

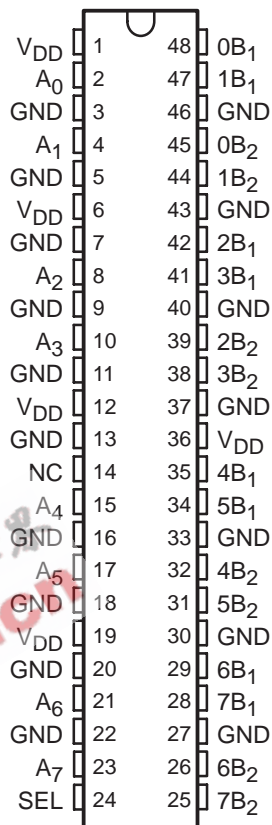
TS3L301

16-BIT TO 8-BIT SPDT GIGABIT LAN SWITCH WITH LOW AND FLAT ON-STATE RESISTANCE

SCDS178B – NOVEMBER 2004 – REVISED APRIL 2005

- **Wide Bandwidth** (BW = 900 MHz Typ)
- **Low Crosstalk** ($X_{TALK} = -41$ dB Typ)
- **Low Bit-to-Bit Skew** [$t_{sk(o)} = 0.2$ ns Max]
- **Low and Flat ON-State Resistance** ($r_{on} = 4 \Omega$ Typ, $r_{on(Flat)} = 0.7 \Omega$ Typ)
- **Low Input/Output Capacitance** ($C_{ON} = 10$ pF Typ)
- **Rail-to-Rail Switching on Data I/O Ports** (0 to 5 V)
- **V_{DD} Operating Range** From 3 V to 3.6 V
- **I_{off} Supports Partial-Power-Down Mode Operation**
- **Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II**
- **ESD Performance Tested Per JESD 22**
 - 2000-V Human-Body Model (A114-B, Class II)
 - 1000-V Charged-Device Model (C101)
- **Suitable for 10/100/1000-Mbit Ethernet Signaling**
- **Applications**
 - 10/100/1000 Base-T Signal Switching
 - Differential (LVDS, LVPECL) Signal Switching
 - Digital Video Signal Routing
 - Notebook Docking Signal Routing
 - Hub and Router Signal Switching

**DGG OR DGV PACKAGE
(TOP VIEW)**



NC – No internal connection

description/ordering information

The TS3L301 is a 16-bit to 8-bit multiplexer/demultiplexer LAN switch with a single select (SEL) input. The SEL input controls the data path of the multiplexer/demultiplexer.

The device provides a low and flat on-state resistance (r_{on}) and an excellent on-resistance match. Low input/output capacitance, high-bandwidth, low skew, and low crosstalk among channels make this device suitable for various LAN applications, such as 10/100/1000 Base-T.

ORDERING INFORMATION

TA	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	TSSOP – DGG	Tape and reel	TS3L301DGGR	TS3L301
	TVSOP – DGV	Tape and reel	TS3L301DGVR	TK301

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.



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.

**TEXAS
INSTRUMENTS**

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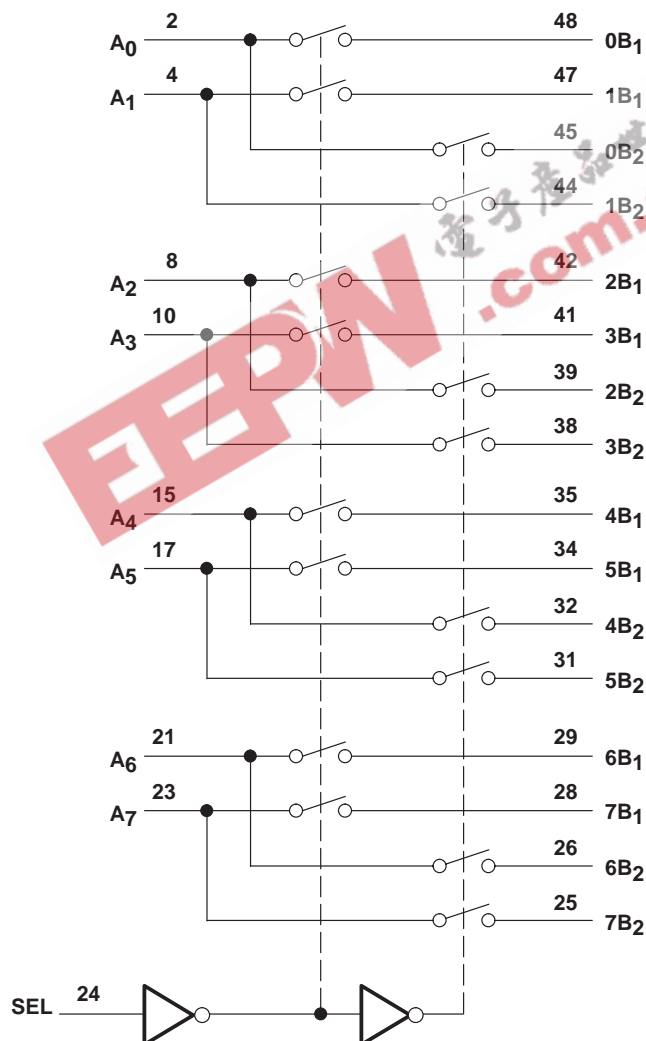
FUNCTION TABLE

INPUT	INPUT/OUTPUT	FUNCTION
SEL	A_n	
L	nB_1	$A_n = nB_1$
H	nB_2	$A_n = nB_2$

PIN DESCRIPTIONS

PIN NAME	DESCRIPTION
A_n	Data I/Os
nB_m	Data I/Os
SEL	Select input

logic diagram (positive logic)



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

Supply voltage range, V_{DD}	–0.5 V to 4.6 V
Control input voltage range, V_{IN} (see Notes 1 and 2)	–0.5 V to 7 V
Switch I/O voltage range, $V_{I/O}$ (see Notes 1, 2, and 3)	–0.5 V to 7 V
Control input clamp current, I_{IK} ($V_{IN} < 0$)	–50 mA
I/O port clamp current, $I_{I/OK}$ ($V_{I/O} < 0$)	–50 mA
ON-state switch current, $I_{I/O}$ (see Note 4)	±128 mA
Continuous current through V_{DD} or GND terminals	±100 mA
Package thermal impedance, θ_{JA} (see Note 5): DGG package	70°C/W
DGV package	58°C/W
Storage temperature range, T_{stg}	–65°C to 150°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 voltages are with respect to ground, unless otherwise specified.
 2. The input and output voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
 3. V_I and V_O are used to denote specific conditions for $V_{I/O}$.
 4. I_I and I_O are used to denote specific conditions for $I_{I/O}$.
 5. The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions (see Note 6)

		MIN	MAX	UNIT
V_{DD}	Supply voltage	3	3.6	V
V_{IH}	High-level control input voltage (SEL)	2	5.5	V
V_{IL}	Low-level control input voltage (SEL)	0	0.8	V
$V_{I/O}$	Input/output voltage	0	5.5	V
T_A	Operating free-air temperature	–40	85	°C

NOTE 6: All unused control inputs of the device must be held at V_{DD} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

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electrical characteristics for 1000 Base-T ethernet switching over recommended operating free-air temperature range, $V_{DD} = 3.3 \text{ V} \pm 0.3 \text{ V}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP†	MAX	UNIT
V_{IK}	SEL	$V_{DD} = 3.6 \text{ V}$,	$I_{IN} = -18 \text{ mA}$	-0.7	-1.2		V
I_{IH}	SEL	$V_{DD} = 3.6 \text{ V}$,	$V_{IN} = V_{DD}$			± 1	μA
I_{IL}	SEL	$V_{DD} = 3.6 \text{ V}$,	$V_{IN} = \text{GND}$			± 1	μA
I_{off}		$V_{DD} = 0$,	$V_O = 0 \text{ to } 3.6 \text{ V}$,			1	μA
I_{CC}		$V_{DD} = 3.6 \text{ V}$,	$I_{I/O} = 0$,	250	600		μA
C_{IN}	SEL	$f = 1 \text{ MHz}$,	$V_{IN} = 0$	2.5	3		pF
C_{OFF}	B port	$V_I = 0$,	$f = 1 \text{ MHz}$, Outputs open,	3.5	4		pF
C_{ON}		$V_I = 0$,	$f = 1 \text{ MHz}$, Outputs open,	10	10.9		pF
r_{on}		$V_{DD} = 3 \text{ V}$	$1.5 \text{ V} \leq V_I \leq V_{DD}$,	4	8		Ω
$r_{on(\text{flat})}^\ddagger$		$V_{DD} = 3 \text{ V}$	$V_I = 1.5 \text{ V}$ and V_{DD} ,	0.7			Ω
Δr_{on}^\S		$V_{DD} = 3 \text{ V}$,	$1.5 \text{ V} \leq V_I \leq V_{DD}$,	0.2	1.2		Ω

V_I , V_O , I_I , and I_O refer to I/O pins. V_{IN} refers to the control inputs.

† All typical values are at $V_{DD} = 3.3 \text{ V}$ (unless otherwise noted), $T_A = 25^\circ\text{C}$.

‡ $r_{on(\text{flat})}$ is the difference of r_{on} in a given channel at specified voltages.

§ Δr_{on} is the difference of r_{on} from center (A4, A5) ports to any other port.

electrical characteristics for 10/100 Base-T ethernet switching over recommended operating free-air temperature range, $V_{DD} = 3.3 \text{ V} \pm 0.3 \text{ V}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP†	MAX	UNIT
V_{IK}	SEL	$V_{DD} = 3.6 \text{ V}$,	$I_{IN} = -18 \text{ mA}$	-0.7	-1.2		V
I_{IH}	SEL	$V_{DD} = 3.6 \text{ V}$,	$V_{IN} = V_{DD}$			± 1	μA
I_{IL}	SEL	$V_{DD} = 3.6 \text{ V}$,	$V_{IN} = \text{GND}$			± 1	μA
I_{off}		$V_{DD} = 0$,	$V_O = 0 \text{ to } 3.6 \text{ V}$,			1	μA
I_{CC}		$V_{DD} = 3.6 \text{ V}$,	$I_{I/O} = 0$,	250	600		μA
C_{IN}	SEL	$f = 1 \text{ MHz}$,	$V_{IN} = 0$	2.5	3		pF
C_{OFF}	B port	$V_I = 0$,	$f = 1 \text{ MHz}$, Outputs open,	3.5	4		pF
C_{ON}		$V_I = 0$,	$f = 1 \text{ MHz}$, Outputs open,	10	10.9		pF
r_{on}		$V_{DD} = 3 \text{ V}$	$1.25 \text{ V} \leq V_I \leq V_{DD}$,	4	8		Ω
$r_{on(\text{flat})}^\ddagger$		$V_{DD} = 3 \text{ V}$	$V_I = 1.25 \text{ V}$ and V_{DD} ,	0.7			Ω
Δr_{on}^\S		$V_{DD} = 3 \text{ V}$,	$1.25 \text{ V} \leq V_I \leq V_{DD}$,	0.2	1.2		Ω

V_I , V_O , I_I , and I_O refer to I/O pins. V_{IN} refers to the control inputs.

† All typical values are at $V_{DD} = 3.3 \text{ V}$ (unless otherwise noted), $T_A = 25^\circ\text{C}$.

‡ $r_{on(\text{flat})}$ is the difference of r_{on} in a given channel at specified voltages.

§ Δr_{on} is the difference of r_{on} from center (A4, A5) ports to any other port.

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switching characteristics over recommended operating free-air temperature range,
 $V_{DD} = 3.3\text{ V} \pm 0.3\text{ V}$, $R_L = 200\ \Omega$, $C_L = 10\text{ pF}$ (unless otherwise noted) (see Figures 4 and 5)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	MIN	TYP†	MAX	UNIT
t_{pd}^\ddagger	A or B	B or A		0.25		ns
t_{PZH} , t_{PZL}	SEL	A or B	1.5		11.5	ns
t_{PHZ} , t_{PLZ}	SEL	A or B	1		8.5	ns
$t_{sk(o)}^\S$	A or B	B or A		0.1	0.2	ns
$t_{sk(p)}^\P$				0.1	0.2	ns

† All typical values are at $V_{DD} = 3.3\text{ V}$ (unless otherwise noted), $T_A = 25^\circ\text{C}$.

‡ The propagation delay is the calculated RC time constant of the typical ON-state resistance of the switch and the specified load capacitance when driven by an ideal voltage source (zero output impedance).

§ Output skew between center port (A_4 to A_5) to any other port

¶ Skew between opposite transitions of the same output in a given device $|t_{PHL} - t_{PLH}|$

dynamic characteristics over recommended operating free-air temperature range,
 $V_{DD} = 3.3\text{ V} \pm 0.3\text{ V}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS			TYP†	UNIT
X _{TALK}	$R_L = 100\ \Omega$,	$f = 250\text{ MHz}$,	See Figure 7	-41	dB
O _{IRR}	$R_L = 100\ \Omega$,	$f = 250\text{ MHz}$,	See Figure 8	-39	dB
BW	$R_L = 100\ \Omega$,	See Figure 6		900	MHz

† All typical values are at $V_{DD} = 3.3\text{ V}$ (unless otherwise noted), $T_A = 25^\circ\text{C}$.

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OPERATING CHARACTERISTICS

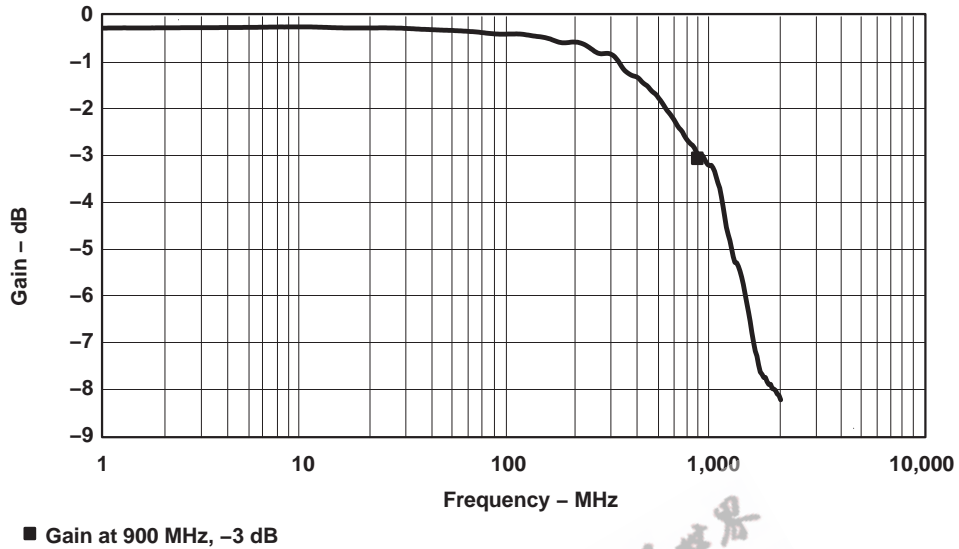


Figure 1. Gain vs Frequency

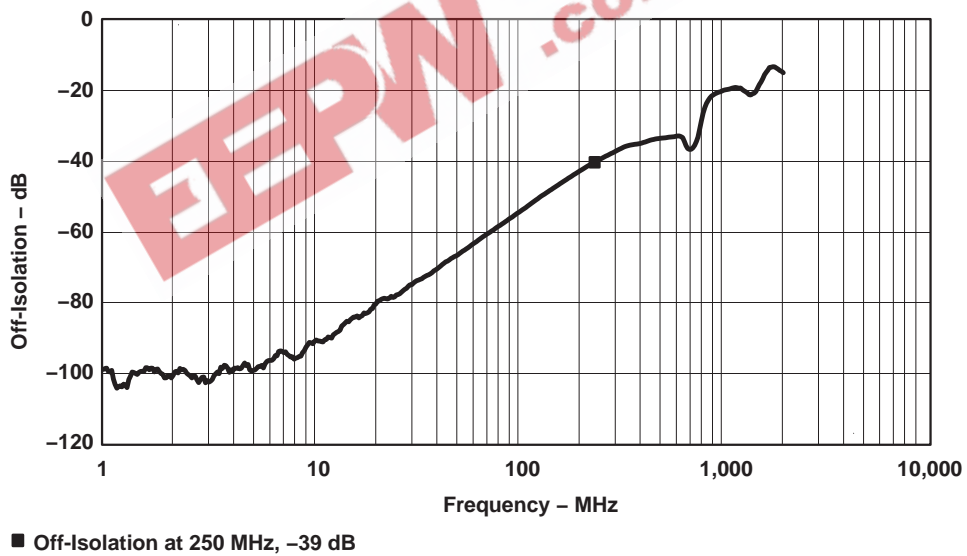


Figure 2. Off-Isolation vs Frequency

OPERATING CHARACTERISTICS (continued)

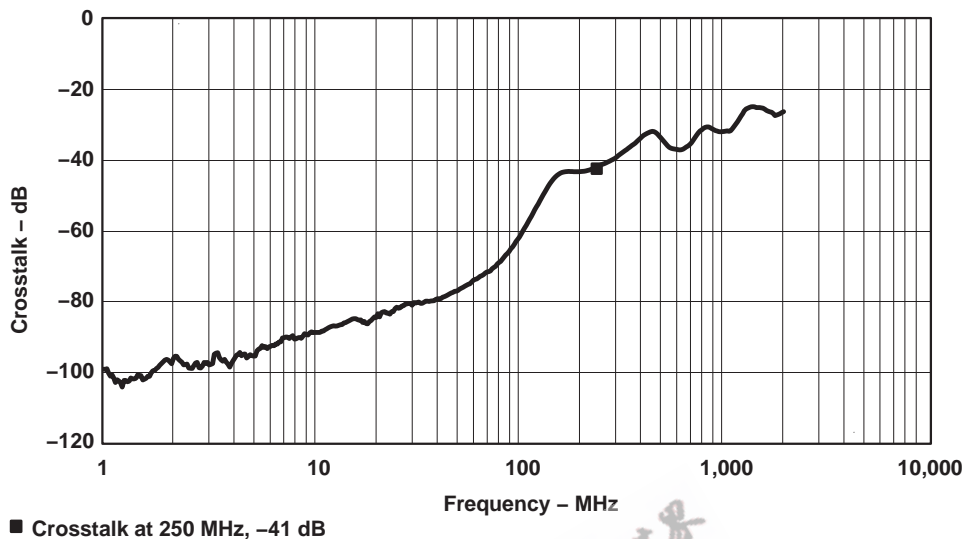


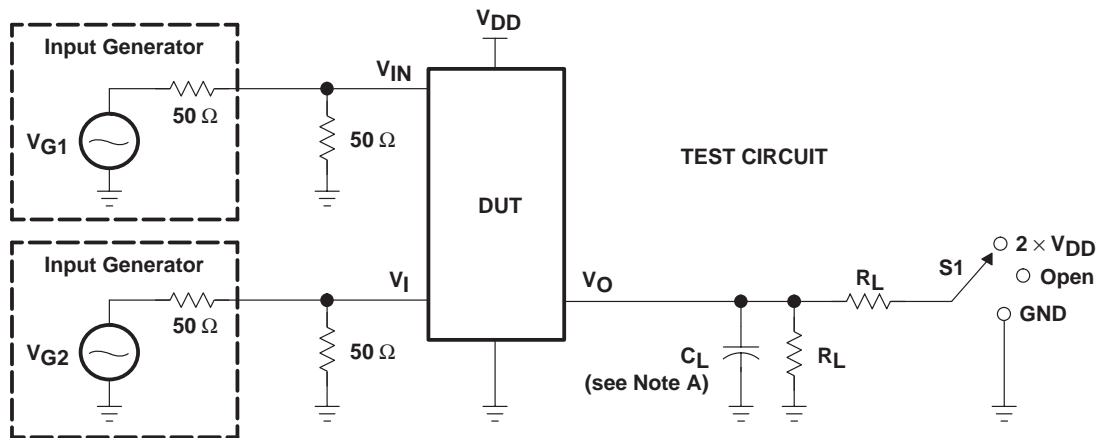
Figure 3. Crosstalk vs Frequency

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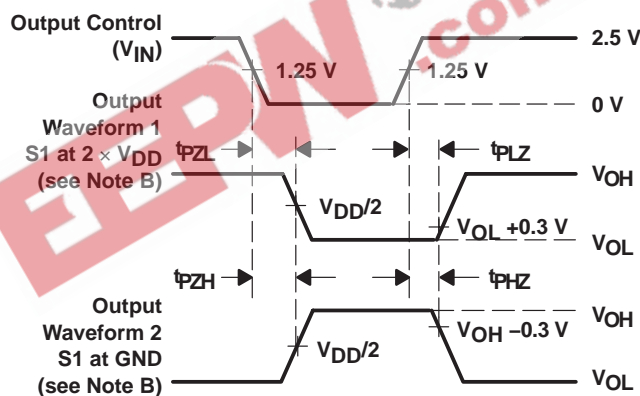
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PARAMETER MEASUREMENT INFORMATION
FOR ENABLE AND DISABLE TIMES



TEST	V _{DD}	S1	R _L	V _I	C _L	V _Δ
t _{PLZ} /t _{PZL}	3.3 V ± 0.3 V	2 × V _{DD}	200 Ω	GND	10 pF	0.3 V
t _{PHZ} /t _{PZH}	3.3 V ± 0.3 V	GND	200 Ω	V _{DD}	10 pF	0.3 V



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

- NOTES: A. C_L includes probe and jig capacitance.
 B. Waveform 1 is for an output with internal conditions such that the output is low, except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output control.
 C. All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz, Z_O = 50 Ω, t_r ≤ 2.5 ns, t_f ≤ 2.5 ns.
 D. The outputs are measured one at a time, with one transition per measurement.
 E. t_{PLZ} and t_{PHZ} are the same as t_{dis}.
 F. t_{PZL} and t_{PZH} are the same as t_{en}.

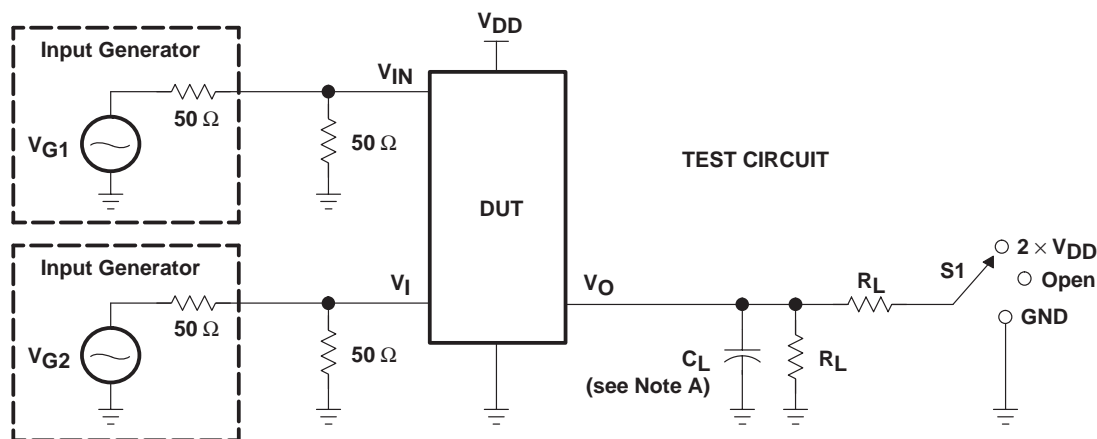
Figure 4. Test Circuit and Voltage Waveforms

TS3L301

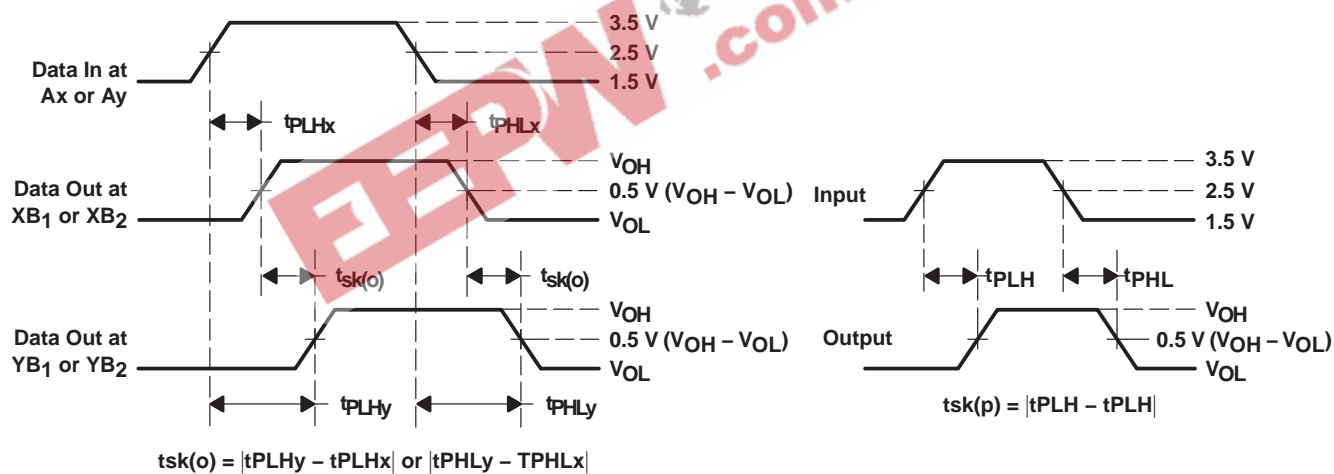
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PARAMETER MEASUREMENT INFORMATION FOR SKEW



TEST	V _{DD}	S1	R _L	V _I	C _L	V _Δ
t _{sk(o)}	3.3 V ± 0.3 V	Open	200 Ω	V _{DD} or GND	10 pF	
t _{sk(p)}	3.3 V ± 0.3 V	Open	200 Ω	V _{DD} or GND	10 pF	



**VOLTAGE WAVEFORMS
OUTPUT SKEW (t_{sk(o)})**

**VOLTAGE WAVEFORMS
PULSE SKEW (t_{sk(p)})**

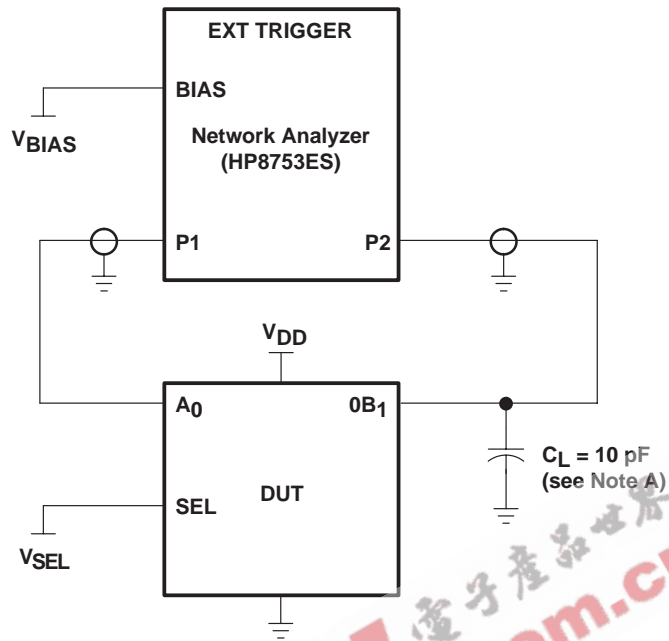
- NOTES: A. C_L includes probe and jig capacitance.
 B. Waveform 1 is for an output with internal conditions such that the output is low, except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output control.
 C. All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz, Z_O = 50 Ω, t_r ≤ 2.5 ns, t_f ≤ 2.5 ns.
 D. The outputs are measured one at a time, with one transition per measurement.

Figure 5. Test Circuit and Voltage Waveforms

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PARAMETER MEASUREMENT INFORMATION



NOTE A: C_L includes probe and jig capacitance.

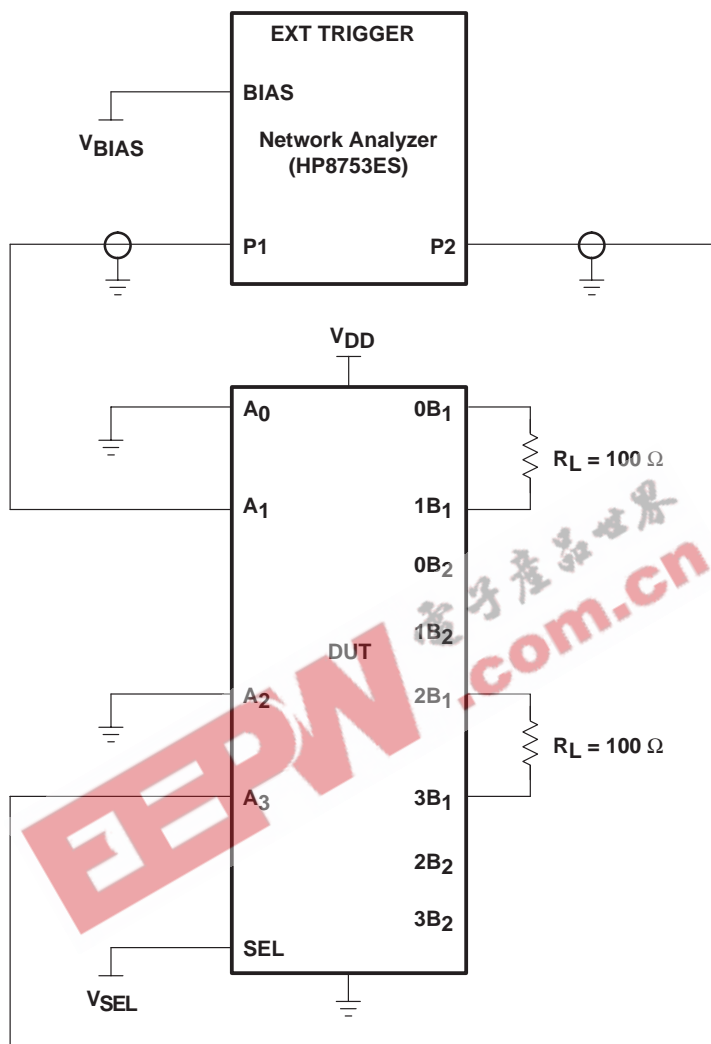
Figure 6. Test Circuit for Frequency Response (BW)

Frequency response is measured at the output of the ON channel. For example, when $V_{SEL} = 0$ and A_0 is the input, the output is measured at OB_1 . All unused analog I/O ports are left open.

HP8753ES setup

- Average = 4
- RBW = 3 kHz
- $V_{BIAS} = 0.35$ V
- ST = 2 s
- P1 = 0 dBm

PARAMETER MEASUREMENT INFORMATION



- NOTES: A. C_L includes probe and jig capacitance.
 B. A 50- Ω termination resistor is needed to match the loading of the network analyzer.

Figure 7. Test Circuit for Crosstalk (X_{TALK})

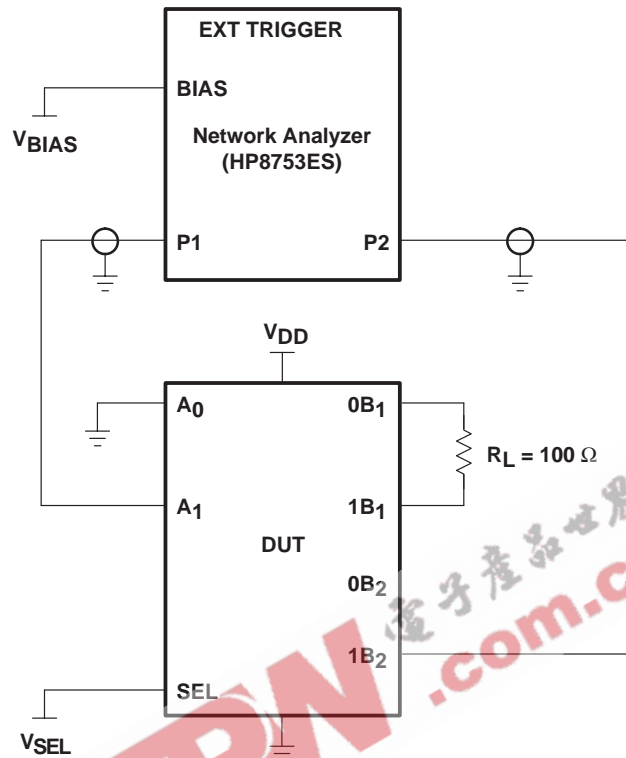
Crosstalk is measured at the output of the nonadjacent ON channel. For example, when $V_{SEL} = 0$ and A_1 is the input, the output is measured at A_3 . All unused analog input (A) ports are connected to GND, and output (B) ports are left open.

HP8753ES setup

- Average = 4
- RBW = 3 kHz
- $V_{BIAS} = 0.35$ V
- ST = 2 s
- P1 = 0 dBm

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PARAMETER MEASUREMENT INFORMATION



- NOTES: A. C_L includes probe and jig capacitance.
 B. A 50- Ω termination resistor is needed to match the loading of the network analyzer.

Figure 8. Test Circuit for Off Isolation (O_{IRR})

OFF isolation is measured at the output of the OFF channel. For example, when $V_{SEL} = GND$ and A_1 is the input, the output is measured at $1B_2$. All unused analog input (A) ports are connected to ground, and output (B) ports are left open.

HP8753ES setup

- Average = 4
- RBW = 3 kHz
- $V_{BIAS} = 0.35\text{ V}$
- ST = 2 s
- P1 = 0 dBm

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
TS3L301DGGR	ACTIVE	TSSOP	DGG	48	2000	Pb-Free (RoHS)	CU NIPDAU	Level-1-250C-UNLIM
TS3L301DGVR	ACTIVE	TVSOP	DGV	48	2000	Pb-Free (RoHS)	CU NIPDAU	Level-1-250C-UNLIM

⁽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) 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.

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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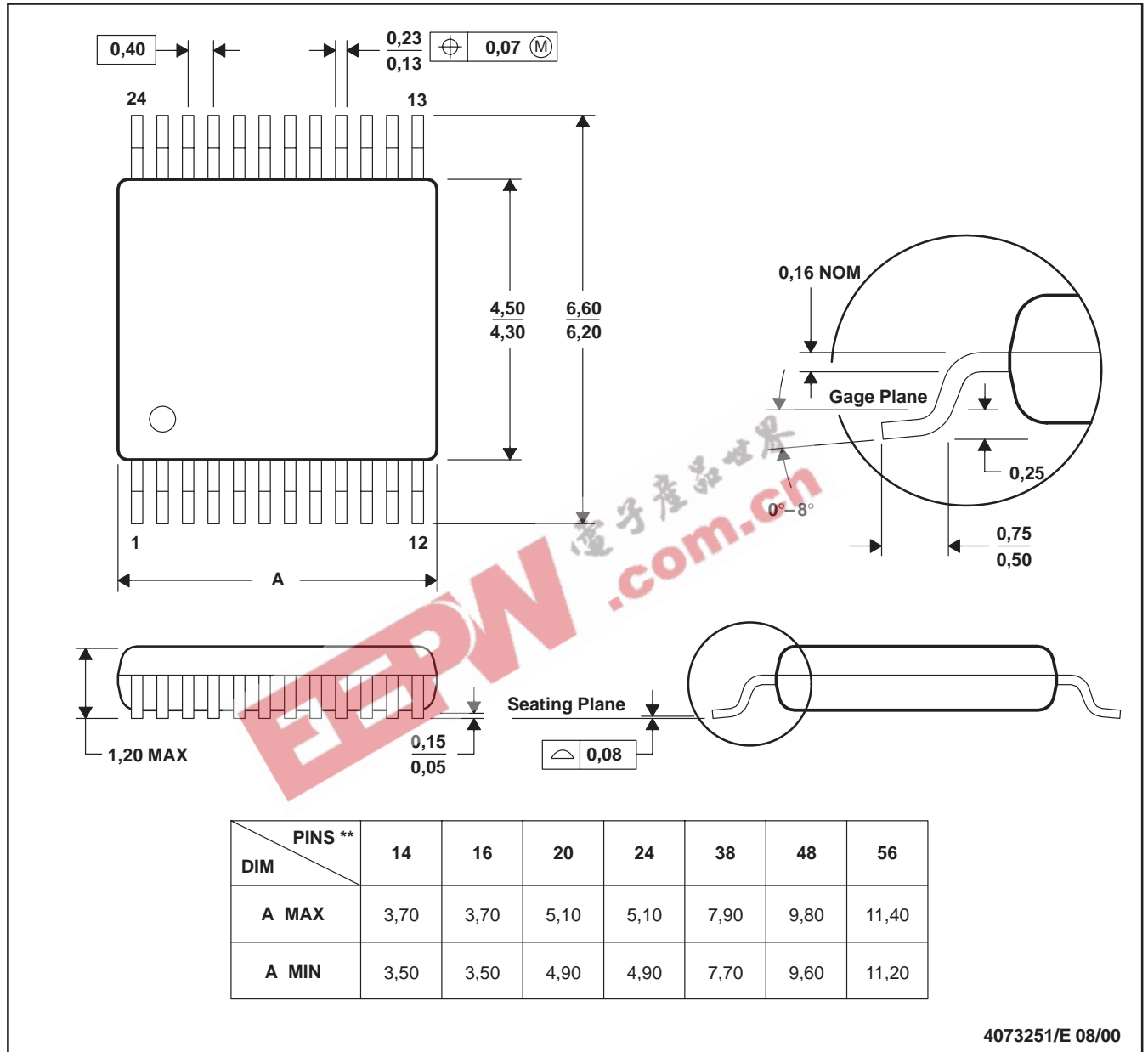
MECHANICAL DATA

MPDS006C – FEBRUARY 1996 – REVISED AUGUST 2000

DGV (R-PDSO-G)**

PLASTIC SMALL-OUTLINE

24 PINS SHOWN



- 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 per side.
 D. Falls within JEDEC: 24/48 Pins – MO-153
 14/16/20/56 Pins – MO-194

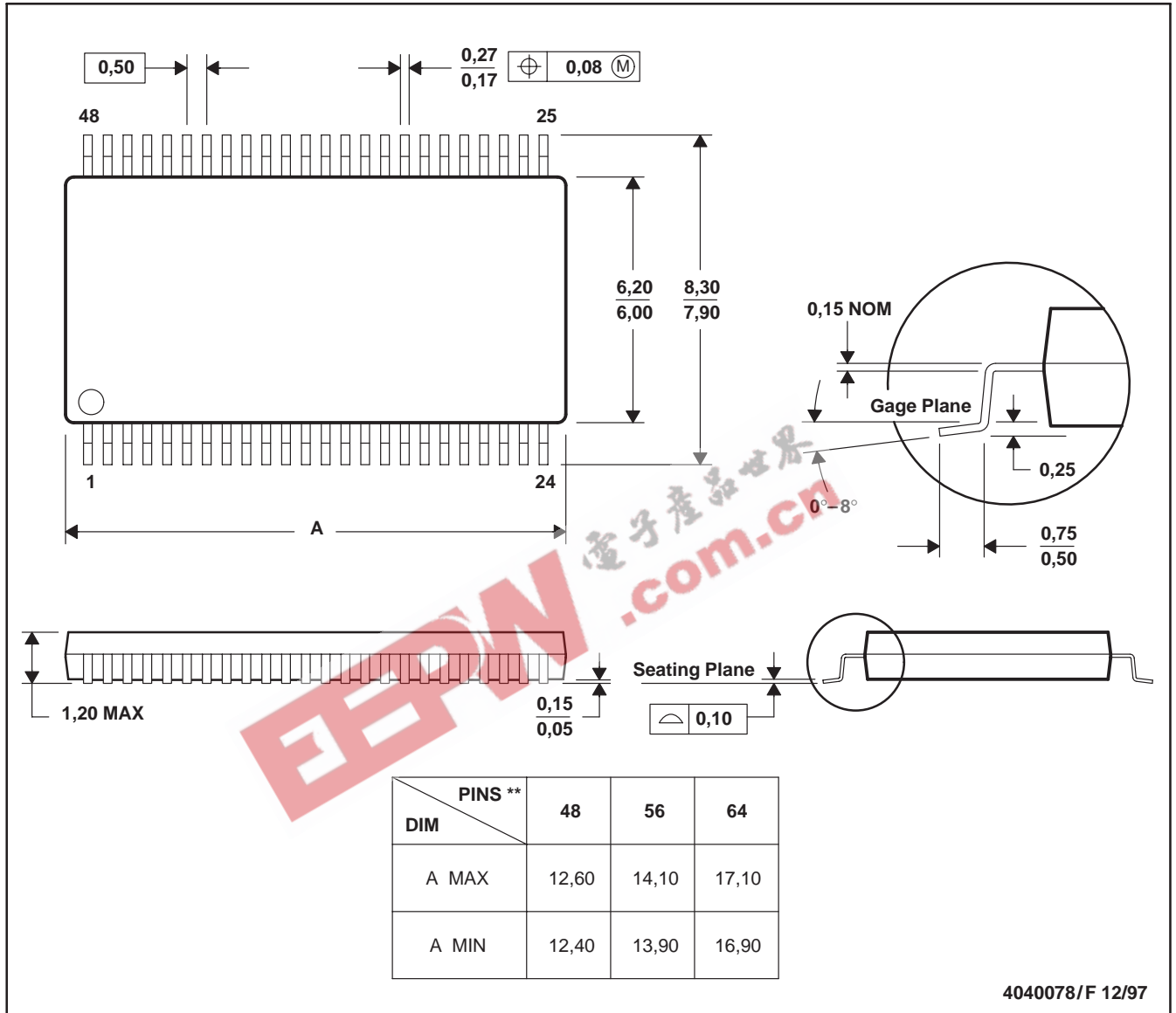
MECHANICAL DATA

MTSS003D – JANUARY 1995 – REVISED JANUARY 1998

DGG (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

48 PINS SHOWN



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

4040078/F 12/97

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