RAJ306001, RAJ306010

General-Purpose Motor Control IC

1. Overview

RAJ306001 and RAJ306010 are general-purpose motor control ICs for three phase Brushless DC motor applications. RAJ306001 and RAJ306010 combine MCU(RL78/G1F) and a pre-driver in a single package. The pre-driver includes half bridge gate drivers, 5V regulator, a current sense amplifier, hall IC comparators, Back-EMF amplifier, and various protection functions (overtemperature, over/under voltage, overcurrent and the motor lock detection).

Three half bridge gate drivers provide the high efficiency and high flexibility by adjustable gate drive peak current (500mA), self-align dead time generator, selectable gate drive voltage, and control signal configuration function. Self-align dead time generator prevents the short-through current and provides the safe evaluation environment.

MCU supports H/W of the safe standard of IEC60730. The development tools of the RL78 family are available. This IC can realize the suitable motor control and performance corresponding to each application by F/W construction and optimization of register settings.

2. Features

- Operating Power Supply Voltage
  - RAJ306001: 6V to 30V, RAJ306010: 6V to 42V
- Operating Ambient Temperature
  - RAJ3060xxGNP = -40 to +85°C
  - RAJ3060xxZGNP = -40 to +105°C
- Low VM Supply Current
  - [MCU]: 5.2mA (HS mode: f_{IH} = 32MHz, VDD = 5V)
  - [Pre-Driver]: 13.5mA (VM = 22.5V)
  - VM standby current: 64μA (Typ.)
- GPIO: 28ch, Port for Input: 2ch

Pre-Driver Function

- Three Half-Bridge Gate Drivers for six N-MOSFET
  - Adjustable Gate Drive Peak current up to 500mA
  - Self-Align Dead Time Generator Function
  - Control Signal Configuration Function for flexibility
- Selectable Single/Double Boost Charge Pump for Gate Drive Voltage (10, 13V)
- Support Hall IC type and Hall Sensor-less type
  - Integrated Hall IC Comparators (adjustable threshold and hysteresis voltage)
- Integrated 1 Shunt Current Sense Amplifier
  - Adjustable Gain (8.25, 25, 50V/V)
- Integrated Protection function:
  - UVLO, Overtemperature, Overcurrent, Overvoltage,
  - Motor Lock for Hall IC type, Alarm Condition Indicator feature

Controller Function

- CPU: 16-bit CISC CPU (RL78/G1F)
- Flash ROM: 64KB, Data Flash: 4KB
- RAM: 5.5KB
- CSI: 2Chanel ---- SPI:2ch, IIC:2ch, UART:1ch
- Timer
  - Timer Array Unit: 1unit ---------- 16-bit, 4ch
  - Timer RD for motor control --------- 16-bit, 2ch
  - Timer RG with encoding function – 16-bit, 1ch
  - 64 MHz motor control input capture timer
  - (Timer RX)
- 10-bit resolution A/D Converter: 9ch
- Selectable Reference Voltage: Internal/External
- Event Link Controller (ELC): 6ch (External Input)

3. Applications

- Power Tools, Garden Tools, and Vacuum Cleaners
- Printers, Fans, Pumps, and Robotics

Note: With this data sheet, Renesas recommends to read “RAJ306000 Series User’s Manual: Hardware (R18UZ0066EJ)” to understand deeply. And about detail spec on RL78/G1F, please see “RL78/G1F User’s manual: Hardware (R01UH0516EJ)”. This product has some restriction on function. So please check it on “CHAPTER3 RL78/G1F” in “RAJ306000 Series User’s Manual:Hardware (R18UZ0066EJ)”. And on the electrical characteristics of RL78/G1F, please substitute EVDD0/VDD value to 4.75<=EVDD0/VDD<=5.25V.

4. Ordering Information

Part Number	Operating Voltage	Temperature Range	Package
RAJ3060001GNP	6V to 30V	-40°C to +85°C	64pin QFN (8mm x 8mm)
RAJ3060001ZGNP		-40°C to +105°C	
RAJ3060010GNP	6V to 42V	-40°C to +85°C	
RAJ3060010ZGNP		-40°C to +105°C	

Contents

5. Block Diagram

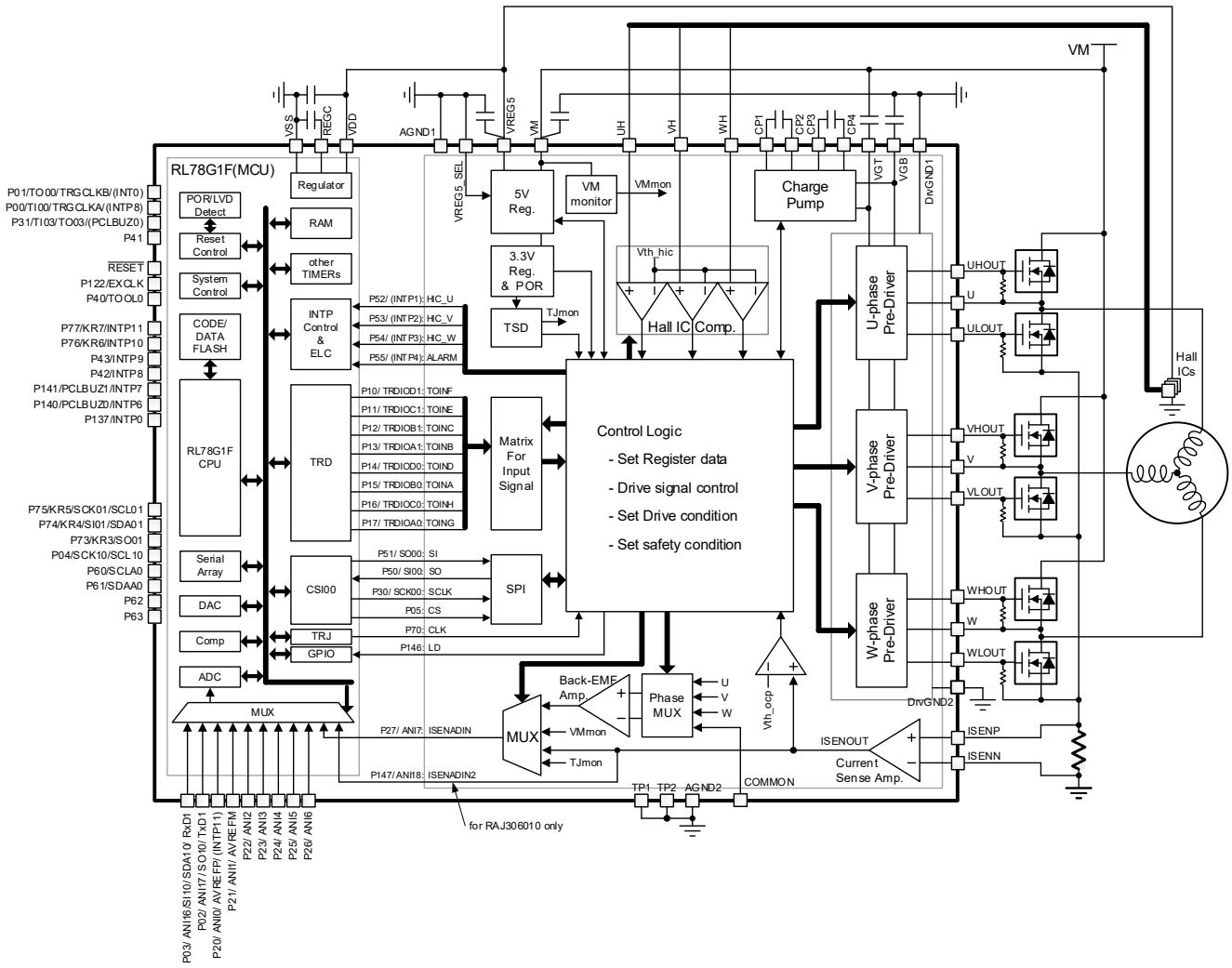


Figure 4-1. Block Diagram (Hall IC type)

- GPIO terminal: 28ch
  (Include ADC:9ch & Terminal for External interrupt: 7ch)
- Input terminal: 2ch
  *1) PIOR00 = 01 [Setting required]
  *2) SSIE00 = 0 [Setting required] ----Invalidation of SSI00

6. Pin Configuration

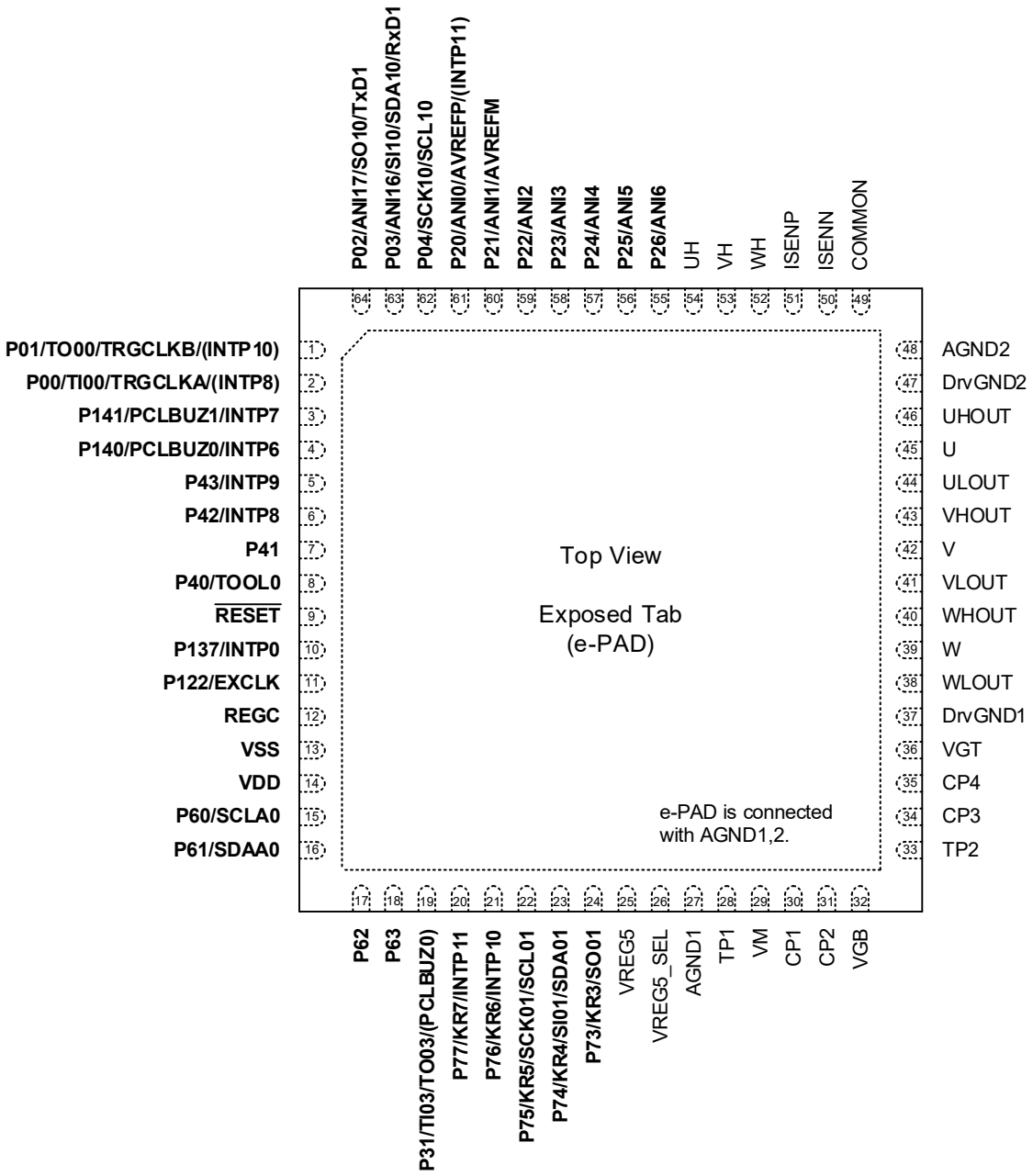


Figure 5-1. Pin configuration diagram

Note: RL78/G1F pins are indicated with the bold font.

7. Pin Description

Table 6-1. Pin description

PIN		Altenate Function	I/O level	IN/OUT or Power/GND	Initial Condition	Function	Remarks
Number	Name						
1	**P01**	**TO00/ TRGCLKB/ (INTP10)**	VDD	IN/OUT	INPUT	GPIO / TAU output / TRG external clock input / (External interrupt input)	1
2	**P00**	**TI00/ TRGCLK/ (INTP8)**	VDD	IN/OUT	INPUT	GPIO / TAU Input / TRG external clock input / (External interrupt input)	1
3	**P141**	**PCLBUZ1/ INTP7**	VDD	IN/OUT	INPUT	GPIO / Programmable clock output / External interrupt input	1
4	**P140**	**PCLBUZ0/ INTP6**	VDD	IN/OUT	INPUT	GPIO / Programmable clock output / External interrupt input	1
5	**P43**	**INTP9**	VDD	IN/OUT	INPUT	GPIO / INTP9	1
6	**P42**	**INTP8**	VDD	IN/OUT	INPUT	GPIO / INTP8	1
7	**P41**	**-**	VDD	IN/OUT	INPUT	GPIO	1
8	**P40**	**TOOL0**	VDD	IN/OUT	INPUT	GPIO / TOOL0 for E1 on-chip debugging	1
9	**$\overline{\text{RESET}}$**	**-**	VDD	-	INPUT	External Reset of RL78	1
10	**P137**	**INTP0**	VDD	IN/OUT	INPUT	Only input / INTP0	1
11	**P122**	**EXCLK**	VDD	IN/OUT	INPUT	Only input / Input of Main clock from External	1
12	**REGC**	**-**	VDD	-	-	Pin for connecting regulator output stabilization capacitance for internal operation of MCU.	1
13	**VSS**	**-**	VDD	GND		Ground potential for MCU	1
14	**VDD**	**-**	VDD	Power		Positive power supply for MCU	1
15	**P60**	**SCLA0**	VDD	IN/OUT	INPUT	GPIO / Serial clock I/O pins of serial interface IICA0	1
16	**P61**	**SDAA0**	VDD	IN/OUT	INPUT	GPIO / Serial data I/O pins of serial interface IICA0	1
17	**P62**	**-**	VDD	IN/OUT	INPUT	GPIO / Chip select input pin of serial interface CSI00 [*2]	1
18	**P63**	**-**	VDD	IN/OUT	INPUT	GPIO	1
19	**P31**	**TI03/ TO03/ (PCLBUZ0)**	VDD	IN/OUT	INPUT	GPIO / TAU input / TAU output / (Output clock, Buzzer output)	1
20	**P77**	**KR7/ INTP11**	VDD	IN/OUT	INPUT	GPIO / KR7 / INTP11	1
21	**P76**	**KR6/ INTP10**	VDD	IN/OUT	INPUT	GPIO / KR6 / INTP10	1
22	**P75**	**KR5/ SCK01/ SCL01**	VDD	IN/OUT	INPUT	GPIO / KR5 / Serial clock I/O pins of CSI01 / Serial clock output pins of IIC01	1
23	**P74**	**KR4/ SI01/ SDA01**	VDD	IN/OUT	INPUT	GPIO / KR4 / Serial data input pins of CSI01 / Serial data I/O pins of IIC01	1
24	**P73**	**KR3/ SO01**	VDD	IN/OUT	INPUT	GPIO / KR3 / Serial data output pins of CSI01	1
25	VREG5	-	VREG5(5V)	IN/OUT	IN/OUT	VREG5 pin function depends on VREG5_SEL VREG5_SEL=GND: Built-in 5V regulator is selected. (Output 5V) VREG5_SEL=5V: External 5V regulator is selected. (Input 5V)	
26	VREG5_SEL	-	VREG5	INPUT	INPUT		
27	AGND1	-	GND	GND	GND	Ground potential 1 for analog and logic circuits of Pre-Driver	
28	TP1	-	VREG5	INPUT	INPUT	Terminal for Test. (Usually conect to GND)	
29	VM	-	VM	POWER	POWER	Power Supply input	
30	CP1	-	VGB	-	-	Charge pump Pin 1 (CP1)	
31	CP2	-	VGB	-	-	Charge pump Pin 2 (CP2)	
32	VGB	-	VGB	OUTPUT	OUTPUT	Gate drive voltage for Low-side	

1: RL78/G1F terminal. Please refer to “RL78/G1F User’s Manual: Hardware” (R01UH0516EJ) about Terminal function of RL78/G1F.This product has some restriction on function. So please check it on “CHAPTER3 RL78/G1F” in “RAJ306000 Series User’s Manual: Hardware (R18UZ0066EJ)”.

*2: The nullification of the /SSI00 function is necessary.

Table 6-2. Pin description (continued)

PIN		Altenate Function	I/O level	IN/OUT or Power/GND	Initial Condition	Function	Remarks
Number	Name						
33	TP2	-	VREG5	INPUT	INPUT	Terminal for Test. (Usually conect to GND)	
34	CP3	-	VM	-	-	Charge pump Pin 3 (CP3)	
35	CP4	-	VGT	-	-	Charge pump Pin 4 (CP4)	
36	VGT	-	VGT	OUTPUT	OUTPUT	Gate drive voltage for High-side	
37	DrvGND1	-	GND	GND	GND	Ground potential 1 for driving circuits of Pre-Driver	
38	WLOUT	-	VGB	OUTPUT	OUTPUT	Output of Pre-driver for W phase Low-side (Nch MOSFET)	
39	W	-	VM	INPUT	INPUT	Detection of BEMF level for W phase	
40	WHOUT	-	VGT	OUTPUT	OUTPUT	Output of Pre-driver for W phase High-side (Nch MOSFET)	
41	VLOUT	-	VGB	OUTPUT	OUTPUT	Output of Pre-driver for V phase Low-side (Nch MOSFET)	
42	V	-	VM	INPUT	INPUT	Detection of BEMF level for V phase	
43	VHOUT	-	VGT	OUTPUT	OUTPUT	Output of Pre-driver for V phase High-side (Nch MOSFET)	
44	ULOUT	-	VGB	OUTPUT	OUTPUT	Output of Pre-driver for U phase Low-side (Nch MOSFET)	
45	U	-	VM	INPUT	INPUT	Detection of BEMF level for U phase	
46	UHOUT	-	VGT	OUTPUT	OUTPUT	Output of Pre-driver for U phase High-side (Nch MOSFET)	
47	DrvGND2	-	GND	GND	GND	Ground potential 2 for driving circuits of Pre-Driver	
48	AGND2	-	GND	GND	GND	Ground potential 2 for analog and logic circuits of Pre-Driver	
49	COMMON	-	VM	INPUT	INPUT	Input for Common signal of Motor	
50	ISENN	-	VREG5	INPUT	INPUT	Connect Negative side of Shunt resistor	
51	ISENP	-	VREG5	INPUT	INPUT	Connect Positive side of Shunt resistor	
52	WH	-	VREG5	IN/OUT	INPUT	Input of Hall IC signal for W phase/ Output BEMF AMP Signal (RAJ306010 Only)	3
53	VH	-	VREG5	INPUT	INPUT	Input of Hall IC signal for V phase	
54	UH	-	VREG5	INPUT	INPUT	Input of Hall IC signal for U phase	
55	**P26**	**ANI6**	VDD	IN/OUT	ANALOG	GPIO / ADC analog input	1
56	**P25**	**ANI5**	VDD	IN/OUT	ANALOG	GPIO / ADC analog input	1
57	**P24**	**ANI4**	VDD	IN/OUT	ANALOG	GPIO / ADC analog input	1
58	**P23**	**ANI3**	VDD	IN/OUT	ANALOG	GPIO / ADC analog input / DAC output / PGA reference voltage input	1
59	**P22**	**ANI2**	VDD	IN/OUT	ANALOG	GPIO / ADC analog input / DAC output / PGA voltage input	1
60	**P21**	**ANI1/ AVREFM**	VDD	IN/OUT	ANALOG	GPIO / ADC analog input / ADC reference(- side) input	1
61	**P20**	**ANI0/ AVREFP/ (INTP11)**	VDD	IN/OUT	ANALOG	GPIO / ADC analog input / ADC reference (+ side) input / (External interrupt input)	1
62	**P04**	**SCK10/ SCL10**	VDD	IN/OUT	ANALOG	GPIO / Serial clock I/O pins of CSI10 / Serial clock output pins of IIC10	1
63	**P03**	**ANI16/ SI10/ SDA10/ RXD1**	VDD	IN/OUT	ANALOG	GPIO / ADC analog input / Serial data input pins of CSI10 / Serial data I/O pins of IIC10 / Serial data output pins of UART	1
64	**P02**	**ANI17/ SO10/ TxD1**	VDD	IN/OUT	ANALOG	GPIO / ADC analog input / Serial data output pins of CSI10 / Serial data output pins of UART	1

*1: The following pins of RL78/G1F are used for internal connection. P05, P06, P10-17, P27, P30, P50-55, P146, P147

*3: The Hall signal input function is available on both RAJ306001 and RAJ306010. The output function of BEMF AMP Signal is available only for RAJ306010.

8. Electrical Characteristics

8.1 Absolute Maximum Rating for RAJ306001 Note1

Item	Symbol	Rating	unit	Note
Power dissipation	Pd	5840	mW	This spec is applied for HWQFN64.
Thermal derating	Kθ	-46.7	mW/degC	This spec is applied for HWQFN64. Condition: refer to P.10
Power supply for motor drive	VM	-0.3 to +60	V	Refer to Note2
Power supply	VDD	- 0.3 to +6.5	V	Pin: VDD (MCU)
REGC terminal input voltage	VIREGC	-0.3 to +2.8	V	Pin: REGC Note3
VREG5 terminal input voltage	VIVREG5	-0.3 to +6.5	V	Pin: VREG5
VGT output voltage range	VVGT	-0.3 to +48.0	V	Pin :VGT
CP4 terminal voltage range	VCP4	-0.3 to +48.0	V	Pin :CP4
CP3 terminal voltage range	VCP3	-0.3 to +48.0	V	Pin :CP3
VGB output voltage range	VVGB	-0.3 to +18.0	V	Pin :VGB
CP2 terminal voltage range	VCP2	-0.3 to +18.0	V	Pin :CP2
CP1 terminal voltage range	VCP1	-0.3 to +18.0	V	Pin :CP1
UHOUT, VHOUT, WHOUT constant output voltage range 1	VH_OUT1	-1.0 to +48.0	V	Pin :UHOUT, VHOUT, WHOUT
UHOUT, VHOUT, WHOUT peak output voltage range 2	VH_OUT2	-8.0 to +48.0	V	Pin :UHOUT, VHOUT, WHOUT Note6
U, V, W, COMMON constant output voltage range 1	Vphase1	-1.0 to +48.0	V	Pin :U, V, W, COMMON
U, V, W, COMMON peak output voltage range 2	Vphase2	-8.0 to +48.0	V	Pin :U, V, W, COMMON Note6
ULOUT, VLOUT, WLOUT output voltage range	VL_OUT	-0.5 to +18.0	V	Pin :ULOUT, VLOUT, WLOUT
Sense current terminal	ISEN	-0.3 to VREG5 + 0.3	V	Pin : ISENP, ISENN
Digital terminal Input voltage range	DVIN1	-0.3 to VDD + 0.3	V	Pin :P00 to P04, P20~P26, P31, P40 to P43, P73 to P77, P122, P137, P140, P141, EXCLK, /RESET, Note4
	DVIN2	-0.3 to +6.5	V	Pin: P60 to P63 (Nch open-drain)
Output Voltage	DVOUT	-0.3 to VDD+0.3	V	Pin: P00 to P04, p20 to P26, P31, P40 to P43, P73 to P77, P140, P141, Note4
Analog input voltage	AVIN1	-0.3 to VDD + 0.3 and -0.3 to AVREFP + 0.3	V	Pin: ANI0 to ANI6, ANI16, ANI17 Note4,5
	AVIN2	-0.3 to VREG5 + 0.3	V	Pin :VREG5_SEL, TP1, TP2
Hall sensor input terminal voltage	HVIN	-0.3 to VREG5 + 0.3	V	Pin : UH, VH, WH

Note1: Not subject to production test, specified at Ta=25degC by design

Note2: Please do not apply the voltage more than 48V to VM terminal more than 1us.

In addition, when the VM voltage is as above 48V at DC level, the serge protective circuit of this IC works, and the applied voltage is clamped.

Note3: Connect the REGC pin to VSS via a capacitor (0.47 to 1uF). This value regulates the absolute maximum rating of REGC pin.

Do not use this pin with voltage applied to it.

Note4: Must be 6.5 V or lower.

Note5: Do not exceed AVREFP +0.3 V in case of A/D conversion target pin.

Note6: This value is for design only and the condition is (PWM period = 20KHz) and (Negative period = 150nsec).

When there is some possibility to exceed the maximum ratings, please investigate to add protection circuit written in “8. External Circuit”.

Note7: This value is for design only and the condition is (PWM period = 20KHz) and (Period = 1usec). Do not use beyond the rating.

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.

Absolute Maximum Rating for RAJ306001 (continued)

Note1

Item	Symbol	Rating	unit	Note
Digital output current of High level 1	DIOH1	-40	mA/Terminal	Pin :P00 to P04, P31, P40 to P43, P73 to P77, P140, P141
		-70	mA/Total	Pin : P00 to P04, P40 to P43, P140, P141
		-100	mA/Total	Pin :P31, P73 to P77
Digital output current of High level 2	DIOH2	-0.5	mA/Terminal	Pin : P20 to P26 (Total current of these terminals: 1.7mA)
Digital output current of Low level 1	DIOL1	+40	mA/Terminal	Pin :P00 to P04, P31, P40 to P43, P60 to P63, P73 to P77, P140, P141
		+70	mA/Total	Pin :P00 to P04, P40 to P43, P140, P141
		+100	mA/Total	Pin :P31, P73 to P77
Digital output current of Low level 2	DIOL2	+1	mA/Terminal	Pin : P20 to P26 (Total current of their terminal: 4.3mA)
Maximum junction temperature	Tj	+150	degC	Pre-Driver chip
Operating temperature (Normal Operation)	Tope1	-40 to +85	degC	RAJ306001GNP
		-40 to +105		RAJ306001ZGNP
Operating temperature (at Flash Memory Programming)	Tope2	-40 to +85	degC	RAJ306001GNP
		-40 to +105		RAJ306001ZGNP
Storage temperature	Tstg	-65 to +150	degC	

Note1: Not subject to production test, specified at Ta=25degC by design

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.

Remark1: Unless specified otherwise, the characteristics of alternate-function pins are same as those of the port pins.

Remark2: AVREFP: positive side reference voltage of the A/D converter.

Remark3: GND pins: Drive block: DrvGND1, DrvGND2, Analog block: AGND1, AGND2
VSS pin: VSS (MCU)

Absolute Maximum Rating for RAJ306010 Note1

Item	Symbol	Rating	unit	Note
Power dissipation	Pd	5840	mW	This spec is applied for HWQFN64.
Thermal derating	Kθ	-46.7	mW/degC	This spec is applied for HWQFN64. Condition: refer to P.10
Power supply for motor drive	VM	-0.3 to +60	V	Refer to Note2
Power supply	VDD	- 0.3 to +6.5	V	Pin: VDD (MCU)
REGC terminal input voltage	VIREGC	-0.3 to +2.8	V	Pin: REGC Note3
VREG5 terminal input voltage	VIVREG5	-0.3 to +6.5	V	Pin: VREG5
VGT output voltage range	VVGT	-0.3 to +48.0	V	Pin :VGT
CP4 terminal voltage range	VCP4	-0.3 to +48.0	V	Pin :CP4
CP3 terminal voltage range	VCP3	-0.3 to +48.0	V	Pin :CP3
VGB output voltage range	VVGB	-0.3 to +18.0	V	Pin :VGB
CP2 terminal voltage range	VCP2	-0.3 to +18.0	V	Pin :CP2
CP1 terminal voltage range	VCP1	-0.3 to +18.0	V	Pin :CP1
UHOUT, VHOUT, WHOUT constant output voltage range 1	VH_OUT1	-1.0 to +48.0	V	Pin :UHOUT, VHOUT, WHOUT
UHOUT, VHOUT, WHOUT peak output voltage range 2	VH_OUT2	-8.0 to +48.0	V	Pin :UHOUT, VHOUT, WHOUT Note6
U, V, W, COMMON constant output voltage range 1	Vphase1	-1.0 to +48.0	V	Pin :U, V, W, COMMON
U, V, W, COMMON peak output voltage range 2	Vphase2	-8.0 to +48.0	V	Pin :U, V, W, COMMON Note6
ULOUT, VLOUT, WLOUT output voltage range	VL_OUT	-0.5 to +18.0	V	Pin :ULOUT, VLOUT, WLOUT
Sense current terminal	ISEN	-0.3 to VREG5 + 0.3	V	Pin : ISENP, ISENN
Digital terminal Input voltage range	DVIN1	-0.3 to VDD + 0.3	V	Pin :P00 to P04, P20~P26, P31, P40 to P43, P73 to P77, P122, P137, P140, P141, EXCLK, /RESET, Note4
	DVIN2	-0.3 to +6.5	V	Pin: P60 to P63 (Nch open-drain)
Output Voltage	DVOUT	-0.3 to VDD+0.3	V	Pin: P00 to P04, p20 to P26, P31, P40 to P43, P73 to P77, P140, P141, Note4
Analog input voltage	AVIN1	-0.3 to VDD + 0.3 and -0.3 to AVREFP + 0.3	V	Pin: ANI0 to ANI6, ANI16, ANI17 Note4,5
	AVIN2	-0.3 to VREG5 + 0.3	V	Pin :VREG5_SEL, TP1, TP2
Hall sensor input terminal voltage	HVIN	-0.3 to VREG5 + 0.3	V	Pin : UH, VH, WH

Note1: Not subject to production test, specified at Ta=25degC by design

Note2: Please do not apply the voltage more than 48V to VM terminal more than 1us. In addition, when the VM voltage is as above 48V at DC level, the serge protective circuit of this IC works, and the applied voltage is clamped.

Note3: Connect the REGC pin to VSS via a capacitor (0.47 to 1uF). This value regulates the absolute maximum rating of REGC pin. Do not use this pin with voltage applied to it.

Note4: Must be 6.5 V or lower.

Note5: Do not exceed AVREFP +0.3 V in case of A/D conversion target pin.

Note6: This value is for design only and the condition is (PWM period = 20KHz) and (Negative period = 150nsec).

When there is some possibility to exceed the maximum ratings, please investigate to add protection circuit written in “8. External Circuit”.

Note7: This value is for design only and the condition is (PWM period = 20KHz) and (Period = 1usec).Do not use beyond the rating.

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.

Absolute Maximum Rating for RAJ306010 (continued) Note1

Item	Symbol	Rating	unit	Note
Power dissipation	Pd	5840	mW	This spec is applied for HWQFN64.
Thermal derating	Kθ	-46.7	mW/degC	This spec is applied for HWQFN64. Condition: refer to P.10
Power supply for motor drive	VM	-0.3 to +60	V	Refer to Note2
Power supply	VDD	- 0.3 to +6.5	V	Pin: VDD (MCU)
REGC terminal input voltage	VIREGC	-0.3 to +2.8	V	Pin: REGC Note3
VREG5 terminal input voltage	VIVREG5	-0.3 to +6.5	V	Pin: VREG5
VGT output voltage range	VVGT	-0.3 to +48.0	V	Pin :VGT
CP4 terminal voltage range	VCP4	-0.3 to +48.0	V	Pin :CP4
CP3 terminal voltage range	VCP3	-0.3 to +48.0	V	Pin :CP3
VGB output voltage range	VVGB	-0.3 to +18.0	V	Pin :VGB
CP2 terminal voltage range	VCP2	-0.3 to +18.0	V	Pin :CP2
CP1 terminal voltage range	VCP1	-0.3 to +18.0	V	Pin :CP1
UHOUT, VHOUT, WHOUT constant output voltage range 1	VH_OUT1	-1.0 to +48.0	V	Pin :UHOUT, VHOUT, WHOUT
UHOUT, VHOUT, WHOUT peak output voltage range 2	VH_OUT2	-8.0 to +48.0	V	Pin :UHOUT, VHOUT, WHOUT Note6
U, V, W, COMMON constant output voltage range 1	Vphase1	-1.0 to +48.0	V	Pin :U, V, W, COMMON
U, V, W, COMMON peak output voltage range 2	Vphase2	-8.0 to +48.0	V	Pin :U, V, W, COMMON Note6
ULOUT, VLOUT, WLOUT output voltage range	VL_OUT	-0.5 to +18.0	V	Pin :ULOUT, VLOUT, WLOUT
Sense current terminal	ISEN	-0.3 to VREG5 + 0.3	V	Pin : ISENP, ISENN
Digital terminal Input voltage range	DVIN1	-0.3 to VDD + 0.3	V	Pin :P00 to P04, P20~P26, P31, P40 to P43, P73 to P77, P122, P137, P140, P141, EXCLK, /RESET, Note4
	DVIN2	-0.3 to +6.5	V	Pin: P60 to P63 (Nch open-drain)
Output Voltage	DVOUT	-0.3 to VDD+0.3	V	Pin: P00 to P04, p20 to P26, P31, P40 to P43, P73 to P77, P140, P141, Note4
Analog input voltage	AVIN1	-0.3 to VDD + 0.3 and -0.3 to AVREFP + 0.3	V	Pin: ANI0 to ANI6, ANI16, ANI17 Note4,5
	AVIN2	-0.3 to VREG5 + 0.3	V	Pin :VREG5_SEL, TP1, TP2
Hall sensor input terminal voltage	HVIN	-0.3 to VREG5 + 0.3	V	Pin : UH, VH, WH

Note1: Not subject to production test, specified at Ta=25degC by design

Note2: Please do not apply the voltage more than 48V to VM terminal more than 1us.

In addition, when the VM voltage is as above 48V at DC level, the serge protective circuit of this IC works,

and the applied voltage is clamped.

Note3: Connect the REGC pin to VSS via a capacitor (0.47 to 1uF). This value regulates the absolute maximum rating of REGC pin.

Do not use this pin with voltage applied to it.

Note4: Must be 6.5 V or lower.

Note5: Do not exceed AVREFP +0.3 V in case of A/D conversion target pin.

Note6: This value is for design only and the condition is (PWM period = 20KHz) and (Negative period = 150nsec).

When there is some possibility to exceed the maximum ratings, please investigate to add protection circuit written in “8. External Circuit”.

Note7: This value is for design only and the condition is (PWM period = 20KHz) and (Period = 1usec).Do not use beyond the rating.

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.

Absolute Maximum Rating (continued)

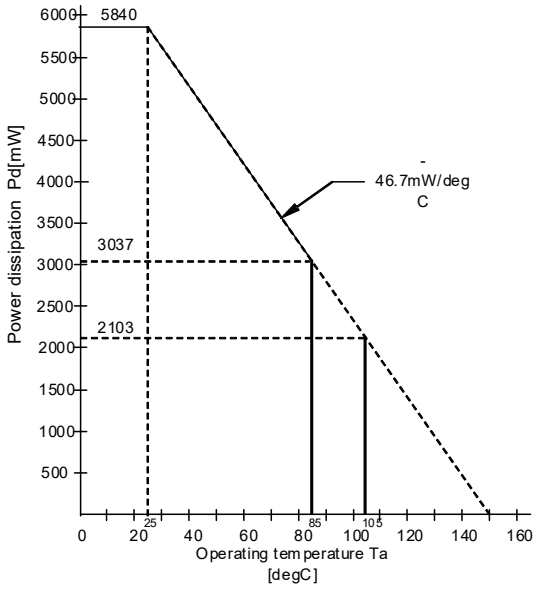


Figure 7-1. Thermal Derating characteristic

Note: Glass epoxy board: 76.2mm x 114.5mm x 1.6mm, copper-occupancy ratio in a 4-layer board: 50% in layers 1 and 4, 95% in layers 2 and 3.
[Note that the allowable power consumption depends on the conditions imposed on the board.]

Item	Rating Unit	Notes
ψjt	1.69 degC/W	junction-to-case (package top surface) thermal resistance
θja	21.4 degC/W	junction-to-ambient thermal resistance
Exposed power pad / heat slug area	42.3mm^2	-

Note1: Glass epoxy board: 76.2mm x 114.5mm x 1.6mm,
copper-occupancy ratio in a 4-layer board: 50% in layers 1 and 4, 95% in layers 2 and 3.
[Note that the thermal resistance depends on the conditions imposed on the board.]

8.2 Recommended Operating Conditions

Item	Symbol	Rating	unit	Note
Power supply voltage for motor drive	VM	+6 to +30	V	RAJ306001
	VM	+6 to +42	V	RAJ306010
5V Regulator (VREG5) output current	IVREG5	30 [Max]	mA	Total: 60mA [Max] Note1
5V Regulator (VREG5) output voltage	VREG5	+4.75~5.25	V	VREG5_SEL=Hi Note2
MCU operating voltage range	VDD	VREG5-0.25~VREG5+0.25	V	Note3

Note1: Total maximum current including RAA3060xx internal load is 60mA (Max).

For external parts: 30mA (Max), For RAA3060xx: 30mA

Please keep the junction temperature within Tjmax.

Note2: When VREG5 is supplied from external, please keep the sequence as follows.

1. Start up: Supply VM → Supply VREG5 → Release Reset
2. Supply voltage off: Reset → VREG5 Off → VM off

Note3: This operating condition is a restriction of RL78/G1F when using this IC. This value is different from the operating condition in “RL78/G1F User’s manual: Hardware” (R01UH0516EJ).

Therefore, this IC cannot operate normally at VDD supply voltage outside the operating voltage range, such as 3.3V.

8.3 Electrical Characteristics

Note: All specifications are for Ta=25degC, VM=22.5V unless otherwise noted.

Parameter	Symbol	Condition	Rated level			Unit	Notes
			MIN	TYP	MAX		
Power Supplies (VM, VREG5)							
VM operation current	I_{VM}	PS_ALL Reg. (02h): 01h PS Reg. (04h): 09Fh,		13.5	19	mA	Pre Driver block (Using Hall IC)
VM standy current	I_{STBY}	PS_ALL Reg. (02h): 00h PS Reg. (04h): 00h, System clock: Stop		64	96	uA	Pre Driver block (Using Hall IC)
VREG5 Output voltage	V_{VREG5}	IOUT = 1 to 30mA	4.75	5	5.25	V	
VREG5 load current ability	I_{VREG5}				30	mA	
Gate Driver Block (VGT, VGB, UHOUT, VHOUT, WHOUT, ULOUT,VLOUT, WLOUT)							
Charge pump voltage for High side	Vvgt	CPSET2 Reg. (34h)= 02h, Io=100uA	VM+10	13	VM+15	V	
		CPSET2 Reg. (34h)= 0Ch, Io=100uA		VM+10		V	
Charge pump voltage for Low side	Vvgb	CPSET2 Reg. (34h)= 02h, Io=100uA	10	13	15	V	
		CPSET2 Reg. (34h)= 0Ch, Io=100uA		10		V	
Gate drive output voltage for High side	V_{OUTH}	CPSET2 Reg. (34h)= 02h, Io=100uA	VM+10	13	VM+15	V	
Gate drive output voltage for Low side	V_{OUTL}	CPSET2 Reg. (34h)= 02h, Io=100uA	10	13	15	V	
Impedance of the gate drive output (High side)	R_{OUTH}	IDR_H_P = 111	- 20%	9.5	+ 20%	Ω	Note 1)
		IDR_H_P = 100		14.0		Ω	
		IDR_H_P = 000		65.0		Ω	
		IDR_H_N = 111	- 25%	38.5	+ 25%	Ω	
		IDR_H_N = 100		10.0		Ω	
		IDR_H_N = 000		5.0		Ω	
Impedance of the gate drive output (Low side)	R_{OUTL}	IDR_L_P = 111	- 20%	5.0	+ 20%	Ω	Note 1)
		IDR_L_P = 100		7.0		Ω	
		IDR_L_P = 000		27.0		Ω	
		IDR_L_N = 111	- 25%	17.5	+ 25%	Ω	
		IDR_L_N = 100		5.0		Ω	
		IDR_L_N = 000		2.5		Ω	
Current Sense Amplifier (ISENP, ISENN)							
Input voltage range	V_{ICSA}		0.0	-	1.0	V	with respect to ISENN
Amplifier Gain	G_{CSA}	CS_SET1 Reg. (20h)= 00h		50		V/V	
		CS_SET1 Reg. (20h)= 40h		25		V/V	
		CS_SET1 Reg. (20h)= 50h		8.25		V/V	
Hall signal Block (UH, VH,WH)							
Hall IC input signal Threshold voltage level	HIC_TH	HAIC_TH: 000	+ 0.32	+ 0.40	+ 0.48	V	
		HAIC_TH: 001	+ 0.56	+ 0.70	+ 0.84		
		HAIC_TH: 010	+ 0.80	+ 1.00	+ 1.20		
		HAIC_TH: 011	+ 1.04	+ 1.30	+ 1.56		
		HAIC_TH: 100	+ 1.28	+ 1.60	+ 1.92		
		HAIC_TH: 101	+ 1.52	+ 1.90	+ 2.28		
		HAIC_TH: 110	+ 1.76	+ 2.20	+ 2.64		
		HAIC_TH: 111	+ 2.00	+ 2.50	+ 3.00		
Hystersis	HIC_hys	HAIC_HYS: 00		0		mV	Note 1)
		HAIC_HYS: 01		50			
		HAIC_HYS: 10		100			
BEMF Sense Amplifier (U,V,W)							
Input voltage range	V_{IBSA}		-0.5	-	VM+0.5	V	
Amplifier Gain	G_{BSA}			1		V/V	

Note1: This specification is the design target of this IC, and Renesas cannot guarantee this specification.

Electrical Characteristics (continued)

Note: All specifications are for Ta=25degC, VM=22.5V unless otherwise noted.

Parameter	Symbol	Condition	Rated level			Unit	Notes
			MIN	TYP	MAX		
Power Supplies (VM, VREG5)							
VM operation current	I_{VM}	PS_ALL Reg. (02h): 01h PS Reg. (04h): 09Fh,		13.5	19	mA	Pre Driver block (Using Hall IC)
VM standy current	I_{STBY}	PS_ALL Reg. (02h): 00h PS Reg. (04h): 00h, System clock: Stop		64	96	uA	Pre Driver block (Using Hall IC)
VREG5 Output voltage	V_{VREG5}	IOUT = 1 to 30mA	4.75	5	5.25	V	
VREG5 load current ability	I_{VREG5}				30	mA	
Gate Driver Block (VGT, VGB, UHOUT, VHOUT, WHOUT, ULOUT,VLOUT, WLOUT)							
Charge pump voltage for High side	Vvgt	CPSET2 Reg. (34h)= 02h, Io=100uA	VM+10	VM+13	VM+15	V	
		CPSET2 Reg. (34h)= 0Ch, Io=100uA		VM+10		V	
Charge pump voltage for Low side	Vvgb	CPSET2 Reg. (34h)= 02h, Io=100uA	10	13	15	V	
		CPSET2 Reg. (34h)= 0Ch, Io=100uA		10		V	
Gate drive output voltage for High side	V_{OUTH}	CPSET2 Reg. (34h)= 02h, Io=100uA	VM+10	VM+13	VM+15	V	
Gate drive output voltage for Low side	V_{OUTL}	CPSET2 Reg. (34h)= 02h, Io=100uA	10	13	15	V	
Impedance of the gate drive output (High side)	R_{OUTH}	IDR_H_P = 111	- 20%	9.5	+ 20%	Ω	Note 1)
		IDR_H_P = 100		14.0		Ω	
		IDR_H_P = 000		65.0		Ω	
		IDR_H_N = 111	- 25%	38.5	+ 25%	Ω	
		IDR_H_N = 100		10.0		Ω	
		IDR_H_N = 000		5.0		Ω	
Impedance of the gate drive output (Low side)	R_{OUTL}	IDR_L_P = 111	- 20%	5.0	+ 20%	Ω	Note 1)
		IDR_L_P = 100		7.0		Ω	
		IDR_L_P = 000		27.0		Ω	
		IDR_L_N = 111	- 25%	17.5	+ 25%	Ω	
		IDR_L_N = 100		5.0		Ω	
		IDR_L_N = 000		2.5		Ω	
Current Sense Amplifier (ISENP, ISENN)							
Input voltage range	V_{ICSA}		0.0	-	1.0	V	with respect to ISENN
Amplifier Gain	G_{CSA}	CS_SET1 Reg. (20h)= 00h		50		V/V	
		CS_SET1 Reg. (20h)= 40h		25		V/V	
		CS_SET1 Reg. (20h)= 50h		8.25		V/V	
Hall signal Block (UH, VH,WH)							
Hall IC input signal Threshold voltage level	HIC_TH	HAIC_TH: 000	+ 0.32	+ 0.40	+ 0.48	V	
		HAIC_TH: 001	+ 0.56	+ 0.70	+ 0.84		
		HAIC_TH: 010	+ 0.80	+ 1.00	+ 1.20		
		HAIC_TH: 011	+ 1.04	+ 1.30	+ 1.56		
		HAIC_TH: 100	+ 1.28	+ 1.60	+ 1.92		
		HAIC_TH: 101	+ 1.52	+ 1.90	+ 2.28		
		HAIC_TH: 110	+ 1.76	+ 2.20	+ 2.64		
		HAIC_TH: 111	+ 2.00	+ 2.50	+ 3.00		
Hystersis	HIC_hys	HAIC_HYS: 00		0		mV	Note 1)
		HAIC_HYS: 01		50			
		HAIC_HYS: 10		100			
BEMF Sense Amplifier (U,V,W)							
Input voltage range	V_{IBSA}		-0.5	-	VM+0.5	V	
Amplifier Gain	G_{BSA}			1		V/V	

Note1: This specification is the design target of this IC.

9. External Circuit

The recommended external circuit with the following conditions is shown as Figure 8-1.

- Integrated 5V regulator is used for RL78/G1F and Hall IC.
- Charge Pump circuit uses the double boost function. (R34h: D3, CP_BOOST_N=0)
  VGB= 13V, VGT= VM+13V
- Hall IC type

The user can select each condition independently according to the actual application.

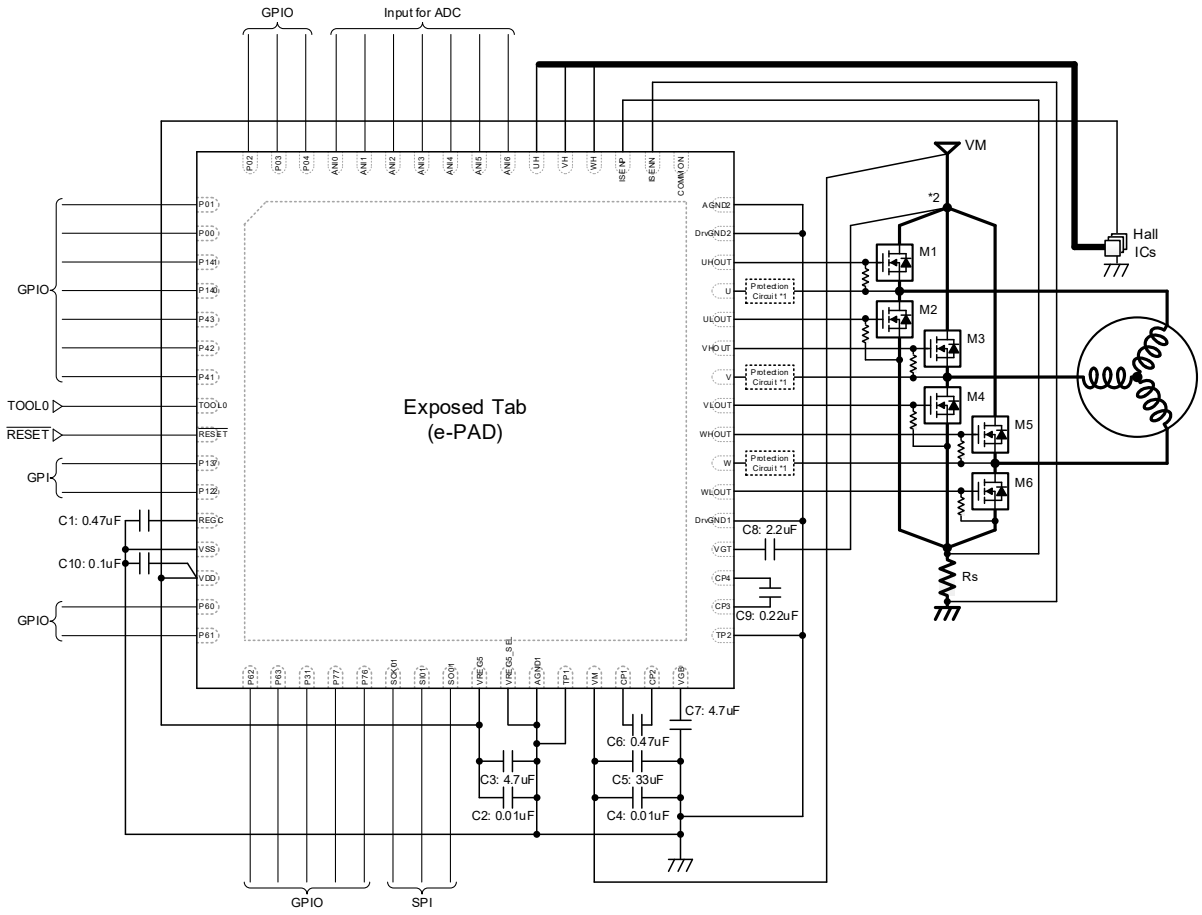
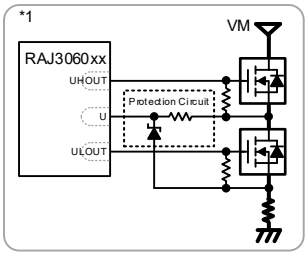


Figure 8-1. Recommended External Circuit example

1. There are some possibility to add resistor and/or diode according to motor spec and drive condition



2. Please pay attention that the connection point of C8 which is attached to terminal VGT is near the drain of M1, M3 and M5 as close as possible.

   This request is to synchronize voltage change between Upper External MOS's drain and VGT terminal.
   This layout can decrease the potential to be added unexpected VGS voltage on Upper External MOS.

The recommended external circuit with the following conditions is shown as Figure 8-2.

- External 5V regulator is used for RL78/G1F and Hall IC.
- Charge Pump circuit does NOT use the double boost function. (R34h: D3, CP_BOOST_N=1)
  VGB= 10V, VGT= VM+10V
- Hall sensor-less type

The user can select each condition independently according to the actual application.

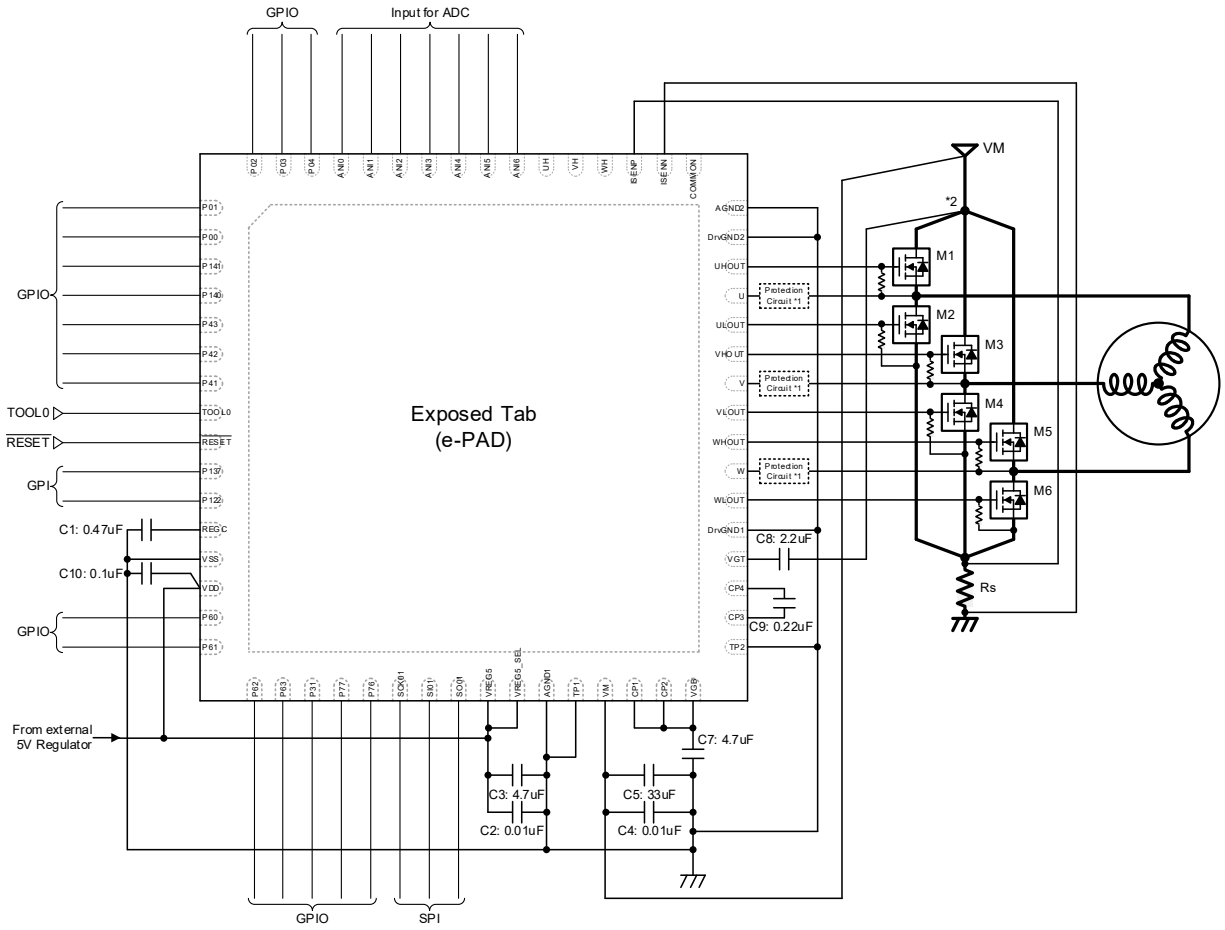


Figure 8-2. Recommended External Circuit example with using external 5V regulator, single boost function, and Hall sensor-less type

1. There are some possibility to add resistor and/or diode according to motor spec and drive condition. Refer to *1 note in Figure8-1.
2. Please pay attention that the connection point of C8 which is attached to terminal VGT is near the drain of M1, M3 and M5 as close as possible.
   This request is to synchronize voltage change between Upper External MOS's drain and VGT terminal.
   This layout can decrease the potential to be added unexpected VGS voltage on Upper External MOS.

10. Block Explanation

10.1 Power ON Sequence

Fig.9-1 shows the example of Power ON sequence regarding VM, VREG5, and VREG3 (internal Regulator). When the power supply of RL78G1F is VREG5, the operation state of RL78/G1F (MCU) and Pre-Driver depends on VREG5 and VREG3 voltage. When VM is applied, VREG5 and VREG3 starts in synchronization with VM.

RL78/G1F (MCU) and Pre-Driver work as follows sequentially.

1. After VREG3 > VREC3 (2.83V),

- RL78/G1F (MCU): “RESET” is maintained.
- Pre-Driver: “RESET” is released and goes “Stop”.
- Pre-Driver keeps the motor stop as the control signals from RL78/G1F (MCU) is reset.

2. After VREG5 > VLVDH (4.06V),

- RL78/G1F (MCU): “RESET” is released and goes “Normal”.
- After RL78/G1F (MCU) sets VREG5_TRIM register (R40h) to the written data in TRIM_DATA0

(Address: EFFECh) of RL78/G1F, VREG5 becomes 5V typical. The default voltage is 4.8V.

- Pre-Driver can drive the motor by the control of RL78/G1F (MCU).

3. When VREG5 < VLVDL (3.98V),

- RL78/G1F (MCU) goes “RESET”.
- Pre-Driver stops driving the motor as the control signals from RL78/G1F (MCU) is reset.

4. Same as (2)
5. Same as (3)
6. After VREG3 < VSD3 (2.70V),

- RL78/G1F (MCU): “RESET” is maintained.
- Pre-Driver keeps the motor stop by “RESET” state.

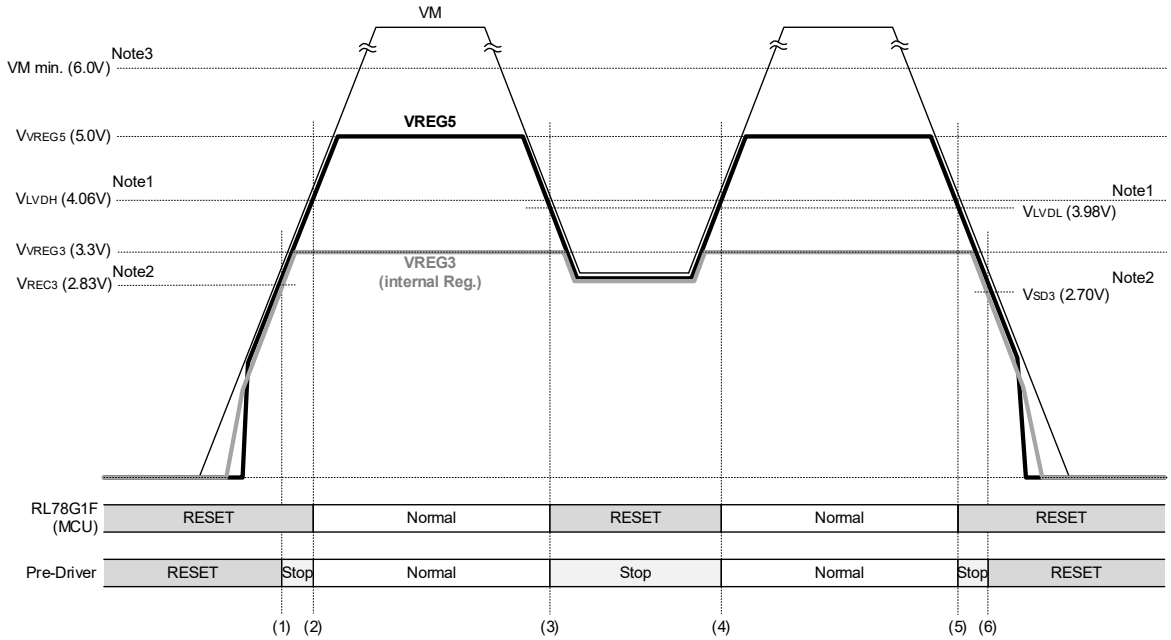


Figure 9-1. Power ON Sequence of VM VREG5, and VREG3

Note1: When a user writes in data of Firmware to Flash, the user needs to set MCU as follows.

Voltage Detector Function: Enable

Setting “Reset mode” of Voltage Detector Function.

Setting ‘4.06V of Rising edge’ and ‘3.98V of Falling edge’ on Detection voltage (VLVD).

Note2: VREC3 and VSD3 are the design target.

Note3: When VM is less than 6V, VGB for the Power MOS gate drive becomes less than 10V.

Refer to section 7.2 “Recommended Operating Condition”.

10.2 Serial Array Unit

RL78/G1F(MCU) has two Serial Array Unit. Serial Array Unit 0 is consisted four Serial channel. Serial Array Unit 1 is consisted two Serial channels. The Serial channel has three modes (CSI, UART, and Simplified I2C). Please refer to Chapter 19 Serial Array Unit in “RL78/G1F User’s manual: Hardware” (R01UH0516EJ).

Channel of CSI00: CSI00 is used for the communication of RL78/G1F MCU and the Pre-driver at the inside. The valid function of communication for peripheral circuit are the following.

Unit	Channel	Used as CSI	Used as UART	Used as simplified I^2C
0	0 [internal connection] Note 1	CSI00 (Can’t use slave select input function) [internal connection] Note 1		
	1	CSI01		IIC01
	2	CSI10	UART1(TxD1)	IIC10
	3		UART1(RxD1)	
1	0			
	1			

Note 1 Communication between RL78/G1F(MCU) and Pre-Driver

P51, P50, and P30 pins of RL78/G1F(MCU) are connected internally with Pre-Driver. Pre-Driver registers can be access via CSI0 (Channel 0 of Serial Array Unit 0).

Please set to CSI00 settings as follows.

- To disable slave select input function (/SSI00 pin), setting of SSIE00 =0 in ISC register is required. Refer to Chapter 19.3.15 Input switch control register (ISC) in “RL78/G1F User’s manual: Hardware” (R01UH0516EJ).
- To use type1 (DAP00=0, and CPK00=0 in SCR00 register). Refer to Chapter 19.3.4 Serial communication operation setting register mn (SCRmn) in “RL78/G1F User’s manual: Hardware” (R01UH0516EJ).

10.3 CSI timing specification

The following table shows the CSI timing specification during communication at same potential.

HS (Hi-speed main) mode

parameter	Symbol	Condition		CSI00			Unit
				MIN	TYP	MAX	
SCK00 cycle time	tKCY1	tKCY1 >= 4/fCLK	4.75V <= VDD <= 5.25V	-	1000	-	ns
SCK00 high/low-level width	tKH1, tKL1	4.75V <= VDD <= 5.25V		tKCY1/2 –24	-	-	ns
SIp setup time (from SCK00 ↑)	tSIK1	4.75V <= VDD <= 5.25V		66	-	-	ns
SIp hold time (from SCK00 ↑)	tKSI1			38	-	-	ns
Delay from SCK00↓ to SO00 output	tKSO1	C = 30pF *note1		-	-	50	ns

MCU SCR00 register, DAP00=0, CKP00=0, /SSIE=0

Note1: C is the load capacitance of SCK00 and SO00.

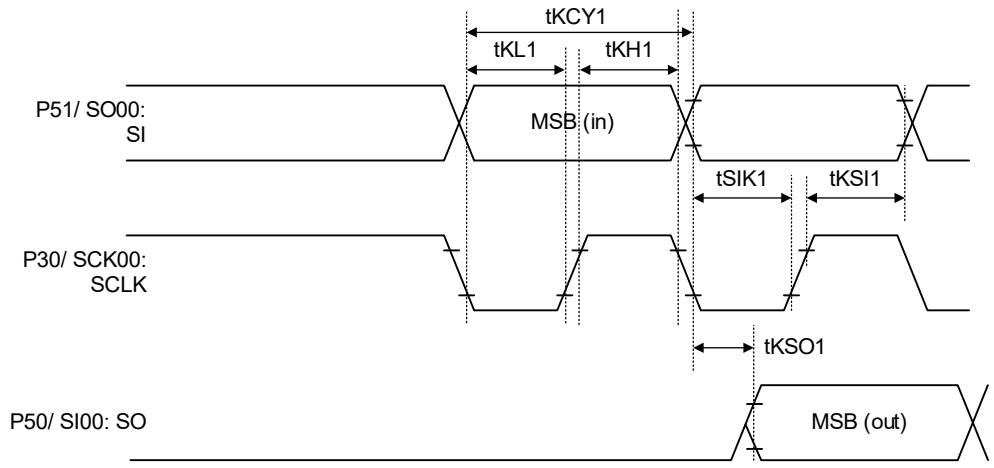
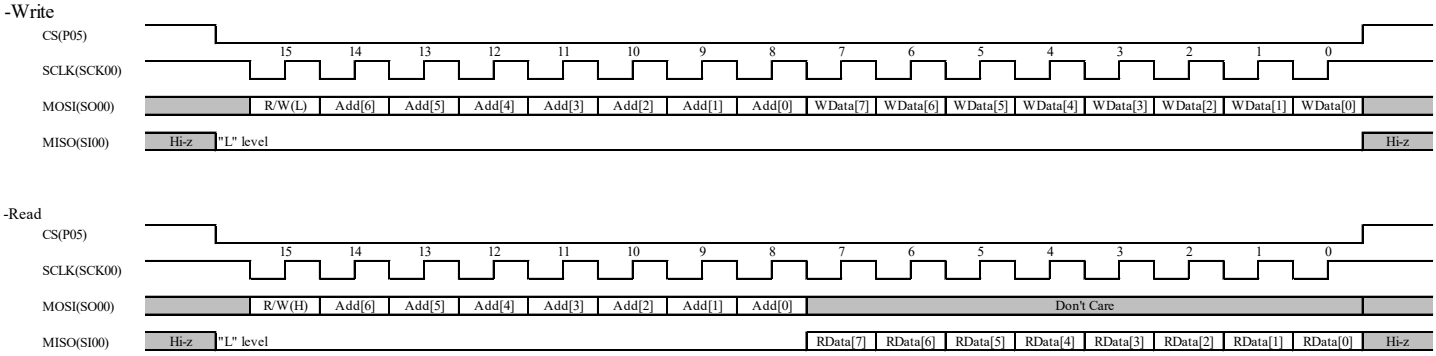


Figure 9-2. CSI Timing Diagram

10.4 CSI Communication Format

Fig.9-3 shows CSI communication format of both write and read mode.

If the communication format is different from this, its communication becomes invalid.



11. Control Register Map

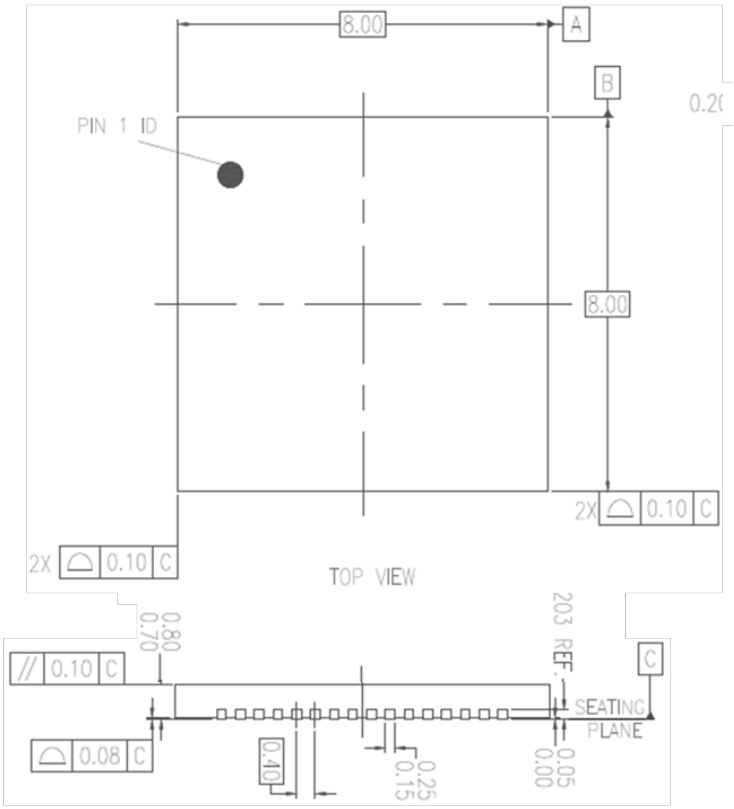
Table 10-1 shows the RAJ3060xx's register map. Check the "2.4 Pre-Driver register " in "RAJ306000 Series User's Manual:Hardware (R18UZ0066EJ)" for details.

Table 10-1. Register Map

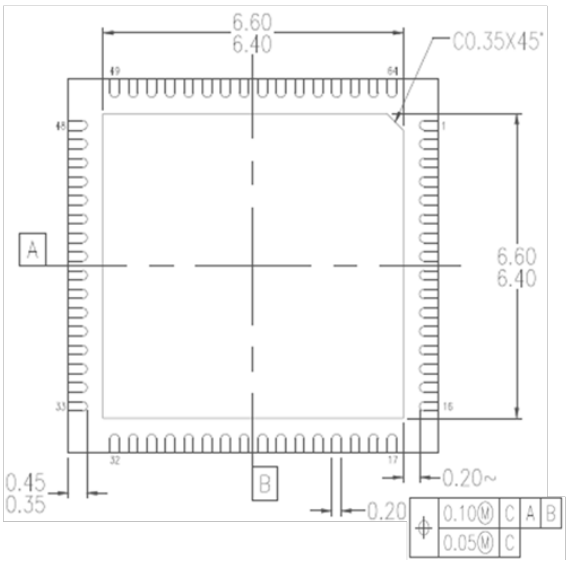
Add.	Register Name	Symbol	Initial value	7	6	5	4	3	2	1	0
02h	Power Save Control Register	PS_ALL	00h	0	0	0	0	0	0	0	PS_ALL_N
04h	By Function Power Save Control Setting Register	PS	00h	PS_PRE_N	0	PS_BMF_N	PS_CSAMP_N	PS_VMC_N	PS_HALL_N	PS_CPREG_N	PS_CP_N
06h	Software Reset Register	SW_RESET	00h	0	0	0	0	0	0	0	SW_RESET0
08h	ADC Selector Register	ADC_SEL	00h	0	0	0	0	ADC_CH_SEL3 to 0			
0Ah	U Phase Moter Control Signal Select Register	SELSIG_U	03h	0	SELSIG_U_H2 to 0			0	SELSIG_U_L2 to 0		
0Ch	V Phase Moter Control Signal Select Register	SELSIG_V	14h	0	SELSIG_V_H2 to 0			0	SELSIG_V_L2 to 0		
0Eh	W Phase Moter Control Signal Select Register	SELSIG_W	25h	0	SELSIG_W_H2 to 0			0	SELSIG_W_L2 to 0		
10h	Hall Signal Processing Setting Register	HALL_SIG	00h	BEMF_MODE_SEL	CENTERTAP_SEL	HALL_MODE_SEL	PWM_SEL	HALL_POLA	HALL_SEL2 to 0		
12h	ALARM Status Register1	ALMSTS1	FFh	VREG5_OVP_N	VGT_OVP1_N	VGT_OVP2_N	VGT_UVP_N	VGB_OVP_N	VGB_UVP_N	OCP_N	TSD_N
14h	ALARM Operation Setting Register1	ALMOPE1	00h	0	0	0	VGT_UVP_OPE_N	0	VGB_UVP_OPE_N	OCP_OPE_N	TSD_OPE_N
16h	ALARM Pin Output Setting Register1	ALMOUT1	00h	VREG5_OVP_ALE_N	VGT_OVP1_ALE_N	VGT_OVP2_ALE_N	VGT_UVP_ALE_N	VGB_OVP_ALE_N	VGB_UVP_ALE_N	OCP_ALE_N	TSD_ALE_N
18h	ALARM Status Register2	ALMSTS2	FFh	1	1	1	1	1	1	1	VM_UVP_N
1Ah	Current Sense setting Register2	CS_SET2	00h	CSAMP_IREF1 to 0		CSAMP_ATT		0	0	0	0
1Ch	ALARM Pin Output Setting Register2	ALMOUT2	00h	0	0	0	0	0	0	0	VM_UVP_ALE_N
1Eh	Error Detection Wait Time Setting Register	ERROR_WAIT	00h	0	0	0	REGV5_OVP_WAIT	UVCP_WAIT1 to 0		OCPWAIT1 to 0	
20h	Current Sense setting Register1	CS_SET1	00h	0	SHUNT_SEL2 to 0			OCP_SEL_H3 to 0			
22h	Hall IC Threshold Adjustment Register	HAIC_TH	00h	0	0	HAIC_HYS1 to 0		0	HAIC_TH2 to 0		
24h	Pre-Driver Drive Status Register	PDDSTS	F0h	1	1	1	LDS_N	FG	HALL_MON_U	HALL_MON_V	HALL_MON_W
26h	LD Judgment Wait Time Register	LD_WAIT	00h	LD_ALE_N	0	0	0	0	LD_WAIT2 to 0		
28h	Motor Drive Control Setting Register	DRIVE_SET	00h	OCP_HYS_N	ALM_LATCH_CLR	0	DECAY_MODE_SEL	DT_REG_N	OCP_ERR_SEL	DIR_SEL	MOT_EN
2Ah	-	-	-	0	0	0	0	0	0	0	0
2Ch	High Side Output Current Capability Setting Register	IDRCNT_H	00h	0	IDR_H_P2 to 0			0	IDR_H_N2 to 0		
2Eh	Low Side Output Current Capability Setting Register	IDRCNT_L	00h	0	IDR_L_P2 to 0			0	IDR_L_N2 to 0		
30h	Pch Slew Rate Setting Register	TRCNT_P	00h	0	TR_H_P2 to 0			0	TP_L_P2 to 0		
32h	Charge Pump Setting Register1	CPSET1	01h	0	0	0	0	0	0	CP_CLK_DIV1 to 0	
34h	Charge Pump Setting Register2	CPSET2	02h	0	0	0	0	CP_BOOST_N	VREG10_OUT	VREG6P5_OUT	0
36h	Cahrge Pump Trimming Register	CP_TRIM	00h	CP_TRIM7 - CP_TRIM0							
38h to 3Eh	-	-	-	0	0	0	0	0	0	0	0
40h	5V Regulator Voltage Setting	VREG5_TRIM	00h	VREG5_TRIM7 - VREG5_TRIM0							
42h	Ext. FET Curent Detect AMP Setting Register	CSAMP_TRIM	00h	CSAMP_TRIM7 - CSAMP_TRIM0							
44h to 56h	-	-	-	0	0	0	0	0	0	0	0
58h	ALARM Raw Status Monitor Register1	ALMRAW1	FFh	1	VGT_OVP1_RAW_N	VGT_OVP2_RAW_N	VGT_UVP_RAW_N	VGB_OVP_RAW_N	VGB_UVP_RAW_N	1	1
5Ah	-	-	-	0	0	0	0	0	0	0	0
5Ch	TOIN Pin Monitor Register	TOIN_MONI	-	TOINA	TOINB	TOINC	TOIND	TOINE	TOINF	TOING	TOINH
5Eh	WHO_AM_I	WHO_AM_I	RAJ306001:6Ah RAJ306010:6Bh	WHO_AM_I_7 - WHO_AM_I_0							
60h	Trimming Protect Register	TRIM_PT	00h	TRIM_PT7 - TRIM_PT0							
62h to 72h	-	-	-	0	0	0	0	0	0	0	0
74h	Trimming Data Valid Regsiter	TRIM_EN	00h	0	0	0	0	0	0	0	TRIM_EN
76h	-	-	-	0	0	0	0	0	0	0	0
78h	High Precise BGR Temp. Correction Register	BGR_TRIM	FFh	BGR_TRIM_7 - BGR_TRIM0							
7Ah	BUFFAMP Absolute Vaue Correction Register	BFAMP_TRIM	FFh	BFAMP_TRIM_7 - BFAMP_TRIM_0							
7Ch to 7Eh	-	-	-	0	0	0	0	0	0	0	0

12. Package Description

TOP VIEW



BOTTOM VIEW



13. Revision History

Revision	Date	Description
1.1	Mar 24, 2021	To update the format of the datasheet.

General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Precaution against Electrostatic Discharge (ESD)
   A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.
2. Processing at power-on
   The state of the product is undefined at the time when power is supplied. The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the time when power is supplied. In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the time when power is supplied until the reset process is completed. In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the time when power is supplied until the power reaches the level at which resetting is specified.
3. Input of signal during power-off state
   Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.
4. Handling of unused pins
   Handle unused pins in accordance with the directions given under handling of unused pins in the manual. The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of the LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible.
5. Clock signals
   After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is stabilized. When the clock signal is generated with an external resonator or from an external oscillator during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Additionally, when switching to a clock signal produced with an external resonator or by an external oscillator while program execution is in progress, wait until the target clock signal is stable.
6. Voltage application waveform at input pin
   Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).
7. Prohibition of access to reserved addresses
   Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.
8. Differences between products
   Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

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