

2-Gbps DIFFERENTIAL SWITCH 8-Bit, 1:2 MULTIPLEXER/DEMULTIPLEXER WITH 3-SIDE BAND SIGNALS

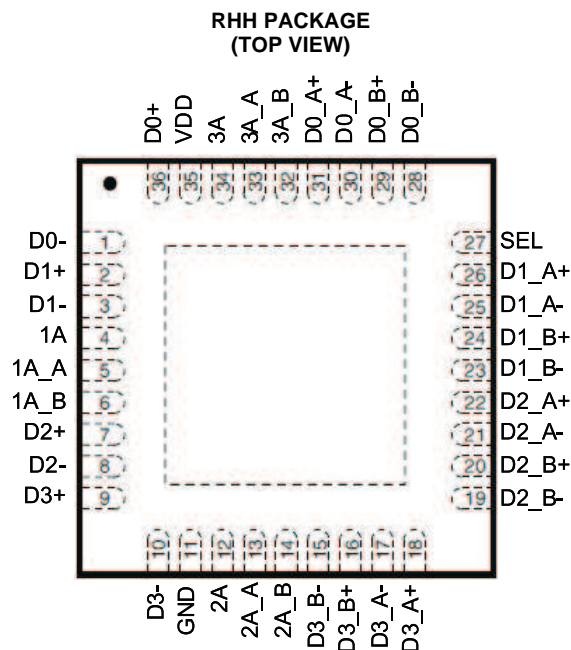
Check for Samples: [TS3DV20812](#)

FEATURES

- Four High-Speed Bidirectional Differential Pair Channel MUX/DEMUX
- Supports up to 2 Gbps Data Rate
- V_{DD} Operating Range 2.5 V or 3.3
 - -0 V to 3.3 V Rail To Rail at 2.5 V
 - -0 V to 5 V Rail To Rail at 3.3V
- I_{OFF} partial Powerdown and Back-Drive Protection.
- 5-V Input Tolerant on Control Pin
- Supports Both AC- and DC-Coupled Signals
- Low Crosstalk: -38 dB at 825 MHz, 2.5 V or 3.3 V
- Insertion Loss: -1.5 dB at 825 MHz, 2.5 V or 3.3 V
- Off Isolation -24.67 dB at 825 MHz
- Low Bit-to-Bit Skew within Pair 5 ps Maximum
- Channel-to-Channel Skew: 30 ps Maximum
- Propagation Delay Times: 250 ps Maximum
- ESD Performance Tested per JESD 22
 - 2000-V Human Body Model (A114-B, Class II)
 - 1000-V Charged-Device Model (C101)

APPLICATIONS

- HDMI/DVI Video MUX
- Panel LVDS Bus MUX
- LVDS, LVPECL, CML
- Analog Signals VGA
- Gigabit LAN Signal MUX
- Serial Backplane Signal MUX
- Optical Module
- Central Office Telecommunication
- Wireless Base Station
- High-Speed Logic Data I/O MUX



DESCRIPTION/ORDERING INFORMATION

TS3DV20812 is a High Speed Data Rate up to 2Gbps for Differential Signal Passive bi-directional Multiplexer and De-multiplexer for I/O rails up to 5V Level with Low Crosstalk and Insertion Loss.

TS3DV20812 can be used in either HDMI/DVI sink side or source side with 4-differential pair supporting the high speed and control pins.

The Ioff and back drive protection allowing to connect the external cable and prevent the back flow current when the Vcc is into 0V.

The 3 side band signals can be used in DDC (SDAL, SCL) and CEC Signal MUX.

TS3DS20812 is characterized for operation from -40C to 85C.



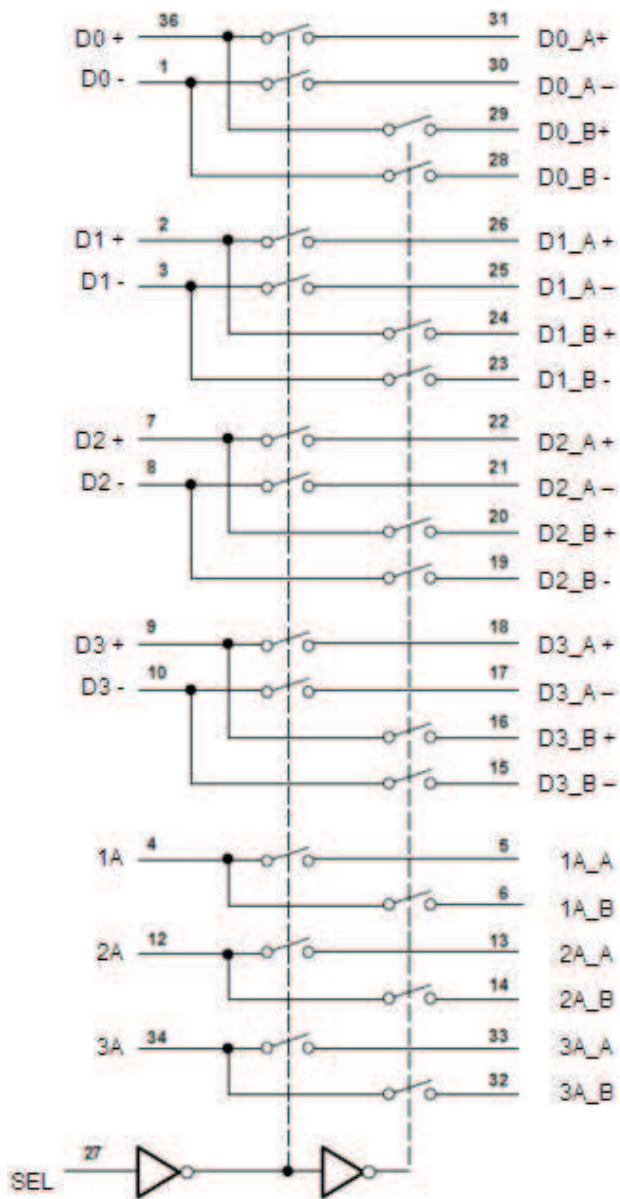
Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

Table 1. ORDERING INFORMATION

T _A	PACKAGE ⁽¹⁾ (2)		ORDERABLE PART NUMBER	TOP-SIDE MARKING
-40°C to 85°C	QFN – RHH	Tape and reel	TS3DV20812RHH	TBD

- (1) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.
- (2) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at www.ti.com.

LOGIC DIAGRAM



FUNCTION TABLE

INPUT SEL	DIFFERENTIAL SIGNAL I/Os	FUNCTIONS	
		A-PORT	B-PORT
L	Dn (±), nA (AUX (±), HPD, CAD/CEC)	DnA (±), nA_A	High-impedance mode
H		High-impedance mode	DnB (±), nA_B

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⁾	SEL	-0.5	7	V
		I/O	-0.5	7	V
V _{IO}	Switch I/O voltage range (all three I/O ports) ⁽⁴⁾	D0-D3, Aux, HPD, CAD/CEC	-0.5	V _{CC} + 0.5	V
		A port and B port	-0.5	V _{CC} + 0.5	V
I _{IK}	Control input clamp current	V _{IN} < 0		-50	mA
I _{I/O} K	I/O port clamp current	V _O < 0		-50	mA
I _{IO}	Continuous output current ⁽⁵⁾	ON-state switch		±128	mA
			Continuous current through VDD or GND		±100
Θ _{JA}	Package thermal impedance ⁽⁶⁾	RHH package		31.8	°C/W
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_{IO}.
- (5) I_I and I_O are used to denote specific conditions for I_{IO}.
- (6) The package thermal impedance is calculated in accordance with JESD 51-7.

RECOMMENDED OPERATING CONDITIONS

			MIN	MAX	UNIT
V _{DD}	Supply voltage		2.25	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	All ports	0	5.5	V
V _{ANALOG}	Analog signal range	Differential signal range	0	V _{DD}	V
V _I	Input tolerant	SEL	0	5.5	V
T _A	Operating free-air temperature		-40	85	°C

ELECTRICAL CHARACTERISTICS

for high-frequency switching over recommended operating free-air temperature range $V_{DD} = 3.3 \text{ V} \pm 0.3 \text{ V}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS ⁽¹⁾		MIN	TYP ⁽²⁾	MAX	UNIT
V_{IK}	SEL	$V_{DD} = 3.6 \text{ V}$,	$I_{IN} = -18 \text{ mA}$		-0.7	-1.2	V
I_{IH}	SEL	$V_{DD} = 3.6 \text{ V}$,	$V_{IN} = V_{DD}$			± 1	μA
I_{IL}	SEL	$V_{DD} = 3.6 \text{ V}$,	$V_{IN} = \text{GND}$			± 1	μA
I_{OFF}		$V_{DD} = 06 \text{ V}$,	$V_O = 0 \text{ to } 3.6 \text{ V}$, $V_I = 0$, $V_{IN} = 0$			1	μA
I_{CC}		$V_{DD} = 3.6 \text{ V}$,	$I_{IO} = 0$		250	500	μA
C_{IN}	SEL	$f = 10 \text{ MHz}$,	$V_{IN} = 0$		2	2.5	pF
C_{OFF}	3-Port	$f = 10 \text{ MHz}$,	$V_{IN} = 0$, Output is Open, Switch is OFF		2.5	4	pF
C_{ON}	3-Port	$f = 10 \text{ MHz}$,	$V_{IN} = 0$, Output is Open, Switch is ON		8		pF
r_{ON}		$V_{DD} = 3.6 \text{ V}$	$1.5 \text{ V} \leq V_I \leq V_{DD}$, $I_O = -40 \text{ mA}$		4	6	Ω
$r_{ON(\text{flat})}$ ⁽³⁾		$V_{DD} = 3.6 \text{ V}$	$1.5 \text{ V} \leq V_I \leq V_{DD}$, $I_O = -40 \text{ mA}$		0.5		Ω
Δr_{ON} ⁽⁴⁾		$V_{DD} = 3.6 \text{ V}$	$1.5 \text{ V} \leq V_I \leq V_{DD}$, $I_O = -40 \text{ mA}$		0.4	1	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 $V_{DD} = 3.3 \text{ V}$ (unless otherwise noted), $T_A = 25^\circ$.
(3) $r_{ON(\text{flat})}$ is the difference of r_{ON} in a given channel at specified voltages.
(4) Δr_{ON} is the difference of r_{ON} from center (D0 to Dn) ports to any other port.

ELECTRICAL CHARACTERISTICS

for high-frequency switching over recommended operating free-air temperature range $V_{DD} = 2.5 \text{ V} \pm 0.25 \text{ V}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS ⁽¹⁾		MIN	TYP ⁽²⁾	MAX	UNIT
V_{IK}	SEL	$V_{DD} = 2.5 \text{ V}$,	$I_{IN} = -18 \text{ mA}$		-0.7	-1.2	V
I_{IH}	SEL	$V_{DD} = 2.5 \text{ V}$,	$V_{IN} = V_{DD}$			± 1	μA
I_{IL}	SEL	$V_{DD} = 2.5 \text{ V}$,	$V_{IN} = \text{GND}$			± 1	μA
I_{OFF}		$V_{DD} = 06 \text{ V}$,	$V_O = 0 \text{ to } 2.5 \text{ V}$, $V_I = 0$, $V_{IN} = 0$			1	μA
I_{CC}		$V_{DD} = 2.5 \text{ V}$,	$I_{IO} = 0$		250	500	μA
C_{IN}	SEL	$f = 10 \text{ MHz}$,	$V_{IN} = 0$		2	2.5	pF
C_{OFF}	3-Port	$f = 10 \text{ MHz}$,	$V_{IN} = 0$, Output is Open, Switch is OFF		2.5	4	pF
C_{ON}	3-Port	$f = 10 \text{ MHz}$,	$V_{IN} = 0$, Output is Open, Switch is ON		8		pF
r_{ON}		$V_{DD} = 2.5 \text{ V}$	$1.5 \text{ V} \leq V_I \leq V_{DD}$, $I_O = -40 \text{ mA}$		4	6	Ω
$r_{ON(\text{flat})}$ ⁽³⁾		$V_{DD} = 2.5 \text{ V}$	$V_I = 1.5 \text{ V}$ and V_{DD} , $I_O = -40 \text{ mA}$		0.5		Ω
Δr_{ON} ⁽⁴⁾		$V_{DD} = 2.5 \text{ V}$	$1.5 \text{ V} \leq V_I \leq V_{DD}$, $I_O = -40 \text{ mA}$		0.4	1	Ω

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SWITCHING CHARACTERISTICS

over recommended operating free-air temperature range, $V_{DD} = 3.3\text{ V} \pm 0.3\text{ V}$, $R_L = 200\ \Omega$, $C_L = 10\text{ pF}$ (unless otherwise noted) (see [Figure 9](#) and [Figure 10](#))

PARAMETER	FROM (INPUT)	TO (OUTPUT)	MIN	TYP ⁽¹⁾	MAX	UNIT
$t_{pd}^{(2)}$	Dn	D _A or D _B		149		ps
t_{pZH} , t_{pZL}	SEL	D _A or D _B	0.5		15	ns
t_{pHZ} , t_{pLZ}	SEL	D _A or D _B	0.9		12	ns
SEL to switch turn on time		D _A or D _B		9	14	ns
SEL to switch turn off time		D _A or D _B		5	11	ns
$t_{sk(o)}^{(3)}$	Dn (+)(-), DA(+)(-), DB(+)(-)			22	28	ps
$t_{sk(o)}$	Dn (all), DnA(all), DnB(All)			19	25	ps
$t_{sk(p)}^{(4)}$				22	31	ps

(1) All typical values are at $V_{DD} = 2.5\text{ V}$ (unless otherwise noted), $T_A = 25^\circ$.

(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 to any other port.

(4) Skew between opposite transitions of the same output in a given device $|t_{pHL} - t_{pLH}|$

SWITCHING CHARACTERISTICS

over recommended operating free-air temperature range, $V_{DD} = 2.5\text{ V} \pm 0.25\text{ V}$, $R_L = 200\ \Omega$, $C_L = 10\text{ pF}$ (unless otherwise noted) (see [Figure 9](#) and [Figure 10](#))

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t_{pZH} , t_{pZL}	SEL	D _A or D _B	0.5		14	ns
t_{pHZ} , t_{pLZ}	SEL	D _A or D _B	0.9		15	ns
SEL to switch turn on time		D _A or D _B		9	17	ns
SEL to switch turn off time	D _A or D _B	D _A or D _B		5	18	ns
$t_{sk(o)}^{(3)}$	Dn (+)(-), DA(+)(-), DB(+)(-)			22	31	ps
$t_{sk(o)}$	Dn (all), DnA(all), DnB(All)			19	23	ps
$t_{sk(p)}^{(4)}$				22	33	ps

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(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, $V_{DD} = 3.3\text{ V} \pm 0.3\text{ V}$, $R_L = 50\ \Omega$, $C_L = 10\text{ pF}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	TYP	UNIT
X_{TALK}	Differential crosstalk	825 MHz, 1.65Gbps, $R_L = 50\ \Omega$, $C_L = 10\text{ pF}$, see Figure 11	-34.67	dB
O_{IRR}	Differential OFF isolation	825 MHz, 1.65Gbps, $R_L = 50\ \Omega$, $C_L = 10\text{ pF}$, see Figure 12	-19.09	dB
I_{LOSS}	Differential insertion loss	825 MHz, 1.65Gbps, $R_L = 50\ \Omega$, $C_L = 10\text{ pF}$, see Figure 13	-2.84	dB
I_{RETURN}	Differential return loss	825 MHz, 1.65Gbps, $R_L = 50\ \Omega$, $C_L = 10\text{ pF}$, see Figure 13	-9.43	dB
DR	Data rate		2.20	Gbps
BW	Differential bandwidth		1.10	Ghz

DYNAMIC CHARACTERISTICS

over recommended operating free-air temperature range, $V_{DD} = 2.5\text{ V} \pm 0.25\text{ V}$, $R_L = 50\ \Omega$, $C_L = 10\text{ pF}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	TYP	UNIT
X_{TALK}	Differential crosstalk	825 MHz, 1.65Gbps, $R_L = 50\ \Omega$, $C_L = 10\text{ pF}$, see Figure 7	-34.94	dB
O_{IRR}	Differential OFF isolation	825 MHz, 1.65Gbps, $R_L = 50\ \Omega$, $C_L = 10\text{ pF}$, see Figure 8	-18.39	dB
I_{LOSS}	Differential insertion loss	825 MHz, 1.65Gbps, $R_L = 50\ \Omega$, $C_L = 10\text{ pF}$, see Figure 9	-3.07	dB
I_{RETURN}	Differential return loss	825 MHz, 1.65Gbps, $R_L = 50\ \Omega$, $C_L = 10\text{ pF}$, see Figure 9	-9.56	dB
DR	Data rate		2.20	Gbps
BW	Differential bandwidth		1.10	Ghz

TYPICAL PERFORMANCE

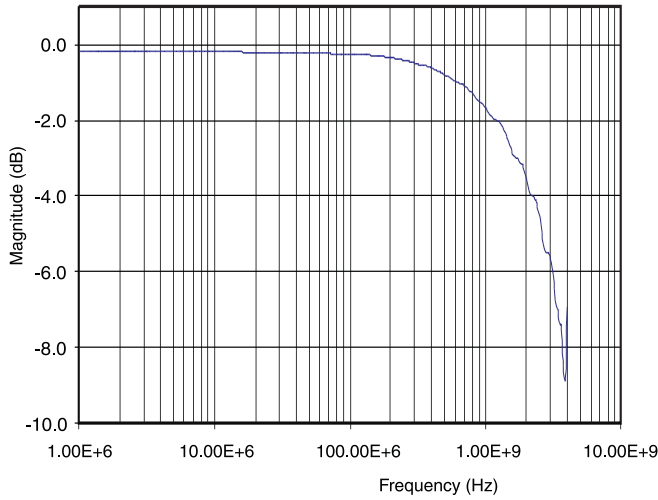


Figure 1. Differential Gain vs Frequency

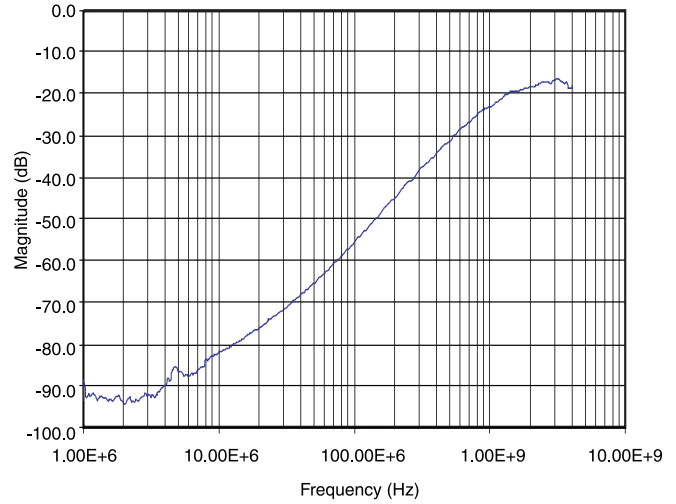


Figure 2. Differential Off Isolation vs Frequency

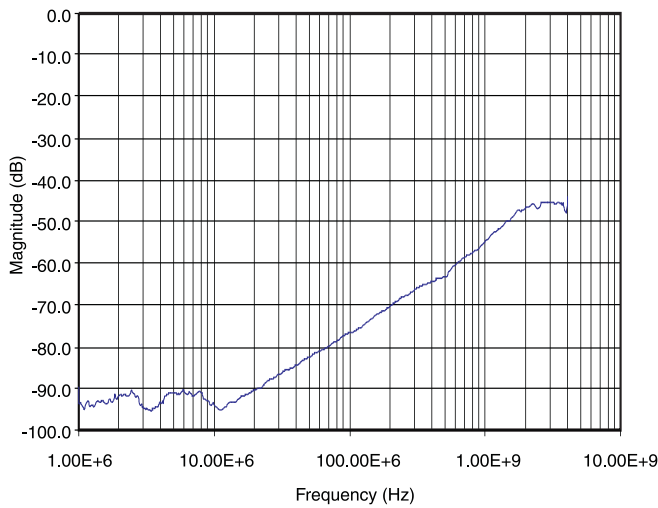


Figure 3. Differential Crosstalk vs Frequency

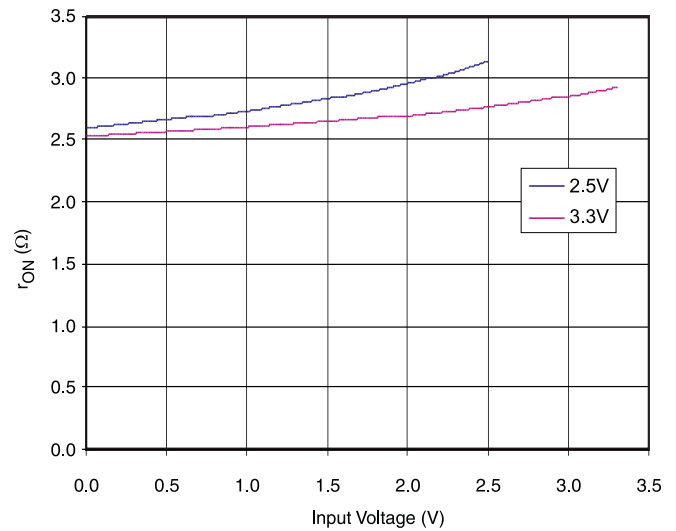


Figure 4. r_{ON} vs V_{COM} (Differential Switch)

APPLICATION INFORMATION

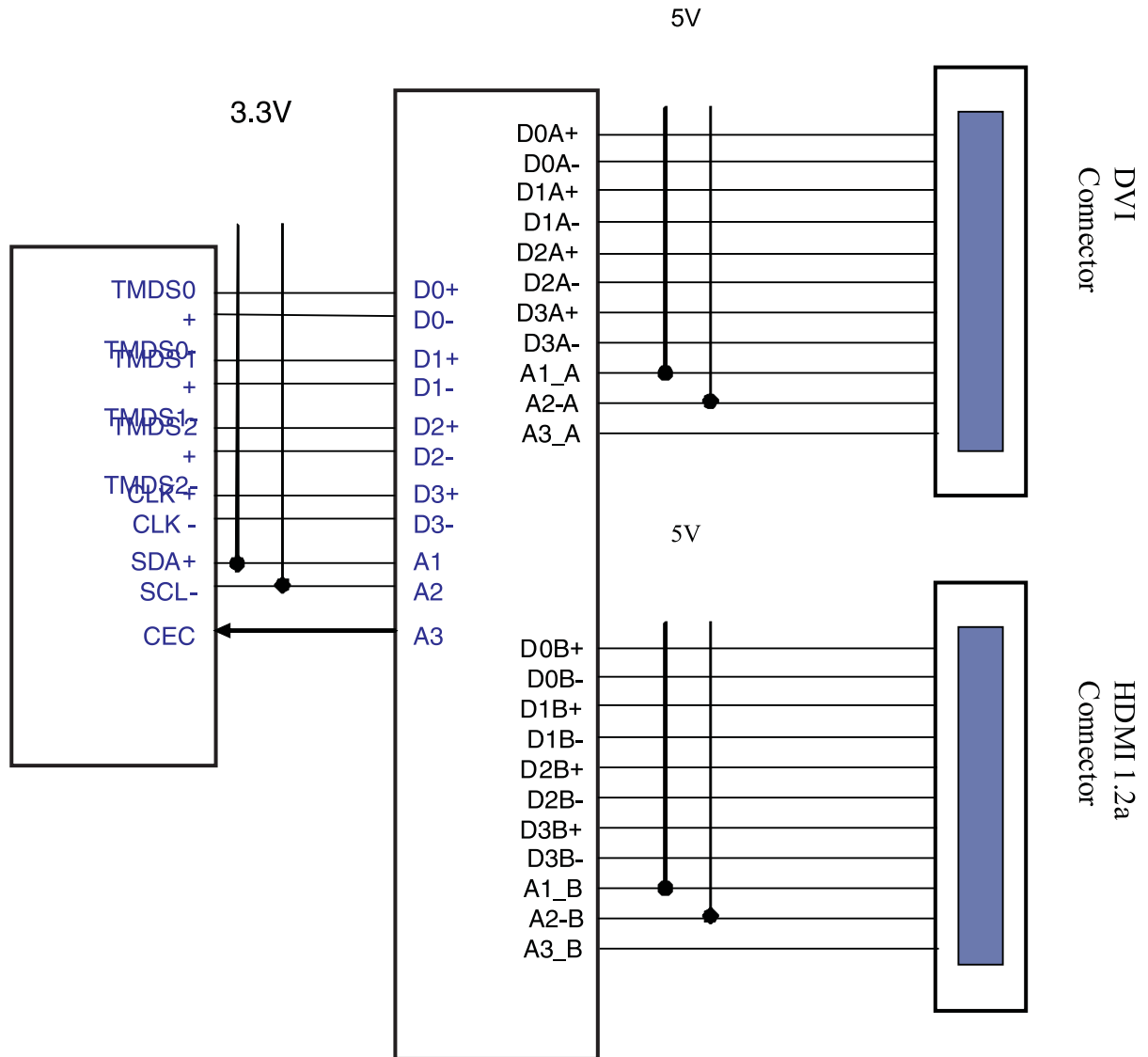


Figure 5. Typical Application Switching HDMI 1.2a and DVI

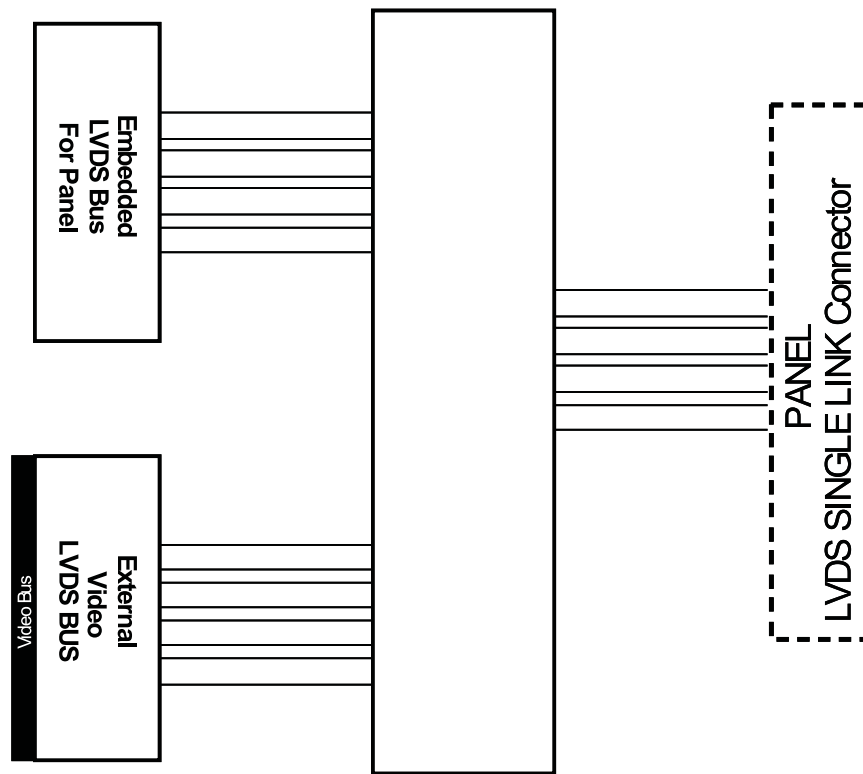
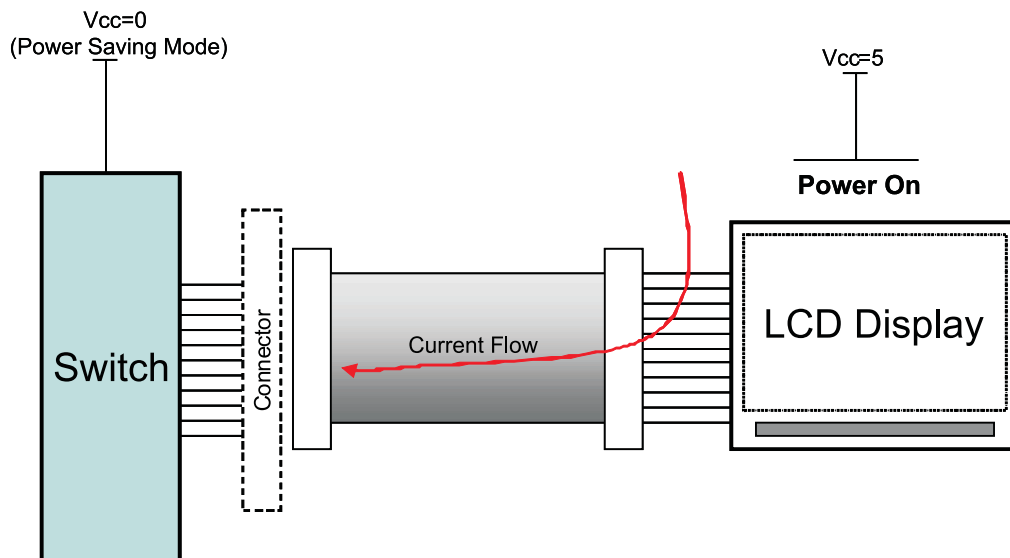


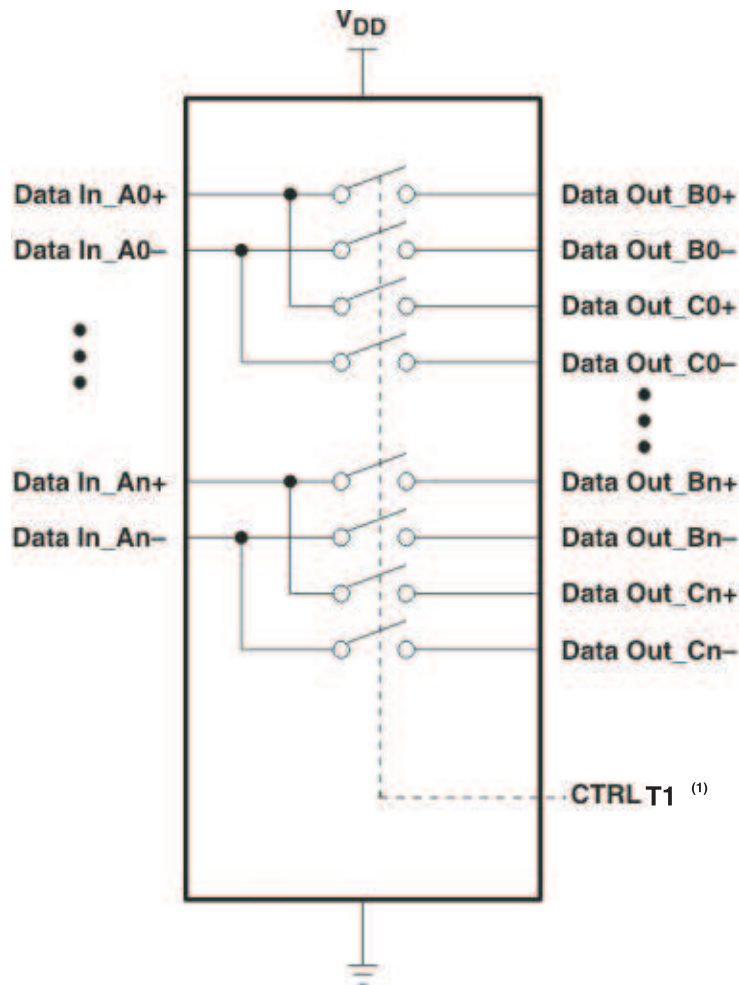
Figure 6. Typical Application for Dual LVDS



- A. The switch already has I_{OFF} circuit and it will reduce the current flow leakage limit to 10 μA maximum and it will prevent the damage from back drive current flow from the power-on circuit.

Figure 7. I_{OFF} (Back Drive Protection)

PARAMETER MEASUREMENT INFORMATION

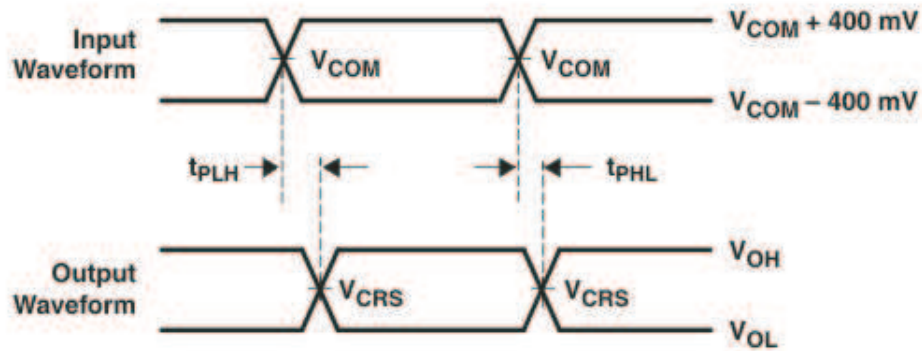
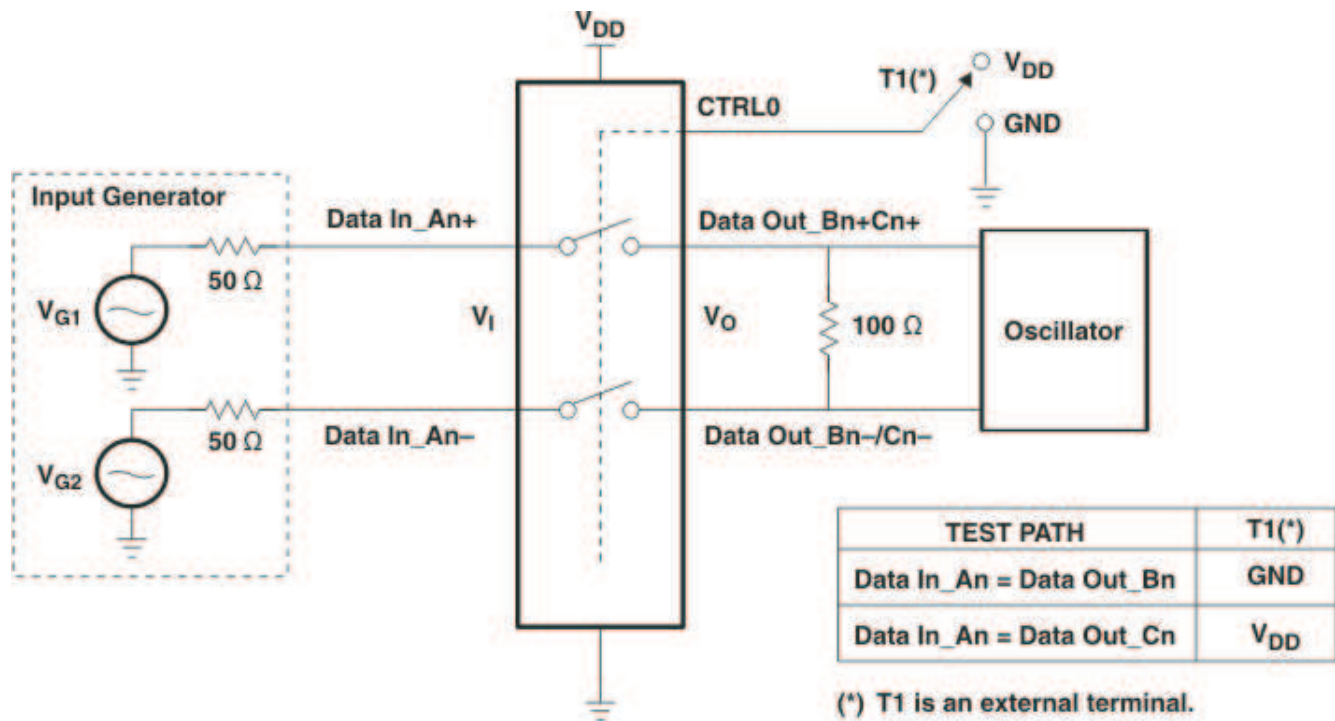


TEST PATH	T1 ⁽¹⁾
Data In_An=Data Out_Bn	GND
Data In_An=Data Out_Cn	V _{DD}

(1) T1 is an external terminal.

Figure 8. Differential Signaling Device

PARAMETER MEASUREMENT INFORMATION (continued)



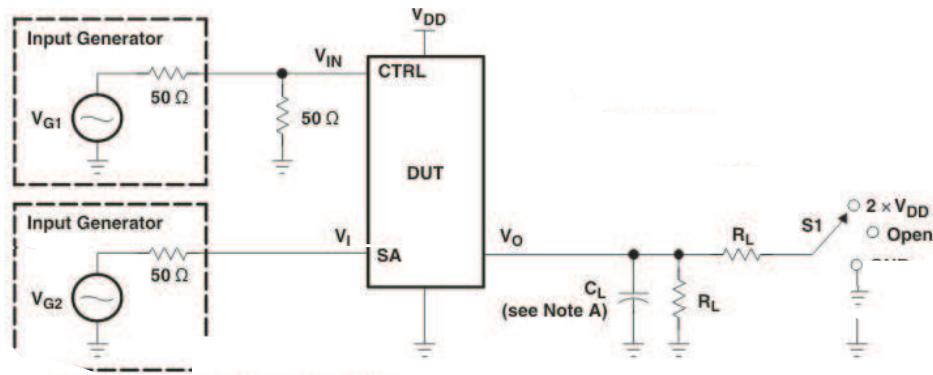
$V_{COM} = 1.5\ \text{V}$

V_{CRS} is the cross-point of the differential signal.

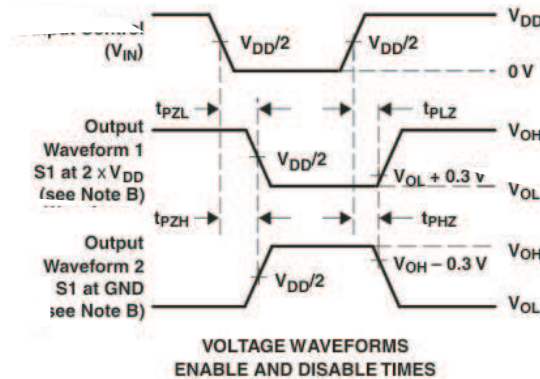
$t_{sk} = |t_{PLHn} - t_{PHLn}|$

Figure 9. Test Circuit for Propagation Delay and Intra-Pair Skew

PARAMETER MEASUREMENT INFORMATION (continued)



TEST	V _{DD}	S1	R _L	V _I	C _L	V _Δ
t _{PLZ} /t _{PZL}	3.3 V ±300 mV	2 × V _{DD}	100 Ω	GND	No load	0.3 V
t _{PZH} /t _{PZH}	3.3 V ±300 mV	GND	100 Ω	V _{DD}	No load	0.3 V



- A. CL 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 ohm, 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 10. Test Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION (continued)

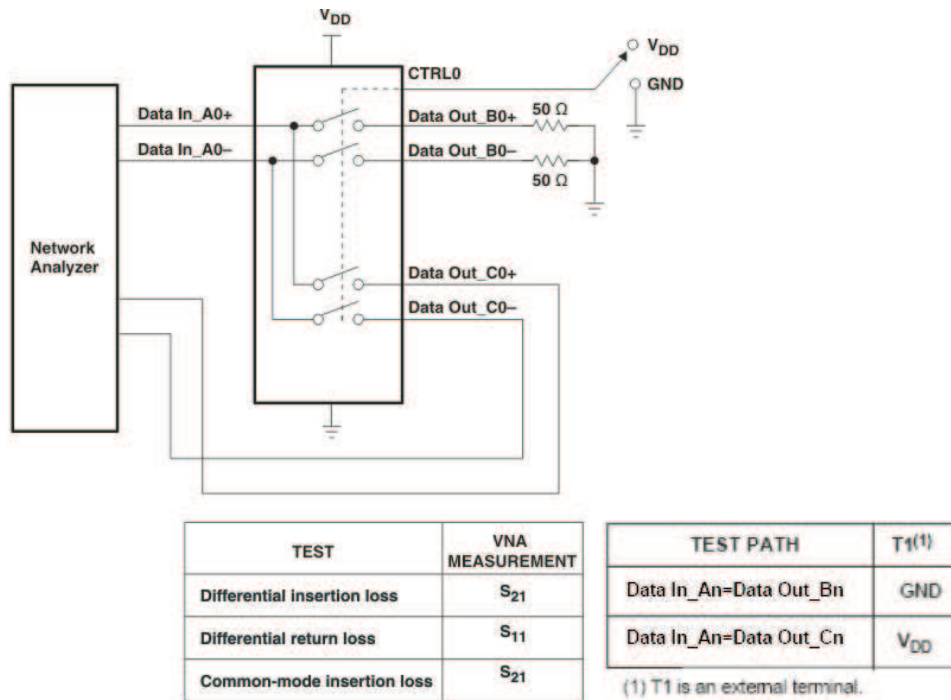
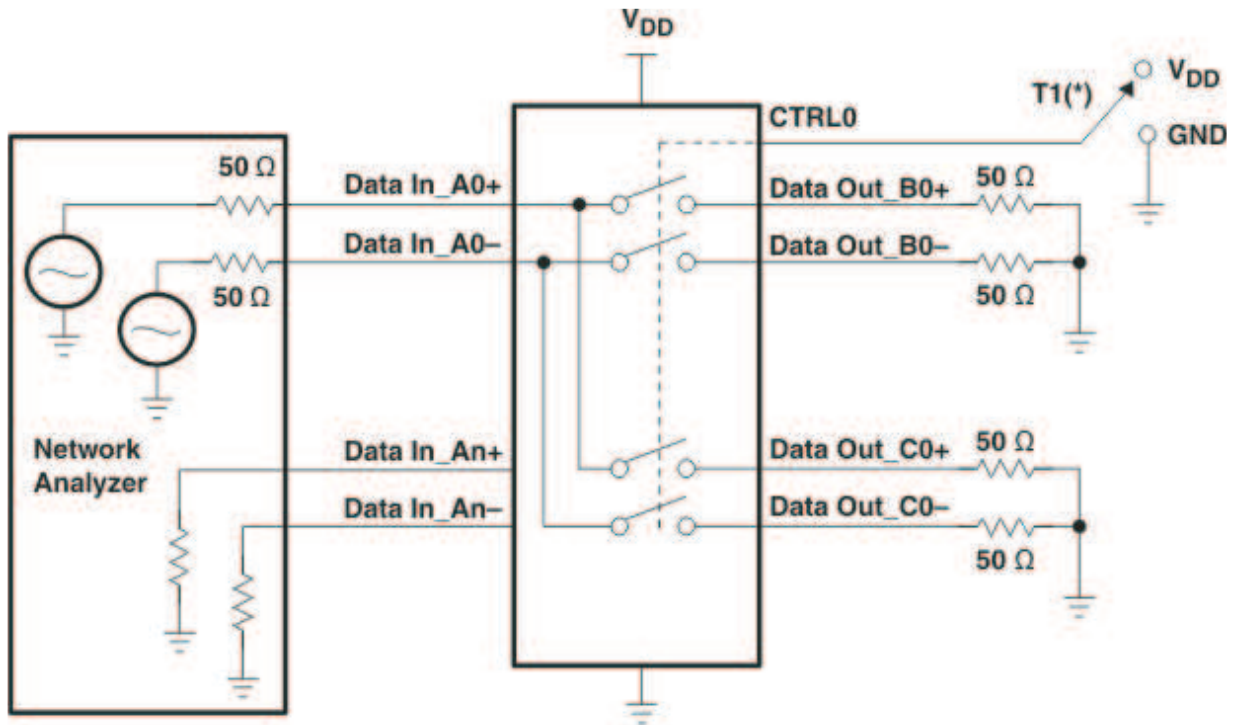


Figure 11. Differential Crosstalk Test Circuit

PARAMETER MEASUREMENT INFORMATION (continued)



(*) T1 is an external terminal.

TEST PATH	T1 ⁽¹⁾
Data In_An=Data Out_Bn	GND
Data In_An=Data Out_Cn	V _{DD}

(1) T1 is an external terminal.

Figure 12. Differential OFF Isolation Test Circuit

PARAMETER MEASUREMENT INFORMATION (continued)

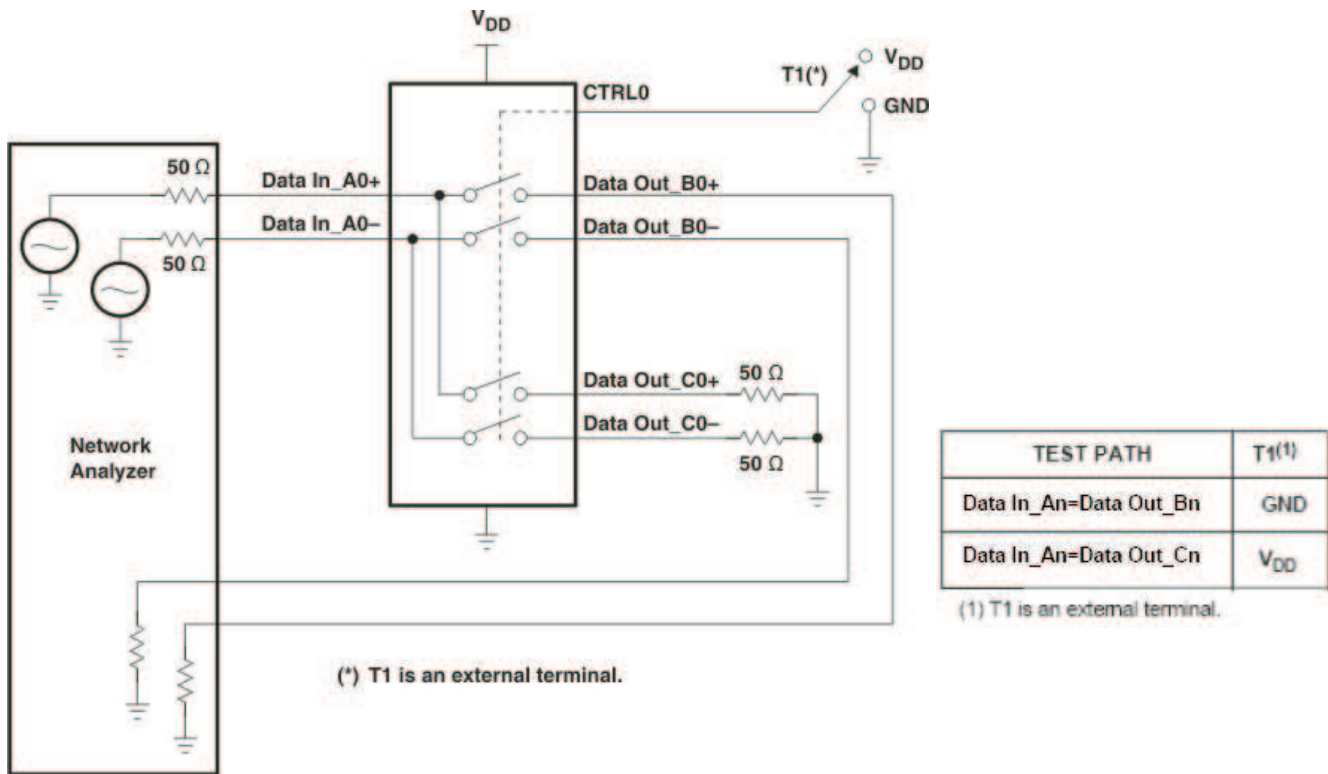


Figure 13. Differential Insertion Loss, Return Loss, and Common-Mode Insertion Loss Test Circuit

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TS3DV20812RHR	ACTIVE	VQFN	RHH	36	2500	Green (RoHS & no Sb/Br)	NIPDAU	Level-3-260C-168 HR	-40 to 85	SY812	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.

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

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TAPE AND REEL INFORMATION



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
TS3DV20812RHHR	VQFN	RHH	36	2500	330.0	16.4	6.3	6.3	1.1	12.0	16.0	Q2

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TS3DV20812RHHR	VQFN	RHH	36	2500	367.0	367.0	38.0

GENERIC PACKAGE VIEW

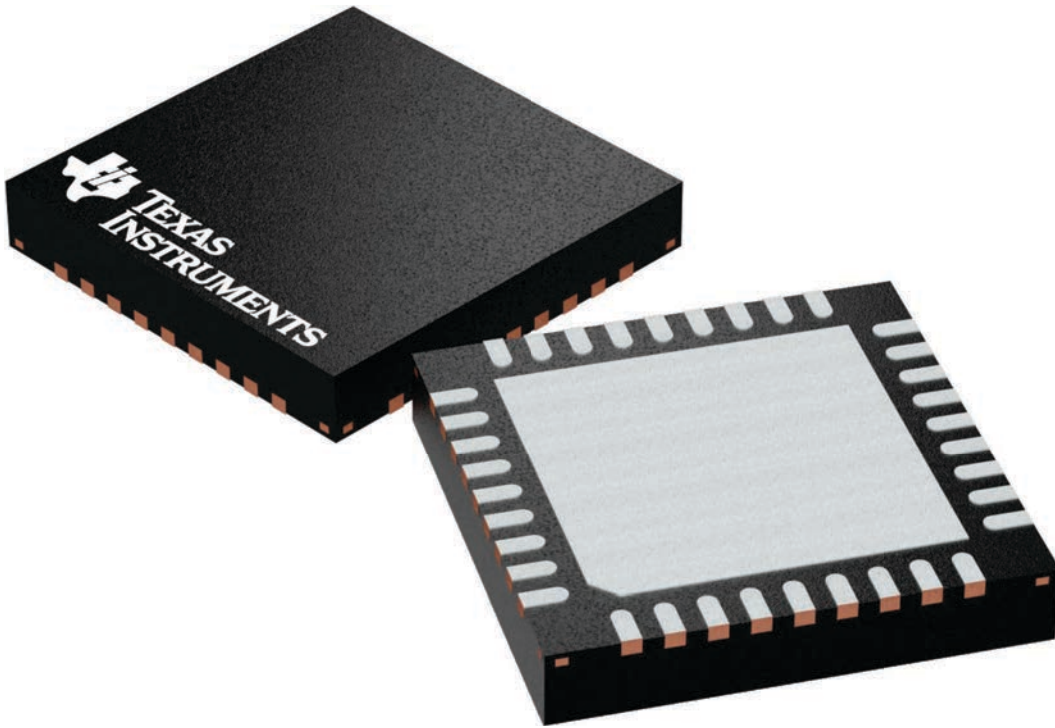
RHH 36

VQFN - 1 mm max height

6 x 6, 0.5 mm pitch

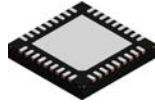
PLASTIC QUAD FLATPACK - NO LEAD

This image is a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.



4225440/A

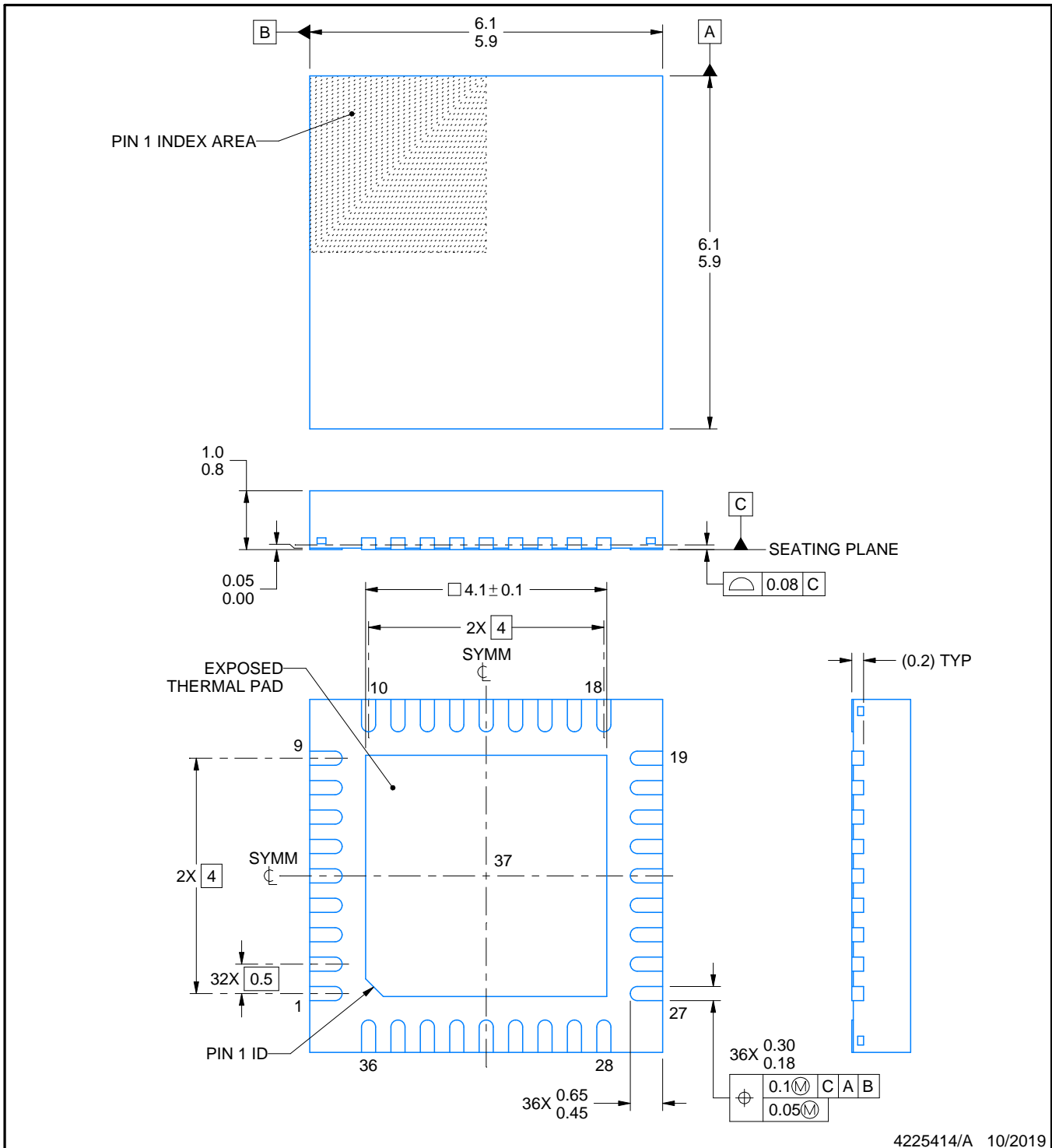
RHH0036B



PACKAGE OUTLINE

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



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NOTES:

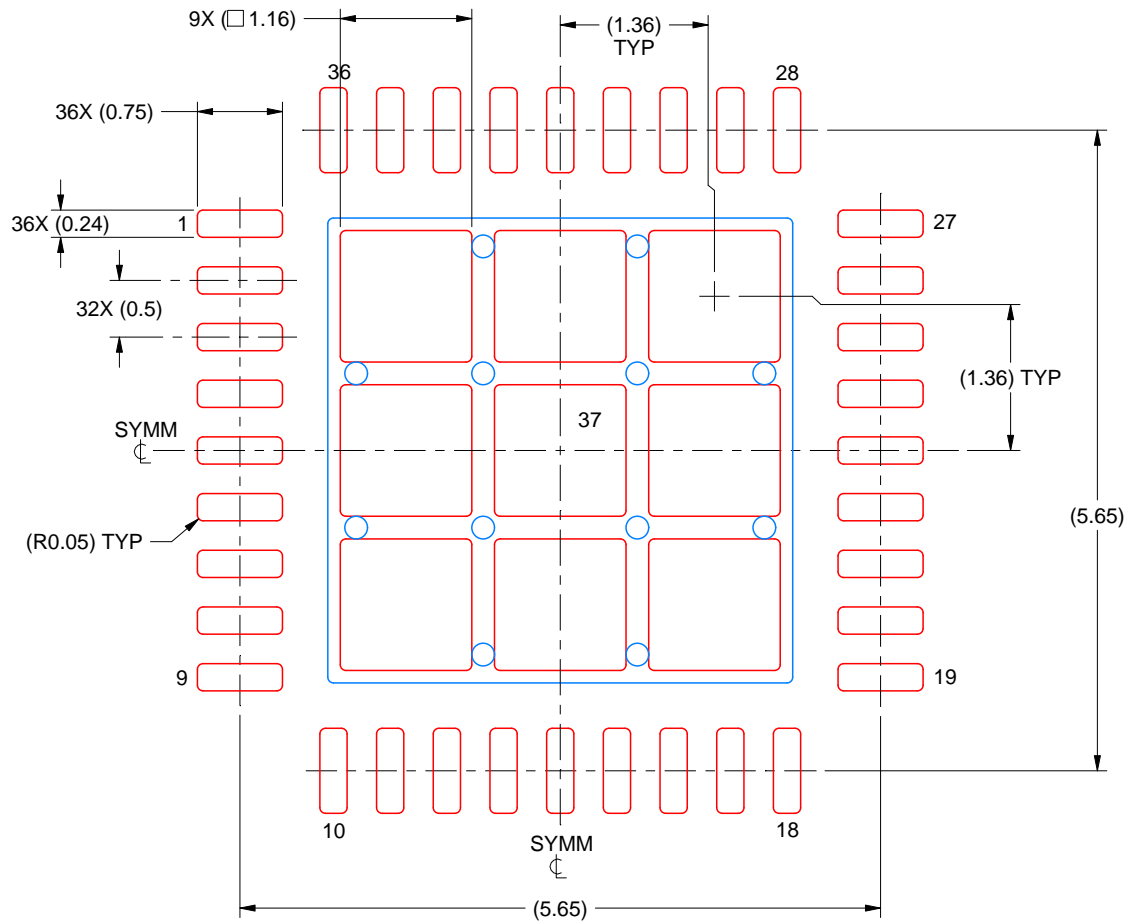
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

EXAMPLE STENCIL DESIGN

RHH0036B

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



SOLDER PASTE EXAMPLE
 BASED ON 0.125 MM THICK STENCIL
 SCALE: 15X

EXPOSED PAD 37
 72% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE

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NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

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