LMV721-N/LMV722 10MHz, Low Noise, Low Voltage, and Low Power Operational Amplifier

Check for Samples: LMV721-N, LMV722-N

FEATURES

- **(For Typical, 5 V Supply Values; Unless Otherwise Noted)**
- **Ensured 2.2V and 5.0V Performance**
- **Low Supply Current LMV721-N/2 930µA/Amplifier at 2.2V**
- **High Unity-Gain Bandwidth 10MHz**
- **Rail-to-Rail Output Swing**
  - **at 600Ω Load 120mV from Either Rail at 2.2V**
  - **at 2kΩ Load 50mV from Either Rail at 2.2V**
- **Input Common Mode Voltage Range Includes Ground**
- **Silicon Dust, SC70-5 Package 2.0x2.0x1.0 mm**
- **Input Voltage Noise 9 nV/$\sqrt{Hz}$ at f = 1KHz**

APPLICATIONS

- **Cellular an Cordless Phones**
- **Active Filter and Buffers**
- **Laptops and PDAs**
- **Battery Powered Electronics**

DESCRIPTION

The LMV721-N (Single) and LMV722 (Dual) are low noise, low voltage, and low power op amps, that can be designed into a wide range of applications. The LMV721-N/LMV722 has a unity gain bandwidth of 10MHz, a slew rate of 5V/us, and a quiescent current of 930uA/amplifier at 2.2V.

The LMV721-N/722 are designed to provide optimal performance in low voltage and low noise systems. They provide rail-to-rail output swing into heavy loads. The input common-mode voltage range includes ground, and the maximum input offset voltage are 3.5mV (Over Temp) for the LMV721-N/LMV722. Their capacitive load capability is also good at low supply voltages. The operating range is from 2.2V to 5.5V.

The chip is built with TI's advanced Submicron Silicon-Gate BiCMOS process. The single version, LMV721-N, is available in 5 pin SOT-23 and a SC70 (new) package. The dual version, LMV722, is available in an SOIC-8 and VSSOP-8 package.

Typical Application

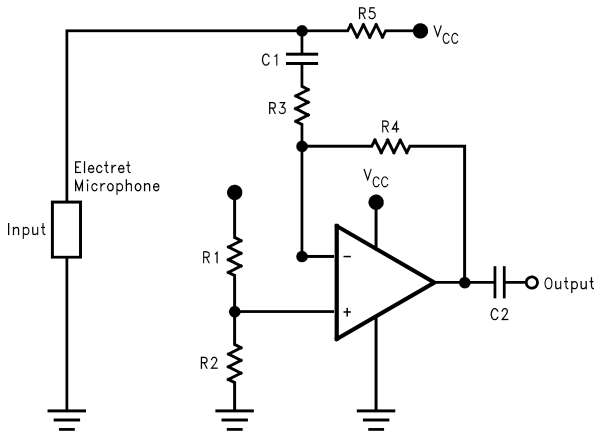

Figure 1. A Battery Powered Microphone Preamplifier

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.

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.

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Absolute Maximum Ratings (1)(2)

ESD Tolerance (3)	
Human Body Model	2000V
Machine Model	100V
Differential Input Voltage	± Supply Voltage
Supply Voltage ($V^+ – V^-$)	6V
Soldering Information	
Infrared or Convection (20 sec.)	235°C
Storage Temp. Range	−65°C to 150°C
Junction Temperature (4)	150°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 ensured. For ensured specifications and the test conditions, see the Electrical Characteristics.
(2) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/ Distributors for availability and specifications.
(3) Human body model, 1.5 kΩ in series with 100 pF. Machine model, 200Ω in series with 100 pF.
(4) The maximum power dissipation is a function of $T_{J(max)}$, θ_{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 into a PC board.

Operating Ratings (1)

Supply Voltage	2.2V to 5.5V
Temperature Range	$−40°C \le T_J \le 85°C$
Thermal Resistance (θ_{JA})	
Silicon Dust SC70-5 Pkg	440°C/W
Tiny SOT-23 package	265 °C/W
SOIC package, 8-pin Surface Mount	190°C/W
VSSOP package, 8-Pin Mini Surface Mount	235 °C/W
SOIC package, 14-Pin Surface Mount	145°C/W

(1) Applies to both single-supply and split-supply operation. Continuous short circuit operation at elevated ambient temperature can result in exceeding the maximum allowed junction temperature of 150°C. Output currents in excess of 30 mA over long term may adversely affect reliability.

2.2V DC Electrical Characteristics

Unless otherwise specified, all limits specified for T_J = 25°C. V^+ = 2.2V, V^- = 0V, $V_{CM} = V^+/2$, $V_O = V^+/2$ and R_L > 1 MΩ. **Boldface** limits apply at the temperature extremes.

Parameter		Test Conditions	Typ (1)	Limit (2)	Units
V_{OS}	Input Offset Voltage		0.02	3 **3.5**	mV max
TCV_{OS}	Input Offset Voltage Average Drift		0.6		µV/°C
I_B	Input Bias Current		260		nA
I_{OS}	Input Offset Current		25		nA
CMRR	Common Mode Rejection Ratio	$0V \le V_{CM} \le 1.3V$	88	70 **64**	dB min
PSRR	Power Supply Rejection Ratio	$2.2V \le V^+ \le 5V$, V_O = 0 V_{CM} = 0	90	70 **64**	dB min
V_{CM}	Input Common-Mode Voltage Range	For CMRR ≥ 50dB	−0.30		V
			1.3		V
A_V	Large Signal Voltage Gain	R_L=600Ω V_O = 0.75V to 2.00V	81	75 **60**	dB min
		R_L= 2kΩ V_O = 0.50V to 2.10V	84	75 **60**	dB min

(1) Typical Values represent the most likely parametric norm.
(2) All limits are specified by testing or statistical analysis.

2.2V DC Electrical Characteristics (continued)

Unless otherwise specified, all limits specified for T_J = 25°C. V^+ = 2.2V, V^- = 0V, V_{CM} = V^+/2, V_O = V^+/2 and R_L > 1 MΩ. **Boldface** limits apply at the temperature extremes.

Parameter		Test Conditions	Typ (1)	Limit (2)	Units
V_O	Output Swing	R_L = 600Ω to V^+/2	2.125	2.090 **2.065**	V min
			0.071	0.120 **0.145**	V max
		R_L = 2kΩ to V^+/2	2.177	2.150 **2.125**	V min
			0.056	0.080 **0.105**	V max
I_O	Output Current	Sourcing, V_O = 0V V_{IN}(diff) = ± 0.5V	14.9	10.0 **5.0**	mA min
		Sinking, V_O = 2.2V V_{IN}(diff) = ± 0.5V	17.6	10.0 **5.0**	mA min
I_S	Supply Current	LMV721-N	0.93	1.2 **1.5**	mA max
		LMV722	1.81	2.2 **2.6**	

2.2V AC Electrical Characteristics

Unless otherwise specified, all limits specified for T_J = 25°C. V^+ = 2.2V, V^- = 0V, V_{CM} = V^+/2, V_O = V^+/2 and R_L > 1 MΩ.**Boldface** limits apply at the temperature extremes.

Parameter		Test Conditions	Typ (1)	Units
SR	Slew Rate	(2)	4.9	V/µs
GBW	Gain-Bandwidth Product		10	MHz
Φ_m	Phase Margin		67.4	Deg
G_m	Gain Margin		−9.8	dB
e_n	Input-Referred Voltage Noise	f = 1 kHz	9	nV/√Hz
i_n	Input-Referred Current Noise	f = 1 kHz	0.3	pA/√Hz
THD	Total Harmonic Distortion	f = 1 kHz A_V = 1 R_L = 600Ω, V_O = 500 mV_{PP}	0.004	%

(1) Typical Values represent the most likely parametric norm.
(2) Connected as voltage follower with 1V step input. Number specified is the slower of the positive and negative slew rate.

5V DC Electrical Characteristics

Unless otherwise specified, all limits specified for T_J = 25°C. V^+ = 5V, V^- = 0V, V_{CM} = V^+/2, V_O = V^+/2 and R_L > 1 MΩ. **Boldface** limits apply at the temperature extremes.

Parameter		Test Conditions	Typ (1)	Limit (2)	Units
V_{OS}	Input Offset Voltage		−0.08	3 **3.5**	mV max
TCV_{OS}	Input Offset Voltage Average Drift		0.6		µV/°C
I_B	Input Bias Current		260		nA
I_{OS}	Input Offset Current		25		nA
CMRR	Common Mode Rejection Ratio	0V ≤ V_{CM} ≤ 4.1V	89	70 **64**	dB min
PSRR	Power Supply Rejection Ratio	2.2V ≤ V^+ ≤ 5.0V, V_O = 0 V_{CM} = 0	90	70 **64**	dB min
V_{CM}	Input Common-Mode Voltage Range	For CMRR ≥ 50dB	−0.30		V
			4.1		V

(1) Typical Values represent the most likely parametric norm.
(2) All limits are specified by testing or statistical analysis.

5V DC Electrical Characteristics (continued)

Unless otherwise specified, all limits specified for T_J = 25°C. V^+ = 5V, V^- = 0V, V_{CM} = V^+/2, V_O = V^+/2 and R_L > 1 MΩ. **Boldface** limits apply at the temperature extremes.

Parameter		Test Conditions	Typ (1)	Limit (2)	Units
A_V	Large Signal Voltage Gain	R_L = 600Ω V_O = 0.75V to 4.80V	87	80 **70**	dB min
		R_L = 2kΩ, V_O = 0.70V to 4.90V,	94	85 **70**	dB min
V_O	Output Swing	R_L = 600Ω to V^+/2	4.882	4.840 **4.815**	V min
			0.134	0.190 **0.215**	V max
		R_L = 2kΩ to V^+/2	4.952	4.930 **4.905**	V min
			0.076	0.110 **0.135**	V max
I_O	Output Current	Sourcing, V_O = 0V V_{IN}(diff) = ±0.5V	52.6	25.0 **12.0**	mA min
		Sinking, V_O = 5V V_{IN}(diff) = ±0.5V	23.7	15.0 **8.5**	mA min
I_S	Supply Current	LMV721-N	1.03	1.4 **1.7**	mA max
		LMV722	2.01	2.4 **2.8**	

5V AC Electrical Characteristics

Unless otherwise specified, all limits specified for T_J = 25°C. V^+ = 5V, V^- = 0V, V_{CM} = V^+/2, V_O = V^+/2 and R_L > 1 MΩ. **Boldface** limits apply at the temperature extremes.

Parameter		Test Conditions	Typ (1)	Units
SR	Slew Rate	(2)	5.25	V/µs
GBW	Gain-Bandwidth Product		10.0	MHz
Φ_m	Phase Margin		72	Deg
G_m	Gain Margin		−11	dB
e_n	Input-Related Voltage Noise	f = 1 kHz	8.5	nV/√Hz
i_n	Input-Referred Current Noise	f = 1 kHz	0.2	pa/√Hz
THD	Total Harmonic Distortion	f = 1kHz, A_V = 1 R_L = 600Ω, V_O = 1 V_{PP}	0.001	%

(1) Typical Values represent the most likely parametric norm.
(2) Connected as voltage follower with 1V step input. Number specified is the slower of the positive and negative slew rate.

Typical Performance Characteristics

Supply Current vs. Supply Voltage (LMV721-N)

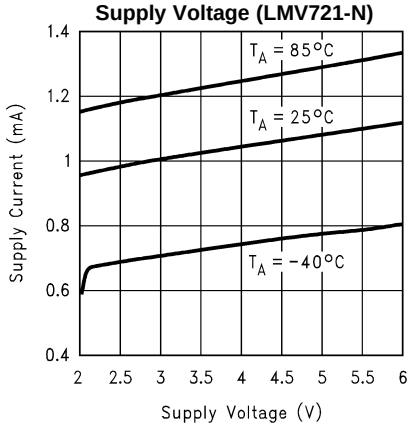


Figure 2.

Sourcing Current vs. Output Voltage (V_S = 2.2V)

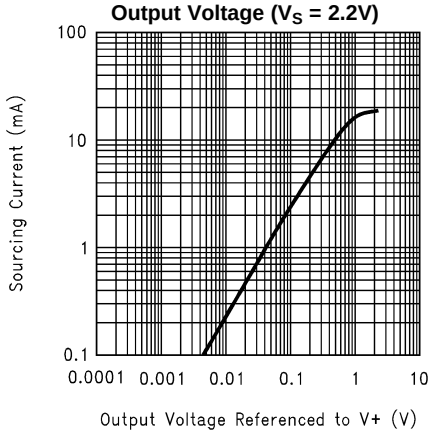


Figure 3.

Sourcing Current vs. Output Voltage (V_S = 5V)

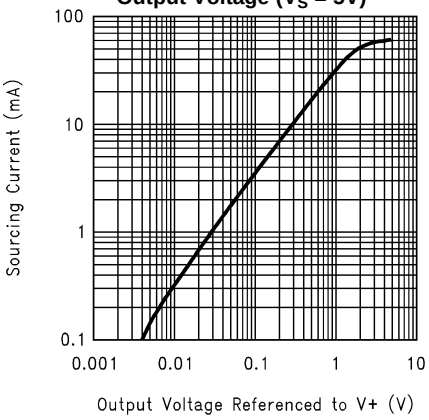


Figure 4.

Sinking Current vs. Output Voltage (V_S = 2.2V)

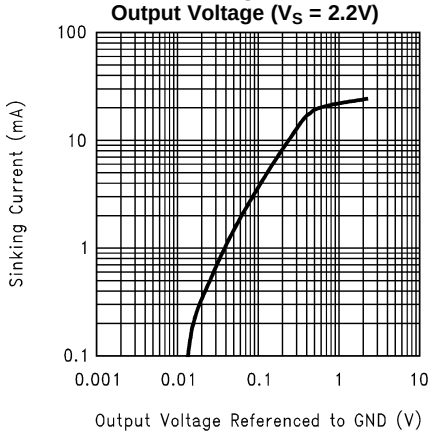


Figure 5.

Sinking Current vs. Output Voltage (V_S = 5V)

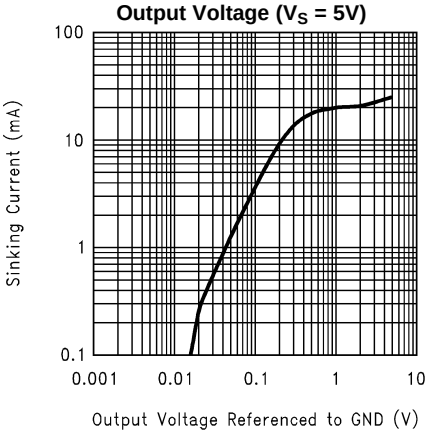


Figure 6.

Output Voltage Swing vs. Supply Voltage (R_L = 600Ω)

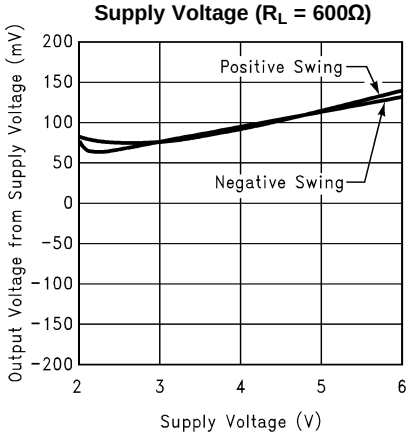


Figure 7.

Typical Performance Characteristics (continued)

Output Voltage Swing vs. Suppy Voltage (R_L = 2kΩ)

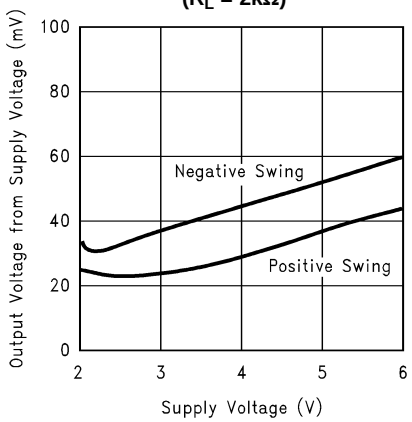


Figure 8.

Input Offset Voltage vs. Input Common-Mode Voltage Range V_S = 2.2V

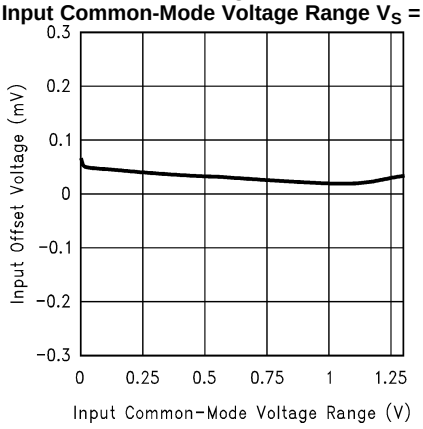


Figure 9.

Input Offset Voltage vs. Input Common-Mode Voltage Range V_S = 5V

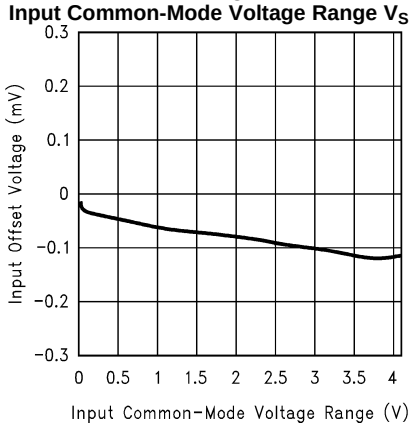


Figure 10.

Input Offset Voltage vs. Supply Voltage (V_{CM} = V^+/2)

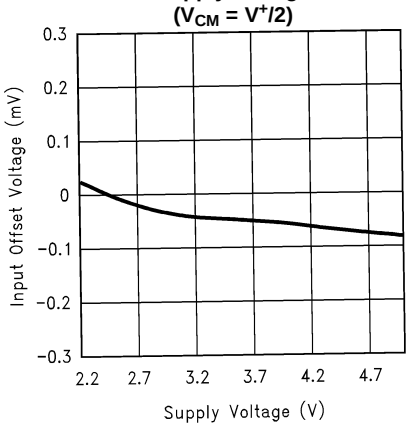


Figure 11.

Input Voltage vs. Output Voltage (V_S = 2.2V, R_L = 2kΩ)

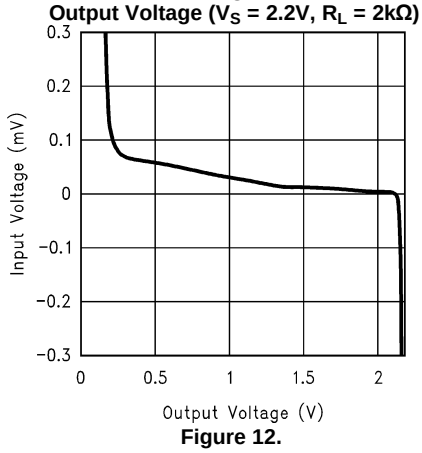


Figure 12.

Input Voltage vs. Output Voltage (V_S = 5V, R_L = 2kΩ)

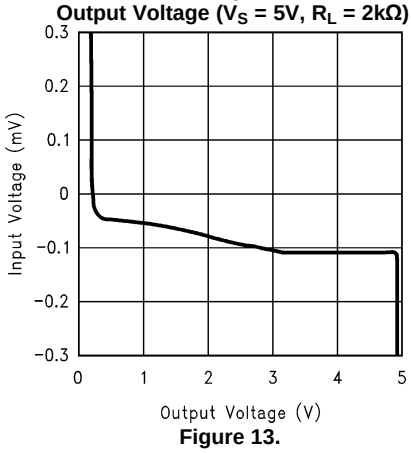


Figure 13.

Typical Performance Characteristics (continued)

Input Voltage Noise vs. Frequency

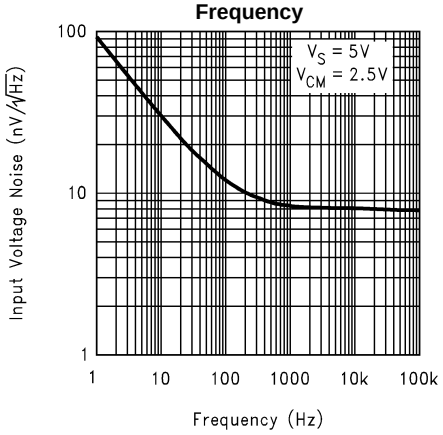


Figure 14.

Input Current Noise vs. Frequency

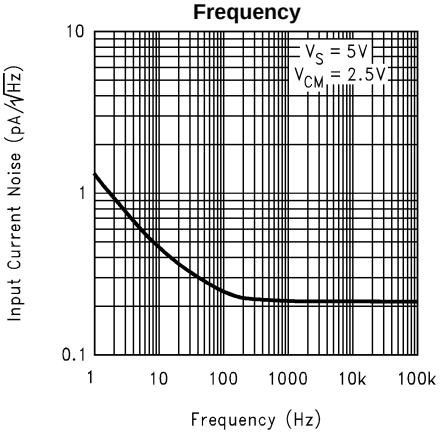


Figure 15.

+PSRR vs. Frequency

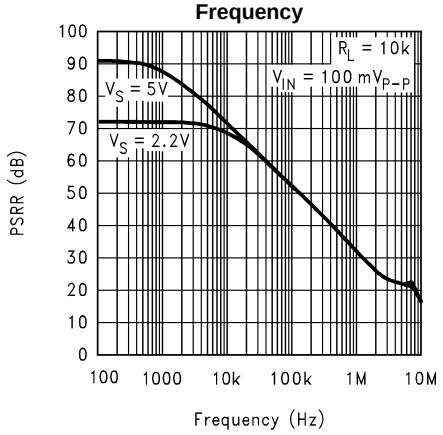


Figure 16.

−PSRR vs. Frequency

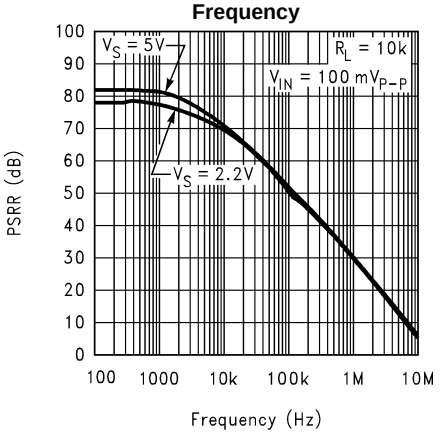


Figure 17.

CMRR vs. Frequency

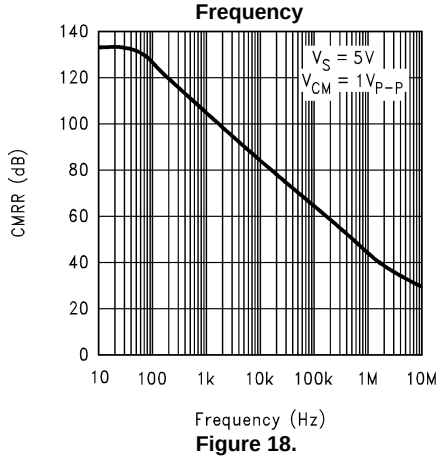


Figure 18.

Gain and Phase Margin vs. Frequency (V_S = 2.2V, R_L 600Ω)

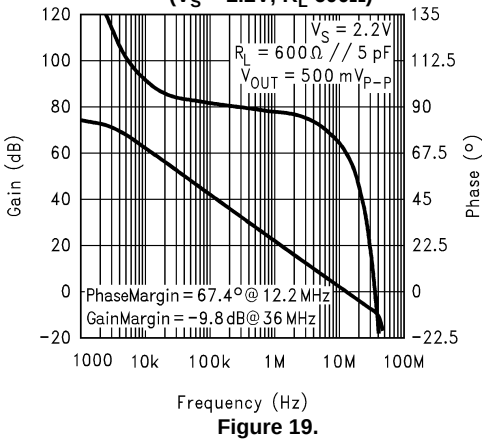


Figure 19.

Typical Performance Characteristics (continued)

Gain and Phase Margin vs. Frequency (V_S = 5V, R_L 600Ω)

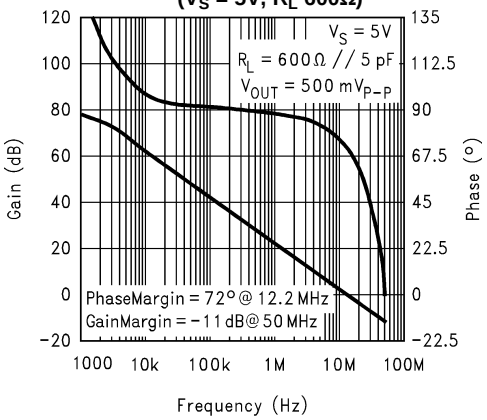


Figure 20.

Slew Rate vs. Supply Voltage

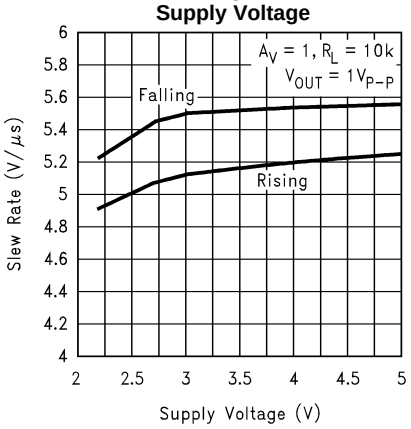


Figure 21.

THD vs. Frequency

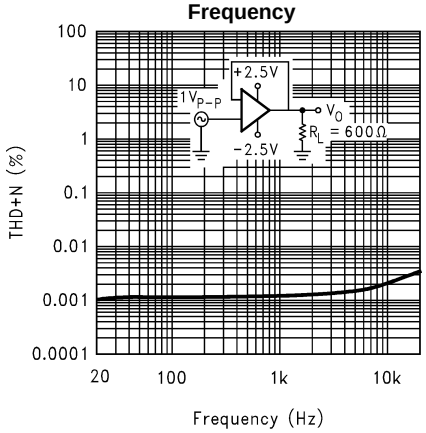


Figure 22.

APPLICATION NOTES

BENEFITS OF THE LMV721-N/722 SIZE

The small footprints of the LMV721-N/722 packages save space on printed circuit boards, and enable the design of smaller electronic products, such as cellular phones, pagers, or other portable systems. The low profile of the LMV721-N/722 make them possible to use in PCMCIA type III cards.

Signal Integrity Signals can pick up noise between the signal source and the amplifier. By using a physically smaller amplifier package, the LMV721-N/722 can be placed closer to the signal source, reducing noise pickup and increasing signal integrity.

Simplified Board Layout These products help you to avoid using long pc traces in your pc board layout. This means that no additional components, such as capacitors and resistors, are needed to filter out the unwanted signals due to the interference between the long pc traces.

Low Supply Current These devices will help you to maximize battery life. They are ideal for battery powered systems.

Low Supply Voltage TI provides ensured performance at 2.2V and 5V. These specifications ensure operation throughout the battery lifetime.

Rail-to-Rail Output Rail-to-rail output swing provides maximum possible dynamic range at the output. This is particularly important when operating on low supply voltages.

Input Includes Ground Allows direct sensing near GND in single supply operation.

Protection should be provided to prevent the input voltages from going negative more than −0.3V (at 25°C). An input clamp diode with a resistor to the IC input terminal can be used.

CAPACITIVE LOAD TOLERANCE

The LMV721-N/722 can directly drive 4700pF in unity-gain without oscillation. The unity-gain follower is the most sensitive configuration to capacitive loading. Direct capacitive loading reduces the phase margin of amplifiers. The combination of the amplifier's output impedance and the capacitive load induces phase lag. This results in either an underdamped pulse response or oscillation. To drive a heavier capacitive load, circuit in Figure 23 can be used.

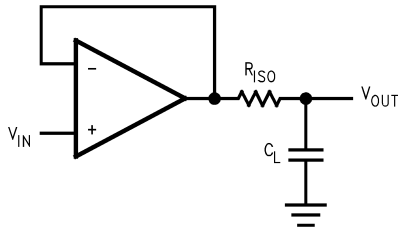


Figure 23. Indirectly Driving A capacitive Load Using Resistive Isolation

In Figure 23, the isolation resistor R_{ISO} and the load capacitor C_L form a pole to increase stability by adding more phase margin to the overall system. the desired performance depends on the value of R_{ISO}. The bigger the R_{ISO} resistor value, the more stable V_{OUT} will be. Figure 24 is an output waveform of Figure 23 using 100kΩ for R_{ISO} and 2000µF for C_L.

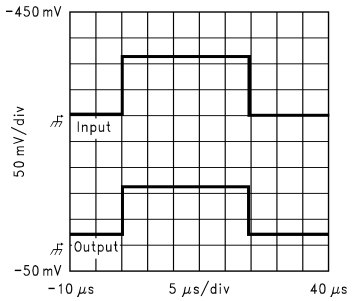


Figure 24. Pulse Response of the LMV721-N Circuit in Figure 23

The circuit in Figure 25 is an improvement to the one in Figure 23 because it provides DC accuracy as well as AC stability. If there were a load resistor in Figure 23, the output would be voltage divided by R_{ISO} and the load resistor. Instead, in Figure 25, R_F provides the DC accuracy by using feed-forward techniques to connect V_{IN} to R_L. Caution is needed in choosing the value of R_F due to the input bias current of the LMV721-N/722. C_F and R_{ISO} serve to counteract the loss of phase margin by feeding the high frequency component of the output signal back to the amplifier's inverting input, thereby preserving phase margin in the overall feedback loop. Increased capacitive drive is possible by increasing the value of C_F. This in turn will slow down the pulse response.

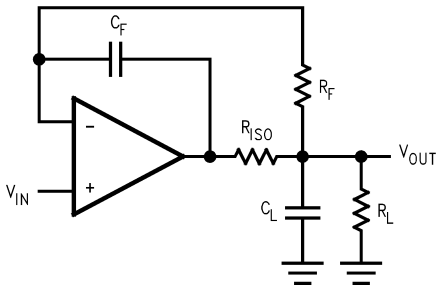


Figure 25. Indirectly Driving A Capacitive Load with DC Accuracy

INPUT BIAS CURRENT CANCELLATION

The LMV721-N/722 family has a bipolar input stage. The typical input bias current of LMV721-N/722 is 260nA with 5V supply. Thus a 100kΩ input resistor will cause 26mV of error voltage. By balancing the resistor values at both inverting and non-inverting inputs, the error caused by the amplifier's input bias current will be reduced. The circuit in Figure 26 shows how to cancel the error caused by input bias current.

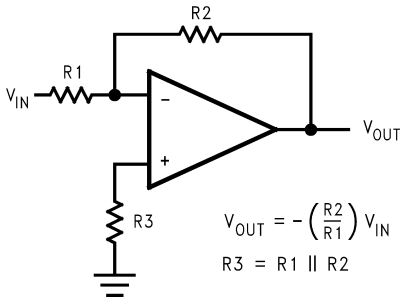


Figure 26. Cancelling the Error Caused by Input Bias Current

TYPICAL SINGLE-SUPPLY APPLICATION CIRCUITS

Difference Amplifier

The difference amplifier allows the subtraction of two voltages or, as a special case, the cancellation of a signal common to two inputs. It is useful as a computational amplifier, in making a differential to single-ended conversion or in rejecting a common mode signal.

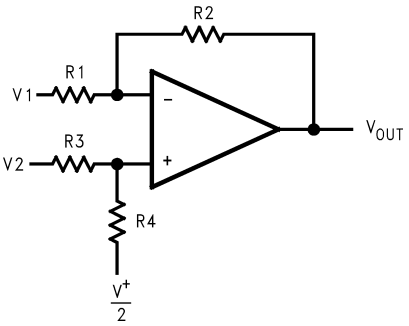


Figure 27. Difference Application

$$V_{OUT} = \left(\frac{R1 + R2}{R3 + R4}\right)\frac{R4}{R1}V_2 - \frac{R2}{R1}V_1 + \left(\frac{R1 + R2}{R3 + R4}\right)\frac{R3}{R1} \bullet \frac{V^+}{2} \quad (1)$$

for R1 = R3 and R2 = R4

$$V_{OUT} = \frac{R2}{R1}\left(V_2 - V_1\right) + \frac{V^+}{2} \quad (2)$$

Instrumentation Circuits

The input impendance of the previous difference amplifier is set by the resistor R_1, R_2, R_3 and R_4. To eliminate the problems of low input impendance, one way is to use a voltage follower ahead of each input as shown in the following two instrumentation amplifiers.

Three-op-amp Instrumentation Amplifier

The LMV721-N/722 can be used to build a three-op-amp instrumentation amplifier as shown in Figure 28

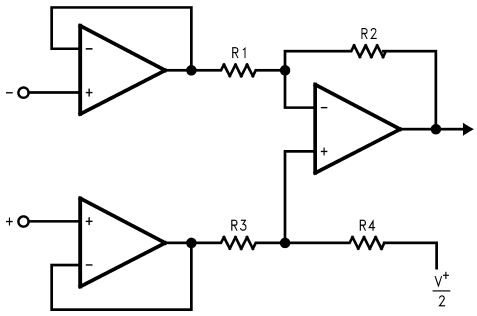


Figure 28. Three-op-amp Instrumentation Amplifier

The first stage of this instrumentation amplifier is a differential-input, differential-output amplifier, with two voltage followers. These two voltage followers assure that the input impedance is over 100MΩ. The gain of this instrumentation amplifier is set by the ratio of R_2/R_1. R_3 should equal R_1 and R_4 equal R_2. Matching of R_3 to R_1 and R_4 to R_2 affects the CMRR. For good CMRR over temperature, low drift resistors should be used. Making R_4 slightly smaller than R_2 and adding a trim pot equal to twice the difference between R_2 and R_4 will allow the CMRR to be adjusted for optimum.

Two-op-amp Instrumentation Amplifier

A two-op-amp instrumentation amplifier can also be used to make a high-input impedance DC differential amplifier (Figure 29). As in the two-op-amp circuit, this instrumentation amplifier requires precise resistor matching for good CMRR. R_4 should equal to R_1 and R_3 should equal R_2.

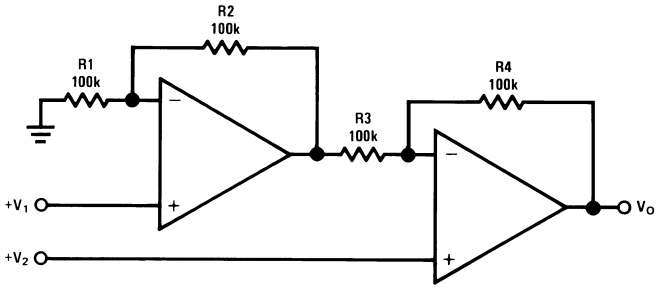


Figure 29. Two-op-amp Instrumentation Amplifier

$$V_O = \left(1 + \frac{R4}{R3}\right)(V_2 - V_1), \text{ where } R1 = R4 \text{ and } R2 = R3$$

$$\text{As shown: } V_O = 2(V_2 - V_1) \quad (3)$$

Single-Supply Inverting Amplifier

There may be cases where the input signal going into the amplifier is negative. Because the amplifier is operating in single supply voltage, a voltage divider using R_3 and R_4 is implemented to bias the amplifier so the input signal is within the input common-common voltage range of the amplifier. The capacitor C_1 is placed between the inverting input and resistor R_1 to block the DC signal going into the AC signal source, V_{IN}. The values of R_1 and C_1 affect the cutoff frequency, fc = ½π R_1C_1.

As a result, the output signal is centered around mid-supply (if the voltage divider provides $V^+/2$ at the non-inverting input). The output can swing to both rails, maximizing the signal-to-noise ratio in a low voltage system.

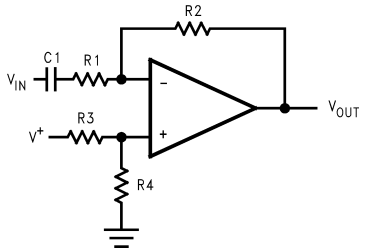


Figure 30. Single-Supply Inverting Amplifier

$$V_{OUT} = -\frac{R2}{R1} V_{IN} \quad (4)$$

Active Filter

Simple Low-Pass Active Filter

The simple low-pass filter is shown in Figure 31. Its low-pass frequency gain ($\omega \rightarrow o$) is defined by $-R_3/R_1$. This allows low-frequency gains other than unity to be obtained. The filter has a −20dB/decade roll-off after its corner frequency fc. R_2 should be chosen equal to the parallel combination of R_1 and R_3 to minimize error due to bias current. The frequency response of the filter is shown in Figure 32.

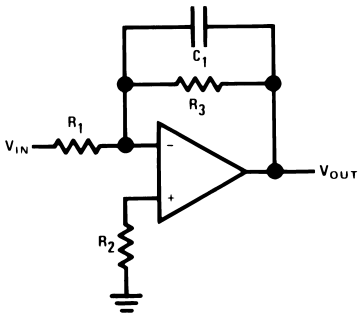


Figure 31. Simple Low-Pass Active Filter

$$A_L = -\frac{R_3}{R_1}$$
$$f_c = \frac{1}{2\pi R_3 C_1}$$
$$R_2 = R_1 \,||\, R_3 \quad (5)$$

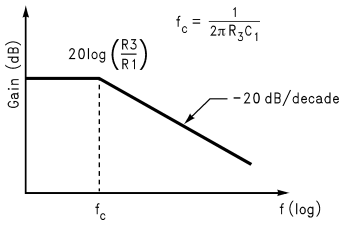


Figure 32. Frequency Response of Simple Low-pass Active Filter in Figure 31

Note that the single-op-amp active filters are used in to the applications that require low quality factor, Q(≤ 10), low frequency (≤ 5KHz), and low gain (≤ 10), or a small value for the product of gain times Q(≤ 100). The op amp should have an open loop voltage gain at the highest frequency of interest at least 50 times larger than the gain of the filter at this frequency. In addition, the selected op amp should have a slew rate that meets the following requirement:

Slew Rate ≥ 0.5 x (ω_H V_{OPP}) X 10^{-6}V/µsec

where

- ω_H is the highest frequency of interest
- V_{OPP} is the output peak-to-peak voltage

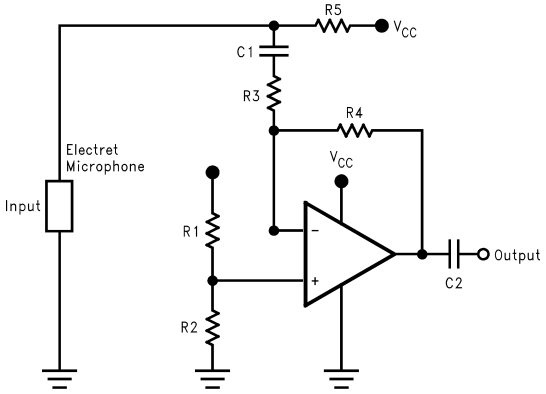


Figure 33. A Battery Powered Microphone Preamplifier

Here is a LMV721-N used as a microphone preamplifier. Since the LMV721-N is a low noise and low power op amp, it makes it an ideal candidate as a battery powered microphone preamplifier. The LMV721-N is connected in an inverting configuration. Resistors, $R_1 = R_2 = 4.7k\Omega$, sets the reference half way between $V_{CC} = 3V$ and ground. Thus, this configures the op amp for single supply use. The gain of the preamplifier, which is 50 (34dB), is set by resistors $R_3 = 10k\Omega$ and $R_4 = 500k\Omega$. The gain bandwidth product for the LMV721-N is 10 MHz. This is sufficient for most audio application since the audio range is typically from 20 Hz to 20kHz. A resistor $R_5 = 5k\Omega$ is used to bias the electret microphone. Capacitors $C_1 = C_2 = 4.7\mu F$ placed at the input and output of the op amp to block out the DC voltage offset.

Connection Diagrams

Top View

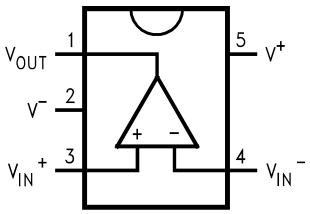


Figure 34. 5-Pin SC70 and SOT-23 Packages
See Package Numbers DCK0005A AND DBV0005A

Top View

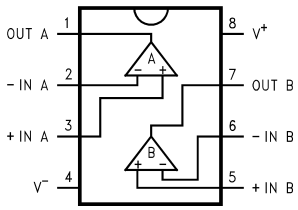


Figure 35. 8-Pin SOIC and VSSOP Packages
See Package Numbers D0008A and DGK0008A

REVISION HISTORY

Changes from Revision G (March 2013) to Revision H	Page
• Changed layout of National Data Sheet to TI format	14

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LMV721M5	NRND	SOT-23	DBV	5	1000	TBD	Call TI	Call TI	-40 to 85	A30A	
LMV721M5/NOPB	ACTIVE	SOT-23	DBV	5	1000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	A30A	Samples
LMV721M5X/NOPB	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	A30A	Samples
LMV721M7	NRND	SC70	DCK	5	1000	TBD	Call TI	Call TI	-40 to 85	A20	
LMV721M7/NOPB	ACTIVE	SC70	DCK	5	1000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	A20	Samples
LMV721M7X/NOPB	ACTIVE	SC70	DCK	5	3000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	A20	Samples
LMV722M	NRND	SOIC	D	8	95	TBD	Call TI	Call TI	-40 to 85	LMV 722M	
LMV722M/NOPB	ACTIVE	SOIC	D	8	95	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	LMV 722M	Samples
LMV722MM/NOPB	ACTIVE	VSSOP	DGK	8	1000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	V722	Samples
LMV722MMX/NOPB	ACTIVE	VSSOP	DGK	8	3500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	V722	Samples
LMV722MX/NOPB	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	LMV 722M	Samples

(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.

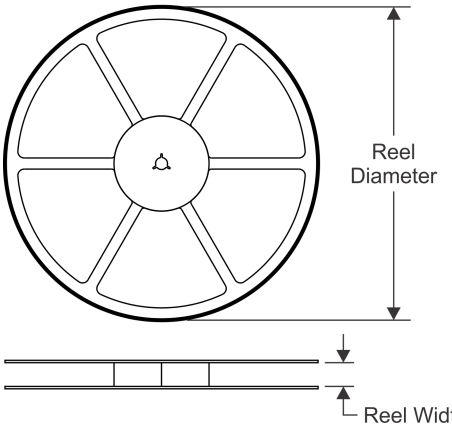
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device 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 Device Marking for that device.

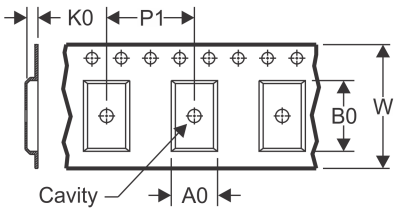
(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

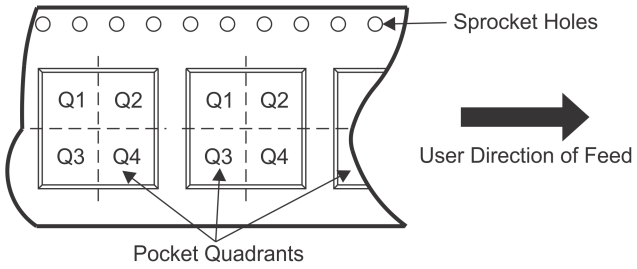


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

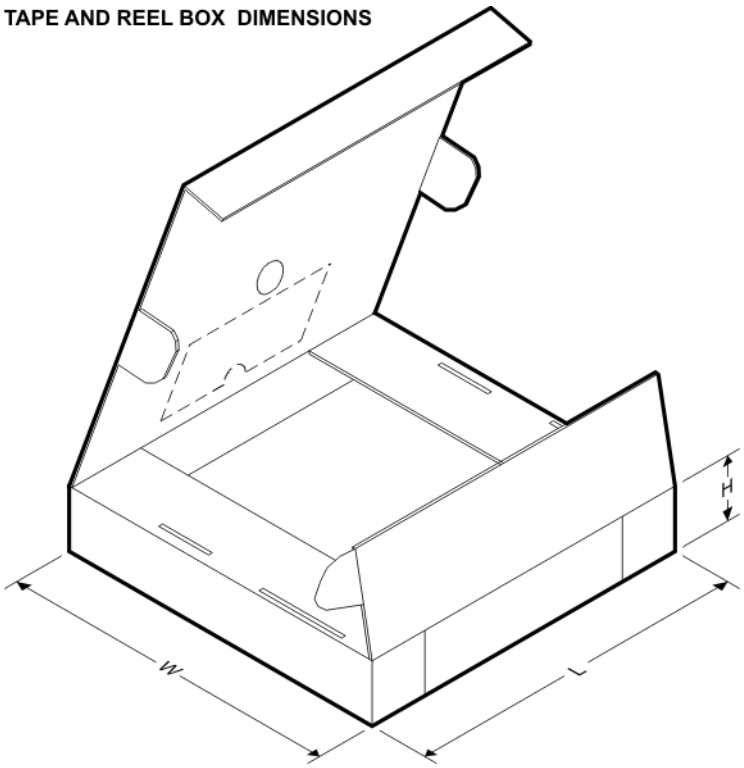
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
LMV721M5	SOT-23	DBV	5	1000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LMV721M5/NOPB	SOT-23	DBV	5	1000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LMV721M5X/NOPB	SOT-23	DBV	5	3000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LMV721M7	SC70	DCK	5	1000	178.0	8.4	2.25	2.45	1.2	4.0	8.0	Q3
LMV721M7/NOPB	SC70	DCK	5	1000	178.0	8.4	2.25	2.45	1.2	4.0	8.0	Q3
LMV721M7X/NOPB	SC70	DCK	5	3000	178.0	8.4	2.25	2.45	1.2	4.0	8.0	Q3
LMV722MM/NOPB	VSSOP	DGK	8	1000	178.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
LMV722MMX/NOPB	VSSOP	DGK	8	3500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
LMV722MX/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1

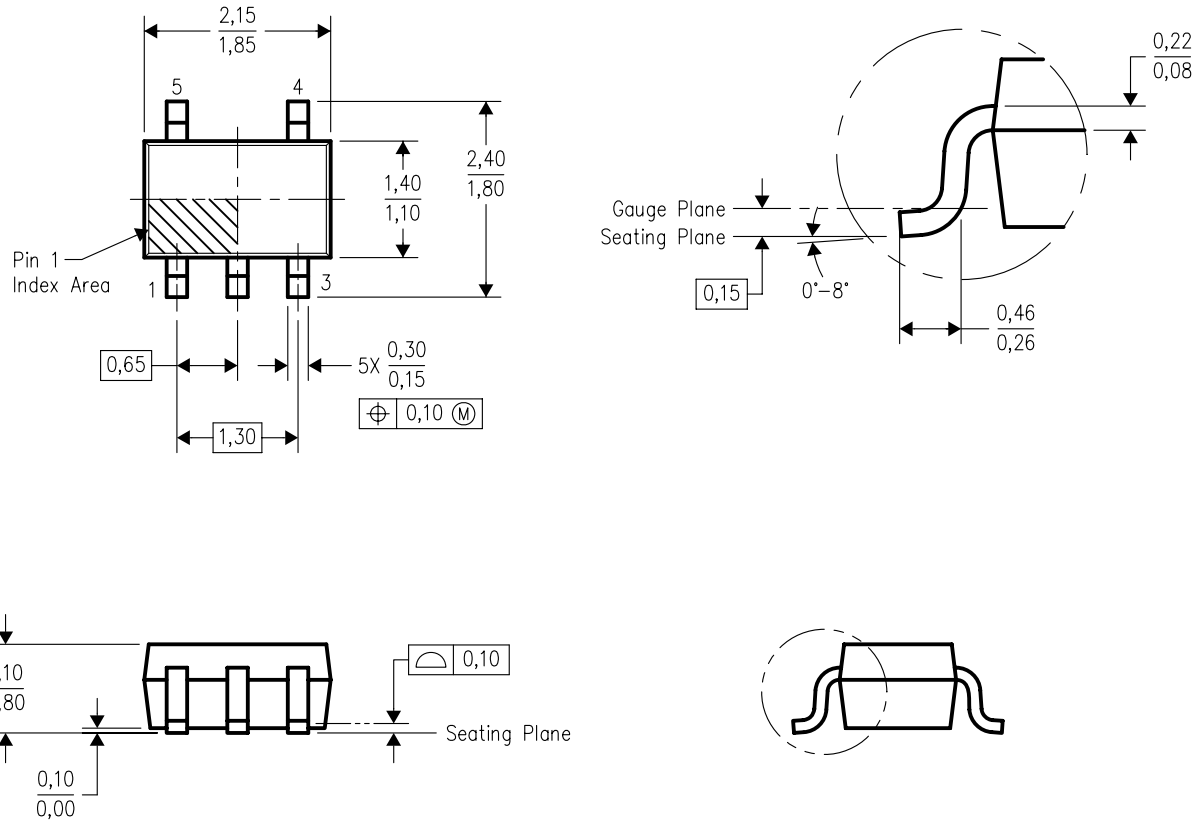
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LMV721M5	SOT-23	DBV	5	1000	210.0	185.0	35.0
LMV721M5/NOPB	SOT-23	DBV	5	1000	210.0	185.0	35.0
LMV721M5X/NOPB	SOT-23	DBV	5	3000	210.0	185.0	35.0
LMV721M7	SC70	DCK	5	1000	210.0	185.0	35.0
LMV721M7/NOPB	SC70	DCK	5	1000	210.0	185.0	35.0
LMV721M7X/NOPB	SC70	DCK	5	3000	210.0	185.0	35.0
LMV722MM/NOPB	VSSOP	DGK	8	1000	210.0	185.0	35.0
LMV722MMX/NOPB	VSSOP	DGK	8	3500	367.0	367.0	35.0
LMV722MX/NOPB	SOIC	D	8	2500	367.0	367.0	35.0

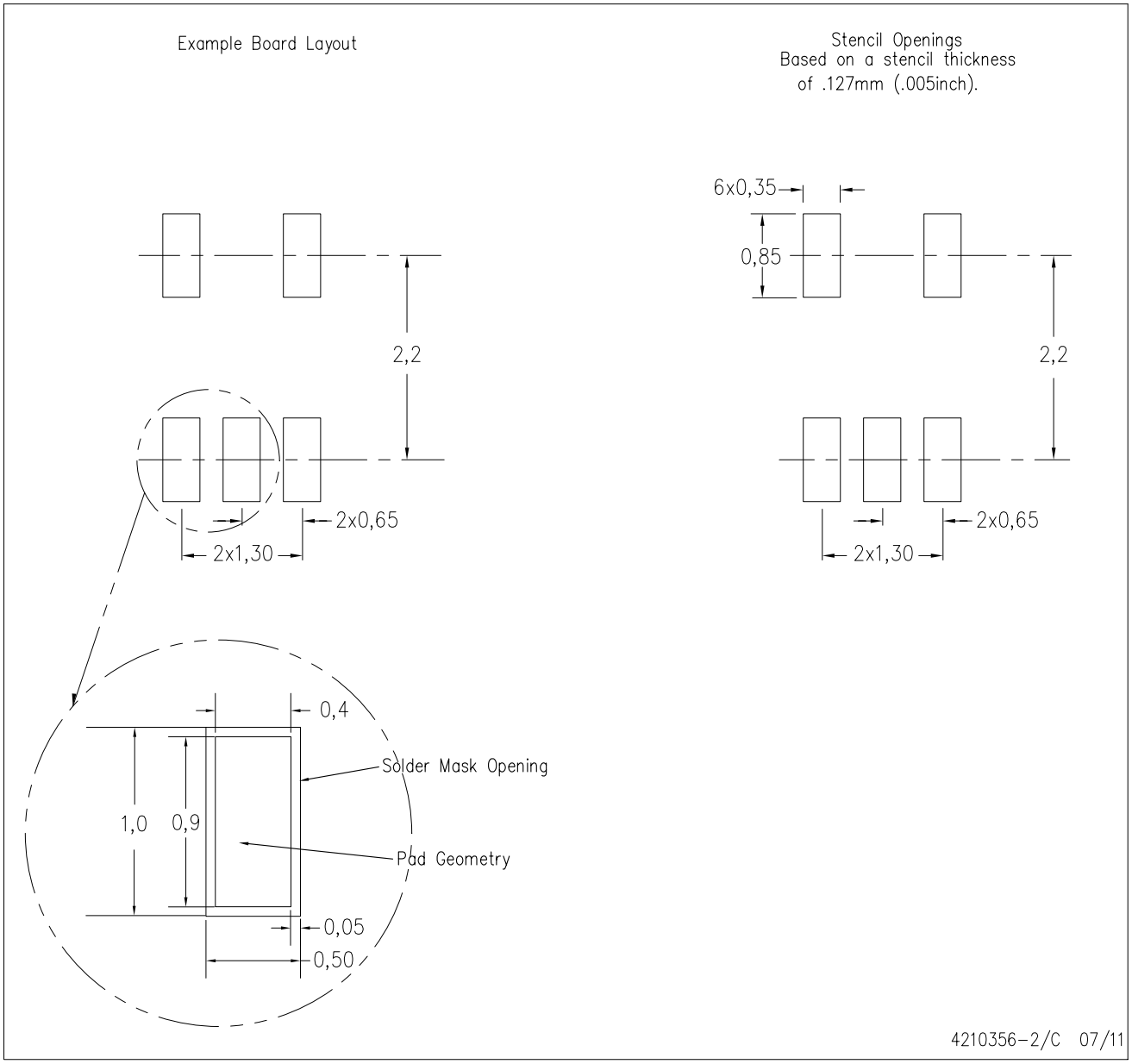
DCK (R–PDSO–G5) PLASTIC SMALL–OUTLINE PACKAGE



4093553–3/G 01/2007

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

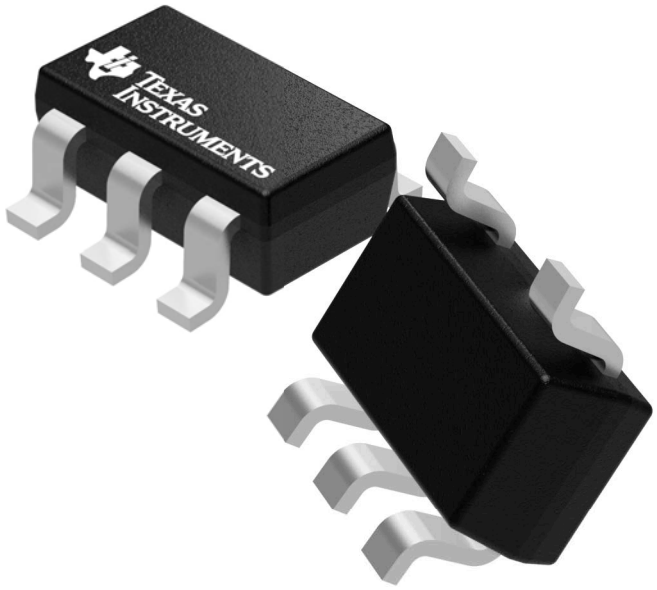
DCK (R–PDSO–G5) PLASTIC SMALL OUTLINE



NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
D. Publication IPC–7351 is recommended for alternate designs.
E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC–7525 for other stencil recommendations.

DBV 5 SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



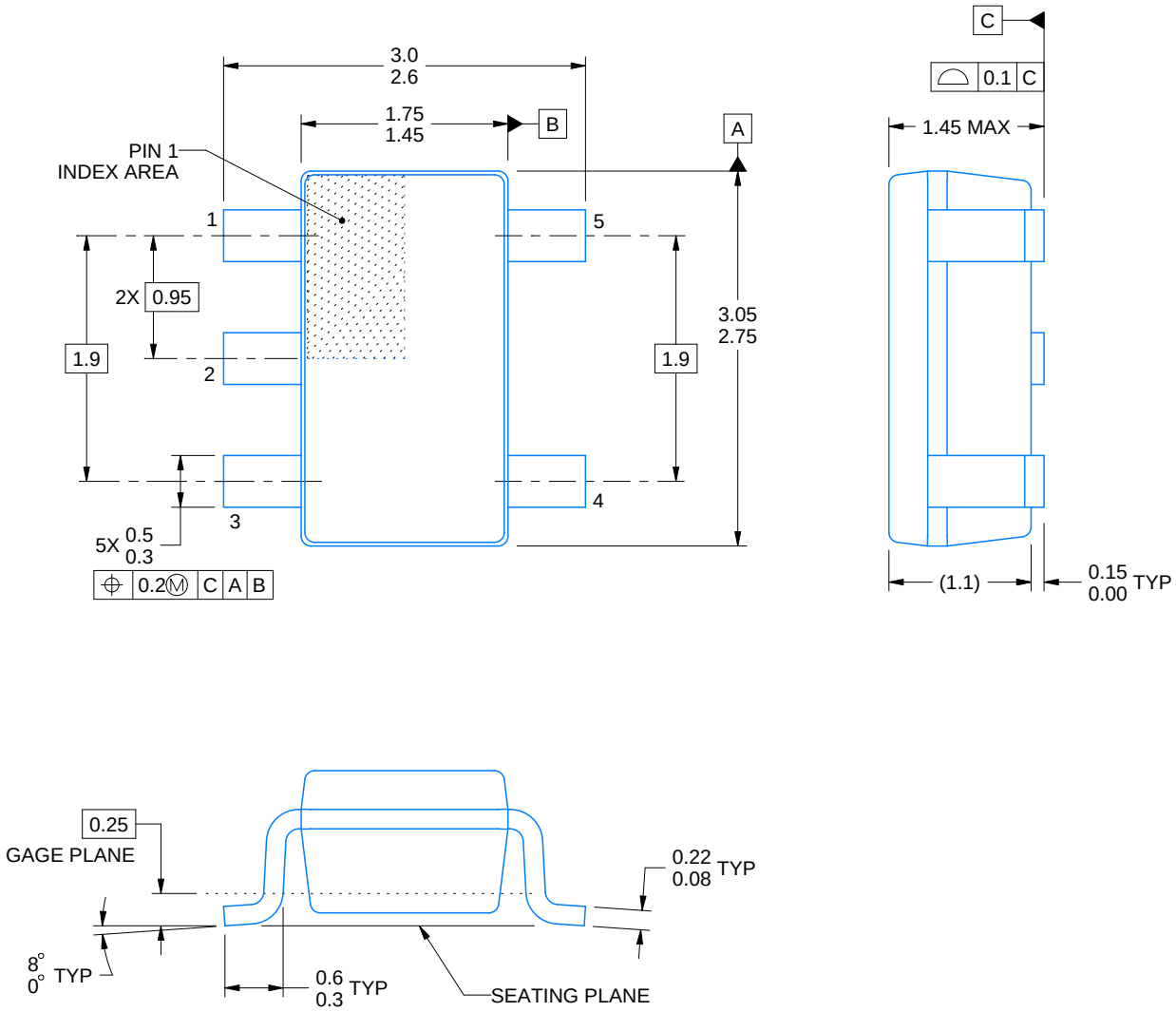
Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

PACKAGE OUTLINE

DBV0005A

SOT-23 - 1.45 mm max height

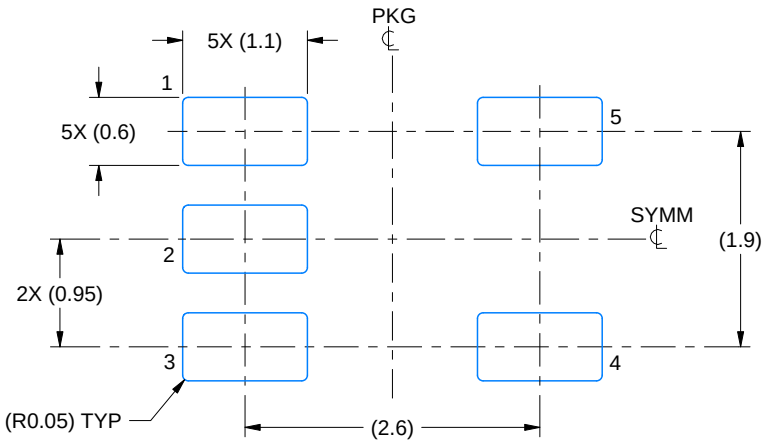
SMALL OUTLINE TRANSISTOR



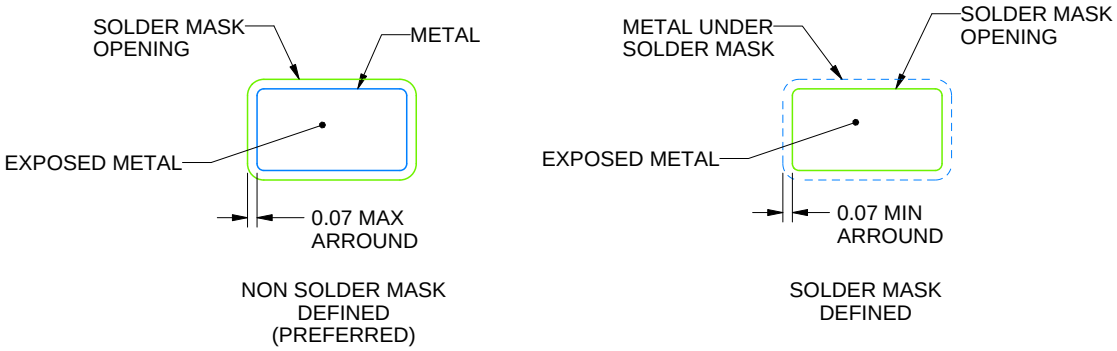
4214839/C 04/2017

NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Refernce JEDEC MO-178.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:15X

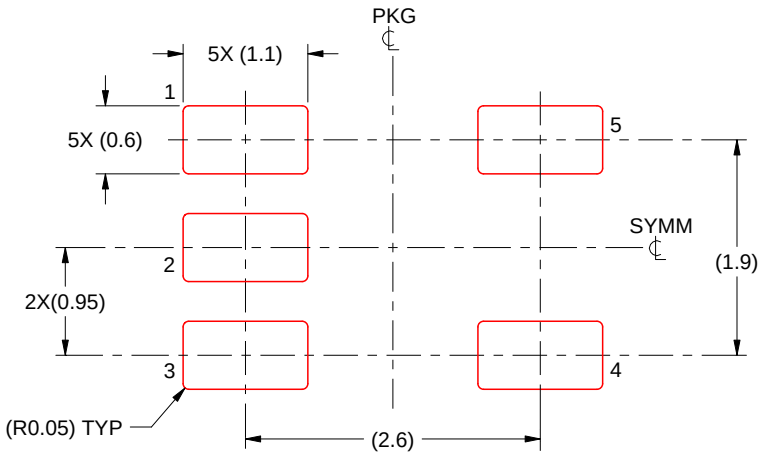


SOLDER MASK DETAILS

4214839/C 04/2017

NOTES: (continued)

4. Publication IPC-7351 may have alternate designs.
5. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



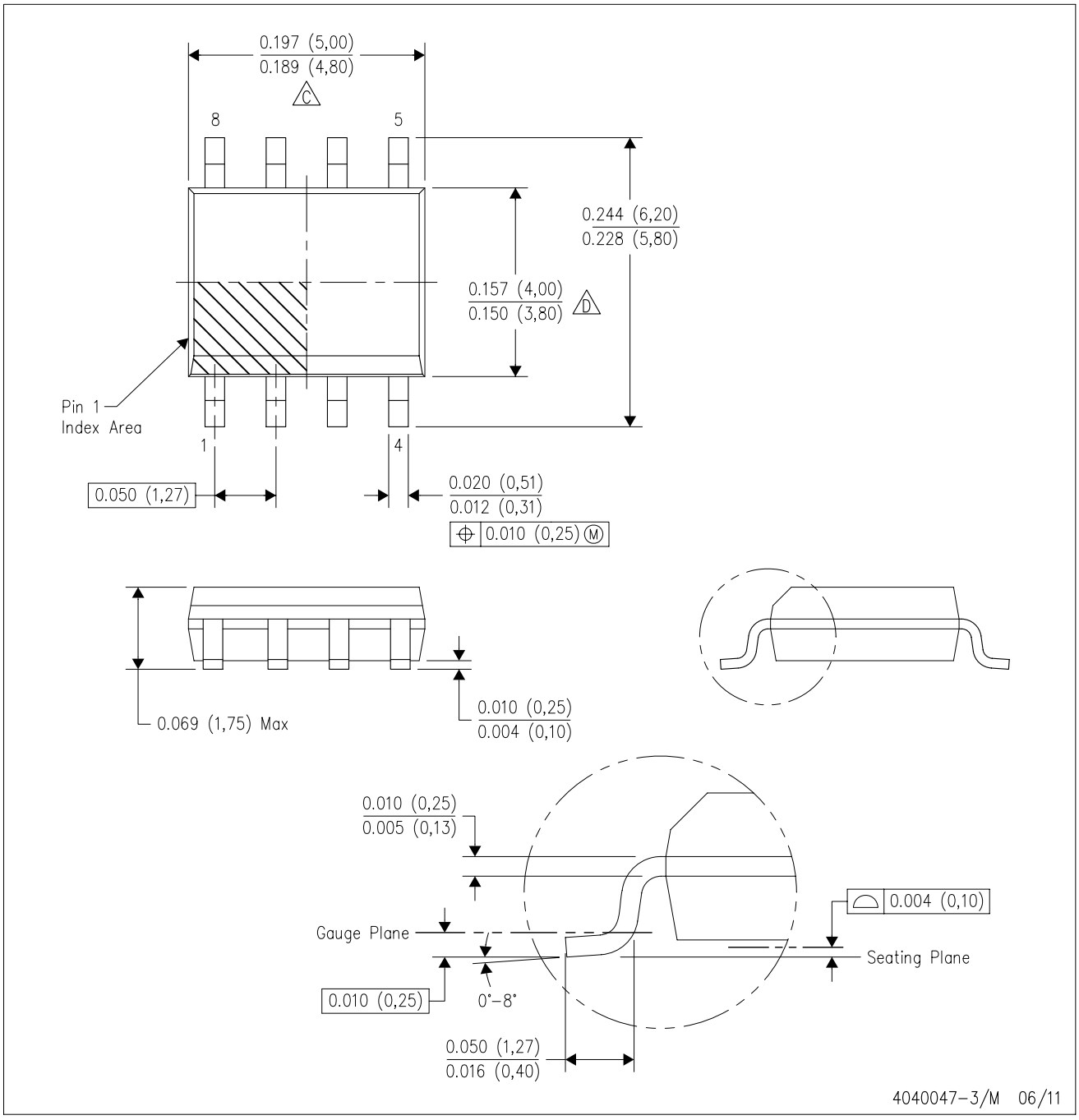
SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:15X

4214839/C 04/2017

NOTES: (continued)

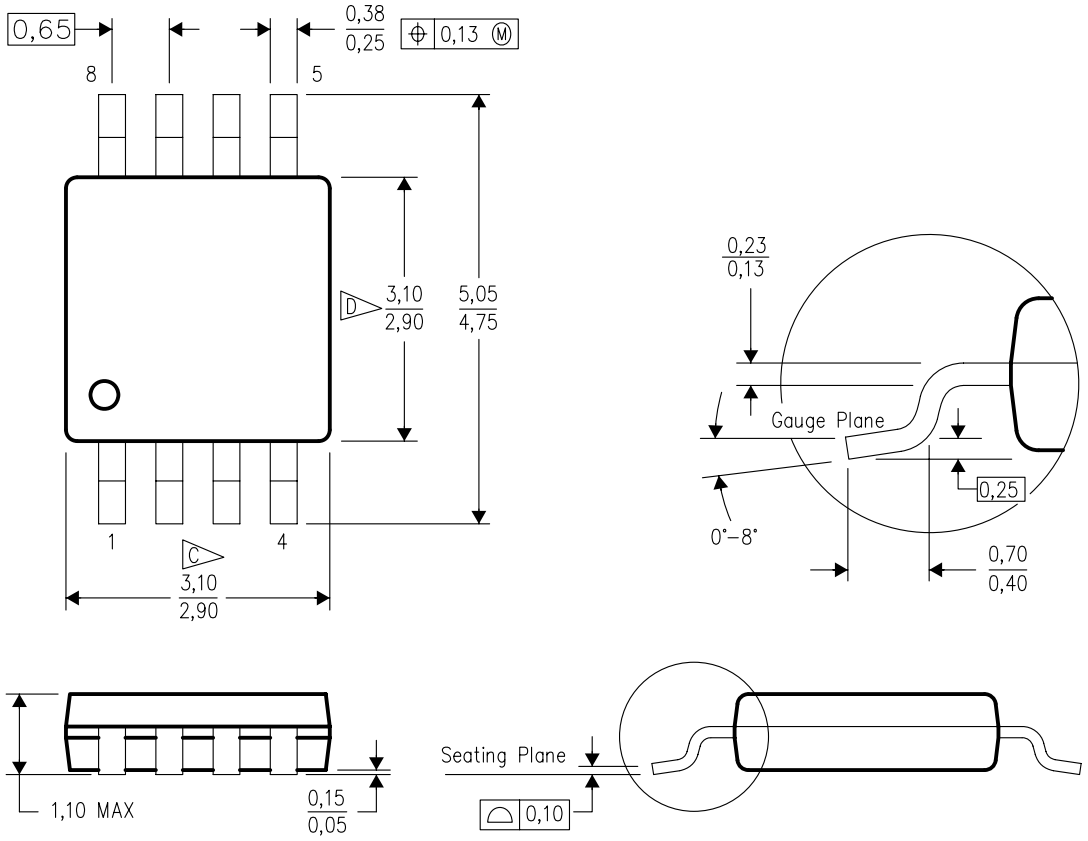
6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
7. Board assembly site may have different recommendations for stencil design.

D (R–PDSO–G8) PLASTIC SMALL OUTLINE



NOTES:
A. All linear dimensions are in inches (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 0.006 (0,15) each side.
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 AA.

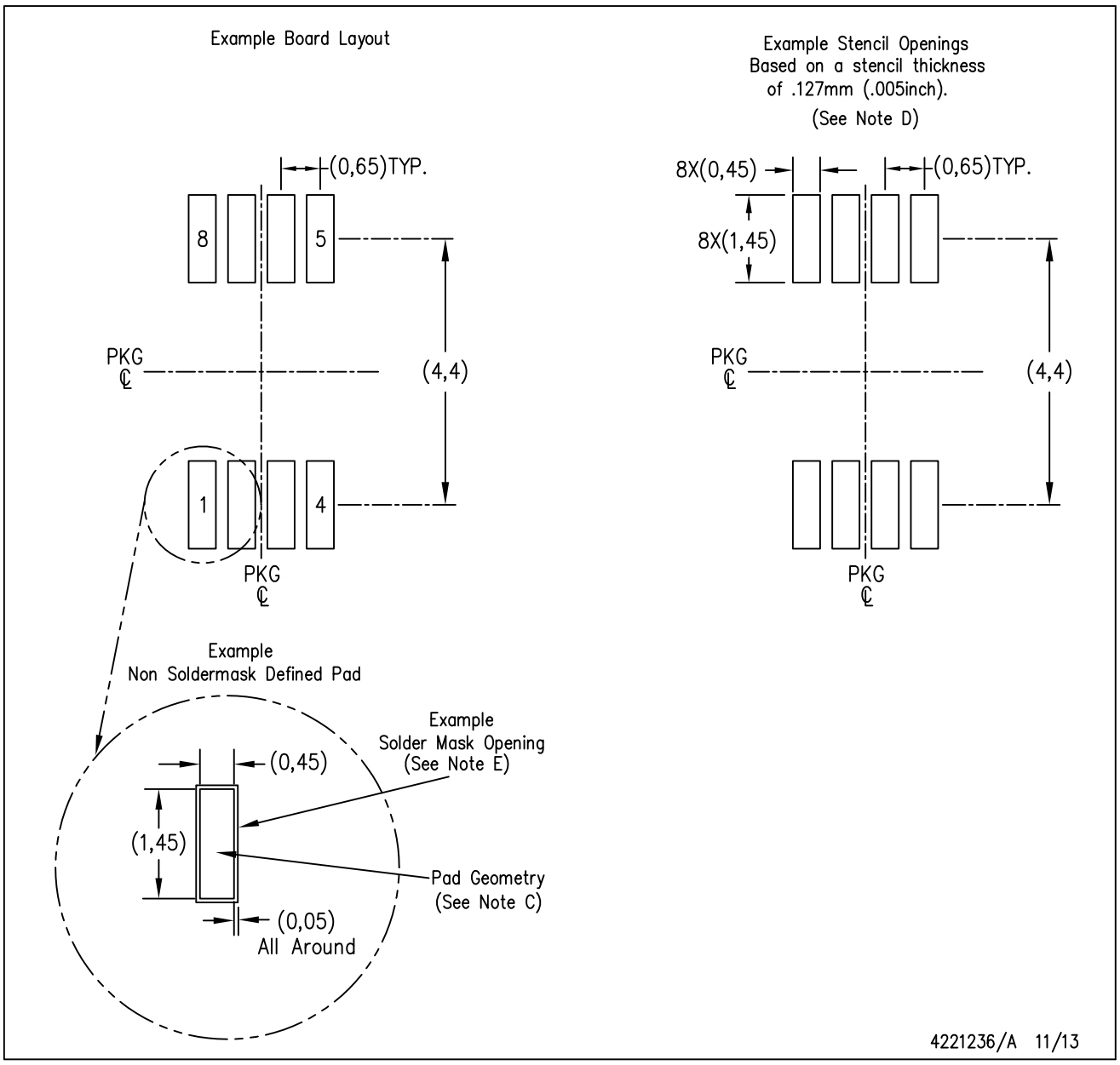
DGK (S–PDSO–G8) PLASTIC SMALL–OUTLINE PACKAGE



4073329/E 05/06

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.

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. Publication IPC–7351 is recommended for alternate designs.
D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC–7525 for other stencil recommendations.
E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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