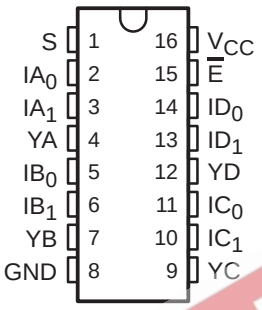
TS3L100
QUAD SPDT WIDE-BANDWIDTH LAN SWITCH WITH LOW ON-STATE RESISTANCE

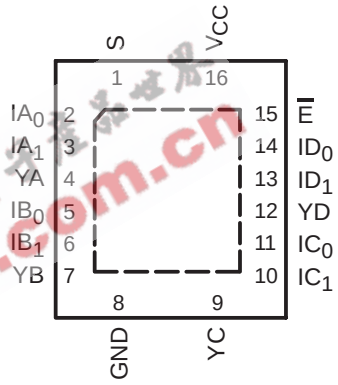
SCDS161A – MAY 2004 – REVISED OCTOBER 2004

- Wide Bandwidth (BW = 350 MHz Min)
- Low Differential Crosstalk (X_{TALK} = −68 dB Typ)
- Low Power Consumption (I_{CC} = 10 μA Max)
- Bidirectional Data Flow, With Near-Zero Propagation Delay
- Low ON-State Resistance (r_{on} = 5 Ω Typ)
- Rail-to-Rail Switching on Data I/O Ports (0 to V_{CC})
- V_{CC} Operating Range From 3 V to 3.6 V
- I_{off} Supports Partial-Power-Down Mode Operation
- Data and Control Inputs Have Undershoot Clamp Diodes
- 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, DBQ, DGV, OR PW PACKAGE
(TOP VIEW)



RGY PACKAGE
(TOP VIEW)



description/ordering information

The TI TS3L100 LAN switch is a 4-bit 1-of-2 multiplexer/demultiplexer with a single switch-enable ($\overline{E}$) input. When $\overline{E}$ is low, the switch is enabled and the I port is connected to the Y port. When $\overline{E}$ 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	TS3L100RGYR	TK100
	SOIC − D	Tube	TS3L100D	TS3L100
		Tape and reel	TS3L100DR	
	SSOP (QSOP) − DBQ	Tape and reel	TS3L100DBQR	TK100
	TSSOP − PW	Tube	TS3L100PW	TK100
		Tape and reel	TS3L100PWR	
	TVSOP − DGV	Tape and reel	TS3L100DGVR	TK100

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

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, $\overline{E}$ 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.

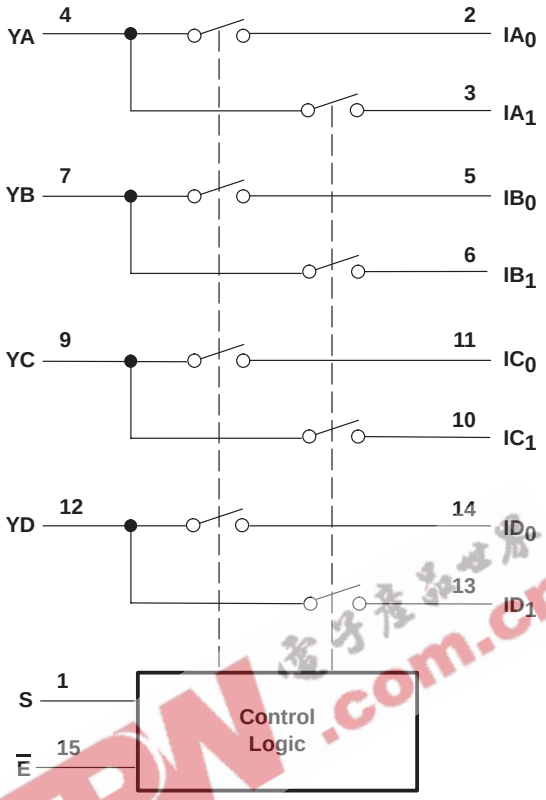
FUNCTION TABLE

INPUTS		INPUT/OUTPUT YX	FUNCTION
$\overline{E}$	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
$\overline{E}$	Enable input
YA−YD	Data I/Os

logic diagram (positive logic)



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

Supply voltage range, V_{CC} . . . . . −0.5 V to 4.6 V
Control input voltage range, V_{IN} (see Notes 1 and 2) . . . . . −0.5 V to 4.6 V
Switch I/O voltage range, $V_{I/O}$ (see Notes 1, 2, and 3) . . . . . −0.5 V to 4.6 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
DB package . . . . . 82°C/W
DBQ package . . . . . 90°C/W
PW package . . . . . 108°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_{CC}	Supply voltage	3	3.6	V
V_{IH}	High-level control input voltage ($\overline{E}$, S)	2	V_{CC}	V
V_{IL}	Low-level control input voltage ($\overline{E}$, S)	0	0.8	V
T_A	Operating free-air temperature	0	70	°C

NOTE 6: 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.

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

PARAMETER		TEST CONDITIONS			MIN	TYP†	MAX	UNIT
V_{IK}	$\overline{E}$, S	V_{CC} = 3 V,	I_{IN} = −18 mA				−1.8	V
V_{hys}	$\overline{E}$, S					150		mV
I_{IH}	$\overline{E}$, S	V_{CC} = 3.6 V,	V_{IN} = V_{CC}				±1	µA
I_{IL}	$\overline{E}$, S	V_{CC} = 3.6 V,	V_{IN} = GND				±1	µA
I_{OZ}‡		V_{CC} = 3.6 V,	V_O = 0 to 3.6 V, V_I = 0,	Switch OFF			±1	µA
I_{OS}§		V_{CC} = 3.6 V,	V_O = 0 to 0.5 V_{CC}, V_I = 0,	Switch ON	50			mA
I_{off}		V_{CC} = 0,	V_O = 0 to 3.6 V,	V_I = 0			15	µA
I_{CC}		V_{CC} = 3.6 V,	$I_{I/O}$ = 0,	Switch ON or OFF		0.1	10	µA
ΔI_{CC}	$\overline{E}$, S	V_{CC} = 3.6 V,	One input at V_{CC} − 0.6 V,	Other inputs at V_{CC} or GND			750	µA
I_{CCD}		V_{CC} = 3.6 V,	I and Y ports open,	V_{IN} input switching 50% duty cycle			0.45	mA/ MHz
C_{IN}	$\overline{E}$, S	f = 1 MHz				3		pF
C_{OFF}	I port	V_I = 0,	f = 1 MHz, Outputs open,	Switch OFF		5		pF
	Y port					10		
C_{ON}		V_I = 0,	f = 1 MHz, Outputs open,	Switch ON		17		pF
r_{on}		V_{CC} = 3 V	V_I = 0 V,	I_O = 48 mA		5	7	Ω
			V_I = 2 V,	I_O = 15 mA		10	15	
Δr_{on}		V_I = 3 V,	Switch ON,	I_O = 15 mA		1		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} = 3.3 V (unless otherwise noted), T_A = 25°C.
‡ For I/O ports, the parameter 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} = 3.3 V ± 0.3 V, R_L = 100 Ω, C_L = 35 pF (unless otherwise noted) (see Figure 4)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	MIN	MAX	UNIT
t_{ON}	S	Y	1	7.5	ns
t_{OFF}	S	Y	1	3.5	ns

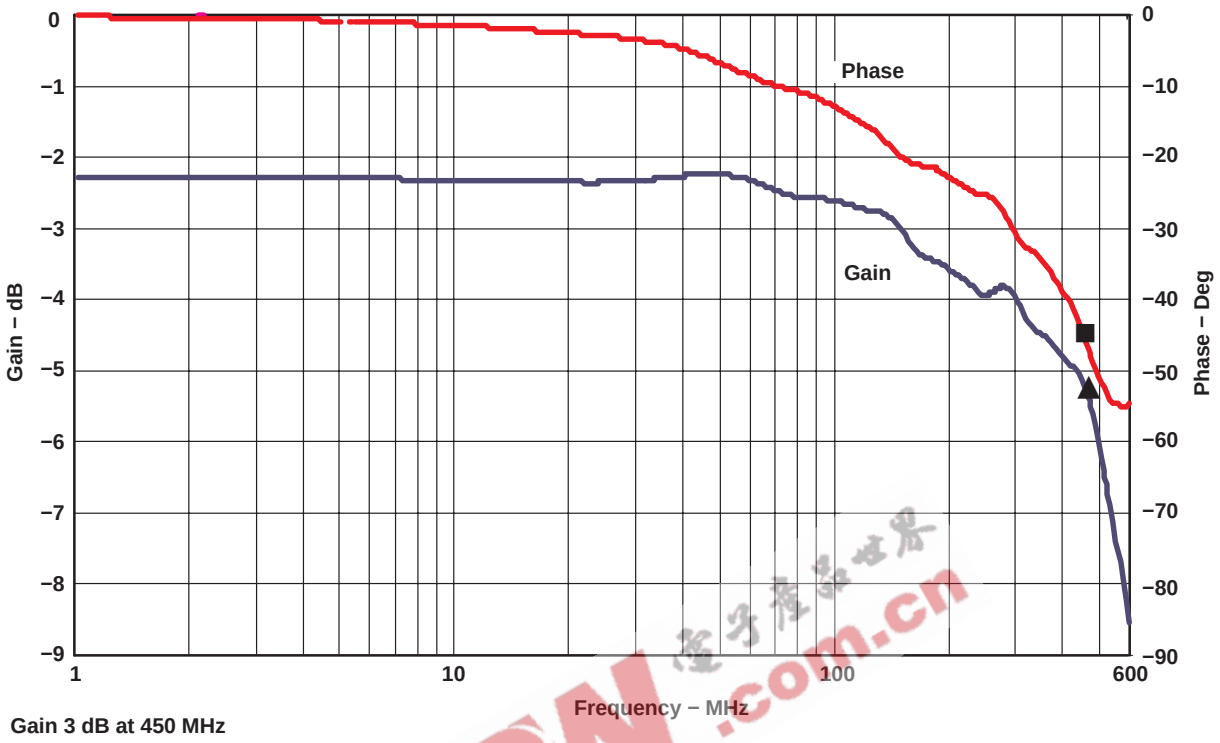
† All typical values are at V_{CC} = 3.3 V (unless otherwise noted), T_A = 25°C.

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

PARAMETER	TEST CONDITIONS			TYP†	UNIT
X_{TALK}(Diff)	R_L = 100 Ω,	f = 10 MHz, see Figure 8,	t_r = t_f = 2 ns	−55	dB
X_{TALK}	R_L = 100 Ω,	f = 30 MHz, see Figure 6		−68	dB
O_{IRR}	R_L = 100 Ω,	f = 30 MHz, see Figure 7		−42	dB
BW	R_L = 100 Ω, see Figure 5			350	MHz

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

OPERATING CHARACTERISTICS

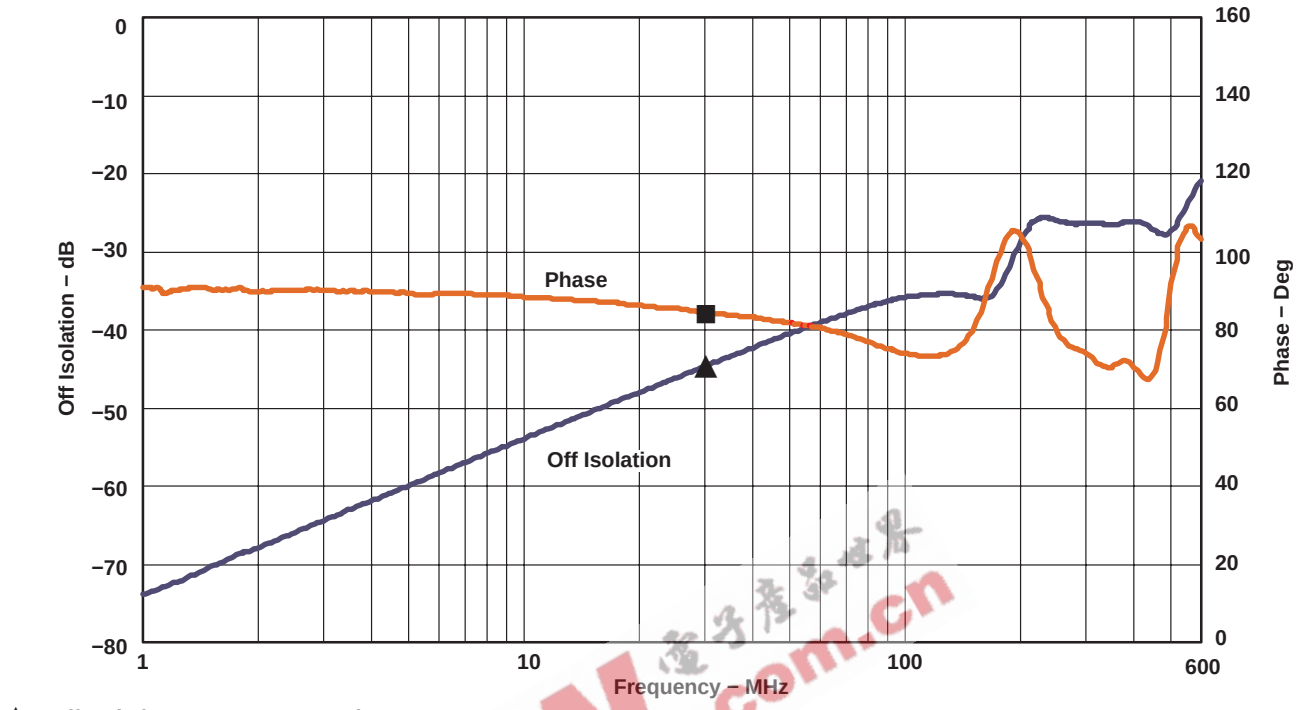


▲ Gain 3 dB at 450 MHz

■ Phase at 3-dB Frequency, −43 Degrees

Figure 1. Gain/Phase vs Frequency

OPERATING CHARACTERISTICS



▲ Off Isolation at 30 MHz, −44.6 dB
■ Phase at 30 MHz, 84.41 Degrees

Figure 2. Off Isolation vs Frequency

OPERATING CHARACTERISTICS

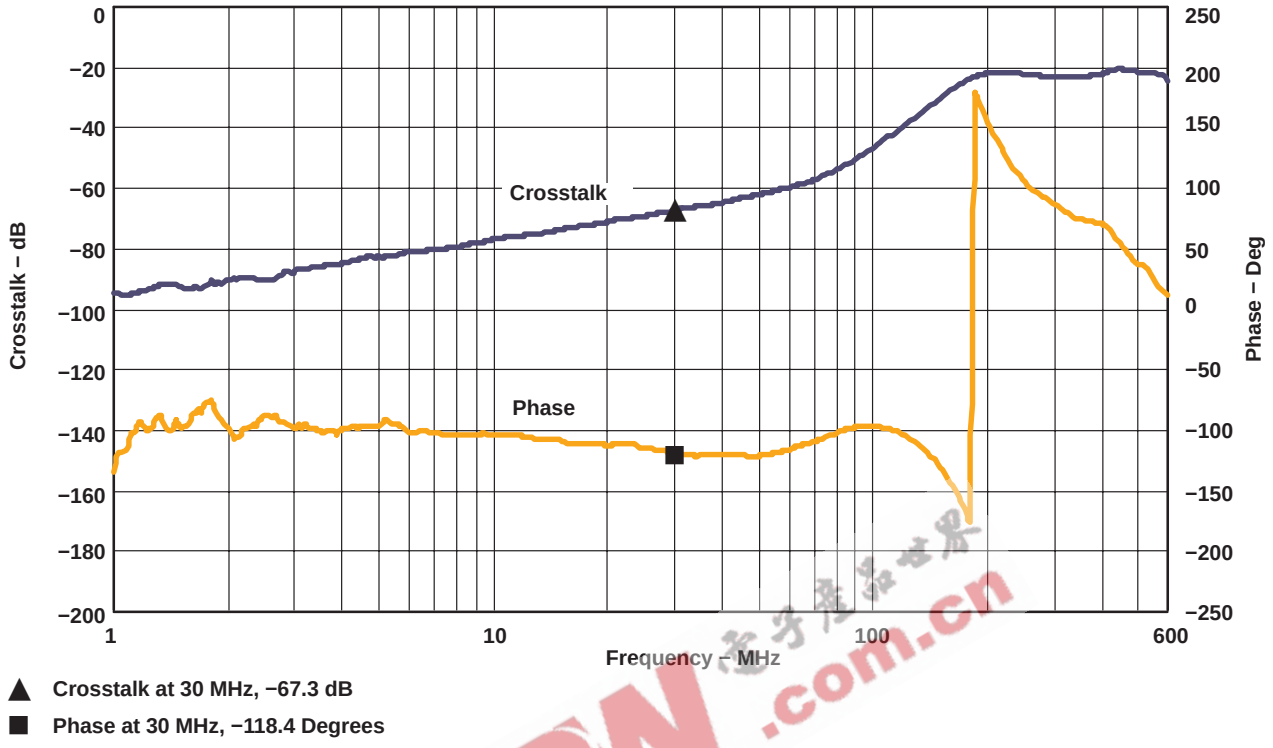
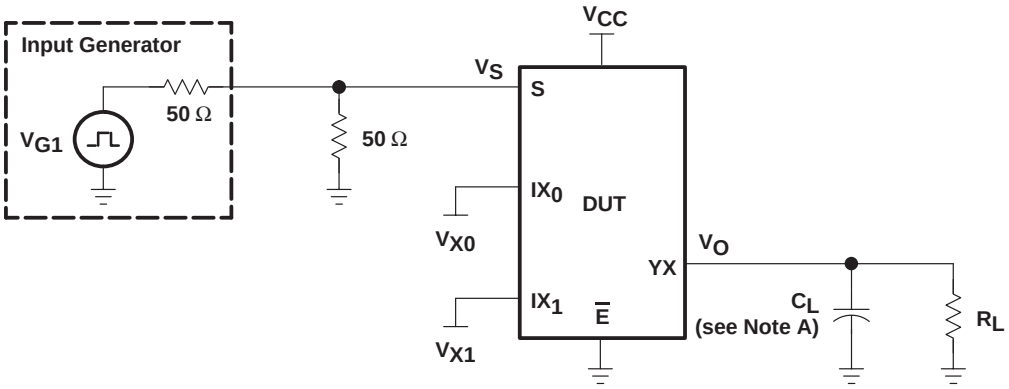
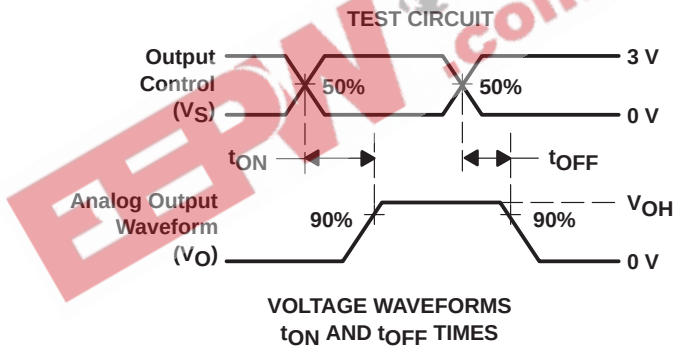


Figure 3. Crosstalk vs Frequency

PARAMETER MEASUREMENT INFORMATION



TEST	V_{CC}	R_L	C_L	V_{X0}	V_{X1}
t_{ON}	3.3 V ± 0.3 V	100 Ω	35 pF	GND	3 V
	3.3 V ± 0.3 V	100 Ω	35 pF	3 V	GND
t_{OFF}	3.3 V ± 0.3 V	100 Ω	35 pF	GND	3 V
	3.3 V ± 0.3 V	100 Ω	35 pF	3 V	GND



VOLTAGE WAVEFORMS
t_{ON} AND t_{OFF} TIMES

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 4. Test Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION

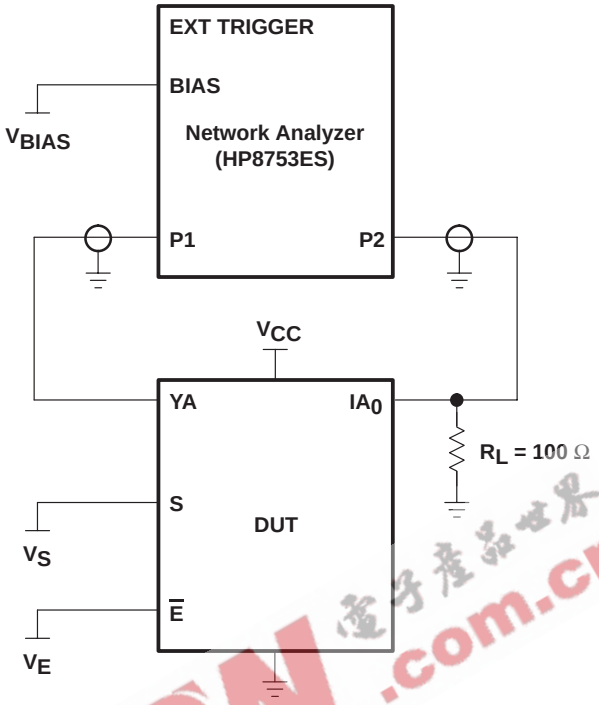


Figure 5. Test Circuit for Frequency Response (BW)

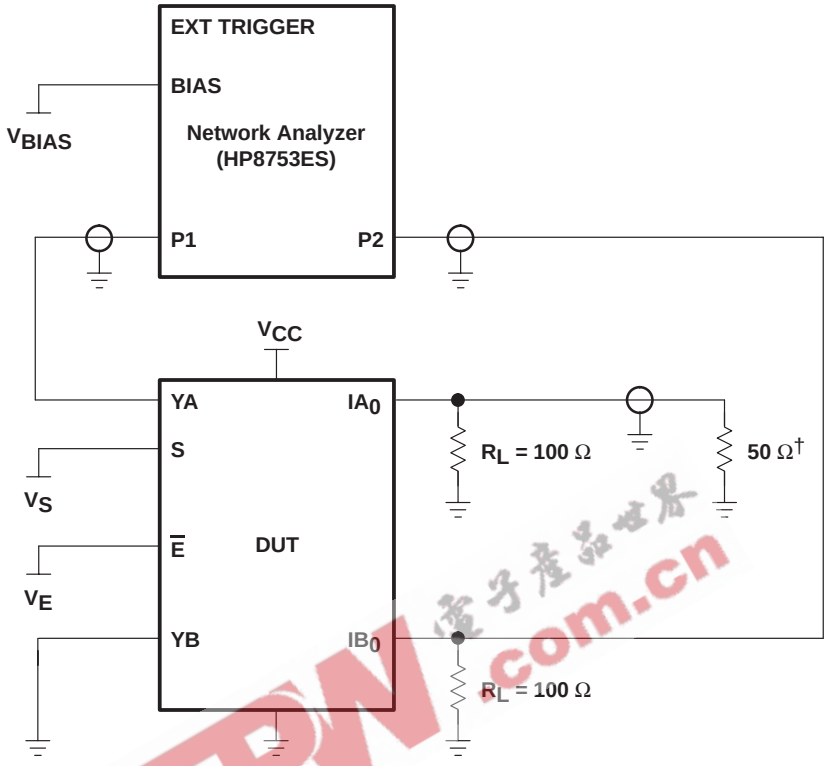
Frequency response is measured at the output of the ON channel. For example, when V_S = 0, V_E = 0, and YA is the input, the output is measured at IA_0. All unused analog I/O ports are left open.

HP8753ES setup

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

TEXAS INSTRUMENTS
POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

PARAMETER MEASUREMENT INFORMATION



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

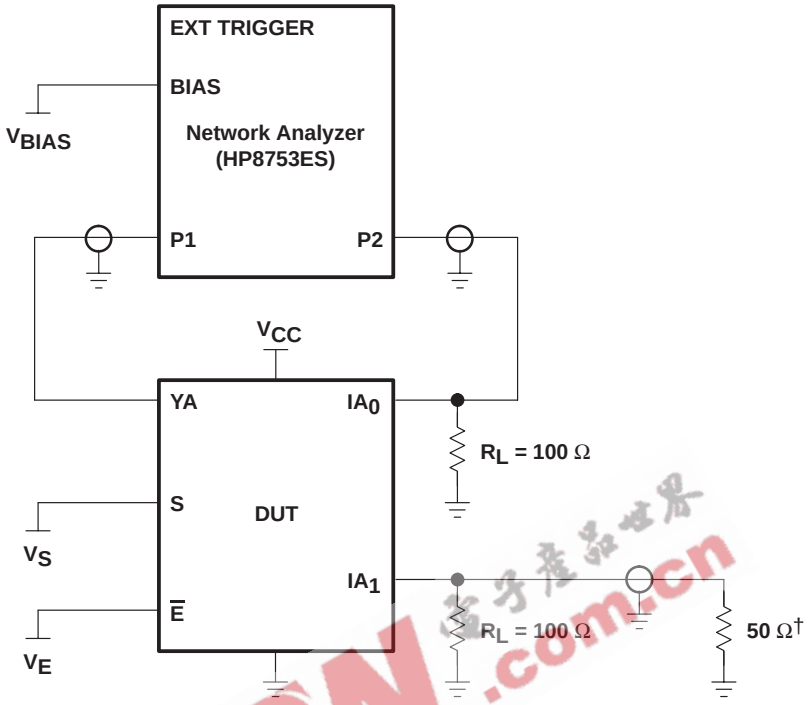
Figure 6. Test Circuit for Crosstalk (X_{TALK})

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 (I) 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



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

Figure 7. 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 (I) 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

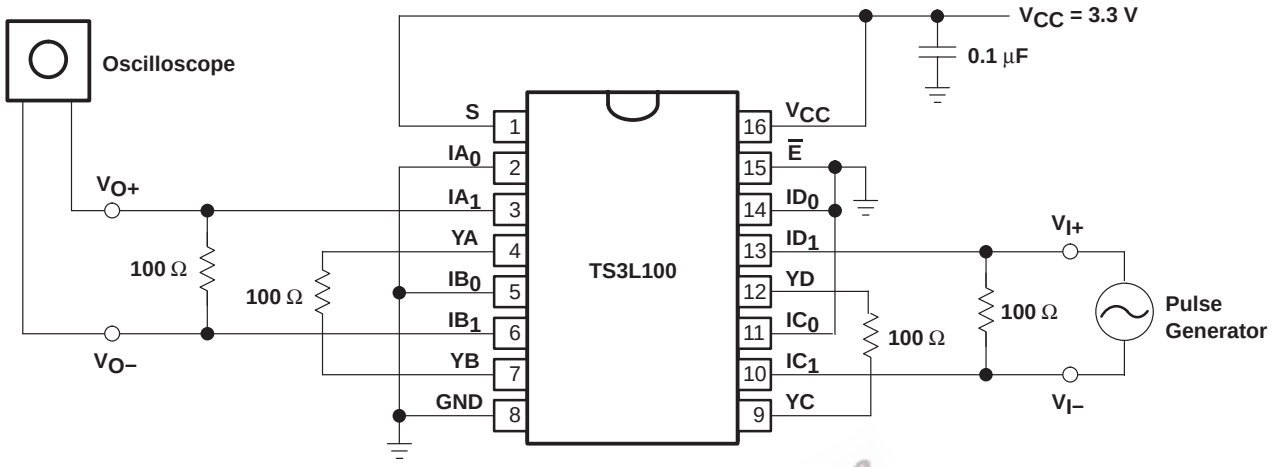


Figure 8. Differential Crosstalk Measurement

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 Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
TS3L100D	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TS3L100DBQR	ACTIVE	SSOP/ QSOP	DBQ	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1YEAR
TS3L100DBQRE4	ACTIVE	SSOP/ QSOP	DBQ	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1YEAR
TS3L100DE4	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TS3L100DGVR	ACTIVE	TVSOP	DGV	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TS3L100DGVRE4	ACTIVE	TVSOP	DGV	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TS3L100DR	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TS3L100DRE4	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TS3L100PW	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TS3L100PWE4	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TS3L100PWR	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TS3L100PWRE4	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TS3L100RGYR	ACTIVE	QFN	RGY	16	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1YEAR

(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.

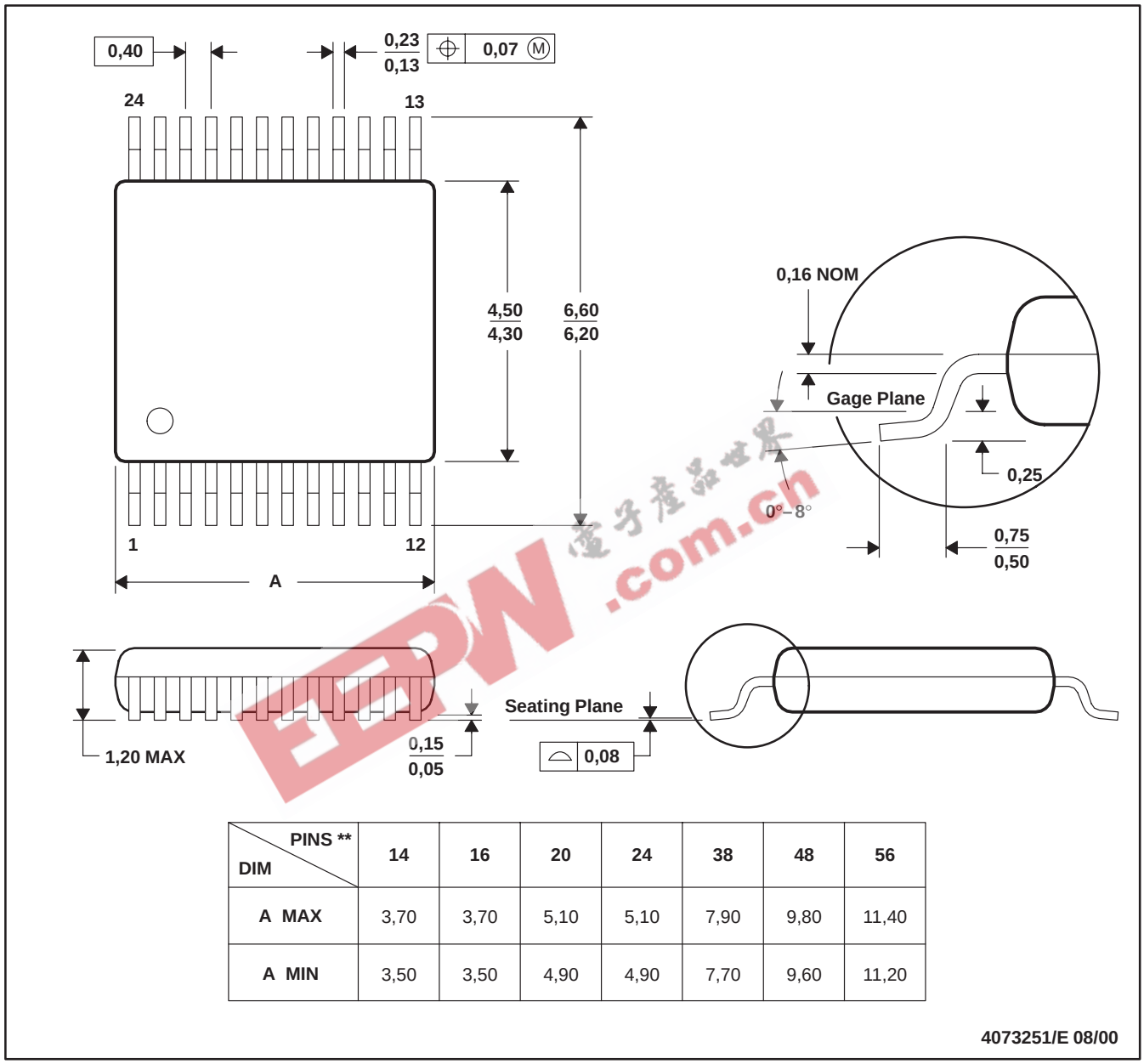
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

MPDS006C – FEBRUARY 1996 – REVISED AUGUST 2000

DGV (R-PDSO-G**)

PLASTIC SMALL-OUTLINE

24 PINS SHOWN

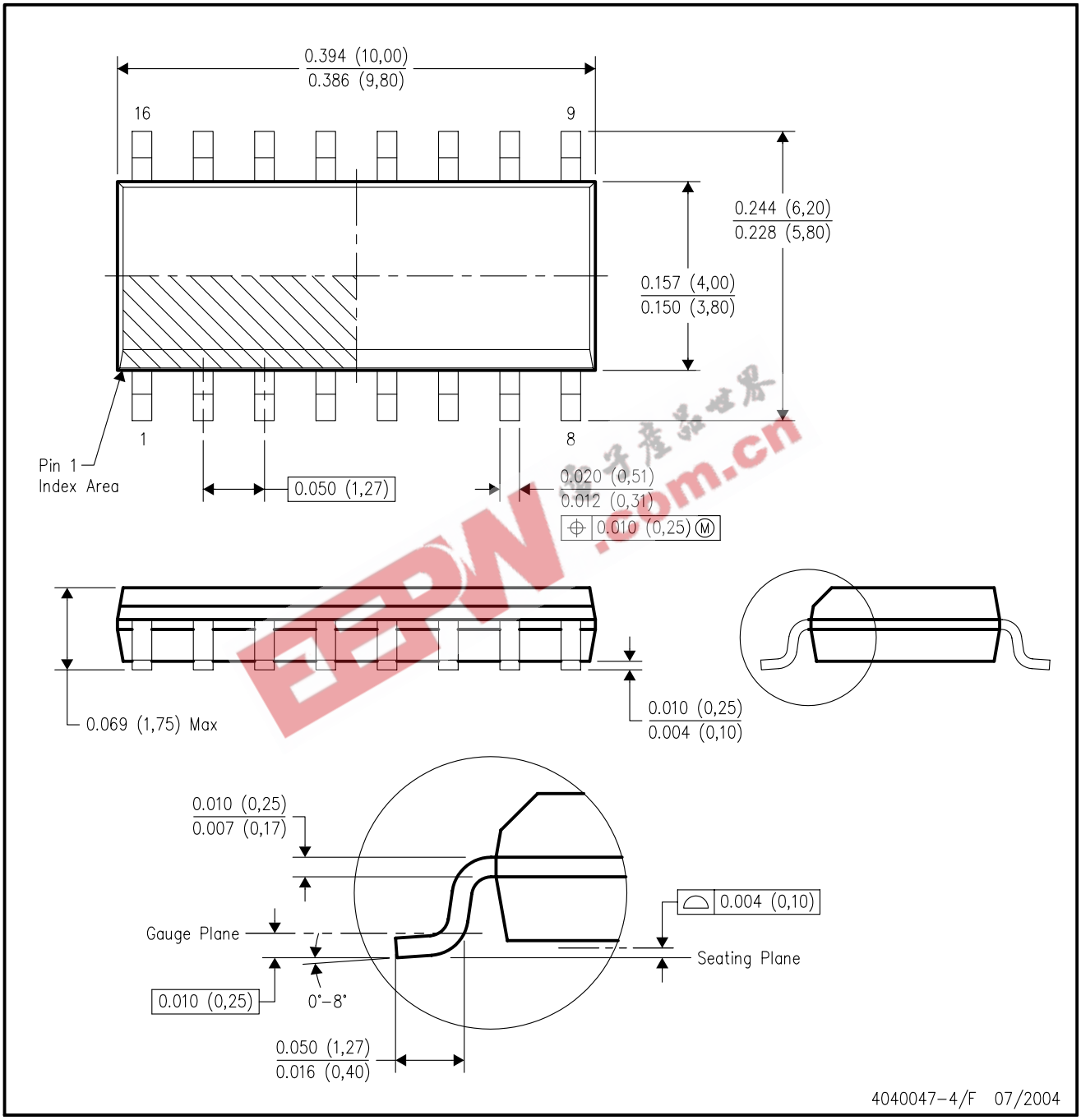


DIM \ PINS **	14	16	20	24	38	48	56
A MAX	3,70	3,70	5,10	5,10	7,90	9,80	11,40
A MIN	3,50	3,50	4,90	4,90	7,70	9,60	11,20

4073251/E 08/00

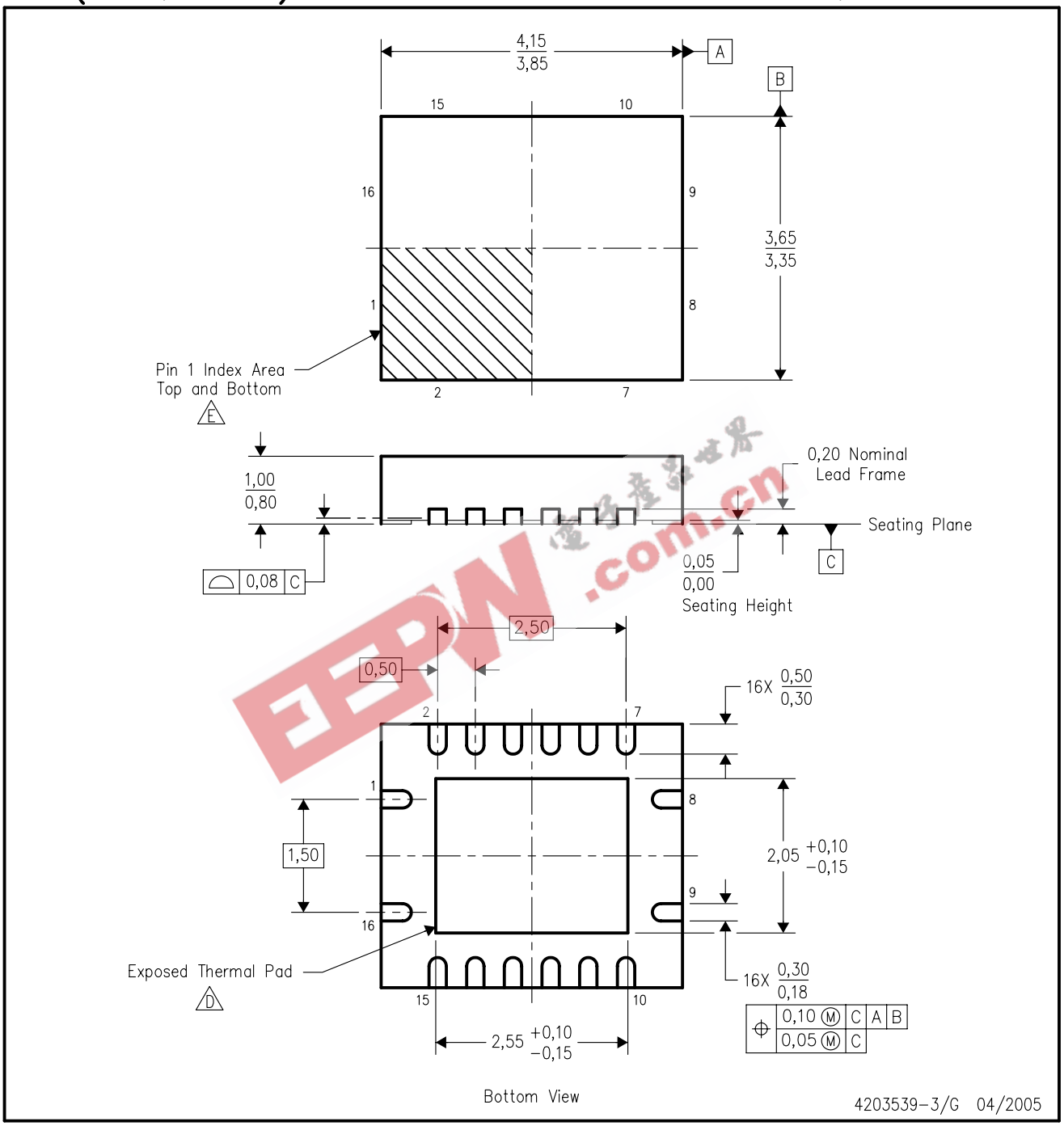
NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15 per side.
D. Falls within JEDEC: 24/48 Pins – MO-153
14/16/20/56 Pins – MO-194

D (R–PDSO–G16) PLASTIC SMALL–OUTLINE PACKAGE



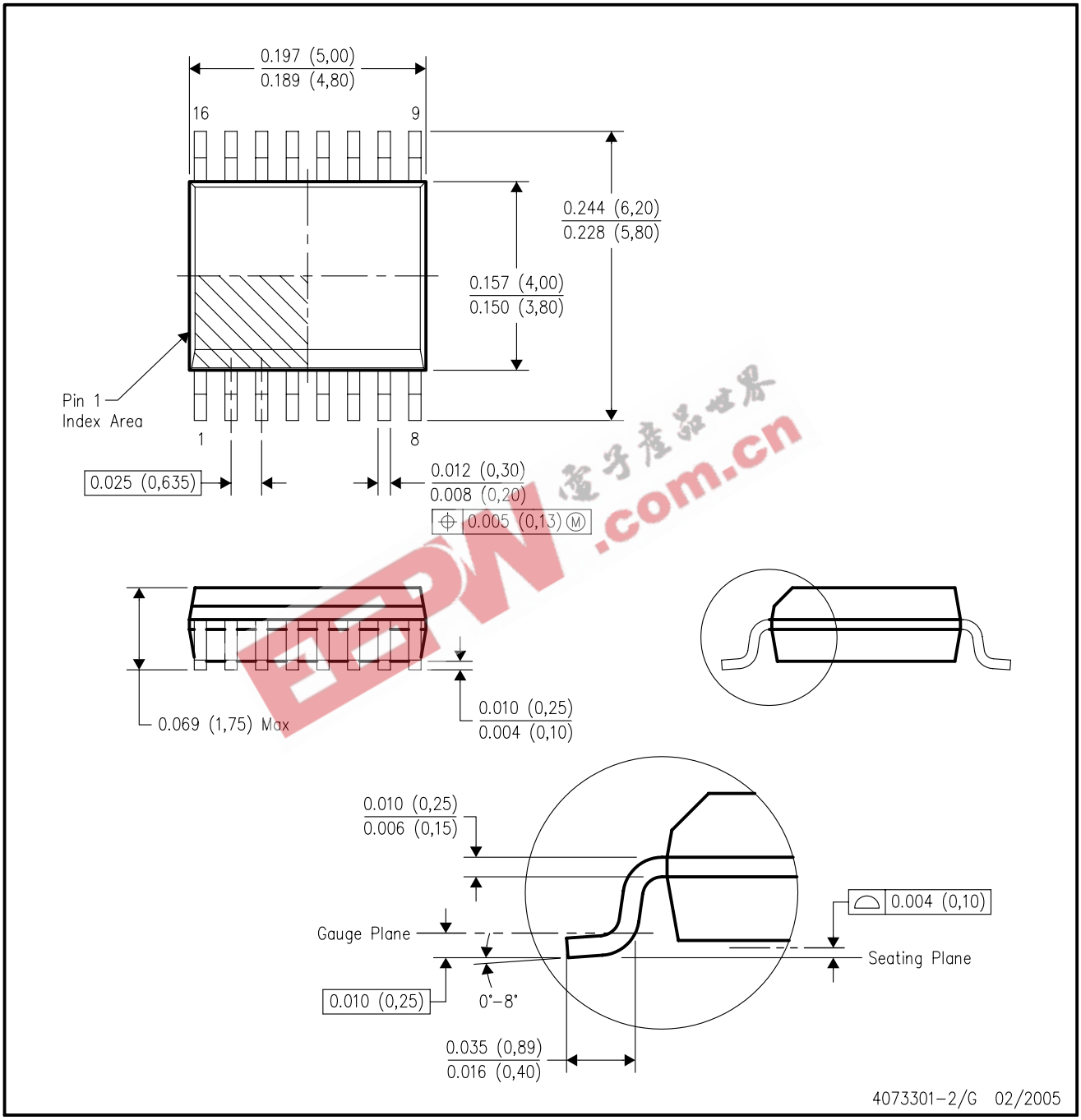
NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
D. Falls within JEDEC MS–012 variation AC.

RGY (R–PQFP–N16) PLASTIC QUAD FLATPACK



NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. QFN (Quad Flatpack No–Lead) package configuration.
D. The package thermal pad must be soldered to the board for thermal and mechanical performance.
E. Pin 1 identifiers are located on both top and bottom of the package and within the zone indicated. The Pin 1 identifiers are either a molded, marked, or metal feature.
F. Package complies to JEDEC MO–241 variation BB.

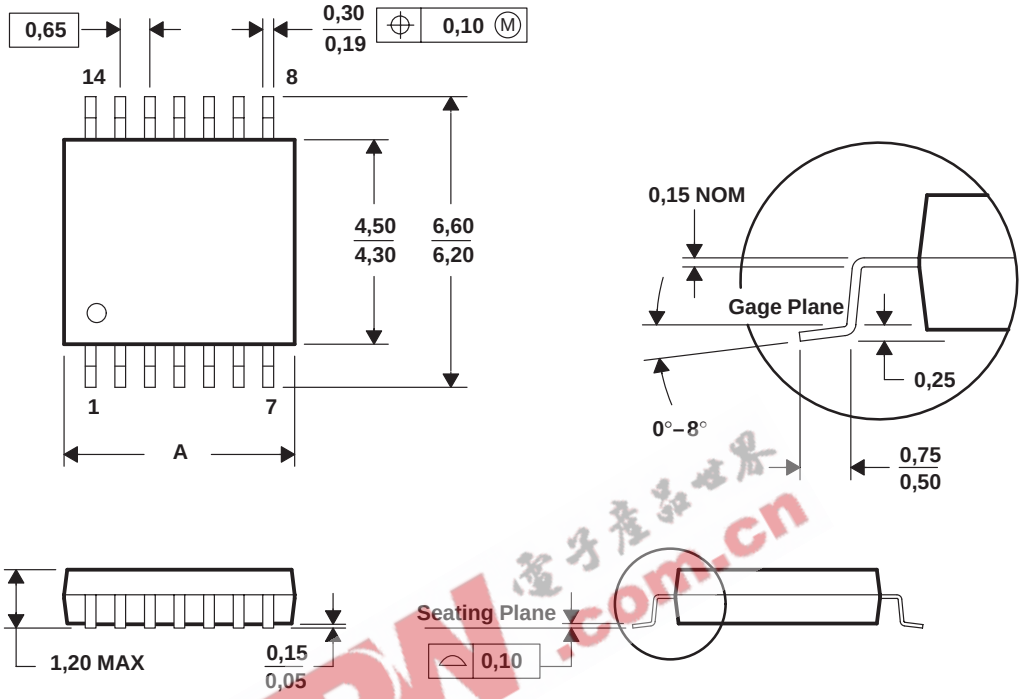
DBQ (R–PDSO–G16) PLASTIC SMALL–OUTLINE PACKAGE



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) per side.
D. Falls within JEDEC MO–137 variation AB.

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

4040064/F 01/97

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

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		**Applications**	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Interface	interface.ti.com	Digital Control	www.ti.com/digitalcontrol
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
		Telephony	www.ti.com/telephony
		Video & Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments
Post Office Box 655303 Dallas, Texas 75265