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User's Manual

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RL78/G1E

User's Manual: Hardware

16-Bit Microcontrollers with Smart Analog IC

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(2012.4)

NOTES FOR CMOS DEVICES

(1) 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 VIL (MAX) and VIH (MIN) due to noise, etc., 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 VIL (MAX) and VIH (MIN).

(2) HANDLING OF UNUSED INPUT PINS: Unconnected CMOS device inputs can be cause of malfunction. If an input pin is unconnected, it is possible that an internal input level may be generated due to noise, etc., causing malfunction. CMOS devices behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using pull-up or pull-down circuitry. Each unused pin should be connected to VDD or GND via a resistor if there is a possibility that it will be an output pin. All handling related to unused pins must be judged separately for each device and according to related specifications governing the device.

(3) PRECAUTION AGAINST ESD: A strong electric field, when exposed to a MOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop generation of static electricity as much as possible, and quickly dissipate it when it has occurred. Environmental control must be adequate. When it is dry, a humidifier should be used. It is recommended to avoid using insulators that 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 should be grounded. The operator should be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with mounted semiconductor devices.

(4) STATUS BEFORE INITIALIZATION: Power-on does not necessarily define the initial status of a MOS device. Immediately after the power source is turned ON, devices with reset functions have not yet been initialized. Hence, power-on does not guarantee output pin levels, I/O settings or contents of registers. A device is not initialized until the reset signal is received. A reset operation must be executed immediately after power-on for devices with reset functions.

(5) POWER ON/OFF SEQUENCE: In the case of a device that uses different power supplies for the internal operation and external interface, as a rule, switch on the external power supply after switching on the internal power supply. When switching the power supply off, as a rule, switch off the external power supply and then the internal power supply. Use of the reverse power on/off sequences may result in the application of an overvoltage to the internal elements of the device, causing malfunction and degradation of internal elements due to the passage of an abnormal current. The correct power on/off sequence must be judged separately for each device and according to related specifications governing the device.

(6) INPUT OF SIGNAL DURING POWER OFF STATE : Do not input signals or an I/O pull-up power supply while the device is not powered. 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. Input of signals during the power off state must be judged separately for each device and according to related specifications governing the device.

How to Use This Manual

Readers

This manual is intended for user engineers who wish to understand the functions of the RL78/G1E and design and develop application systems and programs for these devices.
The target products are as follows.

- 64-pin: R5F10FLx (x = C, D, E)
- 80-pin: R5F10FMx (x = C, D, E)

Purpose

This manual is intended to give users an understanding of the functions described in the **Organization** below.

Organization

The RL78/G1E manual is separated into three parts: this manual, RL78/G1A user's manual, and the RL78 family software user's manual.

RL78/G1E User's Manual (This Manual)	**RL78/G1A Hardware User's Manual**	**RL78 family Software User's Manual**
• Pin functions • Internal block functions • On-chip peripheral functions • Electrical specifications	• Pin functions • Internal block functions • Interrupts • Other on-chip peripheral functions • Electrical specifications	• CPU functions • Instruction set • Explanation of each instruction

How to Read This Manual

It is assumed that the readers of this manual have general knowledge of electrical engineering, logic circuits, and microcontrollers.

- To gain a general understanding of functions:
  → Read this manual in the order of the **CONTENTS**. The mark "<R>" shows major revised points. The revised points can be easily searched by copying an "<R>" in the PDF file and specifying it in the "Find what:" field.

- How to interpret the register format:
  → For a bit number enclosed in angle brackets, the bit name is defined as a reserved word in the assembler, and is defined as an sfr variable using the #pragma sfr directive in the compiler.

- To know details of the microcontroller block:
  →Refer to the separate document **RL78/G1A Hardware User's Manual (R01UH0305E)**.

- To know details of the RL78 microcontroller instructions:
  → Refer to the separate document **RL78 family User's Manual Software (R01US0015E)**.

Conventions

Data significance:	Higher digits on the left and lower digits on the right	
Active low representations:	$\overline{\times\times\times}$ (overscore over pin and signal name)	
Note:	Footnote for item marked with **Note** in the text	
Caution:	Information requiring particular attention	
Remark:	Supplementary information	
Numerical representations:	Binary	···×××× or ××××B
	Decimal	···××××
	Hexadecimal	···××××H

Related Documents The related documents indicated in this publication may include preliminary versions. However, preliminary versions are not marked as such.

Documents Related to Devices

Document Name	Document No.
RL78/G1E User's Manual Hardware	This manual
RL78/G1A User's Manual Hardware	R01UH0305E
RL78 family User's Manual Software	R01US0015E

Documents Related to Flash Memory Programming

Document Name	Document No.
PG-FP5 Flash Memory Programmer User's Manual	R02UT0008E

Other Documents

Document Name	Document No.
Renesas MPUs & MCUs RL78 Family	R01CS0003E
Semiconductor Package Mount Manual	**Note**
Quality Grades on NEC Semiconductor Devices	C11531E
Guide to Prevent Damage for Semiconductor Devices by Electrostatic Discharge (ESD)	C11892E
NEC Semiconductor Device Reliability/Quality Control System	R51ZZ0001E

Note See the "Semiconductor Device Mount Manual" website (http://www.renesas.com/products/package/manual/index.jsp).

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CONTENTS

CHAPTER 1 OUTLINE

<R> 1. 1 Features

The RL78/G1E is a multi-chip package (MCP) device that integrates a chip of an analog block and a chip of 16-bit microcontroller block in a single package. The chip of analog block features a range of front-end analog circuits for small sensor signal processing such as a configurable gain amplifier, gain adjustment amplifier, filter circuit, D/A converter, and temperature sensor. The chip of 16-bit microcontroller block corresponds to the RL78/G1A (64-pin products).

1. 1. 1 Microcontroller block

Low power consumption technology by standby function

- HALT mode
- STOP mode
- SNOOZE mode

RL78 CPU core

- CISC architecture with 3-stage pipeline
- Minimum instruction execution time: Can be changed from 0.03125 μs (32 MHz operation with high-speed on-chip oscillator) to 0.05 μs (20 MHz operation with high-speed system clock)
- Address space: 1 MB
- General-purpose registers: (8-bit register × 8) × 4 banks
- On-chip RAM: 2 to 4 KB

Code flash memory

- Code flash memory: 32 to 64 KB
- Block size: 1 KB
- Prohibition of block erase and rewriting (security function)
- On-chip debug function
- Self-programming (with boot swap function/flash shield window function)

Data flash memory

- Data flash memory: 4 KB
- Back ground operation (BGO): Instructions can be executed from the program memory while rewriting the data flash memory.
- Number of rewrites: 1,000,000 times (TYP.)
- Voltage of rewrites: V_{DD} = 1.8 to 5.5 V

High-speed on-chip oscillator

- Select from 32 MHz, 24 MHz, 16 MHz, 12 MHz, 8 MHz, 6 MHz, 4 MHz, 3 MHz, 2 MHz, and 1 MHz
- High accuracy ±1.0 % (V_{DD} = 1.8 to 5.5 V, T_A = -20 to +85°C)

Operating ambient temperature

- T_A = -40 to +85°C (A: Consumer applications, D: Industrial applications)

Power supply voltage

- V_{DD} (Power supply for microcontroller block) = 1.6 to 5.5 V
- AV_{DD} (Power supply for A/D converter in microcontroller block) = 1.6 to 3.6 V
- AV_{DDn} (Power supply for analog block) = 3.0 to 5.5 V
- DV_{DD} (Power supply for SPI in analog block) = 3.0 to 5.5 V

Power management and reset function

- On-chip power-on-reset (POR) circuit
- On-chip voltage detector (LVD) (Select interrupt and reset from 3 levels)

DMA (Direct Memory Access) controller

- 2 channels
- Number of clocks during transfer between 8/16-bit SFR and internal RAM: 2 clocks

Multiplier and divider/multiply-accumulator

- 16 bits × 16 bits = 32 bits (Unsigned or signed)
- 32 bits ÷ 32 bits = 32 bits (Unsigned)
- 16 bits × 16 bits + 32 bits = 32 bits (Unsigned or signed)

Serial interface

- CSI : 2 channels (64-pin products), 6 channels (80-pin products)
- UART / UART (LIN-bus supported) : 2 channels / 1channel
- I^2C/Simplified I^2C communication : 1 channel (64-pin products), 3 channels (80-pin products)

Timer

- 16-bit timer : 8 channels
- 12-bit interval timer : 1 channel
- Watchdog timer : 1 channel (operable with the dedicated low-speed on-chip oscillator)

A/D converter

- 8/12-bit resolution A/D converter
- Analog input: 13 channels (64-pin products), 17 channels (80-pin products)
- Internal reference voltage (1.45 V) and temperature sensor[Note]

Note Can be selected only in HS (high-speed main) mode

Remarks 1. n = 1 to 3

2. The functions mounted depend on the product. See **1.6 Outline of Functions**.

I/O port

- I/O port : 24 (64-pin products), 30 (80-pin products)
- Can be set to N-ch open drain, TTL input buffer, and on-chip pull-up resistor
- Different potential interface: Can connect to a 1.8/2.5/3 V device
- On-chip key interrupt function
- On-chip clock output/buzzer output controller

Others

- On-chip BCD (binary-coded decimal) correction circuit

ROM, RAM capacities

Flash ROM	Data Flash	RAM	RL78/G1E	
			64 pins	80 pins
32 KB	4 KB	2 KB	R5F10FLC	R5F10FMC
48 KB	4 KB	3 KB	R5F10FLD	R5F10FMD
64 KB	4 KB	4 KB	R5F10FLE	R5F10FME

Remark The functions mounted depend on the product. See **1.6 Outline of Functions**.

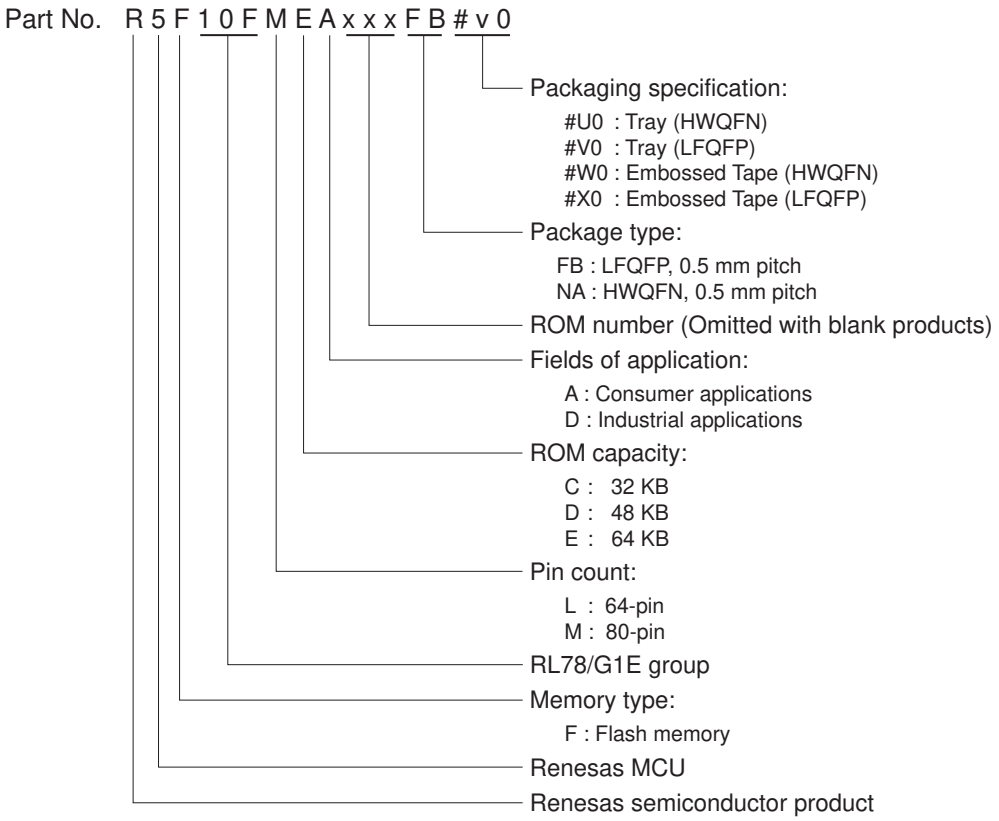
1. 1. 2 Analog block

- Configurable amplifier: 3 channels
- Gain adjustment amplifier: 1 channel
- High-pass filter: 1 channel **Note**
- Low-pass filter: 1 channel
- D/A converter: 4 channels
- Variable output voltage regulator: 1 channel
- Reference voltage generator: 1 channel
- Temperature sensor: 1 channel
- SPI (for analog block): 1 channel

Note 80-pin products only.

Remark The functions mounted depend on the product. See **1.6 Outline of Functions**.

1. 2 List of Part Numbers



<R>

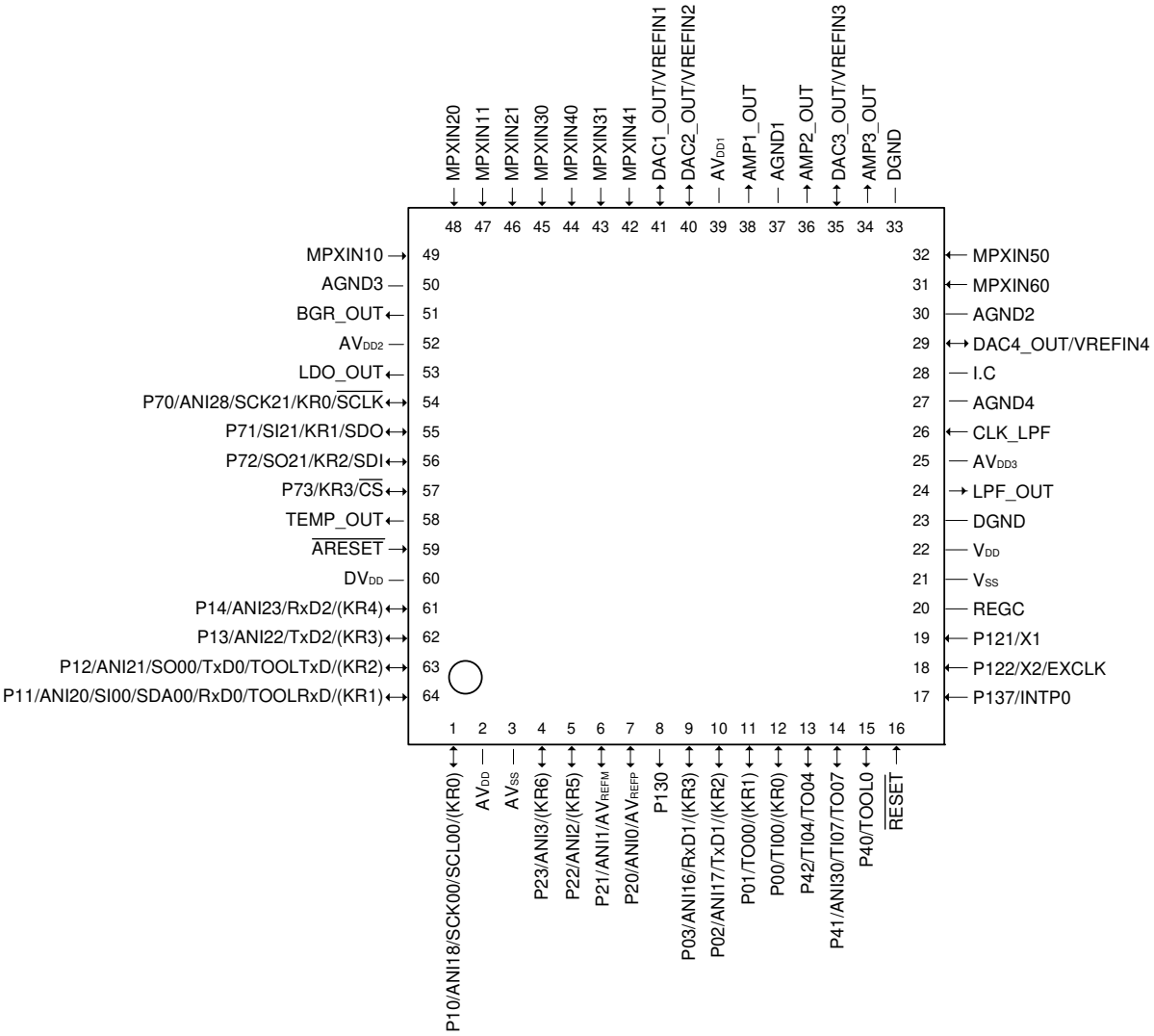
Pin count	Package	Data Flash	Part Number
64 pins	64-pin plastic HWQFN (fine pitch) (9 × 9)	Mounted	R5F10FLCANA#U0, R5F10FLCANA#W0, R5F10FLDANA#U0, R5F10FLDANA#W0, R5F10FLEANA#U0, R5F10FLEANA#W0, R5F10FLCDNA#U0, R5F10FLCDNA#W0, R5F10FLDDNA#U0, R5F10FLDDNA#W0, R5F10FLEDNA#U0, R5F10FLEDNA#W0
80 pins	80-pin plastic LFQFP (12 × 12)	Mounted	R5F10FMCAFB#V0, R5F10FMCAFB#X0, R5F10FMDAFB#V0, R5F10FMDAFB#X0, R5F10FMEAFB#V0, R5F10FMEAFB#X0, R5F10FMCDFB#V0, R5F10FMCDFB#X0, R5F10FMDDFB#V0, R5F10FMDDFB#X0, R5F10FMEDFB#V0, R5F10FMEDFB#X0

Caution The part number above is valid as of when this manual was issued. For the latest part number, see the web page of the target product on the Renesas Electronics website.

<R> 1. 3 Pin Configuration (Top View)

1. 3. 1 64-pin products

64-pin plastic WQFN (fine pitch) (9 × 9)



Cautions 1. Connect the REGC pin to VSS via a capacitor (0.47 to 1 μF).

2. Make the potential of VDD, AVDD1, AVDD2, AVDD3, and DVDD the same.

3. Make the potential of VSS, AGND1, AGND2, AGND3, AGND4, and DGND the same.

4. Leave I.C open.

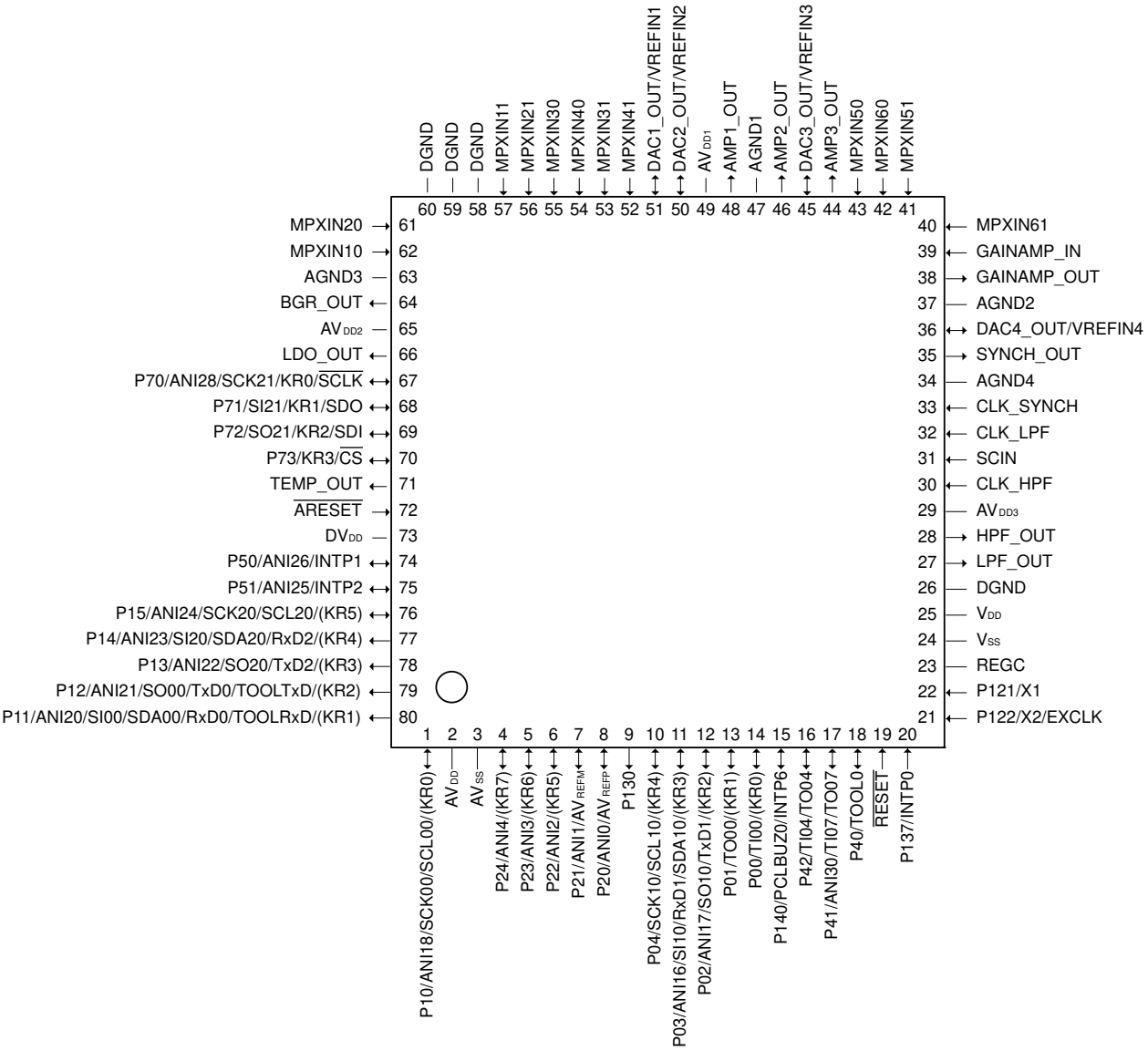
5. Connect the LDO_OUT pin to AGND3 via a capacitor (4.7 μF: recommended).

6. Connect the BGR_OUT pin to AGND3 via a capacitor (0.1 μF: recommended).

7. When using Low-pass filter or High-pass filter,
connect the DAC4_OUT/VREFIN4 pin to AGND1 via a capacitor (470 pF: recommended).

<R> **1. 3. 2 80-pin products**

80-pin plastic LQFP (fine pitch) (12 × 12)



Cautions 1. Connect the REGC pin to VSS via a capacitor (0.47 to 1 μF).

2. Make the potential of VDD, AVDD1, AVDD2, AVDD3, and DVDD the same.

3. Make the potential of VSS, AGND1, AGND2, AGND3, AGND4, and DGND the same.

4. Connect the LDO_OUT pin to AGND3 via a capacitor (4.7 μF: recommended).

5. Connect the BGR_OUT pin to AGND3 via a capacitor (0.1 μF: recommended).

6. When using Low-pass filter or High-pass filter,
connect the DAC4_OUT/VREFIN4 pin to AGND1 via a capacitor (470 pF: recommended).

<R> 1. 4 Pin Identification

○ Microcontroller Block

ANI0-ANI4,	Analog Input	RxD0-RxD2	Receive Data
ANI16-ANI18,		SCK00, SCK10,	Serial Clock Input/Output
ANI20-ANI26,		SCK20, SCK21	
ANI28, ANI30		SCL00, SCL10,	Serial Clock Input/Output
AV_{REFM}	Analog Reference Voltage	SCL20	
	Minus	SDA00, SDA10,	Serial Data Input/Output
AV_{REFP}	Analog Reference Voltage	SDA20	
	Plus	SI00, SI10,	Serial Data Input
EXCLK	External Clock Input	SI20, SI21	
	(Main System Clock)	SO00, SO10	Serial Data Output
INTP0-INTP2	External Interrupt Input	SO20, SO21	
INTP6		TI00, TI04,	Timer Input
KR0-KR7	Key Return	TI07	
P00-P04	Port 0	TO00, TO04,	Timer Output
P10-P15	Port 1	TO07	
P20-P24	Port 2	TOOL0	Data Input/Output for Tool
P40-P42	Port 4	TOOLRxD,	Data Input/Output for External
P50, P51	Port 5		Device
P70-P73	Port 7	TOOLTxD	
P121, P122	Port 12	TxD0-TxD2	Transmit Data
P130, P137	Port 13	V_{DD}	Power Supply
P140	Port 14	V_{SS}	Ground
PCLBUZ0	Programmable Clock Output/	X1, X2	Crystal Oscillator
	Buzzer Output		(Main System Clock)
REGC	Regulator Capacitance	AV_{DD}	Analog Power Supply
$\overline{\text{RESET}}$	Reset	AV_{SS}	Analog Ground