VN610SP

SINGLE CHANNEL HIGH SIDE SOLID STATE RELAY

TYPE	$R_{DS(on)}$	I_{OUT}	V_{CC}
VN610SP	10mΩ	45A	36 V

- OUTPUT CURRENT: 45 A
- CMOS COMPATIBLE INPUT
- 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_{CC}
- REVERSE BATTERY PROTECTION (*)

DESCRIPTION

The VN610SP 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_{CC} pin
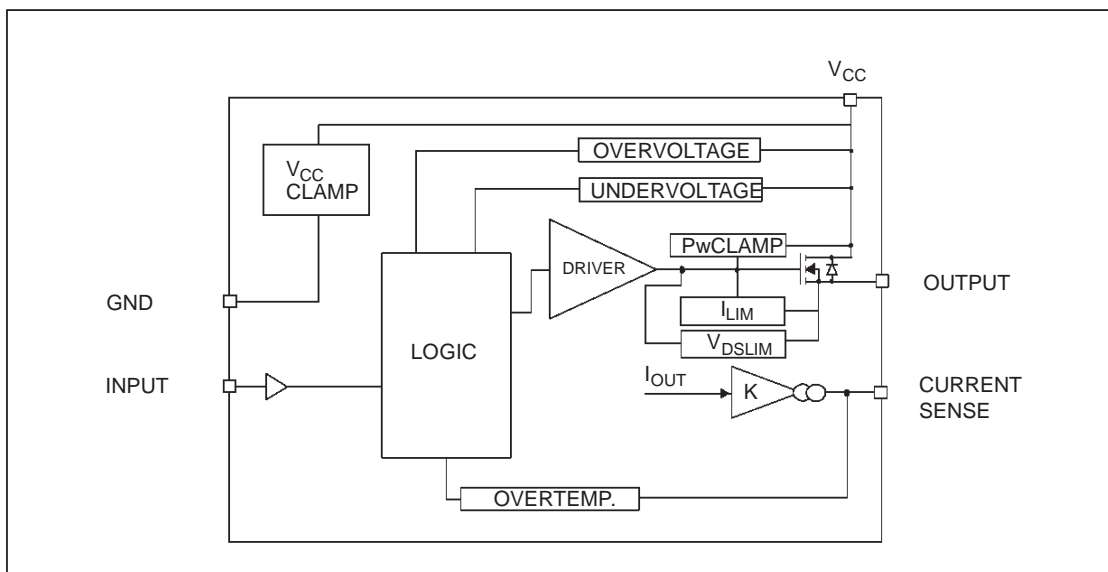
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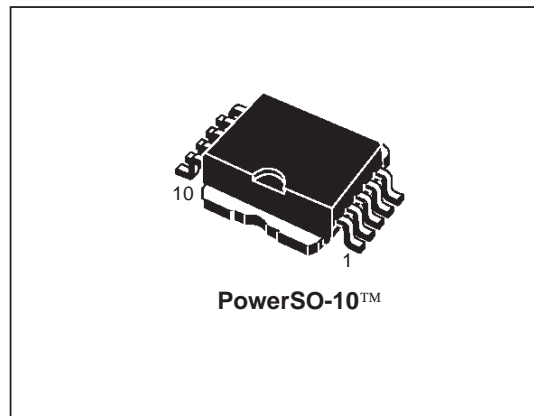
voltage clamp protects the device against low energy spikes (see ISO7637 transient compatibility table). This device integrates an analog current sense which delivers a current proportional to the load current (according to a known ratio). Active current limitation combined with thermal shut-down and automatic restart protect the device against overload. Device automatically turns off in case of ground pin disconnection.

BLOCK DIAGRAM

(*) See application schematic at page 8

September 1999

ABSOLUTE MAXIMUM RATING

Symbol	Parameter	Value	Unit
V_{CC}	DC supply voltage	41	V
$-V_{CC}$	Reverse DC supply voltage	-0.3	V
$-I_{GND}$	DC reverse ground pin current	-200	mA
I_{OUT}	DC output current	Internally limited	A
$-I_{OUT}$	Reverse DC output current	-50	A
I_{IN}	DC input current	+/- 10	mA
V_{CSENSE}	Current sense maximum voltage	-3	V
		+15	V
V_{ESD}	Electrostatic discharge (R=1.5kΩ; C=100pF)	2000	V
P_{TOT}	Power dissipation at $T_C{\leq}25°C$	125	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)
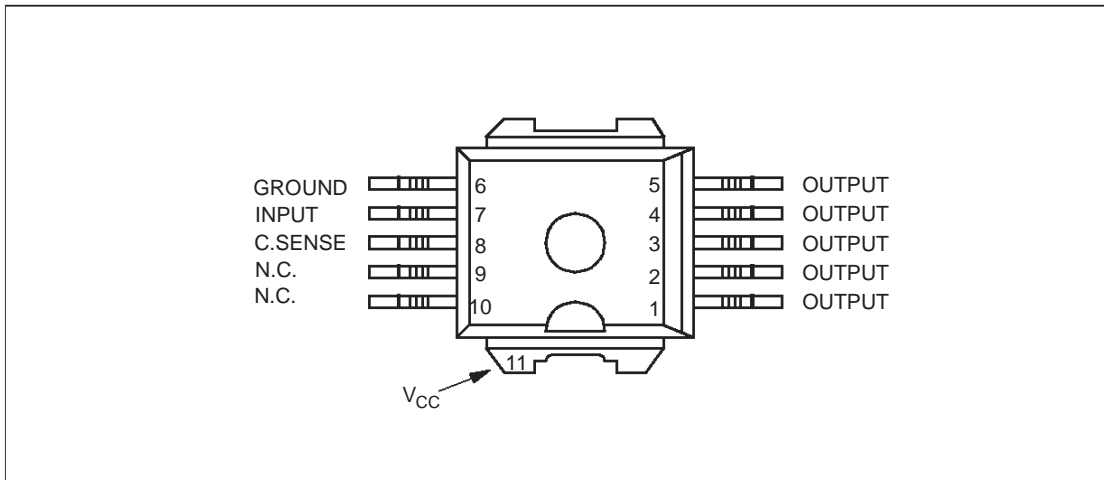
CURRENT AND VOLTAGE CONVENTIONS

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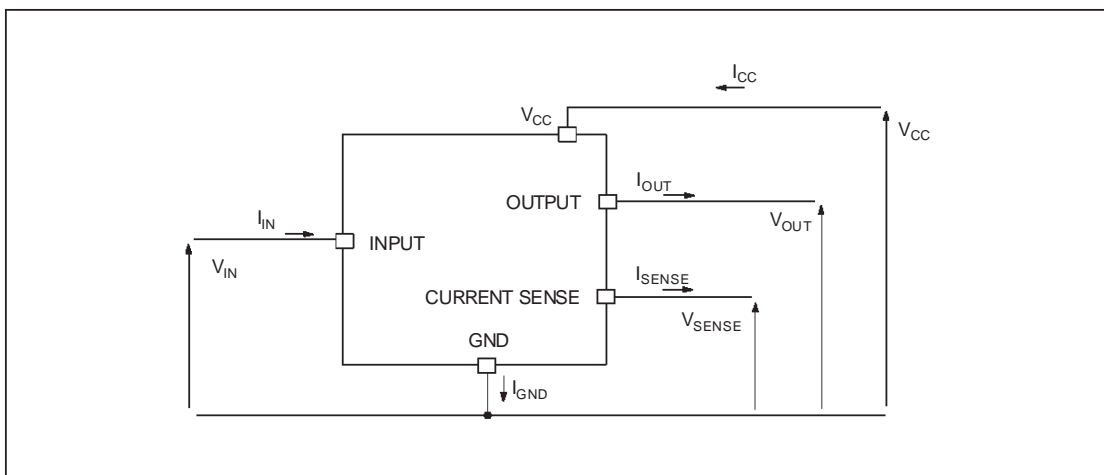
THERMAL DATA

Symbol	Parameter		Value	Unit
$R_{thj-case}$	Thermal resistance junction-case	(MAX)	1	°C/W
$R_{thj-amb}$	Thermal resistance junction-ambient	(MAX)	50	°C/W

ELECTRICAL CHARACTERISTICS ($8V<V_{CC}<36V$; $-40°C<Tj<150°C$; unless otherwise specified)
POWER

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{CC}	Operating supply voltage		5.5	13	36	V
V_{USD}	Undervoltage shutdown		3	4	5.5	V
V_{OV}	Overvoltage shutdown	(See Note 1)	36	42	48	V
R_{ON}	On state resistance	I_{OUT}=15A; T_j=25°C			10	mΩ
		I_{OUT}=15A; T_j=150°C			20	mΩ
		I_{OUT}=9A; V_{CC}=6V			35	mΩ
V_{clamp}	Clamp Voltage	I_{CC}=20 mA (see note 1)	41	48	55	V
I_S	Supply current	Off state; INPUT= n.c.; V_{CC}=13V			25	μA
		On state; V_{IN}=5V; V_{CC}=13V; I_{OUT}=0A; R_{SENSE}=3.9K			5	mA
$I_{L(off)}$	Off state output current	$V_{IN}=V_{OUT}$=0V	0		50	μA

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

SWITCHING (V_{CC}=13V)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$t_{d(on)}$	Turn-on delay time	R1=0.87Ω		50		μs
$t_{d(off)}$	Turn-on delay time	R1=0.87Ω		50		μs
$(dV_{OUT}/dt)_{on}$	Turn-on voltage slope	R1=0.87Ω		0.3		V/μs
$(dV_{OUT}/dt)_{off}$	Turn-off voltage slope	R1=0.87Ω		0.3		V/μs
W_{ON}	Switching losses energy at turn-on	R1=2.6Ω		1.0		mJ
W_{OFF}	Switching losses energy at turn-off	R1=2.6Ω		0.5		mJ

PROTECTIONS

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
I_{lim}	DC Short circuit current	V_{CC}=13V	45	75	120	A
		$5.5V<V_{CC}<36V$			120	A
T_{TSD}	Thermal shutdown temperature		150	175	200	°C
T_R	Thermal reset temperature		135			°C
T_{HYST}	Thermal hysteresis		7	15		°C
V_{DEMAG}	Turn-off output voltage clamp	I_{OUT}=2A; V_{IN}=0; L=6mH	Vcc-41	Vcc-48	Vcc-55	V
V_{ON}	Output voltage drop limitation	I_{OUT}=1.5A T_j= -40°C...+150°C		50		mV

ELECTRICAL CHARACTERISTICS (continued)

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_{OUT}=1.5A; V_{SENSE}=0.5V; T_j= -40°C...150°C	3300	4400	6000	
K_2	I_{OUT}/I_{SENSE}	I_{OUT}=15A; V_{SENSE}=4V; T_j=-40°C	4200	4900	6000	
		T_j=25°C...150°C	4400	4900	5750	
K_3	I_{OUT}/I_{SENSE}	I_{OUT}=45A; V_{SENSE}=4V; T_j=-40°C	4200	4900	5500	
		T_j=25°C...150°C	4400	4900	5250	
V_{SENSE}	Max analog sense output voltage	V_{CC}=5V; I_{OUT} =7.5A; R_{SENSE}=10KΩ	2			V
		V_{CC} >8V; I_{OUT}=15A; R_{SENSE}=10KΩ	4			V
V_{SENSEH}	Analog sense output voltage in overtemperature condition	V_{CC}=13V; R_{SENSE}=3.9KΩ		5.5		V

LOGIC INPUT

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			µA
V_{IH}	Input high level voltage		3.25			V
I_{IH}	High level input current	V_{IN}=3.25V			10	µA
$V_{I(hyst)}$	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

TRUTH TABLE

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

ELECTRICAL TRANSIENT REQUIREMENTS

ISO T/R 7637/1 Test Pulse	TEST LEVELS				
	I	II	III	IV	Delays and Impedance
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

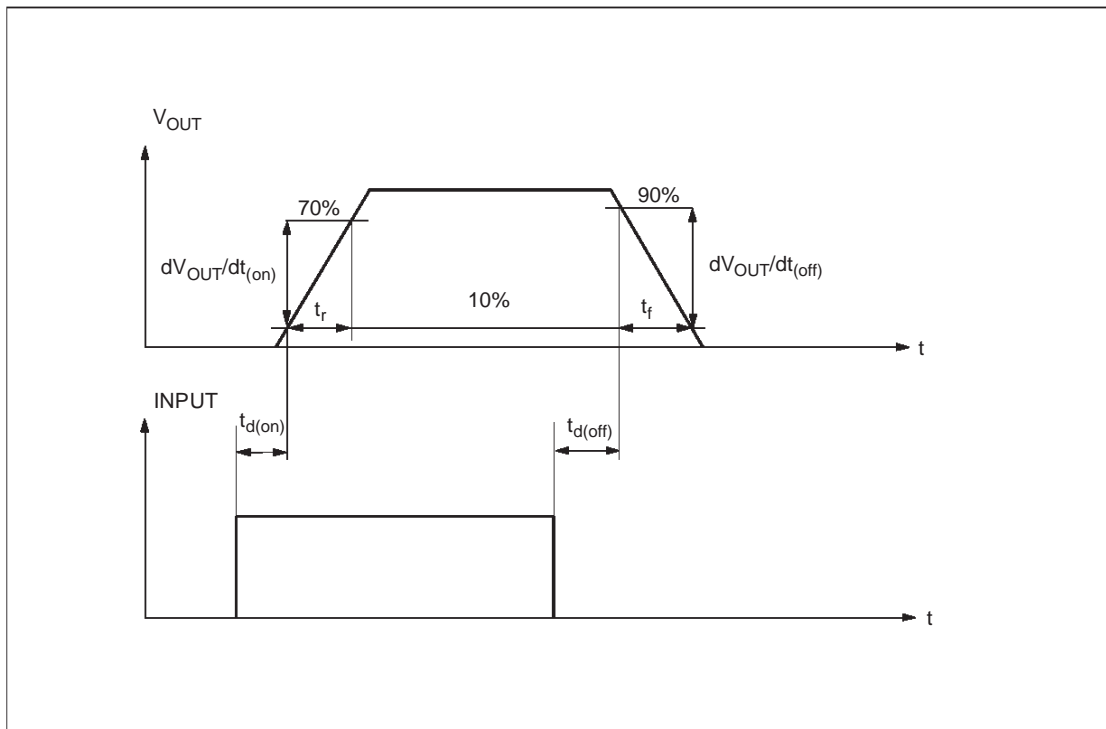| CLASS	CONTENTS
C	All functions of the device are performed as designed after exposure to disturbance.
E	One or more functions of the device is not performed as designed after exposure to disturbance and cannot be returned to proper operation without replacing the device.

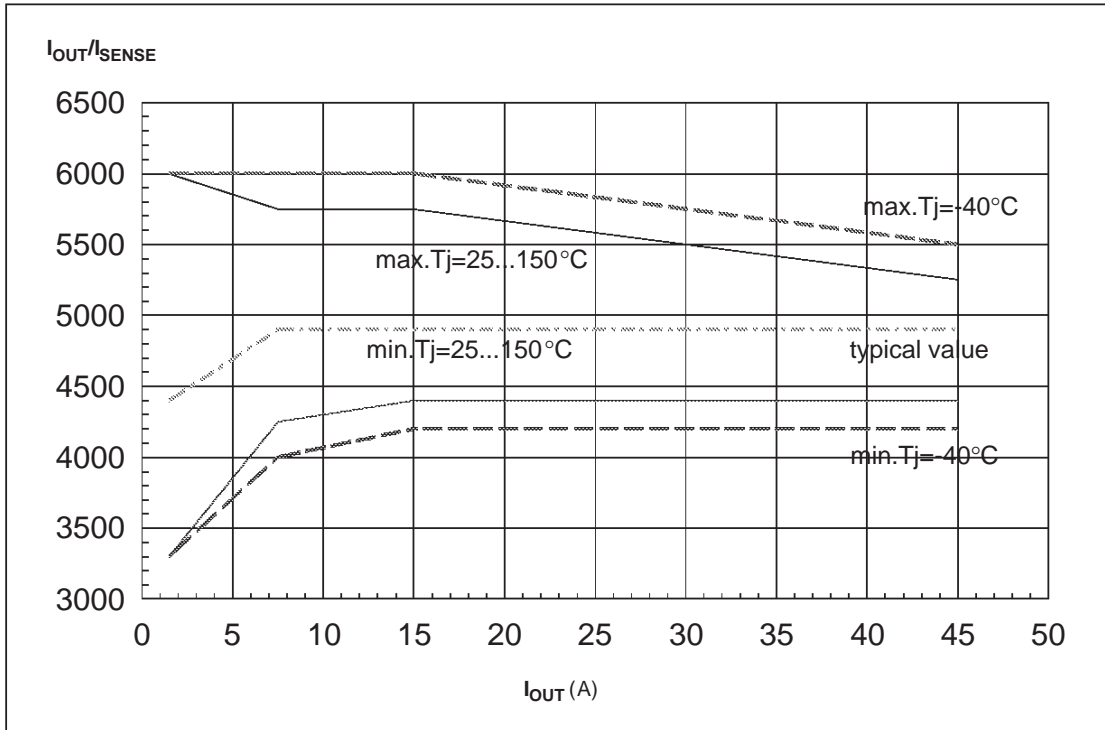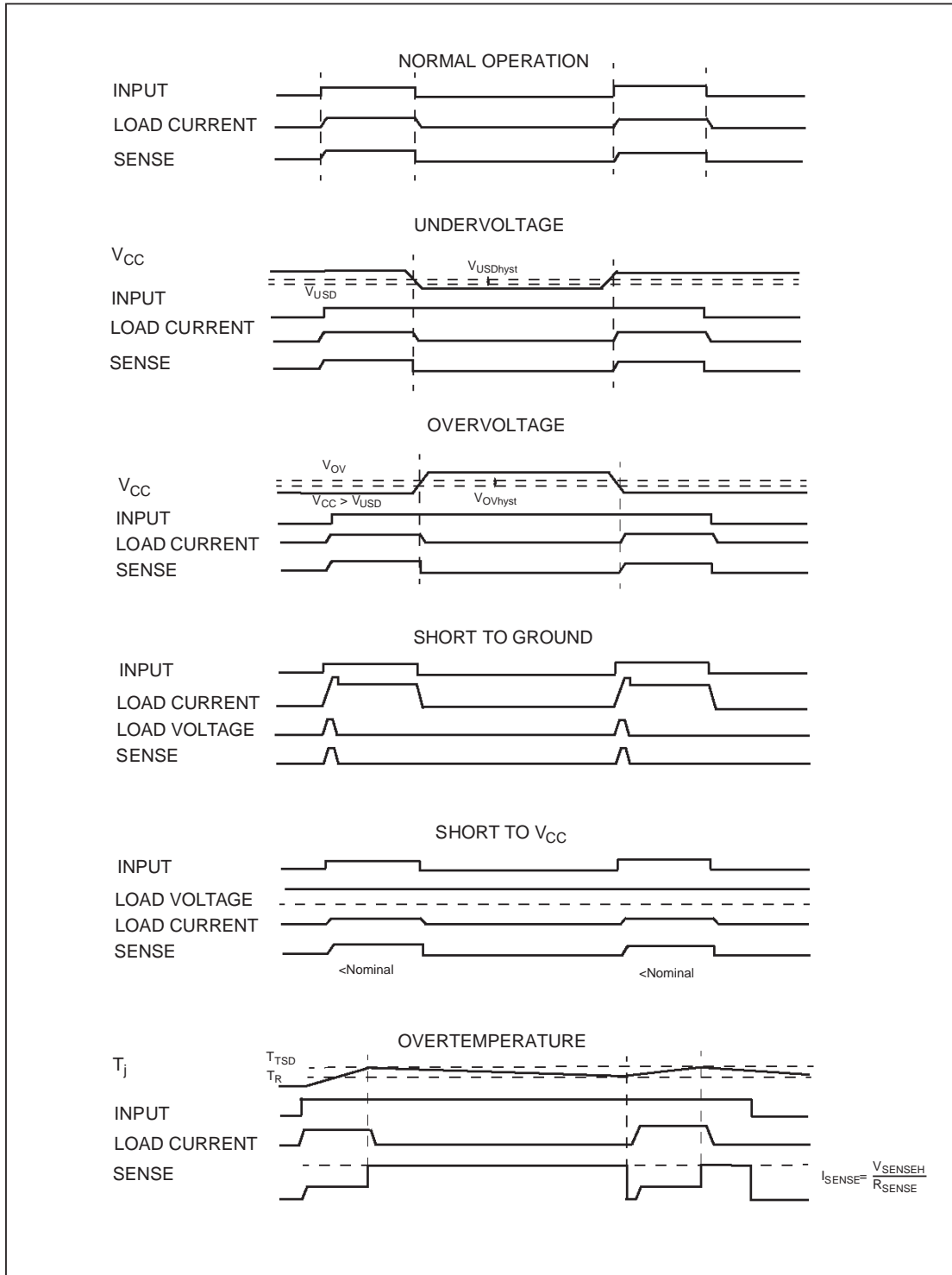## SWITCHING CHARACTERISTICS
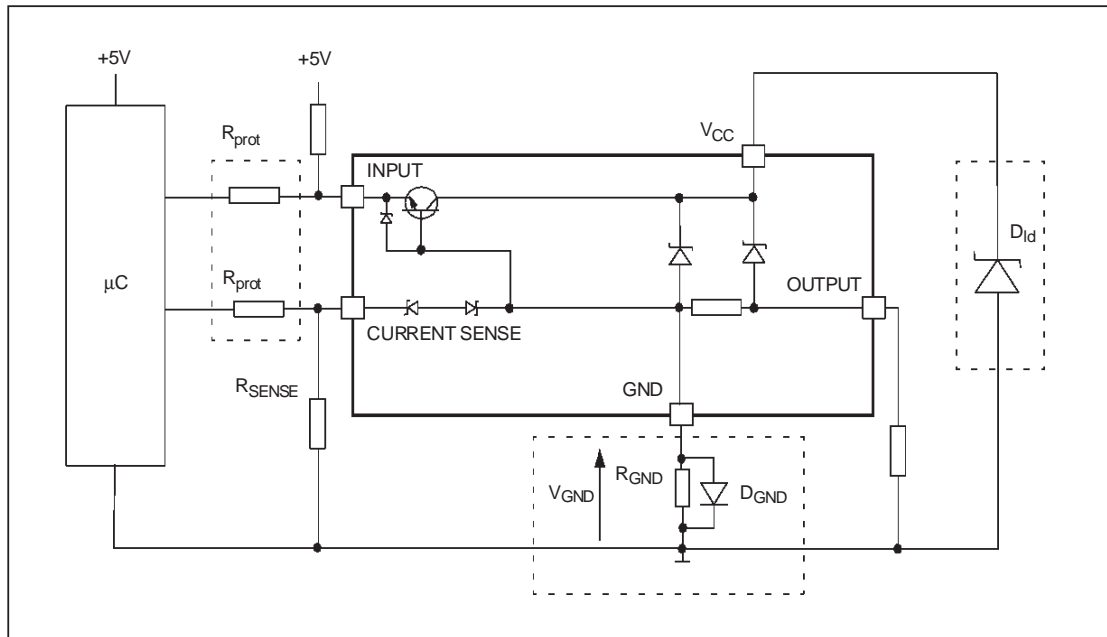
Fig 1: I_{OUT}/I_{SENSE} versus I_{OUT}

Figure1: Waveforms

NORMAL OPERATION

INPUT
LOAD CURRENT
SENSE

UNDERVOLTAGE

V_{CC}
$V_{USDhyst}$
$\overline{V_{USD}}$
INPUT
LOAD CURRENT
SENSE

OVERVOLTAGE

V_{OV}
V_{CC}
$V_{CC} > V_{USD}$ V_{OVhyst}
INPUT
LOAD CURRENT
SENSE

SHORT TO GROUND

INPUT
LOAD CURRENT
LOAD VOLTAGE
SENSE

SHORT TO V_{CC}

INPUT
LOAD VOLTAGE
LOAD CURRENT
SENSE
<Nominal   <Nominal

OVERTEMPERATURE

T_j
T_{TSD}
T_R
INPUT
LOAD CURRENT
SENSE
$$I_{SENSE} = \frac{V_{SENSEH}}{R_{SENSE}}$$

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) $R_{GND} \leq 600mV / (I_{S(on)max})$.

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 $I_{S(on)max}$ 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 ($I_{S(on)max} * R_{GND}$) 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 ($R_{GND}=1k\Omega$) 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 HSD. Also in this case, the presence of the ground network will produce a shift (j 600mV) in the input threshold 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_{ld} 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 transients 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 HSD I/Os (Input levels compatibility) with the latch-up limit of μC I/Os.

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

Calculation example:

For $V_{CCpeak}= -100V$ and $I_{latchup} \geq 20mA$; $V_{OH\mu C} \geq 4.5V$

$5k\Omega \leq R_{prot} \leq 10k\Omega$.
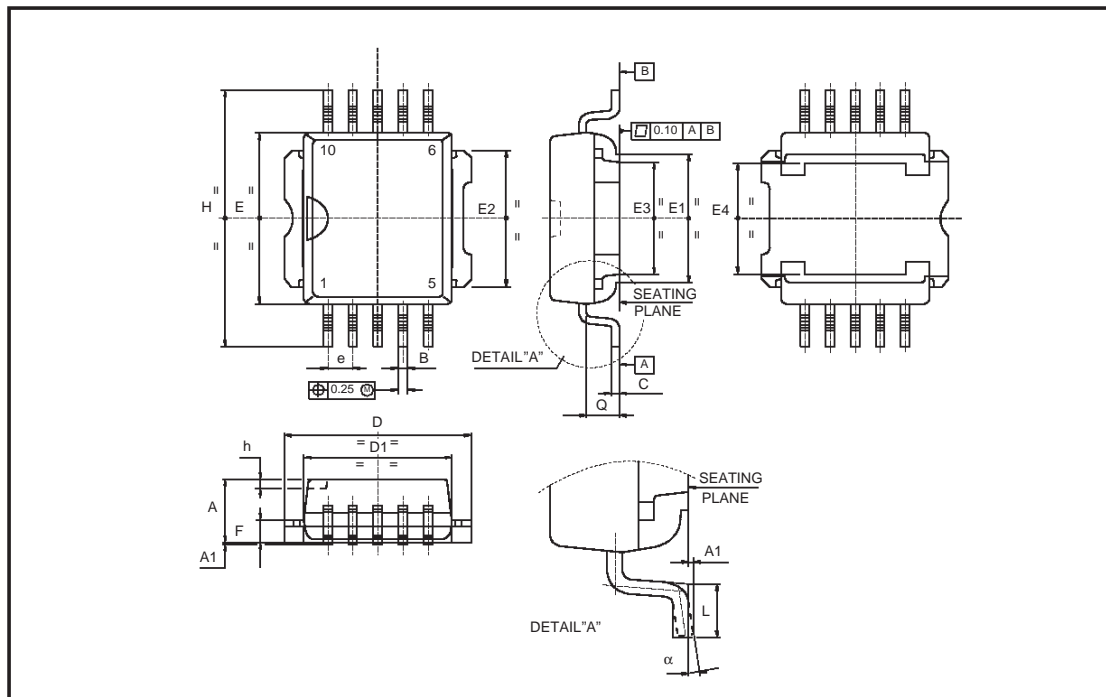
Recommended R_{prot} value is 65kΩ.

PowerSO-10™ MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	3.35		3.65	0.132		0.144
A1	0.00		0.10	0.000		0.004
B	0.40		0.60	0.016		0.024
c	0.35		0.55	0.013		0.022
D	9.40		9.60	0.370		0.378
D1	7.40		7.60	0.291		0.300
E	9.30		9.50	0.366		0.374
E1	7.20		7.40	0.283		0.291
E2	7.20		7.60	0.283		300
E3	6.10		6.35	0.240		0.250
E4	5.90		6.10	0.232		0.240
e		1.27			0.050	
F	1.25		1.35	0.049		0.053
H	13.80		14.40	0.543		0.567
h		0.50			0.002	
Q		1.70			0.067	
α	0º		8º			

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