

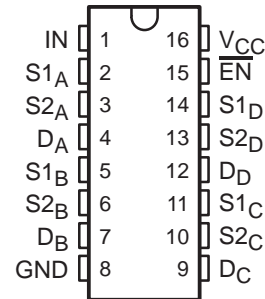
TS5V330

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

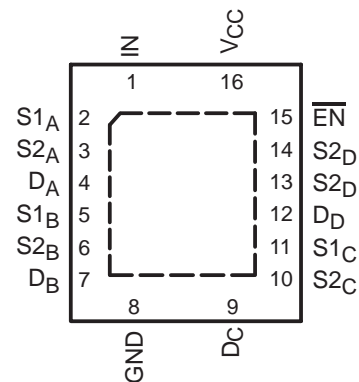
SCDS164A – MAY 2004 – REVISED MAY 2004

- Low Differential Gain and Phase ($D_G = 0.64\%$, $D_P = 0.1$ Degrees Typ)
- Wide Bandwidth (BW = 300 MHz Min)
- Low Crosstalk ($X_{TALK} = -63$ dB Typ)
- Low Power Consumption ($I_{CC} = 3 \mu\text{A}$ Max)
- Bidirectional Data Flow, With Near-Zero Propagation Delay
- Low ON-State Resistance ($r_{on} = 3 \Omega$ Typ)
- V_{CC} Operating Range From 4.5 V to 5.5 V
- I_{off} Supports Partial-Power-Down Mode Operation
- Data and Control Inputs Provide Undershoot Clamp Diode
- Control Inputs Can Be Driven by TTL or 5-V/3.3-V CMOS Outputs
- 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 RGB and Composite-Video Switching

D, DBQ, OR PW PACKAGE
(TOP VIEW)



RGY PACKAGE
(TOP VIEW)



description/ordering information

The TI TS5V330 video switch is a 4-bit 1-of-2 multiplexer/demultiplexer with a single switch-enable (\overline{EN}) input. When \overline{EN} is low, the switch is enabled and the D port is connected to the S port. When \overline{EN} is high, the switch is disabled and the high-impedance state exists between the D and S ports. The select (IN) input controls the data path of the multiplexer/demultiplexer.

ORDERING INFORMATION

T_A	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	QFN – RGY	Tape and reel	TS5V330RGYR	TE330
	SOIC – D	Tube	TS5V330D	TS5V330
		Tape and reel	TS5V330DR	
	SSOP (QSOP) – DBQ	Tape and reel	TS5V330DBQR	TE330
	TSSOP – PW	Tube	TS5V330PW	TE330
		Tape and reel	TS5V330PWR	

† 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.



POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

Copyright © 2004, Texas Instruments Incorporated

TS5V330

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

SCDS164A – MAY 2004 – REVISED MAY 2004

description/ordering information (continued)

Low differential gain and phase make this switch ideal for composite and RGB video applications. This device has wide bandwidth and low crosstalk, making it suitable for high-frequency applications as well.

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. This switch maintains isolation during power off.

To ensure the high-impedance state during power up or power down, \overline{EN} 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 D	FUNCTION
\overline{EN}	IN		
L	L	S1	D port = S1 port
L	H	S2	D port = S2 port
H	X	Z	Disconnect

PIN DESCRIPTIONS

PIN NAME	DESCRIPTION
S1, S2	Analog video I/Os
D	Analog video I/Os
IN	Select input
\overline{EN}	Switch-enable input

TS5V330

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

SCDS164A – MAY 2004 – REVISED MAY 2004

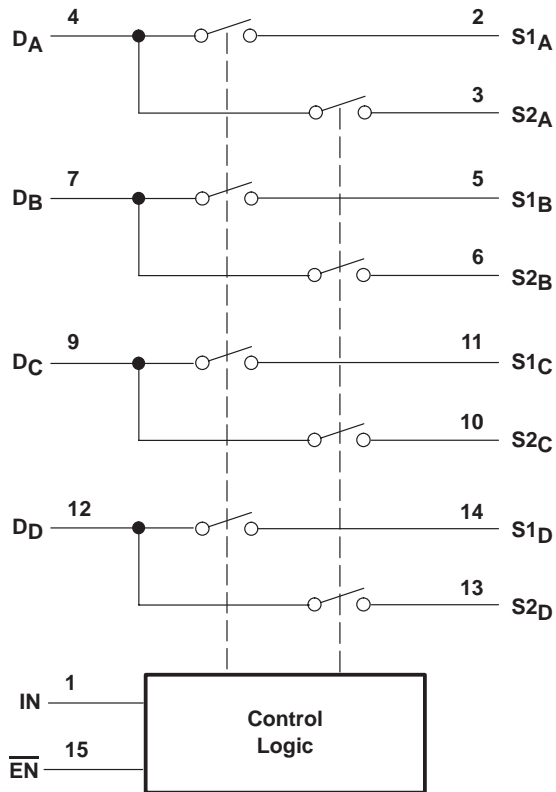
PARAMETER DEFINITIONS

PARAMETER	DESCRIPTION
r_{on}	Resistance between the D and S ports, with the switch in the ON state
I_{OZ}	Output leakage current measured at the D and S ports, with the switch in the OFF state
I_{OS}	Short-circuit current measured at the I/O pins
V_{IN}	Voltage at the IN pin
V_{EN}	Voltage at the \overline{EN} pin
C_{IN}	Capacitance at the control (\overline{EN} , IN) inputs
C_{OFF}	Capacitance at the analog I/O port when the switch is OFF
C_{ON}	Capacitance at the analog I/O port when the switch is ON
V_{IH}	Minimum input voltage for logic high for the control (\overline{EN} , IN) inputs
V_{IL}	Minimum input voltage for logic low for the control (\overline{EN} , IN) inputs
V_{hys}	Hysteresis voltage at the control (\overline{EN} , IN) inputs
V_{IK}	I/O and control (\overline{EN} , IN) inputs diode clamp voltage
V_I	Voltage applied to the D or S pins when D or S is the switch input
V_O	Voltage applied to the D or S pins when D or S is the switch output
I_{IH}	Input high leakage current of the control (\overline{EN} , IN) inputs
I_{IL}	Input low leakage current of the control (\overline{EN} , IN) inputs
I_I	Current into the D or S pins when D or S is the switch input
I_O	Current into the D or S pins when D or S is the switch output
I_{off}	Output leakage current measured at the D or S ports, with $V_{CC} = 0$
t_{ON}	Propagation delay measured between 50% of the digital input to 90% of the analog output when switch is turned ON
t_{OFF}	Propagation delay measured between 50% of the digital input to 90% of the analog output when switch is turned OFF
BW	Frequency response of the switch in the ON state measured at -3 dB
X_{TALK}	Unwanted signal coupled from channel to channel. Measured in $-dB$. $X_{TALK} = 20 \log V_O/V_I$. This is a nonadjacent crosstalk.
O_{IRR}	Off isolation is the resistance (measured in $-dB$) between the input and output with the switch OFF.
D_G	Magnitude variation between analog input and output pins when the switch is ON and the dc offset of composite-video signal varies at the analog input pin. In the NTSC standard, the frequency of the video signal is 3.58 MHz, and dc offset is from 0 to 0.714 V.
D_P	Phase variation between analog input and output pins when the switch is ON and the dc offset of composite-video signal varies at the analog input pin. In the NTSC standard, the frequency of the video signal is 3.58 MHz, and dc offset is from 0 to 0.714 V.
I_{CC}	Static power-supply current
I_{CCD}	Variation of I_{CC} for a change in frequency in the control (\overline{EN} , IN) inputs
ΔI_{CC}	This is the increase in supply current for each control input that is at the specified voltage level, rather than V_{CC} or GND.

TS5V330 QUAD SPDT WIDE-BANDWIDTH VIDEO SWITCH WITH LOW ON-STATE RESISTANCE

SCDS164A – MAY 2004 – REVISED MAY 2004

functional diagram (positive logic)



TS5V330

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

SCDS164A – MAY 2004 – REVISED MAY 2004

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	108°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	4	5.5	V
V_{IH}	High-level control input voltage (\overline{EN} , IN)	2	5.5	V
V_{IL}	Low-level control input voltage (\overline{EN} , IN)	0	0.8	V
V_{ANALOG}	Analog I/O voltage	0	2	V
T_A	Operating free-air temperature	–40	85	°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.

TS5V330

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

SCDS164A – MAY 2004 – REVISED MAY 2004

electrical characteristics over recommended operating free-air temperature range, $V_{CC} = 5\text{ V} \pm 10\%$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP†	MAX	UNIT
V_{IK}	\overline{EN} , IN	$V_{CC} = 4.5\text{ V}$,	$I_{IN} = -18\text{ mA}$				-1.8	V
V_{hys}	\overline{EN} , IN				150			mV
I_{IH}	\overline{EN} , IN	$V_{CC} = 5.5\text{ V}$,	V_{IN} and $V_{EN} = V_{CC}$				± 1	μA
I_{IL}	\overline{EN} , IN	$V_{CC} = 5.5\text{ V}$,	V_{IN} and $V_{EN} = \text{GND}$				± 1	μA
$I_{OZ}‡$		$V_{CC} = 5.5\text{ V}$,	$V_O = 0$ to 5.5 V , $V_I = 0$,	Switch OFF			± 1	μA
$I_{OS}§$		$V_{CC} = 5.5\text{ V}$,	$V_O = 0.5 V_{CC}$, $V_I = 0$,	Switch ON	50			mA
I_{off}		$V_{CC} = 0$,	$V_O = 0$ to 5.5 V ,	$V_I = 0$			1	μA
I_{CC}		$V_{CC} = 5.5\text{ V}$,	$I_{I/O} = 0$,	Switch ON or OFF			3	μA
ΔI_{CC}	\overline{EN} , IN	$V_{CC} = 5.5\text{ V}$,	One input at 3.4 V ,	Other inputs at V_{CC} or GND			2.5	mA
I_{CCD}		$V_{CC} = 5.5\text{ V}$, $V_{EN} = \text{GND}$,	D and S ports open,	V_{IN} input switching 50% duty cycle			0.25	mA/ MHz
C_{IN}	\overline{EN} , IN	V_{IN} or $V_{EN} = 0$,	$f = 1\text{ MHz}$				3.5	pF
C_{OFF}	D port	$V_I = 0$,	$f = 1\text{ MHz}$, Outputs open	Switch OFF			6	pF
	S port						4	
C_{ON}		$V_I = 0$,	$f = 1\text{ MHz}$, Outputs open	Switch ON			14	pF
$r_{on}¶$		$V_{CC} = 4.5\text{ V}$	$V_I = 1\text{ V}$,	$I_O = 13\text{ mA}$,	$R_L = 75\ \Omega$		3	Ω
			$V_I = 2\text{ V}$,	$I_O = 26\text{ mA}$,	$R_L = 75\ \Omega$		7	

V_I , V_O , I_I , and I_O refer to I/O pins.

† All typical values are at $V_{CC} = 5\text{ V}$ (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.

¶ Measured by the voltage drop between the D and S terminals at the indicated current through the switch. ON-state resistance is determined by the lower of the voltages of the two (D or S) terminals.

switching characteristics over recommended operating free-air temperature range, $V_{CC} = 5\text{ V} \pm 10\%$, $R_L = 75\ \Omega$, $C_L = 20\text{ pF}$ (unless otherwise noted) (see Figure 5)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	MIN	TYP	MAX	UNIT
t_{ON}	S	D		2.5	6	ns
t_{OFF}	S	D		1.1	6	ns

dynamic characteristics over recommended operating free-air temperature range, $V_{CC} = 5\text{ V} \pm 10\%$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS			MIN	TYP†	MAX	UNIT
$D_G\#$	$R_L = 150\ \Omega$,	$f = 3.58\text{ MHz}$, see Figure 6			0.64		%
$D_p\#$	$R_L = 150\ \Omega$,	$f = 3.58\text{ MHz}$, see Figure 6			0.1		Deg
BW	$R_L = 150\ \Omega$, see Figure 7			300			MHz
X_{TALK}	$R_L = 150\ \Omega$,	$f = 10\text{ MHz}$,	$R_{IN} = 10\ \Omega$, see Figure 8		-63		dB
O_{IRR}	$R_L = 150\ \Omega$,	$f = 10\text{ MHz}$, see Figure 9			-60		dB

† All typical values are at $V_{CC} = 5\text{ V}$ (unless otherwise noted), $T_A = 25^\circ\text{C}$.

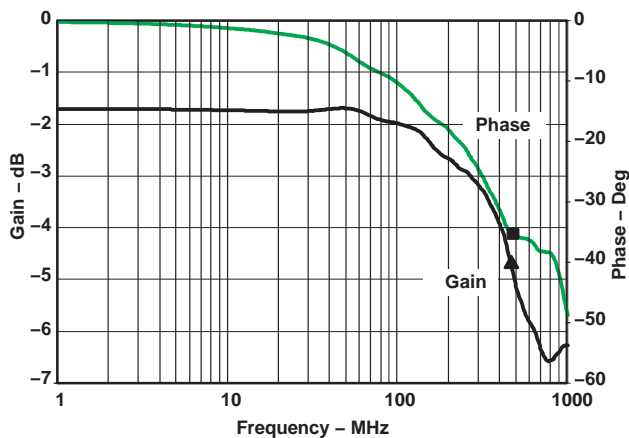
D_G and D_p are expressed in absolute magnitude.



TS5V330 QUAD SPDT WIDE-BANDWIDTH VIDEO SWITCH WITH LOW ON-STATE RESISTANCE

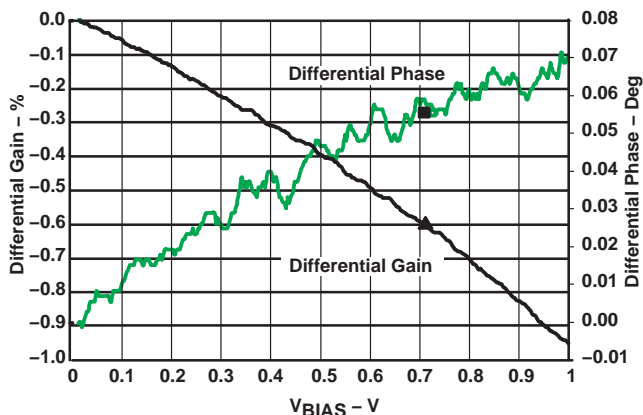
SCDS164A – MAY 2004 – REVISED MAY 2004

OPERATING CHARACTERISTICS



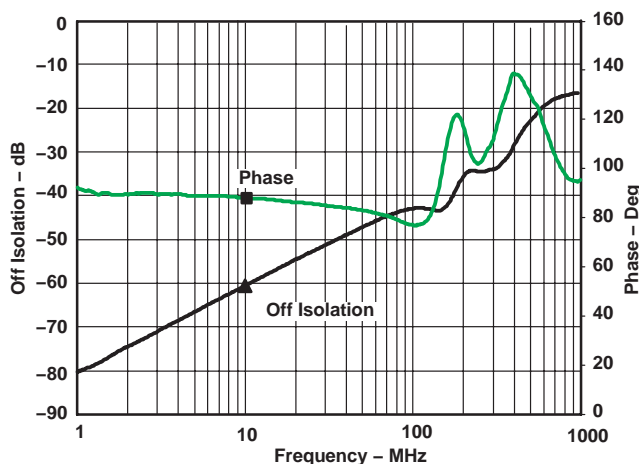
- Phase at -3-dB Frequency, 35 Degrees
- ▲ Gain -3 dB at 460 MHz

Figure 1. Gain/Phase vs Frequency



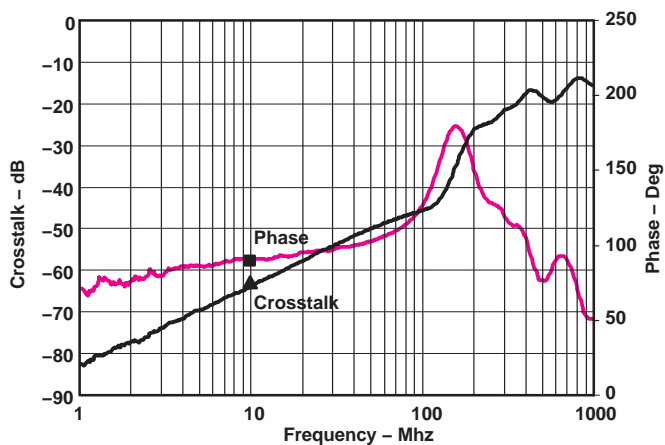
- Differential Phase at 0.714, 0.056 Degree
- ▲ Differential Gain at 0.714, -0.63%

Figure 2. Differential Gain/Phase vs VBIAS



- Phase at 10 MHz, 88.5 Degrees
- ▲ Off Isolation at 10 MHz, -60 dB

Figure 3. Off Isolation vs Frequency



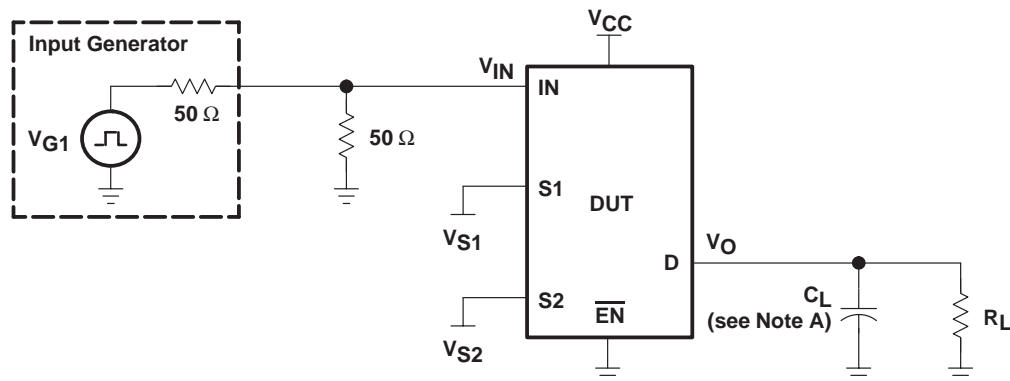
- Phase at 10 MHz, -90.4 Degrees
- ▲ Crosstalk at 10 MHz, -63.9 dB

Figure 4. Crosstalk vs Frequency

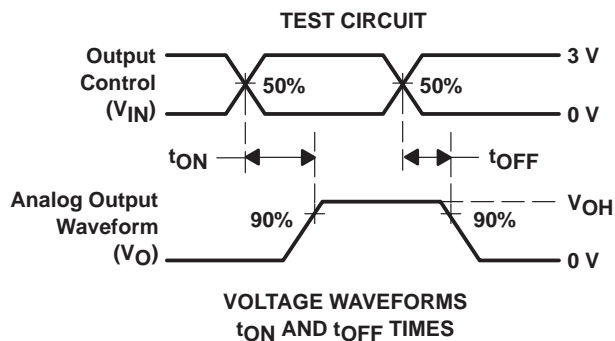
TS5V330
QUAD SPDT WIDE-BANDWIDTH VIDEO SWITCH
WITH LOW ON-STATE RESISTANCE

SCDS164A – MAY 2004 – REVISED MAY 2004

PARAMETER MEASUREMENT INFORMATION



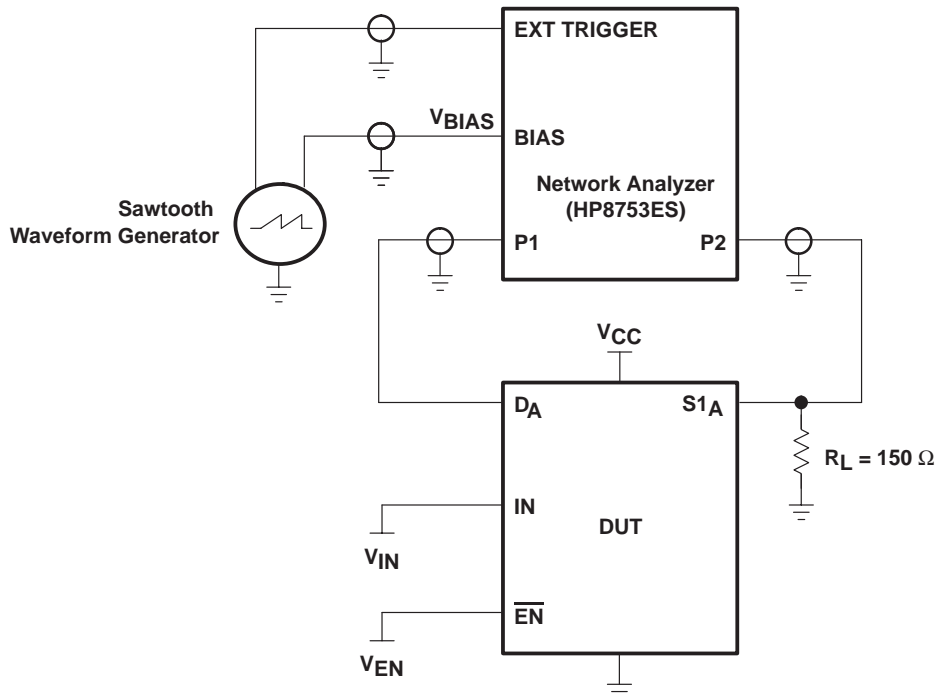
TEST	VCC	RL	CL	VS1	VS2
tON	5 V ± 0.5 V	75	20	GND	3 V
	5 V ± 0.5 V	75	20	3 V	GND
tOFF	5 V ± 0.5 V	75	20	GND	3 V
	5 V ± 0.5 V	75	20	3 V	GND



- NOTES: A. CL includes probe and jig capacitance.
 B. All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz, ZO = 50 Ω, tr ≤ 2.5 ns, tf ≤ 2.5 ns.
 C. The outputs are measured one at a time, with one transition per measurement.

Figure 5. Test Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION



NOTE A: For additional information on measurement method, refer to the TI application report, *Measuring Differential Gain and Phase*, literature number SLOA040.

Figure 6. Test Circuit for Differential Gain/Phase Measurement

Differential gain and phase are measured at the output of the ON channel. For example, when $V_{IN} = 0$, $V_{EN} = 0$, and D_A is the input, the output is measured at $S1_A$.

HP8753ES setup

Average = 20
 RBW = 300 Hz
 ST = 1.381 s
 P1 = -7 dBm
 CW frequency = 3.58 MHz

sawtooth waveform generator setup

$V_{BIAS} = 0$ to 1 V
 Frequency = 0.905 Hz

TS5V330 QUAD SPDT WIDE-BANDWIDTH VIDEO SWITCH WITH LOW ON-STATE RESISTANCE

SCDS164A – MAY 2004 – REVISED MAY 2004

PARAMETER MEASUREMENT INFORMATION

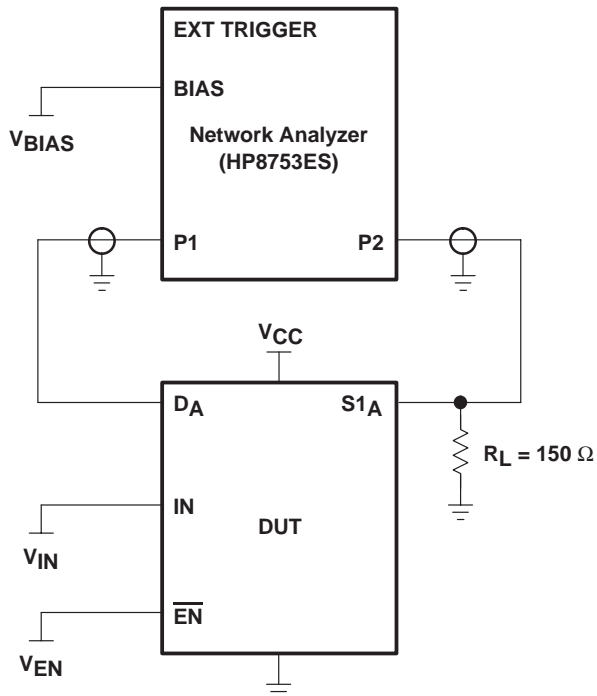


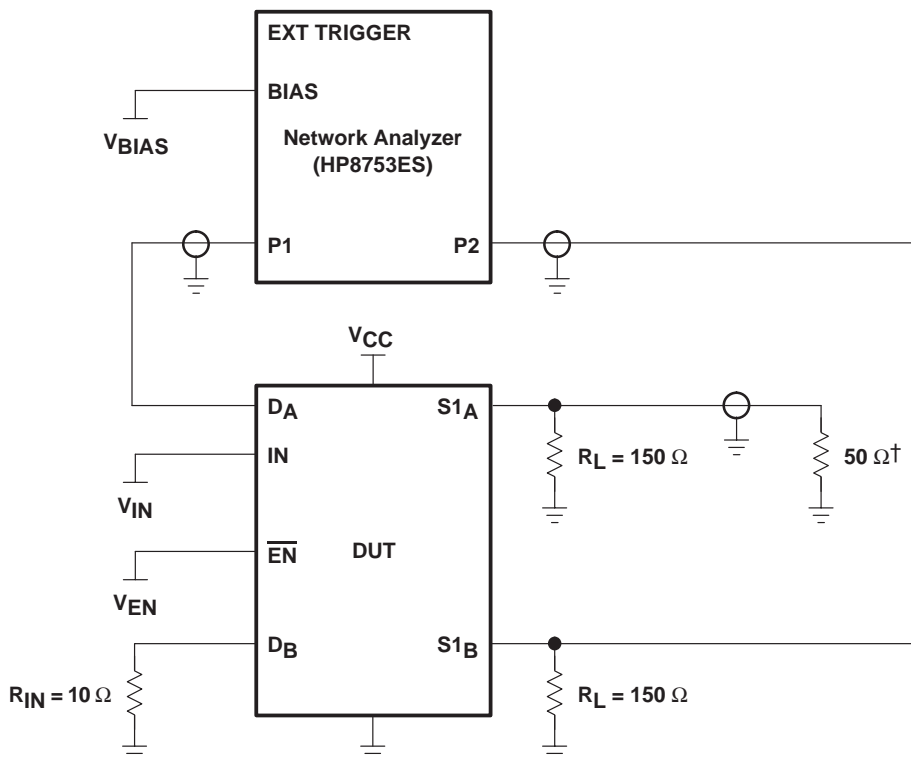
Figure 7. Test Circuit for Frequency Response (BW)

Frequency response is measured at the output of the ON channel. For example, when $V_{IN} = 0$, $V_{EN} = 0$, and D_A is the input, the output is measured at $S1_A$. 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



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

Figure 8. Test Circuit for Crosstalk (X_{TALK})

Crosstalk is measured at the output of the nonadjacent ON channel. For example, when $V_{IN} = 0$, $V_{EN} = 0$, and D_A is the input, the output is measured at $S1_B$. All unused analog input (D) ports and output (S) ports are connected to GND through 10-Ω and 50-Ω pulldown resistors, respectively.

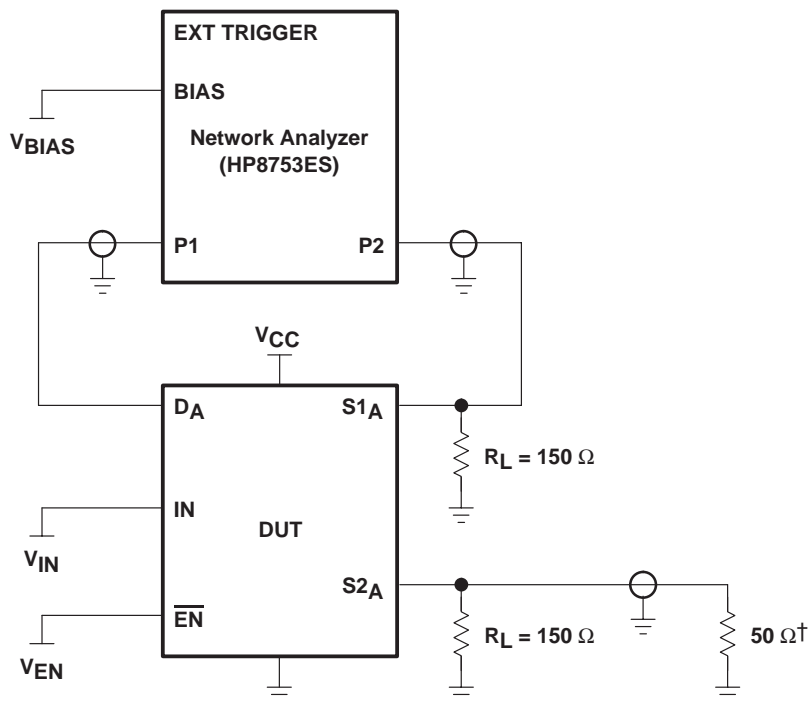
HP8753ES setup

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

TS5V330 QUAD SPDT WIDE-BANDWIDTH VIDEO SWITCH WITH LOW ON-STATE RESISTANCE

SCDS164A – MAY 2004 – REVISED MAY 2004

PARAMETER MEASUREMENT INFORMATION



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

Figure 9. Test Circuit for Off Isolation (O_{IRR})

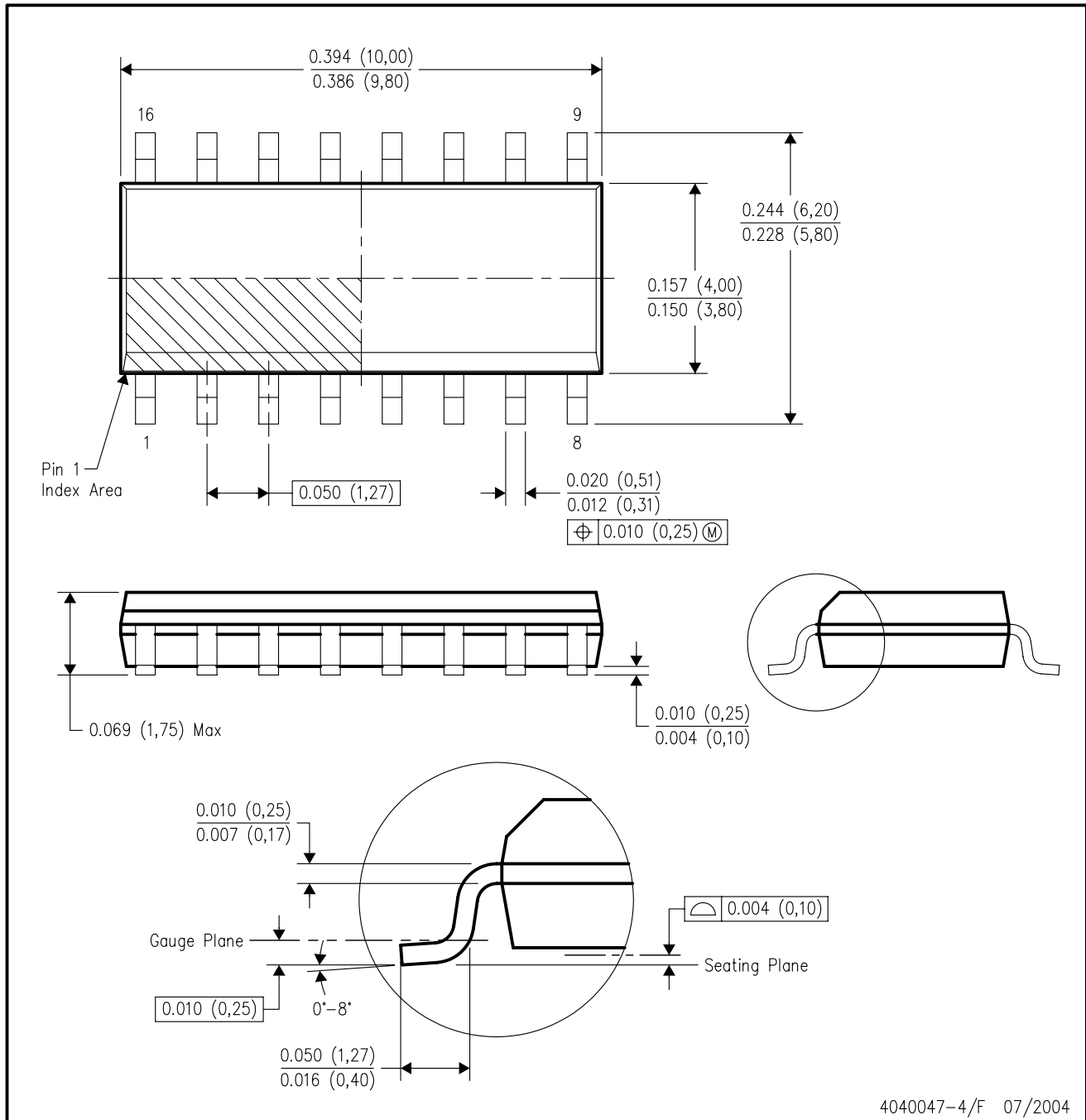
Off-isolation is measured at the output of the OFF channel. For example, when $V_{IN} = V_{CC}$, $V_{EN} = 0$, and D_A is the input, the output is measured at $S1_A$. All unused analog input (D) ports are left open, and output (S) ports are connected to GND through 50- Ω pulldown resistors.

HP8753ES setup

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

D (R-PDSO-G16)

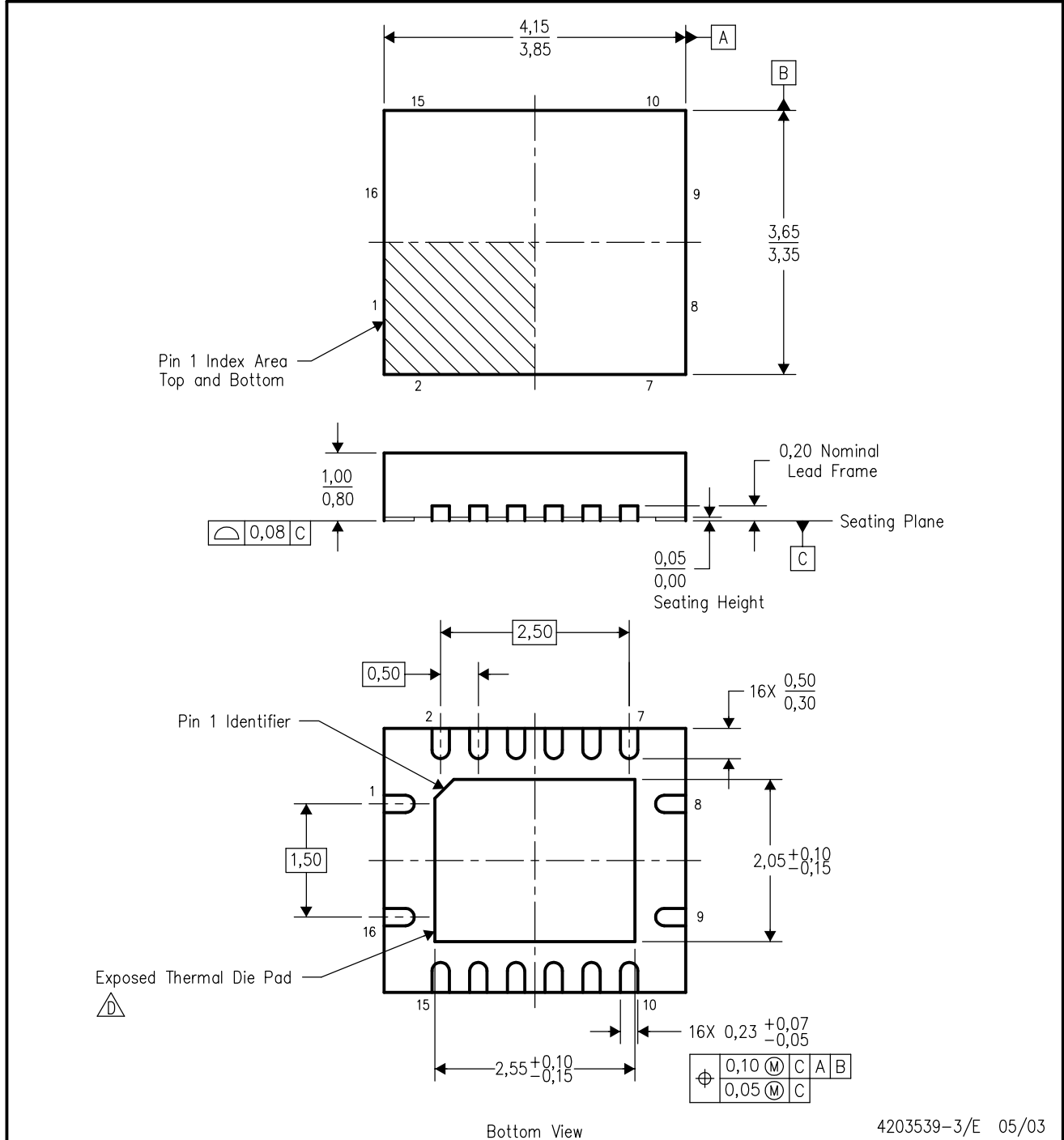
PLASTIC SMALL-OUTLINE PACKAGE




- 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

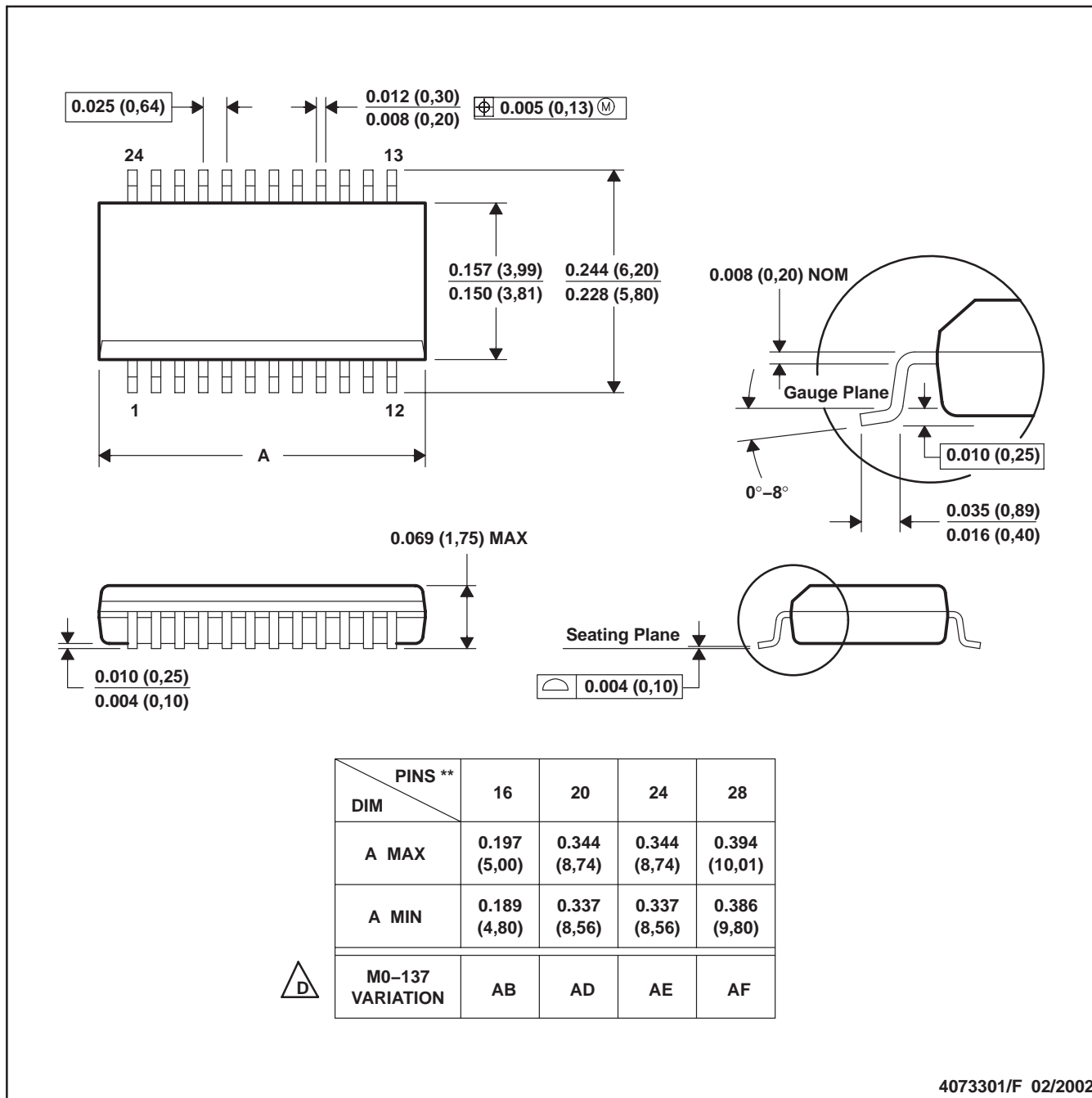


4203539-3/E 05/03

- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. QFN (Quad Flatpack No-Lead) package configuration.
 -  The package thermal performance may be enhanced by bonding the thermal die pad to an external thermal plane. This pad is electrically and thermally connected to the backside of the die and possibly selected ground leads.
 - E. Package complies to JEDEC MO-241 variation BB.

DBQ (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE



4073301/F 02/2002

- 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 MO-137.

PW (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



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

Copyright © 2004, Texas Instruments Incorporated