

## LMV841/LMV841Q/LMV842/LMV842Q/LMV844/LMV844Q CMOS Input, RRIO, Wide Supply Range Operational Amplifiers

Check for Samples: [LMV841](#), [LMV842](#), [LMV844](#)

### FEATURES

- Unless otherwise noted, typical values at  $T_A = 25^\circ\text{C}$ ,  $V^+ = 5\text{V}$ .
- Space saving 5-Pin SC70 package
- Supply voltage range 2.7V to 12V
- Guaranteed at 3.3V, 5V and  $\pm 5\text{V}$
- Low supply current 1mA per channel
- Unity gain bandwidth 4.5MHz
- Open loop gain 133dB
- Input offset voltage 500 $\mu\text{V}$  max
- Input bias current 0.3pA
- CMRR 112dB
- Input voltage noise 20nV/ $\sqrt{\text{Hz}}$
- Temperature range  $-40^\circ\text{C}$  to  $125^\circ\text{C}$
- Rail-to-Rail input
- Rail-to-Rail output
- The LMV841Q, LMV842Q, and LMV844Q are AEC-Q100 grade 1 qualified and are manufactured on automotive grade flow.

### APPLICATIONS

- High impedance sensor interface
- Battery powered instrumentation
- High gain amplifiers
- DAC buffer
- Instrumentation amplifiers
- Active filters

### DESCRIPTION

The LMV841/LMV842/LMV844 are low-voltage and low-power operational amplifiers that operate with supply voltages ranging from 2.7V to 12V and have rail-to-rail input and output capability. Their low offset voltage, low supply current, and MOS inputs make them ideal for sensor interface and battery-powered applications.

The single LMV841 is offered in the space-saving 5-Pin SC70 package, the dual LMV842 in the 8-Pin VSSOP and 8-Pin SOIC packages, and the quad LMV844 in the 14-Pin TSSOP and 14-Pin SOIC packages. These small packages are ideal solutions for area-constrained PC boards and portable electronics.

The LMV841Q, LMV842Q, and LMV844Q incorporate enhanced manufacturing and support processes for the automotive market, including defect detection methodologies.

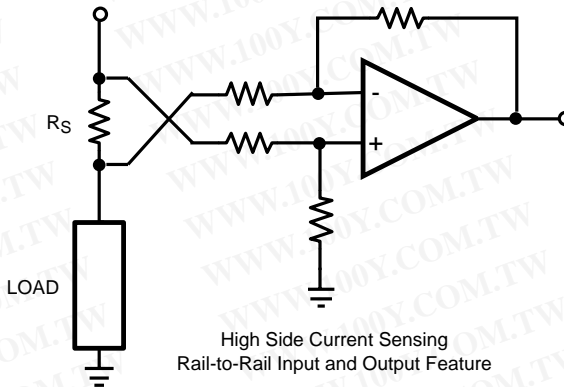
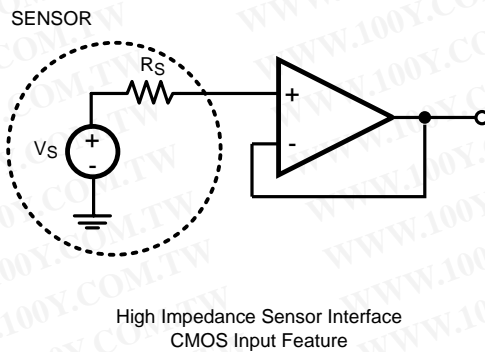
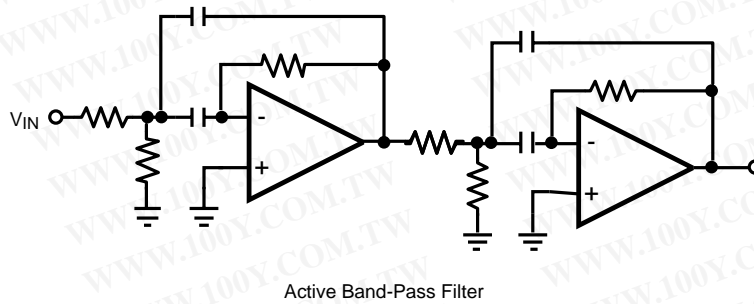
Reliability qualification is compliant with the requirements and temperature grades defined in the AEC-Q100 standard.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

All trademarks are the property of their respective owners.

### Typical Applications



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

### Absolute Maximum Ratings <sup>(1)(2)</sup>

ESD Tolerance <sup>(3)</sup>	
Human Body Model	2 kV
Machine Model	200V
V <sub>IN</sub> Differential	±300 mV
Supply Voltage (V <sup>+</sup> – V <sup>-</sup> )	13.2V
Voltage at Input/Output Pins	V <sup>+</sup> +0.3V, V <sup>-</sup> -0.3V
Input Current	10 mA
Storage Temperature Range	-65°C to +150°C
Junction Temperature <sup>(4)</sup>	+150°C
Soldering Information	
Infrared or Convection (20 sec)	235°C
Wave Soldering Lead Temp. (10 sec)	260°C

- (1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and the test conditions, see the Electrical Characteristics Tables.
- (2) **If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office / Distributors for availability and specifications.**
- (3) Human Body Model, applicable std. MIL-STD-883, Method 3015.7. Machine Model, applicable std. JESD22-A115-A (ESD MM std. of JEDEC) Field-Induced Charge-Device Model, applicable std. JESD22-C101-C (ESD FICDM std. of JEDEC).
- (4) The maximum power dissipation is a function of T<sub>J(MAX)</sub>, θ<sub>JA</sub>, and T<sub>A</sub>. The maximum allowable power dissipation at any ambient temperature is P<sub>D</sub> = (T<sub>J(MAX)</sub> - T<sub>A</sub>) / θ<sub>JA</sub>. All numbers apply for packages soldered directly onto a PC board.

**Operating Ratings** <sup>(1)</sup>

Temperature Range <sup>(2)</sup>	-40°C to +125°C
Supply Voltage ( $V^+ - V^-$ )	2.7V to 12V
Package Thermal Resistance [ $\theta_{JA}$ ] <sup>(2)</sup>	
5-Pin SC70	334 °C/W
8-Pin VSSOP	205 °C/W
8-Pin SOIC	126 °C/W
14-Pin TSSOP	110 °C/W
14-Pin SOIC	93 °C/W

(1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and the test conditions, see the Electrical Characteristics Tables.

(2) The maximum power dissipation is a function of  $T_{J(MAX)}$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any ambient temperature is  $P_D = (T_{J(MAX)} - T_A) / \theta_{JA}$ . All numbers apply for packages soldered directly onto a PC board.

**3.3V Electrical Characteristics** <sup>(1)</sup>

Unless otherwise specified, all limits are guaranteed for  $T_A = 25^\circ\text{C}$ ,  $V^+ = 3.3\text{V}$ ,  $V^- = 0\text{V}$ ,  $V_{CM} = V^+/2$ , and  $R_L > 10\text{M}\Omega$  to  $V^+/2$ .

**Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min <sup>(2)</sup>	Typ <sup>(3)</sup>	Max <sup>(2)</sup>	Units
$V_{OS}$	Input Offset Voltage			±50	±500 ±800	μV
$TCV_{OS}$	Input Offset Voltage Drift <sup>(4)</sup>			0.5	±5	μV/°C
$I_B$	Input Bias Current <sup>(4) (5)</sup>			0.3	10 300	pA
$I_{OS}$	Input Offset Current			40		fA
CMRR	Common Mode Rejection Ratio LMV841	$0\text{V} \leq V_{CM} \leq 3.3\text{V}$	84 80	112		dB
	Common Mode Rejection Ratio LMV842 and LMV844	$0\text{V} \leq V_{CM} \leq 3.3\text{V}$	77 75	106		dB
PSRR	Power Supply Rejection Ratio	$2.7\text{V} \leq V^+ \leq 12\text{V}$ , $V_O = V^+/2$	86 82	108		dB
CMVR	Input Common-Mode Voltage Range	CMRR ≥ 50 dB	-0.1		3.4	V
$A_{VOL}$	Large Signal Voltage Gain	$R_L = 2\text{ k}\Omega$ $V_O = 0.3\text{V to } 3.0\text{V}$	100 96	123		dB
		$R_L = 10\text{ k}\Omega$ $V_O = 0.2\text{V to } 3.1\text{V}$	100 96	131		dB
$V_O$	Output Swing High, (measured from $V^+$ )	$R_L = 2\text{ k}\Omega$ to $V^+/2$		52	80 120	mV
		$R_L = 10\text{ k}\Omega$ to $V^+/2$		28	50 70	mV
	Output Swing Low, (measured from $V^-$ )	$R_L = 2\text{ k}\Omega$ to $V^+/2$		65	100 120	mV
		$R_L = 10\text{ k}\Omega$ to $V^+/2$		33	65 75	mV

(1) Electrical table values apply only for factory testing conditions at the temperature indicated. Factory testing conditions result in very limited self-heating of the device.

(2) Limits are 100% production tested at 25°C. Limits over the operating temperature range are guaranteed through correlations using statistical quality control (SQC) method.

(3) Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration. The typical values are not tested and are not guaranteed on shipped production material.

(4) This parameter is guaranteed by design and/or characterization and is not tested in production.

(5) Positive current corresponds to current flowing into the device.

### 3.3V Electrical Characteristics <sup>(1)</sup> (continued)

Unless otherwise specified, all limits are guaranteed for  $T_A = 25^\circ\text{C}$ ,  $V^+ = 3.3\text{V}$ ,  $V^- = 0\text{V}$ ,  $V_{\text{CM}} = V^+/2$ , and  $R_L > 10\text{M}\Omega$  to  $V^+/2$ . **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (2)	Typ (3)	Max (2)	Units
$I_{\text{O}}$	Output Short Circuit Current (6) (7)	Sourcing $V_{\text{O}} = V^+/2$ $V_{\text{IN}} = 100\text{ mV}$	20 <b>15</b>	32		mA
		Sinking $V_{\text{O}} = V^+/2$ $V_{\text{IN}} = -100\text{ mV}$	20 <b>15</b>	27		mA
$I_{\text{S}}$	Supply Current	Per Channel		0.93	1.5 <b>2</b>	mA
SR	Slew Rate <sup>(8)</sup>	$A_V = +1$ , $V_{\text{O}} = 2.3\text{ V}_{\text{PP}}$ 10% to 90%		2.5		V/ $\mu\text{s}$
GBW	Gain Bandwidth Product			4.5		MHz
$\Phi_{\text{m}}$	Phase Margin			67		Deg
$e_{\text{n}}$	Input-Referred Voltage Noise	$f = 1\text{ kHz}$		20		nV/ $\sqrt{\text{Hz}}$
$R_{\text{OUT}}$	Open Loop Output Impedance	$f = 3\text{ MHz}$		70		$\Omega$
THD+N	Total Harmonic Distortion + Noise	$f = 1\text{ kHz}$ , $A_V = 1$ $R_L = 10\text{ k}\Omega$		0.005		%
$C_{\text{IN}}$	Input Capacitance			7		pF

(6) The maximum power dissipation is a function of  $T_{\text{J(MAX)}}$ ,  $\theta_{\text{JA}}$ , and  $T_A$ . The maximum allowable power dissipation at any ambient temperature is  $P_{\text{D}} = (T_{\text{J(MAX)}} - T_A) / \theta_{\text{JA}}$ . All numbers apply for packages soldered directly onto a PC board.

(7) Short circuit test is a momentary test.

(8) Number specified is the slower of positive and negative slew rates.

### 5V Electrical Characteristics <sup>(1)</sup>

Unless otherwise specified, all limits are guaranteed for  $T_A = 25^\circ\text{C}$ ,  $V^+ = 5\text{V}$ ,  $V^- = 0\text{V}$ ,  $V_{\text{CM}} = V^+/2$ , and  $R_L > 10\text{M}\Omega$  to  $V^+/2$ . **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (2)	Typ (3)	Max (2)	Units
$V_{\text{OS}}$	Input Offset Voltage			$\pm 50$	$\pm 500$ <b><math>\pm 800</math></b>	$\mu\text{V}$
$\text{TCV}_{\text{OS}}$	Input Offset Voltage Drift <sup>(4)</sup>			0.35	<b><math>\pm 5</math></b>	$\mu\text{V}/^\circ\text{C}$
$I_{\text{B}}$	Input Bias Current (4) (5)			0.3	10 <b>300</b>	pA
$I_{\text{OS}}$	Input Offset Current			40		fA
CMRR	Common Mode Rejection Ratio LMV841	$0\text{V} \leq V_{\text{CM}} \leq 5\text{V}$	86 <b>80</b>	112		dB
	Common Mode Rejection Ratio LMV842 and LMV844	$0\text{V} \leq V_{\text{CM}} \leq 5\text{V}$	81 <b>79</b>	106		dB
PSRR	Power Supply Rejection Ratio	$2.7\text{V} \leq V^+ \leq 12\text{V}$ , $V_{\text{O}} = V^+/2$	86 <b>82</b>	108		dB
CMVR	Input Common-Mode Voltage Range	CMRR $\geq 50\text{ dB}$	<b>-0.2</b>		<b>5.2</b>	V
$A_{\text{VOL}}$	Large Signal Voltage Gain	$R_L = 2\text{ k}\Omega$ $V_{\text{O}} = 0.3\text{V to } 4.7\text{V}$	100 <b>96</b>	125		dB
		$R_L = 10\text{ k}\Omega$ $V_{\text{O}} = 0.2\text{V to } 4.8\text{V}$	100 <b>96</b>	133		dB

(1) Electrical table values apply only for factory testing conditions at the temperature indicated. Factory testing conditions result in very limited self-heating of the device.

(2) Limits are 100% production tested at  $25^\circ\text{C}$ . Limits over the operating temperature range are guaranteed through correlations using statistical quality control (SQC) method.

(3) Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration. The typical values are not tested and are not guaranteed on shipped production material.

(4) This parameter is guaranteed by design and/or characterization and is not tested in production.

(5) Positive current corresponds to current flowing into the device.

### 5V Electrical Characteristics <sup>(1)</sup> (continued)

Unless otherwise specified, all limits are guaranteed for  $T_A = 25^\circ\text{C}$ ,  $V^+ = 5\text{V}$ ,  $V^- = 0\text{V}$ ,  $V_{\text{CM}} = V^+/2$ , and  $R_L > 10\text{M}\Omega$  to  $V^+/2$ . **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min <sup>(2)</sup>	Typ <sup>(3)</sup>	Max <sup>(2)</sup>	Units
$V_O$	Output Swing High, (measured from $V^+$ )	$R_L = 2\text{ k}\Omega$ to $V^+/2$		68	100 <b>120</b>	mV
		$R_L = 10\text{ k}\Omega$ to $V^+/2$		32	50 <b>70</b>	mV
	Output Swing Low, (measured from $V^-$ )	$R_L = 2\text{ k}\Omega$ to $V^+/2$		78	120 <b>140</b>	mV
		$R_L = 10\text{ k}\Omega$ to $V^+/2$		38	70 <b>80</b>	mV
$I_O$	Output Short Circuit Current <sup>(6)</sup> <sup>(7)</sup>	Sourcing $V_O = V^+/2$ $V_{\text{IN}} = 100\text{ mV}$	20 <b>15</b>	33		mA
		Sinking $V_O = V^+/2$ $V_{\text{IN}} = -100\text{ mV}$	20 <b>15</b>	28		mA
$I_S$	Supply Current	Per Channel		0.96	1.5 <b>2</b>	mA
SR	Slew Rate <sup>(8)</sup>	$A_V = +1$ , $V_O = 4 V_{\text{PP}}$ 10% to 90%		2.5		V/ $\mu\text{s}$
GBW	Gain Bandwidth Product			4.5		MHz
$\Phi_m$	Phase Margin			67		Deg
$e_n$	Input-Referred Voltage Noise	$f = 1\text{ kHz}$		20		nV/ $\sqrt{\text{Hz}}$
$R_{\text{OUT}}$	Open Loop Output Impedance	$f = 3\text{ MHz}$		70		$\Omega$
THD+N	Total Harmonic Distortion + Noise	$f = 1\text{ kHz}$ , $A_V = 1$ $R_L = 10\text{ k}\Omega$		0.003		%
$C_{\text{IN}}$	Input Capacitance			6		pF

(6) The maximum power dissipation is a function of  $T_{\text{J(MAX)}}$ ,  $\theta_{\text{JA}}$ , and  $T_A$ . The maximum allowable power dissipation at any ambient temperature is  $P_D = (T_{\text{J(MAX)}} - T_A) / \theta_{\text{JA}}$ . All numbers apply for packages soldered directly onto a PC board.

(7) Short circuit test is a momentary test.

(8) Number specified is the slower of positive and negative slew rates.

### $\pm 5\text{V}$ Electrical Characteristics <sup>(1)</sup>

Unless otherwise specified, all limits are guaranteed for  $T_A = 25^\circ\text{C}$ ,  $V^+ = 5\text{V}$ ,  $V^- = -5\text{V}$ ,  $V_{\text{CM}} = 0\text{V}$ , and  $R_L > 10\text{M}\Omega$  to  $V_{\text{CM}}$ . **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min <sup>(2)</sup>	Typ <sup>(3)</sup>	Max <sup>(2)</sup>	Units
$V_{\text{OS}}$	Input Offset Voltage			$\pm 50$	$\pm 500$ <b><math>\pm 800</math></b>	$\mu\text{V}$
$\text{TCV}_{\text{OS}}$	Input Offset Voltage Drift <sup>(4)</sup>			0.25	<b><math>\pm 5</math></b>	$\mu\text{V}/^\circ\text{C}$
$I_B$	Input Bias Current <sup>(4)</sup> <sup>(5)</sup>			0.3	10 <b>300</b>	pA
$I_{\text{OS}}$	Input Offset Current			40		fA
CMRR	Common Mode Rejection Ratio LMV841	$-5\text{V} \leq V_{\text{CM}} \leq 5\text{V}$	86 <b>80</b>	112		dB
	Common Mode Rejection Ratio LMV842 and LMV844	$-5\text{V} \leq V_{\text{CM}} \leq 5\text{V}$	86 <b>80</b>	106		dB

(1) Electrical table values apply only for factory testing conditions at the temperature indicated. Factory testing conditions result in very limited self-heating of the device.

(2) Limits are 100% production tested at  $25^\circ\text{C}$ . Limits over the operating temperature range are guaranteed through correlations using statistical quality control (SQC) method.

(3) Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration. The typical values are not tested and are not guaranteed on shipped production material.

(4) This parameter is guaranteed by design and/or characterization and is not tested in production.

(5) Positive current corresponds to current flowing into the device.

**±5V Electrical Characteristics <sup>(1)</sup> (continued)**

Unless otherwise specified, all limits are guaranteed for  $T_A = 25^\circ\text{C}$ ,  $V^+ = 5\text{V}$ ,  $V^- = -5\text{V}$ ,  $V_{\text{CM}} = 0\text{V}$ , and  $R_L > 10\text{M}\Omega$  to  $V_{\text{CM}}$ . **Boldface** limits apply at the temperature extremes.

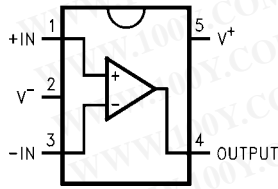
Symbol	Parameter	Conditions	Min <sup>(2)</sup>	Typ <sup>(3)</sup>	Max <sup>(2)</sup>	Units
PSRR	Power Supply Rejection Ratio	$2.7\text{V} \leq V^+ \leq 12\text{V}$ , $V_O = 0\text{V}$	86 <b>82</b>	108		dB
CMVR	Input Common-Mode Voltage Range	$\text{CMRR} \geq 50\text{ dB}$	<b>-5.2</b>		<b>5.2</b>	V
$A_{\text{VOL}}$	Large Signal Voltage Gain	$R_L = 2\text{k}\Omega$ $V_O = -4.7\text{V}$ to $4.7\text{V}$	100 <b>96</b>	126		dB
		$R_L = 10\text{k}\Omega$ $V_O = -4.8\text{V}$ to $4.8\text{V}$	100 <b>96</b>	136		dB
$V_O$	Output Swing High, (measured from $V^+$ )	$R_L = 2\text{k}\Omega$ to $0\text{V}$		95	130 <b>155</b>	mV
		$R_L = 10\text{k}\Omega$ to $0\text{V}$		44	75 <b>95</b>	mV
	Output Swing Low, (measured from $V^-$ )	$R_L = 2\text{k}\Omega$ to $0\text{V}$		105	160 <b>200</b>	mV
		$R_L = 10\text{k}\Omega$ to $0\text{V}$		52	80 <b>100</b>	mV
$I_O$	Output Short Circuit Current <sup>(6)</sup> <sup>(7)</sup>	Sourcing $V_O = 0\text{V}$ $V_{\text{IN}} = 100\text{ mV}$	20 <b>15</b>	37		mA
		Sinking $V_O = 0\text{V}$ $V_{\text{IN}} = -100\text{ mV}$	20 <b>15</b>	29		mA
$I_S$	Supply Current	Per Channel		1.03	1.7 <b>2</b>	mA
SR	Slew Rate <sup>(8)</sup>	$A_V = +1$ , $V_O = 9V_{\text{PP}}$ 10% to 90%		2.5		V/ $\mu\text{s}$
GBW	Gain Bandwidth Product			4.5		MHz
$\Phi_m$	Phase Margin			67		Deg
$e_n$	Input-Referred Voltage Noise	$f = 1\text{kHz}$		20		nV/ $\sqrt{\text{Hz}}$
$R_{\text{OUT}}$	Open Loop Output Impedance	$f = 3\text{MHz}$		70		$\Omega$
THD+N	Total Harmonic Distortion + Noise	$f = 1\text{kHz}$ , $A_V = 1$ $R_L = 10\text{k}\Omega$		0.006		%
$C_{\text{IN}}$	Input Capacitance			3		pF

(6) The maximum power dissipation is a function of  $T_{\text{J(MAX)}}$ ,  $\theta_{\text{JA}}$ , and  $T_A$ . The maximum allowable power dissipation at any ambient temperature is  $P_D = (T_{\text{J(MAX)}} - T_A) / \theta_{\text{JA}}$ . All numbers apply for packages soldered directly onto a PC board.

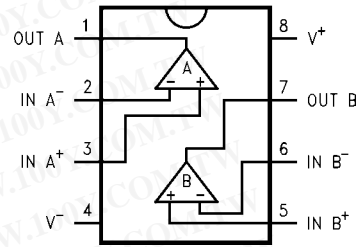
(7) Short circuit test is a momentary test.

(8) Number specified is the slower of positive and negative slew rates.

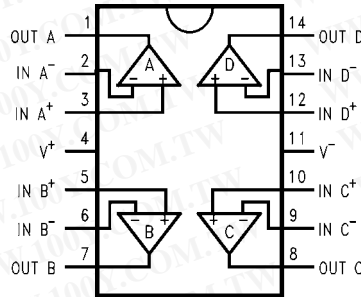
**CONNECTION DIAGRAMS**



**Figure 1. 5-Pin SC70 Top View**



**Figure 2. 8-Pin SOIC and VSSOP Top View**



**Figure 3. 14-Pin SOIC and TSSOP Top View**

**TYPICAL PERFORMANCE CHARACTERISTICS**

At  $T_A = 25^\circ\text{C}$ ,  $R_L = 10\text{k}\Omega$ ,  $V_S = 5\text{V}$ . Unless otherwise specified.

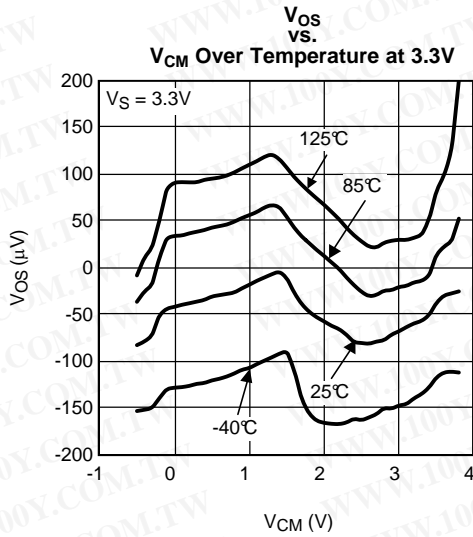


Figure 4.

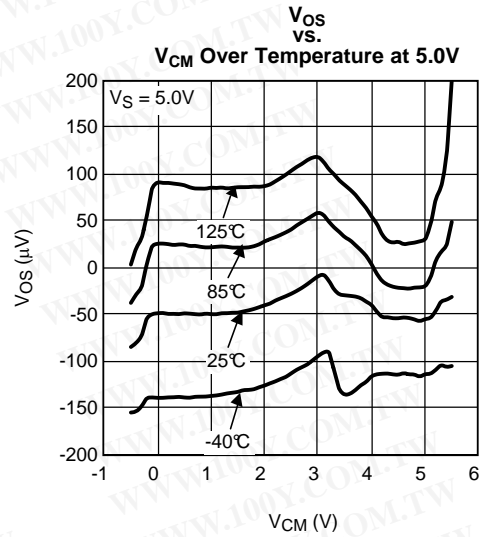


Figure 5.

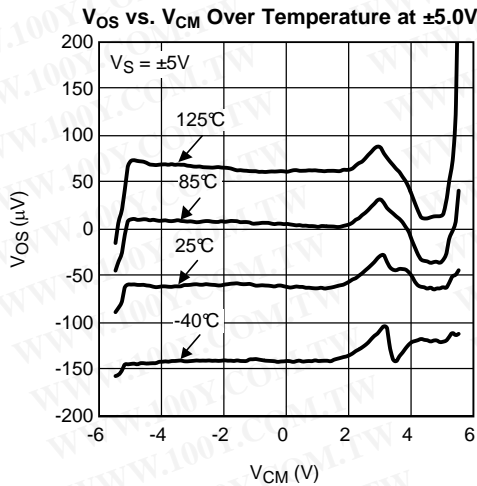


Figure 6.

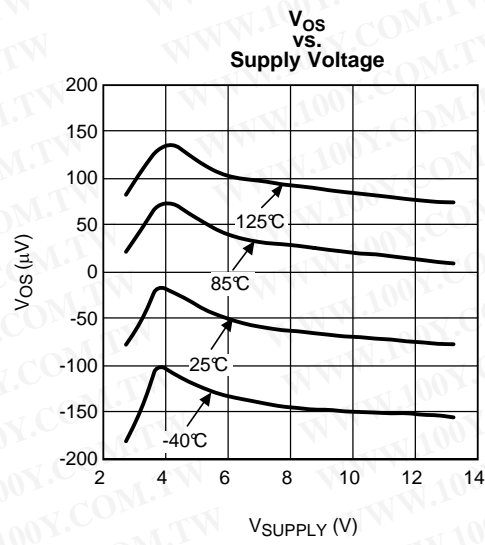


Figure 7.



**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

At  $T_A = 25^\circ\text{C}$ ,  $R_L = 10\text{k}\Omega$ ,  $V_S = 5\text{V}$ . Unless otherwise specified.

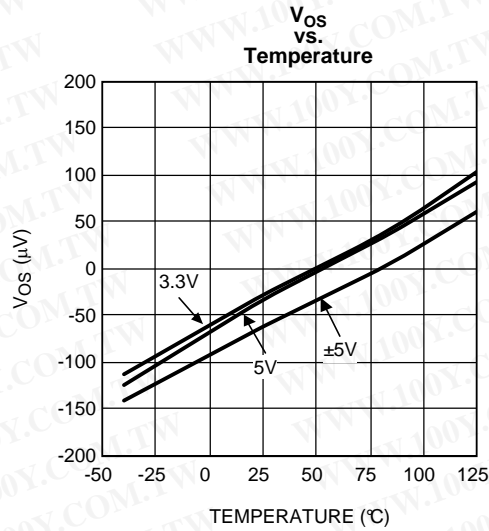


Figure 8.

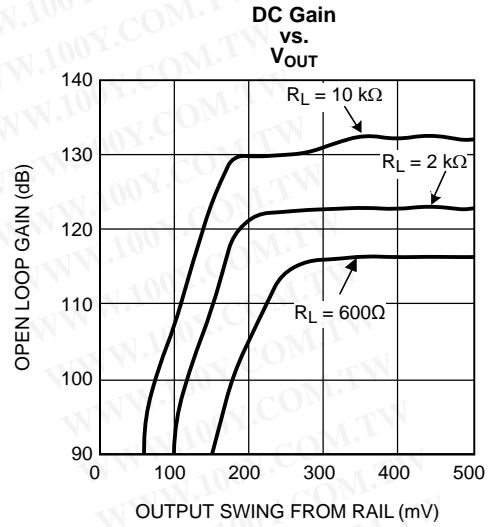


Figure 9.

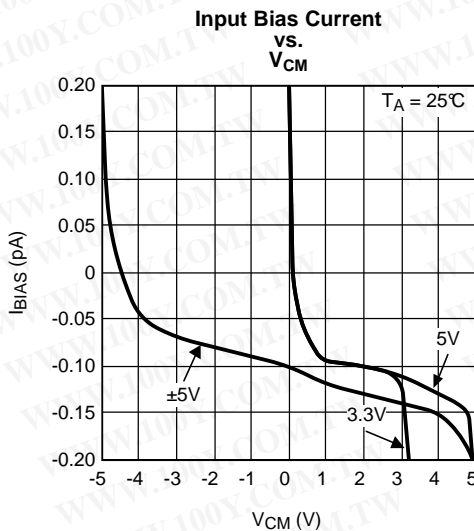


Figure 10.

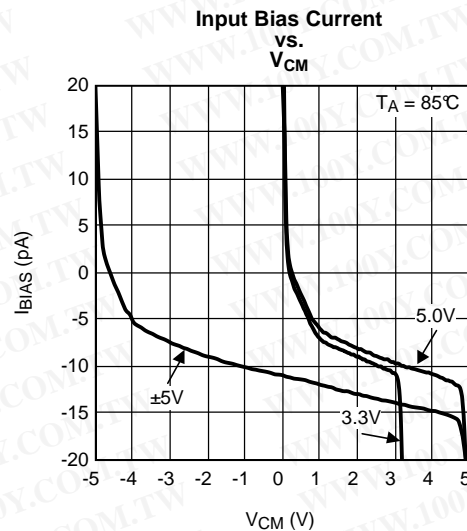


Figure 11.

**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

At  $T_A = 25^\circ\text{C}$ ,  $R_L = 10\text{k}\Omega$ ,  $V_S = 5\text{V}$ . Unless otherwise specified.

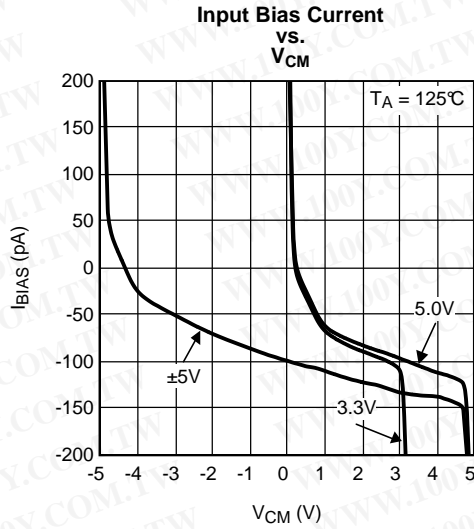


Figure 12.

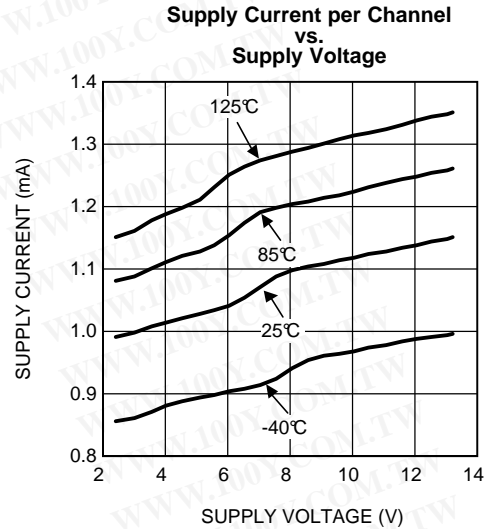


Figure 13.

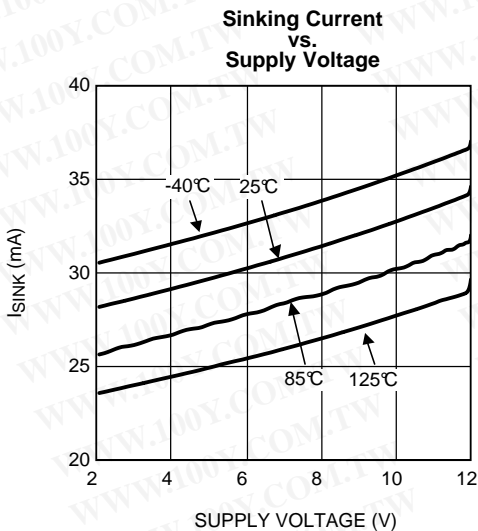


Figure 14.

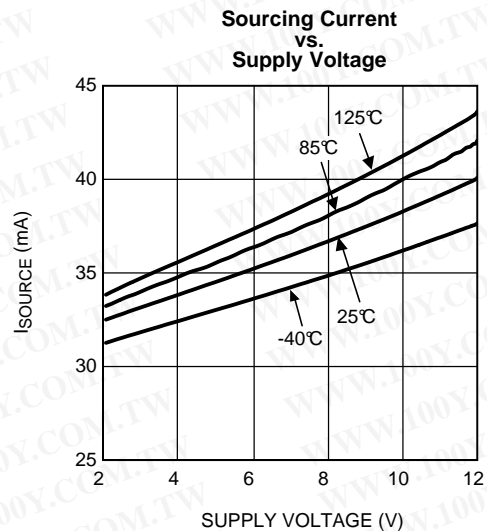


Figure 15.

**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

At  $T_A = 25^\circ\text{C}$ ,  $R_L = 10\text{k}\Omega$ ,  $V_S = 5\text{V}$ . Unless otherwise specified.

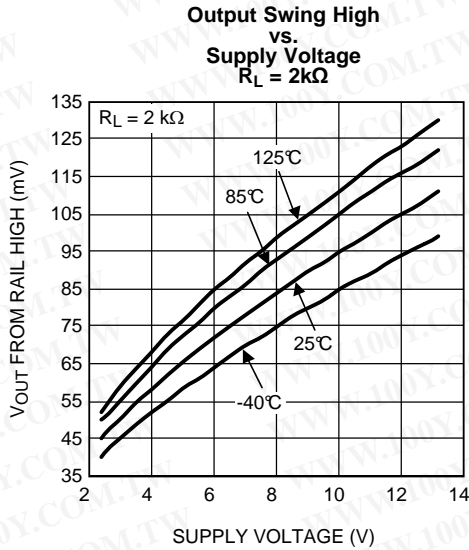


Figure 16.

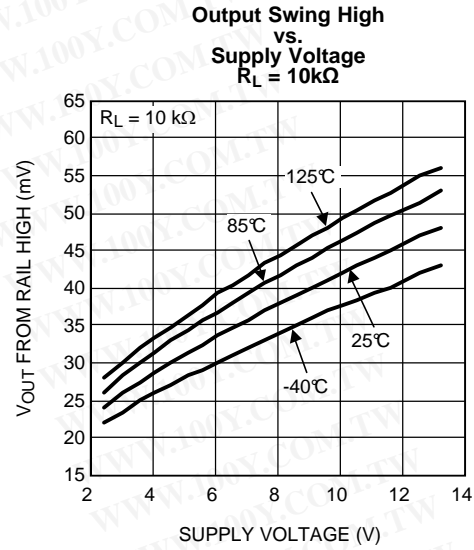


Figure 17.

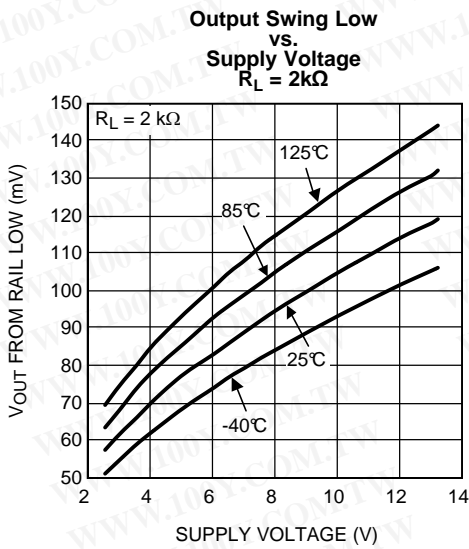


Figure 18.

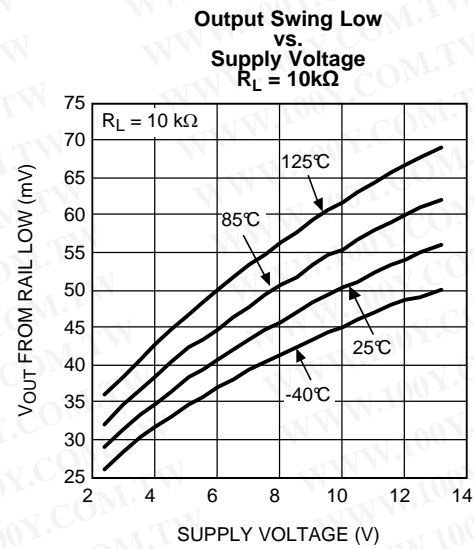


Figure 19.

**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

At  $T_A = 25^\circ\text{C}$ ,  $R_L = 10\text{k}\Omega$ ,  $V_S = 5\text{V}$ . Unless otherwise specified.

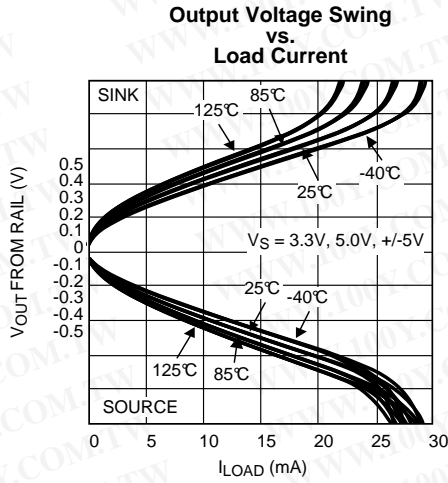


Figure 20.

**Open Loop Frequency Response Over Temperature**

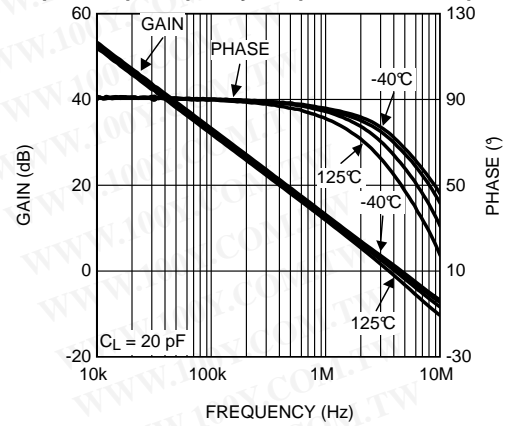


Figure 21.

**Open Loop Frequency Response Over Load Conditions**

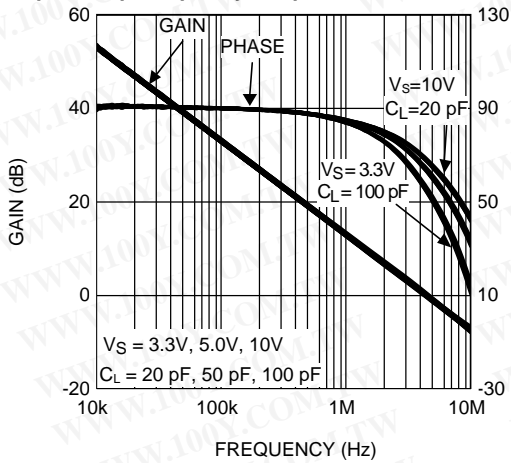


Figure 22.

**Phase Margin  
vs.  
CL**

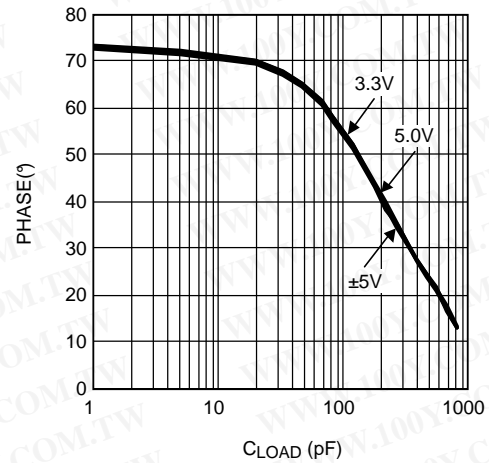


Figure 23.

**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

At  $T_A = 25^\circ\text{C}$ ,  $R_L = 10\text{k}\Omega$ ,  $V_S = 5\text{V}$ . Unless otherwise specified.

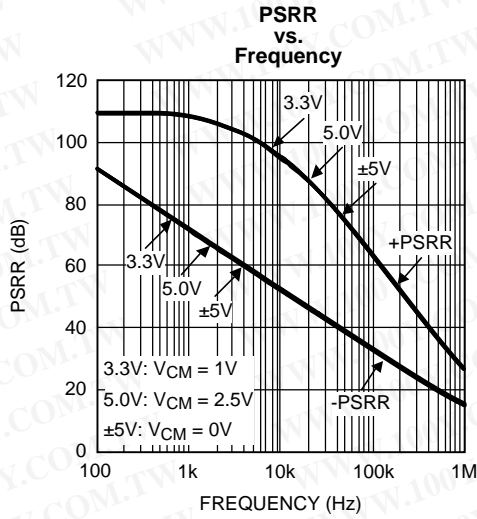


Figure 24.

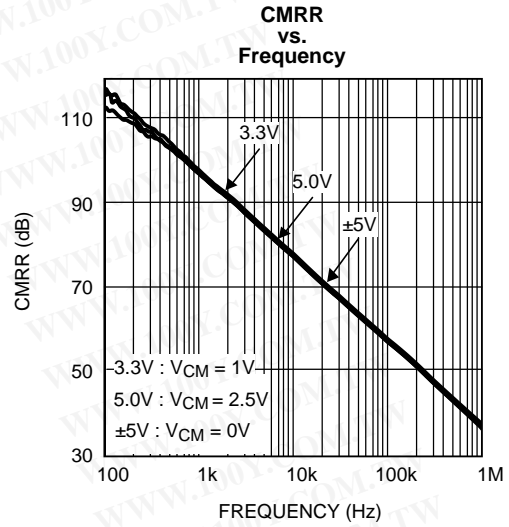


Figure 25.

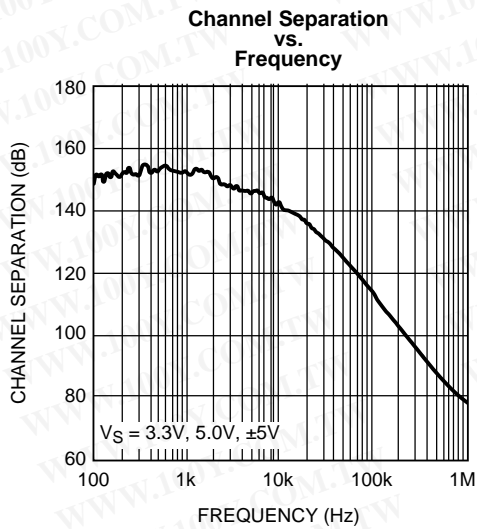


Figure 26.

**Large Signal Step Response with Gain = 1**

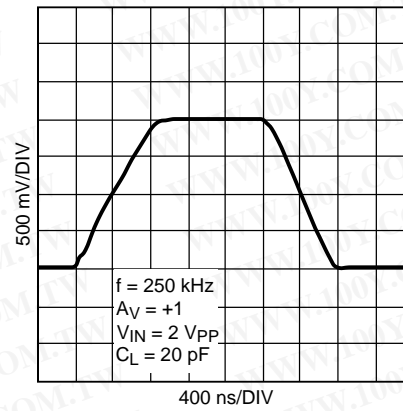


Figure 27.

**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

At  $T_A = 25^\circ\text{C}$ ,  $R_L = 10\text{k}\Omega$ ,  $V_S = 5\text{V}$ . Unless otherwise specified.

**Large Signal Step Response with Gain = 10**

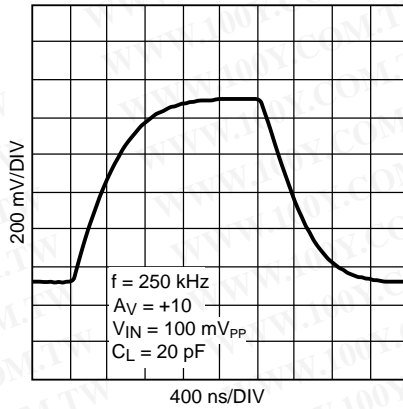


Figure 28.

**Small Signal Step Response with Gain = 1**

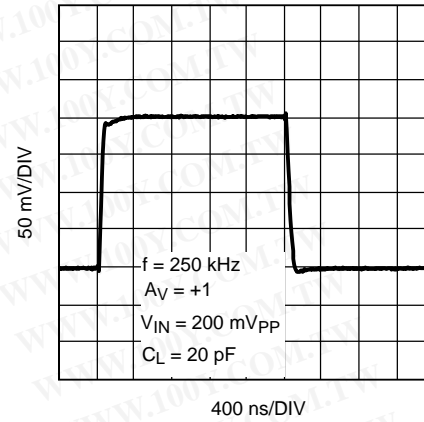


Figure 29.

**Small Signal Step Response with Gain = 10**

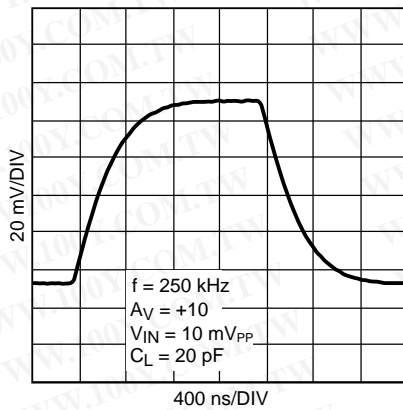


Figure 30.

**Slew Rate vs Supply Voltage**

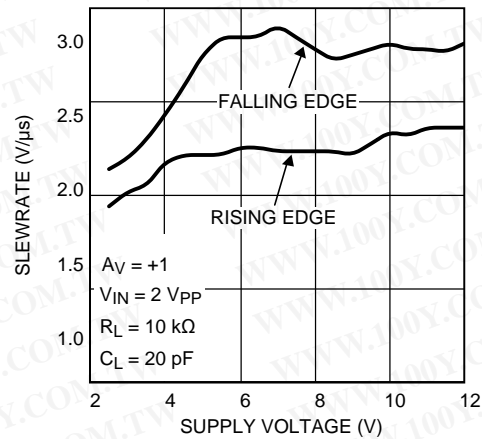


Figure 31.

**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

At  $T_A = 25^\circ\text{C}$ ,  $R_L = 10\text{k}\Omega$ ,  $V_S = 5\text{V}$ . Unless otherwise specified.

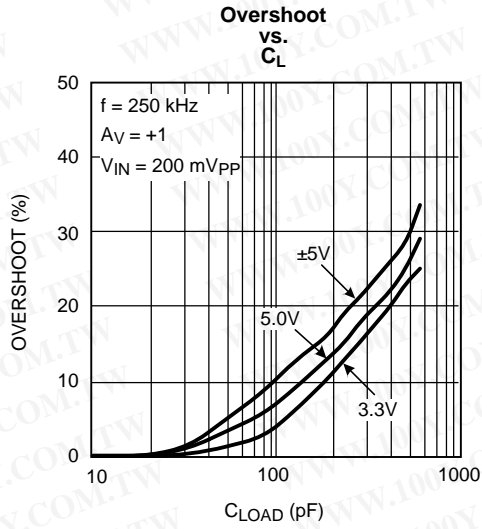


Figure 32.

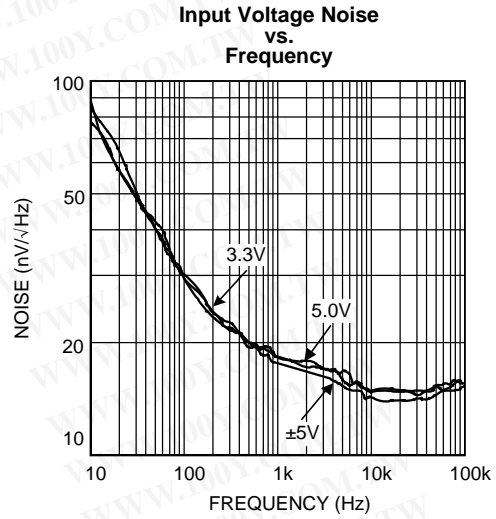


Figure 33.

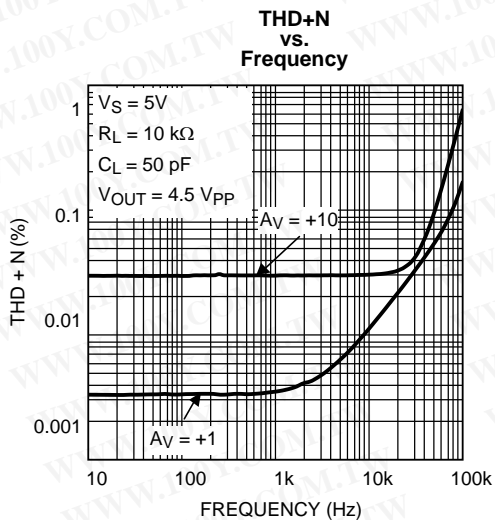


Figure 34.

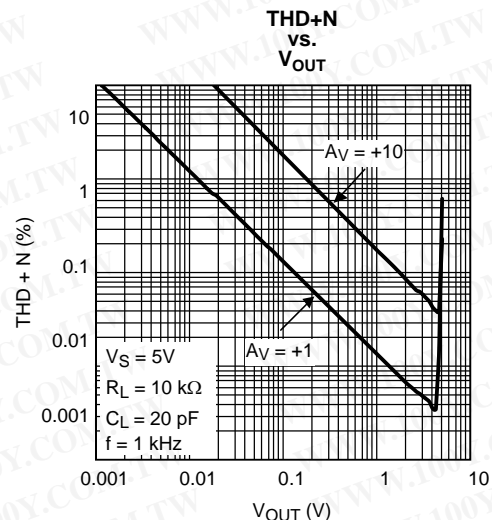


Figure 35.

**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

At  $T_A = 25^\circ\text{C}$ ,  $R_L = 10\text{k}\Omega$ ,  $V_S = 5\text{V}$ . Unless otherwise specified.

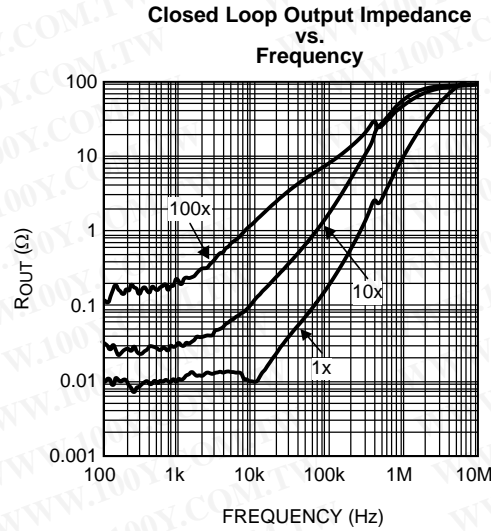


Figure 36.



## APPLICATION INFORMATION

### INTRODUCTION

The LMV841/LMV842/LMV844 are operational amplifiers with near-precision specifications: low noise, low temperature drift, low offset, and rail-to-rail input and output. Possible application areas include instrumentation, medical, test equipment, audio, and automotive applications.

Its low supply current of 1mA per amplifier, temperature range of  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ , 12V supply with CMOS input, and the small SC70 package for the LMV841 make the LMV841/LMV842/LMV844 a unique op amp family and a perfect choice for portable electronics.

### INPUT PROTECTION

The LMV841/LMV842/LMV844 have a set of anti-parallel diodes  $D_1$  and  $D_2$  between the input pins, as shown in Figure 37. These diodes are present to protect the input stage of the amplifier. At the same time, they limit the amount of differential input voltage that is allowed on the input pins.

A differential signal larger than one diode voltage drop can damage the diodes. The differential signal between the inputs needs to be limited to  $\pm 300\text{mV}$  or the input current needs to be limited to  $\pm 10\text{mA}$ .

Note that when the op amp is slewing, a differential input voltage exists that forward biases the protection diodes. This may result in current being drawn from the signal source. While this current is already limited by the internal resistors  $R_1$  and  $R_2$  (both  $130\Omega$ ), a resistor of  $1\text{k}\Omega$  can be placed in the feedback path, or a  $500\Omega$  resistor can be placed in series with the input signal for further limitation.

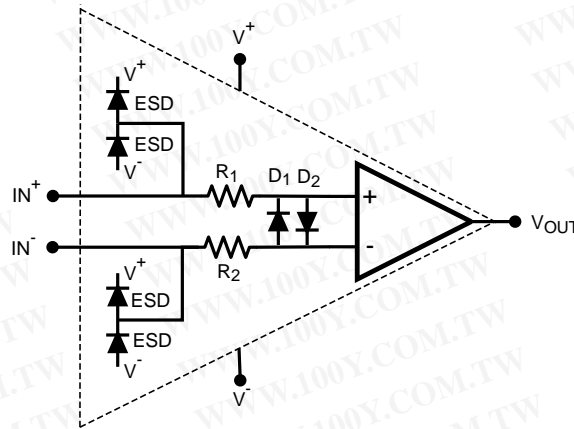


Figure 37. Protection Diodes between the Input Pins

### INPUT STAGE

The input stage of this amplifier consists of both a PMOS and an NMOS input pair to achieve a rail-to-rail input range. For input voltages close to the negative rail, only the PMOS pair is active. Close to the positive rail, only the NMOS pair is active. In a transition region that extends from approximately 2V below  $V^+$  to 1V below  $V^+$ , both pairs are active, and one pair gradually takes over from the other. In this transition region, the input-referred offset voltage changes from the offset voltage associated with the PMOS pair to that of the NMOS pair. The input pairs are trimmed independently to guarantee an input offset voltage of less than 0.5 mV at room temperature over the complete rail-to-rail input range. This also significantly improves the CMRR of the amplifier in the transition region. Note that the CMRR and PSRR limits in the tables are large-signal numbers that express the maximum variation of the amplifier's input offset over the full common-mode voltage and supply voltage range, respectively. When the amplifier's common-mode input voltage is within the transition region, the small signal CMRR and PSRR may be slightly lower than the large signal limits.

## CAPACITIVE LOAD

The LMV841/LMV842/LMV844 can be connected as non-inverting unity gain amplifiers. This configuration is the most sensitive to capacitive loading. The combination of a capacitive load placed on the output of an amplifier along with the amplifier's output impedance creates a phase lag, which reduces the phase margin of the amplifier. If the phase margin is significantly reduced, the response will be under-damped which causes peaking in the transfer and, when there is too much peaking, the op amp might start oscillating.

The LMV841/LMV842/LMV844 can directly drive capacitive loads up to 100pF without any stability issues. In order to drive heavier capacitive loads, an isolation resistor,  $R_{ISO}$ , should be used, as shown in Figure 38. By using this isolation resistor, the capacitive load is isolated from the amplifier's output, and hence, the pole caused by  $C_L$  is no longer in the feedback loop. The larger the value of  $R_{ISO}$ , the more stable the output voltage will be. If values of  $R_{ISO}$  are sufficiently large, the feedback loop will be stable, independent of the value of  $C_L$ . However, larger values of  $R_{ISO}$  result in reduced output swing and reduced output current drive.

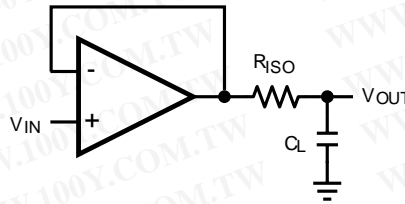


Figure 38. Isolating Capacitive Load

## DECOUPLING AND LAYOUT

For decoupling the supply lines it is suggested that 10nF capacitors be placed as close as possible to the op amp.

For single supply, place a capacitor between  $V^+$  and  $V^-$ . For dual supplies, place one capacitor between  $V^+$  and the board ground, and the second capacitor between ground and  $V^-$ .

## OP AMP CIRCUIT NOISE

The LMV841/LMV842/LMV844 have good noise specifications, and will frequently be used in low-noise applications. Therefore it is important to determine the noise of the total circuit. Besides the input referred noise of the op amp, the feedback resistors may have an important contribution to the total noise.

For applications with a voltage input configuration it is, in general, beneficial to keep the resistor values low. In these configurations high resistor values mean high noise levels. However, using low resistor values will increase the power consumption of the application. This is not always acceptable for portable applications, so there is a trade-off between noise level and power consumption.

Besides the noise contribution of the signal source, three types of noise need to be taken into account for calculating the noise performance of an op amp circuit:

- Input referred voltage noise of the op amp
- Input referred current noise of the op amp
- Noise sources of the resistors in the feedback network, configuring the op amp

To calculate the noise voltage at the output of the op amp, the first step is to determine a total equivalent noise source. This requires the transformation of all noise sources to the same reference node. A convenient choice for this node is the input of the op amp circuit. The next step is to add all the noise sources. The final step is to multiply the total equivalent input voltage noise with the gain of the op amp configuration.

The input referred voltage noise of the op amp is already located at the input, we can use the input referred voltage noise without further transferring. The input referred current noise needs to be converted to an input referred voltage noise. The current noise is negligibly small, as long as the equivalent resistance is not unrealistically large, so we can leave the current noise out for these examples. That leaves us with the noise sources of the resistors, being the thermal noise voltage. The influence of the resistors on the total noise can be seen in the following examples, one with high resistor values and one with low resistor values. Both examples describe an op amp configuration with a gain of 101 which will give the circuit a bandwidth of 44.5kHz. The op amp noise is the same for both cases, i.e. an input referred noise voltage of  $20\text{nV}/\sqrt{\text{Hz}}$  and a negligibly small input referred noise current.

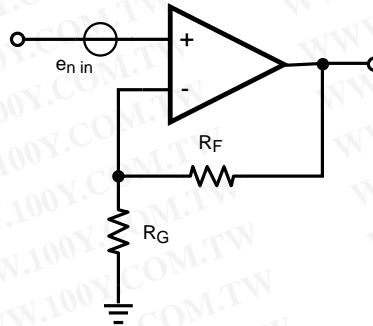


Figure 39. Noise Circuit

To calculate the noise of the resistors in the feedback network, the equivalent input referred noise resistance is needed. For the example in Figure 39, this equivalent resistance  $R_{eq}$  can be calculated using the following equation:

$$R_{eq} = \frac{R_F \times R_G}{R_F + R_G} \quad (1)$$

The voltage noise of the equivalent resistance can be calculated using the following equation:

$$e_{nr} = \sqrt{4kTR_{eq}} \quad (2)$$

where:

$e_{nr}$  = thermal noise voltage of the equivalent resistor

$R_{eq}$  (V/ $\sqrt{\text{Hz}}$ )

$k$  = Boltzmann constant ( $1.38 \times 10^{-23}$  J/K)

$T$  = absolute temperature (K)

$R_{eq}$  = resistance ( $\Omega$ )

The total equivalent input voltage noise is given by the equation:

$$e_{n\text{ in}} = \sqrt{e_{nv}^2 + e_{nr}^2} \quad (3)$$

where:

$e_{n\text{ in}}$  = total input equivalent voltage noise of the circuit

$e_{nv}$  = input voltage noise of the op amp

The final step is multiplying the total input voltage noise by the noise gain, which is in this case the gain of the op amp configuration:

$$e_{n\text{ out}} = e_{n\text{ in}} \times A_{\text{noise}} \quad (4)$$

The equivalent resistance for the first example with a resistor  $R_F$  of 10M $\Omega$  and a resistor  $R_G$  of 100k $\Omega$  at 25°C (298 K) equals:

$$R_{eq} = \frac{R_F \times R_G}{R_F + R_G} = \frac{10 \text{ M}\Omega \times 100 \text{ k}\Omega}{10 \text{ M}\Omega + 100 \text{ k}\Omega} = 99 \text{ k}\Omega \quad (5)$$

Now the noise of the resistors can be calculated, yielding:

$$\begin{aligned} e_{nr} &= \sqrt{4kTR_{eq}} \\ &= \sqrt{4 \times 1.38 \times 10^{-23} \text{ J/K} \times 298\text{K} \times 99 \text{ k}\Omega} \\ &= 40 \text{ nV}/\sqrt{\text{Hz}} \end{aligned} \quad (6)$$

The total noise at the input of the op amp is:

$$\begin{aligned} e_{n \text{ in}} &= \sqrt{e_{nv}^2 + e_{nr}^2} \\ &= \sqrt{(20 \text{ nV}/\sqrt{\text{Hz}})^2 + (40 \text{ nV}/\sqrt{\text{Hz}})^2} = 45 \text{ nV}/\sqrt{\text{Hz}} \end{aligned} \quad (7)$$

For the first example, this input noise will, multiplied with the noise gain, give a total output noise of:

$$\begin{aligned} e_{n \text{ out}} &= e_{n \text{ in}} \times A_{\text{noise}} \\ &= 45 \text{ nV}/\sqrt{\text{Hz}} \times 101 = 4.5 \text{ }\mu\text{V}/\sqrt{\text{Hz}} \end{aligned} \quad (8)$$

In the second example, with a resistor  $R_F$  of 10k $\Omega$  and a resistor  $R_G$  of 100 $\Omega$  at 25°C (298K), the equivalent resistance equals:

$$R_{eq} = \frac{R_F \times R_G}{R_F + R_G} = \frac{10 \text{ k}\Omega \times 100\Omega}{10 \text{ k}\Omega + 100\Omega} = 99\Omega \quad (9)$$

The resistor noise for the second example is:

$$\begin{aligned} e_{nr} &= \sqrt{4kTR_{eq}} \\ &= \sqrt{4 \times 1.38 \times 10^{-23} \text{ J/K} \times 298\text{K} \times 99\Omega} \\ &= 1 \text{ nV}/\sqrt{\text{Hz}} \end{aligned} \quad (10)$$

The total noise at the input of the op amp is:

$$\begin{aligned} e_{n \text{ in}} &= \sqrt{e_{nv}^2 + e_{nr}^2} \\ &= \sqrt{(20 \text{ nV}/\sqrt{\text{Hz}})^2 + (1 \text{ nV}/\sqrt{\text{Hz}})^2} \\ &= 20 \text{ nV}/\sqrt{\text{Hz}} \end{aligned} \quad (11)$$

For the second example the input noise will, multiplied with the noise gain, give an output noise of

$$\begin{aligned} e_{n \text{ out}} &= e_{n \text{ in}} \times A_{\text{noise}} \\ &= 20 \text{ nV}/\sqrt{\text{Hz}} \times 101 = 2 \text{ }\mu\text{V}/\sqrt{\text{Hz}} \end{aligned} \quad (12)$$

In the first example the noise is dominated by the resistor noise due to the very high resistor values, in the second example the very low resistor values add only a negligible contribution to the noise and now the dominating factor is the op amp itself. When selecting the resistor values, it is important to choose values that don't add extra noise to the application. Choosing values above 100k $\Omega$  may increase the noise too much. Low values will keep the noise within acceptable levels; choosing very low values however, will not make the noise even lower, but will increase the current of the circuit.

## ACTIVE FILTER

The rail-to-rail input and output of the LMV841/LMV842/LMV844 and the wide supply voltage range make these amplifiers ideal to use in numerous applications. One of the typical applications is an active filter as shown in Figure 40. This example is a band-pass filter, for which the pass band is widened. This is achieved by cascading two band-pass filters, with slightly different center frequencies.

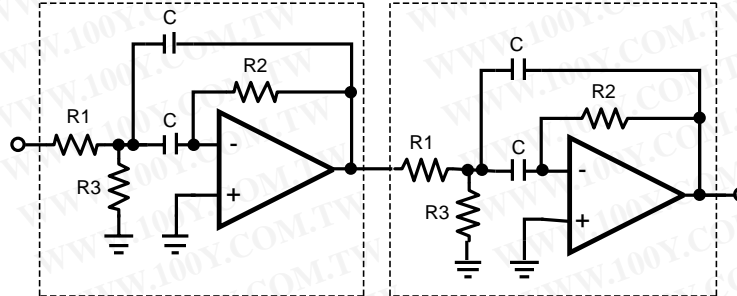


Figure 40. Active Filter

The center frequency of the separate band-pass filters can be calculated by:

$$f_{\text{mid}} = \frac{1}{2\pi C} \sqrt{\frac{R_1 + R_3}{R_1 R_2 R_3}} \quad (13)$$

In this example a filter was designed with its pass band at 10kHz. The two separate band-pass filters are designed to have a center frequency of approximately 10% from the frequency of the total filter:

$$C = 33\text{nF} \quad R_1 = 2\text{k}\Omega \quad R_2 = 6.2\text{k}\Omega \quad R_3 = 45\Omega \quad (14)$$

This will give for filter A:

$$f_{\text{mid}} = \frac{1}{\pi \times 33 \text{ nF}} \sqrt{\frac{2 \text{ k}\Omega + 6.2 \text{ k}\Omega}{2 \text{ k}\Omega \times 6.2 \text{ k}\Omega \times 45\Omega}} = 9.2 \text{ kHz} \quad (15)$$

and for filter B with  $C = 27\text{nF}$ :

$$f_{\text{mid}} = \frac{1}{\pi \times 27 \text{ nF}} \sqrt{\frac{2 \text{ k}\Omega + 6.2 \text{ k}\Omega}{2 \text{ k}\Omega \times 6.2 \text{ k}\Omega \times 45\Omega}} = 11.2 \text{ kHz} \quad (16)$$

Bandwidth can be calculated by:

$$B = \frac{1}{\pi R_2 C} \quad (17)$$

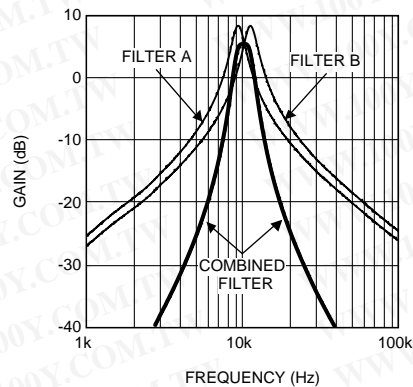
For filter A this will give:

$$B = \frac{1}{\pi \times 6.2 \text{ k}\Omega \times 33 \text{ nF}} = 1.6 \text{ kHz} \quad (18)$$

and for filter B:

$$B = \frac{1}{\pi \times 6.2 \text{ k}\Omega \times 27 \text{ nF}} = 1.9 \text{ kHz} \quad (19)$$

The response of the two filters and the combined filter is shown in Figure 41.



**Figure 41. Active Filter Curve**

The responses of filter A and filter B are shown as the thin lines in Figure 41; the response of the combined filter is shown as the thick line. Shifting the center frequencies of the separate filters farther apart, will result in a wider band; however, positioning the center frequencies too far apart will result in a less flat gain within the band. For wider bands more band-pass filters can be cascaded.

Tip: Use the WEBENCH internet tools at [www.ti.com](http://www.ti.com) for your filter application.

## HIGH-SIDE CURRENT SENSING

The rail-to-rail input and the low  $V_{OS}$  features make the LMV841/LMV842/LMV844 ideal op amps for high-side current sensing applications.

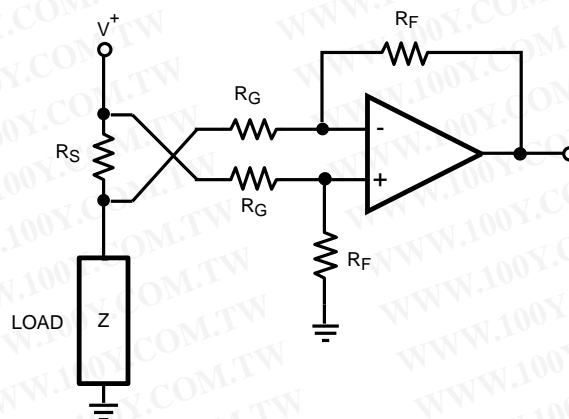
To measure a current, a sense resistor is placed in series with the load, as shown in Figure 42. The current flowing through this sense resistor will result in a voltage drop, that is amplified by the op amp.

Suppose it is necessary to measure a current between 0A and 2A using a sense resistor of 100m $\Omega$ , and convert it to an output voltage of 0 to 5V. A current of 2A flowing through the load and the sense resistor will result in a voltage of 200mV across the sense resistor. The op amp will amplify this 200mV to fit the current range to the output voltage range. Use the formula:

$$V_{OUT} = R_F/R_G * V_{SENSE} \quad (20)$$

to calculate the gain needed. For a load current of 2A and an output voltage of 5V the gain would be  $V_{OUT} / V_{SENSE} = 25$ .

If the feedback resistor,  $R_F$ , is 100k $\Omega$ , then the value for  $R_G$  will be 4k $\Omega$ . The tolerance of the resistors has to be low to obtain a good common-mode rejection.



**Figure 42. High-Side Current Sensing**

## HIGH IMPEDANCE SENSOR INTERFACE

With CMOS inputs, the LMV841/LMV842/LMV844 are particularly suited to be used as high impedance sensor interfaces.

Many sensors have high source impedances that may range up to 10MΩ. The input bias current of an amplifier will load the output of the sensor, and thus cause a voltage drop across the source resistance, as shown in Figure 43. When an op amp is selected with a relatively high input bias current, this error may be unacceptable.

The low input current of the LMV841/LMV842/LMV844 significantly reduces such errors. The following examples show the difference between a standard op amp input and the CMOS input of the LMV841/LMV842/LMV844.

The voltage at the input of the op amp can be calculated with

$$V_{IN+} = V_S - I_B * R_S \quad (21)$$

For a standard op amp the input bias  $I_B$  can be 10nA. When the sensor generates a signal of 1V ( $V_S$ ) and the sensor's impedance is 10MΩ ( $R_S$ ), the signal at the op amp input will be

$$V_{IN} = 1V - 10nA * 10M\Omega = 1V - 0.1V = 0.9V \quad (22)$$

For the CMOS input of the LMV841/LMV842/LMV844, which has an input bias current of only 0.3pA, this would give

$$V_{IN} = 1V - 0.3pA * 10M\Omega = 1V - 3\mu V = 0.999997V \quad (23)$$

The conclusion is that a standard op amp, with its high input bias current input, is not a good choice for use in impedance sensor applications. The LMV841/LMV842/LMV844, in contrast, are much more suitable due to the low input bias current. The error is negligibly small; therefore, the LMV841/LMV842/LMV844 are a must for use with high impedance sensors.

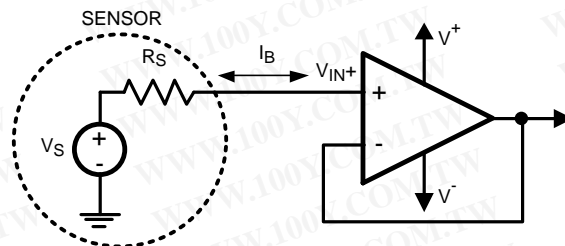


Figure 43. High Impedance Sensor Interface

## THERMOCOUPLE AMPLIFIER

The following is a typical example for a thermocouple amplifier application using an LMV841, LMV842, or LMV844. A thermocouple senses a temperature and converts it into a voltage. This signal is then amplified by the LMV841, LMV842, or LMV844. An ADC can then convert the amplified signal to a digital signal. For further processing the digital signal can be processed by a microprocessor, and can be used to display or log the temperature, or the temperature data can be used in a fabrication process.

### Characteristics of a Thermocouple

A thermocouple is a junction of two different metals. These metals produce a small voltage that increases with temperature.

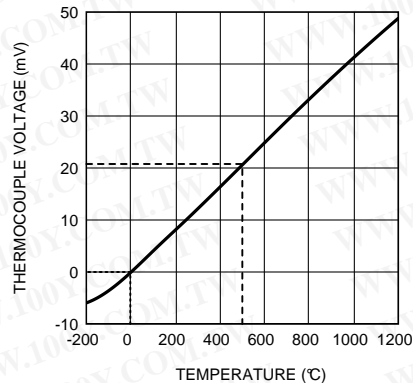
The thermocouple used in this application is a K-type thermocouple. A K-type thermocouple is a junction between Nickel-Chromium and Nickel-Aluminum. This is one of the most commonly used thermocouples. There are several reasons for using the K-type thermocouple. These include temperature range, the linearity, the sensitivity, and the cost.

A K-type thermocouple has a wide temperature range. The range of this thermocouple is from approximately -200°C to approximately 1200°C, as can be seen in Figure 44. This covers the generally used temperature ranges.

Over the main part of the range the behavior is linear. This is important for converting the analog signal to a digital signal.

The K-type thermocouple has good sensitivity when compared to many other types; the sensitivity is 41  $\mu\text{V}/^\circ\text{C}$ . Lower sensitivity requires more gain and makes the application more sensitive to noise.

In addition, a K-type thermocouple is not expensive, many other thermocouples consist of more expensive materials or are more difficult to produce.



**Figure 44. K-Type Thermocouple Response**

### Thermocouple Example

For this example suppose the range of interest is from 0°C to 500°C, and the resolution needed is 0.5°C. The power supply for both the LMV841, LMV842, or LMV844 and the ADC is 3.3V.

The temperature range of 0°C to 500°C results in a voltage range from 0mV to 20.6mV produced by the thermocouple. This is shown in [Figure 44](#).

To obtain the best accuracy the full ADC range of 0 to 3.3V is used and the gain needed for this full range can be calculated as follows:

$$A_V = 3.3\text{V} / 0.0206\text{V} = 160.$$

If  $R_G$  is 2k $\Omega$ , then the value for  $R_F$  can be calculated with this gain of 160. Since  $A_V = R_F / R_G$ ,  $R_F$  can be calculated as follows:

$$R_F = A_V * R_G = 160 * 2\text{k}\Omega = 320\text{k}\Omega$$

To get a resolution of 0.5°C a step smaller than the minimum resolution is needed. This means that at least 1000 steps are necessary (500°C/0.5°C). A 10-bit ADC would be sufficient as this will give 1024 steps. A 10-bit ADC such as the two channel 10-bit ADC102S021 would be a good choice.

### Unwanted Thermocouple Effect

At the point where the thermocouple wires are connected to the circuit, usually copper wires or traces, an unwanted thermocouple effect will occur.

At this connection, this could be the connector on a PCB, the thermocouple wiring forms a second thermocouple with the connector. This second thermocouple disturbs the measurements from the intended thermocouple.

Using an isothermal block as a reference will compensate for this additional thermocouple effect. An isothermal block is a good heat conductor. This means that the two thermocouple connections both have the same temperature. The temperature of the isothermal block can be measured, and thereby the temperature of the thermocouple connections. This is usually called the cold junction reference temperature.

In the example, an LM35 is used to measure this temperature. This semiconductor temperature sensor can accurately measure temperatures from -55°C to 150°C.



The ADC in this example also converts the signal from the LM35 to a digital signal. Now the microprocessor can compensate the amplified thermocouple signal, for the unwanted thermocouple effect.

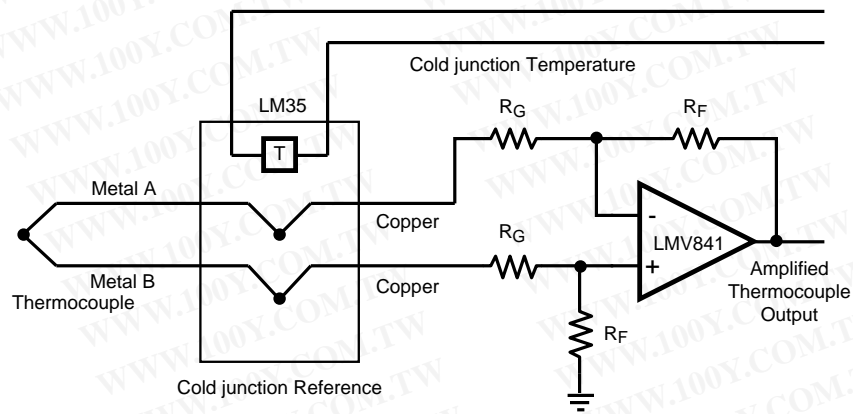


Figure 45. Thermocouple Amplifier

### REVISION HISTORY

#### Changes from Revision F (February 2013) to Revision G

Page

- Changed layout of National Data Sheet to TI format ..... 25

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
LMV841MG/NOPB	ACTIVE	SC70	DCK	5	1000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	A97	<a href="#">Samples</a>
LMV841MGX/NOPB	ACTIVE	SC70	DCK	5	3000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	A97	<a href="#">Samples</a>
LMV841QMG/NOPB	ACTIVE	SC70	DCK	5	1000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	ATA	<a href="#">Samples</a>
LMV841QMGX/NOPB	ACTIVE	SC70	DCK	5	3000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	ATA	<a href="#">Samples</a>
LMV842MA/NOPB	ACTIVE	SOIC	D	8	95	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM		LMV84 2MA	<a href="#">Samples</a>
LMV842MAX/NOPB	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM		LMV84 2MA	<a href="#">Samples</a>
LMV842MM/NOPB	ACTIVE	VSSOP	DGK	8	1000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	AC4A	<a href="#">Samples</a>
LMV842MMX/NOPB	ACTIVE	VSSOP	DGK	8	3500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	AC4A	<a href="#">Samples</a>
LMV842QMA/NOPB	ACTIVE	SOIC	D	8	95	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	LMV84 2QMA	<a href="#">Samples</a>
LMV842QMAX/NOPB	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	LMV84 2QMA	<a href="#">Samples</a>
LMV842QMM/NOPB	ACTIVE	VSSOP	DGK	8	1000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	AA7A	<a href="#">Samples</a>
LMV842QMMX/NOPB	ACTIVE	VSSOP	DGK	8	3500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	AA7A	<a href="#">Samples</a>
LMV844MA/NOPB	ACTIVE	SOIC	D	14	55	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	LMV844MA	<a href="#">Samples</a>
LMV844MAX/NOPB	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	LMV844MA	<a href="#">Samples</a>
LMV844MT/NOPB	ACTIVE	TSSOP	PW	14	94	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	LMV844 MT	<a href="#">Samples</a>
LMV844MTX/NOPB	ACTIVE	TSSOP	PW	14	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	LMV844 MT	<a href="#">Samples</a>
LMV844QMA/NOPB	ACTIVE	SOIC	D	14	55	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	LMV844 QMA	<a href="#">Samples</a>

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
LMV844QMAX/NOPB	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 125	LMV844 QMA	<a href="#">Samples</a>

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) Multiple Top-Side Markings will be inside parentheses. Only one Top-Side Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Top-Side Marking for that device.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**OTHER QUALIFIED VERSIONS OF LMV841, LMV841-Q1, LMV842, LMV842-Q1, LMV844, LMV844-Q1 :**

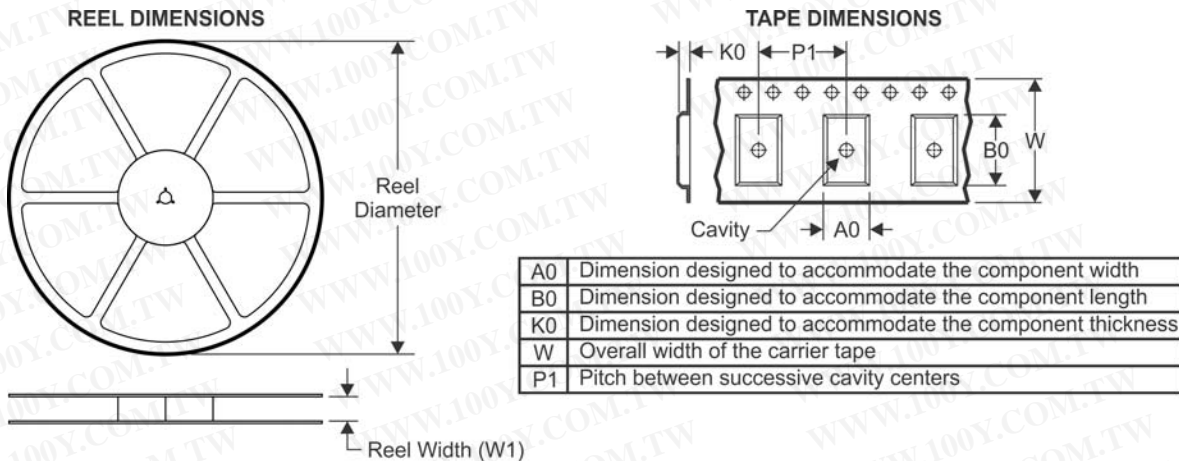
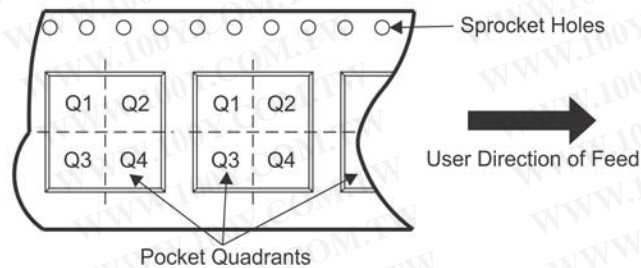
● Catalog: [LMV841](#), [LMV842](#), [LMV844](#)

● Automotive: [LMV841-Q1](#), [LMV842-Q1](#), [LMV844-Q1](#)

---

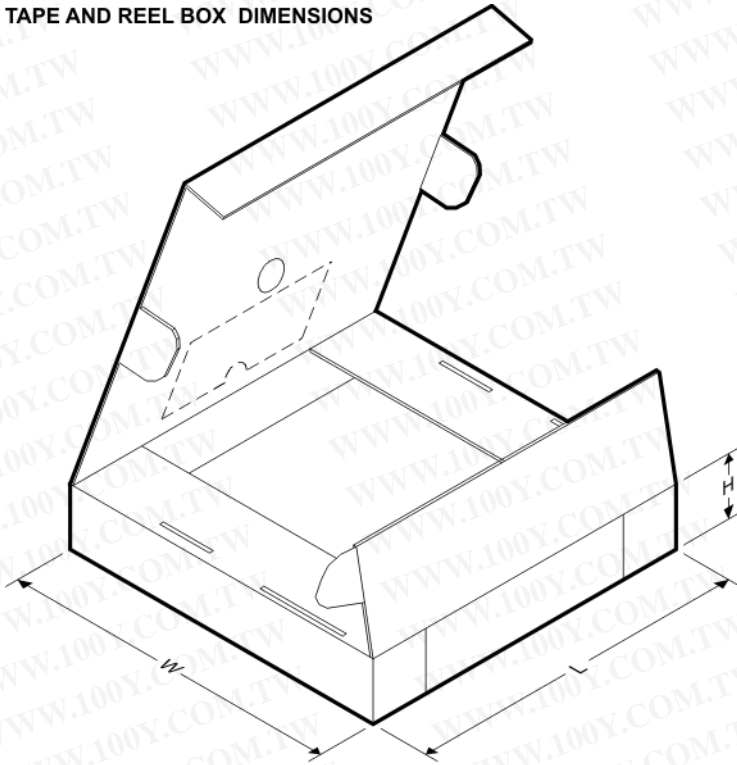
**NOTE: Qualified Version Definitions:**

- Catalog - TI's standard catalog product
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

**TAPE AND REEL INFORMATION**

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LMV841MG/NOPB	SC70	DCK	5	1000	178.0	8.4	2.25	2.45	1.2	4.0	8.0	Q3
LMV841MGX/NOPB	SC70	DCK	5	3000	178.0	8.4	2.25	2.45	1.2	4.0	8.0	Q3
LMV841QMG/NOPB	SC70	DCK	5	1000	178.0	8.4	2.25	2.45	1.2	4.0	8.0	Q3
LMV841QMGX/NOPB	SC70	DCK	5	3000	178.0	8.4	2.25	2.45	1.2	4.0	8.0	Q3
LMV842MAX/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LMV842MM/NOPB	VSSOP	DGK	8	1000	178.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
LMV842MMX/NOPB	VSSOP	DGK	8	3500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
LMV842QMAX/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LMV842QMM/NOPB	VSSOP	DGK	8	1000	178.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
LMV842QMMX/NOPB	VSSOP	DGK	8	3500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
LMV844MAX/NOPB	SOIC	D	14	2500	330.0	16.4	6.5	9.35	2.3	8.0	16.0	Q1
LMV844MTX/NOPB	TSSOP	PW	14	2500	330.0	12.4	6.95	8.3	1.6	8.0	12.0	Q1
LMV844QMAX/NOPB	SOIC	D	14	2500	330.0	16.4	6.5	9.35	2.3	8.0	16.0	Q1

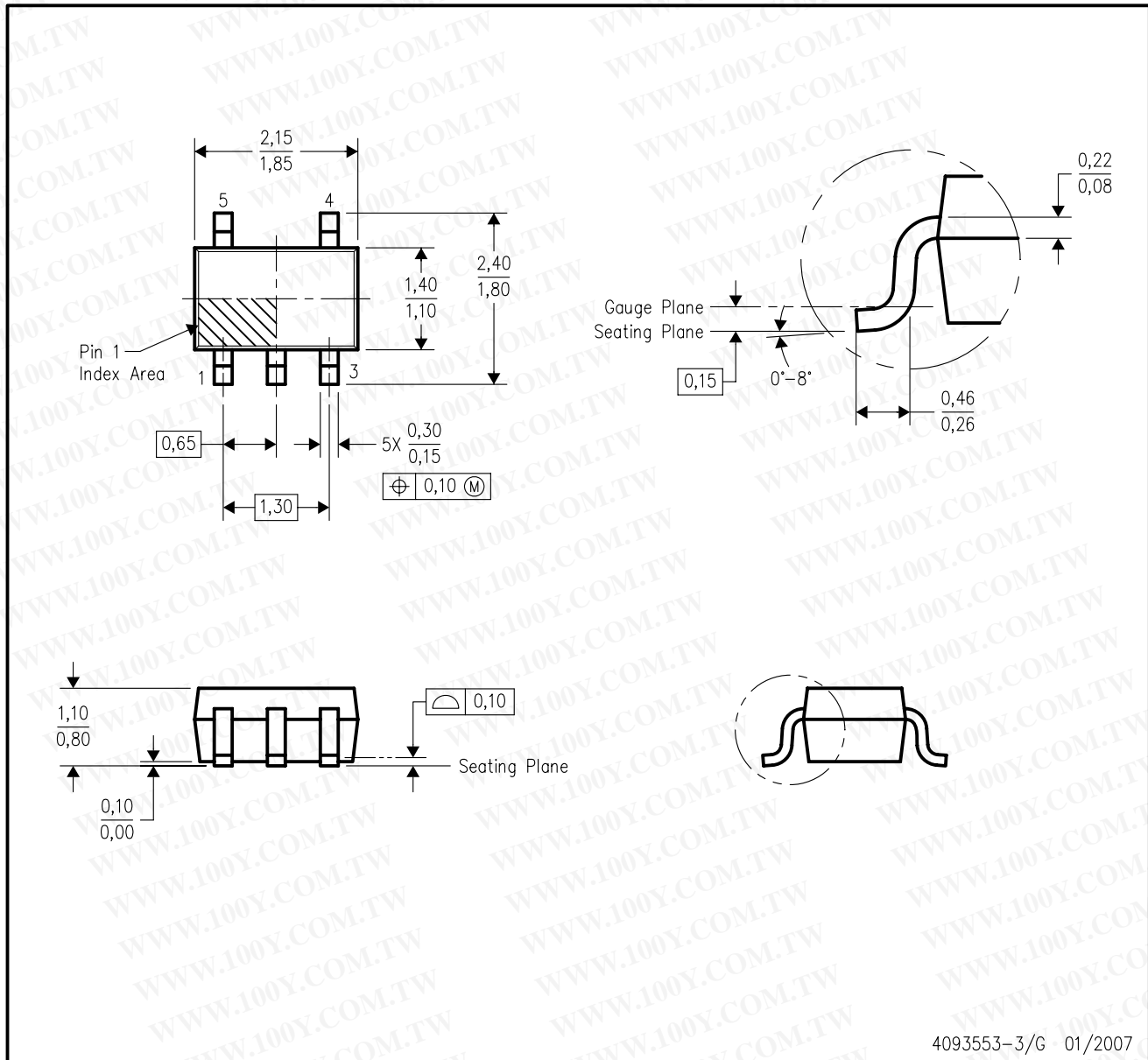
**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LMV841MG/NOPB	SC70	DCK	5	1000	210.0	185.0	35.0
LMV841MGX/NOPB	SC70	DCK	5	3000	210.0	185.0	35.0
LMV841QMG/NOPB	SC70	DCK	5	1000	210.0	185.0	35.0
LMV841QMGX/NOPB	SC70	DCK	5	3000	210.0	185.0	35.0
LMV842MAX/NOPB	SOIC	D	8	2500	367.0	367.0	35.0
LMV842MM/NOPB	VSSOP	DGK	8	1000	210.0	185.0	35.0
LMV842MMX/NOPB	VSSOP	DGK	8	3500	367.0	367.0	35.0
LMV842QMAX/NOPB	SOIC	D	8	2500	367.0	367.0	35.0
LMV842QMM/NOPB	VSSOP	DGK	8	1000	210.0	185.0	35.0
LMV842QMMX/NOPB	VSSOP	DGK	8	3500	367.0	367.0	35.0
LMV844MAX/NOPB	SOIC	D	14	2500	367.0	367.0	35.0
LMV844MTX/NOPB	TSSOP	PW	14	2500	367.0	367.0	35.0
LMV844QMAX/NOPB	SOIC	D	14	2500	367.0	367.0	35.0

## DCK (R-PDSO-G5)

## PLASTIC SMALL-OUTLINE PACKAGE

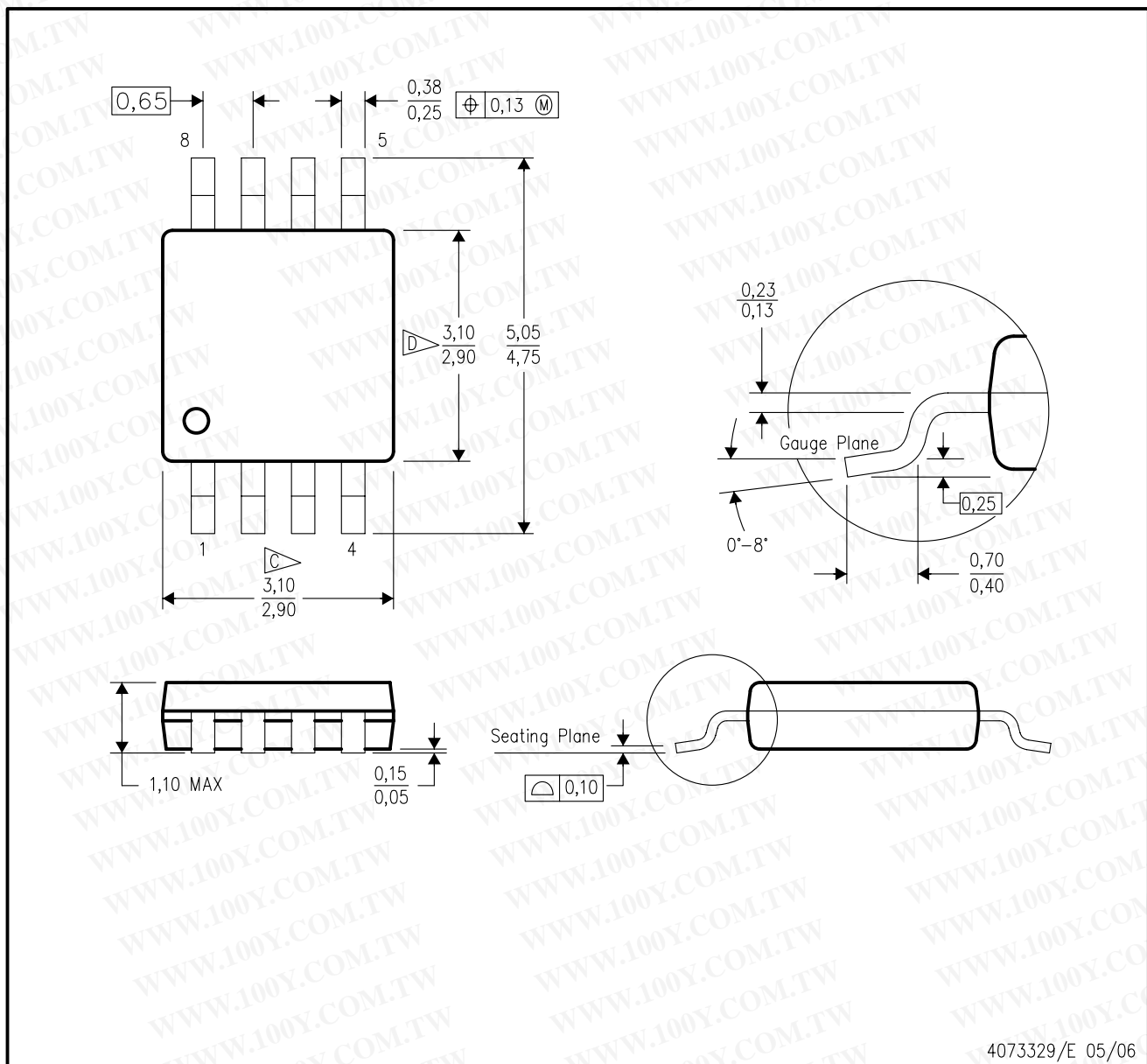


- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
  - Falls within JEDEC MO-203 variation AA.



DGK (S-PDSO-G8)

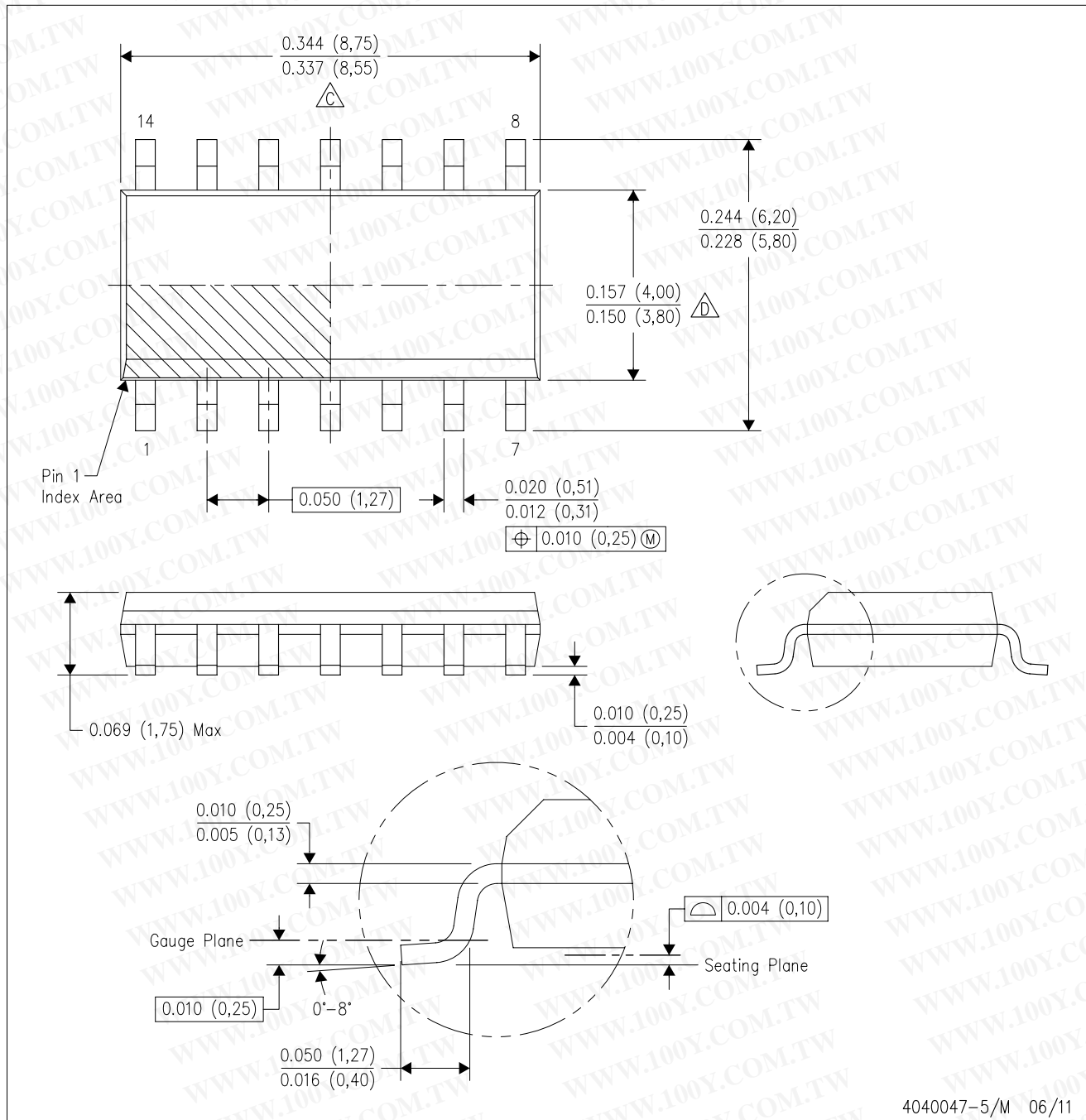
PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 per end.
  - D. Body width does not include interlead flash. Interlead flash shall not exceed 0.50 per side.
  - E. Falls within JEDEC MO-187 variation AA, except interlead flash.

D (R-PDSO-G14)

PLASTIC SMALL OUTLINE



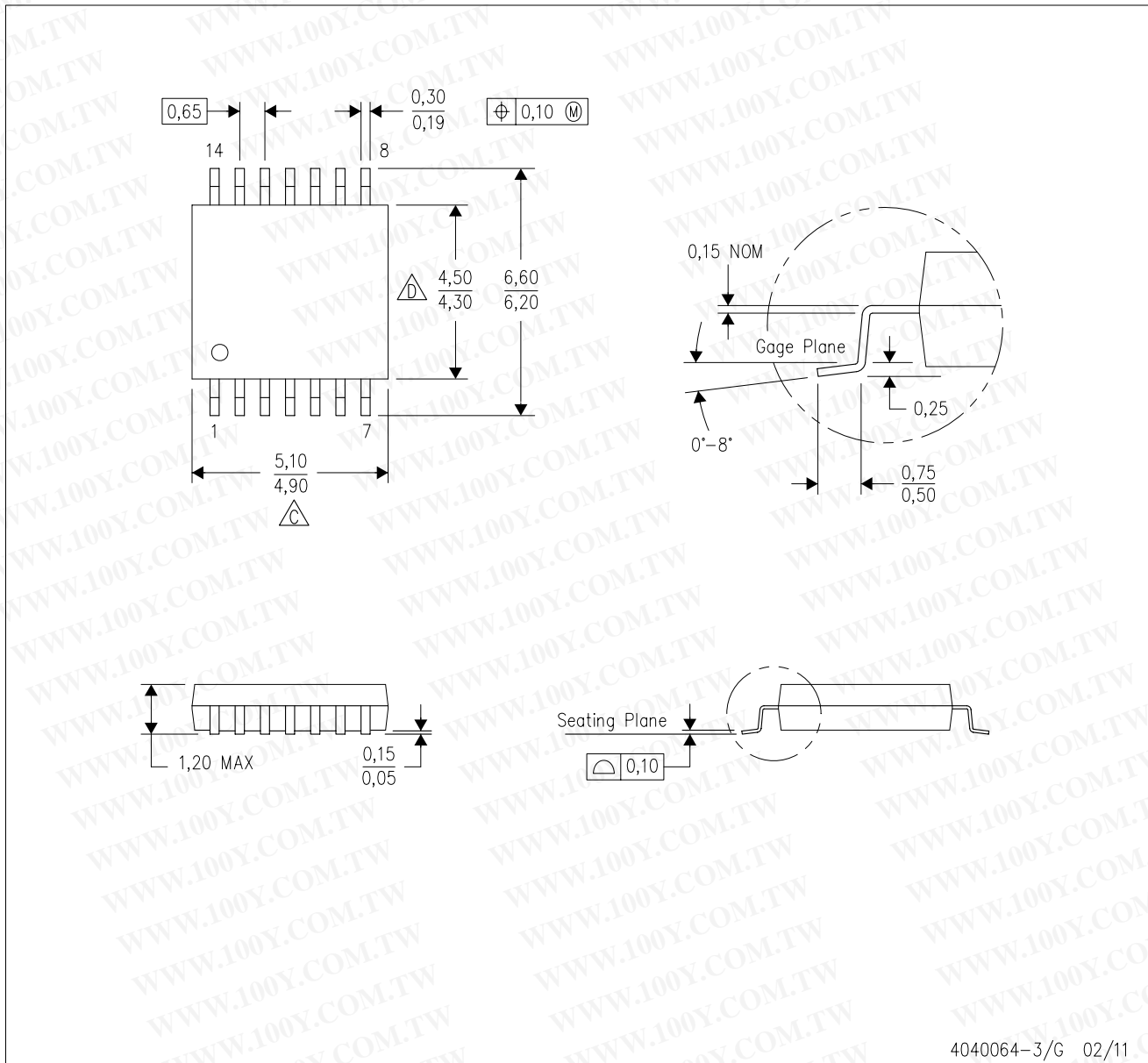
4040047-5/M 06/11

- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - $\triangle C$  Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
  - $\triangle D$  Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
  - E. Reference JEDEC MS-012 variation AB.

# MECHANICAL DATA

PW (R-PDSO-G14)

PLASTIC SMALL OUTLINE

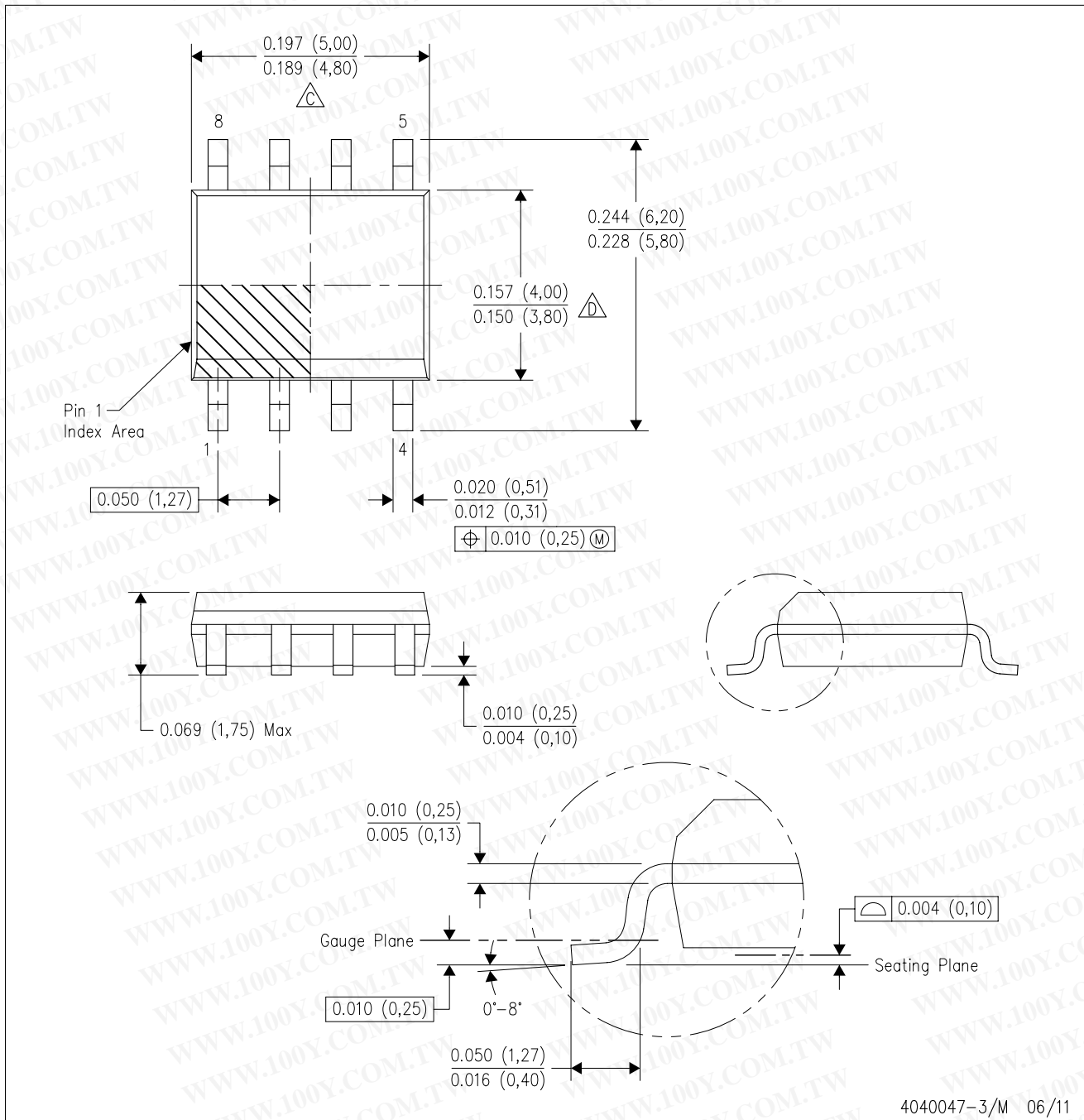


4040064-3/G 02/11



- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
  - B. This drawing is subject to change without notice.
  - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
  - D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
  - E. Falls within JEDEC MO-153

D (R-PDSO-G8)

PLASTIC SMALL OUTLINE



4040047-3/M 06/11

- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  -  Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
  -  Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
  - E. Reference JEDEC MS-012 variation AA.

勝特力材料 886-3-5753170  
勝特力电子(上海) 86-21-34970699  
勝特力电子(深圳) 86-755-83298787  
[Http://www.100y.com.tw](http://www.100y.com.tw)

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

### Products

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Applications Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

Automotive and Transportation	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Energy and Lighting	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Space, Avionics and Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2013, Texas Instruments Incorporated