Automotive CXPI Communication Application Circuit A Driver-Receiver Board

Reference Guide

RD254A-RGUIDE-01

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1. Introduction

This reference guide describes the specifications, usage, and characteristics of the Automotive CXPI Communication Application Circuit A – Driver-Receiver Board (hereinafter referred to as "this design").

CXPI is a next-generation Automotive communication protocol established by the Society of Automotive Engineers of Japan and standardized by the International Organization for Standardization (ISO) as ISO 20794:2020. The protocol was developed to reduce the increase in wiring harnesses associated with communication between HMI (Human Machine Interface) devices and to contribute to overall vehicle weight reduction.

Traditionally, automotive networks have widely adopted LIN communication for controlling components such as door mirrors and LED lighting. In contrast, next-generation CXPI communication offers both low cost and high responsiveness, contributing to efficient control of automotive functions. This design is created with these application scenarios in mind.

This design is a CXPI driver-receiver board for a commander node in CXPI communication. The commander node is connected to a host controller and transmits and receives communications using the CXPI driver-receiver board equipped with the TB9032FNG CXPI physical layer interface IC. Commands from the host controller are sent to each responder node via the CXPI driver-receiver board and the CXPI bus.

2. Appearance and Specifications

2.1. Specifications

Table 2.1 lists the specifications of the RD254A board used in this design.

In this design, the CXPI BUS voltage is determined by the VBAT voltage. When the board is connected to other CXPI nodes, the VBAT voltage should be set so that the CXPI BUS potential is aligned.

In this reference guide, the VBAT voltage is assumed to be 12V.

Table 2.1 RD254A Board Specifications

Item	Condition	Min	Typ.	Max	Unit
Power					
VBAT Voltage		6	12	16	V
VIO		4.5	5	5.5	V
RXD					
Output HIGH Voltage	Load current -1mA, V_{VIO} = 5V	4.5	-	-	V
Output LOW Voltage	Load current 1mA	-	-	0.5	V
TXD					
Input HIGH Voltage	V_{VIO} = 5V	4.0	-	-	V
Input LOW Voltage	V_{VIO} = 5V	-	-	1.0	V
Hysteresis	V_{VIO} = 5V	0.16	0.325	0.65	V
BUS (DC Characteristics)					
Dominant Output Voltage	V_{TXD}=0V, R_L※= 500Ω 10V ≤ VBAT ≤ 18V	-	-	2.0	V
Recessive Output Voltage	TXD=H	0.8 x V_{BAT}	-	V_{BAT}	V
Dominant Threshold Voltage at Receiver	Voltage at which the receiving node determines the BUS level as Low	-	-	0.423 x V_{BAT}	V
Recessive Threshold Voltage at Receiver	Voltage at which the receiving node determines the BUS level as High	0.556 x V_{BAT}	-	-	V
Hysteresis	-	-	-	0.133 x V_{BAT}	V
Other Settings					
Board Layer Structure	FR-4, 2 layers (through-hole via), PCB thickness 1.6mm, Cu thickness 35µm (surface layer)				
Board Size	65mm x 55mm				

Note: R_L is the pull-up resistor connected externally to the IC between BAT and BUS line.

2.2. Block Diagram

Fig 2.1 shows a block diagram of the functional operation of this design.

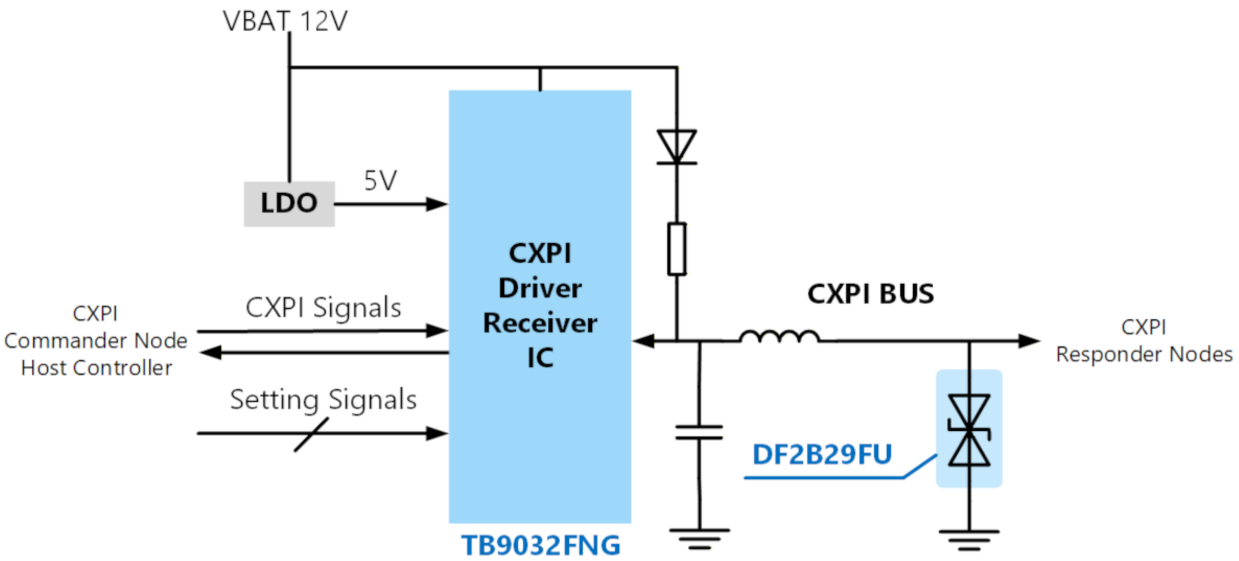


Fig 2.1 Block Diagram

2.3. Appearance

Fig 2.2 shows the appearance of this design.

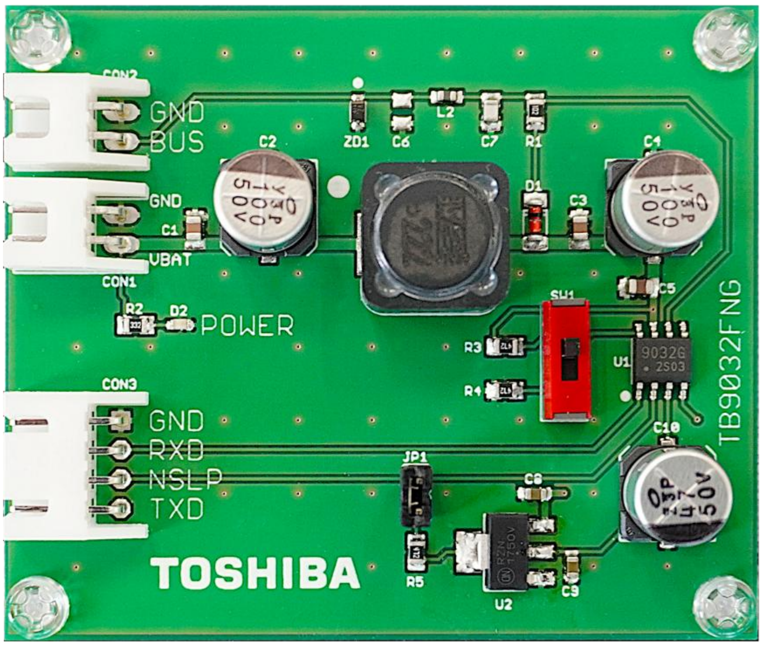
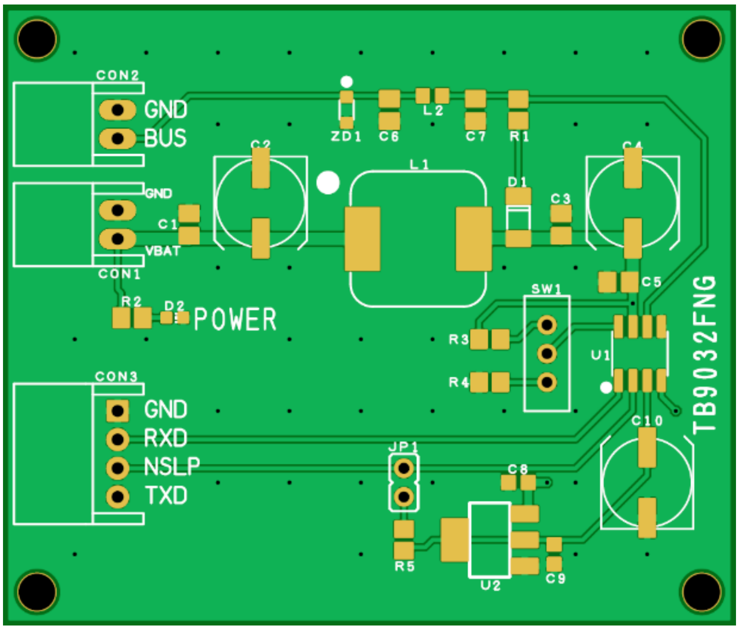


Fig 2.2 Board Appearance

2.4. PCB Component Layout

Fig 2.3 shows the component layout of this design.



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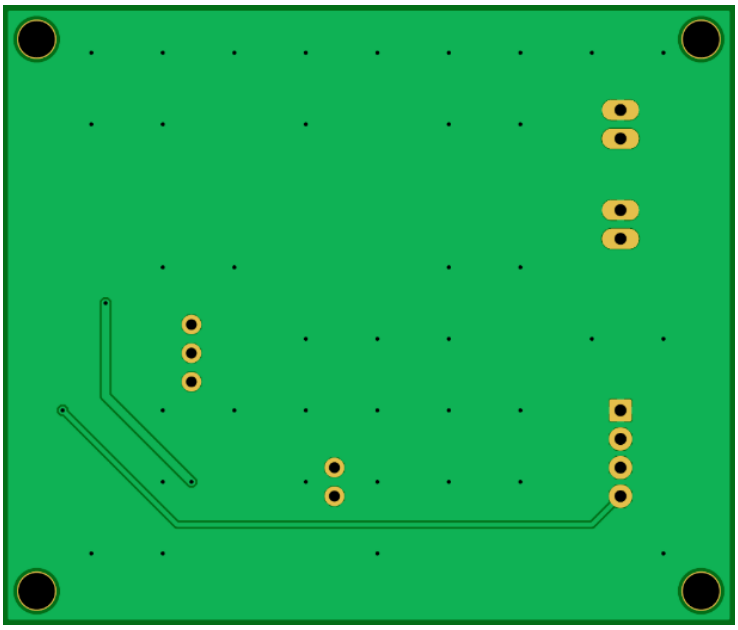


< Back Side >

Fig 2.3 PCB Component Layout

3. Schematic, Bill of Materials, and PCB Pattern Diagram

3.1. Schematic

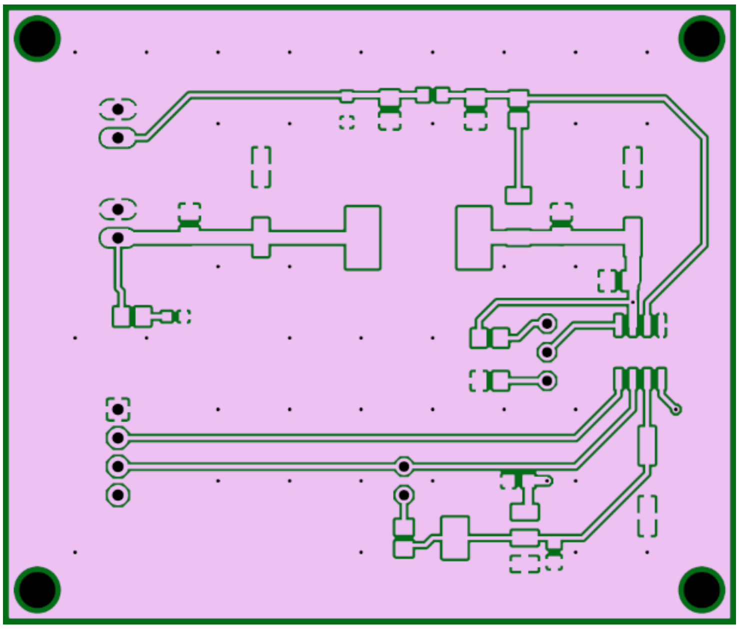
Refer to the following files.
RD254A-SCHEMATIC-xx.pdf
(xx is the revision number)

3.2. Bill of Materials

Refer to the following files.
RD254A-BOM-xx.pdf
(xx is the revision number)

3.3. PCB Pattern Diagram

Fig 3.1 shows PCB pattern diagram of the main board.
Refer to the following files too.
RD254A-LAYER-xx.pdf
(xx is the revision number)



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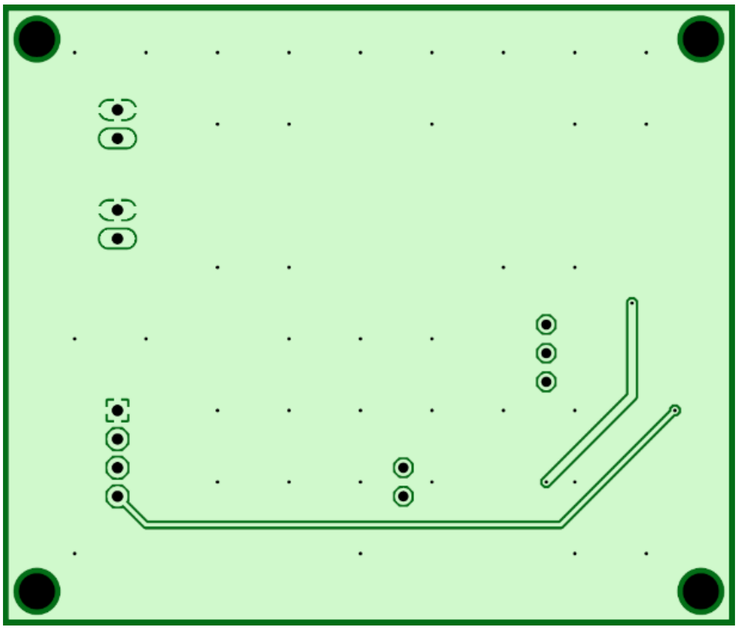

<L2 (Bottom Layer)>

Fig 3.1 PCB Pattern Diagram (Top View)

4. Description of This Design

This section explains the names and functions of each component of the board interface in this design. Fig 4.1 shows the layout of this design.

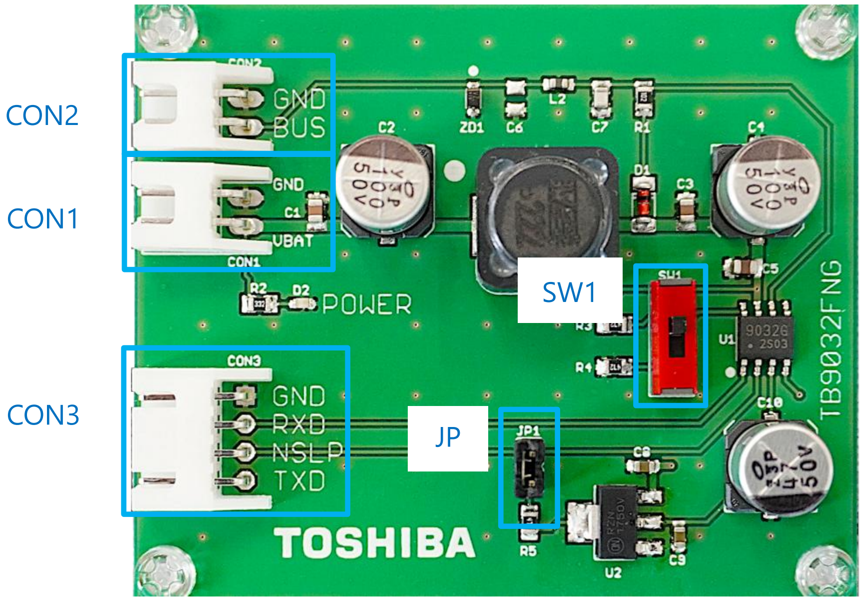

Fig 4.1 Component Layout

4.1. Connectors, Switches

This section describes the connectors and switches of this design.

4.1.1. Power Supply Connector (CON1)

The 2-pin connector CON1 is used to input DC power (VBAT). The VBAT voltage is typically 12V. Connect the VBAT pin last.

Table 4.1 Power Supply Connector Description

Pin No.	Name	Description
1	GND	DC Voltage (-) (GND)
2	VBAT	DC Voltage (+)

4.1.2. CXPI BUS Connector (CON2)

The 2-pin connector CON2 is used to connect to the CXPI BUS. The BUS pin is connected to the BUS terminal of the CXPI driver-receiver IC TB9032FNG and is pulled up to VBAT. For details, refer to the design guide.

Table 4.2 CXPI BUS Connector Description

Pin No.	Name	Description
1	GND	GND
2	BUS	Connect to CXPI BUS

4.1.3. Control Connector (CON3)

The 4-pin connector CON3 is used to connect to the CXPI host controller. Each pin is connected to the corresponding terminal on the CXPI driver-receiver IC TB9032FNG. For details, refer to the TB9032FNG datasheet.

Be aware of the difference in voltage levels between this board and the CXPI host controller and adjust the voltage using a level shifter or a similar device if necessary.

Table 4.3 Control Connector Description

Pin No.	Name	I/O	Description
1	GND	-	GND
2	RXD	Out	Connect to CXPI host controller RXD Output terminal for CXPI signals received from CXPI BUS
3	NSLP	In	Input High: Normal mode Input Low: Sleep mode or Wakeup transmission mode
4	TXD	In	Connect to CXPI host controller TXD Input terminal for CXPI signals to be transmitted to CXPI BUS

4.1.4. Jumper (JP1)

By shorting jumper JP1, the NSLP line can be pulled up to 5V.

Fixing the NSLP line to High

To fix the NSLP line to High, leave the NSLP pin of control connector CON3 open and short JP1.

Driving the NSLP pin with an open-drain output

When driving the NSLP pin with an open-drain output from the CXPI host controller, connect the open-drain output of the CXPI host controller to the NSLP pin of CON3 and short JP1.

4.1.5. Select Switch (SW1)

Switch SW1 allows selection between the commander node and the responder node. Since this design is intended for use as a commander node, set SW1 to ON (High). When using the device as a responder node, SW1 must be set to OFF. In addition, please note that the R1 and D1 components on the BUS line must be removed.

Table 4.4 Select Switch Description

SW1 ON/OFF	SW1 Knob position	High / Low	Node Configuration
ON	Top	High	Commander Node
OFF	Bottom	Low	Responder Node

4.2. Operation Procedure

4.2.1. Connection and Setup Procedure

1. Turn off the power to this board and the CXPI host controller.
2. Refer to *"4.1.5 Select Switch (SW1)"* and set SW1 to either the commander node or the responder node according to the intended use of this board.
3. Refer to *"4.1.3.* Control Connector (CON3)*"* and connect the CXPI host controller to CON3.
4. Refer to *"4.1.4.* Jumper (JP1)*"* and, if necessary, install JP1 and confirm CON3 connections.
5. Refer to *"4.1.2.* CXPI BUS Connector (CON2)*"* and connect the CXPI BUS to CON2.
6. Refer to *"4.1.1 Power Supply Connector (CON1)"* and connect a power supply to CON1.

4.2.2. Activation Procedure

Activation procedure for commander node

1. Apply a DC power supply to the power supply connector CON1 and turn on the power of this board.
2. Turn on the power of the CXPI host controller (Commander node).
3. Initialize communication on the CXPI host controller (Commander node) side. If NSLP is not configured to be fixed at High, input a High signal from the CXPI host controller to the NSLP pin of the control connector CON3 to transition the on-board CXPI driver-receiver IC TB9032FNG to Normal mode.
4. Generate the BUS clock on the CXPI host controller side.
5. Start communication on the CXPI BUS.

Activation procedure for responder node

1. Apply a DC power supply to the power supply connector CON1 and turn on the power of this board.
2. Turn on the power of the CXPI host controller (Responder node).
3. Initialize communication on the CXPI host controller (Responder node) side. If NSLP is not configured to be fixed at High, after transmitting a TXD = Low signal for a duration longer than Ttx_wakeup_mode_on from the CXPI host controller to the CXPI driver-receiver IC TB9032FNG, the CXPI driver-receiver IC TB9032FNG transmits a Wake-up pulse to the commander node via the CXPI BUS. Then, input a High signal from the CXPI host controller to the NSLP pin of the control connector CON3 to transition the on-board CXPI driver-receiver IC TB9032FNG to Normal mode.
4. Start communication on the CXPI BUS.

4.2.3. Signal Communication

Refer to the CXPI driver-receiver IC TB9032FNG datasheet for details.

4.2.4. Shutdown Procedure

Shutdown procedure for commander node

1. Send a Sleep message **(Note 1)** from the CXPI host controller to the CXPI BUS, and stop the bus clock within t_clockstop_m (30Tbit).
2. Input a Low signal to the NSLP pin of the Control Connector (CON3) from the CXPI host controller to transition the CXPI driver-receiver IC TB9032FNG on this board to Sleep mode. If the NSLP line is not configured to be fixed at High, remove JP1 and set the NSLP line to the Low level.
3. Turn off the power supplied to the Power Supply Connector (CON1).

Shutdown procedure for responder node

1. Receive a Sleep message **(Note 1)** from the commander node via the CXPI BUS.
2. Input a Low signal to the NSLP pin of the Control Connector (CON3) from the CXPI host controller to transition the CXPI driver-receiver IC TB9032FNG on this board to Sleep mode. If the NSLP line is not configured to be fixed at High, remove JP1 and set the NSLP line to the Low level.
3. Turn off the power supplied to the Power Supply Connector (CON1).

(Note 1) Sleep message processing is not a function of the TB9032FNG and is not directly related to its operation. The transmission and reception of Sleep messages are described as reference information for Sleep-mode transitions in CXPI communication.

Common Precautions for Evaluation

Please read and follow the precautions below to ensure safe evaluation work.

Precautions for Electric Shock Prevention

- Before applying power, **confirm that the polarity of connectors, terminals, and wiring is correct**.
- Some parts of the board may be exposed to high voltage. **Do not touch the board or components while power is applied**.
- Even after the power is turned off, capacitors may retain residual charge. **Ensure that all capacitors are fully discharged before touching the board**.
- When measuring voltage or current waveforms, **take sufficient precautions to avoid electric shock and maintain a safe distance**.

Precautions for Burn Prevention (High-Temperature Components)

- MOSFETs, diodes, inductors, coils, and semiconductor devices may become **very hot during operation**. Handle them carefully to avoid burns.
- Under high load conditions, heat generation increases. **Use appropriate cooling (such as fans)**.
- Component temperatures may remain high immediately after power-off. **Allow sufficient cooling time before touching**.

Precautions for the Evaluation Environment

- During operation checks, implement safety measures such as **covering the board with a non-conductive enclosure** if necessary **(e.g., acrylic case)**.
- When using motors or other moving parts, **take measures to prevent contact during operation**.
- For designs with shunt or jumper settings, **verify that the settings are correct before operation**.

Other Precautions

- Loads connected to output terminals may generate heat. **Pay attention to load temperature rise**.
- Keep flammable and conductive materials away during evaluation to **avoid short circuits and accidents**.

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