

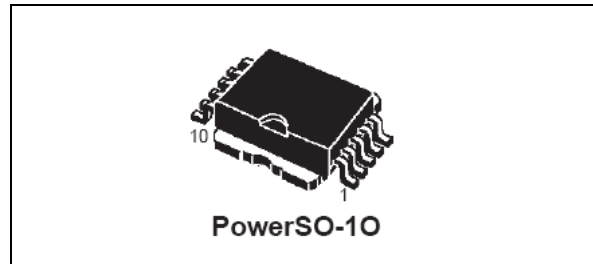


## Smart solenoid driver solid state relay

### Features

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

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



### Description

The VN380SP is monolithic device made using STMicroelectronics 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 of 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

# Contents

- 1      Block diagram and pin description ..... 3**
  
- 2      Electrical specifications ..... 4**
  - 2.1    Absolute maximum ratings ..... 4
  - 2.2    Thermal data ..... 5
  - 2.3    Electrical characteristics ..... 5
  
- 3      Functional description ..... 7**
  - 3.1    Current cut off ..... 7
  - 3.2    Open-load ..... 7
  - 3.3    Thermal shutdown ..... 7
  - 3.4    Overvoltage ..... 7
  
- 4      Package information ..... 9**
  - 4.1    PowerSO-10 mechanical data ..... 9
  
- 5      Revision history ..... 11**

# 1 Block diagram and pin description

Figure 1. Block diagram

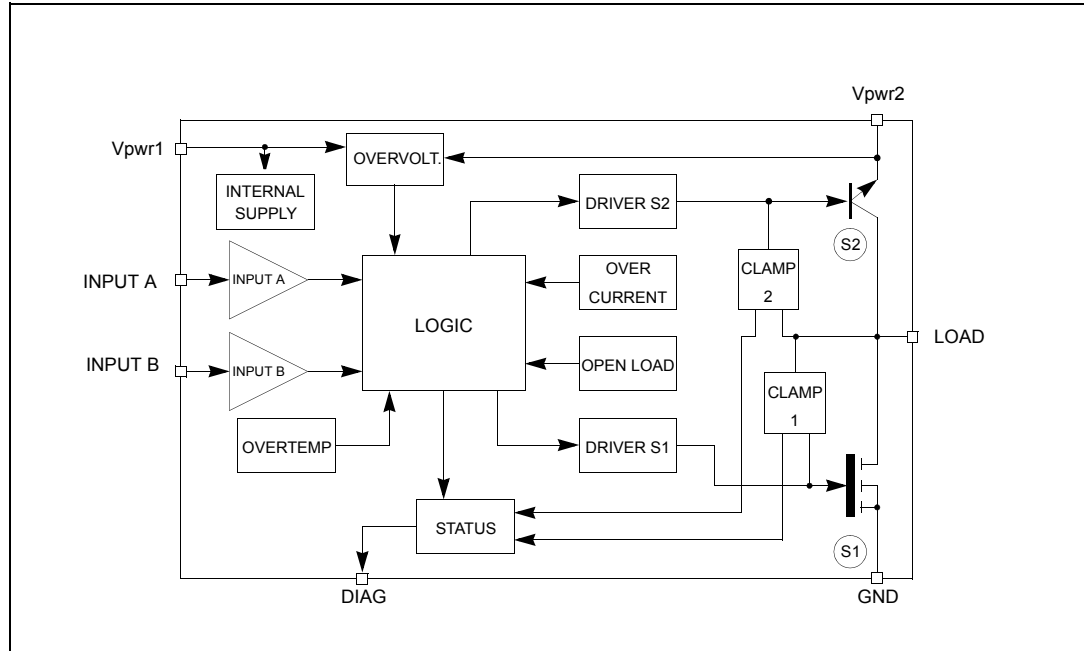
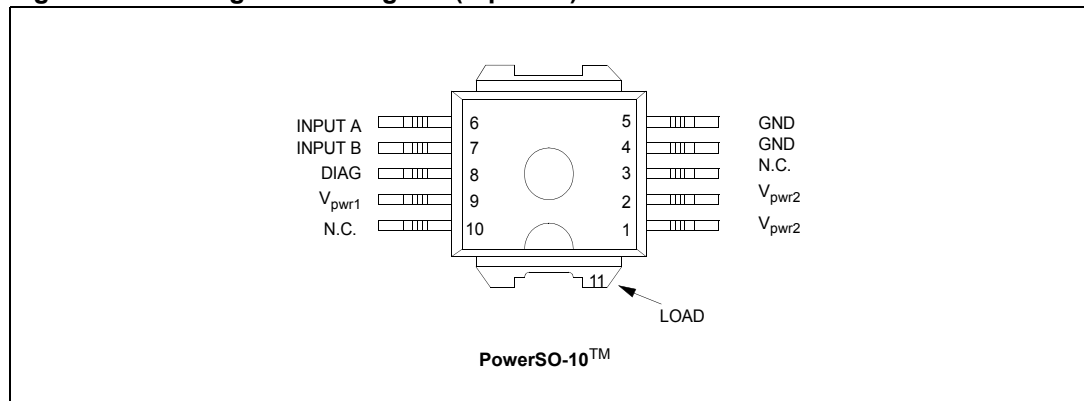
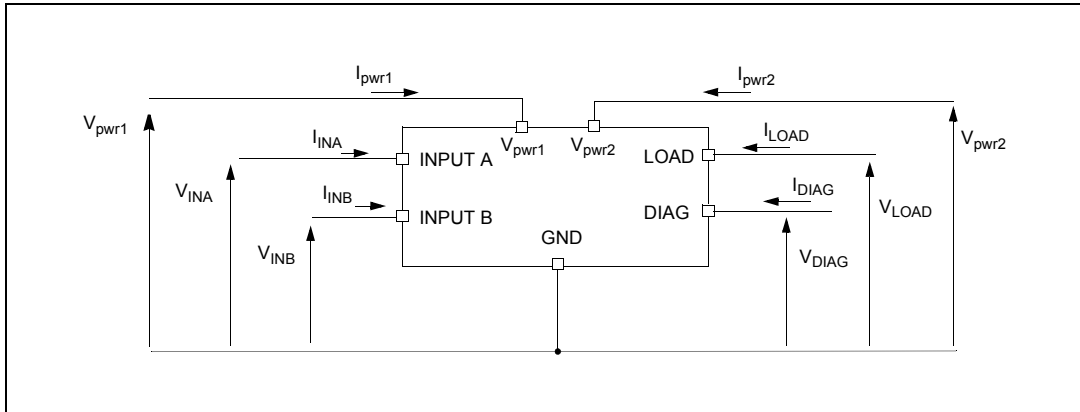


Figure 2. Configuration diagram (top view)



## 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, $T_{case} = 25\text{ }^{\circ}\text{C}$	-10	A
$E_c$	Maximum clamping energy, $T_{case} = 150\text{ }^{\circ}\text{C}$ , $f = 40\text{ Hz}$ , 1000 hours (f: input A frequency)	100	mJ
$E_c$	Maximum clamping energy, $T_{case} = -40\text{ }^{\circ}\text{C}$ , $f = 75\text{ Hz}$ , 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 ( $R = 1.5\text{ k}\Omega$ , $C = 100\text{ pF}$ , 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 <sup>(1)</sup>	$^{\circ}\text{C}$
$T_{stg}$	Storage temperature	-55 to 150	$^{\circ}\text{C}$
$V_{in}$	Input voltages	8	V
$V_{diag}$	Diagnostic output voltage	8	V
$C_{load}$	Load capacity	1	$\mu\text{F}$

1. Higher temperature is allowed during a short time before thermal shutdown. Permanent operation above  $^{\circ}\text{C}$  150 is not allowed.

## 2.2 Thermal data

**Table 3. Thermal data**

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

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

## 2.3 Electrical characteristics

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

**Table 4. Electrical characteristics**

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
<b>Power</b>						
$V_{pwr1}$	Operating voltage		6	13	24	V
$R_{on1}$	On-state resistance (excitation path)	$I_{load} = I_n = 5\text{ A}$ ; $V_{inA} = V_{inB} = 5\text{ V}$			0.2	$\Omega$
$R_{on2}$	On-state resistance (recirculation path)	$V_{pwr1} = 13\text{ V}$ ; $I_{load} = I_n = 5\text{ A}$ $V_{inA} = 5\text{ V}$ ; $V_{inB} = \text{GND}$			0.4	$\Omega$
$V_{ce(sat)}$	Saturation voltage of bipolar S2	$I_{load} = I_n = 5\text{ A}$ $V_{pwr1} = V_{pwr2} = 13\text{ V}$			2	V
		$I_{load} = 10\text{ A}$ ; $T_J > 125\text{ °C}$ $V_{pwr1} = V_{pwr2} = 13\text{ V}$			2	V
$I_{sq}$	Supply quiescent current	$V_{pwr1} = 13\text{ V}$ ; $V_{inA} = V_{inB} = 5\text{ V}$			25	mA
$I_{lk}$	Output leakage current	$V_{pwr1} = 18\text{ V}$ ; $V_{inA} = V_{inB} = \text{GND}$			5	mA
$I_{off}$	Off-state supply current	$V_{inA} = V_{inB} = \text{GND}$ $V_{pwr1} = \text{not connected}$ $10\text{ V} < V_{pwr2} < 24\text{ V}$ $T_J = 25\text{ °C}$			50	$\mu\text{A}$
<b>Switching (excitation path)</b>						
$t_{d(on)}$	Turn-on delay time	$R_{load} = 2.5\ \Omega$ ; $V_{inA} = 5\text{ V}$ (see <a href="#">Figure 4</a> )			50	$\mu\text{s}$
$t_r$	Rise time of output current	$R_{load} = 2.5\ \Omega$ ; $V_{inA} = 5\text{ V}$ (see <a href="#">Figure 4</a> )	1		20	$\mu\text{s}$
$t_{d(off)}$	Turn-off delay time	$R_{load} = 2.5\ \Omega$ ; $V_{inA} = 5\text{ V}$ (see <a href="#">Figure 4</a> )			50	$\mu\text{s}$
$t_f$	Fall time of output current	$R_{load} = 2.5\ \Omega$ ; $V_{inA} = 5\text{ V}$ (see <a href="#">Figure 4</a> )	1		20	$\mu\text{s}$
<b>Logic input</b>						
$V_{il}$	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	$I_{in} = 10 \text{ mA}$	8	9.5	11	V
$I_{in}$	Input current	$V_{inA} = V_{inB} = 2 \text{ V}$ $V_{inA} = V_{inB} = 5 \text{ V}$	20		250	$\mu\text{A}$ $\mu\text{A}$
<b>Protections and diagnostics</b>						
$T_{tsd}$	Thermal shutdown temperature		160	180	200	$^{\circ}\text{C}$
$I_{lim}$	Current cut off level		15		30	A
$V_{ov}$	Overvoltage threshold	$V_{inA} = V_{inB} = 5 \text{ V}$	27			V
$V_{diag}$	Status output voltage	Diagnostic output active (low) $I_{diag} = 2 \text{ mA}$			0.5	V
$V_{diag(CL)}$	Status output clamp voltage	$I_{diag} = 10 \text{ mA}$	8	9.5	11	V
$T_d$	Status propagation delay	Demagnetization mode (fast turn-off) $V_{diag} = 1 \text{ V}$ (see <a href="#">Figure 6</a> )			70	$\mu\text{s}$
$V_{cl1}$	Switch S1 detection clamp	$I_{load} = I_n = 5 \text{ A}$	60	70	80	V
$V_{cl2}$	Output inductive clamp voltage	$I_{load} = I_n = 5 \text{ A}$	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	Off	Off
	L	H	Off	Off
Excitation mode	H	H	On	Off
Recirculation mode	H	L	Off	On
Demagnetization mode (fast turn-off)				
	$V_{pwr2} + V_{cl2} < V_{cl1}$	L	L	Off
$V_{pwr2} + V_{cl2} > V_{cl1}$	L	L	On	On
Thermal shutdown	H	H	Off	On
Current cut off	H	H	Off	On
Open-load	See open-load waveforms on <a href="#">Figure 5</a>			
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 displayed 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 displayed 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**

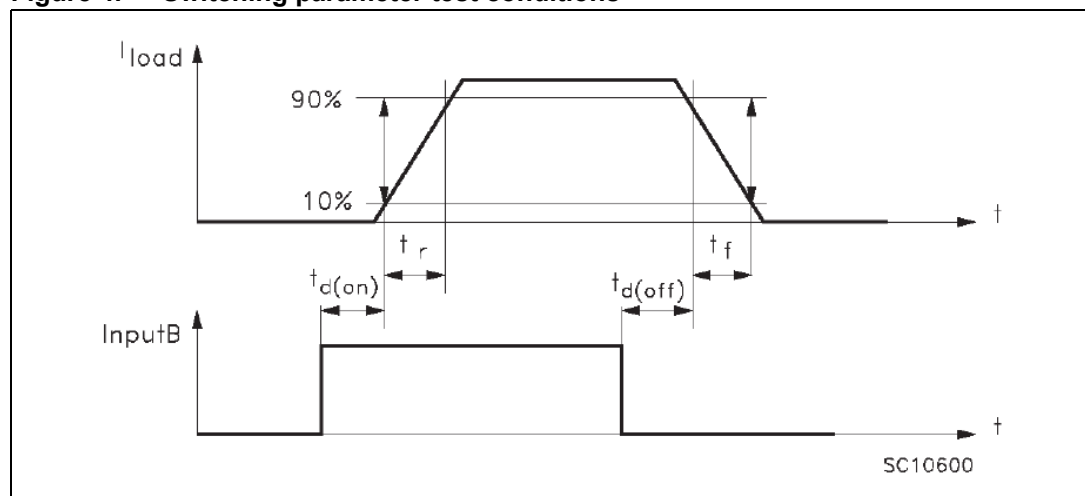


Figure 5. Switching waveforms

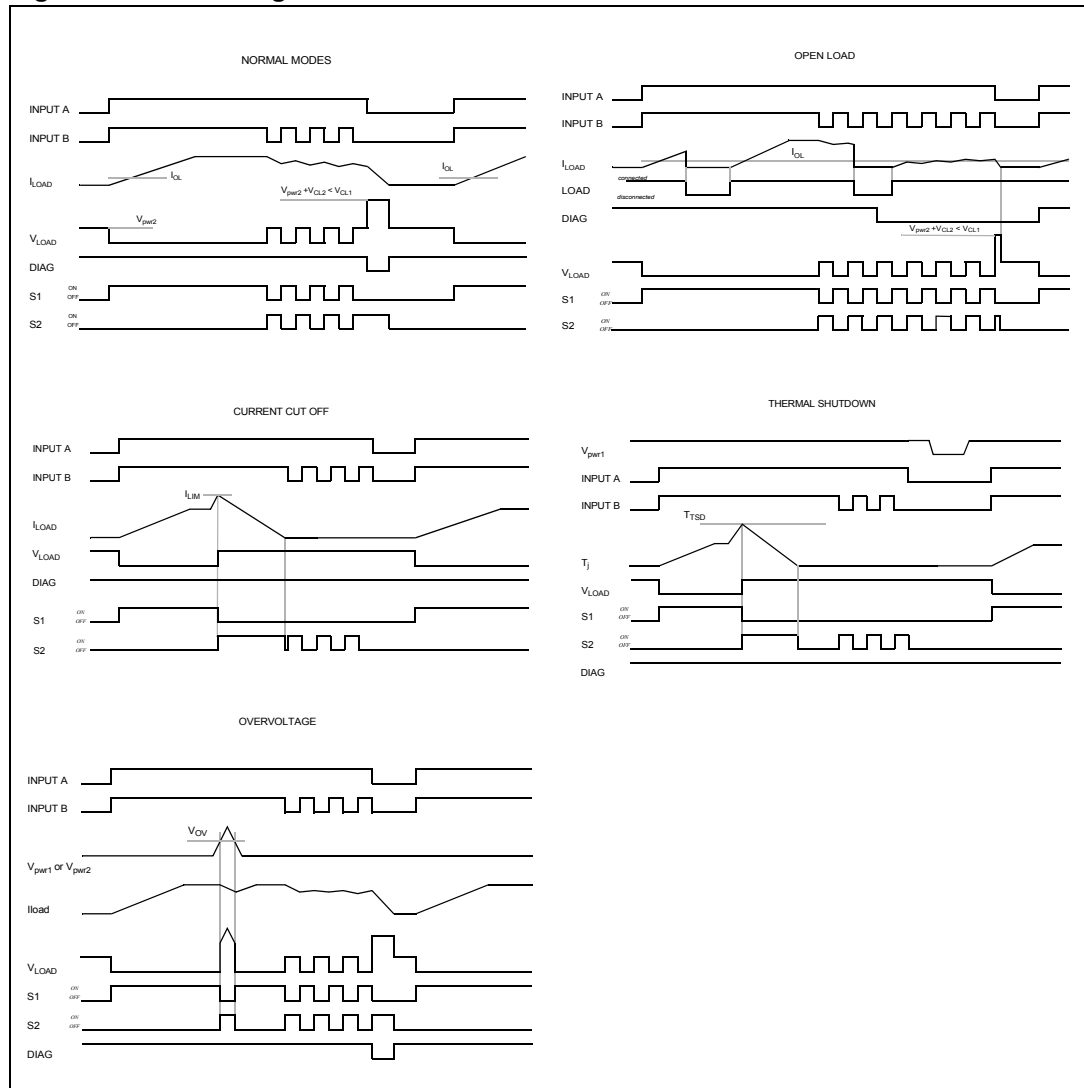
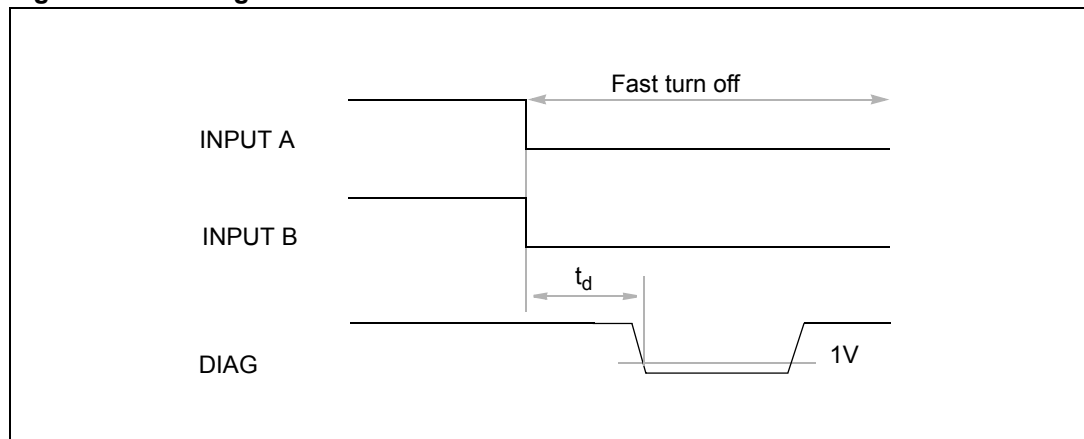


Figure 6. Demagnetization mode



## 4 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com).

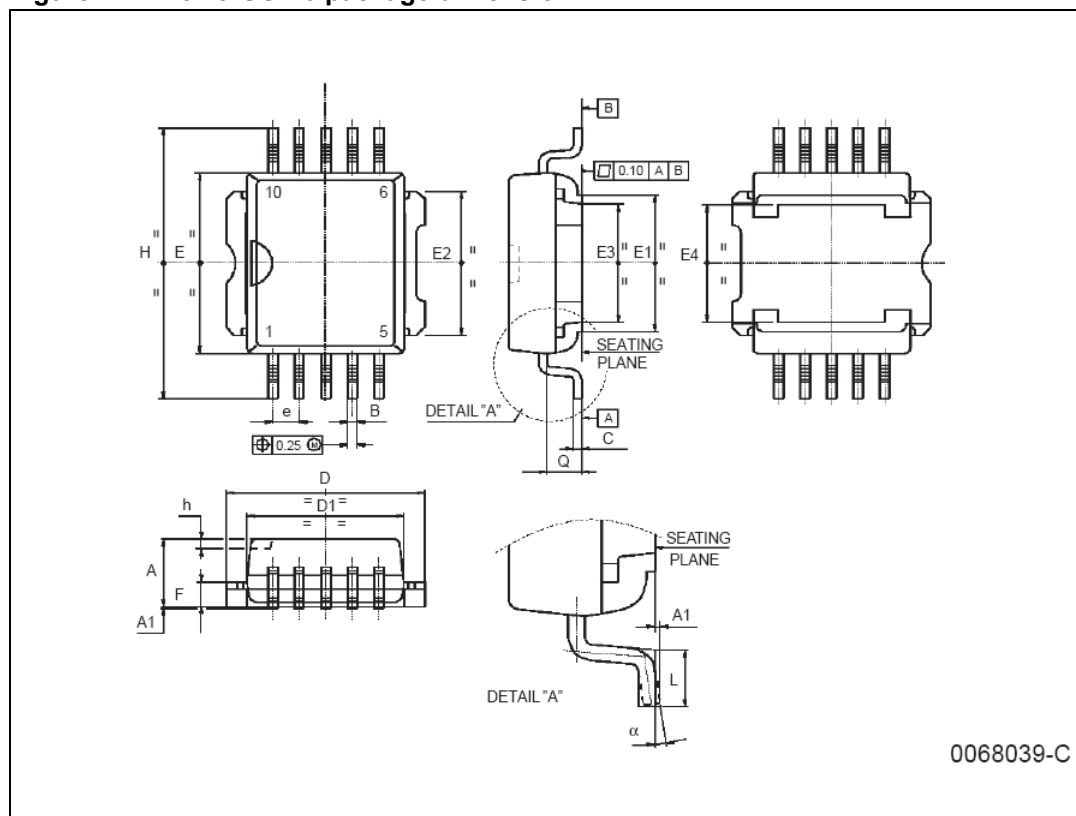
ECOPACK<sup>®</sup> is an ST trademark.

### 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	
$\alpha$	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.

**Please Read Carefully:**

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

**UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.**

**ST PRODUCTS ARE NOT DESIGNED OR AUTHORIZED FOR USE IN: (A) SAFETY CRITICAL APPLICATIONS SUCH AS LIFE SUPPORTING, ACTIVE IMPLANTED DEVICES OR SYSTEMS WITH PRODUCT FUNCTIONAL SAFETY REQUIREMENTS; (B) AERONAUTIC APPLICATIONS; (C) AUTOMOTIVE APPLICATIONS OR ENVIRONMENTS, AND/OR (D) AEROSPACE APPLICATIONS OR ENVIRONMENTS. WHERE ST PRODUCTS ARE NOT DESIGNED FOR SUCH USE, THE PURCHASER SHALL USE PRODUCTS AT PURCHASER'S SOLE RISK, EVEN IF ST HAS BEEN INFORMED IN WRITING OF SUCH USAGE, UNLESS A PRODUCT IS EXPRESSLY DESIGNATED BY ST AS BEING INTENDED FOR "AUTOMOTIVE, AUTOMOTIVE SAFETY OR MEDICAL" INDUSTRY DOMAINS ACCORDING TO ST PRODUCT DESIGN SPECIFICATIONS. PRODUCTS FORMALLY ESCC, QML OR JAN QUALIFIED ARE DEEMED SUITABLE FOR USE IN AEROSPACE BY THE CORRESPONDING GOVERNMENTAL AGENCY.**

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2013 STMicroelectronics - All rights reserved



STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Philippines - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

[www.st.com](http://www.st.com)

## Looking for pricing, stock, or lifecycle information?

Click below to explore more details on WIN SOURCE:

-  [View VN380SP13TR](#) on WIN SOURCE
-  [STMicroelectronics](#) Information

## Optimize Your Supply Chain with WIN SOURCE Solutions

-  Global Sourcing Solution
-  Obsolete Management
-  Cost Control Management
-  Shortage Management
-  Alternative Solution
-  Excess Inventory Management