RH850 FOR HIGH-END AUTOMOTIVE APPLICATIONS

- Body & Gateway
- Chassis & Safety
- Instrument Cluster & Infotainment
- Powertrain
- EV/HEV Motor Control

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AUTOMOTIVE CONTROL SYSTEMS

**Body Electronics**
Healthy flexibility

**Climate Control, Door Modules, Lighting Systems, BCU & Gateway:**
Renesas’ MCU product portfolio is based on common design platforms to achieve optimised scalability from 16 to 32bit. A wide range of analog and power products complete the repertory providing high performance and high reliability solutions.

**Chassis & Safety**
Failure is not an option

**Powersteering, Brake Systems & Airbags:**
Renesas is succeeding in the market of safety relevant applications since many years - offering products meeting highest functional safety requirements for power steering, ABS or Airbag systems, where ASIL D compliance or redundant CPU core are a must.

**Powertrain & Hybrid**
Meet tomorrow’s challenges

**Powertrain:**
Renesas’ leading edge technology for demanding Powertrain and Transmission Control requirements. Solutions targeting CO2 emission reduction and fuel economy improvement: Microcontrollers, Mixed Signal Devices & Power MOSFET.
RH850 F1KX TECHNOLOGY FEATURES

- **CPU**: Worlds leading 32bit MCU core in automotive
- **Power**: 40nm MONOS Flash technology and advanced power down concepts
  High-temperature support with low leakage influence
- **Safety**: “Functional Safety” support based on ISO 26262
  Development compliant for ASIL A to ASIL B
- **Family**: Maximum coverage based on optimized family concept
  Dedicated product line-ups for Powertrain, Chassis, Body, Airbag and Dashboard
  Wide memory range from 512kB to 8MB Flash
  Package scalability: 48 pin LQFP to 324 BGA
- **Security**: Support of up-coming security standards like SHE (Secure Hardware Extension) and HSM (Hardware Security Module)
- **Quality**: Highest quality level in market
WORLD LEADING BODY SOLUTIONS

Body Requirements

- Support **Wide Variety** of Applications

- **Integrate** multiple applications into one ECU

- **Safety & Security**

- **Low power**

Renesas Solution

- **Wide line-up to cover various body systems**
  - Memory: 512KB to 8MB
  - Package: 48pin to 324pin

- **High performance capability and full coverage of networking**
  - Performance: 120MHz Single- to 240MHz Dual Core
  - Network: LIN, CAN, CAN FD, FlexRay, Ethernet AVB, SENT

- Functional Safety support based on ISO 26262
- Development compliant to support ASIL B requirements
- Support of security standards like SHE & EVITA (HSM)

- **Low power operation by support of low power sampler**
  - Power: 0.3 - 0.5mA/MHz (typ.)/ 0.75mA/MHz (max.)
  - Low Power Sampler to monitor analog/digital inputs without CPU interaction to support ECU low power target of < 100µA
RH850 F1KX-SERIES ADVANTAGES
WHAT IS UPGRADED? - ADVANTAGES OF F1KX SERIES (1/2)

Performance Upgrade

- Speed and Power consumption optimized G3HK Core for all F1Kx devices

- Designed to cover up to 240 MHz Single and Multicore with best in class performance / power consumption ratio!

- Max. 180mA @240MHz Single Core (Target Specification)

- Typ. 0,5mA/ MHz / Max. 0,75mA/MHz (Target Specification)

- RUN MODE Power Consumption (Single Core)
  - Typ. 70mA / Max. 185mA @240MHz
  - Typ. 90mA / Max. 205mA @240MHz (During flash programming)
  - Common IP’s and common CPU offer best scalability to serve a wide range of applications

Feature Upgrade

- CAN FD (up to 12 channel) ISO conform (F1K, F1KM, F1KH)

- Ethernet AVB for all devices > 120MHz/ > 2MB (F1KM-S4 176pin and above, F1KH)

- Dual Ethernet AVB for F1KH 8M planned

- RAM/ Flash ratio improved from 1:10 to 1:8 (> 2MB)
  - e.g. +128KB RAM on 4MB device (384KB -> 512KB)

- High Speed Serial Flash I/F to connect additional memories
  - (F1KM-S4 144pin and above, F1KH)

- SENT (Single Edge Nibble Transmission) I/F offers connection to additional sensors: (F1KM, F1KH)
WHAT IS UPGRADED? - ADVANTAGES OF F1KX SERIES (2/2)

Functional safety concept … state of the art
- Processor Element Guard
- Peripheral Guard
- Memory Protection Unit (16 areas can be set)
- ECC for all Memories (Code/Data Flash and on-chip RAM)

Unified security mechanisms … state of the art
- ICU-S (SHE Type) (≤ 2MB; used in F1KM-S1/F1K)
- ICU-M (EvitaMid Type) (> 2MB/120MHz, used in F1KM-S4/F1KH)

General Features
- Pin compatibility as much as possible to first generation F1x
- Designed for large reusability of 1st generation SW and tools
CLASSIFICATION OF F1KX SERIES

Classification

F1K Classic
Up to 120MHz Single Core offering Performance and CAN FD

- F1KH(igh)
  Up to 2x 240MHz Dual Core, marked by Dx

- F1KM(id)
  Up to 240MHz Single Core, marked by Sx
  Offering options in terms of CPU Clock, RAM size and Data Flash size

Dx  F1KH
    up to 2x 240MHz
    3-8MB Flash
    100-324pin

Sx  F1KM
    up to 240MHz
    512-4MB Flash
    48-272pin

F1K  up to 120MHz
     768K-2MB Flash
     100-176pin
## RH850/F1KX SERIES LINE-UP

<table>
<thead>
<tr>
<th>Code Flash</th>
<th>Data Flash</th>
<th>Product</th>
<th>1M</th>
<th>1M</th>
<th>1M</th>
</tr>
</thead>
<tbody>
<tr>
<td>8M</td>
<td>256K</td>
<td>F1KH-D8</td>
<td>512K</td>
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<td>512K</td>
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<td>6M</td>
<td>128K</td>
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<td>384K</td>
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<td>512K</td>
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<td>F1K</td>
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<td>F1KM-S1</td>
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</table>

Window shows RAM size

<table>
<thead>
<tr>
<th>Package</th>
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<tbody>
<tr>
<td>LQFP</td>
<td>FPBGA</td>
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# RH850/F1KX SERIES LINE-UP

<table>
<thead>
<tr>
<th>Code Flash</th>
<th>Data Flash</th>
<th>Product</th>
<th>Code Flash</th>
<th>Flash Size</th>
<th>Package</th>
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</thead>
<tbody>
<tr>
<td>8M</td>
<td>256K</td>
<td>F1KH-D8</td>
<td>1M</td>
<td>512K</td>
<td>LQFP</td>
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<tr>
<td>4M</td>
<td>128K</td>
<td>F1KM-S4</td>
<td>1M</td>
<td>512K</td>
<td>FPBGA</td>
</tr>
<tr>
<td>2M</td>
<td>64K</td>
<td>F1K</td>
<td>1M</td>
<td>192K</td>
<td></td>
</tr>
<tr>
<td>1M</td>
<td>128K</td>
<td>F1KM-S1</td>
<td>1M</td>
<td>128K</td>
<td></td>
</tr>
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</table>

Window shows RAM size
# RH850/F1KX SERIES LINEUP

## 512K - 8MB

<table>
<thead>
<tr>
<th>FLASH</th>
<th>RAM</th>
<th>DFlash</th>
<th>Core</th>
<th>Group</th>
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<td>F1KH-D8</td>
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<tr>
<td>4M</td>
<td>512k</td>
<td>128K</td>
<td>1</td>
<td>F1KM-S4</td>
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<tr>
<td>2M</td>
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<td>F1K</td>
</tr>
<tr>
<td>1M</td>
<td>128K</td>
<td></td>
<td></td>
<td>F1KM-S1</td>
</tr>
</tbody>
</table>

- **F1K**: Dual Core up to 240 MHz
- **F1KM**: Single Core up to 240 MHz
- **F1K**: Single Core up to 120 MHz

<table>
<thead>
<tr>
<th>Package</th>
<th>Qty</th>
<th>Dimensions</th>
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<td>10x10mm</td>
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<td>12x12mm</td>
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<td>176</td>
<td>233</td>
<td>14x14mm</td>
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<tr>
<td>272</td>
<td>324</td>
<td>20x20mm</td>
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<td></td>
<td></td>
<td>24x24mm</td>
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<tr>
<td>15x15mm</td>
<td></td>
<td>17x17mm</td>
</tr>
<tr>
<td>19x19mm</td>
<td></td>
<td>19x19mm</td>
</tr>
</tbody>
</table>

- **QFP 0.5mm pitch**
- **BGA 0.8mm pitch**

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## RH850/F1KX SERIES LINEUP PRODUCT NAMES

<table>
<thead>
<tr>
<th>Flash</th>
<th>RAM</th>
<th>DFlash</th>
<th>Core</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>8M</td>
<td>1M</td>
<td>256K</td>
<td>2</td>
<td>F1KH-D8</td>
</tr>
<tr>
<td>4M</td>
<td>512k</td>
<td>128K</td>
<td>1</td>
<td>F1KM-S4</td>
</tr>
<tr>
<td>2M</td>
<td>192K</td>
<td>64K</td>
<td></td>
<td>F1K</td>
</tr>
<tr>
<td>1M</td>
<td>128K</td>
<td></td>
<td></td>
<td>F1KM-S1</td>
</tr>
</tbody>
</table>

### Flash Memory and RAM Options
- 8M: 256K
- 4M: 512K
- 2M: 192K
- 1M: 128K

### Core Options
- Option 1: F1KM-S4
- Option 2: F1K

### Group Options
- Option 1: F1KH-D8
- Option 2: F1KM-S1

### Memory Sizes
- 8M: 256K
- 4M: 512K
- 2M: 192K
- 1M: 128K

### Core Group
- Option 1: F1KH-D8
- Option 2: F1KM-S1

### Packages
- QFP 0.5mm pitch
- BGA 0.8mm pitch

### Temperature Ranges
- 3 Ta = -40°C to +105°C
- 4 Ta = -40°C to +125°C

### Product Codes
- R7F7016453xFP
- R7F7016473xFP
- R7F7016493xFP
- R7F701651xABG
- R7F701653xABG
- R7F701581xAFP
- R7F701583xFP
- R7F701587xFP

### Package Sizes
- 48-7x7mm
- 64-10x10mm
- 80-12x12mm
- 100-14x14mm
- 144-20x20mm
- 176-24x24mm
- 233-15x15mm
- 272-17x17mm
- 324-19x19mm
RH850/F1KX SERIES SCALABILITY

<table>
<thead>
<tr>
<th>Model</th>
<th>Frequency (MHz)</th>
<th>Flash Memory (MB)</th>
<th>Data Flash (KB)</th>
<th>RAM (KB)</th>
<th>CAN, LIN, FlexRay, Ethernet AVB</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1KM-S1</td>
<td>120</td>
<td>1MB</td>
<td>64KB</td>
<td>256KB</td>
<td>ICU-S</td>
</tr>
<tr>
<td>F1K</td>
<td>120</td>
<td>4MB</td>
<td>64KB</td>
<td>512KB</td>
<td>ICU-M, ICU-S</td>
</tr>
<tr>
<td>F1KM-S4</td>
<td>240</td>
<td>8MB</td>
<td>128KB</td>
<td>1MB</td>
<td>ICU-M, FlexRay, Ethernet AVB</td>
</tr>
<tr>
<td>F1KH-D8</td>
<td>2x 240</td>
<td>8MB</td>
<td>256KB</td>
<td>256KB</td>
<td>ICU-M</td>
</tr>
</tbody>
</table>

* For pin count 176 or higher

※ For detailed specifications of each product, refer to the lineup and peripheral function information in this document
RH850/F1KX SERIES DEVICE PERIPHERALS BY PACKAGE
## RH850/F1K PERIPHERALS

### F1K Common Functions

<table>
<thead>
<tr>
<th>Category</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU</td>
<td>FPU (Single-precision)</td>
</tr>
<tr>
<td></td>
<td>Operating System Timer x 5</td>
</tr>
<tr>
<td></td>
<td>Encoder Timer</td>
</tr>
<tr>
<td></td>
<td>Watchdog Timer x 2</td>
</tr>
<tr>
<td>Security</td>
<td>ICU-S (SHE)</td>
</tr>
<tr>
<td></td>
<td>Clock Monitor</td>
</tr>
<tr>
<td></td>
<td>Core Voltage Monitor</td>
</tr>
<tr>
<td></td>
<td>CRC</td>
</tr>
<tr>
<td></td>
<td>ECC</td>
</tr>
<tr>
<td></td>
<td>Power on Clear/ LVI</td>
</tr>
<tr>
<td></td>
<td>Memory Protection Unit</td>
</tr>
<tr>
<td></td>
<td>PE guard</td>
</tr>
<tr>
<td></td>
<td>Peripheral guard (PBG)</td>
</tr>
<tr>
<td>Other</td>
<td>DMA x 16</td>
</tr>
<tr>
<td></td>
<td>Low Power Sampler</td>
</tr>
<tr>
<td></td>
<td>Motor Control</td>
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</table>

### F1K Peripherals

<table>
<thead>
<tr>
<th>Category</th>
<th>F1K Peripherals</th>
<th>100</th>
<th>144</th>
<th>176</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timer</td>
<td>TAUD (16-bit x 16)</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td></td>
<td>TAUB (16-bit x 16)</td>
<td>1</td>
<td>1</td>
<td>2</td>
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<tr>
<td></td>
<td>TAUJ (32-bit x 4)</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Real-Time Counter</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Sub Oscillator (32.768kHz)</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td></td>
<td>ADC0 (ext. MUX / T&amp;H x 6)</td>
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<td>36</td>
<td>36</td>
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<tr>
<td></td>
<td>ADC1</td>
<td>-</td>
<td>12</td>
<td>24</td>
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<tr>
<td>A/D</td>
<td>CAN/ CAN FD 1)</td>
<td>6/ 6</td>
<td>6/ 6</td>
<td>7/ 6 1)</td>
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<tr>
<td></td>
<td>LIN/ UART</td>
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<td>LIN(Master)</td>
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<td>10</td>
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<td>CSIG/ CSIH</td>
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<td>2/ 4</td>
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<td>Serial IF</td>
<td>IO Port</td>
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<td>External Interrupt</td>
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<td>17</td>
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<td>PWM-Diag</td>
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<td>Key Return</td>
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1) 6x CAN FD + 1x CAN
# RH850/F1KM-S1 PERIPHERALS

## F1KM-S1 Common Functions

<table>
<thead>
<tr>
<th>Category</th>
<th>Functions</th>
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</thead>
<tbody>
<tr>
<td>CPU</td>
<td>FPU (Single-precision)</td>
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<td>Operating System Timer</td>
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<td>Security</td>
<td>ICU-S (SHE)</td>
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<td>Core Voltage Monitor</td>
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<td>ECC</td>
</tr>
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<td>Power on Clear/ LVI</td>
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<td>Memory Protection Unit</td>
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<td>PE guard</td>
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<td>Peripheral guard (PBG)</td>
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<tr>
<td>Other</td>
<td>DMA x 16</td>
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<td></td>
<td>Low Power Sampler</td>
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<td>Motor Control</td>
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## F1KM-S1 Peripherals

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## Table of Peripherals

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<thead>
<tr>
<th></th>
<th>48</th>
<th>64</th>
<th>80</th>
<th>100</th>
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<tbody>
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<td>Timer</td>
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<tr>
<td>A/D</td>
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</tr>
<tr>
<td>Serial IF</td>
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</tr>
<tr>
<td>Other</td>
<td></td>
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</tr>
</tbody>
</table>

### Timer
- TAUD (16-bit x 16)
- TAUB (16-bit x 16)
- TAUJ (32-bit x 4)
- Real-Time Counter
- Sub Oscillator (32.768kHz)

### A/D
- ADC0 (ext. MUX / T&H x 6)
- ADC1

### Serial IF
- CAN FD
- LIN/ UART
- LIN(Master)
- CSIG/ CSIH
- I²C
- SENT
- IOPort
- External Interrupt
- PWM-Diag
- Key Return
RH850/F1KM-S4 PERIPHERALS

F1KM-S4 Common Functions

- CPU:
  - FPU (Single-precision)
- Timer:
  - Operating System Timer x 5
  - Encoder Timer
  - Watchdog Timer x 2
- Security:
  - ICU-M (Evita-Mid)
- Safety:
  - Clock Monitor
  - Core Voltage Monitor
  - ECC
  - Power on Clear/ LVI
  - Memory Protection Unit
  - PE guard
  - Peripheral guard (PBG/HBG)
- Other:
  - DMA x 32
  - Low Power Sampler
  - Motor Control

F1KM-S4 Peripherals

<table>
<thead>
<tr>
<th>Timer</th>
<th>100</th>
<th>144</th>
<th>176</th>
<th>233</th>
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<tr>
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<td>1</td>
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<td>✓</td>
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<td>ADC1</td>
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<tr>
<td>LIN(Master)</td>
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<td>12</td>
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<td>174</td>
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<td>PWM-Diag</td>
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<td>64</td>
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<td>80</td>
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1) A ch, B ch  2) 23 bit Address Bus  3) 24 bit Address Bus
# RH850/F1KH-D8 PERIPHERALS

## F1KH-D8 Common Functions

<table>
<thead>
<tr>
<th></th>
<th>CPU</th>
<th>Timer</th>
<th>Security</th>
<th>Other</th>
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<tbody>
<tr>
<td>CPU</td>
<td>FPU (Single-precision)</td>
<td>Operating System Timer x 10</td>
<td>ICU-M (Evita-Mid)</td>
<td>Low Power Sampler</td>
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<td>Encoder Timer</td>
<td></td>
<td>Motor Control</td>
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<td></td>
<td></td>
<td>Watchdog Timer x 3</td>
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<tr>
<td>Safety</td>
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</tr>
<tr>
<td>ICUM (Evita-Mid)</td>
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<tr>
<td>Other</td>
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## F1KH-D8 Peripherals

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<th>Other</th>
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<td>CPU</td>
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<td>Operating System Timer x 10</td>
<td>ICU-M (Evita-Mid)</td>
<td>Low Power Sampler</td>
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<td>Encoder Timer</td>
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<td>Motor Control</td>
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<td>Safety</td>
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<td>Other</td>
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### CPU Functions
- FPU (Single-precision)
- Operating System Timer x 10
- Encoder Timer
- Watchdog Timer x 3

### Timer Functions
- FPU (Single-precision)
- Operating System Timer x 10
- Encoder Timer
- Watchdog Timer x 3

### Security Functions
- ICU-M (Evita-Mid)
- Core Voltage Monitor
- CRC
- ECC
- Power on Clear/ LVI
- Memory Protection Unit
- PE guard
- Peripheral guard (PBG/HBG)

### Other Functions
- Low Power Sampler
- Motor Control

## F1KH-D8 Peripherals Table

<table>
<thead>
<tr>
<th>Feature</th>
<th>176</th>
<th>233</th>
<th>324</th>
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<tbody>
<tr>
<td>TAUD (16-bit x 16)</td>
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<td>1</td>
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<tr>
<td>TAUB (16-bit x 16)</td>
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<td>2</td>
<td>2</td>
</tr>
<tr>
<td>TAUJ (32-bit x 4)</td>
<td>4</td>
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<td>4</td>
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<tr>
<td>Real-Time Counter</td>
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<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Sub Oscillator (32.768kHz)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>ADC0 (ext. MUX / T&amp;H x 6)</td>
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<td>34</td>
<td>34</td>
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<tr>
<td>ADC1</td>
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<td>12</td>
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<tr>
<td>LIN/ UART</td>
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<td>LIN(Master)</td>
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<tr>
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<td>2 1)</td>
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<td>MEMC</td>
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<td>✓ 2)</td>
<td>✓ 3)</td>
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<td>✓</td>
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<td>35</td>
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<td>PWM-Diag</td>
<td>72</td>
<td>80</td>
<td>96</td>
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<tr>
<td>Key Return</td>
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1) A ch, B ch  2) 23 bit Address Bus  3) 24 bit Address Bus
## MEMORY SIZE/PACKAGE COMPARISON

<table>
<thead>
<tr>
<th>No</th>
<th>ITEM</th>
<th>F1KH-D8</th>
<th>F1KM-S4</th>
<th>F1KM-S1</th>
<th>F1K</th>
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<tbody>
<tr>
<td>1</td>
<td>Code Flash Size</td>
<td>8 MB</td>
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<td>Local RAM</td>
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<td>Global RAM</td>
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<td>192 KB</td>
<td>—</td>
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<td>Retention RAM</td>
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<td>32 KB</td>
<td>64 KB</td>
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<td>4</td>
<td>Pin Count</td>
<td>176/ 233/ 324</td>
<td>100/ 144/ 176/ 233/ 272</td>
<td>48/ 64/ 80/ 100</td>
<td>100/ 144/ 176</td>
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※ For detailed code/data flash size, RAM size, and pin count, please refer to the lineup information in this document or the hardware manual for each device.
# CPU SUBSYSTEM/CLOCK FUNCTION COMPARISON

<table>
<thead>
<tr>
<th>No</th>
<th>ITEM</th>
<th>F1KH-D8</th>
<th>F1KM-S4</th>
<th>F1KM-S1</th>
<th>F1K</th>
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<tbody>
<tr>
<td>5</td>
<td>CPU Core</td>
<td>G3KH 1) x2</td>
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<tr>
<td>6</td>
<td>CPU Frequency (Max.)</td>
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<td>120MHz</td>
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<td>FPU Function</td>
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<td>Interrupt Priority</td>
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<td>Instruction Cache</td>
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<td>11</td>
<td>Memory Protection (MPU)</td>
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<td>16 areas can be set</td>
<td></td>
<td></td>
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<td>12</td>
<td>PE Guard (PEG)</td>
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<td>Included</td>
<td>Included</td>
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</tr>
<tr>
<td>13</td>
<td>Peripheral Guard (PBG/HBG)</td>
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<td>Included (only PBG)</td>
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<td></td>
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<tr>
<td>14</td>
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<td>16/20/24 MHz</td>
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<tr>
<td>15</td>
<td>Sub Oscillator (SubOSC)</td>
<td>32.768 kHz</td>
<td>32.768 kHz (144pin and up)</td>
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<td>32.768 kHz (144pin and up)</td>
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<tr>
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<td>HS IntOSC User Calibration Function</td>
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<td>Included (±1%)</td>
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<td>PLL1 (without SSCG)</td>
<td>PLL (without SSCG)</td>
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<td></td>
<td>PLL1 without SSCG</td>
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1) G3KH is compatible with G3K at the object code level. It is also compatible with G3M except for the double-precision FPU and instruction cache functions.
## PORT/ADC/TIMER COMPARISON

<table>
<thead>
<tr>
<th>No</th>
<th>ITEM</th>
<th>F1KH-D8</th>
<th>F1KM-S4</th>
<th>F1KM-S1</th>
<th>F1K</th>
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<tbody>
<tr>
<td>18</td>
<td>I/O port</td>
<td>Max. 246</td>
<td>Max. 214</td>
<td>Max. 81</td>
<td>Max. 150</td>
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<tr>
<td>19</td>
<td>A/D converter</td>
<td>ADC0</td>
<td>Max. 34 ch (12bit x 16ch + 10bit x 18ch)</td>
<td>Max. 34 ch (12bit x 16ch + 10bit x 18ch)</td>
<td>Max. 36 ch (12bit x 16ch + 10bit x 20ch)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ADC1</td>
<td>Max. 36 ch (12bit x 16ch + 10bit x 20ch)</td>
<td>Max. 36 ch (12bit x 16ch + 10bit x 20ch)</td>
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<tr>
<td>20</td>
<td>Timer Array Unit D (TAUD)</td>
<td>1 unit (16bit x 16ch /unit)</td>
<td>1 unit (16bit x 16ch /unit)</td>
<td>1 unit (16bit x 16ch /unit)</td>
<td>1 unit (16bit x 16ch /unit)</td>
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<tr>
<td>21</td>
<td>Timer Array Unit B (TAUB)</td>
<td>2 unit (16bit x 16ch /unit)</td>
<td>Max. 2 unit (16bit x 16ch /unit)</td>
<td>1 unit (16bit x 16ch /unit) (80pin and up)</td>
<td>Max. 2 unit (16bit x 16ch /unit)</td>
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<tr>
<td>22</td>
<td>Timer Array Unit J (TAUJ)</td>
<td>4 unit (32bit x 4ch /unit)</td>
<td>4 unit (32bit x 4ch /unit)</td>
<td>4 unit (32bit x 4ch /unit)</td>
<td>2 unit (32bit x 4ch /unit)</td>
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<tr>
<td>23</td>
<td>Operating System Timer (OSTM)</td>
<td>10 unit</td>
<td>5 unit</td>
<td>1 unit</td>
<td>5 unit</td>
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<tr>
<td>24</td>
<td>Real-Time Counter (RTCA)</td>
<td>1 unit</td>
<td>1 unit</td>
<td>1 unit (144pin and up)</td>
<td></td>
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<tr>
<td>25</td>
<td>Encoder Timer (ENCA)</td>
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<td>1 unit</td>
<td>1 unit</td>
<td>1 unit</td>
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<tr>
<td>26</td>
<td>Window Watchdog Timer</td>
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<td>2 unit</td>
<td>2 unit</td>
<td>2 unit</td>
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※ The value described as max is the maximum value for the series. For individual device specifications, please refer to the peripheral function information found in this document or in the user's manual.
## NETWORK FUNCTION COMPARISON

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<th>No</th>
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<th>F1K</th>
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<tr>
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<td>Max. 4ch</td>
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<td>Max. 2ch</td>
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<td>Clocked Serial Interface H (CSIH)</td>
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<td>4ch</td>
<td>Max. 4ch</td>
<td>4ch</td>
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<td>RS CAN</td>
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<td>RS CANFD</td>
<td>Max. 12ch</td>
<td>8ch</td>
<td>Max. 6ch</td>
<td>6ch</td>
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<td>29</td>
<td>CAN Interface</td>
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<td>30</td>
<td>LIN/UART Interface (RLIN3)</td>
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<td>Max. 8ch</td>
<td>Max. 4ch</td>
<td>Max. 6ch</td>
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<td>31</td>
<td>LIN Master Interface (RLIN2)</td>
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<td>8ch</td>
<td>Max. 3ch</td>
<td>Max. 10ch</td>
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<td>32</td>
<td>12C Interface (RIIC)</td>
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<td>2ch</td>
<td>2ch</td>
<td>1ch</td>
</tr>
<tr>
<td>33</td>
<td>FlexRay</td>
<td>2ch(Ach,Bch)</td>
<td>2ch(Ach,Bch)</td>
<td>n/a</td>
<td>n/a</td>
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<tr>
<td>34</td>
<td>Ethernet AVB (MII)</td>
<td>Max. 2ch</td>
<td>1ch</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(176pin and up)</td>
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<tr>
<td>35</td>
<td>Single Edge Nibble Transmission</td>
<td>2ch</td>
<td>Max. 2ch</td>
<td>2ch</td>
<td>n/a</td>
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</tbody>
</table>

※ The value described as max is the maximum value for the series. For individual device specifications, please refer to the peripheral function information found in this document or in the user’s manual.
# OTHER FUNCTION COMPARISON

<table>
<thead>
<tr>
<th>No</th>
<th>ITEM</th>
<th>F1KH-D8</th>
<th>F1KM-S4</th>
<th>F1KM-S1</th>
<th>F1K</th>
</tr>
</thead>
<tbody>
<tr>
<td>36</td>
<td>External memory I/F (MEMC)</td>
<td>Included</td>
<td>n/a</td>
<td>n/a</td>
<td></td>
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<tr>
<td>37</td>
<td>Serial Flash Memory I/F (SFMA)</td>
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<td>n/a</td>
<td>n/a</td>
<td></td>
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<td>38</td>
<td>Memory Card I/F (MMCA)</td>
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<td>n/a</td>
<td>n/a</td>
<td></td>
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<tr>
<td>39</td>
<td><strong>External Interrupts</strong></td>
<td>Maskable</td>
<td>24</td>
<td>Max. 24</td>
<td>Max. 13</td>
</tr>
<tr>
<td></td>
<td>Non-maskable (NMI)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td>40</td>
<td>Data CRC (DCRA)</td>
<td>4ch</td>
<td>4ch</td>
<td>Max. 4ch</td>
<td>4ch</td>
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<tr>
<td>41</td>
<td>PWM diagnosis (PWM_DIAG)</td>
<td>Max. 96ch</td>
<td>Max. 96ch</td>
<td>Max. 48ch</td>
<td>Max. 72ch</td>
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<tr>
<td>42</td>
<td>Motor Control</td>
<td>1 unit</td>
<td>1 unit</td>
<td>1 unit</td>
<td>1 unit</td>
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<tr>
<td>43</td>
<td>Key Return (KR)</td>
<td>8ch</td>
<td>8ch</td>
<td>8ch</td>
<td>8ch</td>
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<tr>
<td>44</td>
<td>CLOCK OUTPUT (FOUT)</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
</tr>
<tr>
<td>45</td>
<td><strong>Security</strong></td>
<td>ICUM</td>
<td>ICUM</td>
<td>ICUS</td>
<td>ICUS</td>
</tr>
<tr>
<td></td>
<td>・ICUS: SHE/EVITA-Light equivalent</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>・ICUM: EVITA-Mid equivalent</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>Flash memory for firmware</td>
<td>FCUROM 1)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) Flash(FCU) firmware loading not necessary
※ The value described as max is the maximum value for the series. For individual device specifications, please refer to the peripheral function information found in this document or in the user's manual.
APPENDIX

- RH850/F1Kx Series Functional Configurations
  - F1K
  - F1KM-S1
  - F1KM-S4
  - F1KH-D8

- Functional Safety Compliance
- Security Functions
RH850/F1K 100PIN

32-bit CPU

RH850 Core (G3KH) 120MHz

- 3.0 - 5.5V
- Ta = -40 to +125°C
- 100pin QFP

Floating Point Unit (Single Precision)
Memory Protection Unit
Security Function (ICU-S)

System & Safety
- 16x DMA
- Interrupt Controller
- Low Power Sampler
- Key Return
- CRC
- ECC
- Clock Monitor
- Power On Clear
- Low Voltage Indicator
- Core Voltage Monitor
- Peripheral Bus Guard
- Processor Element Guard

Timer
- 1x TAUD 16x 16bit Timer
- 1x TAUB 16x 16bit Timer
- 2x TAUJ 4x 32bit Timer
- 5x OSTM
- 2x Watchdog Timer

Oscillator
- ext. Main Oscillator
- int. High / Low Speed Oscillator
- PLL

Digital I/F
- 6x CAN or 6x CAN-FD
- SPI: 1x CSIG, 4x CSIH
- 4x UART/ LIN
- 3x LIN (Master)
- 1x I²C
- 81x GPIO

Analog I/F
- 36x ADC0 16x12bit, 20x10bit
- ext. MUX, 6x T&H

Memory Protection Unit
CRC
ECC
Power On Clear
Core Voltage Monitor
Clock Monitor
Memory Protection Unit
Low Voltage Indicator
Core Voltage Monitor
Peripheral Bus Guard
Processor Element Guard

Code Flash 2048KB
RAM 192KB
Data Flash 64KB
RH850/F1K 144PIN

32-bit CPU

RH850 Core (G3KH)
120MHz
3.0 - 5.5V
Ta = -40 to +125°C
144pin QFP

Floating Point Unit
(Single Precision)

On Chip Debug

Memory Protection Unit

Security Function (ICU-S)

<table>
<thead>
<tr>
<th>Code Flash</th>
<th>RAM</th>
<th>Data Flash</th>
</tr>
</thead>
<tbody>
<tr>
<td>2048KB</td>
<td>192KB</td>
<td>64KB</td>
</tr>
</tbody>
</table>

System & Safety

- 16x DMA
- Interrupt Controller
- Low Power Sampler
- Key Return
- CRC
- ECC
- Clock Monitor
- Power On Clear
- Low Voltage Indicator
- Core Voltage Monitor
- Peripheral Bus Guard
- Processor Element Guard

Timer

- 1x TAUD 16x 16bit Timer
- 1x TAUB 16x 16bit Timer
- 2x TAUJ 4x 32bit Timer
- 5x OSTM
- 2x Watchdog Timer
- Real-Time Counter
- Encoder Timer
- Motor Control
- 64x 12bit PWM w/ Diagnosis

Oscillator

- ext. Main / SUB Oscillator
- int. High / Low Speed Oscillator
- PLL

Digital I/F

- 6x CAN or 6x CAN-FD
- SPI: 2x CSIG, 4x CSIH
- 6x UART/ LIN
- 6x LIN (Master)
- 1x I²C
- 120x GPIO

Analog I/F

- 36x ADC0 16x12bit, 20x10bit
- ext. MUX, 6x T&H
- 12x ADC1 8x12bit, 4x10bit
RH850/F1K 176PIN

32-bit CPU
RH850 Core (G3KH)
120MHz
3.0 - 5.5V
Ta = -40 to +125°C
176pin QFP

Floating Point Unit
(Single Precision)
Security Function (ICU-S)

System & Safety
16x DMA
Interrupt Controller
Low Power Sampler
Key Return
CRC
ECC
Clock Monitor
Power On Clear
Low Voltage Indicator
Core Voltage Monitor
Peripheral Bus Guard
Processor Element Guard

Timer
1x TAUD 16x 16bit Timer
2x TAUB 16x 16bit Timer
2x TAUJ 4x 32bit Timer
5x OSTM
2x Watchdog Timer
Real-Time Counter
Encoder Timer
Motor Control
72x 12bit PWM w/ Diagnosis

Oscillator
ext. Main / SUB Oscillator
int. High / Low Speed Oscillator
PLL

Digital I/F
7x CAN or 6x CAN-FD, 1x CAN
SPI: 2x CSIG, 4x CSIH
6x UART/ LIN
10x LIN (Master)
1x I²C
150x GPIO

Analog I/F
36x ADC0 16x12bit, 20x10bit
ext. MUX, 6x T&H
24x ADC1 16x12bit, 8x10bit

Code Flash
2048KB
RAM
192KB
Data Flash
64KB
# RH850/F1KM-S1 48PIN

## 32-bit CPU

**RH850 Core (G3KH)**

- **120MHz**
- **3.0 - 5.5V**
- **Ta = -40 to +125°C**
- **48pin LQFP**
- **Floating Point Unit (Single Precision)**
- **Security Function (ICU-S)**

<table>
<thead>
<tr>
<th>Code Flash</th>
<th>RAM</th>
<th>Data Flash</th>
</tr>
</thead>
<tbody>
<tr>
<td>1024KB</td>
<td>128KB</td>
<td>64KB</td>
</tr>
</tbody>
</table>

## System & Safety

- 16x DMA
- Interrupt Controller
- Low Power Sampler
- Key Return
- CRC
- ECC
- Clock Monitor
- Power On Clear
- Low Voltage Indicator
- Core Voltage Monitor
- Peripheral Bus Guard
- Processor Element Guard

## Timer

- 1x TAUD 16x 16bit Timer
- 4x TAUJ 4x 32bit Timer
- 1x OSTM
- 2x Watchdog Timer
- Real-Time Counter
- Encoder Timer
- Motor Control
- 13x 12bit PWM w/ Diagnosis

## Oscillator

- ext. Main Oscillator
- int. High / Low Speed Oscillator
- PLL

## Digital I/F

- 1x CAN-FD
- SPI: 1x CSIG, 1x CSIH
- 1x UART/LIN
- 2x LIN(Master)
- 2x SENT
- 2x I²C
- 33x GPIO

## Analog I/F

- 12x ADC0 8x12bit, 4x10bit
- ext. MUX / 3x T&H
**RH850/F1KM-S1 64PIN**

**32-bit CPU**

RH850 Core (G3KH)  
120MHz  
3.0 - 5.5V  
Ta = -40 to +125°C  
64pin LQFP

- Floating Point Unit (Single Precision)
- Memory Protection Unit
- Security Function (ICU-S)

<table>
<thead>
<tr>
<th>Code Flash</th>
<th>RAM</th>
<th>Data Flash</th>
</tr>
</thead>
<tbody>
<tr>
<td>1024KB</td>
<td>128KB</td>
<td>64KB</td>
</tr>
</tbody>
</table>

**System & Safety**

- 16x DMA
- Interrupt Controller
- Low Power Sampler
- Key Return
- CRC
- ECC
- Clock Monitor
- Power On Clear
- Low Voltage Indicator
- Core Voltage Monitor
- Peripheral Bus Guard
- Processor Element Guard

**Timer**

- 1x TAUD 16x 16bit Timer
- 4x TAUJ  4x 32bit Timer
- 1x OSTM
- 2x Watchdog Timer
- Real-Time Counter
- Encoder Timer
- Motor Control
- 24x 12bit PWM w/ Diagnosis

**Oscillator**

- ext. Main Oscillator
- int. High / Low Speed Oscillator
- PLL

**Digital I/F**

- 3x CAN-FD
- SPI: 1x CSIG, 1x CSIH
- 2x UART/LIN
- 2x LIN(Master)
- 2x SENT
- 2x I²C
- 49x GPIO

**Analog I/F**

- 21x ADC0 10x12bit, 11x10bit
- ext. MUX / 3x T&H
### RH850/F1KM-S1 80PIN

#### 32-bit CPU
- **RH850 Core (G3KH)**
  - **120MHz**
  - 3.0 - 5.5V
  - Ta = -40 to +125°C
  - 80pin LQFP

#### System & Safety
- 16x DMA
- Interrupt Controller
- Low Power Sampler
- Key Return
- CRC
- ECC
- Clock Monitor
- Power On Clear
- Low Voltage Indicator
- Core Voltage Monitor
- Peripheral Bus Guard
- Processor Element Guard

#### Timer
- 1x TAUD 16x 16bit Timer
- 1x TAUB 16x 16bit Timer
- 4x TAUJ 4x 32bit Timer
- 1x OSTM
- 2x Watchdog Timer
- Real-Time Counter
- Encoder Timer
- Motor Control
- 24x 12bit PWM w/ Diagnosis

#### Oscillator
- ext. Main Oscillator
- Int. High / Low Speed Oscillator
- PLL

#### Digital I/F
- 3x CAN-FD
- SPI: 1x CSIG, 3x CSIH
- 3x UART/LIN
- 2x LIN(Master)
- 2x SENT
- 2x I²C
- 65x GPIO

#### Analog I/F
- 25x ADC0 11x12bit, 14x10bit
- ext. MUX / 3x T&H

#### Memory
- Code Flash: 1024KB
- RAM: 128KB
- Data Flash: 64KB

#### Security Features
- Memory Protection Unit
- Floating Point Unit (Single Precision)
- Security Function (ICU-S)
**RH850/F1KM-S1 100PIN**

<table>
<thead>
<tr>
<th>32-bit CPU</th>
<th>System &amp; Safety</th>
<th>Timer</th>
<th>Digital I/F</th>
<th>Analog I/F</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RH850 Core (G3KH)</strong></td>
<td>16x DMA</td>
<td>1x TAUD 16x 16bit Timer</td>
<td>6x CAN-FD</td>
<td>36x ADC0 16x12bit, 20x10bit</td>
</tr>
<tr>
<td>120MHz</td>
<td>Interrupt Controller</td>
<td>1x TAUB 16x 16bit Timer</td>
<td>SPI: 1x CSIG, 4x CSIH</td>
<td>ext. Main Oscillator</td>
</tr>
<tr>
<td>3.0 - 5.5V</td>
<td>Low Power Sampler</td>
<td>4x TAUJ 4x 32bit Timer</td>
<td>4x UART/LIN</td>
<td>int. High / Low Speed Oscillator</td>
</tr>
<tr>
<td>Ta = -40 to +125°C</td>
<td>Key Return</td>
<td>1x OSTM</td>
<td>3x LIN(Master)</td>
<td>PLL</td>
</tr>
<tr>
<td>100pin LQFP</td>
<td>CRC</td>
<td>2x Watchdog Timer</td>
<td>2x SENT</td>
<td></td>
</tr>
<tr>
<td>Floating Point Unit</td>
<td>ECC</td>
<td>Real-Time Counter</td>
<td>2x I²C</td>
<td></td>
</tr>
<tr>
<td>(Single Precision)</td>
<td>Clock Monitor</td>
<td>Encoder Timer</td>
<td>81x GPIO</td>
<td></td>
</tr>
<tr>
<td>Memory Protection Unit</td>
<td>Power On Clear</td>
<td>Motor Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>On Chip Debug Trace I/F</td>
<td>Low Voltage Indicator</td>
<td>48x 12bit PWM w/ Diagnosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Security Function (ICU-S)</td>
<td>Core Voltage Monitor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Code Flash</td>
<td>Peripheral Bus Guard</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RAM</td>
<td>Processor Element Guard</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1024KB</td>
<td>128KB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Flash</td>
<td>64KB</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Digital I/F**

- 6x CAN-FD
- SPI: 1x CSIG, 4x CSIH
- 4x UART/LIN
- 3x LIN(Master)
- 2x SENT
- 2x I²C
- 81x GPIO

**Analog I/F**

- 36x ADC0 16x12bit, 20x10bit
- ext. MUX / 6x T&H
# RH850/F1KM-S4 100PIN

## 32-bit CPU
- **RH850 Core (G3KH)**
  - 240MHz
  - 3.0 - 5.5V
  - Ta = -40 to +105°C
  - 100pin LQFP

<table>
<thead>
<tr>
<th>Code Flash</th>
<th>RAM</th>
<th>Data Flash</th>
</tr>
</thead>
<tbody>
<tr>
<td>4096KB</td>
<td>512KB</td>
<td>128KB</td>
</tr>
</tbody>
</table>

- Floating Point Unit (Single Precision)
- On Chip Debug
- Memory Protection Unit
- Security Function (ICU-M)

## System & Safety
- 32x DMA
- Interrupt Controller
- Low Power Sampler
- Key Return
- CRC
- ECC
- Clock Monitor
- Power On Clear
- Low Voltage Indicator
- Core Voltage Monitor
- Peripheral Bus Guard
- Processor Element Guard

## Timer
- 1x TAUD 16x 16bit Timer
- 1x TAUB 16x 16bit Timer
- 4x TAUJ  4x 32bit Timer
- 5x OSTM
- 2x Watchdog Timer
- Real-Time Counter
- Encoder Timer
- Motor Control
- 44x 12bit PWM w/ Diagnosis

## System & Safety
- int. High / Low Speed Oscillator
- PLL

## Digital I/F
- 8x CAN-FD
- 2(Ach,Bch) x FlexRay
- SPI: 1x CSIG / 4x CSIH
- 3x UART/LIN
- 3x LIN(Master)
- 1x SENT
- 2x I²C

## Analog I/F
- 32x ADC0 16x12bit, 16x10bit
- ext. MUX / 6x T&H

---

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RH850/F1KM-S4 144PIN

32-bit CPU

- RH850 Core (G3KH) 240MHz
  - 3.0 - 5.5V
  - Ta = -40 to +105°C
  - 144pin LQFP

Floating Point Unit (Single Precision)
Security Function (ICU-M)

<table>
<thead>
<tr>
<th>Code Flash</th>
<th>RAM</th>
<th>Data Flash</th>
</tr>
</thead>
<tbody>
<tr>
<td>4096KB</td>
<td>512KB</td>
<td>128KB</td>
</tr>
</tbody>
</table>

System & Safety

- 32x DMA
- Interrupt Controller
- Low Power Sampler
- Key Return
- CRC
- ECC
- Clock Monitor
- Power On Clear
- Low Voltage Indicator
- Core Voltage Monitor
- Peripheral Bus Guard
- Processor Element Guard

On Chip Debug

Timer

- 1x TAUD 16x 16bit Timer
- 1x TAUB 16x 16bit Timer
- 4x TAUJ 4x 32bit Timer
- 5x OSTM
- 2x Watchdog Timer
- Real-Time Counter
- Encoder Timer
- Motor Control
- 64x 12bit PWM w/ Diagnosis

Oscillator

- ext. Main / SUB Oscillator
- int. High / Low Speed Oscillator
- PLL

Digital I/F

- 8x CAN-FD
- 2(Ach,Bch) x FlexRay
- SPI: 2x CSIG / 4x CSIH
- 6x UART/LIN
- 6x LIN(Master)
- 2x SENT
- 2x I²C

Analog I/F

- 34x ADC0 16x12bit, 18x10bit
- ext. MUX / 6x T&H
- 12x ADC1 8x12bit, 4x10bit

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## RH850/F1KM-S4 176PIN

### 32-bit CPU
- RH850 Core (G3KH) 240MHz
- 3.0 - 5.5V
- Ta = -40 to +105°C
- 176pin LQFP

<table>
<thead>
<tr>
<th>Memory Type</th>
<th>Code Flash</th>
<th>RAM</th>
<th>Data Flash</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4096KB</td>
<td>512KB</td>
<td>128KB</td>
</tr>
</tbody>
</table>

### System & Safety
- 32x DMA
- Interrupt Controller
- Low Power Sampler
- Key Return
- CRC
- ECC
- Clock Monitor
- Power On Clear
- Low Voltage Indicator
- Core Voltage Monitor
- Peripheral Bus Guard
- Processor Element Guard

### Timer
- 1x TAUD 16x 16bit Timer
- 2x TAUB 16x 16bit Timer
- 4x TAUJ 4x 32bit Timer
- 5x OSTM
- 2x Watchdog Timer
- Real-Time Counter
- Encoder Timer
- Motor Control
- 72x 12bit PWM w/ Diagnosis

### Oscillator
- ext. Main / SUB Oscillator
- int. High / Low Speed Oscillator
- PLL

### Digital I/F
- 8x CAN-FD
- Ethernet AVB (MII)
- 2(Ach,Bch) x FlexRay
- SPI: 4x CSIG / 4x CSIH
- 8x UART/LIN
- 10x LIN(Master)
- 2x SENT
- 2x I²C

### Analog I/F
- 34x ADC0 16x12bit, 18x10bit
- ext. MUX / 6x T&H
- 24x ADC1 16x12bit, 8x10bit
## RH850/F1KM-S4 233PIN

### 32-bit CPU
- RH850 Core (G3KH)
  - 240MHz
- 3.0 - 5.5V
- Ta = -40 to +125°C
- 233pin FPBGA

### Memory Protection Unit
- (Single Precision)

### Security Function (ICU-M)
- On Chip Debug

<table>
<thead>
<tr>
<th>Code Flash</th>
<th>RAM</th>
<th>Data Flash</th>
</tr>
</thead>
<tbody>
<tr>
<td>4096KB</td>
<td>512KB</td>
<td>128KB</td>
</tr>
</tbody>
</table>

### System & Safety
- 32x DMA
- Interrupt Controller
- Low Power Sampler
- Key Return
- CRC
- ECC
- Clock Monitor
- Power On Clear
- Low Voltage Indicator
- Core Voltage Monitor
- Peripheral Bus Guard
- Processor Element Guard

### Timer
- 1x TAUD 16x 16bit Timer
- 2x TAUB 16x 16bit Timer
- 4x TAUJ 4x 32bit Timer
- 5x OSTM
- 2x Watchdog Timer
- Real-Time Counter
- Encoder Timer
- Motor Control
- 80x 12bit PWM w/ Diagnosis

### Oscillator
- ext. Main / SUB Oscillator
- int. High / Low Speed Oscillator
- PLL

### Digital I/F
- 8x CAN-FD
- Ethernet AVB (MII)
- 2(Ach,Bch) x FlexRay
- SPI: 4x CSIG / 4x CSIH
- 8x UART/LIN
- 12x LIN(Master)
- 2x SENT
- 2x I²C

### Analog I/F
- 34x ADC0 16x12bit, 18x10bit
- ext. MUX / 6x T&H
- 36x ADC1 16x12bit, 20x10bit

### On Chip
- Floating Point Unit (Single Precision)
- ECC

### Key Return
- Low Power Sampler
- Clock Monitor
- Power On Clear
- Low Voltage Indicator
- Core Voltage Monitor
- Peripheral Bus Guard
- Processor Element Guard

### Power On Clear
- Low Voltage Indicator
- Core Voltage Monitor
- Clock Monitor
- Power On Clear
- Low Voltage Indicator
- Core Voltage Monitor
- Processor Element Guard

### Core Voltage Monitor
- Power On Clear
- Low Voltage Indicator
- Core Voltage Monitor
- Peripheral Bus Guard
- Processor Element Guard
# RH850/F1KM-S4 272PIN

## 32-bit CPU

<table>
<thead>
<tr>
<th>RH850 Core (G3KH)</th>
<th>240MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0 - 5.5V</td>
<td></td>
</tr>
<tr>
<td>Ta = -40 to +125°C</td>
<td></td>
</tr>
<tr>
<td>272pin FPBGA</td>
<td></td>
</tr>
</tbody>
</table>

- Floating Point Unit (Single Precision)
- On Chip Debug
- Memory Protection Unit
- Security Function (ICU-M)

## System & Safety

- 32x DMA
- Interrupt Controller
- Low Power Sampler
- Key Return
- CRC
- ECC
- Clock Monitor
- Power On Clear
- Low Voltage Indicator
- Core Voltage Monitor
- Peripheral Bus Guard
- Processor Element Guard

## Timer

- 1x TAUD 16x 16bit Timer
- 2x TAUB 16x 16bit Timer
- 4x TAUJ  4x 32bit Timer
- 5x OSTM
- 2x Watchdog Timer
- Real-Time Counter
- Encoder Timer
- Motor Control
- 96x 12bit PWM w/ Diagnosis

## Oscillator

- ext. Main / SUB Oscillator
- int. High / Low Speed Oscillator
- PLL

## Digital I/F

- 8x CAN-FD
- Ethernet AVB (MII)
- 2(x Ach,Bch) x FlexRay
- SPI: 4x CSIG / 4x CSIH
- 8x UART/LIN
- 12x LIN(Master)
- 2x SENT
- 2x I²C

## Analog I/F

- 34x ADC0 16x12bit, 18x10bit
- ext. MUX / 6x T&H
- 36x ADC1 16x12bit, 20x10bit

## Code Flash

<table>
<thead>
<tr>
<th>Code Flash</th>
<th>RAM</th>
<th>Data Flash</th>
</tr>
</thead>
<tbody>
<tr>
<td>4096KB</td>
<td>512KB</td>
<td>128KB</td>
</tr>
</tbody>
</table>

---

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### RH850/F1KH-D8 176PIN

#### 32-bit CPU

**RH850 Core (G3KH)**
- **240MHz x2**
- 3.0 - 5.5V
- Ta = -40 to +105°C
- 176pin LQFP

<table>
<thead>
<tr>
<th>Memory</th>
<th>Code Flash</th>
<th>8192KB</th>
<th>1024KB</th>
<th>256KB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Security Function (ICU-M)</td>
<td>RAM</td>
<td>On Chip Debug</td>
<td>Floating Point Unit (Single Precision)</td>
<td></td>
</tr>
</tbody>
</table>

#### System & Safety

- 64x DMA
- Interrupt Controller
- Low Power Sampler
- Key Return
- CRC
- ECC
- Clock Monitor
- Power On Clear
- Low Voltage Indicator
- Core Voltage Monitor
- Processor Element Guard
- Peripheral Bus Guard
- Memory Protection Unit
- On Chip Debug

#### Timer

- 1x TAUD 16x 16bit Timer
- 2x TAUB 16x 16bit Timer
- 4x TAUJ 4x 32bit Timer
- 10x OSTM
- 3x Watchdog Timer
- Real-Time Counter
- Encoder Timer
- Motor Control
- 72x 12bit PWM w/ Diagnosis

#### Oscillator

- ext. Main / SUB Oscillator
- int. High / Low Speed Oscillator
- PLL

#### Digital I/F

- 8x CAN-FD
- Ethernet AVB (MII)
- 2(Ach,Bch) x FlexRay
- SPI: 5x CSIG / 5x CSIH
- 8x UART/LIN
- 10x LIN(Master)
- 2x SENT
- 2x I²C
- 144x GPIO
- Serial Flash Memory I/F
- External Memory I/F (23bit)

#### Analog I/F

- 34x ADC0 16x12bit, 18x10bit
- ext. MUX / 6x T&H
- 24x ADC1 16x12bit, 8x10bit
# RH850/F1KH-D8 233PIN

## 32-bit CPU

<table>
<thead>
<tr>
<th>RH850 Core (G3KH)</th>
<th>240MHz x2</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0 - 5.5V</td>
<td>233pin FPBGA</td>
</tr>
<tr>
<td>Ta = -40 to +125°C</td>
<td></td>
</tr>
</tbody>
</table>

- Floating Point Unit (Single Precision)
- On Chip Debug
- Memory Protection Unit
- Security Function (ICU-M)

<table>
<thead>
<tr>
<th>Code Flash</th>
<th>RAM</th>
<th>Data Flash</th>
</tr>
</thead>
<tbody>
<tr>
<td>8192KB</td>
<td>1024KB</td>
<td>256KB</td>
</tr>
</tbody>
</table>

## System & Safety

- 64x DMA
- Interrupt Controller
- Low Power Sampler
- Key Return
- CRC
- ECC
- Clock Monitor
- Power On Clear
- Low Voltage Indicator
- Core Voltage Monitor
- Peripheral Bus Guard
- Processor Element Guard

## Timer

- 1x TAUD 16x 16bit Timer
- 2x TAUB 16x 16bit Timer
- 4x TAUJ 4x 32bit Timer
- 10x OSTM
- 3x Watchdog Timer
- Real-Time Counter
- Encoder Timer
- Motor Control
- 80x 12bit PWM w/ Diagnosis

## Oscillator

- ext. Main / SUB Oscillator
- int. High / Low Speed Oscillator
- PLL

## Digital I/F

- 8x CAN-FD
- Ethernet AVB (MII)
- 2x I²C
- 2x SENT
- 12x LIN(Master)
- SPI: 5x CSIG / 5x CSIH
- 8x UART/LIN
- 8x CAN-FD
- External Memory I/F (23bit)
- 174x GPIO
- Code Flash RAM
- Data Flash
- 8192KB 1024KB 256KB

## Analog I/F

- 34x ADC0 16x12bit, 18x10bit
- ext. MUX / 6x T&H
- 36x ADC1 16x12bit, 20x10bit

---

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# RH850/F1KH-D8 324PIN

## 32-bit CPU
- **RH850 Core (G3KH)**
  - 240MHz ×2
- 3.0 - 5.5V
- Ta = -40 to +125°C
- 324pin FPBGA

## System & Safety
- 64x DMA
- Interrupt Controller
- Low Power Sampler
- Key Return
- CRC
- ECC
- Clock Monitor
- Power On Clear
- Low Voltage Indicator
- Core Voltage Monitor
- Peripheral Bus Guard
- Processor Element Guard

## Timer
- 1x TAUD 16x 16bit Timer
- 2x TAUB 16x 16bit Timer
- 4x TAUJ 4x 32bit Timer
- 10x OSTM
- 3x Watchdog Timer
- Real-Time Counter
- Encoder Timer
- Motor Control
- 96x 12bit PWM w/ Diagnosis

## Oscillator
- ext. Main / SUB Oscillator
- int. High / Low Speed Oscillator
- PLL

## Digital I/F
- 12x CAN-FD
- 2x Ethernet AVB (MII)
- 2(Ach,Bch) × FlexRay
- SPI: 5x CSIG / 5x CSIH
- 8x UART/LIN
- 16x LIN(Master)
- 2x SENT
- 2x I²C

## Analog I/F
- 34x ADC0 16x12bit, 18x10bit
- ext. MUX / 6x T&H
- 36x ADC1 16x12bit, 20x10bit

## Memory Protection Unit
- CRC
- ECC
- Security Function (ICU-M)

## Floating Point Unit (Single Precision)
- Floating Point Unit
- Security Function (ICU-M)

## Code Flash
- 8192KB

## RAM
- 1024KB

## Data Flash
- 256KB
<table>
<thead>
<tr>
<th>Hardware</th>
<th>Software</th>
<th>Work products</th>
<th>Consulting</th>
</tr>
</thead>
</table>
RH850/F1KX FUNCTIONAL SAFETY COMPLIANCE

- Software library including core self-test function provided for a fee
- Memory Protection function (MPU) can detect and suppress unauthorized use of system resources
- Program and data memory checked by CRC
- Code Flash, Data Flash, RAM, Cache run-time error code detection
- Window watchdog timer to prevent software malfunction
- Serial interface with loopback function for self-test
- A/D converter with self-test function
- Processor Element Guard (PEG) function prevents unauthorized access to CPU resources;
- Peripheral Guard function prevents unauthorized access to peripheral functions
- Clock monitor to detect high-speed internal oscillation, main clock, PLL clock errors
- CSI, LIN, CAN
- Clock
- ADC

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RENESAS SAFETY SUPPORT PROGRAM COVERAGE

Functional safety support program

- Assumed safety requirements
- Safety application note
- Verified SW driver

System safety concept & Design information

- FMEDA tool (CAR Tool)

Consulting

- Reunites device safety analysis database

- HW work product

- SW work product

Verified SW driver

System SW

Safety application note

Assumed safety requirements

Renesas device safety analysis database

HW work product

SW work product

System safety analysis report
SAFETY RELATED DELIVERABLES & SERVICE

**Standard FuSa deliverables**

- DIR (Development Interface Report)
- Safety requirement specification
- Safety application note (HW SW interface)
- Static FMEDA
- Safety case (List of work products and status)
- Functional safety assessment report

*1 Summary version is provided. It shows completion of the activity and its summary of the results.
*2 This is delivered along with hardware product if required.
*3 Static FMEDA is delivered by static CAR tool.
MAJOR SECURITY USE CASES
(FOR IN-VEHICLE SECURITY)

- Secure on-board communications
- Secure download / programming
- Secure boot
- Protection against manipulation during run-time
- Secure data storage (e.g. “one-way” counters)
- Life cycle management (ECU / MCU)

Vehicle-To-X Communications (V2X)
- Secure OTA communications
  (ultra high-speed authentication)

Gateway
- Secure back-end communications
- Firewalling

Infotainment
- Content protection & DRM
- Firewalling

All Renesas solutions can support the above use cases

Main objectives: integrity & authenticity checks
SECURITY SERVICES

To tackle the need for security in automotive applications, Renesas introduced dedicated MCU peripherals for cryptographic operations.

Two types of these peripherals are used to address different application needs:

- ICU-S: (Intelligent Cryptographic Unit “Slave”)
- ICU-M: (Intelligent Cryptographic Unit “Master”)

*1 Secure Hardware Extension
*2 Hardware Security Module
INTELLIGENT CRYPTOGRAPHIC UNIT SLAVE (ICU-S)

AES-128 encryption/decryption and true random number generator (TRNG) in hardware

Provides 128-bit AES CMACs (Cipher-based MAC) for Code and Data authenticity and integrity

Secure Boot function

Supports software individualization based on device ID

Protected data flash for device IDs, secret keys etc.

ICU-S supported on devices listed below

- F1K
- F1KM-S1
INTELLIGENT CRYPTOGRAPHIC UNIT MASTER (ICU-M)

Dedicated RH850 CPU core acting as a Hardware Security Module

Hardware AES-128 block cipher per FIPS PUB 197

Support for CBC, CTR, CFB and OFB mode

AIS31 compatible hardware random number generator (TRNG) for 32-bit seed

Flash master with unconditional access to secure flash

Direct control of 2 GPIO ports (CPU bypass)

Debug port control based on challenge/response authentication scheme

Controls microcontroller boot process

ICU-M supported on devices listed below:

- F1KM-S4
- F1KH-D8
## ICUS VS ICUM

<table>
<thead>
<tr>
<th></th>
<th>ICUS</th>
<th>ICUM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cryptographic Accelerators</strong></td>
<td>Simple AES-128 engine (ECB &amp; CBC modes)</td>
<td>Complex AES block ciphers</td>
</tr>
<tr>
<td><strong>System control</strong></td>
<td>Finite State Machine (up to 50 MHz)</td>
<td>RH850 CPU (up to 100 MHz)</td>
</tr>
<tr>
<td><strong>Security services</strong></td>
<td>Fixed (SHE services)</td>
<td>Programmable (user defined)</td>
</tr>
<tr>
<td><strong>System interfaces</strong></td>
<td>Slave</td>
<td>Slave &amp; master</td>
</tr>
<tr>
<td><strong>Accessible resources</strong></td>
<td>Data flash (1 KB or 2KB depending on number of User Keys supported)</td>
<td>All on-chip resources</td>
</tr>
<tr>
<td><strong>Tamper resistance</strong></td>
<td>HW isolation of the ICUS Data Flash</td>
<td>HW isolation of the ICUM Code &amp; Data Flash</td>
</tr>
<tr>
<td>Term</td>
<td>Explanation</td>
<td></td>
</tr>
<tr>
<td>------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>AES</td>
<td>Advanced Encryption Standard (Rijndael Algorithm - Symetric-key algorithm)</td>
<td></td>
</tr>
<tr>
<td>CBC</td>
<td>Cipher Block Chaining - Each block of plaintext is XORed with the previous cipher text block before being encrypted</td>
<td></td>
</tr>
<tr>
<td>CFB</td>
<td>Cipher feedback</td>
<td></td>
</tr>
<tr>
<td>CTR</td>
<td>Counter</td>
<td></td>
</tr>
<tr>
<td>ECB</td>
<td>Electronic Codebook - The message is divided into blocks, and each block is encrypted separately.</td>
<td></td>
</tr>
<tr>
<td>FIPS</td>
<td>Federal Information Processing Standards</td>
<td></td>
</tr>
<tr>
<td>MAC</td>
<td>Message Authentication Code</td>
<td></td>
</tr>
<tr>
<td>OFB</td>
<td>Output feedback</td>
<td></td>
</tr>
<tr>
<td>Public-Key algorithm</td>
<td>Asymmetric-Key algorithm. Two separate keys are used for encrypting and decrypting.</td>
<td></td>
</tr>
<tr>
<td>Symetric-Key algorithm</td>
<td>Same key is used for encrypting and decrypting</td>
<td></td>
</tr>
</tbody>
</table>
BENCHMARK RESULTS
PERFORMANCE BENCHMARK RESULTS

*results are based on estimation of 120MHz device & no arbitration occurs in case of multi-core devices

<table>
<thead>
<tr>
<th>Device Group</th>
<th>Core</th>
<th>FPU</th>
<th>Operating Speed</th>
<th>Testbench</th>
<th>Compiler/ Revision</th>
<th>Result (absolute)</th>
<th>Result per Core (relative)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1KM-S1</td>
<td>G3KH</td>
<td>Yes</td>
<td>120MHz</td>
<td>CoreMark 1.0</td>
<td>Green Hills 2015.1.3</td>
<td>343 CM</td>
<td>2.9 CM / MHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dhrystone 2.1</td>
<td>Green Hills 2015.1.3</td>
<td>271 DMIPS</td>
<td>2.3 DMIPS / MHz</td>
</tr>
<tr>
<td>F1K</td>
<td>G3KH</td>
<td>Yes</td>
<td>120MHz</td>
<td>CoreMark 1.0</td>
<td>Green Hills 2015.1.3</td>
<td>343 CM</td>
<td>2.9 CM / MHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dhrystone 2.1</td>
<td>Green Hills 2015.1.3</td>
<td>271 DMIPS</td>
<td>2.3 DMIPS / MHz</td>
</tr>
<tr>
<td>F1KM-S4</td>
<td>G3KH</td>
<td>Yes</td>
<td>240MHz</td>
<td>CoreMark 1.0</td>
<td></td>
<td>686 CM*</td>
<td>2.9 CM / MHz*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dhrystone 2.1</td>
<td></td>
<td>542 DMIPS*</td>
<td>2.3 DMIPS / MHz*</td>
</tr>
<tr>
<td>F1KH-D8</td>
<td>G3KH</td>
<td>Yes</td>
<td>2x 240MHz</td>
<td>CoreMark 1.0</td>
<td></td>
<td>1372 CM*</td>
<td>2.9 CM / MHz*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dhrystone 2.1</td>
<td></td>
<td>1084 DMIPS*</td>
<td>2.3 DMIPS / MHz*</td>
</tr>
</tbody>
</table>

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## Hardware - Overview

### RH850/F1KX Starter Kits

<table>
<thead>
<tr>
<th>Features</th>
<th>Y-ASK-RH850F1K-V3</th>
<th>Y-ASK-RH850F1KM-S4-V3</th>
<th>Y-ASK-RH850F1KH-D8-V3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Picture</strong></td>
<td><img src="image1" alt="Y-ASK-RH850F1K-V3" /></td>
<td><img src="image2" alt="Y-ASK-RH850F1KM-S4-V3" /></td>
<td><img src="image3" alt="Y-ASK-RH850F1KH-D8-V3" /></td>
</tr>
<tr>
<td><strong>CAN(-FD)</strong></td>
<td>2ch CAN(-FD)</td>
<td>2ch CAN(-FD)</td>
<td>2ch CAN(-FD)</td>
</tr>
<tr>
<td>FlexRay</td>
<td>-</td>
<td>1ch</td>
<td>1ch</td>
</tr>
<tr>
<td>Ethernet</td>
<td>-</td>
<td>1ch</td>
<td>1ch</td>
</tr>
</tbody>
</table>
| **Others**        | 1ch LIN, 1ch RS232/UART  
External Multiplexer for digital inputs of Low Power Sampler  
Pin headers for direct access to every device pin  
User interaction through potentiometer, rotary switch, buttons and LEDs  
E1 debug connector | 142mm x 108mm |
## HARDWARE - OVERVIEW
### EVALUATION PLATFORM – X2X EXTENSION BOARDS

<table>
<thead>
<tr>
<th>Part name</th>
<th>Description</th>
<th>Outline Picture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y-RH850-EMMC-SFMA-EXT-BRD</td>
<td>eMMC/SFMA Extension board</td>
<td></td>
</tr>
<tr>
<td>Y-RH850-SENT-EXT-BRD</td>
<td>SENT Extension board</td>
<td></td>
</tr>
<tr>
<td>Y-RH850-TFT-EXT-BRD</td>
<td>TFT display / 2.8&quot; TFT Touch Shield with Capacitive Touch</td>
<td></td>
</tr>
</tbody>
</table>
THIS IS THE END SLIDE