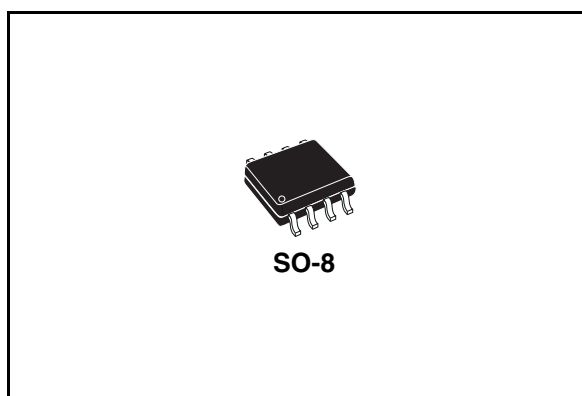


## High voltage high-side driver

### Features

- High voltage rail up to 160 V
- dV/dt immunity  $\pm 50$  V/nsec in full temperature range
- Driver current capability:  
500 mA source,  
500 mA sink
- Switching times 100 ns rise/fall with 2.5 nF load
- CMOS/TTL Schmitt trigger inputs with hysteresis
- Under voltage lock out
- Clamping on  $V_{CC}$
- Loading circuit for external Bootstrap capacitor
- Inverting input
- Reset circuitry
- SO-8 package



### Description

The L9856 is an high voltage device, manufactured with the BCD "OFF-LINE" technology.

It has the capability of driving N-Channel Power MOS transistors. The upper (floating) section is enabled to work with voltage rail up to 160 V. The logic Inputs are CMOS/TTL compatible for ease of interfacing with controlling devices.

**Table 1. Device summary**

Order code	Operating temp range, °C	Package	Packing
L9856	-40 to +125	SO-8	Tube
L9856TR	-40 to +125	SO-8	Tape and Reel

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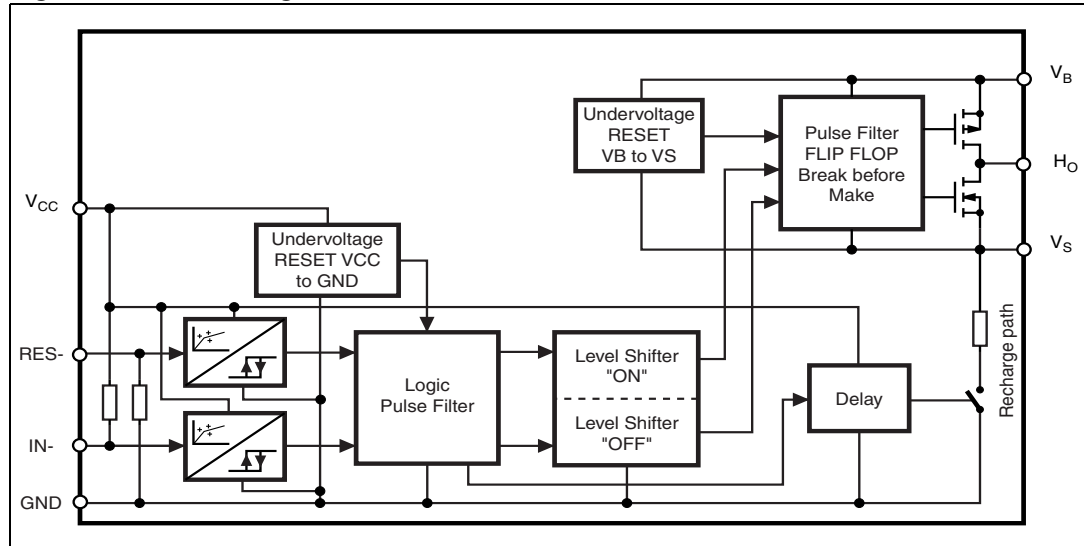
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# 1 Block diagram and pin description

## 1.1 Block diagram

Figure 1. Block diagram



## 1.2 Pin description

Figure 2. Pin connection (top view)

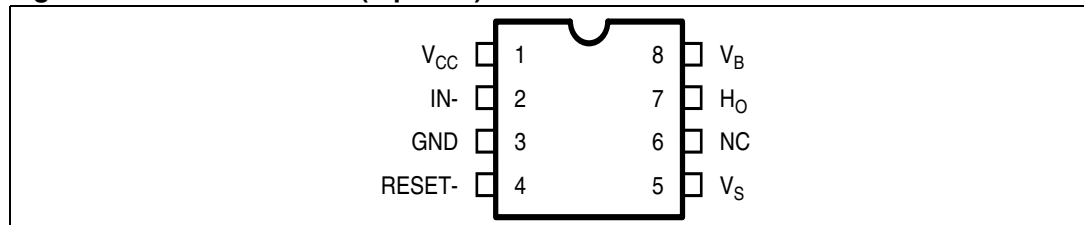


Table 2. Pin function

Pin #	Pin name	Description
1	V <sub>CC</sub>	Driver supply, typical 5V
2	IN-	Driver control signal input (negative logic)
3	GND	Ground
4	RESET-	Driver enable signal input (negative logic)
5	V <sub>S</sub>	MOSFET source connection
6	NC	No connection (no bondwire)
7	H <sub>O</sub>	MOSFET gate connection
8	V <sub>B</sub>	Driver output stage supply

## 2 Electrical specifications

### 2.1 Thermal data

Table 3. Thermal data

Symbol	Parameter	Value	Unit
$R_{th(j-amb)}$	Thermal resistance junction to ambient	Max. 150	°C/W

### 2.2 Absolute maximum ratings

Absolute maximum ratings indicate sustained limits beyond which damage to the device may occur. All voltage parameters are absolute voltages referenced to GND, all currents are defined positive into any lead. An operation above the absolute maximum limit is not implied and can damage the part.

Table 4. Absolute maximum ratings

Symbol	Parameter	Value		Units
		Min.	Max.	
$V_{BS}$	High side floating supply voltage.	-0.3	20	V
$V_B$	High side driver output stage voltage neg. transient: 0.5 ms, external MOSFET off.	-5	166	V
$V_S$	High side floating supply offset voltage neg. transient 0.1 $\mu$ s, repetitive pulse over lifetime at every switching event.	-8	150	V
$V_{HO}$	Output voltage gate connection.	$V_S - 0.3$	$V_B + 0.3$	V
$V_{CC}$	Supply voltage.	-0.3	20	V
$V_{IN}$	Input voltage.	-0.3	$V_{CC} + 0.3$	V
$I_{IN}$	Input injection current. Full function, no latch-up; (guaranteed by design). Test at 5 V and 7 V on Eng. Samples.	---	+1	mA
$V_{RES}$	Reset input voltage.	-0.3	$V_{CC} + 0.3$	V
$V_{esd}$	Electrostatic discharge voltage (human body model).	2k		V
$V_{CDM}$	Charge device model CDM, EOS/ESD Ass. Std 5.3. Number of discharges per pin: 6.	500		V
dV/dt	Allowable offset voltage slew rate.	-50	50	V/nsec
$T_J$	Junction temperature.	-55	150	°C
$T_{stg}$	Storage temperature.	-55	150	
$T_L$	Lead temperature (Soldering, 10 seconds) 3 times Bosch soldering profile acc. to Bosch soldering conditions, Gen. Spec.	-	300	

## 2.3 Recommended operating conditions

For proper operations the device should be used within the recommended conditions.

**Table 5. Recommended operating conditions**

Symbol	Parameter	Value		Units
		Min.	Max.	
$V_B^{(1)}$	High side driver output stage voltage	VS+4.4	VS+18	V
$V_S$	High side floating supply offset voltage (25°C) (125°C)	-3.2 -2.9	150 150	V
$V_{HO}$	Output voltage gate connection	$V_S$	$V_B$	V
$V_{CC}$	Supply voltage	4.4	6.5	V
$V_{IN}$	Input voltage	0	$V_{CC}$	V
$V_{RES}$	Reset input voltage	0	$V_{CC}$	V
$dV/dt^{(2)}$	Allowable offset voltage slew rate	-50	50	V/nsec
$F_S$	Switching frequency		200	kHz

1. Reset-Logic functional for  $V_{BS} > 2V$ , independent from  $V_{CC}$ -level.

2. Guaranteed by design.

## 2.4 Electrical characteristics

**Table 6. Electrical characteristics**

Unless otherwise specified,  $V_{CC} = 5 V$ ,  $V_{BS} = 7 V$ ,  $V_S = 0 V$ ,  $IN = 0 V$ ,  $RES = 5 V$ , load  $R = 50 \Omega$ ,  $C = 2.5 nF$ . Unless otherwise noted, these specifications apply for an operating ambient temperature range of  $-40 \text{ }^\circ\text{C} < T_{amb} < 125 \text{ }^\circ\text{C}$ .

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
<b><math>V_{CC}</math> supply</b>						
$V_{CCUV+}$	$V_{CC}$ supply undervoltage positive going threshold	$V_{CC}$ rising from 0 V			4.3	V
$V_{CCUV-}$	$V_{CC}$ supply undervoltage negative going threshold	$V_{CC}$ dropping from 5 V	2.8			
$V_{CCUVHYS}$	$V_{CC}$ supply undervoltage lockout hysteresis		0.02	0.3	0.6	
$td_{UVCC}$	Undervoltage lockout response time	$V_{CC}$ steps either from 6.5 V to 2.7 V or from 2.7 V to 6.5 V	0.5		20	$\mu\text{s}$
$I_{QCC}$	$V_{CC}$ supply current				400	$\mu\text{A}$

**Table 6. Electrical characteristics (continued)**

Unless otherwise specified,  $V_{CC} = 5\text{ V}$ ,  $V_{BS} = 7\text{ V}$ ,  $V_S = 0\text{ V}$ ,  $I_N = 0\text{ V}$ ,  $R_{ES} = 5\text{ V}$ , load  $R = 50\ \Omega$ ,  $C = 2.5\text{ nF}$ . Unless otherwise noted, these specifications apply for an operating ambient temperature range of  $-40\text{ }^\circ\text{C} < T_{amb} < 125\text{ }^\circ\text{C}$ .

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
<b>V<sub>BS</sub> supply</b>						
$V_{BSUV+}$	$V_{BS}$ supply undervoltage positive going threshold	$V_{CC}$ rising from 0 V			4.3	V
$V_{BSUV-}$	$V_{BS}$ supply undervoltage negative going threshold	$V_{CC}$ dropping from 5 V	2.8			V
$V_{BSUVHYS}$	$V_{BS}$ supply undervoltage lockout hysteresis		0.02	0.3	0.4	
$t_{dUVBS}$	Undervoltage lockout response time	$V_{BS}$ steps either from 6.5 V to 2.7 V or from 2.7 V to 6.5V	0.5		20	$\mu\text{s}$
$I_{QBS1}$	$V_{BS}$ supply current	static mode, $I_N = 0\text{ V}$ or 5 V			100	$\mu\text{A}$
$I_{QBS2}$		static mode, $V_{BS} = 16\text{ V}$ , $I_N = 0\text{ V}$ or 5 V			200	$\mu\text{A}$
$\Delta V_{BS}$	$V_{BS}$ drop due to output turn-on	$C_{BS} = 1\ \mu\text{F}$ , $t_{dIG-IN} = 3\ \mu\text{s}$ , $t_{TEST} = 100\ \mu\text{s}$			210	mV
<b>Gate driver characteristics</b>						
$I_{PKS01}$	Peak output source current	$T_j = 25\text{ }^\circ\text{C}$	120	250		mA
$I_{PKS02}$			70	150		
$I_{PKS03}$		$V_{BS} = 16\text{ V}$ , $T_j = 25\text{ }^\circ\text{C}$	250	500		
$I_{PKS04}$		$V_{BS} = 16\text{ V}$	150	300		
$I_{HO,off}$	HO off state leakage current	guaranteed by design			1	$\mu\text{A}$
$t_{r1}$	Output rise time	$T_j = 25\text{ }^\circ\text{C}$		0.2	0.4	$\mu\text{s}$
$t_{r2}$				0.3	0.5	
$t_{r3}$		$V_{BS} = 16\text{ V}$ , $T_j = 25\text{ }^\circ\text{C}$		0.1	0.2	
$t_{r4}$		$V_{BS} = 16\text{ V}$		0.15	0.3	
$I_{PKSi1}$	Peak output sink current	$I_N = 5\text{ V}$ , $T_j = 25\text{ }^\circ\text{C}$	120	250		mA
$I_{PKSi2}$		$I_N = 5\text{ V}$	70	150		
$I_{PKSi3}$		$I_N = 5\text{ V}$ , $T_j = 25\text{ }^\circ\text{C}$ $V_{BS} = 16\text{ V}$	250	500		
$I_{PKSi4}$		$I_N = 5\text{ V}$ , $V_{BS} = 16\text{ V}$	150	300		
$t_{f1}$	Output fall time	$I_N = 5\text{ V}$ , $T_j = 25\text{ }^\circ\text{C}$		0.2	0.4	$\mu\text{s}$
$t_{f2}$		$I_N = 5\text{ V}$ ,		0.3	0.5	
$t_{f3}$		$V_{BS} = 16\text{ V}$ , $I_N = 5\text{ V}$ , $T_j = 25\text{ }^\circ\text{C}$		0.1	0.2	
$t_{f4}$		$V_{BS} = 16\text{ V}$ , $I_N = 5\text{ V}$ ,		0.15	0.3	



**Table 6. Electrical characteristics (continued)**

Unless otherwise specified,  $V_{CC} = 5\text{ V}$ ,  $V_{BS} = 7\text{ V}$ ,  $V_S = 0\text{ V}$ ,  $I_N = 0\text{ V}$ ,  $R_{ES} = 5\text{ V}$ , load  $R = 50\ \Omega$ ,  $C = 2.5\text{ nF}$ . Unless otherwise noted, these specifications apply for an operating ambient temperature range of  $-40\text{ }^\circ\text{C} < T_{amb} < 125\text{ }^\circ\text{C}$ .

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
$t_{plhi}$	Input-to-output turn-on propagation delay (50 % input level to 10 % output level)			0.1	0.35	$\mu\text{s}$
$t_{phli}$	Input-to-output turn-off propagation delay (50 % input level to 90 % output level)			0.1	0.4	
$t_{plhr}$	RES-to-output turn-on propagation delay (50 % input level to 10% output level)			0.1	0.4	
$t_{phlr}$	RES-to-output turn-off propagation delay (50 % input level to 90 % output level)			0.1	0.4	
<b>Input characteristics</b>						
$V_{INH}$	High logic level input threshold	$V_{CC} = 5\text{ V}$	0.6 $V_{CC}$			V
$V_{INL}$	Low logic level input threshold				0.28 $V_{CC}$	
$R_{IN}$	High logic level input resistance		60	100	250	$\text{k}\Omega$
$I_{IN}$	High logic level input current	$V_{IN} = V_{CC}$			5	$\mu\text{A}$
$V_{RESH}$	High logic level RES input threshold	$V_{CC} = 5\text{ V}$	0.6 $V_{CC}$			
$V_{RESL}$	Low logic level RES input threshold				0.28 $V_{CC}$	
$R_{RES}$	High logic level RES Input resistance		60	100	250	$\text{k}\Omega$
$I_{RES}$	Low logic level input current	$V_{RES} = 0$			5	$\mu\text{A}$
<b>Recharge characteristics</b>						
$t_{on\_rech}$	Recharge transistor turn-on propagation delay	$V_S = 5\text{ V}$	3	6	9	$\mu\text{s}$
$t_{off\_rech}$	Recharge transistor turn-off propagation delay			0.1	0.5	$\mu\text{s}$
$V_{RECH}$	Recharge output transistor on-state voltage drop	1 mA forced on recharge path on	0.5		1.2	V
<b>Deadtime characteristics</b>						
$DT_{HOFF}$	High side turn-off to recharge gate turn-on	$V_{CC} = 5\text{ V}$	3	6	9	$\mu\text{s}$
$DT_{HON}$	Recharge gate turn-off to high side turn-on		0.1	0.4	0.7	

## 2.5 Logic table

Table 7. Logic table

Supply voltages and thresholds		Signals		Output Ho	Recharge path
V <sub>CC</sub>	V <sub>BS</sub>	RESET-	IN-		
< V <sub>CCUV-</sub>	X	X	X	OFF	ON
X	X	LOW	X	OFF	ON
X	X	X	HIGH	OFF	ON
> V <sub>CCUV+</sub>	> V <sub>BSUV+</sub>	HIGH	LOW	ON	OFF
> V <sub>CCUV+</sub>	< V <sub>BSUV-</sub>	HIGH	LOW	OFF	OFF

Note: X means independent from signal.

### 3 Timing diagrams

Figure 3. Input/output timing diagram

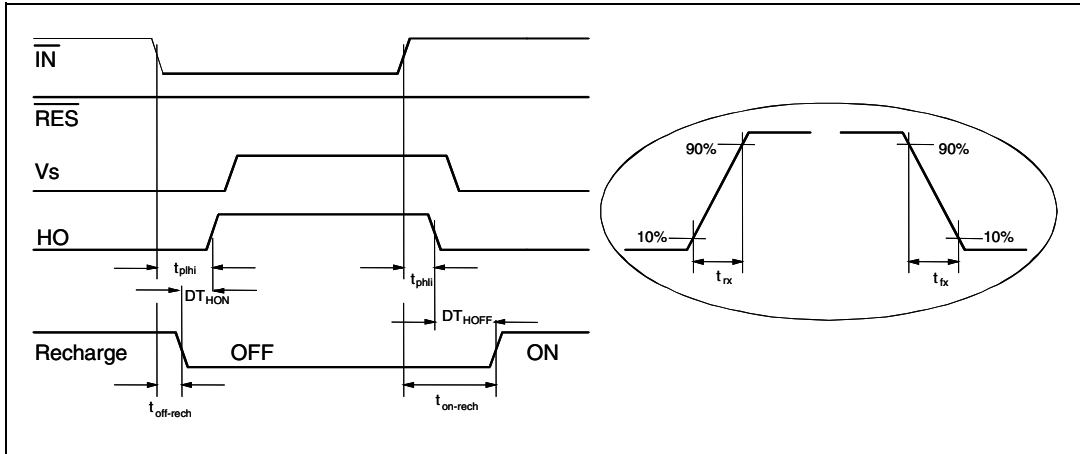
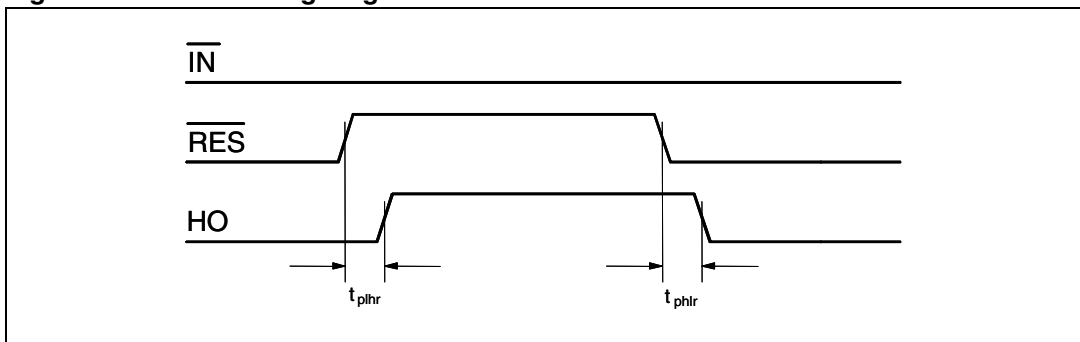


Figure 4. Reset timing diagram

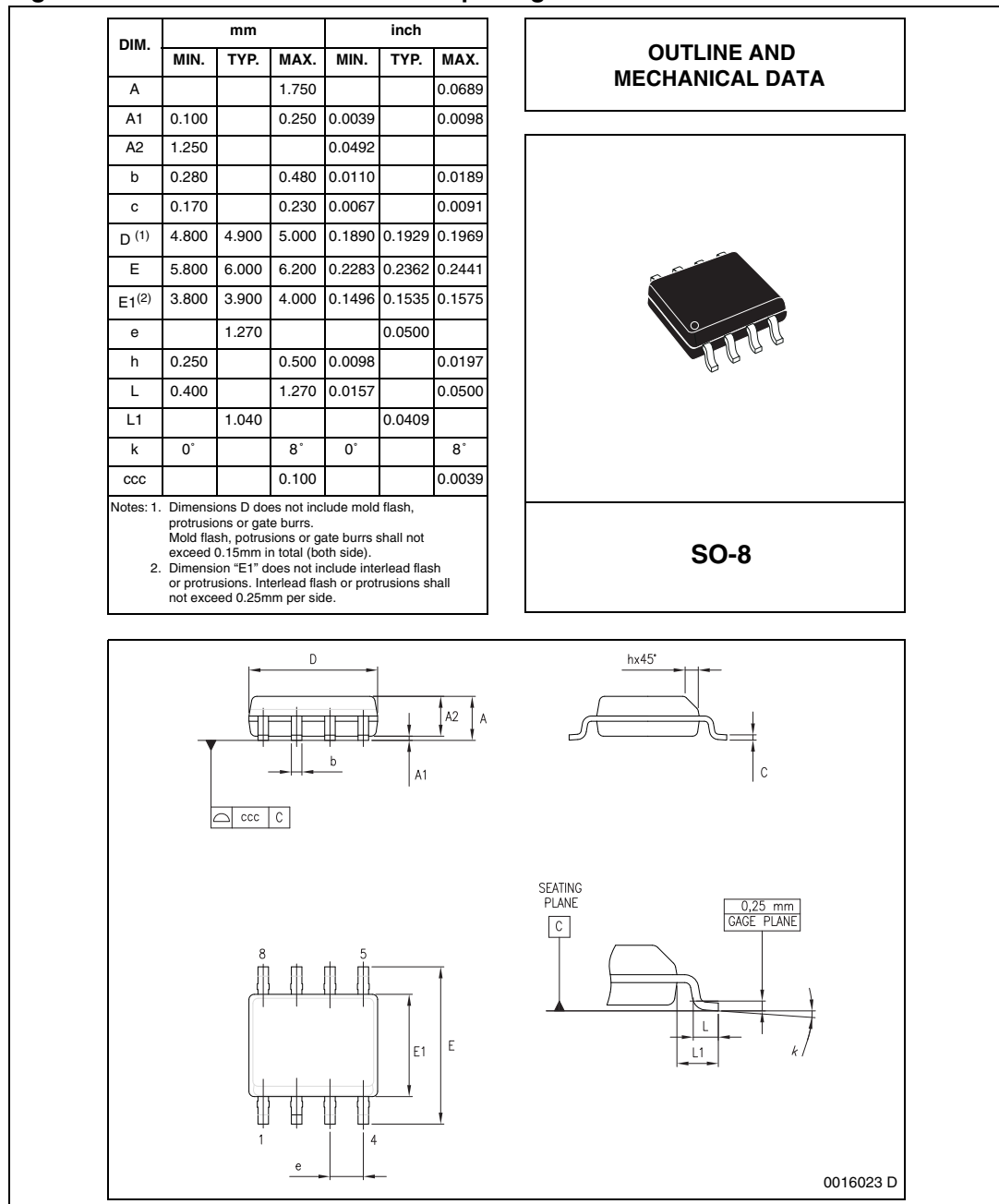


# 4 Package information

In order to meet environmental requirements, ST (also) offers these devices in ECOPACK® packages. ECOPACK® packages are lead-free. The category of second Level Interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label.

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**Figure 5. SO-8 mechanical data and package dimensions**



## 5 Revision history

**Table 8. Document revision history**

Date	Revision	Changes
29-Jun-2007	1	Initial release.
30-May-2008	2	Update Features section on page 1. Updated <a href="#">Table 4: Absolute maximum ratings on page 6</a> . Updated <a href="#">Table 5: Recommended operating conditions on page 7</a> .
20-Sep-2013	3	Updated disclaimer.

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