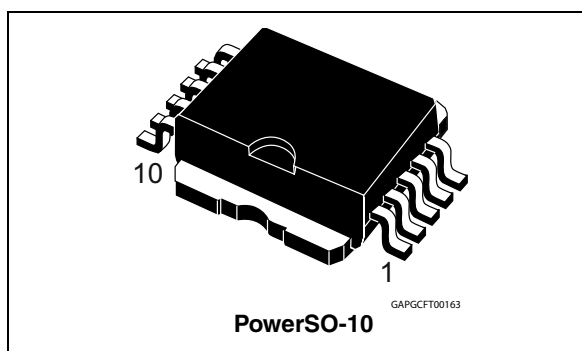


## High voltage ignition coil driver power integrated circuit

Type	V <sub>cl</sub>	I <sub>cl</sub>	I <sub>d(on)</sub>
VB027SP-E	300 V	9 A	130 mA

### 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

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# 1 Block diagram and pins description

Figure 1. Block diagram

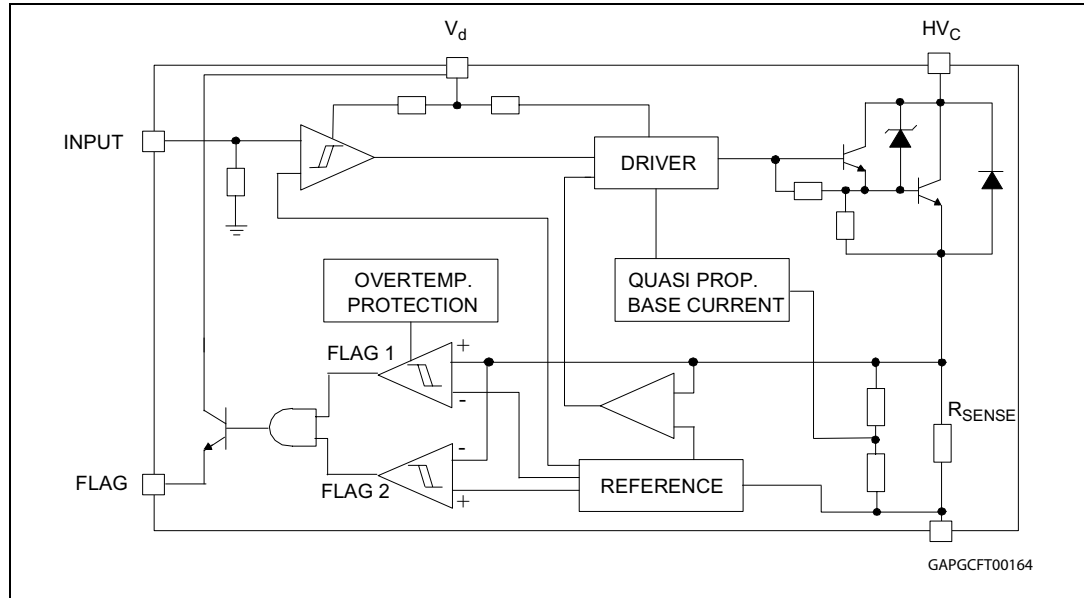


Figure 2. Configuration diagram (top view)

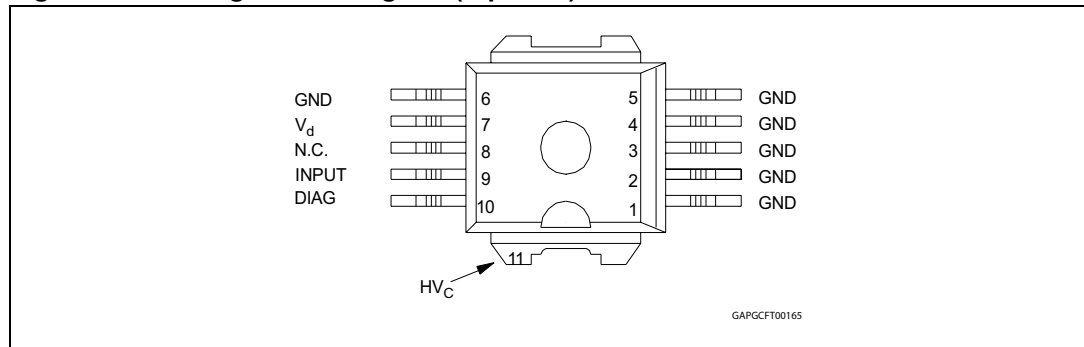


Table 2. Pin function

Pin number	Name	Function
1÷5	GND	Emitter power ground
6 <sup>(1)</sup>	GND	Control ground
7	V <sub>d</sub>	Driving stage supply voltage
8	N.C.	
9	INPUT	Logic input channel
10	DIAG	Diagnostic output signal
TAB	HV <sub>C</sub>	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

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

**Table 5. Electrical characteristics**

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
$V_{cl}$	High voltage clamp	$V_{IN} = 0.4\text{ V}$ ; $-40\text{ °C} \leq T_j \leq 125\text{ °C}$ ; $I_C = 6\text{ A}$	300	360	400	V
$V_{cg(sat)}$	Power stage saturation voltage	$I_C = 6\text{ A}$ ; $V_{IN} = 4\text{ V}$ ; $I_d = 80\text{ mA}$		1.5		V
$V_{cg(sat)td}$	Power stage saturation voltage derating in temperature	$I_C = 6\text{ A}$ ; $V_{IN} = 4\text{ V}$ ; $-40\text{ °C} \leq T_j \leq 125\text{ °C}$ ; $I_d = 85\text{ mA}$			2	V
$I_{d(off)}$	Power-off supply current	$V_{IN} = 0.4\text{ V}$			8	mA
$I_{d(on)}$	Power-on supply current	$V_{IN} = 4\text{ V}$ ; $I_C = 6\text{ A}$ ; $-40\text{ °C} \leq T_j \leq 125\text{ °C}$			130	mA
$V_d$	Driving stage supply voltage		4.5		5.5	V
$I_{cl}$	Collector current limit	$V_{IN} = 4\text{ V}^{(1)}$	8	8.5	9	A
$I_{cl(td)}$	Collector current limit drift with temperature	See <a href="#">Figure 3</a>				
$V_{INH}$	High level input voltage	$HV_C < 2\text{ V}$	4		5.5	V
$V_{INL}$	Low level input voltage	$I_C < 2\text{ mA}$ ; $HV_C = V_{CC}$	0		0.8	V
$I_{INH}$	High level input current	$V_{IN} = 4\text{ V}$	40		200	$\mu\text{A}$
$V_{diagH}$	High level diagnostic output voltage	$R_{EXT} = 22\text{ K}\Omega$ (See <a href="#">Figure 6</a> )	3.5	<sup>(2)</sup>	$V_d$	V
$V_{diagL}$	Low level diagnostic output voltage	$R_{EXT} = 22\text{ K}\Omega$ (See <a href="#">Figure 6</a> )			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 <a href="#">Figure 4</a>				
$I_{C(diag2)}$	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 <a href="#">Figure 5</a>				
$t_{d(off)}$	Turn-off delay time of output current	$I_C = 5.5\text{ A}$		25		$\mu\text{s}$
$t_{f(off)}$	Turn-off fall time of output current	$I_C = 5.5\text{ A}$		8		$\mu\text{s}$
$t_{d(diag)}$	Delay time of diagnostic current	$R_{EXT} = 22\text{ K}\Omega$ (See <a href="#">Figure 6</a> )		1		$\mu\text{s}$
$t_{r(diag)}$	Turn-on rise time of diagnostic current	$R_{EXT} = 22\text{ K}\Omega$ (See <a href="#">Figure 6</a> )		1		$\mu\text{s}$
$t_{f(diag)}$	Turn-off fall time of diagnostic current	$R_{EXT} = 22\text{ K}\Omega$ (See <a href="#">Figure 6</a> )		1		$\mu\text{s}$

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  $I_{C1}$  vs temperature

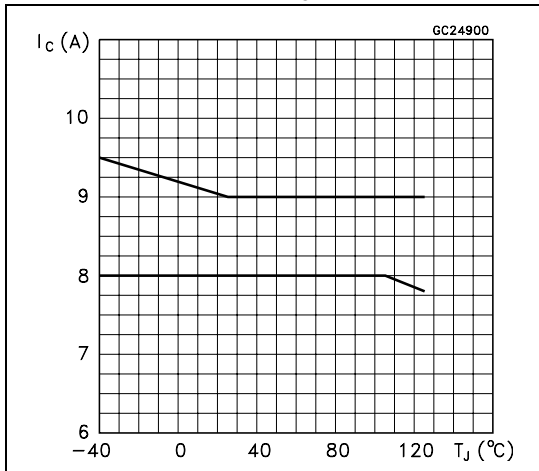


Figure 4.  $I_{C(diag1)}$  vs temperature

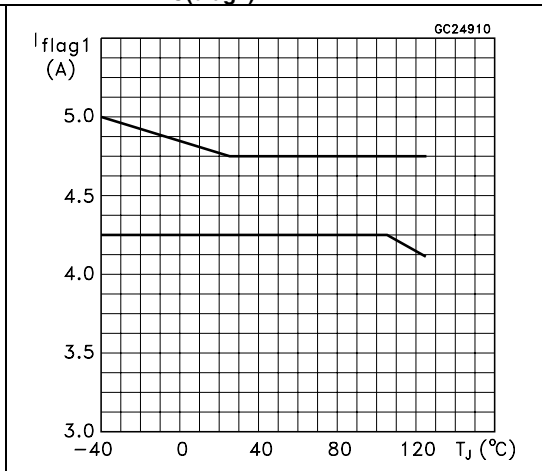
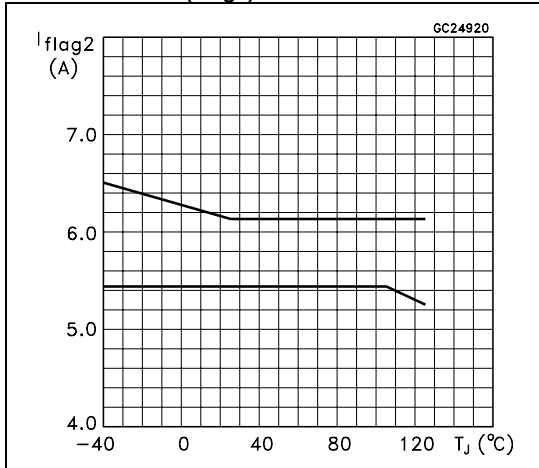


Figure 5.  $I_{C(diag2)}$  vs temperature





## 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  $\mu C$  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.

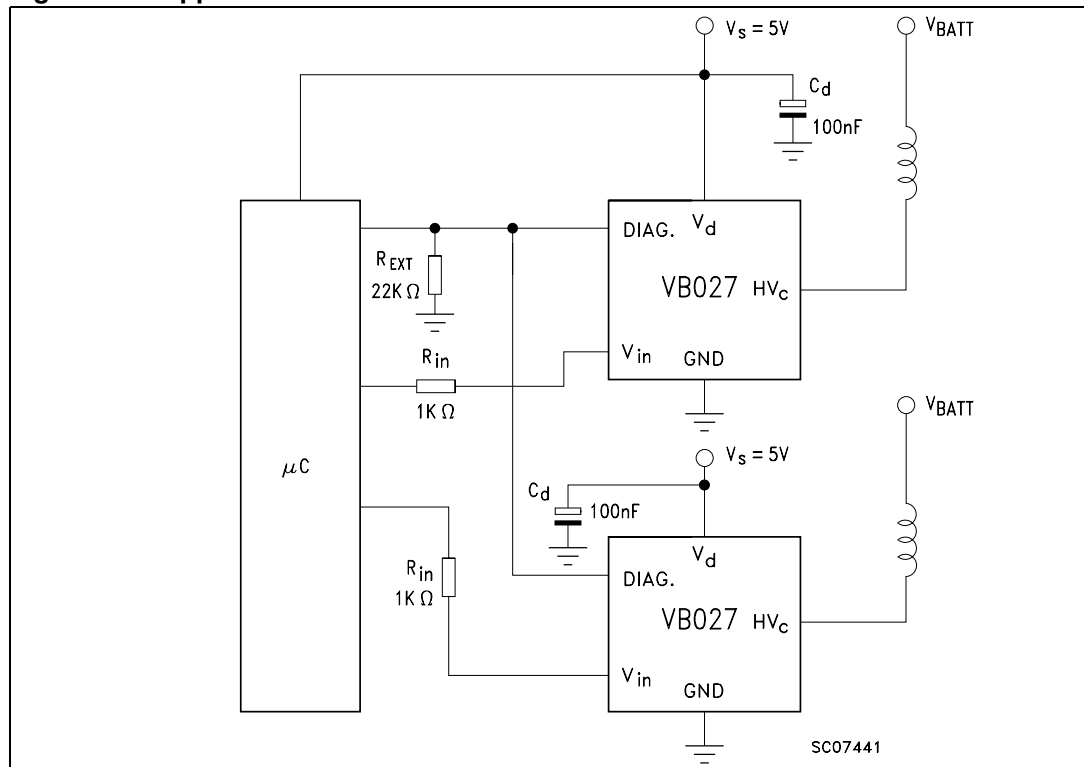
As soon as the temperature rises over the overtemperature threshold, the first diagnostic is shifted down to about 1.5 A and, in this example, the switch-off current is  $kx * 1.5 / 2.5$ .

### 3.3 Overvoltage

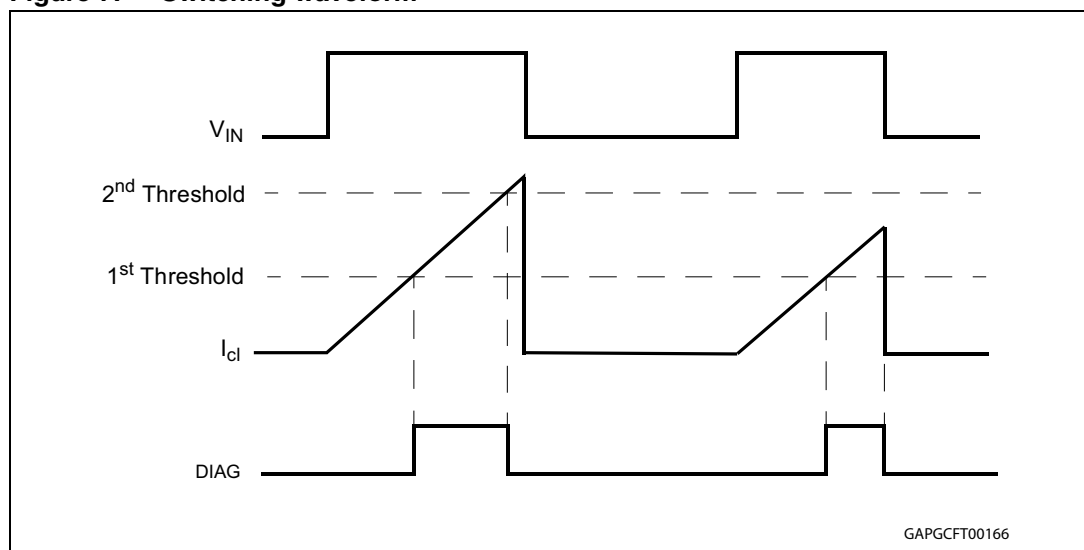
The VB027SP-E can withstand the following transients of the battery line:

- 100 V / 2 ms ( $R_i = 10 \Omega$ )
- +100 V / 0.2 ms ( $R_i = 10 \Omega$ )
- +50 V / 400 ms ( $R_i = 4.2 \Omega$ , with  $V_{IN} = 3 V$ )

**Figure 6. Application circuit**



**Figure 7. Switching waveform**



## 4 Package and packing information

### 4.1 ECOPACK®

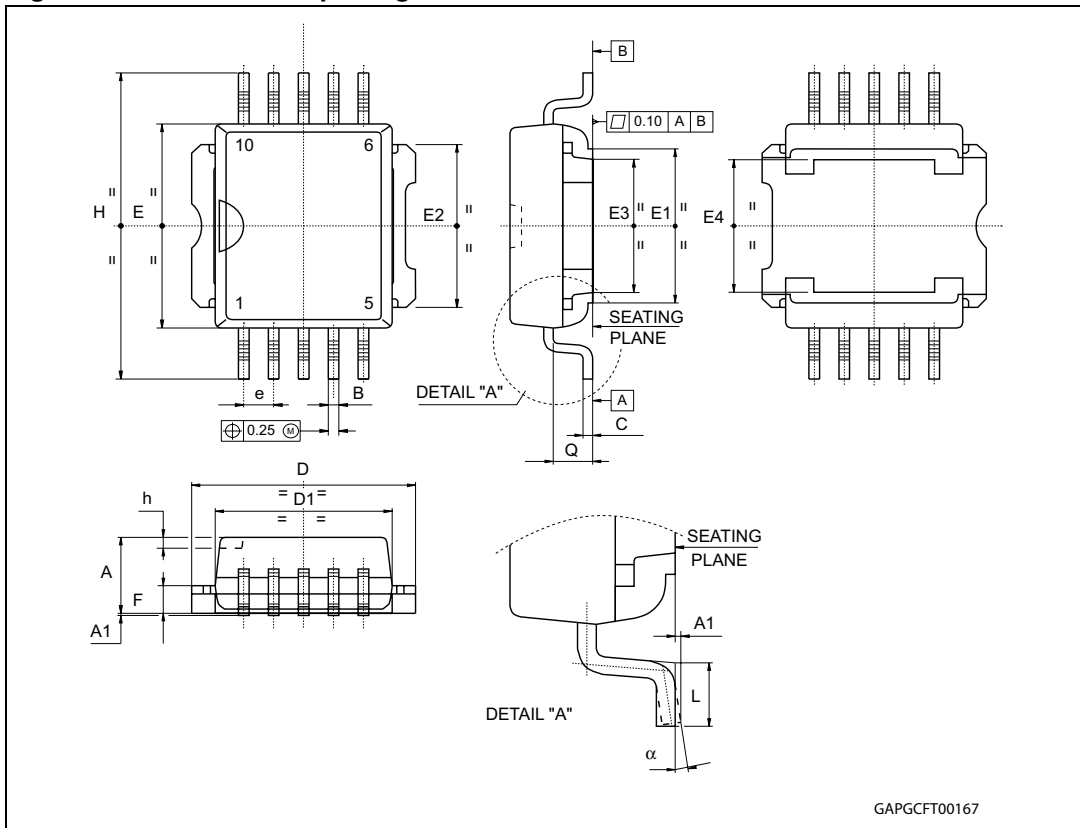
In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK® is an ST trademark.

### 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	
$\alpha$	0°		8°			

Figure 8. PowerSO-10 package dimensions



## 5 Revision history

Table 7. Document revision history

Date	Revision	Changes
14-May-2011	1	Initial release.

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