Ground Fault Circuit Interrupter
4.95mV，190uA

1 Description

The CN54124 is a precision, low-power, Ground Fault Circuit Interrupter (GFCI) controller used for detecting ground fault leakage paths in electrical circuits，witch can detect type A and type AC leakage currents. When the leakage current occurs on the L and N lines, the ZCT(zero current transformer) will detect the leakage current signal，the post-circuit converts the leakage current signal into a voltage signal and transmits it to the input terminal of the chip, when the peak value of the input voltage signal exceeds 4.95mV, the output pin of the chip generates a high level with a minimum duration of 20ms to drive the external SCR.

The CN54124 integrates functional modules such as regulated power supply, amplification circuit, comparison circuit, trip controller and trip drive circuit, and only needs current transformer and a small number of resistor capacitors externally.

2 Features

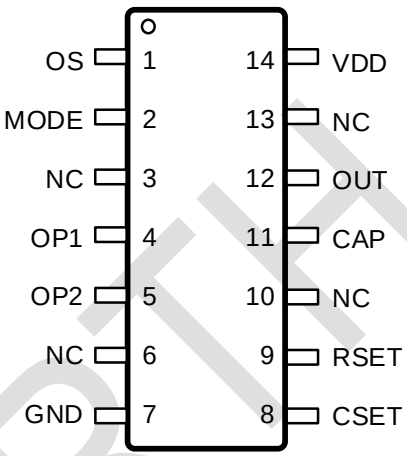
- Applied intype A and AC leakage detection
- High input sensitivity (4.95mV typical)
- Low quiescent current of 190uA
- Wide operating voltage range (3V~5.5V)
- Wide AC input voltage range: 50V~380V(50/60Hz)
- >20ms output pulse width can drive SCR
- Consistent leakage detection threshold
- Delay time can be adjusted
- Excellent EMC protection
- Wide operating temperature range (Ta=-40~+105°C)

3 Applications

- Ground Fault Circuit breakers
- Ground Fault Circuit relays

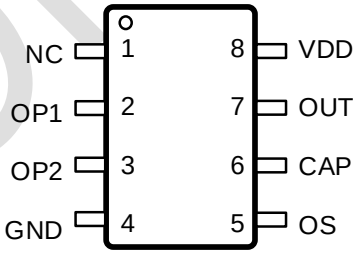
4 Pin Configuration

CN54124A



SOP14

CN54124B/C/D



SOP8L

5 Ordering Information

Part NO	Marking	Package	Qty/Tape
CN54124A	CN54124A YYWW	SOP14	3000/Tape
CN54124B	CN54124B YYWW	SOP8L	4000/Tape
CN54124C	CN54124C YYWW	SOP8L	4000/Tape
CN54124D	CN54124D YYWW	SOP8L	4000/Tape

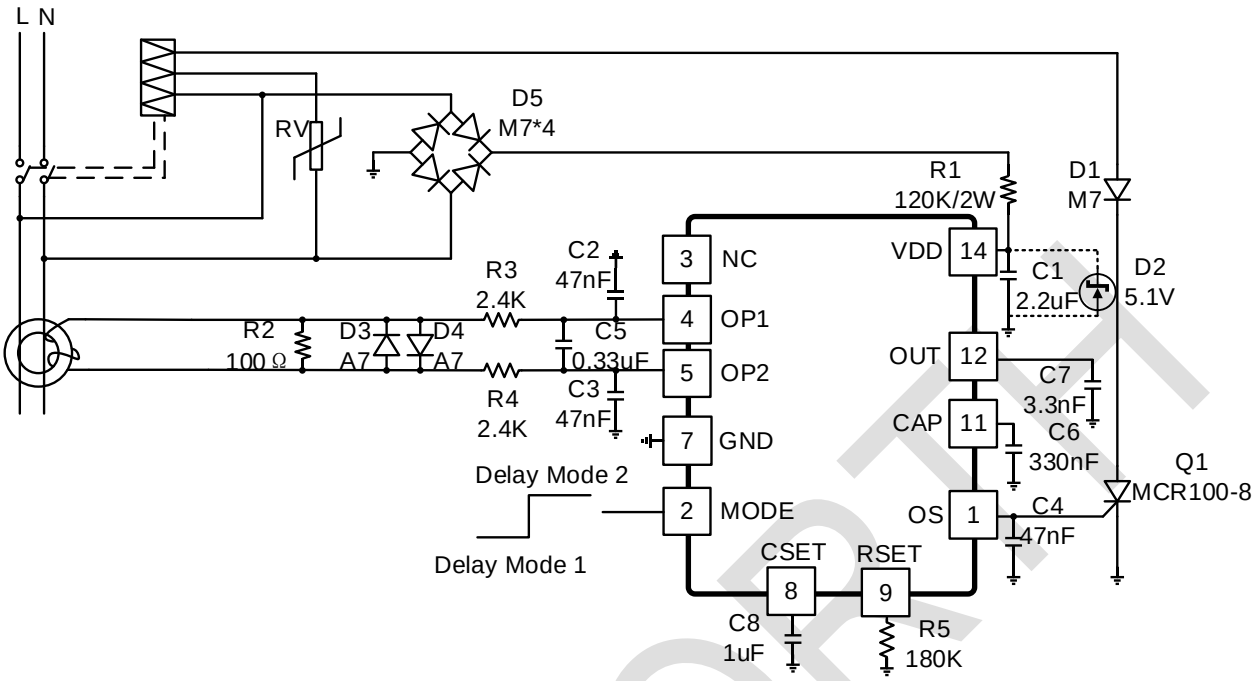
Note: YY=Year WW=Week.

Green (RoHS & HF): CHIPNORTH defines "Green" to mean Pb-Free (RoHS compatible) and free of halogen substances.

If you have additional comments or questions, please contact your CHIPNORTH representative directly.

Moisture sensitivity level(MSL):3

6 Typical Application



Note: MODE=GND for delay mode 1; MODE=4.5V for delay mode 2.

Figure6.1 CN54124A Typical Application

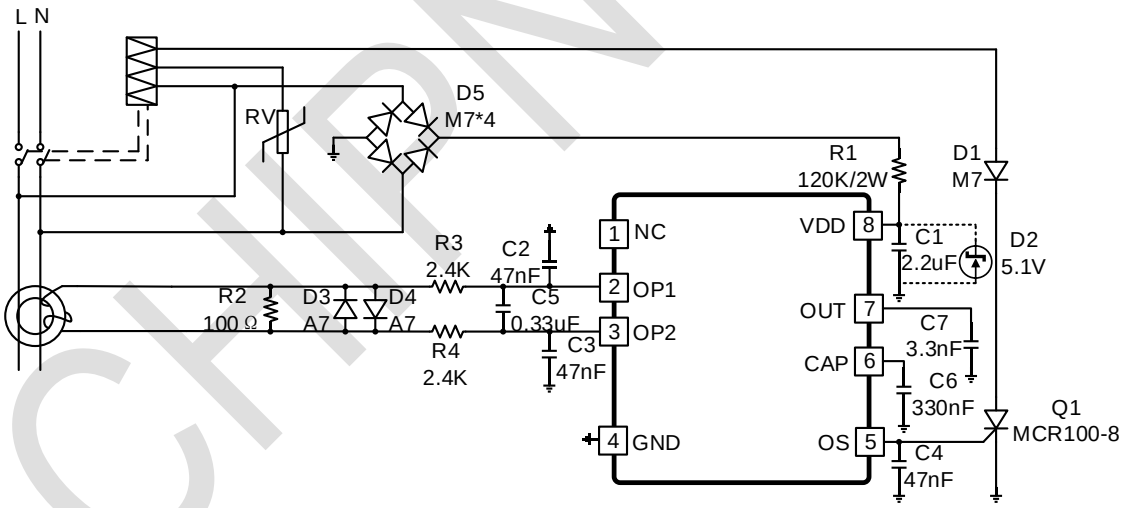


Figure6.2 CN54124B/C/D Typical Application

7 Block Diagram

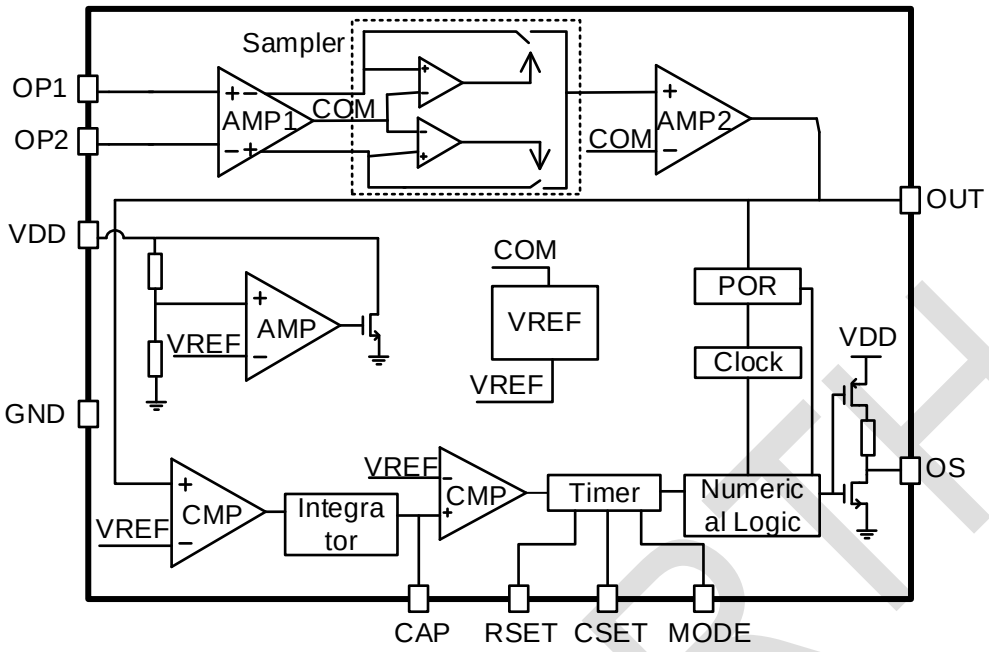


Figure 7.1 CN54124A Block Diagram

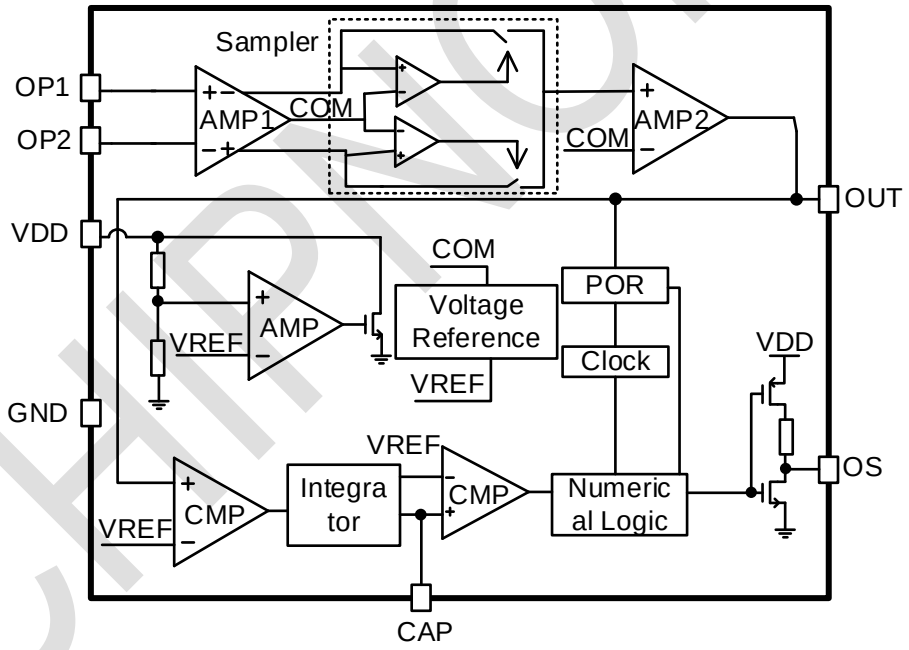


Figure 7.2 CN54124B Block Diagram

8 Pin Descriptions

Part NO		Pin Name	Descriptions
CN54124A	CN54124B/C/D		
3，6，10，13	1	NC	No Connect
4	2	OP1	Signal amplifier input 1
5	3	OP2	Signal amplifier input 2
7	4	GND	Ground
1	5	OS	Output control SCR
11	6	CAP	Delay setting, connect capacitor
12	7	OUT	Amplifier output, connect capacitor
14	8	VDD	Power Supply Input
9	N/A	RSET	Connect resistor, adjust delay time
8	N/A	CSET	Connect capacitor, adjust delay time
2	N/A	MODE	Input, select delay mode. MODE=GND for delay mode 1; MODE=4.5V for delay mode 2.

9 Specifications

9.1 Absolute Maximum Ratings

Parameter	Symbol	Value	Units
Operation Voltage	VDD	-0.4~+8	V
Other Pins	VIO	GND - 0.3, VDD + 0.3	V
Soldering temperature	T_{LEAD}	260（soldering,10s）	°C
Operating Ambient Temperature Range	T_A	-40~+105	°C
Storage Temperature Range	T_{STG}	-55~+150	°C

Note*: Stress exceeds these ratings listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Expose to absolute-maximum-rated conditions for extended periods may affect device reliability.

9.2 ESD Ratings

Discharge mode	Specification	Value	Units
HBM	ESDA/JEDEC JS-001-2017	±8000	V
CDM	ANSI/ESDA/JEDEC JS-002-2022	±2000	V

9.3 Recommended Operating Range

Parameter	Symbol	Min.	Max.	Units
Operation Voltage	VDD	3	5.5	V
Operating Ambient Temperature Range	T_A	-40	105	°C

9.4 Thermal Information

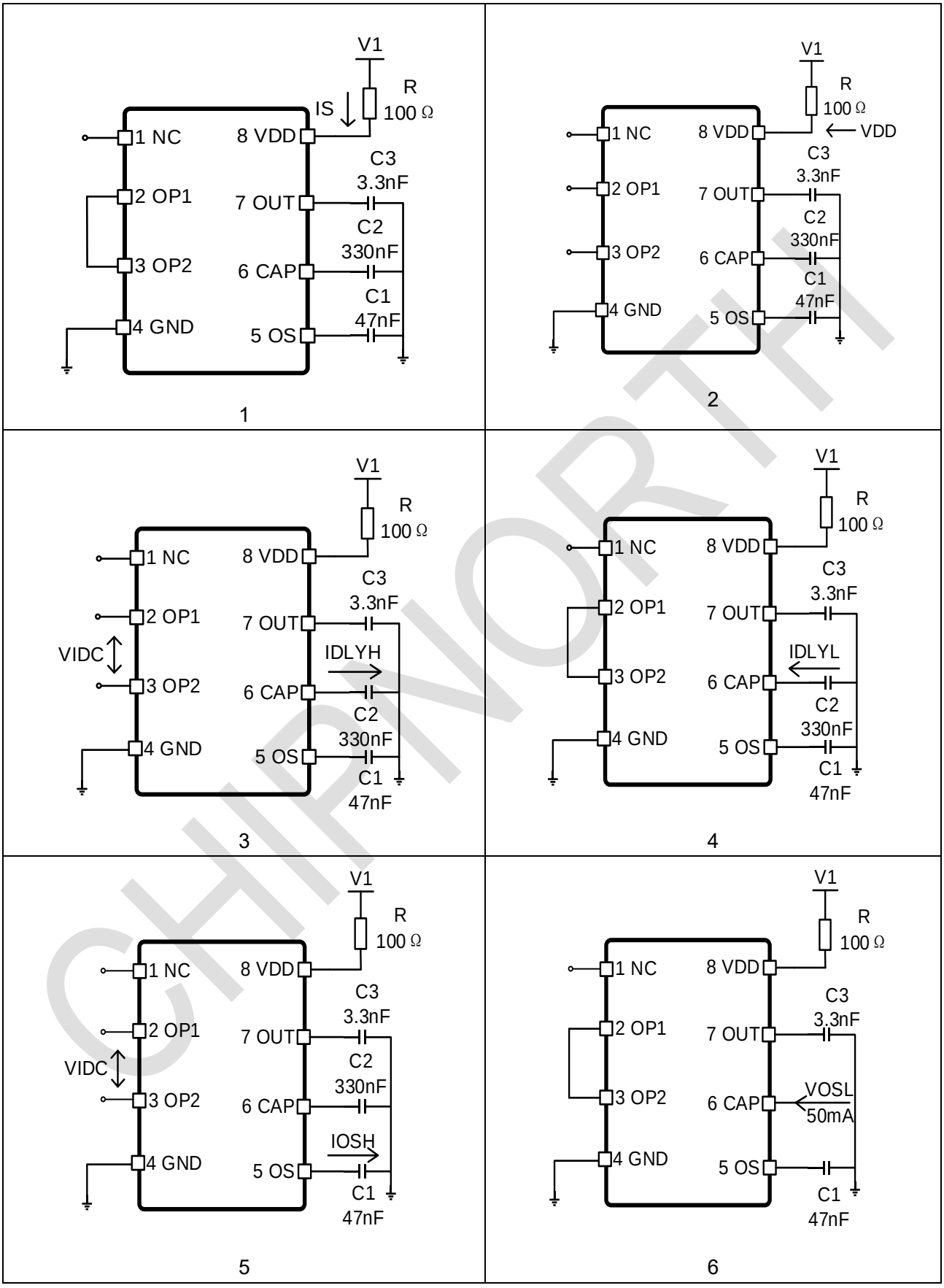
Parameter	Symbol	Value	Unit
Junction-to-ambient thermal resistance	$R\theta_{JA}$	100	°C/W

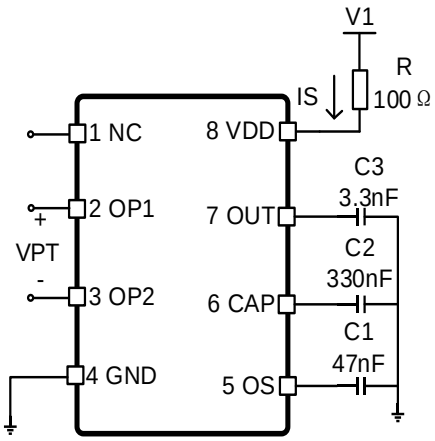
9.5 Electrical Characteristics

(V_{IN}=4.5V, T_A=25°C, unless otherwise specified.)

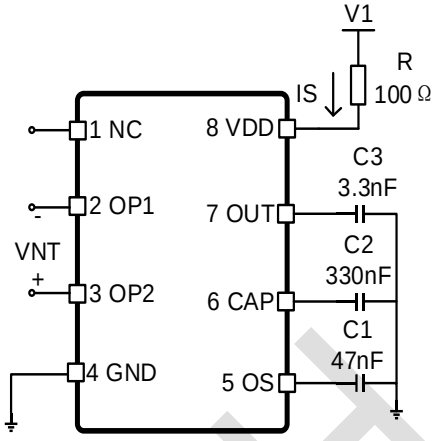
Parameter	Symbol	Conditions	Test circuit	Min	Typ	Max	Unit
Quiescent current	IQ	VCC=4.5V OP1 - OP2=0mV	1	100	190	280	uA
Operation Voltage	VDD	I_VCC=5mA	2	4.6	4.8	5	V
CAP outputs high current	I_CAPH	OP1 - OP2=30mV	3	50	65	80	uA
CAP outputs low current	I_CAPL	OP1 - OP2=0mV	4	1.5	2	2.5	uA
OS outputs high current	I_OSH	OP1 - OP2=30mV, CN54124A	5	1	1.7	3	mA
		OP1 - OP2=30mV, CN54124B		0.18	0.23	0.28	mA
		OP1 - OP2=30mV, CN54124C		1	1.7	3	mA
		OP1 - OP2=30mV, CN54124D		0.18	0.23	0.28	mA
OS outputs low voltage	V_OSL	OP1 - OP2=0mV, IOSL=10mA	6		0.05	0.112	V
Positive operating voltage	V_PT	OP1 - OP2	7	4.65	4.95	5.35	mV
Negative operating voltage	V_NT	OP2 - OP1	8	4.65	4.95	5.35	mV
Latch time	TON	CN54124A	9	20			mS
		CN54124B		20			mS
		CN54124C		20	32	45	mS
		CN54124D		20	32	45	mS

9.6 Test Circuit

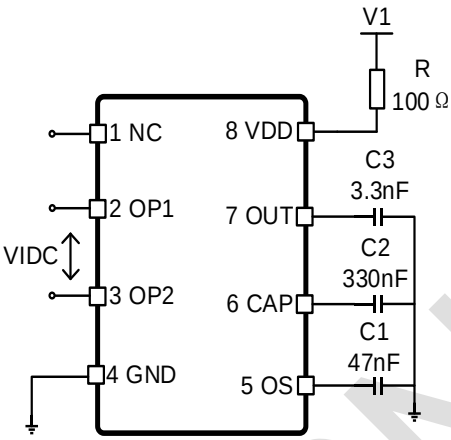




7



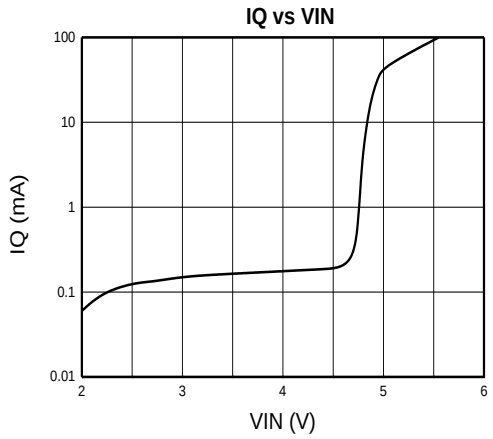
8

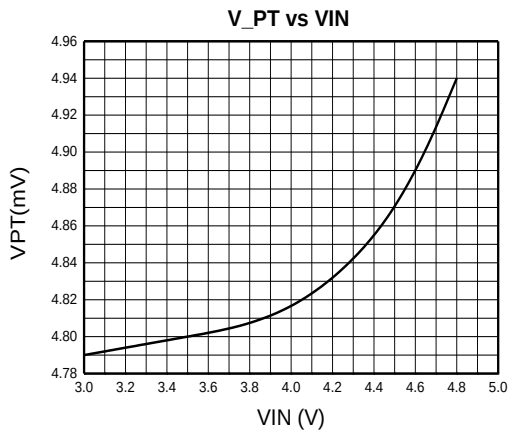


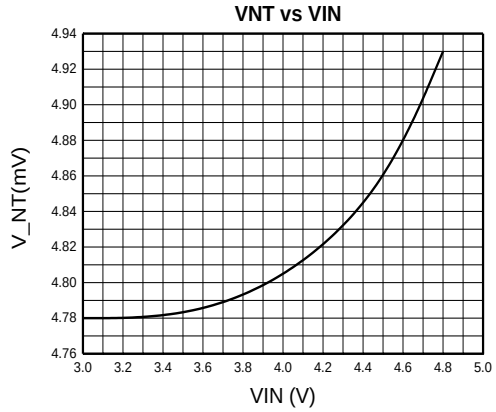
9

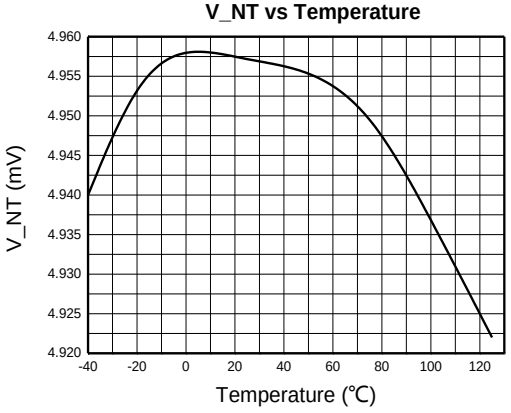
9.7 Characteristics Curve

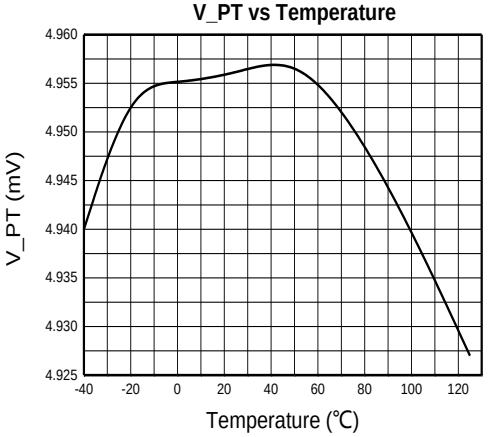
(V_{IN}=4.5V, T_A=25°C, unless otherwise specified.)

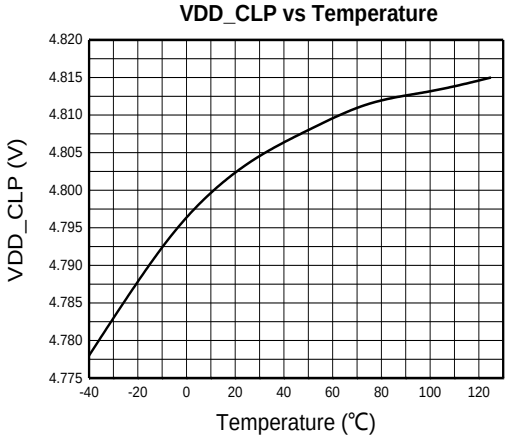




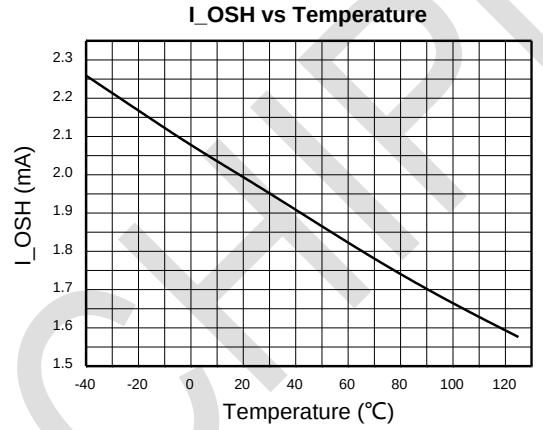




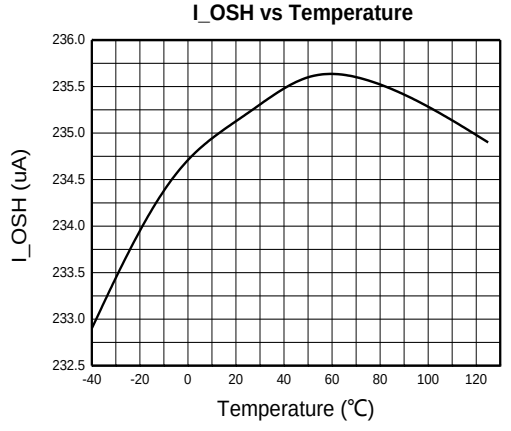




CN54124A



CN54124B



10 Detailed Description

The CN54124 is used to detect the leakage on the live and neutral lines. When a leakage signal is generated, the ZCT detects the leakage signal and the secondary coil outputs an inductive signal as the input of the main chip for the Earth leakage circuit breaker. The chip can detect the residual current of type A and type AC. When the RMS value of the leakage current is greater than the rated current (RMS) specified by the Earth leakage circuit breaker, the OS generates an action level with a minimum pulse width of 20ms, which drives the SCR to turn on.

10.1 CN54124A Delay Function

When there is a leakage signal and the CAP pin is high, the regulator charges the capacitor outside the CSET pin. The resistor at the RSET terminal (typical value R5 = 180k) R5 provides the reference current I_{REF} for charging the C8 capacitor on the CSET pin, and in order to ensure the accuracy of the I_{REF} current and the corresponding delay time, it is recommended to use a high-precision resistor (±2%).

MODE=0, Delay Mode 1: CSET charging current is 0.6*VOUT/R5. Delay time correlates with leakage current magnitude—higher leakage results in shorter delay.

MODE=VDD, Delay Mode 2: CSET charging current is 0.6*VREF/R5. Fixed delay time is set.

The I_{REF} of MODE=VDD can be calculated by the following formula:

$$I_{REF} = \frac{V_{REF}}{R_5} \times 0.6$$

When the CSET voltage is greater than 1.2V, the OS becomes high and the trip is triggered.The T_{delay} of MODE=VDD can be calculated by the following formula:

$$T_{delay} = \frac{C_8 \times R_5}{0.6}$$

- C_8 is the capacitor connected to the CSET pin,
- R_5 is the off-chip high-precision resistor connected to the RSET pin

For example, C_8 = 1uF and R_5 = 180K, then T_{delay} = 300ms.

C_8=1uF，R_5=1.2M, then T_{delay}=2s.

To ensure that the OS can turn off the driver in a timely manner after the leakage is eliminated, the OUT signal will be detected upon expiration of the latch time (typical 32 ms). If the OUT pin is at a low level, the OS driver will be turned off.

10.2 Control Timing

The figure below is an operation diagram of the CN54124B, detecting the leakage signal between OP1 and OP2, when the peak value of the input voltage signal exceeds 4.95mV, the output pin OS generates an action level, and the level pulse width is 20ms minimum, driving the external SCR to turn on.

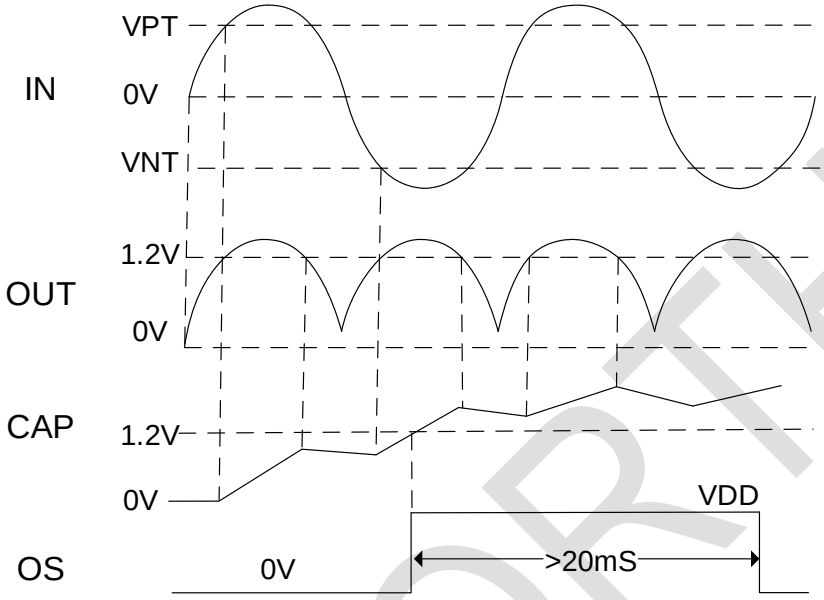


Figure 5 AC Type Leakage

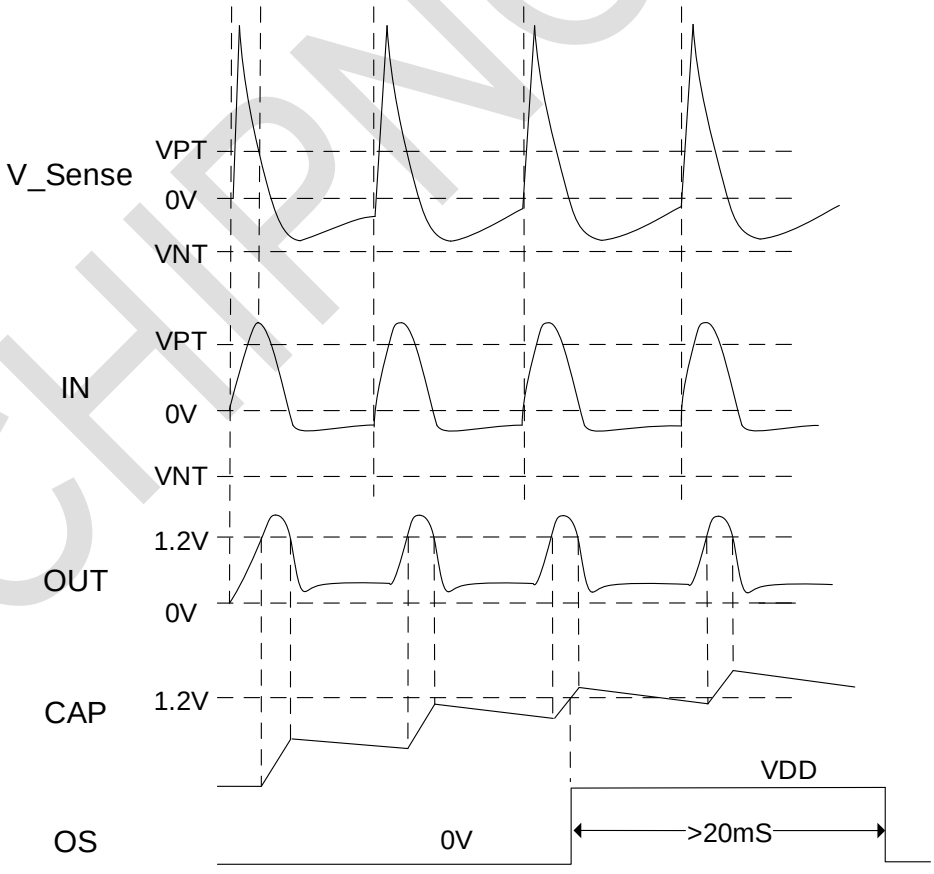


Figure 6 A+90° Type Leakage

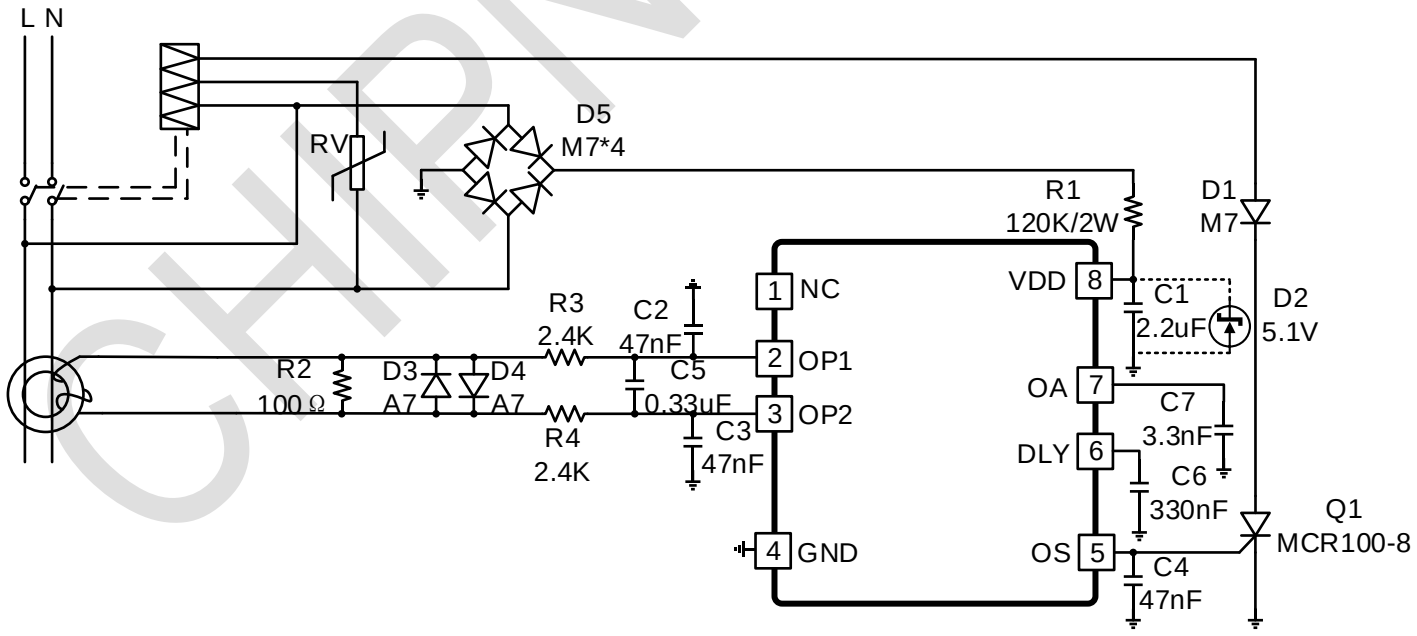
11 Application Information

11.1 CN54124 Selection Table

Part NO	I_OS	OS output	Applicable scenarios
CN54124A	1.7mA	When the leakage current occurs on the L and N lines,the OS outputs pulses until the leakage is removed.	AC input voltage range: 50V~380V(50/60Hz), full-bridge rectification , A type and AC type leakage
CN54124B	0.2mA	When the leakage current occurs on the L and N lines,the OS outputs high until the leakage is removed.	AC input voltage range: 50V~380V(50/60Hz), half-bridge and full-bridge rectification , A type and AC type leakage
CN54124C	1.7mA	When the leakage current occurs on the L and N lines,the OS outputs a single pulse of at least 20ms.	AC input voltage range: 50V~380V(50/60Hz), full-bridge rectification , A type and AC type leakage
CN54124D	0.2mA	When the leakage current occurs on the L and N lines,the OS outputs only a single pulse of at least 20ms.	AC input voltage range: 50V~380V(50/60Hz), half-bridge and full-bridge rectification , A type and AC type leakage

11.2 Typical Application

The figure below shows a schematic diagram of CN54124B typical application circuit that can be used to evaluate its performance.



In the above application circuit diagram, T0 is the ZCT used to induce the leakage current on the power supply line, R2 is the leakage protection action sensitivity adjustment resistance, the value of the resistance is related to the leakage current required to act and the turn ratio of the ZCT,the action sensitivity inside the CN54124B is 4.95mV, then ideally

$$R_2 = \frac{4.95mV \times n \times k}{\sqrt{2} \times I_{\Delta n}}$$

- $I_{\Delta n}$ is the set threshold current for leakage action
- n is the number of turns of the zero-sequence current transformer T0
- k is the inductance coefficient of the current transformer

R1, C1 and the clamping circuit inside the CN54124B form the power supply circuit, the value of R1 needs to consider the power requirements under the condition of maximum working voltage and the minimum working voltage requirements. Under the condition that the minimum operating voltage is 50 V AC, the maximum clamping current of VDD is 50 mA, considering the heat generation,120kΩ/2W is recommended for R1 and 2.2uF/50V for C1.

C2 and C3 are common-mode filter capacitors, it is recommended that C2 and C3 use 47nF capacitors.

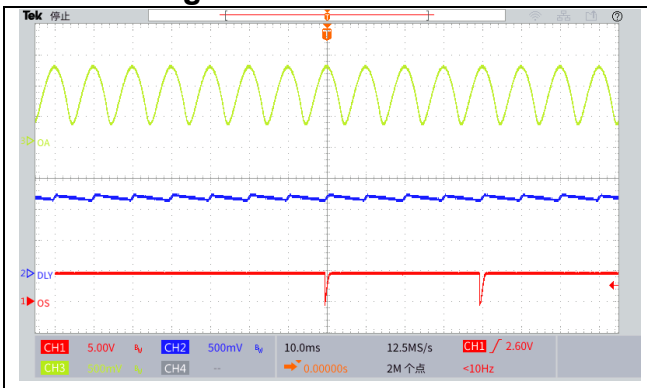
R3 and R4 are current-limiting resistors, and theoretically R3 and R4 are larger to protect the IC, but because the CN54124B uses a voltage amplifier internally, its impedance is limited, so it is recommended that the values of R3 and R4 should not exceed 2.4kΩ. At the same time, R3, R4 and C5 form a low-pass filter circuit, and R3*C5 is the frequency retort point (the retort frequency is 1kHz). It is recommended that the value of C5 should not be greater than 330 nF.

C4 filters the high-frequency interference noise that may occur in the circuit breaker, and avoids the false triggering of the SCR Q1 during the power-on process of the circuit breaker.

C6 is the CN54124B delay adjustment capacitor, when the absolute value voltage of the difference between OP1 and OP2 at the input end of the CN54124B is greater than 4.95mV, the output current of the CAP pin of the CN54124B charges C6, and when the voltage of C6 rises to 1.23V, the output of the OS pin of the CN54124B drives the pull-up driving current of the SCR, which is 230uA.

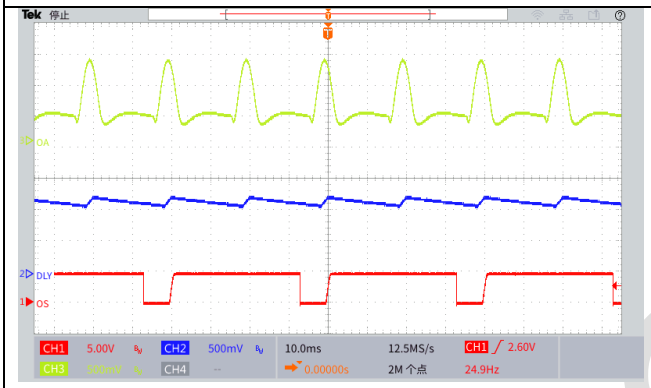
In normal operation, the clamping circuit inside the chip can ensure that the power supply voltage of the chip is below 5V, so as to ensure the normal operation of the chip. However, when a high voltage is directly applied to the power supply pin of the chip when the chip is not working normally (for example, the voltage on the live capacitor C1 is directly applied to the power pin of the chip during the placement process), the chip is at risk of being damaged by the high voltage because the internal clamping circuit has not been started normally. The function of the Zener Diode D2 is to avoid damage to the chip caused by the live capacitor during the production process, and if the selected capacitor C1 has released the residual charge before leaving the factory or before the SMT, the Zener Diode D2 can be omitted.

11.3 Working waveform



AC

A+0°



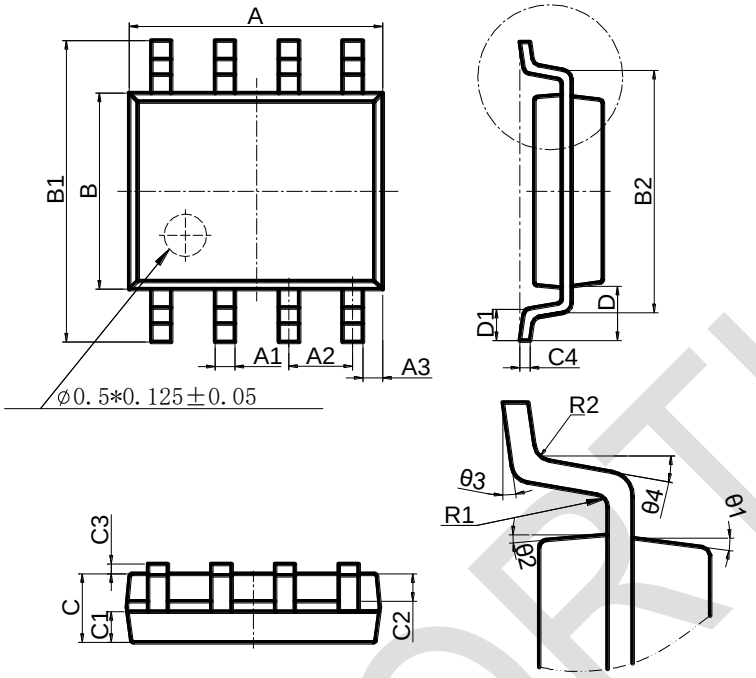
A+90°

A+135°

A+6mA

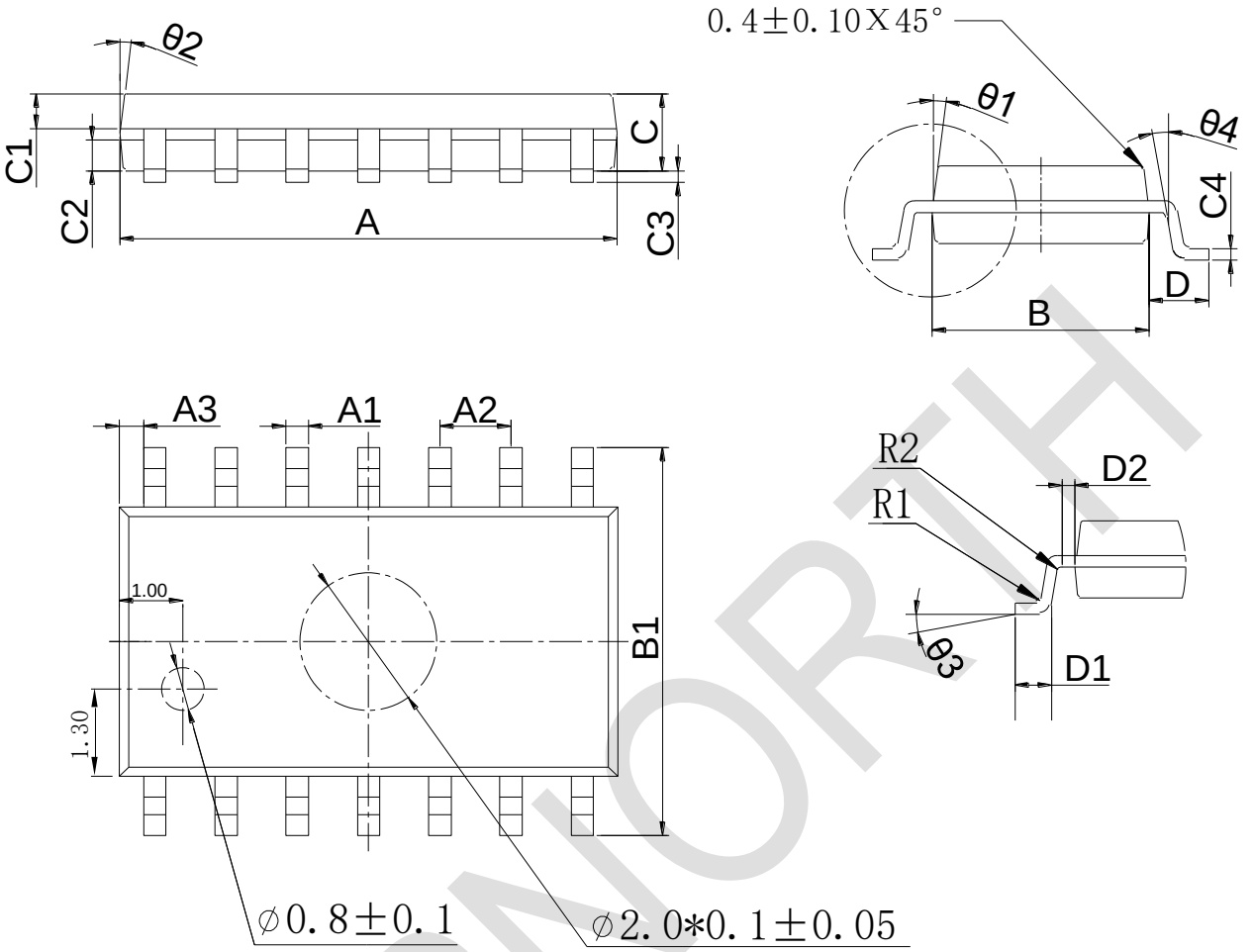
12 Package Information

SOP8L



Symbol	MILLIMETER		Symbol	MILLIMETER	
	MIN	MAX		MIN	MAX
A	4.80	5.00	C3	0.05	0.20
A1	0.356	0.456	C4	0.203	0.233
A2	1.27TYP		D	1.05TYP	
A3	0.345TYP		D1	0.40	0.80
B	3.80	4.00	R1	0.20TYP	
B1	5.80	6.20	R2	0.20TYP	
B2	5.00TYP		θ1	17°TYP4	
C	1.30	θ2	θ2	13°TYP4	
C1	0.55	0.65	θ3	0°~8°	
C2	0.55	0.65	θ4	4°~12°	

SOP14



Symbol	MILLIMETER		Symbol	MILLIMETER	
	MIN	MAX		MIN	MAX
A	8.55	8.75	C4	0.193	0.213
A1	0.356	0.456	D	0.95	1.15
A2	1.27TYP		D1	0.40	0.70
A3	0.312TYP		D2	0.20TYP	
B	3.80	4.00	R1	0.20TYP	
B1	5.80	6.20	R2	0.20TYP	
C	1.40	1.60	θ1	8°~12°TYP4	
C1	0.60	0.70	θ2	8°~12°TYP4	
C2	0.55	0.65	θ3	0°~8°	
C3	0.05	0.25	θ4	4°~12°	

13 Important Statement

Chipnorth Electronic Technology (Nanjing) Co., Ltd. and its subsidiaries reserve the right to make modifications, improvements, corrections, or other changes to this document and to any of the products described herein at any time without notice. Chipnorth Electronic Technology (Nanjing) Co., Ltd. disclaims any liability arising out of the use of this document or any of the products described herein; Chipnorth Electronic Technology (Nanjing) Co., Ltd. does not transfer any license to its patents or trademarks or other rights. Any customer or user using this document or any of the products described herein assumes all risk and agrees to hold harmless Chipnorth Electronic Technology (Nanjing) Co., Ltd. and all companies whose products are displayed on Chipnorth Electronic Technology (Nanjing) Co., Ltd.

Chipnorth Electronic Technology (Nanjing) Co., Ltd. makes no warranty and assumes no responsibility for any products purchased through unauthorized sales channels. In the event that a customer purchases or uses a product from Chipnorth Electronic Technology (Nanjing) Co., Ltd. for any unintended or unauthorized use, the customer shall indemnify and hold harmless Chipnorth Electronic Technology (Nanjing) Co., Ltd. and its representatives from and against all claims, damages, and attorney's fees arising from any personal injury or death, directly or indirectly, arising out of or in connection with such purchase or use.