

# LMV821, LMV824

## Single and Quad Low Voltage, Rail-to-Rail Operational Amplifiers

The LMV821 and LMV824 are operational amplifiers with low input voltage offset and drift vs. temperature. In spite of low quiescent current requirements these devices have 5 MHz bandwidth and 1.4 V/ $\mu$ s slew rate. In addition they provide rail-to-rail output swing into 600  $\Omega$  loads. The input common-mode voltage range includes ground, and the maximum input offset voltage is only 3.5 mV. Substantially large capacitive loads can be driven by simply adding a pullup resistor or isolation resistor.

The LMV821 (single) is available in a space-saving SC70-5 while the quad comes in SOIC and TSSOP packages.

### Features

- Low Offset Voltage: 3.5 mV
- Very low Offset Drift: 1.0  $\mu$ V/ $^{\circ}$ C
- High Bandwidth: 5 MHz
- Rail-to-Rail Output Swing into a 600  $\Omega$  load
- Capable of driving highly capacitive loads
- Small Packages:
  - LMV821 in SC-70
  - LMV824 in SOIC-14 and TSSOP-14
- These Devices are Pb-Free and are RoHS Compliant

### Typical Applications

- Notebook Computers
- PDAs
- Modem Transmitter/ Receivers

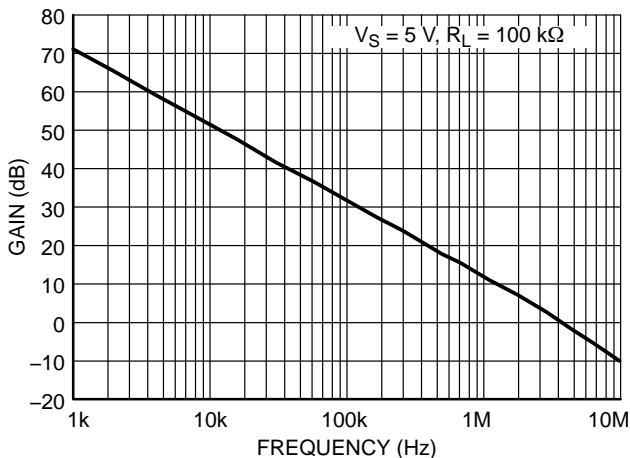


Figure 1. Gain vs. Frequency

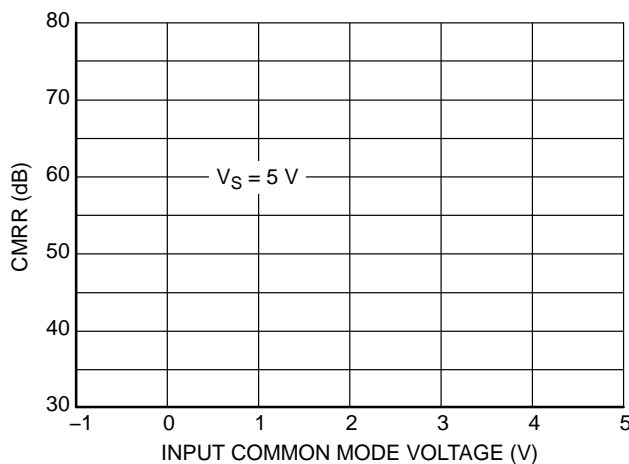


Figure 2. CMRR vs. Input Common Mode Voltage



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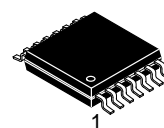
[www.onsemi.com](http://www.onsemi.com)



SC-70  
CASE 419A



SOIC-14  
CASE 751A



TSSOP-14  
CASE 948G

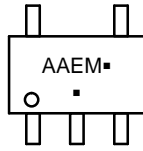
### ORDERING AND MARKING INFORMATION

See detailed ordering, marking and shipping information in the package dimensions section on page 2 of this data sheet.

# LMV821, LMV824

## MARKING DIAGRAMS

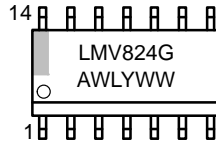
### SC-70



AAE = Specific Device Code  
 M = Date Code  
 ■ = Pb-Free Package

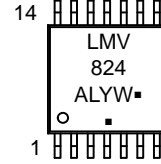
(Note: Microdot may be in either location)

### SOIC-14



LMV824 = Specific Device Code  
 A = Assembly Location  
 WL = Wafer Lot  
 Y = Year  
 WW = Work Week  
 G = Pb-Free Package

### TSSOP-14

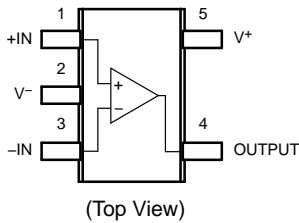


LMV824 = Specific Device Code  
 A = Assembly Location  
 L = Wafer Lot  
 Y = Year  
 W = Work Week  
 ■ = Pb-Free Package

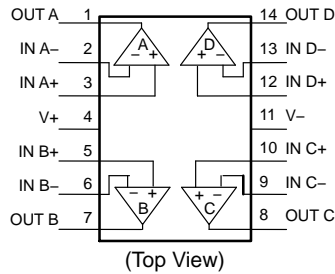
(Note: Microdot may be in either location)

## PIN CONNECTIONS

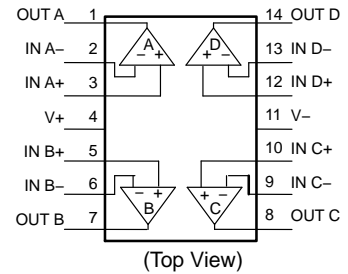
### SC70-5



### SOIC-14



### TSSOP-14



## ORDERING INFORMATION

Order Number	Number of Channels	Specific Device Marking	Package Type	Shipping†
LMV821SQ3T2G	Single	AAE	SC-70 (Pb-Free)	3000 / Tape & Reel
LMV824DR2G	Quad	LMV824	SOIC-14 (Pb-Free)	2500 / Tape & Reel
LMV824DTBR2G	Quad	LMV 824	TSSOP-14 (Pb-Free)	2500 / Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

# LMV821, LMV824

## MAXIMUM RATINGS

Symbol	Rating	Value	Unit
V <sub>S</sub>	Supply Voltage (Operating Range V <sub>S</sub> = 2.7 V to 5.5 V)	5.5	V
V <sub>IDR</sub>	Input Differential Voltage	± Supply Voltage	V
V <sub>ICR</sub>	Input Common Mode Voltage Range	-0.5 to (V+) +0.5	V
	Maximum Input Current	10	mA
t <sub>SO</sub>	Output Short Circuit (Note 1)	Continuous	
T <sub>J</sub>	Maximum Junction Temperature (Operating Range -40°C to 85°C)	150	°C
θ <sub>JA</sub>	Thermal Resistance		°C/W
	SC-70	280	
	SOIC-14	156	
	TSSOP-14	190	
T <sub>STG</sub>	Storage Temperature	-65 to 150	°C
	Mounting Temperature (Infrared or Convection – 20 sec)	235	°C
V <sub>ESD</sub>	ESD Tolerance	Machine Model	200
		Human Body Model	2000

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Continuous short-circuit operation to ground at elevated ambient temperature can result in exceeding the maximum allowed junction temperature of 150°C. Output currents in excess of 45 mA over long term may adversely affect reliability. Shorting output to either V+ or V- will adversely affect reliability.

## LMV821, LMV824

**2.7V DC ELECTRICAL CHARACTERISTICS** Unless otherwise noted, all min/max limits are guaranteed for  $T_A = 25^\circ\text{C}$ ,  $V_+ = 2.7\text{ V}$ ,  $V_- = 0\text{ V}$ ,  $V_{CM} = V_+/2$ ,  $V_O = V_+/2$  and  $R_L > 1\text{ M}\Omega$ . Typical specifications represent the most likely parametric norm. Min/Max specifications are guaranteed by testing, characterization, or statistical analysis.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Input Offset Voltage	$V_{IO}$			1	3.5	mV
		$T_A = -40^\circ\text{C to } +85^\circ\text{C}$			4	
Input Offset Voltage Average Drift	$TCV_{OS}$			1		$\mu\text{V}/^\circ\text{C}$
Input Bias Current	$I_B$			105	210	nA
		$T_A = -40^\circ\text{C to } +85^\circ\text{C}$			315	
Input Offset Current	$I_{IO}$			0.5	30	nA
		$T_A = -40^\circ\text{C to } +85^\circ\text{C}$			50	
Common-Mode Rejection Ratio	CMRR	$0\text{ V} \leq V_{CM} \leq 1.7\text{ V}$	70	85		dB
		$T_A = -40^\circ\text{C to } +85^\circ\text{C}$	68			
Power Supply Rejection Ratio	PSRR	$1.5\text{ V} \leq V_+ \leq 4\text{ V}$ , $V_- = -1\text{ V}$ , $V_O = 0\text{ V}$ , $V_{CM} = 0.0\text{ V}$	75	85		dB
		$T_A = -40^\circ\text{C to } +85^\circ\text{C}$	70			
Input Common-Mode Voltage Range	$V_{CM}$	For CMRR $\geq 53\text{ dB}$ and $T_A = -40^\circ\text{C to } +85^\circ\text{C}$	-0.2	-0.3 to 2.0	1.9	V
Large Signal Voltage Gain	AV	$R_L = 600\ \Omega$ , $V_O = 0.5\text{ V to } 2.5\text{ V}$	80	95		dB
		$T_A = -40^\circ\text{C to } +85^\circ\text{C}$	70			
		$R_L = 2\text{ k}\Omega$ , $V_O = 0.5\text{ V to } 2.5\text{ V}$	83	89		
		$T_A = -40^\circ\text{C to } +85^\circ\text{C}$	80			
Output Swing	$V_{OH}$	$R_L = 600\ \Omega$ to $1.35\text{ V}$	2.5	2.58		V
		$T_A = -40^\circ\text{C to } +85^\circ\text{C}$	2.4			
	$V_{OL}$	$R_L = 600\ \Omega$ to $1.35\text{ V}$		0.13	0.21	
		$T_A = -40^\circ\text{C to } +85^\circ\text{C}$			0.3	
	$V_{OH}$	$R_L = 2\text{ k}\Omega$ to $1.35\text{ V}$	2.6	2.66		
		$T_A = -40^\circ\text{C to } +85^\circ\text{C}$	2.5			
Output Current	$I_O$	Sourcing, $V_O = 0\text{ V}$	12			mA
		Sinking, $V_O = 2.7\text{ V}$	12	26		
Supply Current	$I_{CC}$	LMV821 (Single)		0.242	0.3	mA
		$T_A = -40^\circ\text{C to } +85^\circ\text{C}$			0.5	
		LMV824 (All Four Channels)		1	1.3	
		$T_A = -40^\circ\text{C to } +85^\circ\text{C}$			1.5	

## LMV821, LMV824

**2.5V DC ELECTRICAL CHARACTERISTICS** Unless otherwise noted, all min/max limits are guaranteed for  $T_A = 25^\circ\text{C}$ ,  $V_+ = 2.5\text{ V}$ ,  $V_- = 0\text{ V}$ ,  $V_{CM} = V_+/2$ ,  $V_O = V_+/2$  and  $R_L > 1\text{ M}\Omega$ . Typical specifications represent the most likely parametric norm. Min/Max specifications are guaranteed by testing, characterization, or statistical analysis.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Input Offset Voltage	$V_{IO}$	$T_A = -40^\circ\text{C to } +85^\circ\text{C}$		1	3.5	mV
					4	
Output Swing	$V_{OH}$	$R_L = 600\ \Omega \text{ to } 1.25\text{ V}$	2.3	2.37		V
		$T_A = -40^\circ\text{C to } +85^\circ\text{C}$	2.2			
	$V_{OL}$	$R_L = 600\ \Omega \text{ to } 1.25\text{ V}$		0.13	0.20	
		$T_A = -40^\circ\text{C to } +85^\circ\text{C}$			0.3	
	$V_{OH}$	$R_L = 2\text{ k}\Omega \text{ to } 1.25\text{ V}$	2.4	2.46		
		$T_A = -40^\circ\text{C to } +85^\circ\text{C}$	2.3			
	$V_{OL}$	$R_L = 2\text{ k}\Omega \text{ to } 1.25\text{ V}$		0.08	0.12	
		$T_A = -40^\circ\text{C to } +85^\circ\text{C}$			0.20	

**2.7V AC ELECTRICAL CHARACTERISTICS** Unless otherwise specified, all limits are guaranteed for  $T_A = 25^\circ\text{C}$ ,  $V_+ = 2.7\text{ V}$ ,  $V_- = 0\text{ V}$ ,  $V_{CM} = 1.0\text{ V}$ ,  $V_O = V_+/2$  and  $R_L > 1\text{ M}\Omega$ . Typical specifications represent the most likely parametric norm. Min/Max specifications are guaranteed by testing, characterization, or statistical analysis.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Slew Rate	SR	(Note 2)		1.5		V/ $\mu\text{S}$
Gain Bandwidth Product	GBWP			5		MHz
Phase Margin	$\theta_m$			55		$^\circ$
Gain Margin	$G_m$			12.9		dB
Input-Referred Voltage Noise	$e_n$	$f = 1\text{ kHz}, V_{CM} = 1\text{ V}$		12		nV/ $\sqrt{\text{Hz}}$
Input-Referred Current Noise	$i_n$	$f = 1\text{ kHz}$		0.2		pA/ $\sqrt{\text{Hz}}$
Total Harmonic Distortion	THD	$f = 1\text{ kHz}, AV = -2, R_L = 10\text{ k}\Omega, V_O = 1.8\text{ V}_{PP}$		0.023		%
Amplifier-to-Amplifier Isolation		(Note 3)		135		dB

2. Connected as voltage follower with input step from 0.5 V to 1.5 V. Number specified is the average of the positive and negative slew rates.
3. Input referred,  $R_L = 100\text{ k}\Omega$  connected to  $V_+/2$ . Each amp excited in turn with 1kHz to produce  $V_O = 3\text{ V}_{PP}$ . For Supply Voltages  $< 3\text{ V}$ ,  $V_O = V_+$ .

## LMV821, LMV824

**5V DC ELECTRICAL CHARACTERISTICS** Unless otherwise noted, all min/max limits are guaranteed for  $T_A = 25^\circ\text{C}$ ,  $V_+ = 5\text{ V}$ ,  $V_- = 0\text{ V}$ ,  $V_{CM} = V_+/2$ ,  $V_O = V_+/2$  and  $R_L > 1\text{ M}\Omega$ . Typical specifications represent the most likely parametric norm. Min/Max specifications are guaranteed by testing, characterization, or statistical analysis.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Input Offset Voltage	$V_{IO}$			1	3.5	mV
		$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$			4	
Input Offset Voltage Average Drift	$TCV_{OS}$			1		$\mu\text{V}/^\circ\text{C}$
Input Bias Current	$I_B$			119	245	nA
		$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$			380	
Input Offset Current	$I_{IO}$			0.5	30	nA
		$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$			50	
Common-Mode Rejection Ratio	CMRR	$0\text{ V} \leq V_{CM} \leq 4.0\text{ V}$	72	90		dB
		$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$	70			
Power Supply Rejection Ratio	PSRR	$1.7\text{ V} \leq V_+ \leq 4\text{ V}$ , $V_- = 1\text{ V}$ , $V_O = 0\text{ V}$ , $V_{CM} = 0.0\text{ V}$	75	85		dB
		$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$	70			
Input Common-Mode Voltage Range	$V_{CM}$	For CMRR $\geq 58\text{ dB}$ and $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$	-0.2	-0.2 to 4.3	4.2	V
Large Signal Voltage Gain	$A_V$	$R_L = 600\ \Omega$ , $V_O = 1.0\text{ V}$ to $4.0\text{ V}$	87	100		dB
		$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$	73			
		$R_L = 2\text{ k}\Omega$ , $V_O = 1.0\text{ V}$ to $4.0\text{ V}$	84	99		
		$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$	82			
Output Swing	$V_{OH}$	$R_L = 600\ \Omega$ to $2.5\text{ V}$	4.75	4.84		V
		$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$	4.7			
	$V_{OL}$	$R_L = 600\ \Omega$ to $2.5\text{ V}$		0.17	0.33	
		$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$			0.4	
	$V_{OH}$	$R_L = 2\text{ k}\Omega$ to $2.5\text{ V}$	4.85	4.9		
		$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$	4.8			
Output Current	$I_O$	Sourcing, $V_O = 0\text{ V}$	20	45		mA
		$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$	10			
		Sinking, $V_O = 5\text{ V}$	20	40		
		$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$	15			
Supply Current	$I_{CC}$			0.3	0.4	mA
		$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$			0.6	
		LMV822 (Both Applications)		0.5	0.7	
		$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$			0.9	
		LMV824 (All Four Applications)		1	1.3	
		$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$			1.5	

## LMV821, LMV824

**5V AC ELECTRICAL CHARACTERISTICS** Unless otherwise specified, all limits are guaranteed for  $T_A = 25^\circ\text{C}$ ,  $V_+ = 5\text{ V}$ ,  $V_- = 0\text{ V}$ ,  $V_{CM} = 2.0\text{ V}$ ,  $V_O = V_+/2$  and  $R_L > 1\text{ M}\Omega$ . Typical specifications represent the most likely parametric norm. Min/Max specifications are guaranteed by testing, characterization, or statistical analysis.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Slew Rate	SR	(Note 4)		2		V/ $\mu\text{S}$
Gain Bandwidth Product	GBWP			5.6		MHz
Phase Margin	$\theta_m$			63		$^\circ$
Gain Margin	$G_m$			11.7		dB
Input-Referred Voltage Noise	$e_n$	$f = 1\text{ kHz}$ , $V_{CM} = 1\text{ V}$		11		nV/ $\sqrt{\text{Hz}}$
Input-Referred Current Noise	$i_n$	$f = 1\text{ kHz}$		0.21		pA/ $\sqrt{\text{Hz}}$
Total Harmonic Distortion	THD	$f = 1\text{ kHz}$ , $A_V = -2$ , $R_L = 10\text{ k}\Omega$ , $V_O = 4.11\text{ VPP}$		0.012		%
Amplifier-to-Amplifier Isolation		(Note 5)		135		dB

4. Connected as voltage follower with input step from 0.5 V to 3.5 V. Number specified is the average of the positive and negative slew rates.
5. Input referred,  $R_L = 100\text{ k}\Omega$  connected to  $V_+/2$ . Each amp excited in turn with 1 kHz to produce  $V_O = 3\text{ VPP}$ . (For Supply Voltages  $< 3\text{ V}$ ,  $V_O = V_+$ ).

TYPICAL PERFORMANCE CHARACTERISTICS

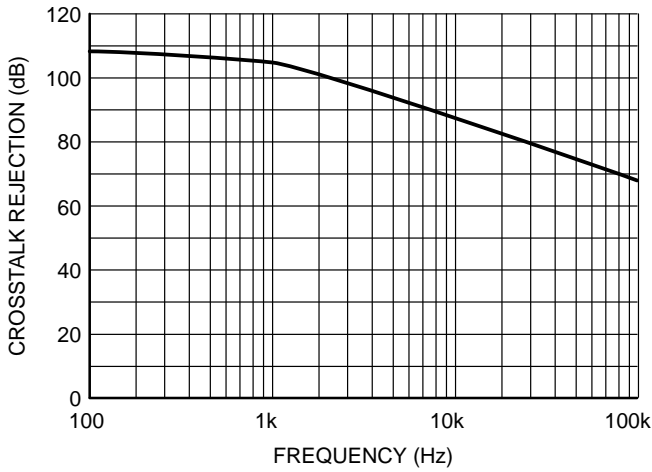


Figure 3. Crosstalk Rejection vs. Frequency

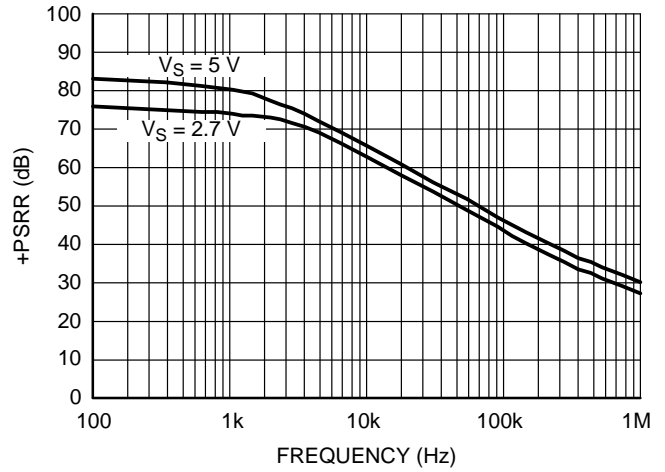


Figure 4. +PSRR vs. Frequency

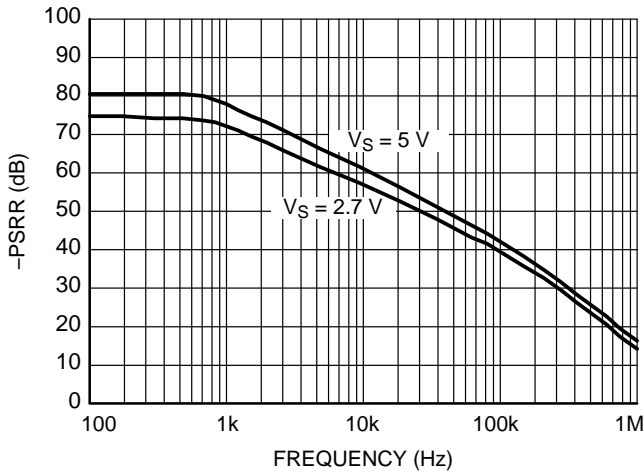


Figure 5. -PSRR vs. Frequency

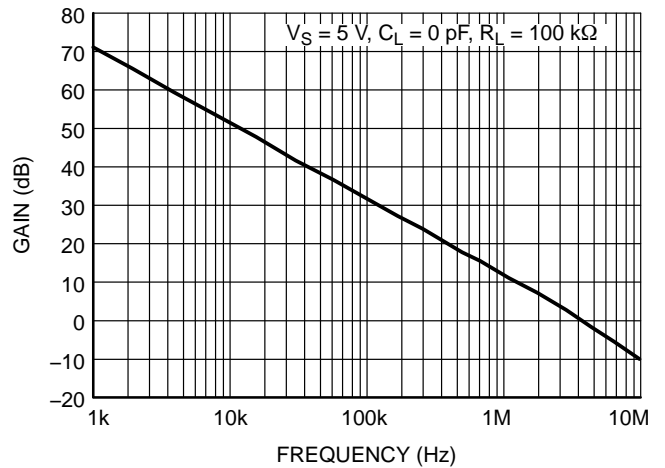


Figure 6. Gain vs. Frequency

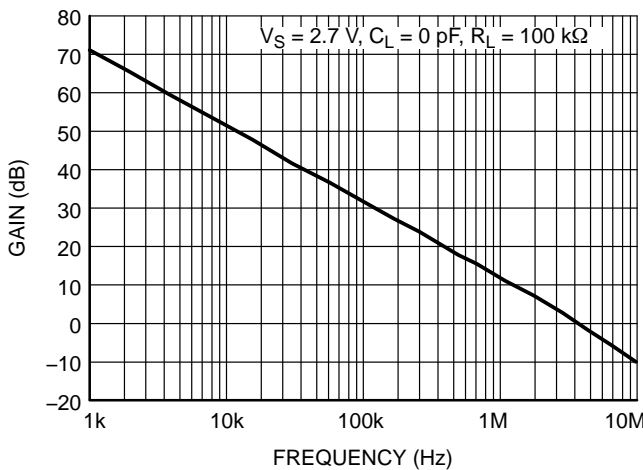


Figure 7. Gain vs. Frequency

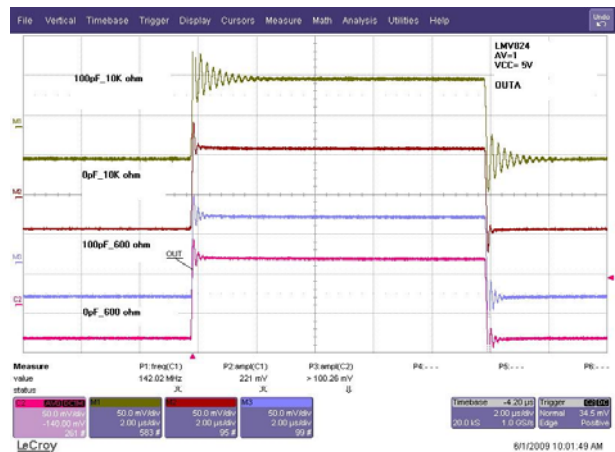


Figure 8. Non-Inverting Stability vs. Capacitive Load



# LMV821, LMV824

## TYPICAL PERFORMANCE CHARACTERISTICS

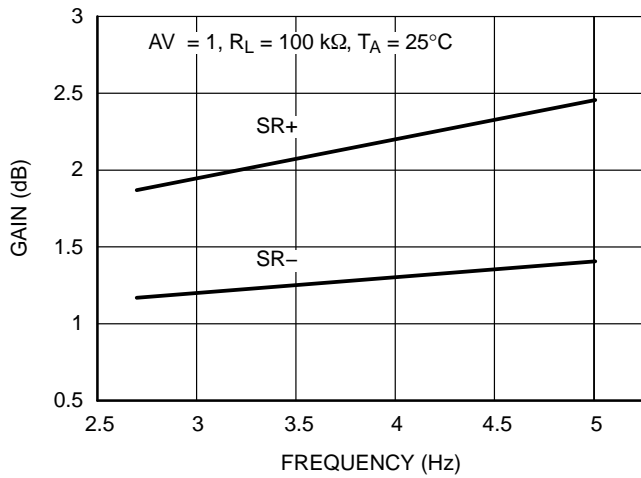


Figure 9. Gain vs. Frequency



Figure 10. Non-Inverting Large Signal Step Response

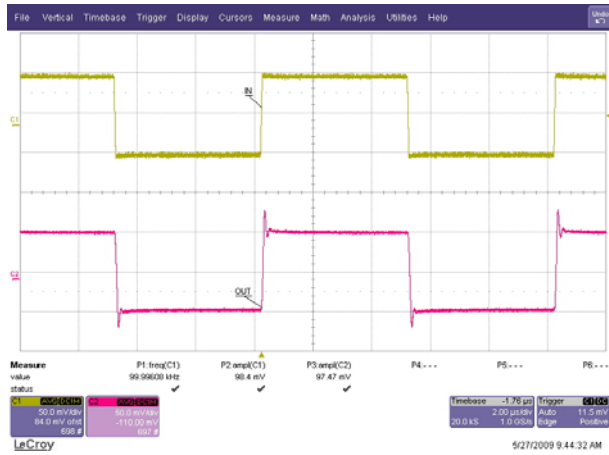


Figure 11. Non-Inverting Small Signal Step Response

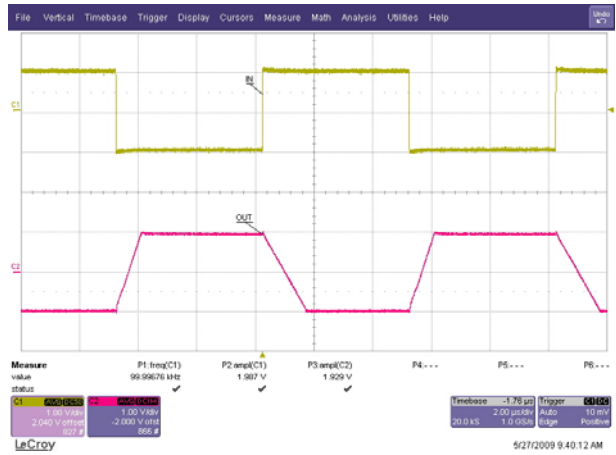


Figure 12. Inverting Large Signal Step Response

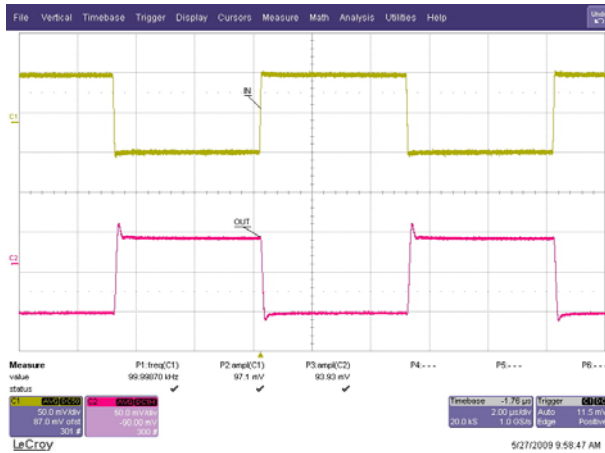


Figure 13. Inverting Small Signal Step Response

# LMV821, LMV824

## APPLICATIONS INFORMATION

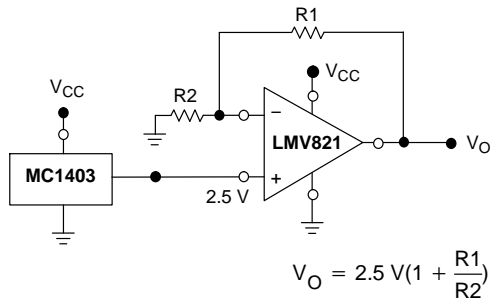


Figure 14. Voltage Reference

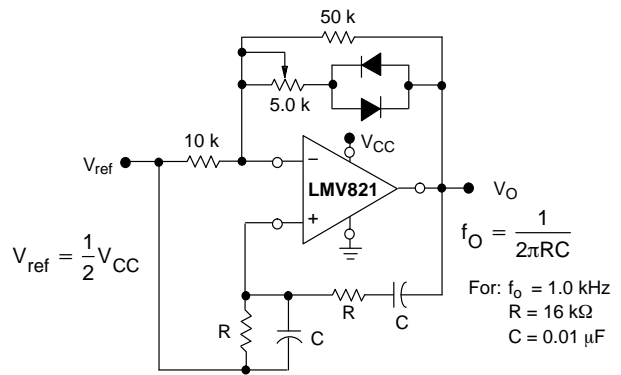


Figure 15. Wien Bridge Oscillator

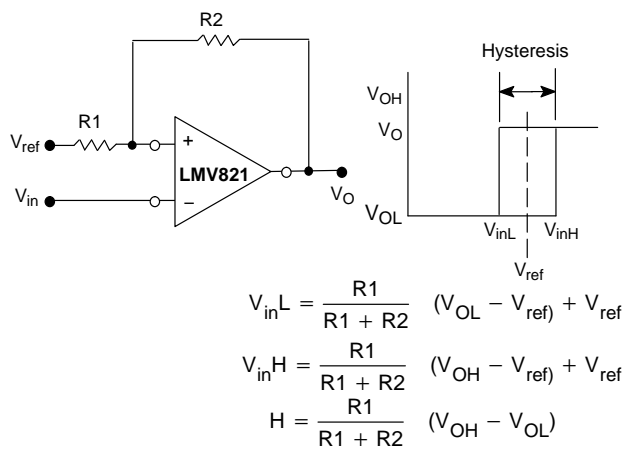
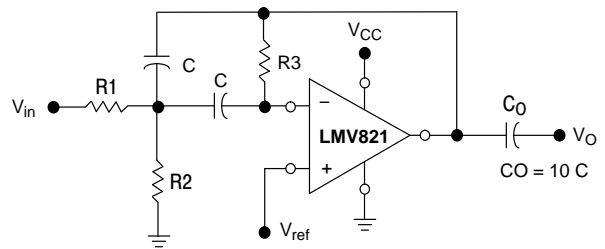


Figure 16. Comparator with Hysteresis



Given:  $f_o$  = center frequency  
 $A(f_o)$  = gain at center frequency

Choose value  $f_o, C$

$$\text{Then: } R_3 = \frac{Q}{\pi f_o C}$$

$$R_1 = \frac{R_3}{2 A(f_o)}$$

$$R_2 = \frac{R_1 R_3}{4Q^2 R_1 - R_3}$$

For less than 10% error from operational amplifier,  
 $((Q_o f_o)/BW) < 0.1$  where  $f_o$  and  $BW$  are expressed in Hz.  
 If source impedance varies, filter may be preceded with  
 voltage follower buffer to stabilize filter parameters.

Figure 17. Multiple Feedback Bandpass Filter

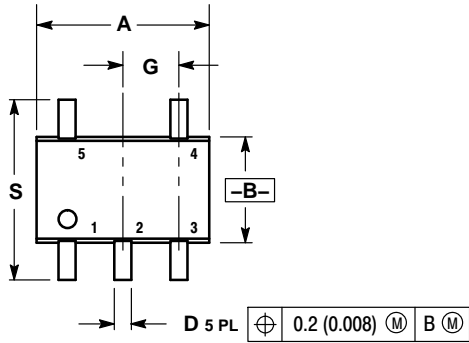
# LMV821, LMV824

## PACKAGE DIMENSIONS

SC-88A (SC-70-5/SOT-353)

CASE 419A-02

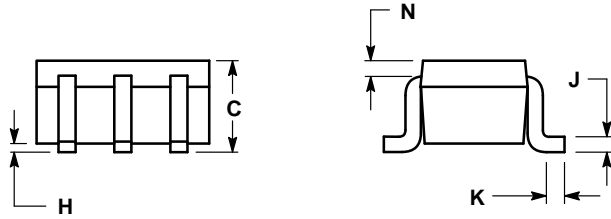
ISSUE L



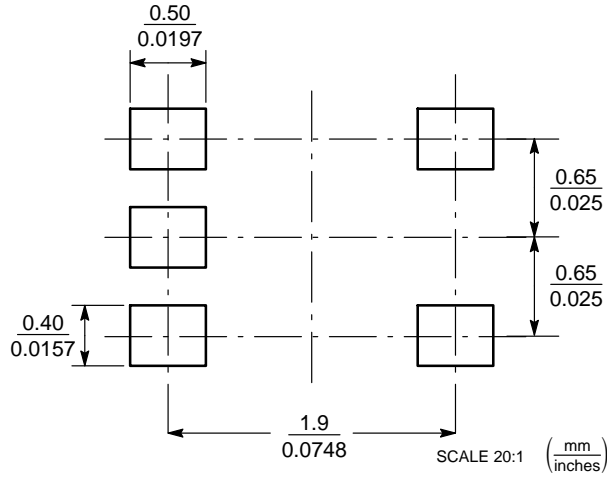
NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. 419A-01 OBSOLETE. NEW STANDARD 419A-02.
4. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.071	0.087	1.80	2.20
B	0.045	0.053	1.15	1.35
C	0.031	0.043	0.80	1.10
D	0.004	0.012	0.10	0.30
G	0.026 BSC		0.65 BSC	
H	---	0.004	---	0.10
J	0.004	0.010	0.10	0.25
K	0.004	0.012	0.10	0.30
N	0.008 REF		0.20 REF	
S	0.079	0.087	2.00	2.20



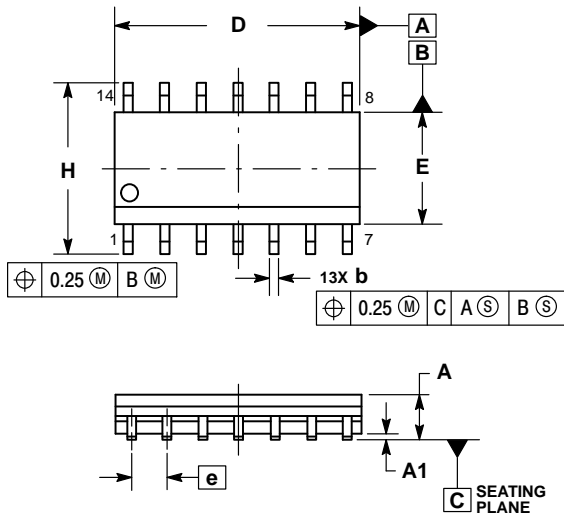
### SOLDER FOOTPRINT



# LMV821, LMV824

## PACKAGE DIMENSIONS

SOIC-14  
CASE 751A-03  
ISSUE K

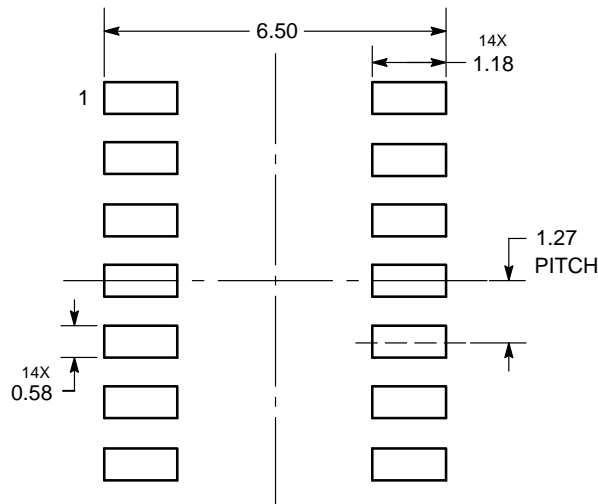


NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE PROTRUSION SHALL BE 0.13 TOTAL IN EXCESS OF AT MAXIMUM MATERIAL CONDITION.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD PROTRUSIONS.
5. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	1.35	1.75	0.054	0.068
A1	0.10	0.25	0.004	0.010
A3	0.19	0.25	0.008	0.010
b	0.35	0.49	0.014	0.019
D	8.55	8.75	0.337	0.344
E	3.80	4.00	0.150	0.157
e	1.27 BSC		0.050 BSC	
H	5.80	6.20	0.228	0.244
h	0.25	0.50	0.010	0.019
L	0.40	1.25	0.016	0.049
M	0°	7°	0°	7°

### SOLDERING FOOTPRINT\*



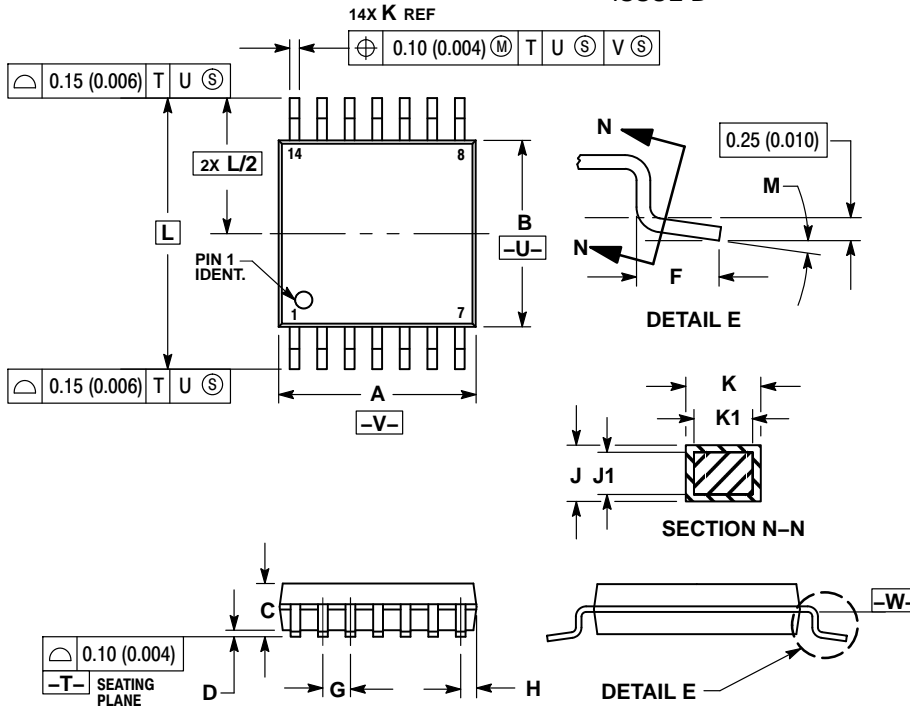
DIMENSIONS: MILLIMETERS

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

# LMV821, LMV824

## PACKAGE DIMENSIONS

### TSSOP-14 CASE 948G ISSUE B

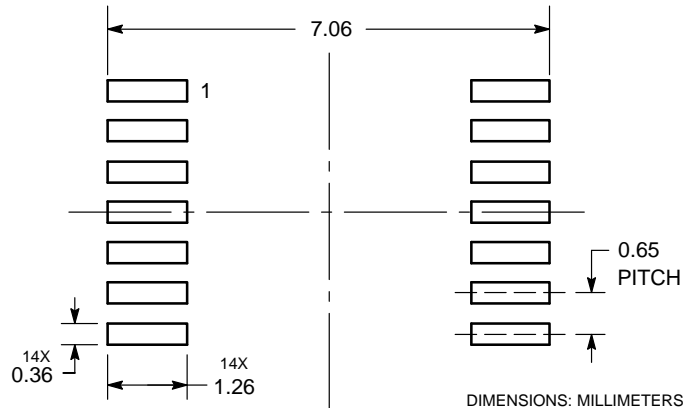


#### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
5. DIMENSION K DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE K DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
7. DIMENSION A AND B ARE TO BE DETERMINED AT DATUM PLANE -W-.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.90	5.10	0.193	0.200
B	4.30	4.50	0.169	0.177
C	—	1.20	—	0.047
D	0.05	0.15	0.002	0.006
F	0.50	0.75	0.020	0.030
G	0.65 BSC		0.026 BSC	
H	0.50	0.60	0.020	0.024
J	0.09	0.20	0.004	0.008
J1	0.09	0.16	0.004	0.006
K	0.19	0.30	0.007	0.012
K1	0.19	0.25	0.007	0.010
L	6.40 BSC		0.252 BSC	
M	0°	8°	0°	8°

### SOLDERING FOOTPRINT



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