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ABSTRACT

This user's guide describes the characteristics, operation, and use of the TXS-EVM Evaluation Module (EVM). A complete printed-circuit board layout, schematic diagrams, and bill of materials are included in this document.

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1 Introduction

The TXS and TXB auto bidirectional voltage translators are designed for interfacing between 1.2 V to 5.5 V drivers. TXB translation devices are suited for high-impedance push-pull driver interfacing, while TXS translation devices specialize in open-drain applications such as I²C, One-Wire, and MMC-card interfacing. Watch [choosing the right auto-bidirectional translator](#) video for more information on TXS and TXB.

This evaluation module (EVM) supports the customizable evaluation of the one-, two-, four-, and eight-bit devices of the TXS family.

1.1 Features

1.1.1 TXS Family

The TXS family uses two separate configurable power supply rails V_{CCA} and V_{CCB} with A ports tracking the V_{CCA} supply and B ports tracking the V_{CCB} supply. These devices are fully specified for partial-power-down applications using I_{OFF} . The I_{OFF} circuitry ([SCEA026](#)) disables the outputs, preventing damaging current backflow through the device when it is powered down. The V_{CC} isolation feature ensures that if either V_{CC} supply is powered down (0V), then the I/O ports are in a high-impedance state.

The TXS family share the same architecture and one-shot circuitry for faster logic level transitions. In addition to the One-Shot circuitry, the TXS has a “weak-buffer” I/O structure which enables both slow speed open drain compatibility and higher speed push-pull operation up to 100 Mbps. [TXS0101](#), [TXS0102](#), and [TXS0104E](#) devices have a fixed internal 10 k Ω pull-up resistor on the I/O ports. The [TXS0108E](#) has smart pull-up resistors that switch between 4 k Ω when the output is driving a high and 40 k Ω when the output is driving a low. Refer to the application note [A guide to voltage translation with the TXS family](#) for more information on TXS family characteristics. Careful consideration should be taken when using external pull-up or pull-down resistors with TXS devices. Refer to the application note [Effects of external pullup and pulldown resistors](#) for further information.

[Table 1-1](#) shows the comparison between the [TXB](#), [TXS](#) and [LSF](#) Auto-Bidirectional families of TI.

Table 1-1. Auto-Bidirectional Families

Metrics	TXB	TXS	LSF
Translation mechanism	Weak buffered translation	Passive translation with NMOS and internal pull-up resistors	Passive translation with NMOS and external pull-up resistors
Drive strength	Very low drive of 20ua due to 4K limiting buffer	No DC drive	No DC drive
Applications/ Interface	Push-pull applications	Open-drain applications	Push-pull and open-drain applications
Speed	Up to 140Mbps	Up to 24Mbps	High speed up to 200Mbps
Translation flexibility	Buffered and fixed translation on A and B ports	Integrated pull-up resistors-reduces BOM cost of the system; Fixed translation on A and B ports	Flexible translation due to external pull-up resistors Frequency vs load balance trade-off
I/O ports	A ports referenced to V_{CCA} and B ports referenced to V_{CCB}	A ports referenced to V_{CCA} and B ports referenced to V_{CCB}	A ports not referenced to V_{CCA} , B ports not referenced to V_{CCB} ; allows multi-voltage translation
Edge- acceleration	Integrated one-shot edge acceleration circuitry	Integrated one-shot edge acceleration circuitry	No integrated one-shot acceleration circuitry
Vih/Vil requirements	Datasheet spec has Vih/Vil specifications	Has Vih /Vil spec but no R_{ON} for the FET	No Vih / Vil conditions, has R_{ON} specifications
Additional care-about	$V_{CCA} \leq V_{CCB}$	$V_{CCA} \leq V_{CCB}$	$V_{CCB} > V_{CCA} + 0.8 V$

Table 1-2 shows the packages supported by the TXS-EVM.

Table 1-2. TXS-EVM Packages and Devices supported

Device	Package	Pins	Device Populated
TXS0101	DCK	6	Yes
TXS0102 (TXS0102-Q1) ⁽¹⁾	DCU	8	Yes
TXS0104E (TXS0104E-Q1) ⁽¹⁾	PW	14	Yes
TXS0108E (TXS0108E-Q1) ⁽¹⁾	PW	20	No
	RGY	20	Yes

(1) -Q1 devices are not populated on the EVM but are footprint compatible to the non -Q1 devices.

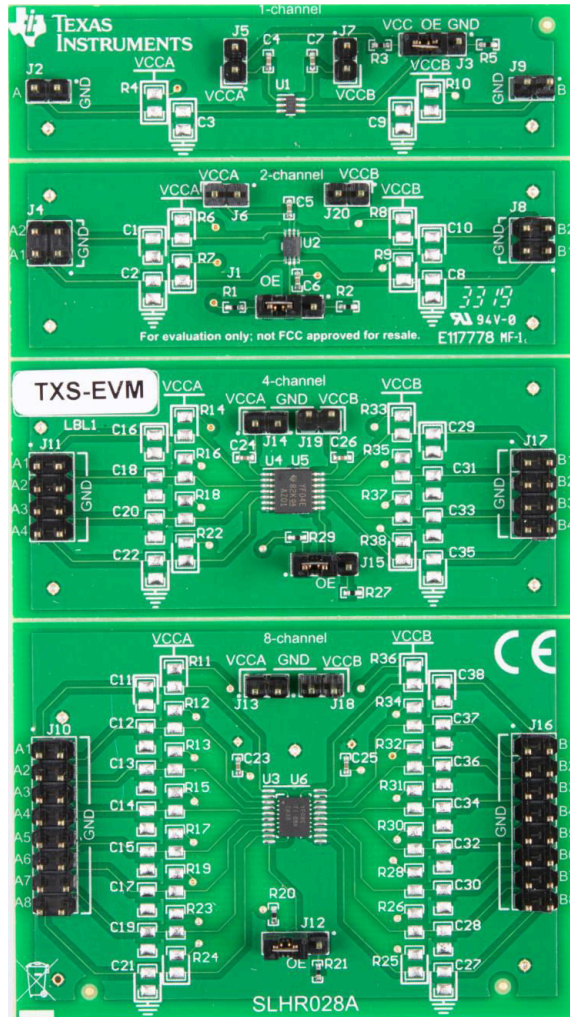


Figure 1-1. TXS-EVM

1.2 Hardware Description

1.2.1 Headers

All headers on this EVM are 100 mil. Each PCB has a header arrays for connection to the A and B side data pins, with ground oriented towards the device and the data headers closer to the board edges. Data pins are marked A1..A8 and B1..B8 from top to bottom. All ground pins on the board are at the same ground potential.

1.2.2 Voltage Supply

Supply headers are located at the top of each PCB for V_{CCA} and V_{CCB} . The following table denotes the operational voltage ranges for TXS devices.

Table 1-3. TXS Device Voltage Supply Ranges

	V_{CCA} range	V_{CCB} range
TXS0101 , TXS0102 , TXS0104E	1.65 V – 3.6 V	2.3 V – 5.5 V
TXS0108E	1.2 V – 3.6 V	1.65 V – 5.5 V

1.2.3 Bypass Capacitors

0.1 μ F Surface Mount (SM) 0402 capacitors are populated near V_{CCA} and V_{CCB} device pins on each board (C4, C5, C6, C7, C23, C24, C25, C26). These are in place to smooth transient voltage supply spikes during start up and normal device operation.

1.2.4 OE Select

A 3x1 100-mil header provides access to the Output Enable (OE) pin on the device. The 100 mil jumper is available for selecting a known state for the OE pin if desired. The outer header pins access V_{CCA} or GND through a 10 k Ω resistor. OE on TXS devices may be safely initialized to either V_{CCA} or GND, although using a pull up resistor on OE during device power on may result in higher power consumption until V_{CCA} is stable. Output enable pin is the input for the device and should never be left floating. The CMOS inputs must be held at a known state, either V_{CC} or ground, to ensure proper device operation. Refer to *Implications of Slow or Floating CMOS Inputs* ([SCBA004](#)).

1.2.5 RC Loading

Each data I/O trace connects to an 0805 surface mount (SM) pad with access to V_{CCA} for customizable pull-up resistors and an 0805 SM pad with access to GND for a customizable load. Large pads were chosen for ease of access and the option to compose a load out of multiple, smaller, SM components if desired (for load tests, rise/fall time adjustments, etc..). [Figure 1-1](#) shows the SM pad locations. Pull-down pads are marked with a ground symbol, pull-up pads are marked with a power port symbol on the board.

2 Board Layout

Figure 2-1 illustrates the TXS-EVM layout.

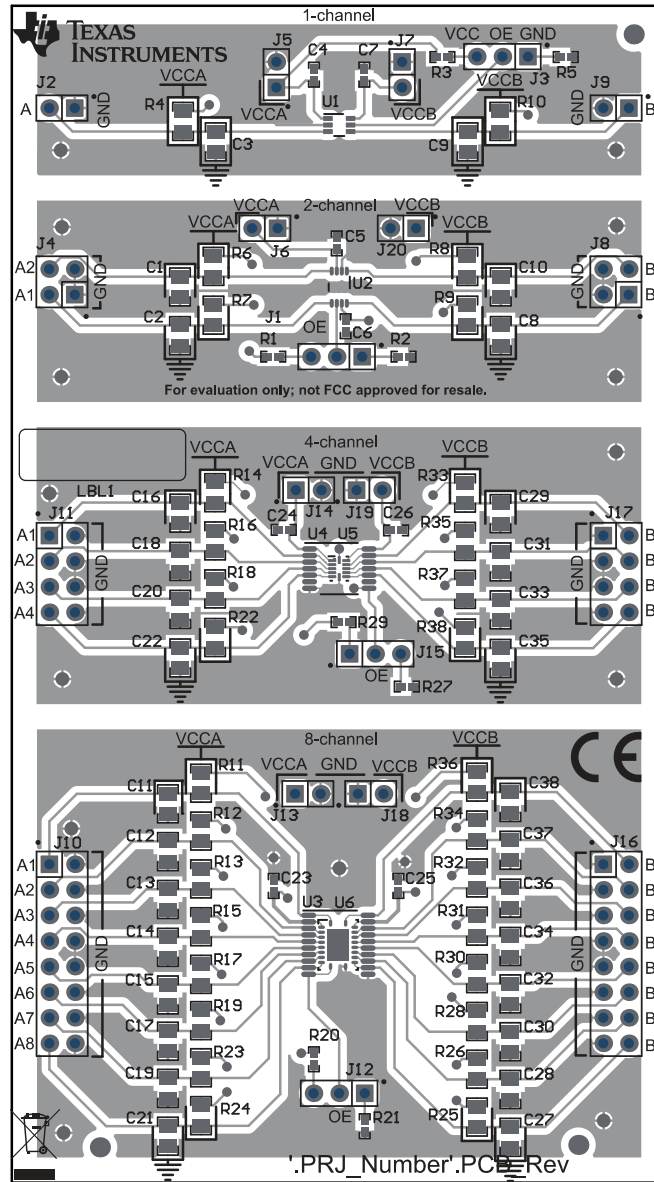


Figure 2-1. TXS-EVM Layout

3 Schematic and Bill of Materials

3.1 Schematic

Figure 3-1, Figure 3-2, Figure 3-3, and Figure 3-4 illustrate the TXS-EVM schematic.

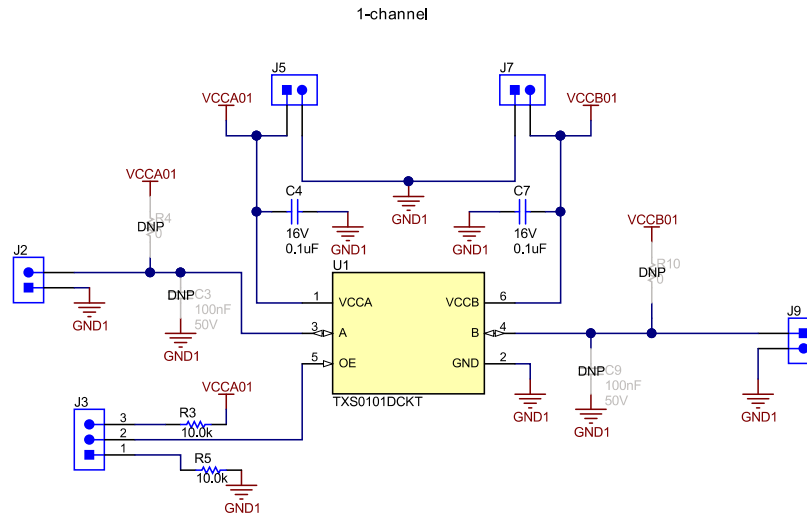


Figure 3-1. 1-Channel TXS0101

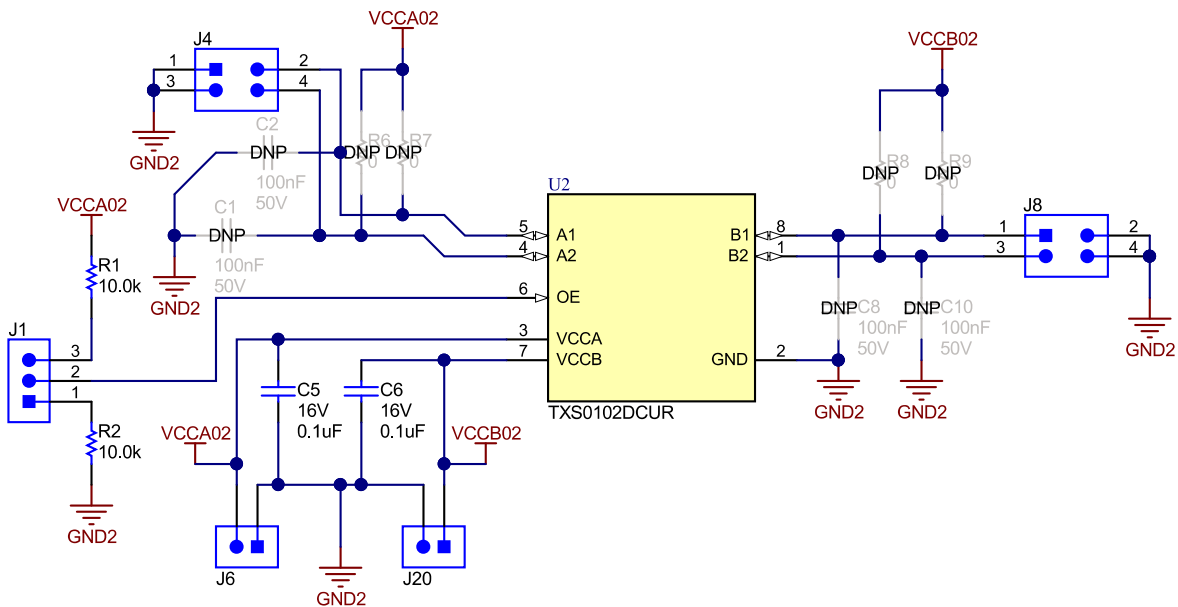


Figure 3-2. 2-Channel TXS0102

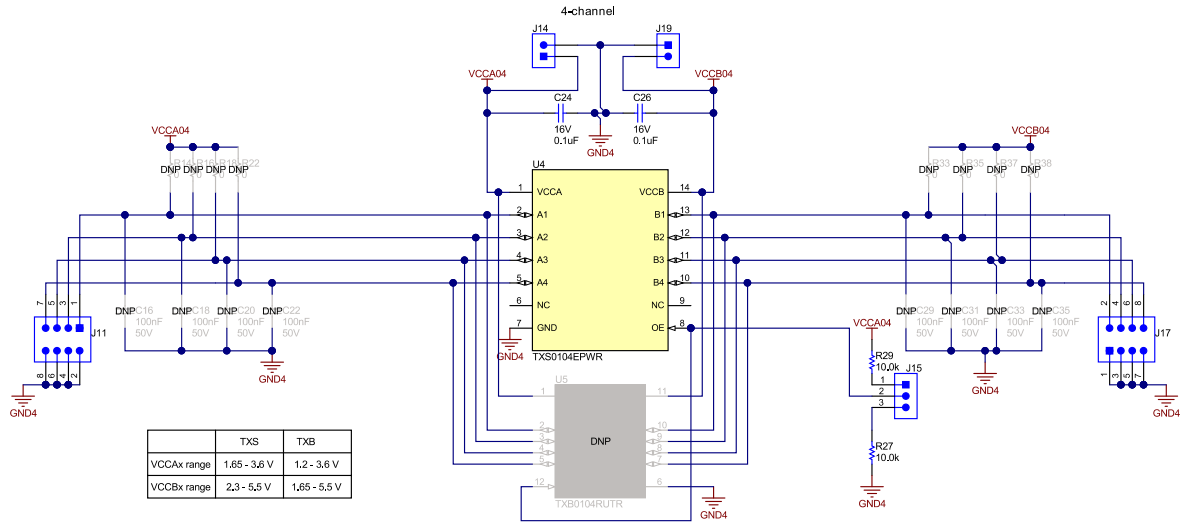


Figure 3-3. 4-Channel TXS0104E

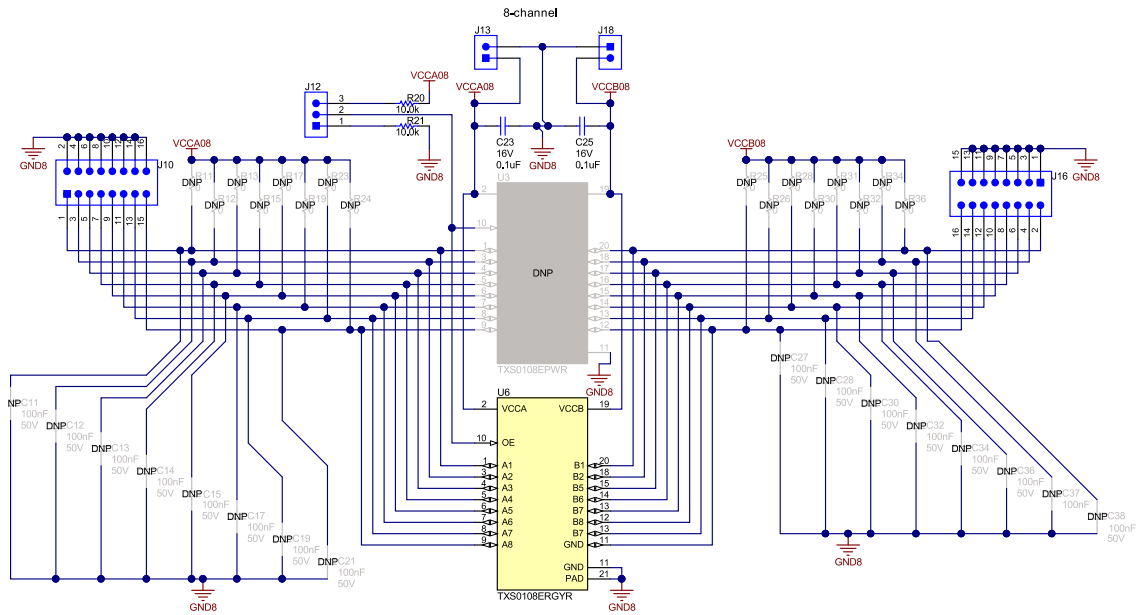


Figure 3-4. 8-Channel TXS0108E

3.2 Bill of Materials

Table 3-1 lists the TXS-EVM bill of materials.

Table 3-1. TXS-EVM Bill of Materials

Designator	Quantity	Description	Part Number	Manufacturer
C4, C5, C6, C7, C23, C24, C25, C26	8	CAP, CERM, 0.1 uF, 16 V, +/- 10%, X7R, 0402	0402YC104KAT2A	AVX
J1, J3, J12, J15	4	Header, 100mil, 3x1, Gold, TH	HTSW-103-07-G-S	Samtec
J2, J5, J6, J7, J9, J13, J14, J18, J19, J20	10	Header, 100mil, 2x1, Gold, TH	HTSW-102-07-G-S	Samtec
J4, J8	2	Header, 100mil, 2x2, Gold, TH	TSW-102-07-G-D	Samtec
J10, J16	2	Header, 100mil, 8x2, Gold, TH	TSW-108-07-G-D	Samtec
J11, J17	2	Header, 100mil, 4x2, Gold, TH	TSW-104-07-G-D	Samtec
R1, R2, R3, R5, R20, R21, R27, R29	8	RES, 10.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	RMCF0402FT10K0	Stackpole Electronics
SH-J1, SH-J3, SH-J12, SH-J15	4	Shunt, 100mil, Flash Gold, Black	SPC02SYAN	Sullins Connector
U1	1	1-Bit Bidirectional Voltage-Level Shifter for Open-Drain and Push-Pull Application, DCK0006A (SOT-SC70-6)	TXS0101DCKR	Texas Instruments
U2	1	2-Bit Bidirectional Voltage-Level Shifter for Open-Drain and Push-Pull Application, DCU0008A (VSSOP-8)	TXS0102DCUR	Texas Instruments
U4	1	4-Bit Bidirectional Voltage-Level Shifter for Open-Drain and Push-Pull Applications, PW0014A (TSSOP-14)	TXS0104EPWR	Texas Instruments
U6	1	8-Bit Bidirectional Voltage-Level Shifter For Open-Drain And Push-Pull Application, RGY0020A (UQFN-20)	TXS0108ERGYR	Texas Instruments
C1, C2, C3, C8, C9, C10, C11, C12, C13, C14, C15, C16, C17, C18, C19, C20, C21, C22, C27, C28, C29, C30, C31, C32, C33, C34, C35, C36, C37, C38	0	CAP, CERM, 0.1 uF, 50 V, +/- 5%, X7R, 0805	08055C104JAT2A	AVX
R4, R6, R7, R8, R9, R10, R11, R12, R13, R14, R15, R16, R17, R18, R19, R22, R23, R24, R25, R26, R28, R30, R31, R32, R33, R34, R35, R36, R37, R38	0	RES, 10.0 k, 0.5%, 0.125 W, 0805	RT0805DRE0710KL	Yageo America
U3	0	8-Bit Bidirectional Voltage-Level Shifter For Open-Drain And Push-Pull Application, PW0020A (TSSOP-20)	TXS0108EPWR	Texas Instruments
U5	0	4-Bit Bidirectional Voltage-Level Shifter with Auto Direction Sensing and +/-15 kV ESD Protect, RUT0012A (UQFN-12)	TXB0104RUTR	Texas Instruments

4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision A (January 2020) to Revision B (June 2021)	Page
• Updated the numbering format for tables, figures and cross-references throughout the document.....	2

Changes from Revision * (October 2019) to Revision A (January 2020)	Page
• Added <i>Auto-Bidirectional Families</i> comparison table.....	2

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