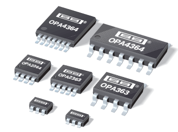
Burr-Brown Products
from Texas Instruments

OPA363
OPA2363
OPA364
OPA2364
OPA4364



SBOS259B – SEPTEMBER 2002 – REVISED FEBRUARY 2003

1.8V, 7MHz, 90dB CMRR, SINGLE-SUPPLY, RAIL-TO-RAIL I/O OPERATIONAL AMPLIFIER

FEATURES

- **1.8V OPERATION**
- ***Micro*SIZE PACKAGES**
- **BANDWIDTH: 7MHz**
- **CMRR: 90dB (typical)**
- **SLEW RATE: 5V/µs**
- **LOW OFFSET: 500µV (max)**
- **QUIESCENT CURRENT: 750µA/Channel (max)**
- **SHUTDOWN MODE: < 1µA/Channel**

APPLICATIONS

- **SIGNAL CONDITIONING**
- **DATA ACQUISITION**
- **PROCESS CONTROL**
- **ACTIVE FILTERS**
- **TEST EQUIPMENT**

	OPA363	OPA364	OPA2363	OPA2364	OPA4364
SOT23-5		x			
SOT23-6	x				
MSOP-8				x	
MSOP-10			x		
SO-8	x	x		x	
TSSOP-14					x
SO-14					x

DESCRIPTION

The OPA363 and OPA364 families are high-performance CMOS operational amplifiers optimized for very low voltage, single-supply operation. These miniature, low-cost amplifiers are designed to operate on single supplies from 1.8V (±0.9V) to 5.5V (±2.75V). Applications include sensor amplification and signal conditioning in battery-powered systems.

The OPA363 and OPA364 families offer excellent CMRR without the crossover associated with traditional complimentary input stages. This results in excellent performance for driving Analog-to-Digital (A/D) converters without degradation of differential linearity and THD. The input common-mode range includes both the negative and positive supplies. The output voltage swing is within 10mV of the rails.

The OPA363 family includes a shutdown mode. Under logic control, the amplifiers can be switched from normal operation to a standby current that is less than 1µA.

The single version is available in the *Micro*SIZE SOT23-5 (SOT23-6 for shutdown) and SO-8. The dual version is available in MSOP-8, MSOP-10, and SO-8 packages. Quad packages are available in TSSOP-14 and SO-14 packages. All versions are specified for operation from –40°C to +125°C.

ABSOLUTE MAXIMUM RATINGS(1)

Supply Voltage	+5.5V
Signal Input Terminals, Voltage(2)	–0.5V to (V+) + 0.5V
Current(2)	±10mA
Enable Input	(V–) – 0.5V to 5.5V
Output Short-Circuit(3)	Continuous
Operating Temperature	–40°C to +150°C
Storage Temperature	–65°C to +150°C
Junction Temperature	+150°C
Lead Temperature (soldering, 10s)	+300°C

NOTES: (1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not implied. (2) Input terminals are diode-clamped to the power-supply rails. Input signals that can swing more than 0.5V beyond the supply rails should be current limited to 10mA or less. (3) Short-circuit to ground one amplifier per package.

ELECTROSTATIC DISCHARGE SENSITIVITY

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

PACKAGE/ORDERING INFORMATION

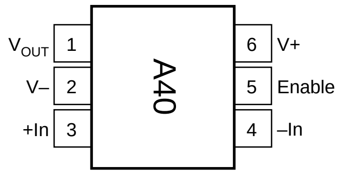
PRODUCT	PACKAGE-LEAD	PACKAGE DESIGNATOR(1)	SPECIFIED TEMPERATURE RANGE	PACKAGE MARKING	ORDERING NUMBER	TRANSPORT MEDIA, QUANTITY
OPA363I	SOT23-6	DBV	–40°C to +125°C	A40	OPA363IDBVT	Tape and Reel, 250
"	"	"	"	"	OPA363IDBVR	Tape and Reel, 3000
OPA363I	SO-8	D	–40°C to +125°C	OPA363	OPA363ID	Rails, 100
"	"	"	"	"	OPA363IDR	Tape and Reel, 2500
OPA2363I	MSOP-10	DGS	–40°C to +125°C	BHK	OPA2363IDGST	Tape and Reel, 250
"	"	"	"	"	OPA2363IDGSR	Tape and Reel, 2500
OPA364I	SOT23-5	DBV	–40°C to +125°C	A41	OPA364IDBVT	Tape and Reel, 250
"	"	"	"	"	OPA364IDBVR	Tape and Reel, 3000
OPA364I	SO-8	D	–40°C to +125°C	OPA364	OPA364ID	Rails, 100
"	"	"	"	"	OPA364IDR	Tape and Reel, 2500
OPA2364I	MSOP-8	DGK	–40°C to +125°C	BHL	OPA2364IDGKT	Tape and Reel, 250
"	"	"	"	"	OPA2364IDGKR	Tape and Reel, 2500
OPA2364I	SO-8	D	–40°C to +125°C	OPA2364	OPA2364ID	Rails, 100
"	"	"	"	"	OPA2364IDR	Tape and Reel, 2500
OPA363AI	SOT23-6	DBV	–40°C to +125°C	A40	OPA363AIDBVT	Tape and Reel, 250
"	"	"	"	"	OPA363AIDBVR	Tape and Reel, 3000
OPA363AI	SO-8	D	–40°C to +125°C	OPA363A	OPA363AID	Rails, 100
"	"	"	"	"	OPA363AIDR	Tape and Reel, 2500
OPA2363AI	MSOP-10	DGS	–40°C to +125°C	BHK	OPA2363AIDGST	Tape and Reel, 250
"	"	"	"	"	OPA2363AIDGSR	Tape and Reel, 2500
OPA364AI	SOT23-5	DBV	–40°C to +125°C	A41	OPA364AIDBVT	Tape and Reel, 250
"	"	"	"	"	OPA364AIDBVR	Tape and Reel, 3000
OPA364AI	SO-8	D	–40°C to +125°C	OPA364A	OPA364AID	Rails, 100
"	"	"	"	"	OPA364AIDR	Tape and Reel, 2500
OPA2364AI	SO-8	D	–40°C to +125°C	OPA2634A	OPA2364AID	Rails, 100
"	"	"	"	"	OPA2364AIDR	Tape and Reel, 2500
OPA2364AI	MSOP-8	DGK	–40°C to +125°C	BHL	OPA2364AIDGKT	Tape and Reel, 250
"	"	"	"	"	OPA2364AIDGKR	Tape and Reel, 2500
OPA4364AI	SO-14	D	–40°C to +125°C	OPA4364A	OPA4364AID	Rails, 58
"	"	"	"	"	OPA4364AIDR	Tape and Reel, 2500
OPA4364AI	TSSOP-14	PW	–40°C to +125°C	OPA4364A	OPA4364AIPWT	Tape and Reel, 250
"	"	"	"	"	OPA4364AIPWR	Tape and Reel, 2500

NOTES: (1) For the most current specifications and package information, refer to our web site at www.ti.com.

PIN CONFIGURATIONS

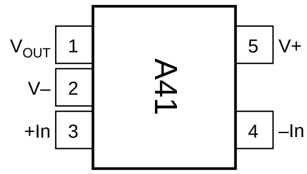
Top View

OPA363[(1)]



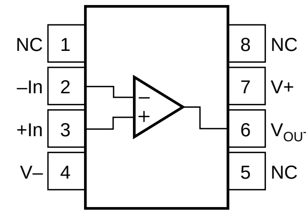
SOT23-6

OPA364[(1)]



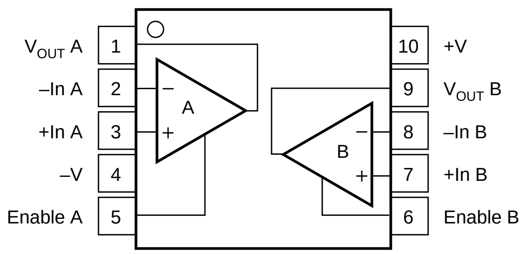
SOT23-5

OPA364



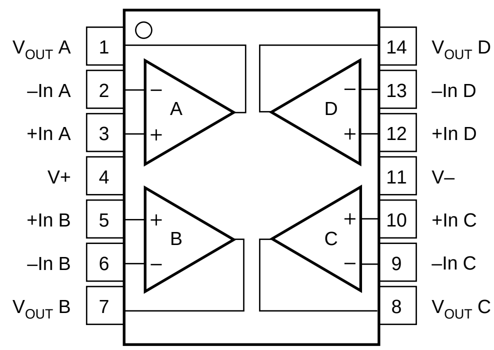
SO-8

OPA2363



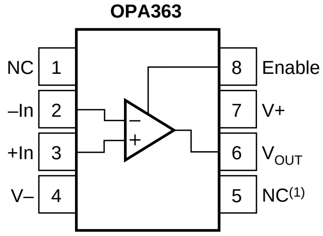
MSOP-10

OPA4364



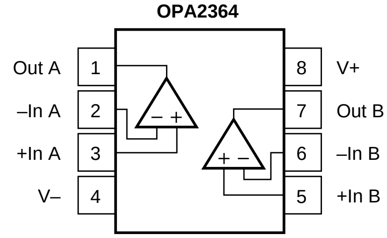
SO-14, TSSOP-14

OPA363



SO-8

OPA2364



MSOP-8, SO-8

NOTE: (1) Orient according to marking.

NC = No Internal Connection.

ELECTRICAL CHARACTERISTICS: V_S = +1.8V to +5.5V

Boldface limits apply over the specified temperature range, T_A = –40°C to +125°C.

At T_A = +25°C, R_L = 10kΩ connected to $V_S/2$, and $V_{OUT} = V_S/2$, $V_{CM} = V_S/2$, unless otherwise noted.

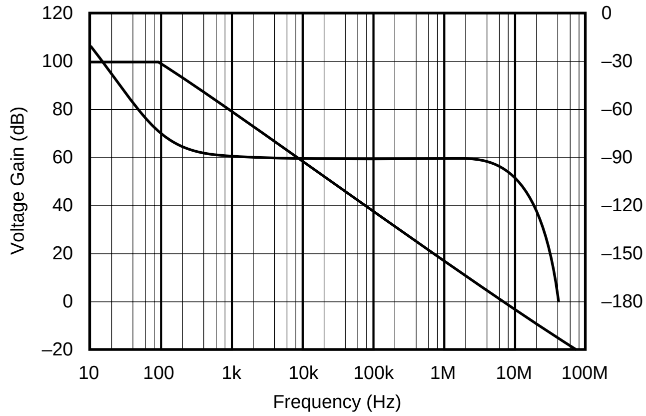
PARAMETER		CONDITION	OPAx363, OPAx364 MIN	TYP	MAX	UNITS
OFFSET VOLTAGE						
Input Offset Voltage, OPA363I, OPA364I	V_{OS}	V_S = +5V			500	µV
OPA2363I, OPA2364I					900	µV
OPA363AI, OPA364AI, OPA2363AI, OPA2364AI, OPA4364AI				1	2.5	mV
Drift	**dV_{OS}/dT**			**3**		**µV/°C**
vs Power Supply	**PSRR**	**V_S = 1.8V to 5.5V, V_{CM} = 0**		**80**	**330**	**µV/V**
Channel Separation, dc				1		µV/V
INPUT BIAS CURRENT						
Input Bias Current	I_B			±1	±10	pA
over Temperature				See Typical Characteristics		
Input Offset Current	I_{OS}			±1	±10	pA
NOISE						
Input Voltage Noise, f = 0.1Hz to 10Hz	e_n			10		µVp-p
Input Voltage Noise Density, f = 10kHz	e_n			17		nV/$\sqrt{Hz}$
Input Current Noise Density, f = 10kHz	i_n			0.6		fA/$\sqrt{Hz}$
INPUT VOLTAGE RANGE						
Common-Mode Voltage Range	V_{CM}		(V–) – 0.1		(V+) + 0.1	V
Common-Mode Rejection Ratio	**CMRR**	**(V–) – 0.1V < V_{CM} < (V+) + 0.1V**	**74**	**90**		**dB**
INPUT CAPACITANCE						
Differential				2		pF
Common-Mode				3		pF
OPEN-LOOP GAIN		R_L = 10kΩ, 100mV < V_O < (V+) – 100mV				
Open-Loop Voltage Gain	A_{OL}		94	100		dB
OPA4364AI			90			dB
over Temperature		**V_S = +1.8V to +5.5V**	**86**			**dB**
FREQUENCY RESPONSE		C_L = 100pF				
Gain Bandwidth Product	GBW			7		MHz
Slew Rate SR		G = +1		5		V/µs
Settling Time, 0.1%	t_S	V_S = +5V, 4V Step, G = +1		1		µs
0.01%		V_S = +5V, 4V Step, G = +1		1.5		µs
Overload Recovery Time		V_{IN} • Gain > V_S		0.8		µs
Total Harmonic Distortion + Noise	THD+N	V_S = +5V, G = +1, f = 20Hz to 20kHz		0.002		%
OUTPUT						
Voltage Output Swing from Rail		R_L = 10kΩ		10	20	mV
over Temperature		**R_L = 10kΩ**			**20**	**mV**
Short-Circuit Current	I_{SC}			See Typical Characteristics		mA
Capacitive Load Drive	C_{LOAD}			See Typical Characteristics		
SHUTDOWN (for OPAx363)						
t_{OFF}				1		µs
t_{ON}(1)				20		µs
V_L (shutdown)					(V–) + 0.8	V
V_H (amplifier is active)			0.75 (V+)		5.5	V
I_{QSD}					0.9	µA
POWER SUPPLY						
Specified Voltage Range	V_S		1.8		5.5	V
Operating Voltage Range				1.8 to 5.5		V
Quiescent Current (per amplifier)	I_Q	**V_S = +1.8V**		**650**	**750**	**µA**
		V_S = +3.6V		**850**	**1000**	**µA**
		V_S = +5.5V		**1.1**	**1.4**	**mA**
TEMPERATURE RANGE						
Specified Range			–40		+125	°C
Operating Range			–40		+150	°C
Storage Range			–65		+150	°C
Thermal Resistance	θ_{JA}					
SOT23-5, SOT23-6				200		°C/W
MSOP-8, MSOP-10, SO-8				150		°C/W
TSSOP-14, SO-14				100		°C/W

NOTE: (1) Part is considered enabled when input offset voltage returns to specified range.

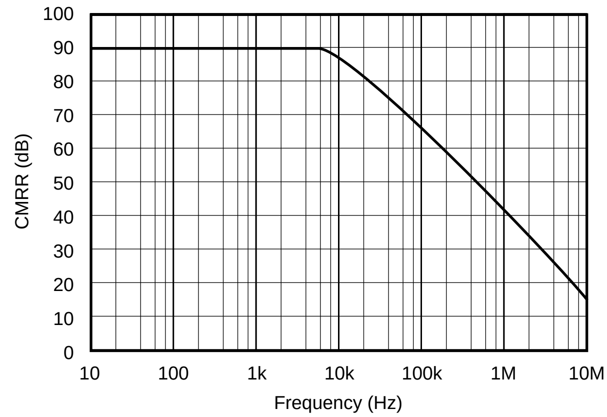
TYPICAL CHARACTERISTICS

At T_{CASE} = +25°C, R_L = 10kΩ, and connected to $V_S/2$, $V_{OUT} = V_S/2$, $V_{CM} = V_S/2$, unless otherwise noted.

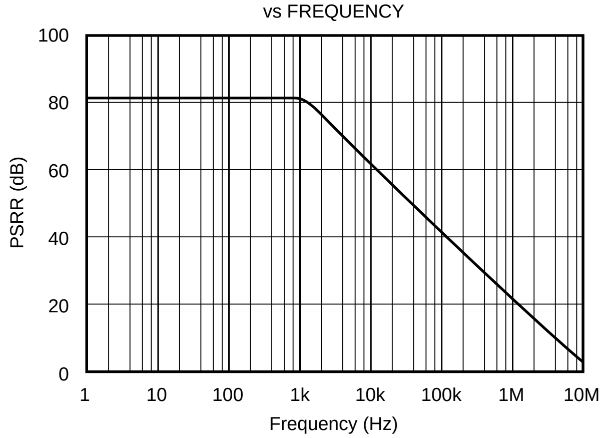
OPEN-LOOP GAIN/PHASE vs FREQUENCY



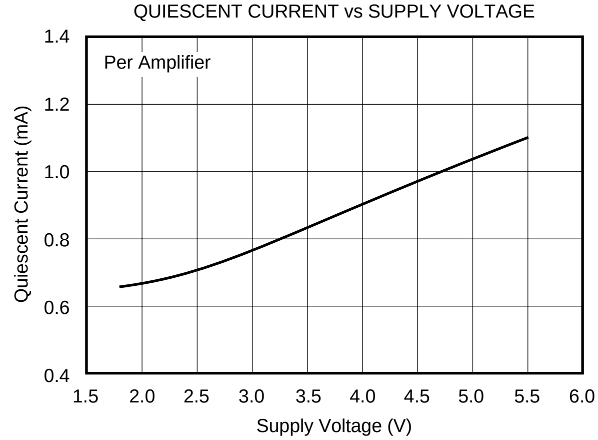
COMMON-MODE REJECTION RATIO vs FREQUENCY



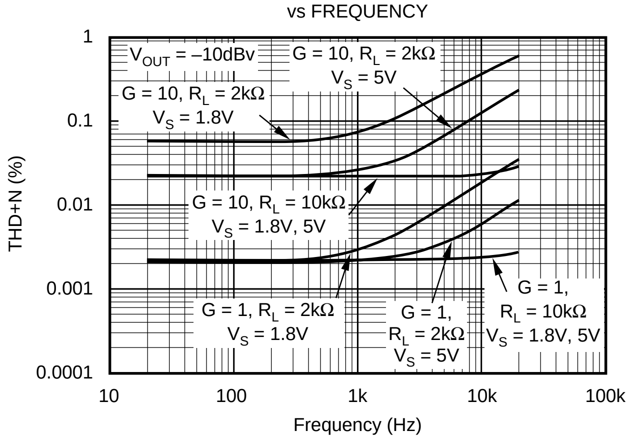
POWER-SUPPLY REJECTION RATIO vs FREQUENCY



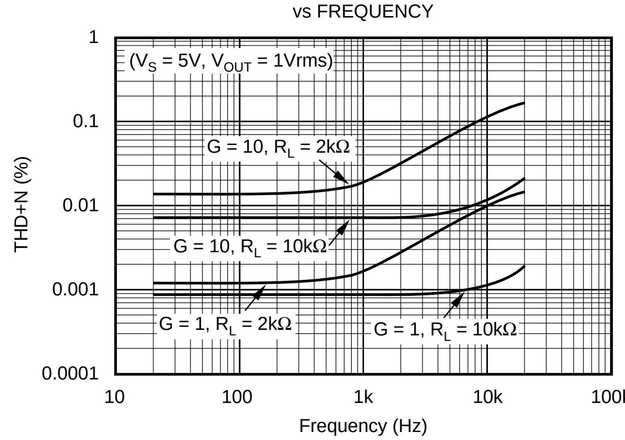
QUIESCENT CURRENT vs SUPPLY VOLTAGE



TOTAL HARMONIC DISTORTION + NOISE vs FREQUENCY



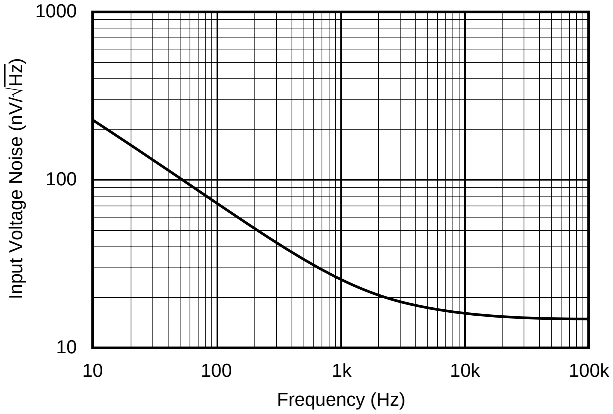
TOTAL HARMONIC DISTORTION + NOISE vs FREQUENCY



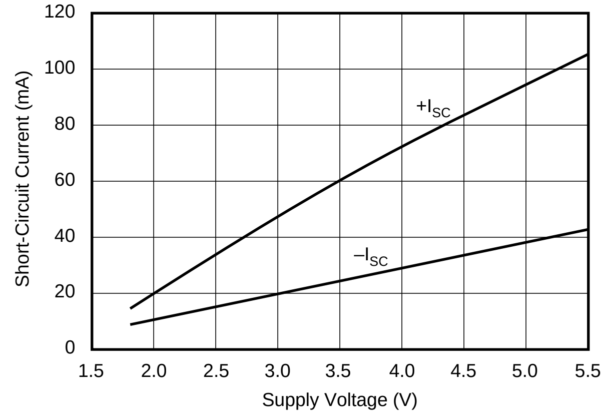
TYPICAL CHARACTERISTICS (Cont.)

At T_{CASE} = +25°C, R_L = 10kΩ, and connected to $V_S/2$, $V_{OUT} = V_S/2$, $V_{CM} = V_S/2$, unless otherwise noted.

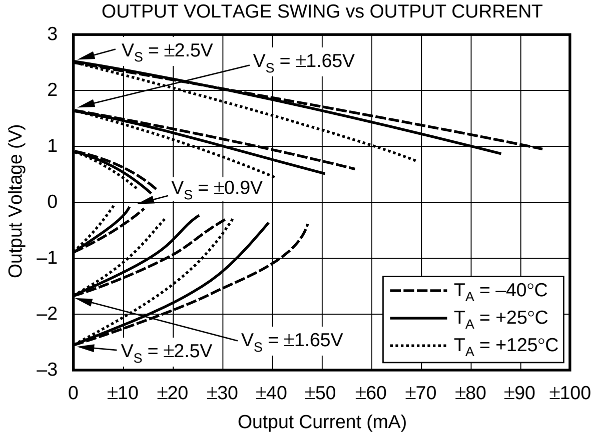
INPUT VOLTAGE NOISE SPECTRAL DENSITY
vs FREQUENCY



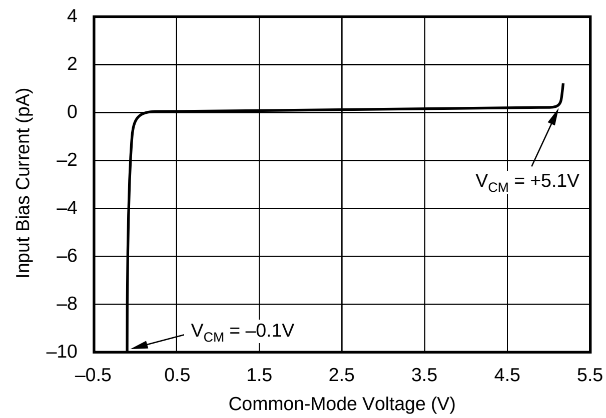
SHORT-CIRCUIT CURRENT vs SUPPLY VOLTAGE



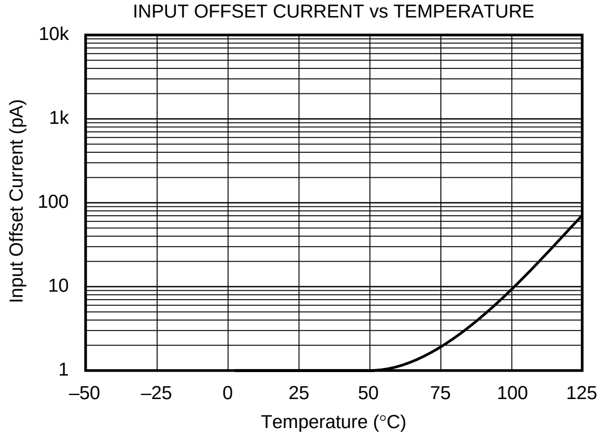
OUTPUT VOLTAGE SWING vs OUTPUT CURRENT



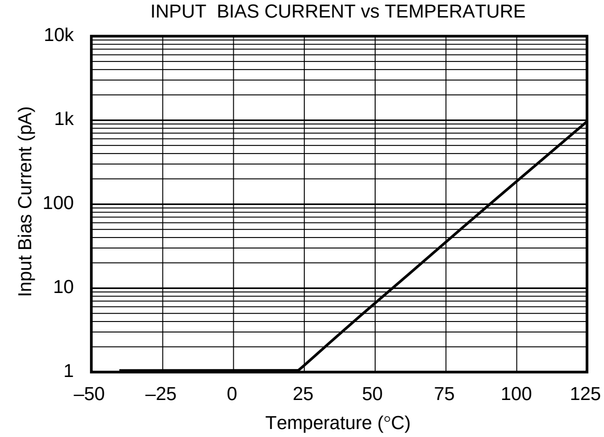
INPUT BIAS CURRENT
vs INPUT COMMON-MODE VOLTAGE



INPUT OFFSET CURRENT vs TEMPERATURE



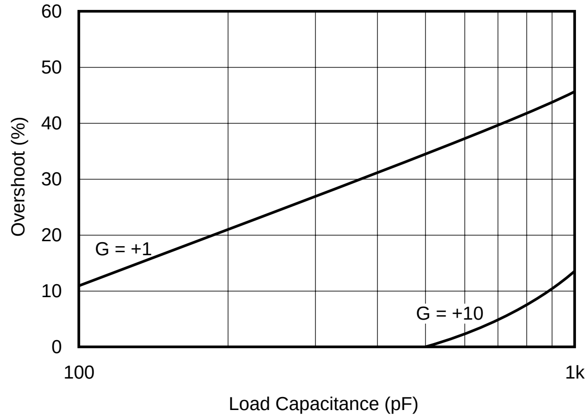
INPUT BIAS CURRENT vs TEMPERATURE



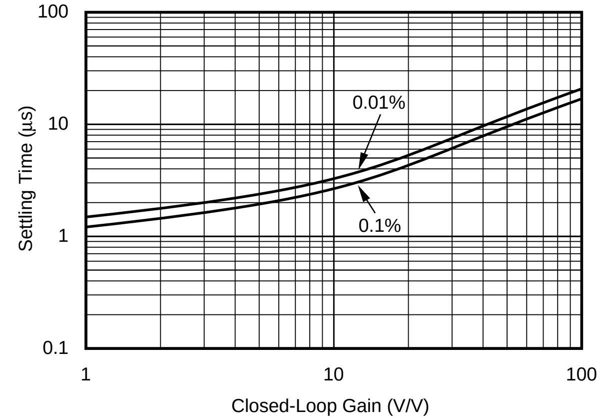
TYPICAL CHARACTERISTICS (Cont.)

At T_{CASE} = +25°C, R_L = 10kΩ, and connected to $V_S/2$, $V_{OUT} = V_S/2$, $V_{CM} = V_S/2$, unless otherwise noted.

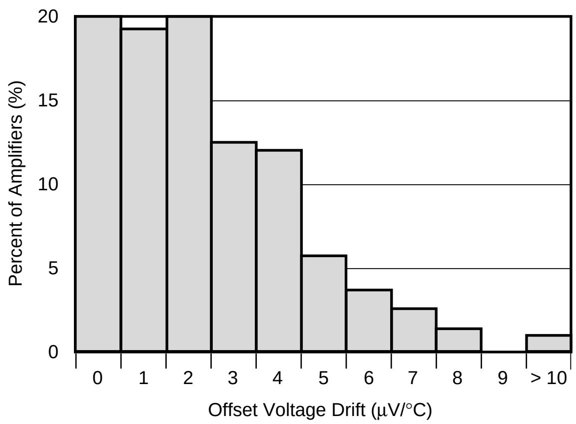
SMALL-SIGNAL OVERSHOOT vs LOAD CAPACITANCE



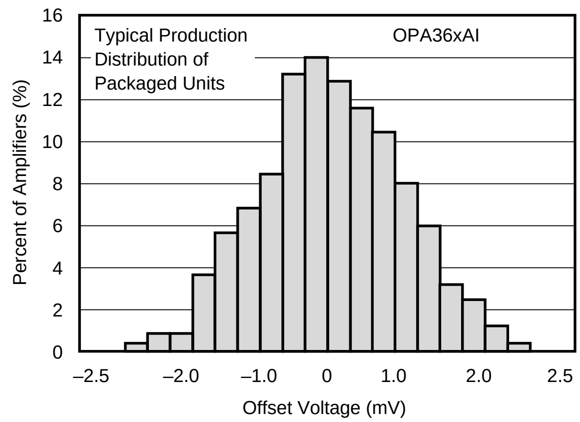
SETTLING TIME vs CLOSED-LOOP GAIN



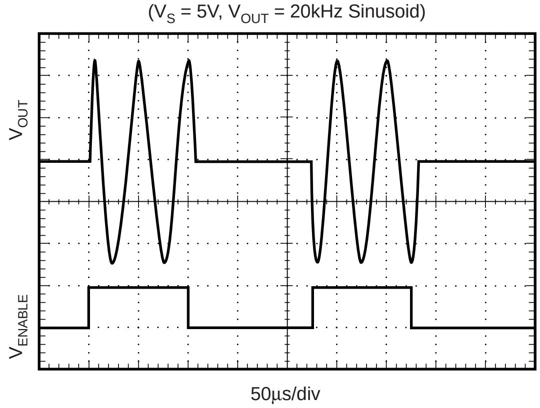
OFFSET DRIFT DISTRIBUTION



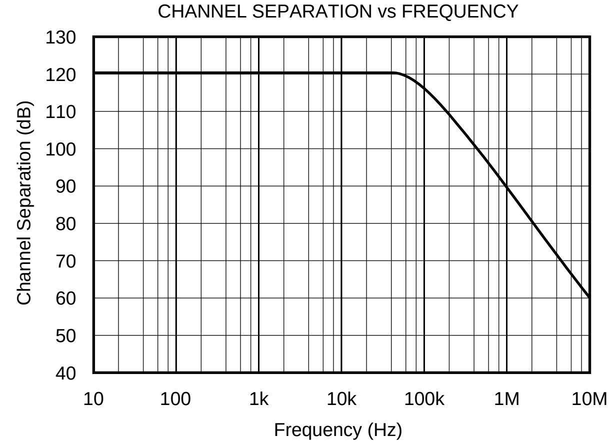
OFFSET VOLTAGE PRODUCTION DISTRIBUTION



OUTPUT ENABLE CHARACTERISTIC
(V_S = 5V, V_{OUT} = 20kHz Sinusoid)

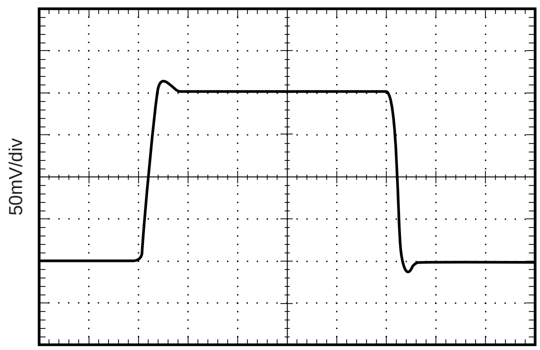


CHANNEL SEPARATION vs FREQUENCY

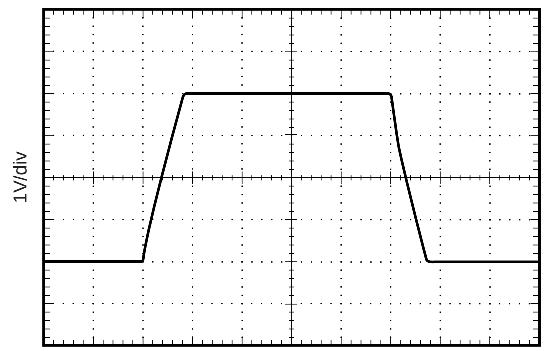


At T_{CASE} = +25°C, R_L = 10kΩ, and connected to $V_S/2$, $V_{OUT} = V_S/2$, $V_{CM} = V_S/2$, unless otherwise noted.

SMALL-SIGNAL STEP RESPONSE (C_L = 100pF)



LARGE-SIGNAL STEP RESPONSE (C_L = 100pF)



APPLICATIONS INFORMATION

The OPA363 and OPA364 series op amps are rail-to-rail operational amplifiers with excellent CMRR, low noise, low offset, and wide bandwidth on supply voltages as low as ±0.9V. The OPA363 features an additional pin for shutdown/ enable function. These families do not exhibit phase reversal and are unity-gain stable. Specified over the industrial temperature range of –40°C to +125°C, the OPA363 and OPA364 families offer precision performance for a wide range of applications.

RAIL-TO-RAIL INPUT

The OPA363 and OPA364 feature excellent rail-to-rail operation, with supply voltages as low as ±0.9V. The input common-mode voltage range of the OPA363 and OPA364 family extends 100mV beyond supply rails. The unique input topology of the OPA363 and OPA364 eliminates the input offset transition region typical of most rail-to-rail complimentary stage operational amplifiers, allowing the OPA363 and OPA364 to provide superior common-mode performance over the entire common-mode input range, as seen in Figure 1. This feature prevents degradation of the differential linearity error and THD when driving A/D converters. A simplified schematic of the OPA363 and OPA364 is shown in Figure 2.

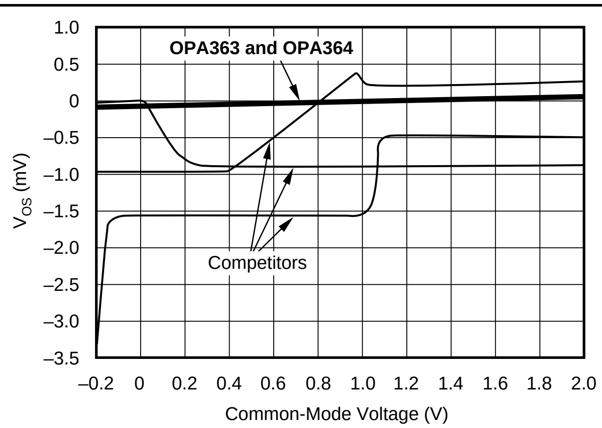


FIGURE 1. OPA363 and OPA364 have Linear Offset Over Entire Common-Mode Range.

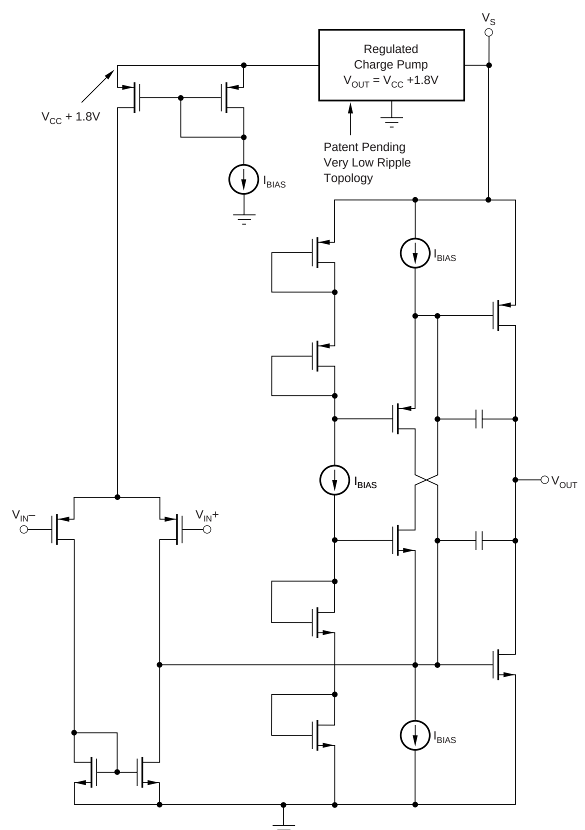


FIGURE 2. Simplified Schematic.

OPERATING VOLTAGE

The OPA363 and OPA364 series op amp parameters are fully specified from +1.8V to +5.5V. Single 0.1µF bypass capacitors should be placed across supply pins and as close to the part as possible. Supply voltages higher than 5.5V (absolute maximum) may cause permanent damage to the amplifier. Many specifications apply from –40°C to +125°C. Parameters that vary significantly with operating voltages or temperature are shown in the Typical Characteristics.

ENABLE FUNCTION

The shutdown (enable) function of the OPA363 is referenced to the negative supply voltage of the operational amplifier. A logic level HIGH enables the op amp. A valid logic HIGH is defined as voltage > 75% of the positive supply applied to the enable pin. The valid logic HIGH signal can be as much as 5.5V above the negative supply, independent of the positive supply voltage. A valid logic LOW is defined as < 0.8V above the negative supply pin. If dual or split power supplies are used, care should be taken to ensure logic input signals are properly referred to the negative supply voltage. This pin should be connected to a valid high or low voltage or driven, not left open circuit.

The logic input is a high-impedance CMOS input. Dual op amps are provided separate logic inputs. For battery-operated applications, this feature may be used to greatly reduce the average current and extend battery life. The enable time is 20µs; disable time is 1µs. When disabled, the output assumes a high-impedance state. This allows the OPA363 to be operated as a “gated” amplifier, or to have its output multiplexed onto a common analog output bus.

CAPACITIVE LOAD

The OPA363 and OPA364 series op amps can drive a wide range of capacitive loads. However, all op amps under certain conditions may become unstable. Op amp configuration, gain, and load value are just a few of the factors to consider when determining stability. An op amp in unity-gain configuration is the most susceptible to the effects of capacitive load. The capacitive load reacts with the output resistance of the op amp to create a pole in the small-signal response, which degrades the phase margin.

In unity gain, the OPA363 and OPA364 series op amps perform well with a pure capacitive load up to approximately 1000pF. The ESR (Equivalent Series Resistance) of the loading capacitor may be sufficient to allow the OPA363 and OPA364 to directly drive very large capacitive loads (> 1µF). Increasing gain enhances the amplifier’s ability to drive more capacitance. See the typical characteristic “Small-Signal Overshoot vs Capacitive Load.”

One method of improving capacitive load drive in the unity-gain configuration is to insert a 10Ω to 20Ω resistor in series with the output, as shown in Figure 3. This significantly reduces ringing with large capacitive loads. However, if there is a resistive load in parallel with the capacitive load, it creates a voltage divider introducing a dc error at the output and slightly reduces output swing. This error may be insignificant. For instance, with R_L = 10kΩ and R_S = 20Ω, there is only about a 0.2% error at the output.

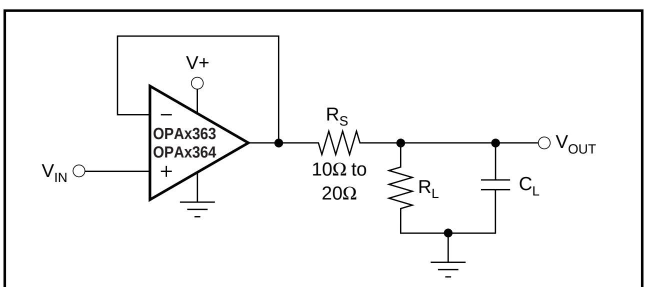


FIGURE 3. Improving Capacitive Load Drive.

INPUT AND ESD PROTECTION

All OPA363 and OPA364 pins are static protected with internal ESD protection diodes tied to the supplies. These diodes will provide overdrive protection if the current is externally limited to 10mA, as stated in the absolute maximum ratings and shown in Figure 4.

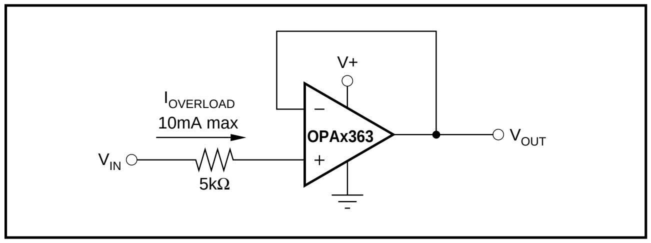


FIGURE 4. Input Current Protection.

ACHIEVING OUTPUT SWING TO THE OP AMP’S NEGATIVE RAIL

Some applications require an accurate output voltage swing from 0V to a positive full-scale voltage. A good single supply op amp may be able to swing within a few mV of single supply ground, but as the output is driven toward 0V, the output stage of the amplifier will prevent the output from reaching the negative supply rail of the amplifier.

The output of the OPA363 or OPA364 can be made to swing to ground, or slightly below, on a single supply power source. To do so requires use of another resistor and an additional, more negative power supply than the op amp’s negative supply. A pulldown resistor may be connected between the output and the additional negative supply to pull the output down below the value that the output would otherwise achieve as shown in Figure 5.

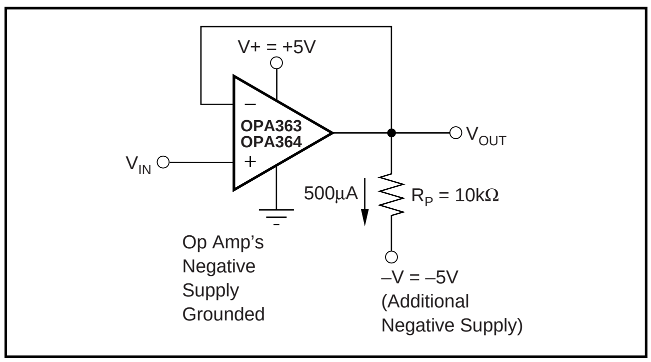


FIGURE 5. OPA363 and OPA364 Swing to Ground.

This technique will not work with all op amps. The output stage of the OPA363 and OPA364 allows the output voltage to be pulled below that of most op amps, if approximately 500µA is maintained through the output stage. To calculate the appropriate value load resistor and negative supply, R_L = –V/500µA. The OPA363 and OPA364 have been characterized to perform well under the described conditions, maintaining excellent accuracy down to 0V and as low as –10mV. Limiting and nonlinearity occur below –10mV, with linearity returning as the output is again driven above –10mV.

BUFFERED REFERENCE VOLTAGE

Many single-supply applications require a mid-supply reference voltage. The OPA363 and OPA364 offer excellent capacitive load drive capability, and can be configured to provide a 0.9V reference voltage, as can be seen in Figure 6. For appropriate loading considerations, see the “Capacitive Load” section.

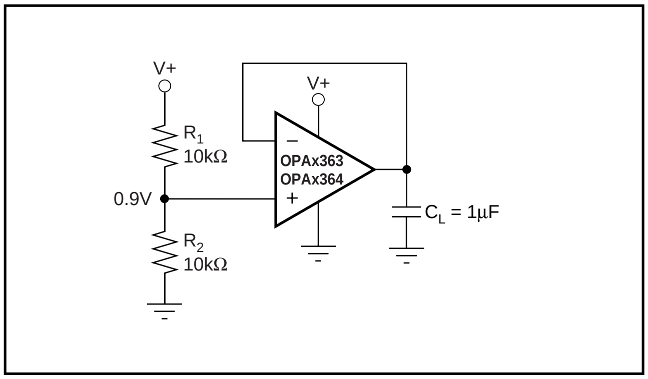


FIGURE 6. The OPA363 and OPA364 Provide a Stable Reference Voltage.

DIRECTLY DRIVING THE ADS8324 AND THE MSP430

The OPA363 and OPA364 series op amps are optimized for driving medium speed (up to 100kHz) sampling A/D converters. However, they also offer excellent performance for higher speed converters. The no crossover input stage of the OPA363 and OPA364 directly drive A/D converters without degradation of differential linearity and THD. They provide an effective means of buffering the A/D converters input capacitance and resulting charge injection while providing signal gain. Figure 7 and Figure 8 show the OPA363 and OPA364 configured to drive the ADS8324 and the 12-bit A/D converter on the MSP430.

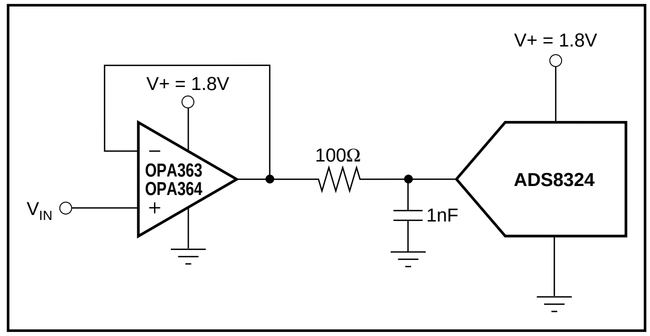


FIGURE 7. The OPA363 and OPA364 Directly Drive the ADS8324.

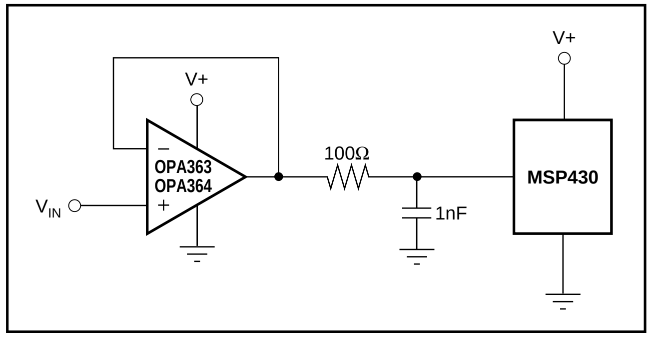


FIGURE 8. Driving the 12-Bit A/D Converter on the MSP430.

AUDIO APPLICATIONS

The OPA363 and OPA364 op amp family has linear offset voltage over the entire input common-mode range. Combined with low-noise, this feature makes the OPA363 and OPA364 suitable for audio applications. Single supply 1.8V operation allows the OPA2363 and OPA2364 to be optimal candidates for dual stereo-headphone drivers and microphone pre-amplifiers in portable stereo equipment, see Figures 9 and 10.

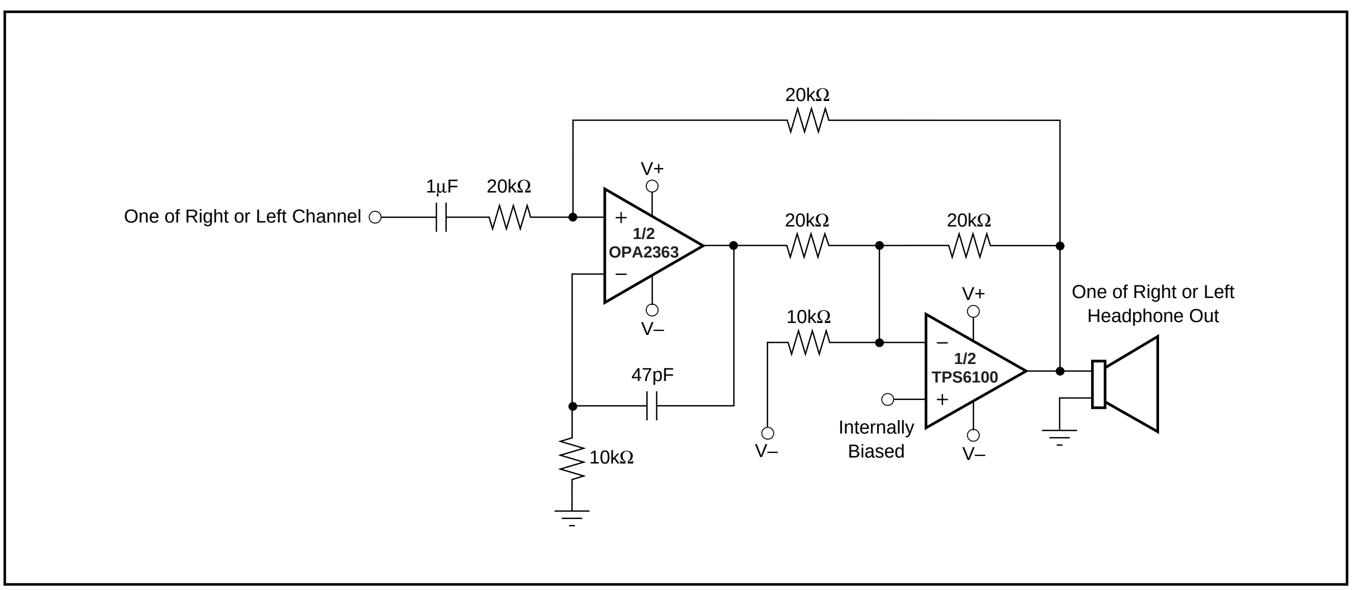


FIGURE 9. OPA2363 Configured as Half of a Dual Stereo Headphone Driver.

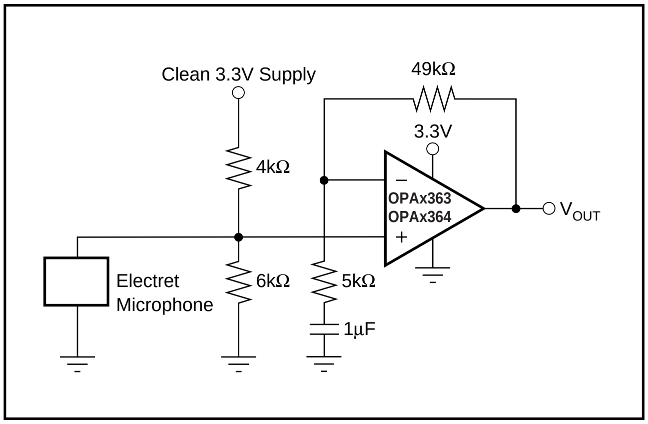


FIGURE 10. Microphone Preamplifier.

ACTIVE FILTERING

Low harmonic distortion and noise specifications plus high gain and slew rate make the OPA363 and OPA364 optimal candidates for active filtering. Figure 11 shows the OPA2363 configured as a low-distortion, 3rd-order GIC (General Immittance Converter) filter. Figure 12 shows the implementation of a Sallen-Key, 3-pole, low-pass Bessel filter.

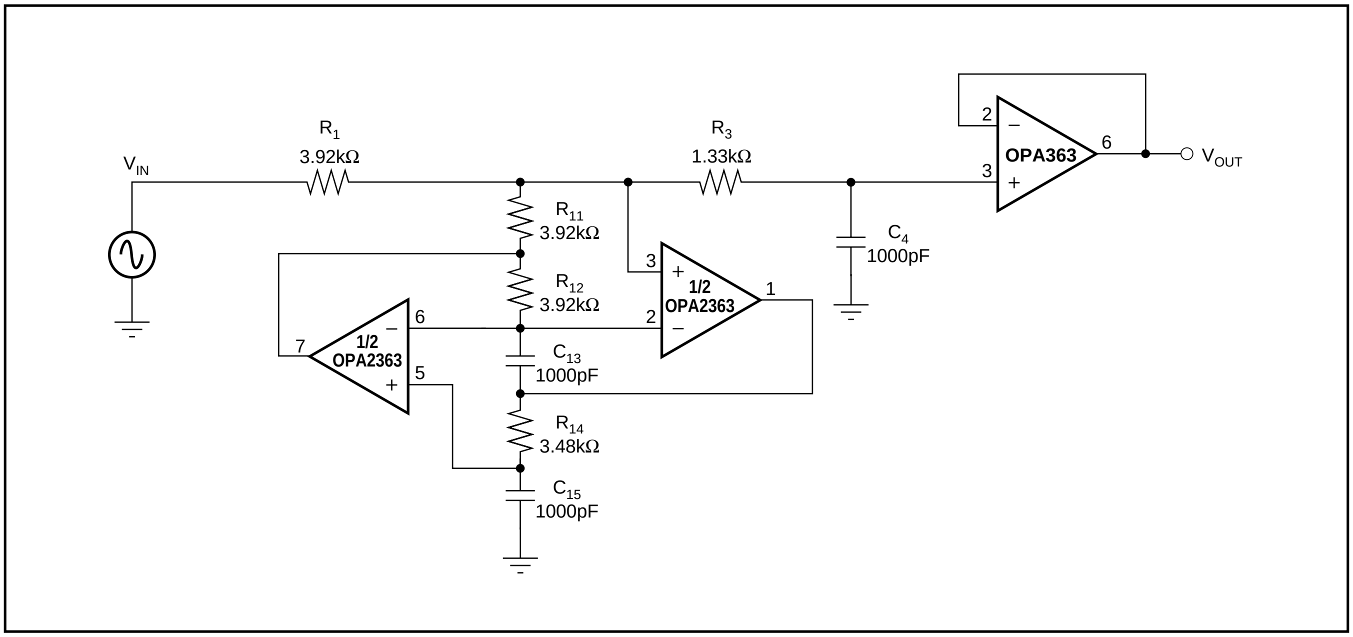


FIGURE 11. The OPA2363 as a 3rd-Order, 40kHz, Low-Pass GIC Filter.

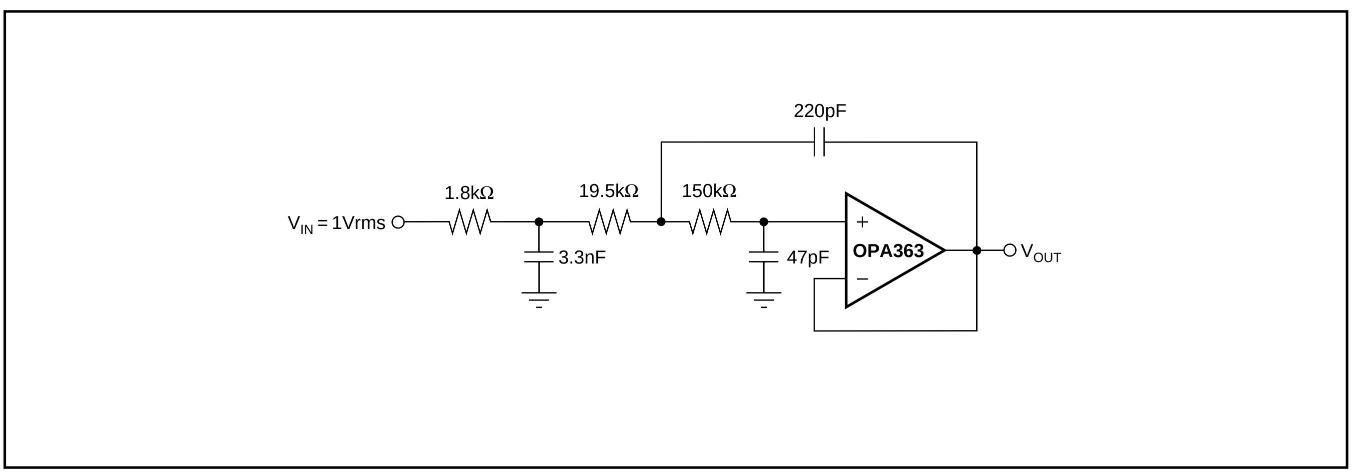


FIGURE 12. The OPA363 or OPA364 Configured as a 3-Pole, 20kHz, Sallen-Key Filter.

PACKAGING INFORMATION

Orderable Device	Status [1]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [2]	Lead/Ball Finish	MSL Peak Temp [3]
OPA2363AIDGSR	ACTIVE	MSOP	DGS	10	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2363AIDGSRG4	ACTIVE	MSOP	DGS	10	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2363AIDGST	ACTIVE	MSOP	DGS	10	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2363AIDGSTG4	ACTIVE	MSOP	DGS	10	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2363IDGSR	ACTIVE	MSOP	DGS	10	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2363IDGSRG4	ACTIVE	MSOP	DGS	10	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2363IDGST	ACTIVE	MSOP	DGS	10	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2363IDGSTG4	ACTIVE	MSOP	DGS	10	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2364AID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2364AIDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2364AIDGKR	ACTIVE	MSOP	DGK	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2364AIDGKRG4	ACTIVE	MSOP	DGK	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2364AIDGKT	ACTIVE	MSOP	DGK	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2364AIDGKTG4	ACTIVE	MSOP	DGK	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2364AIDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2364AIDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2364ID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2364IDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2364IDGKR	ACTIVE	MSOP	DGK	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2364IDGKRG4	ACTIVE	MSOP	DGK	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2364IDGKT	ACTIVE	MSOP	DGK	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2364IDGKTG4	ACTIVE	MSOP	DGK	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2364IDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA2364IDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA363AID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
OPA363AIDBVR	ACTIVE	SOT-23	DBV	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA363AIDBVRG4	ACTIVE	SOT-23	DBV	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA363AIDBVT	ACTIVE	SOT-23	DBV	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA363AIDBVTG4	ACTIVE	SOT-23	DBV	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA363AIDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA363ID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA363IDBVR	ACTIVE	SOT-23	DBV	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA363IDBVRG4	ACTIVE	SOT-23	DBV	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA363IDBVT	ACTIVE	SOT-23	DBV	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA363IDBVTG4	ACTIVE	SOT-23	DBV	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA363IDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA364AID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA364AIDBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA364AIDBVRG4	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA364AIDBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA364AIDBVTG4	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA364AIDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA364AIDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA364AIDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA364ID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA364IDBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA364IDBVRG4	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA364IDBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA364IDBVTG4	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA364IDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA364IDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
OPA364IDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA4364AID	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA4364AIDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA4364AIDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA4364AIDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA4364AIPWR	ACTIVE	TSSOP	PW	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA4364AIPWRG4	ACTIVE	TSSOP	PW	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA4364AIPWT	ACTIVE	TSSOP	PW	14	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
OPA4364AIPWTG4	ACTIVE	TSSOP	PW	14	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR

(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.

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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 OPA4364 :

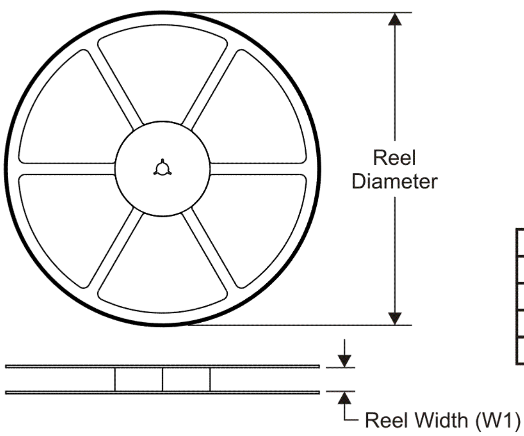
- Automotive: OPA4364-Q1

NOTE: Qualified Version Definitions:

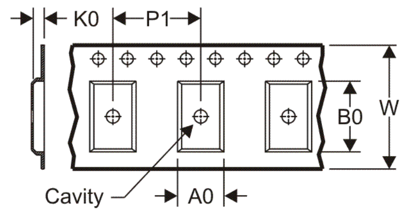
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

TAPE AND REEL INFORMATION

REEL DIMENSIONS

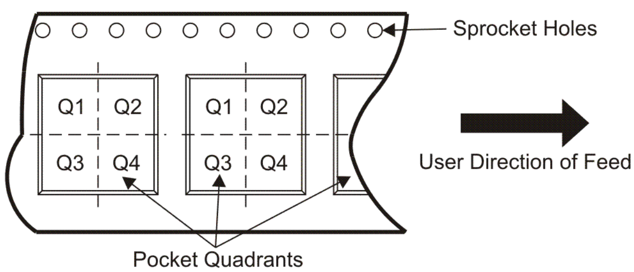


TAPE DIMENSIONS



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

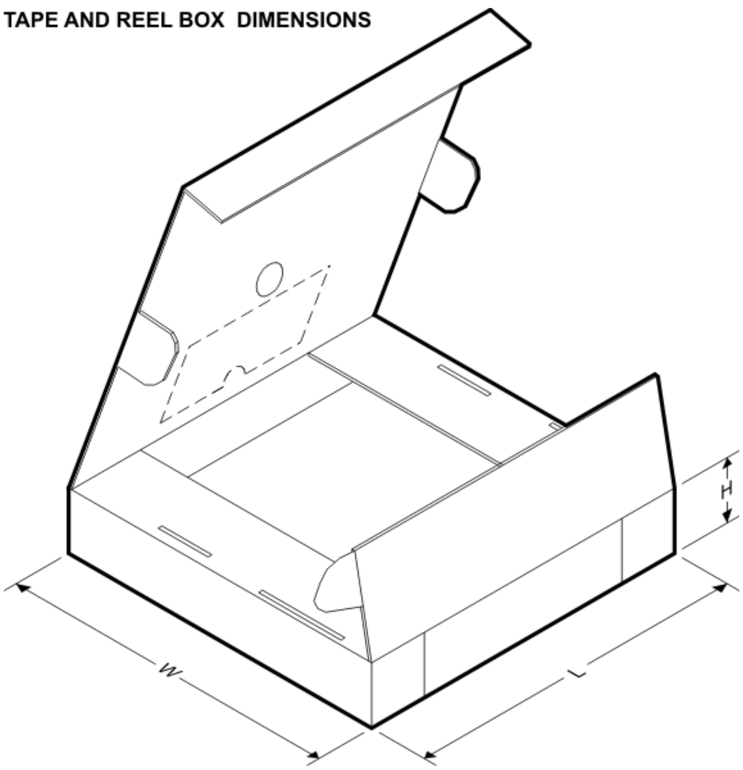


*All dimensions are nominal

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
OPA2363AIDGSR	MSOP	DGS	10	2500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
OPA2363AIDGST	MSOP	DGS	10	250	180.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
OPA2363IDGSR	MSOP	DGS	10	2500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
OPA2363IDGST	MSOP	DGS	10	250	180.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
OPA2364AIDGKR	MSOP	DGK	8	2500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
OPA2364AIDGKT	MSOP	DGK	8	250	180.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
OPA2364AIDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
OPA2364IDGKR	MSOP	DGK	8	2500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
OPA2364IDGKT	MSOP	DGK	8	250	180.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
OPA2364IDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
OPA363AIDBVR	SOT-23	DBV	6	3000	180.0	8.4	3.2	3.1	1.39	4.0	8.0	Q3
OPA363AIDBVT	SOT-23	DBV	6	250	180.0	8.4	3.2	3.1	1.39	4.0	8.0	Q3
OPA363IDBVR	SOT-23	DBV	6	3000	180.0	8.4	3.2	3.1	1.39	4.0	8.0	Q3
OPA363IDBVT	SOT-23	DBV	6	250	180.0	8.4	3.2	3.1	1.39	4.0	8.0	Q3
OPA364AIDBVR	SOT-23	DBV	5	3000	180.0	8.4	3.2	3.1	1.39	4.0	8.0	Q3
OPA364AIDBVT	SOT-23	DBV	5	250	180.0	8.4	3.2	3.1	1.39	4.0	8.0	Q3
OPA364AIDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
OPA364IDBVR	SOT-23	DBV	5	3000	180.0	8.4	3.2	3.1	1.39	4.0	8.0	Q3

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
OPA364IDBVT	SOT-23	DBV	5	250	180.0	8.4	3.2	3.1	1.39	4.0	8.0	Q3
OPA364IDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
OPA4364AIDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
OPA4364AIPWR	TSSOP	PW	14	2500	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
OPA4364AIPWT	TSSOP	PW	14	250	180.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS

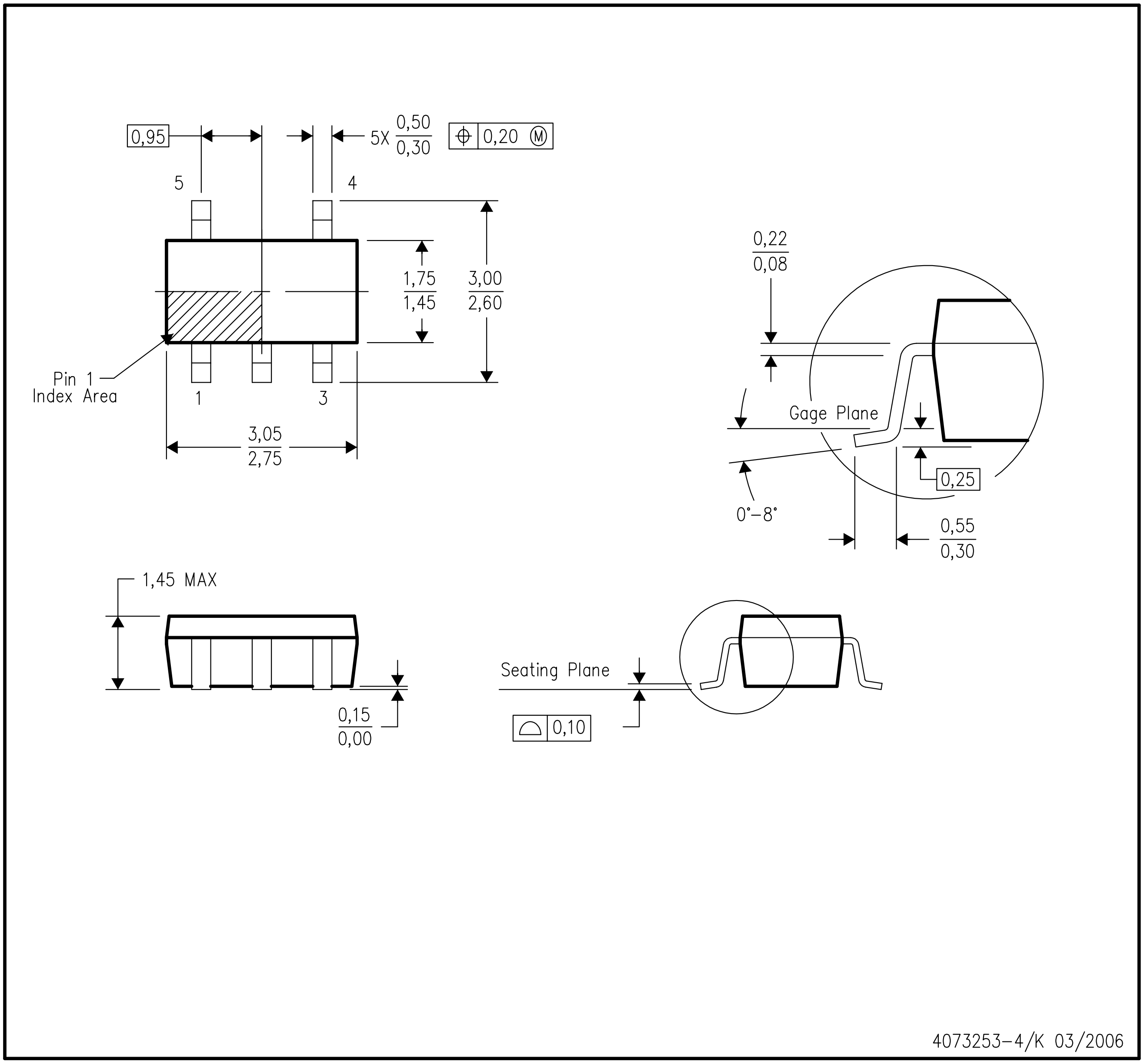


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
OPA2363AIDGSR	MSOP	DGS	10	2500	346.0	346.0	29.0
OPA2363AIDGST	MSOP	DGS	10	250	190.5	212.7	31.8
OPA2363IDGSR	MSOP	DGS	10	2500	346.0	346.0	29.0
OPA2363IDGST	MSOP	DGS	10	250	190.5	212.7	31.8
OPA2364AIDGKR	MSOP	DGK	8	2500	346.0	346.0	29.0
OPA2364AIDGKT	MSOP	DGK	8	250	190.5	212.7	31.8
OPA2364AIDR	SOIC	D	8	2500	346.0	346.0	29.0
OPA2364IDGKR	MSOP	DGK	8	2500	346.0	346.0	29.0
OPA2364IDGKT	MSOP	DGK	8	250	190.5	212.7	31.8
OPA2364IDR	SOIC	D	8	2500	346.0	346.0	29.0
OPA363AIDBVR	SOT-23	DBV	6	3000	190.5	212.7	31.8
OPA363AIDBVT	SOT-23	DBV	6	250	190.5	212.7	31.8

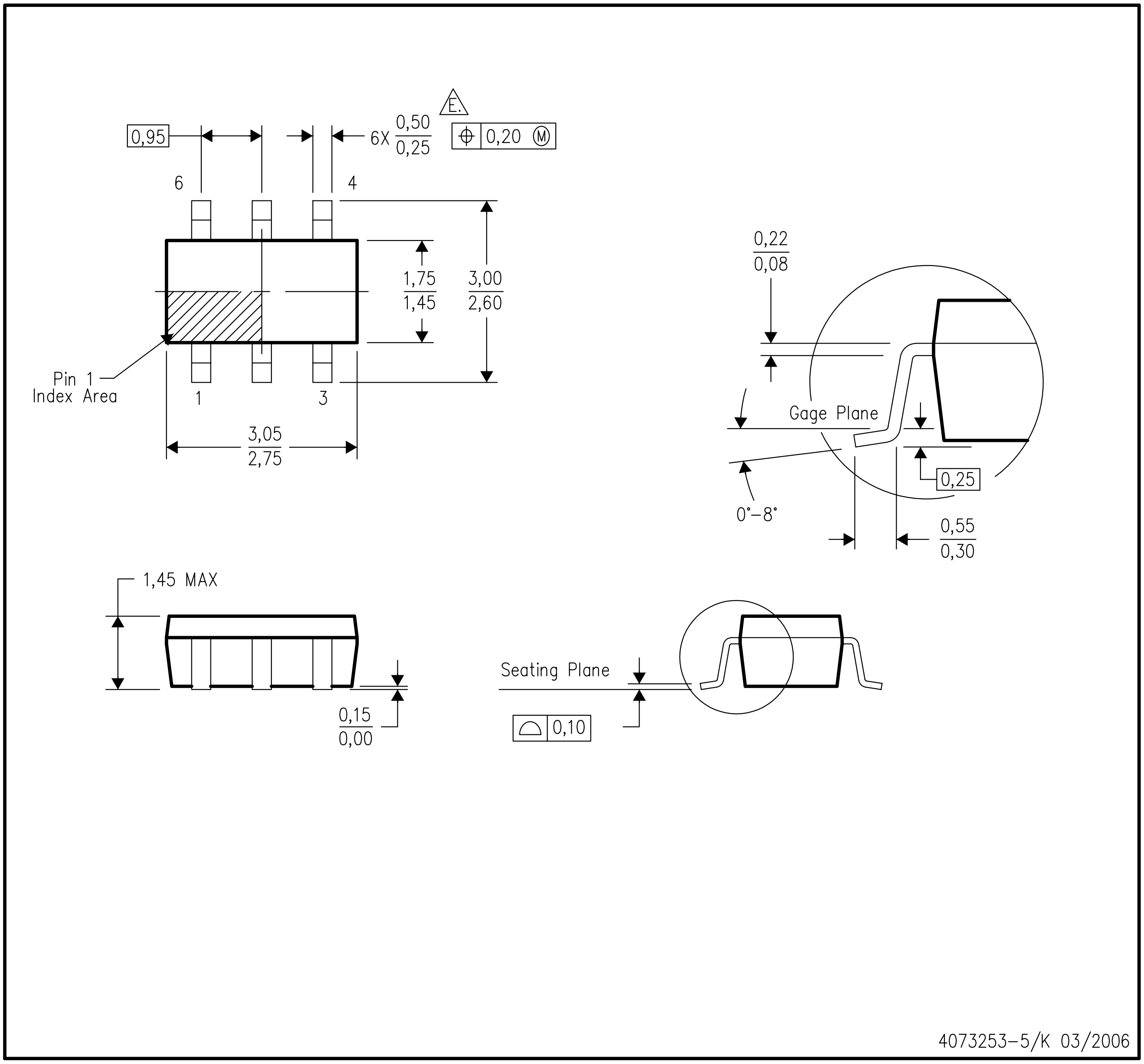
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
OPA363IDBVR	SOT-23	DBV	6	3000	190.5	212.7	31.8
OPA363IDBVT	SOT-23	DBV	6	250	190.5	212.7	31.8
OPA364AIDBVR	SOT-23	DBV	5	3000	190.5	212.7	31.8
OPA364AIDBVT	SOT-23	DBV	5	250	190.5	212.7	31.8
OPA364AIDR	SOIC	D	8	2500	346.0	346.0	29.0
OPA364IDBVR	SOT-23	DBV	5	3000	190.5	212.7	31.8
OPA364IDBVT	SOT-23	DBV	5	250	190.5	212.7	31.8
OPA364IDR	SOIC	D	8	2500	346.0	346.0	29.0
OPA4364AIDR	SOIC	D	14	2500	346.0	346.0	33.0
OPA4364AIPWR	TSSOP	PW	14	2500	346.0	346.0	29.0
OPA4364AIPWT	TSSOP	PW	14	250	190.5	212.7	31.8

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



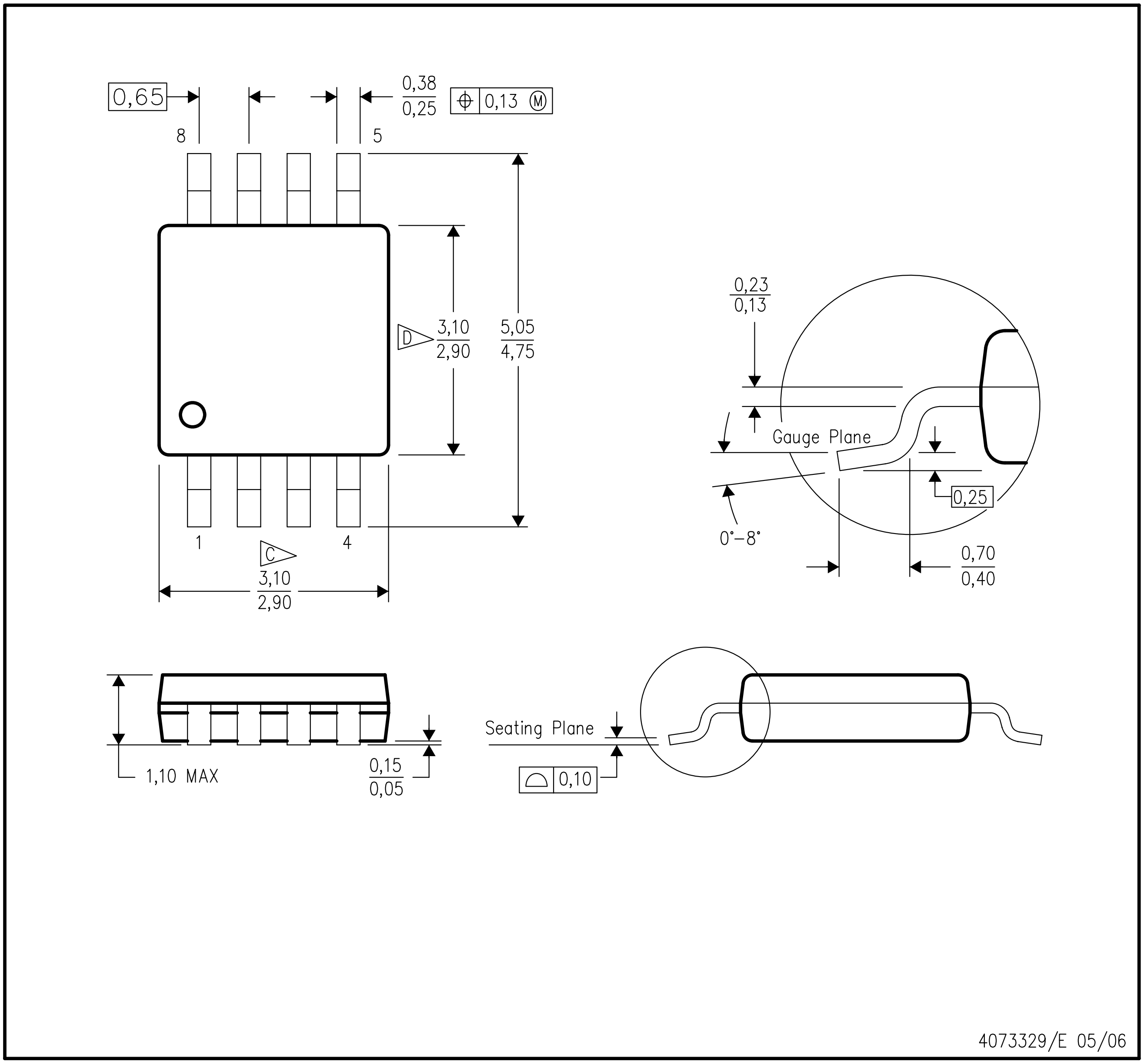
NOTES:
- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
- D. Falls within JEDEC MO–178 Variation AA.

DBV (R-PDSO-G6) PLASTIC SMALL-OUTLINE PACKAGE



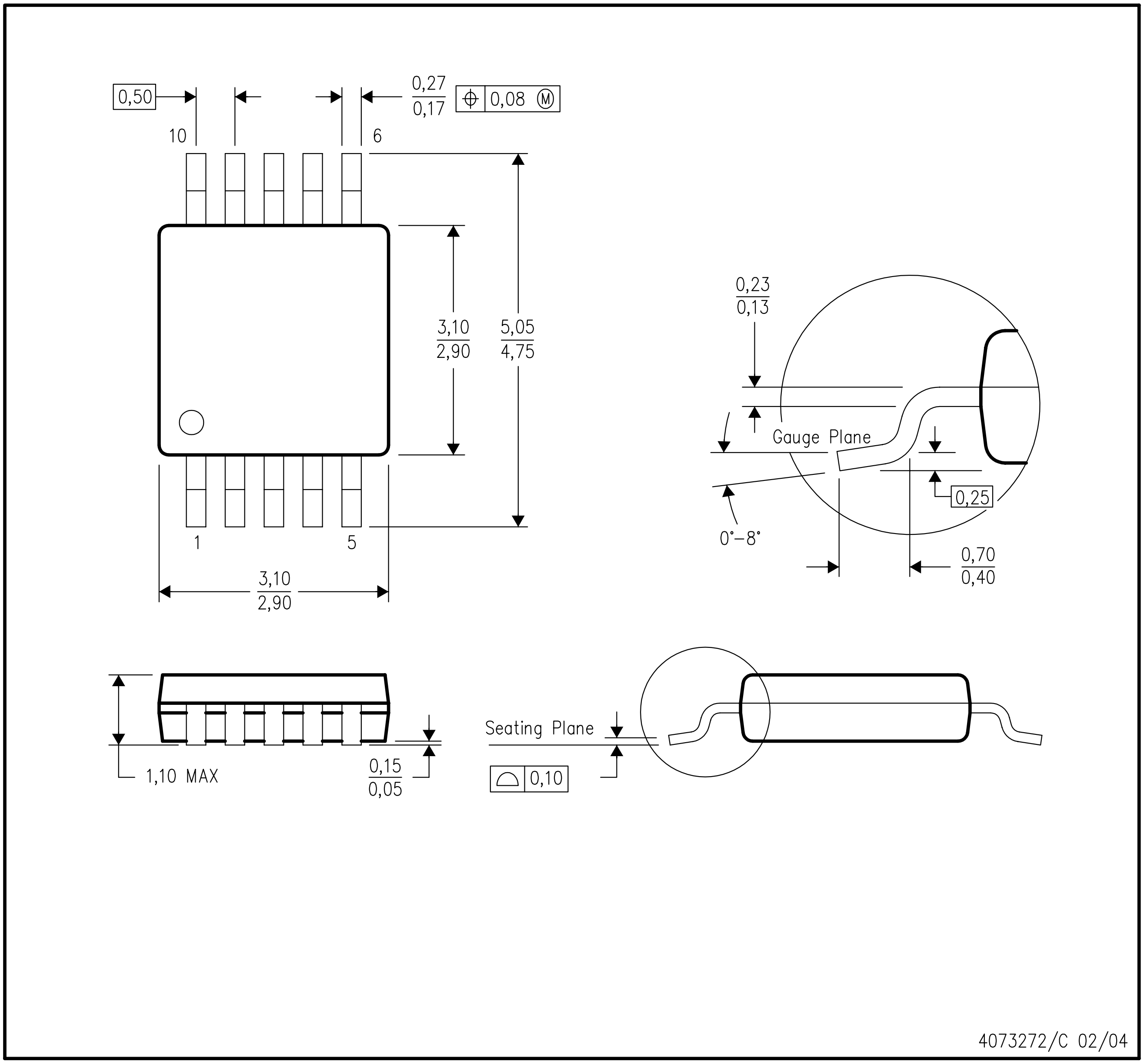
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
D. Leads 1,2,3 may be wider than leads 4,5,6 for package orientation.
E. Falls within JEDEC MO-178 Variation AB, except minimum lead width.

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



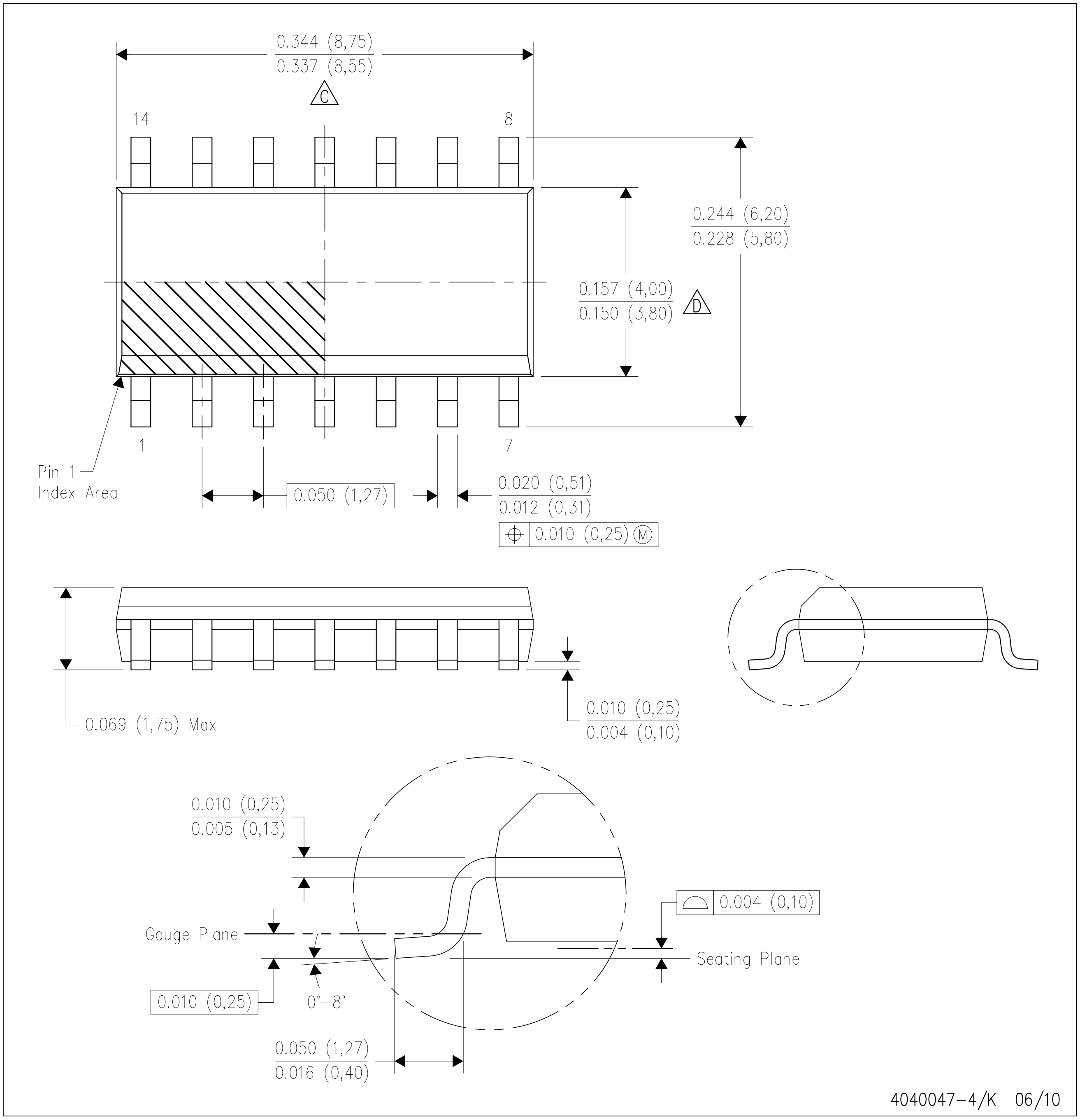
NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 per end.
D. Body width does not include interlead flash. Interlead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

DGS (S-PDSO-G10) PLASTIC SMALL-OUTLINE PACKAGE



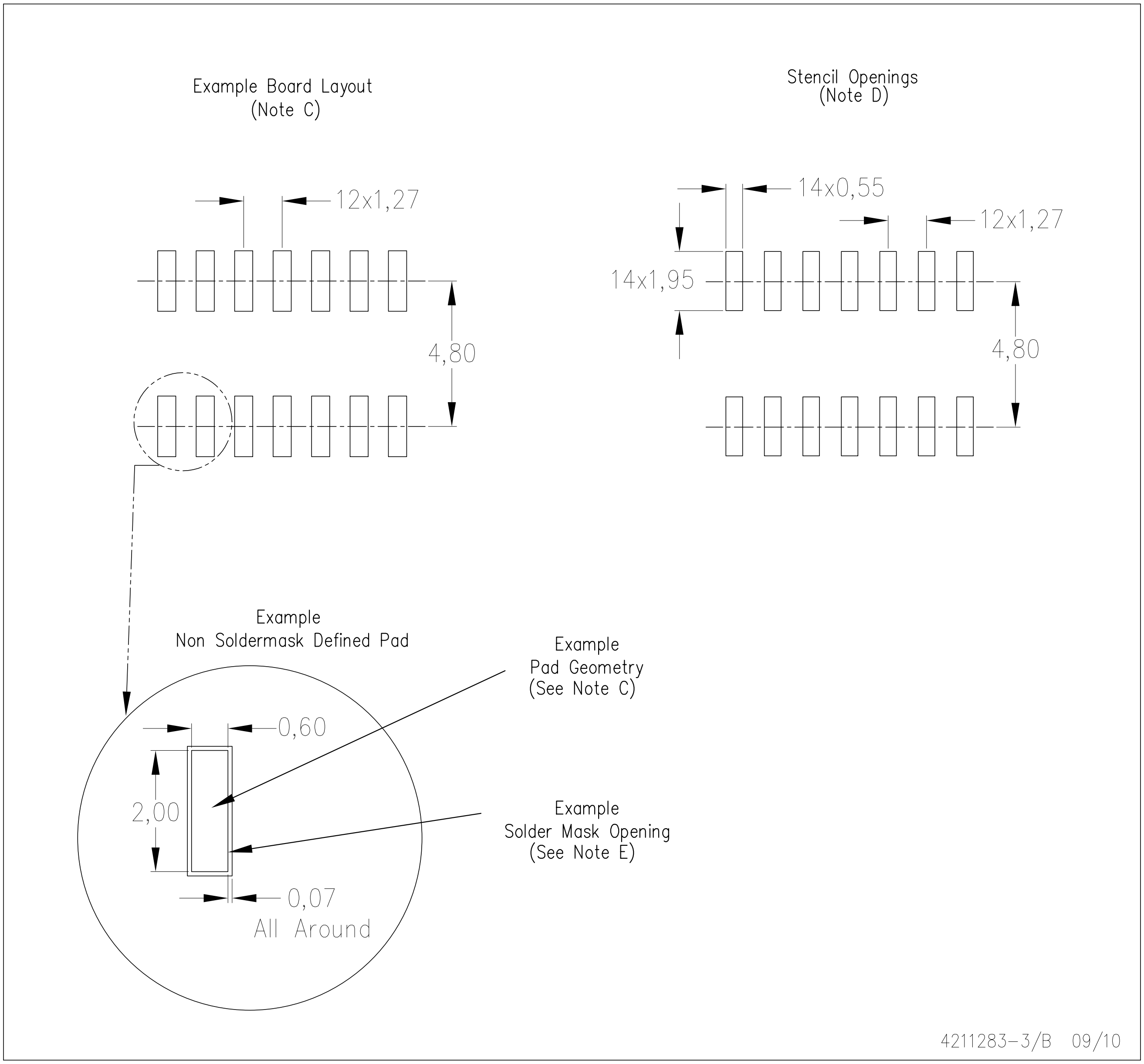
NOTES:
- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Body dimensions do not include mold flash or protrusion.
- D. Falls within JEDEC MO-187 variation BA.

D (R–PDSO–G14) PLASTIC SMALL–OUTLINE PACKAGE



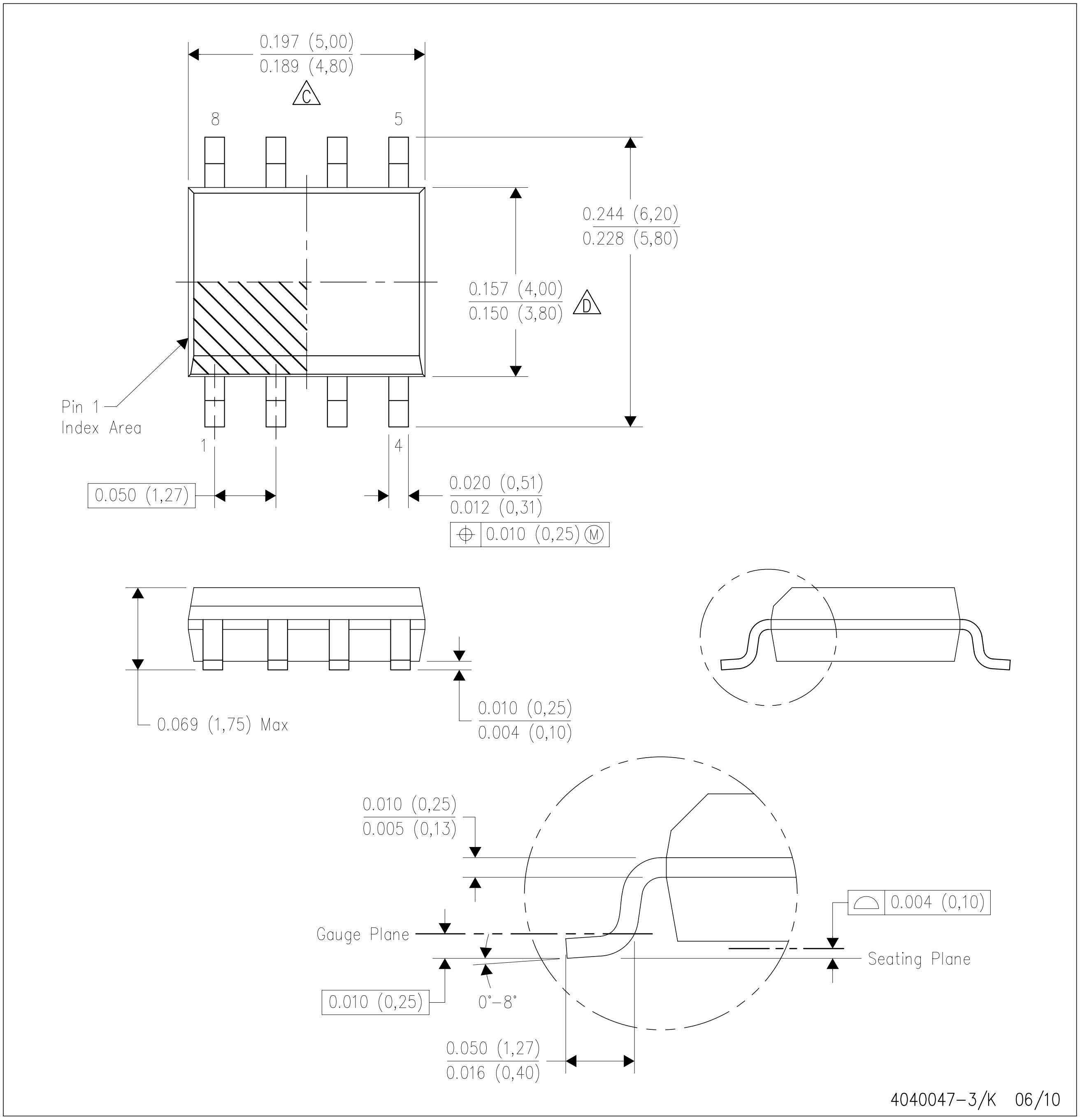
NOTES:
- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 (0,15) per end.
- D. Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
- E. Reference JEDEC MS–012 variation AB.

D (R-PDSO-G14) PLASTIC SMALL OUTLINE



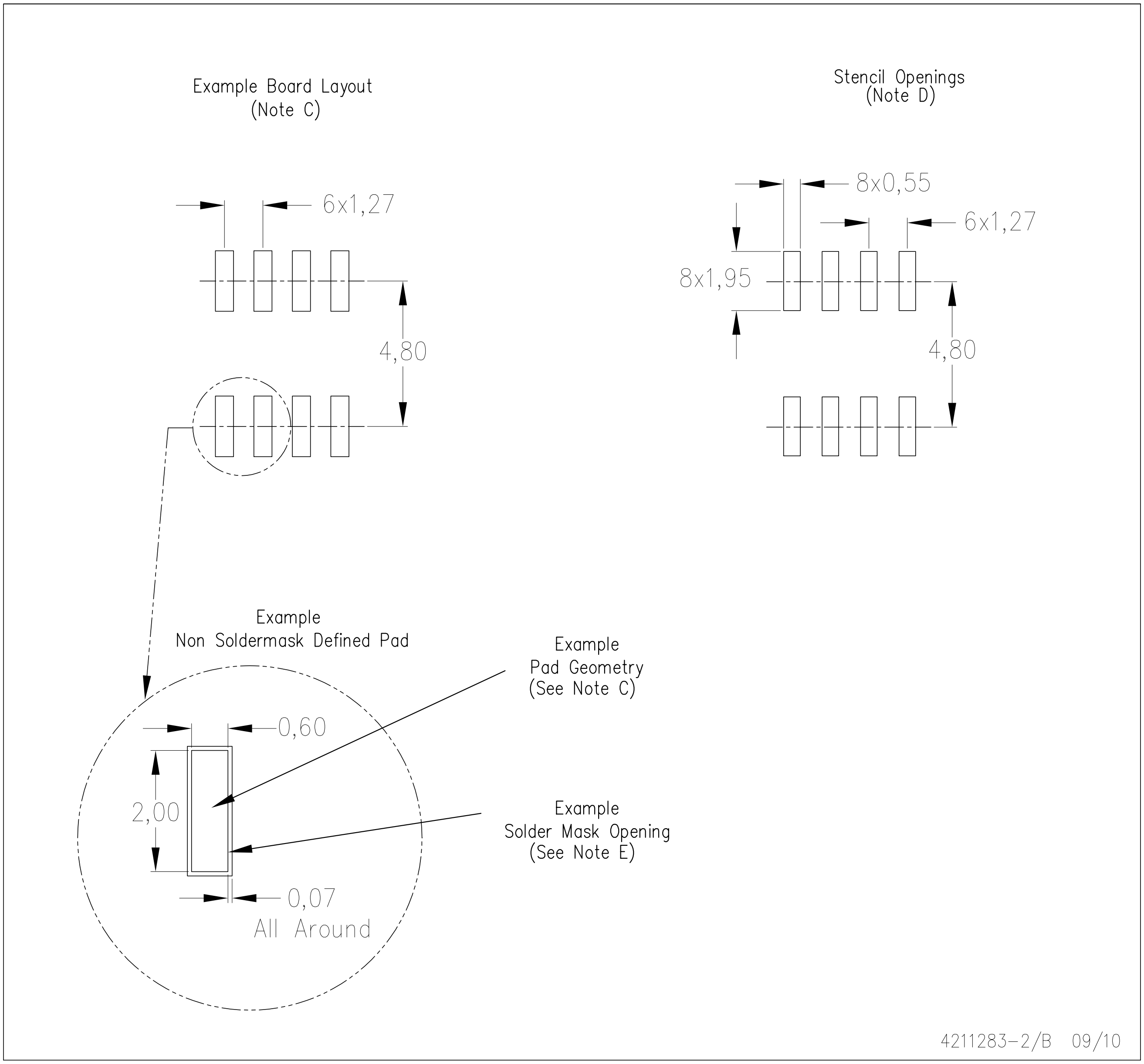
NOTES:
- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Publication IPC-7351 is recommended for alternate designs.
- D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should 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.

D (R–PDSO–G8) PLASTIC SMALL–OUTLINE PACKAGE



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 .006 (0,15) per end.
D. Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
E. Reference JEDEC MS-012 variation AA.

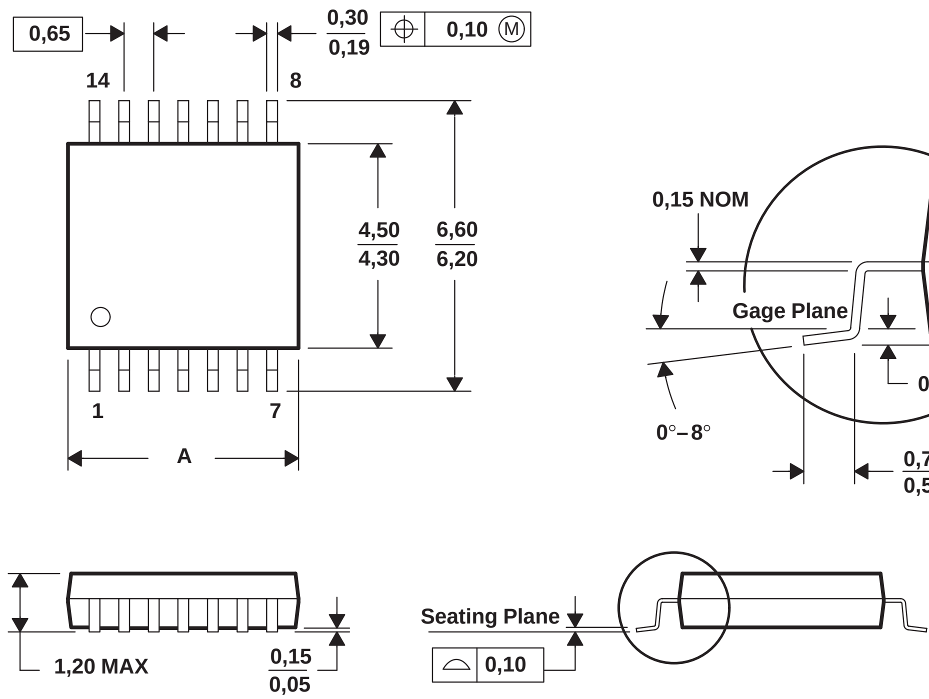
D (R-PDSO-G8) PLASTIC SMALL OUTLINE



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.

PW (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14 PINS SHOWN



PINS ** / DIM	8	14	16	20	24	28
A MAX	3,10	5,10	5,10	6,60	7,90	9,80
A MIN	2,90	4,90	4,90	6,40	7,70	9,60

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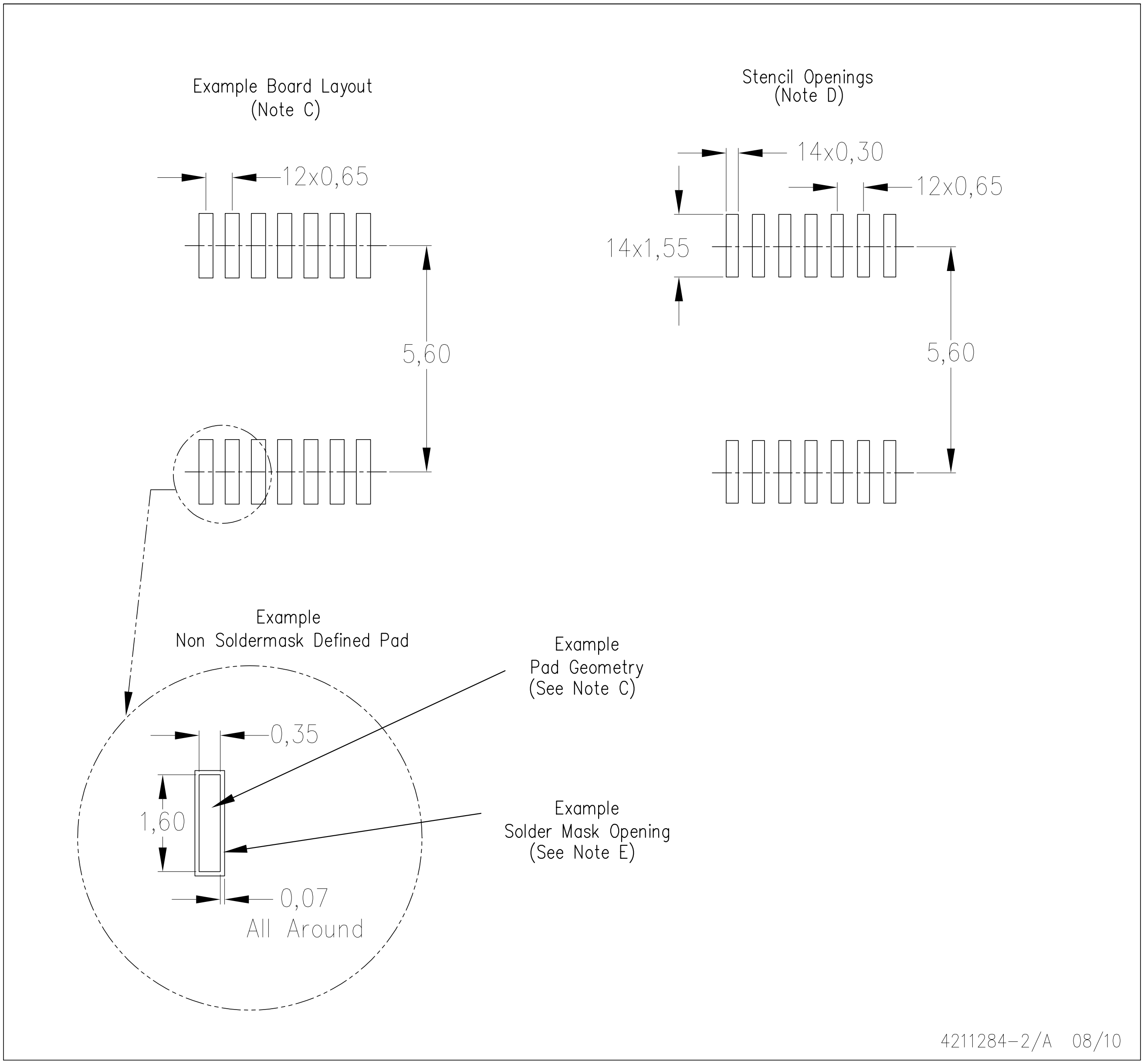
NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
D. Falls within JEDEC MO-153

PW (R-PDSO-G14) PLASTIC SMALL OUTLINE



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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