

# RT8H044K

Adopting a system that counts three waves in 1.5 cycle.

## DESCRIPTION

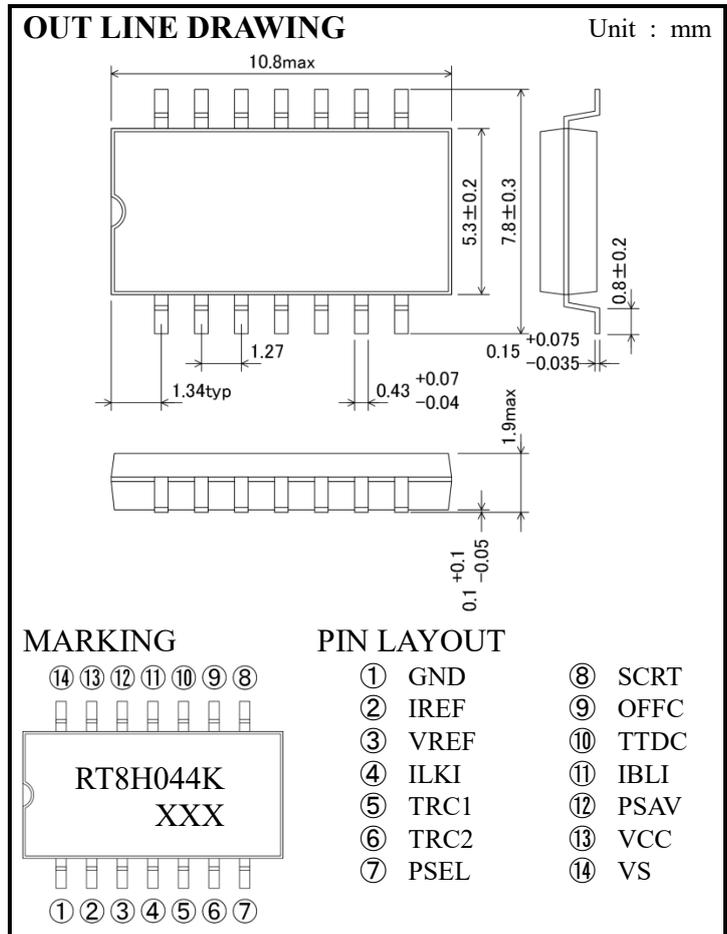
The RT8H044K is a semiconductor integrated circuit designed for high-speed type earth leakage breakers. This IC includes leakage and abnormal voltage detecting functions

## FEATURES

- Switchable earth leakage detection mode ; counting three waves of 1.5 cycle.  
⇔ counting two waves of a cycle.
- 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.
- High input sensitivity ; 7.5mV (DC)
- Low current dissipation ;
  - In stand-by condition : 900uA typical ( $V_s = 9V, T_a = 25\text{ }^\circ\text{C}$ )
  - When SCR is ON : 620uA typical ( $V_s = 9V, T_a = 25\text{ }^\circ\text{C}$ )
- Adopt Pulse output (thyristor drive)
- supply voltage range ; 7V to 12V
- operating ambient temperature ; -20 to 105 °C

## APPLICATION

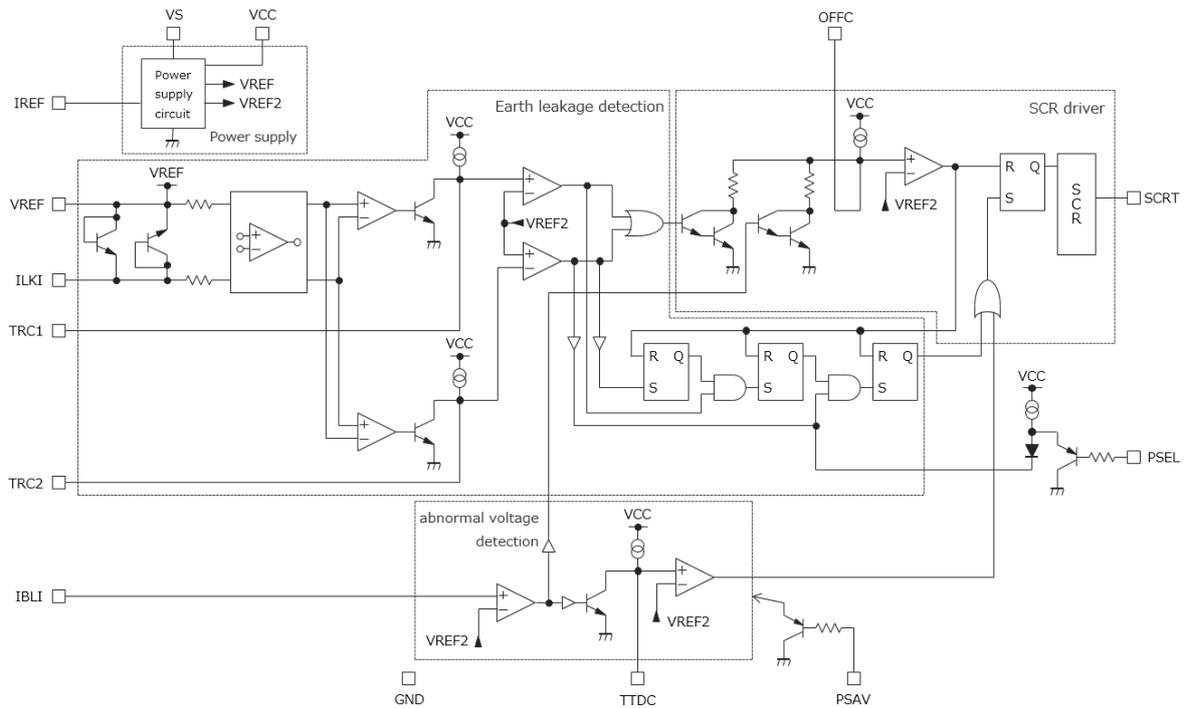
Earth leakage breaker



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## BLOCK DIAGRAM



## PIN FUNCTION DESCRIPTION

| Pin No. | Pin Name | Function  |
|---------|----------|---|
| 1       | GND      | Grounding   |
| 2       | IREF     | Connects to resistor  |
| 3       | VREF     | Input reference level pin.  |
| 4       | ILKI     | Input pin of the leakage detection circuit.   |
| 5       | TRC1     | Connects to capacitor for integrating output signals of the leakage input signal level discriminator. (negative)  |
| 6       | TRC2     | Connects to capacitor for integrating output signals of the leakage input signal level discriminator. (positive)  |
| 7       | PSEL     | Logic function switching pin used when detecting leakage.<br>When the pin is grounded, counting three waves of 1.5 cycle. (neg.→pos.→neg.)<br>When the pin is VCC, counting two waves of 1 cycle. (neg.→pos.) |
| 8       | SCRT     | Output pin for drive a SCR.   |
| 9       | OFFC     | The pin connects to capacitor for time setting of this function.  |
| 10      | TTDC     | Connects to capacitor for time setting of the abnormal voltage detection circuit.   |
| 11      | IBLI     | Input pin of the abnormal voltage detection circuit.  |
| 12      | PSAV     | Switching pin used when detecting leakage ON/OFF.<br>When the pin is grounded, enable detecting leakage.<br>When the pin is VCC, disable detecting leakage.   |
| 13      | VCC      | Output pin of internal constant-voltage circuit.  |
| 14      | VS       | Power supply  |

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

| Symbol | Parameter                     | Conditions | Ratings  | Unit  |
|--------|-------------------------------|------------|----------|-------|
| IS     | Source current                |            | 4        | mA    |
| VS     | Supply voltage                |            | 15       | V     |
| VIL    | Voltage between VREF and ILKI |            | -1.4~1.4 | V     |
| IIL    | Current between VREF and ILKI |            | -5~5     | mA    |
| IVREF  | VREF input voltage            |            | 10       | mA    |
| IIBLI  | IBLI input current            |            | 4        | mA    |
| Pd     | Power dissipation             | Ta ≥ 25°C  | 200      | mW    |
| Kθ     | Thermal derating              |            | 1.6      | mW/°C |
| Tstg   | Storage temperature           | (keep dry) | -40~125  | °C    |
| Topr   | Operating temperature         | (keep dry) | -20~105  | °C    |

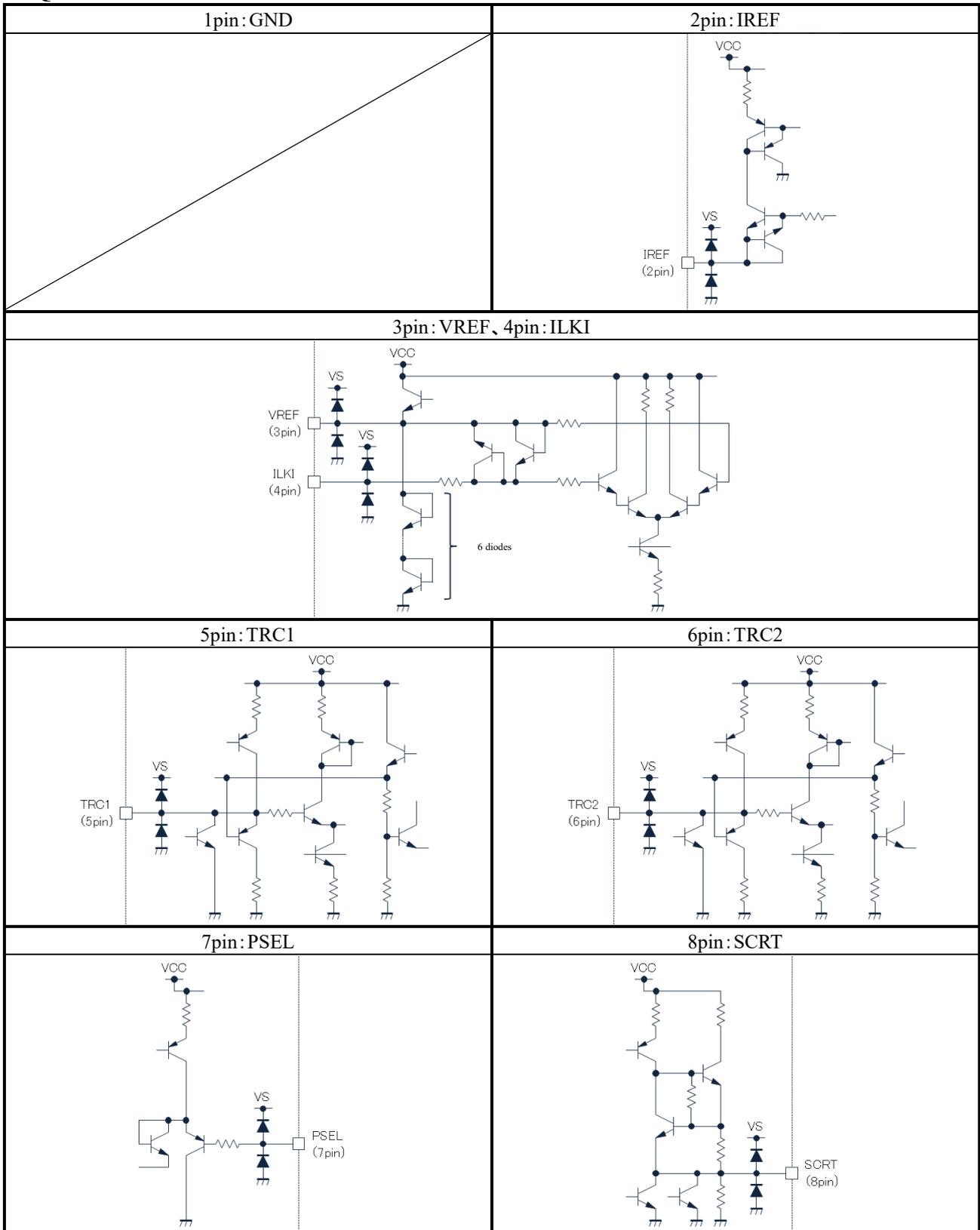
**ELECTRICAL CHARACTERISTICS (Ta = 25°C, VS = 9V unless otherwise noted)**

| Symbol | Parameter                                       | Test conditions              | Limits   |       |      | Unit  |    |
|--------|---|------------------------------|----------|-------|------|-------|----|
|        |   |                              | Min      | Typ   | Max  |       |    |
| IS0    | Supply current : in stand-by                    | PSAV=VCC                     | 630      | 900   | 1040 | uA    |    |
| IS1    | Supply current : in detecting earth leakage     | PSAV=VCC                     | 670      | 950   | 1080 | uA    |    |
| IS2    | Supply current : in detecting abnormal voltage  | PSAV=VCC                     | 630      | 900   | 1060 | uA    |    |
| IS3    | Supply current : in Immediately after SCR drive | PSAV=VCC                     | 430      | 620   | 730  | uA    |    |
| IS0'   | Supply current : in stand-by                    | PSAV=GND                     | 570      | 810   | 950  | uA    |    |
| IS1'   | Supply current : in detecting earth leakage     | PSAV=GND                     | 590      | 840   | 960  | uA    |    |
| IS3'   | Supply current : in Immediately after SCR drive | PSAV=GND                     | 430      | 620   | 730  | uA    |    |
| -      | IS0 : Temperature dependency                    | Ta=-20~85°C                  | -        | -0.12 | -    | %/V   |    |
| VSmax  | Maximum current voltage                         | IS=4mA                       | -        | 14.3  | 15.5 | V     |    |
| Vion   | Earth leakage detection : DC input voltage      | vs. VREF                     | -        | ±7.5  | -    | mV    |    |
| IiH    | ILK1 pin input bias current                     | VIN=VREF                     | -        | 2     | 15   | nA    |    |
| VO     | VREF pin output voltage                         |                              | -        | 2.6   | -    | V     |    |
| VILKI  | ILKI-VREF input clamp voltage                   | IILKI=±3mA                   | -        | ±1.3  | -    | V     |    |
| VRCL   | VREF-GND clamp voltage                          | IRCL=5mA                     | -        | 5.0   | -    | V     |    |
| EIOH   | TRC1 pin "H" output current precision           | VO=0V:IOH=-10.4uA            | -20      | -     | 20   | %     |    |
| VTH    | TRC1 threshold voltage                          |                              | -        | 2.3   | -    | V     |    |
| ETW1   | TW1 pulse width precision                       | C=0.01uF:TW1=2.1ms           | -15      | -     | 15   | %     |    |
| -      | TW1 variation with ambient temperature          | Ta=-20~85°C                  | -        | -0.06 | -    | %/°C  |    |
| EIOH   | TRC2 pin "H" output current precision           | VO=0V:IOH=-10uA              | -20      | -     | 20   | %     |    |
| VTH    | TRC2 threshold voltage                          |                              | -        | 2.3   | -    | V     |    |
| ETW2   | TW2 pulse width precision                       | C=0.0047uF:TW2=1.0ms<br>1.1m | -15      | -     | 15   | %     |    |
| -      | TW2 variation with ambient temperature          | Ta=-20~85°C                  | -        | -0.06 | -    | %/°C  |    |
| VT     | Total leakage detecting AC voltage              | 60Hz                         | 5.2      | 6.5   | 7.8  | mVrms |    |
| VBLT   | Abnormal voltage detecting voltage              |                              | 2.1      | 2.3   | 2.5  | V     |    |
| -      | VBLT variation with supply voltage              |                              | -        | 0.01  | -    | %/V   |    |
| -      | VBLT variation with ambient temperature         | Ta=-20~85°C                  | -        | 0.06  | -    | %/°C  |    |
| IiBLT  | IBLI pin input bias current                     | VIN=VREF                     | -        | 120   | 300  | nA    |    |
| VIBLC  | IBLI-GND clamp voltage                          | IIN=1mA                      | -        | 7.9   | -    | V     |    |
| EIOH   | TTDC pin "H" output current precision           | VO=0V:IOH=-8uA               | -20      | -     | 20   | %     |    |
| VTH    | TTDC threshold voltage                          |                              | -        | 2.4   | -    | V     |    |
| ETW4   | Delay time pulse width precision                | C=1.0uF:TW4=280ms            | -30      | -     | 30   | %     |    |
| EIOH   | OFFC pin "H" output current precision           | VO=0V:IOH=-10uA              | -20      | -     | 20   | %     |    |
| VTH    | OFFC threshold voltage                          |                              | -        | 2.3   | -    | V     |    |
| ETW3   | Reset timer pulse width precision               | C=0.33uF:TW3=52ms            | -30      | -     | 30   | %     |    |
| VOL    | SCRT pin "L" output voltage                     | IOL=200uA                    | -        | 0.1   | 0.2  | V     |    |
| IOHc   | SCRT pin "H" output current                     | VO=0.8V                      | Ta=-20°C | -200  | -280 | -     | uA |
| IOHn   |   |                              | Ta=25°C  | -100  | -230 | -     | uA |
| IOHh   |   |                              | Ta=85°C  | -70   | -160 | -     | uA |
| Vsoff  | IOH holding supply voltage                      |                              | -        | 3.0   | 4.5  | V     |    |

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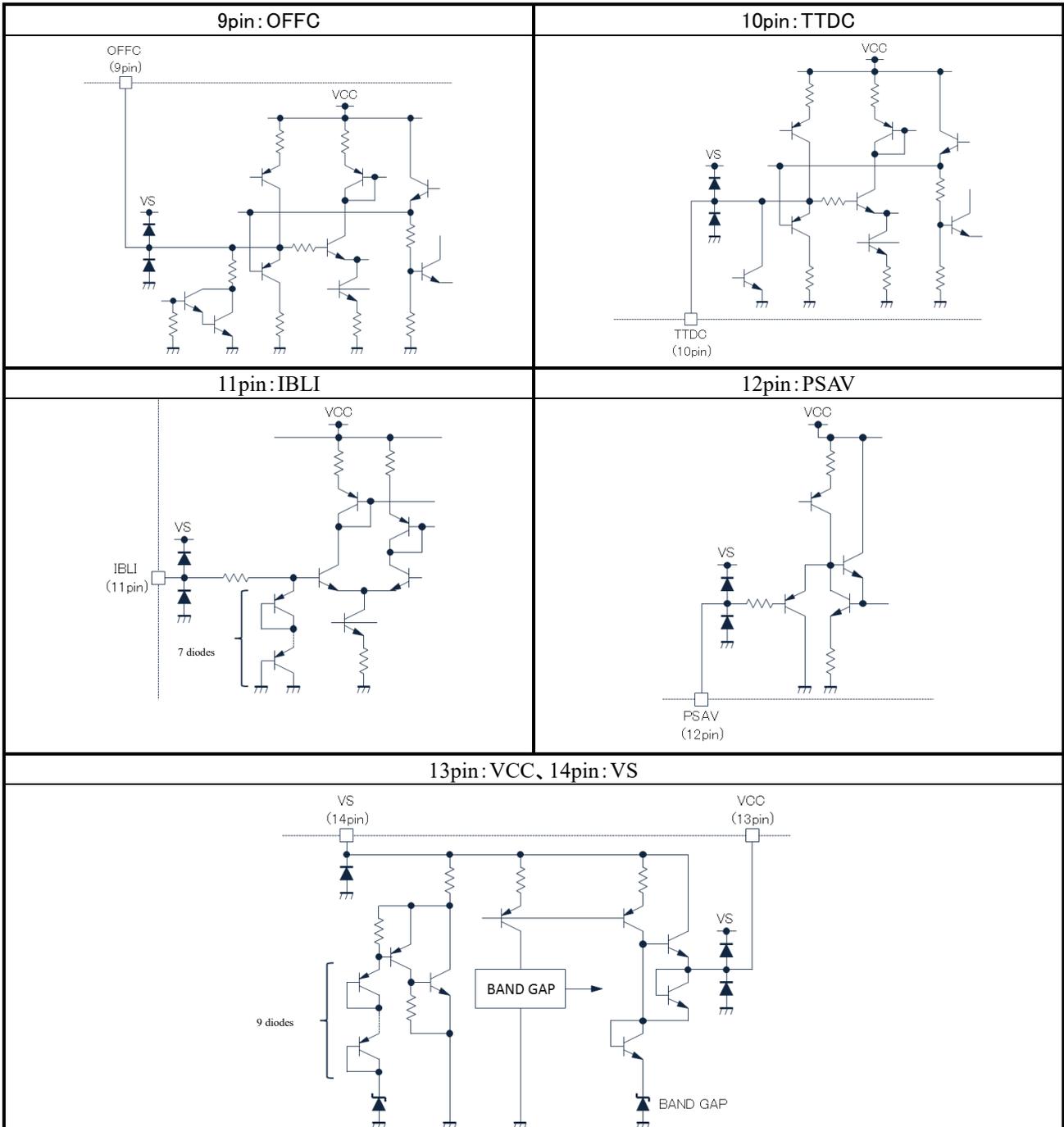
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## I/O EQUIVALENT CIRCUIT



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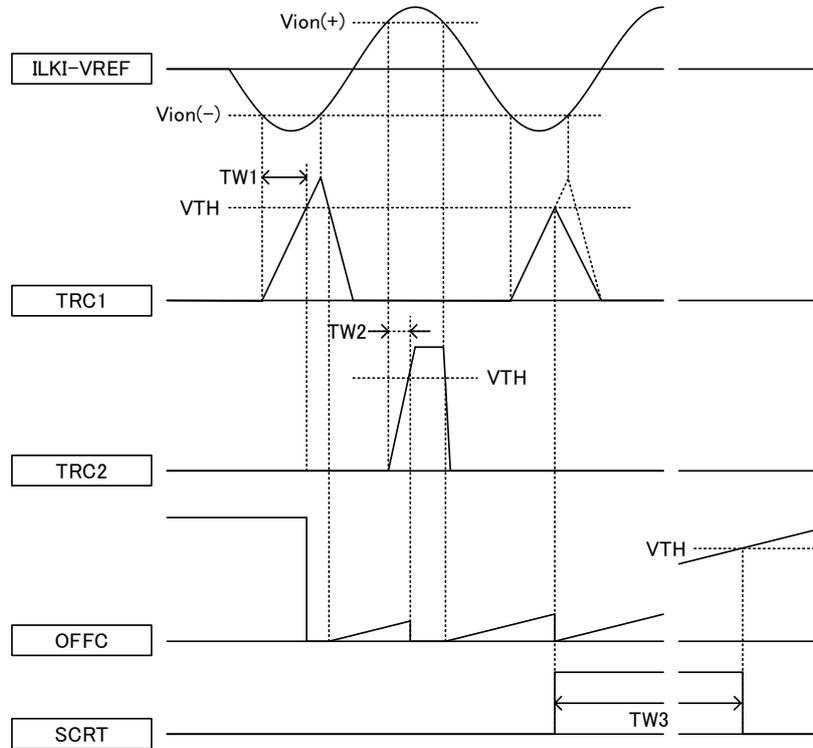
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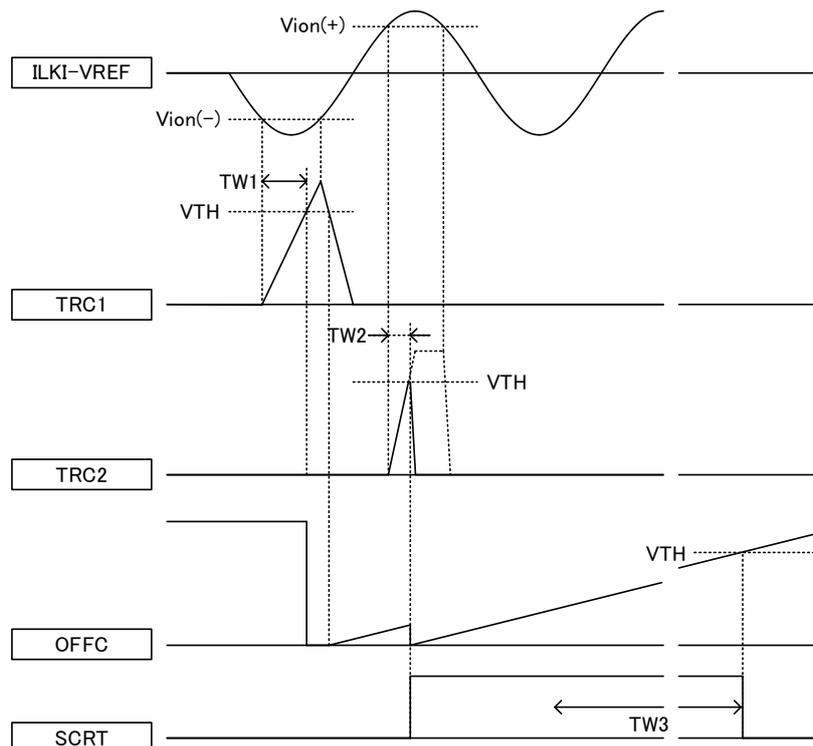
## Timing chart

1. In detecting earth leakage

(1) Counting three waves of 1.5 cycle. (PSEL=GND)



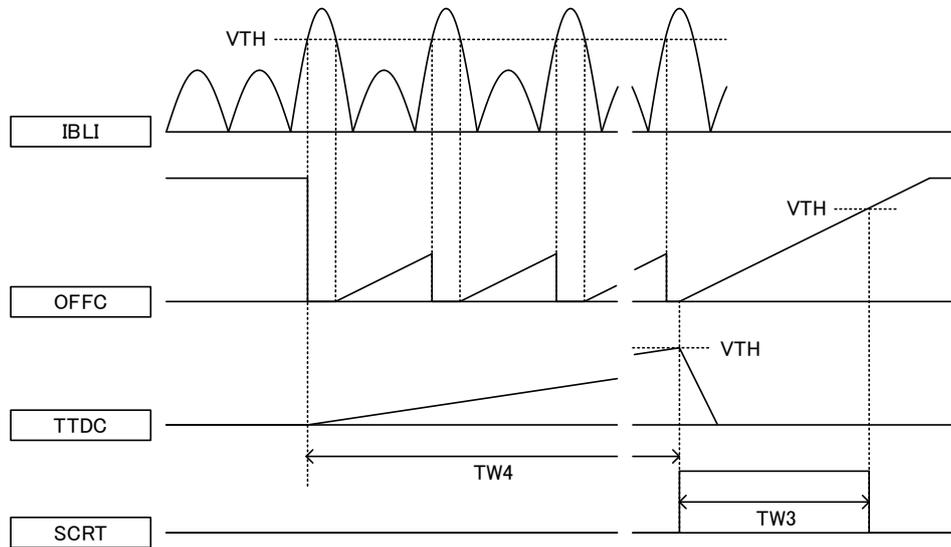
(2) Counting two waves of a cycle. (PSEL=VCC)



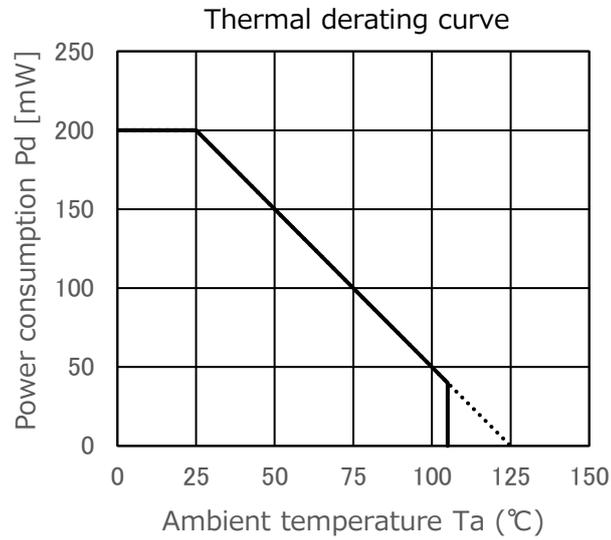
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2. In detecting abnormal voltage.



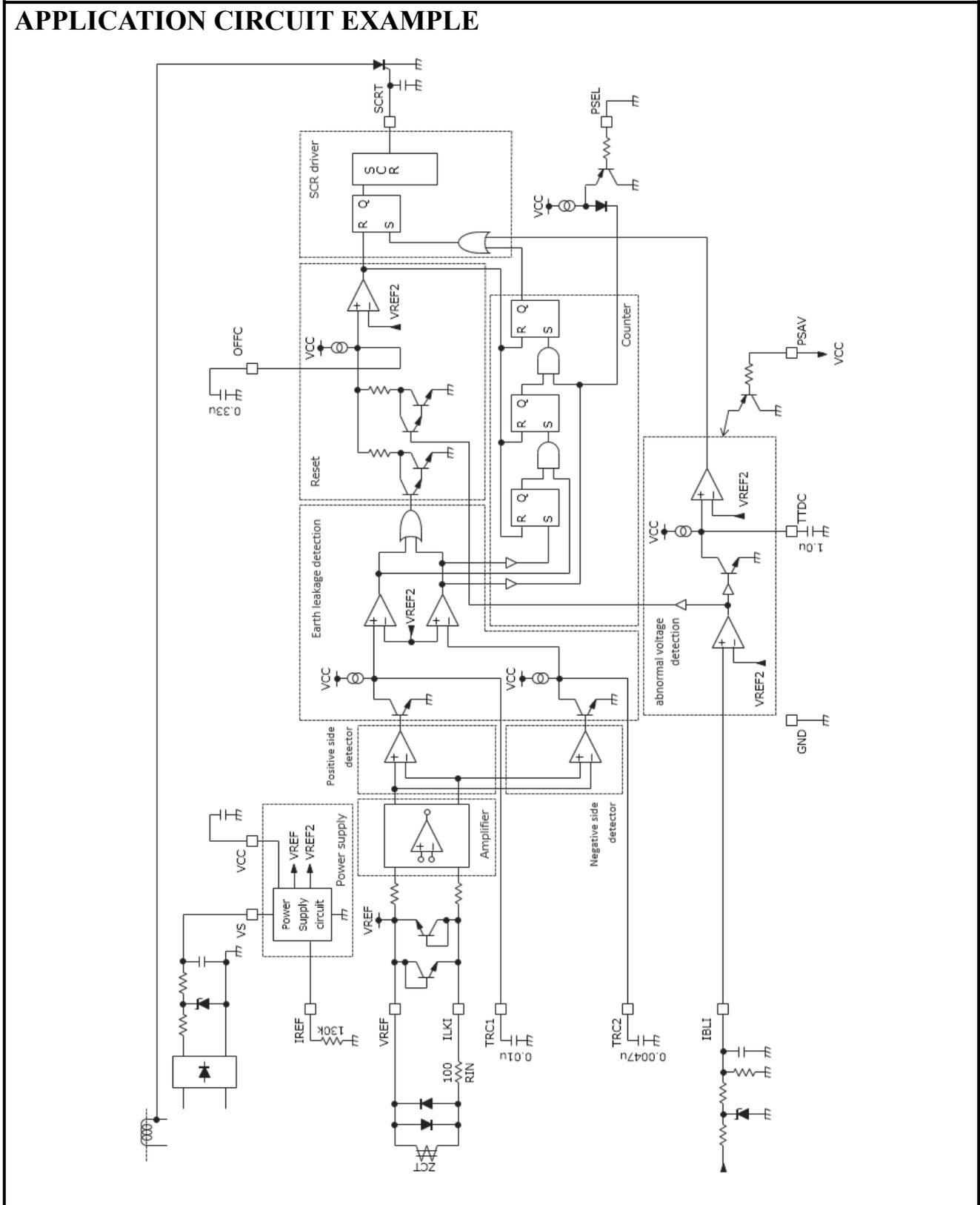
**Thermal derating curve**



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## APPLICATION CIRCUIT EXAMPLE

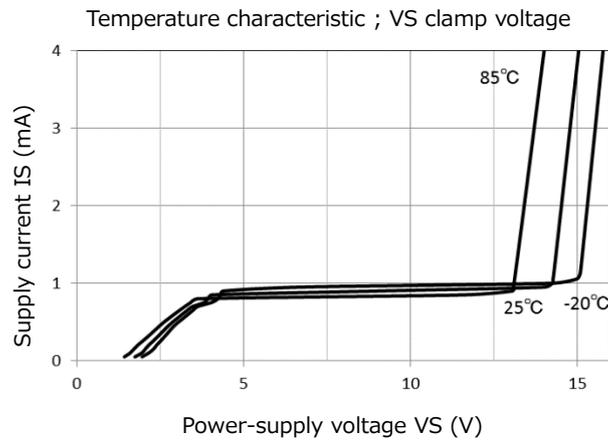


## PRECAUTIONS FOR APPLICATION

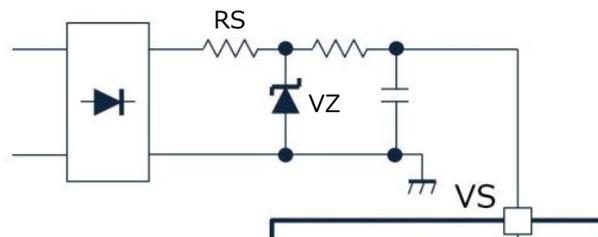
The notes on using RT8H044K are shown below. The following precautions are only examples. Please carry out sufficient verification.

### VS applied voltage

- (1) IS circuit current (clamp circuit characteristics of the equivalent circuit) is as shown in TYPICAL CHARACTERISTICS figure.



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



- As  $V_Z$ , be sure to use zener diode of 15V or less (not exceeding the absolute maximum rating of 12V).
- At high temperatures, clamp voltage decreases and  $I_S$  increases. Increase of  $I_S$  will be restricted at  $R_S$ , however.

- (3) If normal DC power supply is used, use the IC at  $V_S=7$  to 10V.

### Resistor of IREF pin ( $R = 130\text{k}\Omega$ )

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 ( $\pm 2\%$ ) is recommended.

Although it is possible to suppress the circuit current by setting  $R = 150\text{ k}\Omega$  etc., please perform sufficient verification.

## 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.

## About SCRT output pin

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

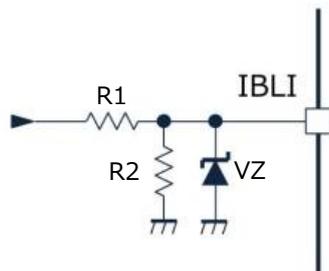
Change in sensitivity due to insulation deterioration

If the insulation of ZCT input pin from the high voltage part might deteriorate, improvement might be expected by connecting a resistor of about  $R=100\text{k}\Omega$  between VREF pin and GND. It should be noted that the circuit current will increase at  $I=2.6\text{V}/R$  (approx.).

## Clamp diode of IBLI input pin

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

- (1) At high temperatures, the drop in diode VF may decrease the clamp voltage of the pin. If the voltage approaches the reference level of the comparator (2.3V) and current leaks occur, the overvoltage detection level may slightly fluctuate. Form the detection circuit as the figure below. It is recommended that R1, R2 and VZ be set as shown below.
- (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). •  $VZ = 4.0\text{V}$



$$\bullet R1 + R2 > 200\text{k}\Omega$$

$$\bullet \frac{R1 \times R2}{R1 + R2} < 7\text{k}\Omega$$

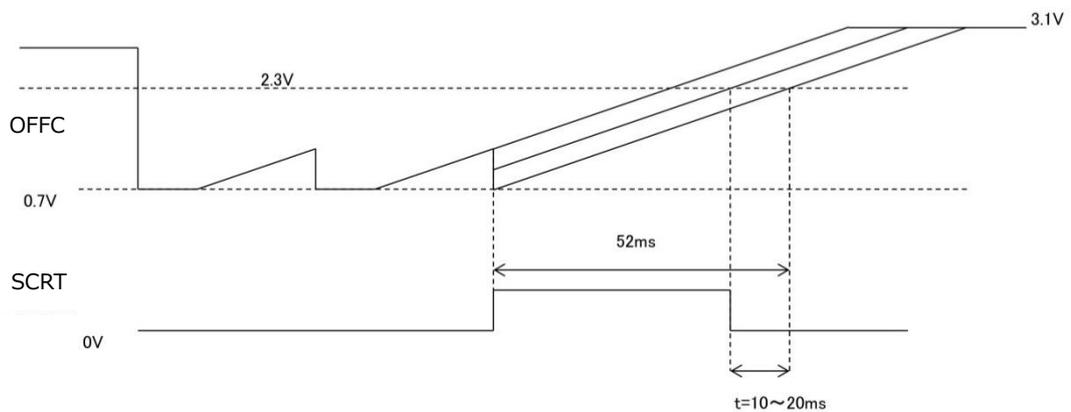
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## Reset time in reset circuit.

This circuit is designed as a timer circuit of  $V_L = 0.7V$ ,  $V_H = 2.3V$  and  $I_o = 10\mu A$ . When SCR is ON, the power supply route of the leakage detection and abnormal voltage detection circuits are shut off,  $V_L$  does not drop to  $0.7V$  as shown below and therefore reset time may become shorter. Set the reset time somewhat longer in advance.

$$T = \frac{CX(VH-VL)}{I} = \frac{0.33\mu F \times (2.3-0.7)}{10\mu A} \doteq 52ms$$



Note. t : time shorter than setting value

- In the case of leakage detection : May become 10ms (50Hz) shorter
- In the case of abnormal voltage detection : May become 20ms (50Hz) shorter



**Keep safety first in your circuit designs!**

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