

## 1.9 A DC-DC converter modules

Preliminary Data

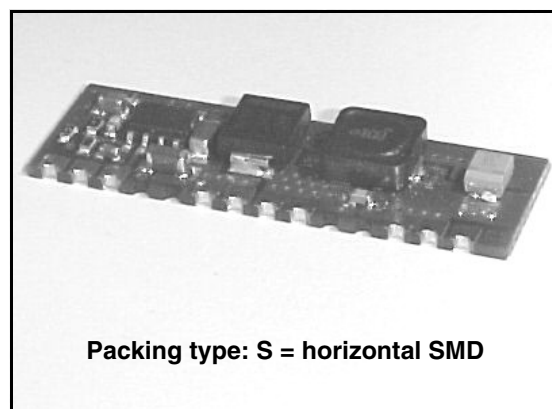
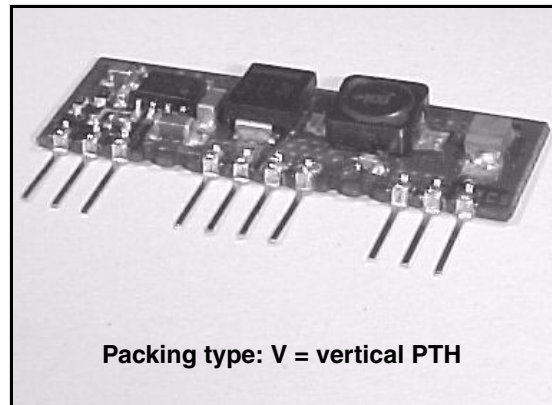
### Features

- MTBF 1 000 000 hours ( $T_A = 25\text{ }^\circ\text{C}$ )
- 1.9 A max output current
- 16 V max input voltage
- 1.5 V max drop-out voltage
- Remote logic inhibit/enable
- Synchronization
- Not-latching overload and short circuit protection
- Thermal shutdown
- Fixed or adjustable output
- No heatsink required
- Operating temperature range  $-25\text{ }^\circ\text{C} \div 85\text{ }^\circ\text{C}$

### Description

The GS-R12FP series is a family of high efficiency step down switching voltage regulator, designed to replace linear regulators.

Based on L5973AD device, this non isolated family of regulators are suitable for the full spectrum of applications including telecom, industry, computer and distributed power system applications having a widely ranging input voltage.



**Table 1. Device summary**

Order codes	Output voltage [V]	Input voltage [V]	Output ripple [mVpp]	Efficiency [%]	Notes
GS-R12FP0181.9	$1.8 \pm 4\%$	$4.5 \div 15$	25	63 - 68	Fixed output voltage
GS-R12FP0251.9	$2.5 \pm 4\%$	$4.5 \div 15$	25	70 - 73	Fixed output voltage
GS-R12FP0331.9	$3.3 \pm 4\%$	$4.5 \div 15$	25	74 - 77	Fixed output voltage
GS-R12FP0501.9	$5.0 \pm 4\%$	$6.6 \div 15$	25	82 - 83	Fixed output voltage
GS-R12FP0001.9	$1.235 \div 5.5$	$4.5 \div 15$	25	61 - 83	Progr. output voltage

# Contents

<b>1</b>	<b>Pin settings</b> .....	<b>3</b>
1.1	Pin connection and mechanical data (dimensions in mm) .....	3
1.2	Pin description .....	4
<b>2</b>	<b>Maximum ratings</b> .....	<b>5</b>
2.1	Absolute maximum ratings .....	5
2.2	Thermal data .....	5
2.3	Thermal de-rating .....	5
<b>3</b>	<b>Electrical characteristics</b> .....	<b>6</b>
<b>4</b>	<b>Application information</b> .....	<b>7</b>
4.1	Input voltage .....	7
4.2	Reference voltage .....	7
4.3	Inhibit function .....	7
4.4	Multiple units synchronization .....	7
4.5	Current limitation .....	7
4.6	Thermal shutdown .....	8
4.7	Output voltage programming (GS-R12FP0001.9 .....	8
4.8	Loop compensation (GS-R12FP0001.9 only) .....	8
4.9	Soldering .....	9
<b>5</b>	<b>Additional features and protections</b> .....	<b>10</b>
5.1	Output overvoltage protection .....	10
<b>6</b>	<b>Ordering scheme</b> .....	<b>12</b>
<b>7</b>	<b>Revision history</b> .....	<b>13</b>

# 1 Pin settings

## 1.1 Pin connection and mechanical data (dimensions in mm)

Figure 1. Pin connection GS-R12FVxxx1.9

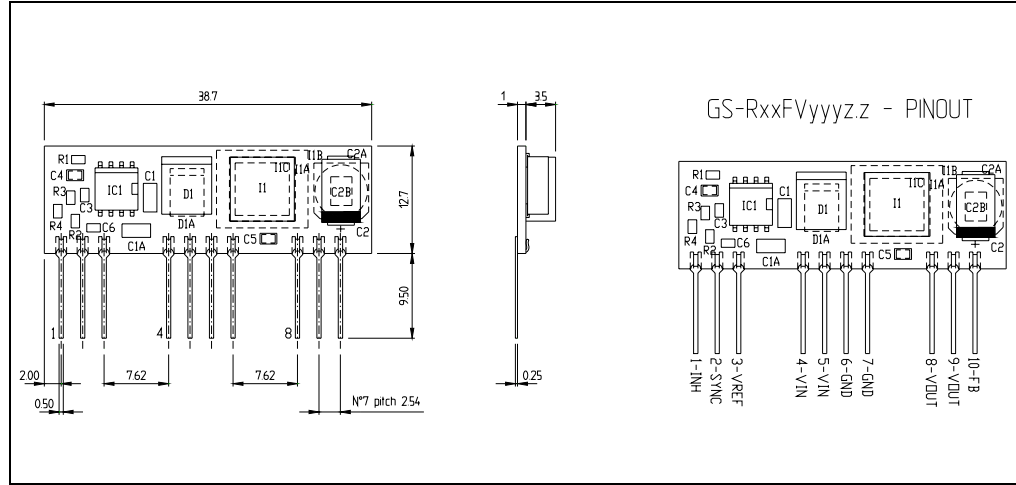
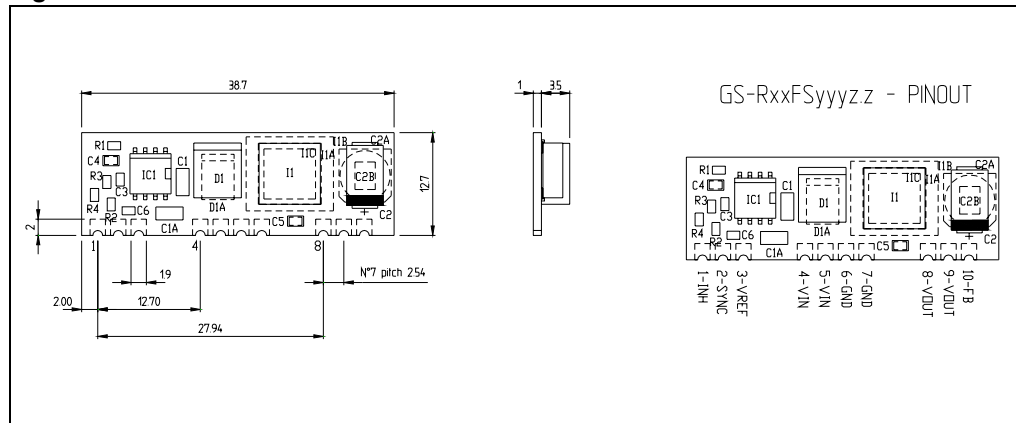


Figure 2. Pin connection GS-R12FSxxx1.9



## 1.2 Pin description

**Table 2. Pin description**

Name	Function	Description
1	INH	A logic high level disables the device. When the pin is open, an internal pull up disables the device
2	Sync	Master/slave synchronization
3	$V_{ref}$	3.3 V reference voltage
4	Input +	DC input voltage
5	Input +	DC input voltage
6	Input/output GND	Return for input/output voltage source
7	Input/output GND	Return for input/output voltage source
8	$V_{out}$	Regulated power output
9	$V_{out}$	Regulated power output
10	FB	Feedback input, available on adjustable device and on request for additional compensation

## 2 Maximum ratings

### 2.1 Absolute maximum ratings

Table 3. Absolute maximum ratings

Symbol	Parameter	Value	Unit
$V_I$	DC input voltage	16	V
$I_{out}$	Maximum output current	int. limit	
$V_1$	INH	-0.3 to $V_i$	V
$V_2$	Sync	-0.3 to 4	V
$V_{10}$	FB	4	V

### 2.2 Thermal data

Table 4. Thermal data

Symbol	Parameter	Value	Unit
$T_{STG}$	Storage temperature range	-40 ÷ 105	°C
$T_{OP}$	Operating ambient temperature	-25 ÷ 85	°C

### 2.3 Thermal de-rating

Table 5. Thermal de-rating for free air condition (all versions)

Symbol	Parameter	Test condition	Value	Unit
$I_o$	Output current	$V_I = 4.5 \div 16 \text{ V}, T_A = 30 \text{ }^\circ\text{C}$	1.90	A
		$V_I = 4.5 \div 16 \text{ V}, T_A = 40 \text{ }^\circ\text{C}$	1.85	
		$V_I = 4.5 \div 16 \text{ V}, T_A = 50 \text{ }^\circ\text{C}$	1.80	
		$V_I = 4.5 \div 16 \text{ V}, T_A = 60 \text{ }^\circ\text{C}$	1.75	
		$V_I = 4.5 \div 16 \text{ V}, T_A = 65 \text{ }^\circ\text{C}$	1.65	
		$V_I = 4.5 \div 16 \text{ V}, T_A = 70 \text{ }^\circ\text{C}$	1.55	
		$V_I = 4.5 \div 16 \text{ V}, T_A = 75 \text{ }^\circ\text{C}$	1.40	
		$V_I = 4.5 \div 16 \text{ V}, T_A = 80 \text{ }^\circ\text{C}$	1.25	
		$V_I = 4.5 \div 16 \text{ V}, T_A = 85 \text{ }^\circ\text{C}$	1.10	

### 3 Electrical characteristics

$T_A = 25\text{ °C}$ , unless otherwise specified

**Table 6. Electrical characteristics (all version)**

Symbol	Parameter	Test condition	Min	Typ	Max	Unit
$V_r$	Ripple voltage	$V_i = 12\text{ V}, I_o = 1.9\text{ A}$		25	35	mVpp
	Temperature stability	$V_i = V_o + 1.5\text{ V}, I_o = 1.9\text{ A}$		TBD		mV/°C
$I_o$	Output current	$V_i = 4.5 \div 16\text{ V}$	0		1.9	A
$I_{oL}$	Current limit	$V_i = 4.5 \div 16\text{ V}$		2.3		A
$I_q$	Quiescent current	$V_i = 12\text{ V}, I_o = 0\text{ A}$			2.7	mA
$I_{qst-by}$	Total stand-by quiescent current	$V_{inh} > 2.2\text{ V}$		50	100	μA
$f_s$	Switching frequency	$V_i = 12\text{ V}, I_o = 1.9\text{ A}$		500		kHz
$V_{ref}$	Reference voltage	$V_i = 4.5 \div 15\text{ V}$ $I_{ref} = 0 \div 5\text{ mA}$	3.2	3.3	3.399	V
	Short circuit current		10	18	30	mA
INH	INH threshold voltage	Device ON			0.8	V
		Device OFF	2.2			V
$V_{FB}$	Feedback voltage	$V_i = 4.5 \div 15\text{ V}, I_o = 0 \div 2\text{ A}$	1.22	1.235	1.25	V

## 4 Application information

### 4.1 Input voltage

The recommended maximum operating DC input voltage is 15 V including ripple voltage.

### 4.2 Reference voltage

No capacitor is required for stability.

### 4.3 Inhibit function

The inhibit feature allows to put the device in stand-by mode.

With INH pin 1 is higher than 2.2 V the device is disabled and the current consumption is reduced to less than 100  $\mu$ A for  $V_i = 15$  V.

With INH pin lower than 0.8 V, the device is enabled.

If the INH pin is left floating, an internal pull up ensures that the voltage at the pin reaches the inhibit threshold and the device is disabled.

The pin can be pulled to  $V_i$  to disable the device.

### 4.4 Multiple units synchronization

Using more than one unit on the same circuit, it is possible to synchronize the switching frequency, connecting all pin 2 together (see [Figure 6](#)).

The unit with higher frequency becomes the master.

### 4.5 Current limitation

The device has two current limit protections, pulse by pulse and frequency fold back.

The current is sensed through a resistor and if it reaches the threshold, the on time is reduced and consequently the output voltage, too.

Since the minimum switch ON time (necessary to avoid false overcurrent signal) is not enough to obtain a sufficiently low duty cycle at 500 Hz, the output current could increase again, in strong overcurrent or short circuit conditions.

For this reason the switching frequency is also reduced to keep the inductor current within its maximum threshold limit.

The frequency depends on the feedback voltage.

As the feedback voltage decreases (due to the reduced duty cycle), the switching frequency decrease too.

## 4.6 Thermal shutdown

The shutdown block generates a signal that turns OFF the power stage if the temperature of the internal chip goes higher than a fixed internal threshold (150 °C min).

The sensing element of the chip is very close to the PDMOS area, so ensuring an accurate and fast temperature detection.

An hysteresis of approximately 20 °C avoids that the devices turns ON and OFF continuously.

## 4.7 Output voltage programming (GS-R12FP0001.9 only)

The GS-R12FP0001.9 output voltage is 5.54 V  $\pm$ 4 %, to reduce this value connect a resistor between pin 10 (FB) and pin 9 ( $V_{out}$ ).

The resistor must be located very close to the proper pins, to minimize the injected noise (see [Figure 4](#)).

The resistor value is calculated using the following formula:

$$R_v = [(V_{out} - 1.235) * 11.3] / 5.54 - V_{out} \quad [k\Omega]$$

$V_{out}$  can be adjusted between 1.235 V ( $R_v = 0 \Omega$ ) and 5.54 V ( $R_v = \text{open}$ )

## 4.8 Loop compensation (GS-R12FP0001.9 only)

If required by particular load conditions, it is possible to change the feedback loop compensation, adding an external capacitor between pin 10 (FB) and pin 9 ( $V_{out}$ ), which will act as speed up (see [Figure 5](#)).



## 4.9 Soldering

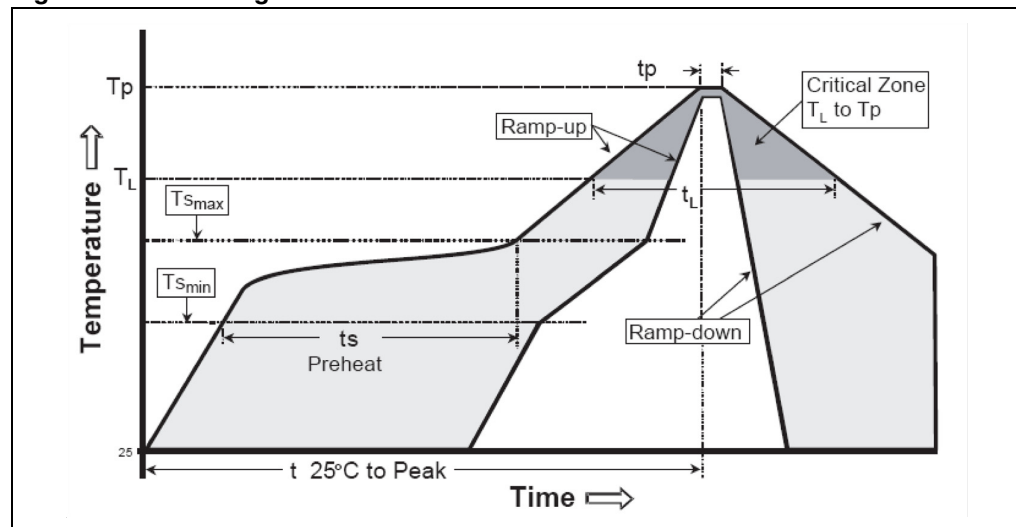
Soldering phase has to be executed with care : in order to avoid undesired melting phenomenon, particular attention has to be taken on the set up of the peak temperature.

Here following some suggestions for the temperature profile based on IPC/JEDEC J-STD-020C ,July 2004 recommendations.

**Table 7. Soldering**

Profile feature	PB free assembly
Average ramp up rate ( $T_{S_{MAX}}$ to $T_P$ )	3 °C / sec max
Preheat	
Temperature min ( $T_S$ MIN)	150 °C
Temperature max ( $T_S$ MAX)	200 °C
Time ( $T_S$ MIN to $T_S$ MAX ) ( $t_s$ )	60 – 100 sec
Time maintained above :	
Temperature $T_L$	217 °C
Time $t_L$	40 – 70 sec
Peak temperature ( $T_P$ )	240 + 0 °C
Time within 5 °C of actual peak temperature ( $t_p$ )	10 – 20 sec
Ramp down rate	6 °C / sec
Time from 25 °C to peak temperature	8 minutes max

**Figure 3. Soldering**



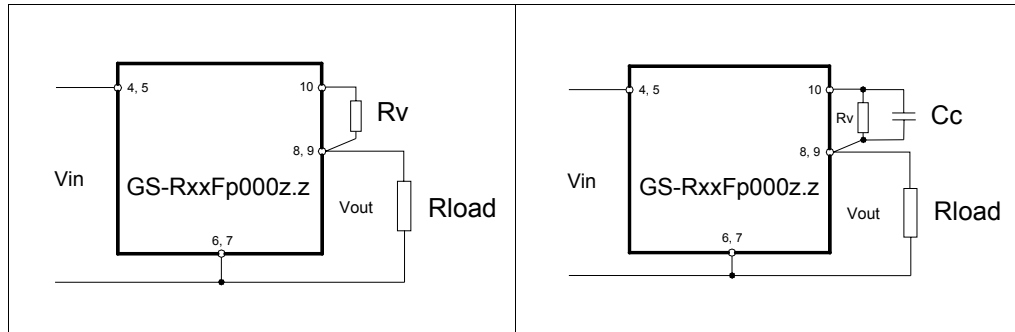
## 5 Additional features and protections

### 5.1 Output overvoltage protection

The overvoltage protection, OVP, is realized by using an internal comparator, whose input is connected to the feedback. It turns off the power stage when the OVP threshold is reached.

This threshold is typically 30 % higher than the feedback voltage.

**Figure 4. Output voltage programming** **Figure 5. Loop compensation**



**Figure 6. Multiple units synchronization**

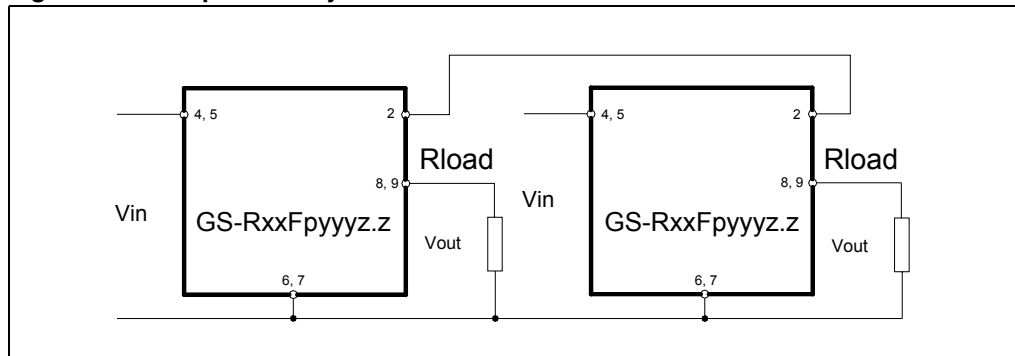
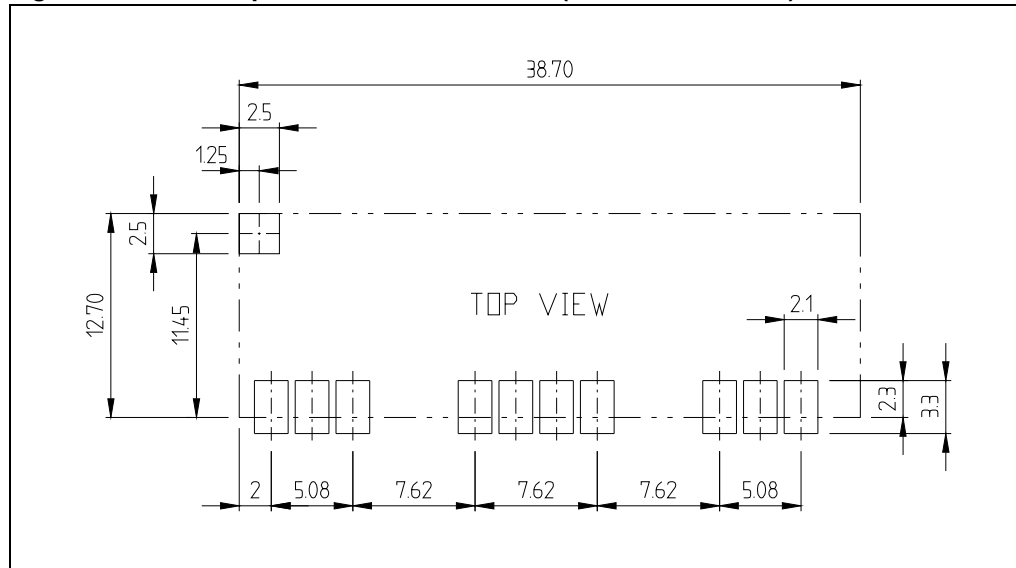


Figure 7. PCB footprint for GS-R12FSxxx1.9 (dimensions in mm)



## 6 Ordering scheme

Table 8. Ordering information scheme

	GS-	R12	FV	018	1.9
<b>Input voltage</b>					
12 = 12 V					
<b>Package</b>					
V = Vertical					
S = SMD					
<b>Output voltage</b>					
018 = 1.8 V					
025 = 2.5 V					
033 = 3.3 V					
050 = 5.0 V					
000 = 1.235 ÷ 5.5 V					
<b>Output current</b>					
1.9 = 1.9 A					

## 7 Revision history

Table 9. Document revision history

Date	Revision	Changes
13-Oct-2006	1	Initial release
27-Feb-2008	2	Added: <a href="#">Section 4.9: Soldering on page 9</a>

**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.**

**UNLESS EXPRESSLY APPROVED IN WRITING BY AN AUTHORIZED ST REPRESENTATIVE, ST PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER'S OWN RISK.**

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.

© 2008 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 - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

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