Renesas Microcomputer 16-bit All Flash

Renesas Microcomputer 16-bit All Flash

78K0R Microcontrollers

Empower your creativity

Renesas Electronics Corporation

SALES OFFICES

http://www.renesas.com

Renesas Electronics Corporation

Colophon 1.0
All of our new 16-bit general-purpose microcontrollers incorporate flash memories.

**All Flash Continues to Evolve, Contributing to the Success of Customers**

The "Shifting to All Flash" concept involves switching to flash memory products for the entire lineup of microcontrollers offered by Renesas Electronics. This lineup comprises the V850E and V850ES 32-bit microcontrollers delivering high performance for system control, and the 78K0 and 78K0S 8-bit microcontrollers, which boast a small size and low power consumption making them ideal as subcontrollers.

Renesas Electronics’ All Flash lineup is completed by the 78K0R 16-bit microcontrollers, positioned between 8-bit and 32-bit microcontrollers.

Renesas Electronics’ All Flash lineup supports from 30 to 144 pins and ROM capacities of 16 to 512 KB. The lineup also inherits the existing 78K0 and 78K0S 8-bit microcontrollers. Should 8-bit microcontrollers fall short in terms of performance and ROM capacity for the intended application, smooth migration to 16-bit microcontrollers is possible.

Renesas Electronics also offers an infrastructure that enables more effective and simple use of All Flash. Our products and environment, which make the most of the merits of flash memory products, work for the success of our customers everywhere.

### Application examples

All Flash microcontrollers are suitable for various systems using an 8- or 16-bit microcontroller and raise the commercial value of customer systems.

- **Cameras**: Digital still cameras, digital video cameras, SLR cameras
- **Audio**: Portable audio, component stereo systems, home theater systems
- **Industrial equipment**: Industrial motors, control equipment, vending machines, power meters
- **Computer peripherals**: LBP, PPC, MF, inkjet printers, scanners, fax machines
- **Video and recording equipment**: Blu-ray players, Blu-ray recorders, industrial cameras
- **Portable devices**: PDA, IC recorders
- **Home appliances**: Air conditioners, refrigerators, washing machines, microwave ovens
- **Healthcare equipment**: Body fat scales, blood pressure monitors
- **Other**: Electronic instruments, electric bidets, toys, remote controllers, etc.

### Road Map

**78K0R/Kx3**
- Wide-voltage operation support
- Inverter control support
- Analog enhancement, low power, wide-voltage operation support
- Low-power, USB support

**78K0R/Ix3**
- Inverter control support

**78K0R/Lx3**
- LCD controller/drivers, analog enhancement, low power

**µPD78F8043**
- IO-Link support

**µPD78F8058**
- RF remote control support

**78K0R/Hx3**
- CAN support, analog enhancement

**78K0R/Kx3-L**
- Low-power and wide-voltage operation support

**78K0R/Kx3-L (USB)**
- Analog enhancement, low power, wide-voltage operation support

**78K0R/Kx3-A**
- Analog enhancement, low power, wide-voltage operation support

**78K0R/Kx3-C**
- Low-power, digital home electronics communication support

**78K0R/Kx3-C-L**
- Low-power, digital home electronics communication support

**78K0R/Ix3-L**
- Wide-voltage operation support

**78K0R/Lx3**
- LCD controller/drivers, analog enhancement, low power

**µPD78F8043**
- IO-Link support

**µPD78F8058**
- RF remote control support

**78K0R/Hx3**
- CAN support, analog enhancement

**78K0R/Kx3**
- Inverter control support

**78K0R/Ix3**
- Inverter control support

**78K0R/Lx3**
- LCD controller/drivers, analog enhancement, low power

**µPD78F8043**
- IO-Link support

**µPD78F8058**
- RF remote control support

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- Low-power and wide-voltage operation support

**78K0R/Kx3-L (USB)**
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- Analog enhancement, low power, wide-voltage operation support

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- Low-power, digital home electronics communication support

**78K0R/Ix3-L**
- Wide-voltage operation support

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**78K0R/Ix3-L**
- Wide-voltage operation support

**78K0R/Lx3**
- LCD controller/drivers, analog enhancement, low power

**µPD78F8043**
- IO-Link support

**µPD78F8058**
- RF remote control support

**78K0R/Hx3**
- CAN support, analog enhancement
Flash microcontrollers can boost the competitiveness of your systems. Based on this concept, we are shifting to "All Flash".

Flash microcontrollers offer overwhelming advantages.

Compared to mask ROM microcontrollers, flash microcontrollers definitely contribute to speeding up system development. Microcontrollers can be ordered before program completion and programs can be written even after the microcontroller has been mounted on the board. Microcontroller order placement and program development can therefore be done concurrently, allowing TAT to be shortened as a result.

In addition, when flash microcontrollers are used for products with many different versions or that are localized for specific regions, the cost of ordering mask ROM microcontrollers is eliminated and purchase and stock management costs can be slashed.

For hardware designers

Mass-produced flash microcontrollers require evaluation only once, reducing development man-hours. In the case of mass-produced mask ROM microcontrollers, evaluations of both flash microcontrollers and mask ROM microcontrollers are required.

Since evaluated flash microcontrollers can be directly mass-produced, the man-hours required for development are reduced by half, resulting in greatly shortened development TAT.

For purchasing divisions

Mass-produced mask ROM microcontrollers may become dead stock as the result of changes in software or fluctuations in demand. On the other hand, flash microcontrollers can be mass-produced immediately after software changes and used for other products, resulting in fewer lost opportunities, less dead stock, and lower ordering costs.

For manufacturing divisions

Parts sharing makes production planning easier and boosts production efficiency. In the case of mass-produced mask ROM microcontrollers, the use of different software for different products necessitates the use of a different microcontroller for each type of product. In contrast, mass-produced flash microcontrollers facilitate the sharing of parts since they can be used for various products by simply rewriting the software.

Software can be changed just before mass production starts and development TAT can also be shortened.

Since mask ROM microcontrollers cannot be ordered until their specifications are finalized, last-minute software changes can be problematic. On the other hand, specifications for flash microcontrollers can be changed just prior to the start of mass production. Thus orders for flash microcontrollers can be placed while the software is still being developed, allowing the development TAT to be shortened.

Software development

The predicted demand burden is reduced because a blanket order can be placed.

Overstock or shortage

Can be used for other products to compensate for shortages.

Reordering and dead stock

No reordering is required even when software is changed, allowing you to start manufacturing immediately without having dead stock.

Software development

Assembly (using several types)

Set A

Set B

Set C

Set A

Set B

Set C

Set A

Set B

Set C

No dead stock

Shortening of TAT

The demand prediction burden is reduced because a blanket order can be placed.

Development and evaluation of flash microcontrollers

Mass production of flash microcontrollers

Man-hours required for development reduced by half.

Development and evaluation of mask ROM microcontrollers

Mass production of mask ROM microcontrollers

Development and evaluation

Man-hours required for development reduced by half.

Development and evaluation of flash microcontrollers

Mass production of flash microcontrollers

Man-hours required for development reduced by half.

Development and evaluation of mask ROM microcontrollers

Mass production of mask ROM microcontrollers

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Man-hours required for development reduced by half.

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Development and evaluation of mask ROM microcontrollers

Mass production of mask ROM microcontrollers

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Development and evaluation of flash microcontrollers

Mass production of flash microcontrollers

Man-hours required for development reduced by half.

Development and evaluation of mask ROM microcontrollers

Mass production of mask ROM microcontrollers

Development and evaluation

Man-hours required for development reduced by half.

Development and evaluation of flash microcontrollers

Mass production of flash microcontrollers

Man-hours required for development reduced by half.
Voltage detection function

MEM

ID

0.19 mA

Fetch

MEM

Interrupt: 1 month max.

Have you ever had to give up creating system performance and fast development TAT. However, the use of high performance microcontrollers and flash microcontrollers often imposes compromises, in terms of higher power consumption and the compatibility of existing software resources.

Renesas Electronics’ 78KOR 16-bit microcontroller realizes 16-bit performance with All Flash without such compromises.

The use of high-performance microcontrollers and flash microcontrollers has become widespread to support ever increasing system performance and fast development TAT. However, the use of high performance microcontrollers and flash microcontrollers often imposes compromises, in terms of higher power consumption and the compatibility of existing software resources.

Renesas Electronics’ 78KOR 16-bit microcontroller realizes 16-bit performance with All Flash without such compromises.

The 78KOR 16-bit microcontrollers are provided with features such as flash memory, the 78KOR/Kx3-L, which has a low standby current, the 78KOR/Kx3-A with a built-in high-performance 12-bit A/D converter and the 78KOR/Lx3 with a built-in LCD driver, and the 78KOR/Hx3, which has a fast operating speed of 24 MHz. Our 16-bit All Flash microcontrollers are available in either a 40-pin 6 x 6 mm QFN or a 48-pin 7 x 7 mm QFN. These packages are 41% thinner and 72% smaller than our conventional 16-bit microcontroller package (which is a 100-pin LQFP with a size of 14 mm x 14 mm), helping you reduce the size of your set. With this extensive lineup, you can choose the optimal product.

We offer 202 products!

To respond to demands for various types of microcontrollers, we offer a range of 202 All Flash 16-bit microcontrollers. Among those are the 78KOR/Kx3-L, which features a large-capacity memory, the 78KOR/Kx3-A, which has a low standby current, the 78KOR/Kx3-A with a built-in high-performance 12-bit A/D converter and the 78KOR/Lx3 with a built-in LCD driver, and the 78KOR/Hx3, which has a fast operating speed of 24 MHz. Our 16-bit All Flash microcontrollers are available in either a 40-pin 6 x 6 mm QFN or a 48-pin 7 x 7 mm QFN. These packages are 41% thinner and 72% smaller than our conventional 16-bit microcontroller package (which is a 100-pin LQFP with a size of 14 mm x 14 mm), helping you reduce the size of your set. With this extensive lineup, you can choose the optimal product.

Low power consumption

Go fast. Stay cool.

Combining high performance with low power consumption!

Through the use of a 16-bit design, Renesas Electronics has achieved 3-stage pipeline architecture CPUs that boast a performance of 30.5MIPS at 24 MHz! These microcontrollers save energy thanks to their supply current, which is low compared to the 16-bit products of other companies. They also feature a calendar function (RTC) that automatically updates the time and date until 2099 without the need to boot the CPU, helping extend battery life in systems that require a watch counter.

Current users of 16-bit microcontrollers can achieve lower power consumption, while 8-bit microcontroller users can enjoy higher performance without an increase in power consumption.

We offer inexpensive, easy-to-use, and convenient tools!

In addition to a large lineup of programming tools, we also offer programming services! Renesas Electronics provides an easy-to-use and convenient development environment, exemplified by our newly released CubeSuite™ integrated development platform. CubeSuite can be used to compile and debug programs, manage pin layouts, generate code for microcontroller peripherals, and execute high-speed building. Add MINICUBE2, an on-chip debugger with flash memory programming capability, into the mix and you have a powerful environment that enables fast and accurate system development.

Support for mass production

Renesas Electronics and partner manufacturers offer a large number of programming tools, making programming possible in many different settings such as development environments and production lines. Moreover, programming services are also available from partner manufacturers both in Japan and overseas, serving a broad range of needs such as large-volume programming after shipping.

Rich development environment

Our wide variety of products for specific applications includes high-performance CPU and sophisticated peripheral functions!

The 78KOR microcontrollers execute most instruction processing in one clock via three-stage pipeline control. 32-bit (16 bits x 16 bits) calculations can also be performed thanks to the on-chip multiplier. Furthermore, a sophisticated timer function can be realized by interlocking the operation of multiple-channel timers. The 78KOR/Kx3 enables A/D conversion in synchronization with 3-phase sine-wave PWM output and timers.

High performance and functionality

Our products incorporate our experience and technology in the automotive field as well as software protection functions!

All our products incorporate the experience we have gained in the process of supplying microcontrollers for over 1,000 types of applications and the technology we developed for flash microcontrollers for the automotive field. Our products also feature functions that disable reading and malicious software operation and erasing, thus offering maximum protection of your valuable software.

High reliability

Our wide variety of products for specific applications includes high-performance CPU and sophisticated peripheral functions!

The 78KOR microcontrollers execute most instruction processing in one clock via three-stage pipeline control. 32-bit (16 bits x 16 bits) calculations can also be performed thanks to the on-chip multiplier. Furthermore, a sophisticated timer function can be realized by interlocking the operation of multiple-channel timers. The 78KOR/Kx3 enables A/D conversion in synchronization with 3-phase sine-wave PWM output and timers.

Low cost

Reducing the total cost!

The 78KOR 16-bit microcontrollers are provided with features such as flash memory instead of EEPROM, an oscillator, a voltage detector, and a power-on reset function. The number of components used and the system costs can be reduced in contrast to products not provided with these features. Also, costs can be further reduced because the 78KOR/Kx3-A and 78KOR/Lx3 include an operational amplifier, contrast to products not provided with these features. Also, costs can be further reduced because the 78KOR/Kx3-A and 78KOR/Lx3 include an operational amplifier.

16-bit All Flash microcontrollers that do not compromise

Large selection

We offer 202 products!

To respond to demands for various types of microcontrollers, we offer a range of 202 All Flash 16-bit microcontrollers. Among those are the 78KOR/Kx3-L, which features a large-capacity memory, the 78KOR/Kx3-A, which has a low standby current, the 78KOR/Kx3-A with a built-in high-performance 12-bit A/D converter and the 78KOR/Lx3 with a built-in LCD driver, and the 78KOR/Hx3, which has a fast operating speed of 24 MHz. Our 16-bit All Flash microcontrollers are available in either a 40-pin 6 x 6 mm QFN or a 48-pin 7 x 7 mm QFN. These packages are 41% thinner and 72% smaller than our conventional 16-bit microcontroller package (which is a 100-pin LQFP with a size of 14 mm x 14 mm), helping you reduce the size of your set. With this extensive lineup, you can choose the optimal product.

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Large selection (1/2)

We offer flash microcontrollers in various packages and ROM or RAM sizes, allowing you to select the best flash microcontroller for your product or application.

<table>
<thead>
<tr>
<th>Commercial Name</th>
<th>Pin Count</th>
<th>ROM (bytes)</th>
<th>78K0R/K3-L</th>
<th>78K0R/K3-A</th>
<th>78K0R/KJ3</th>
<th>78K0R/KC3-L</th>
<th>78K0R/KC3-A</th>
<th>78K0R/KF3</th>
<th>78K0R/KG3</th>
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<tr>
<td>Product name</td>
<td>40/44-pin</td>
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**78K0R/Kx3 Microcontrollers**

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<th>Pin Count</th>
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<th>78K0R/Kx3-L</th>
<th>78K0R/Kx3-A</th>
<th>78K0R/Kx3</th>
<th>78K0R/KJ3</th>
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<td>78K0R/KJ3</td>
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*1 28 KB when the self programming function is used.
*2 7 KB when the self programming function is used.
*3 11 KB when the self programming function is used.
*4 Under development.
*5 2 KB when the self programming function is used.
*6 12-bit A/D Converter
*7 7 KB when the self programming function is used.

**Remark:** The packages are shown in their actual size.
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<tr>
<th>Commercial Name</th>
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<th>ROM (bytes)</th>
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<td>PD78F1050*</td>
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<tr>
<td>78K0R/LG3</td>
<td></td>
<td></td>
<td>32-pin</td>
<td>PD78F1059*</td>
</tr>
<tr>
<td>78K0R/LH3</td>
<td></td>
<td></td>
<td>16-pin</td>
<td>PD78F1060*</td>
</tr>
</tbody>
</table>

*1 Under development. *2 7 KB when the self programming function is used. *3 2 KB when the self programming function is used.

Remark The packages are shown in their actual size.
Low cost

All the required peripheral functions are provided on chip, saving you money and space.

16-bit microcontroller performance combined with low power consumption
Sophisticated application functions can be realized while maintaining low power consumption.

World’s lowest power consumption for 16-bit microcontrollers

Lowered standby power consumption realized through lower standby current and enhanced watch count function
As a result, energy saving for applications and longer battery life can be achieved.

Function that implements low power consumption has been added

RTC (real-time counter)

- No need for updating with the CPU!  Calendar function for automatic updating until 2099.
- Sustained watch operation without wake-up!  Power consumption can be reduced.
- Built-in alarm function starts the microcontroller at an arbitrary set time (day, hour, minute).
**Wide variety of products for specific applications (1/2)**

We offer ideal products for various applications. You can choose the optimal product for your needs.

**Microcontroller for digital AV applications (78K0R/Kx3-C)**

1. **HDMI™-CEC transmission/reception via hardware**
   - Digital AV devices can be mutually controlled by simply connecting them via an HDMI cable.
   - Example: When a DVD is inserted into a DVD recorder, the TV is automatically switched on and the active channel is switched to video input.

2. **Improved system operability**
   - The CEC circuit and remote control signal receiver are provided as hardware. CEC and remote control can therefore be processed simultaneously and easily.
   - Development efficiency has been improved by reducing the labor required for developing software.

3. **Operating current during HDMI-CEC transmission/reception reduced to 1/1000**
   - CEC and remote control operations performed using subclock.
   - Current reduction compared to software.
   - About 5 µA (Standby current)
   - Operating current corresponding to remote control reception
   - Operating current corresponding to CEC transmission/reception

4. **Application evaluation board CEC-78K0R/KG3C provided to evaluate HDMI-CEC functions**
   - The application evaluation board CEC-78K0R/KG3C expands the functions of the starter kit TK-78K0R/KG3C and enables application evaluation of the HDMI-CEC functions. A debugger, compiler, and circuit diagrams are included as standard, so that programs can be developed right away by connecting the board to a PC (versions with limited functions). Furthermore, dedicated software to enable easy development of the CEC functions is also included. Specified CEC command transmission and CEC communication using the CEC data log can be reproduced and executed by using the dedicated software.

**Microcontroller for inverter control (78K0R/Ix3)**

1. **On-chip multi-function timer enabling fine inverter control**
   - Twelve timer channels each having a 16-bit counter and a capture/compare register are provided in one unit.
   - In addition to individual timer operations, multiple channels can be operated in conjunction to enable fine inverter control.
   - Various waveforms can also be output.

   Example 1: [6-phase triangular wave PWM output function (with dead time)] (180° excitation)
   - Controllable motors: Brushless DC motors, AC motors

   Example 2: [Non-complementary method modulation output function] (120° excitation)
   - Controllable motors: Brushless DC motors

   **Remark**
   - HDMI (High-Definition Multimedia Interface): Standardized digital audio/video I/O interface for home electronics and AV devices.
   - CEC (Consumer Electronics Control): Control protocol (control method) for device control signals standardized by HDMI.
   - By using CEC, multiple AV devices can be controlled by using one remote controller.
Wide variety of products for specific applications (2/2)

We offer ideal products for various applications. You can choose the optimal product for your needs.

USB microcontrollers (78K0R/KC3-L, 78K0R/KE3-L)
1. USB 2.0 function interface included on the chip
   To reduce componentry and reduce set size, we have integrated a USB 2.0 function interface on the microcontroller chip, so you do not have to connect an external USB chip. We also provide a large number of endpoints so you can use our USB microcontrollers in a wide range of applications.
   - USB specifications
     - On-chip USB 2.0 function (full-speed) interface
     - USB function interface endpoint configuration: Two endpoints for Control transfers, two endpoints for Bulk transfers, and two endpoints for Interrupt transfers
     - FIFO size: 64 bytes × 2 (Bulk transfer × 2)
     - 64 bytes (Control transfer × 2, Interrupt transfer × 2)
   - All our USB microcontrollers are USB certified.

2. Extensive USB driver support
   We supply drivers to implement USB function applications, helping you build your system quickly.
   - USB function driver
     - Renesas Electronics provides free sample code.

Remark
HID: Human interface device
CDC: Communication device class

3. Example applications
   - Healthcare equipment
   - Printer/scanners
   - POS peripherals

USB function driver configuration

<table>
<thead>
<tr>
<th>User application</th>
<th>USB self programming</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class driver</td>
<td>Class driver (Option)</td>
</tr>
<tr>
<td>HID or CDC</td>
<td></td>
</tr>
</tbody>
</table>

Sample code for these sections is supplied by Renesas Electronics (download from our website).

Microcontroller for industrial system sensors (μPD78F8043)
Renesas Electronics has commercialized the μPD78F8043, a 16-bit 78K0R microcontroller with an on-chip transceiver that can communicate with IO-Link devices. By using the μPD78F8043, you can build a sophisticated sensor network. We have also provided a software stack to help you develop your system more efficiently.

1. IO-Link
   Many industrial systems today include controllers that operate in combination with multiple sensors and actuators. To respond to the increasing sophistication of these sensors and actuators, today’s industrial systems must have capabilities such as acquiring quantitative data using digital communication as well as diagnostic features. IO-Link is a new and popular standard for standardizing communication between the controllers and sensors & actuators in industrial systems.

2. Features of IO-Link
   - Used to connect controllers to sensors and actuators in industrial systems.
   - Complies with the IEC61131-2 standard.
   - Supports asynchronous serial communication and pulse modulation.
   - Supports transmission and reception of quantitative data and parameters, and self-diagnosis.
   - Maximum communication rate: 230.4 kbps
   - Point-to-point connection
   - Operating mode can be switched between IO-Link communication mode and standard I/O mode.
   - Existing cables (M12, etc.) can be used.

3. μPD78F8043 microcontroller with on-chip IO-Link transceiver
   - A 16-bit 78K0R microcontroller with an on-chip IO-Link device transceiver
   - Includes a DMA controller to reduce the software load when transferring data.
   - Has overcurrent and wake-up detection capabilities.
   - We provide a software stack for IO-Link communication that lets you concentrate on developing your application.

RF microcontroller (μPD78F8058)
1. Microcontroller and RF transceiver integrated into a single package
   The μPD78F8058 integrates a 16-bit microcontroller and 2.4 GHz RF transceiver into a single package. Now you can design your system without having to add an external RF transceiver. Your system will have fewer components and can be made much smaller.
   - RF transceiver specifications
     - Compliance with IEEE802.15.4-2006 (modulation system: OF-OFSK, spread spectrum: DS-UWB, communication rate: 250 kbps)
     - PHY block
       - 16 channels operating in a 2.405 to 2.483 GHz ISM band
       - Sensitivity: -95 dBm, Input level: 3 dBm (max.)
       - RSSI (received signal strength indicator) ADC and IQ (in-phase/quadrature phase) DAC included
     - Auto ACK response
     - Security engine

2. Supportive development environment
   Renesas Electronics provides an RF transceiver-compliant starter kit—the TK-RF5058+SB (from TESSERA Technology Inc.)—which you can use to develop a small-scale, low-power wireless communication system. See Connecting ZigBee® on the Application examples page for details.

3. Example applications
   - Wireless remote control (RF4CE compliant)
   - Digital TVs
   - Water meters, power meters, etc.
High performance and functionality (1/2)

High-performance CPU embedded
We provide reliable performance for system function expansion.

Performance equivalent to 16-bit microcontrollers

- At 24 MHz operation

<table>
<thead>
<tr>
<th>CPU</th>
<th>Performance (MIPS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>78K0R</td>
<td>30.5</td>
</tr>
<tr>
<td>Other company's 16-bit MCU A</td>
<td>11</td>
</tr>
</tbody>
</table>

Functions for enhancing performance
Reduces the CPU processing load.

DMA
Data exchanges can be performed automatically between the special function registers (SFRs) of the peripheral hardware and the internal RAM without the CPU, using interrupts from the timer, serial interface, or A/D converter, or software triggers.

- Functions
  - Number of channels: 4 (78K0R/Hx3), 2 (other than 78K0R/Hx3)
  - Transfer unit: 8 bits/16 bits
  - Maximum number of transfers: 1024
  - Transfer type: 2-cycle transfer
  - Transfer mode: Single transfer mode
  - Transfer targets: SFRs ↔ internal RAM

Applications
- CSI, UART (continuous transfer)
- A/D converter (continuous read of analog data, etc.)
- Timer (A/D conversion result, port value read, etc., at fixed intervals)
- Software trigger (DMA startup trigger can be generated through software)

Multiplier (78K0R/Kx3)
Function
- Executes processing of 16 bits x 16 bits = 32 bits with 1 clock

Multiplier/divider (78K0R/Kx3-L, 78K0R/Kx3-C, 78K0R/Hx3, 78K0R/Kx3-A, 78K0R/Lx3, µPD78F8043, µPD78F8058)
Function
- 16 bits x 16 bits = 32 bits, 32 bits ÷ 32 bits = 32 bits

Performance-enhancing oscillator
Oscillators enable realization of a high-performance watchdog timer, a reduction in the number of external resonators, and improved timer resolution.

- 78K0R/Kx3
  - Low-speed internal oscillator: 240 kHz (TYP.)
  - High-speed internal oscillator: 8 MHz (TYP.)
  - X1 clock
  - Subclock

- 78K0R/Kx3-L
  - Low-speed internal oscillator: 30 kHz ±10%
  - High-speed internal oscillator: 1 MHz ±13%, 8 MHz ±1.8%
  - 20 MHz ±2.4%
  - X1 clock
  - Subclock

Reason for high performance
3-stage pipeline, takes 1 clock for 1 instruction

Achieves high performance with 16-bit, 3-stage pipeline architecture

CPU core
DMA controller
Transfer source
Transfer destination
Transfer count
Internal bus
Internal SFRs
Internal bus
Internal RAM
Internal SFRs
CPU core
DMA controller
Multiplier/divider block
Multiplier
Divisor
Multiplicand
Data flow during multiplication
Data flow during division

Multiplier/division data register A
Multiplier/division data register B
Multiplier/division data register C
Multiplier/division data register D
Multiplcation/division block
Multiplier
Divisor
Multiplicand
Data flow during multiplication

16-bit All Flash 2010.12
High performance and functionality (2/2)

Enhanced functions for greater user friendliness

**Timer array unit**
- On-chip timer unit incorporating one 16-bit counter and one capture/compare register per channel
- In addition to standalone operation of each timer, many different functions can be realized by operating multiple channels together.
- Functions:
  - Interval timer
  - Frequency divider function
  - External event counter
  - Input pulse interval measurement
- In the case of the 78K0R/KG3:
  - Interval counting for up to 8 channels is possible.
  - PWM output for up to 7 channels is possible.
  - Half-bus driver for 2 channels is possible.
  - Full-bus driver is possible.
- PWM output through combination of multiple timers

**Serial array unit**
- The serial array unit provides one shift register and one buffer register per channel, allowing the configuration of a 3-wire serial communication function and simple I2C function with one channel. Using two channels, a full-duplex UART function can be realized.
- Functions:
  - CSI
  - UART
  - Simple I2C
- Example:

<table>
<thead>
<tr>
<th>Channel</th>
<th>Combination Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>UART</td>
</tr>
<tr>
<td>2</td>
<td>CSI</td>
</tr>
</tbody>
</table>

**CAN controller (78K0R/Hx3)**
- Complies with CAN protocol standard ISO 11898.
- Both standard and extended frames can be sent and received.
- Transfer rate: Up to 1 Mbps
- On-chip 16-message buffer

**LIN-UART (78K0R/Hx3)**
- Communication using 9-bit data possible
- Transfer rate: Up to 1 Mbps
- On-chip 18-message buffer (using 2 channels)
- Hardware-based auto baud rate correction capability (slave)

**LCD controller/driver (78K0R/Lx3)**
- Three different display methods can be selected according to the LCD application.
  - External resistive division
  - Edge-lit backlight
  - Capacitive division
- The 78K0R/Lx3 and 78K0R/Kx3-A provide enhanced analog features, including 12-bit A/D converters, 12-bit D/A converters, operational amplifiers, and an analog voltage reference. These features enable sensor inputs to be converted into high-resolution digital signals, and eliminate the need to externally attach analog components, allowing you to reduce the size of your system.

**Enhanced analog features (78K0R/Lx3**, **78K0R/Kx3-A)**
- Capacitive division
  - Drive capacity: High
  - Display voltage: Depends on VDD
  - Contrast adjustment feature (contrast adjustable between 2.4 V and 5.4 V)
- Voltage boosting
  - Drive capacity: Standard
  - Display voltage: Constant: does not depend on VDD.
- Shifting to high-performance 16-bit microcontrollers can be performed smoothly, taking compatibility with 8-bit microcontrollers into consideration.

**CPU that can inherit 8-bit microcontroller resources.**
- Instructions have been added to further raise efficiency and performance.
High reliability

The reliability technologies developed for automotive flash microcontrollers can be found in all our flash microcontrollers, making them a safe choice.

**Record of shipment & applications employing our flash microcontrollers**

A flash security setting function is provided to protect your software from malicious rewriting and reading.

**Software protection function**

- **PG-FPS Flash memory programmer**
  - Writing: You can disable writing.
  - Erasing: You can disable erasing.
  - Reading: No commands for reading are provided.

A boot swap function is provided to protect important programs even when power shuts down during self-programming.

**Boot swap function**

- **Boot 0**
  - Boot Program
  - Setting:
    - Writing boot 0
    - Erasing boot 0
    - Program

- **Boot 1**
  - Boot Program
  - Setting:
    - Writing boot 1
    - Setting program

The microcontroller can start normally even when momentary power shutdown occurs during boot rewriting.

**Problems during self-rewriting**

- Momentary power shutdown: Power shutdown during self-rewriting may disable microcontroller recovery.

**Software protection function**

- **Boot swap function**
  - Writing boot 1
  - Erasing boot 0
  - Boot swap

- **Boot 0**
  - Boot Program
  - Boot Program

- **Boot 1**
  - Boot Program
  - Boot Program

The microcontroller can start normally even when momentary power shutdown occurs during boot rewriting.

**Note**

- Used for more than 1,000 types of applications.

**WDT independent from CPU**

The enhanced watchdog timer (WDT) offers improved reliability and functionality equivalent to that of an external WDT.

- **WDT function**
  - Independent from CPU
  - Conventional microcontrollers
    - The watchdog timer also stops and the microcontroller may not be detected.
    - No need to worry about haywire because counts are cleared by 1-bit flags.

- **Window WDT**
  - Four types of Window settings can be selected according to the system.
  - The Window WDT can detect infinite loops.

- **Option byte function**
  - Four types of Window settings can be selected according to the system.
  - The Window WDT can detect infinite loops.

**Window WDT**

- Outline of Window WDT
  - WDT start counting
  - RESET
  - Window fully open (default)
  - Window opens.
  - Window closes.

**Option byte function**

- **000C1H**
  - No need to worry about haywire because counts are cleared by the byte instruction.

**Note**

- The microcontroller starts normally even when momentary power shutdown occurs during boot rewriting.

**Software protection function**

- **Problems during self-rewriting**
  - Momentary power shutdown:
    - Power shutdown during self-rewriting may disable microcontroller recovery.

- **Software protection function**
  - **Boot swap function**
    - Writing boot 1
    - Erasing boot 0
    - Boot swap
  - **Boot 0**
    - Boot Program
    - Setting:
      - Writing boot 0
      - Erasing boot 0
      - Program
  - **Boot 1**
    - Boot Program
    - Setting:
      - Writing boot 1
      - Setting program

**Note**

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  - Window opens.
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**Option byte function**

- **000C1H**
  - No need to worry about haywire because counts are cleared by the byte instruction.

**Note**

- The microcontroller starts normally even when momentary power shutdown occurs during boot rewriting.
Rich development environment

Various development environments for each development phase are available.

### Lineup of development environment

#### Target board for MINICUBE2
- API78K0R/LF3
- API78K0R/LG3
- API78K0R/LH3
- API78K0R/KC3-L, KD3-L, KE3-L, KF3-L, KG3-L
- API78K0R/IB3, IC3, ID3, IE3

#### Starter kit
- Made by TESSERA Technology Inc.

#### Software development

- Microcontroller integrated development environment (CubeSuite)
- Device driver configurator
- Simulator (SM+) for 78K0R
- Assembler (RA78K0R)
- Real-time OS (RX78K0R)
- Compiler (CC78K0R)
- Compiler (P78K0R/Kx3-A, P78K0R/Kx3-L)

#### Software resources

- C source can be transported almost as is

#### Debugging/verification

- On-chip debug emulator with programming function (MINICUBE2)

#### Writing

- MINICUBE2 wireless option (QB-MINI2-RF)
- Flash memory programmer (PG-FFP5)

### Rich lineup of tools for each development phase

#### Hardware

- **Full-function in-circuit emulator (IECUBE)**
  - Enables detailed debugging through equivalent emulation of microcontrollers, using trace, time measurement, and other functions.

- **On-chip debug emulator with programming function (MINICUBE2)**
  - On-chip debugging possible simply by starting integrated debugger
  - Flash programming possible by starting programming GUI
  - Supports V850, 78K0, and 78K0S All Flash microcontrollers
  - Small and lightweight

#### Software

- **Enables debugging through equivalent emulation of microcontrollers, using trace, time measurement, and other functions.**

- **Built-in boot swap function**
  - The flash memory can be programmed with the microcontroller itself, without using a programmer.

- **Buttons provided for frequently used commands**
  - Can be started up with a simple mouse click

- **Operates on Windows**
  - Can be started up with a simple mouse click

- **Evaluation possible without target prior to target connection**
  - The flash memory can be programmed with the microcontroller itself, without using a programmer.

- **GUI design similar to that of integrated debugger**
  - Enables debugging without referring to the device's user's manual.

- **Self-programming library**
  - Built-in boot swap function for protecting the boot area at power down

- **Full-function in-circuit emulator**
  - Enables debugging through equivalent emulation of microcontrollers, using trace, time measurement, and other functions.

- **System simulator**
  - Enables debugging through equivalent emulation of microcontrollers, using trace, time measurement, and other functions.

- **Self-programming library**
  - Built-in boot swap function for protecting the boot area at power down

- **Device driver configurator**
  - The setting sources of the built-in peripheral functions can be automatically generated through GUI operation

### Significant man-hours are required to develop and modify software from existing chips. We propose developing environments to support such situations.
Support for mass production

You can select the mass production method with the largest merit, according to delivery time or mass production quantity.

Notes 1.

Programming by the customer

- Support for introducing in-line programming

- Support for introducing programming processes to production line

Naito Densei Machida Mfg. Co., Ltd.
Yokogawa Digital Computer Corporation

Consultation for introduction of programming processes

Flexible support for small-volume programming and short delivery time

Notes 1.

Programming by partner companies

- Various products selectable for your purposes and price range

- Compatible list after according to product

PG-FPS
FL-PRS
NET IMPRESS series
TF-3000-8
Stick GANG Writer
StickWriter

Various functions achieved with 78K0R All Flash features and libraries

New functions can be easily constructed. One example is introduced below.

Speaking (ADPCM: Adaptive Differential Pulse Code Modulation)

System control and voice function now in one chip! Contributes to reduced costs.

ADPCM library (ADPCM-SP) features

- The above processing times are processing times for individual data

- When mounted in a system, extra processing time is required for real-time processing

- "Voice data compression can be chosen from 3 patterns.

- Voice data compression can be chosen from 3 patterns.

Connecting (ZigBee™)

Our All Flash microcontrollers comply with ZigBee PRO, providing total support for low-power wireless network applications. You can start developing your application straight away.

- ZigBee PRO, SimpleNET application

- RF4CE (wireless remote control) application

- ZigBee SDK™ (software development kit)
<table>
<thead>
<tr>
<th>Product name</th>
<th>78K0R/KE3</th>
<th>78K0R/KF3</th>
<th>78K0R/KG3</th>
<th>78K0R/KH3</th>
<th>78K0R/KJ3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pin count</td>
<td>64-pin</td>
<td>80-pin</td>
<td>100-pin</td>
<td>128-pin</td>
<td>144-pin</td>
</tr>
<tr>
<td>RAM (bytes)</td>
<td>4 K</td>
<td>6 K</td>
<td>8 K</td>
<td>10 K</td>
<td>12 K**</td>
</tr>
<tr>
<td>External interface</td>
<td>External memory expansion space</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Bus type</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Address bus</td>
<td>–</td>
<td>–</td>
<td>Selectable from 8, 12, 16, and 20</td>
<td>Selectable from 8, 12, 16, and 20</td>
<td>Selectable from 8, 12, 16, and 20</td>
</tr>
<tr>
<td>Data bus</td>
<td>–</td>
<td>–</td>
<td>8/16 bits</td>
<td>8/16 bits</td>
<td>8/16 bits</td>
</tr>
<tr>
<td>Power supply voltage</td>
<td>Normal operation mode</td>
<td>1.8 to 5.5 V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flash memory programming mode</td>
<td>2.7 to 5.5 V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum instruction execution time</td>
<td>0.05 μs (20 MHz: VDD = 2.7 to 5.5 V), 0.2 μs (5 MHz: VDD = 1.8 to 5.5 V)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clock</td>
<td>Main clock</td>
<td>High-speed system clock</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>High-speed internal oscillation clock</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subclock</td>
<td></td>
<td>Ceramic/external: 2 to 20 MHz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Crystal: 32.768 kHz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low-speed internal oscillation clock</td>
<td></td>
<td>240 kHz (Typ.) (for WDT)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I/O pins</td>
<td>Total</td>
<td>55</td>
<td>70</td>
<td>88</td>
<td>116</td>
</tr>
<tr>
<td></td>
<td>CMOS I/O</td>
<td>46</td>
<td>61</td>
<td>79</td>
<td>107</td>
</tr>
<tr>
<td></td>
<td>CMOS input</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>CMOS output</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Clock/open-drain</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Subclock</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Timer</td>
<td>16-bit timer</td>
<td>Number of channels</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Function</td>
<td>6 channels max.</td>
<td>7 channels max.</td>
<td>7 channels max.</td>
<td>10 channels max.</td>
</tr>
<tr>
<td></td>
<td>PWM</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Watchdog timer (WDT)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td></td>
<td>Real-time counter (RTC)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Serial interface</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CSI: 2 channels, UART: 1 channel</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>CSI: 2 channels, UART: 1 channel, single I/F: 2 channels</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
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<td>CSI: 2 channels, UART: 1 channel, single I/F: 2 channels</td>
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<td>CSI: 2 channels, UART: 1 channel, single I/F: 2 channels</td>
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<tr>
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<td>CSI: 2 channels, UART: 1 channel, single I/F: 2 channels</td>
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<td>–</td>
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<td>CSI: 2 channels, UART: 1 channel, single I/F: 2 channels</td>
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<td>–</td>
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<td>–</td>
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<tr>
<td></td>
<td>CSI: 2 channels, UART: 1 channel, single I/F: 2 channels</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>CSI: 2 channels, UART: 1 channel, single I/F: 2 channels</td>
<td>–</td>
<td>–</td>
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<td></td>
<td>UART: 1 channel, single I/F: 1 channel</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>UART: 1 channel, single I/F: 1 channel</td>
<td>–</td>
<td>–</td>
<td>–</td>
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<td>UART (supporting LIN)</td>
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<tr>
<td></td>
<td>UART</td>
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<td>–</td>
<td>–</td>
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<tr>
<td></td>
<td>Simple I/F</td>
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<td>–</td>
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<td></td>
<td>FC</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>LCD controller/driver</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
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<tr>
<td></td>
<td>Segment signal output</td>
<td>–</td>
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<tr>
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<td>Common signal output</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>A/D converter</td>
<td>10 bits × 8</td>
<td>10 bits × 8</td>
<td>10 bits × 16</td>
<td>10 bits × 16</td>
<td>10 bits × 16</td>
</tr>
<tr>
<td>D/A converter</td>
<td>–</td>
<td>8 bits + 2</td>
<td>8 bits + 2</td>
<td>8 bits + 2</td>
<td>8 bits + 2</td>
</tr>
<tr>
<td>DMA controller</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
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<tr>
<td>Interrupt</td>
<td>External</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Internal</td>
<td>25</td>
<td>28</td>
<td>32</td>
<td>32</td>
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</table>

**Notes:**
1. 10 KB when the self programming function is used.
2. 28 KB when the self programming function is used.
### Product specifications (2/4)

<table>
<thead>
<tr>
<th>Commercial name</th>
<th>Pin count</th>
<th>Product name</th>
<th>40-pin</th>
<th>44-pin</th>
<th>48-pin</th>
<th>52-pin</th>
<th>64-pin</th>
<th>80-pin</th>
<th>100-pin</th>
<th>48-pin</th>
<th>64-pin</th>
<th>64-pin</th>
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<tr>
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<td></td>
<td></td>
<td>16 K</td>
<td>32 K</td>
<td>48 K</td>
<td>64 K</td>
<td>16 K</td>
<td>32 K</td>
<td>48 K</td>
<td>64 K</td>
<td>128 K</td>
<td>256 K</td>
</tr>
<tr>
<td>RAM (bytes)</td>
<td></td>
<td></td>
<td>1 K</td>
<td>1.5 K</td>
<td>2 K</td>
<td>3 K</td>
<td>1 K</td>
<td>1.5 K</td>
<td>2 K</td>
<td>3 K</td>
<td>1.5 K</td>
<td>2 K</td>
</tr>
<tr>
<td><strong>External bus</strong></td>
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<td></td>
<td>-</td>
<td>-</td>
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<td>-</td>
<td>-</td>
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<td>-</td>
</tr>
<tr>
<td><strong>Power supply</strong></td>
<td></td>
<td></td>
<td>0.05 V</td>
<td>0.05 V</td>
<td>0.05 V</td>
<td>0.05 V</td>
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<td>0.05 V</td>
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<td>0.05 V</td>
<td>0.05 V</td>
</tr>
<tr>
<td><strong>Clock</strong></td>
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<td></td>
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<td>-</td>
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</tr>
<tr>
<td><strong>Other peripheral functions</strong></td>
<td></td>
<td></td>
<td>-</td>
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<td>-</td>
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<td>-</td>
<td>-</td>
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</tr>
<tr>
<td><strong>Notes</strong></td>
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<td></td>
<td>1.</td>
<td>2.</td>
<td>3.</td>
<td>4.</td>
<td>6.</td>
<td>7.</td>
<td>8.</td>
<td>9.</td>
<td>10.</td>
<td>11.</td>
</tr>
</tbody>
</table>

**Notes**

1. Under development
2. 2 KB when the self programming function is used.
3. 7 KB when the self programming function is used.
4. 4 KB when the self programming function is used.
5. Operation up to 16 MHz
6. 1.9/1.2/0.7 (Initial values): 2.2/2.38/3.53/2.68/2.84/2.99/3.15/3.30/3.45/3.61/3.76/3.92/4.07/4.22 V ±0.05 V (selectable by software), low-voltage detection for an external input pin (ELVLI) can be performed.
7. Power-on reset: 1.61 V ±0.05 V, power-down reset: 1.59 V ±0.05 V
8. Low-voltage detector (LVI): CMOS output
9. ±2% (target), 8 MHz
10. ±2% (target), 20 MHz
11. ±10% (for WDT)
12. ±10% (for WDT)
13. ±13% (target), 8 MHz
14. ±13% (target), 20 MHz
| Commercial name | 78K0R/KF3-C | 78K0R/KG3-C | 78K0R/HC3 | 78K0R/HGE3<sup>Note 1</sup> | 78K0R/HF3<sup>Note 1</sup> | 78K0R/HG3<sup>Note 1</sup> | PD78F8043 | PD78F8058<sup>Note 2</sup> |
|-----------------|-------------|-------------|-----------|-----------------|----------------|----------------|--------|----------------|}
| Pin count       | 80-pin      | 100-pin     | 48-pin    | 64-pin          | 80-pin         | 100-pin        | 56-pin | 56-pin         |
| Product memory  | 1.91/2.07/2.22/2.38/2.53/2.68/2.84/2.99/3.15 V (initial value) | 1.91/2.07/2.22/2.38/2.53/2.68/2.84/2.99/3.15 V (initial value) | 1.91/2.07/2.22/2.38/2.53/2.68/2.84/2.99/3.15 V (initial value) | 1.91/2.07/2.22/2.38/2.53/2.68/2.84/2.99/3.15 V (initial value) | 1.91/2.07/2.22/2.38/2.53/2.68/2.84/2.99/3.15 V (initial value) | 1.91/2.07/2.22/2.38/2.53/2.68/2.84/2.99/3.15 V (initial value) | 1.91/2.07/2.22/2.38/2.53/2.68/2.84/2.99/3.15 V (initial value) | 1.91/2.07/2.22/2.38/2.53/2.68/2.84/2.99/3.15 V (initial value) |
| Flash memory (bytes) | 64 K | 128 K | 64 K | 128 K | 64 K | 128 K | 64 K | 128 K |
| RAM (bytes) | 8 K | 8 K | 8 K | 8 K | 8 K | 8 K | 8 K | 8 K |
| External bus interface | External memory expansion space | External memory expansion space | External memory expansion space | External memory expansion space | External memory expansion space | External memory expansion space | External memory expansion space | External memory expansion space |
| Type | | | | | | | | |
| Bus type | | | | | | | | |
| Address bus | | | | | | | | |
| Data bus | | | | | | | | |
| Power supply voltage | | | | | | | | |
| 3.0 to 5.5 V | 3.0 to 5.5 V | 3.0 to 5.5 V | 3.0 to 5.5 V | 3.0 to 5.5 V | 3.0 to 5.5 V | 3.0 to 5.5 V | 3.0 to 5.5 V | 3.0 to 5.5 V |
| Minimum instruction execution time | | | | | | | | |
| 0.05 μs (20 MHz: VDD = 2.7 to 5.5 V) | 0.05 μs (20 MHz: VDD = 2.7 to 5.5 V) | 0.05 μs (20 MHz: VDD = 2.7 to 5.5 V) | 0.05 μs (20 MHz: VDD = 2.7 to 5.5 V) | 0.05 μs (20 MHz: VDD = 2.7 to 5.5 V) | 0.05 μs (20 MHz: VDD = 2.7 to 5.5 V) | 0.05 μs (20 MHz: VDD = 2.7 to 5.5 V) | 0.05 μs (20 MHz: VDD = 2.7 to 5.5 V) | 0.05 μs (20 MHz: VDD = 2.7 to 5.5 V) |
| Clock | | | | | | | | |
| Main clock | Ceramic/crystal/external clock: 2 to 20 MHz | Ceramic/crystal/external clock: 2 to 20 MHz | Ceramic/crystal/external clock: 2 to 20 MHz | Ceramic/crystal/external clock: 2 to 20 MHz | Ceramic/crystal/external clock: 2 to 20 MHz | Ceramic/crystal/external clock: 2 to 20 MHz | Ceramic/crystal/external clock: 2 to 20 MHz | Ceramic/crystal/external clock: 2 to 20 MHz | Ceramic/crystal/external clock: 2 to 20 MHz |
| CPU clock | 4 MHz | 4 MHz | 4 MHz | 4 MHz | 4 MHz | 4 MHz | 4 MHz | 4 MHz | 4 MHz |
| Voltage | ±40 to 0.09 V, power-down reset: 1.59 V | ±40 to 0.09 V, power-down reset: 1.59 V | ±40 to 0.09 V, power-down reset: 1.59 V | ±40 to 0.09 V, power-down reset: 1.59 V | ±40 to 0.09 V, power-down reset: 1.59 V | ±40 to 0.09 V, power-down reset: 1.59 V | ±40 to 0.09 V, power-down reset: 1.59 V | ±40 to 0.09 V, power-down reset: 1.59 V | ±40 to 0.09 V, power-down reset: 1.59 V |
| Temperature | 85 °C | 85 °C | 85 °C | 85 °C | 85 °C | 85 °C | 85 °C | 85 °C | 85 °C |
| RAM (bytes) | 6 K | 8 K | 6 K | 8 K | 6 K | 8 K | 6 K | 8 K |
| Flash memory (bytes) | 8 K | 16 K | 8 K | 16 K | 8 K | 16 K | 8 K | 16 K |
| Clock | | | | | | | | |
| Main clock | Ceramic/crystal/external clock: 2 to 20 MHz | Ceramic/crystal/external clock: 2 to 20 MHz | Ceramic/crystal/external clock: 2 to 20 MHz | Ceramic/crystal/external clock: 2 to 20 MHz | Ceramic/crystal/external clock: 2 to 20 MHz | Ceramic/crystal/external clock: 2 to 20 MHz | Ceramic/crystal/external clock: 2 to 20 MHz | Ceramic/crystal/external clock: 2 to 20 MHz | Ceramic/crystal/external clock: 2 to 20 MHz |
| CPU clock | 4 MHz | 4 MHz | 4 MHz | 4 MHz | 4 MHz | 4 MHz | 4 MHz | 4 MHz | 4 MHz |
| Voltage | ±40 to 0.09 V, power-down reset: 1.59 V | ±40 to 0.09 V, power-down reset: 1.59 V | ±40 to 0.09 V, power-down reset: 1.59 V | ±40 to 0.09 V, power-down reset: 1.59 V | ±40 to 0.09 V, power-down reset: 1.59 V | ±40 to 0.09 V, power-down reset: 1.59 V | ±40 to 0.09 V, power-down reset: 1.59 V | ±40 to 0.09 V, power-down reset: 1.59 V | ±40 to 0.09 V, power-down reset: 1.59 V |
| Temperature | 85 °C | 85 °C | 85 °C | 85 °C | 85 °C | 85 °C | 85 °C | 85 °C | 85 °C |
| RAM (bytes) | 6 K | 8 K | 6 K | 8 K | 6 K | 8 K | 6 K | 8 K |
| Flash memory (bytes) | 8 K | 16 K | 8 K | 16 K | 8 K | 16 K | 8 K | 16 K |

Notes:
1. Under development
2. 7 KB when the self programming function is used.
3. Three of these pins are connected to the IO-Link Transceiver.
4. Four of these pins are connected to the RF Transceiver.
5. Power-on clear (POC) is prohibited.

Remark:
- The specifications of products still under development are subject to change without notice.
<table>
<thead>
<tr>
<th>Commercial name</th>
<th>78K0R/IB3</th>
<th>78K0R/IC3</th>
<th>78K0R/ID3</th>
<th>78K0R/I3</th>
<th>78K0R/LF3</th>
<th>78K0R/LG3</th>
<th>78K0R/LH3</th>
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</thead>
<tbody>
<tr>
<td>Pin count</td>
<td>30-pin</td>
<td>38-pin</td>
<td>44-pin</td>
<td>48-pin</td>
<td>52-pin</td>
<td>64-pin</td>
<td>80-pin</td>
</tr>
<tr>
<td>RAM (bytes)</td>
<td>1 K</td>
<td>1.5 K</td>
<td>1.5 K</td>
<td>1 K</td>
<td>2 K</td>
<td>64 K</td>
<td>64 K</td>
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<tr>
<td>Flash memory (bytes)</td>
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<td>32 K</td>
<td>16 K</td>
<td>32 K</td>
<td>48 K</td>
<td>64 K</td>
<td>64 K</td>
</tr>
<tr>
<td>Power-on clear</td>
<td>1.61 V</td>
<td>1.91 V</td>
<td>2.22 V</td>
<td>2.53 V</td>
<td>2.84 V</td>
<td>3.15 V</td>
<td>3.45 V</td>
</tr>
<tr>
<td>Low-voltage detector (LVI)</td>
<td>2.7 V±0.1%</td>
<td>2.7 V±0.1%</td>
<td>2.7 V±0.1%</td>
<td>2.7 V±0.1%</td>
<td>2.7 V±0.1%</td>
<td>2.7 V±0.1%</td>
<td>2.7 V±0.1%</td>
</tr>
<tr>
<td>Oscillation clock (Ceramic/crystal/external clock)</td>
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<td>2 MHz±2%</td>
<td>2 MHz±2%</td>
<td>2 MHz±2%</td>
<td>2 MHz±2%</td>
<td>2 MHz±2%</td>
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<tr>
<td>Interface</td>
<td>External memory expansion space</td>
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<td>–</td>
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<tr>
<td>Interrupt</td>
<td>External</td>
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<td>–</td>
<td>–</td>
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<tr>
<td>Multiplier/divider</td>
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<tr>
<td>Low-voltage detector (LVI)</td>
<td>(selectable by software)</td>
<td>(selectable by software)</td>
<td>(selectable by software)</td>
<td>(selectable by software)</td>
<td>(selectable by software)</td>
<td>(selectable by software)</td>
<td>(selectable by software)</td>
</tr>
<tr>
<td>Other peripheral functions</td>
<td>Comparator: 2 channels, programmable gain amplifier: 1 channel</td>
<td>Comparator: 2 channels, programmable gain amplifier: 1 channel</td>
<td>Comparator: 2 channels, programmable gain amplifier: 1 channel</td>
<td>Comparator: 2 channels, programmable gain amplifier: 1 channel</td>
<td>Comparator: 2 channels, programmable gain amplifier: 1 channel</td>
<td>Comparator: 2 channels, programmable gain amplifier: 1 channel</td>
<td>Comparator: 2 channels, programmable gain amplifier: 1 channel</td>
</tr>
<tr>
<td>Operating temperature</td>
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<td>–40 to +85°C</td>
<td>–40 to +85°C</td>
<td>–40 to +85°C</td>
<td>–40 to +85°C</td>
<td>–40 to +85°C</td>
<td>–40 to +85°C</td>
</tr>
</tbody>
</table>

Notes:
1. 2 KB when the self-programming function is used.
2. The 40 MHz clock is only supplied to the timer array unit and the 20 MHz clock is supplied to the CPU and peripheral functions.
3. The 40 MHz clock is only supplied to the timer array unit and the 20 MHz clock is supplied to the CPU and peripheral functions.
4. Values in parentheses are the number of signal outputs when 80 pin is used. High-level drive is also restricted to 1 channel.
5. The A/D converter has 10-bit resolution in the µPD78F15A.
6. Not available in the µPD78F15A.
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