

V850 platform brochure

Renesas 32-bit Microcontrollers





Renesas' V850 microcontrollers (MCUs) are the world's leading 32-bit RISC architecture with solutions for a wide range of products in the automotive, industrial, office, medical, and consumer markets. The entire V850 family covers more than nine series specific for different applications, with each series having several sub-series to support high-end to low-end system designs. Our ongoing R&D ensures that these popular product lines, consisting of hundreds of devices with different combinations of features, memory and packages, continue to expand and improve. This brochure covers the key families ideally suited to industrial applications.



Low Power, Small Package, Full Scalable Platform, GP, USB and Ethernet



Highest Performance 32-bit MCU Dedicated to Industrial Automation, Drives & Servo motor control



Multiple CAN channels Full Scalable Platform High Temperature grades



High Performance cores, Enhanced analog & Safety, 3-phase motor control



Innovative V850ES MCUs Provide Increased Power Efficiency for Portable Applications

Renesas' V850 microcontrollers (MCUs) are the world's leading 32-bit solutions for a wide range of products in the automotive, industrial, office, medical, and consumer markets. The entire V850 family covers more than nine series specific for different applications, with each series having several sub-series to support high-end to low-end system design. Our ongoing R&D ensures that these popular product lines, consisting of hundreds of devices with different combinations of features, memory and packages, continue to expand and improve.

V850ES J Series Combining high-performance processing with low power consumption and small packaging, the V850ES J Series is an ideal MCU platform for creating portable applications.



High performance - Low power - Small packaging

General Purpose	Ultra-low-power General Purpose	USB and Ethernet
V850ES/Jx3 62 DMIPS (v2.1) Max Freq: 32 MHz Voltage: 2.85 - 3.6 V Pins: 100 - 144 Flash: 384 KB - 1024 KB RAM: 32 KB - 60 KB	V850ES/Jx3-L STOP current: 1.5 µA Max Freq: 20 MHz DMIPS (v2.1): 38 Voltage: 2.0 V - 3.6 V Pins: 40 - 128 Flash: 16 KB - 1024 KB RAM: 8 KB - 80 KB	V850ES/Jx3-H 81 DMIPS (v2.1), USB Device Max Freq: 48 MHz Voltage: 2.85V - 3.6V Pins: 40 - 128 Flash: 16 KB - 512 KB RAM: 8 KB - 56 KB
		V850ES/Jx3-U 81 DMIPS (v2.1), USB Device + Host Max Freq: 48 MHz Voltage: 2.85V - 3.6V Pins: 100 - 128 Flash: 384 KB - 512 KB RAM: 48 KB - 56 KB
	V850ES/Jx3-L USB Device Max Freq: 20 MHz DMIPS (v2.1): 38 Voltage: 2.0V - 3.6V Pins: 100 - 128 Flash: 256 KB - 1024 KB RAM: 40 KB - 80 KB	V850ES/Jx3-E 84 DMIPS (v2.1), Eth MAC + USB Device Max Freq: 50 MHz Voltage: 2.85V - 3.6V Pins: 128 - 144 Flash: 256 KB - 512 KB RAM: 76 KB - 128 KB

WQFN (0.5 mm Pitch): 48 pins, 7mm; 40 pins, 6mm

BGA (0.65 mm/0.5 mm Pitch): 121 pins, 8mm; 64 pins, 5mm

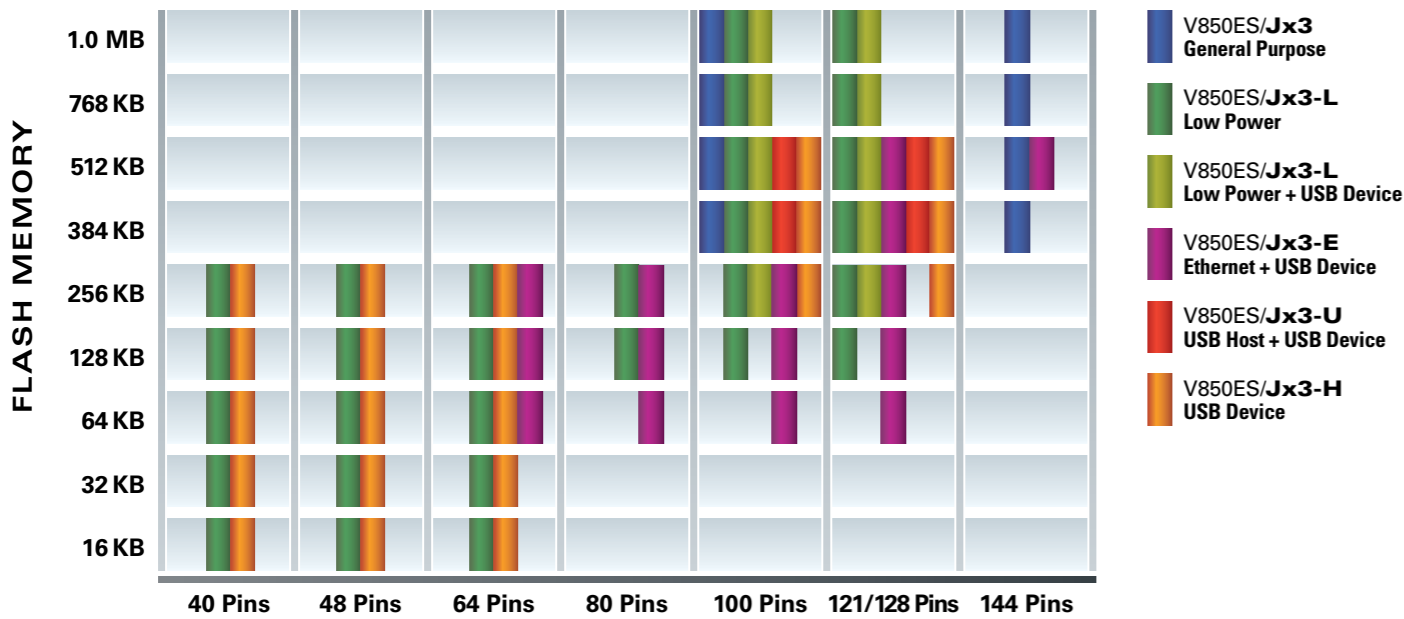
0.75mm

> Some devices available in extremely small sizes

Scalable and flexible V850ES J Series product line

This line of microcontrollers, ranging from 40-pin 16 KB to 144-pin 1 MB, provides optimized solutions for meeting different system requirements and cost structures.

Performance: **38 – 84 DMIPS (v21)**
 Packages: **40 – 144 Pins**
 Flash Memory: **16 k-1 MB**



Extensive Array of Peripherals

The V850ES J Series, including the V850ES/JG3-L featured in the block diagram, was designed with a multitude of peripherals to support your design needs.



Memory	System	Timers	Communications	Clocks	Digital I/O
Flash: 256 KB – 1 MB RAM: 40 KB – 80 KB	2.0 V – 3.6 V -40 to +85°C Low Voltage Indicator Cyclic Redundancy Check Key Interrupt DMA 4-ch, 8/16-bit External Bus 22-bit address 16-bit data On-chip Debug/Programming	16-bit timer (TMP) 2 x cap/comp, PWM 16-bit timer (TMQ) encode, U/D counter 16-bit timer TMM 1 x comp. interval Real-time Counter with own VDD Real-time Port Watch Timer Watch Dog Timer Clock Monitor	CSI up to 5 UART up to 7 I2C up to 3 9-bit UART USB 2.0 Full Speed	Internal OSC 220 kHz Sub-clock 32.768 kHz	5 V tolerant I/O GP I/O pins: 66 – 84 I/O lines

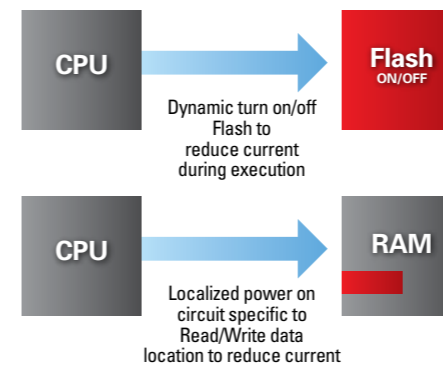
DESIGN FOCUS V850ES/Jx3-L for Portable Applications

Many Renesas customers aim to take advantage of end-users' eagerness for handheld products rather than desktop or portable versions – particularly when the handheld units combine enhanced functionality with increased convenience. To facilitate the design of compact, battery-powered embedded systems, Renesas offers two V850ES/Jx3-L MCU groups, one with USB function and one without it. With their high performance, low power and compact size, the V850ES/Jx3-L MCUs are just the ticket for portable devices.



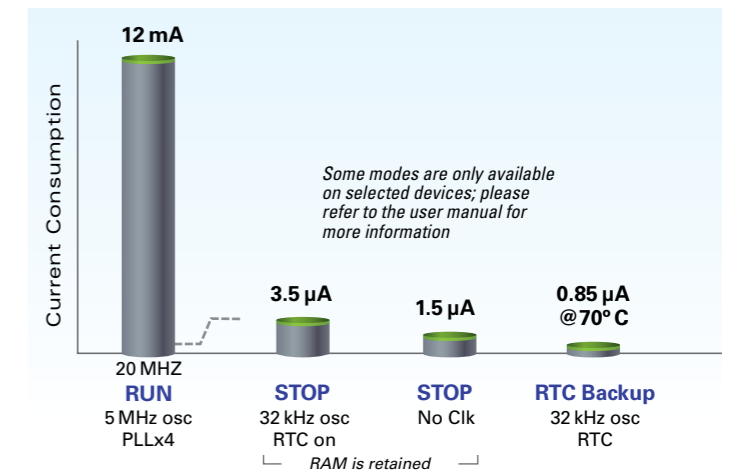
Energy-optimized architecture achieves 300 µA/DMIPS

- Flash is turned off during a non-fetch cycle, such as after fetching two 16-bit instructions in one clock cycle
- RAM is optimized for current consumption for byte, half-word and word accesses



Exceptionally low current consumption

- Low power process technology, combined with energy-optimized architecture, provides exceptionally low current consumption without sacrificing performance



Flexible power-down modes

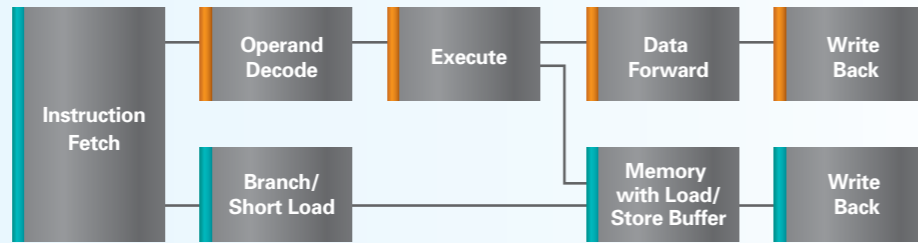
- Most of the low-power modes retain memory and register, enabling a system to maintain its state during power down while operating. A special mode called RTC Backup only maintains real time during "on-the-shelf" time.

Mode	Condition								
	32 kHz Osc	Main Osc	PLL	CPU	Peripherals		Regulator	Flash	RAM/Register
					RTC	Others			
RUN	ON ²	ON	ON ²	ON	ON	ON	ON	ON	Retained
HALT	ON ²	ON	ON ²	STOP	ON	ON	ON	ON	Retained
IDLE 1	ON ²	ON	ON ²	STOP	STOP ¹	STOP ¹	ON	ON	Retained
IDLE 2	ON ²	ON	ON ²	STOP	STOP ¹	STOP ¹	ON	OFF	Retained
STOP	ON ²	STOP	STOP	STOP	STOP ¹	STOP ¹	Low Power	OFF	Retained
RTC Backup (Jx3-L, with 384 KB or up)	ON	STOP	STOP	STOP	ON	STOP	OFF	OFF	Only RTC Registers

1. RTC and some peripherals such as UART can be left on
 2. 32 kHz oscillator can be switched on/off

Enhanced 32-bit Architecture Delivering 1.9 DMIPS/MHz (v2.1)

- > Enhanced branch/short load pipe stage reduces latency
- > Load/store buffer with data forward stage reduces pipeline stalls
- > Performance-oriented instructions
 - Saturated arithmetic operation
 - Single-cycle shift operation
 - Single-cycle bit manipulation operation
 - Single-cycle byte swap accelerate processing



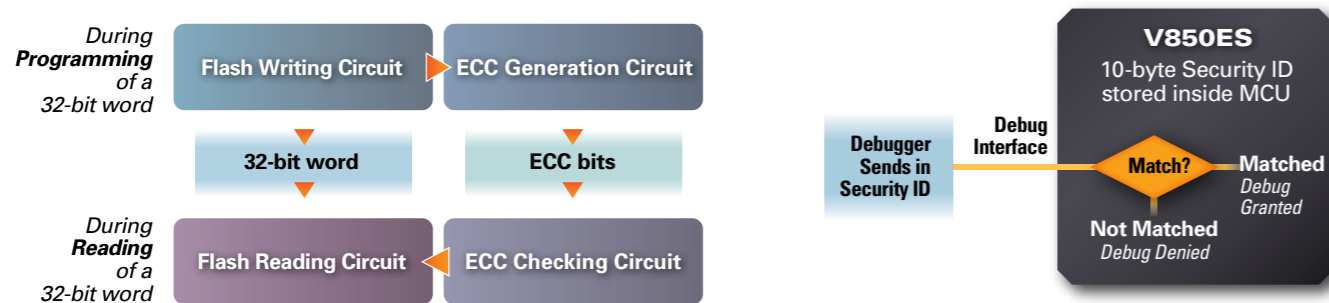
High Reliability Flash with Safety Functions

Highly reliable on-chip Flash

- > Up to 1 MB Flash to support increasingly sophisticated software
- > Deploying the same high-quality Flash technology used in our automotive microcontrollers
- > Transparent ECC automatically corrects 1-bit error without degrading performance

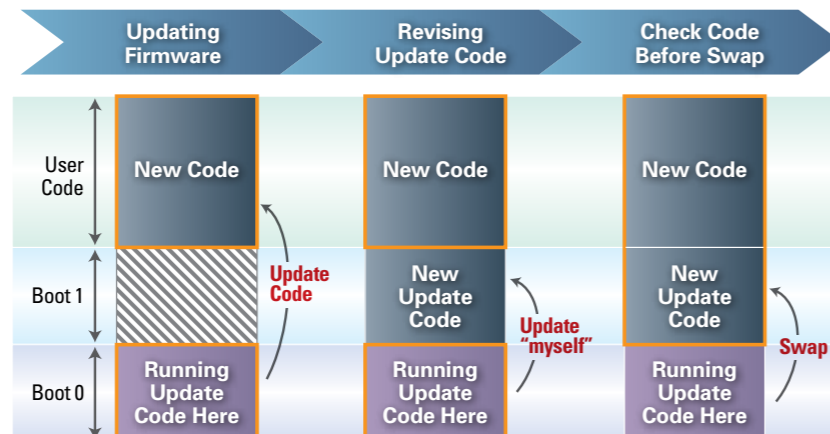
Authenticated Debug and Flash Security protect Software IP

- > Built-in debug security to authenticate debugging session
- > Additional Flash Security to prohibit READ, WRITE and/or ERASE



Fail-safe Firmware update with Boot Swap

- > Power failure during firmware update could cause unrecoverable system failure
- > User can configure Flash for two-boot area
- > Update code is not overwritten during firmware update
- > After checking code, proceed with swap. MCU will see new boot code



Tools that make product R&D go quickly and smoothly

V850ES/Jx3-L Low Power Demonstrator

Test out the low-power capabilities of the V850ES/Jx3-L. Provides support for current measurement during various operation modes. A PC GUI SW controls the different operations and graphs out data from an on-board temperature and humidity sensor.



Renesas Starter Kits

Renesas Starter Kits provide a convenient way to evaluate the V850ES microcontroller. It is bundled with a MiniCube2 and packaged with an evaluation version of CubeSuite and sample software.

- Order code: EB-V850ES/JG3L-EE
- Order code: V850ES-H-PLUGIT
- Order code: V850ES-U-PLUGIT
- Order code: V850ES-NETWORKIT



MiniCube2 Target boards

QB-V850ESJG3L-TB



QB-V850ESJG3U-TB*



(*supports Jx3-U, Jx3-H)

QB-V850ESJJ3-TB



MiniCube2 Debugger

Ultra low cost; requires no dedicated pins because it shares the debug interface with a serial port. This debugging method requires a small software monitor code.



QB-MINI2-EE

MiniCube Debugger

Non-invasive debugging; uses dedicated pin to debug the microcontroller. Does not require any software monitor code.



QB-V850MINIL-EE

IE Cube In-Circuit Emulator

IE Cube is a sophisticated, full function in-circuit emulator with real-time trace and other advanced functions that are required in real-time debugging.



QB-V850ESJX3L-ZZZ-EE
QB-V850ESJX3H-ZZZ-EE*
(*supports Jx3-U)
QB-V850ESJX3E-ZZZ-EE
QB-V850ESSX2-ZZZ-EE**
(**supports Jx3-E)

PG-FP5 Flash Programmer

Supports programming without a PC, stores several binary files, and can program multiple devices simultaneously.



PG-FP5

Direct third-party support for V850ES J Series MCUs

The V850ES ecosystem includes many products and services from third-party vendors, complementing the system development tools Renesas provides. This ecosystem also encompasses long-term support programs.

RTOS and Middleware

Micrium

µC/OS-II
www.micrium.com



embOS RTOS
www.segger.com



freeRTOS is available at
www.freertos.org



RTX RTOS support
www.cmx.com

Integrated Development Environment



e2studio Integrated Development Environment based on Eclipse. Includes free of charge V850 GNU compiler.

Integrated Development Environment



IDE with optimizing C/C++ compiler and C-Spy debugging from IAR Systems
www.iar.com/ewV850

V850ES J Series

Device		Memory		Interfaces		Timers & Other Peripherals										Miscellaneous Information				
Nickname	Part Number	RAM [Byte]	Size [KB]	I/O /Pins	CSIs/UARTs (LIN) /I ² C	USB	CAN	Ethernet	Timer Channels (8-bit/16-bit)	Special Timers	PWMs	Clock Speed [MHz]	Internal Oscillator(s)	Analog Features	DMA	Supply Voltage [V]	Packages	Qualification	Others Features*	Starter Kit
V850ES/JG3	μPD70F3739	384	32K	84 / 100	5/3 (3)/3	-	-	-	-/8	-	9	32	220 kHz	-	4 ch	2.8 - 3.6	GC-UEU-AX (LOFP)	STD	LVI, MUL, DIV	-
	μPD70F3740	512	40K	84 / 100	5/3 (3)/3	-	-	-	-/8	-	9	32	220 kHz	-	4 ch	2.8 - 3.6	GC-UEU-AX (LOFP)	STD	LVI, MUL, DIV	-
	μPD70F3741	768	60K	128 / 144	6/4 (4)/3	-	-	-	-/11	-	10	32	220 kHz	-	4 ch	2.8 - 3.6	GJ-GAE-AX (LOFP)	STD	LVI, MUL, DIV	-
	μPD70F3742	1024	80K	128 / 144	6/4 (4)/3	-	-	-	-/11	-	10	32	220 kHz	-	4 ch	2.8 - 3.6	GJ-GAE-AX (LOFP)	STD	LVI, MUL, DIV	-
V850ES/JJ3	μPD70F3743	384	32K	27 / 40	2/2 (2)/2	-	-	-	-/8	-	8	20	220 kHz	-	4 ch	2.2 - 3.6	K8-4B4-AX (WQFN)	STD	LVI, RTO, Key return, CRC, Clock monitor	-
	μPD70F3744	512	40K	27 / 40	2/2 (2)/2	-	-	-	-/8	-	8	20	220 kHz	-	4 ch	2.2 - 3.6	K8-4B4-AX (WQFN)	STD	LVI, RTO, Key return, CRC, Clock monitor	-
	μPD70F3745	768	60K	34 / 48	4/3 (3)/3	-	-	-	-/8	-	9	20	220 kHz	-	4 ch	2.2 - 3.6	GA-GAM-AX (LOFP), K8-5B4-AX (WQFN)	STD	LVI, RTO, Key return, CRC, Clock monitor	-
	μPD70F3746	1024	80K	34 / 48	4/3 (3)/3	-	-	-	-/8	-	9	20	220 kHz	-	4 ch	2.2 - 3.6	GA-GAM-AX (LOFP), K8-5B4-AX (WQFN)	STD	LVI, RTO, Key return, CRC, Clock monitor	-
V850ES/JC3-L	μPD70F3747	16	16K	66 / 80	3/3 (3)/2	-	-	-	-/6	-	7	20	220 kHz	-	4 ch	2.2 - 3.6	GC-GAD-AX (LOFP), GK-GAK-AX (LOFP)	STD	LVI, MUL, DIV	-
	μPD70F3748	32	32K	66 / 80	3/3 (3)/2	-	-	-	-/6	-	7	20	220 kHz	-	4 ch	2.2 - 3.6	GC-GAD-AX (LOFP), GK-GAK-AX (LOFP)	STD	LVI, MUL, DIV	-
	μPD70F3749	64	64K	84 / 100	5/3 (3)/3	-	-	-	-/8	-	9	20	220 kHz	-	4 ch	2.2 - 3.6	GC-UEU-AX (LOFP), GC-GAS-AX (LOFP), FI-CAH-X (FBGA), FI-CAH-A (FBGA), GC-UEU-AX (LOFP), GC-GAS-AX (LOFP)	STD	LVI, RTO, Key return, CRC, Clock monitor	-
	μPD70F3750	128	128K	84 / 100	5/3 (3)/3	-	-	-	-/8	-	9	20	220 kHz	-	4 ch	2.2 - 3.6	GC-UEU-AX (LOFP), GC-GAS-AX (LOFP), FI-CAH-X (FBGA), FI-CAH-A (FBGA), GC-UEU-AX (LOFP), GC-GAS-AX (LOFP)	STD	LVI, RTO, Key return, CRC, Clock monitor	-
V850ES/JG3-E	μPD70F3751	128	8K	29 / 64	3/3 (3)/2	-	-	-	-/10	-	6	50	220 kHz	-	4 ch	2.85 - 3.6	GB-5AH-AX (LOFP), KB-6B4-AX (WQFN), FI-CAH-A (FBGA), GC-UEU-AX (LOFP)	STD	LVI, RTO, Key return, CRC, Clock monitor	-
	μPD70F3752	256	16K	29 / 64	3/3 (3)/2	-	-	-	-/10	-	6	50	220 kHz	-	4 ch	2.85 - 3.6	GB-5AH-AX (LOFP), KB-6B4-AX (WQFN), FI-CAH-A (FBGA), GC-UEU-AX (LOFP)	STD	LVI, RTO, Key return, CRC, Clock monitor	-
	μPD70F3753	512	32K	41 / 80	5/4 (4)/3	-	-	-	-/10	-	13	50	220 kHz	-	4 ch	2.85 - 3.6	GB-5AH-AX (LOFP), KB-6B4-AX (WQFN), FI-CAH-A (FBGA), GC-UEU-AX (LOFP)	STD	LVI, RTO, Key return, CRC, Clock monitor	-
	μPD70F3754	1024	64K	41 / 80	5/4 (4)/3	-	-	-	-/10	-	13	50	220 kHz	-	4 ch	2.85 - 3.6	GB-5AH-AX (LOFP), KB-6B4-AX (WQFN), FI-CAH-A (FBGA), GC-UEU-AX (LOFP)	STD	LVI, RTO, Key return, CRC, Clock monitor	-
V850ES/JH3-E	μPD70F3755	128	48K	64 / 100, 64 / 121	5/4 (4)/3	-	-	-	-/10	-	14	50	220 kHz	-	4 ch	2.85 - 3.6	GC-UEU-AX (LOFP), FI-CAH-A (FBGA)	STD	LVI, RTO, Key return, CRC, Clock monitor	-
	μPD70F3756	256	96K	64 / 100, 64 / 121	5/4 (4)/3	-	-	-	-/10	-	14	50	220 kHz	-	4 ch	2.85 - 3.6	GC-UEU-AX (LOFP), FI-CAH-A (FBGA)	STD	LVI, RTO, Key return, CRC, Clock monitor	-
	μPD70F3757	512	192K	84 / 126	8/7 (3)/4	-	-	-	-/8	-	13	50	220 kHz	-	4 ch	2.85 - 3.6	GF-GAT-AX (LOFP)	STD	LVI, RTO, Key return, CRC, Clock monitor	-
	μPD70F3758	1024	384K	84 / 126	8/7 (3)/4	-	-	-	-/8	-	13	50	220 kHz	-	4 ch	2.85 - 3.6	GF-GAT-AX (LOFP)	STD	LVI, RTO, Key return, CRC, Clock monitor	-
V850ES/JJ3-E	μPD70F3759	512	124K	100 / 144	10/9 (4)/5	-	-	-	-/8	-	-	50	220 kHz	-	4 ch	2.85 - 3.6	GJ-GAE-AX (LOFP)	STD	LVI, RTO, Key return, CRC, Clock monitor	-
	μPD70F3760	1024	248K	100 / 144	10/9 (4)/5	-	-	-	-/8	-	-	50	220 kHz	-	4 ch	2.85 - 3.6	GJ-GAE-AX (LOFP)	STD	LVI, RTO, Key return, CRC, Clock monitor	-
	μPD70F3761	16	16K	25 / 40	4/3 (3)/1	-	-	-	-/10	-	4	48	220 kHz	-	4 ch	2.85 - 3.6	K8-4B4-AX (WQFN)	STD	LVI, RTO, Key return, CRC, Clock monitor	-
	μPD70F3762	32	32K	25 / 40	4/3 (3)/1	-	-	-	-/10	-	4	48	220 kHz	-	4 ch	2.85 - 3.6	K8-4B4-AX (WQFN)	STD	LVI, RTO, Key return, CRC, Clock monitor	-
V850ES/JC3-H	μPD70F3763	16	16K	32 / 48	4/4 (4)/2	-	-	-	-/10	-	6	48	220 kHz	-	4 ch	2.85 - 3.6	GA-GAM-AX (LOFP), K8-5B4-AX (WQFN)	STD	LVI, RTO, Key return, CRC, Clock monitor	-
	μPD70F3764	32	32K	32 / 48	4/4 (4)/2	-	-	-	-/10	-	6	48	220 kHz	-	4 ch	2.85 - 3.6	GA-GAM-AX (LOFP), K8-5B4-AX (WQFN)	STD	LVI, RTO, Key return, CRC, Clock monitor	-
	μPD70F3765	64	64K	45 / 64	4/4 (4)/2	-	-	-	-/10	-	12	48	220 kHz	-	4 ch	2.85 - 3.6	GB-GAH-AX (LOFP), K8-6B4-AX (WQFN), FI-BA3-A (FBGA)	STD	LVI, RTO, Key return, CRC, Clock monitor	-
	μPD70F3766	128	128K	45 / 64	4/4 (4)/2	-	-	-	-/10	-	12	48	220 kHz	-	4 ch	2.85 - 3.6	GB-GAH-AX (LOFP), K8-6B4-AX (WQFN), FI-BA3-A (FBGA)	STD	LVI, RTO, Key return, CRC, Clock monitor	-
V850ES/JH3-H	μPD70F3767	256	256K	77 / 100	5/5/3	-	-	-	-/13	-	15	48	220 kHz	-	4 ch	2.85 - 3.6	GC-UEU-AX (LOFP)	STD	RTC, LVI, MUL, RTP, CRC	-
	μPD70F3768	512	512K	77 / 100	5/5/3	-	-	-	-/13	-	15	48	220 kHz	-	4 ch	2.85 - 3.6	GC-UEU-AX (LOFP)	STD	RTC, LVI, MUL, RTP, CRC	-
	μPD70F3769	1024	1024K	77 / 100	5/5/3	-	-	-	-/13	-	15	48	220 kHz	-	4 ch	2.85 - 3.6	GC-UEU-AX (LOFP)	STD	RTC, LVI, MUL, RTP, CRC	-
	μPD70F3770	2048	2048K	77 / 100	5/5/3	-	-	-	-/13	-	15	48	220 kHz	-	4 ch	2.85 - 3.6	GC-UEU-AX (LOFP)	STD	RTC, LVI, MUL, RTP, CRC	-
V850ES/JG3-U	μPD70F3771	256	256K	78 / 128	5/5/3	-	-	-	-/13	-	15	48	220 kHz	-	4 ch	2.85 - 3.6	GF-GAT-AX (LOFP)	STD	RTC, LVI, MUL, RTP, CRC	-
	μPD70F3772	512	512K	78 / 128	5/5/3	-	-	-	-/13	-	15	48	220 kHz	-	4 ch	2.85 - 3.6	GF-GAT-AX (LOFP)	STD	RTC, LVI, MUL, RTP, CRC	-
	μPD70F3773	1024	1024K	78 / 128	5/5/3	-	-	-	-/13	-	15	48	220 kHz	-	4 ch	2.85 - 3.6	GF-GAT-AX (LOFP)	STD	RTC, LVI, MUL, RTP, CRC	-
	μPD70F3774	2048	2048K	78 / 128	5/5/3	-	-	-	-/13	-	15	48	220 kHz	-	4 ch	2.85 - 3.6	GF-GAT-AX (LOFP)	STD	RTC, LVI, MUL, RTP, CRC	-

V850ES (32-bit) J Series



Innovative V850E2 MCUs

Provide World's Highest Performance & Safety Features for Industrial Inverter applications

V850E2 Mx4 Series Combining high-performance single & dual core processing with low power consumption, the V850E2 Mx4 Series is an ideal MCU platform for high-end inverter solutions for Industrial & Building Automation applications.

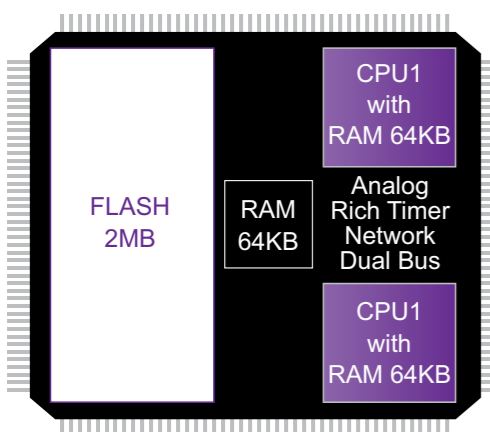
The V850E2/Mx4 is a 32-bit single-chip microcontroller that integrates up to two V850E2 32-bit RISC CPU cores. The V850E2/Mx4 includes flash memory, RAM, and a large array of peripheral functions and is used to perform DSP calculations, large-capacity data-processing and advanced real-time control.

The V850E2 CPU improves the CPU processing performance through optimisation of the two-way superscalar seven-stage pipeline control. A floating point unit (FPU) that conforms to IEEE754-1985 is also included.

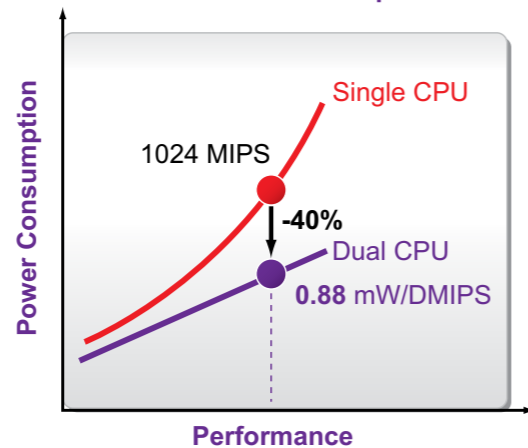
Key features

- > Single & Dual core devices
- > Single & Double precision Floating Point Unit (FPU)
- > 512 MIPS @ 200MHz per core
- > Large Memory (1MB, 2MB Flash)
- > 3-phase Motor control functionality
- > Enhanced analog (12-bit ADC)
- > Ethernet, CAN, USB Host & Function
- > Dual external memory interfaces
- > System Protection Functions (SPR)

High Performance Dual Core

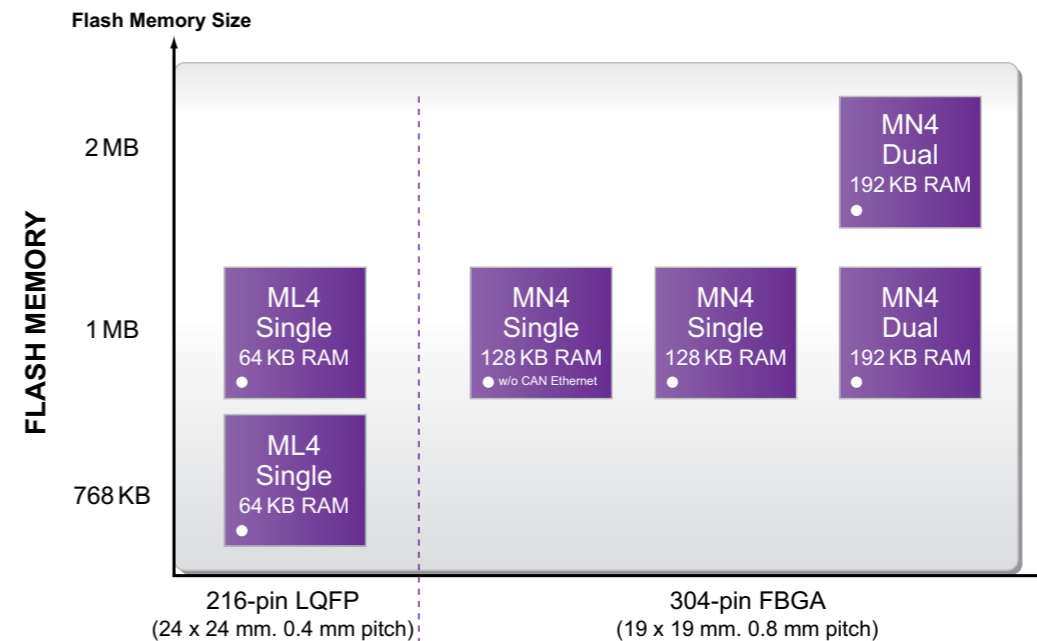


Low Power Consumption



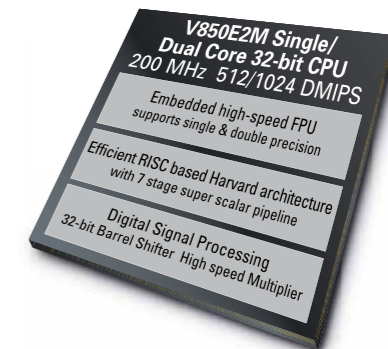
Mx4 Line-up

This line of microcontrollers, ranging from single core 216-pin 768KB to dual core 304-pin 2MB Flash, provides optimum solutions for meeting different system requirements and cost structures.



Mx4 Block diagram

The V850E2/Mx4 includes peripheral functions such as a DMA controller, timer array, UART, CSI, CAN, A/D converter, USB function controller, USB host controller, Ethernet controller, on-chip debugger, and two memory controllers. Due to the high level of peripheral integration, the cost, number of components, and mounting area can be reduced.



Memory
Flash: 768 KB – 2 MB
RAM: 64 KB – 192 KB
H bus shared memory: 64 KB

System
3.0 V to 3.6 V
Low Voltage Indicator
Power on Clear
HW multiplier 32x32-64
HW divider 32/32-32, remn32
16 ch x DMA
PMEM (SRAM/SDRAM) X 16/32-bit
sMEM (SRAM/SDRAM) X 16/32-bit
On-chip debug interface

Timers
64 ch x 16-bit timer
69 ch x Interval timer
4 ch x 1 unit 32-bit Timer Array
16 ch x 4 unit 16-bit Timer Array
2 ch x Watchdog timer
60 ch x PWM (>8-bit res)

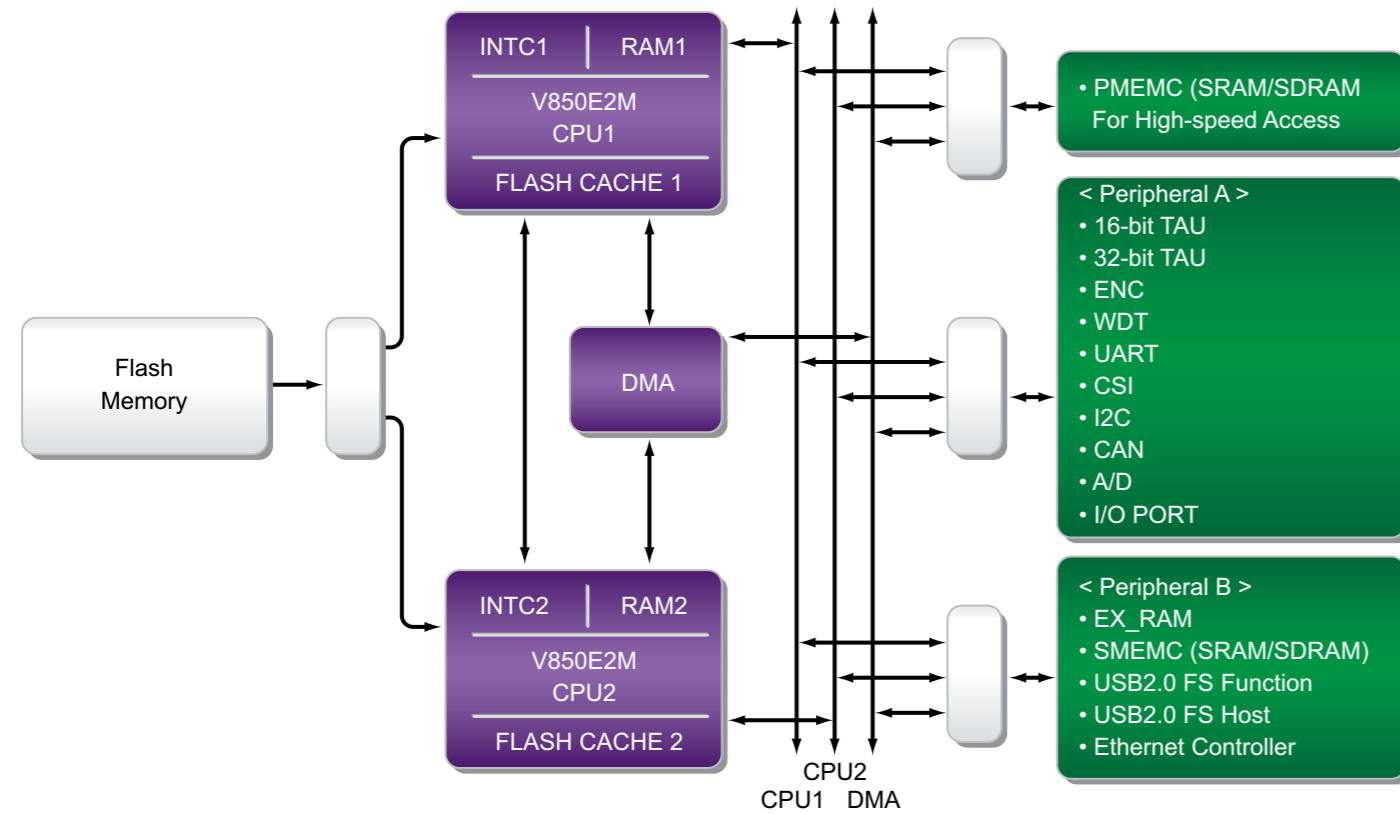
Digital I/O
5V tolerant I/O
188 GP I/O pins:
Analog
12 ch x 12-bit ADC

Communications
10 ch x CSI
10 ch x UART
2 ch x FCAN
6 ch x I ² C
1 ch x USB Function
1 ch x USB Host
1 ch x Ethernet

Clocks
Internal Oscillators
240 kHz, 8 MHz
Sub-clock
32.768 kHz

Mx4 Performance

The internal system bus that connects each CPU and DMA controller to the peripheral functions has multiple layers. The bus has a total of three layers: one layer for each CPU, and one layer for the DMA controller. The multilayer internal system bus reduces the overhead due to bus arbitration, achieving high-speed real-time operation.

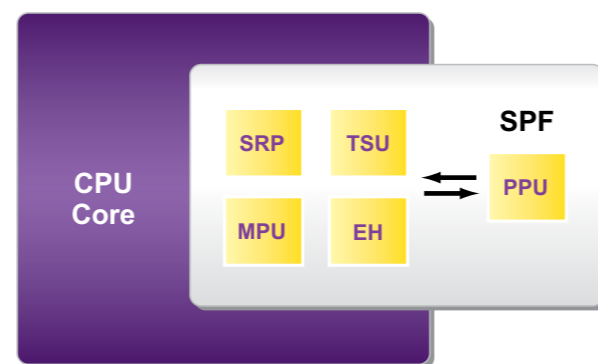


Mx4 Safety

V850E2/Mx4 V850E2/Mx4 has resource protection for illegal access and timing supervision functions.

System Protection Functions (SPF):

- > Protect MCU resources:
 - » Memory
Memory Protection Unit (MPU)
 - » Peripheral registers
Peripheral Protection Unit (PPU)
 - » System registers
System Register Protection (SRP)
 - » Execution time of CPU
Timing Supervision Unit (TSU)
- > Remove interference between application programs to:
 - » improve system stability, simplify debugging
 - » permits independent module development



Mx4 Motor Control

The timer option function (TAPA), timer array unit A (TAUA), and/or peripheral interconnection (PIC) can be used as an inverter function that controls a 3 phase brushless motor.

> Asynchronous Hi-Z control functions

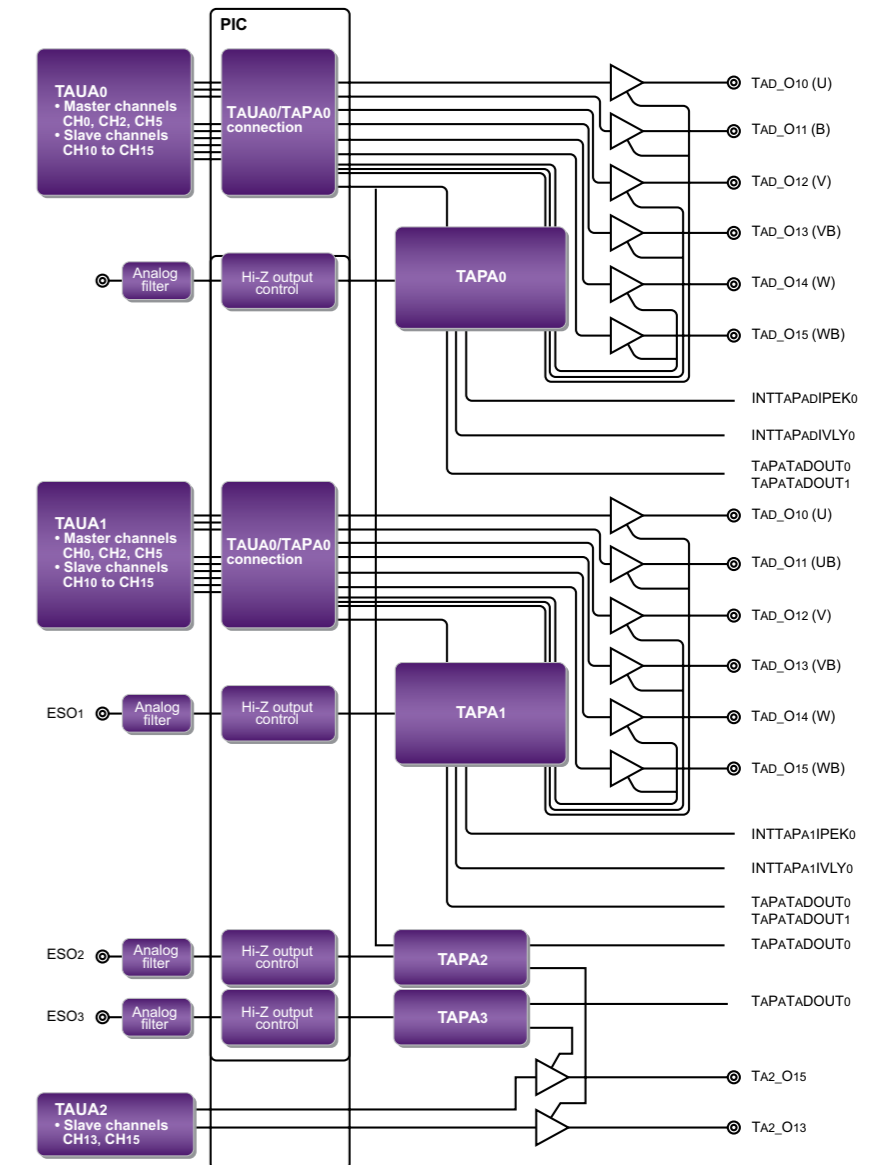
Timer output for motor control can be forcibly stopped by asynchronously setting its level to high-impedance.

> INT signal output selection function

Two types of interrupts, peak interrupts and valley interrupts, can be output based on the INTn signal output by the TAUA

> A/D conversion trigger selection function

Two A/D conversion trigger signals can be output based on the INTn signal output by the TAUA.



Mx4 Connectivity

Ethernet controller

The Ethernet controller includes a 10/100 Mbps Ethernet Media Access Controller (MAC) conforming to IEEE802.3, a FIFO controller for flow control, and a checksum calculation unit (only for received packets) conforming to RFC1071.

USB Function & USB Host controllers

This microcontroller has an internal USB function controller (USBF) and USB host controller (USBH) conforming to the Universal Serial Bus Specification. Data communication using the polling method is performed between the USB function controller and external host device by using a token-based protocol.

CAN controller

The product features 2 channels of on-chip CAN (Controller Area Network) controllers that comply with the CAN protocol as standardized in ISO 11898.

V850E2/Mx4 Series

	Miscellaneous Information	
	Starter Kit	-
	Others Features*	Single / Dual cores
Timers & Other Peripherals	Qualification	STD
	Packages	F1-HN6-A (FBGA)
	Supply Voltage [V]	1.2 - 3.3
	DMA	16 ch
	Analog Features	-
	A/D / D/A-Converter	12ch x 12-bit / -
	TFT control	-
	Subclock 32.768 kHz	-
	Internal Oscillator(s)	-
	Clock Speed [MHz]	200
Interfaces	PWMs	-
	Special Timers	16-bit : 16 ch x 4 unit 32bit : 4 ch x 1 unit ENC timer : 2 ch
	Timer Channels (8-bit/16-bit)	-
	Ethernet	- / ✓
	USB	✓
Memory	CAN	2
	CSIs/UARTs (LIN) / I ² C	10 / 10 / 6
	I/O / Pins	188 / 304
	RAM [Byte]	64 K
Device	Size [KB]	1000
	Part Number	μPD70F3510 μPD70F3512 μPD70F3514 μPD70F3515 μPD70F4021 μPD70F4022
Nickname	V850E2/MN4	
Core	V850E2M (32-bit) M_Series	

V850E2/Mx4 Hardware development tools

RTE-V850E2MN4-EB (Midas-Lab)

Features

- > Hi Functional
- > Embedded with MN4 (Single or Dual)
- > On board Memory: SRAM, SDRAM
- > Connectors: UART connector, CAN, analog input port, USB Function and Host, Ethernet.



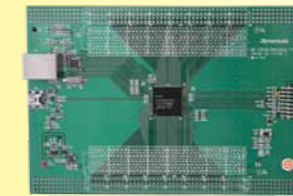
E1 emulator or Minicube



QB-V850E2MN4-TB (Renesas)

Features

- > Low Price
- > Embedded with V850E2/MN4 (Dual)
- > On board Memory: Nothing
- > Connectors: USB Function, Ethernet.
- > Widely universal area (2.54 mm pitch)



Midas RTE-2000H-TP emulator



V850E2/Mx4 Software development tools



e2studio Integrated Development Environment based on Eclipse. Includes free of charge V850 GNU compiler.



MULTI IDE combines a powerful debugger, editor, code browser, configuration manager and uses Green Hills software's optimizing C, C++ compilers



IAR Embedded workbench is an integrated development environment and optimized C++ compiler, with emulator debug support, instruction set simulator & run time libraries



uC/OS-II is a portable, scalable, preemptive, real-time deterministic multitasking kernel for microcontrollers



embOS is a priority controlled real time operating system, designed to be used as foundation for the development of embedded real time applications



CoDeSys 3S-Smart Software Solutions GmbH is the leading IEC 61131-3 development system for programming and creating controller applications



Innovative V850E2 MCUs Provide Increased Performance & Safety Features for CAN applications

V850E2 Fx4 Series: Combining high-performance processing & low power consumption with multiple CAN communication channels, the V850E2 Fx4 Series is an ideal MCU platform for Industrial CAN applications.

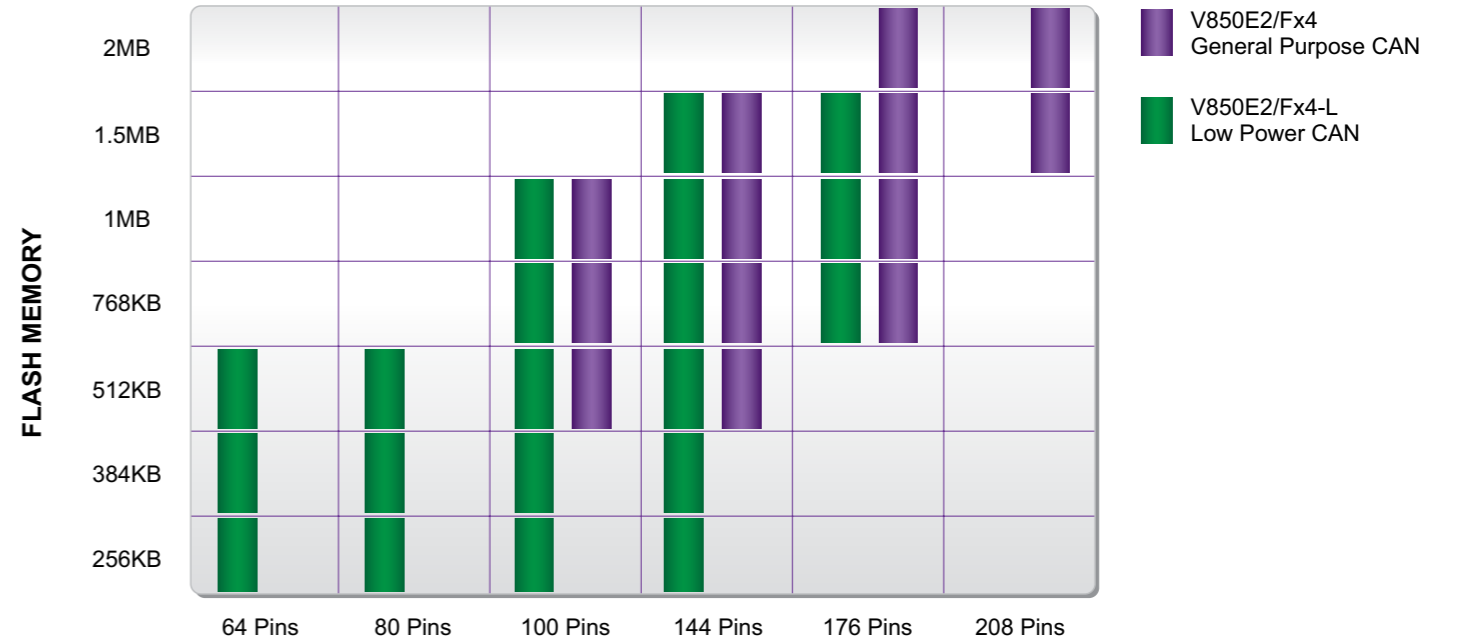
- > Improved features
 - » CPU clock to 80MHz
 - » Flash memory to 2 Mbytes
 - » ADC accuracy up to 12-bit
- > Expanded timer structure
- > New peripherals
 - » FlexRay
 - » MOST
 - » PWM generation / diagnosis
 - » Voltage comparator with hysteresis
 - » LIN master
- > New system protection functionality
 - » Memory protection unit (MPU)
 - » Peripheral register protection unit (PPU)
 - » System register protection (SRP)
 - » CPU execution controlled by timing supervision unit (TSU)
- > High temperature options
 - » A = -40°C to +85°C
 - » A1 = -40°C to +110°C
 - » A2 = -40°C to +125°C



Fx4, Fx4-L line-up

This line of microcontrollers, ranging from 64-pin 256KB to 208-pin 2MB, provides optimised solutions for meeting different system requirements and cost structures.

Performance: 64 MHz - 80 MHz
Packages: 64 - 208 pins
Flash Memory: 256 KB - 2 MB



Extensive Array of Peripherals

The V850 Fx4 Series, including the V850E2/FG4 featured in the block diagram, was designed with multiple CAN channels and a multitude of peripherals to support your design needs.



Memory
Flash: 256 KB - 1 MB
RAM: 40 KB - 80 KB
Data Flash: 32 KB

System
3.0 V to 5.5 V A = -40°C to +85°C A1 = -40°C to +110°C A2 = -40°C to +125°C
Low Voltage Indicator
Power on Clear
8ch x DMA
System Protective Functions (MPU, PPU, SRP, TSU)
On-chip debug interface

Timers
32ch x 16-bit timer
8ch x 32-bit timer
1ch x Watchdog timer
36ch x PWM (>8-bit)
1 x 16ch Timer Array Unit

Communications
3ch x CSI
5ch x UART
5ch x LIN
2ch x FCAN
1ch x I2C
FlexRay

Digital I/O
5V tolerant I/O
72 GP I/O pins:

Clocks
Internal Oscillators 240kHz, 8MHz

Analog
20ch x 12-bit ADC

V850E2/Fx4 Series

Other features	BUR, DMA, POC, SPF		BUR, DMA, POC, SPF		BUR, DMA, POC, SPF		BUR, DMA, POC, SPF		BUR, DMA, POC, SPF		BUR, DMA, POC, SPF		BUR, DMA, POC, SPF		BUR, DMA, POC, SPF		BUR, DMA, POC, SPF		BUR, DMA, POC, SPF		
T _{o, max} [°C]	85, 110, 125		85, 110, 125		85, 110, 125		85, 110, 125		85, 110, 125		85, 110, 125		85, 110, 125		85, 110, 125		85, 110, 125		85, 110, 125		
Packages	GB-GAH-G		GK-GAK-G		GC-UEU-G		GJ-GAE-G		GM-GAR-G		GC-UEU-G		GJ-GBG-G		GM-GBK-G		GD-FAD-G, F1-JN1-A				
Pins	64		80		100		144		176		100		144		176		208, 272				
Supply voltage (I/O) [V]	4.5...5.5		4.5...5.5		4.5...5.5		4.5...5.5		4.5...5.5		3.0...5.5		3.0...5.5		3.0...5.5		3.0...5.5				
A/D converter / D/A converter	12 x 10-bit/-		14 x 10-bit/-		20 x 10-bit/-		24 x 10-bit/-		24 x 10-bit/-		20 x 12-bit/-		24 x 12-bit/-		40 x 12-bit/-		48 x 12-bit/-				
Subclock [32 kHz]	-		-		-		-		-		-		✓		✓		✓				
Internal oscillator(s)	240 kHz & 8 MHz		240 kHz & 8 MHz		240 kHz & 8 MHz		240 kHz & 8 MHz		240 kHz & 8 MHz		240 kHz & 8 MHz		240 kHz & 8 MHz		240 kHz & 8 MHz		240 kHz & 8 MHz				
Clock speed [MHz]	48		48		48, 64		48, 64		64		80		80		80		80				
PWMs	15		18		18		30		31		36		65		68		84				
Timer channels [8-/16-/32-bit]	-/16/4		-/16/4		-/16/4		-/32/4		-/32/4		-/32/8		-/32/8		-/32/8		-/32/8				
Other interfaces	-		-		-		-		-		FlexRay		FlexRay		FlexRay		FlexRay				
External bus I ² C	1		1		1		2		2		2		3		4		5				
CAN	1		1		2		2		2		2		3		4		5				
CSI/UART (LIN)	2/2(2)		2/2(2)		3/3(3)		3/5(5)		4/5(5)		3/5(5)		4/6(6)		5/8(8)		5/12(12)				
I/O lines	43		57		76		116		141		72		112		136		164				
FPU	-		-		-		-		-		-		-		-		-				
Core	V850E2		V850E2		V850E2		V850E2		V850E2		V850E2		V850E2		V850E2		V850E2				
Data flash [B]	32 K		32 K		32 K		32 K		32		32 K		32 K		32 K		32 K				
RAM [B]	24 K	28 K	32 K	24 K	28 K	32 K	24 K	28 K	32 K	24 K	28 K	32 K	24 K	28 K	32 K	24 K	28 K	32 K	24 K	28 K	32 K
Flash size [B]	256 K	384 K	512 K	256 K	384 K	512 K	256 K	384 K	512 K	256 K	384 K	512 K	256 K	384 K	512 K	256 K	384 K	512 K	256 K	384 K	512 K
Part number	μPD70F3570	μPD70F3571	μPD70F3572	μPD70F3573	μPD70F3574	μPD70F3575	μPD70F3576	μPD70F3577	μPD70F3578	μPD70F3579	μPD70F3580	μPD70F3581	μPD70F3582	μPD70F3583	μPD70F3584	μPD70F3585	μPD70F3586	μPD70F3587	μPD70F3588	μPD70F3589	μPD70F3590
Nickname/ Group	V850E2/FE4-L		V850E2/FF4-L		V850E2/FG4-L		V850E2/FJ4-L		V850E2/FK4-L		V850E2/FG4		V850E2/FJ4		V850E2/FK4		V850E2/FL4				

V850E2/Fx4 hardware development tools

IECUBE2

In-circuit emulator (ICE)



E1

On-chip debugging (OCD)



AB-050-Fx4-...

Evaluation boards



PG-FP5

Flash programmer



On-chip debugger (OCD)

In-circuit emulation (ICE) & On-chip debugging (OCD)



V850E2/Fx4 software development tools

Software	Type	Supplier
C/C++ compiler	Package	Greenhills, IAR, e2studio
AUTOSAR	Package	Electrobit, Vector
OSEK	Operating system	Vector
FlexRay	Device configurator	Electrobit, Vector
CAN	Communication software	Vector
LIN	Communication software	Vector
Flash	Bootloader	Electrobit, Vector
Data flash	Library software	Renesas
Self programming	Library software	Renesas

V850ES/Fx3 Series

Device		Memory			Interfaces			Timers & Other Peripherals						Miscellaneous Information							
		Size [KB]	Type	RAM [B]	I/O Lines	CSIs/UARTs (LIN)	CAN	I ² C	External Bus	Timer Channels [8-bit/16-bit]	PWMs	Clock Speed [MHz]	Internal Oscillator(s)	Subclock [32 kHz]	LCD	A/D- / D/A- Converter	Supply Voltage [V]	Pins	Packages	Qualification	Other Features
V850ES/FE3	μPD70F3370 μPD70F3371	128	Flash	8 K	51	2/2 (2)	1	1	-	-7	8	240 kHz, 8 MHz	✓	-	10 x 10-bit/-	3.3 - 5.5	64	6B-GAH-AX	A, A1, A2	DFM, POC, LVI, DMA	✓
		256		16 K																	
V850ES/FF3	μPD70F3372 μPD70F3373	128	Flash	8 K	67	2/2 (2)	1	1	-	-7	8	240 kHz, 8 MHz	✓	-	12 x 10-bit/-	3.3 - 5.5	80	GK-GAK-AX	A, A1, A2	DFM, POC, LVI, DMA	✓
		256		16 K																	
V850ES/FG3	μPD70F3374 μPD70F3375	128	Flash	8 K	84	2/3 (3)	2	1	-	-8	11	240 kHz, 8 MHz	✓	-	16 x 10-bit/-	3.3 - 5.5	100	GC-UJU-AX	A, A1, A2	DFM, POC, LVI, DMA	✓
		256		24 K																	
V850ES/FJ3	μPD70F3376 μPD70F3377	384	Flash	24 K	128	2/5 (5)	4	-	-	-9	14	240 kHz, 8 MHz	✓	-	24 x 10-bit/-	3.3 - 5.5	144	GJ-GAE-AX	A, A1, A2	DFM, POC, LVI, DMA	✓
		512		32 K																	
V850ES/FK3	μPD70F3378 μPD70F3379	256	Flash	16 K	152	3/3 (3)	3	-	✓	-12	17	240 kHz, 8 MHz	✓	-	16 x 10-bit, 24 x 10-bit/-	3.3 - 5.5	176	GM-GAR-AX	A, A1, A2	DFM, POC, LVI, DMA	✓
		384		24 K																	
V850ES/FE3-L	μPD70F3380 μPD70F3381	512	Flash	32 K	51	3/6 (6)	1	1	-	-6	5	240 kHz, 8 MHz	✓	-	10 x 10-bit/-	3.3 - 5.5	64	6B-GAH-AX	A, A1, A2	POC, LVI	✓
		768		40 K																	
V850ES/FE3-L	μPD70F3382 μPD70F3383	1024	Flash	48 K	67	4/6 (6)	4	-	-	-6	5	240 kHz, 8 MHz	✓	-	12 x 10-bit/-	3.3 - 5.5	80	GK-GAK-AX	A, A1, A2	POC, LVI	✓
		512		32 K																	
V850ES/FE3-L	μPD70F3384 μPD70F3385	768	Flash	48 K	84	4/8 (8)	5	1	-	-	5	240 kHz, 8 MHz	✓	-	16 x 10-bit/-	3.3 - 5.5	100	GC-UJU-AX	A, A1, A2	POC, LVI	✓
		1024		60 K																	
V850ES/FE3-L	μPD70F3610 μPD70F3611	64	Flash	6 K	51	2/2 (2)	1	1	-	-	5	240 kHz, 8 MHz	✓	-	10 x 10-bit/-	3.3 - 5.5	64	6B-GAH-AX	A, A1, A2	POC, LVI	✓
		96		8 K																	
V850ES/FE3-L	μPD70F3612 μPD70F3613	128	Flash	8 K	67	2/2 (2)	1	1	-	-	5	240 kHz, 8 MHz	✓	-	12 x 10-bit/-	3.3 - 5.5	80	GK-GAK-AX	A, A1, A2	POC, LVI	✓
		192		12 K																	
V850ES/FE3-L	μPD70F3614 μPD70F3615	256	Flash	16 K	84	2/2 (2)	1	1	-	-	5	240 kHz, 8 MHz	✓	-	16 x 10-bit/-	3.3 - 5.5	100	GC-UJU-AX	A, A1, A2	POC, LVI	✓
		64		6 K																	
V850ES/FE3-L	μPD70F3616 μPD70F3617	96	Flash	6 K	67	2/2 (2)	1	1	-	-	5	240 kHz, 8 MHz	✓	-	12 x 10-bit/-	3.3 - 5.5	80	GK-GAK-AX	A, A1, A2	POC, LVI	✓
		128		8 K																	
V850ES/FE3-L	μPD70F3618 μPD70F3619	192	Flash	12 K	84	2/2 (2)	1	1	-	-	5	240 kHz, 8 MHz	✓	-	16 x 10-bit/-	3.3 - 5.5	100	GC-UJU-AX	A, A1, A2	POC, LVI	✓
		256		16 K																	
V850ES/FE3-L	μPD70F3620 μPD70F3621	128	Flash	8 K	84	2/3 (2)	1	1	-	-	5	240 kHz, 8 MHz	✓	-	16 x 10-bit/-	3.3 - 5.5	100	GC-UJU-AX	A, A1, A2	POC, LVI	✓
		192		12 K																	
V850ES/FE3-L	μPD70F3622	256	Flash	16 K	84	2/3 (2)	1	1	-	-	5	240 kHz, 8 MHz	✓	-	16 x 10-bit/-	3.3 - 5.5	100	GC-UJU-AX	A, A1, A2	POC, LVI	✓
		256		16 K																	



High Performance cores, Enhanced analog & Safety, 3-phase motor control

V850 I Series Combining high-performance processing, powerful 16-bit inverter timers and enhanced analog features with advanced security & safety features, the V850 I Series is an ideal MCU platform for multi 3-phase motor control applications.

Core	Device		Memory		Interfaces					Timers & Other Peripherals										Miscellaneous Information				
	Nickname	Part Number	Size [KB]	RAM [Byte]	I/O / Pins	CSIs/UARTs (LIN) / I ² C	CAN	USB	Ethernet	Timer Channels (8-bit/16-bit)	Special Timers	PWMs	Clock Speed [MHz]	Internal Oscillator(s)	Subclock 32.768 kHz	TFT control	A/D / D/A-Converter	Analog Features	DMA	Supply Voltage [V]	Packages	Qualification	Others Features*	Starter Kit
V850ES (32-bit) I Series	V850ES/IK1	μPD703327	64	4 K	39 / 64	1/2	-	-	-	-/7	Inverter timer (16-bit) x 1	12	32	-	-	-	8 x 10-bit/-	-	-	3.5 - 5.5	GC-8BS-A (LQFP), K8-9B5-AX (WQFN)	STD	POC, MUL	
		μPD703329	128	6 K																				
		μPD70F3329																						
	V850ES/IE2	μPD70F3713	64	7 K	39 / 64	1/2	-	-	-	-/7	Inverter timer (16-bit) x 1	16	20	-	-	-	4 x 10-bit/-	-	-	3.5 - 5.5	GC-8BS-A (LQFP)	STD	POC, MUL	
μPD70F3714		128																						
V850E (32-bit) I Series	V850E/IA3	μPD703183	128	6 K	50 / 80	2/2	-	-	-	-/8	Inverter timer (16-bit) x 1	8	64	-	-	-	12 x 10-bit/-	-	4 ch	3.5 - 5.5	GC-8BT-A (LQFP)	STD	MUL	
		μPD703184	256	12 K																				
	V850E/IF3	μPD70F3451	128	8 K	48 / 80	3/4	-	-	-	-/13	Inverter timer (TMQOP) x 2	64	64	-	-	-	4 x 10-bit, 10 x 12-bit/-	-	4 ch	3.5 - 5.5	GC-UBT-A (LQFP)	STD	POV, LVI, MUL	
		μPD70F3452	256	12 K																				
	V850E/IG3	μPD70F3453	128	8 K	64 / 100	3/4	-	-	-	-/13	Inverter timer (TMQOP) x 3	64	64	-	-	-	8 x 10-bit, 10 x 12-bit/-	-	4 ch	3.5 - 5.5	GC-8EA-A (LQFP), GF-GAS-A (LQFP)	STD	POV, LVI, MUL	
		μPD70F3454	256	12 K																				
	V850E/IA4	μPD703185	128	6 K	64 / 100	2/2	-	-	-	-/9	Inverter timer (16-bit) x 2	18	64	-	-	-	16 x 10-bit/-	-	4 ch	3.5 - 5.5	GC-8EU-A (LQFP), GF-3BA-A (LQFP)	STD	MUL	
		μPD703186	256	12 K																				
		μPD70F3186																						
	V850E/IG4	μPD70F3913	256		67 / 100	3/4(0)	-	-	-	-/13	2 x Motor Control PWM	22	100	-	-	-	1 x 10-bit, 2 x 12-bit/-	6 x Opamp, 12 x Comparator	7 ch	1.35 - 1.65, 4.0 - 5.5	GC-UEU-AX (LQFP), GF-GAS-AX (LQFP)	STD	POC, LVI, MUL	
		μPD70F3914	384	24 K																				
		μPD70F3915	480																					
	V850E/IH4	μPD70F3916	256		80 / 128	3/4(0)	-	-	-	-/13	2 x Motor Control PWM	22	100	-	-	-	1 x 10-bit, 2 x 12-bit/-	6 x Opamp, 12 x Comparator	7 ch	1.35 - 1.65, 4.0 - 5.5	GF-GAT-AX (LQFP)	STD	POC, LVI, MUL	
		μPD70F3917	384	24 K																				
μPD70F3918		480																						
V850E/IG4-H	μPD70F3919	256		63 / 100	3/4(0)	-	✓	-	-/13	2 x Motor Control PWM	22	100	-	-	-	1 x 10-bit, 2 x 12-bit/-	6 x Opamp, 12 x Comparator	7 ch	1.35 - 1.65, 4.0 - 5.5	GC-UEU-AX (LQFP)	STD	POC, LVI, MUL		
	μPD70F3920	384	24 K																					
	μPD70F3921	480																						
V850E/IH4-H	μPD70F3922	256		80 / 128	3/4(0)	-	✓	-	-/13	2 x Motor Control PWM	22	100	-	-	-	1 x 10-bit, 2 x 12-bit/-	6 x Opamp, 12 x Comparator	7 ch	1.35 - 1.65, 4.0 - 5.5	GF-GAT-AX (LQFP)	STD	POC, LVI, MUL		
	μPD70F3923	384	24 K																					
	μPD70F3924	480																						



The Renesas Ecosystem



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RENESAS

