

ESD NOISE CLIPPING DIODE

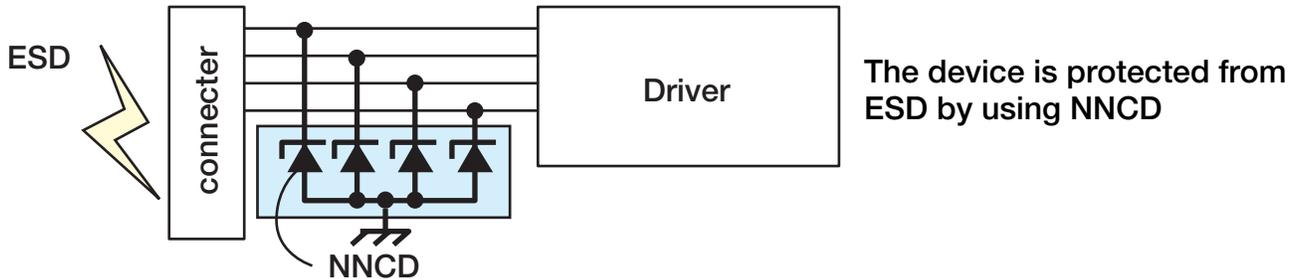


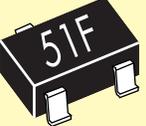
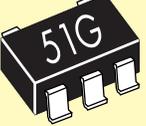
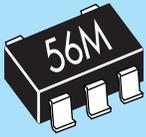
February 2001

NEC Noise Clipping Diode NNCD

Suitable device can be selected in three types of NNCD series.

Low capacitance NNCD (8kV/10pF) and Low capacitance High ESD NNCD (30kV/20pF) are the suitable ESD protection device for high speed data line such as USB 1.1. High ESD NNCD (30kV) is the suitable device to protect ESD in normal speed data line.

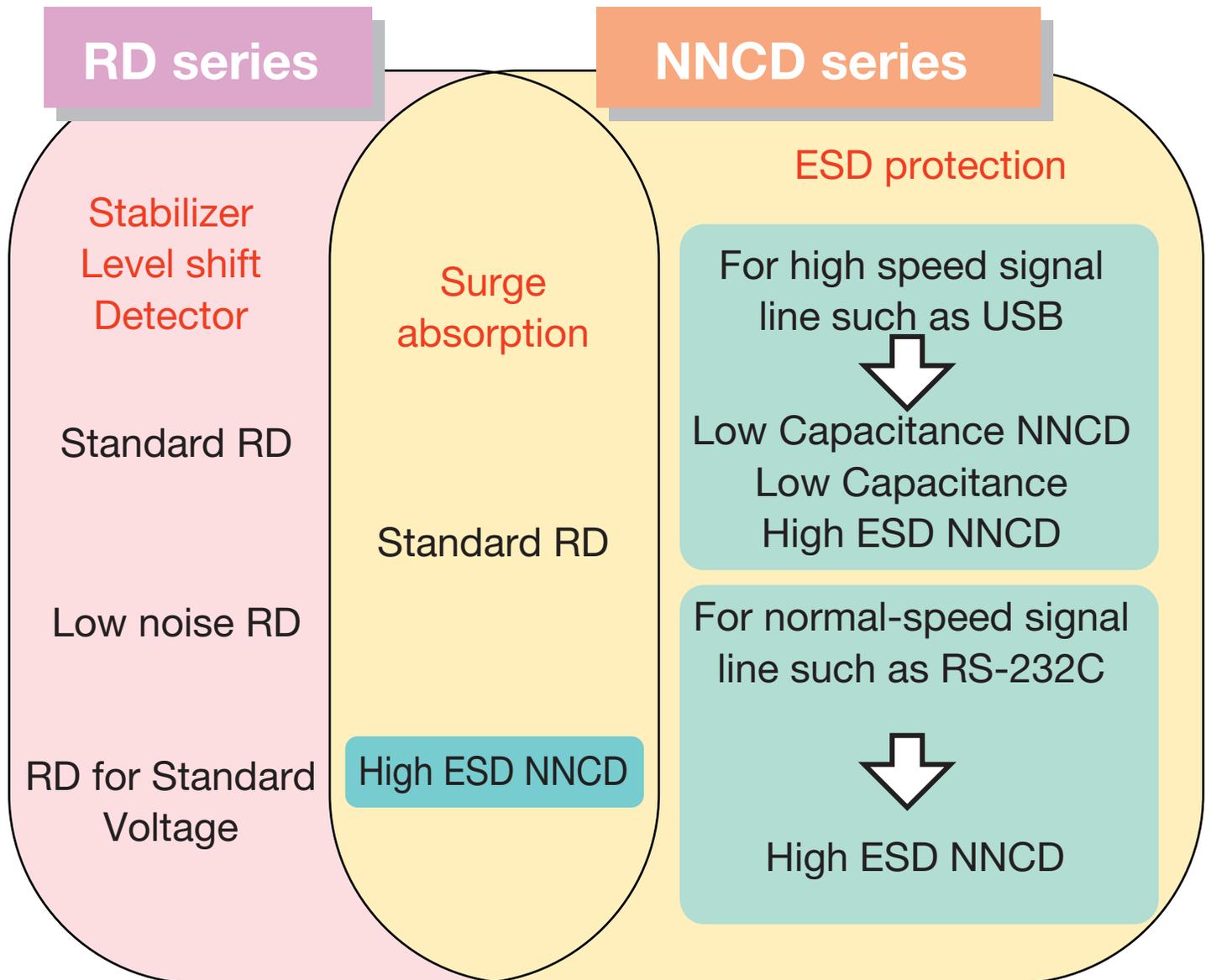


Data rate(bps)		
100k	1M	10M
<p>High ESD (30kV)</p> <p> NNCD**C SC-78 $V_{BR}=3.3V$ to 12V  </p> <p> NNCD**D SC-76 $V_{BR}=3.3V$ to 12V  </p> <p> NNCD**F SC-59 (Dual, Anode common) $V_{BR}=3.3V$ to 12V  </p> <p> NNCD**G SC-74A (Quad, Anode common) $V_{BR}=3.3V$ to 7.5V, 27V  </p>		<p>Low Capacitance High ESD (30kV/20pF)</p> <p> NNCD**MF SC-59 (Dual, Anode common) $V_{BR}=6.2V$  </p> <p> NNCD**MG SC-74A (Quad, Anode common) $V_{BR}=5.6V, 6.2V, 6.8V$  </p>
<p>Low Capacitance (8kV/10pF)</p> <p> NNCD**LG SC-74A (Quad, Anode common) $V_{BR}=5.6V, 6.2V, 6.8V$  </p> <p> NNCD**LH SC-88A (Quad, Anode common) $V_{BR}=5.6V, 6.2V, 6.8V$  </p>		
RS-232C	IMT-2000	RS-422B USB1.1

Note 1: ESD rating is tested based on IEC61000-4-2.
 Note 2: Capacitance is tested at $f=1MHz$ and $V_R=0V$.

Protection device from Electrostatic Discharge and Surge

NNCD is the diode developed for the protection device from ESD(Electrostatic Discharge) and surge.



NEC Noise Clipping Diode NNCD

ESD protection by using NNCD

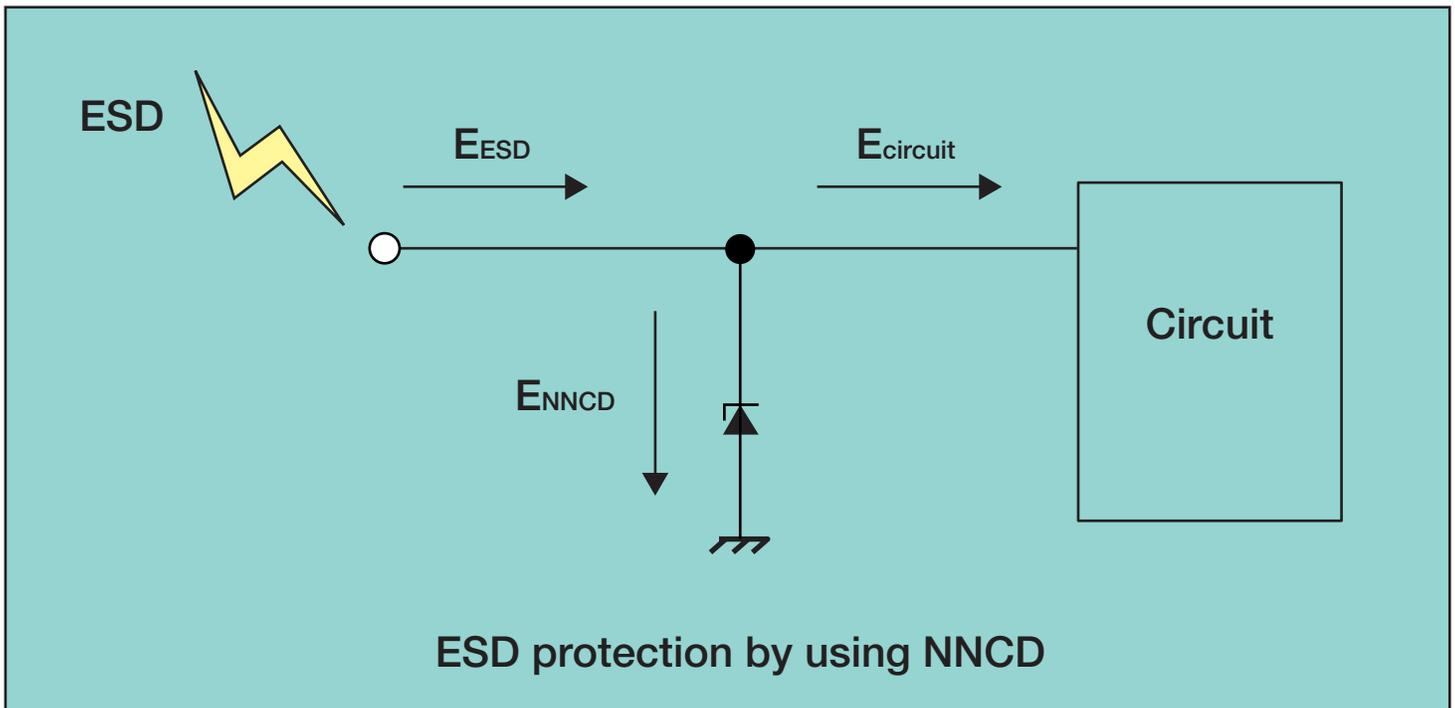
When ESD invades the circuit shown in next figure, E_{ESD} (energy of ESD) divides into E_{NNCD} (energy flowing into NNCD) and $E_{circuit}$ (energy flowing into circuit).

$$E_{ESD} = E_{NNCD} + E_{circuit}$$

The impedance of NNCD is smaller than that of the circuit,

$$E_{NNCD} \gg E_{circuit}$$

Most of E_{ESD} flows to GND through the NNCD and the circuit can be protected from ESD.



Diode developed for ESD protection

NNCD is diode developed for ESD protection.

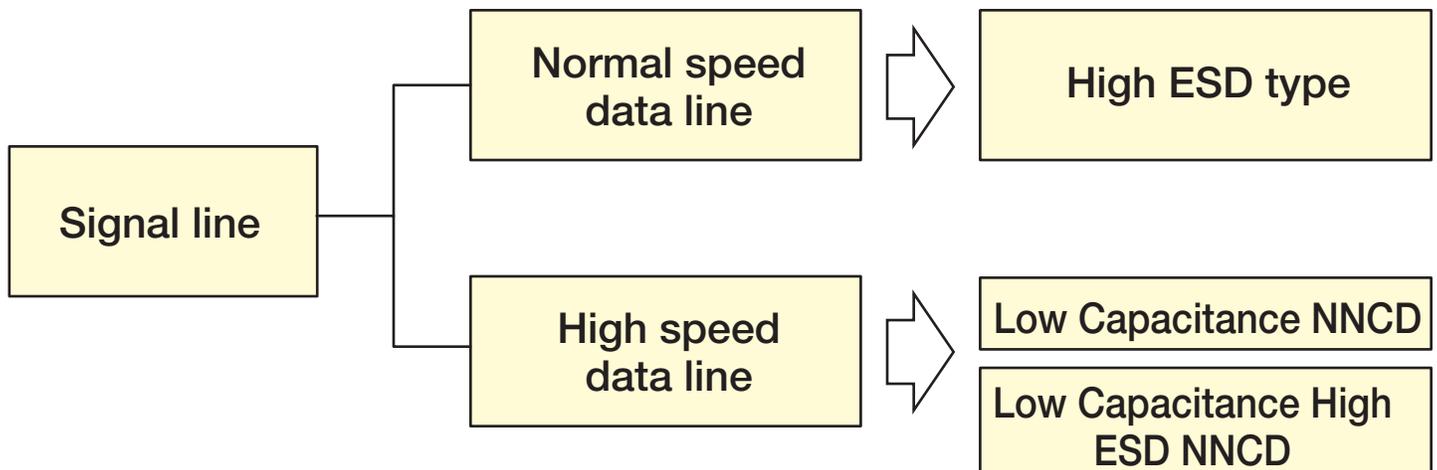
(1) High ESD series

The High ESD NNCD series is 30kV ESD rating or more based on IEC61000-4-2 test. This series presents the product from 3.3V to 12V break down voltage for power supply application.

(2) Low Capacitance NNCD series

In Low Capacitance NNCD series have two types and presents the product from 5.6V to 6.8V break down voltage for 5V signal line.

Series	ESD rating	Capacitance
Low Capacitance NNCD	8kVmin.	10pF(typ.)
Low Capacitance High ESD NNCD	30kVmin.	20pF(typ.)

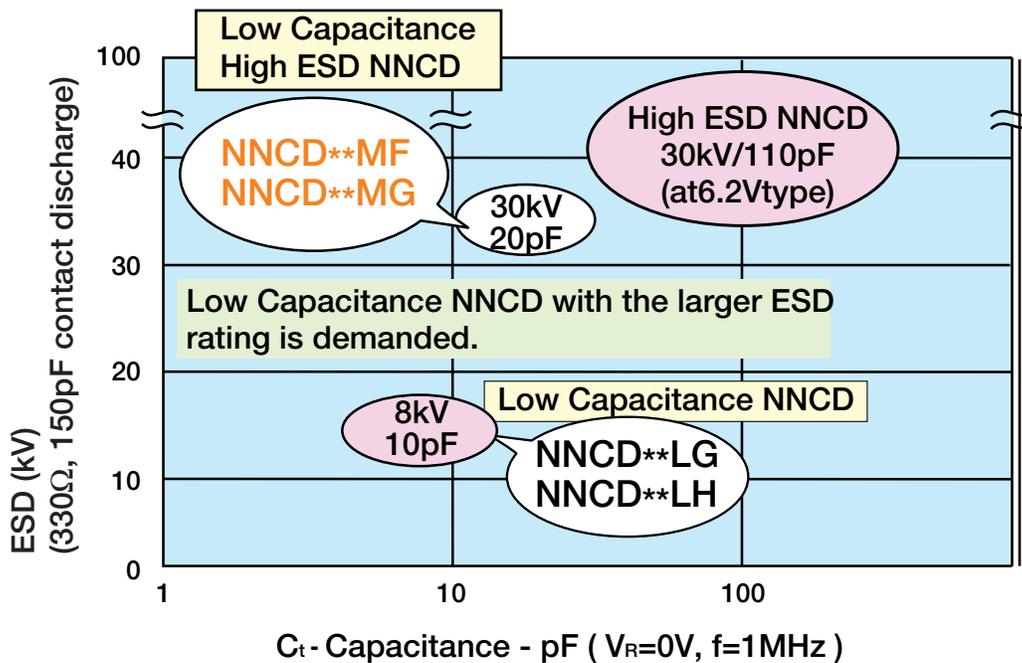


NEC Noise Clipping Diode NNCD

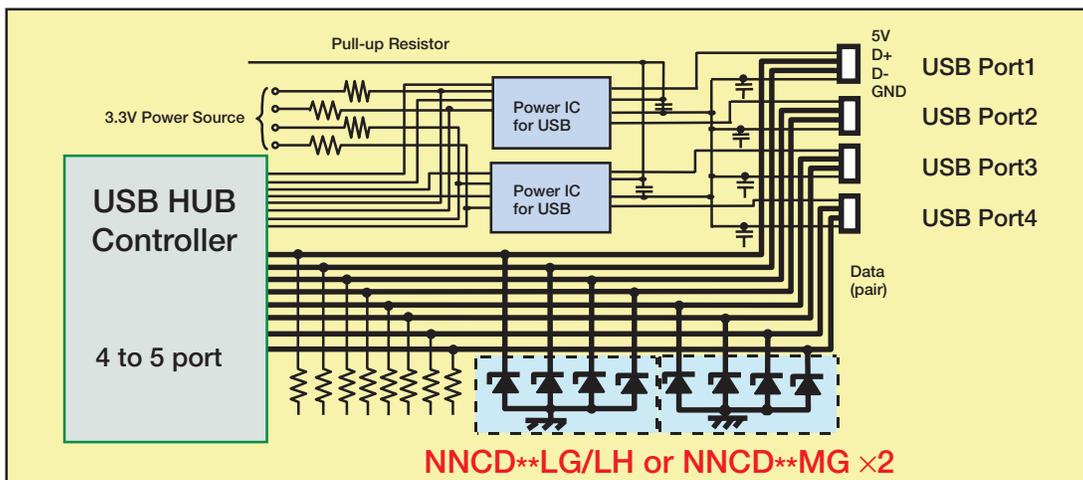
Low Capacitance NNCD series

NNCD**LG, NNCD**LH, NNCD**MF, NNCD**MG

There are two types of Low capacitance NNCD and the suitable device for high speed data line can be selected by combining capacitance and ESD rating.



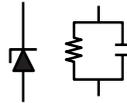
Circuit Example in USB HUB application



Capacitance

The diode behaves as a capacitor, except during absorbing ESD. In general, the capacitance increases the rise time and makes some problem. The small capacitance device is useful to reduce the rise time.

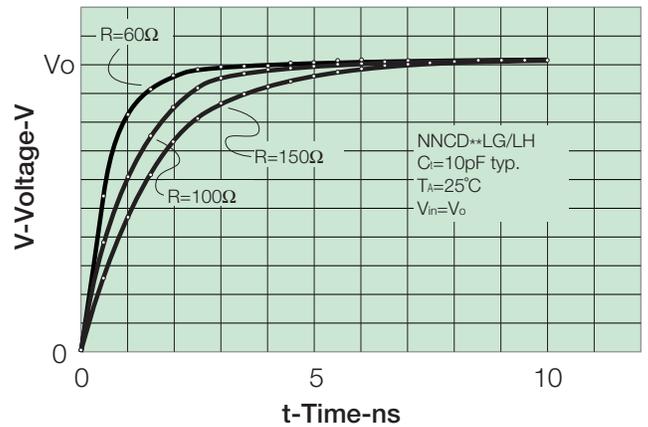
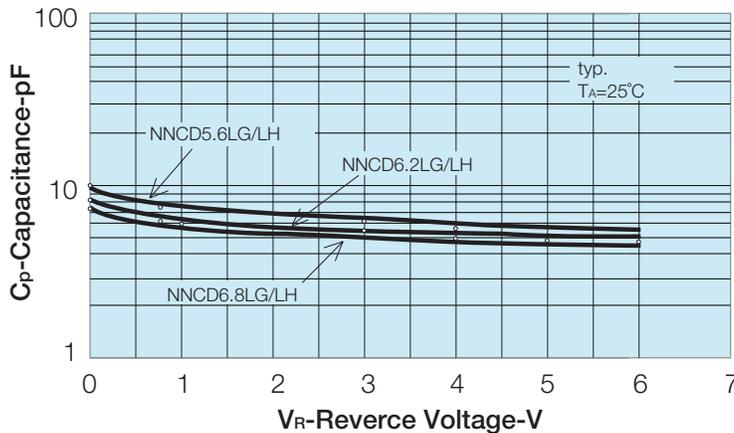
The equivalent circuit of diode



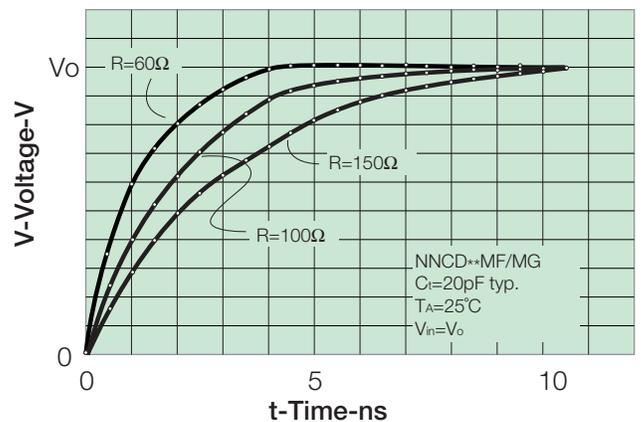
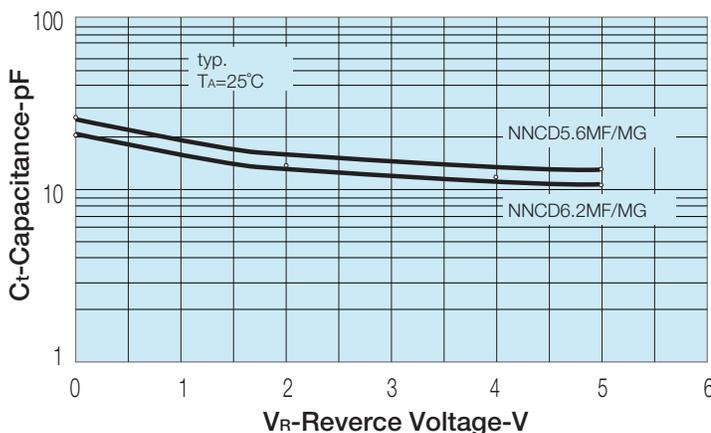
The capacitance of Low Capacitance NNCD series is 10pF or 20pF. These devices give margin for designing line impedance.

Capacitance and Rise of waveform

(1) NNCD**LG/LH series



(2) NNCD**MF/MG series

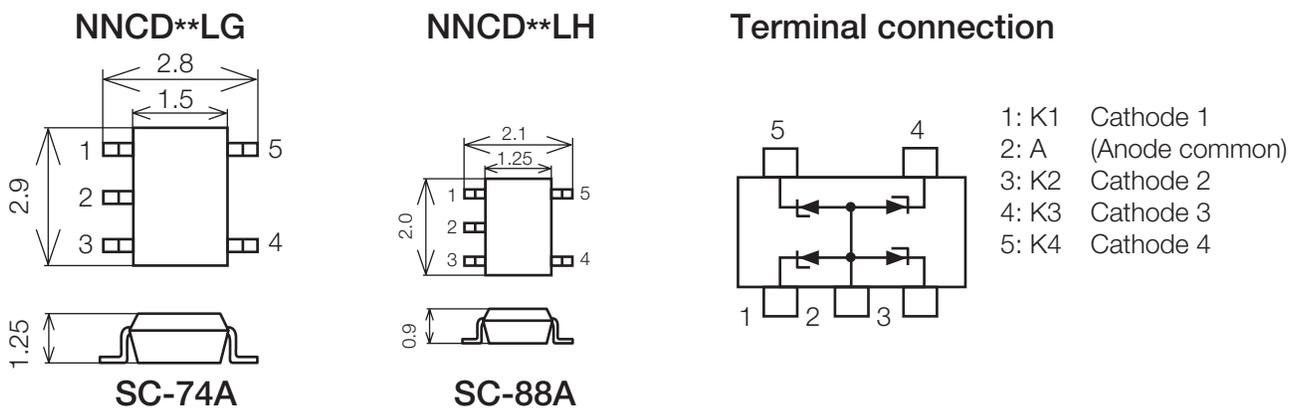


NEC Noise Clipping Diode NNCD

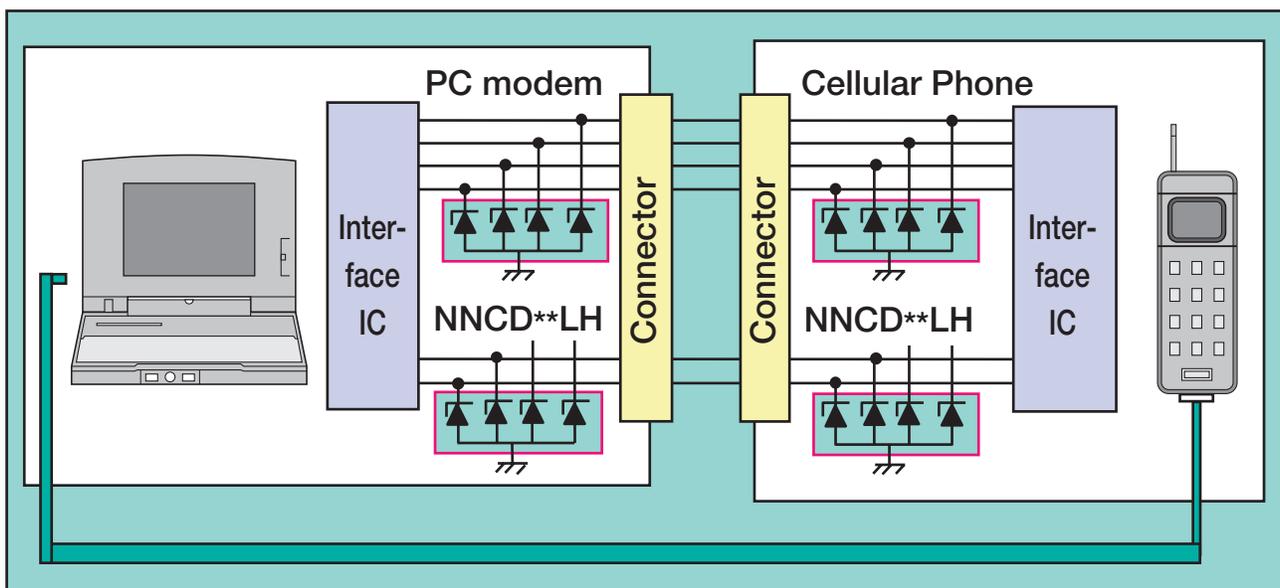
Down-sizing of package

NNCD**LG ,NNCD**LH and NNCD**MG are 4diode elements in one package and they can cope with more high density assembling. Especially,NNCD**LH fabricated in SC-88A package is about 50% reduction comparing with the area of NNCD**LG.

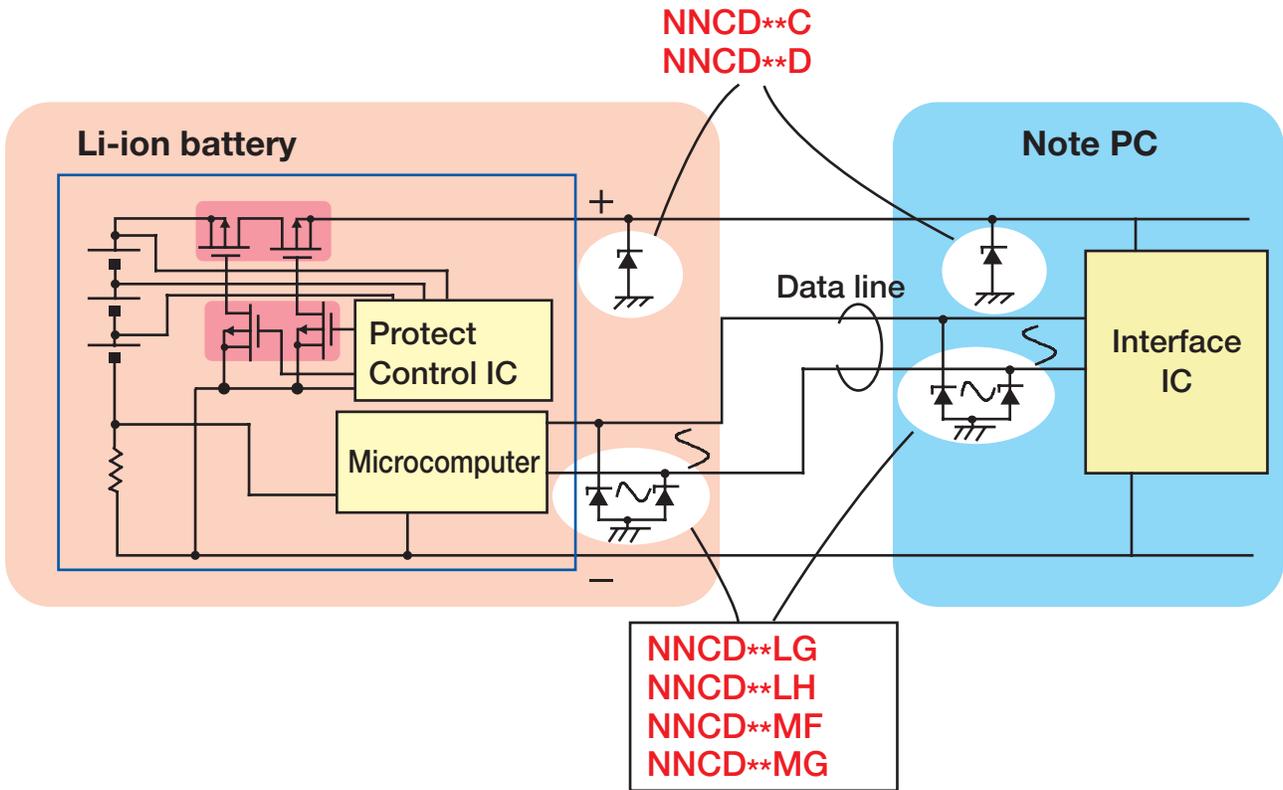
NNCD**LH is the suitable device to the ESD protection of the equipment such as cellular phone that miniaturization and lightening are demanded.



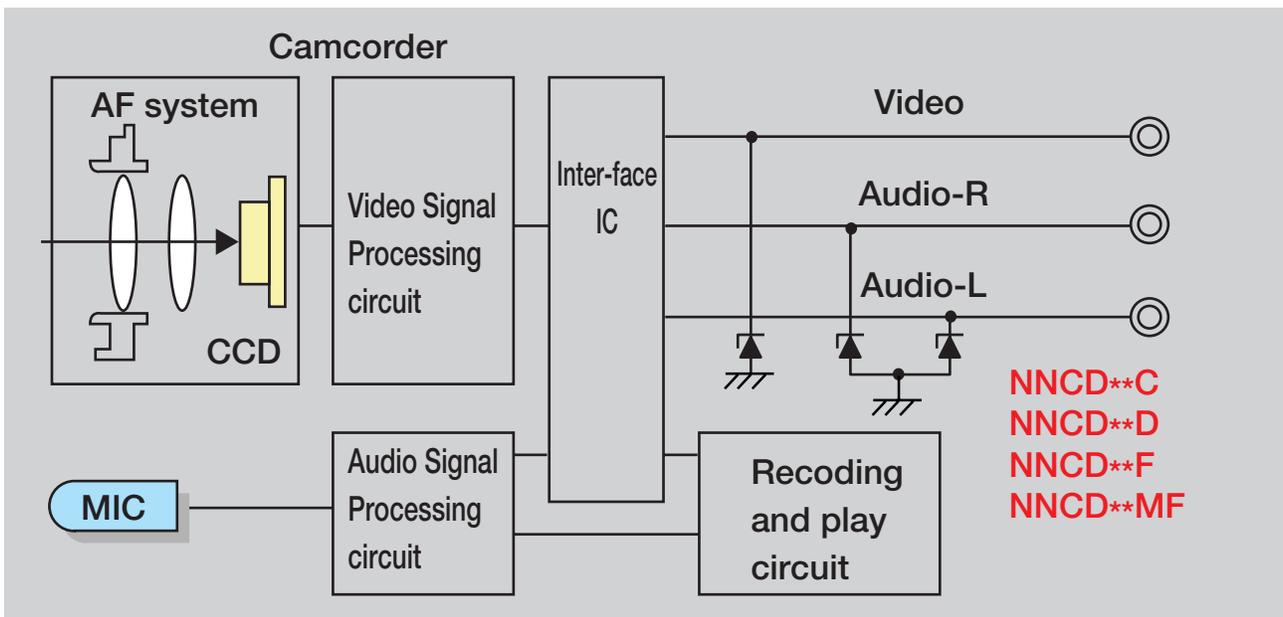
Circuit example in Cellular Phone application



Circuit example in Li-ion Battery application



Circuit example in DVC application

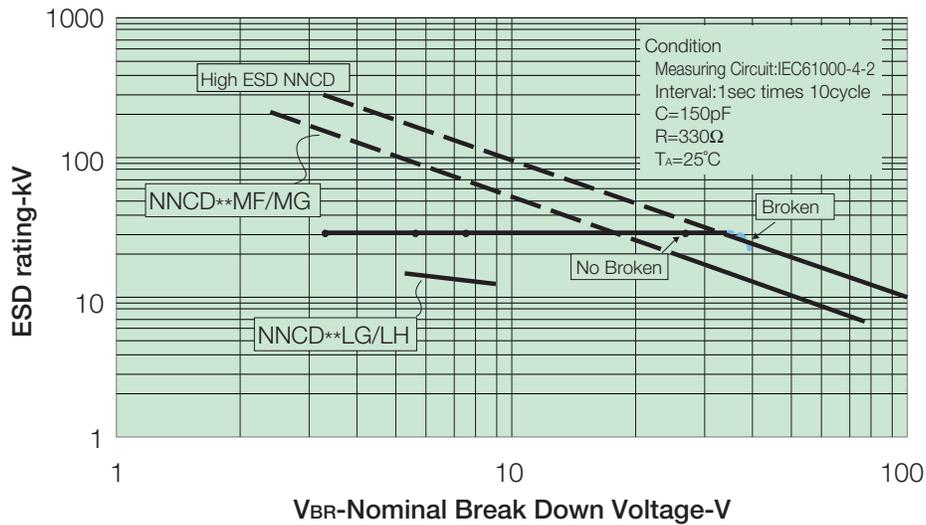


NEC Noise Clipping Diode NNCD

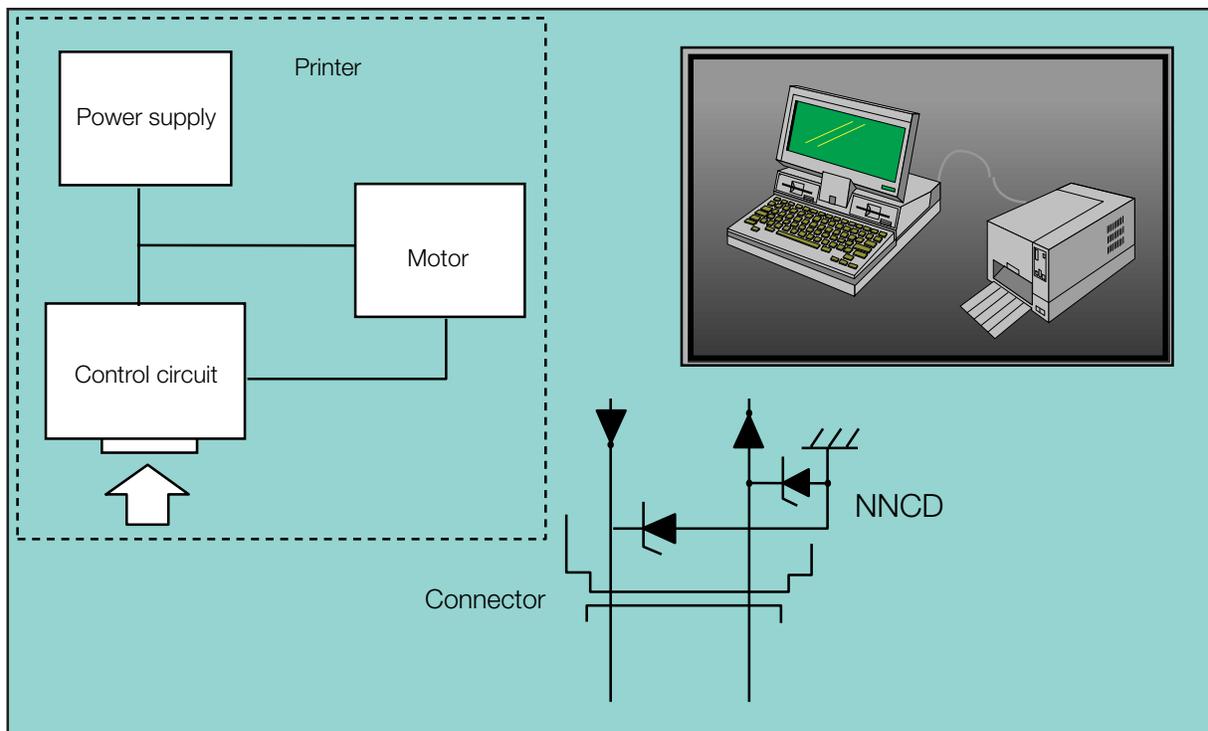
High ESD NNCD

NNCDA, NNCD**B, NNCD**C, NNCD**D
NNCD**E, NNCD**F, NNCD**G**

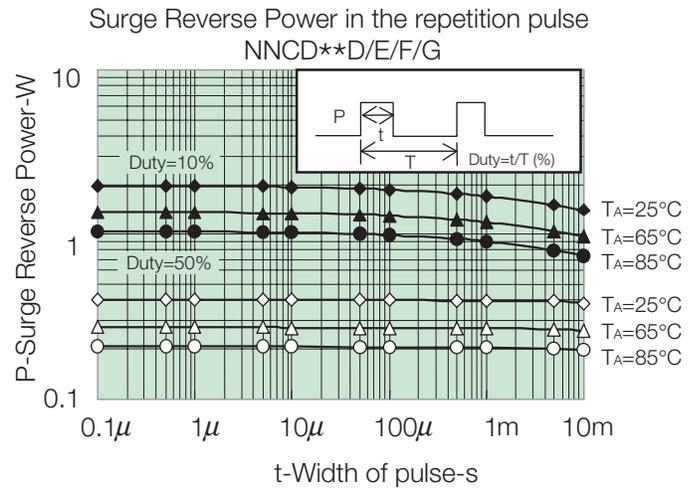
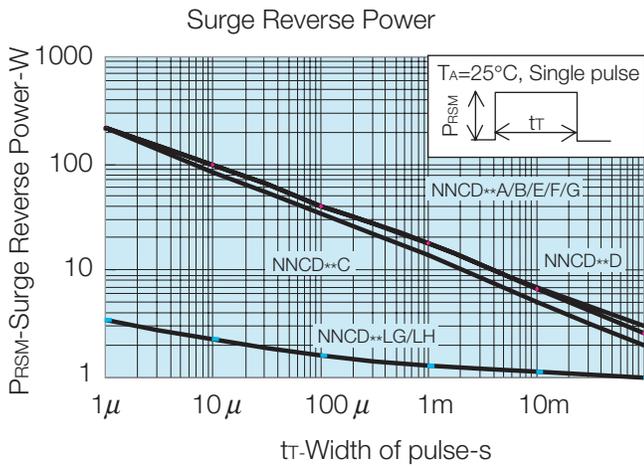
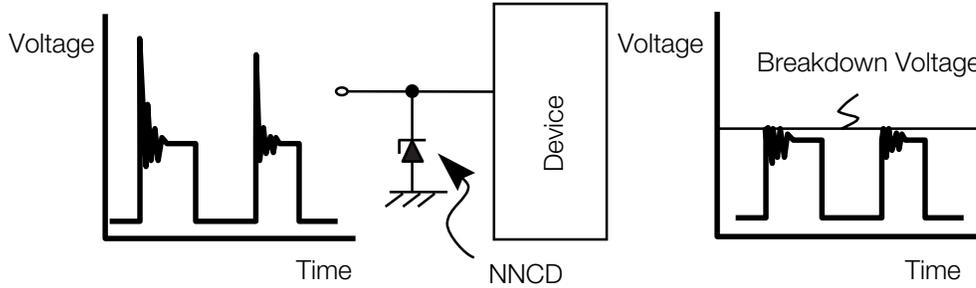
High ESD NNCD assures the endurance of 30kV ESD, based on the IEC61000-4-2 test on EMI.



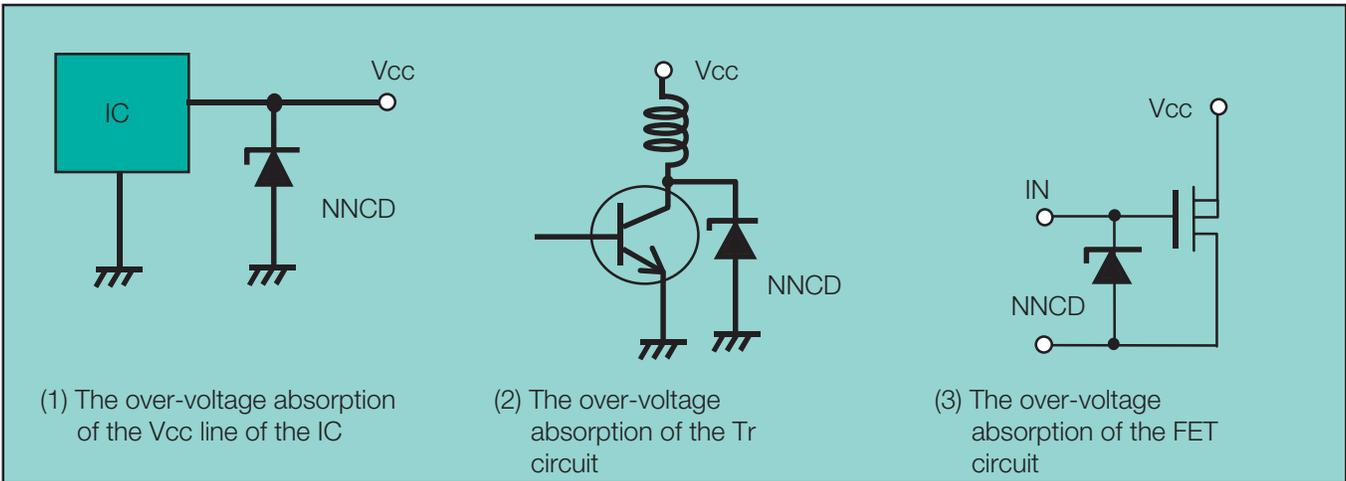
Circuit Example in RS-232C application



High ESD NNCD series can be used for the protection against the surge which appears in the circuit, such as the DC power supply.



Circuit example



NEC Noise Clipping Diode NNCD

Product Line Up of NNCD

SMD products

Series	Breakdown Voltage	Number of Type	ESD	Power Dissipation	Package
NNCD**C	3.3 to 12V	15	30kVmin	150mW	2pin USM (SC-78)
NNCD**D				200mW	2pin SSP (SC-76)
NNCD**E					3pin MM (SC-59)

SMD products (Compound type with anode common)

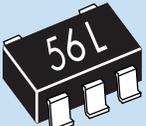
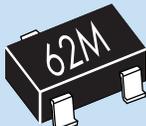
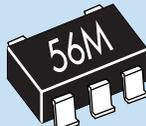
Series	Breakdown Voltage	Number of Type	ESD	Power Dissipation	Package
NNCD**F	3.3 to 12V	15	30kVmin	200mW	3pin MM (Dual) (SC-59)
NNCD**G	3.3 to 7.5 27V	12			5pin MM (Quad) (SC-74A)
NNCD**LG	5.6 to	3	8kVmin		5pin SSP (Quad) (SC-88A)
NNCD**LH	6.8V		3pin MM (Dual) (SC-59)		
NNCD**MF	6.2V	1	30kVmin		3pin MM (Dual) (SC-59)
NNCD**MG	5.6 to 6.8V	3			5pin MM (Quad) (SC-74A)

DHD products

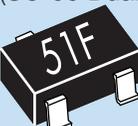
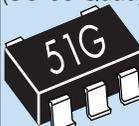
Series	Breakdown Voltage	Number of Type	ESD	Power Dissipation	Package
NNCD**A	3.3 to 12V	15	30kVmin	400mW	DO-34
NNCD**B				500mW	DO-35

NNCD products line up

Low capacitance series

Type		Low Capacitance		Low Capacitance High ESD	
Power		200mW		200mW	
ESD		8kV min.		30kV min.	
Capacitance		10pF typ.		20pF typ.	
Series		NNCD**LG	NNCD**LH	NNCD**MF	NNCD**MG
V _{BR}	5.6V	NNCD5.6LG	NNCD5.6LH		NNCD5.6MG
	6.2V	NNCD6.2LG	NNCD6.2LH	NNCD6.2MF	NNCD6.2MG
	6.8V	NNCD6.8LG	NNCD6.8LH		NNCD6.8MG
Package		SC-74A (Quad) 	SC-88A (Quad) 	SC-59 (Dual) 	SC-74A (Quad) 

High ESD series

Power	400mW	500mW	150mW	200mW				
Series	NNCD**A	NNCD**B	NNCD**C	NNCD**D	NNCD**E	NNCD**F	NNCD**G	
Breakdown Voltage	3.3V	NNCD3.3A	NNCD3.3B	NNCD3.3C	NNCD3.3D	NNCD3.3E	NNCD3.3F	NNCD3.3G
	3.6V	NNCD3.6A	NNCD3.6B	NNCD3.6C	NNCD3.6D	NNCD3.6E	NNCD3.6F	NNCD3.6G
	3.9V	NNCD3.9A	NNCD3.9B	NNCD3.9C	NNCD3.9D	NNCD3.9E	NNCD3.9F	NNCD3.9G
	4.3V	NNCD4.3A	NNCD4.3B	NNCD4.3C	NNCD4.3D	NNCD4.3E	NNCD4.3F	NNCD4.3G
	4.7V	NNCD4.7A	NNCD4.7B	NNCD4.7C	NNCD4.7D	NNCD4.7E	NNCD4.7F	NNCD4.7G
	5.1V	NNCD5.1A	NNCD5.1B	NNCD5.1C	NNCD5.1D	NNCD5.1E	NNCD5.1F	NNCD5.1G
	5.6V	NNCD5.6A	NNCD5.6B	NNCD5.6C	NNCD5.6D	NNCD5.6E	NNCD5.6F	NNCD5.6G
	6.2V	NNCD6.2A	NNCD6.2B	NNCD6.2C	NNCD6.2D	NNCD6.2E	NNCD6.2F	NNCD6.2G
	6.8V	NNCD6.8A	NNCD6.8B	NNCD6.8C	NNCD6.8D	NNCD6.8E	NNCD6.8F	NNCD6.8G
	7.5V	NNCD7.5A	NNCD7.5B	NNCD7.5C	NNCD7.5D	NNCD7.5E	NNCD7.5F	NNCD7.5G
	8.2V	NNCD8.2A	NNCD8.2B	NNCD8.2C	NNCD8.2D	NNCD8.2E	NNCD8.2F	–
	9.1V	NNCD9.1A	NNCD9.1B	NNCD9.1C	NNCD9.1D	NNCD9.1E	NNCD9.1F	–
	10V	NNCD10A	NNCD10B	NNCD10C	NNCD10D	NNCD10E	NNCD10F	–
11V	NNCD11A	NNCD11B	NNCD11C	NNCD11D	NNCD11E	NNCD11F	–	
12V	NNCD12A	NNCD12B	NNCD12C	NNCD12D	NNCD12E	NNCD12F	–	
27V	–	–	–	–	–	–	NNCD27G	
Package	DO-34 	DO-35 	2pin USM (SC-78) 	2pin SSP (SC-76) 	3 pin MM (SC-59) 	3 pin MM (SC-59 Dual) 	5 pin MM (SC-59 Quad) 	

NEC Noise Clipping Diode NNCD

Out line of package

SMD products

Unit: mm

Package	2pin Ultra Super Mini Mold (SC-78)	2pin Super Mini Mold (SC-76)	3pin Mini Mold (SC-59)
Appearance			
Out line drawing			
Package	5pin Mini Mold (SC-74A)	5pin Super Mini Mold (SC-88A)	
Appearance			
Out line drawing			

DHD products

Unit: mm

Package	DO-34	DO-35
Out line drawing		

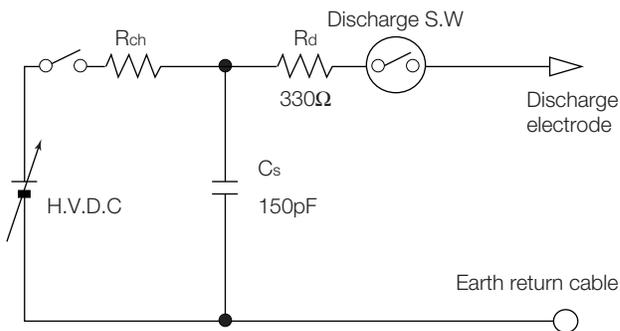
Mounting pad dimension (Minimum recommended value)

Unit: mm

Package	2pin Ultra Super Mini Mold (SC-78)	2pin Super Mini Mold (SC-76)	3pin Mini Mold (SC-59)
Mounting pad dimension			
Package	5pin Mini Mold (SC-74A)	5pin Super Mini Mold (SC-88A)	
Mounting pad dimension			

IEC61000-4-2

[Testing circuit]



[Testing levels]

1a-Contact discharge

Level	Test Voltage
1	2 kV
2	4 kV
3	6 kV
4	8 kV
X	Special

1b-Air discharge

Level	Test Voltage
1	2 kV
2	4 kV
3	8 kV
4	15 kV
X	Special

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