

## RAA271005

General Purpose IC for Power Management Automotive Applications

The [RAA271005](#) is a general-purpose Power Management IC (PMIC) suitable for R-Car SoC series.

The RAA271005 contains five DC/DC switching regulators and 6 low-drop out linear regulators (LDO). DCDC5 switching regulator can be configured to work in buck mode or can be configured as a boost. The RAA271005 PMIC supports low power operation, where three of the switching regulators (Buck3-Buck5) have been optimized to consume low quiescent current.

RAA271005 supports up to ASIL D functional safety, and includes an independent reference for monitoring of the output voltages, dual internal temperature monitors, challenge response watchdog timer, SoC and MCU error pin monitors, reset generator, a dedicated safety-control state machine, and safety shutdown path. An integrated 12-bit ADC monitors all input rails, output rails, internal temperature, and includes additional inputs to monitor external analog sources.

RAA271005 is available in a 6×11 BGA package with 0.65mm pitch. The device is offered as AEC-Q100 Grade 1 operation supporting an ambient temperature range of -40°C to 125°C.

### Applications

- Automotive gateway systems
- Automotive vision systems
- Automotive LIDAR systems
- Ideal power supply for Renesas R-Car S4 SoC

### Features

- Input voltage range 2.7V - 5.5V
- Five High efficiency switching regulators with adjustable output voltages
  - 12A (Buck1);  $V_{OUT}$  from 0.3V to 3.3V
  - 2.5A (Buck2-Buck5);  $V_{OUT}$  from 0.3V to 3.3V
  - Merge-mode 2 x 2.5A regulators = 5A
  - Buck5 can operate as asynchronous boost
- Six Linear Drop Out (LDO) Regulators
  - 4×60mA;  $V_{OUT}$  = 1.8V or 3.3V
  - 2×500mA;  $V_{OUT}$  = 0.6V to 3.3V
- Programmable current limits for all bucks
- 12-bit analog-to-digital converter for monitoring with programmable OV/UV thresholds.
- Programmable power sequence. Fully supports S4 sequence requirements.
  - Low-Iq Deep-stop/Always On (AWO) Mode
  - Suspend-to-RAM/DDR-backup Mode
- Supports R-Car Soc Activation
- Q&A watchdog timer
- Configurable through I<sup>2</sup>C or SPI interface
- SoC and MCU error pin monitors
- [AEC-Q100](#)
- Grade 1 qualified

## Contents

<b>1. Overview</b>	<b>3</b>
1.1 Typical Applications	3
1.2 Block Diagram	5
<b>2. Pin Information</b>	<b>6</b>
2.1 Pin Assignments	6
2.2 Pin Description	7
2.2.1 IO Pin Assignments	9
2.2.2 IO Pin Descriptions	10
<b>3. Package Outline Drawing</b>	<b>11</b>
<b>4. Revision History</b>	<b>12</b>

# 1. Overview

## 1.1 Typical Applications

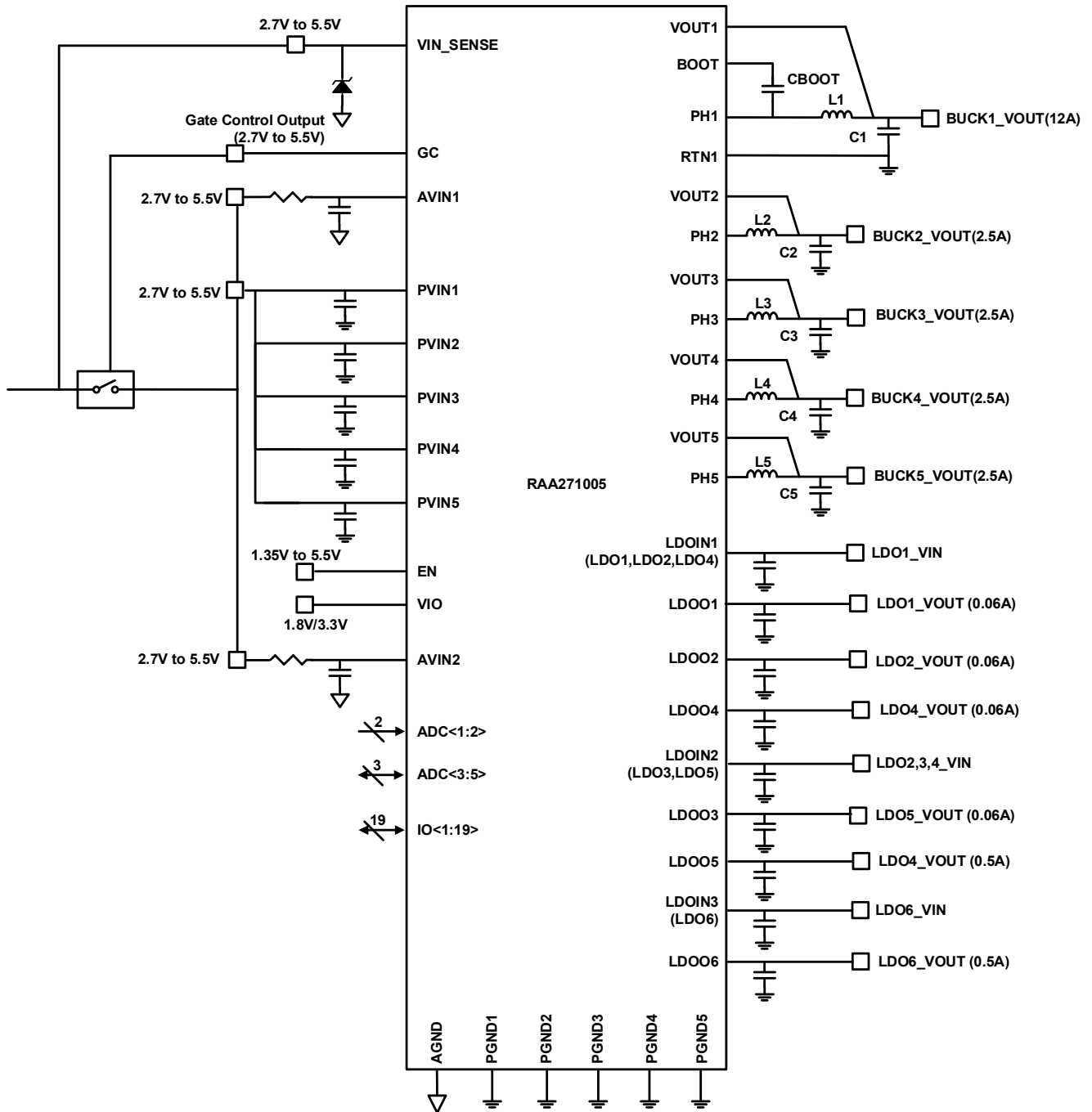


Figure 1. Typical Application with 5 Bucks

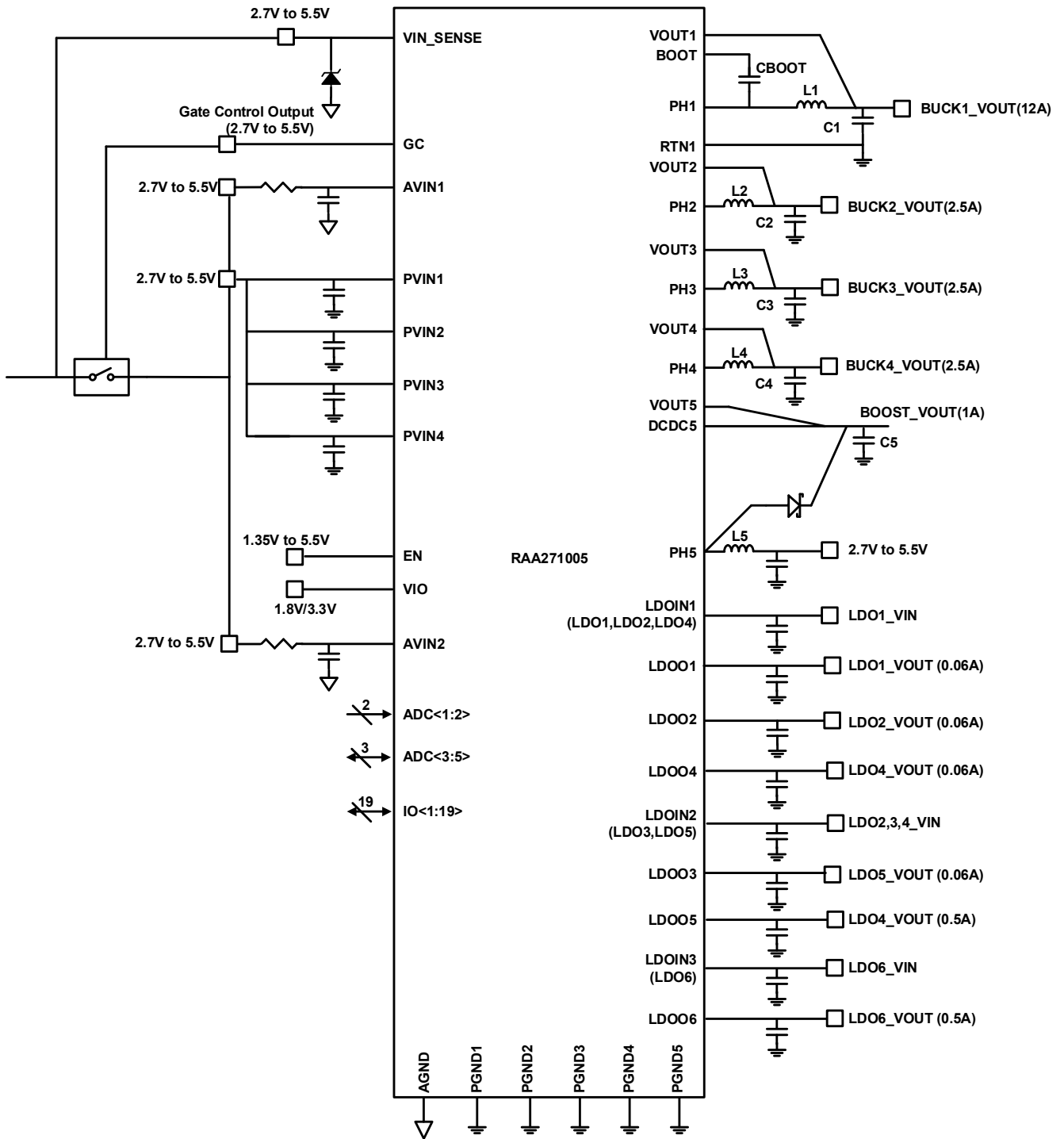


Figure 2. Typical Application with 4 Bucks + 1 Boost

## 1.2 Block Diagram

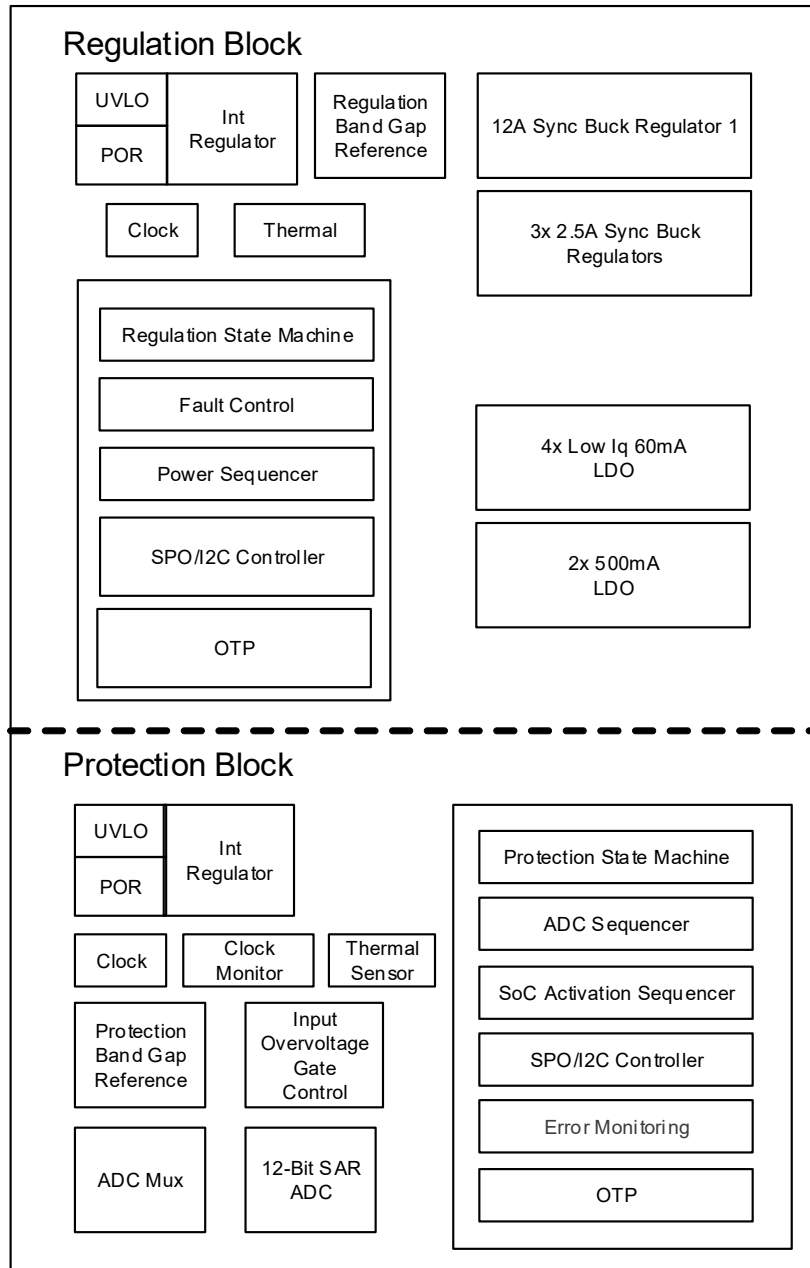


Figure 3. Simplified Block Diagram (Under Development)

## 2. Pin Information

### 2.1 Pin Assignments

	1	2	3	4	5	6
A	IO8	IO11	AGND	ADC4	AVIN2	ADC2
B	IO7	IO9	IO10	ADC5	ADC3	ADC1
C	IO17	IO12	VOUT4	VOUT5	EN	IO13
D	IO15	IO16	VOUT3	RTN1	IO18	IO4
E	PVIN4	AVIN1	LDOO5	VOUT1	IO19	PVIN5/ DCDC5
F	PH4	GC	LDOO6	VOUT2	IO14	PH5
G	PGND4	LDOO4	LDOO3	AGND	VIO	PGND5
H	PGND3	VIN_SENSE	LDOO2	LDOO1	IO2	PGND2
J	PH3	LDOIN3	LDOIN2	IO6	IO3	PH2
K	PVIN3	BOOT	LDOIN1	IO5	IO1	PVIN2
L	PVIN1	PH1	PGND1	PGND1	PH1	PVIN1

Balls Facing Down

## 2.2 Pin Description

Pin Number	Pin Name	Pin Type	Description
A1	IO8	Input/Output	Refer to IO Pin configuration table for programmability and descriptions.
A2	IO11	Input/Output	
A3	AGND	GND	Analog ground
A4	ADC4	Input/Output	External ADC input or ADC decoder output
A5	AVIN2	Input	Analog supply voltage 2, 2.7V to 5.5V. This should be connected to AVIN1 on PCB.
A6	ADC2	Input	External ADC input
B1	IO7	Input/Output	Refer to IO Pin configuration table for programmability and descriptions.
B2	IO9	Input/Output	
B3	IO10	Input/Output	
B4	ADC5	Input/Output	External ADC input or ADC decoder output
B5	ADC3	Input/Output	External ADC input or ADC decoder output
B6	ADC1	Input	External ADC input
C1	IO17	Input/Output	Refer to IO Pin configuration table for programmability and descriptions.
C2	IO12	Input/Output	
C3	VOOUT4	Input	Remote sense of the output voltage of Buck 4
C4	VOOUT5	Input	Remote sense of the output voltage of Buck 5.
C5	EN	Input	Chip enable
C6	IO13	Input/Output	Refer to IO Pin configuration table for programmability and descriptions.
D1	IO15	Input/Output	Refer to IO Pin configuration table for programmability and descriptions.
D2	IO16	Input/Output	Refer to IO Pin configuration table for programmability and descriptions.
D3	VOOUT3	Input	Remote sense of the output voltage of Buck 3
D4	RTN1	Input	Remote ground sense at the load for Buck 1
D5	IO18	Input/Output	Refer to IO Pin configuration table for programmability and descriptions.
D6	IO4	Input/Output	
E1	PVIN4	Input	Power supply for Buck 4 power stage.
E2	AVIN1	Input	Analog supply voltage 1
E3	LDOO5	Output	LDO 5 power output
E4	VOOUT1	Input	Remote sense of the output voltage of Buck 1
E5	IO19	Input/Output	Refer to IO Pin configuration table for programmability and descriptions.
E6	PVIN5/ DCDC5	Input	Power supply for Buck 5 power stage.
F1	PH4	Output	Switching node for Buck 4 power stage.
F2	GC	Output	Gate control
F3	LDOO6	Output	LDO 6 power output
F4	VOOUT2	Input	Remote sense of the output voltage of Buck 2
F5	IO14	Input/Output	Refer to IO Pin configuration table for programmability and descriptions.

Pin Number	Pin Name	Pin Type	Description
F6	PH5	Output	Switching node for Buck 5 power stage.
G1	PGND4	GND	Ground connection for Buck 4 power stage.
G2	LDOO4	Output	LDO 4 power output
G3	LDOO3	Output	LDO 3 power output
G4	AGND	GND	Analog ground
G5	VIO	Input	I/O Supply Voltage
G6	PGND5	GND	Ground connection for Buck 5 power stage.
H1	PGND3	GND	Ground connection for Buck 3 power stage.
H2	VIN_SENSE	Input	Input voltage monitoring pin for input over voltage protection gate control
H3	LDOO2	Output	LDO 2 power output
H4	LDOO1	Output	LDO 1 power output
H5	IO2	Input/Output	Refer to IO Pin configuration table for programmability and descriptions.
H6	PGND2	GND	Ground connection for Buck 2 power stage.
J1	PH3	Output	Switching node for Buck 3 power stage.
J2	LDOIN3	Input	LDO 6 power input
J3	LDOIN2	Input	LDO 3 & 5 power input
J4	IO6	Input/Output	Refer to IO Pin configuration table for programmability and descriptions.
J5	IO3	Input/Output	
J6	PH2	Output	Switching node for Buck 2 power stage.
K1	PVIN3	Input	Power supply for Buck 3 power stage.
K2	BOOT	Input	Supply for boosted gate drive for Buck 1
K3	LDOIN1	Input	LDO 1, 2 & 4 power input
K4	IO5	Input/Output	Refer to IO Pin configuration table for programmability and descriptions.
K5	IO1	Input/Output	
K6	PVIN2	Input	Power supply for Buck 2 power stage.
L1	PVIN1	Input	Power supply for Buck 1 power stage.
L2	PH1	Input	Switching node for Buck 1 power stage.
L3	PGND1	GND	Ground connection for Buck 1 power stage.
L4	PGND1	GND	Ground connection for Buck 1 power stage.
L5	PH1	Output	Switching node for Buck 1 power stage.
L6	PVIN1	Input	Power supply for Buck 1 power stage.



## 2.2.1 IO Pin Assignments

Table 1. IO Pin configuration table

Pin Mode	IO1	IO2	IO3	IO4	IO5	IO6	IO7	IO8	IO9	IO10	IO11	IO12	IO13	IO14	IO15	IO16	IO17	IO18	IO19
0x0	SCK	SS_B2	SS_B	MOSI	MISO	PGOOD	SDI1	PRESET#	SDO1	SDO2	PRESET OUT	SDI2	EXTPOC#	IRQ#	SDI3	SDI4	PWR_CTRL1	PWR_CTRL2	BKUP
0x1	SCL	SDA	GPIO1	GPIO2	GPIO3	PGOOD	SDI1	PRESET#	SDO1	SDO2	PRESET OUT	SDI2	EXTPOC#	IRQ#	SDI3	SDI4	PWR_CTRL1	PWR_CTRL2	BKUP

## 2.2.2 IO Pin Descriptions

IO Name	Type	Description
PGOOD	Output	Power Good signal to R-Car S4
SDI1 / ERROROUT	Input	R-Car S4 Error Notification Signal
PRESET#	Output	Reset Signal sent to R-Car S4
SDO1 / STB_N*	Output	Standby Control Signal for CAN transceiver
SDO2 / SSP*	Output	Secondary Safety Path Signal
EXTPOC	Output	External Power on Clear Input to the R-Car S4
IRQ#*	Output	Interrupt signal to R-Car S4
PWR_CTRL1,2	Input	Power Control inputs from the R-Car S4 to sequence certain rails
PRESETOUT	Input	Reset notification signal from R-Car S4 SoC
SDI2 / VMONOUT0	Input	Digital CVM Error signal notification from R-Car S4 SoC
SDI3 / VMONOUT1	Input	Digital CVM Error signal notification from R-Car S4 MCU
SDI4	Input	Safety Defined Input
BKUP	Output	Signal indicating the turn-off of non-memory and non-AWO rails in suspend to RAM mode
SS_B, SS_B2	Input	SPI Slave select signals
SCK	Input	SPI clock signal
MOSI	Input	SPI Master Output Slave Input Signal
MISO	Output	SPI Master Input Slave Output Signal
SCL	Input	I2C Clock Signal
SDA	Input/ Output	I2C Data Signal
GPIOx*	Input/ Output	General Purpose IO

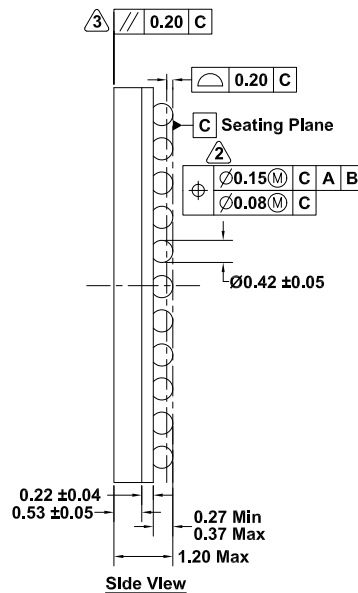
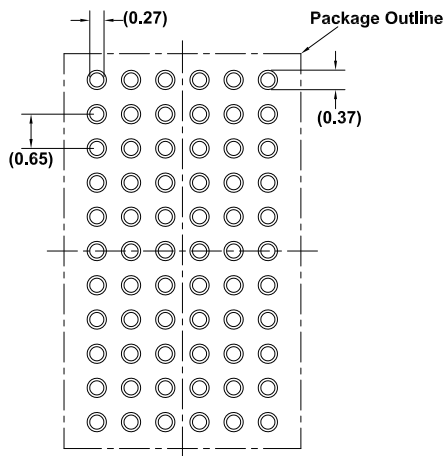
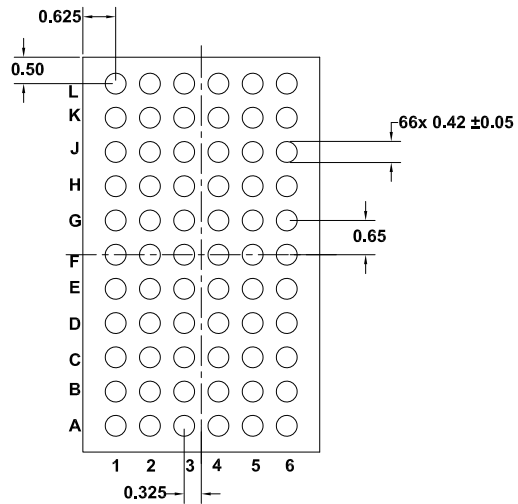
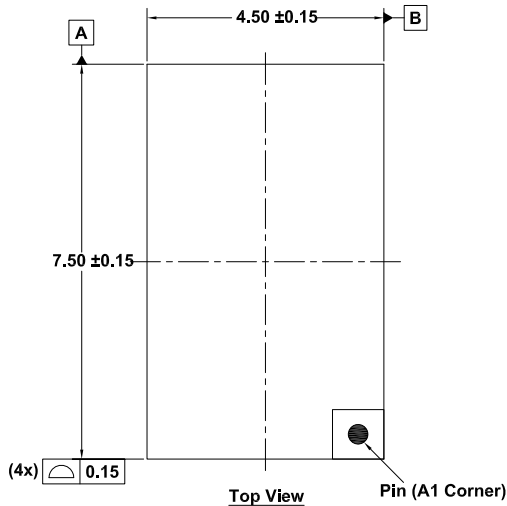
### 3. Package Outline Drawing

For the most recent package outline drawing, see [V66.4.50x7.50](#).

V66.4.50x7.50

66 Low Profile Ball Grid Array Package (LFBGA)

Rev 0, 5/2021



**Notes:**

1. All dimensions and tolerances conform to ASME Y14.5 - 2009.
- ② Datum C (Seating Plane) is defined by the spherical crowns of the solder balls.
- ③ Parallelism measurement shall exclude any effect of mark on top surface of package.
4. Unless otherwise specified, dimensions are in millimeters.

## 4. Revision History

Revision	Date	Description
1.00	Sep 27, 2021	Initial release.

## Notice

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.
2. Renesas Electronics hereby expressly disclaims any warranties against and liability for infringement or any other claims involving patents, copyrights, or other intellectual property rights of third parties, by or arising from the use of Renesas Electronics products or technical information described in this document, including but not limited to, the product data, drawings, charts, programs, algorithms, and application examples.
3. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
4. You shall be responsible for determining what licenses are required from any third parties, and obtaining such licenses for the lawful import, export, manufacture, sales, utilization, distribution or other disposal of any products incorporating Renesas Electronics products, if required.
5. You shall not alter, modify, copy, or reverse engineer any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copying or reverse engineering.
6. Renesas Electronics products are classified according to the following two quality grades: "Standard" and "High Quality". The intended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below.

"Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; industrial robots; etc.

"High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.

Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems; surgical implantations; etc.), or may cause serious property damage (space system; undersea repeaters; nuclear power control systems; aircraft control systems; key plant systems; military equipment; etc.). Renesas Electronics disclaims any and all liability for any damages or losses incurred by you or any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet, user's manual or other Renesas Electronics document.

7. No semiconductor product is absolutely secure. Notwithstanding any security measures or features that may be implemented in Renesas Electronics hardware or software products, Renesas Electronics shall have absolutely no liability arising out of any vulnerability or security breach, including but not limited to any unauthorized access to or use of a Renesas Electronics product or a system that uses a Renesas Electronics product. RENESAS ELECTRONICS DOES NOT WARRANT OR GUARANTEE THAT RENESAS ELECTRONICS PRODUCTS, OR ANY SYSTEMS CREATED USING RENESAS ELECTRONICS PRODUCTS WILL BE INVULNERABLE OR FREE FROM CORRUPTION, ATTACK, VIRUSES, INTERFERENCE, HACKING, DATA LOSS OR THEFT, OR OTHER SECURITY INTRUSION ("Vulnerability Issues"). RENESAS ELECTRONICS DISCLAIMS ANY AND ALL RESPONSIBILITY OR LIABILITY ARISING FROM OR RELATED TO ANY VULNERABILITY ISSUES. FURTHERMORE, TO THE EXTENT PERMITTED BY APPLICABLE LAW, RENESAS ELECTRONICS DISCLAIMS ANY AND ALL WARRANTIES, EXPRESS OR IMPLIED, WITH RESPECT TO THIS DOCUMENT AND ANY RELATED OR ACCOMPANYING SOFTWARE OR HARDWARE, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE.
8. When using Renesas Electronics products, refer to the latest product information (data sheets, user's manuals, application notes, "General Notes for Handling and Using Semiconductor Devices" in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to maximum ratings, operating power supply voltage range, heat dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident arising out of the use of Renesas Electronics products outside of such specified ranges.

9. Although Renesas Electronics endeavors to improve the quality and reliability of Renesas Electronics products, semiconductor products have specific characteristics, such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a failure or malfunction of Renesas Electronics products, such as safety design for hardware and software, including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for evaluating the safety of the final products or systems manufactured by you.
10. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
11. Renesas Electronics products and technologies shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.
12. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document.
13. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
14. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products.  
(Note 1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.  
(Note 2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

(Rev. 4.0-2 April 2020)

## Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,  
Koto-ku, Tokyo 135-0061, Japan  
[www.renesas.com](http://www.renesas.com)

## Contact Information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit:  
[www.renesas.com/contact/](http://www.renesas.com/contact/)

## Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.