M54128L/FP

EARTH LEAKAGE CURRENT DETECTOR

DESCRIPTION

The M54128 is a semiconductor integrated circuit designed for high-speed type earth leakage breakers. This IC includes leakage and abnormal voltage detecting functions.

FEATURES

- Improvement of ability against unwanted tripping due to lightning -surge.
  - Adopt the two times counting system.
  - Improvement of ability against needless action due to lightning-impulse.
- It is a possible that cope with IEC owing to mode change.
  - Adopt the 1.5 times counting system.
- High input impedance :
  - Filter circuit can be formed with externally attached C/R.
  - Improvement of ability against needless action due to high frequency and high harmonics.
- High input sensitivity : V_T = 6.5mVrms
- Abnormal voltage detecting (neutral conductor open-phase protection) function :
  - Neutral conductor open-phase protection at single-phase three-wire system
  - In case of no use this function, stop this function and reduction of circuit current, possible.
- Low voltage operation : 7 to12V (conventional Mitsubishi ICs : 12 to 20V)
- Low current dissipation :
  - In stand-by condition : 820μA typical (Vs = 9V, Ta = 25°C)
  - When SCR is ON : 740μA typical (Vs = 9V, Ta = 25°C)
- Highly stable design : Employment of circuits of which characteristics fluctuations resulting from changes in supply voltage/ambient temperature are small.

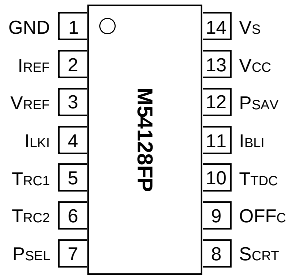
APPLICATION

Earth leakage breaker

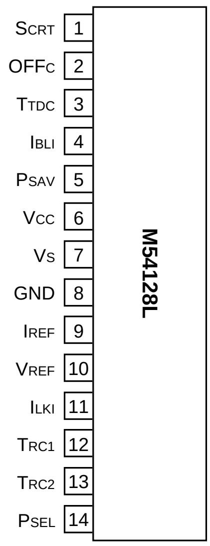
RECOMMENDED OPERATING CONDITIONS

Supply voltage range 7 to12V
Operating ambient temperature .... -20 to +85°C

PIN CONFIGURATION (TOP VIEW)

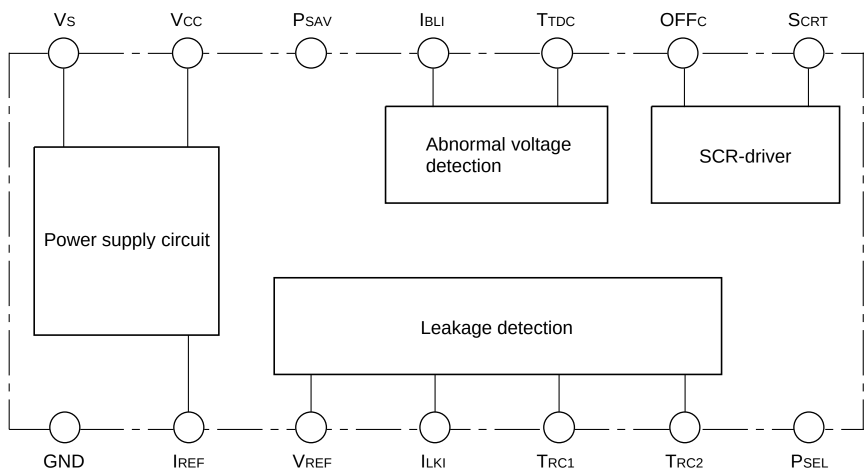


Outline 14P2N-A



Outline 14P5A

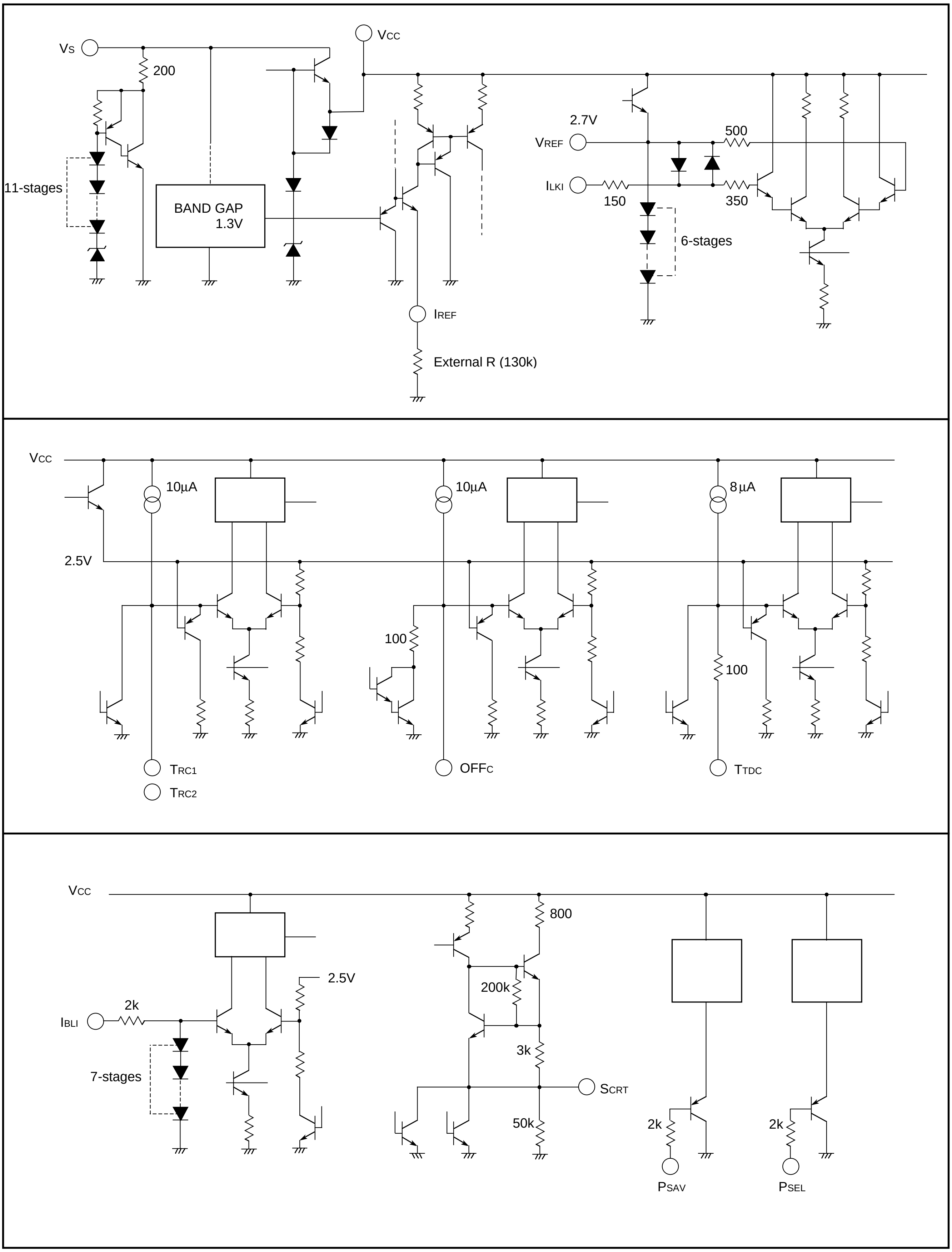
BLOCK DIAGRAM



PIN FUNCTION DESCRIPTION

Pin No.		Pin name	Function
L	FP		
Common			
⑦	⑭	V_S	Power supply
⑥	⑬	V_{CC}	Output pin of internal constant-voltage circuit. Connects to capacitor for decoupling.
⑨	②	I_{REF}	Connects to resistor which sets constant current of each internal circuit. Approx. 1.3V.
⑧	①	GND	Grounding
⑤	⑫	P_{SAV}	When in normal use, connect the pin to V_{CC} pin. When the abnormal voltage detection function is not in use, ground the pin. Circuit current can be reduced. Ground I_{BLI} pin and T_{TDC} pin also.
Leakage detection, abnormal voltage detection, SCR drive circuits			
⑩	③	V_{REF}	Input reference level pin of the leakage detection circuit. Approx. 2.7V.
⑪	④	I_{LKI}	Another input pin of the leakage detection circuit.
⑫	⑤	T_{RC1}	Connects to capacitor for integrating output signals of the leakage input signal level discriminator.
⑬	⑥	T_{RC2}	Connects to condeser for removing noise.
⑭	⑦	P_{SEL}	Logic function switching pin used when detecting leakage. When the pin is grounded, S_{CRT} operates with the logic flow of negative input → positive input → negative input. when it is connected to V_{CC} pin, S_{CRT} operates with the logic flow of negative input → positive input.
②	⑨	OFF_C	This IC will be restored to the initial condition after the specified period if : leakage input signal does not continue ; abnormal voltage input signal does not continue ; or leakage/abnormal voltage is detected and SCR becomes ON. The pin connects to capacitor for time settinng of this function.
④	⑪	I_{BLI}	Input pin of the abnormal voltage detection circuit.
③	⑩	T_{TDC}	Connects to capacitor for time setting of the abnormal voltage detection circuit.
①	⑧	S_{CRT}	Output pin for drive a SCR.

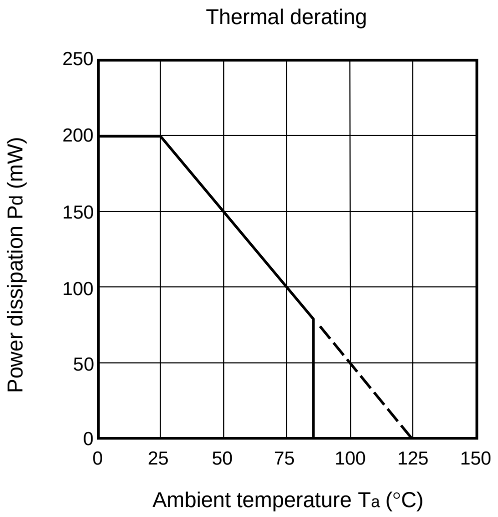
I/O EQUIVALENT CIRCUIT



ABSOLUTE MAXIMUM RATINGS (Ta = 25°C, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
I_S	Source current		4	mA
$V_{S\ MAX}$	Max. supply voltage		15	V
ΔV_{IL}	Input voltage	I_{LKI} - V_{REF}	-1.4 to +1.4	V
I_{IL}	Input current	I_{LKI} - V_{REF}	-5 to +5	mA
I_{IG}	Input current	V_{REF} - GND	10	mA
V_{IBL}	Input voltage	I_{BLI} - GND	-0.3 to +4.0	V
I_{IBL}	Input current	I_{BLI} - GND	4	mA
P_d	Power dissipation		200	mW
T_{opr}	Operating temperature		-20 to 85	°C
T_{stg}	Storage temperature		-55 to125	°C

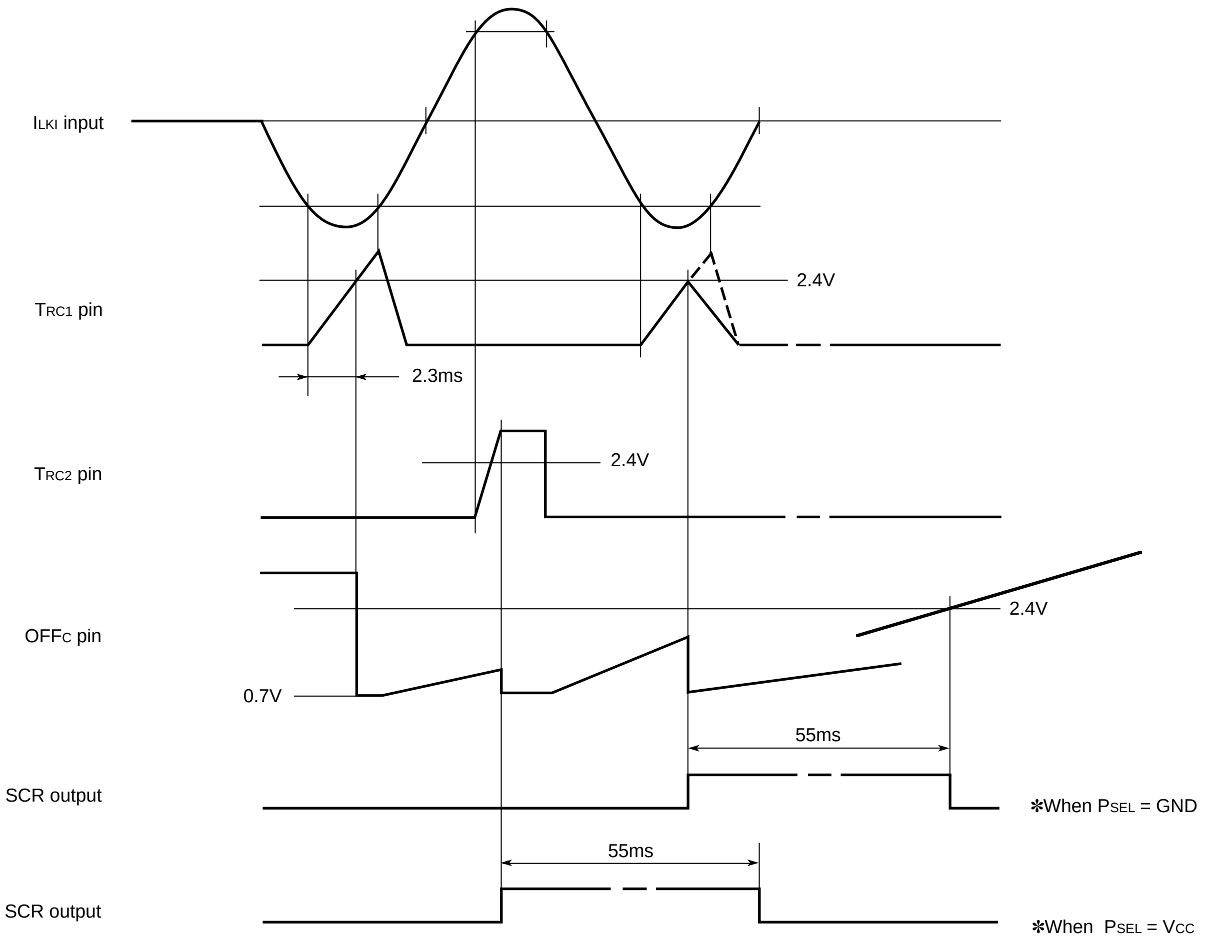
TYPICAL CHARACTERISTICS



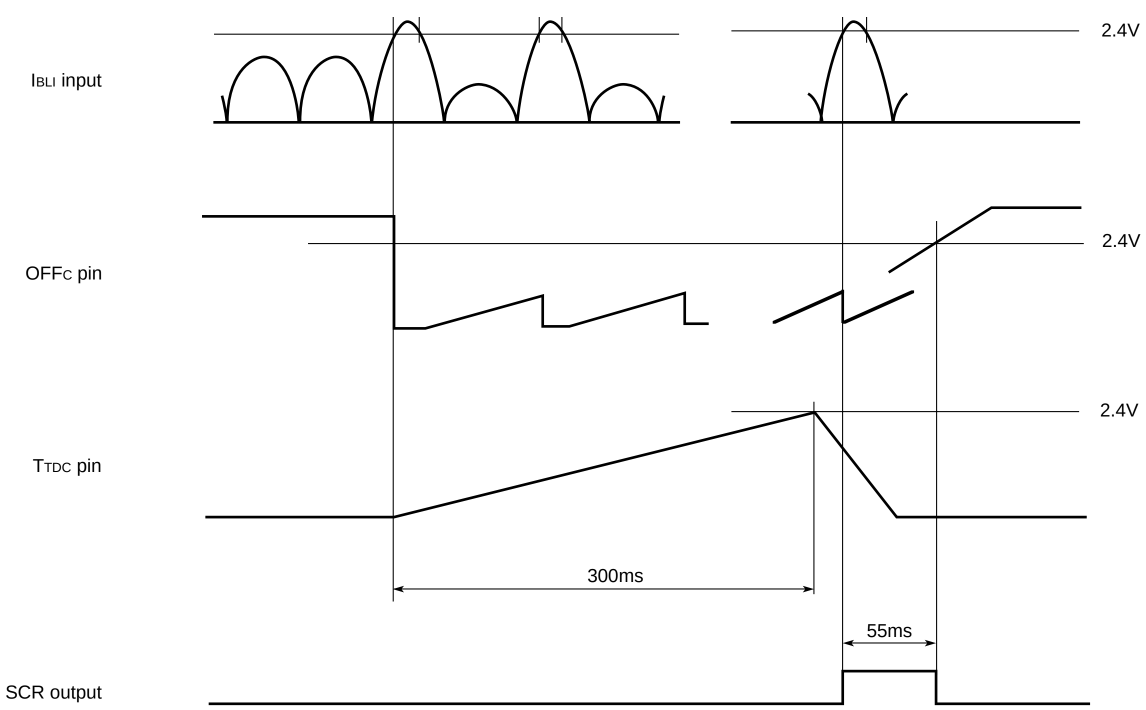
ELECTRICAL CHARACTERISTICS (Ta = 25°C, unless otherwise noted)

Symbol	Parameter		Test conditions		Limits			Unit
			V_S		Min.	Typ.	Max.	
I_{S0}	Power supply circuit	Source current: In stand-by condition	9V	P_{SAV} = V_{CC}	570	820	950	µA
I_{S1}		Source current: While detecting leakage			570	840	950	µA
I_{S2}		Source current: While detecting abnormal voltage			570	810	950	µA
I_{S3}		Source current: Immediately after driving of SCR			520	740	870	µA
I_{S0}'		Source current: In stand-by condition	9V	P_{SAV} = GND	520	740	870	µA
I_{S1}'		Source current: While detecting leakage			520	760	870	µA
I_{S3}'		Source current: Immediately after driving of SCR			520	740	870	µA
–		I_{SO} variation with ambient temperature	9V	Ta = -20 to 85°C	–	-0.07	–	%/°C
$V_{S\ max}$		Maximum current voltage	–	I_S = 4mA	–	13.9	15	V
V_{ion}	Leakage detection circuit	Leakage detecting DC input voltage	9V	I_{LKI} -V_{REF}	–	±7.5	–	mVdc
I_{IH}		ILKI pin input bias current		V_{IN} = V_{REF}	–	2	15	nA
V_O		V_{REF} pin output voltage			–	2.7	–	V
V_{ILKI}		ILKI-V_{REF} input clamp voltage		I_{ILKI} = ±3mA	–	±1.2	–	V
V_{RCL}		V_{REF}-GND clamp voltage		I_{RCL} = 5mA	–	4.6	–	V
E_{IOH}	2ms circuit	TRC1 pin "H" output current precision	9V	V_O = 0V : I_{OH} = -10.4µA	-20	–	20	%
V_{TH}		TRC1 threshold voltage			–	2.4	–	V
ET_{W1}		T_{W1} pulse width precision		C = 0.01µF : T_{W1} = 2.3ms	-15	–	15	%
–		T_{W1} variation with ambient temperature		Ta = -20 to 85°C	–	-0.06	–	%/°C
E_{IOH}	1ms circuit	TRC2 pin "H" output current precision	9V	V_O = 0V : I_{OH} = -10.4µA	-20	–	20	%
V_{TH}		TRC2 threshold voltage			–	2.4	–	V
ET_{W2}		T_{W2} pulse width precision		C = 0.0047µF : T_{W2} = 1.1ms	-15	–	15	%
–		T_{W2} variation with ambient temperature		Ta = -20 to 85°C	–	-0.06	–	%/°C
V_T		Total leakage detecting AC voltage	9V	60Hz	–	6.5	–	mVrms
–		V_T variation with ambient temperature	9V	Ta = 25 → 85°C	–	-4.0	–	%
				Ta = 25 → -20°C	–	-4.0	–	%
V_{BLT}	Abnormal voltage detecting circuit	Abnormal voltage detecting voltage	9V		2.2	2.4	2.6	V
–		V_{BLT} variation with supply voltage	–		–	0.01	–	%/V
–		V_{BLT} variation with ambient temperature	9V	Ta = -20 to 85°C	–	0.06	–	%/°C
I_{IBLT}		IBLI pin input bias current		V_{IN} = V_{REF}	–	120	300	nA
V_{IBLC}		IBLI-GND clamp voltage		I_{IN} = 1mA	–	7.2	–	V
E_{IOH}		TTDC pin "H" output current precision		V_O = 0V : I_{OH} = -8µA	-20	–	20	%
V_{TH}		TTDC threshold voltage			–	2.4	–	V
ET_{W4}		Delay time pulse width precision		C = 1.0µF : T_{W4} = 300ms	-30	–	30	%
E_{IOH}	Reset circuit	OFFC pin "H" output current precision	9V	V_O = 0V : I_{OH} = -10µA	-20	–	20	%
V_{TH}		OFFC threshold voltage			–	2.4	–	V
ET_{W3}		Reset timer pulse width precision	9V	C = 0.33µF : T_{W3} = 55ms	-30	–	30	%
V_{OL8}	SCR drive circuit	SCRT pin "L" output voltage	9V	I_{OL} = 200µA	–	0.1	0.2	V
I_{OHc}		SCRT pin "H" output current	9V	V_O = 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}		I_{OH} holding supply voltage	–		–	3.0	4.5	V

EARTH LEAKAGE DETECTION



ABNORMAL VOLTAGE DETECTION

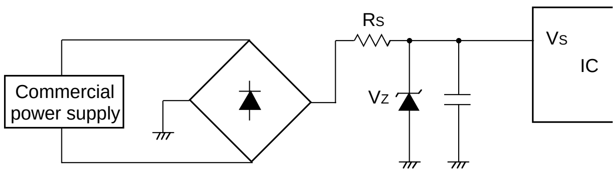


PRECAUTIONS FOR APPLICATION

Note that the improvement examples in the following precautions for application of M54128FP/L are merely examples.

1. VS applied voltage

(1) Is circuit current (clamp circuit characteristics of the equivalent circuit) is as shown in TYPICAL CHARACTERISTICS figure 1 on page 9. Attention should be given to the circuit current when designing the power supply circuit.



(2) Use of the IC by rectifying commercial power supply

a) As Vz, be sure to use zener diode of 12V or less (not exceeding the absolute maximum rating of 15V).

b) At high temperatures, clamp voltage decreases and Is increases. Increase of Is will be restricted at Rs, however.

(3) If normal DC power supply is used, use the IC at Vs=7to10V.

2. Resistor of IREF pin (R = 130kΩ)

Reference constant current source of the IC (for restraining fluctuations in supply voltage characteristics and ambient temperature characteristics).

Since this resistor determines the characteristics of each circuit, use of high-precision resistor (±2%) is recommended.

3. Layout of printed circuit board

External noise (noise simulator etc.) may cause faulty operation of the IC.

To improve the noise immunity, layout the printed circuit board so that the wiring of the external C and R is made as short as possible.

Special attention should be given to the wiring of the condensers connected to Vs, Vcc and SCRT pins.

4. Be careful that the voltage of SCRT output pin does not become lower than the GND level.

5. Change in sensitivity due to insulation deterioration

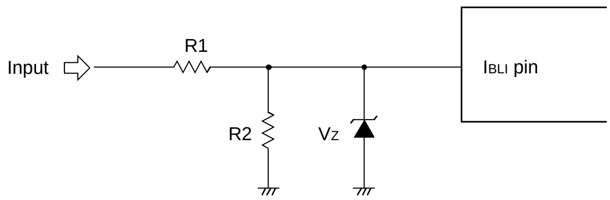
If the insulation of ZCT input pin from the high voltage part might deteriorate, improvement might be expected by connecting a resistor of about R=100kΩ between V_{REF} pin and GND.

It should be noted that the circuit current will increase at I ≒ 2.7V/R (approx.).

6. Clamp diode of IBLI input pin

As shown in the equivalent circuit, it is made up of series resistor (approx. 2kΩ) and seven stages of forward diode.

(1) At high temperatures, the drop in diode V_F may decrease the clamp voltage of the pin. If the voltage approaches the reference level of the comparator (2.4V) and current leaks occur, the overvoltage detection level may slightly fluctuate. Form the detection circuit as the figure below. It is recommended that R_1, R_2 and V_Z be set as shown below.



- $R_1 + R_2 > 200k\Omega$
- $\frac{R_1 \times R_2}{R_1 + R_2} < 7k\Omega$

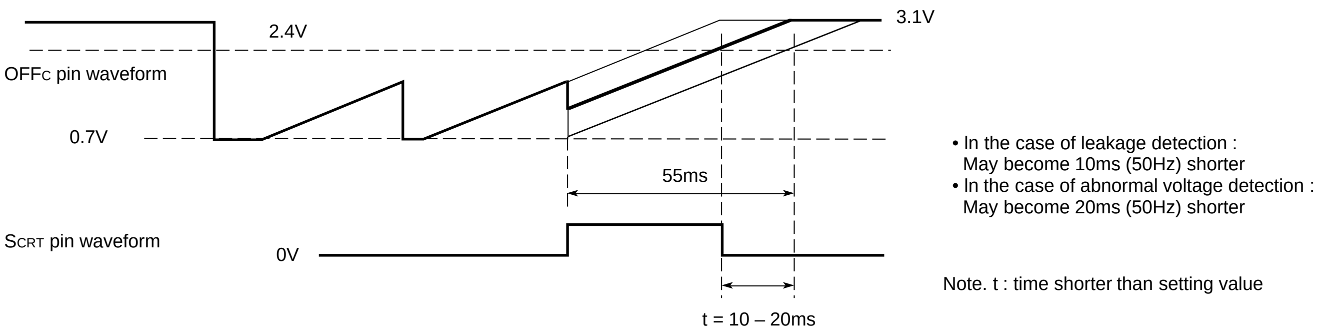
(2) During excessive input, as shown above, setting should be made so that the input pin voltage becomes 4.3V or lower (to prevent the saturated comparator circuit from operating).

- V_Z ≒ 4.0V

7. Reset time in reset circuit

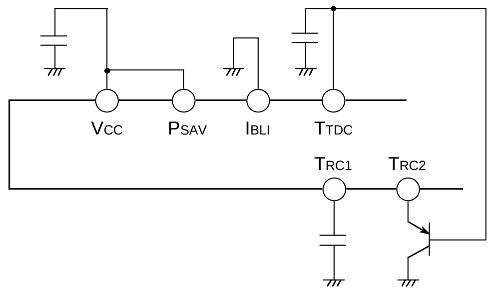
This circuit is designed as a timer circuit of V_L = 0.7V, V_H = 2.5V and Io = 10μA. When SCR is ON, the power supply route of the leakage detection and abnormal voltage detection circuits are shut off, VL does not drop to 0.7V as shown below and therefore reset time may become shorter.
Set the reset time somewhat longer in advance.

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

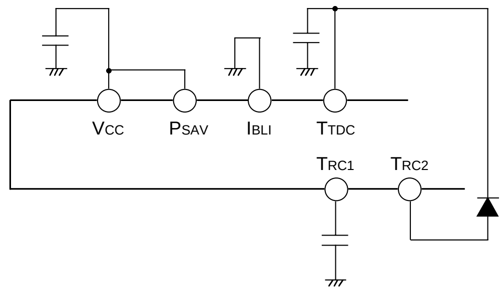


8. Application of leakage detection function to time delay function

As shown in the figure below, by applying the neutral conductor open-phase protection function, it is possible to provide the leakage detection function with time delay function (several 100ms). In this case, however, the neutral conductor open-phase protection function disappears. Pin No. in parentheses are of L type.



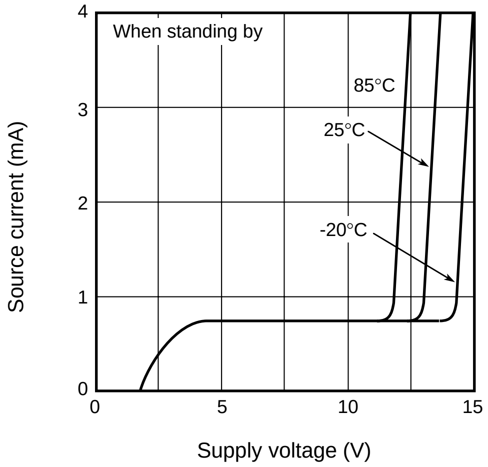
(Example 1)



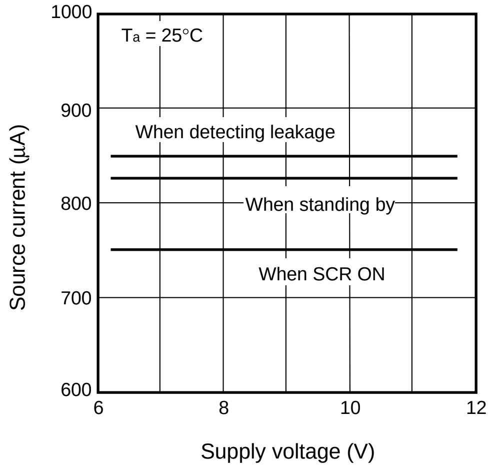
(Example 2)

TYPICAL CHARACTERISTICS

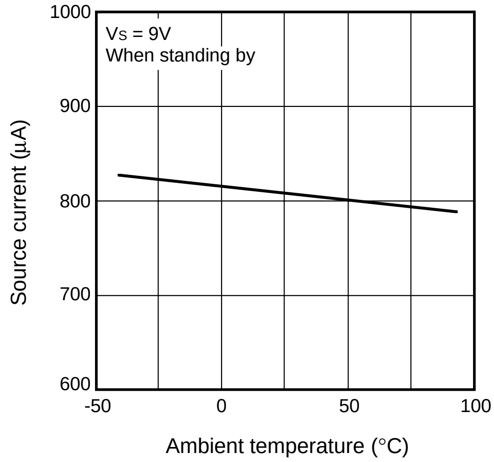
Source Current vs. Supply Voltage



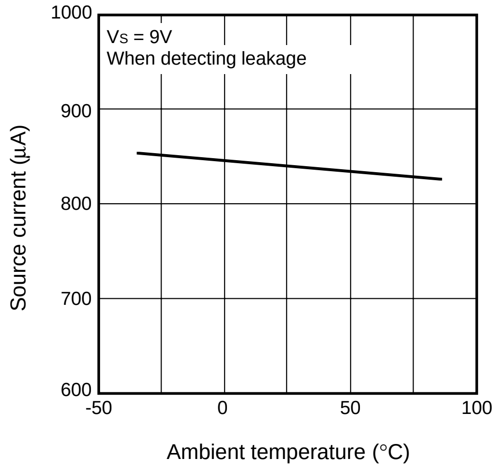
Source Current vs. Supply Voltage



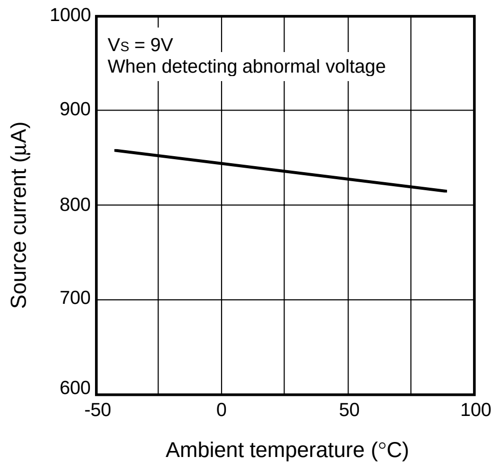
Source Current vs. Ambient Temperature



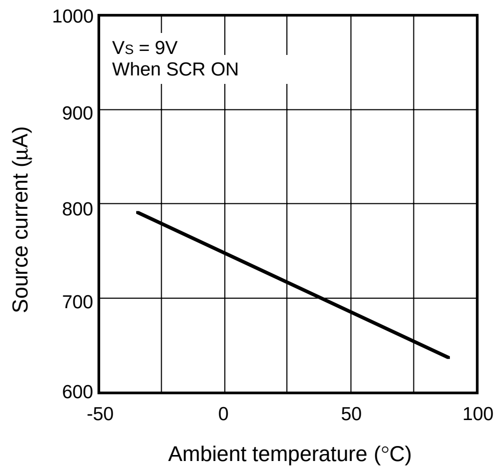
Source Current vs. Ambient Temperature



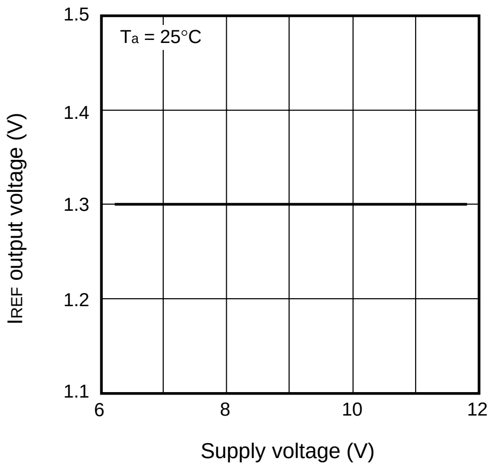
Source Current vs. Ambient Temperature



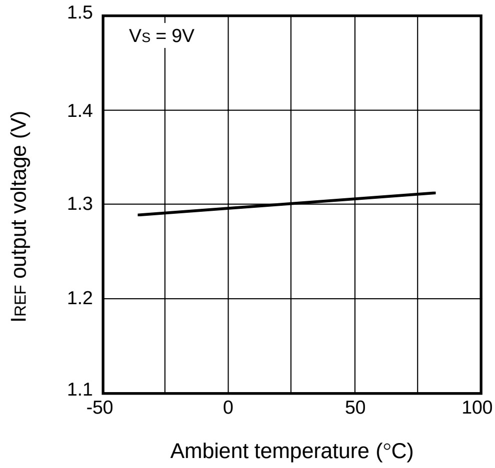
Source Current vs. Ambient Temperature



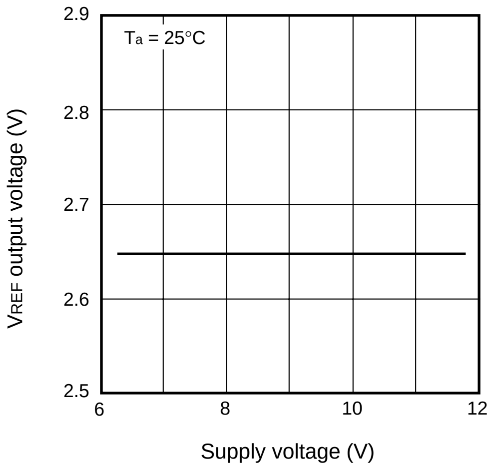
IREF Output Voltage vs. Supply Voltage



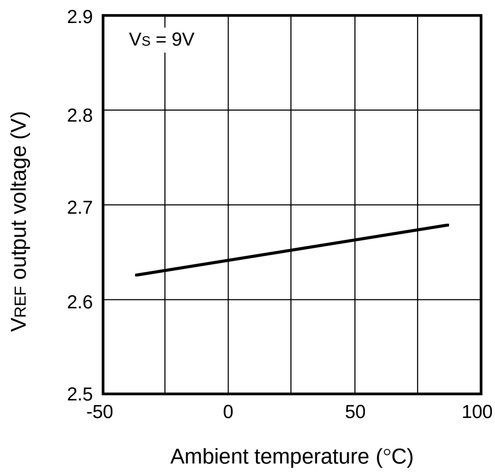
IREF Output Voltage vs. Ambient Temperature



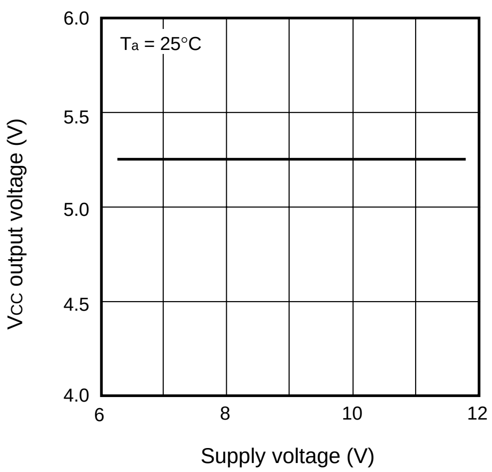
VREF Output Voltage vs. Supply Voltage



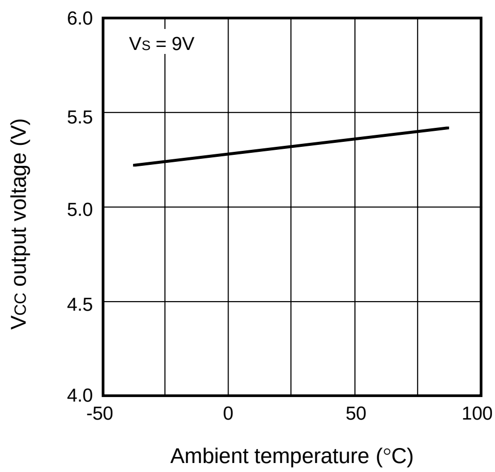
VREF Output Voltage vs. Ambient Temperature



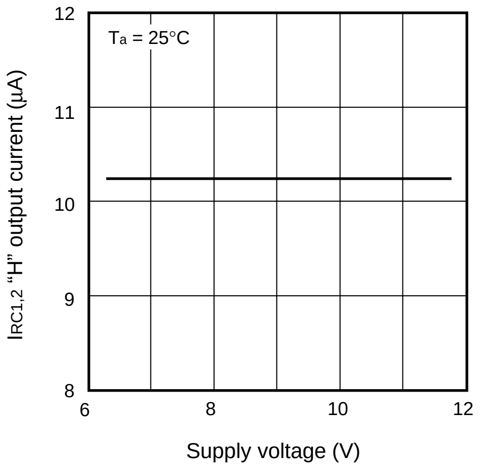
VCC Output Voltage vs. Supply Voltage



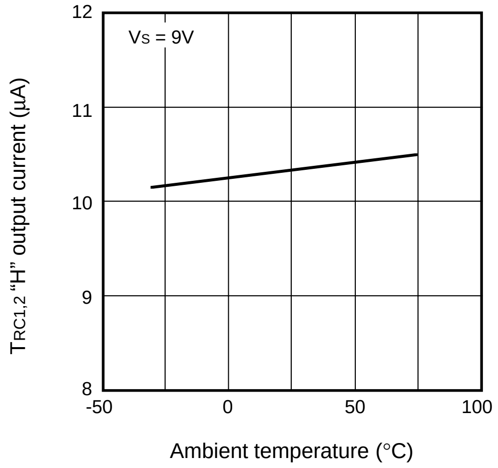
VCC Output Voltage vs. Ambient Temperature



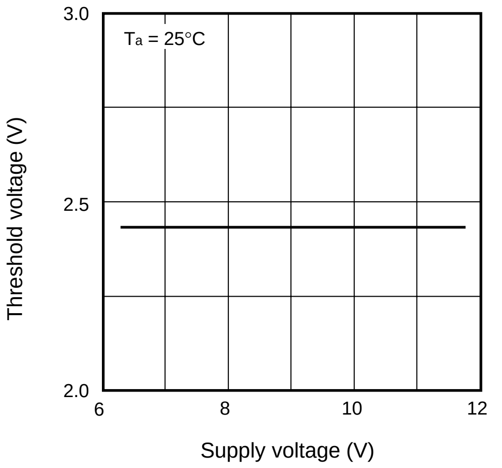
$T_{RC1,2}$ “H” Output Current vs. Supply Voltage



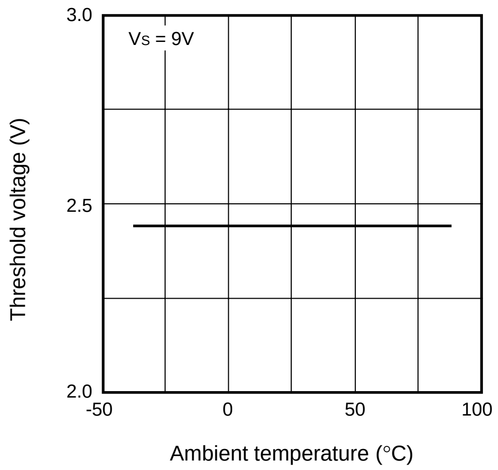
$T_{RC1,2}$ “H” Output Current vs. Ambient Temperature



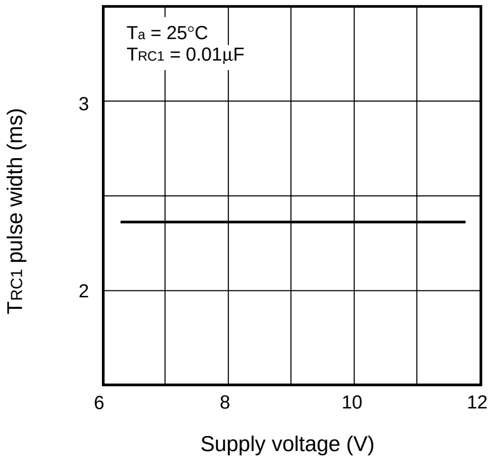
$T_{RC1,2}$/OFF_C/I_{BLI}/T_{TDC} Threshold Voltage vs. Supply Voltage



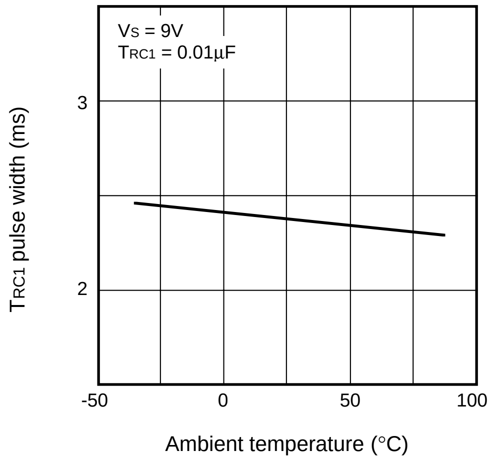
$T_{RC1,2}$/OFF_C/I_{BLI}/T_{TDC} Threshold Voltage vs. Ambient Temperature



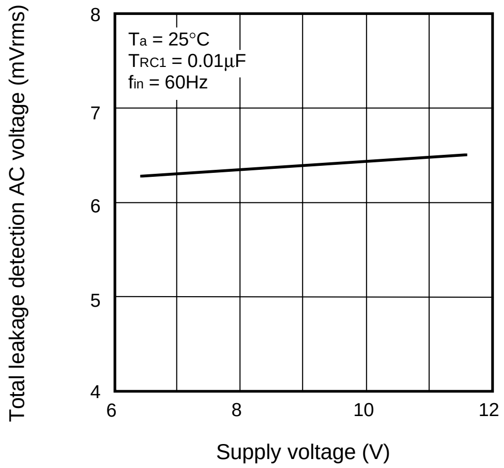
T_{RC1} Pulse Width vs. Supply Voltage



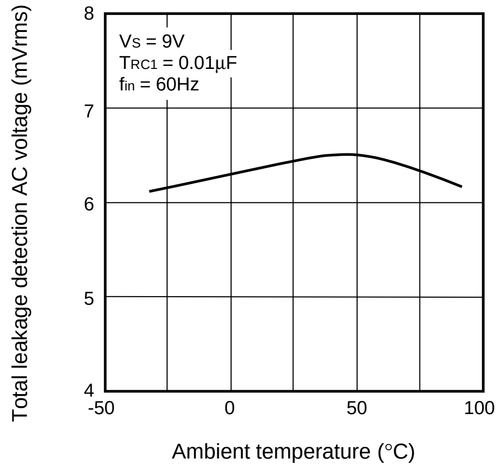
T_{RC1} Pulse Width vs. Ambient Temperature



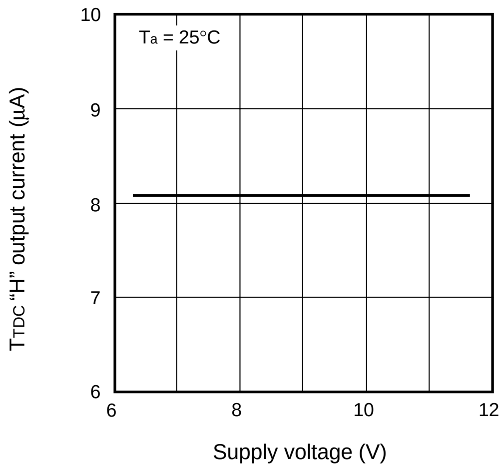
Total Leakage Detection AC Voltage vs. Supply Voltage



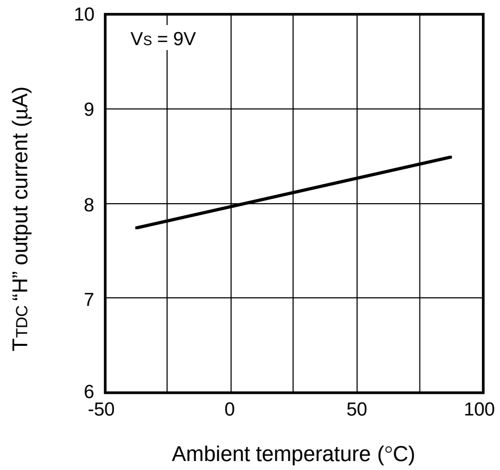
Total Leakage Detection AC Voltage vs. Ambient Temperature



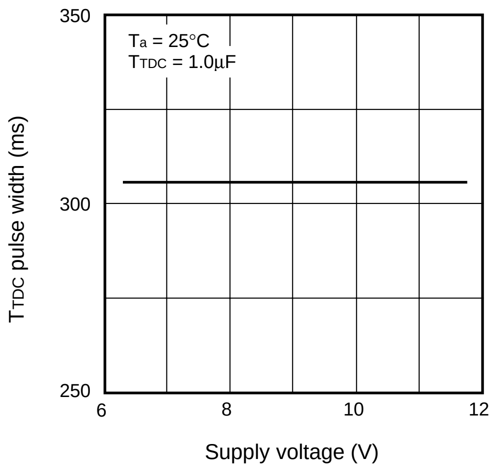
T_{TDC} "H" Output Current vs. Supply Voltage



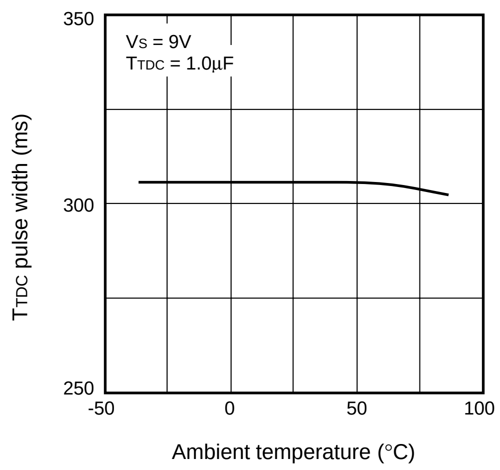
T_{TDC} "H" Output Current vs. Ambient Temperature



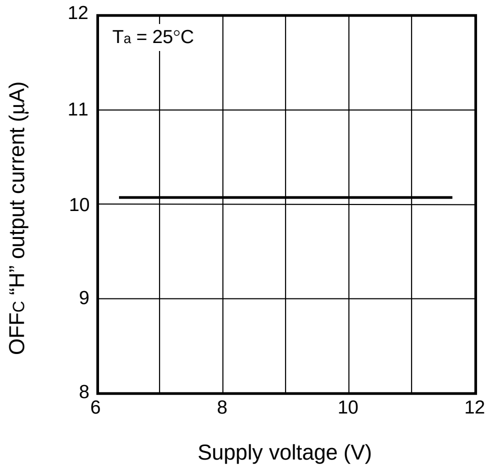
T_{TDC} Pulse Width vs. Supply Voltage



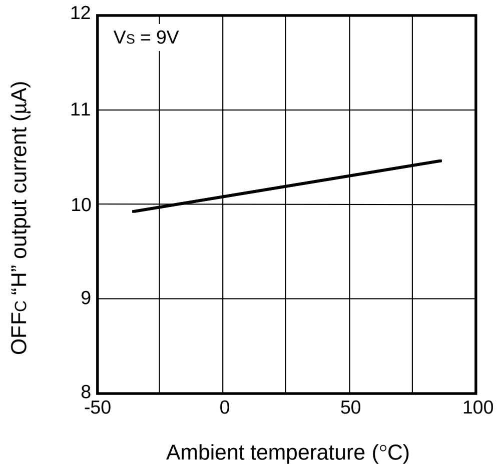
T_{TDC} Pulse Width vs. Ambient Temperature



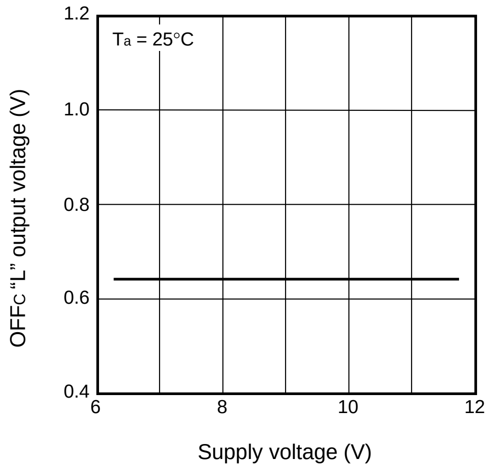
OFFC “H” Output Current vs. Supply Voltage



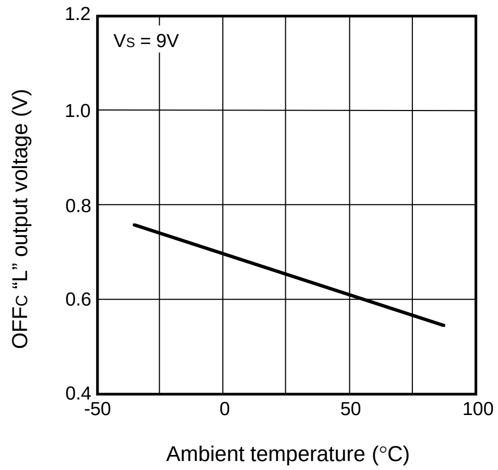
OFFC “H” Output Current vs. Ambient Temperature



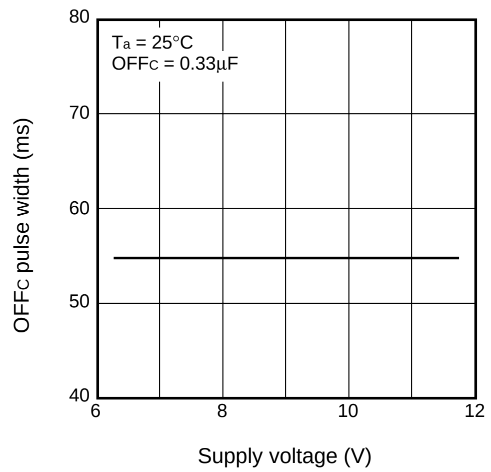
OFFC “L” Output Voltage vs. Supply Voltage



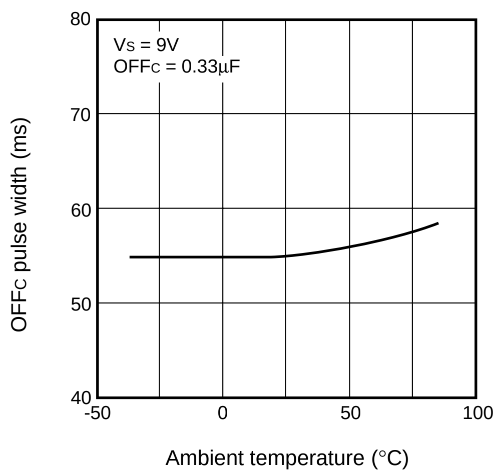
OFFC “L” Output Voltage vs. Ambient Temperature



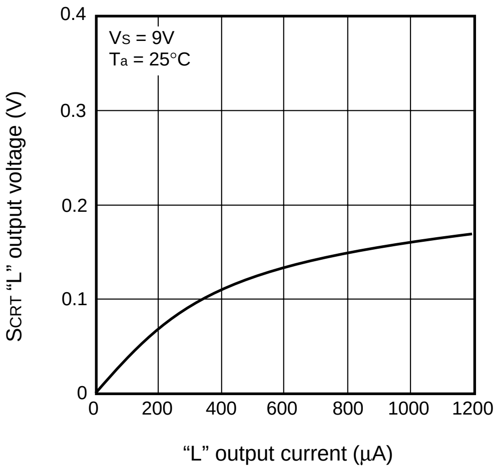
OFFC Pulse Width vs. Supply Voltage



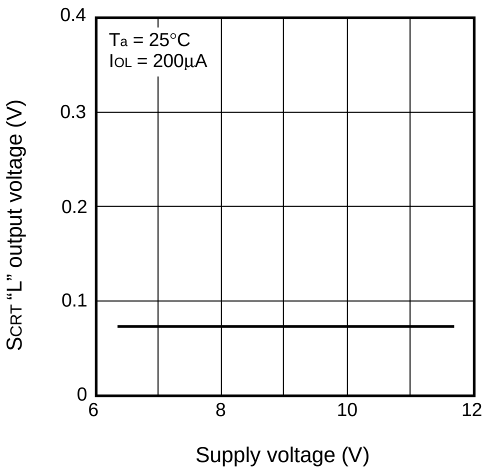
OFFC Pulse Width vs. Ambient Temperature



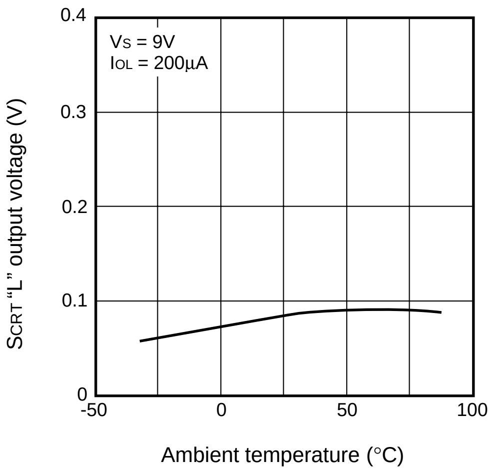
SCRT "L" Output Voltage vs. "L" Output Current



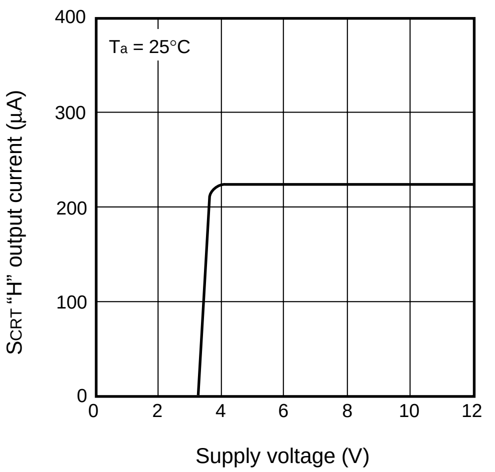
SCRT "L" Output Voltage vs. "L" Supply Voltage



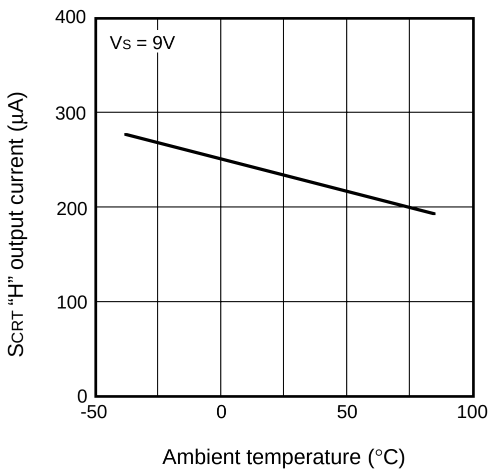
SCRT "L" Output Voltage vs. Ambient Temperature



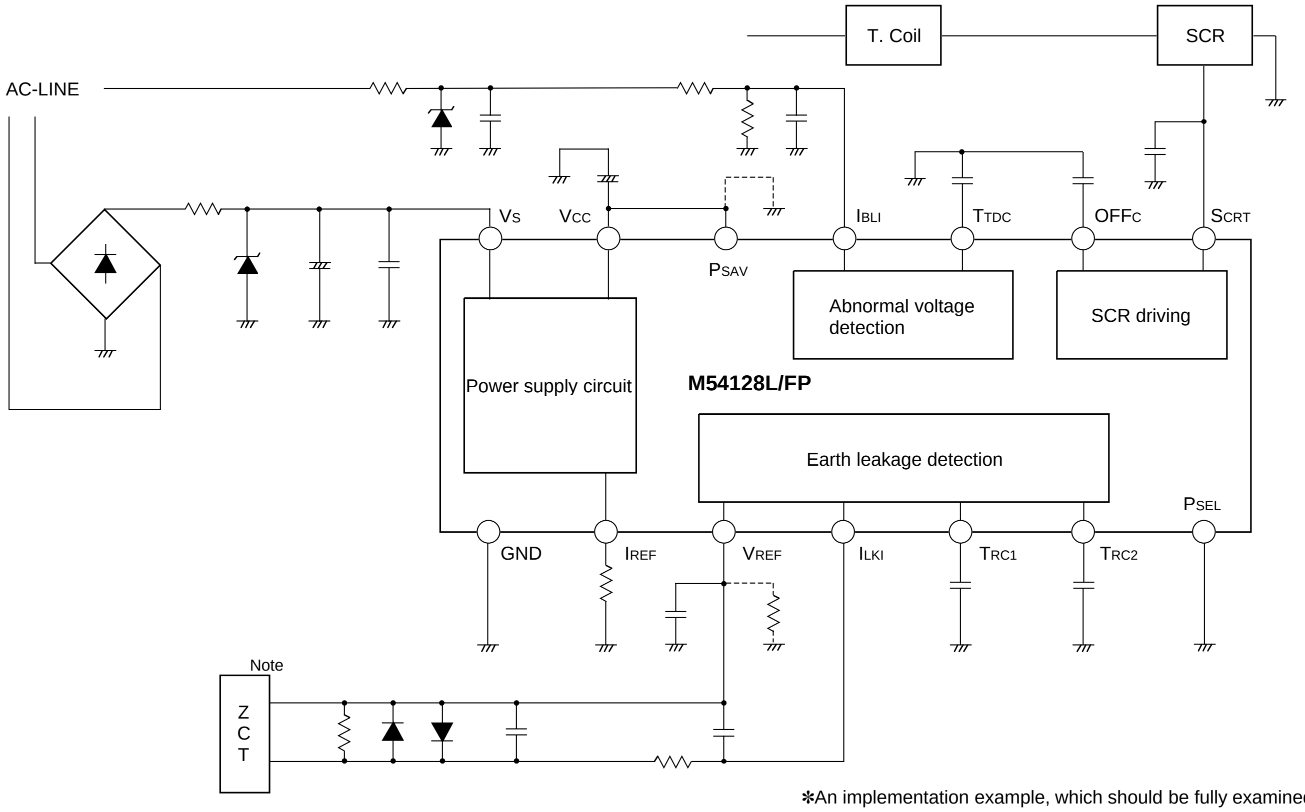
SCRT "H" Output Current vs. Supply Voltage



SCRT "H" Output Current vs. Ambient Temperature



APPLICATION EXAMPLE



✻An implementation example, which should be fully examined.

Note : MZ Core Series by Soryo Denshi Kagaku Co., Ltd (Mitsubishi Subsidiary)
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