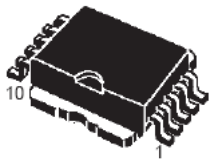
VN380SP

Smart solenoid driver solid state relay

Features

Type	$V_{load(cl)}$	I_n	R_{on}
VN380SP	60 V	5 A	0.11 Ω

- Load current up to 7 A
- CMOS compatible
- Thermal shutdown
- Diagnostic output
- Integrated clamps
- Over current protection
- Open coil detection
- Overvoltage detection



PowerSO-10

Description

The VN380SP is monolithic device made using STMicroelectonics VIPower™ Technology, intended for driving inductive loads. The inputs are CMOS compatible. The diagnostic output provides an indication of open-load and demagnetization mode. Built-in thermal shutdown protects the chip from over temperature. In case or over current or over temperature or overvoltage the product will automatically operate in recirculation mode.

Table 1. Device summary

Package	Order codes			
	Tube	Tube (lead free)	Tape and reel	Tape and reel (lead free)
PowerSO-10	VN380SP	VN380SP-E	VN380SP13TR	VN380SPTR-E

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1 Block diagram and pin description

Figure 1. Block diagram

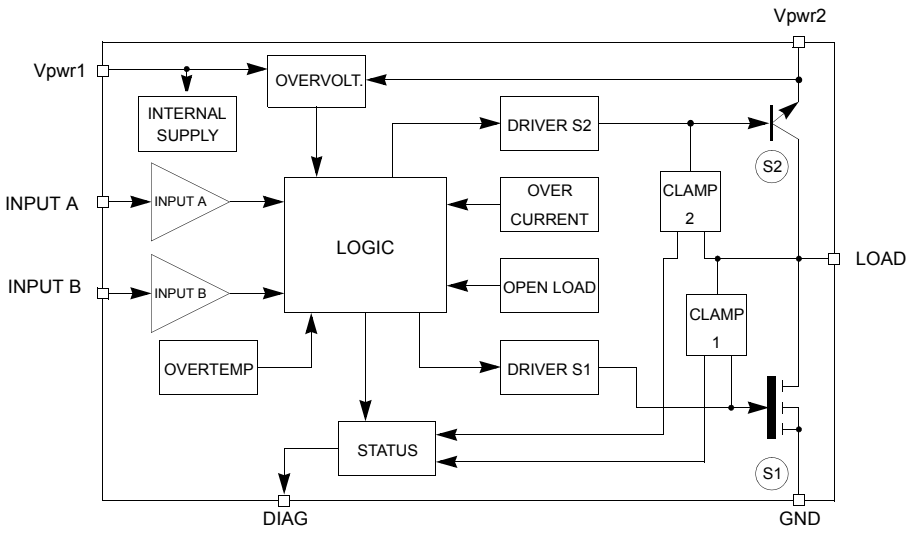
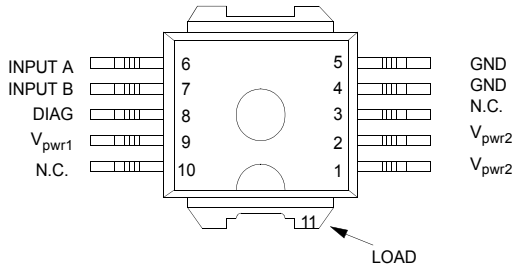


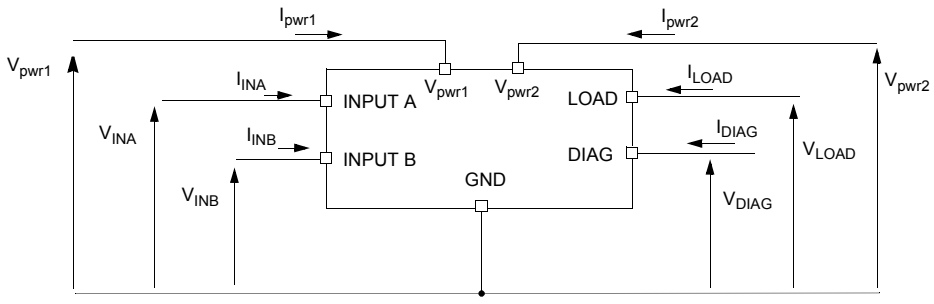
Figure 2. Configuration diagram (top view)



PowerSO-10™

2 Electrical specifications

Figure 3. Current and voltage conventions



2.1 Absolute maximum ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{load}	Maximum DC load voltage	Internally clamped	V
I_{load}	Maximum DC load current	Internally clamped	A
I_{rload}	Reverse load current, T_{case} = 25 °C	-10	A
E_c	Maximum clamping energy, T_{case} = 150 °C, f = 40 Hz, 1000 hours (f: input A frequency)	100	mJ
E_c	Maximum clamping energy, T_{case} = -40 °C, f = 75 Hz, 5 minutes (f: input A frequency)	100	mJ
I_{in}	Inputs current	+/-10	mA
I_{diag}	Diagnostic output current	+/-10	mA
V_{ESD}	Electrostatic discharge (R = 1.5 kΩ, C = 100 pF, all pins)	2000	V
V_{pwr1}	Power voltage 1	60	V
V_{pwr2}	Power voltage 2	60	V
R_{Vpwr}	Reverse power voltage	-0.3	V
T_j	Junction operating temperature	-40 to 150(1)	°C
T_{stg}	Storage temperature	-55 to 150	°C
V_{in}	Input voltages	8	V
V_{diag}	Diagnostic output voltage	8	V
C_{load}	Load capacity	1	µF

1. Higher temperature is allowed during a short time before thermal shutdown. Permanent operation above °C 150 is not allowed.

2.2 Thermal data

Table 3. Thermal data

Symbol	Parameter	PowerSO-10	Unit
$R_{thj\text{-}case}$	Thermal resistance junction-case max	1.67	°C/W
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient max(1)	50	°C/W

1. When mounted using minimum recommented pad size on FR-4 board.

2.3 Electrical characteristics

10 V < V_{PWR1} < 18 V; -40 °C < T_J < 150 °C unless otherwise specified

Table 4. Electrical characteristics

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
Power						
V_{pwr1}	Operating voltage		6	13	24	V
R_{on1}	On-state resistance (excitation path)	I_{load} = I_n = 5 A V_{inA} = V_{inB} = 5 V			0.2	Ω
R_{on2}	On-state resistance (recirculation path)	V_{pwr1} = 13 V; I_{load} = I_n = 5 A V_{inA} = 5 V; V_{inB} = GND			0.4	Ω
$V_{ce(sat)}$	Saturation voltage of bipolar S2	I_{load} = I_n = 5 A V_{pwr1} = V_{pwr2} = 13 V I_{load} = 10 A; T_J > 125 °C V_{pwr1} = V_{pwr2} = 13 V			2 2	V V
I_{sq}	Supply quiescent current	V_{pwr1} = 13 V; V_{inA} = V_{inB} = 5 V			25	mA
I_{lk}	Output leakage current	V_{pwr1} = 18 V; V_{inA} = V_{inB} = GND			5	mA
I_{off}	Off-state supply current	V_{inA} = V_{inB} = GND V_{pwr1} = not connected 10 V < V_{pwr2} < 24 V T_J = 25 °C			50	µA
Switching (excitation path)						
$t_{d(on)}$	Turn-on delay time	R_{load} = 2.5 Ω; V_{inA} = 5 V (see *Figure 4*)			50	µs
t_r	Rise time of output current	R_{load} = 2.5 Ω; V_{inA} = 5 V (see *Figure 4*)	1		20	µs
$t_{d(off)}$	Turn-off delay time	R_{load} = 2.5 Ω; V_{inA} = 5 V (see *Figure 4*)			50	µs
t_f	Fall time of output current	R_{load} = 2.5 Ω; V_{inA} = 5 V (see *Figure 4*)	1		20	µs
Logic input						
V_{il}	Input low level voltage				1.5	V

Table 4. Electrical characteristics (continued)

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
V_{ih}	Input high level voltage		3.5			V
$V_{i(hyst)}$	Input hysteresis voltage		0.5	0.8	2	V
$V_{i(CL)}$	Input clamp voltage	I_{in} = 10 mA	8	9.5	11	V
I_{in}	Input current	V_{inA} = V_{inB} = 2 V V_{inA} = V_{inB} = 5 V	20		 250	µA µA
Protections and diagnostics						
T_{tsd}	Thermal shutdown temperature		160	180	200	°C
I_{lim}	Current cut off level		15		30	A
V_{ov}	Overvoltage threshold	V_{inA} = V_{inB} = 5 V	27			V
V_{diag}	Status output voltage	Diagnostic output active (low) I_{diag} = 2 mA			0.5	V
$V_{diag(CL)}$	Status output clamp voltage	I_{diag} = 10 mA	8	9.5	11	V
T_d	Status propagation delay	Demagnetization mode (fast turn-off) V_{diag} = 1 V (see*Figure 6*)			70	µs
V_{cl1}	Switch S1 detection clamp	I_{load} = I_n = 5 A	60	70	80	V
V_{cl2}	Output inductive clamp voltage	I_{load} = I_n = 5 A	24	28.5	33	V
V_{fb}	Flyback diagnostic threshold	Demagnetization mode (fast turn-off) V_{cl} = V_{cl1} or V_{cl2}	V_{cl}-5		V_{cl}	V
I_{ol}	Open-load current level		5		700	mA

Table 5. Truth table

Conditions	In A	In B	S1	S2
Standby modes	L L	L H	Off Off	Off Off
Excitation mode	H	H	On	Off
Recirculation mode	H	L	Off	On
Demagnetization mode (fast turn-off) V_{pwr2} +V_{cl2} <V_{cl1} V_{pwr2} +V_{cl2} >V_{cl1}	 L L	 L L	 Off On	 On On
Thermal shutdown	H	H	Off	On
Current cut off	H	H	Off	On
Open-load	See open-load waveforms on *Figure 5*			
Overvoltage	H	H	Off	On

3 Functional description

3.1 Current cut off

When the load current rise above the current cut off level, S1 is automatically switched off and the devices operates in recirculation mode (S2 active). S1 is latched off until A goes low and high again.

This default is not displayed by diagnostic flag.

3.2 Open-load

If the load current is below the open-load current level, the flag of the open-load block is activated but this default is displayed by the diagnostic output on the falling edge of input B and the diagnostic output is latched at low level until input A goes low and high again. In case an open-load is detected during an active phase of input B, but disappears before a falling edge of input B, this default is not dispayed by the diagnostic flag (see open-load waveforms on *Figure 5*).

3.3 Thermal shutdown

The device is internally protected against over temperatures by the thermal circuit protection. When the device junction temperature exceeds the protection limit, S1 is automatically switched off. Therefore the device operates in recirculation mode (S2 active). S1 remain latched off until V_{pwr1} goes low and high again. This default is not dispayed by the diagnostic flag.

3.4 Overvoltage

During the on-state of S1 switch, if V_{pwr1} or V_{pwr2} is rising above the threshold detection S1 is automatically switched off, therefore the device operates in recirculation mode.

Figure 4. Switching parameter test conditions

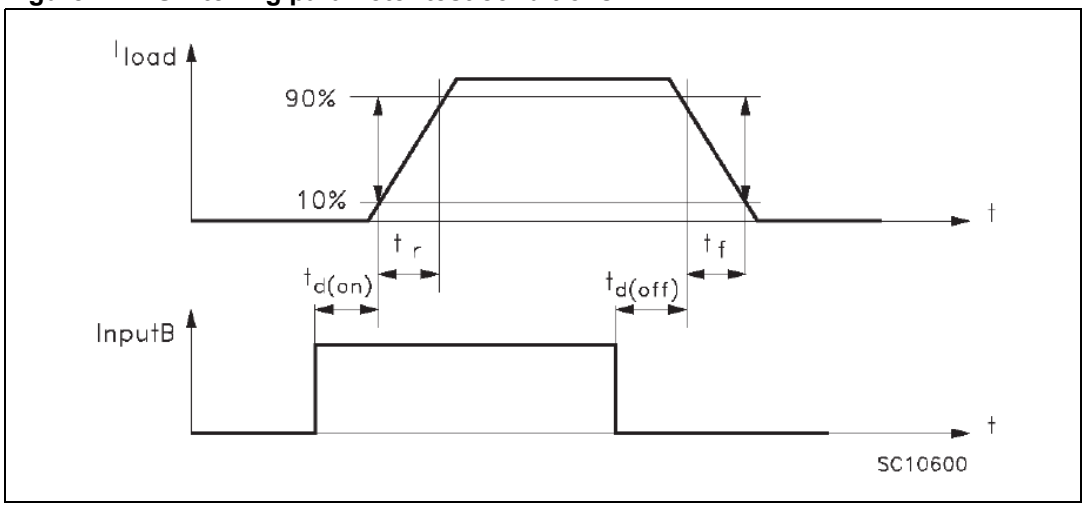


Figure 5. Switching waveforms

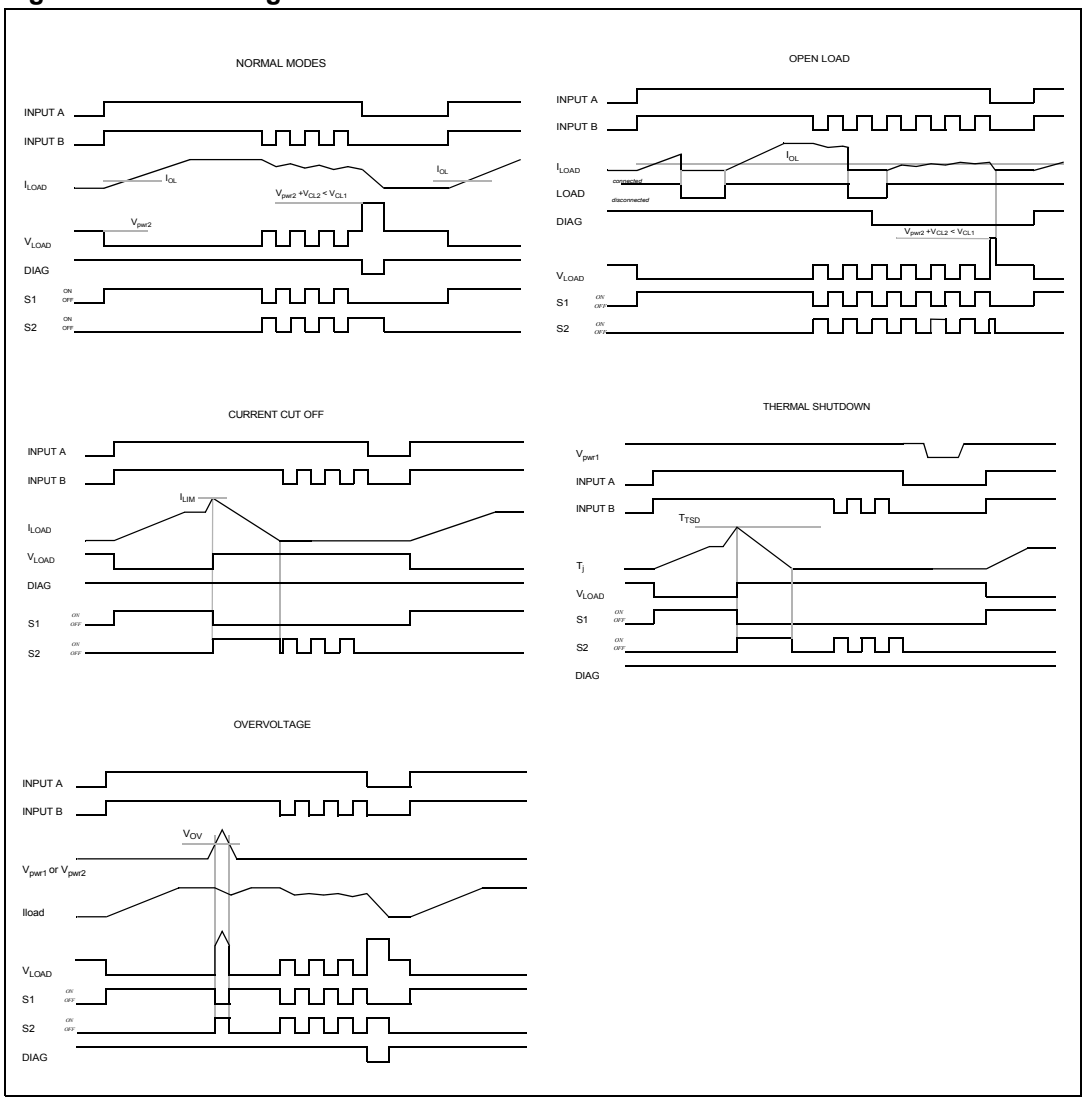
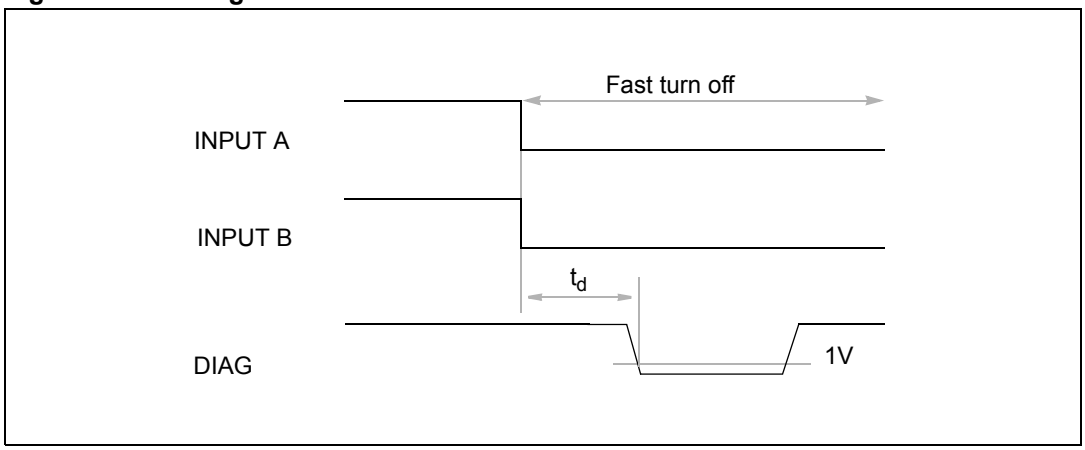


Figure 6. Demagnetization mode



4 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: *www.st.com*.

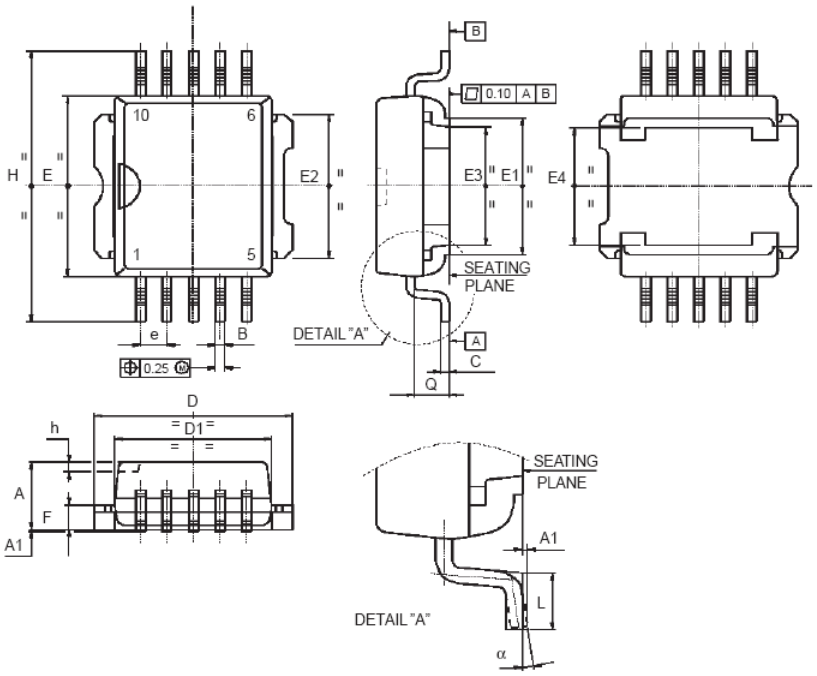
ECOPACK® is an ST trademark.

4.1 PowerSO-10 mechanical data

Table 6. 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		0.300
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	
L	1.20		1.80	0.047		0.071
q		1.70			0.067	
α	0°		8°			

Figure 7. PowerSO-10 package dimension



5 Revision history

Table 7. Document revision history

Date	Revision	Changes
10-Jun-2009	1	Initial release.
20-Sep-2013	2	Updated Disclaimer.

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