R9A02G011

ASSP (USB Power Delivery Controller)

R19DS0088EJ0130
Rev.1.30
Jan. 29, 2019

1. OVERVIEW

The R9A02G011 is a USB Power Delivery Controller that is based on the Universal Serial Bus (USB) Power Delivery Specification Revision 3.0 and USB Type-C™ Cable and Connecter Specification Revision 1.3. The R9A02G011 performs negotiation for more current and/or higher voltages over the USB cable (VBUS) than are defined in the USB2.0, USB3.0 or BC1.2 specifications, and controls circuitry to select local power source or power sink. The R9A02G011 uses a 300kbps BMC modulated signal through the CC wire in the USB Type-C™ cable. It comes in a small 32-pin QFN package and integrates several commonly required external components, making it ideally suited for applications with limited PCB space. In addition, the R9A02G011 incorporates Renesas' low-power technologies.

1.1 Features

- Compliant with USB Power Delivery Specification Revision 3.0 and USB Type-C™ Cable and Connector Specification Revision 1.3.
  - Certified by USB Implementers Forum: TID= 1061007 (Silicon), 1020074 (E-marker)
  - Supports Programmable Power Supply
  - Supports IEC63002
  - Supports up to 260 bytes data transfer
  - Supports all USB Type-C™ Connection State Diagrams for USB Type-C™ port control
- Compliant with USB Power Delivery Specification Revision 2.0
  - Certified by USB Implementers Forum: TID=1000004 (Silicon), 1020073 (E-marker)
  - Supports alternate mode and electronically marked cables
  - Supports Dual Role operation and Role Swap protocol
  - Supports Dead Battery operation
- Single Power Supply with wide voltage range from 3.0 to 5.5V
- Integrated CC-PHY and CC-logic
- On-chip Flash ROM
- On-chip Oscillator
- On-chip Power-On-Reset (POR) circuit
- Small Footprint
  - Small and low pin count package with simple pin assignment for PCB layout
  - Integration of many peripheral components
- Supports SMBus Master and Slave interfaces
- Suitable for Energy Star and EuP specifications for low-power PC peripheral systems.

1.2 Applications

AC Adapter, Power outlet, USB PD Hub, PC, Tablet, Smartphone, Docking Station, PC Peripheral Device (Monitor, Printer, Router, External HDD), Consumer Electronics (DTV, STB, Home Gateway), etc.

1.3 Ordering Information

Part Number	Package	Remark
R9A02G011GNP#AC0	32-pin QFN (5 × 5 mm)	Lead-free product

1.4 Block Diagram

Figure 1-1. R9A02G011 Block Diagram

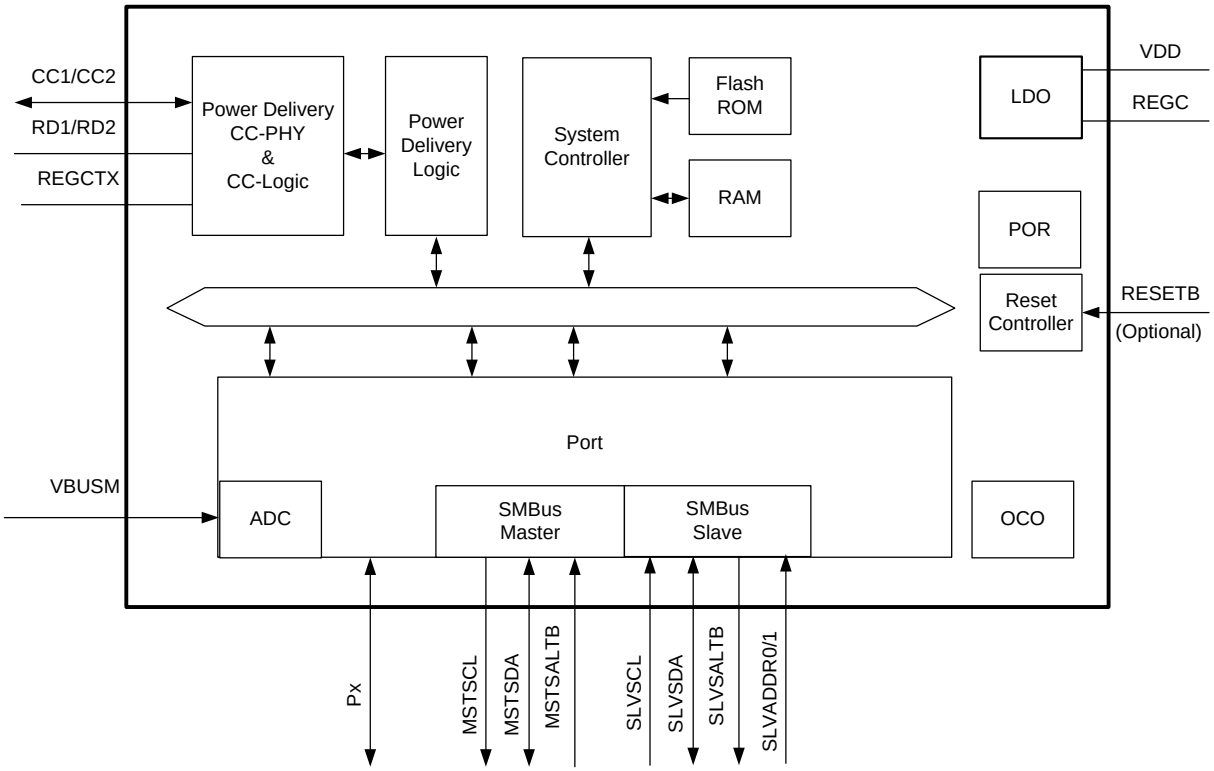


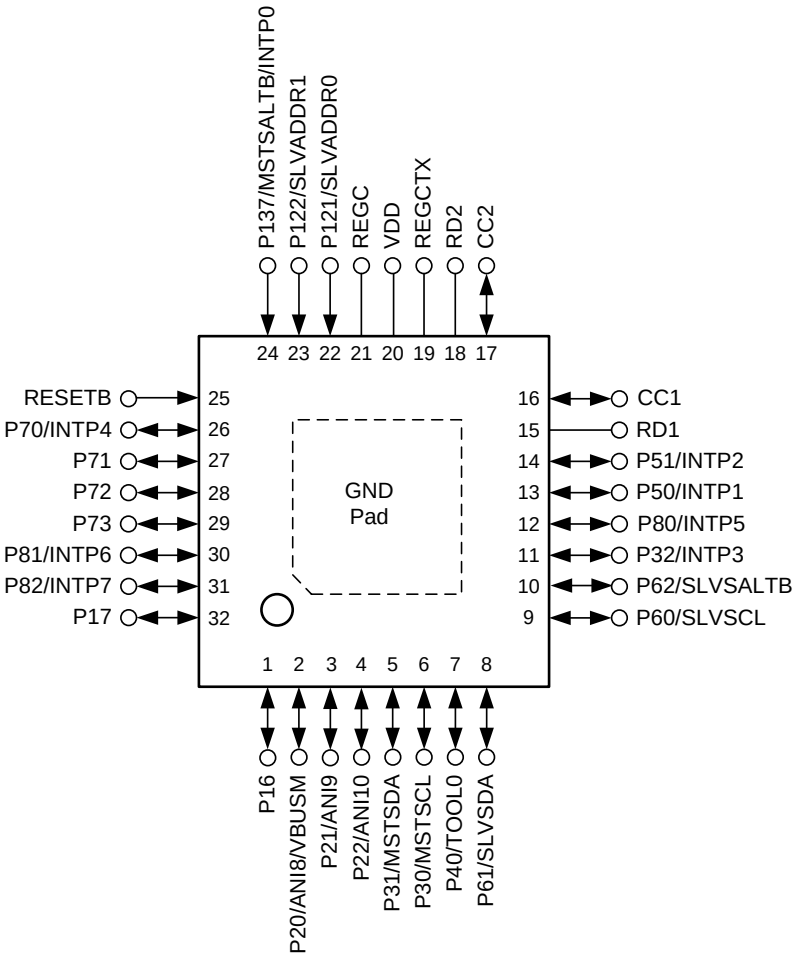
Table 1-1. Terminology

Block Name	Description
Power Delivery CC-PHY & Logic	CC-PHY (Tx/Rx), CC-logic, and LDO used for CC-PHY
Power Delivery Logic	Power Delivery logic controller
System Controller	System CPU core (RL78)
Flash ROM	Internal Flash ROM
RAM	Internal SRAM
SMBus Slave	Interface signals to external SMBus Master.
SMBus Master	Interface signals to external SMBus Slave.
Port	Controls Port I/O signals
OCO	On-Chip Oscillator
POR	Internal Power-On-Reset circuit
Reset Controller	External reset signal (Optional)
ADC	AD Converter
LDO	Low Drop Out regulator integrated in this IC

1.5 Pin Configuration

- **32-pin QFN (5 × 5 mm)**

Figure 1-2. Pin Configuration of R9A02G011 32-pin QFN (Top View)



2. PIN FUNCTION

This section describes each pin's function.

2.1 Power supply

Pin Name	Pin No.	I/O Type	Function
VDD	20	Power	Power supply (from 3.0V to 5.5V)
REGCTX	19	Power	Regulator capacitance for CC-PHY. Connecting regulator output stabilization capacitance for internal operation.
REGC	21	Power	Regulator capacitance. Connecting regulator output stabilization capacitance for internal operation.
GND	Die Pad	-	Ground

2.2 System Interface Pins

Pin Name	Pin No.	I/O Type	Function
RESETB	25	IN	Chip Reset Input (L active)

2.3 USB PD and Type-C™ Port Pins

Pin Name	Pin No.	I/O Type	Function
RD1	15	I/O	Rd resistor 1, Analog pin from CC-PHY.
CC1	16	I/O	Configuration Channel 1, Analog pin from CC-PHY
CC2	17	I/O	Configuration Channel 2, Analog pin from CC-PHY
RD2	18	I/O	Rd resistor 2, Analog pin from CC-PHY

2.4 I/O Port Pins

Pin Name	Pin No.	I/O Type	During reset	After reset	Function
P16	1	I/O	Input	Input	Port 1, 2 bit I/O port.
P17	32	I/O	Input	Input	Port 1, 2 bit I/O port.

Pin Name	Pin No.	I/O Type	During reset	After reset	Function
P20	2	I/O	Input	Input	Port 2, 3 bit I/O port. It is also configurable as VBUSM or ANI8
P21	3	I/O	Input	Input	Port 2, 3 bit I/O port. It is also configurable as ANI9
P22	4	I/O	Input	Input	Port 2, 3 bit I/O port. It is also configurable as ANI10
P30	6	I/O	Input	Input	Port 3, 3 bit I/O port. It is also configurable as MSTSCL.
P31	5	I/O	Input	Input	Port 3, 3 bit I/O port. It is also configurable as MSTSDA
P32	11	I/O	Input	Input	Port 3, 3 bit I/O port. It is also configurable as INTP3
P40	7	I/O	Input	Input Pull-up	Port 4, 1 bit I/O port. It is also configurable as TOOL0
P50	13	I/O	Input	Input	Port 5, 2 bit I/O port. It is also configurable as INTP1
P51	14	I/O	Input	Input	Port 5, 2 bit I/O port. It is also configurable as INTP2
P60	9	I/O	Input	Input	Port 6, 3 bit I/O port. It is also configurable as SLVSCL
P61	8	I/O	Input	Input	Port 6, 3 bit I/O port. It is also configurable as SLVSDA
P62	10	I/O	Input	Input	Port 6, 3 bit I/O port. It is also configurable as SLVSALTB
P70	26	I/O	Input	Input	Port 7, 4 bit I/O port. It is also configurable as INTP4
P71	27	I/O	Input	Input	Port 7, 4 bit I/O port.
P72	28	I/O	Input	Input	Port 7, 4 bit I/O port.
P73	29	I/O	Input	Input	Port 7, 4 bit I/O port.
P80	12	I/O	Input	Input	Port 8, 3 bit I/O port. It is also configurable as INTP5
P81	30	I/O	Input	Input	Port 8, 3 bit I/O port. It is also configurable as INTP6
P82	31	I/O	Input	Input	Port 8, 3 bit I/O port. It is also configurable as INTP7
P121	22	IN	Input	Input	Port 12, 2 bit Input port. It is also configurable as SLVADDR0
P122	23	IN	Input	Input	Port 12, 2 bit Input port. It is also configurable as SLVADDR1
P137	24	IN	Input	Input	Port 13, 1 bit Input port. It is also configurable as MSTSALTB or INTP0.

2.5 Alternate Functions on I/O Port Pins

I/O ports support the following alternate functions.

Function Name	I/O	Function
ANI8 to ANI10	Input	Analog Input
MSTSCL	I/O	SMBus master clock input/output (open-drain) Note 1
MSTSDA	I/O	SMBus master data input/output (open-drain) Note 1
MSTSALTB	Input	SMBus master alert input Note 1
SLVSCL	I/O	SMBus slave clock input/output (open-drain) Note 2
SLVSDA	I/O	SMBus slave data input/output (open-drain) Note 2
SLVSALTB	Output	SMBus slave alert output (open-drain)
SLVADDR0	input	SMBus slave address bit [1] Note 2
SLVADDR1	input	SMBus slave address bit [2] Note 2
VBUSM	Input	VBUS voltage monitor input. The pin assignment is fixed to this function.
INTP0 to INTP7	Input	Interrupt detection input. The valid edge (rising edge, falling edge, or rising and falling edges) can be specified.
TOOL0	I/O	Data input/output for flash programming tool. The pin assignment is fixed to this function.

Note 1. The pin assignment is fixed to this function when SMBus Master is enabled.
Note 2. The pin assignment is fixed to this function when SMBus Slave is enabled.

3. ELECTRICAL SPECIFICATIONS

This chapter describes the following electrical specifications.

3.1 Absolute Maximum Ratings

Absolute Maximum Ratings (1/2)

Parameter	Symbols	Conditions	Ratings	Unit
Supply voltage	V_{DD}		−0.5 to +6.5	V
	V_{SS}		−0.5 to +0.3	V
REGC pin input voltage	V_{IREGC}	REGC	−0.3 to +2.8 and −0.3 to V_{DD} +0.3 Note 1	V
	$V_{IREGCTX}$	REGCTX	−0.3 to +2.8	V
Input voltage	V_I	P16, P17, P20 to P22, P30 to P32, P40, P50, P51, P60 to P62, P70 to P73, P80 to P82, P121, P122, P137, RESETB	−0.3 to V_{DD} +0.3 Note 2	V
Output voltage	V_O	P16, P17, P20 to P22, P30 to P32, P40, P50, P51, P60 to P62, P70 to P73, P80 to P82	−0.3 to V_{DD} +0.3 Note 2	V
Analog input voltage	V_{AI1}	ANI8 to ANI10	−0.3 to V_{DD} +0.3 Note 2	V
	V_{AI2}	CC1, CC2, RD1, RD2	−0.5 to +6.5	V

Notes 1. Connect the REGC pin to Vss via a capacitor (0.47 to 1 μF). This value regulates the absolute maximum rating of the REGC pin. Do not use this pin with voltage applied to it.

2. Must be 6.5 V or lower.

Caution Product quality may suffer if the absolute maximum rating is exceeded even momentarily for any parameter. That is, the absolute maximum ratings are rated values at which the product is on the verge of suffering physical damage, and therefore the product must be used under conditions that ensure that the absolute maximum ratings are not exceeded.

Remarks 1. Unless specified otherwise, the characteristics of alternate-function pins are the same as those of the port pins.

2. V_{SS} : Reference voltage

Absolute Maximum Ratings (2/2)

Parameter	Symbols	Conditions		Ratings	Unit
Output current, high	I_{OH1}	Per pin	P16, P17, P20 to P22, P30 to P32, P40, P50, P51, P60 to P62, P70 to 73, P80 to P82	–40	mA
		Total of all pins		-170	mA
Output current, low	I_{OL1}	Per pin	P16, P17, P20 to P22, P30 to P32, P40, P50, P51, P60 to P62, P70 to 73, P80 to P82	40	mA
		Total of all pins		170	mA
Operating ambient temperature	T_A	In normal operation mode		–40 to +105	°C
		In flash memory programming mode			
Storage temperature	T_{stg}			–65 to +150	°C

Caution Product quality may suffer if the absolute maximum rating is exceeded even momentarily for any parameter. That is, the absolute maximum ratings are rated values at which the product is on the verge of suffering physical damage, and therefore the product must be used under conditions that ensure that the absolute maximum ratings are not exceeded.

Remark Unless specified otherwise, the characteristics of alternate-function pins are the same as those of the port pins.

3.2 Oscillator Characteristics

3.2.1 On-chip oscillator characteristics

(T_A = –40 to +105°C, 3.0 V ≤ V_{DD} ≤ 5.5 V, V_{SS} = 0 V)

Oscillators	Parameters	Conditions		MIN.	TYP.	MAX.	Unit
High-speed on-chip oscillator clock frequency Notes 1	f_{IH}				24		MHz
High-speed on-chip oscillator clock frequency accuracy		–20 to +85 °C	3.0 V ≤ V_{DD} ≤ 5.5 V	-1		+1	%
		–40 to –20 °C	3.0 V ≤ V_{DD} ≤ 5.5 V	-1.5		+1.5	%
		+85 to +105 °C	3.0 V ≤ V_{DD} ≤ 5.5 V	-2		+2	%

Notes 1. This indicates the oscillator characteristics only. Refer to AC Characteristics for instruction execution time.

3.3 DC Characteristics

3.3.1 Pin characteristics

(T_A = –40 to +105°C, 3.0 V ≤ V_{DD} ≤ 5.5 V, V_{SS} = 0 V) (1/3)

Items	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Input voltage, high	V_{IH1}	P16, P17, P20 to P22, P30 to P32, P50, P51, P60 to P62, P70 to P73, P80 to P82	TTL input buffer 4.0 V ≤ V_{DD} ≤ 5.5 V	2.2		V_{DD}	V
			TTL input buffer 3.3 V ≤ V_{DD} < 4.0 V	2.0		V_{DD}	V
			TTL input buffer 3.0 V ≤ V_{DD} < 3.3 V	1.5		V_{DD}	V
	V_{IH2}	P40, P121, P122, P137, RESETB		0.8 V_{DD}		V_{DD}	V
Input voltage, low	V_{IL1}	P16, P17, P20 to P22, P30 to P32, P50, P51, P60 to P62, P70 to P73, P80 to P82	TTL input buffer 4.0 V ≤ V_{DD} ≤ 5.5 V	0		0.8	V
			TTL input buffer 3.3 V ≤ V_{DD} < 4.0 V	0		0.5	V
			TTL input buffer 3.0 V ≤ V_{DD} < 3.3 V	0		0.32	V
	V_{IL2}	P40, P121, P122, P137, RESETB		0		0.2 V_{DD}	V

Caution The maximum value of all pins is V_{DD}, even in the N-ch open-drain mode.

Remark Unless specified otherwise, the characteristics of alternate-function pins are the same as those of the port pins.

(T_A = –40 to +105°C, 3.0 V ≤ V_{DD} ≤ 5.5 V, V_{SS} = 0 V) (2/3)

Items	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Output voltage, high	V_{OH1}	P16, P17, P20 to P22, P30 to P32, P40, P50, P51, P60 to P62, P70 to P73, P80 to P82	3.0 V ≤ V_{DD} ≤ 5.5 V, I_{OH1} = –1.5 mA	V_{DD} – 0.5			V
Output voltage, low	V_{OL1}	P16, P17, P20 to P22, P30 to P32, P40, P50, P51, P60 to P62, P70 to P73, P80 to P82	3.0 V ≤ V_{DD} ≤ 5.5 V, I_{OL1} = 1.5 mA			0.4	V

Caution All pins do not output high level in N-ch open-drain mode.

Remark Unless specified otherwise, the characteristics of alternate-function pins are the same as those of the port pins.

(T_A = –40 to +105°C, 3.0 V ≤ V_{DD} ≤ 5.5 V, V_{SS} = 0 V) (3/3)

Items	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Input leakage current, high	I_{LIH1}	P16, P17, P20 to P22, P30 to P32, P40, P50, P51, P60 to P62, P70 to P73, P80 to P82, P137, RESETB	$V_I = V_{DD}$			1	μA
	I_{LIH2}	P121, P122	$V_I = V_{DD}$, In input port			1	μA
Input leakage current, low	I_{LIL1}	P16, P17, P20 to P22, P30 to P32, P40, P50, P51, P60 to P62, P70 to P73, P80 to P82, P137, RESETB	$V_I = V_{SS}$			–1	μA
	I_{LIL2}	P121, P122	$V_I = V_{SS}$, In input port			–1	μA
On-chip pull-up resistance	R_U	P16, P17, P20 to P22, P30 to P32, P40, P50, P51, P60 to P62, P70 to P73, P80 to P82	$V_I = V_{SS}$, In input port	10	20	100	kΩ

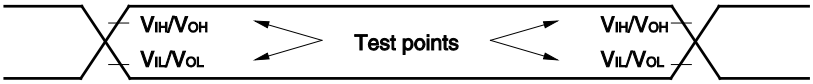
Remark Unless specified otherwise, the characteristics of alternate-function pins are the same as those of the port pins.

3.4 AC Characteristics

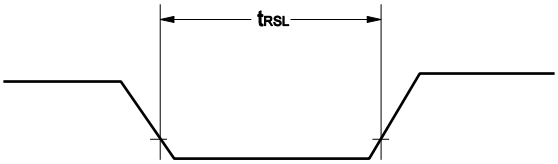
(T_A = –40 to +105°C, 3.0 V ≤ V_{DD} ≤ 5.5 V, V_{SS} = 0 V)

Items	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
RESETB low-level width	t_{RSL}		10			μs

AC Timing Test Points



RESETB Input Timing



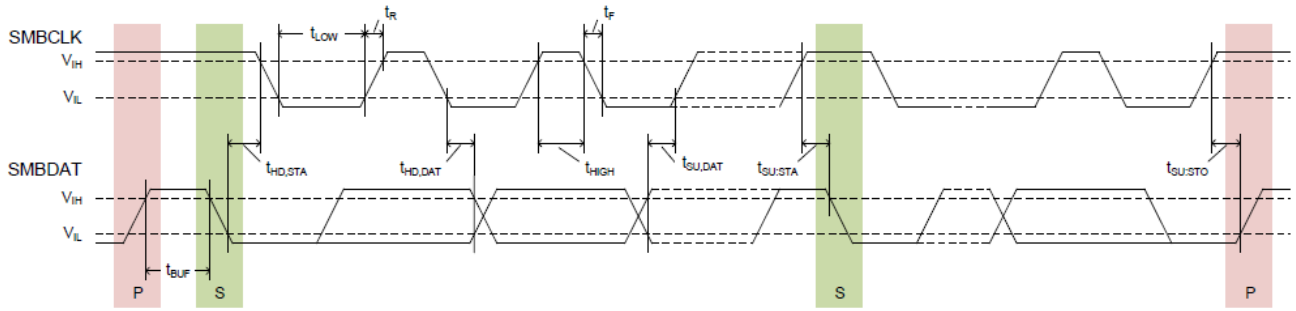
3.5 Peripheral Functions Characteristics

3.5.1 SMBus Interface

(T_A = –40 to +105°C, 3.0 V ≤ V_{DD} ≤ 5.5 V, V_{SS} = 0 V)

Parameter	Symbol	Condition	100 kHz Class		400 kHz Class		1 MHz Class		Units
			MIN	MAX	MIN	MAX	MIN	MAX	
SMBus operating frequency	F_{SMB}		10	100	10	400	10	1000	kHz
Bus free time between stop and start condition	T_{BUF}		4.7		1.3		0.5		µs
Hold time after (Repeated) start condition. After this period, the first clock is generated.	$T_{HD:STA}$		4.0		0.6		0.26		µs
Repeated start condition setup time	$T_{SU:STA}$		4.7		0.6		0.26		µs
Stop condition setup time	$T_{SU:STO}$		4.0		0.6		0.26		µs
Data hold time	$T_{HD:DAT}$		0		0		0		ns
Data setup time	$T_{SU:DAT}$		250		100		50		ns
Clock low period	T_{LOW}		4.7		1.3		0.5		µs
Clock high period	T_{HIGH}		4.0	50	0.6	50	0.26	50	µs
Cumulative clock low extend time (slave device)	$T_{LOW:SEXT}$			25		25		25	ms
Cumulative clock low extend time (master device)	$T_{LOW:MEXT}$			10		10		10	ms
Clock/Data fall time	T_F			300		300		120	ns
Clock/Data rise time	T_R			1000		300		120	ns
Noise spike suppression time	T_{spike}				0	50	0	50	ns
Operational time after power-on reset	T_{POR}			500		500		500	ms

Figure 3-1. SMBus Signal Timing



3.6 Analog Characteristics

3.6.1 A/D converter characteristics

(TA = –40 to +105°C, 3.0 V ≤ VDD ≤ 5.5 V, VSS = 0 V, Reference voltage (+) = VDD, Reference voltage (–) = VSS)

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
Resolution	RES			8		10	bit
Overall error[Notes 1, 2]	AINL	10-bit resolution	3.0 V ≤ VDD ≤ 5.5 V		1.2	±7.0	LSB
Analog input voltage	VAIN	ANI8 to ANI10		0		VDD	V

Notes 1. Excludes quantization error (±1/2 LSB).

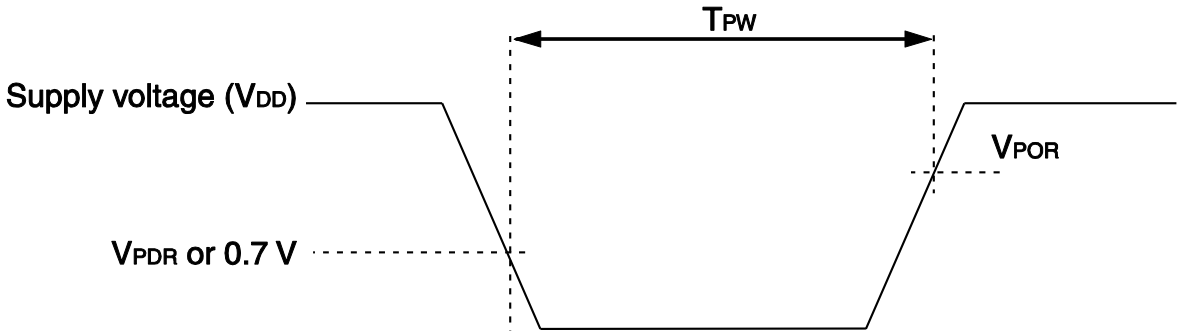
2. This value is indicated as a ratio (%FSR) to the full-scale value.

3.6.2 POR circuit characteristics

(TA = –40 to +105°C, VSS = 0 V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Detection voltage	VPOR	Power supply rise time	1.43	1.51	1.59	V
	VPDR	Power supply fall time	1.42	1.50	1.58	V
Minimum pulse width	TPW		300			μs

Note Minimum time required for a POR reset when VDD exceeds below VPDR. This is also the minimum time required for a POR reset from when VDD exceeds below 0.7 V to when VDD exceeds VPOR while STOP mode is entered or the main system clock is stopped through setting bit 0 (HIOSTOP) and bit 7 (MSTOP) in the clock operation status control register (CSC).



3.6.3 Power supply voltage rising slope characteristics

(TA = –40 to +105°C, VSS = 0 V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Power supply voltage rising slope	SVDD				54	V/ms

Caution Make sure to keep the internal reset state by the LVD circuit or an external reset until VDD reaches the operating voltage range.

3.6.4 CC-PHY characteristics

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
CC Current Source (Default)	I80u		64	80	96	μA
CC Current Source (1.5A)	I180u		166	180	194	μA
CC Current Source (3A)	I330u		304	330	356	μA
Transmitter Output Impedance	zDriver		33		75	Ω
Transmitter Rise Time	tRISE_TX		300			ns
Transmitter Fall Time	tFALL_TX		300			ns
Receiver Input Impedance	zBMCRX		1			MΩ

3.7 Flash Memory Programming Characteristics

(T_A = –40 to +105°C, 3.0 V ≤ V_{DD} ≤ 5.5 V, V_{SS} = 0 V)

Parameter	Symbol	Conditions		MIN.	TYP.	MAX.	Unit
System clock frequency	f_{CLK}	3.0 V ≤ V_{DD} ≤ 5.5 V		1		24	MHz
Number of code flash rewrites Notes 1,2,3	C_{erwr}	Retained for 20 years	T_A = 85°C Notes 4	1,000			Times

Notes 1. 1 erase + 1 write after the erase is regarded as 1 rewrite. The retaining years are until next rewrite after the rewrite.

2. When using flash memory programmer and Renesas Electronics self-programming library.

3. These are the characteristics of the flash memory and the results obtained from reliability testing by Renesas Electronics Corporation.

4. This temperature is the average value at which data are retained.

3.8 Pin Capacitance

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
System Interface Pin capacitance	C_{SYS}				5	pF
I/O Port Pin capacitance	C_{IO}				5	pF

3.9 Power Consumption

(T_A = 25°C, V_{DD} = 3.3 V, V_{SS} = 0 V)

Parameter	Conditions		TYP.	Unit
Operating current as Source role	Sink attached.	No PD Communication.	3.2	mA
		PD Communication.	4.1	mA
Operating current as Sink role	Source attached.	No PD Communication.	2.7	mA
		PD Communication.	3.6	mA
Supply current in sleep mode	Unplugged. SMBus, WAKEUP/INTP and CC enabled for wakeup. Source role.		205	µA
Supply current in deep sleep mode	Unplugged. SMBus and WAKEUP/INTP enabled for wakeup.		2.8	µA

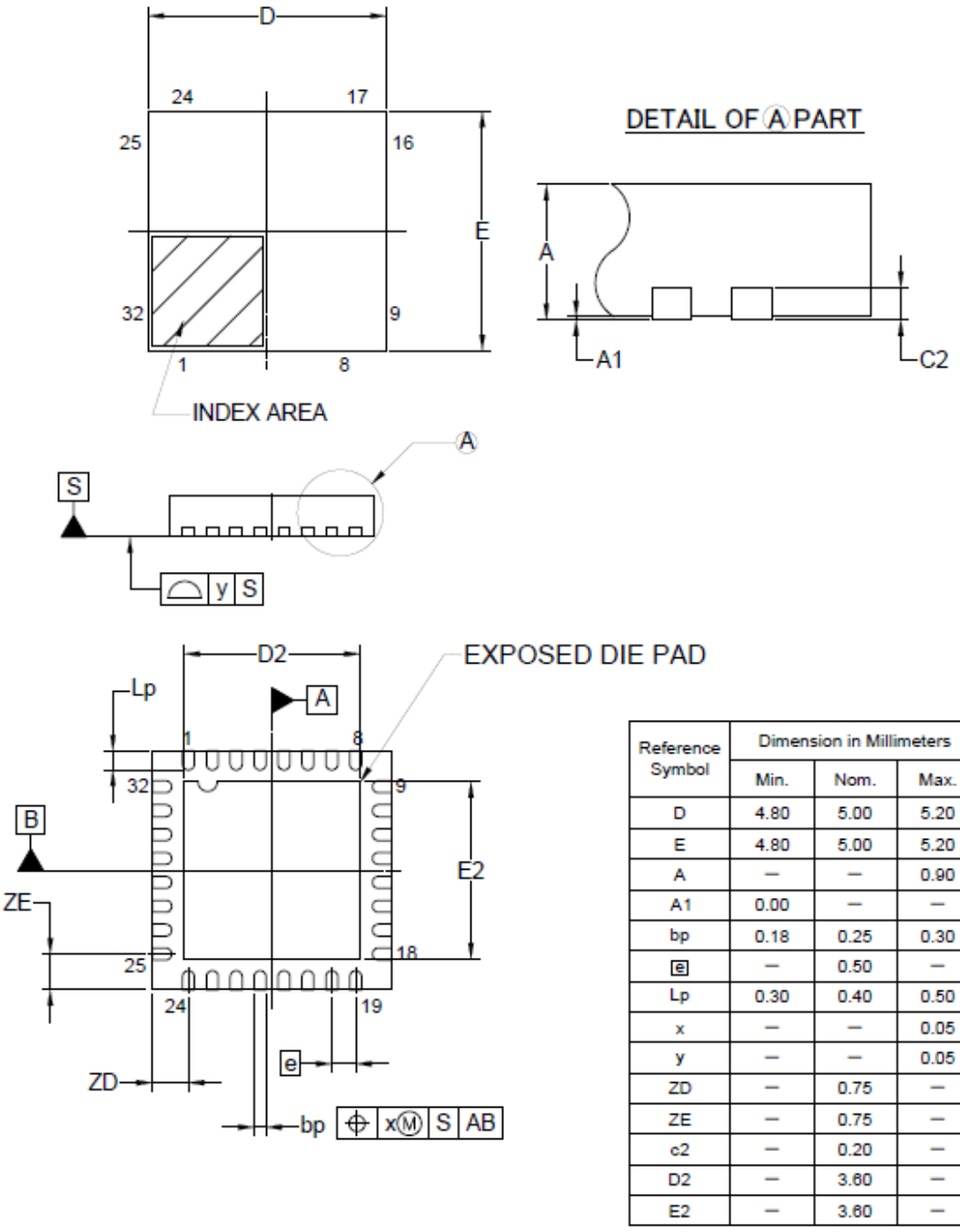
(T_A = 25°C, V_{DD} = 5.0 V, V_{SS} = 0 V)

Parameter	Conditions		TYP.	Unit
Operating current as Source role	Sink attached.	No PD Communication.	3.9	mA
		PD Communication.	4.8	mA
Operating current as Sink role	Source attached.	No PD Communication.	3.4	mA
		PD Communication.	4.3	mA
Supply current in sleep mode	Unplugged. SMBus, WAKEUP/INTP and CC enabled for wakeup. Source role.		230	µA
Supply current in deep sleep mode	Unplugged. SMBus and WAKEUP/INTP enabled for wakeup.		3.2	µA

4. PACKAGE DRAWINGS

32-PIN QFN (5 x 5 mm)

JEITA Package code	RENESAS code	Previous code	MASS(TYP.)[g]
P-HVQFN32-5x5-0.50	PVQN0032KG-A	T32K8-50-BAP	0.07



Reference Symbol	Dimension in Millimeters		
	Min.	Nom.	Max.
D	4.80	5.00	5.20
E	4.80	5.00	5.20
A	—	—	0.90
A1	0.00	—	—
bp	0.18	0.25	0.30
e	—	0.50	—
Lp	0.30	0.40	0.50
x	—	—	0.05
y	—	—	0.05
ZD	—	0.75	—
ZE	—	0.75	—
c2	—	0.20	—
D2	—	3.60	—
E2	—	3.60	—

Revision History	R9A02G011 Data Sheet

Rev.	Date	Description	
		Page	Summary
1.0	Nov. 25, 2016	-	First Edition issued
1.01	Feb. 17, 2017	3	Updated Figure 1-2
		5	Updated section 2.4
		6	Updated section 2.5
1.02	Oct. 24, 2017	1	Updated section 1, section 1.1
		-	Corrected writing errors
1.10	Jan. 29, 2018	1	Updated section 1, section 1.1, section 1.3
		3	Updated section 1.5
		15	Updated section 3.6.2
		18	Updated section 3.9
		19	Updated section 4
1.20	Mar. 27, 2018	1	Updated section 1.1
1.30	Jan. 29, 2019	4-6	Updated section 2.4, section 2.6

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(Rev.4.0-1 November 2017)

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