

Revision History

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References

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5	RH_Design_Ether_ver.1.0.pdf	1.0	May 25, 2020
6	RH_Design_GNSS_ver.1.0.pdf	1.0	May 25, 2020

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1. Overview

This document includes principles and steps for circuits and boards design of Reference Hardware.

Reference Hardware aims to provide a standard environment for developing in-vehicle infotainment system and so on. Reference Hardware consists of PCBs with a different functionality. Therefore, a SoC or peripheral circuitry can be easily replaced without compatibility issues when a common principal design is adopted. It helps build development environment faster and is able to be directly installed in a vehicle when the size is 2DIN.

2. Hardware Structure

The structure consists of three main blocks: Vehicle block which processes vehicle signals and in-vehicle networks such as CAN, Audio block which processes sound input and output, and Control block which processes MultiMedia and HLOS, etc. Boards are grouped into each block and the same two 120pin connector and one 40pin connector are used to connect between blocks. Same signals are connected in the same manner. Vehicle block and Audio block can be combined as one block depending on a scale or purpose of the development.

Each peripheral circuit, or peripheral board, is divided by one specific functionality which enables various configuration to meet different purposes or functional requirements.

Figure 1 shows overall board structure.

Figure 2 shows that the control signals are transmitted between the SoC and each peripheral board via FPGA on Control Board, and the connecting terminals can be changed by reconfiguring the FPGA's internal circuit.

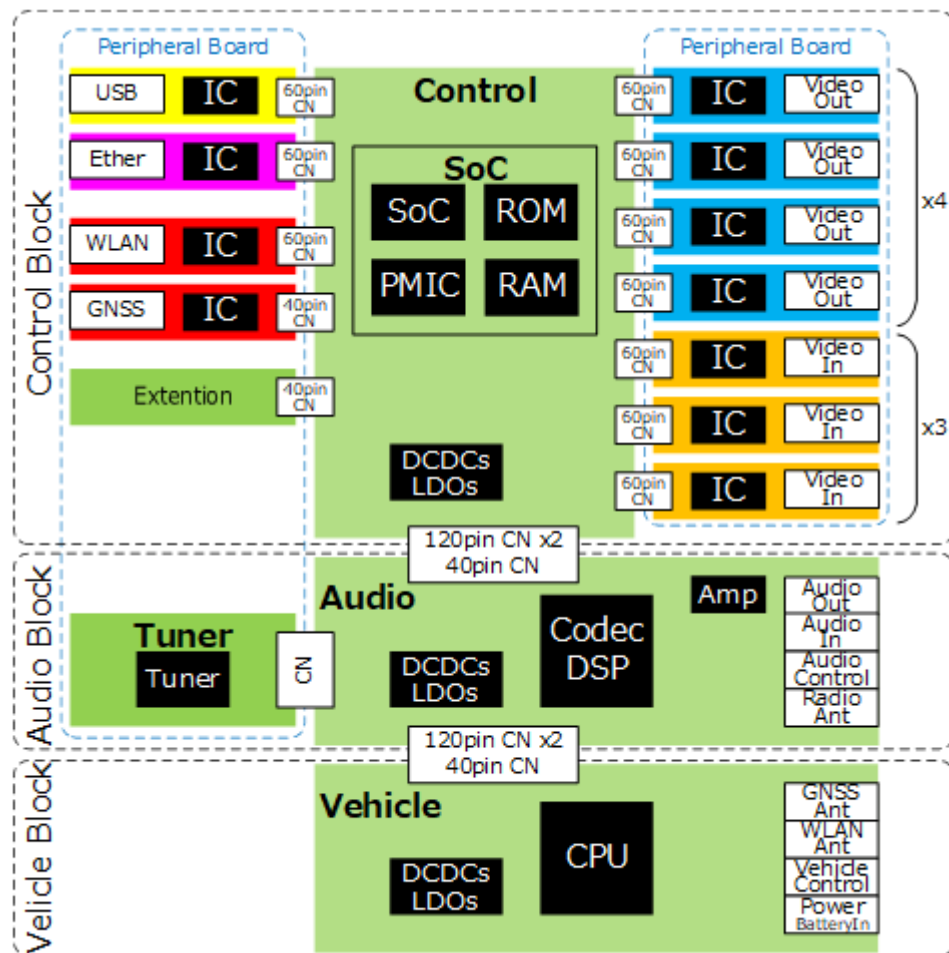


Figure 1 Reference Hardware Board Structure

Reference Hardware Design Guideline for Control (+SoC) Board

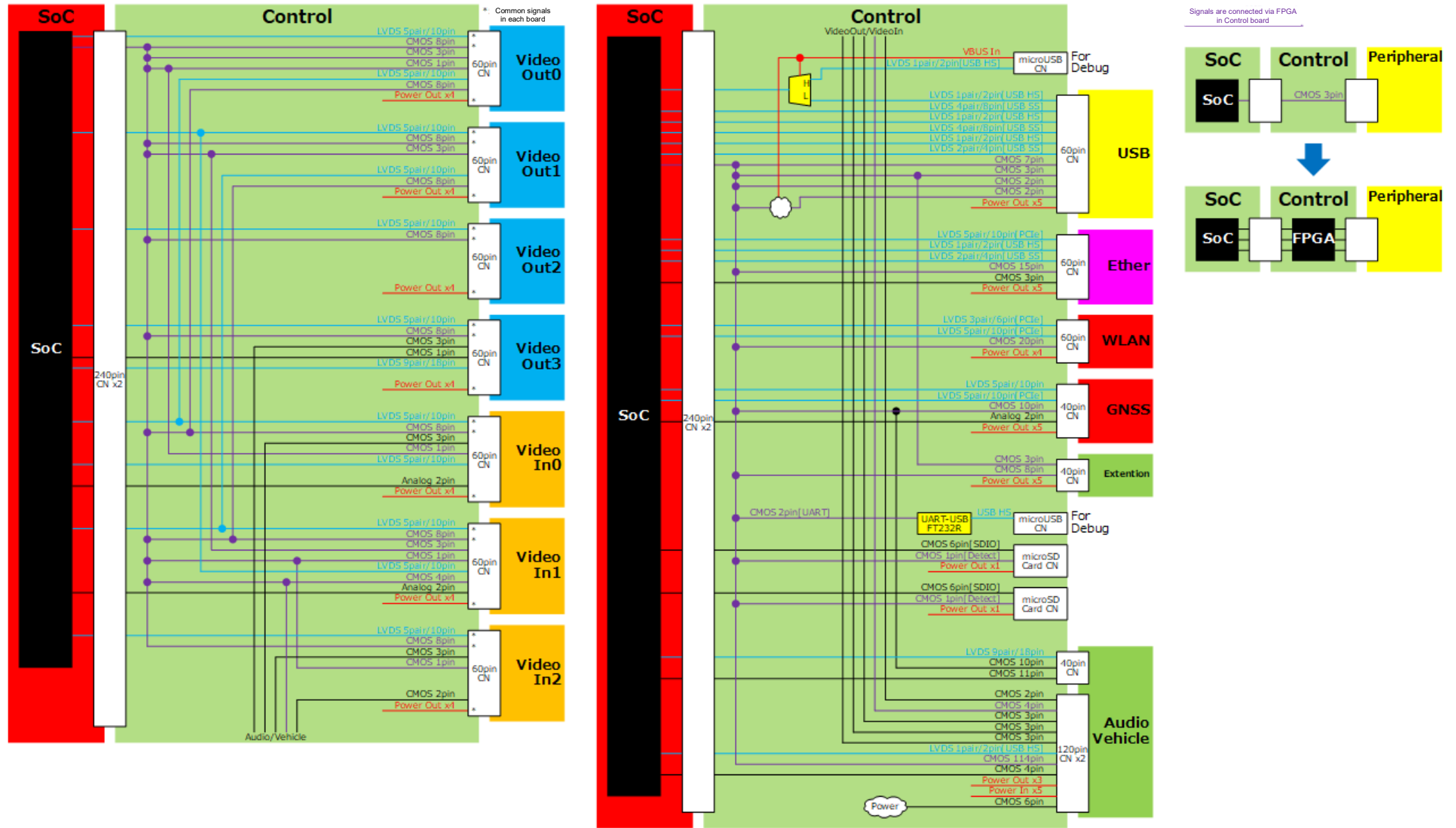


Figure 2 Overall Connection

2.1. Outline and Composition

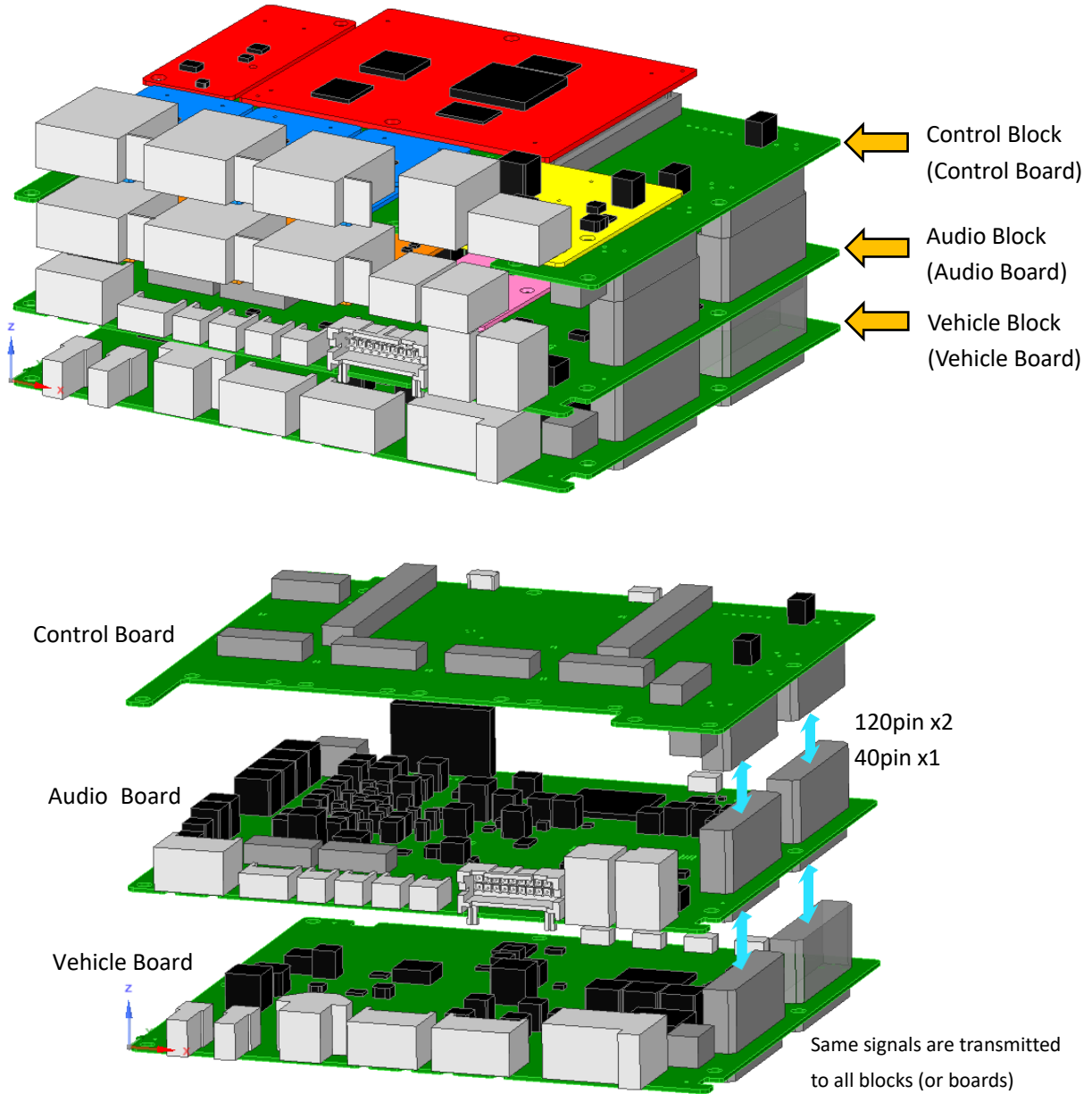


Figure 3 Assembled Hardware Structure

Reference Hardware Design Guideline for Control (+SoC) Board

Boards with different functionality including SoC can be connected to Control Board. Each Peripheral Board provides a distinctive functionality and that is SoC Board, GNSS Board, WLAN Board, VideoOut Board x4, VideoIn Board x3, USB Board, Ether Board, or Extension Board.

SoC Board is connected by two 240pin board-to-board connectors, GNSS Board and Extension Board are connected by 40pin board-to-board connector, WLAN Board, VideoOut Board, VideoIn Board, USB Board, Ether Board are connected by 60-pin board-to-board connector.

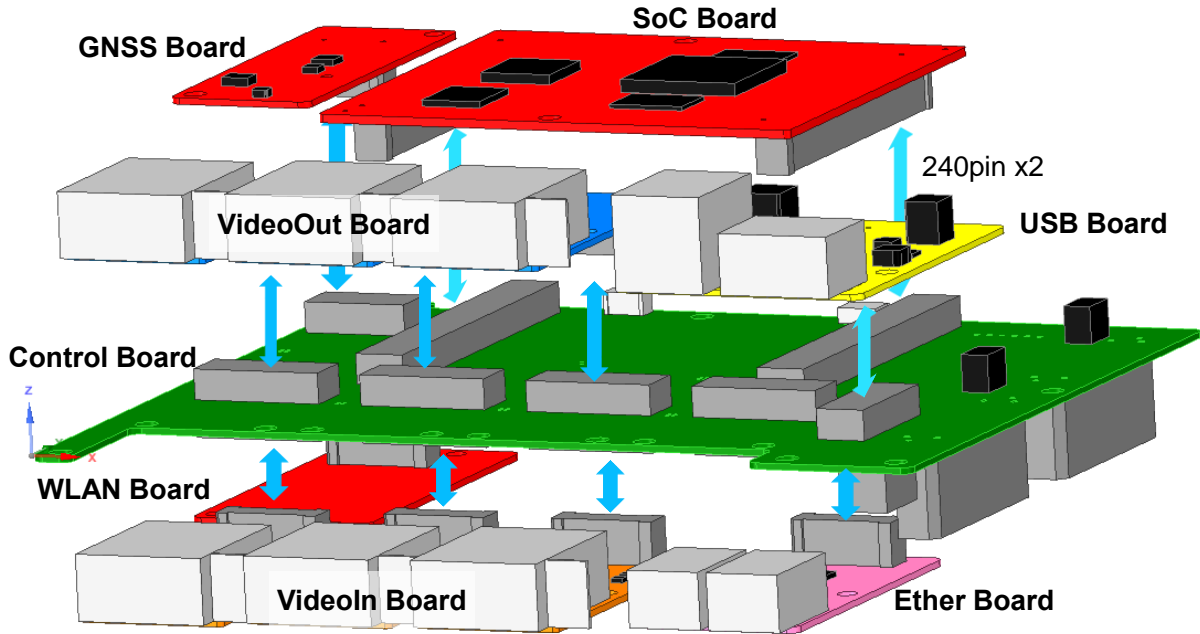


Figure 4 Control Board Structure

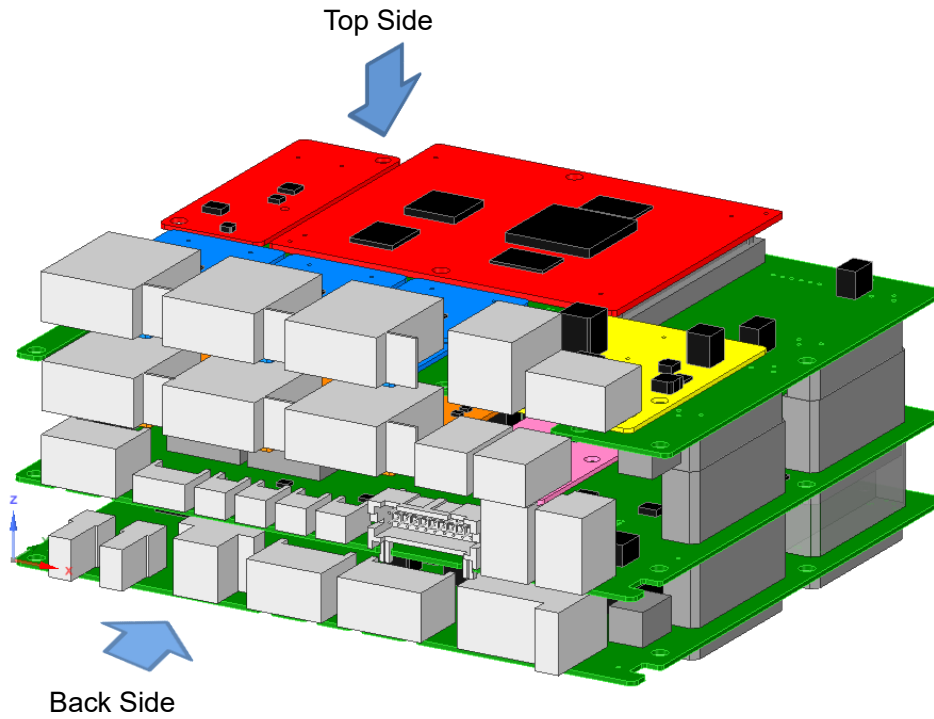


Figure 5 Assembled Board Outline

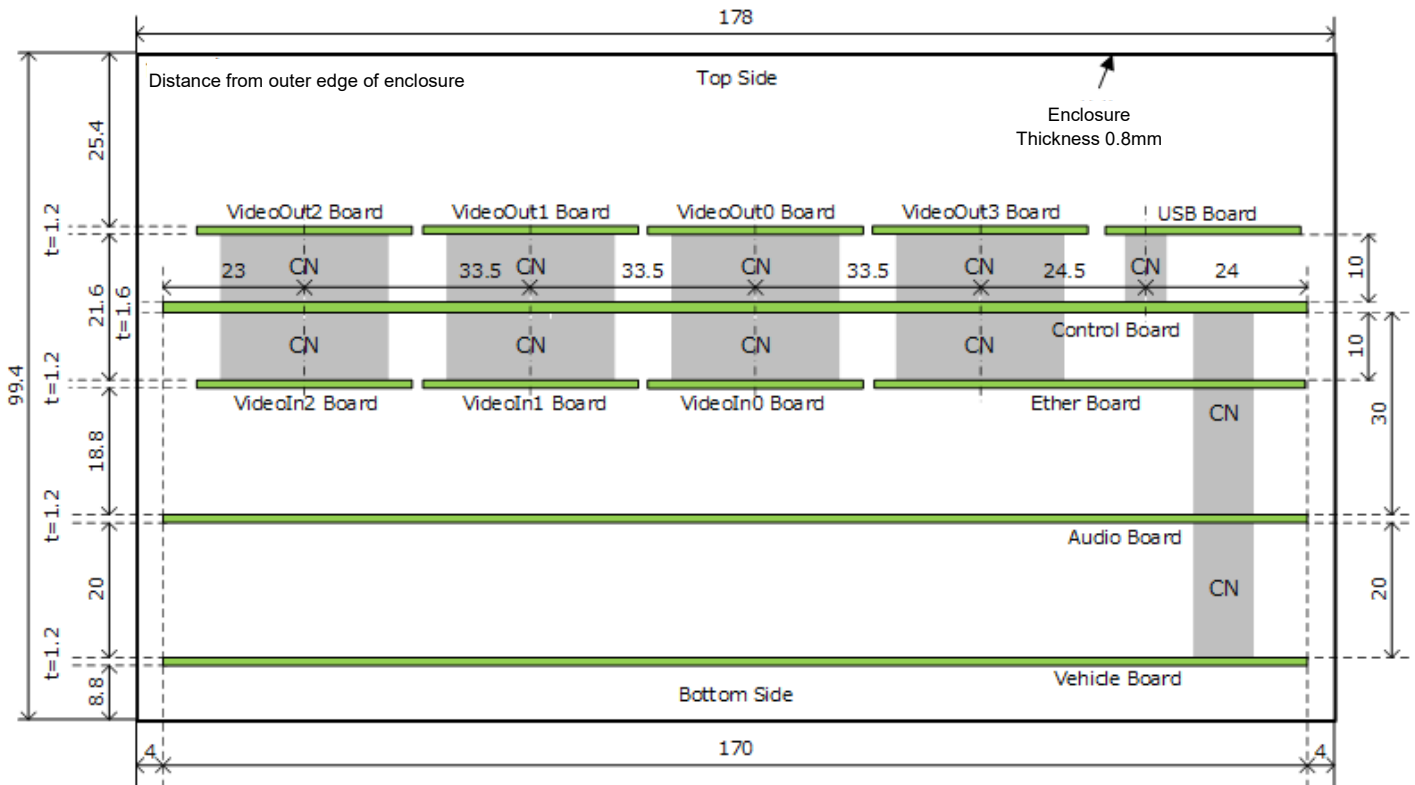


Figure 6 Board position viewed from back side of enclosure

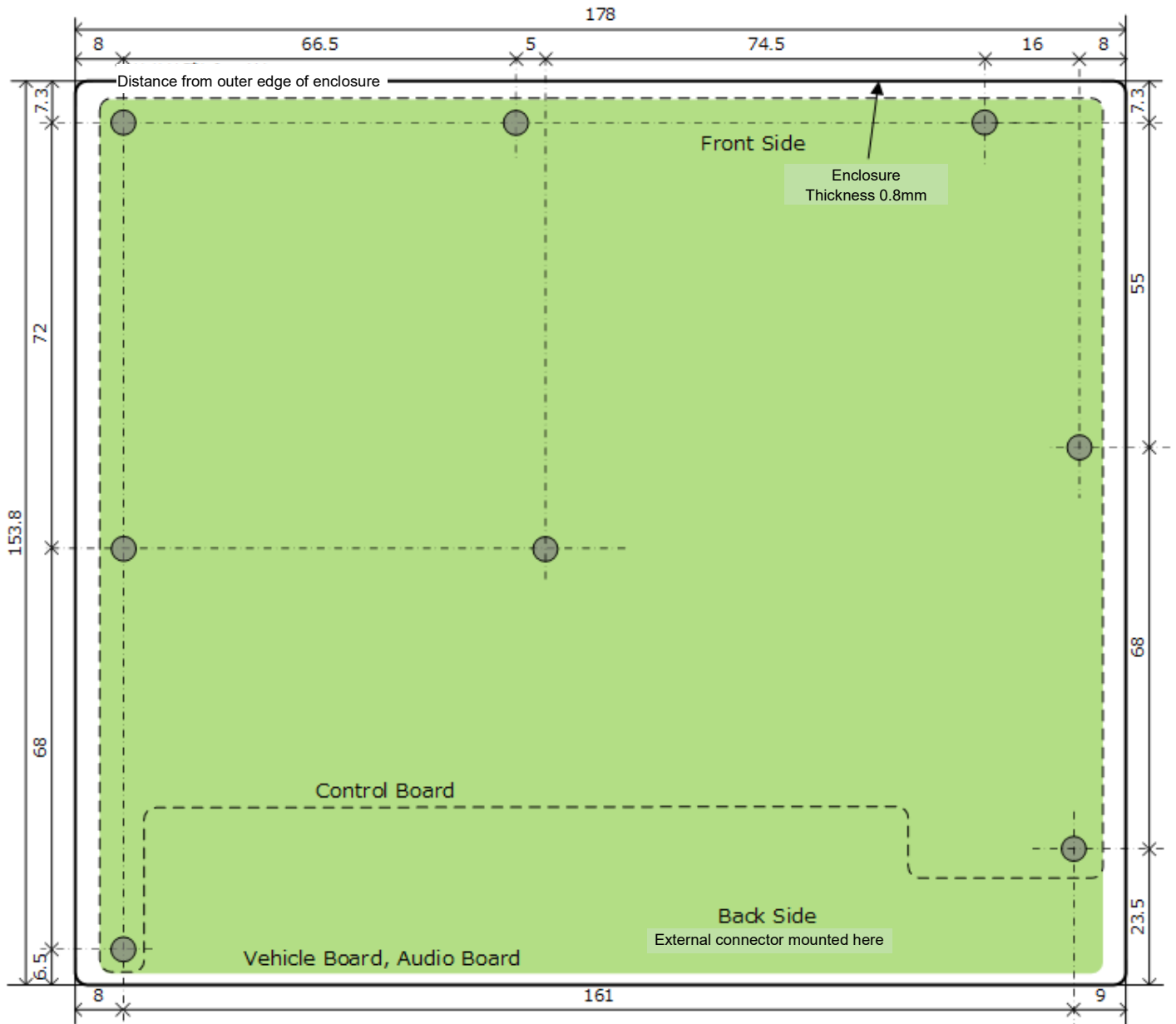


Figure 7 Board position view from the top side of enclosure

3. Vehicle/Audio Board Outline

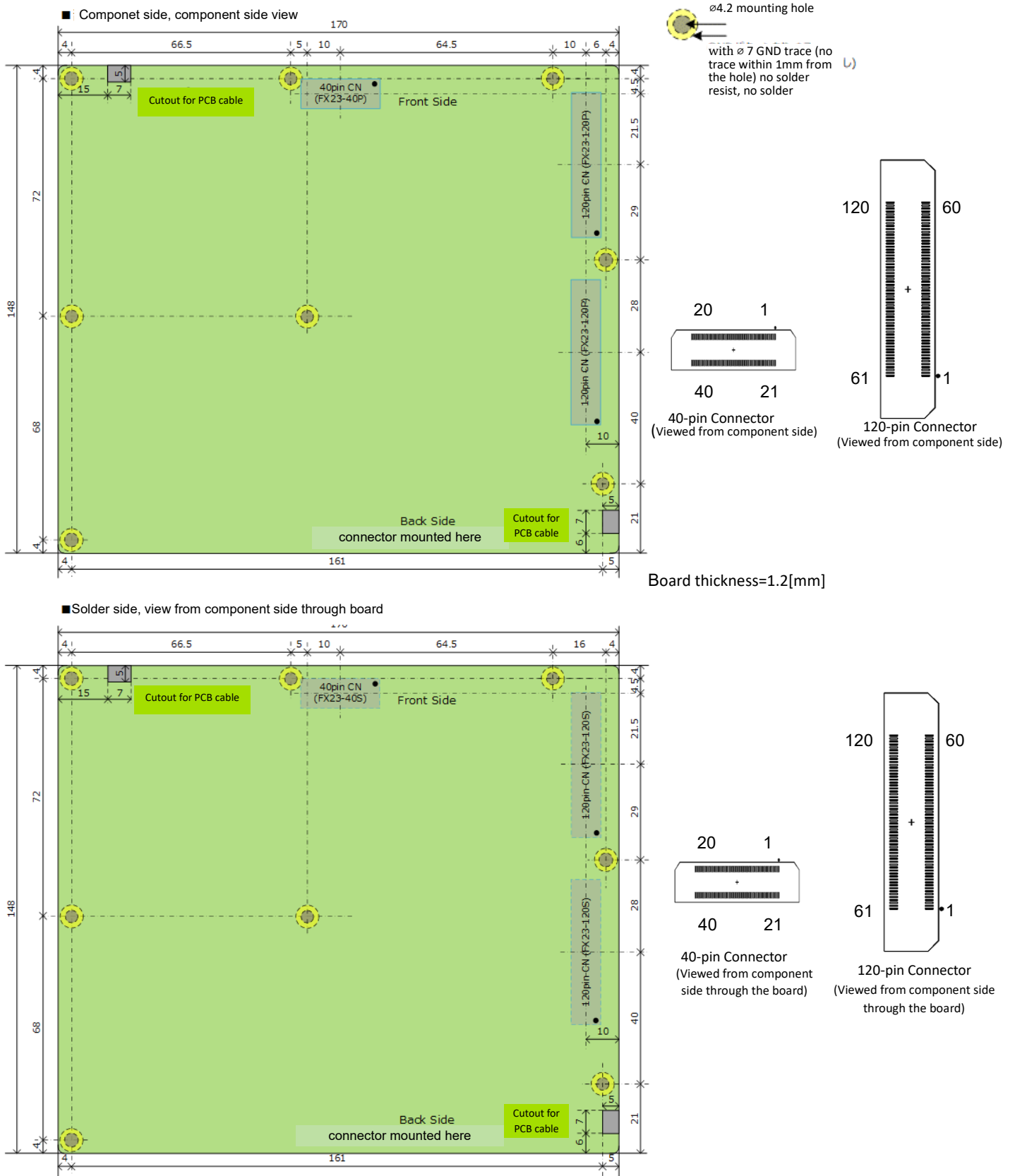
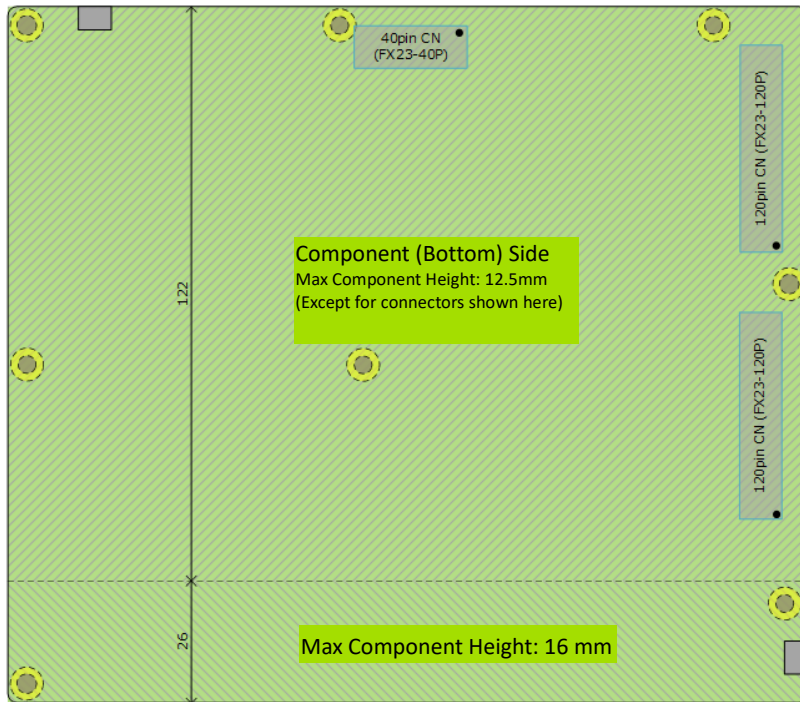


Figure 8 Vehicle/Audio Board Outline

■ Component side, component side view



■ Solder side, view from component side through the board



Figure 9 Vehicle/Audio Board Component Height Constraint

4. Control Board Outline

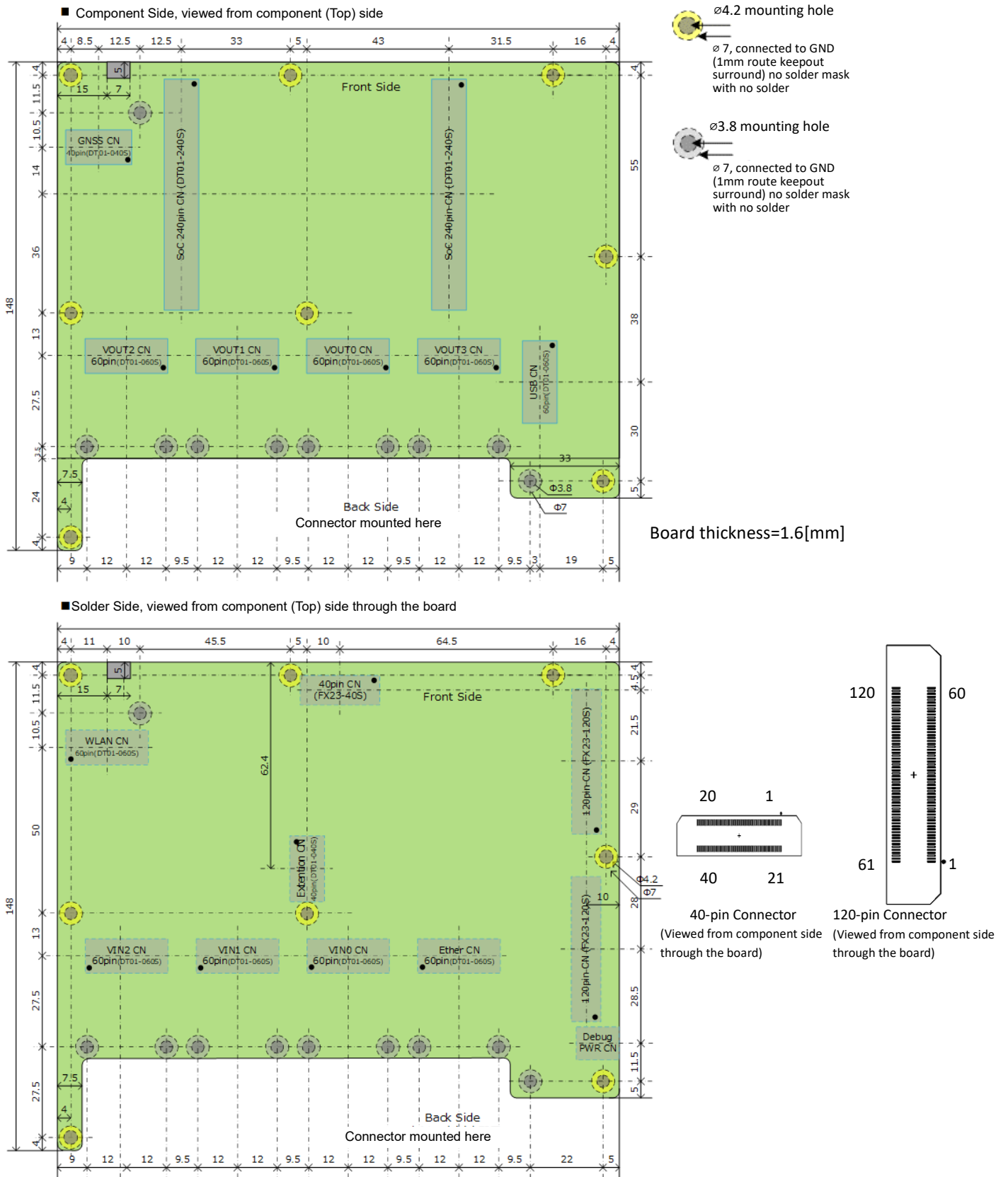


Figure 10 Control Board Outline

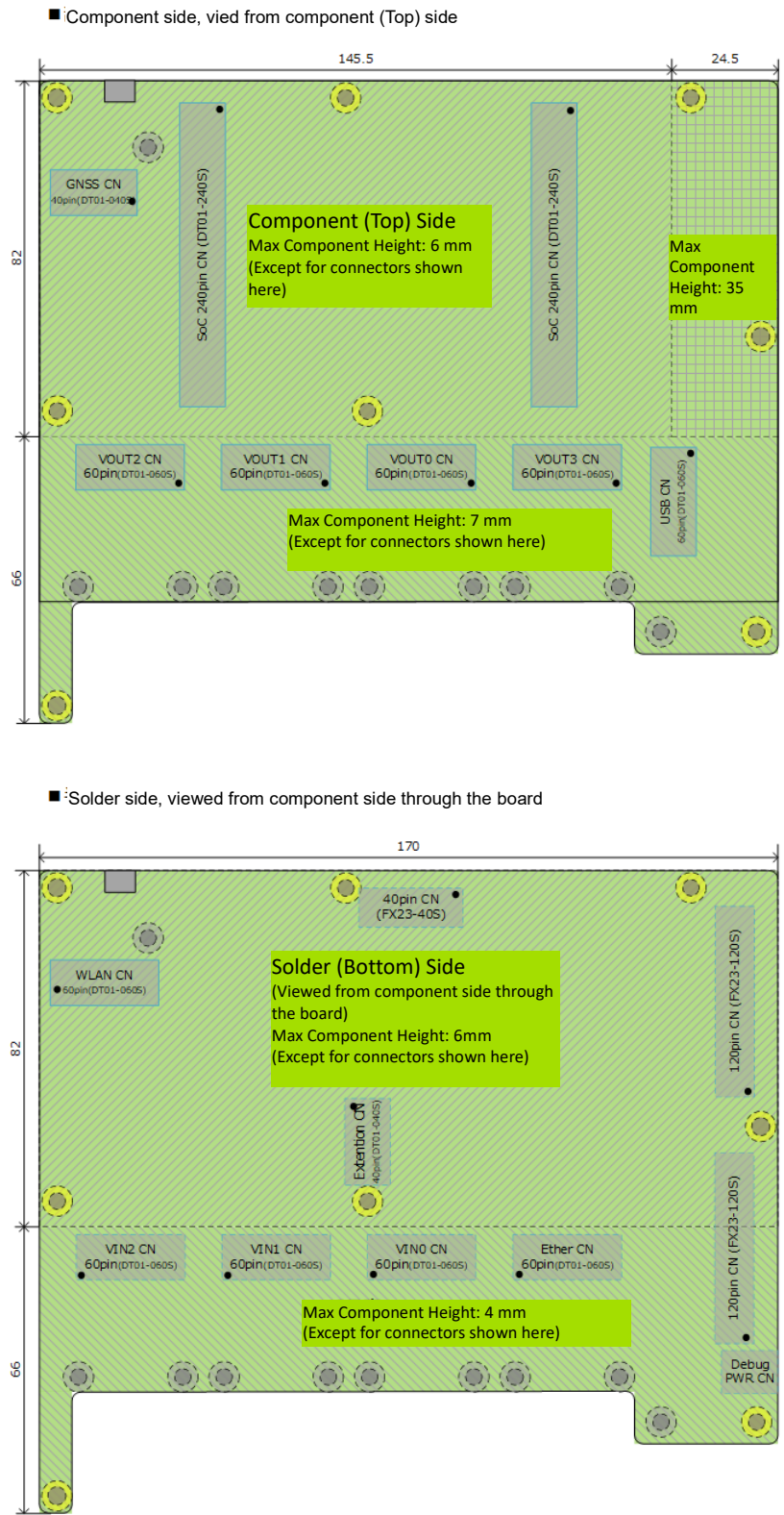


Figure 11 Control Board Component Height Constraint

5. Power Supply Configuration

Power from vehicle battery (+12[V]) is supplied to Vehicle Board. +12[V] is distributed to each board via Vehicle Board. Power each board requires should be generated within the boards from +12[V] basically. +5.8[V] and +3.8[V] power supplies are built on Vehicle Board are connected along with +12[V] through a 120pin connector. +5.8[V] is used for the source of commonly used +5[V] power supply and +3.8[V] is used for the source of commonly used +3.3[V] and +1.8[V] power supplies. When current from +12[V] power used on each board is not enough, +12[V] can be supplied via other dedicated connector (BATT connector) instead of 120pin connector. Components supplied +12[V] from vehicle should use withstand voltage higher than +27[V]. Power IC should be designed to be non-flammable or smoke-free when shorted at output side. Use of Power IC with OCP (Over Current Protection) is recommended.

Total of 11[A] is the current capacity of the 120pin connector can provide at +12[V] through 10 pins rated for 0.5[A/pin] and 2 pins rated for 3.0[A/pin]. Current rating which +12[V] from BATT connector can supplies is 9[A] when a cable used is higher than AWG28 (bigger than AWG28) as 6 pins of 1.5[A/pin] is used.

DCDC/inductor's capacity for the source of +5V power supply line is 5.5[A], and the current capacity of 11 pins rated for 0.5[A/pin] is 5.5[A]. DCDC/inductor's capacity for the source of +3.3V power supply line is 3.5[A], and the current capacity of 7 pins rated for 0.5[A/pin] is 3.5[A]. However, as both power supplies are used in Vehicle Board (0.5[A] retained), 5.0[A] from the source of +5V power supply and 3.0[A] from the source of +3.3V power supply are the electrical current can be consumed on Audio Board and Control Board.

Power that terminals require for signaling between boards is also supplied via the 120pin connector.

Vehicle board supplies power to the terminals required for the board through the signal named as IO_VEHICLE, Audio board supplies power to its terminals through the signal named as IO_AUDIO, and Control boards supplies power to its terminals through the signals named as IO_PF (for SoC terminals), IO_VIDEO (for VideoOut board terminals) and IO_IF (USB board terminals)

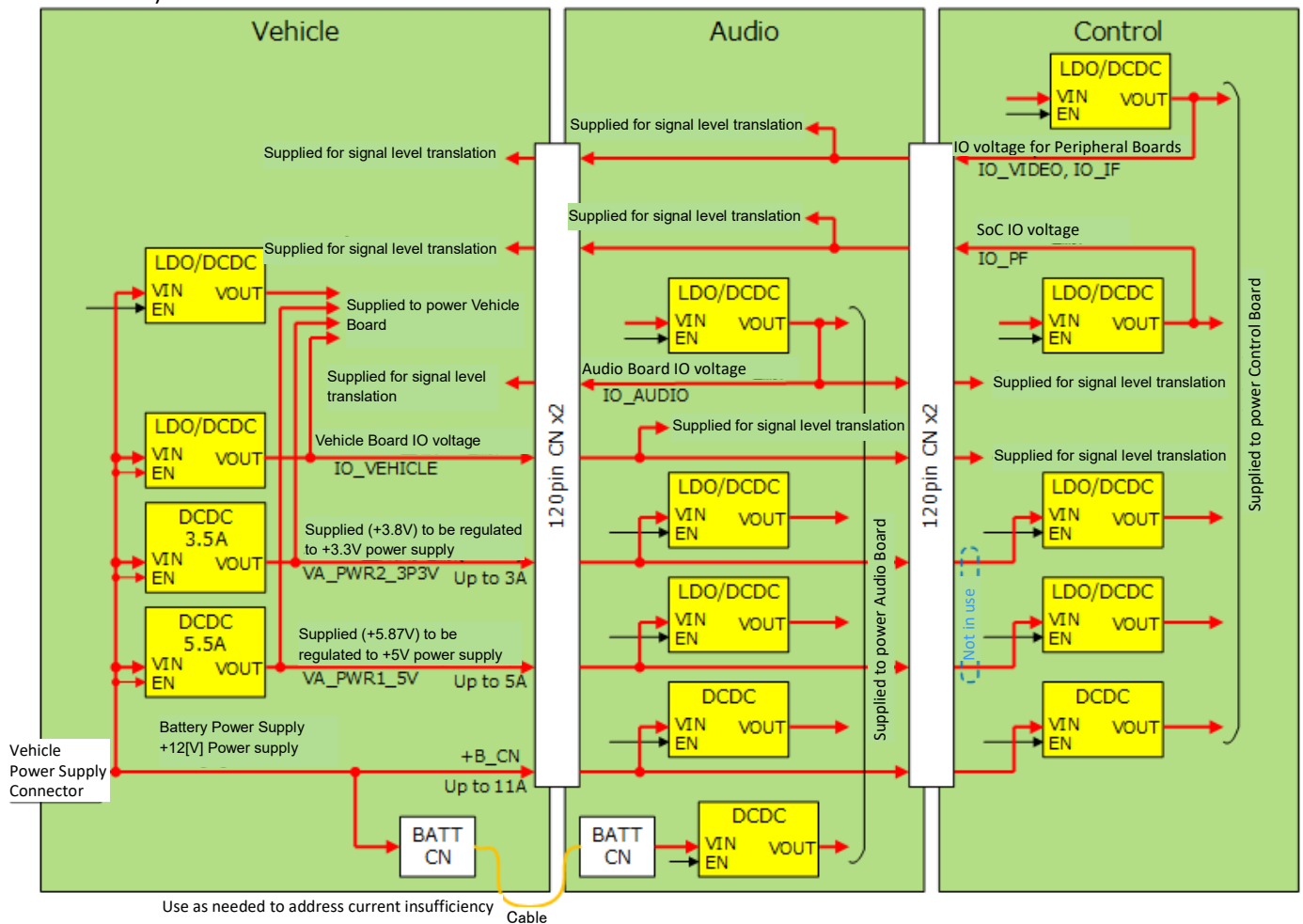


Figure 12 Power Supply Diagram

Reference Hardware Design Guideline for Control (+SoC) Board

Table 1 shows current rating of each power supply and assigned amperage of power consumed at the destination terminal. If the assigned amperage for the destination terminal is not sufficient, it can be adjusted according to the consumption in other boards. (If there's power that is not consumed in another board and is usable, it can be added to where more power is required.) See design specification of each board.

Table 1 Control Board Power Supply Current Rating

Voltage Name	Input Voltage* ¹	Output Voltage	Current Rating	Power Supply Destination and Assigned Current Capacity									
				Total	Subtotal	Control* ²	SoC	WLAN	GNSS	VOUT(x4)	VIN(x3)	USB	Ether
VPH_PWR	+B_VPH	3.4-5V	11.0A	6.6A	4.8A		4800mA						
VPH_PWR_WLAN	VPH_PWR	VPH_PWR	2.0A	-	1.2A			1200mA					
VPH_PWR_GNSS	VPH_PWR	VPH_PWR	2.0A	-	0.8A				800mA				
VDD_5P8V	+B_CN	5.87V	3.0A	3.0A	2.95A			200mA	150mA	200mA	200mA	1000mA	200mA
VCCAUX_FPGA	VDD_5P8V	3.3V	0.2A	-	0.05A	50mA							
VDD_3P3V	+B_VPH	3.3V	5.5A	5.5A	1.9A	100mA				200mA	200mA	200mA	200mA
VDD_1P8V	VDD_3P3V	1.8V	1.0A	1.0A	0.8A						200mA		200mA
VDD_1P8V_VO	VDD_3P3V	1.8V	1.0A	-	0.8A					200mA			
VCC_FPGA	VDD_3P3V	1.2V	1.0A	-	0.1A	100mA							
VDD_ADJ	VDD_3P3V	1.2V	1.0A	0.4A	0.0A								
VDD_ADJ2	VDD_3P3V	1.5V	1.0A	1.0A	0.0A								
VDD_WLAN_IO	VREG_SOC_IO	3.3V	0.2A	-	0.1A			100mA					
VDD_GNSS_IO	VREG_GNSS_IO	3.3V	0.2A	-	0.1A				100mA				
VDD_VOUT_IOBANK	VDD_3P3V	3.3V	0.2A	-	0.1A	100mA							
VDD_VIN_IOBANK	VDD_3P3V	3.3V	0.2A	-	0.1A	100mA							
VDD_USB_IOBANK	VDD_3P3V	3.3V	0.2A	-	0.1A	100mA							
VDD_VOUT_CORE	VDD_ADJ2	1.5V	1.0A	-	0.6A					150mA			
VDD_VIN_CORE	VDD_ADJ2	1.5V	1.0A	-	0.3A						100mA		
VDD_ETH_CORE	VDD_ADJ	1.2V	1.0A	-	0.2A								200mA
VDD_GNSS_CORE	VDD_ADJ2	1.5V	1.0A	-	0.1A				100mA				
VDD_USB_1P8V	VDD_1P8V	1.8V	1.0A	-	0.2A							200mA	
VDD_USB_CORE	VDD_ADJ	1.2V	1.0A	-	0.2A							200mA	

Settings in this table are defaults (preselected when released initially) and can be adjusted.

6. Block-to-Block Signals

Vehicle Board, Audio Board, and Control Board each use two 120pin Board-to-Board connectors and one 40pin Board-to-Board connector.

120pin/40pin connectors are mounted on both component side and solder side of Vehicle Board or Audio Board and each pin of the boards are vertically connected.

120pin/40pin connectors of Vehicle Board, Audio Board, and Control Board should be mounted in the positions where the pins on each board can exactly match to transmit the same signal between the boards. The signals of terminals except the terminals decided signals such as power supply, etc., can be used for optional signals between the boards. It is optional but recommended to use preconfigured pin assignments as the pins are configured with the intention to meet expected application purposes.

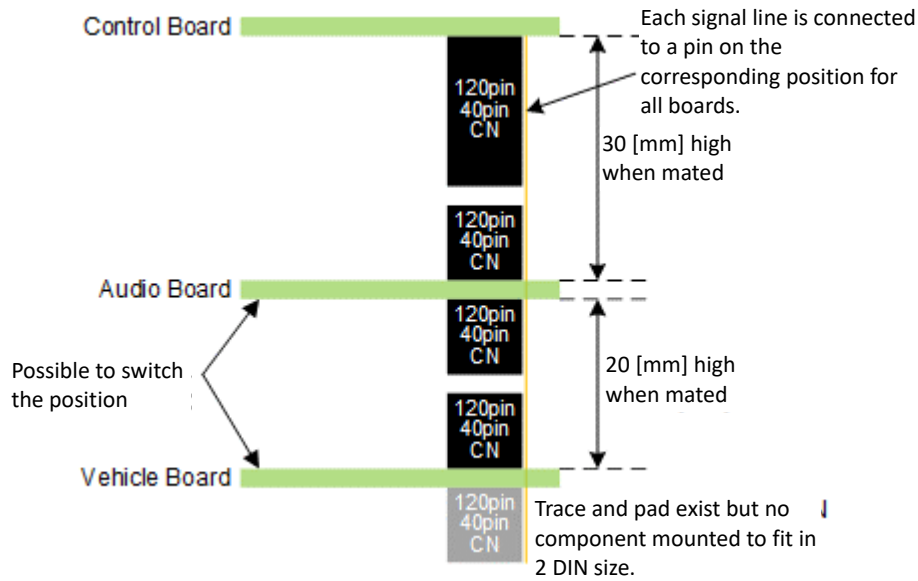


Figure 14 120-pin Board-to-Board Connector

6.1. Connector

Two 120pin Board-to-Board connectors and one 40pin Board-to-Board connector are used to connect Control Board, Vehicle Board and Audio Board. These three connectors are referred to as “block-to-block connector” in this document.

FX23 series of Hirose Electric Co., Ltd. is used for the block-to-block connector. The floating structure (± 0.6 [mm] in X and Y directions) type is used to mitigate position gap and oscillation effect.

FX23-120P-0.5SV20B and FX23-40P-0.5SV20B on component side, FX23-120S-0.5SVB and FX23-40S-0.5SVB (FX23-120S-0.5SV10B and FX23-40S-0.5SV10B are used to keep a 30mm stack height for the Control Board.) on solder side are used. A PCB with each connector should be arranged on top and bottom surface of the same axis with parallel connecting. (Same signals are assigned to all the terminals of 120pin/40pin connectors on Control board, Vehicle board, and Audio board)

Table 2 Block-to-Block Connector Specifications

	FX23 Series	
	Signal	Power Supply Part (There are 4 terminals in addition to the ones for signal)
Current Rating (per pin)	FX23 Series	FX23 Series
Withstand Voltage	Signal	Signal
Contact Resistance	0.5[A]	0.5[A]
Insulation Resistance	AC150[V], 1 min	AC150[V], 1 min
Operating Temp:	-55 up to +105[°C]	
Floating Range	± 0.6 [mm] in X and Y directions	
Applicable Signal	8+[Gbps], Differential 100[Ω]	-

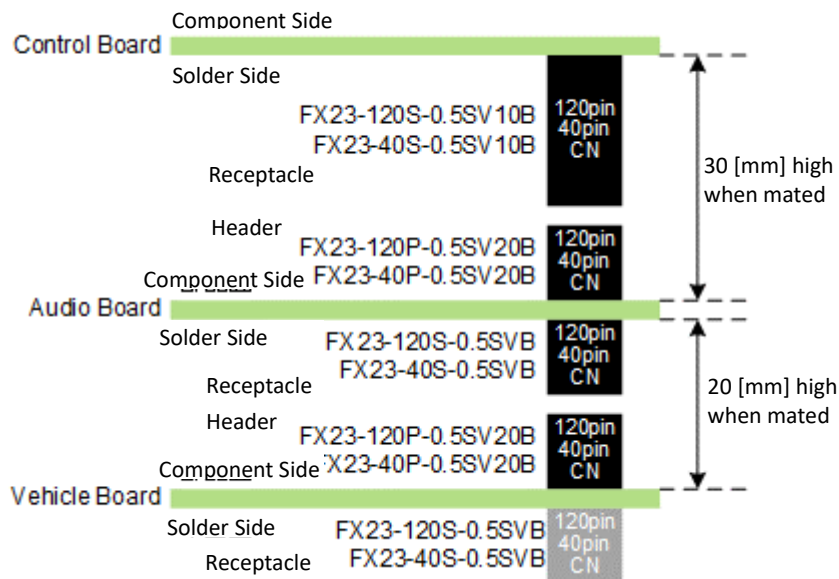


Figure 15 Block-to-Block Connector Matching Part Numbers

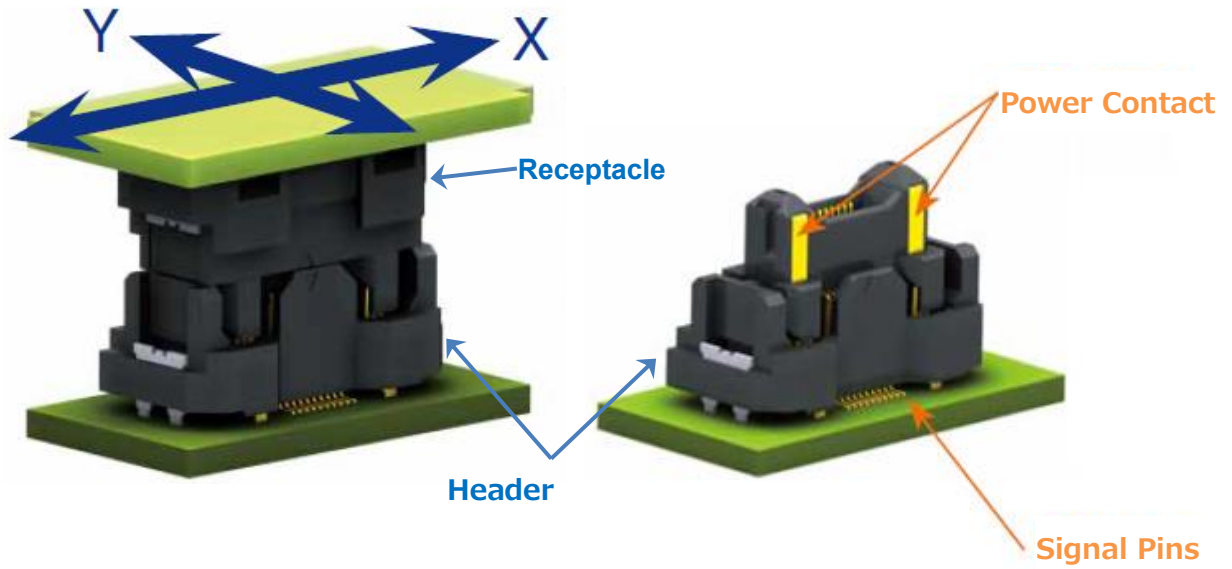


Figure 16 Block-to-Block Connector Features

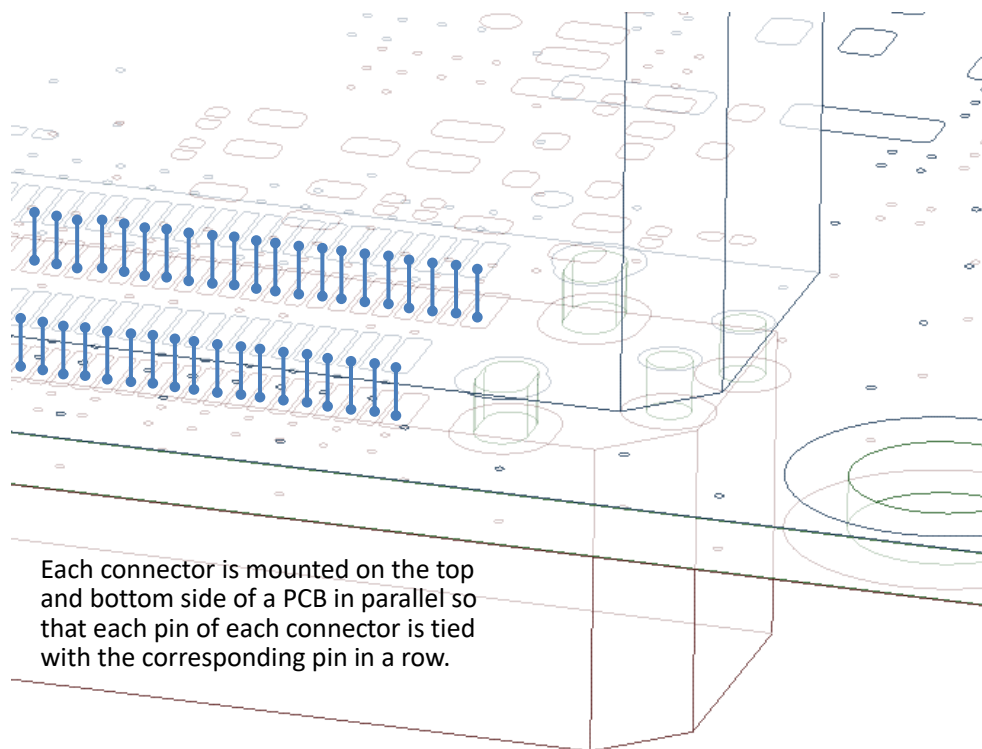


Figure 17 Block-to-Block Connector Pin Application

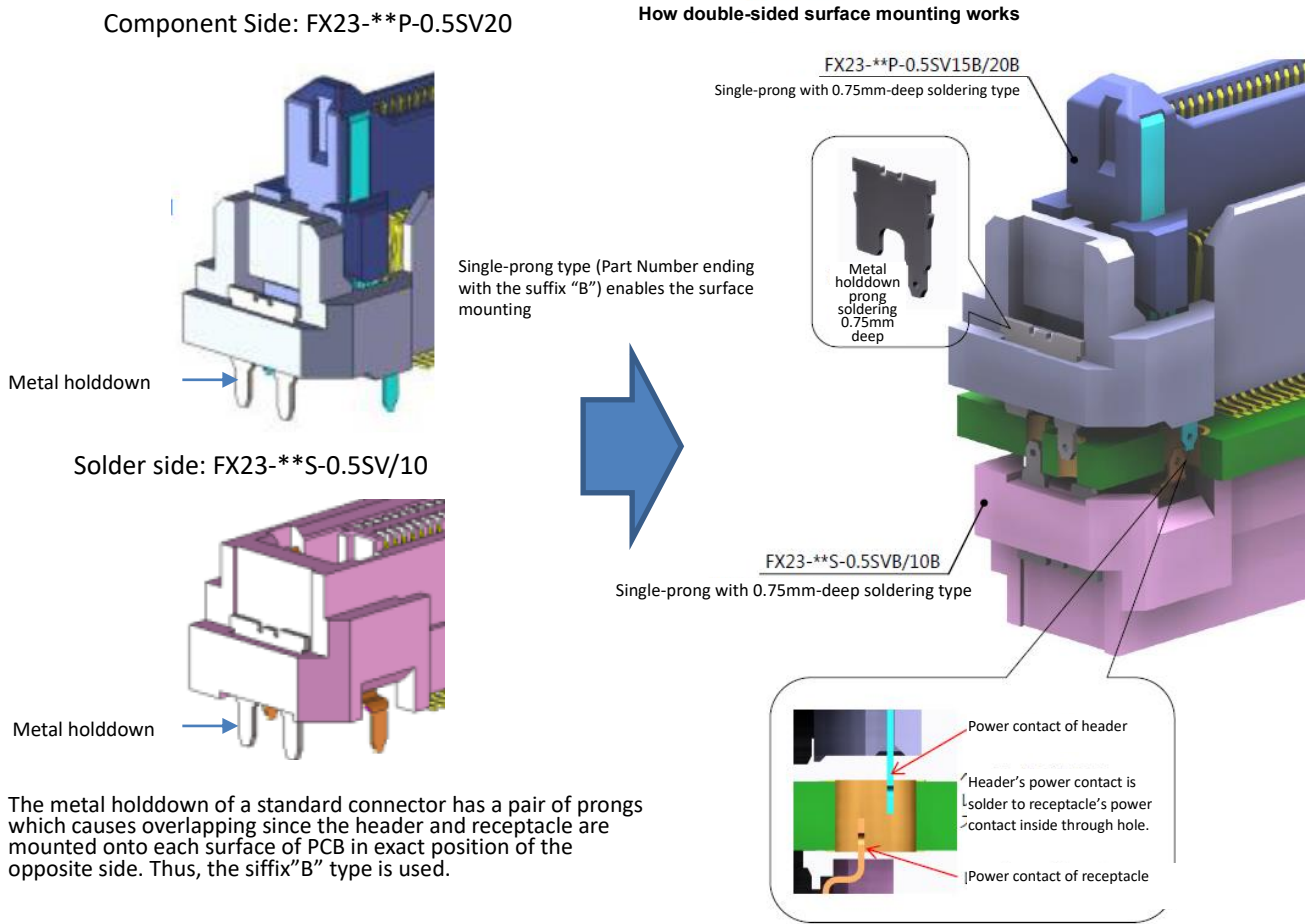


Figure 18 Block-to-Block Connector Consideration

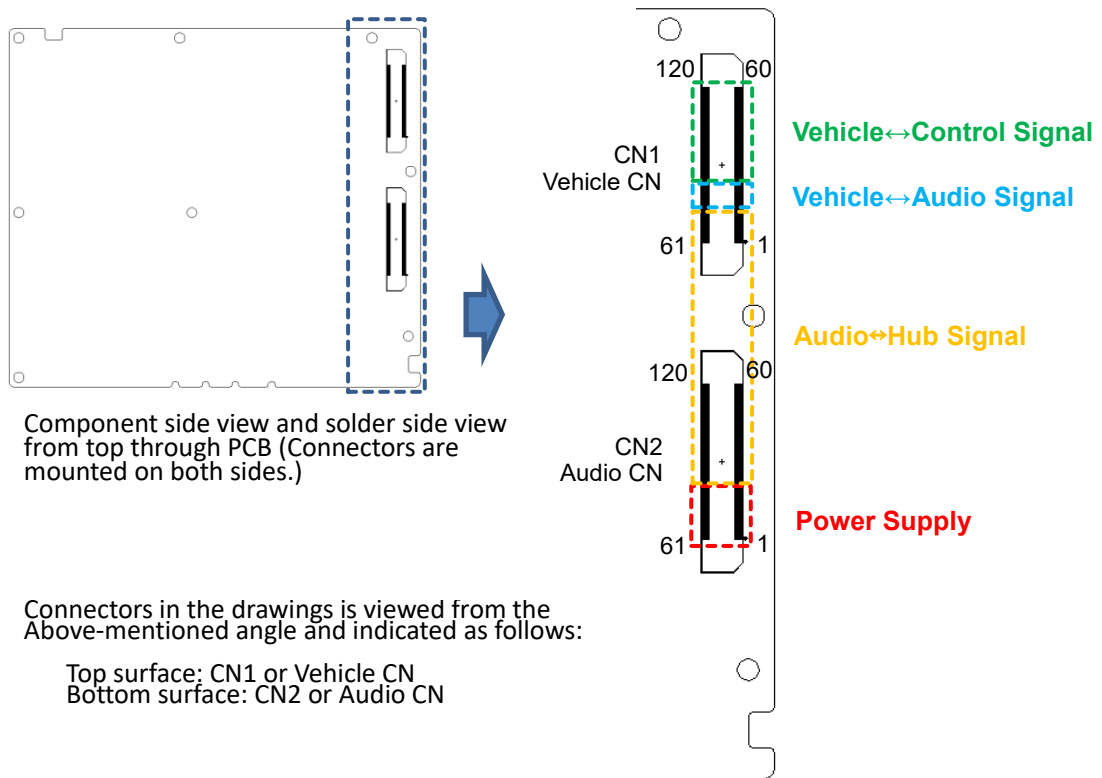


Figure 19 Block-to-Block Connector Signal Type Grouping

6.2. Connector Pin Assignment

To find the information about pin assignment of each connector, please refer to respective design guidelines.

6.3. Signal Level Consistency

Figure 20 illustrates points to note on voltage levels to manage signals between Control, Audio, and Vehicle Boards.

The voltage levels of signals transmitted from/to Audio board, Control board, CN1 and CN2 on Vehicle Board do not require special care. However, voltage level of pins for input and output signal for Vehicle Board except for the pin to supply power for the signal pins, or IO_VEHICLE, should be shifted to the level of IO_VEHICLE voltage. Signals transmitted via CN3 are directly connected to SoC so that the voltage level may need to be regulated on Vehicle Board according to the SoC specification.

Signals transmitted between Control Board, CN1 and CN2 on Audio Board do not have voltage level requirement. However, voltage levels of input and output signals, which is not the level of IO_AUDIO voltage for input and output signals of Audio Board, should be shifted to the level of IO_AUDIO voltage.

The voltage level of signals transmitted via Vehicle Board, CN1 and CN2 should be shifted to the level of IO_VEHICLE power supply voltage.

On Control Board, the voltage level of signals transmitted between Vehicle Board and Control Board via CN1 and CN2 should be shifted to IO_VEHICLE voltage level, the voltage level of signals transmitted between Audio Board and Control Board as well should be shifted to IO_AUDIO voltage level. Each signal voltage level is listed on the table of Connector Pinout in design guidelines of each functional board.

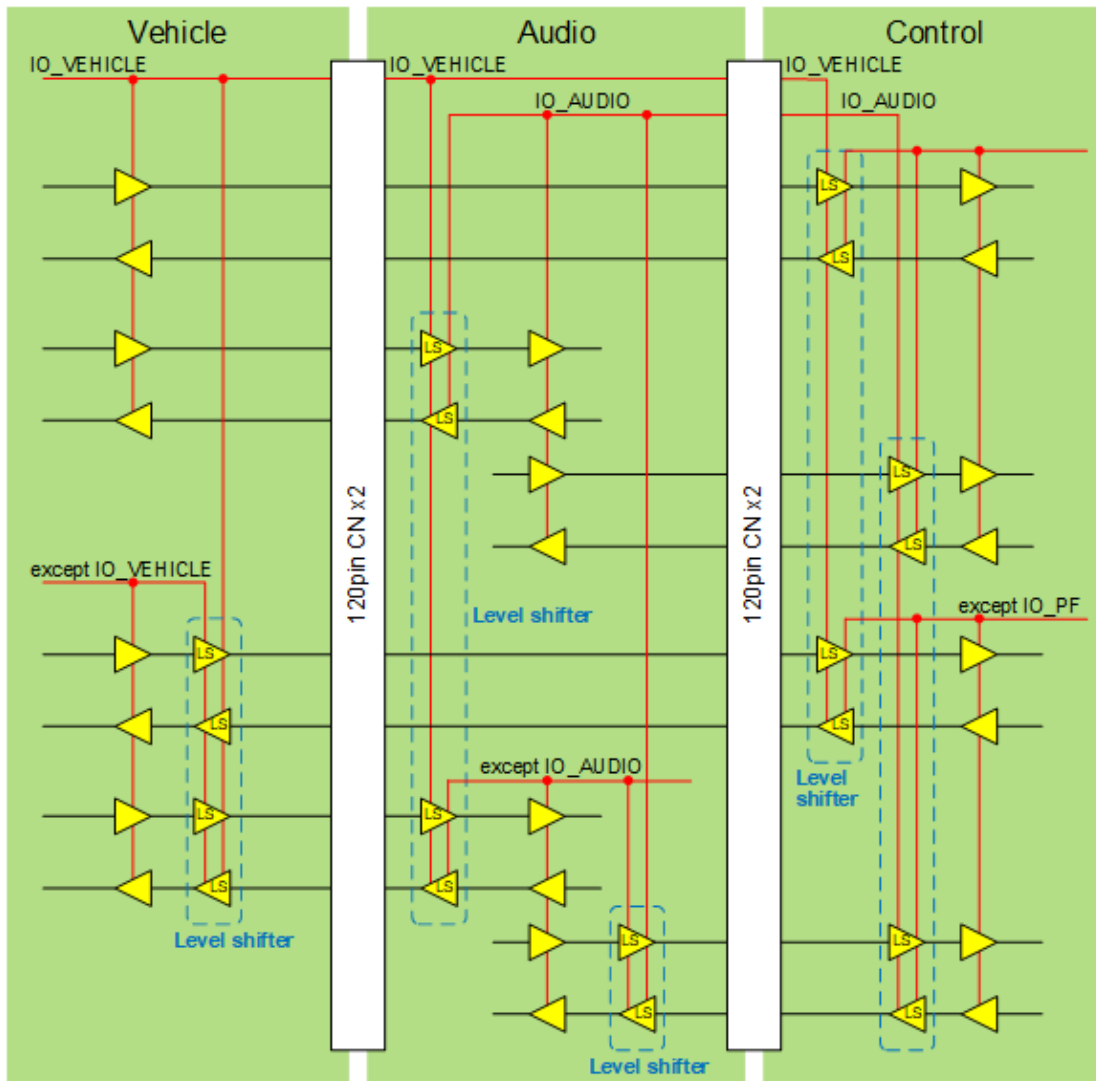


Figure 20 Board-to-Board Signal Voltage Level Compatibility of Signals between Boards

7. R-Car H3 Reference Hardware Structure and Specifications

In R-Car H3 Reference Hardware, Vehicle Board and Audio Board are combined as one board.

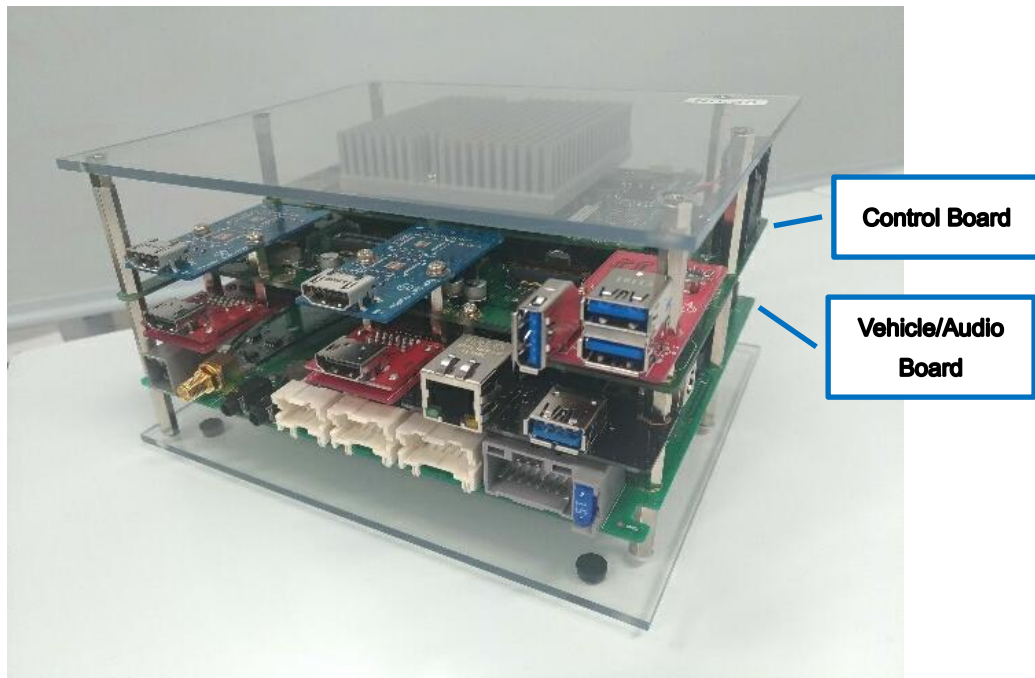


Figure 21 R-Car H3 Reference Hardware Structure

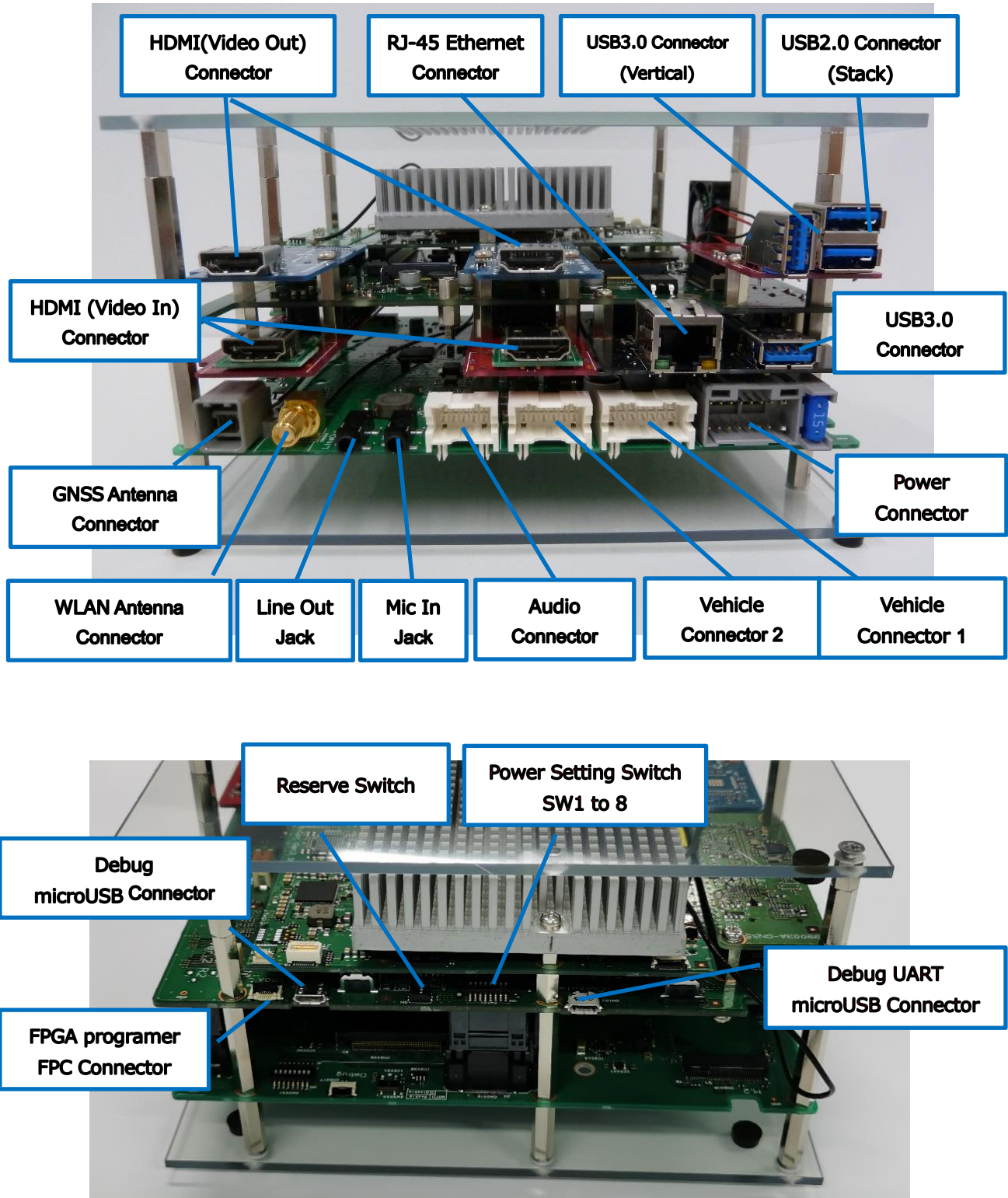


Figure 22 R-Car H3 Reference Hardware External Interfaces

Functional specifications supported by R-Car H3 Reference Hardware are listed on Table 3.

Table 3 Functional Specifications

Block	Spec.
CPU	R-CAR H3 SiP
Memories	<ul style="list-style-type: none"> • 8GByte LPDDR4 • 16MByte QSPI FlashROM • 64GByte eMMC
Connectors	<ul style="list-style-type: none"> • External Connectors x 4 (Power,GPIO,CAN,etc.) • WLAN antenna/GPS antenna • Line Out Jack/Mic In Jack • Debug USB/Debug UART • MicroSD Card Socket • USB3.0 x 2 / USB2.0 x 2 • RJ-45 Ethernet(1000Base-T) • HDMI(Video Out) x 2/HDMI(Video In) x 2
Board configuration	<ul style="list-style-type: none"> • SoC Board • Control Board • Vehicle Board • VideoOut Board x 2 • VideoIn Board x 2 • USB Board • Ether Borad • GNSS Board (• WLAN Board)
Product specification	<ul style="list-style-type: none"> • Dimensions : 154mm x 178mm x 101mm (Excluding protrusions) • Weight : 1000g • External Power supply DC=10.5V~16V@Max 10A • Operating ambient temperature -10°C~60°C
Accessories	<ul style="list-style-type: none"> • AC Adaptor • Power Harness (DC-Jack to External Connector) • External Connector Harness (Reserved) • GNSS Antenna

7.1. Block Diagram

R-Car H3 Reference Hardware Block Diagram is shown below.

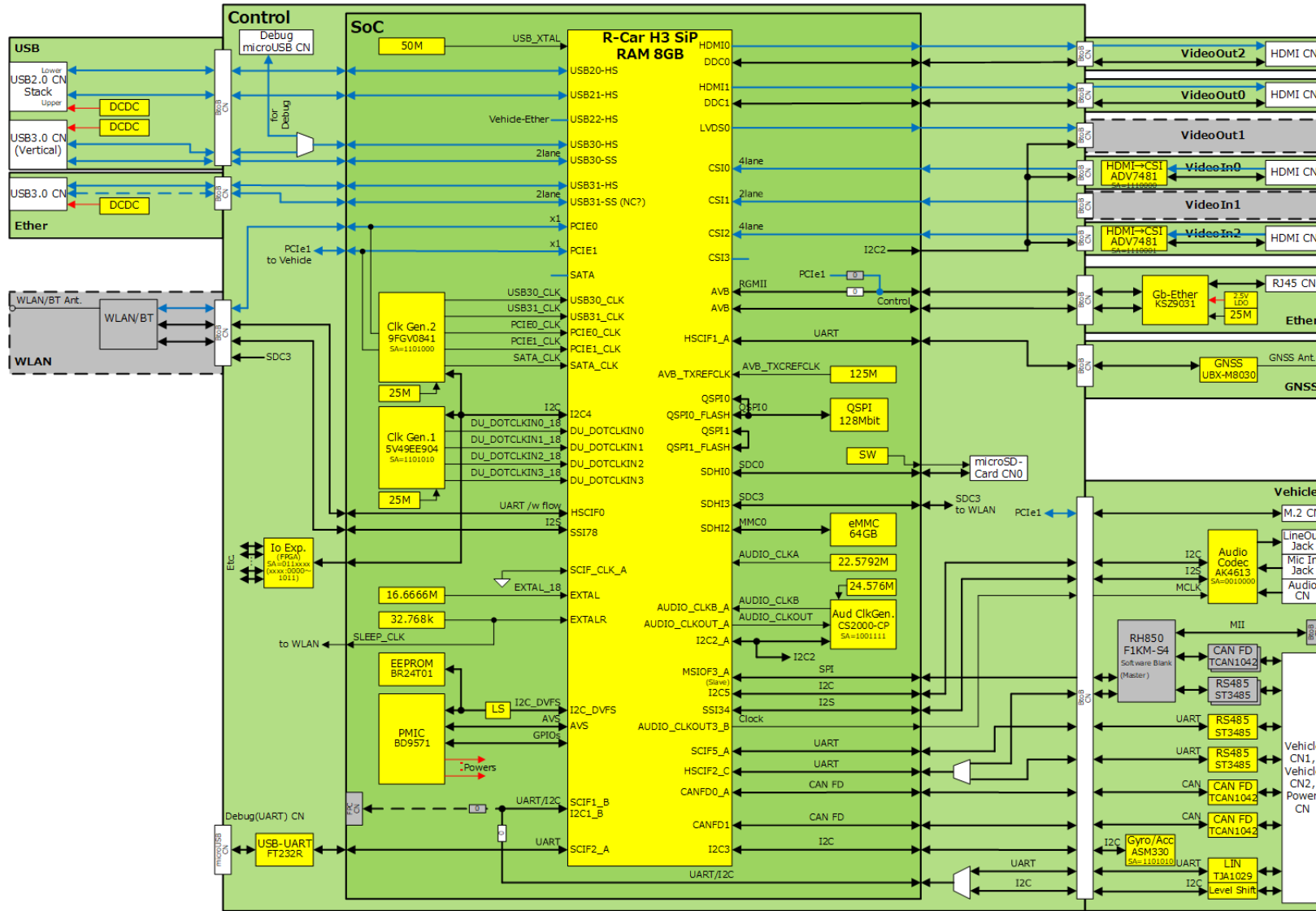


Figure 23 Block Diagram

7.3. Power Sequence

Figure 25 shows power ON sequence when Vehicle Board's SoC boot control setting switch (SW 7) is OFF (Hardware Control)

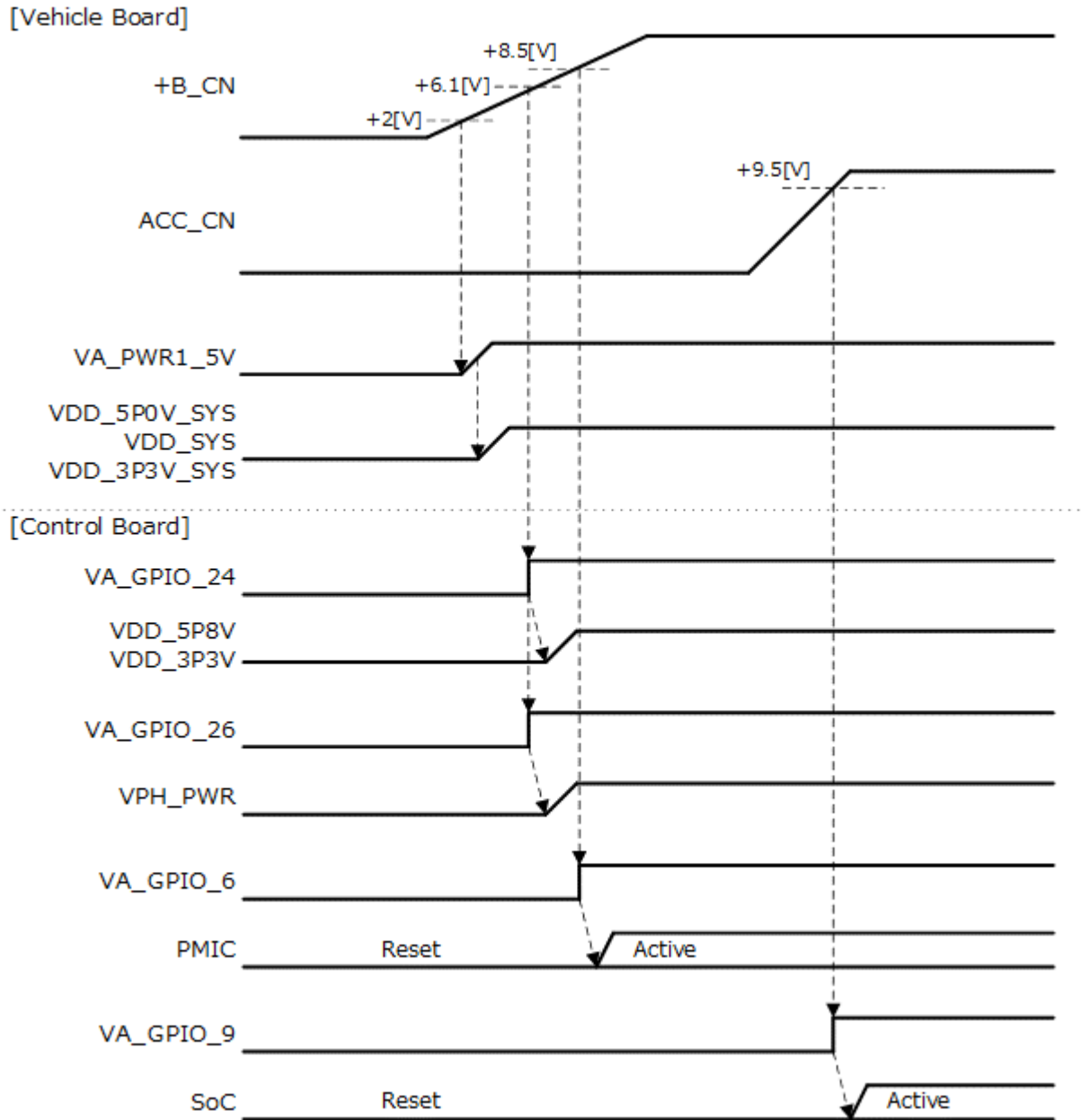


Figure 25 Power ON Sequence

7.4. Circuit Structure

The following figure shows the arrangement and connections between the components in R-Car H3 Reference Hardware Control (+SoC) Board.

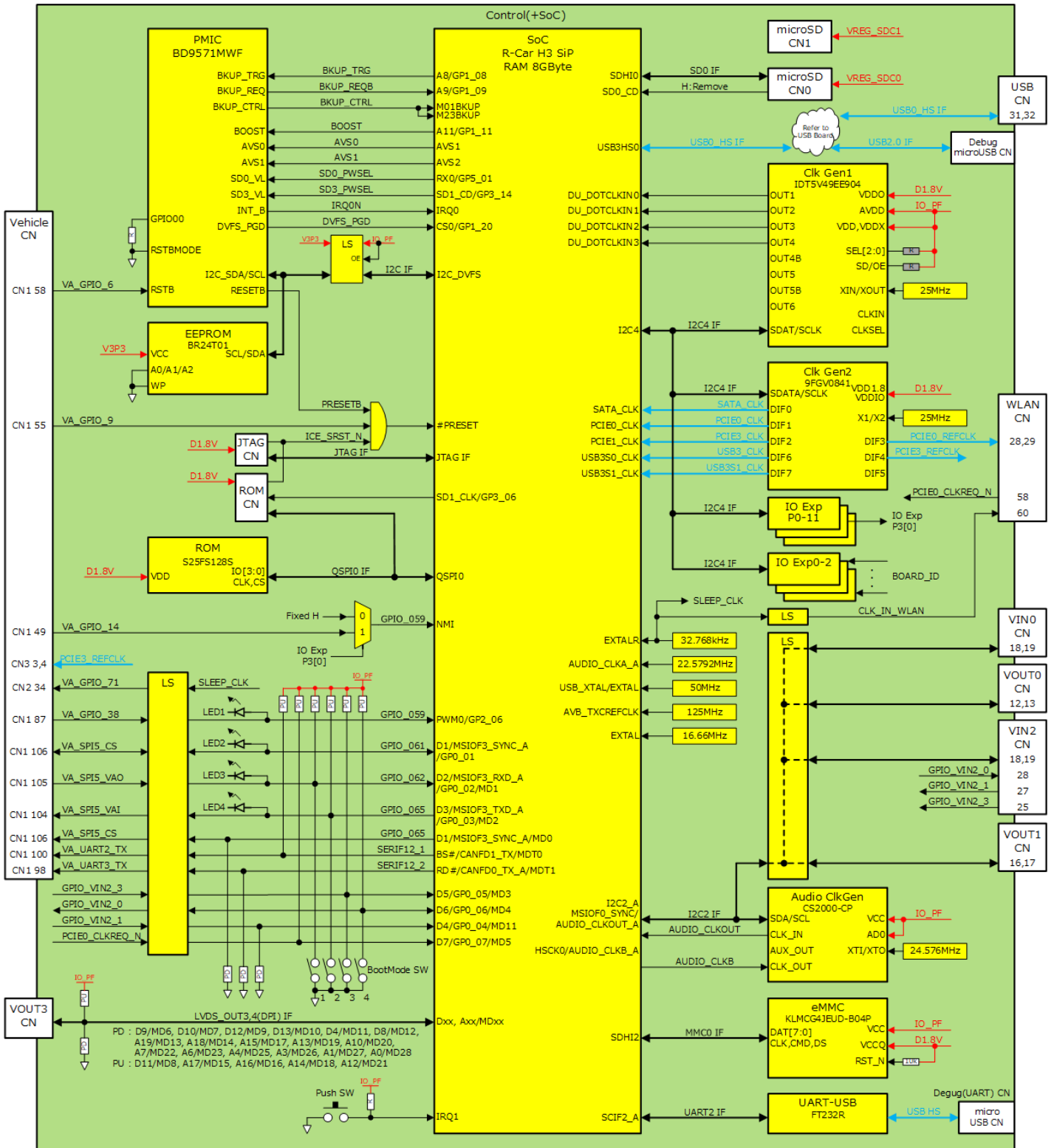


Figure 26 Control (+SoC) Board Schematic

7.5. Block-to-Block Connector Pin Assignment

To find the information about pin assignment of each connector, please refer to respective design guidelines.

8. Disclaimer

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