

32-bit RISC microcontroller for high-performance inverter control systems

The V850ES/IE2 is a 32-bit RISC (Reduced Instruction Set Computer) microcontroller for high-performance inverter control systems. The controller is equipped with a 3-phase PWM timer (inverter timer) with dead time for motor. Performance enhancement, down-sizing, and cost reduction of the system can be achieved with the on-chip software pull-up resistor, POC/LVI as well as high-speed CPU of 20 MHz, a multi-function timer, high-speed A/D converter, and a high-speed serial interface. A full-function in-circuit emulator of 20 MHz with a motor-system dedicated debugging function is also made available to ensure safety.

Our product lineup includes the V850ES/IK1, V850E/IA3, and V850E/IA4 that were developed by improving the CPU operation frequencies to 32 MHz and 64 MHz, and by adding and improving timers as well as A/D converters, compared to the V850ES/IE2. They can therefore handle a variety of system development applications.

- **Improves high performance at 20 MHz/26 MIPS**

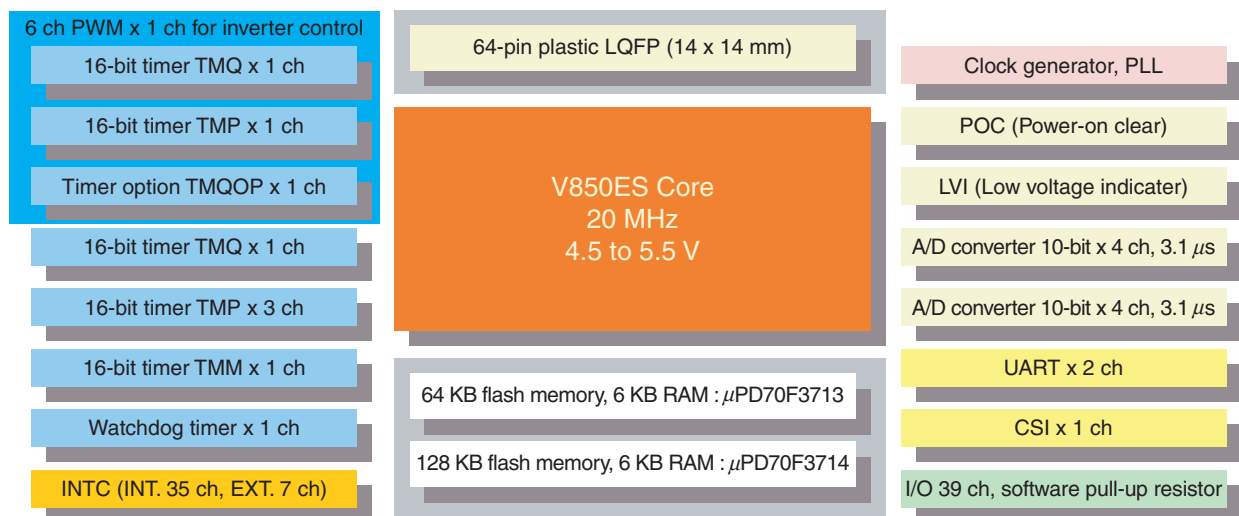
The V850ES core improves high-speed processing at 26 MIPS^{Note} under 20 MHz operation, assisting the performance enhancement of system functions and introduction of multifunction by software. This microcontroller that is capable of an interrupt response time of 200 ns (at 20 MHz operation) is most suitable for high-speed high-precision inverter control systems.

Note Based on Dhystone benchmark 1.1

- **On-chip multifunction inverter timer**

The inverter timer (TMQ+TMQOP) has a total of four on-chip compare registers for 16-bit counter and a carrier, and duty. Data can be written to all of the four registers simultaneously, preventing mismatch of output waveforms. Data can be written to each compare register as required through setting operation. An A/D converter trigger can be generated at any timing through synchronous operation of the 16-bit timer/event counter (TMP) and TMQ for shunt control.

- **Outline of the Specification**



The information in this document is subject to change without notice. Before using this document, please confirm that this is the latest version.

Not all products and/or types are available in every country. Please check with an NEC Electronics sales representative for availability and additional information.

- **On-chip two circuits of high-speed A/D converters handling shunt control**

The V850ES/IE2, which is equipped with two circuits of 10-bit resolution high-speed conversion A/D converter of 3.1 μ s under 20 MHz operation, can measure two power device driving current systems. A conversion trigger can be selected from three factors, an external trigger from a pin, software setting, and an inverter timer. The A/D conversion trigger from the inverter timer can be set at any two points synchronized with the inverter timer. The V850ES/IE2 can perform shunt control through motor driving current measurement performed by the functions of the two on-chip A/D converter circuits.

- **POC/LVI and software pull-up resistor function**

POC (power-on clear)/LVI (low voltage indicator) is a function equivalent to a reset IC and a low-voltage detection circuit. The V850ES/IE2 is also equipped with a software pull-up resistor function where connection of only the pin that is set to the input mode excluding the A/D converter and the output high impedance pin is effective. These built-in functions are useful for downsizing and cost reduction of the system.

- **Various functions for enhancing the system safety**

Absolute safety is required for the system that controls motors through an inverter since the system handles generation and control of high voltages using a power device. High impedance operation of the inverter timer output pin can be selected from each function of an external interrupt pin input, software setting, watchdog timer overflow, and clock monitor. The clock monitor function monitors the stopping of main clock oscillation through the on-chip CR oscillation circuit.

- **Other on-chip functions**

PLL: Mounts an 8 times multiplication PLL function
 UART: Maximum transfer rate of 1.25 Mbps. The digital 2-point sampling function performed at receive operation prevents noise receive operation
 CSI: Maximum transfer rate of 5 Mbps. Settable of an 8-16 bit length in bit units as the transfer bit length. Possible of continuous transfer

- **The difference between ROM, RAM and package in V850ES/IE2, V850ES/IK1, V850E/IA3 and V850E/IA4**

V850ES/IE2	μ PD70F3713:	flash memory	64 KB,	RAM	6 KB,	64-pin LQFP
	μ PD70F3714:	flash memory	128 KB,	RAM	6 KB,	64-pin LQFP
V850ES/IK1	μ PD703327:	mask ROM	64 KB,	RAM	4 KB,	64-pin LQFP
	μ PD703329:	mask ROM	128 KB,	RAM	6 KB,	64-pin LQFP
	μ PD70F3329:	flash memory	128 KB,	RAM	6 KB,	64-pin LQFP
V850E/IA3	μ PD703183:	mask ROM	128 KB,	RAM	6 KB,	80-pin QFP
	μ PD70F3184:	flash memory	256 KB,	RAM	12 KB,	80-pin QFP
V850E/IA4	μ PD703185:	mask ROM	128 KB,	RAM	6 KB,	100-pin LQFP/QFP
	μ PD703186:	mask ROM	256 KB,	RAM	12 KB,	100-pin LQFP/QFP
	μ PD70F3186:	flash memory	256 KB,	RAM	12 KB,	100-pin LQFP/QFP

- **Offer safe development environment at low cost**

A full-function in-circuit emulator that can perform debugging at 20 MHz is available as a hardware tool. As a power device safety function, this in-circuit emulator has a function that automatically sets the inverter timer output pin to high impedance at breaking. The tool can perform debugging safely and efficiently with this function.

- **Applications**

This V850ES/IE2 is most suitable for various inverter control systems such as outdoor units of air-conditioners, clothes wash dryers, fully automatic washing machines, refrigerators, IH cooking heaters, robots, AC servos, general-purpose inverters, UPS, and motor-assisted bicycles, and various embedded devices that require a 5 V interface.