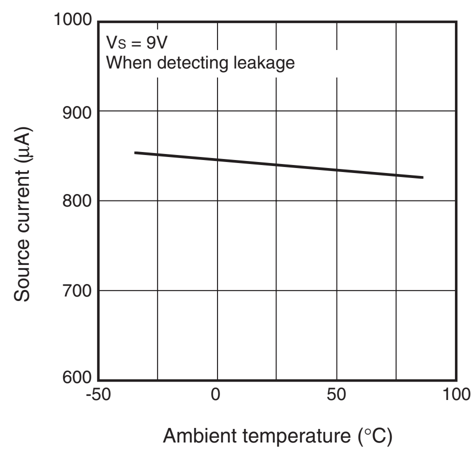
Source Current vs. Supply Voltage



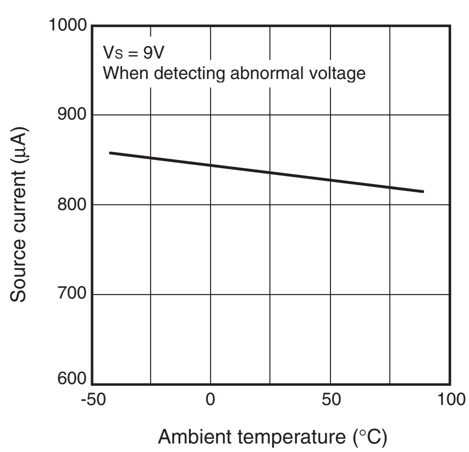
Source Current vs. Ambient Temperature



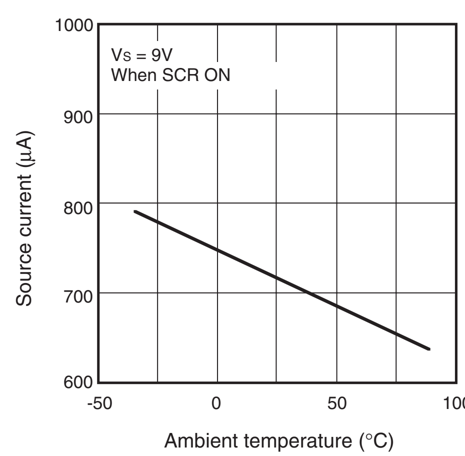
Source Current vs. Ambient Temperature



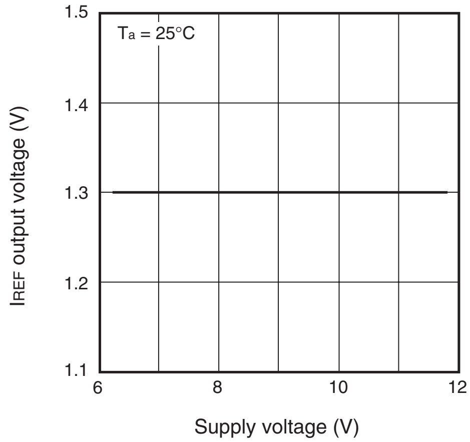
Source Current vs. Ambient Temperature



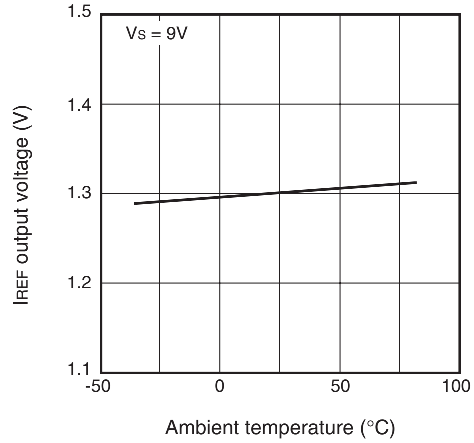
Source Current vs. Ambient Temperature



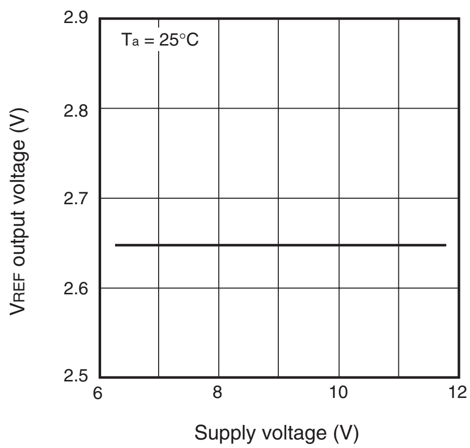
I_{REF} Output Voltage vs. Supply Voltage



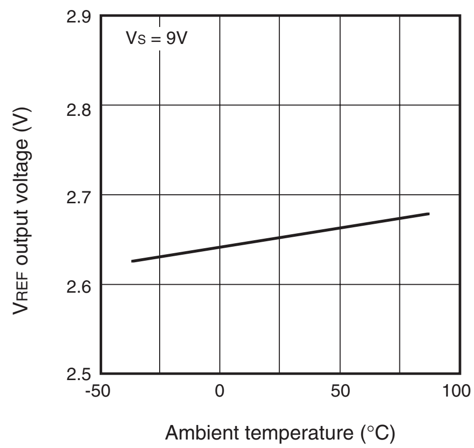
I_{REF} Output Voltage vs. Ambient Temperature



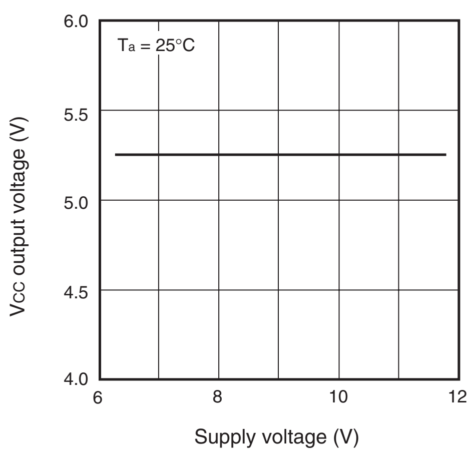
V_{REF} Output Voltage vs. Supply Voltage



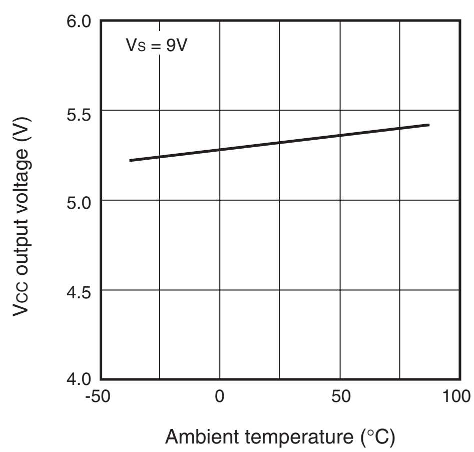
V_{REF} Output Voltage vs. Ambient Temperature



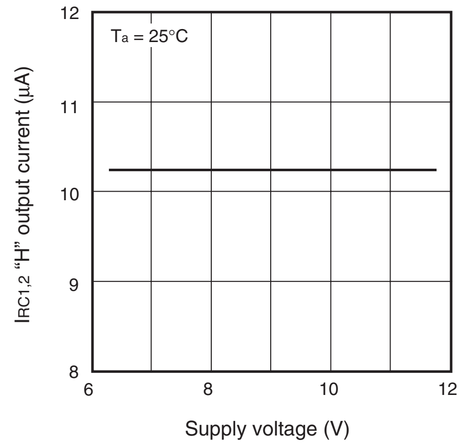
V_{CC} Output Voltage vs. Supply Voltage



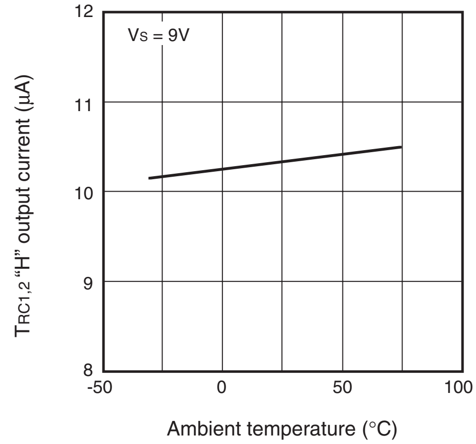
V_{CC} Output Voltage vs. Ambient Temperature



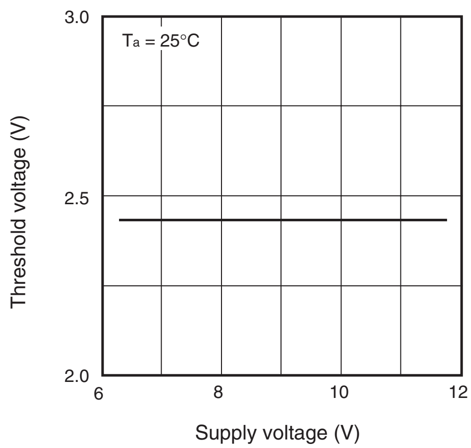
TRC1,2 “H” Output Current vs. Supply Voltage



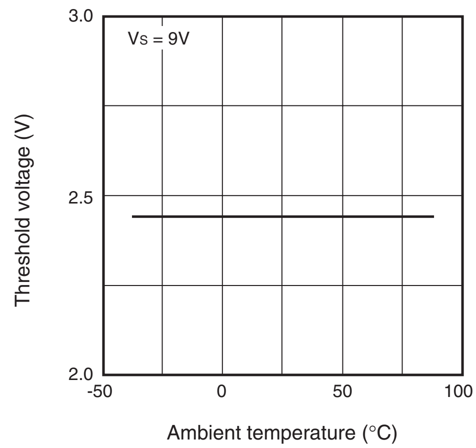
TRC1,2 “H” Output Current vs. Ambient Temperature



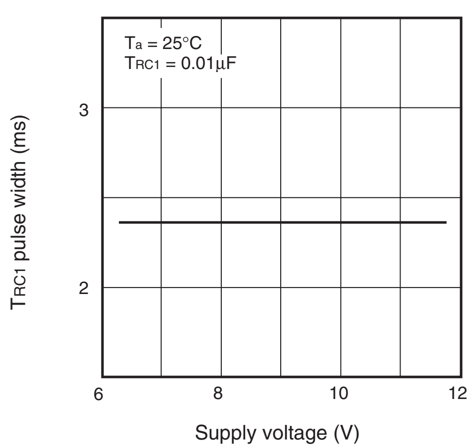
TRC1,2/OFFC/IBLI/TTDC Threshold Voltage vs. Supply Voltage



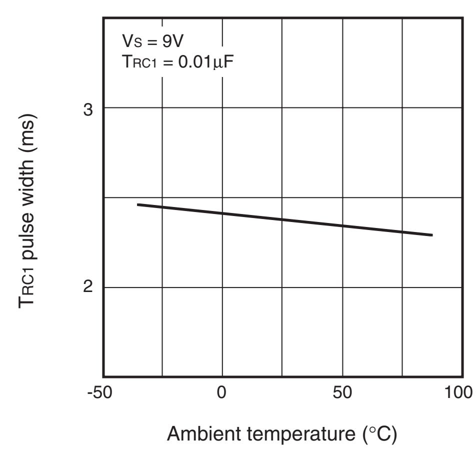
TRC1,2/OFFC/IBLI/TTDC Threshold Voltage vs. Ambient Temperature



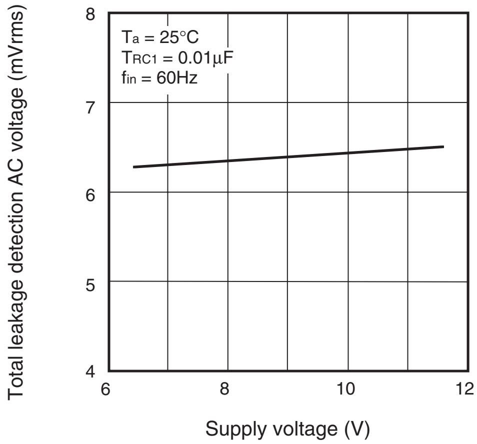
TRC1 Pulse Width vs. Supply Voltage



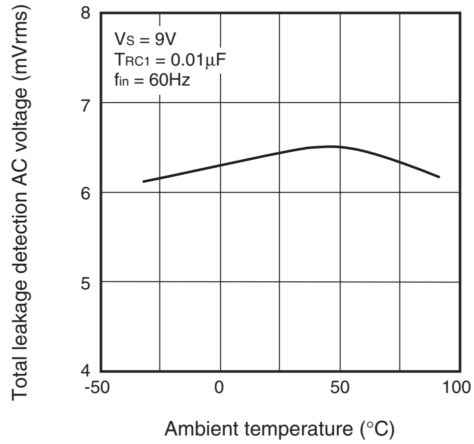
TRC1 Pulse Width vs. Ambient Temperature



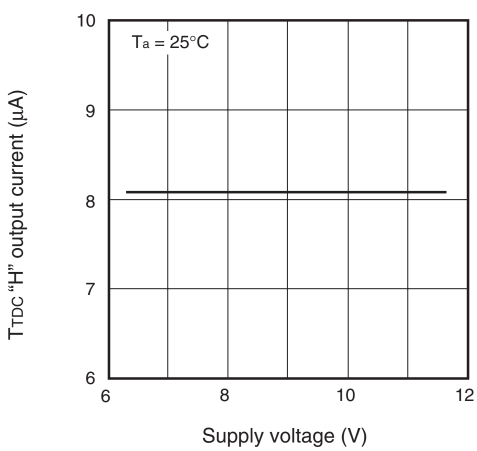
Total Leakage Detection AC Voltage vs. Supply Voltage



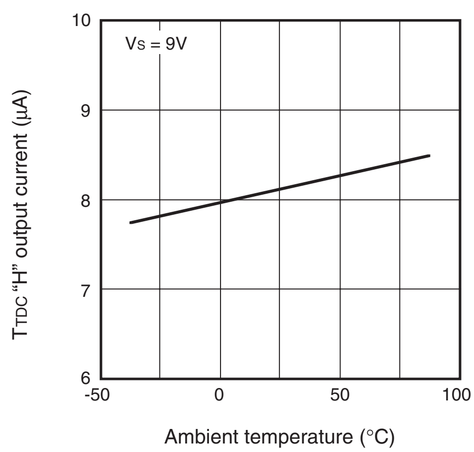
Total Leakage Detection AC Voltage vs. Ambient Temperature



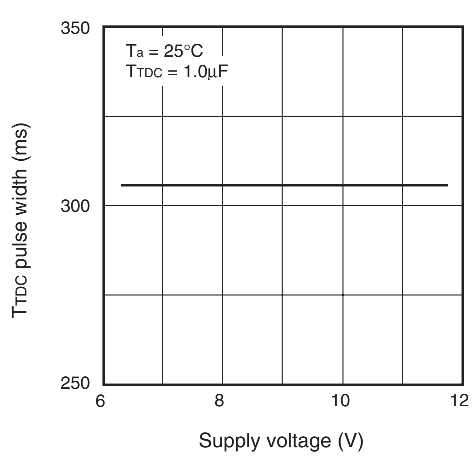
T_{TDC} “H” Output Current vs. Supply Voltage



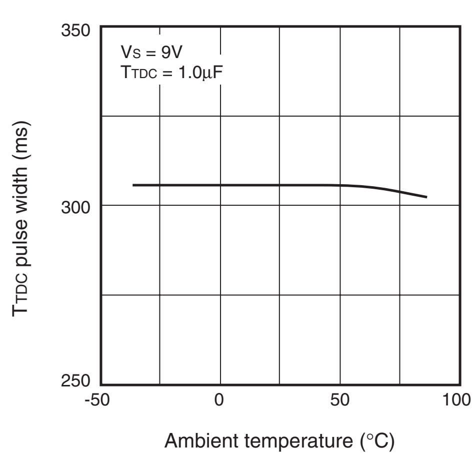
T_{TDC} “H” Output Current vs. Ambient Temperature



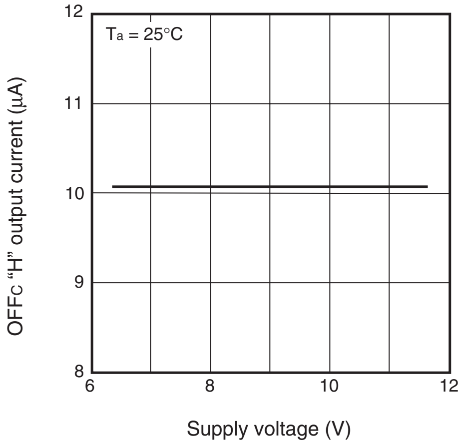
T_{TDC} Pulse Width vs. Supply Voltage



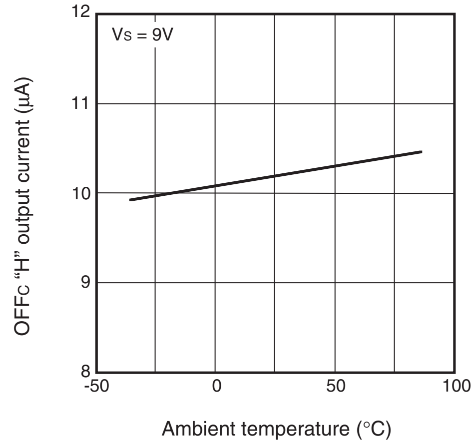
T_{TDC} Pulse Width vs. Ambient Temperature



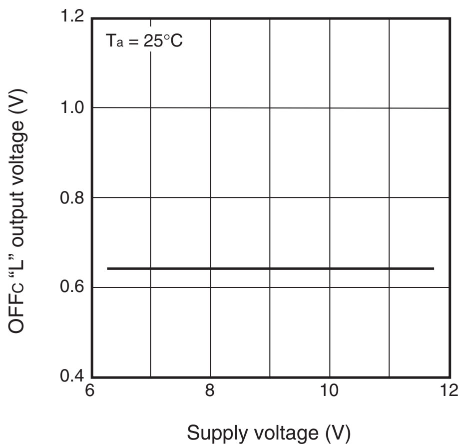
OFFC "H" Output Current vs. Supply Voltage



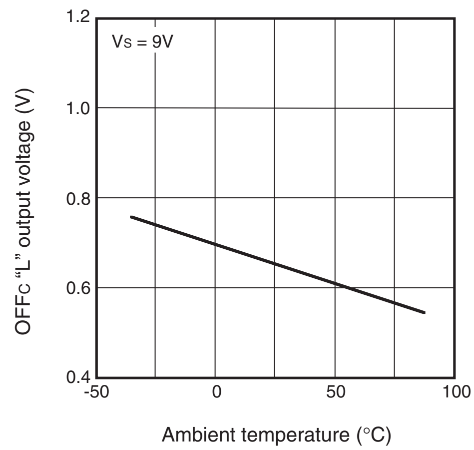
OFFC "H" Output Current vs. Ambient Temperature



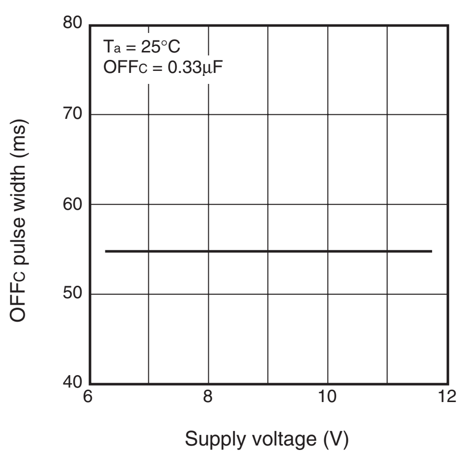
OFFC "L" Output Voltage vs. Supply Voltage



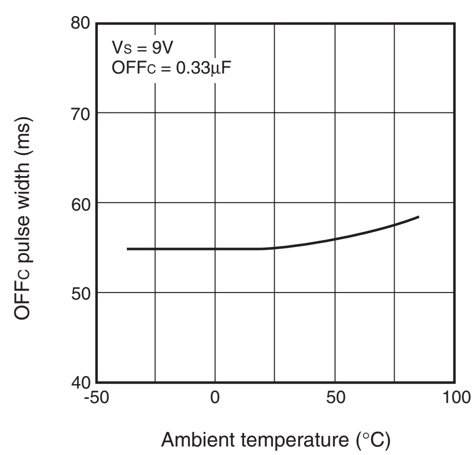
OFFC "L" Output Voltage vs. Ambient Temperature



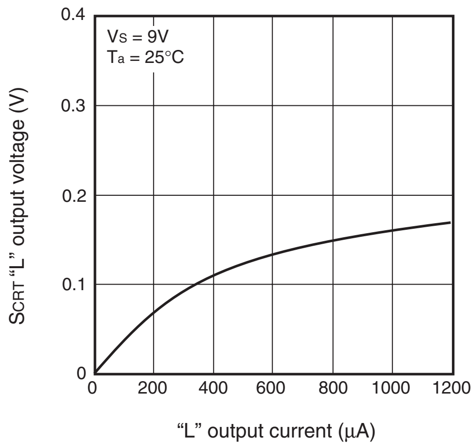
OFFC Pulse Width vs. Supply Voltage



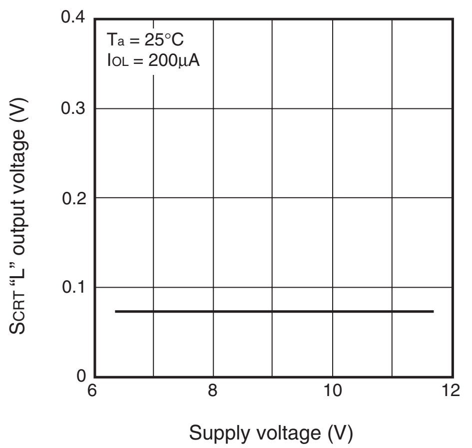
OFFC Pulse Width vs. Ambient Temperature



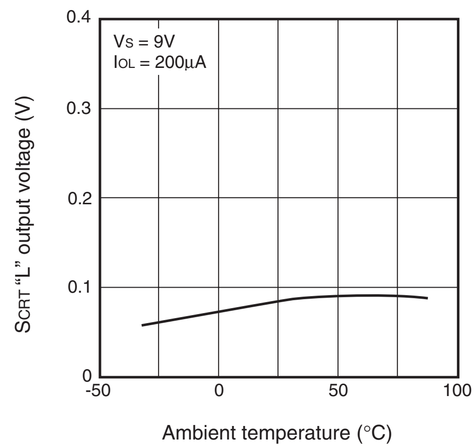
SCRT "L" Output Voltage vs. "L" Output Current



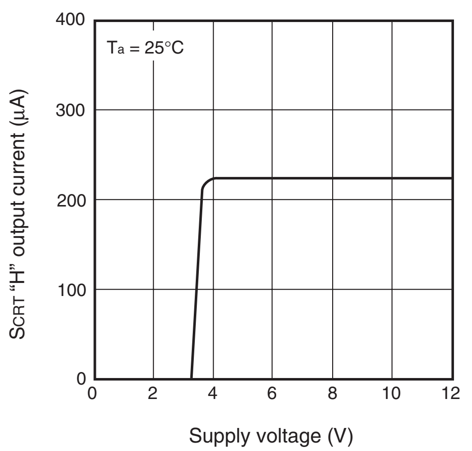
SCRT "L" Output Voltage vs. "L" Supply Voltage



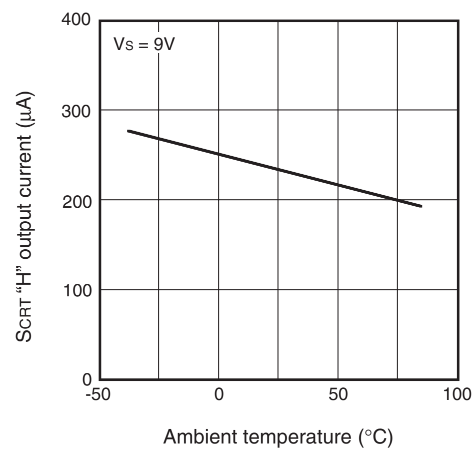
SCRT "L" Output Voltage vs. Ambient Temperature



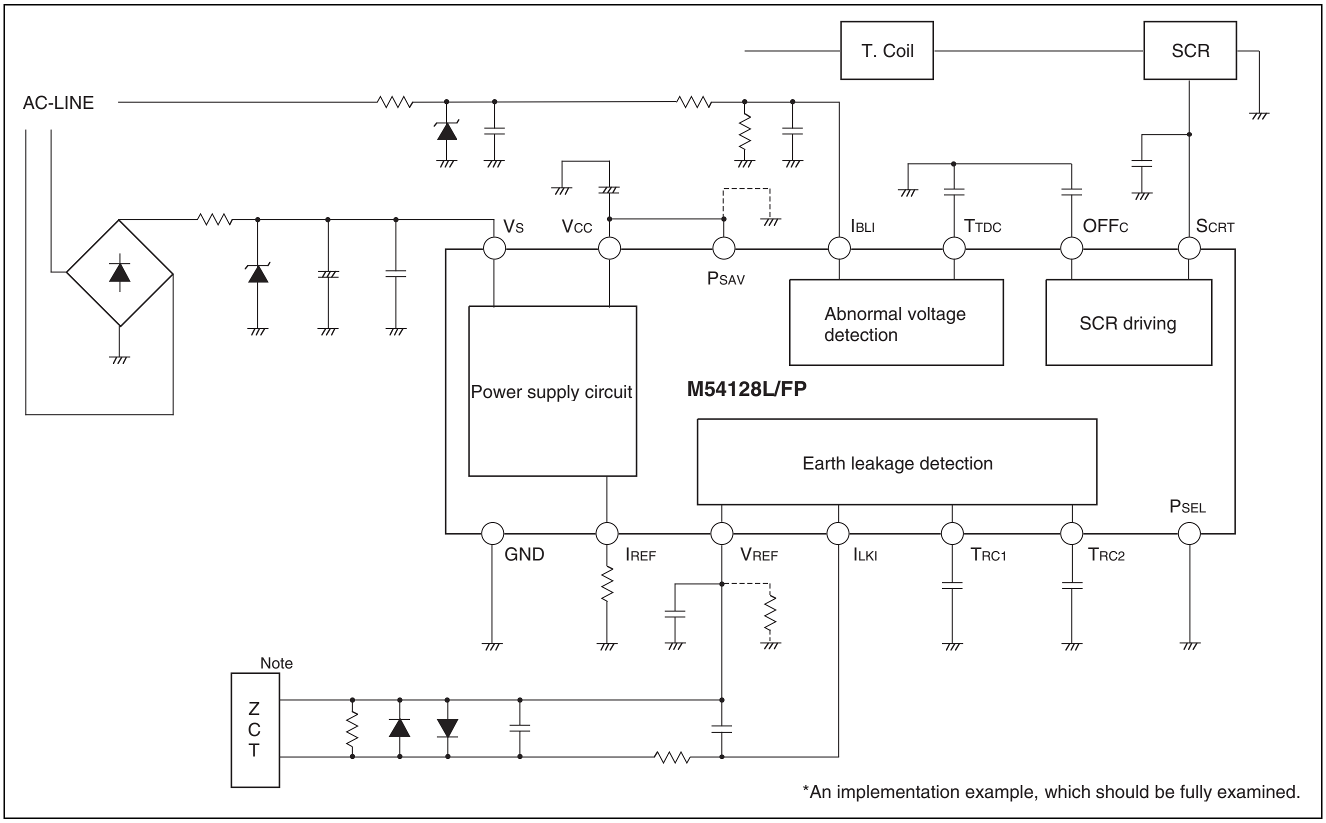
SCRT "H" Output Current vs. Supply Voltage



SCRT "H" Output Current vs. Ambient Temperature



Application Circuit Example



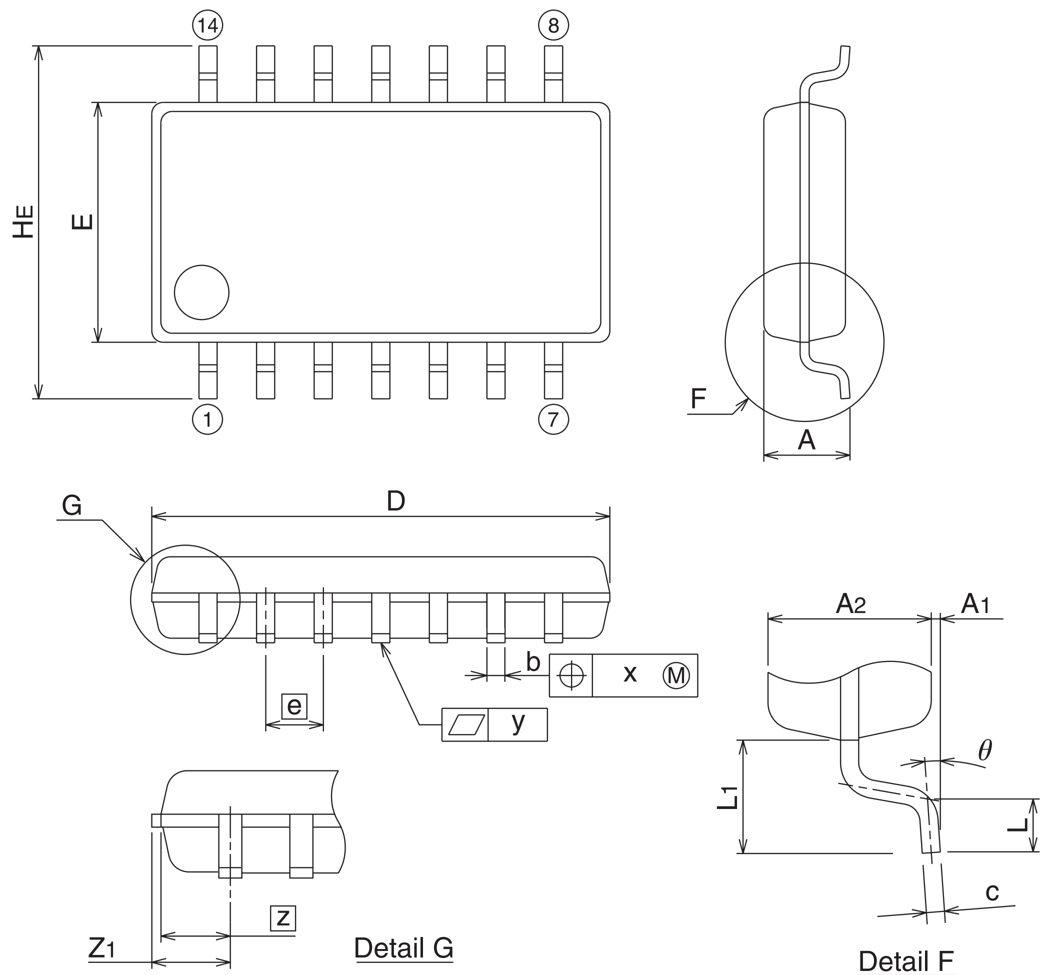
RENESAS

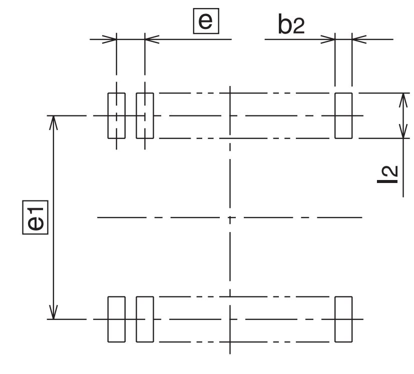
Package Dimensions

14P2N-A (MMP)

Plastic 14pin 300mil SOP

EIAJ Package Code	JEDEC Code	Weight(g)	Lead Material
SOP14-P-300-1.27	–	0.2	Cu Alloy





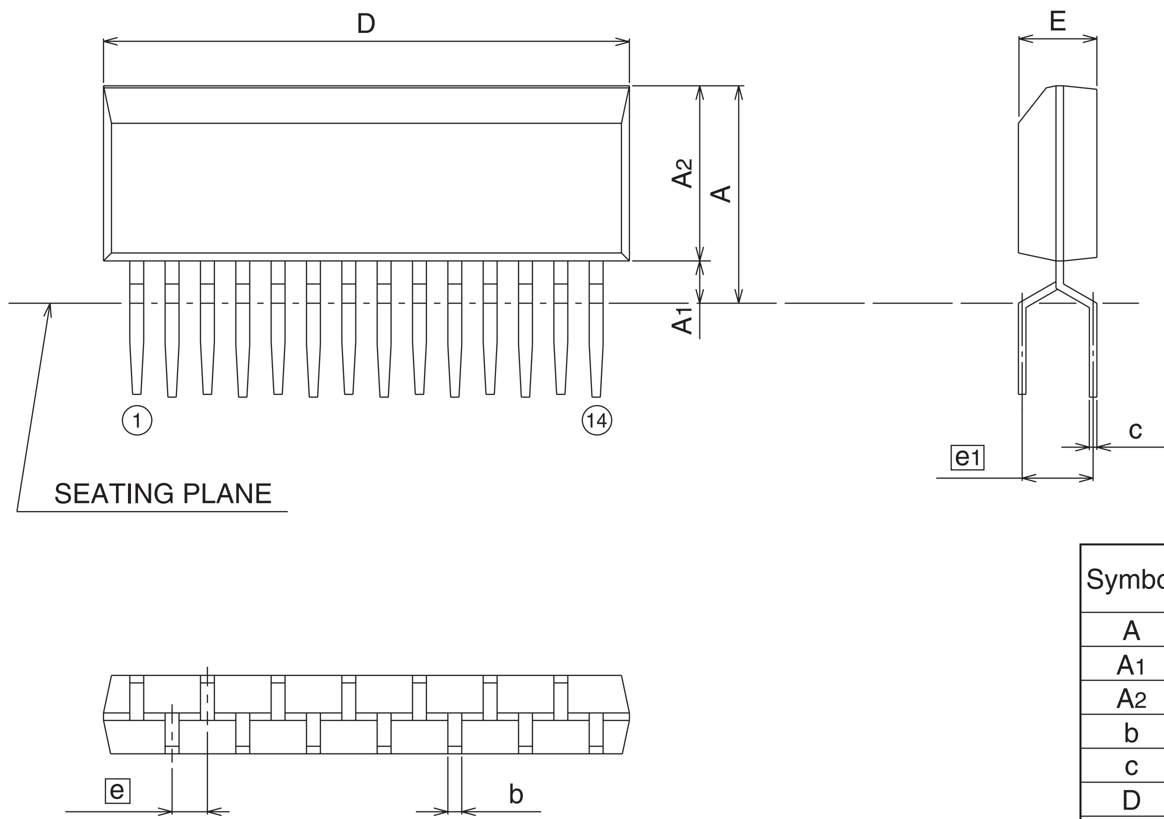
Recommended Mount Pad

Symbol	Dimension in Millimeters		
	Min	Nom	Max
A	–	–	2.1
A_1	0	0.1	0.2
A_2	–	1.8	–
b	0.35	0.4	0.5
c	0.18	0.2	0.25
D	10.0	10.1	10.2
E	5.2	5.3	5.4
e	–	1.27	–
H_E	7.5	7.8	8.1
L	0.4	0.6	0.8
L_1	–	1.25	–
z	–	1.24	–
Z_1	–	–	1.39
x	–	–	0.25
y	–	–	0.1
θ	0°	–	8°
b_2	–	0 76	–
e_1	–	7.62	–
l_2	1.27	–	–

14P5A

Plastic 14pin 325mil ZIP

EIAJ Package Code	JEDEC Code	Weight(g)	Lead Material
ZIP14-P-325-1.27	–	0.74	Cu Alloy



Symbol	Dimension in Millimeters		
	Min	Nom	Max
A	–	–	8.3
A_1	0.9	–	–
A_2	–	6.3	–
b	0.4	0.5	0.6
c	0.22	0.27	0.34
D	18.8	19.0	19.2
E	2.6	2.8	3.0
e	–	1.27	–
e_1	–	2.54	–
L	2.8	–	–

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