78K0R/Fx3.

16-bit MCU family now geared for automotive applications.
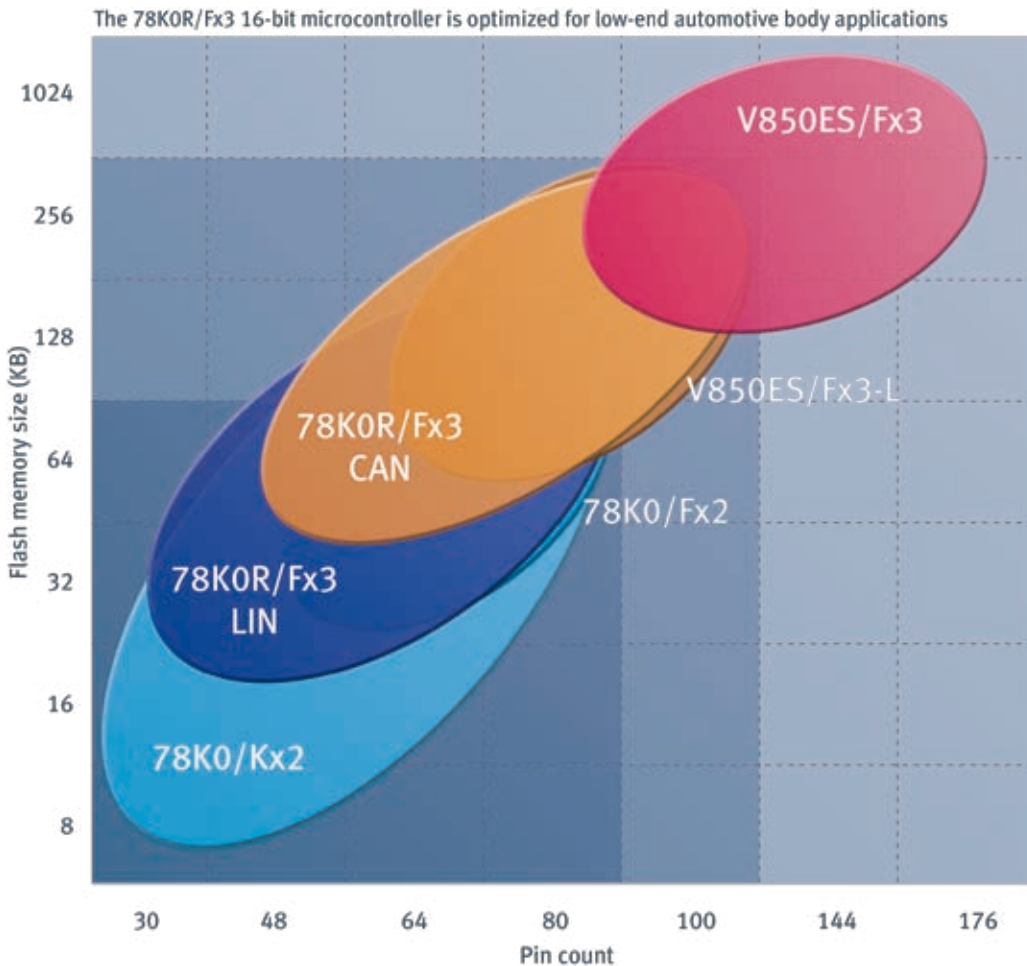
F Series

NEC
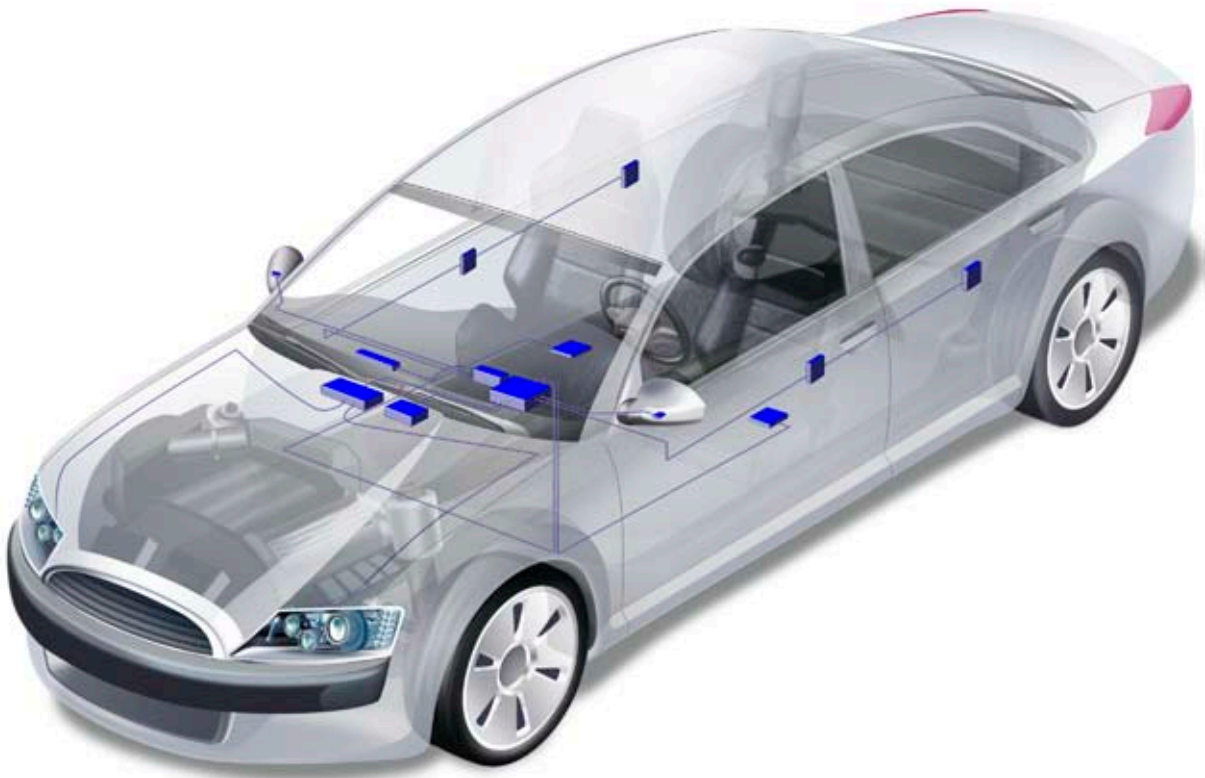
Experience the revolutionary 78K0R/Fx3 microcontrollers

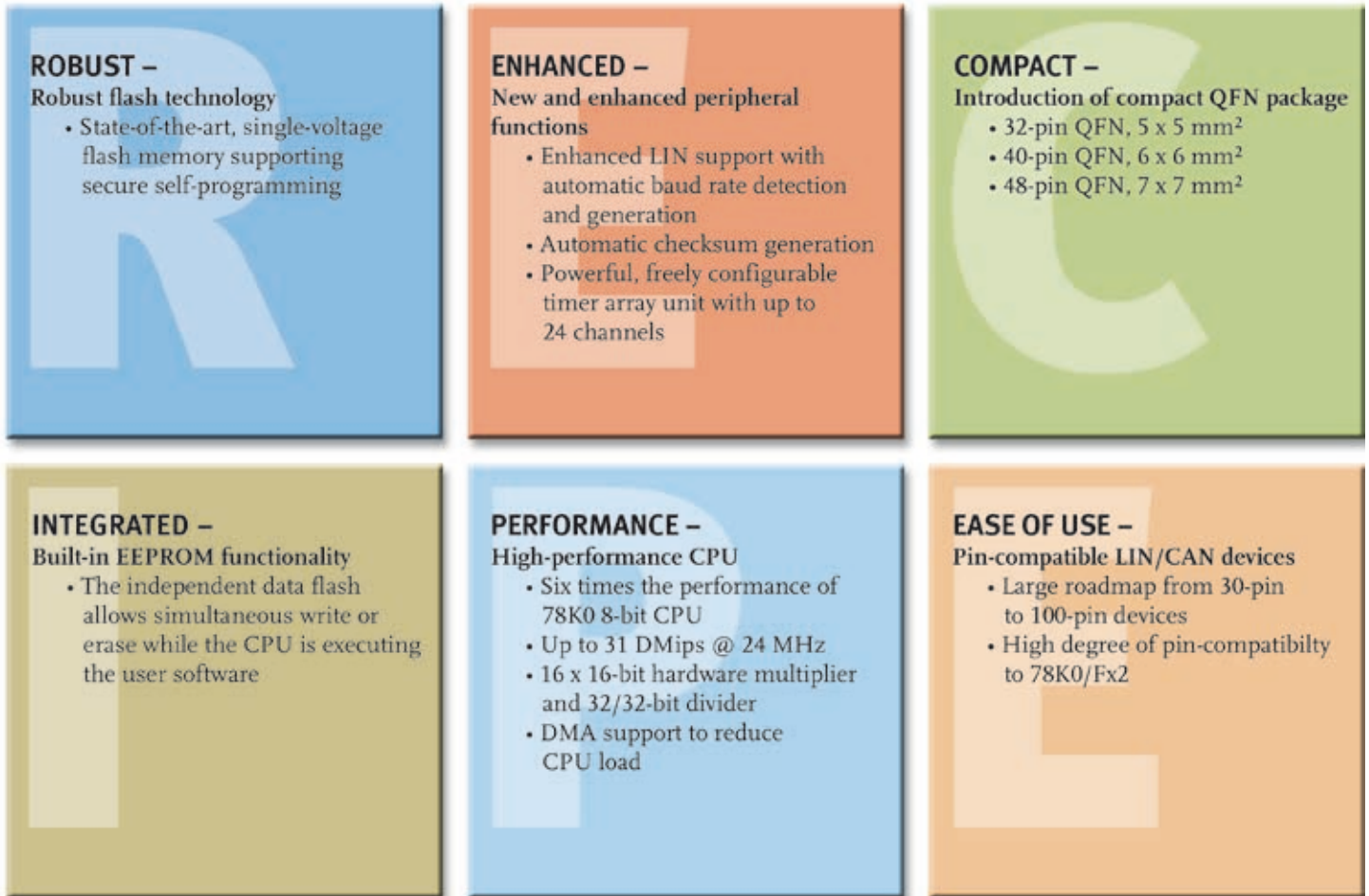## The new mid-range/low-end body control 16-bit MCU family

The 78K0R/Fx3 MCU family is perfectly tuned to perform high-end 8-bit and low-end 16-bit operations in automotive applications, such as body control systems. The 16-bit CPU core uses linear addressing via a 20-bit bus to access its ample memory resources. The embedded data flash on a dedicated bus allows parallel processing during EEPROM emulation. A rich peripheral set, powerful and flexible timer array units and a huge number of A/D input signals provide the requisite functionalities for revolutionary automotive designs and projects.

The 78K0R/Fx3 is a scalable MCU family with proven reliability, backed up by equally innovative design and development tools.

The 78K0R/Fx3 16-bit microcontroller is optimized for low-end automotive body applications

78K0R/Fx3 – your recipe for success

Features

ROBUST –
Robust flash technology
- State-of-the-art, single-voltage flash memory supporting secure self-programming

ENHANCED –
New and enhanced peripheral functions
- Enhanced LIN support with automatic baud rate detection and generation
- Automatic checksum generation
- Powerful, freely configurable timer array unit with up to 24 channels

COMPACT –
Introduction of compact QFN package
- 32-pin QFN, 5 x 5 mm^2
- 40-pin QFN, 6 x 6 mm^2
- 48-pin QFN, 7 x 7 mm^2

INTEGRATED –
Built-in EEPROM functionality
- The independent data flash allows simultaneous write or erase while the CPU is executing the user software

PERFORMANCE –
High-performance CPU
- Six times the performance of 78K0 8-bit CPU
- Up to 31 DMips @ 24 MHz
- 16 x 16-bit hardware multiplier and 32/32-bit divider
- DMA support to reduce CPU load

EASE OF USE –
Pin-compatible LIN/CAN devices
- Large roadmap from 30-pin to 100-pin devices
- High degree of pin-compatibilty to 78K0/Fx2
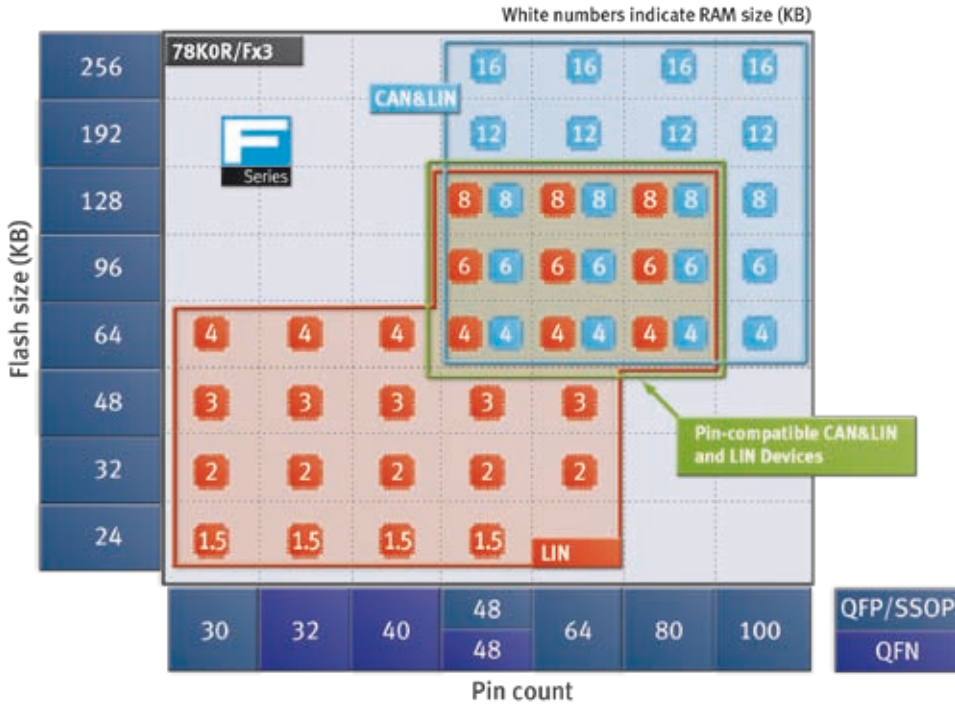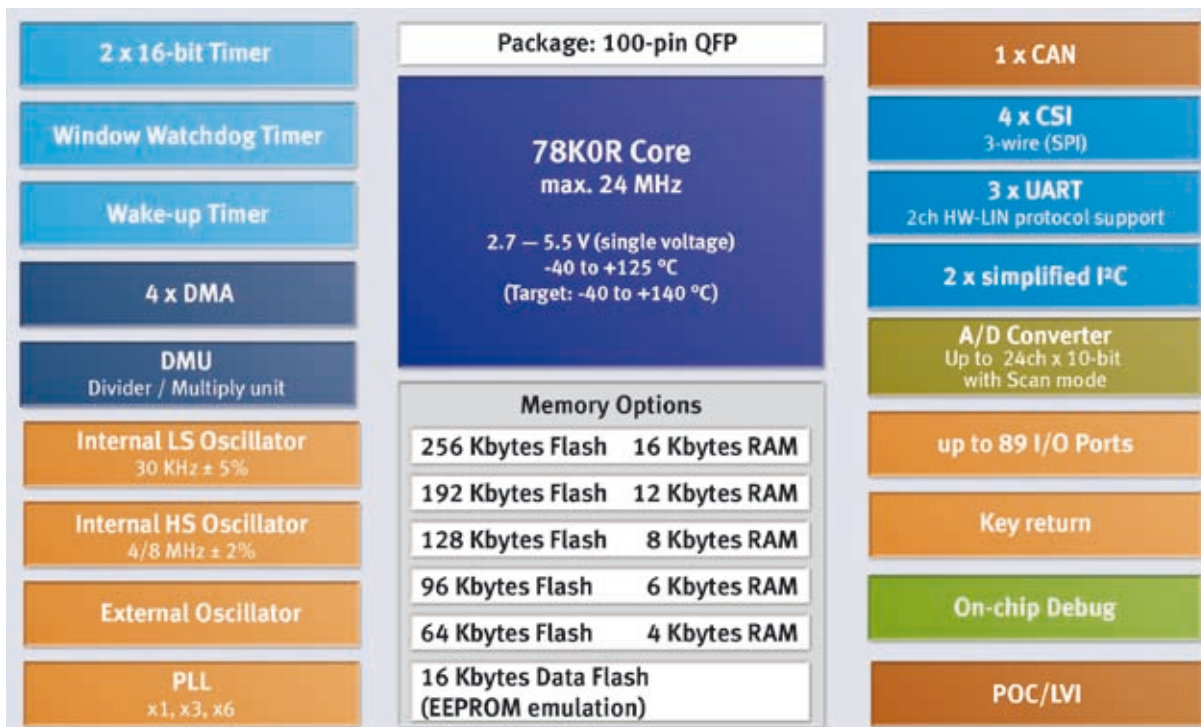
- 46 family members at your service
- Powerful embedded 16-bit 78K0R CISC CPU:
  » Harvard architecture
  » 3-stage pipelining
  » 1 MB linear address space
- Built-in, state-of-the-art, single-voltage flash memory with a zero defect record in data retention*.
- On-chip peripherals include enhanced UART with LIN support, up to 24 channels of 16-bit timers, up to 24 channels A/D inputs, high-precision internal oscillator, embedded CAN controller, DMA module, window watchdog with separate clock source from CPU, low-voltage detection function, power-on-clear function
- All devices support a dual-operation 16 KB data flash to eliminate the cost of an external EEPROM
- 32-, 40- and 48-pin QFN packages to shrink PCB size
- Ultra-low power consumption

* Total of 5,500,000,000 flash devices shipped to date (source: NEC Electronics Corporation 2008).
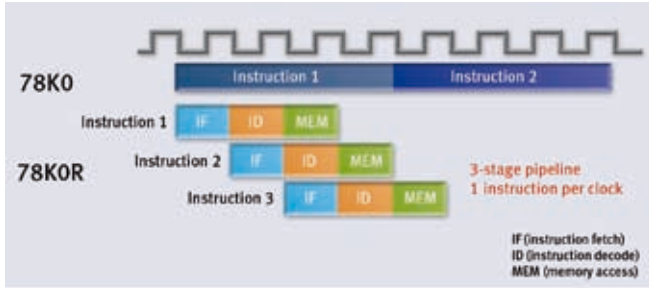
Fully scalable device family

White numbers indicate RAM size (KB)

Flash size (KB)								
256	78K0R/Fx3			16	16	16	16	
192	F Series	CAN&LIN		12	12	12	12	
128			8 8	8 8	8 8	8		
96			6 6	6 6	6 6	6		
64	4	4	4	4 4	4 4	4 4	4	
48	3	3	3	3	3			Pin-compatible CAN&LIN and LIN Devices
32	2	2	2	2	2			
24	1.5	1.5	1.5	1.5	LIN			

| Pin count | 30 | 32 | 40 | 48 / 48 | 64 | 80 | 100 | QFP/SSOP QFN |

78K0R/FG3 block diagram (100-pin MCU)

| 2 x 16-bit Timer	Package: 100-pin QFP	1 x CAN
Window Watchdog Timer		4 x CSI 3-wire (SPI)
Wake-up Timer	**78K0R Core** max. 24 MHz	3 x UART 2ch HW-LIN protocol support
4 x DMA	2.7 — 5.5 V (single voltage) -40 to +125 °C (Target: -40 to +140 °C)	2 x simplified I²C
DMU Divider / Multiply unit		A/D Converter Up to 24ch x 10-bit with Scan mode
Internal LS Oscillator 30 KHz ± 5%	**Memory Options** 256 Kbytes Flash 16 Kbytes RAM	up to 89 I/O Ports
Internal HS Oscillator 4/8 MHz ± 2%	192 Kbytes Flash 12 Kbytes RAM 128 Kbytes Flash 8 Kbytes RAM	Key return
External Oscillator	96 Kbytes Flash 6 Kbytes RAM 64 Kbytes Flash 4 Kbytes RAM	On-chip Debug
PLL x1, x3, x6	16 Kbytes Data Flash (EEPROM emulation)	POC/LVI

CPU core performance

- Superset of 78K0 with 71 base instructions
- Maximum operating frequency: 24 MHz
- Minimum instruction execution time: 42 ns
- 31 DMips @ 24 MHz (based on Dhrystone 2.1), < 1 mW/DMips
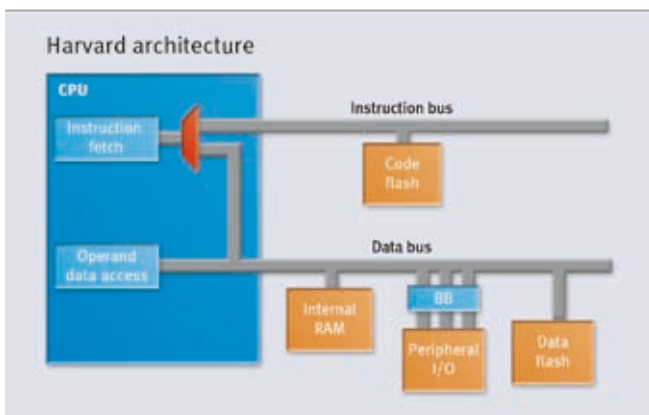
78K0R/FG3 flash memory (100-pin MCU)
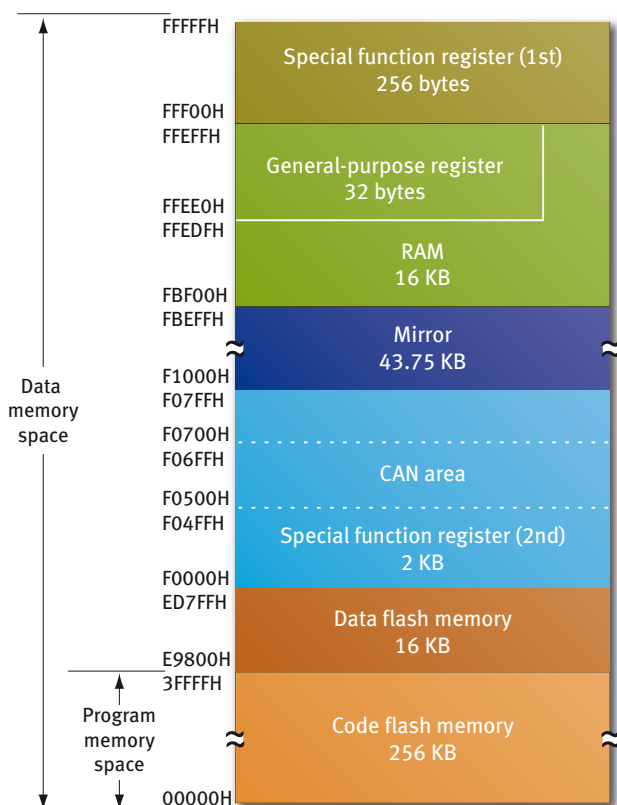
- Internal 20-bit bus supports large data and program memory spaces
- Linear memory mapping eliminates bank or page switching
- Highly reliable, high-endurance embedded flash technology

5

Timers

- Up to three flexible and powerful timer array units each with up to 8-channel 16-bit timers.
- Freely configurable channel operation:
  - » Interval timer, square wave output, external event counter, divider function, input pulse interval measurement, measurement of high-/low-level width of input signal functions with single-channel operation mode.
  - » PWM output, one-shot pulse output, multiple PWM output with combined channel operating mode.
- On-chip secure window watchdog uses separate clock source. An optional interval interrupt occurs when 75% of the overflow time is reached.
- A 16-bit wake-up timer initiates periodic system wake-up or time scheduler for operating system.

Interfaces

- Embedded Advanced Full CAN controller (1 channel):
  - » Complies with ISO 11898 and tested to ISO/DIS 16845 (CAN conformance test) (CAN 2.0 A/B)
  - » Standard frame and extended frame transmission/ reception enabled
  - » Transfer rate: 1 Mbps max. (8 MHz CAN input clock)
  - » 16 message buffers
  - » Receive/transmit history list function
  - » Automatic block transmission function
  - » Multi-buffer receive block function
  - » Mask setting of four patterns possible for each channel
- Up to 1 Mbps enhanced UART module (2 channels):
  - » Specially designed for latest LIN protocol communication
  - » Breakfield reception/transmission in LIN communication format
  - » Hardware ID parity check
  - » Automatic baud rate detection and generation
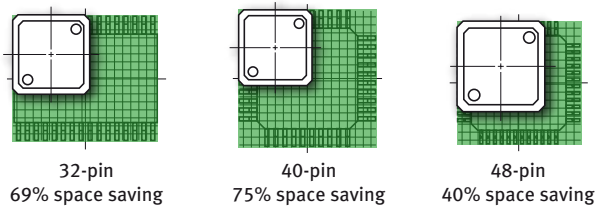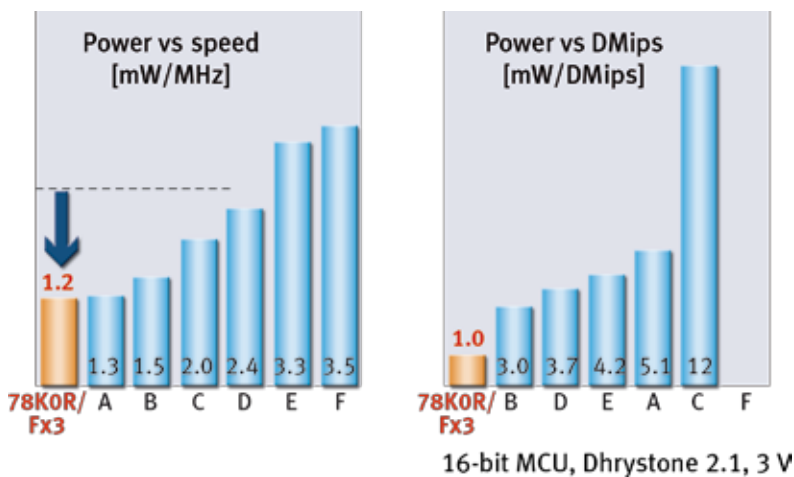 - » Automatic checksum generation
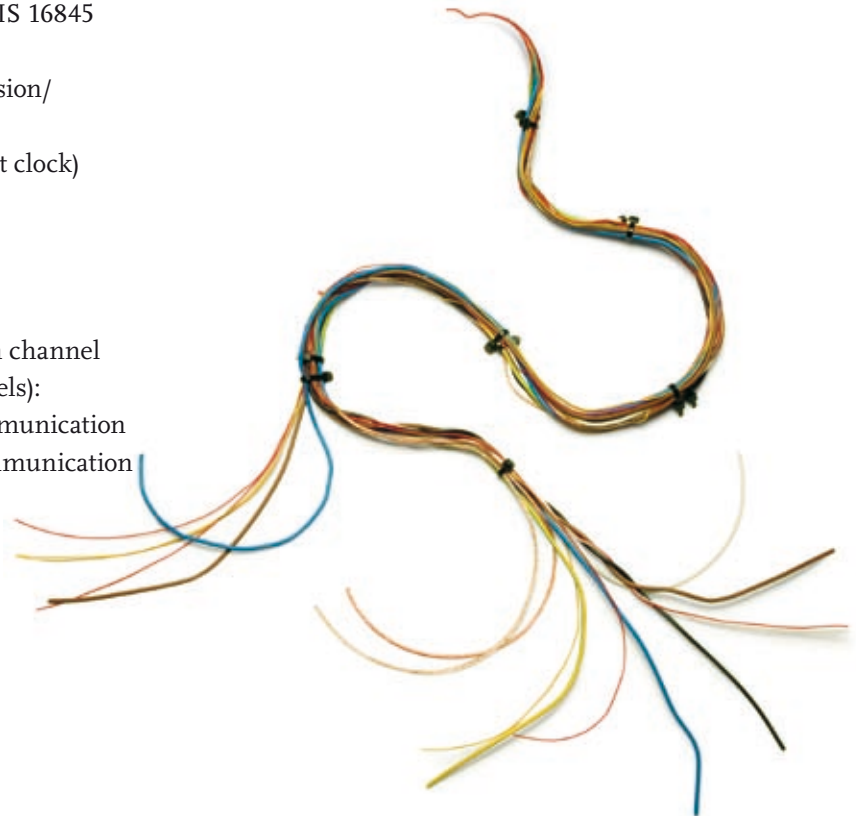
Packages

- The 78K0R comes in standard LQFP and SSOP packages and now also in the new QFN package which brings many additional benefits:
  - » Very small size
  - » Significant reduction of PCB space
  - » No co-planarity issues
  - » Very good heat dissipation
  - » Exposed pad for even lower R_{TH}
  - » Much cheaper than FPBGA for equivalent size
  - » Low profile

LQFP

SSOP

QFN

QFN (bottom side with exposed pad)

QFN space advantage over LQFP/SSOP

32-pin	40-pin	48-pin
69% space saving	75% space saving	40% space saving

Power consumption

Power vs speed [mW/MHz]

1.2

78K0R/Fx3 A 1.3 B 1.5 C 2.0 D 2.4 E 3.3 F 3.5

Power vs DMips [mW/DMips]

1.0
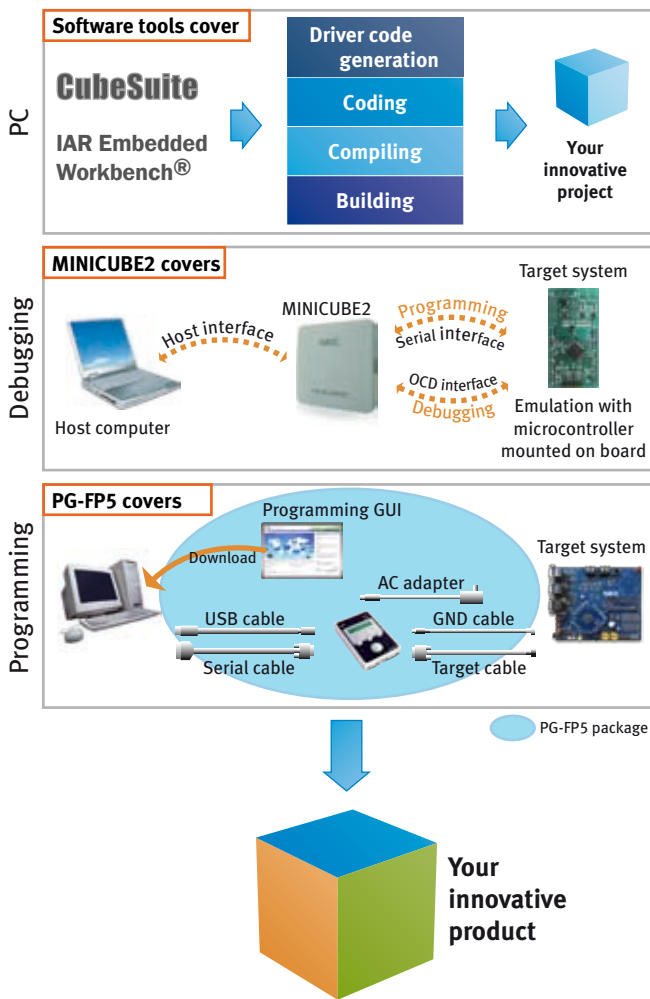
78K0R/Fx3 B 3.0 D 3.7 E 4.2 A 5.1 C 12 F

16-bit MCU, Dhrystone 2.1, 3 V

- Best power performance under normal operating conditions of all equivalent products on the market
- Two standby modes (HALT and STOP) can be activated by internal or external events
- Extremely low current consumption in STOP mode

NEC ELECTRONICS supports its microcontroller products with a large choice of hardware and software development platforms. Contact your local NEC ELECTRONICS representative to find out which development systems are available in your region.

Development tools

Software tools cover

PC

CubeSuite

IAR Embedded Workbench®

Driver code generation

Coding

Compiling

Building

Your innovative project

MINICUBE2 covers

Debugging

Host interface

MINICUBE2

Host computer

Programming

Serial interface

OCD interface

Debugging

Target system

Emulation with microcontroller mounted on board

PG-FP5 covers

Programming

Programming GUI

Download

Target system

AC adapter

USB cable

GND cable

Serial cable

Target cable

PG-FP5 package

Your innovative product

- CubeSuite, the new integrated development environment, for a completely new programming experience
- Only one MINICUBE2 required for debugging and prototype programming
- Continue to use the PG-FP5 for mass production programming
- More development tools are available from our partners:

IAR SYSTEMS

LAUTERBACH

vector Technische Informatik

i SYSTEM

NEC ELECTRONICS' Applilet helps to get your project going. Free to download, Applilet is a simple graphical user interface software tool that generates driver code to incorporate on-chip peripherals in your design.

Evaluation board

Launch your 78K0R/Fx3 project with a full function evaluation board.
Main board functions:

- DC and stepper motor control
- LED/7-segment LED output module
- Clock output/buzzer/tuner output module
- External interrupt input circuit and keyboard functionality
- Lamp driver/controller with short-circuit detection
- External EEPROM data storage function
- LCD display function
- Network in vehicle: CAN/LIN/K-Line/RS-232
- Remote keyless entry function (receiver)
- Debug/flash interface for on-chip debug function and flash programming

MINICUBE2 target board

This simple board allows rapid evaluation of the device's I/O capability. It is supported by MINICUBE (sold separately).

- 78K0R/FG3 (µPD78F1845GCA-UEU-G)
- Flash memory: 256 KB code, 16 KB data
- RAM: 16 KB
- Two LIN channels including transceivers
- One CAN channel including transceiver
- Flash programming interface
- On-chip debugging
- 20 MHz main clock
- One switch, two LEDs
- User breadboard area

IECUBE – debugger with extended functionality

Depending on the target device, IECUBE offers:

- Frequency, voltage and memory capacity same as target device
- USB 2.0 host interface
- Break functions:
  - » Event break:
    - Execution: up to eight points
    - Access: up to eight points
  - » Software: up to 2000 points
- Trace functions:
  - » Trace memory capacity up to 128K frames
  - » Trace modes are: unconditional trace, section trace, qualify trace, delay trigger trace
- Real-time RAM monitor function
- Time measurement:
  - » Clock: 60 MHz (optional x1 to x2048 prescaler)
  - » Maximum measurement up to 41 h (@ 17 ns resolution)
  - » Maximum resolution 17 ns
  - » Three timers available for measurement

Selection guide

Series name	Part number	Memory			Co-processing		Clock						I/O		Timers				Interfaces			
		Code flash size [KB]	Data flash size [KB]	RAM size [KB]	DMA channels	Hardware multiplier/divider	Max. operating frequency [MHz]	Int. high-speed oscillator [MHz]	Int. 30 kHz oscillator	PLL	Clock output	Clock monitor	I/O ports	Open-drain output	Timer array unit 16-bit timer channels	Max. PWM output [16-bit]	16-bit wake-up timer	Watchdog timer	CAN controller (AFCAN)	LIN controller (UARTF)	UART	CSI
78K0R/FB3	µPD78F1804	24	16	1.5	2	✓	24	4/8	✓	✓	–	✓	23	–	13	11	1	✓	–	2	–	2
	µPD78F1804												25	4								
	µPD78F1805	32		2									23	–								
	µPD78F1805												25	4								
	µPD78F1806	48		3									23	–								
	µPD78F1806												25	4								
	µPD78F1807	64		4									23	–								
	µPD78F1807												25	4								
78K0R/FC3	µPD78F1808	24	16	1.5	2	✓	24	4/8	✓	✓	✓	✓	33	4	16	14	1	✓	–	2	–	2
	µPD78F1809	32		2																		
	µPD78F1810	48		3																		
	µPD78F1811	64		4																		
	µPD78F1812	24		1.5	4								41									
	µPD78F1813	32		2																		
	µPD78F1814	48		3																		
	µPD78F1815	64		4																		
	µPD78F1816	96		6																		
	µPD78F1817	128		8																		
	µPD78F1826	64	16	4	4	✓	24	4/8	✓	✓	✓	✓	41	4	16	14	1	✓	1	2	–	2
	µPD78F1827	96		6																		
	µPD78F1828	128		8																		
	µPD78F1829	192		12																		
	µPD78F1830	256		16																		
78K0R/FE3	µPD78F1818	32	16	2	4	✓	24	4/8	✓	✓	✓	✓	55	4	20	17	1	✓	–	2	–	3
	µPD78F1819	48		3																		
	µPD78F1820	64		4																		
	µPD78F1821	96		6																	1	
	µPD78F1822	128		8																		
	µPD78F1831	64	16	4	4	✓	24	4/8	✓	✓	✓	✓	55	4	20	17	1	✓	1	2	1	3
	µPD78F1832	96		6																		
	µPD78F1833	128		8																		
	µPD78F1834	192		12																		
	µPD78F1835	256		16																		
78K0R/FF3	µPD78F1823	64	16	4	4	✓	24	4/8	✓	✓	✓	✓	71	4	20	17	1	✓	–	2	1	3
	µPD78F1824	96		6																		
	µPD78F1825	128		8																		
	µPD78F1836	64	16	4	4	✓	24	4/8	✓	✓	✓	✓	71	4	20	17	1	✓	1	2	1	3
	µPD78F1837	96		6																		
	µPD78F1838	128		8																		
	µPD78F1839	192		12																		
	µPD78F1840	256		16																		
78K0R/FG3	µPD78F1841	64	16	4	4	✓	24	4/8	✓	✓	✓	✓	89	4	24	21	1	✓	1	2	1	4
	µPD78F1842	96		6																		
	µPD78F1843	128		8																		
	µPD78F1844	192		12																		
	µPD78F1845	256		16																		

I²C	Interrupts			OCD	ADC	Power		Package	Ta
	External interrupts	Key return interrupts	Internal interrupts	On-chip debug	10-bit A/D converter	POC LVI	Supply voltage [V]	Package [mm]	Ambient temperature
–					8			30-pin SSOP (7.62)	
1					6			32-pin QFN (5 x 5)	
–					8			30-pin SSOP (7.62)	
1	8	–	32	✓	6	✓	2.7...5.5	32-pin QFN (5 x 5)	A, A2, A3
–					8			30-pin SSOP (7.62)	
1					6			32-pin QFN (5 x 5)	
–					8			30-pin SSOP (7.62)	
1					6			32-pin QFN (5 x 5)	
	9				8			40-pin QFN (6 x 6)	
1		4	37	✓		✓	2.7...5.5		A, A2, A3
	10				11			48-pin LQFP (7 x 7), 48-pin QFN (7 x 7)	
1	10	4	41	✓	11	✓	2.7...5.5	48-pin LQFP (7 x 7), 48-pin QFN (7 x 7)	A, A2, A3
1	10	8	41	✓	15	✓	2.7...5.5	64-pin LQFP (10 x 10)	A, A2, A3
2									
2	11	8	47	✓	15	✓	2.7...5.5	64-pin LQFP (10 x 10)	A, A2, A3
2	12	8	43	✓	16	✓	2.7...5.5	80-pin LQFP (12 x 12)	A, A2, A3
2	12	8	47	✓	16	✓	2.7...5.5	80-pin LQFP (12 x 12)	A, A2, A3
2	12	8	49	✓	24	✓	2.7...5.5	100-pin LQFP (14 x 14)	A, A2, A3

■ without CAN controller
■ with CAN controller

Hardware multiplier/divider:
16 bits x 16 bits = 32 bits
32 bits ÷ 32 bits = 32 bits, 32-bit remainder

Ambient temperature:
A : -40...+85 °C
A2: -40...+125 °C
A3: -40...+140 °C

✓ provided
– not available

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NEC Electronics (Europe) GmbH
January 2010
Document No. U20210EA1V1PF00

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