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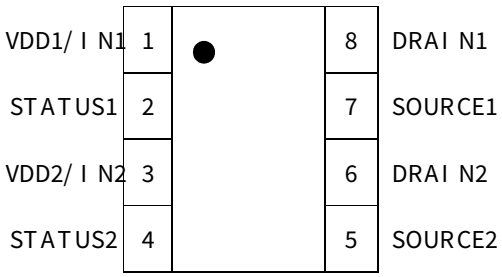
P n Conf gurat on and Funct ons



F igure 1.1 NSD12409-Q1 Pinout

Tab le 1.1 SO-8 Pin Configuration and Description

PIN NO	YMBOL	F NC ION
1,3	VDD1,2/ I N1,2	Voltage controlled input pin with hysteresis, CMOS compatib le. T hey control output switch state
2,4	STAT US1,2	Open drain digital diagnostic pin
8,6	DRAI N1,2	PowerMOS drain
7 ,5	SOURCE1,2	PowerMOS source and ground referencefor the control section

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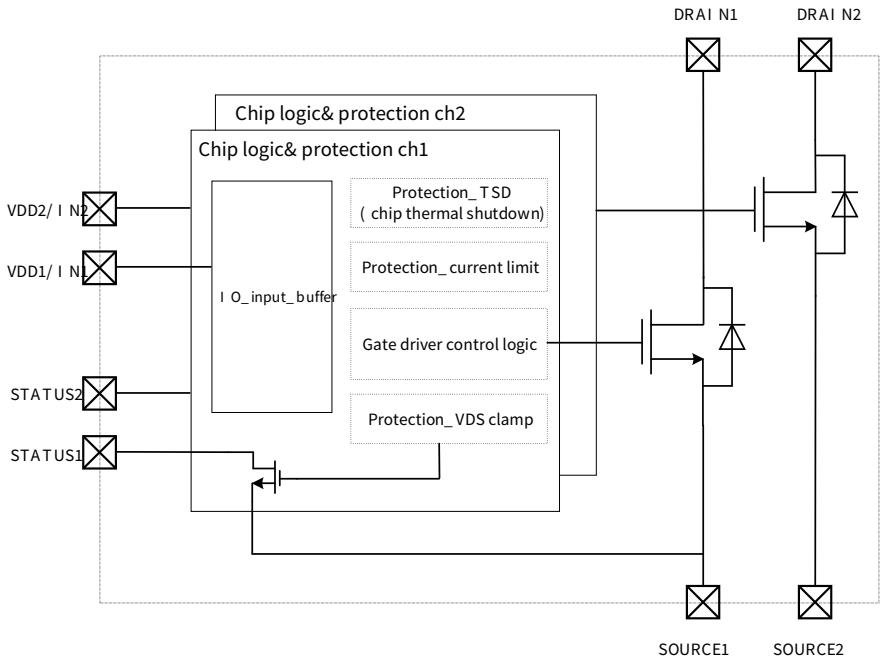

F igure 2.1 NSD12409-Q1 Block diagram

Abso lute Max u at ngs

Para eters	y bo l	M n	yp	Max	v n t
Drain-Source Voltage	V_{DS}			I nternally clamped	V
DC Drain Current	I_D			Thermal limited	A
VDD/ I NPUT Pin Current	$_{IN}$	-1		10	mA
STAT US Pin Current	$_{STAT}$	-1		10	mA
J unction Temperature	T_J	-40		150	° C
Storage Temperature	T_{stg}	-55		150	° C
Single pulse avalanche energy (L = 3 mH; $_J$ =T150 ° C; $_L$ R 0; $_{OUT}$ = $_{lim}$)	E_{AS}			50	mJ

E D rat ngs

Para eters	y bo l	a ue	v n t
V(ESD) Electrostatic discharge	Human-b ody model, per A EC-Q100-002-RevD, $V_{ESD-HBM}$	±4000	V
	Charged-device model, per A EC-Q100-011-RevB, $V_{ESD-CDM}$	±750	V

her a lInfor at on

Para eters	y bo l	O	v n t

pec f cat ons

E ectr ca lCharacter st cs

(VDD = VI N= 4.5 V to 5 .5 V; T= -40° C to 15 0° C. Unless otherwise noted.)

Para eters	y bo l	M n	yp	Max u n t		Co ents
Power MO FE						
ON-state resistance	R_{ON}		90		mΩ	I_D = 1.6 A; T_J = 25 ° C; V_{DD} = V_{IN} = 5 V
				180	mΩ	I_D = 1.6 A; T_J = 15 0° C; V_{DD} = V_{IN} = 5 V
Drain-source clamp voltage	V_{CLAMP}	46	48	5 6	V	V_{IN} = 0V, I_D = 1.6 A
Drain-source clamp threshold voltage	V_{CLTH}	40			V	V_{IN} = 0V, I_D = 2 mA
OF F -state output current	I_{DSS}	0		3	µA	V_{IN} = 0 V; V_{DS} = 13 V; T_J = 25 ° C
		0		5	µA	V_{IN} = 0 V; V_{DS} = 13 V; T_J = 125 ° C
Body diode forward voltage	V_{BD}		0.8		V	I_D = 1.6 A; V_{IN} = 0 V
Input sect on						
Supply current from input pin	$I_{I SS}$		25	6 5	µA	ON-state; V_{DD} = V_{IN} = 5 V; V_{DS} = 0 V
I nput clamp voltage	V_{CL}	5 .5		8	V	$I_{I CL}$ = 1 mA
			-0.7			I_{CL} = -1 mA
I nput threshold voltage	V_{INTH}	1		3 .5	V	V_{DS} = V_{IN}, I_D = 1 mA
tatus nd cator						
Status low output voltage	V_{STAT}			0.5	V	I_{STAT} = 1 mA
Status leak age current	I_{LSTAT}			10	µA	V_{STAT} = 5 V
Status pin input capacitance	C_{STAT}			100	pF	V_{STAT} = 5 V
Status clamp voltage	V_{STCL}	5 .5		8	V	I_{STAT} = 1 mA
			-0.7			I_{STAT} = - 1 mA
w tch ng character st cs						
Turn-on delay time	$t_{d(ON)}$		6		µs	R_L = 8.2 Ω, V_{CC} = 13 V
Turn-off delay time	$t_{d(OFF)}$		11		µs	R_L = 8.2 Ω, V_{CC} = 13 V
Rise time	t_r		5 .7		µs	R_L = 8.2 Ω, V_{CC} = 13 V
F all time	t_f		4.5		µs	R_L = 8.2 Ω, V_{CC} = 13 V
Switching energy losses at turn-on	W_{ON}		17		µJ	R_L = 8.2 Ω, V_{CC} = 13 V

Para eters	y bo l	M n	yp	Max	ν n t	Co ents
Switching energy losses at turn-off	W_{OFF}		3 8		µJ	R_L = 8.2 Ω, V_{CC} = 13 V
Protect on and d agnost cs						
DC short-circuit current	I_{lim}	5 .5	8	10.5	A	V_{DS} = 13 V, V_{DD} = V_{IN} = 5 V
Shutdown temperature	T_{TSD}	15 0	17 5	200	° C	
Reset temperature	T_R	T_{RS} + 1	T_{RS} + 5		° C	
Thermal reset of STAT US	T_{RS}	13 5			° C	
Thermal hysteresis (T_{SD} - T_R)	T_{HYST}		7		° C	
Dynamic temperature	ΔT_J		40		K	T_J = -40° C, V_{CC} = 13 V
Dynamic temperature hysteresis	$\Delta T_{J\ (HYS)}$		15		K	

yp ca lPerfor ance Character st cs

rue tab le

Cond t ons	Input	Dra n	tatus
Normal operation	L	H	H
	H	L	H
Current limitation	L	H	H
	H	X	H
Over-temperature limitation	L	H	H
	H	H	L
VDD under-voltage	L	H	X
	H	H	X

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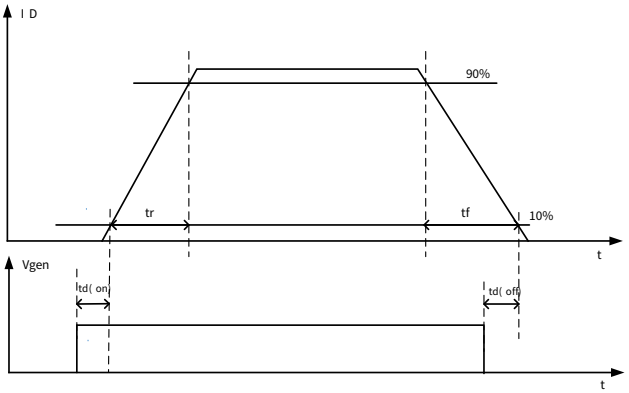


F igure 6 .2.2 NSD12409-Q1 Switching Characteristics

Protect ons

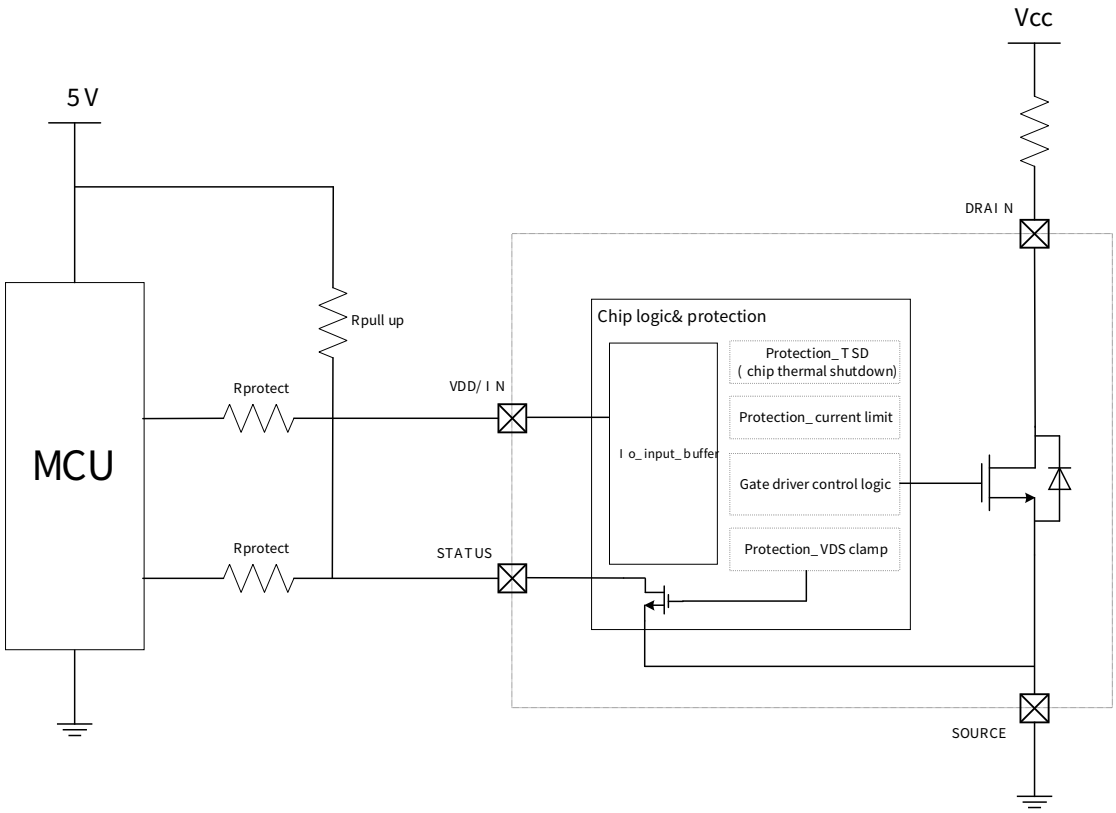
Current L tat on

NSD12409-Q1 has current limitation to protect the silicon and bonding wire in case of overload or short circuit to battery.

her a lshutdown and ther a lsw ng

This device has both absolute and dynamic temperature protection. There are two thermal sensors on the controller and the MOSFET, the one on the MOSFET is the hottest and another one on the controller is the coldest. The absolute temperature protection is to shut down the MOSFET when the hottest junction temperature exceeds the T_{SD}, and the dynamic temperature protection is also to shut down the MOSFET when the temperature difference between the hottest and the coldest exceeds ΔT_J.

App lcat on nfor at on



F igure 8.1 NSD12409-Q1SPR application schematic

MCU I O protection

NSD12409 has Zener diodes inside for ESD protection and the intrinsic NPN parasitic bipolar, so that resistors for protection are necessary in series with the digital inputs to limit the current to protect MCU I / Os during transient and reverse battery conditions.

The value of resistors for protection can be calculated by the formula as shown below:

$$\frac{0.7}{I_{latchup}} \le R_{prot} \le \frac{V_{MCU\_OUT} - V_{IH}}{I_{IHmax}}$$

Where $I_{latchup}$ is the MCU I / O latch up current, V_{MCU_OUT} is the output voltage of MCU I / O, V_{IH} is the High-level input voltage of NSD12409, I_{IH} is the High-level input current.

Let: $I_{latchup} \ge 20mA$; $V_{MCU\_OUT} \ge 4.5V$, so $35\Omega \le R_{prot} \le 15k\Omega$, the recommended value is $1k\Omega$.

The value of Adv pull up resistor

Because the STATUS pin is open drain output, a pull up resister is needed to fix the high voltage during normal operation. When the fault occurs, the voltage level of STATUS is pulled down by the internal MOSFET on. The value of pull up resistor can be calculated by the formula as shown below:

$$\left(\frac{V_{pull\text{-}up}}{V_{OL}} - 1\right) \cdot R_{on} < R_{pull\text{-}up} < \frac{V_{pull\text{-}up} - V_{OH}}{I_{leak}}$$

Where V_{pullup} is the minimum of pull-up supply, V_{OL} is the maximum of MCU logic low, R_{on} is the on resistance of the MOSFET of STATUS pin, V_{OH} is the minimum of MCU logic high, I_{leak} is the maximum leakage current of STATUS pin.

Let: $V_{pullup} = 4.5V$; $R_{on} = V_{STAT} / I_{STAT} = 500\Omega$, $V_{OL} = 0.9V$; $V_{OH} = 2.1V$; $I_{leak} = 10uA$, so $2k\Omega \le R_{pullup} \le 240k\Omega$.

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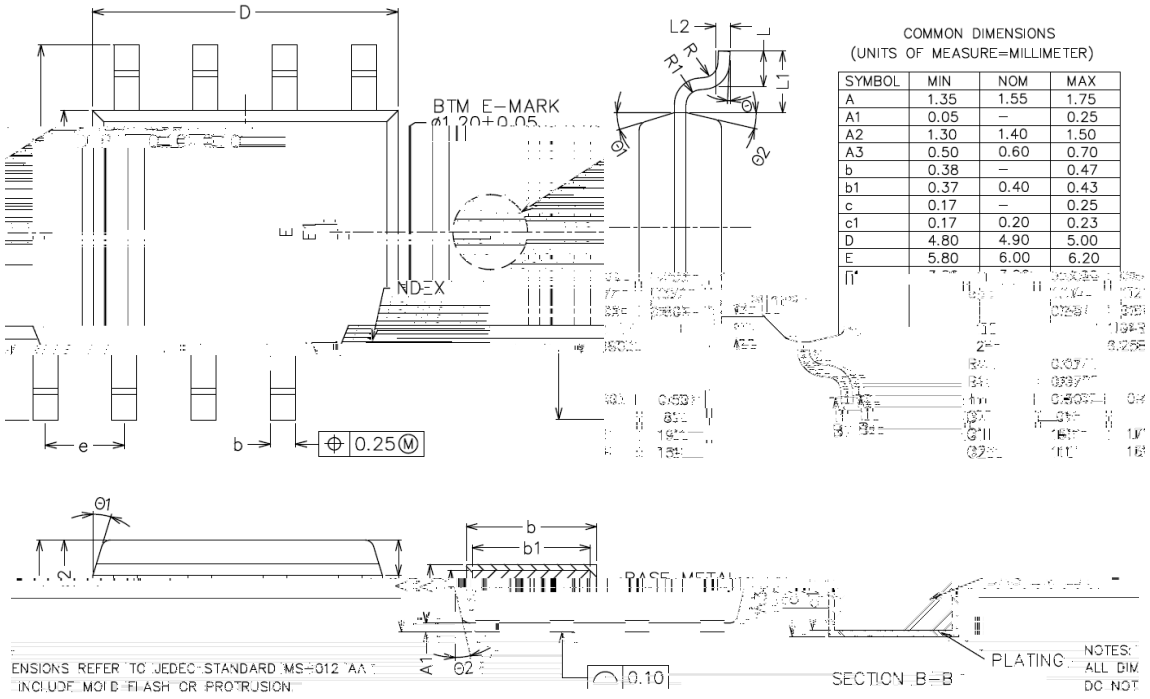

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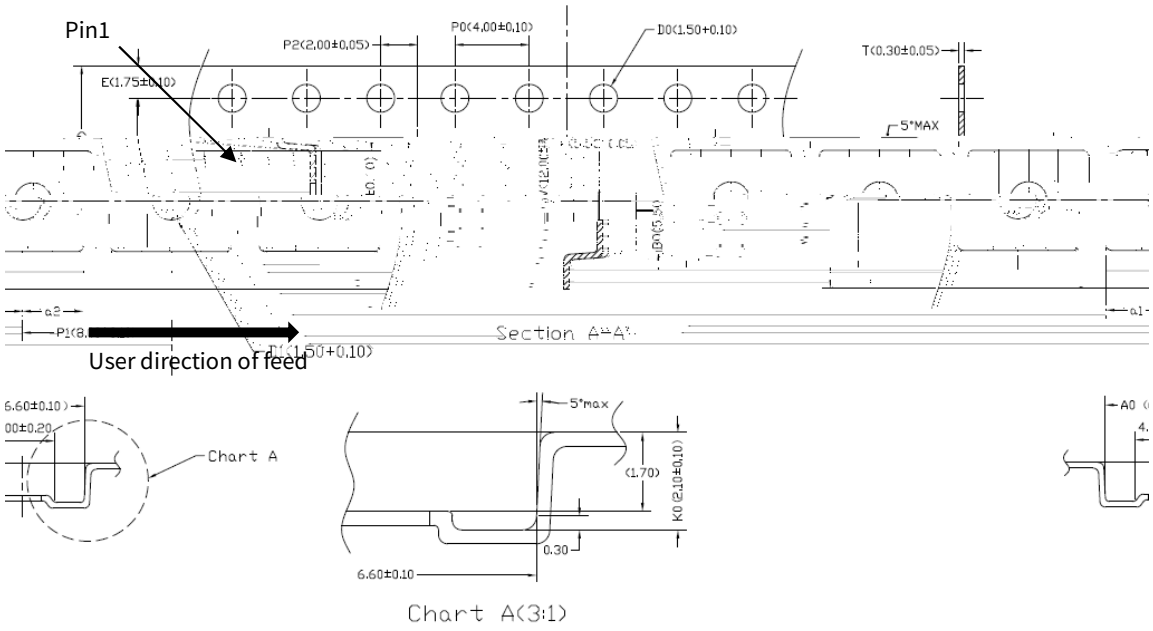

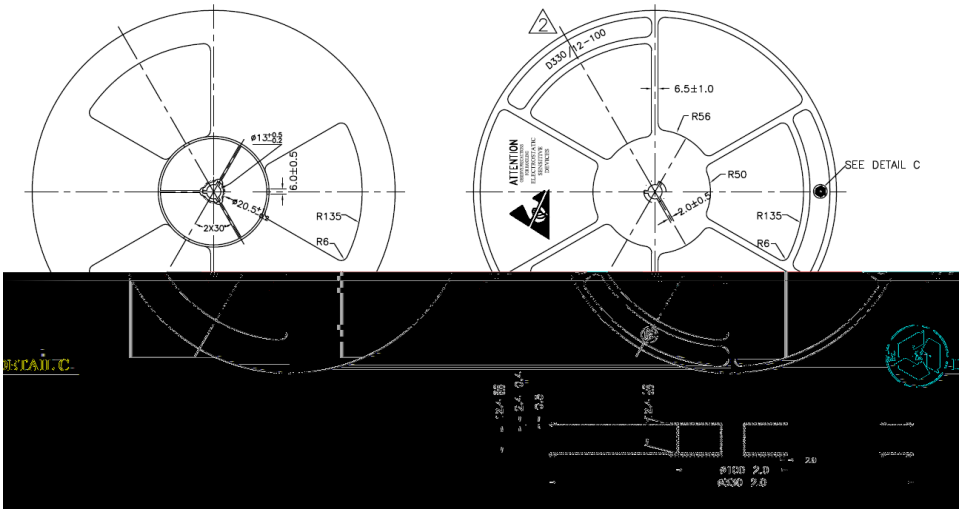

Order ng Infor at on

Part Nu ber	Pac age	M L	PQ
NSD12409-Q1SPR	SO-8	3	25 00

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