Earth Leakage Current Detector

General Description

The RP54123 is a semiconductor integrated circuit with amplifier for a high-speed earth leakage circuit breaker. The RP54123 circuit for the amplifying parts of earth leakage circuit breaker consists of differential amplifier, latch circuit and voltage regulator. It is connected to the secondary side of the zero-current transformer (ZCT) which detects leakage current in the both input of the differential amplifier. Signals amplified by differential amplifier are integrated by an external capacitor, and connects to the input terminal of latch circuit with output suitable for the characteristics of high-speed earth leakage circuit breaker. Latch circuit keeps low in the output till the input voltage reaches the fixed level, and output becomes high when the leakage current more than fixed flows. It drives a thyristor connected to the output terminal of latch circuit.

Features

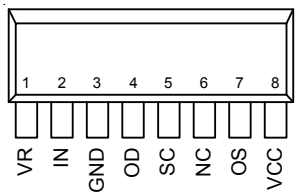
- **Suitable for JIS C 8371**
- **Good temperature characteristics of input sensitivity current**
- **High input sensitivity (V_T = 6.1mV Typ)**
- **Low external component count**
- **High noise and surge-proof**
- **Low power dissipation (Pd = 5mW Typ) and may be used from 100V to 220V**
- **High mounting density by SIP package with 8 pins**
- **Wide temperature range (T_A = -20°C to +80°C)**

Application

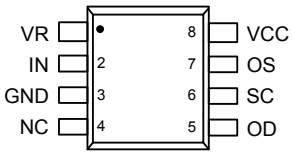
- High speed earth leakage circuit breaker

Pin Configurations

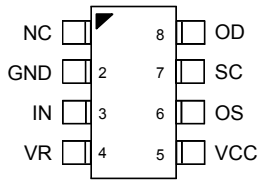
(TOP VIEW)



SIP-8



SOP-8



SOT-23-8

Ordering Information

RP54123 □□

Package Type
S : SOP-8
I : SIP-8
V8: SOT-23-8

Operating Temperature Range
G: Green (Halogen Free with Commercial Standard

Note :

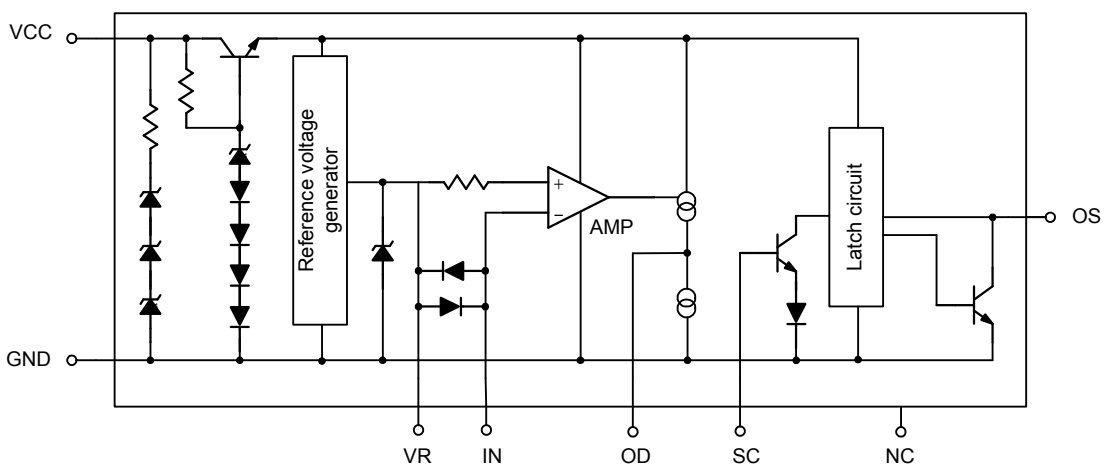
Richpower Green products are :

- RoHS compliant and compatible with the current requirements of IPC/JEDEC J-STD-020.
- Suitable for use in SnPb or Pb-free soldering processes.

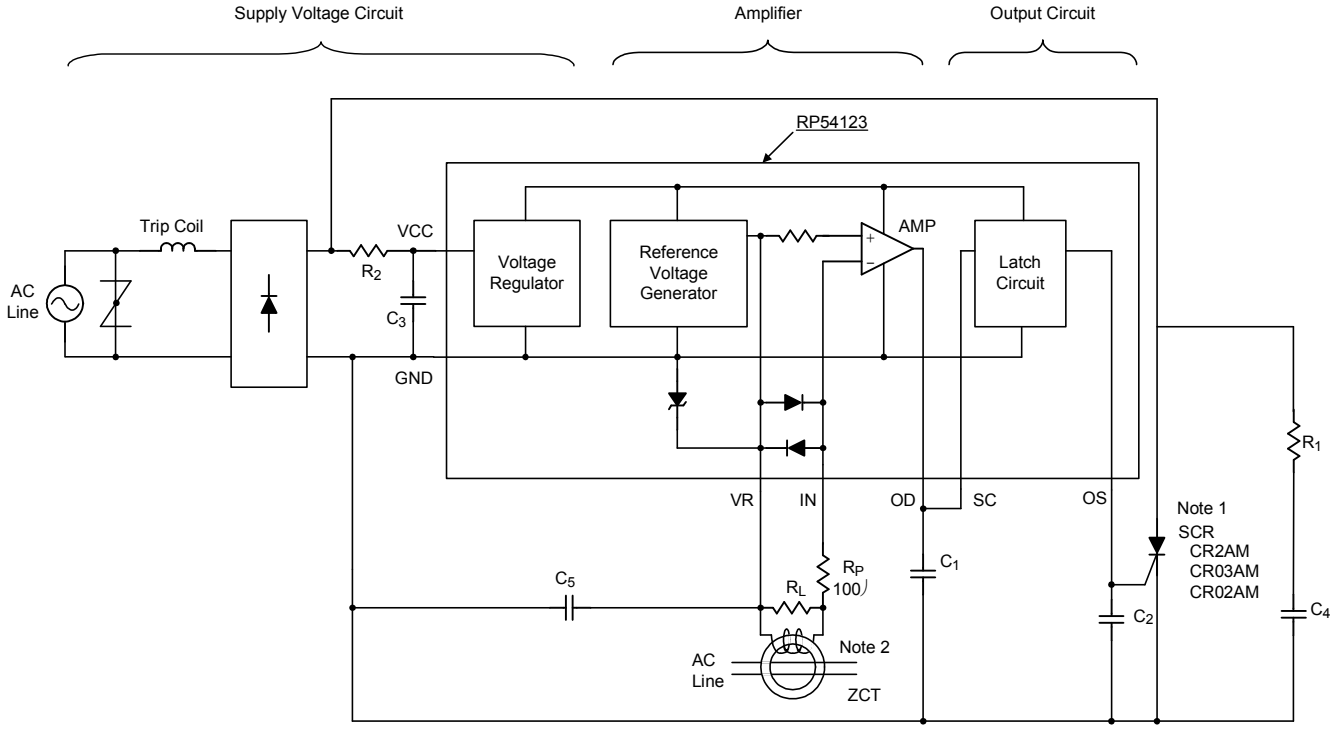
Functional Pin Description

Pin Number			Pin Name	Pin Function
SIP-8	SOP-8	SOT-23-8		
1	1	4	VR	Reference Voltage Input.
2	2	3	IN	Input Signal.
3	3	2	GND	Ground.
4	5	8	OD	Differential Amplifier Output.
5	6	7	SC	Latch Input.
6	4	1	NC	No Internal Connection.
7	7	6	OS	Latch Output.
8	8	5	VCC	Supply Voltage.

Function Block Diagram



Typical Application Circuit



Note 1: Gate current must be selected.
Please select voltage resistance by AC supply voltage.
Note 2: MZ Core Series by Soryo Denshi Kagaku Co., Ltd (Mitsubishi Subsidiary)

Absolute Maximum Ratings

(T_A = -20°C to 80°C, unless otherwise specified)

Parameter	Symbol	Conditions	Ratings	Unit
Supply Current	I_{CC}		8	mA
VR pin Current	I_{VR}	Between VR - IN (Note 1)	250	mA
		Between VR - GND	30	
		Between IN - VR (Note 1)	-250	
IN Terminal Current	I_{IN}	Between IN - VR (Note 1)	250	mA
		Between IN-GND	30	
		Between VR - IN (Note 1)	-250	
SC Terminal Current	I_{SC}		5	mA
Power Dissipation	Pd	SIP-8	200	mW
		SOP-8	500	
Operating Temperature	Topr		-20 to 80	°C
Storage Temperature	Tstg		-55 to 125	°C

Recommended Operating Conditions

(T_A = -20°C to 80°C, unless otherwise specified)

Parameter	Symbol	Limits			Unit
		Min	Typ	Max	
Supply voltage when latch circuit is off-state	VCC	12	--	--	V
External capacitor between VCC and GND	C_{VCC}	1	--	--	µF
External capacitor between OS and GND	C_{OS}	–	--	1	µF

Note 1. Current value between VR and IN, and between IN and VR is less than 1ms in the pulse width, and duty cycle is less than 12%. In applying AC current continuously, it is 100mArms in the off-state.

Remarks. GND terminal (pin 3) of the circuit is a basis of all the voltage except differential input clamp voltage of DC electrical characteristics, and direction of current is plus (no signal) in flowing into the circuit and is minus (-signal) in flowing out of it. Maximum value and minimum one are shown as absolute value. Please don't apply voltage whose standard is GND terminal in VR and IN pin.

Electrical Characteristics

(T_A = -20°C to 80°C, unless otherwise specified)

Parameter	Symbol	Test Conditions	Temper-ature(°C)	Test circuit	Limits (Note 1)			Unit
					Min	Typ	Max	
Supply Current	I_{S1}	VCC = 12V, V_{VR} - V_{IN} = 30mV	-20	1	--	--	580	µA
			25	1	--	400	530	
			80	1	--	--	480	

To be continued

Parameter	Symbol	Test Conditions		Temp-erature (°C)	Test circuit	Limits (Note 1)			Unit
						Min	Typ	Max	
Trip Voltage	V_T	VCC = 16V, V_{VR} - V_{IN} (Note 2)		-20 to 80	2	4	6.1	9	mVrms
Timed Current 1	I_{TD1}	VCC=16V, V_{VR}-V_{IN}= 30mV V_{OD} = 1.2V		25	3	-12	--	-30	μA
Timed Current 2	I_{TD2}	VCC = 16V, short circuit between V_{VR} and V_{IN}, V_{OD} = 0.8V		25	4	17	--	37	μA
Output Current	I_O	V_{SC}=1.6V V_{OS}=0.8V	I_{CC1}= 580μA	-20	5	-200	--	--	μA
			I_{CC1}= 530μA	25	5	-100	--	--	
			I_{CC1}= 480μA	80	5	-75	--	--	
S_C "ON" Voltage (Note 3)	$V_{SC"ON"}$	VCC = 16V		25	6	0.7	--	1.6	V
S_C Input Current	$I_{SC"ON"}$	VCC = 12V		25	7	--	--	5	μA
Output Low-level Current	I_{OSL}	VCC = 12V, V_{OSL} = 0.2V		-20 to 80	8	200	--	--	μA
Input Clamp Voltage	V_{IC}	VCC = 12V, I_{IC} = 20mA		-20 to 80	9	4.3	--	6.7	V
Differential Input Clamp Voltage	V_{IDC}	I_{IDC} = 100mA		-20 to 80	10	0.4	--	2	V
Maximum Current Voltage	V_{SM}	I_{SM} = 7mA		25	11	20	--	28	V
Supply Current 2 (Note 4)	I_{CC2}	V_{VR} - V_{IN} V_{OS} = 0.6V (Note 5)		-20 to 80	12	--	--	900	μA
Latch Circuit is Off-state Supply Voltage (Note 6)	$V_{S"OFF"}$			25	13	0.5	--	--	V
Operating Time (Note 7)	T_{ON}	VCC = 16V, V_{VR} - V_{IN} = 0.3V		25	14	2	--	4	ms

Note 1. Typical values are at T_A = 25° C.

Note 2. When standard value of voltage (60Hz) between VR and VI is minimum, and output OS is low-level, or when standard value of voltage (60Hz) between VR and VI is maximum, and output OS is high-level, it is considered as a good one.

Note 3. When standard value of voltage $V_{SC"ON"}$ is minimum, and output OS is low-level, or when standard value of voltage $V_{SC"ON"}$ is maximum, and output OS is high-level, it is considered as a good one.

Note 4. Supply current 2 is necessary to keep high in output OS.

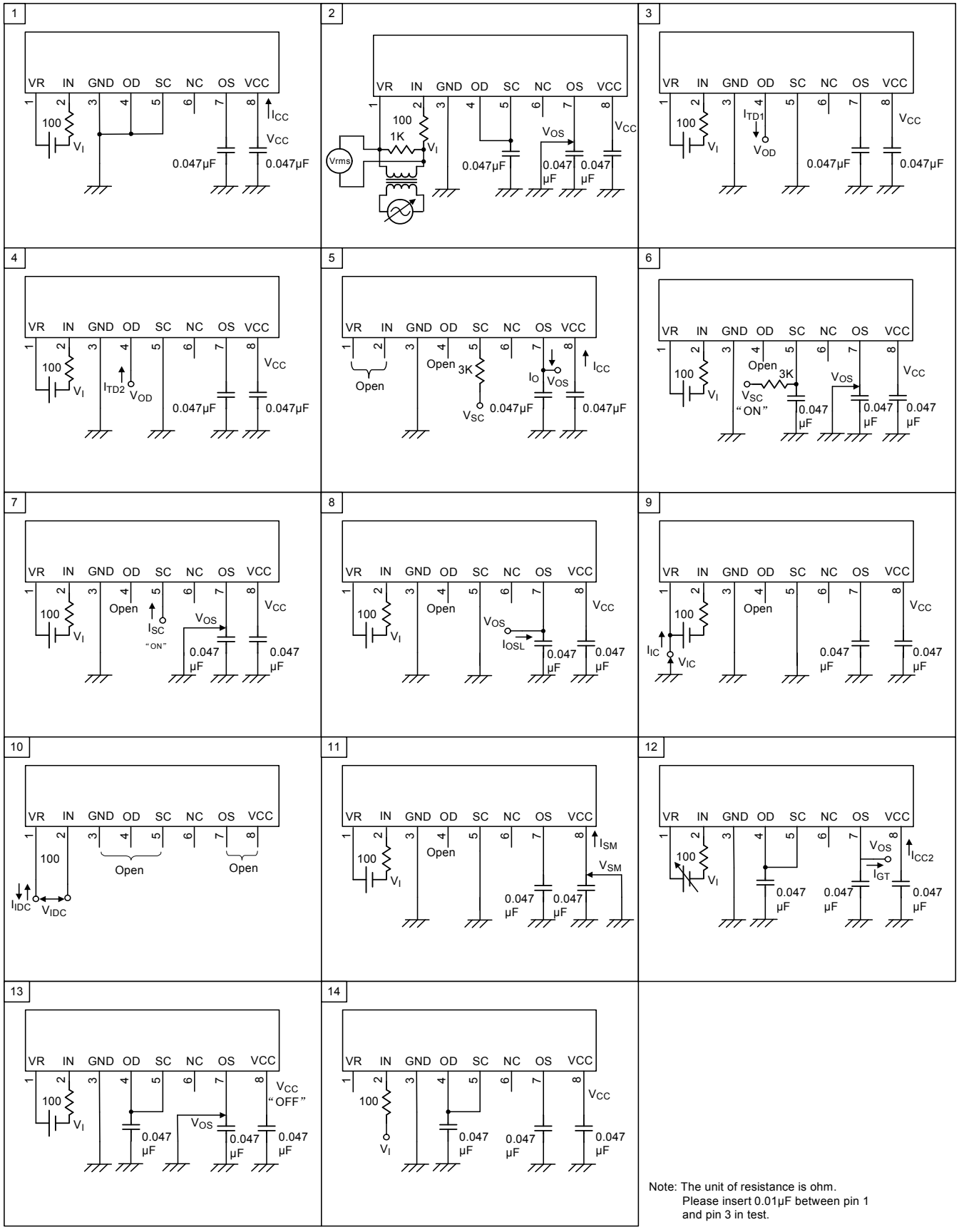
Note 5. After applying 30mV between VR and VI and shorting between them, it is considered as a good one if standard value of I_{GT} flows out of output OS.

Note 6. After supply voltage applies 12V and output OS is high-level, it is considered as a good one in the standard value of supply voltage and in the low-level of output OS.

Note 7. Operating time is a time from applying fixed input till operating latch circuit in 0.047μF between OD and GND.

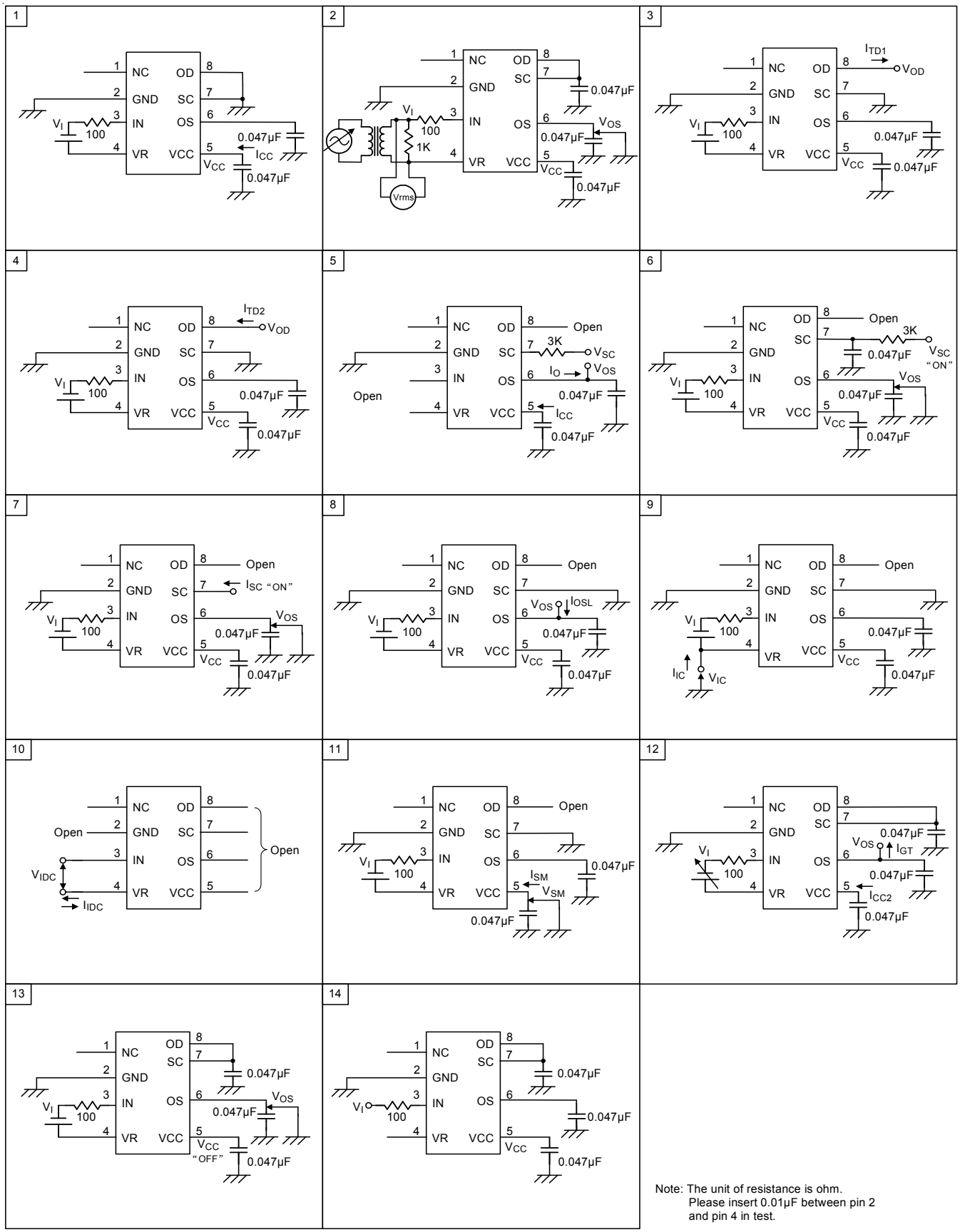
Test Circuit

SIP-8



Note: The unit of resistance is ohm.
Please insert 0.01μF between pin 1 and pin 3 in test.

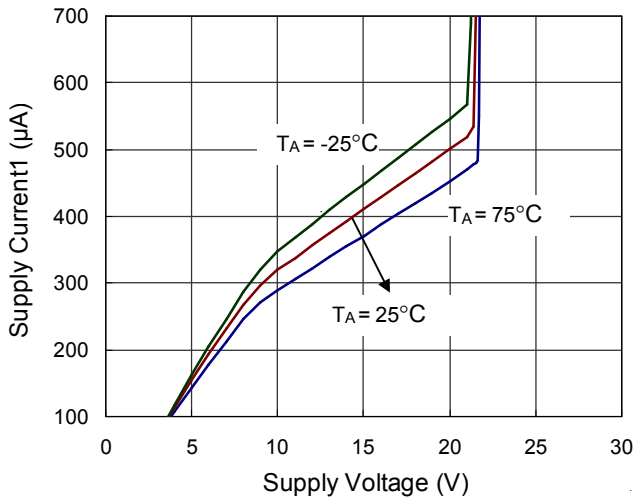
SOT-23-8



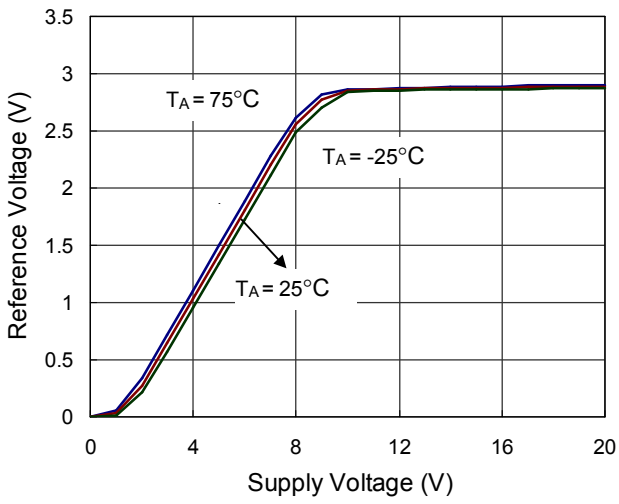
Note: The unit of resistance is ohm.
Please insert 0.01μF between pin 2 and pin 4 in test.

Typical Operating Characteristics

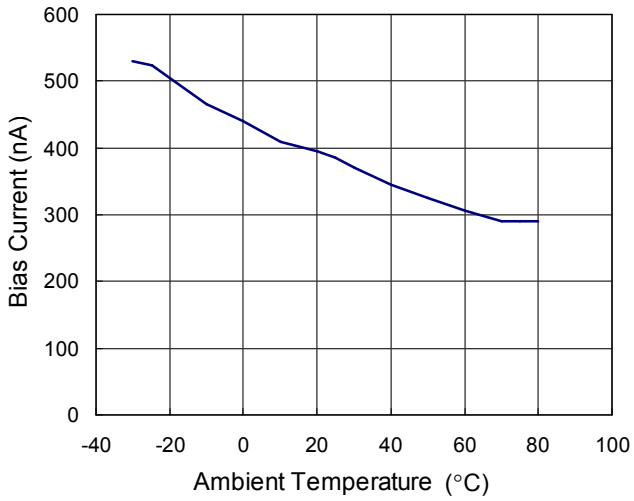
Supply Current1 vs. Supply Voltage



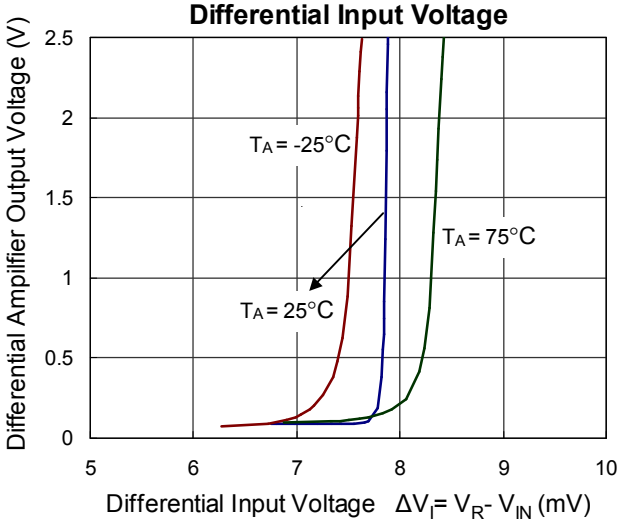
Reference Voltage vs. Supply Voltage



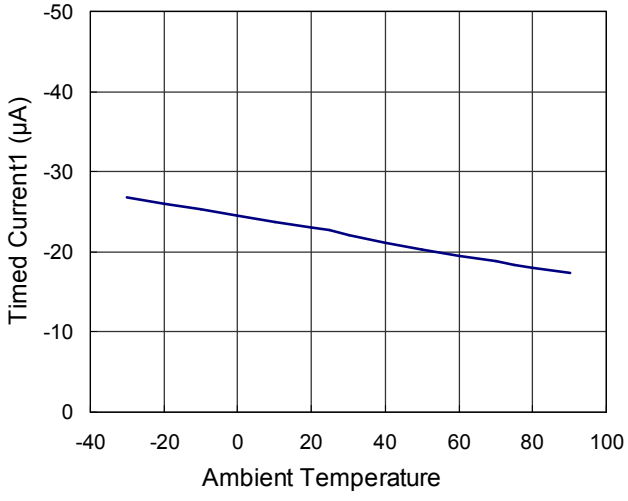
Bias Current vs. Ambient Temperature



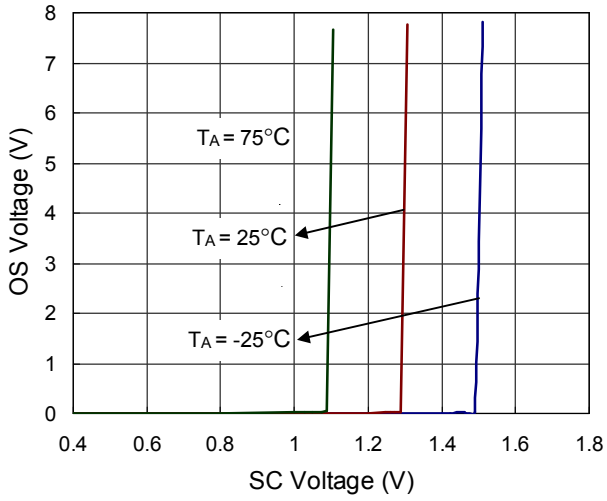
Differential Ampilfier Output Voltage vs. Differential Input Voltage



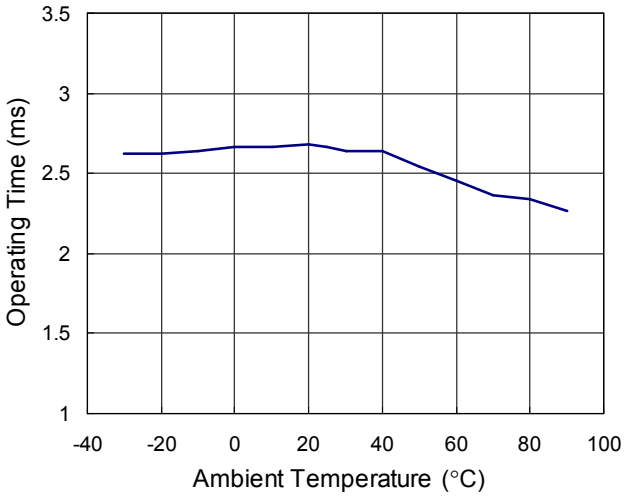
Timed Current1 vs. Ambient Temperature



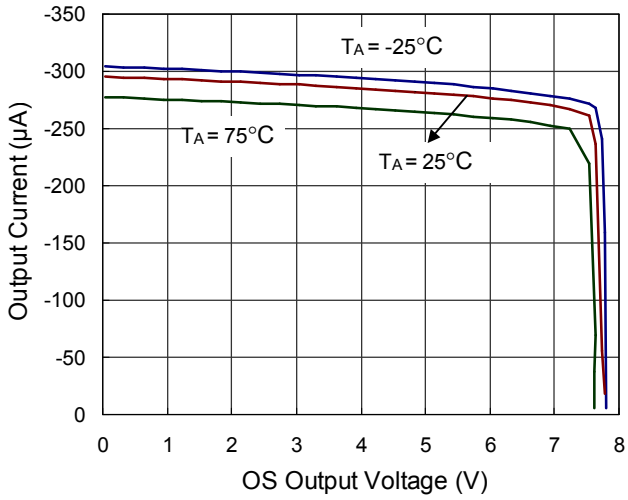
OS Voltage vs. SC Voltage



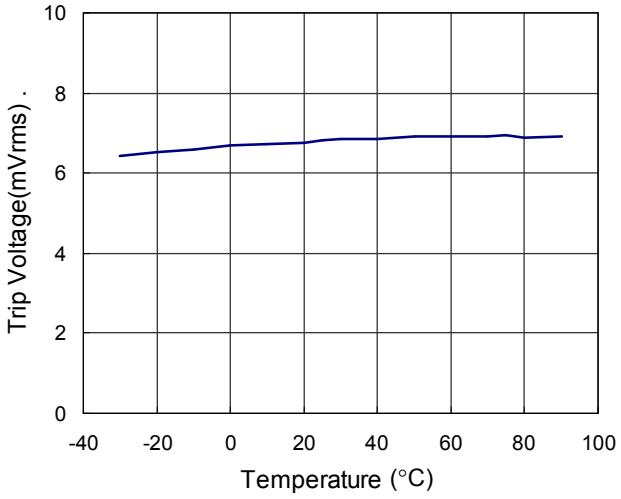
Operating Time vs. Ambient Temperature



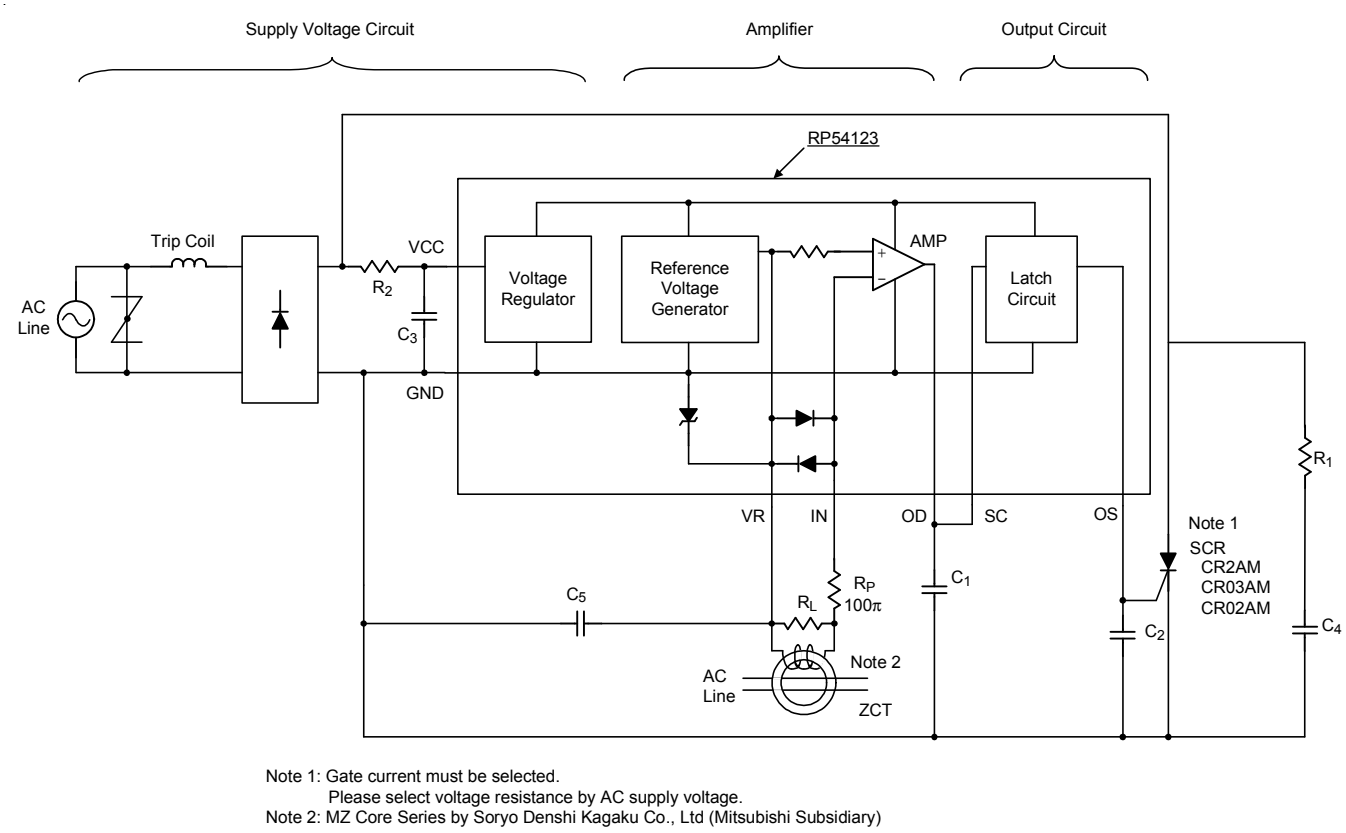
Output Current vs. OS Output Voltage



Trip Voltage vs. Temperature



Application Information



Note 1: Gate current must be selected.
Please select voltage resistance by AC supply voltage.
Note 2: MZ Core Series by Soryo Denshi Kagaku Co., Ltd (Mitsubishi Subsidiary)

Figure 1. High-Speed Leakage Circuit Breaker With RP54123

Supply voltage circuit is connected as a previous diagram. Please decide constants R_1, R_2, C_3 and C_4 of a filter in order to keep at least 12V in V_S, when normal supply current flows.

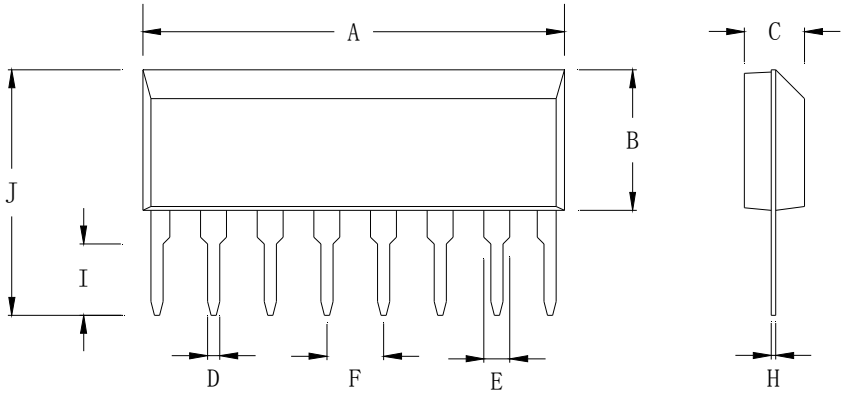
In this case, please connect C_3 (more than 1μF) and C_2 (less than 1μF). ZCT and load resistance R_L of ZCT are connected between input pin 1 and pin 2. In this case protective resistance (R_P = 100Ω) must be insurted. Sensitivity current is regulated by R_L, and output of amplifier shows in pin 4. External capacitor C_1 between pin 4 and GND is used for noise removal.

When large current is grounded in the primary side (AC line) of ZCT, the wave form in the secondary side of ZCT is distorted and some signals doesn't appear in the output od amplifier. So please connect a varistor or a diode (2 pcs.) to ZCT in parallel.

Latch circuit is used to inspect the output level of amplifier and to supply gate current on the external SCR. When input pin becomes more than 1.1V (Typ.), latch circuit operates and supply gate current in the gate of SCR connected to the output pin 7.

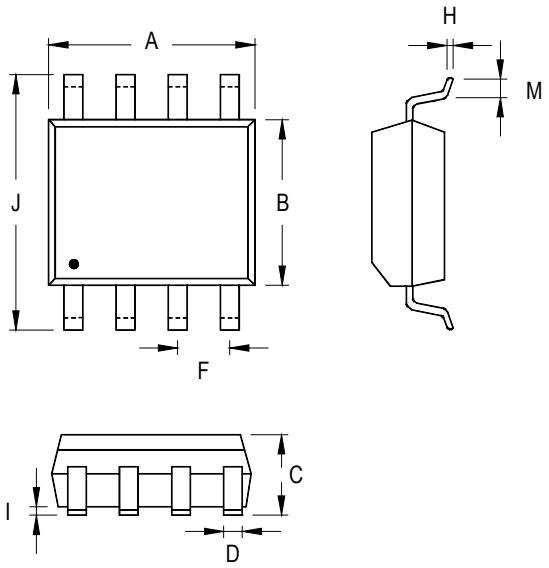
Capacitor C_5 between pin 1 and GND is used to remove noise and is about 0.047μF.

Outline Dimension



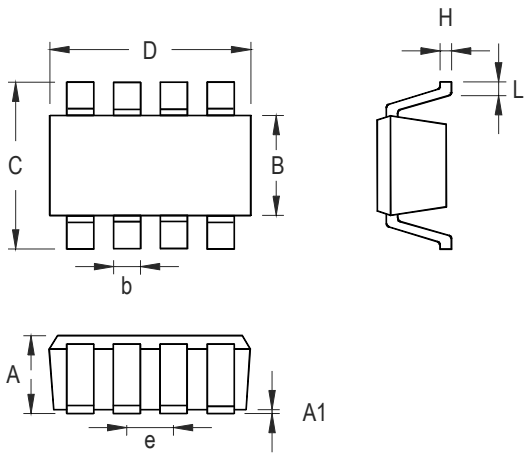
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	18.90	19.10	0.744	0.752
B	6.30	6.50	0.248	0.256
C	2.70	2.90	0.106	0.114
D	0.35	0.65	0.014	0.026
E	0.95	1.45	0.037	0.057
F	2.54		0.100	
H	0.20	0.35	0.008	0.014
I	3.20		0.126	
J	11.00	11.40	0.433	0.449

8-Lead SIP Plastic Package



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	4.801	5.004	0.189	0.197
B	3.810	3.988	0.150	0.157
C	1.346	1.753	0.053	0.069
D	0.330	0.508	0.013	0.020
F	1.194	1.346	0.047	0.053
H	0.170	0.254	0.007	0.010
I	0.050	0.254	0.002	0.010
J	5.791	6.200	0.228	0.244
M	0.400	1.270	0.016	0.050

8-Lead SOP Plastic Package



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.000	1.450	0.039	0.057
A1	0.000	0.150	0.000	0.006
B	1.500	1.700	0.059	0.067
b	0.220	0.500	0.009	0.020
C	2.600	3.000	0.102	0.118
D	2.800	3.000	0.110	0.118
e	0.585	0.715	0.023	0.028
H	0.100	0.220	0.004	0.009
L	0.300	0.600	0.012	0.024

SOT-23-8 Surface Mount Package

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