M54134FP/GP

Earth Leakage Current Detector

REJ03F0030-0100Z
Rev.1.0
Sep.16.2003

Description

The M54134FP/GP is a semiconductor integrated circuit developed for use in high-speed earth leakage breakers incorporating functions to protect against voltage surges and inverter noise.

Features

- Lightning surge protection
  Two-count method adopted
  Improved dead-time performance for lightning impulses
- Inverter support
  For active/low-pass filter use
  Internal op-amp (low current consumption)
  Improved high-frequency, high harmonic superposition performance
- Internal time delay function
  A time delay function can be configured
- High input sensitivity
  VT=11.5 mV_{rms}
- Low current consumption
  Standby: 610 µA (typical)
  Leakage detection: 650 µA (typical)
- High-stability design
  Adopts a circuit with minimal characteristic fluctuation when changes occur in the power supply voltage or ambient temperature

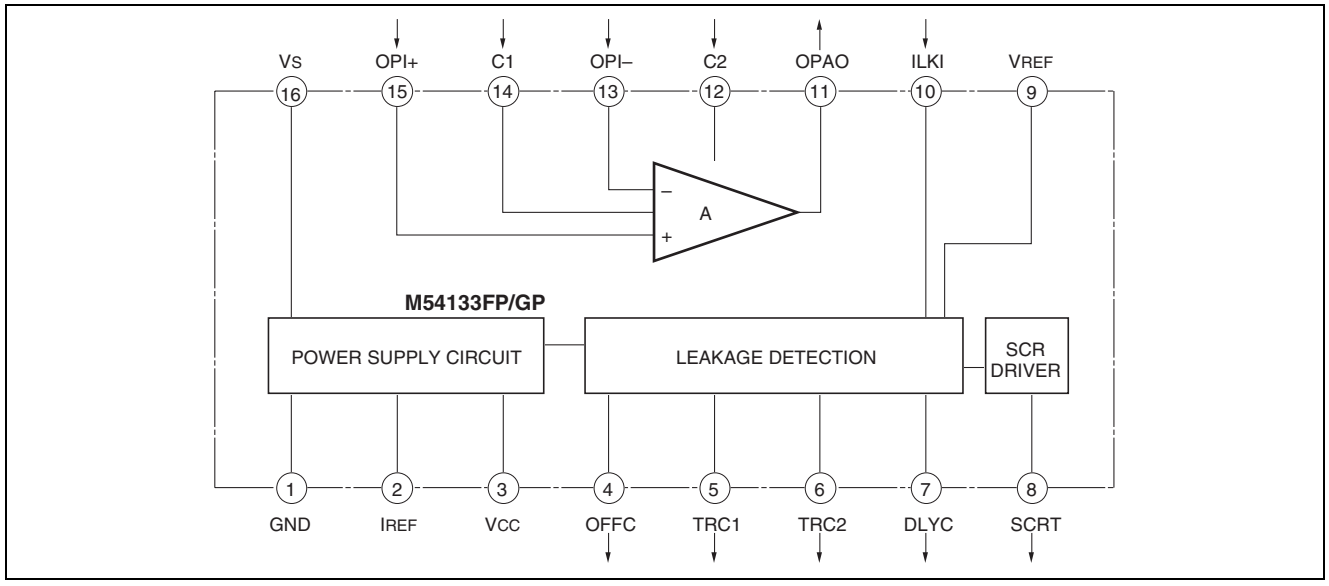
Applications

- Earth leakage breaker

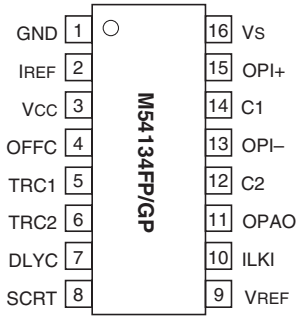
Recommended Operating Conditions

- Operating power supply voltage range: 7 to 12 V
- Operating ambient temperature: –20 to 85°C

Block Diagram



Pin Configuration



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

Pin Description

Pin no.	Name	Function
16	VS	Power supply
• Common		
3	VCC	Output pin for internal constant-voltage circuit; connected to decoupling capacitor
2	IREF	Pin for connection to resistor to set constant current for internal circuits; approx. 1.3 V
1	GND	Ground
• Op-amp		
13	CPI–	Op-amp input pins
15	CPI+	
14	C1	Pin for connection to capacitors to prevent noise-induced erroneous operation; connected between pins [13], [14] and pins [15], [14]
12	C2	Pin for connection to capacitor to prevent oscillation; connected with pin [11].
11	OPAO	Op-amp output pin
• Leakage detection, SCR driving circuit		
9	VREF	Input reference level pin for leak detection circuit; approx. 2.4 V
10	ILKI	Another input pin for leak detection circuit
5	TRC1	Pin to connect a capacitor used to integrate the level discriminator output signal of the leak input signal
6	TRC2	Pin to connect a capacitor for noise elimination
4	OFFC	When leak input signal is not continued When a leak 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.
7	DRYC	Pin to connect a capacitor to set the time when using the time delay function
8	SCRT	Thyristor driving output pin

Absolute Maximum Ratings

(Unless otherwise noted, Ta = 25°C)

Symbol	Parameter	Test conditions	Ratings	Unit
I_S	Power supply current		4	mA
$IV_{Smax.}$	Maximum power supply voltage		15	V
Vid	Differential input voltage	Across OPI+ and OPI–	–0.8 to 0.8	V
I_{IOP}	Differential input current	Across OPI+ and OPI–	–5 to 5	mA
I_{IG}	Input current	Across VREF and GND	10	mA
Pd	Power consumption		200	mW
Topr	Operating ambient temperature		–20 to 85	°C
Tstg	Storage temperature		–55 to 125	°C

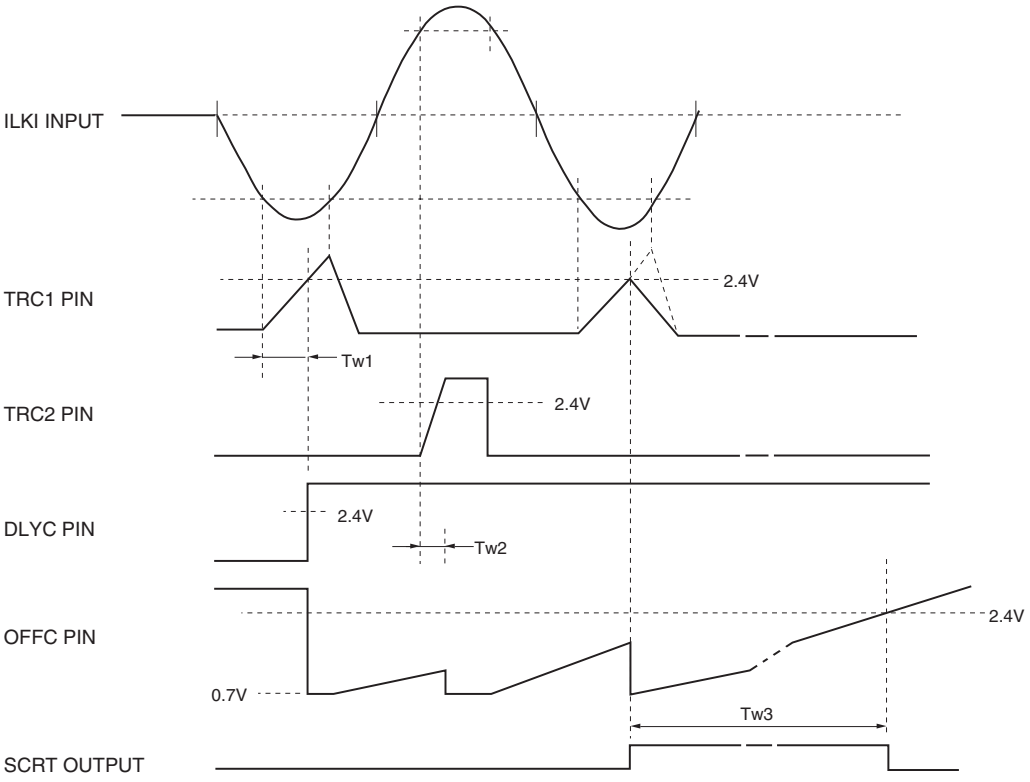
Electrical Characteristics

(Unless otherwise noted, Ta = 25°C)

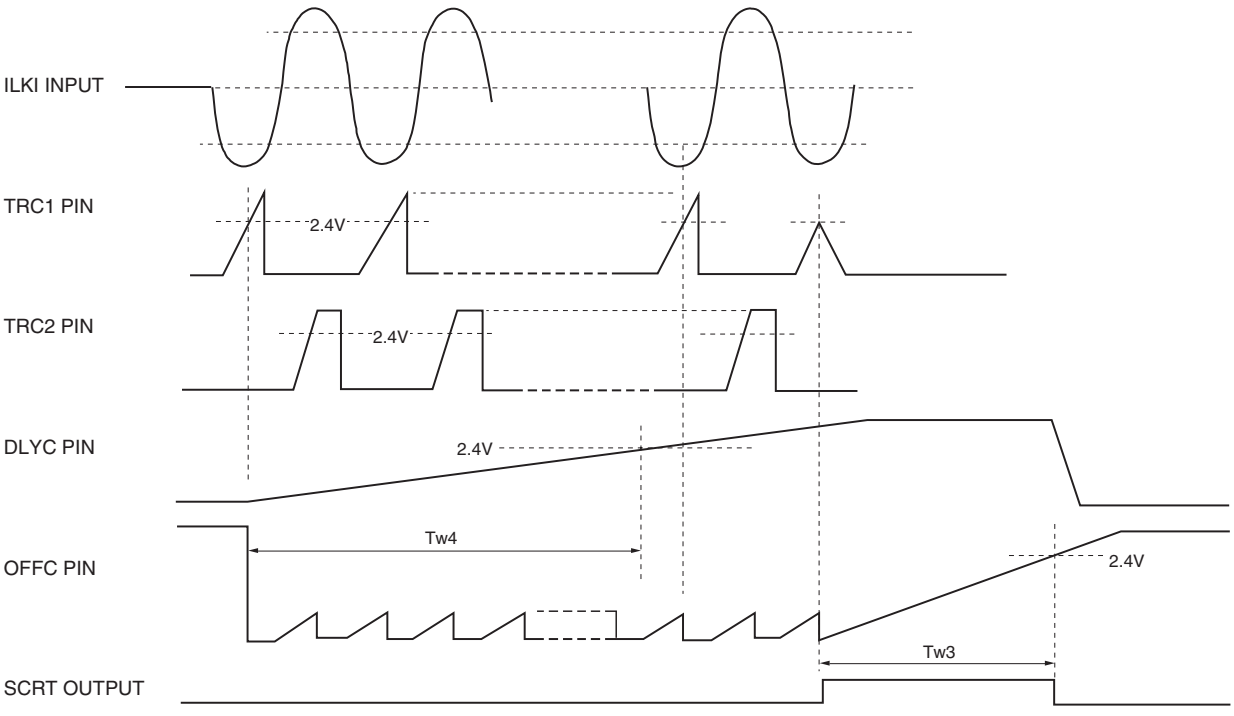
Sym-bol	Quantity		Measurement conditions			Ratings			Units
			Vs			Min.	Typ.	Max.	
I_{s0}	Power supply circuit	Power supply current, during standby	9 V			520	610	700	µA
I_{s1}		Power supply current, during leak detection				560	650	740	µA
I_{s2}		Power supply current, immediately after SCR driving				480	570	660	µA
—		Is0 ambient temp. storage dependence	9 V	Ta = –20 to 85°C		—	–0.2	—	%/°C
$V_{Smax.}$		Voltage at max. current	—	I_S = 4 mA		—	13.9	15	V
V_{CC}		VCC pin output voltage	9 V	I_{OH} = –1 mA		—	5.2	—	V
G_V	Op-amp	Voltage amplification	9 V	f = 1 kHz		—	40	—	dB
B_W		Frequency band		–3 dB		—	6	—	kHz
V_O		Maximum output voltage				—	3.5	—	Vpp
I_{SOURCE}		OPAO pin "H" output current				—	2.8	—	mA
I_{SINK}		OPAO pin "L" output current				—	0.8	—	mA
V_{OF}		Output offset voltage				—	0	—	mV
I_{IB}		Input bias current				—	125	—	nA
V_{IB}		Differential input clamping voltage		Iidc = ±4 mA		—	±0.8	—	V
V_{ION}	Leak-age detec-tion circuit	Leakage detection DC input voltage	9 V	vs. VREF		—	±14	—	mVdc
I_{IH}		ILK1 pin input bias current		V_{IN} = VREF		—	220	—	nA
V_{REF}		VREF pin output voltage		I_{OH} = –200 µA		—	2.4	—	V
V_{CL}		VREF-GND clamping voltage		I_{RCL} = 5 mA		—	4.7	—	V
E_{IOH1}	3 ms circuit	TRC1 pin "H" output current precision	9 V	V_O = 0; I_{OH} = –7.6 µA		–10	—	10	%
V_{TH1}		TRC1 pin threshold voltage				—	2.4	—	V
E_{TW1}		Tw1 pulse width precision		C_1 = 0.01 µF; T_{W1} = 3 ms		–15	—	15	%
—		Tw1 ambient temperature dependence		Ta = –20 to 85°C		—	0	—	%/°C
E_{IOH2}	1 ms circuit	TRC2 pin "H" output current precision	9 V	V_O = 0; I_{OH} = –7.6 µA		–10	—	10	%
V_{TH2}		TRC2 pin threshold voltage				—	2.4	—	V
E_{TW2}		Tw2 pulse width precision		C_2 = 0.0047 µF; T_{W2} = 1.5 ms		–15	—	15	%
—		Tw2 ambient temperature dependence		Ta = –20 to 85°C		—	0	—	%/°C
E_{IOH3}	Reset circuit	OFFC pin "H" output current precision	9 V	V_O = 0; I_{OH} = –7.6 µA		–10	—	10	%
V_{TH3}		OFFC threshold voltage				—	2.4		V
E_{TW3}		Reset timer pulse width precision	9 V	C_3 = 0.33 µF; T_{W2} = 75 ms		–30	—	30	%
E_{IOH4}	Time delay circuit	DLYC pin "H" output current precision	9 V	V_O = 0; I_{OH} = –7.6 µA		–10	—	10	%
V_{TH4}		DLYC threshold voltage				—	2.4		V
E_{TW4}		Time delay timer pulse width precision	9 V	C_4 = 1.0 µF; T_{W2} = 300 ms		–30	—	30	%
V_{OL8}	SCR driver circuit	SCRT pin "L" output voltage	9 V	I_{OL} = 200 µA		—	0.1	0.2	V
I_{OHc}		SCRT pin "H" output current	9 V	V_O = 0.8 V	Ta = –20°C	–100	–160	—	µA
I_{OHn}					Ta = 25°C	–50	–130	—	µA
I_{OHh}					Ta = 85°C	–30	–100	—	µA
Vsoff		IOH hold power supply voltage	—			—	3.0	4.0	V
V_T	Over-all trip	Overall leak detection AC voltage	9 V	60 Hz		—	11.5	—	mVrms
—		VT ambient temperature dependence		Ta = +25 to 80°C		—	–8.0	—	%/°C
				Ta = +25 to –20°C		—	+2.0	—	

Timing Charts

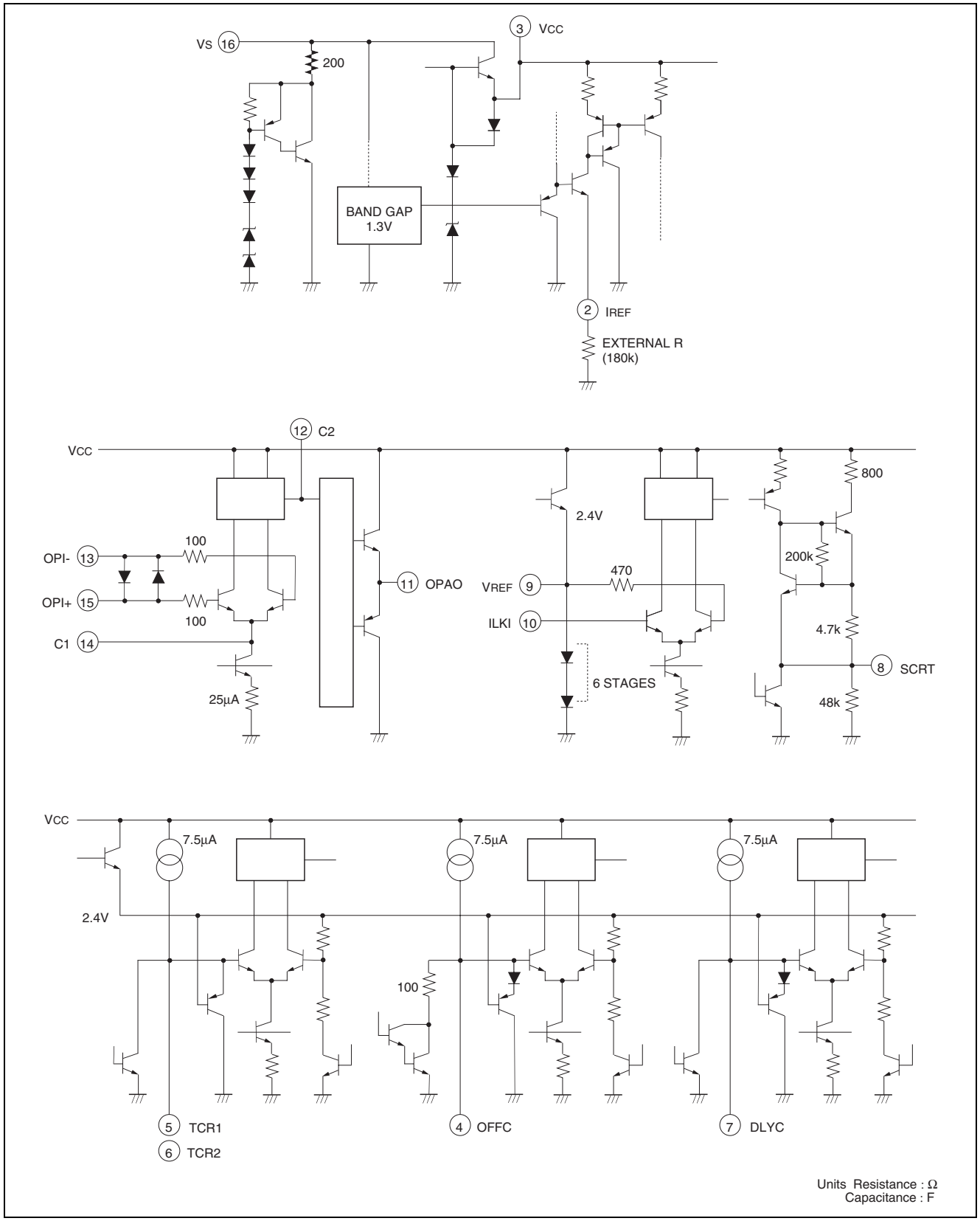
WITHOUT DELAY FUNCTION



USING DELAY FUNCTION



Input/Output Equivalent Circuit



Precaution for Application

Described below are precautions on usage of the M54134FP and the M54134GP. Note that each precaution presents a still better example. It is advisable to review it carefully to learn optimal conditions.

1. Voltage applied to V_S

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

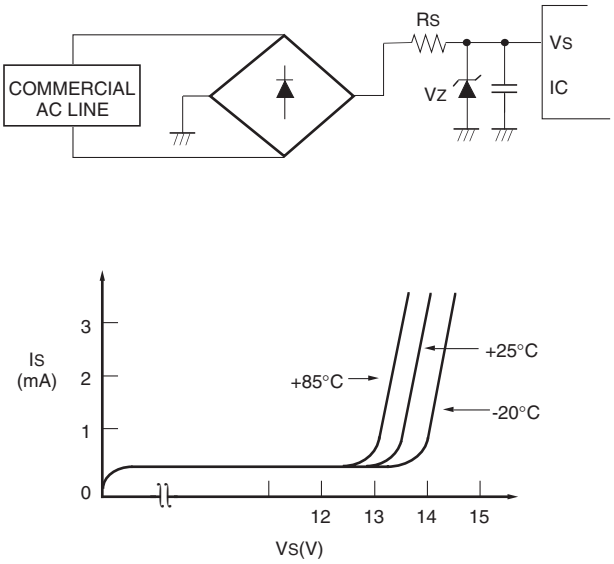


Fig. 1 CHARACTERISTICS OF Vs TO Is

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

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

2. Resistor (R = 180kΩ) at I_{REF} 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.

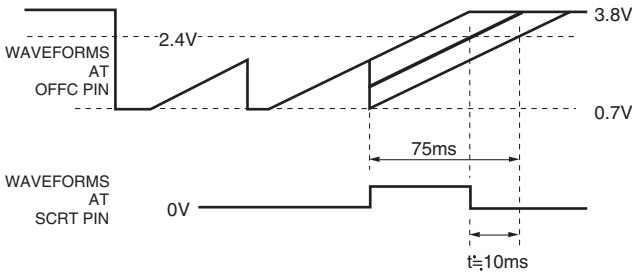
Carefully design patterns especially for wiring capacitors to V_S of [16] pin , V_{CC} of [3] pin , and SCRT of [8] pin.

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

5. Reset time applicable to reset timer circuit

The M54134 has reset timer circuit of V_L=0.7V, V_H=2.4V, and I_O=7.5µA. When SCR is on, power supply path is disconnected from leak detector circuit. As shown in illustration below, disconnection may inhibit V_L from falling to 0.7V. Accordingly, reset time may get shortened. To avoid shortage, predetermine a reset time that includes extra time.

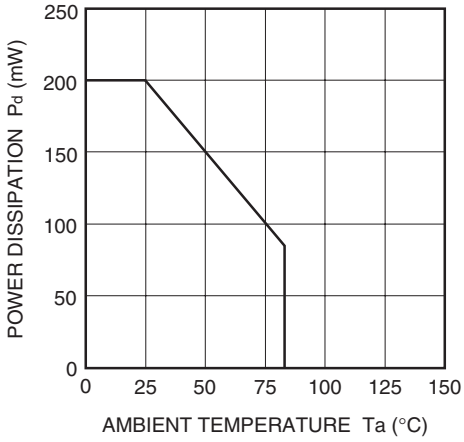
$$T = \frac{C_X(V_H - V_L)}{I_O} = \frac{0.33\mu F \times (2.4 - 0.7)}{7.5\mu A} \fallingdotseq 75ms$$



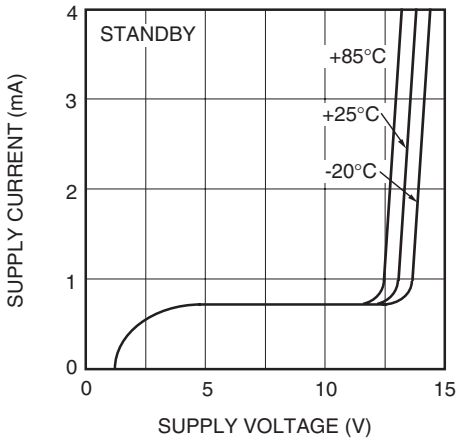
Note. Predetermined reset time may get shortened by t.

Typical Characteristics

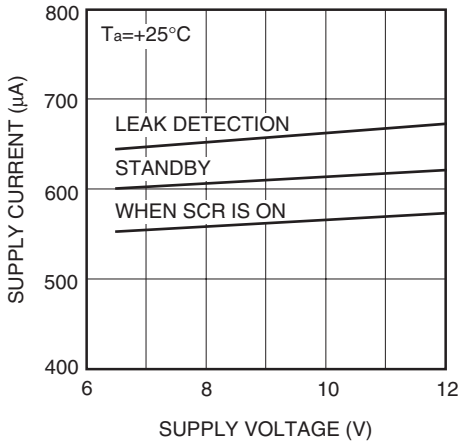
THERMAL DERATING
(MAXIMUM RATING)



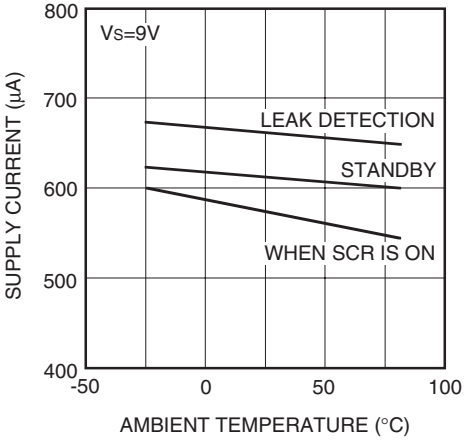
SUPPLY CURRENT VS. SUPPLY VOLTAGE
CHARACTERISTICS



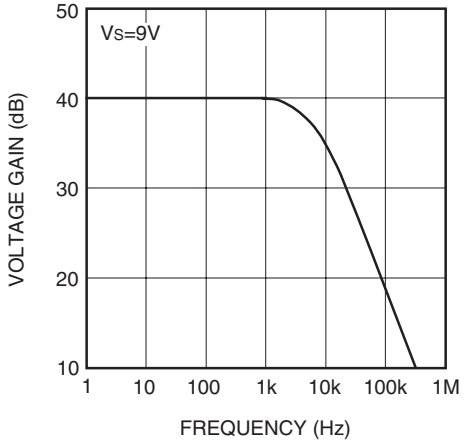
SUPPLY CURRENT VS. SUPPLY VOLTAGE
CHARACTERISTICS



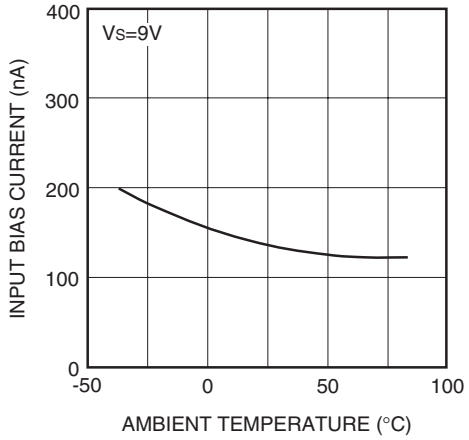
SUPPLY CURRENT VS. AMBIENT TEMPERATURE
CHARACTERISTICS



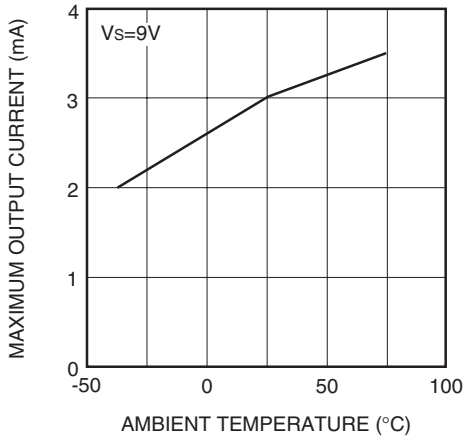
VOLTAGE GAIN VS. FREQUENCY
CHARACTERISTICS



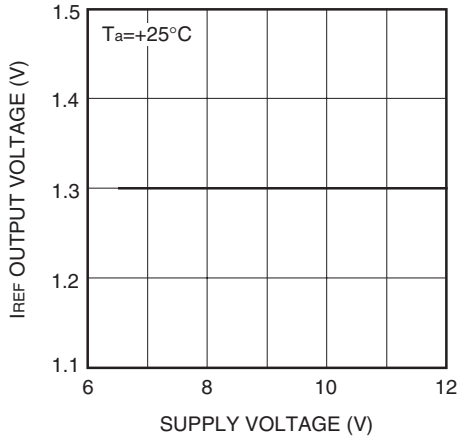
OPERATIONAL AMPLIFIER INPUT CURRENT BIAS VS. AMBIENT TEMPERATURE CHARACTERISTICS



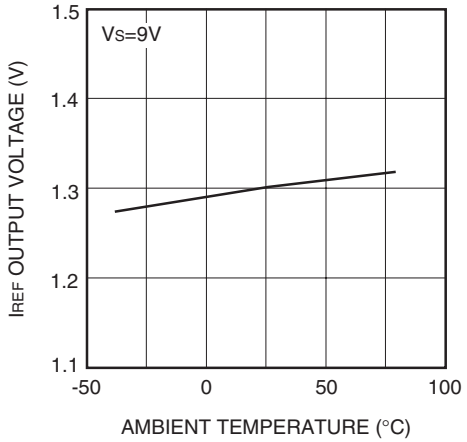
MAXIMUM OPERATIONAL AMPLIFIER OUTPUT CURRENT VS. AMBIENT TEMPERATURE CHARACTERISTICS



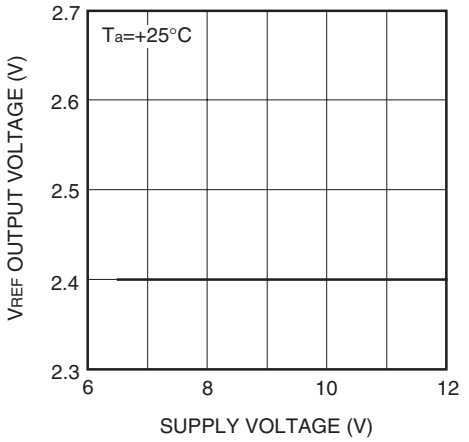
IREF OUTPUT VOLTAGE VS. SUPPLY VOLTAGE CHARACTERISTICS



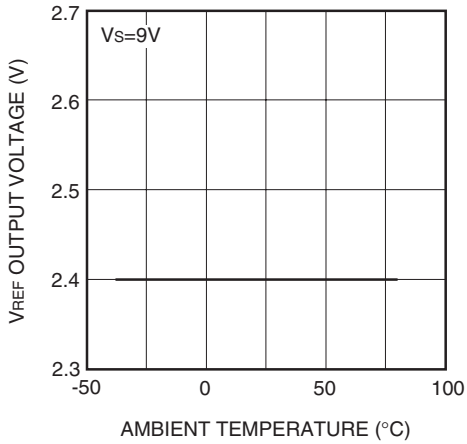
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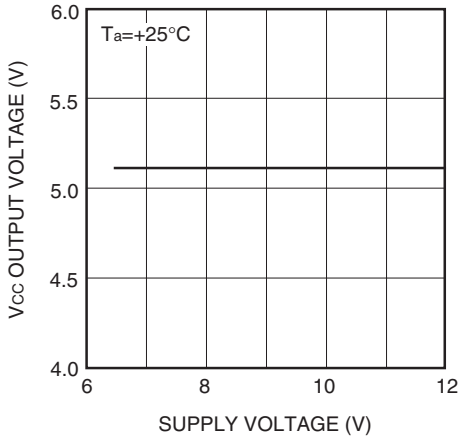
VREF OUTPUT VOLTAGE VS. SUPPLY VOLTAGE CHARACTERISTICS



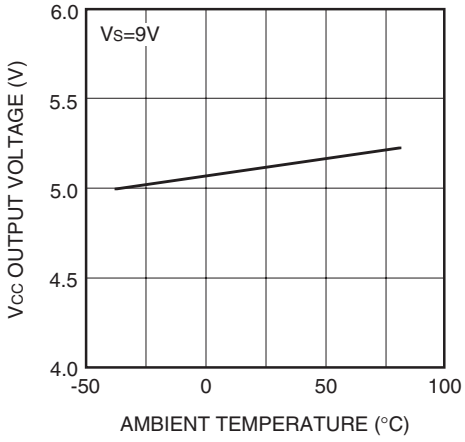
VREF OUTPUT VOLTAGE VS. AMBIENT TEMPERATURE CHARACTERISTICS



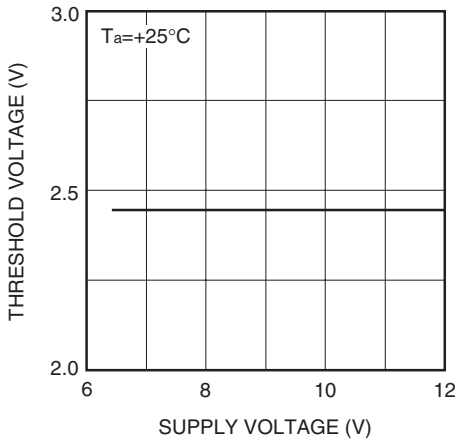
Vcc OUTPUT VOLTAGE VS. SUPPLY VOLTAGE CHARACTERISTICS



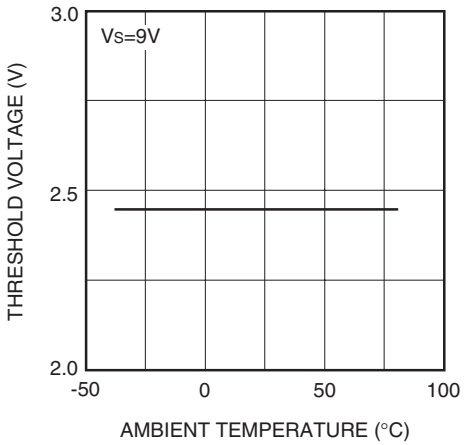
Vcc OUTPUT VOLTAGE VS. AMBIENT TEMPERATURE CHARACTERISTICS



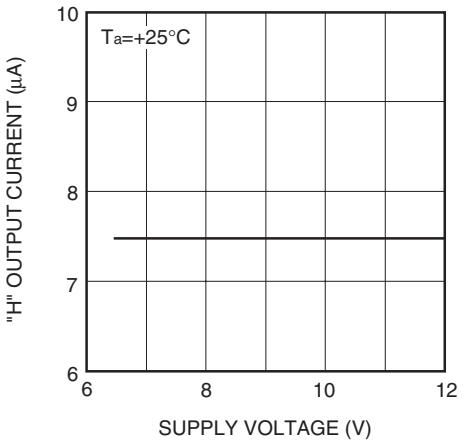
TRC1/TRC2/OFFC/DLYC THRESHOLD VOLTAGE VS. SUPPLY VOLTAGE CHARACTERISTICS



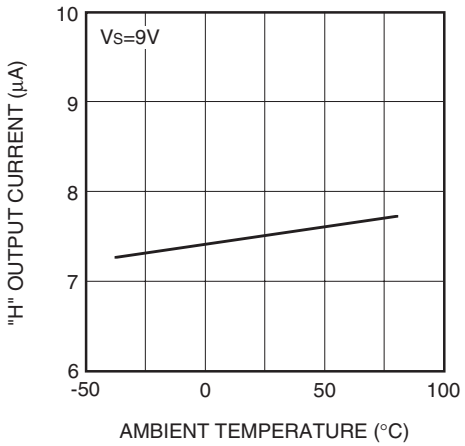
TRC1/TRC2/OFFC/DLYC THRESHOLD VOLTAGE VS. AMBIENT TEMPERATURE CHARACTERISTICS



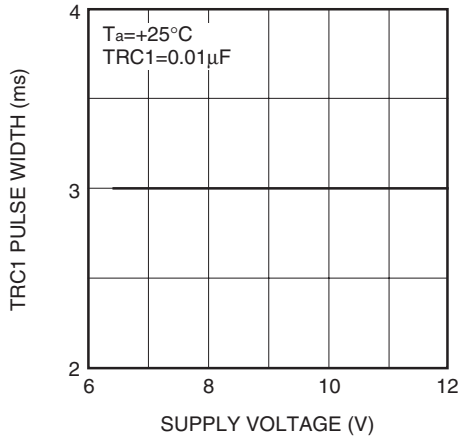
TRC1/TRC2/OFFC/DLYC "H" OUTPUT CURRENT VS. SUPPLY VOLTAGE CHARACTERISTICS



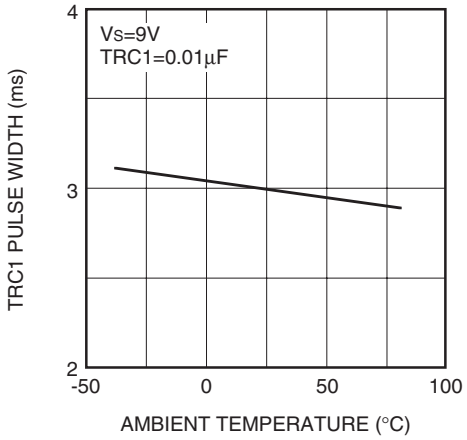
TRC1/TRC2/OFFC/DLYC "H" OUTPUT CURRENT VS. AMBIENT TEMPERATURE CHARACTERISTICS



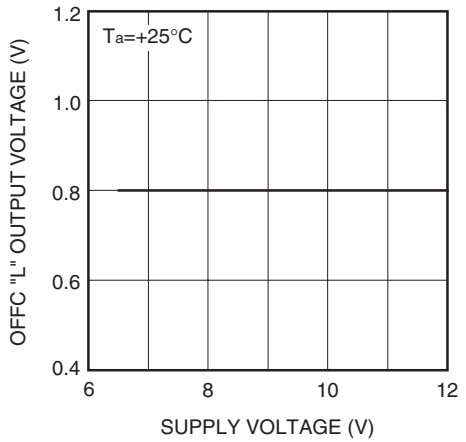
TRC1 PULSE WIDTH VS. SUPPLY VOLTAGE CHARACTERISTICS



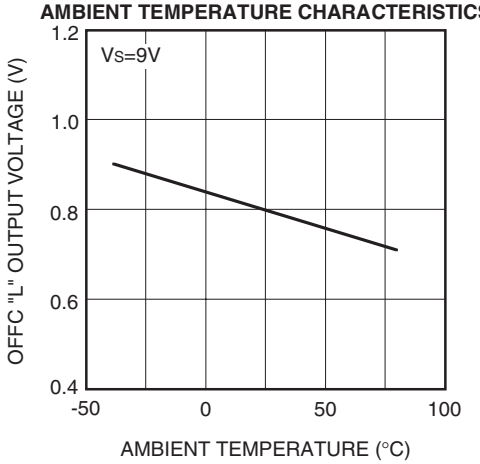
TRC1 PULSE WIDTH VS. AMBIENT TEMPERATURE CHARACTERISTICS



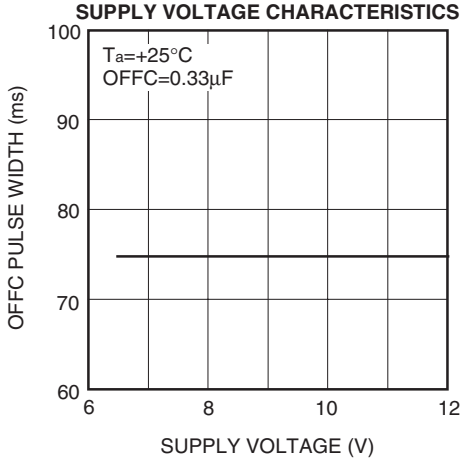
OFFC "L" OUTPUT VOLTAGE VS. SUPPLY VOLTAGE CHARACTERISTICS



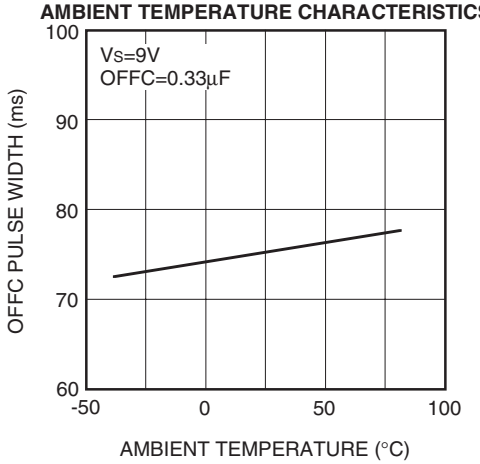
OFFC "L" OUTPUT VOLTAGE VS. AMBIENT TEMPERATURE CHARACTERISTICS



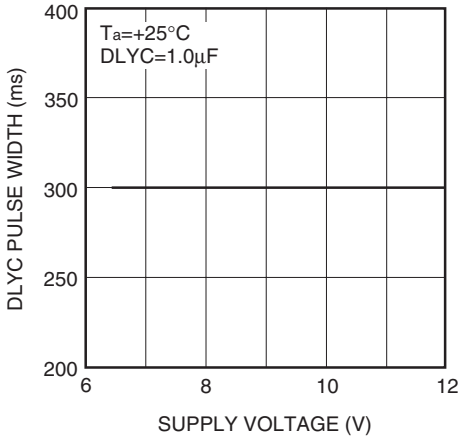
OFFC PULSE WIDTH VS. SUPPLY VOLTAGE CHARACTERISTICS



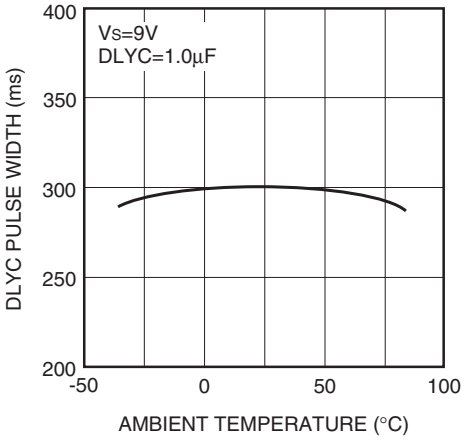
OFFC PULSE WIDTH VS. AMBIENT TEMPERATURE CHARACTERISTICS



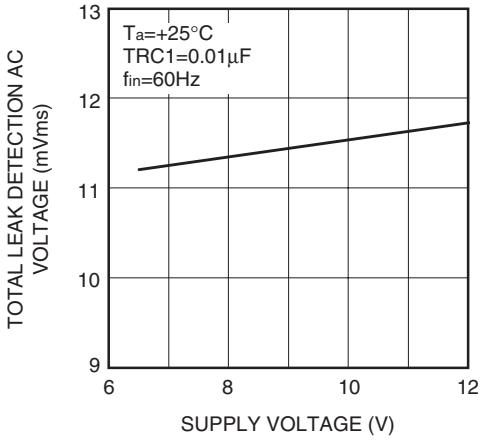
DLYC PULSE WIDTH VS. SUPPLY VOLTAGE CHARACTERISTICS



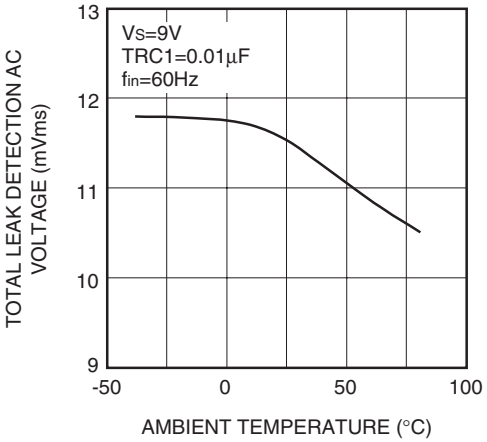
DLYC PULSE WIDTH VS. AMBIENT TEMPERATURE CHARACTERISTICS



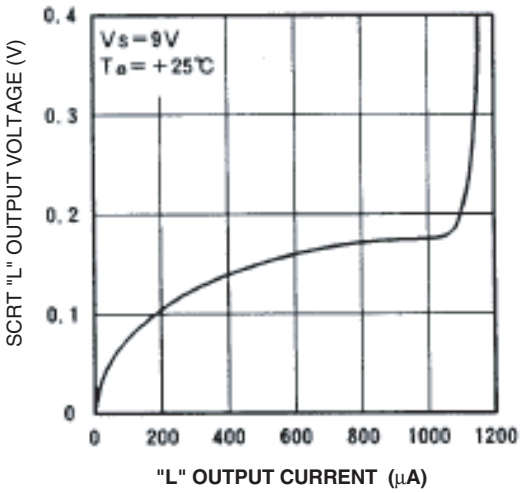
TOTAL LEAK DETECTION AC VOLTAGE VS. SUPPLY VOLTAGE CHARACTERISTICS



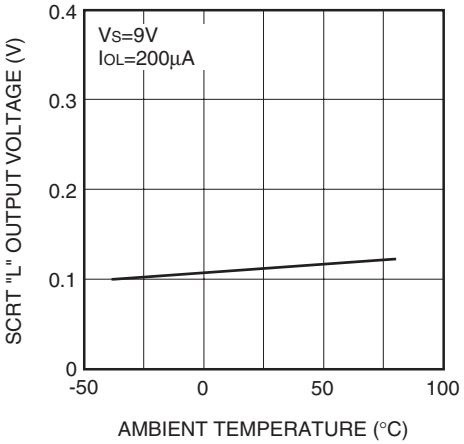
TOTAL LEAK DETECTION AC VOLTAGE VS. AMBIENT TEMPERATURE CHARACTERISTICS



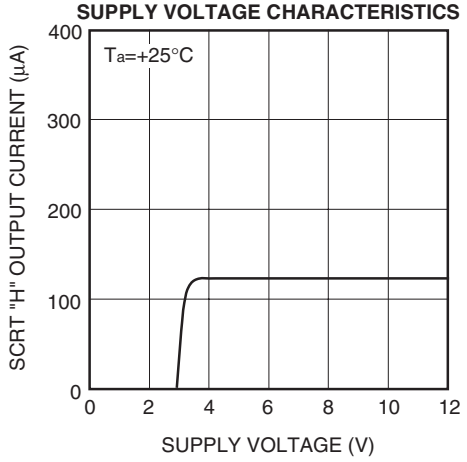
SCRT "L" OUTPUT VOLTAGE VS. "L" OUTPUT CURRENT CHARACTERISTICS



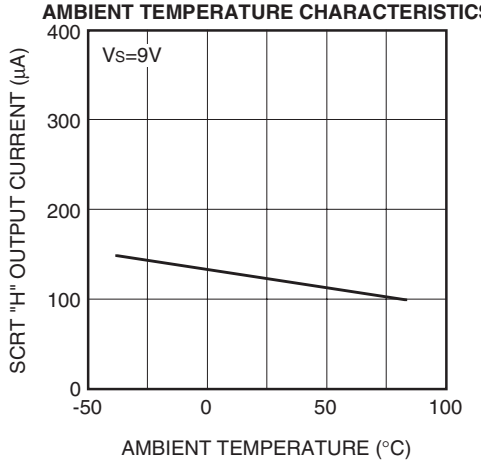
SCRT "L" OUTPUT VOLTAGE VS. AMBIENT TEMPERATURE CHARACTERISTICS



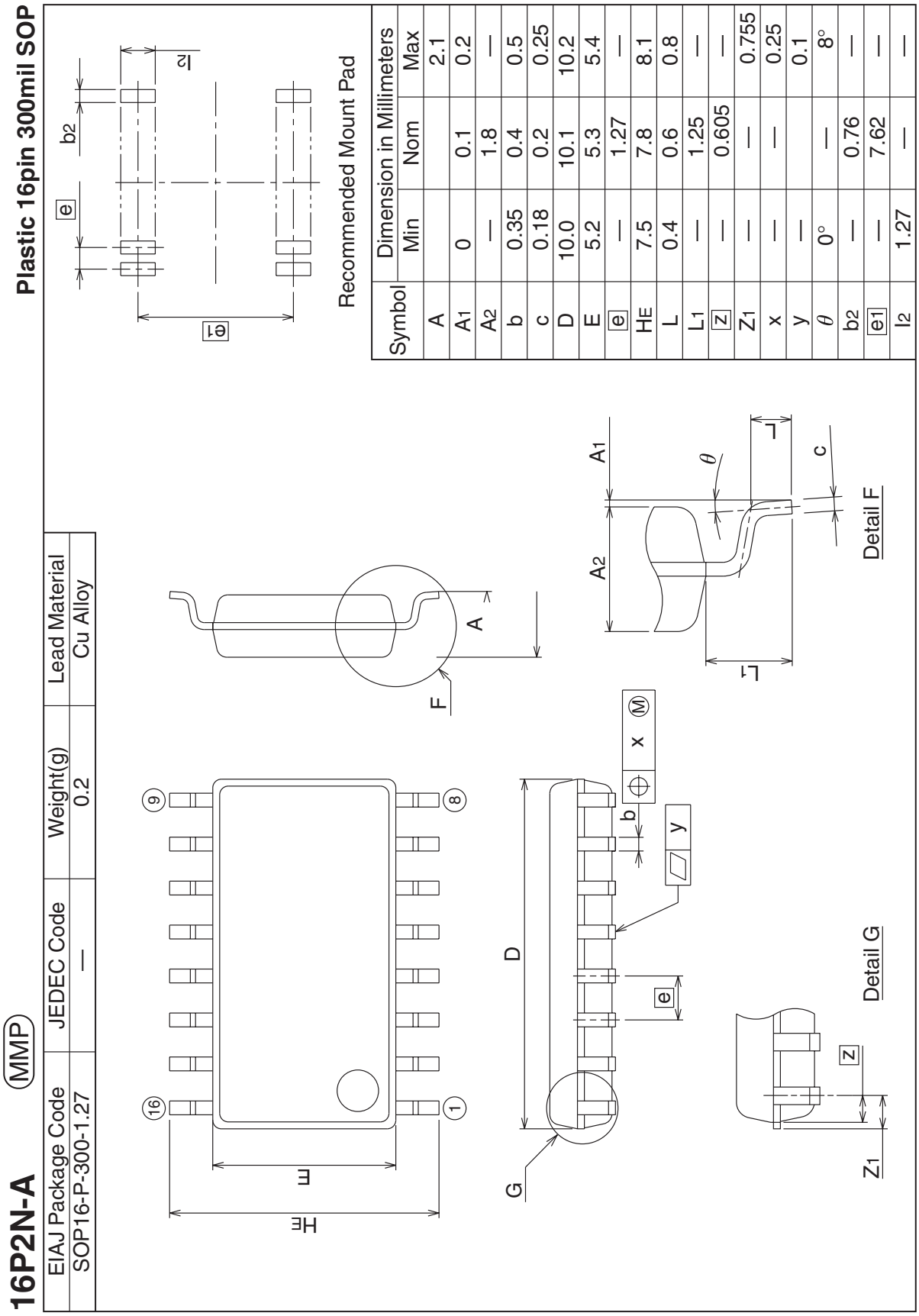
SCRT "H" OUTPUT CURRENT VS.
SUPPLY VOLTAGE CHARACTERISTICS



SCRT "H" OUTPUT CURRENT VS.
AMBIENT TEMPERATURE CHARACTERISTICS



Package Dimensions

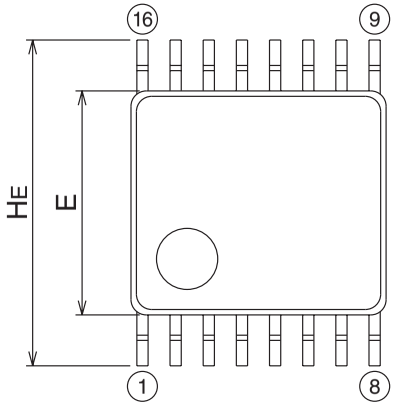


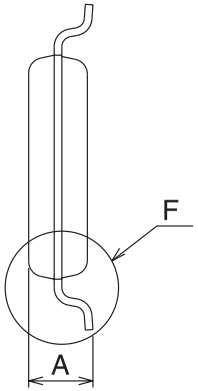
Symbol	Dimension in Millimeters		
	Min	Nom	Max
A			2.1
A_1	0	0.1	0.2
A_2	—	1.8	—
b	0.35	0.4	0.5
c	0.18	0.2	0.25
D	10.0	10.1	10.2
E	5.2	5.3	5.4
e	—	1.27	—
HE	7.5	7.8	8.1
L	0.4	0.6	0.8
L_1	—	1.25	—
z	—	0.605	—
Z_1	—	—	0.755
x	—	—	0.25
y	—		0.1
θ	0°	—	8°
b2	—	0.76	—
e1	—	7.62	—
l2	1.27	—	—

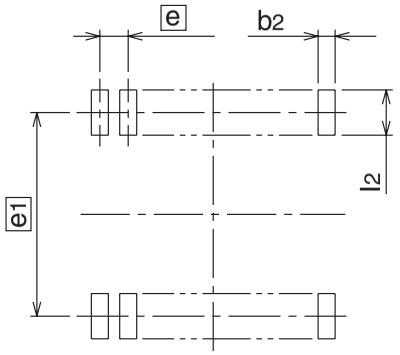
16P2E-A

Plastic 16pin 225mil SSOP

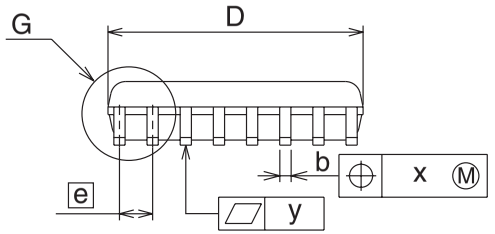
EIAJ Package Code	JEDEC Code	Weight(g)	Lead Material
SSOP16-P-225-0.65	—	0.06	Alloy 42

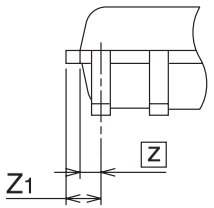




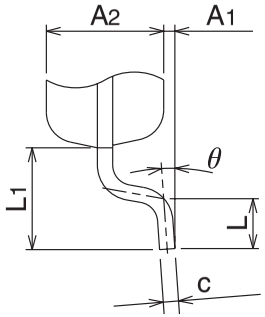


Recommended Mount Pad





Detail G



Detail F

Symbol	Dimension in Millimeters		
	Min	Nom	Max
A	—	—	1.45
A_1	0	0.1	0.2
A_2	—	1.15	—
b	0.17	0.22	0.32
c	0.13	0.15	0.2
D	4.9	5.0	5.1
E	4.3	4.4	4.5
e	—	0.65	—
H_E	6.2	6.4	6.6
L	0.3	0.5	0.7
L_1		1.0	—
z	—	0.225	—
Z_1	—	—	0.375
x	—	—	0.13
y	—	—	0.1
θ	0°	—	10°
b_2	—	0.35	
e_1	—	5.8	—
l_2	1.0	—	—

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