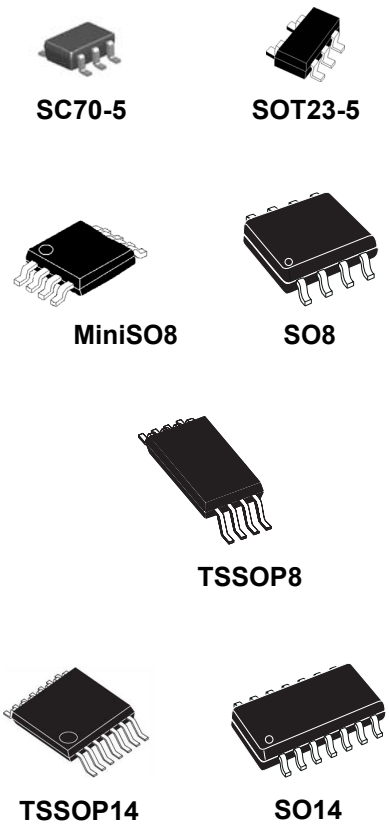
LMV321L, LMV358L, LMV324L

Low-power, general-purpose operational amplifiers

Datasheet - production data



Applications

- Battery-powered applications
- Portable devices
- Signal conditioning
- Active filtering
- Medical instrumentation

Description

The LMV321L, LMV358L, and LMV324L are single, dual, and quad operational amplifiers with rail-to-rail output capabilities. They are specifically designed to operate at low voltages (2.7 V to 5 V) with enhanced performances compared to the industry standard LM3xx series.

The LMV321L, LMV358L, and LMV324L are offered in tiny packages, allowing the devices to be used in small portable electronic applications and to be placed closer to the actual signal.

The LMV321L, LMV358L, and LMV324L are complete cost-effective solutions for application designs where cost is of primary importance.

Features

- Low-power consumption: 250 µA max at 5 V
- Low offset voltage: 7 mV max at 25 °C
- Industrial temperature range: -40 °C to +125 °C
- Low supply voltage: 2.7 V - 5.5 V
- Gain bandwidth product: 1.3 MHz
- Tiny packages

Contents

1 **Package pin connections 3**

2 **Absolute maximum ratings and operating conditions 4**

3 **Electrical characteristics 5**

4 **Application information 11**

4.1 Operating voltages 11

4.2 Input common-mode range 11

4.3 Rail-to-rail output 11

4.4 Input offset voltage drift over temperature 11

4.5 PCB layouts 11

4.6 Macromodel 11

5 **Package information 12**

5.1 SC70-5 (SOT323-5) package information 13

5.2 SOT23-5 package information 14

5.3 MiniSO8 package information 15

5.4 SO8 package information 16

5.5 TSSOP8 package information 17

5.6 TSSOP14 package information 18

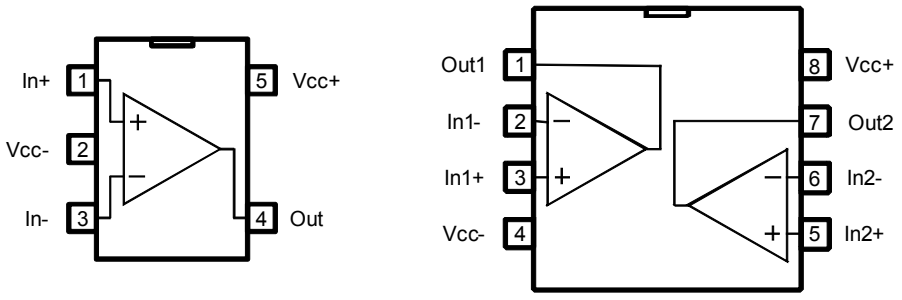
5.7 SO14 package information 19

6 **Ordering information 20**

7 **Revision history 20**

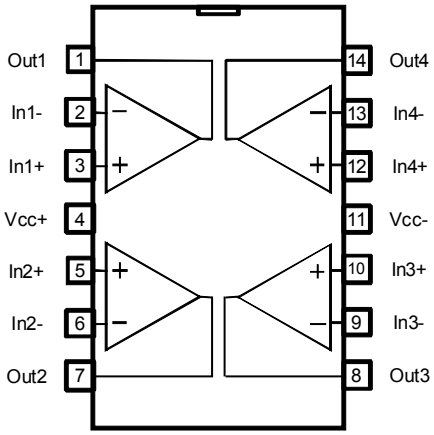
1 Package pin connections

Figure 1. Pin connections for each package (top view)



SC70-5/SOT23-5

MiniSO8/SO8/TSSOP8



TSSOP14/SO14

2 Absolute maximum ratings and operating conditions

Table 1. Absolute maximum ratings (AMR)

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage(1)	6	V
V_{id}	Differential input voltage(2)	$\pm V_{CC}$	
V_{in}	Input pins (IN+ and IN- pins) voltage(3)	V_{CC-} - 0.3 to V_{CC+} + 0.2	
I_{in}	Input current(4)	10	mA
T_{stg}	Storage temperature	-65 to +150	°C
R_{thja}	Thermal resistance junction to ambient(5)(6)		°C/W
	SC70-5	205	
	SOT23-5	250	
	MiniSO8	190	
	SO8	125	
	TSSOP8	120	
	TSSOP14	100	
	SO14	105	
T_j	Maximum junction temperature	150	°C
ESD	HBM: human body model(7)	4000	V
	MM: machine model(8)	250	
	CDM: charged device model(9)	1300	
	Latch-up immunity	200	mA

1. All voltage values, except differential voltage, are with respect to network ground terminal
2. Differential voltage is the non-inverting input terminal with respect to the inverting input terminal
3. V_{CC}-V_{in} must not exceed 6 V, V_{in} must not exceed 6 V
4. Input current must be limited by a resistor in series with the inputs
5. Short-circuits can cause excessive heating and destructive dissipation
6. R_{th} are typical values
7. Human body model: 100 pF discharged through a 1.5 kΩ resistor between two pins of the device, done for all couples of pin combinations with other pins floating.
8. Machine model: a 200 pF cap is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5 Ω), done for all couples of pin combinations with other pins floating.
9. Charged device model: all pins plus package are charged together to the specified voltage and then discharged directly to the ground.

Table 2. Operating conditions

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage	2.7 to 5.5	V
V_{icm}	Common mode input voltage range	(V_{CC-}) - 0.2 to (V_{CC+}) - 1	
T_{oper}	Operating free-air temperature range	-40 to +125	°C

3 Electrical characteristics

Table 3. Electrical characteristics at V_{CC+} = 2.7 V with V_{CC-} = 0 V, V_{icm} = V_{CC}/2, T_{amb} = 25 °C, and R_L connected to V_{CC}/2 (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
V_{io}	Input offset voltage			1	7	mV
$\Delta V_{io}/\Delta T$	Input offset voltage drift(1)	-40 °C < T< 125 °C		5		µV/°C
I_{io}	Input offset current	V_{out} = V_{cc}/2		0.5	30	nA
I_{ib}	Input bias current			27	60	
CMRR	Common mode rejection ratio(1)	Vic = 0 V to V_{cc}-1 V, V_{out} = V_{cc}/2	70	75		dB
V_O	Output swing	R_L = 10 kΩ, high level	2.6	2.69		V
		R_L = 10 kΩ, low level		65	180	mV
I_{CC}	Supply current (per channel)	No load, V_{out} = V_{CC}/2		120	180	µA
AC performance						
GBP	Gain bandwidth product	R_L > 1 MΩ, C_L = 200 pF		1.3		MHz
Φ_m	Phase margin			60		degrees
G_m	Gain margin			10		dB
SR	Slew rate	R_L > 1 MΩ, C_L = 200 pF V_{out} = 0.5 V to V_{CC} - 0.5V		0.6		V/µs
e_n	Equivalent input noise voltage	f = 1 kHz f = 10 kHz		31 20		$\frac{nV}{\sqrt{Hz}}$
i_n	Equivalent input noise current	f = 1 kHz		0.30		$\frac{pA}{\sqrt{Hz}}$

1. CMRR (dB) = 20 log ($\Delta V_{icm}/\Delta V_{io}$)

Table 4. Electrical characteristics at V_{CC+} = 5 V with V_{CC-} = 0 V, V_{icm} = V_{CC}/2, T_{amb} = 25 °C, and R_L connected to V_{CC}/2 (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
V_{io}	Input offset voltage			1	7	mV
		-40 °C < T< 125 °C			9	
$\Delta V_{io}/\Delta T$	Input offset voltage drift(1)	-40 °C < T< 125 °C		5		µV/°C
I_{io}	Input offset current	V_{out} = V_{cc}/2		0.5	30	nA
		-40 °C < T< 125 °C			50	
I_{ib}	Input bias current	V_{out} = V_{cc}/2		27	60	
		-40 °C < T< 125 °C			110	
CMRR	Common mode rejection ratio(2)	V_{ic} = 0 V to V_{cc}-1 V,V_{out} = V_{cc}/2	72	75		dB
SVRR	Supply voltage rejection ratio	V_{cc} = 2.7 to 5 V	72	79		
A_{vd}	Large signal voltage gain	R_L= 2 kΩ, V_{out} = 0.5 V to (V_{CC}-0.5 V)	90	100		
		-40 °C < T< 125 °C	80			
V_{OH}	Output swing high level	R_L = 10 kΩ	4.90	4.99		V
		R_L = 10 kΩ, -40 °C < T< 125 °C	4.80			
		R_L = 2 kΩ	4.70	4.96		
		R_L = 2 kΩ, -40 °C < T< 125 °C	4.60			
V_{OL}	Output swing low level	R_L = 10 kΩ		65	180	mV
		R_L = 10 kΩ, -40 °C < T< 125 °C			280	
		R_L = 2 kΩ		120	300	
		R_L = 2 kΩ, -40 °C < T< 125 °C			400	
I_{out}	Output short circuit current	Sinking, V_{out} = V_{CC}	35	43		mA
		Sourcing, V_{out} = 0 V	60	70		
I_{CC}	Supply current (per channel)	No load, V_{out} = V_{CC}/2		130	250	µA
		-40 °C < T< 125 °C			350	
AC performance						
GBP	Gain bandwidth product	R_L > 1 MΩ, C_L = 200 pF		1.3		MHz
F_u	Unity gain frequency			1		
Φ_m	Phase margin			60		degrees
G_m	Gain margin			10		dB
SR	Slew rate	R_L > 1 MΩ, C_L = 200 pF, V_{out} = 0.5 V to V_{CC} - 0.5V		0.7		V/µs

Table 4. Electrical characteristics at V_{CC+} = 5 V with V_{CC-} = 0 V, V_{icm} = V_{CC}/2, T_{amb} = 25 °C, and R_L connected to V_{CC}/2 (unless otherwise specified) (continued)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
e_n	Equivalent input noise voltage	f = 1 kHz f = 10 kHz		30 20		$\frac{nV}{\sqrt{Hz}}$
i_n	Equivalent input noise current	f = 1 kHz		0.30		$\frac{pA}{\sqrt{Hz}}$

1. See *Section 4.4: Input offset voltage drift over temperature*
2. CMRR (dB) = 20 log ($\Delta V_{icm}/\Delta V_{io}$)

Figure 2. Supply current vs. supply voltage at $V_{icm} = V_{CC}/2$

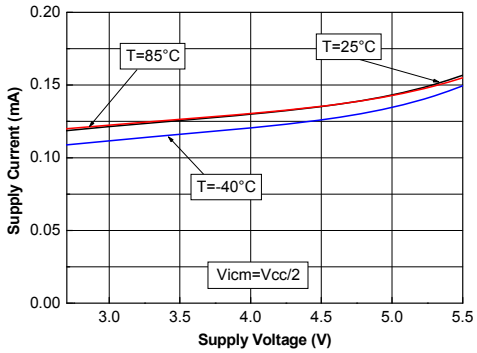


Figure 3. Input offset voltage vs. input common mode voltage at V_{CC} = 5 V

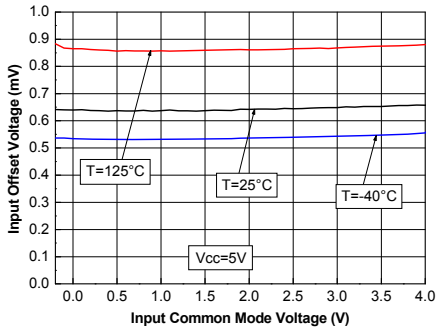


Figure 4. Output current vs. output voltage at V_{CC} = 2.7 V

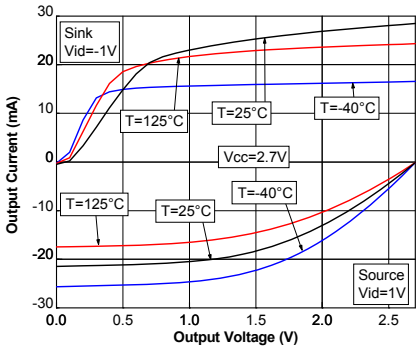


Figure 5. Output current vs. output voltage at V_{CC} = 5 V

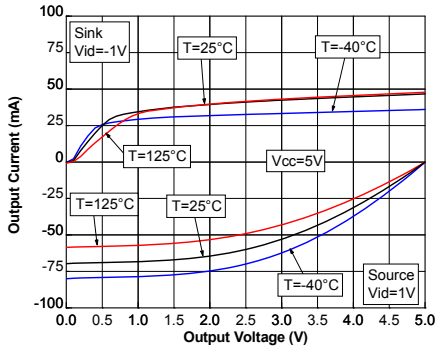


Figure 6. Output current vs. supply voltage at $V_{icm} = V_{CC}/2$

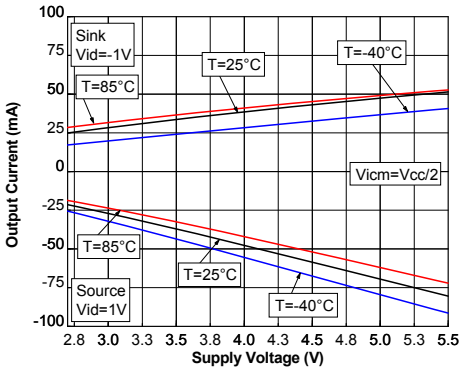


Figure 7. Voltage gain and phase with Cl = 200 pF

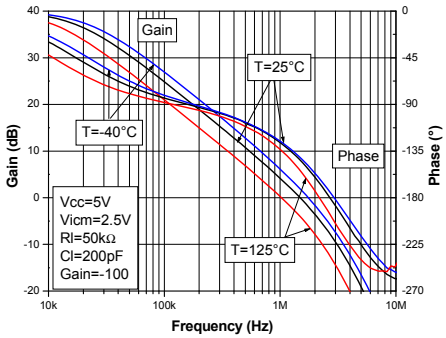


Figure 8. Gain margin vs. load capacitor at V_{CC} = 5 V

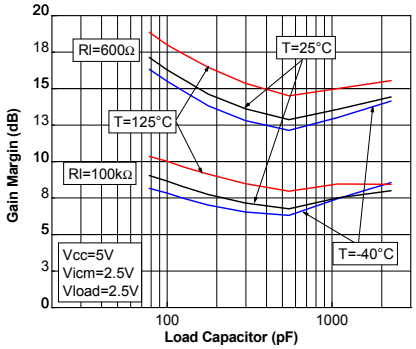


Figure 9. Phase margin vs. load capacitor at V_{CC} = 5 V

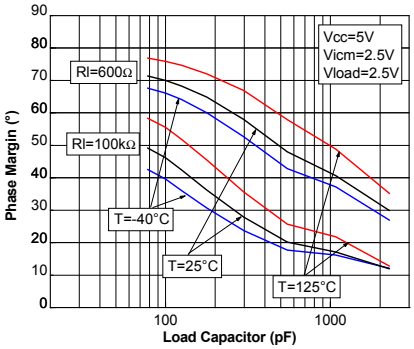


Figure 10. Closed-loop gain in voltage follower configuration for different capacitive loads

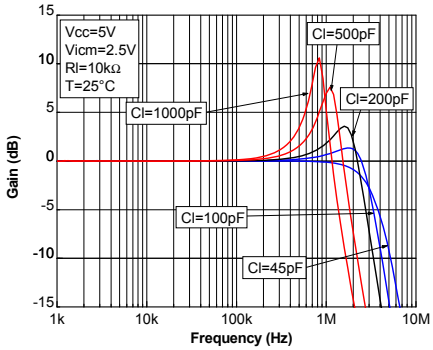


Figure 11. Phase margin vs. output current at V_{CC} = 5 V

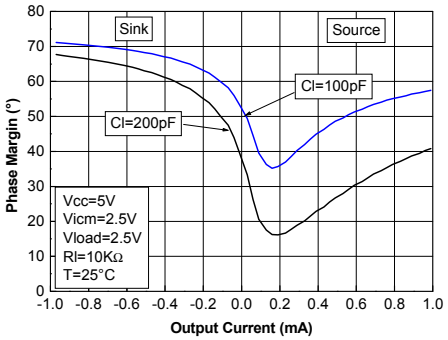


Figure 12. Positive and negative slew rate vs. supply voltage

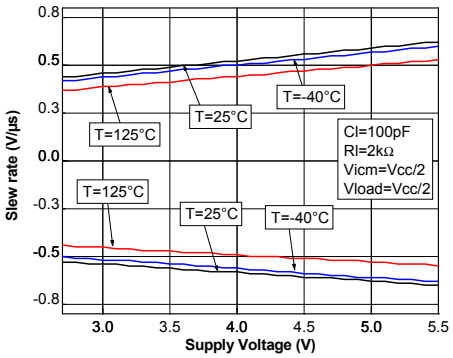


Figure 13. Positive slew rate at V_{CC} = 5 V with Cl = 100 pF

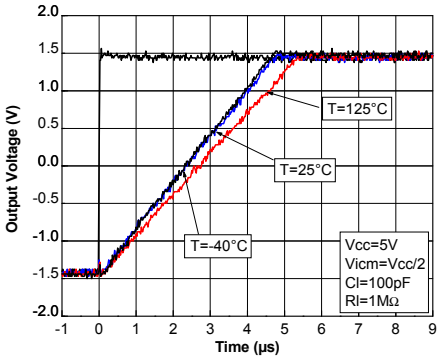


Figure 14. Negative slew rate at V_{CC} = 5 V with Cl = 100 pF

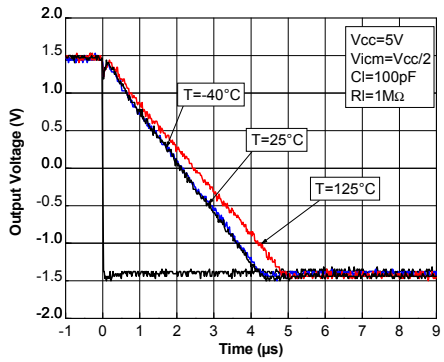


Figure 15. Noise vs. frequency

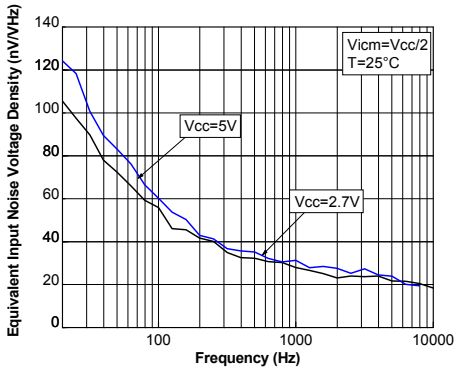


Figure 16. Distortion + noise vs. frequency

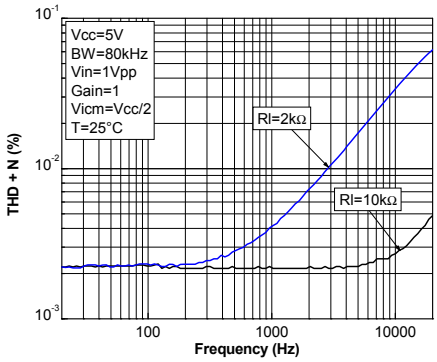
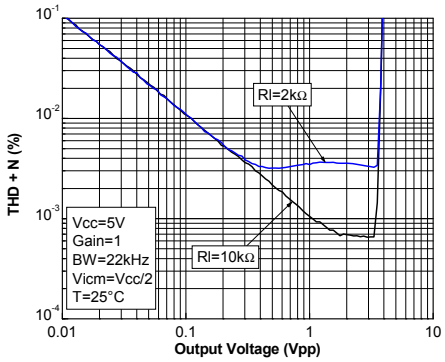


Figure 17. Distortion + noise vs. output voltage



4 Application information

4.1 Operating voltages

The LMV321L, LMV358L, and LMV324L can operate from 2.7 to 5.5 V. The devices' parameters are fully specified for 2.7 V and 5 V power supplies. Additionally, the main specifications are guaranteed in extended temperature ranges from -40 °C to 125 °C.

4.2 Input common-mode range

The LMV321L, LMV358L, and LMV324L have an input common-mode range that includes ground. The input common-mode range is extended from (V_{CC-}) - 0.2 V to (V_{CC+}) - 1 V, with no output phase reversal.

4.3 Rail-to-rail output

The operational amplifiers' output levels can go close to the rails: 180 mV maximum above and below the rail when connected to a 10 kΩ resistive load to $V_{CC}/2$.

4.4 Input offset voltage drift over temperature

The maximum input voltage drift over the temperature variation is defined as follows.

$$\frac{\Delta Vio}{\Delta T} = \max\left|\frac{Vio(T) - Vio(25°C)}{T - 25°C}\right|$$

for $T_{min} < T < T_{max}$.

4.5 PCB layouts

For correct operation, it is advised to add 10 nF decoupling capacitors as close as possible to the power supply pins.

4.6 Macromodel

Accurate macromodels of the LMV321L, LMV358L, and LMV324L are available on STMicroelectronics' web site at www.st.com. These models are a trade-off between accuracy and complexity (that is, time simulation) of the LMV321L, LMV358L, and LMV324L operational amplifiers. They emulate the nominal performances of a typical device within the specified operating conditions mentioned in the datasheet. They also help to validate a design approach and to select the right operational amplifier, *but they do not replace on-board measurements*.

5 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.

5.1 SC70-5 (SOT323-5) package information

Figure 18. SC70-5 (SOT323-5) package mechanical drawing

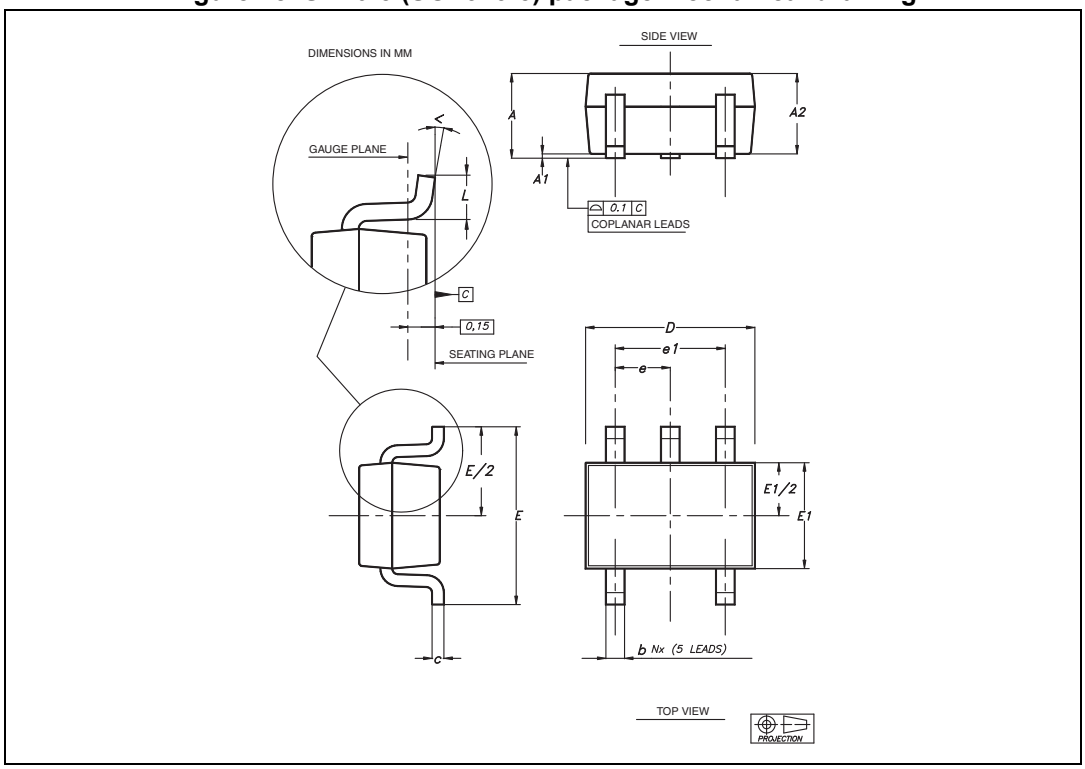


Table 5. SC70-5 (or SOT323-5) package mechanical data

Ref	Dimensions					
	Millimeters			Inches		
	Min	Typ	Max	Min	Typ	Max
A	0.80		1.10	0.315		0.043
A1			0.10			0.004
A2	0.80	0.90	1.00	0.315	0.035	0.039
b	0.15		0.30	0.006		0.012
c	0.10		0.22	0.004		0.009
D	1.80	2.00	2.20	0.071	0.079	0.087
E	1.80	2.10	2.40	0.071	0.083	0.094
E1	1.15	1.25	1.35	0.045	0.049	0.053
e		0.65			0.025	
e1		1.30			0.051	
L	0.26	0.36	0.46	0.010	0.014	0.018
<	0 °		8 °	0 °		8 °

5.2 SOT23-5 package information

Figure 19. SOT23-5 package mechanical drawing

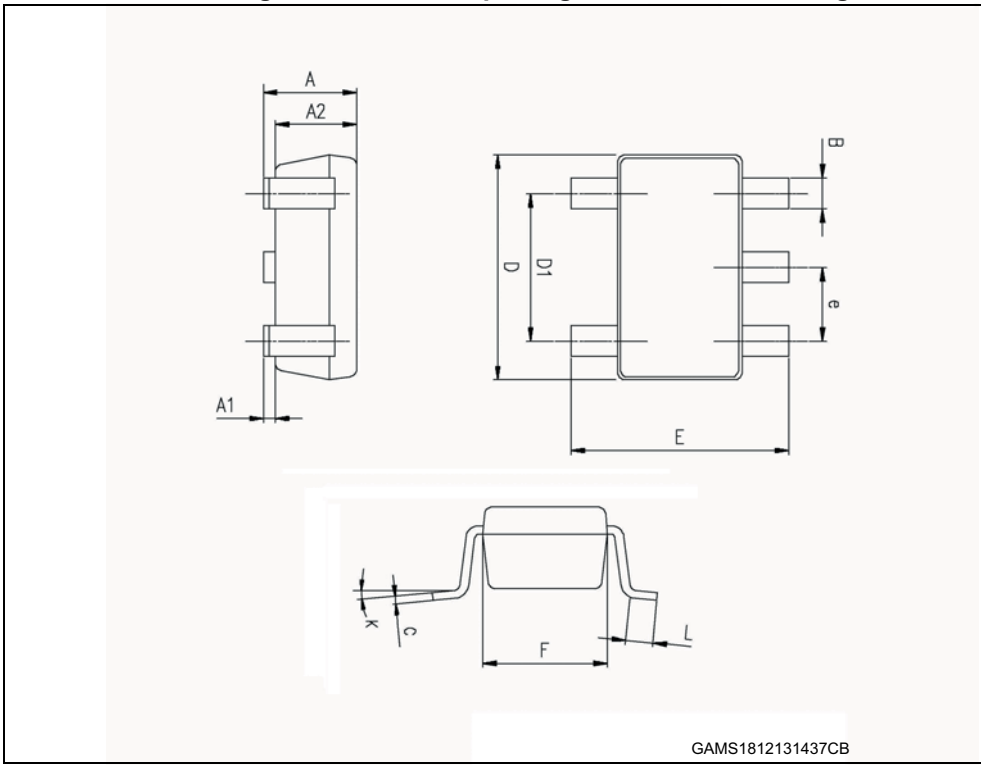


Table 6. SOT23-5 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	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
B	0.35	0.40	0.50	0.014	0.016	0.020
C	0.09	0.15	0.20	0.004	0.006	0.008
D	2.80	2.90	3.00	0.110	0.114	0.118
D1		1.90			0.075	
e		0.95			0.037	
E	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	0.014	0.024
K	0 °		10 °	0 °		10 °

5.3 MiniSO8 package information

Figure 20. MiniSO8 package mechanical drawing

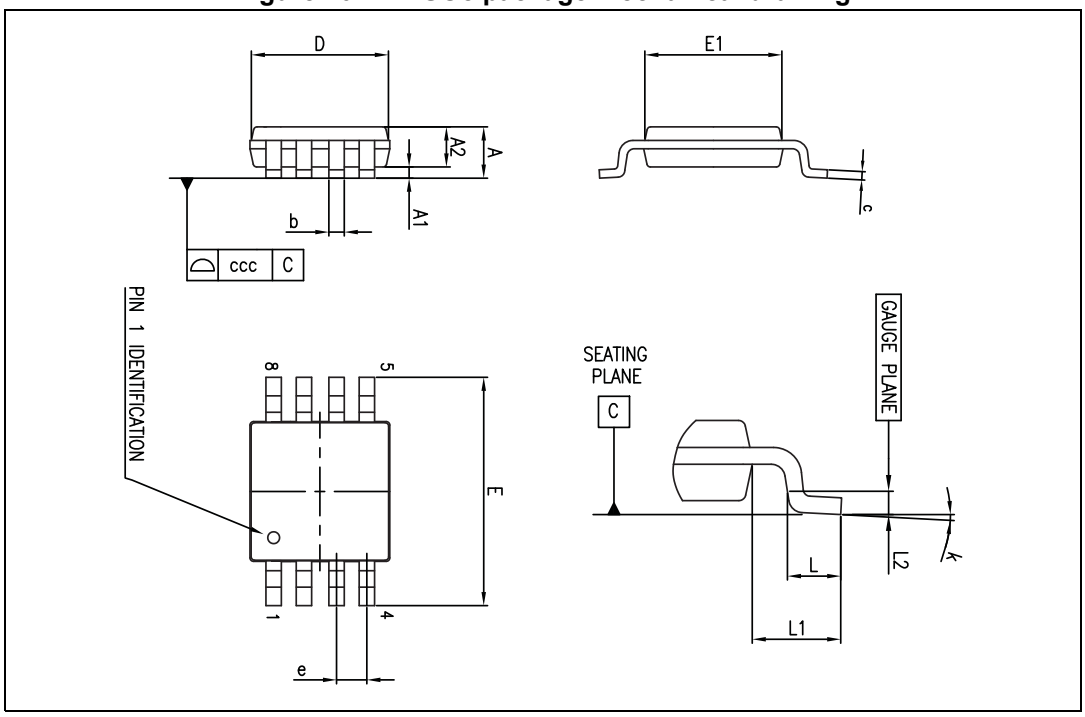


Table 7. MiniSO8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.1			0.043
A1	0		0.15	0		0.006
A2	0.75	0.85	0.95	0.030	0.033	0.037
b	0.22		0.40	0.009		0.016
c	0.08		0.23	0.003		0.009
D	2.80	3.00	3.20	0.11	0.118	0.126
E	4.65	4.90	5.15	0.183	0.193	0.203
E1	2.80	3.00	3.10	0.11	0.118	0.122
e		0.65			0.026	
L	0.40	0.60	0.80	0.016	0.024	0.031
L1		0.95			0.037	
L2		0.25			0.010	
k	0 °		8 °	0 °		8 °
ccc			0.10			0.004

5.4 SO8 package information

Figure 21. SO8 package mechanical drawing

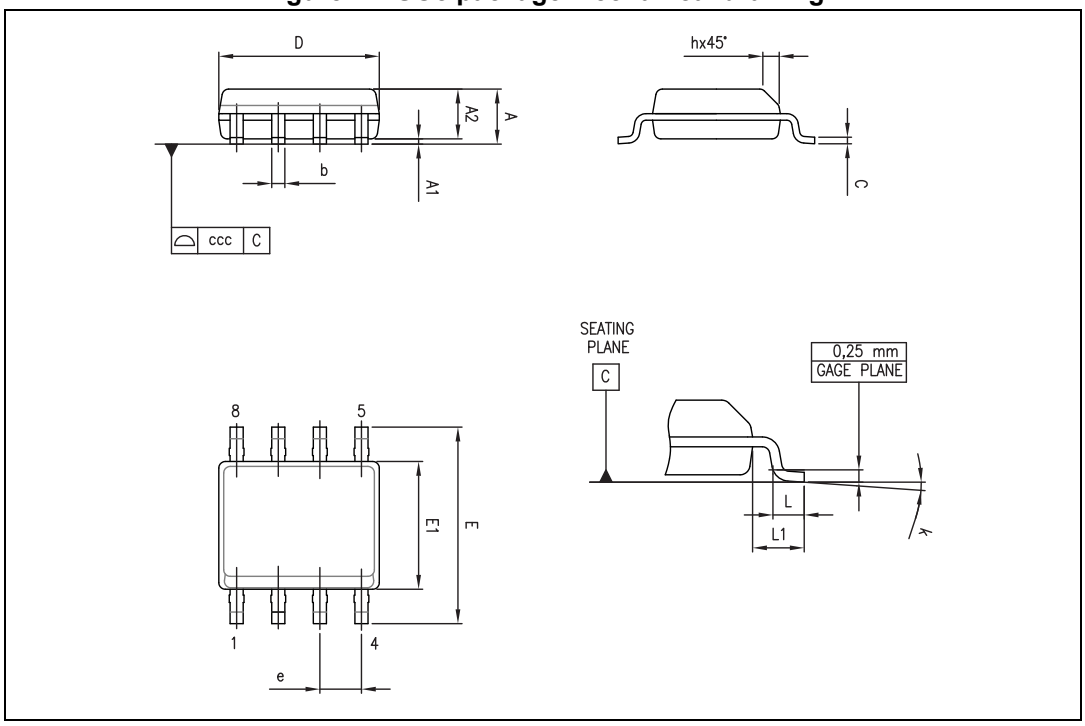


Table 8. SO8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			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
c	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
e		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

5.5 TSSOP8 package information

Figure 22. TSSOP8 package mechanical drawing

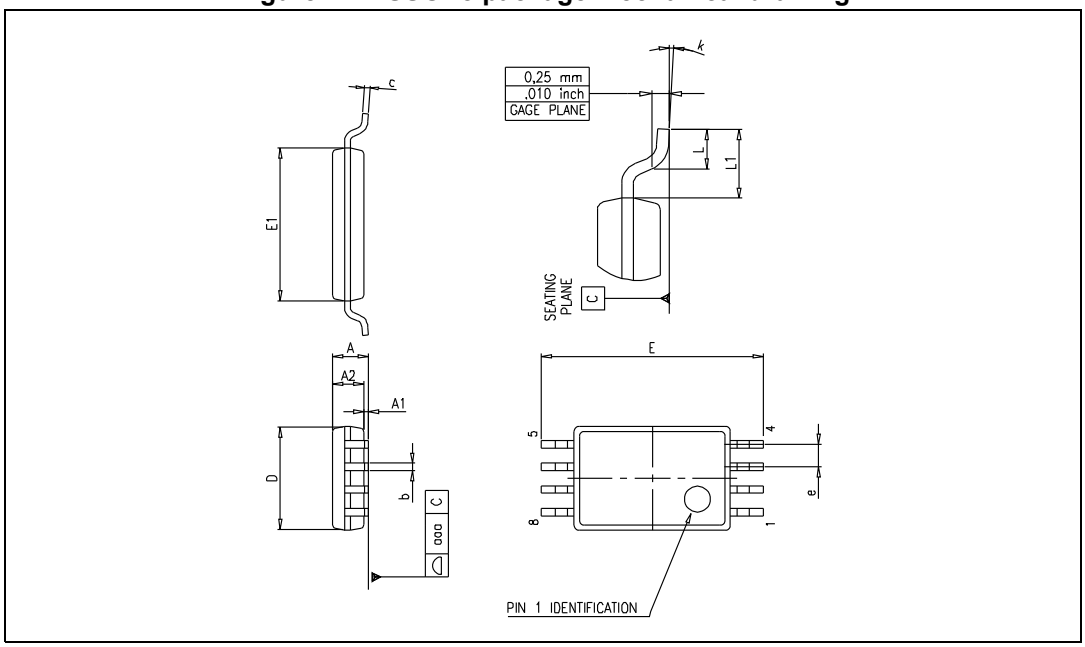


Table 9. TSSOP8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.2			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
c	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
e		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		0.1			0.004	

5.6 TSSOP14 package information

Figure 23. TSSOP14 package mechanical drawing

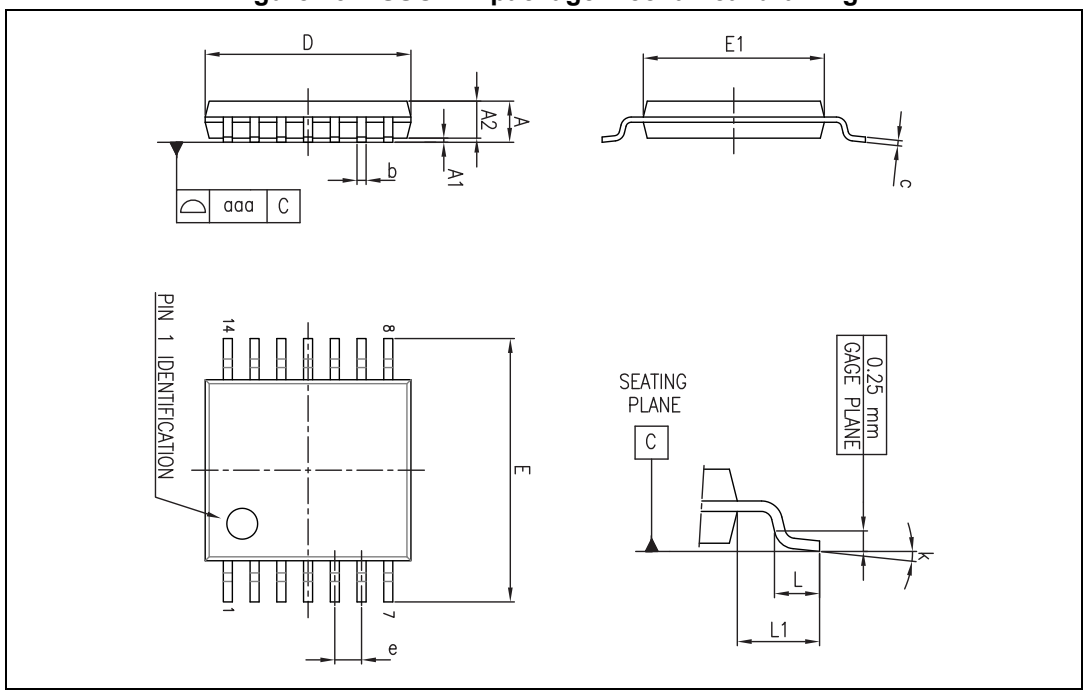


Table 10. TSSOP14 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			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
c	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
e		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

5.7 SO14 package information

Figure 24. SO14 package mechanical drawing

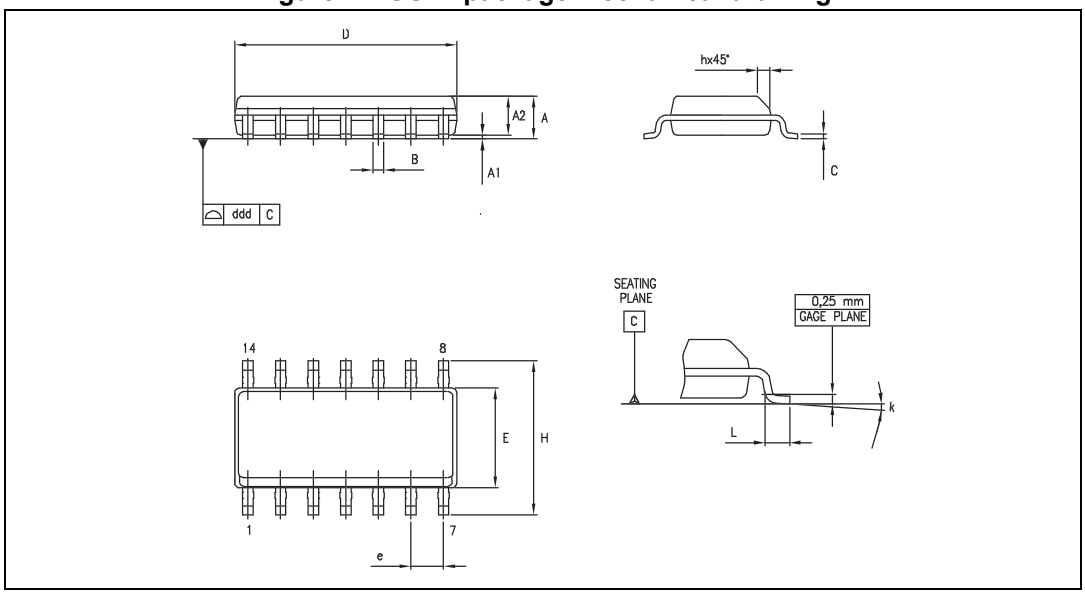


Table 11. SO14 package mechanical data

Dimensions						
Ref.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	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
B	0.33		0.51	0.01		0.02
C	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
e		1.27			0.05	
H	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	8 ° (max.)					
ddd			0.10			0.004

6 Ordering information

Table 12. Order codes for devices without shutdown feature

Order code	Temperature range	Package	Packing	Marking
LMV321LICT	-40 °C to +125 °C	SC70-5	Tape and reel	K25
LMV321LILT		SOT23-5		K170
LMV358LIST		MiniSO8		K170
LMV358LIPT		TSSOP8		V358L
LMV358LIDT		SO8		LMV358L
LMV324LIPT		TSSOP14		LMV324L
LMV324LIDT		SO14		LMV324L

7 Revision history

Table 13. Document revision history

Date	Revision	Changes
04-May-2012	1	Initial release.
19-Dec-2013	2	New template
09-Dec-2014	3	Added TSSOP8 package *Table 6*: updated some of the “inches” dimensions *Table 12*: added new order code LMV358LIPT