



## DOUBLE CHANNEL HIGH SIDE SOLID STATE RELAY

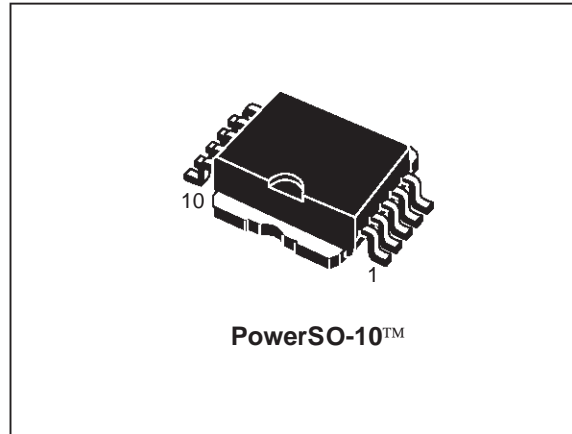
TARGET SPECIFICATION

TYPE	R <sub>DS(on)</sub>	I <sub>lim</sub>	V <sub>CC</sub>
VND600SP	30mΩ	25A	36 V

- DC SHORT CIRCUIT CURRENT: 25 A
- CMOS COMPATIBLE INPUTS
- PROPORTIONAL LOAD CURRENT SENSE
- UNDERVOLTAGE AND OVERVOLTAGE SHUT-DOWN
- OVERVOLTAGE CLAMP
- THERMAL SHUT DOWN
- CURRENT LIMITATION
- VERY LOW STAND-BY POWER DISSIPATION
- PROTECTION AGAINST:
  - LOSS OF GROUND AND LOSS OF V<sub>CC</sub>
- REVERSE BATTERY PROTECTION (\*)

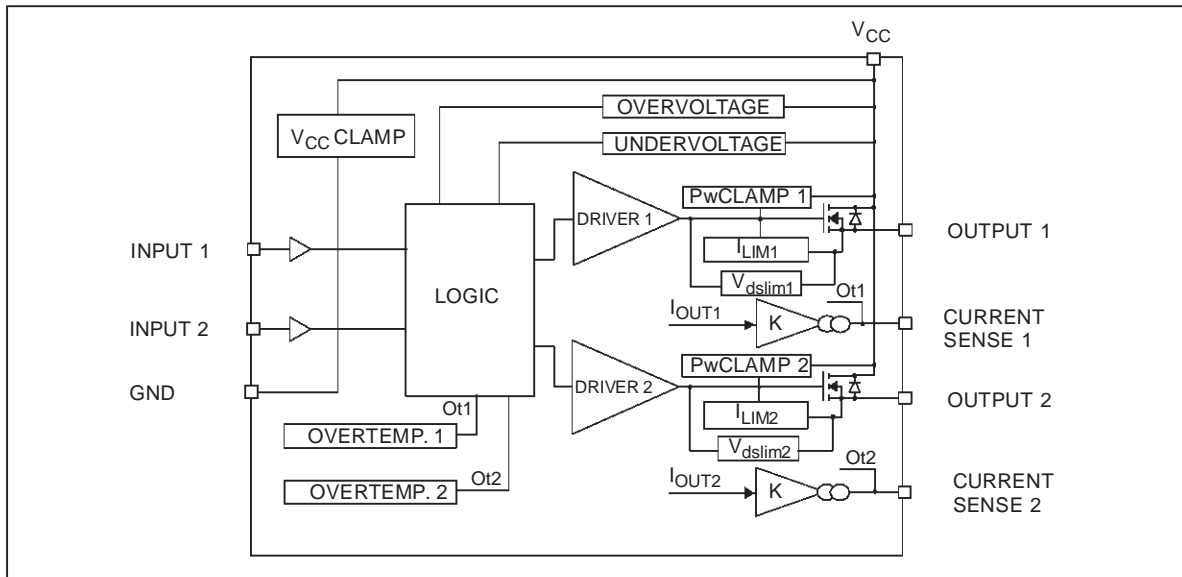
**DESCRIPTION**

The VND600SP is a monolithic device made using STMicroelectronics VIPower technology. It is intended for driving resistive or inductive loads with one side connected to ground. Active V<sub>CC</sub> pin voltage clamp protects the device against low energy spikes (see ISO7637 transient



compatibility table). This device has two channels in high side configuration; each channel has an analog sense output on which the sensing current is proportional (according to a known ratio) to the corresponding load current. Built-in thermal shut-down and outputs current limitation protect the chip from over temperature and short circuit. Device turns off in case of ground pin disconnection.

**BLOCK DIAGRAM**



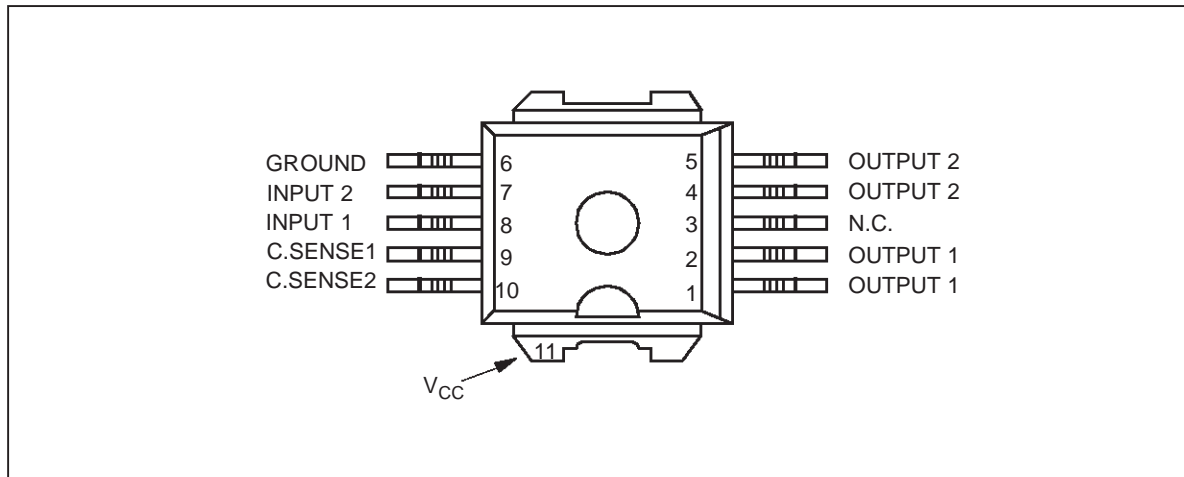
(\*) See application schematic at page 7

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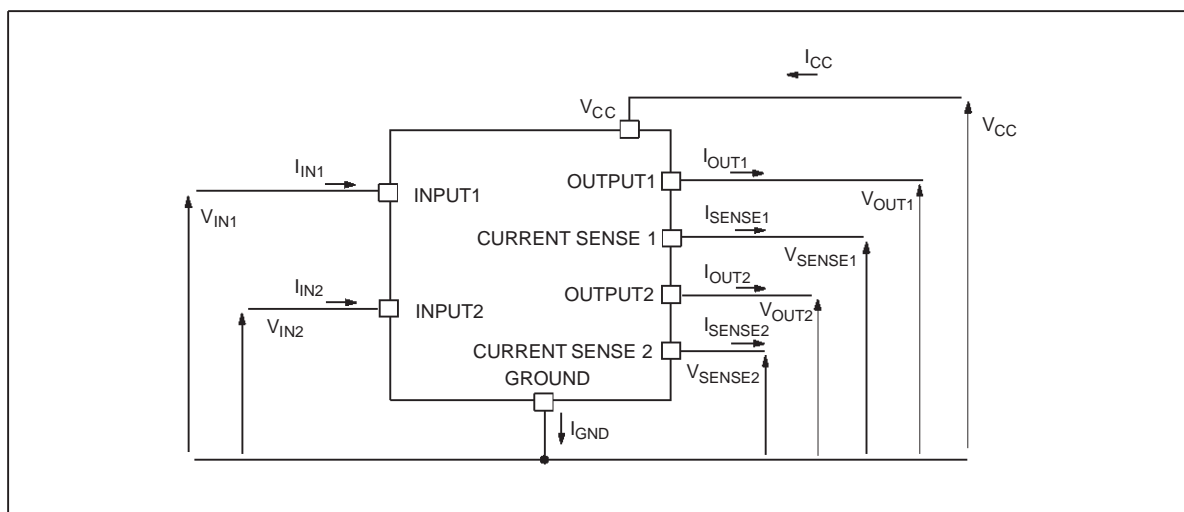
## ABSOLUTE MAXIMUM RATING

Symbol	Parameter	Value	Unit
$V_{CC}$	DC supply voltage	41	V
$-V_{CC}$	Reverse supply voltage	-0.3	V
$-I_{GND}$	DC reverse ground pin current	-200	mA
$I_{OUT}$	Output current	Internally limited	A
$I_R$	Reverse output current	-21	A
$I_{IN}$	Input current	+/- 10	mA
$V_{CSSENSE}$	Current sense maximum voltage	-3	V
		+15	V
$V_{ESD}$	Electrostatic discharge (R=1.5k $\Omega$ ; C=100pF)	2000	V
$P_{TOT}$	Power dissipation at T <sub>c</sub> =25°C	90	W
$T_j$	Junction operating temperature	Internally limited	°C
$T_c$	Case operating temperature	-40 to 150	°C
$T_{STG}$	Storage temperature	-55 to 150	°C

## CONNECTION DIAGRAM (TOP VIEW)



## CURRENT AND VOLTAGE CONVENTIONS



## THERMAL DATA

Symbol	Parameter	Value	Unit
R <sub>thj-case</sub> (1)	Thermal resistance junction-case (MAX)	1.75	°C/W
R <sub>thj-case</sub> (2)	Thermal resistance junction-case (MAX)	1.2	°C/W
R <sub>thj-amb</sub>	Thermal resistance junction-ambient (MAX)	50	°C/W

Note: (1) one channel ON  
(2) two channels ON

**ELECTRICAL CHARACTERISTICS** (8V < V<sub>CC</sub> < 36V; -40°C < T<sub>j</sub> < 150°C; unless otherwise specified)  
(Per each channel)

## POWER

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V <sub>CC</sub>	Operating supply voltage		5.5	13	36	V
V <sub>USD</sub>	Undervoltage shutdown		3	4	5.5	V
V <sub>OV</sub>	Overvoltage shutdown		36	42	48	V
R <sub>ON</sub>	On state resistance	I <sub>OUT</sub> =5A; T <sub>j</sub> =25°C I <sub>OUT</sub> =5A; T <sub>j</sub> =150°C I <sub>OUT</sub> =3A; V <sub>CC</sub> =6V			30 60 100	mΩ
V <sub>clamp</sub>	Clamp voltage	I <sub>CC</sub> =20 mA (see note 1)	41	48	55	V
I <sub>S</sub>	Supply current	Off state; Input n.c.; V <sub>CC</sub> =13V On state; V <sub>IN</sub> =5V; V <sub>CC</sub> =13V; I <sub>OUT</sub> =0A; R <sub>SENSE</sub> =3.9kΩ			40 6	μA mA
I <sub>L(off)</sub>	Off state output current	V <sub>IN</sub> =V <sub>OUT</sub> =0V	0		50	μA

SWITCHING (V<sub>CC</sub>=13V)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
t <sub>d(on)</sub>	Turn-on delay time	R1=2.6Ω		30		μs
t <sub>d(off)</sub>	Turn-off delay time	R1=2.6Ω		30		μs
(dV <sub>OUT</sub> /dt) <sub>on</sub>	Turn-on voltage slope	R1=2.6Ω		0.20		V/μs
(dV <sub>OUT</sub> /dt) <sub>off</sub>	Turn-off voltage slope	R1=2.6Ω		0.20		V/μs

## PROTECTIONS

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
I <sub>lim</sub>	DC short circuit current	V <sub>CC</sub> =13V 5.5V < V <sub>CC</sub> < 36V	25	40	70 70	A A
T <sub>TSD</sub>	Thermal shut-down temperature		150	175	200	°C
T <sub>R</sub>	Thermal reset temperature		135			°C
T <sub>HYST</sub>	Thermal hysteresis		7	15		°C
V <sub>demag</sub>	Turn-off output voltage clamp	I <sub>OUT</sub> =2A; V <sub>IN</sub> =0V; L=6mH	V <sub>CC</sub> -41	V <sub>CC</sub> -48	V <sub>CC</sub> -55	V
V <sub>ON</sub>	Output voltage drop limitation	I <sub>OUT</sub> =0.5A T <sub>j</sub> = -40°C...+150°C		50		mV

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### CURRENT SENSE ( $9V \leq V_{CC} \leq 16V$ ) (See fig. 1)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$K_1$	$I_{OUT}/I_{SENSE}$	$I_{OUT1}$ or $I_{OUT2}=0.5A$ ; $V_{SENSE}=0.5V$ ; other channels open; $T_j = -40^\circ C \dots 150^\circ C$	3300	4400	6000	
$K_2$	$I_{OUT}/I_{SENSE}$	$I_{OUT1}$ or $I_{OUT2}=5A$ ; $V_{SENSE}=4V$ ; other channels open; $T_j = -40^\circ C$ $T_j = 25^\circ C \dots 150^\circ C$	4200	4900	6000	
			4400	4900	5750	
$K_3$	$I_{OUT}/I_{SENSE}$	$I_{OUT1}$ or $I_{OUT2}=15A$ ; $V_{SENSE}=4V$ ; other channels open; $T_j = -40^\circ C$ $T_j = 25^\circ C \dots 150^\circ C$	4200	4900	5500	
			4400	4900	5250	
$V_{SENSE1,2}$	Max analog sense output voltage	$V_{CC}=5.5V$ ; $I_{OUT1,2}=2.5A$ ; $R_{SENSE}=10k\Omega$ $V_{CC}>8V$ , $I_{OUT1,2}=5A$ ; $R_{SENSE}=10k\Omega$	2			V
			4			V
$V_{SENSEH}$	Analog sense output voltage in overtemperature condition	$V_{CC}=13V$ ; $R_{SENSE}=3.9k\Omega$		5.5		V

### LOGIC INPUT (Channels 1,2)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$V_{IL}$	Input low level voltage				1.25	V
$I_{IL}$	Low level input current	$V_{IN}=1.25V$	1			$\mu A$
$V_{IH}$	Input high level voltage		3.25			V
$I_{IH}$	High level input current	$V_{IN}=3.25V$			10	$\mu A$
$V_{I(hyst)}$	Input hysteresis voltage		0.5			V
$V_{ICL}$	Input clamp voltage	$I_{IN}=1mA$	6.5	7.4	8.5	V
		$I_{IN}=-1mA$		-0.7		V

Note 1:  $V_{clamp}$  and  $V_{OV}$  are correlated. Typical difference is 5V.

### TRUTH TABLE (per channel)

CONDITIONS	INPUT	OUTPUT	SENSE
Normal operation	L	L	0
	H	H	Nominal
Overtemperature	L	L	0
	H	L	$V_{SENSEH}$
Undervoltage	L	L	0
	H	L	0
Overvoltage	L	L	0
	H	L	0
Short circuit to GND	L	L	0
	H	L	0
Short circuit to $V_{CC}$	L	H	0
	H	H	< Nominal
Negative output voltage clamp	L	L	0

**ELECTRICAL TRANSIENT REQUIREMENTS**

ISO T/R 7637/1 Test Pulse	TEST LEVELS				Delays and Impedance
	I	II	III	IV	
1	-25 V	-50 V	-75 V	-100 V	2 ms 10 Ω
2	+25 V	+50 V	+75 V	+100 V	0.2 ms 10 Ω
3a	-25 V	-50 V	-100 V	-150 V	0.1 μs 50 Ω
3b	+25 V	+50 V	+75 V	+100 V	0.1 μs 50 Ω
4	-4 V	-5 V	-6 V	-7 V	100 ms, 0.01 Ω
5	+26.5 V	+46.5 V	+66.5 V	+86.5 V	400 ms, 2 Ω

ISO T/R 7637/1 Test Pulse	TEST LEVELS RESULTS			
	I	II	III	IV
1	C	C	C	C
2	C	C	C	C
3a	C	C	C	C
3b	C	C	C	C
4	C	C	C	C
5	C	E	E	E

CLASS	CONTENTS
C	All functions of the device are performed as designed after exposure to disturbance.
E	One or more functions of the device is not performed as designed after exposure to disturbance and cannot be returned to proper operation without replacing the device.

**SWITCHING CHARACTERISTICS**

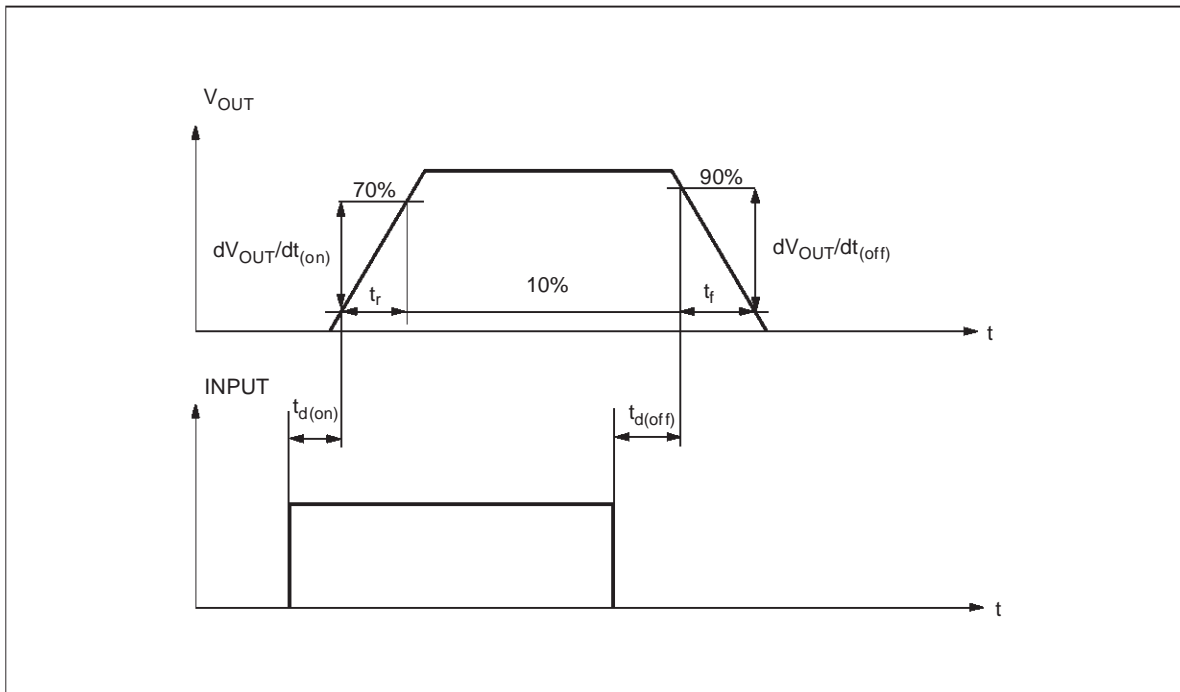
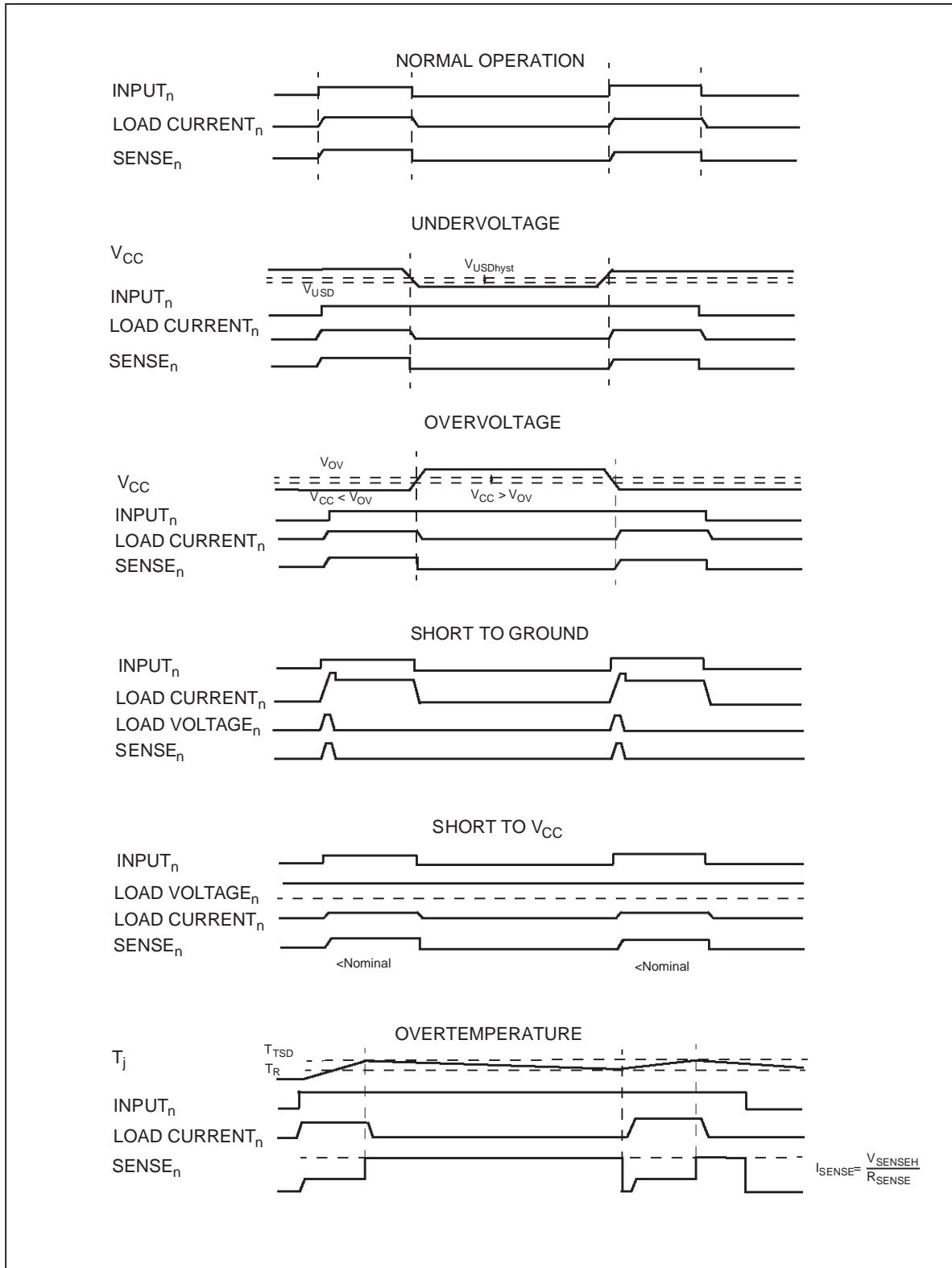
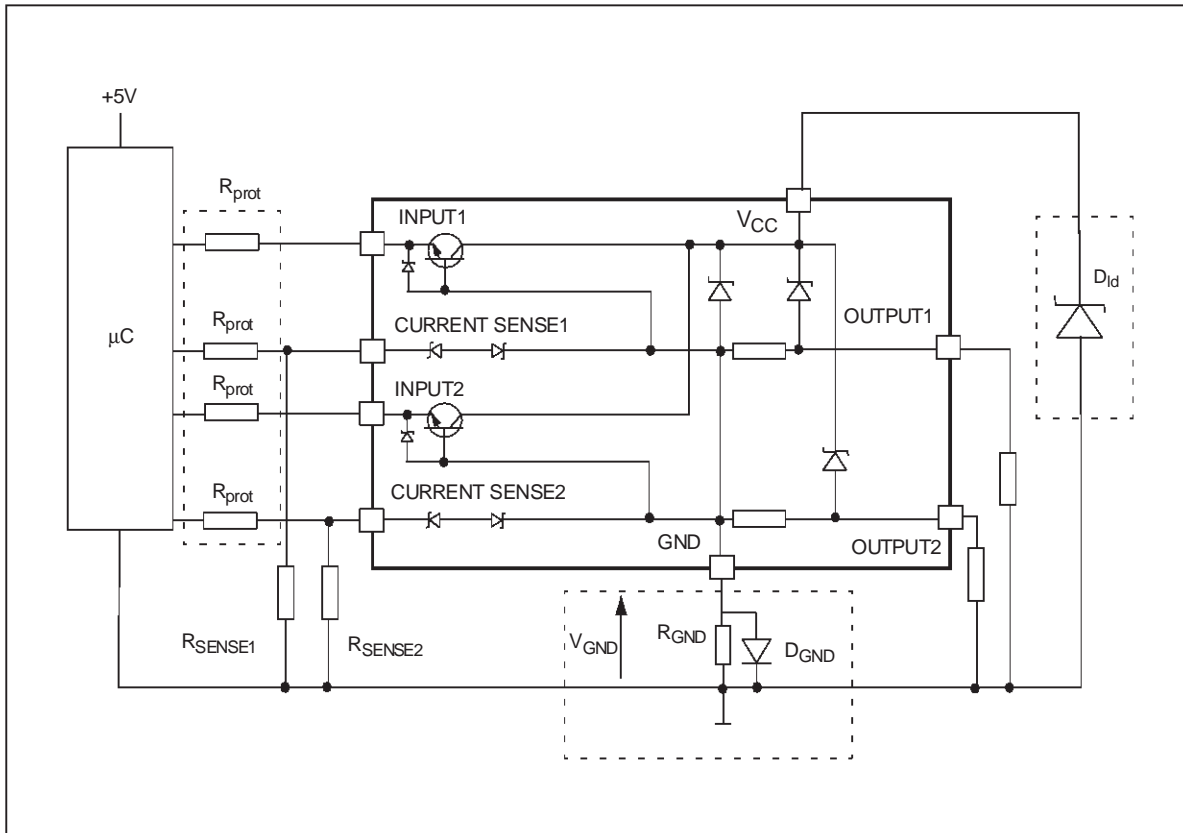


Figure1: Waveforms



## APPLICATION SCHEMATIC



### GND PROTECTION NETWORK AGAINST REVERSE BATTERY

**Solution 1:** Resistor in the ground line ( $R_{GND}$  only). This can be used with any type of load.

The following is an indication on how to dimension the  $R_{GND}$  resistor.

- 1)  $R_{GND} \leq 600\text{mV} / I_{S(\text{on})\text{max}}$
- 2)  $R_{GND} \geq (-V_{CC}) / (-I_{GND})$

where  $-I_{GND}$  is the DC reverse ground pin current and can be found in the absolute maximum rating section of the device's datasheet.

Power Dissipation in  $R_{GND}$  (when  $V_{CC} < 0$ : during reverse battery situations) is:

$$P_D = (-V_{CC})^2 / R_{GND}$$

This resistor can be shared amongst several different HSD. Please note that the value of this resistor should be calculated with formula (1) where  $I_{S(\text{on})\text{max}}$  becomes the sum of the maximum on-state currents of the different devices.

Please note that if the microprocessor ground is not common with the device ground then the  $R_{GND}$  will produce a shift ( $I_{S(\text{on})\text{max}} * R_{GND}$ ) in the input thresholds and the status output values. This shift will vary depending on how many devices are ON in the case of several high side drivers sharing the same  $R_{GND}$ .

If the calculated power dissipation leads to a large resistor or several devices have to share the same resistor then the ST suggests to utilize Solution 2 (see below).

**Solution 2:** A diode ( $D_{GND}$ ) in the ground line.

A resistor ( $R_{GND} = 1\text{k}\Omega$ ) should be inserted in parallel to  $D_{GND}$  if the device will be driving an inductive load.

This small signal diode can be safely shared amongst several different HSDs. Also in this case, the presence of the ground network will produce a shift (j 600mV) in the input thresholds and the status output values if the microprocessor ground is not common with the device ground. This shift will not vary if more than one HSD shares the same diode/resistor network.

### LOAD DUMP PROTECTION

$D_{Id}$  is necessary (Transil or MOV) if the load dump peak voltage exceeds  $V_{CC}$  max DC rating. The same applies if the device will be subject to transients on the  $V_{CC}$  line that are greater than the ones shown in the ISO T/R 7637/1 table.

### µC I/Os PROTECTION:

If a ground protection network is used and negative transient are present on the  $V_{CC}$  line, the control pins will be pulled negative. ST suggests to insert a resistor ( $R_{prot}$ ) in line to prevent the µC I/Os pins to latch-up.

The value of these resistors is a compromise between the leakage current of µC and the current required by the

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HSD I/Os (Input levels compatibility) with the latch-up limit of  $\mu\text{C}$  I/Os.

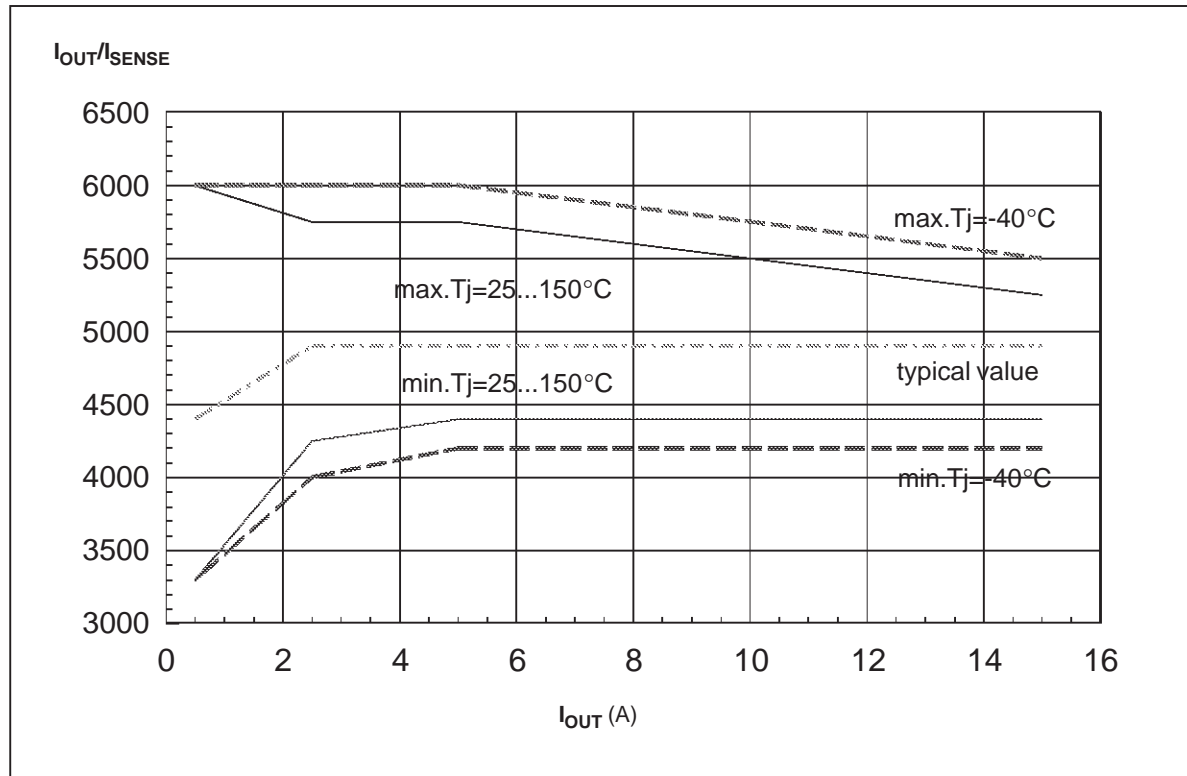
$$-V_{\text{CCpeak}}/I_{\text{latchup}} \leq R_{\text{prot}} \leq (V_{\text{OH}\mu\text{C}} - V_{\text{IH}} - V_{\text{GND}}) / I_{\text{IHmax}}$$

Calculation example:

For  $V_{\text{CCpeak}} = -100\text{V}$  and  $I_{\text{latchup}} \geq 20\text{mA}$ ;  $V_{\text{OH}\mu\text{C}} \geq 4.5\text{V}$   
 $5\text{k}\Omega \leq R_{\text{prot}} \leq 65\text{k}\Omega$ .

Recommended  $R_{\text{prot}}$  value is  $10\text{k}\Omega$ .

**Fig 1:**  $I_{\text{OUT}}/I_{\text{SENSE}}$  versus  $I_{\text{OUT}}$







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