TS3L301
16-BIT TO 8-BIT SPDT GIGABIT LAN SWITCH WITH LOW AND FLAT ON-STATE RESISTANCE

SCDS178C – NOVEMBER 2004 – REVISED APRIL 2006

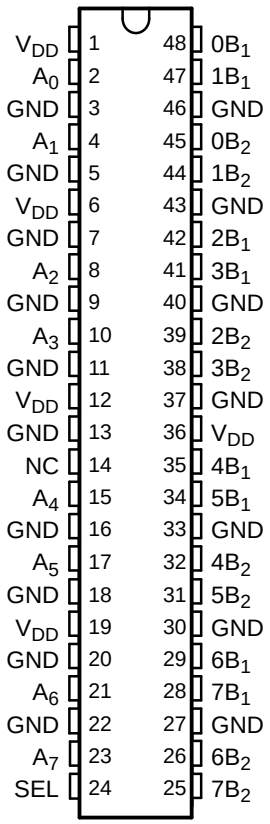
FEATURES

- **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 Ω Typ, $r_{on(flat)}$ = 0.7 Ω 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 local area network (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-state 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

T_A	PACKAGE(1)		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

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

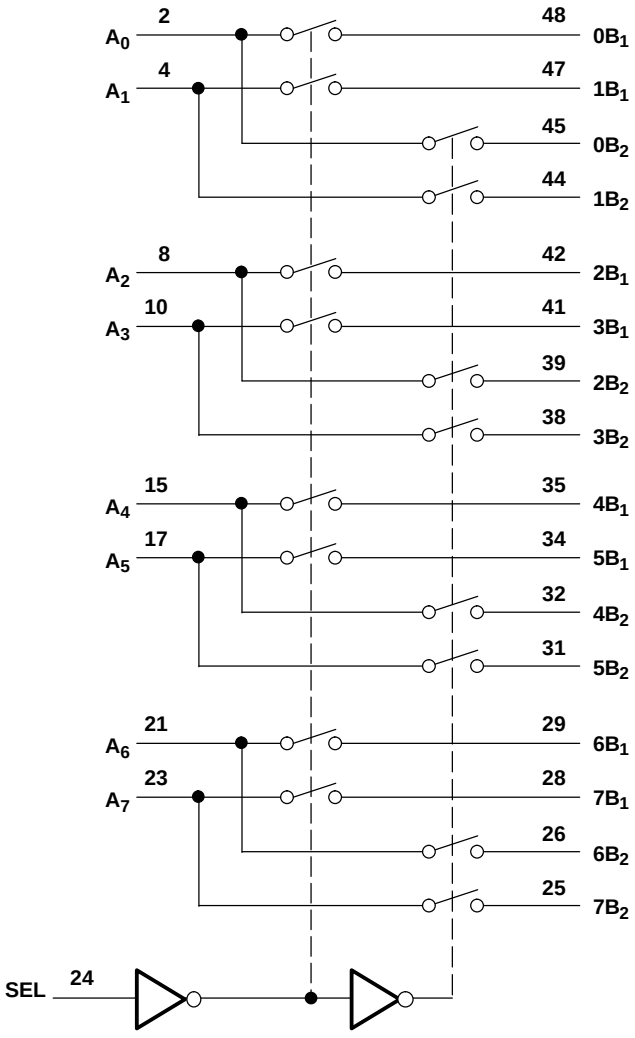
FUNCTION TABLE

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

PIN DESCRIPTION

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

LOGIC DIAGRAM (POSITIVE LOGIC)



Absolute Maximum Ratings(1)

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

			MIN	MAX	UNIT
V_{DD}	Supply voltage range		–0.5	4.6	V
V_{IN}	Control input voltage range(2)(3)		–0.5	7	V
$V_{I/O}$	Switch I/O voltage range(2)(3)(4)		–0.5	7	V
I_{IK}	Control input clamp current	$V_{IN} < 0$		–50	mA
$I_{I/OK}$	I/O port clamp current	$V_{I/O} < 0$		–50	mA
$I_{I/O}$	ON-state switch current(5)			±128	mA
	Continuous current through V_{DD} or GND			±100	mA
θ_{JA}	Package thermal impedance(6)	DGG package		70	°C/W
		DGV package		58	
T_{stg}	Storage temperature range		–65	150	°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.
(2) All voltages are with respect to ground, unless otherwise specified.
(3) The input and output voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
(4) V_I and V_O are used to denote specific conditions for $V_{I/O}$.
(5) I_I and I_O are used to denote specific conditions for $I_{I/O}$.
(6) The package thermal impedance is calculated in accordance with JESD 51-7.

Recommended Operating Conditions(1)

		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

(1) 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.

Electrical Characteristics

for 1000 Base-T Ethernet switching over recommended operating free-air temperature range, V_{DD} = 3.3 V ± 0.3 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS(1)				MIN	TYP(2)	MAX	UNIT
V_{IK}	SEL	V_{DD} = 3.6 V,	I_{IN} = –18 mA				–0.7	–1.2	V
I_{IH}	SEL	V_{DD} = 3.6 V,	V_{IN} = V_{DD}					±1	µA
I_{IL}	SEL	V_{DD} = 3.6 V,	V_{IN} = GND					±1	µA
I_{off}		V_{DD} = 0,	V_O = 0 to 3.6 V,	V_I = 0				1	µA
I_{DD}		V_{DD} = 3.6 V,	$I_{I/O}$ = 0,	Switch ON or OFF			250	600	µA
C_{IN}	SEL	f = 1 MHz,	V_{IN} = 0				2.5	3	pF
C_{OFF}	B port	V_I = 0,	f = 1 MHz,	Outputs open,	Switch OFF		3.5	4	pF
C_{ON}		V_I = 0,	f = 1 MHz,	Outputs open,	Switch ON		10	10.9	pF
r_{on}		V_{DD} = 3 V,	1.5 V ≤ V_I ≤ V_{DD},	I_O = –40 mA			4	8	Ω
$r_{on(flat)}$(3)		V_{DD} = 3 V,	V_I = 1.5 V and V_{DD},	I_O = –40 mA			0.7		Ω
Δr_{on}(4)		V_{DD} = 3 V,	1.5 V ≤ V_I ≤ V_{DD},	I_O = –40 mA			0.2	1.2	Ω

(1) V_I, V_O, I_I, and I_O refer to I/O pins. V_{IN} refers to the control inputs.
(2) All typical values are at V_{DD} = 3.3 V (unless otherwise noted), T_A = 25°C.
(3) $r_{on(flat)}$ is the difference of r_{on} in a given channel at specified voltages.
(4) Δr_{on} is the difference of r_{on} from center (A_4, A_5) 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 V ± 0.3 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS(1)				MIN	TYP(2)	MAX	UNIT
V_{IK}	SEL	V_{DD} = 3.6 V,	I_{IN} = –18 mA				–0.7	–1.2	V
I_{IH}	SEL	V_{DD} = 3.6 V,	V_{IN} = V_{DD}					±1	µA
I_{IL}	SEL	V_{DD} = 3.6 V,	V_{IN} = GND					±1	µA
I_{off}		V_{DD} = 0,	V_O = 0 to 3.6 V,	V_I = 0				1	µA
I_{DD}		V_{DD} = 3.6 V,	$I_{I/O}$ = 0,	Switch ON or OFF			250	600	µA
C_{IN}	SEL	f = 1 MHz,	V_{IN} = 0				2.5	3	pF
C_{OFF}	B port	V_I = 0,	f = 1 MHz,	Outputs open,	Switch OFF		3.5	4	pF
C_{ON}		V_I = 0,	f = 1 MHz,	Outputs open,	Switch ON		10	10.9	pF
r_{on}		V_{DD} = 3 V,	1.25 V ≤ V_I ≤ V_{DD},	I_O = –10 mA to –30 mA			4	8	Ω
$r_{on(flat)}$(3)		V_{DD} = 3 V,	V_I = 1.25 V and V_{DD},	I_O = –10 mA to –30 mA			0.7		Ω
Δr_{on}(4)		V_{DD} = 3 V,	1.25 V ≤ V_I ≤ V_{DD},	I_O = –10 mA to –30 mA			0.2	1.2	Ω

(1) V_I, V_O, I_I, and I_O refer to I/O pins. V_{IN} refers to the control inputs.
(2) All typical values are at V_{DD} = 3.3 V (unless otherwise noted), T_A = 25°C.
(3) $r_{on(flat)}$ is the difference of r_{on} in a given channel at specified voltages.
(4) Δr_{on} is the difference of r_{on} from center (A_4, A_5) ports to any other port.

Switching Characteristics

over recommended operating free-air temperature range, V_{DD} = 3.3 V ± 0.3 V, R_L = 200 Ω, C_L = 10 pF (unless otherwise noted) (see Figures 4 and 5)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	MIN	TYP(1)	MAX	UNIT
t_{pd}(2)	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
$t_{sk(o)}$(3)	A or B	B or A		0.1	0.2	ns
$t_{sk(p)}$(4)				0.1	0.2	ns

(1) All typical values are at V_{DD} = 3.3 V (unless otherwise noted), T_A = 25°C.
(2) 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).
(3) Output skew between center port (A_4 to A_5) to any other port
(4) Skew between opposite transitions of the same output in a given device $|t_{PHL} - t_{PLH}|$

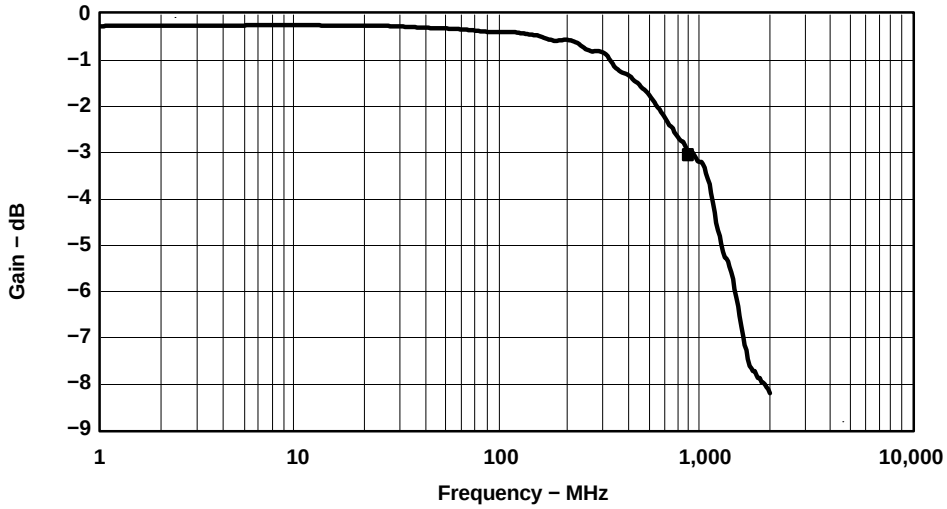
Dynamic Characteristics

over recommended operating free-air temperature range, V_{DD} = 3.3 V ± 0.3 V (unless otherwise noted)

PARAMETER	TEST CONDITIONS			TYP(1)	UNIT
X_{TALK}	R_L = 100 Ω,	f = 250 MHz,	See Figure 7	–41	dB
O_{IRR}	R_L = 100 Ω,	f = 250 MHz,	See Figure 8	–39	dB
BW	R_L = 100 Ω,	See Figure 6		900	MHz

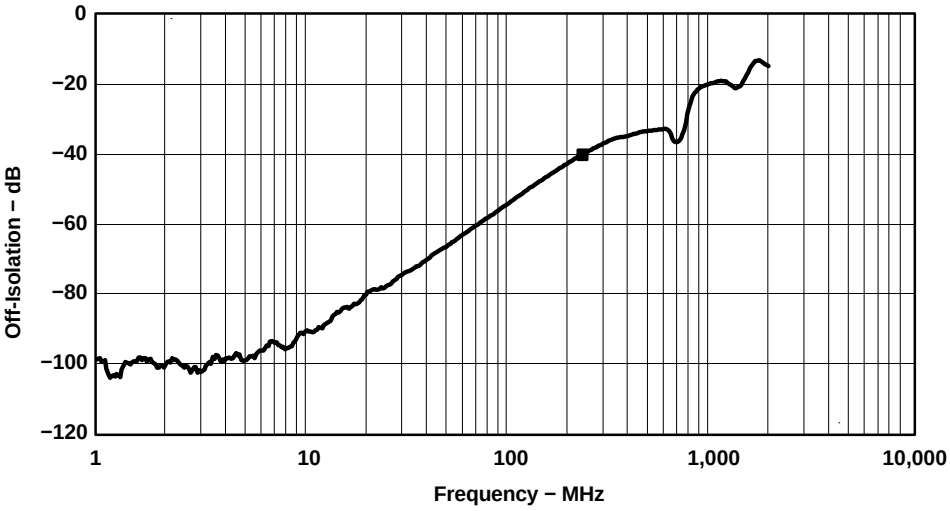
(1) All typical values are at V_{DD} = 3.3 V (unless otherwise noted), T_A = 25°C.

OPERATING CHARACTERISTICS



■ Gain at 900 MHz, −3 dB

Figure 1. Gain vs Frequency



■ OFF Isolation at 250 MHz, −39 dB

Figure 2. OFF Isolation vs Frequency

OPERATING CHARACTERISTICS (continued)

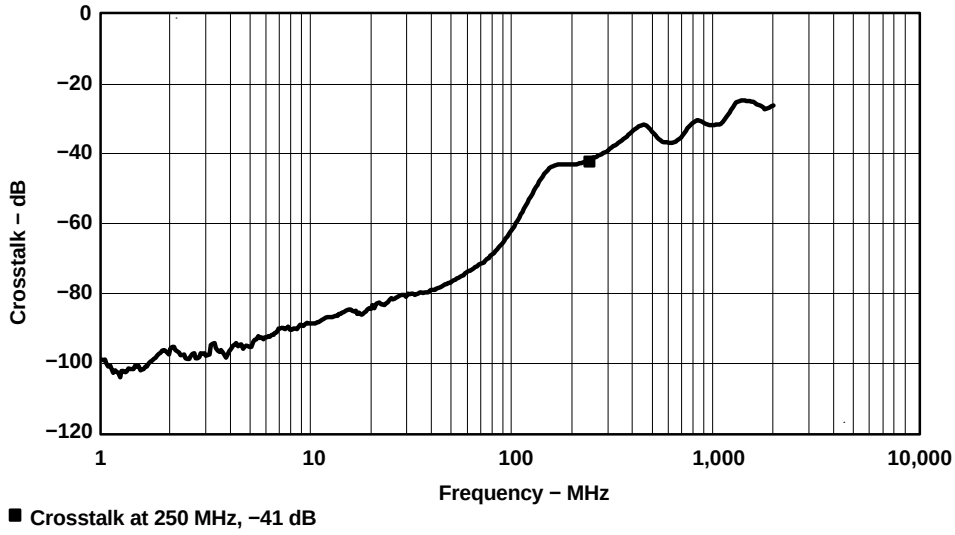
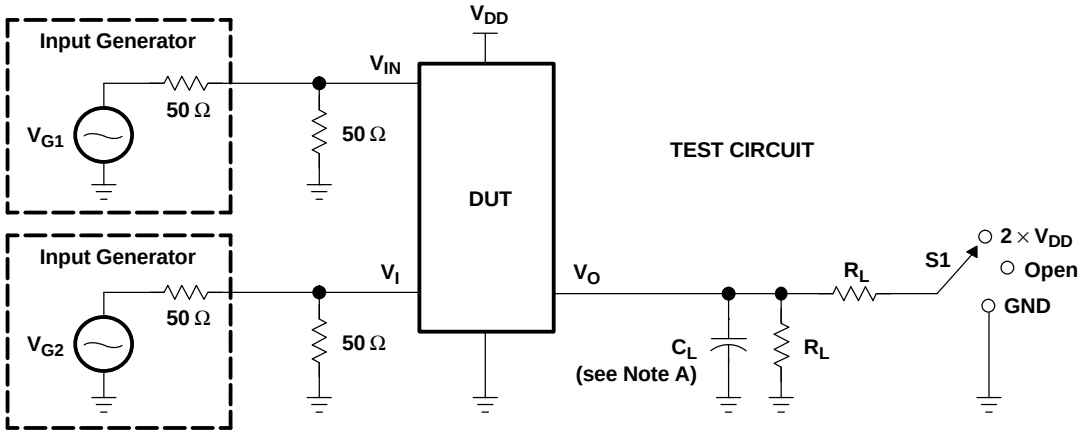
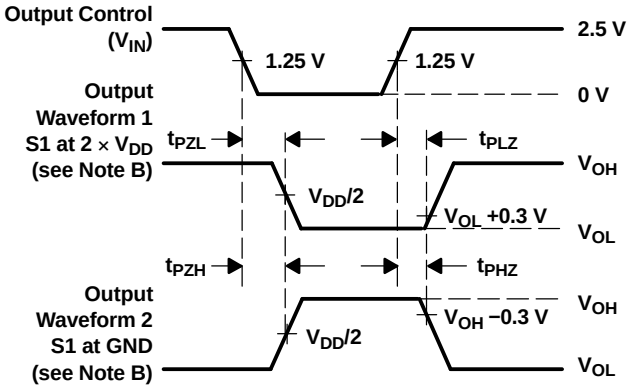


Figure 3. Crosstalk vs Frequency

PARAMETER MEASUREMENT INFORMATION
(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

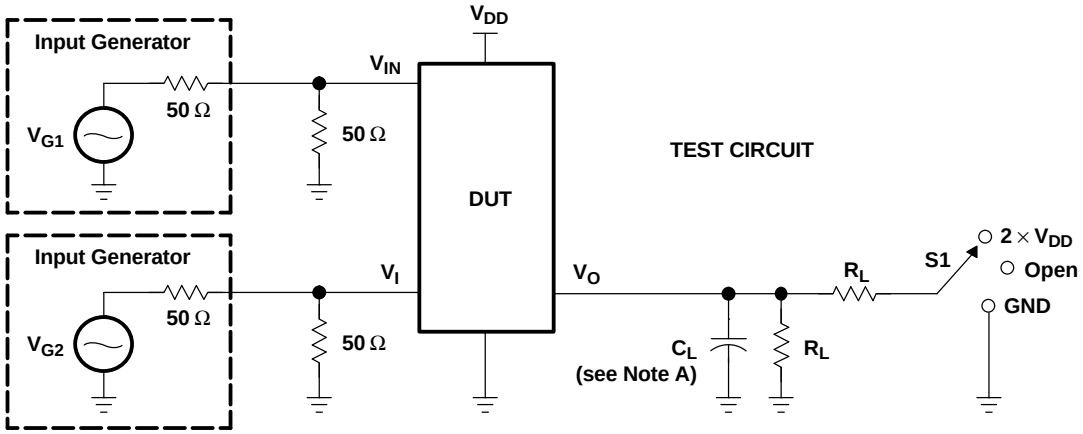


VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

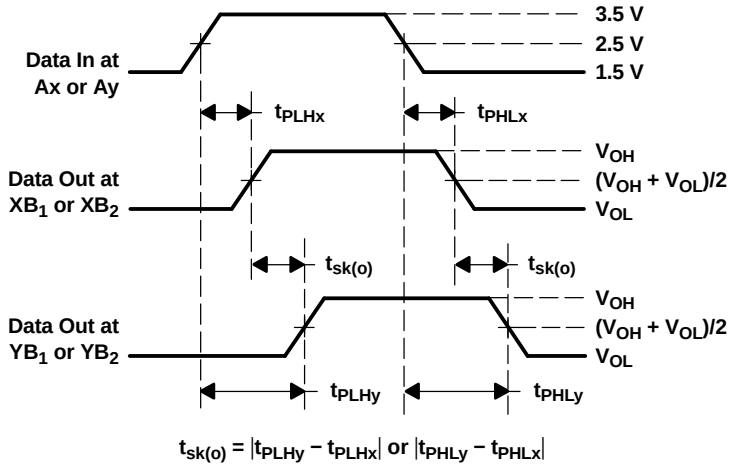
NOTES: A. C_L includes probe and jig capacitance.
B. Waveform 1 is for an output with internal conditions such that the output is low, except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output control.
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

PARAMETER MEASUREMENT INFORMATION
(Skew)

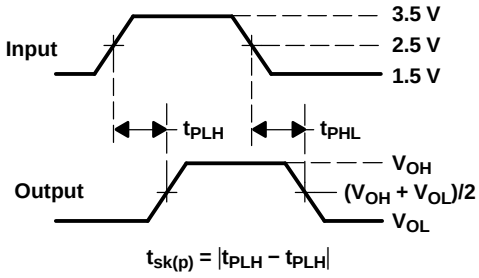


TEST	V_{DD}	S1	R_L	V_I	C_L
$t_{sk(o)}$	3.3 V ± 0.3 V	Open	200 Ω	V_{DD} or GND	10 pF
$t_{sk(p)}$	3.3 V ± 0.3 V	Open	200 Ω	V_{DD} or GND	10 pF



$t_{sk(o)} = |t_{PLHy} - t_{PLHx}|$ or $|t_{PHLy} - t_{PHLx}|$

VOLTAGE WAVEFORMS
OUTPUT SKEW [$t_{sk(o)}$]



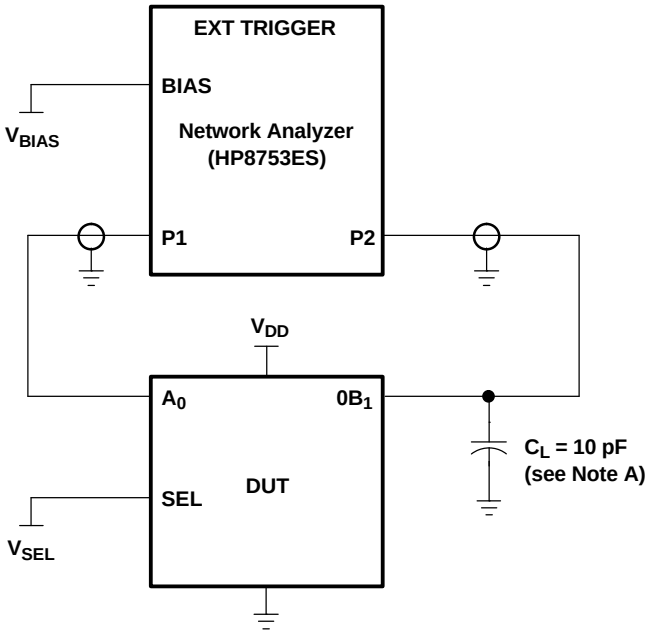
$t_{sk(p)} = |t_{PLH} - t_{PLH}|$

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, $Z_O = 50\ \Omega$, $t_r \le 2.5$ ns, $t_f \le 2.5$ ns.
D. The outputs are measured one at a time, with one transition per measurement.

Figure 5. Test Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION



A. C_L includes probe and jig capacitance.

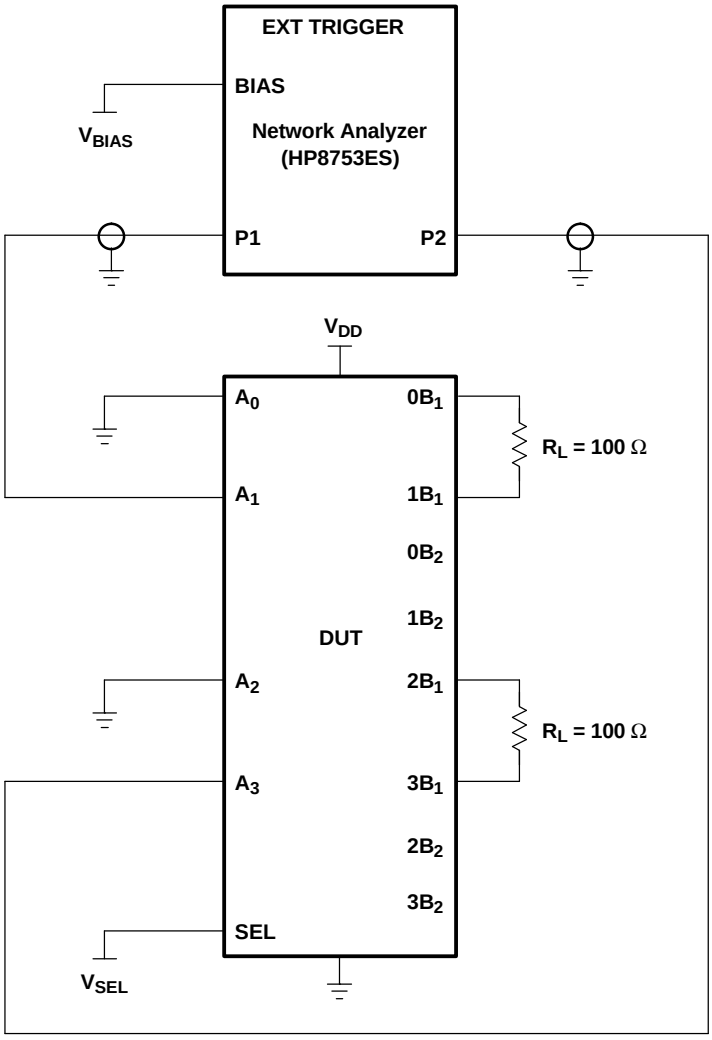
Figure 6. Test Circuit for Frequency Response (BW)

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 $0B_1$. 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 (continued)



A. C_L includes probe and jig capacitance.

B. A 50-Ω termination resistor is needed to match the loading of the network analyzer.

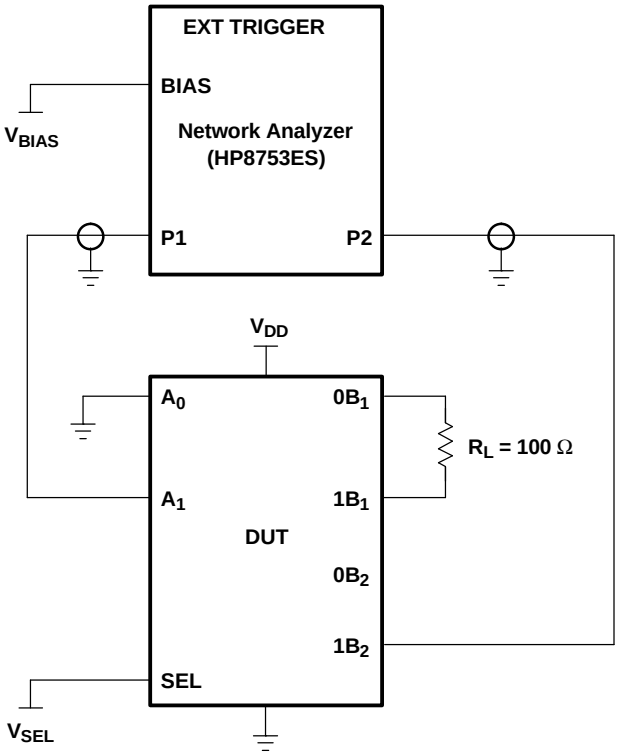
Figure 7. Test Circuit for Crosstalk (X_{TALK})

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

PARAMETER MEASUREMENT INFORMATION (continued)



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 V
ST = 2 s
P1 = 0 dBM

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TS3L301DGG	ACTIVE	TSSOP	DGG	48	40	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	TS3L301	Samples
TS3L301DGGR	ACTIVE	TSSOP	DGG	48	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	TS3L301	Samples
TS3L301DGGRE4	ACTIVE	TSSOP	DGG	48	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	TS3L301	Samples
TS3L301DGGRG4	ACTIVE	TSSOP	DGG	48	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	TS3L301	Samples
TS3L301DGVR	ACTIVE	TVSOP	DGV	48	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	TK301	Samples

(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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

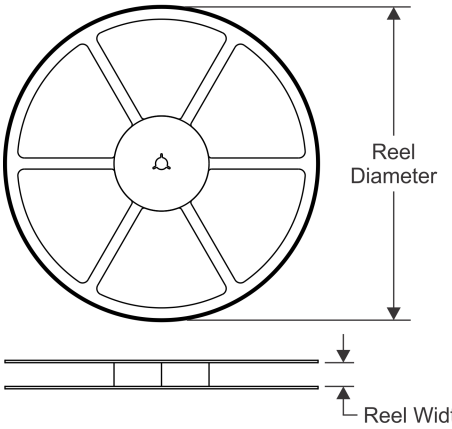
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

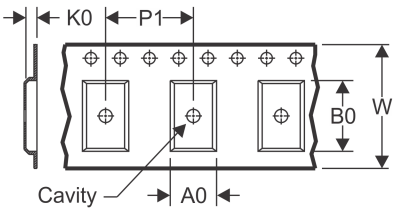
(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

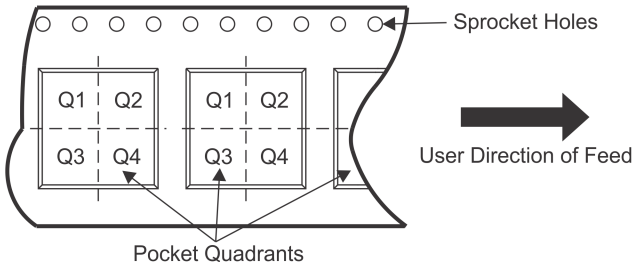


TAPE DIMENSIONS



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

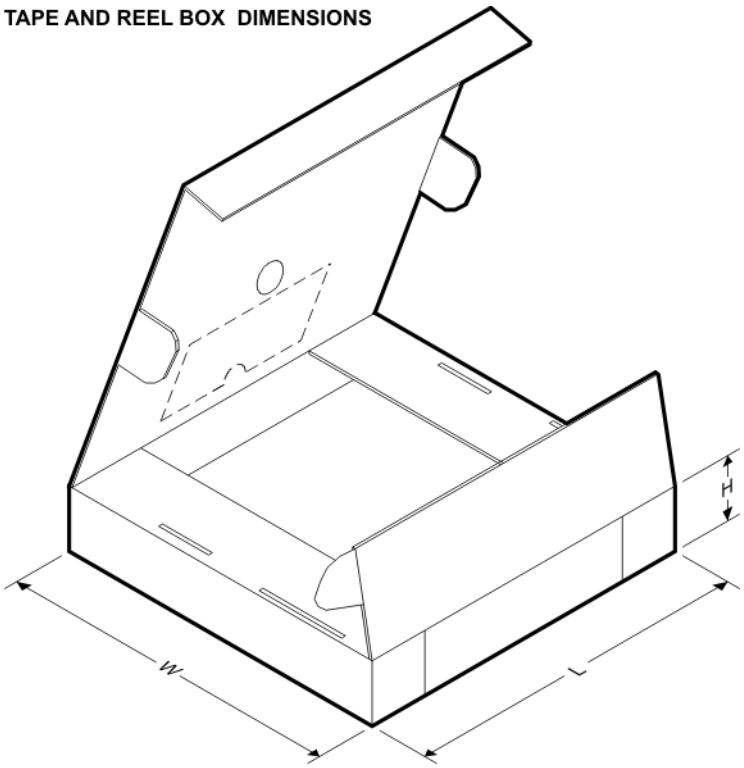
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
TS3L301DGGR	TSSOP	DGG	48	2000	330.0	24.4	8.6	13.0	1.8	12.0	24.0	Q1
TS3L301DGVR	TVSOP	DGV	48	2000	330.0	16.4	7.1	10.2	1.6	12.0	16.0	Q1

TAPE AND REEL BOX DIMENSIONS

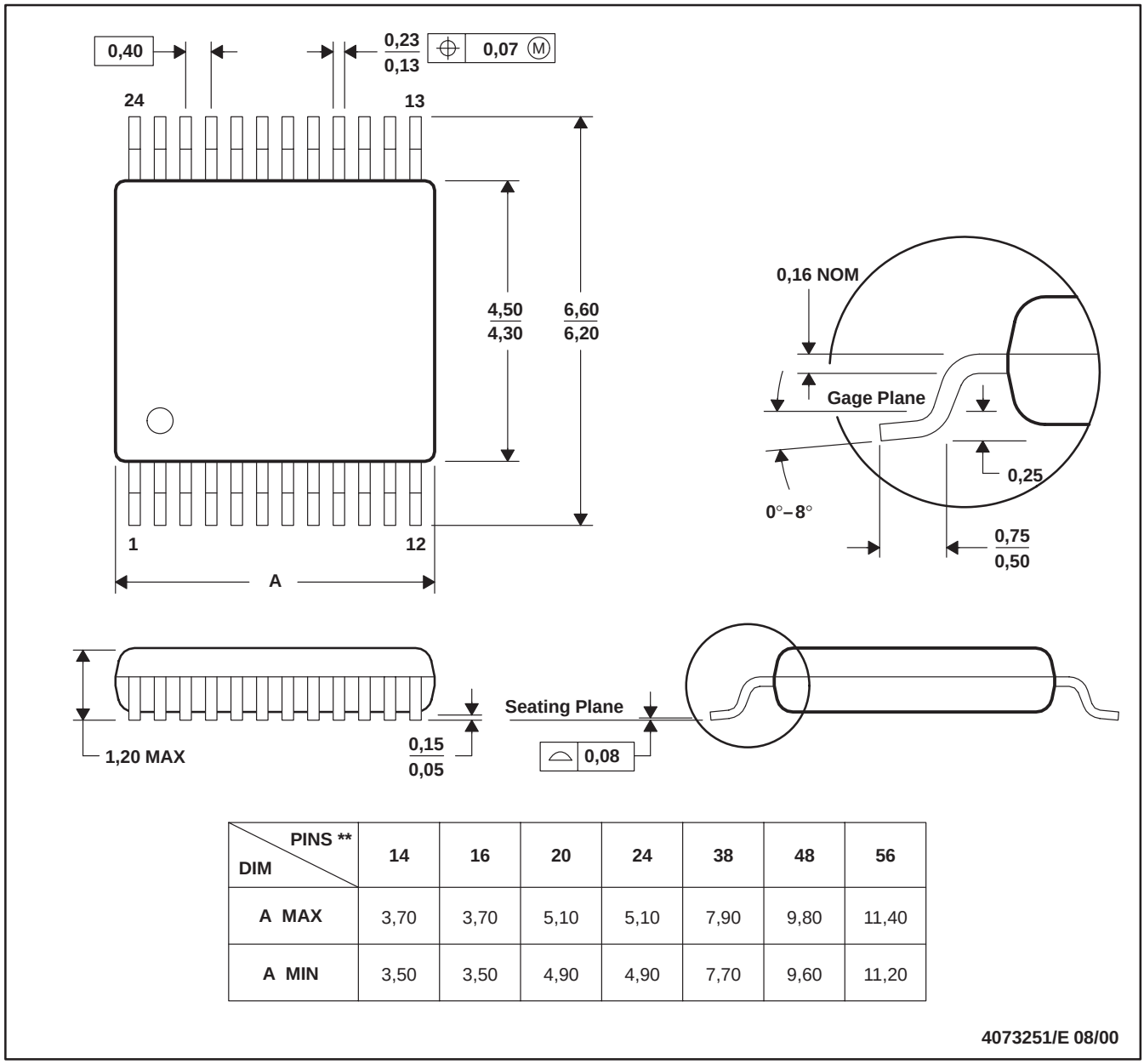


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TS3L301DGGR	TSSOP	DGG	48	2000	367.0	367.0	45.0
TS3L301DGVR	TVSOP	DGV	48	2000	853.0	449.0	35.0

DGV (R-PDSO-G)** **PLASTIC SMALL-OUTLINE**

24 PINS SHOWN



DIM \ PINS **	14	16	20	24	38	48	56
A MAX	3,70	3,70	5,10	5,10	7,90	9,80	11,40
A MIN	3,50	3,50	4,90	4,90	7,70	9,60	11,20

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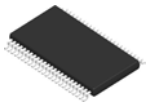
NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15 per side.
D. Falls within JEDEC: 24/48 Pins – MO-153
14/16/20/56 Pins – MO-194

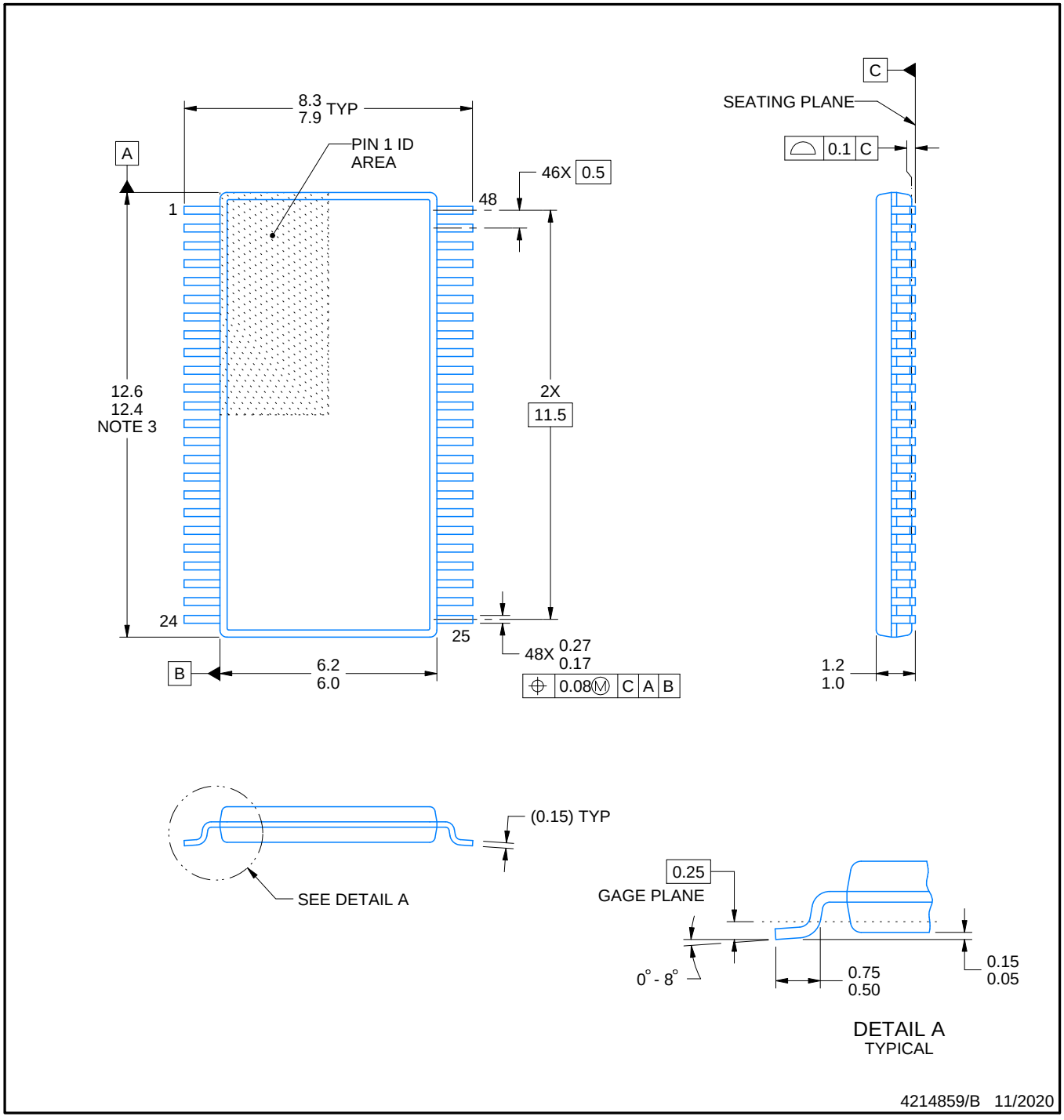


PACKAGE OUTLINE

DGG0048A

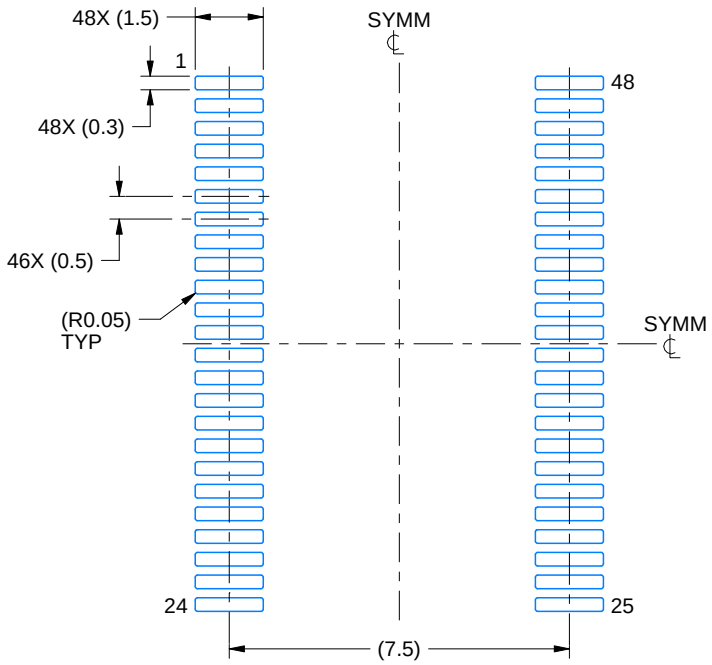
TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE

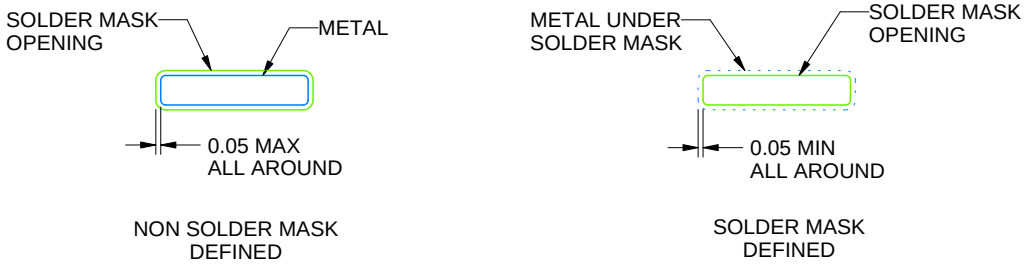


NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. Reference JEDEC registration MO-153.



LAND PATTERN EXAMPLE
SCALE:6X

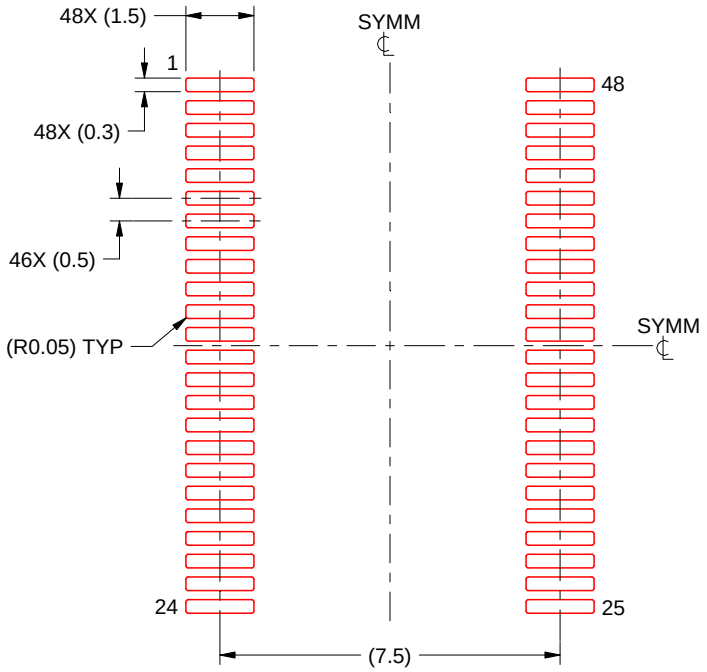


SOLDER MASK DETAILS

4214859/B 11/2020

NOTES: (continued)

5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:6X

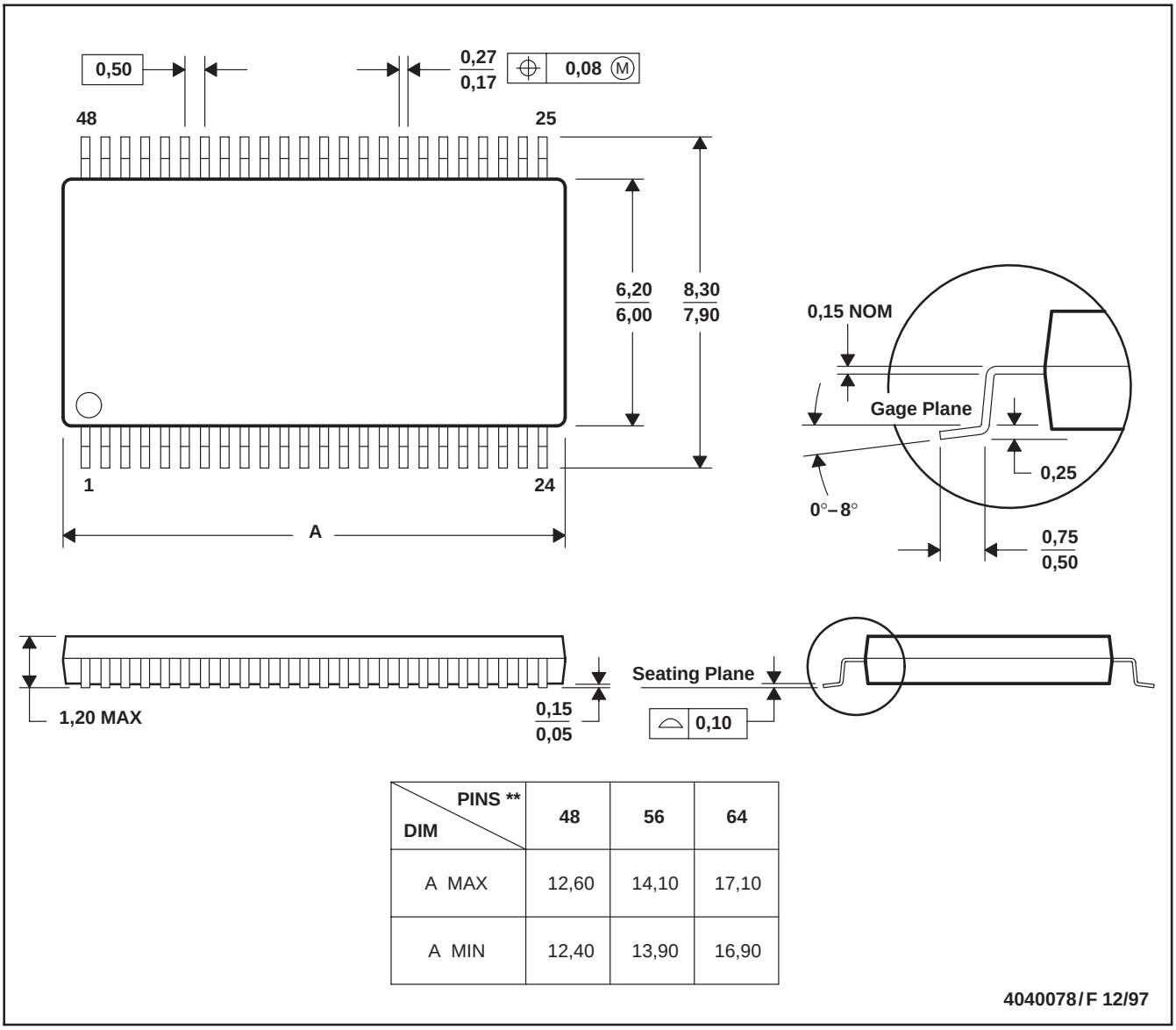
4214859/B 11/2020

NOTES: (continued)

7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
8. Board assembly site may have different recommendations for stencil design.

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

48 PINS SHOWN



DIM \ PINS **	48	56	64
A MAX	12,60	14,10	17,10
A MIN	12,40	13,90	16,90

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

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