RA FAMILY
RA4T1 AND RA6T3 GROUP
INTRODUCTION
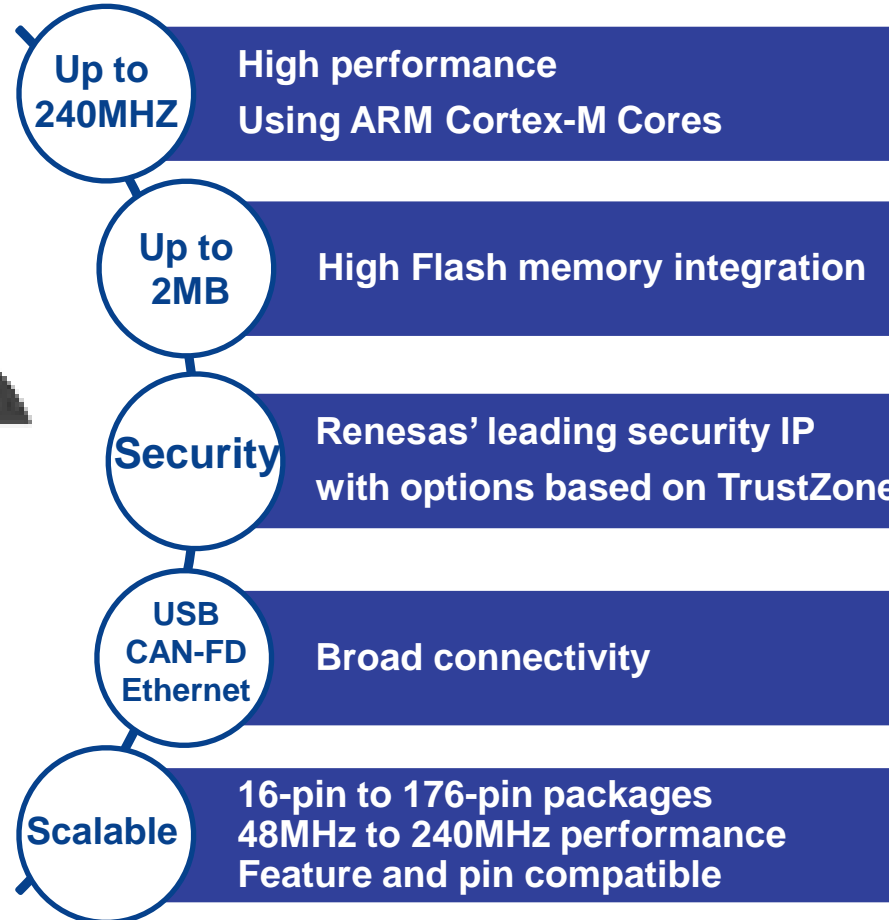
RA4T1, RA6T3

RENESAS

INTRODUCING 32-BIT RENESAS RA FAMILY
HIGH PERFORMANCE, HIGH SECURITY, BROAD CONNECTIVITY AND WIDE LINE-UP

Up to 240MHZ — High performance Using ARM Cortex-M Cores

Up to 2MB — High Flash memory integration

Security — Renesas' leading security IP with options based on TrustZone

USB CAN-FD Ethernet — Broad connectivity

Scalable — 16-pin to 176-pin packages 48MHz to 240MHz performance Feature and pin compatible

TARGET MARKETS AND APPLICATIONS

Industrial Automation

- Long product life
- 105°C support
- Industrial quality grade
- Strongest robustness

Security

- TrustZone support
- Integrated Crypto Module
- Key isolation and management
- True Random Number Generator (TRNG)

Connectivity

- Large On-chip RAM suitable for stacks
- CAN/USB/Ethernet
- Large amount on serial Interfaces
- QSPI and OCTA SPI Interfaces
- HW Crypto Module on-chip

Building Automation

- High On-Chip Flash/RAM memory ratio
- Wide range of connectivity: CAN/USB/Ethernet
- Rich analog features
- Small packages

Metering

- Scalable lineup
- Industrial quality grade
- Long product life
- Encryption On-Chip

Home Appliance

- Temp up to 105°C
- Extensive family lineup
- Motor control solutions
- Capacitive Touch Interface

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# RENESAS RA FAMILY VALUE PROPOSITIONS

ARM® Core
- Cortex®-M4 → Next generation Cortex-M23/M33
- Including TrustZone for advanced security

Security for IoT
- SCE / TrustZone security solutions for IoT
- Excellent ease-of-use tools and offering

Flexible Software Package (FSP)
- Fast-start software for Security & Connectivity
- Flexible open architecture supporting customers legacy code and environment
- Extensive 3rd parties ecosystem
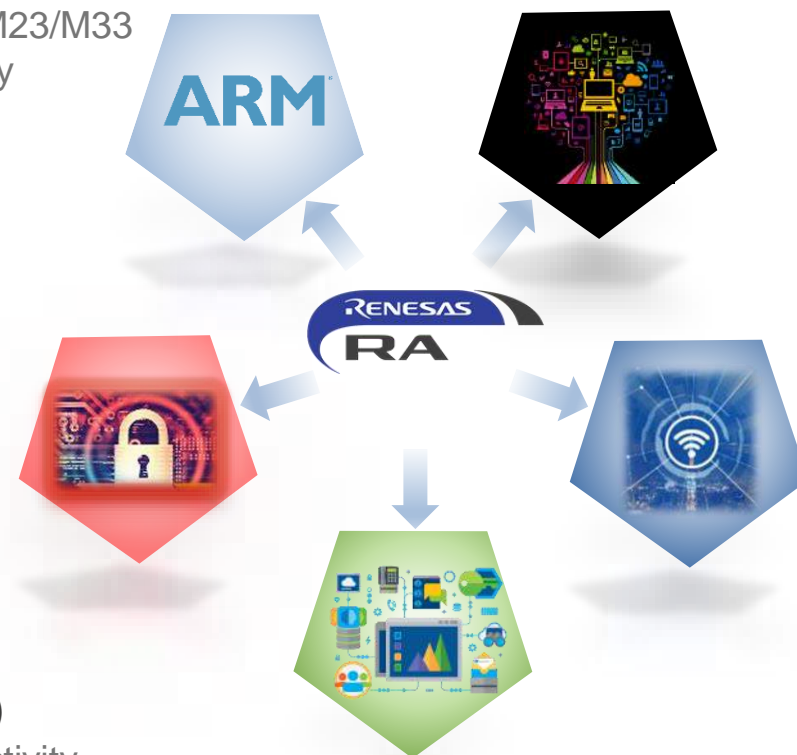
Advanced Technology
- Best in class peripheral IP's, built on strong MCU heritage
- Excellence in embedded flash, performance & field upgrades
- Class leading Capacitive Touch technology

Connectivity Solutions
- BLE, 802.15.4, LORA, NB-IoT, Wi-Fi
- Excellent wired connectivity solutions
- Integrated MCU+RF solutions
- Supporting 3rd party RF solutions

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Series **Groups**

Wide line-up
- 3 Series
- 19 Groups
- 255 Devices

+ 2 Groups
+ 15 Devices

Series	Mainstream Line /Low Power		Entry Line	Rich Analog	Wireless	Motor Control
RA8 240MHz~						
RA6 ~240MHz	**RA6M3** 120MHz Cortex-M4, ~2MB Flash Ethernet, USBHS, CAN, Graphics, JPEG, TFT LCD, SCE7	**RA6M5** 200MHz Cortex-M33, ~2MB Flash TrustZone, Ethernet, USBFS+ USBHS, CAN-FD, Octa SPI, SCE9	**RA6E2** 200MHz Cortex-M33, ~256kB Flash TrustZone, USBFS, CAN FD, I3C			**RA6T3** *New* 200MHz Cortex-M33, 256KB Flash PGA, CMP, TFU, CAN FD, USBFS
	RA6M2 120MHz Cortex-M4, ~1MB Flash Ethernet, USBFS, CAN, SCE7	**RA6M4** 200MHz Cortex-M33, ~1MB Flash TrustZone, Ethernet, USBFS, CAN, Octa SPI, SCE9	**RA6E1** 200MHz Cortex-M33, ~1MB Flash TrustZone, Ethernet, USBFS, CAN			**RA6T2** 240MHz Cortex-M33, 512KB Flash PWM, PGA, Motor Accelerator, CAN-FD, SCE5
	RA6M1 120MHz Cortex-M4, 512KB Flash USBFS, CAN, SCE7					**RA6T1** 120MHz Cortex-M4, ~ 512KB Flash PWM, PGA, CMP, SCE7
RA4 ~100MHz		**RA4M3** 100MHz Cortex-M33, ~1MB Flash TrustZone, USBFS, CAN, SCE9	**RA4E2** 100MHz Cortex-M33, 128KB Flash TrustZone, USBFS, CAN FD, I3C		**RA4W1** 48MHz Cortex-M4, 512kB Flash, Bluetooth, USBFS, CAN, Segment LCD, CTSU Touch Sensing	**RA4T1** *New* 100MHz Cortex-M33, ~256kB Flash PGA, CMP, TFU, CAN FD
	RA4M1 48MHz Cortex-M4, 256KB Flash USBFS, CAN, Seg. LCD, CTSU Touch Sensing, 14bit SAR ADC, SCE5	**RA4M2** 100MHz Cortex-M33, ~512KB Flash TrustZone, USBFS, CAN, SCE9	**RA4E1** 100MHz Cortex-M33, ~512KB Flash TrustZone, USBFS, CAN			
RA2 ~60MHz		**RA2L1** 48MHz Cortex-M23, ~256KB Flash CAN, CTSU Touch Sensing	**RA2E2** 48MHz Cortex-M23, ~64KB Flash I3C, WLCSP, 125degC	**RA2A1** 48MHz Cortex-M23, 256KB Flash USBFS, CAN, CTSU Touch Sensing, 24bit SD-ADC, 16bit SAR ADC		
			RA2E1 48MHz Cortex-M23, ~128KB Flash CTSU Touch Sensing, WLCSP			

Status: 14th of March 2023

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FEATURE-SET FOR RA FAMILY MOTOR CONTROL MCU

Features of RA4T1 group and RA6T3 group

- Optimized peripheral functions for single motor control and low-cost low-end to middle-range applications.
- Newly support I3C, USB FS (RA6T3) and 32-pin small package to meet various needs.

Group	Core	Freq.	Code ROM	RAM Data ROM	PWM	Analog			Motor Accelerator	Communication		Pin Count
RA6T2 2.7~3.6V	CM33	240MHz	256K -512KB Flash	64KB 16KB	PWM 20ch	16b ADC x2, 29ch	HSCMP x4	PGA x4	TFU IIR Filter	SCI x6 SPI x2 I2C x2	CANFD x1	48-100 pin
RA6T3 2.7~3.6V	CM33	200MHz	256KB Flash	40KB 4KB	PWM 12ch	12b ADC x1, 12ch	HSCMP x3	PGA x3	TFU	SCI x2 SPI x2 I3C x1	CANFD x1 USBFS x1	32-64 pin
RA6T1 2.7~3.6V	CM4	120MHz	256K -512KB Flash	64KB 8KB	PWM 26ch	12b ADC x2, 17ch	HSCMP x6	PGA x6		SCI x7 SPI x2 I2C x2	CAN x1	64-100 pin
RA4T1 2.7~3.6V	CM33	100MHz	128K -256KB Flash	40KB 4KB	PWM 12ch	12b ADC x1, 12ch	HSCMP x3	PGA x3	TFU	SCI x2 SPI x2 I3C x1	CANFD x1	32-64 pin

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NEW MOTOR CONTROL MCU GROUPS, RA4T1 AND RA6T3
OFFERING OPTIMAL FEATURES AND PERFORMANCE FOR SINGLE-MOTOR CONTROL

- Cost-effective for motor control with Cortex®-M33 core with FPU, 770+ CoreMark@200MHz

- Small package option;
  - 5mm x 5mm 32-pin QFN
  - 7mm x 7mm 48-pin QFN

- Various connectivity;
  - USB FS
  - CAN FD
  - I3C/I2C

- Feature resources for the motor control and easy to use hardware/software evaluation environments

Performance
- CM33 Core with FPU, Max operating frequency: 200MHz
- Equipped with TFU[*1] to speed up coordinate transformation, position control and phase calculation

*1 Trigonometric Function Unit

Inverter control
- General-purpose 16-bit enhanced PWM timer,
- 12-bit ADC (1unit w/ 3ch S/H), DAC (2ch)
- Built-in functions that contribute to BOM reduction, Data Flash, PGA, Comparator

New features
- Support 32-pin small package (7x7 LQFP, 5x5 QFN)
- Wide variety of communication IFs, USB FS (RA6T3), CAN FD, I3C/I2C

Motor Solution
- Integrated Motor Control evaluation hardware kits
- Provide various sample programs for motor control
- GUI tool for real-time debugging, Renesas Motor Workbench 3.0

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RA4T1 GROUP
ARM CORTEX-M33 - 128KB TO 256KB FLASH WITH 40KB RAM

Performance

RA2 48MHz

RA4 Up to 100MHz

RA6 Up to 240MHz

RA8 More than 240MHz

- 40-nm high-performance process
- 32-bit Cortex-M33 Core with FPU
- TrustZone
- Operating temperature range: Ta = -40°C to 105°C
- Operating Voltage: 2.7-3.6V
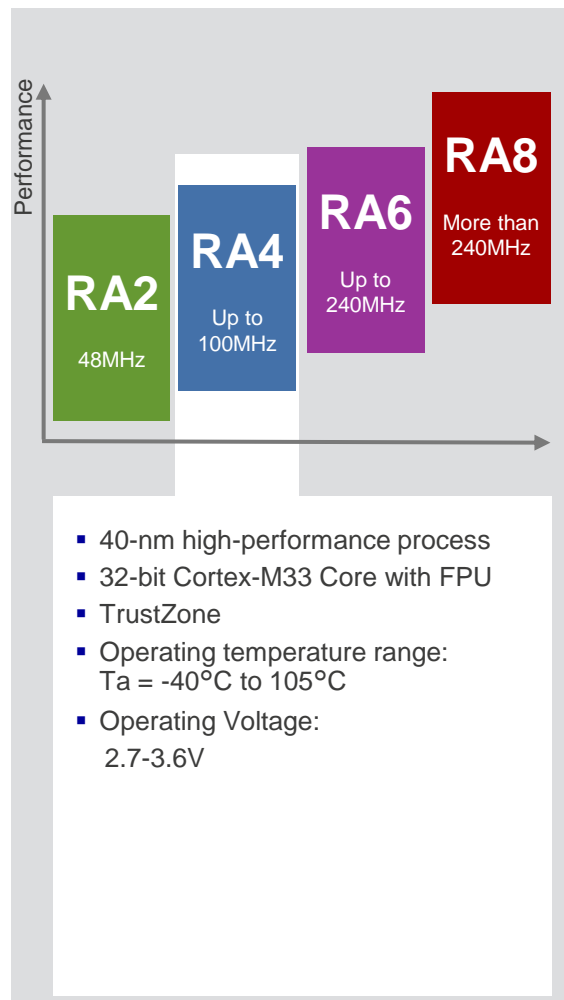
RA4T1 **100MHz 32-Bit Arm® Cortex®-M33 Core**   NVIC │ SWD │ ETB

Memory
Code Flash (128KB, 256KB)
SRAM 32KB Parity
SRAM 8KB ECC
Data Flash (4KB)

Analogue
12-bit ADC (12ch, 1unit w/ 3ch S/H)
12-bit DAC (2ch)
PGA (3ch)
Comparator (3ch)
POE
Temperature Sensor

Timers
GPT16E (6ch)
Low-power GPT (2ch)
WDT

Accelerator
Trigonometric Function Unit

Communication
CAN FD x1
I3C x1
SCI x2
SPI x2

System
DMA (8ch), DTC, ELC
Clock Generation
On-Chip Oscillator
HOCO (16/18/20MHz)
MOCO (8MHz)
LOCO (32KHz)
ILOCO (15KHz)
Low-power Modes
Interrupt Controller
TrustZone

Safety
Memory Protection Unit
SRAM Parity Check
ECC SRAM
Clock Frequency Accuracy Measurement
CRC calculator
IWDT
Data Operation Circuit
Flash Area Protection
ADC self test

Security
128-bit Unique ID
TRNG

Package
LQFP 32, 48, 64
QFN 32, 48

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RA6T3 GROUP
ARM CORTEX-M33 - 256KB FLASH WITH 40KB RAM

Performance

RA2	RA4	RA6	RA8
48MHz	Up to 100MHz	Up to 240MHz	More than 240MHz

- 40-nm high-performance process
- 32-bit Cortex-M33 Core with FPU
- TrustZone
- Operating temperature range: Ta = -40°C to 105°C
- Operating Voltage: 2.7-3.6V
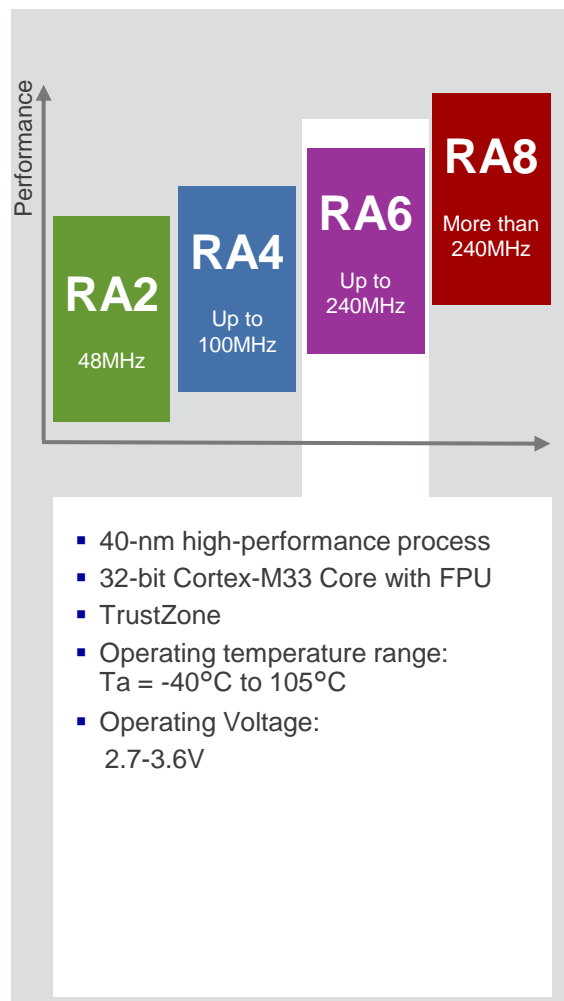
RA6T3 — 200MHz 32-Bit Arm® Cortex®-M33 Core — NVIC | SWD | ETB

Memory
Code Flash (256KB)
SRAM 32KB Parity
SRAM 8KB ECC
Data Flash (4KB)

Analogue
12-bit ADC (12ch, 1unit w/ 3ch S/H)
12-bit DAC (2ch)
PGA (3ch)
Comparator (3ch)
POE
Temperature Sensor

Timers
GPT16E (6ch)
Low-power GPT (2ch)
WDT

Accelerator
Trigonometric Function Unit

Communication
USB2.0 FS Device x1 *
CAN FD x1
I3C x1
SCI x2
SPI x2

* Excluding 32-pin package

System
DMA (8ch), DTC, ELC
Clock Generation
On-Chip Oscillator
HOCO (16/18/20MHz)
MOCO (8MHz)
LOCO (32KHz)
ILOCO (15KHz)
Low-power Modes
Interrupt Controller
TrustZone

Safety
Memory Protection Unit
SRAM Parity Check
ECC SRAM
Clock Frequency Accuracy Measurement
CRC calculator
IWDT
Data Operation Circuit
Flash Area Protection
ADC self test

Security
128-bit Unique ID
TRNG

Package
LQFP 32, 48, 64
QFN 32, 48

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RA4T1, RA6T3 GROUP PRODUCT LINEUP

Flash (RAM)	256kB (40kB)	R7FA6T3BB3CNH R7FA4T1BB3CNH	R7FA6T3BB3CFJ R7FA4T1BB3CFJ	R7FA6T3BB3CNE R7FA4T1BB3CNE	R7FA6T3BB3CFL R7FA4T1BB3CFL	R7FA6T3BB3CFM R7FA4T1BB3CFM
	128kB (40kB)	R7FA4T1B93CNH	R7FA4T1B93CFJ	R7FA4T1B93CNE	R7FA4T1B93CFL	R7FA4T1B93CFM
Pin Count		32pin		48pin		64pin
Package type		QFN	LQFP	QFN	LQFP	LQFP
Package view		5 mm / 5 mm QFN 32, 0.5 mm pitch	7 mm / 7 mm LQFP 32, 0.8 mm pitch	7 mm / 7 mm QFN 48, 0.5 mm pitch	7 mm / 7 mm LQFP 48, 0.5 mm pitch	10 mm / 10 mm LQFP 64, 0.5 mm pitch

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RA4T1 AND RA6T3
TARGET MARKETS AND APPLICATIONS

RA4T1

- ✓ Home appliance
  Dishwasher, Vacuum cleaner, Refrigerator, IH cooker(inverter), etc
- ✓ Building automation and Office automation
  Fan, Pump, Compressor, Label/Thermal printer, etc
- ✓ Mid~Low-end power tools, etc

RA6T3

- ✓ Home appliance
  Refrigerator, Washing machine, Air conditioner, etc
- ✓ Building automation, Industrial automation and Office automation
  Fan, Pump, HVAC, Low-end AC Drive/AC Servo, MFP, etc
- ✓ Small robots, Small mobility (e-scooter, e-bike),
  High-end power tools, etc

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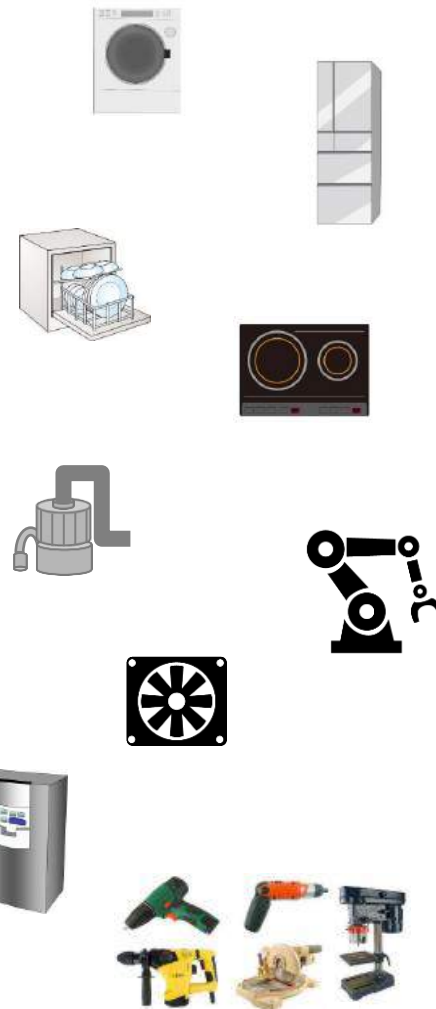
SINGLE MOTOR CONTROL SYSTEM CONFIGURATION EXAMPLE
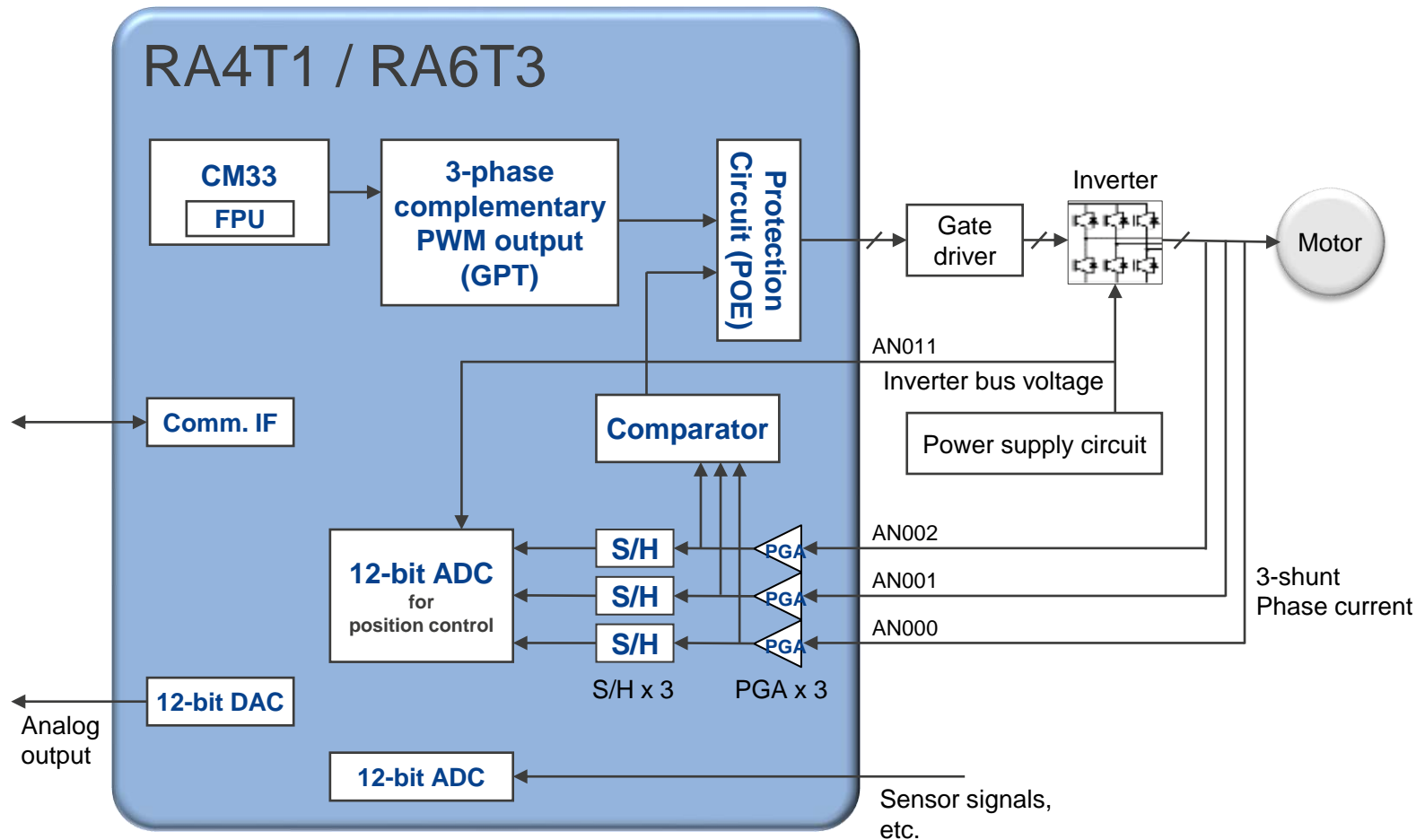
Key components

- **Control 3-phase inverter x 1**
  - ✓ **GPT** for 3-phase complementary PWM output

- **Process 3-shunt current detection simultaneously**
  - ✓ **Simultaneous S/H circuit** x 3
  - ✓ **PGA** to amplify shunt current x3

- **Output protection for safety**
  - ✓ **Comparator** to detect overcurrent
  - ✓ **POE** to forcibly shut off PWM

- **CPU performance for algorithm control**
  - ✓ **100-200MHz** CPU frequency

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DEVELOPMENT ENVIRONMENT FOR RA4T1 AND RA6T3
EASY TO USE AND AS FLEXIBLE AS POSSIBLE

On-Chip Debug

- Renesas E2 & E2 Lite

- Segger J-Link

IDE

- Renesas e²studio

- Keil MDK

  KEIL™
  Tools by ARM

- IAR Embedded Workbench

  IAR SYSTEMS

Compiler

- GNU

- Arm Compiler V6

  KEIL™
  Tools by ARM

- IAR ARM Compiler

  IAR SYSTEMS

Support Tools

- FSP driver selection and configuration
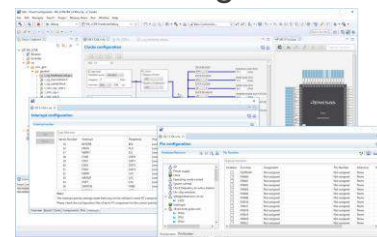
- Intelligent pin mapping
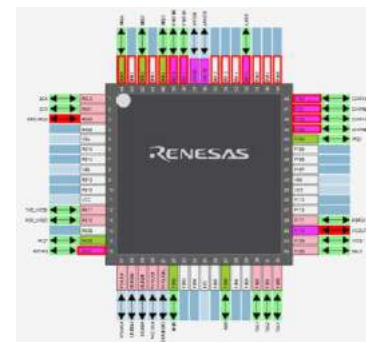
Kits and Boards

- Evaluation Kits

  MCB-RA4T1

  MCB-RA6T3
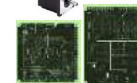
  MCK-RA4T1

  MCK-RA6T3

- Motor Workbench

- Sample S/W (APN)

MCB: Motor Control CPU Board
MCK: Motor Control Kit

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RA4T1 AND RA6T3
MOTOR CONTROL KIT OVERVIEW

(*) Can be purchased individually.

P/N	Nickname	Title	included items
RTK0EMA430S00020BJ	MCK-RA4T1	Renesas Flexible Motor Control Kit for RA4T1 MCU Group	• RA4T1 CPU Board (MCB-RA4T1) • Inverter Board (MCI-LV-1) • 36V BLDC Motor and Cables
RTK0EMA330S00020BJ	MCK-RA6T3	Renesas Flexible Motor Control Kit for RA6T3 MCU Group	• RA6T3 CPU Board (MCB-RA6T3) • Inverter Board (MCI-LV-1) • 36V BLDC Motor and Cables
RTK0EM0000S04020BJ (*)	MCI-LV-1	Renesas Flexible Motor Control Inverter Board Low Voltage 48V/10A for Three-Phase BLDC/PMSM Motor	Inverter Board, 36V BLDC Motor
RTK0EMXC90S00000BJ (*)	MC-COM	Renesas Flexible Motor Control Communication Board	Communication Board, Com cable, USB cable
RTK0EMA430C00000BJ (*)	MCB-RA4T1	Renesas Flexible Motor Control CPU Board for RA4T1 MCU Group	RA4T1 CPU Board, USB cable
RTK0EMA330C00000BJ (*)	MCB-RA6T3	Renesas Flexible Motor Control CPU Board for RA6T3 MCU Group	RA6T3 CPU Board, USB cable

MCK-RA4T1, MCK-RA6T3

MCB-RA4T1, MCB-RA6T3
(CPU Board)

MCI-LV-1
(Inverter Board)

BLDC Motor

Cables

MC-COM
(Communication Board)

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RA4T1 AND RA6T3
SAMPLE PROGRAM AND APPLICATION NOTE

Item	Schedule
Sensorless vector control for permanent magnetic synchronous Single motor (3-shunt current detection)	Available
Sensorless vector control for permanent magnetic synchronous Single motor (1-shunt current detection)	Available
Vector Control for Permanent Magnet Synchronous Motor with Encoder	Available
120-degree conducting control (Hall sensor)	Available
120-degree conducting control (Sensorless)	Available
Vector Control for Permanent Magnet Synchronous Motor with inductive sensor	Available
Accelerators (IIRFA/TFU) performance in motor application	Available (*)
Vector Control for Permanent Magnetic Synchronous Motor with hall sensor	Q4/2023

* TFU only
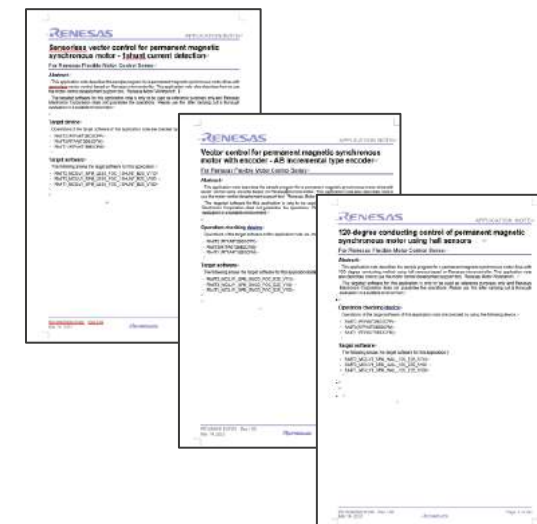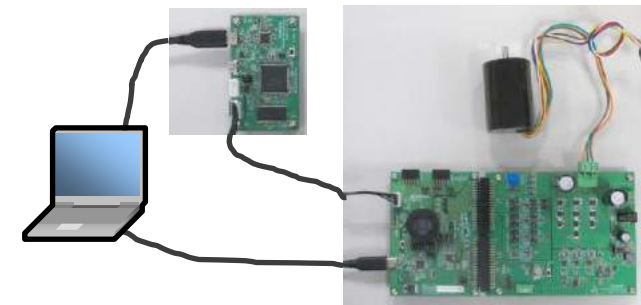
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DOCUMENTATION

Please visit: renesas.com/ra4t1

renesas.com/ra6t3

Documentation / Models

| Title, start typing to filter 🔍 | All types ▼ ⇕ | Date ⇕ |

- ⭐ **RA4T1 Group Flyer**
- ⭐ **RA4T1 Group Datasheet**
- ⭐ **RA4T1 Group User's Manual: Hardware**
- ⭐ **Application Note: Notes on RA4T1 Group High-Temperature Operation**
- ⭐ **R7FA4T1XXX Reliability Report**
- ⭐ **IBIS Models for RA4T1**

- ⭐ **RA6T3 Group Flyer**
- ⭐ **RA6T3 Group Datasheet**
- ⭐ **RA6T3 Group User's Manual: Hardware**
- ⭐ **Application Note: Notes on RA6T3 Group High-Temperature Operation**
- ⭐ **R7FA6T3XXX Reliability Report**
- ⭐ **IBIS Models for RA6T3**

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PART NUMBER LIST

Group	Part number	Flash	RAM	DataFlash	Operating Temperature	Package	Package dimensions	Pin Pitch
RA4T1	R7FA4T1BB3CFM	256kB	40kB	4kB	−40 to +105℃	LQFP 64pin	10x10mm body	0.5mm
	R7FA4T1BB3CFL					LQFP 48pin	7x7mm body	0.5mm
	R7FA4T1BB3CNE					QFN 48pin	7x7mm body	0.5mm
	R7FA4T1BB3CFJ					LQFP 32pin	7x7mm body	0.8mm
	R7FA4T1BB3CNH					QFN 32pin	5x5mm body	0.5mm
	R7FA4T1B93CFM	128kB				LQFP 64pin	10x10mm body	0.5mm
	R7FA4T1B93CFL					LQFP 48pin	7x7mm body	0.5mm
	R7FA4T1B93CNE					QFN 48pin	7x7mm body	0.5mm
	R7FA4T1B93CFJ					LQFP 32pin	7x7mm body	0.8mm
	R7FA4T1B93CNH					QFN 32pin	5x5mm body	0.5mm
RA6T3	R7FA6T3BB3CFM	256kB	40kB	4kB	−40 to +105℃	LQFP 64pin	10x10mm body	0.5mm
	R7FA6T3BB3CFL					LQFP 48pin	7x7mm body	0.5mm
	R7FA6T3BB3CNE					QFN 48pin	7x7mm body	0.5mm
	R7FA6T3BB3CFJ					LQFP 32pin	7x7mm body	0.8mm
	R7FA6T3BB3CNH					QFN 32pin	5x5mm body	0.5mm

Part number	Nickname	Title
RTK0EMA430S00020BJ	MCK−RA4T1	Renesas Flexible Motor Control Kit for RA4T1 MCU Group
RTK0EMA330S00020BJ	MCK−RA6T3	Renesas Flexible Motor Control Kit for RA6T3 MCU Group
RTK0EMA430C00000BJ	MCB−RA4T1	Renesas Flexible Motor Control CPU Board for RA4T1 MCU Group
RTK0EMA330C00000BJ	MCB−RA6T3	Renesas Flexible Motor Control CPU Board for RA6T3 MCU Group

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Renesas.com/RA