Automotive CXPI Communication Application Circuit B Door Mirror Drive Board

Reference Guide

RD254B-RGUIDE-01

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1. Introduction

This reference guide describes the specifications, usage, and characteristics of the Automotive CXPI Communication Application Circuit B - Door Mirror Drive 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 door mirror driver board with a CXPI interface as an example of a responder node in CXPI communication. The CXPI interface IC is the TB9033FTG, which has 16 GPIO pins. The automotive motor control driver (MCD) uses the TB9054FTG to drive the door mirror opening/closing (folding) motor, and the TB9101FNG to drive the door mirror angle adjustment motor. The N-channel MOSFET SSM3K341R is used to control the Blinker LEDs.

2. Appearance and Specifications

2.1. Specifications

Table 2.1 lists the specifications of the RD254B board used in this design.

In this design, the CXPI BUS voltage, motor drive voltage, and LED drive voltage are 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 RD254B Board Specifications

Item	Condition	Min	Typ.	Max	Unit
Power					
VBAT voltage		7	12	16	V
VCC	Output from TB9033FTG	4.8	5	5.2	V
BUS					
Dominant Voltage at Reception	Voltage at which the receiving node determines Low level	-	-	0.423 x V_{BAT}	V
Recessive Voltage at Reception	Voltage at which the receiving node determines High level	0.556 x V_{BAT}	-	-	V
Hysteresis		-	-	0.133 x V_{BAT}	V
GPIO_xx: Digital Input					
Input HIGH Voltage	VCC = 5V	4	-	-	V
Input LOW Voltage	VCC = 5V	-	-	1	V
GPIO_xx: Digital Output					
Output HIGH Voltage	Load current = -2mA, VCC = 5V	4	-	-	V
Output LOW Voltage	Load current = 2mA, VCC = 5V	-	-	1	V
AD converter					
Operating Voltage		4.8	5	5.2	V
Door Mirror Adjustment Motor Drive (Motor 1, Motor 2)					
Output Current		-	0.5	1	A
Output ON Resistance		-	1.2	2.4	Ω
Door Mirror Folding Motor drive (Motor 3)					
Output Current	2ch coupling mode	-	-	10	A
Output ON Resistance	2ch coupling mode	-	100	125	mΩ
Blinker LED Drive					
LED-driving Voltage	Depends on VBAT	7	12	16	V
LED drive Current		-	-	200	mA
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.

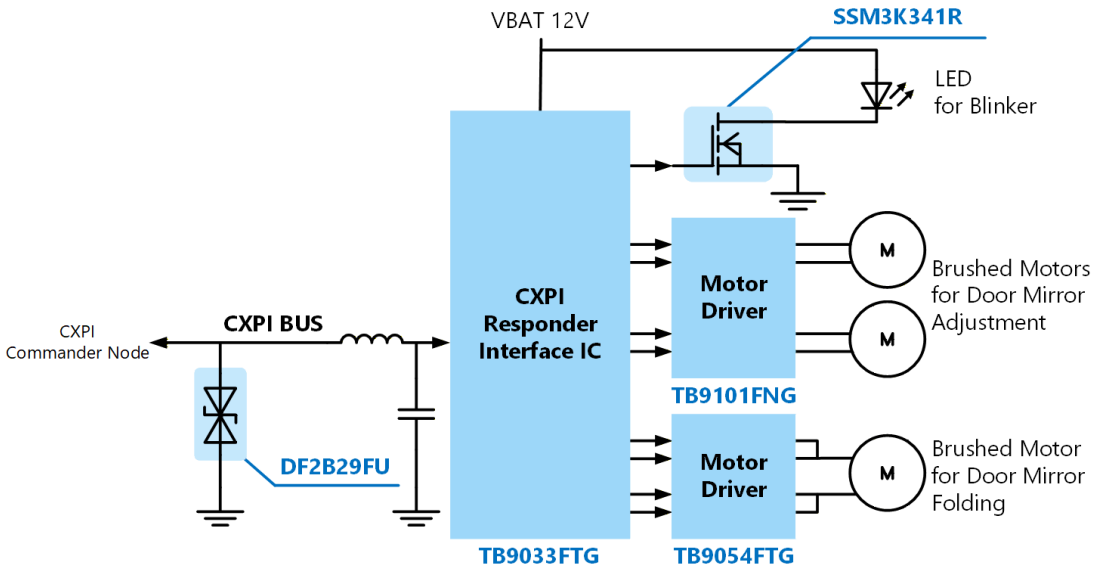


Fig 2.1 Block Diagram

2.3. Appearance

Fig 2.2 shows the appearance of this design.

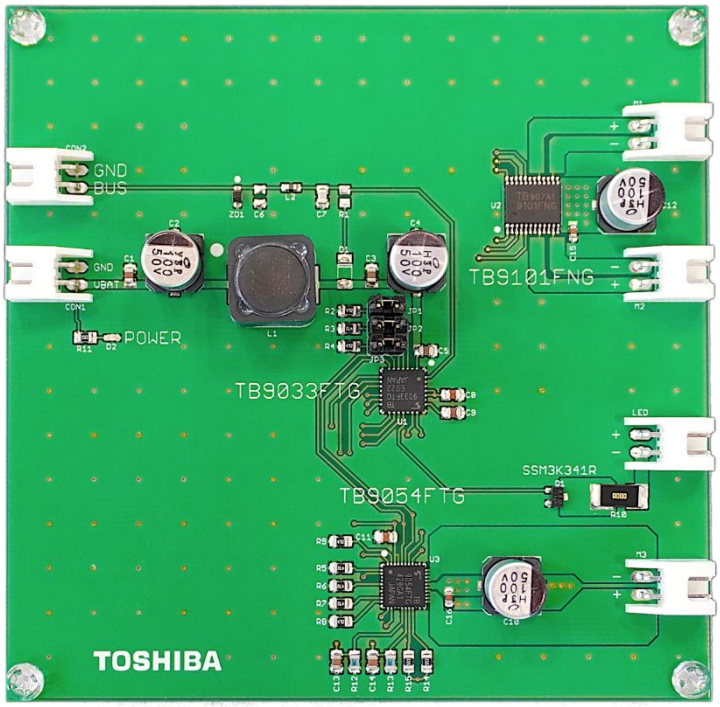
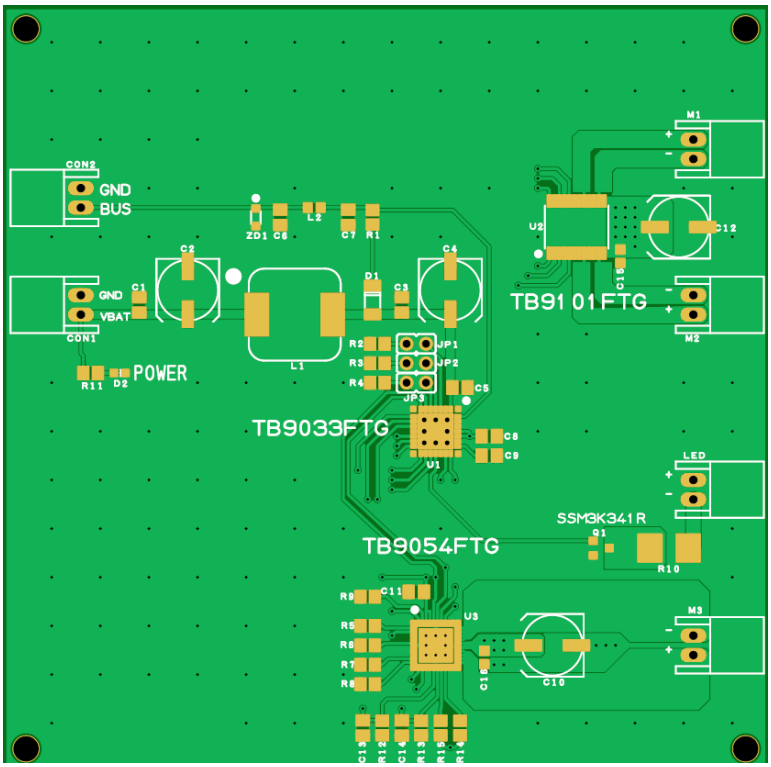


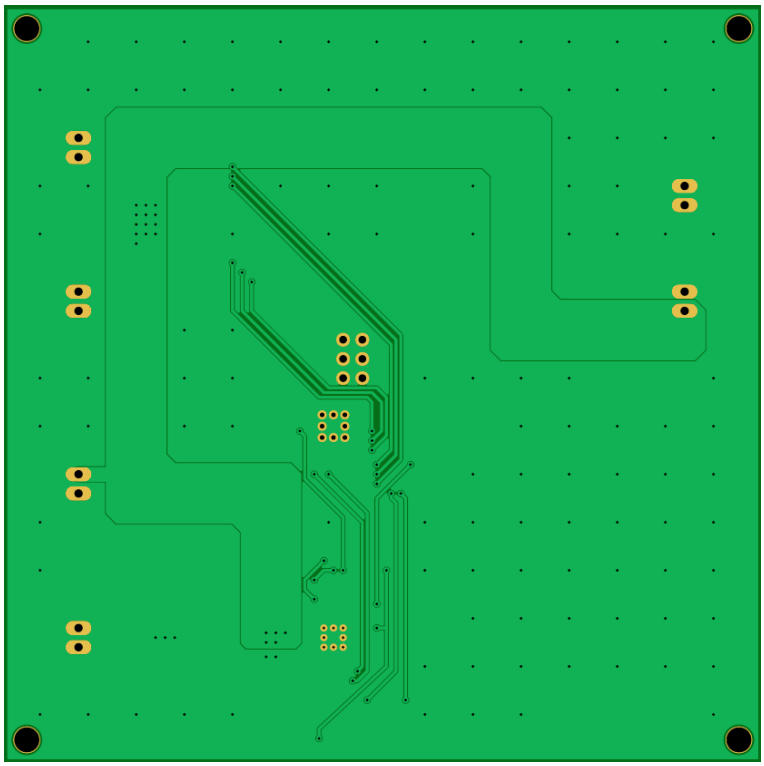
Fig 2.2 Board Appearance

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

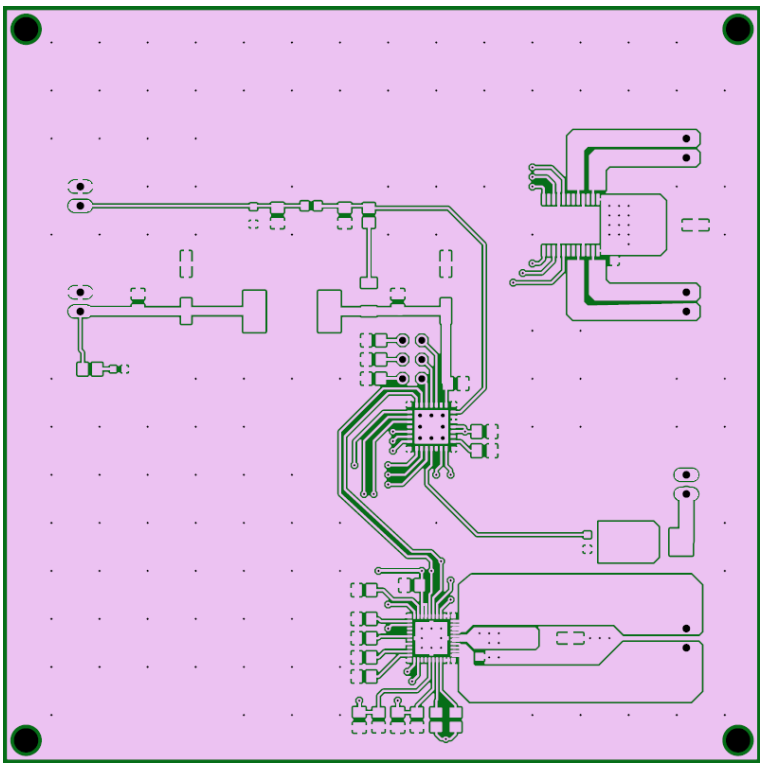
Refer to the following files.
RD254B-SCHEMATIC-xx.pdf
(xx is the revision number)

3.2. Bill of Materials

Refer to the following files.
RD254B-BOM-xx.pdf
(xx is the revision number)

3.3. PCB Pattern Diagram

Fig 3.1 shows the PCB pattern diagram of this design.
Refer to the following files too.
RD254B-LAYER-xx.pdf
(xx is the revision number)



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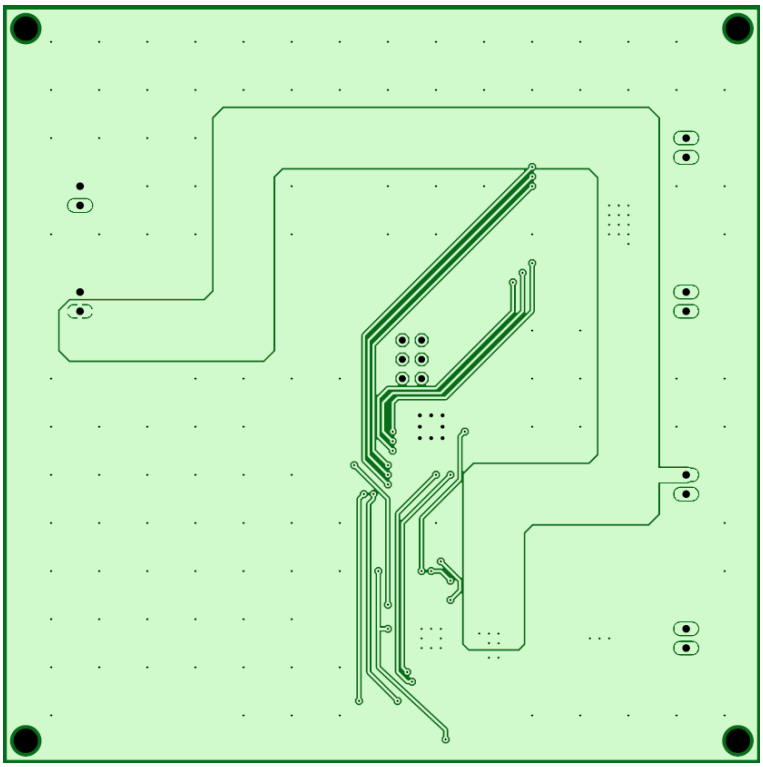

<L2 (Bottom Layer)>

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.

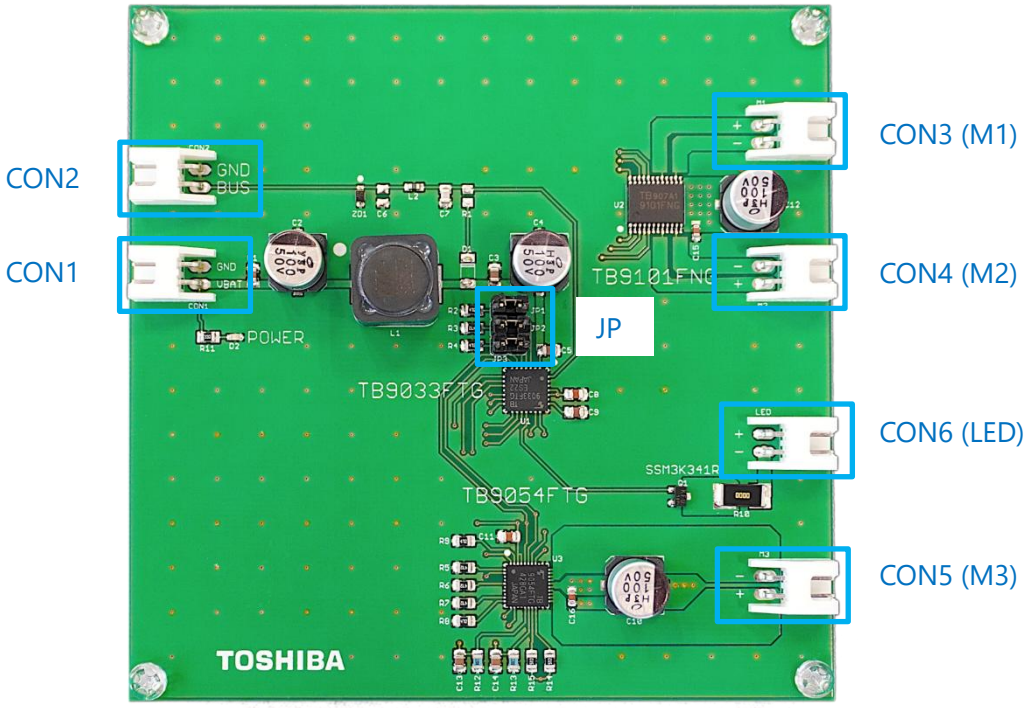

Fig 4.1 Component Layout

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 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. Door Mirror Adjustment Motor Connectors (CON3, CON4)

These connectors are used to connect brushed DC motors for door mirror adjustment. Connect motors that meet the specifications listed in Table 2.1. For details, refer to the datasheet for the automotive motor control driver (MCD) TB9101FNG, which drives the two motors.

To stop a rotating motor, apply a Low signal to both terminals to enter brake mode, and then stop the motor.

Table 4.3 Door Mirror Adjustment Motor Connectors Description

Pin No.	Name	Description
1	M-	Stop (Brake) : M- L, M+ L Forward (CW) : M- L, M+ H Reverse (CCW) : M- H, M+ L Stop (Standby) : M- OFF, M+ OFF
2	M+	

4.1.4. Door Mirror Folding Motor Connector (CON5)

This connector is used to connect a brushed DC motor for door mirror folding (open/close operation). Connect a motor that meets the specifications listed in Table 2.1. For details, refer to the datasheet for the automotive motor control driver (MCD) TB9054FTG.

Table 4.4 Door Mirror Folding Motor Connector Description

Pin No.	Name	Description
1	OUT1/2	Forward (CW) : OUT1/2 H , OUT3/4 L Reverse (CCW) : OUT1/2 L , OUT3/4 H
2	OUT3/4	

4.1.5. Blinker Connector (CON6)

The 2-pin connector CON6 is used to connect the blinker. Connect a blinker that meets the specifications listed in Table 2.1, and replace the current-limiting resistor (R10) if necessary.

Table 4.5 Blinker Connector Description

Pin No.	Name	Description
1	GND	GND
2	LED	VBAT

4.1.6. 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 4.6 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. Connection and Setup Procedure

1. Disconnect the power supply connected to this board.
2. Refer to *"4.1.6 Initial Node Address Setting Jumpers (JP1, JP2, JP3)"* and set the node address. (Initial setup only.)
3. Refer to *"4.1.5 Blinker Connector (CON6)"* and connect the blinker to CON6. Replace the current-limiting resistor (R10) if necessary.
4. Refer to *"4.1.3 Door Mirror Adjustment Motor Connectors (CON3, CON4)"* and *"4.1.4 Door Mirror Folding Motor Connector (CON5)"* to connect brushed DC motors.
   For safety, do not touch the connectors after turning on the power.
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 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. Confirm that loads such as motors and LEDs are in a normal standby state.
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 the motors and blinker.
5. The CXPI commander node transmits a message to activate the motor and the turn blinker.

4.2.3. Signal Communication

Please contact us for details.

4.2.4. Shutdown Procedure

1. The CXPI commander node then transmits a stop message, and it is verified that all motors stop and the turn blinker turn 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).

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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