

LMV321, LMV358, LMV324

Low cost, low power, input/output rail-to-rail operational amplifiers

Features

- Operating range from V_{CC} = 2.7 V to 6 V
- Rail-to-rail input and output
- Extended V_{icm} (V_{DD} 0.2 V to V_{CC} + 0.2 V)
- Low supply current (145 µA)
- Gain bandwidth product (1 MHz)
- ESD tolerance (2 kV)
- Latch-up immunity
- Available in SOT23-5 micropackage

Applications

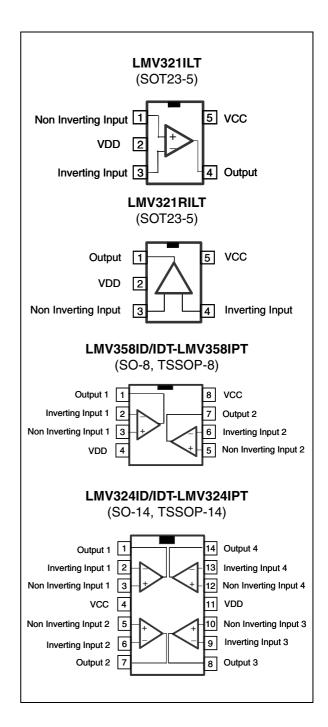
- Two-cell battery powered systems
- Battery powered electronic equipment
- Cordless phones
- Personal medical care (glucose meters)
- Laptops
- PDAs

Description

The LMV321/358/324 family (single, dual and quad) answers the need for low-cost, general-purpose operational amplifiers. They operate with voltages as low as 2.7 V and feature both input and output rail-to-rail, 145 μ A consumption current and 1 MHz gain bandwidth product (GBP).

With such a low consumption and a sufficient GBP for many applications, these op-amps are very well-suited for any kind of battery supplied and portable equipment application.

The LMV321 is housed in the space-saving 5-pin SOT23-5 package, which simplifies board design (overall dimensions are 2.8 mm x 2.9 mm). The SOT23-5 has two pinning configurations to answer all application requirements.



1 Absolute maximum ratings and operating conditions

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V _{CC}	Supply voltage (1)	7	V
V _{id}	Differential input voltage ⁽²⁾	±1	V
V _{in}	Input voltage	V _{DD} -0.3 to V _{CC} +0.3	V
T _{oper}	Operating free air temperature range	-40 to + 125	°C
T _{stg}	Storage temperature	-65 to +150	°C
Tj	Maximum junction temperature	150	°C
R _{thja}	Thermal resistance junction to ambient ⁽³⁾ SOT23-5 SO-8 SO-14 TSSOP8 TSSOP14	250 125 103 120 100	°C/W
R _{thjc}	Thermal resistance junction to case ⁽³⁾ SOT23-5 SO-8 SO-14 TSSOP8 TSSOP14	81 40 31 37 32	°C/W
	HBM: human body model ⁽⁴⁾	2	kV
ESD	MM: machine model ⁽⁵⁾	200	V
	CDM: charged device model ⁽⁶⁾	1.5	kV
	Lead temperature (soldering, 10sec)	250	°C
	Output short-circuit duration	see note ⁽⁷⁾	

- 1. All voltage values, except differential voltage are with respect to network terminal.
- 2. Differential voltages are the non-inverting input terminal with respect to the inverting input terminal. If $V_{id} > \pm 1$ V, the maximum input current must not exceed ± 1 mA. In this case ($V_{id} > \pm 1$ V), an input series resistor must be added to limit input current.
- Short-circuits can cause excessive heating. Destructive dissipation can result from simultaneous short-circuits on all amplifiers. All values are typical.
- 4. Human body model: a 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5 k Ω resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.
- 5. Machine model: a 200 pF capacitor is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5 Ω). This is done for all couples of connected pin combinations while the other pins are floating.
- 6. Charged device model: all pins and the package are charged together to the specified voltage and then discharged directly to the ground through only one pin. This is done for all pins. No value specified for CDM on SOT23-5L package. The value is given for SO and TSSOP packages.
- Short-circuits from the output to V_{CC} can cause excessive heating. The maximum output current is approximately 48 mA, independent of the magnitude of V_{CC}. Destructive dissipation can result from simultaneous short-circuits on all amplifiers.

2/16 Doc ID 11887 Rev 4

Table 2. Operating conditions

Symbol	Parameter	Value	Unit
V _{CC}	Supply voltage	2.7 to 6	V
V _{icm}	Common mode input voltage range (1)	V _{DD} -0.2 to V _{CC} + 0.2	V
V _{icm}	Common mode input voltage range (2)	V _{DD} to V _{CC}	V
T _{oper}	Operating free air temperature range	-40 to + 125	°C

^{1.} At 25°C, for 2.7 \leq V_{CC} \leq 6 V, V_{icm} is extended to V_{DD} - 0.2 V, V_{CC} + 0.2 V.

^{2.} In full temperature range, both rails can be reached when $\rm V_{\rm CC}$ does not exceed 5.5 V.

2 Electrical characteristics

Table 3. V_{CC} = +2.7 V, V_{DD} = 0 V, C_L and R_L connected to V_{CC} /2, T_{amb} = 25°C (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Тур.	Max.	Unit
V _{io}	Input offset voltage	$\begin{aligned} V_{icm} &= V_{out} = V_{CC}/2 \\ T_{min} &\leq T_{amb} \leq T_{max} \end{aligned}$		0.1	3 6	mV
ΔV_{io}	Input offset voltage drift			2		μV/°C
I _{io}	Input offset current	$V_{icm} = V_{out} = V_{CC}/2^{(1)}$ $T_{min} \le T_{amb} \le T_{max}$		1	9 25	nA
I _{ib}	Input bias current	$\begin{aligned} V_{icm} &= V_{out} = V_{CC}/2^{(1)} \\ T_{min} &\leq T_{amb} \leq T_{max} \end{aligned}$		10	50 85	nA
CMR	Common mode rejection ratio	$0 \le V_{icm} \le V_{CC}$	55	85		dB
SVR	Supply voltage rejection ratio	V _{icm} = V _{CC} /2	70	80		dB
A _{vd}	Large signal voltage gain	$V_{out} = 0.5 \text{ V to } 2.2 \text{ V}$ $R_L = 10 \text{ k}\Omega$ $R_L = 2 \text{ k}\Omega$	80 70	100 88		dB
V _{OH}	High level output voltage	$V_{id} = 100 \text{ mV}$ $T_{min} \le T_{amb} \le T_{max}$ $R_{L} = 10 \text{ k}\Omega$ $R_{L} = 2 \text{ k}\Omega$	2.6 2.55	2.65 2.6		V
V _{OL}	Low level output voltage	$V_{id} = -100 \text{ mV}$ $T_{min} \le T_{amb} \le T_{max}$ $R_{L} = 10 \text{ k}\Omega$ $R_{L} = 2 \text{ k}\Omega$		15 50	90 100	mV
I _o	Output current	Output source current $V_{id} = 100 \text{ mV}, V_O = V_{DD}$ Output sink current $V_{id} = -100 \text{ mV}, V_O = V_{CC}$	5 5	46 46		mA
I _{CC}	Supply current (per amplifier)	$\begin{aligned} &V_{out} = V_{CC}/2 \\ &A_{VCL} = 1, \text{ no load} \\ &T_{min} \leq T_{amb} \leq T_{max} \end{aligned}$		145	200 230	μА
GBP	Gain bandwidth product	$R_L = 10 \text{ k}\Omega \text{ C}_L = 100 \text{ pF},$ f = 100 kHz		1		MHz
SR	Slew rate	$R_L = 600 \ \Omega, \ C_L = 100 \ pF,$ $A_V = 1$		0.35		V/µs
φm	Phase margin	$R_L = 600 \Omega$, $C_L = 100 pF$		44		Degrees
en	Input voltage noise			40		nV/√Hz
THD	Total harmonic distortion			0.01		%

^{1.} Maximum values include unavoidable inaccuracies of the industrial tests.

Table 4. V_{CC} = +5 V, V_{DD} = 0 V, C_L and R_L connected to $V_{CC}/2$, T_{amb} = 25°C (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Тур.	Max.	Unit
V _{io}	Input offset voltage	$\begin{aligned} V_{icm} &= V_{out} = V_{CC}/2 \\ T_{min} &\leq T_{amb} \leq T_{max} \end{aligned}$		0.1	3 6	mV
ΔV_{io}	Input offset voltage drift			2		μV/°C
I _{io}	Input offset current	$V_{icm} = V_{out} = V_{CC}/2$ (1) $T_{min} \le T_{amb} \le T_{max}$		1	9 25	nA
I _{ib}	Input bias current	$\begin{aligned} V_{icm} &= V_{out} = V_{CC}/2^{(1)} \\ T_{min} &\leq T_{amb} \leq T_{max} \end{aligned}$		16	63 95	nA
CMR	Common mode rejection ratio	$0 \le V_{icm} \le V_{CC}$	65	95		dB
SVR	Supply voltage rejection ratio	$V_{icm} = V_{CC}/2$	70	90		dB
A _{vd}	Large signal voltage gain	$\begin{aligned} V_{out} &= 0.5 \text{ V to } 4.5 \text{ V} \\ R_L &= 10 \text{ k} \Omega \\ R_L &= 2 \text{ k} \Omega \end{aligned}$	85 77	97 93		dB
V _{OH}	High level output voltage	$\begin{aligned} & V_{id} = 100 \text{ mV} \\ & T_{min} \leq T_{amb} \leq T_{max} \\ & R_L = 10 \text{ k}\Omega \\ & R_L = 2 \text{ k}\Omega \end{aligned}$	4.85 4.8	4.95 4.91		V
V _{OL}	Low level output voltage	$\begin{aligned} V_{id} &= \text{-}100 \text{ mV} \\ T_{min} &\leq T_{amb} \leq T_{max} \\ R_L &= 10 \text{ k}\Omega \\ R_L &= 2 \text{ k}\Omega \end{aligned}$		40 80	180 200	mV
I _o	Output current	Output source current $V_{id} = 100 \text{ mV}, V_O = V_{DD}$ Output sink current $V_{id} = -100 \text{ mV}, V_O = V_{CC}$	7	48 48		mA
I _{CC}	Supply current (per amplifier)	$\begin{aligned} &V_{out} = V_{CC}/2 \\ &A_{VCL} = 1, \text{ no load} \\ &T_{min} \leq T_{amb} \leq T_{max} \end{aligned}$		162	220 250	μА
GBP	Gain bandwidth product	$R_L = 10 \text{ k}\Omega \text{ C}_L = 100 \text{ pF},$ f = 100 kHz		1.3	_	MHz
SR	Slew rate	$R_L = 600 \Omega, C_L = 100 pF,$ $A_V = 1$		0.45		V/µs
φm	Phase margin	$R_L = 600 \Omega, C_L = 100 pF$		48		Degrees
en	Input voltage noise			40		nV/√Hz
THD	Total harmonic distortion			0.01		%

^{1.} Maximum values include unavoidable inaccuracies of the industrial tests.

Figure 1. Supply current/amplifier vs. supply Figure 2. Input bias current vs. temperature voltage

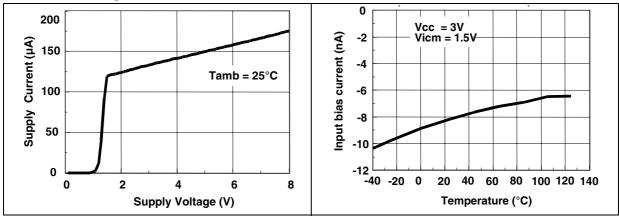


Figure 3. Input bias current vs. temperature Figure 4. Common mode rejection vs. temperature

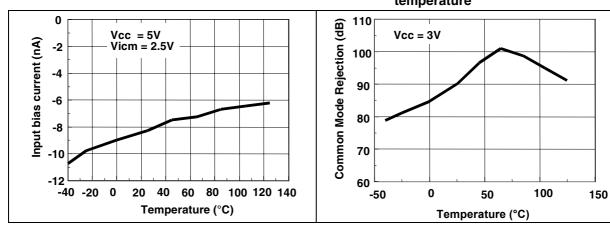
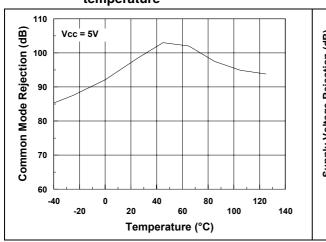
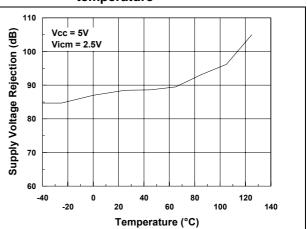


Figure 5. Common mode rejection vs. Figure 6. temperature



igure 6. Supply voltage rejection vs. temperature



6/16 Doc ID 11887 Rev 4

Figure 7. Open-loop gain vs. temperature

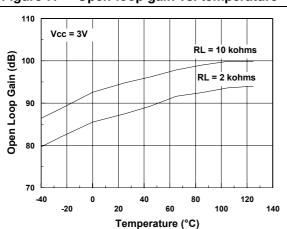


Figure 8. Open-loop gain vs. temperature

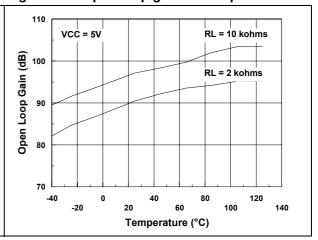


Figure 9. Supply voltage rejection vs. temperature

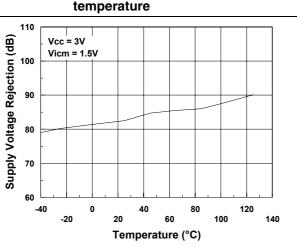


Figure 10. Output current vs. output voltage

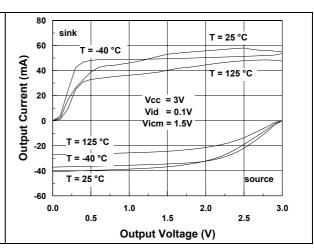
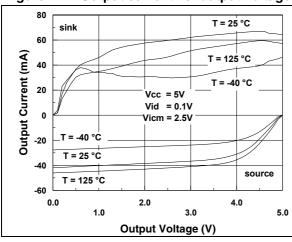
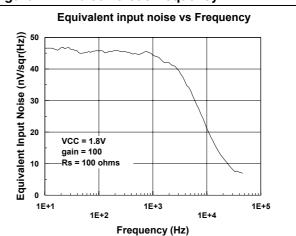


Figure 11. Output current vs. output voltage Figure 12. Noise versus frequency





3 Package information

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.

8/16 Doc ID 11887 Rev 4

3.1 SOT23-5 package information

Figure 13. SOT23-5 package mechanical drawing

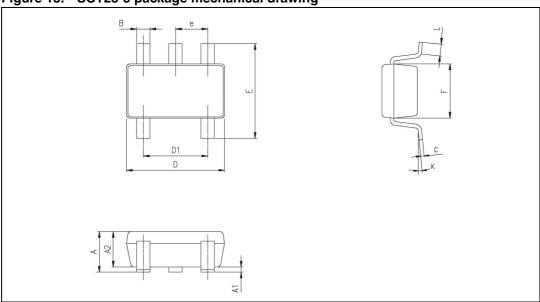


Table 5. SOT23-5 package mechanical data

	Dimensions							
Ref.		Millimeters			Inches			
	Min.	Тур.	Max.	Min.	Тур.	Max.		
Α	0.90	1.20	1.45	0.035	0.047	0.057		
A1			0.15			0.006		
A2	0.90	1.05	1.30	0.035	0.041	0.051		
В	0.35	0.40	0.50	0.013	0.015	0.019		
С	0.09	0.15	0.20	0.003	0.006	0.008		
D	2.80	2.90	3.00	0.110	0.114	0.118		
D1		1.90			0.075			
е		0.95			0.037			
Е	2.60	2.80	3.00	0.102	0.110	0.118		
F	1.50	1.60	1.75	0.059	0.063	0.069		
L	0.10	0.35	0.60	0.004	0.013	0.023		
K	0 degrees		10 degrees					

3.2 SO-8 package information

Figure 14. SO-8 package mechanical drawing

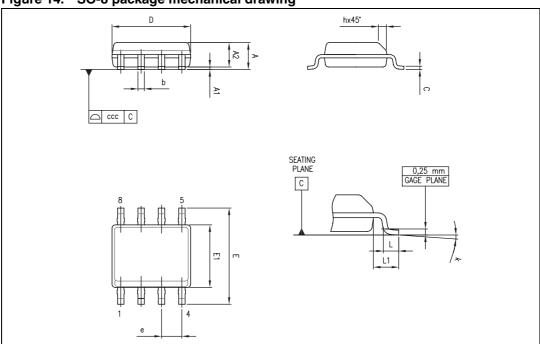


Table 6. SO-8 package mechanical data

Table 0.	T T Parita;	ge meename						
	Dimensions							
Ref.		Millimeters			Inches			
	Min.	Тур.	Max.	Min.	Тур.	Max.		
Α			1.75			0.069		
A1	0.10		0.25	0.004		0.010		
A2	1.25			0.049				
b	0.28		0.48	0.011		0.019		
С	0.17		0.23	0.007		0.010		
D	4.80	4.90	5.00	0.189	0.193	0.197		
E	5.80	6.00	6.20	0.228	0.236	0.244		
E1	3.80	3.90	4.00	0.150	0.154	0.157		
е		1.27			0.050			
h	0.25		0.50	0.010		0.020		
L	0.40		1.27	0.016		0.050		
L1		1.04			0.040			
k	0		8°	1°		8°		
ccc			0.10			0.004		

3.3 TSSOP8 package information

Figure 15. TSSOP8 package mechanical drawing

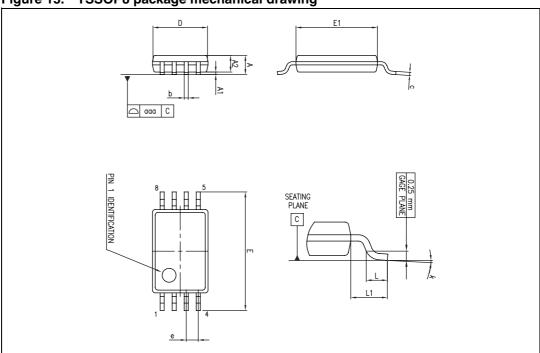


Table 7. TSSOP8 package mechanical data

			Dimer	nsions		
Ref.		Millimeters			Inches	
	Min.	Тур.	Max.	Min.	Тур.	Max.
Α			1.20			0.047
A1	0.05		0.15	0.002		0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.012
С	0.09		0.20	0.004		0.008
D	2.90	3.00	3.10	0.114	0.118	0.122
E	6.20	6.40	6.60	0.244	0.252	0.260
E1	4.30	4.40	4.50	0.169	0.173	0.177
е		0.65			0.0256	
k	0°		8°	0°		8°
L	0.45	0.60	0.75	0.018	0.024	0.030
L1		1			0.039	
aaa			0.10			0.004

3.4 SO-14 package information

Figure 16. SO-14 package mechanical drawing

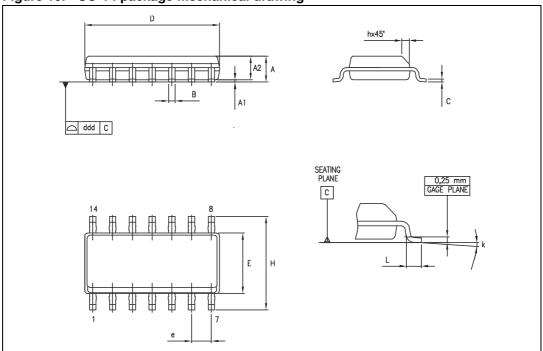


Table 8. SO-14 package mechanical data

			Dimensions			
Def		Millimeters			Inches	
Ref.	Min.	Тур.	Max.	Min.	Тур.	Max.
Α	1.35		1.75	0.05		0.068
A1	0.10		0.25	0.004		0.009
A2	1.10		1.65	0.04		0.06
В	0.33		0.51	0.01		0.02
С	0.19		0.25	0.007		0.009
D	8.55		8.75	0.33		0.34
E	3.80		4.0	0.15		0.15
е		1.27			0.05	
Н	5.80		6.20	0.22		0.24
h	0.25		0.50	0.009		0.02
L	0.40		1.27	0.015		0.05
k		<u>'</u>	8° (max.)	<u>'</u>	
ddd			0.10			0.004

3.5 TSSOP14 package information

Figure 17. TSSOP14 package mechanical drawing

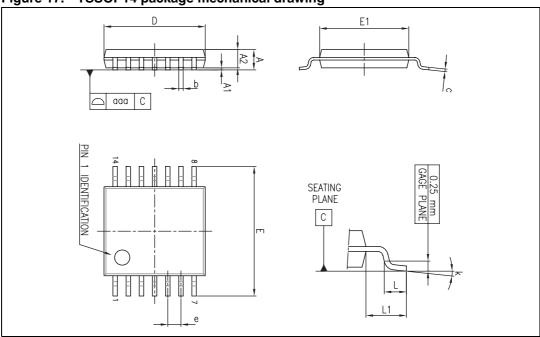


Table 9. TSSOP14 package mechanical data

			Dimer	nsions		
Ref.		Millimeters			Inches	
	Min.	Тур.	Max.	Min.	Тур.	Max.
А			1.20			0.047
A1	0.05		0.15	0.002	0.004	0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.012
С	0.09		0.20	0.004		0.0089
D	4.90	5.00	5.10	0.193	0.197	0.201
E	6.20	6.40	6.60	0.244	0.252	0.260
E1	4.30	4.40	4.50	0.169	0.173	0.176
е		0.65			0.0256	
L	0.45	0.60	0.75	0.018	0.024	0.030
L1		1.00			0.039	
k	0°		8°	0°		8°
aaa			0.10			0.004

4 Ordering information

Table 10. Order codes

Order code	Temperature range	Package	Packaging	Marking
LMV321ILT		SOT23-5	Tono 9 rool	K177
LMV321RILT		50123-5	Tape & reel	K176
LMV321IYLT ⁽¹⁾		SOT23-5	Tana 9 raal	K180
LMV321RIYLT ⁽²⁾		(Automotive grade)	Tape & reel	K185
LMV358ID LMV358IDT		SO-8	Tube or tape & reel	LMV358
LMV358IYD ⁽¹⁾ LMV358IYDT ⁽¹⁾		SO-8 (Automotive grade)	Tube or tape & reel	LMV358IY
LMV358IPT	-40°C, +125 °C	TSSOP8	Tape & reel	MV358
LMV358IYPT ⁽²⁾		TSSOP8 (Automotive grade)	Tape & reel	K181Y
LMV324ID LMV324IDT		SO-14	Tube or tape & reel	LMV324
LMV324IYD ⁽¹⁾ LMV324IYDT ⁽¹⁾		SO-14 (Automotive grade)	Tube or tape & reel	V324Y
LMV324IPT		TSSOP14	Tape & reel	MV324
LMV324IYPT ⁽¹⁾		TSSOP14 (Automotive grade)	Tape & reel	V324IY

Qualification and characterization according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q 002 or equivalent.

^{2.} Qualification and characterization according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q 002 or equivalent are ongoing.

5 Revision history

Table 11. Document revision history

Date	Revision	Changes
1-Dec-2005	1	First release - Products in full production.
25-May-2007	2	Added automotive grade part numbers to order codes table. Moved order codes table to Section 4 on page 14.
20-Feb-2008	3	Added Figure 12: Noise versus frequency on page 7. Updated presentation of package information. Corrected footnote for automotive grade part numbers in order codes table.
18-Jan-2010	4	Updated document format. Updated packages in <i>Chapter 3: Package information</i> . Modified <i>Note 1</i> and added <i>Note 2</i> under <i>Table 10: Order codes</i> .

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.

© 2010 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

16/16 Doc ID 11887 Rev 4

