

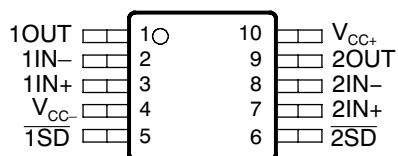
## FEATURES

- 5-MHz Gain Bandwidth Product
- 5-V/ $\mu$ s Slew Rate
- Low Noise: 20 nV/ $\sqrt{\text{Hz}}$
- 1.22-mA/Channel Supply Current
- $V_{OS} < 3$  mV Max
- Low Supply Voltage: 2.7 V to 5 V
- Rail-to-Rail Inputs and Outputs
- Unity Gain Stable
- 1.5- $\mu$ A Shutdown  $I_{CC}$
- 2.2- $\mu$ s Turn On

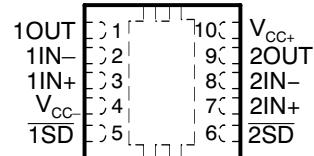
## APPLICATIONS

- Power-Amplifier Control Loops
- Cellular Phones
- Portable Equipment
- Wireless LANs
- Radio Systems
- Cordless Phones

DGS PACKAGE  
(TOP VIEW)



DRC PACKAGE  
(TOP VIEW)



## DESCRIPTION/ORDERING INFORMATION

The LMV712 dual operational amplifier is a high-performance BiCMOS operational amplifier intended for applications requiring rail-to-rail inputs, combined with speed and low noise. The device offers a bandwidth of 5 MHz, a slew rate of 5 V/ $\mu$ s, and operates with capacitive loads of up to 200 pF without oscillation.

The LMV712 offers two independent shutdown (1SD, 2SD) pins. This feature allows disabling of each device separately and reduces the supply current to less than 1  $\mu$ A typical. The output voltage rapidly and smoothly ramps up with no glitch as the amplifier comes out of the shutdown mode.

The LMV712 is offered in the space-saving SON (DRC) package and in an MSOP (DGS) package. These packages are designed to meet the demands of small size, low power, and low cost required by cellular phones and similar battery-operated portable electronics.

## ORDERING INFORMATION

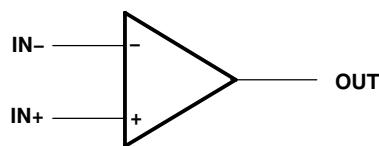
T <sub>A</sub>	PACKAGE <sup>(1)</sup>	ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	MSOP – DGS	Reel of 2500	RNB
		Reel of 250	
	SON – DRC	Reel of 3000	PREVIEW
		Reel of 250	

(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).

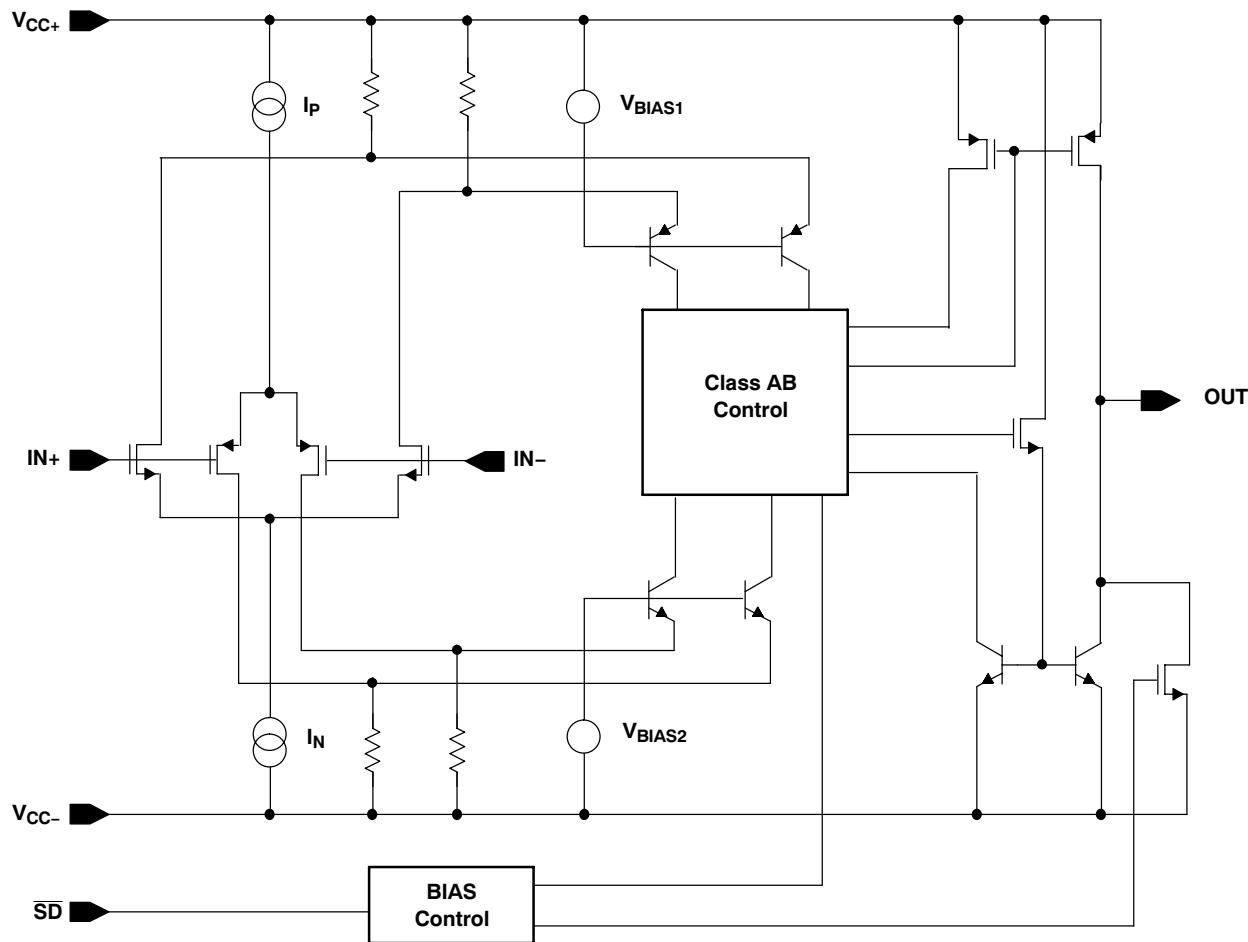


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## SYMBOL (EACH AMPLIFIER)



## SIMPLIFIED SCHEMATIC (EACH AMPLIFIER)



**Absolute Maximum Ratings<sup>(1)</sup>**

over operating free-air temperature range (unless otherwise noted)

		MIN	MAX	UNIT
$V_{CC+} - V_{CC-}$	Supply voltage <sup>(2)</sup>		5.5	V
$V_{ID}$	Differential input voltage <sup>(3)</sup>		$\pm$ Supply voltage	V
$V_I$	Input voltage range (any input)	$V_{CC-} - 0.4$	$V_{CC+} + 0.4$	V
$V_O$	Output voltage range	$V_{CC-} - 0.4$	$V_{CC+} + 0.4$	V
$I_I$	Input current <sup>(4)</sup>		$\pm 10$	mA
$I_O$	Output current		$\pm 50$	mA
$\theta_{JA}$	Package thermal impedance <sup>(5)(6)</sup>	DGS package	165	°C/W
		DRC package	TBD	
$T_J$	Operating virtual junction temperature		150	°C
$T_{stg}$	Storage temperature range	-65	150	°C

- (1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltage values (except differential voltages and  $V_{CC}$  specified for the measurement of  $I_{OS}$ ) are with respect to the network GND.
- (3) Differential voltages are at IN+ with respect to IN-.
- (4) Excessive input current will flow if a differential input voltage in excess of approximately 0.6 V is applied between the inputs, unless some limiting resistance is used.
- (5) Maximum power dissipation is a function of  $T_J$ (max),  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(\max) - T_A)/\theta_{JA}$ . Operating at the absolute maximum  $T_J$  of 150°C can affect reliability.
- (6) The package thermal impedance is calculated in accordance with JESD 51-7.

**ESD Protection**

	TYP	UNIT
Human-Body Model	1500	V
Machine Model	150	V

**Recommended Operating Conditions**

	MIN	MAX	UNIT	
$V_{CC+} - V_{CC-}$	Supply voltage	2.7	5	V
$T_A$	Operating free-air temperature	-40	85	°C

**Electrical Characteristics** $V_{CC+} = 2.7 \text{ V}$ ,  $V_{CC-} = \text{GND}$ ,  $V_{CM} = 1.35 \text{ V}$ , and  $R_L > 1 \text{ M}\Omega$  (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T <sub>A</sub>	MIN	TYP	MAX	UNIT	
V <sub>IO</sub>	Input offset voltage	$V_{CM} = 0.85 \text{ V}$ and $1.85 \text{ V}$		25°C		0.4	3	mV	
				–40°C to 85°C			3.2		
I <sub>IB</sub>	Input bias current			25°C		5.5	115	pA	
				–40°C to 85°C			130		
CMRR	Common-mode rejection ratio	$0 \leq V_{CM} \leq 2.7 \text{ V}$		25°C	50	75		dB	
				–40°C to 85°C	45				
PSRR	Power-supply rejection ratio	$2.7 \text{ V} \leq V_{CC+} \leq 5 \text{ V}$	$V_{OM} = 0.85 \text{ V}$	25°C	70	90		dB	
				–40°C to 85°C	68				
			$V_{CM} = 1.85 \text{ V}$	25°C	70	90			
				–40°C to 85°C	68				
CMVR	Common-mode voltage range	$\text{CMRR} \geq 50 \text{ dB}$		25°C			–0.3	–0.2	
					2.9	3		V	
I <sub>SC</sub>	Output short-circuit current <sup>(1)</sup>	Sourcing $V_O = 0$		25°C	15	25		mA	
				–40°C to 85°C	12				
		Sinking $V_O = 2.7 \text{ V}$		25°C	25	50			
				–40°C to 85°C	22				
V <sub>O</sub>	Output voltage swing	$R_L = 10 \text{ k}\Omega$ to $1.35 \text{ V}$	$V_{OH}$	25°C	2.62	2.68		V	
				–40°C to 85°C	2.6				
			$V_{OL}$	25°C		0.01	0.12		
				–40°C to 85°C			0.15		
		$R_L = 600 \text{ }\Omega$ to $1.35 \text{ V}$	$V_{OH}$	25°C	2.52	2.55			
				–40°C to 85°C	2.5				
			$V_{OL}$	25°C		0.05	0.23		
				–40°C to 85°C			0.3		
V <sub>O(SD)</sub>	Output voltage level in shutdown mode			25°C		10	200	mV	
I <sub>CC</sub>	Supply current per channel	ON mode		25°C		1.22	1.7	mA	
				–40°C to 85°C			1.9		
		Shutdown mode		25°C		0.12	1.5		
				–40°C to 85°C			2		
A <sub>VOL</sub>	Large-signal voltage gain	Sourcing $R_L = 10 \text{ k}\Omega$ , $V_O = 1.35 \text{ V}$ to $2.3 \text{ V}$		25°C	80	115		dB	
				–40°C to 85°C	76				
		Sinking $R_L = 10 \text{ k}\Omega$ , $V_O = 0.4 \text{ V}$ to $1.35 \text{ V}$		25°C	80	113			
				–40°C to 85°C	76				
		Sourcing $R_L = 600 \text{ }\Omega$ , $V_O = 1.35 \text{ V}$ to $2.2 \text{ V}$		25°C	80	97			
				–40°C to 85°C	76				
		Sinking $R_L = 600 \text{ }\Omega$ , $V_O = 0.5 \text{ V}$ to $1.35 \text{ V}$		25°C	80	100			
				–40°C to 85°C	76				
V <sub>SD</sub>	Shutdown pin voltage	ON mode		25°C	2.4 to 2.7	2 to 2.7		V	
					0 to 0.8	0 to 1			
GBWP	Gain bandwidth product			25°C		5		MHz	
SR <sup>(2)</sup>	Slew rate			25°C		5		V/μs	
$\Phi_m$	Phase margin			25°C		60		°	
V <sub>n</sub>	Input referred voltage noise	$f = 1 \text{ kHz}$		25°C		20		nV/√Hz	

(1) Shorting the output to either supply rail adversely affects reliability.

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

**Electrical Characteristics (continued)**

$V_{CC+} = 2.7$  V,  $V_{CC-} = \text{GND}$ ,  $V_{CM} = 1.35$  V, and  $R_L > 1 \text{ M}\Omega$  (unless otherwise noted)

PARAMETER	TEST CONDITIONS	$T_A$	MIN	TYP	MAX	UNIT
			2.2	4	4.6	
$T_{(on)}$	Turn-on time from shutdown	25°C				μs

**Electrical Characteristics** $V_{CC+} = 5 \text{ V}$ ,  $V_{CC-} = \text{GND}$ ,  $V_{CM} = 2.5 \text{ V}$ , and  $R_L > 1 \text{ M}\Omega$  (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T <sub>A</sub>	MIN	TYP	MAX	UNIT	
V <sub>IO</sub>	Input offset voltage	$V_{CM} = 0.85 \text{ V}$ and $1.85 \text{ V}$		25°C		0.4	3	mV	
				–40°C to 85°C		3.2			
I <sub>IB</sub>	Input bias current			25°C		5.5	115	pA	
				–40°C to 85°C		130			
CMRR	Common-mode rejection ratio	$0 \leq V_{CM} \leq 5 \text{ V}$		25°C	50	80		dB	
				–40°C to 85°C	45				
PSRR	Power-supply rejection ratio	$2.7 \text{ V} \leq V_{CC+} \leq 5 \text{ V}$	$V_{CM} = 0.85 \text{ V}$	25°C	70	90		dB	
				–40°C to 85°C	68				
			$V_{CM} = 1.85 \text{ V}$	25°C	70	90			
				–40°C to 85°C	68				
CMVR	Common-mode voltage range	$\text{CMRR} \geq 50 \text{ dB}$		25°C			–0.3	V	
					5.2	5.3			
I <sub>SC</sub>	Output short-circuit current <sup>(1)</sup>	Sourcing $V_O = 0$		25°C	20	35		mA	
				–40°C to 85°C	18				
		Sinking $V_O = 5 \text{ V}$		25°C	25	50			
				–40°C to 85°C	21				
V <sub>O</sub>	Output voltage swing	$R_L = 10 \text{ k}\Omega$ to $2.5 \text{ V}$	$V_{OH}$	25°C	4.92	4.98		V	
				–40°C to 85°C	4.9				
			$V_{OL}$	25°C		0.01	0.12		
				–40°C to 85°C		0.15			
		$R_L = 600 \text{ }\Omega$ to $2.5 \text{ V}$	$V_{OH}$	25°C	4.82	4.85			
				–40°C to 85°C	4.8				
			$V_{OL}$	25°C		0.05	0.23		
				–40°C to 85°C		0.3			
V <sub>O(SD)</sub>	Output voltage level in shutdown mode			25°C		10	200	mV	
I <sub>CC</sub>	Supply current per channel	ON mode		25°C		1.17	1.7	mA	
				–40°C to 85°C		1.9			
		Shutdown mode		25°C		0.12	1.5		
				–40°C to 85°C		2			
A <sub>VOL</sub>	Large-signal voltage gain	Sourcing $R_L = 10 \text{ k}\Omega$ , $V_O = 2.5 \text{ V}$ to $4.6 \text{ V}$		25°C	80	130		dB	
				–40°C to 85°C	76				
		Sinking $R_L = 10 \text{ k}\Omega$ , $V_O = 0.4 \text{ V}$ to $2.5 \text{ V}$		25°C	80	130			
				–40°C to 85°C	76				
		Sourcing $R_L = 600 \text{ }\Omega$ , $V_O = 2.5 \text{ V}$ to $4.6 \text{ V}$		25°C	80	110			
				–40°C to 85°C	76				
		Sinking $R_L = 600 \text{ }\Omega$ , $V_O = 0.4 \text{ V}$ to $2.5 \text{ V}$		25°C	80	107			
				–40°C to 85°C	76				
V <sub>SD</sub>	Shutdown pin voltage	ON mode		25°C	4.5 to 5	3.5 to 5		V	
					0 to 0.8	0 to 1.5			
GBWP	Gain bandwidth product			25°C		5		MHz	
SR <sup>(2)</sup>	Slew rate			25°C		5		V/μs	
Φ <sub>m</sub>	Phase margin			25°C		60		°	
V <sub>n</sub>	Input referred voltage noise	$f = 1 \text{ kHz}$		25°C		20		nV/√Hz	

(1) Shorting the output to either supply rail adversely affects reliability.

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

**Electrical Characteristics (continued)**

$V_{CC+} = 5$  V,  $V_{CC-} = \text{GND}$ ,  $V_{CM} = 2.5$  V, and  $R_L > 1 \text{ M}\Omega$  (unless otherwise noted)

PARAMETER	TEST CONDITIONS	$T_A$	MIN	TYP	MAX	UNIT
$T_{(on)}$	Turn-on time from shutdown	25°C		1.6	4	$\mu\text{s}$

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## TYPICAL CHARACTERISTICS

### GRAPH PREVIEWS

Supply Current per Channel vs Supply Voltage (ON Mode)

Supply Current per Channel vs Supply Voltage (Shutdown Mode)

Input Offset Voltage vs Common-Mode Voltage

Bias Current vs Common-Mode Voltage Over Temperature

Output Positive Swing vs Supply Voltage ( $R_L = 600 \Omega$ )

Output Negative Swing vs Supply Voltage ( $R_L = 600 \Omega$ )

Sourcing Current vs Output Voltage ( $V_{CC} = 2.7 \text{ V}$ )

Sourcing Current vs Output Voltage ( $V_{CC} = 5 \text{ V}$ )

Sinking Current vs Output Voltage ( $V_{CC} = 2.7 \text{ V}$ )

Sinking Current vs Output Voltage ( $V_{CC} = 5 \text{ V}$ )

PSRR vs Frequency ( $V_{CC} = 2.7 \text{ V}$ )

PSRR vs Frequency ( $V_{CC} = 5 \text{ V}$ )

CMRR vs Frequency ( $V_{CC} = 2.7 \text{ V}$ )

CMRR vs Frequency ( $V_{CC} = 5 \text{ V}$ )

Open-Loop Frequency Response vs  $R_L$  ( $V_{CC\pm} = 2.7 \text{ V}$ )

Open-Loop Frequency Response vs  $R_L$  ( $V_{CC\pm} = 5 \text{ V}$ )

Open-Loop Frequency Response vs  $C_L$  ( $V_{CC\pm} = 2.7 \text{ V}$ )

Open-Loop Frequency Response vs  $C_L$  ( $V_{CC\pm} = 5 \text{ V}$ )

Voltage Noise vs Frequency ( $V_{CC} = 2.7 \text{ V}$ )

Voltage Noise vs Frequency ( $V_{CC} = 5 \text{ V}$ )

Non-Inverting Large Signal Pulse Response ( $V_{CC} = 2.7 \text{ V}$ )

Non-Inverting Large Signal Pulse Response ( $V_{CC} = 5 \text{ V}$ )

Non-Inverting Small Signal Pulse Response ( $V_{CC} = 2.7 \text{ V}$ )

Non-Inverting Small Signal Pulse Response ( $V_{CC} = 5 \text{ V}$ )

Inverting Large Signal Pulse Response ( $V_{CC} = 2.7 \text{ V}$ )

Inverting Large Signal Pulse Response ( $V_{CC} = 5 \text{ V}$ )

Inverting Small Signal Pulse Response ( $V_{CC} = 2.7 \text{ V}$ )

Inverting Small Signal Pulse Response ( $V_{CC} = 5 \text{ V}$ )

Turn-On Response Time ( $V_{CC} = 5 \text{ V}$ )

Input Common-Mode Capacitance vs Common-Mode Voltage ( $V_{CC} = 5 \text{ V}$ )

**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>	Samples (Requires Login)
LMV712IDGSR	ACTIVE	MSOP	DGS	10	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
LMV712IDGSRG4	ACTIVE	MSOP	DGS	10	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
LMV712IDGST	ACTIVE	MSOP	DGS	10	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
LMV712IDGSTG4	ACTIVE	MSOP	DGS	10	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	

<sup>(1)</sup> 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.

<sup>(2)</sup> 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.

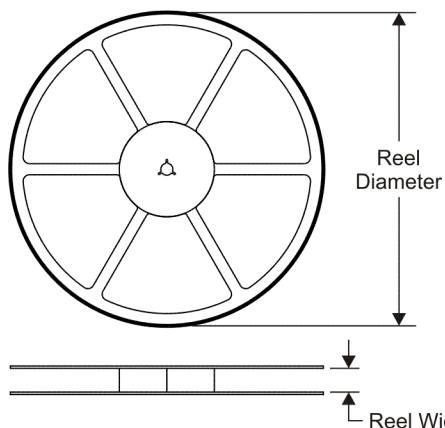
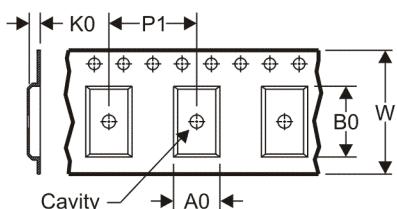
**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**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)

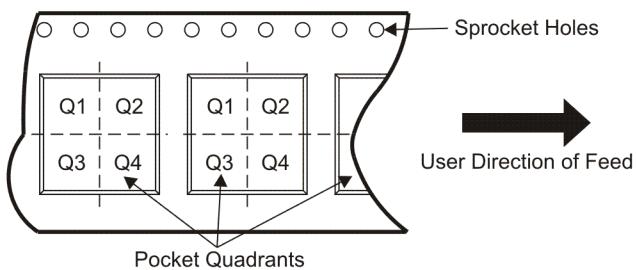
<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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**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
LMV712IDGSR	MSOP	DGS	10	2500	330.0	12.4	5.3	3.3	1.3	8.0	12.0	Q1

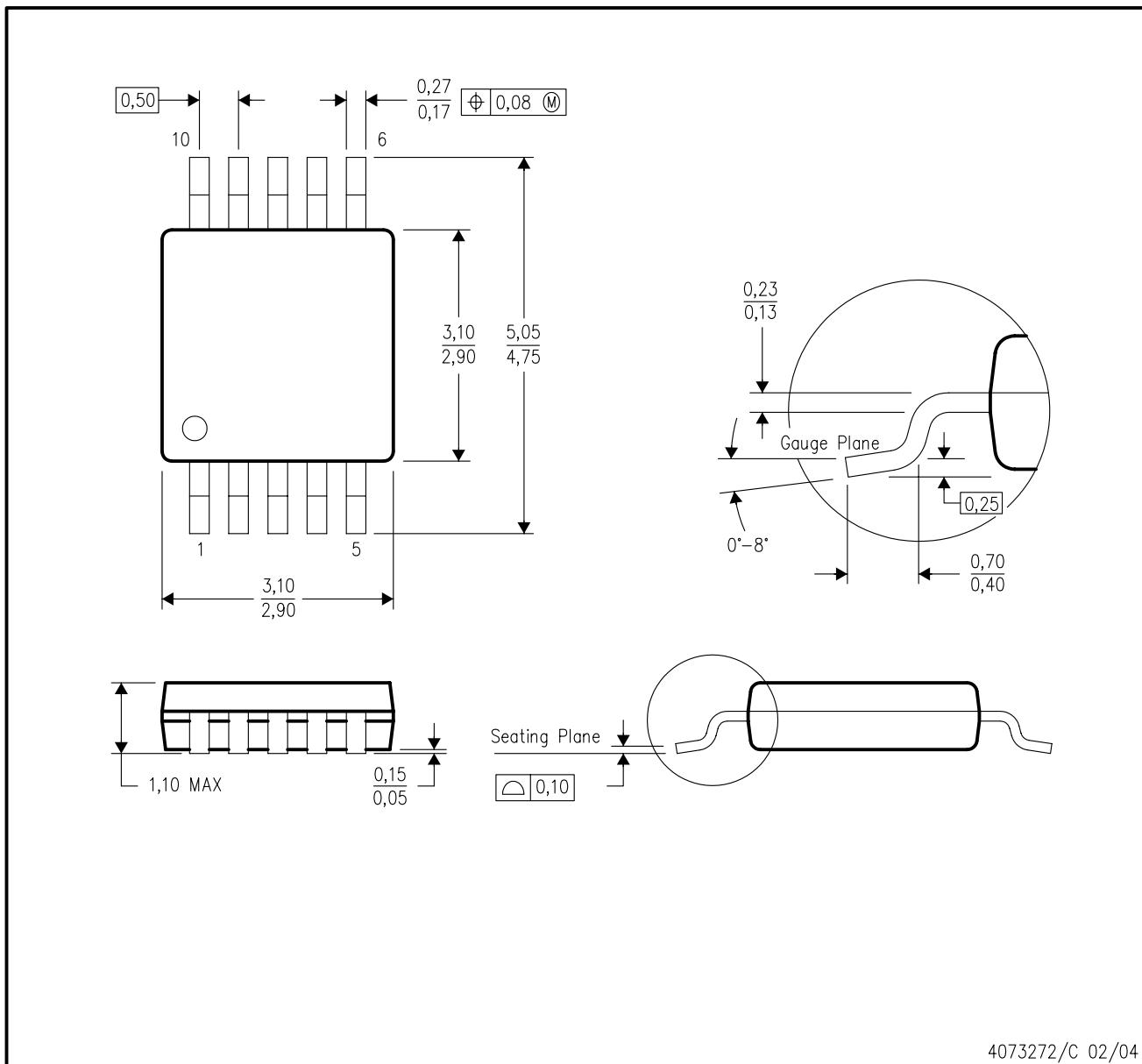
**TAPE AND REEL BOX DIMENSIONS**

\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LMV712IDGSR	MSOP	DGS	10	2500	370.0	355.0	55.0

## DGS (S-PDSO-G10)

## PLASTIC SMALL-OUTLINE PACKAGE



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.
- D. Falls within JEDEC MO-187 variation BA.

4073272/C 02/04

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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>
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