

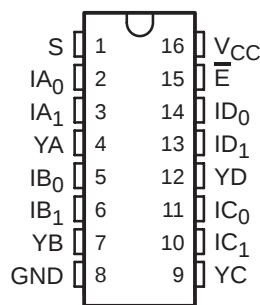
TS5L100

QUAD SPDT WIDE-BANDWIDTH LAN SWITCH WITH LOW ON-STATE RESISTANCE

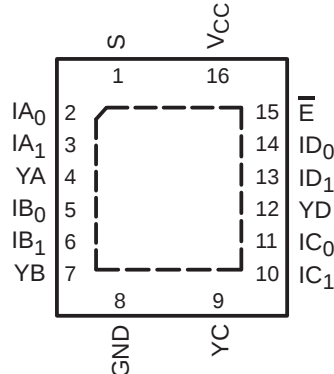
SCDS163A – MAY 2004 – REVISED MAY 2004

- Wide Bandwidth (BW = 300 MHz Min)
- Low Differential Crosstalk ($X_{TALK} = -60$ dB Typ)
- Low Power Consumption ($I_{CC} = 3$ μ A Max)
- Bidirectional Data Flow, With Near-Zero Propagation Delay
- Low ON-State Resistance ($r_{on} = 3$ Ω Typ)
- V_{CC} Operating Range From 6 V to 6.5 V
- I_{off} Supports Partial-Power-Down Mode Operation
- Data and Control Inputs Provide Undershoot Clamp Diode
- 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 Both 10 Base-T/100 Base-T Signaling

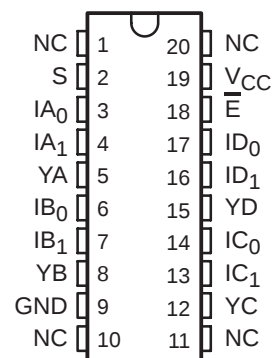
D OR DBQ PACKAGE
(TOP VIEW)



RGY PACKAGE
(TOP VIEW)



PW PACKAGE
(TOP VIEW)



NC – No internal connection

description/ordering information

The TI TS5L100 LAN switch is a 4-bit 1-of-2 multiplexer/demultiplexer with a single switch-enable ($\bar{E}$) input. When $\bar{E}$ is low, the switch is enabled and the I port is connected to the Y port. When $\bar{E}$ is high, the switch is disabled and the high-impedance state exists between the I and Y ports. The select (S) input controls the data path of the multiplexer/demultiplexer.

ORDERING INFORMATION

T_A	PACKAGE [†]		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	QFN – RGY	Tape and reel	TS5L100RGYR	TG100
		Tube	TS5L100D	TS5L100
	SOIC – D	Tape and reel	TS5L100DR	
		Tape and reel	TS5L100DBQR	TG100
	TSSOP – PW	Tube	TS5L100PW	TG100
		Tape and reel	TS5L100PWR	

[†] 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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TS5L100

QUAD SPDT WIDE-BANDWIDTH LAN SWITCH WITH LOW ON-STATE RESISTANCE

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description/ordering information (continued)

This device can be used to replace mechanical relays in LAN applications. This device has low r_{on} , wide bandwidth, and low differential crosstalk, making it suitable for 10 Base-T, 100 Base-T, and various other LAN applications.

This device is fully specified for partial-power-down applications using I_{off} . The I_{off} feature ensures that damaging current will not backflow through the device when it is powered down. The device has isolation during power off.

To ensure the high-impedance state during power up or power down, $\bar{E}$ should be tied to V_{CC} through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

FUNCTION TABLE

INPUTS		INPUT/OUTPUT YX	FUNCTION
$\bar{E}$	S		
L	L	IX_0	$YX = IX_0$
L	H	IX_1	$YX = IX_1$
H	X	Z	Disconnect

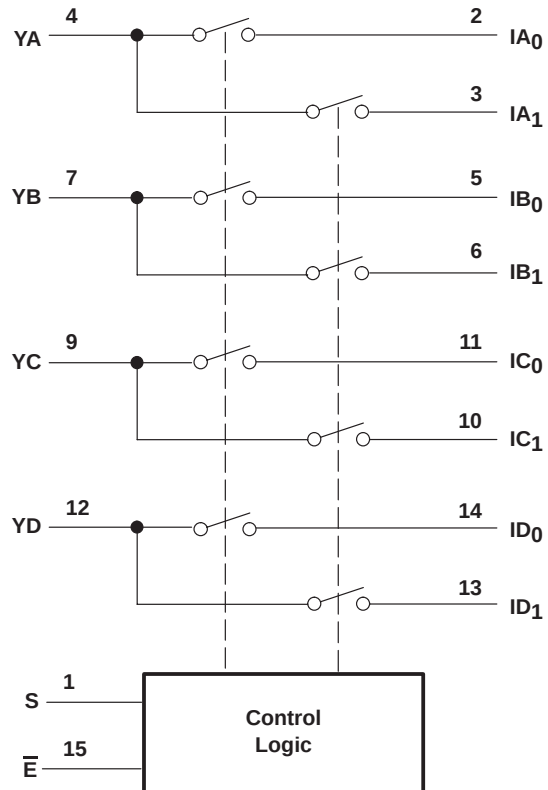
PIN DESCRIPTIONS

PIN NAME	DESCRIPTION
$IAn-IDn$	Data I/Os
S	Select input
$\bar{E}$	Enable input
$YA-YD$	Data I/Os

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logic diagram (positive logic)



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QUAD SPDT WIDE-BANDWIDTH LAN SWITCH WITH LOW ON-STATE RESISTANCE

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

Supply voltage range, V_{CC}	–0.5 V to 7 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_{CC} or GND terminals	±100 mA
Package thermal impedance, θ_{JA} (see Note 5): D package	73°C/W
(see Note 5): DBQ package	90°C/W
(see Note 5): PW package	83°C/W
(see Note 6): RGY package	39°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.
 6. The package thermal impedance is calculated in accordance with JESD 51-5.

recommended operating conditions (see Note 7)

	MIN	MAX	UNIT
V_{CC} Supply voltage	6	6.5	V
V_{IH} High-level control input voltage ($\bar{E}$, S)	2.5	6.5	V
V_{IL} Low-level control input voltage ($\bar{E}$, S)	0	0.8	V
T_A Operating free-air temperature	0	70	°C

NOTE 7: All unused control inputs of the device must be held at V_{CC} 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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QUAD SPDT WIDE-BANDWIDTH LAN SWITCH
WITH LOW ON-STATE RESISTANCE

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**electrical characteristics over recommended operating free-air temperature range,
 $V_{CC} = 6\text{ V to }6.5\text{ V}$ (unless otherwise noted)**

PARAMETER		TEST CONDITIONS		MIN	TYP [†]	MAX	UNIT
V_{IK}	$\overline{E}, S$	$V_{CC} = 6\text{ V},$	$I_{IN} = -18\text{ mA}$			-1.8	V
V_{hys}	$\overline{E}, S$				150		mV
V_O		$V_I = 4.5\text{ V},$	$\overline{E} = \text{low},$	$R_L = 100\ \Omega,$	3.7	4.06	V
I_{IH}	$\overline{E}, S$	$V_{CC} = 6.5\text{ V},$	$V_{IN} = V_{CC}$			± 1	μA
I_{IL}	$\overline{E}, S$	$V_{CC} = 6.5\text{ V},$	$V_{IN} = \text{GND}$			± 1	μA
$I_{OZ}^{\ddagger}$		$V_{CC} = 6.5\text{ V},$	$V_O = 0\text{ to }6.5\text{ V},$ $V_I = 0,$	Switch OFF		± 1	μA
$I_{OS}^{\S}$		$V_{CC} = 6.5\text{ V},$	$V_O = 0\text{ to }0.5\text{ V}_{CC},$ $V_I = 0,$	Switch ON	50		mA
I_{off}		$V_{CC} = 0,$	$V_O = 0\text{ to }6.5\text{ V},$	$V_I = 0$		1	μA
I_{CC}		$V_{CC} = 6.5\text{ V},$	$I_{IO} = 0,$	Switch ON or OFF		3	μA
ΔI_{CC}	$\overline{E}, S$	$V_{CC} = 6.5\text{ V},$	One input at 3.4 V,	Other inputs at V_{CC} or GND		6	mA
I_{CCD}		$V_{CC} = 6.5\text{ V},$	I and Y ports open,	V_{IN} input switching 50% duty cycle		0.35	mA/ MHz
C_{IN}	$\overline{E}, S$	$f = 1\text{ MHz}$			3.5		pF
C_{OFF}	I port	$V_I = 0,$	$f = 1\text{ MHz},$ Outputs open,	Switch OFF	4.5		pF
	Y port				6.5		
C_{ON}		$V_I = 0,$	$f = 1\text{ MHz},$ Outputs open,	Switch ON	14		pF
r_{on}	M1	$V_I = 4.5\text{ V},$	Switch ON,	$R_L = 100\ \Omega,$ see Figure 11	7.5	11.2	Ω
	M2				2	3	
Δr_{on}		$V_I = 4.5\text{ V},$	Switch ON		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 $V_{CC} = 6.2\text{ V}$ (unless otherwise noted), $T_A = 25^\circ\text{C}$.

[‡] For I/O ports, I_{OZ} includes the input leakage current.

[§] The I_{OS} test is applicable to only one ON channel at a time. The duration of this test is less than one second.

**switching characteristics over recommended operating free-air temperature range,
 $V_{CC} = 6\text{ V to }6.5\text{ V}, R_L = 100\ \Omega, C_L = 35\text{ pF}$ (unless otherwise noted) (see Figure 7)**

PARAMETER	FROM (INPUT)	TO (OUTPUT)	MIN	MAX	UNIT
t_{ON}	S	Y		7	ns
t_{OFF}	S	Y		4	ns

[†] All typical values are at $V_{CC} = 6.2\text{ V}$ (unless otherwise noted), $T_A = 25^\circ\text{C}$.

**dynamic characteristics over recommended operating free-air temperature range,
 $V_{CC} = 6\text{ V to }6.5\text{ V}$ (unless otherwise noted)**

PARAMETER	TEST CONDITIONS		MIN	TYP [†]	MAX	UNIT
$X_{TALK}(\text{Diff})$	$R_L = 100\ \Omega,$	$f = 10\text{ MHz},$ see Figure 12, $t_r = t_f = 2\text{ ns}$	-40	-60		dB
X_{TALK}	$R_L = 100\ \Omega,$	$f = 30\text{ MHz},$ see Figure 9		-50		dB
O_{IRR}	$R_L = 100\ \Omega,$	$f = 30\text{ MHz},$ see Figure 10		-40		dB
BW	$R_L = 100\ \Omega,$	see Figure 8		350		MHz

[†] All typical values are at $V_{CC} = 6.2\text{ V}$ (unless otherwise noted), $T_A = 25^\circ\text{C}$.



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OPERATING CHARACTERISTICS

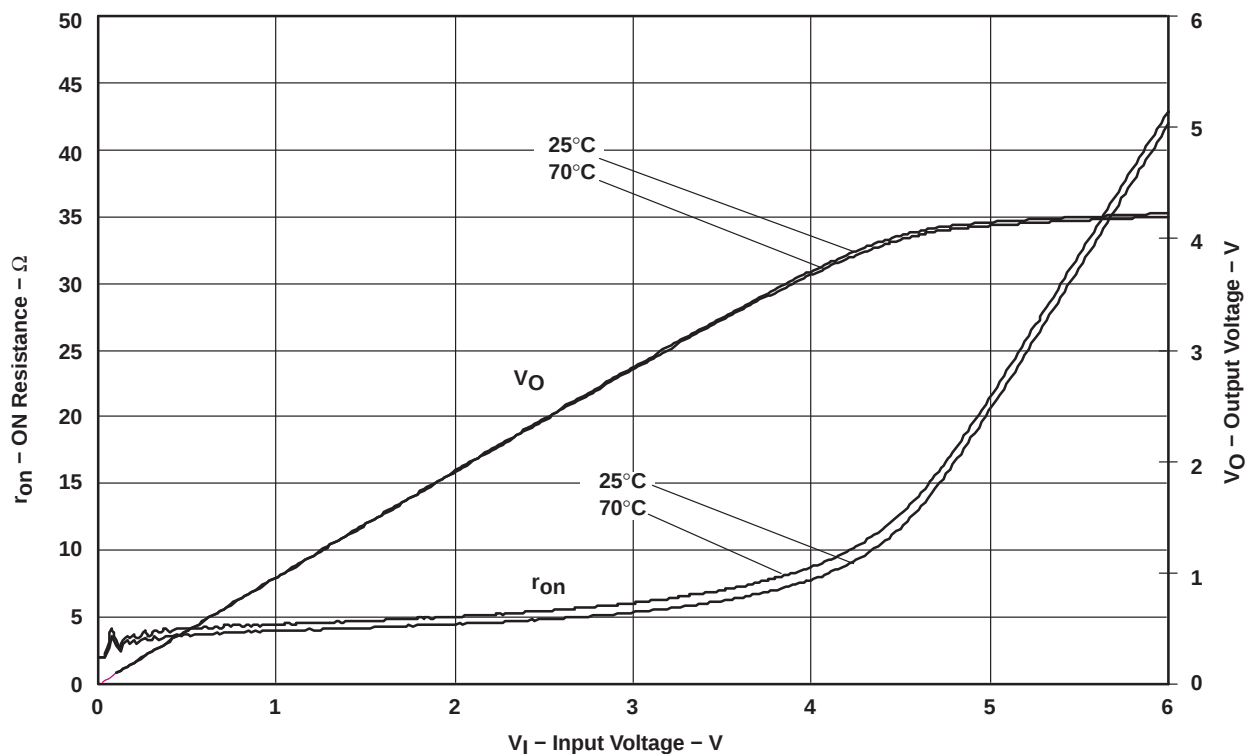


Figure 1. r_{on} and V_O vs V_I Over Temperature ($V_{CC} = 6$ V)

OPERATING CHARACTERISTICS

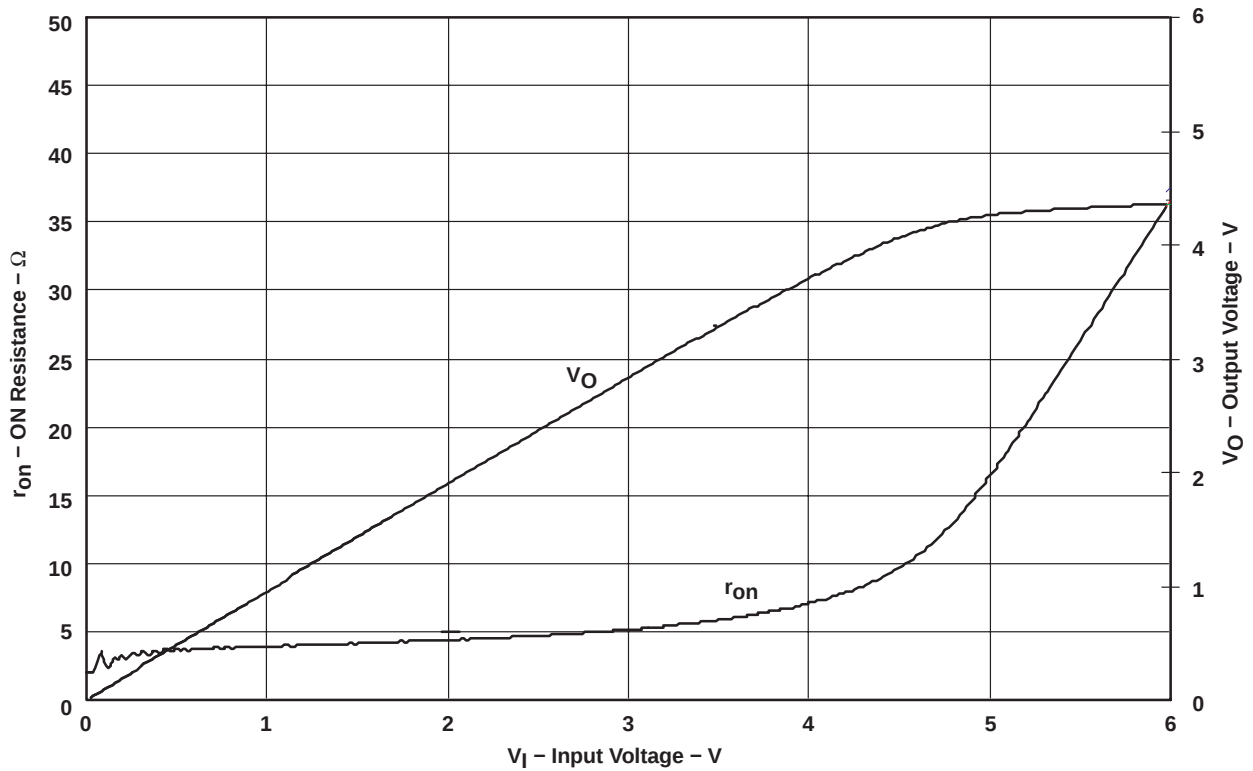


Figure 2. r_{on} and V_O vs V_I ($V_{CC} = 6.2$ V and $T_A = 25^\circ\text{C}$)

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OPERATING CHARACTERISTICS

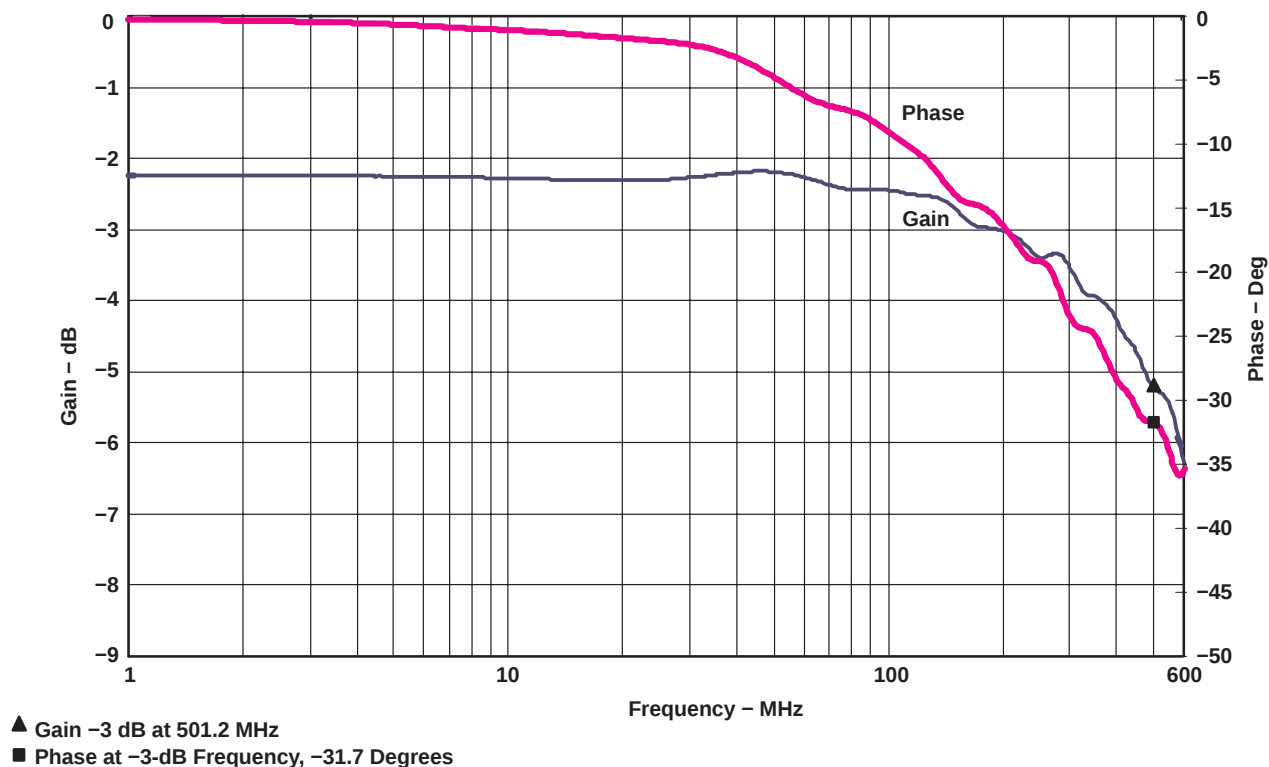


Figure 3. Gain/Phase vs Frequency

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OPERATING CHARACTERISTICS

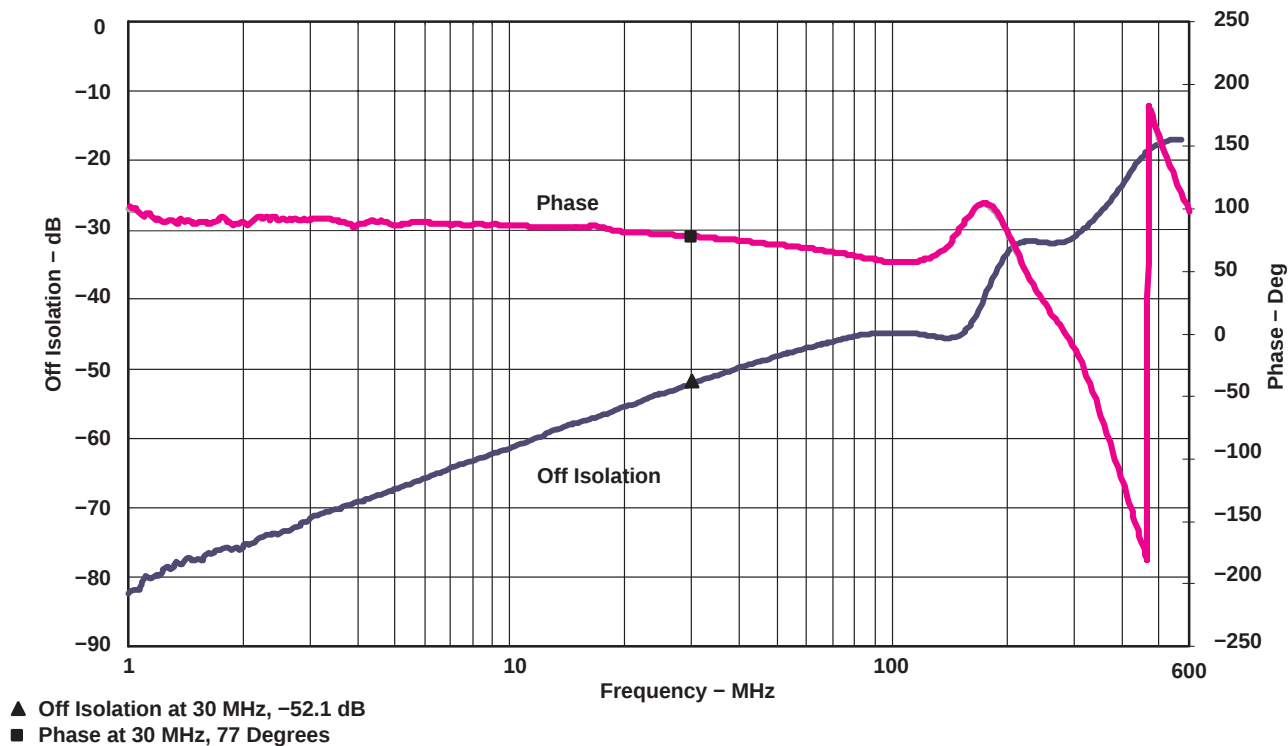


Figure 4. Off Isolation vs Frequency

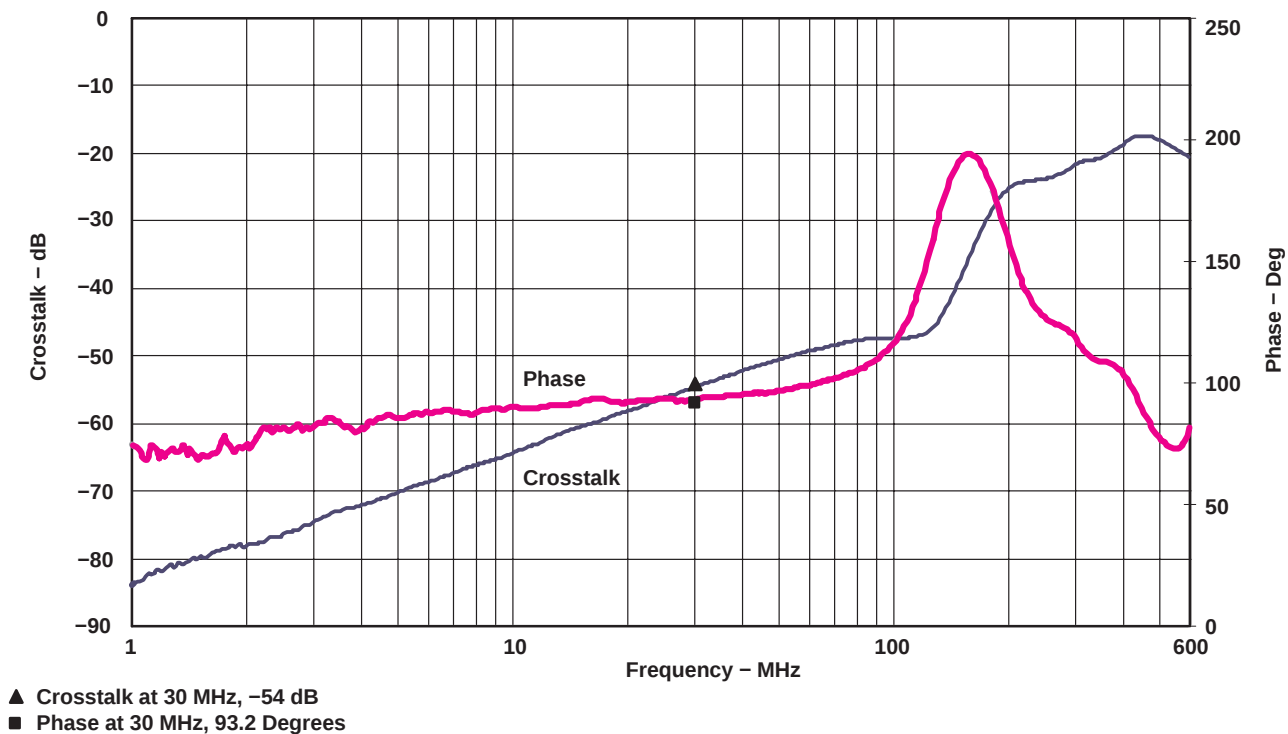


Figure 5. Crosstalk vs Frequency



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OPERATING CHARACTERISTICS

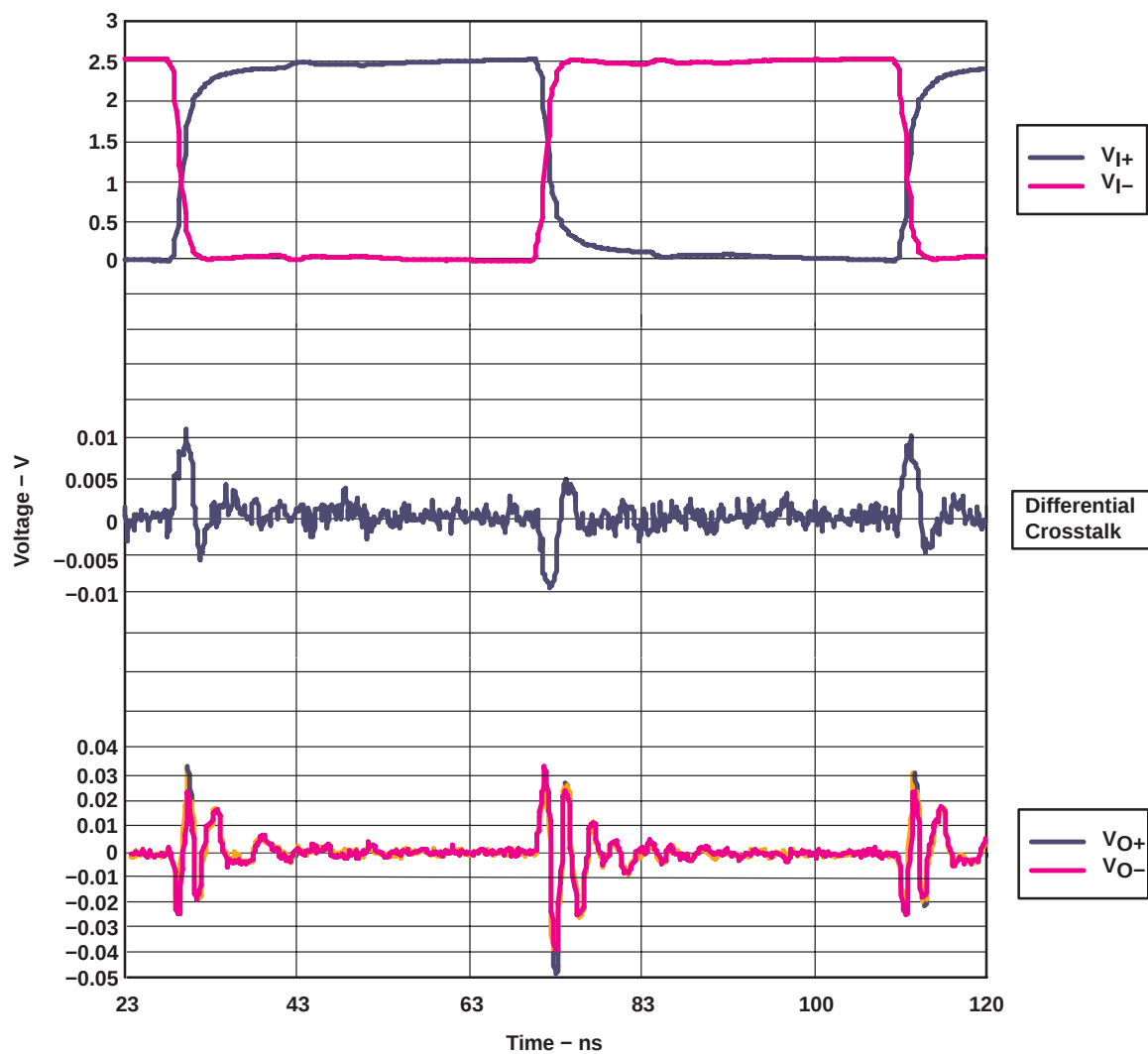


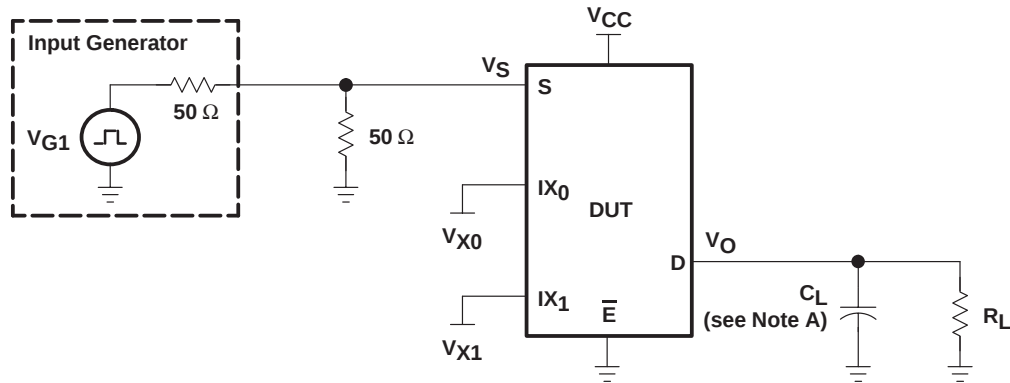
Figure 6. Differential Crosstalk

TS5L100

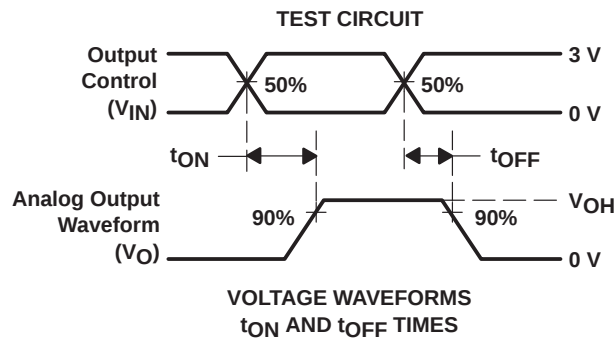
QUAD SPDT WIDE-BANDWIDTH LAN SWITCH WITH LOW ON-STATE RESISTANCE

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PARAMETER MEASUREMENT INFORMATION



TEST	V _{CC}	R _L	C _L	V _{X0}	V _{X1}
t _{ON}	6.2 V	100 Ω	35 pF	GND	4.5 V
	6.2 V	100 Ω	35 pF	4.5 V	GND
t _{OFF}	6.2 V	100 Ω	35 pF	GND	4.5 V
	6.2 V	100 Ω	35 pF	4.5 V	GND



- NOTES: A. C_L includes probe and jig capacitance.
 B. 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.
 C. The outputs are measured one at a time, with one transition per measurement.

Figure 7. Test Circuit and Voltage Waveforms

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QUAD SPDT WIDE-BANDWIDTH LAN SWITCH

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PARAMETER MEASUREMENT INFORMATION

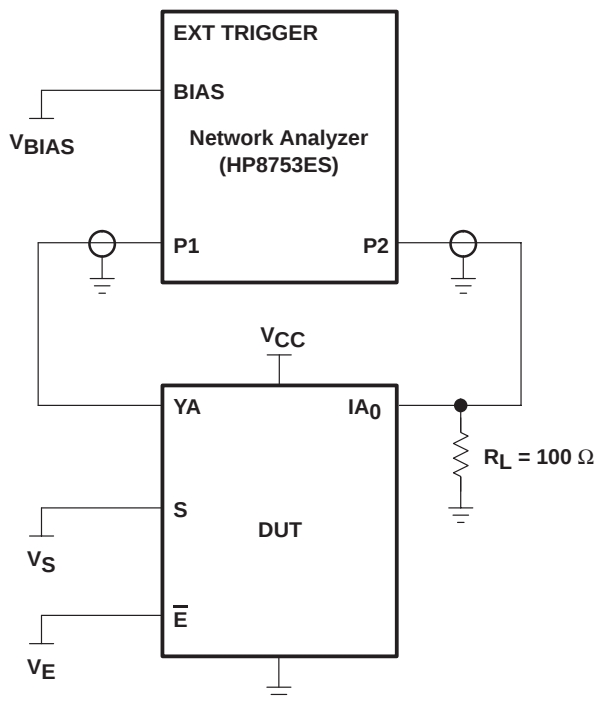


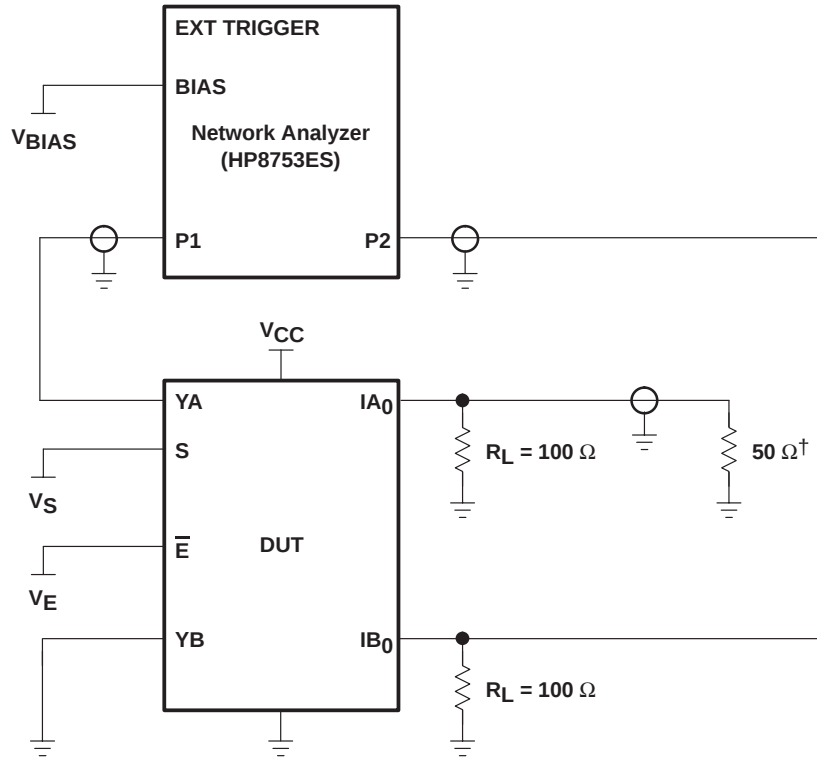
Figure 8. Test Circuit for Frequency Response (BW)

Frequency response is measured at the output of the ON channel. For example, when $V_S = 0$, $V_E = 0$, and YA is the input, the output is measured at IA0. All unused analog I/O ports are left open.

HP8753ES setup

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

PARAMETER MEASUREMENT INFORMATION



† A 50-Ω termination resistor is needed for the network analyzer.

Figure 9. Test Circuit for Crosstalk (X_{TALK})

Crosstalk is measured at the output of the nonadjacent ON channel. For example, when $V_S = 0$, $V_E = 0$, and YA is the input, the output is measured at IB_0 . All unused analog input (Y) ports are connected to GND, and output (A) ports are connected to GND through 50-Ω pulldown resistors.

HP8753ES setup

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

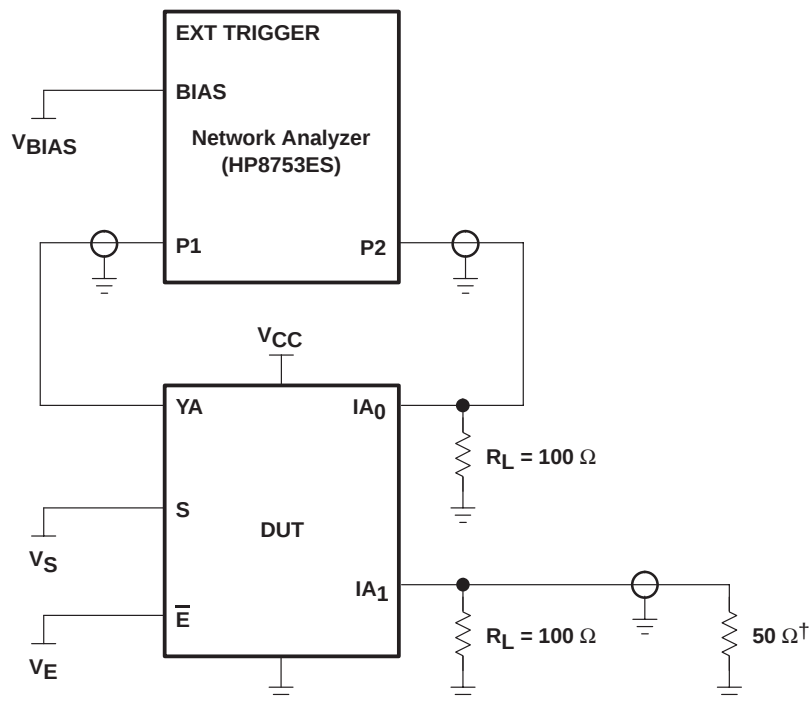
TS5L100

QUAD SPDT WIDE-BANDWIDTH LAN SWITCH

WITH LOW ON-STATE RESISTANCE

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PARAMETER MEASUREMENT INFORMATION



† A 50- Ω termination resistor is needed for the network analyzer.

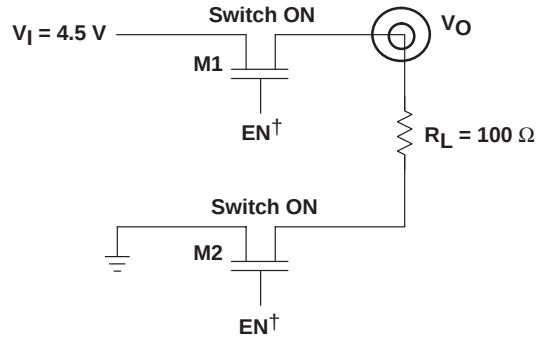
Figure 10. Test Circuit for Off Isolation (O_{IRR})

Off isolation is measured at the output of the OFF channel. For example, when $V_S = V_{CC}$, $V_E = 0$, and YA is the input, the output is measured at IA_0 . All unused analog input (Y) ports are left open, and output (A) ports are connected to GND through 50- Ω pulldown resistors.

HP8753ES setup

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

PARAMETER MEASUREMENT INFORMATION



† EN is the internal enable signal applied to the switch.

NOTE A: r_{on} (M1) and r_{on} (M2) are calculated from the voltage drop and current across the two terminals of M1 and M2, respectively.

Figure 11. Test Circuit for V_O and r_{on}

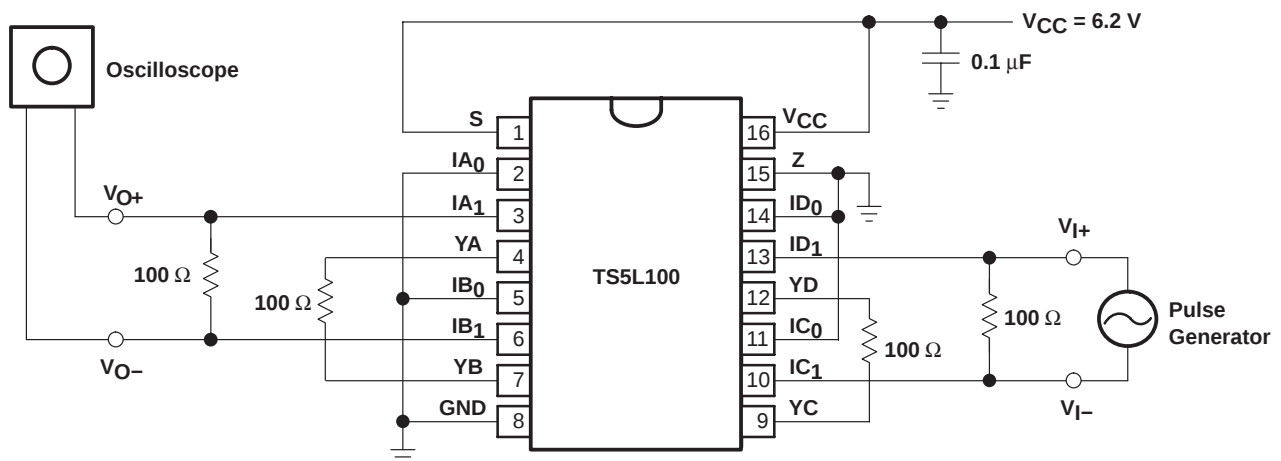


Figure 12. Differential Crosstalk Measurement

Differential crosstalk is a measure of coupling noise between a transmit and receive pair in the LAN application. Differential crosstalk depends on the edge rate, frequency, and load. This is calculated from the equation, $X_{TALK}(Diff)_{db} = 20 \log V_O(Diff)/V_I(Diff)$, where $V_O(Diff)$ is the differential output voltage and $V_I(Diff)$ is the differential input voltage.

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package Pins	Package qty Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
TS5L100D	Active	Production	SOIC (D) 16	40 TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	TS5L100
TS5L100D.A	Active	Production	SOIC (D) 16	40 TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	TS5L100
TS5L100DBQR	Active	Production	SSOP (DBQ) 16	2500 LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	0 to 70	TG100
TS5L100DBQR.A	Active	Production	SSOP (DBQ) 16	2500 LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	0 to 70	TG100
TS5L100DR	Active	Production	SOIC (D) 16	2500 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	TS5L100
TS5L100DR.A	Active	Production	SOIC (D) 16	2500 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	TS5L100
TS5L100PWR	Active	Production	TSSOP (PW) 20	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	TG100
TS5L100PWR.A	Active	Production	TSSOP (PW) 20	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	TG100

⁽¹⁾ **Status:** For more details on status, see our [product life cycle](#).

⁽²⁾ **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

⁽³⁾ **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

⁽⁴⁾ **Lead finish/Ball material:** Parts 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.

⁽⁵⁾ **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

⁽⁶⁾ **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "-" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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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.

TAPE AND REEL INFORMATION



*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
TS5L100DBQR	SSOP	DBQ	16	2500	330.0	12.5	6.4	5.2	2.1	8.0	12.0	Q1
TS5L100DR	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1
TS5L100PWR	TSSOP	PW	20	2000	330.0	16.4	6.95	7.0	1.4	8.0	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)
TS5L100DBQR	SSOP	DBQ	16	2500	353.0	353.0	32.0
TS5L100DR	SOIC	D	16	2500	340.5	336.1	32.0
TS5L100PWR	TSSOP	PW	20	2000	353.0	353.0	32.0

TUBE



*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
TS5L100D	D	SOIC	16	40	507	8	3940	4.32
TS5L100D.A	D	SOIC	16	40	507	8	3940	4.32

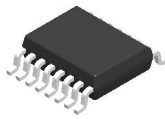
D (R-PDSO-G16)

PLASTIC SMALL OUTLINE



4040047-6/M 06/11

- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
 - D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
 - E. Reference JEDEC MS-012 variation AC.

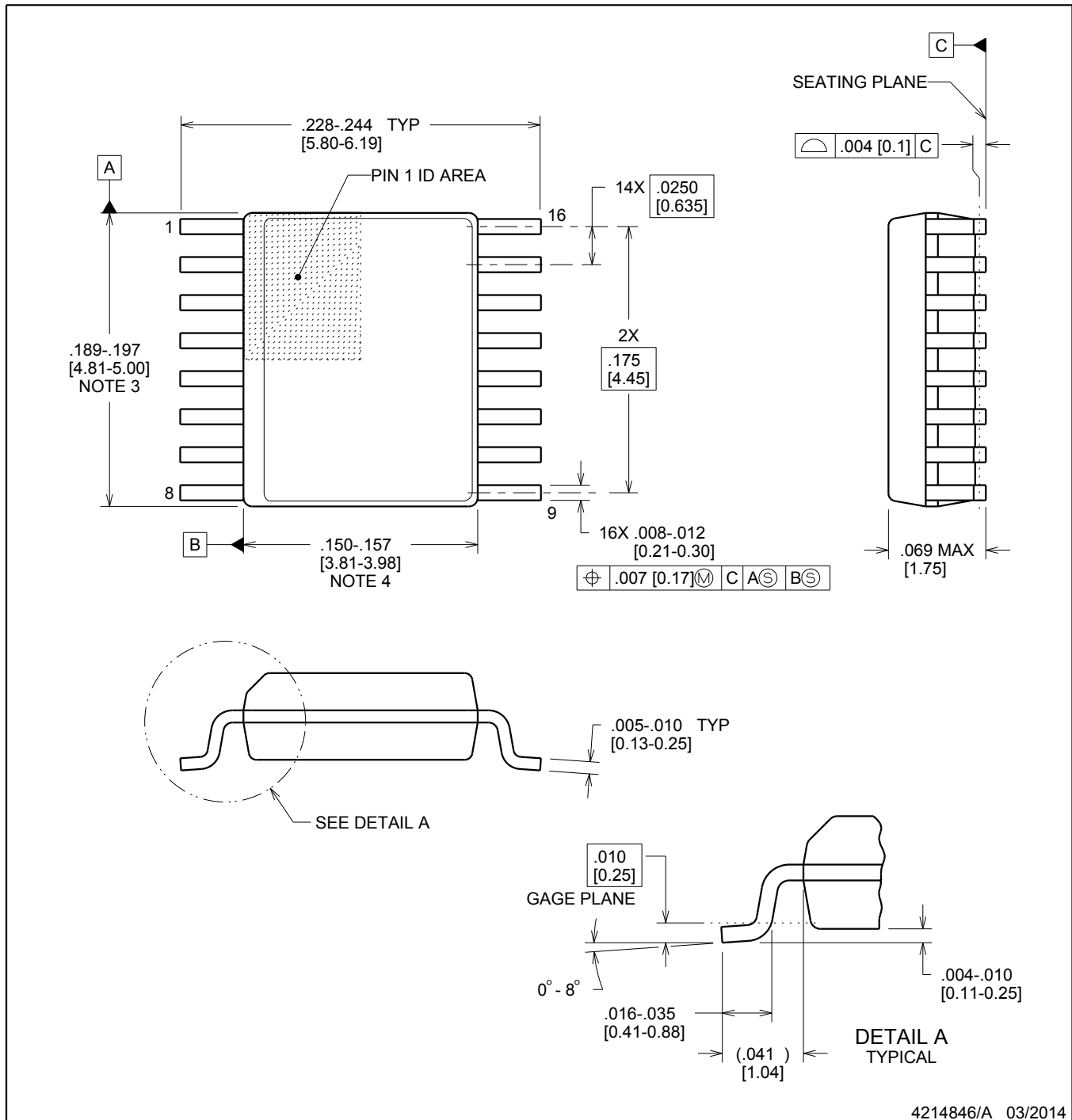


DBQ0016A

PACKAGE OUTLINE

SSOP - 1.75 mm max height

SHRINK SMALL-OUTLINE PACKAGE



4214846/A 03/2014

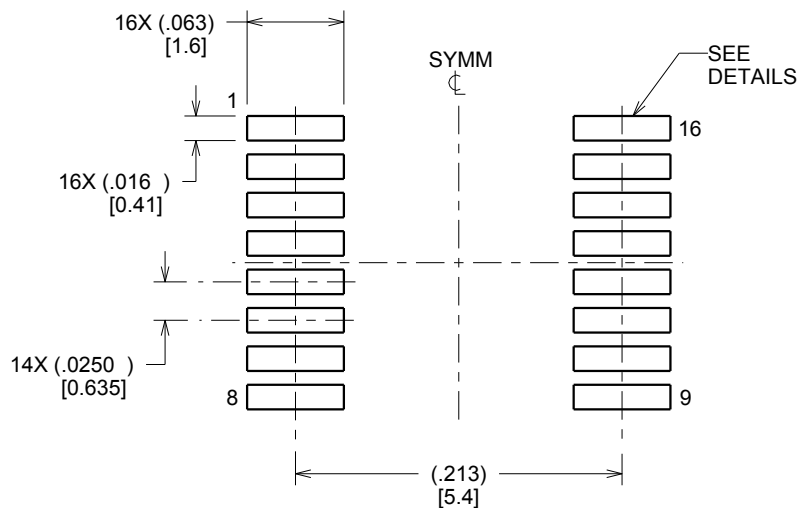
NOTES:

- Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. Dimensioning and tolerancing per ASME Y14.5M.
- This drawing is subject to change without notice.
- This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 inch, per side.
- This dimension does not include interlead flash.
- Reference JEDEC registration MO-137, variation AB.

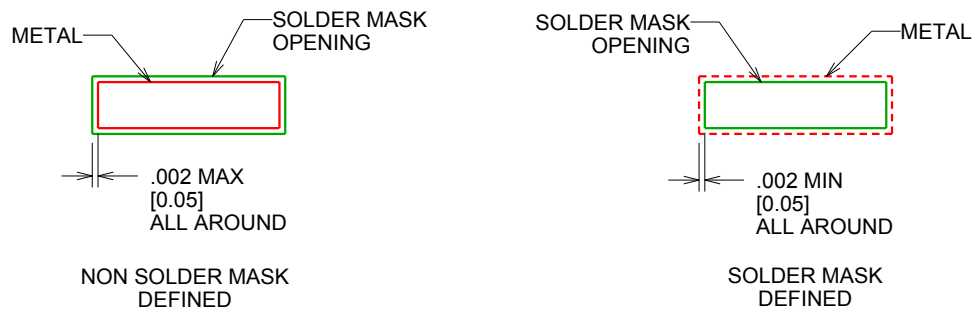
DBQ0016A

SSOP - 1.75 mm max height

SHRINK SMALL-OUTLINE PACKAGE



LAND PATTERN EXAMPLE
SCALE:8X



SOLDER MASK DETAILS

4214846/A 03/2014

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

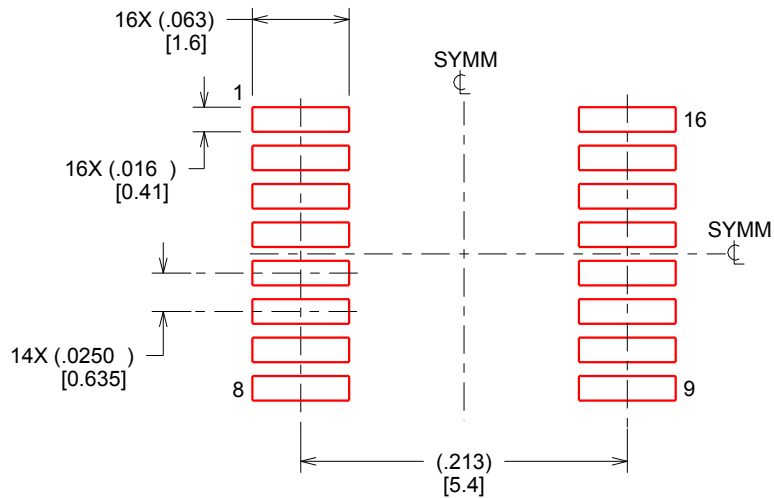
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DBQ0016A

SSOP - 1.75 mm max height

SHRINK SMALL-OUTLINE PACKAGE



SOLDER PASTE EXAMPLE
BASED ON .005 INCH [0.127 MM] THICK STENCIL
SCALE:8X

4214846/A 03/2014

NOTES: (continued)

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

EXAMPLE BOARD LAYOUT

PW0020A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X



4220206/A 02/2017

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

PW0020A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 10X

4220206/A 02/2017

NOTES: (continued)

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

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