M54133FP/GP

EARTH LEAKAGE CURRENT DETECTOR

DESCRIPTION

The M54133 is a semiconductor integrated circuit designed for high-speed type earth leakage breakers. This IC has built-in anti-lightning-surge function and anti-inverter-noise function.

FEATURES

- Improvement of ability against unwanted tripping by lightning -surge.
  - •Adopt the two times counting system.
  - •Improvement of ability against needless action for lightning-impulse.
- Improvement of ability against unwanted tripping by inverter -noise.
  - •Built-in operational amplifier (of low current dissipation) for active low-pass filter.
  - •Improvement of ability against needless action for high frequency and high harmonics.
- Built-in delay time function
  - •An external capacitor is used to set the delay time.
- High input sensitivity : V_T=11.5mVrms Typ.
- Low-current dissipation (at R_{IREF}=180kΩ)
  - •In stand-by condition : I_S=610μA Typ.
- High stabilities design
  - •Adopt the circuits that is not affected by fluctuations of supply voltage/ambient temperature.

APPLICATION

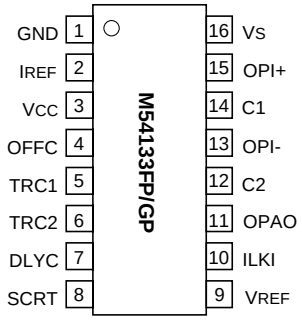
Earth leakage breaker

RECOMMENDED OPERATING CONDITIONS

Supply voltage range.....7 to 12V

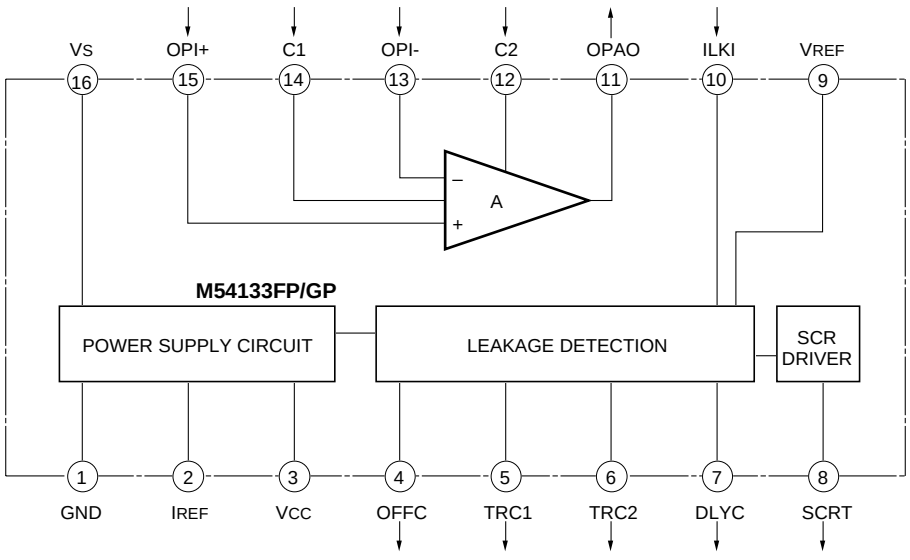
Operating ambient temperature.....-20 to +85°C

PIN CONFIGURATION (TOP VIEW)



Outline 16P2N-A(FP)
16P2E-A(GP)

BLOCK DIAGRAM



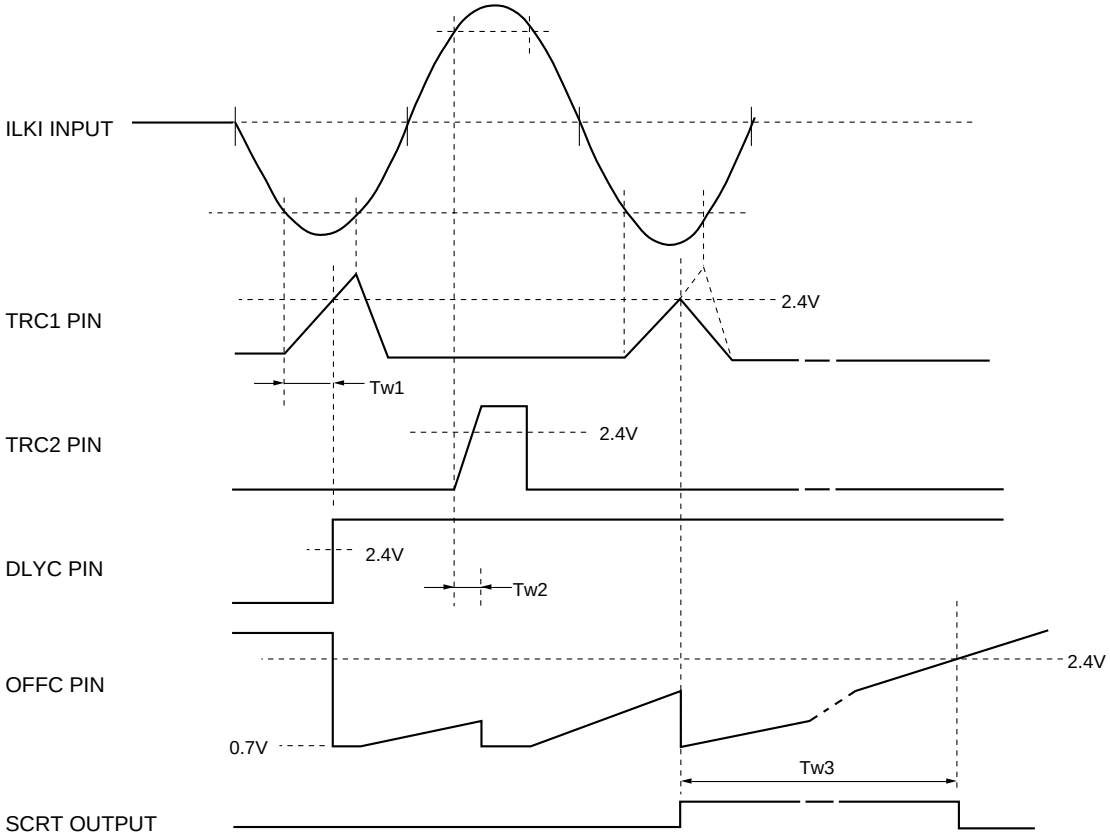
ABSOLUTE MAXIMUM RATINGS (Ta=25°C, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
IS	Supply current		4	mA
V_{SMAX}	Maximum supply voltage		15	V
Vid	Differential input voltage	OPI+ to OPI-	-0.8 to +0.8	V
IIOP	Differential input current	OPI+ to OPI-	-5 to +5	mA
IIG	Input current	V_{REF} to GND	10	mA
Pd	Power dissipation		200	mW
Topr	Operating ambient temperature		-20 to+85	°C
Tstg	Storage temperature		-55 to+125	°C

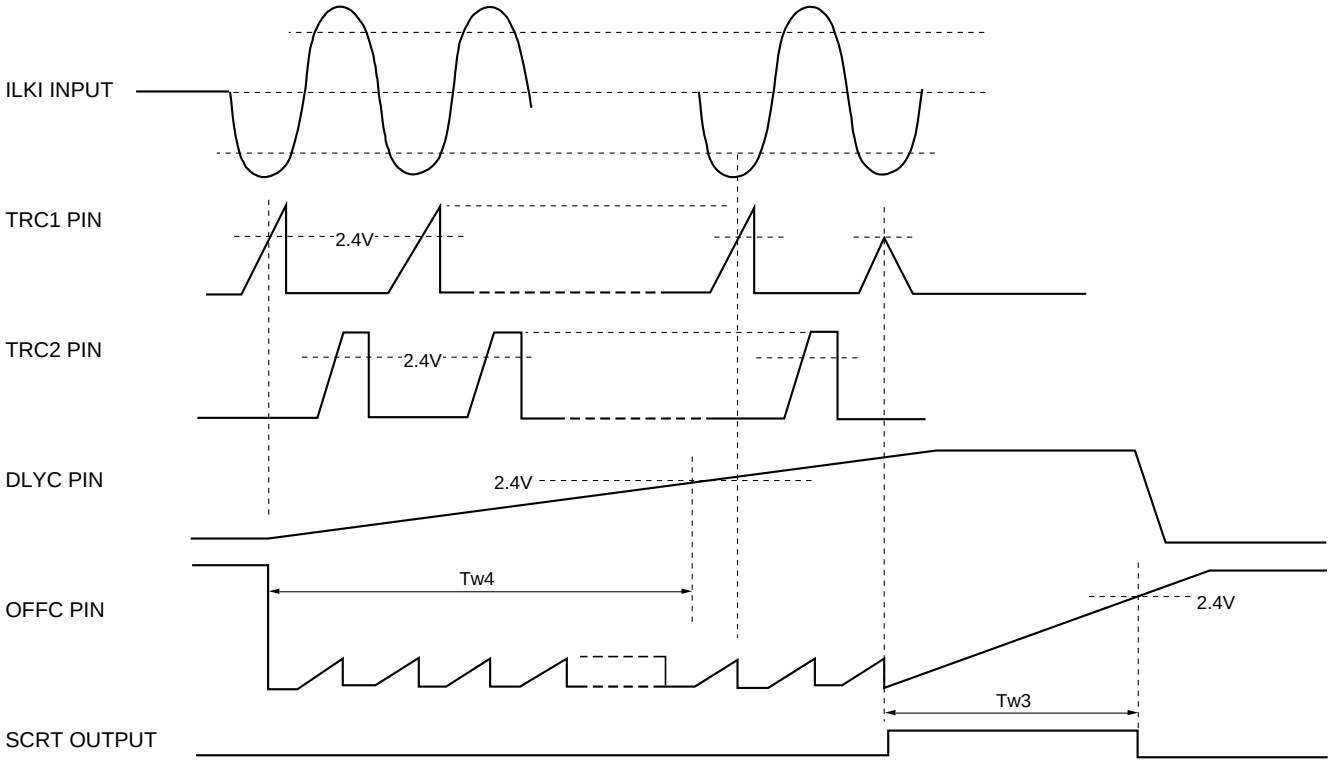
ELECTRICAL CHARACTERISTICS (Ta=25°C, unless otherwise noted)

Symbol	Parameter		V_S	Test conditions		Limits Min.	Limits Typ.	Limits Max.	Unit
I_{S0}	Power supply circuit	Supply current (in standby)	9V			520	610	700	µA
I_{S1}		Supply current (while detecting leakage)				560	650	740	µA
I_{S2}		Supply current (immediately after drive a SCR)				480	570	660	µA
–		Ambient temperature dependence of I_{S0}	9V	Ta=-25 to +85°C		–	-0.2	–	%/°C
V_{SMAX}		Maximum supply voltage		I_S=4mA		–	13.9	15	V
V_{CC}		V_{CC}-pin output voltage	9V	I_{OH}=-1mA		–	5.2	–	V
GV	Operational amplifier	Voltage gain	9V	f=1kHz		–	40	–	dB
BW		Frequency band width		-3dB		–	6	–	kHz
VO		Maximum output voltage				–	3.5	–	V_{PP}
IOH		OPOA-pin “H” output current				–	2.8	–	mA
IOL		OPOA-pin “L” output current				–	0.8	–	mA
VOoff		Output offset voltage				–	0	–	mV
IIC		Input bias current				–	125	–	nA
VIC		Differential input clamp voltage		Iidc=±4mA		–	±0.8	–	V
Vion	Leak detector circuit	DC input voltage of leakage detection	9V	With respect to V_{REF}		–	±14.0	–	mVdc
I_{IH}		ILKI-pin input bias current		V_{IN}=V_{REF}		–	220	–	nA
V_O		V_{REF}-pin output voltage		I_{OH}=-200µA		–	2.4	–	V
V_{RCL}		V_{REF}-GND clamp voltage		IRCL=5mA		–	4.7	–	V
Eloh1	3-ms circuit	Accuracy of TRC1-pin “H” output current	9V	V_O=0V ; I_{OH1}=-7.6µA		-20	–	+20	%
V_{TH1}		TRC1 threshold voltage				–	2.4	–	V
ETw1		Accuracy of Tw1 pulse width		C=0.01µF ; Tw1=3ms		-15	–	+15	%
–		Ambient temperature dependence of Tw1		Ta=-20 to +85°C		–	0	–	%/°C
Eloh2	1-ms circuit	Accuracy of TRC2-pin “H” output current	9V	V_O=0V ; I_{OH2}=-7.6µA		-20	–	+20	%
V_{TH2}		TRC2 threshold voltage				–	2.4	–	V
ETw2		Accuracy of Tw2 pulse width		C=0.0047µF ; Tw2=1.5ms		-15	–	+15	%
–		Ambient temperature dependence of Tw2		Ta=-20 to +85°C		–	0	–	%/°C
V_T		Total AC input voltage of leakage detection	9V	60Hz		–	11.5	–	mVrms
–		Ambient temperature dependence of V_T		Ta=+25°C→+85°C		–	-8.0	–	%
				Ta=+25°C→-20°C		–	+2.0	–	%
E_{IOH}	Reset circuit	Accuracy of OFFC-pin “H” output current	9V	V_O=0V ; I_{OH}=-7.6µA		-20	–	+20	%
V_{TH}		OFFC threshold voltage				–	2.4	–	V
ETw3		Accuracy of reset time pulse width	9V	C=0.33µF ; Tw3=75ms		-30	–	+30	%
E_{IOH}	Delay circuit	Accuracy of DLYC-pin “H” output current	9V	V_O=0V ; I_{OH}=-7.6µA		-20	–	+20	%
V_{TH}		DLYC threshold voltage				–	2.4	–	V
ETw4		Accuracy of delay timer pulse width	9V	C=1.0µF ; Tw4=300ms		-30	–	+30	%
$V_{OL}8$	SCR driver 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=8V	Ta=-20°C	-100	-160	–	µA
I_{OHn}					Ta=+20°C	-50	-130	–	µA
I_{OHh}					Ta=+85°C	-33	-100	–	µA
Vsoff		Supply voltage for I_{OH} hold	–			–	3.0	4.0	V

WITHOUT DELAY FUNCTION

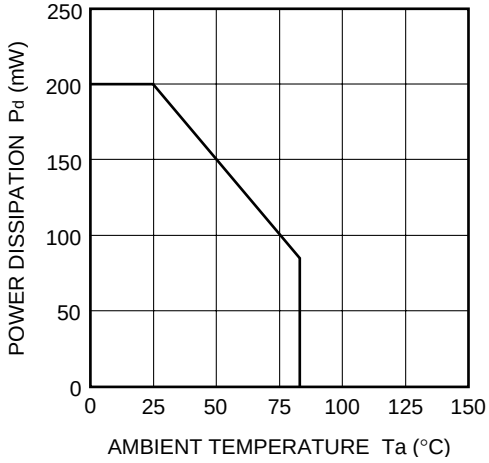


USING DELAY FUNCTION

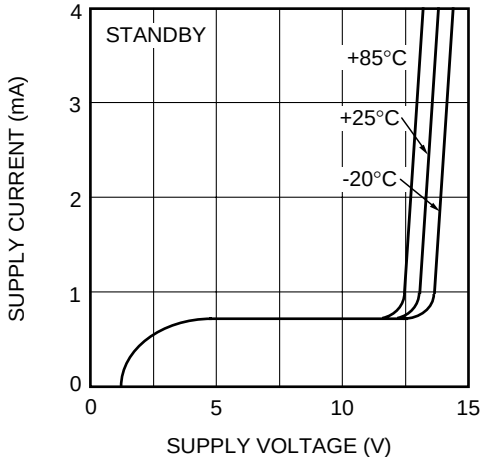


TYPICAL CHARACTERISTICS

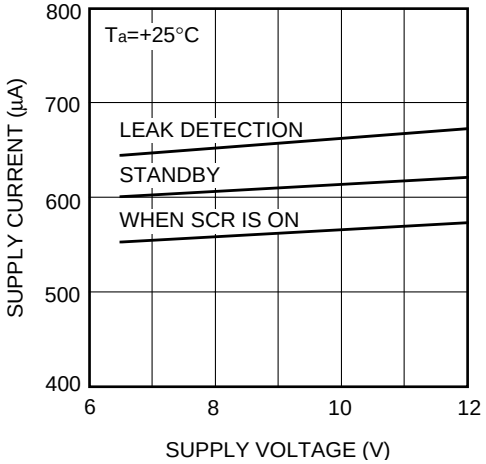
THERMAL DERATING (MAXIMUM RATING)



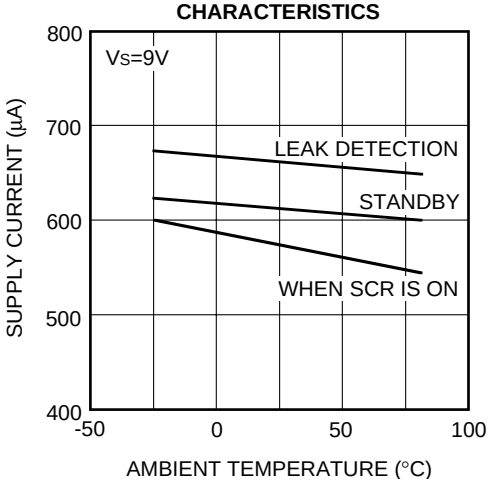
SUPPLY CURRENT VS. SUPPLY VOLTAGE CHARACTERISTICS



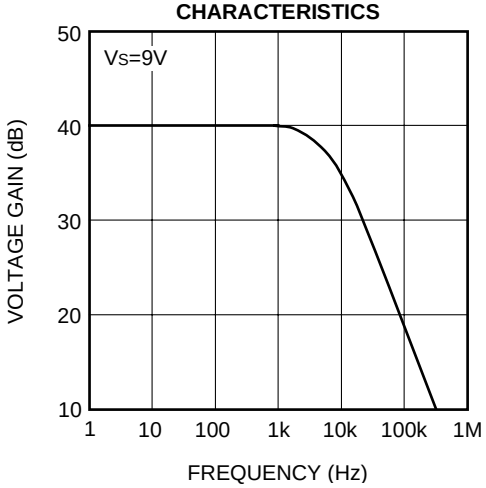
SUPPLY CURRENT VS. SUPPLY VOLTAGE CHARACTERISTICS



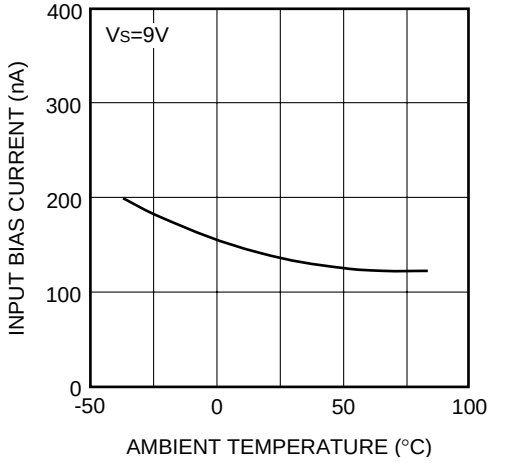
SUPPLY CURRENT VS. AMBIENT TEMPERATURE CHARACTERISTICS



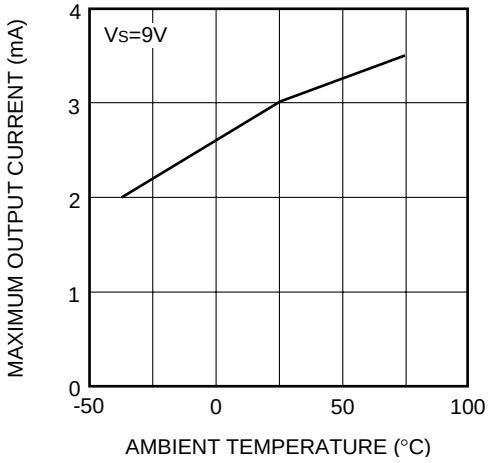
VOLTAGE GAIN VS. FREQUENCY CHARACTERISTICS



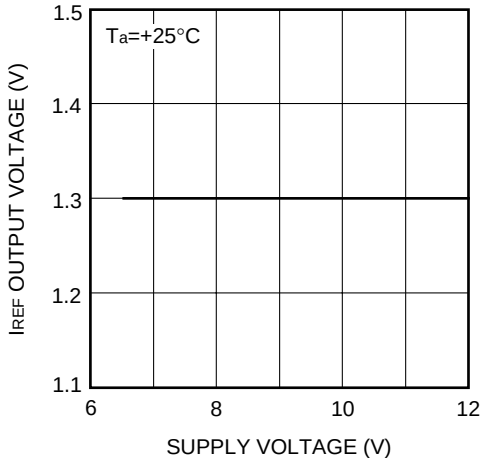
OPERATIONAL AMPLIFIER INPUT CURRENT BIAS VS. AMBIENT TEMPERATURE CHARACTERISTICS



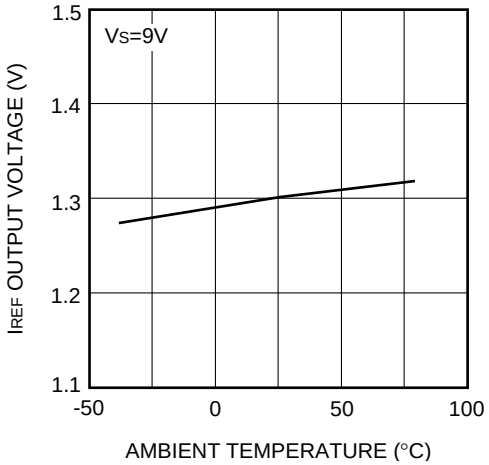
MAXIMUM OPERATIONAL AMPLIFIER OUTPUT CURRENT VS. AMBIENT TEMPERATURE CHARACTERISTICS



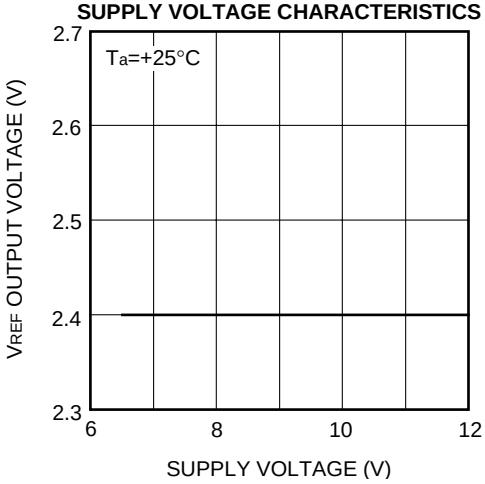
IREF OUTPUT VOLTAGE VS. SUPPLY VOLTAGE CHARACTERISTICS



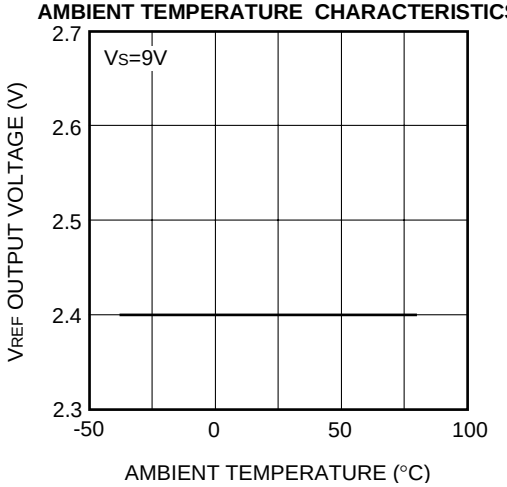
IREF OUTPUT VOLTAGE VS. AMBIENT TEMPERATURE CHARACTERISTICS



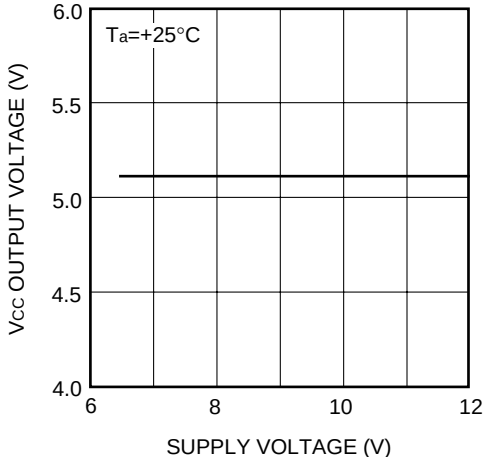
VREF OUTPUT VOLTAGE VS. SUPPLY VOLTAGE CHARACTERISTICS



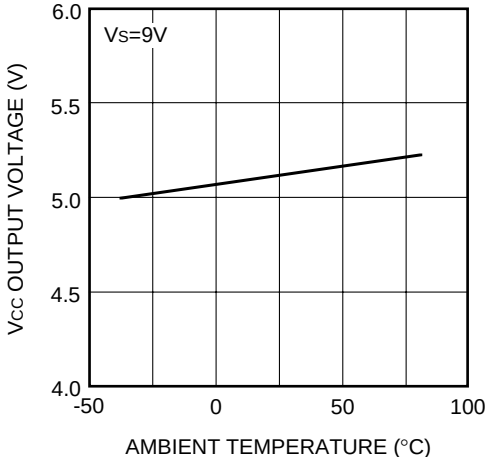
VREF OUTPUT VOLTAGE VS. AMBIENT TEMPERATURE CHARACTERISTICS



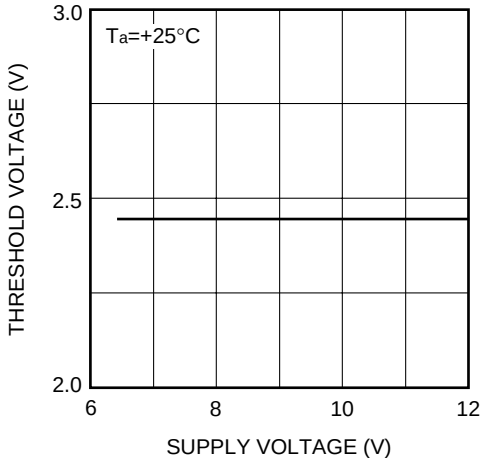
Vcc OUTPUT VOLTAGE VS. SUPPLY VOLTAGE CHARACTERISTICS



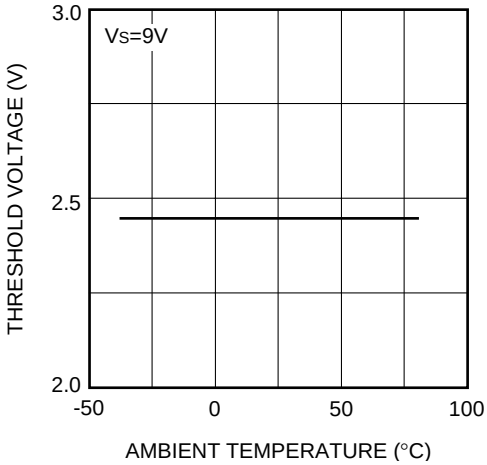
Vcc OUTPUT VOLTAGE VS. AMBIENT TEMPERATURE CHARACTERISTICS



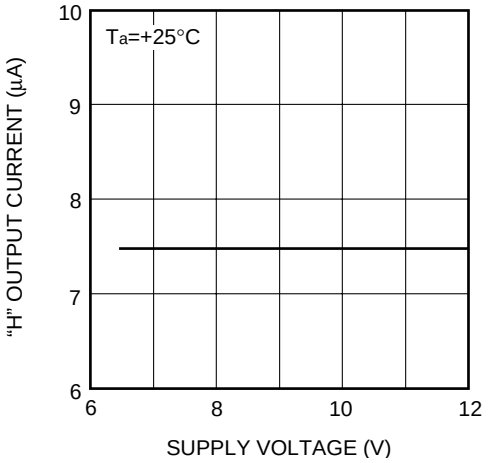
TRC1/TRC2/OFFC/DLYC THRESHOLD VOLTAGE VS. SUPPLY VOLTAGE CHARACTERISTICS



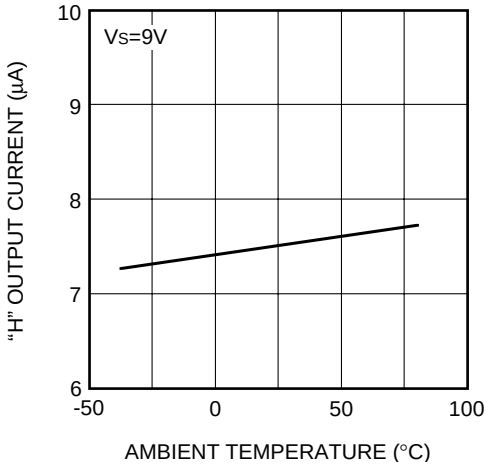
TRC1/TRC2/OFFC/DLYC THRESHOLD VOLTAGE VS. AMBIENT TEMPERATURE CHARACTERISTICS



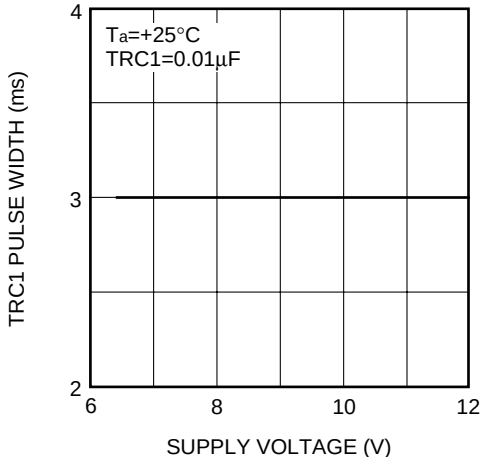
TRC1/TRC2/OFFC/DLYC "H" OUTPUT CURRENT VS. SUPPLY VOLTAGE CHARACTERISTICS



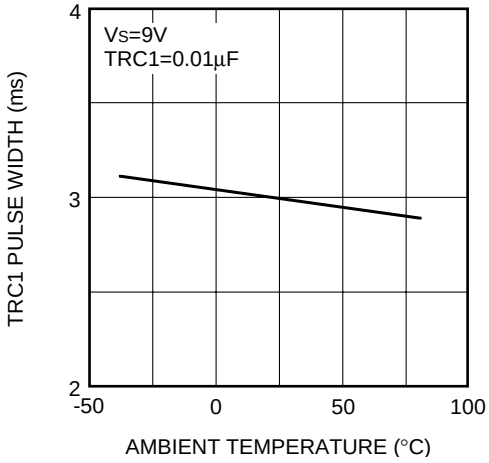
TRC1/TRC2/OFFC/DLYC "H" OUTPUT CURRENT VS. AMBIENT TEMPERATURE CHARACTERISTICS



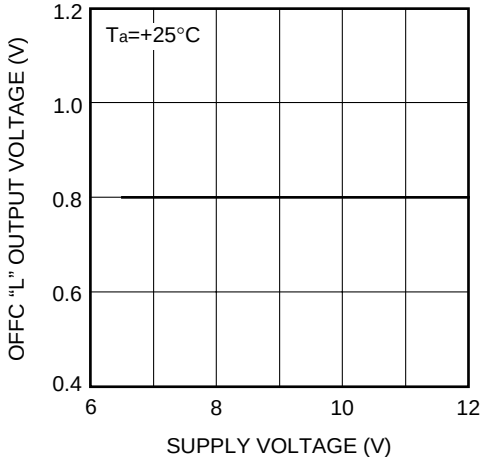
TRC1 PULSE WIDTH VS. SUPPLY VOLTAGE CHARACTERISTICS



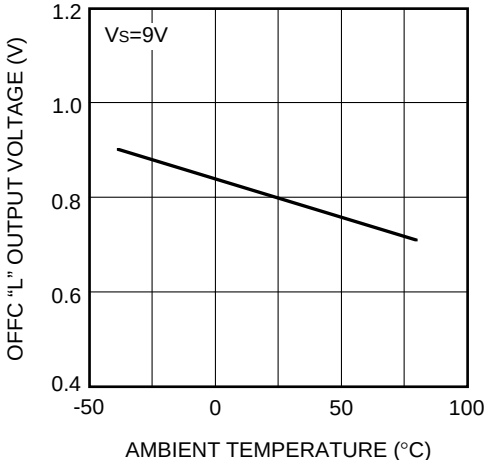
TRC1 PULSE WIDTH VS. AMBIENT TEMPERATURE CHARACTERISTICS



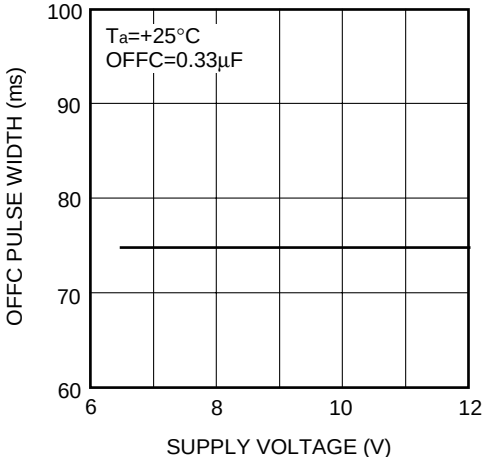
OFFC "L" OUTPUT VOLTAGE VS. SUPPLY VOLTAGE CHARACTERISTICS



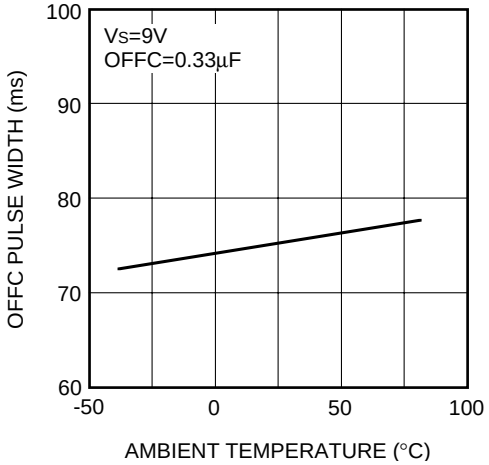
OFFC "L" OUTPUT VOLTAGE VS. AMBIENT TEMPERATURE CHARACTERISTICS



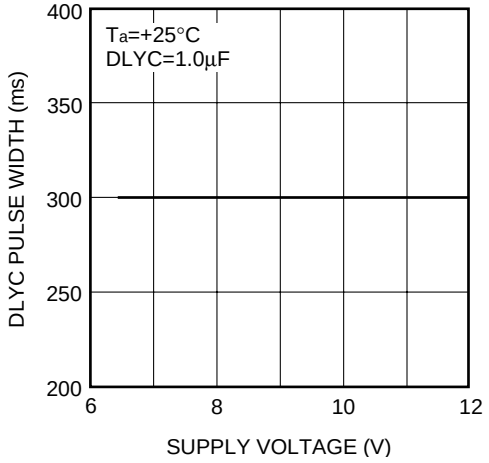
OFFC PULSE WIDTH VS. SUPPLY VOLTAGE CHARACTERISTICS



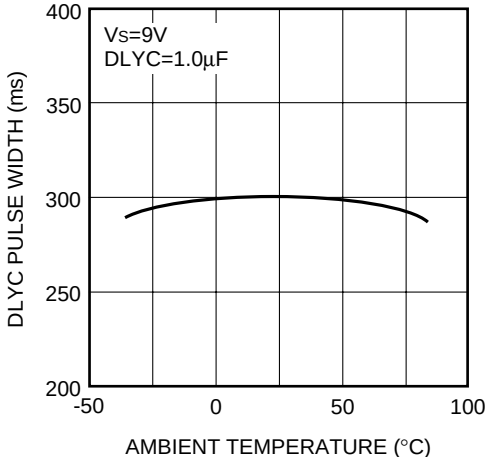
OFFC PULSE WIDTH VS. AMBIENT TEMPERATURE CHARACTERISTICS



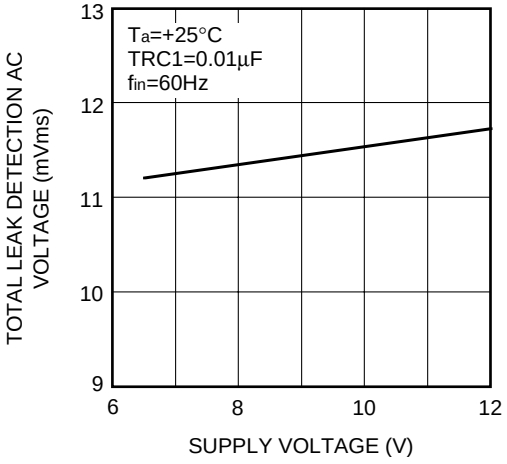
DLYC PULSE WIDTH VS. SUPPLY VOLTAGE CHARACTERISTICS



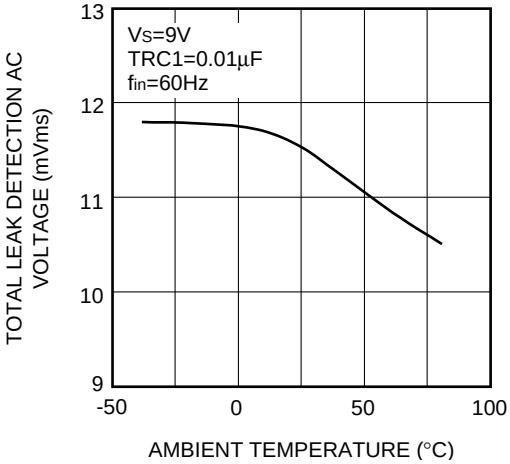
DLYC PULSE WIDTH VS. AMBIENT TEMPERATURE CHARACTERISTICS



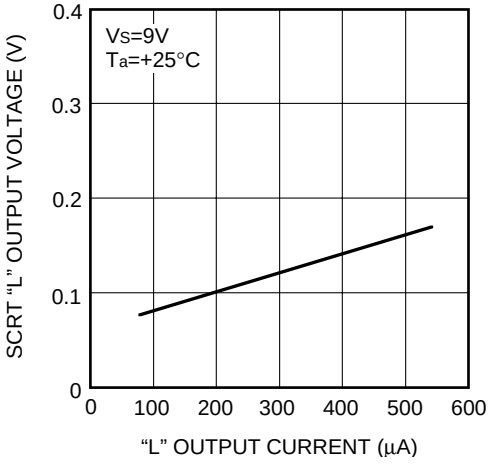
TOTAL LEAK DETECTION AC VOLTAGE VS. SUPPLY VOLTAGE CHARACTERISTICS



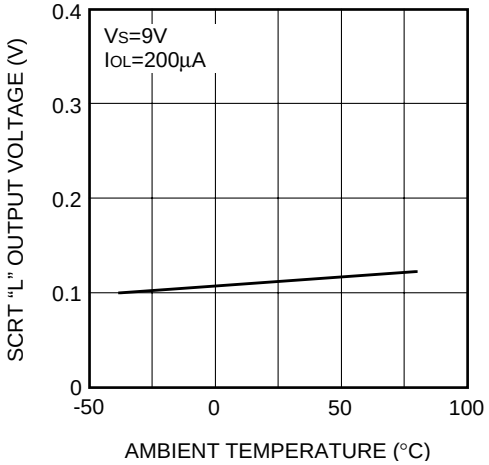
TOTAL LEAK DETECTION AC VOLTAGE VS. AMBIENT TEMPERATURE CHARACTERISTICS



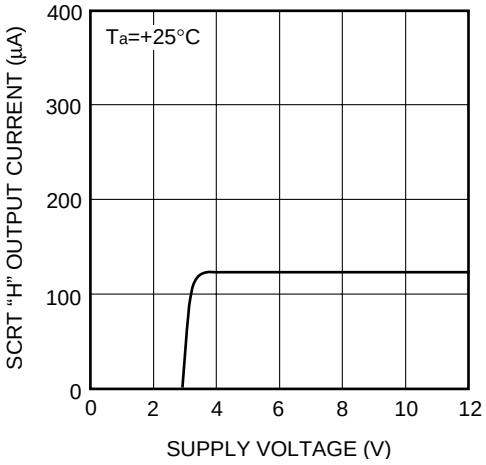
SCRT "L" OUTPUT VOLTAGE VS. "L" OUTPUT CURRENT CHARACTERISTICS



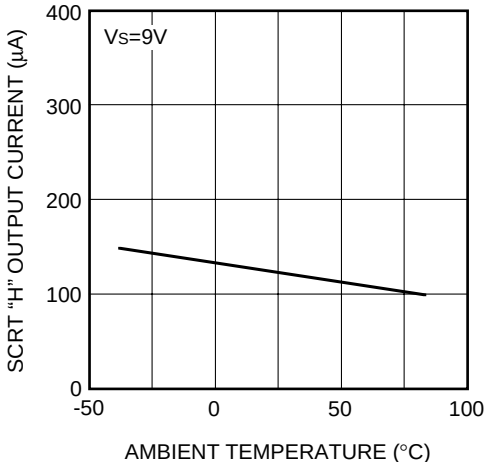
SCRT "L" OUTPUT VOLTAGE VS. AMBIENT TEMPERATURE CHARACTERISTICS



SCRT "H" OUTPUT CURRENT VS. SUPPLY VOLTAGE CHARACTERISTICS



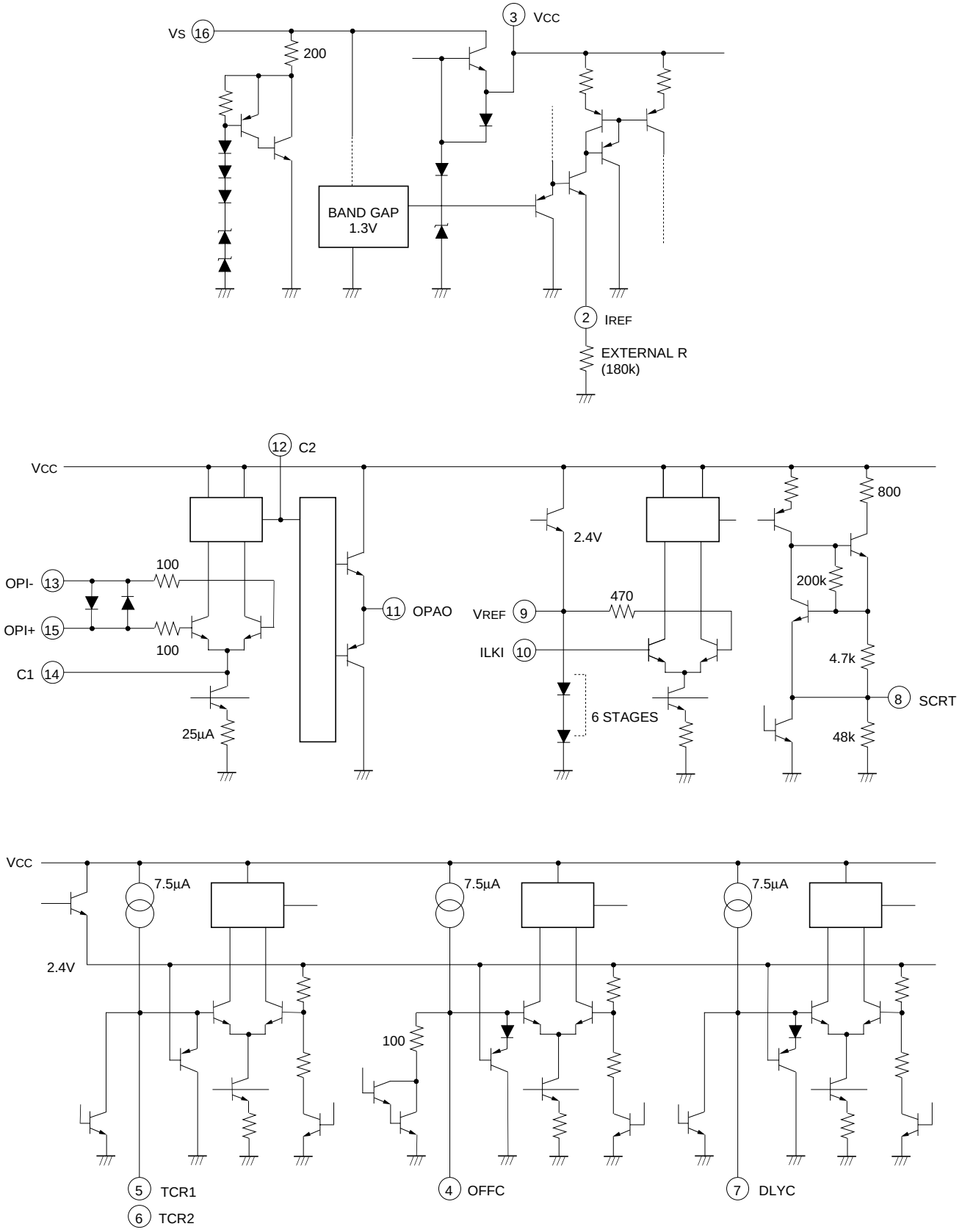
SCRT "H" OUTPUT CURRENT VS. AMBIENT TEMPERATURE CHARACTERISTICS



DESCRIPTION OF PIN

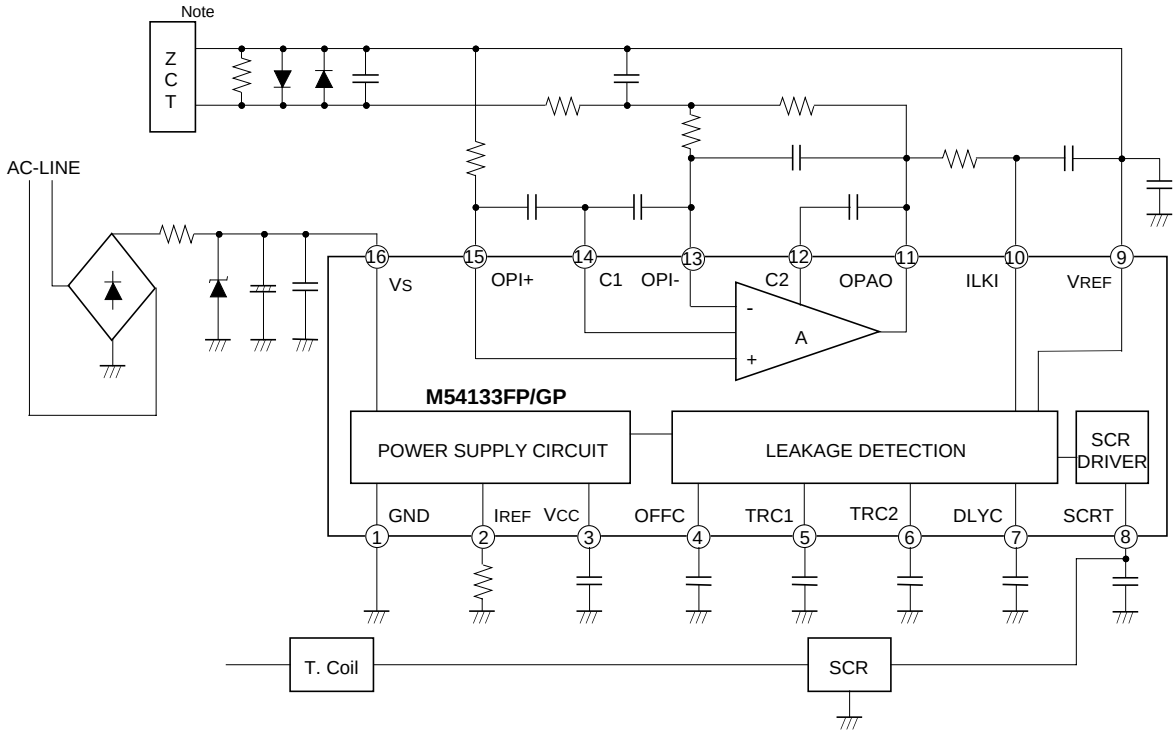
Pin No.	Name	Function
Common blocks		
⑯	VS	Power supply
③	VCC	Output pin of the internal constant-voltage circuit. Connect decoupling capacitor.
②	IREF	Pin for connecting resistor that sets constant current through each internal circuit. About 1.3V appears.
①	GND	Grounding
Operational amplifier		
⑬	OPI-	Input pins of operational amplifier
⑮	OPI+	
⑭	C1	Pin for connecting capacitor that prevents noise from causing malfunction. Connect capacitors across IC at pins ⑬ and ⑭ and across IC at pins ⑮ and ⑭ .
⑫	C2	Pin for connecting capacitor that prevents abnormal oscillations. Connect capacitor across IC at pins ⑪ and ⑫ .
⑪	OPAO	Output pin of operational amplifier.
Leak detector and SCR driver circuits		
⑨	VREF	Pin for providing input reference level of leakage detection. About 2.4V appears.
⑩	ILKI	Other input pin of leakage detection.
⑤	TRC1	Pin for connecting capacitor that integrates signal output from discriminator of leak-signal input level.
⑥	TRC2	Pin for connecting capacitor to eliminate noise.
④	OFFC	Leakage input signal does not continue. Leakage is detected and SCR turn on. In these cases, this IC will be restored to the initial condition after a predetermined time. Connect capacitor that determines restore time.
⑦	DLYC	Pin for connecting capacitor that sets delay time in case of using delay function.
⑧	SCRT	Output pin for drive a SCR.

INPUT/OUTPUT EQUIVALENT CIRCUIT



Units Resistance : Ω
Capacitance : F

APPLICATION EXAMPLE



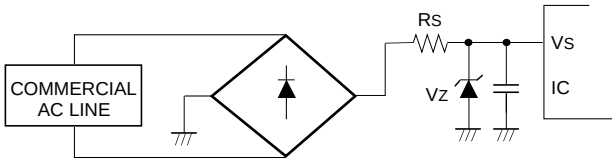
Note : MZ Core Series by Soryo Denshi Kagaku Co., Ltd (Mitsubishi Subsidiary)
Tel. +81-427-74-7813

PRECAUTION FOR APPLICATION

Described below are precautions on usage of the M54133FP and the M54133GP. Note that each precaution presents a still better example. It is advisable to review it carefully to learn optimal conditions.

1. Voltage applied to Vs

1. Fig.1 shows characteristics of circuit current Is. (Is characterizes clamp circuit shown in INPUT/OUTPUT equivalent circuits.) To design power supply, adapt it to IC, considering Is characteristics.
2. Rectification for use of commercial AC line as power source.



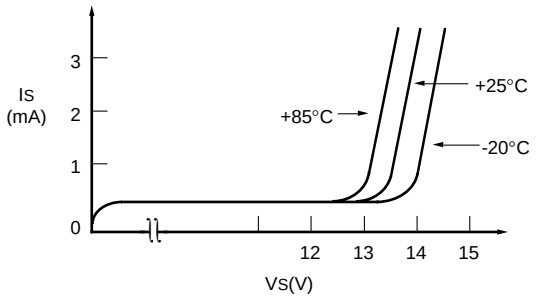


Fig. 1 CHARACTERISTICS OF Vs TO Is

a) For Vz, select zener diode of 12V or less. (Prevent supply voltage Vs from exceeding absolute maximum rating of 15V.)
b) Escalated temperature may decrease supply voltage to produce large current Is. In this case, Rs limits Is.

3. For use of common DC power supply, set supply voltage Vs within range of 7 to 12V.

2. Resistor (R=180kΩ) at IREF pin

This resistor provides constant-reference-current source for IC. (Constant current source protects IC against fluctuations in supply voltage and ambient temperature.)

Since every circuit is characterized by resistance of this resistor, the use of high-precision resistor (accuracy of ±2%) is recommended.

3. Laying out printed-circuit board

Foreign noise (from noise simulator, for example) may cause malfunctions.

To improve noise resistance, lay out printed-circuit patterns so that wirings of IC to additional capacitors and resistors can be made as short as possible.

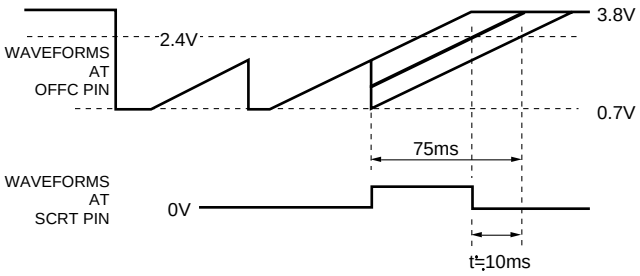
Carefully design patterns especially for wiring capacitors to Vs of pin ⑯, Vcc of pin ③, and SCRT of pin ⑧.

4. Avoid SCRT output pin voltage from falling negative below GND level.

5. Reset time applicable to reset timer circuit

The M54133 has reset timer circuit of VL=0.7V, VH=2.4V, and Io=7.5µA. When SCR is on, power supply path is disconnected from leak detector circuit. As shown in illustration below, disconnection may inhibit VL from falling to 0.7V. Accordingly, reset time may get shortened. To avoid shortage, predetermine a reset time that includes extra time.

$$T = \frac{C_X(V_H - V_L)}{I_O} = \frac{0.33\mu F \times (2.4 - 0.7)}{7.5\mu A} \fallingdotseq 75ms$$



Note. Predetermined reset time may get shortened by t.