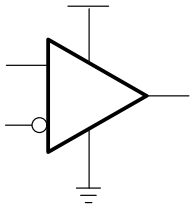
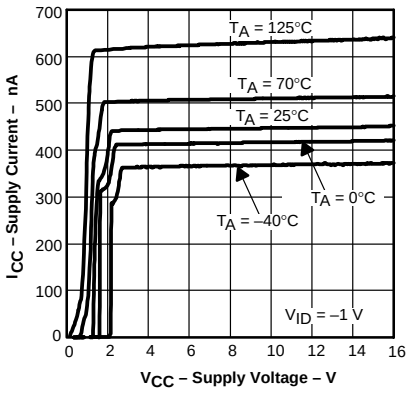
- **Low Supply Current . . . 470 nA/Per Channel**
- **Input Common-Mode Range Exceeds the Rails . . . –0.1 V to V_{CC} + 5 V**
- **Supply Voltage Range . . . 2.5 V to 16 V**
- **Reverse Battery Protection Up to 18 V**
- **Open Drain CMOS Output Stage**
- **Specified Temperature Range**
  - **0°C to 70°C – Commercial Grade**
  - **–40°C to 125°C – Industrial Grade**
- **Ultrasmall Packaging**
  - **5-Pin SOT-23 (TLV3401)**
  - **8-Pin MSOP (TLV3402)**
- **Universal Op-Amp EVM (Reference SLOU060 for more information)**



SUPPLY CURRENT vs SUPPLY VOLTAGE

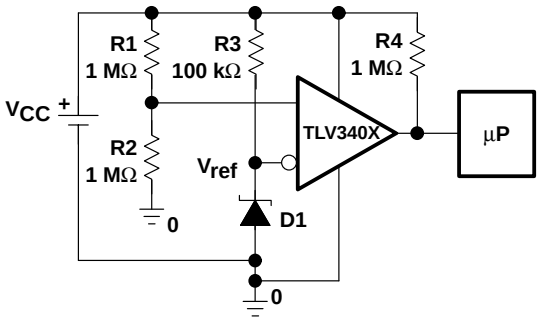


description

The TLV340x is Texas Instruments' first family of nanopower comparators with only 470 nA per channel supply current, which make this device ideal for battery power and wireless handset applications.

The TLV340x has a minimum operating supply voltage of 2.7 V over the extended industrial temperature range (T_A = –40°C to 125°C), while having an input common-mode range of –0.1 to V_{CC} + 5 V. The low supply current makes it an ideal choice for battery powered portable applications where quiescent current is the primary concern. Reverse battery protection guards the amplifier from an over-current condition due to improper battery installation. For harsh environments, the inputs can be taken 5 V above the positive supply rail without damage to the device.

high side voltage sense circuit



All members are available in PDIP and SOIC with the singles in the small SOT-23 package, duals in the MSOP, and quads in the TSSOP package.

A SELECTION OF OUTPUT COMPARATORS†

DEVICE	V_{CC} (V)	V_{IO} (µV)	I_{CC}/Ch (µA)	I_{IB} (pA)	t_{PLH} (µs)	t_{PHL} (µs)	t_f (µs)	t_r (µs)	RAIL-TO-RAIL	OUTPUT STAGE
TLV340x	2.5 – 16	250	0.47	80	55	30	5	–	I	OD
TLV370x	2.5 – 16	250	0.47	80	25	30	5	3.5	I	PP
TLC3702/4	3 – 16	1200	9	5	1.1	0.65	0.5	0.125	–	PP
TLC393/339	3 – 16	1400	11	5	1.1	0.55	0.22	–	–	OD
TLC372/4	3 – 16	1000	75	5	0.65	0.65	–	–	–	OD

† All specifications are typical values measured at 5 V.

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.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

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TLV3401 AVAILABLE OPTIONS

T_A	V_{IO}max AT 25°C	PACKAGED DEVICES			
		SMALL OUTLINE (D)†	SOT-23 (DBV)‡	SYMBOL	PLASTIC DIP (P)
0°C to 70°C	3600 μV	TLV3401CD	TLV3401CDBV	VBDC	—
-40°C to 125°C		TLV3401ID	TLV3401IDBV	VBDI	TLV3401IP

† This package is available taped and reeled. To order this packaging option, add an R suffix to the part number (e.g., TLV3401CDR).
‡ This package is only available taped and reeled. For standard quantities (3000 pieces per reel), add an R suffix (i.e., TLV3401CDBVR. For small quantities (250 pieces per mini-reel), add a T suffix to the part number (e.g., TLV3401CDBVT).

TLV3402 AVAILABLE OPTIONS

T_A	V_{IO}max AT 25°C	PACKAGED DEVICES			
		SMALL OUTLINE (D)†	MSOP (DGK)†	SYMBOL	PLASTIC DIP (P)
0°C to 70°C	3600 μV	TLV3402CD	TLV3402CDGK	xxTIAJJ	—
–40°C to 125°C		TLV3402ID	TLV3402IDGK	xxTIAJK	TLV3402IP

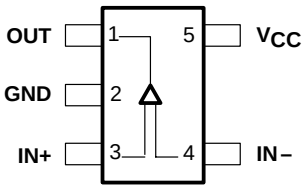
† This package is available taped and reeled. To order this packaging option, add an R suffix to the part number (e.g., TLV3402CDR).

TLV3404 AVAILABLE OPTIONS

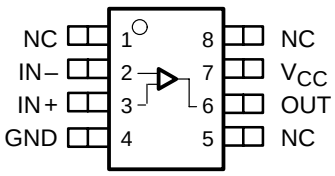
T_A	V_{IO}max AT 25°C	PACKAGED DEVICES		
		SMALL OUTLINE (D)†	PLASTIC DIP (N)	TSSOP (PW)
0°C to 70°C	3600 μV	TLV3404CD	—	TLV3404CPW
–40°C to 125°C		TLV3404ID	TLV3404IN	TLV3404IPW

† This package is available taped and reeled. To order this packaging option, add an R suffix to the part number (e.g., TLV3404CDR).

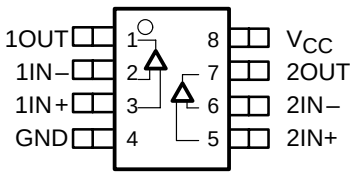
TLV3401
DBV PACKAGE
(TOP VIEW)



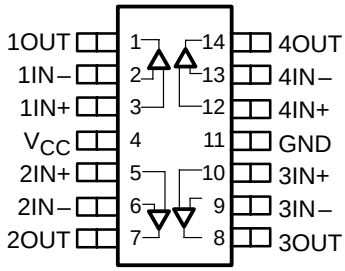
TLV3401
D OR P PACKAGE
(TOP VIEW)



TLV3402
D, DGK, OR P PACKAGE
(TOP VIEW)



TLV3404
D, N, OR PW PACKAGE
(TOP VIEW)



absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, V_{CC} (see Note 1) . . . . . 17 V
Differential input voltage, V_{ID} . . . . . ±20 V
Input voltage range, V_I (see Notes 1 and 2) . . . . . 0 to V_{CC} + 5 V
Input current range, I_I . . . . . ±10 mA
Output current range, I_O . . . . . ±10 mA
Continuous total power dissipation . . . . . See Dissipation Rating Table
Operating free-air temperature range, T_A: C suffix . . . . . 0°C to 70°C
I suffix . . . . . –40°C to 125°C
Maximum junction temperature, T_J . . . . . 150°C
Storage temperature range, T_{stg} . . . . . –65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds . . . . . 260°C

† 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.

NOTES: 1. All voltage values, except differential voltages, are with respect to GND.
2. Input voltage range is limited to 20 V or V_{CC} + 5 V, whichever is smaller.

DISSIPATION RATING TABLE

PACKAGE	θ_{JC} (°C/W)	θ_{JA} (°C/W)	$T_A \le 25°C$ POWER RATING	$T_A = 125°C$ POWER RATING
D (8)	38.3	176	710 mW	142 mW
D (14)	26.9	122.6	1022 mW	204.4 mW
DBV (5)	55	324.1	385 mW	77.1 mW
DGK (8)	54.2	259.9	481 mW	96.2 mW
N (14)	32	78	1600 mW	320.5 mW
P (8)	41	104	1200 mW	240.4 mW
PW (14)	29.3	173.6	720 mW	144 mW

recommended operating conditions

			MIN	MAX	UNIT
Supply voltage, V_{CC}	Single supply	C-suffix	2.5	16	V
		I-suffix	2.7	16	
	Split supply	C-suffix	±1.25	±8	
		I-suffix	±1.35	±8	
Common-mode input voltage range, V_{ICR}			–0.1	V_{CC}+5	V
Operating free-air temperature, T_A	C-suffix		0	70	°C
	I-suffix		–40	125	

electrical characteristics at specified operating free-air temperature, V_{CC} = 2.7 V, 5 V, 15 V (unless otherwise noted)

dc performance

PARAMETER		TEST CONDITIONS	T_A†	MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage	V_{IC}= V_{CC}/2, R_S = 50 Ω, R_P = 1 MΩ	25°C		250	3600	μV
			Full range			4400	
α_{VIO}	Offset voltage drift		25°C		3		μV/°C
CMRR	Common-mode rejection ratio	V_{IC}= 0 to 2.7 V, R_S = 50 Ω	25°C	55	72		dB
			Full range	50			
		V_{IC}= 0 to 5 V, R_S = 50 Ω	25°C	60	76		
			Full range	55			
		V_{IC}= 0 to 15 V, R_S = 50 Ω	25°C	65	88		
			Full range	60			
A_{VD}	Large-signal differential voltage amplification	R_P = 1 MΩ	25°C		1000		V/mV

† Full range is 0°C to 70°C for C suffix and –40°C to 125°C for I suffix. If not specified, full range is –40°C to 125°C.

input/output characteristics

PARAMETER		TEST CONDITIONS	T_A†	MIN	TYP	MAX	UNIT
I_{IO}	Input offset current	V_{IC} = V_{CC}/2, R_P = 1 MΩ, R_S = 50 Ω	25°C		20	100	pA
			Full range			1000	
I_{IB}	Input bias current		25°C		80	250	pA
			Full range			1500	
$r_{i(d)}$	Differential input resistance		25°C		300		MΩ
I_{OZ}	High-impedance output leakage current	V_{IC} = V_{CC}/2, V_O = V_{CC}, V_{ID} = 1 V	25°C		50		pA
V_{OL}	Low-level output voltage	V_{IC} = V_{CC}/2, I_{OL} = 2 μA, V_{ID} = –1 V	25°C		8		mV
		V_{IC} = V_{CC}/2, I_{OL} = 50 μA, V_{ID} = –1 V	25°C		80	200	
			Full range			300	

† Full range is 0°C to 70°C for C suffix and –40°C to 125°C for I suffix. If not specified, full range is –40°C to 125°C.

power supply

PARAMETER		TEST CONDITIONS		T_A†	MIN	TYP	MAX	UNIT
I_{CC}	Supply current (per channel)	R_P = No pullup	Output state low	25°C		470	550	nA
				Full range			750	
			Output state high	25°C		560	640	
				Full range			950	
PSRR	Power supply rejection ratio	V_{IC} = V_{CC}/2 V, No load	V_{CC}= 2.7 V to 5 V	25°C	75	100		dB
				Full range	70			
			V_{CC}= 5 V to 15 V	25°C	85	105		
				Full range	80			

† Full range is 0°C to 70°C for C suffix and –40°C to 125°C for I suffix. If not specified, full range is –40°C to 125°C.

switching characteristics at recommended operating conditions, V_{CC} = 2.7 V, 5 V, 15 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A	MIN	TYP	MAX	UNIT
$t_{(PLH)}$	Propagation delay time, low-to-high-level output	f = 10 kHz, V_{STEP} = 1 V, R_P = 1 MΩ, C_L = 10 pF	Overdrive = 2 mV	25°C		175		µs
			Overdrive = 10 mV			80		
			Overdrive = 50 mV			55		
$t_{(PHL)}$	Propagation delay time, high-to-low-level output		Overdrive = 2 mV	25°C		300		
			Overdrive = 10 mV			60		
			Overdrive = 50 mV			30		
t_f	Fall time	R_P = 1 MΩ,	C_L = 10 pF	25°C		5		µs

NOTE: The response time specified is the interval between the input step function and the instant when the output crosses 1.4 V.

TYPICAL CHARACTERISTICS

Table of Graphs

			FIGURE
	Input bias/offset current	vs Free-air temperature	1
	Open collector leakage current	vs Free-air temperature	2
V_{OL}	Low-level output voltage	vs Low-level output current	3, 4, 5
I_{DD}	Supply current	vs Supply voltage	6
I_{DD}	Supply current	vs Free-air temperature	7
	Low-to-high level output response for various input overdrives		8, 9, 10
	High-to-low level output response for various input overdrives		11, 12, 13
	Output fall time	vs Supply voltage	14

TYPICAL CHARACTERISTICS

INPUT BIAS/OFFSET CURRENT vs FREE-AIR TEMPERATURE

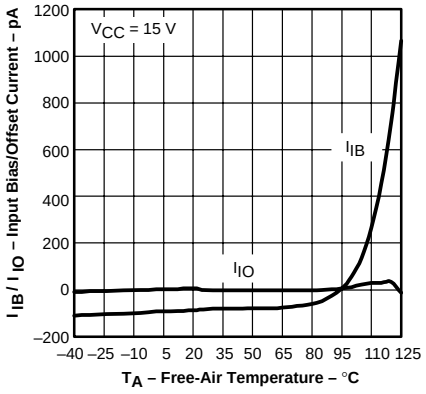


Figure 1

OPEN COLLECTOR LEAKAGE CURRENT vs FREE-AIR TEMPERATURE

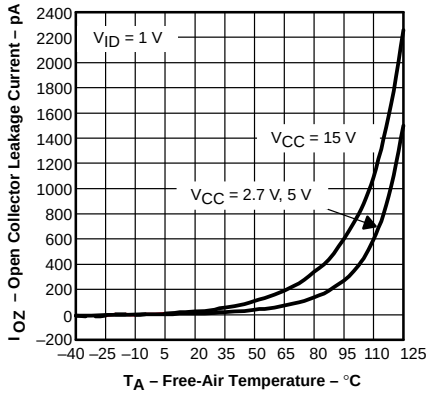


Figure 2

LOW-LEVEL OUTPUT VOLTAGE vs LOW-LEVEL OUTPUT CURRENT

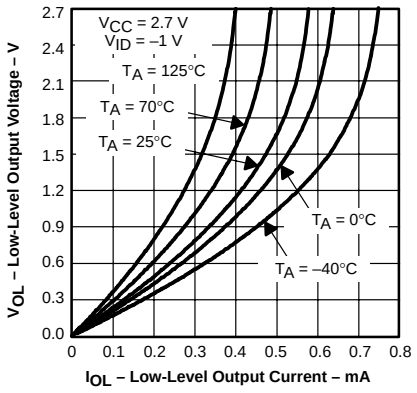


Figure 3

LOW-LEVEL OUTPUT VOLTAGE vs LOW-LEVEL OUTPUT CURRENT

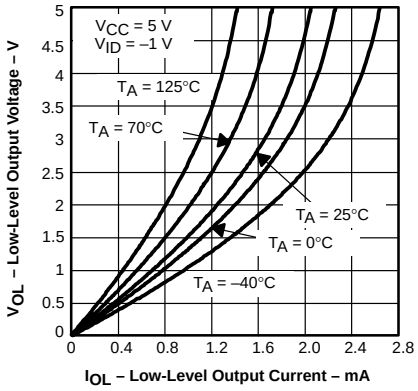


Figure 4

LOW-LEVEL OUTPUT VOLTAGE vs LOW-LEVEL OUTPUT CURRENT

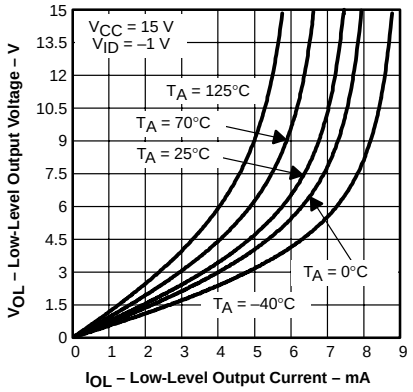


Figure 5

SUPPLY CURRENT vs SUPPLY VOLTAGE

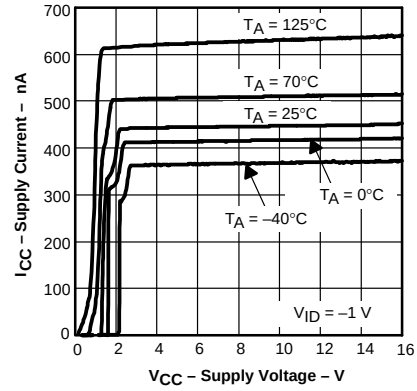


Figure 6

SUPPLY CURRENT vs FREE-AIR TEMPERATURE

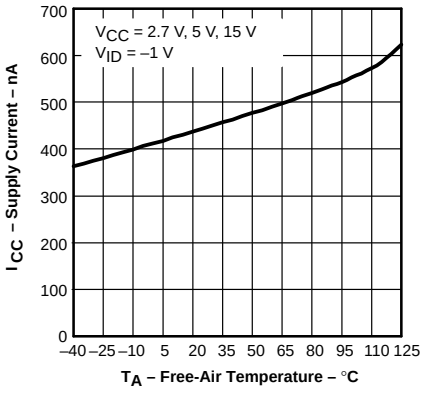


Figure 7

LOW-TO-HIGH LEVEL OUTPUT RESPONSE FOR VARIOUS INPUT OVERDRIVES

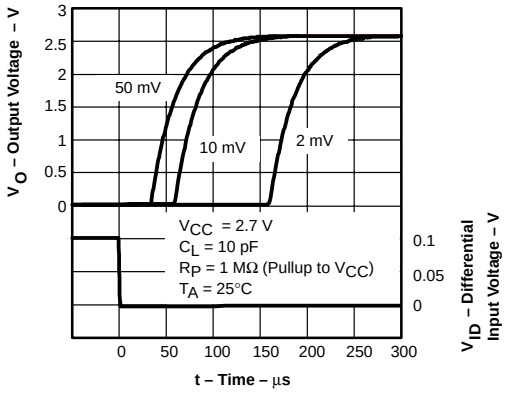


Figure 8

TYPICAL CHARACTERISTICS

LOW-TO-HIGH LEVEL OUTPUT RESPONSE FOR VARIOUS INPUT OVERDRIVES

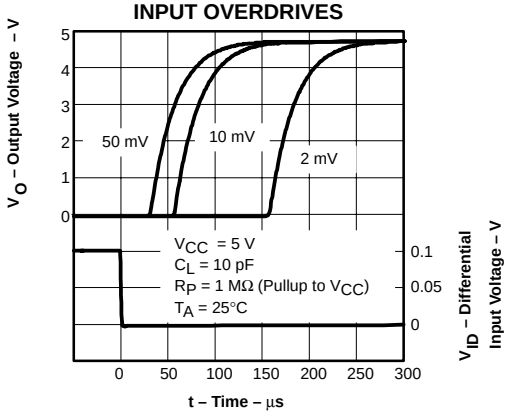


Figure 9

LOW-TO-HIGH LEVEL OUTPUT RESPONSE FOR VARIOUS INPUT OVERDRIVES

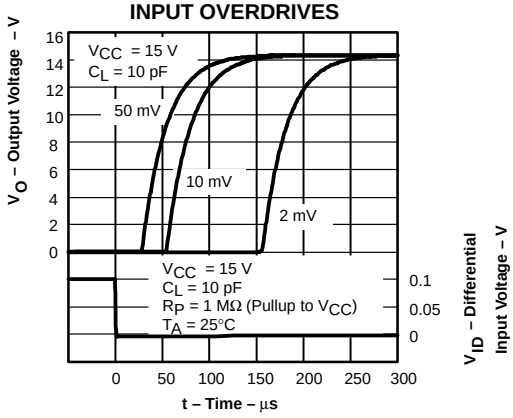


Figure 10

HIGH-TO-LOW LEVEL OUTPUT RESPONSE FOR VARIOUS INPUT OVERDRIVES

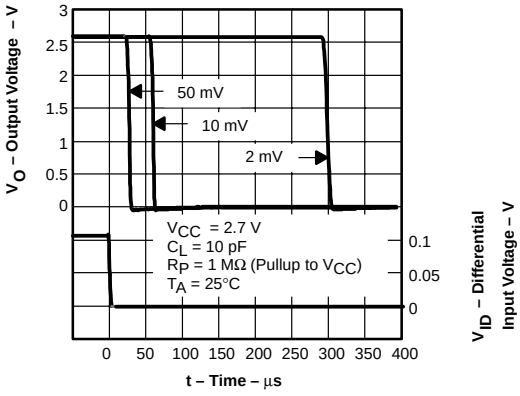


Figure 11

HIGH-TO-LOW LEVEL OUTPUT RESPONSE FOR VARIOUS INPUT OVERDRIVES

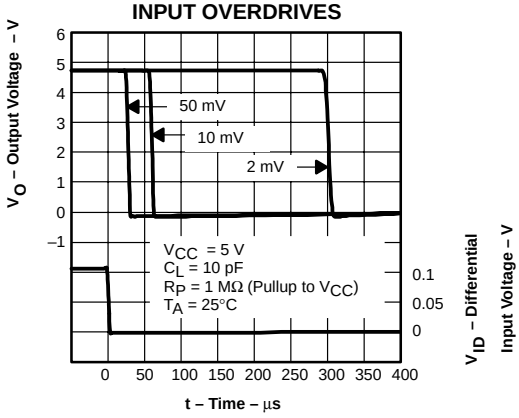


Figure 12

HIGH-TO-LOW LEVEL OUTPUT RESPONSE FOR VARIOUS INPUT OVERDRIVES

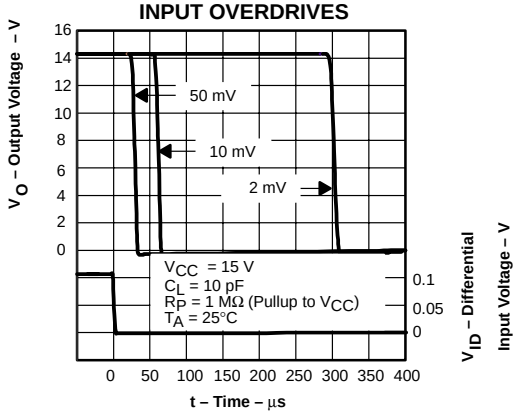


Figure 13

OUTPUT FALL TIME vs SUPPLY VOLTAGE

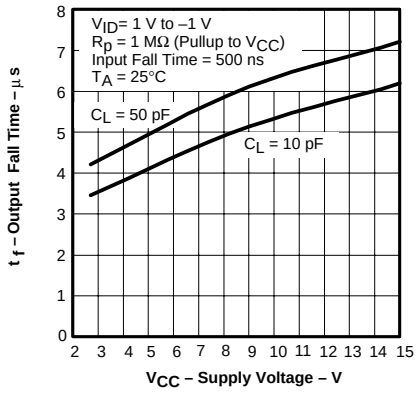
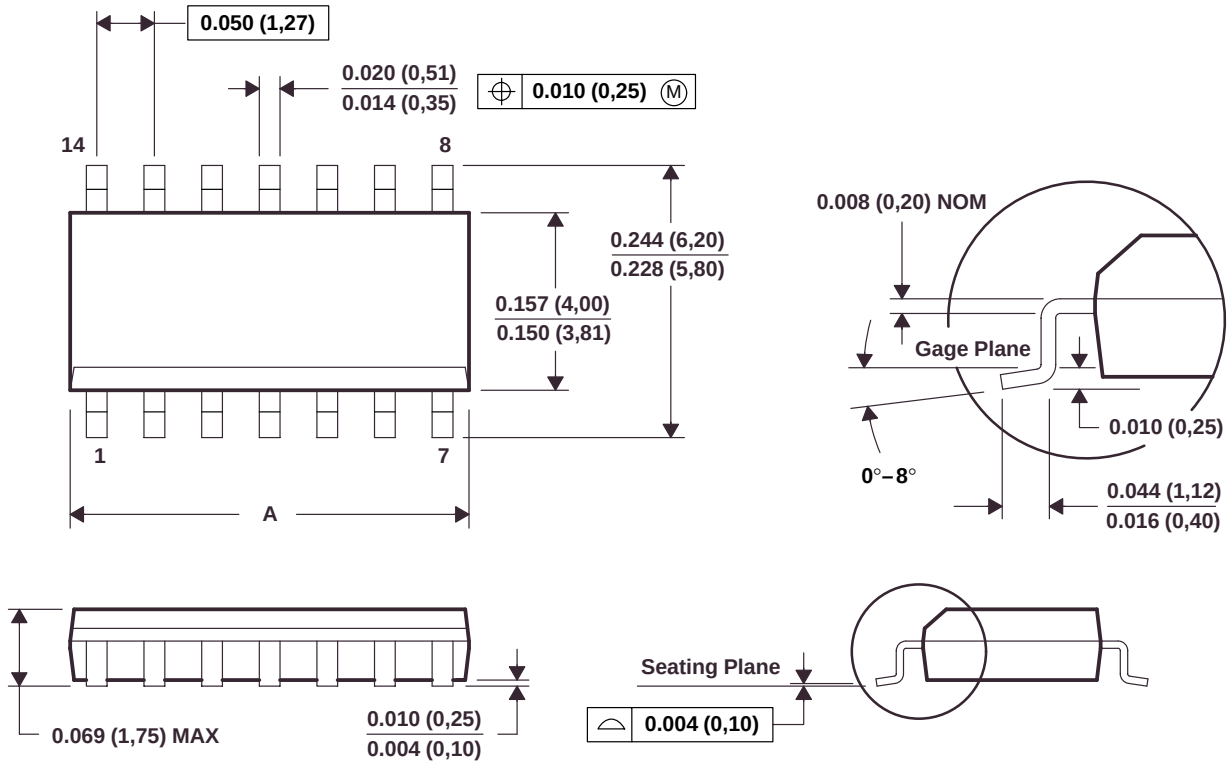


Figure 14

MECHANICAL DATA

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

14 PINS SHOWN



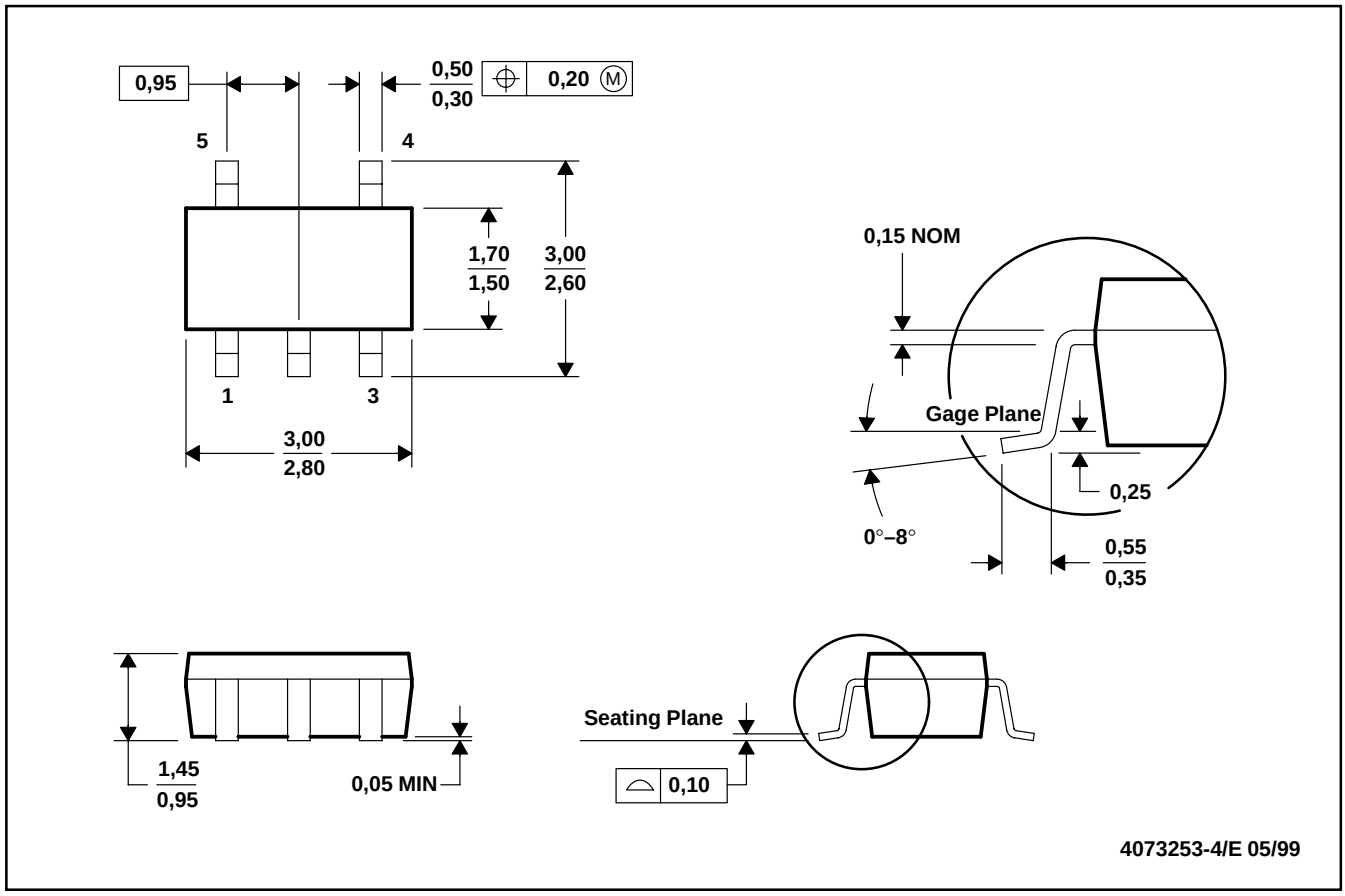
DIM \ PINS **	8	14	16
A MAX	0.197 (5,00)	0.344 (8,75)	0.394 (10,00)
A MIN	0.189 (4,80)	0.337 (8,55)	0.386 (9,80)

4040047/D 10/96

NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion, not to exceed 0.006 (0,15).
D. Falls within JEDEC MS-012

MECHANICAL DATA

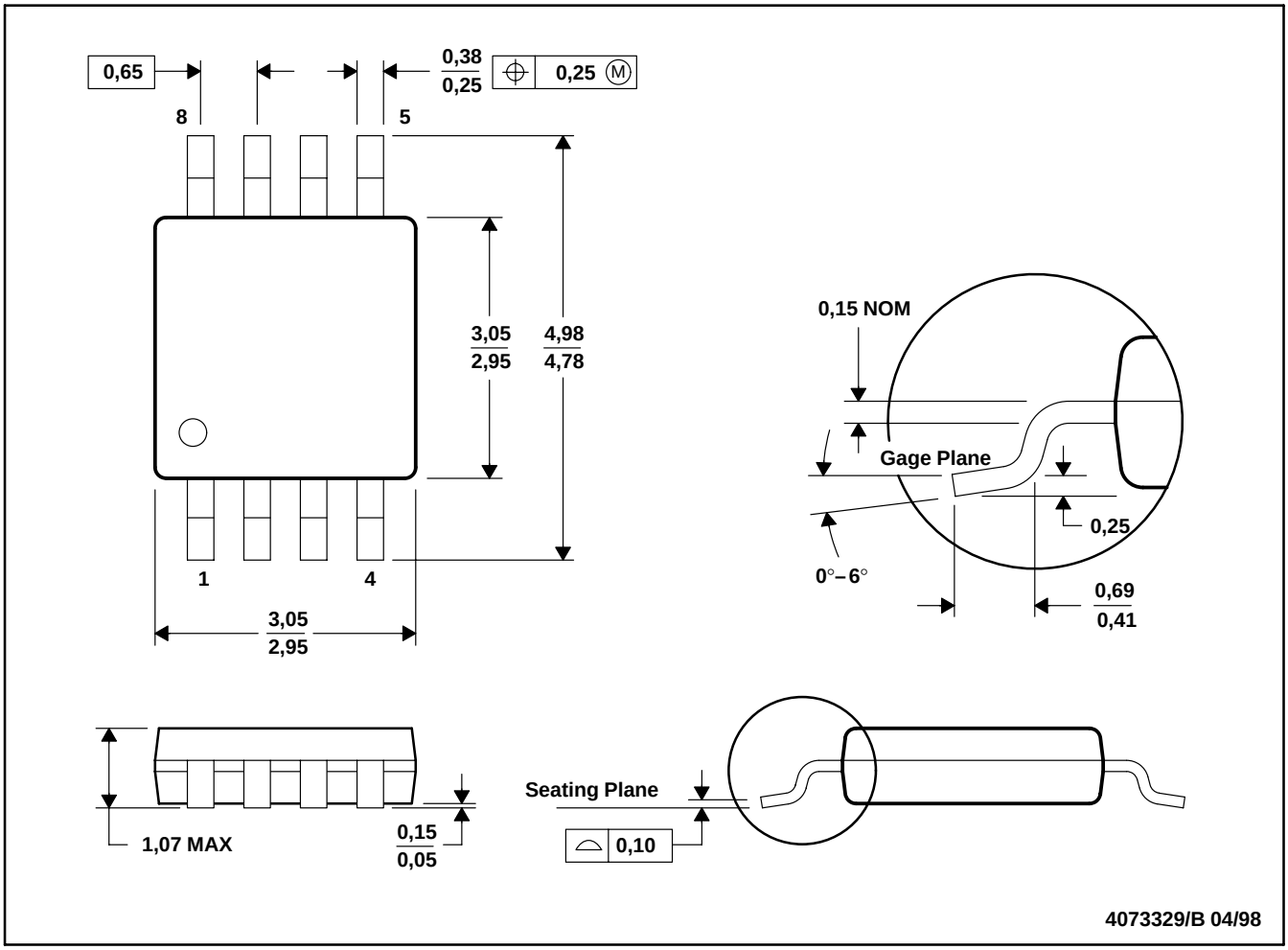
DBV (R-PDSO-G5) **PLASTIC SMALL-OUTLINE**



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-178

MECHANICAL DATA

DGK (R-PDSO-G8) **PLASTIC SMALL-OUTLINE PACKAGE**



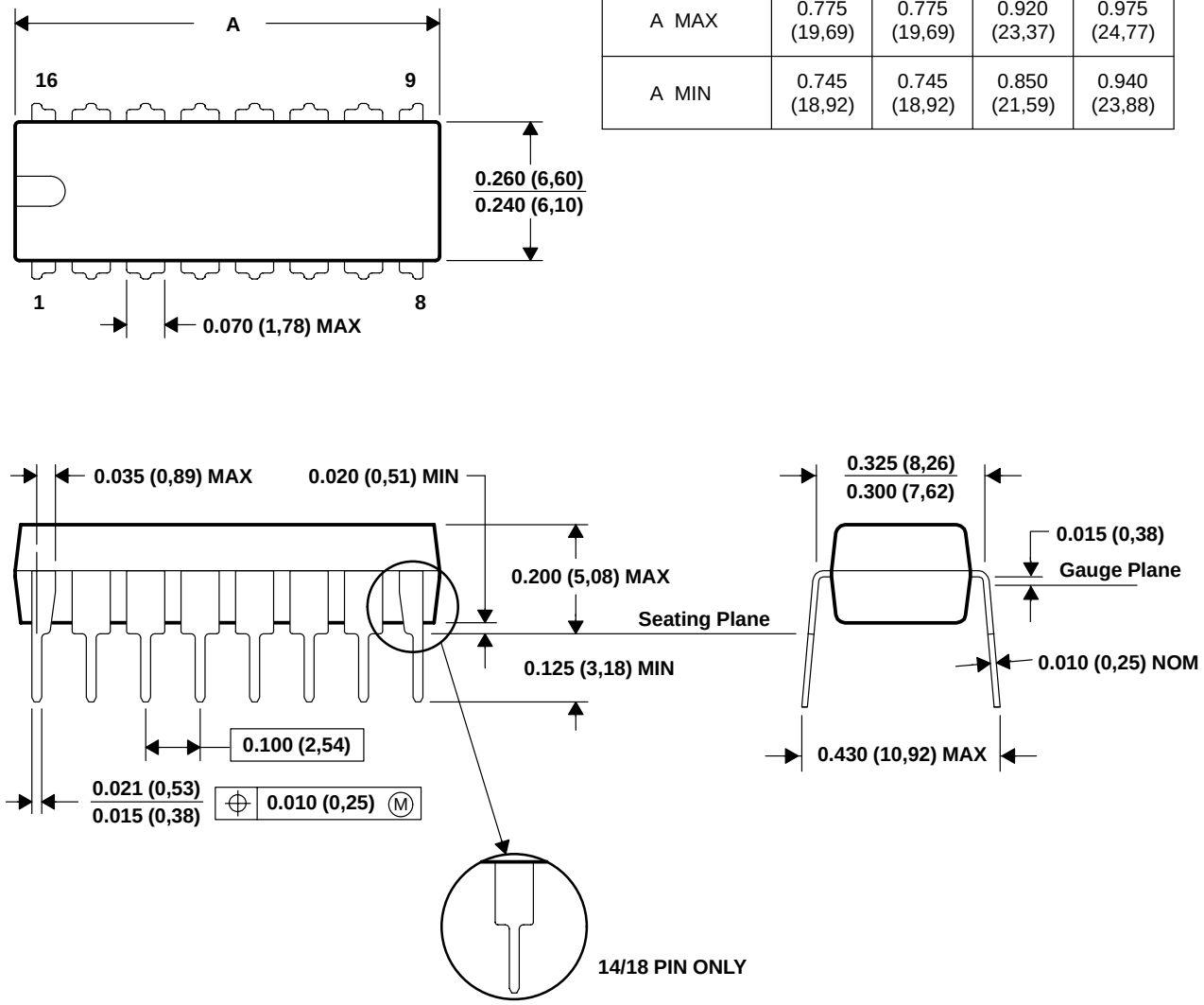
NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion.
D. Falls within JEDEC MO-187

MECHANICAL DATA

N (R-PDIP-T)** **PLASTIC DUAL-IN-LINE PACKAGE**

16 PINS SHOWN

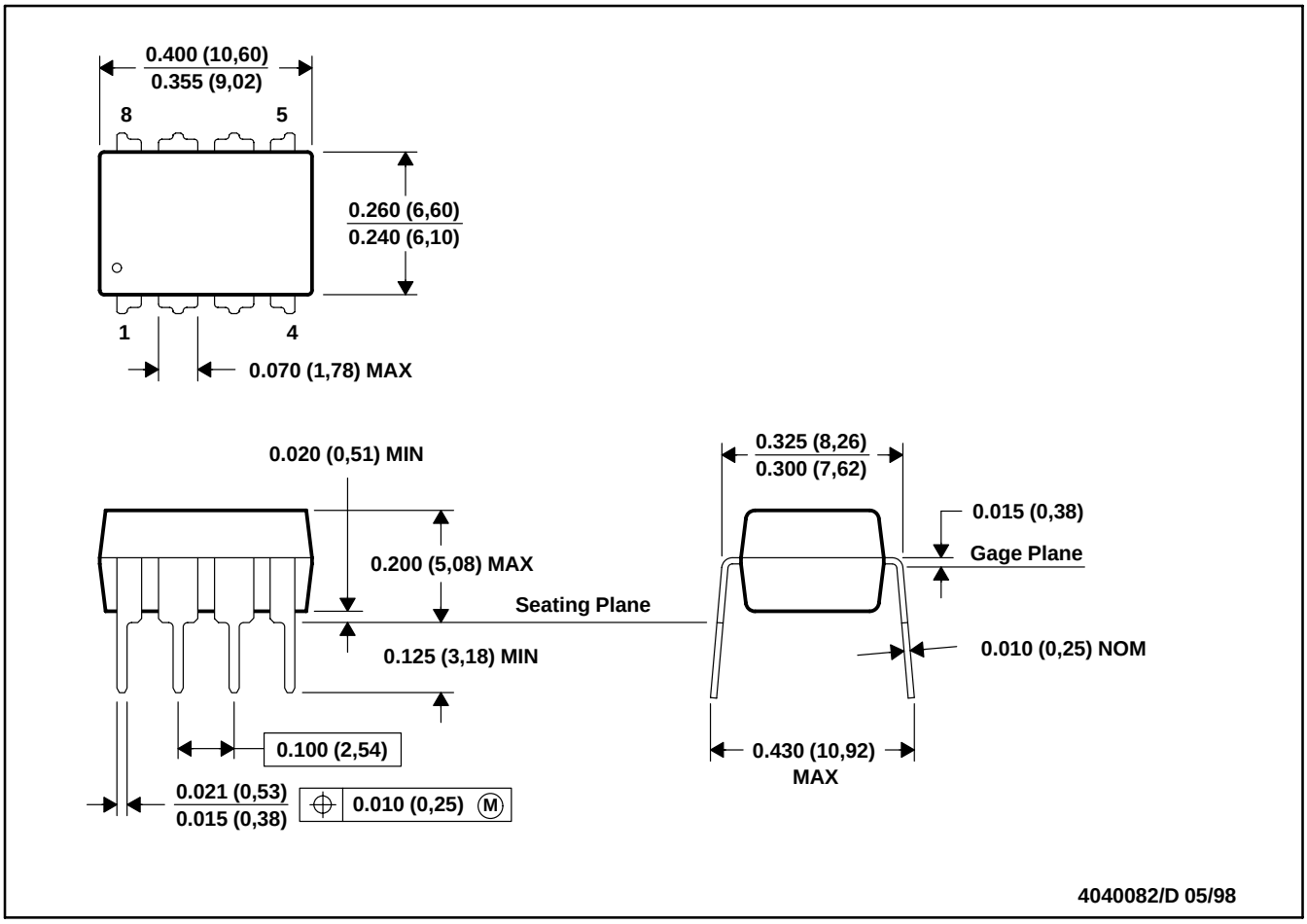
DIM \ PINS **	14	16	18	20
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	0.975 (24,77)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)



NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS-001 (20-pin package is shorter than MS-001).

MECHANICAL DATA

P (R-PDIP-T8) **PLASTIC DUAL-IN-LINE**



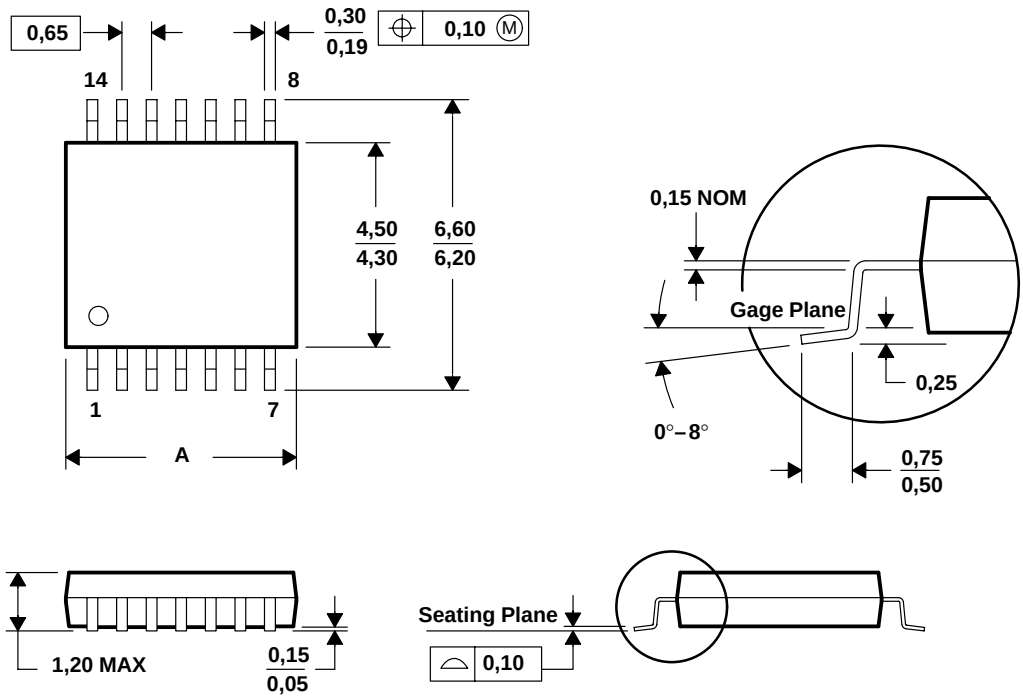
NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS-001

For the latest package information, go to http://www.ti.com/sc/docs/package/pkg_info.htm

MECHANICAL DATA

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

14 PINS SHOWN



DIM \ PINS **	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

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Mailing Address:

Texas Instruments
Post Office Box 655303
Dallas, Texas 75265

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