VB027SP-E

High voltage ignition coil driver power integrated circuit

Type	V_{cl}	I_{cl}	$I_{d(on)}$
VB027SP-E	300 V	9 A	130 mA

PowerSO-10

Features

- ECOPACK®: lead free and RoHS compliant
- Automotive Grade: compliance with AEC guidelines
- Primary coil voltage internally set
- Coil current limit internally set
- Logic level compatible input
- Driving current quasi proportional to collector current
- Double flag-on coil current
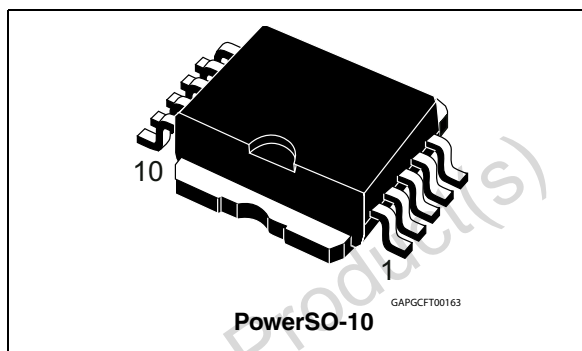
Description

The VB027SP-E is a high voltage power integrated circuit made using the STMicroelectronics™ VIPower™ technology, with vertical current flow power darlington and logic level compatible driving circuit.

Built-in protection circuit for coil current limiting and collector voltage clamping allows the device to be used as smart, high voltage, high current interface in advanced electronic ignition system.

Table 1.   Device summary

Package	Order code	
	Tube	**Tape and reel**
PowerSO-10	VB027SP-E	VB027SPTR-E

Contents

List of tables

List of figures

1 Block diagram and pins description

Figure 1. Block diagram

Figure 2. Configuration diagram (top view)
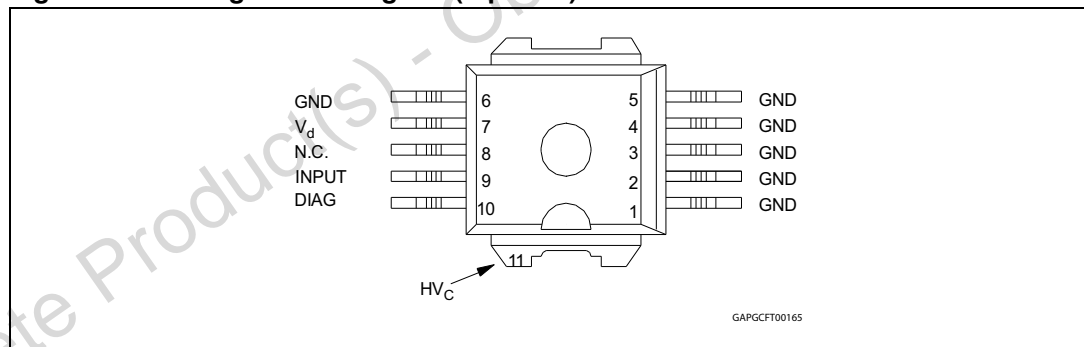
Table 2. Pin function

Pin number	Name	Function
1÷5	GND	Emitter power ground
6[1]	GND	Control ground
7	V_d	Driving stage supply voltage
8	N.C.	
9	INPUT	Logic input channel
10	DIAG	Diagnostic output signal
TAB	HV_C	Primary coil output signal

1. Pin 1÷5 = power GND, pin 6 = signal GND. Pin 6 must be connected to pins 1÷5 externally.

2 Electrical specifications

2.1 Absolute maximum ratings

Stressing the device above the rating listed in the Table 3: Absolute maximum ratings may cause permanent damage to the device. These are stress ratings only and operation of the device at these or any other conditions above those indicated in the operating sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. Refer also to the STMicroelectronics SURE program and other relevant quality documents.

Table 3.   Absolute maximum ratings

Symbol	Parameter	Value	Unit
HV_c	Collector voltage	Internally limited	V
I_C	Collector current	Internally limited	A
V_d	Driving stage supply voltage	7	V
I_d	Driving circuitry supply current	200	mA
V_{IN}	Input voltage	10	V
T_j	Junction operating temperature	-40 to 150	°C
T_{stg}	Storage temperature	-55 to 150	°C

2.2 Thermal data

Table 4.   Thermal data

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case (MAX)	1.12	°C/W
$R_{thj-amb}$	Thermal resistance junction-ambient (MAX)	62.5	°C/W

2.3 Electrical characteristics

V_{CC} = 13.5 V; V_d = 5 V; T_j = 25 °C; R_{coil} = 510 mΩ; L_{coil} = 7 mH unless otherwise specified.

Table 5. **Electrical characteristics**

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
V_{cl}	High voltage clamp	V_{IN} = 0.4 V; -40 °C ≤ T_j ≤ 125 °C; I_C = 6 A	300	360	400	V
$V_{cg(sat)}$	Power stage saturation voltage	I_C = 6 A; V_{IN} = 4 V; I_d = 80 mA		1.5		V
$V_{cg(sat)td}$	Power stage saturation voltage derating in temperature	I_C = 6 A; V_{IN} = 4 V; -40 °C ≤ T_j ≤ 125 °C; I_d = 85 mA			2	V
$I_{d(off)}$	Power-off supply current	V_{IN} = 0.4 V			8	mA
$I_{d(on)}$	Power-on supply current	V_{IN} = 4 V; I_C = 6 A; -40 °C ≤ T_j ≤ 125 °C			130	mA
V_d	Driving stage supply voltage		4.5		5.5	V
I_{cl}	Collector current limit	V_{IN} = 4 V[1]	8	8.5	9	A
$I_{cl(td)}$	Collector current limit drift with temperature	See *Figure 3*				
V_{INH}	High level input voltage	HV_C < 2 V	4		5.5	V
V_{INL}	Low level input voltage	I_C < 2 mA; HV_C = V_{CC}	0		0.8	V
I_{INH}	High level input current	V_{IN} = 4 V	40		200	μA
V_{diagH}	High level diagnostic output voltage	R_{EXT} = 22 KΩ (See *Figure 6*)	3.5	[2]	V_d	V
V_{diagL}	Low level diagnostic output voltage	R_{EXT} = 22 KΩ (See *Figure 6*)			0.5	V
$I_{C(diag1)}$	First threshold level collector current		4.25	4.5	4.75	A
$I_{C(diag1)td}$	First threshold level collector current drift with temperature	See *Figure 4*				
$I_{C(diag2)}$	Second threshold level collector current		5.45	5.8	6.15	A
$I_{C(diag2)td}$	Second threshold level collector current drift with temperature	See *Figure 5*				
$t_{d(off)}$	Turn-off delay time of output current	I_C = 5.5 A		25		μs
$t_{f(off)}$	Turn-off fall time of output current	I_C = 5.5 A		8		μs
$t_{d(diag)}$	Delay time of diagnostic current	R_{EXT} = 22 KΩ (See *Figure 6*)		1		μs
$t_{r(diag)}$	Turn-on rise time of diagnostic current	R_{EXT} = 22 KΩ (See *Figure 6*)		1		μs
$t_{f(diag)}$	Turn-off fall time of diagnostic current	R_{EXT} = 22 KΩ (See *Figure 6*)		1		μs

1. The primary coil current value I_{cl} must be measured 1 ms after desaturation of the power stage.

2. V_d - $V_{be(on)}$.

2.4 Electrical characteristics curves
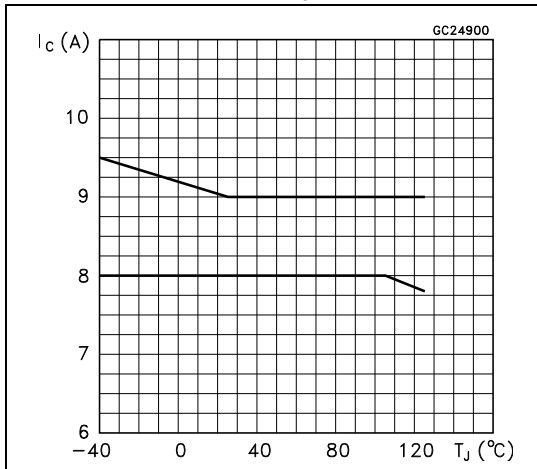
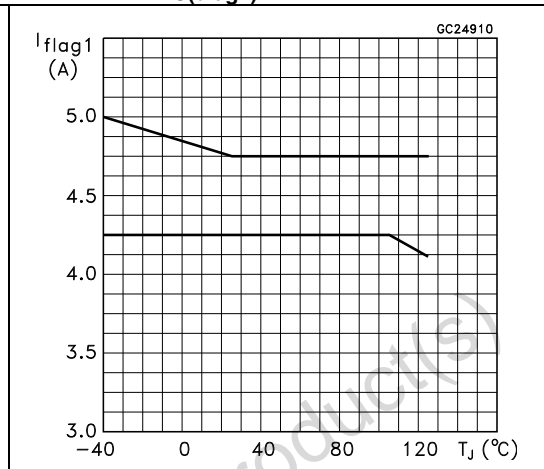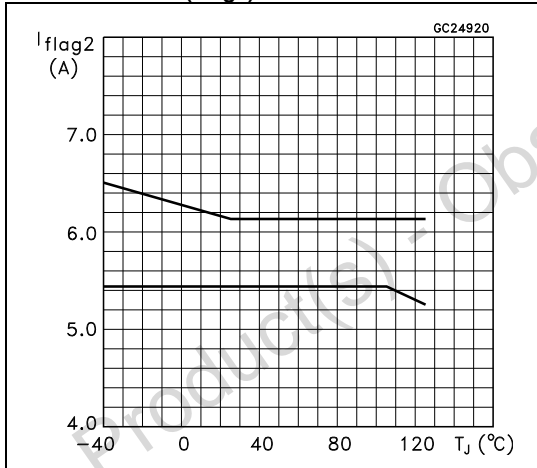**Figure 3. Maximum I_{cl} vs temperature** **Figure 4. $I_{C(diag1)}$ vs temperature**

Figure 5. $I_{C(diag2)}$ vs temperature

3 Application information

3.1 Principle of operation

The VB027SP-E is mainly intended as high voltage power switch device driven by a logic level input and interfaces directly to a high energy electronic ignition coil.

The input V_{IN} of the VB027SP-E is fed from a low power signal generated by an external controller that determines both dwell time and ignition point. During V_{IN} high ($\geq$ 4 V) the VB027SP-E increases current in the coil to the desired, internally set current level.

When the collector current exceeds 4.5 A, the diagnostic signal is turned high and it remains so, until the load current reaches 5.8 A (second threshold). At that value, the diagnostic signal is turned low, and the µC forces the V_{IN} to the low state. During the coil current switch-off, the primary voltage HV_C is clamped by a series of Zener diodes at an internally set value V_{cl}, typically 360 V.

The collector current sensed through the R_{sense}, is limited thanks to the "Current limiter" block that, as soon as the I_{cl} level is reached, forces the darlington (using the "Driver" block) to limit the current provided.

The transition from saturation to desaturation, coil current limiting phase, must have the ability to accommodate an overvoltage. A maximum overshoot of 20 V is allowed. There can be some short period of time in which the output pin (HV_C) is pulled below ground by a negative current due to leakage inductances and stray capacitances of the ignition coil. This can cause parasitic glitches on the diagnostic output. VB027SP-E has a built-in protection circuit that allows to lock the p-buried layer potential of the linear stage to the collector power, when the last one is pulled underground.

3.2 Thermal behaviour

You can see in the block diagram of the VB027SP-E (see *Figure 1*) a box called overtemperature protection. The purpose of this circuit is to shift the current level at which the first diagnostic is activated down of about 1 A.

This information can be managed by the micro that can take the corrective action in order to reduce the power dissipation. This block is not an effective protection but just an overtemperature detection. The shift down of the first flag level cannot be present for temperatures lower than 125 °C.

As an example of its behavior you can suppose a very simple motor management system in which the micro does just a simple arithmetic calculation to decide when to switch-off the device after the first flag threshold.

Example

$I_{C(DIAG1)}$ info after x ms ($I_{C(DIAG1)}$ = 2.5 A)

$I_{switch-off}$ info after kx ms.

As soon as the temperature rises over the overtemperature threshold, the first diagnostic is shifted down to about 1.5 A and, in this example, the switch-off current is kx * 1.5 / 2.5.

3.3 Overvoltage

The VB027SP-E can withstand the following transients of the battery line:

-100 V / 2 ms (R_i = 10 Ω)

+100 V / 0.2 ms (R_i = 10 Ω)

+50 V / 400 ms (R_i = 4.2 Ω, with V_{IN} = 3 V)

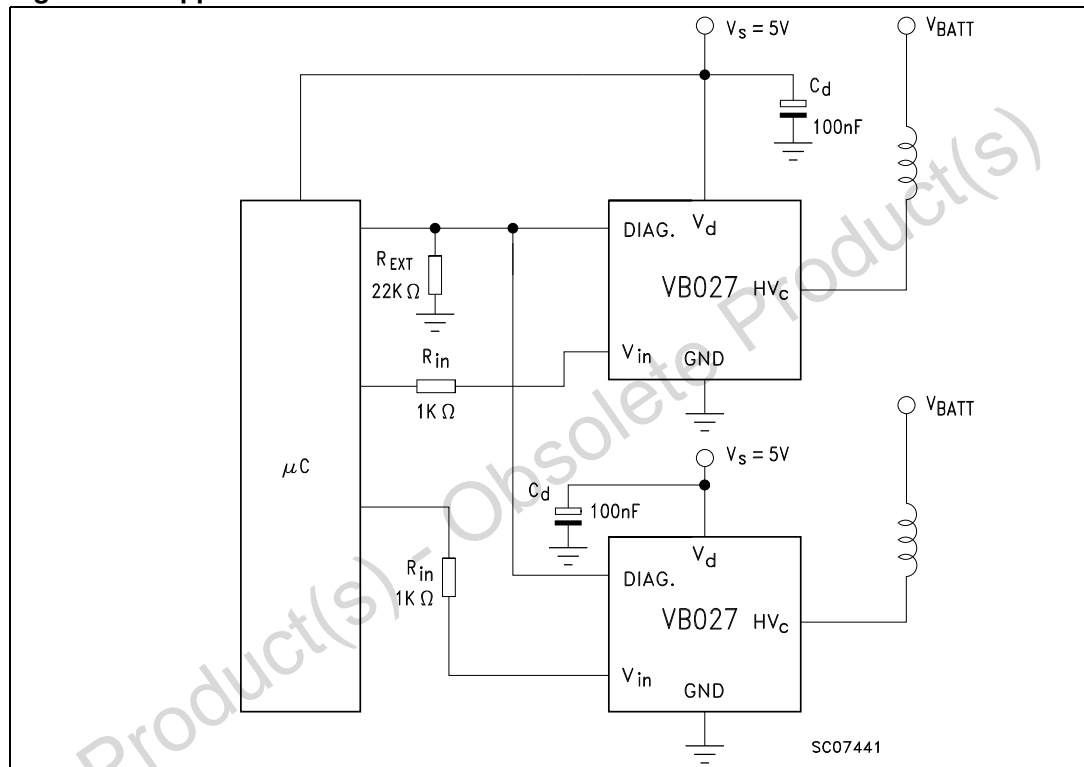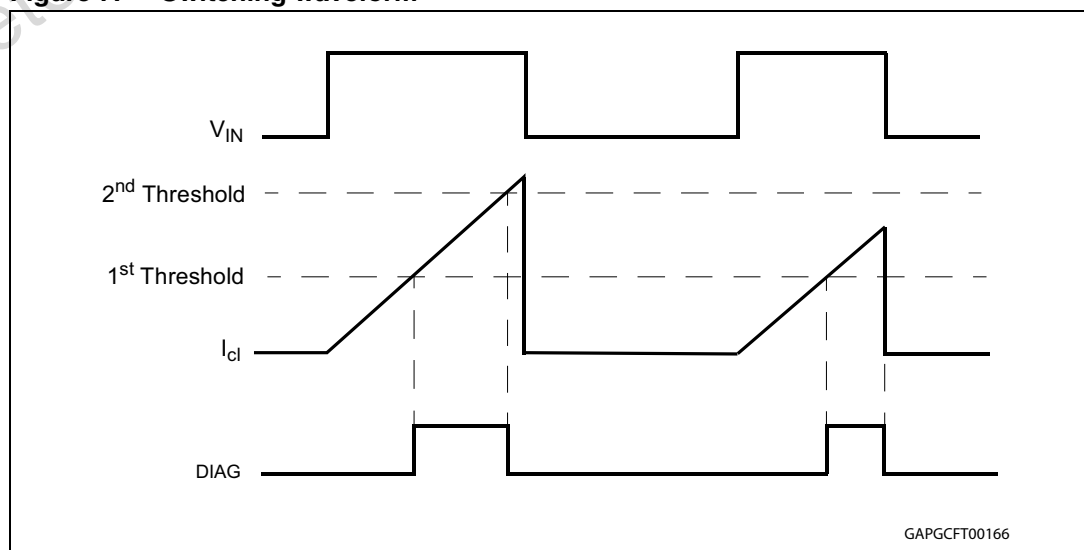**Figure 6.   Application circuit**

Figure 7.   Switching waveform

4 Package and packing information

4.1 ECOPACK®

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.

4.2 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		0.299
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	0°		8°			

Figure 8. PowerSO-10 package dimensions

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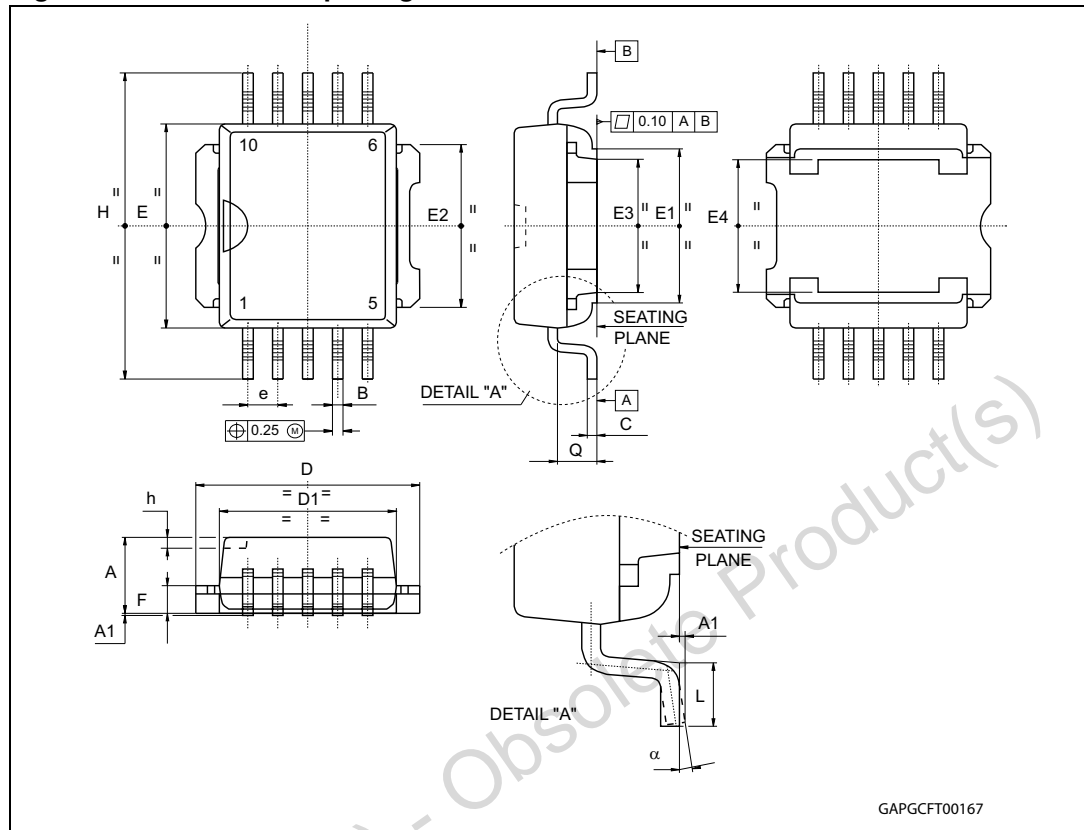
5 Revision history

Table 7. Document revision history

Date	Revision	Changes
14-May-2011	1	Initial release.
24-Sep-2013	2	Updated Disclaimer.

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