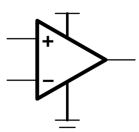
FAMILY OF LOW-POWER WIDE BANDWIDTH SINGLE SUPPLY OPERATIONAL AMPLIFIERS WITH AND WITHOUT SHUTDOWN

FEATURES

- **Rail-To-Rail Output**
- **V_{ICR} Includes Ground**
- **Gain-Bandwidth Product . . . 9 MHz**
- **Supply Current . . . 730 μA/Channel**
- **Single, Duals, and Quad Versions**
- **Ultralow Power Down Mode**
  - **$I_{DD(SHDN)}$ = 4 μA/Channel**
- **Specified Temperature Range**
  - **–40°C to 125°C . . . Industrial Grade**
- **Supply Voltage Range . . . 2.7 V to 5.5 V**
- **Ultrasmall Packaging**
  - **5 or 6 Pin SOT-23 (TLV2630/1)**
  - **8 or 10 Pin MSOP (TLV2632/3)**
- **Universal Op-Amp EVM (See SLOU060 for More Information)**

Operational Amplifier



DESCRIPTION

The TLV263x single supply operational amplifiers provide rail-to-rail output with an input range that includes ground. The TLV263x takes the minimum operating supply voltage down to 2.7 V over the extended industrial temperature range (–40°C to 125°C) while adding the rail-to-rail output swing feature. The TLV263x also provides a 9 MHz gain-bandwidth product from only 730 μA of supply current. The maximum recommended supply voltage is 5.5 V, which, when coupled with a 2.7-V minimum, allows the devices to be operated from lithium ion cells.

The combination of wide bandwidth, low noise, and low distortion makes it ideal for high speed and high resolution data converter applications. The ground input range allows it to directly interface to ground rail referred systems.

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.

The 2.7-V operation makes it compatible with Li-Ion powered systems and the operating supply voltage range of many micro-power microcontrollers available today including TI's MSP430.

AMPLIFIER SELECTION TABLE

DEVICE	V_{DD} [V]	I_{DD}/ch [μA]	V_{ICR} [V]	GBW [MHz]	SLEW RATE [V/μs]	V_n, 1 kHz [nV/√Hz]	I_O [mA]
OPAx343	2.5–5.5	850	–0.3 to V_{DD} + 0.3	5.5	6	25	40
OPAx743	3.5–12	1100	–0.1 to V_{DD} + 0.1	7	10	30	20
TLV278x	1.8–3.6	650	–0.2 to V_{DD} + 0.2	8	5	9	10
TLV263x	**2.7–5.5**	**730**	**GND to V_{DD} – 1**	**9**	**9.5**	**50**	**28**
TLV262x	2.7–5.5	750	1 V to V_{DD} + 0.2	11	10	27	28
OPAx353	2.7–5.5	8000	–0.1 to V_{DD} + 0.1	44	22	7	40

PACKAGE/ORDERING INFORMATION

PRODUCT	PACKAGE	PACKAGE CODE	SYMBOL	SPECIFIED TEMPERATURE RANGE	ORDER NUMBER	TRANSPORT MEDIA
Single with Shutdown						
TLV2630ID	SOIC–8	D	—	–40°C to 125°C	TLV2630ID TLV2630IDR	Tube Tape and Reel
TLV2630IDBV	SOT–23–6	DBV	VAYI		TLV2630IDBVR† TLV2630IDBVT‡	Tape and Reel
TLV2630IP	DIP–8	P	—		TLV2630IP	Tube
Single without Shutdown						
TLV2631ID	SOIC–8	D	—	–40°C to 125°C	TLV2631ID TLV2631IDR	Tube Tape and Reel
TLV2631IDBV	SOT–23–5	DBV	VAZI		TLV2631IDBVR† TLV2631IDBVT‡	Tape and Reel
TLV2631IP	DIP–8	P	—		TLV2631IP	Tube
Dual without Shutdown						
TLV2632ID	SOIC–8	D	—	–40°C to 125°C	TLV2632ID TLV2632IDR	Tube Tape and Reel
TLV2632IDGK	MSOP–8	DGK	AKG		TLV2632IDGK TLV2632IDGKR	Tube Tape and Reel
TLV2632IP	DIP–8	P	—		TLV2632IP	Tube
Dual with Shutdown						
TLV2633ID	SOIC–14	D	—	–40°C to 125°C	TLV2633ID TLV2633IDR	Tube Tape and Reel
TLV2633IDGS	MSOP–10	DGS	AKK		TLV2633IDGS TLV2633IDGSR	Tube Tape and Reel
TLV2633IN	DIP–14	N	—		TLV2633IN	Tube
Quad without Shutdown						
TLV2634ID	SOIC–14	D	—	–40°C to 125°C	TLV2634ID TLV2634IDR	Tube Tape and Reel
TLV2634IN	DIP–14	N	—		TLV2634IN	Tube
TLV2634IPW	TSSOP–14	PW	—		TLV2634IPW TLV2634IPWR	Tube Tape and Reel
Quad with Shutdown						
TLV2635ID	SOIC–16	D	—	–40°C to 125°C	TLV2635ID TLV2635IDR	Tube Tape and Reel
TLV2635IN	DIP–16	N	—		TLV2635IN	Tube
TLV2635IPW	TSSOP–16	PW	—		TLV2635IPW TLV2635IPWR	Tube Tape and Reel

† The SOT23 package devices are only available taped and reeled. The R Suffix denotes quantities (3,000 pieces per reel).
‡ The T Suffix denotes smaller quantities (250 pieces per mini-reel).

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

Supply voltage, V_{DD} (see Note 1) . . . 6 V
Differential input voltage, V_{ID} . . . $\pm V_{DD}$
Input voltage range, V_I (see Note 1) . . . GND to V_{DD} – 1 V
Input current, I_I (any input) . . . ± 10 mA
Output current, I_O . . . ±40 mA
Continuous total power dissipation . . . See Dissipation Rating Table
Operating free-air temperature range, T_A: 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.
NOTE 1: All voltage values, except differential voltages, are with respect to GND.

recommended operating conditions

		MIN	MAX	UNIT
Supply voltage, V_{DD}	Single supply	2.7	5.5	V
	Split supply	±1.35	±2.75	
Common-mode input voltage range, V_{ICR}		GND	V_{DD}–1	V
Operating free-air temperature, T_A	I-suffix	–40	125	°C
Shutdown on/off voltage level‡	V_{IL}		0.4	V
	V_{IH}	2		

‡ Relative to GND.

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

dc performance

PARAMETER		TEST CONDITIONS		T_A	MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage	$V_{IC} = V_{DD}/2$, $V_O = V_{DD}/2$		25°C		250	3500	µV
				Full range			4500	
			TLV2634/5	25°C		250	4200	µV
				Full range			5200	
α_{VIO}	Temperature coefficient of input offset voltage			25°C		3		µV/°C
CMRR	Common-mode rejection ratio	V_{IC} = GND to V_{DD}–1 V	V_{DD} = 2.7 V	25°C	76	100		dB
				Full range	67			
			V_{DD} = 5 V	25°C	77	100		
				Full range	74			
A_{VD}	Large-signal differential voltage amplification	R_L = 2 kΩ, $V_{O(PP)} = V_{DD}$–1 V		25°C	90	100		dB
				Full range	82			

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

input characteristics

PARAMETER		TEST CONDITIONS	T_A†	MIN	TYP	MAX	UNIT
I_{IO}	Input offset current	$V_{IC} = V_{DD}/2$, $V_O = V_{DD}/2$	25°C		1	50	pA
			Full range			100	
I_{IB}	Input bias current		25°C		1	50	
			Full range			200	
$r_{i(d)}$	Differential input resistance		25°C		1000		GΩ
$C_{i(c)}$	Common-mode input capacitance	f = 1 kHz	25°C		12		pF

† Full range is –40°C to 125°C for the I suffix.

output characteristics

PARAMETER		TEST CONDITIONS		T_A†	MIN	TYP	MAX	UNIT
V_{OH}	High-level output voltage	$V_{IC} = V_{DD}/2$, I_{OH} = –1 mA	V_{DD} = 2.7 V	25°C	2.6	2.67		V
				Full range	2.55			
			V_{DD} = 5 V	25°C	4.92	4.98		
				Full range	4.9			
		$V_{IC} = V_{DD}/2$, I_{OH} = –10 mA	V_{DD} = 2.7 V	25°C	2.25	2.43		
				Full range	2.15			
			V_{DD} = 5 V	25°C	4.7	4.8		
				Full range	4.65			
V_{OL}	Low-level output voltage	$V_{IC} = V_{DD}/2$, I_{OL} = 1 mA	V_{DD} = 2.7 V	25°C		0.03	0.1	mV
				Full range			0.15	
			V_{DD} = 5 V	25°C		0.025	0.08	
				Full range			0.1	
		$V_{IC} = V_{DD}/2$, I_{OL} = 10 mA	V_{DD} = 2.7 V	25°C		0.26	0.45	
				Full range			0.47	
			V_{DD} = 5 V	25°C		0.2	0.3	
				Full range			0.35	
I_O	Output current	V_{DD} = 2.7 V, V_O = 0.5 V from rail	Sourcing	25°C		14		mA
			Sinking			19		
		V_{DD} = 5 V, V_O = 0.5 V from rail	Sourcing			28		
			Sinking			28		
I_{OS}	Short-circuit output current	Sourcing	V_{DD} = 2.7 V	25°C		50		mA
			V_{DD} = 5 V			95		
		Sinking	V_{DD} = 2.7 V			50		
			V_{DD} = 5 V			95		

† Full range is –40°C to 125°C for the I suffix.

power supply

PARAMETER		TEST CONDITIONS		T_A†	MIN	TYP	MAX	UNIT
I_{DD}	Supply current (per channel)	$V_O = V_{DD}/2$,	$\overline{SHDN} = V_{DD}$	25°C		730	1000	µA
				Full range			1350	
PSRR	Supply voltage rejection ratio (ΔV_{DD} /ΔV_{IO})	V_{DD} = 2.7 V to 5.5 V, $V_{IC} = V_{DD}/2$	No load	25°C	70	90		dB
				Full range	65			

† Full range is –40°C to 125°C for the I suffix.

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

dynamic performance

PARAMETER		TEST CONDITIONS		T_A†	MIN	TYP	MAX	UNIT
GBWP	Gain-bandwidth product	R_L = 2 kΩ, C_L = 10 pF, f = 10 kHz		25°C		9		MHz
SR+	Positive slew rate at unity gain	R_L = 2 kΩ, C_L = 50 pF	V_{DD} = 2.7 V, $V_{O(PP)}$ = 1.7 V			6		V/µs
			V_{DD} = 5 V, $V_{O(PP)}$ = 3.5 V			6		
SR–	Negative slew rate at unity gain	R_L = 2 kΩ, C_L = 50 pF	V_{DD} = 2.7 V, $V_{O(PP)}$ = 1.7 V			10		V/µs
			V_{DD} = 5 V, $V_{O(PP)}$ = 3.5 V			9.5		V/µs
ϕ_m	Phase margin	R_L = 2 kΩ,	C_L = 10 pF			50		°
	Gain margin					20		dB

† Full range is –40°C to 125°C for the I suffix.

noise/distortion performance

PARAMETER		TEST CONDITIONS		T_A	MIN	TYP	MAX	UNIT
THD + N	Total harmonic distortion plus noise	$V_{O(PP)}$ = V_{DD}/2, R_L = 2 kΩ, f = 10 kHz	A_V = 1	25°C		0.003%		
			A_V = 10			0.02%		
			A_V = 100			0.095%		
V_n	Equivalent input noise voltage	f = 1 kHz				50		nV/√Hz
		f = 10 kHz				30		
I_n	Equivalent input noise current	f = 1 kHz				0.9		fA/√Hz

shutdown characteristics

PARAMETER		TEST CONDITIONS		T_A†	MIN	TYP	MAX	UNIT
$I_{DD(SHDN)}$	Supply current, per channel in shutdown mode (TLV2630, TLV2633, TLV2635)	$\overline{SHDN}$ = 0.4 V		25°C		4	17	µA
				Full range			19	
$t_{(on)}$	Amplifier turnon time‡	R_L = 2 kΩ, C_L = 10 pF	V_{DD} = 2.7 V	25°C		4.5		µs
			V_{DD} = 5 V			1.5		
$t_{(off)}$	Amplifier turnoff time‡					200		ns

† Full range is –40°C to 125°C for the I suffix.
‡ Disable time and enable time are defined as the interval between application of the logic signal to $\overline{SHDN}$ and the point at which the supply current has reached half its final value.

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	122.3	1022 mW	204.4 mW
D (16)	25.7	114.7	1090 mW	218 mW
DBV (5)	55	324.1	385 mW	77.1 mW
DBV (6)	55	294.3	425 mW	85 mW
DGK (8)	54.2	259.9	481 mW	96.1 mW
DGS (10)	54.1	259.7	485 mW	97 mW
N (14, 16)	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
PW (16)	28.7	161.4	774 mW	154.9 mW

TYPICAL CHARACTERISTICS

Table of Graphs

			FIGURE
V_{IO}	Input offset voltage	vs Common-mode input voltage	1, 2
CMRR	Common-mode rejection ratio	vs Frequency	3
V_{OH}	High-level output voltage	vs High-level output current	4, 6
V_{OL}	Low-level output voltage	vs Low-level output current	5, 7
I_{DD}	Supply current	vs Supply voltage	8
I_{DD}	Supply current	vs Free-air temperature	9
PSRR	Power supply rejection ratio	vs Frequency	10
A_{VD}	Differential voltage amplification & phase	vs Frequency	11
	Gain-bandwidth product	vs Supply voltage	12
		vs Free-air temperature	13
SR	Slew rate	vs Supply voltage	14
		vs Free-air temperature	15, 16
ϕ_m	Phase margin	vs Load capacitance	17
V_n	Equivalent input noise voltage	vs Frequency	18
	Crosstalk	vs Frequency	19
	Voltage-follower large-signal pulse response		20
	Voltage-follower small-signal pulse response		21
$I_{DD(SHDN)}$	Shutdown supply current	vs Free-air temperature	22
$I_{DD(SHDN)}$	Shutdown supply current	vs Supply voltage	23
$I_{DD(SHDN)}$	Shutdown supply current/output voltage	vs Time	24

TYPICAL CHARACTERISTICS

INPUT OFFSET VOLTAGE vs COMMON-MODE INPUT VOLTAGE

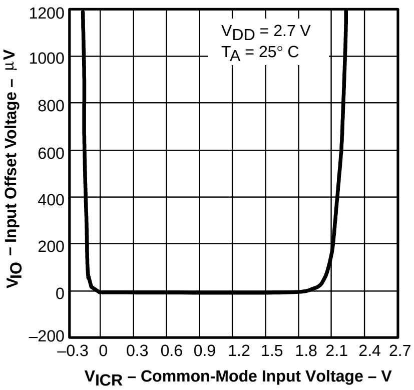


Figure 1

INPUT OFFSET VOLTAGE vs COMMON-MODE INPUT VOLTAGE

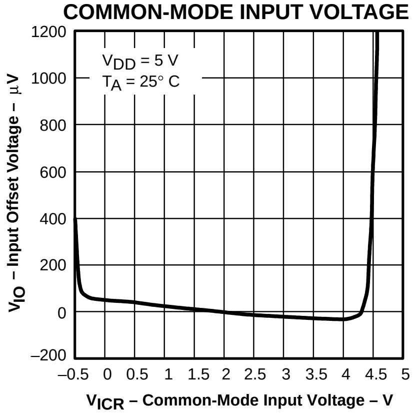


Figure 2

COMMON-MODE REJECTION RATIO vs FREQUENCY

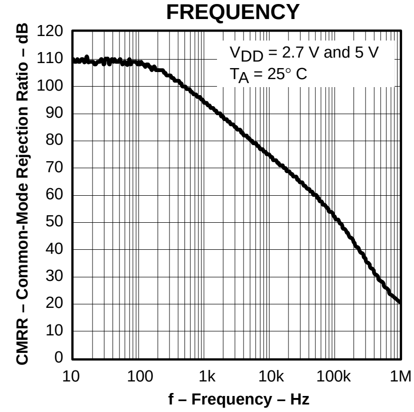


Figure 3

HIGH-LEVEL OUTPUT VOLTAGE vs HIGH-LEVEL OUTPUT CURRENT

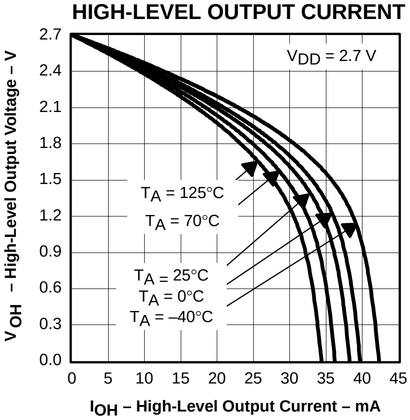


Figure 4

LOW-LEVEL OUTPUT VOLTAGE vs LOW-LEVEL OUTPUT CURRENT

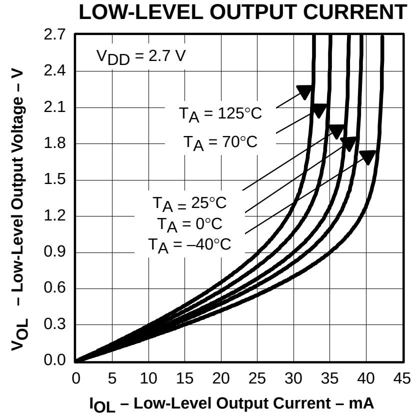


Figure 5

HIGH-LEVEL OUTPUT VOLTAGE vs HIGH-LEVEL OUTPUT CURRENT

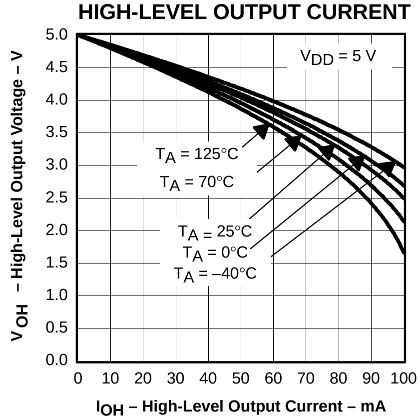


Figure 6

LOW-LEVEL OUTPUT VOLTAGE vs LOW-LEVEL OUTPUT CURRENT

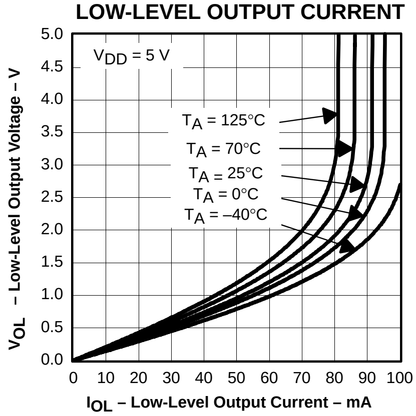


Figure 7

SUPPLY CURRENT vs SUPPLY VOLTAGE

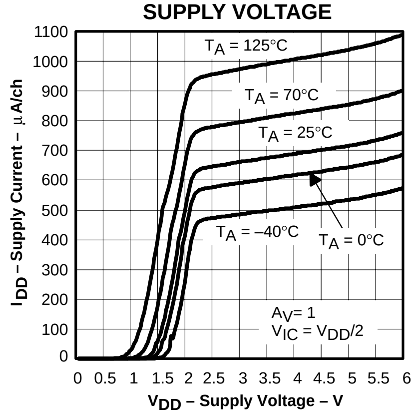


Figure 8

SUPPLY CURRENT vs FREE-AIR TEMPERATURE

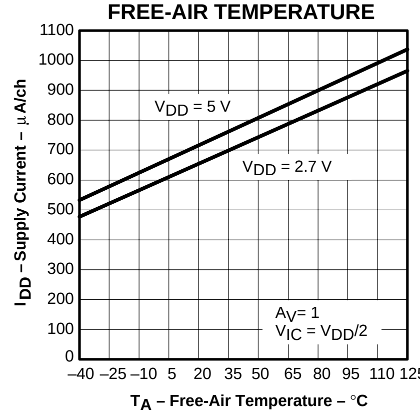


Figure 9

TYPICAL CHARACTERISTICS

POWER SUPPLY REJECTION RATIO
vs
FREQUENCY

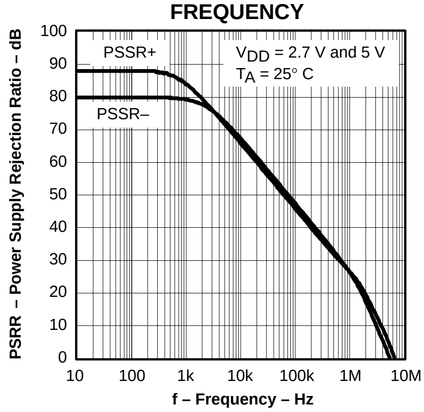


Figure 10

DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE
vs
FREQUENCY

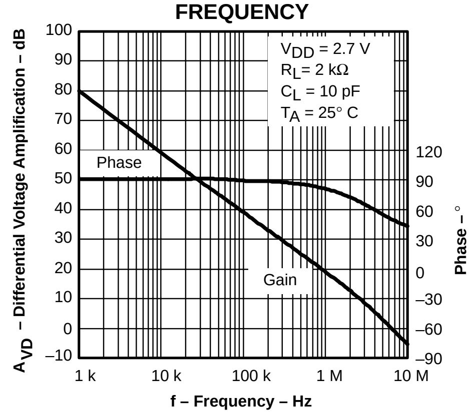


Figure 11

GAIN-BANDWIDTH PRODUCT
vs
SUPPLY VOLTAGE

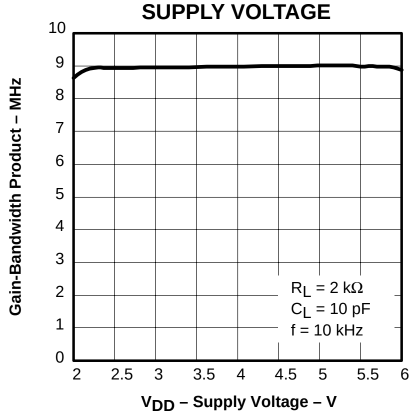


Figure 12

GAIN-BANDWIDTH PRODUCT
vs
FREE-AIR TEMPERATURE

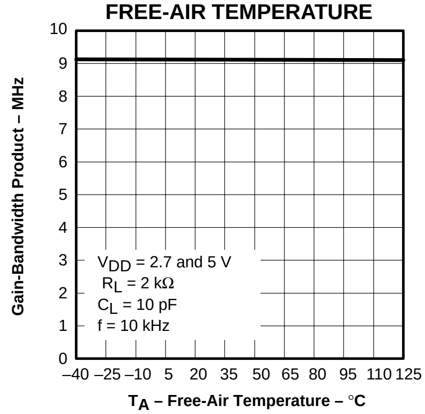


Figure 13

SLEW RATE
vs
SUPPLY VOLTAGE

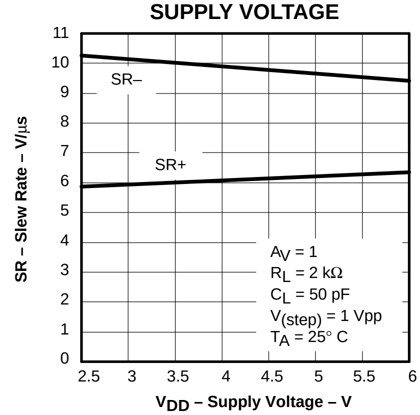


Figure 14

SLEW RATE
vs
FREE-AIR TEMPERATURE

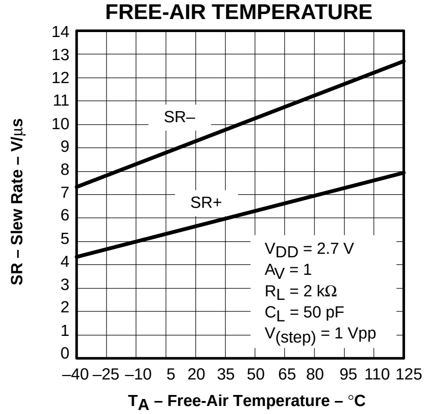


Figure 15

SLEW RATE
vs
FREE-AIR TEMPERATURE

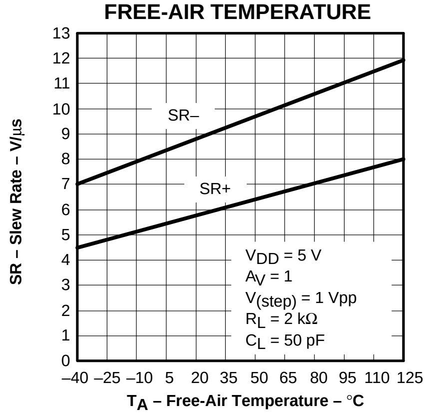


Figure 16

PHASE MARGIN
vs
LOAD CAPACITANCE

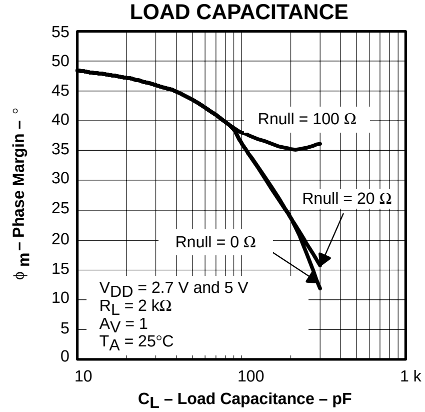


Figure 17

TYPICAL CHARACTERISTICS

EQUIVALENT INPUT NOISE VOLTAGE
vs
FREQUENCY

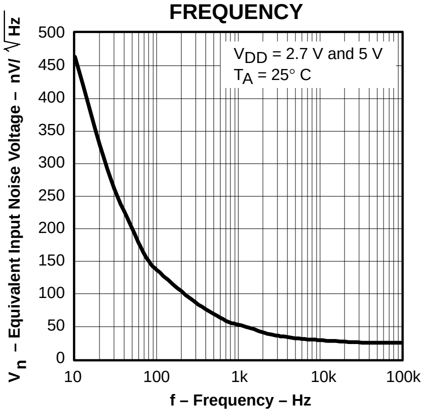


Figure 18

CROSSTALK
vs
FREQUENCY

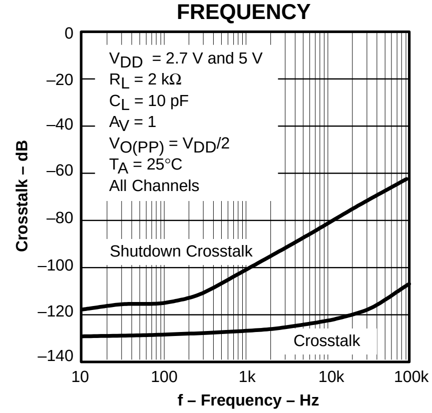


Figure 19

VOLTAGE-FOLLOWER LARGE-SIGNAL
PULSE RESPONSE

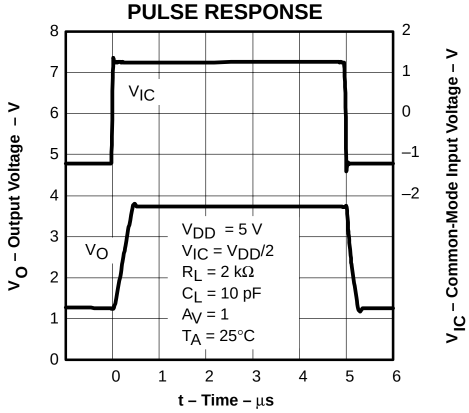


Figure 20

VOLTAGE-FOLLOWER SMALL-SIGNAL
PULSE RESPONSE

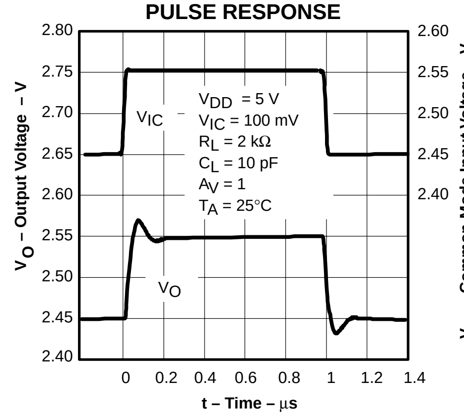


Figure 21

SHUTDOWN SUPPLY CURRENT
vs
FREE-AIR TEMPERATURE

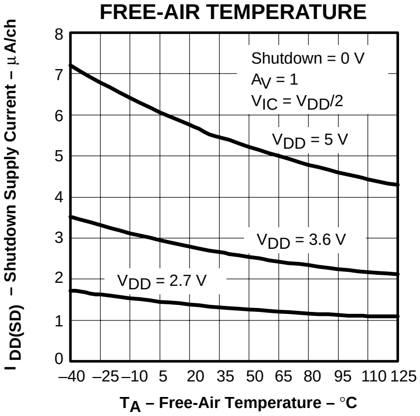


Figure 22

SHUTDOWN SUPPLY CURRENT
vs
SUPPLY VOLTAGE

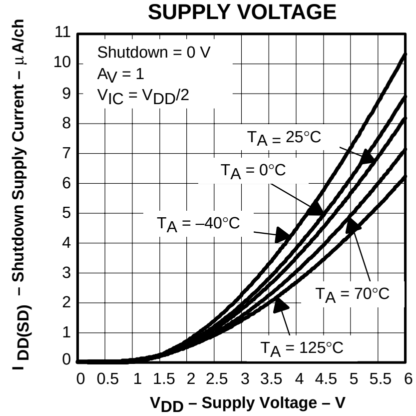


Figure 23

TYPICAL CHARACTERISTICS

**SHUTDOWN SUPPLY CURRENT / OUTPUT VOLTAGE
vs
TIME**

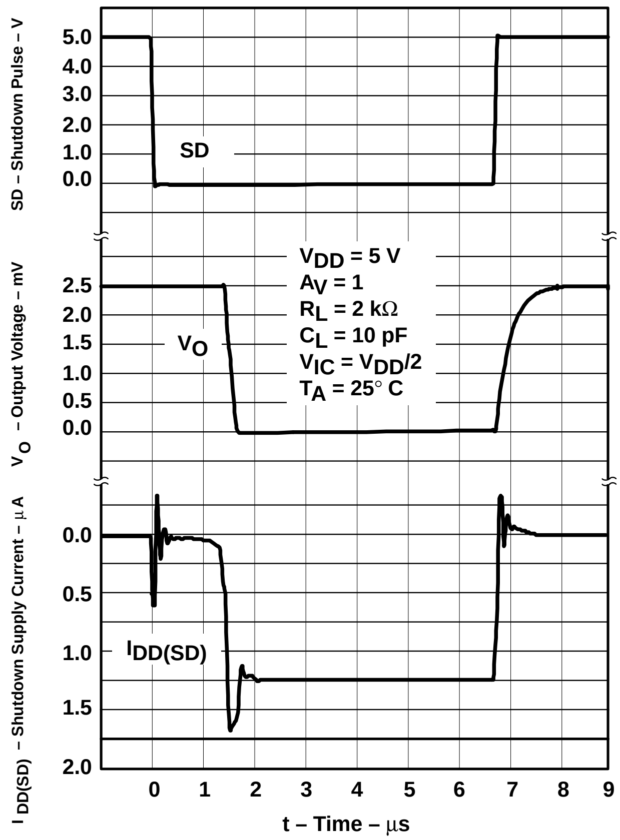
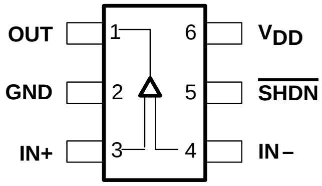


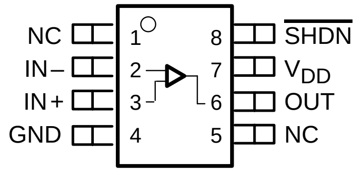
Figure 24

TLV263x PACKAGE PINOUTS

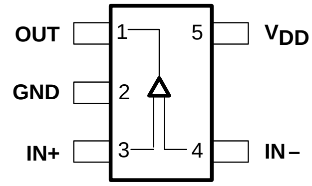
TLV2630
DBV PACKAGE
(TOP VIEW)



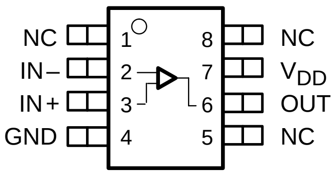
TLV2630
D OR P PACKAGE
(TOP VIEW)



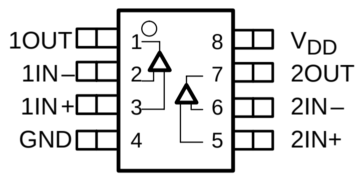
TLV2631
DBV PACKAGE
(TOP VIEW)



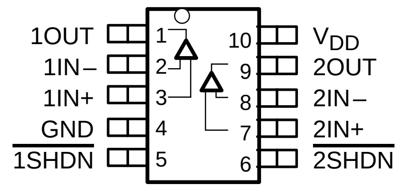
TLV2631
D OR P PACKAGE
(TOP VIEW)



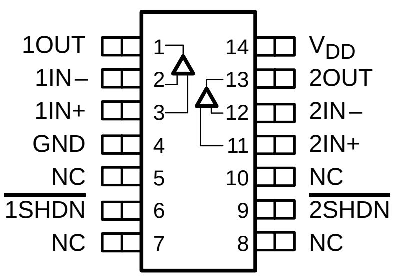
TLV2632
D, DGK, OR P PACKAGE
(TOP VIEW)



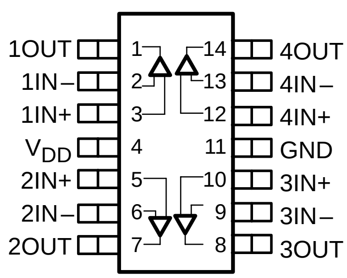
TLV2633
DGS PACKAGE
(TOP VIEW)



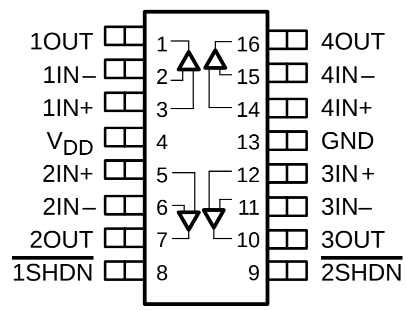
TLV2633
D OR N PACKAGE
(TOP VIEW)



TLV2634
D, N, OR PW PACKAGE
(TOP VIEW)



TLV2635
D, N, OR PW PACKAGE
(TOP VIEW)

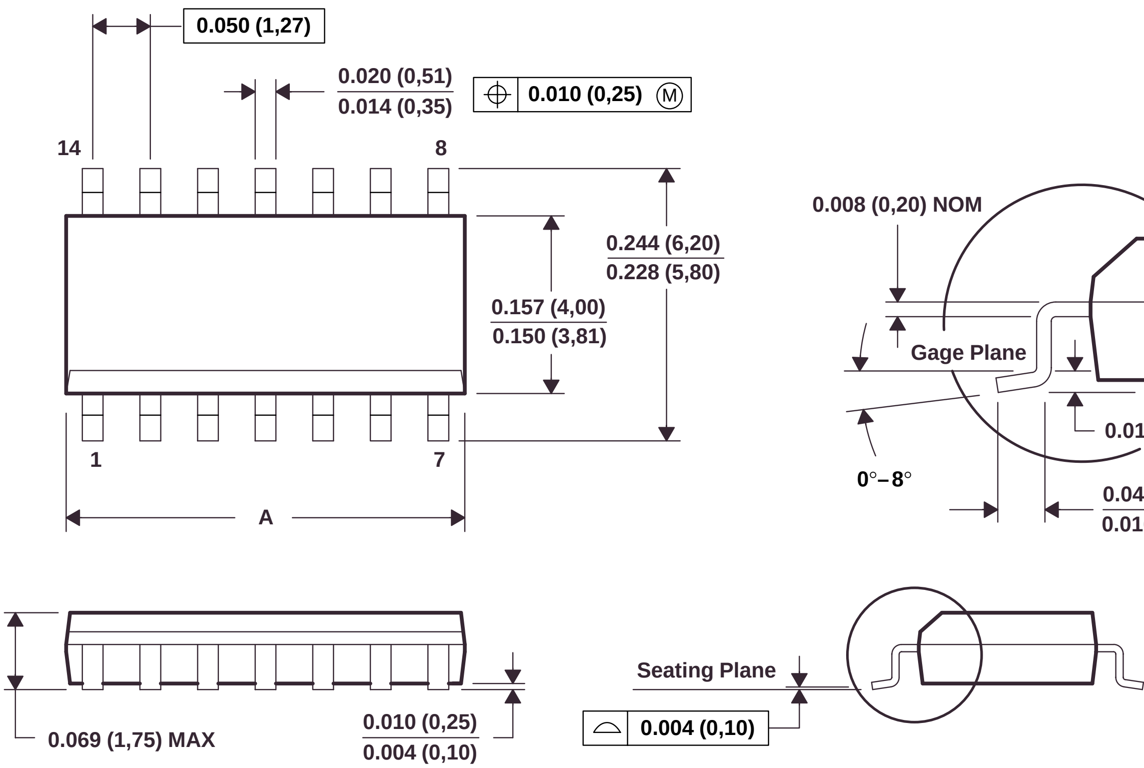


NC – No internal connection

MECHANICAL DATA

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

14 PIN SHOWN



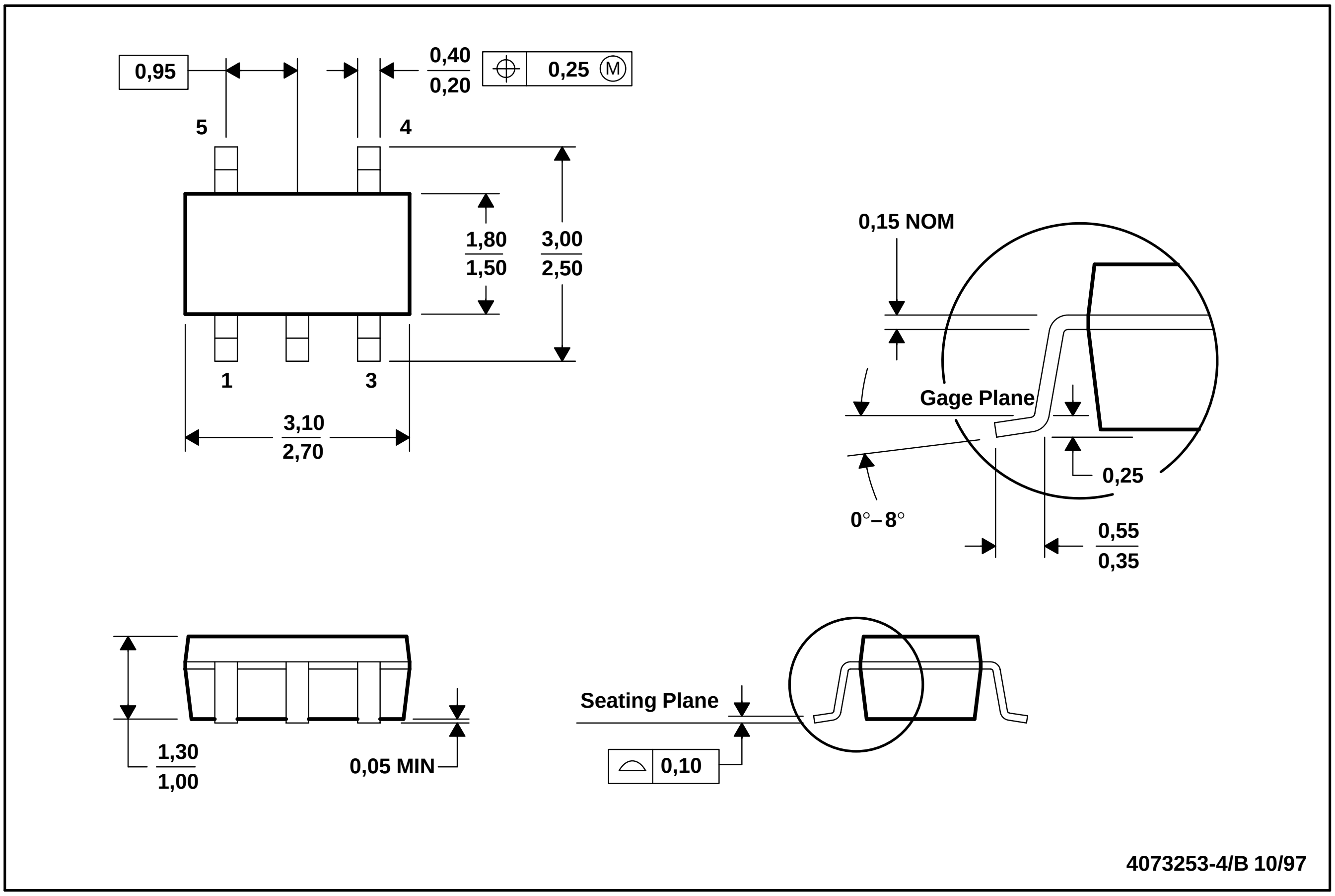
DIM \ PINS **	8	14	16
A MAX	0.197 (5,00)	0.344 (8,75)	0.394 (10,00)
A MIN	0.189 (4,80)	0.337 (8,55)	0.386 (9,80)

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).

MECHANICAL INFORMATION

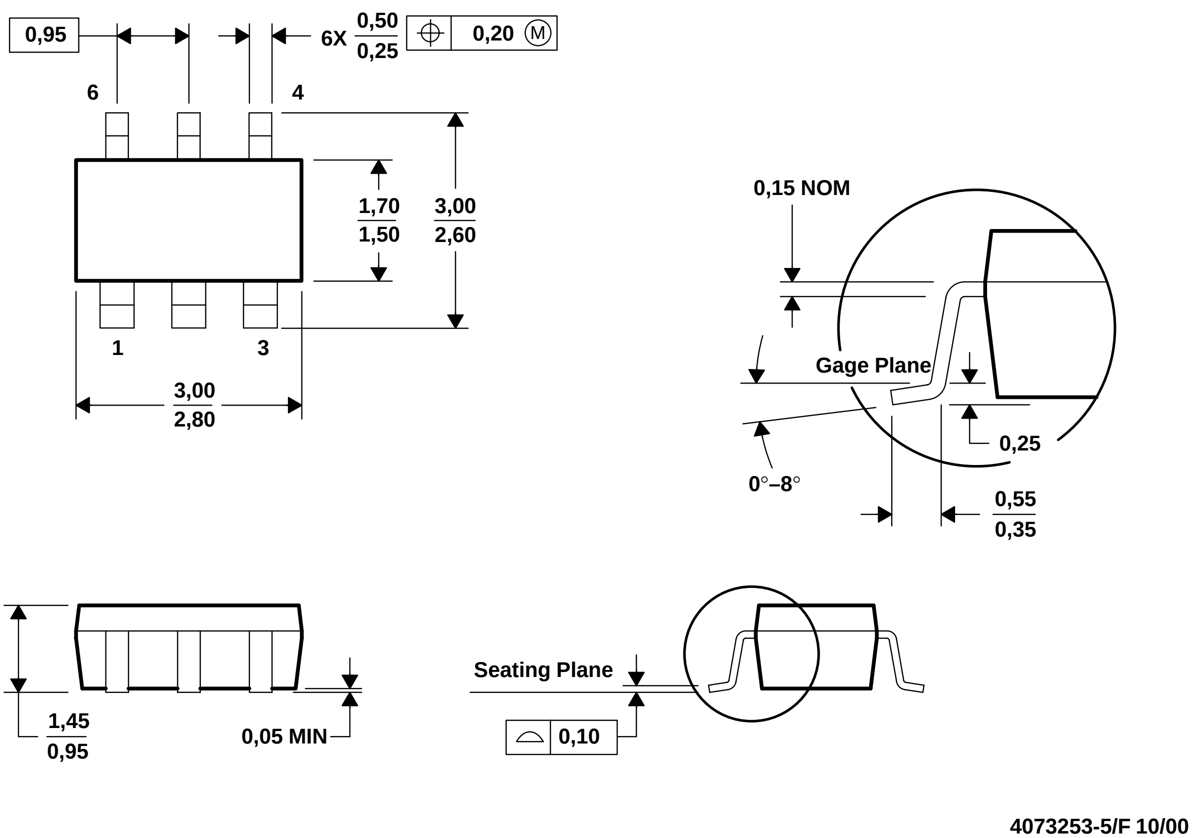
DBV (R-PDSO-G5) **PLASTIC SMALL-OUTLINE PACKAGE**



NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions include mold flash or protrusion.

MECHANICAL INFORMATION

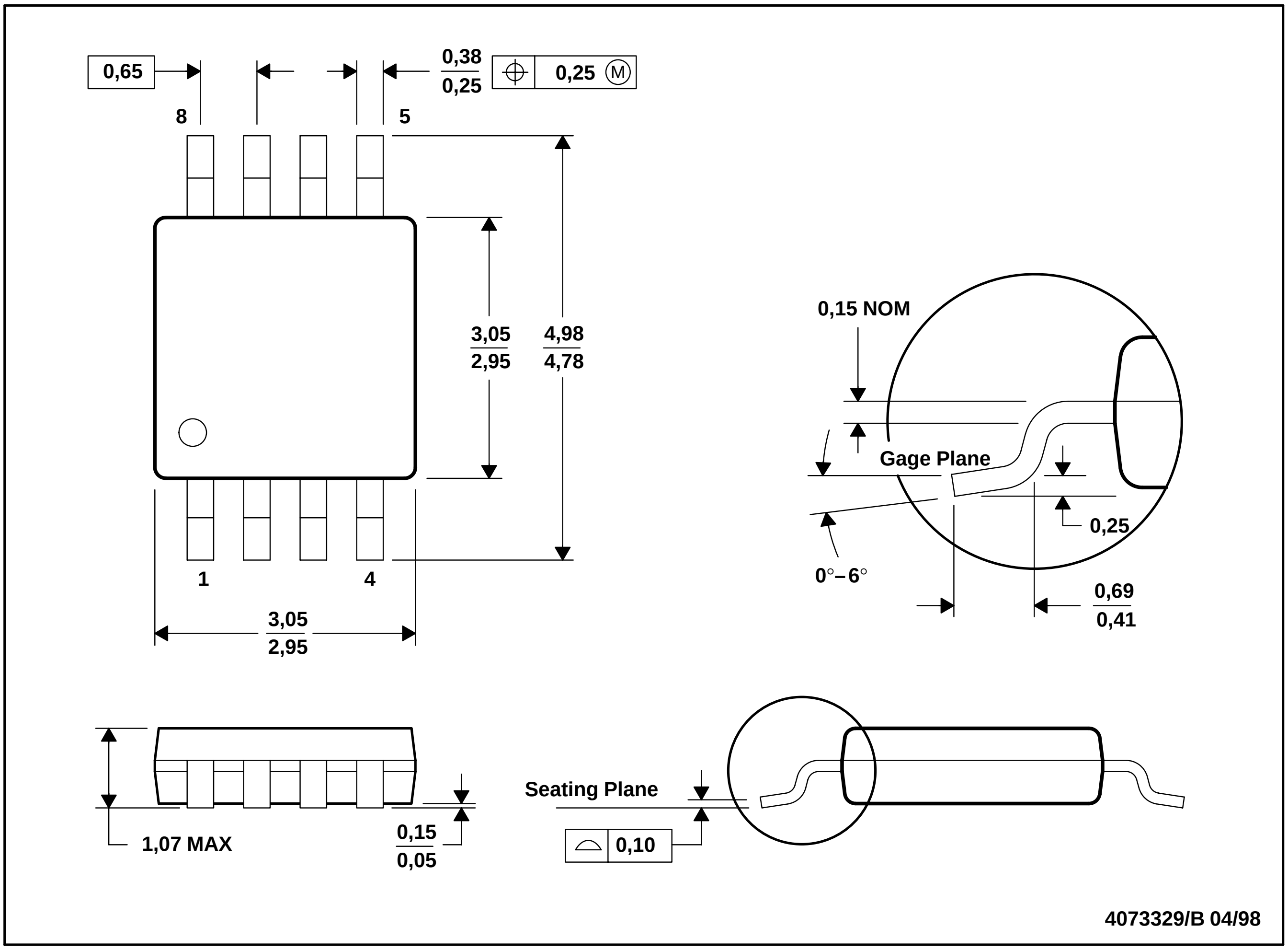
DBV (R-PDSO-G6) **PLASTIC SMALL-OUTLINE**



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. Leads 1, 2, 3 are wider than leads 4, 5, 6 for package orientation.

MECHANICAL INFORMATION

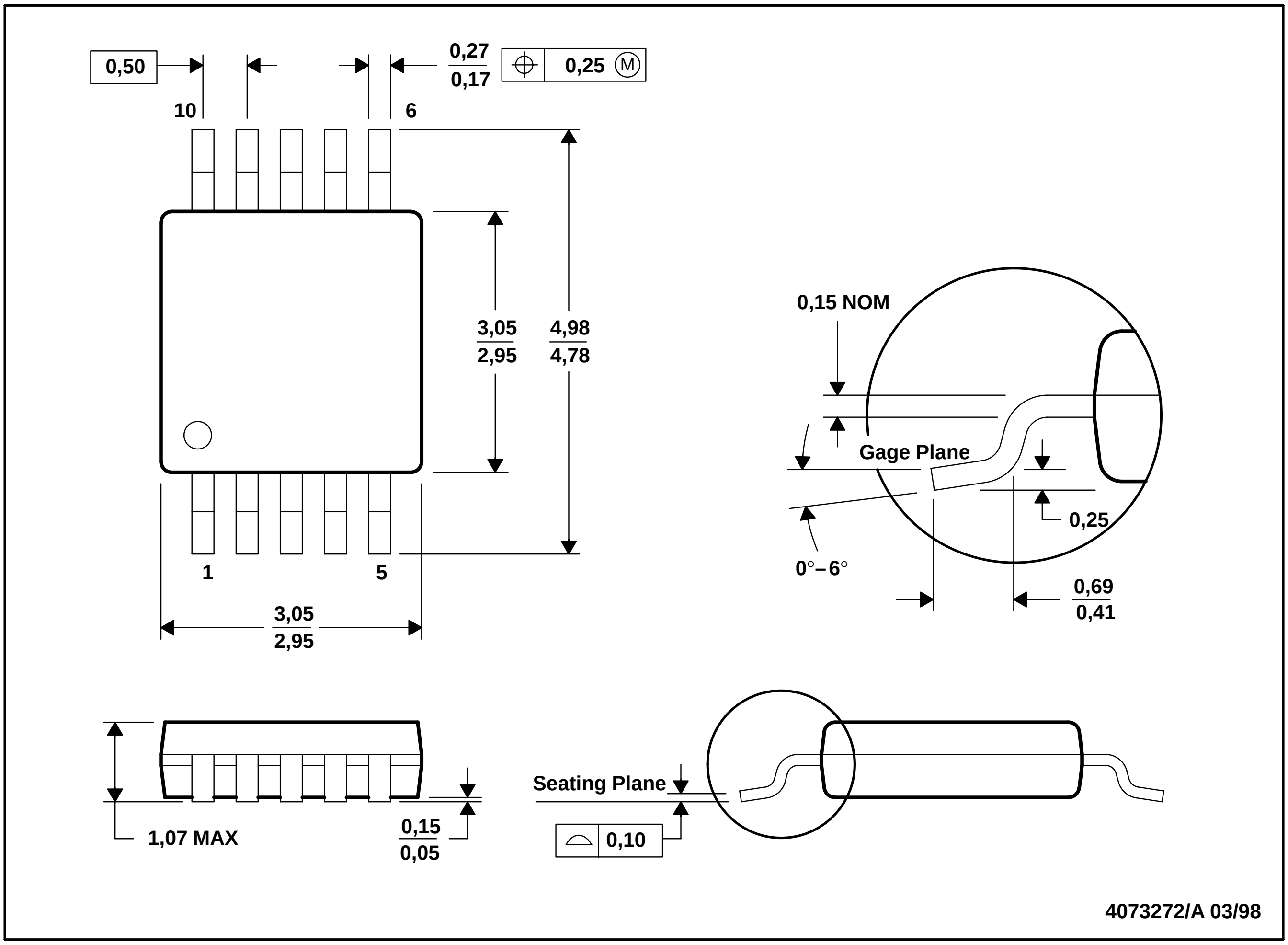
DGK (R-PDSO-G8) **PLASTIC SMALL-OUTLINE PACKAGE**



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 INFORMATION

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



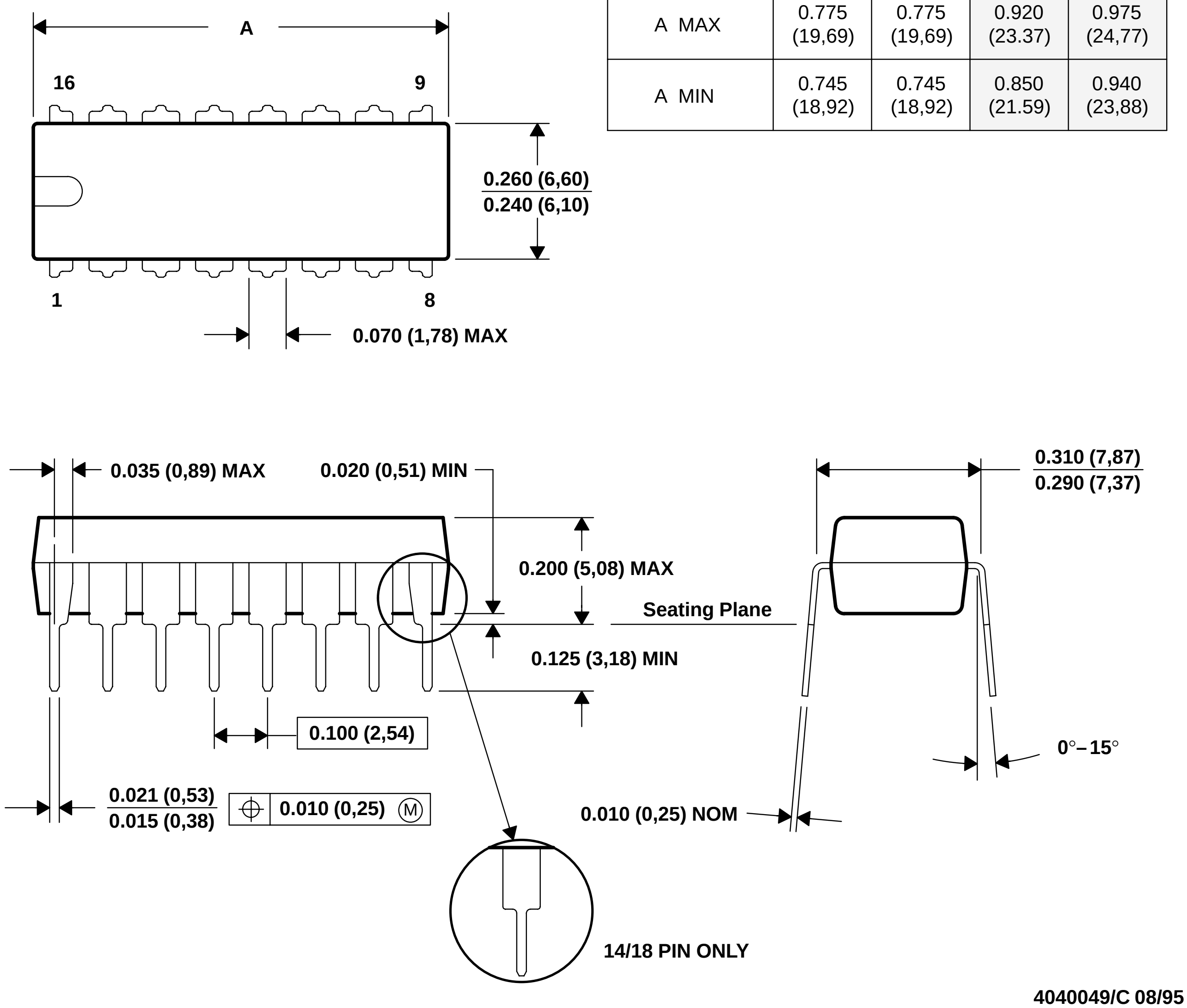
NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion.

MECHANICAL INFORMATION

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

16 PIN SHOWN

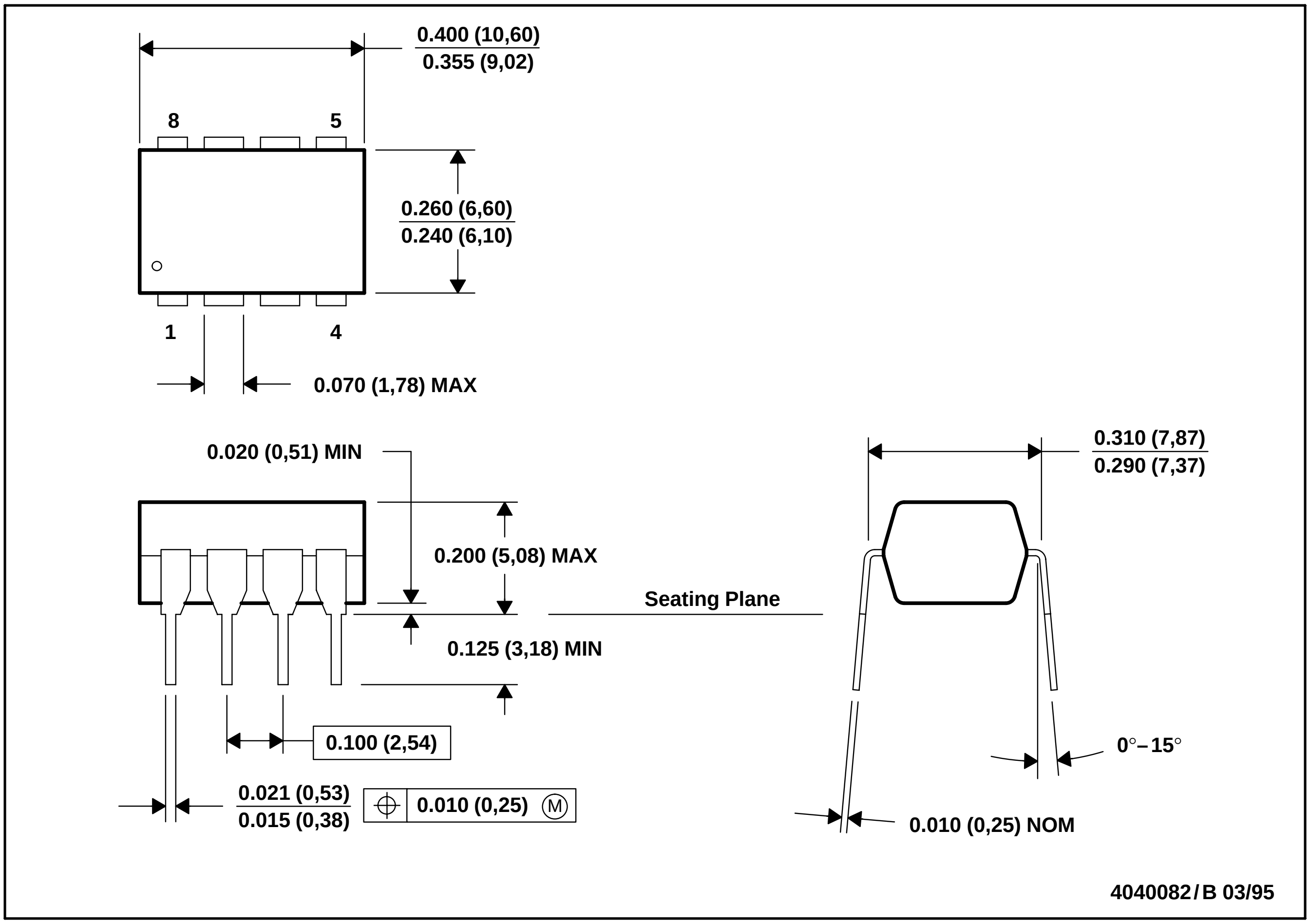
PINS ** / DIM	14	16	18	20
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23.37)	0.975 (24,77)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21.59)	0.940 (23,88)



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 then MS-001.)

MECHANICAL INFORMATION

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

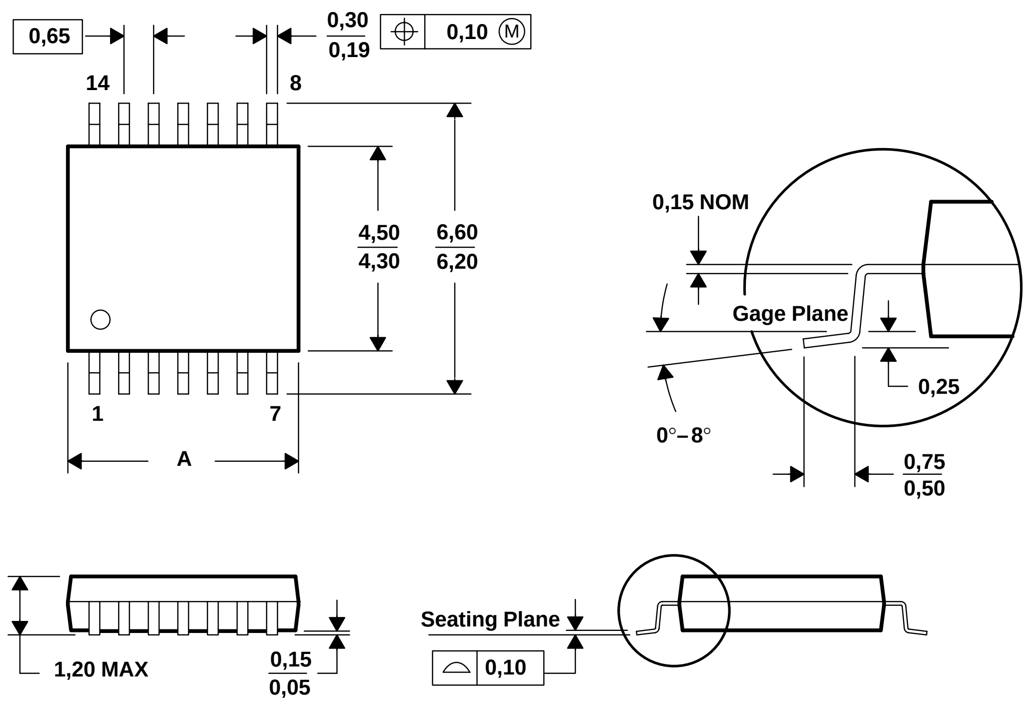


NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS-001

MECHANICAL INFORMATION

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

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