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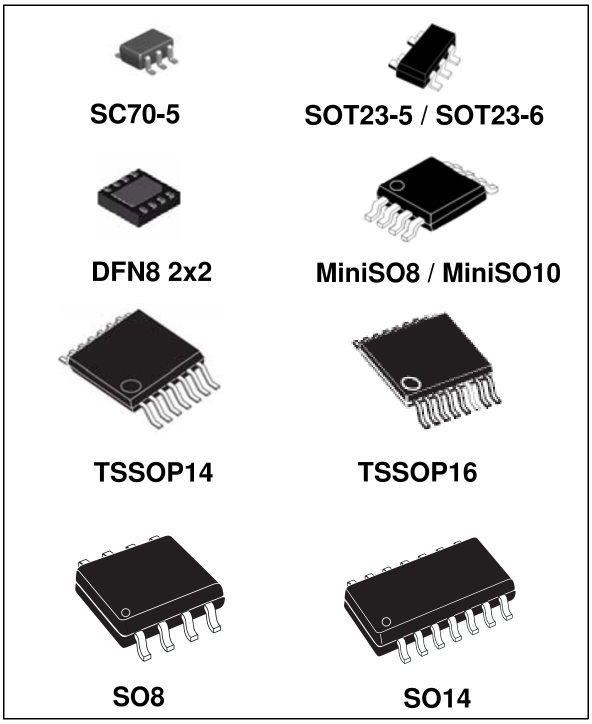
LMV82x, LMV82xA

Low power, high accuracy, general-purpose operational amplifier

Datasheet — production data



Features

- Low power consumption: 400 µA max at 5 V
- Low power shutdown mode: 50 nA max
- Low offset voltage: 0.8 mV max at 25°C
- Tiny packages
- Extended temperature range: -40°C to +125°C
- Low supply voltage: 2.5 V - 5.5 V
- Gain bandwidth product: 5.5 MHz
- Automotive qualification

Benefits

- Longer lifetime in battery-powered applications
- Higher accuracy without calibration
- Smaller form factor than equivalent competitor devices
- Application performances guaranteed over wide temperature range

Related products

- See TSV85x series for lower power consumption (180 µA max at 5 V)

Applications

- Battery-powered applications
- Portable devices
- Automotive signal conditioning
- Active filtering
- Medical instrumentation

Description

The LMV82x and LMV82xA series of single, dual, and quad operational amplifiers offer low voltage operation with rail-to-rail output swing. They outperform the industry standard LMV321, especially with regard to the gain bandwidth product (5.5 MHz). The LMV821, LMV822 and LMV824 are offered with standard pinouts.

The LMV820, LMV823, and LMV825 include a power-saving shutdown feature that reduces the supply current to a maximum of 50 nA at 25 °C.

The wide temperature range, high ESD tolerance, and automotive grade qualification make them particularly suitable for use in harsh automotive applications.

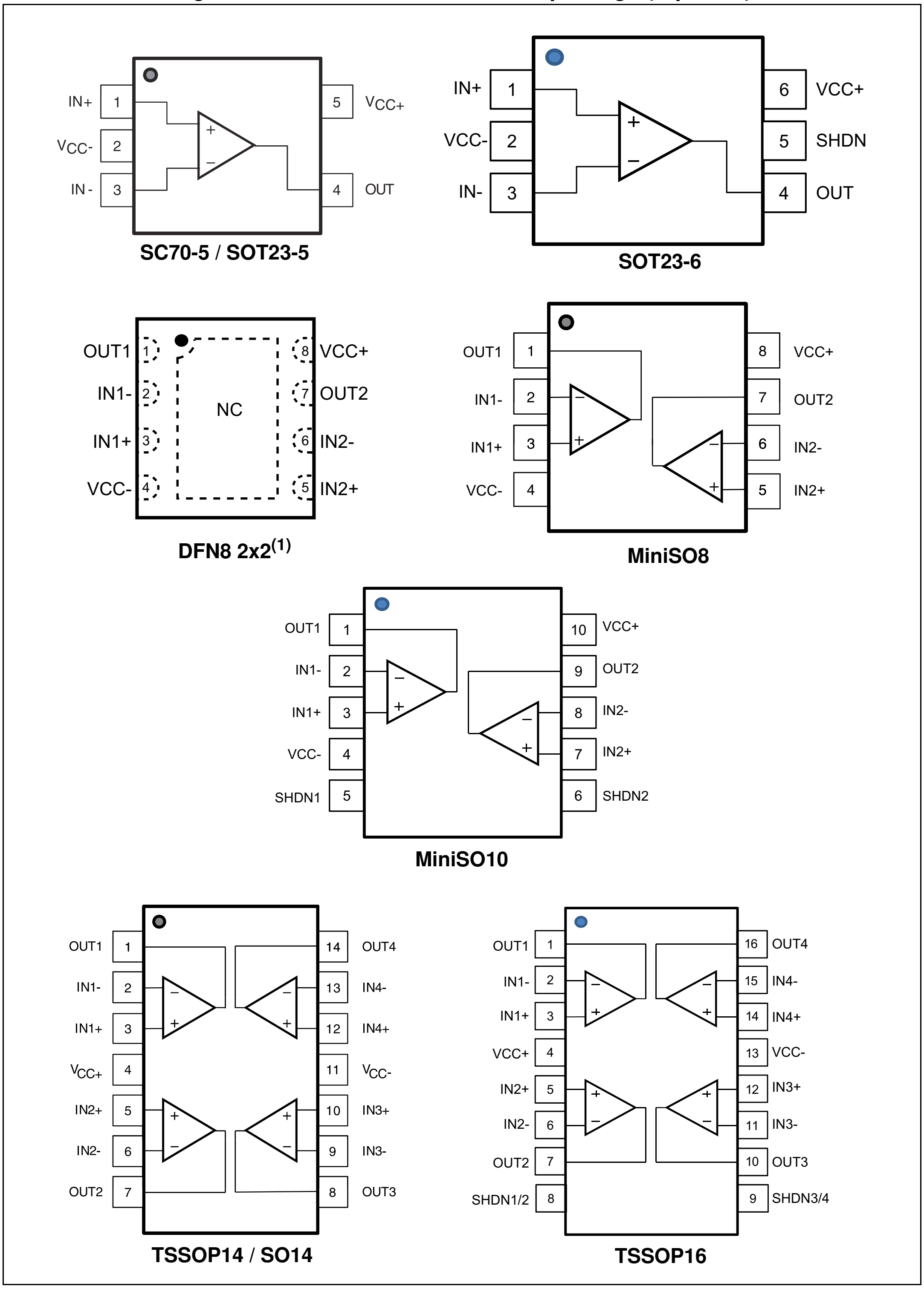
Table 1. Device summary

	Without shutdown		With shutdown	
	Standard Vio	Enhanced Vio	Standard Vio	Enhanced Vio
Single	LMV821	LMV821A	LMV820	LMV820A
Dual	LMV822	LMV822A	LMV823	LMV823A
Quad	LMV824	LMV824A	LMV825	LMV825A

Contents

1 Package pin connections

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



1. The exposed pad of DFN8 2x2 can be connected to VCC- or left floating.

2 Absolute maximum ratings and operating conditions

Table 2. 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+} + 0.3	
I_{in}	Input current(4)	10	mA
$\overline{SHDN}$	Shutdown voltage(5)	V_{cc-} - 0.2 to V_{cc+} + 0.2	V
T_{stg}	Storage temperature	-65 to +150	°C
R_{thja}	Thermal resistance junction to ambient(6)(7)		°C/W
	– SC70-5	205	
	– SOT23-5	250	
	– DFN8 2x2	57	
	– MiniSO8	190	
	– SO8	125	
	– TSSOP14	100	
	– SO14	105	
	– SOT23-6	240	
	– MiniSO10	113	
	– TSSOP16	95	
T_j	Maximum junction temperature	150	°C
ESD	HBM: human body model (except shutdown pin)(8)	4	kV
	HBM: human body model (shutdown pin)(8)	3.5	
	MM: machine model(9)	250	V
	CDM: charged device model(10)	1.3	kV
	CDM: charged device model LMV825(10)	1	
	Latch-up immunity	200	mA

1. All voltage values, except the differential voltage are with respect to the network ground terminal.
2. Differential voltages are 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. The input current must be limited by a resistor in series with the inputs.
5. V_{cc}-V_{shdn} must not exceed 6 V, V_{in} must not exceed 6 V.
6. Short-circuits can cause excessive heating and destructive dissipation.
7. R_{th} are typical values.
8. Human body model: a 100 pF capacitor is discharged through a 1.5 kΩ resistor between two pins of the device. This is done for all couples of pin combinations while other pins are floating.
9. 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 pin combinations while other pins are floating.
10. Charged device model: all pins and package are charged together to the specified voltage and then discharged directly to ground.

Table 3. Operating conditions

Symbol	Parameter	Value	Unit
V_{cc}	Supply voltage	2.5 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 4. Electrical characteristics at V_{cc+} = 2.5 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	LMV82xA			0.8	mV
		LMV82x			3.5	
		LMV82xA, -40 °C < T< 125 °C			2	
		LMV82x, -40 °C < T< 125 °C			4	
$V_{CC}-V_{OH}$	High level output voltage	R_L = 600 Ω			220	
		R_L = 600 Ω, -40 °C < T< 125 °C			320	
		R_L = 2 kΩ			120	
		R_L = 2 kΩ, -40 °C < T< 125 °C			220	
V_{OL}	Low level output voltage	R_L = 600 Ω			220	
		R_L = 600 Ω, -40 °C < T< 125 °C			320	
		R_L = 2 kΩ			120	
		R_L = 2 kΩ, -40 °C < T< 125 °C			200	
I_{out}	I_{sink} (V_{out} = V_{cc}) V_{id} = -1 V		5			mA
		-40 °C < T< 125 °C	5			
	I_{source} (V_{out} = 0 V) V_{id} = 1 V		5			
		-40 °C < T< 125 °C	5			

Table 5. Shutdown characteristics V_{CC} = 2.5 V

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
I_{CC}	Supply current in shutdown mode (all operators) $\overline{SHDN}$ = V_{CC-}	T = 25 °C		2.5	50	nA
		-40°C < T< 85 °C			200	
		-40°C < T< 125 °C			1.5	µA
t_{on}	Amplifier turn-on time(1)	R_L = 2 kΩ, V_{out} = V_{CC-} to V_{CC-} + 0.2 V		300		ns
t_{off}	Amplifier turn-off time(1)	R_L = 2 kΩ, Vout = V_{CC+} - 1 V to V_{CC+} - 1.2 V		20		
V_{IH}	$\overline{SHDN}$ logic high		V_{cc}-0.5			V
V_{IL}	$\overline{SHDN}$ logic low				0.5	
I_{IH}	$\overline{SHDN}$ current high	$\overline{SHDN}$ = V_{CC+}		10		pA
I_{IL}	$\overline{SHDN}$ current low	$\overline{SHDN}$ = V_{CC-}		10		
I_{OLeak}	Output leakage in shutdown mode	$\overline{SHDN}$ = V_{CC-}		50		
		-40°C < T< 125°C		1		nA

1. See *Section 4.7: Shutdown function on page 17*.

Table 6. 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	LMV82xA			0.8	mV
		LMV82x			3.5	
		LMV82xA, -40 °C < T< 125 °C			2	
		LMV82x, -40 °C < T< 125 °C			4	
$\Delta V_{io}/\Delta T$	Input offset voltage drift(1)	-40 °C < T< 125 °C		1		µV/°C
I_{io}	Input offset current (V_{out} = V_{cc}/2)			0.5	30	nA
		-40 °C < T< 125 °C		1	50	
I_{ib}	Input bias current (V_{out} = V_{cc}/2)			60	120	
		-40 °C < T< 125 °C			180	
CMR	Common mode rejection ratio 20 log ($\Delta V_{icm}/\Delta V_{io}$) Vic = 0 V to V_{cc}-1V, V_{out} = V_{cc}/2		70	75		dB
		-40 °C < T< 125 °C	68			
A_{vd}	Large signal voltage gain V_{out} = 0.5V to (V_{cc}-0.5V)	R_L = 600 Ω	90	100		
		R_L = 600 Ω, -40 °C < T< 125 °C	85			
		R_L = 2 kΩ	95	100		
		R_L = 2 kΩ, -40 °C < T< 125 °C	90			
V_{CC}-V_{OH}	High level output voltage	R_L = 600 Ω			200	mV
		R_L = 600 Ω, -40 °C < T< 125 °C			300	
		R_L = 2 kΩ			100	
		R_L = 2 kΩ, -40 °C < T< 125 °C			200	
V_{OL}	Low level output voltage	R_L = 600 Ω			200	
		R_L = 600 Ω, -40 °C < T< 125 °C			300	
		R_L = 2 kΩ			120	
		R_L = 2 kΩ, -40 °C < T< 125 °C			200	
I_{out}	I_{sink} (V_{out} = V_{cc}) V_{id} = -1 V		15	26		mA
		-40 °C < T< 125 °C	12			
	I_{source} (V_{out} = 0 V) V_{id} = 1 V		15	21		
		-40 °C < T< 125 °C	12			
I_{CC}	Supply current (per channel) No load, V_{out} = V_{cc}/2			220	300	µA
		-40 °C < T< 125 °C			500	

Table 6. 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) (continued)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
	AC performance					
GBP	Gain bandwidth product	R_L > 1 MΩ, C_L = 22 pF		5.5		MHz
F_u	Unity gain frequency			4.5		
Φ_m	Phase margin			60		degrees
G_m	Gain margin			10		dB
SR	Slew rate	R_L > 1 MΩ, C_L = 22 pF, V_{out} = 0.5 V to V_{CC} - 0.5V	1.2	1.7		V/μs
e_n	Equivalent input noise voltage	f = 1 kHz f = 10 kHz		18 15		$\frac{nV}{\sqrt{Hz}}$
i_n	Equivalent input noise current	f = 1 kHz		0.30		$\frac{pA}{\sqrt{Hz}}$
THD+N	Total harmonic distortion + noise	f_{in} = 1 kHz, A_{CL} = 1, R_L = 100 kΩ Vicm = Vcc/2, BW = 22 kHz, Vout = 3 Vpp		0.001		%

Table 7. Shutdown characteristics V_{CC} = 2.7 V

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
I_{CC}	Supply current in shutdown mode (all operators)	$\overline{SHDN}$ = V_{CC-}		2.5	50	nA
		-40°C < T< 85°C			200	
		-40°C < T< 125°C			1.5	µA
t_{on}	Amplifier turn-on time(1)	R_L = 2 kΩ, V_{out} = V_{CC-} to V_{CC-} + 0.2 V		300		ns
t_{off}	Amplifier turn-off time(1)	R_L = 2 kΩ, Vout = V_{CC+} - 1 V to V_{CC+} - 1.2 V		20		
V_{IH}	$\overline{SHDN}$ logic high		V_{cc}- 0.5			V
V_{IL}	$\overline{SHDN}$ logic low				0.5	
I_{IH}	$\overline{SHDN}$ current high	$\overline{SHDN}$ = V_{CC+}		10		pA
I_{IL}	$\overline{SHDN}$ current low	$\overline{SHDN}$ = V_{CC-}		10		
I_{OLeak}	Output leakage in shutdown mode	$\overline{SHDN}$ = V_{CC-}		50		
		-40°C < T< 125°C		1		nA

1. See *Section 4.7: Shutdown function on page 17*.

Table 8. 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	LMV82xA			0.8	mV
		LMV82x			3.5	
		LMV82xA, -40 °C < T< 125 °C			2	
		LMV82x, -40 °C < T< 125 °C			4	
$\Delta V_{io}/\Delta T$	Input offset voltage drift(1)	-40 °C < T< 125 °C		1		µV/°C
I_{io}	Input offset current (V_{out} = V_{cc}/2)			0.5	30	nA
		-40 °C < T< 125 °C		1	50	
I_{ib}	Input bias current (V_{out} = V_{cc}/2)			60	120	
		-40 °C < T< 125 °C			180	
CMR	Common mode rejection ratio 20 log ($\Delta V_{icm}/\Delta V_{io}$) Vic = 0 V to V_{cc}-1V, V_{out} = V_{cc}/		72	90		dB
		-40 °C < T< 125 °C	70			
SVR	Supply voltage rejection ratio 20 log ($\Delta V_{cc}/\Delta V_{io}$)	V_{cc} = 2.5 to 5 V				
			70	75		
		-40 °C < T< 125 °C	65			
A_{vd}	Large signal voltage gain V_{out} = 0.5V to (V_{cc}-0.5V)	R_L = 600 Ω	95	100		
		R_L = 600 Ω, -40 °C < T< 125 °C	90			
		R_L = 2 kΩ	95	100		
		R_L = 2 kΩ, -40 °C < T< 125 °C	90			
V_{CC}-V_{OH}	High level output voltage	R_L = 600 Ω			250	mV
		R_L = 600 Ω, -40 °C < T< 125 °C			400	
		R_L = 2 kΩ			150	
		R_L = 2 kΩ, -40 °C < T< 125 °C			200	
V_{OL}	Low level output voltage	R_L = 600 Ω			250	
		R_L = 600 Ω, -40 °C < T< 125 °C			300	
		R_L = 2 kΩ			150	
		R_L = 2 kΩ, -40 °C < T< 125 °C			200	
I_{out}	I_{sink} (V_{out} = V_{cc}) V_{id} = -1 V		35	43		mA
		-40 °C < T< 125 °C	25			
	I_{source} (V_{out} = 0 V) V_{id} = 1 V		60	70		
		-40 °C < T< 125 °C	50			
I_{CC}	Supply current (per channel) No load, V_{out} = V_{cc}/2			300	400	µA
		-40°C < T< 125°C			600	

Table 8. 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
	AC performance					
GBP	Gain bandwidth product	R_L > 1 MΩ, C_L = 22 pF		5.5		MHz
F_u	Unity gain frequency			4.5		
Φ_m	Phase margin			60		degrees
G_m	Gain margin			10		dB
SR	Slew rate	R_L > 1 MΩ, C_L = 22 pF, V_{out} = 0.5 V to V_{CC} - 0.5 V	1.4	1.9		V/µs
e_n	Equivalent input noise voltage	f = 1 kHz f = 10 kHz		16 13		$\frac{nV}{\sqrt{Hz}}$
i_n	Equivalent input noise current	f = 1 kHz		0.30		$\frac{pA}{\sqrt{Hz}}$
THD+N	Total harmonic distortion + noise	f_{in} = 1 kHz, A_{CL} = 1, R_L = 100 kΩ, Vicm = Vcc/2, BW = 22 kHz, Vout = 3 Vpp		0.001		%

1. See *Section 4.4: Input offset voltage drift over temperature*.

Table 9. Shutdown characteristics V_{CC} = 5 V

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
I_{CC}	Supply current in shutdown mode (all operators) $\overline{SHDN}$ = V_{CC-}	T= 25°C		2.5	50	nA
		-40°C < T< 85°C			200	
		-40°C < T< 125°C			1.5	µA
t_{on}	Amplifier turn-on time(1)	R_L = 2 kΩ, V_{out} = V_{CC-} to V_{CC-} + 0.2 V		300		ns
t_{off}	Amplifier turn-off time(1)	R_L = 2 kΩ, Vout = V_{CC+} - 1 V to V_{CC+} - 1.2 V		20		
V_{IH}	$\overline{SHDN}$ logic high		V_{cc}- 0.5			V
V_{IL}	$\overline{SHDN}$ logic low				0.5	
I_{IH}	$\overline{SHDN}$ current high	$\overline{SHDN}$ = V_{CC+}		10		pA
I_{IL}	$\overline{SHDN}$ current low	$\overline{SHDN}$ = V_{CC-}		10		
I_{OLeak}	Output leakage in shutdown mode	$\overline{SHDN}$ = V_{CC-}		50		
		-40°C < T< 125°C		1		nA

1. See *Section 4.7: Shutdown function on page 17*.

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

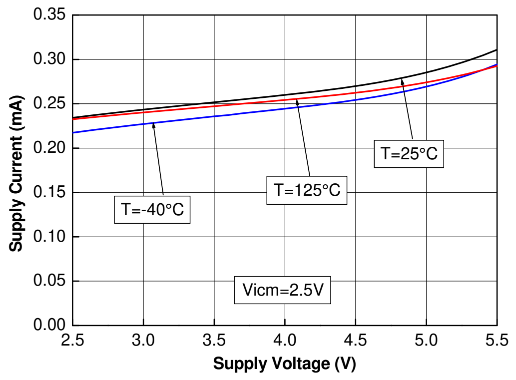


Figure 3. Supply current vs. Vicm at V_{CC} = 5 V

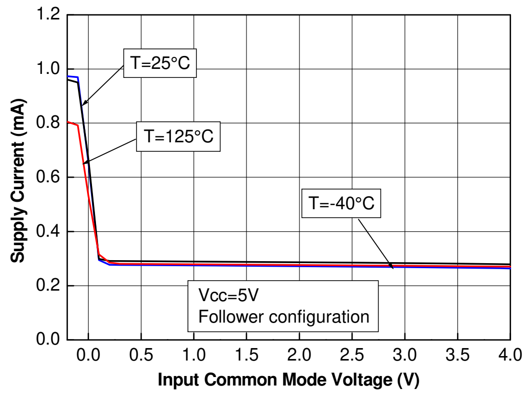


Figure 4. Vio distribution at V_{CC} = 5 V

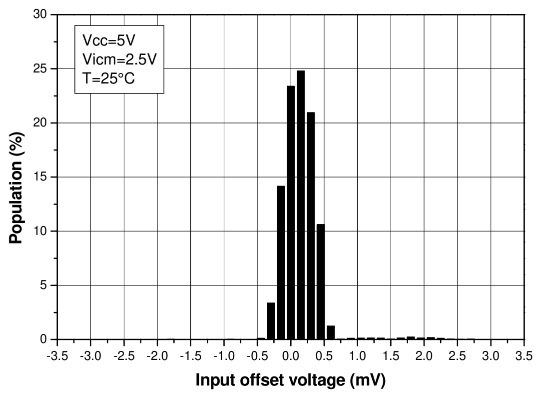


Figure 5. Input offset voltage vs. input common mode voltage at V_{CC} = 5 V

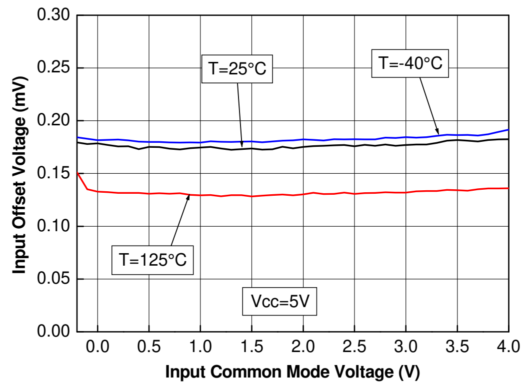


Figure 6. Output current vs. output voltage at V_{CC} = 2.7 V

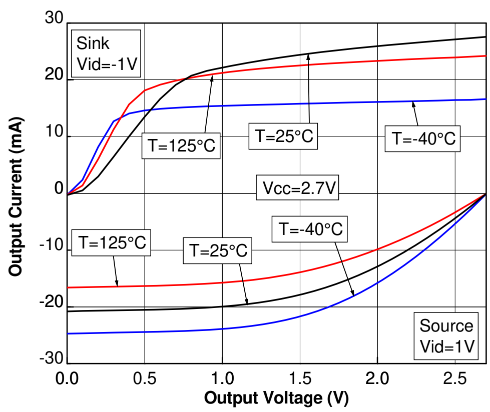


Figure 7. Output current vs. output voltage at V_{CC} = 5 V

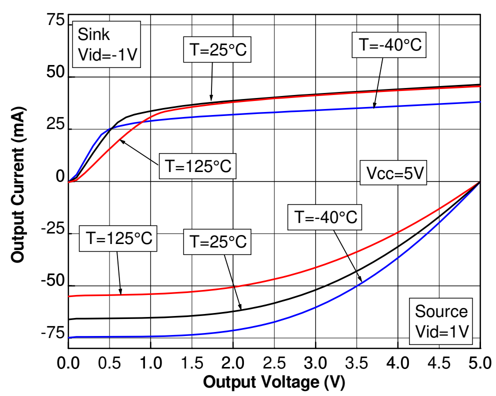


Figure 8. Output current vs. supply voltage at Vicm = $V_{CC}/2$

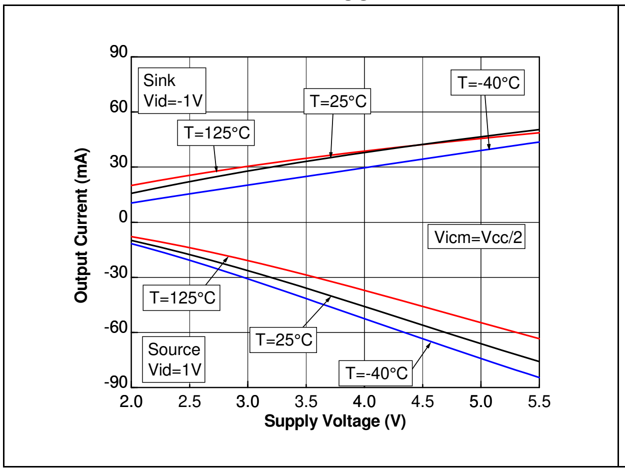


Figure 9. Voltage gain and phase with C_L = 40 pF

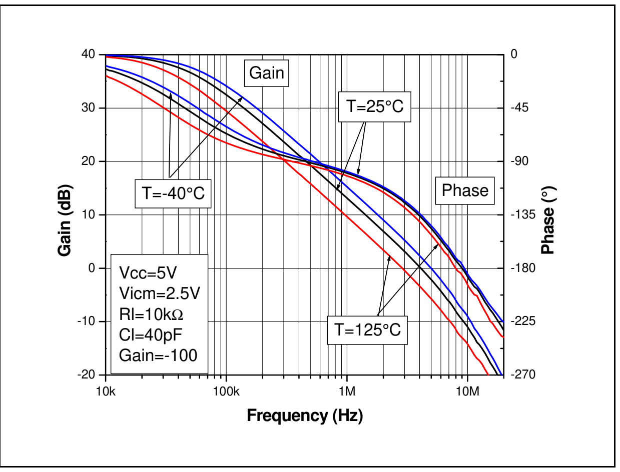


Figure 10. Voltage gain and phase with C_L = 100 pF

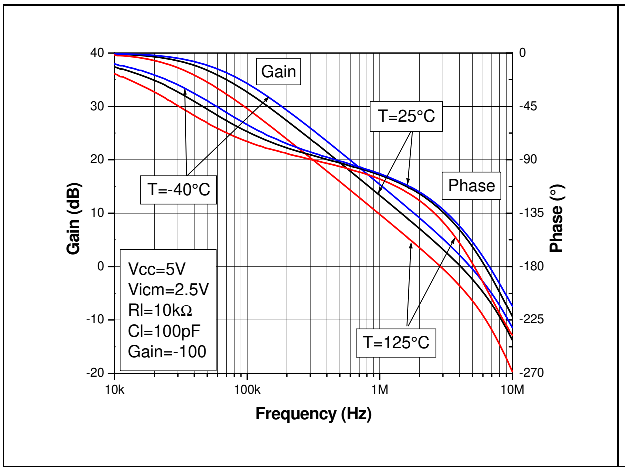


Figure 11. Voltage gain and phase with C_L = 200 pF

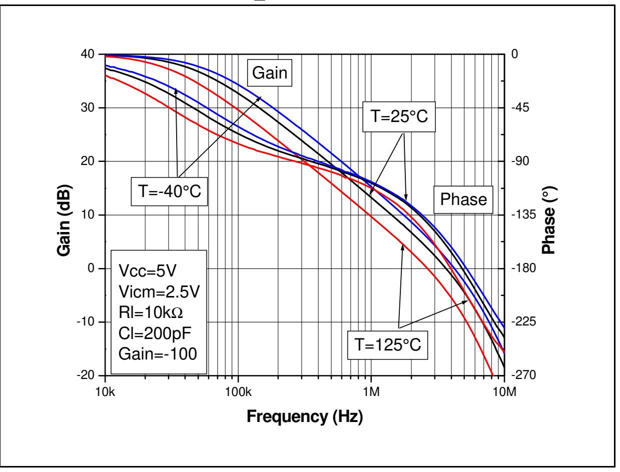


Figure 12. Phase margin vs. output current at V_{CC} = 5 V

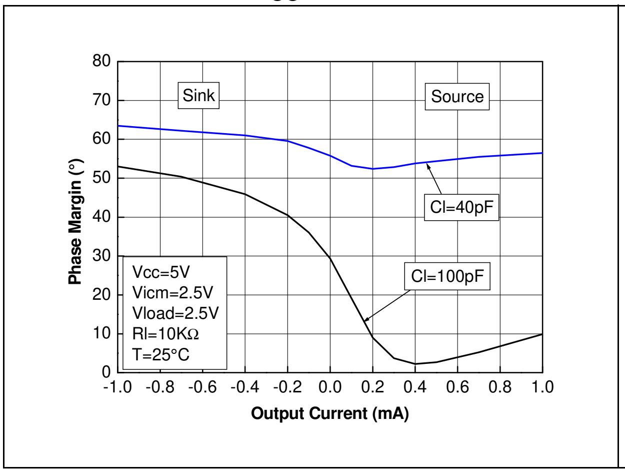


Figure 13. Stability in follower configuration

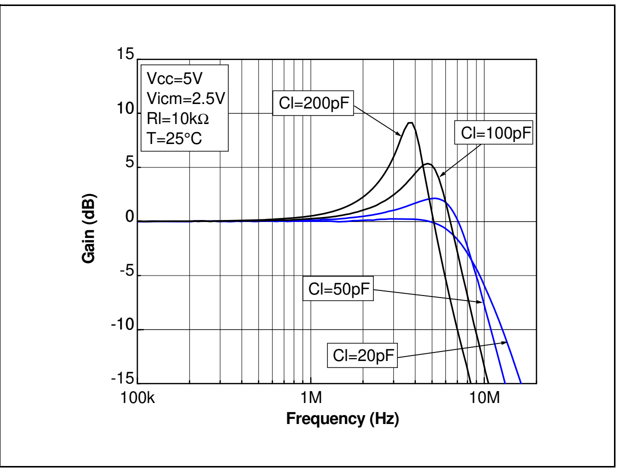


Figure 14. Positive and negative slew rate vs. supply voltage

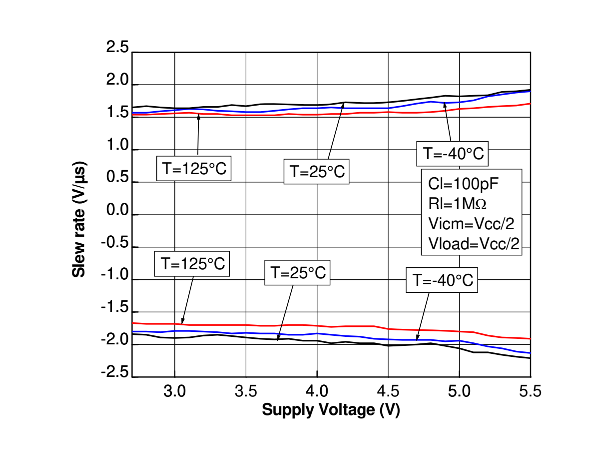


Figure 15. Positive slew rate at V_{CC} = 5 V with C_L = 100 pF

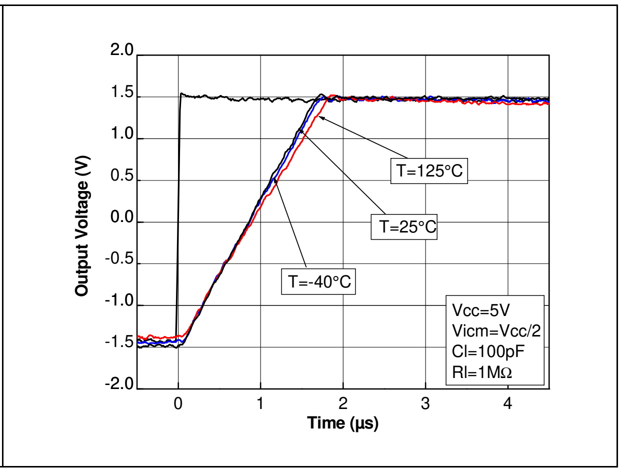


Figure 16. Negative slew rate at V_{CC} = 5 V with C_L = 100 pF

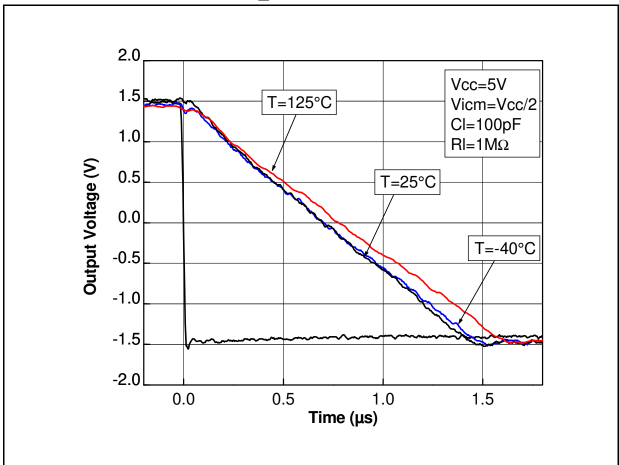


Figure 17. Noise vs. frequency at V_{CC} = 5 V

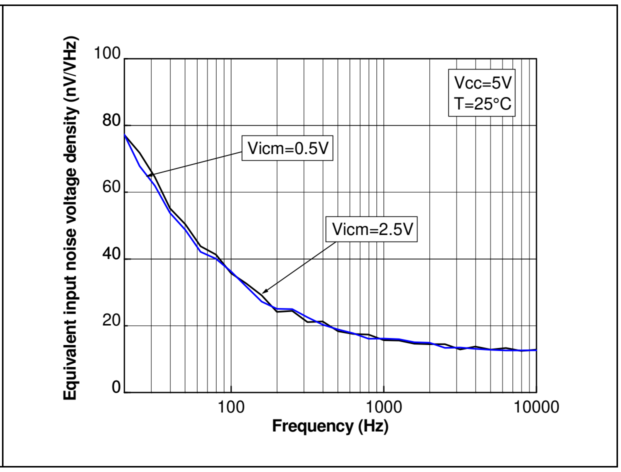


Figure 18. 0.1 Hz to 10 Hz noise at V_{CC} = 5 V

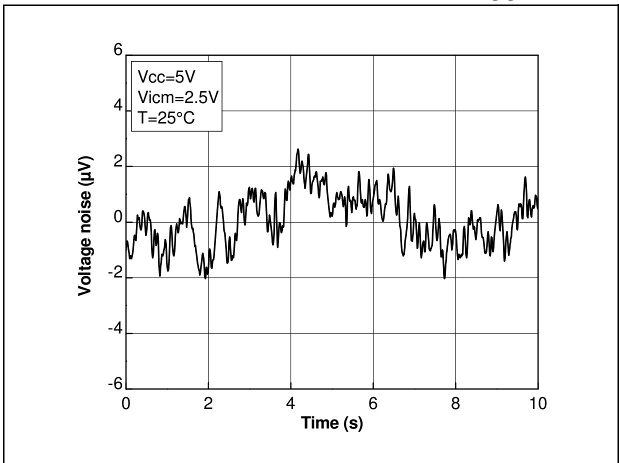


Figure 19. Distortion + noise vs. frequency

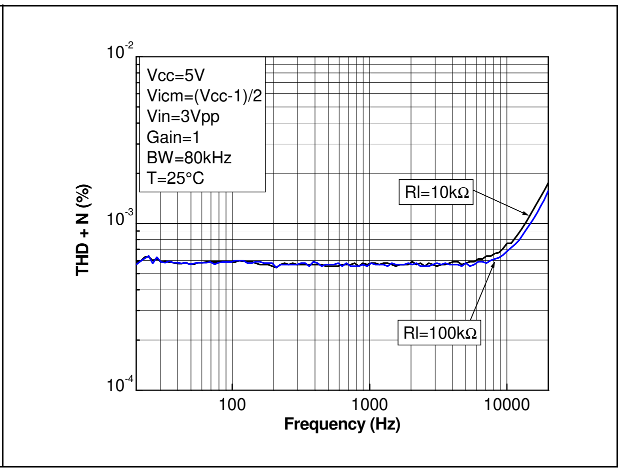
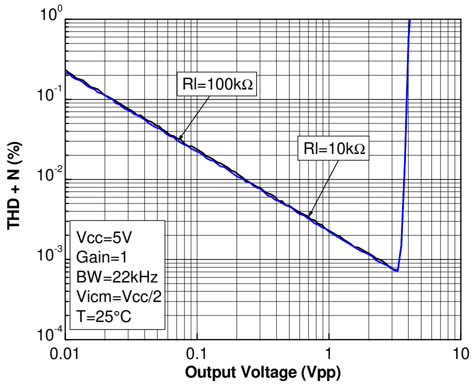


Figure 20. Distortion + noise vs. output voltage



4 Application information

4.1 Operating voltages

The LMV82x and LMV82xA can operate from 2.5 to 5.5 V. The devices' parameters are fully specified for 2.5, 2.7, and 5 V power supplies. Additionally, the main specifications are guaranteed at extended temperature ranges from -40° C to +125° C.

4.2 Input common mode range

The LMV82x and LMV82xA devices 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: 150 mV maximum above and below the rail when connected to a 2 kΩ resistive load to $V_{cc}/2$.

4.4 Input offset voltage drift over temperature

The maximum input voltage drift over temperature variation is defined in *Equation 1*.

Equation 1

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

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 LMV82x and LMV82xA 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 LMV82x and LMV82xA 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*.

4.7 Shutdown function

The operational amplifier is enabled when the $\overline{\text{SHDN}}$ pin is pulled high. To disable the amplifier, the $\overline{\text{SHDN}}$ pin must be pulled down to V_{CC-}. When in shutdown mode, the amplifier output is in a high impedance state. The $\overline{\text{SHDN}}$ pin must never be left floating but tied to V_{CC+} or V_{CC-}.

The turn-on and turn-off times are calculated for an output variation of ±200 mV. *Figure 21* and *Figure 22* show the test configurations. *Figure 23* and *Figure 24* show the respective results with these test configurations.

Figure 21. Test configuration for turn-on time (Vout pulled down)

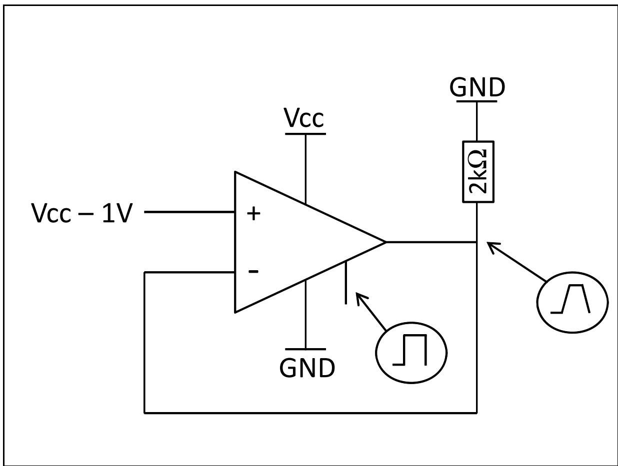


Figure 22. Test configuration for turn-off time (Vout pulled down)

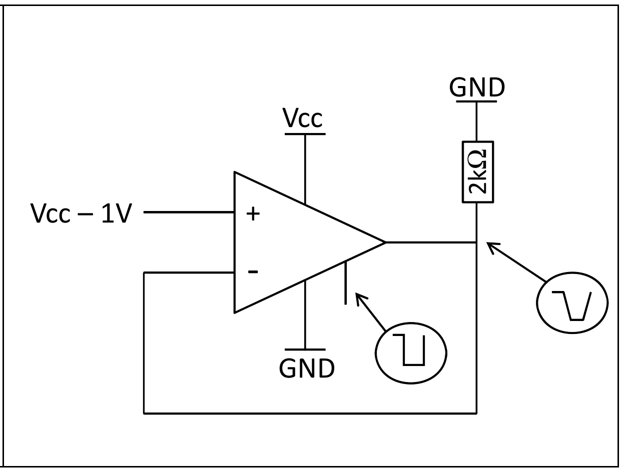


Figure 23. Turn-on time, V_{CC} = 5 V, Vout pulled down, T = 25 °C

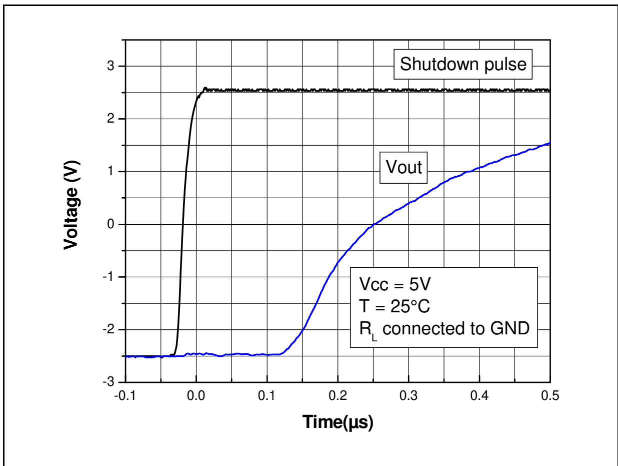
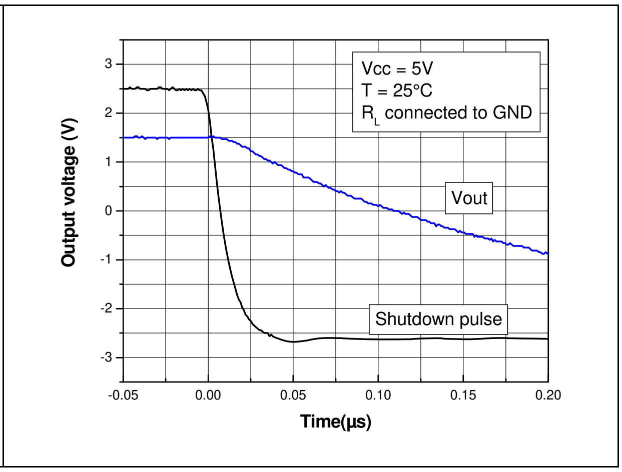


Figure 24. Turn-off time, V_{CC} = 5 V, Vout pulled down, T = 25 °C



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 (or SOT323-5) package information

Figure 25. SC70-5 (or SOT323-5) package mechanical drawing

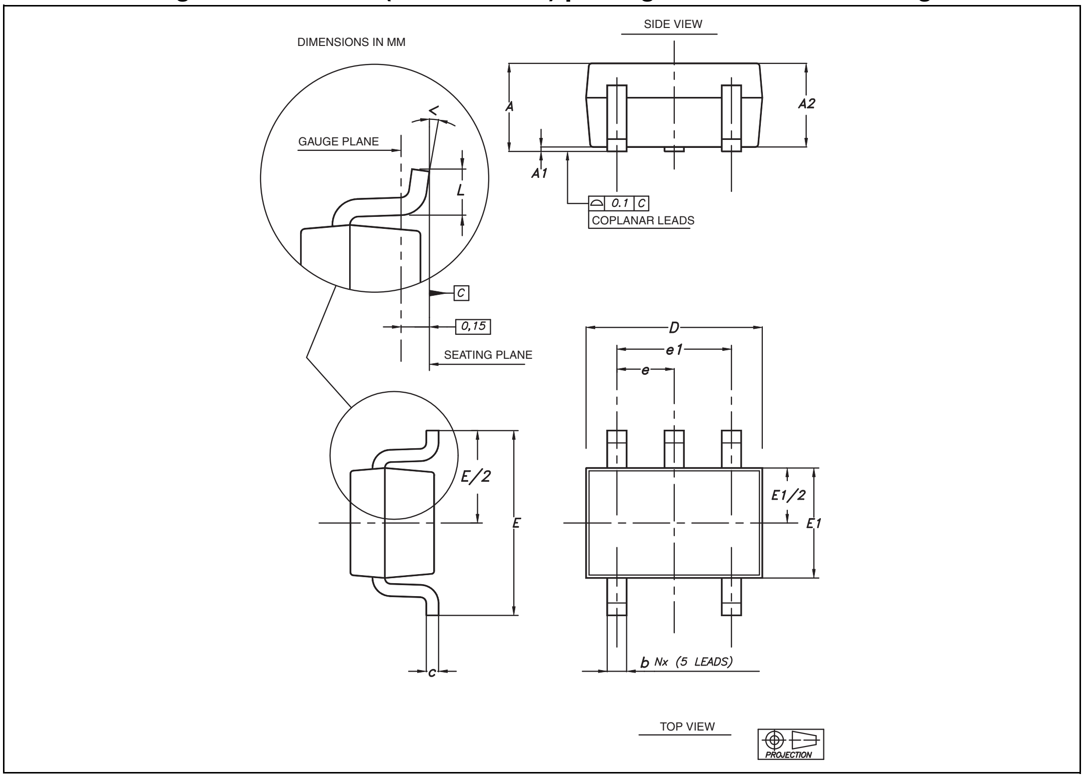


Table 10. SC70-5 (or SOT323-5) package mechanical data

Ref	Dimensions					
	Millimeters			Inches		
	Min	Typ	Max	Min	Typ	Max
A	0.80		1.10	0.032		0.043
A1			0.10			0.004
A2	0.80	0.90	1.00	0.032	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 26. SOT23-5 package mechanical drawing

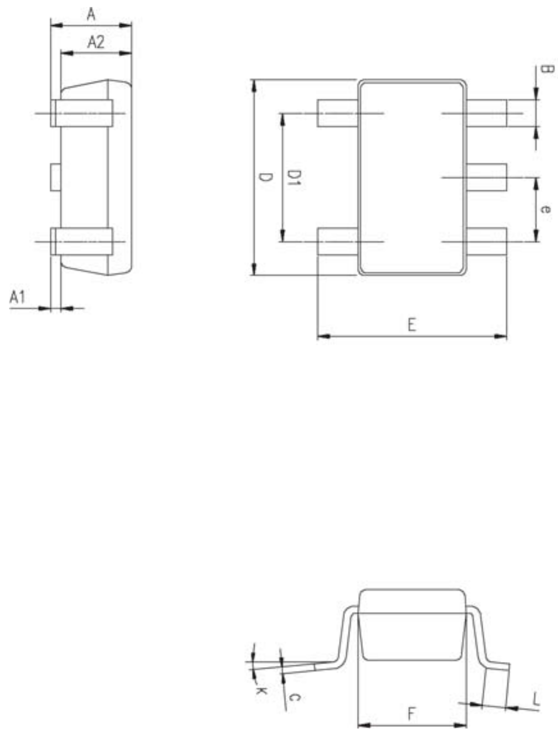


Table 11. SOT23-5 package mechanical data

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	0.013	0.015	0.019
C	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	
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	0.013	0.023
K	0 °		10 °	0 °		10 °

5.3 SOT23-6 package information

Figure 27. SOT23-6 package mechanical drawing

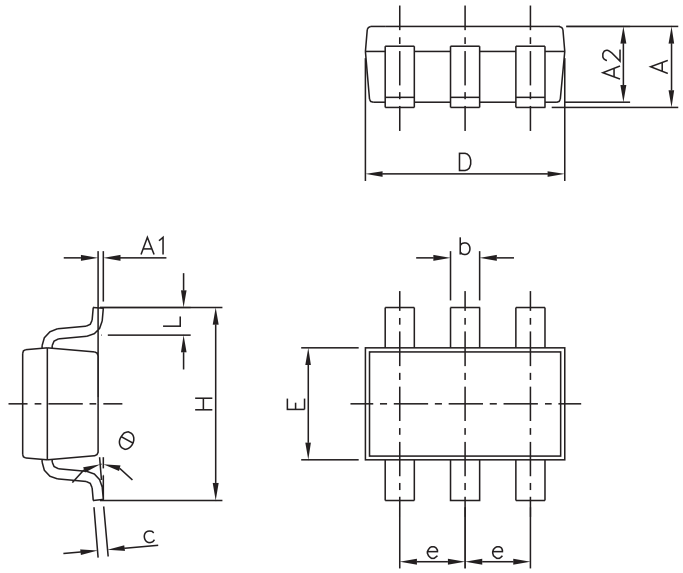


Table 12. SOT23-6 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.90		1.45	0.035		0.057
A1			0.10			0.004
A2	0.90		1.30	0.035		0.051
b	0.35		0.50	0.013		0.019
c	0.09		0.20	0.003		0.008
D	2.80		3.05	0.110		0.120
E	1.50		1.75	0.060		0.069
e		0.95			0.037	
H	2.60		3.00	0.102		0.118
L	0.10		0.60	0.004		0.024
θ	0 °		10 °	0 °		10 °

5.4 DFN8 2 x 2 mm package information

Figure 28. DFN8 2 x 2 mm package mechanical drawing (pitch 0.5 mm)

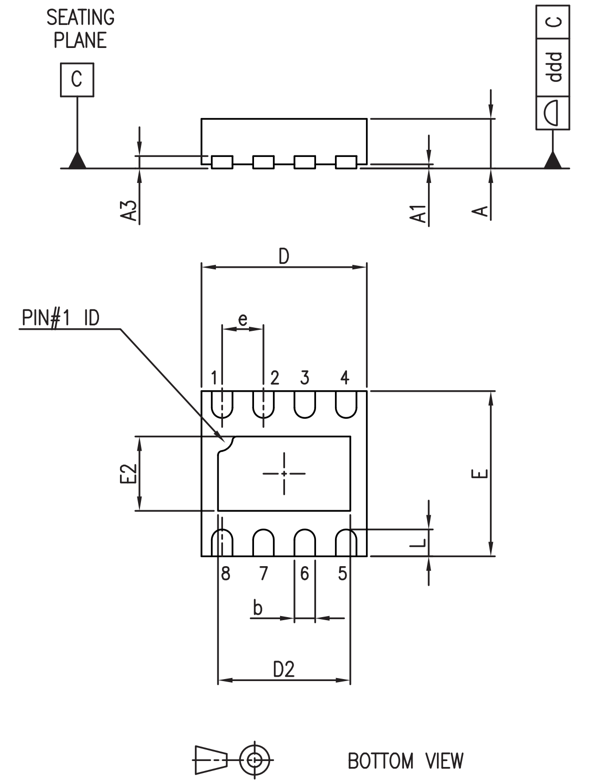


Table 13. DFN8 2 x 2 mm package mechanical data (pitch 0.5 mm)

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.51	0.55	0.60	0.020	0.022	0.024
A1			0.05			0.002
A3		0.15			0.006	
b	0.18	0.25	0.30	0.007	0.010	0.012
D	1.85	2.00	2.15	0.073	0.079	0.085
D2	1.45	1.60	1.70	0.057	0.063	0.067
E	1.85	2.00	2.15	0.073	0.079	0.085
E2	0.75	0.90	1.00	0.030	0.035	0.040
e		0.50			0.020	
L			0.425			0.017
ddd			0.08			0.003

5.5 MiniSO-8 package information

Figure 29. MiniSO-8 package mechanical drawing

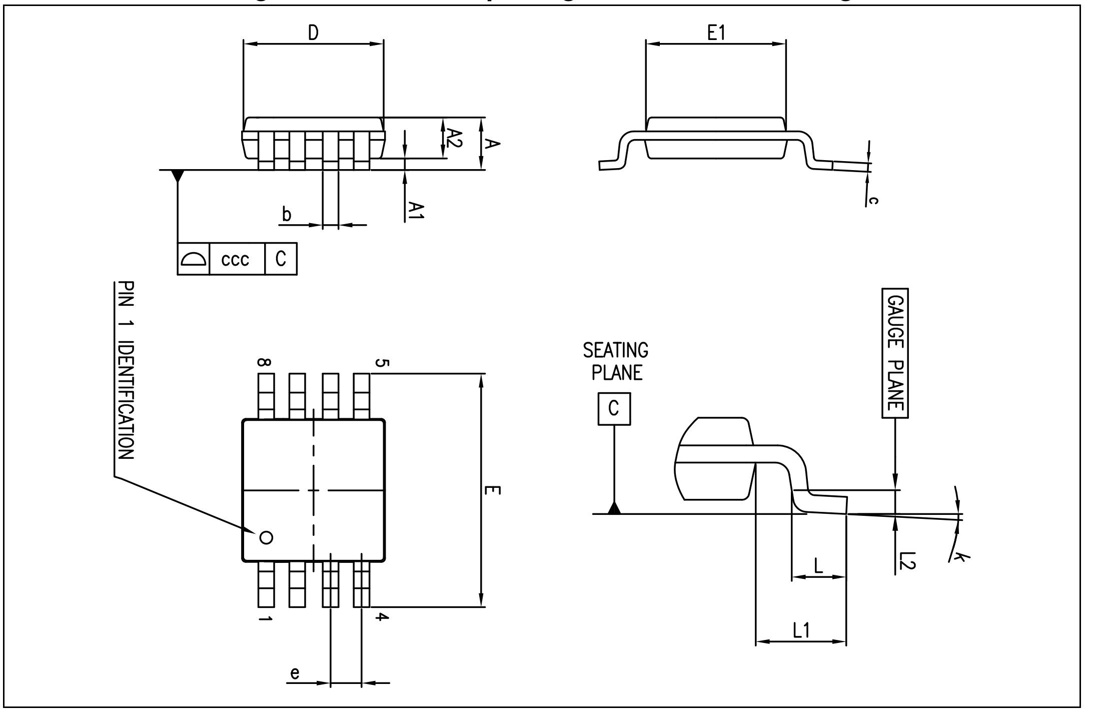


Table 14. MiniSO-8 package mechanical data

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

5.6 MiniSO-10 package information

Figure 30. MiniSO-10 package mechanical drawing

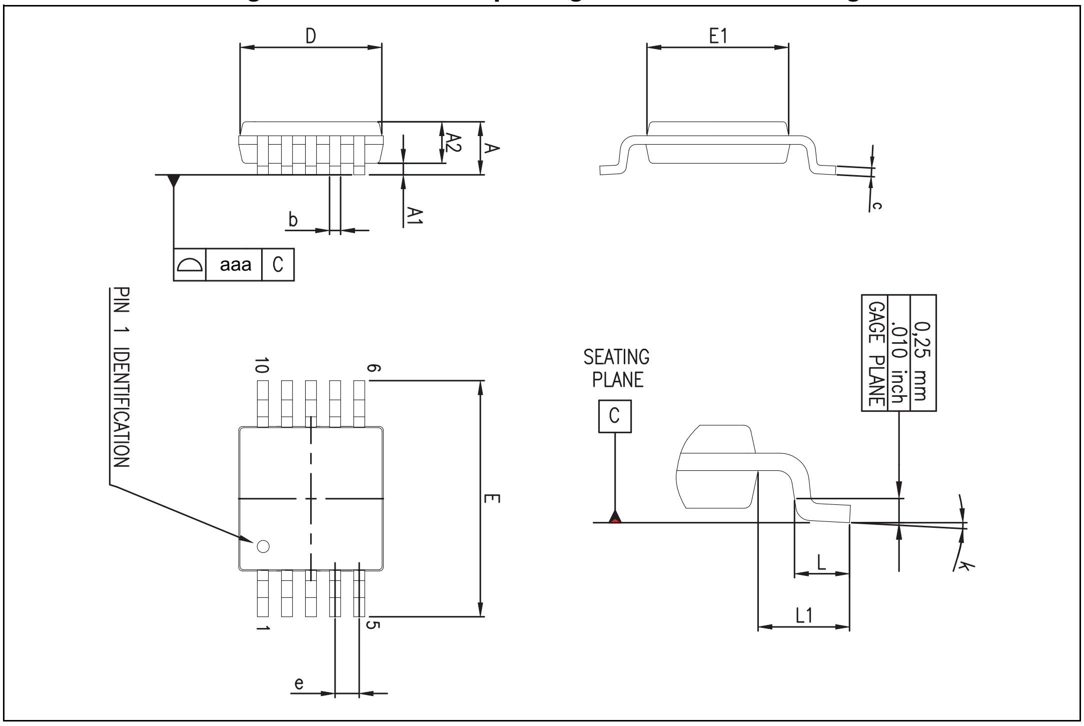


Table 15. MiniSO-10 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.10			0.043
A1	0.05	0.10	0.15	0.002	0.004	0.006
A2	0.78	0.86	0.94	0.031	0.034	0.037
b	0.25	0.33	0.40	0.010	0.013	0.016
c	0.15	0.23	0.30	0.006	0.009	0.012
D	2.90	3.00	3.10	0.114	0.118	0.122
E	4.75	4.90	5.05	0.187	0.193	0.199
E1	2.90	3.00	3.10	0.114	0.118	0.122
e		0.50			0.020	
L	0.40	0.55	0.70	0.016	0.022	0.028
L1		0.95			0.037	
k	0 °	3 °	6 °	0 °	3 °	6 °
aaa			0.10			0.004

5.7 TSSOP14 package information

Figure 31. TSSOP14 package mechanical drawing

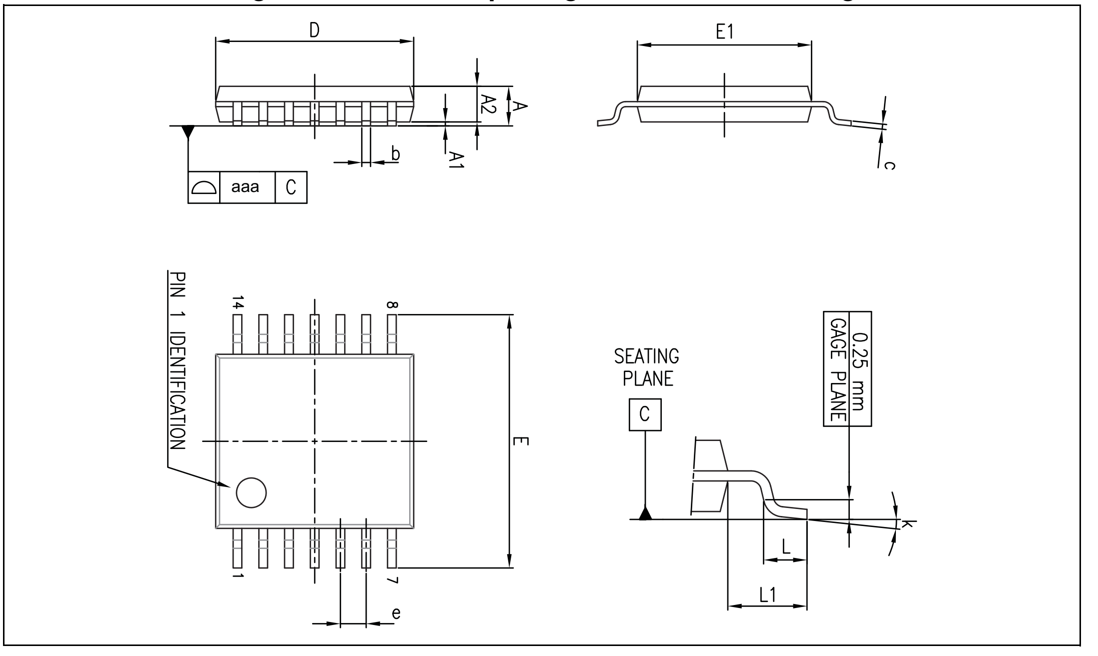


Table 16. TSSOP14 package mechanical data

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