

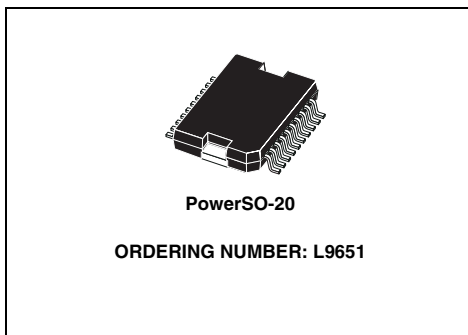


**THE DATASHEET OF  
L9651**



## SMART QUAD SWITCH

- Modified VDMOS Power Stage ( $U_{DSBR} > 80V$ )
- $RD_{SON} < 500\text{ m}\Omega$  ( $T_j = 25^\circ C$ )
- CMOS Compatible Inputs
- Enable Input (Reset)
- Outputs Capable of up to 2.2 Amperes
- Outputs Internally Clamped at 70V for Fast Inductive Load Switch Off
- Wide operating supply voltage from 4.7V up to 30V
- DIAGNOSTIC FUNCTIONS
- Open Load Detection (Output off, 100 $\mu$ s-filtering time)
- Short to Ground Detection (Output off, 100 $\mu$ s-filtering time)
- Short to Battery Detection (Output on)
- Over temperature detection (Output on)
- Storage of last fault in 8 Bit - Serial Register
- Fault Signal Indication at Serial Data Out without need to read out the Serial Interface
- Daisy Chainable Serial Diagnostic

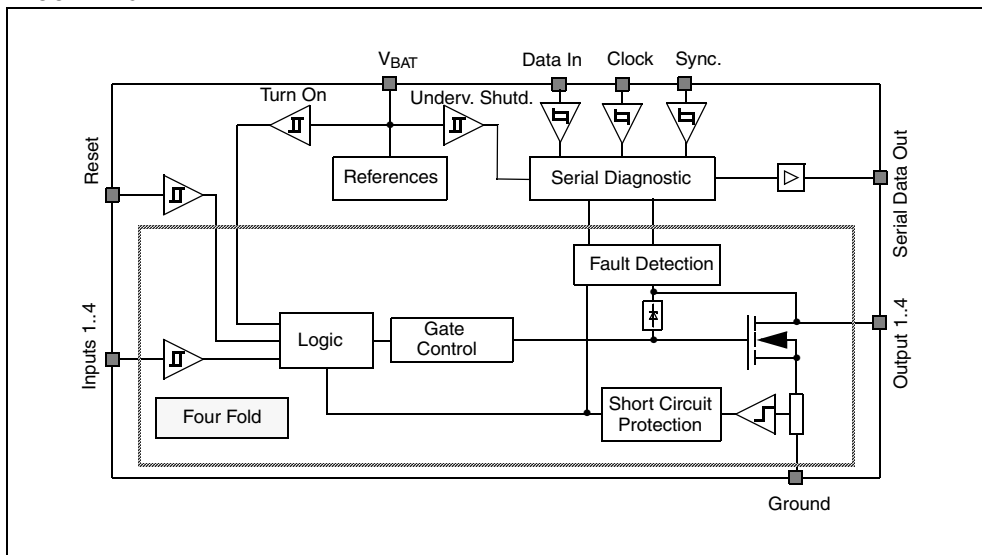


- Serial Interface Clock Frequency up to 500kHz

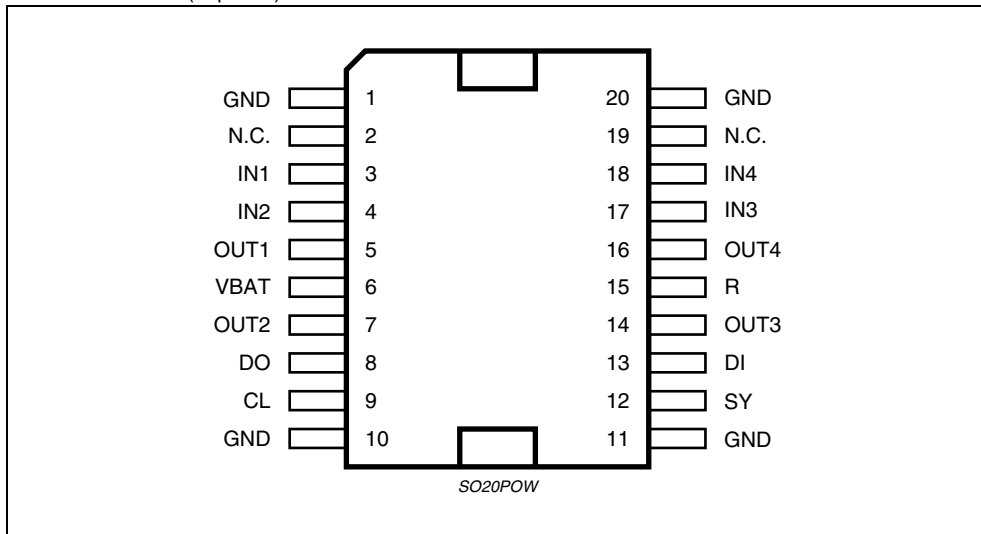
### DESCRIPTION

The L9651 consists of four identical low side power switches. A serial diagnostic interface indicates failure mode of each switch (short circuit to  $V_{BAT}$  or ground and open load or over temperature).

### BLOCK DIAGRAM



## PIN CONNECTION (Top view)



## PIN FUNCTION

N°	Pin	Function
1, 10, 11, 20	GND	Ground
2, 19	N.C.	Not Connected
3	IN1	Input 1
4	IN2	Input 2
5	OUT1	Output 1
6	VBAT	Supply Voltage
7	OUT2	Output 2
8	DO	Serial Data Out
9	CL	Clock
12	SY	Synchronization
13	DI	Serial Data In
14	OUT3	Output 3
15	R	Reset
16	OUT4	Output 4
17	IN3	Input 3
18	IN4	Input 4

## ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
T <sub>STG</sub>	Storage Temperature	-55 to 150	°C
T <sub>J</sub>	Operating Junction Temperature	-40 to 150	°C
V <sub>BAT</sub>	DC Supply Voltage	-2 to 30	V
V <sub>BATTr</sub>	Transient Supply Voltage; t < 400ms	40	V
V <sub>OUT</sub>	Output Voltage	65	V
V <sub>OUTTr</sub>	Transient Output Voltage; during clamping	78	V
E <sub>CL</sub>	Output Clamping energy; repetition rate < 100 Hz	10	mJ
-I <sub>OUT</sub>	Output reverse current	2	A
V <sub>R</sub> , V <sub>INi</sub> , V <sub>DI</sub> , V <sub>CLVSY</sub>	Control Input voltage	-0.3 to 6.5	V
V <sub>DO</sub>	Control Output voltage	-0.3 to 6.5	V

## THERMAL DATA

Symbol	Parameter	Value	Unit
R <sub>th j-case</sub>	Thermal Resistance Junction to Case	2.5	°C/W

ELECTRICAL CHARACTERISTICS (6.5V < V<sub>BAT</sub> < 25V, -40 < T<sub>J</sub> < 150°C)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
<b>Supply Voltage</b>						
V <sub>BATU</sub>	Turn on threshold voltage		2.0		4.7	V
I <sub>BAT</sub>	Supply current	V <sub>BAT</sub> = 14V V <sub>OUTi</sub> > 0V	4	10	15	mA
<b>Output stage</b>						
R <sub>DSON</sub>	On resistance	V <sub>BAT</sub> = 14V T <sub>J</sub> = 25°C; I <sub>out</sub> = 1A			500	mΩ
		V <sub>BAT</sub> = 14V T <sub>J</sub> = 150°C; I <sub>out</sub> = 1A			850	mΩ
V <sub>CL</sub>	Clamping voltage, inductive load	I <sub>out</sub> = 0.5 A	63	70	76	V
I <sub>OUTi</sub>	Over current shutdown (Shutdown latch resets with pos. slope at INi)	T <sub>J</sub> = -40°C	3.0		4.3	A
		T <sub>J</sub> = 25°C	2.5		3.7	A
		T <sub>J</sub> = 150°C	2.2		3.5	A
Output leakage current see: Open load diagnostic current						

## ELECTRICAL CHARACTERISTICS (continued)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
<b>Logic Inputs IN1...IN4, SY, CL, DI, R</b>						
$V_{IN1LH}$ $V_{SYLH}$ $V_{CLLH}$ $V_{RLH}$ $V_{D1LH}$	Input High level		3.5		6.5	V
$V_{IN1HL}$ $V_{SYHL}$ $V_{CLHL}$ $V_{RHL}$ $V_{D1HL}$	Input Low level		-0.3		1.5	V
$V_{IN1h}$ $V_{SYh}$ $V_{CLh}$ $V_{Rh}$ $V_{D1h}$	Hysteresis		0.2		1	V
- $I_{Ni}$ - $I_{SY}$ - $I_{CL}$ - $I_R$	Input current IN1 ... IN4, SY, CL, R (Internal pull up current source)	$V_{INi} = 0V$	10	40	120	$\mu A$
		$V_{SY} = 0V$ $V_{CL} = 0V$ $V_R = 0V$	10		80	
- $I_{D1}$	Input current DI (Internal pull up current source)	$V_{D1} = 0V$	120	220	250	$\mu A$
<b>Timing</b>						
$t_{don}$	Turn on delay			7.5		$\mu s$
$t_{doff}$	Turn off delay			7.5		$\mu s$
$S_{on}$	Switch on slew rate			10		V/ $\mu s$
$S_{off}$	Switch off slew rate			15		V/ $\mu s$
$t_{oc}$	Over current detection time			0.5		$\mu s$
$t_v$	Open load filtering time		60	100	200	$\mu s$
$t_v$	Short to GND filtering time		60	100	200	$\mu s$
$f_{CL}$	Serial clock frequency		0		500	kHz
$t_{vDV}$	DO: Data valid time		0.03		1	$\mu s$
$t_{vset}$	DI: Data settling time		0.5			$\mu s$
$t_{vhold}$	DI: Data hold time		0			$\mu s$
<b>Diagnostic</b>						
$V_{BATDU}$	Under voltage threshold		4.7		7.5	V
Serial Data output (External pull up required)						
$V_{DO}$	Data output low voltage	$I_{DO} < 1.6mA$ $7.5V < V_{BAT} < 22V$	0		0.45	V
$ I_{DO} $	Data output leakage current				10	$\mu A$

**ELECTRICAL CHARACTERISTICS** (continued)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
Output voltage monitoring Output off						
V <sub>OL</sub>	Open load threshold voltage (fault detected if V <sub>OUTi</sub> < V <sub>OL</sub> )	7.5V < V <sub>BAT</sub> < 22V		2/3V <sub>BAT</sub>		
V <sub>SG</sub>	Short to GND threshold voltage (fault detected if V <sub>OUTi</sub> < V <sub>SG</sub> )	7.5V < V <sub>BAT</sub> < 22V		1/3V <sub>BAT</sub>		
Open load diagnostic current Output off						
	Open load output voltage	I <sub>OUT</sub> = 0 A V <sub>INI</sub> = 5V 7.5V < V <sub>BAT</sub> < 22V		1/2V <sub>BAT</sub>		
- I <sub>OUTi</sub>	Output current	V <sub>OUT</sub> = 1V V <sub>INI</sub> = 5V	50	100	150	μA
I <sub>OUTi</sub>	Output current	V <sub>OUT</sub> = V <sub>BAT</sub> V <sub>INI</sub> = 5V 7.5V < V <sub>BAT</sub> < 22V	200	320	500	μA
Overload Diagnostic						
	Over temperature diagnostic	T <sub>J</sub>		175		°C
I <sub>OUTi</sub>	Over current	T <sub>J</sub> = -40°C	3.0		4.3	A
		T <sub>J</sub> = 25°C	2.5		3.7	A
		T <sub>J</sub> = 150°C	2.2		3.5	A

**Figure 1. Typical Timing Diagram for Serial Diagnostic**

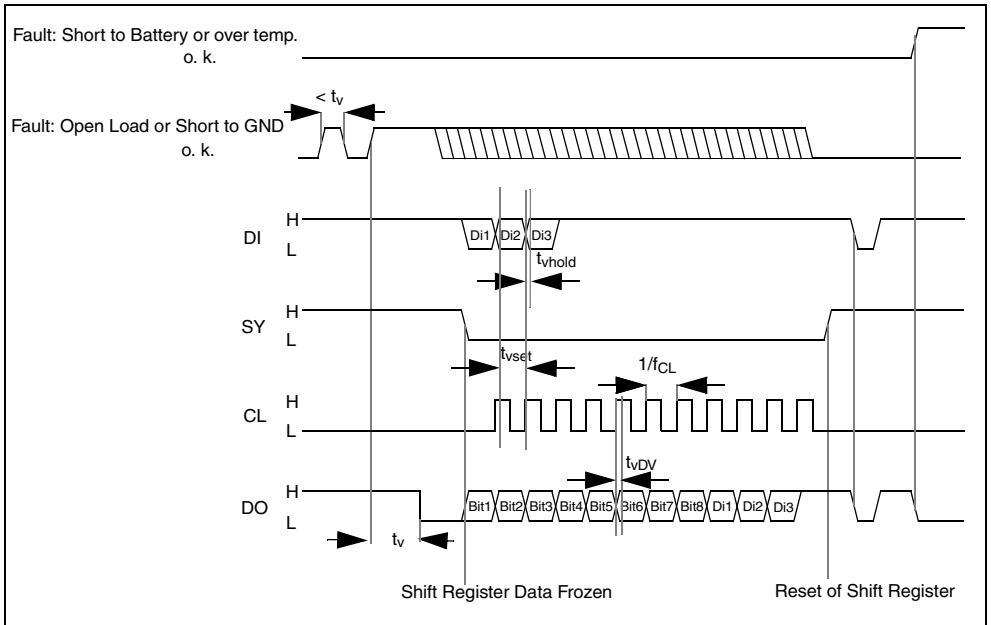


Figure 2. Serial Interface Error Coding

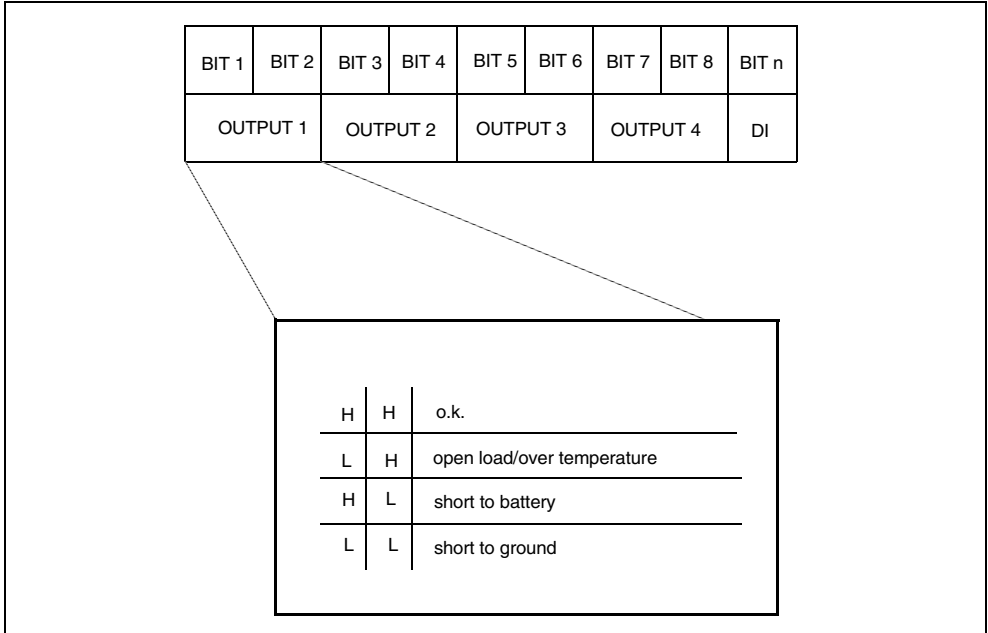


Figure 3. Output voltage TIMING for inductive load

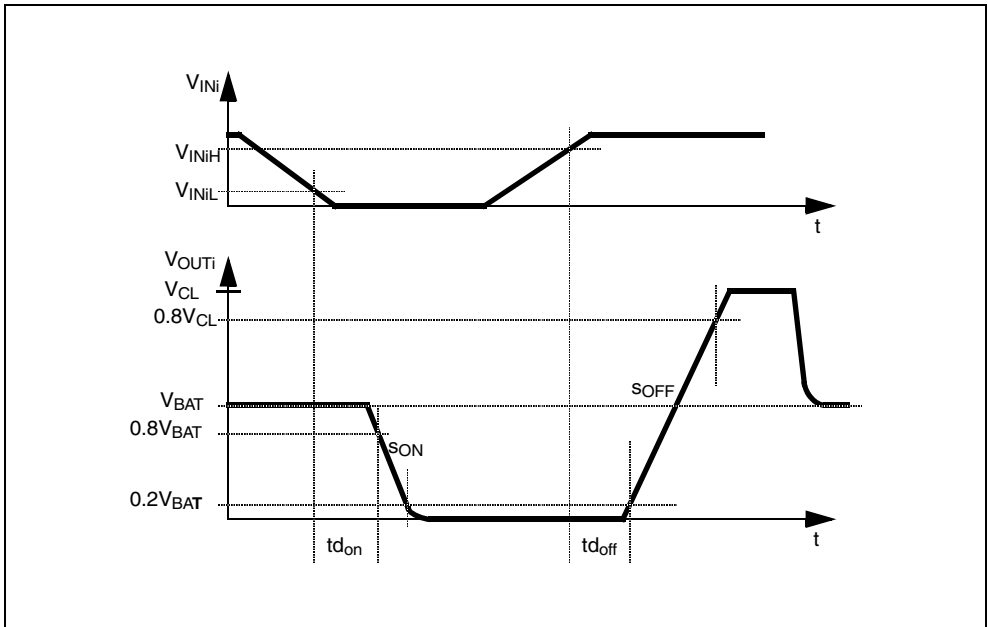
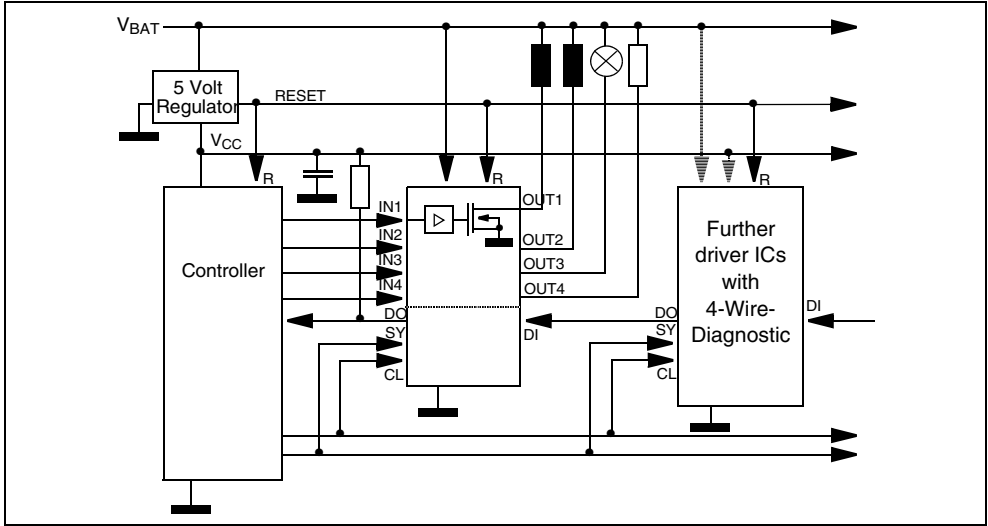


Figure 4. Application Circuit

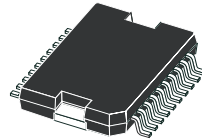


DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			3.6			0.142
a1	0.1		0.3	0.004		0.012
a2			3.3			0.130
a3	0		0.1	0.000		0.004
b	0.4		0.53	0.016		0.021
c	0.23		0.32	0.009		0.013
D (1)	15.8		16	0.622		0.630
D1 (2)	9.4		9.8	0.370		0.386
E	13.9		14.5	0.547		0.570
e		1.27			0.050	
e3		11.43			0.450	
E1 (1)	10.9		11.1	0.429		0.437
E2			2.9			0.114
E3	5.8		6.2	0.228		0.244
G	0		0.1	0.000		0.004
H	15.5		15.9	0.610		0.626
h			1.1			0.043
L	0.8		1.1	0.031		0.043
N	8°(typ.)					
S	8°(max. )					
T		10			0.394	

- (1) "D and E1" do not include mold flash or protusions.  
 - Mold flash or protusions shall not exceed 0.15mm (0.006")  
 - Critical dimensions: "E", "G" and "a3".  
 (2) For subcontractors, the limit is the one quoted in jedec MO-166

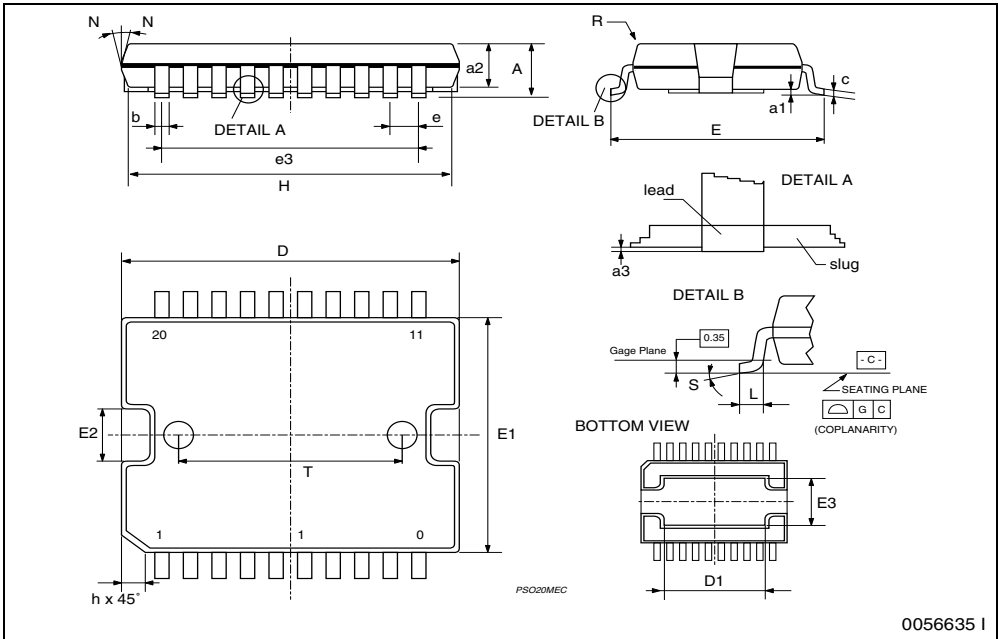
## OUTLINE AND MECHANICAL DATA

Weight: 1.9gr



JEDEC MO-166

PowerSO-20



**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 L9651 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