BOOSTXL-RS232 BoosterPack™ Hardware

User's Guide

Literature Number: SLLU250
November 2016

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BOOSTXL-RS232 BoosterPack™ Hardware

1 Trademarks

BoosterPack, LaunchPad are trademarks of Texas Instruments.
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2 Introduction

2.1 Overview

The RS232 BoosterPack provides the opportunity to communicate to and from a TI LaunchPad™ using the RS232 serial protocol. This opens new capabilities for the microcontrollers to interface with industrial equipment for debugging, for accessing memory directly for backup recovery, and for simplified data transfer between systems with proprietary code.

The featured product is the TRS3122E, an ultra-low power, high-speed dual RS232 transceiver. It supports data [RX, TX] channels as well as flow control [RTS, CTS] channels that can be easily assigned to 1 of 10 general purpose input/output (GPIO) pins. These channels on the TRS3122E can be configured to be either one set of data channels and one set of control channels for flow control or to be two sets of data channels. However, this BoosterPack is configured for one set of data channels [RX, TX] and one set of control channels [RTS, CTS]. With its unique doubler and tripler charge pump architecture, the TRS3122E can operate at a VCC as low as 1.8 V while maintaining compatibility with 3.3-V and 5-V supplies. This BoosterPack allows for operating voltages of 1.8 V or 3.3 V.

This device features a shutdown mode that reduces supply current as low as 0.5 µA. This can be done manually or by setting the TRS3122E into its *Auto-Powerdown Plus* mode. See Section 4 for more information on the modes of operation of the TRS3122E along with how to set up the BoosterPack for these modes.

2.1.1 What Is Included?

- 1× RS232 BoosterPack
- 7× Shunt Jumper

Figure 1 is a photo of the BOOSTXL-RS232 board.

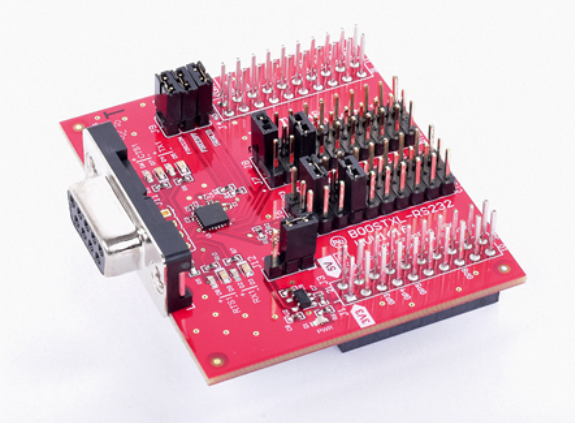


Figure 1. BOOSTXL-RS232

3 Hardware Description

3.1 Top and Bottom View

Figure 2 is a top view of the BOOSTXL-RS232 and Figure 3 is a bottom view of the BOOSTXL-RS232.

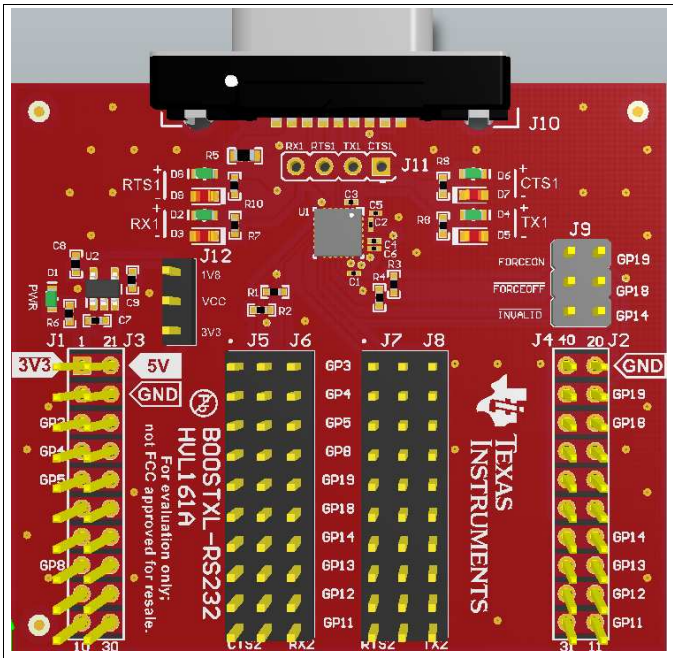


Figure 2. Top View of BOOSTXL-RS232

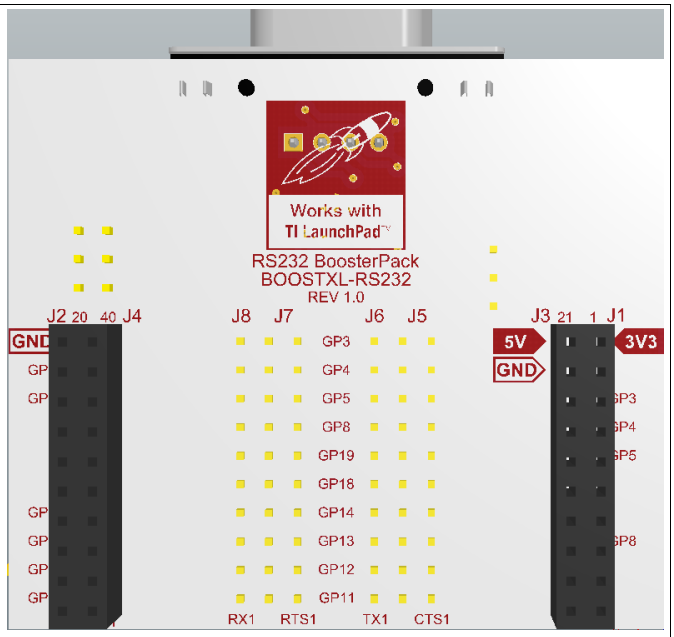


Figure 3. Bottom View of BOOSTXL-RS232

3.2 Board Overview

Figure 4 shows an overview of the BOOSTXL-RS232 BoosterPack. The main features such as devices, connectors, headers, and LEDs are highlighted.

See Section 3.4, Section 3.5, and Section 3.6 for additional details regarding each portion of the board.

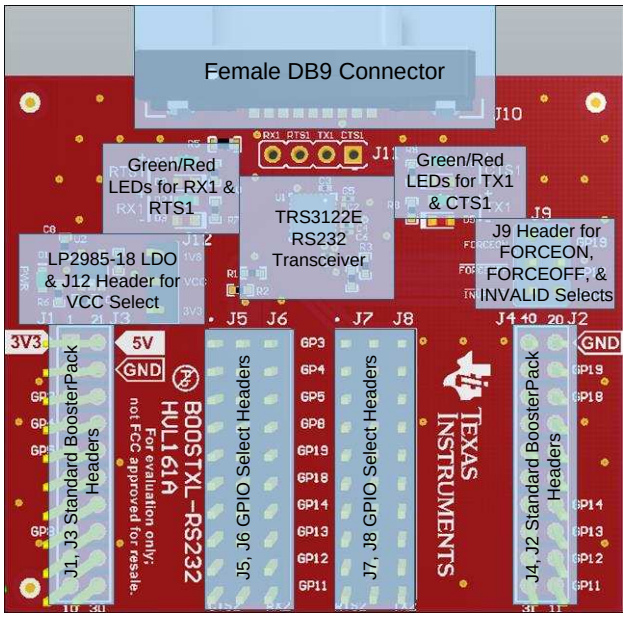


Figure 4. BOOSTXL-RS232 Overview

3.3 Block Diagram

Figure 5 details a block diagram of the BOOSTXL-RS232 BoosterPack. The 40-pin BoosterPack header allows the BoosterPack to be easily interfaced with LaunchPads. A 3-pin header is available to change V_{CC}/V_L between 3.3 V and 1.8 V. This allows the BoosterPack to communicate with LaunchPads either at 3.3-V or 1.8-V logic levels. See Section 3.5.4 for more details. The two 30-pin GPIO headers allow for the selection of GPIO pins on the LaunchPad to be connected to the TRS3122E. See Section 3.5.1 for more information. A 6-pin header is available to allow for the FORCEON, $\overline{\text{FORCEOFF}}$, and $\overline{\text{INVALID}}$ pins on the TRS3122E to be connected to LaunchPad GPIO pins for more control. See Section 3.5.2 and Section 3.5.3 for more information.

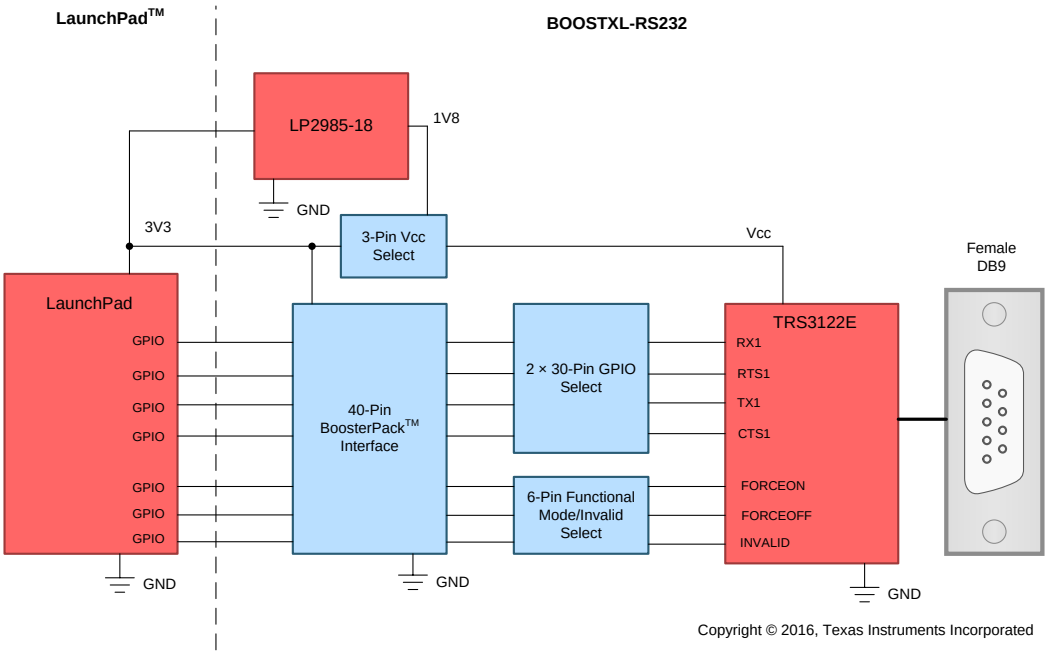


Figure 5. BOOSTXL-RS232 Block Diagram

3.4 DB9 Connector

The BoosterPack includes a female data circuit-terminating equipment (DCE) DB9 port. Female DCE ports are designed to connect with the male data terminal equipment (DTE) port of the computer. The labeling for Figure 6 is from the perspective of the computer with the DTE port. Therefore, RX1 is actually an output from the BoosterPack to the connected device through the RS232 interface, while TX1 is an input from the connected device to the BoosterPack through the RS232 interface. The same applies to the RTS1 (input) and CTS1 (output) ports. The RX2, TX2, CTS2, and RTS2 ports are used to interface with the microcontroller through 0-V to 3.3-V (or 1.8-V) TTL signals. See Table 1 for information on how the DB9 connector is routed on the BOOSTXL-RS232 BoosterPack.

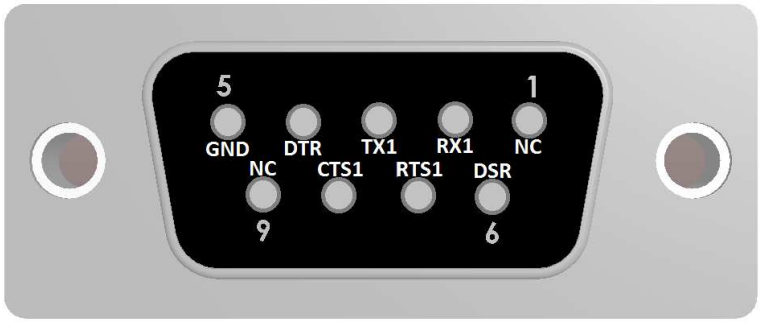


Figure 6. DB9 Pinout

Table 1. RS-232 Female DB9 Connector Pin Summary

Pin	Function
1	NC
2	UART Receive 1 (RX1)
3	UART Transmit 1 (TX1)
4	Shorted to pin 6 (unused flow control line)
5	GND
6	Shorted to pin 4 (unused flow control line)
7	Request to Send 1 (RTS1)
8	Clear to Send 1 (CTS1)
9	NC

3.5 Header Descriptions

3.5.1 Using J5, J6 and J7, J8 GPIO Headers

The J5, J6 and J7, J8 10 × 3 headers are for assigning the TRS3122E UART Drivers or Receivers (labeled as CTS2, RX2, RTS2, and TX2 on the BoosterPack) to various LaunchPad GPIOs. The default jumper setup has TX2, RX2, RTS2, and CTS2 assigned to LaunchPad GPIO pins GP3, GP4, GP5, and GP8, respectively. TI recommends tying TX2 and RX2 to GP3 and GP4, respectively, since GP3 and GP4 are typically the UART transmit and receive ports on TI LaunchPads, this is not required but should be kept in mind. RTS2 and CTS2 can be connected to any desired GPIO pin.

Each pin of the middle column of the 10 × 3 headers correlates to a particular GPIO pin. The pin it is connected to is labeled in between the J5, J6 and J7, J8 header groups, this is seen in Figure 7. The columns on either side of the middle column are connected to their coinciding transceiver pins, which are labeled at the bottom of each column, this is seen in Figure 7. For example, looking at header J5, J6 in Figure 7, the right column coincides with RX2. Placing a jumper across the first pins of the middle column and the right column would short GP3 from the LaunchPad to the DIN1 pin on the TRS3122E.

NOTE: See Section 5 for information on headers J1-4 and how they interface with the LaunchPad ecosystem.

NOTE: See Figure 13 and Figure 14 for more clarification of how the headers are routed.

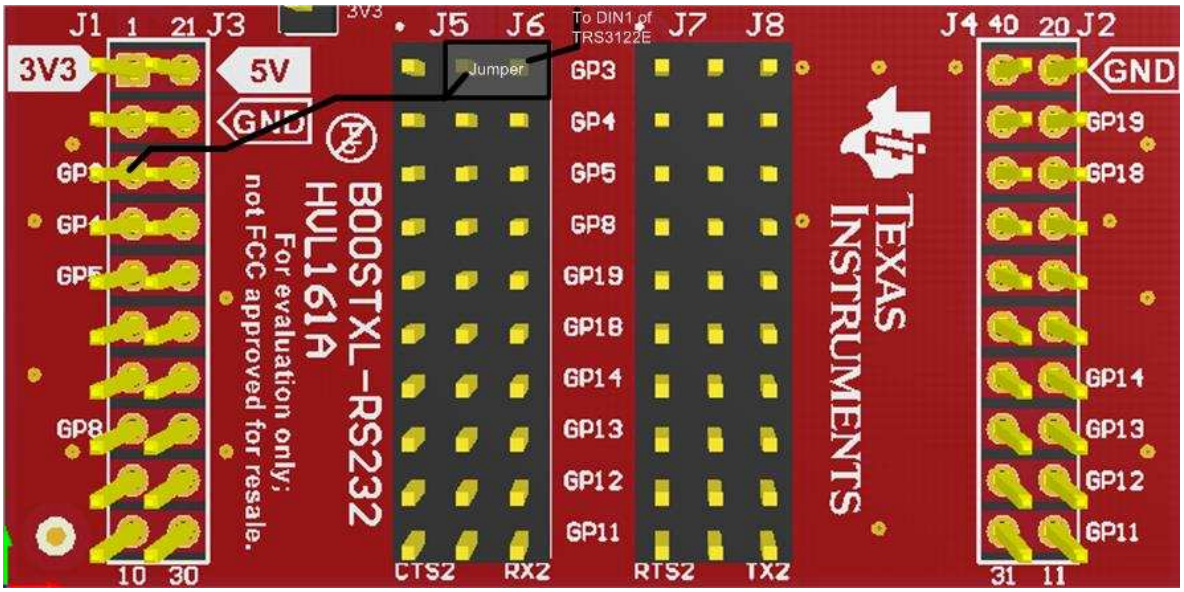


Figure 7. GPIO Headers

3.5.2 Utilizing FORCEON and $\overline{\text{FORCEOFF}}$

The J9 3 × 2 header allows for the option to assign FORCEON and $\overline{\text{FORCEOFF}}$ to GP19 and GP18, respectively. FORCEON can be connected to GP19 by placing a jumper across pins 1 and 2 on J9 and $\overline{\text{FORCEOFF}}$ can be connected to GP18 by placing a jumper across pins 3 and 4 on J9, see Figure 8. This allows for the control of the different functional modes of the TRS3122E. See Section 4 to learn more about the different functional modes and how to control them using FORCEON and $\overline{\text{FORCEOFF}}$.

NOTE: If FORCEON and $\overline{\text{FORCEOFF}}$ are not intended to be controlled, then remove the jumpers discussed.

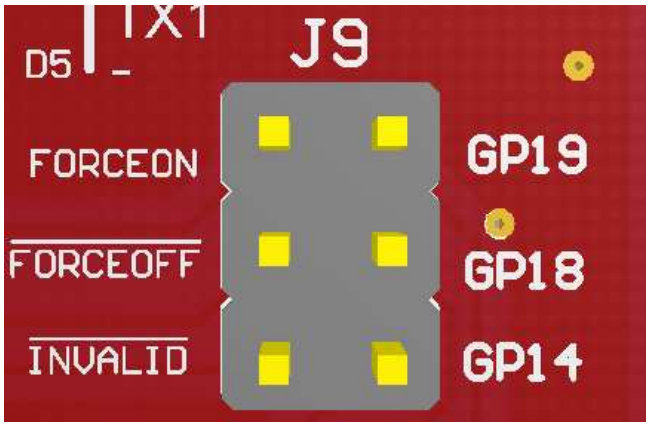


Figure 8. Header J9

3.5.3 Utilizing INVALID Signal

The J9 3 × 2 header also allows for the option to monitor the $\overline{\text{INVALID}}$ pin of the TRS3122E by linking it to a GPIO pin on a LaunchPad. By placing a jumper across pins 5 and 6 on J9, see Figure 8, the $\overline{\text{INVALID}}$ pin will be connected to GP14. The GPIO port on a LaunchPad can then be set to an input and used to monitor the $\overline{\text{INVALID}}$ pin. See Section 4.4 to learn more about the $\overline{\text{INVALID}}$ pin.

NOTE: If the $\overline{\text{INVALID}}$ pin is not intended to be monitored, remove the jumper.

3.5.4 Assigning Desired Supply Voltage

The BOOSTXL-RS232 BoosterPack is populated with a linear regulator to drop the typical 3.3-V V_{CC} on most LaunchPads to 1.8 V. This allows for communication with LaunchPads that are capable of communicating at 1.8-V logic levels. To switch between a 1.8-V and 3.3-V supply, use a jumper on J12 to short the center V_{CC} pin to the desired supply voltage, see Figure 9. A short between pin 1 and 2 results in 3.3-V V_{CC} and a short between 2 and 3 results in 1.8-V V_{CC}. Pin 1 on J12 is denoted with a white line along one edge of the pin, as seen in Figure 9. While V_L and V_{CC} are independent on the TRS3122E device itself, these two pins are tied together on the BoosterPack. This way V_L cannot accidentally be set higher than V_{CC}. This option was added to display the ultra-low voltage capabilities of the TRS3122E.

NOTE: V_{CC} and V_L should only be set to 1.8 V if the BOOSTXL-RS232 is intended to interface with a LaunchPad that operates at 1.8-V logic levels. Otherwise TI recommends leaving the jumper across pins 1 and 2 of J12.

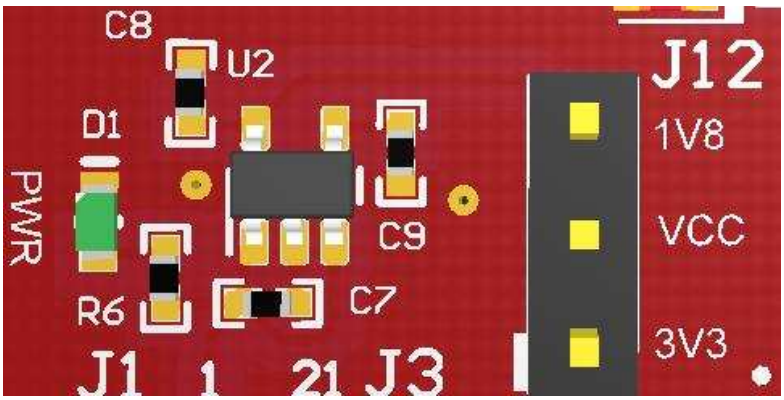


Figure 9. Supply Select

3.6 LED Description

For this BoosterPack, there are two LEDs per RS232 line (RTS1, RX1, CTS1, TX1) and one power indication LED, see Figure 10. The LEDs serve as a reference when connecting the BoosterPack to a LaunchPad and up to a RS232 serial port. A red LED for an RS232 line indicates negative voltage or a LOW signal, while a green LED indicates positive voltage or a HIGH signal. This information is also denoted next to each LED; a '+' sign for the green LED and a '-' sign for the red LED. Upon powering the BoosterPack, the power LED will turn on and the driver and receiver line LEDs may also be on, depending on what the board is connected to.

Since RS232 TX and RX lines sit at a LOW voltage level until data is transmitted or received, the red LED for TX1 and RX1 on the board will be on until data is transmitted or received. While transmitting or receiving, the green LED will blink for the line in use. End of transmission is indicated with just a red LED. The RTS1 green LED will be on when a request-to-send signal is raised and the CTS1 green LED will be on when the clear-to-send signal is raised. Otherwise, the red LEDs will be on.

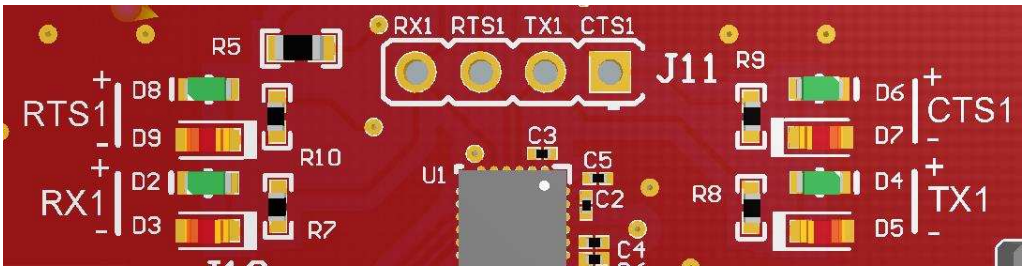


Figure 10. RS232 LEDs

4 Functional Modes

The BOOSTXL-RS232 BoosterPack has three modes of operation: On with Auto-Powerdown Plus enabled, Forced On, and Forced Off. Included in this section is the discussion of the INVALID pin.

4.1 Auto-Powerdown Plus

Auto-Powerdown Plus is enabled when FORCEON is set LOW and $\overline{\text{FORCEOFF}}$ is set HIGH. Using the integrated edge-detection circuitry and timer of the TRS3122E, the device can sense when there is no activity on the driver or receiver inputs for 30 seconds. When this condition is sensed by the device, it automatically shuts the charge pump off, reducing supply current to 0.5 µA. When a valid transition is sensed on one of the driver or receiver inputs, the charge pump turns back on and TRS3122E exits powerdown mode. The typical time to exit powerdown mode is typically 30 µs, but can be as long as 150 µs. As a result, the system saves power without requiring any software control. While in the low power mode with Automatic Powerdown enabled ($\overline{\text{FORCEOFF}}$ = HIGH and FORCEON = LOW), the receiver inputs are still enabled.

The FORCEON and $\overline{\text{FORCEOFF}}$ pins control the power states of the transceiver. When the jumpers short FORCEON to GP19 and $\overline{\text{FORCEOFF}}$ to GP18, the power down states of the transceiver can be controlled through GPIO, see Table 2 and Table 3.

4.2 Forced On

If the FORCEON and $\overline{\text{FORCEOFF}}$ pins are both set HIGH, the device will power on with Auto-Powerdown Plus disabled. Both the drivers and receivers will be active regardless of inactivity, as shown in Table 2 and Table 3.

4.3 Forced Off

The device can be manually powered down by externally setting the $\overline{\text{FORCEOFF}}$ pin LOW. Both the drivers and receivers will be powered off, as shown in Table 2 and Table 3. This mode overrides the other modes.

Table 2. Driver Functions(1)

Inputs				Output	Driver Status
DIN	FORCEON	$\overline{\text{FORCEOFF}}$	Time Elapsed Since Last RIN or DIN Transition	DOUT	
X	X	L	X	Z	Powered off
L	H	H	X	H	Normal operation with auto-powerdown plus disabled
H	H	H	X	L	
L	L	H	< 30 s	H	Normal operation with auto-powerdown plus enabled
H	L	H	< 30 s	L	
L	L	H	> 30 s	Z	Powered off by auto-powerdown plus feature
H	L	H	> 30 s	Z	

(1) H = high level, L = low level, X = irrelevant, Z = high impedance (off), 30 s is typical inactivity time

Table 3. Receiver Functions(1)

Inputs			Output	Receiver Status
RIN	$\overline{\text{FORCEOFF}}$	Time Elapsed Since Last RIN or DIN Transition	ROUT	
X	L	X	Z	Powered off
L	H	X	H	Normal operation with auto-powerdown plus disabled or enabled
H	H	X	L	
Open	H	X	H	

(1) H = high level, L = low level, X = irrelevant, Z = high impedance (off), Open = input disconnected or connected driver off

4.4 Invalid

The $\overline{\text{INVALID}}$ pin senses whether or not there is a cable connected to the port. A HIGH voltage level on the pin means there is a connection and a LOW voltage level on the pin means there is not a connection, see Table 4.

Table 4. $\overline{\text{INVALID}}$ Status(1)

Inputs				Output
RIN1, RIN2	**FORCEON**	**$\overline{\text{FORCEOFF}}$**	**Time Elapsed Since Last RIN or DIN Transition**	**$\overline{\text{INVALID}}$**
Any L or H	X	X	X	H
All Open	X	X	X	L

(1) H = high level, L = low level, X = irrelevant, Z = high impedance (off), Open = input disconnected or connected driver off

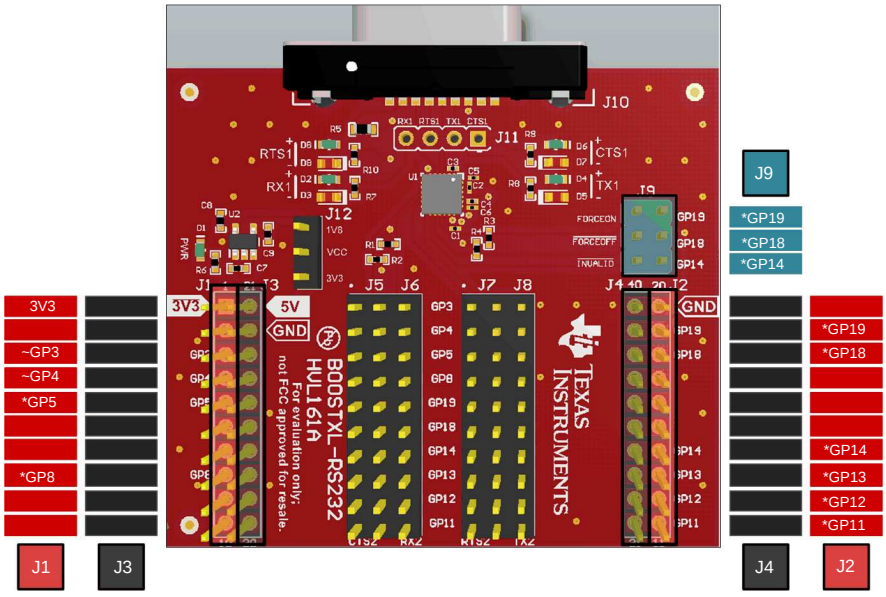
5 Interfacing with External Hardware

TI BoosterPacks are designed in a way that allows multiple devices (BoosterPacks and LaunchPads) to continually stack on top of each other.

CAUTION

When stacking devices, correctly align the two devices and make sure that any unwanted connections are not made by accident. Unwanted connections occur when header pins on the bottom device contacts vias or through-hole solder joints of the upper device. These unwanted contacts can create shorts that may cause incorrect circuit operation and could potentially cause damage to the hardware.

Figure 11 shows the top layer of the BOOSTXL-RS232 with the headers J1-4 and J9 highlighted. J1-4 are eventually connected directly to LaunchPad pins. J9 is highlighted because the right column is routed directly to header pins that are connected to LaunchPad pins. The highlighted headers are color matched to the description boxes on the exterior of the image of the board. If the description boxes are labeled, it means that they are specifically routed on the BoosterPack. For example, the first red box on the left is labeled 3V3 and it is lined up with pin 1 of J1, which is highlighted red. This means that pin 1 of J1 is connected to the 3V3 pin of the LaunchPad. If they are empty, they are not routed. You will notice that the inner, black headers are not routed at all. This is because they are not needed for the operation of this board and are left available to stack other development boards that might need them. See ti.com/launchpad for details regarding connecting to other development boards.



(1) Pins with no name or description are not connected. Pins with the same name or description are shorted together.

(2) * these pins are not required for BoosterPack operation.

(3) ~ these pins are not required to be used but are recommended

Figure 11. Interfacing With LaunchPad

6 Additional Information

6.1 Design Files

All design files including schematics, layout, bill of materials (BOM), Gerber files, and documentation are available in the *Texas Instruments Resource Explorer*:

dev.ti.com/tirex

The schematic is shown in Section 6.3, the top layer and bottom layer PCB layouts are illustrated in Figure 13 and Figure 14.

6.2 Hardware Change Log

Table 5 details descriptions of hardware changes.

Table 5. Description of Hardware Changes

PCB Revision	Description of Changes
Rev 1.0	Initial Release

6.3 Schematic

Figure 12 illustrates the BOOSTXL-RS232 schematic.

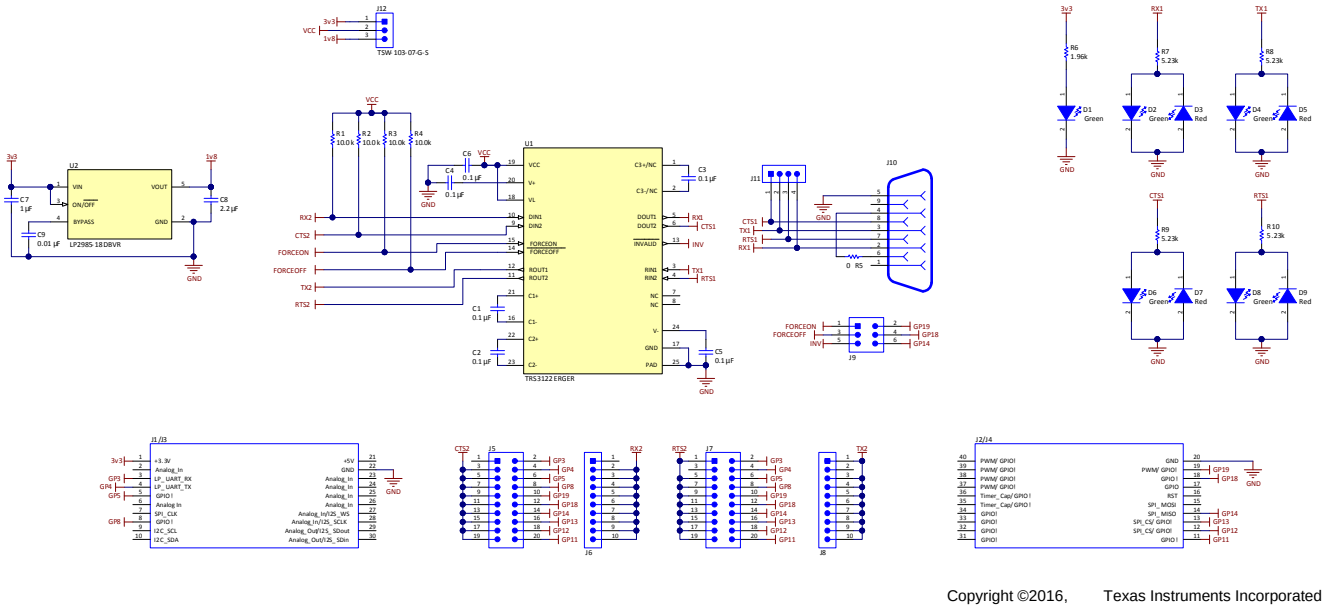


Figure 12. BOOSTXL-RS232 Schematic (Zoom for Higher Resolution)

6.4 PCB Layout

Figure 13 shows the top layer routing of the BOOSTXL-RS232. Figure 14 shows the bottom layer routing of the BOOSTXL-RS232.

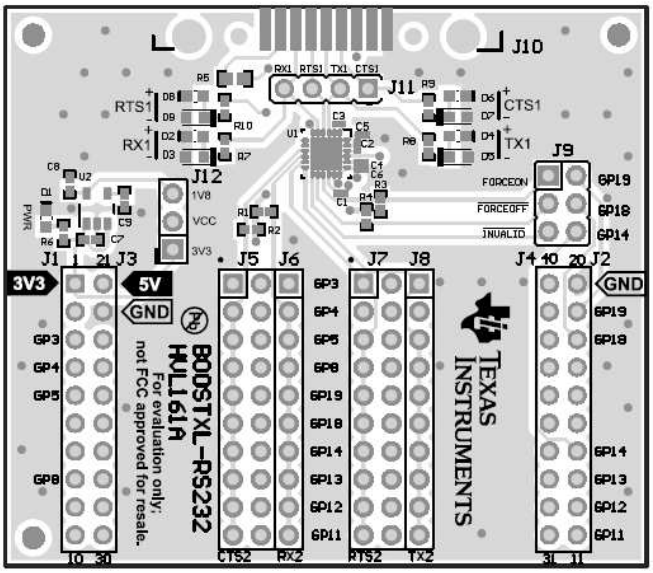


Figure 13. Top Layer Routing

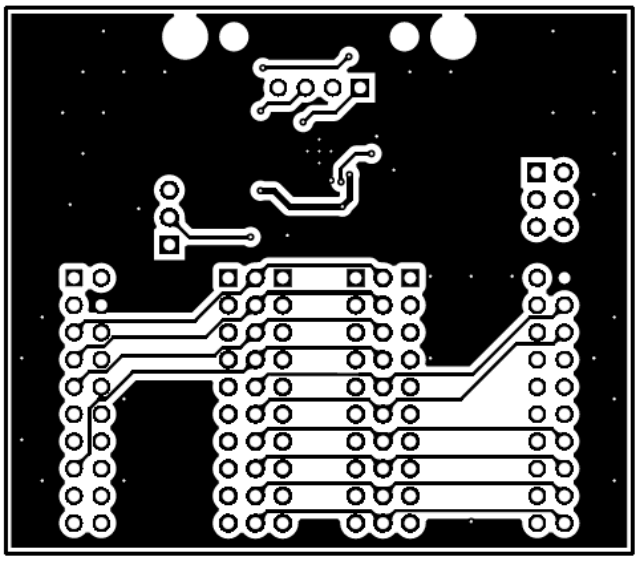


Figure 14. Bottom Layer Routing

STANDARD TERMS AND CONDITIONS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including demonstration software, components, and/or documentation which may be provided together or separately (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms and conditions set forth herein. Acceptance of the EVM is expressly subject to the following terms and conditions.

   1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM (“Software”) shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms and conditions that accompany such Software

   1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

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   2.1 These terms and conditions do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

   2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for any defects that are caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI. Moreover, TI shall not be liable for any defects that result from User's design, specifications or instructions for such EVMs. Testing and other quality control techniques are used to the extent TI deems necessary or as mandated by government requirements. TI does not test all parameters of each EVM.

   2.3 If any EVM fails to conform to the warranty set forth above, TI's sole liability shall be at its option to repair or replace such EVM, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

3 *Regulatory Notices:*

   3.1 *United States*

      3.1.1 *Notice applicable to EVMs not FCC-Approved:*

      This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

      3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

      CAUTION

      This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

      Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

      FCC Interference Statement for Class A EVM devices

      NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 *Japan*

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required by Radio Law of Japan to follow the instructions below with respect to EVMs:

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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2. 実験局の免許を取得後ご使用いただく。
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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page
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4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

6. *Disclaimers:*

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