Automotive CXPI Communication Application Circuit C LED Ambient Light Drive Board

Reference Guide

RD254C-RGUIDE-01

Toshiba Electronic Devices & Storage Corporation

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1. Introduction

This reference guide describes the specifications, usage, and characteristics of the Automotive CXPI Communication Application Circuit C LED Ambient Light Driver (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 an LED ambient light driver board equipped with a CXPI interface, serving as an example of a responder node in CXPI communication. The TB9033FTG, which provides 16 GPIO pins, is used as the CXPI interface IC. The N-channel MOSFET SSM3K341R is used for ambient light LED driving.

2. Appearance and Specifications

2.1. Specifications

Table 2.1 shows the specifications of the RD254C 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 RD254C Board Specifications

Item	Condition	Min	Typ.	Max	Unit
Power					
VBAT Voltage		6	12	16	V
VCC		4.8	5	5.2	V
GPIO_xx: Digital Output (PWM)					
Dominant Voltage during reception	Voltage at which the receiving node determines Low level	-	-	0.423× V_{VBAT}	V
Recessive Voltage during reception	Voltage at which the receiving node determines High level	0.556 × V_{VBAT}	-	-	V
Hysteresis		-	-	0.133× V_{VBAT}	V
GPIO_xx: Digital Output (PWM)					
Output HIGH Voltage	Load current -2mA, VCC = 5V	4	-	-	V
Output LOW Voltage	Load current 2 mA, VCC = 5V	-	-	1	V
LED ambient light driver					
LED Supply Voltage		-	12	24	V
LED Drive Current		-	-	3	A
Other settings					
Board Layer Structure	FR-4, 2 layers (through-hole via), PCB thickness 1.6mm, Cu thickness 35µm (surface layer)				
Board Size	100mm x 100mm				

2.2. Block Diagram

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

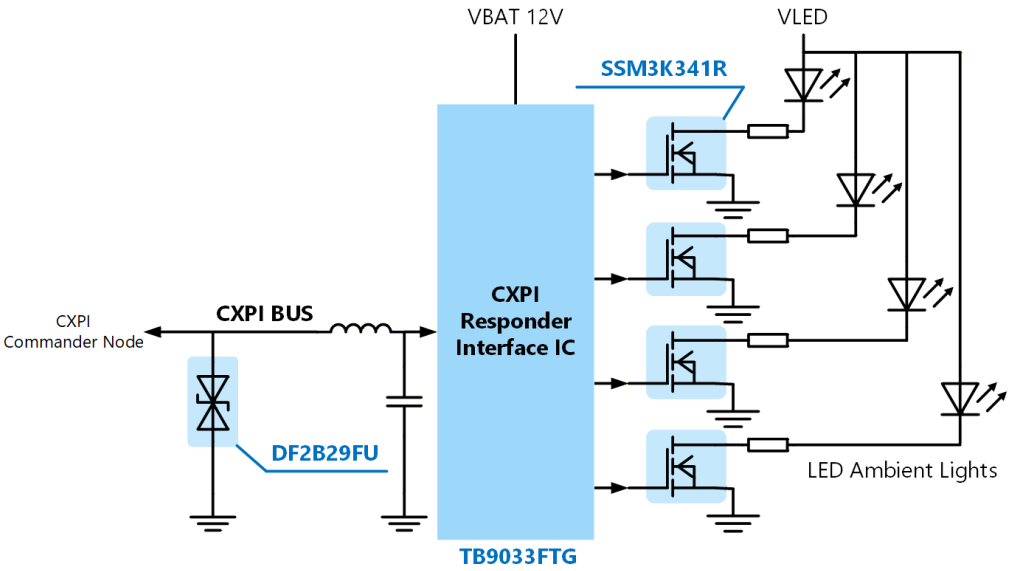


Fig 2.1 Block Diagram

2.3. Appearance

Fig 2.2 shows the appearance of this design.

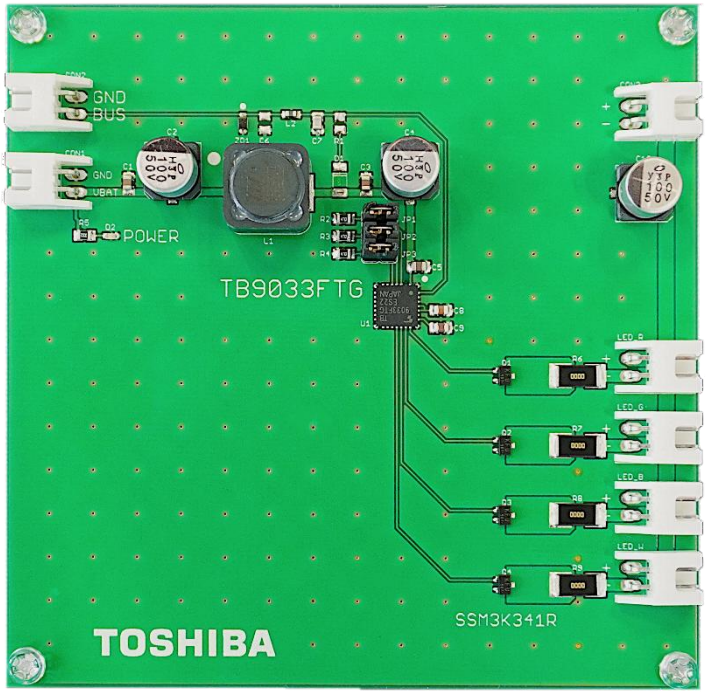
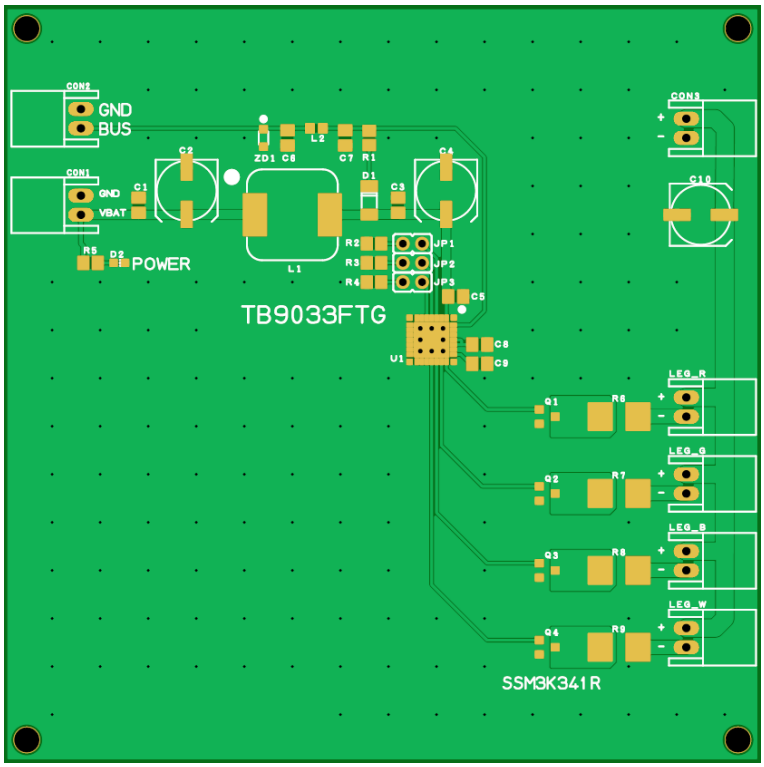


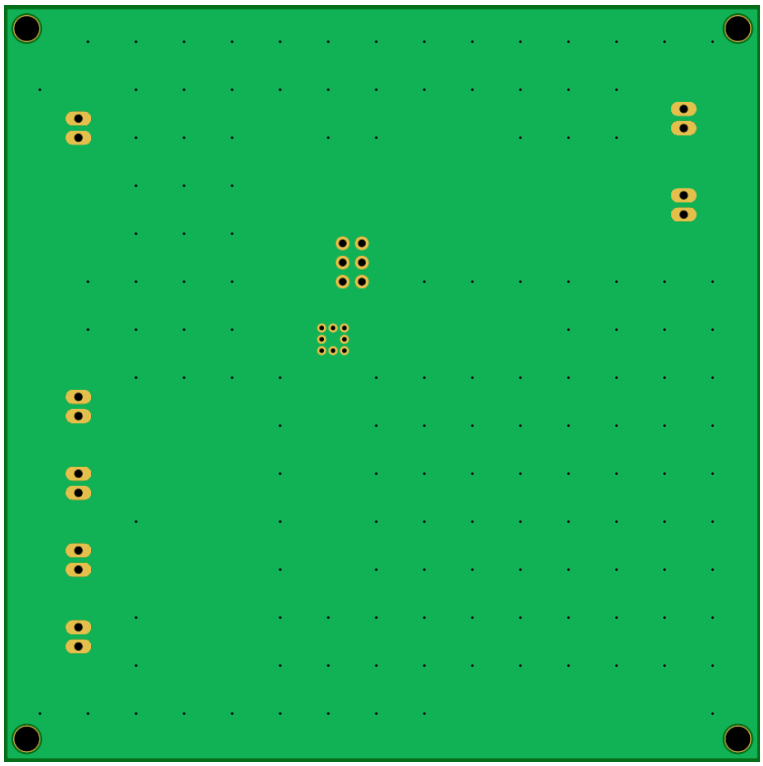
Fig 2.2 Board Appearance

2.4. PCB Component Layout

Fig 2.3 shows the component layout of this design.



< Front Side >



<Back Side>

Fig 2.3 PCB Component Layout

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

3.1. Schematic

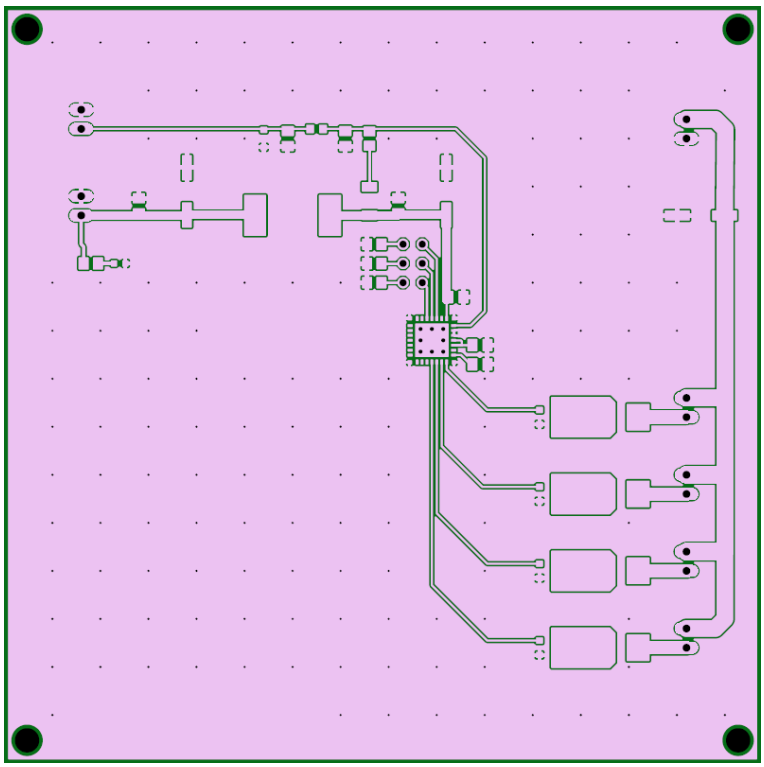
Refer to the following files.
RD254C-SCHEMATIC-xx.pdf
(xx is the revision number)

3.2. Bill of Materials

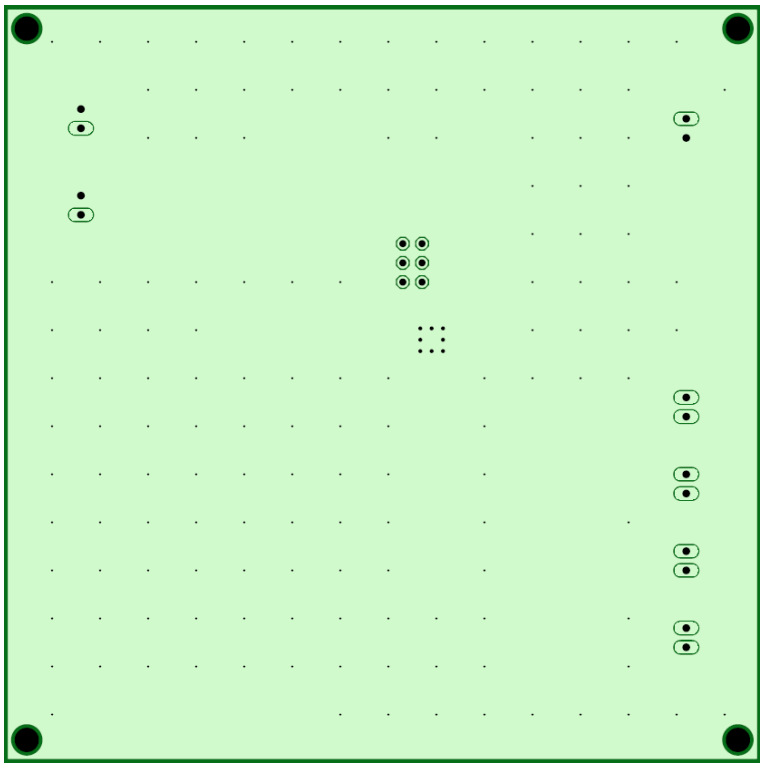
Refer to the following files.
RD254C-BOM-xx.pdf
(xx is the revision number)

3.3. PCB Pattern Diagram

Fig 3.1 shows PCB pattern diagram of the main board.
Refer to the following files too.
RD254C-LAYER-xx.pdf
(xx is the revision number)



<L1 (Top Layer)>



<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.

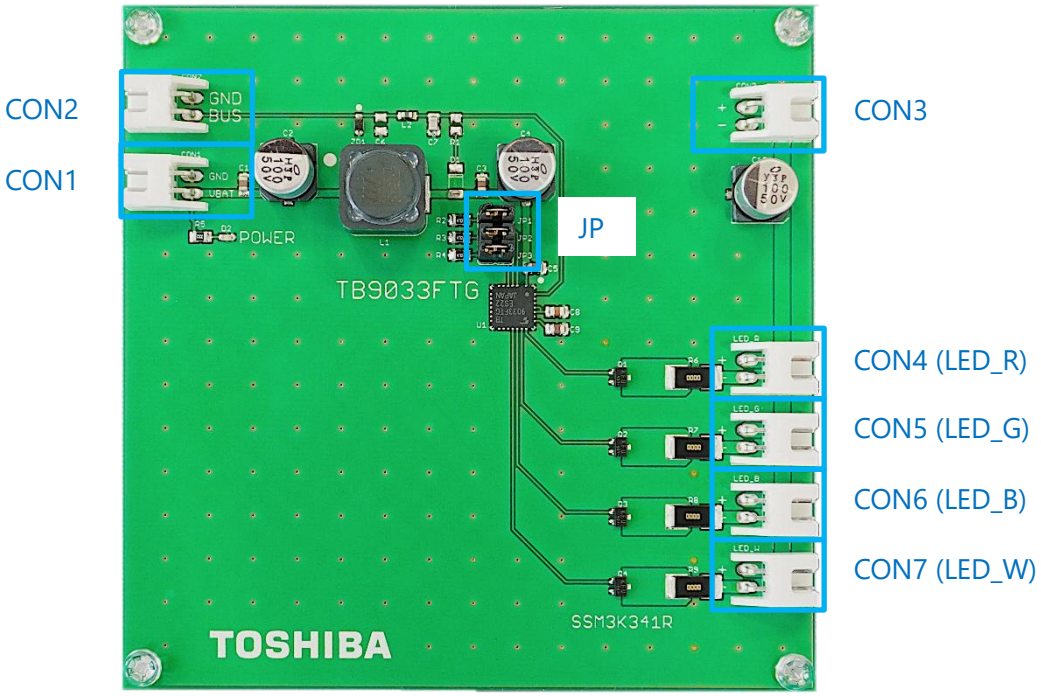


Fig 4.1 Component Layout

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 interface IC TB9033FTG 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. LED Power Supply Connector (CON3)

The 2-pin connector CON3 is used to input DC power for the LEDs. Connect an appropriate power supply that meets the specifications in Table 2.1 to light the target LEDs.

Table 4.3 LED Power Connector Description

Pin No.	Name	Description
1	GND	GND
2	VLED	Power Supply for LED

4.1.4. LED Ambient Light Connectors (CON4, CON5, CON6, CON7)

These connectors CON4 to CON7 **(Note 1)** are used to connect LED ambient lights. Connect LEDs that meet the specifications in Table 2.1 and replace the limiting resistors R6 to R9 if necessary.

Table 4.4 LED Ambient Light Connectors Description

Pin No.	Name	Description
1	GND	GND
2	LED	VBAT

(Note1) : Although it is marked as LED_(color) on the board, there is no restriction on the color of the LED to be connected.

4.1.5. Initial Node Address Setting Jumpers (JP1, JP2, JP3)

The initial node address as a CXPI responder node can be set using jumpers JP1 to JP3. Shorting the jumpers pulls down the node address setting terminal. For details, refer to the design guide.

Table 4.5 Initial Node Address Setting Jumpers Description

Pin No.	Name	Description
JP1	ADR0	Short 0, Open 1
JP2	ADR1	
JP3	ADR2	

4.2. Operation Procedure

4.2.1. Setup Procedure

1. Disconnect the power supply connected to this board.
2. Refer to *"4.1.5 Initial Node Address Setting Jumpers (JP1, JP2, JP3)"* and set the node address. (Initial setup only.)
3. Refer to *"4.1.4 LED Ambient Light Connectors (CON4, CON5, CON6, CON7)"* and connect the LEDs to several LED Ambient Light Connectors. Replace the current-limiting resistors (R6 to R9) if necessary.
4. Refer to *"4.1.3 LED Power Supply Connector (*CON3)*"* and connect an appropriate DC power supply to CON3.
5. Refer to *"4.1.2. CXPI BUS Connector (CON2)"* to connect the CXPI BUS to CON2.
6. Refet to *"4.1.1. Power Supply Connector (CON1)"* and connect a DC power supply to CON1.

4.2.2. Activation Procedure

1. Turn on the DC power supply to the Power Supply Connector (CON1) to start up this board.
2. Turn on the DC power supply for LEDs to the LED Power Supply Connector (CON3).
3. Execute communication initialization on the CXPI commander node and generate the bus clock.
4. Establish communication on the CXPI BUS and enable control of LEDs.
5. The CXPI commander node transmits a message to activate the LEDs.

4.2.3. Signal Communication

Please contact us for details.

4.2.4. Shutdown Procedure

1. The CXPI commander node transmits a message to turn off the LEDs, and it is verified that all LEDs are turned off.
2. Send a Sleep message to this board from the commander node via the CXPI BUS. After receiving the Sleep message, the CXPI interface IC TB9033FTG on this board transitions to Sleep mode.
3. Turn off the power supplied to the Power Supply Connector (CON1).
4. Turn off the power supply to the LED Power Supply Connector (CON3).

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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