X-capacitor Automatic Discharge Controller IC

1. Feature

Designed for 0 power consumption X capacitor discharge circuit *

Built-in bidirectional current automatic exhaust passage

The application system supports 0.1~6.8uF X capacitor

High isolation structure design, pin redundancy

Self-safe isolation distance exceeds 4mm

Self-powered design, no external equipment dependencies required

No need for high common mode capability without additional ground connection

Internal integrated switch withstand voltage up to 950V

The circuit can be directly connected in parallel with the X capacitors on both sides.

Can be safely applied before or after the fuse

Meet global X capacitor discharge safety requirements

The ideal choice for energy efficient systems

Power consumption is less than 5mW for all applicable X capacitors

TUV and CB IEC62368 certified and certified

2. Application

Switching power supply

Household appliances

Various systems with X capacitors

3. Description

The LN9901 is an automatic discharge controller IC specifically designed for X-capacitor systems. The chip has a highly reliable AC power calibration system that automatically discharges the X capacitor after the system is powered down, making it a safety requirement. The voltage is discharged below the allowable voltage, and automatically remains off during normal operation, and the power consumption is maintained at no more than 5mW to realize a zero-power X-capacitor system.

The built-in high-voltage switch supports up to 6.8uF X-capacitor discharge operation. In use, it is only necessary to use the corresponding resistors in series on both sides of the chip, so that a larger X capacitor can be used in a general system to reduce the use. Large inductance reduces system cost.

The redundant pin design keeps the system effective when either pin is open, ensuring robust safety.

A safe isolation distance of up to 4mm does not limit the safety features of the system design and meets various altitude requirements.

Halogen-free SOP8 green packaging is available.

** : IEC 62301 clause 4.5 defines standby power below 5 mW as zero power.*

4. Internal functional block diagram

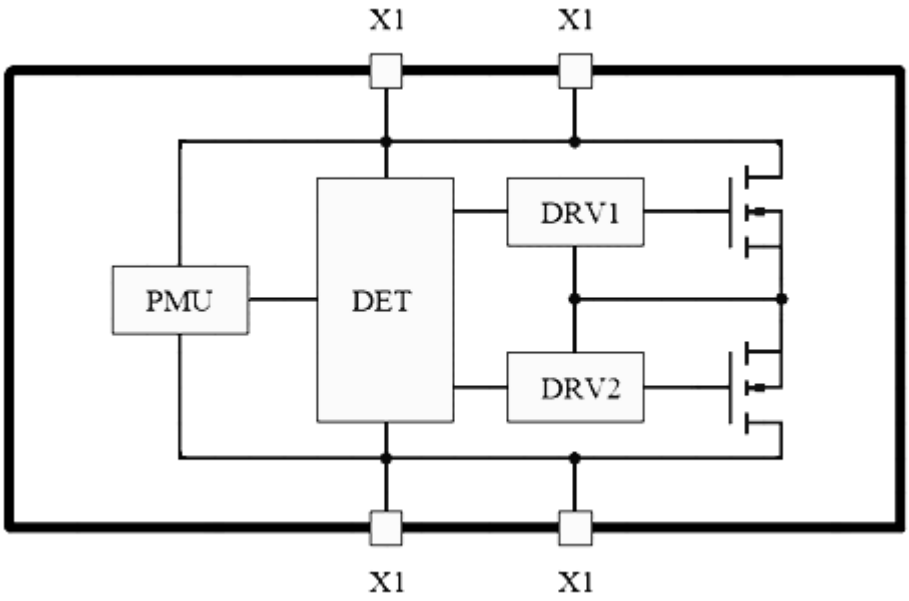

Fig1. Internal functional block diagram

5. Pin definition

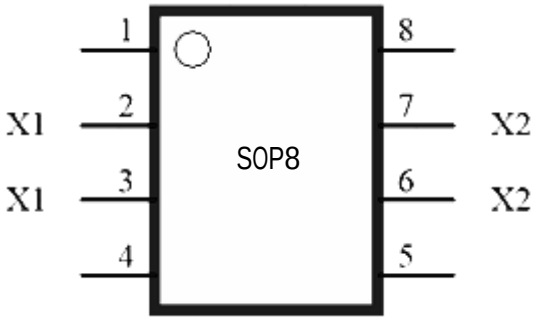

Fig2. Pin definition

6. Pin function description

Pin No.	Pin Name	Pin Function Description
2/3	X1	Discharge switch pin 1，Non-directional with 6/7，but according to safety regulations, 2/3 must be connected at the same time
6/7	X2	Discharge switch pin 2，，Non-directional with 2/3，but according to safety regulations, 6/7 must be connected at the same time
1/4/5/8	NC	Empty foot, no connection internal, 1/4 can be connected with 2/3, 5/8 can be connected with 6/7

7. Typical connection diagram

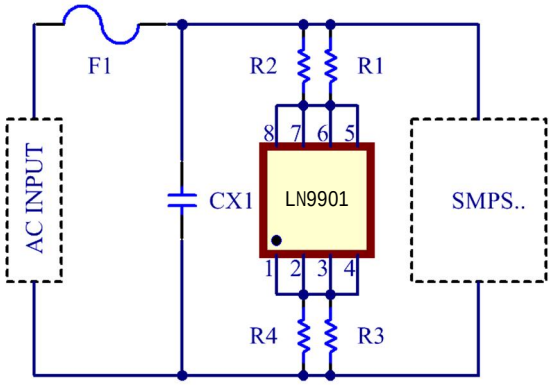

Fig3. Typical connection diagram

Note: For X capacitors from 0.1uF to 6.8uF, the recommended total resistance of R1~R4 is 6.8MΩ~120KΩ, so that the discharge time constant is less than 1s*.

Warning

Must strictly observe the following two points when using：

1) When installing this component, all requirements of the mentioned standard must be fulfilled；

2) It is built-in component and suitable enclosure should be provided in end system.

Note*：

1. Article 4.5 of IEC 62301 specifies that the standby power is less than 5 mW is zero power consumption.

2. General requirement. The RC time constant needs to be less than 1 second.

8. Maximum parameter *

Parameter	Rating	Unit
Pin input voltage	+950V ~ -950V**	V
Pin maximum current	5	mA
Min/Max Operation Junction Temperature T_J	-40 to +150	℃
Min/Max Operating Ambient Temperature Ta	-10 to +105	℃
Min/Max Storage Temperature Tstg	-55 to +150	℃
PD allows average power dissipation	600***	mW

Note*: Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute maximum-rated conditions for ex tended periods may affect device reliability.** : with 1mA limit. *** : with SOP8 package soldering to an area of 100mm^2 on a 2oz copper for use 6.8uF Xcap at AC=300V.

9. Recommended operating conditions

Symbol	parameter	Min.	Typ.	Max.	unit
VAC	AC input voltage	50	-	300	Vac
C	X capacitor	0.1	-	6.8	uF
R	Series resistance	0.12	-	6.8	Meg.Ω
TA	Operating Ambient Temperature	-10		105	℃

10. Electrical Characteristics (Ta = 25℃, if not otherwise noted)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	unit
BV_{DSS}	Switch breakdown voltage	I |X1-X2|=2mA	950	1000		V
I_Q	Quiescent Current	AC=240V,50Hz,C_{EXT}=OPEN			20	uA
I_{SAT}	Switching saturation current	X1-X2=100V,R1+R2=10K	2.5	3.5		mA
t_{DET}	Power failure detection time	AC=100~240V,47~63Hz		45	55	ms

Thermal Data

Symbol	Description	Parameter	Unit
θJA1	Semiconductor junction to ambient thermal resistance	160	℃/W
θJC2	Semiconductor junction to package thermal resistance	40	℃/W

Notes: 1. All pins are soldered on a 200mm^2 area, 2OZ thick copper foil; 2, measured on the surface of the package near the center.

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12. Application and Information

12.1 R1~R4 series resistance selection

The IC will maintain an approximate open state of very small quiescent current when the system is powered on. When the system is powered down, it will turn into an approximate short-circuit state. Therefore, the X capacitor bleeder time is determined by the external series resistance, just according to the external The size of the X capacitor capacity can be reasonably selected in series with the corresponding R1~R4 resistors on both sides of the chip. The total resistance of the series resistor should meet the requirements of the safety regulations for the discharge time constant less than 1 s. The typical common series resistance can be referred to. The following table:

X Capacitor	R1~R4 Total Resistance
0.1uF	6.8MΩ (6.8MΩ//6.8MΩ+6.8MΩ//6.8MΩ)
0.22uF	4MΩ
0.33uF	2.4MΩ
0.47uF	1.82MΩ
0.68uF	1.22MΩ
0.82uF	1.02MΩ
1uF	980KΩ
2.2uF	400KΩ
3.3uF	240KΩ
4.7uF	182KΩ
5.6uF	150KΩ
6.8uF	120KΩ (120KΩ//120KΩ+120KΩ//120KΩ)

In addition, the power consumption of the resistor should also be considered to affect the type of resistor. In particular, when a short-circuit fault occurs across the IC, ensure that the resistor does not overheat. If necessary, use more resistors in series to reduce its power loss; for example, In 60KΩ+60KΩ applications, the resistor will consume approximately 220mW+220mW at 230Vac input.

12.2 Varistor selection

When the system requires lightning protection level higher than 1.5KV, the necessary varistor (MOV) device should be used at the input end. The varistor specification should be reasonably selected according to the lightning strike level. When the IC is placed at the input front end, the varistor should be Parallel in front of the IC.

12.3 External bypass shunt capacitor

In the final lightning test verification, it should also ensure that the voltage spikes on both sides of the IC do not exceed the allowable voltage withstand capability, and reserve a margin of not less than 50V. When the margin is less than 50V, it should be paralleled between the pins at both ends of the IC. A capacitor of no more than 47 PF, such as 33 PF / 1 KV. See Figure C1 below:

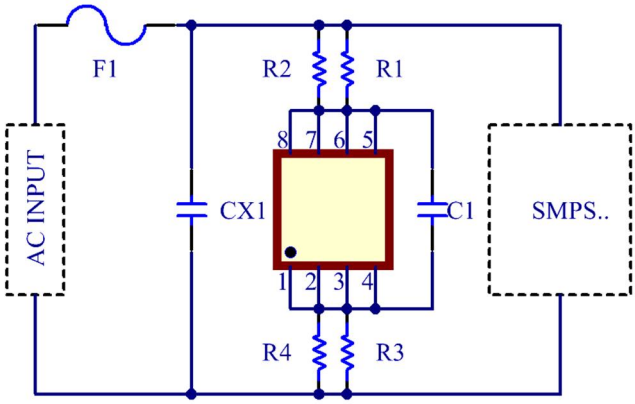


Fig4. External bypass capacitor setting

13. Typical Layout Reference

The PCB should be properly arranged so that the system meets the safety requirements and avoids accidental discharge due to too close distances on both sides of the IC. The reference layout is shown below:

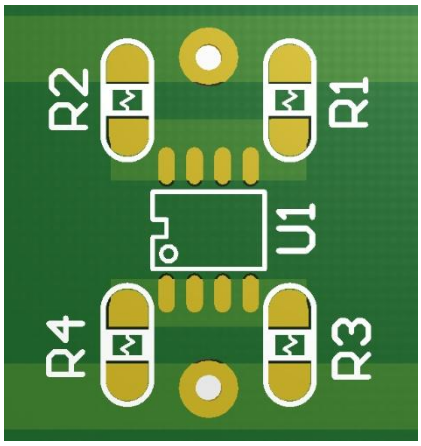
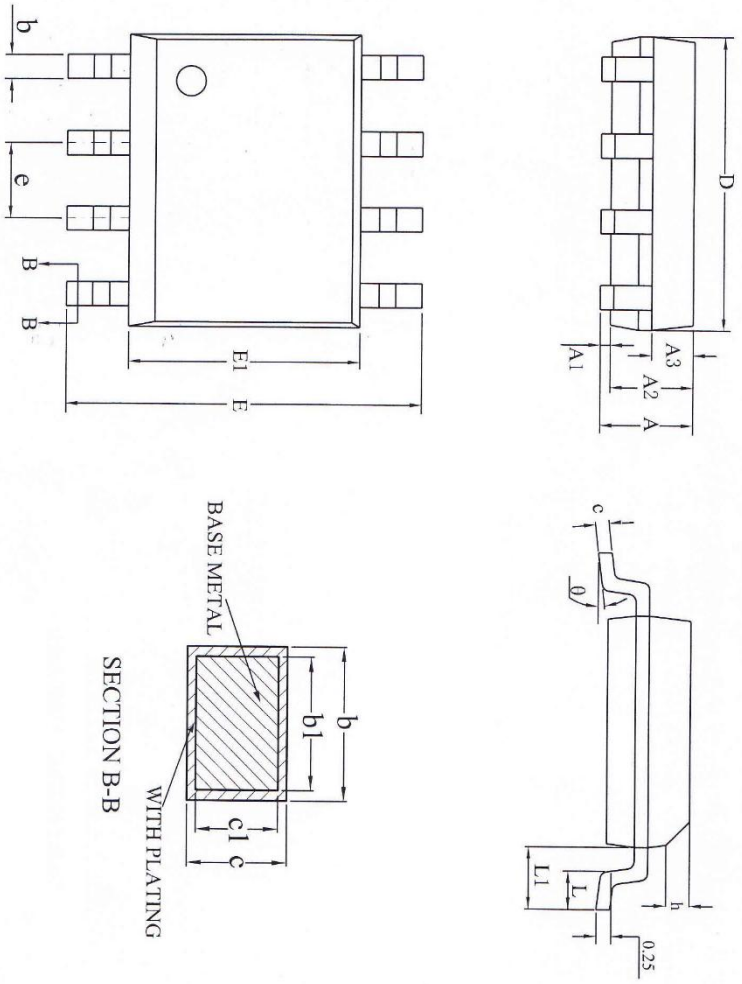


Fig5. Reference PCB layout

14. Package information

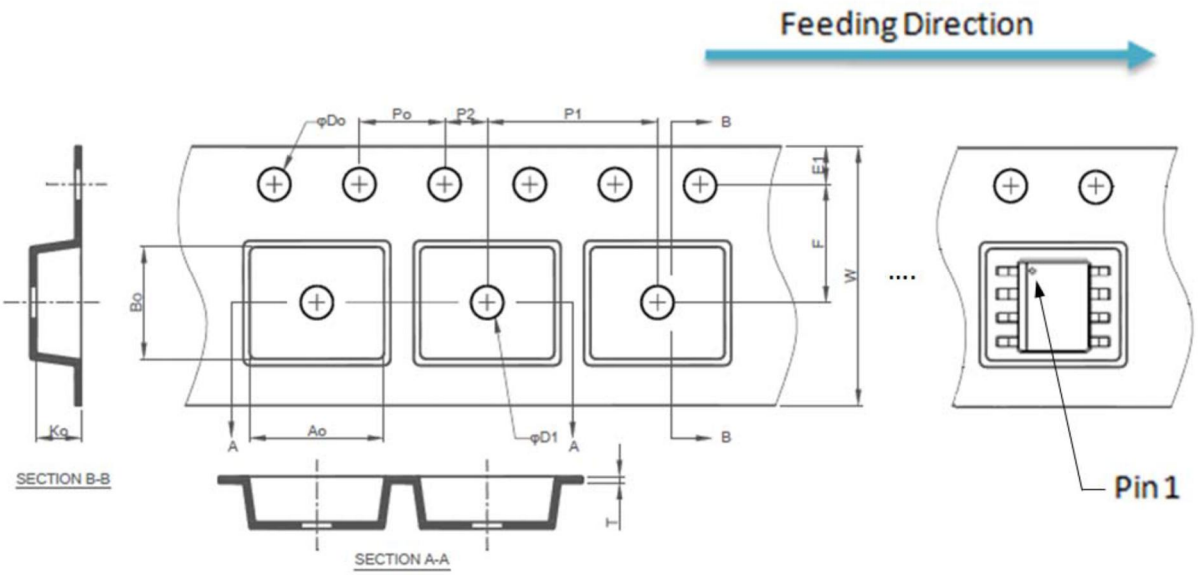
SOP8



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.75
A1	0.10	—	0.225
A2	1.30	1.40	1.50
A3	0.60	0.65	0.70
b	0.39	—	0.47
b1	0.38	0.41	0.44
c	0.20	—	0.24
c1	0.19	0.20	0.21
D	4.80	4.90	5.00
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27BSC		
h	0.25	—	0.50
L	0.50	—	0.80
L1	1.05REF		
θ	0	—	8°

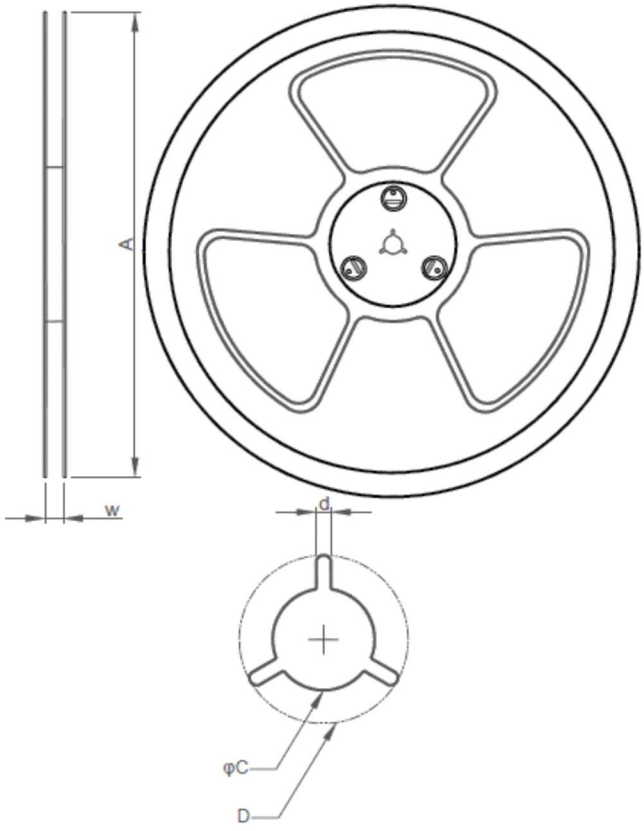
Fig6. Package information

Tape/Reel



Note: 1. Refer to EIA-481-B
2. 10 sprocket hole pitch cumulative tolerance ± 0.2
3. Material: conductive polystyrene
4. Ao and Bo measured on a plane 0.3mm above the bottom of the pocket
5. Ko measured from a plane on the inside bottom of the pocket to the top surface of the carrier

SYMBOL	Ao	Bo	Ko	T	Do	D1
SPEC.	6.90± 0.20	5.40± 0.20	2.10± 0.20	0.30± 0.05	1.50 $^{+0.10}_{-0.00}$	1.50 min.
SYMBOL	Po	P1	P2	E1	F	W
SPEC.	4.00± 0.10	8.00± 0.10	2.00± 0.05	1.75± 0.10	5.50± 0.05	12.00± 0.30



Package Type	A	W	C	d	D
TO-252-3L	330± 2	16.4 $^{+2.0}_{-0.0}$	13.0 $^{+0.5}_{-0.2}$	1.5 MIN.	20.2 MIN.
SOP-8 SOT-223	330± 2	12.4 $^{+2.0}_{-0.0}$	13.0 $^{+0.5}_{-0.2}$	1.5 MIN.	20.2 MIN.
SOT-89-3L	178± 2	12.4 $^{+2.0}_{-0.0}$	13.0 $^{+0.5}_{-0.2}$	1.5 MIN.	20.2 MIN.

Note: Refer to EIA-481-B

Fig7. Tape packaging diagram

15. Ordering Information

Part Number	Marking	Package	Packaging
LN9901-R	LN9901	SOP8	4000PCS/Reel
LN9901-T	LN9901	SOP8	100PCS/Tube

16. Important Notice

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