



Low-Power, Synchronous Voltage-to-Frequency Converter

FEATURES

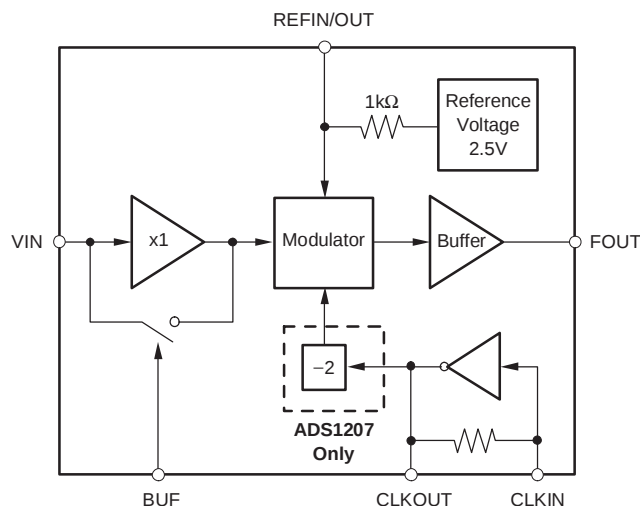
- Synchronous Operation
- Frequency Set By External Clock
- Maximum Input Frequency:
 - 1MHz for ADS1206
 - 4MHz for ADS1207
- Selectable High-Impedance Buffered Input
- 2% Internal, 2.5V Reference Voltage
- High-Current Output Driver
- Power Supply 3.3V or 5V
- Low Power : 3mW (typ)
- Alternate Source for AD7740
- –40°C to +85°C Operating Temperature Range

APPLICATIONS

- Galvanic Isolation Measurement
- High Voltage Measurement
- Low-Cost Analog-to-Digital Conversion
- Motor Control
- Industrial Process Control
- Instrumentation
- Smart Transmitters
- Portable Instruments

DESCRIPTION

The ADS1206 and ADS1207 are a low-cost, high-performance, synchronous voltage-to-frequency converters (VFC). Both devices can operate from a single 3.0V to 3.6V or 4.5V to 5.5V power supply, consuming only 1mA. The output signal is synchronous with the input clock, CLKIN. The clock input is TTL- and CMOS-compatible and the onboard clock generator can also accept an external crystal or resonator. The maximum input clock frequency for the ADS1206 is 1MHz and for the ADS1207 is 4MHz. The clock divider on the ADS1207 scales the input frequency to 2MHz, which permits the core to operate at the higher rate. The high-impedance input is ideal for direct connection to high-impedance transducers or high-voltage resistive dividers. Counting output pulses over a 4ms period results in an effective 12-bit resolution for the ADS1206 using a 1MHz input clock. For the ADS1207 using a 4MHz input clock, the same result occurs over a 2ms period. Both devices are designed for use in medium-resolution measurements. They are available in an 8-lead VSSOP package.



PRODUCT PREVIEW



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

All trademarks are the property of their respective owners.



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.

ORDERING INFORMATION⁽¹⁾

PRODUCT	MAXIMUM INTEGRAL LINEARITY ERROR (%FS)	MAXIMUM GAIN ERROR (%)	PACKAGE-LEAD	PACKAGE DESIGNATOR	SPECIFIED TEMPERATURE RANGE	PACKAGE MARKING	ORDERING NUMBER	TRANSPORT MEDIA, QUANTITY
ADS1206	±0.012	±0.7	VSSOP-8	DGK	-40°C to +85°C	TBD	ADS1206IDGKT	Tape and Reel, 250
						TBD	ADS1206IDGKR	Tape and Reel, 2000
ADS1207	±0.012	±0.7	VSSOP-8	DGK	-40°C to +85°C	TBD	ADS1207IDGKT	Tape and Reel, 250
						TBD	ADS1207IDGKR	Tape and Reel, 2000

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

ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature range unless otherwise noted⁽¹⁾

	ADS1204	UNIT
Supply Voltage, GND to V _{DD}	-0.3 to 7	V
Analog Input Voltage with Respect to GND	GND - 0.3 to V _{DD} + 0.3	V
Reference Input Voltage with Respect to GND	GND - 0.3 to V _{DD} + 0.3	V
Digital Input Voltage with Respect to GND	GND - 0.3 to V _{DD} + 0.3	V
Input Current to Any Pin Except Supply	-20 to 20	mA
Power Dissipation	See Dissipation Rating Table	
Operating Virtual Junction Temperature Range, T _J	-40 to +150	°C
Operating Free-Air Temperature Range, T _A	-40 to +85	°C
Storage Temperature Range, T _{STG}	-65 to +150	°C
Lead Temperature (1.6mm or 1/16-inch from case for 10s)	+260	°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.

RECOMMENDED OPERATING CONDITIONS

PARAMETER		MIN	NOM	MAX	UNIT
Supply Voltage, GND to V _{DD}	Low-Voltage Levels	3.0		3.6	V
	5V Logic Levels	4.5	5	5.5	V
Reference Input Voltage		TBD	2.5	V _{DD}	V
Analog Inputs	BUF = 0	0		V _{REF}	V
	BUF = 1	0.1		V _{DD} - 0.2	V
External Clock	ADS1206	TBD		1	MHz
	ADS1207	TBD		4	MHz
Operating Junction Temperature Range, T _J		-40		105	°C

⁽¹⁾ with reduced accuracy, minimum clock can go up to 500kHz.

DISSIPATION RATING TABLE

BOARD	PACKAGE	T _A ≤ 25°C POWER RATING	DERATING FACTOR ABOVE T _A = 25°C ⁽¹⁾	T _A = 70°C POWER RATING	T _A = 85°C POWER RATING
Low-K ⁽²⁾	DGK	469.6mW	3.756mW/°C	300.5mW	244.2mW
High-K ⁽³⁾	DGK	691.4mW	5.531mW/°C	442.5mW	359.5mW

⁽¹⁾ This is the inverse of the traditional junction-to-ambient thermal resistance (R_{θJA}). Thermal resistances are not production tested and are for informational purposes only.

⁽²⁾ The JEDEC Low-K (1s) board design used to derive this data was a 3-inch x 3-inch, two-layer board with 2-ounce copper traces on top of the board.

⁽³⁾ The JEDEC High-K (2s2p) board design used to derive this data was a 3-inch x 3-inch, multilayer board with 1-ounce internal power and ground planes and 2-ounce copper traces on the top and bottom of the board.

ELECTRICAL CHARACTERISTICS

Over recommended operating free-air temperature range at -40°C to $+85^{\circ}\text{C}$, $V_{\text{DD}} = 5\text{V}$ or $V_{\text{DD}} = 3\text{V}$, $V_{\text{REF}} = \text{internal } +2.5\text{V}$, $\text{CLKIN} = 1\text{MHz}$, unless otherwise noted.

PARAMETER		TEST CONDITIONS	ADS1206I, ADS1207I			UNITS
			MIN	TYP(1)	MAX	
DC Accuracy						
INL	Integral linearity error(2)	BUF = 1		±0.012	% FSR	
		BUF = 0		±0.018	% FSR	
DNL	Differential nonlinearity(3)			TBD	% FSR	
VOS	Offset error	BUF = 0, VIN = 0V		±7	±35	mV
		BUF = 1, VIN = 0.1V		±7	±35	mV
TCVOS	Offset error drift			5	20	μV/°C
GERR	Gain error(4)	Referenced to VREF		±0.1	±0.7	% FSR
TCGERR	Gain error drift			20		ppm/°C
	Noise			TBD		μVrms
PSRR	Power-supply rejection ratio	4.5V < VDD < 5.5V		55		dB
		3.0V < VDD < 3.6V		65		dB
Analog Input						
FSR	Full-scale range	BUF = 0	0	VREF		V
		BUF = 1	0.1	VDD - 0.2		V
	Input capacitance	BUF = 0		3		pF
		BUF = 1		3		pF
	Input current	BUF = 0		8	10	μA
		BUF = 1		5	100	nA
	Differential input resistance			100		kΩ
	Differential input capacitance			1		pF
BW	Bandwidth	FS sinewave, -3dB, BUF = 0		TBD		MHz
		FS sinewave, -3dB, BUF = 1		TBD		MHz
Output Signal						
FOUT	Output frequency span	ADS1206I	0.1	0.9		CLKIN
		ADS1207I	0.05	0.45		CLKIN
Voltage Reference Output						
VOUT	Reference voltage output		2.3	2.5	2.7	V
	Initial accuracy				±8	%
dVOUT/dT	Output voltage temperature drift			±50		ppm/°C
	Output voltage noise	f = 0.1Hz to 10Hz, CL = 10μF		100		μVpp
		f = 10Hz to 10kHz, CL = 10μF		TBD		μVrms
PSRR	Power-supply rejection ratio	VDD = 4.5V to 5.5V		-70		dB
		VDD = 3.0V to 3.6V		-60		dB
	Reference output resistance			1		kΩ
	Turn-on settling time	to 0.1% at CL = 0		30		μs
Voltage Reference Input						
VREF	Reference voltage input		TBD	2.5	VDD	V
	Reference input capacitance			5		pF
	Reference input current			±200		μA

(1) All typical values are at $T_A = +25^{\circ}\text{C}$.

(2) Integral nonlinearity is defined as the maximum deviation of the line through the end points of the transfer curve for $V_{\text{IN}} = 0\text{V}$ to V_{REF} or 0.1V to $V_{\text{DD}} - 0.2\text{V}$, expressed either as the number of LSBs or as a percent of measured input range.

(3) Ensured by design.

(4) Maximum values, including temperature drift, are ensured over the full specified temperature range.

(5) Applicable for 5.0V nominal supply: $V_{\text{DD}}(\text{min}) = 4.5\text{V}$ and $V_{\text{DD}}(\text{max}) = 5.5\text{V}$.

(6) Applicable for 3.0V nominal supply: $V_{\text{DD}}(\text{min}) = 3.0\text{V}$ and $V_{\text{DD}}(\text{max}) = 3.6\text{V}$.

ELECTRICAL CHARACTERISTICS (continued)

Over recommended operating free-air temperature range at -40°C to $+85^{\circ}\text{C}$, $V_{\text{DD}} = 5\text{V}$ or $V_{\text{DD}} = 3\text{V}$, $V_{\text{REF}} = \text{internal } +2.5\text{V}$, $\text{CLKIN} = 1\text{MHz}$, unless otherwise noted.

PARAMETER		TEST CONDITIONS	ADS1206I, ADS1207I			UNITS
			MIN	TYP(1)	MAX	
Digital Inputs(5)						
Logic family			CMOS			
V _{IH}	High-level input voltage		0.7×V _{DD}		V _{DD} +0.3	V
V _{IL}	Low-level input voltage		−0.3		0.3×V _{DD}	V
I _{IN}	Input current	V _I = V _{DD} or GND			±1	μA
C _I	Input capacitance			5		pF
Digital Outputs(5)						
Logic family			CMOS			
V _{OH}	High-level output voltage	V _{DD} = 4.5V, I _{OH} = −100μA	4.44			V
		V _{DD} = 4.5V, I _{OH} = −2mA	2.5			V
V _{OL}	Low-level output voltage	V _{DD} = 4.5V, I _{OH} = 2mA	0.5			V
I _O	Output sink current	1.5V < V _{OL} < V _{DD}	10			mA
C _O	Output capacitance		5			pF
C _L	Load capacitance		30			pF
Digital Inputs(6)						
Logic family			LVCMOS and LVTTTL			
V _{IH}	High-level input Voltage	V _{DD} = 3.6V	2		V _{DD} +0.3	V
V _{IL}	Low-level input voltage	V _{DD} = 3.0V	−0.3		0.8	V
I _{IN}	Input current	V _I = V _{DD} or GND			±1	nA
C _I	Input capacitance		5			pF
Digital Outputs(6)						
Logic family			LVCMOS and LVTTTL			
V _{OH}	High-level output voltage	V _{DD} = 3V, I _{OH} = −100μA	V _{DD} −0.2			V
		V _{DD} = 3V, I _{OH} = −2mA	2.4			V
V _{OL}	Low-level output voltage	V _{DD} = 3V, I _{OH} = 100μA	0.2			V
		V _{DD} = 3V, I _{OH} = 2mA	0.4			V
I _O	Output sink current		10			mA
C _O	Output capacitance		5			pF
C _L	Load capacitance		30			pF
Power Supply						
V _{DD}	Power-supply voltage	Low-voltage levels	3.0		3.6	V
		5V logic levels	4.5		5.5	V
I _{DD}	Supply current	BUF = GND		0.9	1.25	mA
		BUF = V _{DD}		1.1	1.5	mA
	Power dissipation	V _{DD} = 3.3V		3.63	4.95	mW
		V _{DD} = 5V		5.5	7.5	mW

(1) All typical values are at $T_{\text{A}} = +25^{\circ}\text{C}$.

(2) Integral nonlinearity is defined as the maximum deviation of the line through the end points of the transfer curve for $V_{\text{IN}} = 0\text{V}$ to V_{REF} or 0.1V to $V_{\text{DD}} - 0.2\text{V}$, expressed either as the number of LSBs or as a percent of measured input range.

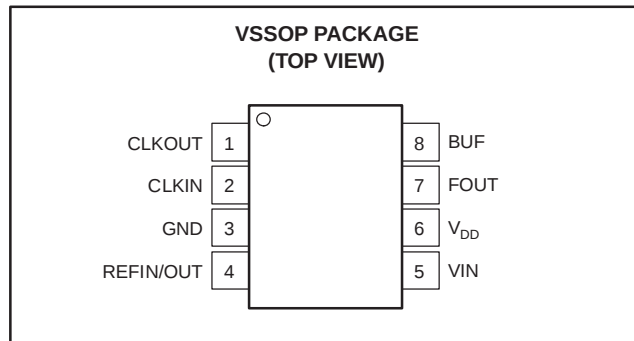
(3) Ensured by design.

(4) Maximum values, including temperature drift, are ensured over the full specified temperature range.

(5) Applicable for 5.0V nominal supply: $V_{\text{DD}} (\text{min}) = 4.5\text{V}$ and $V_{\text{DD}} (\text{max}) = 5.5\text{V}$.

(6) Applicable for 3.0V nominal supply: $V_{\text{DD}} (\text{min}) = 3.0\text{V}$ and $V_{\text{DD}} (\text{max}) = 3.6\text{V}$.

PIN ASSIGNMENTS



Terminal Functions

TERMINAL NAME	NO.	DESCRIPTION
CLKOUT	1	Clock output
CLKIN	2	Master clock input
GND	3	Ground
REFIN/OUT	4	Reference voltage input or output
VIN	5	Analog input
V _{DD}	6	Power supply, +3.3V or +5V nominal
FOUT	7	Modulator output
BUF	8	Buffered mode select

PARAMETER MEASUREMENT INFORMATION

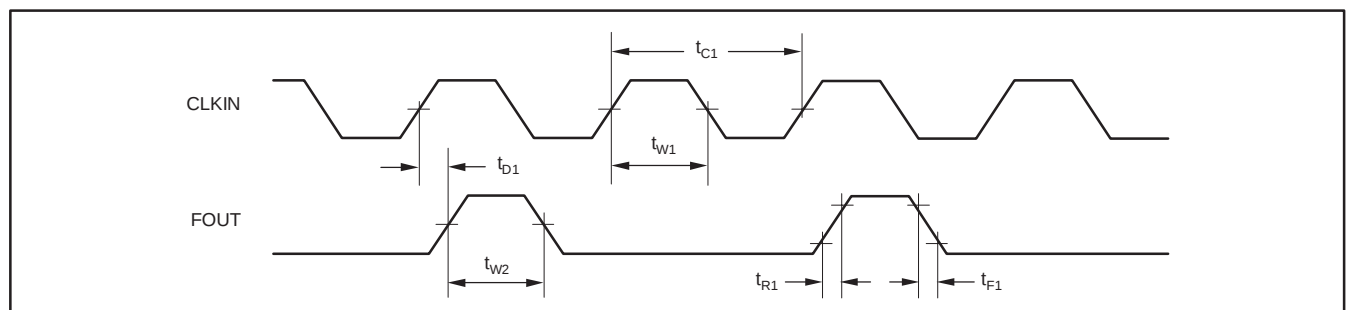


Figure 1. Timing Diagram

TIMING REQUIREMENTS: 5.0V

over recommended operating free-air temperature range at -40°C to $+85^{\circ}\text{C}$., and $V_{DD} = 5\text{V}$, unless otherwise noted.

PARAMETER		MIN	MAX	UNITS
t_{C1}	Input clock period	1000	TBD	ns
	ADS1207	250	TBD	ns
t_{W1}	Input clock high time	$(t_{C1}/2) - 100$	$(t_{C1}/2) + 100$	ns
t_{D1}	FOUT rising edge delay after input clock rising edge	TBD	TBD	ns
t_{W2}	FOUT high time	$t_{C1} - 20$	$t_{C1} + 20$	ns
t_{R1}	FOUT rise time	TBD	TBD	ns
t_{F1}	FOUT fall time	TBD	TBD	ns

NOTE: Applicable for 5.0V nominal supply: $V_{DD}(\text{min}) = 4.5\text{V}$ and $V_{DD}(\text{max}) = 5.5\text{V}$. All input signals are specified with $t_R = t_F = 5\text{ns}$ (10% to 90% of V_{DD}) and timed from a voltage level of $(V_{IL} + V_{IH})/2$. See timing diagram.

TIMING REQUIREMENTS: 3.3V

over recommended operating free-air temperature range at -40°C to $+85^{\circ}\text{C}$., and $V_{DD} = 3.3\text{V}$, unless otherwise noted.

PARAMETER		MIN	MAX	UNITS
t_{C1}	Input clock period	1000	TBD	ns
	ADS1207	250	TBD	ns
t_{W1}	Input clock high time	$(t_{C1}/2) - 100$	$(t_{C1}/2) + 100$	ns
t_{D1}	FOUT rising edge delay after input clock rising edge	TBD	TBD	ns
t_{W2}	FOUT high time	$t_{C1} - 8$	$t_{C1} + 8$	ns
t_{R1}	FOUT rise time	TBD	TBD	ns
t_{F1}	FOUT fall time	TBD	TBD	ns

NOTE: Applicable for 3.3V nominal supply: $V_{DD}(\text{min}) = 3.0\text{V}$ and $V_{DD}(\text{max}) = 3.6\text{V}$. All input signals are specified with $t_R = t_F = 5\text{ns}$ (10% to 90% of V_{DD}) and timed from a voltage level of $(V_{IL} + V_{IH})/2$. See timing diagram.

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
ADS1206IDGKR	PREVIEW	MSOP	DGK	8	2500	None	Call TI	Call TI
ADS1206IDGKT	PREVIEW	MSOP	DGK	8	250	None	Call TI	Call TI
ADS1207IDGKR	PREVIEW	MSOP	DGK	8		None	Call TI	Call TI
ADS1207IDGKT	PREVIEW	MSOP	DGK	8		None	Call TI	Call TI

⁽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 - May not be currently available - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

None: Not yet available Lead (Pb-Free).

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.

Green (RoHS & no Sb/Br): TI defines "Green" to mean "Pb-Free" and in addition, uses package materials that do not contain halogens, including bromine (Br) or antimony (Sb) above 0.1% of total product weight.

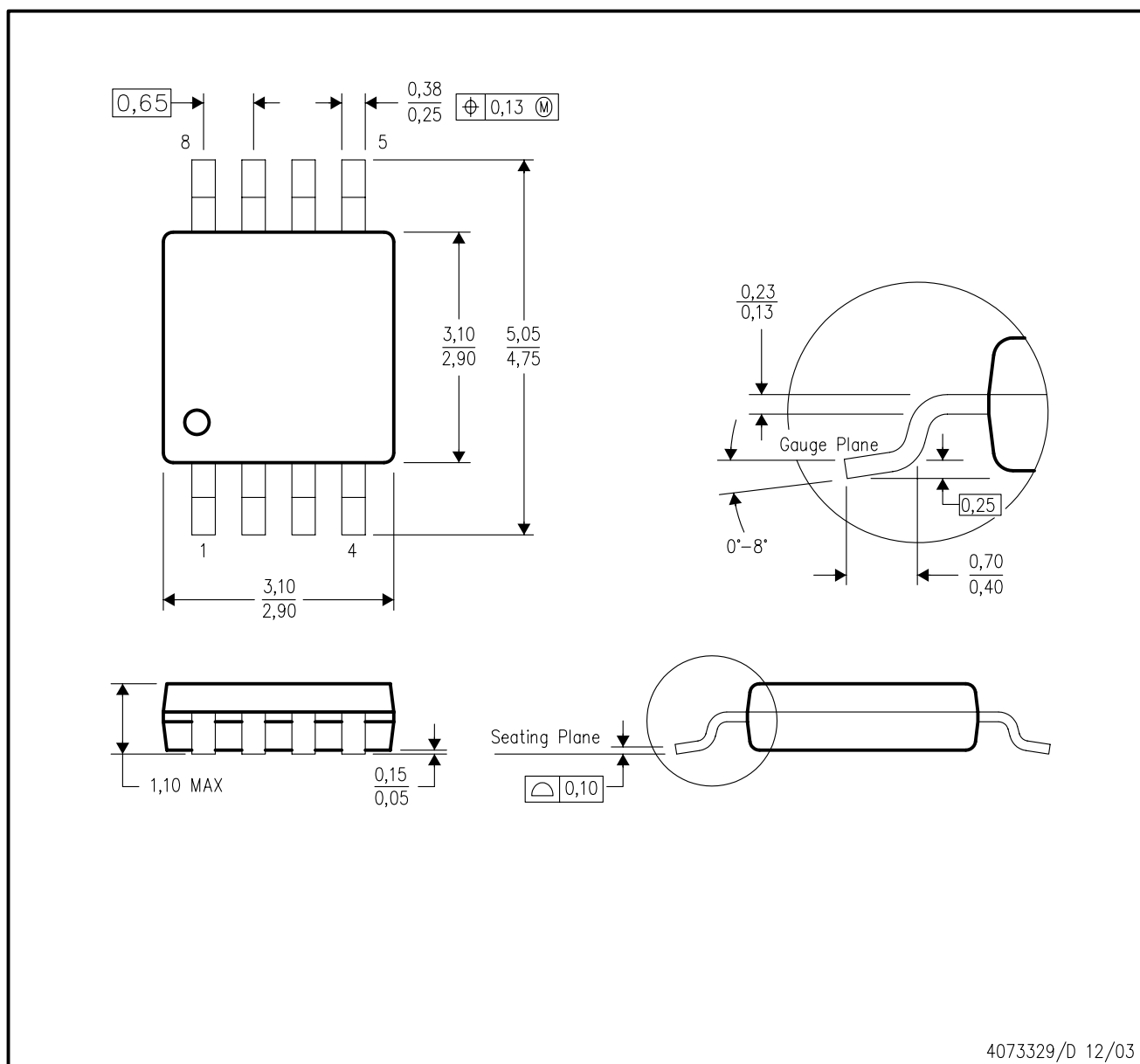
⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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

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

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 dimensions do not include mold flash or protrusion.
 - D. Falls within JEDEC MO-187 variation AA.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

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

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

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

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

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

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		Applications	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Interface	interface.ti.com	Digital Control	www.ti.com/digitalcontrol
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
		Telephony	www.ti.com/telephony
		Video & Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments
Post Office Box 655303 Dallas, Texas 75265

Copyright © 2005, Texas Instruments Incorporated