5-CHANNEL DIFFERENTIAL 10:20 MULTIPLEXER SWITCH FOR DVI/HDMI APPLICATIONS

FEATURES

- **Compatible With HDMI v1.2a (Type A) DVI 1.0 High-Speed Digital Interface**
  - **Wide Bandwidth to support throughput of over 1.65 Gbps (Data rate 1.9 Gbps Typ)**
  - **Serial Data Stream at 10× Pixel Clock Rate**
  - **Supports All Video Formats up to 1080p and SXGA (1280 × 1024 at 75 Hz)**
  - **Total Raw Capacity 4.95 Gbps (Single Link)**
  - **HDCP Compatible**
- **Compatible with SXGA Video Display formats up to 1080P (1280 × 1024 at 75Hz)**
- **Low Crosstalk (X_{TALK} = –37 dB Typ)**
- **Low Bit-to-Bit Skew ($t_{sk(o)}$ = 0.1 ns Max)**
- **Low and Flat ON-State Resistance (r_{on} = 4 Ω Typ, $r_{on(flat)}$ = 0.5 Ω Typ)**
- **Low Input/Output Capacitance (C_{ON} = 8 pF Typ)**
- **Rail-to-Rail Switching on Data I/O Ports (0 to 3.6 V)**
- **V_{CC} Operating Range From 3 V to 3.6 V**
- **Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II**
- **ESD Performance Tested**
  - **14-kV Human-Body Model Per JESD 22 (A114-B, Class II)**
  - **7.5-kV Contact Discharge Per IEC 61000-4-2**

APPLICATIONS

- **DVI/HDMI Signal Switching**
- **Differential DVI, HDMI Signal Multiplexing for Audio/Video Receivers and High-Definition Televisions (HDTVs)**

DESCRIPTION/ORDERING INFORMATION

The TS3DV520E is a 20-bit to 10-bit multiplexer/demultiplexer digital video switch with a single select (SEL) input. SEL controls the data path of the multiplexer/demultiplexer. The device provides five differential channels for digital video signal switching.

This device provides low and flat ON-state resistance (r_{on}) and excellent ON-state resistance match. Low input/output capacitance, high bandwidth, low skew, and low crosstalk among channels make this device suitable for various digital video applications, such as DVI and HDMI.

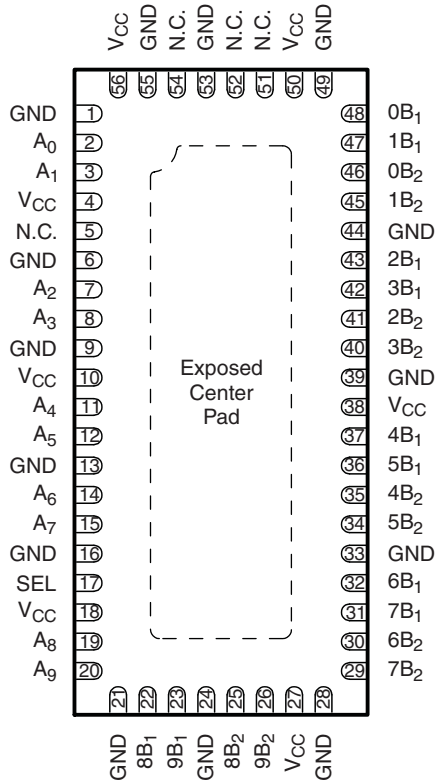
Voltage on the SEL pin should be less or equal to V_{CC}, even in the power-down mode (V_{CC} = 0 V).

ORDERING INFORMATION

T_A	PACKAGE(1)(2)		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	TQFN – RHU	Reel of 2000	TS3DV520ERHURG4	SD520E
	QFN – RUA	Reel of 2000	TS3DV520ERUAR	SD520E

(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.

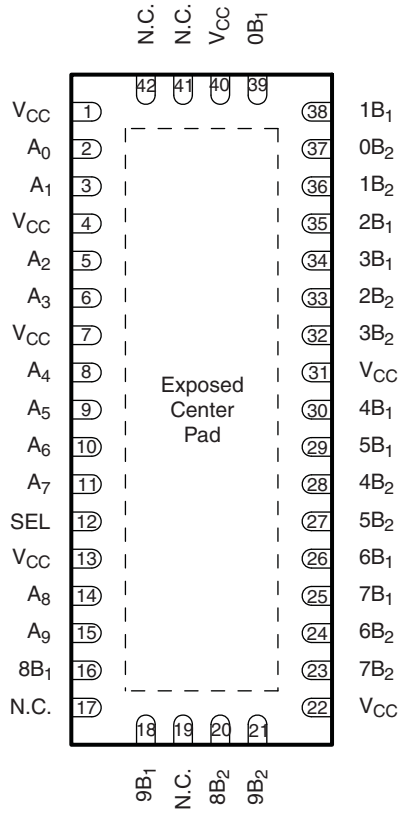
RHU PACKAGE
(TOP VIEW)



The exposed center pad, if used, must be connected to GND or left electrically open.

N.C. – No internal connection

RUA PACKAGE
(TOP VIEW)



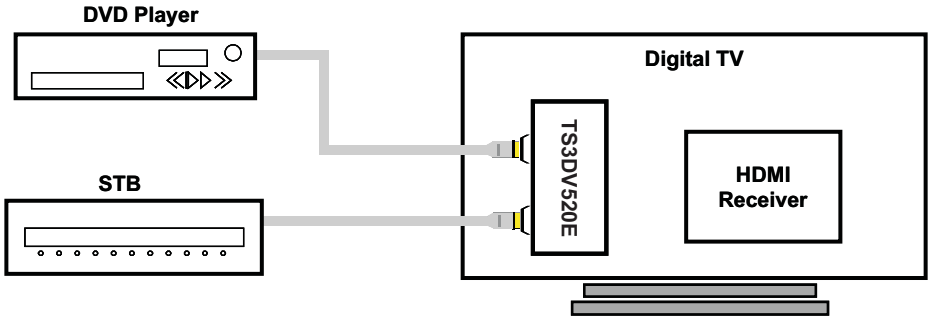
The exposed center pad must be connected to GND for proper device operation.

FUNCTION TABLE

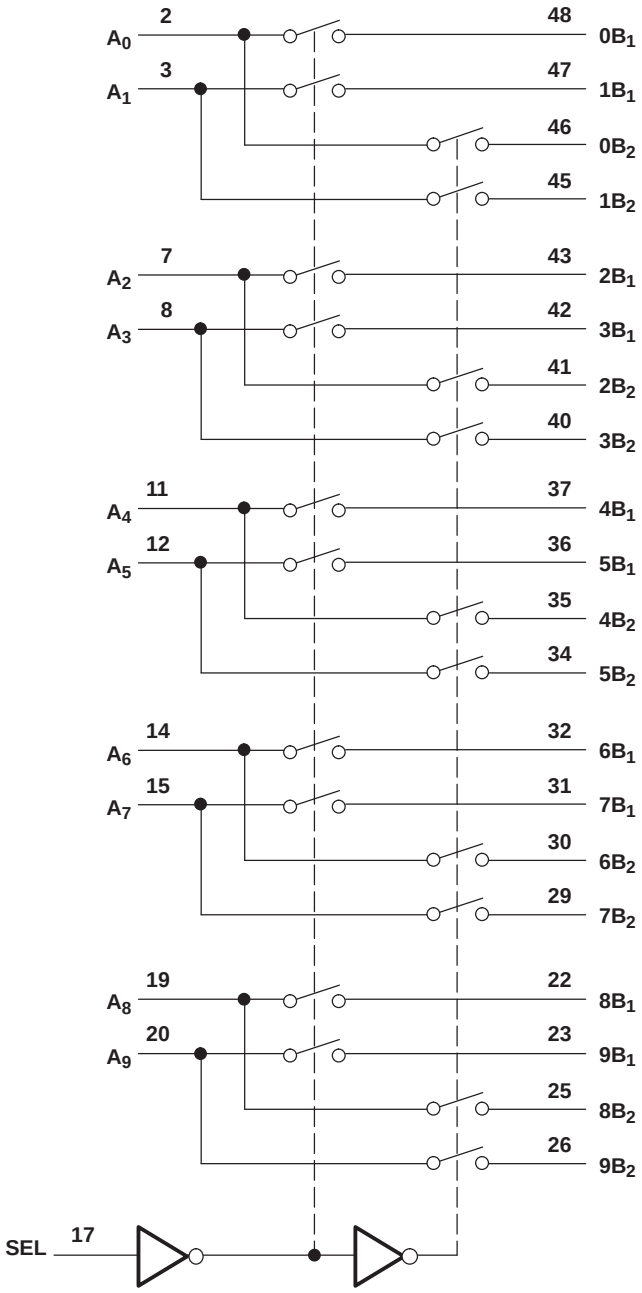
INPUT SEL	INPUT/OUTPUT An	FUNCTION	
L	nB_1	$A_n = nB_1$	nB_2 high-impedance mode
H	nB_2	$A_n = nB_2$	nB_1 high-impedance mode

PIN DESCRIPTION

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


DVD Player
STB
Digital TV
TS3DV520E
HDMI
Receiver

LOGIC DIAGRAM (POSITIVE LOGIC)



ABSOLUTE MAXIMUM RATINGS(1)

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

			MIN	MAX	UNIT
V_{CC}	Supply voltage range		–0.5	4.6	V
V_{IN}	Control input voltage range(2)(3)		–0.5	V_{CC} + 0.5	V
$V_{I/O}$	Switch I/O voltage range(2)(3)(4)		–0.5	V_{CC} + 0.5	V
I_{IK}	Control input clamp current	V_{IN} < 0 or V_{IN} > V_{CC}	–50	50	mA
$I_{I/OK}$	I/O port clamp current	$V_{I/O}$ < 0 or $V_{I/O}$ > V_{CC}	–50	50	mA
$I_{I/O}$	ON-state switch current(5)			±128	mA
	Continuous current through V_{CC} or GND			±100	mA
θ_{JA}	Package thermal impedance(6)	RHU package		31.8	°C/W
		RUA package		51.2	
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_{CC}	Supply voltage	3	3.6	V
V_{IH}	High-level control input voltage (SEL)	2	V_{CC}	V
V_{IL}	Low-level control input voltage (SEL)	0	0.8	V
$V_{I/O}$	Input/output voltage	0	V_{CC}	V
T_A	Operating free-air temperature	–40	85	°C

(1) 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(1)

for high-frequency switching over recommended operating free-air temperature range, V_{CC} = 3.3 V ± 0.3 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS				MIN	TYP(2)	MAX	UNIT
V_{IK}	SEL	V_{CC} = 3.6 V,	I_{IN} = –18 mA				–0.7	–1.2	V
I_{IH}	SEL	V_{CC} = 3.6 V,	V_{IN} = V_{CC}					±1	µA
I_{IL}	SEL	V_{CC} = 3.6 V,	V_{IN} = GND					±1	µA
I_{CC}		V_{CC} = 3.6 V,	$I_{I/O}$ = 0,	Switch ON or OFF			250	600	µA
C_{IN}	SEL	f = 1 MHz,	V_{IN} = 0				2	2.5	pF
C_{OFF}	B port	V_I = 0,	f = 1 MHz,	Outputs open,	Switch OFF		3	4	pF
C_{ON}		V_I = 0,	f = 1 MHz,	Outputs open,	Switch ON		9	9.8	pF
r_{on}		V_{CC} = 3 V,	1.5 V ≤ V_I ≤ V_{CC},	I_O = –40 mA			4	8	Ω
$r_{on(flat)}$(3)		V_{CC} = 3 V,	V_I = 1.5 V and V_{CC},	I_O = –40 mA			0.7		Ω
Δr_{on}(4)		V_{CC} = 3 V,	1.5 V ≤ V_I ≤ V_{CC},	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_{CC} = 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_{CC} = 3.3 V ± 0.3 V, R_L = 200 Ω, C_L = 10 pF (unless otherwise noted) (see Figure 5 and Figure 6)

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	0.5		15	ns
t_{PHZ}, t_{PLZ}	SEL	A or B	0.5		9	ns
$t_{sk(o)}$(3)	A or B	B or A		0.05	0.1	ns
$t_{sk(p)}$(4)				0.05	0.1	ns

(1) All typical values are at V_{CC} = 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_{CC} = 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 8	–37	dB
O_{IRR}	R_L = 100 Ω,	f = 250 MHz,	See Figure 9	–37	dB
BW	R_L = 100 Ω,	See Figure 7		950	MHz

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

OPERATING CHARACTERISTICS

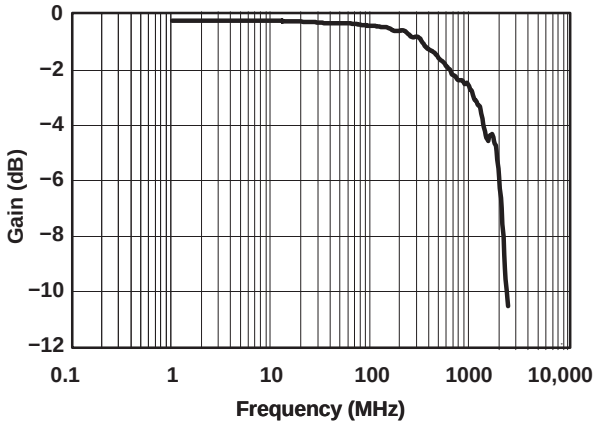


Figure 1. Gain/Phase vs Frequency

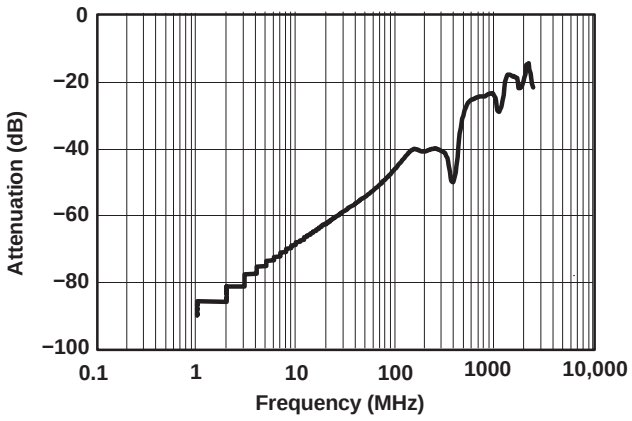


Figure 2. OFF Isolation vs Frequency

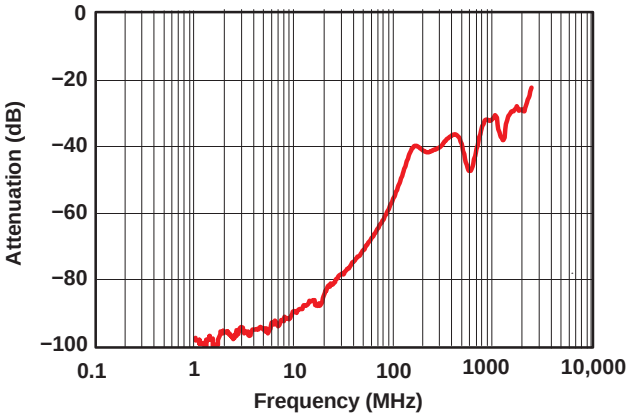


Figure 3. Crosstalk vs Frequency

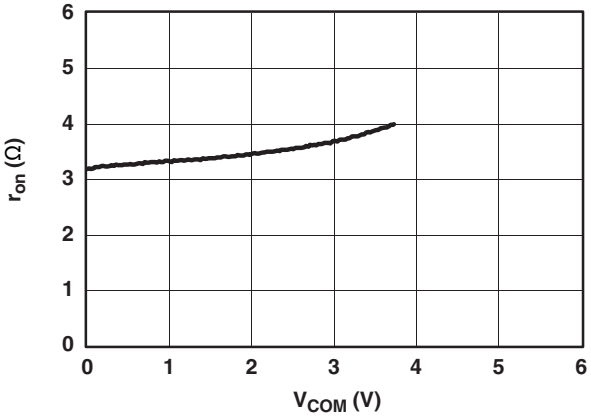
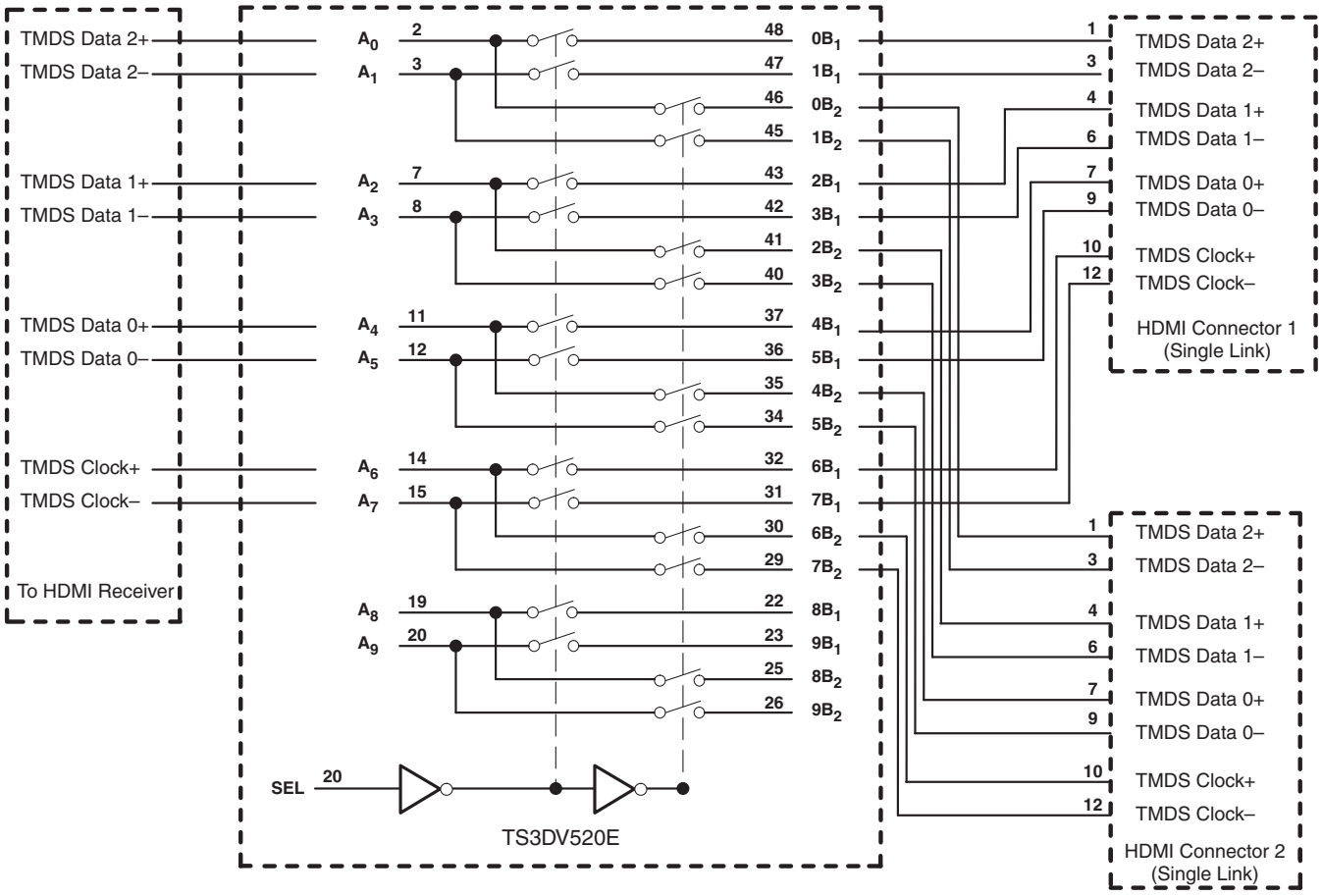
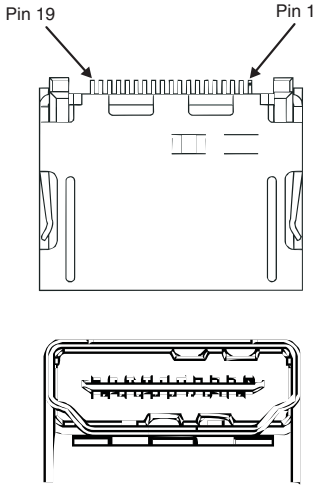


Figure 4. r_{on} vs V_{COM} (V_{CC} = 3.6 V

APPLICATION INFORMATION



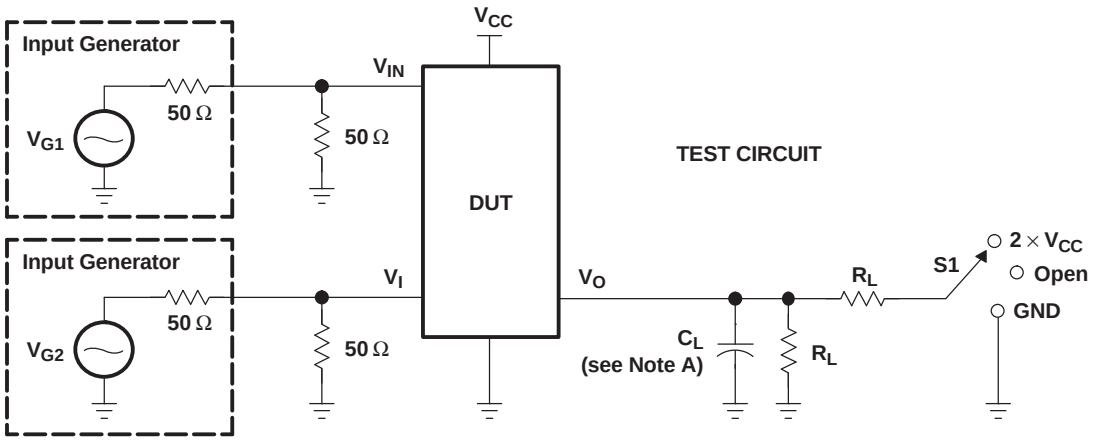
Typical HDMI Connector



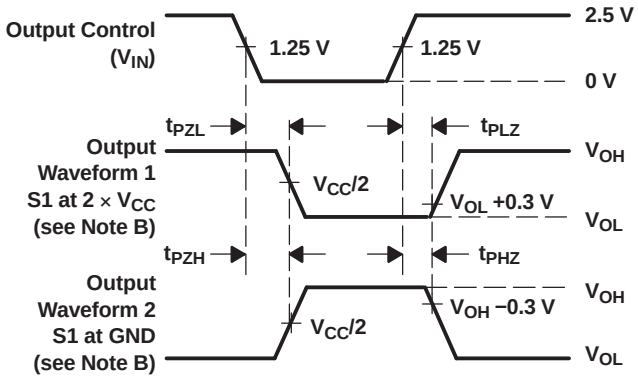
Pin	Signal Assignment
1	TMDS Data 2+
2	TMDS Data 2 Shield
3	TMDS Data 2–
4	TMDS Data 1+
5	TMDS Data 1 Shield
6	TMDS Data 1–
7	TMDS Data 0+
8	TMDS Data 0 Shield
9	TMDS Data 0–
10	TMDS Clock+
11	TMDS Clock Shield
12	TMDS Clock–
13	CEC
14	Reserved (N.C. on device)
15	SCL
16	SDA
17	DDC/CEC Ground
18	5 V Power
19	Hot Plug Detect

The TS3DV520E can be used to switch between two digital video ports.

PARAMETER MEASUREMENT INFORMATION
(Enable and Disable Times)



TEST	V_{CC}	S1	R_L	V_I	C_L	V_Δ
t_{PLZ}/t_{PZL}	3.3 V ± 0.3 V	2 × V_{CC}	200 Ω	GND	10 pF	0.3 V
t_{PHZ}/t_{PZH}	3.3 V ± 0.3 V	GND	200 Ω	V_{CC}	10 pF	0.3 V

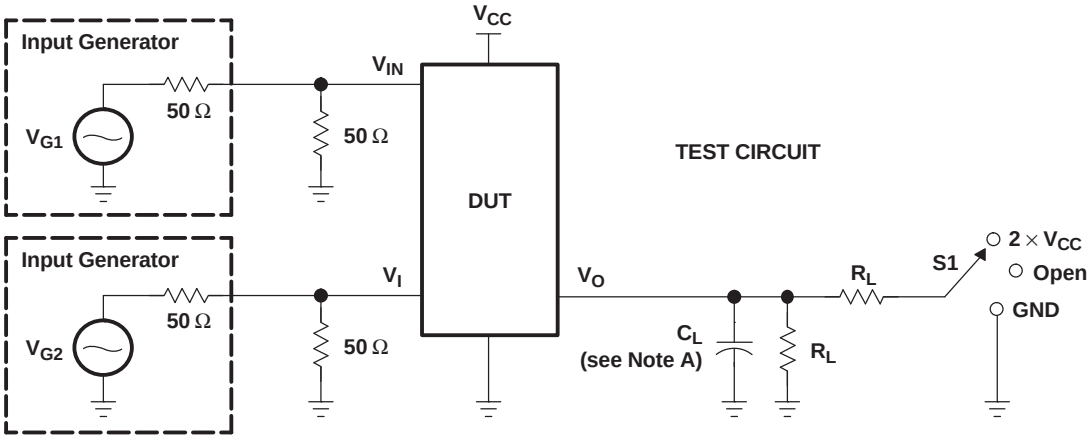


VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

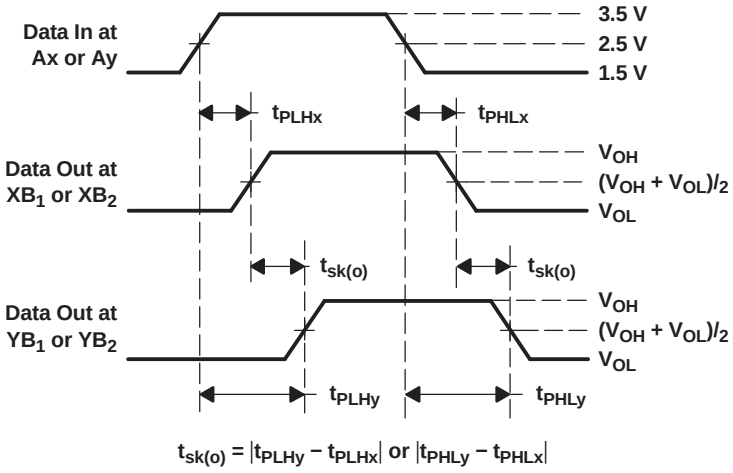
NOTES: A. C_L includes probe and jig capacitance.
B. Waveform 1 is for an output with internal conditions such that the output is low, except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output control.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

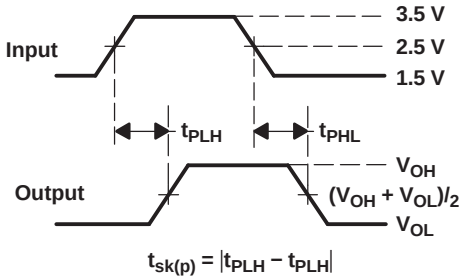
PARAMETER MEASUREMENT INFORMATION (Skew)



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



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



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 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.

Figure 6. Test Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION

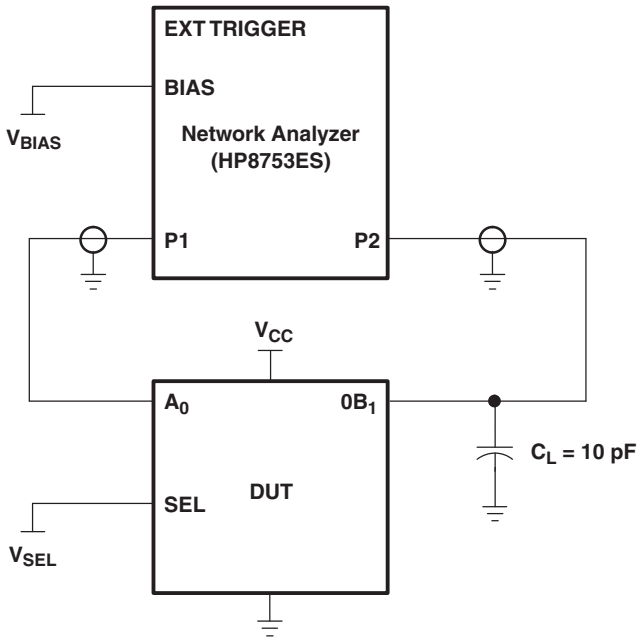


Figure 7. Test Circuit for Frequency Response (BW)

Frequency response is measured at the output of the ON channel. For example, when V_{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

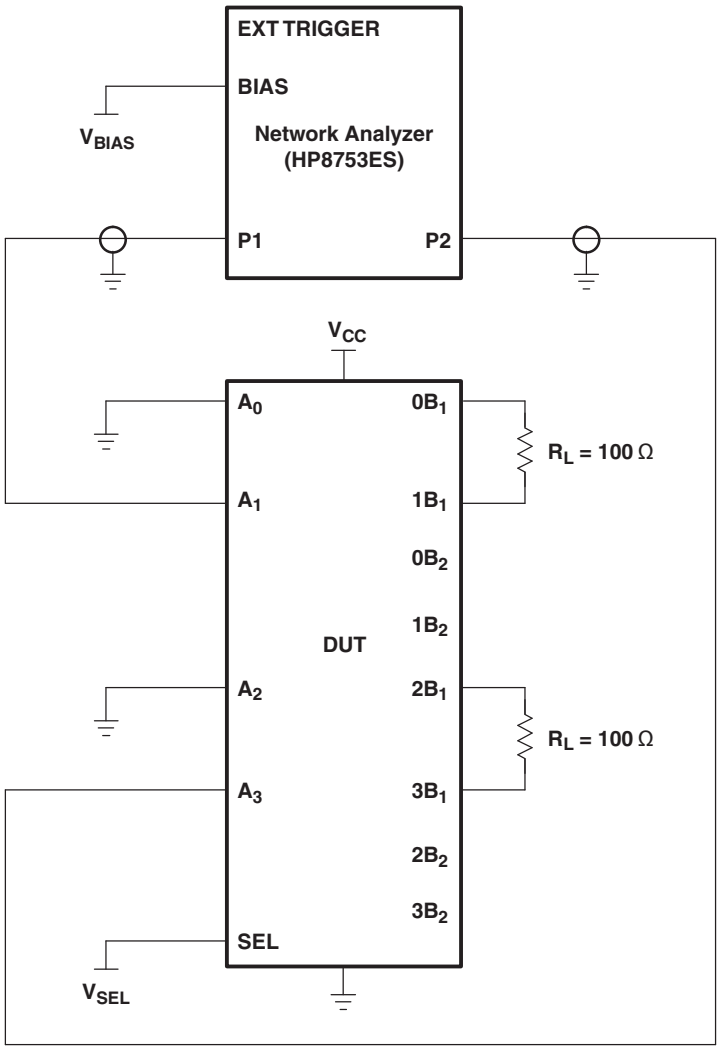
RBW = 3 kHz

V_{BIAS} = 0.35 V

ST = 2 s

P1 = 0 dBM

PARAMETER MEASUREMENT INFORMATION



A. A 50-Ω termination resistor is needed to match the loading of 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_{SEL} = 0 and A_0 is the input, the output is measured at $1B_1$. All unused analog input (A) ports are connected to GND, and output (B) ports are connected to GND through 50-Ω pulldown resistors.

HP8753ES setup

Average = 4

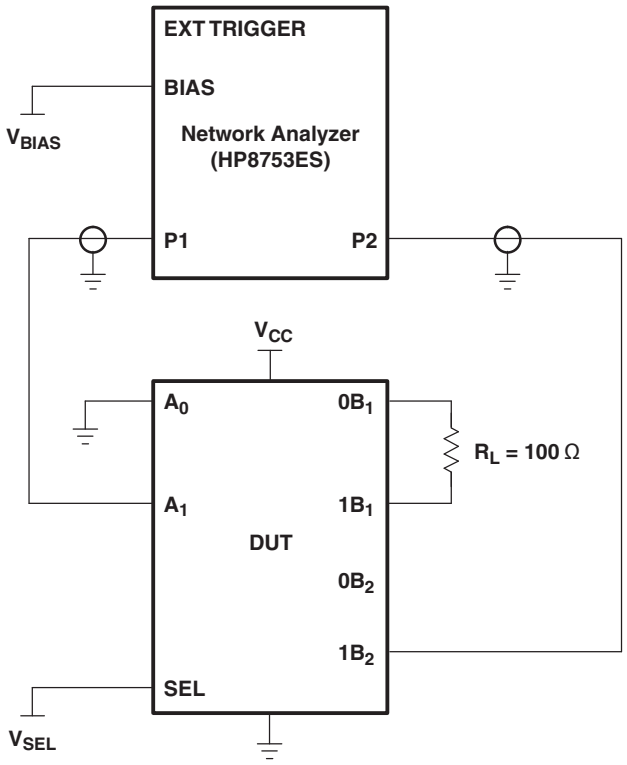
RBW = 3 kHz

V_{BIAS} = 0.35 V

ST = 2 s

P1 = 0 dBM

PARAMETER MEASUREMENT INFORMATION



A. A 50-Ω termination resistor is needed to match the loading of 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_{SEL} = V_{CC} and A_0 is the input, the output is measured at $0B_2$. All unused analog input (A) ports are left open, and output (B) ports are connected to GND through 50-Ω pulldown resistors.

HP8753ES setup

Average = 4

RBW = 3 kHz

V_{BIAS} = 0.35 V

ST = 2

P1 = 0 dBM

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)
TS3DV520ERUAR	Active	Production	WQFN (RUA) | 42	3000 | LARGE T&R	Yes	NIPDAUAG	Level-1-260C-UNLIM	-40 to 85	SD520E
TS3DV520ERUAR.B	Active	Production	WQFN (RUA) | 42	3000 | LARGE T&R	Yes	NIPDAUAG	Level-1-260C-UNLIM	-40 to 85	SD520E

(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.

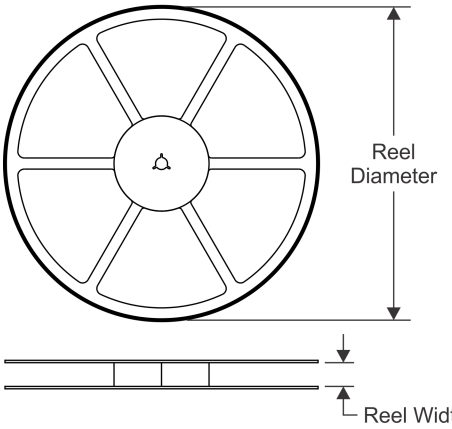
(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will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

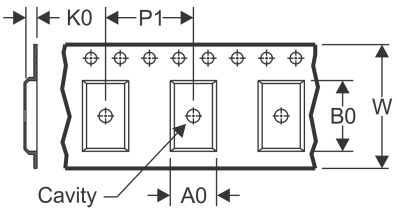
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

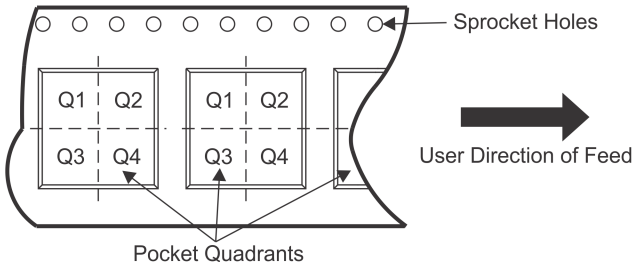


TAPE DIMENSIONS



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

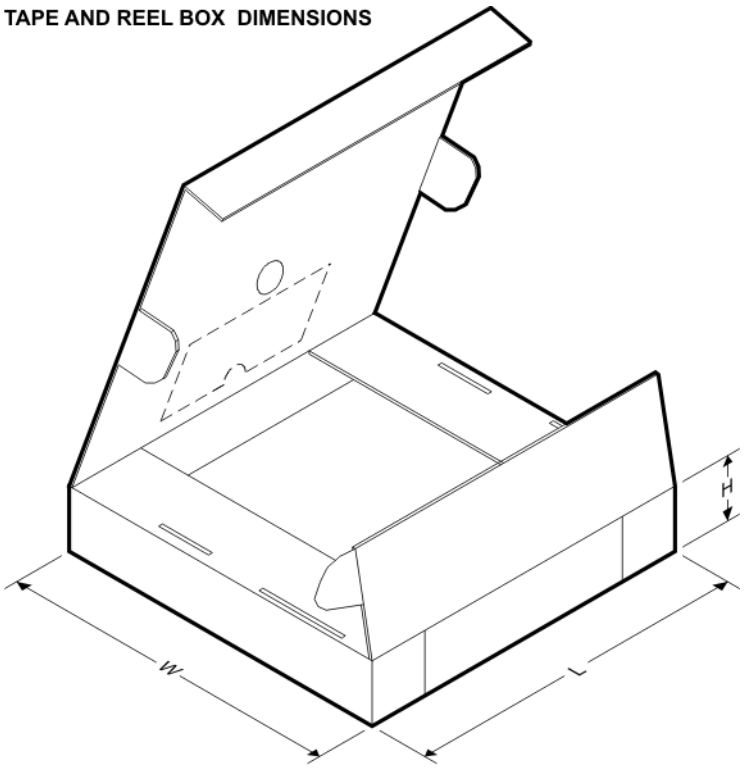
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
TS3DV520ERUAR	WQFN	RUA	42	3000	330.0	24.4	3.9	9.4	1.0	8.0	24.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TS3DV520ERUAR	WQFN	RUA	42	3000	346.0	346.0	35.0

GENERIC PACKAGE VIEW

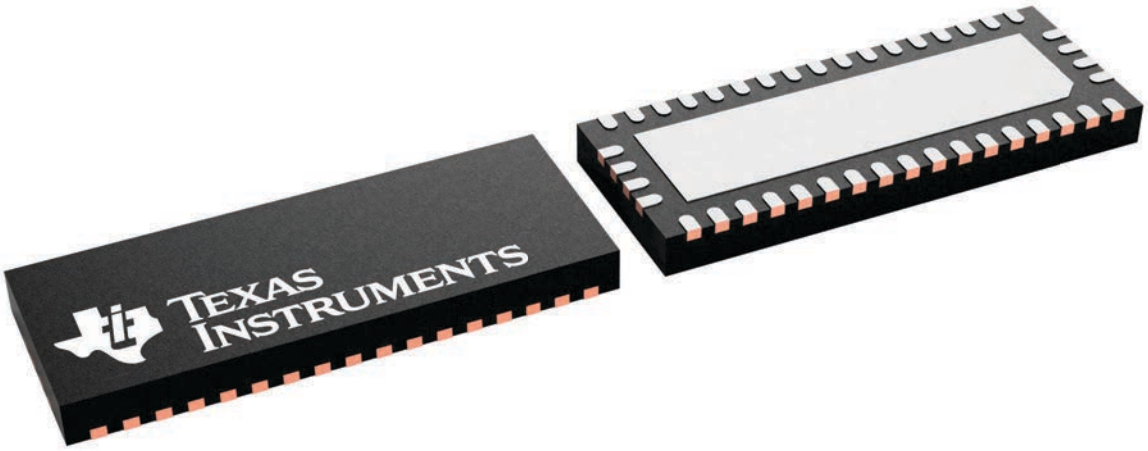
RUA 42

WQFN - 0.8 mm max height

9 x 3.5, 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.



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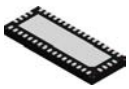
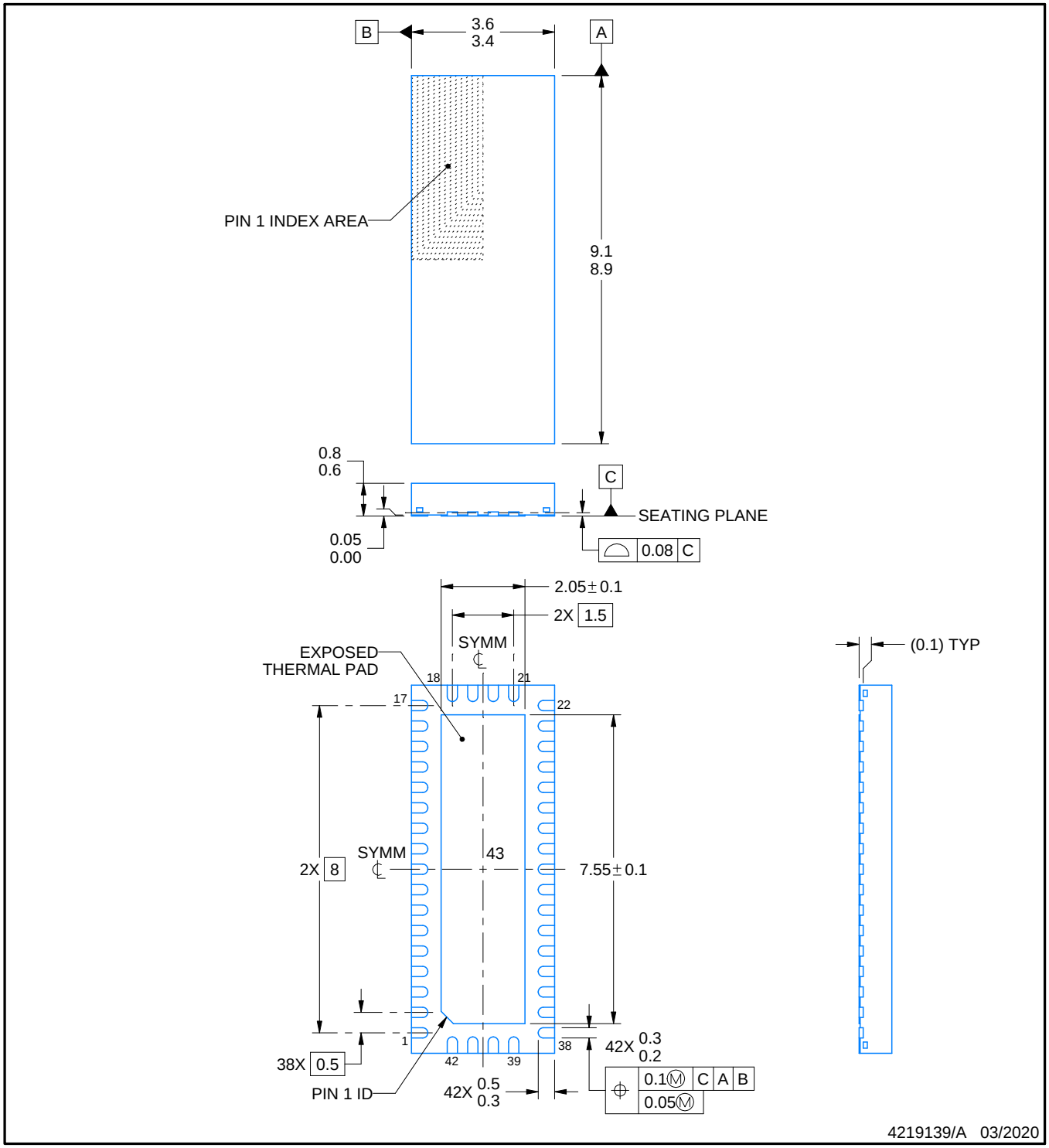
PACKAGE OUTLINE

RUA0042A



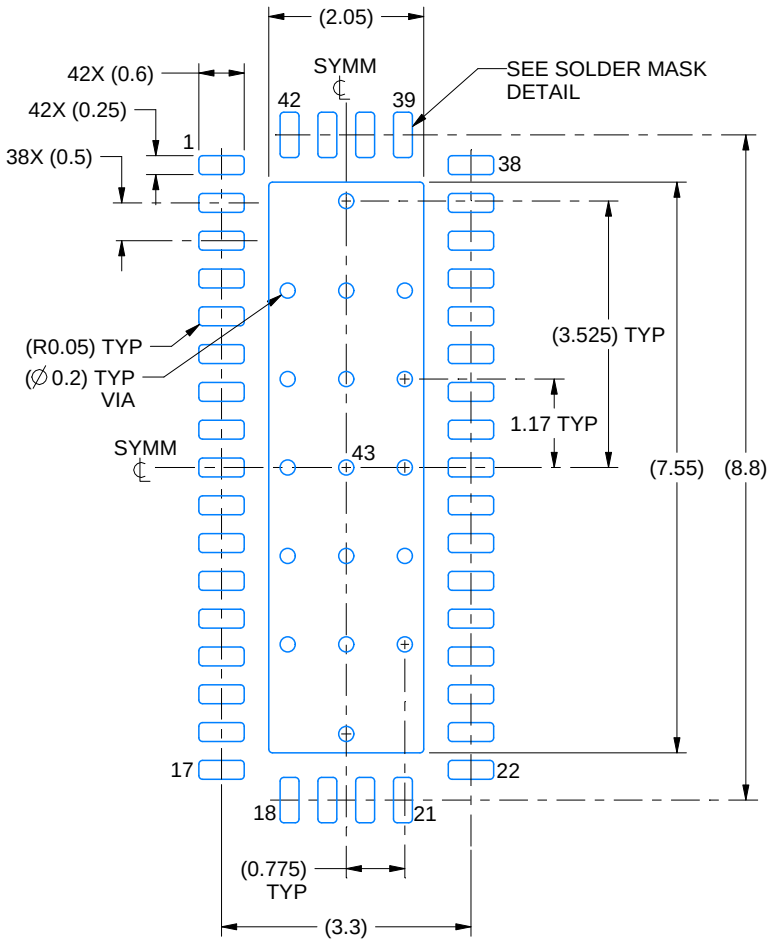
WQFN - 0.8 mm max height

PLASTIC QUAD FLATPACK - NO LEAD

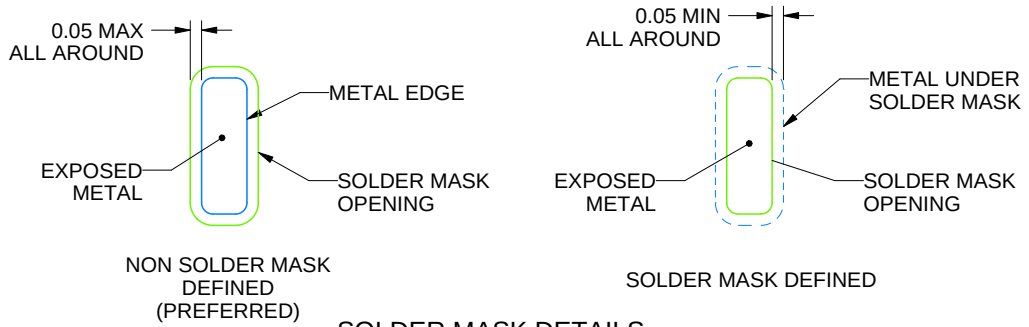


NOTES:

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.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X



SOLDER MASK DETAILS

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NOTES: (continued)

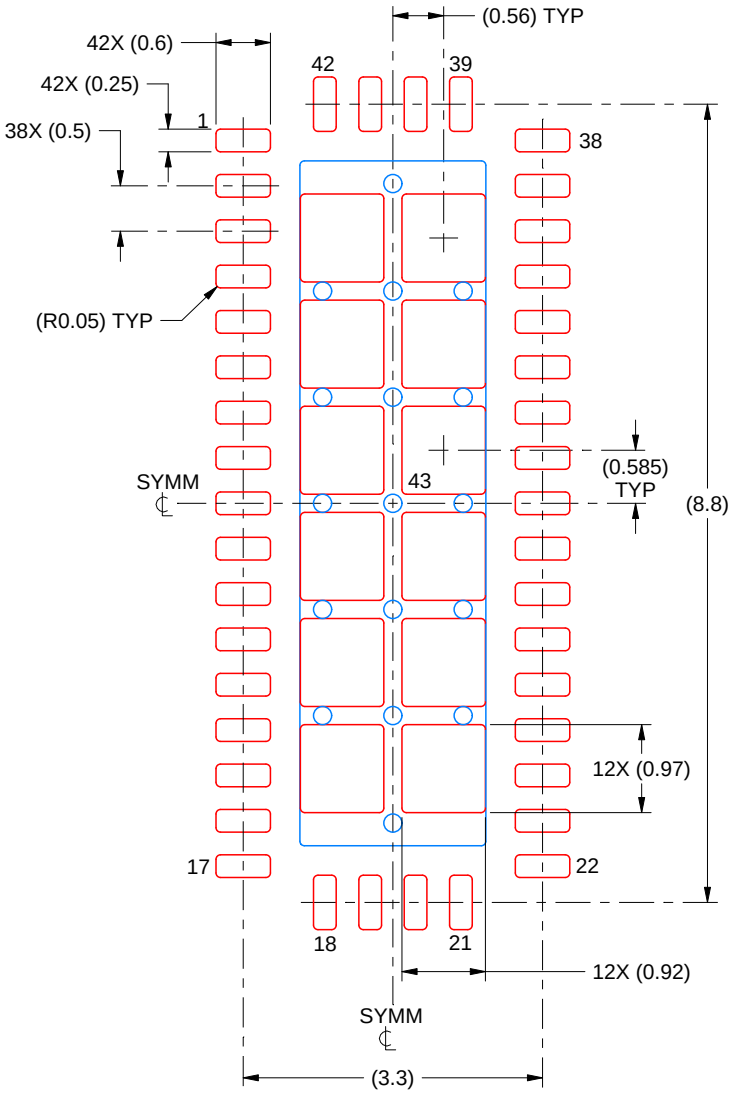
4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

EXAMPLE STENCIL DESIGN

RUA0042A

WQFN - 0.8 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



SOLDER PASTE EXAMPLE
BASED ON 0.125 MM THICK STENCIL
SCALE: 12X

EXPOSED PAD 43
69% 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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